BEA
Bureau d'Enquêtes et d'Analyses
pour la sécurité de l'aviation civile
www.bea.aero
@BEA_Aero

INVESTIGATION REPORT

Incident to the AIRBUS - A318 - 100 registered F-GUGD

on 20 December 2019
close to Hyères-Le Palyvestre airport (Le Var)

Time	Around 09:16[1]
Operator	Air France
Type of flight	Passenger commercial air transport
Persons on board	Captain (PM), co-pilot[2] (PF), 3 cabin crew members and 114 passengers
Consequences and damage	None

This is a courtesy translation by the BEA of the Final Report on the Safety Investigation published in September 2021. As accurate as the translation may be, the original text in French is the work of reference.

Acquisition of a false glide slope signal on approach, increase in pitch attitude with autopilot engaged, activation of the flight envelope protections

1 - HISTORY OF THE FLIGHT

Note: the following information is principally based on flight data recorder data, statements and the radiocommunication recordings.

The flight was out of Paris-Orly airport (Val-de-Marne), bound for Hyères-Le Palyvestre airport. The crew passed JULEE waypoint of the approach procedure at flight level 110 (FL 110), in descent. They were in contact with Toulon approach, were number 1 in the inbound traffic and cleared to descend to 1,900 ft[3] (see Figure 1 point ❶). The crew selected the altitude of 1,900 ft on the Flight Control Unit (FCU).

[1] Except where otherwise indicated, the times in this report are in Coordinated Universal Time (UTC). One hour should be added to obtain the legal time applicable in Metropolitan France on the day of the event.

[2] In Air France, a co-pilot is designated by the term First Officer (FO).

[3] Unless indicated otherwise, the altitudes are QNH altitudes.

RÉPUBLIQUE FRANÇAISE
Liberté
Égalité
Fraternité

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

BEA2019-0731.en/**October 2021**

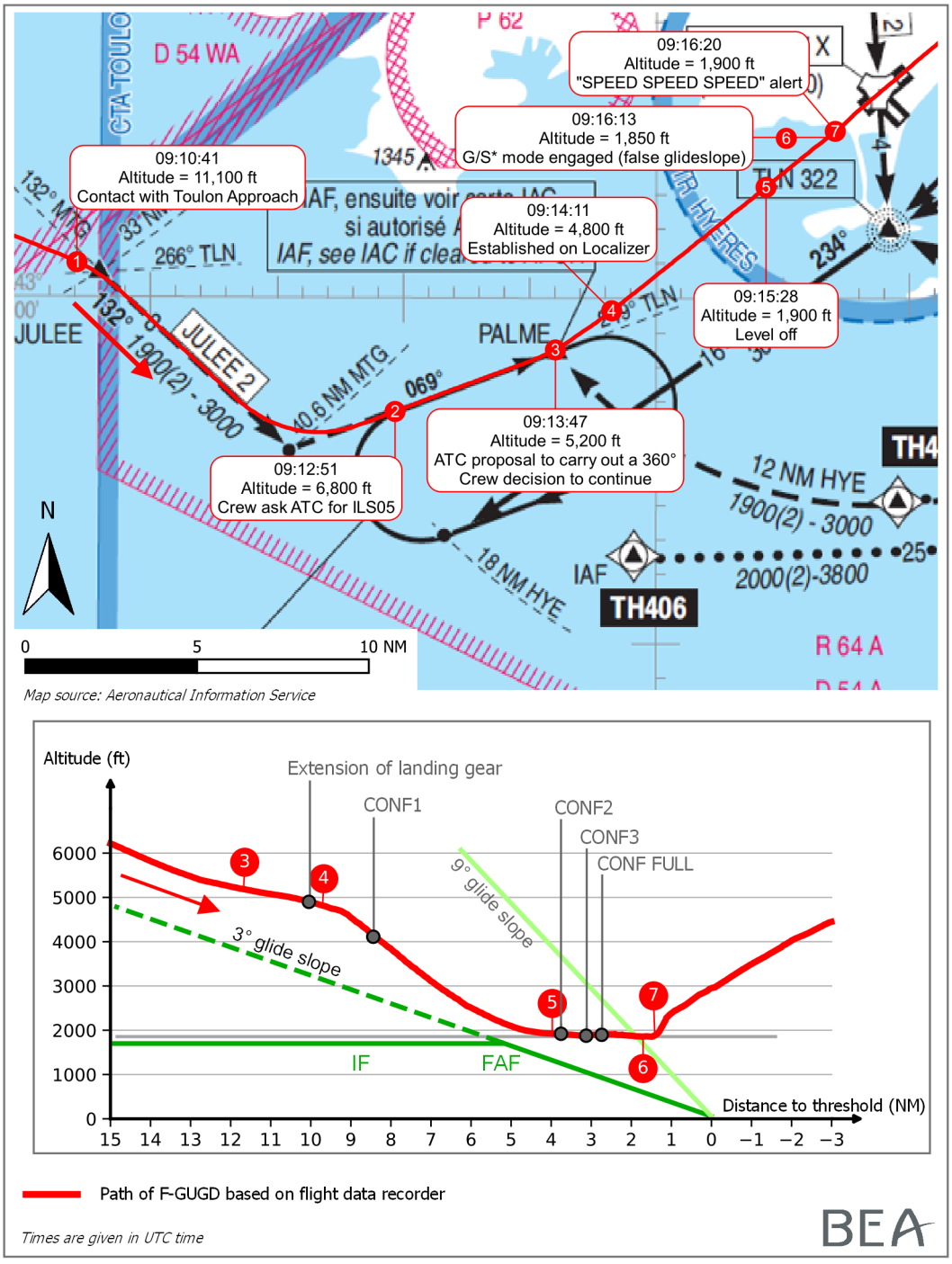


Figure 1: F-GUGD's flight path

The controller informed them that runway 23 was in use, the wind was 150° at 12 to 19 kt and that the weather conditions were perhaps a bit tight for runway 23[(4)].

During the left turn to join the Initial Approach Fix (IAF) (PALME waypoint), the tailwind component recorded by the aeroplane went from 0 to 50 kt in around 40 s. It remained higher than 40 kt during the descent to roughly 3,000 ft.

[(4)] This airport is equipped with a single ILS on runway 05. When runway 23 is in use, air traffic control leaves the crew the choice of using runway 05 if the landing performance permits this (see paragraph 2). The controller's remark may have referred to the ceiling which, on the day of the occurrence, was close to the minima.

The crew asked the controller if they could use runway 05, having first checked that the aeroplane's landing performance permitted it in the conditions of the day (see Figure 1 point ❷). The controller accepted the crew's request. At this point, the plane, in the clean configuration, was around 16 NM from the runway threshold, at an altitude of approximately 6,500 ft in a -2,000 ft/min descent, with an indicated airspeed of 250 kt. The speedbrakes were extended, and the AutoPilot (AP) and Auto-THRust (A/THR) were engaged in OP DES/ NAV and THR IDLE modes.

Around one minute later, the crew passed the IAF. The controller asked the crew if they wanted to make a direct approach or to carry out a holding pattern in order to descend. The crew replied that they wanted to make a direct approach for runway 05. The controller cleared them for the approach. At the same time, the APPR mode and AP 1 were engaged. At this point, the aeroplane was 12 NM from the runway threshold at an altitude of 5,170 ft, i.e. approximately 1,350 ft above a 3° glide slope, with an indicated airspeed of 237 kt and decreasing, and a ground speed of 307 kt (see Figure 1 point ❸ and Figure 2).

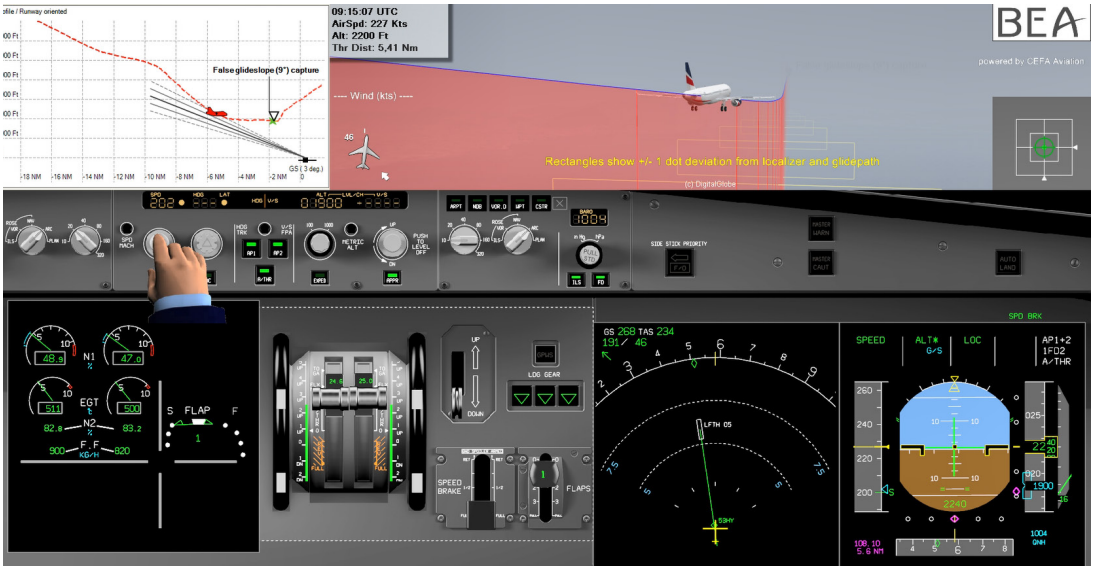
Source: BEA

Figure 2: Reconstruction of flight path and main flight instruments at 09:13:47 on passing the IAF. The left window shows the vertical profile of the flight path and the 3° Instrument Landing System (ILS) glide slope; the main view shows the flight path in 3D.

A few seconds later, the indicated airspeed reached 220 kt, the landing gear was extended and the aeroplane was established on the localizer (see Figure 1 point ❹). The slats and flaps were then set to configuration 1.

Thirty seconds later, at 6.4 NM from the runway threshold, the AP changed to ALT* mode and started the acquisition of the selected altitude of 1,900 ft, corresponding to the first clearance given by the Toulon approach controller. The crew indicated that they did not detect this mode change.

Shortly after, at 09:15:07, the crew passed the Final Approach Fix (FAF) situated at 5.3 NM from the runway threshold. At this point, the altitude was 2,200 ft and decreasing, i.e. 500 ft above the published altitude of the FAF (1,700 ft). The crew engaged the managed speed mode. The position of the glide index on the Primary Flight Display (PFD) was close to the lower limit indicating that the aeroplane was above the glide slope (see Figure 3).



Source: BEA

Figure 3: Situation at 09:15:07 on passing FAF

On reaching an altitude of 1,900 ft, the AP changed to ALT mode and the aeroplane was stabilized in level flight, taking it even further from the nominal 3° glide slope (see Figure 1 point ❺). The crew did not realise that the aeroplane was in level flight and did not have sight of the runway because of the cloud cover. In the 20 s that followed, they set the slats and flaps to configuration 2, 3 and then FULL. According to the crew, the landing checklist was carried out immediately afterwards. At this point, the ground speed was 175 kt and decreasing.

The aeroplane reached the 9° slope of the secondary lobe and the AP G/S* mode engaged (see Figure 1 point ❻). The aeroplane flew through the 9° slope in level flight and was then positioned above it. The AP then ordered a nose-up movement[(5)].

The plane's pitch attitude passed from a nose-up angle of 1° to 30° in roughly 20 s. The crew indicated in their statements that the increase in pitch, although quick, was barely perceptible.

During this period, the air traffic controller instructed the crew to fly a missed approach, the crew did not read this back. The increase in pitch attitude caused the angle of attack to increase and the speed to decrease. The A/THR started to increase the thrust. When the angle of attack reached the trigger threshold, the Low energy alert was activated and the aural alert "*SPEED SPEED SPEED*" sounded in the cockpit (see Figure 1 point ❼ and Figure 4). Two seconds later, at 09:16:22, the ALPHA PROT protection was activated, the PF put the thrust levers in the TOGA detent. The PF indicated that he did not call out this action to the captain. In the following second, the crew disconnected both APs and the ALPHA FLOOR protection was activated. The PF saw the TOGA LK message come up on the Flight Mode Annunciator (FMA). He put the thrust levers in the IDLE position to disconnect the A/THR and cancelled the TOGA LK. He then returned the levers to the TOGA position.

(5) In this ILS secondary lobe, the guidance sent to the aeroplane is inversed. A nose-up signal is received when the aeroplane is above the glide slope (see paragrpah 2.1).

Source: BEA

Figure 4: Situation at 09:16:20 on triggering of LOW ENERGY alert

When the pitch reached 30°, the angle of attack reached 16° and exceeded the Alpha Max (15°) for one second before decreasing under the combined effect of the triggering of the ALPHA PROT protection and the nose-down inputs made by the PF. The indicated airspeed also decreased and reached a minimum of 96 kt, i.e. 20 kt below the VLS[(6)] and 2 kt above the VS1G[(7)].

The PF then climbed on the runway centreline at a rate of around 1,000 ft/min. During the climb, the PF initially held a pitch of 15° which was consistent with the Flight Director (FD) command bars in SRS mode. As a result, the angle-of-attack was held at values close to 12°, which is the threshold of the ALPHA PROT protection (which was triggered again for ten seconds), and the indicated airspeed was held below the VLS.

The crew selected the retraction of the flaps to position 3. The speed passed above the VLS again at 09:17:08, having remained below this value for 46 s.

On reaching 4,000 ft, the crew selected 4,000 ft on the FCU and set the thrust levers to CLIMB. The crew retracted the flaps to position 2, stabilized the altitude at 4,000 ft, engaged AP 2 and then the A/THR. The controller proposed to radar vector the crew to ILS 05. The second approach and landing were carried out without further incident.

(6) Velocity Lowest Selectable. Minimum speed that the crew can request the A/THR to follow and below which manoeuvres are rarely performed.

(7) For aeroplanes in the Airbus A320 family, VS1G is the stall speed at 1g load factor. In practice, the stall speed varies according to the load factor and can be temporarily below VS1G if the load factor is less than 1 which is the case at this point of the flight.

2 - ADDITIONAL INFORMATION

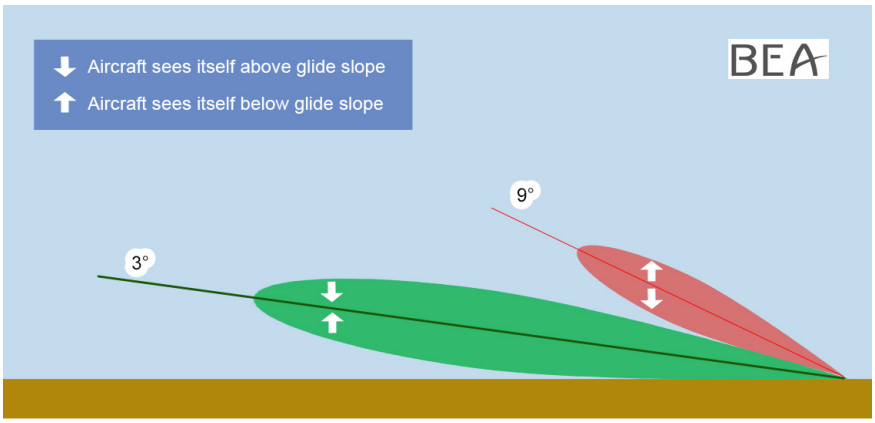
2.1 Description of ILS glide signal and secondary lobes

The ILS glide signal is generated by a set of antennas situated close to the runway threshold. This signal, received by the aircraft, informs it of its position (angular deviation) with respect to the nominal approach slope (in most cases 3°).

The main lobe, centred on 3°, concentrates the majority of the transmission energy and corresponds to the published glide path. An unwanted secondary lobe is present at around 9° due to the nature of the glide antenna radiation. In this lobe, the glide signal is inversed (see Figure 5).

The arrows in the diagram below show how the ILS signal is interpreted by the aircraft and how the AP reacts:

- An arrow pointing upwards means that the aircraft sees itself below the slope. The AP generates an order to intercept the slope which will be globally a nose-up order.
- An arrow pointing downwards means that the aircraft sees itself above the slope. The AP generates an order to intercept the slope which will be globally a nose-down order.



Source: BEA

Figure 5: Schematic diagram of ILS

In particular, when the aircraft is situated above the 9° glide slope, in the secondary lobe, it sees itself below the nominal approach slope and the AP commands nose-up orders.

In the scope of an investigation into a serious incident in 2013[8], the Dutch Safety Board (DSB) published a video dealing with the interception of a false ILS glide slope signal and explaining how it functions (https://www.youtube.com/watch?v=PxBoTMs_iEs).

[8] See paragraph 2.9.

2.2 Aeroplane systems information

2.2.1 Autopilot glide slope acquisition mode (G/S*)

The vertical mode for the glide slope acquisition engages automatically if the crew have pressed the "APPR" button on the FCU.

The G/S* mode engages when the glide path deviation passes below the lower threshold of two dots (glide path deviation limit on PFD). The aeroplane systems do not check the consistency of the glide signal with the other information available (DME distance, altitude).

In this incident, the aeroplane approached the 9° slope in level flight, from below. The G/S* mode was engaged shortly before the aeroplane reached the 9° slope. As the aeroplane was at this point below the 9° slope, the AP generated nose-down orders (see § 2.1). This "nose-down" phase which lasted three seconds was too short to modify the flight path and the aeroplane crossed the 9° slope in level flight. Once above the glide slope, the aeroplane received an ILS signal to pitch up and the AP generated nose-up orders which resulted in the excessive increase in pitch.

At the time of the incident, the A318 did not have the Anti-pitch up excursion protection which is available on other Airbus aeroplanes (see paragraph 2.8).

2.2.2 Protections and alert associated with flight envelope of aeroplane

2.2.2.1 Low energy alert

An aural alert, "SPEED SPEED SPEED" tells the pilot that the speed is too low and that the energy of the aeroplane is below a threshold under which the thrust must be increased and the pitch adjusted. It enables the crew to react before the angle-of-attack protections engage.

In the occurrence, this alert was activated during the pitch increase phase, before the triggering of the ALPHA FLOOR protection.

2.2.2.2 ALPHA PROT and ALPHA FLOOR protections

When the angle of attack of the plane increases and is greater than a certain threshold α_{prot}, the pitch flight control laws are modified: the automatic nose-up compensation stops and the angle of attack varies proportionally with the movement of the side stick.

If there is no side stick input, the angle of attack is maintained at the α_{prot} value. The angle of attack can be increased by a nose-up input from the pilot, up to the maximum value of α_{max}.

In this occurrence, this protection was activated twice:

- A first time, after the activation of the Low energy alert. The AP was engaged and the angle of attack increased to more than 13°. The protection was activated for four seconds.
- A second time, eight seconds later. This time the AP was disengaged, the pilot globally made nose up inputs and the pitch attitude and angle of attack were stabilized at high values. The protection was activated for ten seconds.

If the angle of attack increases again and reaches a threshold value of α_{floor}, the A/THR changes to ALPHA FLOOR mode and automatically controls maximum TOGA thrust, which it then holds whatever the position of the thrust control levers. The locking of this maximum thrust is called "TOGA LOCK". The pilot's inputs on the thrust levers no longer control the thrust. This mode can only be disengaged by manually disconnecting the A/THR.

In this occurrence, the ALPHA FLOOR protection was engaged for six seconds just after the first activation of the ALPHA PROT.

2.3 Interception of glide slope from above

The Airbus Flight Crew Operating Manual (FCOM) describes a procedure to intercept the glide slope from above for an ILS approach once the aeroplane is established on the localizer. This procedure consists of, with the AP engaged:

- Arming the APPR mode, if not already armed, arms the G/S (glide slope) mode.
- Selecting an altitude on the FCU greater than the aeroplane's actual altitude.
- Engaging the V/S (vertical speed) mode and initially selecting -1500 ft/min.

Arming the G/S mode arms the glide slope acquisition and means that the risk of Controlled Flight Into Terrain (CFIT) is avoided. The selection of an altitude above the actual altitude means that unwanted levelling off during the descent is avoided. If an altitude below the actual altitude is selected on the FCU, the AP will intercept this altitude except if the G/S* or G/S mode is engaged.

During the interception of the glide slope, A/THR is in SPD mode and controls the speed which forestalls the possible exceedance of the maximum speed for the manoeuvre and the use of high-lift devices (VFE). The rate of descent is controlled by the crew by means of the vertical speed value displayed on the FCU.

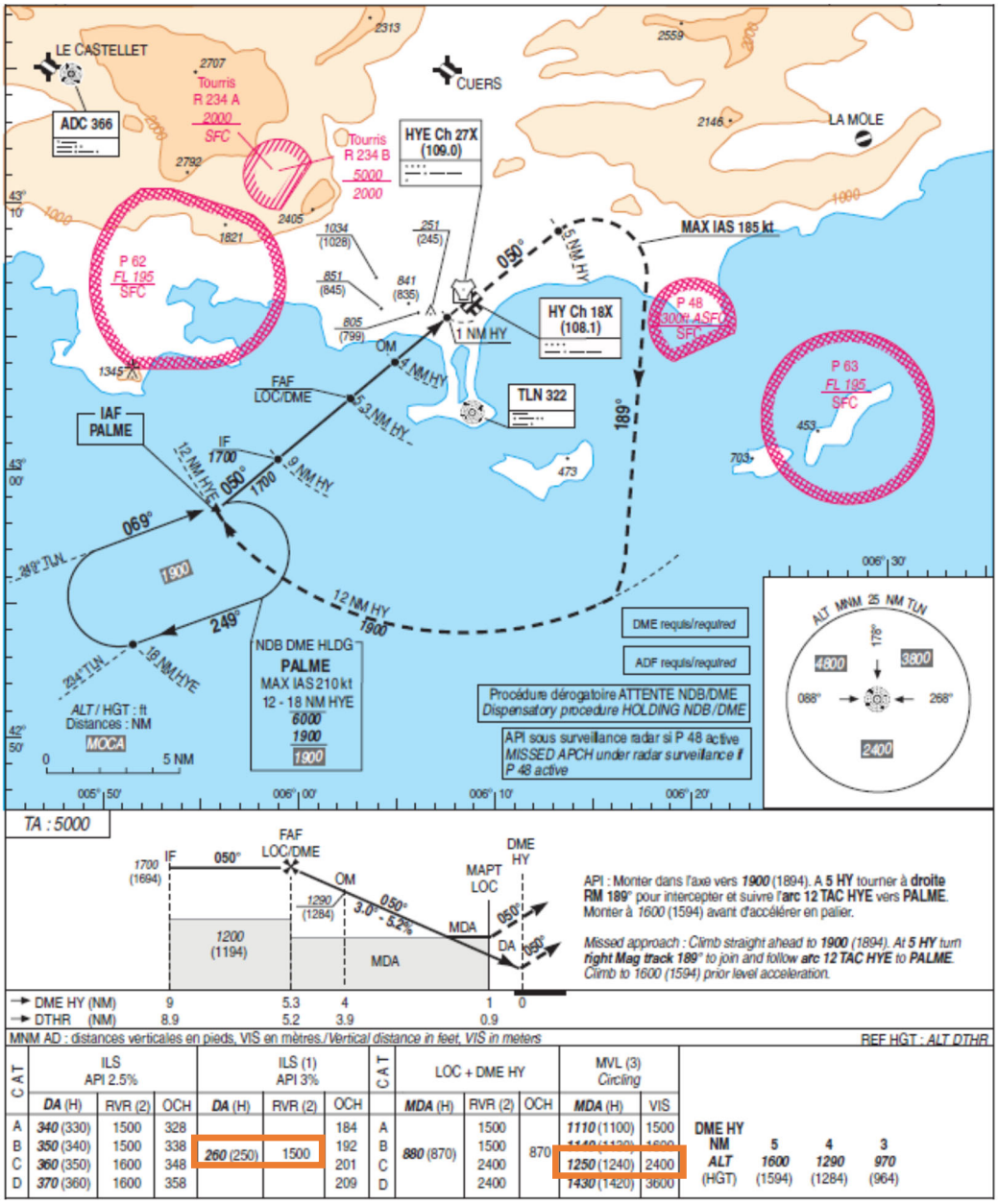
Once the ILS glide slope has been acquired by the AP, the crew must change the altitude selected on the FCU and display the go-around altitude.

Furthermore, the Air France documentation specifies that this procedure must not be carried out above a 5° flight path to the runway threshold to avoid the risk of acquiring a false glide slope signal. During the incident, the crew remained below a 5° flight path to the runway threshold until levelling off at 1,900 ft.

2.4 Aerodrome information

Hyères-Le Palyvestre is a restricted-use airport equipped with a main runway 05-23 measuring 2,123 m long and a secondary runway 13-31, measuring 1,902 m long. The threshold of runway 05 being displaced, the Landing Distance Available (LDA) on this runway is 1,904 m.

Runway 05 is equipped with an ILS while runway 23 is only accessible by a circling manoeuvre. The carrying out of a circling manoeuvre rather than an ILS approach is more penalising for the crews as it imposes a higher workload and more restrictive minima: the minimum descent altitude is 1,250 ft for the circling manoeuvre while the decision altitude is 260 ft for the ILS 05 procedure (see Figure 6). Consequently, even if runway 23 is in use, crews generally prefer using runway 05 if the aeroplane's landing performance permits it. For this reason, the air traffic controllers may let the crew choose the runway for landing, which was the case for this flight.



Source: AIS

Figure 6: Excerpt of ILS approach chart for runway 05

2.5 Meteorological information

According to the 09:00 UTC automatic weather report, the meteorological conditions at Hyères-Le Palyvestre airport were the following:

- wind 12 kt, varying in direction between 100° and 160°, temporarily wind of 20 kt with gusts of 40 kt from 170°;
- visibility of 5,000 m;
- presence of rain and mist;
- three layers of broken clouds based at a height of 1,700 ft, 2,200 ft and 4,600 ft and presence of towering cumulus, cloud cover evolving towards a broken cloud layer based at 1,800 ft and overcast at 3,400 ft.

2.6 Crew information and statements

2.6.1 Co-pilot, PF

The co-pilot joined Air France in February 2019 and finished his line training in June 2019. He had logged approximately 5,500 flight hours of which 400 hours on aeroplanes in the Airbus A320 family. It was the first time that he had landed at Hyères-Le Palyvestre airport on the A320. The following information is based on his statement.

During the descent, the air traffic controller informed the crew that the meteorological conditions were perhaps a bit tight for a circling manoeuvre to runway 23. The co-pilot indicated that based on his experience, he thought that it would not be possible. He knew that there was a strong southerly surface wind and that visibility was low but that the performance for runway 05 was in the limits. He therefore suggested carrying out an ILS approach to runway 05 to the captain, which the latter accepted. The controller was then asked for clearance to carry out the ILS 05 approach and this was given. During the approach briefing, the co-pilot mentioned, in particular, the risk of windshear. The threat relating to the presence of a tailwind was also specified for the landing.

He added that according to him, the descent was started in time but during the approach he was aware that they were high with respect to the glide slope and a bit fast, with a lot of tailwind. However, in agreement with the captain, they preferred carrying out a direct approach to runway 05 rather than the holding pattern proposed by the controller. The co-pilot indicated that he was not particularly worried as it was possible to continue the descent to 1,000 ft even if it meant carrying out a go-around at this altitude if they were not stabilized. He therefore chose to continue the approach using the automatic systems to the most in order to keep some resources available.

The objective was then to configure the aeroplane early to intercept the glide slope and be stabilized before arriving at 1,000 ft. The co-pilot did not detect the levelling off at 1,900 ft and the associated mode changes. Once the aeroplane was configured, the crew carried out the pre-landing checklist. The co-pilot indicated that they were in the cloud layer and that he did not think that he had had sight of the runway otherwise he would have realised where they were.

Once the checklist had been completed, the co-pilot looked at his PFD again and saw the aeroplane's high nose-up pitch and the TOGA LK message. He then disconnected the A/THR and put the lever in the TOGA detent while reducing the pitch to 15°. According to him, these values corresponded to the pitch/thrust of the Unreliable speed indication procedure and gave him a few seconds to get back into the flight. He remembered having heard the Low Energy alert at around the same time that he applied TOGA thrust. He then switched to a go-around scenario without, however, announcing it to the captain. The second approach and landing were uneventful.

He indicated that he had not been aware that he had been situated in the secondary lobe of the ILS during the occurrence. He added that he should have taken greater account of the high tailwind component during the approach. He explained that he had been concentrated on the indicated airspeed and had not looked at the ground speed which might have alerted him to the chances of the approach being successful. He also indicated that the pre-landing checklist was probably not carried out at the right moment.

He indicated that he had little experience in intercepting the glide slope from above. He had felt no time pressure on this flight, neither had he felt particularly tired.

2.6.2 Captain, PM

The captain started as co-pilot on the Airbus A320 (around 2,300 flight hours), then on the Boeing 777 (just over 10,000 flight hours) before returning to the A320 as captain at the beginning of 2019. It had been around 20 years since he last landed at Hyères-Le Palyvestre airport. The following information is based on his statement.

He indicated that the beginning of the flight and en route had been standard and that there had been no time pressure for this leg. The approach briefing carried out by the PF had listed the threats, in particular, landing with a tailwind and the possible presence of birds on the airfield. They calculated the performance for runway 05 which was wet, and with a tailwind. As the performance in the conditions of the day was compatible with landing on runway 05, they agreed that landing on this runway was the first option, the second being a circling manoeuvre to runway 23 which might be complicated given the meteorological conditions.

According to him, the descent was started in time. He did not carry out checks of the glide path during the descent nor did he clearly identify the influence of the tailwind during the approach. He was aware that they were a bit high on the glide slope but given that the landing gear and speedbrakes were extended, he thought that they would be able to intercept it without difficulty. He could not remember having sight of the runway during the approach.

When the controller suggested that they carry out a holding pattern to descend, he turned to the co-pilot who gave him the sign that it was ok. The captain can no longer remember if he checked the glide path at this point.

The announced objective was to be stabilized at 1,500 ft; as a result of this, the captain indicated that he was focalised on the speed in order to extend the slats and flaps in the corresponding speed ranges. The landing checklist was carried out before 1,500 ft; he had not been aware that the aeroplane had stabilized at the target altitude of 1,900 ft as his eyes were on the checklist.

After completing the checklist and while stowing the documentation, he heard the "SPEED SPEED SPEED" alert. He initially focused on the very low speed and did not look at the pitch. The thrust was on TOGA and his first concern was to stay on the runway centreline, without banking, to limit the load factor and increase the speed. When he looked at the pitch on the PFD, it was normal. He added that he had not been aware of the TOGA LK.

During the go-around which had not been stressful, they initially kept the aeroplane's configuration. They then retracted the slats, flaps and landing gear and climbed to 4,000 ft. He remembered that there was high ground nearby.

During the second approach, he realised the strength of the tailwind component on intercepting the localizer. The tailwind at this point was roughly 50 kt.

Lastly, he indicated that he was surprised when he saw the data from the flight analysis in the days which followed the occurrence. In his opinion, the low speed was probably due to windshear.

In hindsight, he indicated that he could have taken greater account of the influence of the tailwind on the path and the ground speed value which gives an idea of the time remaining before the runway, and reinforced the checks of the glide path during the approach.

He had intercepted the ILS from above a few times since holding his A320 rating. It is a rare operational situation which he said he was not used to.

2.7 Analysis of approach and landing threats

The threat linked to the presence of a tailwind was mentioned by the crew during the approach briefing. However, this threat concerned the landing and not the approach phase. The crew's statements show that this threat during the approach was not sufficiently taken into account. Several factors may explain this underestimation:

- The presence of other threats which may have appeared more serious, such as windshear, might have overshadowed the tailwind during approach threat.
- The risk linked to a tailwind is often taken into account for landing and less so for the approach. This is particularly the case for this flight; as the crew had to land with a tailwind on a wet runway, the threats linked to the landing performance were more prominent than those linked to the glide path.
- In the flight file, it was indicated that there was a tailwind of 25 kt on the approach path, which is a lower value than that actually encountered in flight. The threat was thus not easily identifiable during flight preparation.

Due to the strong tailwind during the approach and the flight speed, less than 2 min 30 s elapsed between the moment the crew, at 12 NM from the runway, decided to continue the direct approach for runway 05 without flying a holding pattern, and the AP acquiring the false glide slope signal. During this period, the crew tried to intercept the glide slope from above and prepared the aeroplane for landing. With this workload, the tailwind during the approach threat, of little prominence in the initial assessment, was forgotten or not taken into account.

2.8 Recovery of the Upset situation

Following the Low energy alert, the PF selected TOGA thrust which engaged the FD SRS mode, and resumed manual control. When the pitch reached 30°, he made a nose-down input, initially less than that indicated by the FD, and then held the pitch at values of around 15° which was consistent with following the FD command bars in SRS mode in the conditions of the day.

The Air France documentation specifies that when the pitch exceeds 25°, the aeroplane is in an Upset situation. In this case, the Upset recovery techniques should be applied. In case of an excessive nose-up pitch, the technique specifies the following PF actions:

- Recognise and confirm the situation.
- Disconnect the AP and A/THR and resume manual control.
- Make a nose-down input of sufficient amplitude to enter a nose-down attitude.
- Adjust thrust.
- Adjust roll without exceeding a bank angle of 60°.
- Return to level flight with a sufficient speed.

The PF's initial reaction corresponded to the first items of the recovery technique. Subsequently, holding the pitch at around 15°, corresponded more to the FD commands being followed than carrying out the recovery technique. The consequence of this was to prolong the low speed (below VLS) situation. Fully complying with the Upset recovery technique linked to an excessive nose-up pitch might have contributed to the crew getting out of the aircraft's low-energy situation faster.

2.9 Similar occurrences and safety actions taken before the incident

Several similar occurrences concerning the acquisition of a false ILS glide signal occurred before this incident. These include:

- The serious incident to the Airbus A340 registered F-GLZU operated by Air France on 13 March 2012 on approach to Paris-Charles-de-Gaulle. This occurrence was the subject of a BEA report with five safety recommendations[9].
- The serious incident to the Boeing 737-800 registered EI-ENL operated by Ryanair on 31 May 2013 on approach to Eindhoven (The Netherlands). This occurrence was the subject of a DSB report with four safety recommendations[10].

The recommendations issued by the BEA and the actions taken by the various actors following the event of March 2012 covered the following topics:

- The definition of an explicit operational limit providing pilots with a decision aid before intercepting a glide slope from above. The Air France FCOM now specifies in the interception of glide slope from above procedure, that this cannot be performed above a 5° flight path to the runway threshold.
- Raising the awareness of air traffic control and operators about non-stabilised approaches, the interception of the glide slope from above being a precursor of this type of approach. Air France, following the incident to F-GLZU, issued an internal bulletin to pilots to remind them of the phenomena which may be associated with acquiring a false ILS glide signal and circulated an internal explanatory video produced by the DSB.
- The implementation of a system to help air traffic controllers determine the position of the aircraft in the vertical profile with respected to the published approach slope. In this incident, the military air traffic controllers at Hyères-Le Palyvestre airport did not have a display of the aeroplane in the vertical profile but, nonetheless, warned the crew about its position with respect to the glide slope and proposed an alternative.
- The implementation of protections in the aircraft systems designed to prevent the acquisition of a false glide slope signal and inappropriate pitch attitudes being adopted with the AP engaged. An Anti pitch-up excursion protection has been developed by Airbus to limit the consequences of an excessive pitch attitude being adopted in G/S* mode: the FD commands cannot put the aeroplane into climb. When a false glide slope signal is acquired with the AP engaged, the aeroplane remains in level flight. This protection is part of the standard avionics for the A350, A380 and A320neo. It is also available for the aeroplanes in the A330/A340 family according to the version of the onboard computers[11]. The Anti pitch-up excursion protection will also be progressively available on all the computer versions equipping the conventional A320 family (A320 CEO) from 2023.

[9] https://bea.aero/fileadmin/documents/docspa/2012/f-zu120313.en/pdf/f-zu120313.en_06.pdf

[10] https://www.onderzoeksraad.nl/en/media/attachment/2018/7/10/b10255e47744rapport_stick_shaker_en_interactief.pdf

[11] The Air France A330s are equipped with this protection.

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 the approach briefing for Hyères le Palyvestre airport, the crew chose to give preference to an ILS approach to runway 05, the landing performance in the conditions of the day permitting this. The crew mentioned the presence of a tailwind in connection with the landing performance and not in connection with the approach path. Other threats such as windshear and the possible presence of birds on the airport were of greater concern for the crew.

On first contact with the Toulon approach controller, the crew selected an altitude of 1,900 ft on the Flight Control Unit (FCU) in compliance with the instructions received.

During the descent, the controller informed the crew that the meteorological conditions were a bit tight for runway 23 which in the crew's mind meant that the minima would not have permitted this approach being carried out. The crew knew that they were above the glide slope and had, therefore, extended the speedbrakes and then the landing gear.

When the controller proposed that the crew carry out a holding pattern in order to descend, the crew chose to continue the direct approach to runway 05. The PF knew that he still had the possibility of carrying out a missed approach if they were not stabilized at 1,000 ft and the PM sided with the PF's opinion. However, the crew underestimated the influence the tailwind might have on the approach path and did not sufficiently assess the feasibility of intercepting the glide slope from above.

Thereafter, the two crew members were attentive to the evolving indicated airspeed but did not take into account the high ground speed and high vertical speed values. The interception of the glide slope increased the crew's workload, and the high ground speed due to the strong tailwind reduced the time required to reach the runway. These two factors resulted in the pilots losing situational awareness. The crew did not realise that the altitude selected on the FCU was still 1,900 ft and then did not detect that the plane had levelled off at this altitude, and the associated FMA mode changes.

The levelling off increased the distance between the aeroplane and the 3° glide slope and resulted in the interception of a false glide slope signal with a slope of 9°. During this period, the crew finished configuring the aeroplane for landing and carried out the landing checklist.

The interception of the false glide slope signal caused the pitch attitude to increase up to 30°, without this being perceived by the crew, and then the activation of the Low energy alert, the activation of the angle of attack protection and a reduction in speed. The Low energy alert was activated 1 min 25 s after the undetected activation of the ALT* mode, a period during which the crew's actions bear witness to a loss of situational awareness. The PF responded by applying TOGA thrust without calling this out to the PM, and by reducing the pitch attitude. The crew then carried out a go-around and the second approach was carried out without further incident.

Contributing factors

The following factors may have contributed to a false glide slope signal being captured, followed by the AutoPilot (AP) increasing the pitch attitude and the activation of the flight envelope protections:

- The underestimation of the threat that a strong tailwind represents during the approach, mentioned for the landing phase during the approach briefing and insufficiently taken into account thereafter. Several factors may explain this underestimation:
  - The presence of other threats possibly perceived as more serious, such as windshear, might have overshadowed this threat.
  - The risk linked to a tailwind is often taken into account for landing and less so for the approach.
  - In the flight file, the reported wind for the approach was a tailwind of 25 kt. The threat was therefore not easily identifiable during flight preparation.
- Insufficient monitoring of the glide path by the PM and the PF during the approach.
- Not taking into account the controller's suggestion to fly a missed approach.
- The crew not having an objective in terms of altitude and distance to the threshold and not carrying out the checks at the key points of the approach, in particular on passing the Final Approach Point (FAP).
- The two pilots having had little exposure, in training and line flying, to the interception of the glide slope from above despite their aviation experience.

Measures taken after the occurrence

In July 2020, Air France published an information document (FOCUS) aimed at pilots, about intercepting a glide slope from above. This document which is used as a support in instruction sessions specifies in particular:

- If an aeroplane is above a 5° flight path to the runway threshold, there is a significant risk of acquiring a false glide slope signal.
- To check the plane's position with respect to a 5° flight path to the runway threshold, multiply its height in thousands of feet by two (e.g. at 5,000 ft, the 5° flight path is at 10 NM from the runway threshold).
- The glide slope is intercepted from above once established on the localizer, in compliance with the procedure described in the FCOM.

The crew should renounce intercepting the glide slope if they have not calculated their position with respect to the 5° flight path to the runway threshold, or if there are unanticipated gestures, and fly a missed approach.

Safety lessons

Taking into account tailwind during approach

Tailwind is a threat often associated with the landing phase. During an approach, a strong tailwind plays a part in destabilizing the approach path as well as reducing the remaining time before the runway, which considerably modifies the usual parameters. Hence, even if it is not immediately associated with serious risks, it contributes in two ways to increasing the crew's workload. It is thus an important factor to be taken into account to assess the chances of success of an approach.

Interception of glide slope from above

Intercepting the glide slope from above is a rectification manoeuvre which is little carried out in training and unusual in line flying. The PF and the PM have to carry out additional actions with respect to a standard approach. It is thus another factor increasing the crew's workload. A crew, even experienced, may have a small degree of experience in a given operational situation. In this case, their ability to absorb an increase in the workload is reduced and they become more vulnerable to a loss of situational awareness.

During the interception of the glide slope from above, the PF is even more engaged in managing the flight path and the energy of the aeroplane, the role of the PM is therefore all the more important. His primary task is to monitor the aeroplane's flight path; actions not linked to the flight path should not be carried out to the detriment of this primary monitoring. However, the PM has to find a balance as he must also maintain a sufficient distance in order to be able to assess the chances of success of the interception manoeuvre and anticipate the consequences for the stabilization of the approach.

Sharing of action plan

In case of a go-around, the standard call-out, "GO AROUND, FLAPS" by the crew member who starts the manoeuvre allows the other pilot to share the action plan, to mentally activate the sequence of actions which will follow and thus make crew cooperation possible in a very dynamic phase.

Flight envelope protections

Should a crew find themselves crossing the 9° ILS glide slope with the autopilot engaged, the presence of Anti pitch-up excursion protections, available on the latest generations of Airbus means that the adoption of an excessive pitch attitude is avoided. This protection is part of the standard avionics for the A350, A380 and A320neo. It is also available for the aeroplanes in the A330/A340 family according to the version of the onboard computers. The Anti pitch-up excursion protection will also be progressively available on all the computer versions equipping the conventional A320 family (A320 CEO) from 2023.