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pour la sécurité de l'aviation civile

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REPORT
SERIOUS INCIDENT

Approach above glide path, interception of ILS sidelobe signal, increase in pitch angle commanded by autopilot

Aircraft	Airbus A340-300 registered F-GLZU
Date and time	13 March 2012 at 04 h 50[1]
Operator	Air France
Place	On approach to Paris Charles de Gaulle Airport (95)
Type of flight	International public transport of passengers
Persons on board	Captain (PF) Co-pilot (PNF)
Consequences and damage	None

[1] All times in this report are in Universal Time Coordinated (UTC), except where otherwise specified.

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 or reference.

HISTORY OF FLIGHT

Note: the history of flight has been drawn up from flight data from the Direct Access Recorder, air navigation services' radar data and voice recordings as well as crew and controller testimony. The aircraft cockpit voice recorder (CVR) no longer contained the event flight at the time this was notified to the BEA.

The crew took off from Bamako (Mali) aerodrome on 12 March 2012 at 23 h 59 heading for Paris Charles de Gaulle (CDG) airport. On arrival, the ATIS indicated that the low visibility procedure (LVP) was in force. The crew prepared themselves for a CAT III precision approach.

The aeroplane was stable at FL90 at about 30 NM from the threshold of runway 08R. Autopilot 1 was engaged in HDG and ALT mode. The ATHR was engaged in SPEED mode. The speed was stable at 250 kt in accordance with the controller's request. The crew was in contact with CDG approach. They were cleared to intercept localizer 08R.

At 04 h 40 min 20, the controller cleared the crew to descend to FL80 and five seconds later the aeroplane, stable at FL90, passed above the 3° glide path. The crew was then cleared to descend to FL60. They selected an altitude of 6,000 ft on the FCU and the autopilot mode changed to OP DES. The autopilot captured the localizer 08R signal (LOC*) and then the LOC mode engaged. When the aeroplane descended to 7,220 ft, and was 17.5 NM from the threshold, or about 1,275 ft above the glide path, the controller requested that a speed of more than 200 kt be maintained. The aeroplane's speed was about 250 kt. The crew read back and requested to continue the descent. The controller apologised for his omission then cleared the crew to descend to 3,000 ft to intercept the 08R ILS.

The crew selected 220 kt and 3,000 ft. The OP DES mode remained active. The aeroplane speed and rate of descent decreased[2] which resulted in increasing the deviation from the glide path. The crew extended the airbrakes. When the aeroplane speed reached the target speed of 220 kt, the rate of descent increased again to a value of -1,840 ft/min[3].

[2] In OP DES mode, the decrease in speed has priority over the acquisition of altitude.

[3] At that moment, there was a 10 kt head wind. The rate of descent for a glide path of 3° at the aeroplane's speed is about 1,100 ft/min.

At 10 NM from the runway threshold and at an altitude of 5,500 ft, the approach controller requested that the crew maintain a speed of more than 160 kt and that they contact the tower. He did not inform the tower controller that the aeroplane was above the glide path. The crew selected a speed of 210 kt then 183 kt and wing slats/flaps configuration 1. Again, the rate of descent decreased and the aeroplane deviated from the 3° glide path.

The crew contacted the tower and indicated that they were 9 NM out. The aeroplane was at an altitude of 4,950 ft (1,750 ft above the glide path). The controller initially cleared the crew to continue the approach. The latter read back *"Cleared to land 08 right… "*. The controller indicated that he then checked that the CAT III ground services were clear then confirmed clearance to land.

The crew selected slats/flaps configuration 2 and retracted the airbrakes. About one minute later, they re-extended the airbrakes, set the G/S mode using the APPR switch and engaged autopilot 2. The glide deviation displayed on the PFD indicated to the crew that they were approaching the glide path from above. The aeroplane was 4 NM from the runway threshold, at about 3,700 ft (that is 2,100 ft above the glide path at 3°) and was located in an ILS signal sidelobe.

About 30 seconds later, the crew extended the landing gear. The glide path capture mode (G/S*) was activated when the aeroplane was 2 NM from the runway threshold at 2,850 ft (that is about 1,600 ft above the glide path at 3°). The ATHR changed to SPEED mode. The pitch attitude increased from 1° to 26° in 12 seconds. The PNF stated that he had called out the difference in the pitch attitude when the chevrons[4] appeared. When the aeroplane pitched up, the speed dropped from 163 kt to 130 kt, the vertical speed changed from – 1,600 ft/min to + 3,300 ft/min. When the pitch attitude reached 26°, the crew disconnected both autopilots and the PF made a pitch down input almost down to the stop. The pitch attitude and vertical speed decreased. The crew retracted the airbrakes. The throttle levers were in the IDLE position. The speed was 143 kt and the ATHR disengaged. About 30 seconds later, autopilot 1 was engaged, the levers were repositioned on the CL setting and the ATHR was activated. The PF explained that he engaged autopilot 1 to perform a go-around on automatic[5]. The LOC and G/S modes were active and the ATHR was in SPEED mode. The speed was 147 kt. The aeroplane was directly above the runway threshold at an altitude of about 2,700 ft. The pitch attitude then decreased from 2° to -5° and the aeroplane descended.

The PF stated that he realised that the modes displayed on the FMA were not appropriate. He then disengaged the AP 8 seconds after having activated it and then displayed a pitch attitude of about 6° and placed the throttle levers in the TOGA setting at an altitude of about 2,000 ft.

The crew made a second approach and landed without further difficulties.

[4] The pitch attitude of 30° was represented by chevrons on the PFD to indicate to the crew to decrease pitch attitude when the aircraft's pitch attitude was close to this value.

[5] The go-around procedure specifies displaying a pitch attitude of 12.5° and positioning the levers on the TOGA setting.

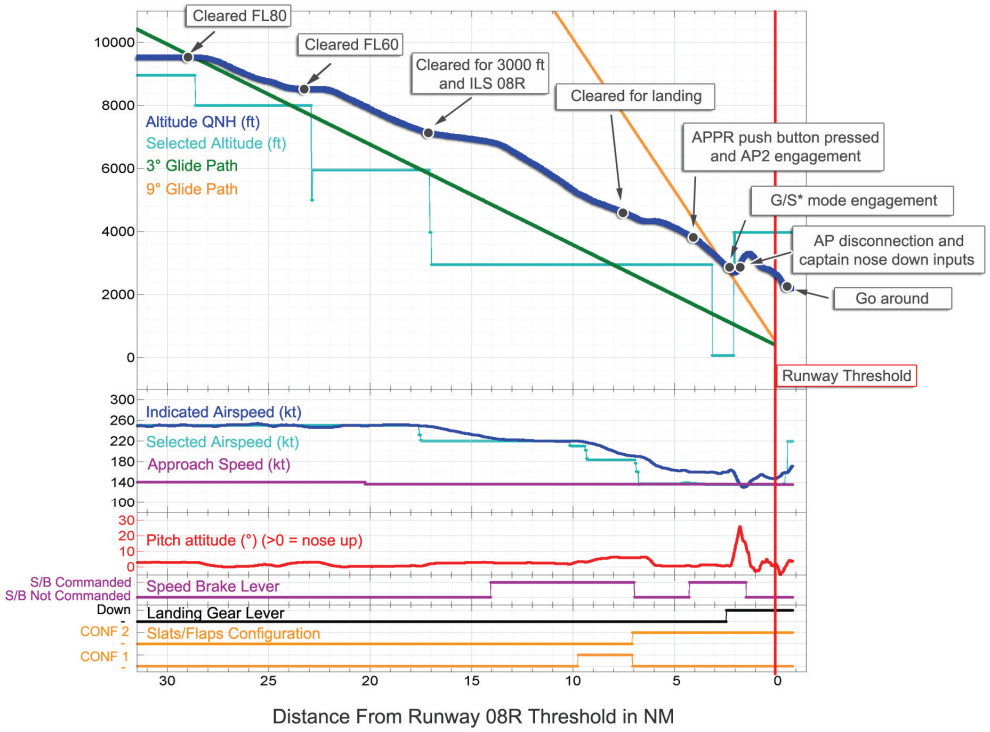

Figure 1: Vertical flight path of F-GLZU

ADDITIONAL INFORMATION

Crew testimony

The crew knew that they were above the ILS glide path. They explained that they tried to correct the path when the controller cleared them to intercept the ILS.

The controller's clearance strengthened their conviction that they were in a situation enabling them to meet this request.

The crew stated that they were tired on approach and not really aware of their distance in relation to the runway threshold. They had planned to continue the approach as far as the stabilisation altitude (1,000 ft).

Approach controller's testimony

The controller stated that because there was an aeroplane on parallel approach on runway 09L, he was not able to allow the F-GLZU to descend as it wished. He forgot to ask the F-GLZU crew to continue the descent when the separation became adequate. He realised this omission and that the aeroplane was above the glide path when the crew called him. He cleared them to intercept the ILS and to descend to 3,000 ft to enable them to intercept the path[6]. Having ensured the separation between the two aircraft on approach, he did not take into account the reference points at his disposal to ensure correct ILS interception. He said that, without the crew's objection, he had thought that the approach was feasible. After this last clearance, he focussed on managing other aeroplanes and did not check if his action had had the expected result. He transferred the crew to the following controller without informing him that the aeroplane was above the glide path.

[6]The approach procedure published specifies that in the event of clearance at 3,000 ft, the FAP is located 8.2 NM away (see chart extract that follows).

Procedure for intercepting the glide path from above

Air France defined a procedure for intercepting an ILS glide path from above in autopilot for an Airbus A340:

➤ **Si capture G/S par le dessus :**

Si l'avion est au-dessus du G/S, sa capture ne s'effectuera pas automatiquement.
L'équipage doit capturer le G/S en mode V/S.
Quand LOC* ou LOC est engagé et que G/S est armé :
V/S..... SELECTE / ENGAGE
Ne pas dépasser - 2500 ft/mn.
ALTITUDE.....SELECTEE
Sélecter au FCU une altitude > à l'altitude avion.

NOTE
Si l'on atteint VFE, l'AP/FD maintient VFE en réduisant la V/S sans réversion de mode.

A l'engagement du mode G/S vert
ALTITUDE DE REMISE DE GAZ..... SELECTEE
Sélecter au FCU l'altitude de remise de gaz.

Air France pilots are trained in this procedure but generally prefer to intercept the glide path from above in manual.

ILS CATIII RWY 08R approach procedure

The ILS CATIII RWY 08R AIP approach chart for 8 March 2012 defined the FAP position according to the clearance altitude given by the controller in the following way:

- At 5,000 ft, the FAP is about 14 NM from the runway threshold;
- At 4,000 ft, the FAP is about 11 NM from the runway threshold;
- At 3,000 ft, the FAP is about 8 NM from the runway threshold;
- At 2,000 ft, the FAP is about 5 NM from the runway threshold.

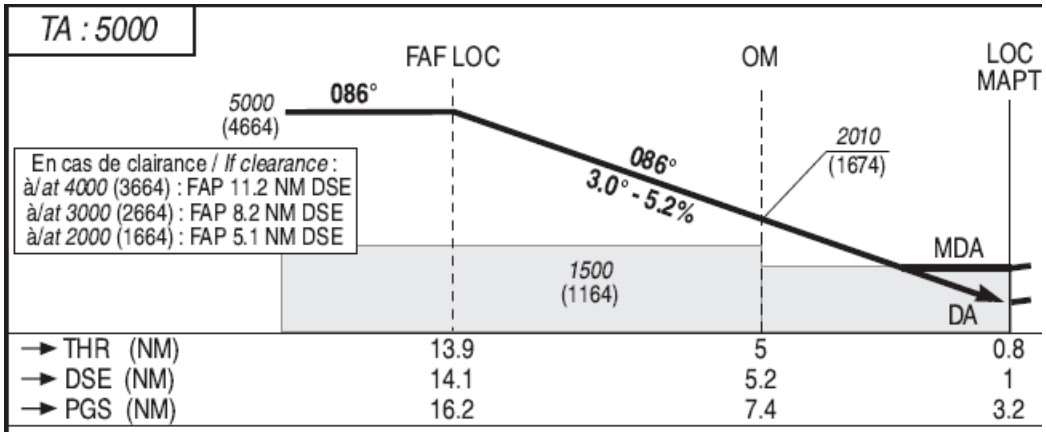

Figure 2: Extract from the AIP approach chart

Stabilised approaches

During a symposium on stabilised approaches in 2006, the DGAC published a handbook for aviation professionals entitled: "Stabilised approaches, good practice guide"

http://www.developpement-durable.gouv.fr/IMG/pdf/GUIDEBPDBLEGB.pdf

The guide contains the following:

Radar vectoring

PILOTS

You should be aware of your horizontal and vertical position in respect of a stabilised approach at all times when under radar control.

Refuse clearances that send you too high and/or too fast; or would reduce separation due to a tail-wind or cause glide slope interception from above...

CONTROLLERS

Make sure that radar vectors end on a published approach procedure at the right altitude before the final descent point (FAF/FAP).

Take tailwinds into account during radar control particularly on final approach because they are an important contributory factor towards unstabilised approaches.

The French air navigation services provider (Direction des Services de la Navigation Aérienne DSNA) drew up a plan of action at the end of the symposium. Since then, controllers have been made aware during their training course of the concept of stabilised approaches. Assistance available on their radar screen is described in the operations manual:

"For CDG centrelines, it is advisable to:

- *In the event of simultaneous approaches:*
  - *Have the intercept occur at the latest at the chevron*
- *… "*

The aeroplane should intercept the LOC signal at the chevrons and at the FAP altitude indicated on the diagram below (from the operations manual) so that interception is correct.

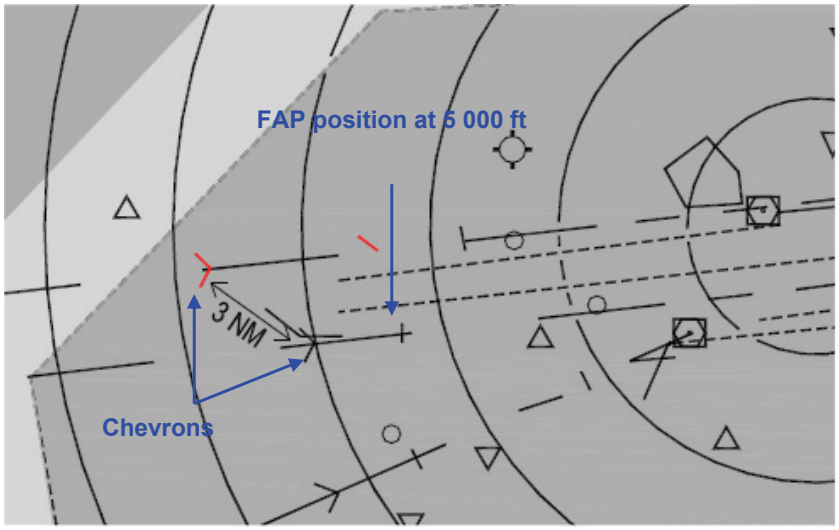

Figure 3: Visual reference points on the radar screen

The visual reference points are to allow levelling off before final descent (standard approach) and to ensure aircraft separation in the event of simultaneous approaches.

Those on the screen for runway 08R correspond to the position of the FAP at an altitude of 5,000 ft.

In LVP the controller must in particular obey the following additional constraints:

- Vi ≤ 180 kt at 15 NM from the threshold;
- Vi ≤ 160 kt at interception of the glide path.

Description of the ILS glide path signal

The simplified principle of the deviation direction of the glide path signal is described by the diagram below: the main lobe at 3° forms the published glide path and a sidelobe is present at about 9°. In this sidelobe, the signs of deviation are inverted by design.

The arrows in the diagram below indicate how the signal is analysed by the AP:

- An arrow pointing up means that the autopilot interprets the signal as being below the glide path;
- An arrow pointing down means that the autopilot interprets the signal as being above the glide path.

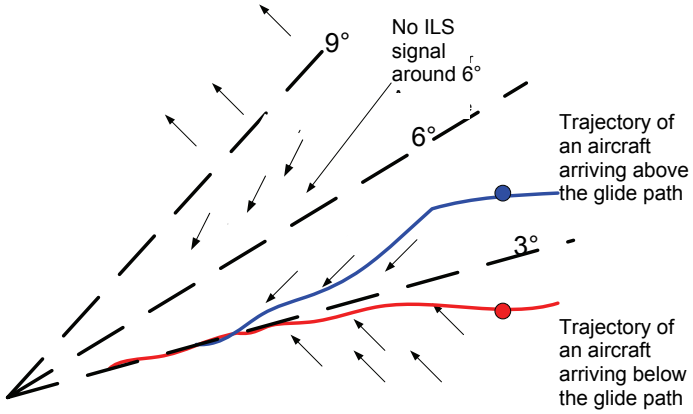

Figure 4: Direction of the ILS signal deviation

The parameters recorded by the aeroplane made it possible to determine that the ILS 08R sidelobe slope was close to 10° on the day of the incident.

Interception of the glide path signal

During this incident, in autopilot, the G/S* mode was engaged on an ILS signal of a sidelobe defining a descent slope of about 10°. The autopilot interpretation of the ILS signal led to an increase in pitch. This pitch up increase continued until it reached 26°. The crew then disconnected the autopilot and performed a missed landing.

Statistics on approaches above the glide path at CDG

The DSNA has no systematic tool for analyzing recorded radar data to establish statistics on non-compliant approaches. Developments are currently underway to meet this need.

LESSONS LEARNED AND CONCLUSIONS

Flight path monitoring

Because of the air traffic constraints, the controller vectored the crew above the ILS glide path and requested they maintain high speeds. After a message from the crew, the controller realised that he had forgotten to clear descent continuation. When the aeroplane was about 1,200 ft above the glide path and 17 NM from the runway threshold, he estimated that the separation with another aeroplane on approach was adequate. He no longer took into consideration the visual references at his disposal on his radar screen and cleared the crew to intercept the ILS. The crew did not mention possible difficulties in carrying out the manoeuvre, which served to strengthen the controller's confidence in his strategy.

CDG controllers vector aeroplanes to carry out correct ILS interceptions, to ensure stabilised approaches for crews. The constraints of managing air-traffic may lead aeroplanes into unusual situations, particularly above the glide path.

With radar vectoring, best practice from the DGAC symposium encourages:

- Crews to monitor the aeroplane's trajectory, to refuse any request from ATC that does not appear feasible and not to delegate monitoring of their flight path.
- Controllers to vector the aeroplane to intercept the ILS and to make sure that the position and speed of the aeroplane are compatible with a published approach.

During this incident, the controller cleared the crew to intercept the ILS thinking that they would indicate any difficulty they had in carrying out the manoeuvre. The crew thought that, in LVP conditions, the controller was going to vector them as far as interception of the glide path and that he would not clear them to intercept it if it was not feasible. Thus each of them thought that the other would indicate to him/her if there was a problem during the approach.

Intercepting the glide path from above

The crew knew that they were above the path but were not aware of the short distance to the threshold. They thought they could intercept the path, while the recorded flight path showed that the aeroplane had deviated from it. This situation was linked to inadequate monitoring of their position, to the use of the autopilot in an unsuitable mode and was not in compliance with the operator's procedure (OP DES mode). In fact, this procedure provides, specifically, for the use of V/S mode to capture the glide path signal from above.

The aeroplane entered a sidelobe beam at 10°. The glide path indication strengthened the crew's conviction that they were getting closer to the path at 3° from above whereas in reality they were getting closer to the path at 10° from below. The crew set up the G/S mode while the aeroplane was beyond the FAP, 2,100 ft above the path and 4 NM from the threshold.

Autopilot capture of the sidelobe

The activation on autopilot of the glide path capture mode at 10°, corresponding to an ILS signal sidelobe, led the aeroplane to a nose-up attitude of 26°. Aeroplane systems do not check the consistency of the path signal with the other information available (DME distance, altitude).

Fatigue

The event occurred at 4 h 50, at a time when crew and controllers could be subject to a considerable degree of fatigue. The effects of fatigue may have led to an increase in the number of errors, omissions and reaction time and to a decrease in coordination (team work) and decision-making abilities.

Use of visual reference points by controllers

In order to favour a stabilised approach, the controller has visual reference points on the radar screen. These reference points are placed at the recommended altitude for glide path interception on the approach chart. If the controller gives an interception clearance at a lower altitude, he no longer has these reference points and can no longer estimate the deviation of the aeroplane vertically in relation to the published trajectory.

During this incident, the controller forgot to request the crew to descend. When he realised this, the aeroplane could no longer follow the published trajectory with an FAP at an altitude of 5,000 ft. The controller could not therefore use the only reference points available on his screen to check the flight path.

CONCLUSION

This serious incident was due to:

- Inadequate monitoring of the aeroplane's flight path by the controller and by the crew during the CAT III precision approach under radar vectoring;
- The crew's decision to continue the approach after the FAP when the aeroplane was above the glide path.

The following factors contributed to it:

- The absence of visual reference points on the controllers' radar screen for glide path interception at altitudes lower than 5,000 ft.
- The crew's use of an unsuitable method to intercept the glide path from above.
- The autopilot's capture of an ILS signal from a sidelobe, which generated an excessive increase in pitch attitude.

Flight crew and controller fatigue may have contributed to the occurrence of this serious incident.

SAFETY RECOMMENDATIONS

Note: In accordance with Article 17.3 of European Regulation (EU) 996/2010 of the European Parliament and Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation, a safety recommendation shall in no case create a presumption of blame or liability for an accident, a serious incident or an incident. The addressee of a safety recommendation shall inform the safety investigation authority which issued the recommendation of the actions taken or under consideration, under the conditions described in Article 18 of the aforementioned Regulation.

The Air France procedure relating to intercepting the glide path from above does not define operational limits for its execution (deviation tolerated in relation to the flight path, meteorological conditions and position during the approach procedure). This lack of definition does not give crews adequate criteria to decide whether to continue an approach.

Consequently the BEA recommends that:

- **EASA ensure that the national authorities ensure that all operators define explicit operational limits in their documentation providing pilots with assistance in the decision before intercepting the glide path from above. [Recommendation FRAN-2013-005]**

Intercepting the glide path from above was identified in 2006, during a symposium relating to stabilised approaches organised by the DGAC, as being a warning of a non-stabilised approach. In a handbook published for this event, mention was made of advice for controllers as well as for pilots.

Consequently the BEA recommends that:

- **DGAC ensure that operators and the DSNA be made aware of the lessons from the 2006 symposium organised by the DGAC relating to non-stabilised approaches. [Recommendation FRAN-2013-006]**

Air traffic controllers have no tools enabling them to detect that an aeroplane is not on the published glide path and to follow any evolution in this deviation during the approach. Such a tool would enable controllers to vector an aircraft by checking its position in relation to the published glide path and help reduce the number of non-stabilised approaches.

Consequently the BEA recommends that:

- **DGAC study the implementation of a system enabling controllers to determine the vertical position of an aircraft in relation to the published glide path. [Recommendation FRAN-2013-007]**

The investigation showed that it was possible to intercept a sidelobe ILS glide path in autopilot without alerting the crew. Furthermore, under these conditions, the autopilot put the aeroplane in an unusual attitude (26° pitch-up) during a critical phase of the flight. This issue could well involve other aircraft in public transport.

Consequently the BEA recommends that:

- **EASA ensure that aircraft ILS modes are not engaged on an ILS signal other than the one corresponding to the published descent path; that failing this, a system enabling the crew to be alerted be put in place; [Recommendation FRAN-2013-008]**

And that

- **EASA ensure that the activation of aircraft ILS modes in autopilot does not lead to inappropriate attitudes during approach. [Recommendation FRAN-2013-009]**