



Date: November 18, 2013

UNEXPECTED AUTOPILOT BEHAVIOUR ON ILS APPROACH

Potential severe pitch-up upset when intercepting the instrument landing system (ILS) glide slope from above, which can lead to (approach to) stall conditions.

The particulars

- Different types of Instrument Landing System (ILS) glide slope systems are used worldwide. Signal characteristics in the area above the (standard) 3 degree glide slope are system dependent.
- Similar glide slope capture logic in automatic flight control systems (autopilot) is used for the majority of aircraft types currently in service worldwide.
- While intercepting the ILS glide slope signal from above the 3 degree flight path with the automatic flight control system engaged, the aircraft can capture a false glide slope resulting in an unexpected rapid pitch-up command (automation surprise).

Preliminary investigative findings

The Dutch Safety Board is investigating a severe and sudden pitch-up upset during an ILS approach to Eindhoven Airport in 2013. The airspeed dropped rapidly to a near stall situation (stick shaker). The crew carried out a go-around. During the investigation the Board has become aware of similar events. Analysis revealed that the common factor linking these events is the ILS antenna type; M-array (Capture effect) ILS antenna. The M-array ILS antenna type is used around the world, including at major airports and military air bases in the Netherlands.

Regulations mandate that ILS systems be periodically checked with a Flight Inspection in order to be certified for operational use. The Flight Inspection focuses exclusively on the 3 degree glide slope area. The signal characteristics in the area above the 3 degree glide slope were examined as part of the Dutch Safety Board's investigation. Flight tests were conducted to measure the M-array antenna signal and determine the 'glide slope field' characteristics above the 3 degree glide path while established on the localizer.

Analysis of the measurements show that between the 3 and 9 degree glide path, signal strength changes. For the pilot this can result in observable movement of the ILS glide slope marker on the primary flight display. At this time two important characteristics of the M-array ILS antenna 'glide slope field' have been identified:

1. A signal reversal was always present at approximately 9 degree glide path.
2. A signal reversal was sometimes present at approximately 6 degree glide path.¹

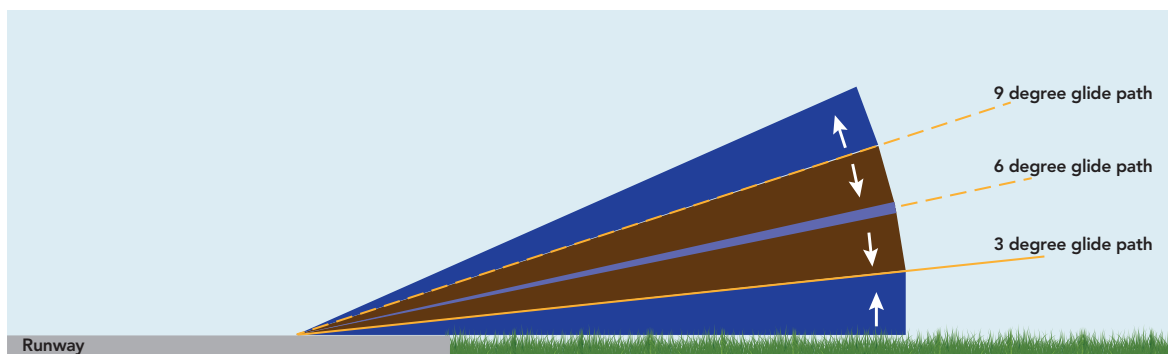


Figure 1: Cross section view of the M-array ILS antenna system. Schematic overview of the "Fly up"(blue) and "Fly down"(brown) indication.

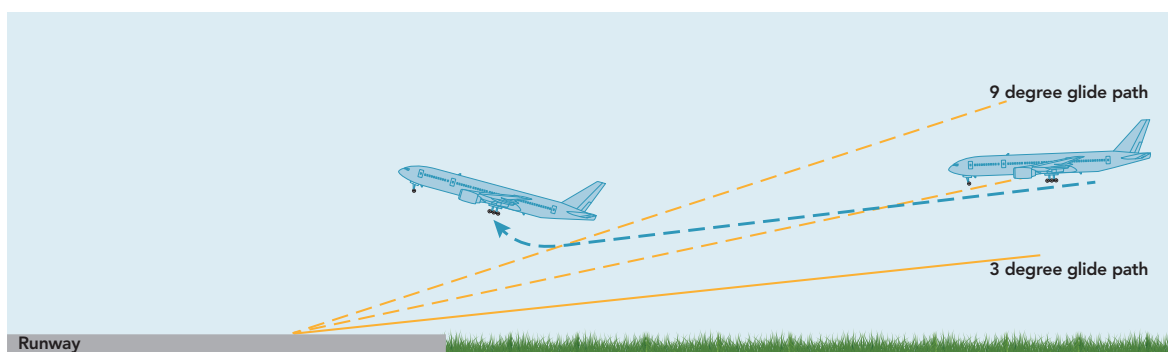


Figure 2: Example of glide slope capture with a pitch upset above 3 degree glide path.

Depending on the glide slope field, signal reversal occurs occasionally at 6 degree, and always at the 9 degree glide path. This reversal activates the glide slope capture mode after which the autopilot follows the glide slope signal without restrictions. During flight tests the reversal resulted in the automatic flight control system commanding a severe pitch-up. Immediate flight crew intervention was required to regain aircraft control.

Furthermore the flight tests have shown that commonly available information on false glide slope (internet, manuals and literature) does not necessarily reflect glide slope signal characteristics of all ILS antenna types in use worldwide. For example, in some aircraft manuals it is noted that a false glide slope signal can be identified by a higher than normal descent rate. This particular description does not accurately reflect what happens when a false glide slope of an M-array antenna is captured.

¹ During measurements at two different Airports in the Netherlands the 6 degree glide path reversal was not always present.

Thus far the investigation has revealed that aircraft from four different manufacturers operated by different airlines have experienced a pitch-up upset caused by a false glide slope either under test conditions or during operation.

This investigative information has led the Dutch Safety Board to issue this Safety Alert to address the following safety concern: to generate awareness of different ILS signal characteristics and the potential of aircraft pitch-up upset due to capturing a false glide slope, which can lead to (approach to) stall conditions.

Related incidents

During the ongoing investigation the Dutch Safety Board was notified of a similar event with a different aircraft type at Amsterdam Airport Schiphol in 2011.

In 2012 the French Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile (BEA) investigated a pitch upset of an Airbus A340 on approach to Charles de Gaulle Airport. Also in this case the airspeed dropped rapidly and the crew carried out a go-around. The Dutch Safety Board has been provided with information that the M-array antenna system is used at Charles de Gaulle Airport.

For more information www.bea.aero - report *"Approach above glide path, interception of ILS sidelobe signal, increase in pitch angle commanded by autopilot"*, September 2013.

Information for pilots; what can you do?

Pilots should be aware of the ILS glide slope signal characteristics and the dangers accompanying flying in the area above the 3 degree glide path during the approach. In particular the aircraft behaviour while flying on autopilot with the glide slope mode armed should be noted.

Information for operators; what can you do?

Operators should consider the need to implement additional operational procedures or provide additional guidance in order to mitigate the risks of unexpected autopilot behaviour when on ILS approaches.

If after reading this Safety Alert you think a similar occurrence has taken place within your company, please contact your investigation authority agency and provide any relevant information of the event.

Information for Air Traffic Control; what can you do?

Adhering to prescribed navigation procedures reduces the flight crew workload and will position the aircraft to intercept the glide slope from below.

Information for Aircraft Manufacturers; what can you do?

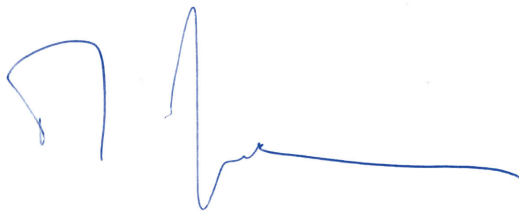
Aircraft Manufacturers should consider the need to provide additional guidance in order to mitigate the risks of unexpected autopilot behaviour when on ILS approaches.

What can the Aviation Authorities do?

Thought should be given by the Aviation Authorities to monitor and enforce the need for mitigating actions by the relevant parties to reduce the risk of false glide slope encounters.

This Safety Alert is not intended to apportion blame or liability to any party. The sole purpose of the Safety Alert is to inform the aviation community of a safety concern which has been identified by the Dutch Safety Board during an investigation.

The publication of the Final Report (Stick shaker warning during ILS approach, Boeing 737-800, May 31, 2013 - Eindhoven Airport) is scheduled for May 2014.



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