

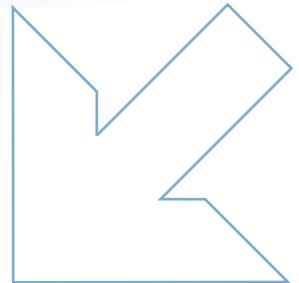


A320/ Possible consequences of VMO/MMO exceedance



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1 | Introduction

This article is a follow up on a presentation given at the last Flight Safety Conference in Barcelona on October 2007.

It describes the solutions, which have been developed and implemented in the latest ELAC L84 and L93 software standards in order to assist the crews in avoiding large altitude incursions linked to VMO/MMO exceedance scenarios.

It will describe as well the modifications brought to the last standards of the Flight Warning Computer In order to improve pilot awareness in case of Auto Pilot disconnection.

The aircraft typically has the Auto Pilot engaged, and the wind gradient will lead it to exceed the High Speed protection (HSP) threshold (the speed or Mach number at which the HSP activates depend on the flight conditions, but do not exceed VMO+6kt or MMO+0.015). The triggering of the HSP will automatically disconnect the Auto Pilot.

2.1 First scenario : no pilot input following AP disconnection

If the side stick is free, HSP activation will automatically add a small positive G demand until the aircraft returns within the flight envelope.

From experience, the altitude excursion is limited to less than 700 ft (fig. 1).

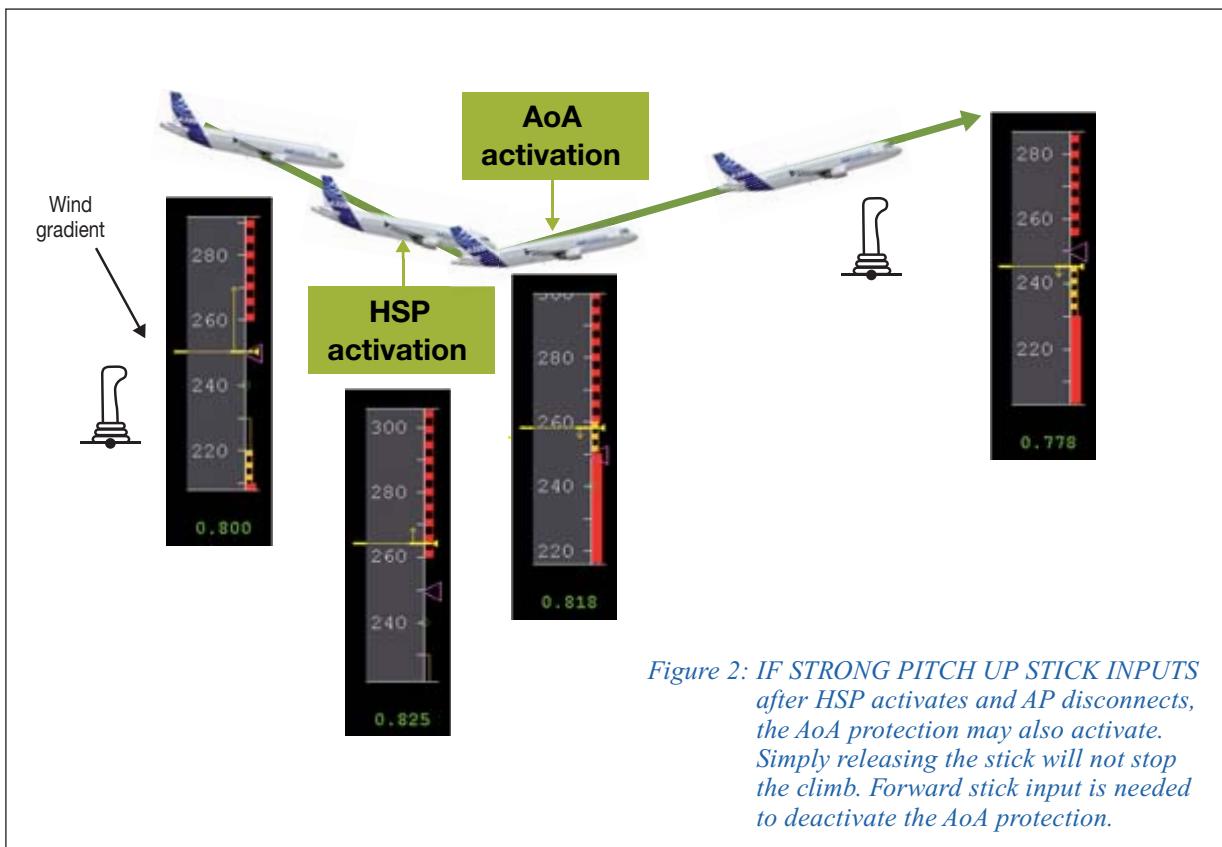
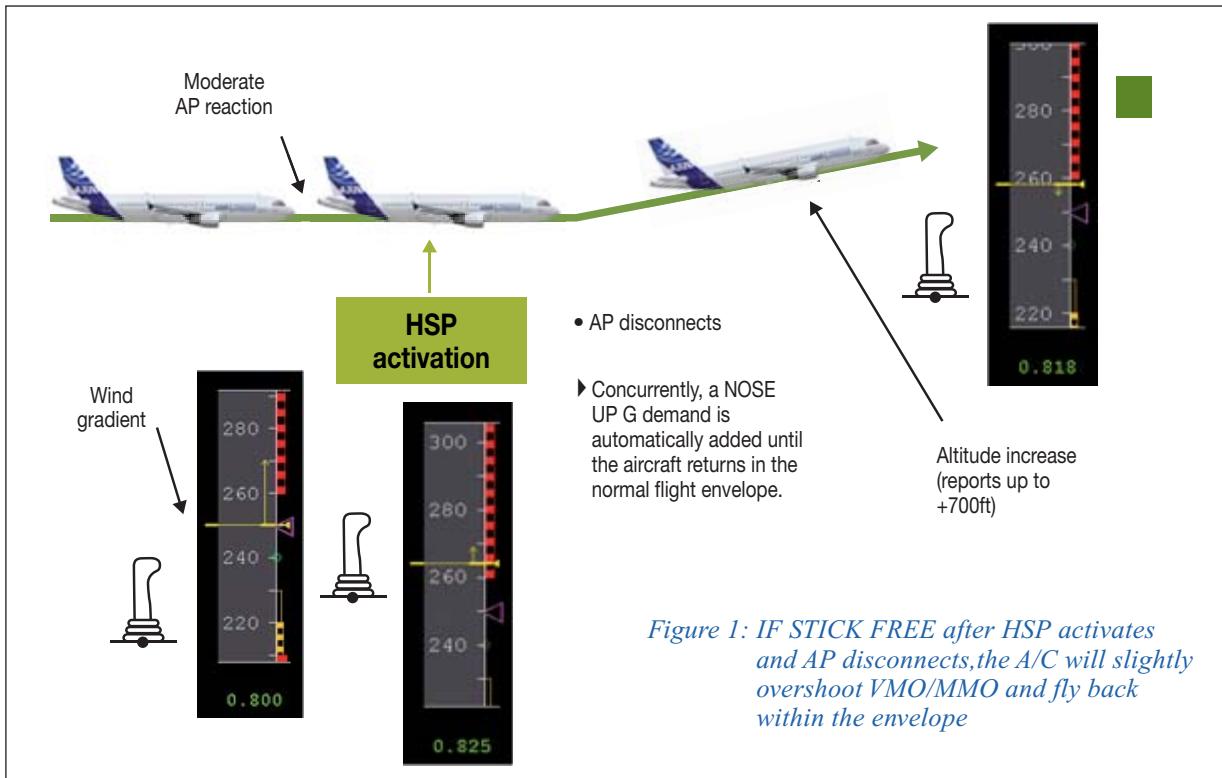
2.2 Second scenario : strong pilot input following AP disconnection

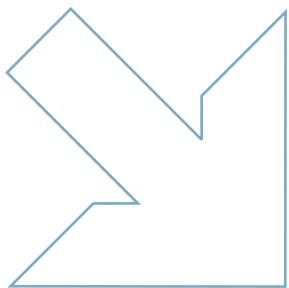
If the pilot reacts to the over speed by pulling too strongly on the side stick (in which case the pilot input will be added to the HSP input), the Angle Of Attack (AOA) protection may be triggered. This means that the aircraft will climb at the highest AOA value for as long as the protection is activated. Since deactivation may only be achieved through nose down side stick input, simply releasing the stick will not stop the climb.

Delayed reaction from pilots in applying forward stick input results in large altitude excursions (fig. 2).

2 | Description of two possible scenarios

VMO/MMO exceedance events usually happen in cruise or during descent, when the aircraft encounters a significant wind gradient.





3 | HSP activation/ AP disconnection logics change implemented in ELAC L84 and L93

As indicated above, HSP activation disconnects the AP.

In order to avoid the above type of scenario, it was decided to:

- Introduce a 3 second filter to avoid AP disconnection in case of very short overspeed situations
- Increase the HSP activation threshold so as to keep the benefit of the Auto Pilot at higher speeds and Mach numbers.

3.1 New speed threshold for HSP activation/AP disconnection

L83/L91 standards	L84/L93 standards
356 kt	365 kt (3 second filter)

In the L84/L93 standards, a 3 second filter has been introduced and the speed threshold has been increased by 9 kt.

3.2 New Mach threshold for HSP activation/AP disconnection

L83/L91 standards	L84/L93 standards
A319/ A320	M. 83
A318/ A321 ¹	M.83 (3 second filter) M.86 (no filter)

In the L84/L93 standards, the Mach threshold is a function of the Flight Path Angle and is identical for the whole A320 family. The main aim is to have a better protection of the aircraft during cruise (fig. 3).

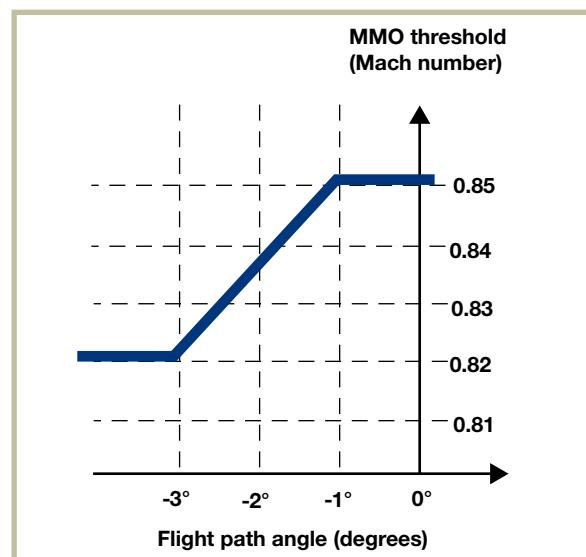


Figure 3: L84/L93 Mach threshold for HSP activation/AP disconnection.

ELAC hardware	ELAC software	Mod. number	Service Bulletin
A or A'	L84 standard	38105 ²	Not yet available
B	L93 standard	38008 ²	27-1182

¹This L83/L91 standards logic is limited to the A318/A321 because of A319/A321 compatibility issues with previous standards
² Activation of VMO/MMO protection function through hard pin program Mod. n° 38298, SB n° 27-1183

4 | AP disconnection unawareness

With the old FWC standards, the VMO/MMO OVERSPEED aural warning (continuous repetitive chime) may supersede the AP disconnection aural warning (cavalry charge).

The overspeed warning is activated at VMO+4kt or MMO+0.006 i.e. before the activation of the HSP, and hence disconnection of the AP

The following has been reported: upon activation of the VMO/MMO OVERSPEED warning, a crew member had pressed the Master Warning pushbutton, thereby cancelling the AP disconnection aural warning, even though it had not yet been generated (since it was superseded by the overspeed warning). This may lead to situations where the pilots are unaware of the AP disconnection.

Note: AP disconnection will lead as well to the generation of an AUTO FLT AP OFF alert message on the ECAM, which cannot be cleared through the Master Warning pushbutton.

The logics for the cancellation of the VMO/MMO OVERSPEED and AP disconnection warnings are as follows :

- VMO/MMO Overspeed warning cancellation:
 - Whatever the FWC standard, a Continuous Repetitive Chime (CRC) cannot be cleared by an action on the Master Warning P/B.
- AP disconnection caution cancellation:
 - Old FWC standards (H1E2, H2E2):
The Cavalry charge may be cancelled by an action on the Master Warning even if not yet generated (hidden by CRC).
 - Newer FWC standards (H1E3, H2E3, H2E4, H2F2, H2F3):
The cavalry charge can only be cancelled if generated.

5 | Conclusion

In order to avoid significant altitude excursions and AP disconnection unawareness in case of VMO/MMO exceedance, Airbus recommends installation of :

- Standards L84 or L93 of the ELAC
- Standards H1E3 or H2E3, H2E4, H2F2, H2F3 of the FWC.



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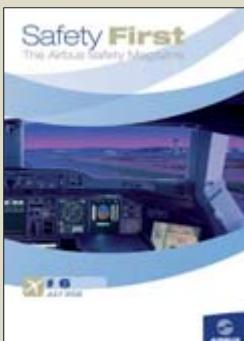
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