



Overspeed event with crew take-over and OEB49 application

While flying at FL380, an A340 aircraft encountered a strong and abrupt tailwind decrease that triggered significant M_{MO} overshoot and overspeed warning.

The crew disconnected the AP, took over and inappropriately applied OEB49 (ADR2 & ADR3 set to OFF).

This article describes this event and presents two main aspects from its analysis: the management of an overspeed situation and the inappropriate OEB49 application.

It details the rationale for the OEB49 (on A330/A340 aircraft) and OEB48 (on A320 family) and their conditions of application. It explains why they must not be trained on simulator and recalls the aircraft modifications allowing to cancel the OEB.

ANALYSIS OF AN EVENT

Event Description

Overspeed in cruise due to a tailwind drop

An A340 aircraft was flying at FL380 with a managed Mach number of 0.82 and a tailwind of around 64 kt. Prior to reaching top of descent, a sudden drop in tailwind of 41 kt in 14 seconds caused a significant airspeed increase and triggered an OVERSPEED warning for 9s despite the thrust reduction commanded by the autothrust (A/THR) (**fig.1**).

Manual AP disconnection with large pitch up sidestick input and selection of a low Mach target

The Captain reacted to the overspeed warning by manually disconnecting the autopilot (AP) and then by applying large pitch up inputs on the side stick. The speedbrakes were not used. The flight crew then selected a Mach number of 0.7, which actually corresponds to an airspeed below V_{LS} . The aircraft consequently started to climb at a pitch rate of up to 5700 ft/min. The speed was decreasing with the thrust at idle in accordance with the selected Mach.

Dual ADR switch OFF : Alternate law, loss of A/THR, protections and FD

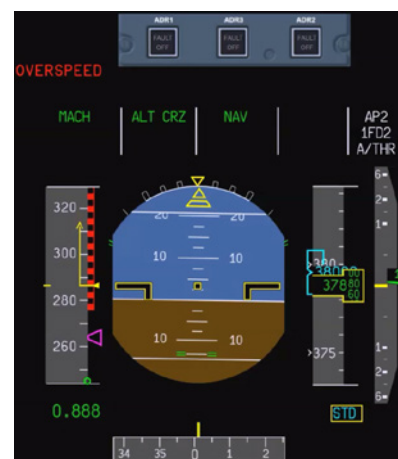
The flight crew erroneously applied the OEB49 procedure and switched off the ADR 2 and ADR 3 about 15 seconds after the autopilot disconnection. This caused the aircraft to revert to Alternate law, with the loss of the FD bars and disconnection of autothrust. As a consequence, the thrust remained at the current value which was still idle at that time (**fig.2**). Indeed the THR LK function at autothrust disconnection maintains the thrust at its current value until the thrust levers are moved again. This is indicated by the associated “**ENG THRUST LOCKED**” ECAM alert that requests to move the thrust levers and the “**THR LOCK**” displayed on the FMA.

32 seconds of climb with idle thrust until reaching STALL warning

After the A/THR disconnection, the thrust levers were not moved for 32 s. During this time, the aircraft therefore continued its climb with the thrust at idle and decreasing speed. While reaching FL399, four successive stall warnings triggered. The crew reacted by applying stall recovery maneuvers and sent a MAYDAY call.

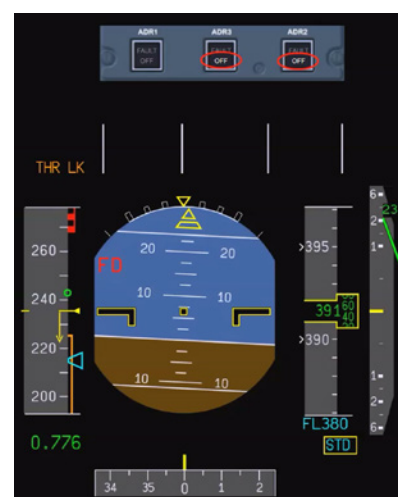
ADRs switched back to ON

The flight crew finally switched ADR2 and ADR3 back to ON. This enabled the flight crew to reengage both the AP and A/THR. The aircraft resumed normal flight and landed without further incident.



(fig.1)

View of the PFD at the time of the overspeed



(fig.2)

View of the PFD after switching off ADR2 and ADR3

“ Autopilot is robust to overspeed situations ”

Flight Data Analysis

Analysis of the flight data highlights two main aspects of this event: the handling of overspeed and the improper application of the OEB49.

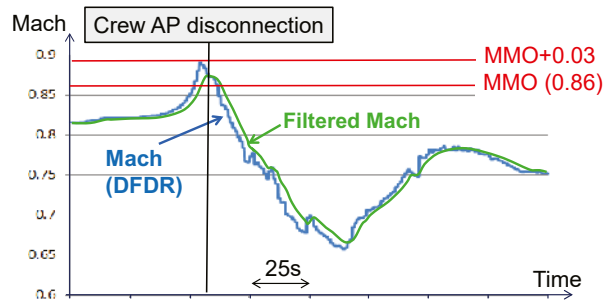
Overspeed handling

During this event, the flight crew disconnected the autopilot following the OVERSPEED warning. However, the autopilot is robust to overspeed situations. The autopilot automatically disconnects only when the filtered Mach becomes higher than $M_{MO} + \text{margin}$ ($M_{MO} + 0.03$ on A330/A340 aircraft). The filtered Mach is a smoothed and slightly delayed Mach which dampens any abrupt variation of the current Mach and makes the autopilot even more robust against automatic disconnection.

Simulations show that if the autopilot had been left engaged, it would have remained engaged during this event (**fig.3**). As a result, the aircraft would have stayed on its trajectory.

(fig.3)

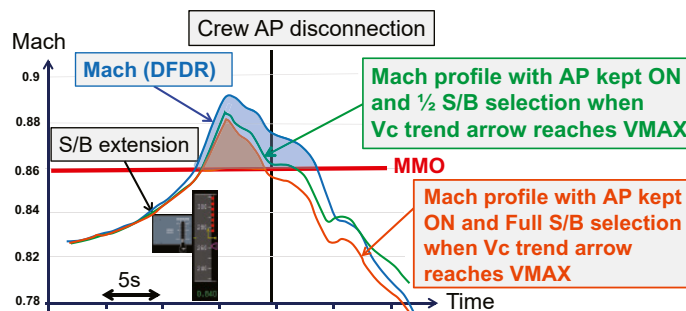
Evolution of the filtered Mach versus the current Mach and versus the autopilot automatic disconnection threshold value ($M_{MO} + 0.03$)



In addition, the use of speedbrakes (S/B) is an efficient way to limit the V_{MO}/M_{MO} overshoot in cruise. This event has been simulated with autopilot kept ON and S/B selection at the time the Vctrend arrow reaches V_{MAX} . The comparison of the event Mach with the Mach resulting from these simulations shows that the use of AP combined with a S/B extension would have minimized the altitude excursion as well as the V_{MAX} overshoot and overshoot duration (**fig.4**).

(fig.4)

Comparison of the recorded Mach evolution with the simulated Mach evolutions if AP was kept ON with the selection of half and full S/B when the Vc trend arrow reached V_{MAX}



For more information on the handling of an overspeed situation in cruise, refer to the Safety first article “Management of overspeed events in cruise”.

Improper application of OEB49

During this event, the flight crew interpreted a rising of the alpha protection strip on the PFD as an entry condition of the “Abnormal V Alpha prot” OEB49 and switched off ADR2 and 3. However, none of the OEB entry conditions were actually encountered. ■

AVOIDING IMPROPER APPLICATION OF OEB48/49

Only 2 cases of improper AOA protection activation occurred since the introduction of Airbus fly-by-wire aircraft 31 years ago.

The first time was in November 2012 on an A330 aircraft after the introduction of conic AOA cover plates. All the conic plates were immediately removed subsequent to this event and the original flat cover plate design type was refitted.

The second event occurred 2 years later on an A321 equipped with the initial AOA flat cover plate design. This is the only case of undue AOA protection activation with this configuration which has accumulated more than 300 Million flight hours.

OEB48 for A320 family and OEB49 for A330/A340 family were however issued at that time to cover the risk of undue activation of AOA protection in case of multiple AOA blockage at a consistent high value.

These OEB request the flight crew to keep only one ADR ON and switch off the other two ADR. This forces reversion to alternate law which will disable flight envelope protections and thus prevent inappropriate activation of the high angle of attack protection.

OEB48/49 entry conditions

OEB48 and OEB49 have two types of entry conditions: one reactive entry and some preventive entries.

These OEB must be applied only if one of the entry conditions has been confirmed, remembering that only the reactive entry condition requires immediate action.

Reactive entry condition for OEB48 and OEB49: Incorrect activation of the AoA Protection

The reactive entry condition is unique, simple and the same for the A320 family, A330 and A340 aircraft (fig.5). The OEB procedure must be immediately applied if the aircraft goes to a continuous nose down pitch rate that cannot be stopped with full backward sidestick inputs while flying at a speed above V_{LS} .

- **AT ANY TIME, with a speed above VLS, if the aircraft goes to a CONTINUOUS NOSE DOWN PITCH RATE that cannot be stopped with backward sidestick inputs, IMMEDIATELY APPLY:**
ONE ADR.....KEEP ON
TWO ADRs.....OFF

Preventive entries based on PFD speedscale monitoring

These OEB also describe “preventive” entry conditions that enable to detect an abnormal overestimation of the **aProt** strip on the PFD, which could lead to an undue activation of the AoA protection later in the flight. The flight crew must confirm that all the parameters of the preventive entry condition are true before applying the OEB.

“ This is the only case of undue AOA protection activation with the flat cover plate configuration which has accumulated more than 300 Million flight hours ”

“ Only the reactive entry condition requires immediate action ”

“ The reactive entry condition is unique, simple and the same for the A320 family, A330 and A340 aircraft ”

(fig.5)

Immediate actions of the OEB48/49 procedure

OPERATIONS

Overspeed Event with Crew Take-over and OEB49 Application

“ The flight crew must confirm that all the parameters of the preventive entry condition are true before applying the OEB ”

(fig.6)

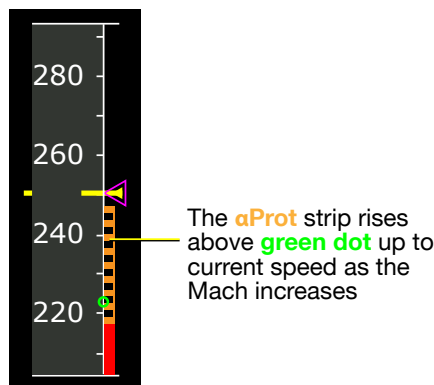
Preventive entry conditions of the OEB49 for A330 and A340 aircraft

The effects on the PFD speedscale differ depending on the aircraft type:

- A330/A340 aircraft (OEB49)

On A330 or A340 aircraft, the preventive entry condition is when the **αProt** strip continuously increases and exceeds Green Dot (GD) speed as the Mach increases in a stabilized wings-level flight path (typically during the climb phase) **(fig.6)**.

In stabilized wings-level flight

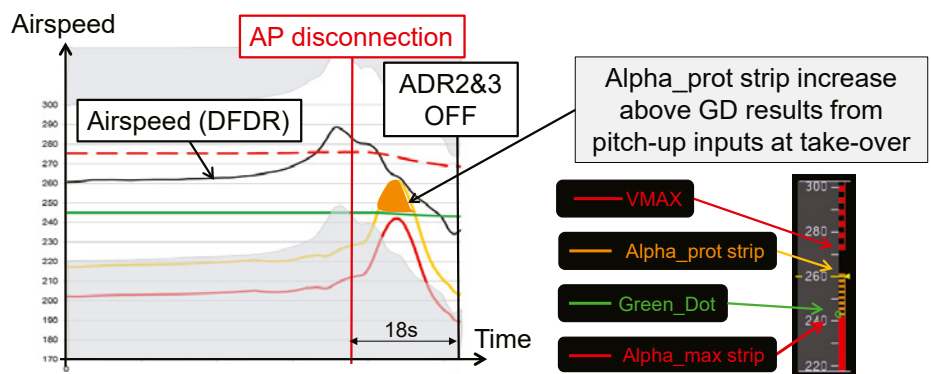


In the event described, the flight crew of the A340 improperly applied OEB49. The **αProt** strip increase above green dot speed did not occur with Mach increasing and in stabilized wings-level flight, but instead resulted from sidestick pitch up inputs **(fig.7)**.

The preventive entry condition of the OEB49 was therefore not fulfilled. The reactive entry was not fulfilled either as the aircraft was climbing when the OEB was applied.

(fig.7)

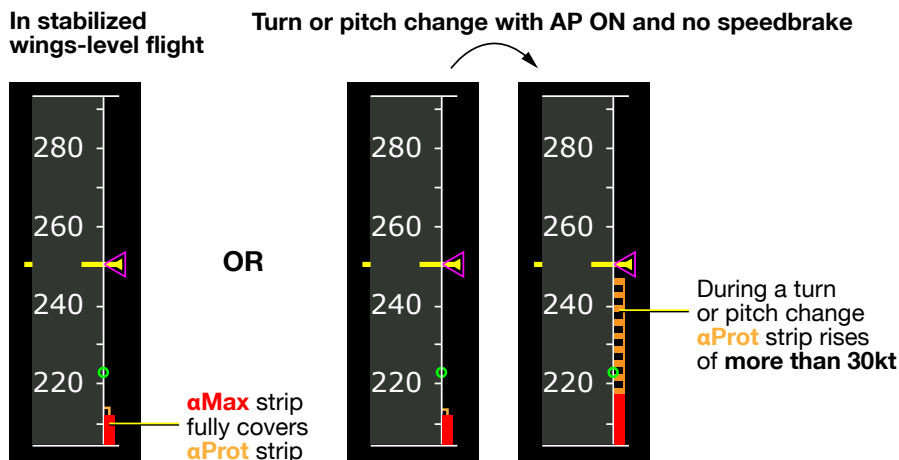
Plot of the recorded airspeed, green dot speed, Valpha prot, Valpha max and Vmax during the event



- A320 family aircraft (OEB48)

On A320 family aircraft, by design, the **αProt** strip is limited by VLS out of g-load conditions, so that an abnormal **αProt** strip increase becomes visible only during manoeuvres (turn or pitch change)

- 1st preventive entry: The **αMax** strip completely hides the **αProt** strip in a stabilized wings-level flight path (without an increase in load factor)
- 2nd preventive entry: With the Auto Pilot (AP) engaged and the speed brakes in the retracted position, the **αProt** strip rapidly moves by more than 30 kt during flight manoeuvres with an increase in load factor, for example turns or pitch variations.



(fig.8)

Preventive entry conditions of the OEB48 for A320 aircraft

No reported cases of proper application of OEB48 or OEB49

No cases of proper OEB48 or OEB49 application have been reported to Airbus since their publication in December 2014. However, there were six cases of improper application of these OEB procedures.

The OEB was applied in one event where the aircraft was already in alternate law when AOA protection is not available.

Two cases were reported on A320 family after a normal 20 kt α Prot strip increase during a turn with autopilot engaged.

Three cases, including the A340 event described, occurred in similar conditions. The OEB was improperly applied in an overspeed context, after take-over with significant pitch-up inputs applied.

Avoid negative training

Improperly applying these OEB in overspeed situations could result from inappropriate training for the following reasons:

The current simulators cannot properly simulate the scenario requiring the application of these OEB. However some operators wrongly use some scenarios such as the dual “TOTAL PITOT BLOCKAGE” to train their pilots to switch off two ADRs following an undue activation of the High Speed Protection. This undoubtedly generates negative training and can impair the pilots’ understanding and trust of the flight envelope protection. The article “The Adverse Effects of Unrealistic Simulator Scenarios” explains why the use of the Dual “TOTAL PITOT BLOCKAGE” scenario in simulators is inappropriate and must not be used.

Ensuring that Flight crews understand the reasons for applying OEB48/49 and knowing their entry conditions is essential. Supporting training material, such as instructional videos, are available on the Airbus World portal. For more information on the material available, refer to Flight Operations Transmission (FOT) 999.0148/14 Rev 01 dated 23-DEC-2014 for A330/A340 aircraft and to FOT 999.0147/14 Rev 01 dated 23-DEC-2014 for A320 family aircraft.

“ The application of these OEB must not be trained in simulator. This is negative training and can impair the pilot’s trust of flight envelope protection ”

“ Supporting training material, such as instructional videos, are available on the Airbus World portal ”

Switching two ADR to OFF has a significant impact on the flight

Switching two ADR to OFF has a significant consequences for the flight, especially in dynamic conditions.

Reversion to ALTERNATE law means the loss of the flight envelope protections including High angle of attack, bank angle and pitch attitude protections. The loss of autopilot and Flight Directors increases the workload of the flight crew. Finally, when the A/THR disconnects the thrust remains at this value as long as the thrust levers are not moved.

The OEB48/49 cancellation fix is available: upgrade your fleet

Two modifications are now available that will cancel OEB48 & OEB49 when implemented on affected aircraft.

These modifications consists in installing at least two Thales AoA probes, which are more robust to potential blockage at high AoA value, and in a software update for the Flight Control Computers.

This software update introduces two additional monitoring functions:

- Reinforced AoA monitoring

Updated monitoring will detect AoA probe blockages including multiple and consistent blockages and will reject the data of the concerned probe(s).

- “AoA protection watchdog” monitoring

This function is an additional independent monitoring that is active at high speeds. It detects inconsistencies between the actual aircraft behavior and the AoA protection activation. In the case of inconsistency, it disables the AoA protection. This independent monitoring would detect undue activation of the AoA protection caused by any possible unforeseen conditions.

Note: These two monitoring functions are already implemented on all A350 and A380 aircraft.

The installation of the probes and of the software update is mandated by Airworthiness Directives on A320 family and A330/A340 aircraft and cancels the OEB48/49.

(fig.9)

Summary of the relevant EASA Airworthiness Directives with their respective compliance date

AIRCRAFT TYPE	SOFTWARE STANDARD	EASA AD	COMPLIANCE DATE (EASA)
A330	FCPC P15 or equivalent	2017-0246R1	25-Dec-18
A340-200/-300	FCPC L25 or L26	2019-0028	21-Nov-19
A340-500/-600	FCPC W14	2019-0028	21-Nov-19
A320	ELAC L97+	2018-0007R1	2-Jun-17
A318/A319/A321	ELAC L99	2018-0007R1	24-Jan-20

AIRCRAFT TYPE	RETROFIT OF AT LEAST 2 THALES AOA PROBES EASA AD	COMPLIANCE DATE (EASA)
A330/A340	2015-0134	31-Mar-17
A318/A319/A320/A321	2015-0135	31-Mar-17

OEB48 & OEB49 must not be applied after the fix

It is the operator's responsibility to remove the OEB from the FCOM and QRH as soon as the corrective modifications are installed on the aircraft and inform flight crews that the OEB is cancelled and its procedure must not be applied anymore. ■

“ Once the OEB is cancelled, it must not be applied anymore ”

CONTRIBUTORS:

Panxika CHARALAMBIDES

Incident/Accident
Investigator
Product Safety

Capt. Gilbert SAVARY

Head of Flight
Operations Support
and Training
Standard pilots group

**With thanks to the A330/A340
Handling qualities and Flight
Control laws Engineering teams**

The «abnormal Valpha prot» OEB48 and OEB49 have been issued following only one event of undue activation of the angle of attack protection in over 300 million flight hours.

No case of proper application of OEB48 or OEB49 has been reported to Airbus since they were published. However, six cases of improper application were reported.

Application of the OEB48/49 must not be trained in simulator since it can't be adequately simulated. Instead, flight crews must understand the full context of these OEB and be able to identify their entry conditions for proper application if required. Supporting training materials on these OEB have been made available to the flight operations division of all Airbus operators. They can still be downloaded from the Airbus World portal.

An improper application of OEB48 and OEB49 may have significant consequences, especially in dynamic flight conditions due to the loss of autopilot, Flight Directors, autothrust and reversion to alternate law with loss of flight envelope protections.

The OEB48 and OEB49 cancellation fix is mandated by Airworthiness Directive and available for both A320 and A330/A340 aircraft families. It is highly recommended to upgrade aircraft as soon as possible with these modifications. Remove the OEB from the documentation as soon as the fix is installed and ensure that flight crews will no longer apply them.

Safety first, #28 June, 2019. Safety first is published by Airbus S.A.S. - 1, rond point Maurice Bellonte - 31707 Blagnac Cedex/France. Publisher and Editor: Yannick Malinge, Chief Product Safety Officer. Concept Design by Airbus Multi Media Studio 20190588. Reference: X00D16031905 Issue 28. Photos by Airbus.

This brochure is printed on Stucco.

This paper is produced in factories that are accredited EMAS and certified ISO 9001-14001, PEFC™ and FSC®CoC. It is produced using pulp that has been whitened without either chlorine or acid. The paper is entirely recyclable and is produced from trees grown in sustainable forest resources.

The printing inks use organic pigments or minerals. There is no use of basic dyes or dangerous metals from the cadmium, lead, mercury or hexavalent chromium group.

© Airbus S.A.S. 2019 – All rights reserved.
Proprietary documents.

By taking delivery of this Brochure (hereafter "Brochure"), you accept on behalf of your company to comply with the following guidelines:

» No other intellectual property rights are granted by the delivery of this Brochure than the right to read it, for the sole purpose of information.

» This Brochure and its content shall not be modified and its illustrations and photos shall not be reproduced without prior written consent of Airbus.

» This Brochure and the materials it contains shall not, in whole or in part, be sold, rented, or licensed to any third party subject to payment.

This Brochure contains sensitive information that is correct at the time of going to press.

This information involves a number of factors that could change over time, effecting the true public representation. Airbus assumes no obligation to update any information contained in this document or with respect to the information described herein.

Airbus S.A.S. shall assume no liability for any damage in connection with the use of this Brochure and of the materials it contains, even if Airbus S.A.S. has been advised of the likelihood of such damages.

Safety first

The Airbus magazine contributing to the enhancement of the safety of aircraft operations by increasing knowledge and communication on safety related topics.

Safety first is published by the Product Safety department. It is a source of specialist safety information for the use of airlines who fly and maintain Airbus aircraft. It is also distributed to other selected organizations and is available on digital devices.

Material for publication is obtained from multiple sources and includes selected information from the Airbus Flight Safety Confidential Reporting System, incident and accident investigation reports, system tests and flight tests. Material is also obtained from sources within the airline industry, studies and reports from government agencies and other aviation sources.

All articles in Safety first are presented for information only and are not intended to replace ICAO guidelines, standards or recommended practices, operator-mandated requirements or technical orders. The contents do not supersede any requirements mandated by the State of Registry of the Operator's aircraft or supersede or amend any Airbus type-specific AFM, AMM, FCOM, MMEL documentation or any other approved documentation.

Articles may be reprinted without permission, except where copyright source is indicated, but with acknowledgement to Airbus. Where Airbus is not the author, the contents of the article do not necessarily reflect the views of Airbus, neither do they indicate Company policy.

Contributions, comment and feedback are welcome. Enquiries related to this publication should be addressed to:

Airbus
Product Safety department (GS)
1, rond point Maurice Bellonte
31707 Blagnac Cedex - France
Fax: +33(0)5 61 93 44 29
safetycommunication@airbus.com

Safety first app available here

