Safety first

The Airbus Safety **Magazine**

Edition January 2011

CONTENT:

Issue **11**

AIRBUS

Safety First

The Airbus Safety Magazine
For the enhancement of safe flight through increased knowledge and communications

Safety First is published by the Flight Safety Department of Airbus. It is a source of specialist safety information for the restricted use of flight and ground crew members who fly and maintain Airbus aircraft. It is also distributed to other selected organisations.

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, MEL 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. For technical reasons the editors may be required to make editorial changes to manuscripts, however every effort will be made to preserve the intended meaning of the original. Enquiries related to this publication should be addressed to:

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

A380
Water pool test

Safety First, #11 January 2011. Safety First is published by Airbus S.A.S.. 1, rond point Maurice Bellonte. 31707 Blagnac Cedex/ France. Editor: Yannick Malinge, Chief Product Safety Officer, Nils Fayaud, Director Product Safety Information. Concept Design by Airbus Multi Media Support Ref. 20101536. Computer Graphic by Quat'coul. Copyright: GSn°420.0190/10. Photos copyright Airbus. Photos by ExM Company: H. Berenger, P. Masclet, H. Goussé. Printed in France by Airbus Print Centre.

Yannick MALINGE
Chief Product Safety Officer

Editorial

For those of you who knew Yves Benoist, it is my sad duty to inform you that Yves passed away suddenly, at the end of December.

Yves held the position of Vice-President Flight Safety at Airbus for 16 years, before retiring in 2004.

Throughout my time working with him, he passed on three main lessons: investigations require rigor, thorough technical understanding and patience. These lessons remain valid today, despite the greater challenge imposed by today's environment.

In addition to this, Yves stressed the importance of the dissemination of information and sharing of lessons learnt. This led him, in 1994, to launch the annual Airbus Flight Safety Conference as well as the Airbus Safety Magazine, Hangar Flying (now Safety First), which are still today the most visible part of Yves' heritage.

Our thoughts at this time are with Yves' family. I have no doubt you will join me in appreciation of his remarkable achievements.

Today, our challenge is to build upon Yves' legacy.

Let me wish you a happy new year, to you and your family.

Yannick MALINGE
Chief Product Safety Officer

Contents

The Airbus Safety Magazine

Nils FAYAUD
Director Product Safety Information

Information

Magazine distribution

If you wish to subscribe to Safety First, please fill out the subscription form that you will find at the end of this issue.

Please note that the paper copies will only be forwarded to professional addresses.

Your articles

As already said, this magazine is a tool to help share information.

We would appreciate articles from operators, that we can pass to other operators through the magazine.

If you have any inputs then please contact Nils Fayaud at:

e-mail : nils.fayaud@airbus.com
fax : +33 (0) 5 61 93 44 29

Safety Information on the Airbus websites

On the AirbusWorld website we are building up more safety information for you to use.

The present and previous issues of Safety First can be accessed to in the Flight Operations Community- Safety and Operational Materials chapter-, at **https://w3.airbusworld.com**

Other safety and operational expertise publications, like the Getting to Grips with…brochures, e-briefings etc…are regularly released as well in the Flight Operations Community at the above site.

If you do not yet have access rights, please contact your IT administrator.

Flight Safety
Hotline: +33 (0)6 29 80 86 66
E-mail: account.safety@airbus.com

News

SAVE THE DATE

17th Flight safety conference
Rome, 21-24 March 2011

Following the successful event in Brussels, in March of this year, we are pleased to announce that the 17th Flight Safety Conference will take place in Rome, Italy, from 21st to 24th of March 2011.

The Flight Safety Conference provides an excellent forum for the exchange of information between Airbus and customers. The event is a dedicated forum for all Airbus operators. We do not accept outside parties. This ensures that we can have an open dialogue to promote flight safety across the fleet.

The formal invitations with information regarding registration and logistics and the preliminary agenda have been sent to our customers in December 2010.

As always we welcome presentations from you, the conference is a forum for everybody to share information. If you have something you believe will benefit other operators and/or Airbus or need additional invitations or information, please contact Nuria Soler at:
e-mail: nuria.soler@airbus.com
fax: +33 (0) 5 61 93 44 29

Jacques ROSAY
VP Chief Test Pilot

What is stall? How a pilot should react in front of a stall situation

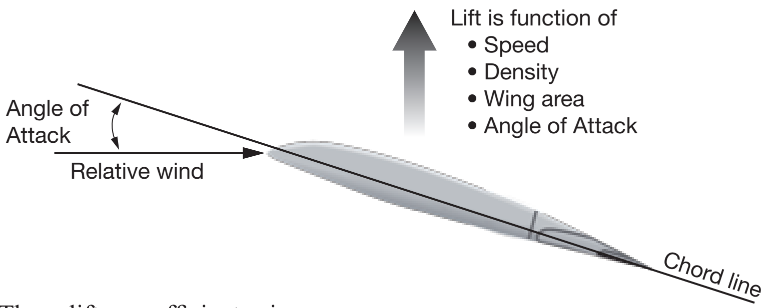
1. Introduction

The worldwide air transport fleet has recently encountered a number of stall events, which indicate that this phenomenon may not be properly understood and managed in the aviation community. As a consequence, the main aircraft manufacturers have agreed together to amend their stall procedures and to reinforce the training. A working group gathering Authorities and aircraft manufacturers will publish recommendations for harmonized procedures and appropriate training. This article aims at reminding the aerodynamic phenomenon associated to the stall, and the recently published new procedures.

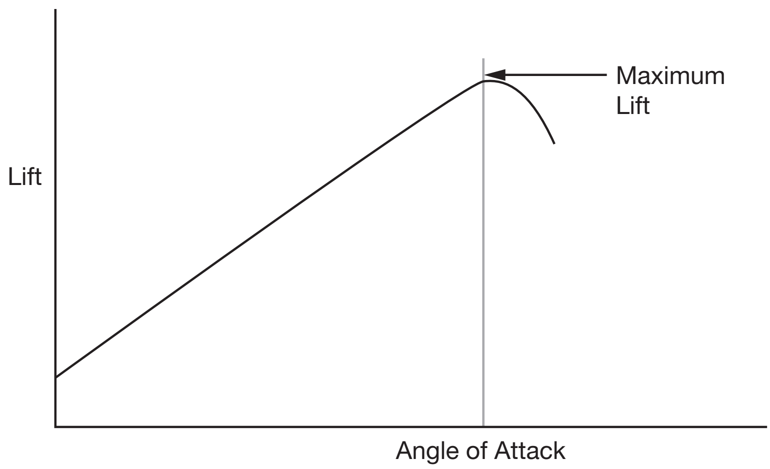
2. The lift

A wing generates a lift equal to $1/2 \rho S V^2 Cl$.

With:
ρ = air density
S = wing surface reference
V = True Air Speed
Cl = lift coefficient of the wing



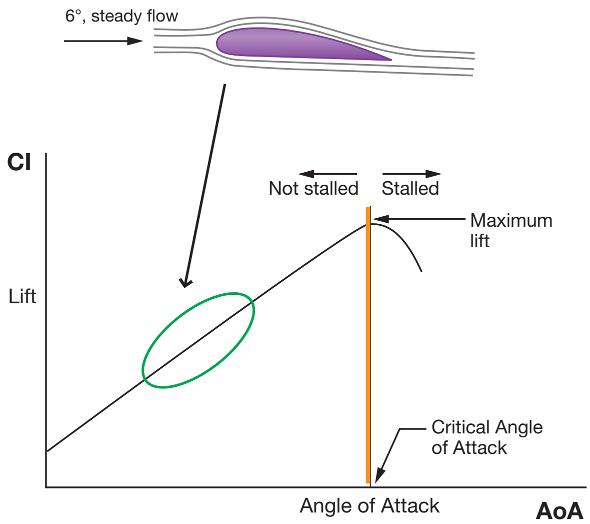
The lift coefficient increases as a function of the Angle of Attack (AoA) up to a value, called Maximum lift, where it starts to decrease.



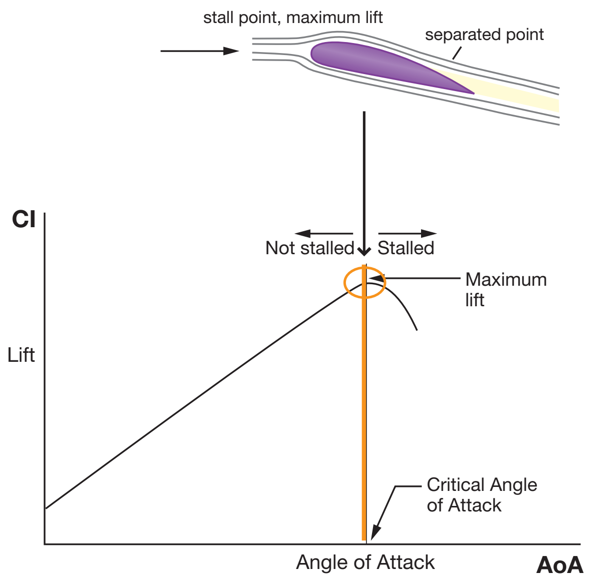
For a given configuration, a given speed and a given altitude, the lift is only linked to the AoA.

3. The stall phenomenon

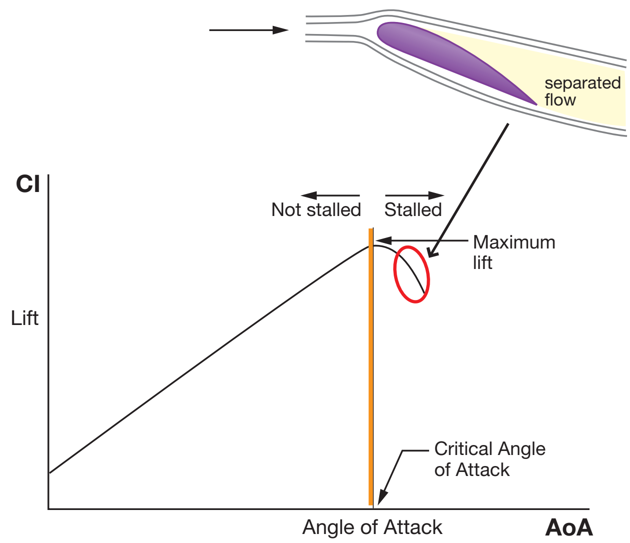
The linear part of the curve corresponds to a steady airflow around the wing.



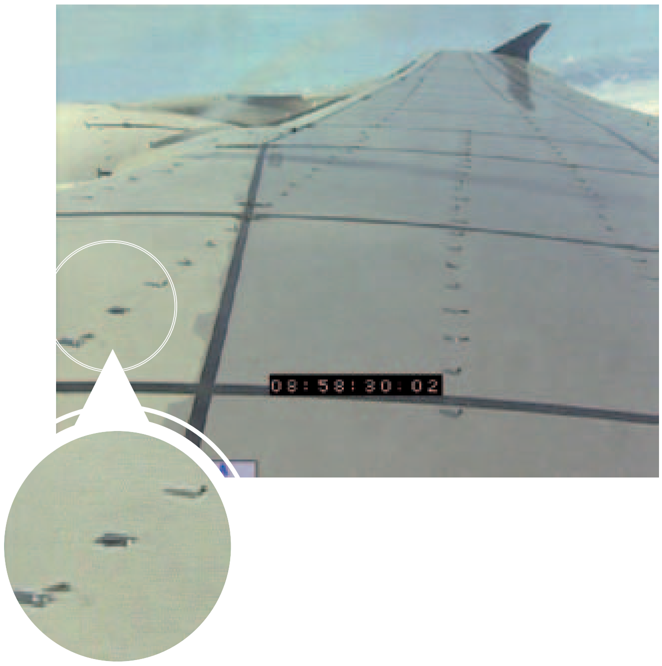
When the AoA reaches the value of the maximum Cl, the airflow starts to separate.



Beyond this point, the lift decreases as the flow is separated from the wing profile. The wing is stalled.



On this picture (extracted from a video footage), the erratic positions of the flow cones on this A380 wing during a stall test show that the flow is separated.



4. Some important things to remember about the stall

► For a given configuration and at a given Mach number, a wing stalls at a given Angle of Attack (AoA) called AoA STALL. When the Mach number increases, the value of the AoA STALL decreases.

► When approaching the AoA STALL, the wing generates a certain level of buffeting, which tends to increase in level at high Mach number.

► When the AoA increases and approaches the AoA STALL, in certain cases, a phenomenon of pitch up occurs as a result of a change in the distribution of the lift along the wingspan. The effect of the pitch up is a self-tendency of the aircraft to increase its Angle of Attack without further inputs on the elevators. Generally, for a given wing, this phenomenon occurs at a lower Angle of Attack and is more prominent when the Mach number is higher.

► The only mean to counter the pitch up is to apply a nose down elevator input.

► When the aerodynamic flow on the wing is stalled, the only possible mean to recover a normal flow regime is to decrease the AoA at a value lower than the AoA STALL.

► Stall is an AoA problem only. It is NOT directly a speed issue.

Knowing those two last characteristics is absolutely paramount, as they dictate the only possible way to get out of a stall.

Figure 1
In NORMAL LAW, the EFCS limits the AoA to a value lower than AoA STALL

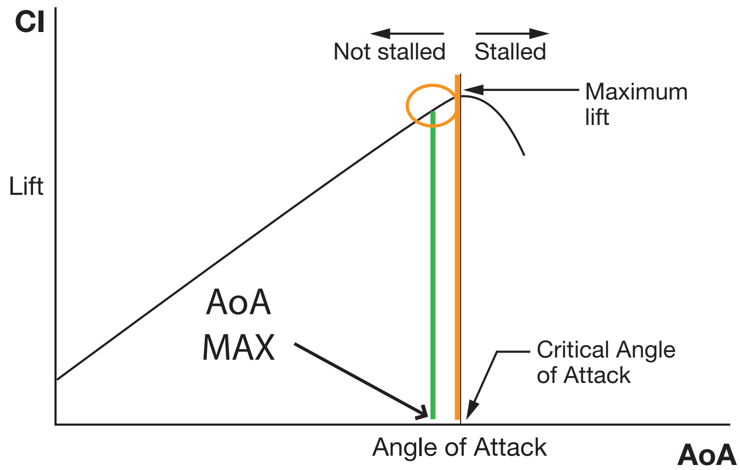
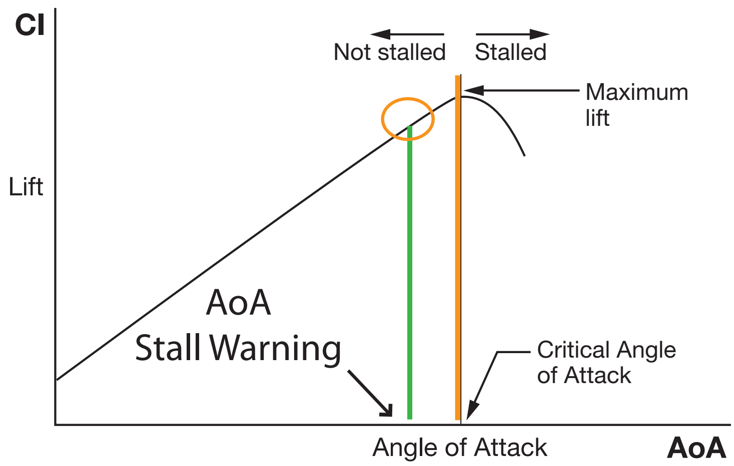


Figure 2
In ALTERNATE and DIRECT LAW, the aural Stall Warning is set at a value lower than AoA STALL



5. Protections against the stall in NORMAL LAW on FBW aircraft

In NORMAL LAW, the Electronic Flight Controls System (EFCS) takes into account the actual AoA and limits it to a value (AoA MAX) lower than AoA STALL (fig. 1).

The EFCS adjusts the AoA MAX limitation to account for the reduction of the AoA STALL with increasing Mach number.

Equally, for a given Mach number and a given AoA, the EFCS takes into account the natural pitch up effect of the wing for this Mach number and this AoA, and applies on the elevators the appropriate longitudinal pre-command to counter its effect.

6. Protections against the stall in ALTERNATE and DIRECT LAW on FBW and conventional aircraft

On FBW aircraft, following certain malfunctions, in particular in case of sensor or computer failure, the flight controls cannot ensure the protections against the stall. Depending on the nature of the failure, they revert to ALTERNATE LAW or to DIRECT LAW.

In both cases, the pilot has to ensure the protection against the stall, based upon the aural Stall Warning (SW), or a strong buffeting which, if encountered, is an indication of an incipient stall condition.

The conventional aircraft are permanently in DIRECT LAW, and regarding the stall protection, they are in the same situation as the FBW aircraft in DIRECT LAW.

In both ALTERNATE and DIRECT LAW, the aural SW is set at a value called AoA Stall Warning (AoA SW), which is lower than the AoA STALL (fig. 2).

The triggering of the Stall Warning just means that the AoA has reached the AoA SW, which is by definition lower than the AoA STALL, and that the AoA has to be reduced.

Knowing what the SW is, there is no reason to overreact to its triggering. It is absolutely essential for the pilots to know that the onset of the aural Stall Warning does not mean that the aircraft is stalling, that there is no reason to be scared, and that just a gentle and smooth reaction is needed.

The value of the AoA SW depends on the Mach number. At high Mach number, the AoA SW is set at a value such that the warning occurs just before encountering the pitch up effect and the buffeting.

If the anemometric information used to set the AoA SW is erroneous, the SW will not sound at the proper AoA. In that case, as mentioned above, the clue indicating the approach of the stall is the strong buffeting. In the remainder of this document, for this situation, "SW" must be read as "strong buffeting".

7. Margin to the Stall Warning in cruise at high Mach number and high altitude

Typically, in cruise at high Mach number and high altitude, at or close to the maximum recommended FL, there is a small margin between the actual cruise AoA and the AoA STALL. Hence, in ALTERNATE or DIRECT LAW, the margin with the AoA SW is even smaller.

The encounter of turbulence induces quick variations of the AoA. As a consequence, when the aircraft is flying close to the maximum recommended altitude, it is not unlikely that turbulence might induce temporary peaks of AoA going beyond the value of the AoA SW leading to intermittent onsets of aural SW.

Equally, in similar high FL cruise conditions, in particular at turbulence speed, if the pilot makes significant longitudinal inputs, it is not unlikely that it reaches the AoA SW value.

For those reasons, when in ALTERNATE or DIRECT LAW, it is recommended to fly at a cruise flight level lower than the maximum recommended. A 4,000 ft margin is to be considered. Then, for the same cruise Mach number, the IAS will be higher, the AoA will be lower, and therefore the AoA margin towards AoA SW will be significantly increased.

In addition, as in RVSM space the use of the AP is mandatory, any failures leading to the loss of the AP mandates to descend below the RVSM vertical limit.

8. Stall Warning and stall

The traditional approach to stall training consisted in a controlled deceleration to the Stall Warning, followed by a power recovery with minimum altitude loss.

Experience shows that if the pilot is determined to maintain the altitude, this procedure may lead to the stall.

A practical exercise done in flight in DIRECT LAW on an A340-600 and well reproduced in the simulator consists in performing a low altitude level flight deceleration at idle until the SW is triggered, and then to push the THR levers to TOGA while continuing to pull on the stick in order to maintain the altitude.

The results of such a manoeuvre are:

► In clean configuration, even if the pilot reacts immediately to the SW by commanding TOGA, when the thrust actually reaches TOGA (20 seconds later), the aircraft stalls.

► In approach configuration, if the pilot reacts immediately to the SW, the aircraft reaches AoA stall -2°.

► In approach configuration, if the pilot reacts with a delay of 2 seconds to the SW, the aircraft stalls.

This shows that increasing the thrust at the SW in order to increase the speed and hence to decrease the AOA is not the proper reaction in many cases (this will be developed in the following chapter).

In addition, it is to be noticed that, at high altitude, the effect of the thrust increase on the speed rise is very slow, so that the phenomenom described above for the clean configuration is exacerbated.

Obviously, such a procedure leads to potentially unrecoverable situations if it is applied once the aircraft has reached the aerodynamic stall (see next chapter).

Even if the traditional procedure can work in certain conditions if the pilot reacts immediately to the SW, or if he is not too adamant on keeping the altitude, the major issue comes from the fact that once the Stall Warning threshold has been crossed, it is difficult to know if the aircraft is still approaching to stall or already stalled. Difference between an approach to stall and an actual stall is not easy to determine, even for specialists.

Several accidents happened where the "approach to stall" procedure was applied when the aircraft was actually stalled.

For those reasons, the pilots should react the same way for both "approach to stall" and "stall" situations.

9. How to react

What is paramount is to decrease the AoA. This is obtained directly by decreasing the pitch order.

The pitch control is a direct AoA command (fig. 3).

The AoA decrease may be obtained indirectly by increasing the speed, but adding thrust in order to increase the speed leads to an initial adverse longitudinal effect, which trends to increase further the AoA (fig. 4).

It is important to know that if such a thrust increase was applied when the aircraft is already stalled, the longitudinal effect would bring the aircraft further into the stall, to a situation possibly unrecoverable.

Conversely, the first effect of reducing the thrust is to reduce the AoA (fig. 5).

Figure 3
Pitch control is a direct AoA command

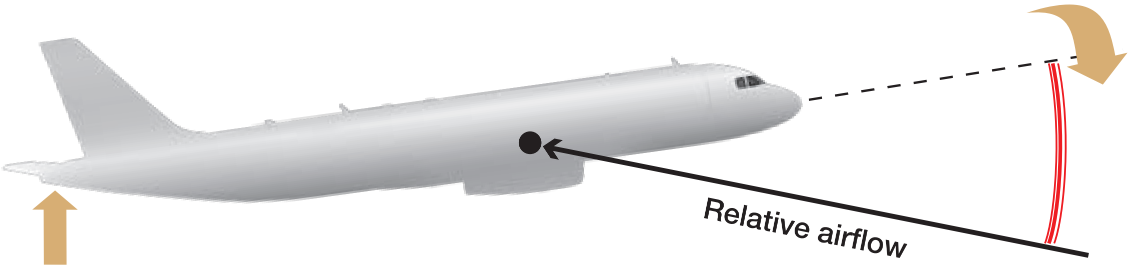


Figure 4
Adding thrust leads to an increase in AoA

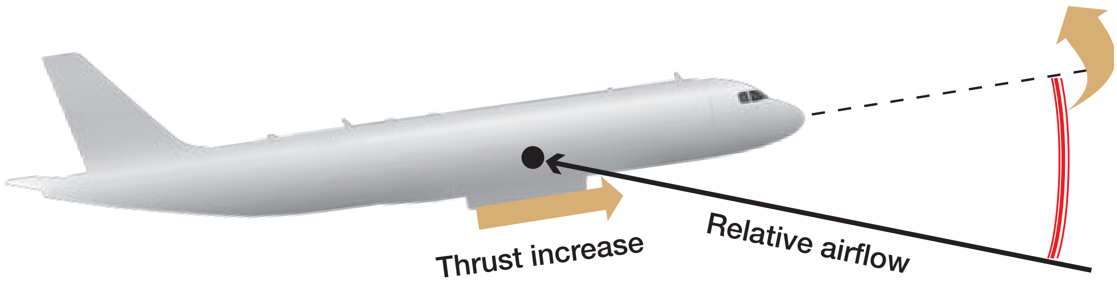
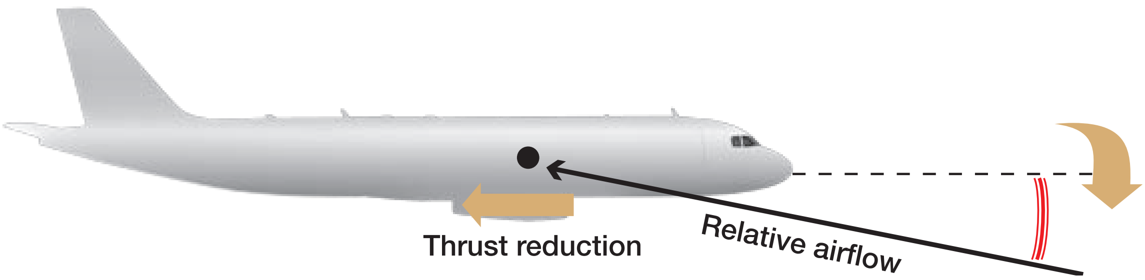


Figure 5
Reducing thrust leads to a decrease in AoA



In summary:

FIRST: The AoA MUST BE REDUCED. If anything, release the back pressure on stick or column and apply a nose down pitch input until out of stall (no longer have stall indications). In certain cases, an action in the same direction on the longitudinal trim may be needed. Don't forget that thrust has an adverse effect on AoA for aircraft with engines below the wings.

SECOND: When the stall clues have disappeared, increase the speed if needed. Progressively increase the thrust with care, due to the thrust pitch effect.

In practice, in straight flight without stick input, the first reaction when the SW is triggered should be to gently push on the stick so as to decrease the pitch attitude by about two or three degrees in order to decrease the AoA below the AoA SW.

During manoeuvres, the reduction of the AoA is generally obtained just by releasing the backpressure on the stick; applying a progressive forward stick inputs ensures a quicker reduction of the AoA.

If the SW situation occurs with high thrust, in addition to the stick reaction, reducing the thrust may be necessary.

10. Procedure

As an answer to the stall situation, a working group gathering the FAA and the main aircraft manufacturers, including Airbus, ATR, Boeing, Bombardier and Embraer, have established a new generic procedure titled "**Stall Warning or Aerodynamic Stall Recovery Procedure**" applicable to all aircraft types.

This generic procedure will be published as an annex to the FAA AC 120.

This new procedure has been established in the following spirit:

- One single procedure to cover ALL stall conditions
- Get rid of TOGA as first action
- Focus on AoA reduction.

Generic Stall Warning or Aerodynamic Stall Recovery Procedure

Immediately do the following at the first indication of stall (buffet, stick shaker, stick pusher, or aural or visual indication) during any flight phases *except at lift off*.

1. Autopilot and autothrottle............................ Disconnect

Rationale: While maintaining the attitude of the aircraft, disconnect the autopilot and autothrottle. Ensure the pitch attitude does not change adversely when disconnecting the autopilot. This may be very important in mis-trim situations. Manual control is essential to recovery in all situations. Leaving one or the other connected may result in in-advertent changes or adjustments that may not be easily recognized or appropriate, especially during high workload situations.

2. a) Nose down pitch control… Apply until out of stall (no longer have stall indications)

b) Nose down pitch trim................................. As needed

Rationale: a) The priority is reducing the angle of attack.

There have been numerous situations where flight crews did not prioritize this and instead prioritized power and maintaining altitude. This will also address autopilot induced full back trim.

b) If the control column does not provide the needed response, stabilizer trim may be necessary. However, excessive use of trim can aggravate the condition, or may result in loss of control or in high structural loads.

3. Bank.. Wings Level

Rationale: This orientates the lift vector for recovery.

4. Thrust... As Needed

Rationale: During a stall recovery, many times maximum power is not needed. When stalling, the thrust can be at idle or at high thrust, typically at high altitude. Therefore, the thrust is to be adjusted accordingly during the recovery. For engines installed below the wing, applying maximum thrust can create a strong nose up pitching moment, if speed is low. For aircraft with engines mounted above the wings, thrust application creates a helpful pitch down tendency. For propeller driven aircraft, thrust application energizes the air flow around the wing, assisting in stall recovery.

5. Speed Brakes... Retract

Rationale: This will improve lift and stall margin.

6. Bank.. Wings Level

Rationale: Apply gentle action for recovery to avoid secondary stalls then return to desired flight path.

Revision of Airbus' Operational documentation

Airbus has updated its operational documentation in order to reflect the changes introduced by the new generic stall recovery procedures. In order to allow simultaneous fleetwide introduction, the procedure was provided via Temporary Revision.
This information was provided together with an FCTM update advance copy and FOT 999.0044/10, on May 12, 2010.

A300:
A300 FCOM volume 8GE Temporary Revision number 219-1
A300 FCOM volume 8PW Temporary Revision number 051-1
A300 QRH Temporary Revision number 076-1

A300FFCC:
A300FFCC FCOM volume 2 Temporary Revision number 052-1
A300FFCC QRH Temporary Revision number 025-1

A300-600/A300-600F:
A300-600/A300-600F FCOM volume 2 Temporary Revision number 002-2
A300-600/A300-600F QRH Temporary Revision number 217-1

A310:
A310 FCOM volume 2 Temporary Revision number 004-2
A310 QRH Temporary Revision number 224-1

A318/319/320/321:
FCOM volume 3 Temporary Revision number 323-1
QRH Temporary Revision number 727-1

A330:
FCOM volume 3 Temporary Revision number 552-1
QRH Temporary Revision number 353-1

A340:
FCOM volume 3 Temporary Revision number 512-1 (A340-200/-300)
FCOM volume 3 Temporary Revision number 513-1 (A340-500/-600)
QRH Temporary Revision number 369-1

A380:
FCOM Procedures / Non-ECAM Abnormal and Emergency Procedures / Operating Techniques

Claude LELAIE
Special Advisor to CEO

Minimum control speed tests on A380

When the aircraft has an engine shut down with the 3 others at maximum thrust, it has a tendency to yaw toward the "failed" engine. The pilot can deflect the rudder and create a yaw moment in the other direction in order to maintain the heading. However, when the speed is decreasing the engines create more or less the same yaw, but the aerodynamic efficiency of the fin and the rudder are reducing. At a given speed, with wings level, the rudder is on the stop and just able to counter the effect of the engines. Then, we could say that we have reached some kind of minimum control speed as it is a limit of manoeuvrability.

On any multi-engine aircraft, below the Minimum Control speeds (VMC), there is a risk of losing the control of the plane in the case of failure of one engine (outer for a quad) with the other(s) at maximum thrust. There are several VMC: for takeoff configurations, it is called VMCA (A for Airborne), for approach, VMCL (L for Landing). On a quad, another one, VMCL-2, is associated with the failure of 2 engines on the same side, in the approach configuration. It has to be demonstrated for certification, although this last situation is mainly considered when taking off for a ferry flight on 3 engines, without passengers, and if unfortunately a failure happens on the other engine of the same side. Finally, there is a VMC covering the case of the ground acceleration at takeoff. It is called VMCG (G for Ground).

Everything is not black and white and it is not because the aircraft is flying below a VMC that control will always be lost or that a crash will inevitably occur. But what is sure is that, when reaching the VMC, the pilot is on a limit of manoeuvrability and he cannot do what he wants freely in a manoeuvring sense. Some rules of determination of the VMCs are rather strange, and it is difficult to understand which logic is behind that. Nevertheless they have been applied for a very long time and their validity has been proven by the long experience on a huge number of flight hours on all aircraft types. For all VMC airborne, there is first a static demonstration of the value, followed by dynamic tests to show that the manoeuvrability remains sufficient at this speed. VMCG is obtained only by a dynamic exercise.

By nature, determinations of VMCA and VMCL are risky flight tests, as one engine is shut down at very low altitude. On a twin, the failure of the "live" engine gives just enough time to relight the other one. On a quad, the situation is different, as in the event of the loss of the other engine on the same side as the "failed" one, the thrust on the remaining engines must be reduced immediately to avoid a loss of control.

However, the risk of failure of another engine during these tests has a very low probability. The critical issue is the execution of the dynamic tests, as it can lead very quickly to a loss of control, due to the rapid build up of side slip. Such an event occurred a very long time ago in a test flight, but fortunately control was immediately recovered and then modifications were made to the flight controls to reduce drastically this risk. Anyway, we have to be very cautious in the execution of these tests and they are only performed by well experienced test pilots.

Measurement of VMCs is not a key priority at the beginning of the development of a long range aircraft. The reason is that all these speeds are rather low and therefore do not affect takeoff and landing performances, except for operations at very low weights. This is not penalizing for an aircraft like the A380. However, it is always useful to perform some measurements at an early stage of the flight program to be sure that we will not have a bad surprise, which might have an impact on performances at higher weight than expected or could necessitate a modification of the design of the flight controls.

For the A380, we had an issue to start these tests as, during the first month of flights, we discovered that the vertical fin had to be modified. Due to the delay necessary for this modification, it was decided to postpone VMCs determination by several weeks, until we receive the improved fin.

Figure 1
VMCA determination

1. VMCA, VMCL, VMCL-2

When engines and systems are configured, we start about 20 kt above the predicted value, then, we decelerate slowly keeping heading constant. Necessary rudder increases as the speed decreases, eventually up to the stop. Further deceleration will need some bank to still keep the heading constant. The "true" VMCA is obtained when the bank angle reaches 5° in the opposite sense to the "failed" engine (fig. 1). This bank angle is very important as it allows a further speed reduction of about 5 to 10 kt, compared to the same test performed with wings levelled. Where is this strange rule coming from? It is a mystery! Maybe that, in the old times, when reliable flight test installations where not existing, somebody had imagined to have some tolerance on the bank angle, because it is true that a perfect stabilization of the bank angle is difficult when the rudder is on the stop. In doing so, he put some knots "in his pocket"! Then the tradition has been kept and officialised. This hypothesis could explain the choice of this odd 5° value.

The tests to obtain VMCL and VMCL-2 are similar.

But there is more to do. A demonstration that the roll manoeuvrability at VMC is sufficient must be performed. The rules are slightly different for VMCA and VMCL and here we will just show one example for the VMCL. At this speed, the rolling capacity is reduced on the side of the deflection of the rudder (at the opposite of the "failed" engine). The rule is that it must be possible to go from 5° bank angle on the side of the rudder deflection, up to 25° in less than 5 seconds. Whatever the type of aircraft, there are risks in this test as the side slip is building up very quickly, because it cannot be compensated by the yaw damper, the rudder being already on the stop. When passing 25° bank, the recovery must be immediate and very smooth, with the engines reduced to idle, the speed increased and the side slip carefully minimized. At the very beginning of the Fly By Wire programs, there was plenty of roll capability at low speed. But in order to avoid reaching too high side slip, the roll rate commanded by the pilot was divided by 2 to be limited at 7.5 deg/s at low speed when the flight controls computers detect a large asymmetry in thrust. This roll rate allows this test to be passed with almost no margin. The available roll efficiency to react to turbulence is not modified.

There are some other specific dynamic tests at VMCA, but the demonstration is straightforward for our aircraft.

The first VMCA and VMCL test flight on A380 were performed at the end of May 2006, unfortunately in weather conditions not ideal for these types of measurements. Some days later, with better weather, a second flight allowed us to confirm the results and also to perform VMCL-2 tests. A third and final flight was dedicated to certification. Usually, on other programs, all these tests are performed directly with the Authorities on board. However, due to some particularities of the aircraft, the decision was made to perform preliminary flights to be sure that there was no issue with what was going to be presented for certification.

There was no surprise coming from these flights and the VMCA, VMCL and VMCL-2 values were found to be as expected.

2. VMCG

The VMCG is established with a dynamic test. The aircraft is accelerated with all engines at maximum thrust, with the nose wheel steering disconnected to simulate a wet or contaminated runway. At a given speed, the outer engine is shut down with the master lever. The pilot must try to minimize the lateral excursion, using the rudder (fig. 2). As for the VMCA, at high speed a small deflection is needed. But at low speed, even with full rudder, there could be a significant deviation. By definition, the VMCG is the shut down speed for which the deviation is 30 ft.

This test must be performed in perfect weather conditions, because even a very light cross wind or some small turbulence can have an impact on the results. Generally the flight test is planned at sunrise. The first test is usually not critical, as the shut down speed is about 10 kt above the planned VMCG. Then some more trials are performed with a progressive reduction of the shut down speed, by steps of 3, 2 or even 1 kt, depending on the results. Most of the time, after about 6 tests, the 30 ft deviation is reached.

In fact, we try to have at least one result above 30 ft to be able to interpolate back to the VMCG, but we have to be careful as around VMCG, the lateral deviation is very sensitive to the engine cut-off speed.

During this series of tests, the pilot in the left hand seat is in charge of the trajectory. He tries to minimize the deviation and then completes the takeoff when the maximum deviation has been reached. The pilot in the right hand seat shuts down the engine at the planned value.

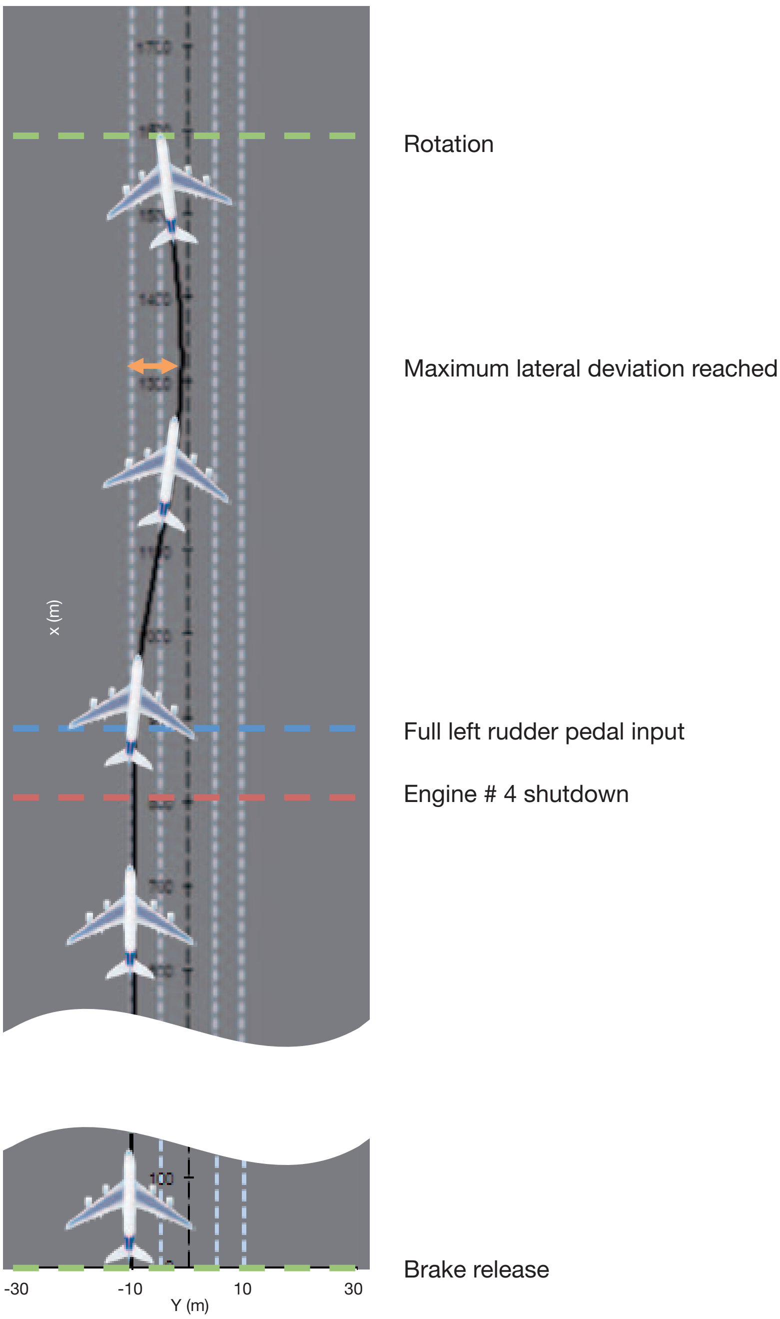


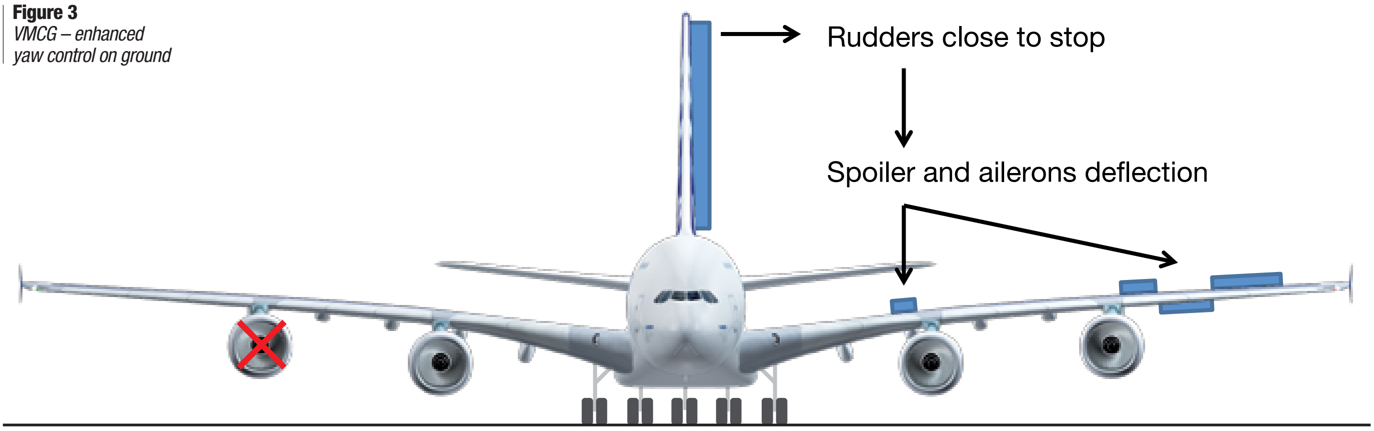
Figure 2
VMCG test

It is important to have always the same pilot doing the same action as, if there is a bias in the shut down speed, it is most probably going to be the same for all tests and the speed decrease is going to be as progressive as planned. Data reduction will then allow the analysis team to determine the right value. In the cockpit, on the jump seat, a test flight engineer monitors the engines and is in charge of the specific relight procedures generally given by the engine Manufacturers, following such shut downs at maximum thrust.

As for the VMCA, most of the time, these tests are directly used for certification, with an EASA pilot in the left hand seat and an Airbus pilot on the right. One of the reasons for minimising the number of times these tests are done, is that repeating several shut downs at maximum thrust is damaging for an engine and we try to reduce this risk. However, for the A380, due to numerous new systems features and some uncertainties on the predictions, we decided to perform a first evaluation ourselves. The initial results demonstrated that we were right.

The first VMCG flight could only be performed after the installation of the modified fin and it took place on March 30th 2006. Takeoff weight was 450 tons, configuration 3 and the predicted VMCG was 122 kt. As usual, we decided to perform the first test with the engine shut down at 132 kt, 10 kt above the predicted value. It was planned to “fail” the right outer engine, therefore we lined up the aircraft 10 meters on the left of the centre line. To help, we have on one of the Toulouse runways, full length blue lines at 5 and 10 meters on each side. This makes it easier for the handling pilot to keep precisely the distance from the centre line during the acceleration. The right engine was shut down at 132 kt as planned. At a speed about 10 kt above the VMCG, the deviation should not exceed 2 meters, but we had a surprise as the aircraft started to skid laterally and we eventually reached

Figure 3
VMCG – enhanced yaw control on ground



a deviation of 15 meters and we went on the other side of the centre line. A good demonstration that it was a sound idea to take some precautions and line up 10 meters on the left, as if we were already at the VMCG! An extrapolation let us think that the VMCG was probably at least 13 kt above the estimated value, which would have had serious adverse consequences for aircraft performance.

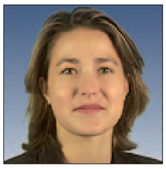
We landed immediately and decided to redo the test at a slightly higher speed: 134 kt. A new surprise: the deviation was almost the same, just a bit smaller. The videos were showing the tyres of the main landing gears skidding on the runway. A third test was performed at 136 kt. The deviation was 18 meters. It was increasing with the speed! Clearly, something was abnormal.

The following day, in order to understand the reasons of this strange behaviour, we tried again, but this time with a configuration 1+F instead of 3. With a lower flaps setting, we were expecting higher forces on the landing gears, which should have improved friction and therefore reduce skidding. We shut down the engine at 135 kt and the deviation reached 18 meters. Basically, no change! On top, we discovered an anomaly: because of a hidden failure, the deflection of one of the 2 rudders was too slow. Only one servo control of this rudder was active, instead of 2 in this type of situation. This was not the main reason for the huge deviation, but the system was not robust. A batch of modifications was needed before continuing VMCG tests.

To improve the situation, it was necessary to enhance the efficiency of the flight controls in yaw after an engine failure. Therefore, in order to create some additional yaw, the solution was to increase the drag on the wing which is on the side of the deflected rudders when they are close to their stop. For that, one spoiler and 2 of the 3 ailerons were fully deflected in the upper direction while the centre aileron was put down (fig. 3). Having ailerons in different directions permitted to minimize the effect on the bank angle. Some modifications were also made in the computers, allowing faster deflection of rudders in this specific situation.

Due to weather conditions, we performed the tests with all these modifications at Istres Air Base on June 14th with excellent results: the VMCG was now as planned, around 122 kt. However the exact value was finally determined during the certification flight at the beginning of September. The reason is that the value of the VMCG is very sensitive to the pilot reaction time. This one is around 0.6 seconds, but 0.1 second more or less can modify the VMCG by 1 or 2 kt. The official value is given by the tests performed by the certification pilot from EASA. The final value agreed after data reduction for the Rolls Royce engines is 119 or 121 kt, depending upon the maximum engine thrust (option chosen by the Customers), which is slightly less than the planned figures.


Marc BAILLION
Flight Safety Director


Lorraine DE BAUDUS
Group Manager A318/A319/A320/A321
Operational Standards, Customer Services

Radio Altimeter erroneous values

1. Introduction

In-service events occurred where a Radio Altimeter (RA) provided an erroneous height indication, which was recognized as valid information by the aircraft systems. This resulted in an early flare activation during the approach.

In response to these events, Airbus launched a series of investigation that led to the following conclusions:
in the most critical scenario, an early activation of the flare law may lead to an increase of the Angle of Attack which, if not corrected, could reach the stall value. All Airbus aircraft are affected except the A380.

As a result of these investigations, Airbus published:

► A set of Operator Information Telex/Flight Operations Telex (OIT/FOT) and Red Operations Engineering Bulletins (OEB) describing the operational consequences, and containing recommendations to follow, should a RA provide erroneous height readings.

► New tasks in the Trouble Shooting Manual (TSM) and Maintenance Planning Document (MPD) related to the RA antennas and coaxial cables.

Erroneous RA occurrences should be systematically reported so as to allow proper implementation of the recommended maintenance tasks. These consist in the inspection of the RA antennas coaxial cables, cleaning of the antennas and possibly replacement of the RA.

Design improvements are currently under development on the Radio Altimeter as well as on other aircraft systems, in order to better detect RA errors and to avoid untimely flare engagement.

2. System architecture

All Airbus aircraft, except the A380, are equipped with two RAs, which provide height information to several aircraft systems (fig. 1).

The A380 is fitted with three RAs, which provide the aircraft's systems with a single median height value. As a result of this system architecture, a single erroneous RA height indication is not an issue for the A380.

This article will therefore concentrate on the other members of Airbus' family of aircraft, fitted with two Radio Altimeters.

These two RAs provide height information to the Auto Pilots (AP), Auto Thrust (A/THR), Primary Flight Displays (PFD)/ Navigation Displays (ND), Weather Radar (WXR), Flight Warning Computers (FWC), Traffic Alert and Collision Avoidance System (TCAS) and all audio indicators.

Height information is received from one RA at a time. In case of detected failure, the remaining RA is used as a back-up.

The following systems are designed to receive an RA signal from only a single source:

► On all aircraft models the Terrain Awareness and Warning System (TAWS) receives signals from RA1 only.

► On the A300B2/B4, A300-600 and A310, the Auto Pilot/ Flight Director use only their on-side RA.

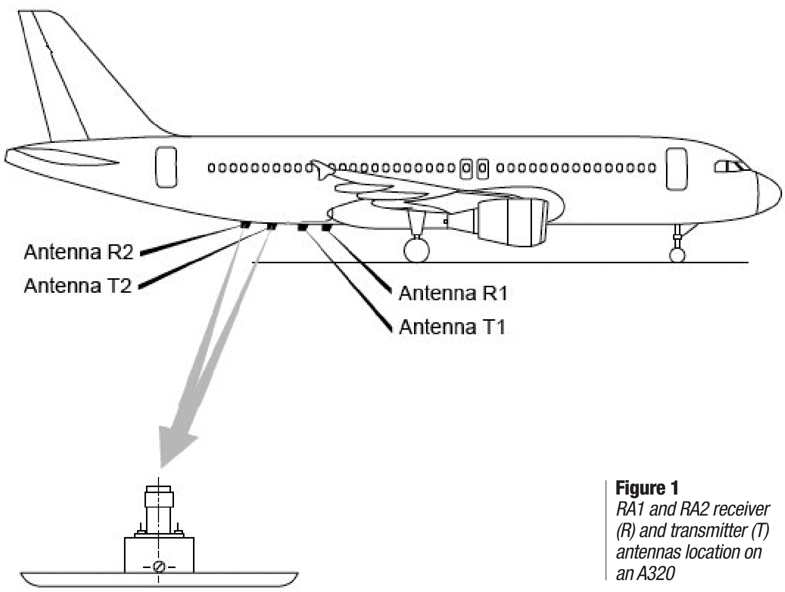


Figure 1
RA1 and RA2 receiver (R) and transmitter (T) antennas location on an A320

3. Typical cause of erroneous RA height indications

In-service experience has shown that a Radio Altimeter may provide erroneous height indications due to a direct link between the transmitter and the receiver antennas, without ground reflection. This can be related to causes that are either internal or external to the RA system.

The internal causes may be linked to:

► Water flow on the antennas, e.g. due to a defective drain valve.

► Water ingress into the RA antenna installation affecting the antennas, and potentially the coaxial cables.

► Carbon dirt or ice accretion on the antennas.

► Degraded installation at connectors level.

The external causes may be linked to aircraft flying over:

► Other aircraft, hail clouds or bright spots, i.e. terrain presenting reflectivity variations.

► Runways contaminated with water or snow.

In these cases, the RA condition may not be detected by the systems, which continue to use the erroneous RA values. A value of -6ft has been observed in a number of events.

4. Operational consequences and recommendations

An erroneous RA height indication may have effects on the:

► Primary Flight Displays (PFD)

► Systems Displays (SD)

► Warnings and callouts

► Auto Flight System mode changes

► Aircraft protections, such as the unavailability of the High Angle of Attack Auto Pilot disconnection.

The two following examples illustrate possible effects of an erroneous RA indication on an A320 Family/A330/A340 aircraft:

a) Indication lower than real height on RA1 during an ILS approach, with both APs/FDs engaged:

► Figure 2 shows the crew's PFDs before the RA1 issue. Both RAs function properly and provide the same height of 1 960 ft. The vertical mode is on G/S, and the lateral mode is on LOC. The A/THR is engaged in SPEED.

► Figure 3 RA 1 provides an erroneous height indication of – 6 ft, while RA 2 delivers the correct height of 1 400 ft.

Consequences on the aircraft's systems:

► RA 1 provides height information to PFD 1, AP 1 and to the A/THR (the A/THR uses the same RA as the master AP).

Therefore:

- The RA reading on PFD 1 is – 6 ft
- AP 1 engages in FLARE mode and PFD 1 displays "FLARE" on the FMA
- The A/THR engages in RETARD mode and displays "THR IDLE" on the FMA of PFD 1 and PFD 2.

Figure 2
Both RAs provide correct height of 1 960 ft

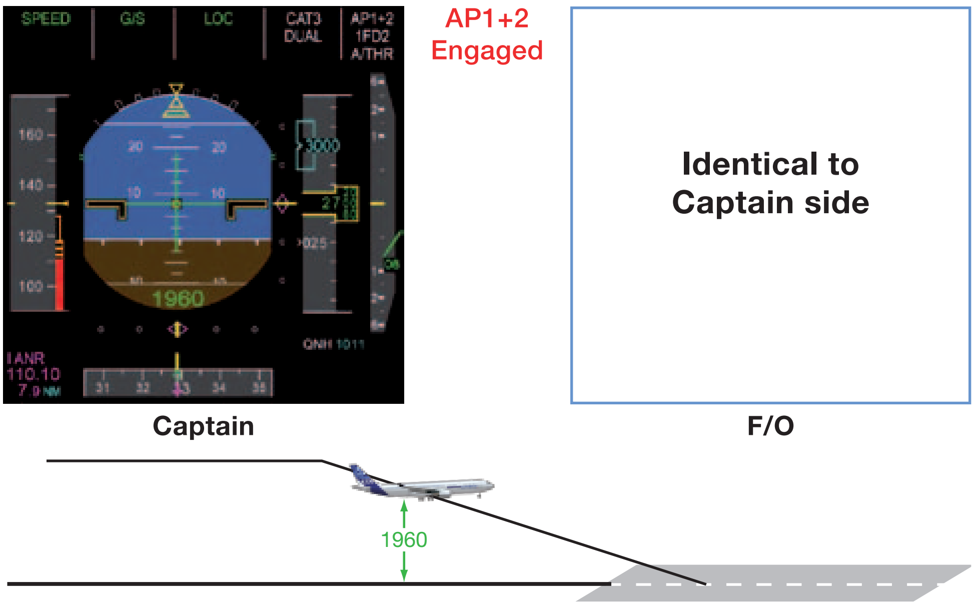
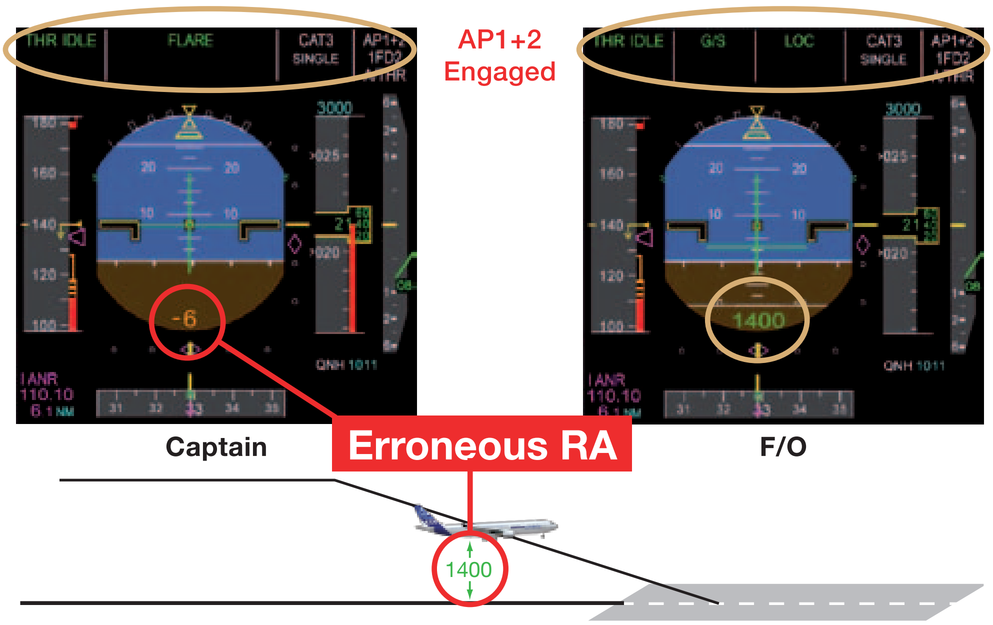


Figure 3
Erroneous RA 1 reading is – 6 ft, correct RA 2 reading is 1 400 ft. Both AP/FDs are engaged



► RA 2 provides height information to PFD 2 and to AP 2.

Therefore:

- The RA reading on PFD 2 is 1 400 ft
- AP 2 is still engaged in G/S vertical mode and LOC lateral mode. PFD 2 therefore displays “G/S” and “LOC” on the FMA.

► AP 1 is engaged in FLARE mode and one RA height goes below 200 feet. In addition, the difference between both RA height indications is greater than 15 feet.

Therefore:

- The AUTOLAND warning lights are activated.

Figure 4
Both RAs provide correct height of 1 960 ft

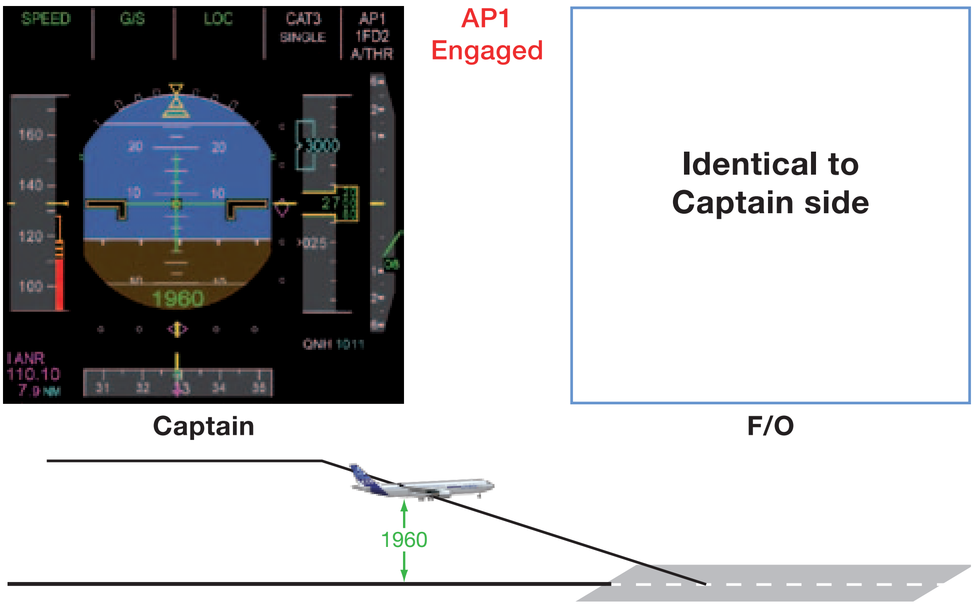
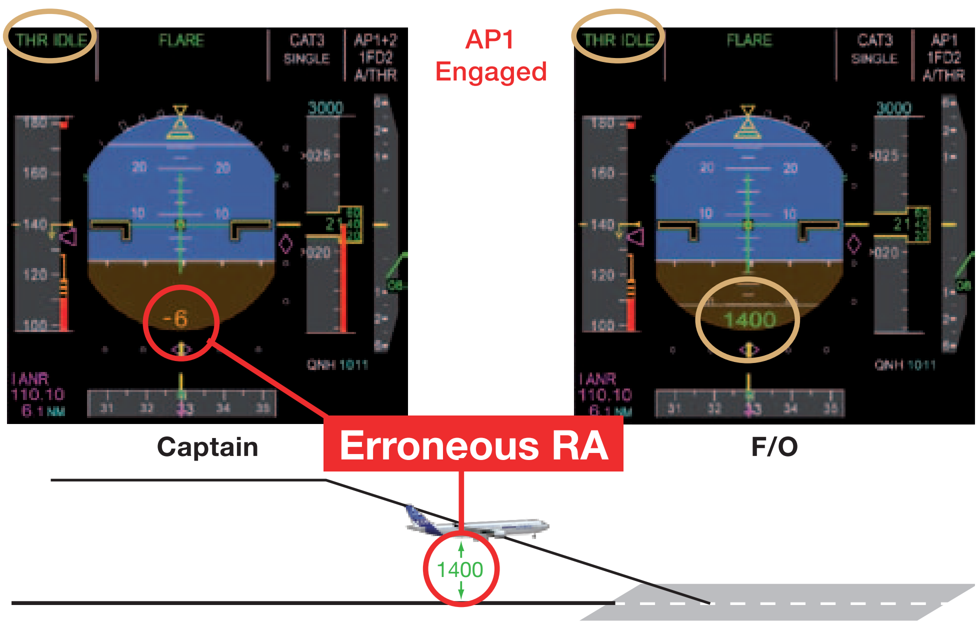


Figure 5
Erroneous RA 1 reading is – 6 ft, correct RA 2 reading is 1 400 ft. AP 1 and both FDs are engaged



b) Indication lower than real height on RA1 during an ILS approach, with AP 1 and both FDs engaged:

► Figure 4 shows the crew’s PFDs before the RA1 issue. Both RAs function properly and provide the same height of 1 960 ft. The vertical mode is on G/S, and the lateral mode is on LOC. The A/THR is engaged in SPEED.

► Figure 5 shows that RA 1 provides an erroneous height indication of – 6 ft, while RA 2 delivers the correct height of 1 400 ft.

Consequences on the aircraft’s systems:

► RA 1 provides height information to PFD 1, AP 1 and to the A/THR (the A/THR uses the same RA as the master AP).

Therefore:

- The RA reading on PFD 1 is – 6 ft
- AP 1 engages in FLARE mode and displays “FLARE” on the FMAs of PFD 1 and PFD 2.
- The A/THR engages in RETARD mode and displays “THR IDLE” on the FMAs of PFD 1 and PFD 2.

► RA 2 provides height information to PFD 2.

Therefore:

- The RA reading on PFD 2 is 1 400 ft.

► AP 1 is engaged in FLARE mode and one RA height goes below 200 feet. In addition, the difference between both RA height indications is greater than 15 feet.

Therefore:

- The AUTOLAND warning lights are activated.

In the examples above, the risk of early flare engagement due to the too low height indication is compounded by the possible impact on the aircraft protections. On the A320 Family, for example, the CONF FULL High Angle of Attack Auto Pilot disconnection is not available in the event of a very low erroneous RA height indication.

Therefore, if a manual takeover is not performed when this early flare engagement occurs, the Angle Of Attack will increase and may reach the stall value.

The detailed effects on aircraft protection on the A300/A310, A320 and A330/A340 families can be found in the OIT / FOT and OEB referenced at the end of this article. These documents include as well the following operational recommendations in the event of an erroneous RA height reading:

- During all phases of flight, the flight crew must monitor and crosscheck all primary flight parameters and FMA indications.
- During ILS (or MLS, GLS) approach with AP engaged, in the event of an unexpected THR IDLE and FLARE modes engagement, the flight crew must immediately react as follows:
  - **Immediately perform an automatic Go Around** (thrust levers set in TOGA),

  Or

  - **Immediately disconnect the AP**, then continue the landing using raw data or visual references (FDs set to OFF) or, perform a manual Go Around with thrust levers set to TOGA (significant longitudinal sidestick input may be required).

See OEB for detailed procedures

Several symptoms may assist the crew in identifying a potential erroneous RA reading:

- Untimely ECAM L/G NOT DOWN warnings
- Untimely or no “RETARD” callout
- Interruption of, or no RA automatic callout
- Untimely TAWS alert (“PULL UP” or “TERRAIN AHEAD”)
- Impossible NAV mode engagement after takeoff
- Pulsing Cabin Differential Pressure Advisory on ECAM CAB PRESS page.

In addition to the above cockpit indications, RA fault messages from the Electrical Flight Control System (EFCS) may also be recorded in the Post Flight Record.

The Flight crews must report any of the above symptoms in the aircraft technical logbook, in order to ensure no dispatch with an erroneous RA.

5. Maintenance recommendations

If the flight crews report symptoms of an erroneous RA height indication, the following maintenance actions should be performed:

- Clean the RA antennas and the adjacent area with cleaning agents (Material N° 11.010) and a lint free cloth
- If, during any subsequent flight, the symptoms persist:
  - Replace the RA antennas
  - Inspect the RA antennas coaxial cables. If they are not in correct conditions, repair or replace them.

These recommendations have been added in the following new TSM tasks:

- 34-42-00-810-844 (A320 Family)
- 34-42-00-810-862 (A330/A340)
- 34-42-00-006-00 (A300/A310).

In addition, scheduled maintenance (MPD) include new tasks related to the RA:

- Every 6 months: RA antenna surface cleaning
- Every 12 years: replacement of RA antennas and RA coaxial cables during the heavy maintenance visit for the structure section.

6. Design Improvements

The following improvements are being implemented in the RA system as well as in the aircraft systems which use the RA information:

- RA system:
  - A new gel gasket, between the antenna and the aircraft structure, will provide better isolation against water ingress.
  - A digital RA, with self monitoring capability to eliminate the erroneous heights, is under certification.
- Aircraft systems:
  - Both the Auto Pilot and flight control systems will be enhanced to detect most RA erroneous height values.

7. Conclusion

The aircraft systems may not always detect an erroneous Radio Altimeter value. Depending on the flight phase and AP/FD and A/THR status, prompt action from the crew may be required to prevent the consequences of such situation.

It is essential that the crew identifies the symptoms of an erroneous RA reading so as to:

- Take immediate actions.
- Report these symptoms to help maintenance teams troubleshoot erroneous RA readings.

References:

OIT/FOT SE 999.0034/09 dated 4th May 2009 for A320/A330/A340 operators

- A318/A319/A320/A321: RED OEB 201/2
- A330: RED OEB 076/2
- A340: RED OEB 091/2

OIT/FOT SE 999.0035/09 dated 30th April 2009 for A300/A310 operators (no RED OEB as the operational consequences are different than for the A320/A330/A340).

The OIT/FOTs and OEBs are not applicable to the A380.


Stéphane GRANGER
A320 Family Autoflight System Manager
Design Office


Eric JEANPIERRE
System Manager
A320 Family Program

Automatic NAV engagement at Go Around

1. Introduction

Whatever the reasons to perform a Go Around, the need has arisen for an automatic engagement of Navigation (NAV) mode.

To meet this increasing interest, an operational enhancement called "NAV in Go Around" has been developed by Airbus.

This article presents the operational context, and the solution proposed with its advantages.

2. Operational context

2.1. Go Around options

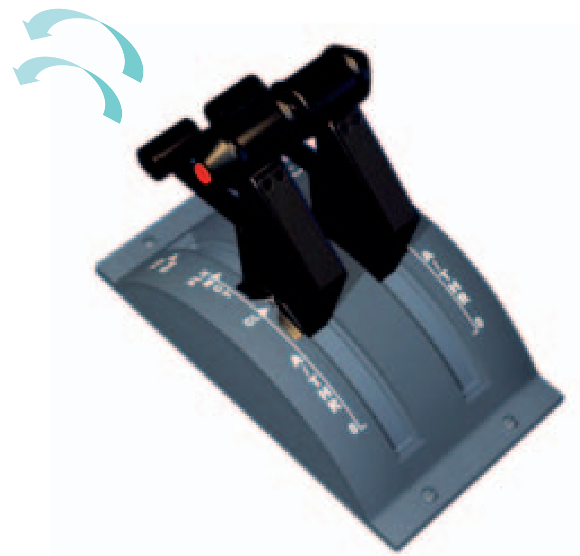
The crew must always be prepared for a Go Around, even though it is an infrequent occurrence.

After the initiation of a Go Around, there are two options:

- In the most probable one, the crew follows the published Missed Approach procedure.
- Otherwise, if cleared by ATC, the crew follows a constant heading. The heading target can be preset by the crew during the approach.

2.1. Current Go Around procedure

The Go Around is systematically initiated by pushing the thrust levers to TOGA.



This ensures the engagement of the Go Around Track (GA TRK) Auto Pilot and/or Flight Director lateral mode[1].

The FMS entered published Missed Approach procedure becomes part of the ACTIVE F-PLN and the previously flown approach is strung back into the F-PLN at the end of the Missed Approach procedure.

The GA TRK mode guides the aircraft on a constant track (which is the current track when the Go Around is initiated with wings level).

Once the Go Around is initiated, the crew will likely fly the published Missed Approach procedure: the Pilot Flying (PF) or the Pilot Non Flying (PNF) will have to engage the NAV mode by pushing the HDG/TRK selector on the Flight Control Unit (FCU).

Therefore, in the most probable Go Around scenario, the crew will perform two main actions (as far as the Autoflight system is concerned):

- Push the thrust levers to TOGA
- Push the HDG/TRK selector.

2.2. Objectives of the modification

The modification reduces the crew workload, and limits the potential deviations from the required flight path when performing a Go Around.

It covers the most probable Go Around scenario, where the crew has to follow the published Missed Approach procedure. Moreover, it makes the Go Around procedure as similar as possible to the Take Off procedure.

Finally, in the context of RNP-AR operations where the aircraft is more likely to be in a turn, it will not interrupt the turn in case of a Go Around.

1: As well as the Speed Reference System (SRS) Auto Pilot and/or Flight Director longitudinal mode, if the aircraft is not in a clean configuration.

3. Principle of the modification

The principle is to keep the NAV mode engaged or, if a valid flight plan exists, to arm the NAV mode at the initiation of the Go Around. The pilot does not need to push the FCU selector anymore: the new logics do it automatically.

The Auto Flight System automatically follows the published Missed Approach procedure.

The AP/FD modes engaged are identical to the modes that would have been engaged by pushing on the FCU "HGD-TRK" selector immediately after the Go Around:

- In a non-precision approach with managed lateral guidance (NAV, APP NAV or FINAL APP), the NAV mode is kept engaged.
- In a non-precision approach with selected lateral guidance (HDG or TRK), the HDG or TRK mode is kept engaged and the NAV mode is automatically armed (if a valid flight plan exists).
- In a precision approach (ILS, MLS or GLS) or in a FLS / Mixed LOC-VNAV approach, the GA TRK mode is initially engaged (as currently) and the NAV mode is automatically armed (if a valid flight plan exists and if no heading preset has been selected during the approach).

In other words, the AP/FD mode engagement sequence is strictly the same as when the pilot pushes the thrust levers to TOGA and pushes the HDG/TRK FCU selector.

The "NAV in Go Around" modification does not modify the aircraft behaviour on the longitudinal axis.

4. Typical operational scenarios

Go Arounds during Precision Approaches are typically performed when visibility conditions are not met at the Decision Altitude/Height (DA/DH). The Standard Operating Procedures specify that a Go Around is performed by setting both thrust levers to TOGA.

The following table illustrates the reduction in workload introduced by the "NAV in Go Around" modification.

Without
"NAV in Go Around" modification

TOGA thrust is applied
and the SRS / GA TRK modes are engaged.

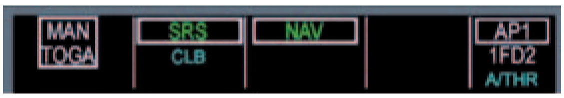
The crew has to arm the NAV mode manually
by pushing on the FCU HDG/TRK knob.

Then, the FMA displays the NAV mode.

With
"NAV in GO Around" modification

When TOGA thrust is applied,
the SRS / GA TRK modes are engaged.
In addition, the NAV mode is automatically armed
without any crew action on the FCU.

The NAV mode engages immediately (or as soon as the aircraft
passes above 100ft if the Go Around has been initiated below 100 ft).



The aircraft is guided along the Missed Approach procedure.

The "NAV in Go Around" modification does not change operational procedures in the following scenarios:

► **Go Around in Heading mode with a heading preset**

When cleared by ATC to follow a constant heading in case of Missed Approach, the crew may preset the heading on the FCU. If a Go Around is initiated, the NAV mode is not automatically armed (priority is given to the preset). The crew will then just have to pull the FCU HDG/TRK knob to engage the Heading mode.

► **Go Around in Heading mode without heading preset**

In case of a late clearance from ATC to follow a constant heading after the Go Around (no heading preset), the crew will have to turn the FCU HDG/TRK knob to select the heading target then pull to engage the Heading mode. In this case, the NAV mode is automatically armed then engaged at Go Around until the pull action on the FCU.

5. CONCLUSION

With the "NAV in Go Around" modification, the NAV mode is automatically armed at the initiation of the Go Around[2]. The mode will then engage as soon as the capture conditions are met.

This modification reduces the crew workload, and limits the potential deviations from the required flight path, when performing a Go Around.

The new logics are consistent with the most probable Missed Approach scenario and are essential for specific operations such as low RNP.

2 : If no heading preset.

Impact on aircraft and associated MOD and SB

For the A320 Family, A330/A340 and A380, the activation of the function requires the following:

► The hardware pin programming of each FMG(E)C or software pin programming of each PRIM computers, and if required, the upgrade of the flight guidance or PRIM software.

► The update of volumes: 1.22.30, 3.03.2, 4.05.80. of the Flight Crew Operating Manual (FCOM).

Aircraft type	MOD Number	SB reference	FMG(E)C or PRIM minimum standards
A320 Family	38399	22-1296	P1I11 (MOD 37311) or S4I11 (MOD 37252) for A320 IAE/PW Family P1C12 (MOD 37934) or S4C12 (MOD 37935) for A320 CFM Family
A330/ A340	200383	Pending FMGEC certification	P4HJ1 (MOD 57545) or T4HJ1 (MOD 57547) for A330 PW/RR P4G1 (for 57544) or T4G1 (MOD 57548) for A330 GE P4F1 (MOD 57546) or T4F1 (MOD 57549) for A340-200/300 P4K2 or T4K2 (MOD To Be Defined) for A340-600
A380	Under development		

A320 Family

The "NAV in Go Around" modification will become the production standard starting from:
A318: MSN 4169
A319: MSN 4522
A320: MSN 4674
A321: MSN 4560

It will also be included in the low RNP modification packages (MOD 38073 Low RNP step2+, MOD 150371 / 150372 / 150373 Low RNP step 3 and MOD 151180 RNP 0.3 AR).

A330/A340

The "NAV in Go Around" modification will become the production standard, MSN to be confirmed.

It will also be included in the low RNP modification packages (MOD 200192 Low RNP step 2 for FMS R1A Thales on the A330 and new MODS RNP step 2 for FMS R1A Honeywell on the A330 and A340-500/600).

A380

The "NAV in Go Around" modification will become the production standard, MSN to be confirmed.

Articles published in previous Safety First issues

Issue 10, August 2010

– A380: Flutter tests
– Operational Landing Distances: A new standard for in-flight landing distance assessment
– Go Around handling
– A320: Landing gear downlock
– Situation awareness and decision making

Issue 9, February 2010

– A320 Family: Evolution of ground spoiler logic
– Incorrect pitch trim setting at takeoff
– Technical Flight Familiarization
– Oxygen safety

Issue 8, July 2009

– The Runway Overrun Prevention System
– The Take Off Securing function
– Computer mixability: An important function
– Fuel spills during refueling operations

Issue 7, February 2009

– Airbus AP/FD TCAS mode: A new step towards safety improvement
– Braking system cross connections
– Upset Recovery Training Aid, Revision 2
– Fuel pumps left in OFF position
– A320: Avoiding dual bleed loss

Issue 6, July 2008

– A320: Runway overrun
– FCTL check after EFCS reset on ground
– A320: Possible consequence of VMO/MMO exceedance
– A320: Prevention of tailstrikes
– Low fuel situation awareness
– Rudder pedal jam
– Why do certain AMM tasks require equipment resets ?
– Slide/raft improvement
– Cabin attendant falling through the avionics bay access panel in cockpit

Issue 5, December 2007

– New CFIT event during Non Precision Approach
– A320: Tail strike at takeoff ?
– Unreliable speed
– Compliance to operational procedures
– The future air navigation system FANS B

Issue 4, June 2007

– Operations Engineering Bulletin reminder function
– Avoiding high speed rejected takeoffs due to EGT limit exceedance
– Do you know your ATC/TCAS panel ?
– Managing hailstorms
– Introducing the Maintenance Briefing Notes
– A320: Dual hydraulic loss
– Terrain Awareness and Warning Systems operations based on GPS data

Issue 3, December 2006

– Dual side stick inputs
– Trimmable horizontal stabilizer damage
– Pitot probes obstruction on ground
– A340: Thrust reverser unlocked
– Residual cabin pressure
– Cabin Operations Briefing Notes
– Hypoxia: An invisible enemy

Issue 2, September 2005

– Tailpipe or engine fire
– Managing severe turbulence
– Airbus Pilot Transition (ATP)
– Runway excursions at takeoff

Issue 1, January 2005

– Go Arounds in Addis-Ababa due to VOR reception problems
– The importance of the pre-flight flight control check
– A320: In-flight thrust reverser deployment
– Airbus Flight Safety Manager Handbook
– Flight Operations Briefing Notes

Safety first

Subscription Form

Safety **first** The Airbus Safety **Magazine**

Subscription Form

To be sent back to

AIRBUS FLIGHT SAFETY OFFICE
Fax: 33 (0)5 61 93 44 29
Mail to:marie-josee.escoubas@airbus.com

Name . . . .

Surname . . . .

Job title/Function. . . . .

Company/Organization. . . . .

Address . . . .

. . . .

. . . .

Post/Zip Code . . . .

Country . . . .

Telephone . . . .

Cell phone . . . .

Fax . . . .

E-mail . . . .
(Mandatory for both digital and paper copies)

Please send me the digital copy* ☐

Please send me the paper copy* ☐ (Please note that paper copies will only be forwarded to professional addresses)

* Please tick the appropriate case

AIRBUS

AN EADS COMPANY