The Airbus safety magazine

Safety first #39

AIRBUS

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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 Aviation 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.

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editorial

YANNICK MALINGE

SVP - Head
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Dear Aviation Colleagues,

Firstly, I wish to extend my sincerest condolences to the families, friends, and colleagues of the 225 people who lost their lives in the tragic events involving commercial jet aircraft in 2024. This is in contrast to the remarkable year in 2023, with no fatal accidents recorded for commercial jet aircraft. As we enter 2025, the industry faces compounding challenges with global supply chain issues, geopolitical tensions, and this is particularly critical considering the increasing demand of constant traffic growth. It is a clear reminder about the importance of our relentless mission of prevention. It is our permanent quest to reach zero accidents.

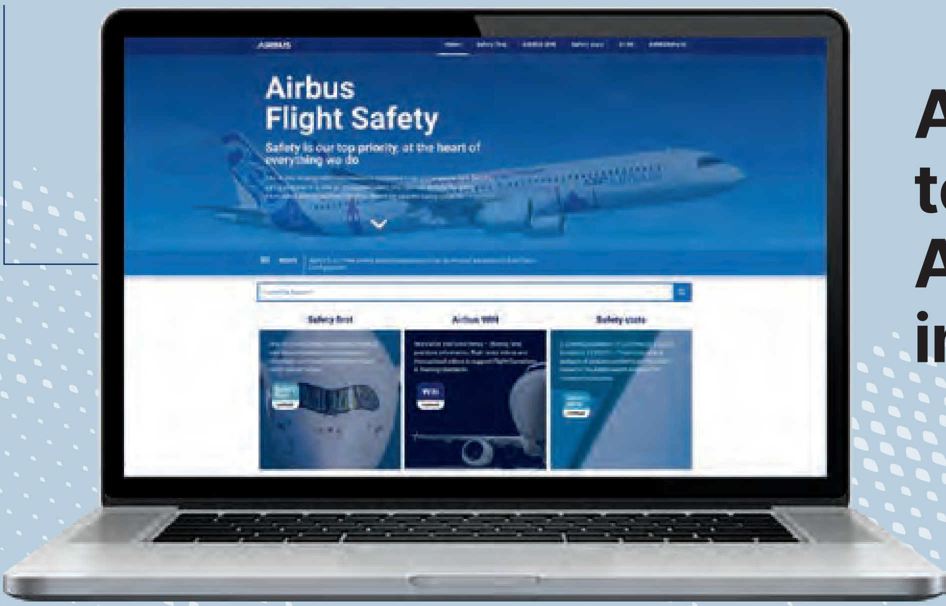
The last 30 years has seen huge changes and global events that affected aviation transport. It has also been an era of overall improvement in the industry's safety record, despite the huge growth of aircraft in service. Today, flying in a commercial jet is still one the safest forms of transport, but complacency is the enemy of safety. The key to preventing aviation accidents lies in our safety culture. This edition marks 30 years since we first produced our safety magazine. We had in mind the aim of increasing aviation safety knowledge, maintaining transparency in sharing safety information, and working together to continuously enhance safety.

The earliest versions were called "Hangar Flying", which was first published following a series of accidents in the early 1990s, including an A330 flight test accident in 1994. It was imperative to maintain regular and recurring sharing of valuable lessons learned and experience from Airbus to its operators. This is especially important today with the large number of newcomers to the Air Transport System, and so I encourage every reader to share this publication with any aviation professionals in your networks who may not yet be aware of it.

As we commit ourselves to continuing our shared safety journey, I also want to take this opportunity to wish all of you, your family, friends, and colleagues a safe and prosperous new year.

Airbus
Flight Safety Website

Safety is our top priority, at the heart of everything we do



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NEWS

The 29th Airbus Flight Safety Conference will be held in Amsterdam, 17-20 March 2025

This event provides the opportunity for Airbus and its customers to exchange and share experiences to further strengthen safety across our air transport system.

The agenda of the conference will focus on the importance of manual flying including training and certification considerations. It will also cover the benefits of technology for safety and airlines speakers will share perspectives about safety challenges in organisations managing operations across multiple AOC.

Growing our safety culture, sharing experiences, and building safety networks is essential for safety and so we encourage all our customers to join us at our 29th Flight Safety Conference.

Safety first #39

Flight Operations

Cabin Operations

Ground Operations

Maintenance

Closing MEL Items: Why Sooner is Better

It is not always possible to repair a system failure before the next flight. The MEL permits the dispatch of an aircraft with inoperative equipment or functions for a limited period of time, and under specific conditions, while maintaining an acceptable level of safety.

Current in-service data shows an increase in the number of requests for MEL extension indicating an increase of departures with multiple open MEL items. Even if dispatch under MEL always guarantees an acceptable level of safety, it increases the risk of exposure to multiple failures with their inherent operational consequences.

This article recalls the importance of fixing MEL items at the earliest opportunity to reduce this risk of exposure to multiple failures, and provides best practices where MEL extensions are necessary to maintain the highest possible margin of safety.

CASE STUDY

Event Description

An A330 aircraft was dispatched on a non-ETOPS flight under MEL item 36-11-01A ENGINE BLEED AIR SUPPLY SYSTEM on engine 1. Before departure, ENG 1 BLEED push button switch was set to OFF, the X BLEED selector set to OPEN and APU and APU BLEED were confirmed as operative, as per the dispatch condition of the MEL item **(fig.1)**.

36-11-01 | Engine Bleed Air Supply System

Dispatch Condition 36-11-01A : Non ETOPS

Repair Interval	Nbr Installed	Nbr Required	Placard
C	2	1	Yes

(o) Refer to MMEL/MO-36-11 Engine Bleed Air Supply System

One may be inoperative provided that:

1. ETOPS is not conducted, and
2. The associated ENG BLEED pb-sw is set to OFF, and
3. The X bleed valve is set to OPEN, and
4. The APU and APU bleed air supply system are operative.

Note : In the case of depressurization at altitudes higher than 37 400 ft (11 400 m) oxygen masks may drop down during the descent.

(fig.1)
MEL item 36-11-01
Engine Bleed Air System

During the cruise phase at FL390, the AIR ENG AIR ENG 1+2 BLEED FAULT ECAM alert triggered. The flight crew followed the ECAM instructions and managed to reset the ENG 2 bleed system. 20 seconds later, the AIR ENG 1+2 BLEED FAULT ECAM alert triggered again. The flight crew attempted to reset the ENG 2 bleed system but the reset was unsuccessful.

The flight crew then declared a PAN PAN situation to ATC and requested to descend to FL100. The CAB PR EXCESS CAB ALT ECAM alert triggered. The flight crew put on their oxygen masks and performed an emergency descent. Passenger oxygen masks automatically deployed during the descent. At FL190, the flight crew started the APU and set APU BLEED to ON. The APU bleed remained ON until the end of the flight. At FL100, the flight crew again attempted a reset of the ENG 2 bleed system, which was successful.

A decision to divert was taken and the aircraft climbed to FL170, then performed an approach and landed without further events.

Event Analysis

Significant operational impact

With the MEL applied for the inoperative ENG 1 bleed air supply system, the failure of the ENG 2 bleed air supply system during the flight led to the loss of cabin pressure at cruise altitude requiring an emergency descent and diversion. This had a notable operational impact, including the impression on the passengers who were aware of the sudden descent and observed the deployment of the oxygen masks in the cabin.

An acceptable margin of safety

Despite the significant operational impact, an acceptable margin of safety was maintained throughout this event thanks to the correct application of the MEL item dispatch conditions and operational procedures by the flight crew.

The impacts of one inoperative engine bleed system, combined with a subsequent failure of the other engine bleed system, are described and addressed in the dispatch conditions and operational procedures of the MEL item. The condition of an operative APU BLEED, and the likelihood of passenger oxygen masks deploying when at cruise altitude above 37 400 ft, are also described.

INFORMATION

The dispatch conditions are defined following a 3-step safety methodology that is detailed in a previous Safety first article "A Recall on the Correct Use of the MEL" and which ensures that an acceptable level of safety is always maintained.

POSSIBLE BUT TEMPORARY SOLUTIONS TO FACE DISPATCH CHALLENGES

Raise of Dispatch Challenges

An increase of the operational pressure to fly is observed. In addition, various operational constraints such as supply chain disruption affecting parts availability or the lack of qualified maintenance personnel may make it difficult to repair or replace the equipment within the time frame allowed by the MEL. This leads to an increase of the number of aircraft dispatched with open MEL items and therefore an increased exposure to multiple failure situations as described in the case study.

In-service reports also show that the number of incorrectly applied MEL items is increasing.

INFORMATION

The Safety first article "A Recall on the Correct Use of the MEL" describes how to use the MEL and gives recommendations on how to identify the correct MEL item associated with the failure.

MMEL/MEL Extension Management

In limited cases, the initial MEL repair interval time can be extended to face the dispatch challenges described above.

One-time extension of an MEL

A one-time extension of standard repair intervals (B, C, D) is possible as defined by regulations (EASA Part-ORO.MLR.105(f), CS MMEL.135 and TCCA CASA 2022-02 for repair intervals B, C and D; FAA OpsSpecD095 for repair intervals B and C). Where applicable, this one-time extension is taken into account in the safety analysis of each MMEL item. An acceptable level of safety is therefore maintained for such cases. A dedicated process for the application of one-time extensions must be defined with the operator's national airworthiness authority.

Operations outside MEL conditions but still within the MMEL

The MEL defined by the operator for their aircraft is either as restrictive or more restrictive than the MMEL provided by the OEM for the aircraft type. An operator has the option to operate the aircraft outside the conditions of their MEL provided it complies with the equivalent conditions of the MMEL. An acceptable level of safety is maintained as the dispatch remains within the certified MMEL scope. It is however considered as a deviation from the operator's MEL and formal approval must be given by their relevant national aviation authority each time this option is required.

In AOG situations

To avoid AOG situations, under exceptional circumstances, Airbus has developed a process called **A**pproved **D**eviation to **O**SD-**M**MEL (ADOM). It is a document issued by Airbus to support operators if they need to urgently dispatch an aircraft outside of the scope of the MMEL. For each ADOM, a safety analysis is performed following the same safety methodology as for the development of the MMEL items refined to the actual aircraft status and the planned mission to ensure that sufficient safety margins are maintained. Additional limitations can be required.

INFORMATION

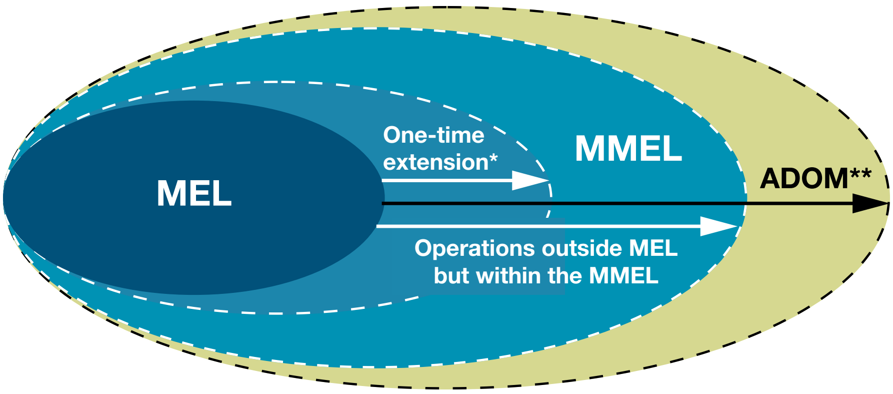
An ADOM is an EASA approved document and can be used only for deviation from the EASA MMEL. It cannot be applied for the FAA MMEL or the TCCA MMEL. For the FAA MMEL, extensions for intervals A and D and additional extensions can be granted on a case-by-case basis by the FAA according to FAA AC 120-125 and FAA Order 8900.1 Vol 4, Chap 4, Section 3, 4-688.

ADOM can be used:

- to **further extend the repair interval** A or the other intervals B, C and D following the first extension, or
- to **dispatch the aircraft with a combination of open MEL items not permitted by MMEL**, or
- when the operational or maintenance procedure cannot be applied.

It is a document issued by Airbus **on a case-by-case basis** following analysis of the specific aircraft configuration and conditions. It is valid for a limited period of time and operators have to obtain authorisation from their relevant national aviation authority to apply the MEL deviation in accordance with the ADOM.

(fig.2)
Possible MMEL/MEL extensions



Any MEL extension must be agreed with the Operator's local authorities
*** Not applicable to repair interval A** **** Applicable to EASA MMEL only**

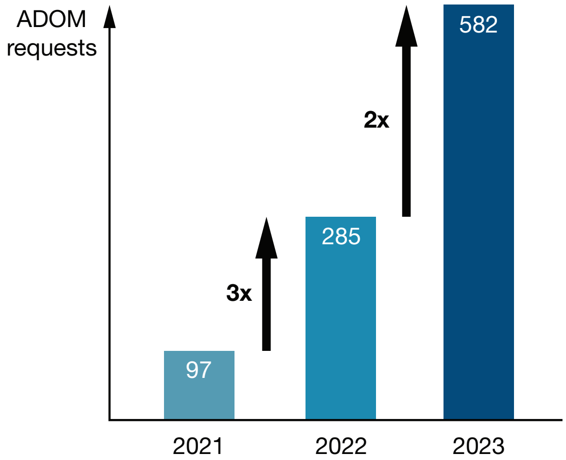
KEYPOINT

The ADOM is only issued if the safety analysis demonstrates that **an acceptable level of safety margin can still be maintained.**

Increase of ADOM Requests

The number of ADOM requests has increased significantly each year since 2021. One reason is the difficulty to obtain parts due to the post pandemic supply chain challenges. This can further delay the repair or replacement of the affected equipment, increasing the exposure to multiple failure situations as described in the case study above.

(fig.3)
Evolution of the number of ADOM requests between 2021 and 2023



KEYPOINT

The ADOM has to be used on an exceptional basis

BEST PRACTICES FOR SAFE DISPATCH

Dispatch with open MEL items requires specific attention from both flight crews and maintenance crews with dedicated tasks. In case of extended MEL items and multiple MEL items, those tasks can take more time, be more complex and have a significant impact on the crew's workloads.

Best Practices for Flight Crews

Aircraft acceptance

It is the responsibility of the flight crew to review all open MEL items, confirm that the associated dispatch conditions and limitations are taken into account, and are compatible with the flight and the crew workload. It is also necessary to confirm that any applicable maintenance procedures described in the MEL dispatch conditions have been performed and are recorded in the technical logbook. The flight crew have to also assess the consequences of the inoperative equipment in combination with other possible, or multiple, failures. The complexity of their tasks can increase with multiple open MEL items. The captain has the final decision to accept the aircraft or can refuse to depart if they conclude that the number of open MEL items is impacting too much on the flight crew workload during a flight or erodes the margin of safety.

Best Practices for Maintenance Crews

As part of the dispatch, the maintenance crew has to define an equipment repair or replacement strategy at the earliest opportunity and order the necessary parts as soon as possible. It is important to confirm the time limited MELs do not expire before the next confirmed maintenance opportunity. They should also take actions to prevent accumulation of multiple open MEL items, especially where they can directly impact the flight crew workload and increase the risk of multiple failure situations.

Extended MEL items and the number of open MEL items can increase the workload and the complexity of these monitoring actions of the maintenance crews.

BEST PRACTICE

It is important that both the maintenance crew, who are responsible to apply and close the MEL items, and the flight crew, who manage the dispatch conditions of the open MEL items during the flight, are aware of each other's tasks. They can better assess the operational consequences of their decisions and find more appropriate solutions to reduce the risks associated with multiple open MEL items situations.

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Dispatch of aircraft with MEL items is a common practice in operations. It enables the repair and replacement of inoperative equipment at a next maintenance opportunity within a defined timeframe. Each MEL item is assessed to ensure that an acceptable level of safety is always maintained when it is applied.

Certain situations, such as spares availability issues, may cause a delay in the repair or replacement of the inoperative equipment. Aviation authorities and Airbus have defined possibilities to extend the MEL time limit on a case-by case basis. These include operating outside the MEL conditions, but within the constraints of the MMEL, or requesting an ADOM, which is an approved document issued by Airbus to temporarily operate beyond the MMEL conditions. Both of these actions must be authorized by the operator's own national aviation authority.

In-service reports show that the number of ADOM requests received by Airbus is increasing, as is the number of dispatches of aircraft with multiple open MEL items. This requires extra vigilance, especially to anticipate the potential consequences of multiple failure situations in flight. Communication and collaboration between the maintenance crew and the flight crew is essential to understand and to mitigate these risks together.

Preventing Tailstrike During Go-around near the Ground

The focus of this article is go-around near the ground, sometimes called, “rejected landing”. This follows our previous article: “A Focus on the Landing Flare” article published September 2020 and “A Focus on the Takeoff Rotation” published January 2021. Those articles provided recommendations for avoiding tailstrikes when performing landing flare and takeoff rotation.

There is also a higher risk of tailstrike when a go-around is required near the ground. This article provides additional recommendations and observations for flight crews to help them avoid tailstrike events during this phase.

CASE STUDY 1

Event Description

An A320 aircraft was performing an RNAV approach on a day with good weather conditions. The METAR indicated wind with a 10 kt headwind component and a negligible crosswind. The landing was intended to be done in CONF FULL. The VAPP was 137 kt. The First Officer, who was the PF, disconnected the autopilot at 930 ft RA and maintained the autothrust ON. At 500 ft, the approach was stabilized.

Nose down input and wind gradient at 80 ft

1 At 80 ft RA, the PF applied 1/3 of full nose-down input **(fig.1)**. Simultaneously, the wind, which was about 5 kt headwind, suddenly changed to a 3 kt tailwind. The aircraft pitch reduced from +3.5° at 80 ft to 2 +2.5° at 40 ft.

Go-around initiation during a light bounce

From 40 ft RA, the PF started the flare with a progressive nose-up input up to a full nose-up input in the last 10 ft. 3 Thrust levers were retarded to idle at 10 ft RA. The pitch increased from +2.5° up to 4 +9° up at touchdown.

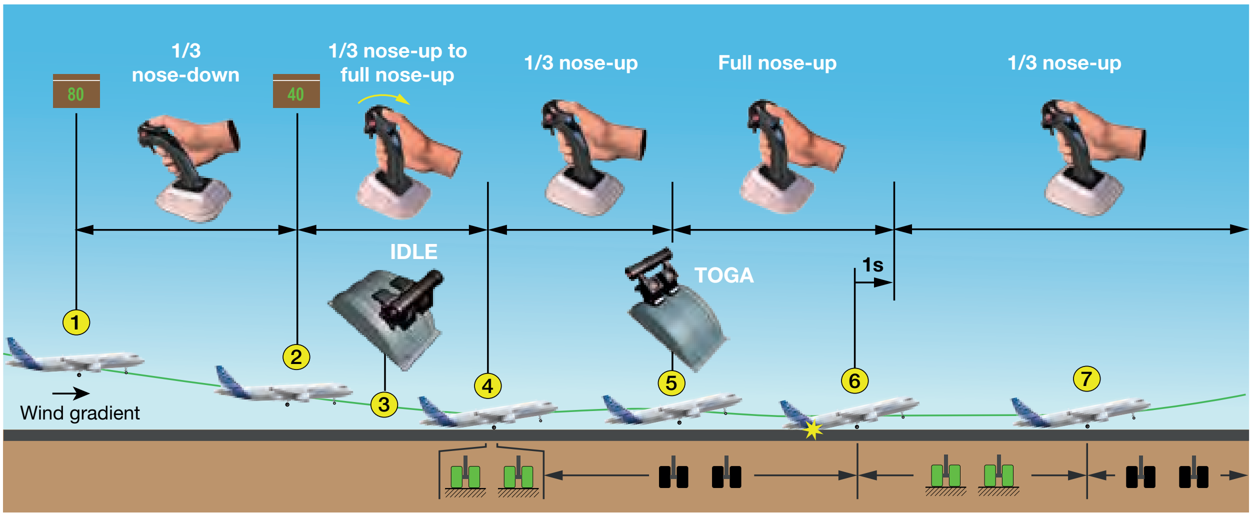
The aircraft slightly bounced while the ground spoilers started to extend, and the PF maintained an average 1/3 nose-up input during 2 s. 5 The pitch reached +12° when the PF applied TOGA thrust and applied a full nose-up input.

Tailstrike during second touchdown

6 The aircraft touched down a second time during the engine spool-up and ground spoilers retraction. A tailstrike occurred with a pitch of +12.7° at a speed of 127 kt (VAPP - 10kt). The PF maintained the full nose-up input for 1 more second. The aircraft speed at that point was 122 kt (VAPP - 15 kt). The PF then partially released the nose-up input to 1/3 of full nose-up input. 7 The pitch reduced to +11° and the aircraft achieved lift-off when the speed reached 128 kt.

The PF continued the go-around maneuver and performed a successful second approach.

(fig.1)
Illustration of the event: Case Study 1



Event Analysis

Light bounce due to high vertical speed and high pitch at touchdown

Both the wind gradient and PF input at 80 ft RA created a lift reduction that led the aircraft vertical speed to increase to -800 ft/min at 40 ft RA. The flare reduced the vertical speed, which was still -350 ft/min at the first touchdown. The energy returned through the main landing gear shock absorbers, combined with the lift provided by the high pitch at touchdown (+9°), caused the aircraft to bounce.

Continuous nose-up input during the bounce and full backstick input at the initiation of the go-around near the ground caused the tailstrike

The ground spoilers extension during the bounce reduced the lift, and caused the second touchdown. The continuous nose-up input of the PF after the first touchdown, in addition to the full nose-up input when TOGA was selected, led to the pitch increase from +9° to +12.7°, which caused the tailstrike on the second touchdown.

Image (above): A320 aircraft with a specific tail bumper fitted to protect the fuselage when performing Velocity Minimum Unstick (VMU) test

CASE STUDY 2

Event Description

An A330 aircraft was performing an ILS approach with good visibility, but in gusty wind conditions. The intended landing configuration was CONF FULL.

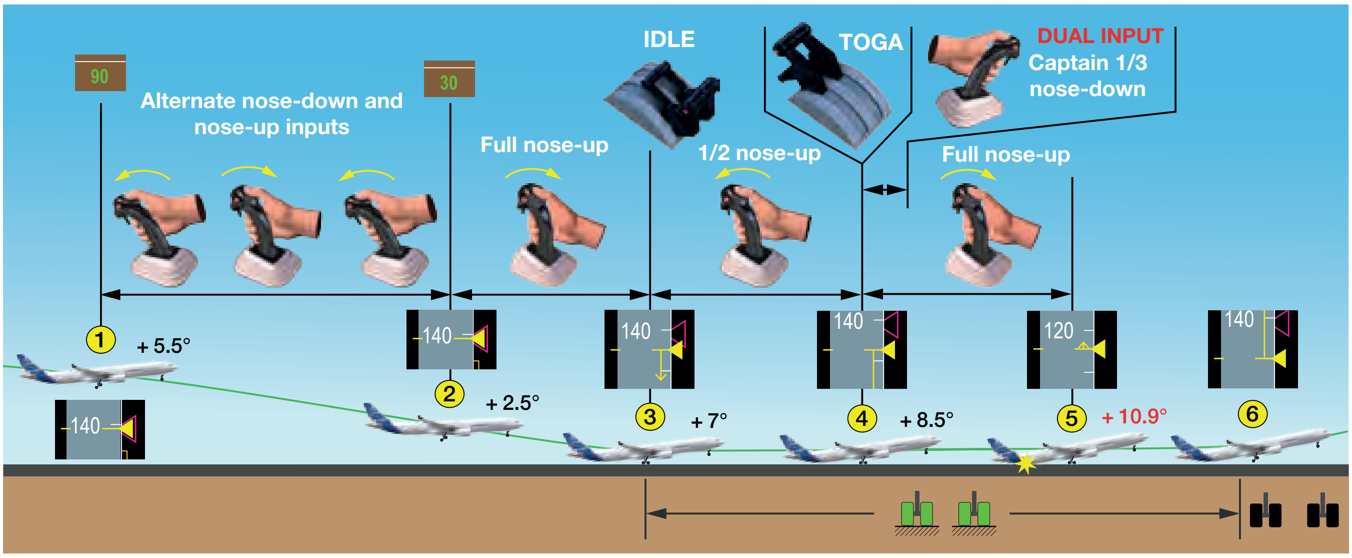
The approach was stabilized at 500 ft RA. The First Officer, who was PF, disconnected the autopilot and kept the autothrust ON. The VAPP was 139 kt.

1 From 90 ft RA, the PF alternated nose-down and nose-up inputs, leading to a nose-down tendency. The pitch reduced from +5.5° to 2 +2.5° at 30 ft. The flare was initiated at 30 ft by application of a close to full nose-up input, which was partially released and then followed by another full nose-up input just prior to touchdown. 3 The thrust levers were retarded to IDLE simultaneously at the point of the hard touchdown. The pitch was +7° and the speed was 135 kt (VAPP - 4 kt) decreasing.

The PF maintained ½ full nose-up input for 2s and then 4 set the thrust levers to the TOGA detent combined with a full nose-up input. The Captain simultaneously applied 1/3 nose down input briefly, which led to a "DUAL INPUT" callout. The engines began spool up to TOGA thrust, but the speed was still decreasing and the pitch increasing due to the full nose-up inputs applied by the PF. 5 A tailstrike occurred and the pitch reached 10.9° at a speed of 116 kt (VAPP - 23 kt).

6 The aircraft then accelerated and lift-off was achieved at around 130 kt. The PF continued the go-around maneuver and performed a successful second approach.

(fig.2)
Illustration of the event:
Case Study 2



Event Analysis

Hard landing caused by a nose-down tendency at 30 ft and a late flare

The alternate nose-up and nose-down inputs, between 90 ft and 30 ft, led to a vertical speed increase from -550 ft/min at 90 ft up to -850 ft/min at 30 ft when the PF started the flare. This late flare, combined with the high vertical speed, led to the hard landing.

Continuous nose-up inputs after touchdown and full backstick order at low speed led to the tailstrike

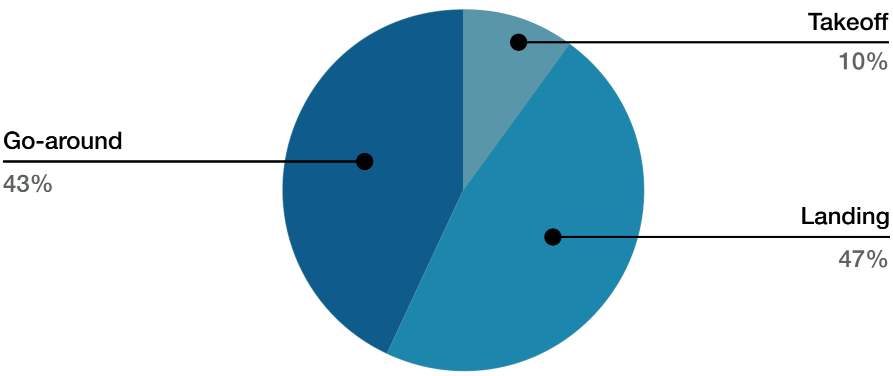
The PF maintained a nose-up input after touchdown, leading the pitch to increase from 7° to 8.5° when the go-around was initiated. The PF then applied full nose-up input simultaneously with the TOGA thrust selection while the aircraft speed was as low as 116 kt (VAPP -23 kt). This led to the tailstrike.

Dual input

The brief nose-down input performed by the Captain, without pressing the sidestick priority pushbutton when the go-around was initiated, was not sufficient to counteract the full nose-up demand by the First Officer.

OPERATIONAL CONSIDERATIONS

Between January 2022 and September 2024, 49 tailstrike events were reported to Airbus with 5 (10 %) during takeoff, 23 (47 %) during landing and 21 (43 %) during a go-around near the ground **(fig.3)**.



(fig.3)
Percentage of tailstrike events per flight phase

INFORMATION

For more information on tailstrike prevention during takeoff and landing, refer to the "A Focus on the Landing Flare" article published in September 2020, and "A Focus on the Takeoff Rotation" published later in January 2021.

Performing a Safe Go-around Near the Ground

The PF and the PM must carefully monitor the pitch during the maneuver

When going around close to the ground, both the PF and the PM must carefully monitor the pitch during the maneuver. The PM must make the "PITCH" callout when the pitch reaches the value provided in the standard callout chapter of the SOP.

Avoid high rotation rate

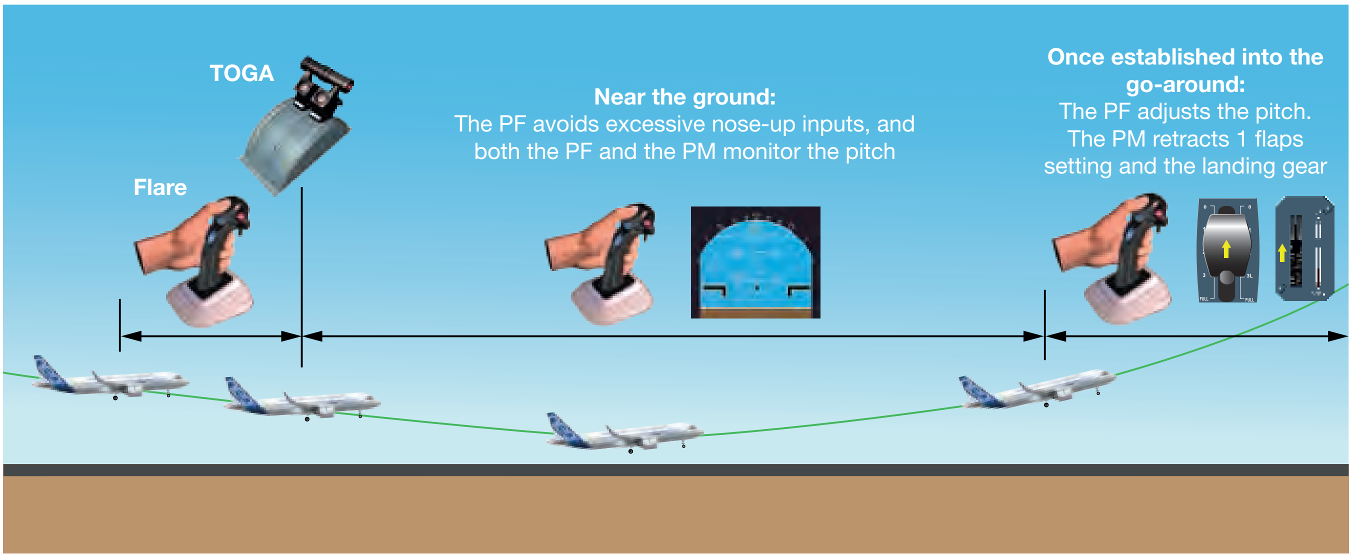
The application of full back stick by the flight crew was reported in many of the tailstrikes during go-around near to the ground events. This was a common contributor to these events as this action led to a high rate of rotation.

When performing a go-around near the ground, the PF and PM must monitor the pitch and the PF must avoid excessive nose-up input **(fig.4)**.

Retract flaps and landing gear only when safely established into the go-around

During a go-around near the ground, the flight crew must delay the flaps and landing gear retraction until the aircraft is established on its go-around trajectory **(fig.4)**. Delaying the flaps retraction prevents the need for higher pitch in the early stage of the maneuver, when the aircraft is closer to the ground.

(fig.4)
Management of a go-around near the ground



Landing gear contact with the ground may happen

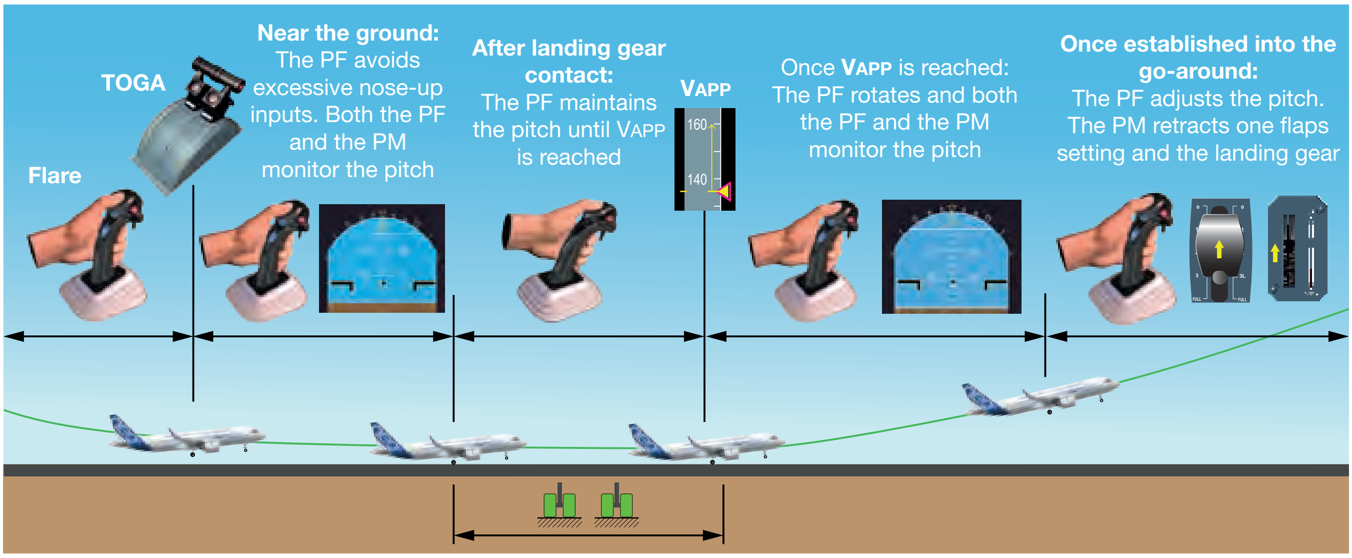
If the go-around is initiated when the aircraft is very close to the ground, the landing gear may contact the runway. The PF should not try to avoid this contact by further increasing the pitch.

Manage the energy of the aircraft

In many reported cases of tailstrike during go-around, the high nose-up demand applied when the aircraft was on ground, and at low speed, led to the tailstrike.

If engines are at idle when the go-around is initiated, they can take a few seconds to spool up. The flight crew should wait until the aircraft speed reaches at least VAPP to rotate the aircraft **(fig.5)**.

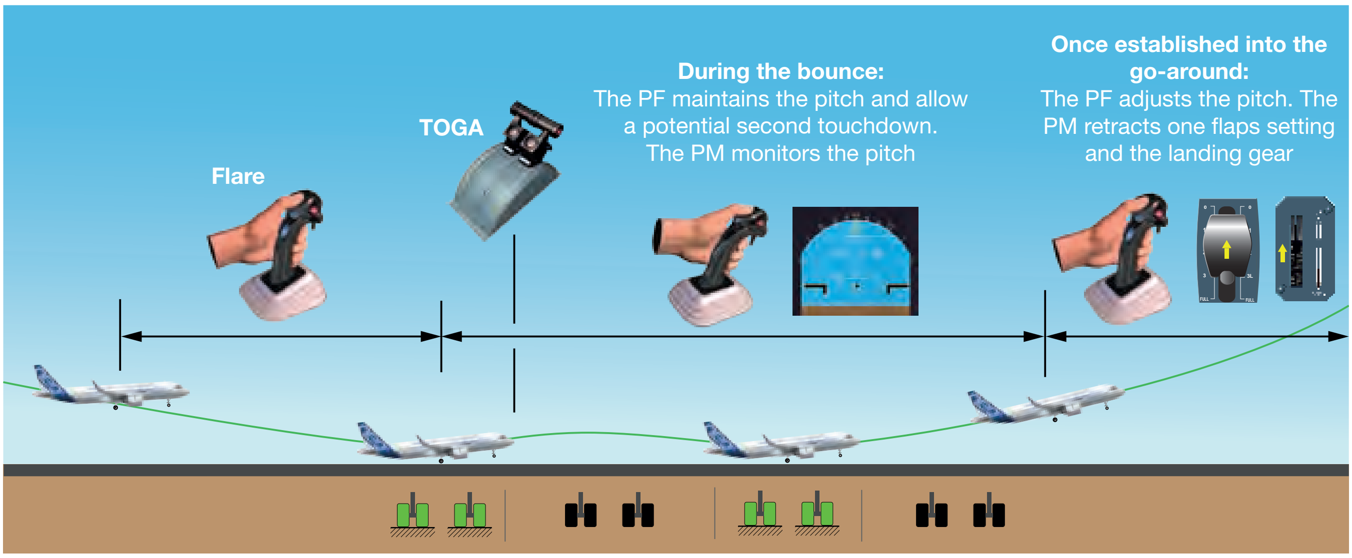
(fig.5)
Management of energy after landing gear contact



Don't try to avoid a second touchdown in the case of a go-around initiated during a bounce

If a go-around is initiated during a bounce, the PF should maintain the pitch, allowing a potential second touchdown to happen. Then the PF can further adjust the pitch, ask the PM to retract one flap setting and retract the landing gear when the aircraft is established on its go-around trajectory **(fig.6)**.

(fig.6)
Management of a bounce during go-around



Only one flight crew flies at a time

Case study 2 shows that the PM may intend to take control in such dynamic situations. As per the FCTM chapter about the use of sidestick: only one flight crew flies at a time. If the PM intends to apply inputs using the sidestick, they must do the following actions:

- Clearly announce **"I have control"**

- **Press and maintain the sidestick priority pushbutton** in order to get full control of the Fly-By-Wire system.

The flight crew should keep in mind that sidestick inputs are algebraically added and the **"DUAL INPUT"** alert triggers if the priority pushbutton is not pressed and maintained.

In case study 2, the dual input of the PM on the Captain's sidestick did not prevent the tailstrike. In other reported cases, the dual input from the PM in the same direction as the PF increased the inputs up to an equivalent of full nose-up, and the resulting increased rate of rotation contributed to the tailstrike.

Thrust reversers selection means full stop

It is important to recall the SOP that states **the flight crew must not initiate a go-around once the reversers have been selected.**

In several tailstrike events reported to Airbus, the go-around was initiated after the reversers selection. This contributed to the tailstrike due to the reduction of the aircraft speed before the go-around was initiated. The time taken for the thrust reversers to retract and lock also causes a delay of the engine spool-up to TOGA.

INFORMATION

For more information, refer to the "Thrust Reverser Selection is a Decision to Stop" article published in June 2023.

TRAINING CONSIDERATION

The Airbus Flight Crew Training Standards Manual (FCTS) recommends to train go-around near the ground in a simulator.

To create surprise effect and to have training conditions close to the conditions observed during in-service events, the instructor should order the go-around once thrust levers are set in idle position during the flare initiation.

INFORMATION

For more information on the management of go-arounds, including go-arounds near the ground, refer to the "Go-around: Some threats and mitigations" video available on the Airbus Worldwide Instructor News (WIN) website.

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With thanks to Eric JEANPIERRE from the Product Safety Enhancement team in Aviation Safety

Performing a Go-around near the ground is a very dynamic phase with a risk of tailstrike. If a go-around is initiated, the maneuver must be completed.

To ensure a safe go-around near the ground, the flight crew must avoid application of inputs that lead to a high rate of rotation, retract flaps, and retract the landing gear only when the aircraft is safely established in the go-around maneuver.

If the landing gear is in brief contact with the ground, this is acceptable. The PF should not try to avoid this contact by further increasing the pitch.

If the engines are already at idle when the go-around is initiated and the aircraft energy is low, the flight crew should wait until the aircraft speed reaches at least VAPP to rotate the aircraft.

Do not try to avoid the secondary touchdown in the case of a go-around initiated during a bounce. The PF should maintain the pitch, allowing a potential second touchdown to happen. Then the PF can further adjust the pitch, ask the PM to retract one flap setting and retract the landing gear when the aircraft is established on its go-around trajectory.

In all cases, it is important to recall that the SOP requires that a flight crew must not initiate a go-around once the reversers have been selected.

For further reading about avoiding tail strikes in other phases, you can read "A Focus on the Landing Flare" article published September 2020 and "A Focus on the Takeoff Rotation" published January 2021.

Engine Relight After an All-Engine Flameout

An all-engine flameout is one of the most stressful situations where flight crews need to urgently relight the aircraft engines. Incorrect application of the engine relight sequence can lead to delayed or unsuccessful engine restarts.

This article describes an in-service event in which such a situation was encountered. It recalls the various steps of the engine relight sequence in the ALL ENG FAIL procedure of the QRH and highlights the improvements that have been made on the operational procedure of A300, A310, A320 family, A330, A340, A350 and A380 aircraft.

CASE STUDY

Event Description

Diversion to alternate airport

An A320 aircraft equipped with CFM56-5B engines was approaching its destination airport. Due to adverse weather conditions, the flight crew decided to divert to an alternate airport, where they performed a safe landing at 18:40 local time. After a three-hour stopover, the aircraft departed the diversion airport at 21:51 local time, heading towards its initial destination.

Weather avoidance and storm encounter

During the night flight, persistent adverse weather remained along their route. 1 The flight crew requested a northward deviation to avoid storm cells that they detected on their weather radar. 2 The aircraft was cruising at FL 240 with autopilot and autothrust ON when the flight crew executed a 90° left turn toward their final destination.

Severe storm and dual engine flameout

3 Shortly after the turn, the aircraft encountered severe turbulence and hail. Loud impact noises were heard, and both the left and right windscreen sustained damage. Several ECAM alerts were triggered, including ANTI ICE R WINDSHIELD, ANTI ICE L WINDSHIELD, ENG 1 STALL, NAV RA 2 FAULT.

4 The autopilot and autothrust disconnected, and within one second, the cockpit went dark. Flight recorder data is not available for the following 2 min and 46 s due to an EMER ELEC configuration. 5 During this time, the thrust levers were moved to TOGA position.

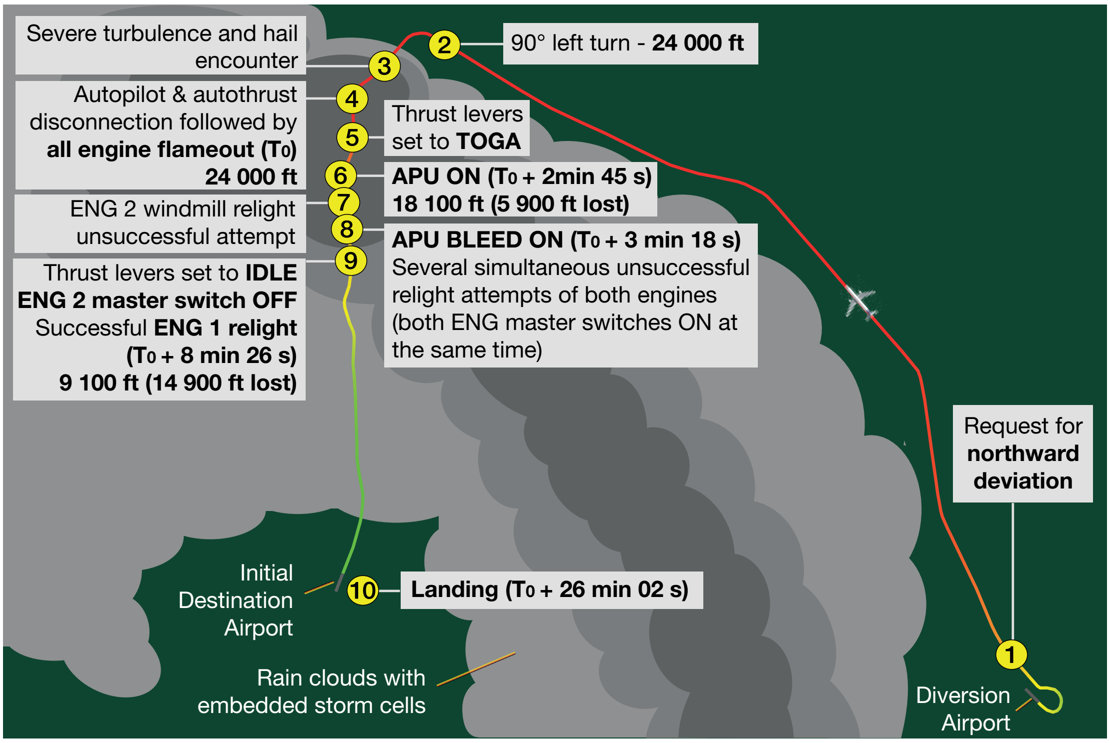
Both engines had flamed out combined with an unreliable airspeed indication. The flight crew switched the APU to ON. 6 When the APU came online, electrical power was restored. The aircraft pitch was -3.5°, corresponding to the pitch provided in the QRH to reach the optimum windmill relight speed. The speed, which was unreliable, was 232 kt indicated on the captain PFD and the aircraft altitude was 18 100 ft (5 900 ft lost from cruise altitude). The aircraft was in ALTERNATE flight control law and thrust levers remained in the TOGA position.

7 One windmilling relight attempt of ENG 2 was recorded, then 8 the flight crew switched APU BLEED ON and performed several simultaneous attempts (both ENG Master switches ON at the same time) of starter-assisted engine relight with the thrust levers still in the TOGA position. 9 The flight crew eventually set the thrust levers to IDLE and both master levers OFF before performing a successful ENG1 starter-assisted relight with ENG 2 master switch left to the OFF position. The altitude was 9 100 ft, representing a loss of 14 900 ft from the cruise altitude. The flight crew then tried to relight engine #2 twice, but both attempts were unsuccessful.

Safe landing with single engine, unreliable airspeed and ALTERNATE law

The aircraft emerged from the storm and continued to the destination airport. 10 The flight crew performed a safe landing with a single engine operative, ALTERNATE flight control law, unreliable airspeed indication, and significantly damaged windshields impairing visibility.

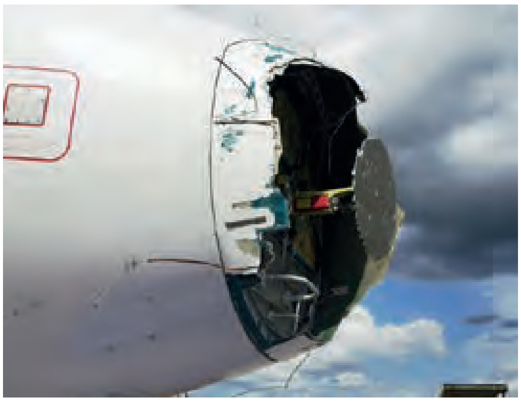
(fig.1)
Lateral trajectory of the aircraft during the event



(fig.2)
View of the damaged windshield and radome after the event (photos: Investigation Board)

Severely damaged aircraft

When the aircraft came to a stop, the crew assessed the aircraft's damage, including a destroyed radome.



Event Analysis

Unsuccessful weather avoidance

Night conditions and numerous storms in the area made effective weather avoidance challenging. Despite having an automatic radar and performing both automatic and manual scanning, the flight crew entered a severe hailstorm.

INFORMATION

For more information on the use of weather radar for weather avoidance, refer to:
- the FCTM "Aircraft Systems - Weather Radar" chapter,
- the "Optimum use of weather radar" article published in July 2016,
- the "Operational use of the weather radar" WIN video.
- the Pilot's guide of the weather radar manufacturer.

Extreme weather conditions

The hailstorm significantly exceeded the engine design and certification criteria. The water/ice content was approximately **twice the level for which engines are designed and certified.** This explains the observed engine damage and flameout.

Radome damage impact

Radome damage disrupted airflow around the air data probes, causing unreliable airspeed indications and reversion to the ALTERNATE flight control law.

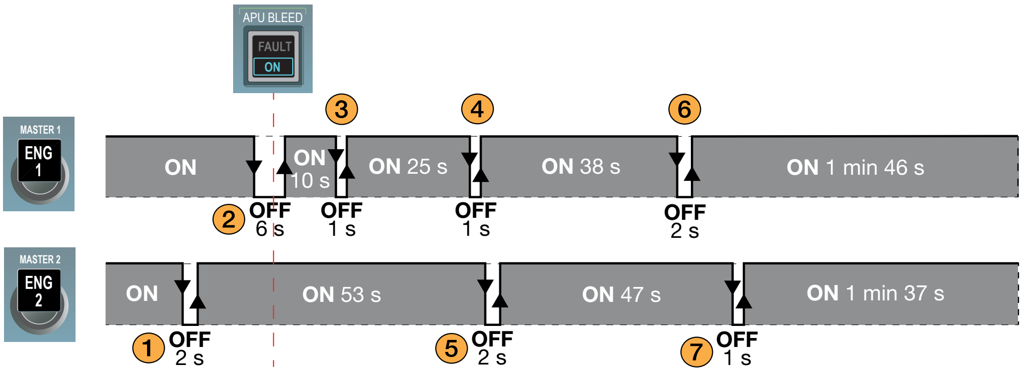
Thrust lever positioning

The thrust levers remained in the TOGA position during seven relight attempts. The ALL ENG FAIL QRH procedure requires setting the thrust levers to IDLE before attempting to relight the engines.

Unsuccessful engine relight attempts

Recorder's data enabled analysis of the sequence of the various engine relight attempts.

1 The flight crew cycled the ENG 2 master switch OFF then ON 2 s later. 2 They switched the ENG 1 master switch to OFF. APU BLEED was set to ON shortly after. The ENG 1 master switch was then set back to ON 6s after being switched OFF. 10 s later, 3 the ENG 1 master switch was cycled OFF then ON. 25 s later, both 4 ENG 1 and 5 ENG 2 master switches were cycled OFF then ON. The flight crew then 6 cycled ENG 1 master switch again shortly followed by 7 ENG 2 master switch. All relight attempts were unsuccessful. The thrust levers remained in the TOGA position.



(fig.3)
Sequence of unsuccessful relight attempts during the event

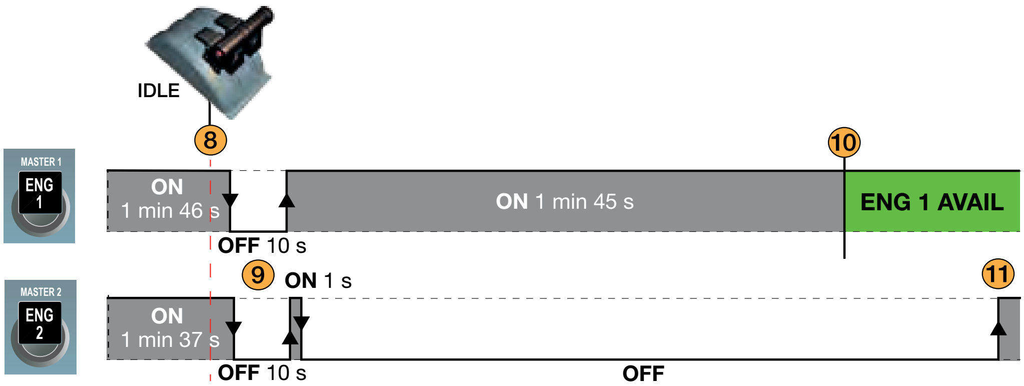
These Simultaneous starter-assisted relight attempts failed due to the fact that APU bleed provides sufficient air pressure to restart only one engine at a time. It was observed that no ventilation of 30s was performed between each relight attempt.

Successful ENG 1 relight

8 The crew then set the thrust levers to IDLE and 9 set both engine master switches to OFF. The ENG 1 master switch was set back to ON, while the ENG 2 master switch was briefly set to ON then back to OFF. Within 1 minute and 45 seconds, ENG1 N2 and EGT increased and 10 ENG1 successfully restarted.

The ENG 2 master switch being OFF enabled sufficient bleed pressure to be delivered to ENG 1 starter for a successful relight.

(fig.4)
Successful ENG 1 relight



Damaged ENG2

11 The flight crew then tried two ENG 2 relights, but both attempts remained unsuccessful. Detailed inspection revealed sufficient damage to ENG 2 preventing successful inflight restart.

Significant relight time and altitude loss

ENG 1 became available 8 min 26 s after the all-engine flameout. The aircraft altitude was 9 100 ft, representing a loss of 14 900 ft from the 24 000 ft initial cruise altitude.

OPERATIONAL CONSIDERATIONS

Careful application of the windmill and starter-assisted relight procedures in the ALL ENG FAIL QRH procedure (A300, A310, A320 family, A330 and A340 aircraft) and in the ENG ALL ENGINES FAILURE ECAM alert (A350 and A380 aircraft) is critical for successful in-flight engine restart.

Windmill Relight

In the case of an all-engine flameout, the windmill relight is possible at higher altitudes while the starter assisted relight is only available below FL200. In addition, a windmill relight enables the flight crew to perform simultaneous engine restart attempts.

1 Maintain optimum relight speed

Maintaining aircraft optimum relight speed provides sufficient airflow for the engines to reach a rotation speed that produces sufficient compression of the air in the compressor and combustion chamber necessary for a successful engine relight.

The optimum relight speed is provided:

- in the ENG ALL ENGINES FAILURE ECAM alert and in the QRH ALL ENG FAIL procedure of A320 family, A330 and A340 aircraft
- in the ENG ALL ENGINES FAILURE ECAM alert of A350 and A380 aircraft
- in the ALL ENG FAIL FCOM/QRH memory item of A300 and A310 aircraft.

2 Thrust levers set to IDLE

Positioning the thrust levers to idle will enable stable idle restart, and a reduced risk of stall that may be caused by immediate acceleration to high thrust if the thrust levers remained above the idle position.

3 ENG mode selector set to IGN

Set ENG mode selector to IGN to activate combustion chamber ignitors.

(fig.5)
First steps of the windmill relight sequence

4 ALL ENG MASTER switches to OFF for 30 s

This step will ventilate the combustion chamber to remove any residual fuel before the first relight attempt, and between relight attempts. Failure to ventilate the engine may result in an engine stall, an EGT overlimit, a tailpipe fire, or an unsuccessful relight attempt.

5 ALL ENG Master switches to ON

All ENG MASTER switches can be simultaneously set to ON for windmill relight attempts.

6 Monitor Engine parameters for at least 30 s

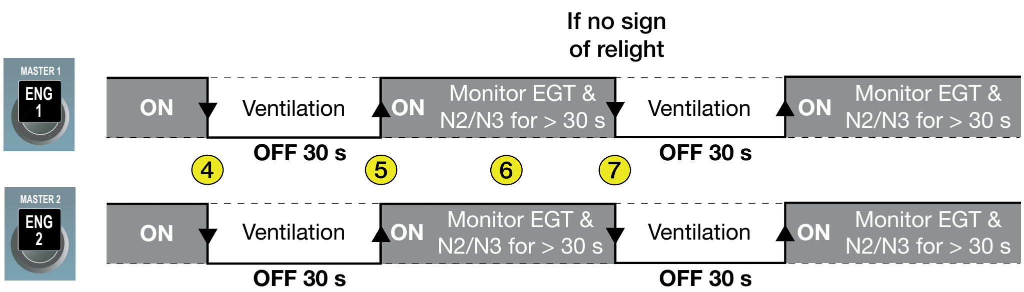
Monitor the EGT and N2 (N3 for Rolls Royce engines) for signs of relight for at least 30 s. If increase in N2/N3 and EGT is observed, continue with the relight attempt.

A successful in-flight windmill relight can take up to 2 minutes.

7 Repeat attempts if no restart occurs

If no sign of relight appears within 30 s, switch both engine master levers to OFF for 30 s to ventilate the engines and repeat the relight attempts until successful, or until reaching FL 200 where a starter-assisted relight can be attempted.

(fig.6)
Windmill relight sequence (simultaneous relight attempts)



Starter-Assisted Relight (Below FL 200)

The ALL ENG FAIL QRH procedure requests to start the APU when below the upper ceiling of the APU starting envelope, enabling recovery of the electrical power and the use of APU bleed.

Below FL 200, if the windmill relight was unsuccessful and if the APU is available, the flight crew can attempt a starter-assisted relight. **Only one engine (two on A380 aircraft) can be restarted at a time when attempting a starter-assisted engine relight.**

Thrust levers set to IDLE

The thrust levers should already be set to IDLE in the first part of the procedure.

ENG mode selector set to IGN

The ENG mode selector should also already be in the IGN position to activate combustion chamber ignitors.

1 ENG MASTER switches to OFF

Each engine must first be switched off for ventilation to remove residual fuel from the combustion chamber before any engine relight attempt. The time to perform the next two steps ensure a sufficient ventilation close to 30 s.

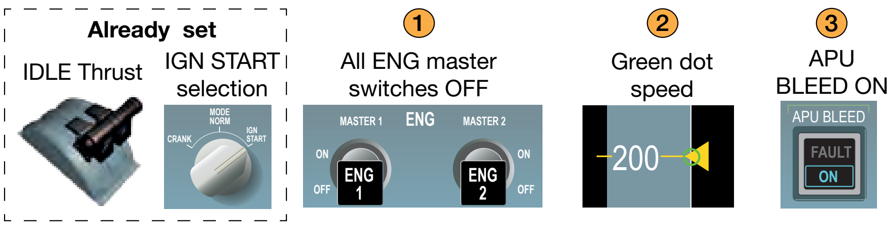
2 Reduce speed to green dot speed

Reducing the speed down to green dot speed reduces the aircraft rate of descent.

3 APU BLEED ON

APU BLEED should be set to ON.

(fig.7)
First steps of the starter-assisted relight sequence



4 Only one ENG MASTER switch to ON (two on A380 aircraft)

The flight crew must attempt to relight only one engine at a time during a starter-assisted relight on A300, A310, A320, A330, A340 and A350 aircraft. The APU cannot provide sufficient bleed pressure to relight two (or four) engines at the same time. On A380 aircraft, the relight attempt can be done on two engines simultaneously.

5 Monitor Engine parameters

Monitor the EGT and N2 (N3 for Rolls Royce engines) for signs of relight for at least 30 s. If increase in N2/N3 and EGT is observed, continue with the relight attempt.

A successful in-flight starter-assisted relight can take up to 2 minutes.

6 If no sign of relight within 30 s, all ENG MASTER switches OFF

If there is no sign of relight within 30 s, the flight crew should switch the engine master switch back to OFF to ventilate the engine.

Two options are then possible:

- **7 Immediate relight attempt of the other engine**

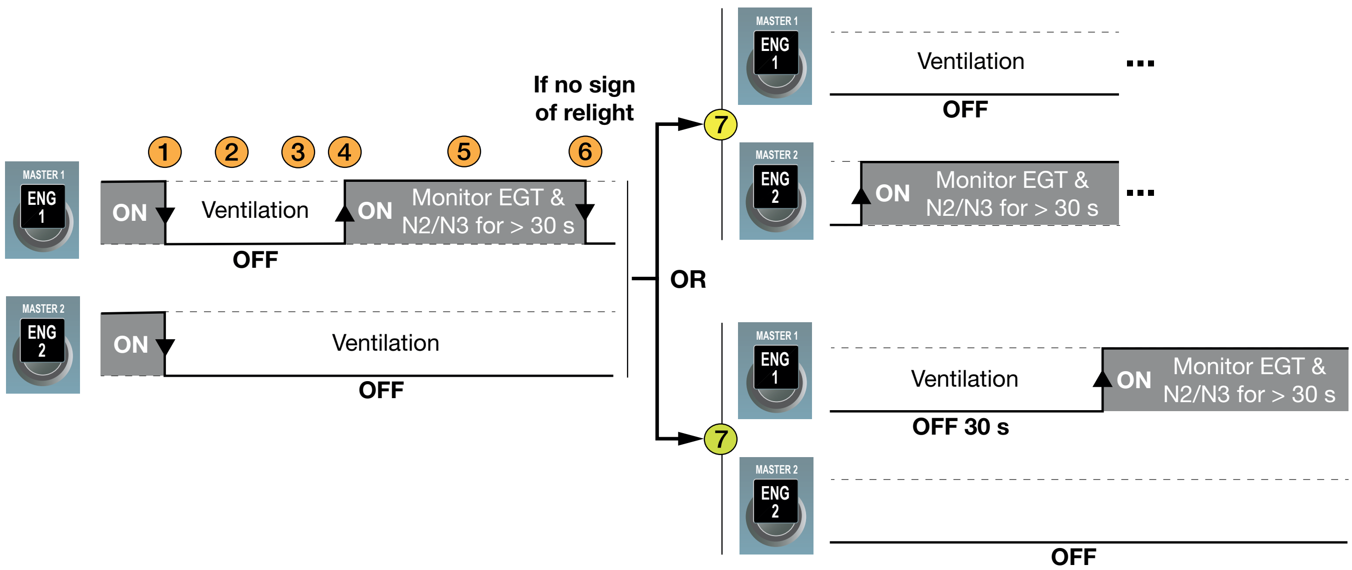
The flight crew can attempt to relight the other engine immediately since it was ventilated during the relight attempt of the first engine.

OR

- **7 Relight attempt of the same engine after a 30 s ventilation**

If the flight crew wants to relight the same engine if the other engine is damaged, they have to wait for 30s with the master switch to OFF until the engine is ventilated.

(fig.8)
Starter-assisted relight sequence (one engine at a time)



PRODUCT ENHANCEMENTS

Operational Documentation Improvement

The event described previously led Airbus to improve the operational documentation to prevent misinterpretation of the starter-assisted relight procedure included in the ALL ENG FAIL procedure of A300, A300-600, A310, A320 family, A330, A340, A350 and A380 aircraft. The update of the ALL ENG FAIL procedure in QRH/FCOM (for A300/A310/A320/A330/A340) and ECAM/FCOM (for A350/A380) is also associated to an update of the All Engines Failure procedure in the FCTM. This improvement is available in the following documentation revisions:

- A320 family, A330 and A340 aircraft: November 2024
- A300, A300-600 and A310 aircraft: March 2025
- A350 aircraft: mid 2025
- A380 aircraft: 2026

(fig.9)
Example of the procedure update on A320 family aircraft

Previous Procedure

- **If APU available and windmill relight unsuccessful: Starter Assisted Relight below FL 200**

  ALL ENG MASTERS....................................OFF
  OPTIMUM SPEED: GREEN DOT
  (REFER TO QRH/OPS Operating Speeds)
  WING ANTI ICE...OFF
  APU BLEED...ON
  ENG MASTER (ONE AT A TIME)..................ON
  Between each attempt to relight the same engine, wait at least 30 s with the associated ENG MASTER lever set to OFF.

Improved Procedure

- **If APU available and windmill relight not successful: Starter Assisted Relight below FL 200**

  ALL ENG MASTERS..OFF
  OPTIMUM SPEED: GREEN DOT
  (REFER TO QRH/OPS Operating Speeds)
  WING ANTI ICE...OFF
  APU BLEED...ON
  ENG RELIGHT (One at a time)
  ALL ENG MASTERS..OFF
  ENG MASTER 1 or 2...ON
  ENG PARAMETERS (N2/EGT).........MONITOR AT LEAST 30S
  - **If relight not successful**

    ALL ENG MASTERS..OFF
    FOR SAME ENGINE RELIGHT..........................WAIT 30S
    ENGINE RELIGHT (one at a time)........TRY REGULARLY

Flight Warning System Enhancements (A350 and A380 aircraft)

A Flight Warning System update is under study on A350 and A380 aircraft to improve the ECAM procedure.

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An all-engine flameout is a high-stress situation that requires immediate and precise crew action. Successful engine relight depends on meticulous execution of the procedure.

The 30 seconds engine ventilation removes any residual fuel from the engine's combustion chamber before the first relight attempt, and between relight attempts if unsuccessful. It prevents risks of engine stall, EGT overlimit, tailpipe fire or unsuccessful relight.

Windmill relights enable attempts to restart all engines at the same time at higher altitude.

Starter-assisted relights enable restart of only one engine at a time (two engines at a time on A380 aircraft only) due to APU bleed air limitations and can only be performed below FL200.

Flight crew should monitor the EGT and N2 (N3 for Rolls Royce engines) for signs of relight for at least 30 s. If there are signs of relight within 30 sec, continue with the current engine restart attempt. A successful in-flight relight may take up to 2 minutes. If there are no signs of relight within 30 s, set all ENG MASTER switches to OFF and initiate a new relight attempt.

The event described in this article also illustrates the importance of maintaining situational awareness during emergencies, and correctly applying QRH procedures during an extremely high stress situation.

Further Preventing Loss of Control In-flight

Loss of Control In-flight (LOC-I) has been one of the main categories of fatal accidents since the beginning of commercial jet aviation. While flight envelope protections in fourth-generation aircraft have reduced LOC-I incidents by 90% compared to third-generation aircraft, the continuous enhancement of aircraft systems is necessary to further prevent potential future accidents. Airbus has leveraged lessons learned from in-service events to implement advanced safety improvements in A350 aircraft, further mitigating the risk of LOC-I accidents. The objective is now to upgrade the A320 family, A330, and A380 aircraft to get as close as possible to the A350 standard for LOC-I prevention.

This article will describe these safety improvements, and outline a strategy for implementing them across the Airbus fleet.

STRENGTHENED PROTECTIONS

There are three barriers against LOC-I events that are available on fourth generation commercial jet aircraft.

1. Autoflight

Autoflight assists flight crew in phases such as high altitude flying and can maintain control of the aircraft when difficult conditions are encountered, like turbulence. Flight crew workload is also reduced when autoflight is used, allowing them to focus on management of system failures should they occur.

2. Flight Crew Awareness

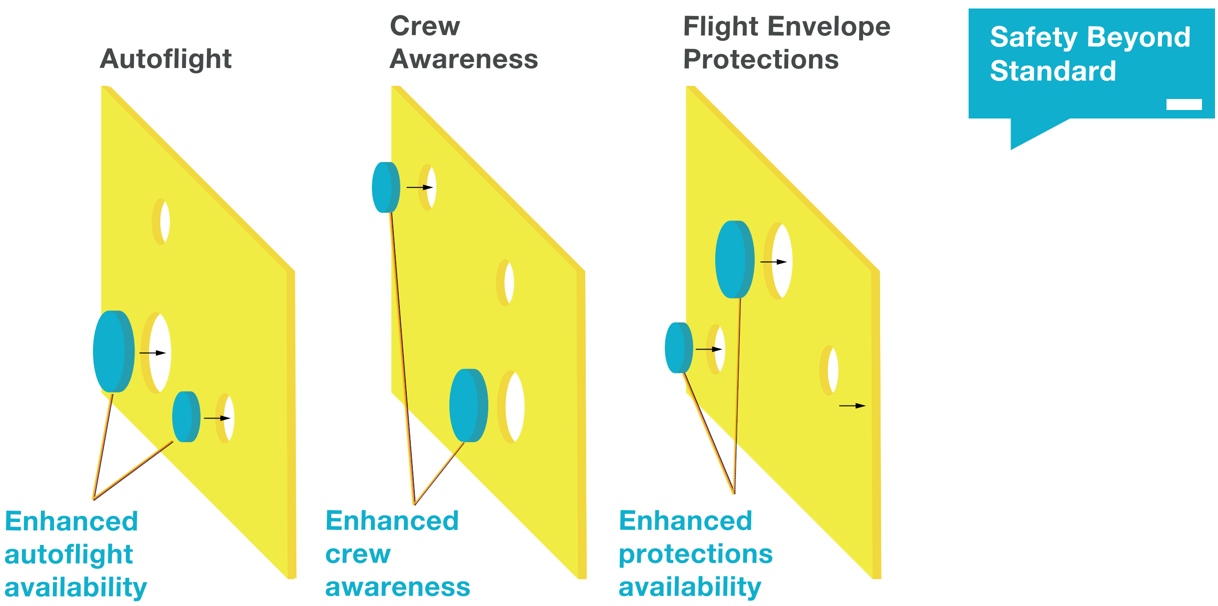
When autoflight is not used, or if autoflight capability is lost due to a system failure, or autopilot domain exceedance, the flight crew's awareness of the situation will enable them to react and perform appropriate manual flying inputs.

3. Flight Envelope Protections

In certain, but rare conditions, the flight crew may lose situational awareness, which can cause them to make inappropriate inputs on the flight controls. The crew may also need to make rapid flight control inputs to perform an avoidance maneuver. In these cases, the flight envelope protection introduced on the fourth generation of jet aircraft, provides the third barrier to prevent LOC-I events.

Lessons learned from inservice events have driven the design of additional enhancements for each of the three safety barriers on the A350 aircraft. The objective of the Safety Beyond Standard initiative is to also implement these enhancements on the eligible A320 Family, A330 and A380 aircraft to bring most of the Airbus fleet closer to the A350 standard. ■

(fig.1)
The three barriers against LOC-I that are available on fourth generation jet aircraft and strengthened protections available.



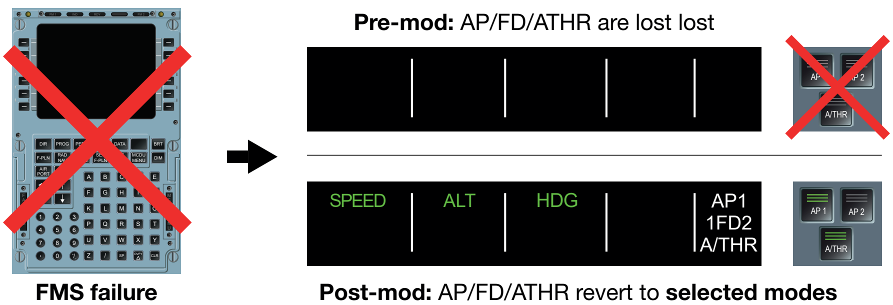
ENHANCED AUTOFLIGHT AVAILABILITY

This increases the availability of the autopilot and autothrust, and reduces the risk of flight crew startle due to a sudden loss of autopilot and autothrust. The difference of the original configuration (pre-mod) and the increased availability after implementation (post-mod) is described for each enhancement.

Enhanced Autoflight: Robustness to FMS Failures

A majority of cases reporting loss of autoflight system are due to a failure or reset of the Flight Management System (FMS). In pre-mod configuration, when the FMS fails or resets, the autopilot (AP), Flight Director (FD) and autothrust (ATHR) disconnect **(fig.2)**.

In post-mod configuration, the AP/FD/ATHR remain available in selected mode if the FMS fails or resets.



(fig.2)
Enhanced Autoflight Robustness to FMS Failures

Availability of the robustness to FMS failures

This enhancement is available on all A320 family aircraft manufactured from 2021. It is available for retrofit on all A320 family aircraft manufactured before 2021.

A330 aircraft with GENEPI FMGEC hardware, which represents around 70% of the fleet, can have the enhancement after upgrade to the H7 FMGEC standard that is available from 2022.

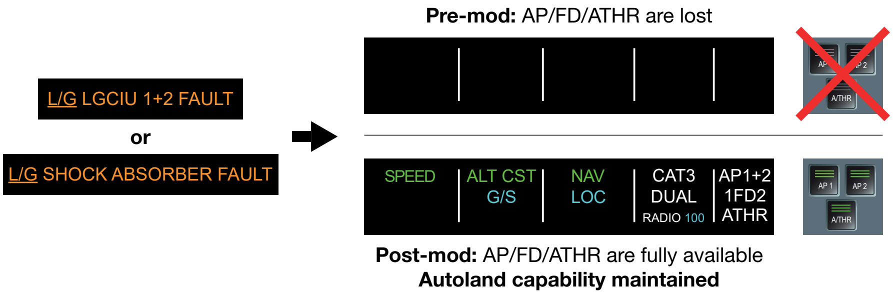
This enhancement was installed as standard (or basic) on all A380 aircraft.

A320				A330				A380			
% Fleet	Computer	Standard	Avail. date	% Fleet	Computer	Standard	Avail. date	% Fleet	Computer	Standard	Avail. date
100 %	FMGC	FG3G: PC20/ PI18	Avail.	70 %	FMGEC "GENEPI" hardware only	H7	Avail.	100% (basic)	PRIM	All	Basic

Enhanced Autoflight Robustness to LGCIU Failures

Autoflight needs landing gear information (extended/retracted and compressed/uncompressed). As a consequence, in the initial design, AP/FD/ATHR are lost in the case of a L/G LGCIU 1+2 FAULT or L/G SHOCK ABSORBER FAULT **(fig.3)**.

In post-mod configuration, the flight guidance uses an additional source for landing gear information. AP/FD/ATHR will remain available if both Landing Gear Control Interface Unit (LGCIU) fail or in the case of a LDG SHOCK ABSORBER FAULT ECAM alert, maintaining capacity to perform CAT II or CAT III operations. This enhancement was installed as standard (basic) on all A330 and A380 aircraft



(fig.3)
Enhanced autoflight robustness to dual LGCIU failure

Availability of the robustness to LGCIU failures

This enhancement is standard (basic) on all A320 family aircraft manufactured from 2021. It can be retrofitted on all previously built A320 family aircraft.

This enhancement was installed as standard (basic) on all A330 and A380 aircraft.

A320				A330				A380			
% Fleet	Computer	Standard	Avail. date	% Fleet	Computer	Standard	Avail. date	% Fleet	Computer	Standard	Avail. date
100 %	FMGC	FG3G: PC20/ PI18	Avail.	100% (basic)	FMGEC	All	Basic	100% (basic)	PRIM	All	Basic

Enhanced Autoflight Robustness to Air Data Failures

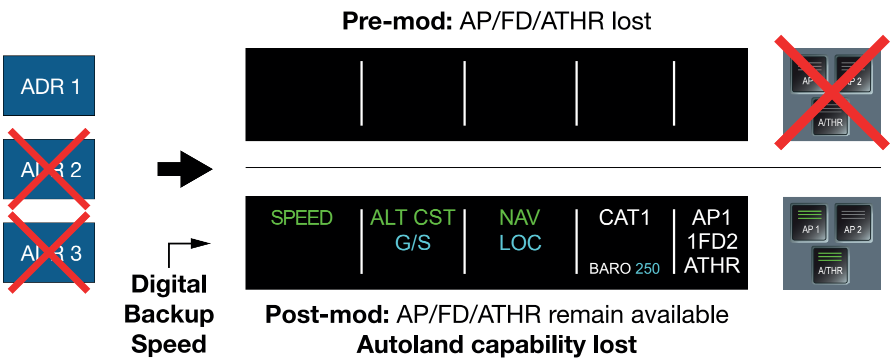
In pre-mod configuration, AP/FD/ATHR requires at least two independent and consistent airspeed sources to be available. As a consequence, AP/FD/ATHR are lost in the case of a loss of the data from 2 ADRs.

Speed Monitoring function (Unreliable Airspeed Mitigation Mean (UAMM) step 2)

In post-mod configuration, the use of an independent airspeed estimator, called **"Digital Back-Up Speed" (DBUS)**, is based mainly on angle-of-attack, load factor value, aircraft weight and configuration, which enables **monitoring of the remaining ADR speed data.** As a consequence, the following autoflight availability is reinforced in the case of loss of air data as follows:

Only one ADR available

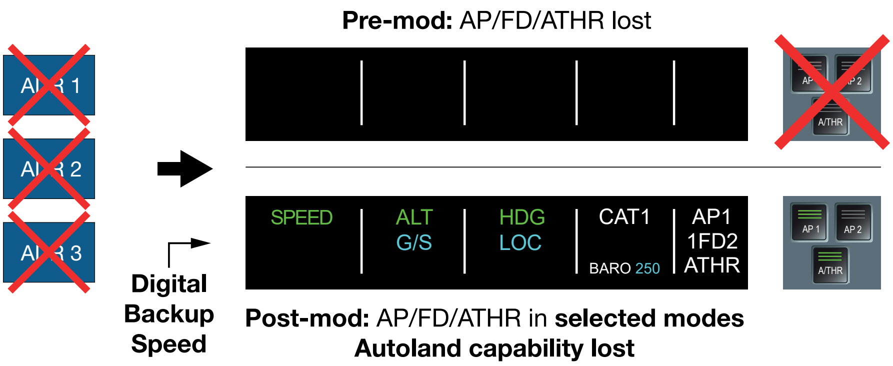
The AP/FD/ATHR will remain available even if two ADRs are lost . Automatic landing is however no longer available. CAT I operations remain possible (G/S and LOC modes remain available).



(fig.4)
Enhanced autoflight robustness to dual air data failure

Only digital backup speed available

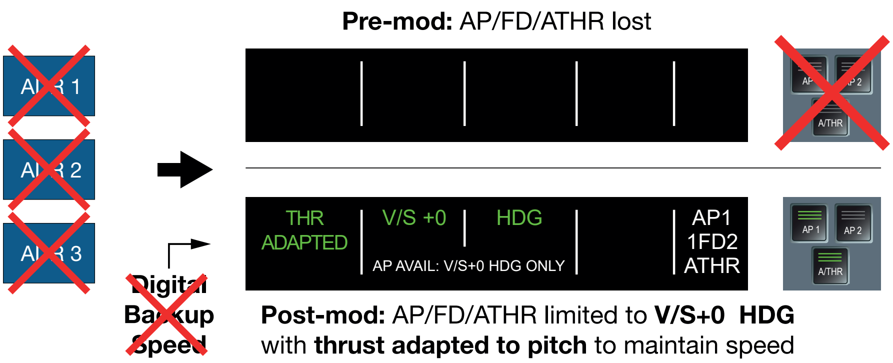
If only the digital backup speed is available, the AP/FD/ATHR remain available, but in only selected modes. Automatic landing is however no longer available. CAT I operations remain possible (G/S and LOC modes remain available).



(fig.5)
Enhanced autoflight robustness to triple air data failure

No air data available

If no air data is available, including the digital backup speed, the AP/FD/ATHR remains available in clean configuration, but it will be in a degraded mode that maintains the aircraft in level flight and heading only. The ATHR will adapt thrust to maintain the aircraft in the middle of the flight envelope. ■



(fig.6)
Enhanced autoflight robustness to triple air data failure (digital backup speed not available)

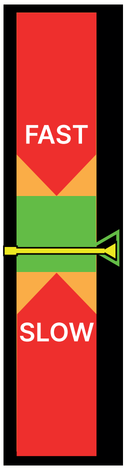
Availability of the robustness to air data failures

A320	A330				A380
	% Fleet	Computer	Standard	Avail.date	
Not available	A330-900: 100%	FMGEC (Genepi hardware only)	H7	Available	Not available
		EIS2	L14		
		FWC	T9		
		FCPC	M30neo		

ENHANCED CREW AWARENESS

Unexpected events in flight require appropriate action from the flight crew. Examples of events include: Approach to stall, unreliable airspeed and excessive bank angle. When these situations occur, flight crews must apply recovery actions in a controlled and calm manner. Improved alerting cues and additional speed information will assist flight crews to manage these unexpected events.

These enhancements improve situational awareness and aid in assessing the situation quickly. With better awareness and assessment, flight crews can apply the correct procedures safely and more effectively.



(fig.7)
Pre-mod backup speed scale

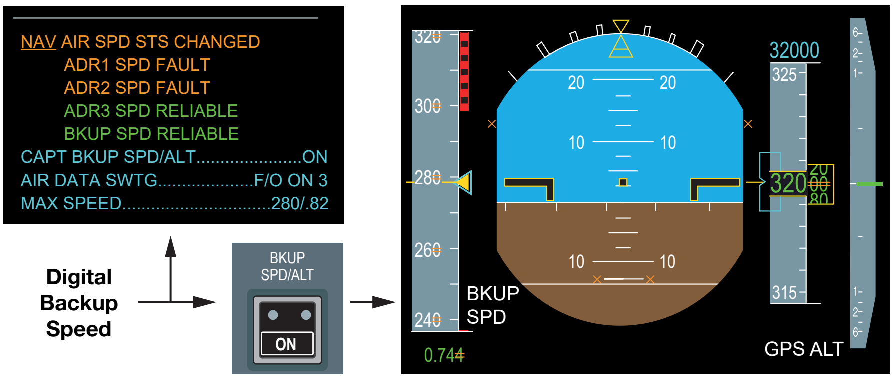
Digital Back-Up Speed/Altitude Display and Assistance to Speed Information Selection

In pre-mod configuration, the aircraft are equipped with a backup speed scale based on angle-of-attack value, providing speed information to the flight crew using color bands that they can use below FL 250 **(fig.7)**.

In post-mod configuration, the introduction of a digital backup speed **(fig.8)** computed with angle of attack value, aircraft weight and load factor provides an additional speed indication to the flight crew that can be displayed on the PFD when necessary. The digital backup speed has an accuracy of +/- 15 kt, which means that the last digit of the speedscale is shown with a strikethrough line on the PFD. The flight crew can display or remove the digital backup speed by pressing a dedicated pushbutton for each PFD.

As the majority of pitot freezing events observed in-flight are temporary in nature, the display of digital backup speed is reversible, which enables it to be switched off and revert to the anemometric speed if the ADR data is recovered and reliable.

The independent airspeed source provided by the digital back-up speed also enables additional monitoring of the data from the ADRs. An enhanced ECAM procedure provides a status of the speed data from the 3 ADRs and of the digital backup speed. It also provides guidance to the flight crew for selection of the correct air data and will request the flight crew to switch the digital backup speed indication to ON when necessary.



(fig.8)
Post-mod digital back-up speed indication and assistance to ADR switching

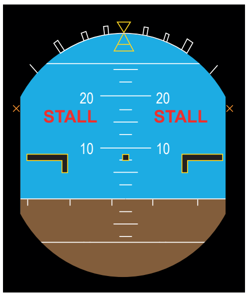
A380 aircraft: Same ADR monitoring and automatic airspeed switching as on A350 aircraft

On A380 aircraft, the same ADR monitoring function and automatic PFD airspeed display as on A350 aircraft will be available from Avionic batch 8.

Availability of the Digital Back-Up Speed/Altitude Display and Assistance to Speed Information Selection

A320				A330				A380		
% Fleet	Computer	Standard	Avail. date	% Fleet	Computer	Standard	Avail. date	% Fleet	Computer	Avail. date
45 %	FAC C	CAA13	Avail.	A330-900: 100%	FCPC	M28 neo	Avail.	100%	Avionic Batch 8	2027
	FWC	H2F13			FWC	T9				
	EIS2	S16			EIS2	L13				
	FDIMU	FS3.1			FDIMU	FL4				
	Wiring & Push buttons				FCDC	L27 HS				
					Wiring & Push buttons					

STALL message on PFD



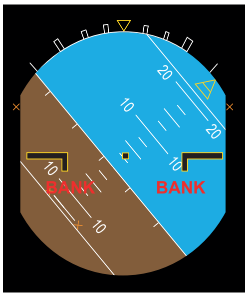
An update of the EIS introduces a visual red alert on the PFD in addition to the existing aural stall warning. This improves the warning of an approaching stall situation and alerts the flight crew that they must apply corrective or recovery actions to avoid the stall condition.

(fig.9) "STALL" message on the PFD

Availability of the STALL message on the PFD

A320				A330				A380			
% Fleet	Computer	Standard	Avail. date	% Fleet	Computer	Standard	Avail. date	% Fleet	Computer	Standard	Avail. date
100 % (12% with EIS1 LRU upgrade)	EIS	EIS2 S12 EIS1 V80	Avail.	100%	EIS	EIS1 V114/V515 EIS2/EEIS L9E	Avail.	100%	Basic		

Excessive Bank Angle Alert in Alternate and Direct Laws



This enhancement introduces a message on the PFD and a **"BANK BANK"** aural alert when the aircraft reaches an excessive bank angle (above 45°) in alternate and direct laws where no excessive bank angle protections are provided.

(fig.10) "BANK BANK" message on the PFD

Availability of the excessive bank angle alert in alternate and direct laws

This enhancement is available for all manufactured aircraft , or for retrofit on all of the existing A320 family and A330 aircraft fleets. However, aircraft fitted with EIS 1 standard will only have the audio alert. This enhancement was installed as standard (basic) on all A380 aircraft.

A320				A330				A380			
% Fleet	Computer	Standard	Avail. date	% Fleet	Computer	Standard	Avail. date	% Fleet	Computer	Standard	Avail. date
100 % (12% EIS1 audio only)	FAC B hardware	Next standard	TBD	A330-800 & -900: 100%	FCPC	P17A/ M28neo	Avail.	100%	Basic		
	FAC C hardware FWC EIS2	CAA13 F13 S16	Avail.		FWC	T9-2	Avail.				
					EIS2	L13	Avail.				
					FCDC	L27	Avail.				

ENHANCED FLIGHT ENVELOPE PROTECTION AVAILABILITY

Enhancement of the flight envelope protection availability strengthens the third safety barrier that prevents LOC-I events.

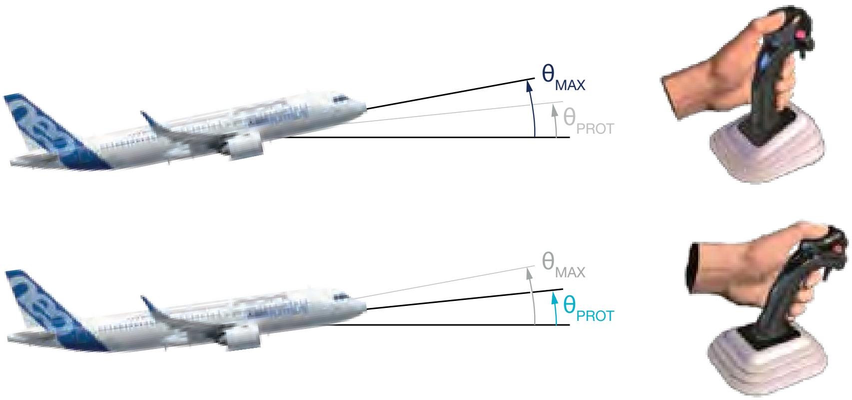
Pitch Attitude Limitation in Alternate Law

In pre-modification configuration, there is no flight envelope protection available for the pitch axis in alternate law.

In post modification configuration, a pitch angle limitation is available in alternate law when the aircraft is in clean configuration **(fig.11)**. This prevents rapid speed decay, reducing the risk of going too far outside of the flight envelope. Two limitations are introduced:

- ***θmax*** is the maximum pitch angle that can be reached with the sidestick maintaining a pitch-up demand
- ***θprot*** is the maximum pitch angle that can be maintained with the sidestick in the neutral position.

Both maximum pitch angles vary as a function of altitude. Potential stall situations are therefore limited in case of inappropriate flight crew nose-up inputs.



(fig.11)
Pitch attitude limitation in Alternate law

Availability of the pitch attitude limitation in alternate law

A320				A330				A380		
% Fleet	Computer	Standard	Avail. date	% Fleet	Computer	Standard	Avail. date	% Fleet	Standard	Avail. date
100 % (except A318)	ELAC	L104	Avail.	**A330-200 electrical rudder: 100 %**	FCPC	P19	2025	**100 %**	Avionic Batch 8	2027

Flight envelope protections maintained in the case of yaw damping function loss on A320 family aircraft

In pre-mod configuration, in the case of a loss of the yaw damping function caused by **loss of both yaw dampers** or **loss of both FAC computers,** normal law and flight envelope protections are lost, leading to a reversion to Alternate law.

In post-mod configuration, the aircraft also reverts to Alternate law, but **the protections from the normal law remain available** with possible reduced efficiency due to the absence of yaw damping.

Availability of the maintained protections in case of yaw damping function loss

A320				A330	A380
% Fleet	Computer	Standard	Avail. date		
100 % (except A318)	ELAC	L104	Avail.	Not available	Not available

Avoid undue simultaneous FAC Resets on A320 family aircraft

In the case of a Rudder travel limiter fault on A320 aircraft, the ECAM procedure requests the flight crew to reset each FACs in a sequence to try to recover the function. The enhancement introduced improves the procedure by adding an "IF UNSUCCESSFUL:" line to make it more obvious to the flight crew to avoid performing simultaneous resets of the FACs, which results in a temporary loss of the normal law and its associated flight envelope protections.

(fig.12)
Enhanced ECAM procedure to prevent simultaneous FAC reset

Pre-mod

AUTO FLT AP OFF
AUTO FLT RUD TRV LIM SYS
RUD WITH CARE ABV 140 KT
- FAC 1 ....OFF THEN ON
- FAC 2 ....OFF THEN ON

Post-mod

AUTO FLT AP OFF
AUTO FLT RUD TRV LIM SYS
RUD WITH CARE ABV 140 KT
- FAC 1 ....OFF THEN ON
. IF UNSUCCESSFUL :
- FAC 2 ....OFF THEN ON

Availability of the enhanced AUTO FLT RUD TRV LIM SYS ECAM alert

A320				A330	A380
% Fleet	Computer	Standard	Avail. date		
100 %	FWC	F12	Avail.	Not applicable	Not applicable

ENHANCEMENTS IMPLEMENTATION

Making these safety enhancements available is part of the continuous enhancement of all Airbus aircraft. The opportunity to implement these enhancements as a retrofit solution on the existing Airbus fleet is key to further prevention of LOC-I events. Airbus has several monitored retrofit campaigns to encourage and assist Operators to implement these enhancements for their operational aircraft.

Software provided free of charge

To facilitate the retrofit of these enhancements on the compatible aircraft, Airbus provides the software updates free of charge to Operators.

Limited grounding time

The software updates that introduce these enhancements can be done in a relatively short time, limiting the time of aircraft on ground and limiting the cost of labor hours.

For more information on the monitored retrofit campaign, please contact the Retrofit Operations team at monitored.retrofit@airbus.com.

Mixed Fleet considerations

Operators may have aircraft with different technical configurations that are not all compatible with the retrofit of certain enhancements. This should not prevent them from implementing the enhancement on their aircraft that are compatible. It is an essential step to take safety beyond the standard for those aircraft that are configured and capable of being retrofitted. This will enhance the overall safety resilience of the fleet.

Limited operational impact

All the listed enhancements have a limited operational impact since most of them are enhancement of the availability of already existing functions. The new displays, and new or updated procedures are described in the FCOM and QRH.

Limited training requirement

Analysis of the training requirements showed that either a **level A** (self Instruction) or **level B** (aided instruction) training is required to familiarize flight crews with these enhancements.

	Enhancements	Training level	Documentation Impact
Enhanced autoflight availability	Enhanced Autoflight Robustness to FMS Failures and LGCIU failures	**B**	FCOM, FCTM
	Enhanced Autoflight Robustness to Air Data Failures (Alternate AP)	**B**	FCOM, FCTM, AFM, QRH
Enhanced crew awareness	Digital Back-Up Speed (UAMM step 2)	**B**	FCOM, FCTM, QRH, AFM, MMEL
	Excessive Bank Angle Alert	**A**	FCOM, FCTM, AFM
	Stall message on PFD	**A**	FCOM
Enhanced flight envelope protections availability	Avoid undue simultaneous FAC Resets on A320 family aircraft	**A**	FCOM
	Pitch Attitude Limitation in Alternate Law (PALAL)	**A**	FCOM
	Flight envelope protections maintained in the case of yaw damping function loss on A320 family aircraft	**A**	FCOM

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Customer Support

Airbus has developed safety enhancements for the eligible A320 family, A330, and A380 aircraft to address Loss of Control In-flight (LOC-I) risks. The objective of these enhancements is to bring the entire Airbus fleet as close as possible with A350 safety standards with a focus on the three key areas of: Enhanced autoflight availability, improved flight crew awareness, and strengthened flight envelope protection.

Implementation of these enhancements on the aircraft with capable configurations are designed to allow retrofit with minimal operational impact, optimized costs of integration (e.g. software updates provided free-of-charge by Airbus), require limited additional crew training (Level A or B).

These enhancements enhance LOC-I prevention, which is why operators with partially compatible or mixed fleet configurations are encouraged to implement upgrades where possible, as the safety benefits outweigh any potential fleet inconsistencies.

By adopting these improvements, operators contribute to an increase in overall fleet safety. The enhancements are an essential step in taking safety beyond standard, through leveraging operational experience and technology to further prevent LOC-I events. Airbus has launched monitored retrofit campaigns, working with operators to implement these safety enhancements at the earliest opportunity, reinforcing our collective commitment to aviation safety.

A platform that provides Airbus Flight Instructors worldwide with videos, presentations and other information from the Airbus Flight Operations and Training Standards department.

Available on

Website
airbus-win.com

Androïd
app

iOS
app

1995-2025

30 years of safety information sharing