The Airbus safety magazine

#37

Safety first

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.

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editorial

YANNICK MALINGE

SVP & Chief
Product Safety Officer

Dear Aviation Colleagues,

Three of the most recent Safety first articles have highlighted events with unexpected, or unintended, aircraft behavior. In such cases, reporting these events is essential to better understand the cockpit conditions and human factors involved. This allows for the immediate actions such as raising awareness and increasing the flight crew's vigilance to detect these potential problems.

Reported events also provide data needed for analysis and development of possible enhancements that can further increase the resilience of the aircraft's systems. This is why the importance of reporting will be a topic in focus at our upcoming 28th Airbus Annual Flight Safety Conference.

Airline speakers will provide testimony about how they empower and encourage their flight, cabin, and maintenance crews to speak up and report events, even for an incident when there were no operational consequences. We will also recall how Airbus manages in service reports and practical illustrations of when reporting has made the difference and further enhanced safety.

Whilst we may reflect on the good safety record of last year, the first week of 2024 provided a stark reminder for why we must remain vigilant in all aspects of aviation safety. The images of the JAL516 flight after a ground collision with the Japan Coast Guard aircraft was an unfortunate realization of runway safety risks recently in focus for a number aviation organizations globally. It is a call for timely action and to redouble our collective efforts in addressing all such safety risks.

Thankfully, we can acknowledge the swift actions of the flight and cabin crew to effectively evacuate all passengers from the aircraft, which highlights the importance of regular training, practice and a strong safety culture. I also extend my sincere and heartfelt condolences to the families and friends of the Japan Coast guard members who lost their lives.

Despite this very challenging start to the year, together with the Airbus Safety team, I pass on our best wishes for a safe and prosperous year ahead.

Safety Publications

Safety first

The Airbus safety magazine

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The 28th Airbus Flight Safety Conference will be held in Bangkok, 18-21 March 2024

This event provides the opportunity for Airbus and its customers to exchange on how we can further strengthen safety in our Air Transport System.

With the current rapid increase of passenger demand, our industry still has to face a number of safety challenges to maintain its safety record. This is why the agenda of the conference will include a review of the risks, associated mitigations, and best practices based on recent in-service events, including: dispatch challenges, runway safety, severe weather and investigation updates. We will also focus on the importance of reporting with illustrative examples given by airlines and Airbus presenters.

Growing our safety culture and building safety networks is essential for safety and so we encourage all our customers to join us.

Safety first #37

Flight Operations

Cabin Operations

Ground Operations

Maintenance

OPERATIONS

Inadvertent Autopilot Engagement during Takeoff on A220 Aircraft

Several in-service events were reported to Airbus where the flight crew inadvertently selected the autopilot while attempting to engage the autothrottle during the takeoff roll. Inadvertent autopilot engagement may result in early rotation that can lead to a tail strike, inability to climb, runway overrun, or even loss of control.

The purpose of this article is to describe the circumstances leading to this type of event with a case study and to provide details about the procedure updates and planned product enhancements that aim to prevent recurrence.

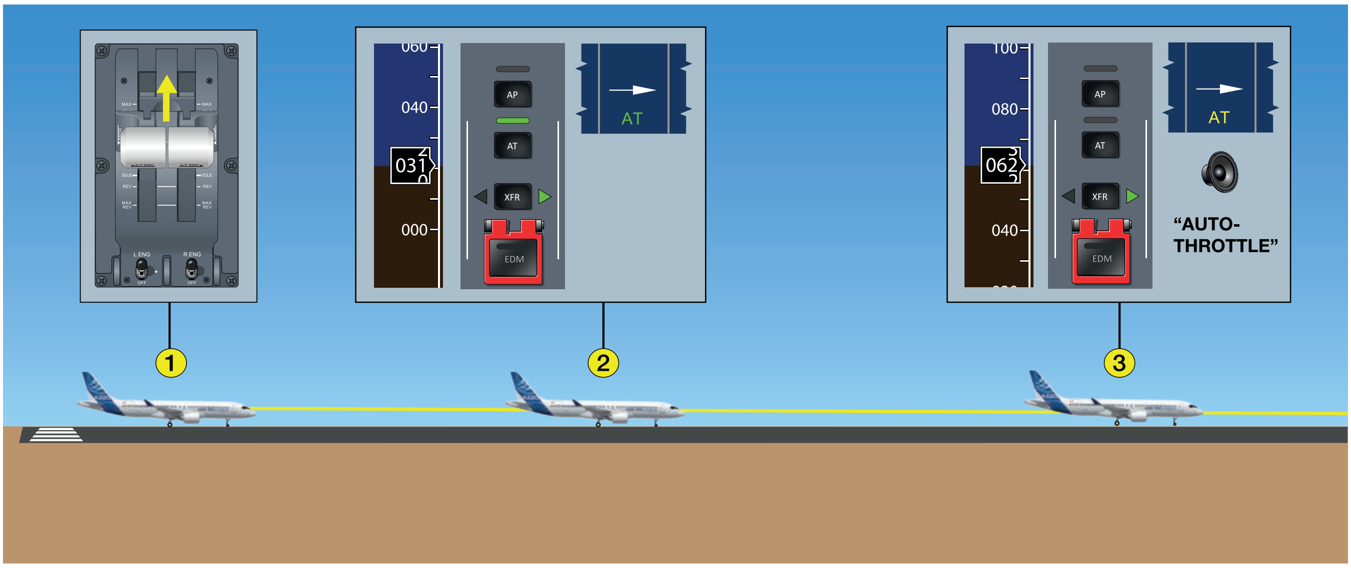
Check the latest version of this article on **safetyfirst.airbus.com** and on the Safety first app for iOS and Android devices.

CASE STUDY

Event Description

An A220 aircraft was aligned on the runway and ready for a flap 2 and TO-3 derated takeoff. The computed takeoff speeds were 135 kt for V1, 137 kt for VR, and 141 kt for V2. The autothrottle was armed **(fig.1)**.

1 The flight crew moved the thrust levers forward to initiate takeoff. 2 The autothrottle engaged at approximately 31 kt and the takeoff thrust (81.5% N1) was reached at approximately 40 kt. 3 At 62 kt, the autothrottle unexpectedly disconnected, accompanied by the “**AUTOTHROTTLE**” aural alert.

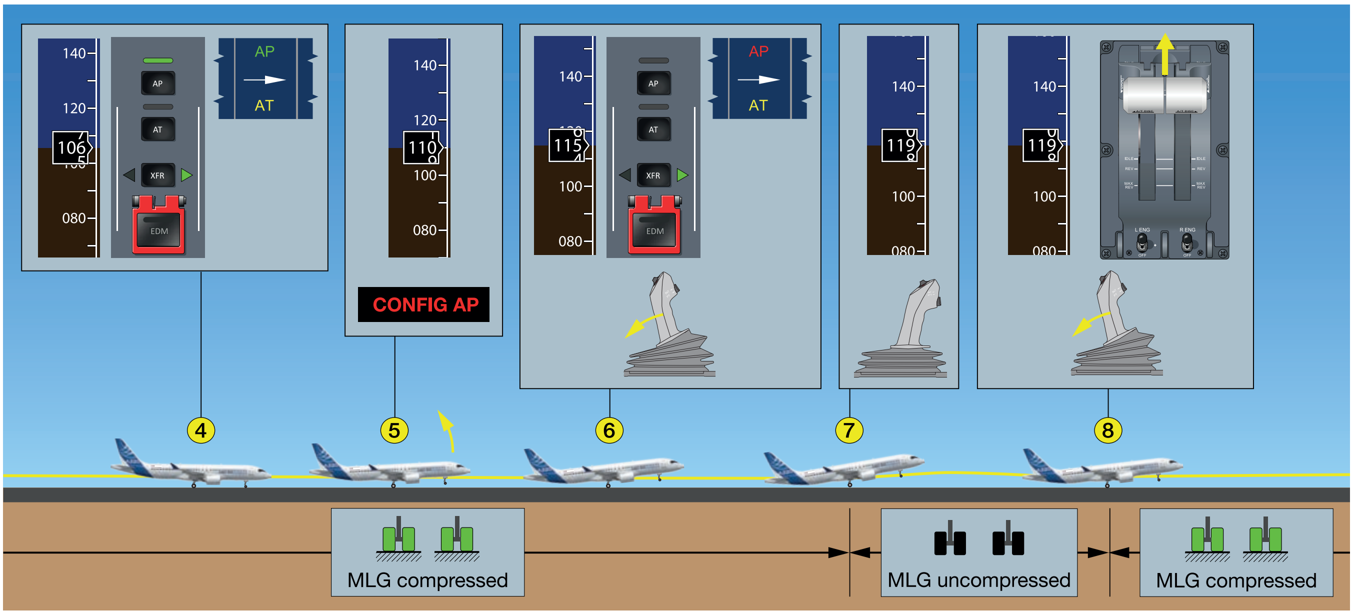


(fig.1)
Illustration of the event - part 1

4 At 106 kt, the flight crew wanted to re-engage the autothrottle but they pressed the autopilot AP switch instead of the AT switch on the Flight Control Panel (FCP). 5 The CONFIG AP EICAS alert triggered at 110 kt (VR- 27 kt), but without the associated “CONFIG AUTOPILOT” aural alert as the “**AUTOTHROTTLE**” aural alert was still repeating. With the AP engaged, the aircraft started to rotate. 6 At 115 kt (VR-22 kt), the PF disconnected the autopilot and briefly applied

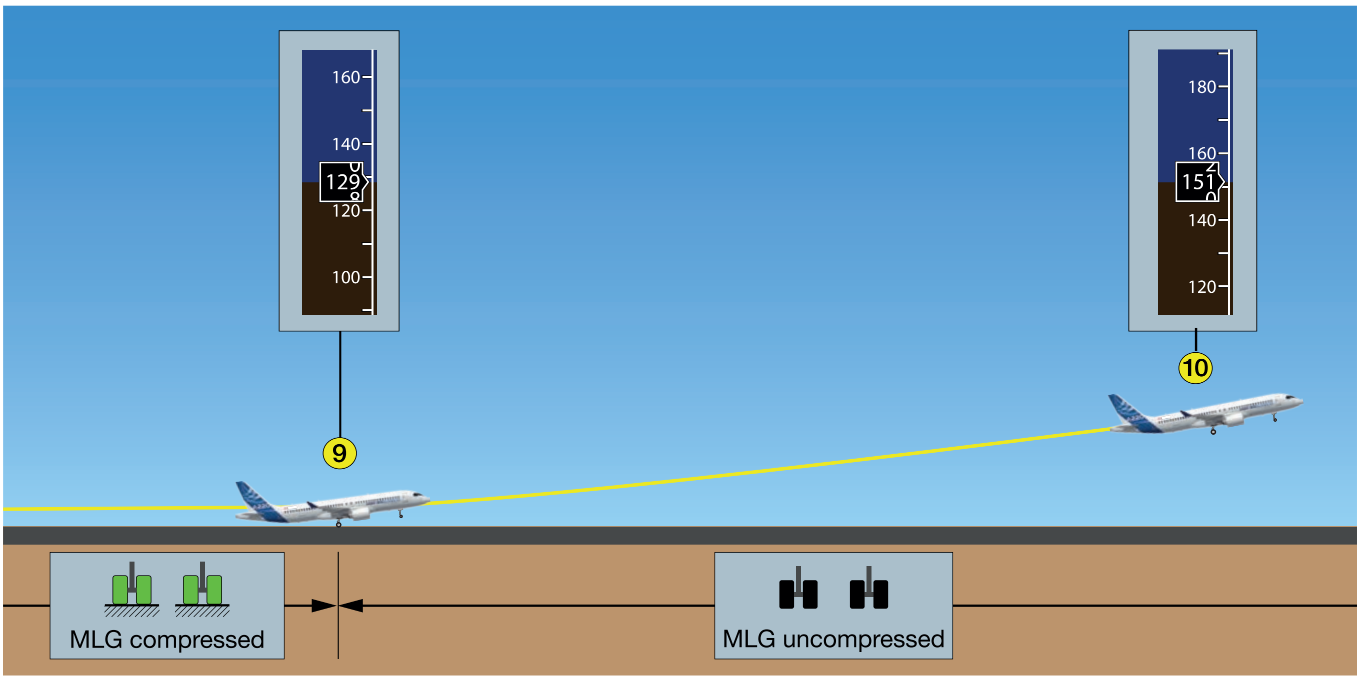
(fig.2)
Illustration of the event - part 2

66% backstick input before releasing the sidestick to neutral. 7 At 119 kt (VR-18 kt), the aircraft pitch reached 10.7 ° and the strut of the main landing gear decompressed. 8 1s later, the landing gear was compressed again and the aircraft pitch reduced slightly to 7.5 °. The captain (PM) pushed the thrust levers to MAX and the first officer applied 50% backstick inputs.



(fig.3)
Illustration of the event - part 3

9 The landing gear decompressed again when the aircraft reached 129 kt (VR-8 kt) and began to climb. 10 The aircraft reached 151 kt (V2 + 10kt) at 100 ft RA. The flight crew deactivated the repetitive “**AUTOTHROTTLE**” aural alert and continued the flight.



Event Analysis

Inadvertent selection of the autopilot

When the autothrottle unexpectedly disconnected during the takeoff roll, the flight crew tried to manually reengage it using the autothrottle switch, but they inadvertently pressed the autopilot switch instead. This caused the autopilot to be engaged with the aircraft still on ground.

Autopilot commanded rotation

The autopilot commanded a pitch-up when it was inadvertently activated on the ground to reach the flight guidance pitch target. This caused the aircraft to rotate too early when the aircraft was still 27 kt below VR.

No "CONFIG AUTOPILOT" aural alert

The "**CONFIG AUTOPILOT**" aural alert did not sound, because the repetitive "**AUTOTHROTTLE**" aural alert was still active when the CONFIG AP EICAS alert was triggered.

Reduced Tailstrike Margin

During the event, at step 7, the aircraft pitch attitude was 10.7° when the aircraft was still on the ground, which corresponds to a tailstrike margin as low as 1 to 2 ft.

OPERATIONAL CONSIDERATIONS

The A220 FCOM and AFM were updated and the red OEB 001 was published to provide procedures and information to flight crews with the aim to raise awareness and prevent any unintentional selection and engagement of the autopilot during the takeoff roll if attempting to select and engage the autothrottle.

No autothrottle selection during takeoff roll

The flight crew must not attempt to select and engage the autothrottle during the takeoff roll. This will reduce the risk of unintentional selection of the autopilot switch.

As a reminder, the autothrottle selection pushbutton on the FCP is inhibited above 60 kt when the HOLD Mode activates and remains inhibited until reaching 400 ft AGL.

Managing autothrottle disconnect during takeoff

A220 FCOM 2 “Normal Procedures - Normal takeoff / High wind takeoff, Step (3) Autothrottle“ was updated to provide flight crews with a procedure if the autothrottle disconnects during the takeoff roll.

Autothrottle disconnect below 60kt

If the autothrottle disconnects below 60 kt, the flight crew must abort takeoff.

Autothrottle disconnect above 60 kt

- **In the case of a TO or FLEX takeoff,** the thrust levers must be set to MAX to continue the takeoff.

- **In the case of a derated takeoff (TO-1, TO-2, or TO-3):**

  - If the N1 of both engines matches the N1 target, the flight crew can continue the takeoff

  - If the N1 of either or both engine(s) does not match the N1 target, the flight crew must abort the takeoff.

When stabilized in climb (not below 400 ft)

After the aircraft is established on a stabilized climb above 400 ft, the flight crew can reengage the autothrottle as required. For derated thrust or FLEX takeoff, they must confirm that the autothrottle is selected on.

AFM update

The AFM was updated to add a warning in the limitations section for the autopilot. It states that **“Autopilot engagement during takeoff roll can result in premature rotation, possibly leading to tail strike, inability to climb or loss of control. Immediate crew intervention is required.”**

Training

The Operations Training Transmission A220-OTT-22-00-001 Rev 00 (dated 14-July-2023) recommends that Operators and Training Organizations:

- Reinforce flight crew knowledge on:
  - The importance of reviewing OEBs together during preflight
  - The content of the red OEB "INADVERTENT AUTOPILOT ENGAGEMENT DURING TAKEOFF"
  - The temporary AFM and FCOM 2 takeoff normal procedure "Autothrottle disconnect during takeoff"
- Highlight the importance of the role of Pilot Monitoring.

INFORMATION

Further information can be found in the following documents:

- **FOT A220-FOT-22-00-001** dated 09-NOV-22 "ATA 22 – A220 Inadvertent Autopilot Engagement During Takeoff" available on the A220World portal
- **TCCA Emergency AD CF-2022-64**
- **FAA Emergency AD 2022-25-51**
- **A220 Red OEB-001.01 Inadvertent Autopilot Engagement During Takeoff** published on 28-March-2023
- **A220 AFM - Limitations, Autopilot**
- **A220 FCOM – Normal Procedures - Normal takeoff / High Wind Takeoff, Step (3) Autothrottle**
- **A220-OTT-22-00-001 Rev 00** dated 14-July-2023A

PRODUCT ENHANCEMENTS

Airbus will introduce the following enhancements to prevent inadvertent engagement of the autopilot when the aircraft is still on the ground and improve flight crew awareness to prevent any errors.

Modification to inhibit autopilot

To prevent autopilot engagement during the takeoff roll, the Primary Flight Control Computer (PFCC) will be upgraded to inhibit AP engagement during takeoff and until 6 seconds after liftoff. This modification will be introduced in PFCC standard 009, planned for Q2 2024.

Enhancement of the autothrottle disconnection logic

The autothrottle disconnect logic is also being updated to address the issues that cause it to disconnect during the takeoff roll. A first set of improvements will be introduced with the next 8A3 avionics software and further improvements are currently being developed.

"CONFIG AUTOPILOT" priority over "AUTOTHROTTLE" aural alert

EICAS software will be upgraded to give higher priority to takeoff configuration warning messages, such as "CONFIG AUTOPILOT", or when other CONFIG takeoff alerts are posted, even if the AUTOTHROTTLE aural alert is not silenced. This improvement should also be available in the 8A3 avionics software.

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Flight crews should be aware of the consequences of inadvertent selection of the autopilot during the takeoff roll, which may lead to a risk of tail strike, inability to climb, runway overrun, and possible loss of control. A220 FCOM procedures were updated and AFM limitations were added to help flight crews learn from the experience of previously reported events and prevent this kind of event from recurring.

This should be reinforced by all operators applying the applicable recommendations, including the need for the flight crew to review applicable OEBs together during preflight and the importance of the Pilot Monitoring role. Product enhancements, modifications, and updates will be implemented as additional safety features that will inhibit autopilot engagement during the takeoff roll, increase the robustness of the autothrottle monitoring, and improve the priority sequencing of aural alerts.

Cockpit Control Confusion

Inadvertent use of the wrong cockpit control instead of the intended control is a potential situation that pilots may encounter on any aircraft type. This kind of error can occur with even the most experienced pilots and this article explores what factors can influence and lead to this type of occurrence.

The resilience of the aircraft systems to cope with such an error provides effective safety barriers to prevent serious events. The aim of this article is also to raise awareness of the potential causes and effects of cockpit control confusion incidents and provide information about best practices, which can help pilots to reduce the risks that may lead to operational and safety consequences.

CASE STUDY

Event Description

The First Officer, who was Pilot Flying (PF), called the ground crew operating the towbarless pushback vehicle connected to the A319, to state that they were cleared for pushback and engine start. The ground crew called to release the brakes and the First Officer set the PARKING BRK handle to OFF. The flight crew completed the "Before Start" checklist and a few moments after the aircraft began to move, the First Officer called out "starting engine one". The Captain acknowledged the First Officer's call. The First Officer then inadvertently set the PARKING BRK handle to ON causing the aircraft to abruptly stop. The sudden stop caused the nose landing gear to jump out of the tow clamp of the towbarless pushback vehicle and it became lodged on top of the vehicle platform with the nosewheel deflected at more than 90 degrees **(fig.1)**. Two cabin crew members, who were performing the safety demonstration at the time of the incident, received minor injuries. The passengers and crew exited the aircraft using steps positioned at the rear cabin door, with no further injuries.

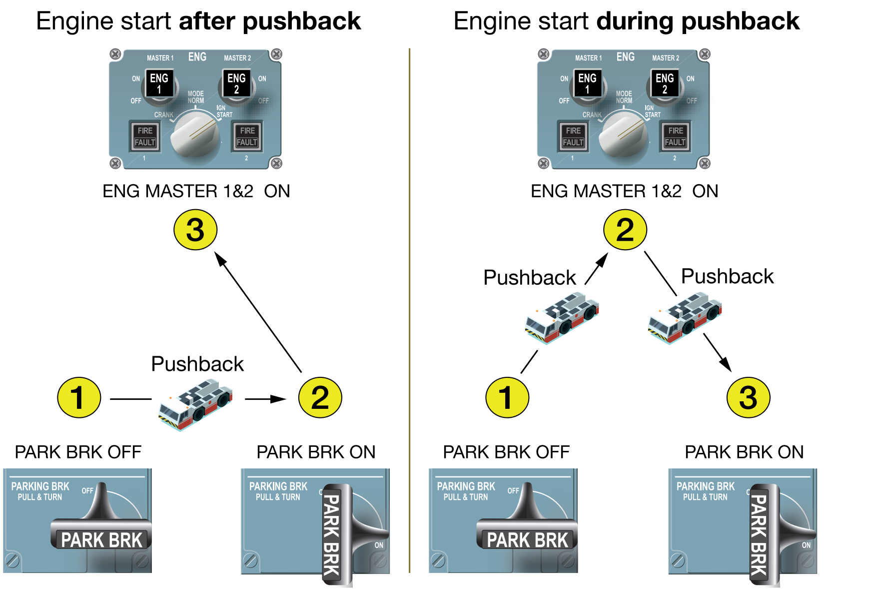
(fig.1)
Picture of the event
(Source: Operator)

Event Analysis

Parking Brake Handle vs. Engine Mode Selector

During the engine start sequence, the PF inadvertently set the PARKING BRK handle to ON instead of setting the ENG MODE selector to IGN/START. Both controls are located on the pedestal. The PARKING BRK handle needs to be pulled, turned in the clockwise direction to ON, and released. The ENG MODE selector also needs to be turned in the clockwise direction to IGN/START. Both controls are used in the pushback and start sequence by either: **(fig.2)**:

- Setting the PARKING BRK handle to OFF before pushback, and setting it back to ON when pushback is complete, and then setting the ENG MODE selector to IGN/START to start the engine, or
- Setting the PARKING BRK handle to OFF before pushback, then setting the ENG MODE selector to IGN/START to start the engine during pushback, and setting the PARKING BRK handle back to ON when pushback is complete



(fig.2)
The pushback/engine start sequence may vary depending on the situation

Many pilots position their hand on the PARKING BRK handle without making any visual check before moving it as they know very well the specific shape of the PARKING BRK handle on the pedestal and the specific action of pulling and turning to move it.

CAUSES OF COCKPIT CONTROL CONFUSION

Situations and Context

The cockpit control confusion situation described in this article occurred in normal operational conditions. Situations that cause high workload, additional stress, and cognitive overload for flight crews can lead to human errors. This is, however, not necessarily the case for cockpit control confusion incidents. In these cases, it is not due to a lack of knowledge and skills of the flight crews. In fact, even the most experienced pilots on current type can experience cockpit control confusion and so there are other contributing factors.

Humans create routines

Humans evolved by optimizing capabilities, and when a skill is acquired and frequently used in the same environment, the human brain creates routines. This human ability for pattern seeking and automatically performing actions allows us to preserve our brain's cognitive resources, making it possible to focus on something else when performing routine actions. For example, flight crews can often perform instantaneous monitoring of the aircraft in normal flight conditions whilst communicating with air traffic control.

Skill-Based Errors

Behaviors based on routines, or so-called "skill-based behaviors", are when humans perform automatic actions with low conscious control on how they are performing them. According to aviation human factors expert, James Reason*, there are two types of skill-based errors:

- Lapses: when an action is missed

- **Slips: when an action is performed incorrectly**

*Reason, James. Human error. Cambridge university press, 1990.

Inadvertently using a cockpit control instead of another in normal situations is a "slip". Although performed incorrectly, the intention of the action was correct. The momentary absence of attentional control and active thinking when performing the action caused the error and it is not related to a lack of skills or knowledge.

KEYPOINT

Cockpit control confusion incidents are skill-based errors or, "slips", where the intention is correct, but there is a failure of execution. These incidents happen when a pilot is acting without conscious control over their actions.

Contributing Factors

Routines

Cockpit control confusion situations are often encountered on the **most frequently used controls,** because routines are more developed on those controls. This is why cockpit control confusion is more often observed with **experienced pilots** performing **well-known procedures.**

Human Factors

Other contributing factors for slips are **fatigue, overconfidence,** and **momentary distractions** such as pilot preoccupation or an unexpected interruption when performing a well-known sequence of actions or a flow pattern. **Anticipation** of the action is also a contributing factor. For example, when a pilot habitually rests their hand on the control before activating it, this indicates that the pilot's mind is already committed to performing the next action with that control even if a different control action is called for. This can result in the inadvertent use of that cockpit control.

Shape & Position of the Controls

There are reported cases of confusion between the expedite (EXPED) pushbutton and the approach (APPR) pushbutton **(fig.3)**. The EXPED and APPR pushbuttons are located next to each other on the FCU panel, and they have a similar shape and action to select.

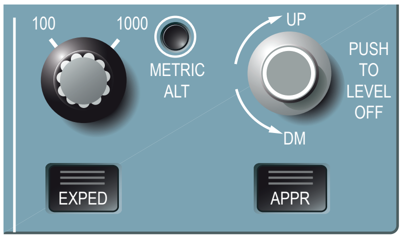
Similarly on the A220 aircraft, there are reported cases of control confusion between the autopilot (AP) pushbutton-switch and the autothrottle (AT) pushbutton-switch. For more information about this example, refer to the Safety first article on "**Inadvertent Autopilot Engagement During Takeoff on A220 aircraft**".

In the case of cockpit control confusion, a pilot performs a skill without conscious control over their action, therefore, even controls with different shapes and locations in the cockpit can still be confused. For example, there are reported cases of control confusion between the landing gear lever (located on the main instrument panel) and the flaps lever (located on the pedestal).

Proximity Factors

When a control is positioned closer for the pilot to reach, then it is more likely to be subject to cockpit control confusion. For example, when PFs are in the left seat they are more likely to experience a skill-based error or slip, related to the EXPED pushbutton, because it is located on the left side of the FCU panel. When Pilots Monitoring (PMs) are in the right seat they are more likely to experience cockpit control confusion related to the flaps lever because it is located on the right of the pedestal.

(fig.3)
EXPED and APPR pushbutton on the FCU of an A320 aircraft



Challenges

The lack of attentional control and active thinking when performing the action that caused the error is not due to the lack of skills or knowledge, and therefore, cockpit control confusion or slips, cannot be mitigated by conventional training.

Changing the design of a cockpit control that is very familiar to many thousands of pilots can be counterintuitive, and it is not possible to cover all cockpit control confusion cases.

The Importance of Reporting

The aircraft systems are very resilient to inadvertent use of cockpit controls, pilots will react quickly to correct their error, and there is often no operational consequence. It may not seem necessary for the flight crew to report the cockpit control confusion incident, but it is important to better understand the contributing factors and identify the possible mitigations. That is why it is so important for airlines to foster a speak-up culture and just and fair policy, that encourages pilots to report such events.

KEYPOINT

Given the challenges faced to reduce the number of cockpit control confusion incidents, it is important for flight crews to report such events. The more cases that are reported, the more accurate the analysis and identification of trends will be, allowing for the most effective mitigations.

PREVENTIVE ACTIONS

Reporting cockpit control confusion events, analyzing trends, developing best practices, and raising awareness among pilots is the most effective means of prevention. Some operators have reinforced this by creating additional callouts for their flight crews when carrying out routine tasks in the cockpit.

Recognized best practices are described in the Flight Crew Techniques Manual (FCTM) of all Airbus aircraft (A300-600, A310, A320 Family, A330/A340 Family, A380, A350, A220) in the "Cockpit Philosophy" chapter.

The main recommendations for flight crews are:

- Do not rest your hands on controls.
- Do not anticipate actions by putting your hands on the controls before you need to.
- Perform a visual check on the control before using it. Even if you are focused on the PFD you should look at the controls before using them.
- Check the result of the action, which is essential.
- Break the automated loop and raise the level of active thinking and attention. Use the standard callouts and use additional callouts, if necessary.

Examples of additional callouts from an Operator:

- During the Engine Start procedure, the PF points to the ENG MODE selector and calls "ENG MODE SELECTOR" before using it.
- Before using the flaps, the PM puts their hand on the lever and calls out "Flaps" before moving the lever and calling out the flap position.
- Before using the landing gear, the PM puts their hand on the lever and calls out "Gear" before moving the lever and calling out "Up" or "Down".

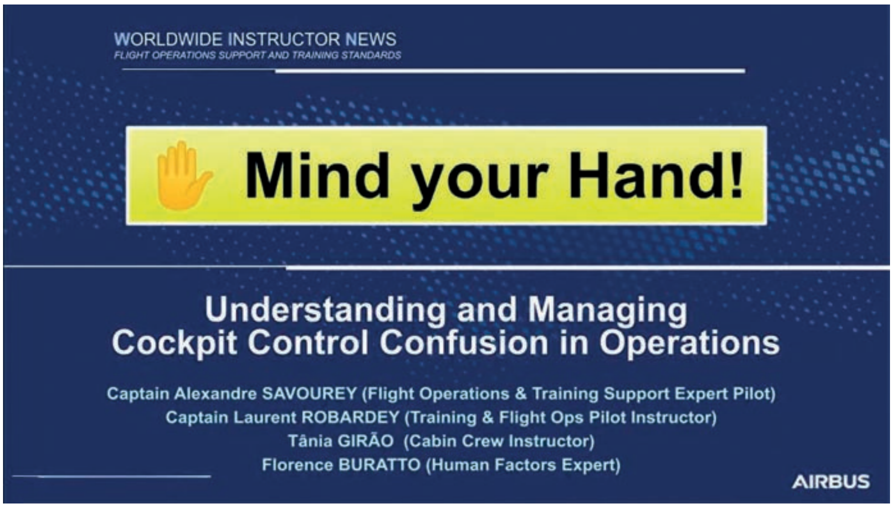
These additional callouts reduced the number of inadvertent uses of the parking brake handle instead of the ENG MODE selector, and the inadvertent flaps selection or landing gear selection, by increasing the attentional focus of the flight crew. However, the risk remains that such "attention-getters" can also become routine.

BEST PRACTICE

During training sessions, instructors should be vigilant to identify cockpit control confusion and debrief the flight crew to raise their awareness of this behavior. This is more likely to occur during recurrent training and is less often seen during initial training sessions.

INFORMATION

For more information on cockpit control confusion, the video "**Understanding and Managing Cockpit Control Confusion in Operations**" is available on the Airbus Worldwide Instructor News (WIN) website.



Thank you to both easyJet and KLM for their contribution to this article. With effective speak-up cultures and just and fair policies, flight crews were empowered to report several incidents that were studied to better understand the circumstances that contributed to cockpit control confusion. This allowed for more precise and targeted recommendations to reduce the risk of cockpit control confusion for all flight crews.

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The human mind creates routines for acquired skills in an effort to save cognitive resources for other tasks. When pilots are performing routine tasks in the cockpit, they may occasionally lose attentional control over the actions they are performing. This can lead to a cockpit control confusion scenario.

Fatigue, overconfidence, distraction, and anticipation are some of the contributing factors to cockpit control confusion. A lack of attentional control and active thinking when performing the action causes the error, and not a lack of skills or knowledge. Cockpit control confusion can happen on any aircraft type and to any pilot, regardless of their experience. It can be the case that more experienced pilots are even more likely to have cockpit control confusion due to the longer time they have spent performing repetitive and routine tasks.

The most effective mitigation means are to always check the control before acting on it and to always check the result of the action. Reporting cockpit control confusion events, analyzing trends, raising awareness, and sharing best practices are other mitigation means to also take into account. Recommendations for pilots to prevent cockpit control confusion are available in the FCTM for all Airbus aircraft (A300-600, A310, A320 Family, A330/A340 Family, A380, A350, and A220). The key point for pilots is to consciously maintain their focus on each action they perform. Operators who have also developed additional callouts for their flight crews observed a reduction in the number of reported cockpit control confusion events.

The aircraft systems are resilient to many of the effects from cockpit control confusion. Their protections offer an effective safety barrier to prevent more serious situations from occurring. It is a timely reminder to apply the golden rules for pilots and always "take action if things do not go as expected."

Lightning Strikes

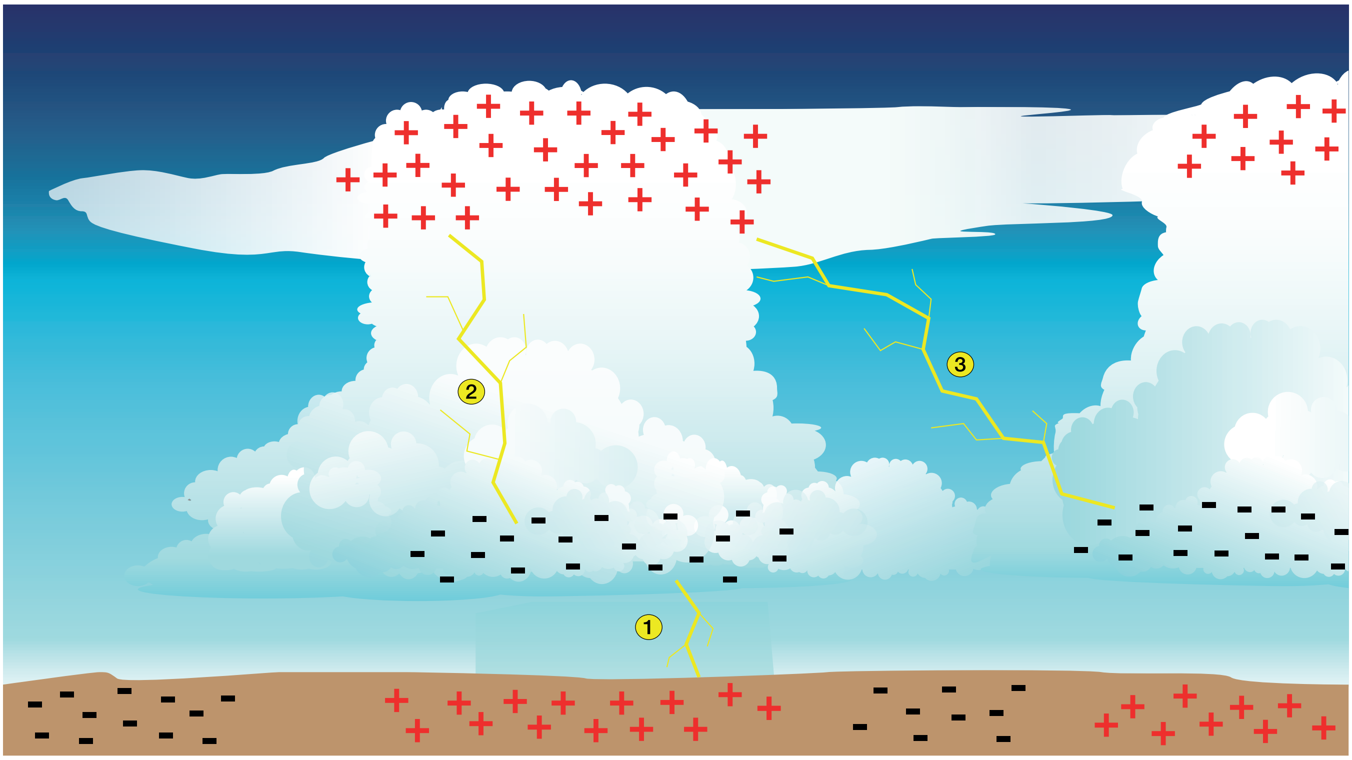
Each in-service aircraft is struck by lightning at least once per year, on average. Even if the level of energy of lightning strikes is high, their effects on an aircraft are limited.

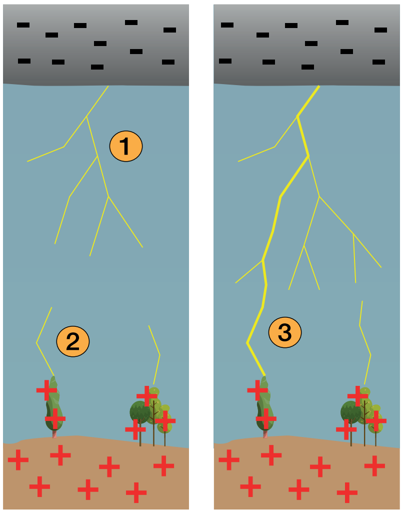
This article explains the lightning phenomenon and why aircraft are prone to lightning strikes. It describes how aircraft are designed to limit the effects of a lightning strike and ensure that the safety of the flight is not impaired. It also recalls several safety precautions to take in flight and on the ground, and what must be done when an aircraft is struck by lightning.

LIGHTNING PHENOMENON

Within storm clouds, thermal convection causes collisions between ice particles resulting in the transfer of electrons between them. This process leads to the accumulation of electrical charges inside the cloud. When the electrical tension between these charged areas reaches a critical point, it overcomes the insulating properties of the air that separates them, resulting in a lightning discharge. **(fig.1)**. Lightning can happen 1 between cloud and ground, 2 inside a cloud, or 3 between two clouds. Earth experiences an average of approximately 44 lightning strikes every second.

(fig.1)
Typical types of lightning





(fig.2)
Lightning initiation

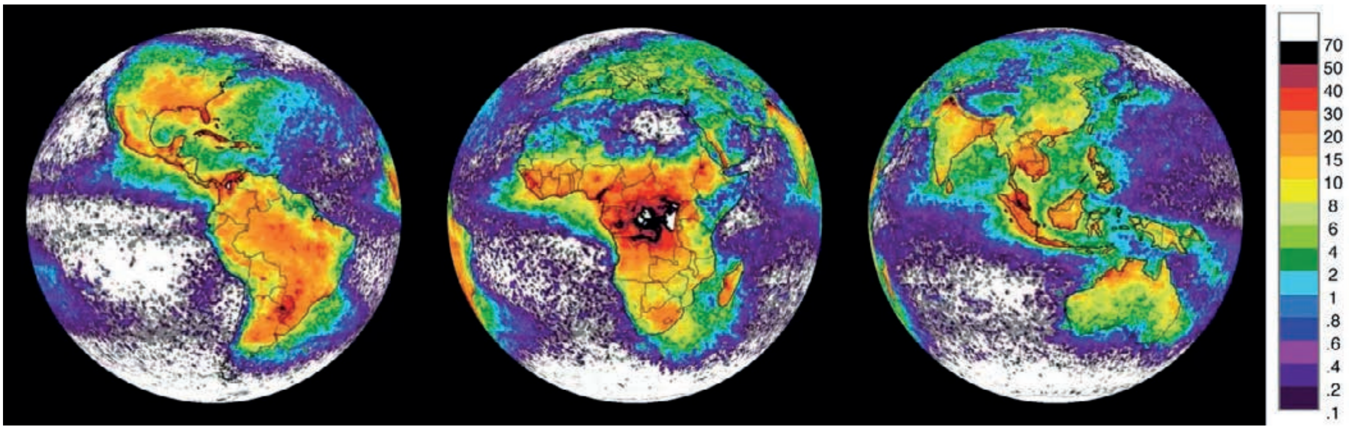
Lightning bolts

A lightning bolt initiates with a column of ionized air **(fig.2)** that generally 1 starts from the negative part of the cloud and moves towards the positively charged area. This column is called a 'leader'. As it nears the positively charged area, 2 secondary leaders develop from it. 3 When the two leaders come into contact with each other, an electrical current flows to neutralize the opposite electrical charges accumulated in the two areas.

There are often several successive discharges in a single lightning bolt. The discharge current can reach 200 000 A and the temperature inside the lightning channel can reach 30 000 °C. Cloud-to-ground lightning bolts are usually the most powerful.

Worldwide distribution of lightning strikes to ground

The average worldwide frequency is 3 lightning strikes per square km per year (strike/km²/yr). However, there is a strong disparity of this value depending on the location on the planet. Based on a National Aeronautics and Space Administration (NASA) study, the regions more prone to lightning strikes are Central Africa and South America with more than 20 strikes/km²/yr and more than 70 strikes/km²/yr in Central Africa, reaching 158 strikes/km²/yr in Congo. In comparison, oceanic areas have a frequency of less than 1 strike/km²/yr reaching less than 0.1 strike/km²/yr in the polar regions and South Pacific area **(fig.3)**.



(fig.3)
Worldwide lightning distribution from 1995 to 2003 with color range indicating the average annual number of lightning flashes per square kilometre. Credits: National Oceanic and Atmospheric Administration (NOAA) Science and National Aeronautics and Space Administration (NASA).

AIRCRAFT AND LIGHTNING STRIKES

Using the 3 strikes/km²/yr average value and an average aircraft surface of 300 m², an aircraft should theoretically be struck by lightning once every 1 000 years. The operational reality is that an in-service aircraft will be struck by lightning on average once a year, or every 3 000 flight hours. This is 1 000 times the projected value above.

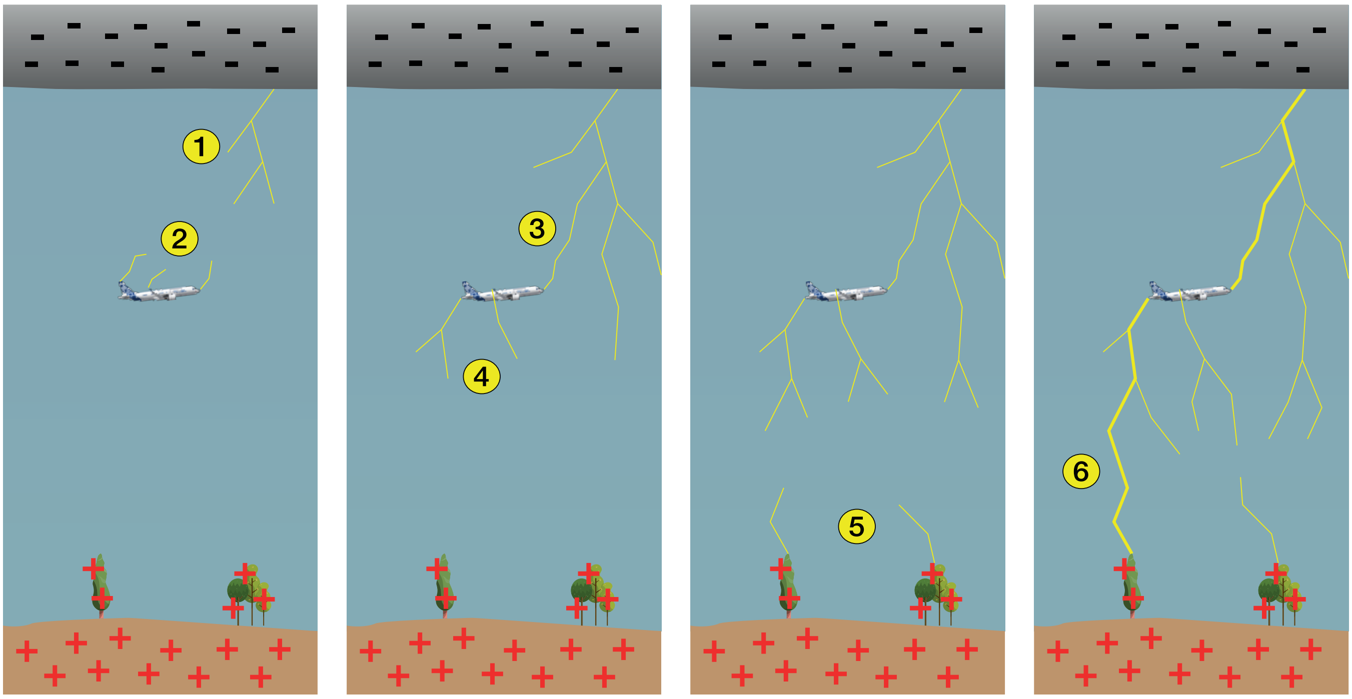
This difference can be explained by the fact that an aircraft will tend to attract lightning in flight when it is in the proximity of a storm's high electrical field **(fig.4)**.

If a lightning leader initiates close to an aircraft 1, some lightning leaders will also initiate from the aircraft extremities (e.g. nose cone, wing tips, vertical tailplane) toward the lightning leader 2.

If one aircraft leader joins with the lightning leader, the aircraft becomes part of the lightning channel 3, and continuing leaders initiate from the other extremities of the aircraft toward the positively charged area (ground) 4.

When one of these leaders nears this positively charged area, 5 new leaders initiate from it and 6 create lightning when joining the main leader.

(fig.4)
How lightning strikes an aircraft.



Aircraft design considerations

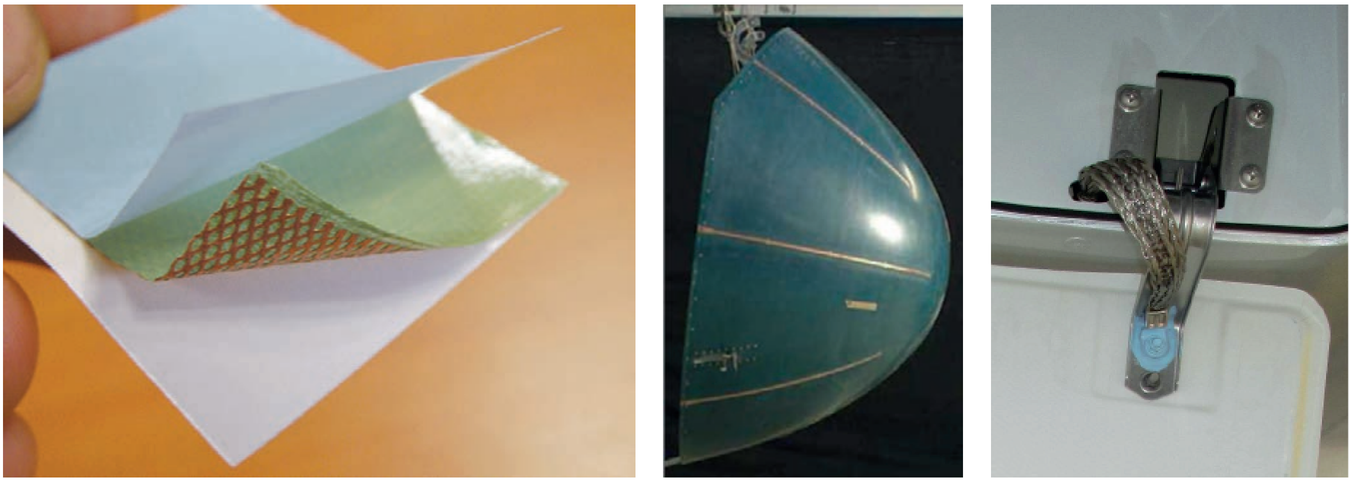
All large aircraft must be designed and certified to withstand lightning strikes without sustaining significant damage to their structure or effects on their systems that would adversely affect safety for the remainder of the flight. This includes protection of the airframe structure against the direct effects of lightning, and the protection of the electronic circuitry versus lightning current induced effects.

Conductive structure

The aircraft structure is designed to conduct the electrical current induced by a lightning strike. For composite fuselages or components, integrated conductive metallic foils and metallic strips are used to ensure this.

All components of the aircraft structure (metallic or composite) must be bonded together with bonding leads or with fasteners to ensure electrical continuity **(fig.5)**. This will enable the lightning current to travel through the aircraft structure without creating significant damage.

(fig.5)
Metallic foil integrated into composite structure (left), conductive metallic strips on the radome (centre), and bonding leads ensure electrical continuity between structural components (right).



Direct effects of a lightning strike are normally limited to the damage caused by the lightning strike at its initial point of contact. The observable effects of a lightning strike include:

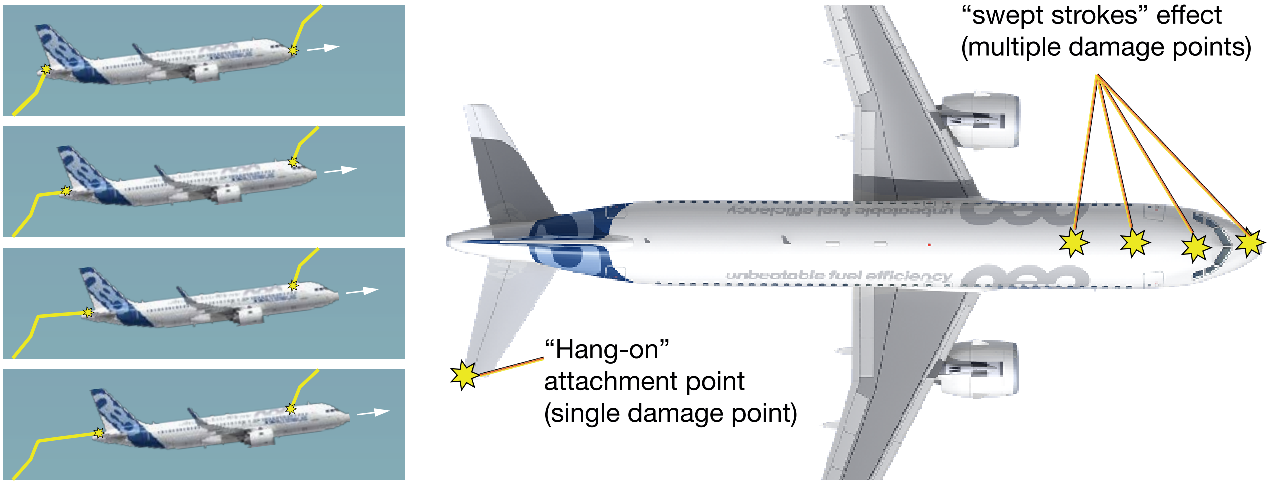
- **Metallic components:** Burns, pitting, holes, and melt marks on the aircraft skin or structure, structural deformation, heat damage, and paint discoloration.

- **Composite components:** Paint discoloration, skin punctures, fiber damage (including fiber tufts or fiber delamination), loss or damage of copper foil mesh and metallic strips.

As the aircraft moves during the strike, and due to the pulsating discharge of the electrical current, the lightning attachment points (on entry or exit) can move along the surface of the aircraft creating the so-called multiple **“swept strokes”** (up to 20 strokes) **(fig.6)**. They can also remain fixed on the rearmost parts of the aircraft (known as a “hang-on” attachment point), which is a single attachment point sustaining several discharges.

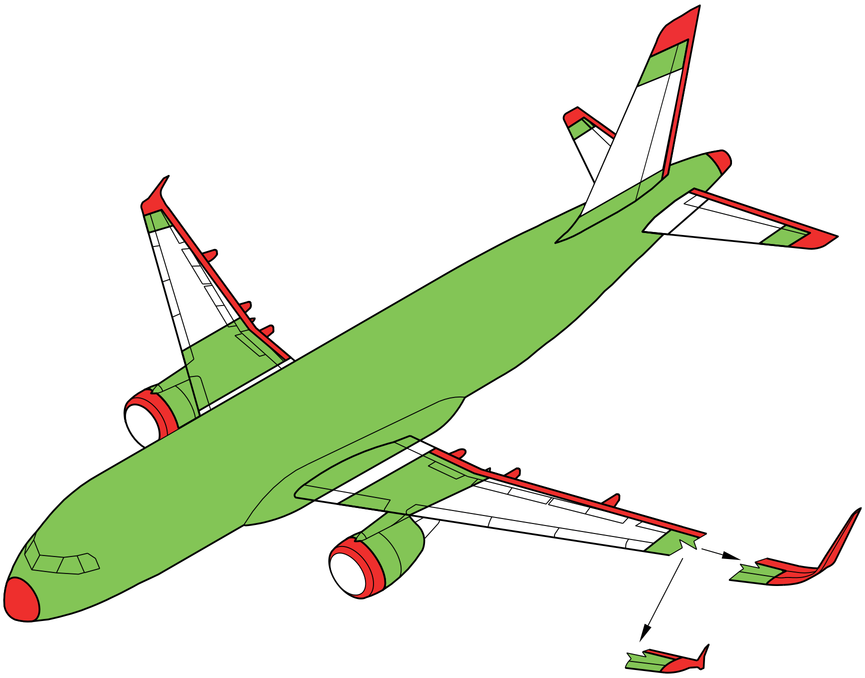
The level of damage at the attachment points depends on the intensity of the lightning strike.

(fig.6)
Example of “swept strokes” and “hang-on” attachment points shown on an A320 aircraft with the initial entry point of the lightning current on the nose cone and an exit point on the left side of the horizontal tailplane.



Aircraft Lightning Attachment Zones

Lightning attachment zones are identified depending on the probability and type of lightning attachment on the aircraft structure **(fig.7)**.



Zone 1: Areas where damage is most probable (initial entry or exit points)

Zone 2: Areas where damage is probable (swept strokes)

Zone 3: Areas where damage is less probable

(fig.7)
Lightning attachment zones shown on an A320 aircraft (AMM extract)

Protection against the indirect effects of lightning strikes

Electromagnetic fields related to a lightning strike can cause unwanted transient voltages and currents in the aircraft wiring and its systems. As required by the regulations, aircraft must be designed so that there is no perturbation of a critical or essential system in the case of a lightning strike that could temporarily or permanently affect its operation. The level of protection given to a particular system depends on the likelihood of the system being affected by lightning and the impact that a loss of this system would have on the safety of the flight.

Protection from the indirect effects of lightning strikes is ensured by:

- System redundancy
- Physical and electrical segregation of the redundant systems
- Electromagnetic protection on the electrical harness where required, using differential transmission lines, shielding and over-shielding, and specific routing rules
- Electrical isolation or use of lightning surge arrestors specified inside equipment ports depending on their potential exposure to lightning strike effects
- Management of corrupted data by system software.

INFORMATION

Detailed information on the lightning phenomenon and its effect on aircraft can be found in the "**Lightning Protection of Aircraft Handbook**" created by Franklin A. Fisher and J. Anderson Plumer, available for download on the **FAA Technical library**.

The standard ED-91A - Lightning Zoning and the SAE Aerospace Recommended Practice (ARP) ARP5414B - Aircraft Lightning Zone, provides information on lightning strike zones and guidelines for locating them on particular aircraft.

Lightning Protection of Aircraft Handbook

FAA Technical library

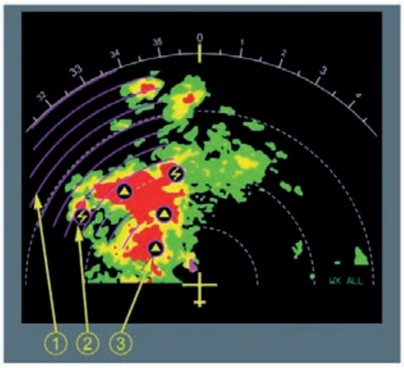
LIGHTNING STRIKE PREVENTION & SAFETY PRECAUTIONS

Most of the reported lightning strike events on aircraft usually occur **in flight between 5 000 ft and 15 000 ft,** or when the aircraft is on the ground.

Lightning Avoidance In-flight

Flight crews should take advantage of all available means to avoid lightning conditions such as weather forecasts, use of the onboard weather radar, and ATC guidance.

Certain weather radars are equipped with a lightning prediction function that provides additional indications to the flight crew of areas within a storm where an aircraft may be more prone to lightning strikes **(fig.8)**.



(fig.8)
FCOM illustration of the Honeywell weather radar RDR-4000 with 1 rain echo attenuation indication, 2 lightning prediction, and 3 hail prediction icons ikes an aircraft.

INFORMATION

Information on the use of weather radar and storm avoidance can be found in:

- A220 FCOM1 (section 16-06) and A320/A330/A340/A350/A380 FCTM Aircraft Systems/weather radar
- Safety first article “**Optimum use of weather radar**” published in July 2016
- Airbus WIN video “**Operational Use of the Weather Radar**” published in November 2017

Optimum use of weather radar

Operational Use of the Weather Radar

Safety Precautions when on Ground

In the case of a storm with lightning activity when the aircraft is parked or stored outside for maintenance activities, the maintenance and ground servicing personnel should apply specific safety precautions to limit the consequences of a potential lightning strike.

Aircraft electrical grounding (earthing)

Grounding (earthing) the aircraft reduces the risk of injury to personnel and risk of damage to the aircraft in the case of a lightning strike. If the aircraft is not grounded, the lightning current can exit from any point of the aircraft structure. This is normally close to the landing gears where it can cause significant damage and a risk of serious injury. Any ground servicing equipment (e.g. platforms, access stairs, cargo loaders, ground service carts, cargo loaders, and pushback vehicles) that may be in contact with an aircraft that is not grounded when it is struck by lightning, may also be damaged.

A grounding cable with less than 500 mOhm of resistance and with a minimum cross section of 22 mm2 (0.034 in2) must be attached to one of the aircraft grounding points.

Suspension of maintenance and servicing activities

Maintenance or ground servicing operations should be stopped pending the end of the storm and lightning conditions. Even if the aircraft is grounded, the resulting shockwave created by a lightning strike can cause injuries to ground personnel. Anyone working in the vicinity of the aircraft should not touch metal parts equipment or any other item connected to the aircraft.

Disconnection of all external equipment

Disconnection of external equipment (e.g. external power supply, air conditioning carts, and other ground servicing vehicles) prevents damage in the case of a lightning strike.

In lightning conditions, ground operators should disconnect or remove their headsets and communicate with the crew in the cockpit using standard hand signals.

Adherence to local regulations

When available, the operators must review and follow the local airport or airline policy and procedures for managing safety when there is lightning and storms.

INFORMATION

More information and guidelines can be found in the International Air Transport Association (IATA) documentation:

IATA Airport Handling Manual, (AHM) 462 "Safe Operating Practices In Aircraft Handling", section 11; 11.3 Weather Terms and Definitions; 11.5 Severe Weather Forecasting; 11.6 Severe Weather Notification; 1.6.2 Notification Methods; 11.7.3 Thunderstorm/Lightning; 11.8 Thunderstorm/Lightning Safety.

IATA Ground Operations Manual, (IGOM) 3.3 Adverse Weather Conditions

MANAGING LIGHTNING STRIKES

When lightning strikes an aircraft, a specific process must be applied to detect any damage caused by the strike, evaluate the damage, and perform the necessary repair before returning the aircraft back into service.

Informing Maintenance of a Lightning Strike Event

In the case of a lightning strike, the flight crew must make a **logbook entry** to inform maintenance personnel of the event, so that they can perform the appropriate inspection and necessary repairs. The flight crew should **provide as much information as possible** such as the landing gear position when the strike happened, a description of any system malfunction during or after the strike, and a list of the ECAM (EICAS for A220) alerts that may have been triggered.

Inspection of the aircraft for damage

Preparation of the inspection

The maintenance personnel should gather all the information provided by the flight crew about the event and print a **Post Flight Report (PFR)** to analyze any effect on the aircraft systems.

Choice of inspection

It is possible to choose between several types of post lightning strike inspection (except for A220 and A300 aircraft). This enables flexibility depending on airline operations, time constraints, human resources, availability of ground support equipment, etc.

Standard post-lightning strike Inspection

The standard inspection after a lightning strike is divided into several phases. The first phase being **initial damage detection** consisting of a thorough inspection of the entire surface of the aircraft and testing certain systems. The following phases are **additional checks** to be performed further to damage detection.

Quick Release Inspection (QRI)

The Quick Release Inspection (QRI) allows the operator to perform a reduced inspection to release the aircraft in a shorter time frame, and postpone the full standard inspection for a limited number of flight cycles when time and logistics permit. The QRI is only available for A300-600, A310, A320 family, A330, A340, A350, and A380 aircraft.

The QRI consists of inspecting the areas that are most prone to lightning strikes and testing certain systems. If no damage is found during the QRI, the aircraft can be dispatched for up to 50 or 200 Flight Cycles (FC) depending on the aircraft type. A full standard lightning strike inspection must be performed on the aircraft before the end of this grace period. If a new lightning strike occurs during the grace period, a new QRI must be performed, but the grace period applicable before a full inspection remains the 50 or 200 FC from the initial lightning strike event.

1-flight-back inspection (2 FC)

This alternative was added in the A320 family AMM to enable further flexibility and allows a maximum of 2 FC (ferry or revenue flight) to return the aircraft to an airfield with sufficient manpower and logistics to perform a standard or quick release inspection. However, this procedure is not applicable if one of the following conditions occurred:

- The flight crew reported a lightning flash with the sound of detonation
- The flight crew decided to divert the flight after a lightning strike event in flight
- There were Injuries to passengers and/or crew members caused by the lightning strike event.

The 1 flight back inspection consists of:

- A visual Inspection of the Air Data/Inertial Reference System (ADIRS) probes and sensors (at touching distance)
- A visual inspection of the flight control surfaces (from a 3m platform or passenger entry stairs)
- A functional check of the aileron and elevator servo controls
- A functional test of the flight control surfaces.

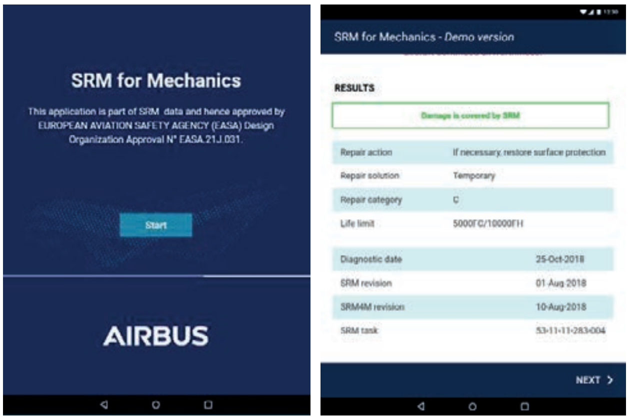
The 1-flight-back inspection was made available for A350 aircraft in the 01-NOV-2023 revision and is under study for A330, A340, and A380 aircraft.

<table>
<tr><th>Inspection Type</th><th>A220</th><th>A300</th><th>A300-600/ A310</th><th>A320 Family</th><th>A330/A340 Family</th><th>A350</th><th>A380</th></tr>
<tr><td>Standard inspection</td><td>YES</td><td>YES</td><td>YES</td><td>YES</td><td>YES</td><td>YES</td><td>YES</td></tr>
<tr><td rowspan="2">QRI Quick Release Inspection</td><td rowspan="2">N/A</td><td rowspan="2">N/A</td><td>50 FC</td><td>200 FC</td><td>200 FC</td><td>200 FC</td><td>200 FC</td></tr>
<tr><td colspan="5">Note: If a new lightning strike occurred during the grace period, the grace period remains 200 FC or 50FC from the time of the initial lightning strike event</td></tr>
<tr><td>1 Flight Back (2 FC)</td><td>N/A</td><td>N/A</td><td>N/A</td><td>YES</td><td>Under Study</td><td>YES</td><td>Under Study</td></tr>
</table>

Damage Evaluation & Repair

Damage due to lightning strikes should be repaired using an approved repair as per local authority regulations. Airbus recommends using the SRM or ASR (for A350) or ASRP (for A220) to evaluate and repair the damage. SRM/ASR/ASRP repairs are certified to be capable of withstanding additional lightning strikes.

(fig.9)
SRM for Mechanics (SRM4M) application for Android and iOS



Damage outside of the SRM/ASR/ASRP limits

When the lightning strike damage is outside of the SRM/ASR/ASRP limits, it is necessary to obtain repair instructions either from Airbus via a Repair and Design Approval Form (RDAF) or a Repair Engineering Order (REO) for A220 aircraft, or via an instruction provided by an EASA PART 21 approved organization.

To obtain the Airbus RDAF/REO, the operator or repair organization should prepare a damage assessment as required in SRM/ASR/ASRP.

INFORMATION

The "SRM for Mechanics" (SRM4M) mobile application provides a quick and easy way to use the SRM for A320 family aircraft.

Report lightning strike events to Airbus

Airbus analyzes any reported lightning strike events in order to further increase knowledge in this domain. Operators and repair organizations are encouraged to report lightning strike occurrences to Airbus even if no damage is found on the aircraft after the inspection. Operators can also participate in the forums and working groups organized by Airbus. For example, Airbus hosts a Lightning Strikes Expert Forum in order to exchange experience about managing lightning strikes with all operators. An SRM working group (except A220) also meets regularly since 2014 to exchange experience about structural repair topics.

INFORMATION

Further information can be found in the AMM/MP, SRM/ASR/ASRP documents available on the AirbusWorld portal and in the following published documents:

- **OIT 999.0066/15**
- **OIT 999.0003/20 ATA 51 – STRUCTURAL REPAIR MANUALS AND AIRCRAFT STRUCTURAL REPAIR MANUALS CONTINUOUS IMPROVEMENTS**
- **Safety first #18 - Safe Operations with Composite Aircraft**
- **FAST #22 - Lightning Strikes and Airbus Fly-By-Wire Aircraft**

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Aircraft are often struck by lightning. Aircraft manufacturers must demonstrate that their aircraft remain safe after a lightning strike.

Flight crews should avoid areas with lightning conditions as much as possible by using weather forecasts, onboard weather radar, and ATC guidance.

When an aircraft is parked or stored outside in lightning conditions, it is important to apply precautionary measures such as electrically grounding the aircraft, pausing ground or maintenance operations, and disconnecting any external equipment. It is also important that all operators are familiar with the local airport regulations and procedures for severe storms and lightning events, and have their own policies in place for their flight crews, maintenance crews, and ground crews.

For every lightning strike event, it is essential for flight crews to make an accurate logbook entry and for maintenance crews to adhere to the AMM/MP/AMP procedures to perform inspection and damage assessment. Any repair must be done using the SRM (ASR on A350 and ASRP on A220).

Operators should report all their lightning strike events to Airbus, even if there is no damage found in the post lightning strike inspection. This will provide data that contributes to further enhancing industry knowledge on the subject.

Inappropriate V/S Target during Autoflight Mode Reversion

Two cases of inappropriate V/S target during an autoflight reversion to V/S mode after a go-around were recently reported to Airbus. In both cases, the inappropriate V/S target resulted in a pitch down command of the autopilot with high thrust. The flight guidance used the previously selected V/S value set during the preceding ILS glide slope intercept from above as a V/S target for the mode reversion.

This article describes one of these events in detail and explains the conditions that caused this autoflight behavior. It provides operational recommendations to flight crews to prevent and detect this situation. It also lists the system enhancements that were launched to avoid the use of an inappropriate V/S or FPA target during a mode reversion of the flight guidance.

CASE STUDY

Event Description

An A320 aircraft was descending toward its destination airport in IMC and the flight crew prepared for an ILS approach. Late clearance from air traffic control meant that the aircraft was high. The aircraft captured the localizer, but was above the ILS glide slope **(fig.1)**.

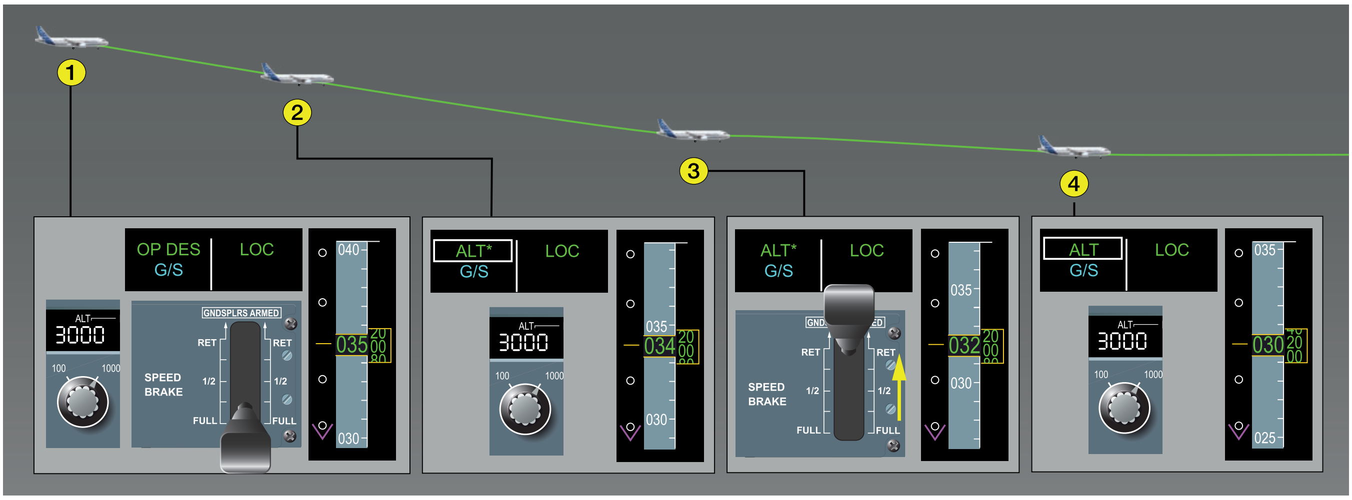
1 At 3 500 ft, the aircraft was in OP DES | LOC mode with AP, FD, and autothrust ON. The selected altitude was 3 000 ft, the speed brakes were fully deployed, and speed was selected at 174 kt. Flaps configuration was CONF 2 and the landing gear was down.

2 At approximately 3 400 ft, the ALT* mode engaged.

3 At 3 200 ft, the flight crew retracted the speed brakes and twice attempted to engage the V/S mode by pulling the V/S/FPA knob, but the ALT* mode reengaged 1 s after each attempt.

4 At 3 000 ft, the ALT mode engaged and the aircraft leveled off.

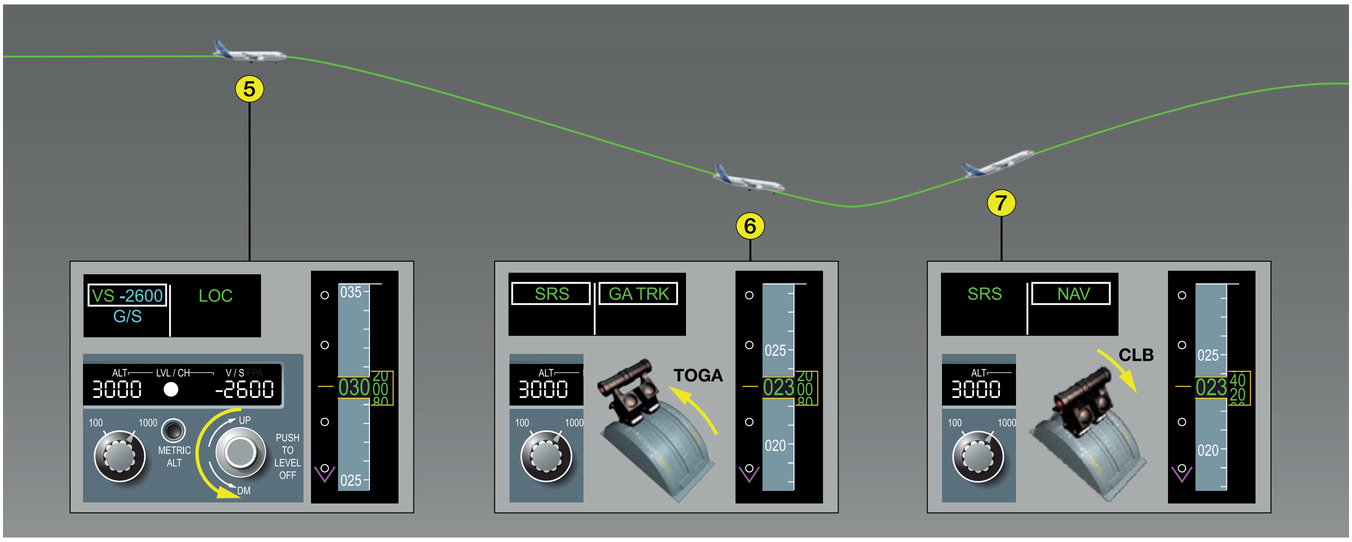
(fig.1)
Event description (1 of 3)



5 The flight crew then pulled the V/S/FPA knob to engage the V/S mode and selected a V/S value of -2 600 ft/min on the FCU. The aircraft began to descend.

6 At approximately 2 300 ft (1 600 ft RA), the aircraft was still too high above the glide slope and the flight crew pushed the thrust levers to TOGA to initiate a go-around with the autopilot engaged. The aircraft started to climb toward the 3 000 ft altitude that was still selected on the FCU. The NAV mode engaged shortly after and 7 the PF moved the thrust levers back to the CLB detent at approximately 2 700 ft.

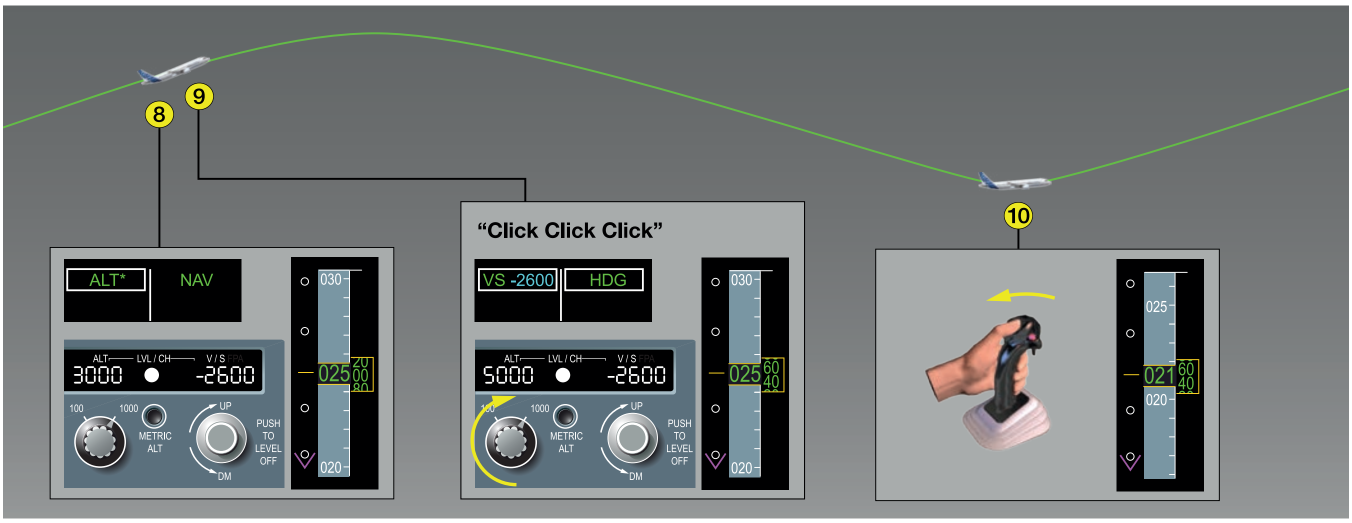
(fig.2)
Event description (2 of 3)



8 The ALT* mode engaged at approximately 2 500 ft. 9 The flight crew immediately increased the altitude target from 3 000 ft to 5 000 ft on the FCU. As a result, the flight guidance reverted to V/S I HDG modes with associated alerts (triple-click sound, white box on FMA, and FD bars flashing for 10s). The aircraft pitch began to decrease. It climbed up to approximately 2 950 ft and then started to descend and accelerate. At 2 800 ft, the aircraft vertical speed reached -2 600 ft/min and remained constant until 10 the flight crew manually took over by pulling the sidestick. The aircraft reached 2 100 ft (1 400 ft RA) and started to climb again.

The flight crew later reengaged the autopilot and successfully performed a second ILS approach.

(fig.3)
Event description (3 of 3)



Event Analysis

Reversion to the previously selected V/S value

When the flight crew increased the selected altitude from 3 000 ft to 5 000 ft on the FCU in step 9, the ALT* mode was engaged. This triggered a reversion to the V/S mode as per flight guidance logic. Since the V/S value was modified shortly before the go-around, it was still in the memory and displayed on the FCU. This led the V/S mode to use this previously selected value instead of the current aircraft V/S. We will describe this inappropriate behavior later in this article.

Flight crew reaction

It took more than 30 s from the mode reversion to V/S - 2600 in step 9, and 24 s from the start of the pitch down, for the flight crew to realize that the aircraft did not respond as expected.

AUTOFLIGHT SYSTEM BEHAVIOR

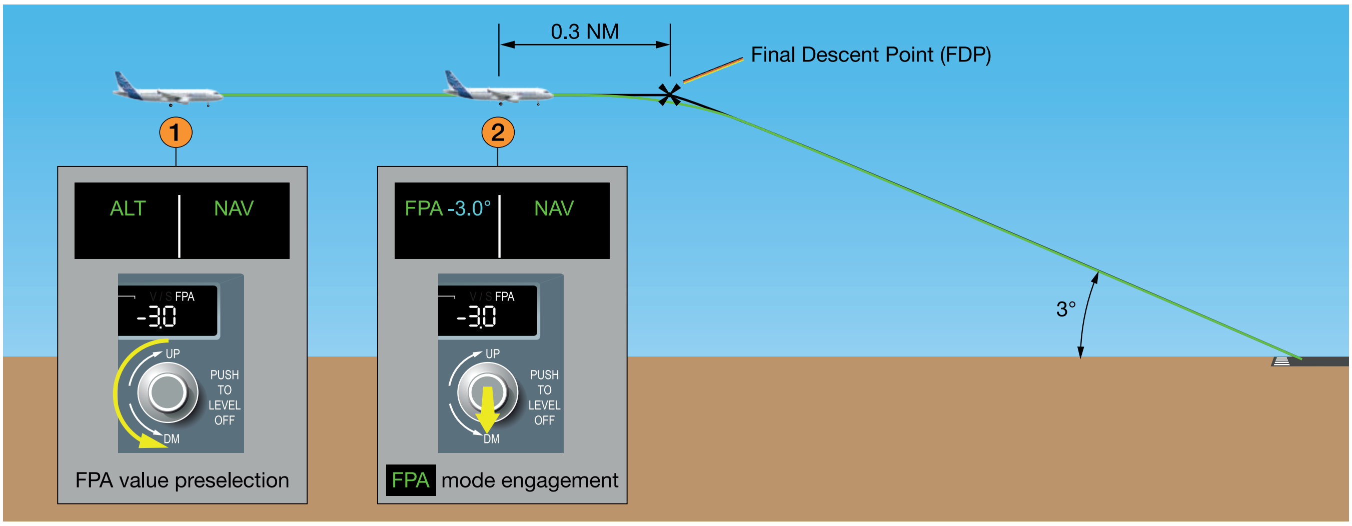
The event described above is due to a combination of two functions of the flight guidance system: **The V/S or FPA preselection** function and the **reversion to V/S or FPA modes.**

V/S or FPA Target Preselection

The V/S or FPA target preselection enables the flight crew to preselect a V/S or FPA target to be prepared to activate the associated flight guidance mode when appropriate. To do so, when the flight crew selects a V/S or FPA target on the FCU, this preselected value is **stored in the memory and remains displayed on the FCU for 45 s** (10 s on A300, A310, and A300-600 aircraft) to activate the guidance mode later.

INFORMATION

The duration of the V/S or FPA preselected value stored in the memory was increased from 10 s (on A300, A300-600, A310 aircraft) to 45 s for the A320 family, A330, A340, A350, and A380 aircraft. It enables the flight crew to 1 preselect an FPA value earlier while the aircraft flies toward the Final Descent Point (FDP) during an approach using FPA guidance, in order to 2 anticipate the engagement of the FPA mode when the aircraft reaches the FDP.



(fig.3)
Preselection of the FPA value is used during approach using FPA guidance

Mode Reversion to V/S or FPA modes

The flight guidance automatic mode reversion to V/S or FPA modes is a logic designed to maintain the current aircraft trajectory when the altitude selection by the flight crew is inconsistent with the objectives of the current guidance mode. In the event described in this article, the reversion was triggered by changing the target altitude while the autopilot was in the ALT* altitude capture mode.

FCOM **DSC-AUTO FLIGHT - FLIGHT GUIDANCE - AP/FD MODES - V/S / FPA MODE** provides all the conditions for reversion to V/S or FPA modes.

An Inappropriate Combination

During a reversion to V/S or FPA modes, the flight guidance V/S or FPA target usually synchronizes with the current aircraft V/S or FPA in order to maintain the aircraft trajectory. However, if a V/S or FPA value is selected on the FCU and if the mode reversion happens within 45 s (10 s on A300-600 and A310 aircraft), the flight guidance V/S or FPA target synchronizes with this selected value.

This inappropriate combination of the V/S or FPA target preselection function with the mode reversion function may cause inappropriate behavior of the flight guidance as seen in the previous example.

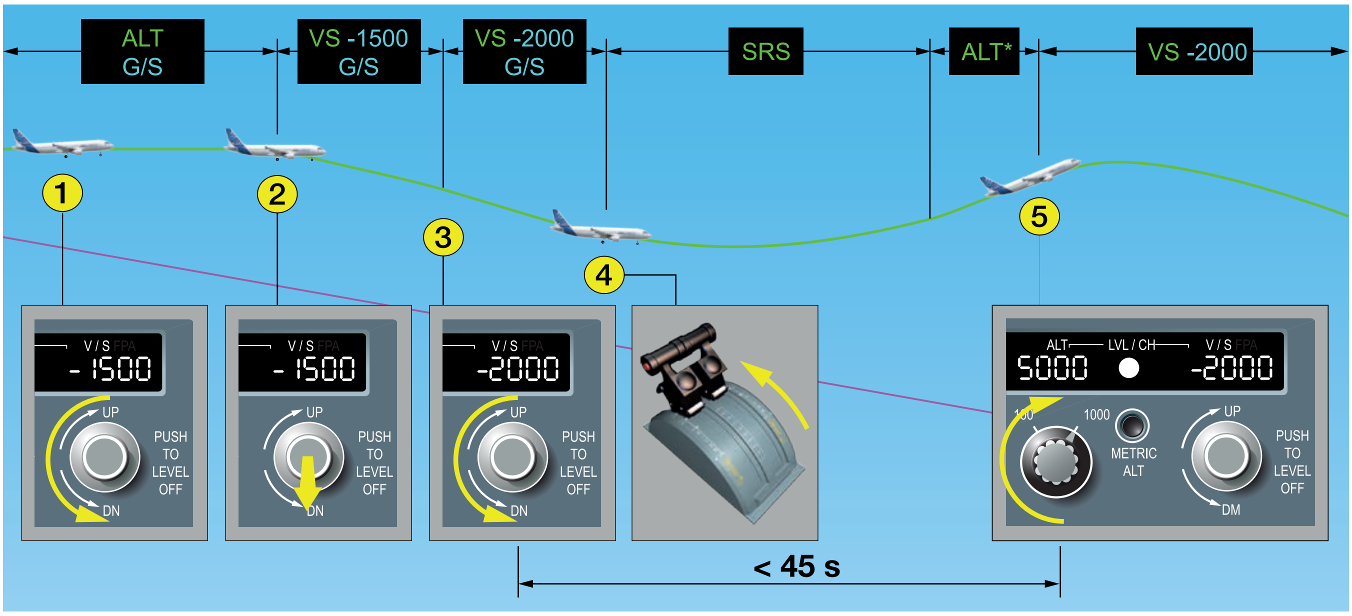
The shorter time that the preselected value on A300-600 and A310 aircraft is stored in the memory significantly reduces the probability of mode reversion to the selected value within 10 s after the selection.

Several scenarios can lead to this inappropriate behavior, but not all aircraft are concerned due to some differences in their guidance logic.

Scenario 1: Go-around during glide slope intercept from above (A300-600, A310 and A320 family aircraft only)

The most common scenario where the flight crew may face this issue is a go-around during or after a glide slope intercept from above, as in the example described earlier in this article. 1 A V/S value is preselected, 2 V/S mode is engaged and 3 the V/S may be adjusted. 4 A go-around is then performed. 5 If the mode reversion happens within the 45 s after the V/S value preselection or last V/S modification, the inappropriate behavior will occur.

Only A300-600, A310, and A320 family aircraft are concerned. On A330, A340, A350, and A380 aircraft, the V/S or FPA preselected value is canceled as soon as the V/S or FPA is engaged.



(fig.5)
Scenario 1: Go-around during glide slope intercept from above (A300-600 A310, and A320 family aircraft only)

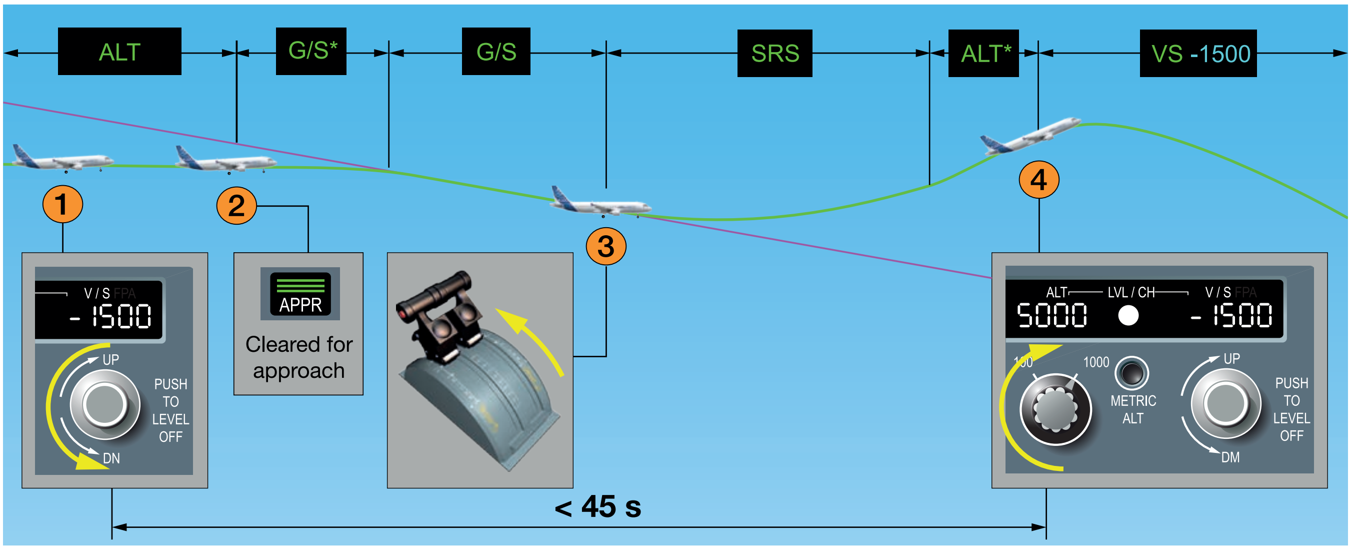
(fig.6)

Scenario 2: Go-around before glide slope intercept from above (before engaging V/S mode)

Scenario 2: Go-around before glide slope intercept from above (before engaging V/S mode)

In this case, 1 a negative V/S value is preselected in anticipation of a glide slope intercept from above due to possible late ATC clearance. 2 When cleared for approach, the flight crew presses the APPR pushbutton and G/S* mode engages, followed by G/S mode. 3 A go-around is performed. 4 If a mode reversion happens less than 45 s after the V/S preselection, the preselected negative V/S value is used.

All aircraft are concerned by this scenario, except A220 aircraft and A350 aircraft that are equipped with PRIM 14.1. (because the V/S or FPA selected value is reset at go-around engagement with PRIM 14.1).



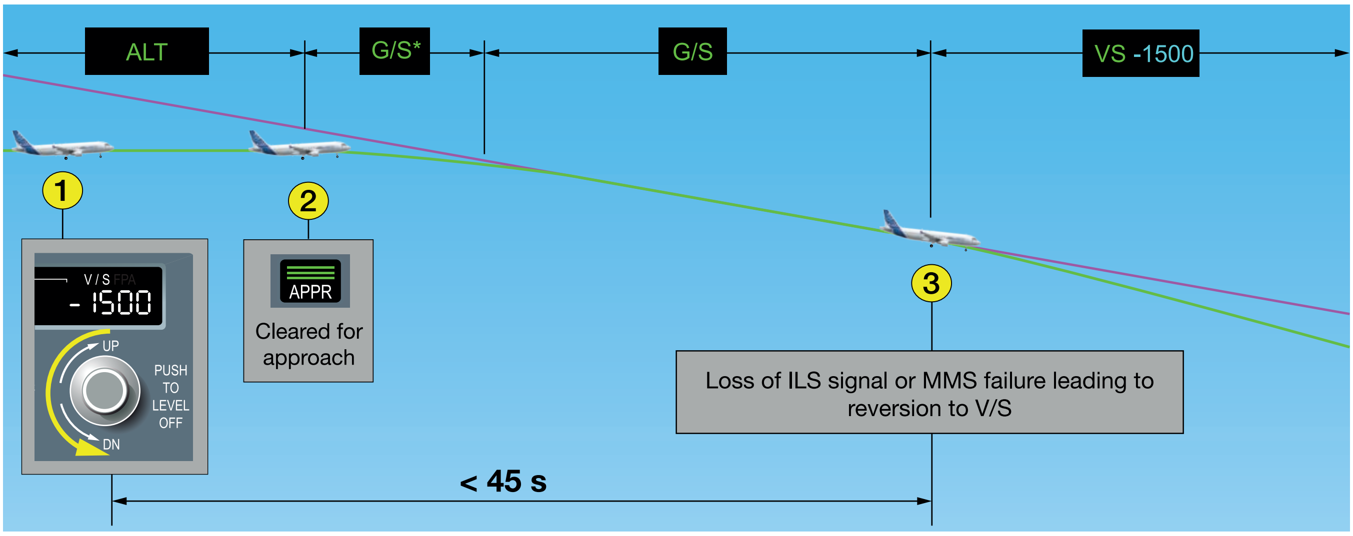
Scenario 3: Mode reversion due to the loss of an approach mode

In this scenario, 1 a V/S or FPA value was preselected, as it was for scenario 2, and 2 Approach mode is engaged when cleared by ATC. A mode reversion happens during the next 45 s after the preselection due to a loss of approach mode for reasons such as:

- G/S or F-G/S, APP DES or FINAL APP mode disengagement (e.g. loss of ILS signal, MMR failure, loss of flight plan, etc.)
- LOC or F-LOC or NAV mode disengagement
- The flight crew selects a target altitude higher than the actual aircraft altitude on FCU in DES or OP DES mode.

In this case, the effect on the trajectory is generally limited due to an already descending trajectory. It may be more difficult for the flight crew to detect the behavior.

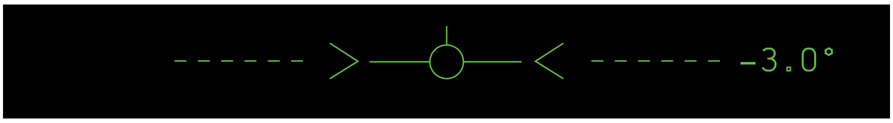
(fig.7)
Scenario 3: Mode reversion due to the loss of an approach mode



Scenario 4: Visual manual approach using HUD

When performing a visual manual approach using the Head Up Display (HUD), the flight crew may select the FPA value corresponding to the final approach path on the FCU as a guidance **(fig.8).**

If a go-around is performed the FD will come ON and SRS mode will engage. If a mode reversion happens within 45s after the last selection of the FPA value, the guidance mode will revert to V/S mode using V/S value corresponding to the FPA selected value, typically around -700 ft/min for a -3° FPA.



(fig.8)
Selection of the FPA during a visual approach using FPA mode can also lead to the unintended behavior if a mode reversion happens within the next 45 s.

OPERATIONAL CONSIDERATIONS

Flight crews can identify an occurrence of an inappropriate V/S target during autoflight mode reversion thanks to several cues.

Aural and visual alerts

When a reversion to V/S or FPA mode occurs, the triple-click (except on A300-600 and A310 aircraft), FD flashing and guidance mode boxing on the FMA triggers to attract the attention of the flight crew who can check the reversion parameters.

Understand your FMA at all times

Careful monitoring and understanding of the FMA, as stated in the "Airbus Golden Rules for Pilots" will enable the flight crew to detect the reversion to V/S or FPA mode, and detect any inappropriate V/S or FPA target value.

Effect on the pitch

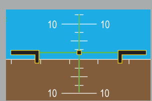
An unexpected pitch command by the autopilot can also be the sign of an inappropriate V/S or FPA target after a mode reversion. Note that in scenario 3 described above (mode reversion due to the loss of an approach mode), the unexpected autopilot pitch command may be limited and, therefore, difficult to perceive.

(fig.9)
Several cues enable the flight crew to detect an inappropriate V/S target during an autoflight mode reversion

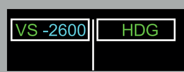
Cues of inappropriate V/S Target during autoflight mode reversion:

"Click Click Click"

Triple-click aural alert



Flashing FD bars for 10s



Inapropriate V/S or FPA on the FMA

Unexpected autopilot pitch command*

*The autopilot pitch command may be difficult to perceive in some situations.

Importance of the Pilot Monitoring

The pilot monitoring plays an important role in detecting the issue and alerting the pilot flying when the pilot flying does not detect the inappropriate behavior.

Take action if things do not go as expected

If the inappropriate behavior occurs, the flight crew should take appropriate action as per the golden rules.

SYSTEM ENHANCEMENT

System enhancements are available, or will be made available on most of the concerned aircraft to prevent the inappropriate combination of the V/S or FPA Target Preselection function with the Mode Reversion function.

Enhancement 1: Reset of the V/S or FPA Preselected Value after V/S or FPA Mode Engagement

Whenever a V/S or FPA target is preselected in the FCU, if the flight crew engages V/S or FPA mode, the preset value is used for the guidance and is reset when the V/S or FPA mode engages. It prevents the use of a preselected value in a subsequent reversion to V/S or FPA as in the example described in this article but also in other phases of flight.

This modification is already installed on A330, A340, A350 and A380 aircraft **(table 1).** It is planned to be introduced on A320 family aircraft. No availability date was defined at the time of authoring of this article.

(table 1)
Availability of the reset of the V/S or FPA preset value after V/S or FPA mode engagement

Aircraft	A300/ A300-600/ A310	A320 Family	A330	A340	A380	A350	A220
Availability	Not planned	To be defined	Already installed	Already installed	Already installed	Already installed	N/A

Enhancement 2: Reset of the V/S or FPA Preselected Value at Go-around Engagement

This modification cancels any V/S or FPA preset value when the flight crew performs a go-around. This prevents the use of an inappropriate V/S of FPA value if V/S or FPA mode was not engaged before the go-around.

This enhancement was already implemented on A350 aircraft in PRIM P14.1 standard certified in December 2022. The enhancement will be introduced on A320 family, A330, and A380 aircraft **(table 2).**

(table 2)
Availability of the reset of the V/S or FPA Preselected value at go-around engagement

Aircraft	A300/ A300-600/ A310	A320 Family	A330	A340	A380	A350	A220
Availability	Not planned	To be defined	Planned on FMGEC H8+ (Q1 2025)	Not planned	Planned for PRIM P14	PRIM P14.1 (DEC 2022)	N/A

Enhancement 3: Reset of the V/S or FPA Preselected or Selected Value in the Case of a Reversion to V/S or FPA Mode

(table 3)

Reset of the V/S or FPA preselected or selected value in the case of a reversion to V/S or FPA mode

This enhancement ensures that the current V/S or FPA is used during a mode reversion so that the current trajectory is maintained.

This enhancement is planned to be installed on A320 family, A330, A350, and A380 aircraft **(see table 3).**

Aircraft	A300/ A300-600/ A310	A320 Family	A330	A340	A380	A350	A220
Availability	Not planned	To be defined	To be defined	Not planned	Planned for PRIM P14 (Batch 8)	Planned for PRIM P15	N/A

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V/S or FPA Target Preselection and Mode Reversion to V/S or FPA mode are two useful functions of the flight guidance system. However, in certain circumstances, their combination may create inappropriate behavior of the flight guidance. System enhancements are available, or will be made available on most of the concerned aircraft to prevent the inappropriate combination of the two functions.

The role of the pilot monitoring is especially important to support the pilot flying in detecting when an inappropriate reversion to V/S or FPA mode occurs. The warning to listen and look for are the triple-click (except on A300-600 and A310 aircraft), FD flashing, and guidance mode boxing on the FMA. These cues get the attention of the flight crew who can check the reversion parameters and take action if needed.

To “understand the FMA at all times” and “take action if things do not go as expected” are two of the Airbus Golden Rules for Pilots that are very relevant to avoid the effects of inappropriate V/S target during autoflight mode reversion.


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