The Airbus safety magazine

#36

Safety first

AIRBUS

Safety first, #36 July 2023. Safety first is published by Airbus S.A.S. - 1, rond point Maurice Bellonte - 31707 Blagnac Cedex/France.
Editor: Yannick Malinge, Chief Product Safety Officer.
Concept Design by Airbus MultiMedia Studio 20230957. Reference: X00D16031905.
Photos by Airbus, S. Ramadier, H. Goussé, G. Estragnat.

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

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

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editorial

YANNICK MALINGE

SVP & Chief
Product Safety Officer

Dear Aviation Colleagues,

The rate of accidents for commercial jet transport remains relatively stable today. A very slight increase of the accident rate for the fourth generation of commercial jets was recorded in 2022 due to two events with fatal injuries to four people in ground vehicles that entered an operational runway. It shows that, even though the commercial air transport system has significantly improved its safety record over the years, we all need to be permanently vigilant and to avoid any increase in the accident rate. Another warning sign is the reported number of recent close call runway incursions, requiring all of us to reinforce the safety barriers to prevent an accident.

We all welcome the returning demand for flights. It also comes with its inherent risk exposure. Especially when this is coupled with the departure of experienced aviation professionals across all sectors during the pandemic, and the need to onboard many industry newcomers. It is important to pass on the knowledge, skills and values to them, with the top value of safety as our first priority.

Amongst the top safety values, we all agree that complying with procedures and sharing safety information through best practices or lessons learnt are key elements. This is precisely the aim of these Safety first articles. With this in mind, you will find a particular example in the "Thrust Reverser Selection is a Decision to Stop" article, which shows how not following procedures might lead to potentially catastrophic consequences. It is essential reading for every pilot to avoid these kinds of events, and it is a timely reminder for why correctly following the procedures is so vital to always keeping safety first.

Concerning this safety magazine, we are very pleased to observe the constant positive trend showing an increasing number of readers (700 000 connections per year and 1 600 readers every day on safetyfirst.airbus.com and the Safety first app). Let's make it our common safety value to share this information widely, because it is surely an effective way to prevent accidents or serious incidents. Our ambition is for every flight, maintenance and cabin crew member working with Airbus aircraft, and indeed for all aviation professionals from across the industry, to benefit from the information shared in Safety first.

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Safety first

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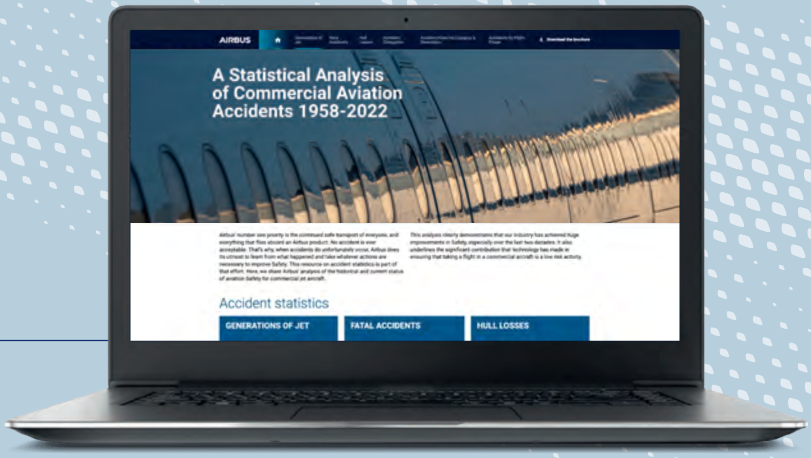

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NEWS

Save the Date! The 28th Airbus Flight Safety Conference will be held 18-21 March, 2024

Save the date in your calendars for the next Airbus Flight Safety Conference to be held 18-21 March, 2024 in Bangkok, Thailand. Invitations for the event will be sent to all of our customers in January 2024.

Safety first #36

OPERATIONS

Flight Operations

Cabin Operations

Ground Operations

Maintenance

Non-Engagement of the Go-Around Modes in CLEAN Flaps Configuration

There were several events reported to Airbus where the go-around guidance modes did not engage when flight crews initiated a go-around. The analysis of these events indicated that the aircraft were on approach in CLEAN flaps configuration. Some of these events led to a high-energy situation toward the ground at low altitudes.

This article explains why the go-around guidance modes do not engage on some aircraft if the go-around is initiated while the aircraft is in CLEAN flaps configuration. The article provides recommendations for flight crews if they face this situation.
It describes the modifications that are planned to ensure that the go-around guidance modes engage when the flight crew initiates a go-around, even if the aircraft is on approach in CLEAN flaps configuration.

CASE STUDY

Event Description

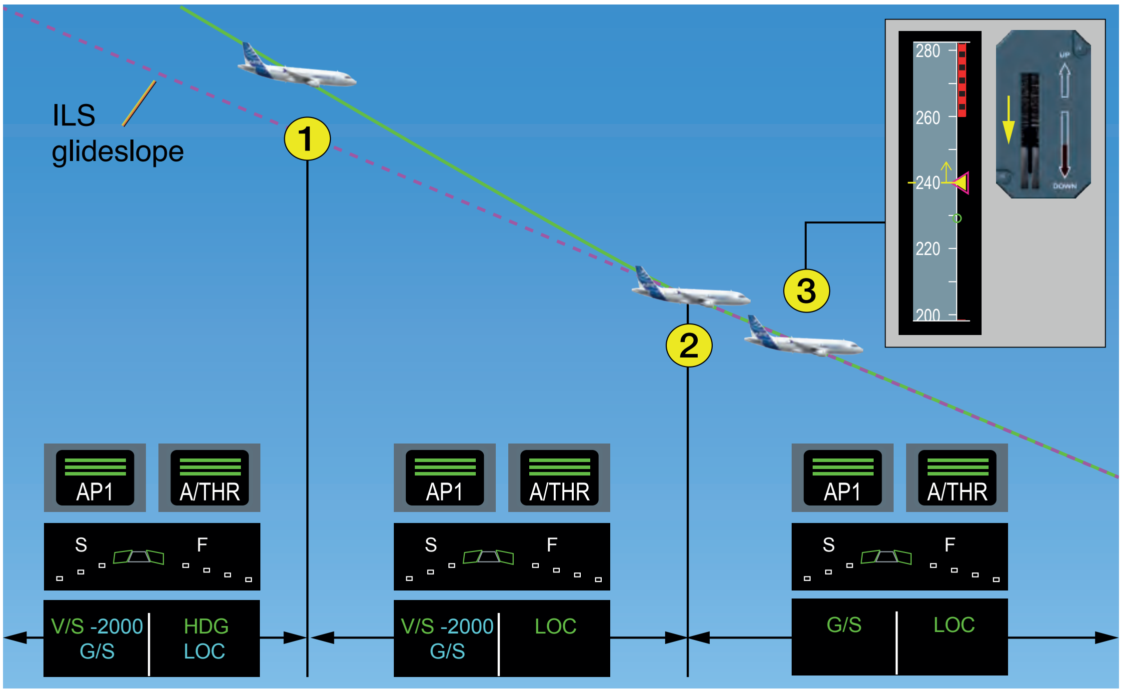
An A319 aircraft was on descent with autopilot and autothrust ON. The flight crew was preparing to perform an ILS interception from above. The aircraft experienced moderate turbulence conditions during the approach phase.

1 The aircraft captured the localizer 10 NM from the runway threshold. The aircraft was descending in V/S mode at 2 000 ft/min in CLEAN flaps configuration, and with a selected altitude of 2 500 ft QNH.

2 The aircraft intercepted the ILS 3° glidepath from above at approximately 2 500 ft QNH, which was 7 NM from the runway threshold, at a speed of 225 kt.

3 Crossing 2 300 ft QNH, the aircraft speed was 236 kt increasing. The flight crew decided to extend the landing gear to reduce the speed.

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



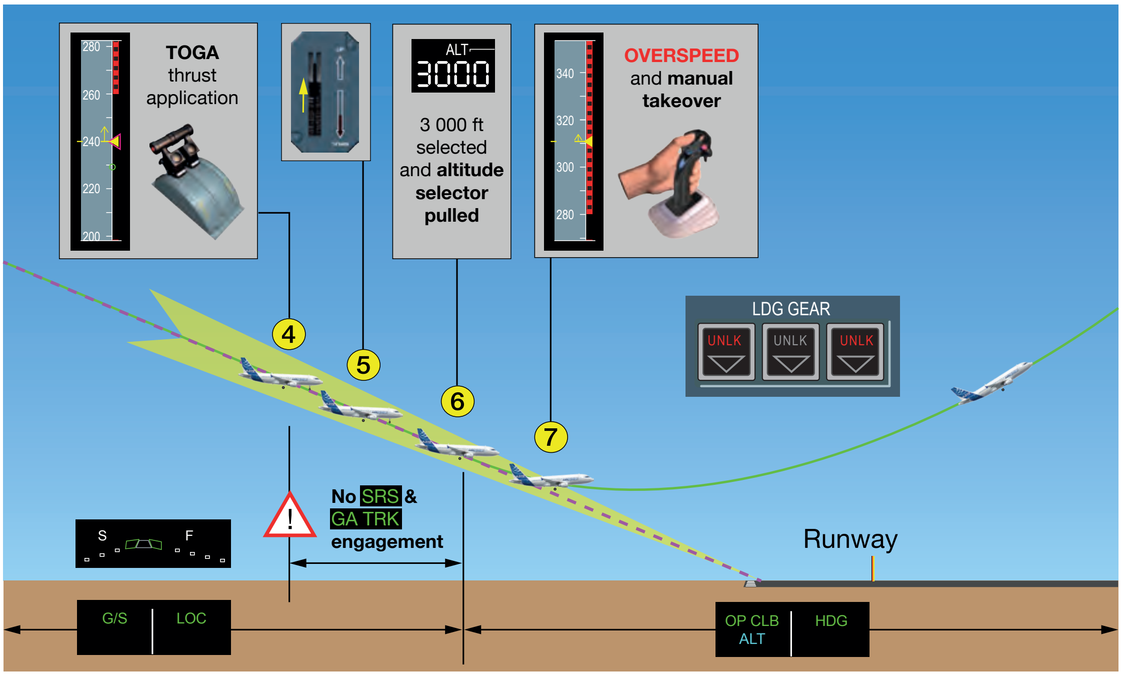
4 Crossing 1 300 ft QNH, the aircraft was still in CLEAN flaps configuration and its speed was 240 kt. The flight crew pushed the thrust levers to TOGA to initiate a go-around. The LOC and G/S guidance modes remained engaged and the aircraft started to accelerate toward the ground, along the 3° glideslope.

5 Crossing 1 130 ft QNH, the aircraft speed was 243 kt increasing. The flight crew selected gear up, but the VLO for retraction of 220 kt was already exceeded.

6 At approximately 800 ft, the flight crew selected a 3 000 ft target altitude and pulled on the altitude knob-selector. The OP CLB guidance mode engaged and sent a nose-up command to the autopilot. Aerodynamic forces meant that retraction of the landing gear was difficult. The nose landing gear retracted, but the left and right Main Landing Gear (MLG) remained extended.

7 The overspeed warning triggered due to the VLE (280 kt) exceedance. The PF disconnected the autopilot and applied nose-up inputs. The aircraft reached 312 kt at 600 ft before climbing back up to 3 000 ft where the PF reengaged the autopilot in ALT mode. The MLG fully retracted 2 min 30 s later while in level flight, with a speed of 205 kt at 3 000 ft. The flight crew eventually performed a second approach and safely landed the aircraft.

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



Event Analysis

High-energy approach

The aircraft started its glideslope interception from above in CLEAN configuration at high speed. As a result, the flight crew was not able to sufficiently slow down the aircraft to stabilize its speed and they decided to perform a go-around.

Non-engagement of the go-around guidance modes

On A320 family, the SRS go-around mode and GA TRK mode engages if:

- The flight crew sets a thrust lever at the TOGA detent, and
- The aircraft is airborne, or on ground for less than 30 s, and
- The slats or the flaps are extended.

Therefore, when the PF pushed the thrust levers to TOGA, the SRS and GA TRK modes did not engage and the autopilot remained in G/S and LOC final approach modes.

Crew reaction time

It took 30 s for the crew to react and disconnect the autopilot, leading to an overspeed condition (312 kt with main gear extended) near the ground (600 ft).

FLIGHT GUIDANCE BEHAVIOR DURING GO-AROUND IN CLEAN FLAPS CONFIGURATION

At the time of publication of this article, on all Airbus aircraft except the A220 and the A350 with PRIM P12 and subsequent standards, the flaps configuration must be selected other than a CLEAN flaps configuration in order to activate the go-around guidance modes. **Table 1** summarizes the slats/flaps condition for the activation of the go-around guidance modes applicable for each Airbus aircraft type. Full conditions for activation can be found in the FCOM description chapter for flight guidance on each aircraft type.

Table 1
Summary of the slats/flaps condition for engagement of the go-around guidance modes

<table>
<tr><th>Aircraft</th><th>A300</th><th>A300-600/ A310</th><th>A320 Family/ A330/A340/ A380</th><th colspan="2">A350</th><th>A220</th></tr>
<tr><td>Guidance Modes</td><td>GO ARND</td><td>GO AROUND</td><td>SRS and GA TRK</td><td colspan="2">SRS and GA TRK</td><td>VGA and GA</td></tr>
<tr><td rowspan="2">Slats/Flaps Condition*</td><td rowspan="2">≥ 8°</td><td rowspan="2">≥ 15/0</td><td rowspan="2">≥ CONF 1</td><td>Up to PRIM P11</td><td>From PRIM P12</td><td rowspan="2">No slats/flaps condition</td></tr>
<tr><td>≥ CONF 1</td><td>≥ CONF 1
or CONF 0 with aircraft below FCU altitude and below 2500 ft RA</td></tr>
</table>

*The slats/flaps condition may be the flap lever position and/or the actual flap position depending on the aircraft type. Refer to the FCOM for more information.

A220 and A350 aircraft with PRIM P12 and subsequent standards

A220 aircraft are not concerned by this non-engagement of the go-around modes in CLEAN flaps configuration: the VGA and GA modes are activated when the flight crew presses one of the TOGA switches on the thrust lever regardless of the position of the slats/flaps.

On A350 aircraft with **PRIM computer standard P12 and subsequent standards,** the go-around modes are also engaged in CLEAN flaps configuration if the aircraft is below the altitude selected on the FCU altitude and below 2 500 ft RA.

OPERATIONAL CONSIDERATIONS

Flight crews must be aware of the potential for go-around guidance modes to not engage on some aircraft when the aircraft is in CLEAN flaps configuration.

Risk of high energy near the ground

The FCTM states that if the thrust levers are set to the TOGA detent (or the go levers are triggered on A300-600/A310) during approach with the FLAPS lever at 0, the following occurs:

- The AP/FD remains engaged in approach or landing mode (e.g. GS, LOC, LAND, FLARE on the FMA)
- The FMS does not engage the go-around phase and remains in APPR phase
- LVR CLB flashes on the FMA (or the FMA displays THR L on A300-600/A310).

This means that when the thrust levers are set to the TOGA detent (or the go-levers are triggered on A300-600/A310), the aircraft energy will rapidly increase, but the aircraft will remain on its approach path. In this situation, the flight crew must take appropriate action without delay.

SOPs guidance for configuration on approach

Correct SOPs application should prevent the aircraft from being in a CLEAN configuration during final approach. The SOPs state that the aircraft should be **at least in CONF 1** at the start of the final approach in the case of a decelerated approach, or in landing configuration in the case of an early stabilized approach.

INFORMATION

For more information about the two approach speed techniques, decelerated and early stabilized, refer to the FCTM Normal Procedures - Standard Operating Procedures - Approach - Configuration management and the "**Control your speed…During Descent, Approach and Landing**" Safety first article

Glideslope interception from above

When intercepting an ILS glideslope from above, the FCTM recommends that the flight crew should select **at least CONF 2** to ensure that the aircraft speed does not increase during the interception.

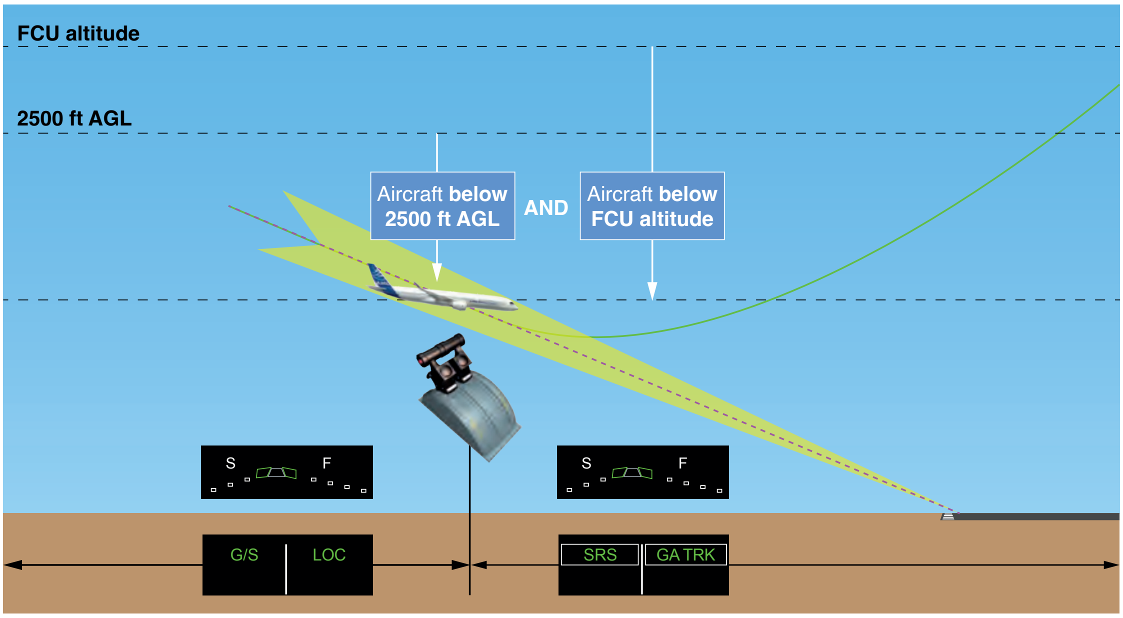
Check of the FMA

Constant monitoring of the FMA as per SOPs enables a quick detection of the non-engagement of the go-around modes, allowing a quick flight crew reaction.

SYSTEM ENHANCEMENTS

An update of the flight guidance mode was launched on A320 family, A330, and A380 aircraft to have a similar engagement logic as the A350 fleet fitted with the PRIM P12 or subsequent standards. The updated logic will enable the engagement of the SRS and GA TRK when in CLEAN flaps configuration, if the flight crew sets the thrust lever to TOGA and provided that the aircraft is **below 2 500 ft AGL AND is below the FCU altitude (fig.3)**. The planned availability of the flight guidance modification of each aircraft type is indicated in **Table 2**.

(fig.3)
Go-around engagement logic on A350 aircraft with PRIM P12 and subsequent standards.



Aircraft	A300/ A300-600/ A310	A320 Family		A330	A340	A380	A350	A220
Computer standards	N/A	FG PI20 and PC22	FG C16 and I17	Standard not yet defined	N/A	From PRIM Batch 8	From PRIM P12	N/A
Availability	Not planned	Mid 2026	2027	To be defined	Not planned	End 2026	Available	Available

Table 2
Planned availability of the engagement of the go-around modes in CLEAN flaps configuration.

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With thanks to Marc LE-LOUER from the A300/A310 Flight Operations Support and Daniel LOPEZ FERNANDEZ from the Product Safety Enhancement team.

Today, on most Airbus aircraft (except the A220 and the A350 with PRIM P12 and subsequent standards), the flaps configuration must be different than CLEAN to activate the go-around guidance modes. The flight crew must be aware of the potential non-engagement of the go-around modes when initiating a go-around in CLEAN flaps configuration. If this happens, the flight crew must take appropriate action without delay to prevent them from being in a high-energy situation near the ground.

Application of the SOPs should prevent the flight crew from being in CLEAN flaps configuration during final approach as the SOPs recommend to be at least in CONF 1 at the start of the final descent.

As an additional safety net, an update of the flight guidance modes is planned on A320 family, A330, and A380 aircraft to enable engagement of the go-around modes in CLEAN flaps configuration. This is provided that the aircraft is below the FCU selected altitude and below 2 500 ft, as on A350 aircraft.

Using Approved Tools and Ground Support Equipment for Maintenance

Special tools or Ground Support Equipment (GSE) may be required to perform some maintenance tasks. Airbus provides a list of approved suppliers for GSE or tools in the Tools and Equipment Manual (TEM). GSE or tools from suppliers that are not listed in the TEM may be offered to Operators and maintenance organizations as alternatives. However, these alternative GSE or tools may not always be designed or manufactured to meet the technical, quality, and safety requirements of Airbus.

This article describes events where the use of unapproved GSE or tools led to serious incidents. It explains why it is important to only use GSE or tools from approved suppliers to ensure safe aircraft maintenance and operations.

CASE STUDY 1

Event Description

The engine of an A321 aircraft was being replaced. The maintenance team installed the engine bootstrap equipment that is used to hold and lower the engine during the removal task. When the engine was disconnected and separated from the pylon, the engine suddenly fell **(fig.1)**. Fortunately, nobody was injured. The engine pylon was damaged and needed to be partially replaced. The engine was damaged beyond economical repair.

(fig.1)
Picture of the event

Event Analysis

Rupture of a bootstrap attachment

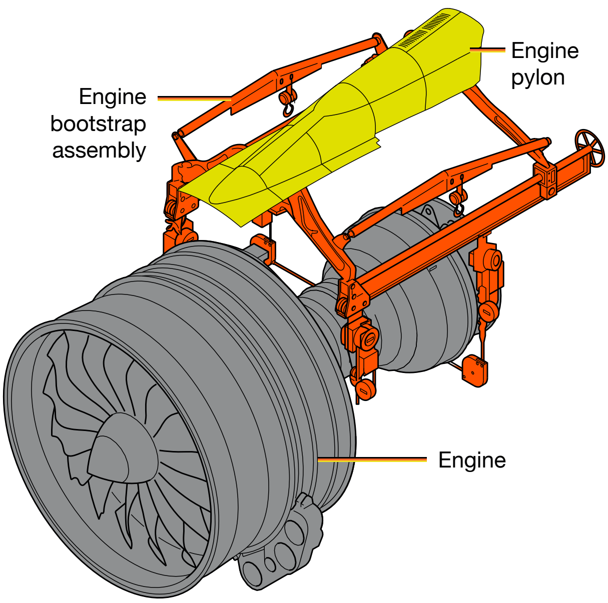
Inspection of the bootstrap equipment on the hanging engine showed that one of its attachments had bent under the load of the engine and it eventually ruptured, which released the engine it was supporting, causing it to be damaged from the fall.

Unapproved bootstrap

The investigation found that the bootstrap equipment was not compliant with the Airbus technical specifications. The sizing and material of the attachments, which were a part of this equipment, were not correctly sized and this caused the equipment to fail.

The supplier of the engine bootstrap equipment was not listed in the Airbus Tools and Equipment Manual (TEM). The Operator had found the equipment supplier on the internet. The bootstrap equipment advertised on this supplier's website indicated the same part number as the one listed in the AMM, but its cost was significantly lower than the equipment available from approved suppliers listed in the TEM.

(fig.2)
Example of an engine bootstrap for A320 aircraft



CASE STUDY 2

Event Description

An A319 aircraft was preparing for takeoff. During the takeoff roll, the PF initiated the rotation at around 138 kt. The aircraft responded with a high pitch rate, despite limited inputs by the PF, and the pitch angle quickly reached 14°. The flight crew continued the flight and landed safely. When back on the ground, the flight crew reported the unexpected high pitch rate experienced during the takeoff. The aircraft was kept on the ground for further inspection.

Event Analysis

A weight and balance analysis was performed, but no loading or balance issue was identified.

The flight data recorder confirmed that the aircraft had a dynamic rotation with limited stick inputs, as well as an unexpected center of gravity (CG) value from the Flight Augmentation Computers (FAC). This value was significantly different from the actual CG calculated during the aircraft weighing

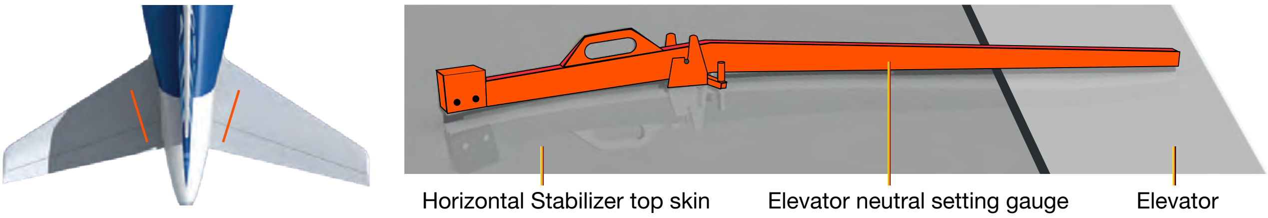
Too high pitch-up elevator setting

Inspection of the aircraft flight control surfaces revealed an incorrect setting of the elevators, which were set at a higher pitch-up position than expected. It explained the aggressive pitch-up during takeoff rotation and why the aircraft was 'trying to rotate' before rotation speed as reported by the flight crew.

Unapproved neutral setting gauge

The investigation revealed that the elevators were erroneously set using an unapproved elevator neutral setting gauge (fig.3). The unapproved gauge was found to be a rough copy of the approved tool. The gauge used could not be correctly placed on the horizontal stabilizer skin due to its incorrect dimension and this led to an incorrect reference for the elevator neutral position being used for the setting of the elevators.

(fig.3)
Illustration of the elevators neutral setting gauge



USING THE CORRECT GSE & TOOLS

Why using the approved GSE and tools is important

Approved GSE and tools are designed to meet specific needs

Approved GSE and special tools are designed so that they can precisely fit and sustain the loads that they will be exposed to when used. Specific materials, dimensions, and manufacturing processes for GSE and tools ensure that when used correctly, they will not fail in use, cause damage to the aircraft, or injure people.

Be vigilant when searching for GSE and tools online

Many suppliers selling unapproved GSE and tools can be found online and may propose alternative versions or part numbers. There is no guarantee that these tools meet the Airbus requirements and standards.

Types of unapproved GSE and tools

Unapproved GSE and tools can be categorized into three main groups:

- **Imitations of Airbus or vendor proprietary GSE and tools**
  This type of unapproved GSE and tools has the same part number as the Airbus approved items, but may not have the same characteristics due to differences in the material used, dimensions, and manufacturing quality.

- **"Alternate" tool designs sold as so-called "equivalents"**
  This type of unapproved GSE and tools will not have the same part number as the approved items, but their suitability and quality cannot be guaranteed by Airbus.

- **Out of date second-hand market tools**
  These GSE and tools may initially come from an approved supplier and then be sold on the second-hand market. They may be of an older standard that does not comply with the latest specifications, therefore, making this GSE or tool not fit for the purpose anymore.

(fig.4)
Example of approved tools

Risks when using unapproved GSE and tools

Airbus and its approved suppliers/vendors did not review, test or validate the unapproved GSE and tools. It is likely that these items may not be of the appropriate quality or may not perform their intended function in a safe and satisfactory manner. These items can cause injuries or damage to the aircraft, which may adversely impact maintenance and operations as demonstrated in the two events described above.

Golden rules to get an approved GSE & Tools

Maintenance documentation is the only source of information about the correct GSE or tools to be used to perform maintenance tasks on Airbus aircraft.

Operators and maintenance organizations must ensure that the GSE and tools used to perform a task have the same part number as the one listed in the AMM. However, since unapproved GSE and tools may exist with the same part number, Airbus recommends only purchasing or leasing the GSE and tools from one of the approved vendors referenced in the TEM **(fig.5)**.

(fig.5)
Extract of the A320 TEM for the Elevator neutral setting gauge

Technical data related to a tool

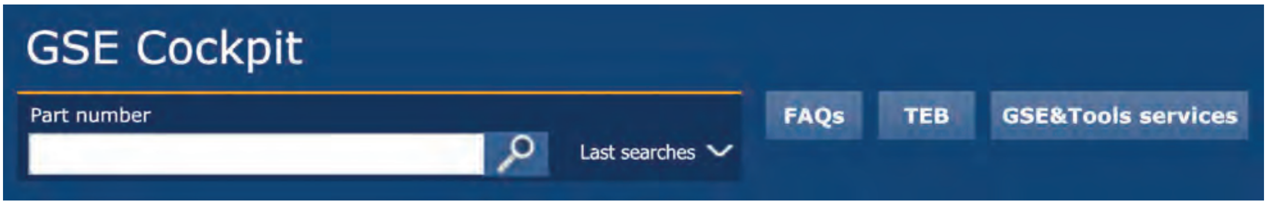
Part No.	:	98D27309006000 (FAPE3)
Designation	:	GAUGE-ELEVATOR NEUTRAL SETTING
Description	:	This tool is used to set the neutral position of the elevator.
References	:	AMM 27-34-00

Figure 01 N TE 273400 00 ANM0 01 00
Additional Information

Part Number	Keyword	Drawing	Dimension	Maintenance Manual	Vendor Code	Supplier Code
98D27309006000	GAUGE	NO	LENGTH: mm/2250 WIDTH: mm/370 HEIGHT: mm/510 WEIGHT: g/74000.000 (LENGTH: mm/2113 WIDTH: mm/210 HEIGHT: mm/144 WEIGHT: g/10000.000)		FAPE3	D4296
Optional Vendors Codes						

It is also the responsibility of the Operator or maintenance organization to consult the latest Tool Equipment Bulletin (TEB) on the GSE cockpit of **AirbusWorld** portal **(fig.6)** to check for information on GSE and tools. TEBs are issued when a new tool is introduced or deleted from the documentation. They also provide information about tool modifications. A TEB is applicable until the TEM and AMM includes the information it contains. Operators and maintenance organizations can subscribe to the TEB notification service in **AirbusWorld** and receive an alert by email for each new TEB publication.

(fig.6)
Interface of the GSE cockpit available on the AirbusWorld portal



In case of any doubt about the origin, suitability, and approval status of GSE or tools, the Operator should contact Airbus or the original equipment manufacturer to confirm that it is an Airbus approved item.

KEYPOINT

- **Check for the correct GSE or tool part number** in the AMM
- Airbus recommends ordering GSE or tools only from **an approved supplier/vendor listed in the TEM**
- **Consult the latest TEB** for any new information about GSE and tools or any related modification, addition, or cancellation from the documentation
- **If in doubt, ask Airbus to confirm that the item is an Airbus approved GSE or tool**

INFORMATION

Further information can be found in the following documents available on the **AirbusWorld** portal:

- **OIT 999.0047/21 & A220-OIT-00-00-011 NC** - Manufacturing and Sourcing Rules for Airbus Proprietary GSE and Tools
- **OIT AI/SE 999.0089/01**- Use of Non-Approved Aircraft Maintenance Tools
- **Frequently asked questions on GSE and tools** available on the GSE cockpit of **Airbusworld**

Maintenance of GSE & Tools

GSE and tools require regular maintenance, as specified by the manufacturer, to operate correctly, prevent failure, and ensure safe aircraft maintenance and operations.

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Ground Support Equipment (GSE) and special tools are designed so that they can perfectly fit and sustain the loads and conditions they are designed to be exposed to when they are used. Unapproved GSE and tools provided by suppliers not listed in the TEM may not meet the Airbus technical specifications. They may not perform their intended function in a safe and satisfactory manner. Unapproved items can cause injuries to people working on or around the aircraft and damage to the aircraft and its components.

Operators should only use GSE and tools corresponding with the part numbers that are listed in the Aircraft Maintenance Manual and ensure that they are procured from the approved suppliers referenced in the Tool and Equipment Manual. Operators should also consult the latest Tool Equipment Bulletin for new information about GSE and tools or any new modification, addition, or cancellation from the documentation.

In case of any doubt about the origin of GSE or tool, Operators can contact Airbus to confirm that the GSE or tool is an approved item.

GSE and tools require regular maintenance. Adherence to the GSE or tool maintenance instructions will contribute to ensuring its safe operation during maintenance tasks without risk of failure.

Thrust Reverser Selection is a Decision to Stop

The SOP for landing requests that the flight crew perform a full stop landing after thrust reversers selection. However, in-service flight data analysis revealed that the equivalent of one go-around per month is performed after selection of thrust reversers.

This article describes an event where the flight crew performed a go-around after they had selected thrust reversers on an A320 aircraft. The reverser on one engine remained deployed until the end of the flight.

The article explains how adherence to SOPs will prevent recurrence of this kind of event and describes the product enhancements that Airbus developed as additional safety barriers.

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

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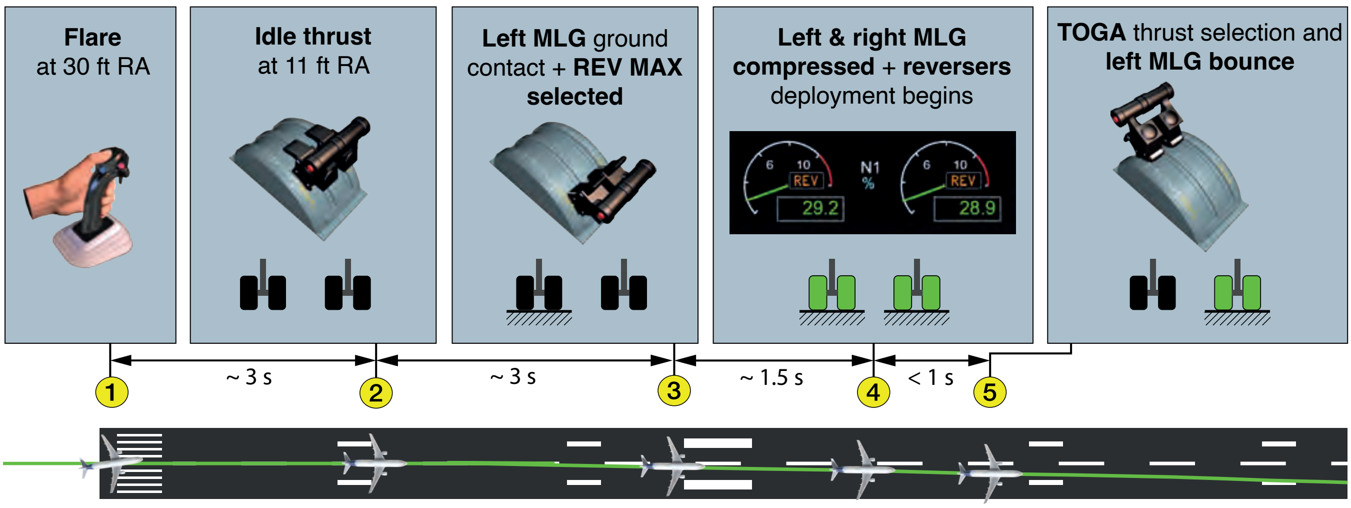
CASE STUDY

Event Description

An A320 aircraft fitted with CFM56 engines was on an ILS approach in FLAP 3 configuration with good visibility conditions. There was a 25 kt crosswind and wind gusts from the left side **(fig.1)**.

1 The PF initiated the flare slightly above 30 ft RA, started the decrab maneuver at 24 ft RA, and 2 set the thrust levers to idle at 11 ft RA. 3 The left Main Landing Gear (MLG) briefly touched the runway, but was not fully compressed when the flight crew set the thrust lever to maximum reverse.

4 When both the left and right MLG touched the runway and were compressed, the thrust reversers began to deploy. 5 The flight crew then decided to perform a go-around. The left MLG was briefly uncompressed when the PF applied TOGA thrust. They selected CONF2 and applied nose-up inputs.

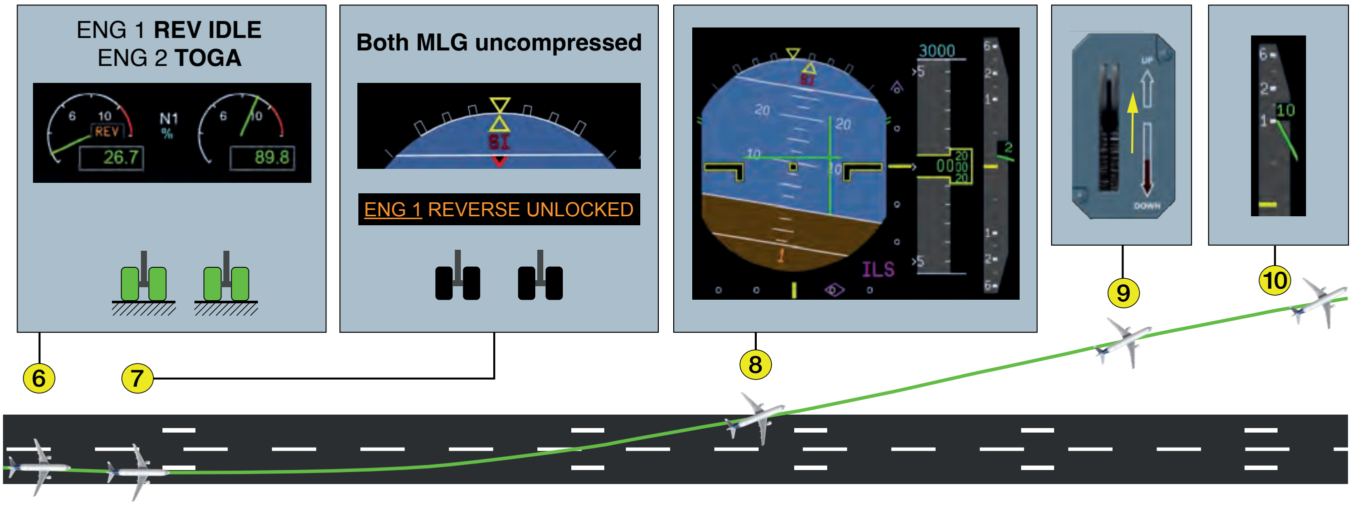


(fig.1)
Sequences of the event from landing flare to the application of TOGA thrust for go-around

6 ENG 2 spooled up to reach TOGA thrust, but ENG 1 remained at idle with the REV indication still displayed on the Engine Warning Display (EWD) **(fig.2)**. The aircraft began to veer to the left. The PF reacted and applied a half of maximum right rudder input. Both the left and right MLG were briefly compressed again. 7 The aircraft continued to veer to the left and the ENG 1 REVERSE UNLOCKED ECAM alert triggered when the left and right MLG were uncompressed. The beta target symbol on the PFD was flagged. 8 The aircraft overflew the left runway edge by 1 ft.

(fig.2)
Sequences of the event after TOGA thrust selection

9 The flight crew commanded the landing gear up and the aircraft started to climb on a trajectory that was shifted by approximately 20° to the left of the runway axis. When the landing gear was retracted and the pitch was set close to 12.5°, corresponding to the target for go-around with one engine inoperative, 10 the vertical speed reached 1 000 ft/min.



The flight crew then set the ENG1 thrust lever to IDLE at 360 ft and shut down ENG 1, as per the ECAM procedure at 1 260 ft QNH. The beta target symbol appeared again on the PFD, which enabled the PF to correctly trim the rudder, and the autopilot was engaged.

The flight crew performed a second ILS approach and manually landed the aircraft with its ENG 1 inoperative.

The aircraft arrived at the gate with three of the four ENG 1 thrust reverser blocker doors deployed and not locked **(fig.3)**. The fourth door was not deployed, but was unlocked.

(fig.3)
Aircraft at gate after the event with three out of four thrust reverser blocker doors deployed on ENG 1 (photos: Accident Investigation Board)

Event Analysis

Thrust Reverser Deployment Sequence

The thrust reversers unlocked when both the left and right MLG were compressed. When the PF applied TOGA thrust, the thrust reversers of the left and right engines were not fully deployed (the amber REV indication was still displayed on the EWD).

Thrust Reverser Stowage Logic (on CFM56 Engines)

When the thrust levers are moved from the REV sector to idle or forward thrust sector, the Electronic Control Unit (ECU) of each engine computes a “ground” or “flight” status using the “compressed” or “uncompressed” status for the left and right MLG. This is provided by the Landing Gear Control and Interface Unit (LGCIU).

If the computed status is "ground" when the thrust levers are moved out of the REV sector, then the ECU will send a "stow" command until the thrust reversers are stowed. If the computed status is "flight", then the ECU does not send a signal to initiate the stow sequence.

Why ENG 2 thrust reverser stowed and locked

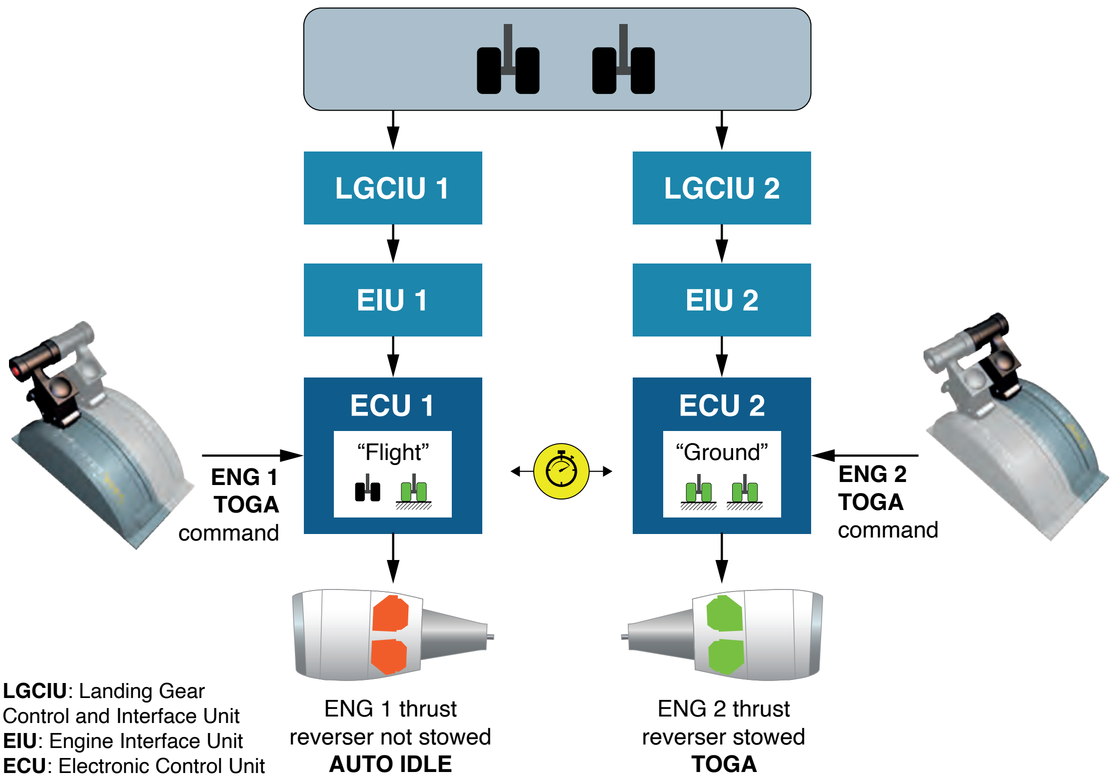
When the PF set TOGA thrust, ECU 2 computed the "ground" status using information from LGCIU 2. This sent the "stow" command to the ENG 2 thrust reverser. The ENG 2 thrust reverser stowed and locked correctly and ENG 2 spooled up to reach TOGA thrust.

Why ENG 1 thrust reverser did not stow and lock

When the PF set TOGA thrust, ECU 1 computed the "flight" status using information from LGCIU 1. ECU 1 did not send a stow command to the ENG 1 reverser and its blocker doors remained deployed. The automatic idle protection activated and sent a signal to prevent ENG 1 increasing thrust. What caused the difference between ENG 1 and ENG 2.

A short asynchronism between the computation of the ground/flight status by both ECUs, combined with a bounce of the left landing gear, explains the different behaviors of the ECUs. This timing difference can be explained by the fact that thrust levers may not be closely aligned when the flight crew moves them from the REV sector to idle or forward thrust sector. In addition, a very slight delay may appear between the signals and computation chain of LGCIU-EIU-ECU, which are independent for the left and right sides **(fig.4)**.

(fig.4)
A short delay between the computation of the "ground" or "flight" status by ECU 1 and ECU 2, combined with a left MLG "bounce" condition caused the ENG 1 thrust reverser blocker doors to remain deployed and ENG 1 set at AUTO IDLE



LGCIU: Landing Gear Control and Interface Unit
EIU: Engine Interface Unit
ECU: Electronic Control Unit

Limited to aircraft with CM56 engines

A study of the reverser stowing logic was performed on A320 aircraft equipped with all other types of engine, as well as on other Airbus aircraft types including the A220. It confirmed that only A320 and A340 aircraft equipped with CFM56 engines can be affected by this potential for the thrust reversers to not retract if the crew decides to perform a go-around after the thrust reversers are selected.

Beta target not displayed due to EIS logic

The current EIS logic flags the beta target symbol on the PFD if the reversers are not stowed and the auto-idle protection is active. This explains why the beta target symbol was flagged in the early stage of the go-around and before ENG 1 was shut down. As soon as ENG 1 was shut down, the beta target reappeared on the PFD.

Impact on aircraft control and performance

The flight crew had to cope with a fast lateral trajectory deviation, together with a significant degradation of climb performance, during an already demanding maneuver.

Significant pitch and roll values reached closed to the ground

In the initial phase of the go-around, the aircraft attitude went close to wing tip and tailstrike conditions **(fig.5)** but remained within the ground clearance limits.

(fig.5)
Screen captures from the video reconstitution of the event showing the aircraft attitude in the early stage of the go-around phase (Flight Animation System from APS Aerospace)

OPERATIONAL CONSIDERATIONS

Adherence to the SOP for landing will prevent recurrence of a similar event and ensure optimum and safe use of the thrust reversers, regardless of the engine type, and on any aircraft.

Select reversers immediately after touchdown

The SOP for landing requests that the flight crew select thrust reversers immediately after landing gear touchdown, but not before, to ensure timely deployment of the thrust reversers for optimum aircraft deceleration on landing.

Thrust reverser selection means full stop

The SOP for landing also states that as soon as the flight crew selects reverse thrust, they must perform a full-stop landing. This is also highlighted for a go-around near the ground in the FCTM, which states, **"the PF must not initiate a go-around after the selection of the thrust reversers."** Adherence to this SOP will avoid any repeat of the event described in this article. The A220 FCOM limitation chapter also states that **"Go-around maneuver and touch-and-go are prohibited after deployment of the thrust reversers."**

INFORMATION

A similar event, described in a previous Safety first article, occurred on an A300-600 with a different reverser system architecture. The root cause was different, but it also highlighted how adherence to the SOP for landing would have prevented the incident.

Refer to the "**Thrust reverser selection means full-stop**" article published in June 2012.

PRODUCT ENHANCEMENTS

Airbus performed flight data analysis with inputs from 31 operators for 3.4 million flights of A320 family aircraft. The results showed that the equivalent of one go-around per month is performed with the thrust reversers already selected, which represents significant exposure. Consequently, Airbus decided to address this issue with updates to the ECU software, the EIS software, and the relevant documentation.

ECU software update for CFM56 engines

An update of the ECU software for CFM56 engines is under development. It includes an enhanced stow logic in the case of a rejected landing with reversers already selected, which will prevent recurrence of the event described in this article. The ECU software update is planned to be available in 2025 for CFM56-5B engines and is under review for CFM56-5A and -5C.

EIS update

A320 family EIS 2 software will be modified to enable the display of the beta target on the PFD when REV doors are unlocked. This enhancement will be implemented in the next EIS 2 standard.

Enhancement of the SOP for landing

The SOP for landing will be updated to move the following text from the FCOM layer 2 (L2) to a note in the FCOM layer 1 (L1), making it more visible to the flight crew: "The flight crew must select reverse thrust immediately after landing gear touchdown" and "As soon as the flight crew selects reverse thrust, they must perform a full-stop landing".

The SOP for landing states that as soon as the flight crew selects reverse thrust, they must perform a full-stop landing. Analysis of in-service data shows that there is still a risk exposure with flight crews deciding to perform a go-around after the thrust reversers were selected.

An incident that happened on an A320 aircraft highlighted a risk of having one of the engines with the reversers still deployed in the case of a go-around initiated after reverser deployment on aircraft equipped with CFM56 engines. Application of the SOP should prevent this kind of event from happening. However, Airbus decided to introduce aircraft modifications to further prevent this scenario from happening and enhance the documentation by making the recommendation to perform a full-stop landing after selection of thrust reversers more visible to the flight crew.

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Best Maintenance Practices for Redundant Systems

Performing similar maintenance tasks on redundant systems at the same time, or by the same person during a particular maintenance check, may lead to the repetition of a maintenance error. This creates a risk of simultaneous failure of the redundant systems when the aircraft is back into service.

This article provides best practices to reduce this risk and ensure that the benefits of redundancy of systems or components on the aircraft is not compromised.

CASE STUDY 1

Event Description

The loss of two hydraulic systems in flight

An A330 aircraft experienced the loss of two hydraulic systems in the cruise phase of a long-range flight. The initial HYD B RSVR LO LVL and HYD B RSVR LO PR ECAM cautions were triggered, and the HYD B + Y SYS LO PR ECAM warning appeared approximately 30 minutes later. The flight crew applied the appropriate procedure and set the affected hydraulic pumps to OFF, causing the flight control system to revert to alternate law.

The flight crew diverted the aircraft and landed safely without further incident. The aircraft was kept on the ground for further inspection.

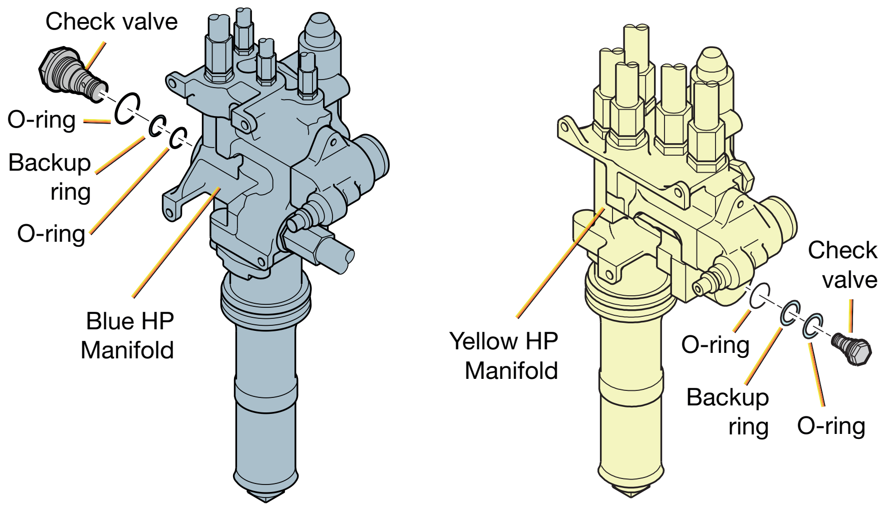
Event Analysis

The same leak in two hydraulic systems

After an initial inspection, the maintenance engineer discovered signs indicating a hydraulic leak that came from the High Pressure (HP) manifold on both the blue and yellow hydraulic systems. They decided to replace both HP manifolds and sent them to Airbus for further analysis.

The hydraulic fluid leak was confirmed as coming from the check valves installed in both the blue and yellow hydraulic system HP manifolds. O-rings reserved only for transportation and storage were found installed on both selectors. The Aircraft Maintenance Manual (AMM) requests the removal of these transportation and storage O-rings before the installation of the check valves on the aircraft. These O-rings are not for operational use as they are not designed to sustain hydraulic system pressure. These transportation O-rings were damaged and were confirmed as the origin of the hydraulic fluid leak.

(fig.1)
Check valves of the blue and yellow HP manifolds with their respective O-rings



A maintenance error repeated on two hydraulic systems

Maintenance records showed that the check valves were replaced a few days prior to the event. The same maintenance personnel performed the task on both the blue and yellow manifolds at the same time. They erroneously left the transportation O-rings on both check valves.

CASE STUDY 2

Event Description

Engine fire after landing

An ENG 1 FIRE ECAM warning was triggered on an A320neo aircraft shortly after landing. The flight crew set the ENG MASTER lever to OFF, and pressed the ENG 1 FIRE pushbutton to discharge AGENT 1. The ECAM warning remained, so the flight crew discharged AGENT 2. The warning disappeared and the aircraft safely came to a stop at the gate without further incident.

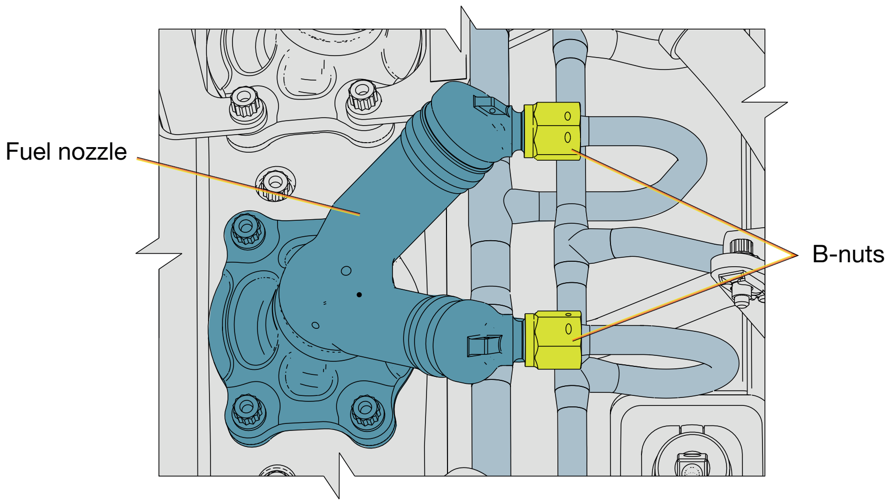
Event Analysis

Evidence of fire

A preliminary maintenance inspection confirmed evidence of fire found on the engine core at the 12 o'clock position. The operator decided to replace engine 1 for further investigation and repair.

Fuel leaking from a fuel nozzle

Further inspection revealed that the engine fire was caused by **a fuel leak from a fuel nozzle B-nut that was not torqued to the correct value specified in the AMM.** The B-nuts of the other fuel nozzles were also incorrectly torqued, but they showed no sign of leaks.



(fig.2)
Example of a fuel nozzle and its B-nuts on an A320neo engine

A maintenance error on engine 1 repeated on engine 2

A check of engine 2 enabled the operator to discover that the fuel nozzle B-nuts were also incorrectly torqued as was the case for engine 1. The correct torque was then applied to all of the engine 2 nozzle B-nuts and there were no further discrepancies.

Maintenance records revealed that the aircraft had a maintenance check 16 days prior to the event. The fuel nozzles of both engines were replaced. The same maintenance personnel performed the nozzle replacement on both engine 1 and engine 2 and improperly torqued their B-nuts.

APPLYING BEST PRACTICES

Operators and approved maintenance organizations should **identify when there is the risk of errors** being repeated in identical maintenance tasks during a particular maintenance check. This will allow for application of the following best practices to prevent simultaneous failures in redundant systems.

Stagger the scheduling

When possible, avoid scheduling similar maintenance tasks on redundant systems at the same time. This reduces the risk of having a simultaneous failure of the redundant systems as a result of a repeated maintenance error.

Assign different people to redundant systems

If it is not possible to stagger the scheduling of similar maintenance tasks, then a different person or team should carry out the task on each redundant system or component. This reduces the probability of repeating a potential maintenance error made by the same person or team.

Additional inspection and cross-check

Identify the task as one that requires an additional inspection, cross-check, and dual signature verification that the task was completed correctly and in accordance with the maintenance procedures.

Test one system at a time

If a system test or engine run is necessary, the maintenance personnel should ensure that only one of the redundant systems or engines is tested at a time, unless the task provides other specific instructions. This reduces the risk of simultaneous failures or unexpected behavior of the systems/engines during the test.

Always follow the maintenance procedures

As a general rule, strictly adhering to the maintenance procedures reduces the risk of introducing human errors during maintenance tasks.

Regulatory requirements

ETOPS operations

For ETOPS operations, requirements and guidelines shall be applied. For example:

- US 14 CFR Part 121 section 121.374, "Continuous airworthiness maintenance program (CAMP) for two-engine ETOPS - Limitations on dual maintenance."
- FAA AC 120-42, "MAINTENANCE REQUIREMENTS FOR TWO-ENGINE ETOPS AUTHORIZATION - Dual Maintenance" paragraph
- EASA AMC 20-6 (AMJ 120-42/IL 20). "4. CONTINUING AIRWORTHINESS MANAGEMENT EXPOSITION" chapter.

EU and UK regulations

EU and UK regulations also request that operators establish procedures that prevent the risk of repeating errors on identical systems (independently of the type of operations):

- EU Part-145: Item 145.A.48(c)(3) and its AMC1 145.A.48(c)(3) & GM1 145.A.48(c)(3)
- UK CAA Part-145: Item 145.A.48(c) and its AMC 145.A.48(c) & GM 145.A.48(c).

INFORMATION

Further information can be found in the following documents available on the **AirbusWorld/A220World** portal:

- **OIT 999.0097/16** "BEST PRACTICES FOR SIMULTANEOUS MAINTENANCE ON REDUNDANT ITEMS"
- **OIT AI/SE 999.0044/99** "DUAL SYSTEM MAINTENANCE RECOMMENDATIONS"
- The introduction section of the Aircraft Maintenance Manual (AMM) & A220 Aircraft Maintenance Publication (AMP) provides general recommendations related to the risk of human error during maintenance tasks.

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Performing similar maintenance tasks on redundant systems at the same time, or by the same person during a particular maintenance check, may lead to the repetition of a maintenance error. This creates a risk of simultaneous failure of the redundant systems when the aircraft is back into service.

There are a range of safeguards or best practices that can be applied to prevent repetition of a maintenance error. These include staggered scheduling of the task, using different personnel to carry out the task, performing an additional cross-check inspection, and requiring a dual signature to verify that the task was correctly carried out and in accordance with the maintenance procedures. Where possible, and unless otherwise specified, carry out a test of one system or one engine run at a time.

In all cases, it is important to correctly apply the maintenance procedures.