Safety first

The Airbus Safety magazine

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.

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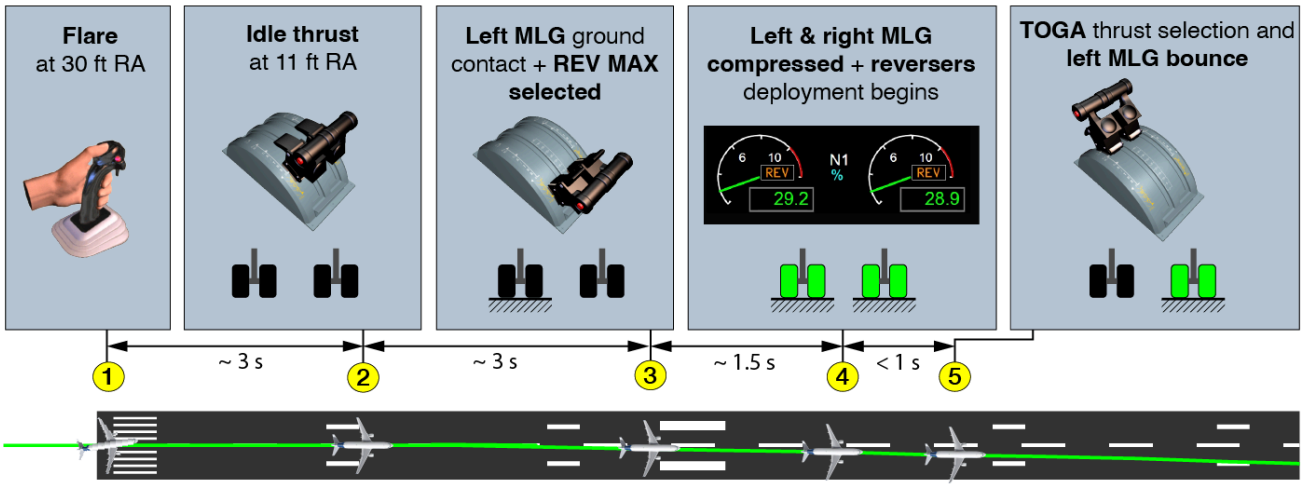
CASE STUDY

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.

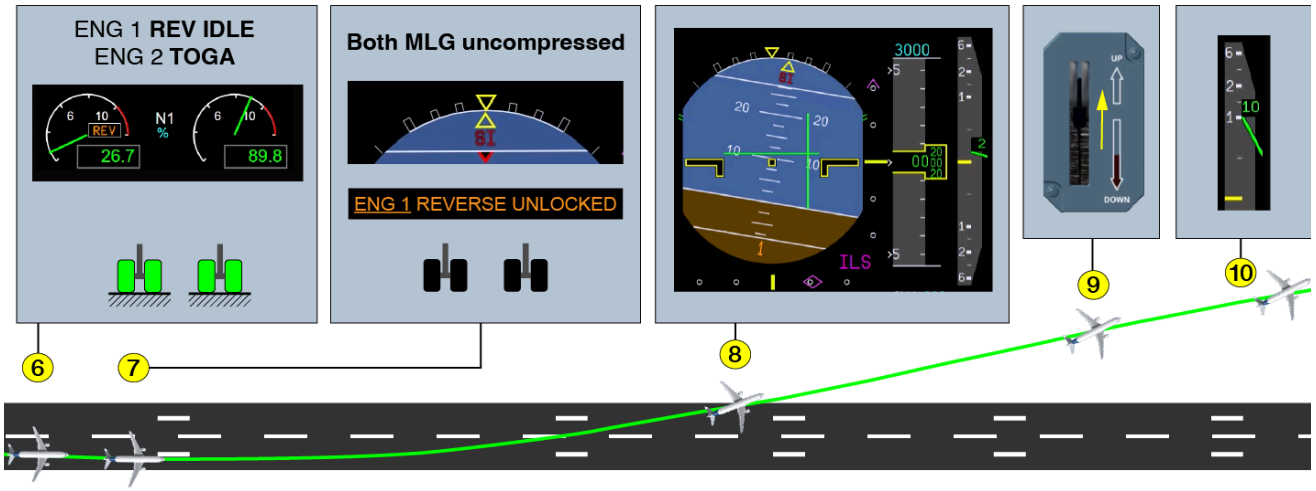
④ When both the left and right MLG touched the runway and were compressed, the thrust reversers began to deploy. ⑤ The flight crew then decided to perform a go-around. The left MLG was briefly uncompressed when the PF applied TOGA thrust. They selected CONF2 and applied nose-up inputs.



(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.

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.

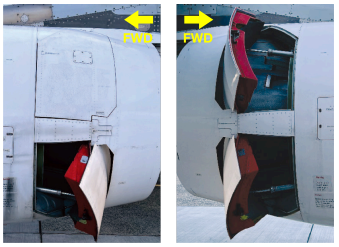


(fig.2) Sequences of the event after TOGA thrust selection

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

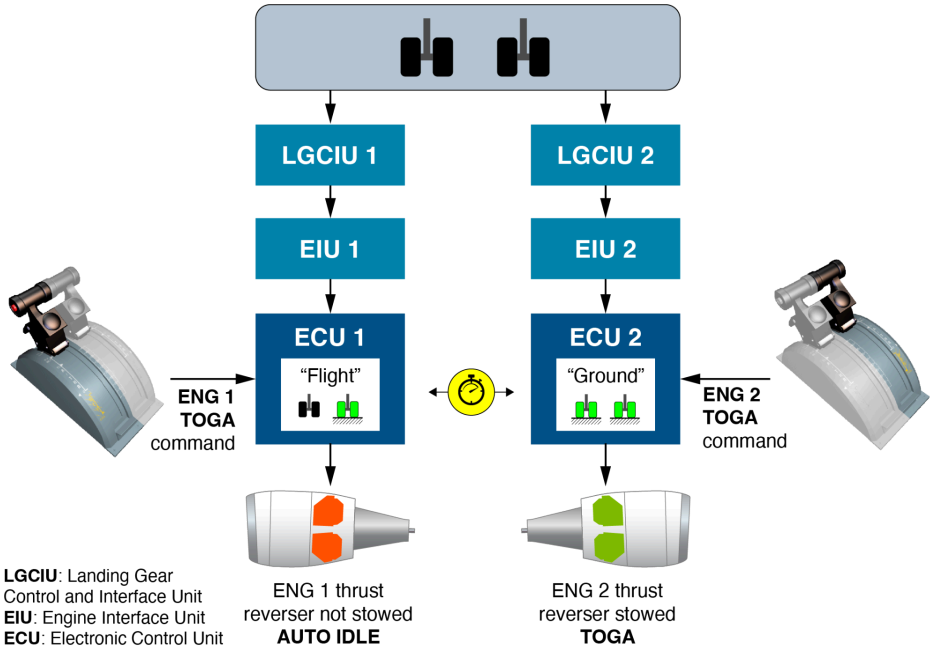
When the PF set TOGA thrust, ECU 2 computed the “ground” status using information from LGCIU 2. This sent the “stow” command to the ENG 2 thrust reverser. The ENG 2 thrust reverser stowed and locked correctly and ENG 2 spooled up to reach TOGA thrust.

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

Limited to aircraft with CFM56 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 reconstruction 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*"

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With thanks to Matthias MAEDER from Airbus Canada

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.

Safety first, 2023. Safety first is published by Airbus S.A.S. 1, rond point Maurice Bellonte - 31707 Blagnac Cedex/France.

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Safety first

The Airbus Safety magazine

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