The Airbus safety magazine

#31

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,

I hope that the new year finds you, your families, friends, and colleagues well. The entire Airbus safety team and I pass on our best wishes for a brighter 2021. With the vaccine solutions now becoming available, it gives us hope that we will begin to emerge from this COVID-19 situation. However, we will still face some uncertainty, together with all of its associated challenges.

Seeing so many grounded and parked aircraft in 2020 was disheartening for everyone, especially in contrast to the normally dynamic operational environment of commercial aviation. In this context, there is also the heightened risk of falling into the complacency trap. It is why we must remain vigilant, and ensure we do everything that is required to safely return to the skies.

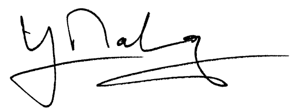
In response to the evolving circumstances of 2020, aviation actors had to adapt and develop risk management strategies, in particular to avoid this complacency trap. At Airbus, we launched our own task force, which included a dedicated focus on supporting Operators with storage, parking, maintenance practices, and preparing aircraft for their return to service including flight operations aspects. The significant work achieved by our colleagues in Airbus Customer Services and Engineering teams is reflected in the **Safety first** articles published throughout 2020.

These included *Aircraft Parking and Storage* (May), which was followed up by *Preparing for a Safe Return to the Skies* (June), and with further updates provided in the *Parking and Storage / Return to Service Summary Letter*. For flight crews who have recently flown much less than usual, there are articles on *Prevention of Unstable Approaches* (October), *A Focus on the Landing Flare* (September), and the latest article, *A Focus on the Takeoff Rotation* (January). Each article provides operational best practices and the key safety elements for pilots to recall during these critical flight phases.

Nevertheless, the aviation industry is not yet clear of the COVID-19 “wake vortex” effect. Therefore, we need to remain focussed on fully applying a risk management mindset and to implement all of the resulting risk mitigation strategies. It is why I strongly encourage every one of us to keep going, and for you to make full use of the above-mentioned Airbus safety information, which will support a safe return to flying.

Safety in aviation is a part of our professional DNA and our shared passion for aviation. It is why we are pleased to see the readership of the Airbus **Safety first** articles continue to grow, with over 500,000 visits to safetyfirst.airbus.com and the **Safety first** app in 2020. I want to thank all of you for engaging with the safety information that we are sharing and for continuing to connect your aviation colleagues with Airbus **Safety first** in 2021.

I look forward to seeing you in the safe skies ahead.



NEWS

News: Parking and Storage / Return to Service Summary Letter

A dedicated task force in Airbus Customer Support was created in response to the unprecedented impact of the global pandemic on our industry since March this year. As there have been many aircraft grounded for an extended period of time, this letter provides Operators with the latest Airbus guidance on parking & storage of aircraft and to ensure their safe return to service.

You can download the latest issue of the ***"Parking and Storage/Return to Service Summary Letter"*** by scanning this QR code.

This Summary Letter can also be found on the AirbusWorld portal in the *Content Library/Publications/Newsletter* section.

Safety first #31

- Flight Operations
- Cabin Operations
- Ground Operations
- Maintenance

OPERATIONS

A Focus on the Landing Flare

There were several cases of aircraft touching down with their nose landing gear first or hard landings reported to Airbus over the last 2 years. This article will present some key points coming from the analysis of two of these incidents and recall the operational recommendations for performing the flare phase that are key to ensuring a safe landing.

CASE STUDY 1: BOUNCED LANDING, NOSE LANDING GEAR IMPACT, AND A TAIL STRIKE ON GO-AROUND

Event Description

An A320 was on the final approach segment of its ILS approach, configured for landing (CONF FULL).

The Pilot Flying (PF) disconnected the autopilot at 370 ft Radio Altitude (RA) and kept autothrust ON. At 200 ft, tailwind variations caused the airspeed to drop below approach speed (Vapp).

1 From 100 ft RA and below, high tailwind gradients maintained the **airspeed below Vapp -5 kt** despite autothrust increase and reached a minimum of 119 kt (Vapp -20 kt) at 5 ft RA.

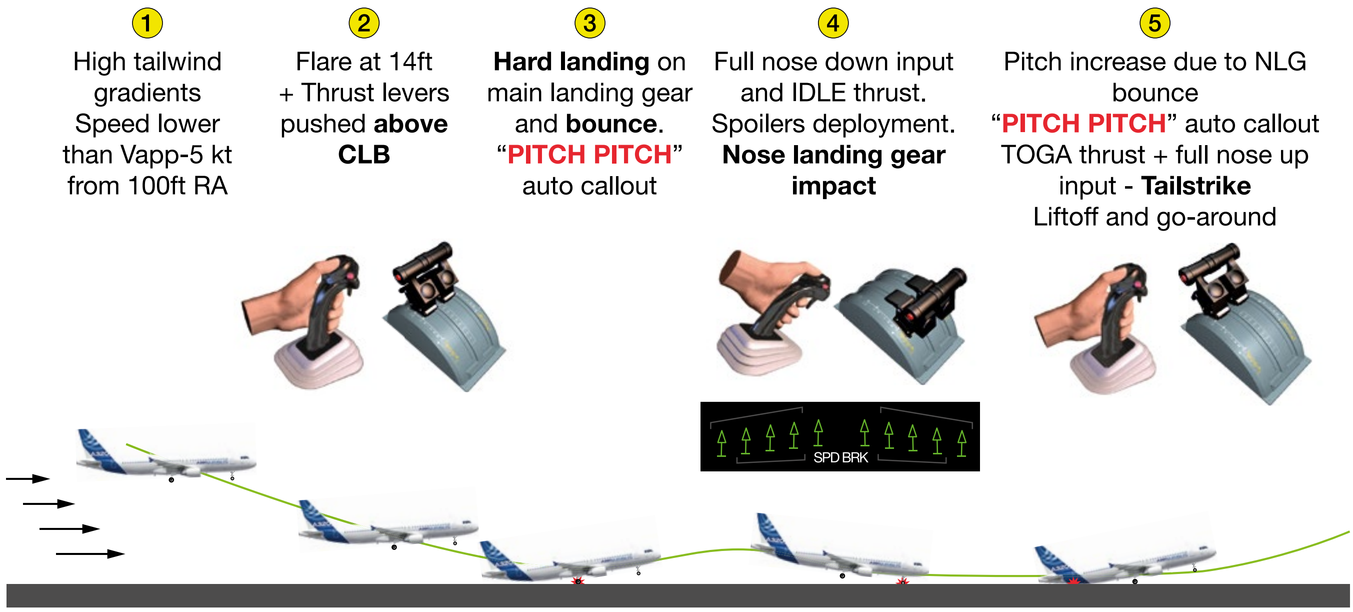
2 The PF performed **the flare at 14 ft** and at the same time started to slowly push the **thrust levers above CLB detent**.

3 The aircraft touched down on its main landing gear and **bounced**. During the bounce, a **PITCH PITCH** auto callout triggered.

4 The PF applied **full nose down order** and retarded the thrust levers to **IDLE**. This triggered an extension of ground spoilers leading the aircraft to heavily impact the runway, first with its nose landing gear and then its main landing gear.

5 The impact of the nose gear resulted in another sudden increase of the aircraft's pitch and the **PITCH PITCH** auto callout triggered for a second time. The PF initiated a **go-around** by setting TOGA thrust and applying a full nose up command. There was a tail strike as the aircraft lifted off from the runway at 133 kt.

The NLG wheels separated due to the impact of the NLG on the runway and one wheel was sucked into Engine 1, causing this engine to stall. Other system failures occurred due to the impact on the NLG and these caused the aircraft to revert to alternate law. The flight crew diverted to a different airport and eventually landed the aircraft.



(fig.1)
Sequence of events from case study 1

Operational Considerations

Role of the Pilot Monitoring (PM)

The FCOM SOP for landing requests a SPEED callout by the PM in the case of speed deviation of 5 kt below the target speed. The PF should initiate a go-around unless they consider that a stabilized condition can be recovered by small corrections to the aircraft and within sufficient time prior to landing.

The FCTM states that the risk of tail strike is increased due to the high angle of attack and high pitch attitude if the speed of the aircraft is allowed to decrease too far below Vapp before the flare.

Looking at step 1 in the event described above, it shows the speed went below Vapp -5 kt from 100 ft and below. If the PM had made a "SPEED" callout then the PF may have noticed the speed decay and attempted to correct it or initiate a go-around if it was not likely to stabilize in time.

Flare Height

The FCOM states that in a stabilized approach, the flare should be initiated at 30 ft for A320 family aircraft (the values for other Airbus aircraft are provided later in this article).

The FCTM recommends initiating the flare earlier if there is a tailwind. This is because a tailwind will contribute to a higher ground speed with an associated increase in vertical speed to maintain the approach slope.

Initiating the flare earlier would have reduced the high vertical speed of the aircraft in the event described above.

Thrust Lever Management

The A320 FCTM explains that the flight crew can rapidly retard all thrust levers to IDLE either earlier or later than the 20 ft "RETARD" auto callout reminder depending on the conditions. However, the thrust levers should be at IDLE by touchdown to ensure that the ground spoilers will extend and keep the aircraft on the ground.

In step 2 of the event, the PF pushed the thrust levers above the CLB detent during flare. This increased thrust and inhibited the ground spoiler extension during the initial touchdown, which contributed to the aircraft bounce.

Bounce Management

For a high bounce, as was the case in the incident described above, the FCTM recommends maintaining the aircraft's pitch attitude and performing a go-around.

The hard impact of the nose landing gear with the runway described in step 4 of the event was caused by extension of the ground spoilers when the thrust levers were retarded to IDLE during the bounce combined with a full forward stick input after the bounce.

Go-Around Close to the Ground

The FCTM recommends avoiding an excessive rotation rate during a go-around close to the ground and to counteract any pitch-up effect due to the thrust increase.

In step 5 of the event, it was the full back stick input combined with the nose landing gear bounce and thrust increase that contributed to the tail strike.

CASE STUDY 2: A321 NOSE LANDING GEAR LANDING

Event Description

The A321 performed an ILS approach in night conditions. The weather was fine and there was a 10 kt headwind.

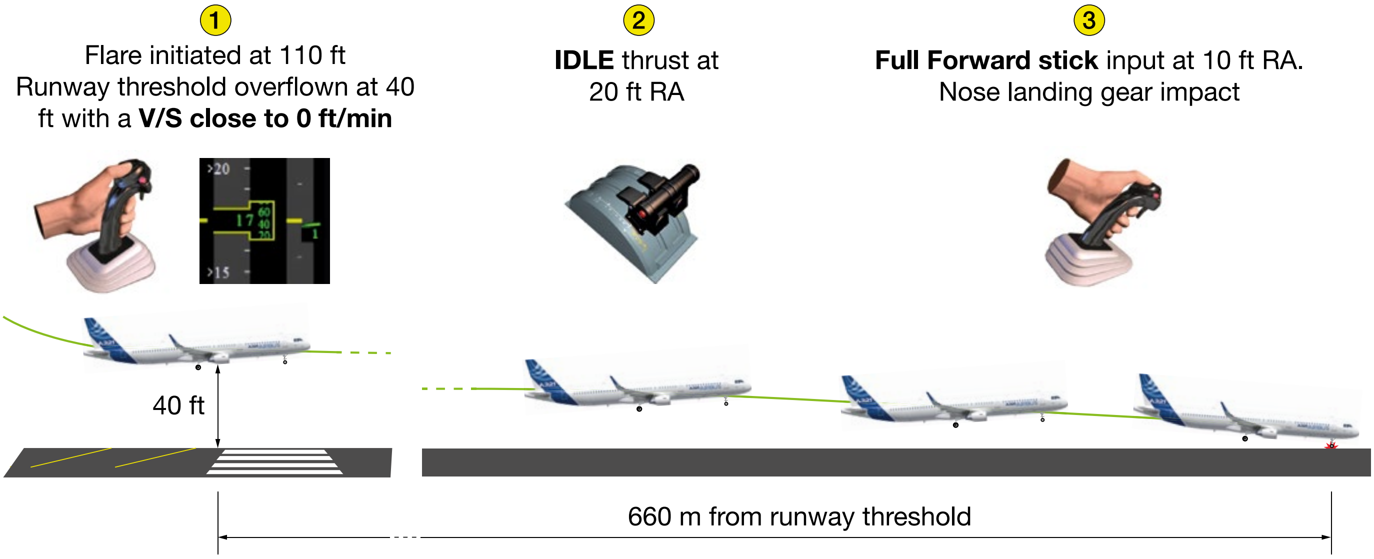
The flight crew switched OFF the autopilot at 940 ft RA and kept the FD ON. The autothrust was ON and the speed was stabilized at approach speed.

1 From 110 ft RA to 50 ft RA, the PF applied several nose up inputs that increased the aircraft pitch attitude to 3.8° nose up. The autothrust commanded a thrust increase to maintain Vapp. The aircraft consequently flew over the runway threshold at around 40 ft RA with a vertical speed close to 0 ft/min.

2 The PF applied several pitch up inputs that maintained the nose up pitch attitude and the aircraft subsequently floated above the runway for 4 seconds. At around 20 ft RA, the PF retarded the thrust levers progressively to IDLE.

3 4 seconds later the aircraft was at around 10 ft and the PF applied a **full forward stick input**. The nose landing gear heavily impacted the runway 660 m after the runway threshold, followed by the main landing gear.

Both nose landing gear wheels separated due to the severe impact and the aircraft finally stopped on the runway centerline resting on its nose landing gear axle.



(fig.2)
Sequence of events from case study 2

Operational Considerations

Flare Height

The FCOM recommends a flare manoeuvre at around 30ft for an A320 family aircraft in a stabilized condition.

The flare described in the case study 2 was initiated too early at 110 ft RA and autothrust was kept engaged. This Led to the aircraft crossing the runway threshold with a vertical speed close to 0 ft/min.

Thrust Lever Management

The autothrust is active and targets the approach speed or selected speed as long as thrust levers are not retarded to IDLE detent.

In this event, the aircraft descent rate was almost 0 ft/min at the runway threshold. The A/THR was still active (thrust levers remained in CLB detent) and targeting the approach speed. This led the aircraft to float above the runway for several seconds until the PF retarded the thrust levers.

Pitch Control

The FCTM states that the PF must avoid using nose down inputs once flare is initiated. The PF can release the back stick input slightly as required.

In step 3 of this event, the aircraft pitch down effect due to the full forward stick input, combined with the aircraft's descent rate, resulted in a heavy impact of the nose landing gear with the runway surface.

Go-Around Decision

The FCTM states that if a normal touchdown point cannot be reached, a go-around (or rejected landing) should be performed.

In this event, the appropriate action would have been for the PF to initiate a go-around when the aircraft was in a float condition above the runway.

RECIPE FOR A SAFE LANDING

The recommendations below summarize the procedures and techniques provided in the FCOM and FCTM.

Be stabilized

A safe flare can only be achieved when the aircraft is stabilized, meaning that all of the flight parameters areas expected, including:

- the aircraft is on its expected final flight path (lateral and vertical)
- speed is close to Vapp, and
- wings are level.

If the aircraft reaches the flare height at the correct speed and it is on the expected flight path, then a normal flare technique will lead to a safe landing.

PM must call out any flight parameter deviation

Careful monitoring of the flight parameters including speed, pitch, bank and vertical speed, enables the PM to raise the attention of the PF to any deviation during the final approach. This will enable the PF to respond accordingly and initiate a go-around, if required.

Refer to the FCOM SOP for Approach for more information about the PM callout related to the flight parameter deviation threshold.

Flare at the right time

Flare should be initiated at around **30 ft RA (A220/A300/A310/A320) / 40 ft (A330/A340/A350/A380)** in stabilized conditions.

Factors that may require an earlier initiation of the flare:

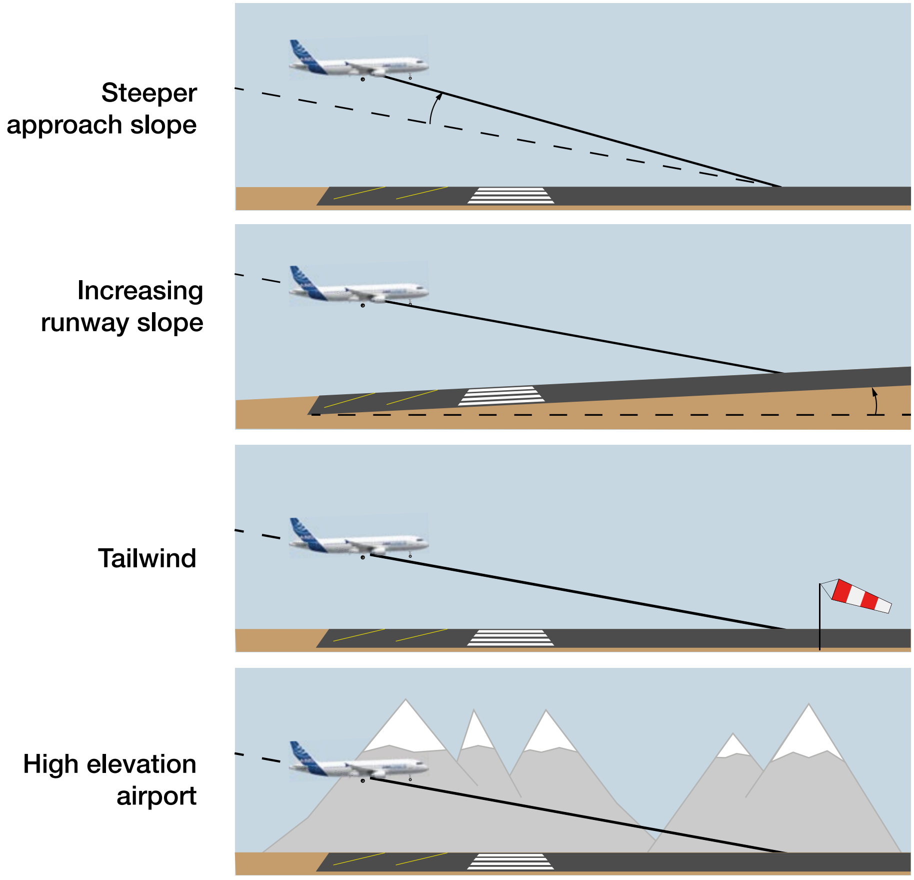
- Steeper approach slope (more than the nominal 3°)
- Increasing runway slope or rising terrain before the runway threshold
- Tailwind
- High airport elevation.

“If the aircraft reaches the flare height at the correct speed and it is on the expected flight path, then a normal flare technique will lead to a safe landing.”

“Careful monitoring of the flight parameters including speed, pitch, bank and vertical speed, enables the PM to raise the attention of the PF to any deviation during the final approach.”

(fig.3)
Factors that may require an earlier flare

Factors requiring an earlier flare:



Flare correctly

On Airbus fly-by-wire aircraft

The PF should apply a progressive and gentle back stick order until touchdown.

The PF must avoid forward stick inputs once flare is initiated. The PF can gradually release the back stick input if needed. The PF must perform a go-around If a normal touchdown point cannot be reached.

Any forward stick input after flare is initiated will increase the risk of landing on NLG with hard impact.

> “ The PF must avoid forward stick inputs once flare is initiated. ”

(fig.4)
Flare technique on Airbus fly-by-wire aircraft

Flare using a **progressive** back stick order

Once flare is initiated:
No forward stick input !
Release back stick pressure if needed

On A300/A310 aircraft:

The PF must start the flare with a positive and prompt back pressure on the control column to break the descent rate. The PF must then maintain a constant and positive back input on the control column until touchdown.

Retard!

A320/A330/A340/A350/A380 aircraft

The 20 ft "RETARD" auto callout is a reminder, not an order. The PF can retard the thrust levers earlier or later depending on the conditions.

The PF must ensure that the thrust levers are at idle in any case, by touchdown at the latest, to enable automatic extension of the ground spoilers.

Delaying the retard of the thrust levers may increase the landing distance because the autothrust will target Vapp or the selected speed until it is disconnected by moving the levers to the IDLE detent.

A220 aircraft

The A220 is different from the rest of the Airbus family, because when the thrust levers are engaged, they continuously respond to autothrust commands. The A220 does not have any callout for retard. The Flight Mode Annunciator displays the status of the autothrust (when it is armed and active) at the top of the PFD or the HUD. When the autothrust RETARD function is activated, it will automatically reduce the thrust levers to idle. When the autothrust RETARD function is armed, it will be activated at 30 ft AGL(except in the case of an autoland, when it will be activated between 20 and 15 ft AGL depending on the condition).

If the autothrust is not armed or if the autothrust RETARD function is not activated, the flight crew manually retards the thrust levers to idle at 30 ft AGL.

Note that the A220 ground spoiler is activated if the thrust levers are at or near the idle position.

A300/A310 aircraft

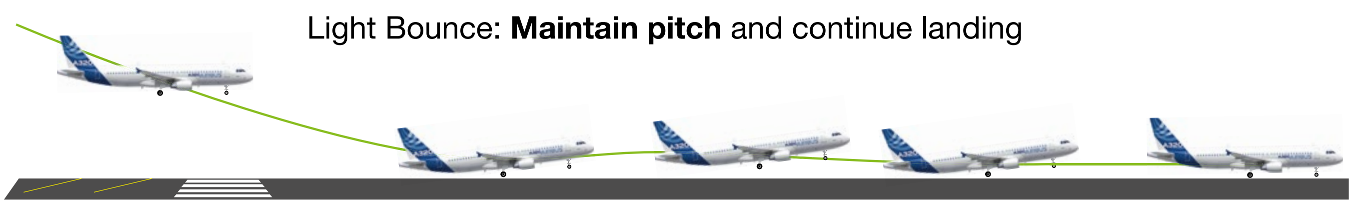
If autothrust is engaged, the PF monitors throttle reduction to idle at 30 ft. If the thrust is controlled manually, the PF retards throttles progressively to idle at 20-30 ft. The PF should hold a positive back pressure input on the control column to counter the nose-down pitching moment as the thrust is reduced.

Maintain the aircraft pitch in the case of a bounce

The FCTM recommends to maintain the pitch attitude in the case of a light bounce at landing. The aircraft will make a second lighter touchdown and the landing roll can continue.

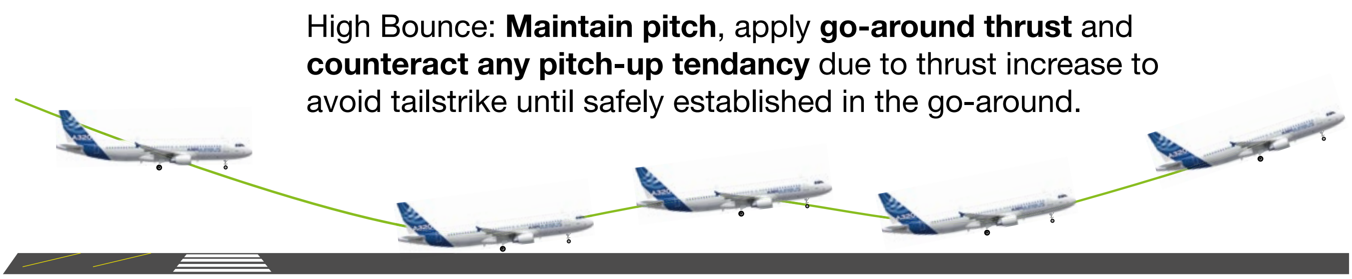
> "The PF must ensure that the thrust levers are at idle in any case, by touchdown at the latest, to enable automatic extension of the ground spoilers."

(fig.5)
Management of a light bounce



(fig.6)
Management of a high bounce

The FCTM recommends to maintain the pitch attitude and initiate a go-around in the case of a high bounce . Maintaining the pitch attitude, and counteracting any pitch-up tendency due to the thrust increase, enables the flight crew to avoid a tail strike and ensure a softer secondary touchdown should this occur.



> "The PF can abort the landing and go-around at any time until the thrust reversers are selected. However, when the reversers are selected, the landing must be continued."

Be go-around minded

The PF must perform a go-around if any parameter deviation becomes excessive, or if the aircraft is destabilized just prior to the flare.

If the aircraft floats above the runway, the flight crew must initiate a go-around instead of attempting to recover the situation.

The PF can abort the landing and go-around at any time until the thrust reversers are selected. However, when the reversers are selected, the landing must be continued.

Avoid excessive rotation rate in a go-around close to the ground

When the flight crew initiates a go-around close to the ground, they must avoid an excessive rotation rate to limit the risk of tail strike.

The flight crew must wait until the aircraft is safely established in the go-around before retracting the flaps by one step and the landing gear.

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The landing phase is very demanding and it requires good coordination between the flight crew. The FCOM procedure and FCTM provide the recommended techniques that must be carefully followed to ensure a safe landing.

The Pilot Flying must ensure that the aircraft is established on the expected final approach path at the approach speed. They will apply progressive back stick input at the correct height, which has been determined depending on external parameters. Any forward stick inputs must be avoided once flare is initiated. The thrust levers must be retarded to IDLE, by touchdown at the latest, for the ground spoilers to deploy.

In the case of a bounce at touchdown, the PF must maintain the pitch attitude and decide to either continue the landing if the bounce was light, or to go-around if it is a high bounce. In the case of a high bounce, the PF must not attempt to land the aircraft by applying nose down input on the sidestick.

The PM also plays an essential role throughout the entire landing sequence.The PM is expected to call out any deviation of the flight parameter to the PF, which will ensure that the PF can react accordingly or initiate a go-around if the deviation cannot be corrected in a timely manner. Avoiding an excessive rotation rate of the aircraft for a go-around initiated close to the ground will prevent a tail strike.

The PF must be prepared for a go-around, and initiate a go-around in the case of late destabilization or if the aircraft floats above the runway. A go-around can be initiated at any time during flare or landing roll until thrust reversers are selected. However when the reversers are selected, the landing must be continued.

Prevention of Unstable Approaches

Unstable approach has been a problem since the very beginning of commercial aviation. Even so, it is still one of the most common contributing factors to many of the incidents and accidents that occur on landing today.

Regardless of the changes or cycles our industry faces, this article is a timeless reminder for the importance of efficient preparation for approach including anticipation of late changes, and the need for cooperation between flight crews and air traffic controllers. The article also provides tips to detect a potential unstable approach in advance so that it can be corrected long before the stabilization height. Respecting stabilized approach criteria is also highlighted as well as being go-around minded in the case of late destabilization.

MANAGING CHANGES IN AVIATION

New challenges

A global pandemic, such as COVID-19, has several ramifications for the aviation industry. This includes the challenge for pilots to maintain recency in the face of an unprecedented drop in air traffic. Ongoing concerns about the effects of the pandemic can also be distracting for flight crews. It is an important reminder for crews to remain focused on their tasks throughout the flight. Especially during very dynamic and variable phases such as arrival, approach, and landing.

Modified ATC guidance

In a congested airspace, ATC sequences the large number of aircraft arriving at their destination airport by providing speed and trajectory guidance. However, ATC may not transmit this guidance when the traffic is low. Flight crews should therefore avoid the trap of expecting ATC to provide this guidance in usually congested airspaces, and always be aware of the need to monitor and control their energy.

Shortened approach trajectories

When an airspace is less congested in situations like the COVID-19 pandemic, ATC can clear flight crews on more direct routings. The flight crew must then quickly adapt their strategy to efficiently manage the aircraft energy due to the shortened approach trajectories.

In all cases, the flight crew must take advantage of the various tools and techniques available to efficiently manage and monitor their energy.

PREPARATION FOR A STABILIZED APPROACH

Energy Management

Good aircraft energy management from the top of descent is a prerequisite for a stabilized approach. Aircraft energy management is a combination of tools, anticipation, and a flexible flight crew action plan.

Use of the Flight Management System

The use of the FMS during descent, approach, and landing provides efficient assistance to the flight crew to manage the energy of the aircraft and reach the final approach at the correct speed. The “Procedures - Normal Procedures - Standard Operating Procedures - Descent ” from the FCTM provides details on how the FMS computes the descent profile and how the use of the managed guidance modes enables the aircraft to stay near this ideal profile during descent. This is also described in the “Control your speed during descent, approach and landing” Safety first article published in July 2017.

Anticipation of late changes

In areas that use specifically constructed arrivals and approaches that enable sequencing of high volumes of traffic in congested environments, the anticipation of a late “direct to” request from ATC, if traffic is low, can help to reduce the crew workload and stress. The flight crew should review the planned approach trajectory and be prepared for the “worst case” scenario of a “direct to” that would significantly reduce the track miles to the runway.

Discussing the approach strategy during the Approach Briefing

During the approach briefing, management of late changes due to ATC requests should be anticipated and discussed, ensuring the strategy and task sharing are clearly defined. This should be part of the flight crew’s Threat and Error Management (TEM) considerations.

Cooperation between flight crews and air traffic controllers

Cooperation between flight crews and ATC is essential to prevent situations that may lead to an unstable approach. The Air Traffic Controller should inform the flight crew if a shorter route is expected as soon as possible . This would enable the flight crew to anticipate and adapt their strategy accordingly and avoid high workload in the last phases of the approach.

Flight crews should alert ATC when they are unable to comply with any request and should ask for additional track miles to manage the aircraft’s energy if necessary.

Selecting the appropriate approach speed technique

The **decelerated approach** is the standard technique for approach using xLS (ILS, MLS, GLS or FLS) or FINAL APP guidance.

However, Airbus recommends that the flight crews use an **early stabilized approach** technique when:

- a selected guidance is used (TRK/FPA or LOC/FPA)
- the final approach path is at a high glide path angle
- the intermediate approach segment is at a lower altitude than usual, and as a result, the Final Descent Point (FDP) is at a shorter distance from the runway

The flight crew should enter Vapp as a speed constraint at the FDP, enabling the FMS to calculate the adjusted vertical descent profile (not applicable to A220 aircraft).

The "Control your speed during descent, approach and landing" Safety first article, published in July 2017, illustrates the two approach speed techniques.

EARLY DETECTION OF AN UNSTABLE APPROACH

In many cases, a potential unstable approach can be detected long before the stabilization height. The flight crew should take advantage of the tools and techniques available for early detection of an unstable approach. This will enable them to take the time to recover the situation using trajectory modification in cooperation with ATC. This will avoid the need for last-minute corrections by the flight crew or a discontinued approach.

Situational awareness

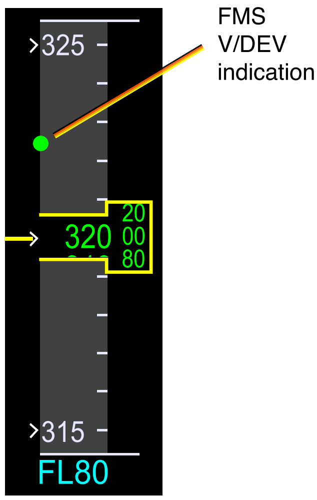
Use of the FMS V/DEV indication during descent

The use of the FMS V/DEV indication available on the FMS PROG page (A320/A330/A340), PERF DES page (A380/A350), or FMS DES page (A220) and its indication on the PFD altitude scale **(fig.1)** and VSD (A220) provides the flight crew with an indication of the aircraft position compared with the FMS descent profile.

This indication is also useful when radar vectored and flying near the FMS route.

Sequencing of the FMS Flight Plan

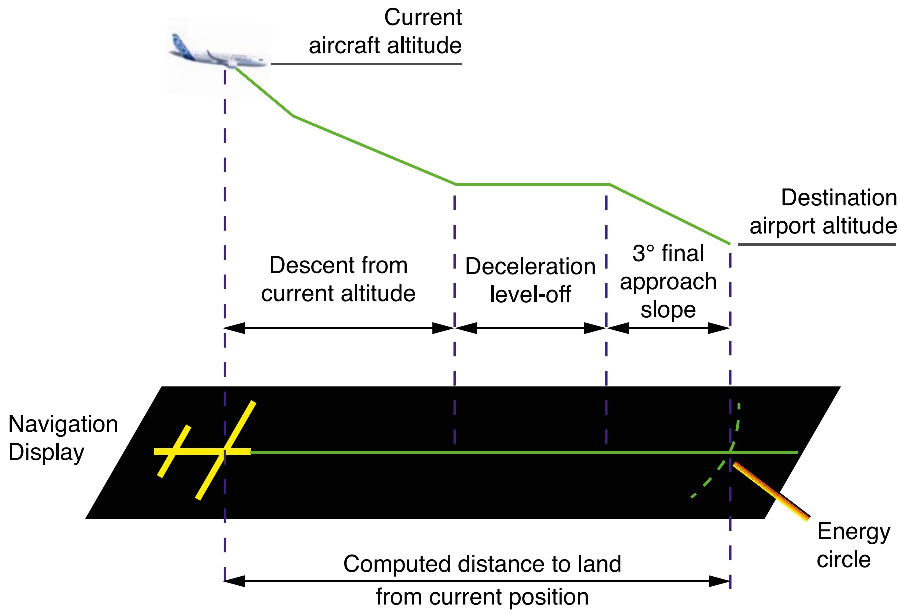
The flight crew needs to sequence the FMS flight plan if it is not done automatically when in selected lateral modes during radar vectors. It enables the FMS to compute an updated descent and approach trajectory and therefore to still provide a useful reference to the crew. In addition, it allows the flight crew to switch back to managed guidance mode when cleared from ATC constraints. More information on the Flight Plan sequencing is available in *"Procedures - Normal Procedures - Standard Operating Procedures - Approach - Configuration Management - Initial approach"* in the FCTM.



(fig.1)
Example of a V/DEV indication on the PFD altitude scale of an A320

Use of the energy circle (A320/A330/A340/A350/A380)

(fig.2)
Computation principle of the energy circle



The ND will display the energy circle when the aircraft is in HDG or TRK lateral guidance modes and within 180 NM of its destination. It provides a visual cue of the minimum required distance to land, i.e. the distance required to descend in a straight line from the current aircraft position at its current speed down to the altitude of the destination airport at approach speed. The descent profile used to compute the distance takes into account speed limits, the wind, a deceleration level-off segment and a 3° final approach segment **(fig.2)**. If the airport is inside the energy circle, the flight crew should take action to adjust the situation using speed or rate of descent adjustments or speedbrakes as necessary or by requesting additional track miles from ATC.

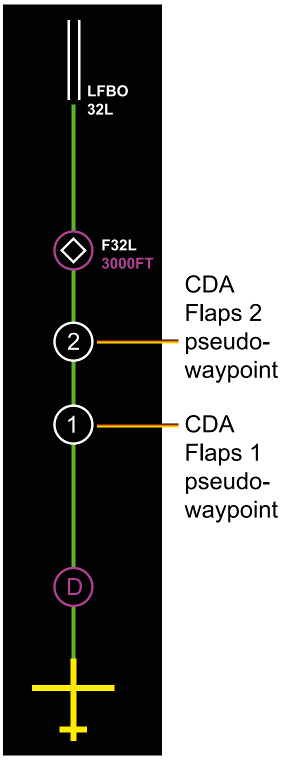
The flight crew needs to keep in mind the computation logics of the energy circle to better take advantage of the indications displayed on the ND.

Use of the bearing/distance field in the PROG page

The flight crew should consider inserting the landing threshold in the BRG/DIST field of the FMS PROG page. This will provide the direct distance to the landing threshold, and therefore, a very conservative estimation of the shortest possible distance to land. To do a quick mental estimation of the vertical position vs. distance, the flight crew can use the formula DELTA FL = DIST (nm) * 3 DEG.

Continuous Descent Approach (CDA) function (A320/A330/A350)

The CDA function is standard on all A350 aircraft and is an option on A320 and A330 aircraft equipped with Release 2 FMS standard. The CDA function computes a continuous descent profile that ensures the aircraft is configured for landing and is at VAPP, at 1 000 ft AAL. The CDA function displays pseudo waypoints on the ND **(fig.3)** indicating to the flight crew the latest position to extend the slats and flaps in order to follow the vertical profile of the approach.



(fig.3)
CDA pseudo waypoints on the Navigation Display

Cross-crew Communication

Efficient crew communication is essential during the entire flight, especially during the whole dynamic approach phase that can include several changes in speed and aircraft configuration in addition to the navigation and the guidance toward the final segment. Flight crewmembers should express any concern they may have about a parameter they are not comfortable with, even before reaching the stabilization height. Such an exchange can bring the attention of the other flight crewmember to a parameter that may not have been noticed. This communication between the crewmembers will also prepare them for a potential discontinued approach or go-around and will prevent a rushed go-around maneuver at the last minute.

BE PREPARED TO INTERRUPT THE APPROACH AT ANY TIME

The flight crew should be prepared to discontinue the approach or go-around at any time, if it is not possible to reach or maintain a stabilized flight path.

Discontinued approach versus go-around

If the flight crew needs to interrupt the approach at or above the FCU altitude, then the “Discontinued approach” procedure should be considered. If the flight crew interrupts the approach below the FCU altitude, then the go-around procedure should be applied. For more information, refer to the “Flying a Go-around, Managing Energy” Safety first article published in January 2014.

Soft go-around

To limit the aircraft acceleration during go-around, especially when the aircraft is light, the soft go-around can be used on aircraft equipped with the soft go-around function. Refer to the “Introduction to the Soft Go-around Function” Safety first article published in January 2017 for more information.

THE STABILIZATION GATE

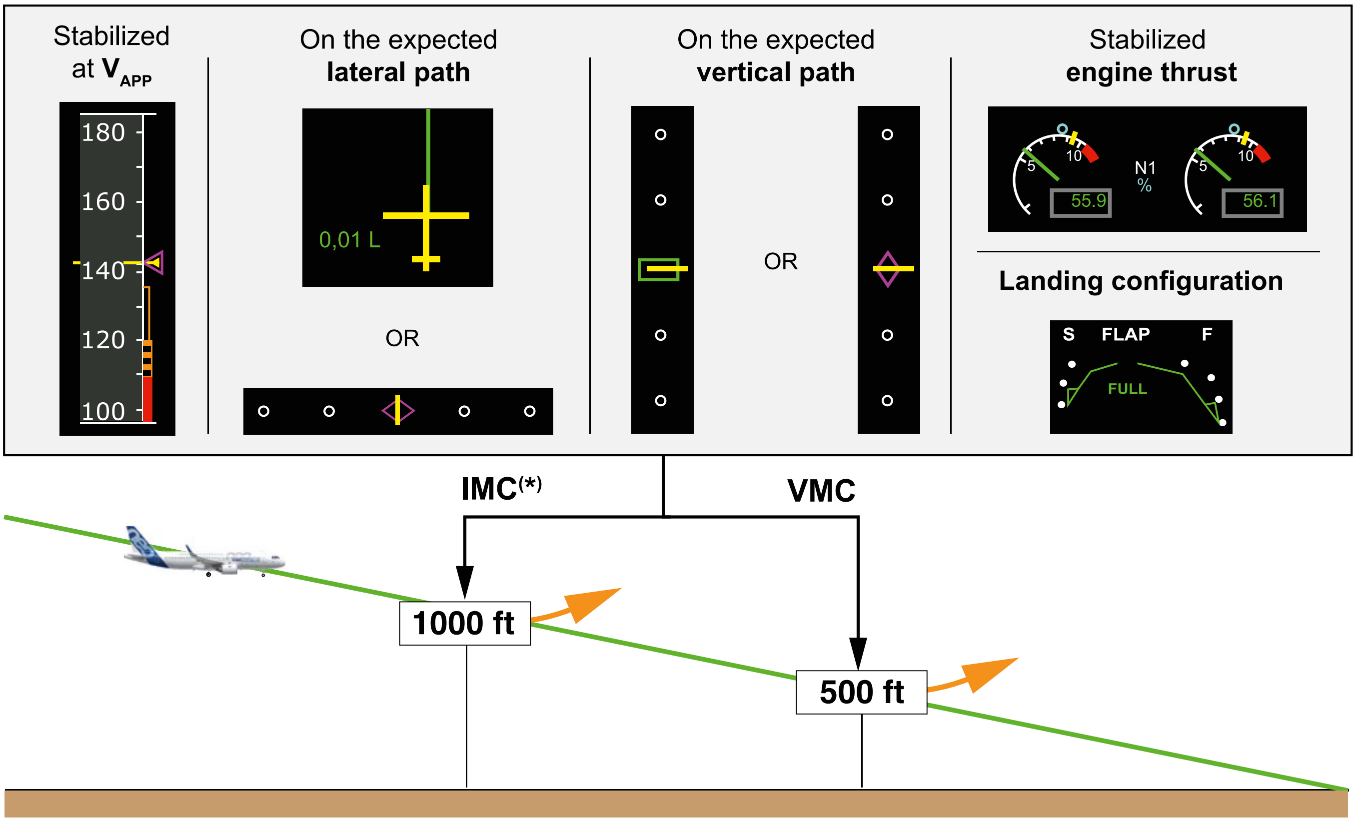
Rigorous respect of a stabilization gate provides a good basis for the accomplishment of a subsequent safe landing: a stabilized aircraft at the stabilization height enables the pilot flying to be prepared for a safe and efficient landing flare.

Operators should define and provide their flight crew with a clear definition of their stabilization criteria and stabilization height based on the FCOM guidance, their local regulations and experience.

Operators should encourage their flight crews to strictly respect the stabilization gate and to perform a go-around if they cannot achieve the criteria or if they do not feel comfortable with the stabilization of their aircraft. A non-punitive policy regarding go-arounds combined with adequate go-around training using various scenarios will increase flight crew confidence in their handling of the maneuver and will improve their go-around decision making.

Stabilization criteria from the FCOM **(fig.4)** illustrated below provides guidance to help Operators define their own stabilization policy. If one of the conditions is not satisfied, the flight crew should initiate a go-around, unless they estimate that only small corrections are required to recover stabilized approach conditions.

(fig.4)
FCOM stabilization criteria for an A320 aircraft



(*)In IMC, a later speed and thrust stabilization can be acceptable provided that:

- It is allowed by Operator policies and regulations
- The aircraft is decelerating toward the target approach speed
- The flight crew stabilizes speed and thrust as soon as possible and no later than 500 ft AAL.
- The flight crew does not detect any excessive flight parameter deviation.

LATE AIRCRAFT DESTABILIZATION

Being stabilized at a gate is not sufficient to ensure a safe and efficient landing. The flight crew must keep the flight parameters stable and within the limits until the landing.

However, some external conditions such as wind gradients may lead to late destabilization.

Close monitoring of the flight parameters

The nearer the aircraft gets to the ground, the greater the importance of efficient monitoring of the flight parameters is.

The PM must make a callout if any flight parameter deviates above the defined thresholds. The PF must then either correct the deviating parameter, if possible, or initiate a go-around if the correction cannot be made in a timely manner.

Refer to the FCOM “Procedures - Normal Procedures - Standard callouts - Flight parameters ” for information about the callouts to be used during approach and the thresholds for flight parameters deviations.

The “A focus on the Landing Flare” Safety first article, published in September 2020, provides an example of a late destabilization in final approach and the associated recommendations for go-around near the ground.

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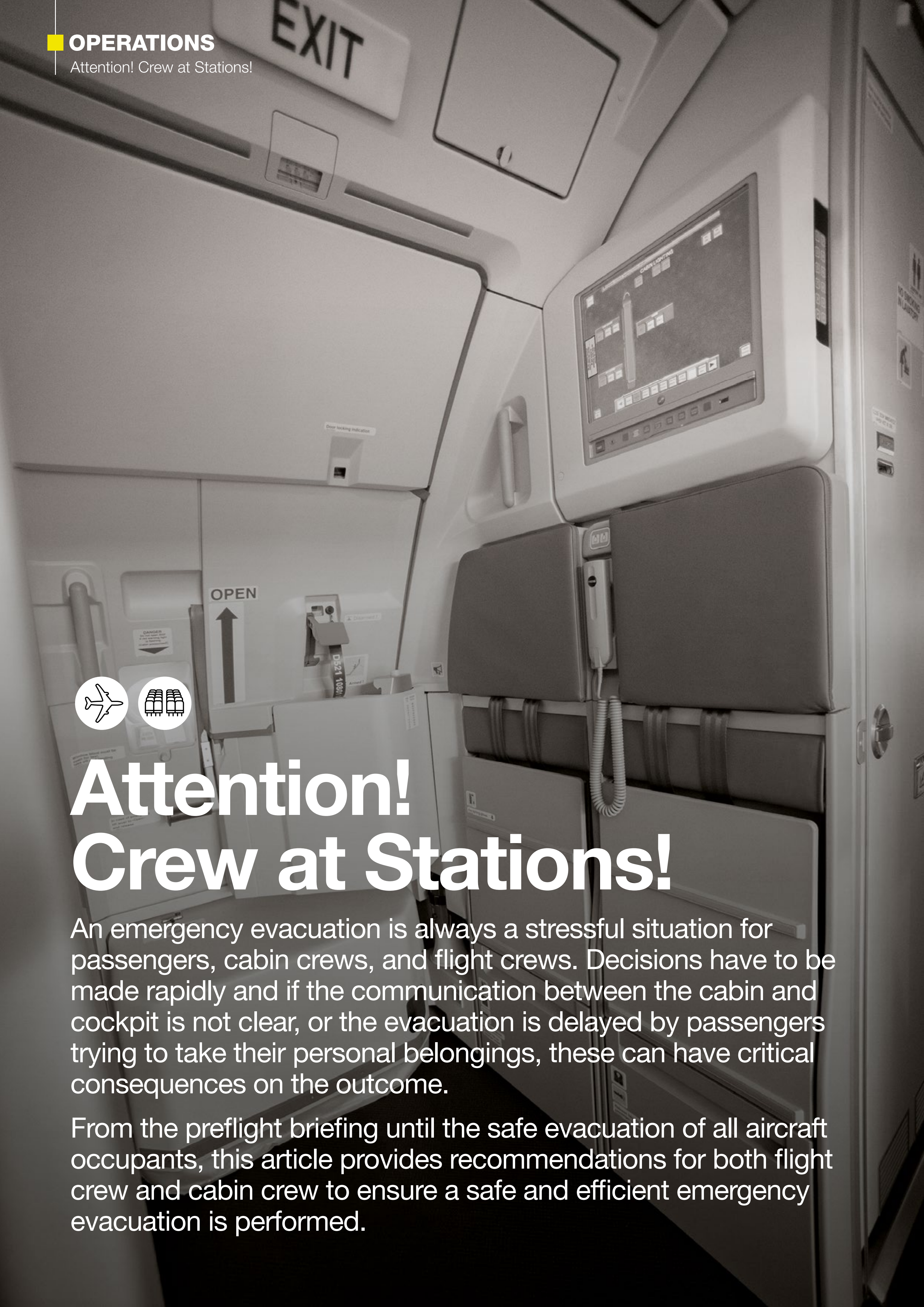
With thanks to Marc LE-LOUER from the A300/A310 Flight Operations Support and Andris LITAVNIKS from Airbus Canada.

Every pilot is already aware of the potential safety consequences of an unstable approach condition. Knowing that an unstable approach is still a contributing factor to many accidents or incidents during approach and landing, it is why repeating and sharing the lessons learned can ensure the flight crew is well prepared to ensure a safe landing.

Flight crews should anticipate scenarios that can happen during descent and approach during their approach briefing, such as late changes requested by ATC. The aircraft's energy can then be efficiently managed by using the available tools and techniques provided in Airbus documentation. This will also enable the flight crew to identify any possibility of an unstable approach as soon as possible, allowing for early intervention to either recover the situation or to interrupt the approach. Anticipating late change in the action plan for the approach and landing phases is part of the Threat and Error Management (TEM) considerations.

Cooperation with ATC is essential to ensure that the flight crew are informed of any expected shortened trajectory in advance, so they can adapt their strategy accordingly. Flight crews should alert ATC when they are not able to comply with a request, and if necessary, ask for additional track miles to manage the aircraft’s energy.

Operators should promote strict adherence to stabilization criteria with flight crews and to consider the stabilization height as a hard decision gate that should not be passed if any of the stabilization criteria is not met. A non-punitive policy regarding go-around should apply together with appropriate training for go-around in various situations. This will increase the confidence and competencies of the flight crews to discontinue the approach or perform a safe go-around at the appropriate time in the case -or with the risk- of an unstable approach.



Attention! Crew at Stations!

An emergency evacuation is always a stressful situation for passengers, cabin crews, and flight crews. Decisions have to be made rapidly and if the communication between the cabin and cockpit is not clear, or the evacuation is delayed by passengers trying to take their personal belongings, these can have critical consequences on the outcome.

From the preflight briefing until the safe evacuation of all aircraft occupants, this article provides recommendations for both flight crew and cabin crew to ensure a safe and efficient emergency evacuation is performed.

CASE STUDY 1

Event Description

An A319 was taxiing along the taxiway when the passengers and the cabin crew detected smoke in the cabin. The purser used the interphone to notify the flight crew and asked the captain's permission to evacuate. The captain set the parking brake to stop the aircraft on the taxiway, and called ATC to report that they detected smoke in the cabin and that they would initiate an emergency evacuation.

As the smoke became thicker in the cabin, the purser called again to the cockpit, insisting that an evacuation was necessary and requested that the captain urgently initiate the evacuation. The captain turned on the evacuation alarm by pressing the COMMAND pushbutton-switch on the EVAC panel to initiate the evacuation, but did not make an announcement to the cabin using the Passenger Address (PA) system.

The cabin crew immediately began the evacuation but both engines were still running.

The cabin crew at the rear doors of the aircraft had to hold up the passengers ready to evacuate the aircraft for more than 30 seconds until the engines were shut down. The flight crew saw the ECAM alert indicating that the doors were open with engines running, and shut down the engines using the engine fire pushbuttons instead of the master switches.

Event Analysis

Without the presence of any ECAM alerts and with pressure from the cabin crew, the captain initiated the emergency evacuation. The QRH EMER EVAC procedure, that specifically requests the flight crew to ensure that the engines are shut down before initiating the evacuation, was not followed.

Because no announcement was made in the cabin for the evacuation, some passengers mistook the evacuation alarm as a smoke alarm and they did not immediately react, causing some delay to begin the evacuation. Other passengers gathered their personal belongings, this resulted in some minor injuries caused by people pushing past them or climbing over one another in the aisle to reach the exits.

CASE STUDY 2

Event Description

The left engine of an A320 suffered a contained failure during the takeoff roll at a ground speed of 31 knots. The captain immediately rejected the takeoff and brought the aircraft to a stop on the runway. He announced "ATTENTION CREW ON STATION" twice.

The flight crew completed the ECAM actions, shut down the left engine, and contacted the Rescue and Fire Fighting Services to make sure that no fire was visible outside the aircraft. The flight crew decided to taxi the aircraft off the runway and were about to tell the cabin crew to resume normal operations, but the purser had already initiated an emergency evacuation.

Event Analysis

The purser initiated the emergency evacuation and did not inform the flight crew despite the "ATTENTION CREW ON STATION" announcement, which clearly indicated that the flight crew was in control of the situation.

Lack of knowledge of the communication system hindered communication between the crew members. Even though there was no sign of immediate danger, the purser initiated the emergency evacuation without a decision from the captain and with the right engine still running.

Fortunately, only some passengers suffered minor injuries, some of which were caused by them being blown over by the jet exhaust coming from the right engine that was still running. Many of the passengers gathered their personal belongings and took these with them when they evacuated the aircraft.

BE PREPARED FOR EVACUATION

Being prepared makes it easier to perform an emergency evacuation and will help the crew in their capacity to make decisions and apply the Standard Operating Procedures in a stressful environment.

Aircraft Knowledge

To ensure efficient evacuation, the cabin crew must have extensive knowledge of the aircraft systems. This includes the cabin communication system and the aircraft configuration, especially the cabin layout that could impact visibility of the cabin and other cabin crew members or generate congested areas. Operating a diverse fleet can imply various cabin configurations that have different numbers of exits or positions of galleys and toilets. Cabin crew must be familiar with the cabin layout to ensure an efficient emergency evacuation.

> "Maintaining effective communication and ensuring compliance with the Standard Operating Procedures starts with the preflight briefing."

Crew Briefing

Maintaining effective communication and ensuring compliance with the Standard Operating Procedures starts with the preflight briefing. This is when the flight crew and cabin crew should define together any parameters that could affect their decision-making if an emergency were to occur. It is also the opportunity to review the emergency evacuation procedure with the associated standard callouts, and discuss them in the context of the upcoming flight. The crew should take into account any specific conditions such as airport equipment, external conditions, and the application of MEL items.

Passenger Identification & Briefing

At the beginning of the flight, the cabin crew must select the Able Bodied Passengers (ABP) who are able to assist them in the case of evacuation. They must also identify any passengers who may require additional support during evacuation for example unaccompanied children.

The preflight briefing will help passengers to be better prepared for an evacuation if passengers are encouraged to pay attention. The cabin crew will indicate the location of the nearest emergency exits, and should remind passengers to leave all personal belongings inside the aircraft in the event of an evacuation.

“The cabin crew should remind passengers to leave all personal belongings inside the aircraft in the event of an evacuation.”

BEST PRACTICE

The Silent Review

The silent review (or 30-second review) is recommended for cabin crew to mentally recall the key aspects of the emergency evacuation procedure while they are seated at their station before each takeoff and landing, and decreases the risk of distraction. This silent review will help the cabin crew to focus and be prepared in case an emergency evacuation is required. This technique will also help to minimize the startle effect.

STOP - INFORM - ECAM - ASSESS

In the case of an emergency situation during takeoff or landing, task sharing should be established and respected so that the crew are well prepared for a potential emergency evacuation.

Stop the aircraft

The flight crew must bring the aircraft to a stop and set the parking brake. In the case of fire, they should consider positioning the aircraft so that the wind direction will blow the flames away from the fuselage.

Inform ATC

Once the aircraft is stopped, the flight crew should notify the ATC.

Captain: Inform Cabin Crew

After the aircraft stops, the captain tells the cabin crew to prepare for a possible evacuation. The "ATTENTION CREW AT STATION" callout is made through the Passenger Address system, which lets the cabin crew know the flight crew is not incapacited and that they are performing actions to determine if evacuation is required. This callout avoids unnecessary evacuations initiated by the cabin crew.

First Officer: Clear ECAM Actions

The first officer should independently perform any ECAM action in a "read and do" manner. On A220 aircraft, the first officer should independently perform the Electronic Checklist (ECL) procedure from any EICAS message in a "read and do" manner.

When the ECAM actions (or ECL procedures) are completed, the first officer can then assist the captain with the situation assessment.

Captain: Assess the Situation

The captain should use any possible means to get a clear and comprehensive overview of the situation. They can use direct communication with any relevant person, for example, cabin crew, ATC, ground personnel, Rescue and Fire Fighting Services. The decision to evacuate should rely on the captain's judgement based on their assessment of the overall situation.

> "The decision to evacuate should rely on the captain's judgement based on their assessment of the overall situation."

Cabin crew: Assess the Situation and Identify Usable Exits

As soon as the flight crew informs the cabin crew of the possible evacuation, the cabin crew must assess the situation at each cabin station. They should identify the available exits and begin to assess the outside conditions as well as the conditions inside the cabin. The cabin crew must communicate any pertinent information to the flight crew.

DECIDE - SECURE - INITIATE

Decide if evacuation is required

The situations that lead to an emergency evacuation are very stressful with a high workload in a short period of time for both flight crew and cabin crew. The decision to evacuate is irreversible and can have severe consequences.

The main factors that result in the crew initiating an emergency evacuation are uncontrollable fire, thick smoke, and severe structural damage.

In most cases, the flight crew initiates the evacuation. However, in catastrophic situations with immediate risks of life-threatening injuries or when the flight crew is incapacitated, the cabin crew can decide to initiate the evacuation.

No evacuation required

If the situation does not require an evacuation, the captain should notify the cabin crew and ATC, and should resume normal operations.

Need for evacuation

If the situation requires an evacuation, the captain calls for the EMER EVAC procedure to be performed.

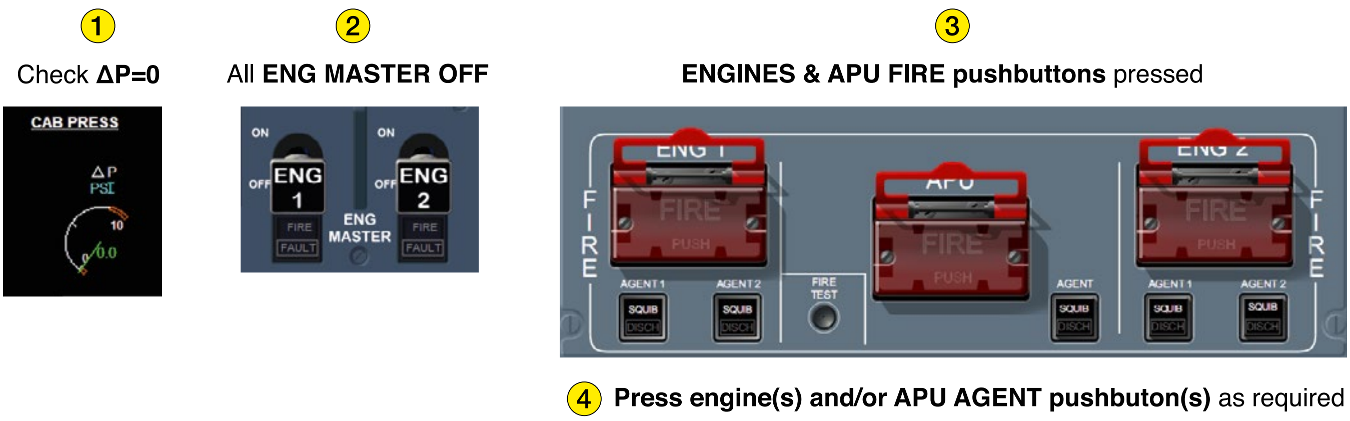
Secure the aircraft as per EMER EVAC Procedure

To ensure safe evacuation, the flight crew must secure the aircraft before the evacuation is initiated by performing the following actions:

- (1) Check the cabin ΔP=0 on the CAB PRESS SD page to prevent explosive door opening due to residual pressure if manual pressure mode was used in flight.
- (2) Set all engine master switches to OFF
- (3) Press all engines and APU FIRE pushbuttons to secure them
- (4) Press relevant ENG and/or APU AGENT pushbuttons as required in case of engine and/or APU fire.

On A220 aircraft, step (1) is performed after step (4). The flight crew ensures cabin ΔP=0 by setting the EMER DEPRESS guarded switch to ON.

“To ensure safe evacuation, the flight crew must secure the aircraft before the evacuation is initiated.”



(fig.1)
Example of the A320 aircraft securing steps before evacuation initiation

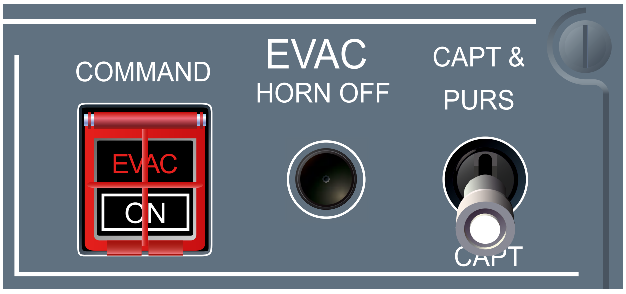
Order from flight crew

The captain initiates the evacuation with a short and clear announcement to the cabin crew over the PA.

For aircraft equipped with the EVAC panel (optional for A300-600/A310/A320/A330/A340/A350 aircraft, standard for A380 aircraft), the captain presses the EVAC COMMAND guarded pushbutton-switch.

For A220 aircraft, the captain presses the EVAC CMD guarded switch. This ensures clear communication with the cabin crew and helps the flight crew to focus on other actions in this high-workload situation.

Immediately after the emergency evacuation is initiated, the captain advises the ATC.



(fig.2)
Example of EVAC panel on A350 aircraft

NOTE

On A220, A330/A340 aircraft equipped with aircraft modification 49314 (CIDS emergency power update), A340-500/600, A350, and A380 aircraft, the flight crew must switch off the batteries. This is to make sure that after the aircraft comes to a stop, power is still supplied to the CIDS for 10 minutes. This is required by regulations in the case of emergency evacuation due to an electrical emergency.

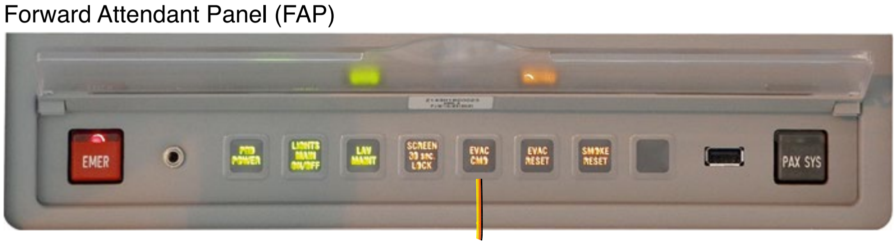
Order from cabin crew

The cabin crew can initiate an emergency evacuation only in the case of a catastrophic event or if the flight crew is incapacitated and normal disembarkation is no longer possible. The cabin crew can use the EVAC command available on the Flight Attendant Panel or as an option on any Additional Attendant Panel. They can also use this command to request that the flight crew initiate an evacuation if they are not authorized to do so directly.

KEYPOINT

Even if the cabin crew can initiate an emergency evacuation they must try to contact the flight crew first to avoid any unnecessary evacuation.

Forward Attendant Panel (FAP)



Evacuation command button

(fig.3)
Example of Forward Attendant Panel (FAP) lower section A320 aircraft

EVACUATE, EVACUATE, OPEN SEAT BELTS!

An efficient evacuation is a quick and safe evacuation

The objective of an emergency evacuation is to evacuate all aircraft occupants as quickly and as safely as possible to ensure they have the best chance of survival in the case of a life-threatening situation.

Therefore, after the cabin crew identify the usable exits and check that the slides are deployed and inflated, the objective for them is to maintain an evenly-distributed flow of passengers towards all available exits.

> "The objective for cabin crew is to maintain an evenly-distributed flow of passengers towards all available exits."

Crew Coordination and Adaptation

Throughout the evacuation process, a constant real time assessment of the situation is necessary in terms of aircraft and external conditions, exit usability, and passenger flow. The situation can change rapidly and efficient communication between all the crew is essential to share any elements that can impact the evacuation: Presence of immediate danger such as fire or smoke, an exit becoming unusable due to a damaged slide or external conditions, a congested exit, or an exit with a reduced flow of passengers.

As a result, the crew must rapidly make decisions and adapt to changing scenarios in a dynamic and stressful environment. This will ensure a constant flow of passengers to each usable exit, and therefore, a quick evacuation.

Passenger Management

Multiple and unpredictable behaviors

Under stressful conditions, people can have varied reactions. Unlike cabin crew who are trained, passengers are not. They can have unpredictable reactions that can jeopardize their own safety and that of the other aircraft occupants. Panic can lead to “frozen” passengers overwhelmed by the situation or passengers trying to evacuate as soon as possible by aggressively pushing past other passengers as referred to in Case Study 1.

Risks to slow down the evacuation

Passengers that do not comply with cabin crew instructions can put the success of an evacuation at risk. Baggage retrieval, use of phones, and not jumping on the evacuation slides are the most common factors that slow down an evacuation.

Be assertive!

Assertive management of passengers is key to dealing with the risks that could impact the success of an evacuation. The cabin crew must use clear and concise orders, and use a loud voice and assertive body language to ensure that all passengers follow their instructions. The challenge for the cabin crew is to switch from a nice and smiling cabin crew to an assertive one able to use physical force, if necessary.

> “Assertive management of passengers is key to dealing with the risks that could impact the success of an evacuation.”

Evacuation of the Crew

Each cabin crew member should check for any remaining passengers, and as soon as their assigned area is empty, evacuate the aircraft.

When the actions are completed in the cockpit, the first officer should assist the cabin crew with the evacuation of the passengers in the cabin, if accessible, and on the ground.

The captain should be the last crew member to evacuate the cockpit and the last one to evacuate the aircraft after a final check that all aircraft occupants have evacuated. They are in charge of the operations on ground until the rescue and emergency services arrive on site.

Keep focused even after the evacuation

After evacuation, the crew remains responsible for the passengers until the rescue and emergency services arrive. In 2008, after a successful evacuation, one passenger went back inside the aircraft using an evacuation slide to retrieve their personal belongings.

To prevent this situation from occurring, the cabin crew should gather the passengers away from the aircraft and from any potential danger. They should also count them and provide first aid, if necessary. For that, they have to take any necessary equipment during the evacuation to help them with crowd management on ground such as flash lights (if night conditions) or megaphones if not at an airfield.

THE IMPORTANCE OF REALISTIC TRAINING

To be able to deal with these stressful situations, appropriate training is crucial for both the flight crew and the cabin crew.

For Flight Crews

The emergency evacuation procedure applies the same philosophy to all Airbus aircraft. This consistency across the Airbus fleet and over time is a positive contributing factor to ensuring safe application of the procedure. The emergency evacuation procedure is short and clear, the key factor is how it is trained.

It is essential that the flight crew members understand task sharing: they have to know exactly what actions must be performed, by whom, and when. It is important for the flight crew to keep in mind when to work independently and when to come back together. To help understand this, the training scenarios need to be as realistic as possible and especially have to simulate the high workload that is often encountered in these situations. Instructors should be able to keep the captain busy by simulating conversations with ATC and the cabin while the first officer is performing the ECAM actions. It trains captains not following first officers actions in this specific situation and first officers continuing with ECAM actions without captain confirmation.

For Cabin Crews

Cabin crew training is both theoretical and practical. Scenarios have to be as realistic as possible, based both on evacuations and on a return to normal operations. Cabin crew training should be conducted on a training device in order to create a realistic environment and based on case studies where possible. This enables trainees to learn from past experience and it highlights the importance of reporting incidents to learn from in the future.

The Cabin Safety training is designed using regulations by EASA and FAA and approved by local airworthiness authorities. It is performed annually and includes the emergency evacuation procedure.

The standard training focuses on exit and slide management, but the latest publications from aviation authorities such as the EASA and the FAA, encourage trainers to put more emphasis on passenger management, especially techniques to discourage passengers from retrieving personal belongings or baggage because it has a significant impact on the efficiency of any evacuation.

CRM Training

Given the importance of communication and crew coordination, Crew Resource Management (CRM) training is of utmost importance for both flight crews and cabin crews. It should include stress management, decision-making, leadership, human factors, including surprise and startle effect management, and risk assessment.

“The emergency evacuation procedure is short and clear, the key factor is how it is trained.”

“Scenarios have to be as realistic as possible”

INFORMATION

For more information on managing emergency evacuation, you can watch the “Evacuation Management” video available on the Airbus Worldwide Instructor News (WIN) website.

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With thanks to Marc LE-LOUER from A300/A310 Flight Operations Support and Capt. Xavier LESCEU from Airbus Canada.

Preparation by flight crews and cabin crews is key to conducting an effective and efficient emergency evacuation. Clear communication and the knowledge of Standard Operating Procedures are vital. Knowing the aircraft systems and the cabin layout is fundamental for cabin crews.

The preflight crew briefing and the passenger safety briefing help ensure everyone onboard the aircraft is better prepared to face an emergency evacuation scenario.

The silent review that cabin crew should perform before takeoff and landing is an excellent technique that helps the crew to remain focused and to be ready to act in the case of an emergency.

Knowing the essential steps and the associated task sharing of any evacuation STOP - INFORM - ECAM - ASSESS - DECIDE - SECURE - INITIATE, and regularly practicing realistic training scenarios can save lives in the event of an emergency.

When emergency evacuation commences, passenger management can have a huge impact on the outcome. Passengers may feel disoriented, panicked, and helpless. Their behaviors, such as retrieving their personal belongings before moving to the nearest exit, not only endangers their own safety but also the safety of others. Well-trained and assertive cabin crew are required to urge passengers to move to the nearest available exit and to assemble outside the aircraft in a safe place away from the aircraft.

An emergency evacuation is always a dynamic situation where time is critical, and it requires constant situational awareness combined with rapid decision-making. This can only be achieved through efficient coordination and communication between all flight crews, cabin crews, ATC, and rescue and fire fighting services on ground.

A Focus on the Takeoff Rotation

An appropriate takeoff rotation maneuver is a balance between good takeoff performance and sufficient margin versus tail strike, stall speed, and minimum control speeds.

Applying the 3°/s rotation rate requested in the SOPs is the key to ensure that the aircraft meets the expected takeoff performance. Flight data monitoring shows that the rotation rate values in service vary and a lower rotation rate is observed in some cases with the associated degradation of takeoff performance. This article describes both the takeoff rotation laws available on Airbus Fly-by-Wire (FBW) aircraft and the recommended rotation techniques that will enable flight crew to achieve consistent takeoff rotations at the requested rotation rate.

CASE STUDY: A340 LONG TAKEOFF

Event Description

A takeoff from a high altitude airport (8360 ft)

An A340-300 was performing a takeoff from a high altitude airport. A TOGA thrust takeoff in CONF2 was selected. The takeoff performance was calculated for a 4 kt tailwind and was limited by the runway length (takeoff run in One Engine Inoperative (OEI) condition). The gross weight of the aircraft was 236.9 t and was close to the Maximum Takeoff Weight of 237 t in the conditions of the day.

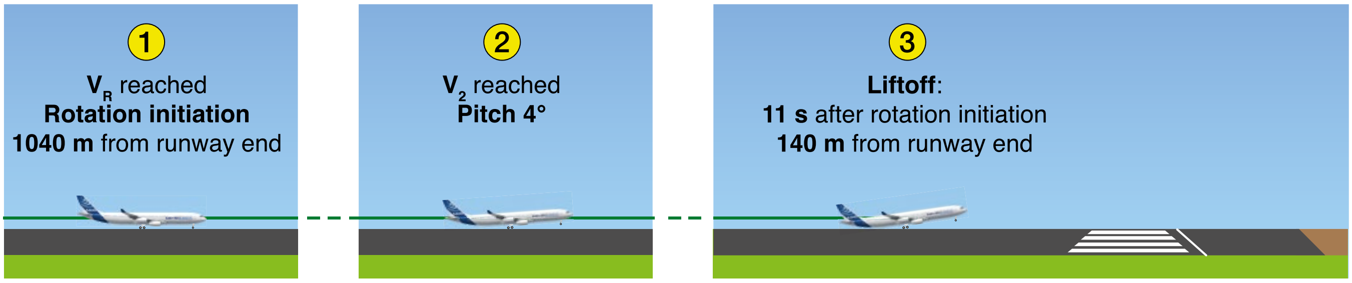
An uneventful takeoff roll

The aircraft reached **V_1** (128 kt) 54 s after brake release and TOGA thrust application. 1 The Pilot Flying (PF) then initiated the rotation close to VR. The nose landing gear lifted off the ground 1 s later and the pitch began to increase.

A late liftoff

2 **V_2** (149 kt) was reached with the aircraft still on the ground. The main landing gear was still compressed and the aircraft had a pitch of 4° up. 3 Liftoff occurred 11 s after rotation initiation at 155 kt, and at only 140 m from the runway end with a recorded pitch of 9° up.

(fig.1)
Sequence of events from V_R to liftoff

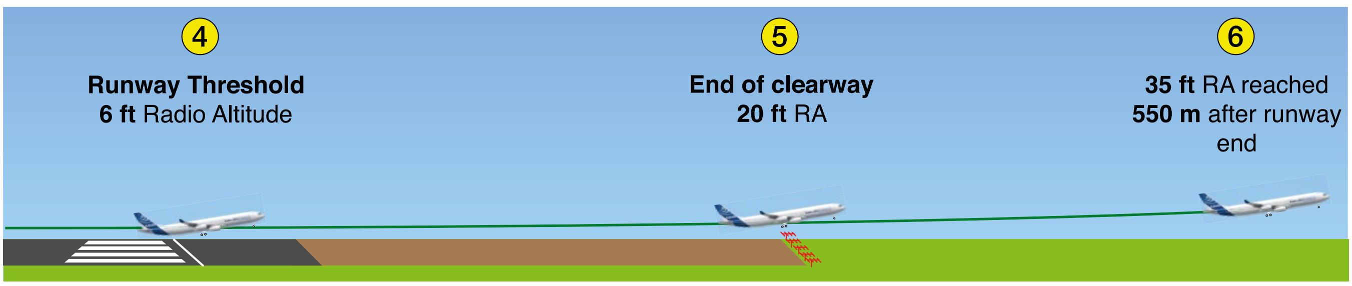


Runway end overflown at 6 ft radio altitude

4 The aircraft flew over the runway end at 6 ft Radio Altitude (RA), and then 5 overflew the end of the clearway at 20 ft RA and avoided the LOC antennas by only 12 ft. 6 The aircraft eventually reached 35 ft RA 550 m after the runway end. The landing gear was selected up 3 s later at 135 ft RA with a vertical speed of 1300 ft/min, pitch at 12°, and speed at 160 kt. The aircraft continued its climb and completed its flight uneventfully.

Despite what seemed to be a standard takeoff roll, the aircraft lifted off the runway very late, overflying the LOC antennas located at the end of the clearway with very little clearance. How did this happen?

(fig.2)
Sequence of events from runway threshold to 35 ft RA



Event Analysis

A nominal aircraft acceleration performance until V_R

The analysis of the DFDR data showed that the aircraft acceleration was in accordance with the expected performance in the conditions of the day reported as wet runway with 4 kt tailwind.

A slow rotation rate during takeoff

The sidestick inputs ordered by the PF during the rotation resulted in an average rotation rate of 1°/sec. Airbus SOPs request a 3°/s rotation rate. This slow rotation rate resulted in degraded takeoff performance leading to a significant increase in the takeoff distance.

THE REQUESTED TAKEOFF ROTATION RATE VALUE

The origin of the requested rotation rate

The rotation rate that is used to compute the takeoff performance was determined during the takeoff performance flight test campaign together with the Airworthiness Authorities. This value is the average of the rotation rates recorded during all of the test aircraft takeoffs performed in a variety of operating conditions.

The requested 3°/s rotation rate was the value selected and is applicable to all Airbus aircraft except for the A220, which has a 3 to 5°/s rate requested in its FCOM. This value ensured that the actual takeoff distance is closest to the computed distance. If the PF applies a rotation rate that is lower than the requested rotation rate, the aircraft may not take off according to the computed performance, leading to an increased takeoff distance and a decreased obstacle clearance.

> “The requested 3°/s rotation rate was the value selected and is applicable to all Airbus aircraft except for the A220, which has a 3 to 5°/s rate requested in its FCOM.”

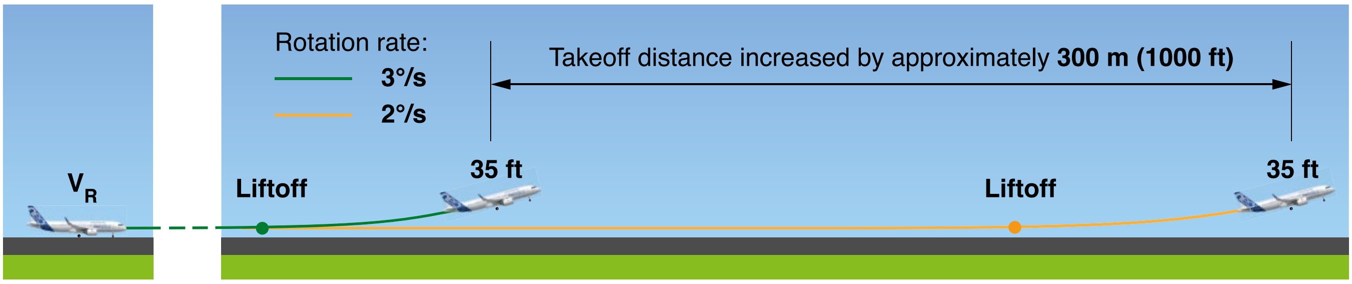
Rotation rate too low in some takeoffs

Flight data monitoring shows that the rotation rate values recorded in service vary. A low rotation rate with an associated takeoff performance degradation was observed in some cases. Safety margins used in takeoff performance computation prevent any significant problems in most cases. However, these margins may not be sufficient in certain situations as can be seen in the event described above. It is why flight crews should always perform the takeoff rotation at a rate as close as possible to the requested rotation rate, and this is especially important in conditions where performance is limited by runway length or obstacle clearance.

A significant impact on takeoff performance

A rotation rate lower than the requested 3°/s in the SOPs significantly increases the takeoff distance. For example, a takeoff performed with a 2°/s rotation rate increases the takeoff distance by approximately 300 m (1000 ft) compared to a 3°/s rotation rate.

(fig.3)
Impact of a lower rotation rate on the takeoff distance



Takeoff Distance (TOD) margins

The regulatory Takeoff Distance (**TOD**) on a dry runway is calculated by taking the greatest value of:

- the **TOD** computed with one engine failure happening just prior to reaching V1 (**TOD_{N-1}**), or
- the **TOD** computed with all engines operative (**TOD_N**) with an additional margin of 15 %.

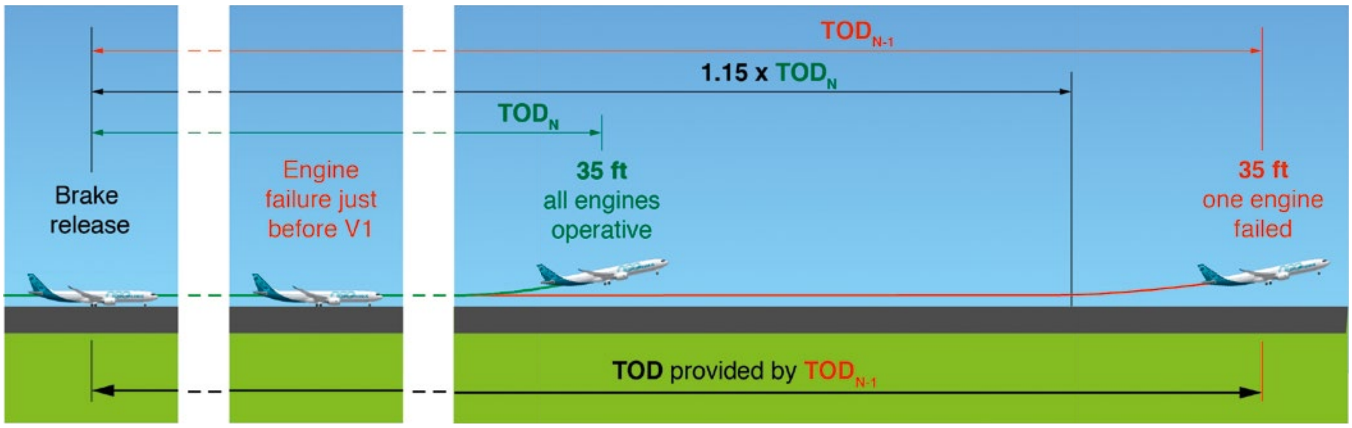
$$TOD_{dry} = \text{max of } \{ TOD_{N-1} \text{ ; } 1.15 \times TOD_N \}$$

Twin-engine aircraft

On a twin-engine aircraft, the **TOD** is often provided by the **TOD_{N-1}** because the loss of half of its thrust strongly impacts the takeoff distance. This calculation provides additional margin for a takeoff with both engines operative.

While the PF should perform the requested rotation rate of 3°/s in all conditions, it is even more important in case of engine failure during takeoff, because there is no additional margin for the calculated **TOD**.

(fig.4)
Example of a TOD computation for a twin-engine aircraft

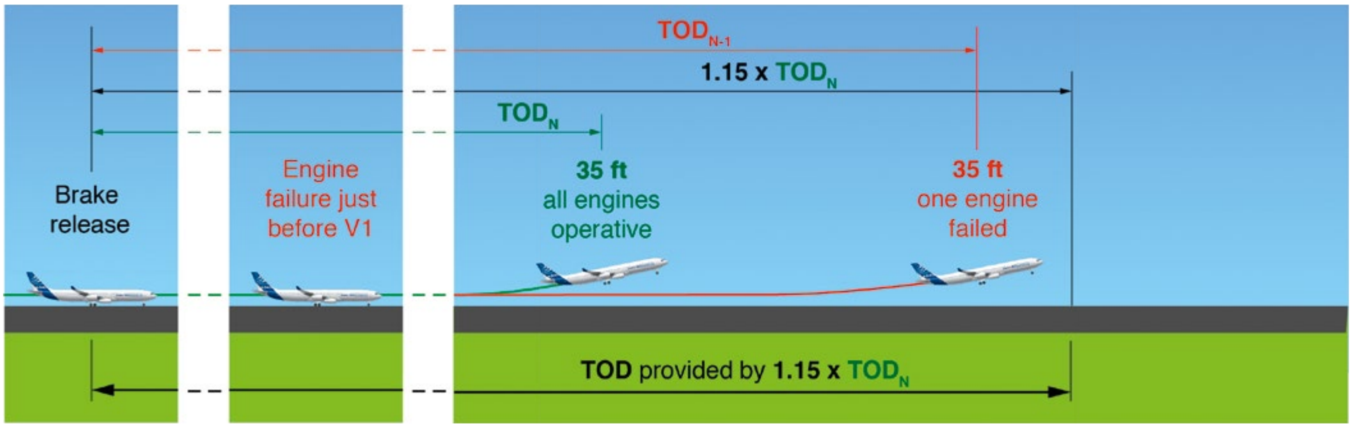


Four-engine aircraft

On a four-engine aircraft, the **TOD** is often sized by the factored **TOD_N** because the **TOD_{N-1}** is often the shortest as it is computed with a loss of thrust limited to a quarter of the total available thrust.

Achieving the requested rotation rate of 3°/s is especially important in daily operations (i.e. when all four engines are operative), because this condition is usually the sizing one, and therefore, does not provide additional margin on top of the **1.15** factor.

(fig.5)
Example of a TOD computation for a twin-engine aircraft



TAKEOFF ROTATION LAWS AVAILABLE ON FBW AIRCRAFT

The takeoff rotation law helps the flight crew to perform the optimum takeoff rotation. The takeoff rotation law consists of both the rotation law and tail strike prevention functions.

There are different types of takeoff rotation law depending on the aircraft model.

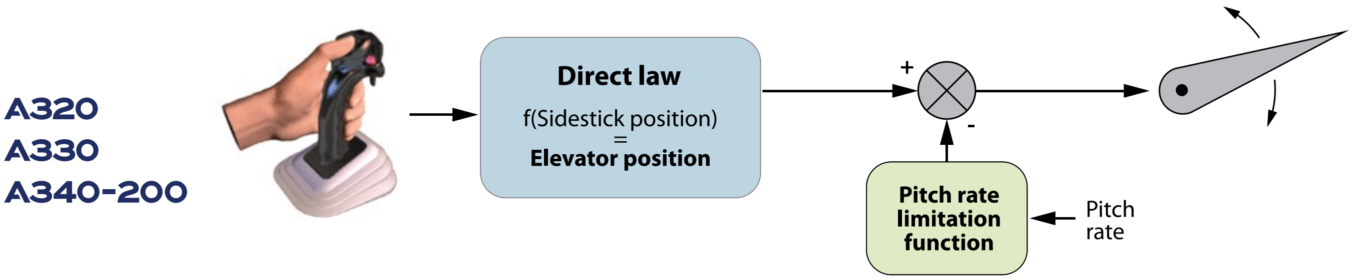
Rotation assistance on A320ceo, A330ceo, and A340-200/300 aircraft

Rotation law: Direct law

There is a direct relationship between the sidestick deflection and the elevator deflection on these aircraft models. The rotation rate obtained by a fixed sidestick deflection value may vary noticeably with different operating conditions such as aircraft weight, center of gravity position, slats/flaps configuration, engine thrust, and takeoff speeds.

Tail strike prevention: Pitch rate limitation function (A320ceo, A330ceo, A340-200)

A limitation function reduces the pitch-up command sent to the elevators to reduce the risk of tail strike in case of excessive pitch rate. **This pitch rate limitation function does not provide tail strike protection**: If a nose-up input is maintained on the sidestick, a tail strike can still occur.

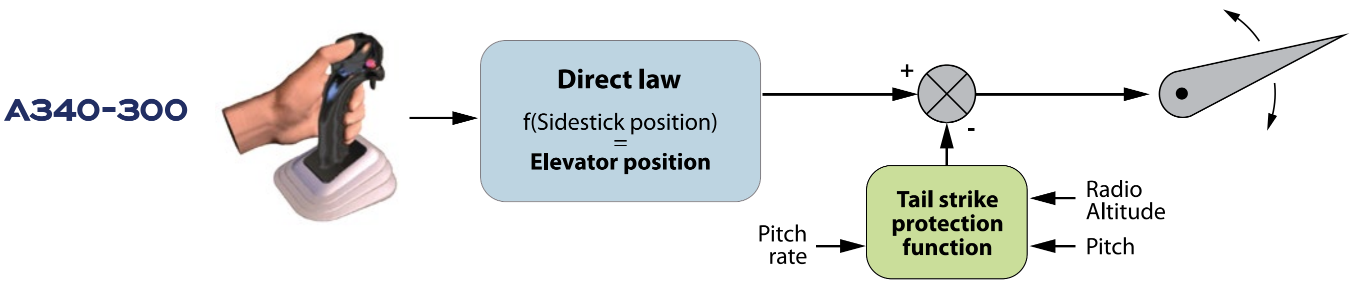


(fig.6)
Rotation law on A320ceo, A330 and A340-200 aircraft

Tail strike protection function (A340-300 only)

A tail strike protection function estimates the rear fuselage clearance margin based on radio-altimeter height and pitch attitude. This function modulates the nose-up input order sent to the elevator whenever the clearance of the tail to the ground becomes too small. **The function protects the aircraft against tail strike for average sidestick deflection values until the sidestick deflection reaches approximately ¾ of nose-up order**. The PF can override this protection by pulling back on the sidestick beyond ¾ of nose-up.

(fig.7)
Rotation law on A340-300 aircraft



Rotation assistance on A320neo, A330neo, A340-500/600, A350, and A380 aircraft

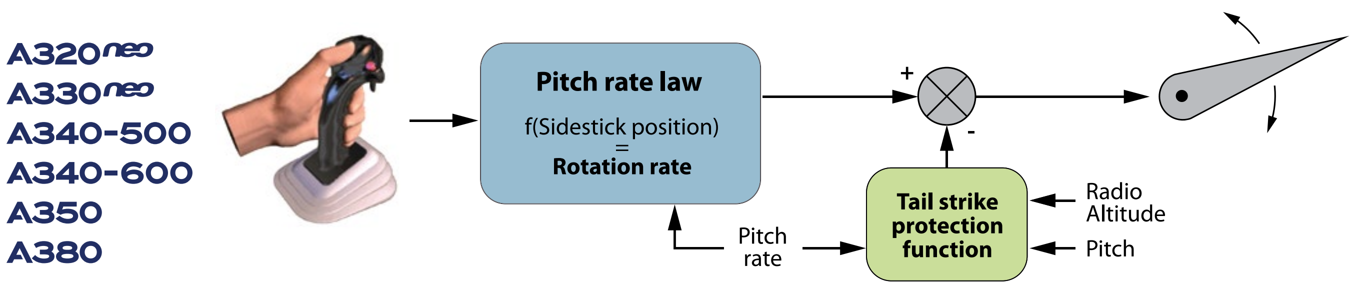
Rotation law: Pitch rate target

On these aircraft, the rotation law ensures that an equivalent and repeatable rotation rate is achieved for a given sidestick deflection, and independent of the variable operating conditions such as aircraft weight, center of gravity position, slats/flaps configuration, engine thrust, and takeoff speeds.

Tail strike protection function

A tail strike protection function similar to the one available on A340-300 is also available on these aircraft.

(fig.8)
Rotation law on A320neo, A330neo, A340-500/600, A350 and A380 aircraft



(fig.9)
Example of a tail strike pitch limit indication on an A330 aircraft

Tail strike pitch limit indication at takeoff (A330/A340 family and A380 aircraft)

The tail strike pitch limit indication is currently displayed at takeoff and landing on all A340 and A380 aircraft. The tail strike pitch limit was an option on the earlier models of the A330ceo, but was later installed as standard for all A330ceo produced after mid-2013.

A320, A321, A330neo, and A350 aircraft also have a tail strike pitch limit, but it is only displayed on landing, because it is not necessary at takeoff. There is no tail strike pitch limit indication on A318 and A319 aircraft, because these aircraft have shorter length fuselage and less risk of tail strike.

Removing the tail strike pitch limit for takeoff

In-service experience showed that when the tail strike pitch limit indicator appears on the display, it may cause the PF to unnecessarily reduce the rotation rate of the aircraft during takeoff and prevent the aircraft from reaching the requested 3°/s rotation rate. As a result, Airbus decided to deactivate the tail strike pitch limit indicator at takeoff and to keep it activated only on landing for all aircraft models.

The tail strike protection function proved to provide A340-300, A340-500/600, and A380 aircraft with sufficient tail strike protection.

The pitch rate limitation function on A330ceo aircraft, combined with its tail strike margin is sufficient protection against the risk of tail strike.

Deactivation of the tail strike pitch limit indication for takeoff will be performed at the opportunity of a next A330/A340 Flight Management Guidance and Enveloppe Computer (FMGEC) or A380 Flight Control and Guidance Computer (FCGC) update.

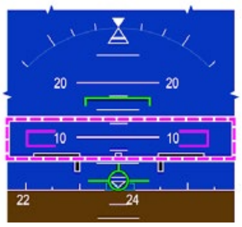
Rotation assistance on A220 aircraft

Rotation law: Direct law

There is a direct relationship between the sidestick deflection and elevator deflection with a compensation for forward or aft center of gravity conditions on A220 aircraft.

Pitch Target Marker (PTM)

The Pitch Target Marker (PTM) on the PFD provides the initial pitch for the flight crew to target during the takeoff rotation until FD guidance is available.



(fig.10)
Pitch Target Marker (PTM)
on the PFD of an A220 aircraft

Tail strike prevention: Pitch rate reduction

A limitation function will reduce the pitch-up command sent to the elevators in case of excessive pitch rate, and will reduce the risk of tail strike. **The flight crew should be aware that this pitch rate limitation is not protection against tail strike**: A tail strike event can still occur if a nose-up input is maintained on the sidestick.

A tail strike symbol is displayed on the Head-Up Display (HUD) during rotation when the PTM is not displayed and the aircraft pitch angle approaches the tail strike angle by less than 3 degrees or when the pitch rate is excessive.

THE TAKEOFF ROTATION TECHNIQUE

A technique common to all FBW and non-FBW aircraft

A similar technique is used on all Airbus aircraft. It can be found in the FCOM SOPs, and additional information is provided in the Flight Crew Techniques Manual (FCTM).

Step 1: Initiate Rotation

When the aircraft reaches V_R, the PF should apply a 1 **positive backward sidestick (or control column) input to initiate the rotation**.

Step 2: Use outside visual references to achieve & maintain rotation rate

After the PF initiates the rotation, they should 2 **use outside visual references to achieve and maintain the rotation rate**.

Adjustments may be necessary to achieve and maintain the required rotation rate. On aircraft with direct rotation law or non-FBW aircraft, the flight crew should adapt to the takeoff conditions on the day. On aircraft that have the pitch rate rotation law, the law assists the flight crew to achieve an equivalent rotation in all conditions.

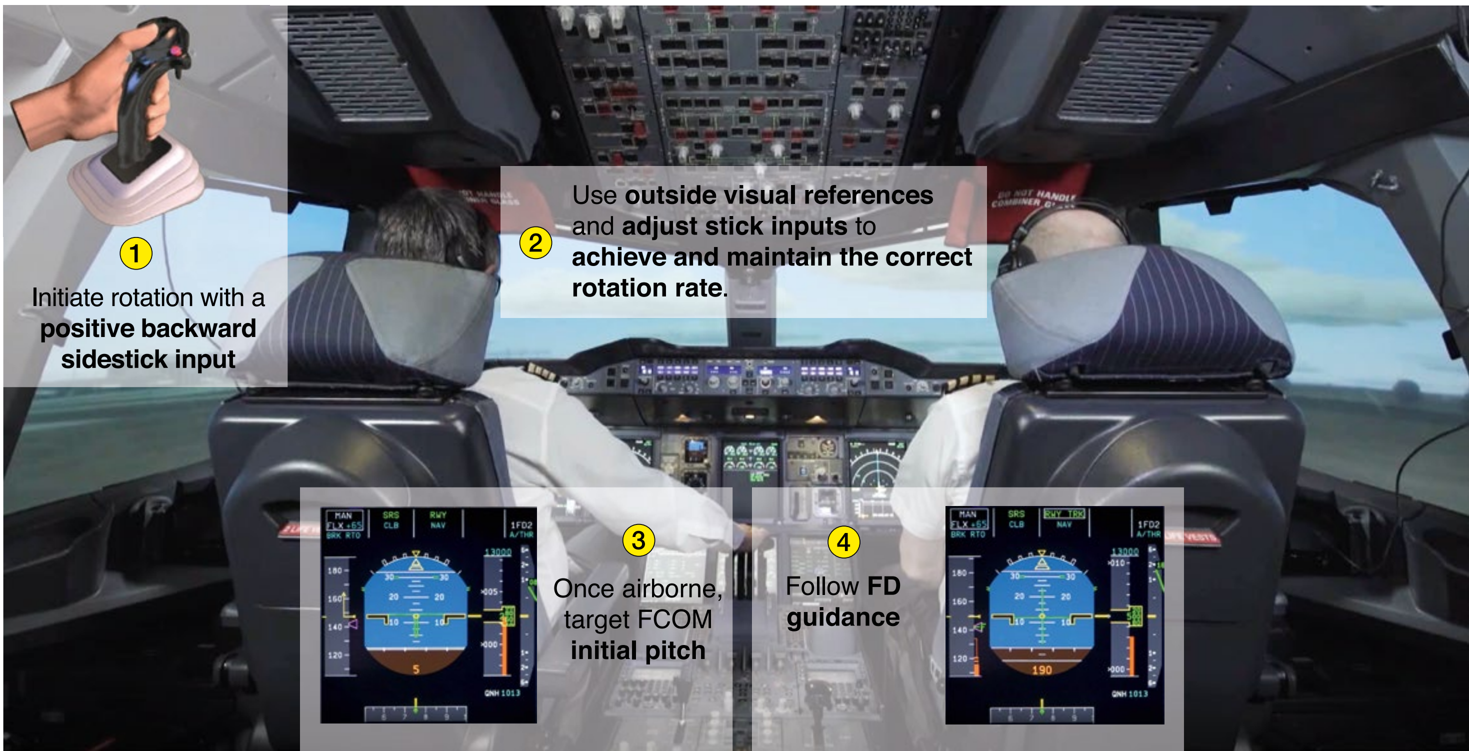
With a suitable rotation rate, the aircraft typically lifts off approximately 4 to 5 s after the PF initiates the rotation and when the pitch reaches approximately 10°.

Step 3: Target initial pitch attitude after liftoff then follow FD guidance

When the aircraft is airborne, the PF should 3 **adjust the pitch toward the initial pitch target** provided in the FCOM (e.g. 15° or 12.5° if one engine failed on A320 aircraft). On A220 aircraft, the Pitch Target Marker (PTM) provides a visual indication of the initial target pitch. The PF should then 4 **follow the FD guidance**.

"A similar technique is used on all Airbus aircraft"

(fig.11)
Recommended rotation technique



INFORMATION

The “What about rotation technique?” video is available on the Worldwide Instructor News (WIN) website and provides a step-by-step review of a full takeoff sequence performed in an A380 simulator.

NOTE

Training Areas of Special Emphasis (TASE) for A340 family aircraft

An EASA Safety Information Bulletin (SIB 2017/20) was published in 2017 following the incident described in this article. In 2018, a Training Areas of Special Emphasis (TASE) was included in the A340 Operational Suitability Data (OSD) for flight crew in response to the SIB. The TASE emphasizes the need to ensure flight crews know how to perform the correct takeoff rotation technique during initial and recurrent training. This includes:

- How to initiate the rotation
- How to achieve and maintain the rotation rate
- How to achieve the pitch attitude after liftoff.

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Flight data monitoring shows that the takeoff rotation rates recorded in service vary and that a lower rotation rate is observed in some cases, with the associated degradation of takeoff performance.

Achieving an appropriate rotation rate is essential to ensure takeoff performance, while maintaining a sufficient margin with tail strike, stall speed, and minimum control speeds.

Airbus aircraft are designed, tested, and certified to achieve the necessary rotation rate, while having sufficient margins against the tail strike. Flight control laws include features that reduce the risk of tail strike.

The flight crew should apply the FCOM procedures and FCTM techniques to achieve the requested rotation rate:

After the rotation is initiated with a positive nose-up input, the flight crew should use outside visual references to achieve and maintain the rotation. The flight crew should fly the rotation, and make any necessary adjustments to achieve and maintain the required rotation rate. When the aircraft is airborne, the PF adjusts the pitch toward the initial FCOM pitch target and then follows the FD guidance.

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- Preparing for a safe return to the skies
- Mind the oebs

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