The Airbus safety magazine

#38

Safety first

AIRBUS

Safety first

The Airbus magazine contributing to the enhancement of the safety of aircraft operations by increasing knowledge and communication on safety related topics.

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

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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Dear Aviation Colleagues,

The demand for air travel is very strong, and we are likely to continue growing beyond the pre-pandemic levels achieved in 2019. This is positive for the industry, but we also must acknowledge the challenge of our air transport system to cope with the need to increase capacity. This is true for operators and manufacturers alike and requires extra vigilance to avoid increasing the risk of a fatal accident linked to this growth.

When the air transport system, its existing infrastructure and supply chain are stretched, more than ever, collaboration with all actors across the air transport system is key to ensure that our safety values are maintained. It is a continuous challenge to retain existing skills, attracting more people to work in aviation, and to train them. It can begin with a reminder of the basics, including lessons from past accidents or reported events, and ensuring the knowledge is passed on. This relies on openly sharing information and data, ensuring a shared spirit of speak-up, listen-up, and closing-the-loop.

How can we support? By sharing safety information and the materials that you can use to promote safety values, including our own lessons learned and best practices, which can be relevant for pilots, technicians, cabin crew, dispatchers, and everyone who works in aviation. It is what we aim to provide through the Safety first articles, instructive videos, and infographics in an easy-to-access safety information portal at flightsafety.airbus.com.

Because it is all about learning from each other and we encourage all of our operators to join with us in the safety information sharing forums such as our annual Flight Safety Conference and Destination 10X collaborative regional events. It is this connection around shared safety values that maintains our safety culture, which is the most effective means to prevent increasing the risk of an aircraft accident.

I look forward to continuing to grow our aviation safety culture together, for safe work and safe journeys ahead.

Save the Date! The 29th Airbus Flight Safety Conference will be held 17-20 March, 2025

Save the date in your calendars for the next Airbus Flight Safety Conference to be held 17-20 March, 2025 in Amsterdam, The Netherlands. Invitations for the event will be sent to all of our customers in January 2025.

Safety first #38

Flight Operations

Cabin Operations

Ground Operations

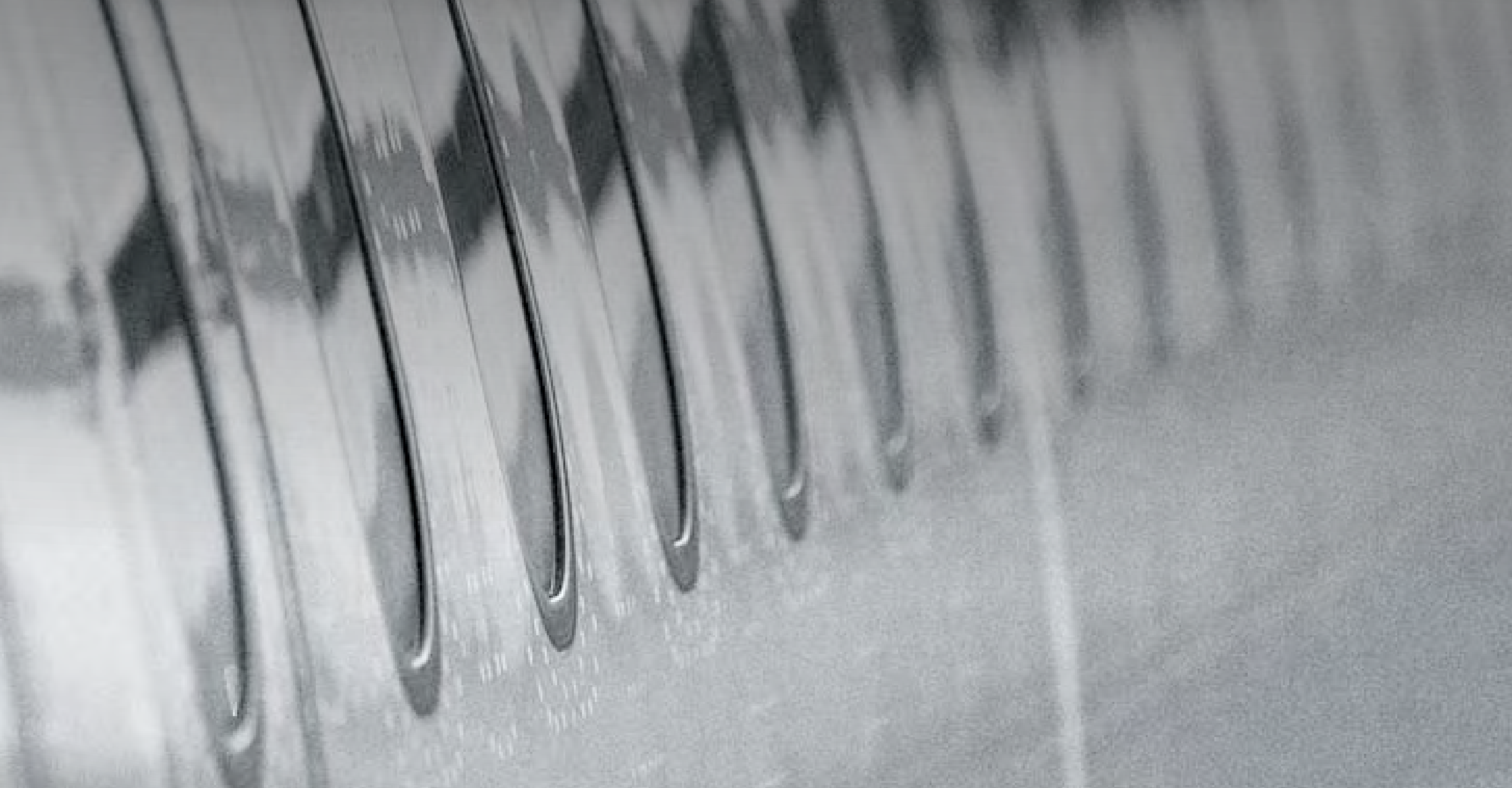
Maintenance

OPERATIONS

Under the Spotlights

Two recent events with damage to the passenger windows of the aircraft were reported to Airbus. Similar events also happened on non-Airbus aircraft. The damage was caused by the heat of spotlights used during promotional filming sessions. One of these events could have had serious safety consequences as damage was not detected on ground, and caused some window panes to detach from the aircraft during the next flight.

This article describes this event in more detail and how to prevent heat damage due to exterior lighting. It also recommends checking the condition of the aircraft before it returns to service.



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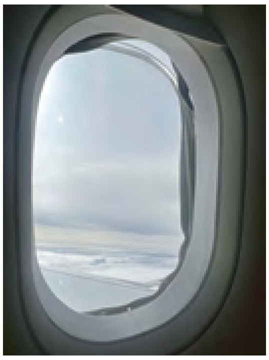
CASE STUDY

Event Description



(fig.1)
Picture of the window during the event (source: operator)

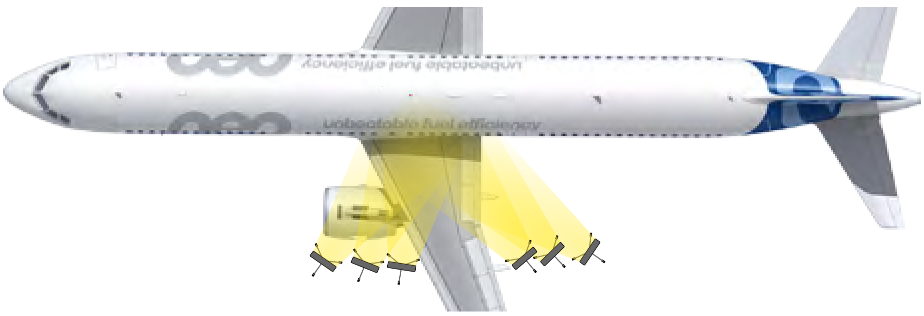
An A321neo aircraft was performing a positioning flight before several sectors of operations. A limited number of people including some cabin crew members were on board. The aircraft was climbing toward its target altitude. At 10 000 ft, one of the cabin crew noticed an excessive amount of cabin noise and cold temperature while walking toward the empty middle part of the aircraft. He discovered that one of the windows on the left side of the cabin appeared to have slipped down from its usual position and that the window seal was flapping in the outside airflow **(fig.1)**. He immediately informed the flight crew who decided to descend to 9 000 ft and to perform an in-flight turnback. The aircraft landed safely and without further incident.

(fig.2)
Picture of the damaged and missing windows after landing (source: investigation board)

When on the ground and with the aircraft parked, the flight crew performed an inspection of the aircraft exterior. They observed that two windows were missing and one was dislodged **(fig.2)**. Damage to the lower side of the left stabilizer, probably due to an impact of a departing part, was also noticed. Further inspection revealed that two additional windows were damaged on the left side of the fuselage and one window also showed signs of damage on the right side of the fuselage.

Event Analysis

One day before the event, there was a filming session inside the aircraft, around the middle cabin area. There were 6 halogen (tungsten) lamphead spotlights, rated at 12 kW, placed outside the cabin windows to light the area being filmed. The 6 spotlights were first located on the right side of the aircraft at a distance between 6 to 9 meters from the fuselage, close to the overwing emergency exits, with the light beams focussed on the same area of fuselage **(fig.3)**. The lights were then moved to the left side of the aircraft for the second part of the filming session.



(fig.3)
Lighting setup during the filming session (not to scale)

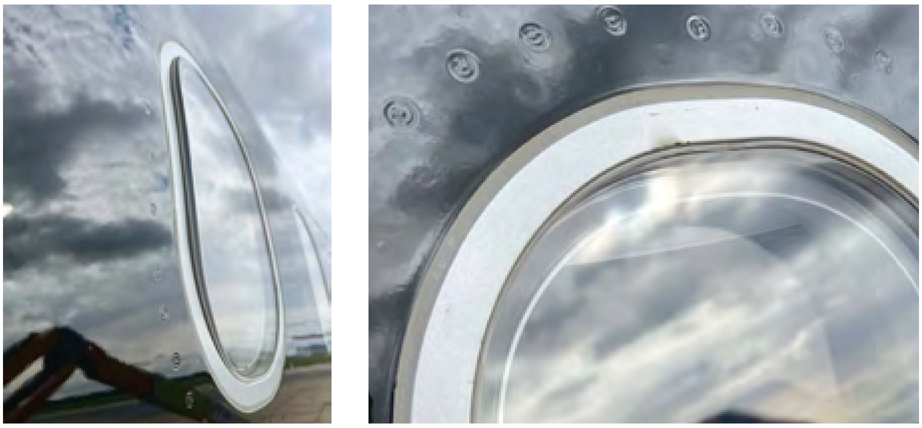
(fig.4)
Picture of the filming session (source: operator)

Heat damage

The combined power of the 6 lamps in the halogen lighting setup was 72 kW. The exposure of the fuselage area to the spotlights lasted more than 4 hours on each side of the aircraft. The heat produced by the infrared radiation from the halogen spotlights damaged several cabin windows. This damage was not detected prior to the next flight.

The damage found on the affected windows during post-flight inspection included:

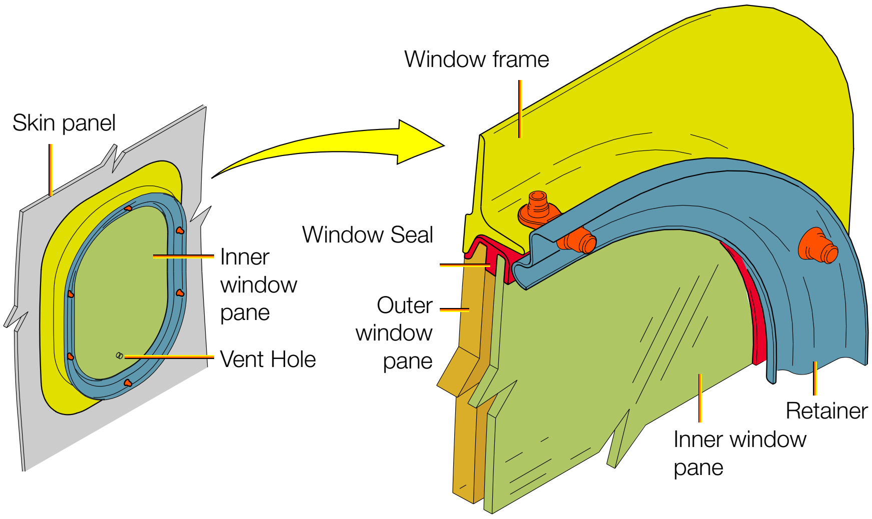
- Two window assemblies completely missing (one pane was retrieved on the runway)
- One window with missing outer pane
- Deformation of several other window panes
- Window seals in degraded condition
- Visible burn marks
- Melted foam ring at the interface between the window and the cabin lining.



(fig.5)
Window protrusion due to deformation (left) and burn marks on the top of an outer pane (right) (source: investigation board)

CABIN WINDOWS

A cabin window assembly is typically composed of one inner and one outer pane made of **stretched acrylic** contained in a window seal **(fig.6)**. An additional transparent lining (not shown in the illustration) is present on the cabin side to protect the inner pane from impacts or scratches from the passenger side.



(fig.6)
Typical structure of a cabin window

A plug-type structural element

The cabin window assembly is a plug-type structural component. In other words, it is positioned from the inside of the aircraft and its size is bigger than the window frame so that the differential pressure pushes it against the window frame. The window assembly is maintained in place by a retainer, which is attached to the window frame by bolts.

A fail-safe structural part

Each cabin window pane (i.e. both the inner and outer panes) are able to independently sustain the maximum cabin differential pressure usually experienced during a flight.

The outer pane sustains the loads. A small vent hole on the inner pane lets the cabin pressure into the space between the two panes. This prevents the inner pane from sustaining pressurization cycles on each flight. The inner pane is, therefore, not exposed to structural fatigue.

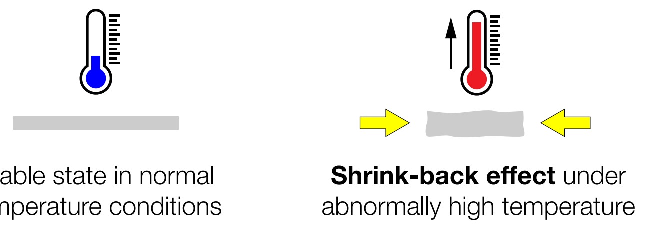
If the outer pane fails during a flight, the inner pane is designed to sustain the differential pressure loads and maintain the cabin pressure, which allows the continuation of the flight. The window assembly can then be replaced when the aircraft is back on the ground.

Risks associated with abnormal heat exposure

Shrink-back effect of acrylic

Cabin window panes are manufactured from a thick acrylic sheet that is heated to become softer, then stretched until the required thickness is reached. In normal operating temperature conditions, the acrylic remains in a stable state. However, if excessive heat is applied to a stretched acrylic object, the acrylic softens and the object tends to shrink back to its original shape **(fig.7)**.

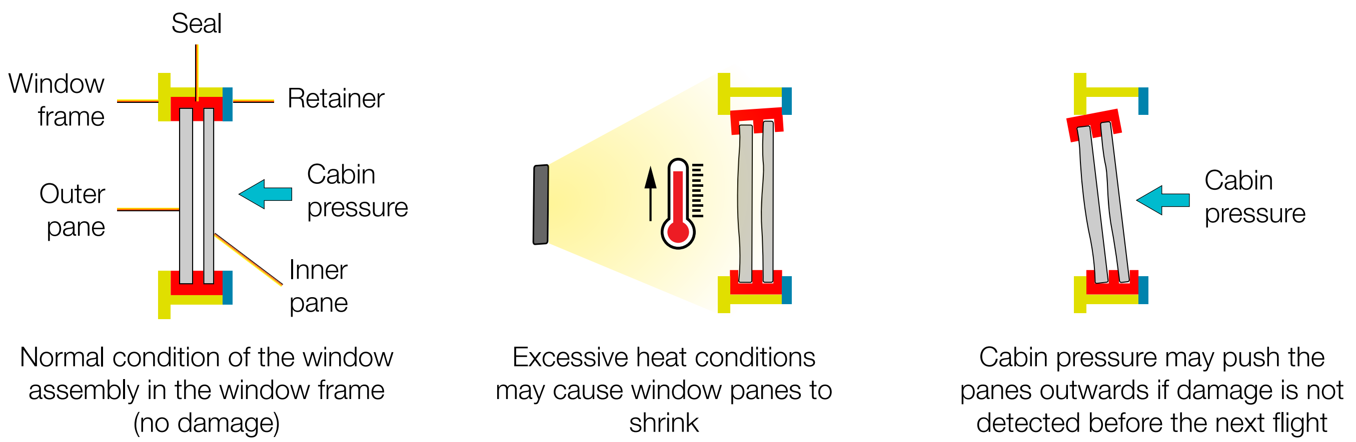
(fig.7)
Shrink-back effect of the stretched acrylic under abnormally high temperature



Risk of window pane ejection

If the passenger window panes are exposed to an excessive amount of heat, **the panes may start to shrink and could become smaller than the window frame**. If a damaged window is not detected before the aircraft returns to service, as in the event described earlier, there is a risk that the cabin pressure differential at altitude will force the affected window pane outwards, causing cabin air pressure leaks and eventually the ejection of the window pane **(fig.8)**. If both the inner and outer panes are affected by the heat damage, the complete window assembly could fail and be ejected.

(fig.8)
Risk of window pane ejection if the heat damage is not detected before the next flight



PREVENTING HEAT DAMAGE

When performing a filming session or photoshoot that requires the use of artificial lighting in close proximity to an aircraft, the following recommendations will prevent heat from the lights causing damage to the windows and fuselage.

Avoid using high thermal radiation lighting

Airbus recommends not to use high thermal radiation lighting devices, such as halogen (tungsten) or HMI lighting, during photoshoots or filming sessions outside or inside an aircraft. This type of lighting device emits a large amount of thermal energy. **Only use low energy lighting devices, such as LED lights**, which provide good lighting capabilities with low heat emission.

Limit exposure and regularly monitor the surface temperature

Switch off any lighting devices when not necessary to **limit the exposure time to the minimum**.

Even though Airbus aircraft materials have been qualified for use in elevated temperature environments, for example, taking into account operations or storage in hot weather regions, Airbus recommendation is to make sure that the surface temperature of cabin and passenger windows, fuselage, interior equipment and all aircraft parts exposed to the lighting sources, **are monitored and do not exceed 55°C**.

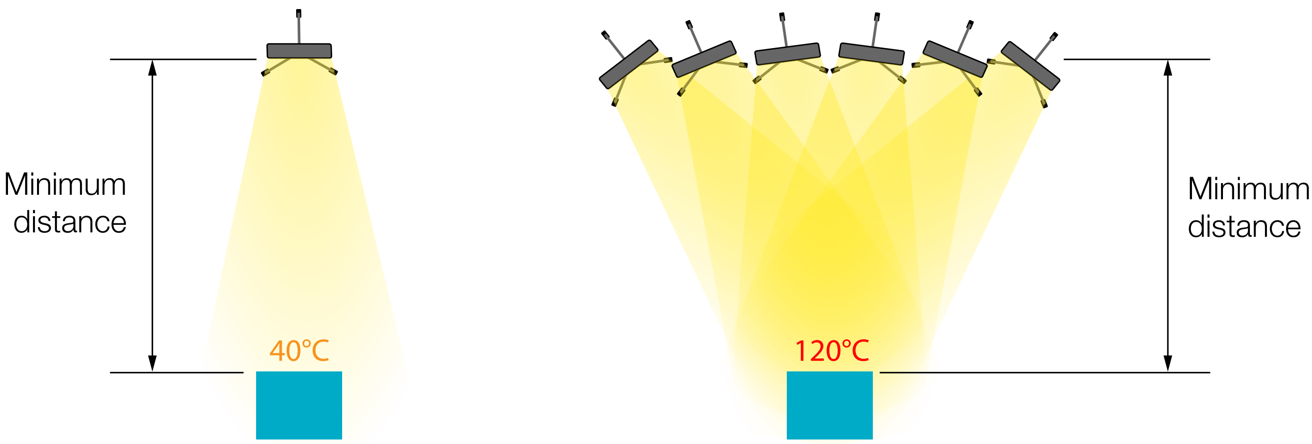
Beware of the thermal radiation cumulative effect

Even if the minimum distance to the subject defined by the lighting device instructions is respected, **when multiple lighting units are used at the same time, there is a thermal radiation cumulative effect** that may cause overheating and damage to the aircraft.

For example, one halogen lighting unit located at the minimum recommended distance, and pointed at the fuselage may increase the surface temperature of the fuselage to 40°C **(fig.9)**.

Using six similar halogen lighting devices simultaneously, which are located at the recommended minimum distance and all pointed at the fuselage, may quickly raise the surface temperature to 120°C due to the cumulation of the thermal radiation emitted from each light. This high temperature may cause damage to the object.

(fig.9)
Thermal radiation cumulative effect



Thermal radiation cumulative effect

Check the aircraft for damage before return into service

After the filming session or photoshoot is finished, **Airbus recommends performing a visual inspection** of all cabin windows that were exposed to the lightning to check they are free of any damage or distortion before returning the aircraft to service.

INFORMATION

The European Union Aviation Safety Agency (EASA) published a Safety Information Bulletin related to this subject in March 2024: SIB 2024-04 “Risks from using high power lights close to aircraft structures”. It can be found on the EASA website.

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The use of lighting devices during a filming session or photoshoot around an aircraft, or in the cabin, can have unintended consequences. High energy lighting devices can emit a level of thermal radiation that can damage the aircraft's fuselage, windows, or cabin interiors. This may even result in a failure in flight of the window assemblies due to the effects of the heat damage, leading to a loss of cabin pressure at altitude and potential injury to passengers or crew.

Several recommendations should be taken into consideration when planning a filming session or photo shoot involving any aircraft. These include only using low heat emitting lighting devices, such as LED lighting equipment, limiting the exposure of the fuselage, windows, or cabin interior to the lights, and regularly monitoring the surface temperature so that it does not exceed 55°C when exposed to the lights.

After the completion of the filming session, it is important to perform a thorough visual inspection of the areas that were exposed to the lighting to ensure there is no damage and that the aircraft is in a safe condition for its return to service.

Bird or Hail Strikes on the Radome

Abnormal events such as bird strikes and hail strikes can occur at any time. When the aircraft is struck by birds or Foreign Object Debris (FOD), the correct inspection process must be followed, before the next flight, to determine if the aircraft is safe to fly.

This article focuses on the effect that a bird or hail strike can have on the radome of the aircraft. It recalls the recommendations to flight and maintenance crews to ensure correct detection, reporting, and management of a bird or hail strike. It also explains why it is important to always check both the outer and inner sides of a radome after any bird or hail strike event.

CASE STUDY

Event Description

An A350 aircraft was climbing towards its cruise altitude when the SURV WXR 1 FAULT ECAM alert triggered just before reaching 12 000 ft. The flight crew pressed the WXR SYS 2 pushbutton of the SURV panel to switch to weather radar system 2. The SURV WXR 2 FAULT ECAM alert triggered shortly after. The flight crew then performed several weather radar system switchovers with the same result during the climb. The aircraft eventually reached its cruising altitude of 35 000 ft. The SURV WXR 1+2 FAULT ECAM alert triggered. The flight crew contacted their Operations Control Center and decided to perform an in-flight turnback. They initiated the turnback and started to descend. The flight crew then heard a loud noise, followed by strong aerodynamic noise, and observed indicated speed discrepancies. The following ECAM cautions subsequently triggered: NAV ISIS SPD UNRELIABLE, NAV AIR DATA REDUNDANCY LOST, and NAV RNP AR CAPABILITY DOWNGRADED. Three minutes after the collapse, the flight control system temporarily reverted to alternate law for 17 minutes. Normal law was then recovered and was maintained for the remainder of the descent. There was another reversion to alternate law that occurred at the beginning of the approach lasting almost two minutes, after which normal law was recovered and maintained until landing.

When the aircraft reached the gate, the ground crew observed that the nose radome had collapsed onto the radar **(fig.1)**.

(fig.1)
View of the collapsed radome (source: operator)

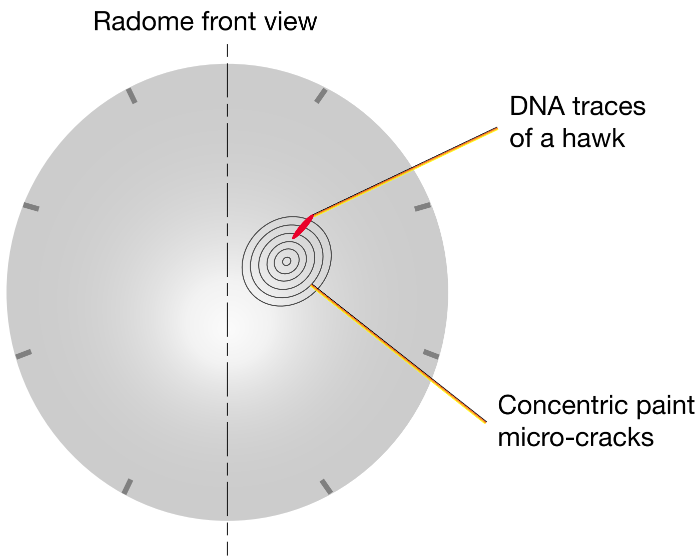
Event Analysis

Previous report of bird strike

The aircraft technical logbook revealed that the aircraft had a bird strike on the left side of the radome one month prior to the event. The technical logbook stated that an inspection was performed in accordance with the MP A350-A-05-51-14-00001-282A-A - Inspection of the Aircraft after a Bird Strike and that traces of bird strike were found on the outer surface left side of the radome, but there was no damage detected. The logbook did not specifically mention if the inner surface of the radome was also inspected. Therefore, it is not possible to confirm if a complete inspection of the radome was performed.

Confirmation of the bird strike

A detailed examination of the collapsed radome by Airbus confirmed that there was a bird strike to the left side of the radome prior to the event where the radome collapsed. DNA of a hawk was found as well as some paint micro-cracking around the likely impact area **(fig.2)**.



(fig.2)
Location of the bird strike based on the observed paint micro-cracks

Damage at the impact area

The inner skin disbonded from the composite structure of the radome, and there was damage to the honeycomb structure near the location of the bird strike. This damage compromised the structural resilience of the radome, which resulted in the radome collapsing.

WXR antenna drive failure messages on previous flights

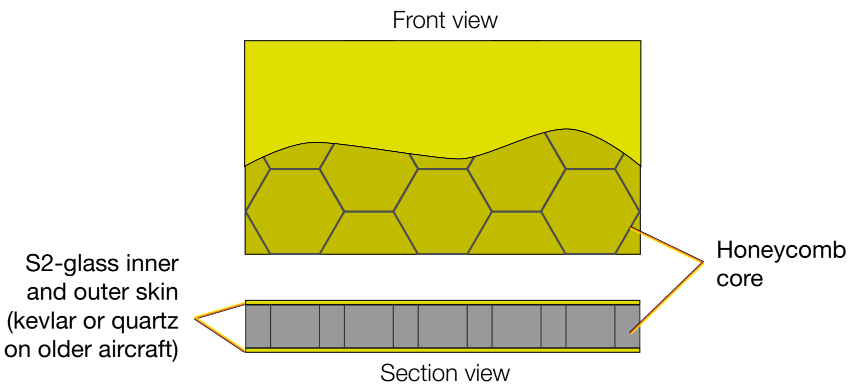
The Post Flight Reports (PFR) of the aircraft showed intermittent and repetitive SURV WXR 1 FAULT, SURV WXR 2 FAULT, and SURV WXR 1+2 FAULT ECAM alerts triggered during the three previous flights with the associated "**Drive Unit - WXR antenna**" failure message. This failure message is triggered if the antenna fails to move to its commanded position during an antenna scan cycle. It may be the result of a failure of the drive unit of the antenna or of a mechanical blockage of the antenna. System tests were performed on the ground at the end of each of the three flights with no fault found. The condition of the inner skin that had disbonded from the radome structure was not detected during these ground checks.

EFFECTS OF A BIRD OR HAIL STRIKE ON A RADOME

The radome is an aerodynamic weatherproof fairing that protects the radar antenna. It is manufactured with materials that allow transmission and reception of the radar radio waves with minimal interference.

Radome Structure

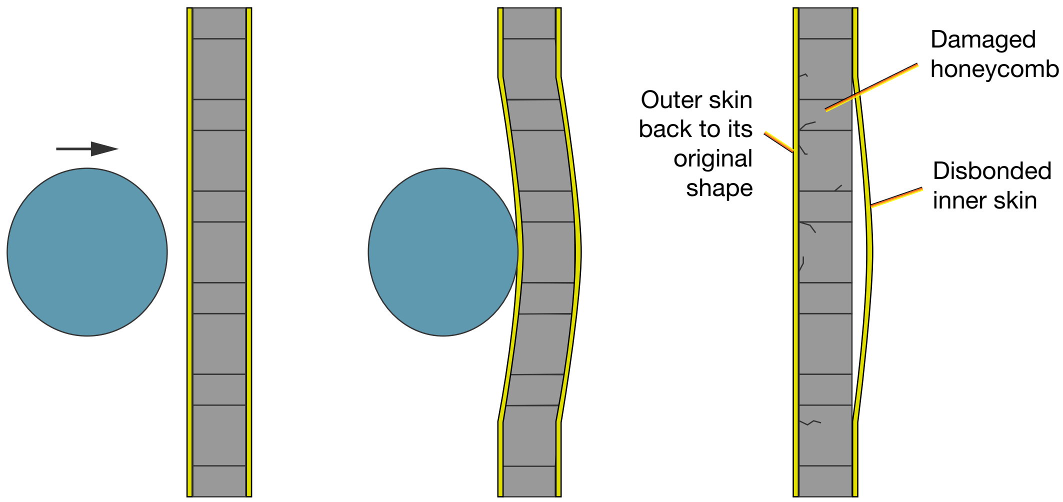
All radomes on Airbus commercial aircraft since the A300 are composed of a composite sandwich structure constructed of a honeycomb core located between internal and external skins (except A380 which has a double sandwich honeycomb core). These skins were previously manufactured from Glass, Kevlar & quartz. The latest radomes are manufactured from S2-glass® materials.



(fig.3)
Typical structure of a radome (the shape of the honeycomb may vary depending on the aircraft)

Effect of an impact on the radome

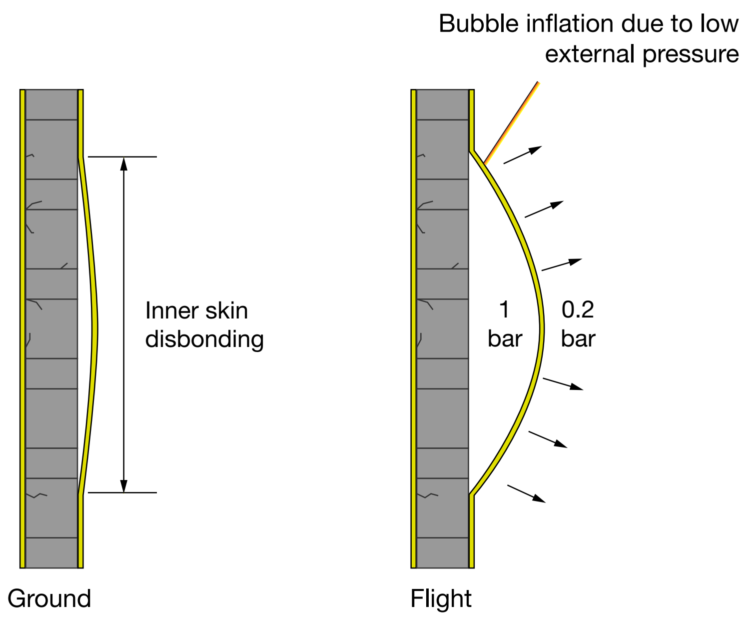
When impacted by hail, a bird strike, or other foreign objects, a sandwich composite structure deforms and then may return to its original shape with little to no damage visible on its external surface, but with potentially significant damage to its internal structure **(fig.4)**. In-service experience shows that there is often very little trace of the impact on the outer surface of the radome whereas the honeycomb core can be damaged and the radome inner skin can be disbonded around the impact zone.



(fig.4)
Example of damage due to an impact on a composite panel

Inflation of the disbonding during flight

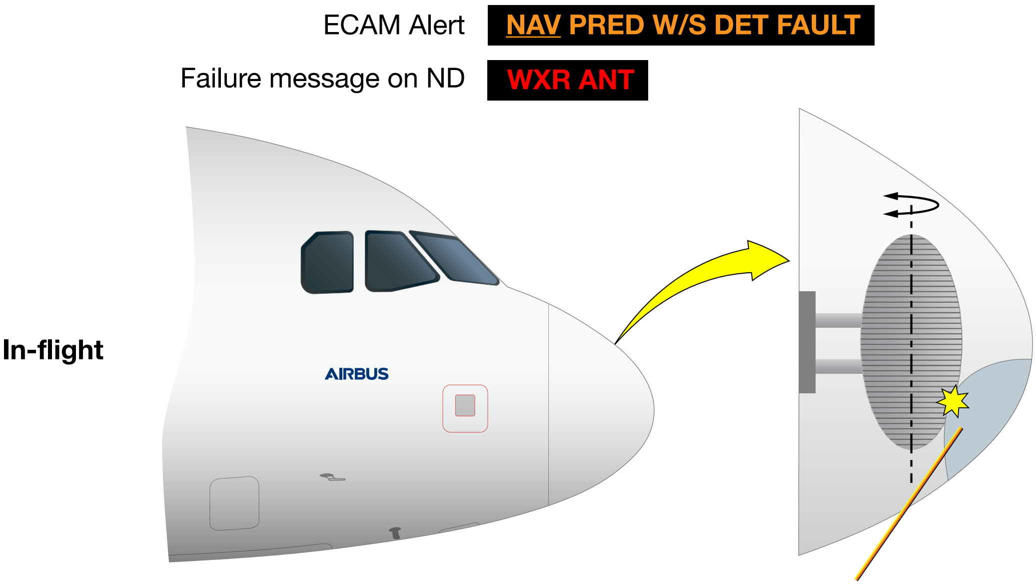
If the damage due to bird or hail strikes is not detected on the ground, the damaged area will be subject to several flight cycles. The air trapped between the honeycomb and disbonded skin (around 1 bar on the ground) will tend to inflate during each flight and create a bubble where the skin is disbanded due to the lower ambient air pressure at altitude (around 0.2 bar at cruise altitude) **(fig.5)**.



(fig.5)
Inflation effect at altitude where the skin has disbonded from the structure

Weather radar faults as a secondary effect

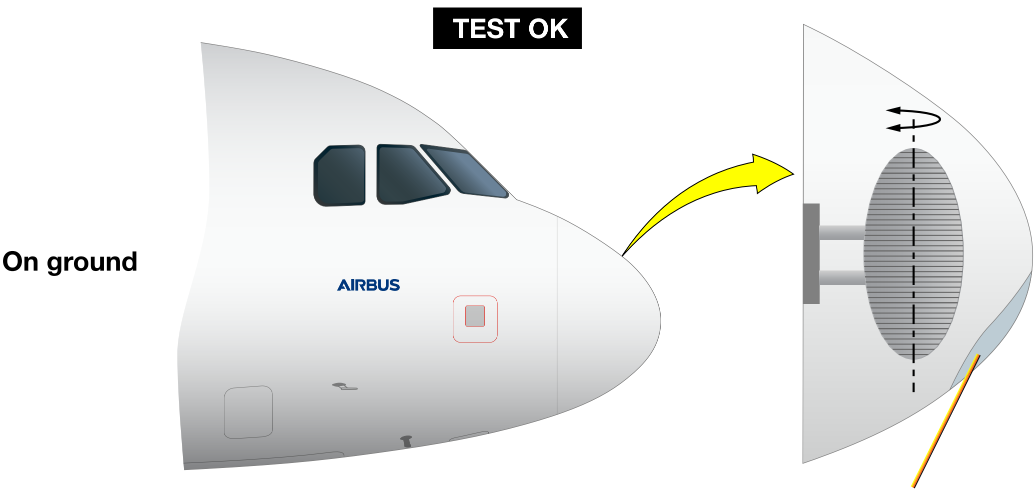
If a damage is not detected, depending on its size and location, it may impair the movement of the weather radar antenna and trigger the weather radar alerts **(fig.6)**.



Inflation of the inner skin bubble during flight **impairing radar antenna movement**

(fig.6)
Example of secondary effects of radome damage on A320 aircraft

When the aircraft is back on the ground and the radome inner skin bubble deflates, it may no longer impair the movement of the antenna **(fig.7)**. This can explain why there was no fault found during the troubleshooting test of the weather radar system on ground.



The bubble in the inner surface skin deflates with the aircraft on ground and **there may be no fault found during the weather radar system test**

(fig.7)
Radar system troubleshooting tests performed on ground may not identify the fault despite the radome damage still being present

OPERATIONAL CONSIDERATIONS

Flight crews have an important role to play in reporting and detecting damage due to bird or hail strikes.

Report any bird or hail strikes to maintenance personnel

In the case of an actual or suspected bird or hail strike during flight, and regardless of the location on the aircraft, the flight crew must make a **logbook entry** to report the event to maintenance personnel, so that they can perform the appropriate aircraft inspection.

The flight crew report should provide detailed information to aid in isolating any issues such as:

At the time of the bird or hail strike event:

- Aircraft configuration (position of the landing gears and flight controls)
- Flight phase

At the time of **and after** the bird or hail strike event:

- Any erroneous engine, radio, or navigation system behaviors
- Any smells noticed in the air conditioning system (burning smells or other odors)
- List of ECAM (EICAS for A220) alerts that triggered
- Description of any other system malfunctions during or after the event

Check for bird or hail strike during exterior walkaround

Conducting a thorough exterior walkaround inspection of the aircraft is also an opportunity to detect any potential bird/hail or FOD related damage. Should traces of bird or hail strike or FOD be found on any aircraft part, the flight crew must inform maintenance personnel and make a logbook entry.

MAINTENANCE CONSIDERATIONS

Aircraft Inspection after a Bird or Hail Strike

Careful inspection of the aircraft as per the AMM/MP/AMP after a reported bird or hail strike is essential, to check if the aircraft is safe to perform the next flight or if component repair or replacement is required.

Perform bird or hail strike inspections as soon as possible

In-service experience shows that it may be difficult to identify the signs of a bird or hail strike due to the fact that composite parts may return back to their original profiles after impact and this may mask or hide damage to the internal structure. The inspection must, therefore, be performed right after the bird or hail strike event to maximize the chance of findings.

Use lights for accurate detection

High quality additional lighting should be used to perform the inspection if in low light conditions. The use of a grazing light (applying directional light near the surface and lighting it at a narrow angle) to accentuate the shadows of uneven areas can help to detect defects.

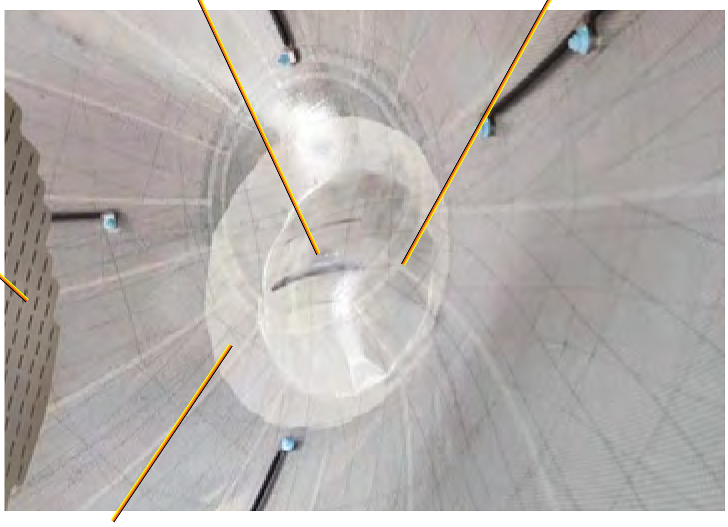
Perform a radome inspection for any reported bird or hail strikes

In the case of a bird or hail strike, the damage may not be limited to a single zone. Therefore, regardless of the location of the reported bird or hail strike (e.g. engine, fuselage, wing leading edges, etc.) the radome must always be inspected since it may also be affected by the strike.

Inspect the Radome external AND internal structure

In all cases after bird or hail strikes, in addition to the external inspection, it is mandatory to open and inspect the internal structure and surface of the radome for signs of delamination and disbonding, even if there is no trace on the external side of the radome. Typical signs of disbonding of the inner skin can be uneven surfaces or skin discoloration **(fig.8)**. If any damage is detected, it must be checked that it is within the allowable damage limit provided in the SRM/ASR/ASRP to continue in service. If the damage is outside the allowable damage limits, then the radome must be repaired or replaced.

The documentation for A380 aircraft (with double sandwich honeycomb core structure), and for A220 aircraft (single sandwich honeycomb core structure but with a different manufacturing process), does not currently require a systematic inspection of the internal surface of the radome in the case of every reported bird or hail strike. An update is under evaluation of the need to harmonize the procedure with the other Airbus aircraft types.



(fig.8)
Example of out-of-limits damage on the inner surface of the radome (source: Operator)

Weather Radar Antenna Drive Troubleshooting

At the time of the event described above, the A350 fault isolation task to be applied in the case of a fault message concerning the weather antenna drive requested the confirmation of the fault by performing a radar system test:

- If the system test failed, the task requested an inspection of the inner structure and surface of the radome.
- If the system test revealed no fault, no further action was requested. However, as per Aircraft Fault Isolation philosophy, after three or more occurrences of a fault, the full fault identification procedure must be done. This includes inspecting the inner structure and surface of the radome when there are three or more occurrences of a weather radar antenna fault message.

Troubleshooting and fault isolation task improvements

An update of the troubleshooting/aircraft fault isolation task linked to the weather antenna drive failure was launched for A320/A330/A340 and A350 aircraft. This is to take into account the conditions described in the above event causing the possible inflation at altitude, and deflation on the ground of the disbonded inner skin bubble of the radome. The procedure now requires a **systematic inspection of the inner structure or surface of the radome** to check for damage whenever there is a failure message related to the weather antenna or antenna drive.

INFORMATION

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

- ISI 53.15.00024: A320Fam - Radome Information - standards/interchangeability & events procedures.
- ISI 53.51.00001: A300, A330 & A340Fam - Radomes information - standard and interchangeability possibilities.
- ISI 53.15.00026: A350 - Radome Information - standards/interchangeability & event procedures.

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Customer Support

Any bird strike, hail strike, or foreign object debris striking any part of the aircraft must be reported to maintenance personnel, and the flight crew must make an entry in the logbook. It is important to provide as much detailed information as possible to aid in isolating any issues. The inspection should be carried out as soon as possible, because damage to composite parts may not be easily detected if the external surface is left to return to its original profile over time, masking or hiding the damage to the internal structure.

Whenever a bird or hail strike occurs anywhere on the aircraft, the radome must always be inspected using good quality lighting to check both the external and internal surfaces and structures. A fault message concerning the weather radar antenna may also be indicative of damage to the radome. When there is a weather radar antenna fault message, the updated troubleshooting procedures request a thorough inspection of the internal surfaces and structures of the radome to check for damage that could impair the movement of the radar in flight.

It is also important to recall the fault isolation philosophy that requires the full fault identification procedure to be carried out for the system when there are three or more occurrences of the same fault.

Is it a Loss of Braking?

The LOSS OF BRAKING procedure memory items have to be applied in the extremely remote case of a failure of the braking system. In-service experience shows that inappropriate application of the LOSS OF BRAKING procedure may contribute to a risk of runway excursion.

This article recalls the conditions to apply the LOSS OF BRAKING procedure and highlights the risk of confusion by the flight crew when monitoring the aircraft deceleration during landing on contaminated runway.

CASE STUDY

Event Description

An A320 aircraft was stabilized in final approach in CONF FULL. Autobrake MED was selected. The runway length was 3700 m. Autopilot and autothrust were both engaged. External conditions were combining snow showers and left crosswinds between 16 kt and 22 kt. The runway was reported as contaminated with snow.

Normal touchdown

1 The touchdown was performed nominally at 140 kt ground speed (GS). The spoilers extended, 2 MAX REV was applied, and the MED autobrake mode activated. 3 The DECEL light on the MED pushbutton switch transiently turned on and 4 then went OFF shortly after. The ON light remained ON.

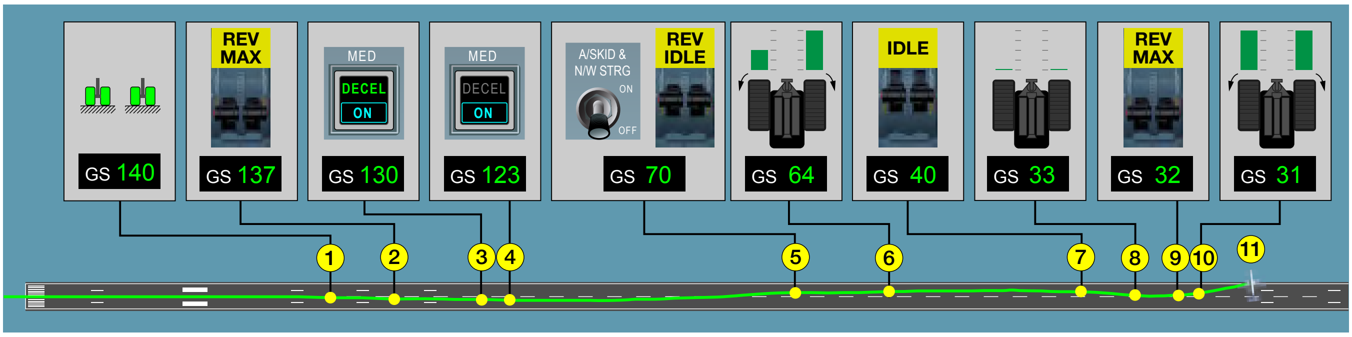
Application of the LOSS OF BRAKING procedure

5 At around 70 kt, the flight crew set the A/SKID & N/W STRG switch to OFF. The PF selected REV IDLE almost simultaneously. The aircraft was slightly diverging from the centerline toward the left edge of the runway.

Lateral runway excursion

6 The PF applied differential braking and rudder inputs to the right to try to recover the runway centerline. 7 The flight crew set the engine thrust levers to IDLE and 8 the PF released the brake pedals for some seconds. 9 They selected REV MAX again and 10 applied maximum pedal braking. The aircraft skidded, deviated from the centerline and 11 came to a stop at 90° from the centerline with the nose landing gear out of the runway.

(fig.1)
Description of the first event (rudder inputs not illustrated)



Event Analysis

Autobrake and anti-skid correct activation

Analysis of the flight recorder data showed that the autobrake activated correctly and that the anti-skid function released the brake pressure several times to prevent wheel blockage due to the snow on the runway surface. This resulted in an average deceleration of 0.2 g, below the autobrake MED target of 0.3 g. As a consequence, the DECEL light briefly illuminated at the beginning of the landing roll.

Inappropriate application of the LOSS OF BRAKING procedure

The pilot report confirmed that the LOSS OF BRAKING procedure was applied with no further details provided. Airbus could not identify the reason for application of the LOSS OF BRAKING procedure because analysis of the flight recorder data showed the brake system functioned normally in autobrake normal braking mode until the flight crew switched the A/SKID & N/W STRG switch to OFF. A possible explanation is that the limited deceleration, due to the runway contamination with snow, may have been interpreted as a loss of braking function by the flight crew.

CASE STUDY 2

Event Description

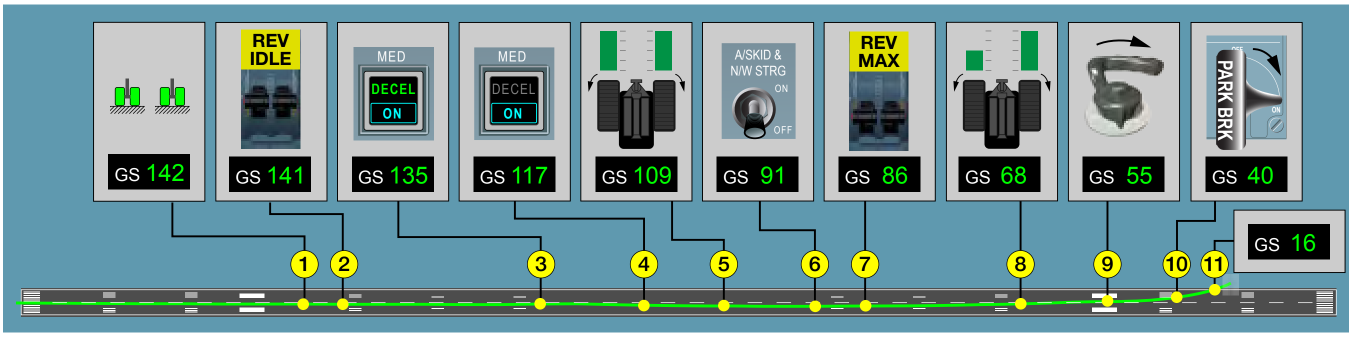
An A321 was stabilized in final approach in CONF FULL. The runway length was 2400 m. The Captain was PF, autobrake MED was selected, autopilot was OFF and autothrust engaged. The airport was subject to heavy rainfall. The ATIS and tower reported WET runway condition. The ENG 2 thrust reverser was inhibited as per MEL item 78-30-01A. The flight crew planned to select REV IDLE during the landing roll.

Nominal touchdown and autobrake activation

1 The touchdown was performed nominally at 142 kt ground speed, with a 2 kt tailwind. The spoilers extended, 2 REV IDLE was selected as planned, and the MED autobrake mode activated. The aircraft began to decelerate and 3 the DECEL light of the MED pushbutton switch illuminated.

Sudden deceleration drop followed by manual braking application

The flight crew then felt a sudden deceleration drop. 4 The PM observed that the ON light of the autobrake MED pushbutton switch was illuminated but the DECEL light had extinguished. He announced that the autobrake was lost. 5 The PF took over from the autobrake by applying full manual braking.



(fig.2)
Description of the second event (rudder inputs not illustrated)

Application of the LOSS OF BRAKING procedure

The flight crew could not feel an increase in deceleration and decided five seconds later to apply the LOSS OF BRAKING procedure, 6 by setting the A/SKID & N/W STRG switch to OFF while the brake pedals were still fully deflected. This resulted in the instantaneous blocking of the four main landing gear wheels.

Aircraft skidding and REV MAX application

The aircraft skidded for 10 seconds and the PF applied right rudder input to maintain the aircraft's alignment with the runway. The PF then 7 set both reversers to REV MAX, whilst maintaining right rudder inputs.

Application of differential braking and nose wheel steering tiller inputs

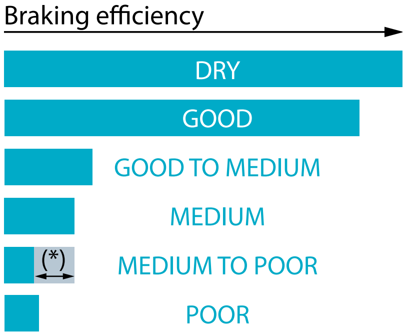
8 While maintaining right rudder input, the PF started to apply differential braking by transiently releasing the left hand brake pedal. The aircraft veered to the left. 9 The PF applied full right inputs on the nose wheel steering tiller whilst differential braking was maintained. The aircraft quickly deviated toward the left hand edge of the runway.

Parking brake application and runway excursion

10 The flight crew applied the parking brake and 11 the aircraft exited the runway at 16kt before coming to a stop with the aircraft nose positioned at around 90° from the runway axis and 200 m from the end of the runway.

The flight crew set the thrust lever to IDLE and switched off both engines.

(fig.3)
Braking efficiency per reported braking action for landing distance computation (data from the FAA AC-25-32)



(*) Varies with speed due to aquaplanning

Event Analysis

Autobrake correct activation

Analysis of the flight recorder data showed the autobrake MED activated correctly.

Sudden change in deceleration

The sudden change in deceleration felt by the flight crew, and confirmed by the analysis of the flight recorder data, was due to the fact that the aircraft entered a portion of the runway with a very degraded runway friction performance, which is probably due to a significant layer of standing water. Performance computation based on the actual aircraft deceleration showed that **the runway condition dropped abruptly from an equivalent of GOOD to POOR** and remained POOR until the end of the landing roll. This runway condition was below the MED TO POOR condition that would be expected in the case of a runway contamination by standing water and used for landing distance computation **(fig.3)**.

Significant anti-skid activation

The POOR runway friction caused the anti-skid function to be very active as it released the brakes several times to prevent wheel skidding. This reduced the deceleration rate below 80% of the target rate of the MED autobrake mode. This caused the DECEL light of the MED pushbutton switch to extinguish.

Inappropriate application of the LOSS OF BRAKING procedure

The sudden change in deceleration due to the uneven runway contamination, combined with the significant activation of the anti-skid function when manual braking was applied, led the flight crew to interpret the situation as a loss of braking and inappropriately apply the LOSS OF BRAKING.

A/SKID & N/W STRG switch set to OFF with pedals fully pressed

The flight crew set the A/SKID & N/W STRG switch to OFF while the PF was pressing the brake pedals. This caused the wheels to lock instantly due to full application of the alternate brake pressure without anti-skid modulation.

Use of the nose wheel steering tiller

The attempt to use the steering tiller during the final seconds of the landing roll was ineffective because the nose wheel steering was unavailable due to the application of the LOSS OF BRAKING procedure.

OPERATIONAL CONSIDERATIONS

The LOSS OF BRAKING procedure was introduced to cover an extremely rare **failure of the automatic switching to the alternate/emergency braking mode, in cases where the normal braking mode failed**. This may happen after a takeover from automatic to manual braking during landing or rejected takeoff. It may also happen during taxi. In- service experience has shown that the application of this procedure has been also efficient to cope with other kinds of braking system malfunction.

The LOSS OF BRAKING procedure consists in a **manual activation of the alternate braking mode without anti-skid (emergency braking mode on A350 and A380 aircraft)** using the A/SKID & N/W STRG switch on A320 family, A330 and A340-200/300 aircraft, or the A/SKID switch onA340-500/600, A350 and A380 aircraft, or the BRK/ANTI SKID switch on A300-600 and A310 aircraft. Ultimately, the procedure requests the application of the PARK BRK if the alternate/emergency braking also fails.

There is no equivalent LOSS OF BRAKING procedure on A220 aircraft because it has a different braking system design.

When to apply the procedure

The procedure must **only be applied during manual braking**, and only if the flight crew **does not feel any effect on the deceleration while pressing on the brake pedals**.

Consequences of the application of the LOSS OF BRAKING procedure

Applying the LOSS OF BRAKING procedure has non negligeable consequences which depends on the aircraft type:

- **Loss of anti-skid function only on A300, A300-600, A310, A340-500/600, A350 and A380 aircraft**. This may reduce the braking performance of the aircraft, increase the risk of tyre burst, and potentially lead to runway excursion.

- **Loss of both the anti-skid function and the Nose Wheel Steering (NWS) on A320 family, A330 and A340-200/300 aircraft**. The braking performance may be reduced as well as the ground handling capabilities. The flight crew has to use the rudder at high speed and differential braking at lower speed for lateral control.

Wet and Contaminated Runway: Is it a Loss of Braking?

The two case studies described previously highlight the need to pay particular attention when landing on wet or contaminated runways in order to prevent inappropriate application of the LOSS OF BRAKING procedure. It is important that flight crews are aware of the behavior of the aircraft and its braking system when landing on wet or contaminated runways. This will prevent them from interpreting some normal phenomena linked to the conditions of the runway as loss of braking.

Lower deceleration in the case of a high anti-skid activity

The rate of deceleration perceived by the flight crew may be less on a contaminated runway than on a dry runway, particularly in the case of standing water or presence of other contaminants. There is a high probability that the anti-skid function will activate, reducing the perceived rate of deceleration. Even if it is the case, flight crew should be aware **that the anti-skid is designed to ensure the optimum deceleration rate adapted for the runway condition**.

Sudden deceleration change due to inconsistent contamination

The second case study showed the level of contamination of a runway, and therefore the runway condition, may vary along its length. This can lead to sudden changes in the rate of deceleration perceived by the flight crew, which may cause them to incorrectly determine they have a loss of braking.

Change in deceleration during transition from REV MAX to REV idle

Flight crews should also be aware that a sudden deceleration drop may be felt during the transition from REV MAX to REV IDLE, especially on wet or contaminated runways since the braking efficiency is reduced. This does not mean that the braking capability is lost.

Autobrake DECEL light (A320/A330/A340) and DECEL message on the PFD (A320/A330/A340/A380)

On A320, A330 and A340 aircraft, if the DECEL light of the autobrake pushbutton switch is not illuminated, or extinguishes during the landing roll, this does not mean that the autobrake mode has failed. As explained in the FCOM description chapter, the DECEL light of the autobrake pushbutton switches is an **indication that the deceleration is above 80% of the target deceleration** of the selected braking mode. As a consequence, the DECEL light may not illuminate or extinguish during the landing roll, or during RTO, if the deceleration is reduced due to the runway condition and anti-skid activation.

The use of the MED mode on wet or contaminated runways increases the probability of an extinction of the DECEL light. The illumination threshold of the DECEL light may not be reached or only temporarily reached.

A display of a DECEL message below the PFD speedscale as well as a display of the autobrake mode on the FMA is available on A350 and A380 aircraft as well as on A320 aircraft equipped with EIS 2 standard S14 combined with BSCU L4-10 (MOD 157491) and SDAC H2E3 (MOD 151314), and subsequent standards. It is also available on A330/A340 aircraft equipped with EIS 2 standard L10 (MOD 205162) combined with BSCU S9D (MOD 205183), and SDAC C11 (MOD 203928), and subsequent standards.

	Autobrake mode OFF	Autobrake mode armed **or** engaged with deceleration **below 80%(*)** of the target deceleration rate	Autobrake mode engaged with deceleration **above 80%** of the target deceleration rate
Autobrake pushbutton switch (A320/A330/A340 only)	MED DECEL ON	MED DECEL ON	MED DECEL ON
DECEL on PFD speed scale (if installed)	060	060	060 DECEL
Autobrake mode on FMA (if installed)		BRK MED or BRK MED	BRK MED

(*) Once illuminated, the DECEL light extinguishes if the deceleration diminishes below 60% or 70% of the target rate, depending on the aircraft type.

"DECEL" standard callout

As per SOP, the PM should make the "**DECEL**" standard callout **when they feel the deceleration and confirm it with the speed trend** on the PFD. **It is not based on the display of the DECEL light** of the autobrake pushbutton switch.

If no deceleration is felt, and it is confirmed on the PFD speed trend, the PF should call "**NO DECEL**".

Importance of the Arrival Briefing

Being prepared to manage the effects of a wet or contaminated runway on the aircraft deceleration **prevents any surprise** effects during landing that could lead to the flight crew inappropriately applying the LOSS OF BRAKING procedure.

During the arrival briefing:
- Discuss the runway conditions based on the available information
- Discuss the stop margin and the available deceleration means. **A drop in deceleration may be felt during the landing roll if the anti-skid activates, and when reversers are selected from REV MAX to REV IDLE**, and
- If the weather conditions are expected to change or in the case of significant precipitation at the airport, the flight crew should be prepared for a reduction of the braking performance. The case study n°2 showed us that a reported WET runway can quickly be contaminated with standing water, degrading the braking action from an expected MEDIUM to a MEDIUM TO POOR. The flight crew should therefore consider making a second computation of the landing distance with the worst condition possible.

TRAINING CONSIDERATIONS

The Flight Crew Training Standard (FCTS) manual recommends training the LOSS OF BRAKING procedure in the simulator in order to recall and apply the memory items with the associated callouts.

Train LOSS OF BRAKING at low speed and at high speed

This can be performed at low speed such as during taxi, and also at high speed during landing. It is recommended to perform one of these scenarios with a startle effect situation.

Simulator limitation

Due to the limitation of the simulator ground model, **instructors must not mix a LOSS OF BRAKING with contaminated runway conditions**. Combining both situations would not be representative of the real aircraft behavior and would therefore give a negative training scenario. However, the specific behavior of the aircraft on wet and contaminated runways and possible confusion with a loss of braking should be reviewed during the briefing of the simulator session using the LOSS OF BRAKING section of the Flight Crew Techniques Manual (FCTM).

INFORMATION

A video dedicated to the LOSS OF BRAKING procedure is also available on the Airbus Worldwide Instructor News (WIN) website.

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With thanks to Cesar GARCIA CASTILLA from Aviation Safety and Thomas GOBEAUT from the A300/A310 Flight Operations Support.

The LOSS OF BRAKING procedure was introduced to cover an extremely rare failure of the automatic switching to the alternate/emergency braking mode, in cases where the normal braking mode failed. It must only be applied during manual braking, and only if the flight crew does not feel any effect on the deceleration while pressing on the brake pedals.

To prevent inappropriate application of the LOSS OF BRAKING PROCEDURE, flight crew should be aware that, on contaminated runways, the perceived rate of deceleration may be lower than the rate of deceleration felt on dry runways. It is likely when there is activation of the anti-skid function.

Flight crew should also be aware that an uneven contamination of the runway, or the presence of standing water in some areas of the runway after a heavy rainfall, may cause sudden changes in the deceleration rate. This could cause the flight crew to incorrectly determine they have a total loss of braking.

Flight crew should also be prepared for the sudden change in the perceived rate of deceleration when they transition from REV MAX to REV IDLE, especially on wet or contaminated runways, since the braking efficiency is reduced.

It is essential to discuss these effects during the arrival briefing so that the flight crew will not be surprised should they perceive a sudden change in the rate of deceleration during the landing roll. This will prevent inappropriate application of the LOSS OF BRAKING procedure.

Training of the LOSS OF BRAKING PROCEDURE should be performed according to the Flight Crew Training Standard (FCTS) manual requirements and taking into account the limitations of the simulator ground simulation model.

Correct Cargo Door Seal Installation for Safe Operation

Incorrect installation of a cargo doors seal may lead to unsafe in-flight operations such as abnormal cabin pressurization or an ineffective cargo fire extinguishing system.

This article recalls the essential steps of the AMM for correct cargo door seal installation, including the required inspection after installation.

CASE STUDY

Event Description

An A319 aircraft was performing a non-revenue flight from its main base, following a maintenance check. There were two passengers and two flight crew members onboard. During climb, a CAB PR EXCESS CAB ALT ECAM warning triggered. The flight crew initiated an emergency descent and opted to perform an in-flight turn back. The aircraft safely landed without further incident.

Event Analysis

Cargo door seal found incorrectly installed

During troubleshooting, the maintenance crew observed that the aft cargo door pressure seal was incorrectly installed.

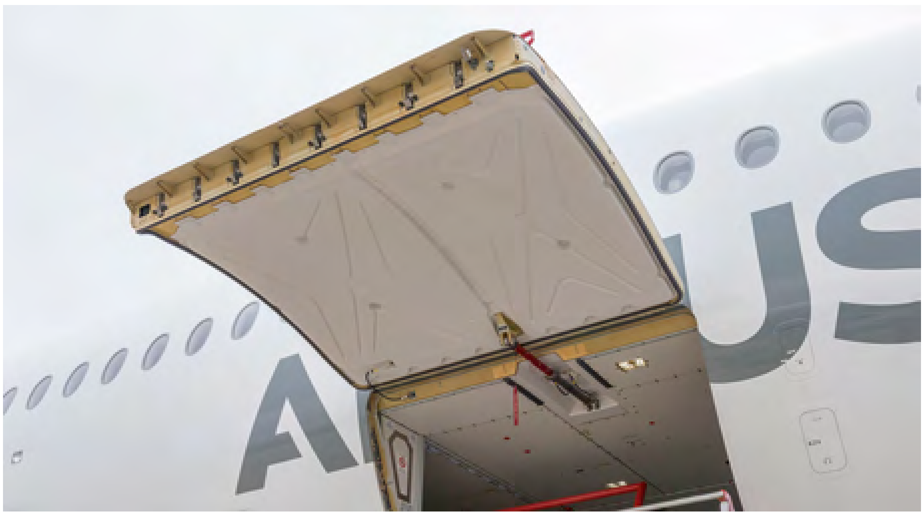
Records showed that the cargo door seals were replaced during the maintenance check as per the mandatory Service Bulletin (SB) A320-52-1195.

The seal of the aft cargo door failed to inflate due to its incorrect installation causing an air leak, which caused the CAB PR EXCESS CAB ALT ECAM warning to trigger.

The aircraft safely returned to operation when the aft cargo door seal was reinstalled correctly and inspected.

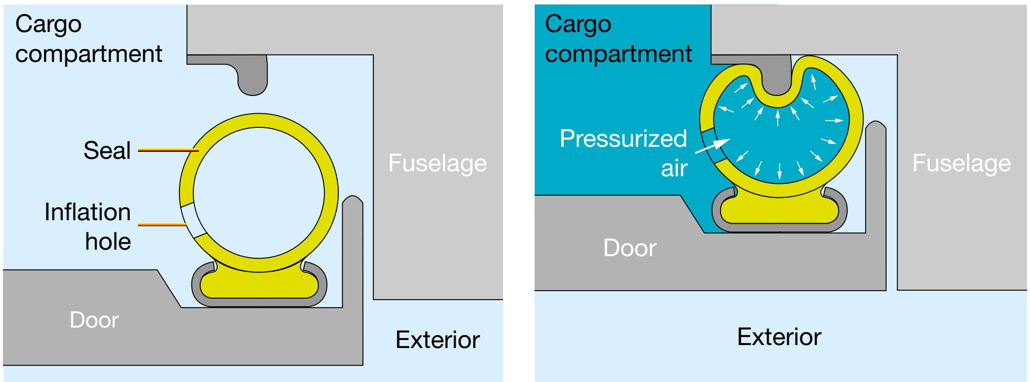
CARGO DOOR SEAL

Cargo door seals are made of reinforced silicone rubber and are installed in the retainer around the door structure. They ensure air tightness around the cargo door to maintain aircraft pressurization.



Seal Design

On Airbus aircraft, the airtightness of the cargo doors are ensured by inflatable seals. Inflatable cargo door seals have inflation holes located on their inner surface (the cargo facing side) of the seal, that allows the pressurized air from the cabin to enter the seal, which causes it to inflate as the altitude increases and this ensures the airtightness around the seal **(fig.1)**.



Opened door on the ground

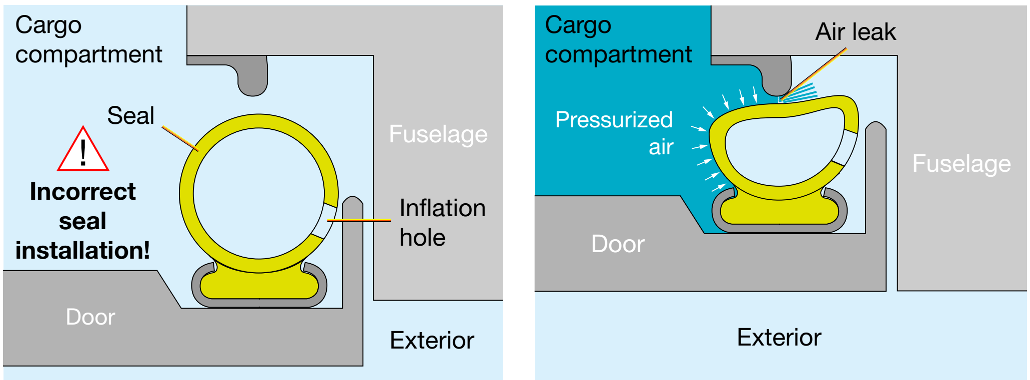
Closed door in flight (inflated seal)

(fig.1)

Concept of an inflatable seal - typical view

Incorrect Installation Causing Air Leaks

If the inflatable seal is installed incorrectly, and the inflation hole is in the wrong position, the pressurized air can compress the seal and create air leaks **(fig.2)**.



Opened door on the ground

Closed door in flight (non-inflated seal)

(fig.2)

Incorrect installation of the inflatable seal can create air leaks

Effects of incorrect installation

Two potential effects from incorrect seal installation include pressurization issues and the reduced effectiveness of the cargo fire extinguishing system. Air leaking around the cargo door seal can make it difficult to pressurize the aircraft, or it can potentially cause an in-flight depressurization event requiring an emergency descent. In the event of a cargo fire, the air leaking around the seal may allow the extinguishing agent to escape the cargo compartment and fail to extinguish the fire.

Increased Risk Exposure on A320 Family Aircraft

Most of the reported cases of incorrect seal installation occurred on A320 family aircraft for two main reasons:

High number of cargo door seal replacements required by service bulletin

The Airworthiness Directive (AD) 2021-0049 published by the EASA in March 2021 mandates the installation of a new seal via Service Bulletins (SB) before March 2029 on all in-service A320 family aircraft delivered before November 2019. SB A320 52-1195 (for CEO aircraft) and SB A320 52-1196 (for NEO aircraft) require replacement of the aircraft's cargo doors seals, canceling the need for repetitive cleaning and greasing of the old seal requested by the AD pending its replacement. The new seal has improved airtightness and does not require regular greasing to improve its efficiency.

This mandatory replacement of the seals on A320 family aircraft significantly increases the risk exposure to incorrect installation of the seal. Replacement of a cargo door seal is normally only performed when it is damaged during operation.

Different seal characteristics

Another reason A320 family cargo doors may have reported incorrect installations is because the seals on A320 family aircraft have a symmetrical shape and they are more flexible when compared to the seals installed on other Airbus aircraft models. On the other aircraft types (A220, A330, A340, A350 and A380 aircraft), the seals have a higher rigidity and some have an asymmetrical shape, which can aid the operator to correctly install the seal.

ENSURING CORRECT CARGO DOOR SEAL INSTALLATION

Even if A330, A340, A350, A380 and A220 aircraft are less prone to incorrect installation, maintenance personnel must carefully follow the AMM/MP/AMP instruction to ensure that the seals are installed correctly. This includes careful consideration of the warnings, cautions, procedure and illustrations.

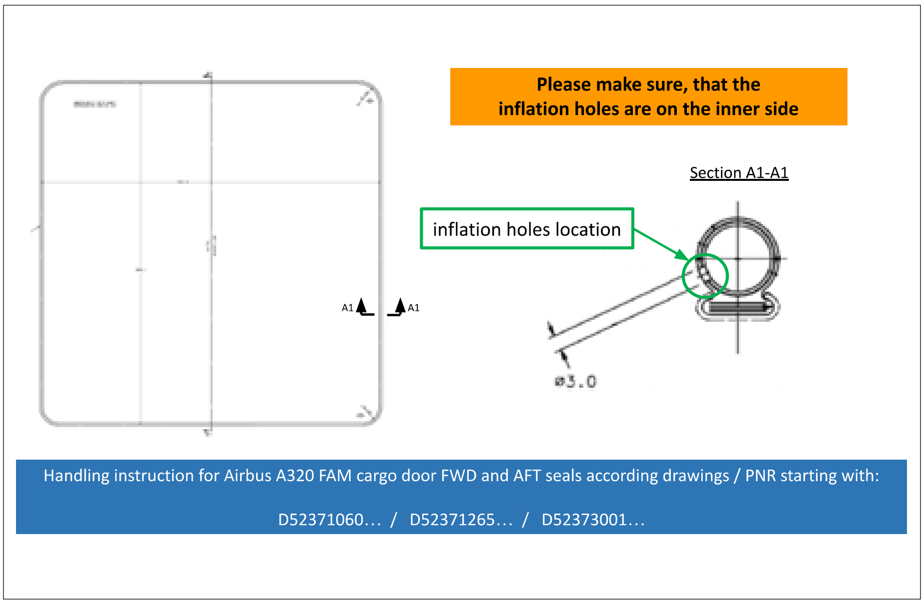
Additional inspection and dual signature

A recommendation as an additional safety barrier is to require an additional inspection and dual signature for the cargo door seal installation task.

Ensuring correct seal installation on A320 family

Introduction of a caution tag

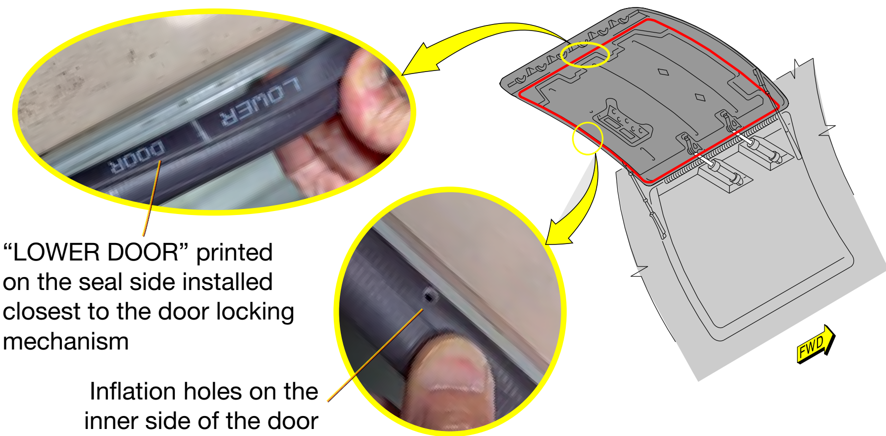
To prevent incorrect seal installation, the seal manufacturer has introduced an instruction notice included with seal deliveries **(fig.3)**. This notice highlights the need to pay particular attention to the correct orientation of the cargo door seal holes.



(fig.3)
Instruction notice included with seal deliveries

Correct positioning of the seal

Maintenance personnel must ensure that the inflation holes are located on the inner side (the cargo facing side) of the door. In addition, the cargo door seals do not have inflation holes in their lower part and so the maintenance personnel must ensure that the side of the seal marked with "**LOWER DOOR**" is positioned closest to the door locking mechanism **(fig.4)**.



(fig.4)
Example of Correct positioning of an aft cargo door seal on an A320 family aircraft

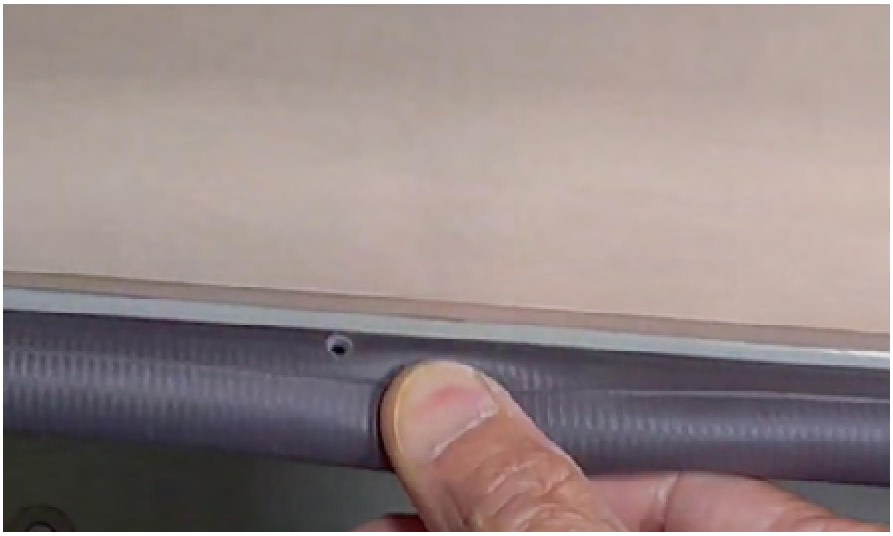
Installation of pre-formed corners

Maintenance personnel should install the four pre-formed corners first to ensure the seal is in the correct position and to prevent wrinkles. White alignment marks help to identify and correctly position the pre-formed corners **(fig.5)**.

(fig.5)
Installation of the pre-formed corners before the straight sides ensures correct installation of the seal along the door frame

Mandatory Visual inspection

A careful inspection of the seal as per AMM is required to ensure correct seal installation. The maintenance personnel must inspect the entire circumference of the cargo door seal. They must ensure the seal is not twisted and check that the inflation holes are facing towards the inner side of the cargo door by gently bending the seal **(fig.6)**.



(fig.6)
Slightly bending the seal enables the maintenance personnel to check the inflation holes are facing towards the inner surface of the door, which is the cargo side

A320 Cargo Doors Seal Installation Video

Airbus developed an awareness video to illustrate these essential steps for correct cargo doors seal installation on the A320 family.

Video: A320 Family - Cargo door installation

INFORMATION

Further information can be found in the AMM/AMP and on the AirbusWorld portal and in the following documents:

- OIT Ref.: 999.0040/23 - ATA 52 – CARGO DOORS SEALS INSTALLATION
- ISI Ref.: 00.00.00437 - A320 Family Systems Ageing global ISI
- Maintenance Briefing Notes (MBN): Forward & aft cargo door seal installation
- TFU: Ref.: 52.30.00034 - A320 Fam CARGO COMPARTMENT DOORS SEAL ADAPTATION FOR HALON LEAKAGE IMPROVEMENT
- RIL Reference: SA52M20001620

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On Airbus aircraft, the airtightness around the cargo doors is ensured by an inflatable cargo door seal. The inflation holes must be correctly oriented towards the inner surface of the door, which is facing the cargo, to function correctly. Incorrect installation of the seal may lead to a failure to pressurize the aircraft, loss of aircraft cabin pressure inflight, or cause the cargo fire extinguishing system to be less effective in the event of a cargo fire.

The AMM/MP/AMP provides instructions, warnings and illustrations to ensure correct installation of the cargo door seal and reminders are now also attached to each replacement seal for A320 family aircraft.

Once the seal is installed, a visual inspection of the entire seal is required to ensure that the seal is not twisted and the inflation holes are oriented towards the inner side of the cargo doors. It is recommended to require an additional inspection and dual certification of a cargo door seal installation task as an additional safety barrier.