The Airbus safety magazine

#35

Safety first

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Safety first

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

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

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Dear Aviation Colleagues,

The welcome return of passengers to the skies shows the resilience of our industry and highlights why we must continue to always keep safety first, especially as the pace of the recovery accelerates toward pre-pandemic levels. Even with this recovery target in sight, people from across the air transport system remain focussed on raising the bar for safety.

A focus during the period of massive fleet grounding was to ensure the parked aircraft could return to service airworthy and safe. To face the ramp-up to recovery, it was necessary to go the extra mile for safety together. As a manufacturer, we worked to ensure continuity was maintained with our partners and suppliers. Operators managed recurrent training of pilots, cabin crews, and maintenance crews. The same efforts extended to air traffic controllers, dispatchers, ground crews, and everyone working for a safe air transport system. We share the constant need to continuously develop our people in aviation, to get back to the basics, and to share safety lessons learned.

The public appetite for travel, following the relaxation of restrictions, created a rapid ramp-up in the demand for flights. This causes an increased risk exposure that is similar to the effects of the accelerated industry growth observed from the early 2000s. We worked together to significantly reduce the accident rate throughout this growth period by taking safety beyond compliance, managing risks, and implementing sound safety governance. Even if the accident rate remains very low today, we cannot afford to be complacent. It is our call to action to redouble these efforts and to continuously enhance the safety of a flight, because we all expect zero accidents when we fly.

In facing these challenges together, I sincerely wish everyone successful and safe flying in 2023.

Safety Publications

Safety first

The Airbus safety magazine

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The 27th Airbus Flight Safety Conference will be held in Berlin, 20-23 March 2023

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

The rapid recovery of our industry highlights the strong resilience of our air transport system. However, it also requires us to always keep safety first in the face of the challenges in a post pandemic world. This is why this conference agenda includes presentations that focus on staffing and training, sharing safety information, and continuously growing our safety culture to take safety beyond standard.


A321 AIRBUS

Safety first #35

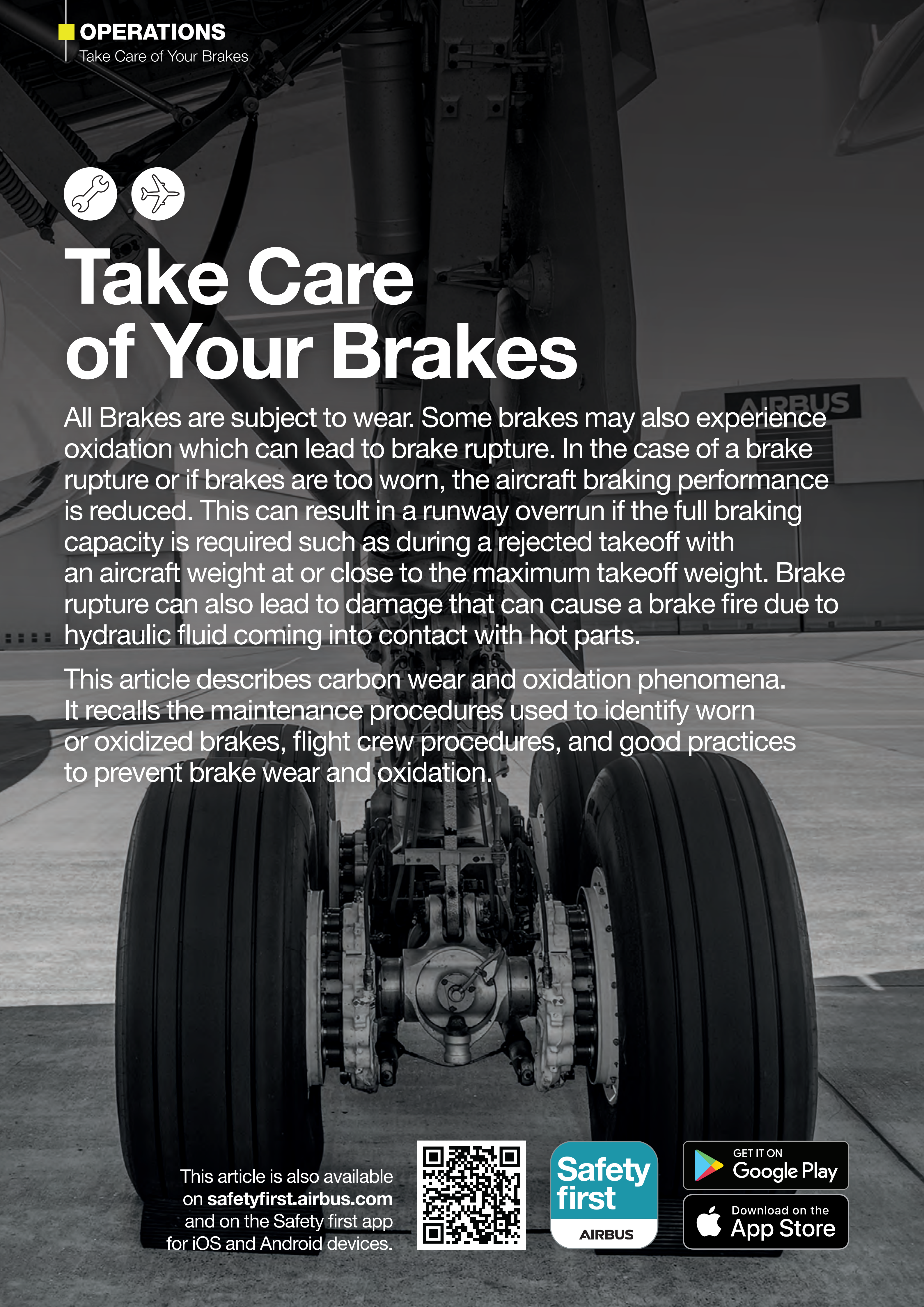
Flight Operations

Cabin Operations

Ground Operations

Maintenance

OPERATIONS & MAINTENANCE



Take Care of Your Brakes

All Brakes are subject to wear. Some brakes may also experience oxidation which can lead to brake rupture. In the case of a brake rupture or if brakes are too worn, the aircraft braking performance is reduced. This can result in a runway overrun if the full braking capacity is required such as during a rejected takeoff with an aircraft weight at or close to the maximum takeoff weight. Brake rupture can also lead to damage that can cause a brake fire due to hydraulic fluid coming into contact with hot parts.

This article describes carbon wear and oxidation phenomena. It recalls the maintenance procedures used to identify worn or oxidized brakes, flight crew procedures, and good practices to prevent brake wear and oxidation.

CASE STUDY

Event Description

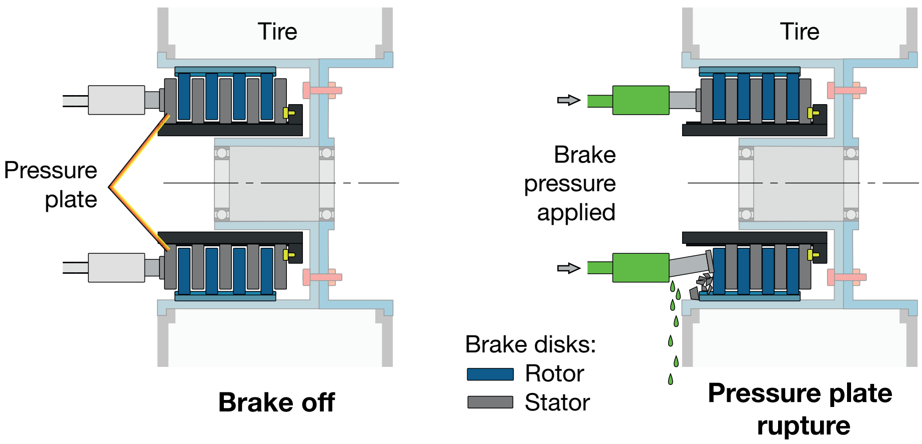
Shortly after landing, the flight crew of an A330 aircraft heard a strong and unusual noise during taxi-in. When the aircraft reached the parking stand, ground crew observed smoke coming from the area of the left Main Landing Gear (MLG) and informed the flight crew. The fire brigade arrived but did not see any fire. The flight crew noticed a 400 °C temperature on wheel no. 6. Maintenance personnel performed a quick inspection of the landing gear, which revealed that one of the brake pistons of wheel no. 6 had twisted and dislodged from its housing with evidence of a hydraulic fluid leak **(fig.1)**. There was no sign of fire on the landing gear structure and components.

(fig.1)
Picture of the damaged piston

Event Analysis

The investigation showed the most probable cause was a rupture of the brake pressure plate during brake application. The brake piston pushed through the pressure plate and came into contact with the first rotor **(fig.2)**. This applied a lateral force to the piston causing it to be dislodged from its housing and causing the hydraulic fluid leak. The hydraulic fluid that leaked onto the hot parts of the brake created the smoke. The pressure plate was found to be significantly oxidized, which was the reason it ruptured when the brake piston pressed against it.

(fig.2)
Rupture of the pressure plate during brake pressure application with damage to one of the brake pistons



BRAKE WEAR VS. BRAKE OXIDATION

Brakes are subject to two different phenomena: Wear and oxidation.

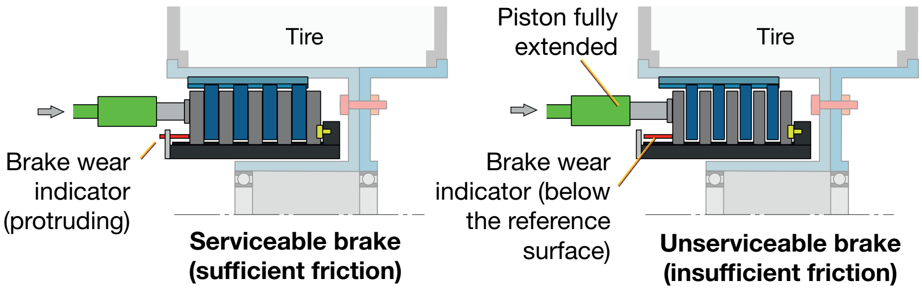
Brake wear

Brake wear is the progressive loss of width on the brake disks due to friction. Brake wear on carbon brakes depends on the number of brake applications and on the brake temperature. Each carbon brake type has its own temperature range for optimum operation and its temperature range for maximum wear. The temperature range varies from one brake manufacturer to another.

Guaranteed braking efficiency until the wear limit

Brakes are guaranteed to provide sufficient braking until the brake wear indicator is flushed with the reference surface. If the indicator is below the reference surface, the brake disks are too worn, and the braking performance can be significantly reduced. If the brake disks are too worn, their width is reduced. As a result, the pistons do not have enough extension to push the disks and create sufficient braking friction to slow down the aircraft **(fig.3)**. In addition, if the brake is too worn, the amount of heat sink mass that is available to absorb braking energy is reduced. In the event of a high speed RTO this can lead to increased risk of runway overrun or brake fire.

(fig.3)
Loss of braking performance due to brake wear



Brake oxidation

(fig.4)
Heavily oxidized brake disks

Carbon from the brakes naturally combines with oxygen from the ambient air to become carbon dioxide (CO_2). Under normal circumstances the oxidation occurs at a very slow rate. However the rate of oxidation can be accelerated by external factors such as high temperature and catalytic (chemical) pollution **(table 1)**. This results in a loss of carbon mass from the brake disks, carbon softening, and delamination. It can ultimately lead to brake rupture if an affected brake is not changed in due time **(fig.4)**. Carbon oxidation due to exposure to high temperatures is referred to as thermal oxidation. When carbon oxidation is due to the presence of catalysts, it is usually referred to as catalytic oxidation.

Thermal oxidation

Thermal oxidation is the main cause of accelerated degradation of carbon brakes. It can occur if high brake temperatures are reached after landing and during taxi. Thermal oxidation affects all brake disks, but the middle disks are most affected because they reach a higher temperature and take longer to cool down. Worn brakes tend to reach higher temperatures making them more prone to the effects of thermal oxidation.

Catalytic oxidation

Catalytic oxidation of the brakes is generally caused by contact with deicing or cleaning fluids. The potassium or sodium coming from some aircraft and runway deicing fluids acts as a catalyst and further accelerates the oxidation **(table 1)**. The presence of the catalyst also reduces the temperature at which significant oxidation occurs. When the potassium or sodium is absorbed by the carbon it remains within the material causing catalytic oxidation to continue well after the end of the winter season. The outer disks, including the pressure plate, are most exposed to external pollution and are usually more susceptible to catalytic oxidation.

Temperature	Time to lose 5 % mass = Time to lose 25 % strength	
	Thermal oxidation only	**Thermal + catalytic oxidation**
25 °C	7.5×10^8 years	3.6×10^8 years
400 °C	3 years	33 days
500 °C	14 days	15 hours
600 °C	12 days	45 minutes
700 °C	49 minutes	4 minutes

(table 1)
High temperatures and catalytic pollution significantly increase the oxidation rate of the brake carbon disks

Risks of brake rupture: loss of performance and potential brake fire

In addition to high maintenance costs, brake oxidation can lead to brake rupture and a loss of braking for the affected wheel. If maximum braking is necessary, such as in the case of a rejected takeoff at or close to the maximum takeoff weight, it may result in a runway overrun.

Brake rupture can also damage brake pistons and lead to leakage of hydraulic fluid. The fluid may vaporize and create smoke if it comes into contact with hot components. This could result in fire. The hydraulic fuses will limit the amount of hydraulic fluid lost and the fire should remain contained to the brake, but damage may be caused to nearby components. Maintenance personnel and flight crews both have a role to play to prevent brake rupture.

BRAKE MAINTENANCE

There are a number of ways to identify worn brakes and prevent brake rupture including visual checks, inspection, and taking precautions when using deicing or cleaning fluids.

Regularly check the brake wear indicator

The Maintenance Planning Document (MPD) requires a regular visual inspection of the brake wear indicator to assess the level of thickness loss of the brake disks **(table 2)**. The check must be done with the braking applied (parking brake ON or pedal pressed or BITE activated). If the brake wear indicator is flushed with the reference surface, the brake unit must be changed.

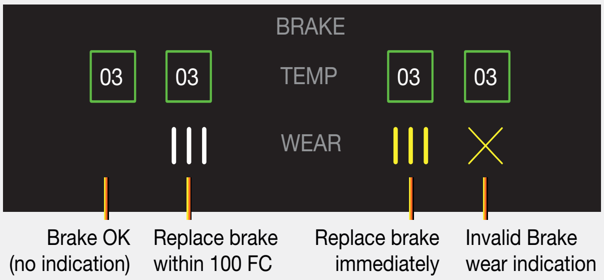
(table 2)
MPD interval for checking the brake wear indicator

A300/A310	A320 Family	A330/340	A350	A380
8 days	6 months or 100 flight cycles	42 flight cycles	10 days	7 days

A220 brake wear monitoring

Brake wear monitoring is done via the EICAS STATUS synoptic page **(fig.5)**. This page provides an indication of the status of the brake wear. When brakes are 100 % worn, three amber bars appear on the EICAS STATUS and a L_BRAKE FAIL or R_BRAKE FAIL caution message appears if the parking brake is applied. If this indication becomes inoperative, the MMEL requests a daily check of the mechanical brake wear indicator located on the brake assembly.

(fig.5)
Brake information on the A220 EICAS STATUS synoptic page



BEST PRACTICE

To estimate the remaining service time of a brake unit, an average wear rate of 1 mm (0.04 in.) for every 20 flight cycles can be used. This number of flight cycles is an average value and can be customized depending on the aircraft operations and aircraft type.

Inspect the brake

Visually inspect the brake assembly at every wheel removal, in accordance with the corresponding AMM/MP procedure, to check that there is no damage or crack on the disks and to check the condition of the brake components. Pay particular attention to any signs of oxidation marks, and if the oxidation is beyond acceptable limits, replace the brake **(fig.6)**.

(fig.6)
Examples of non-oxidized and oxidized brakes

No sign of oxidation

Oxidized stator 3

Highly oxidized brake

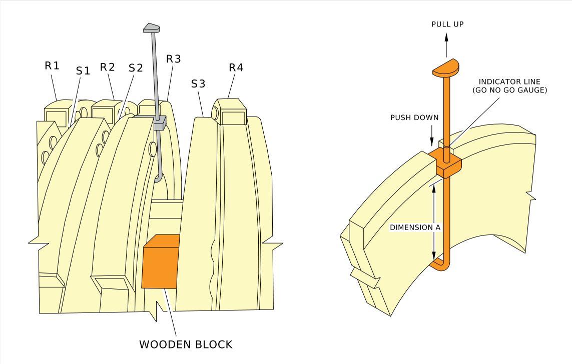
INFORMATION

Brake manufacturers provide training for maintenance personnel to better detect brake disk oxidation. Operators can contact their brake manufacturer for more information.

Optional AMM inspection for A320 aircraft

Some operators are more exposed to the risk of brake rupture due to their specific operations. Airbus proposes an optional brake inspection with the wheel removed. This inspection was developed together with brake manufacturers and can be added to the AMM procedure by request of the operator. Steps were added to the brake inspection procedure that require measuring the outer perimeter of the central stator (Safran Landing Systems and Messier-Goodrich brakes) **(fig.7)** or the radius of the friction surface (Collins Aerospace brakes) **(fig.8)**. The reduction of this measured value provides an additional indicator of brake oxidation

(fig.7)
Optional inspection to measure the perimeter of the central stator on Safran Landing Systems and Messier-Goodrich brakes



(fig.8)
Optional inspection to the radius of the friction surface on Collins brakes

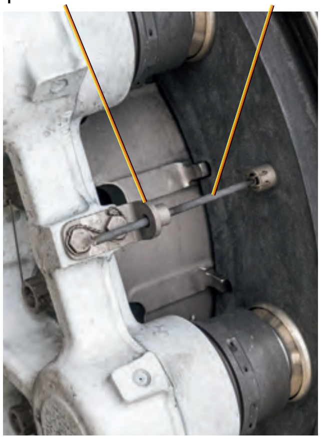
Report any brake damage/rupture

Airbus encourages operators to report any brake damage or rupture through the Tech Request tool using the **Brake Disk Failure Reporting Sheet** available in the AMM/MP procedure for brake inspection.

Precautions during Cleaning and Deicing

When cleaning the aircraft or performing deicing, particular care should be taken to prevent fluids coming into contact with the wheels and brakes. Always follow the AMM/MP/AMP procedures for cleaning and deicing and protect wheels and brakes to prevent them from becoming contaminated with chemicals that will accelerate oxidation.

(fig.9)
Brake wear indicator
of an A350-1000 aircraft



OPERATIONAL CONSIDERATIONS

The flight crew can detect worn brakes before the flight during the exterior walkaround. They can reduce wear and oxidation by using the brakes in an optimal manner during taxi and landing.

Brake wear indicator check on walkaround

A quick check of the brake wear indicator **(fig.9)** during the exterior walkaround will determine if the brakes are worn. If there are only a few millimeters remaining before the indicator is flush with the reference plate, inform maintenance personnel to anticipate and plan for a brake replacement before the wear limit is reached. On A220 aircraft, the flight crew can also check the brake wear status on the EICAS STATUS synoptic page.

Reducing brake use during taxi

Flight crews should reduce the number of brake applications during taxi to limit brake wear. The FCTM and A220 FCOM recommend that on long, straight taxiways, and with no ATC or other ground traffic constraints, the PF should allow the aircraft to accelerate to 30 kt of ground speed, and then use one smooth brake application to decelerate to 10 kt.

Keep thrust at idle

Maintaining idle thrust during taxi enables a reduced number of brake applications to keep the aircraft below the 30 kt maximum taxi speed.

Single engine taxi

Single engine taxi is a fuel saving initiative that also reduces brake wear, because it further reduces the idle thrust during taxi.

Reducing braking energy at landing

The number of thermal oxidation reports is increasing, especially on the A320 family fleet. This phenomenon may be linked with efforts by many operators to save fuel. It was observed that a majority of operators reporting high thermal oxidation were using CONF 3 and thrust reversers on IDLE at landing. There is a trade-off between fuel savings, engine maintenance costs, and increased brake replacement due to higher rates of oxidation. This will depend on the flight conditions, aircraft condition, and the operator's policy.

Use of Flaps FULL (or FLAP 5 on A220)

The use of flaps FULL (FLAP 5 on A220) at landing reduces the approach speed, and therefore, the aircraft energy to be absorbed by the brakes.

Use of autobrake or Brake-to-vacate (BTV) at landing

Use of autobrake or BTV (if installed) enables a single brake application with an optimized braking intensity. When autobrake is used and if conditions permit, the use of autobrake LOW reduces the heat of the brakes, and therefore, reduces the likelihood of oxidation.

Updated AUTOBRAKE LOW mode for A320 family aircraft

An updated autobrake LOW mode with a slightly increased deceleration rate (2 m/s^2 instead of 1.7 m/s^2) and a shorter delay for brake application (2 s instead of 4 s) was introduced on recent A320 aircraft. This updated LOW mode enables the use of the LOW mode on shorter runways and reduces the observed tendency of the flight crew to switch to manual braking due to a perception of late and low braking application. This updated autobrake mode is installed on A320 family aircraft delivered since Q2 2018 and can be retrofitted on earlier aircraft using a dedicated Service Bulletin (SB) **(table 3)**.

A319/320	A319neo/A320neo	A321	A321neo
SB 32-1464	SB 32-1465	SB 32-1476	SB 32-1477

(table 3)
Activation SBs for the updated autobrake LOW mode on A320 family aircraft

Timely thrust reduction during flare

A timely thrust reduction during the landing flare prevents extra thrust provided by the autothrust trying to maintain Vapp after the flare. The flight crew should retard the thrust levers at 20 ft (A320/A330/A340/A350/A380) or 30 ft (A220/A300/A310) as per the SOP, and at the latest, at landing gear touchdown to enable spoiler extension.

Use of thrust reversers at landing

The use of thrust reversers reduces the energy to be absorbed by the brakes. It is therefore a good option to use thrust reversers to limit brake oxidation, especially on short runways.

Use most appropriate runway exit

Taking over the autobrake to use full or strong manual braking to quickly slow down the aircraft in order to reach a specific runway exit may save some taxi time. However, this will also significantly increase brake wear. Using the next exit may slightly increase taxi time, but will also reduce brake wear and temperature.

Use of brake fans

The use of brake cooling fans, when available, reduces the exposure time of the brake units to high temperature after landing. This reduces the effects of carbon thermal oxidation.

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With thanks to Jimmy AVGOUSTIS from the A220 Flight Operations support, Frederic BOUCHER and Simon CAMERON from the Design Office and Laurent COUTURET from Customer Support.

Maximum available braking performance is necessary to prevent the risk of a runway overrun in an event such as a rejected takeoff with a fully loaded aircraft. Brakes need to be closely monitored to ensure that they do not have excessive wear or oxidation that will affect the braking performance of the aircraft or to ensure that they do not degrade to a condition that could cause a brake rupture.

The flight crew or maintenance personnel can quickly check brake wear during the exterior walkaround inspection by looking at the brake wear indicator pin on each brake unit. If the indicator is flush with the reference plate, or below it, the brake must be changed.

It is important to perform a careful visual inspection of the brake assembly at every wheel removal to check for signs of excessive oxidation. Operators should consider adding the optional inspection check developed with the brake manufacturers into their AMM/MP.

Flight crews can apply a number of recommended procedures and techniques to help reduce the rates of brake wear and oxidation. This includes reducing the number of brake applications during taxi, applying techniques that will reduce braking energy at landing, and using brake fans when available.

These operational and maintenance considerations will ensure that the brakes have a longer service life and are in a condition to create the necessary friction for optimal aircraft braking performance.

Use the Correct BARO Setting for Approach

Using an erroneous barometric reference setting during approach may cause the aircraft to fly lower than the published approach path, when the vertical guidance and trajectory deviations use the barometric reference. This can lead to a risk of controlled flight into terrain in poor visibility conditions or at night.

This article explains the potential consequences of an erroneous barometric reference. It also provides guidance to flight crews on how to detect it, and describes the available system enhancements to alert flight crews when an erroneous BARO reference is detected.

This article is also available on **safetyfirst.airbus.com** and on the Safety first app for iOS and Android devices.

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CASE STUDY

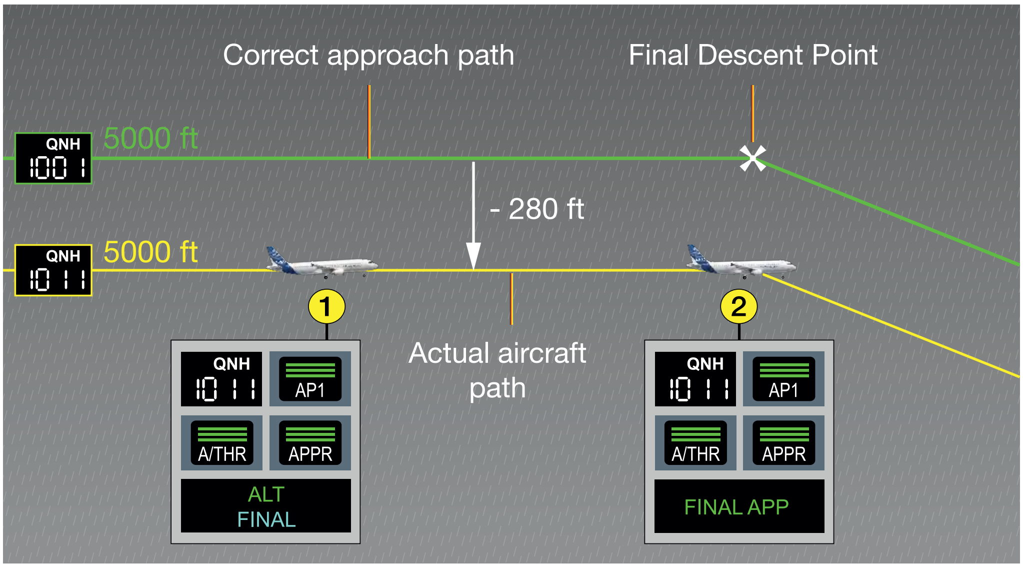
Event Description

The flight crew of an A320 was preparing for an RNP approach with LNAV/VNAV minima toward its destination airport, before initiating descent from their cruise Flight Level. The ATIS provided them with an airport QNH of 1001 hPa.

During the descent, ATC cleared the flight crew to descend to 6 000 ft QNH 1011 hPa, followed 2 minutes later by a clearance down to 5 000 ft QNH 1011 hPa. The flight crew acknowledged both clearances repeating the erroneous 1011 hPa QNH, which was 10 hPa above the current QNH of the airport.

1 The aircraft leveled off at 5 000 ft QNH 1011 hPa **(fig.1)**. This placed it approximately 280 ft below the intended altitude of 5 000 ft with a correct QNH of 1001 hPa. With autopilot and autothrust ON, the A320 reached its Final Descent Point and 2 commenced its final descent using FINAL APP guidance mode. The aircraft was flying with no visual reference and light turbulence through a rain shower.

(fig.1)
The aircraft commenced its approach 280 ft below the published approach



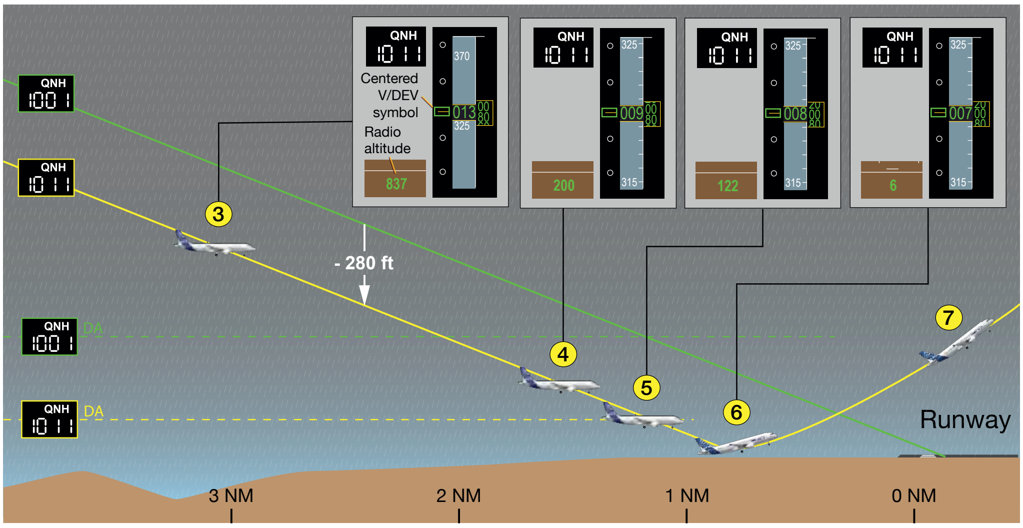
3 At 1 392 ft indicated altitude (1 000 ft above the airfield altitude), the aircraft was stabilized in CONF FULL at Vapp and the ND and PFD indicated that it was on its expected horizontal and vertical flight path **(fig.2)**.

4 ATC received a Minimum Safety Altitude Warning (MSAW) when the aircraft was 1.53 NM from the runway threshold and had an indicated altitude of 891 ft.

5 The aircraft passed an 802 ft indicated altitude, corresponding to the Decision Altitude (DA) of the published approach plus 50 ft as per the airline policy. ATC transmitted a warning to the flight crew stating that they had an MSAW and asked the flight crew to confirm they had the runway in sight. The PF initiated a go-around 6 seconds after crossing the DA, at 735 ft indicated altitude.

(fig.2)
After the initiation of the go-around, the aircraft descended as low as 6 ft radio altitude before climbing

6 The aircraft radio altitude indicated a descent to 6 ft during the go-around maneuver. 7 The flight crew announced the go-around seconds later and were vectored for a second approach.



The second approach was also performed using the erroneous 1011 QNH value. ATC received another MSAW alert and alerted the flight crew. The flight crew had established visual contact with the runway on this approach. They disconnected the autopilot at 572 ft RA, used the PAPI indication to correct their trajectory, and they performed a manual landing.

Event Analysis

During the final approach, the flight crew did not detect the erroneous vertical position because:

- The vertical deviation symbol was centered
- Altitude vs. distance checks were correct
- There was no Terrain Avoidance Warning System (TAWS) alert.

Several RA auto-callouts should have been triggered according to the aircraft configuration. However, the cockpit voice recorder data was deleted during subsequent flights, and was therefore not available to confirm if the auto-callouts were triggered or not.

The runway approach lights were not turned ON for their first approach attempt in poor weather conditions, which made it extremely difficult for the flight crew to visually detect the runway. The lights were switched to ON before the second approach, and the flight crew was able to see the runway and correct their trajectory.

EFFECTS OF AN ERRONEOUS BARO SETTING

An erroneous QNH/QFE value can seriously affect the safety of the flight as presented in the close call event described above.

Barometric altitude shift effect

From the altimetry basics, a 1 hPa difference in the QNH/QFE value creates a 28 ft shift of the barometric altitude displayed on the PFD.

Effect on final approach guidance modes

All final approach guidance modes that use the barometric reference are affected by an erroneous entry on the QNH selector.

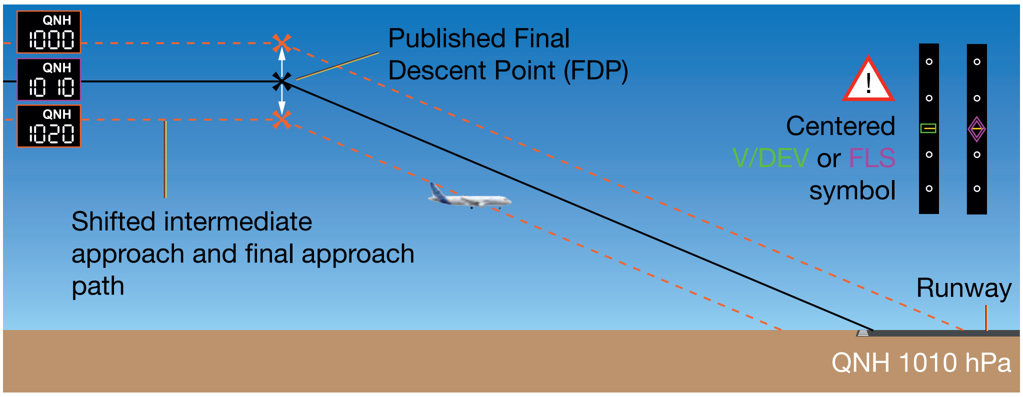
Affected vertical approach modes	A220	A300	A300-600/ A310	A320 Family	A330/ A340	A350	A380
Managed modes	VGP *	N/A	P.DES or P.APP	FINAL APP F-G/S		APP-DES F-G/S	DES F-G/S
Selected modes	FPA	V/PSD PITCH	V/S	FPA			

(*) Only when RNP is selected for VNAV.

Managed guidance

The FMS uses the aircraft barometric altitude to compute the deviation of the aircraft trajectory with the computed final descent path. If an erroneous barometric altitude is used, the aircraft will follow a flight path that is parallel to the published path but is shifted either above or below it **(fig.3)**. The vertical deviation symbol, or the FLS symbol, will indicate that the aircraft is on the correct flight path even if it is not the case.

(fig.3)
Example of the effects of an incorrect BARO setting on A320 family aircraft



Selected guidance

An erroneous barometric setting will also cause the FDP height above ground to be incorrect when using selected guidance. The flight crew is likely to commence final descent from an incorrect height above ground and therefore fly an approach path that is too high or too low.

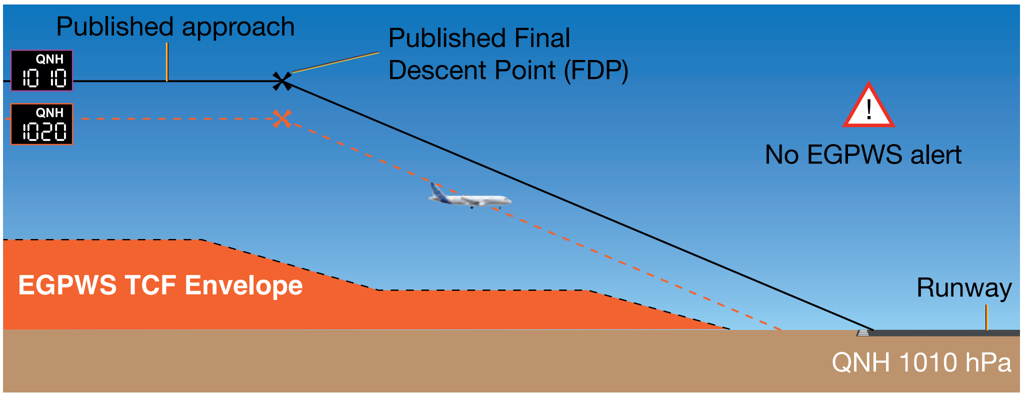
Effect on altitude-vs-distance checks

The flight crew will not detect an incorrect flight path with altitude-vs-distance checks if the barometric setting is erroneous. These checks use the displayed barometric altitude, which is based on the erroneous barometric setting. The effect is the flight crew will observe that they are at the expected altitude for each distance value, even if the aircraft is flying above or below the published flight path.

Potential absence of TAWS alert

Honeywell EGPWS

The relative proximity of the actual flight path to the published path prevents the TOO LOW TERRAIN EGPWS alert from triggering, because the path remains outside of the Terrain Clearance Floor (TCF) alert envelope **(fig.4)**.



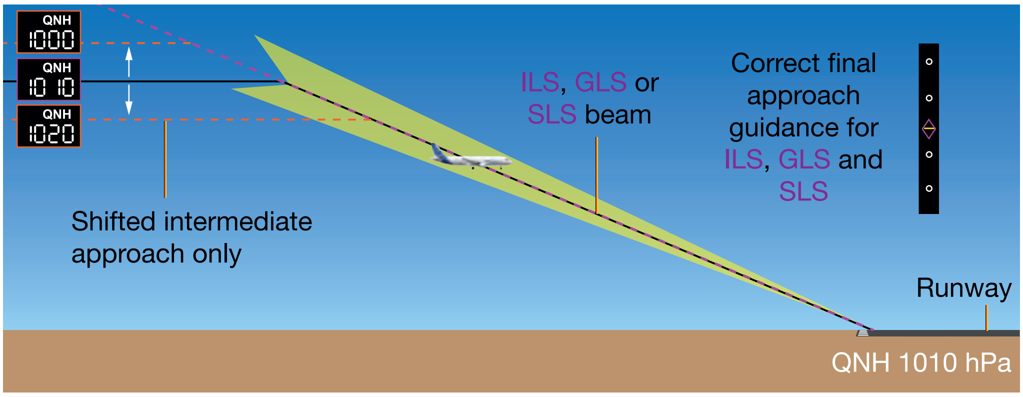
(fig.4)
The TAWS may not detect a too low flight path

ACSS T2CAS and T3CAS

The Premature Descent Alert (PDA) of the T2CAS and T3CAS may also not be triggered depending on the situation.

G/S vertical guidance mode is not affected

The final approach path of approaches using ILS, GLS, or SLS guidance are not affected, because the G/S guidance mode uses the ILS signal or a beam computed with an augmented GPS altitude. The final approach path will remain aligned with the correct ILS/GLS/SLS beam even if the intermediate approach segment shifts due to the erroneous barometric setting **(fig.5)**.



(fig.5)
The final descent path of ILS, GLS, and SLS modes is not affected by an erroneous barometric setting

OPERATIONAL CONSIDERATIONS

Flight crews have two opportunities to detect a barometric reference setting discrepancy. The first is during descent and the second is during final approach.

Crosscheck the barometric reference

During descent, when cleared to an altitude, the flight crew should pay attention to a barometric reference that significantly differs from the ATIS barometric reference used for the approach preparation. Such a difference could be a symptom of barometric reference error. In this case, the flight crew should confirm that they have the correct barometric reference from all available sources.

Unexpected low RA callouts in final approach

An abnormally decreasing RA audio callout while the barometric altitude is still high above airfield elevation is a clue that the aircraft may be too low on its final approach path. This can be due to a barometric reference discrepancy. However, RA callouts depend on the terrain profile and therefore may not be present if low terrain is located before the runway. ■

SYSTEM ENHANCEMENTS

ALTimeter Setting Monitoring (ALTSM) function

The ALTSM function, currently available on some Honeywell EGPWS standards, **compares the barometric altitude on the captain side with the GPS altitude.** If the difference exceeds a threshold, the EGPWS emits an “ALTIMETER SETTING” alert, and it is repeated if an incorrect barometric setting is still detected after some time.

Availability of the ALTSM function

A first step of the ALTSM function is already proposed on A320 and A330 aircraft equipped with Honeywell EGPWS standards P/N 965-1676-006, 69000942-151, and 69000942-251. It can be activated on the compatible computer standards via a Service Bulletin (SB). This first step prepares the introduction of the second step of the function that will add a flashing QNH/QFE value on the PFD in addition to the audio alert. It will also protect the QFE setting. This second step will be included in the Landing Surveillance package, to be incrementally certified from 2023 to 2024. It will be available on production aircraft and proposed for retrofit, for both EGPWS and T3CAS computers. More information on ALTSM and on the Landing Surveillance package is available at:

https://www.navblue.aero/product/landing-surveillance.

A similar function will be available in the next A350 surveillance computer standard that is planned to be available in 2027 on newly produced aircraft.

The following table provides an overview of ALTSM availability on Airbus aircraft:

Function	A220	A300-A310	A320 Family	A330/A340	A350	A380
ALTSM (Audio only)	Not available	Under consideration	Honeywell EGPWS only Activation SB	Honeywell EGPWS only Activation SB	Not available	Not available
ALTSM (Audio + visual indication)	Under consideration	Under consideration	2024 EGPWS and T3CAS	2024 (A330 only) EGPWS and T3CAS	2027 Similar function on new aircraft	Under consideration

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An undetected erroneous BARO setting can cause an aircraft to fly above or below the published final approach flight path when following approach guidance that uses a barometric reference. Vertical deviation indications are shown as correct, even if the aircraft is not on the correct flight path, with an incorrect BARO setting. Standard altitude-vs-distance checks will also wrongly confirm that an aircraft is on the correct trajectory, because it uses the same erroneous barometric reference. If visual conditions are not sufficient, the flight crew may not be able to detect that their aircraft is on an incorrect flight path in time to adjust their trajectory or perform a go-around.

Flight crew can detect a potential erroneous barometric reference by comparing the barometric reference provided by the ATC at the first altitude clearance during descent, with the value provided by the ATIS during descent preparation. If there is a significant discrepancy between the two values, the flight crew should crosscheck the barometric references with all available sources.

Depending on the terrain configuration, abnormally decreasing RA audio callouts while the barometric altitude is still high above airfield elevation might also help the flight crew to diagnose an issue with the barometric reference.

The ALTimeter Setting Monitoring (ALTSM) function is currently available on some TAWS computer standards. It compares the barometric altitude on the captain side with the GPS altitude and warns the flight crew if the difference exceeds a threshold. Airbus is working on an update of the ALTSM function that will be available for more TAWS computer standards and will provide a visual alert in addition to the current audio alert.

Proper Landing Gear Servicing for Safe Operations

Proper servicing of landing gear is obviously important to ensure proper landing gear operations during takeoff and landing. It is equally important to ensure proper retraction and extension to prevent potential interference with other aircraft systems in the case of abnormal landing gear conditions.

If the landing gear servicing tasks are not properly performed, issues can occur such as struts seized in a retracted position and strong vibrations that can affect the function of avionics equipment.

This article provides a description of best practices that maintenance crew can apply when performing the landing gear servicing tasks, with a focus on the shock absorber and the importance of regular lubrication.

CASE STUDY

Event Description

Ten minutes after takeoff, passing FL340, the flight crew of an A319 lost the autopilot (AP) and the autothrust (ATHR). The AUTO FLT AP OFF, AUTO FLT A/THR OFF and ENG THRUST LOCKED ECAM alerts were triggered. The Flight Directors (FDs) were no longer displayed on the PFD. The NAV FM/GPS POS DISAGREE ECAM alert was briefly triggered twice, but this was not seen by the flight crew. The flight crew managed to re-engage the AP and the ATHR 5 minutes later. The flight crew noticed abnormal IRS positions on the MCDU position monitor page. They decided to continue the flight with the support of ATC to assist them with determining their position.

During the ILS approach, the AP and ATHR disconnected again at 4000 ft. The flight crew discontinued the approach. They decided to perform a manual approach using only radio navigation aids and they safely landed the aircraft.

Event Analysis

Severe IRS drift

Recorder data analysis showed that the AP and ATHR disconnected due to severe drift of the 3 IRS. The first IRS was rejected by the Auto Flight System (AFS) during the climb and the AFS: ADIRU 1/2/3 DISAGREE PFR maintenance message was triggered with no operational impact. A discrepancy between the 2 remaining IRS in the following few minutes led to the rejection of both IRS and to the loss of the AP and ATHR. This triggered the AUTO FLT AP OFF and AUTO FLT A/THR OFF ECAM alerts. The IRS drift then decreased and remained stable during the flight, but it increased again during approach, causing the second loss of AP and ATHR.

Effects of the high vibrations

The IRS drift started during the takeoff roll. The analysis showed that the root cause was abnormal shocks and high vibrations transmitted to the 3 Air Data Inertial Reference Units (ADIRUs) by the Nose Landing Gear (NLG) during the takeoff roll. This forced the IRS to operate outside of its qualification envelope and it caused the IRS drift condition.

Effects of incorrect shock absorber servicing

The NLG shock absorber was overinflated during its last service. This made the shock absorber stiffer and reduced its ability to absorb impacts and vibrations. The vibrations experienced during this event were transmitted through the shock absorber to the aircraft structure. The A320 family aircraft ADIRUs are installed in the avionics bay aft of the NLG bay, and they were affected by the excessive vibrations and shocks during the takeoff roll on this flight.

INFORMATION

The "In flight severe IR drift with ADIRU inducing possible loss of AP/FD and ATHR" Technical Follow-Up (TFU 34.12.00.003) is available on **AirbusWorld**, which describes the root cause and the mitigation actions. It recommends performing the "Vibrations felt on the NLG during Takeoff and Lift-off phases" TroubleShooting Manual (TSM) task that focuses more on the NLG shock absorber servicing maintenance task than on the more usual wheels and tires inspections that are also part of this TSM task.

SHOCK ABSORBER SERVICING

Landing Gear shock absorbers on all Airbus aircraft are oleo-pneumatic shock absorbers, which means they use both oil (hydraulic fluid) and gas (nitrogen) to absorb and dissipate the shocks during taxi, takeoff, and landing. The Maintenance Planning Document (MPD) requires regular checks of nitrogen pressure and the quantity of hydraulic fluid in each shock absorber. The shock absorber servicing tasks must be performed if this is out of tolerance and the hydraulic fluid quantity or nitrogen pressure adjusted in accordance with the Airbus AMP/AMM/MP maintenance procedures.

INFORMATION

The In-Service Information (ISI) article 32.21.00002 is available on **AirbusWorld** and describes best practices and the challenges of the NLG shock absorber servicing for the A320 Family aircraft.

Incorrect shock absorber servicing can have serious consequences

The aim of the shock absorber servicing task is to ensure that the shock absorber has the correct gas pressure and quantity of hydraulic fluid to provide optimal shock absorption. Incorrect servicing of the shock absorber can have the following consequences:

- If the shock absorber is too stiff, the vibrations can propagate to the aircraft structure.
- If the shock absorber is too soft, the shocks can damage parts of the landing gear and the structure where the gear is attached to the airframe.
- The NLG wheels may rotate during the retraction or turn in the NLG bay, which will prevent deployment of the NLG.
- Faults and ECAM alerts, for example, L/G SHOCK ABSORBER FAULT, can be triggered during flight leading to operational situations, such as the loss of certain avionics functions or conditions requiring an in-flight turn back.

INFORMATION

A video of **A330/A340 NLG shock absorber servicing** is available to illustrate the different steps of the servicing procedure. This video is for information only. The Airbus AMM procedures always prevail.

Checking and Adjusting the Nitrogen Gas Pressure

Checking and adjusting the gas pressure in the shock absorber can be done with aircraft either on jacks or on wheels.

Waiting time before checking the pressure

It is important to wait for a minimum time period after the last operation of the aircraft to ensure that an accurate measure of the gas pressure in the shock absorber is taken. As an example, the recommendation for the A320 fleet is to wait for at least 2 hours after the last aircraft operation. There are two main reasons for this:

• Effect of the temperature

The pressure of the nitrogen will vary with the temperature of the shock absorber. During cruise, the landing gear bay is at a very low temperature. However, the fast compression of the shock absorber during landing followed by the multiple and quick landing gear movements on ground may quickly increase the temperature of the shock absorber and it will take time with the aircraft on the ground for the temperature to stabilize.

• Emulsion effect

The shock absorbers fitted on the Airbus fleet contain both gas and liquid in direct contact. During landing, an emulsion or mix of gas and fluid is created where the gas and fluid are in contact. This emulsion will affect the pressure level and the temperature of the shock absorber. It will take time with the aircraft stationary on the ground for the gas and oil to separate, and the temperature to stabilize before any check for correct hydraulic fluid levels and nitrogen gas pressure can be made.

Measuring the shock absorber extension and temperature

To assess the shock absorber charge pressure, it is necessary to measure the shock absorber extension (dimension ‘H’ refer **(fig.1)**) and the shock absorber temperature. The AMP/AMM/MP procedures provide tables and graphs that provide the correct value of the dimension ‘H’ relative to the temperature and the pressure. A placard with these graphs is also fitted on the landing gears as a quick reference during the task.

(fig.1)
Shock absorber extension (dimension ‘H’)

KEYPOINT

Use the shock absorber temperature, and not the ambient air temperature to know the correct charge pressure of the shock absorber. Using the wrong temperature value can significantly affect the servicing.

Adjusting the nitrogen quantity

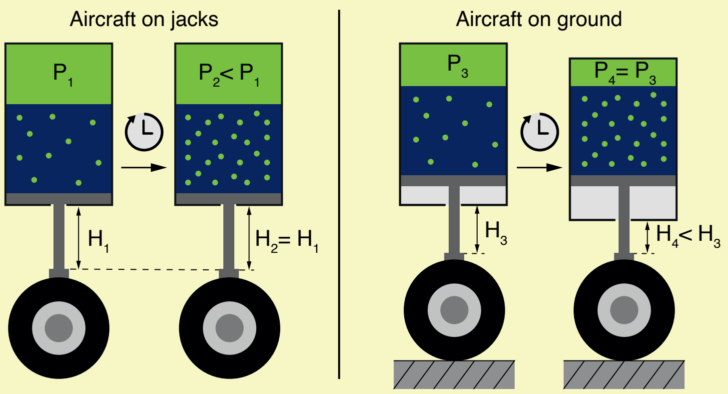
Depending on the pressure value, the quantity of nitrogen may need to be adjusted. On A220, A320, and A350 Family aircraft, the procedure intentionally overestimates the quantity of nitrogen. This is to take into account the dissolution of the nitrogen in the hydraulic fluid. That will lead to a decrease of the H dimension in the days following the nitrogen servicing until it stabilizes.

Gas Dissolution

When a gas is compressed, its molecules will more easily find their way through the fluid that it is in contact with. Gas molecules will pass from the gas chamber inside the fluid **(fig.2)**:

- When the shock absorber is fully extended, this will cause a decrease in the pressure of the gas
- When the aircraft is on the ground, this will decrease the H dimension.

The gas dissolution effect is more perceivable on A220, A320, and A350 aircraft.



(fig.2)
Effects of gas dissolution

The challenge of the “stiction”

“Stiction” is when the sliding cylinder in the shock absorber can “stick” due to the “friction” with the shock absorber housing when performing the servicing task with the weight-on-wheels. This can cause the “H” dimension to suddenly increase when the cylinder overcomes the “stiction” effect. This means that the H dimension may not slowly and continuously move during the nitrogen pressure adjustment task, which can cause the value of the H dimension to vary for a given pressure and can lead to incorrect servicing. To avoid this, it is preferable to perform this task with the aircraft on jacks when possible.

KEYPOINT

Due to the challenge of "stiction", it is recommended to perform this servicing task with aircraft on jacks to alleviate the loads acting on the landing gear. This will ensure accurate and efficient servicing of the shock absorber pressure.

NOTE

Before the introduction of the A350 aircraft, one pressure value at a given temperature was associated with a single 'H' value. Since the introduction of the A350 aircraft, a pressure value at a given temperature is now associated with a range (or min. and max. value) for the measurement of dimension 'H'. The objective is to avoid any risk of bottoming (mechanical contact due to underinflation) and the performance of unnecessary pressure adjustments. This is being implemented for all other Airbus aircraft.

Shock Absorber Hydraulic Fluid Replenishment

This procedure can either be done with aircraft on jacks or the aircraft weight on wheels with the exception of the NLG of A330/A340 aircraft and NLG/MLG of A350 aircraft, for which the procedure is only possible with aircraft on jacks. The check and adjustment of the hydraulic fluid level has a direct impact on the gas pressure, and therefore an adjustment of the nitrogen quantity is also necessary.

Waiting time before checking the fluid level

It is important to wait for a minimum time period after the last operation of the aircraft to ensure an accurate measure is taken of the fluid level in the shock absorber. As an example, the recommendation for the A320 fleet is to wait for at least 2 hours after the last aircraft operation. The reason for this is due to the "emulsion effect", as described above.

The shock absorber needs to be deflated to check the fluid level. If the task is performed too soon after the last aircraft operation, there will still be nitrogen gas emulsified in the hydraulic fluid of the shock absorber. Rapid depressurization will cause emulsion bubbles to be ejected, which may be an injury risk for the maintenance crew performing the task. This will also cause a loss of hydraulic fluid and hydraulic fluid replenishment will be necessary.

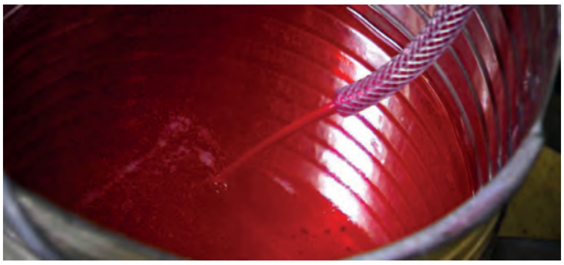
Deflate and compress

The shock absorber needs to be fully deflated to check the hydraulic fluid quantity. Opening the charging valve as slowly as possible will prevent too much fluid loss. After deflation is complete, the shock absorber will then be compressed to observe if hydraulic fluid is released from the charging valve. If no fluid is released, then the level is low and the hydraulic fluid level must be adjusted in accordance with the Airbus AMP/AMM/MP maintenance procedures.

Refill, compress and repeat

After refilling the shock absorber with hydraulic fluid, it is compressed to check the quantity. There is likely to be foam in the hydraulic fluid released from the shock absorber **(fig.3)**. More hydraulic fluid needs to be added and the shock absorber compressed again, repeating these steps until there is no more foam released **(fig.4)**. It is harder to inject hydraulic fluid into the shock absorber with the aircraft weight on wheels, and it is more likely to produce foam in the fluid, making the procedure more difficult to perform.

(fig.3)
Foam noticed while compressing the shock absorber. Hydraulic fluid needs to be added again.



(fig.4)
No foam noticed while compressing the shock absorber.

KEYPOINT

The best way to perform accurate full servicing (hydraulic fluid level and nitrogen gas pressure check) of the shock absorber is with the aircraft on jacks to ensure the optimum hydraulic fluid quantity and pressure.

Extract the nitrogen from the hydraulic fluid

After refilling the shock absorber, the nitrogen needs to be extracted from the mix of new hydraulic fluid with older fluid, which will contain dissolved nitrogen molecules due to the gas dissolution effect. This is done on A220, A320 Family, and A350 aircraft to ensure that the shock absorber is serviced with the correct nitrogen gas pressure. This can only be done with the aircraft on jacks. The pressure valve is slowly opened and the shock absorber is fully compressed. The pressure valve is then closed and the shock absorber can extend under its own weight. This creates a vacuum effect that will draw the nitrogen gas molecules out of the hydraulic fluid. This step can take several minutes depending on the size of the shock absorber (e.g. 30 minutes for A320 Family aircraft, 60 minutes for A220 aircraft, and 90 minutes for A350 aircraft).

Adjust the nitrogen quantity

The shock absorber is inflated with the necessary quantity of nitrogen mentioned in the procedure. For A220, A320 Family, and A350 aircraft, this quantity takes into account the nitrogen dissolution that will occur in the days after the servicing and the consequent decrease of the H dimension before it stabilizes.

Performing the procedure weight on wheels is possible with constraints

For the NLG/MLG of the A220 aircraft and for the NLG of the A320 Family aircraft, it is possible to perform the hydraulic replenishment procedure with weight on wheels. However, this will mean that extraction of the nitrogen from the hydraulic fluid step cannot be performed, and it will make it more difficult to define a precise pressure. Therefore, full servicing (hydraulic fluid and nitrogen gas) is required with aircraft on jacks in the following days on A220 aircraft. For A320 Family aircraft, the nitrogen quantity needs to be checked again, either with aircraft on jacks or with aircraft weight on wheels in both light and heavy load configurations.

Automatic Shock Absorber Servicing Solution:

The Liquid And Nitrogen Charging Equipment (LANCE) tool is being developed to provide Airbus Operators with a precise way to perform shock absorber servicing (for both NLG and MLG) with aircraft weight on wheels. The tool has a cart that automatically ensures that the hydraulic fluid level in the shock absorber is correct and replenished with the exact mass of nitrogen that is required based on the servicing temperature. This solution is currently for use on A320 Family and A350 aircraft and is being assessed to check its feasibility on other aircraft types.

LANDING GEAR LUBRICATION

Lubrication of landing gear at regular intervals protects the joints and moving parts from excessive wear and corrosion. The lubricating grease will attract and contain contaminants and particles. Regular replacement with new grease will remove the contaminated grease before the particles and contaminants trapped can cause abrasion or corrosion. This will prevent wear at the joints and moving parts that could lead to excessive vibrations or even failure to correctly extend or retract in operations.

KEYPOINT

Even during long periods of parking and storage, lubrication must be continuously performed according to the MPD to prevent any jamming of the landing gear during extension and retraction.

(fig.5)
Example of correct greasing

BEST PRACTICE

Depending on the environmental conditions in which the aircraft is operated such as a sandy environment, it may be necessary to lubricate the landing gear at more frequent intervals than specified in the MPD for contaminated grease to be regularly renewed. Refer to the recommendation to lubricate at a higher frequency in TFU 32.11.13.024.

Injecting the Right Quantity of Grease

The grease is injected through the "grease nipples", using an electrical or manual grease pump. Fresh grease must be seen coming out of the dedicated "witnesses" hole or from the part that is being lubricated **(fig.5)**.

For certain lubrication points, the fresh grease will not be visible coming out of the part. In that case, **the maintenance procedure specifies the number of injections** to be performed using only a manual grease pump. For greasers without witnesses, even if no fresh grease is visible after the specified number of grease injections, no additional injection needs to be performed as this may lead to deterioration of the part.

(fig.6)
MLG uplock hook malfunction due to excess of grease

Excess grease can cause malfunctions

On A320 aircraft, for example, the main landing gear uplock hook needs to be lubricated, but it has no "witness" for the maintenance crew to indicate that the correct quantity of grease was injected. Therefore, cases of excessive quantities of grease occurred, which led to the malfunction of the uplock hook and the triggering of the L/G NOT UPLOCKED ECAM alert for the flight crew with associated operational consequences.

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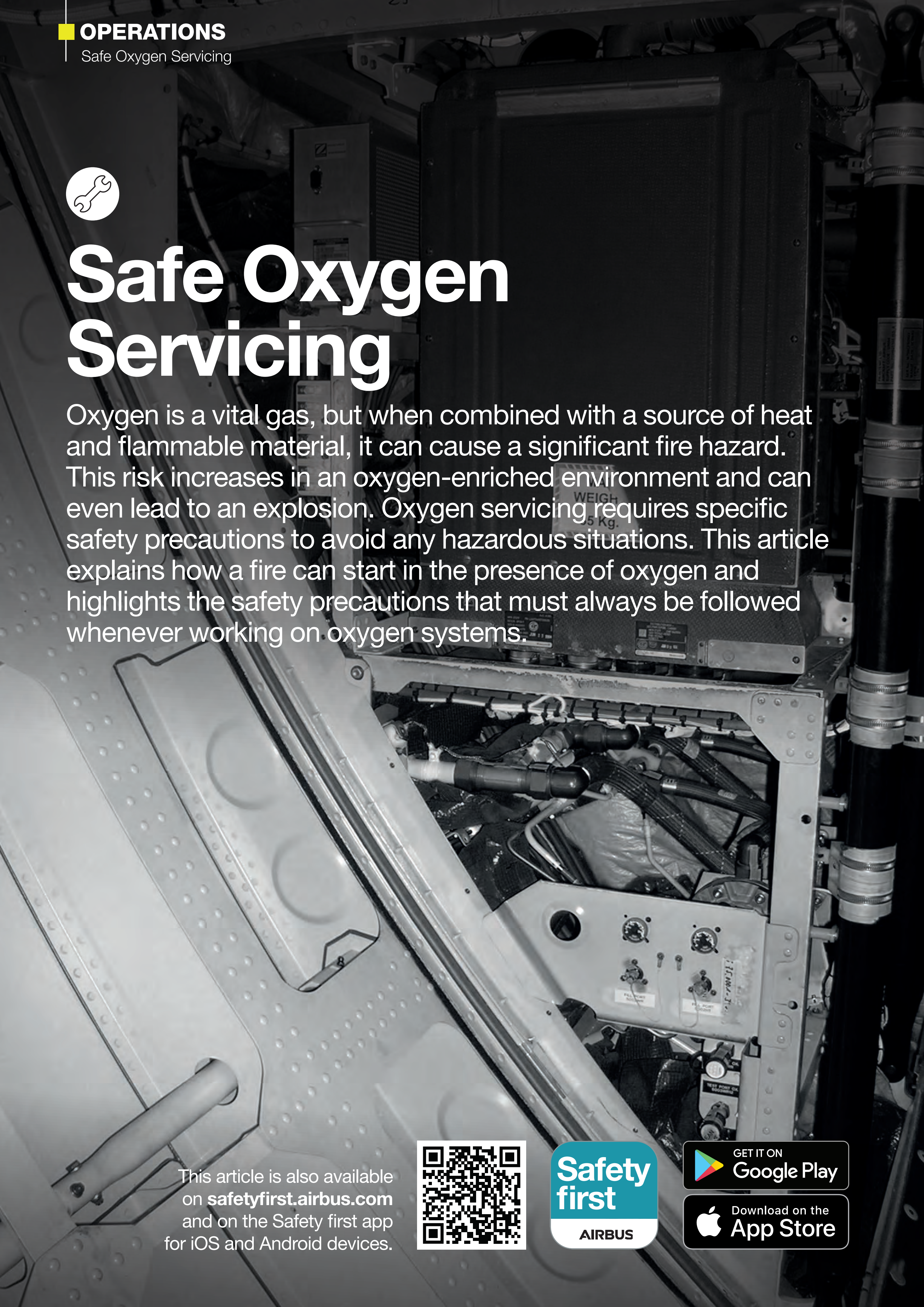
With thanks to Paula ARTEAGA URIBE from Ground Support Equipment

Landing gear servicing tasks include servicing of shock absorbers and lubrication of landing gears. To ensure optimal performance of the landing gear in operation, scheduled maintenance should be performed as defined in the MPD, and Airbus maintenance procedures and best practices should be applied.

Shock absorber servicing should ensure that it contains the correct nitrogen gas pressure and quantity of hydraulic fluid for the optimal absorption of the shocks during taxi, takeoff, and landing. Incorrect servicing can lead to a number of outcomes that may require more regular and costly maintenance, affect operational efficiency, and even have consequences on safety.

The shock absorber servicing procedure must be applied as described in the Airbus aircraft maintenance manuals. The best way to perform precise shock absorber servicing is with aircraft on jacks. Even if there is still the option to perform servicing with weight on wheels on some aircraft, it can be more difficult to charge the shock absorber with the correct nitrogen gas pressure when using this method. For example, it will be necessary to perform an additional check a few days after servicing the A320 NLG shock absorber with weight on wheels by putting the aircraft on jacks or performing a check with the aircraft in both light and heavy load configurations.

The landing gears must also be regularly lubricated to ensure they are functioning correctly. Too little or too much grease can lead to malfunction of the landing gear, which could have serious consequences.



Safe Oxygen Servicing

Oxygen is a vital gas, but when combined with a source of heat and flammable material, it can cause a significant fire hazard. This risk increases in an oxygen-enriched environment and can even lead to an explosion. Oxygen servicing requires specific safety precautions to avoid any hazardous situations. This article explains how a fire can start in the presence of oxygen and highlights the safety precautions that must always be followed whenever working on oxygen systems.

CASE STUDY

Event Description

During the daily check of an A319, the maintenance crew checked the DOOR/OXY system page and noticed that the flight crew oxygen pressure was 1 450 psi instead of 1 500 psi, as per the Operator's own requirement. They decided to perform an oxygen servicing task before the aircraft was dispatched.

During the servicing task, the Pressure Regulator Transmitter (PRT) between the oxygen servicing cart and the crew oxygen cylinder exploded and started a fire that propagated towards the oxygen cylinder. The fire at the PRT melted the inlet hose of the cylinder valve, which caused it to separate from the PRT. Pressurized oxygen gas rapidly discharged and injured a maintenance crew member's face, causing skin and eye irritation. The second maintenance crew member managed to shut off the oxygen supply at the oxygen servicing cart. Other around the aircraft who heard the explosion reacted by shutting off the discharging flight crew oxygen cylinder, cutting power to the aircraft, and calling the emergency services. The maintenance crew member only suffered minor injuries.

Event Analysis

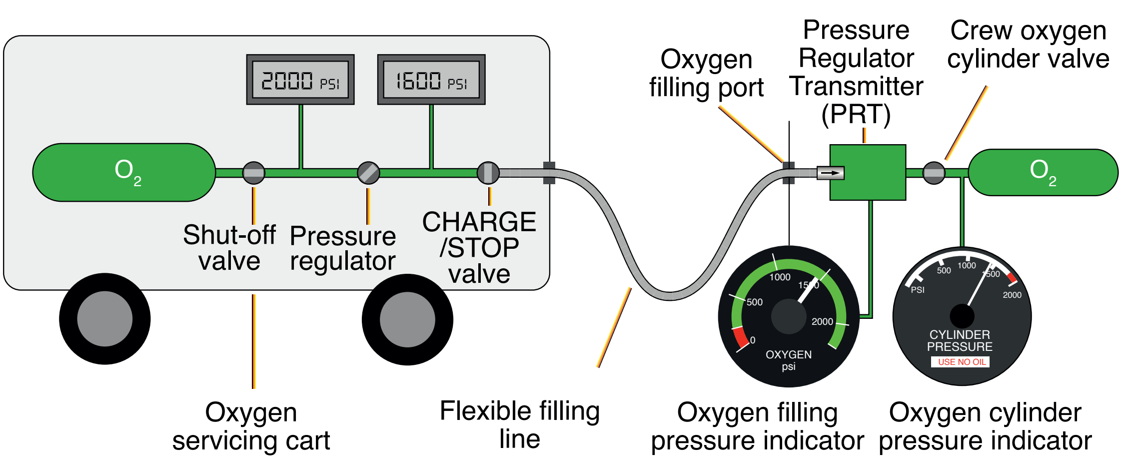
Investigation revealed that the most probable sequence of actions that led to the fire was the following:

The crew oxygen cylinder valve was open and the pressure inside the PRT was around 1 450 psi.

The maintenance crew opened the shut-off valve of the oxygen bottle on the servicing cart, which provided a pressure of 2 000 psi upstream of the cart pressure regulator.

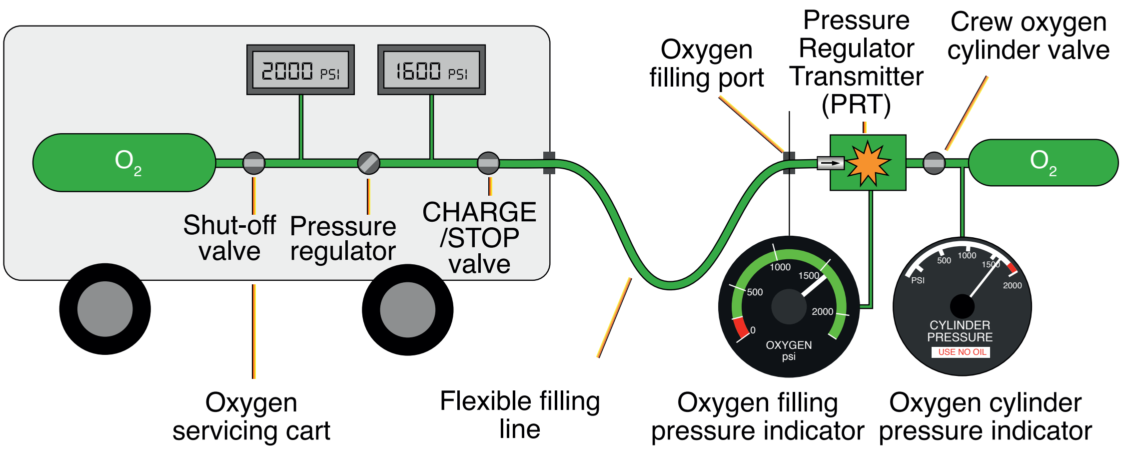
The cart regulator was then opened and set to a regulated pressure of 1 600 psi. At this stage, the flexible filling line was not pressurized, because the CHARGE/STOP valve was in a closed position **(fig.1)**.

(fig.1)
Initial setup of the oxygen servicing cart during the event



(fig.2)
The sudden pressure build-up in the filling line led to a rapid increase of the oxygen temperature to 800°C. It triggered the ignition of an O-ring inside the PRT and the fire propagated to the cylinder valve.

The maintenance crew then opened the CHARGE/STOP valve (set to the CHARGE position). This created a rapid pressurization inside the flexible filling line up to 1 600 psi, which caused the oxygen temperature to increase to approximately 800°C at the entry of the PRT. This phenomenon is called adiabatic compression. An O-ring located at the PRT inlet ignited at this temperature. The resulting fire propagated to the other PRT components and to the cylinder valve inlet, which separated from the PRT and released the oxygen from the cylinder **(fig.2)**.



Importance of following oxygen servicing instructions

The instructions for use of the servicing cart states that the CHARGE/STOP valve must be open before opening the cart pressure regulator. The risk of rapid pressurization was specifically mentioned and carefully following the instructions would have prevented the incident. When pressurizing an oxygen system or device, it is essential to always slowly open the valves and to control the slow pressurization of the system.

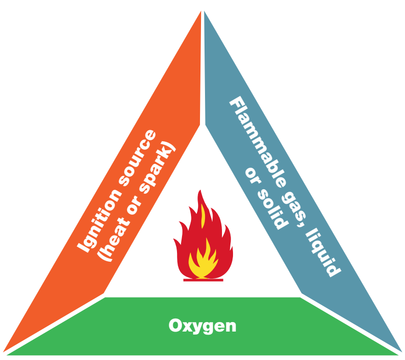
OXYGEN AND THE RISK OF FIRE

Oxygen is not a flammable gas but an excellent oxidizer, which is present at a concentration of approximately 21% in the ambient air. It is odorless, invisible, and difficult to detect.

When an oxidizer comes into contact with flammable materials in gas, liquid, or solid form, and if energy from a heat source or a spark is present, this starts a fire that burns until one of the three components of this fire triangle is removed **(fig.3)**.

Some flammable material such as grease or oil can self-ignite in a pure oxygen atmosphere, but only at fairly high temperatures above 200°C. In an oxygen-enriched environment, those same materials can self-ignite at much lower temperatures depending on the level of oxygen concentration present. In that case, the fire will be of higher intensity and temperature. Even without sparks or an ignition source, large fires and explosions can occur.

(fig.3)
The fire triangle



KEYPOINT

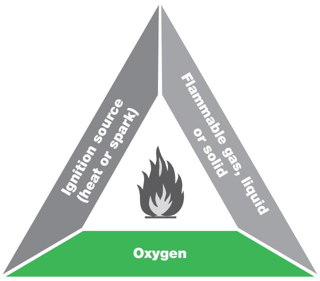
Even a small increase in the oxygen concentration level from 21% (standard air environment) to 24% can create a dangerous situation with rapid and explosive combustion.

SAFETY PRECAUTIONS DURING OXYGEN SERVICING

Oxygen cylinders need regular servicing and they can either be refilled or replaced. There are specific precautions to follow for these tasks. They can only be performed by qualified personnel who are trained to work on oxygen systems and aware of the associated risks, especially fire risks. Only approved tools, materials, and procedures should be used.

The general precautions to take are available in the Airbus AMM/MP/AMP maintenance procedures dealing with oxygen systems.

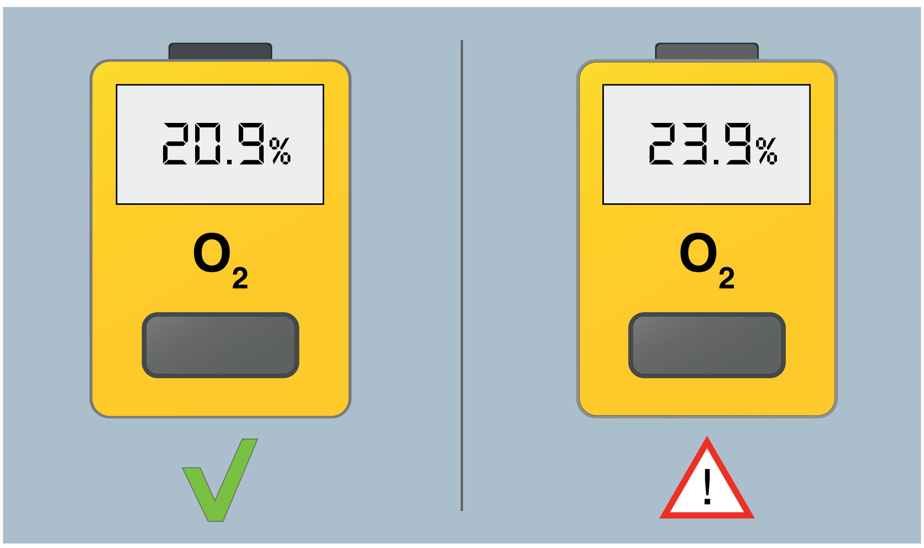
Prevent an oxygen enriched atmosphere



Use an oxygen detector and ventilate confined areas, when necessary

Any oxygen leak can create an oxygen-enriched environment, which could lead to dangerous situations especially when oxygen cylinders are placed in confined spaces. During flight, these areas are ventilated by the aircraft air conditioning system. However, when on the ground there is no ventilation. Therefore, maintenance crews should be aware of the oxygen level before entering those confined areas.

The use of an oxygen detector is recommended **(fig.4)**. If high levels of oxygen concentration is detected, the area must be ventilated before performing any maintenance actions.



(fig.4)
An oxygen detector enables a check of the oxygen concentration in a confined area before starting any maintenance task

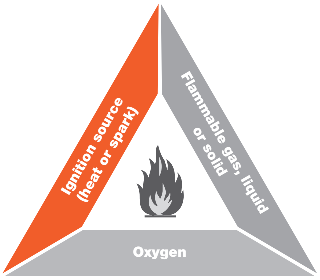
Follow maintenance procedures and instructions of use

To prevent any oxygen leak during servicing, it is crucial to follow the AMM/AMP/MP procedures. It is also crucial to follow the operating instructions for the oxygen servicing cart and the instructions of use for the filling port adapter provided by the ground equipment manufacturer.

Keep track of your oxygen servicing

It is recommended to keep track of the frequency of the oxygen servicing especially if it often occurs before the scheduled maintenance as this could indicate a leak in the oxygen system.

Prevent any ignition source



During oxygen servicing, all possible heat sources should be removed to avoid any fire risk.

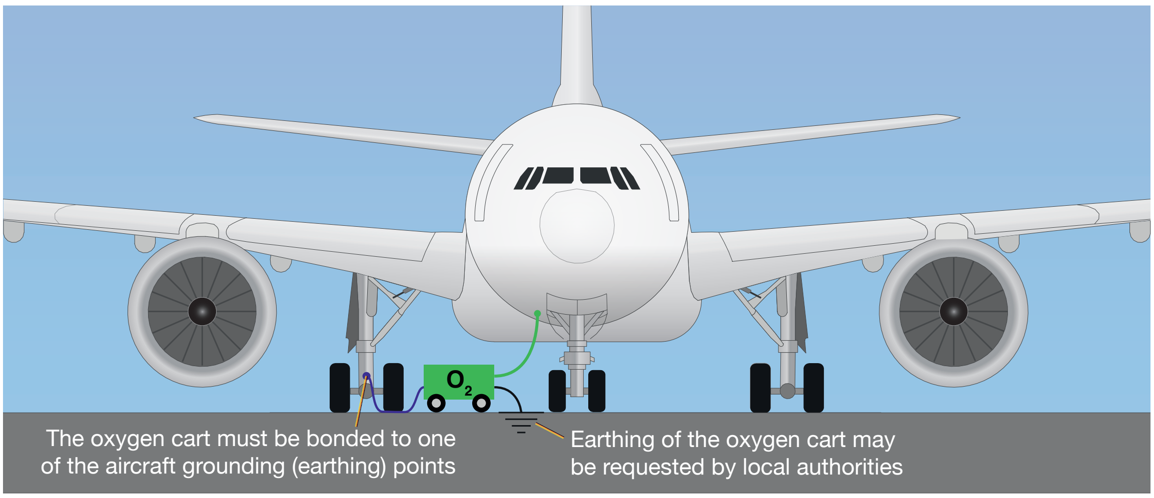
Prevent heat coming from sparks or flames

It is forbidden to smoke during oxygen servicing. Oxygen servicing must not be performed in the proximity of other maintenance activities that could create flames, heat, or sparks such as grinding or drilling.

Prevent heat coming from electrical discharge or electrical overheating

It is forbidden to use mobile phones during servicing and to perform oxygen servicing during thunderstorms. When refilling oxygen, it is mandatory to bond the aircraft to the oxygen servicing cart before connecting the refill valve **(fig.5)**. This will ensure electrical continuity between the aircraft and the oxygen servicing cart and prevent the likelihood of sparks due to a potential difference between the aircraft and the cart. Airbus AMM/MP/AMP maintenance procedures do not require grounding (earthing) of the aircraft or of the oxygen servicing cart, but local authority regulations may request this.

(fig.5)
Mandatory bonding during oxygen servicing operations using an oxygen cart



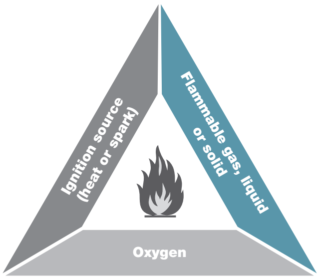
Prevent rapid oxygen pressure build-up

The event described earlier highlights the need to handle oxygen valves with care to prevent rapid oxygen pressure build-up and ignition of flammable materials. Also if dust or debris are present in the system, for example, due to contaminated tooling, a fast oxygen flow could create sparks as a result of particle impact.

Respect a safety zone

As an industry standard, a 5-meter safety zone must be maintained around the oxygen filling port during refilling.

Prevent presence of flammable gas, liquid or solid



Restrict other maintenance activities

Oxygen servicing must not be performed during refueling, cleaning, deicing, when working on fuel and hydraulics, or any systems using flammable materials. Oil, grease, lubricant, fuel, cleaning and deicing materials are flammable and can self-ignite in the presence of concentrated levels of oxygen.

Only use approved lubricant/cleaner

The maintenance crew should only use approved lubricant and cleaner products on oxygen system components.

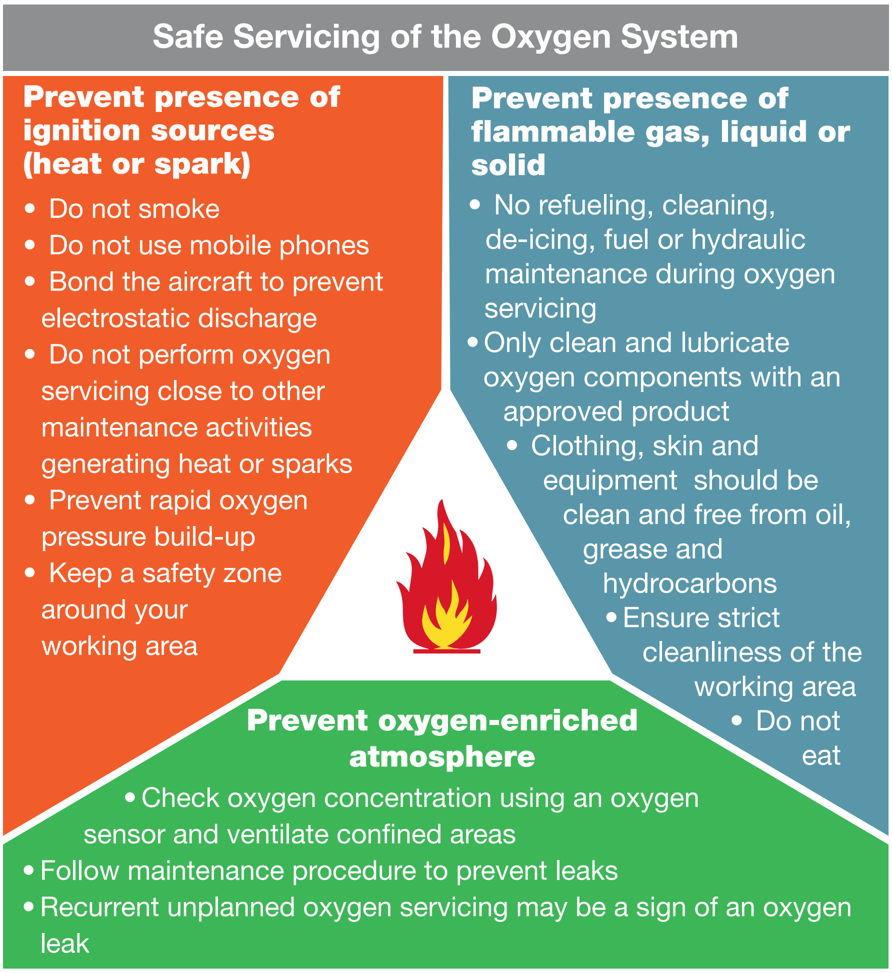
The importance of a clean work area, tools and servicing equipment

A clean work area, tools and servicing equipment should be ensured to prevent dust or debris entering into the oxygen system from the reception and storage of oxygen system components through to the final installation on the aircraft. Check that each person working on the oxygen systems, or performing oxygen servicing tasks, has clean hands, clean clothes, clean tools, and clean working areas. This will avoid oil or grease stains from coming into contact with oxygen gas. This will also avoid the presence of particles or other contaminants that could lead to a fire if combined with a heat source and oxygen.

KEYPOINT

In an oxygen-enriched environment, even a rag with grease on it used during previous maintenance tasks can lead to a fire. Therefore, the maintenance crew must always use clean equipment during servicing to prevent any risk of fire or combustion.

(fig.6)
Summary of the safety precautions for oxygen servicing



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Oxygen in the presence of a source of heat and flammable material can lead to significant fire events. Oxygen-enriched environments can create even more intense fires and explosions. When working on oxygen systems such as during oxygen servicing, specific safety precautions need to be followed to avoid these hazardous situations.

There are safety precautions to reduce the risk of an oxygen-enriched environment due to oxygen leaks. The use of an oxygen detector and the ventilation of confined areas is recommended.

Other safety precautions are intended to remove any source of heat coming from either flames or sparks, from electrical discharge or electrical overheating. It is the reason why it is mandatory to bond the aircraft to the oxygen filling cart when performing oxygen servicing. Grounding the aircraft may also be required by local authorities. In all cases, a safety zone around the filling port must be maintained.

It is essential to remove any flammable material near the oxygen systems during servicing. A clean work area, tools, and servicing equipment must be ensured. Performing maintenance tasks on systems with flammable materials such as fuel, hydraulic fluid, or deicing products must be avoided during servicing of oxygen systems.

Following Airbus maintenance procedures and all procedures and instructions for use provided by the manufacturers of all ground equipment and products used is essential to ensure safe oxygen servicing.