Safety first
The Airbus Safety magazine

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.

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

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

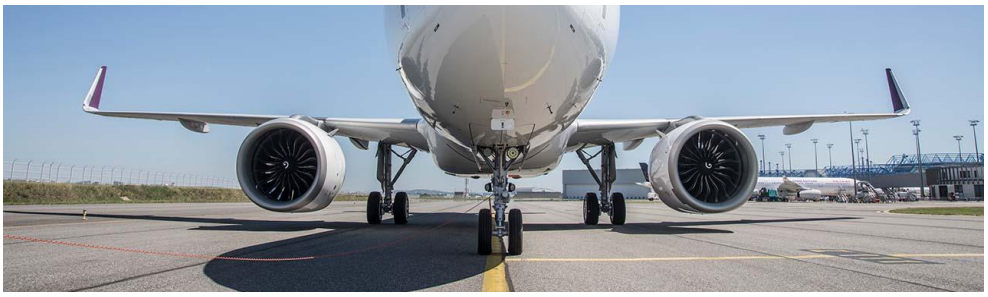
Recorder data analysis showed that the AP and ATHR disconnected due to severe drift of the 3 IRS. The first IRS was rejected by the Auto Flight System (AFS) during the climb and the AFS: ADIRU 1/2/3 DISAGREE PFR maintenance message was triggered with no operational impact. A discrepancy between the 2 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

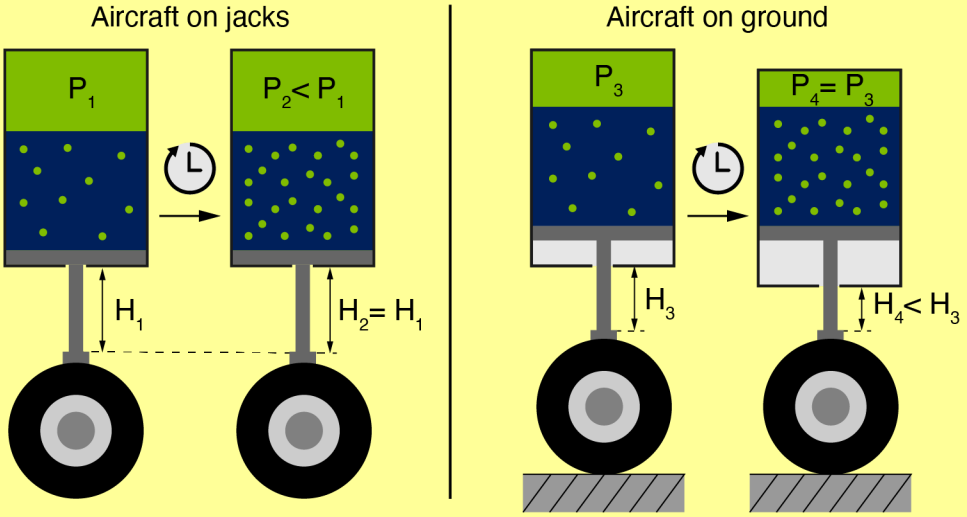
Depending on the pressure value, the quantity of nitrogen may need to be adjusted. On A220, A320, and A350 Family aircraft, the procedure intentionally overestimates the quantity of nitrogen. This is to take into account the dissolution of the nitrogen in the hydraulic fluid. That will lead to a decrease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

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)**.

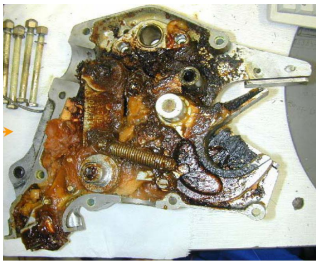
For certain lubrication points, the fresh grease will not be visible coming out of the part. In that case, **the maintenance procedure specifies the number of injections** to be performed using only a manual grease pump. For greasers without witnesses, even if no fresh grease is visible after the specified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

(fig.5) Example of correct greasing

injections, no additional injection needs to be performed as this may lead to deterioration of the part.

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.



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

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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.

Safety first, 2022. Safety first is published by Airbus S.A.S. 1, rond point Maurice Bellonte - 31707 Blagnac Cedex/France.

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20192534. Reference: X00D16031905.

Photos & illustrations by Airbus.

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The Airbus Safety magazine

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

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

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

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