

Landing with Nosewheels at 90 degrees



In the past few years, several events occurred involving landing with the Nose Landing Gear (NLG) wheels turned to 90° from the aircraft centerline.

The investigations identified the root causes, which were different for each event. Mitigating actions were developed and deployed accordingly.

This article describes the outcomes of investigations into several events of aircraft landing with NLG wheels at 90° and shows why they are not related. It also recalls the corrective actions and existing operational recommendations to prevent any recurrence.

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



CASE 1: NLG COMPONENT STRUCTURAL FAILURE

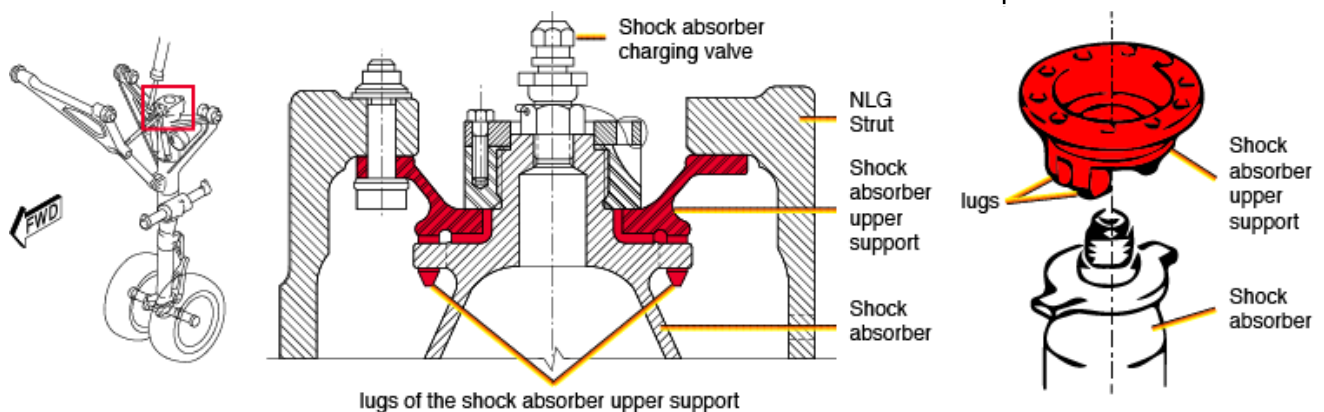
Event description

In 2005, during the takeoff of an A320 family aircraft, a few seconds after landing gear retraction was commanded, the **L/G SHOCK ABSORBER FAULT** ECAM alert was triggered followed by the **WHEEL N/W STRG FAULT** ECAM alert. As a result, the flight crew was not able to retract the Nose Landing Gear (NLG). They suspected an issue with the NLG, and so they performed a flyby allowing ATC to observe the situation of the NLG. ATC confirmed to the crew that the nosewheels of the aircraft were turned at 90°. The flight crew decided to divert to an airport with a longer runway. The aircraft remained airborne to use fuel before landing. The aircraft touched down on the runway and the flight crew delayed the nosewheel touchdown by not using ground spoilers, autobrake, or applying reverse thrust. The nosewheel tires burst shortly after touchdown and the wheels on the runway generated a lot of sparks. The aircraft remained on the runway centerline. After the aircraft stopped, the flight crew deemed that it was not necessary to perform an emergency evacuation and all passengers disembarked the aircraft using stairs.

Event analysis

There are two lugs on the upper support of the NLG shock absorber that prevent it from rotating freely in its housing (**fig.1**). The investigation showed that both lugs had sheared off and this caused the NLG to lose its centered position. This condition was immediately detected by the Landing Gear Control Interface Unit (LGCIU), which triggered the **L/G SHOCK ABSORBER FAULT** ECAM alert. The Braking & Steering Control Unit (BSCU) also detected the rotation and deactivated the Nose Wheel Steering (NWS) system. This triggered the **WHEEL N/W STRG FAULT** ECAM alert. The absence of nosewheel steering, combined with the broken anti-rotation lugs and the aerodynamic loads, enabled the NLG wheels to turn at 90° from the centerline.

It was discovered that the BSCU standard fitted to the aircraft at the time performed a greater number of steering movements during the preland checks compared to previous BSCU standards. This caused more fatigue to the 2 lugs on the upper support of the shock absorber. The internal pressure of the shock absorber was also found to be too high due to incorrect servicing during maintenance. This resulted in additional friction being applied to the NLG self-centering mechanical device, which is connected to the upper support, and eventually caused the 2 lugs to shear.



(fig.1) Position of the 2 lugs on the upper support of the NLG shock absorber

Prevention

New BSCU Standard

BSCU Standard L4.9B was developed with a reduced number of steering movements during the preland tests. The retrofit of this new standard is complete. The BSCU standard responsible for the lug failure is no longer in service.

The temporary solution published in OEB 175/176 is no longer applicable for any of the A320 family aircraft now that the BSCU retrofit campaign is complete.



KEYPOINT

In the case of **L/G SHOCK ABSORBER FAULT** and **WHEEL N/W STRG FAULT** ECAM alerts, no reset is authorized in flight on any A320 family aircraft.

Correct shock absorber servicing

Before this event, it was possible to perform servicing of the shock absorber with weight on wheels but it was difficult to service the correct pressure. This led to a tendency to overpressure the shock absorber and caused increased fatigue on its upper support. NLG shock absorber servicing procedures were improved following the event to allow for easier servicing with weight off wheels using jacks on the NLG. If the shock absorber can only be serviced with weight on wheels, then the servicing task must be done again, and with weight off wheels, within the next 7 days.

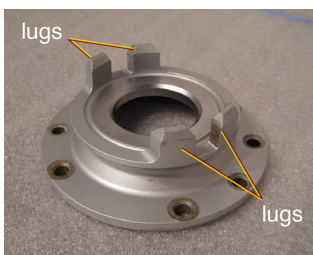


BEST PRACTICE

AMM procedures must be followed when servicing the NLG shock absorber. In particular, the jacks for the NLG should be used to ensure servicing the optimum pressure for the shock absorbers. This will minimize the risk of overpressure, which can cause structural fatigue of NLG components.

Reinforced upper support of the NLG shock absorber

Following another event that led to a landing with the NLG rotated to 90°, which had been caused by installation errors during maintenance, a new foolproof design of the NLG shock absorber was introduced (**fig.2**). This design prevents any lug rupture on the upper support of the shock absorber, and it is installed on all A320 family aircraft in production since 2004 and SB A320-32-1277 (Mod 34160) is available for retrofit.



(fig.2) Differences between the initial design and improved design for the reinforced upper support of the NLG shock absorber

CASE 2: BSCU FAILURE

Event description

In 2007, after the takeoff of an A320 family aircraft, the AUTOBRAKE MAX **ON** light remained on and the **BRAKES SYS 2 FAULT** ECAM alert was triggered.

During cruise, the flight crew pressed the AUTOBRAKE MAX pushbuttons. They also set the A/SKID & N/W STRG switch to OFF and back to ON, which was not requested in any ECAM/QRH/OEB procedure. This had no effect on the AUTOBRAKE MAX **ON** light.

On approach, the AUTOBRAKE MAX **ON** light remained on after the landing gear was extended and the **L/G SHOCK ABSORBER FAULT** ECAM alert was triggered. The flight crew set the A/SKID & N/W STRG switch to OFF and the AUTOBRAKE MAX **ON** light went off but the ECAM alerts remained.

The flight crew eventually landed the aircraft with the nosewheels turned at 90° to the centerline.

Event analysis

It was found that the nosewheels were able to rotate up to 90° because of a hardware failure on the BSCU. The BSCU remained active but it could not be controlled and its outputs became frozen. This caused the **BRAKES SYS 2 FAULT** ECAM alert and malfunction of the AUTOBRAKE MAX **ON** light.

Prevention

An updated design was introduced to improve the robustness of the BSCU and to allow a switch-over to the passive BSCU system when the outputs of the active BSCU system become frozen (i.e. switch from BSCU 1 to BSCU 2 or vice versa).

The retrofit of the updated BSCU standard was mandatory and is now complete. There are no reported events with a similar root cause after the affected BSCU standards were replaced. ■

CASE 3: COMBINATION OF INDEPENDENT FAILURES

Event description

In 2011, during cruise on an A320 family aircraft, the **NAV ILS 1 FAULT** ECAM alert was triggered followed by the **WHEEL N/W STRG FAULT** ECAM alert. The flight crew then observed that the Captain's PFD went blank for a few seconds.

On approach, the **L/G SHOCK ABSORBER FAULT** ECAM alert was triggered after extension of the landing gear. The flight crew suspected an NWS issue, so they performed a flyby for ATC to check the position of the NLG wheels. ATC confirmed that the wheels were turned 90° to the aircraft centreline. The flight crew landed the aircraft by delaying NLG touchdown as recommended in the A320 FCOM procedure, which is applicable when both the **L/G SHOCK ABSORBER FAULT** and **WHEEL N/W STRG FAULT** ECAM alerts are triggered. The aircraft safely came to a stop and the passengers disembarked using the stairs. There were no injuries and one nosewheel tire was damaged during the event.

Event analysis

When the landing gear was extended, no steering control was available because an electrical transient in the power supply to the BSCU 1 caused a loss of steering function. The **WHEEL N/W STRG FAULT** ECAM alert was triggered. The electrical power transient was due to arcing at a connector on IDG1. Power transients affecting BSCU 1 were already observed on several previous flights.

It was also found that a maintenance task on the NLG was not correctly carried out and this resulted in the hydraulic selector valve jammed in the open position. This would usually be detected in the preland test. However, the flight crew were not able to perform the test due to a fault in the landing gear lever position. This fault was present for several previous flights.

With the selector valve jammed open, there was hydraulic pressure on the nosewheels when the nose landing gear extended. The nosewheels began to turn due to the loss of the steering function. The **L/G SHOCK ABSORBER FAULT** ECAM alert was triggered because the nosewheels were not centered. BSCU System 1 switched to System 2, but the NWS system remained inactive as it detected that the nosewheels were not centered. The nosewheels continued to rotate to 90°.

Prevention

Fault classification

In the case of a fault of the landing gear lever position, the **BRAKES SYS 1(2) FAULT** ECAM alert is now triggered. This improvement is available from the BSCU Standard L4.10. It is installed on all A320 family aircraft in production since 2016 and SB A320-32-1432 is available for retrofit.

BSCU standard

Since the introduction of BSCU Standard L4.9B, the BSCU now centers the NLG wheels in case no preland tests are performed. The retrofit of this new standard is completed.

“Display Unit failure” QRH procedure

In this event, the power transient that affected the BSCU was not sufficient to switch to the BSCU 2 sooner, which would have prevented the NLG from turning to 90°.

If the PFD flickers with no **ELEC GEN 1(2) FAULT**, the flight crew should apply the “Display Unit Failure” QRH abnormal procedure. If the Captain’s PFD is affected, GEN 1 should be set to OFF, and if the First Officer’s PFD is affected, GEN 2 should be set to OFF. The application of this procedure forces the BSCU to switch from BSCU 1(2) to BSCU 2(1). ■

CASE 4: WATER INGRESS IN NLG STEERING SENSORS

Event description

In January 2021, during the approach of an A320 family aircraft, the **L/G SHOCK ABSORBER FAULT** and **WHEEL N/W STRG FAULT** ECAM alerts were triggered after extension of the landing gear. The flight crew set the A/SKID & N/W STRG switch to OFF and back to ON again even though it was not requested in any ECAM/QRH/OEB procedure. The flight crew landed the aircraft and delayed the NLG touchdown as long as possible, as recommended in the A320 FCOM procedure applicable when both the **L/G SHOCK ABSORBER FAULT** and **WHEEL N/W STRG FAULT** ECAM alerts are triggered.

After NLG touchdown, both NLG tires burst and the aircraft stopped on the runway. There were no injuries. The NLG wheels were turned to 90° from the aircraft centerline and skid marks of more than 1200 m long were found on the runway (**fig.3**).

Event analysis

During inspection of the NLG after the event, water was found in the two Rotary Variable Differential Transformers (RVDTs). These two sensors provide the angle of the NWS position to the BSCU. Three days before the event, the aircraft was cleaned during a maintenance C check. The water ingress in the RVDTs most probably happened at this time.

A ferry flight was performed after the C check and cleaning. Analysis of the recorder data showed that one RVDT was blocked during this flight. It is likely that this was due to the water in the RVDT freezing at altitude but was probably unblocked as the ice broke up upon landing. A steering offset resulted from this flight and remained for the next 7 flights.

The steering offset was at almost 2° during taxi-out on the flight when the event occurred. The flight crew kept the aircraft from veering off course and continued with the takeoff.

The **L/G SHOCK ABSORBER FAULT** and **WHEEL N/W STRG FAULT** ECAM alerts were triggered when the landing gear extended. The NWS was already at an angle that was too excessive to be corrected by the normal mechanical self-alignment of the wheels.

When the flight crew inappropriately cycled the A/SKID & N/W STRG switch, they reactivated the BSCU and hydraulic pressure was supplied to the steering actuator. During the preland test, the BSCU could not centre the nosewheels because of the faulty sensor and the angle of the NWS position was already too excessive. This resulted in the nosewheels rotating further toward 90° before landing.

Prevention

Compliance with the AMM/MP tasks for aircraft washing

AMM/MP tasks for NLG washing must be followed (12-21-11 "External Cleaning", which refers to AMM/MP 32-21-00 "Cleaning of the Nose Landing Gear"). These tasks clearly warn against the use of high-pressure hoses and provide details on protections to be used.



(fig.3) View of the NLG after landing



INFORMATION

For further information on aircraft washing, an OIT (ref. 999.0042/10) is available on the AirbusWorld portal and the [“Aircraft Protection during Washing and Painting”](#) Safety first article was published in January 2014, highlighting the importance of correctly applying the washing and painting procedures, including the washing of NLG.

Operations with a nosewheel steering offset

The “Operation with Nosewheel Steering Offset” A320 FCOM supplementary procedure states that the flight crew should not attempt to take off with an offset exceeding 1.5°. The nosewheel steering offset is determined based on the rudder trim input necessary to cancel the tendency for the aircraft to veer on taxi out.

No system resets when not authorized

The flight crew must only perform authorized reset procedures in flight. They are described in the System Reset table of the A320 QRH. If the flight crew performs a reset that is not listed in this table it could lead to unintended and serious incidents.



KEYPOINT

The flight crew must only attempt authorized resets as per the System Reset table in the A320 QRH/FCOM. Unauthorized resets can have dramatic consequences. More information about authorized system resets is available in the [“System Reset: Use with Caution”](#) Safety first article.

CASE 5: 180° TURN WITH NLG INOPERATIVE BEFORE TAKEOFF

Event description

In March 2021, an A320 family aircraft was dispatched with the NWS inoperative (MEL item **32-51-01 “Nose Wheel Steering Control System”**). This was due to a failure detected by the BSCU. The **WHEEL N/W STRG FAULT** ECAM alert was triggered during engine start as expected for the dispatch under the MEL.

The MEL operational procedure states that the flight crew must avoid sharp turns when the NWS is inoperative. Differential braking and asymmetric thrust were used to steer the aircraft during the taxi-out. The flight crew then performed a sharp 180° turn to align the aircraft on the runway contrary to the conditions of the MEL. After liftoff, the **L/G SHOCK ABSORBER FAULT** ECAM alert was triggered and the landing gear lever was jammed in the DOWN position. The flight crew performed an In-Flight Turn Back (IFTB) and landed the aircraft. The NLG had rotated to 90° and both NLG tires burst (**fig.4**).



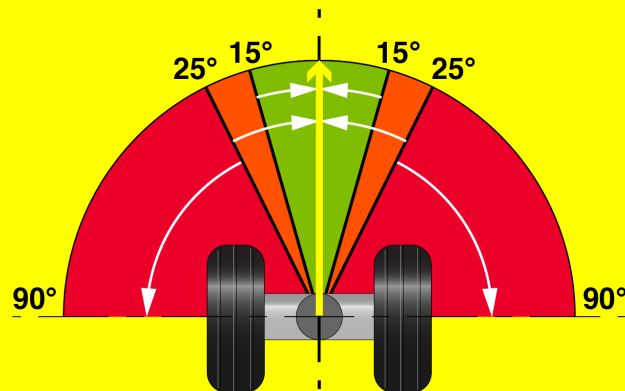
(fig.4) View of the NLG after landing

Event analysis

The NLG wheels were in free-to-castor mode **(fig.5)** because of the inoperative NWS.

Free-to-castor mode

In free-to-castor mode, the NLG wheels will return to 0° after up to 15° of steering due to the self-centering effect offered by the rake angle of the leg. Between 15° and 25°, the wheels will return to 0° but with more difficulty. If the NWS steering angle exceeds 25°, then NLG wheels will rotate toward 90°.

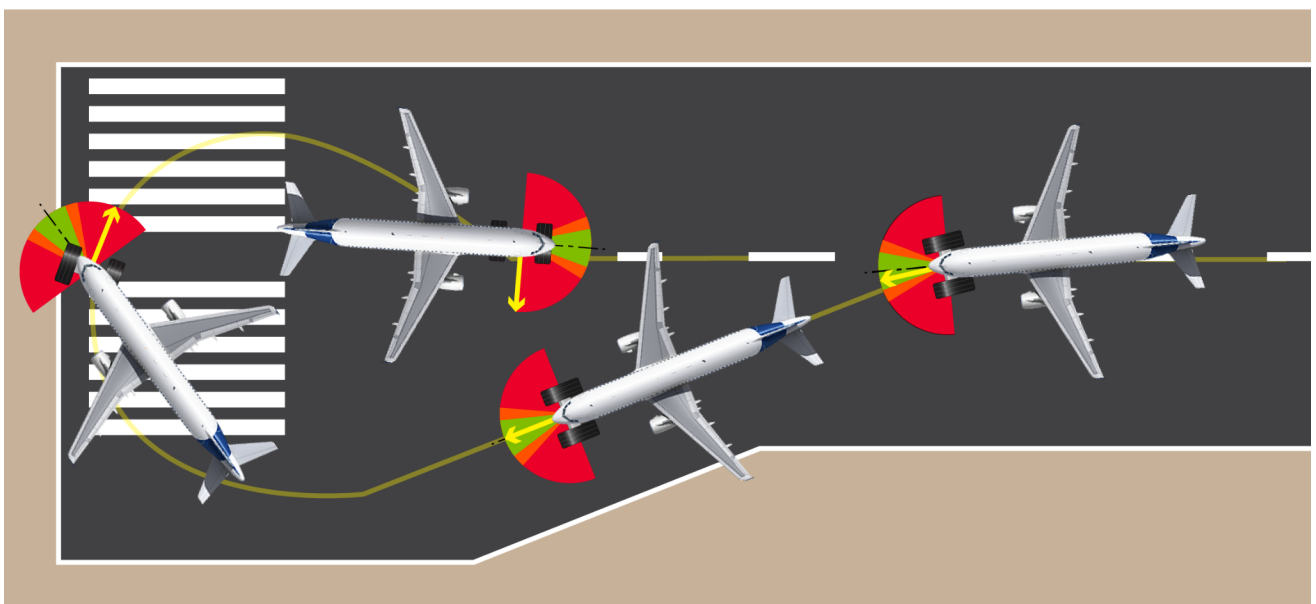


(fig.5) Ability of the NLG wheels to self-center when in free-to-castor mode

Analysis of recorder data showed the evolution of the NWS angle during the taxi-out, which resulted in a U-turn. The NLG wheels remained below 15° during the first left turn and naturally returned to the centered position. During the right turn, the angle of the wheels was more than 25°, which means they will continue rotation towards the 90° position at the end of the sharp 180° turn. The wheels remained in the 90° position during the takeoff roll and upon landing.

The **L/G SHOCK ABSORBER FAULT** ECAM alert was triggered at takeoff because the nosewheels were not centred at 0°. This prevented the flight crew from retracting the landing gear.

(fig.6) Illustration of the 180° turn performed during the event



Prevention

There were very few cases of dispatch with inoperative NWS on A320 family aircraft reported to Airbus over the last 15 years. Dispatching an aircraft with an inoperative NWS requires operational precautions that are explained in the associated operational procedure.

Even if the safety analysis shows that an acceptable level of safety is granted when dispatching the aircraft without an operative NWS system, the operational burden is significant. For that reason, and to avoid such an event occurring again, the Nose Wheel Steering Item 32-51-01 will be removed from the MMEL. It will no longer be possible to dispatch an aircraft with an inoperative NWS system. The updated Master MEL (MMEL) revision will be available in February 2022. An FOT will also be published to further explain the rationale for removing this MMEL item and to provide appropriate mitigation means in the case of inoperative NWS.

It is not possible to dispatch other Airbus aircraft types with an inoperative NLG due to design differences. The only exception is A300/A310 family aircraft. Based on in-service experience and the design of the A300/A310 NLG, the wheels are not likely to turn at 90°.

Operational considerations

The A320 FCOM mentions the possibility of having NLG wheels at 90° when both the **WHEEL N/W STRG FAULT** and **L/G SHOCK ABSORBER FAULT** ECAM alerts are triggered and recommends delaying the nosewheel touchdown at landing. ■

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The events in recent years where A320 family aircraft landed with their NLG wheels turned at 90° have different root causes and are not related. There were no serious injuries or fatalities and the damage caused to the nose gears on these aircraft was repairable.

Actions were taken to prevent recurrence of each event. Updated Brake System Control Unit (BSCU) standards were developed and retrofitted. Improved design for the upper support of the NLG shock absorber was deployed on the A320 family fleet.

Following the maintenance and operational procedures remains the strongest safety net to prevent such occurrence. Compliance with the AMM tasks is essential: for shock absorber servicing to avoid an overpressure condition or for aircraft washing to warn against the use of high-pressure hoses.

It is also important for flight crews to remember that they must only perform the authorized reset procedures in flight, which are described in the System Reset table of the A320 QRH/FCOM. If the flight crew performs a reset that is not listed in this table it could lead to unintended and serious incidents.

The latest action taken is to prevent the dispatch of an aircraft with the NWS system inoperative in order to avoid the risk of having the nosewheels at 90°.

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