

Take Care of the Wheel Tie Bolts



A significant number of missing wheel tie bolts have been reported to Airbus over the last 5 years. A few of these reports have described significant damage to the wheel or brakes.

Carefully checking the condition of the wheel tie bolts during aircraft walkarounds can allow detection of missing or damaged bolts and help to prevent serious incidents in service or during maintenance. Strictly observing the preventive maintenance practices, including planned inspection intervals, ensure that any damaged wheel tie bolts are replaced before they are at risk of failing.

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



ANALYSIS OF AN EVENT

Event Description

An A321 was in cruise when the **HYD G ENG 1 PUMP LO PR** and **HYD G RSVR LO LVL** ECAM alerts were triggered. The flight crew applied the FCOM procedures and switched off the PTU and green hydraulic pump on engine 1.

During the approach, the flight crew switched the green hydraulic pump on again (not requested by the FCOM procedure). The landing gear was extended. Landing and rollout were uneventful and performed with the green hydraulic system selected ON.

The flight crew stopped the aircraft before commencing the taxi-in to switch the green hydraulic system to OFF once again. They resumed the taxi, and finally parked the aircraft at the gate. The engines were selected to OFF and the parking brake was set to ON. The yellow hydraulic pressure started to decrease toward 0 PSI, which was indicating an issue with the yellow hydraulic circuit.

In the meantime, the ground personnel observed that the right main landing gear wheel was on fire and extinguished it using a fire extinguisher at the gate.

Event Analysis

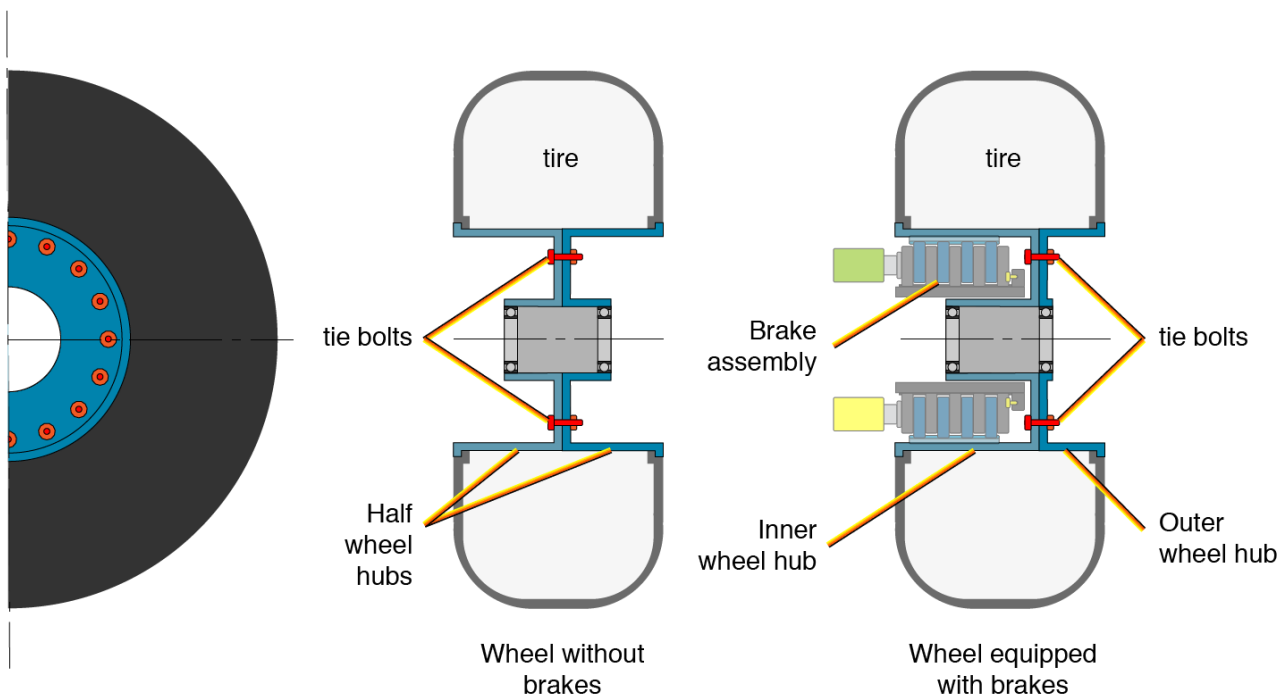
The investigation showed that the head of one of the tie bolts of wheel n°3 had sheared off and progressively migrated toward the brake, causing damage to the brake assembly during the previous flights. This damage eventually caused a leak from the green hydraulic system, which triggered the ECAM messages that indicated low hydraulic system pressure and low fluid levels during the flight. The leak from the yellow hydraulic system happened when the parking brake was set to ON at the gate, causing hydraulic fluid to be in contact with the hot brakes and resulting in the wheel fire. ■

THE CRITICALITY OF WHEEL TIE BOLTS

Ensuring the structural integrity of the wheel

Aircraft landing gear wheels (nose, main, body or wing landing gear) have a similar basic structure, regardless of the wheel manufacturer. Each wheel assembly consists of a tire fitted over two half hubs, which are fastened together by tie bolts. **(fig.1)**. For wheels fitted over brake assemblies, the inner hub of the wheel is designed to house the brake.

The tie bolts ensure the structural integrity of the wheel by sustaining the loads from the tire pressure, the aircraft weight, and the dynamic loads due to the impact of the landing gear during landing. Therefore, **wheel tie bolts should be considered as one of the critical components of the landing gear assembly.**



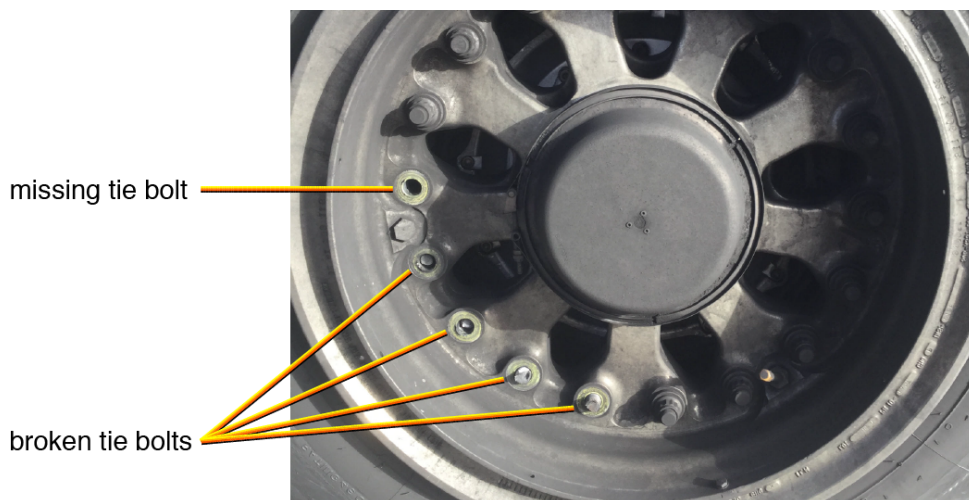
Consequences of a damaged tie bolt

A tie bolt may be damaged and its screw or nut may migrate from its location, potentially causing damage and safety risks.

A reduced structural resistance of the wheel

Any missing tie bolt will result in an increase in the loads on the remaining tie bolts. This can adversely affect their condition and it may reduce the structural integrity of the wheel if it is not replaced (**fig.2**). Damage to the wheel and the aircraft can occur with the associated risk of injury to ground personnel during ground operations.

(fig.1) Typical aircraft wheel structure



(fig.2) Example of tie bolts rupture leading to wheel deflation (picture send by an operator)

A risk of Parts Departing the Aircraft (PDA)

A damaged tie bolt that falls from a wheel can cause damage to the aircraft or injury to people on the ground. If the damaged tie bolt falls on the runway, there is a risk of damage to subsequent aircraft taking off or landing, and especially a risk of engine ingestion.

A risk of damage to the brakes and the aircraft

When a tie bolt is missing from a wheel that houses brakes, the tie bolt can migrate toward the brake, causing extensive damage and a risk of brake jamming. If the pistons of the brake are damaged, there is a risk of hydraulic fluid leak that may trigger a brake fire, as in the example described above.

A significant number of events related to damaged tie bolts

Airbus identified a significant number of reported events related to tie bolt loss in the last five years, although only a few of these events resulted in significant damage. Prevention is key to reducing this trend by early detection of any missing tie bolts in line operations or even by anticipating a tie bolt failure through regular wheel tie bolt inspections that are requested by the maintenance planning. ■

DETECTION OF MISSING/DAMAGED TIE BOLTS IN LINE OPERATIONS

There are numerous opportunities in the line of operations where maintenance personnel and flight crews can detect a missing or damaged tie bolt and prevent potential damage.

Inspection by maintenance personnel

A missing or damaged tie bolt or may be detected during the daily check or preflight walkaround (**fig.3**). If the tie bolt damage is located on the inner hub side of a wheel equipped with brakes, or if the wheel has a brake cooling fan assembly fitted to it, it is more difficult to see if the tie bolts are damaged.

Inspection by flight crews

As an additional safety net, the flight crew should check for the presence of all the tie bolts when checking the condition of the wheels and tires during the exterior walkaround.

Check of the wheel and brake condition if one bolt is found missing

As per the AMM/AMP/MP procedure, if one of the tie bolts is found missing, the wheel must be removed and visually inspected for damage as well as the brake assembly.



(fig.3) Example of missing tie bolt detected during a preflight walkaround (picture sent by an operator)

Depending on the wheel type and manufacturer, the MEL may permit dispatch with one tie bolt missing on a wheel for a limited number of flights. In this case, the condition of the wheel and brake must also be checked before dispatch as per MEL maintenance procedure. ■

DETECTION OF DAMAGED TIE BOLTS DURING WHEEL SHOP MAINTENANCE

Many tie bolt ruptures and losses can be avoided if the damaged tie bolt is detected during planned shop maintenance inspections.

Regular visual inspections

At each tire replacement, the tie bolts must be removed and visually inspected for any damage (refer to the CMM of the wheel manufacturer for the complete procedure).



KEYPOINT



Storage of the tie bolts after removal

The removed wheel tie bolts must not be put together in a box without suitable separation and protection before inspection and reinstallation.

When the bolts are removed from the wheel, they should be handled with care and placed into a box with dedicated compartments for each bolt to ensure that they are not in contact with each other. This prevents contact damage to the bolts.

Regular Non-Destructive Testing (NDT) inspections

Regular NDT inspections are planned to detect any structural damage on the bolt or any indications of fatigue or cracks and ensure that any damaged bolt is replaced before it fails. Inspection intervals vary for each wheel manufacturer and must be observed. These intervals may consider a maximum number of tire replacements on the wheel, or the number of flight cycles, or the maximum number of calendar days since the previous inspection. Often it is a combination of these and whichever occurs first. Refer to each wheel manufacturer CMM to determine the inspection intervals. In the case of an overload (e.g. Hard landing), some additional specific checks might be requested (refer to the CMM).



KEYPOINT

Traceability is key

Traceability is key to ensure that the wheel tie bolts are inspected at the required intervals using NDT inspection methods.

Tie bolts do not have a serial number. Therefore, it is the wheel serial number that must be used to ensure there is a record of the number of tire replacements, flight cycles, and the last recorded NDT inspection date.

The good practices listed below should be followed to ensure that the bolts are inspected at the required intervals:

- After a tire replacement, the same set of tie bolts removed from a wheel assembly should be reinstalled on the same wheel to ease traceability, and the number of tire replacements since the last NDT inspection should be recorded
- When reinstalling the same set of wheel tie bolts onto a wheel assembly it is important to make sure that the tie bolts have not exceeded the number of allowable flight cycles, tire replacements, or calendar days passed since the last NDT inspection date, in accordance with the wheel assembly CMM
- If a wheel tie bolt is removed from a set, the replacement bolt must be a new bolt or a substitute bolt, but only if this bolt was inspected using NDT as per the CMM
- If a new set of tie bolts is installed on a wheel, the maintenance record of the wheel must be updated to indicate this accordingly
- Any tie bolt installed on the wheel must be the same part number specified by the wheel assembly CMM.

Observe the correct torque value

Correctly torquing and greasing the wheel tie bolts is important to ensure the overall structural integrity of the wheel assembly and to prevent damaging the bolts. The correct tightening torque value to apply for the wheel tie bolts is specified in the CMM and must be observed when assembling the wheel. ■



NOTE

To improve the protection of wheels and brakes during parking and storage of aircraft, the recommendations provided in the AMM/MP/AMP procedure for parking/storage of aircraft should be applied.

Contributors:

Xavier BARRIOLA

Accident/Incident
Investigator
Product Safety

**Cesar GARCIA
CASTILLA**

Product Safety
Enhancement
Product Safety

**Arturo MARTINEZ
GRACIDA**

Aircraft Operability
Design Office

**Marina MESTRE
HERRERA**

Braking & Steering
System Engineer
Customer Support

Wheel tie bolts should be considered as a key component of the aircraft landing gear because they ensure the structural integrity of the wheels. The wheel assembly must sustain significant loads and any damaged bolt could shear under stress and reduce the capability of the wheel to resist these loads. This could have the potential to cause injury to personnel on the ground or be a risk of wheel failure on taxi, take off or most likely upon landing. A sheared wheel tie can migrate toward the brake assembly and cause damage that may lead to hydraulic system leak, resulting in loss of brake pressure, and possibly brake fire.

Early detection by maintenance and flight crew who can check for any damaged or missing tie bolts during the preflight exterior walkaround can help to prevent this.

Preventive maintenance allows for early detection of any damaged bolt by regular visual and NDT inspection. Careful traceability of the bolts installed on each wheel assembly will help to ensure that the required NDT inspection intervals are observed. This will enable an early detection of any indication of structural fatigue on the wheel tie bolts so that they may be replaced before there is a risk that they shear in service.

Safety first, 2021. Safety first is published by Airbus S.A.S. 1, rond point Maurice Bellonte - 31707 Blagnac Cedex/France.

Editor: Yannick Malinge, Chief Product Safety Officer.

Editorial team: Guillaume Estragnat, Vanessa Sadi, Gwyneth Duggan, Tim Roach.

20192534. Reference: X00D16031905.

Photos by Airbus, except where mentioned..

© **Airbus S.A.S. 2021 – All rights reserved. Proprietary documents.**

By taking delivery of this Brochure (hereafter "Brochure"), you accept on behalf of your company to comply with the following guidelines:

- No other intellectual property rights are granted by the delivery of this Brochure than the right to read it, for the sole purpose of information.
- This Brochure and its content shall not be modified and its illustrations and photos shall not be reproduced without prior written consent of Airbus.
- This Brochure and the materials it contains shall not, in whole or in part, be sold, rented, or licensed to any third party subject to payment.

This Brochure contains sensitive information that is correct at the time of going to press.

This information involves a number of factors that could change over time, effecting the true public representation. Airbus assumes no obligation to update any information contained in this document or with respect to the information described herein.

Airbus S.A.S. shall assume no liability for any damage in connection with the use of this Brochure and of the materials it contains, even if Airbus S.A.S. has been advised of the likelihood of such damage.

Safety first

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 flight tests. Material is also obtained from sources within the airline industry, studies and reports from government agencies and other aviation sources.

All articles in Safety first are presented for information only and are not intended to replace ICAO guidelines, standards or recommended practices, operator-mandated requirements or technical orders. The contents do not supersede any requirements mandated by the State of Registry of the Operator's aircraft or supersede or amend any Airbus type-specific AFM, AMM, FCOM, MMEL documentation or any other approved documentation.

Articles may be reprinted without permission, except where copyright source is indicated, but with acknowledgement to Airbus. Where Airbus is not the author, the contents of the article do not necessarily reflect the views of Airbus, nor do they indicate Company policy.

Contributions, comments and feedback are welcome. Enquiries related to this publication should be addressed to:

Airbus - Product Safety department (W)

1, rond point Maurice Bellonte
31707 Blagnac Cedex - France
safetycommunication@airbus.com

Visit us at safetyfirst.airbus.com or install the Safety first app:

