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pour la sécurité de l'aviation civile

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REPORT
ACCIDENT

Lateral runway excursion during landing roll, nose landing gear collapse

Aircraft	Airbus A300-B4 registered EI-EAC
Date and time	16 November 2012 at 4 h 25 UTC[1]
Operator	Air Contractors
Place	Bratislava Airport (Slovakia)
Type of flight	International public cargo transport
Persons on board	Captain (PF) ; Copilot (PNF) ; Flight Engineer
Consequences and damage	Aeroplane severely damaged

[1]Except where otherwise stated, the times shown in this report are expressed in Universal Time Coordinated (UTC). One hour should be added to obtain the legal time applicable in metropolitan France on the day of the accident.

This is a courtesy translation by the BEA of the Final Report on the Safety Investigation. As accurate as the translation may be, the original text in French is the work or reference.

1 – HISTORY OF FLIGHT

Note: the following information is based on the data recorded on the FDR and the CVR, as well as on interviews with the crew.

The crew took off from Leipzig Airport (Germany) at 3 h 38 bound for Bratislava Airport (Slovakia). The approximately forty-five minutes flight took place without incident and the crew was cleared for the ILS approach to runway 22. The Captain was PF. During the descent, the controller informed the crew that the wind was from 120° at 7 kt. The crew selected the slats and flaps at 25°. The antiskid and the autobrake were armed in MED mode. The ILS 22 approach was stable until the wheels touched down.

The main landing gear touched the runway about 700 m from the threshold of runway 22. The crew deployed the thrust reversers. About six seconds after the nose gear touched, the crew felt strong vibrations that increased as the speed dropped. At 85 kt, the thrust reversers were retracted. The aeroplane veered towards the left. The PF explained that he applied energetic braking and tried in vain to counter the rocking by using the rudder pedals then the nose gear steering control. He added that the sequence occurred so quickly that he did not think to use differential braking[2] to try to keep the aeroplane on the runway.

[2]Crew inputs on the rudder/brake pedals are not recorded on the FDR.

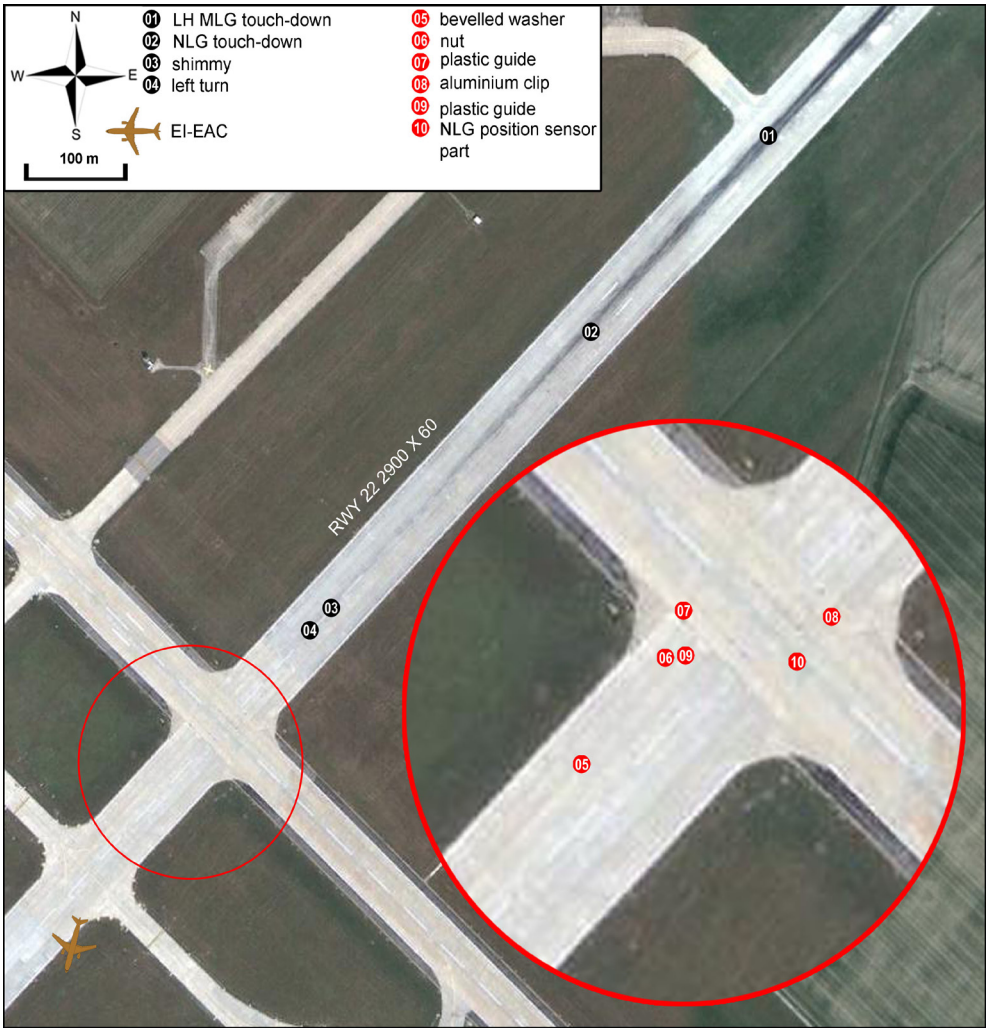
The aeroplane exited the runway to the left at a speed of about 45 kt. Its nose gear struck a concrete inspection pit and collapsed. The aeroplane skidded for a few dozen metres before coming to a stop. The crew evacuated the aeroplane. Between the start of the vibrations and the aeroplane stopping, it had rolled about 400 metres.

2 – ADDITIONAL INFORMATION

2.1 Observations at the accident site

On the runway, a continuous line of rubber from the nose gear tyres was observed. It began on the runway centreline (point 04 on the illustration below) then veered towards the left as far as the edge of the runway. On the last part of the path, another tyre mark from the left rear tyre (tyre n°5) on the left main landing gear was also observed.

On the runway, parts of the nose gear were found at the beginning of the marks made by the nose gear tyres. Among them was the shock strut apex pin (see list of parts referenced in red on the illustration below).



2.2 Description of the nose gear steering control system

Control of the nose gear steering system is ensured by the assembly of the two shock strut arms. The upper arm, moved hydraulically by pilot inputs on the steering control wheel drives, via this hinge, the movement of the linked lower arm bogie torque link.

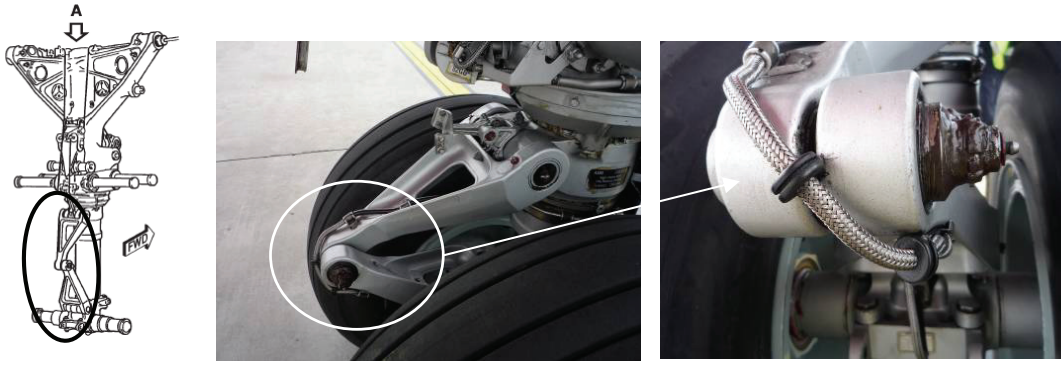
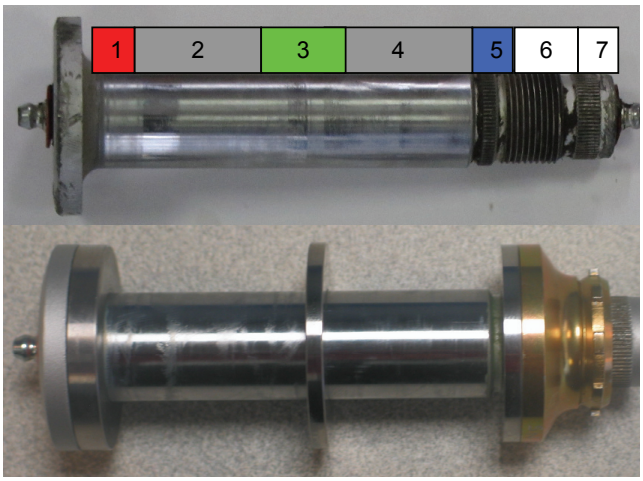


Diagram and photos (side and face views) of the NLG torque link assembly on the A300-B4

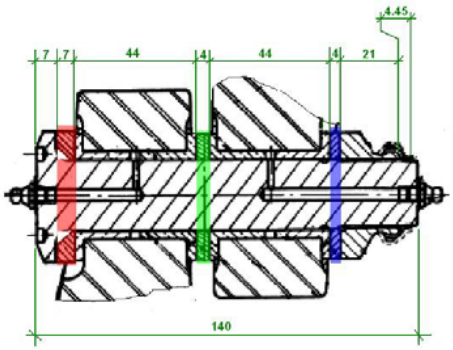
Liaison between the two arms of the torque link is ensured by an apex pin whose end has, successively, grooves, a thread and then more grooves. On this pin the following parts are installed:

1. a bevelled washer (P/N C59853-1),
2. the upper arm bearing,
3. a washer, (P/N C64066-1),
4. the lower arm bearing,
5. a grooved washer (P/N SL40374)
6. a crenelated nut,
7. a washer lock (P/N SL61WTM22P)



Apex pin without the torsion link arms

Dimensional analysis of the nominal installation showed that the total length of the assembled element was 140 mm. Once the last washer lock is positioned, the shaft projects by 4.5 mm. 0.5 mm of grooves are visible on the shaft.



Dimensions

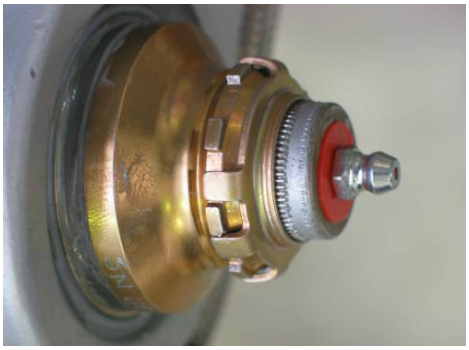
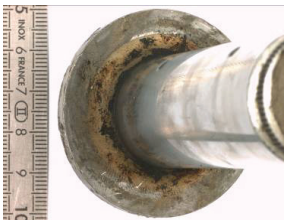


Photo of the end of the shaft with 0.5 mm of grooves visible after the washer lock.

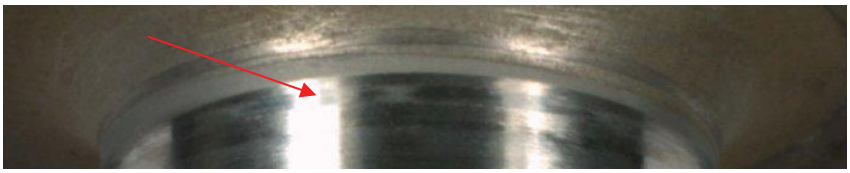
2.3 Examination of the nose gear shock strut assembly on EI-EAC

At the accident site, the grooved washer (in blue on the above diagram and part n°5 on the diagram of the central shaft in paragraph 2.2) was not found. The other parts making up the nose gear shock strut assembly were examined at the BEA. The observations and examinations of the shaft showed:

- Contamination (grease and dust) on the inner side of the shaft head. This seemed to indicate that it was not in contact with the grooved side of the washer (red);

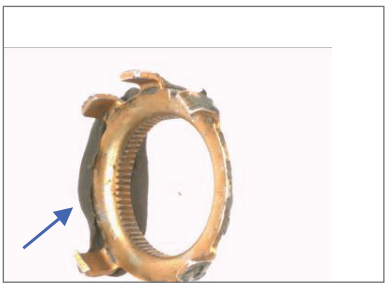


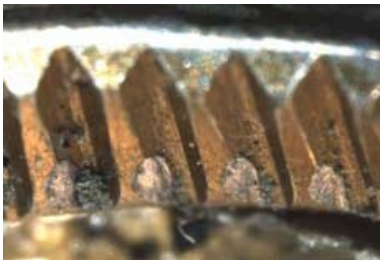
- Circular marks around the fillet. This seemed to indicate the presence of a washer blocked against the fillet;



- The shaft thread in good condition. This seemed to indicate that the nut was not torn off but unscrewed in service. At the end of the last grooves on the shaft, damage was observed;

- The damage to the inner extremities of all of the grooves on the washer lock (n°7).

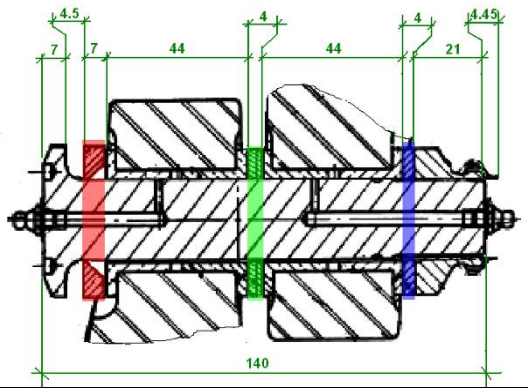
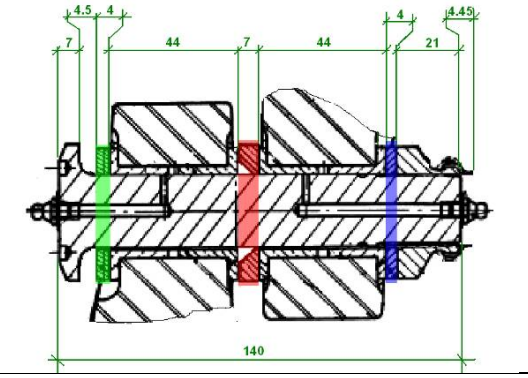




The examinations showed that the washer lock was not completely engaged on the last series of grooves on the shaft.

2.4 Additional tests

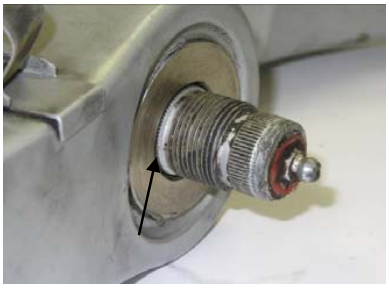
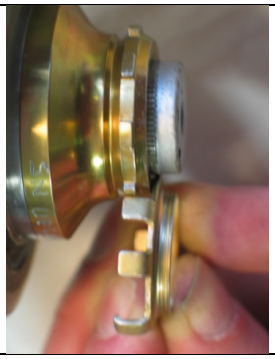
Retaining all of the parts, only two incorrect assemblies are possible.

1st incorrect assembly: The bevelled washer in red in the diagram is installed the wrong way round. In this position, the washer is no longer in direct contact with the shaft head because of the presence of the fillet between the shat and the shaft head.	 **Dimensional diagram 1**
2nd incorrect assembly: In case of inversion of the red and green washers, play is also visible between the shaft head and the badly positioned washer, also because of the fillet.	 **Dimensional diagram 2**

In both cases, play of 4.5 mm appears between the shaft head and the first washer installed. This gap makes complete engagement of the key washer on the grooves impossible at the other end of the shaft. The grooves on the washer lock are engaged over less than 1 mm on the shaft grooves, instead of the nominal 4.45 mm.

In the case of the second assembly, the greater thickness of the n°1 washer (7 mm instead of 4.2 or 4.4 mm) introduces an additional difficulty during insertion of the centre hinge. Abnormally high effort is necessary to align the bearings of the two arms of the torque links and insert the hinge completely. The second assembly scenario is consequently more difficult to perform than the first.

During installation, three steps ensure that assembly is correct:

Step 1	
Correct assembly	**Incorrect assembly**
	
Installation of the bevelled washer with its bevelled side in contact with the shaft head leaves no play.	A 4.5 mm space is visible between the shaft head and the badly positioned washer.
Step 2	
	
The shaft grooves appear. The grooved washer engages in the first grooves. Once in place this washer is prevented from rotating.	The shaft grooves no longer appear. The grooved washer can no longer engage in the shaft grooves. This washer can then rotate freely.
Step 3	
	
About 0.5 mm of shaft grooves is visible after installation of the washer lock.	The key washer cannot completely engage on the shaft grooves. The grooves go past the washer lock.

2.5 Maintenance actions undertaken on the nose gear

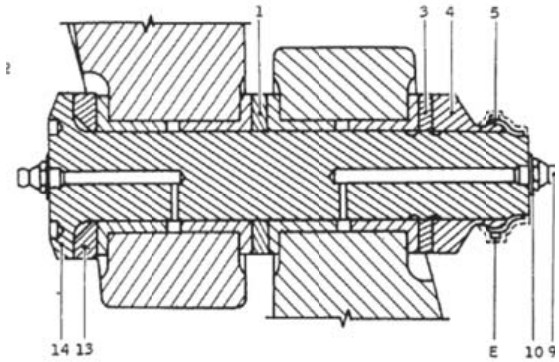
EI-EAC's nose gear was reconditioned and installed on the aeroplane in May 2012. The last maintenance operation was performed on 21 October 2012, that's to say twenty-six days before the accident. Between the maintenance operation and the accident, the aeroplane made about forty hours of flights and thirty-séven cycles.

The maintenance operation, undertaken by a Part-145 approved workshop, involved dealing with a problem of a creaking nose gear shock strut during pushback/towing of the aeroplane. This operation is covered in the manufacturer's AMM 32-21-00 p. Block 801 « Shock Strut – Approved Repairs ». This AMM requires lubrication of the inner part of the shock struck in order to eliminate creaking noises. The procedure specifically requires disconnection at the torque link center hinge level. For this operation, reference is made to the AMM 32-21-15 p. Block 401« Nose gear torque Links – Removal/Installation » which refers to AMM 32-21-15 p. Block 801« Nose gear torque Links – Approved repairs».

2.6 Maintenance documentation associated with the nose gear torque links

The assembly diagram used in the AMM 32-21-15 p. Block 401 « Nose gear torque Links– Removal/Installation » gives exact details of the position and the shape of each washer. However the text associated with the diagram does not specify the order for installation and does not inform the operator of the need to install the first washer with its bevelled side in contact with the shaft head. It states:

- During disassembly, keep the washers (3), (1) and (13) (diagram below).
- During re-assembly, re-install the washers and refer to the AMM 32-21-15 p. Block 801« Nose gear torque Links – Approved repairs» in order to measure the play between the two torque link arms :



Extract from AMM 32-21-15 p. Block 401

According to the AMM 32-21-15 p. Block 801« Nose gear torque Links – Approved repairs», play of 0.2 mm (at the level of the central washer) is allowable between the two torque link arms. It is required to take up any greater play by replacing the central washer (thickness 4.2 mm) by a thicker 4.4 mm washer.

2.7 Loss of control of the steering as a result of nose gear torque link detachment

Airbus informed the BEA of two similar events that occurred in December 2008 (Airbus A300-600 in Vietnam) and June 2009 (Airbus A310 in Pakistan). The aeroplanes having stayed on the runway, these events were not subject to an investigation by the authorities of the countries where the events occurred.

In December 2009, Airbus presented the two previous events to EASA during a continued airworthiness meeting.

The consequences of these two events were minor. EASA and Airbus assessed the risks associated with the loss of control of the nose gear steering and the anti-shimmy system. It was shown that:

- Above 70 kts, A/C direction is ensured by the rudder;
- Below 70 kts differential braking can be used as a back-up in case of loss of control of nose wheel steering.

EASA concluded that this type event had no impact on the aircraft's airworthiness.

2.8 Presence of obstacles on the runway strips

The BEA accident database contains 4 lateral runway excursions that occurred in France during which the nose gear or the MLG collapsed after an impact with a concrete inspection pit that was on the ground surface.

2.9 Regulations concerning the presence of obstacles on runway strips

Supplement A to ICAO Annex 14 « Aerodromes, Volume I – Design and technical operation of aerodromes » and the aerodrome design manual (Doc 9157), Part 6 – Frangibility, states that any equipment in the immediate vicinity of a runway or a runway overrun area must be designed in such a way as to limit to the greatest degree the risks of damage to aeroplanes in case of a runway excursion.

It is specifically stated that a concrete base should not constitute an obstacle for aircraft. This objective is to be achieved by either by sinking the base below ground level or by lowering the sides of the base so that aircraft pass over it with no problems. When the base is sunk, the cavity above the base should be filled with appropriate material.

EASA should, during 2013, make a rule integrating the points from Annex 14 mentioned above. The certification specifications (CS ADR-DSN.B.165 Objects on Runway strips) will specifically require that obstacles buried in the runway strip should be equipped with a ramp so as to eliminate vertical surfaces that may damage the landing gear of aeroplanes in case of a runway excursion.

3 – LESSONS LEARNED AND CONCLUSION

3.1 Safety action already undertaken

Following the accident, Airbus provided all Airbus A300/A300-600/A310/AST customers with recommendations on the maintenance of nose gear steering torque link assembly (Operators Information Transmission - OIT ref 999.0014/13 dated 3 April 2013). This publication draws operators' attention to the importance of correct assembly of the washers on the nose gear torque link centre hinge. It was stated that a warning would be added to the AMM 32-21-15 p. Block 401 « Nose gear torque Links – Removal/Installation » during its next revision.

The manufacturer of the nose gear, Messier-Bugatti-Dowty, will also integrate this warning into its Component Maintenance Manual (CMM).

3.2 Conclusion

Incorrect installation of one or more washers on the nose gear torque link centre hinge made it impossible to lock the hinge shaft nut effectively. The unscrewing and the detachment of the latter in service caused the loss of nose gear steering. Free on its axle, the nose gear bogie began to shimmy, which made the aeroplane veer to the left. The aeroplane exited the runway and the nose gear collapsed during the collision with a concrete inspection pit for access to the runway lighting electric cables.

The runway excursion was due to the incorrect and undetected re-assembly of the nose gear torque links.

Despite the presence of a detailed diagram, the absence of clear and detailed instructions in the text of the manufacturer's AMM, allowing the operator to ensure that the assembly was correct, contributed to the incorrect assembly.

The failure of the nose gear was due to the collision with an obstacle in the runway strip.

The absence of any regulation requiring that equipment in the immediate vicinity of a runway or of a runway overrun area be designed so as to limit as much as possible any damage to aeroplanes, in case of a runway excursion, contributed to the accident.