SUBJECT: DEFECTIVE SELF-LOCKING NUTS - MS21042

Date: Jan 24/13

To all Pilatus Customers, Operators and Service Centers (Maintenance Organizations).

1. Applicability

All PC-12 aircraft using aircraft standard fasteners MS21042 series self-locking nuts.

2. Purpose

The purpose of this service letter is to inform all Pilatus customers, operators and service centers of reported failures of standard parts manufactured by Airfasco based on information provided by EASA.

3. Background

EASA has been investigating a number of failures of standard hardware and has issued the Safety Information Bulletin (SIB) 2012-06R1 to alert the aviation community. The affected hardware are MS21042, NAS1291 and LN9338 self-locking nuts and NAS627 bolts manufactured by Airfasco Industries of Canton, Ohio, USA.

Self-locking nuts have been found cracked, parallel to the nut axis, and in some instances, only a short time after installation.

4. Pilatus Investigation and findings

Investigation by Pilatus has established that among the defective standard hardware, only MS21042 self-locking nuts are used on Pilatus aircraft.

Our supplier has provided written confirmation that no MS21042 self-locking nuts, manufactured by Airfasco, have been supplied to Pilatus Aircraft Ltd. Therefore, these defective parts have not been installed by Pilatus during aircraft production, or supplied directly by Pilatus as spares. However, operators and maintenance organizations may have completed maintenance tasks on aircraft and used MS21042 self-locking nuts manufactured by Airfasco not sourced through Pilatus.

NOTE: NAS1291 and LN9338 self-locking nuts and NAS627 bolts are not used on Pilatus aircraft.

5. Recommendations

Pilatus recommends all operators and maintenance organizations to follow the recommendations of the EASA Safety Information Bulletin (SIB) 2012-06R1 in case MS21042 self-locking nuts, manufactured by Airfasco, have been installed.

6. References

EASA Safety Information Bulletin (SIB) 2012-06R1.

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EASA Safety Information Bulletin

SIB No.: **2012-06R1**
Issued: **07 August 2012**

Subject: **Defective Standard Hardware – MS21042, NAS1291 and LN9338 Self-Locking Nuts, and NAS626 Bolts**

Ref. Publications:
- CAA Israel AD 57-10-06-18, dated 27 July 2010.
- Gulfstream Aerospace LP Service Bulletin (SB) 200-51-366, dated 30 March 2010.
- AgustaWestland Information Letter GEN-11-024, dated 20 July 2011.
- Bell Helicopter Textron Operation Safety Notice GEN-11-43 Revision A, dated 16 September 2011.
- Robinson Helicopter Company Service Letters R22 SL-58, R44 SL-38 and R66 SL-01 (single document), dated 18 August 2011
- L-3 Communications, Aviation Recorder Alert Bulletins FA2100CVDR SB 015, dated 10 January 2011, FA2100CVR SB 018, dated 14 January 2011 and FA2100FDR SB 020, dated 14 January 2011.
- CASA Airworthiness Bulletin 14-002, dated 12 October 2011.
- CAA New Zealand Continuing Airworthiness Notice 14-001, dated 2 December 2011.
- Australian Transportation Safety Board (ATSB) Investigation Report AO-2011-016, dated 30 April 2012.
- Airfasco Industries “Technical Quality Notice Bulletin MS21042 & NAS1291 450 F Steel” dated 16 July 2012, which is attached as pages 4 through 8 of this SIB.

Applicability: The Part Numbers of the affected hardware are MS21042, NAS1291 and LN9338 self-locking nuts, and NAS626 bolts.

The identified defective hardware is known to have been installed on rotorcraft, aeroplanes, appliances and engines.

Reason for revision: Revision 1 of this SIB is issued to recommend a torque check before new lot acceptance, incorporate a reference to an ATSB investigation report, and to include information received from Airfasco Industries (Canton, Ohio, USA), prompted by the original release of this SIB (see pages 5 through 8 of this SIB); the illustration mentioned on page 4 of the Airfasco bulletin (page 8 of this SIB) has not been provided to EASA at time of publication.

Description: Several manufacturers (see ref. publications above) have received numerous reports of defective standard hardware installed on different areas of their products. In particular, many self-locking

nuts have been found cracked, parallel to the nut axis, in some instances only a short time after installation. Broken bolts have also been found.

At this time, apart from the specific case of the Gulfstream 200 and GALAXY (Israel Aircraft Industries) aeroplanes, insufficient evidence is available to determine whether an unsafe condition exists that would warrant the issuance of an AD under EC 1702/2003, Part 21A.3B.

EASA, in cooperation with other aviation authorities and a number of aircraft, engine and equipment manufacturers, is currently investigating the reported occurrences to determine whether (and if so, what) further action is necessary.

Recommendation: Manufacturers, aircraft owners, operators and maintenance staff, are recommended to subject the standard hardware (as identified in the Applicability paragraph of this SIB) to a close visual inspection for surface irregularities, such as gouges or cracks, as illustrated in Figures 1 and 2 of this SIB, before being installed on a product.

In addition, it is recommended to subject incoming lots of self-locking nuts (as identified in the Applicability paragraph of this SIB) to a torque check and inspection, before receiving them in stock, as follows: Install the nuts on the appropriate bolts, with spacers as required, and keep them torqued (see relevant torque values in Table 1 of this SIB) for 1 week. For statistical reasons, a quantity of 1% (round up) or 20 nuts of one manufactured batch – whichever is less – should be tested. After the test period, visually inspect the nuts for cracks on the bearing surface or longitudinally as illustrated in Figure 3 of this SIB.

Suspect parts should be quarantined until conformity to the manufacturing standard is verified.

As not all non-conformities to the manufacturing standards can be visually detected, the importance of quality acceptance criteria for standard parts is also emphasized.

Occurrences of cracked nuts or bolts should be reported through the established channels, as well as to the Agency Occurrence Reporting System, here.

Of particular interest are the hardware Part Number, manufacturer (or markings), lot number, location on the product and time since install.

Contact: For further information contact the Safety Information Section, Executive Directorate, EASA. E-mail: ADs@easa.europa.eu.

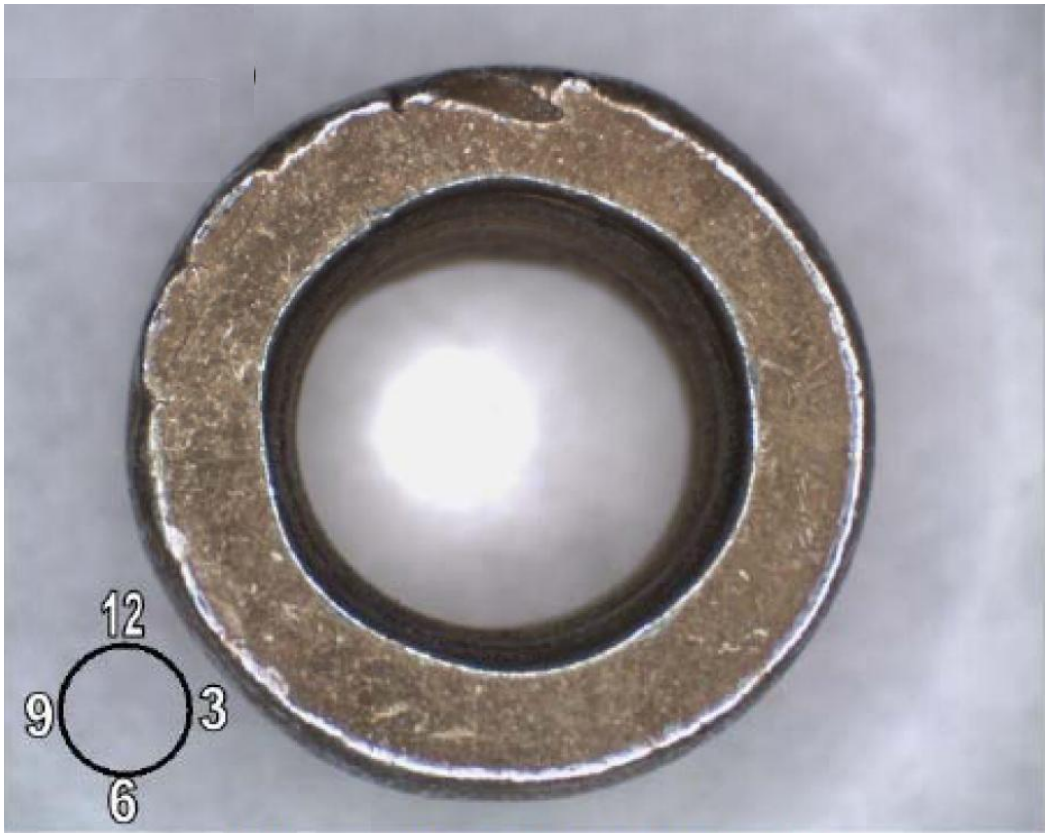

Figure 1: Example of surface irregularities observed on a nut. Overall view.

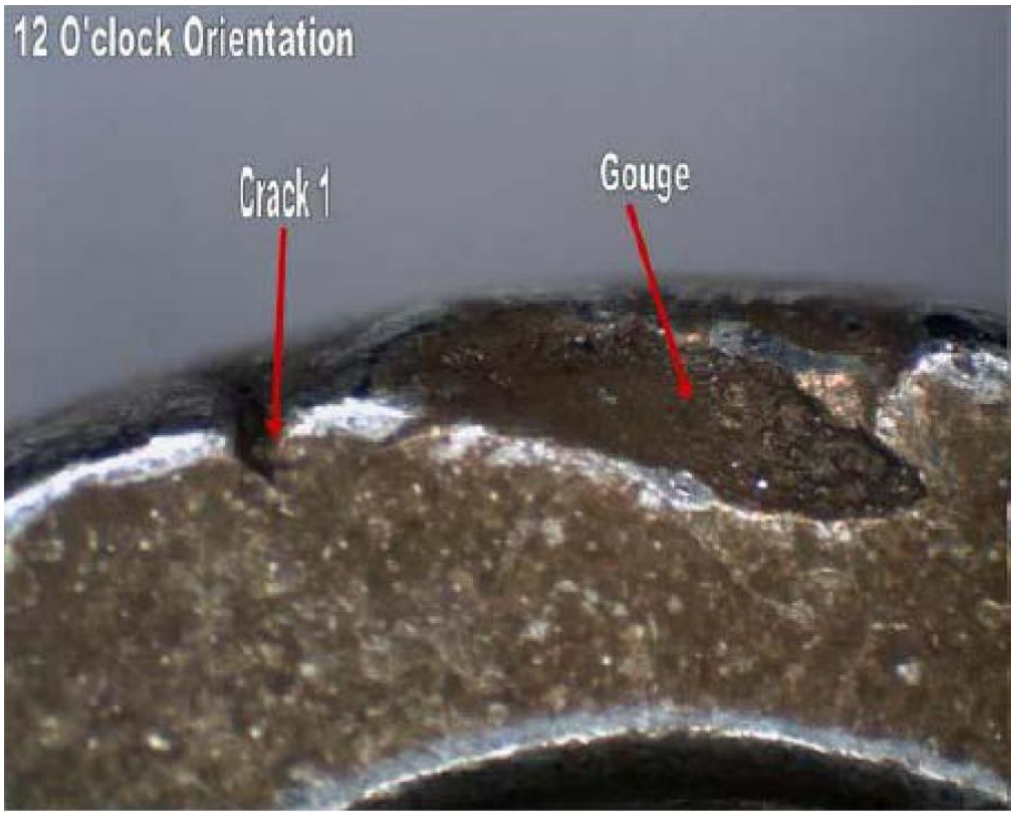

Figure 2: Example of surface irregularities observed on a nut. Detail

Table 1: Torque to be applied during the torque check

Size Dash No.	Thread	Wrenching Torque Test Value		Wrenching Torque Test Value for steel A286 (NAS1291C)	
		in-lb	Nm	in-lb	Nm
-02	.0860-56 UNJC-3B	5	0.6	3	0.4
-04	.1120-40 UNJC-3B	10	1.1	7	0.8
-06	.1380-32 UNJC-3B	20	2.3	15	1.6
-08	.1640-32 UNJC-3B	30	3.4	20	2.4
-3	.1900-32 UNJF-3B	60	6.8	40	4.7
-4	.2500-28 UNJF-3B	150	17	105	12
-5	.3125-24 UNJF-3B	330	37	230	26
-6	.3750-24 UNJF-3B	530	60	370	42
-7	.4375-20 UNJF-3B	825	95	575	65
-8	.5000-20 UNJF-3B	1125	125	780	85
-9	.5625-18 UNJF-3B	1550	175	1075	120
-10	.6250-18 UNJF-3B	2000	225	1390	155

Note: The nut should be tested for wrenching torque by the use of a box or a socket wrench.

Figure 3: Example of longitudinal crack.

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TECHNICAL QUALITY NOTICE BULLETIN MS21042 & NAS1291 450 F STEEL:

(THIN WALL HEX, LIGHTWEIGHT HEX FLANGE NUTS)

The MS21042 and NAS1291 steel design is a very thin wall, lightweight hex flange design (LMC drawings attached) along with the wide range of available torque values and high tensile heat treat values. These nuts are susceptible to galling and post torque ductile overload failure. We have seen the use of high speed air assembly tools which increase the galling process. The steel MS21042 and NAS1291, 450 F nuts have a higher axial strength pound minimum requirement from the procurement standard of 125,000 PSI minimum per NASM25027.

Through our customers, Airfasco has become aware that a few MS21042 and NAS1291 steel nuts have cracked. Other manufacturers of nuts have had similar reports. Airfasco has not verified the installation or the class 3A thread pitch diameter of the male mate(s) and has not confirmed whether the failure resulted from high over values from galling leading to ductile failure from installation. The customer's evaluation and analysis reflected classic failures of hydrogen embrittlement (HE). Hydrogen assisted cracking (HAC) of alloy steel, high tensile strength and electrodeposited cadmium plated hardware has been an ongoing quality issue in the industry for over 50 years.

The specifications for the nuts were intended for weight saving applications and have relatively thin walls. There are many alternate forms of hardware choices that are designed, manufactured and suitable for critical applications. Airfasco has published a weight and least material condition (LMC) selection guide. The original nut this series replaced was the NAS679, 125,000 PSI minimum which was only intended primarily for shear applications. The MS21042 and NAS1291 steel thin wall hex flange nut was designed for a replacement with a higher axial tensile strength for both shear and tensile applications.

Designers and Engineers are advised to check with Airfasco to determine availability of torque value ranges and hardness ranges along with new improved technical designs for special applications to improve the use of these nuts. Airfasco has authorized distributors that offer managed inventory programs for OEM's.

Before installation, verify and assure the correct pitch diameter of the male mate(s), the appropriate assembly torque range and the hardness of the male mate(s). Assemble using calibrated hand tools for the installation as RPM speed and torque pressures of air tools can readily gall and damage the nuts if out of calibration tools are used.

Galling is a form of adhesive wear that can occur in fasteners as they are tightened. Galling is most prevalent in fasteners made from corrosion resistant materials that self-generate a protective oxide surface film [such as stainless steel, aluminum, titanium and nickel based alloys]. As contact pressure increases on the sliding surfaces of the threads during tightening, the oxide layer is stripped off high points on the mating surfaces and the bare unprotected surfaces 'cold weld' together. As the fastener tightening continues, these localized cold welded joints shear, tearing off metal particles. Debris from the stripped oxide film and particles from the sheared joints are entrained in the sliding surfaces which exacerbate the adhesive wear. The process can ultimately lead to seizing of the fasteners and breakage if tightening continues. Seizing can even occur during the loosening process.

Galling is best avoided by: (1) Installation using calibrated hand tools to slow down the RPM tightening process since increased speed generates greater heat from friction and heat accelerates the 'cold weld' process; and/or (2) Providing lubrication, either solid film or anti-galling compound to the threads prior to assembly (see SAE J2270 for additional information); (3) Carefully evaluating the thread fit of the male mate(s) threads. The MS21042 and NAS1291 specify a class 3B thread fit and at maximum material condition with a class 3A male mate(s) thread, there is zero clearance between mating threads. Using a class 2A external thread with these nuts provides some clearance between threads, even at maximum material condition. When design considerations dictate the use of materials for which there is no experience, an evaluation of the material couple's resistance to galling should be made to assess the risk of failures during installation. ASTM G 98 provides a test method for evaluating the galling resistance and determining threshold galling stress. This threshold can then be compared to analytically determine contact pressures of the threaded joint during tightening to provide an assessment of the fastener design. (4) Selecting different alloys with different hardness values or different strengths of the same alloy, thereby providing different hardness values in the threaded joint.

Require all electro-platers to initiate a hydrogen embrittlement prevention (HEP) requirement making it mandatory for plating processors to begin baking immediately after plating and not to exceed one (1) hour for the twenty three (23) hours minimum baking requirement temperature of 375 F degrees +/- 25 F (190 C +/-14 C). This will reduce the possibility of hydrogen embrittlement (HE) and post hydrogen assisted cracking (HAC).

The use of the electro-plating process with any anode base metals on this type of thin wall nut hardware will cause the classic effects of hydrogen embrittlement (HE). Following hydrogen embrittlement prevention (HEP) techniques will minimize the amount of hydrogen embrittlement (HE) and reduce post hydrogen assisted cracking (HAC), but not remove all concentrations of hydrogen content because of the cadmium electro-plating process.

The electro-plating finish of anode cadmium metal along with a post chromate finish treatment are both considered a candidate of "Substance of Very High Concern" (SVHC) with the European Chemicals Health Agency (ECHA) located in Helsinki. These metals and chemicals are NOT compliant with the "Registration, Evaluation, Authorization and Restriction of Chemical" (REACH) substances and the directive "Restriction of Hazardous Substances" (RoHS). REACH in brief calls for the progressive substitution of the most dangerous chemicals when suitable alternatives have been identified. Aerospace is no longer exempt and Article 33 (1) REACH may allow the recipient of the nut provided the concentration of (SVHC) is less than 0.1% weight/weight (w/w) and sufficient information is submitted to determine safe application and installation use. To plate 4,536 kg (10,000 lbs.) of bare steel nuts requires approximately 14 kg (31 lbs.) of cadmium metal and approximately 2 liters (2.12 quarts) of post treatment chromate.

Airfasco suggests an additional hydrogen embrittlement wedge testing (HEWT) of 85% tensile strength for a minimum of 72 hours with a 10 degree wedge test fixture for additional rigorous testing as well as the required standard parallel fixture per NASM1312-5, T=KD/W.

Torque specification range of NASM25027 has a very wide tolerance that can affect final assembly depending on the matting fasteners being used. We have developed a lower torque (LT) series which conforms to lower allowable range of NASM25027 torque specifications. We feel using a lower torque range will create more of an allowable tolerance for the use of dissimilar metals and coatings used in final assembly. We conducted conformance testing and have reduced the hardness range and torque values for use with lower tensile matting fasteners such as the AN bolts and standard 125,000 PSI minimum machine screws. Included in this bulletin is the lower torque (LT) series of MS21042 and NAS1291 steel product line that is recommended.

It should be noted that many distributors sell standard hardware purchase to the minimum sampling plan. It has been brought to our attention that many of the OEM's require additional flow down quality requirements such as C=0 and the standard sampling plan of ANSI/ASQZ1.4-2003 is not acceptable. Many of our OEM's will assign additional flow down quality requirements when purchasing standard AN, MS or NAS hardware and have them 100% NDT Magnaflux tested per ASTM E 1444-11 for their critical applications. NDT per ASTM E 1444-11 sample lot testing is only required on nuts .1900-32 inch (4.83 mm) and larger and not a requirement for the smaller nuts sizes per NASM25027, 4.5.4.1.

Any products manufactured in quantity from all of the manufacturers will always have a very small percentage of fallout when 100% NDT testing is performed. Airfasco does offer and can provide 100% NDT, C=0 for the nuts at an additional cost and reject on any imperfections which exceeds the minimum inspection requirements of NASM25027 Table VII (7) allowing limits of .010" (.25 mm) depths for laps, seams and inclusions.

With reported problems from various manufacturers we feel there are many variables that can cause these problems. The use of out of calibrated hand tools or the use of high RPM assembly of non calibrated lower cost air tools without certified regulated air pressure can readily gall and damage the nuts. If too long of a bolt or screw with a shoulder is used this can create a wedge effect and crack the nut. A high 3A pitch diameter makes for a zero clearance between mating threads and can cause galling during assembly with failure due to over torque or ductile failure. We do recommend anti-galling compound to the male threads prior to assembly per SAE J2270. This will slow the tightening process since increased speeds generate greater heat from friction and heat accelerates the "cold weld" process. We feel the use of lower torque nuts may help this problem and we have attached drawings in the report.

MS21043 and NAS1291C stainless A286 nuts of the same thin wall, light exact design and weight have lower axial tensile strengths of 125,000 PSI minimum and should be considered when design application permits. NAS1291- Rev 13 steel sizes less than .375-24" (9.525 mm) and under axial tensile strengths are crossed off the current drawing and inactive for new design. Airfasco has published a design selection guide referencing the different thread sizes, weights, torque value ranges, axial tensile strength, plating finishes and least material condition (LMC). An illustration of all the sizes for least material condition (LMC) is attached for reference.

Airfasco has designed a hydrogen embrittlement negative (HEN) series of the MS21042 and NAS1291 450 F steel thin walled hex flange nut that is a cadmium replacement, RoHS and REACH compliant finish. The nut meets all the physical, chemical and mechanical properties of the specification except for the improved finish which far exceeds the cadmium salt spray requirements. Totally chrome free finish that exceeds > 2,000 hours salt spray corrosion. The process is a thermal diffusion coating (TDC) at 400 C (752 F) which eliminates any chances of hydrogen embrittlement by process application per ASTM A1059. This finish has the same friction factor (K) as cadmium and provides the same natural lubricant for installation assembling and removal.

Key Words: European Chemicals Health Agency (ECHA), Hydrogen Assisted Cracking (HAC), Hydrogen Embrittlement (HE), Hydrogen Embrittlement Negative (HEN), Hydrogen Embrittlement Wedge Testing (HEWT), Least Material Condition (LMC), Lower Torque (LT), Non Destructive Testing (NDT), Registration, Evaluation, Authorization and Restriction of Chemical (REACH), Restriction of Hazardous Substances (RoHS), Substance of Very High Concern (SVHC), Thermal Diffusion Coating (TDC), Weight to Weight (W/W).

Please contact Dennis Dent Dennis.Dent@Airfasco.com if you have any questions or need any additional information or assistance.