

Engineering Report: AVDALSR071-2

Issue: 1 Date: 9th August 2011

Subject: Through Bolt & 12 Point Cylinder Base Nut Installation

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1. General

- The following procedures have been prepared to guide overhaulers on the recommended procedures for replacing the through-bolt nuts or both bolts and nuts for engines as required by Jabiru Service Bulletin JSB031-1.
- While care has been taken to make these procedures as clear as possible there is a degree of assumed knowledge required to successfully complete this work. Overhaulers should only attempt this task if they are suitably qualified and familiar with the engine maintenance in general and Jabiru Engines in particular.

WARNING

Failure to follow the appropriate procedure exactly may cause damage or harm to the engine, its parts, or components and may lead to injury or death. Any such actions may render the aircraft un-airworthy and will void any warranty issued by Jabiru. This work must only be carried out by suitably trained and authorised personnel.

2. Through-Bolt & 12-Point Nut Exchange

- This procedure is intended for those installing new through-bolts and new 12-point, 3/8" cylinder base nuts. If you do not intend to replace through bolts (i.e. if you are replacing the nuts only) please refer to Section 3 below.
- Replacing through bolts and cylinder base nuts is not a difficult task; however, the steps below should be followed precisely.
- Ideally, only one through bolt should be worked on at a time. However, when installing new through bolts, there is not enough room to extract the through bolt with the cylinder in its installed position: The fins on the cylinder will block the through bolt. The cylinder must therefore be partially extracted and moved to the side to allow the through bolt to be removed. To move each cylinder, all four nuts must be removed thus relieving the intended tension on the crank case halves. This is unavoidable but acceptable – provided the procedures are followed quickly and carefully.
- This procedure is similar to joining a case: cylinders are installed in pairs as they share through bolts, so one can not be fully installed without installing the other.
- Finally, there is little to no difference when working on a 2200 or 3300 engine.
- For further information also refer to the Jabiru Engine Overhaul manual.

2.1. Preparation

- Remove the starter motor from the backing plate (3 x 1/4" x 1" UNC)
- Remove fuel pump from crank case (2 x 5/16" x 1 1/4" UNC)
- Remove dip stick tube (1 x 1/4" x 1/4" UNF grub screw)
- After removing the tube, plug the locating hole in the sump (a clean rag is fine to use) to prevent any debris falling into the sump.
- Loosen intake pipe rubber joiner hose clamps
- Remove rocker covers (4 x 5/16" x 3/4" UNC each)
- Remove 1/8" NPT grub screw plug from rocker cavity
- Loosen rubber-t clamps if lube tubes are installed
- Loosen head bolts so as to remove head assembly from cylinders
- When all head bolts have been unfastened, the complete head assembly can be carefully removed while staying intact. See Figure 1.

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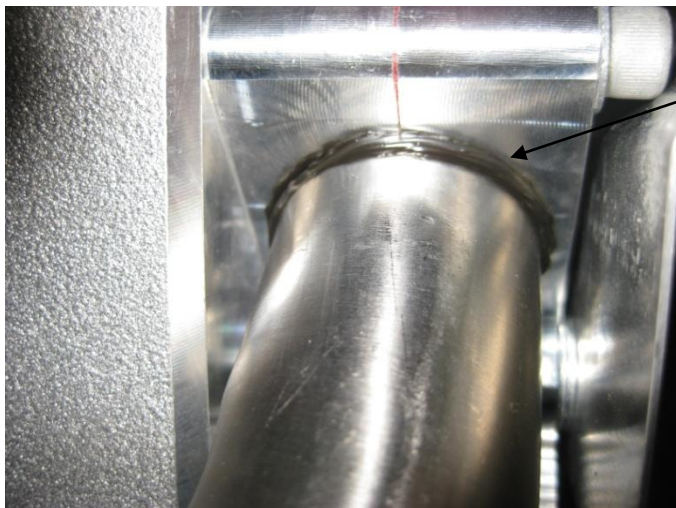
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Intake pipe joiner (short rubber hose)

Figure 1 – Cylinder Head Removed

- The cylinder head assembly includes the head, attached intake and exhaust pipes, push rod tubes with the push rods still in the tubes.
- When removing, ensure that the intake pipe joiner comes off with the head assembly. This is to minimise the chances of disturbing the seal between the plenum chamber and the intake pipes (as shown in Figure 2). If the joiner stays on the lower part of the tube, once the head has been removed it must be carefully removed and fitted to the head side intake pipe.
- In all cases, after the head has been removed the seal (Loctite 2 (30514)) between the intake pipe and the plenum chamber assembly remains intact and is not broken. See Figure 2. If this seal is cracked, the intake pipe must be cleaned and a new bead of Loctite 2 applied before reinstallation.



Ensure there are no cracks in this sealant

Figure 2 – Detail of Plenum / Intake Seal

- Also be sure to check for and remove any build up of combustion material around the spigot of the cylinder and the mating side of the head. Failure to ensure a clean seal around this area will result in a loss of compression.
- **Important:** With the head assemblies removed, the top of the pistons should be clearly visible down the bore of the cylinders. Carefully turn the engine (or prop) so as the #1 and #2 pistons are fully extended and are almost level to the cylinder spigot. See Figure 3. The reason for doing this will become clear when removing the cylinders in the steps below.

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Figure 3 – Piston At Top Of Stroke

2.2. Nut and Through Bolt Installation

- Starting from the front (prop end) and topside of the engine, remove the nut from the short stud. This nut sits on a 3/8 Belleville washer. When removed, clean the end of the stud and 12 point nut with a clean rag and Loctite Primer 7471. Treat both the nut thread and stud thread with a small amount of Loctite 620. Check the Belleville washer is in place, tighten the nut by hand, then tension to 30 ft/lbs. Be sure to clean any excess 620, then repeat with the bottom front nut/stud.
- Each cylinder needs to be partially extracted from the crank case to remove the existing through bolt and install the new through bolt. Remove the four nuts securing the #1 cylinder (closest to the prop). Remove the two front nuts on the #2 cylinder. See Figure 4. As is the nature of the original 'deformed' nuts, when removing from the through bolt, one nut will lock while the other will unfasten. At this point, a pair of locking nuts needs to be used in order to remove the remaining nuts. A pair of 1/2 width nuts of 3/8 UNF thread is adequate for this purpose.



Figure 4 – Cylinder Removed From Case

- With the four nuts removed from the #1 cylinder, and the two front nuts removed from the #2 cylinder, carefully extract the #1 cylinder away from the crank case approximately 2 inches. Do not completely remove or extract the cylinder from the piston/conrod assembly too far as it can be difficult to reinstall the cylinder over the piston rings. See Figure 4. With the cylinder partially extracted, tilt the cylinder to one side. There should be sufficient space to now remove the through bolts. See Figure 5.
- Once the original through bolts have been removed, clean around the face of the cylinder base and the mating area of the crank case. If shims have been previously employed, clean these as well. Insert the new through bolts into the crank case. Apply a thin bead layer of Copper Maxx to cylinder base sealing O-Ring. Do not apply Copper Maxx between the cylinder base and the crankcase. Ensure the cylinder o-ring is seated correctly, then

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carefully slide the cylinder back into position. It is not necessary to replace this o-ring, though if need be, they can be slightly stretched over the cylinder to remove or install.



Figure 5 – Replacing Through Bolts

- Starting at the two front-most studs engaging the #1 cylinder, clean the through bolt thread and 12 point cylinder base nuts with Loctite Cure Accelerator 7471. Apply a small amount of Loctite 620 to both through bolt thread and nut thread. Using a 7/16 ring spanner, tighten by hand, then tension to 30 ft/lbs using a torque wrench. Clean any excess Loctite 620. It is usual procedure to apply Torque Seal to the nut and through bolt/stud after tensioning and cleaning. This is a good visual indicator to see the nut has been tensioned, and to also see if there is any movement of the nut on the through bolt. See Figure 6.

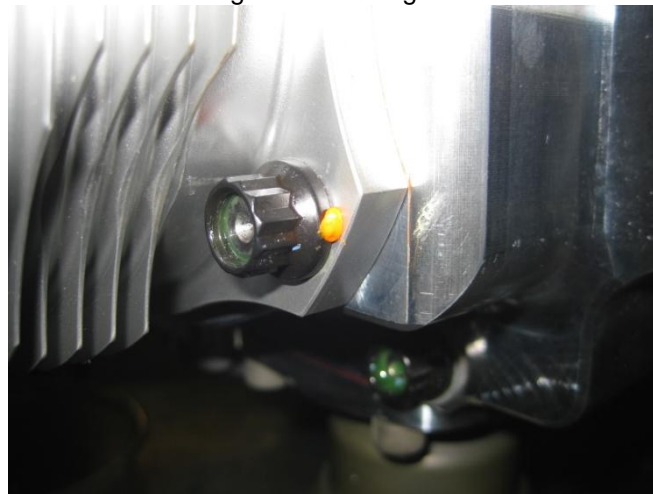


Figure 6 – New 12-Point Nuts Fitted

- With the front studs securing the #1 cylinder, remove the back two nuts on the #2 cylinder and the front two nuts on the #3 cylinder. Using the same strategies used on the #1 cylinder, partially extract the #2 cylinder, clean the cylinder/crank case mating surface area, install the new through bolt and reseal the cylinder with applied Copper Maxx on the O-ring. Clean both ends of the first through bolt with Loctite Cure Accelerator 7471. Apply Loctite 620 to one end of the through bolt as well as the new nut thread. Wind the nut until there is approximately 1 ½ threads of the through bolt protruding from the nut. See Figure 7. Apply Loctite 620 to the opposite end of the through bolt and new nut, winding on until hand tight. Tension one nut to 30 ft/lbs while securing the opposite nut with a 7/16 ring spanner. Repeat for the opposite side. Clean excess Loctite 620 from the nut/through bolt and apply Torque Seal.

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Figure 7 – 12-Point Nut Fitted

- With the #1 cylinder completely secured, and the front two nuts secured on the #2 cylinder, turn the engine (or prop) so the #3 and #4 pistons are fully extended. If you are working on a 3300 engine, after securing the #3 and #4 cylinders, once again, turn the engine so the #5 and #6 pistons are fully extended before installing the through bolts.
- Repeat this procedure until all through bolts and 12 point nuts have been installed.
- When all nuts have been replaced and tensioned to 30 ft/lbs (top and bottom of the engine) and all excess Loctite 620 removed, head assemblies can be reinstalled.
- Procedures for installing the heads can be found in the online manuals found on the Jabiru website: www.jabiru.net.au.
- Locate and secure all intake pipe rubber joiner hose clamps, rubber-t clamps (if applicable), starter motor, fuel pump and dip stick tube.
- This completes the procedure for installing new through bolts and exchanging the original 3/8 reduced hex cylinder base nuts to new 12 point cylinder base nuts.

3. Procedure 1 For 12 Point Cylinder Base Nut Exchange

- This document is intended for those only intending on uninstalling the original 3/8 reduced hex cylinder base nuts and replacing with the new 12 point 3/8 cylinder base nuts. If you intend to replace through bolts as well as cylinder base nuts, please refer to Section 2 above.
- Follow this section only if you have a universal joint shallow socket extension for 7/16" 12-point head. (Snap-On tool number: FU14B) Otherwise please refer to Section 4. **Note that carrying out this work with the FB14B tool allows the job to be done in around half the time it would take without – i.e. using Procedure 2 below.**
- Replacing the original 3/8 reduced hex cylinder base nuts is not a difficult task; however, the steps below should be followed. Ideally when exchanging nuts, **only one stud or through bolt should be worked on at a time.** Unfastening of more than one stud or through bolt can cause issues with head and cylinder alignment. It can also possibly cause oil leakage around the crank case halves.
- It is not necessary to work in a 'top to bottom' routine for the whole engine. Regardless if the engine is installed in a plane or on a work bench, it is simpler to work from front to back along the top of the engine, and then make your way from front to back along the bottom of the engine. As all the studs and through bolts are at tension (with the exception of the one you are working on), there is no need to install the nuts as you would when joining a crank case.
- Finally, there are little to no differences in procedure when working on a 2200 or 3300 engine.

3.1. Preparation

- The simplest procedure for uninstalling and replacing the 3/8" hex nuts is to use a specific universal joint tool to access the nuts concealed by the cylinder heads. If this tool is not available, please refer to Section 4 for details on preparation.
- The relevant tool is a Snap-On tool, part number FU14B. This is a universal joint with a shallow 12-point socket head for 7/16" heads.

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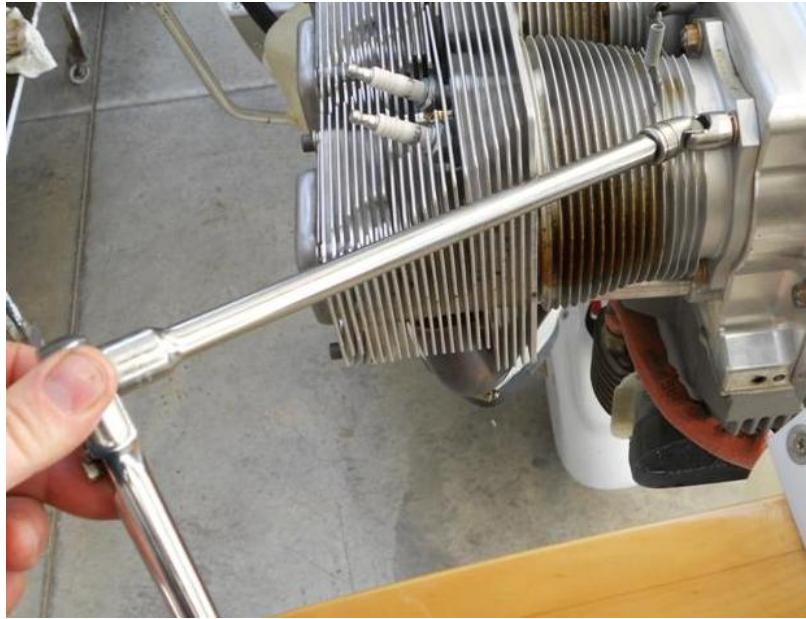


Figure 8 - Universal Joint tool FU14B

- This tool extension permits access to nuts concealed by cylinder heads, exhaust ducts and other hardware. Unlike the “crow’s foot” extension often used, this tool extension does not require any Torque correction to be applied.



Figure 9 - Accessing concealed nuts

- The Snap-On universal joint tool extension will suit both the original reduced-hex nuts and the replacement 12-point nuts. At any point in the following procedure where a nut is inaccessible by regular spanner, use the tool extension to reach the nut.

3.2. Nut Installation

- Starting from the front (prop end) topside of the engine, remove the nut from the short stud. This nut sits on a 3/8 Belleville washer. When removed, clean the end of the stud and 12 point nut with a clean rag and Loctite Cure Accelerator 7471. Treat both the nut thread and stud thread with a small amount of Loctite 620. Check the

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Belleville washer is in place, tighten the nut by hand, then tension to 30 ft/lbs. Be sure to clean any excess Loctite 620, then repeat with the bottom front nut/stud.

- The same procedure is used on the next set of studs (the first stud to attach to a cylinder base)
- At the first through bolt, both nuts need to be removed. As is the nature of the original 'deformed' nuts, when removing from the through bolt, one nut will lock while the other will unfasten. At this point, a pair of locking nuts needs to be used in order to remove the remaining nut. A pair of ½ width nuts of 3/8 UNF thread is adequate for this purpose.



Figure 10 - Using lock nuts to remove the second reduced hex.

- With both nuts removed, clean the through bolt threads as before. Apply Loctite 620 to one through bolt thread and one 12 point nut. Wind the nut on until it overhangs the through bolt by approximately 1 to 1 ½ threads. See figure 3. Repeat the cleaning and Loctite 620 treatment at the opposite end of the through bolt and attach. When both nuts have been attached and the through bolt is centrally located, place a 7/16 spanner on one nut and torque the other to 30 ft/lbs. When at tension, torque the other side to 30 ft/lbs. Clean any excess Loctite 620. Keep in mind each through bolt and 2 nuts must be attended to without losing time as the Loctite will start to cure when starved of oxygen.
- It is usual procedure to apply Torque Seal to the nut and through bolt after tensioning and cleaning. This is a good visual indicator to see the nut has been tensioned, and to also see if there is any movement of the nut on the through bolt. See Figure 15.

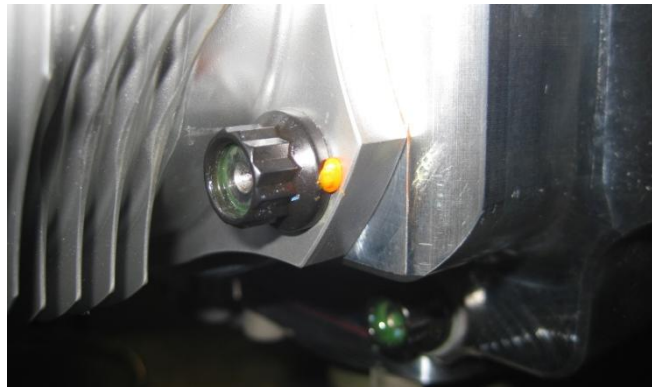


Figure 11 – New 12-Point Nuts Fitted With Torque Seal

- This procedure should be repeated with all remaining through bolts, remembering to work on only one through bolt at a time.

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- At the last stud at the rear of the engine (closest to the backing plate), use the same procedure as the front studs (the rear studs do not use Belleville washers).
- When all nuts have been replaced and tensioned to 30 ft/lbs (top and bottom of the engine) and all excess Loctite 620 removed, head assemblies can be reinstalled. Procedures for installing the heads can be found in the online manuals found on the Jabiru website: www.jabiru.net.au.
- Locate and secure all intake pipe rubber joiner hose clamps, rubber-t clamps (if applicable), starter motor, fuel pump and dip stick tube.
- This completes the procedure for exchanging the original 3/8 reduced hex cylinder base nuts to new 12 point cylinder base nuts.

4. Procedure 2 For 12 Point Cylinder Base Nut Exchange

- This document is intended for those only intending on uninstalling the original 3/8 reduced hex cylinder base nuts and replacing with the new 12 point 3/8 cylinder base nuts. If you intend to replace through bolts as well as cylinder base nuts, please refer to Section 2 above.
- Replacing the original 3/8 reduced hex cylinder base nuts is not a difficult task; however, the steps below should be followed. Ideally when exchanging nuts, **only one stud or through bolt should be worked on at a time.** Unfastening of more than one stud or through bolt can cause issues with head and cylinder alignment. It can also possibly cause oil leakage around the crank case halves.
- It is not necessary to work in a 'top to bottom' routine for the whole engine. Regardless if the engine is installed in a plane or on a work bench, it is simpler to work from front to back along the top of the engine, and then make your way from front to back along the bottom of the engine. As all the studs and through bolts are at tension (with the exception of the one you are working on), there is no need to install the nuts as you would when joining a crank case.
- Finally, there are little to no differences in procedure when working on a 2200 or 3300 engine.

4.1. Preparation

- Remove the starter motor from the backing plate (3 x 1/4" x 1" UNC)
- Remove fuel pump from crank case (2 x 5/16" x 1 1/4" UNC)
- Remove dip stick tube (1 x 1/4" x 1/4" UNF grub screw)
- After removing the tube, plug the locating hole in the sump (a clean rag is fine to use) to prevent any debris falling into the sump.
- Loosen intake pipe rubber joiner hose clamps
- Remove rocker covers (4 x 5/16" x 3/4" UNC each)
- Remove 1/8 NPT grub screw plug from rocker cavity
- Loosen rubber-t clamps if lube tubes are installed
- Loosen head bolts to allow the removal of head assembly from cylinders.



Intake pipe joiner (short rubber hose)

Figure 12 – Cylinder Head Removed

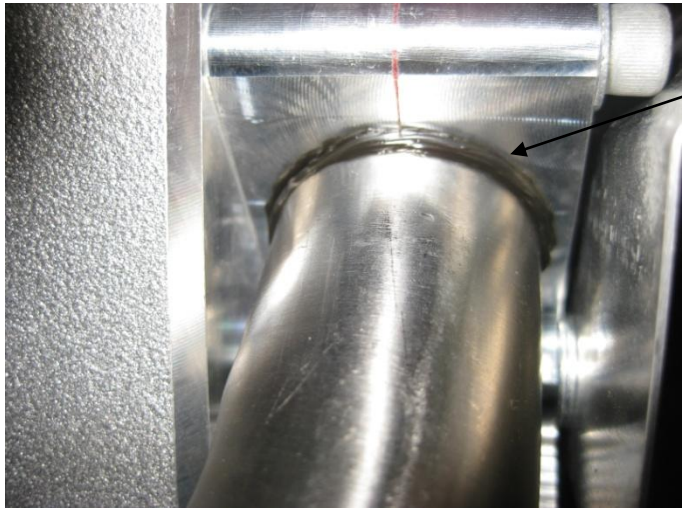
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- When all head bolts have been unfastened, the complete head assembly can be carefully removed while staying intact. See Figure 12.
- The head assembly includes the head, attached intake and exhaust pipes, push rod tubes with the push rods still in the tubes. Ensure the intake pipe joiner is attached to the head assembly. If not, carefully remove from plenum side intake pipe and install on the head side intake pipe. This is to ensure that on reassembly, the seal (Loctite 2(30514)) between the intake pipe and the plenum chamber assembly remains intact and is not broken. See Figure 13. If this seal is cracked, the intake pipe must be cleaned and a new bead of Loctite 2 applied before reinstallation.



Ensure there are no cracks in this sealant

Figure 13 – Detail of Plenum / Intake Seal

- Also be sure to check for and remove any build up of combustion material around the spigot of the cylinder and the mating side of the head. Failure to ensure a clean seal around this area will result in a loss of compression.

4.2. Nut Installation

- Starting from the front (prop end) topside of the engine, remove the nut from the short stud. This nut sits on a 3/8 Belleville washer. When removed, clean the end of the stud and 12 point nut with a clean rag and Loctite Cure Accelerator 7471. Treat both the nut thread and stud thread with a small amount of Loctite 620. Check the Belleville washer is in place, tighten the nut by hand, then tension to 30 ft/lbs. Be sure to clean any excess Loctite 620, then repeat with the bottom front nut/stud.
- The same procedure is used on the next set of studs (the first stud to attach to a cylinder base)
- At the first through bolt, both nuts need to be removed. As is the nature of the original 'deformed' nuts, when removing from the through bolt, one nut will lock while the other will unfasten. At this point, a pair of locking nuts needs to be used in order to remove the remaining nut. A pair of 1/2 width nuts of 3/8 UNF thread is adequate for this purpose.
- With both nuts removed, clean the through bolt threads as before. Apply Loctite 620 to one through bolt thread and one 12 point nut. Wind the nut on until it overhangs the through bolt by approximately 1 to 1 1/2 threads. See figure 3. Repeat the cleaning and Loctite 620 treatment at the opposite end of the through bolt and attach. When both nuts have been attached and the through bolt is centrally located, place a 7/16 spanner on one nut and torque the other to 30 ft/lbs. When at tension, torque the other side to 30 ft/lbs. Clean any excess Loctite 620. Keep in mind each through bolt and 2 nuts must be attended to without losing time as the Loctite will start to cure when starved of oxygen.

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Figure 14 – Piston At Top Of Stroke

- It is usual procedure to apply Torque Seal to the nut and through bolt after tensioning and cleaning. This is a good visual indicator to see the nut has been tensioned, and to also see if there is any movement of the nut on the through bolt. See Figure 15.

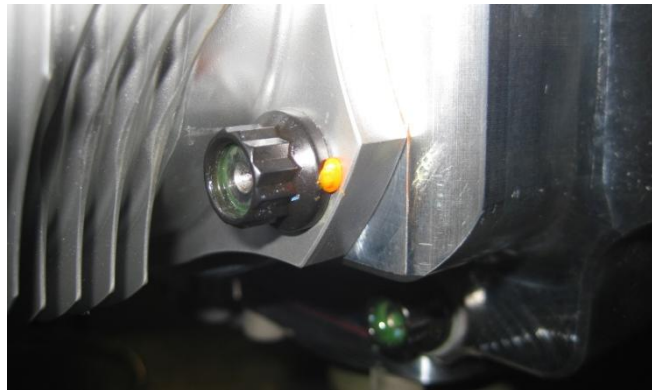


Figure 15 – New 12-Point Nuts Fitted With Torque Seal

- This procedure should be repeated with all remaining through bolts, remembering to work on only one through bolt at a time.
- At the last stud at the rear of the engine (closest to the backing plate), use the same procedure as the front studs (the rear studs do not use Belleville washers).
- When all nuts have been replaced and tensioned to 30 ft/lbs (top and bottom of the engine) and all excess Loctite 620 removed, head assemblies can be reinstalled. Procedures for installing the heads can be found in the online manuals found on the Jabiru website: www.jabiru.net.au.
- Locate and secure all intake pipe rubber joiner hose clamps, rubber-t clamps (if applicable), starter motor, fuel pump and dip stick tube.
- This completes the procedure for exchanging the original 3/8 reduced hex cylinder base nuts to new 12 point cylinder base nuts.