

PACCAR Dealernet



Chassis No: FJ398348

Vehicle type: MX_EPA13-MX-13 USA

J 1400 000000 000 252

overhaul (ENGINE)

PACCAR Dealernet

overhaul (ENGINE)



  1 overhaul (ENGINE)

  1.1 disconnect battery clamp, negative pole

Explanation

Warning, battery clamp and negative terminal



- Do not disconnect the vehicle batteries until the DEF dosing system has completed the purge cycle.
- Before beginning to remove and/or disconnect any components, wait at least 5 minutes after the key switch is turned OFF for the aftertreatment DEF dosing system to purge DEF from the system.
- The purge cycle is an automatic process and does not require active intervention. The aftertreatment DEF dosing unit creates an audible pumping noise during the purging process.



- Electrical shock hazard: Never disconnect the battery clamp when the engine is running.
- Disconnecting the battery clamps while the engine is running may result in death, personal injury, or equipment damage from electrical arching or damage to electronic components.
- Turn off the engine and place the ignition switch in the OFF position before disconnecting the battery clamps.
- Do not place any tools or other materials on top of or close to the batteries. This can cause a dangerous high-current short circuit and, in the worst case, a battery explosion. Keep all objects away from the battery terminals.
- Always break the contact between the battery clamp and the negative terminal before working on the vehicle. Working on a vehicle while the battery is connected may result in electrical injury or damage.
- Always disconnect the battery at the negative terminal when performing service procedures.



- Battery acid can cause chemical burns.
- If you come into contact with battery acid: flush your skin with water and/or apply baking soda or lime to help neutralize the acid.
- If battery acid comes into contact with the eyes, flush immediately with water and seek medical attention.
- Wear protective clothing when handling any part of the battery.

M024327 - 05.03.2010

  1.2 remove dipstick, engine

  1.3 drain oil engine

Explanation

Warning, Lubricating Oil



- Lubricating oil can cause skin irritation or skin injury.
- To prevent skin injury, avoid unnecessary contact with lubricating oil.



- **Wear protective clothing, eyewear and gloves.**
- Run the engine at idle speed for at least one minute, directly after maintenance or repairs of the lubrication system, to allow oil to reach all necessary components.
- Increasing the engine speed directly after maintenance or repairs of the lubrication system can cause damage to various engine components.
- Make sure that all consumers are switched off and the vehicle is in neutral gear position before starting the engine.
- Check if the red oil pressure warning in the instrument panel disappears within ten seconds; if not, key off the engine and investigate the problem.

M032087 - 01.16.2013

Draining engine oil

1. Place the vehicle on a flat and level surface.
2. Drain the engine oil at operating temperature via the drain plug.



- If the engine is filled with new engine oil after repair work has been carried out, replace the oil filter elements as well.

M032177 - 04.04.2013



1.4

drain oil oil module (Lubrication system)

Explanation

Warning, Lubricating Oil



- Lubricating oil can cause skin irritation or skin injury.
- To prevent skin injury, avoid unnecessary contact with lubricating oil.
- **Wear protective clothing, eyewear and gloves.**



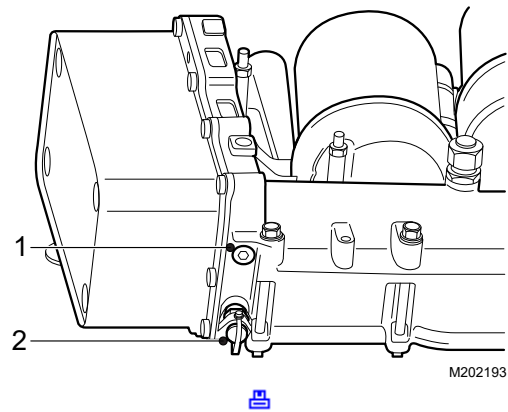
- Run the engine at idle speed for at least one minute, directly after maintenance or repairs of the lubrication system, to allow oil to reach all necessary components.
- Increasing the engine speed directly after maintenance or repairs of the lubrication system can cause damage to various engine components.
- Make sure that all consumers are switched off and the vehicle is in neutral gear position before starting the engine.
- Check if the red oil pressure warning in the instrument panel disappears within ten seconds; if not, key off the engine and investigate the problem.

M032087 - 01.16.2013

Draining oil, oil module

1. Loosen the oil filter element to allow the oil to flow back into the sump.
2. Position suitable containers under the drain plug (1).
3. Drain the oil module via the drain plug (1).

4. After draining, install the drain plug (1) and tighten it to the specified torque.

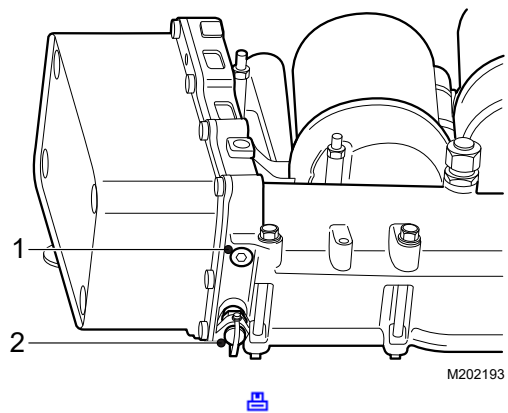


M034618 - 03.07.2016

Technical data

Tightening torque, drain plugs, oil module

Oil drain plug (1)	15 Nm [133 lb-in]
Coolant drain valve (2)	15 Nm [133 lb-in]



M033691 - 02.10.2016

1.5 drain coolant oil module (Lubrication system)

Explanation

Warning, coolant



- Coolant is toxic. Avoid prolonged or repeated contact with the skin. In case of contact, immediately wash the skin with soap and water. In case of eye contact, rinse with plenty of water. Do not ingest. If swallowed, seek immediate medical attention. Do not induce vomiting.

- Do not remove the radiator cap from a hot or running engine. When the coolant is hot, there is overpressure in the cooling system. It can cause scalding coolant to spray out and cause serious personal injury. Carefully remove the filler cap to release the overpressure.

If the engine has been operated within the last 30 minutes, be very careful when removing the radiator cap. Protect face, hands, and arms against escaping fluid and steam by covering the cap with a large, thick rag while carefully removing it.

- Handle coolant and antifreeze carefully. Ethylene glycol antifreeze is poisonous. Store it in the original fluid container only, and always keep it out of the reach of children. • Also, never remove the cap on the surge tank while the engine is still hot. Wait until the coolant temperature is below 50°C (120°F). Scalding steam and fluid under pressure may escape and cause serious personal injuries.



- In order to avoid **damaging the engine block, do not fill up a warm engine with coolant.**

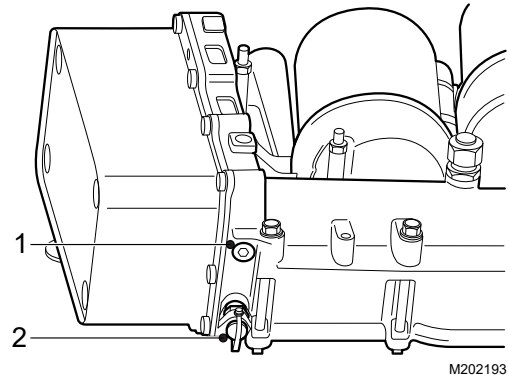


Coolant is harmful to the environment. Unused coolant must be stored as a toxic hazardous substance in leak-proof containers. Used coolant must be processed as industrial chemical waste. Please follow HAZMAT guidelines both with used and unused coolants.

M024408 - 03.07.2013

Draining coolant oil module

1. Position suitable containers under the drain plug (2).
2. Unhook the C-clamp, and pull out the plug from the quick drain valve (2).
3. Use an adapter to drain the oil module.
4. After draining, refit the drain plug (2) and lock it with the C-clamp.



M202193

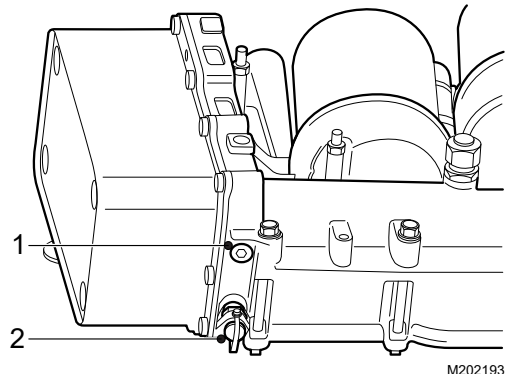


M033685 - 02.10.2016

Technical data

Tightening torque, drain plugs, oil module

Oil drain plug (1)	15 Nm [133 lb-in]
Coolant drain valve (2)	15 Nm [133 lb-in]



M202193



M033691 - 02.10.2016



1.6 drain fuel filtration module (Fuel system)

Explanation

Warning, Fuel System



- **Eye contact:** Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Consult a doctor.
- **Skin contact:** Wash off immediately with plenty of water. If symptoms persist, consult a doctor.

- **Inhalation:** Get some fresh air. If symptoms persist, consult a doctor.
- **Ingestion:** Rinse mouth with water and then drink plenty of water. Do not induce vomiting. Consult a doctor.



- Fuel vapors and spills are potential fire hazards.
- When opening a fuel system, fuel can escape. Collect the fuel during servicing and dispose of it properly to avoid the risk of fire.
- Mixing other fuels, such as gasoline, alcohol or gasohol with diesel can produce an explosive mixture.



To avoid injury from fuel while performing service on any fuel-system-related component(s):

- Prevent fuel from leaking or dripping onto the starter motor.
- Check the fuel components for leakage very carefully.
- Clean spilled or leaked fuel.
- Keep people who are not directly involved in the servicing away from the immediate area.
- Wear protective clothing (including face shield, insulated gloves and apron).
- Keep the work area well ventilated to prevent build-up of volatile fuel vapors.
- Keep all potential ignition sources away from the fuel. This includes: excessive heat, open flames, cigarettes, sparks and electrical sources.



- Do not touch any of the fluoroelastomer seals or O-rings if they have been exposed to a temperature of 315°C or higher. The material of this product does not burn but decomposes into a charred, black, sticky substance. This decomposition may contain hydrofluoric acid. This is very aggressive and difficult to remove once it has contaminated the skin. Use PVC or rubber gloves until the decomposed material has been identified and/or removed. If the substance makes contact with the skin, contact a doctor immediately.



- Dirt or debris in the fuel system can lead to severe engine damage.
- Blocking and/or clamping the fuel pipes can lead to severe engine damage.
- Never block or plug the common rail release valve output, as this can lead to severe rail and common rail pressure release valve damage.
- Immediately plug the openings of the fuel system.
- Clean the area before performing maintenance.
- Cover the crankcase pressure sensor and make sure that it cannot come in contact with any fuel or fuel vapors.

M035658 - 01.09.2017

Draining fuel filtration module

1. Open the filler screw cap of the fuel tank to prevent overpressure in the fuel system.
2. Thoroughly clean the fuel filter screw cap and the area.



Prevent dirt from entering the fuel system.

3. Unscrew the fuel filter cap a few turns until the O-ring is fully visible and wait until the filtration module is fully drained.



Use only a socket or box wrench.

Do not further unscrew the fuel filter cap until the module is drained.

4. Remove the fuel filter screw cap with fuel filter element from the filtration unit.

M058969 - 05.08.2017

1.7 loosen coolant hose, radiator supply 01

Explanation

Warning, coolant



- Coolant is toxic. Avoid prolonged or repeated contact with the skin. In case of contact, immediately wash the skin with soap and water. In case of eye contact, rinse with plenty of water. Do not ingest. If swallowed, seek immediate medical attention. Do not induce vomiting.

- Do not remove the radiator cap from a hot or running engine. When the coolant is hot, there is overpressure in the cooling system. It can cause scalding coolant to spray out and cause serious personal injury. Carefully remove the filler cap to release the overpressure.

If the engine has been operated within the last 30 minutes, be very careful when removing the radiator cap. Protect face, hands, and arms against escaping fluid and steam by covering the cap with a large, thick rag while carefully removing it.

- Handle coolant and antifreeze carefully. Ethylene glycol antifreeze is poisonous. Store it in the original fluid container only, and always keep it out of the reach of children. • Also, never remove the cap on the surge tank while the engine is still hot. Wait until the coolant temperature is below 50°C (120°F). Scalding steam and fluid under pressure may escape and cause serious personal injuries.



- In order to avoid damaging the engine block, do not fill up a warm engine with coolant.



Coolant is harmful to the environment. Unused coolant must be stored as a toxic hazardous substance in leak-proof containers. Used coolant must be processed as industrial chemical waste. Please follow HAZMAT guidelines both with used and unused coolants.

M024408 - 03.07.2013

1.8 loosen coolant hose, radiator outlet 01

Explanation

Warning, coolant



- Coolant is toxic. Avoid prolonged or repeated contact with the skin. In case of contact, immediately wash the skin with soap and water. In case of eye contact, rinse with plenty of water. Do not ingest. If swallowed, seek immediate medical attention. Do not induce vomiting.

- Do not remove the radiator cap from a hot or running engine. When the coolant is hot, there is overpressure in the cooling system. It can cause scalding coolant to spray out and cause serious personal injury. Carefully remove the filler cap to release the overpressure.

If the engine has been operated within the last 30 minutes, be very careful when removing the radiator cap. Protect face, hands, and arms against escaping fluid and steam by covering the cap with a large, thick rag while carefully removing it.

- Handle coolant and antifreeze carefully. Ethylene glycol antifreeze is poisonous. Store it in the original fluid container only, and always keep it out of the reach of children. • Also, never remove the cap on the surge tank while the engine is still hot. Wait until the coolant temperature is below 50°C (120°F). Scalding steam and fluid under pressure may escape and cause serious personal injuries.



- In order to avoid damaging the engine block, do not fill up a warm engine with coolant.



Coolant is harmful to the environment. Unused coolant must be stored as a toxic hazardous substance in leak-proof containers. Used coolant must be processed as industrial chemical waste. Please follow HAZMAT guidelines both with used and unused coolants.

M024408 - 03.07.2013

- ☐  1.9 disconnect starter motor (Alternator and starter motor)
- ☐  1.10 remove starter motor (Alternator and starter motor)
- ☐  1.11 loosen fuel pipe from tank to fuel lift pump (Fuel system)

Explanation

Warning, Fuel System



- Eye contact: Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Consult a doctor.
- Skin contact: Wash off immediately with plenty of water. If symptoms persist, consult a doctor.
- Inhalation: Get some fresh air. If symptoms persist, consult a doctor.
- Ingestion: Rinse mouth with water and then drink plenty of water. Do not induce vomiting. Consult a doctor.



- Fuel vapors and spills are potential fire hazards.
- When opening a fuel system, fuel can escape. Collect the fuel during servicing and dispose of it properly to avoid the risk of fire.
- Mixing other fuels, such as gasoline, alcohol or gasohol with diesel can produce an explosive mixture.



To avoid injury from fuel while performing service on any fuel-system-related component(s):

- Prevent fuel from leaking or dripping onto the starter motor.
- Check the fuel components for leakage very carefully.
- Clean spilled or leaked fuel.
- Keep people who are not directly involved in the servicing away from the immediate area.
- Wear protective clothing (including face shield, insulated gloves and apron).
- Keep the work area well ventilated to prevent build-up of volatile fuel vapors.
- Keep all potential ignition sources away from the fuel. This includes: excessive heat, open flames, cigarettes, sparks and electrical sources.



- Do not touch any of the fluoroelastomer seals or O-rings if they have been exposed to a temperature of 315°C or higher. The material of this product does not burn but decomposes into a charred, black, sticky substance. This decomposition may contain hydrofluoric acid. This is very aggressive and difficult to remove once it has contaminated the skin. Use PVC or rubber gloves until the decomposed material has

been identified and/or removed. If the substance makes contact with the skin, contact a doctor immediately.

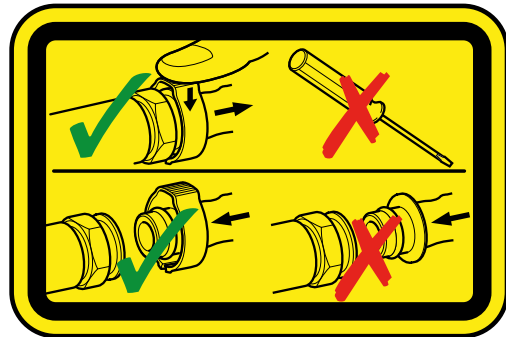


- Dirt or debris in the fuel system can lead to severe engine damage.
- Blocking and/or clamping the fuel pipes can lead to severe engine damage.
- Never block or plug the common rail release valve output, as this can lead to severe rail and common rail pressure release valve damage.
- Immediately plug the openings of the fuel system.
- Clean the area before performing maintenance.
- Cover the crankcase pressure sensor and make sure that it cannot come in contact with any fuel or fuel vapors.

M035658 - 01.09.2017

Disconnecting quick-release coupling

- No tooling is allowed for disconnecting or connecting the quick-release coupling.
- The pipe must be free of any fluid pressure before disconnecting.



i403864



New situation

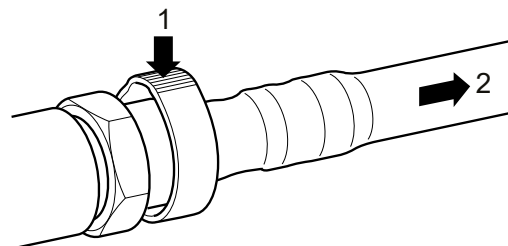
1. Clean the area around the connection.
2. Press and hold the release element (1).



To reach the ribbed surface (1), rotate the release element.

Do not remove the release element from the quick-release coupling.

3. Pull the male quick-release coupling (2) out of the female coupling.



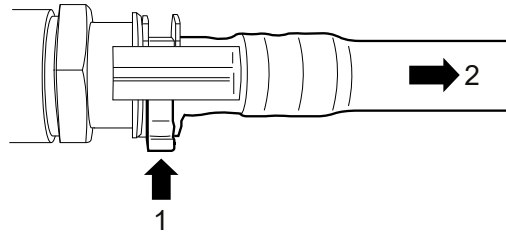
i403787



Old situation

1. Clean the area around the connection.
2. Press and hold the release element (1).
3. Pull the male quick-release coupling (2) out of the female coupling.

Old



R601501



M035352 - 08.17.2016

1.12 loosen fuel tank return pipe (Fuel system)

Explanation

Warning, Fuel System



- Eye contact: Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Consult a doctor.
- Skin contact: Wash off immediately with plenty of water. If symptoms persist, consult a doctor.
- Inhalation: Get some fresh air. If symptoms persist, consult a doctor.
- Ingestion: Rinse mouth with water and then drink plenty of water. Do not induce vomiting. Consult a doctor.



- Fuel vapors and spills are potential fire hazards.
- When opening a fuel system, fuel can escape. Collect the fuel during servicing and dispose of it properly to avoid the risk of fire.
- Mixing other fuels, such as gasoline, alcohol or gasohol with diesel can produce an explosive mixture.



To avoid injury from fuel while performing service on any fuel-system-related component(s):

- Prevent fuel from leaking or dripping onto the starter motor.
- Check the fuel components for leakage very carefully.
- Clean spilled or leaked fuel.
- Keep people who are not directly involved in the servicing away from the immediate area.
- Wear protective clothing (including face shield, insulated gloves and apron).
- Keep the work area well ventilated to prevent build-up of volatile fuel vapors.
- Keep all potential ignition sources away from the fuel. This includes: excessive heat, open flames, cigarettes, sparks and electrical sources.



- Do not touch any of the fluoroelastomer seals or O-rings if they have been exposed to a temperature of 315°C or higher. The material of this product does not burn but decomposes into a charred, black, sticky substance. This decomposition may contain hydrofluoric acid. This is very aggressive and difficult to remove once it has contaminated the skin. Use PVC or rubber gloves until the decomposed material has been identified and/or removed. If the substance makes contact with the skin, contact a doctor immediately.
- Dirt or debris in the fuel system can lead to severe engine damage.

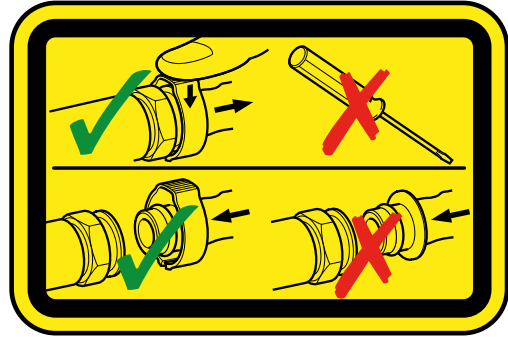


- **Blocking and/or clamping the fuel pipes can lead to severe engine damage.**
- **Never block or plug the common rail release valve output, as this can lead to severe rail and common rail pressure release valve damage.**
- **Immediately plug the openings of the fuel system.**
- **Clean the area before performing maintenance.**
- **Cover the crankcase pressure sensor and make sure that it cannot come in contact with any fuel or fuel vapors.**

M035658 - 01.09.2017

Disconnecting quick-release coupling

- **No tooling is allowed for disconnecting or connecting the quick-release coupling.**
- **The pipe must be free of any fluid pressure before disconnecting.**



i403864



New situation

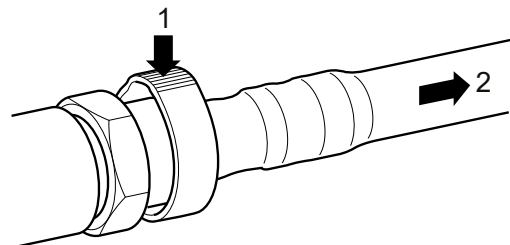
1. Clean the area around the connection.
2. Press and hold the release element (1).



To reach the ribbed surface (1), rotate the release element.

Do not remove the release element from the quick-release coupling.

3. Pull the male quick-release coupling (2) out of the female coupling.



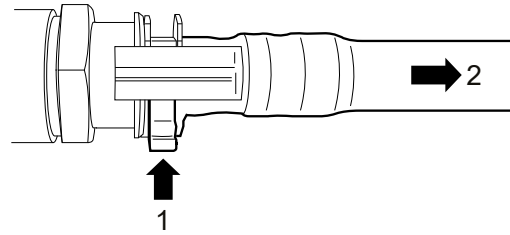
i403787



Old situation

1. Clean the area around the connection.
2. Press and hold the release element (1).
3. Pull the male quick-release coupling (2) out of the female coupling.

Old



R601501

*M035352 - 08.17.2016*

1.13 loosen bracket, fuel system (Fuel system)

1.14 loosen poly-V-belt 8PK (Pulley)

Explanation

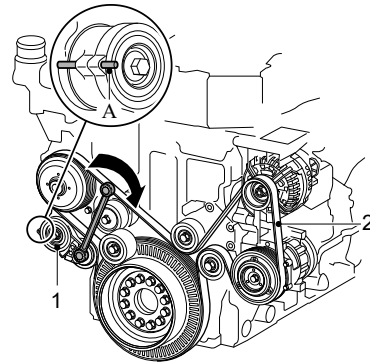
Loosening poly-V-belt 8PK

1. Move the tensioner (1) against the spring force and lock it with a 4 mm thick pin (A).



Use only a hexagonal socket or a hexagonal ring spanner.

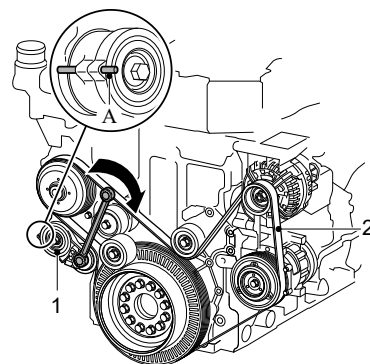
2. Take the poly-V-belt (2) off the idler pulley first and then off the belt pulleys.



i402152



Situation with idler pulley



i403874



Situation without idler pulley

M032906 - 10.28.2016

1.15 remove poly-V-belt 8PK (Pulley)

1.16 loosen poly-V-belt 12PK (Pulley)

Explanation

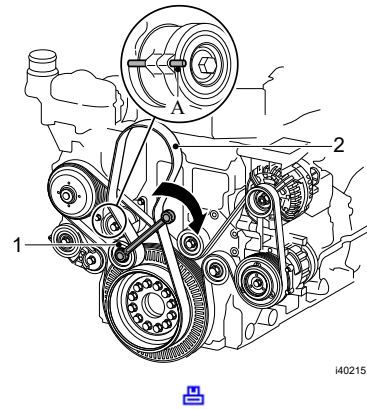
Loosening poly-V belt 12PK

1. Move the tensioner (1) against the spring force and lock it with a 4 mm thick pin (A).



Use only a hexagonal socket or a hexagonal ring spanner.

2. Take the poly-V-belt (2) off the guide roll first and then off the belt pulleys.



M032904 - 01.15.2015

- ☐ ☐ 1.17 remove poly-V-belt 12PK (Pulley)
- ☐ ☐ 1.18 remove right-hand tensioner pulley, poly-V-belt (Pulley)
- ☐ ☐ 1.19 disconnect temperature sensor (Lubrication system)
- ☐ ☐ 1.20 loosen assembly bracket, electrical system (Electrical system, engine)
- ☐ ☐ 1.21 remove oil module (Lubrication system)

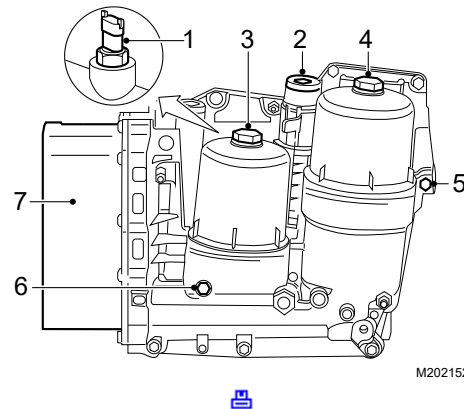
Explanation

Removing oil module

1. Remove the attachment bolts, and remove the oil module by sliding it backward.



- Moving the oil module sideways **damages** the coolant connection pipe.
- Chassis design and engine installation configurations make it necessary in some cases to remove the coolant pump housing to allow the oil module to be removed toward the front of the engine.



M033653 - 01.16.2013

- ☐ ☐ 1.22 check leakage engine oil cooler (Lubrication system)

Explanation

Checking leakage engine oil cooler



- For a correct leakage check of the engine oil cooler (1), test both the oil circuit and the coolant circuit.

1. Mount the oil cooler adapter plate for the leakage testing special tool (1742628) (C) onto the

engine oil cooler (1).

2. Use the oil cooler attachment bolts (2) and tighten them to the specified torque for the oil cooler (1).



Use the included O-rings (F) to seal the connection between the oil cooler (1) and the oil cooler adapter plate (C).

3. Install the hose nipples (A) in the oil cooler adapter plate and tighten them to the specified torque.



Use the included O-rings (B) to seal the connection between the hose nipples (A) and the oil cooler adapter plate (C).

4. Install the plugs (D) in the oil cooler adapter plate and tighten them to the specified torque.



Use the included O-rings (E) to seal the connection between the plugs (D) and the oil cooler adapter plate (C).

5. Connect air hoses to the hose nipples (A) and submerge the assembly in a bucket of water as shown.



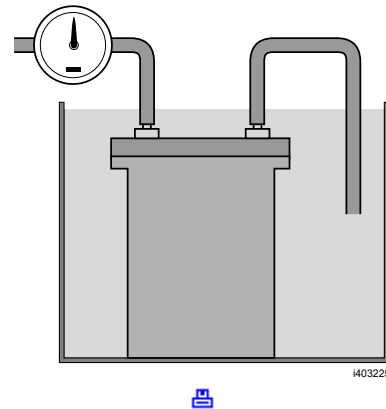
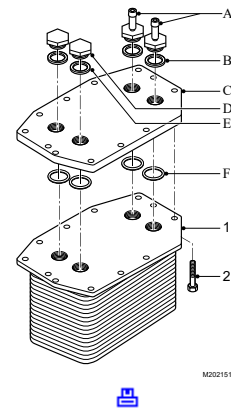
Make sure that no water leaks into the oil cooler, this contaminates the internal oil cooler circuits.

6. Supply compressed air (maximum 5 bar [72.5 psi]) to the engine oil cooler.
7. Check the oil cooler for leakage.



- Make sure not to detect false leaks at the connection of the hose nipples (A) to the oil cooler adapter plate (C).
- **Internal leakage:** Air bubbles appear from the submerged air hose of the oil cooler
- **External leakage:** Air bubbles appear from the engine oil cooler (1).

8. Depressurize the engine oil cooler and remove it from the bucket of water.
9. Swap the air hoses on the hose nipples (A) and repeat steps 4-7 for the other circuit.
10. Depressurize the engine oil cooler, remove it from the bucket of water and dismount the oil cooler adapter plate (C).
11. Replace the engine oil cooler (1) if a leak is detected.





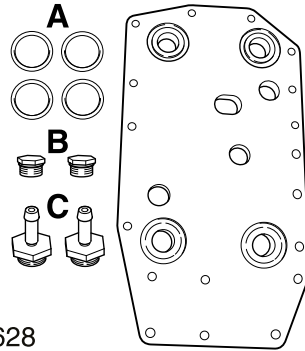
- If no leakage is detected, check other possible causes, for example the gearbox cooler.
- Internal leakage of the engine oil cooler almost certainly causes contamination of the cooling system with engine oil.
- If internal leakage is detected, clean the cooling system according to the procedure described in 'Clean cooling system (Cooling system)'.

M031243 - 02.10.2015

Special tools

Special tool category: Mandatory special tool for: NA region
1742628

Oil cooler adapter plate for leakage testing



1742628

T00143-3

"Contents 1742628"



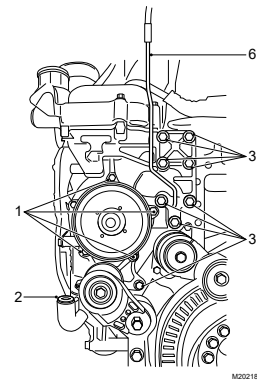
ST1742628 - 08.07.2018

1.23 remove assembly coolant pump, engine (Cooling system)

Explanation

Removing assembly coolant pump, engine

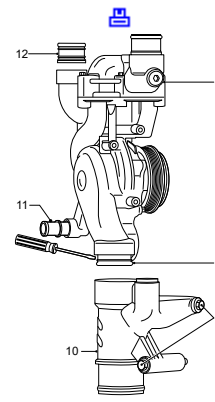
1. Remove the attachment bolts (3).



2. Remove the coolant pump by maneuvering it downward and sideways.



The sealing ring (8 and 12) and coolant connecting pipe (11) must be replaced once the coolant pump has been removed.





M032476 - 08.11.2017

- 1.24 remove assembly air inlet pipe, inlet manifold (Inlet and exhaust element)
- 1.25 remove steel oil sump (Lubrication system)

Explanation

Warning, Lubricating Oil



- Lubricating oil can cause skin irritation or skin injury.
- To prevent skin injury, avoid unnecessary contact with lubricating oil.
- Wear protective clothing, eyewear and gloves.



- Run the engine at idle speed for at least one minute, directly after maintenance or repairs of the lubrication system, to allow oil to reach all necessary components.
- Increasing the engine speed directly after maintenance or repairs of the lubrication system can cause damage to various engine components.
- Make sure that all consumers are switched off and the vehicle is in neutral gear position before starting the engine.
- Check if the red oil pressure warning in the instrument panel disappears within ten seconds; if not, key off the engine and investigate the problem.

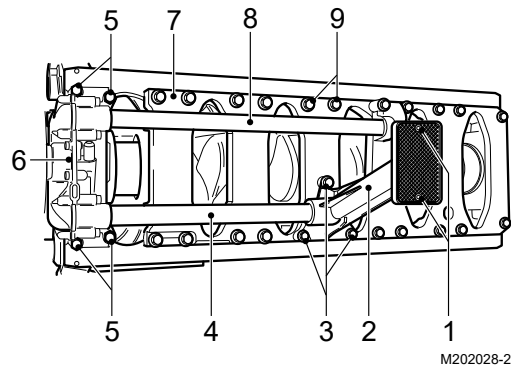
M032087 - 01.16.2013

- 1.26 dismount sealing rubber, oil sump (Lubrication system)
- 1.27 remove oil suction pipe (Lubrication system)

Explanation

Removing oil suction pipe

1. Remove the oil suction pipe attachment bolts (3).
2. Remove the oil suction pipe (2) by sliding it out of the oil pipe, suction side (4).



M202028-2



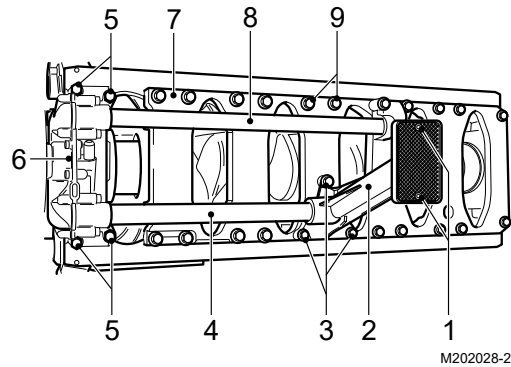
M029602 - 03.31.2014

- 1.28 remove oil pipe, suction side (Lubrication system)
- 1.29 remove oil pipe, delivery side (Lubrication system)
- 1.30 remove engine oil pump (Lubrication system)

Explanation

Removing engine oil pump

1. Remove the engine oil pump attachment bolts (5).
2. Remove the engine oil pump (6).



M202028-2

M029600 - 11.04.2010

- 1.31 remove fixing frame (Lubrication system)
- 1.32 loosen return coolant pipe (Air compressor)

Explanation

Warning, coolant



- Coolant is toxic. Avoid prolonged or repeated contact with the skin. In case of contact, immediately wash the skin with soap and water. In case of eye contact, rinse with plenty of water. Do not ingest. If swallowed, seek immediate medical attention. Do not induce vomiting.
- Do not remove the radiator cap from a hot or running engine. When the coolant is hot, there is overpressure in the cooling system. It can cause scalding coolant to spray out and cause serious personal injury. Carefully remove the filler cap to release the overpressure.

If the engine has been operated within the last 30 minutes, be very careful when removing the radiator cap. Protect face, hands, and arms against escaping fluid and steam by covering the cap with a large, thick rag while carefully removing it.
- Handle coolant and antifreeze carefully. Ethylene glycol antifreeze is poisonous. Store it in the original fluid container only, and always keep it out of the reach of children. • Also, never remove the cap on the surge tank while the engine is still hot. Wait until the coolant temperature is below 50°C (120°F). Scalding steam and fluid under pressure may escape and cause serious personal injuries.



- In order to avoid damaging the engine block, do not fill up a warm engine with coolant.

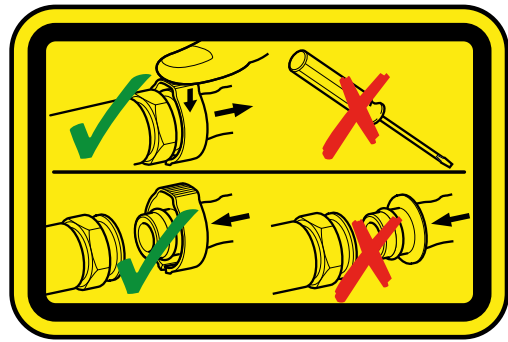


Coolant is harmful to the environment. Unused coolant must be stored as a toxic hazardous substance in leak-proof containers. Used coolant must be processed as industrial chemical waste. Please follow HAZMAT guidelines both with used and unused coolants.

M024408 - 03.07.2013

Disconnecting quick-release coupling

- No tooling is allowed for disconnecting or connecting the quick-release coupling.
- The pipe must be free of any fluid pressure before disconnecting.



i403864



New situation

1. Clean the area around the connection.
2. Press and hold the release element (1).

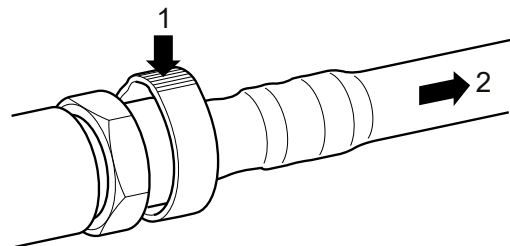


To reach the ribbed surface (1), rotate the release element.

Do not remove the release element from the quick-release coupling.

3. Pull the male quick-release coupling (2) out of the female coupling.

New



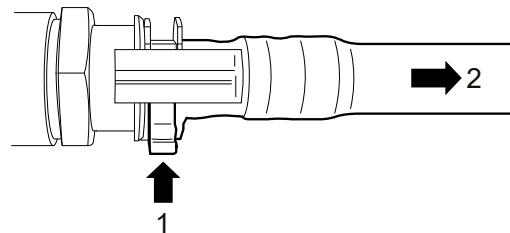
i403787



Old situation

1. Clean the area around the connection.
2. Press and hold the release element (1).
3. Pull the male quick-release coupling (2) out of the female coupling.

Old



R601501



M035352 - 08.17.2016

- 1.33 loosen supply coolant pipe (Air compressor)

Explanation

Warning, coolant



- Coolant is toxic. Avoid prolonged or repeated contact with the skin. In case of contact, immediately wash the skin with soap and water. In case of eye contact, rinse

with plenty of water. Do not ingest. If swallowed, seek immediate medical attention. Do not induce vomiting.

- Do not remove the radiator cap from a hot or running engine. When the coolant is hot, there is overpressure in the cooling system. It can cause scalding coolant to spray out and cause serious personal injury. Carefully remove the filler cap to release the overpressure.

If the engine has been operated within the last 30 minutes, be very careful when removing the radiator cap. Protect face, hands, and arms against escaping fluid and steam by covering the cap with a large, thick rag while carefully removing it.

- Handle coolant and antifreeze carefully. Ethylene glycol antifreeze is poisonous. Store it in the original fluid container only, and always keep it out of the reach of children. • Also, never remove the cap on the surge tank while the engine is still hot. Wait until the coolant temperature is below 50°C (120°F). Scalding steam and fluid under pressure may escape and cause serious personal injuries.



- In order to avoid damaging the engine block, do not fill up a warm engine with coolant.

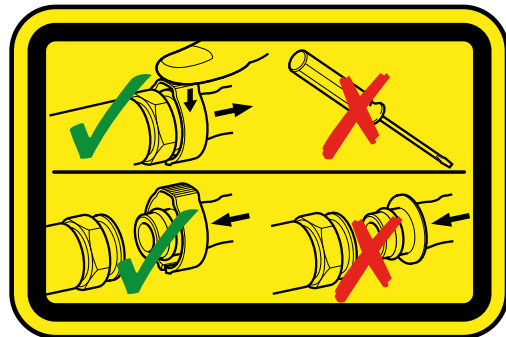


Coolant is harmful to the environment. Unused coolant must be stored as a toxic hazardous substance in leak-proof containers. Used coolant must be processed as industrial chemical waste. Please follow HAZMAT guidelines both with used and unused coolants.

M024408 - 03.07.2013

Disconnecting quick-release coupling

- No tooling is allowed for disconnecting or connecting the quick-release coupling.
- The pipe must be free of any fluid pressure before disconnecting.



i403864



New situation

- Clean the area around the connection.
- Press and hold the release element (1).

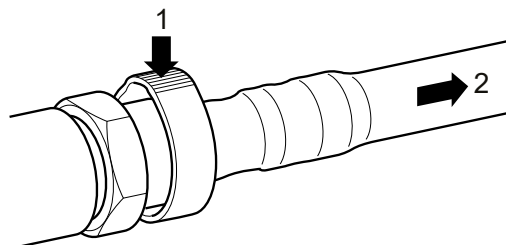


To reach the ribbed surface (1), rotate the release element.

Do not remove the release element from the quick-release coupling.

- Pull the male quick-release coupling (2) out of the female coupling.

New

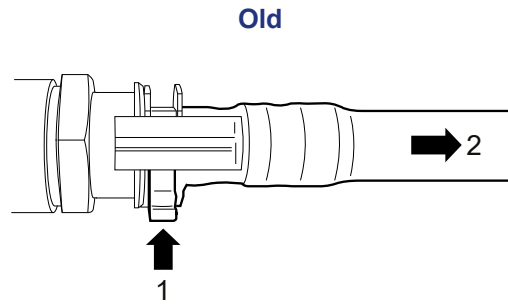


i403787



Old situation

1. Clean the area around the connection.
2. Press and hold the release element (1).
3. Pull the male quick-release coupling (2) out of the female coupling.



R601501



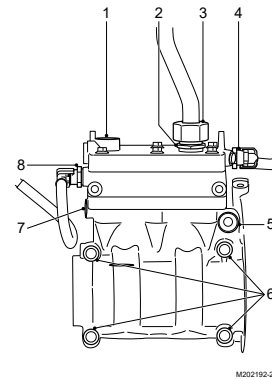
M035352 - 08.17.2016

- ☐  1.34 loosen compressor pipe 01, suction side (Air compressor)
- ☐  1.35 loosen compressor pipe 01, delivery side
- ☐  1.36 loosen tandem pump (Steering pump)
- ☐  1.37 loosen compressor pipe, air dryer command
- ☐  1.38 remove two cylinder air compressor (Air compressor)

Explanation

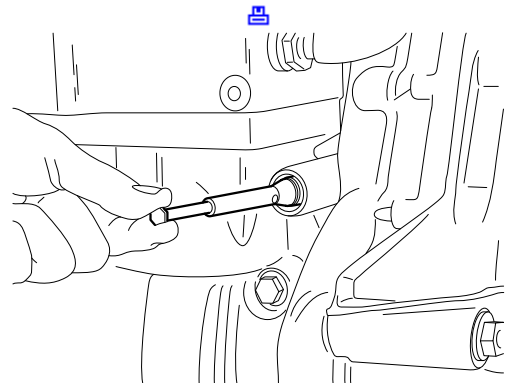
Removing the air compressor

1. Remove the plug (5) to access the connecting pipe with seal behind it.



M202192-2

2. Fit an M6 bolt in the connecting pipe with seal to pull it out of the engine block as shown.
3. Remove the attachment bolts (6) from the air compressor.
4. Remove the air compressor from the flywheel housing.



M201330



M036783 - 04.22.2016

- ☐  1.39 remove 2 (two) fuel injection pipe from pump unit to fuel rail (Fuel system)

Explanation

Warning, Fuel System



- **Eye contact:** Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Consult a doctor.
- **Skin contact:** Wash off immediately with plenty of water. If symptoms persist, consult a doctor.
- **Inhalation:** Get some fresh air. If symptoms persist, consult a doctor.
- **Ingestion:** Rinse mouth with water and then drink plenty of water. Do not induce vomiting. Consult a doctor.



- Fuel vapors and spills are potential fire hazards.
- When opening a fuel system, fuel can escape. Collect the fuel during servicing and dispose of it properly to avoid the risk of fire.
- Mixing other fuels, such as gasoline, alcohol or gasohol with diesel can produce an explosive mixture.



To avoid injury from fuel while performing service on any fuel-system-related component(s):

- Prevent fuel from leaking or dripping onto the starter motor.
- Check the fuel components for leakage very carefully.
- Clean spilled or leaked fuel.
- Keep people who are not directly involved in the servicing away from the immediate area.
- Wear protective clothing (including face shield, insulated gloves and apron).
- Keep the work area well ventilated to prevent build-up of volatile fuel vapors.
- Keep all potential ignition sources away from the fuel. This includes: excessive heat, open flames, cigarettes, sparks and electrical sources.



- Do not touch any of the fluoroelastomer seals or O-rings if they have been exposed to a temperature of 315°C or higher. The material of this product does not burn but decomposes into a charred, black, sticky substance. This decomposition may contain hydrofluoric acid. This is very aggressive and difficult to remove once it has contaminated the skin. Use PVC or rubber gloves until the decomposed material has been identified and/or removed. If the substance makes contact with the skin, contact a doctor immediately.



- Dirt or debris in the fuel system can lead to severe engine damage.
- Blocking and/or clamping the fuel pipes can lead to severe engine damage.
- Never block or plug the common rail release valve output, as this can lead to severe rail and common rail pressure release valve damage.
- Immediately plug the openings of the fuel system.
- Clean the area before performing maintenance.
- Cover the crankcase pressure sensor and make sure that it cannot come in contact with any fuel or fuel vapors.

M035658 - 01.09.2017

Warning, fuel injection pipe



Do not reuse the fuel injection pipe if the "Evaluate the injector back leak" test in DAVIE cannot be performed successfully.



- The high-pressure fuel injection pipes are not intended to be reused indefinitely.
- The fuel injection pipes and connections must be checked properly before reuse.

- **Damaged and / or incorrectly installed injection pipes can cause hot fuel leakage, flammable gases or vapors.**



Highly pressurized fuel is present in the common rail, fuel injection pipes and other high-pressure fuel components when the engine is running and when the engine is switched off. The pressure leaks away slowly when the ignition is switched off.

Wait at least one minute before performing maintenance on high-pressure fuel components.

M030466 - 09.22.2017

Removing fuel injection pipe

1. Clean the fuel injection pipe connection and its surroundings thoroughly.
2. If reusing the fuel injection pipe, **label** the fuel injection pipe so it can be reinstalled in the original position.
3. Loosen the union nuts on both ends and carefully remove the fuel injection pipe.
4. Cover both ends of the fuel injection pipe using clean protective caps.



If reusing the fuel injection pipe, store it in a clean plastic bag.

M036558 - 05.08.2017

1.40 **loosen assembly fuel intake module (Fuel system)**

Explanation

Warning, Fuel System



- **Eye contact:** Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Consult a doctor.
- **Skin contact:** Wash off immediately with plenty of water. If symptoms persist, consult a doctor.
- **Inhalation:** Get some fresh air. If symptoms persist, consult a doctor.
- **Ingestion:** Rinse mouth with water and then drink plenty of water. Do not induce vomiting. Consult a doctor.



- **Fuel vapors and spills are potential fire hazards.**
- **When opening a fuel system, fuel can escape. Collect the fuel during servicing and dispose of it properly to avoid the risk of fire.**
- **Mixing other fuels, such as gasoline, alcohol or gasohol with diesel can produce an explosive mixture.**



To avoid injury from fuel while performing service on any fuel-system-related component(s):

- **Prevent fuel from leaking or dripping onto the starter motor.**
- **Check the fuel components for leakage very carefully.**
- **Clean spilled or leaked fuel.**
- **Keep people who are not directly involved in the servicing away from the immediate area.**

- Wear protective clothing (including face shield, insulated gloves and apron).
- Keep the work area well ventilated to prevent build-up of volatile fuel vapors.
- Keep all potential ignition sources away from the fuel. This includes: excessive heat, open flames, cigarettes, sparks and electrical sources.



- Do not touch any of the fluoroelastomer seals or O-rings if they have been exposed to a temperature of 315°C or higher. The material of this product does not burn but decomposes into a charred, black, sticky substance. This decomposition may contain hydrofluoric acid. This is very aggressive and difficult to remove once it has contaminated the skin. Use PVC or rubber gloves until the decomposed material has been identified and/or removed. If the substance makes contact with the skin, contact a doctor immediately.



- Dirt or debris in the fuel system can lead to severe engine damage.
- Blocking and/or clamping the fuel pipes can lead to severe engine damage.
- Never block or plug the common rail release valve output, as this can lead to severe rail and common rail pressure release valve damage.
- Immediately plug the openings of the fuel system.
- Clean the area before performing maintenance.
- Cover the crankcase pressure sensor and make sure that it cannot come in contact with any fuel or fuel vapors.

M035658 - 01.09.2017

- ☐ 1.41 disconnect fuel or coolant temperature sensor (Sensors electrical system, engine)
- ☐ 1.42 disconnect fuel pressure sensor (Sensors electrical system, engine)
- ☐ 1.43 disconnect 2 (two) common rail pump unit (Fuel system)
- ☐ 1.44 remove 2 (two) common rail pump unit (Fuel system)

Explanation

Warning, Fuel System



- Eye contact: Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Consult a doctor.
- Skin contact: Wash off immediately with plenty of water. If symptoms persist, consult a doctor.
- Inhalation: Get some fresh air. If symptoms persist, consult a doctor.
- Ingestion: Rinse mouth with water and then drink plenty of water. Do not induce vomiting. Consult a doctor.



- Fuel vapors and spills are potential fire hazards.
- When opening a fuel system, fuel can escape. Collect the fuel during servicing and dispose of it properly to avoid the risk of fire.
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To avoid injury from fuel while performing service on any fuel-system-related component(s):

- Prevent fuel from leaking or dripping onto the starter motor.
- Check the fuel components for leakage very carefully.
- Clean spilled or leaked fuel.
- Keep people who are not directly involved in the servicing away from the immediate area.

- Wear protective clothing (including face shield, insulated gloves and apron).
- Keep the work area well ventilated to prevent build-up of volatile fuel vapors.
- Keep all potential ignition sources away from the fuel. This includes: excessive heat, open flames, cigarettes, sparks and electrical sources.



- Do not touch any of the fluoroelastomer seals or O-rings if they have been exposed to a temperature of 315°C or higher. The material of this product does not burn but decomposes into a charred, black, sticky substance. This decomposition may contain hydrofluoric acid. This is very aggressive and difficult to remove once it has contaminated the skin. Use PVC or rubber gloves until the decomposed material has been identified and/or removed. If the substance makes contact with the skin, contact a doctor immediately.



- Dirt or debris in the fuel system can lead to severe engine damage.
- Blocking and/or clamping the fuel pipes can lead to severe engine damage.
- Never block or plug the common rail release valve output, as this can lead to severe rail and common rail pressure release valve damage.
- Immediately plug the openings of the fuel system.
- Clean the area before performing maintenance.
- Cover the crankcase pressure sensor and make sure that it cannot come in contact with any fuel or fuel vapors.

M035658 - 01.09.2017

Removing common rail pump unit



Prevent dirt or debris from entering the common rail pump unit or fuel system. Dirt or debris in the pump unit or fuel system can lead to pump unit failure resulting in an engine no start or severe engine damage.

1. Clean the area around the common rail pump unit and the exterior of the fuel tank.
2. Open the fuel tank cap to release the overpressure in the fuel system.
3. Unscrew the common rail pump unit bolts two turns.



Make sure that the fuel gallery is empty before removing the common rail pump units.

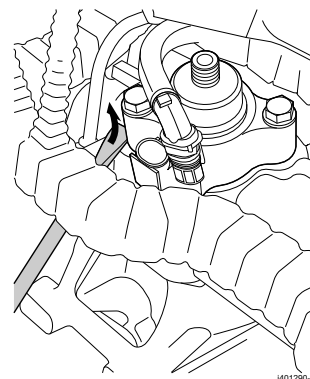
4. Position two screwdrivers under the common rail pump unit flange and tip it loose.
5. Unscrew the common rail pump unit bolts further.
6. Tip up the common rail pump unit again with the screwdrivers.



Keep tipping up the common rail pump unit in this manner until it follows the attachment bolts.

7. Cover the common rail pump unit opening in the engine block.

If reusing the common rail pump unit,



M01290-2



wrap it in a clean plastic bag to prevent dirt from entering it.



- Do not unscrew the common rail pump unit bolts with air or electrical tools.
- Never unscrew the bolts fully in one turn; as a result of the high spring tension, the common rail pump unit might come out of the engine block with great force, causing physical injury and damage to the engine.

M031779 - 01.09.2017

1.45 remove 2 (two) pump unit lifter (Fuel system)

Explanation

Removing pump unit lifter

1. Loosen the locking pin and remove the pump unit tappets.
2. Visually inspect the pump unit lifter and the camshaft for wear and damage.

M028852 - 01.31.2018

1.46 remove oil filler pipe (Lubrication system)

Explanation

Removing oil filling pipe

1. Clean the oil filling pipe (4) and surrounding area.



Use a clean environment and clean tools to prevent dirt from entering the crankcase over the oil fill opening. Failure to do so can damage the engine.

2. Remove the oil filling pipe attachment bolts (1 and 2).



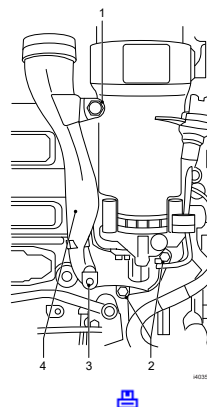
Some truck models use thread hole (3) to mount the power steering line.

3. Remove the oil filling pipe (4) from the engine block.



If oil drips, clean it with a rag.

4. Remove the gasket.



M041845 - 05.13.2014

1.47 disconnect fuel filtration module (Fuel system)

Explanation

Warning: fuel module connectors



- Prevent fuel from contacting the connectors; this can cause electronic and mechanical failure of the connectors.
- For example, use protective covers like 1829108 and 1878441.

M032186 - 11.28.2012

1.48 loosen fuel tank return pipe (Fuel system)

Explanation

Warning, Fuel System



- Eye contact: Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Consult a doctor.
- Skin contact: Wash off immediately with plenty of water. If symptoms persist, consult a doctor.
- Inhalation: Get some fresh air. If symptoms persist, consult a doctor.
- Ingestion: Rinse mouth with water and then drink plenty of water. Do not induce vomiting. Consult a doctor.



- Fuel vapors and spills are potential fire hazards.
- When opening a fuel system, fuel can escape. Collect the fuel during servicing and dispose of it properly to avoid the risk of fire.
- Mixing other fuels, such as gasoline, alcohol or gasohol with diesel can produce an explosive mixture.



To avoid injury from fuel while performing service on any fuel-system-related component(s):

- Prevent fuel from leaking or dripping onto the starter motor.
- Check the fuel components for leakage very carefully.
- Clean spilled or leaked fuel.
- Keep people who are not directly involved in the servicing away from the immediate area.
- Wear protective clothing (including face shield, insulated gloves and apron).
- Keep the work area well ventilated to prevent build-up of volatile fuel vapors.
- Keep all potential ignition sources away from the fuel. This includes: excessive heat, open flames, cigarettes, sparks and electrical sources.



- Do not touch any of the fluoroelastomer seals or O-rings if they have been exposed to a temperature of 315°C or higher. The material of this product does not burn but decomposes into a charred, black, sticky substance. This decomposition may contain hydrofluoric acid. This is very aggressive and difficult to remove once it has contaminated the skin. Use PVC or rubber gloves until the decomposed material has been identified and/or removed. If the substance makes contact with the skin, contact a doctor immediately.



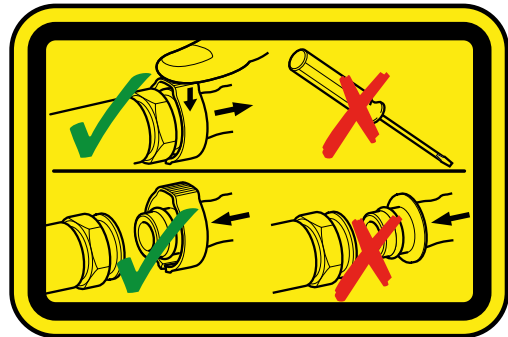
- Dirt or debris in the fuel system can lead to severe engine damage.
- Blocking and/or clamping the fuel pipes can lead to severe engine damage.
- Never block or plug the common rail release valve output, as this can lead to severe rail and common rail pressure release valve damage.
- Immediately plug the openings of the fuel system.

- Clean the area before performing maintenance.
- Cover the crankcase pressure sensor and make sure that it cannot come in contact with any fuel or fuel vapors.

M035658 - 01.09.2017

Disconnecting quick-release coupling

- No tooling is allowed for disconnecting or connecting the quick-release coupling.
- The pipe must be free of any fluid pressure before disconnecting.



i403864



New situation

1. Clean the area around the connection.
2. Press and hold the release element (1).

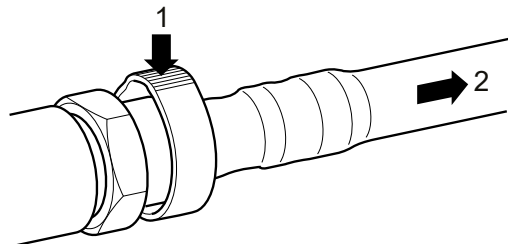


To reach the ribbed surface (1), rotate the release element.

Do not remove the release element from the quick-release coupling.

3. Pull the male quick-release coupling (2) out of the female coupling.

New



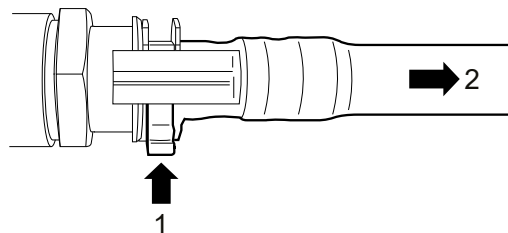
i403787



Old situation

1. Clean the area around the connection.
2. Press and hold the release element (1).
3. Pull the male quick-release coupling (2) out of the female coupling.

Old



R601501



M035352 - 08.17.2016

Explanation

Warning, Fuel System



- **Eye contact:** Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Consult a doctor.
- **Skin contact:** Wash off immediately with plenty of water. If symptoms persist, consult a doctor.
- **Inhalation:** Get some fresh air. If symptoms persist, consult a doctor.
- **Ingestion:** Rinse mouth with water and then drink plenty of water. Do not induce vomiting. Consult a doctor.



- Fuel vapors and spills are potential fire hazards.
- When opening a fuel system, fuel can escape. Collect the fuel during servicing and dispose of it properly to avoid the risk of fire.
- Mixing other fuels, such as gasoline, alcohol or gasohol with diesel can produce an explosive mixture.



To avoid injury from fuel while performing service on any fuel-system-related component(s):

- Prevent fuel from leaking or dripping onto the starter motor.
- Check the fuel components for leakage very carefully.
- Clean spilled or leaked fuel.
- Keep people who are not directly involved in the servicing away from the immediate area.
- Wear protective clothing (including face shield, insulated gloves and apron).
- Keep the work area well ventilated to prevent build-up of volatile fuel vapors.
- Keep all potential ignition sources away from the fuel. This includes: excessive heat, open flames, cigarettes, sparks and electrical sources.



- Do not touch any of the fluoroelastomer seals or O-rings if they have been exposed to a temperature of 315°C or higher. The material of this product does not burn but decomposes into a charred, black, sticky substance. This decomposition may contain hydrofluoric acid. This is very aggressive and difficult to remove once it has contaminated the skin. Use PVC or rubber gloves until the decomposed material has been identified and/or removed. If the substance makes contact with the skin, contact a doctor immediately.

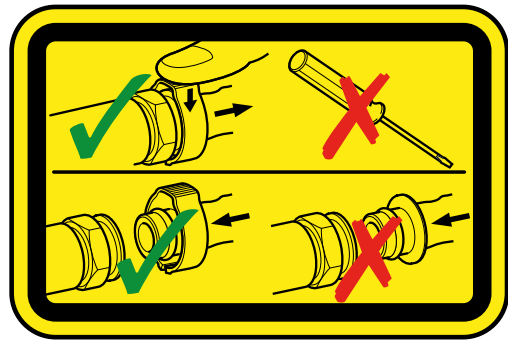


- Dirt or debris in the fuel system can lead to severe engine damage.
- Blocking and/or clamping the fuel pipes can lead to severe engine damage.
- Never block or plug the common rail release valve output, as this can lead to severe rail and common rail pressure release valve damage.
- Immediately plug the openings of the fuel system.
- Clean the area before performing maintenance.
- Cover the crankcase pressure sensor and make sure that it cannot come in contact with any fuel or fuel vapors.

M035658 - 01.09.2017

Disconnecting quick-release coupling

- No tooling is allowed for disconnecting or connecting the quick-release coupling.
- The pipe must be free of any fluid pressure before disconnecting.



i403864



New situation

1. Clean the area around the connection.
2. Press and hold the release element (1).

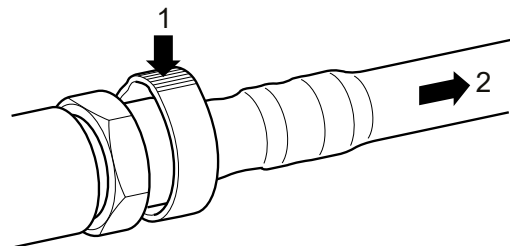


To reach the ribbed surface (1), rotate the release element.

Do not remove the release element from the quick-release coupling.

3. Pull the male quick-release coupling (2) out of the female coupling.

New



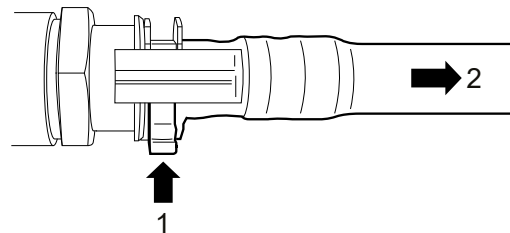
i403787



Old situation

1. Clean the area around the connection.
2. Press and hold the release element (1).
3. Pull the male quick-release coupling (2) out of the female coupling.

Old



R601501



M035352 - 08.17.2016

- 1.50 loosen one side fuel pipe from fuel lift pump to filter (Fuel system)

Explanation

Warning, Fuel System



- Eye contact: Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Consult a doctor.

- **Skin contact:** Wash off immediately with plenty of water. If symptoms persist, consult a doctor.
- **Inhalation:** Get some fresh air. If symptoms persist, consult a doctor.
- **Ingestion:** Rinse mouth with water and then drink plenty of water. Do not induce vomiting. Consult a doctor.



- Fuel vapors and spills are potential fire hazards.
- When opening a fuel system, fuel can escape. Collect the fuel during servicing and dispose of it properly to avoid the risk of fire.
- Mixing other fuels, such as gasoline, alcohol or gasohol with diesel can produce an explosive mixture.



To avoid injury from fuel while performing service on any fuel-system-related component(s):

- Prevent fuel from leaking or dripping onto the starter motor.
- Check the fuel components for leakage very carefully.
- Clean spilled or leaked fuel.
- Keep people who are not directly involved in the servicing away from the immediate area.
- Wear protective clothing (including face shield, insulated gloves and apron).
- Keep the work area well ventilated to prevent build-up of volatile fuel vapors.
- Keep all potential ignition sources away from the fuel. This includes: excessive heat, open flames, cigarettes, sparks and electrical sources.



- Do not touch any of the fluoroelastomer seals or O-rings if they have been exposed to a temperature of 315°C or higher. The material of this product does not burn but decomposes into a charred, black, sticky substance. This decomposition may contain hydrofluoric acid. This is very aggressive and difficult to remove once it has contaminated the skin. Use PVC or rubber gloves until the decomposed material has been identified and/or removed. If the substance makes contact with the skin, contact a doctor immediately.



- Dirt or debris in the fuel system can lead to severe engine damage.
- Blocking and/or clamping the fuel pipes can lead to severe engine damage.
- Never block or plug the common rail release valve output, as this can lead to severe rail and common rail pressure release valve damage.
- Immediately plug the openings of the fuel system.
- Clean the area before performing maintenance.
- Cover the crankcase pressure sensor and make sure that it cannot come in contact with any fuel or fuel vapors.

M035658 - 01.09.2017



1.51 loosen fuel pipe from hand priming pump to fuel lift pump (Fuel system)

Explanation

Warning, Fuel System



- **Eye contact:** Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Consult a doctor.
- **Skin contact:** Wash off immediately with plenty of water. If symptoms persist, consult a doctor.
- **Inhalation:** Get some fresh air. If symptoms persist, consult a doctor.

- **Ingestion: Rinse mouth with water and then drink plenty of water. Do not induce vomiting. Consult a doctor.**



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- **When opening a fuel system, fuel can escape. Collect the fuel during servicing and dispose of it properly to avoid the risk of fire.**
- **Mixing other fuels, such as gasoline, alcohol or gasohol with diesel can produce an explosive mixture.**



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- **Prevent fuel from leaking or dripping onto the starter motor.**
- **Check the fuel components for leakage very carefully.**
- **Clean spilled or leaked fuel.**
- **Keep people who are not directly involved in the servicing away from the immediate area.**
- **Wear protective clothing (including face shield, insulated gloves and apron).**
- **Keep the work area well ventilated to prevent build-up of volatile fuel vapors.**
- **Keep all potential ignition sources away from the fuel. This includes: excessive heat, open flames, cigarettes, sparks and electrical sources.**



- **Do not touch any of the fluoroelastomer seals or O-rings if they have been exposed to a temperature of 315°C or higher. The material of this product does not burn but decomposes into a charred, black, sticky substance. This decomposition may contain hydrofluoric acid. This is very aggressive and difficult to remove once it has contaminated the skin. Use PVC or rubber gloves until the decomposed material has been identified and/or removed. If the substance makes contact with the skin, contact a doctor immediately.**

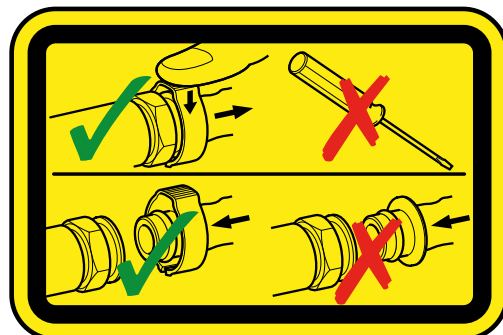


- **Dirt or debris in the fuel system can lead to severe engine damage.**
- **Blocking and/or clamping the fuel pipes can lead to severe engine damage.**
- **Never block or plug the common rail release valve output, as this can lead to severe rail and common rail pressure release valve damage.**
- **Immediately plug the openings of the fuel system.**
- **Clean the area before performing maintenance.**
- **Cover the crankcase pressure sensor and make sure that it cannot come in contact with any fuel or fuel vapors.**

M035658 - 01.09.2017

Disconnecting quick-release coupling

- **No tooling is allowed for disconnecting or connecting the quick-release coupling.**
- **The pipe must be free of any fluid pressure before disconnecting.**



i403864



New situation

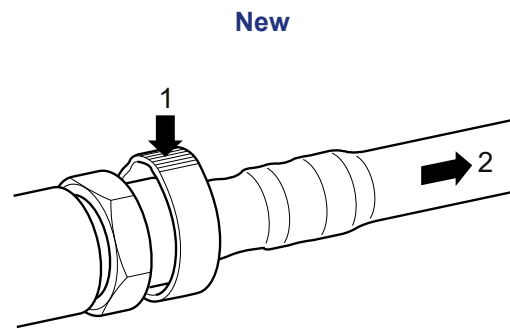
1. Clean the area around the connection.
2. Press and hold the release element (1).



To reach the ribbed surface (1), rotate the release element.

Do not remove the release element from the quick-release coupling.

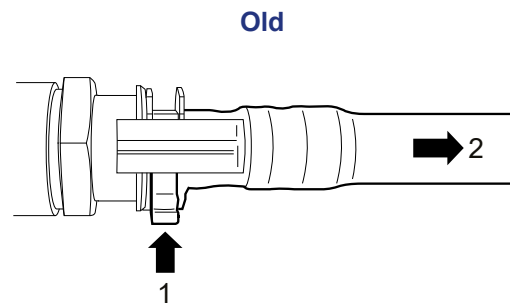
3. Pull the male quick-release coupling (2) out of the female coupling.



i403787

**Old situation**

1. Clean the area around the connection.
2. Press and hold the release element (1).
3. Pull the male quick-release coupling (2) out of the female coupling.



R601501

*M035352 - 08.17.2016*

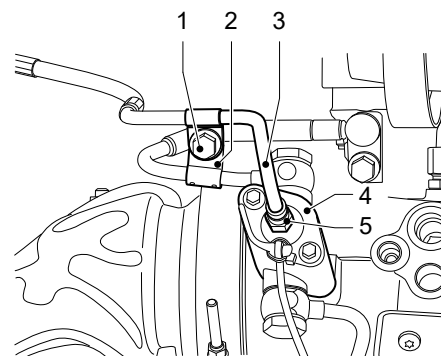
1.52 loosen supply pipe dosing module, fuel (Fuel system)

Explanation**Loosening supply pipe dosing module, fuel**

1. Remove the heat shield.
2. Remove the bolt (1).
3. Loosen the union nut (5) from the fuel dosing module (4).



Pressurized fuel can be present, use a rag to catch possible leaking fuel.



i403701

*M031365 - 09.02.2014*

1.53 remove assembly fuel filtration module (Fuel system)

Explanation

Warning, Fuel System



- **Eye contact:** Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Consult a doctor.
- **Skin contact:** Wash off immediately with plenty of water. If symptoms persist, consult a doctor.
- **Inhalation:** Get some fresh air. If symptoms persist, consult a doctor.
- **Ingestion:** Rinse mouth with water and then drink plenty of water. Do not induce vomiting. Consult a doctor.



- Fuel vapors and spills are potential fire hazards.
- When opening a fuel system, fuel can escape. Collect the fuel during servicing and dispose of it properly to avoid the risk of fire.
- Mixing other fuels, such as gasoline, alcohol or gasohol with diesel can produce an explosive mixture.



To avoid injury from fuel while performing service on any fuel-system-related component(s):

- Prevent fuel from leaking or dripping onto the starter motor.
- Check the fuel components for leakage very carefully.
- Clean spilled or leaked fuel.
- Keep people who are not directly involved in the servicing away from the immediate area.
- Wear protective clothing (including face shield, insulated gloves and apron).
- Keep the work area well ventilated to prevent build-up of volatile fuel vapors.
- Keep all potential ignition sources away from the fuel. This includes: excessive heat, open flames, cigarettes, sparks and electrical sources.



- Do not touch any of the fluoroelastomer seals or O-rings if they have been exposed to a temperature of 315°C or higher. The material of this product does not burn but decomposes into a charred, black, sticky substance. This decomposition may contain hydrofluoric acid. This is very aggressive and difficult to remove once it has contaminated the skin. Use PVC or rubber gloves until the decomposed material has been identified and/or removed. If the substance makes contact with the skin, contact a doctor immediately.



- Dirt or debris in the fuel system can lead to severe engine damage.
- Blocking and/or clamping the fuel pipes can lead to severe engine damage.
- Never block or plug the common rail release valve output, as this can lead to severe rail and common rail pressure release valve damage.
- Immediately plug the openings of the fuel system.
- Clean the area before performing maintenance.
- Cover the crankcase pressure sensor and make sure that it cannot come in contact with any fuel or fuel vapors.

M035658 - 01.09.2017

- ☐ 1.54 remove electronic control unit, engine management system (Electrical system, engine)
- ☐ 1.55 disconnect inlet air boost pressure sensor (Sensors electrical system, engine)
- ☐ 1.56 disconnect boost air temperature sensor (Sensors electrical system, engine)
- ☐ 1.57 remove air bleed pipe (Lubrication system)

1.58 remove valve cover (Basic assembly)

Explanation

Warning, opening engine



- Clean the engine thoroughly before opening the engine or parts of it.
- Dirt or debris entering the engine damages the engine or may cause engine failure.
- Clean the entire engine or the engine compartment where the service must be performed.

M031727 - 07.25.2012

Removing Valve Cover Assembly

1. Loosen the attachment bolts, and remove the valve cover assembly.



Always replace the valve cover gasket.

M031728 - 02.26.2014

1.59 disconnect 2 (two) engine wiring harness J1 A (Electrical system, engine)

1.60 disconnect 6 (six) solenoid valve, engine brake (Basic assembly)

1.61 remove blanking plate, flywheel housing (Flywheel housing)

1.62 remove 6 (six) rocker seat, engine brake (Basic assembly)

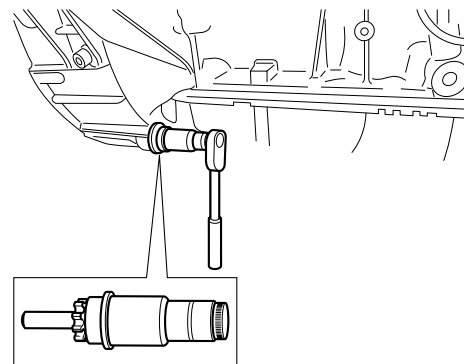
Explanation

Removing rocker seats

1. Carefully remove the rocker seats.



- Depending on the engine position, some rocker seats are under the tension of the valve springs.
- To prevent damaging the rocker seats, removal of the rocker seats must be carried out without tension in the valve springs.
- By cranking the crankshaft $\frac{1}{3}$ turn, each time using the special tool (1903018), the rocker seats can be removed without tension:
 1. Rocker seats for cylinders 1 or 6
 2. Rocker seats for cylinders 2 or 5
 3. Rocker seats for cylinders 3 or 4



I402049



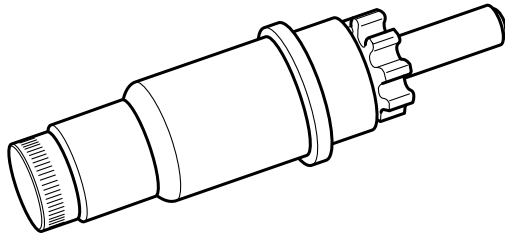
2. If it is unnecessary to replace the rocker seats, mark the rocker seats so that they can be placed back in the same position.

Special tools

Special tool category: Mandatory special tool for: NA region
1903018

Engine Cranking Tool

1453158 is also
suitable



1903018

ST1903018 - 01.07.2013

- ☐  1.63 remove 6 (six) inlet valve lifter rod (Basic assembly)
- ☐  1.64 remove 6 (six) exhaust valve push rod (Basic assembly)
- ☐  1.65 remove injector leak pipe (Fuel system)

Explanation

Warning, Fuel System



- **Eye contact:** Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Consult a doctor.
- **Skin contact:** Wash off immediately with plenty of water. If symptoms persist, consult a doctor.
- **Inhalation:** Get some fresh air. If symptoms persist, consult a doctor.
- **Ingestion:** Rinse mouth with water and then drink plenty of water. Do not induce vomiting. Consult a doctor.



- Fuel vapors and spills are potential fire hazards.
- When opening a fuel system, fuel can escape. Collect the fuel during servicing and dispose of it properly to avoid the risk of fire.
- Mixing other fuels, such as gasoline, alcohol or gasohol with diesel can produce an explosive mixture.



To avoid injury from fuel while performing service on any fuel-system-related component(s):

- Prevent fuel from leaking or dripping onto the starter motor.
- Check the fuel components for leakage very carefully.
- Clean spilled or leaked fuel.
- Keep people who are not directly involved in the servicing away from the immediate area.
- Wear protective clothing (including face shield, insulated gloves and apron).

- **Keep the work area well ventilated to prevent build-up of volatile fuel vapors.**
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- **Immediately plug the openings of the fuel system.**
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- **Cover the crankcase pressure sensor and make sure that it cannot come in contact with any fuel or fuel vapors.**

M035658 - 01.09.2017

- ▲ 1.66 remove hose (Air compressor)
- ▲ 1.67 disconnect engine wiring harness J3 C (Electrical system, engine)
- ▲ 1.68 pressure testing on chassis EGR cooler (EGR system)

Explanation

Pressure testing on chassis EGR cooler



Wait until the coolant is at ambient temperature before pressure testing the EGR cooler. Cooling and contracting air within the EGR cooler causes a loss in pressure, which can be misinterpreted as a leak.

1. Remove the coolant cap.
2. Examine the EGR cooler for blockages using a boroscope.



If blockages exist: (clean the EGR cooler)

3. Examine the adapter fittings and O-rings of the special tool.



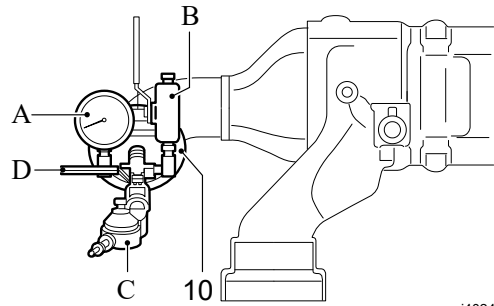
Replace the O-rings in the event of damage, after three test procedures or after one year of proper storage.

4. Clean the contact surfaces of the special tool fittings and EGR cooler exhaust gas inlet and outlet.
5. Add the specified lubricant to the O-rings.



Do not use a silicon-based product. Silicon-based products can damage the equipment.

6. Install the special tool (A) to the EGR cooler exhaust inlet.
7. Refit the V clamp (10) and tighten it to the specified torque.

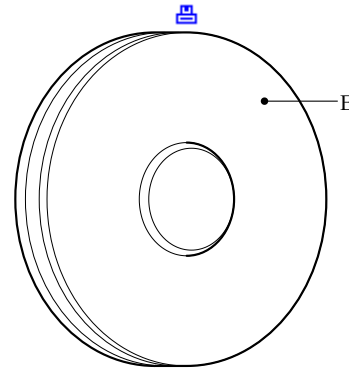


i402467

8. Insert the plug (E) into the EGR cooler exhaust gas outlet.
9. Install the safety cap (H) over the EGR cooler exhaust gas outlet.

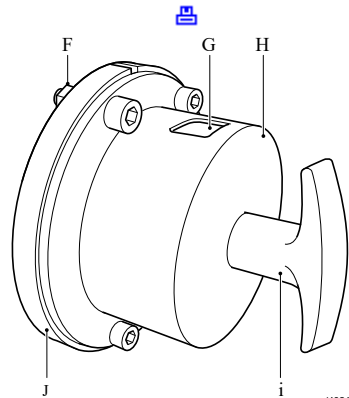


Make sure that the view and leak test port (G) is located on top.



i402537

10. Install the half moon flanges (J).
11. Install the safety cap attachment nuts and bolts (F) and hand tighten them.
12. Install the handle (I) and hand tighten it.

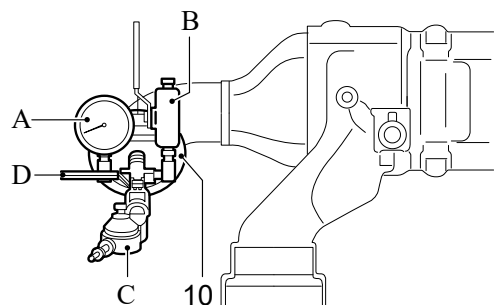


i402468

13. Close the pressure release valve (B).
14. Close the air flow valve (D).
15. Back off the pressure regulator (C) until it is unloaded.



Failure to back off the pressure regulator (C) can damage the equipment.



i402467

16. Supply shop air.
17. Open air flow valve (D).
18. Adjust the pressure regulator (C) to have around 1.40 bar [20 psi] at the pressure gauge of special tool (A).
19. Pressurize the exhaust passages of the EGR cooler for 5 seconds.



If the EGR cooler is over-pressurized:

- Close the air flow valve (D).
- Open the pressure release valve (B).
- Back off the pressure regulator (C).
- Restart the procedure from step 13.

20. Close the air flow valve (D).

21. Remove the shop air hose.

22. Check the special tool for pressure decay due to leakage at the flanges.



- If any pressure decay is noticed, look for fitting leakage using soapy water. If necessary, correct the leakage on the fitting.
- Before removing the special tool, depressurize the EGR cooler using the depressurization valve (B) before removing the V clamp (10) or nuts and bolts (F).
- **Failure to depressurize the system can cause personal injury.**

23. Log the starting pressure.

24. After 15 minutes, examine the results:

- If the pressure does not decay, proceed to the next step.
- If the pressure decays less than 0.14 bar [2 psi], check the integrity of the special tool, then perform the pressure test again.
- If the pressure decays more than 0.14 bar [2 psi], **record the pressure and upload the photo to support net**, then replace the EGR cooler.

25. Depressurize the special tool using the pressure release valve (B).



Failure to depressurize the system can cause personal injury.

26. Remove the special tool from the vehicle.

27. Install the coolant cap.

M036939 - 04.23.2014

Technical data

Mounting product, sealing ring

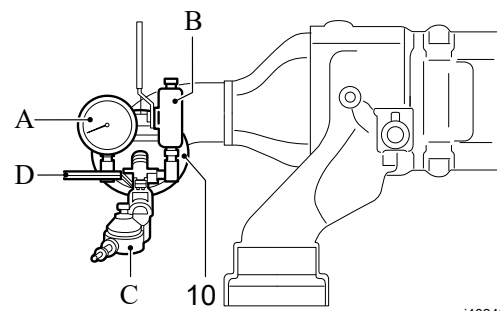
Rubber lubricant

"P80"

M025429 - 02.21.2017

Tightening torque, V clamp, EGR cooler

V clamp (10) 17 Nm [150 lb-in]



M041671 - 03.21.2014

Checking data, pressure testing on chassis EGR cooler

EGR cooler, exhaust gas circuit:

Test pressure 1.40 bar [20 psi]⁽¹⁾
(1) No pressure decay allowed.

In the event of pressure decay (pd);

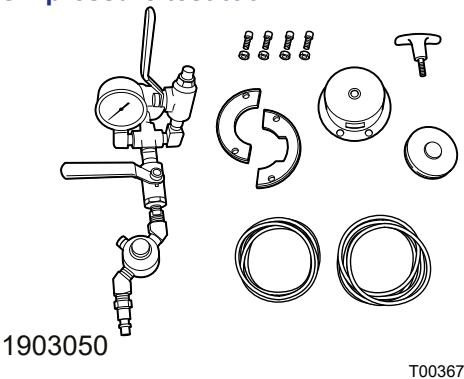
Retest 0.00 < pd < 0.14 bar [0 < pd < 2 psi]
Replace pd > 0.14 bar [pd > 2 psi]

M036709 - 07.02.2013

Special tools

Special tool category: Mandatory special tool for:
1903050

EGR pressure test tool



ST1903050 - 04.19.2013

 1.69 remove assembly EGR cooler (EGR system)

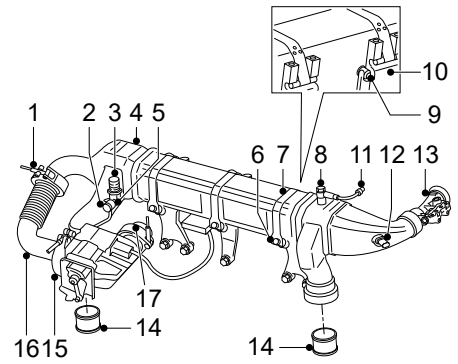
Explanation

Removing assembly EGR cooler

1. Remove the banjo bolt (8) and collect both sealing washers.
2. Put the breather pipe (11) aside.
3. Loosen the three attachment bolts (6) and maneuver the clamping straps (7) aside.
4. Pull off the EGR cooler (4) with a little force.



The mounting product for the venturi (13) and the connecting pieces (14) cause friction when pulling the EGR cooler (4).



i401840-3

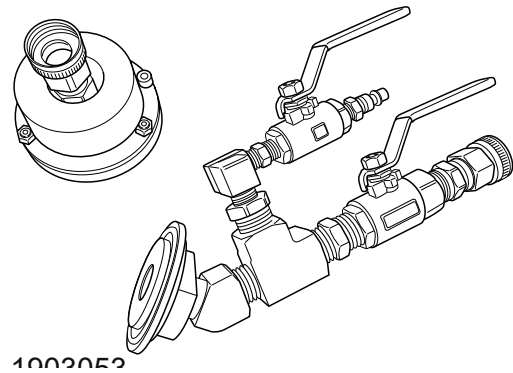


M033328 - 08.30.2013

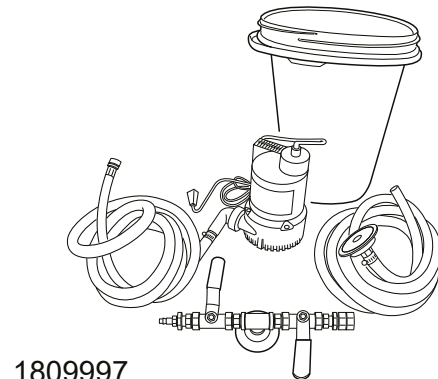
1.70 clean EGR cooler (EGR system)

Explanation

Cleaning exhaust system EGR cooler



1003052



1809997



1. Examine the adapter fittings and O-rings of the special tool.

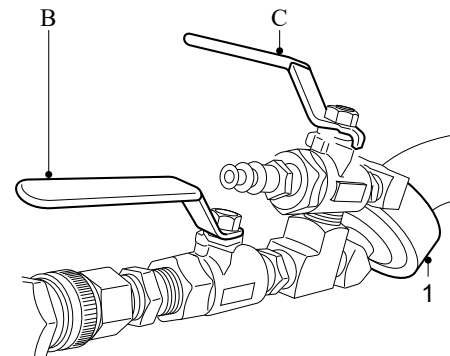


Replace the O-rings in the event of damage, after three test procedures or after one year of proper storage.

2. Apply the specified lubricant to the O-rings.



Do not use a silicon-based product. Silicon-based products can damage the equipment.

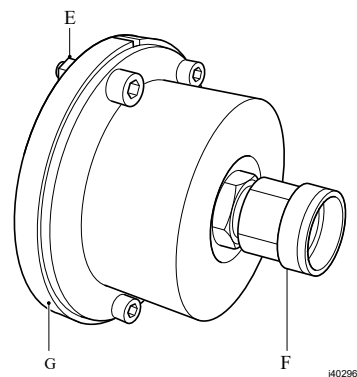


i402967



3. Clean the adapter fittings and EGR cooler exhaust gas inlet and outlet.
4. Install the inlet adapter (A) to the EGR cooler exhaust gas inlet.
5. Refit the V-clamp (1) and tighten it to the specified torque.
6. Insert the outlet adapter (D) into the EGR cooler exhaust gas outlet.
7. Install the half-moon flanges (G).
8. Install the bolts (E) to secure the half-moon flanges and tighten them hand-tight.
9. Close the fluid valve (B).
10. Close the air valve (C).
11. Connect a hose to the inlet adapter (A).
12. Attach the pump from the EPA10 EGR cleaning kit (ST1809997) to the hose connection (F) at the outlet adapter (D).

Inlet adapter (A)



Outlet adapter (D)

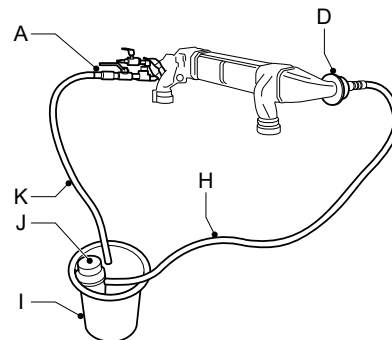


- The flow must enter the EGR cooler from the exhaust gas outlet side and exit from the exhaust gas inlet side.

13. Position both the hose of the inlet adapter (A) and the pump in a bucket with cleaning agent.



- Use the 6.5 gallon bucket from ST1809997.
- Dilute 1 to 2 gallons of PACCAR Part # 1204090105 EGR cooler Cleaning Solution at a 1:1 ratio with hot water.
- MSDS is provided with the solution from PACCAR Parts.
- Use the personal protective equipment as outlined in the MSDS.



14. Make sure that all connections from pump to outlet adapter (D) are secure.
15. Open the fluid valve (B).
16. Pump the cleaning solution through the EGR cooler for a minimum of 45 minutes.
17. Switch off the pump and close the fluid valve (B).
18. Remove the hose from the outlet adapter (D) and replace it with a fresh water source.



Flush a couple of gallons of fresh water through the pump and hoses to purge them of the solution after every use.

19. Open the fluid valve (B) and flush until only clean water exits the cooler.

Take special care to capture all flush water and solvent for proper disposal.



20. Switch off the water supply, close the fluid valve (B) and disconnect the water supply.
21. Connect a hose to the outlet adapter (D) and route it to an empty bucket to capture the air pressure and moisture.



Make sure that the hose is securely in the bucket, as it may flail when pressurized.

22. Attach shop air to the inlet adapter (A) and open the air valve (C).
23. Purge water from the EGR cooler and dry internal passages for a minimum of 5 minutes.

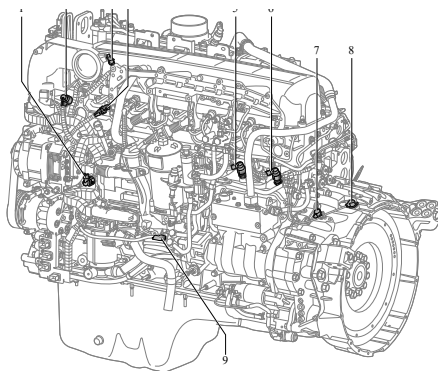


Clean thoroughly to avoid damage to the engine and aftertreatment components.

24. Remove the outlet adapter (D).
25. Open air valve (C) for at least 30 seconds to purge remaining water from the cooler.
26. Close air valve (C) and remove the inlet adapter (A).
27. Clean all lines and hoses connected to the EGR system.



A clogged EGR cooler probably also has clogged lines or hoses.



28. Remove the inlet air boost pressure sensor (2) and inspect the sensor's orifice.



- If the sensor is plugged, replace it.

29. Clean the engine port and install the inlet air boost pressure sensor (2).
30. Flush the pump and all hoses and adapters with

fresh water to purge the remaining cleaning solution.

M038231 - 11.20.2018

Technical data

Mounting product, sealing ring

Rubber lubricant

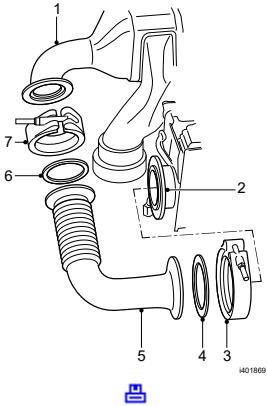
"P80"

M025429 - 02.21.2017

Tightening torque, flexible EGR pipe from control valve to cooler

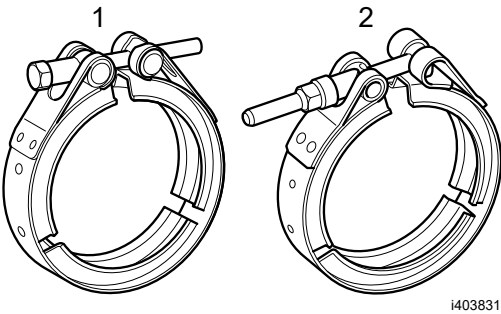
- V clamp (3)
As specified below⁽¹⁾
(Diagonal 2)(3)
- V clamp (7)
17 Nm [150 lb-in]⁽¹⁾(Diagonal 2)(3)

- (1)Always replace the V clamps (3 and 7) and gaskets (4 and 6).
- (2)Position in the orientation shown.
- (3)First tighten V clamp (3) then V clamp (7).



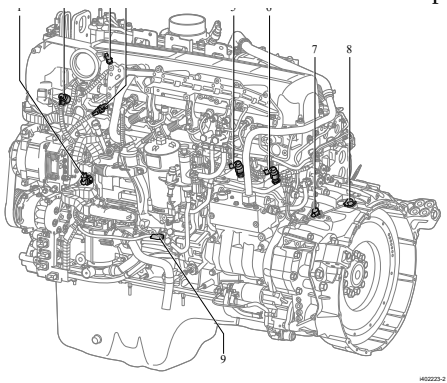
Never reuse the V clamps (3 and 7).
Two different V clamps are used, and both require a different tightening torque.

- V clamp (3)
Type 1
Type 2
- 8 Nm [71 lb-in]
12 Nm [106 lb-in]



M030424 - 01.19.2017

Tightening torque, sensors left side view



Oil pressure sensor (1)	30 Nm [266 lb-in] ⁽²⁾
Inlet air boost pressure sensor (2)	30 Nm [266 lb-in] ⁽²⁾
Intercooler air temperature sensor (3) attachment bolt	10 Nm [89 lb-in] ⁽¹⁾⁽²⁾
Boost air temperature sensor (4) attachment bolt	10 Nm [89 lb-in] ⁽¹⁾⁽²⁾
Fuel temperature sensor (5)	30 Nm [266 lb-in]
Fuel pressure sensor (6)	30 Nm [266 lb-in]
Camshaft sensor (7) attachment bolt	10 Nm [89 lb-in] ⁽³⁾
Crankshaft sensor (8) attachment bolt	10 Nm [89 lb-in] ⁽³⁾
Crankcase pressure sensor (9) attachment bolts	6 Nm [53 lb-in]

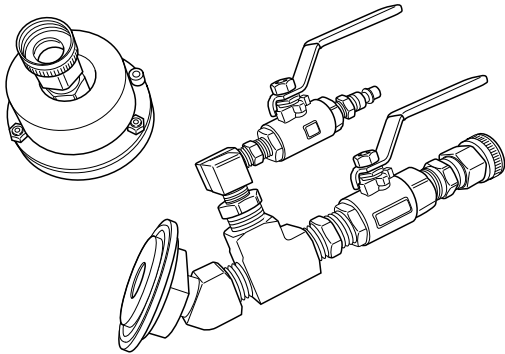
- (1) Do not touch other objects with the tip of the sensor.
- (2) Always use a new sealing ring.
- (3) Always use a new O-ring.

M033435 - 03.10.2016

Special tools

Special tool category: Mandatory special tool for: NA region
1903053

EGR cooler cleaning kit



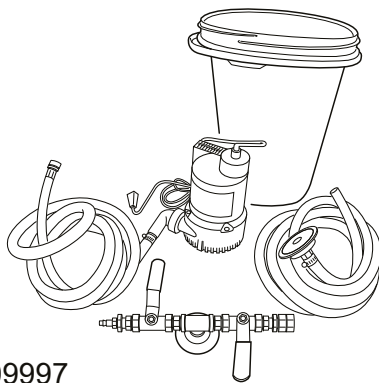
1903053



ST1903053 - 10.16.2013

Special tool category: Mandatory special tool for:
1809997

EGR cleaning kit



1809997



ST1809997 - 11.15.2012

- ☐ ☐ 1.71 disconnect pressure sensor before turbine (Sensors electrical system, engine)
- ☐ ☐ 1.72 disconnect humidity sensor (Sensors electrical system, engine)
- ☐ ☐ 1.73 remove pressure sensor pipe before turbocharger (EGR system)
- ☐ ☐ 1.74 remove air inlet pipe from turbocharger to intercooler
- ☐ ☐ 1.75 remove air inlet pipe from air filter to turbocharger (Inlet and exhaust element)
- ☐ ☐ 1.76 loosen compressor pipe 01, suction side (Air compressor)
- ☐ ☐ 1.77 disconnect pressure sensor after BPV (Sensors electrical system, engine)
- ☐ ☐ 1.78 disconnect temperature sensor, EGR (Sensors electrical system, engine)
- ☐ ☐ 1.79 loosen 3 (three) coolant pipe (EGR system)

Explanation

Loosening coolant pipe

1. Loosen the coupling as shown using the special tool (1893778).



- Only use the tool to disengage the locking mechanism.
- Pull the coupling to release it from the actuator housing and do **not** use the tool as a lever.

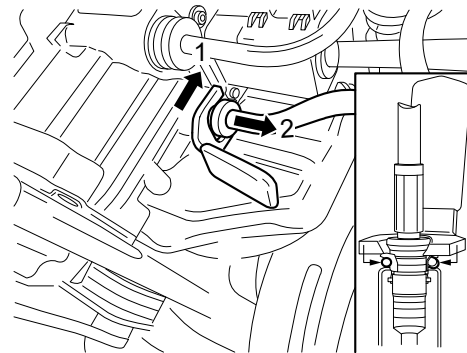
2. Thoroughly clean the inner side of the actuator with a clean towel.



Do not use chemicals or aggressive cleaners to clean the Schäfer coupling and actuator.



Make sure that the connection of the actuator is free of any debris and no dirt enters the coolant circuit of the actuator.



I402299



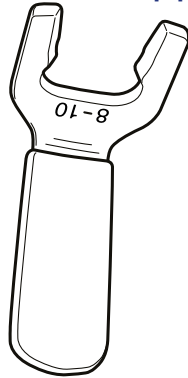
Schäfer type coupling

M034348 - 07.25.2014

Special tools

Special tool category: Recommended special tool
1893778

Release tool cool water pipe. Tool for removing coolant pipes from EGR and back pressure valve.



93778



ST1893778 - 02.13.2014

- ☐  1.80 remove flexible EGR pipe from control valve to EGR cooler (EGR system)
- ☐  1.81 remove pressure sensor pipe after BPV (EGR system)
- ☐  1.82 remove mounting bracket (EGR system)
- ☐  1.83 remove assembly venturi (EGR system)
- ☐  1.84 disconnect turbocharger speed sensor (Inlet and exhaust element)

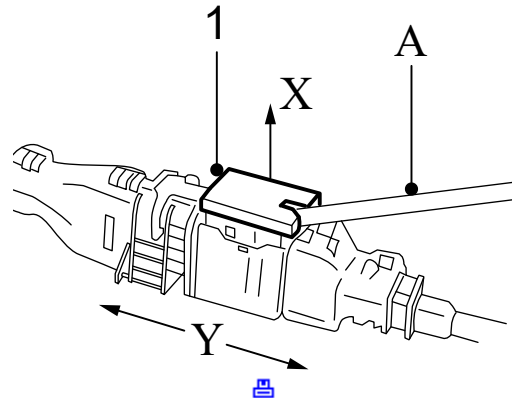
Explanation

Disconnecting HDSCS connector

1. Use a small flathead screwdriver (A) to release (X) the lock clip (1).
2. Disconnect the connector by pulling (Y) it apart.



It might be necessary to release the lock clip (1) further.



M041856 - 05.13.2014

- ☐  1.85 loosen oil pipe, delivery side (Inlet and exhaust element)
- ☐  1.86 loosen oil return pipe (Inlet and exhaust element)
- ☐  1.87 loosen supply coolant pipe (Inlet and exhaust element)
- ☐  1.88 loosen return coolant pipe (Inlet and exhaust element)
- ☐  1.89 loosen assembly Back Pressure Valve (Engine brake)
- ☐  1.90 remove turbocharger with VTG (Inlet and exhaust element)

Explanation

Warning: Turbocharger Replacement



- If the warning and instructions below are not observed, the result can be a runaway engine.
- This can result in personal injury.

As a result of a defective turbocharger, broken parts and/or lubricating oil can enter the intake and exhaust circuit.



Risks of lubricating oil:

- Be aware that oil inside the intake circuit can cause a runaway engine.
- Too much oil inside the exhaust muffler and catalytic converter eventually blocks the exhaust system.



Risk of parts that have broken off:

- The compressor wheel is the barrier between the high-pressure side and the suction side of the air inlet system.

If the compressor wheel is damaged, particles from the compressor wheel are blown into the clean side of the air filter.

- Always replace the air filter element and clean and check the air inlet and exhaust circuit to prevent serious damage to the engine when newly starting up.



i401952



Consequential damage when newly starting up an air inlet circuit that has not been thoroughly cleaned.

M031120 - 09.27.2016

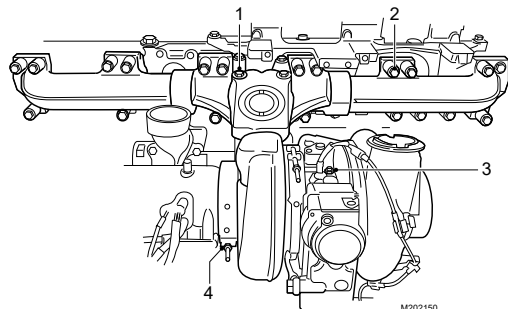
Removing turbo charger with VTG

1. Remove the turbo charger attachment bolts (1).



Let a second person support the turbo charger while loosening the attachment bolts.

2. Carefully remove the turbo charger between the engine and chassis by moving it sideways and upwards.



M202150



M045647 - 11.28.2014

1.91 check turbocharger with VTG (Inlet and exhaust element)

Explanation

Checking turbocharger with VTG

Check the turbocharger for:

- Gas leakage between turbocharger and exhaust manifold.
- Bearing clearance (as instructed below).
- Inspect the turbine and compressor wheel for Foreign Object Damage.



Replace the turbocharger if any damage is found on the turbine or compressor wheel.

If any damage is found on the compressor wheel, the complete inlet system must be inspected and cleaned before a new turbo can be installed.

Axial clearance:

1. Place a dial gauge as shown.

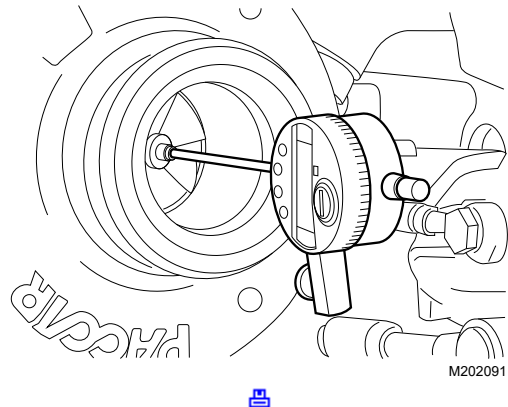


Designed to read tolerances at least as small as 0.025 mm (0.001 in).

2. Set the dial gauge to zero.
3. Push and pull the rotor assembly and make a note of the minimum and maximum readings.
4. Compare the readings with the specified checking data.



Replace the turbocharger if the clearance does not meet the specifications.



Radial clearance:

1. Place a lever type dial gauge as shown.

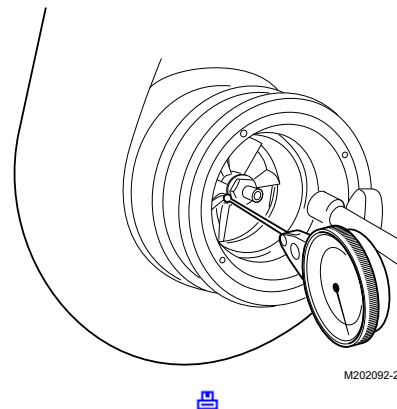


Designed to read tolerances at least as small as 0.025 mm (0.0001 in).

2. Set the dial gauge to zero.
3. Push and pull the compressor wheel towards the housing and make note of the minimum and maximum readings.



Do not rotate the turbocharger shaft.



4. Compare the readings with the specified checking data.

Replace the turbocharger if the



clearance does not meet the specifications.

M030202 - 04.19.2016

Technical data

Checking data, turbocharger with VTG

Axial clearance: 0.051–0.152 mm [0.002–0.006 in]
 Radial clearance: 0.381–0.533 mm [0.015–0.021 in]

M030203 - 10.17.2017

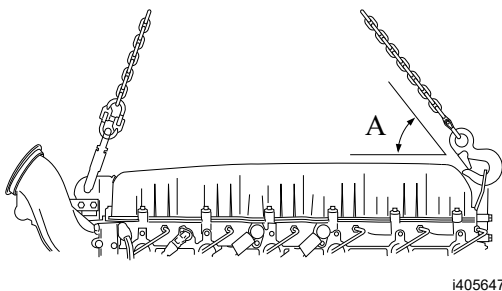
-  1.92 remove bracket, EGR (EGR system)
-  1.93 remove exhaust manifold (Inlet and exhaust element)
-  1.94 install lifting eye

Explanation

Warning, lifting engine



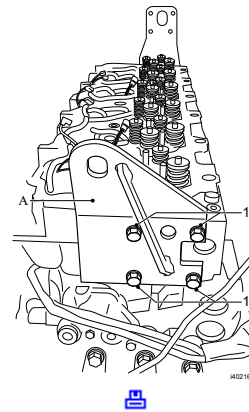
- Hoist the engine securely, using approved lifting device.
- Do not carry out any work underneath an engine that is only supported by a jack or lifting device.
- Make sure that the engine is properly supported before carrying out any work underneath the engine.
- Do not use the oil sump to lift or support the engine.
- The angle (A) of the hoisting equipment must exceed 50°.



M055404 - 11.03.2016

Installing lifting eye

1. Install the lifting eye (A) onto the cylinder head.
2. Tighten the bolts (1) to the specified torque.



M033201 - 06.27.2013

Technical data

Tightening torque, lifting eye

Attachment bolts

60 Nm [531 lb-in]

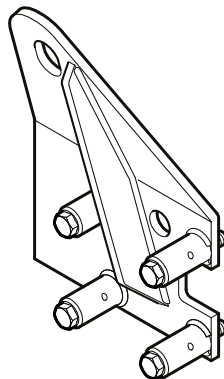
M036868 - 03.25.2013

Special tools

Special tool category: Mandatory special tool for: NA region
1903016

Hoisting tool for cylinder head/engine without transmission. Supersedes 1453180. 1453180 can still be used. "User manual"

This tool replaces
DAF special tool:
1453180 due to
legislation. DAF
special tool
1453180 can still
be used.



1903016



ST1903016 - 11.03.2014

 1.95 remove 6 (six) oil nozzle (Lubrication system)

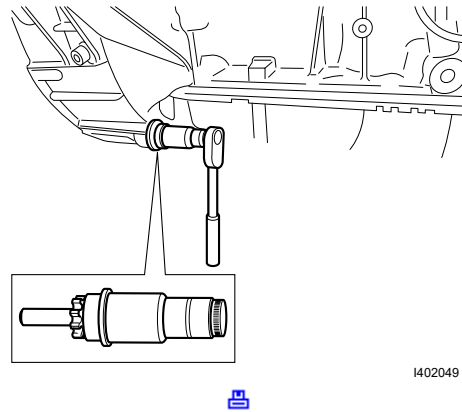
Explanation

Setting Engine to TDC

1. Use the special tool (1903018) to turn the crankshaft counterclockwise as seen from the distribution side.



This corresponds to the direction of rotation of the engine.



I402049

2. Position cylinders 1 and 6 at top dead center (TDC marking on vibration damper).



- Do not use valve setting marks 1/6 for this procedure.
- The TDC mark can also be read on the flywheel.

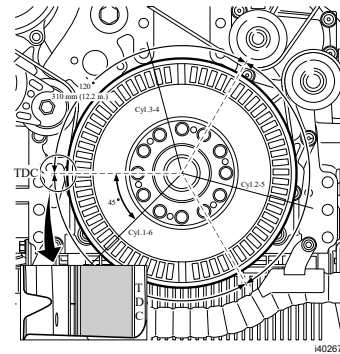
Repeat this procedure for cylinders 2/5 and 3/4, each time rotating the vibration damper 120 degrees (310 mm [12.2 in]).



- By turning the crankshaft 120° (310 mm [12.2 in]) clockwise as seen from the vibration damper side, cylinders 2 and 5 are in TDC position.
- By turning the crankshaft another 120° clockwise (310 mm [12.2 in]), cylinders 3 and 4 are in TDC position.



There is no marking on the vibration damper for the TDC position of cylinders 2/5 and 3/4.



I402675

M037474 - 03.27.2015

Removing Oil Nozzle

1. Place the corresponding piston in the TDC position.
2. Remove the attachment bolt and pull out the oil nozzle.



- Only remove the oil nozzle if the corresponding piston is in the TDC position.
- Remove the oil nozzle carefully.

- If necessary, use the M6 thread in the nozzle to attach an impact puller.
- Use oil nozzles only once.

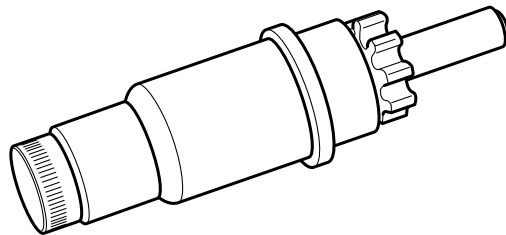
M037482 - 06.04.2013

Special tools

Special tool category: Mandatory special tool for: NA region
1903018

Engine Cranking Tool

1453158 is also
suitable



1903018



ST1903018 - 01.07.2013

1.96 position into workstand engine

Explanation



- Hoist the engine securely, using approved hoisting equipment.
- Make sure that the engine is properly supported before carrying out any work underneath the vehicle.
- Do not carry out any work underneath an engine that is only supported by a jack or lifting device.
- Do not use the oil sump to lift or support the engine.



If the engine is lifted only slightly, it is not necessary to disconnect coolant hoses, air inlet hoses and torque rods between the engine and the radiator.

M029202 - 12.09.2015

1.97 position into workstand engine

Explanation



- Hoist the engine securely, using approved hoisting equipment.
- Make sure that the engine is properly supported before carrying out any work underneath the vehicle.

- Do not carry out any work underneath an engine that is only supported by a jack or lifting device.
- Do not use the oil sump to lift or support the engine.



If the engine is lifted only slightly, it is not necessary to disconnect coolant hoses, air inlet hoses and torque rods between the engine and the radiator.

M029202 - 12.09.2015

1.98 remove assembly cylinder head, engine (Basic assembly)

Explanation

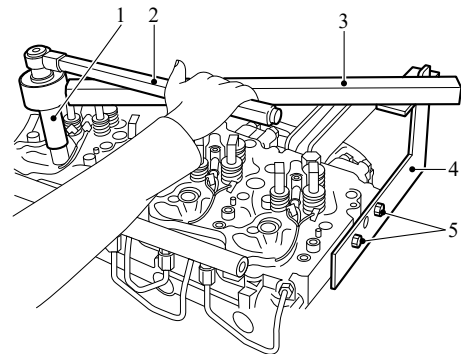
Removing assembly cylinder head

1. Remove the cylinder head bolts in the specified sequence.



To remove the cylinder head bolts, use, for instance, special tool (0882233):

1. Fit the bracket (4) to the cylinder head at the flywheel side. Use attachment bolts (5) to secure the bracket (4).
2. Mount the impact socket (1) of special tool (0911724) to the torque multiplier (3), and fit the assembly onto the cylinder head bolt.
3. Place the torque wrench (2) on the torque multiplier (3).



i402427



2. Remove the cylinder head.
3. Position the cylinder head on suitable supports.



- Be careful; When removing a cylinder head with the injectors still installed, do not place the cylinder head on a flat surface. Use wood blocks to prevent the cylinder head surface and injector tips from contacting any table or bench surface.

The injector tips extend beyond the plane of the cylinder head and can be easily damaged. Any tip contact can result in micro-cracks that may lead to severe engine damage.

- Avoid damaging the rail, fuel injection pipes.

M036590 - 10.22.2015

Warning, lifting components



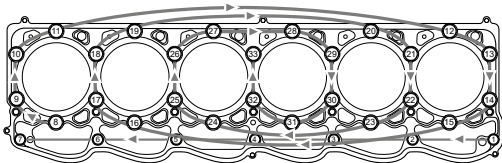
- Use approved and sturdy tools for lifting.
- Do not carry out any work on components that are only supported by a jack or lifting gear.
- Make sure that the component is properly supported before carrying out any work.

M028835 - 03.24.2010

Technical data

Technical data, cylinder head bolts

Loosen the cylinder head bolts in the sequence, as shown.

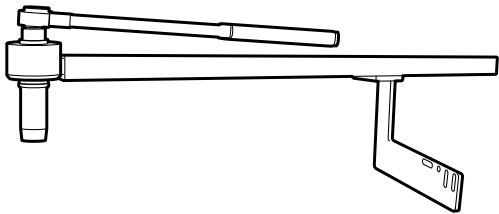


M022961 - 05.29.2013

Special tools

Special tool category: Recommended special tool
0882233

Torque multiplier for cylinder head



T00145



ST0882233 - 03.20.2008

- 1.99 remove cylinder head gasket, engine (Basic assembly)
- 1.100 clean cylinder block (Basic assembly)

Explanation

Cleaning cylinder block

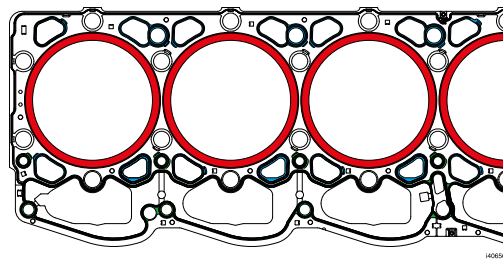
1. Remove the gasket remnants from the cylinder block.
2. Clean the sealing surface of the cylinder block.
 - Use only brass scrapers or brass brushes to clean the residual material on the head-to-block mating surfaces.
 - Do not use steel brushes, steel scrapers, or polishing pads.
 - The striations on the mating surface of the block and the corresponding surface on the head are part of the strategy for preventing gasket fretting and erosion. Do not polish these surfaces.
3. Check the sealing surface and the threaded holes in the cylinder block for damage.
 - Use a rag and solvent to clean any remaining contaminants.



Sealing only takes place on the indicated areas between gasket and cylinder block.

Damage on the cylinder block outside the indicated areas on the cylinder head gasket is not a reason for failure.

- Gas sealing locations are marked red.
- Coolant sealing locations are marked blue.
- Oil sealing locations are marked green.



If coolant leakage is visible outside the cylinder block this will not indicate the actual location of the leakage.

M031143 - 12.18.2018

 1.101 clean cylinder head, engine (Basic assembly)

Explanation

Cleaning cylinder head

1. Check the inlet manifold for oil deposit and debris, and clean, if necessary.
2. Remove the gasket remnants from the cylinder head.
 - Use only brass scrapers or brass brushes to clean the residual material on the head-to-block mating surfaces.
 - Do not use steel brushes, steel scrapers, or polishing pads.

- The striations on the mating surface of the head and the corresponding surface on the block are part of the strategy for preventing gasket fretting and erosion. Do not polish these surfaces.
3. Remove any carbon deposit from the cylinder head.
 4. Clean and degrease the contact surfaces of the cylinder head.
 5. Check the cylinder head for damage.



Machining is not allowed.

M032286 - 12.18.2018

1.102 repair height cylinder liner (Basic assembly)

Explanation

Measure cylinder liner height

This procedure describes the correct method for measuring the cylinder liner height in the event of cavitation.

Only start with this procedure when the height of all liners is measured.

There are different service cylinder liners available to correct the cylinder liner height.

- A service cylinder liner with a 0.50 mm [0.020 in] higher collar.
- A service cylinder liner with a 0.25 mm [0.0098 in] higher collar.
- A service cylinder liner with a 0.04 mm [0.0016 in] higher collar.

Top deck condition before repair

The cylinder liner seat can only be repaired when:

- The damage of the **sealing surface (A1)** of the top deck is not deeper than 0.02 mm.



The fretting damage (A2) around the liner is not on a sealing surface, so no maximum depth is applicable here. There is sealing between liner, gasket and cylinder head.

Acceptable damaged top deck



M205010-3



A1 and A2 show an acceptable amount of damage of the top deck.

Acceptable damaged top deck



M205009



There is evidence of some cavitation between the liners on the top deck.

Acceptable damaged top deck



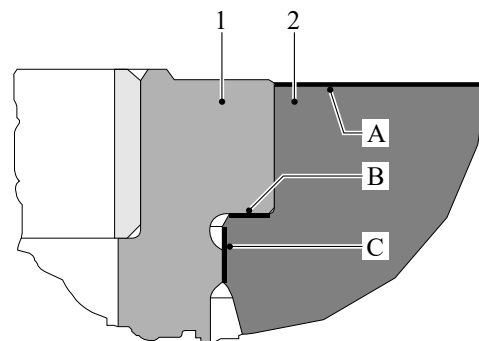
M205011-2



The gap between liner and cylinder block is still acceptable.

Condition before repair

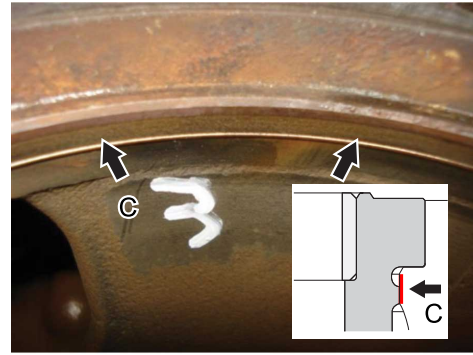
1. Remove the cylinder liner from the cylinder block.
2. Inspect the liner seat and liner bore and make sure that:
 - The cavitated surface of the liner seat (B) is not deeper than 0.45 mm.
 - The damaged surface of the liner bore (C) must not have more cavitation or damage than shown in the pictures. If in doubt, contact your local helpdesk.



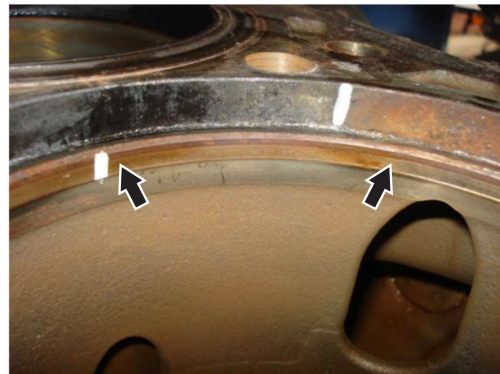
M202227



Acceptable damaged liner bore



M205005-2

**Acceptable damaged liner bore****Acceptable damaged liner bore**

M205007

**Unacceptable damaged liner bore**

M205008-2

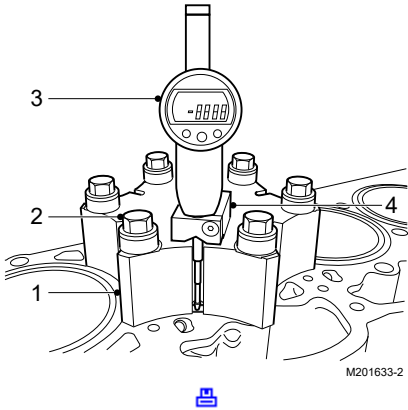


3. Remove the adjacent cylinder liner(s).



Mark the position of the cylinder liners to install them in their original orientation.

4. Machine the surface of the liner seat until it is free of cavitation according to the procedure: ["Repair cylinder liner seat"](#).
5. Install the appropriate service cylinder liner to make sure that only the minimum amount of material has to be removed.
6. Position the special tool (1) (1809948) on the cylinder liner.
7. Check that the tool is properly centered and tighten the attachment bolts (2) in the specified sequence to the specified torque.
8. Place the special tool (4) (1903047) onto the height measurement tool (1).
9. Fit the clock gauge (3) into the cylinder liner height gauge block (4).

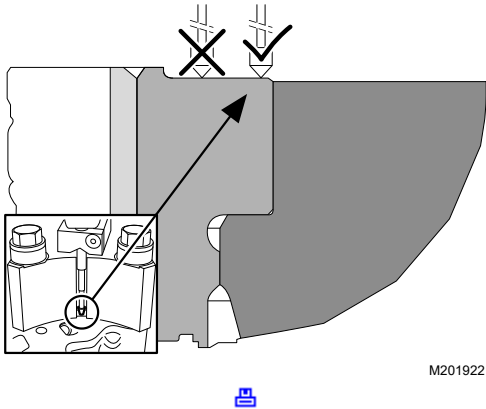


Use a digital clock gauge with an accuracy of 0.005 mm.

10. Position the tip of the clock gauge (3) onto the outside edge of the cylinder liner.
11. Measure the cylinder liner height according to the specified measuring sequence and note the values in the table.



Make sure **not** to measure the cylinder liner height on the damaged part of the top deck.

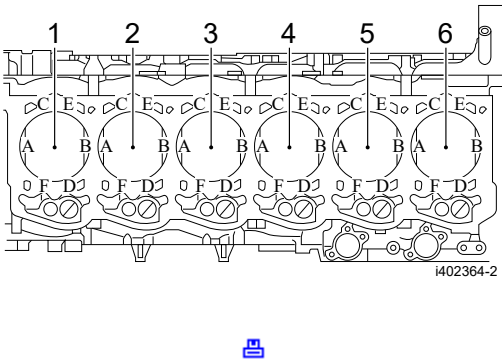


12. Remove the special tool (1) (1809948) from the cylinder liner.
13. Calculate how much supporting surface must be machined using the following calculation method:

Calculating method:

Repair cylinder 1	$Q=(X-0.015)-Y$
Repair cylinder 6	$Q=(X-0.015)-Z$
Repair cylinders 2, 3, 4, 5	$Q=(X-0.015)-(0.5*(Y+Z))$

- Q= total machining depth
- X= average cylinder liner height $((A+B+C+D+E+F)/6)$
- Y= average cylinder liner height from the adjacent liner $((C+A+F)/3)$
- Z= average cylinder liner height from the adjacent liner $((E+B+D)/3)$
- 0.015 mm = setting new cylinder liner





The difference between the average of E, B, D and C, A, F from the adjacent liner must not exceed 0.03 mm.

14. Remove the service cylinder liner from the cylinder block.
15. Machine the supporting surface using this procedure: ["Repair cylinder liner seat"](#)
16. Install the service cylinder liner.
17. Repeat steps 6 to 12.



Make sure that the correct cylinder liner height is reached.

Checking the repair possibility

1. Mark the position of the cylinder liners.



To install the cylinder liner in its original orientation.

2. Position the special tool (1) (1809948) on the cylinder liner.
3. Check that the tool is properly centered and tighten the attachment bolts (2) in the specified sequence to the specified torque.
4. Place the special tool (4) (1903047) onto the height measurement tool (1).
5. Fit the clock gauge (3) into the cylinder liner height gauge block (4).



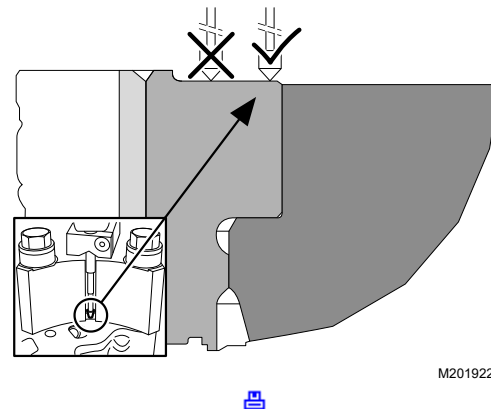
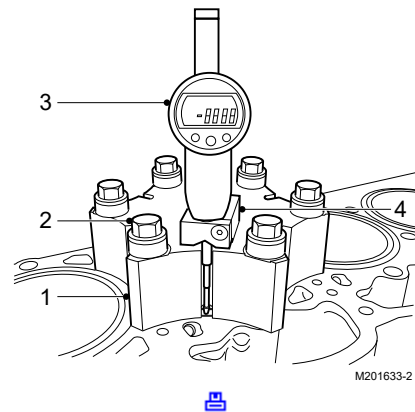
Use a digital clock gauge with an accuracy of 0.005 mm [0.0002 in].

6. Position the tip of the clock gauge (3) onto the outside edge of the cylinder liner.
7. Measure the cylinder liner height according to the specified measuring sequence and note the values in the table.



Re-zero the clock gauge before each individual measurement.

8. Remove the special tool (1) (1809948) from the cylinder liner.
9. Remove the cylinder liner from the cylinder block according to the job: (Remove 1 (one) cylinder liner)
10. Inspect the cylinder block according to the: **Conditions before repair** as described above.
11. Machine the surface of the liner seat until it is free of cavitation according to the procedure:



["Repair cylinder liner seat"](#).

12. Install the service cylinder liner.



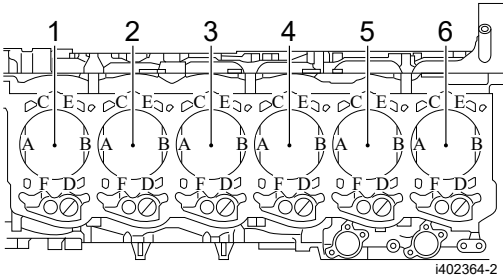
Make sure that the cylinder block is cleaned thoroughly.

13. Repeat steps 2 to 7.

14. Calculate how much supporting surface must be machined using the following calculation method:

Calculating method mm:

Repair cylinder 1	$Q=(X-0.015\text{ mm})-Y$
Repair cylinder 6	$Q=(X-0.015\text{ mm})-Z$
Repair cylinders 2, 3, 4, 5	$Q=(X-0.015\text{ mm})-(0.5*(Y+Z))$



Calculating method inch:

Repair cylinder 1	$Q=(X-0.0006\text{ in})-Y$
Repair cylinder 6	$Q=(X-0.0006\text{ in})-Z$
Repair cylinders 2, 3, 4, 5	$Q=(X-0.0006\text{ in})-(0.5*(Y+Z))$

- Q= total machining depth
- X= average cylinder liner height $((A+B+C+D+E+F)/6)$
- Y= average cylinder liner height from the adjacent liner $((C+A+F)/3)$
- Z= average cylinder liner height from the adjacent liner $((E+B+D)/3)$
- 0.015 mm [0.0006 in] = setting new cylinder liner



The difference between the average of E, B, D and C, A, F from the adjacent liner must not exceed 0.03 mm [0.0012 in].

15. Machine the supporting surface using this procedure: ["Repair cylinder liner seat"](#)

M040943 - 11.15.2018

Repair cylinder liner seat

This procedure describes the correct method of repairing the cylinder liner seat by machining.

The following procedure is carried out using a cylinder liner seat repair tool (1961378) i.c.w. cutting tool (1903061)



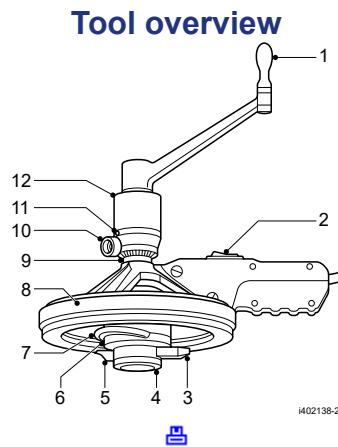
Make sure that all openings are covered before machining the liner seat.

Before the tool can be used, the adjacent cylinder liner(s) must be removed.

Machining of the cylinder liner seat can only be done in two stages.

1. Stage one: Machine the cylinder liner seat until the surface is free of cavitation.
2. Stage two: Machine the cylinder liner seat until the calculated depth is reached.

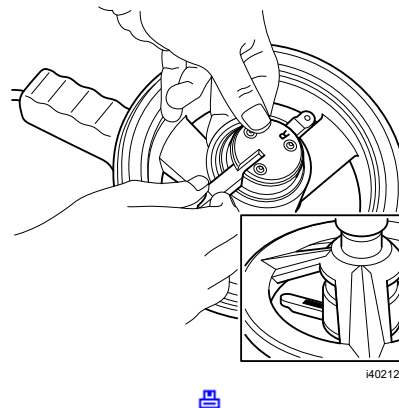
- 1 turning handle
- 2 switch
- 3 centering roll
- 4 main spindle
- 5 cutting tool
- 6 horizontal feed bus
- 7 locking bracket
- 8 magnet base
- 9 vernier
- 10 locking screw
- 11 worm screw
- 12 vertical feed bus



1. Keep the locking bracket up and mount the cutting tool.



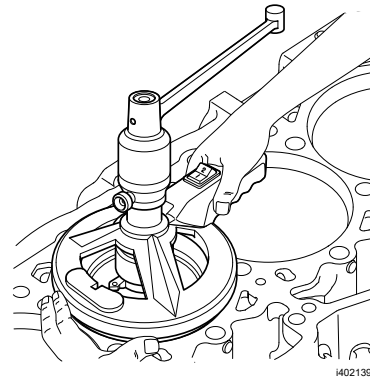
The serrated surface must face the electromagnet, and the **centering roll** must be directed towards the **R** on the spindle.



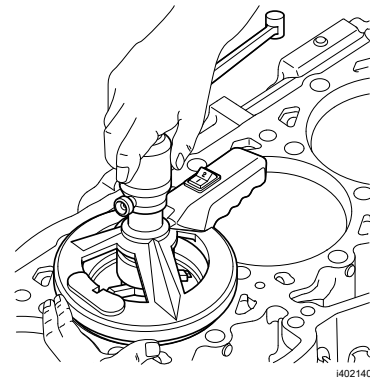
2. Position the tool so that it is slightly shifted from the center of the cylinder.



Make sure that the cylinder block and the tool are cleaned thoroughly.



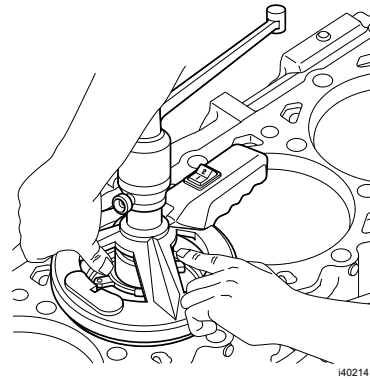
3. Set the switch to position 1 to activate the electromagnet. Screw the vertical feed bus up so that the cutting tool freely passes over the cylinder liner seat.



4. Press the locking bracket downwards, and place the centering roll against the wall of the cylinder liner seat, where the distance to the wall is greatest. Set the switch to position 0.



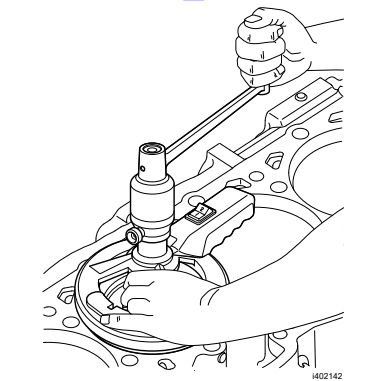
Do **not** set the switch in position 2. Otherwise the magnetism fully disappears.



5. Center the unit by holding the horizontal feed bus with two fingers, and turn the handle **clockwise**. The unit now moves eccentrically with every revolution.



- The eccentric movement decreases and finally stops as the centering roll moves back.
- Release the horizontal feed bus at the right moment, when the centering roll is just slightly touching the counterbore wall all around.
- Rotate counterclockwise when the centering roll loses contact with the counterwall.



6. When the tool is correctly centered, set the switch to position 1.
7. Press the locking bracket downwards and position the cutting tool above the liner seat.

8. Loosen the locking screw and slowly rotate the turning handle and vertical feed bus clockwise until the cutting tool touches the seat.
9. Loosen the worm screw, set the vernier to 0 and tighten the worm screw again.
10. Press the locking bracket downwards and place the cutting tool before the seat.
11. Set the refacing depth by rotating the vertical feed bus, then tighten the locking screw.



Start with 0.05 mm [0.002 in]. Do not exceed 0.15 mm [0.006 in] for the following steps.

12. Rotate the turning handle **clockwise** while holding the horizontal feed bus.



- Let the horizontal feed bus steadily slip between your fingers.
- **Never rotate the turning handle counterclockwise. This damages the cutting tool.**

13. Continue until the cutting tool has machined the entire surface.



Make sure that the entire surface is machined before setting the next depth.

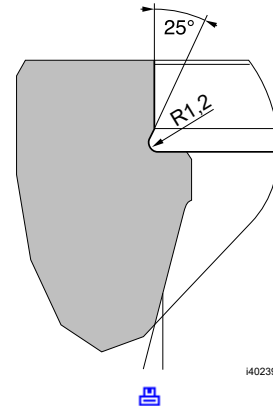
14. Press the locking bracket downwards and place the cutting tool just before the seat.
15. Stage one: check if the surface of the liner seat is free of cavitation. If not, repeat steps 11 to 14.



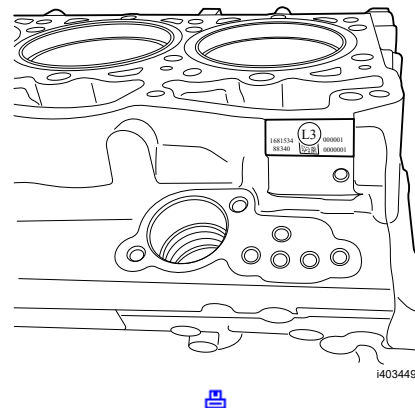
Before the exact machining depth can be calculated, the liner seat must be free of cavitation.

16. Stage two: Continue with steps 11 to 15 until the calculated depth is reached.

17. When the calculated depth is reached, make sure that the radius R 1.2 mm [0.047 in] is machined.
18. Remove the tool.
19. Clean the cylinder block and tool thoroughly.
20. Mark the cylinder block with an L and the number of the repaired cylinder on the DMC location.



i402397



i403449

M041317 - 05.19.2016

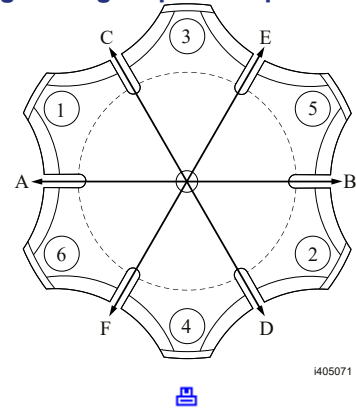
Technical data

Checking data, cylinder liner height

Tighten to 50 Nm [443 lb-in] in two phases in the specified sequence :

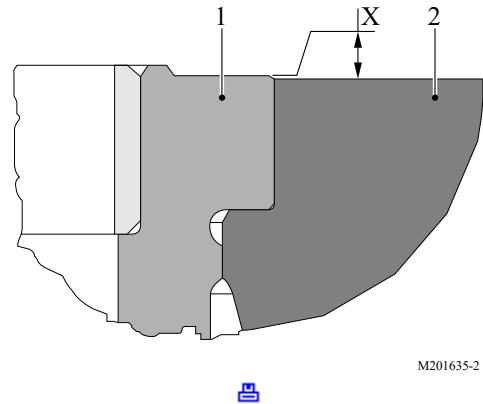
1. Phase 1: 25 Nm [221 lb-in]
2. Phase 2: 50 Nm [443 lb-in]

Tightening sequence special tool



Second phase only after completing first phase on all bolts.

Cylinder liner height (X)	0.10 - 0.18 mm [0.0039 - 0.0070 in]
used cylinder liner	0.0070 in]
Cylinder liner height (X)	0.12 - 0.18 mm [0.0048 - 0.0070 in]
new cylinder liner	0.0070 in]



- 1 Cylinder liner
- 2 Cylinder block

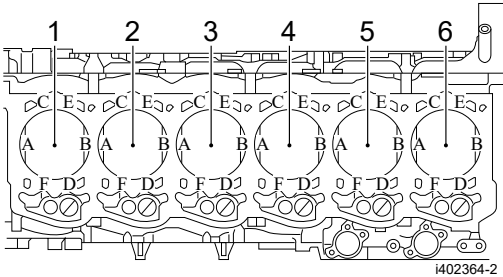
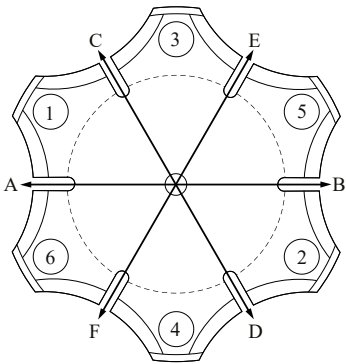


The difference between B and A from the **adjacent liner** must not exceed 0.03 mm [0.0012 in]



All the readings must be within the specified tolerances.

Measuring sequence



M032175 - 07.21.2016

Check form cylinder liner height

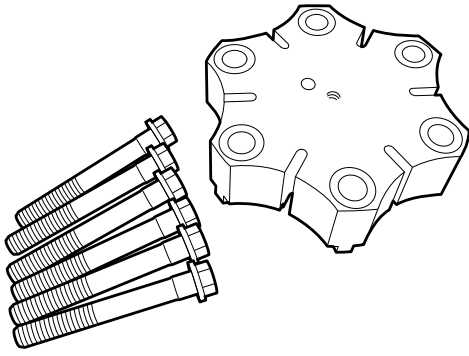
	Cylinder 1 (mm) (in)	Cylinder 2 (mm) (in)	Cylinder 3 (mm) (in)	Cylinder 4 (mm) (in)	Cylinder 5 (mm) (in)	Cylinder 6 (mm) (in)
A						
B						
C						
D						
E						
F						

M045394 - 06.18.2015

Special tools

Special tool category: Mandatory special tool for: NA region
1809948

Auxiliary tool for height measurement of cylinder liner

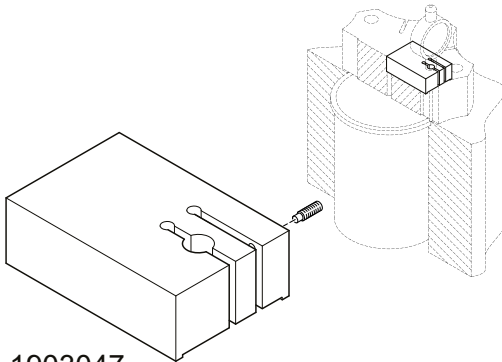


T00141

*ST1809948 - 11.29.2011*

Special tool category: Mandatory special tool for: NA region
1903047

Cylinder liner height gauge block. Supersedes 0694795.

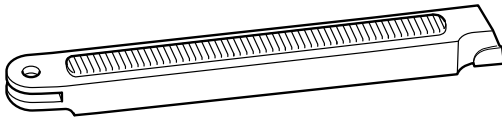


1903047

*ST1903047 - 09.17.2013*

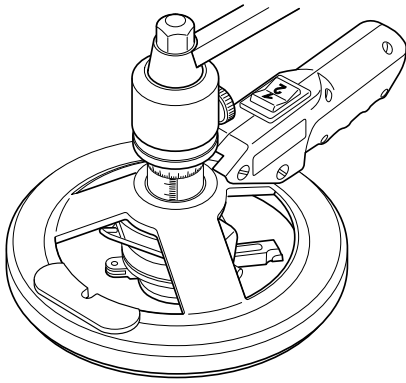
Special tool category: Recommended special tool
1903061

Cutting tool 1.2 i.c.w. 1903077 or 1961378

*ST1903061 - 09.02.2014*

Special tool category: Recommended special tool
1961378

Cylinder liner seat repair tool 120 V i.c.w. 1903061



ST1961378 - 09.15.2014

- ☐ ☐ 1.103 remove crankshaft sensor (Sensors electrical system, engine)
- ☐ ☐ 1.104 remove camshaft sensor (Sensors electrical system, engine)
- ☐ ☐ 1.105 set timing (ENGINE)

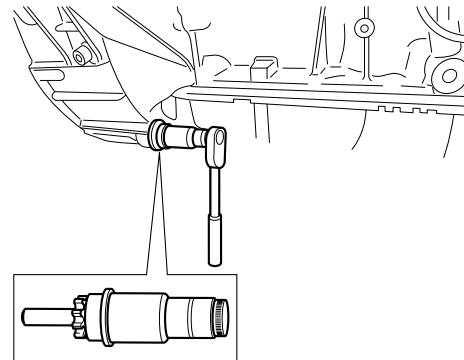
Explanation

Setting Engine to TDC

1. Use the special tool (1903018) to turn the crankshaft counterclockwise as seen from the distribution side.



This corresponds to the direction of rotation of the engine.



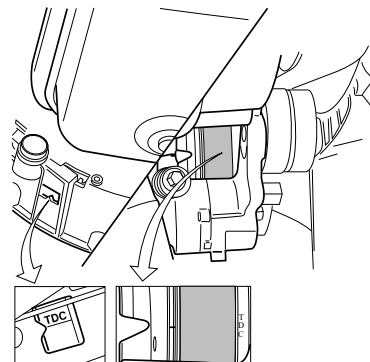
I402049



2. Position cylinder 1 at top dead center (TDC on vibration damper, cylinder 6 in overlap position).



- The TDC position can also be read on the flywheel.



M201304



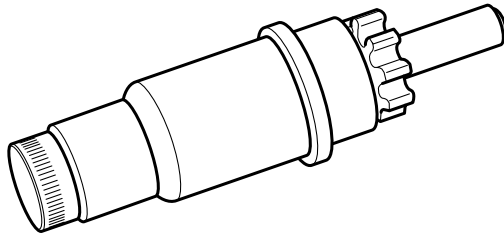
M045906 - 03.28.2015

Special tools

Special tool category: Mandatory special tool for: NA region
1903018

Engine Cranking Tool

1453158 is also
suitable



1903018



ST1903018 - 01.07.2013

□ ▲ 1.106 check flywheel (Flywheel)

Explanation

Checking flywheel

Checking flywheel contact surface

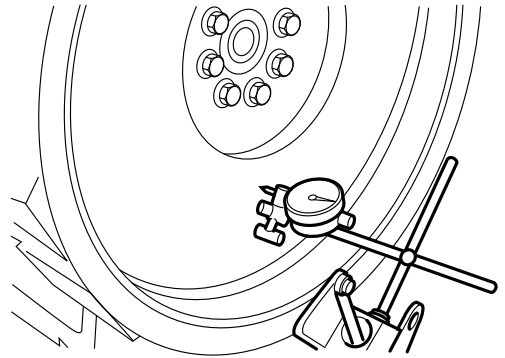
1. Check the contact surface for visible cracks or damage.



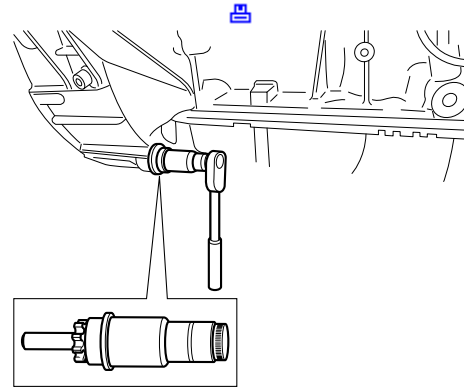
- If damaged, the flywheel may be turned down until the indicator groove on the outer circumference of the contact surface is no longer visible. This corresponds to a **maximum of 2 mm [0.08 in]**.
- Cracks are not allowed:
 - Within 5 mm [0.2 in] of the outer edge.
 - In the contact surface, deeper than 2 mm [0.08 in].

Checking flywheel run-out

1. Clean the flywheel.
2. Place a metal strip on the edge of the flywheel housing to fit a dial gauge.
3. Place the stylus of the dial gauge at the specified radial distance from the center line.
4. Set the dial gauge to '0'.



5. Use the special tool (1903018) to crank the engine through 360°, and measure the maximum dial gauge reading.
6. Compare the measured value with the specified data.

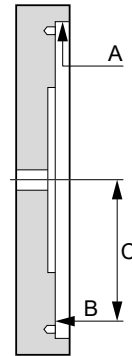


M028842 - 11.13.2014

Technical data

Checking data, flywheel

Radial run-out (A),
measured on the inside of Maximum 0.10 mm [0.004
the flywheel outer edge. in]
Axial deviation (B),
measured at a distance
(C) of 185 mm [7.28 in]
from the center of the Maximum 0.10 mm [0.004
flywheel. in]



M201882

M028843 - 01.14.2013

1.107 remove flywheel (Flywheel)

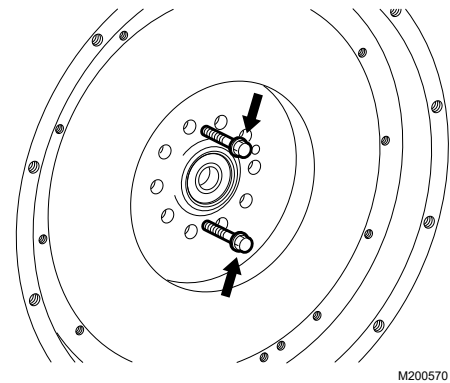
Explanation

Removing flywheel

1. Remove all the flywheel attachment bolts.
2. Use two M10 bolts to push the flywheel off the crankshaft.



Ask a second person to help support the flywheel during removal.



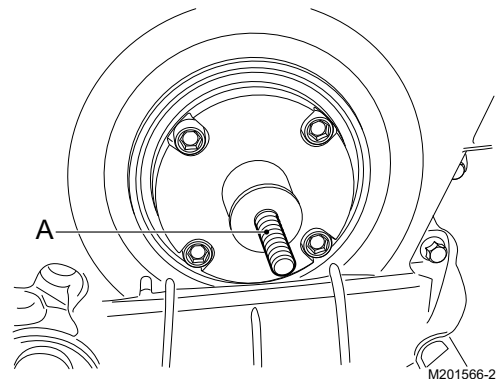
M022007 - 08.04.2010

1.108 remove crankshaft seal ring, flywheel housing (Flywheel housing)

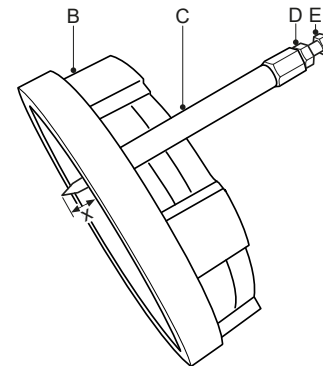
Explanation

Removing crankshaft seal ring, flywheel housing

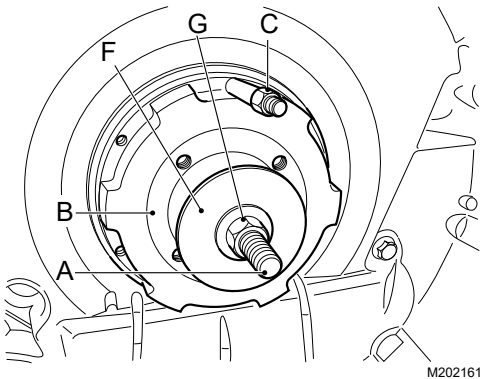
1. Clean the area around the crankshaft seal ring thoroughly.
2. Fit the spindle (A) of the special tool (1453185) onto the crankshaft flange.



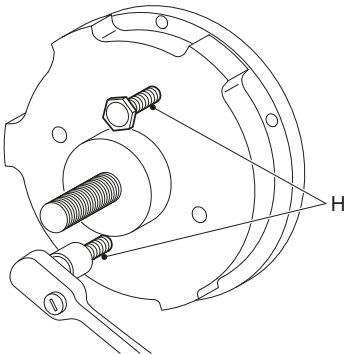
3. Adjust the pin (C) with the bolt (E) until the distance (X) is 10 mm.
4. Lock the pin (C) with the nut (D).



5. Install the adapter (B) to the spindle (A).
6. Install the spacer ring (F) and secure it with the nut (G).
7. Turn the pin (C) into the adapter (B) and keep turning it until the stop is reached.
8. Repeat step 7 for the other five holes.
9. Fit screws into the hole created in the seal ring.
10. Repeat step 9 for the other five holes.
11. Remove the nut (G) and spacer ring (F).



- 12. Turn the bolts (H) evenly until the seal is removed.
- 13. Remove the special tool.



M202162

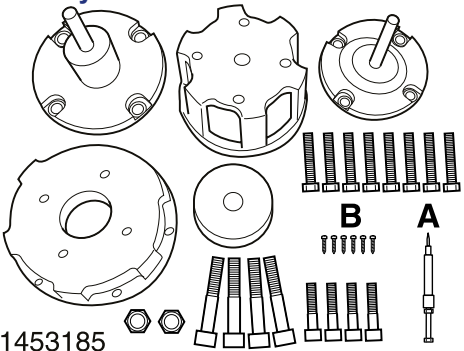


M021480 - 11.05.2012

Special tools

Special tool category: Mandatory special tool for: NA region, NA Service Support
1453185

Assembly and disassembly tool set for front and rear crankshaft seals



"Contents 1453185"



T00112-4

ST1453185 - 10.22.2018

- 1.109 remove both sides engine bracket (Engine mountings)
- 1.110 remove flywheel housing (Flywheel housing)
- 1.111 remove pulse ring (Basic assembly)
- 1.112 remove idler gear (Basic assembly)

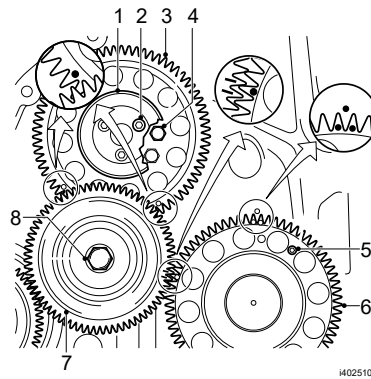
Explanation

Removing idler gear

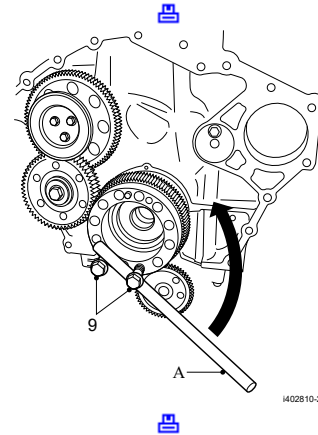
1. Rotate the crankshaft until the timing marks align as shown.



- The position of the mark on the idler gear (7) is irrelevant.
- Rotating the crankshaft without the flywheel housing:
 - Fit two flywheel attachment bolts (9).
 - Use a tommy bar (A) to rotate the crankshaft counter-clockwise.



2. Remove the attachment bolt (8) and the thrust plate.
3. Remove the idler gear (7).



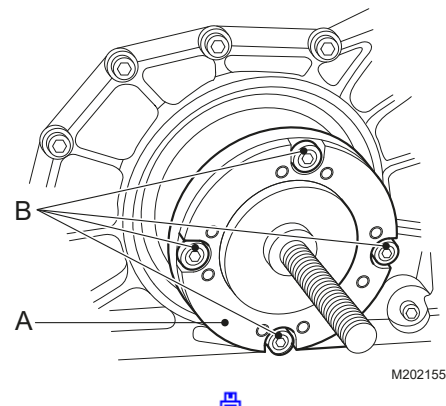
M039473 - 01.09.2014

- ☐ ☐ 1.113 remove camshaft gear (Basic assembly)
- ☐ ☐ 1.114 remove vibration damper (Pulley)
- ☐ ☐ 1.115 remove coolant pump speed sensor (Sensors electrical system, engine)
- ☐ ☐ 1.116 remove left-hand idler pulley, poly-V-belt (Pulley)
- ☐ ☐ 1.117 remove idler pulley, poly-V-belt (Pulley)
- ☐ ☐ 1.118 remove front engine bracket (Engine mountings)
- ☐ ☐ 1.119 remove front crankshaft seal ring (Basic assembly)

Explanation

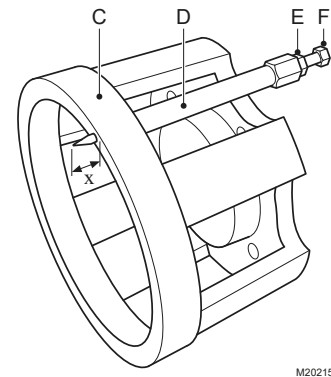
Removing crankshaft seal ring, front cover

1. Clean the area around the crankshaft seal ring thoroughly.
2. Install the spindle (A) of the special tool (1453185) to the crankshaft flange using the bolts (B).

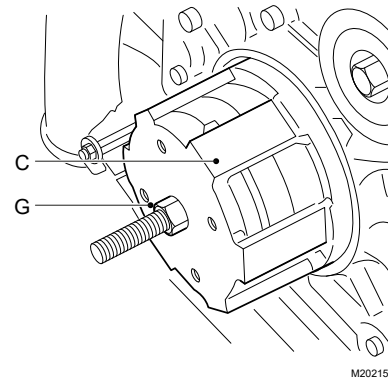


3. Adjust the pin (D) with the bolt (F) until the distance (X) is 10 mm.

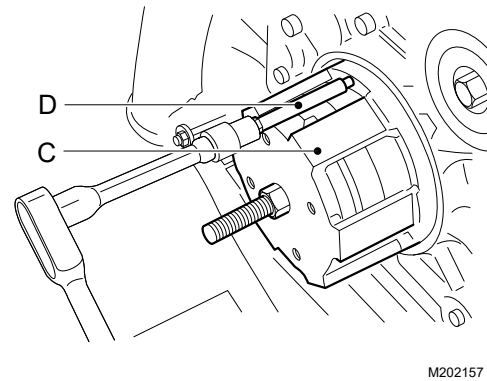
4. Lock the pin (D) with the nut (E).



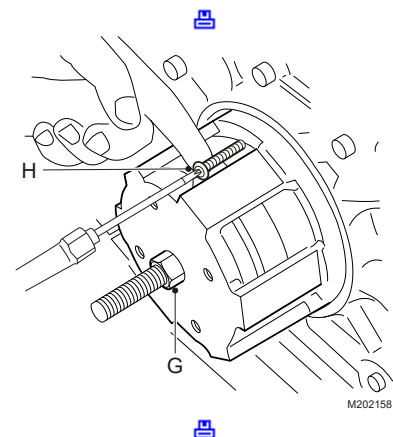
5. Install the adapter (C) to the spindle (A) and secure it with the nut (G).



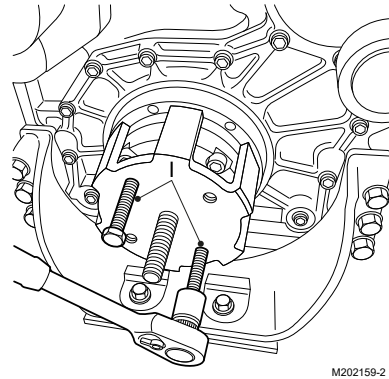
6. Turn the pin (D) into the adapter (C) and keep turning it until the stop is reached.
7. Repeat step 6 for the other five holes.



8. Fit screws (H) into the hole created in the seal ring.
9. Repeat step 8 for the other five holes.
10. Remove the nut (G).



11. Evenly turn the bolts (I) until the seal ring is removed.



M202159-2

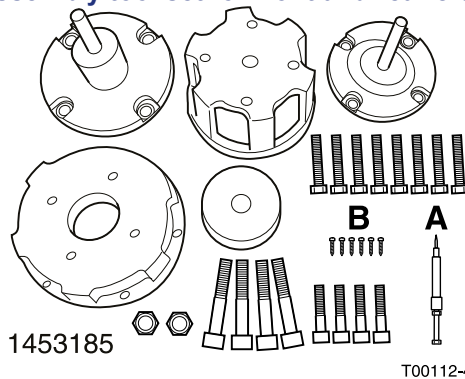


M032050 - 08.17.2012

Special tools

Special tool category: Mandatory special tool for: NA region, NA Service Support
1453185

Assembly and disassembly tool set for front and rear crankshaft seals



"Contents 1453185"



T00112-4

ST1453185 - 10.22.2018

- ☐  1.120 remove engine front cover (Basic assembly)
- ☐  1.121 remove gasket, engine front cover (Basic assembly)
- ☐  1.122 remove alternator bracket (Alternator and starter motor)
- ☐  1.123 loosen dipstick tube (Lubrication system)
- ☐  1.124 remove 6 (six) inlet valve lifter (Basic assembly)
- ☐  1.125 remove 6 (six) exhaust valve lifter (Basic assembly)

Explanation

Removing valve tappets

1. Use the welding wire again to slightly lift the valve tappets.
2. Remove the fixation bolts and lower the valve tappets.
3. Remove the valve tappets through the camshaft bore of the cylinder block.



- Do not reuse the valve tappets if the camshaft is replaced.

1.126 remove 2 (two) pump unit lifter (Fuel system)

Explanation

Removing pump unit lifter

1. Loosen the locking pin and remove the pump unit tappets.
2. Visually inspect the pump unit lifter and the camshaft for wear and damage.

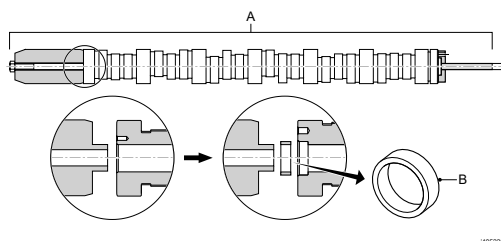
M028852 - 01.31.2018

1.127 remove locking plate (Basic assembly)

1.128 remove camshaft, engine (Basic assembly)

Explanation

Using special tool 1961361 i.c.w. special tool 1453160



- For production purposes, an additional recess in the camshaft was added from specification week 37, 2015
- The recess requires the additional use of the special tool (B) (1961361), in combination with the special tool (A) (1453160), if replacing the camshaft.
- Other recent changes regarding the camshaft can be found in ["PB00256"](#)

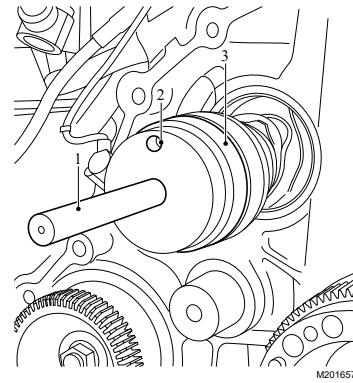
M051630 - 04.04.2016

Removing camshaft, engine

1. Use the special tool (1453160) to remove the camshaft.
2. Insert the handle (1), from the flywheel side of the engine, through the hollow camshaft.



Make sure that the dowel pin in the camshaft falls into the recess (2) in the handle (1).



3. Fit the slide block (3) onto the handle (1) at the front side of the camshaft and tighten the nut (2).

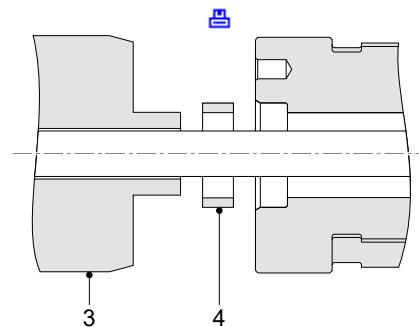
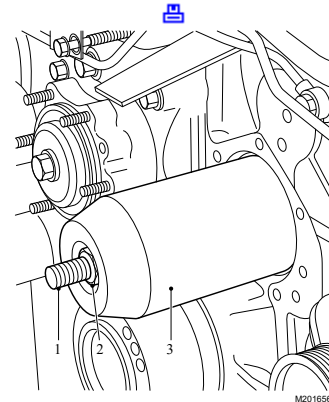


- Make sure that the slide block (3) is perfectly aligned with the camshaft.
- If the camshaft has a recess as shown, use the special tool (4) (1961361) to install it.

4. Use the handle (1) to pull the camshaft carefully out of the engine toward the flywheel side.



Ask a 2nd person to help remove the camshaft.



M022427 - 02.15.2016

Technical data

Checking data, camshaft

Camshaft clearance

Axial clearance

minimum 0.25 mm [0.00984 in]
maximum 0.65 mm [0.02559 in]

Radial clearance

minimum 0.115 mm [0.00453 in]
maximum 0.220 mm [0.00867 in]

Camshaft bearing journal

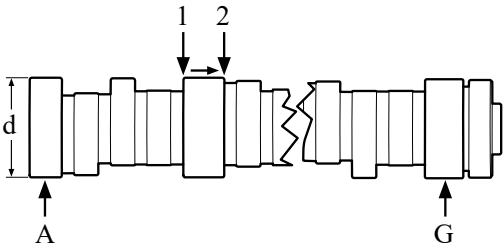
Diameter (d)

minimum 99.935 mm
[3.93444 in]
maximum 99.965 mm
[3.93562 in]

Camshaft housing bore	minimum 105.000 mm [4.13385 in] maximum 105.035 mm [4.13523 in]
Bearing wall thickness	minimum 2.455 mm [0.09665 in] ⁽¹⁾ maximum 2.475 mm [0.09744 in] ⁽¹⁾

(1) Measure only the contact area.

Radial run-out per main bearing journal, measured in reference to the bearing journals (A, G) maximum 0.04 mm [0.00157 in]

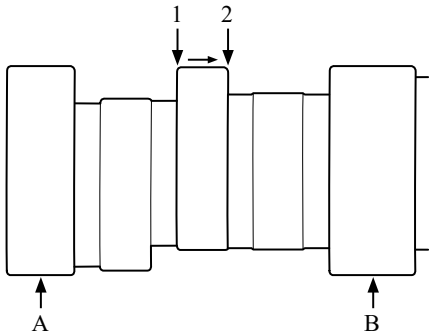


M201947



Cam

Parallelism, for each cam, measured in reference to the adjoining bearing journals (A, B) maximum 0.008 mm [0.00031 in]



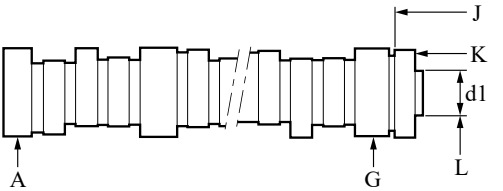
M201948



Camshaft gear journal

Diameter (d ₁)	minimum 49.985 mm [1.96791 in] maximum 50.015 mm [1.96909 in]
----------------------------	--

Axial runout (J), in reference to the bearing journals (A, G) 0.04 mm [0.00157 in]
Axial runout (K), in reference to the bearing journals (A, G) 0.05 mm [0.00197 in]
Radial runout (L), in reference to the bearing journals (A, G) 0.04 mm [0.00157 in]



M202007

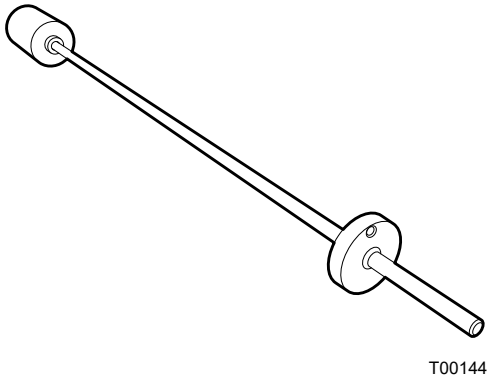


M032198 - 02.26.2014

Special tools

Special tool category: Recommended special tool 1453160

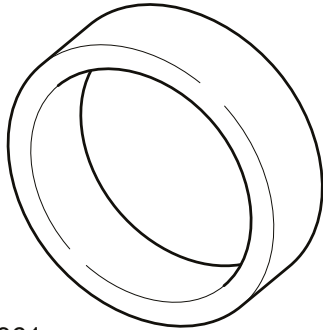
Disassembly and assembly tool for the camshaft



ST1453160 - 03.24.2010

Special tool category: Recommended special tool
1961361

Adapter tool for camshaft (i.c.w. 1453160)



T05012



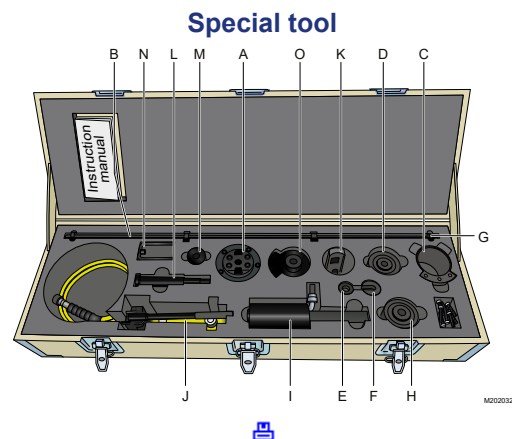
ST1961361 - 01.07.2016

1.129 remove all camshaft bearing (Basic assembly)

Explanation

Removing all Camshaft Bearings

- The engine block is fitted with seven camshaft bearings; the first bearing is located at cylinder one (vibration damper side).
1. The camshaft bearings are removed using the special tool, including:
 - Adapter (A)
 - Spindle (B)
 - Guide adapter (C)
 - Guide/press ring (D), small
 - Shim rings (E)
 - Locking ring (F)
 - Nut (G)
 - Guide/press ring (H), large
 - Hydraulic puller (I)
 - Hydraulic press (J)
 - Stamp (K)



- Fixation pin (L)
- Bush (M)
- End stop (N)
- Guide adapter (O)

Removing Camshaft Bearing 7

1. Use a suitable support and rotate the engine.

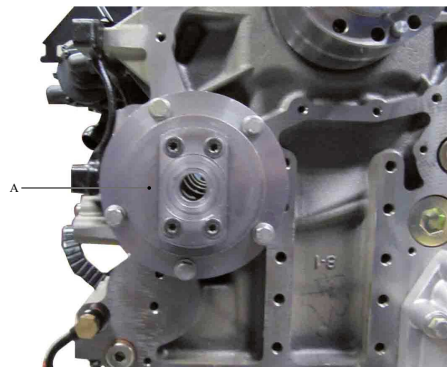


Rotate the engine to gain access to the camshaft cavity.

2. Fit the adapter (A) to the front of the cylinder block.



Tighten the attachment bolts to 30 Nm [22 lb-ft].



3. Fit the guide adapter (C) to the rear of the cylinder block.



- Align it in position using the large guide/press ring (H).
- Tighten the attachment bolts to 30 Nm [22 lb-ft].



M202033



4. Position the spindle (B) in the adapter (A) through the cylinder block and stop before cylinder (6).



Lubricate the spindle (B).

5. Position the small guide/press ring (D) in the 6th camshaft bearing and push the spindle (B) through.



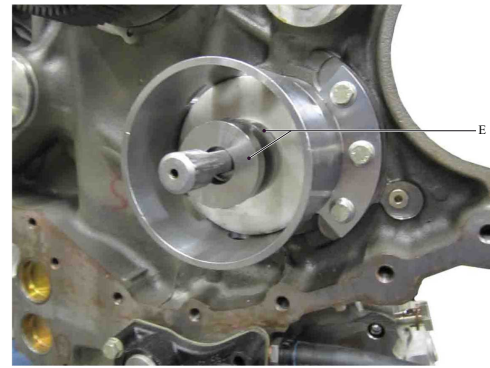
Installing the guide/press ring (D) is necessary to provide additional guidance to the spindle (B).



M202034



6. Push the spindle (B) further through the 7th camshaft bearing through the guide adapter (C).
7. Position the large guide/press ring (H) over the spindle (B) in the 7th camshaft bearing.
8. Position the two shim rings (E) against the large guide/press ring (H).



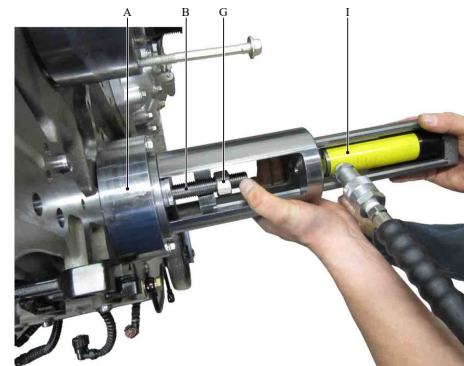
9. Fit the locking ring (F) onto the spindle (B).



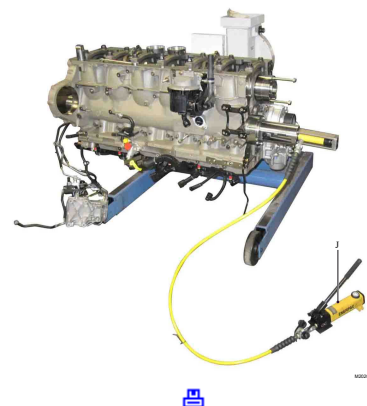
10. Turn the nut (G) onto the spindle (B).
11. Fit the hydraulic puller (I) to the adapter (A) as shown.



Turn the puller a quarter of a turn to secure.



12. Use the hydraulic press (J) to carefully press the 7th camshaft bearing out of the cylinder block.
13. Depressurize the hydraulic press (J) and remove the hydraulic puller (I) from the adapter (A) by turning it a quarter of a turn.



14. Carefully pull out the spindle (B) and remove the 7th camshaft bearing.
15. Remove the small guide/press ring (D) and the large guide/press ring (H).



Removing camshaft bearings 2 to 6

1. Camshaft bearings 2 to 6 are removed in almost the same way as camshaft bearing 7.



The difference is that the small guide/press ring (D) is now used to press, and the large guide/press ring (H) is used to guide.



2. Guide adapter (C) should be exchanged with guide adapter (O).

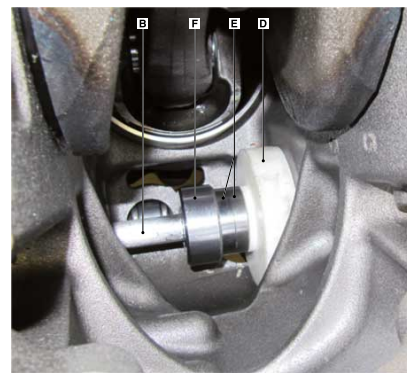


Removing Camshaft Bearing 1

1. Camshaft bearing 1 is removed in almost the same way as camshaft bearing 2 to 6.



The difference is that camshaft bearing 1 is pressed into the adapter (A).

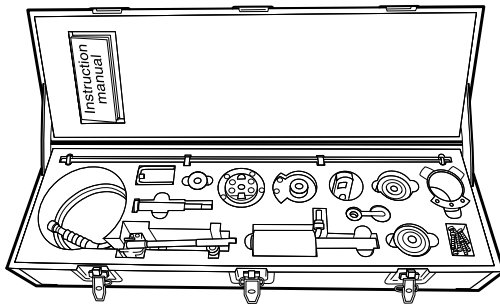


M041115 - 02.26.2014

Special tools

Special tool category: Recommended special tool
1809975

Camshaft bearings, disassembly and assembly tool



ST1809975 - 08.25.2011

1.130 loosen 6 (six) connecting rod, engine (Basic assembly)

Explanation



- The cracked connecting rods are very sensitive to damage on the mating surfaces.
- With cracked connecting rods, temporarily place the connecting rod bolts back into the connecting rod to protect the mating surfaces during the removal procedure.
- If the connecting rod with piston is pushed out, be careful not to damage or leave any substances on the mating surfaces. The mating surfaces will no longer fit correctly when there is damage or any foreign substances.
- Never place the connecting rod and bearing cap on the mating surfaces. Otherwise, the mating surfaces may become damaged or contaminated, and they may no longer fit one another.
- Do not clean the mating surfaces with a steel brush.

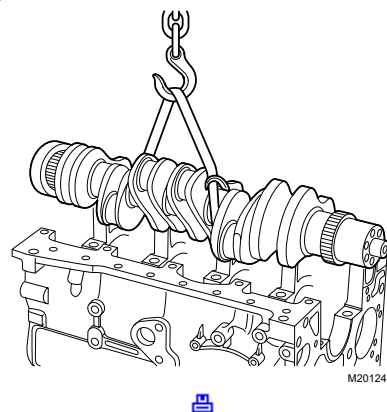
M037538 - 06.04.2013

1.131 remove crankshaft (Basic assembly)

Explanation

Removing crankshaft

1. Position the engine upside down.
2. Mark the main bearing caps so that they can be refitted in the same position.
3. Remove the bearing caps with the bearing shells.
4. Remove all thrust washers.
5. Lift the crankshaft out of the engine.
6. Remove the upper bearing shells.



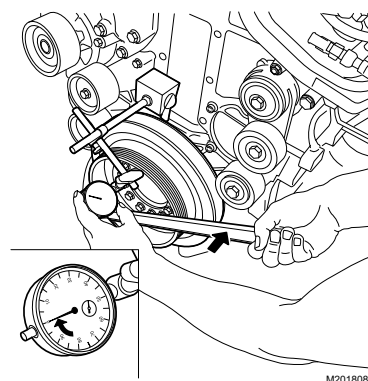
M027486 - 02.21.2017

- ▲ 1.132 remove all thrust washer, crankshaft (Basic assembly)
- ▲ 1.133 remove all crankshaft main bearing shell (Basic assembly)
- ▲ 1.134 check clearance crankshaft (Basic assembly)

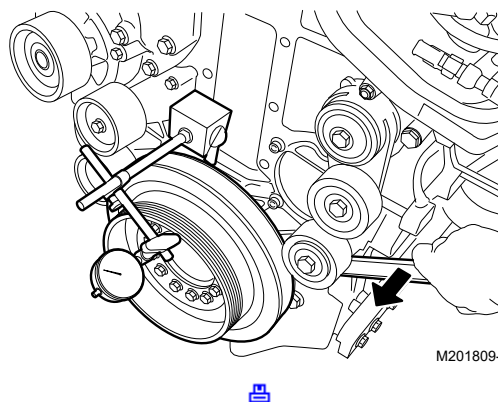
Explanation

Checking crankshaft clearance

1. Position a dial gauge on the vibration damper.
2. Press the crankshaft into the block until the dial gauge stops moving.
3. Zero the dial gauge.



4. Pull out the crankshaft off the block and note the dial gauge reading.
5. Check the reading with the specified axial play.



M032377 - 10.17.2012

Technical data

Checking data, crankshaft

Crankshaft clearance, vibration damper side
Axial clearance

min. 0.075 mm [0.00295 in]

Print
max. 0.265 mm [0.0104 in]

Radial clearance

min. 0.070 mm [0.00276 in]
max. 0.144 mm [0.00567 in]



Clearance measured with the engine in the vehicle.

M023233 - 06.14.2018

1.135 install all camshaft bearing (Basic assembly)

Explanation

Installing all camshaft bearings

- The engine block is fitted with seven camshaft bearings; the first bearing is located at cylinder one.
- The following parts of the special tool are already installed during removal of the bearings:
 - the adapter (A).
 - the guide adapter (O).
- All camshaft bearings are pressed into position with stamp (K).
- Install the camshaft bearings in the order 1st to 7th.

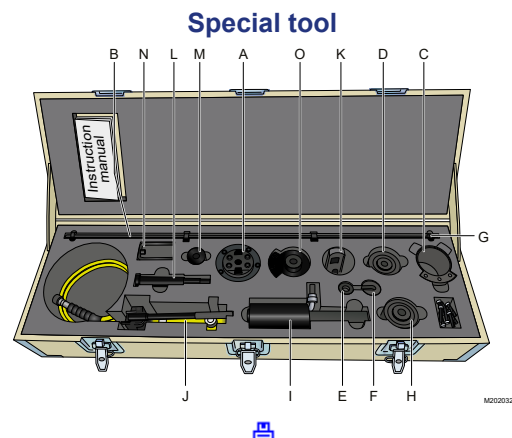


Check for correct part numbers of the camshaft bearings.

This is to prevent damage to the bearings which have just been mounted with the stamp (K).

The camshaft bearings are installed using a special tool, including:

- Adapter (A)
- Spindle (B)
- Guide adapter (C)
- Guide/press ring (D), small
- Shim rings (E)
- Locking ring (F)
- Nut (G)
- Guide/press ring (H), large
- Hydraulic puller (I)
- Hydraulic press (J)
- Stamp (K)
- Fixation pin (L)
- Bush (M)
- End stop (N)
- Guide adapter (O)



Installing camshaft bearing 1

1. Check the camshaft bores for burrs and damage and correct if necessary.
2. Lubricate the stamp (K) and position the 1st camshaft bearing on the stamp (K) as shown.



Make sure that stamp (K) is clean and free from burrs and damage. Correct if necessary.

3. Turn the bolt screw anti-clockwise to secure the oil bore in position.



Lubricate the camshaft bearing before installing.

4. Carefully position the stamp (K) in the camshaft cavity at the 1st cylinder.
5. Position the large guide/press ring (H) in the adjacent camshaft bore to guide the spindle (B).



This is necessary to prevent damaging the camshaft bearing during removal of the spindle.

6. Position spindle (B) into adapter (A) and through the stamp (K).



- Prevent damage to the camshaft bores or newly mounted camshaft bearings while positioning the spindle (B).
- Make sure that spindle (B) is lubricated with clean engine oil.

7. Position two shim rings (E) to the stamp (K).
8. Push the spindle (B) further through the guide/press ring (H) and the guide adapter (O).

9. Insert fixation pin (L) in the respective inlet valve lifter bore until it engages with the stamp (K) as shown.

10. Fit and hand-tighten the tappet fixation bolt to secure fixation pin (L).



Excessive torquing will damage the tappet fixation bolt and the fixation pin (L).

11. Fit the locking ring (F) onto the spindle (B) in the recess just behind the stamp (K).



M02045-2

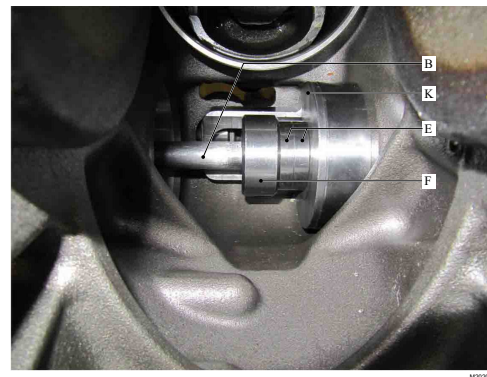


M02043



M03478

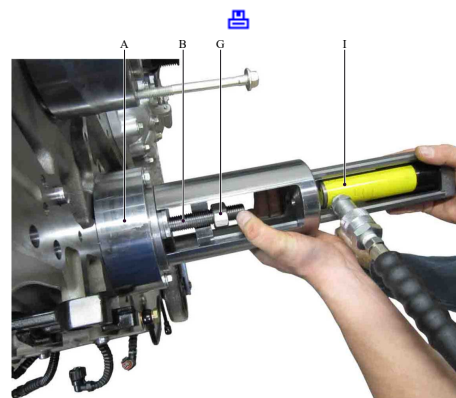




12. Turn the nut (G) onto the spindle (B).
13. Mount the hydraulic puller (I) to the adapter (A) as shown.



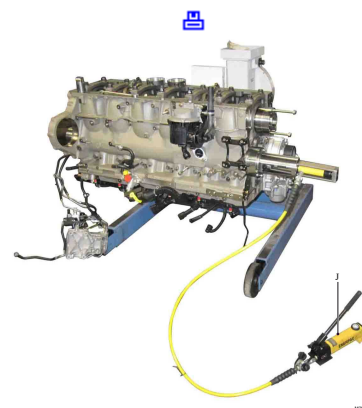
Turn the puller a quarter of a turn to secure it.



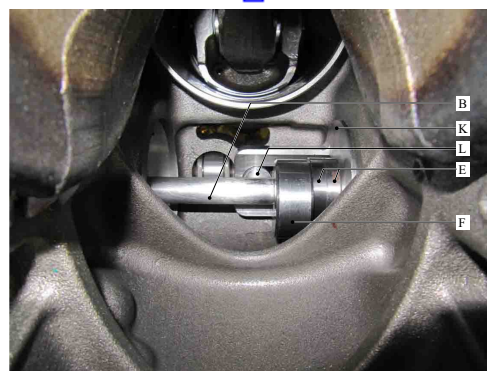
14. Use the hydraulic press (J), and carefully press the 1st camshaft bearing into the cylinder block.



The 1st camshaft bearing is 'in position' if the fixation pin (L) reaches the other end of the slotted hole in the stamp (K) as shown.



15. Depressurize the hydraulic press (J) and remove the hydraulic puller (I) from the adapter (A) by turning it a quarter of a turn.
16. Remove the locking ring (F).
17. Carefully pull out the spindle (B) and collect the two shim rings (E).
18. Remove the adapter (A).
19. Turn the bolt on stamp (K) clockwise to release the stamp (K) from the camshaft bearing.
20. Remove the fixation pin (L).
21. Carefully remove the stamp (K) out of the bearing and from the engine block.
22. Install the adapter (A) and tighten the attachment bolts to 30 Nm.

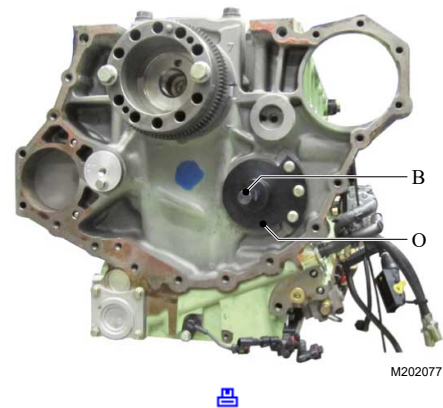


Installing camshaft bearings 2 to 6

1. Camshaft bearings 2 to 6 must be installed in the same way as the 1st camshaft bearing.



The difference is that the adapter (A) does not need to be removed.



Installing camshaft bearing 7

1. Remove the guide adapter (O).
2. Install the guide adapter (C).



- Align the guide adapter (C) with the camshaft bore by pushing the large guide/press ring (H) through the guide adapter (C) and the camshaft bore.
- Tighten the attachment bolts to 30 Nm [22 lb-ft].

3. Reposition the large guide/press ring (H) in the adjacent camshaft bore to guide the spindle (B).



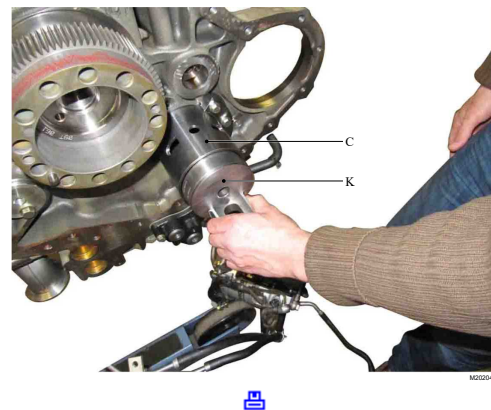
Prevent damage to the camshaft bores or newly mounted camshaft bearings while positioning the spindle (B).

4. Position the 7th camshaft bearing on the stamp (K) as mentioned earlier in this description.
5. Carefully slide the stamp (K) into the guide adapter (C) as shown until it abuts.



- Make sure that stamp (K) is free from burrs and damage. Correct if necessary.
- Lubricate the stamp (K) before mounting the camshaft bearing.
- Lubricate the camshaft bearing before installing.

6. Push the spindle (B) through the stamp (K).
7. Fit the bush (M) onto the spindle and lock it in position with the end stop (N).
8. Push through the spindle (B) and secure it with the locking ring (F).
9. Carefully press the 7th camshaft bearing into the cylinder block as mentioned earlier in this description.

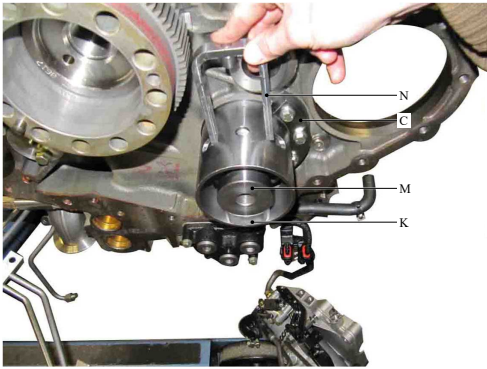


The difference is that the 7th camshaft



bearing is 'in position' if the bush (M) is pushed against the end stop (N).

10. All bearings are now in position; remove all components of the special tool.



M032343 - 02.06.2018

Technical data

Checking data, camshaft

Camshaft clearance

Axial clearance

minimum 0.25 mm [0.00984 in]
maximum 0.65 mm [0.02559 in]

Radial clearance

minimum 0.115 mm [0.00453 in]
maximum 0.220 mm [0.00867 in]

Camshaft bearing journal

Diameter (d)

minimum 99.935 mm
[3.93444 in]
maximum 99.965 mm
[3.93562 in]

Camshaft housing bore

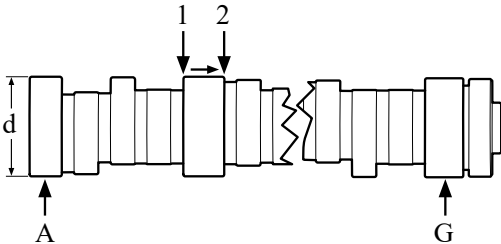
minimum 105.000 mm
[4.13385 in]
maximum 105.035 mm
[4.13523 in]

Bearing wall thickness

minimum 2.455 mm
[0.09665 in]⁽¹⁾
maximum 2.475 mm
[0.09744 in]⁽¹⁾

(1) Measure only the contact area.

Radial run-out per main bearing journal, measured in reference to the bearing journals (A, G) maximum 0.04 mm [0.00157 in]

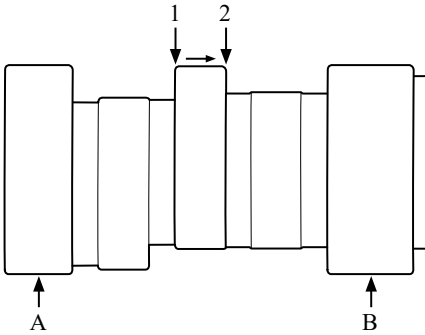


M201947



Cam

Parallelism, for each cam, measured in reference to the adjoining bearing journals (A, B) maximum 0.008 mm [0.00031 in]



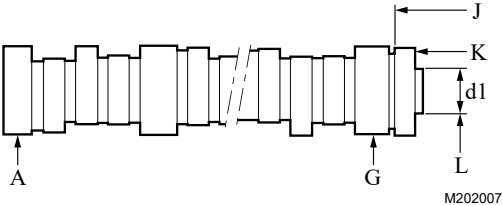
M201948



Camshaft gear journal

Diameter (d_1) minimum 49.985 mm
[1.96791 in]
maximum 50.015 mm
[1.96909 in]

Axial runout (J), in
reference to the bearing
journals (A, G) 0.04 mm [0.00157 in]
Axial runout (K), in
reference to the bearing
journals (A, G) 0.05 mm [0.00197 in]
Radial runout (L), in
reference to the bearing
journals (A, G) 0.04 mm [0.00157 in]



M202007

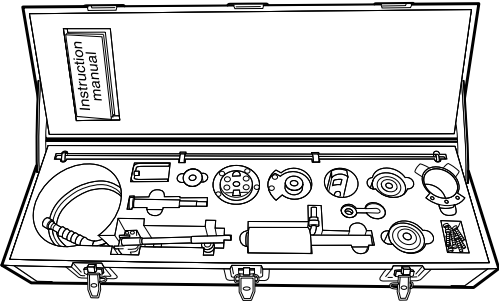


M032198 - 02.26.2014

Special tools

Special tool category: Recommended special tool
1809975

Camshaft bearings, disassembly and assembly tool



ST1809975 - 08.25.2011

 1.136 install camshaft, engine (Basic assembly)

Explanation

Installing camshaft, engine

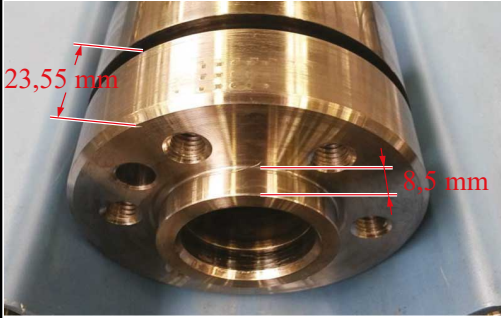
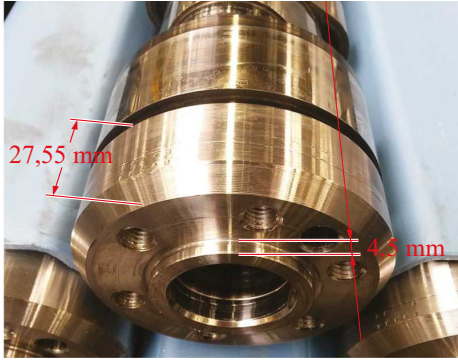
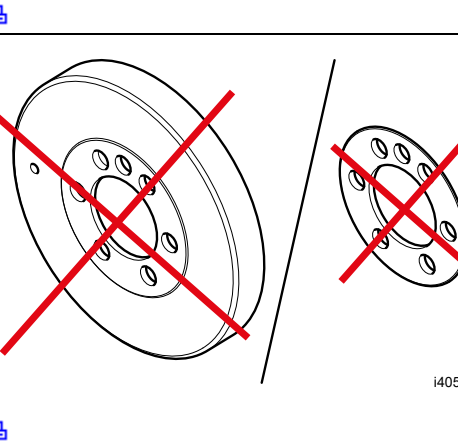
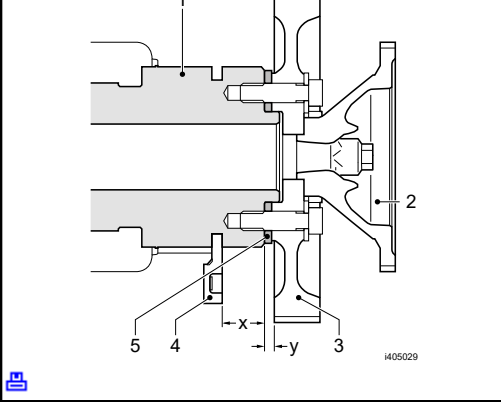
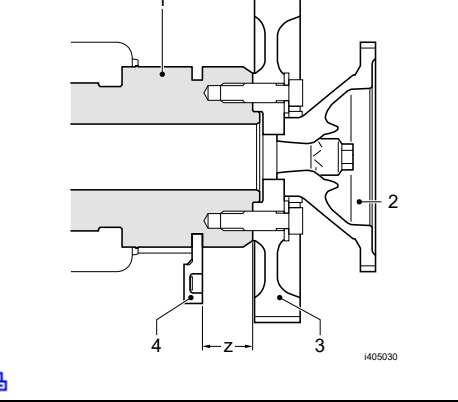


- **Do NOT install a shim ring or vibration damper in combination with a camshaft with integrated shim ring, to prevent the idler gear from touching the camshaft gear.**
- **The related parts bulletin, PB00256 is shown below:**

- The camshaft vibration damper/shim ring is integrated into the camshaft in MX-13 engines.
- Do not reinstall the camshaft vibration damper or the shim ring if the camshaft is replaced with a camshaft with integrated shim ring.



The camshaft vibration damper has been replaced by a shim ring in MX-13 Euro 6 engines as of spec-week 2014-21 (see Part bulletin PB00244).

Camshaft with a vibration damper or a shim ring	Camshaft with integrated shim ring
 i405185	 i405186
 i405191	 i405191
 i405029	 i405030
Dimension X = 23.55 mm Dimension Y = 4 mm	Dimension Z = 27.55 mm
Old part numbers	New part numbers

1889332 non-DEB	2002048 non-DEB
1872340 DEB	2002049 DEB
1946790 non-DEB	2002050 non-DEB
1955880 DEB	2002051 DEB

- 1 Camshaft
- 2 Pulse ring
- 3 Camshaft gear
- 4 Locking plate
- 5 Camshaft vibration damper or shim ring

1. Fit the new cylindrical dowel pin.
2. Prelubricate the camshaft.
3. Carefully install the camshaft in the engine.



- Always use the camshaft support tool.
- The weight of the camshaft is approximately 35-45 kg
- Avoid damaging the camshaft bearings.

M051358 - 12.03.2015

1.137 install locking plate (Basic assembly)

Technical data

Tightening torque, locking plate

Attachment bolts

30 Nm⁽¹⁾

(1) Use Loctite 243 to secure

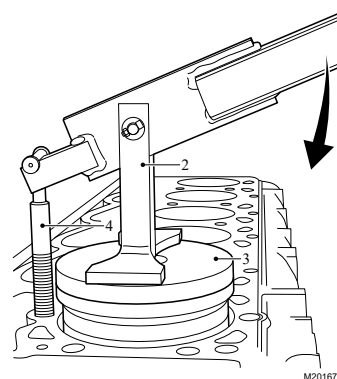
M041212 - 02.19.2014

1.138 install 6 (six) cylinder liner (Basic assembly)

Explanation

Installing cylinder liner

1. Apply the specified grease to the lower half of the cylinder liner.
2. Lower the liner carefully into the engine block until it rests on the O-rings.
3. Mount the hinge bolt (4) (1696707) in the position shown.
4. Mount the pressure plate (3) on the cylinder liner.
5. Press the liner carefully into the block with the lever (2) from the tool set.



M032172 - 02.26.2014

Technical data**Mounting product, sealing ring**

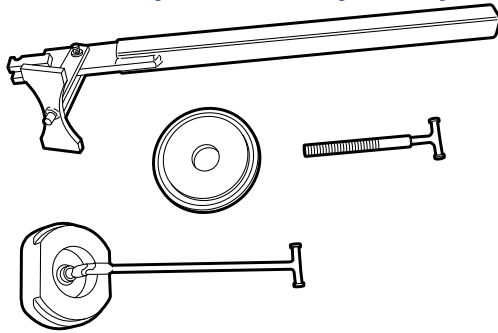
Lubricant

Molykote

M021074 - 04.06.2017

Special tools

Special tool category: Mandatory special tool for: NA region
1696707

Disassembly and assembly tool, cylinder liners

T00148



ST1696707 - 02.21.2008

1.139 install all camshaft bearing (Basic assembly)

Explanation**Installing all camshaft bearings**

- The engine block is fitted with seven camshaft bearings; the first bearing is located at cylinder one.
- The following parts of the special tool are already installed during removal of the bearings:
 - the adapter (A).
 - the guide adapter (O).
- All camshaft bearings are pressed into position with stamp (K).
- Install the camshaft bearings in the order 1st to 7th.



Check for correct part numbers of the camshaft bearings.

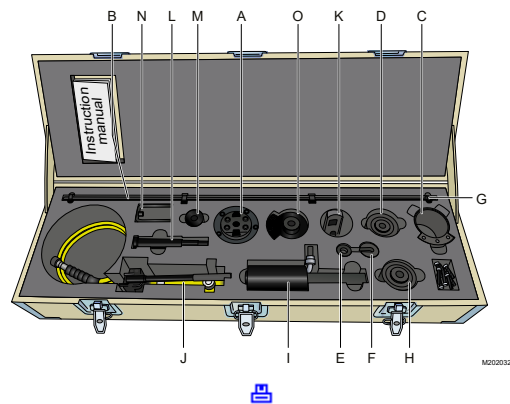
This is to prevent damage to the bearings which have just been mounted with the stamp (K).

The camshaft bearings are installed using a special tool, including:

Special tool

- Adapter (A)

- Spindle (B)
- Guide adapter (C)
- Guide/press ring (D), small
- Shim rings (E)
- Locking ring (F)
- Nut (G)
- Guide/press ring (H), large
- Hydraulic puller (I)
- Hydraulic press (J)
- Stamp (K)
- Fixation pin (L)
- Bush (M)
- End stop (N)
- Guide adapter (O)



Installing camshaft bearing 1

1. Check the camshaft bores for burrs and damage and correct if necessary.
2. Lubricate the stamp (K) and position the 1st camshaft bearing on the stamp (K) as shown.



Make sure that stamp (K) is clean and free from burrs and damage. Correct if necessary.

3. Turn the bolt screw anti-clockwise to secure the oil bore in position.



Lubricate the camshaft bearing before installing.

4. Carefully position the stamp (K) in the camshaft cavity at the 1st cylinder.
5. Position the large guide/press ring (H) in the adjacent camshaft bore to guide the spindle (B).



This is necessary to prevent damaging the camshaft bearing during removal of the spindle.

6. Position spindle (B) into adapter (A) and through the stamp (K).



- Prevent damage to the camshaft bores or newly mounted camshaft bearings while positioning the spindle (B).
- Make sure that spindle (B) is lubricated with clean engine oil.

7. Position two shim rings (E) to the stamp (K).
8. Push the spindle (B) further through the guide/press ring (H) and the guide adapter (O).



9. Insert fixation pin (L) in the respective inlet valve lifter bore until it engages with the stamp (K) as shown.
10. Fit and hand-tighten the tappet fixation bolt to secure fixation pin (L).

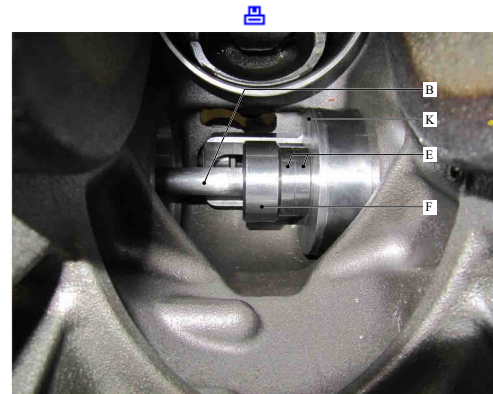


Excessive torquing will damage the tappet fixation bolt and the fixation pin (L).



I403478

11. Fit the locking ring (F) onto the spindle (B) in the recess just behind the stamp (K).

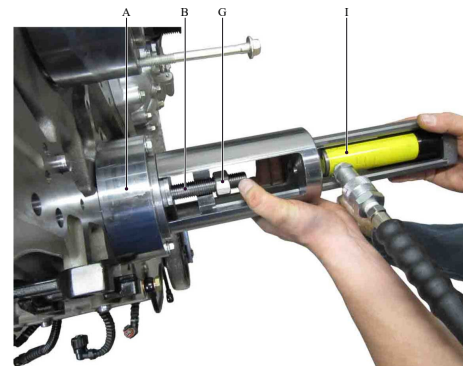


M202045

12. Turn the nut (G) onto the spindle (B).
13. Mount the hydraulic puller (I) to the adapter (A) as shown.



Turn the puller a quarter of a turn to secure it.

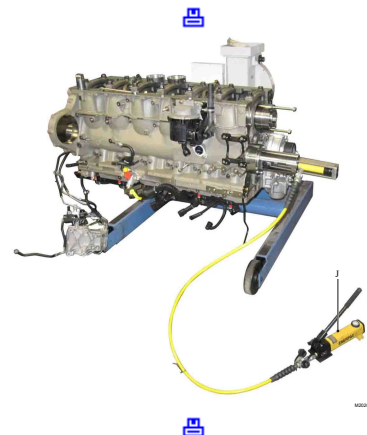


M202037

14. Use the hydraulic press (J), and carefully press the 1st camshaft bearing into the cylinder block.



The 1st camshaft bearing is 'in position' if the fixation pin (L) reaches the other end of the slotted hole in the stamp (K) as shown.



M202038

15. Depressurize the hydraulic press (J) and remove the hydraulic puller (I) from the adapter (A) by turning it a quarter of a turn.
16. Remove the locking ring (F).
17. Carefully pull out the spindle (B) and collect the two shim rings (E).
18. Remove the adapter (A).
19. Turn the bolt on stamp (K) clockwise to release the stamp (K) from the camshaft bearing.
20. Remove the fixation pin (L).
21. Carefully remove the stamp (K) out of the bearing and from the engine block.

22. Install the adapter (A) and tighten the attachment bolts to 30 Nm.



Installing camshaft bearings 2 to 6

1. Camshaft bearings 2 to 6 must be installed in the same way as the 1st camshaft bearing.



The difference is that the adapter (A) does not need to be removed.



M202077

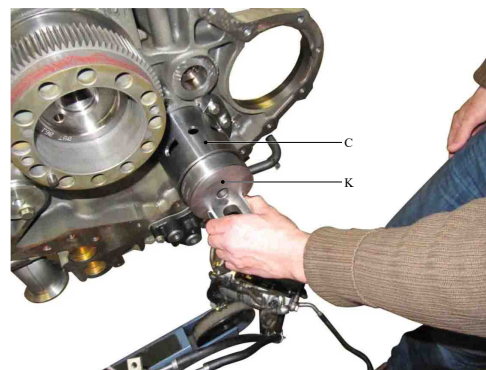


Installing camshaft bearing 7

1. Remove the guide adapter (O).
2. Install the guide adapter (C).



- Align the guide adapter (C) with the camshaft bore by pushing the large guide/press ring (H) through the guide adapter (C) and the camshaft bore.
- Tighten the attachment bolts to 30 Nm [22 lb-ft].



M202047



3. Reposition the large guide/press ring (H) in the adjacent camshaft bore to guide the spindle (B).



Prevent damage to the camshaft bores or newly mounted camshaft bearings while positioning the spindle (B).

4. Position the 7th camshaft bearing on the stamp (K) as mentioned earlier in this description.
5. Carefully slide the stamp (K) into the guide adapter (C) as shown until it abuts.



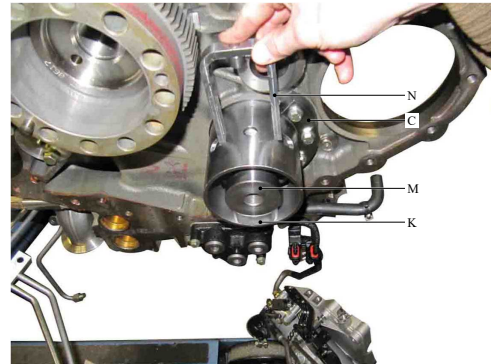
- Make sure that stamp (K) is free from burrs and damage. Correct if necessary.

- Lubricate the stamp (K) before mounting the camshaft bearing.
- Lubricate the camshaft bearing before installing.

6. Push the spindle (B) through the stamp (K).
7. Fit the bush (M) onto the spindle and lock it in position with the end stop (N).
8. Push through the spindle (B) and secure it with the locking ring (F).
9. Carefully press the 7th camshaft bearing into the cylinder block as mentioned earlier in this description.



The difference is that the 7th camshaft bearing is 'in position' if the bush (M) is pushed against the end stop (N).



10. All bearings are now in position; remove all components of the special tool.

M032343 - 02.06.2018

Technical data

Checking data, camshaft

Camshaft clearance

Axial clearance

minimum 0.25 mm [0.00984 in]
maximum 0.65 mm [0.02559 in]

Radial clearance

minimum 0.115 mm [0.00453 in]
maximum 0.220 mm [0.00867 in]

Camshaft bearing journal

Diameter (d)

minimum 99.935 mm
[3.93444 in]
maximum 99.965 mm
[3.93562 in]

Camshaft housing bore

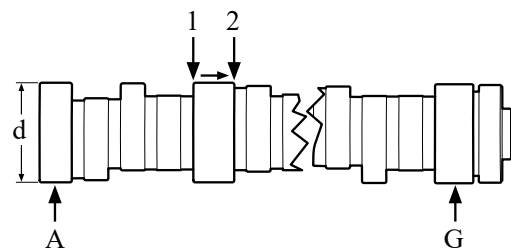
minimum 105.000 mm
[4.13385 in]
maximum 105.035 mm
[4.13523 in]

Bearing wall thickness

minimum 2.455 mm
[0.09665 in]⁽¹⁾
maximum 2.475 mm
[0.09744 in]⁽¹⁾

(1) Measure only the contact area.

Radial run-out per main bearing journal, measured in reference to the bearing journals (A, G) maximum 0.04 mm [0.00157 in]

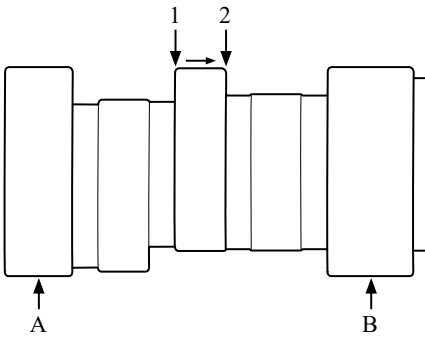


M201947



Cam

Parallelism, for each cam, measured in reference to the adjoining bearing journals (A, B) maximum 0.008 mm [0.00031 in]



M201948



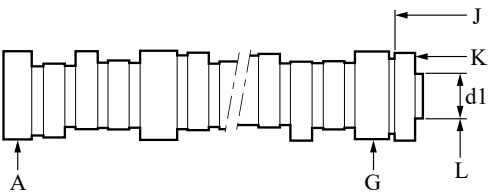
Camshaft gear journal

Diameter (d_1) minimum 49.985 mm [1.96791 in] maximum 50.015 mm [1.96909 in]

Axial runout (J), in reference to the bearing journals (A, G) 0.04 mm [0.00157 in]

Axial runout (K), in reference to the bearing journals (A, G) 0.05 mm [0.00197 in]

Radial runout (L), in reference to the bearing journals (A, G) 0.04 mm [0.00157 in]



M202007

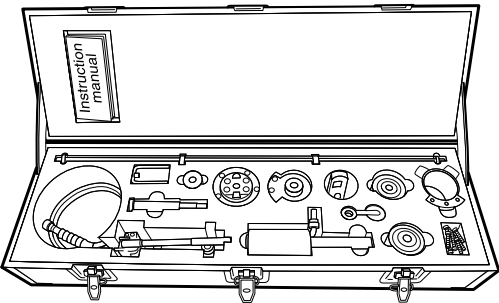


M032198 - 02.26.2014

Special tools

Special tool category: Recommended special tool 1809975

Camshaft bearings, disassembly and assembly tool



ST1809975 - 08.25.2011

 1.140 install all crankshaft main bearing shell (Basic assembly)

Explanation

Installing Crankshaft Main Bearing Shell



If the crankshaft has been ground, fit the correct oversize bearing shells.

1. Thoroughly clean all grease and preservative from the bearing shell contact surfaces.
2. Clean the threaded holes for the main bearing cap bolts.
3. Check that all oil ducts of the bearings and crankshaft are open.
4. Check the dowel pin of the middle bearing.
5. Lubricate the bearing shells with clean engine oil.

M024107 - 10.13.2010

 1.141 install all thrust washer, crankshaft (Basic assembly)

Explanation

Installing upper thrust washer crankshaft

1. Place the upper axial bearing sections to the engine block at the 7th main bearing.



Use clean engine oil to mount the bearing sections.

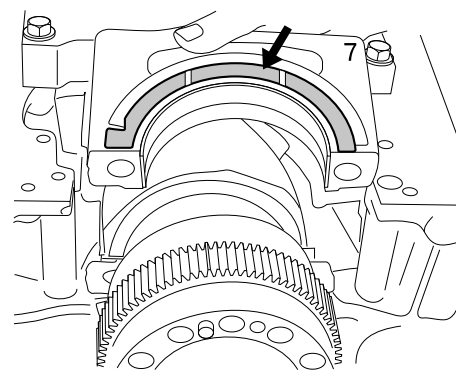
M032275 - 11.05.2012

Installing lower thrust washer, crankshaft

1. Place the lower axial bearing sections onto the 7th main bearing cap as shown.



Use clean engine oil to mount the bearing sections.



M201389



M032278 - 11.05.2012

 1.142 install crankshaft (Basic assembly)

Explanation

Installing crankshaft

1. Clean the threaded holes for the main bearing cap bolts.

2. Lubricate the bearing shells with clean engine oil.



If installing a new crankshaft, always use new crankshaft main bearing shells, thrust washers and connecting rod bearing shells.

3. Screw two flywheel attachment bolts in the crankshaft as shown until they abut.
4. Carefully place the crankshaft in the cylinder block using a suitable hoisting tool.



Make sure that the crankshaft is evenly supported when lifting the crankshaft.

5. Lubricate the bearing journals using clean engine oil.
6. Install the main bearing caps in the original position.



Make sure that the main bearing cap surface is free of any debris.

7. Install the attachment bolts and tighten them to the specified torque.



M032281 - 08.13.2018

Technical data

Tightening torque, crankshaft



Always remove the crankshaft before replacing the main bearing shells.

Main bearing cap attachment bolts

1st phase

70 Nm [52 lb-ft]

2nd phase

250 Nm [185 lb-ft]

3rd phase

150° angular displacement



- Attachment bolts may only be re-used when a new nut (M18 x 2.0) can be screwed by hand over the complete, cleaned bolt thread.
- Apply a drop of clean engine oil to the thread of the bolts and the bearing surface of the bolt heads.

M021965 - 05.04.2018

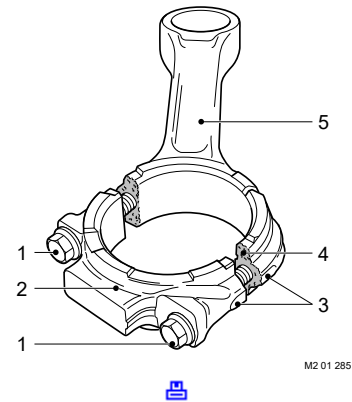
Technical data

Tightening torque, connecting rod

Bearing caps

Attachment bolts (1)

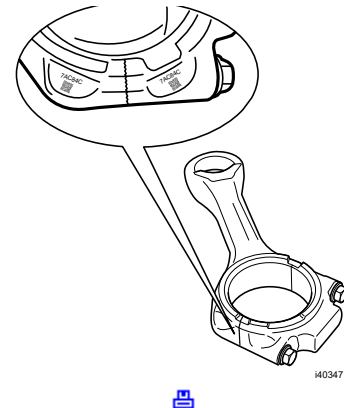
1 st phase	50 Nm [443 lb-in]
2 nd phase	130 Nm [96 lb-ft]
3 rd phase	90° angular displacement



- Attachment bolts may only be reused when a new nut can be screwed by hand over the complete cleaned bolt thread.
- Apply a drop of clean engine oil to the thread of the bolts and the bearing surface of the bolt heads.



- Make sure that the numbers on the connecting rod correspond to the numbers on the connecting rod bearing cap.
- Install the bearing cap with the numbers facing the same side as shown.



M024518 - 04.22.2016

1.144 install 6 (six) oil nozzle (Lubrication system)

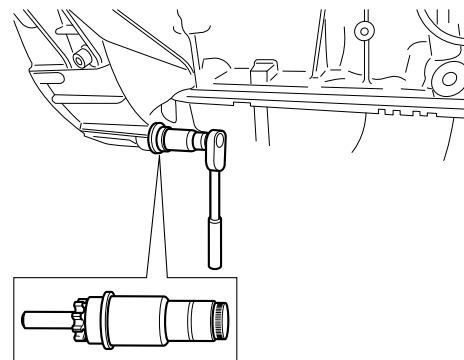
Explanation

Setting Engine to TDC

- Use the special tool (1903018) to turn the crankshaft counterclockwise as seen from the distribution side.



This corresponds to the direction of rotation of the engine.



I402049



2. Position cylinders 1 and 6 at top dead center (TDC marking on vibration damper).



- Do not use valve setting marks 1/6 for this procedure.
- The TDC mark can also be read on the flywheel.

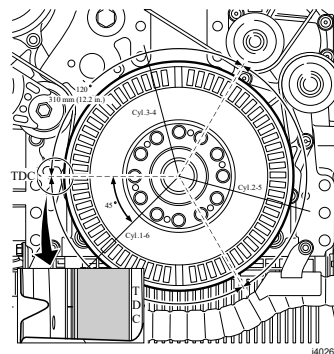
Repeat this procedure for cylinders 2/5 and 3/4, each time rotating the vibration damper 120 degrees (310 mm [12.2 in]).



- By turning the crankshaft 120° (310 mm [12.2 in]) clockwise as seen from the vibration damper side, cylinders 2 and 5 are in TDC position.
- By turning the crankshaft another 120° clockwise (310 mm [12.2 in]), cylinders 3 and 4 are in TDC position.



There is no marking on the vibration damper for the TDC position of cylinders 2/5 and 3/4.



M037474 - 03.27.2015

Installing Oil Nozzle

1. Carefully fit the oil nozzle, and tighten it to the specified torque.



- Do not reuse oil nozzles.
- Install the new oil nozzle only when cylinder one is in the TDC position.
- Make sure that the oil nozzles are not damaged and/or bent during installation.
- Incorrectly positioned oil nozzles result in the piston head

overheating, causing severe engine damage.

M022891 - 05.25.2010

Technical data

Tightening torque, oil nozzle

Attachment bolt (2)

30 Nm [266 lb-in] ⁽¹⁾(Diagonal 2)

- (1) Use "Loctite 243" to secure.
(2) Use oil nozzles only once.

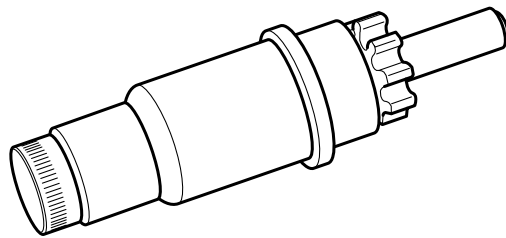
M022892 - 12.08.2017

Special tools

Special tool category: Mandatory special tool for: NA region
1903018

Engine Cranking Tool

1453158 is also suitable



1903018



ST1903018 - 01.07.2013

 1.145 install 6 (six) inlet valve lifter (Basic assembly)

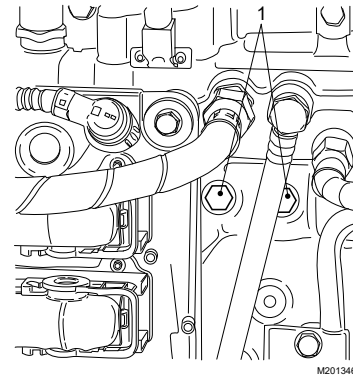
Explanation

Installing valve tappet

1. Fully submerge the new valve lifters in lubricating oil.
2. Fit the new valve lifters through the camshaft bore of the cylinder block.
3. Use a welding wire, for example, to pull up the new valve lifters.
4. Install and hand-tighten the locking bolts (1).
5. Lower the valve lifters on the locking bolts (1), so the camshaft can be installed easily.



Make sure that the valve lifters are not damaged.



M041211 - 03.10.2016

1.146 install 2 (two) pump unit lifter (Fuel system)

Explanation

Installing pump unit lifters



- Always install new pump unit lifters if the camshaft is replaced.
- Never use pump unit lifters that have been dropped, are corroded, or are in any other way damaged.
- New pump unit lifters require a more extensive pre-lubrication. This pre-lubrication is best started during the beginning of the repair activities

Installing NEW pump unit lifters

1. Before installation, the **new** pump unit lifters must be pre-oiled in clean engine oil, observing the following:
 1. Allow the roller to fill with oil by submerging it slowly and keeping it in the oil for the rest of the procedure.
 2. Once submerged, keep them in the oil untouched for 10 minutes.
 3. Move the pump unit lifter back and forth in the engine oil for 30 seconds. Move in the direction of the axle.
 4. Again, keep them in the oil untouched for 10 minutes.
 5. Afterward, check that the roller runs smoothly by manually rotating the roller several times.
 6. The time between dipping and installation must be no longer than 2 hours.
2. Fit the pump unit lifters into the engine block.

Do not drop the pump unit lifter onto the camshaft.



3. Apply the specified mounting product to the locking pins and tighten them to the specified torque.
4. Pour approximately 100 ml [3.38 fl oz] of clean engine oil on top of the pump unit tappets.

Re-installing pump unit lifters

1. Before re-installation, the pump unit lifters must be pre-oiled in clean engine oil, observing the following:
 1. Allow the roller to fill with oil by submerging it slowly and keeping it in the oil for the rest of the procedure.
 2. Once submerged, move the pump unit tappet back and forth in the engine oil for at least 20 seconds.
 3. Afterward, check that the roller runs smoothly by manually rotating the roller several times.
 4. The time between dipping and installation must be no longer than 2 hours.
2. Fit the pump unit lifters into the engine block.



Do not drop the pump unit lifter onto the camshaft.

3. Apply the specified mounting product to the locking pins and tighten them to the specified torque.
4. Pour approximately 100 ml [3.38 fl oz] of clean engine oil on top of the pump unit tappets.

M032497 - 03.18.2015

Technical data

Tightening torque, pump unit lifters

Locking pin

45 Nm [398 lb-in]^{(1)(Diagonal 2)}

(1) Use "Loctite 542" to secure.

(2) Always install new pump unit lifters if the camshaft is replaced.

M032648 - 01.10.2017



1.147 fixing dipstick tube (Lubrication system)

Technical data

Tightening torque, dipstick tube

Attachment bolt M8

30 Nm [266 lb-in]

M038613 - 10.25.2013

1.148 install alternator bracket (Alternator and starter motor)

Technical data

Tightening torque, alternator bracket

Attachment bolts

30 Nm [266 lb-in]

M038743 - 03.19.2015

1.149 install gasket, engine front cover (Basic assembly)

1.150 install engine front cover (Basic assembly)

Explanation

Installing front cover

1. Clean and check the sealing surfaces.
2. Install the front cover and tighten the attachment bolts to the specified torque.



- Always install a new front cover gasket.
- After installing the front cover, cut the remaining gasket at the bottom of the front cover.

M044263 - 10.01.2014

Technical data

Tightening torque, front cover

Attachment bolts (M8)

42 Nm [372 lb-in]

Attachment bolt (M12)

110 Nm [81 lb-ft]

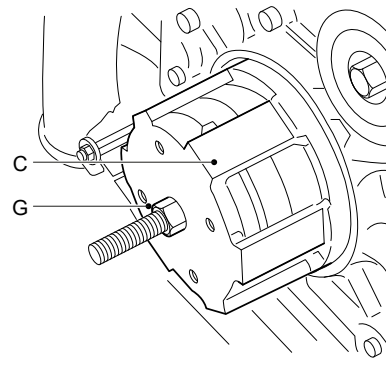
M033629 - 01.10.2017

1.151 install front crankshaft seal ring (Basic assembly)

Explanation

Installing crankshaft seal ring, front cover

1. Clean and check the crankshaft seal ring recess on the front cover.
2. Position the new crankshaft seal ring on the front cover.
3. Position the adapter (C) against the crankshaft seal ring.
4. Turn the nut (G) carefully until the crankshaft seal ring lies against the stop.
5. Remove the special tool.



M202156

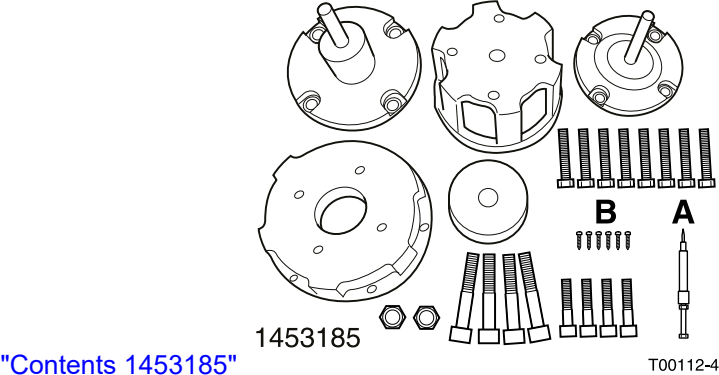


M032051 - 08.17.2012

Special tools

Special tool category: Mandatory special tool for: NA region, NA Service Support
1453185

Assembly and disassembly tool set for front and rear crankshaft seals



"Contents 1453185"

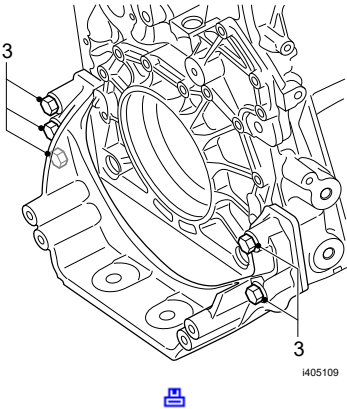
ST1453185 - 10.22.2018

1.152 install front engine bracket (Engine mountings)

Technical data

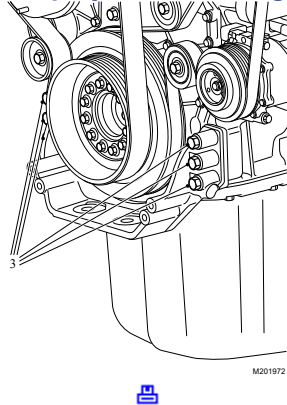
Tightening torque, front engine bracket

Attachment bolts (3) 110 Nm + 60° [81 lb-ft + 60°]



Attachment bolts (3) 110 Nm [81 lb-ft]

Old poly-V-belt routing:



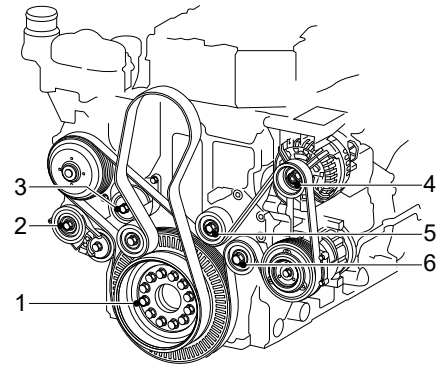
M032335 - 04.30.2018

1.153 install idler pulley, poly-V-belt (Pulley)**Technical data****Tightening torque, idler pulley, poly-V-belt**

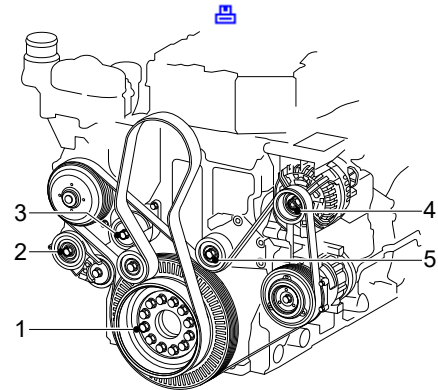
To prevent damage to the air conditioning compressor bearing, from specification week 201501 the poly-V-belt was rerouted. The high load idler pulley (6) was removed

Attachment bolt (5)

60 Nm [531 lb-in]



M202184



i403875

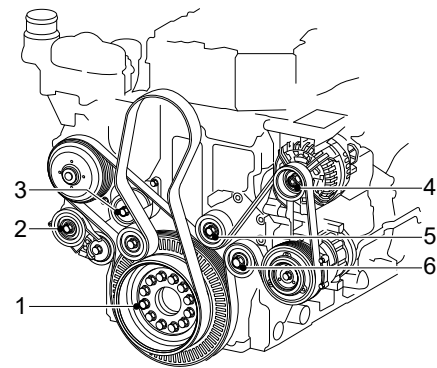
M032310 - 04.22.2016

1.154 install left-hand idler pulley, poly-V-belt (Pulley)**Technical data****Tightening torque, left idler pulley, poly-V-belt**

To prevent damage to the air conditioning compressor bearing, from specification week 201501 the poly-V-belt was rerouted. The high load idler pulley (6) was removed

Attachment bolt (6)

110 Nm [81 lb-ft]



M202184

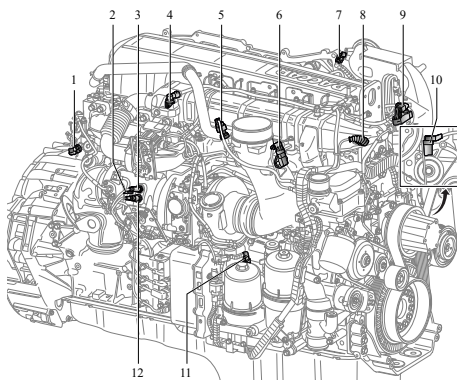


M032309 - 06.27.2016

 1.155 install coolant pump speed sensor (Sensors electrical system, engine)

Technical data

Tightening torque, sensors right side view



Coolant temperature sensor (1)	25 Nm [220 lb-in]
Exhaust gas temperature sensor (2)	45 Nm [400 lb-in] ⁽¹⁾⁽²⁾⁽⁵⁾
NOx sensor before the catalyst (3)	50 Nm [445 lb-in] ⁽¹⁾⁽²⁾⁽⁵⁾
Pressure sensor after BPV (4)	30 Nm [265 lb-in] ⁽¹⁾
Pressure sensor before turbine (5)	30 Nm [265 lb-in] ⁽¹⁾
Humidity sensor (6) attachment bolts	10 Nm [90 lb-in] ⁽¹⁾⁽⁴⁾
Intercooler air temperature sensor (7) attachment bolt	10 Nm [90 lb-in] ⁽³⁾⁽⁴⁾
EGR temperature sensor (8)	35 Nm [310 lb-in] ⁽¹⁾⁽²⁾
EGR pressure difference sensor (9) attachment bolts	20 Nm [177 lb-in]
Coolant pump speed sensor (10) attachment bolt	8 Nm [70 lb-in] ⁽¹⁾
Oil temperature sensor (11)	25 Nm [220 lb-in]
Lambda sensor (12)	50 Nm [445 lb-in] ⁽¹⁾⁽²⁾⁽⁵⁾

- (1) Secure the wiring harness using heat-resistant (170°C [338°F]) clamping straps.
- (2) If using the old sensor, apply a small amount of anti-seize pure nickel paste to the thread of the sensor.
- (3) Do not touch other objects with the tip of the sensor.
- (4) Always use a new O-ring.
- (5) Secure the wiring harness on the BPV bracket using four heat-resistant (240°C [464°F]) clamping straps.

M033446 - 02.22.2016

1.156 install vibration damper (Pulley)**Technical data****Tightening torque, vibration damper**

To prevent damage to the air conditioning compressor bearing, from specification week 201501 the poly-V-belt was rerouted. The high load idler pulley (6) was removed

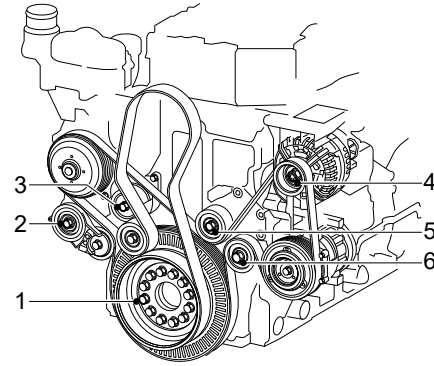
Vibration damper
attachment bolts (1) and
(7)

1st phase

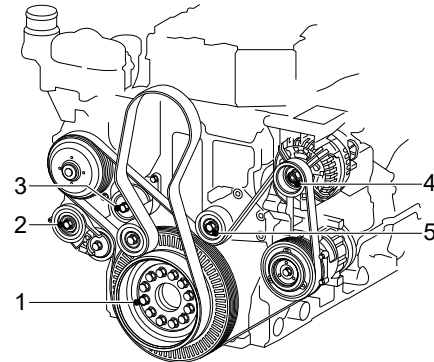
60 Nm [531 lb-in]

2nd phase

90° angular displacement

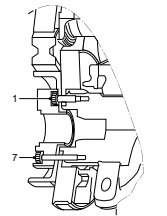
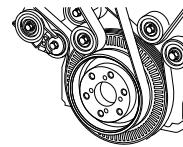


M202184



I403875

Standard situation



I403874

With front end PTO

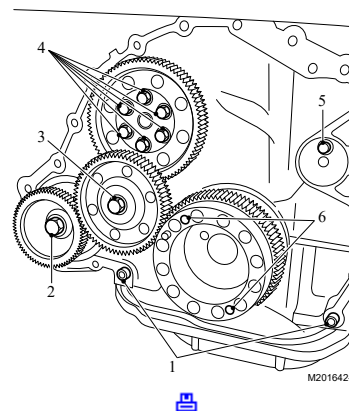
M032052 - 04.22.2016

1.157 install camshaft gear (Basic assembly)**Technical data**

Tightening torque, camshaft gear

Camshaft gear
attachment bolts (4)
(1) Use Loctite 243

60 Nm [531 lb-in] + 45° ⁽¹⁾



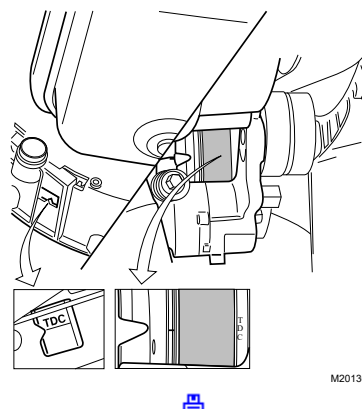
M032205 - 06.08.2018

 1.158 install idler gear (Basic assembly)

Explanation

Installing idler gear

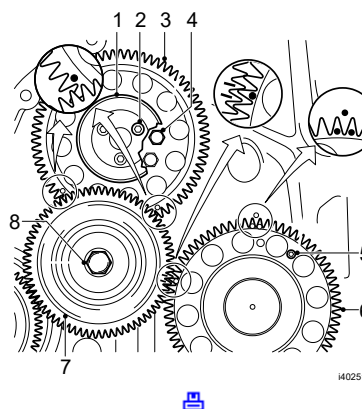
1. Check that cylinder 1 is at top dead center (TDC on the pulley vibration damper, cylinder 6 in overlap position).



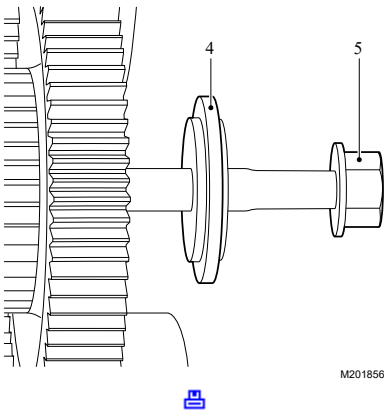
2. Apply clean engine oil to the idler gear and hub.
3. Install the idler gear (7). Make sure that the marks line up with the marks on the camshaft gear (3) and the crankshaft gear (6).



If the crankshaft or the camshaft of an engine is rotated separately without an idler gear (7), the engine's pistons may touch the valves.



4. Install the thrust plate (4).
5. Fit the idler gear attachment bolt (5) and tighten it to the specified torque.

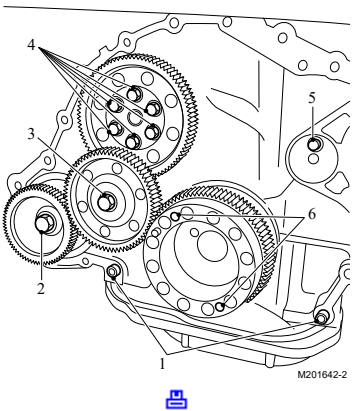


M046143 - 03.27.2015

Technical data

Tightening torque, idler gear

Attachment bolt (3) 170 Nm [125 lb-ft]⁽¹⁾
(1) Use Loctite 243.



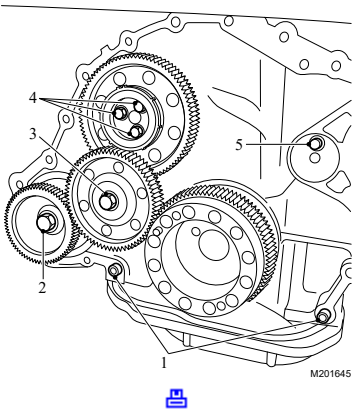
M032214 - 06.08.2018

1.159 install pulse ring (Basic assembly)

Technical data

Tightening torque, pulse ring

Attachment bolts (4) 30 Nm [266 lb-in]⁽¹⁾
(1) Use Loctite 243



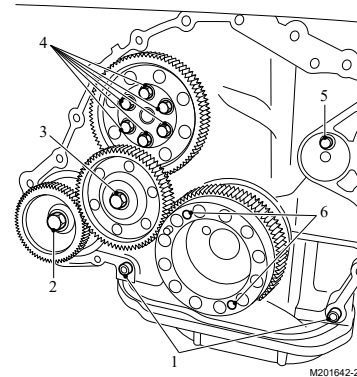
M032206 - 06.08.2018

install flywheel housing (Flywheel housing)

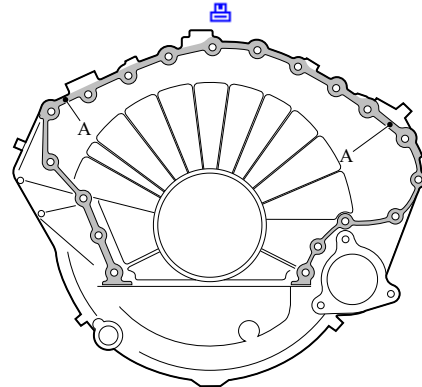
Explanation

Installing flywheel housing

1. Mount centering bushes (1) onto the cylinder block.
2. Clean the sealing surfaces (A) carefully and check for damage.
3. Check the flywheel housing for cracks.
4. Apply the prescribed sealant to the sealing surface (A).
5. Install the flywheel housing.
6. Fit the attachment bolts and tighten them to the specified torque.



M201642-2



M201671-2

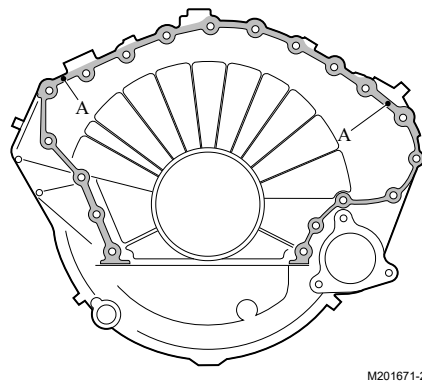
M022915 - 03.24.2010

Technical data

Mounting product, flywheel housing

Sealant for flywheel housing sealing surface (A)

"Loctite 510"



M201671-2

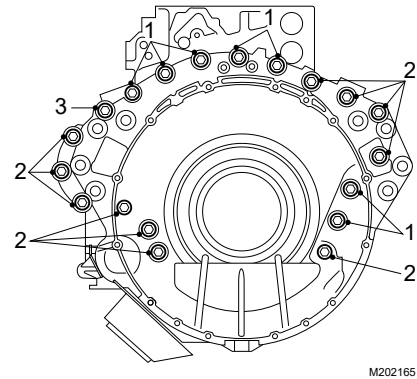
M031384 - 01.10.2019

Tightening torque, flywheel housing

Flywheel housing attachment bolts

110 Nm [82 lb-ft]

Position of flywheel housing attachment bolts



M202165



- 1 Attachment bolt M12 x 60
- 2 Attachment bolt M12 x 100
- 3 Attachment bolt M12 x 120

M033401 - 12.22.2016

-  1.161 install both sides engine bracket (Engine mountings)

Technical data

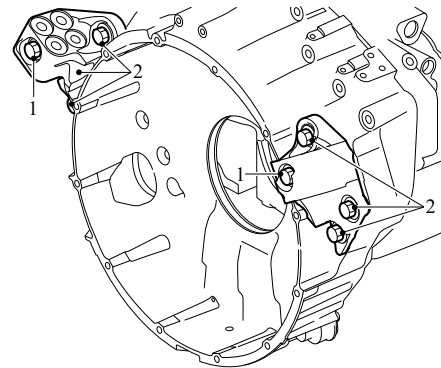
Tightening torque, engine mountings



Refer to ServiceNet document KM813022 for chassis-specific engine mount installation and torque instructions.

Engine mounting at flywheel end

Attachment bolts (1)	260 Nm [192 lb-ft]
Attachment bolts (2)	260 Nm [192 lb-ft]



M201673



M032337 - 09.28.2017

-  1.162 install crankshaft seal ring, flywheel housing (Flywheel housing)

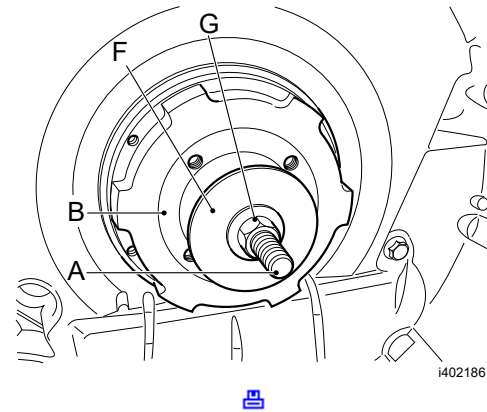
Explanation

Installing crankshaft seal ring, flywheel housing

1. Clean and check the crankshaft seal ring recess in the flywheel housing.
2. Position the new crankshaft seal ring in the flywheel housing.
3. Position the adapter (B) over the spindle (A) against the crankshaft seal ring and secure it

with the nut (G).

4. Turn the nut (G) on the spindle (A) carefully until the crankshaft seal ring lies against the stop.
5. Remove the special tool (1453185).

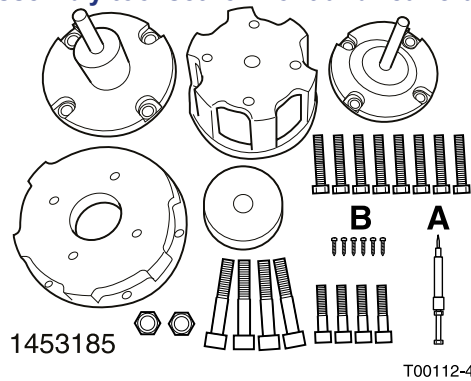


M021481 - 11.05.2012

Special tools

Special tool category: Mandatory special tool for: NA region, NA Service Support
1453185

Assembly and disassembly tool set for front and rear crankshaft seals



"Contents 1453185"

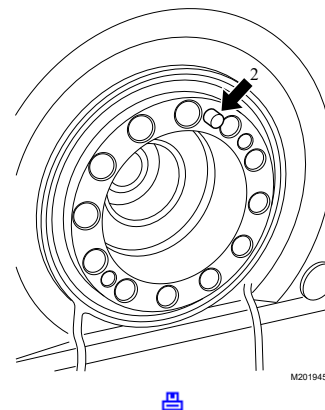
ST1453185 - 10.22.2018

1.163 install flywheel (Flywheel)

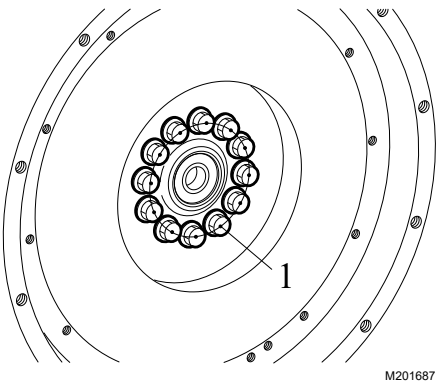
Explanation

Installing flywheel

1. Clean the crankshaft flange and the dowel pin (2).
2. Clean the contact surface of the flywheel holding the crankshaft.
3. Clean the flywheel attachment bolts and apply a drop of engine oil to the thread of the bolts.
4. Install the flywheel.



5. Fit the attachment bolts (1) and tighten them to the specified torque.



M028410 - 03.24.2010

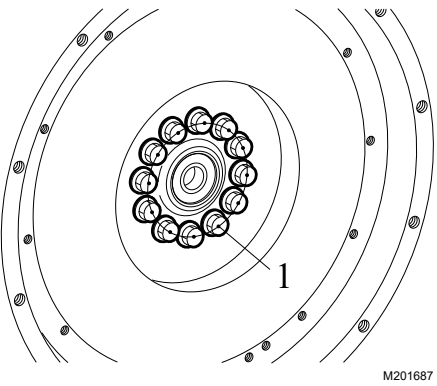
Technical data

Tightening torque, flywheel

Attachment bolts (1)⁽¹⁾

- | | |
|-----------------------|--------------------|
| 1 st phase | 80 Nm [59 lb-ft] |
| 2 nd phase | 260 Nm [192 lb-ft] |
| 3 rd phase | 120° |

(1) Bolts can be used again if a new nut can be screwed on over the complete cleaned bolt thread by hand.

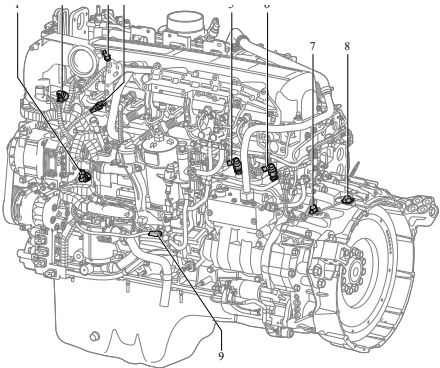


M031000 - 03.19.2015

 1.164 install camshaft sensor (Sensors electrical system, engine)

Technical data

Tightening torque, sensors left side view



Oil pressure sensor (1)
Inlet air boost pressure sensor (2)

30 Nm [266 lb-in]⁽²⁾
30 Nm [266 lb-in]⁽²⁾

Intercooler air temperature sensor (3) attachment bolt	10 Nm [89 lb-in] ⁽¹⁾⁽²⁾
Boost air temperature sensor (4) attachment bolt	10 Nm [89 lb-in] ⁽¹⁾⁽²⁾
Fuel temperature sensor (5)	30 Nm [266 lb-in]
Fuel pressure sensor (6)	30 Nm [266 lb-in]
Camshaft sensor (7) attachment bolt	10 Nm [89 lb-in] ⁽³⁾
Crankshaft sensor (8) attachment bolt	10 Nm [89 lb-in] ⁽³⁾
Crankcase pressure sensor (9) attachment bolts	6 Nm [53 lb-in]

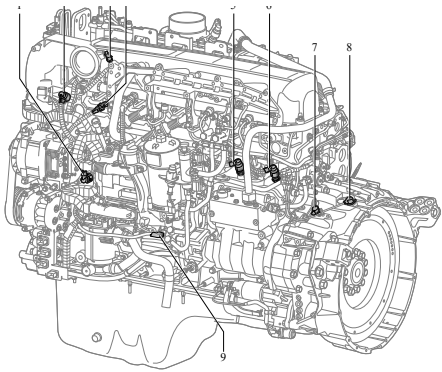
- (1) Do not touch other objects with the tip of the sensor.
- (2) Always use a new sealing ring.
- (3) Always use a new O-ring.

M033435 - 03.10.2016

 1.165 install crankshaft sensor (Sensors electrical system, engine)

Technical data

Tightening torque, sensors left side view



Oil pressure sensor (1)	30 Nm [266 lb-in] ⁽²⁾
Inlet air boost pressure sensor (2)	30 Nm [266 lb-in] ⁽²⁾
Intercooler air temperature sensor (3) attachment bolt	10 Nm [89 lb-in] ⁽¹⁾⁽²⁾
Boost air temperature sensor (4) attachment bolt	10 Nm [89 lb-in] ⁽¹⁾⁽²⁾
Fuel temperature sensor (5)	30 Nm [266 lb-in]
Fuel pressure sensor (6)	30 Nm [266 lb-in]
Camshaft sensor (7) attachment bolt	10 Nm [89 lb-in] ⁽³⁾
Crankshaft sensor (8) attachment bolt	10 Nm [89 lb-in] ⁽³⁾
Crankcase pressure sensor (9) attachment bolts	6 Nm [53 lb-in]

- (1) Do not touch other objects with the tip of the sensor.
- (2) Always use a new sealing ring.
- (3) Always use a new O-ring.

M033435 - 03.10.2016

 1.166 check 6 (six) cylinder liner (Basic assembly)

Explanation

Checking cylinder liner

Take the following measurements to determine the wear on the cylinder liners.



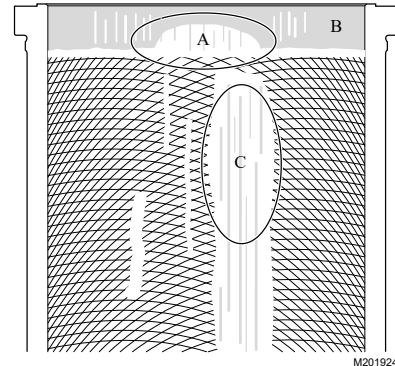
Measuring instructions:

1. Check the condition of the combustion area of the cylinder liner with the specified values.



If the carbon deposit (B) on the top of the liner is interrupted (A), then also check the condition of the piston.

2. Check for bore polish areas (C) and compare these with the specified values.
3. Measure the inside diameter and compare the measurements with the specified values.
4. Measure the ovality and calculate the relative ovality according to the specified values.
5. Replace the cylinder liner if one of the previous measurements was not within the specified values.



M031110 - 06.13.2013

Technical data

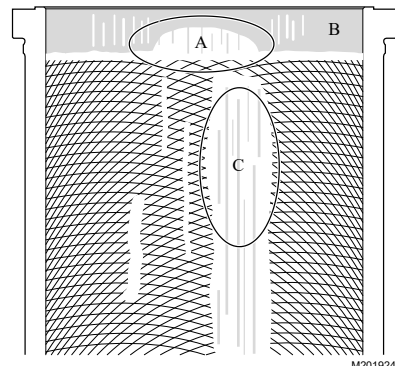
Checking data, cylinder liner

A	Interruption of carbon deposit
B	Carbon deposit area

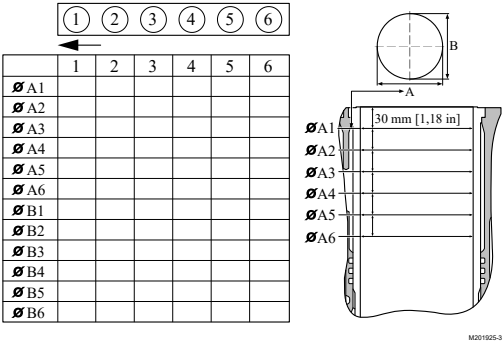
Bore polish reject criteria:

Bore polish area (C) runs from the bottom of the cylinder liner to the top, to the point where the uppermost piston ring is positioned

> 15 mm [0.59 in] width



Overview of wear measurements, cylinder liner:



Inside diameter

129.99 – 130.01 mm [5.1177 - 5.1185 in]

Relative ovality
 $A_x - B_x$

maximum 0.01 mm [0.0004 in]

M031109 - 06.13.2013

 1.167 install cylinder head gasket, engine (Basic assembly)

Explanation

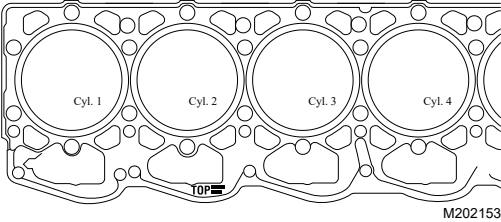
Installing cylinder head gasket

1. Position the cylinder head gasket using both hands.



Make sure that:

- no dirt gets onto the cylinder head gasket.
- the cylinder head and block are **clean and dry** before installing the cylinder head gasket.
- the letters **TOP** are visible.
- it does not bend.



M031254 - 06.20.2018

 1.168 check all cylinder head bolt (Basic assembly)

Explanation

Checking cylinder head bolts

1. Clean the cylinder head bolt thread.
2. Apply a drop of oil on the bolt thread.
3. Check the bolts with a clean new nut, M18x2. (for instance DAF no. 0506668)
4. Screw the nut, by hand, over the full bolt thread length.

If the nut cannot be screwed over the bolt thread, replace the bolt.



M025780 - 05.18.2016

1.169 install assembly cylinder head, engine (Basic assembly)

Explanation

Installing assembly cylinder head

1. Apply a drop of oil to the bearing surface of the bolt heads.
2. Place the cylinder head on the cylinder block and hand-tighten a few of the cylinder head bolts to arrange alignment.
3. Fit the remaining bolts (M18 and M12).
4. Tighten the cylinder head bolts to the specified torque and in the specified sequence.



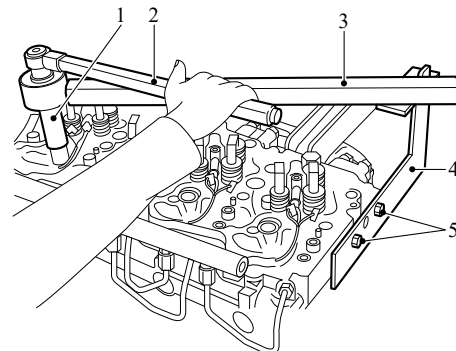
- Lubricate the valve stem seals well with clean engine oil.
- Reuse attachment bolts only, when a new nut can be screwed by hand, over the complete clean bolt thread.

Torque multiplier

- A torque multiplier is a tool that increases the torque. It has both a gear ratio and a torque ratio.
- Make sure to use the **torque ratio** to calculate the input torque value.
- For example:
 - If a torque multiplier has a torque ratio of 1:3.5, to tighten a bolt with 70 Nm [620 lb-in], adjust the torque wrench (2) to 20 Nm [177 lb-in] ($70/3.5=20$ [$619.6/3.5=177$]).

Option: tightening the cylinder head bolts using special tool (0882233)

1. Fit the bracket (4) to the cylinder head at the flywheel side. Use attachment bolts (5) to secure the bracket (4).
2. Mount the impact socket (1) of special tool (0911724) to the torque multiplier (3), and fit the assembly onto the cylinder head bolt.
3. Place the torque wrench (2) on the torque multiplier (3).
4. Tighten the cylinder head bolts to the specified torque and in the specified sequence.



i402427

- Lubricate the valve stem seals





- well with clean engine oil.
- Reuse attachment bolts only, when a new nut can be screwed by hand, over the complete clean bolt thread.

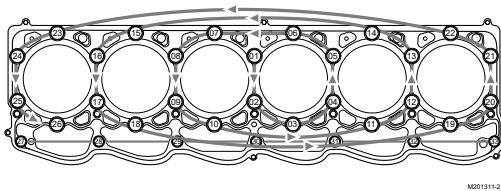
M036608 - 06.22.2017

Technical data

Tightening Torque, Cylinder Head

Cylinder Head Attachment Bolts

Tightening sequence, cylinder head attachment bolts



M201311-2



1st phase	
M18 in the indicated order	70 Nm [52 lb-ft] ⁽¹⁾
2nd phase	
M18 in the indicated order	250 Nm [184 lb-ft]
3rd phase	
M18 in the indicated order	90°
4th phase	
M18 in the indicated order	90°
5th phase	
M12 in the indicated order	60 Nm [531 lb-in] ⁽¹⁾
6th phase	
M12 in the indicated order	120°
(1) Apply a drop of oil to the thread and to the bearing surface of the bolt heads.	



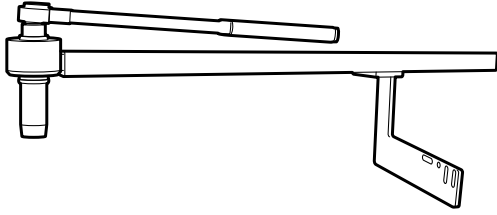
- Attachment bolts may only be reused when a new nut can be screwed by hand over the complete cleaned bolt thread.
- Apply a drop of clean engine oil to the thread of the bolts and the bearing surface of the bolt heads.

M030426 - 04.22.2016

Special tools

Special tool category: Recommended special tool
0882233

Torque multiplier for cylinder head



T00145



ST0882233 - 03.20.2008

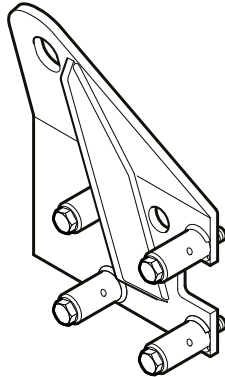
 1.170 remove lifting eye

Special tools

Special tool category: Mandatory special tool for: NA region
1903016

Hoisting tool for cylinder head/engine without transmission. Supersedes 1453180. 1453180 can still be used. ["User manual"](#)

This tool replaces
DAF special tool:
1453180 due to
legislation. DAF
special tool
1453180 can still
be used.



1903016



ST1903016 - 11.03.2014

 1.171 install bracket, EGR (EGR system)

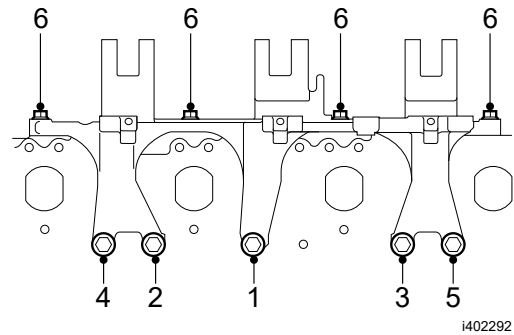
Technical data

Tightening torque, bracket, EGR

**Tighten in the specified
sequence.**

Attachment bolts, M8	30 Nm [266 lb-in]
Attachment bolts, M10	60 Nm [531 lb-in]

Tightening sequence



i402292

M034347 - 10.25.2013

1.172 remove from workstand engine

Explanation

Warning, lifting engine



- Hoist the engine securely, using approved lifting device.
- Do not carry out any work underneath an engine that is only supported by a jack or lifting device.
- Make sure that the engine is properly supported before carrying out any work underneath the engine.

M051458 - 12.04.2015

1.173 install turbocharger with VTG (Inlet and exhaust element)

Explanation

Installing turbocharger with VTG

Before installing the turbocharger, check the following:

- The turbocharger shaft must rotate freely.
- The turbocharger shaft must have some radial clearance.
- The turbocharger shaft must not drag.



When rotating the compressor wheel counterclockwise some resistance is noticeable due to the construction of the axial bearing.

1. Pour some clean engine oil in the oil supply opening and rotate the shaft.



Most of the oil comes out when installing the turbocharger.

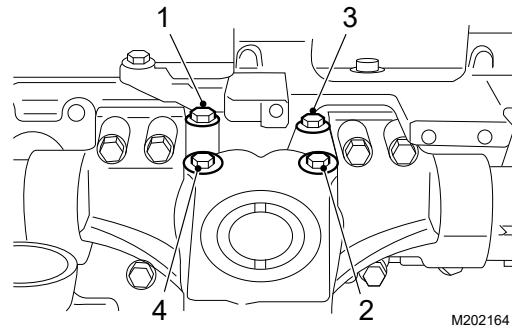
2. Clean the contact surfaces, and fit a new gasket.
3. Install the turbocharger and first hand-tighten the attachment bolts 2 and 3 to ensure proper

orientation.



Use a suitable hoisting tool to lift the turbocharger.

4. Install the attachment bolts 1 and 4.
5. Tighten the attachment bolts to the specified torque using the correct tightening sequence.



M031121 - 11.24.2016

Warning: Turbocharger Replacement



- If the warning and instructions below are not observed, the result can be a runaway engine.
- This can result in personal injury.

As a result of a defective turbocharger, broken parts and/or lubricating oil can enter the intake and exhaust circuit.



Risks of lubricating oil:

- Be aware that oil inside the intake circuit can cause a runaway engine.
- Too much oil inside the exhaust muffler and catalytic converter eventually blocks the exhaust system.



Risk of parts that have broken off:

- The compressor wheel is the barrier between the high-pressure side and the suction side of the air inlet system.

If the compressor wheel is damaged, particles from the compressor wheel are blown into the clean side of the air filter.

- Always replace the air filter element and clean and check the air inlet and exhaust circuit to prevent serious damage to the engine when newly starting up.



Consequential damage when newly starting up an air inlet circuit that has not been thoroughly cleaned.

M031120 - 09.27.2016

Technical data**Tightening torque, turbo charger with VTG**

Turbo charger attachment
bolts (1)⁽¹⁾

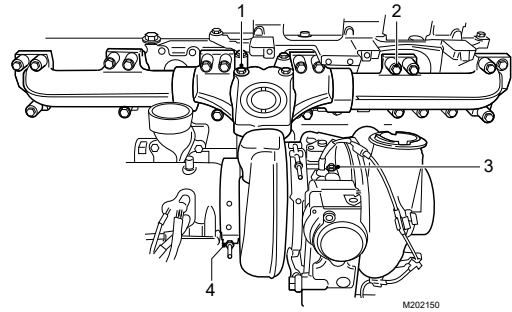
Phase 1

40 Nm [355 lb-in]

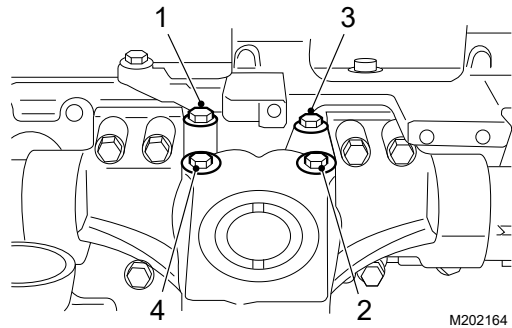
Phase 2

60°

(1) Always use new turbo
charger attachment bolts.



Tightening sequence



M031366 - 02.10.2014

 1.174 fixing return coolant pipe (Inlet and exhaust element)

Technical data**Tightening torque, return coolant pipe**

Coolant pipe attachment bolts

30 Nm [265 lb-in]

M032625 - 10.23.2014

 1.175 fixing supply coolant pipe (Inlet and exhaust element)

Technical data**Tightening torque, supply coolant pipe**

Banjo bolt (1)

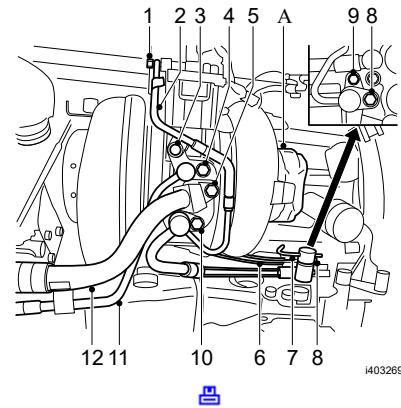
20 Nm [177 lb-in]⁽¹⁾

Coolant pipe attachment
bolts (3, 9, 10)

30 Nm [266 lb-in]⁽²⁾

(1) Always use new unit rings.

(2) Always use a new O-ring.



- 2 Supply coolant pipe
- 6 Discharge coolant pipe
- 7 EGR supply coolant pipe
- 11 Supply oil pipe
- 12 Discharge oil pipe

M032426 - 01.05.2015

-  1.176 install oil return pipe (Inlet and exhaust element)

Technical data

Tightening torque, oil return pipe

Attachment bolts

30 Nm [266 lb-in]

M032391 - 01.14.2013

-  1.177 fixing oil pipe, delivery side (Inlet and exhaust element)

Technical data

Tightening torque, oil pipe delivery side

Sealing plug, fine metric thread⁽¹⁾⁽²⁾

30 Nm [266 lb-in]

Attachment bolts M8⁽²⁾

30 Nm [266 lb-in]

(1) Always use a new unit ring.

(2) Always use a new O-ring.

M031154 - 01.05.2015

-  1.178 connect turbocharger speed sensor (Inlet and exhaust element)

-  1.179 install assembly EGR cooler (EGR system)

Explanation

Installing assembly EGR cooler

1. Check the sealing rings (14) and the sealing rings on the venturi (13) for damage.



If damaged, replace them.

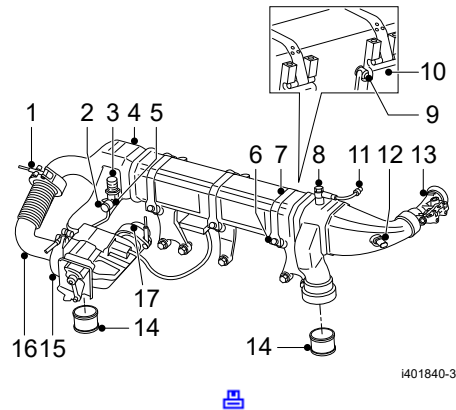
2. Apply the specified mounting product to the

sealing rings (14) and insert them in the coolant pipe and coolant pump.

3. Apply the specified mounting product to the venturi (13), and fit it in the EGR cooler (4).
4. Carefully maneuver the EGR cooler (4) into position.



- Make sure that all three connections are positioned correctly.
- The pin (9) must catch the slot in the central EGR bracket (10).



5. Hook up the fixing bands (7) in the brackets (10), fit the attachment bolts (6) and tighten them to the specified torque.
6. Fit the breather pipe (11), and tighten the banjo (8) with new sealing rings to the specified torque.

M033330 - 08.30.2013

Technical data

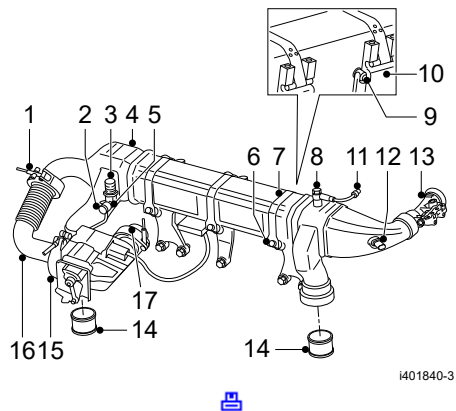
Tightening torque, EGR cooler



Never reuse the V clamps (1 and 15).
Two different V clamps are used, and both require a different tightening torque.

V clamp (1)	17 Nm [106 lb-in] ^{(1)(Diagonal 2)(3)}
V clamp (15)	As specified below ⁽¹⁾ (Diagonal 2)(3)
Attachment bolt (6), tightening strap (7)	12 Nm [106 lb-in]
Banjo bolt (8), breather (M12 x 1.5)	26 Nm [230 lb-in] ⁽⁴⁾
Banjo bolt (2), pressure sensor pipe, (5) (M12 x 1.5)	26 Nm [230 lb-in] ⁽⁴⁾
Pressure sensor after BPV (3)	30 Nm [266 lb-in] ⁽⁶⁾
EGR temperature sensor (12)	35 Nm [310 lb-in]

- (1) Always replace the V clamps and gaskets.
- (2) Position in the orientation shown.
- (3) First tighten clamp (15) and then clamp (1).
- (4) Fit new sealing washers.
- (5) Always use a new sealing ring.
- (6) Secure the wiring harness using the blue heat-resistant clamping straps.



Never reuse the V clamps.



For V clamp (15), two different V clamps are used, and both require a different tightening torque.

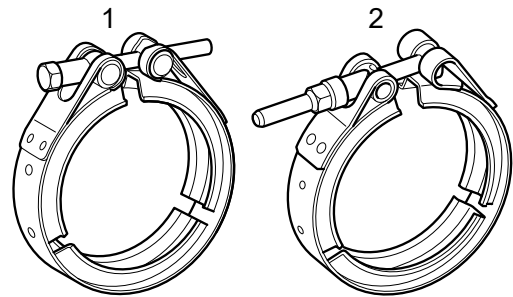
V clamp (15)

Type 1

Type 2

8 Nm [71 lb-in]

12 Nm [106 lb-in]



i403831



M030412 - 04.04.2017

Mounting product, sealing ring

Rubber lubricant

"P80"

M025429 - 02.21.2017

1.180 install mounting bracket (EGR system)

Technical data

Tightening torque, mounting bracket

Attachment studs

30 Nm [265 lb-in]

M033576 - 01.16.2013

1.181 install pressure sensor pipe after BPV (EGR system)

Technical data

Tightening torque, pressure sensor pipe after BPV

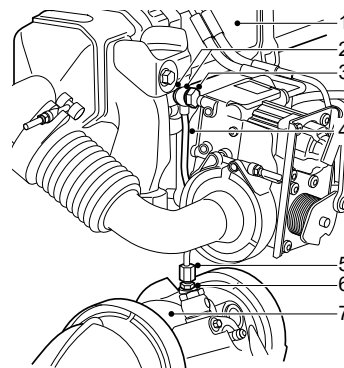
Banjo bolt, sensor pipe (3) 26 Nm [230 lb-in]⁽¹⁾

Union nut, sensor pipe (5) 40 Nm [355 lb-in]^(Diagonal 2)

Fitting in BPV (6) 20 Nm [177 lb-in]

(1) Always fit new sealing washers.

(2) Use a second wrench to avoid overtorquing the fitting in the BPV.



i403646



M034395 - 04.04.2017

1.182 check condition flexible EGR pipe from control valve to EGR cooler (EGR system)

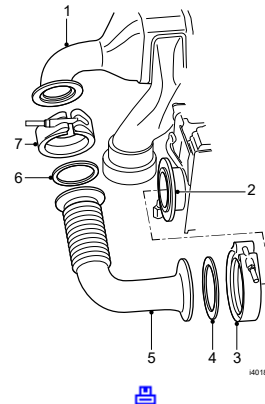
Explanation

Checking flexible EGR pipe from control valve to cooler

1. Check the flexible pipe (4) for damage, scratches, and/or deformation.



- Replace it if the corrugations are damaged, scratched, or deformed.
- The flange in particular is at risk because it compresses the gasket and, in doing so, may warp the contact surface.



2. Carefully clean the contact surfaces of both the flanges.



- Avoid deforming the flexible pipe while cleaning.
- Do not damage the contact surface with sharp tools.

M036543 - 07.25.2014

1.183 install flexible EGR pipe from control valve to EGR cooler (EGR system)

Technical data

Tightening torque, flexible EGR pipe from control valve to cooler

V clamp (3)

As specified below⁽¹⁾
(Diagonal 2)(3)

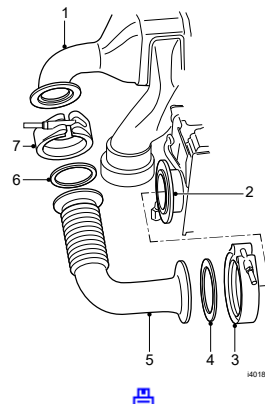
V clamp (7)

17 Nm [150 lb-in]⁽¹⁾(Diagonal
2)(3)

(1) Always replace the V clamps (3 and 7) and gaskets (4 and 6).

(2) Position in the orientation shown.

(3) First tighten V clamp (3) then V clamp (7).



Never reuse the V clamps (3 and 7).

Two different V clamps are used, and both require a different tightening torque.

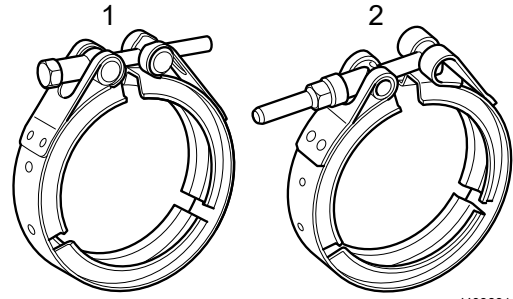
V clamp (3)

Type 1

Type 2

8 Nm [71 lb-in]

12 Nm [106 lb-in]



i403831



M030424 - 01.19.2017

1.184 fixing 3 (three) coolant pipe (EGR system)

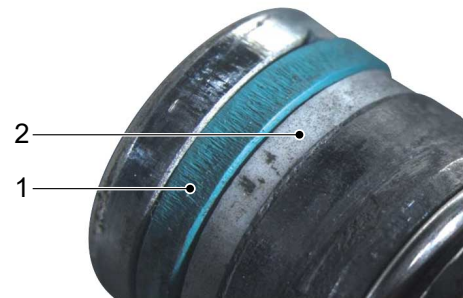
Explanation

Checking Schäfer connection

Coolant pipe

1. Check the Schäfer coupling for wear and damage:

- Clean the Schäfer coupling thoroughly and check it for wear and damage.
- Check the pipe for clogging; clean or replace it if necessary.
- Check the groove and the circlip (3) of the Schäfer coupling for wear and damage and replace them if necessary.
- Check the Teflon ring spacer (2) for damage and deformation and replace it if necessary.
- Always replace the O-rings (1 and 4).



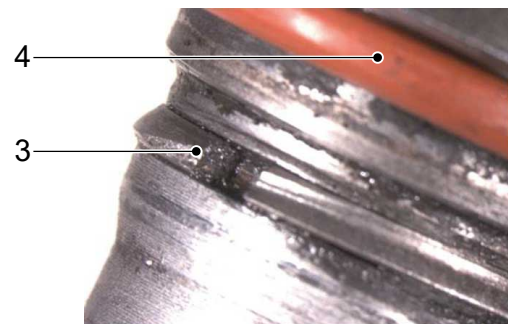
i403640



Avoid damage to the Teflon ring spacer (2).



If the Schäfer coupling is leaking and/or is worn as shown (1 and 3), the actuator must be checked.



i403639



Actuator

2. Check the actuator connection for wear and damage:

- Clean the actuator connection thoroughly and check it for wear and damage.

If the actuator connection is worn, the complete assembly



must be replaced.

- Check the circlips (5) and groove of the actuator connection for wear and damage.

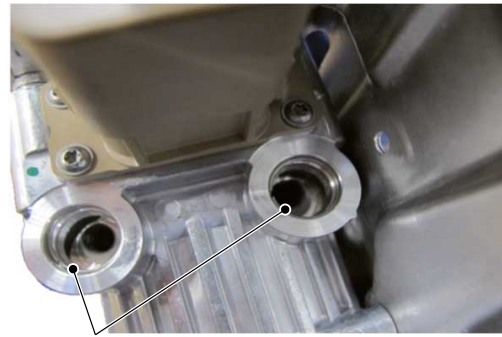


The groove of the actuator must be clean and undamaged. If the groove of the actuator is damaged, the complete assembly must be replaced.

- If re-using the actuator and the Schäfer connection is leaking and/or the circlip is worn as shown, **always** replace the circlip (5).



Make sure that the circlips (5) are present and correctly fitted.



5

i403641



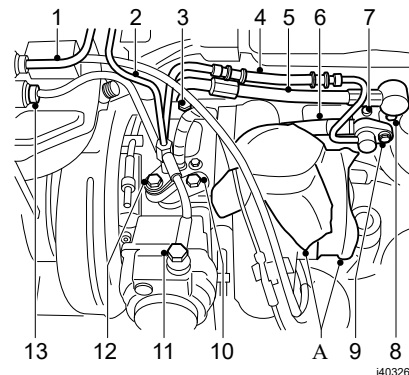
- Before installing the pipe, lubricate the Schäfer coupling with the specified mounting product.
- Check after installing that the coolant pipe is properly locked in the actuator housing.

M043555 - 01.15.2015

Technical data

Tightening torque, coolant pipe

Banjo bolt (11)	16 Nm [142 lb-in] ⁽¹⁾
Attachment bolt (12)	30 Nm [266 lb-in] ^(Diagonal 2)
(1) Use new sealing washers	
(2) Use a new O-ring.	

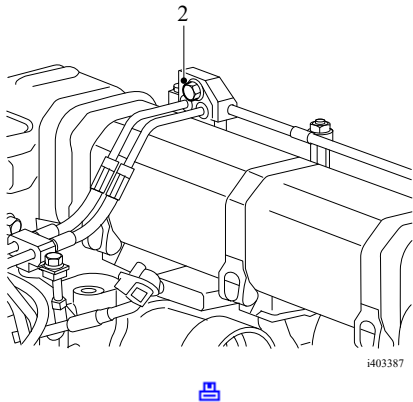


H403268

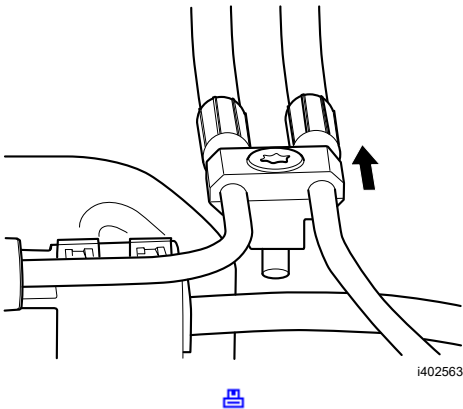


- 1 EGR control valve discharge coolant pipe
- 2 Coolant pipe
- 4 EGR control valve supply coolant pipe
- 5 Turbo charger discharge coolant pipe
- 6 Turbo charger supply coolant pipe
- A Protective cloth

Attachment bolt (2)	30 Nm [266 lb-in] ⁽¹⁾
(1) Use a new O-ring.	



Clamping bolt (M6) 10 Nm [88 lb-in]



M034341 - 03.28.2017

- ☐ ☐ 1.185 connect temperature sensor, EGR (Sensors electrical system, engine)
- ☐ ☐ 1.186 connect pressure sensor after BPV (Sensors electrical system, engine)
- ☐ ☐ 1.187 fixing compressor pipe 01, suction side (Air compressor)

Technical data

Tightening torque, compressor pipe

Bracket attachment bolts	30 Nm [265 lb-in]
Compressor union nut	100 Nm [70 lb-ft]

M032446 - 01.14.2013

- ☐ ☐ 1.188 install air inlet pipe from air filter to turbocharger (Inlet and exhaust element)

Technical data

Tightening torque, air inlet pipe from air filter to turbo charger

Fitting to air inlet pipe	130 Nm [96 lb-ft]
Humidity sensor attachment bolts	10 Nm [90 lb-in]
Pressure sensor before turbine	30 Nm [265 lb-in]
Sensor pipe attachment bolt	30 Nm [265 lb-in] ⁽¹⁾
Hose-pipe clamps	7 Nm [62 lb-in] ⁽²⁾⁽³⁾
Air inlet pipe attachment bolts	30 Nm [265 lb-in]

- (1) Apply P80 to the O-ring.
- (2) Always fit new hose-pipe clamps.
- (3) Position in original orientation.

M032515 - 02.26.2014

 1.189 install air inlet pipe from turbocharger to intercooler

 1.190 install pressure sensor pipe before turbocharger (EGR system)

Technical data

Tightening torque, pressure sensor pipe before turbo

Fitting in the EGR valve

40 Nm [354 lb-in]

Union nut

50 Nm [443 lb-in]⁽¹⁾

Sensor pipe attachment bolt

30 Nm [266 lb-in]⁽²⁾⁽³⁾

(1) Use a second wrench to avoid overtorquing the fitting in the EGR elbow.

(2) Apply P80 to the O-ring.

(3) Always use a new O-ring.

M031519 - 03.19.2016

 1.191 install exhaust manifold (Inlet and exhaust element)

Technical data

Tightening torque, exhaust manifold

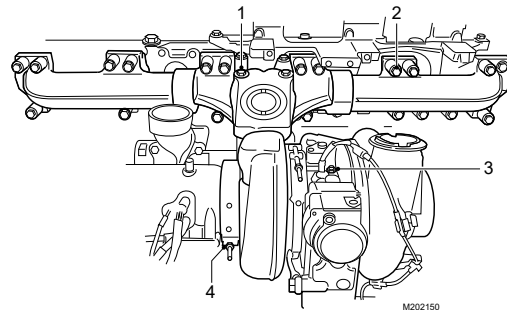
Exhaust manifold

attachment bolts (2)

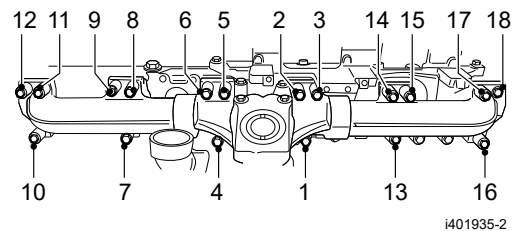
60 Nm [531 lb-in]⁽¹⁾

(1)

- Always use new gaskets.
- Apply a drop of clean engine oil to the thread of the bolt.
- First install all attachment bolts by hand to ensure proper orientation.



Tightening sequence



M031377 - 01.09.2017

 1.192 connect humidity sensor (Sensors electrical system, engine)

 1.193 connect pressure sensor before turbine (Sensors electrical system, engine)

 1.194 connect engine wiring harness J3 C (Electrical system, engine)

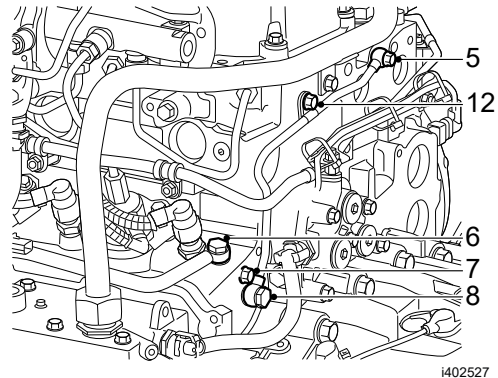
1.195 install hose (Air compressor)

1.196 install injector leak pipe (Fuel system)

Technical data

Tightening torque, injector leak pipe

Banjo bolt (5)	16 Nm [142 lb-in] ⁽¹⁾
Non-return valve (8)	35 Nm [310 lb-in] ⁽¹⁾
Attachment bolt, pipe clip (12)	30 Nm [266 lb-in]
(1) Fit new usit rings.	



M032477 - 05.19.2017

1.197 install 6 (six) inlet valve lifter rod (Basic assembly)

Explanation

Installing valve lifter rod

1. Check the valve lifter rod for damage and deformation and replace it if necessary.
2. Apply clean engine oil to the valve lifter rod and install it into the engine.

M032193 - 08.24.2012

1.198 install 6 (six) exhaust valve push rod (Basic assembly)

Explanation

Installing valve lifter rod

1. Check the valve lifter rod for damage and deformation and replace it if necessary.
2. Apply clean engine oil to the valve lifter rod and install it into the engine.

M032193 - 08.24.2012

1.199 install 6 (six) rocker seat, engine brake (Basic assembly)

Explanation

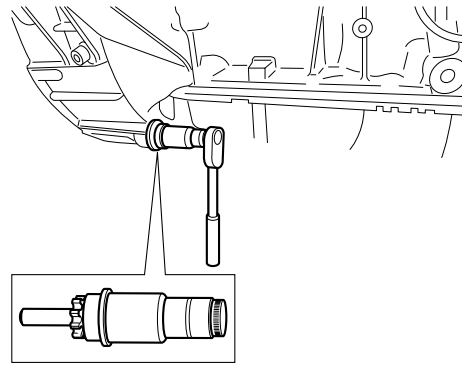
Installing rocker seats

1. Carefully install the rocker seats.
 - Depending on the engine



position, some rocker seats must be positioned against the pressure of the valve springs.

- The rocker seat will resist this spring pressure and therefore cannot be positioned correctly.
- By cranking the crankshaft $\frac{1}{3}$ of a turn each time using the special tool (1903018), the rocker seats of the cylinders can be tightened to the specified torque:
 1. Rocker seats of cylinders 1 or 6.
 2. Rocker seats of cylinders 2 or 5.
 3. Rocker seats of cylinders 3 or 4.



I402049



M032552 - 02.22.2013

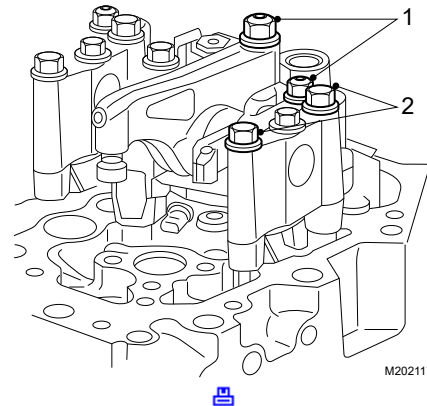
Technical data

Tightening torque, rocker seat

Lock nut (1) for valve adjusting bolt 64 Nm [566 lb-in]

Attachment bolts (2):

Phase 1 50 Nm [443 lb-in]
Phase 2 90°



M202117



- Attachment bolts may only be reused when a new nut can be screwed by hand over the complete cleaned bolt thread.
- Apply a drop of clean engine oil to the thread of the bolts and the bearing surface of the bolt heads.

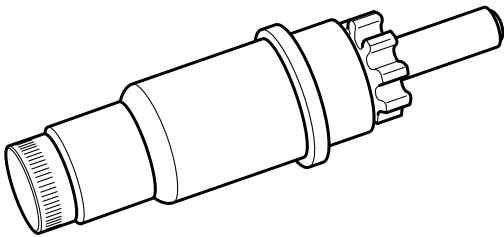
M030452 - 05.02.2017

Special tools

Special tool category: Mandatory special tool for: NA region
1903018

Engine Cranking Tool

1453158 is also suitable



1453158



ST1903018 - 01.07.2013

- 1.200 connect 6 (six) solenoid valve, engine brake (Basic assembly)
- 1.201 check and adjust valve clearance (Basic assembly)

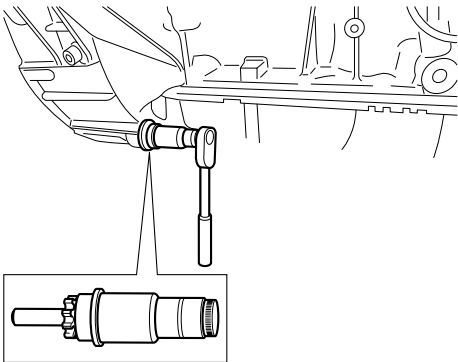
Explanation

Checking and adjusting valve clearance

- 1. Use the special tool (1903018) to turn the crankshaft counterclockwise as seen from the distribution side.



This corresponds to the direction of rotation of the engine.



I402049

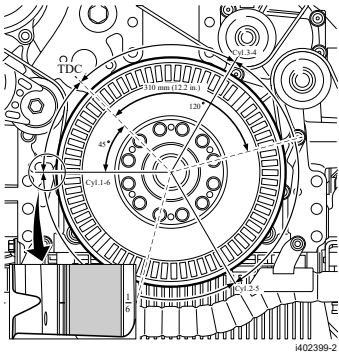


- 2. Crank the engine until the vibration damper is on cylinder mark 1/6.



The position of the pistons can also be read on the flywheel.

- 3. Check which cylinder has all valves closed, corresponding to the information on the cylinder mark. The valve clearance of this cylinder can be checked and adjusted.



I402399-2



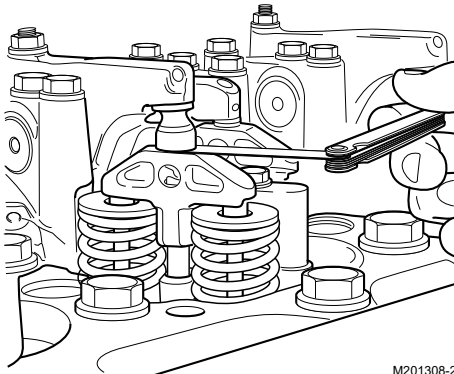
Mark on flywheel	Adjusting valves
------------------	------------------

	of cylinder
1-6	1 or 6
2-5	2 or 5
3-4	3 or 4

4. Press down on the adjusting screw side of the rocker arm so that any oil present between the push rod and rocker arm is ejected, then measure the valve clearance.

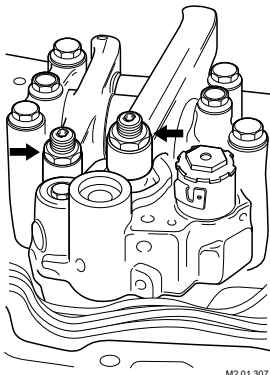


- A valve clearance of more than 1 mm [0.04 in] indicates mechanical damage or wear in the valve train, especially when this is measured on one cylinder only.
- Make sure to check all the valve train parts of that specific cylinder before adjusting the valve clearance to the specified value.



M201308-2

5. Adjust the valve clearance by loosening the lock nut and turning the adjusting screw in the correct direction.
6. By cranking the crankshaft 1/3 stroke each time, using the special tool (1903018), the valves can be adjusted according to the injection sequence 1-5-3-6-2-4.



M2 01 307

M031819 - 03.28.2015

Technical data

Adjusting data, valve clearance

Valve clearance (cold)	
Intake	0.50 mm [0.020 in]
Exhaust	0.70 mm [0.028 in]
Valve clearance (hot)	
Intake	0.50 mm [0.020 in]
Exhaust	0.55 mm [0.022 in]
Lock nut for valve adjusting bolt	64 Nm [566 lb-in]



- A valve clearance of more than 1 mm [0.039 in] indicates mechanical damage or wear in the valve train,

especially when this is measured on one cylinder only.

- Make sure to check all the valve train parts of that specific cylinder before adjusting the valve clearance to the specified value.

M031813 - 03.05.2013

Definition, warm and cold engine

Cold engine	A cold engine is an engine that, having reached operating temperature, has been allowed to cool down for at least six hours .
Warm engine	A warm engine is an engine that, having reached operating temperature, has been at a standstill for not more than thirty minutes .

M031814 - 07.31.2012

Tightening torque, rocker seat

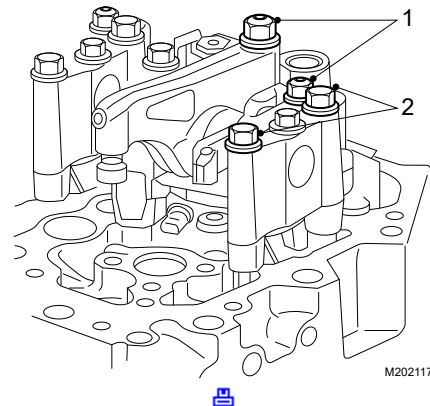
Lock nut (1) for valve adjusting bolt

64 Nm [566 lb-in]

Attachment bolts (2):

Phase 1
Phase 2

50 Nm [443 lb-in]
90°



- Attachment bolts may only be reused when a new nut can be screwed by hand over the complete cleaned bolt thread.
- Apply a drop of clean engine oil to the thread of the bolts and the bearing surface of the bolt heads.

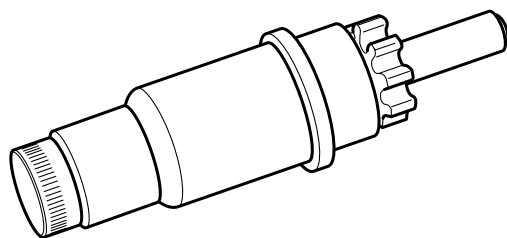
M030452 - 05.02.2017

Special tools

Special tool category: Mandatory special tool for: NA region 1903018

Engine Cranking Tool

1453158 is also
suitable



1000010

ST1903018 - 01.07.2013

-  1.202 install blanking plate, flywheel housing (Flywheel housing)

Technical data

Tightening torque, blanking plate, flywheel housing

Attachment bolts

30 Nm [266 lb-in]

M032380 - 07.02.2013

-  1.203 mount valve cover gasket (Basic assembly)

Explanation

Mounting valve cover gasket



Always install a new valve cover gasket.

1. Clean the sealing surface of the cylinder head and the recess in the valve cover.



Make sure that the sealing surface and recess are fully dry to prevent leakage.

Only when all the surfaces are dry, fit the gasket in the valve cover.

M036889 - 06.13.2013

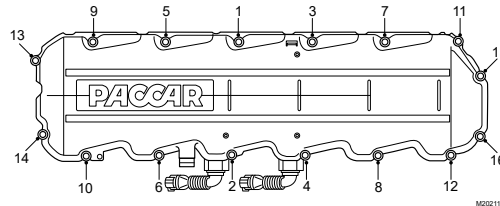
-  1.204 install valve cover (Basic assembly)

Explanation

Installing valve cover

1. Fit the valve cover complete with the attachment bolts and a new valve cover gasket.
2. Tighten the attachment bolts in the specified sequence to the specified torque.

M036888 - 10.20.2014

Technical data**Tightening torque, valve cover****Tightening sequence:**

Attachment bolts

20 Nm [177 lb-in]⁽¹⁾

(1) Always install a new valve cover gasket.

M031734 - 03.05.2013

1.205 fixing air bleed pipe (Lubrication system)**Explanation****Warning, air bleed pipe**

- Check that the air bleed pipe from the valve cover to the oil separator is not damaged.
- Leakage of unfiltered crankcase gas is NOT allowed.

M036863 - 03.07.2013

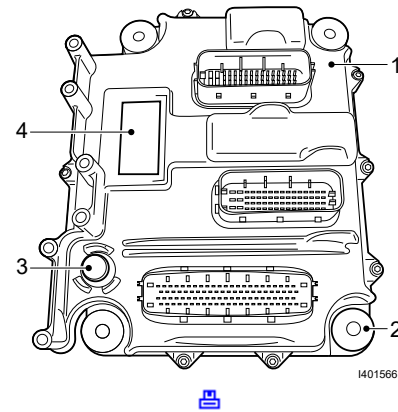
1.206 connect 2 (two) engine wiring harness J1 A (Electrical system, engine)**1.207 connect boost air temperature sensor (Sensors electrical system, engine)****1.208 connect inlet air boost pressure sensor (Sensors electrical system, engine)****1.209 install electronic control unit, engine management system (Electrical system, engine)****Explanation****Installing electronic control unit engine management system**

1. Tighten the attachments bolts evenly to the specified torque.
2. Fit the connectors onto the electronic control unit.
3. Carefully tighten the wiring harness attachment bolts.

Carefully install these self-tapping bolts to avoid damaging the screw



thread in the electronic control unit.



- 1 Electronic control unit
- 2 Rubber insulating bush
- 3 Breather
- 4 Identification plate

M032376 - 02.26.2014

Technical data

Tightening torque, electronic control unit engine management system

Attachment bolts and nuts

30 Nm [265 lb-in]

M032378 - 03.05.2013

 1.210 install assembly fuel filtration module (Fuel system)

Explanation

Installing fuel filtration module

1. Install the gaskets onto the connection pipe (1) and slot (2).



Always use new gaskets and apply the specified mounting agent.

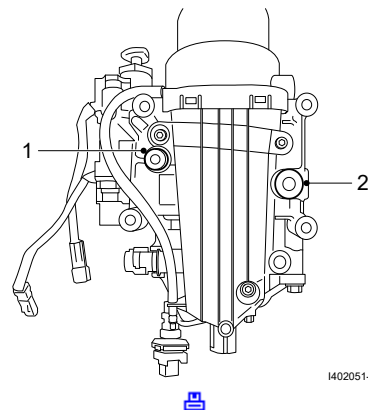
2. Position the fuel filtration module on the engine.

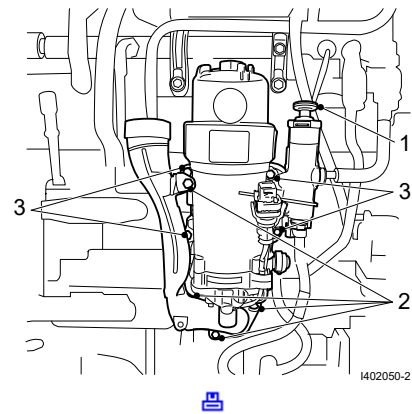


Make sure that:

- The mating holes on the engine are clean.
- The connection pipe (1) is positioned exactly in front of the mating hole.

3. Install the attachment bolts (3) and tighten them to the specified torque.

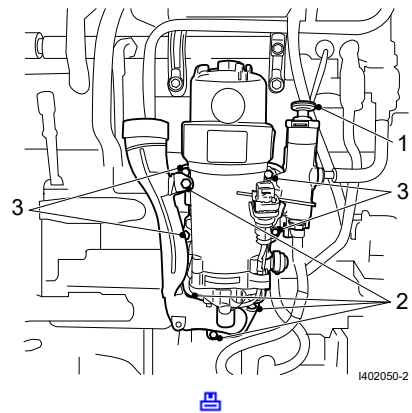




M035166 - 02.26.2014

Technical data

Tightening torque, fuel filtration module



Attachment bolts (3)

30 Nm [265 lb-in]

M032402 - 09.15.2014

Mounting product, sealing ring

Rubber lubricant

"P80"

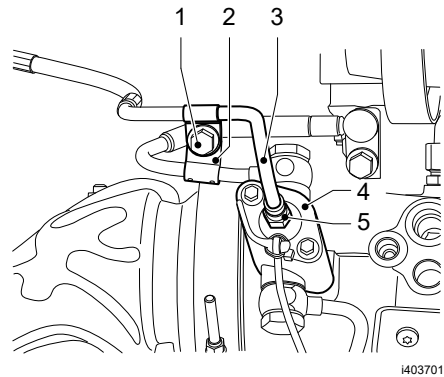
M025429 - 02.21.2017

 1.211 fixing supply pipe dosing module, fuel (Fuel system)

Explanation

Fixing supply pipe dosing module, fuel

1. Fit the union nut (5) onto the fuel dosing module (4), and tighten it to the specified torque.
2. Position the clip, and tighten the attachment bolt (1) to the specified torque.
3. Install the heat shield.

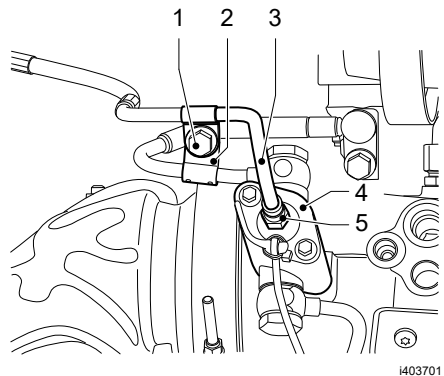


M031368 - 09.02.2014

Technical data

Tightening torque, supply pipe dosing module, fuel

Attachment bolt (1)	20 Nm [177 lb-in]
Union nut (5)	20 Nm [177 lb-in] ⁽¹⁾
(1) Apply a drop of clean engine oil.	



M032330 - 08.12.2014

1.212 fixing supply pipe dosing module, fuel (Fuel system)

Explanation

Connecting quick-release coupling

- No tooling is allowed for disconnecting or connecting the quick-release coupling.

New situation

- Lubricate the O-ring with the specified mounting product.



- Always use a new O-ring.
- Make sure that both male and female quick-release couplings are clean and without damage.

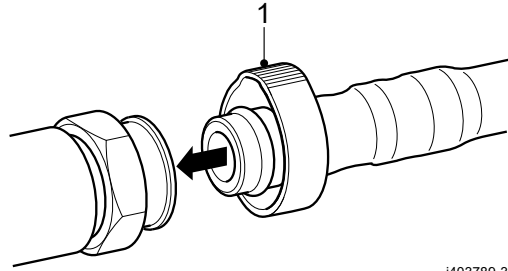
- Insert the male quick-release coupling into the female quick-release coupling until it snaps itself

New

onto the collar of the female quick-release coupling.



- Make sure that the pipes are originally routed.
- Do not press the releasing element (1).
- Replace the releasing element (1) by the c-clip (2), if:
 - it is **damaged**.
 - it is **removed from the quick-release coupling**.



i403789-3



If using a c-clip (2):

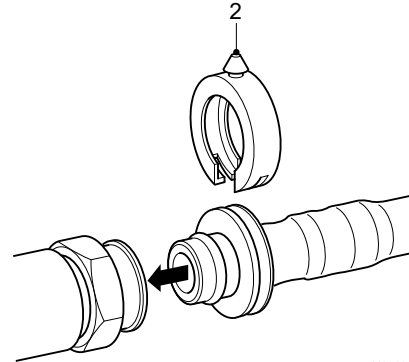
- Insert the male coupling into the female coupling.
- Install the c-clip (2) to lock the connection.
 - Never reuse a c-clip (2).

3. Check whether the quick-release coupling has engaged correctly by pulling it in the opposite direction. The connection must remain intact.



Replace the release element (1) by the c-clip (2) if there is an **axial** and/or **radial** play.

Replacement c-clip



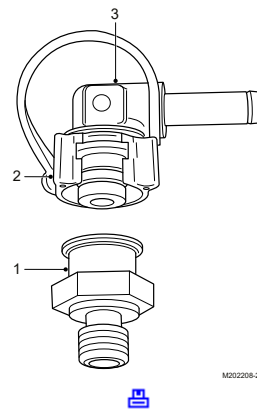
i405100

Old situation

1. Mount the retaining clip (2) as shown.
2. Insert the male quick-release coupling (3) into the female quick-release coupling (1) until the retaining clip (2) locks behind the collar of the female quick-release coupling (1).



- Always use a new O-ring.
- Make sure that both male and female quick-release couplings are clean and without damage.
- Make sure that the pipes are as originally routed.



M002208-2

3. Check whether the quick-release coupling has engaged correctly by pulling it in the opposite direction. The connection must remain intact.

M046086 - 11.12.2015

Technical data

Mounting product, O-ring

Lubricant

"Syntheso GL EP1"

M045846 - 10.28.2016

1.213 fixing fuel pipe from hand priming pump to fuel lift pump (Fuel system)

Explanation

Connecting quick-release coupling

- No tooling is allowed for disconnecting or connecting the quick-release coupling.

New situation

- Lubricate the O-ring with the specified mounting product.



- Always use a new O-ring.
- Make sure that both male and female quick-release couplings are clean and without damage.

- Insert the male quick-release coupling into the female coupling until it snaps itself onto the collar of the female coupling.



- Make sure that the pipes are originally routed.
- Do not press the releasing element (1).
- Replace the releasing element (1) by the c-clip (2), if:
 - it is **damaged**.
 - it is **removed from the quick-release coupling**.



If using a c-clip (2):

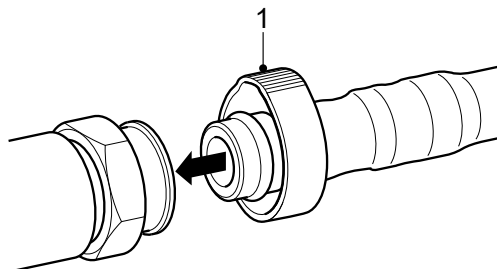
- Insert the male coupling into the female coupling.
- Install the c-clip (2) to lock the connection.
 - Never reuse a c-clip (2).

- Check whether the quick-release coupling has engaged correctly by pulling it in the opposite direction. The connection must remain intact.



Replace the release element (1) by the c-clip (2) if there is an **axial** and/or **radial** play.

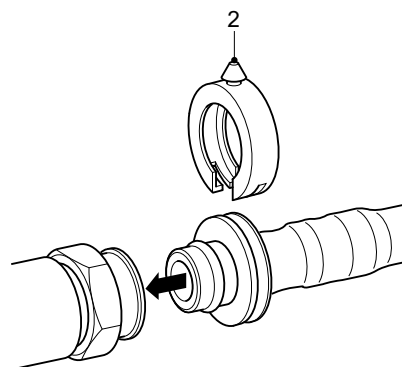
New



i403789-3



Replacement c-clip



i405100



Old situation

- Lubricate the O-ring with the specified mounting product.



- Always use a new O-ring.

Old

2. Insert the male quick-release coupling into the female coupling until it snaps itself onto the collar of the female coupling.

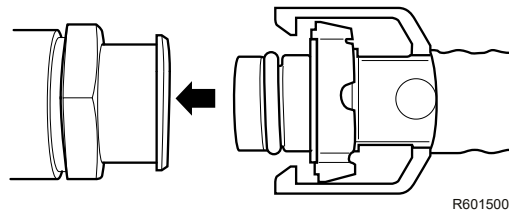


- Do not press the release element.
- Make sure that both male and female quick-release couplings are clean and without damage.



Replace the fuel pipe if the clamping force is reduced or the quick-release coupling is damaged.

- Make sure that the pipes are originally routed.



3. Check whether the quick-release coupling has engaged correctly by pulling it in the opposite direction. The connection must remain intact.

M035573 - 04.05.2018

Technical data

Mounting product, O-ring

Lubricant

"Syntheso GL EP1"

M045846 - 10.28.2016

1.214 fixing one side fuel pipe from fuel lift pump to filter (Fuel system)

Explanation

Connecting quick-release coupling

- No tooling is allowed for disconnecting or connecting the quick-release coupling.

New situation

1. Lubricate the O-ring with the specified mounting product.

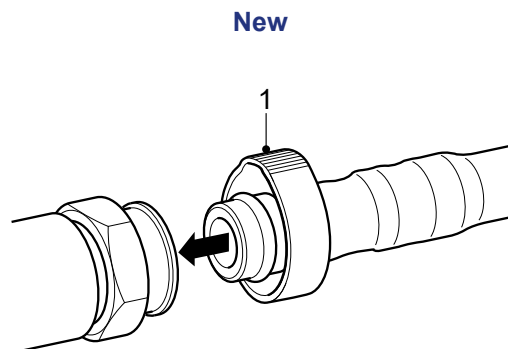


- Always use a new O-ring.
- Make sure that both male and female quick-release couplings are clean and without damage.

2. Insert the male quick-release coupling into the female coupling until it snaps itself onto the collar of the female coupling.



- Make sure that the pipes are originally routed.
- Do not press the releasing element (1).



i403789-3



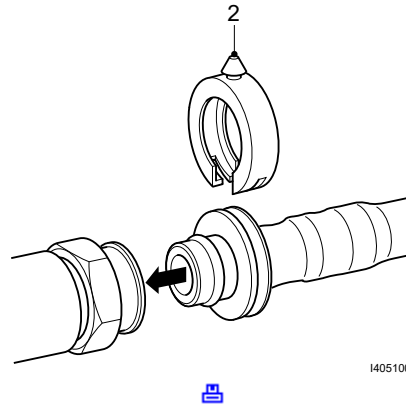
Replacement c-clip

- Replace the releasing element (1) by the c-clip (2), if:
 - it is **damaged**.
 - it is **removed from the quick-release coupling**.



If using a c-clip (2):

- Insert the male coupling into the female coupling.
- Install the c-clip (2) to lock the connection.
 - Never reuse a c-clip (2).



I405100

3. Check whether the quick-release coupling has engaged correctly by pulling it in the opposite direction. The connection must remain intact.



Replace the release element (1) by the c-clip (2) if there is an **axial** and/or **radial** play.

Old situation

1. Lubricate the O-ring with the specified mounting product.



- Always use a new O-ring.

2. Insert the male quick-release coupling into the female coupling until it snaps itself onto the collar of the female coupling.



- Do not press the release element.
- Make sure that both male and female quick-release couplings are clean and without damage.

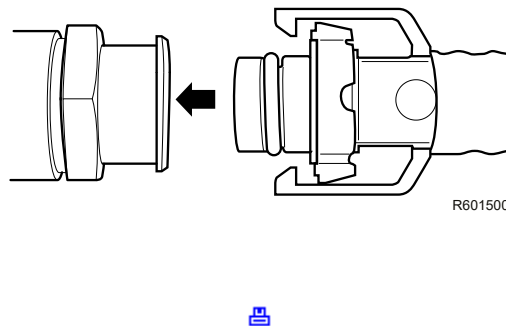


Replace the fuel pipe if the clamping force is reduced or the quick-release coupling is damaged.

- Make sure that the pipes are originally routed.

3. Check whether the quick-release coupling has engaged correctly by pulling it in the opposite direction. The connection must remain intact.

Old



R601500

M035573 - 04.05.2018

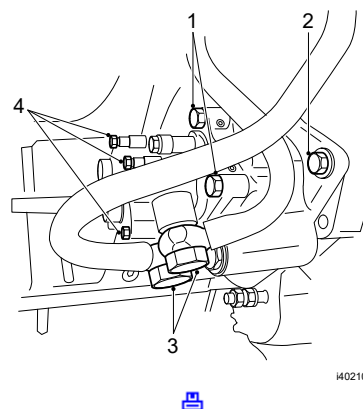
Technical data

Mounting product, O-ring

1.215 fixing one side fuel pipe from fuel lift pump to filter (Fuel system)

Technical data

Tightening torque, fuel lift pump pipes



Banjo bolts, fuel pipes (3)

45 Nm [398 lb-in]

M032558 - 03.28.2017

1.216 fixing fuel pipe from tank to fuel lift pump (Fuel system)

Explanation

Connecting quick-release coupling

- No tooling is allowed for disconnecting or connecting the quick-release coupling.

New situation

- Lubricate the O-ring with the specified mounting product.

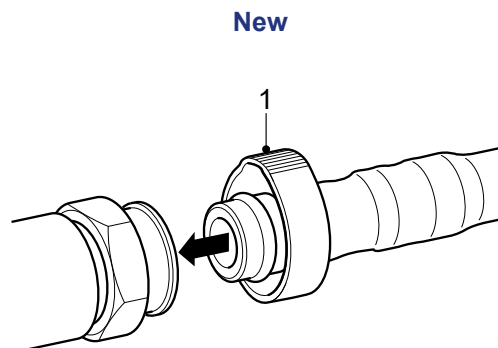


- Always use a new O-ring.
- Make sure that both male and female quick-release couplings are clean and without damage.

- Insert the male quick-release coupling into the female coupling until it snaps itself onto the collar of the female coupling.



- Make sure that the pipes are originally routed.
- Do not press the releasing element (1).
- Replace the releasing element (1) by the c-clip (2), if:
 - it is **damaged**.



Replacement c-clip

- it is removed from the quick-release coupling.



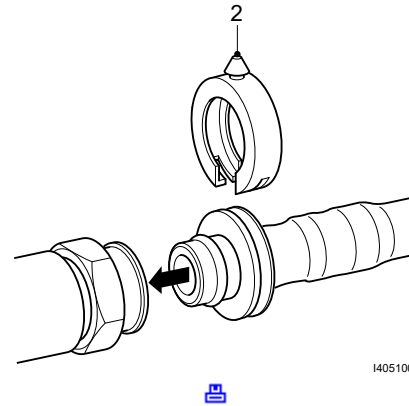
If using a c-clip (2):

- Insert the male coupling into the female coupling.
- Install the c-clip (2) to lock the connection.
- Never reuse a c-clip (2).

3. Check whether the quick-release coupling has engaged correctly by pulling it in the opposite direction. The connection must remain intact.



Replace the release element (1) by the c-clip (2) if there is an **axial** and/or **radial** play.



I405100

Old situation

1. Lubricate the O-ring with the specified mounting product.



- Always use a new O-ring.

2. Insert the male quick-release coupling into the female coupling until it snaps itself onto the collar of the female coupling.



- Do not press the release element.
- Make sure that both male and female quick-release couplings are clean and without damage.

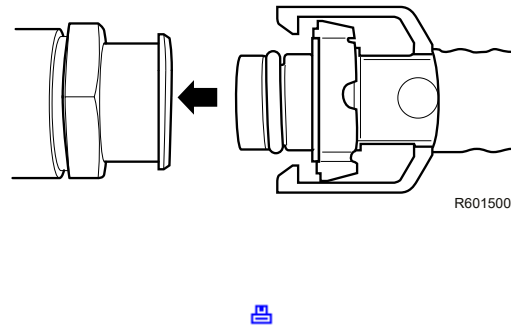


Replace the fuel pipe if the clamping force is reduced or the quick-release coupling is damaged.

- Make sure that the pipes are originally routed.

3. Check whether the quick-release coupling has engaged correctly by pulling it in the opposite direction. The connection must remain intact.

Old



R601500

M035573 - 04.05.2018

Technical data

Mounting product, O-ring

Lubricant

"Syntheso GL EP1"

M045846 - 10.28.2016

1.217 fixing fuel tank return pipe (Fuel system)

Explanation

Connecting quick-release coupling

- No tooling is allowed for disconnecting or connecting the quick-release coupling.

New situation

1. Lubricate the O-ring with the specified mounting product.



- Always use a new O-ring.
- Make sure that both male and female quick-release couplings are clean and without damage.

2. Insert the male quick-release coupling into the female coupling until it snaps itself onto the collar of the female coupling.



- Make sure that the pipes are originally routed.
- Do not press the releasing element (1).
- Replace the releasing element (1) by the c-clip (2), if:
 - it is **damaged**.
 - it is **removed from the quick-release coupling**.



If using a c-clip (2):

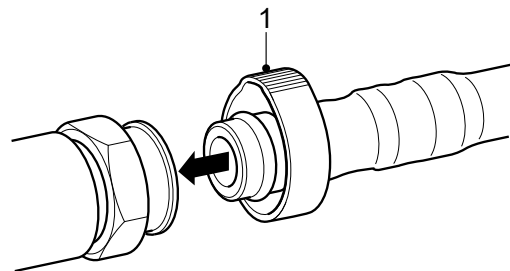
- Insert the male coupling into the female coupling.
- Install the c-clip (2) to lock the connection.
 - Never reuse a c-clip (2).

3. Check whether the quick-release coupling has engaged correctly by pulling it in the opposite direction. The connection must remain intact.



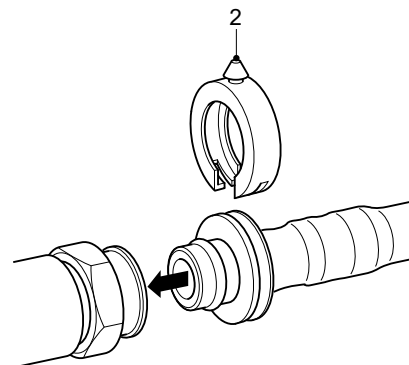
Replace the release element (1) by the c-clip (2) if there is an **axial** and/or **radial** play.

New



i403789-3

Replacement c-clip



i405100

Old

Old situation

1. Lubricate the O-ring with the specified mounting product.



- Always use a new O-ring.

2. Insert the male quick-release coupling into the female coupling until it snaps itself onto the collar of the female coupling.

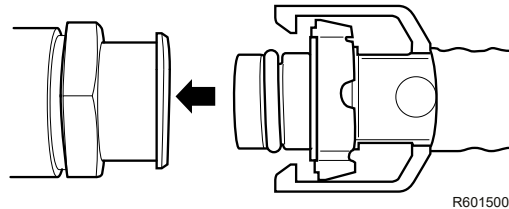


- Do not press the release element.
- Make sure that both male and female quick-release couplings are clean and without damage.



Replace the fuel pipe if the clamping force is reduced or the quick-release coupling is damaged.

- Make sure that the pipes are originally routed.



3. Check whether the quick-release coupling has engaged correctly by pulling it in the opposite direction. The connection must remain intact.

M035573 - 04.05.2018

Technical data

Mounting product, O-ring

Lubricant

"Syntheso GL EP1"

M045846 - 10.28.2016

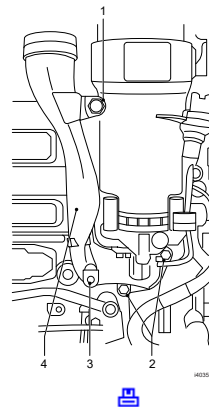
1.218 connect fuel filtration module (Fuel system)

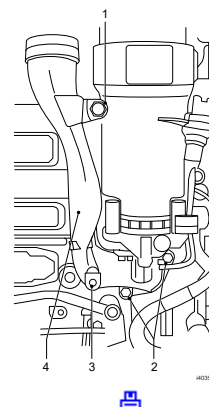
1.219 install oil filler pipe (Lubrication system)

Explanation

Installing oil filling pipe

1. Clean the gasket face of both the engine block and oil filling pipe (4).
2. Place the gasket onto the oil filling pipe (4) and insert the oil filling pipe attachment bolts (2) to hold the gasket in place.
3. Insert the oil fill pipe (4) with the attachment bolts and gasket and guide it into the original mount position.
4. Make sure that the gasket is aligned correctly, then hand-tighten the oil filling pipe attachment bolts (2).
5. Install the oil filling pipe attachment bolt (1) and tighten all attachment bolts to the specified torque.
6. Depending on the truck model, install the power steering hose attachment bolt (3) and tighten it to the specified torque.



Technical data**Tightening torque, oil filling pipe**

Attachment bolts (1 and 2)
 Thread hole (3)
 (1) Always use a new gasket

30 Nm [265 lb-in]⁽¹⁾
 30 Nm [265 lb-in]

M032404 - 07.26.2016

 1.220 **install 2 (two) pump unit lifter (Fuel system)**

Explanation**Installing pump unit lifters**

- Always install new pump unit lifters if the camshaft is replaced.
- Never use pump unit lifters that have been dropped, are corroded, or are in any other way damaged.
- New pump unit lifters require a more extensive pre-lubrication. This pre-lubrication is best started during the beginning of the repair activities

Installing NEW pump unit lifters

1. Before installation, the **new** pump unit lifters must be pre-oiled in clean engine oil, observing the following:
 1. Allow the roller to fill with oil by submerging it slowly and keeping it in the oil for the rest of the procedure.
 2. Once submerged, keep them in the oil untouched for 10 minutes.
 3. Move the pump unit lifter back and forth in the engine oil for 30 seconds. Move in the direction of the axle.

4. Again, keep them in the oil untouched for 10 minutes.
5. Afterward, check that the roller runs smoothly by manually rotating the roller several times.
6. The time between dipping and installation must be no longer than 2 hours.

2. Fit the pump unit lifters into the engine block.



Do not drop the pump unit lifter onto the camshaft.

3. Apply the specified mounting product to the locking pins and tighten them to the specified torque.
4. Pour approximately 100 ml [3.38 fl oz] of clean engine oil on top of the pump unit tappets.

Re-installing pump unit lifters

1. Before re-installation, the pump unit lifters must be pre-oiled in clean engine oil, observing the following:
 1. Allow the roller to fill with oil by submerging it slowly and keeping it in the oil for the rest of the procedure.
 2. Once submerged, move the pump unit tappet back and forth in the engine oil for at least 20 seconds.
 3. Afterward, check that the roller runs smoothly by manually rotating the roller several times.
 4. The time between dipping and installation must be no longer than 2 hours.
2. Fit the pump unit lifters into the engine block.



Do not drop the pump unit lifter onto the camshaft.

3. Apply the specified mounting product to the locking pins and tighten them to the specified torque.
4. Pour approximately 100 ml [3.38 fl oz] of clean engine oil on top of the pump unit tappets.

M032497 - 03.18.2015

Technical data

Tightening torque, pump unit lifters

Locking pin

45 Nm [398 lb-in]⁽¹⁾(Diagonal 2)

(1) Use "[Loctite 542](#)" to secure.

(2) Always install new pump unit lifters if the camshaft is replaced.

M032648 - 01.10.2017

1.221 install 2 (two) common rail pump unit (Fuel system)

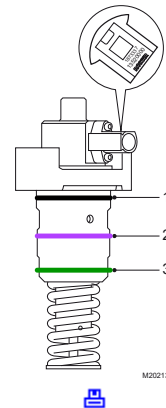
Explanation

Installing common rail pump unit

1. Remove the packaging from the pump units.



- If the pump units are reused, the O-rings must be replaced.
- Install the O-rings in the order as shown.

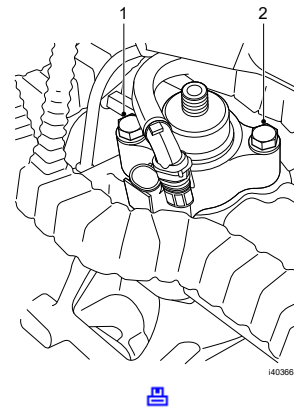


1. Black
2. Violet
3. Green

2. Remove the cover from the common rail pump unit opening in the engine block.
3. Apply a small amount of clean engine oil to the O-rings, and check that the bore in the engine block is well oiled.
4. Install the pump unit.
5. Install the attachment bolts (1 and 2).



- Always use new attachment bolts.
- The pump units are mounted under pretension.



6. Tighten the attachment bolts (1 and 2) alternately, in several steps, until the pump unit abuts the engine block.
7. Tighten the attachment bolts (1 and 2) to the specified torque.

M031781 - 04.09.2015

Technical data

Tightening torque, common rail pump unit

Attachment bolts

30 Nm [266 lb-in] + 60°⁽¹⁾

(1)

Use bolts only once

M031782 - 03.06.2013

1.222 connect engine wiring harness J1 A (Electrical system, engine)

1.223 connect fuel pressure sensor (Sensors electrical system, engine)

1.224 connect fuel or coolant temperature sensor (Sensors electrical system, engine)

1.225 fixing assembly fuel intake module (Fuel system)

Explanation

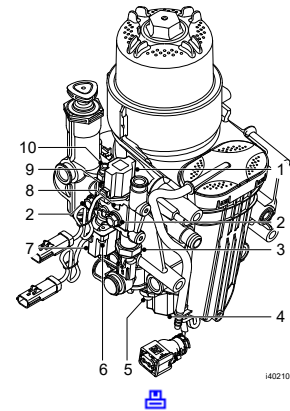
Fixing assembly fuel intake module

1. Clean the sealing surfaces and fit a new gasket.



Always use a new gasket.

2. Install the fuel intake module (8) and tighten the attachment bolts (2) to the specified torque.

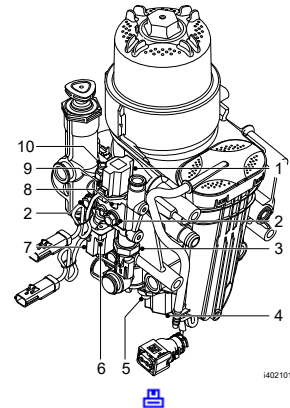


M037848 - 06.27.2013

Technical data

Tightening torque, fuel intake module

Fuel intake module attachment bolts (2)	25 Nm [221 lb-in]
Fuel pressure sensor, fuel intake module (3)	14 Nm [124 lb-in]
Fuel shutoff valve attachment bolts (6)	2.5 Nm [22 lb-in]
Air shutoff valve attachment bolts (9)	2.5 Nm [22 lb-in]
Quick-release coupling, male (10)	17 Nm [150 lb-in]



M032521 - 05.15.2018

1.226 install 2 (two) fuel injection pipe from pump unit to fuel rail (Fuel system)

Explanation

Installing fuel injection pipe from pump unit to fuel rail

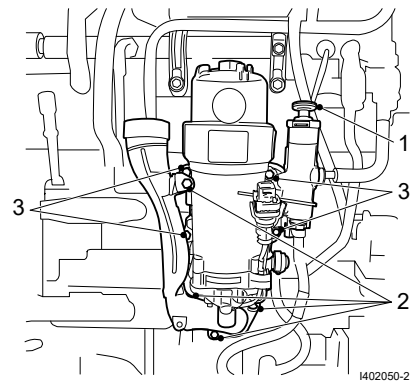
Flushing high-pressure fuel pump

1. Loosen the knob of the fuel lift pump (1) by turning it counterclockwise.
2. Operate the manual fuel lift pump (1) to flush the high-pressure fuel pump.



Make sure that there is no debris in the high-pressure fuel pump output.

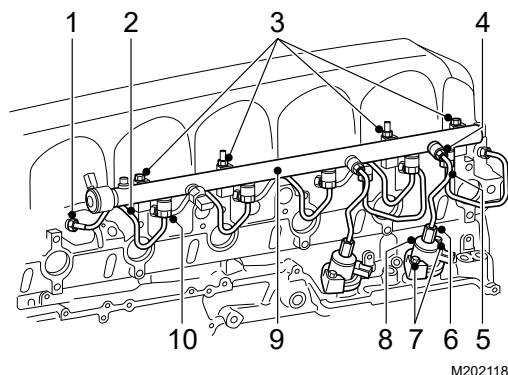
Dirt or debris in the fuel system can lead to severe engine damage.



3. Fit the new fuel injection pipe (5) without tension, and tighten it by hand up to the end of thread.
4. First tighten the union nut (6) on the pump unit to the specified torque.
5. Then tighten the union nut (4) on the rail side to the specified torque.



- Bending the injection pipes leads to cracking, and is therefore prohibited.
- Make sure that the fuel injection pipe is tightened correctly, otherwise external leakage can occur.

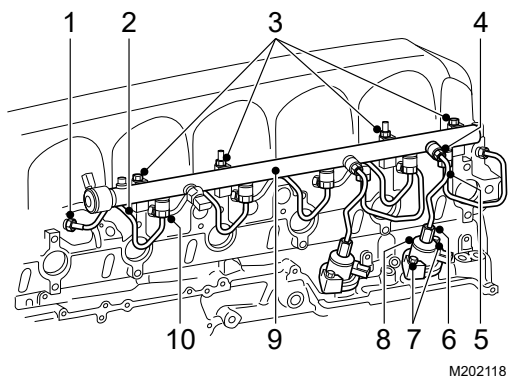


M054373 - 05.08.2017

Technical data

Tightening torque, fuel rail assembly

Fuel rail attachment bolts (3)	30 Nm [266 lb-in]
Fuel injection pipe (2) union nut, cylinder head side (1)	
1 st phase	27 Nm [239 lb-in] ⁽¹⁾
2 nd phase	
New fuel injection pipe	60°
Reused fuel injection pipe	30°
Fuel injection pipe (2) union nut, fuel rail side (10)	
1 st phase	10 Nm [89 lb-in] ⁽¹⁾
2 nd phase	
New fuel injection pipe	60°
Reused fuel injection pipe	30°
Fuel injection pipe union nuts from pump unit to fuel rail (4 and 6)	
1 st phase	10 Nm [89 lb-in] ⁽¹⁾
2 nd phase	



New fuel injection pipe 60°
 Reused fuel injection pipe 30°

- (1) Make sure that all fuel injection pipes are checked and tightened correctly, otherwise external fuel leakage can occur.

M036668 - 01.16.2019

1.227 install two cylinder air compressor (Air compressor)

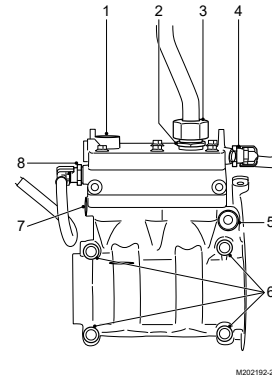
Explanation

Installing the air compressor

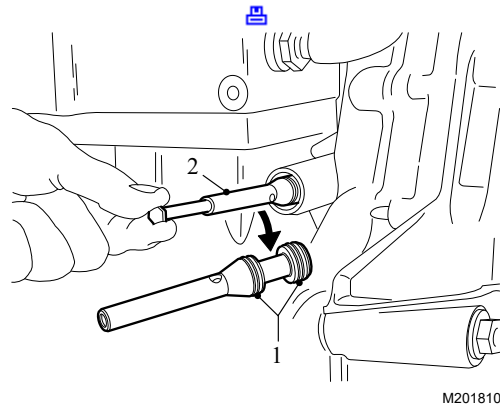
1. Apply a small amount of oil to the O-ring of the air compressor.
2. Slide the air compressor into the flywheel housing.
3. Install the air compressor and fit the attachment bolts (6).



Tighten the attachment bolts (6) later in the process.



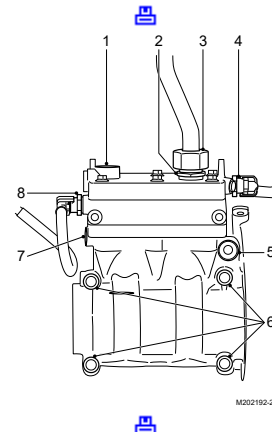
4. Apply a small amount of oil to the new O-rings (1) of the connecting pipe with seal (2).
5. Use an M6 bolt to install the connecting pipe with seal (2) as shown.
6. Tighten the air compressor attachment bolts (6) to the specified torque.



7. Fit a new copper sealing washer onto the sealing plug (5).
8. Install the sealing plug (5) and tighten it to the specified torque.



Always use the original sealing plug (5), so that the distance between the oil connection pipe and the sealing plug (5) is correct.

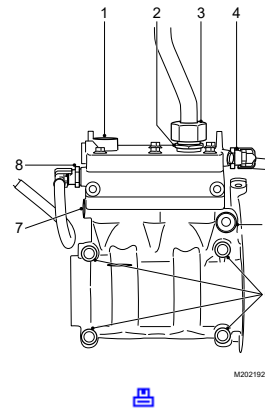


M036775 - 03.23.2016

Technical data

Tightening torque, air compressor

Delivery port (1)	100 Nm [74 lb-ft]
Male coupling, part for pipe coupling (2)	100 Nm [74 lb-ft]
Union nut, compressor pipe (3)	100 Nm [74 lb-ft]
Quick-release coupling, female (4) ⁽¹⁾	40 Nm [360 lb-in]
Oil pipe sealing plug (5)	35 Nm [310 lb-in]
Attachment bolts (6)	60 Nm + 120° [530 lb-in + 120°]
Command port (7)	20 Nm [180 lb-in]
Quick-release coupling, female (8) ⁽¹⁾	40 Nm [360 lb-in]
(1) Always use a new O-ring.	



M033135 - 01.17.2014

1.228 loosen compressor pipe, air dryer command

1.229 fixing tandem pump (Steering pump)

Technical data

Tightening torque, assembly tandem pump

Attachment bolts	60 Nm [531 lb-in]
(1) Always use a new O-ring.	

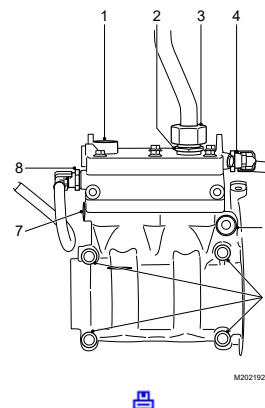
M036491 - 03.26.2015

1.230 fixing compressor pipe 01, delivery side

Technical data

Tightening torque, air compressor

Delivery port (1)	100 Nm [74 lb-ft]
Male coupling, part for pipe coupling (2)	100 Nm [74 lb-ft]
Union nut, compressor pipe (3)	100 Nm [74 lb-ft]
Quick-release coupling, female (4) ⁽¹⁾	40 Nm [360 lb-in]
Oil pipe sealing plug (5)	35 Nm [310 lb-in]
Attachment bolts (6)	60 Nm + 120° [530 lb-in + 120°]
Command port (7)	20 Nm [180 lb-in]
Quick-release coupling, female (8) ⁽¹⁾	40 Nm [360 lb-in]
(1) Always use a new O-ring.	



M033135 - 01.17.2014

1.231 fixing compressor pipe 01, suction side (Air compressor)

Technical data

Tightening torque, compressor pipe

Bracket attachment bolts	30 Nm [265 lb-in]
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1.232 fixing supply coolant pipe (Air compressor)

Explanation

Connecting quick-release coupling

- No tooling is allowed for disconnecting or connecting the quick-release coupling.

New situation

1. Lubricate the O-ring with the specified mounting product.



- Always use a new O-ring.
- Make sure that both male and female quick-release couplings are clean and without damage.

2. Insert the male quick-release coupling into the female coupling until it snaps itself onto the collar of the female coupling.



- Make sure that the pipes are originally routed.
- Do not press the releasing element (1).
- Replace the releasing element (1) by the c-clip (2), if:
 - it is **damaged**.
 - it is **removed from the quick-release coupling**.



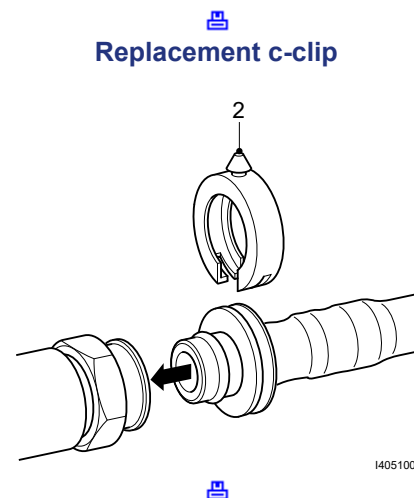
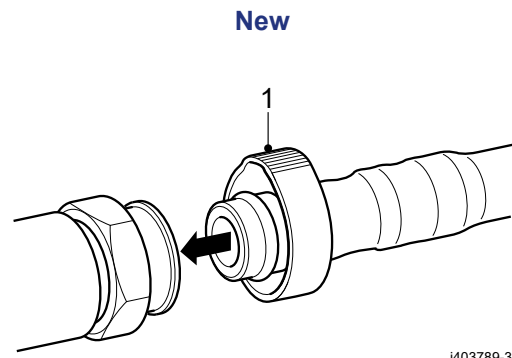
If using a c-clip (2):

- Insert the male coupling into the female coupling.
- Install the c-clip (2) to lock the connection.
 - Never reuse a c-clip (2).

3. Check whether the quick-release coupling has engaged correctly by pulling it in the opposite direction. The connection must remain intact.



Replace the release element (1) by the c-clip (2) if there is an **axial** and/or **radial** play.



Old situation

1. Lubricate the O-ring with the specified mounting product.

Old



- Always use a new O-ring.

2. Insert the male quick-release coupling into the female coupling until it snaps itself onto the collar of the female coupling.



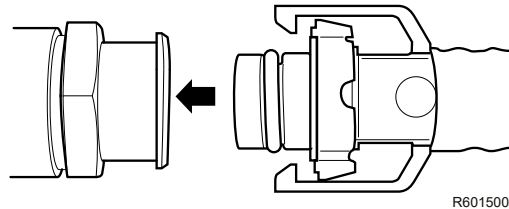
- Do not press the release element.
- Make sure that both male and female quick-release couplings are clean and without damage.



Replace the fuel pipe if the clamping force is reduced or the quick-release coupling is damaged.

- Make sure that the pipes are originally routed.

3. Check whether the quick-release coupling has engaged correctly by pulling it in the opposite direction. The connection must remain intact.



M035573 - 04.05.2018

Technical data

Mounting product, O-ring

Lubricant

"Syntheso GL EP1"

M045846 - 10.28.2016

1.233 fixing return coolant pipe (Air compressor)

Explanation

Connecting quick-release coupling

- No tooling is allowed for disconnecting or connecting the quick-release coupling.

New situation

1. Lubricate the O-ring with the specified mounting product.

New

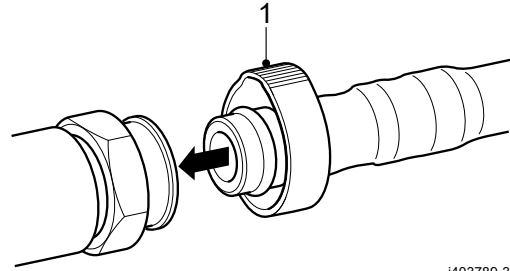


- Always use a new O-ring.
- Make sure that both male and female quick-release couplings are clean and without damage.

2. Insert the male quick-release coupling into the female coupling until it snaps itself onto the collar of the female coupling.



- Make sure that the pipes are originally routed.
- Do not press the releasing element (1).
- Replace the releasing element (1) by the c-clip (2), if:
 - it is **damaged**.
 - it is **removed from the quick-release coupling**.



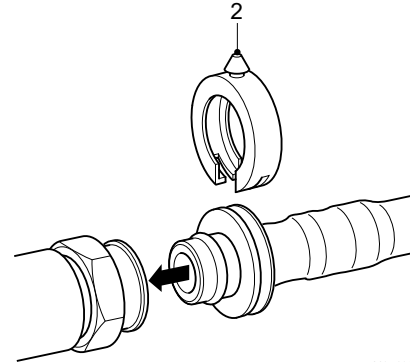
i403789-3



If using a c-clip (2):

- Insert the male coupling into the female coupling.
- Install the c-clip (2) to lock the connection.
 - Never reuse a c-clip (2).

Replacement c-clip



i405100

3. Check whether the quick-release coupling has engaged correctly by pulling it in the opposite direction. The connection must remain intact.



Replace the release element (1) by the c-clip (2) if there is an **axial** and/or **radial** play.

Old situation

1. Lubricate the O-ring with the specified mounting product.



- Always use a new O-ring.

2. Insert the male quick-release coupling into the female coupling until it snaps itself onto the collar of the female coupling.



- Do not press the release element.
- Make sure that both male and female quick-release couplings are clean and without damage.

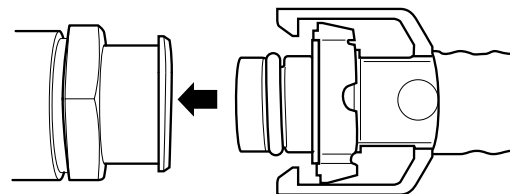


Replace the fuel pipe if the clamping force is reduced or the quick-release coupling is damaged.

- Make sure that the pipes are originally routed.

3. Check whether the quick-release coupling has engaged correctly by pulling it in the opposite direction. The connection must remain intact.

Old



R601500

Technical data**Mounting product, O-ring**

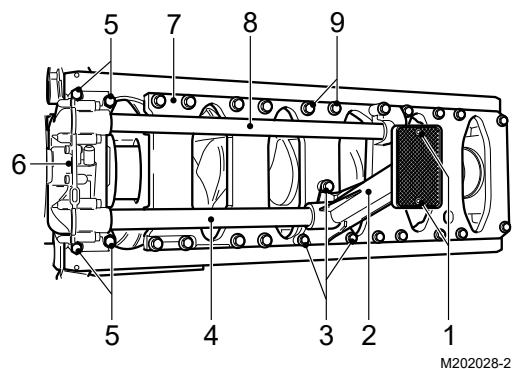
Lubricant

["Syntheso GL EP1"](#)*M045846 - 10.28.2016*

- 1.234 install fixing frame (Lubrication system)

Technical data**Tightening torque, fixing frame**Attachment bolts (9) 110 Nm [81 lb-ft]⁽¹⁾

(1) Use Loctite 243 to secure



M202028-2

*M039058 - 08.20.2015*

- 1.235 install oil pipe, delivery side (Lubrication system)

- 1.236 install engine oil pump (Lubrication system)

Technical data**Tightening torque, engine oil pump**

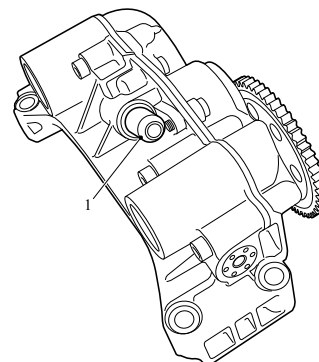
Pressure control valve

plug (1) 27 Nm [239 lb-in]⁽¹⁾Plug M10 x 1.0 (3) 16 Nm [142 lb-in]⁽¹⁾

Pump housing bolts (4) 24 Nm [212 lb-in]

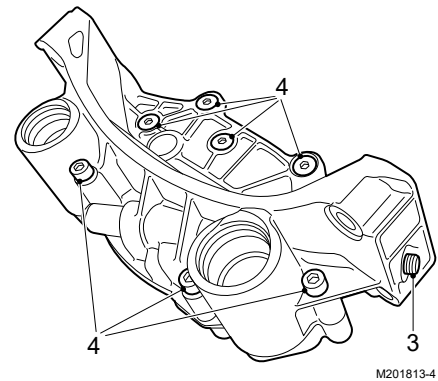
Attachment bolts, pump to engine. 60 Nm [44 lb-ft]⁽¹⁾

(1) Apply Loctite 243



M201812-2





M027771 - 01.14.2013

 1.237 install oil pipe, suction side (Lubrication system)

 1.238 install oil suction pipe (Lubrication system)

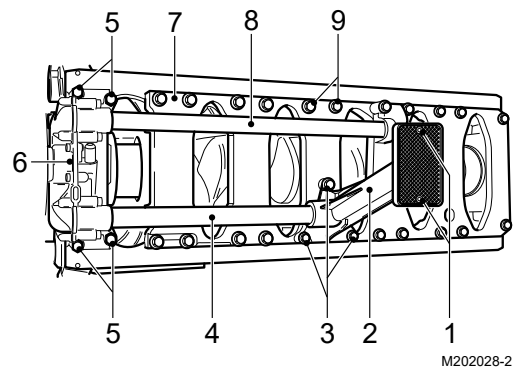
Technical data

Tightening torque, strainer basket

Attachment bolts (3) 60 Nm [531 lb-in]⁽¹⁾⁽²⁾

(1) Use Loctite 243 to secure.

(2) Check the sealing rings before installing the oil pipe, delivery/suction side.



M024044 - 03.06.2013

 1.239 mount sealing rubber, oil sump (Lubrication system)

Explanation

Mounting sealing profile oil sump



Always install a new sealing profile.

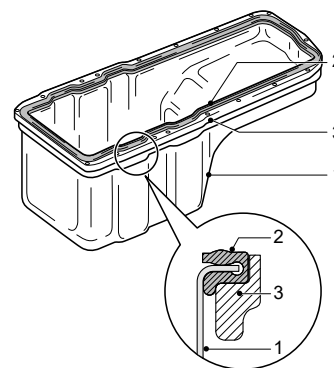
1. Thoroughly clean the sealing surfaces of the oil pan and the cylinder block.
2. Mount the sealing profile (2) in the specified mounting sequence.
3. Clean the recess for the sealing profile in the oil sump.

Make sure that the sealing profile surface and the recess are fully dry to



prevent leakage.

4. Mount the sealing profile into the oil sump.

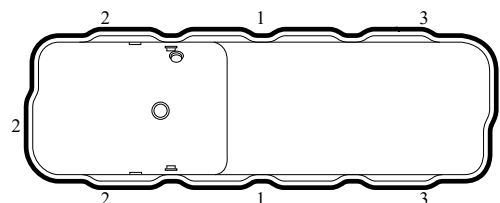


M032178 - 09.19.2017

Technical data

Mounting data sealing profile oil sump

Mounting sequence, oil
sump sealing profile



M201637



M032180 - 12.04.2012

-  1.240 install steel oil sump (Lubrication system)

Explanation

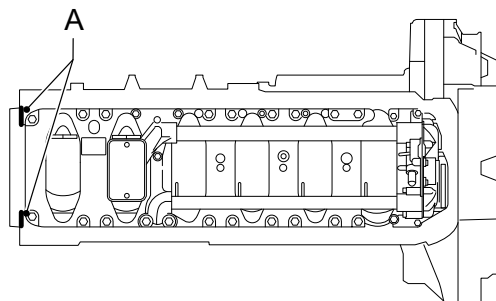
Installing oil sump

1. Clean the sealing surface of the engine with the specified cleaning agent.
2. Apply the specified sealing agent to the indicated transition areas (A) on the junction of the cylinder block and front cover.



Assemble and tighten the parts within 10 minutes after applying the sealing agent.

3. Install the oil sump with the sealing rubber and the attachment ring upright.
4. Fit and hand tighten the attachment bolts.
5. Tighten the attachment bolts in the specified sequence to the specified torque.



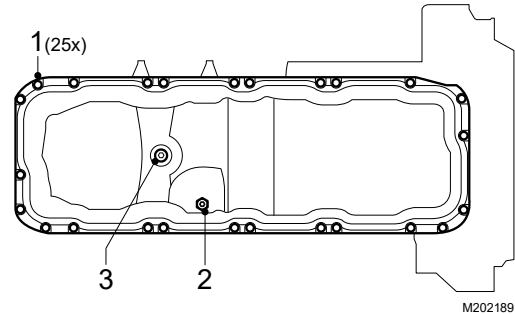
I403237



Technical data**Tightening torque, oil sump**

Attachment bolts (1) 30 Nm [266 lb-in]⁽¹⁾
 Sealing plug (3) 60 Nm [531 lb-in]⁽²⁾

- (1) Tighten crosswise, starting in the center.
 (2) Use a new copper sealing washer.



M032491 - 10.12.2018

Mounting product, oil sump

Cleaning agent
 Sealing agent

Loctite 7070
"Loctite SI 5910"

M028384 - 08.29.2018

- 1.241 install assembly air inlet pipe, inlet manifold (Inlet and exhaust element)

Technical data**Tightening torque, air inlet pipe, inlet manifold**

Air inlet pipe attachment bolts 30 Nm [266 lb-in]⁽¹⁾
 Sealing plug, fine metric thread 20 Nm [177 lb-in]
 (1) Always replace the air inlet gasket

M033246 - 03.19.2016

- 1.242 install oil module (Lubrication system)

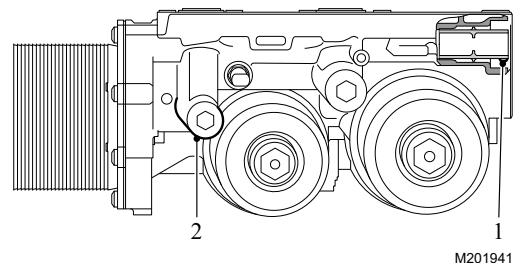
Explanation**Installing oil module**

1. Install new O-rings onto the connecting pipe and lubricate them with the specified mounting product.



- Make sure that the O-rings are not damaged during installation.

2. Install the coolant connection pipe (1) into the oil module.
3. Install the new oil module gasket set.



4. Install the oil module and tighten the attachment bolts to the specified torque.

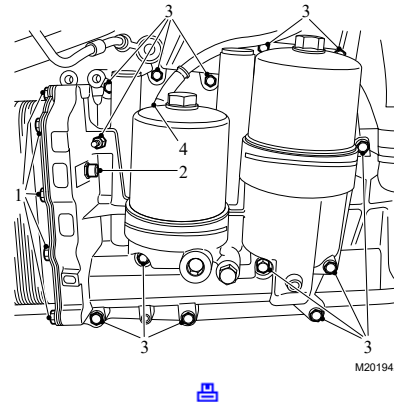
M033652 - 12.04.2015

Technical data

Tightening torque, oil module

Attachment bolts (3) 30 Nm [266 lb-in] ⁽¹⁾

(1) Always use a new oil module gasket set.



M033654 - 06.27.2013

Mounting product, sealing ring

Rubber lubricant

"P80"

M025429 - 02.21.2017

- ☐ ☐ 1.243 fixing assembly bracket, electrical system (Electrical system, engine)

Technical data

Tightening torque, assembly bracket, electrical system

Bracket attachment bolts M8

30 Nm [266 lb-in]

M036112 - 07.19.2013

- ☐ ☐ 1.244 connect temperature sensor (Lubrication system)

- ☐ ☐ 1.245 install engine

Explanation

Install engine

Remember that if any parts are removed, replace the gaskets and O-rings. **DO NOT REMOVE ANY GASKET MATERIAL WITH ANYTHING OTHER THAN SCRAPERS OR RAZOR BLADES. DO NOT USE ANY CLEANING WHEELS OR ABRASIVE MATERIALS THAT MAY ALTER MACHINING MARKS.** Check Rapido for bolt replacement guidelines. If unclear, check with the appropriate personnel for further guidance.

1. Install poly-V-belts and other accessories
 - At this time reinstall all belts and accessories that were removed during out of chassis repair, including the PCI.
2. Install rear lifting bracket

- Reinstall the lifting bracket special tool (1453180)/(1903016)



As mentioned previously, it is recommended that the valve cover be removed during this step to allow for chain clearance.

3. Engine into chassis

Securely affix the engine onto the shop hoisting device. Position the engine back into the chassis, taking care to not damage any components, wiring, or air lines. Allow the rear of the engine to rest slightly above the rear engine mounts.

Options at this point:

- Start the threads of one or more of the rear engine mount bolts in order to secure and stabilize the engine for installation of the front engine mount.
- Install the front engine mount and passenger-side brackets in order to stabilize the engine for installation of the rear engine mount bolts.



- Look for metal shavings and/or other debris, including liquids other than oil.
- The presence of debris or foreign liquids could indicate additional issues other than the original complaint.

4. Mate transmission bell housing to engine

- Once the engine is safely supported and secured, lift the transmission into place using an approved transmission jack.
- Secure the transmission onto the flywheel housing using the bell housing bolts.



- If equipped with an Allison transmission, take notice and align the torque converter mounting holes in the correct orientation, install the bolts and torque to proper specifications.
- If equipped with an Ultrashift or manual transmission, slide the clutch forward and install the clutch bolts. Torque all bolts to the flywheel using proper torque specifications.

5. Remove rear lifting bracket and transmission jack

- With the engine and transmission secured and bolted, remove the rear engine lifting bracket and the transmission jack/support.

6. Install the transmission-mounted

components and wiring

- Reconnect the electronic actuators (Eaton Ultrashift) or hydraulic slave cylinders (Eaton manual 10-speed transmission).



- Review the previously noted orientation of the clutch fork and ensure that it is reinstalled properly to prevent damage to the clutch parts.
- When installing the hydraulic slave cylinder on manual transmissions, be sure to insert the ball on the hydraulic cylinder into the socket on the bottom of the clutch fork.

7. Install exhaust pipe

- Reposition the exhaust pipe between the DOC inlet and the BPV outlet.



Always use new exhaust gaskets and V-clamps.

8. Reattach power steering lines

- Connect the power steering supply and return lines to the power steering pump.

9. Connect starter wires and chassis ground

- Securely route and secure the power and ground harnesses to the starter and reconnect the proper wires to the proper terminals.
- Reconnect the chassis ground wire to the connection point on the outside of the frame rail.

10. Install valve cover

- Reinstall the valve cover.



Use a new gasket when reinstalling the valve cover.

11. Install rear of engine components

- Reconnect the coolant lines, fuel lines (HC Doser and injector return lines), harnesses (HC Doser), and any other accessories on the rear side of the engine.



Portions of this step may not be necessary depending on which rear lifting bracket is being used.

12. Route and connect J2/OEM harness

- Route the large gray and small white engine harness connectors back toward their respective locations on the firewall.

- Reconnect the engine harnesses by pushing the locking tabs upward toward the cab windshield.
- Route the chassis grounds to their respective posts on the underside of the cab (below the harness connections mentioned above).
- Reconnect the aftertreatment harness at the rear of the engine and make all other connections at this point.
- Connect the air line at the air shutoff valve on the fuel module and the air line for the unloader sensing valve.

13. Connect fuel lines

- Reconnect the fuel supply and return lines to the fuel interface module located on the driver's side of the engine.



Ensure that the O-rings for the fuel lines are not cracked or split and the line clips are installed correctly. This will ensure that the lines will not leak fuel and also prevent air from entering the fuel system.

14. Reinstall fan blade and fan shroud with brackets

- Reinstall the fan shroud and fan on the front of the engine.

15. Reinstall radiator and cooler pac

- With the radiator/cooler pac assemblies safely supported, use the attachment bolts on the underside of the cooler pac to secure it to the chassis.
- Reinstall the upper bolts for the side supports to the cooler pac.



If equipped with a fuel cooler, connect the fuel lines at this time.

16. Connect the cold/hot side charge air cooler tubes

- Reinstall the boost tubes.



- When installing the charge air cooler pipes to the engine, be sure to use a new gasket and V-band clamp where required.

17. Install radiator hoses

- Locate and reinstall the coolant hoses from the engine coolant module to the radiator outlets. This includes the Reservoir fill line.

18. Install A/C condenser lines

- Connect the A/C condenser lines at this point, along with other A/C lines that were

disconnected.



You can connect the machine and begin the vacuum and leak test on the A/C system at this time. The vacuum and leak test takes a substantial amount of time to complete. It is recommended that other components be reinstalled during the completion of the cycles. Charging of the A/C system will be addressed in a later step.

19. Install air filter box

- Reconnect all harnesses, air lines, and support brackets for the air filter box.



Be sure to reinstall all fasteners affixing the box to the firewall.

20. Replace all necessary filters

- Depending on the type of repair performed, vehicle miles, etc., replace all required filters (potentially includes air, fuel, and oil filters).

21. Reconnect batteries

- Re-establish all battery connection points that were removed during engine removal.



Ensure that any unique/chassis-specific battery cable configurations are reinstalled in the same location from which they were removed.

22. Fill oil and coolant

- Refill the oil and coolant to their respective levels.



Oil capacities per engine type may be located within Rapido.

23. Prime fuel system

- Following the recommended Rapido procedure, prime the fuel system to eliminate air pockets.

24. Start truck

- Briefly start the engine and let it run to stabilize the oil pressure. Once the pressure is stable, shut off the engine and check the oil level. Add oil if required.
- Restart the engine and allow it to idle for 15 minutes (per fuel priming steps). During this time check all fluid systems for leaks.
- Follow the coolant bleeding procedure as outlined by Rapido to evacuate air pockets in the coolant system.

25. Install hood

- Be sure that adequate support (overhead hoist/additional manpower) is present to install the hood safely without causing personal injury or component damage.

26. Install bumper

- Once the bumper attachment bolts have been installed, ensure that all lights, sensors, etc. are reconnected.
- Depending on the model and application, this may require the assistance of an additional technician to safely maneuver the bumper into position.

27. Charge A/C system

- With the A/C recovery machine connected to the high and low side A/C lines, begin charging the A/C system.



Overcharging of the A/C system can cause component damage.

28. Bleed power steering

- Follow all OEM recommended power steering system bleeding procedures before test driving the vehicle.

29. Connect to truck using DAVIE

- Perform a DAVIE quick check to view currently active codes.
- Cal ID and CVN: Verify that all components are listed and currently valid.
- Change Injector codes: Ensure that the codes are present within DAVIE to ensure optimum engine performance.
- Software: Verify that all software is up to date and valid for the chassis.
- Engine Integration Parameters: Ensure that the customer's required specifications are applied.

30. Test drive

- Take the vehicle on a test drive to verify that the original complaint is repaired and addressed and to ensure that new issues have not developed during the repair procedure.

M055300 - 11.03.2016

 1.246 install right-hand tensioner pulley, poly-V-belt (Pulley)

Technical data

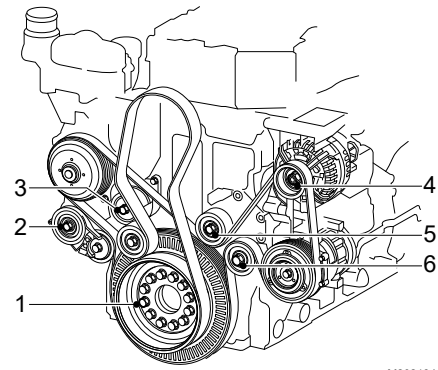
Tightening torque, right tensioner pulley, poly-V-belt



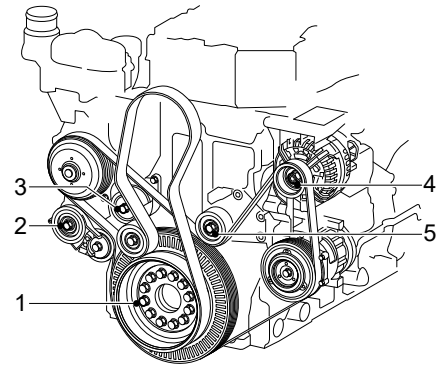
To prevent damage to the air conditioning compressor bearing, from specification week 201501 the poly-V-belt was rerouted. The high load idler pulley (6) was removed

Attachment bolt (2)

60 Nm [531 lb-in]



M202184



I403875

M032302 - 06.20.2016

1.247 install poly-V-belt 12PK (Pulley)

1.248 fixing poly-V-belt 12PK (Pulley)

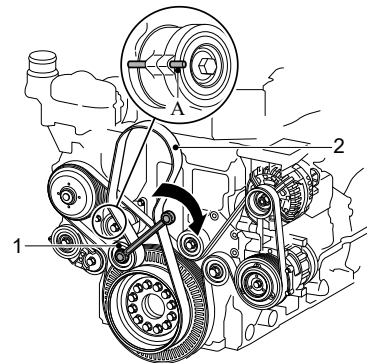
Explanation

Fixing poly-V-belt 12PK

1. Position the poly-V-belt (2) over the pulleys, and route it correctly.
2. Move the tensioner (1) against the spring tension and remove the locking pin (A).



Use only a hexagonal socket or a hexagonal ring spanner.

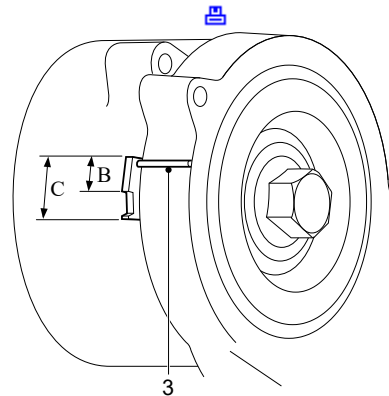


I402151

3. Make sure that the mark (3) on the tensioner arm is within range.



- A new belt must be within range (B). Otherwise the belt is routed incorrectly or outside its specification.
- A used belt must be within range (C). Otherwise the belt is routed incorrectly or outside its specification.



M202130-2



M032905 - 01.15.2015

 1.249 install poly-V-belt 8PK (Pulley)

 1.250 fixing poly-V-belt 8PK (Pulley)

Explanation

Fixing poly-V-belt 8PK

1. Position the poly-V-belt 8PK (2) over the pulleys and route it correctly.

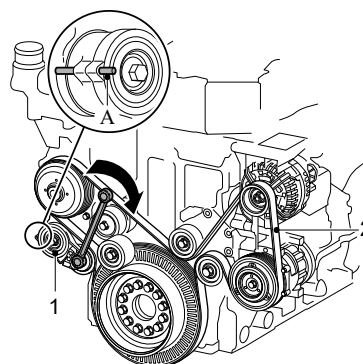


End by positioning the poly-V-belt over an idler pulley.

2. Move the tensioner (1) against the spring tension and remove the locking pin (A).



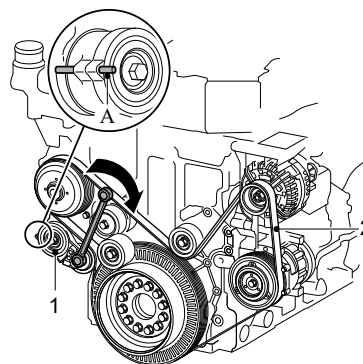
Use only a hexagonal socket or a hexagonal ring spanner.



i402152



Situation with idler pulley



i403874

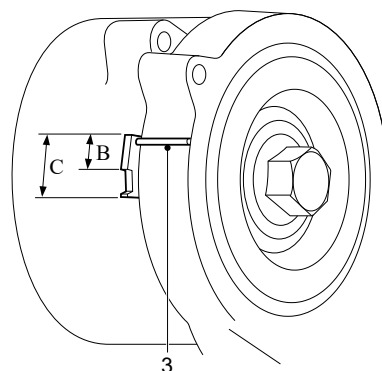


Situation without idler pulley

3. Make sure that the mark (3) on the tensioner arm is within range.



- A new belt must be within range (B). Otherwise the belt is routed incorrectly or outside its specification.
- A used belt must be within range (C). Otherwise the belt is routed incorrectly or outside its specification.



M202130-2



M050346 - 10.28.2016

 1.251 fixing bracket, fuel system (Fuel system)

Technical data

Tightening torque, bracket fuel system

Attachment bolts (M8)

30 Nm [266 lb-in]

M032445 - 09.07.2016

1.252 fixing fuel tank return pipe (Fuel system)

Explanation

Connecting quick-release coupling

- No tooling is allowed for disconnecting or connecting the quick-release coupling.

New situation

- Lubricate the O-ring with the specified mounting product.



- Always use a new O-ring.
- Make sure that both male and female quick-release couplings are clean and without damage.

- Insert the male quick-release coupling into the female coupling until it snaps itself onto the collar of the female coupling.



- Make sure that the pipes are originally routed.
- Do not press the releasing element (1).
- Replace the releasing element (1) by the c-clip (2), if:
 - it is **damaged**.
 - it is **removed from the quick-release coupling**.



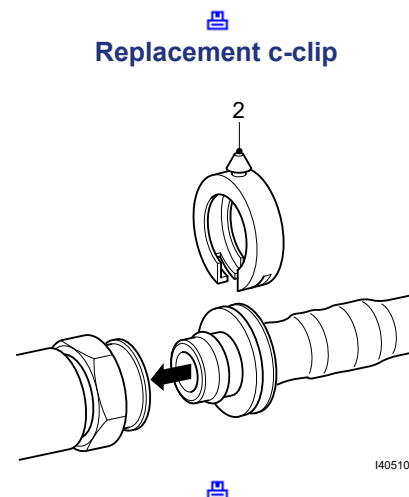
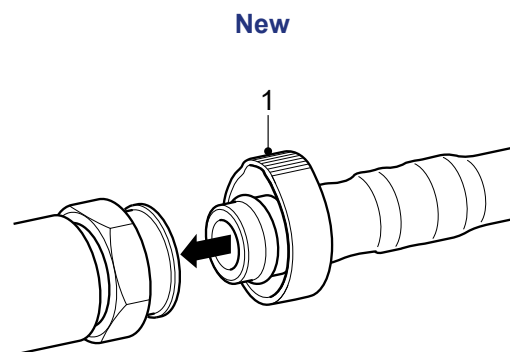
If using a c-clip (2):

- Insert the male coupling into the female coupling.
- Install the c-clip (2) to lock the connection.
 - Never reuse a c-clip (2).

- Check whether the quick-release coupling has engaged correctly by pulling it in the opposite direction. The connection must remain intact.



Replace the release element (1) by the c-clip (2) if there is an **axial** and/or **radial** play.



Old situation

1. Lubricate the O-ring with the specified mounting product.



- Always use a new O-ring.

2. Insert the male quick-release coupling into the female coupling until it snaps itself onto the collar of the female coupling.



- Do not press the release element.
- Make sure that both male and female quick-release couplings are clean and without damage.

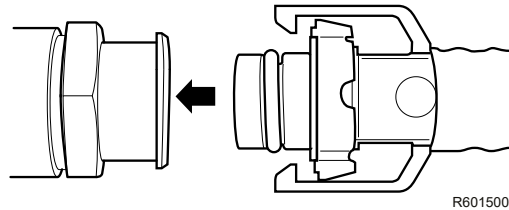


Replace the fuel pipe if the clamping force is reduced or the quick-release coupling is damaged.

- Make sure that the pipes are originally routed.

3. Check whether the quick-release coupling has engaged correctly by pulling it in the opposite direction. The connection must remain intact.

Old



M035573 - 04.05.2018

Technical data

Mounting product, O-ring

Lubricant

"Syntheso GL EP1"

M045846 - 10.28.2016

1.253 fixing fuel pipe from tank to fuel lift pump (Fuel system)

Explanation

Connecting quick-release coupling

- No tooling is allowed for disconnecting or connecting the quick-release coupling.

New situation

1. Lubricate the O-ring with the specified mounting product.

New



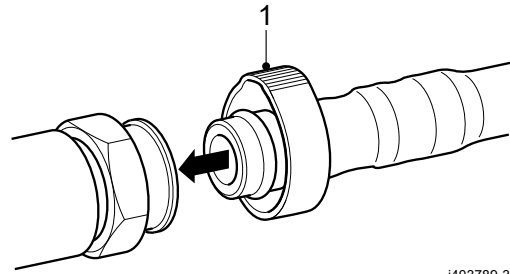
- Always use a new O-ring.
- Make sure that both male and female quick-release couplings are clean and without damage.

2. Insert the male quick-release coupling into the

female coupling until it snaps itself onto the collar of the female coupling.



- Make sure that the pipes are originally routed.
- Do not press the releasing element (1).
- Replace the releasing element (1) by the c-clip (2), if:
 - it is **damaged**.
 - it is **removed from the quick-release coupling**.



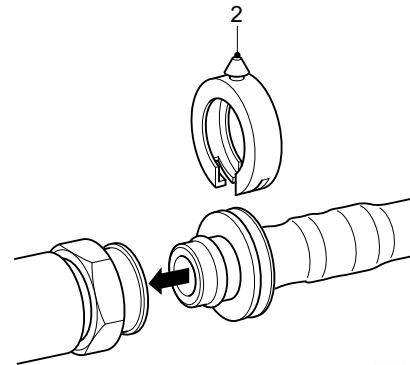
i403789-3



If using a c-clip (2):

- Insert the male coupling into the female coupling.
- Install the c-clip (2) to lock the connection.
 - Never reuse a c-clip (2).

 Replacement c-clip



i405100

3. Check whether the quick-release coupling has engaged correctly by pulling it in the opposite direction. The connection must remain intact.



Replace the release element (1) by the c-clip (2) if there is an **axial** and/or **radial** play.

Old situation

1. Lubricate the O-ring with the specified mounting product.



- Always use a new O-ring.

2. Insert the male quick-release coupling into the female coupling until it snaps itself onto the collar of the female coupling.



- Do not press the release element.
- Make sure that both male and female quick-release couplings are clean and without damage.

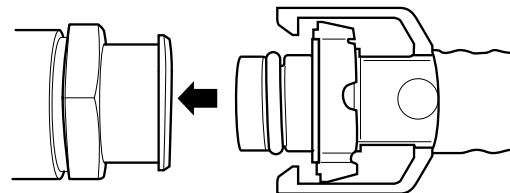


Replace the fuel pipe if the clamping force is reduced or the quick-release coupling is damaged.

- Make sure that the pipes are originally routed.

3. Check whether the quick-release coupling has engaged correctly by pulling it in the opposite direction. The connection must remain intact.

Old



R601500

Technical data

Mounting product, O-ring

Lubricant

["Syntheso GL EP1"](#)

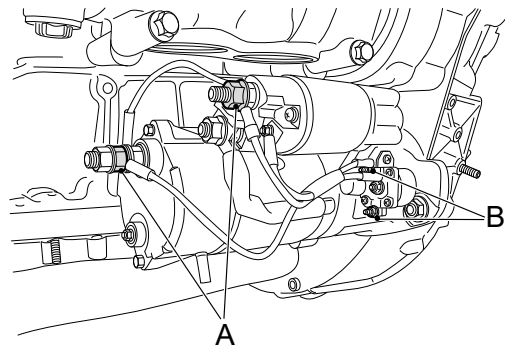
M045846 - 10.28.2016

- 1.254 install starter motor (Alternator and starter motor)

Technical data

Tightening torque, starter motor

Attachment nut (1)	4 Nm [36 lb-in]
Attachment nuts and bolts (2)	79 Nm [58 lb-ft]
Attachment nut (3)	25 Nm [221 lb-in]



M201587



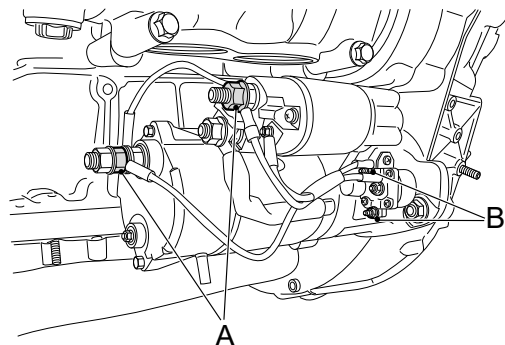
M021697 - 01.16.2013

- 1.255 connect starter motor (Alternator and starter motor)

Technical data

Tightening torque, starter motor

Attachment nut (1)	4 Nm [36 lb-in]
Attachment nuts and bolts (2)	79 Nm [58 lb-ft]
Attachment nut (3)	25 Nm [221 lb-in]



M201587



M021697 - 01.16.2013

- 1.256 fixing coolant hose, radiator outlet 01

- 1.257 fixing coolant hose, radiator supply 01
connect battery clamp, negative pole

Explanation

Warning, battery clamp and negative terminal



- Do not disconnect the vehicle batteries until the DEF dosing system has completed the purge cycle.
- Before beginning to remove and/or disconnect any components, wait at least 5 minutes after the key switch is turned OFF for the aftertreatment DEF dosing system to purge DEF from the system.
- The purge cycle is an automatic process and does not require active intervention. The aftertreatment DEF dosing unit creates an audible pumping noise during the purging process.



- Electrical shock hazard: Never disconnect the battery clamp when the engine is running.
- Disconnecting the battery clamps while the engine is running may result in death, personal injury, or equipment damage from electrical arcing or damage to electronic components.
- Turn off the engine and place the ignition switch in the OFF position before disconnecting the battery clamps.
- Do not place any tools or other materials on top of or close to the batteries. This can cause a dangerous high-current short circuit and, in the worst case, a battery explosion. Keep all objects away from the battery terminals.
- Always break the contact between the battery clamp and the negative terminal before working on the vehicle. Working on a vehicle while the battery is connected may result in electrical injury or damage.
- Always disconnect the battery at the negative terminal when performing service procedures.



- Battery acid can cause chemical burns.
- If you come into contact with battery acid: flush your skin with water and/or apply baking soda or lime to help neutralize the acid.
- If battery acid comes into contact with the eyes, flush immediately with water and seek medical attention.
- Wear protective clothing when handling any part of the battery.

M024327 - 05.03.2010

1.259 install oil sealing plug, fine metric thread (Lubrication system)

Explanation

Installing sealing plug oil sump

1. Fit the sealing plug with a new copper sealing washer and tighten it to the specified torque.

M032183 - 11.21.2012

Technical data

Tightening torque, sealing plug oil sump

Sealing plug

60 Nm [531 lb-in]⁽¹⁾

(1) Fit a new copper sealing washer.

 1.260 remove filler cap, oil filling pipe (Lubrication system)

 1.261 fill oil engine

Explanation

Warning, Lubricating Oil



- Lubricating oil can cause skin irritation or skin injury.
- To prevent skin injury, avoid unnecessary contact with lubricating oil.
- Wear protective clothing, eyewear and gloves.



- Run the engine at idle speed for at least one minute, directly after maintenance or repairs of the lubrication system, to allow oil to reach all necessary components.
- Increasing the engine speed directly after maintenance or repairs of the lubrication system can cause damage to various engine components.
- Make sure that all consumers are switched off and the vehicle is in neutral gear position before starting the engine.
- Check if the red oil pressure warning in the instrument panel disappears within ten seconds; if not, key off the engine and investigate the problem.

M032087 - 01.16.2013

Filling engine oil

1. Fill the engine with the specified quantity and grade of engine oil.



- After the engine has been filled with the specified quantity of engine oil, the mechanical dipstick must indicate a level between middle and maximum levels.
- Depending on the vehicle configuration (engine inclination) the mechanical dipstick may have a small deviation.
- Replace the oil filter elements if the engine has been filled with new engine oil after repair.

M032187 - 10.09.2017

Technical data

Specification, engine oil

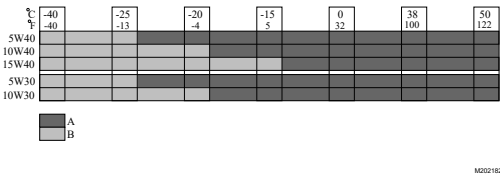
Oil specification

API CJ-4/CK-4 ⁽¹⁾⁽²⁾

(1) See table below for permitted oil viscosity ratings in relation to the ambient temperature

(2) The primary PACCAR recommendation is for the use of 10W30 multigrade lubricating oil for normal operation at ambient temperatures above -15°C [5°F]. For ambient temperatures below -15°C [5°F], SAE 5W30 may be used, provided it meets API CJ-4 oil specifications and biodiesel or biodiesel blended fuel is not used as fuel for the engine. Using a multigrade oil

helps improve engine cranking in low temperature conditions,
reduces deposit formation and increases engine durability.



- A Permitted temperature range
- B Permitted temperature range if the engine is equipped with an active oil sump heater that is used before engine start

Initial oil fill from factory: API CJ-4 10W30

M021451 - 02.23.2017

Filling capacities lubrication system

- Filling capacity for service, including oil filter approximately 40 liters [42.3 quarts]
- Filling capacity, first filling approximately 46 liters [48.6 quarts]⁽¹⁾
- Range of minimum - maximum level approximately 9 liters [9.5 quarts]
- (1) Filling capacity after engine overhaul.

M032190 - 11.13.2014

- 1.262 install filler cap, oil filling pipe (Lubrication system)
- 1.263 install dipstick, engine
- 1.264 fill oil turbocharger with VTG (Inlet and exhaust element)

Explanation

Filling oil, turbocharger



- The turbocharger bearing housing must be filled with engine oil after replacement.
- Only the procedure below guarantees that oil reaches the turbine shaft bearing.

- Check the engine oil level and, if necessary, refill with engine oil.
- Disconnect the crankshaft and camshaft sensor.
- Crank the engine for 60 seconds.

Now the turbocharger is filled with engine oil.



4. Wait for 300 seconds to cool down the starter motor.
5. Connect the crankshaft and camshaft sensor.

M032489 - 09.24.2015

1.265 fill coolant (Cooling system, chassis)

Explanation

Warning, coolant



- Coolant is toxic. Avoid prolonged or repeated contact with the skin. In case of contact, immediately wash the skin with soap and water. In case of eye contact, rinse with plenty of water. Do not ingest. If swallowed, seek immediate medical attention. Do not induce vomiting.
- Do not remove the radiator cap from a hot or running engine. When the coolant is hot, there is overpressure in the cooling system. It can cause scalding coolant to spray out and cause serious personal injury. Carefully remove the filler cap to release the overpressure.
If the engine has been operated within the last 30 minutes, be very careful when removing the radiator cap. Protect face, hands, and arms against escaping fluid and steam by covering the cap with a large, thick rag while carefully removing it.
- Handle coolant and antifreeze carefully. Ethylene glycol antifreeze is poisonous. Store it in the original fluid container only, and always keep it out of the reach of children. • Also, never remove the cap on the surge tank while the engine is still hot. Wait until the coolant temperature is below 50°C (120°F). Scalding steam and fluid under pressure may escape and cause serious personal injuries.



- In order to avoid damaging the engine block, do not fill up a warm engine with coolant.



Coolant is harmful to the environment. Unused coolant must be stored as a toxic hazardous substance in leak-proof containers. Used coolant must be processed as industrial chemical waste. Please follow HAZMAT guidelines both with used and unused coolants.

M024408 - 03.07.2013

Technical data

Specification, coolant



Coolant is a toxic fluid. Protect your skin and eyes. Coolant is harmful to the environment; after use, it must be processed as chemical waste.

Coolant is a mixture of antifreeze and water that is used in the cooling system to protect the system from freezing, corrosion, and cavitation.



The cooling system should only be refilled with extended life coolant (ELC) pre-diluted 50/50 with water.

Coolant suppliers

The table below lists the current suppliers that meet the ASTM D6210 standard specification and are allowed to be used in PACCAR engines.

Do not fill the cooling system with coolants other than those specified in this overview.

Brand Name	Supplier
Extended Life Coolant	TRP
Delo ELC	Chevron
Rotella Ultra ELC	Shell
ELC	Texaco
Final Charge	Old World

M028492 - 04.08.2010

1.266 bleed cooling system (Cooling system, chassis)

Explanation

Filling and bleeding cooling system

1. Set the cabin heater to the maximum temperature.
2. Fill the cooling system with the specified coolant.
3. Run the engine at an increased speed (n = 1200 rpm) for at least three minutes to bleed the cooling system



If a fuel injection pipe has been reused during repair:

- Visually check the fuel injection pipe connections for leakage during:
 - Idling
 - 1200 rpm



Immediately stop the engine if fuel leakage occurs and replace the leaking fuel injection pipe.

4. Check and top up the coolant level during bleeding.



Top up until the coolant level stabilizes at the maximum indicator.

5. Check that both hoses connected to the cabin heater start to warm up.

6. Switch off the engine.



Make sure that the filler cap is installed.

M037767 - 05.08.2017

 1.267 bleed (Fuel system)

Explanation

Warning, Fuel System



- **Eye contact:** Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Consult a doctor.
- **Skin contact:** Wash off immediately with plenty of water. If symptoms persist, consult a doctor.
- **Inhalation:** Get some fresh air. If symptoms persist, consult a doctor.
- **Ingestion:** Rinse mouth with water and then drink plenty of water. Do not induce vomiting. Consult a doctor.



- Fuel vapors and spills are potential fire hazards.
- When opening a fuel system, fuel can escape. Collect the fuel during servicing and dispose of it properly to avoid the risk of fire.
- Mixing other fuels, such as gasoline, alcohol or gasohol with diesel can produce an explosive mixture.



To avoid injury from fuel while performing service on any fuel-system-related component(s):

- Prevent fuel from leaking or dripping onto the starter motor.
- Check the fuel components for leakage very carefully.
- Clean spilled or leaked fuel.
- Keep people who are not directly involved in the servicing away from the immediate area.
- Wear protective clothing (including face shield, insulated gloves and apron).
- Keep the work area well ventilated to prevent build-up of volatile fuel vapors.
- Keep all potential ignition sources away from the fuel. This includes: excessive heat, open flames, cigarettes, sparks and electrical sources.



- Do not touch any of the fluoroelastomer seals or O-rings if they have been exposed to a temperature of 315°C or higher. The material of this product does not burn but decomposes into a charred, black, sticky substance. This decomposition may contain hydrofluoric acid. This is very aggressive and difficult to remove once it has contaminated the skin. Use PVC or rubber gloves until the decomposed material has been identified and/or removed. If the substance makes contact with the skin, contact a doctor immediately.



- Dirt or debris in the fuel system can lead to severe engine damage.
- Blocking and/or clamping the fuel pipes can lead to severe engine damage.
- Never block or plug the common rail release valve output, as this can lead to severe rail and common rail pressure release valve damage.
- Immediately plug the openings of the fuel system.
- Clean the area before performing maintenance.

- **Cover the crankcase pressure sensor and make sure that it cannot come in contact with any fuel or fuel vapors.**

M035658 - 01.09.2017

Prime fuel system

After performing fuel system service, prime the fuel system to remove air from fuel system lines and components. Three priming options are available; however, hand priming should only be performed as a last resort when recommended tooling is not available. After priming, and before releasing the truck, check the dash for residual DTCs.

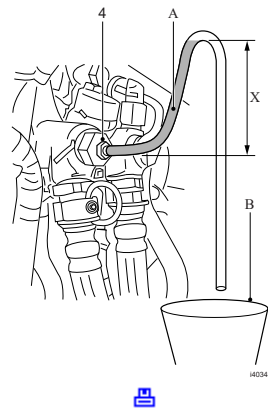
1. ["Priming with DAVCO Shop Pro MX 40/80 \(Base Unit\)"](#)
2. ["Priming with Mityvac MV7430"](#)
3. ["Hand priming"](#)

M057901 - 03.07.2017

Technical data

Tightening torque, breather plug

Bleeding nipple (4)	6 Nm [53 lb-in]
Bleeding assembly	18 Nm [159 lb-in]



M040565 - 06.06.2014

 1.268 check leakage (Fuel system)

Explanation

Warning, Fuel System



- **Eye contact:** Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Consult a doctor.
- **Skin contact:** Wash off immediately with plenty of water. If symptoms persist, consult a doctor.
- **Inhalation:** Get some fresh air. If symptoms persist, consult a doctor.
- **Ingestion:** Rinse mouth with water and then drink plenty of water. Do not induce vomiting. Consult a doctor.



- Fuel vapors and spills are potential fire hazards.
- When opening a fuel system, fuel can escape. Collect the fuel during servicing and dispose of it properly to avoid the risk of fire.
- Mixing other fuels, such as gasoline, alcohol or gasohol with diesel can produce an explosive mixture.



To avoid injury from fuel while performing service on any fuel-system-related component(s):

- Prevent fuel from leaking or dripping onto the starter motor.
- Check the fuel components for leakage very carefully.
- Clean spilled or leaked fuel.
- Keep people who are not directly involved in the servicing away from the immediate area.
- Wear protective clothing (including face shield, insulated gloves and apron).
- Keep the work area well ventilated to prevent build-up of volatile fuel vapors.
- Keep all potential ignition sources away from the fuel. This includes: excessive heat, open flames, cigarettes, sparks and electrical sources.



- Do not touch any of the fluoroelastomer seals or O-rings if they have been exposed to a temperature of 315°C or higher. The material of this product does not burn but decomposes into a charred, black, sticky substance. This decomposition may contain hydrofluoric acid. This is very aggressive and difficult to remove once it has contaminated the skin. Use PVC or rubber gloves until the decomposed material has been identified and/or removed. If the substance makes contact with the skin, contact a doctor immediately.



- Dirt or debris in the fuel system can lead to severe engine damage.
- Blocking and/or clamping the fuel pipes can lead to severe engine damage.
- Never block or plug the common rail release valve output, as this can lead to severe rail and common rail pressure release valve damage.
- Immediately plug the openings of the fuel system.
- Clean the area before performing maintenance.
- Cover the crankcase pressure sensor and make sure that it cannot come in contact with any fuel or fuel vapors.

M035658 - 01.09.2017

 1.269 check oil level engine

Explanation

Warning, Lubricating Oil



- Lubricating oil can cause skin irritation or skin injury.
- To prevent skin injury, avoid unnecessary contact with lubricating oil.
- Wear protective clothing, eyewear and gloves.



- Run the engine at idle speed for at least one minute, directly after maintenance or repairs of the lubrication system, to allow oil to reach all necessary components.
- Increasing the engine speed directly after maintenance or repairs of the lubrication system can cause damage to various engine components.
- Make sure that all consumers are switched off and the vehicle is in neutral gear position before starting the engine.

- Check if the red oil pressure warning in the instrument panel disappears within ten seconds; if not, key off the engine and investigate the problem.

M032087 - 01.16.2013

Checking oil level engine

1. Make sure that the vehicle stands on a flat and level surface.
2. Wait at least 5 minutes before checking the engine oil level of a hot engine.
3. Pull the dipstick out of the dipstick tube.
4. Wipe the dipstick clean with a lint-free cloth.
5. Put the dipstick back into the dipstick tube.
6. Pull the dipstick out again and check the oil level.
7. If necessary, add oil until it reaches the maximum level.

M032189 - 12.04.2012

Technical data

Filling capacities lubrication system

Filling capacity for service, including oil filter	approximately 40 liters [42.3 quarts]
Filling capacity, first filling	approximately 46 liters [48.6 quarts] ⁽¹⁾
Range of minimum - maximum level	approximately 9 liters [9.5 quarts]
(1) Filling capacity after engine overhaul.	

M032190 - 11.13.2014

1.270 major inspection after repair

This information applies exclusively to the entered chassis number or the selected engine type. Please take into account that this information may change daily. Therefore the provided information is only valid on 01-19-2019. You cannot derive any rights from the information provided with respect to vehicles and/or components of another series, with another chassis number, and/or of another date. (FJ398348 / MX_EPA13)