# SERVICE MANUAL

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## F5
## Tier 4B (final) and Stage IV
## Engine

*See the following page for engine model numbers*

**Part number 47730922**
1st edition English
June 2015

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# Safety rules

## Personal safety



This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible death or injury.

Throughout this manual and on machine decals, you will find the signal words DANGER, WARNING, and CAUTION followed by special instructions. These precautions are intended for the personal safety of you and those working with you.

Read and understand all the safety messages in this manual before you operate or service the machine.

DANGER indicates a hazardous situation which, if not avoided, will result in death or serious injury. The color associated with DANGER is RED.

WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury. The color associated with WARNING is ORANGE.

CAUTION, used with the safety alert symbol, indicates a hazardous situation which, if not avoided, could result in minor or moderate injury. The color associated with CAUTION is YELLOW.

**FAILURE TO FOLLOW DANGER, WARNING, AND CAUTION MESSAGES COULD RESULT IN DEATH OR SERIOUS INJURY.**

## Machine safety

***NOTICE:*** *Notice indicates a situation which, if not avoided, could result in machine or property damage. The color associated with Notice is BLUE.*

Throughout this manual you will find the signal word Notice followed by special instructions to prevent machine or property damage. The word Notice is used to address practices not related to personal safety.

## Information

***NOTE:*** *Note indicates additional information which clarifies steps, procedures, or other information in this manual.*

Throughout this manual you will find the word Note followed by additional information about a step, procedure, or other information in the manual. The word Note is not intended to address personal safety or property damage.

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# Engine - General specification

| Specifications | |
|---|---|
| Cycle | 4 stroke |
| Fuel type | Diesel |
| Aspiration | Turbocharged after-cooled |
| Type of combustion | Direct injection |
| Number of cylinders | 4 |
| Cylinder orientation | In-line |
| Number of valves per cylinder | 2 |
| Bore | **99 mm** (**3.90 in**) |
| Stroke | **110 mm** (**4.33 in**) |
| Displacement | **3.4 l** (**207 in³**) |
| Compression ratio | 17.5:1 |
| Firing order | 1, 3, 4, 2 |
| Maximum power rating | **55 kW** (**75 Hp**) **@ 2300 RPM** |
| Engine speed | |
| Low idle | **1125 - 1175 RPM** |
| High idle | **2475 - 2525 RPM** |

# Engine - General specification

| |
|---|
| F5BFL413A*B001 |
| F5BFL413A*B003 |
| F5BFL413A*B007 |
| F5BFL413A*B009 |
| F5BFL413D*B002 |
| F5BFL413D*B003 |
| F5BFL413F*B002 |
| F5BFL413F*B003 |
| F5GFL413A*B003 |
| F5GFL413A*B004 |
| F5GFL413A*B006 |
| F5GFL413A*B007 |
| F5GFL413A*B012 |
| F5GFL413A*B013 |

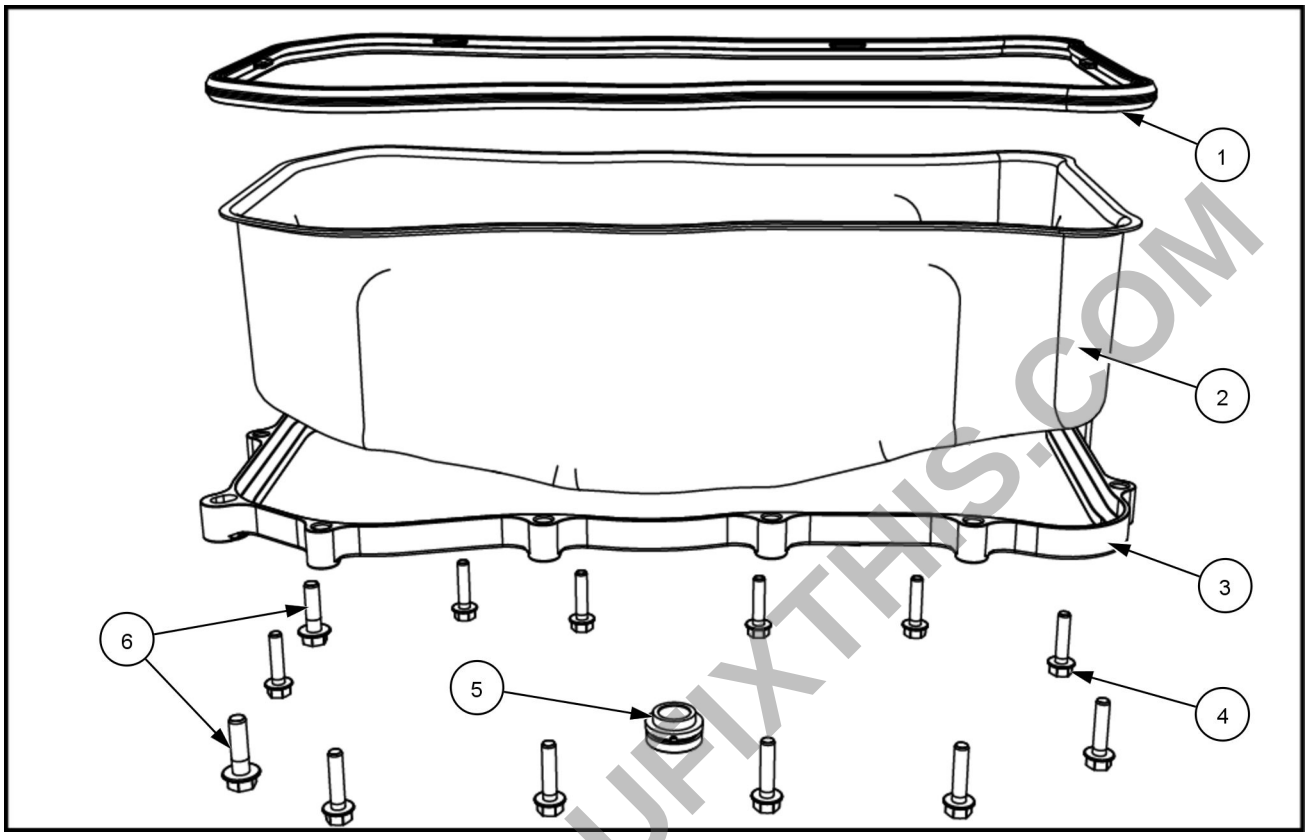
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| Compression ratio | 17.5:1 |
| Firing order | 1, 3, 4, 2 |

# Engine - Service limits

| Timing | |
|---|---|
| Intake | |
| - Start before Top Dead Center (TDC) | **19 °** |
| - End after Bottom Dead Center (BDC) | **37 °** |
| Exhaust | |


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# Engine oil pan - Exploded view




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**(1)** Oil pan gasket
**(2)** Oil pan
**(3)** Oil pan retaining plate
**(4)** M8 x 35 bolts
**(5)** Drain plug
**(6)** M10 x 35 bolts

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# Torque - Minimum tightening torques for normal assembly

## METRIC NON-FLANGED HARDWARE

| NOM. SIZE | CLASS 8.8 BOLT and CLASS 8 NUT | | CLASS 10.9 BOLT and CLASS 10 NUT | | LOCKNUT CL.8 W/CL8.8 BOLT | LOCKNUT CL.10 W/CL10.9 BOLT |
|---|---|---|---|---|---|---|
| | UNPLATED | PLATED W/ZnCr | UNPLATED | PLATED W/ZnCr | | |
| M4 | 2.2 N·m (19 lb in) | 2.9 N·m (26 lb in) | 3.2 N·m (28 lb in) | 4.2 N·m (37 lb in) | 2 N·m (18 lb in) | 2.9 N·m (26 lb in) |
| M5 | 4.5 N·m (40 lb in) | 5.9 N·m (52 lb in) | 6.4 N·m (57 lb in) | 8.5 N·m (75 lb in) | 4 N·m (36 lb in) | 5.8 N·m (51 lb in) |
| M6 | 7.5 N·m (66 lb in) | 10 N·m (89 lb in) | 11 N·m (96 lb in) | 15 N·m (128 lb in) | 6.8 N·m (60 lb in) | 10 N·m (89 lb in) |
| M8 | 18 N·m (163 lb in) | 25 N·m (217 lb in) | 26 N·m (234 lb in) | 35 N·m (311 lb in) | 17 N·m (151 lb in) | 24 N·m (212 lb in) |
| M10 | 37 N·m (27 lb ft) | 49 N·m (36 lb ft) | 52 N·m (38 lb ft) | 70 N·m (51 lb ft) | 33 N·m (25 lb ft) | 48 N·m (35 lb ft) |
| M12 | 64 N·m (47 lb ft) | 85 N·m (63 lb ft) | 91 N·m (67 lb ft) | 121 N·m (90 lb ft) | 58 N·m (43 lb ft) | 83 N·m (61 lb ft) |
| M16 | 158 N·m (116 lb ft) | 210 N·m (155 lb ft) | 225 N·m (166 lb ft) | 301 N·m (222 lb ft) | 143 N·m (106 lb ft) | 205 N·m (151 lb ft) |
| M20 | 319 N·m (235 lb ft) | 425 N·m (313 lb ft) | 440 N·m (325 lb ft) | 587 N·m (433 lb ft) | 290 N·m (214 lb ft) | 400 N·m (295 lb ft) |
| M24 | 551 N·m (410 lb ft) | 735 N·m (500 lb ft) | 762 N·m (560 lb ft) | 1016 N·m (750 lb ft) | 501 N·m (370 lb ft) | 693 N·m (510 lb ft) |

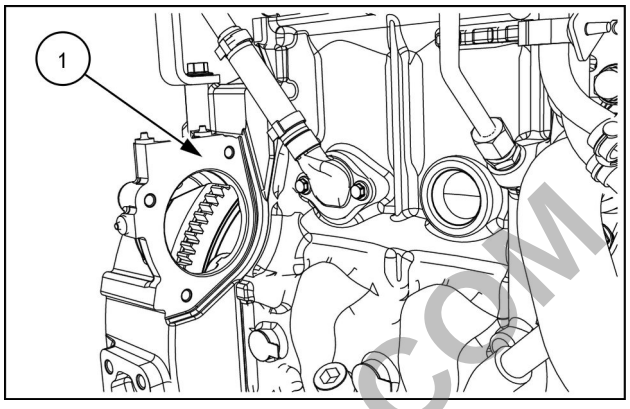
***NOTE:*** *M4 through M8 hardware torque specifications are shown in pound-inches. M10 through M24 hardware torque specifications are shown in pound-feet.*

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# Engine flywheel - Remove

1. Install the starter opening plate **380000988** to the starter flange **(1)** on the flywheel housing.
2. Install tool **380000732** in the starter opening plate to lock the flywheel rotation.

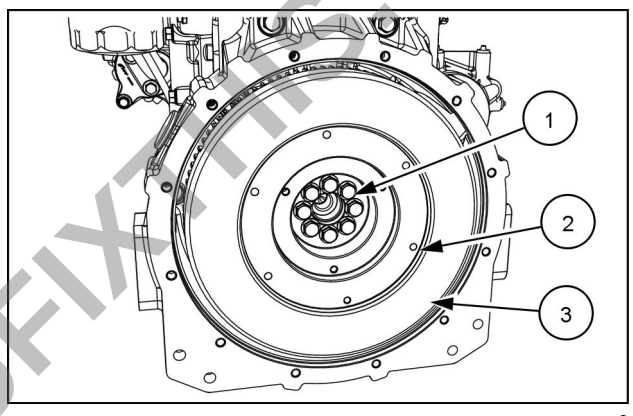



NHIL14ENG0619AA 1

3. Loosen the flywheel mounting bolts **(1)**.

***NOTICE:*** *Do not remove the bolts at this point.*

4. Install two medium length bolts into the threaded holes **(2)** in order to attach a lifting device.
5. Remove two mounting bolts **(1)**.
6. Install guide pins in place of the mounting bolts.
7. Attach a suitable lifting device to the medium length bolts.
8. Remove the remaining mounting bolts.
9. Slide the flywheel along the guide pins.
10. Remove the flywheel **(3)** from the engine.




NHIL14ENG0620AA 2

**Next operation:**
**Engine flywheel - Install (10.103)**

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# Fuel injection system - Troubleshooting

***NOTE:*** *If the rail pressure sensor B-9004 is replaced, it is necessary to perform the Replacement of the Rail Pressure sensor - Reset ECU Data with the Electronic Service Tool (EST) before you return the machine to service. See* ***Common rail pressure sensor - Configure - Reset ECU data (Rail pressure sensor) (55.010)****, if necessary.*

***NOTE:*** *If the Pressure Relief Valve (PRV) is replaced, it is necessary to perform the Replacement of the Rail Pressure Relief Valve (PRV) - Reset ECU Data with the Electronic Service Tool (EST) before you return the machine to service. See* ***Common rail Relief valve - Configure - Reset ECU data (10.218)****, if necessary.*

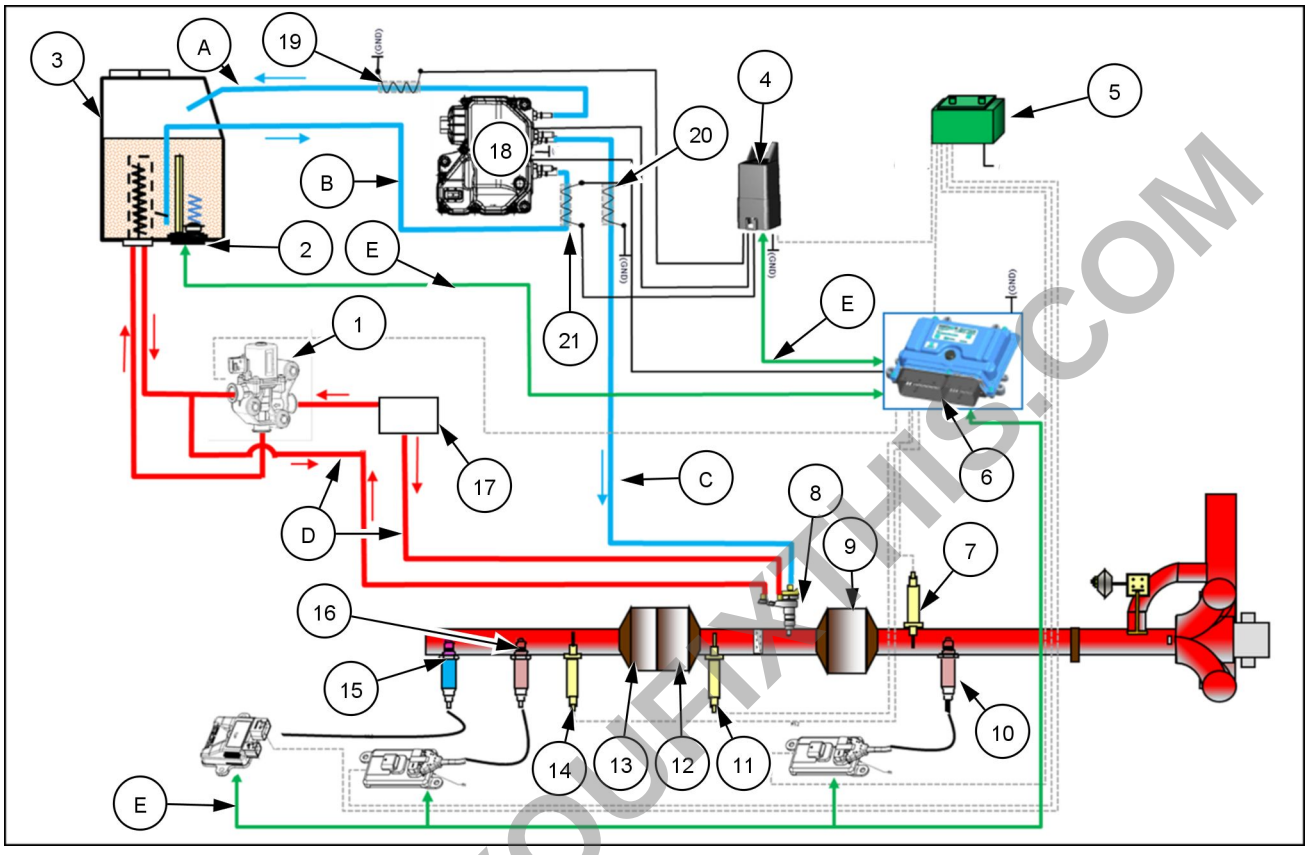
***NOTE:*** *If a fuel injector is replaced, a new IMA code must be programmed. The IMA code may be hidden under the paint on the fuel injector. For more information regarding programming IMA codes, see* ***Fuel injectors - Configure - IMA codes (10.218)****.*

| Problem | Possible Cause | Correction |
|---|---|---|
| **Dark, hazy fuel color** | Poor fuel quality or contamination. Hazy looking fuel typically is a sign of water contamination. Dark fuel is usually indicative of oxidation, possibly from being stored for too long, and is a far more severe stage of diesel fuel contamination. | 1. Drain the fuel tank and replace with new diesel fuel. |
| **Diesel fuel leakage** | Loose or improperly connected fittings, damaged seals or damaged fuel lines. Leakage from fuel filters. | 1. Inspect all hoses, clamps and fittings. If any fittings or clamps are loose or improperly installed, repair as necessary.<br>2. Inspect all fuel filters for leakage. If the filter is damaged or there is leakage from the seal, replace the failed fuel filter.<br>3. Inspect all fuel lines for leakage or damage. If there is any leakage or damage present, repair as necessary.<br>4. Inspect the fuel tank for damage or corrosion. If there is any failures found, repair or replace as necessary.<br>5. Inspect all fuel system components for diesel fuel leakage. If any leakages are present, repair or replace as necessary. |
| **Low fuel system pressure** | Low fuel system pressure can be caused by clogged fuel filters, a faulty electric lift pump (if applicable), a faulty mechanical fuel pump, a faulty fuel metering unit, or leakages present in the system. | 1. Perform a fuel system pressure test to verify the low pressure condition. The fuel pressure at the main fuel filter, after the mechanical gear pump, should be approximately **5.0 bar** (**72.5 psi**). If the pressure is too low, continue to troubleshoot the low pressure side of the fuel system to isolate the failed component. If the pressure is not too low, continue to Step 2.<br>2. Use the Electronic Service Tool (EST) to check for active fault codes related to the fuel metering unit. If any faults are active, diagnose them first and then continue troubleshooting the fuel system. |
| **Fuel system pressure too high** | Too high fuel pressure can be caused by a faulty fuel metering unit, a stuck closed pressure relief valve, or a faulty rail pressure sensor. | 1. Check the operation of the fuel metering, pressure relief valve and the rail pressure sensor. Use the appropriate section of the engine service manual, if necessary. Repair or replace as necessary. |

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# Selective Catalytic Reduction (SCR) exhaust treatment - Component diagram




NHIL15ENG0121FA 1

| | | | | |
|---|---|---|---|---|
| **(A)** Diesel Exhaust Fluid (DEF)/AdBlue® back flow line | **(B)** Suction line | **(C)** Pressure line | **(D)** Coolant line flow | **(E)** Controller Area Network (CAN) signal |

**(1)** Coolant control valve
**(2)** DEF/AdBlue® level and temperature sensor with quality sensor
**(3)** Tank
**(4)** Heater Control Unit (HCU)
**(5)** Battery
**(6)** Engine Control Unit (ECU)
**(7)** Exhaust gas temperature Diesel Oxidation Catalyst (DOC) upstream temperature sensor
**(8)** DEF/AdBlue® dosing module (injector)
**(9)** Diesel Oxidation Catalyst (DOC)
**(10)** Upstream NOx sensor
**(11)** Selective Catalytic Reduction (SCR) upstream temperature sensor
**(12)** SCR muffler
**(13)** Clean-up Catalyst (CUC), internal to the SCR muffler
**(14)** SCR downstream temperature sensor
**(15)** NH3 sensor
**(16)** Downstream NOx sensor
**(17)** Engine block
**(18)** Supply module
**(19)** Back flow line heater
**(20)** Pressure line heater
**(21)** Suction line heater

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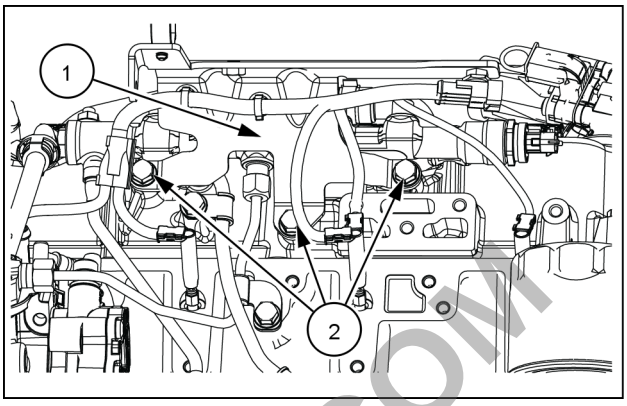
[55.202] Cold start aid ..... 55.7
[55.301] Alternator ..... 55.8
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[55.989] Exhaust Gas Recirculation (EGR) electrical system ..... 55.10

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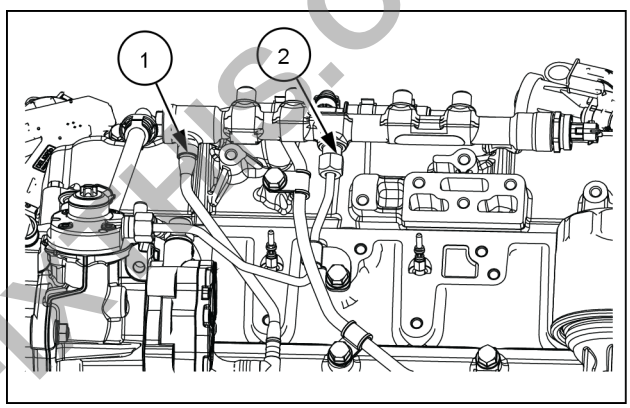
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11. Remove the three bolts **(2)** from the main connector harness bracket.
12. Remove the main connector harness bracket **(1)**.



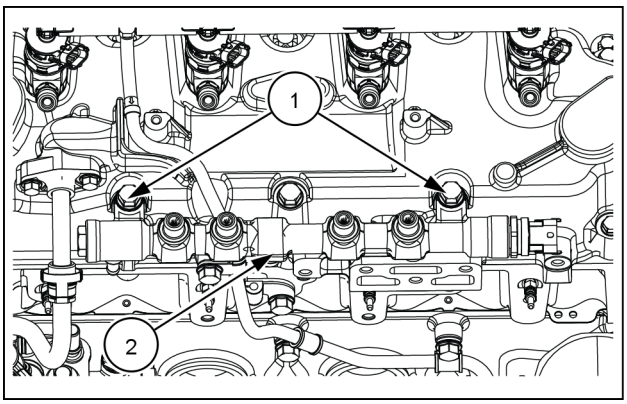

NHIL14ENG1068AA 8

13. Remove the fuel return line **(1)** from the common rail.
14. Remove the high pressure supply line **(2)** from the common rail.



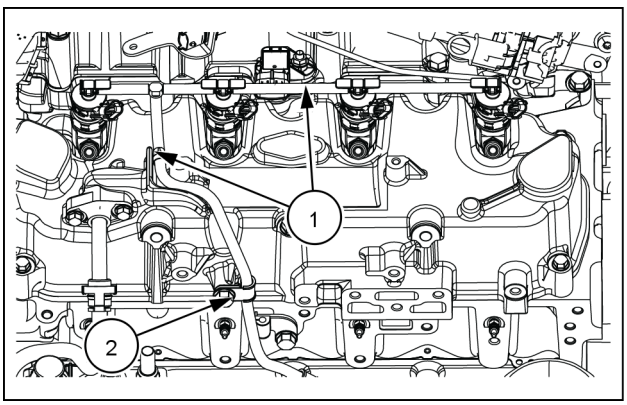

NHIL14ENG1069AA 9

15. Remove the two bolts **(1)** from the common rail.
16. Remove the common rail **(2)**.




NHIL14ENG1070BA 10

17. Remove the clamps **(2)** from the fuel return line.
18. Remove the fuel return lines **(1)**.

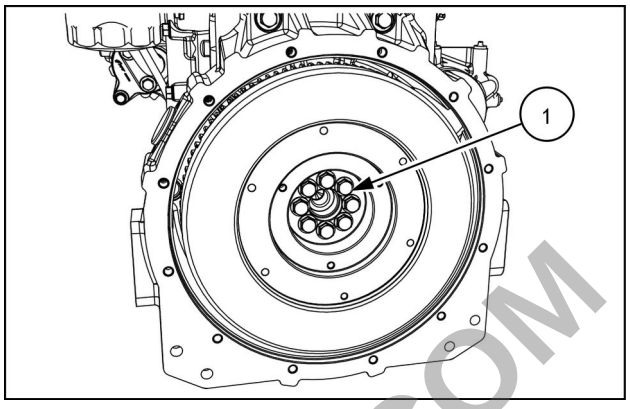



NHIL14ENG1071BA 11

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7. Torque the flywheel mounting bolts **(1)** in two stages:
   1. Stage 1: **25 - 35 N·m** (**18 - 26 lb ft**)
   2. Stage 2: Turn an additional **90 °**




NHIL14ENG0620AA 5

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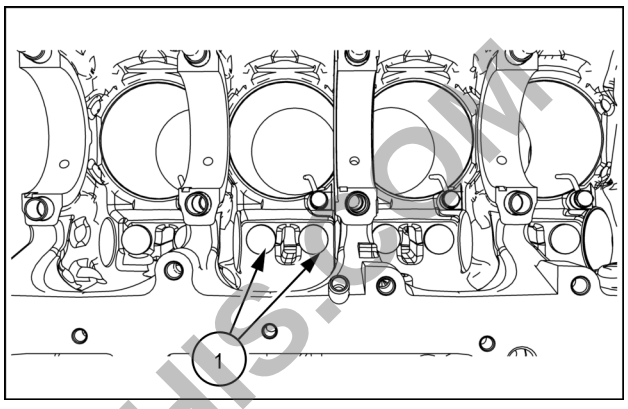

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# Camshaft Tappets - Remove

**Prior operation:**
**Camshaft - Remove (10.106)**

***NOTE:*** *Mark the location of the tappets to ensure the same position during installation.*

1. Remove the tappets **(1)** from the bottom side of the engine block.




NHIL14ENG0645AA 1

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### Turbocharger and lines - 250


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Turbocharger

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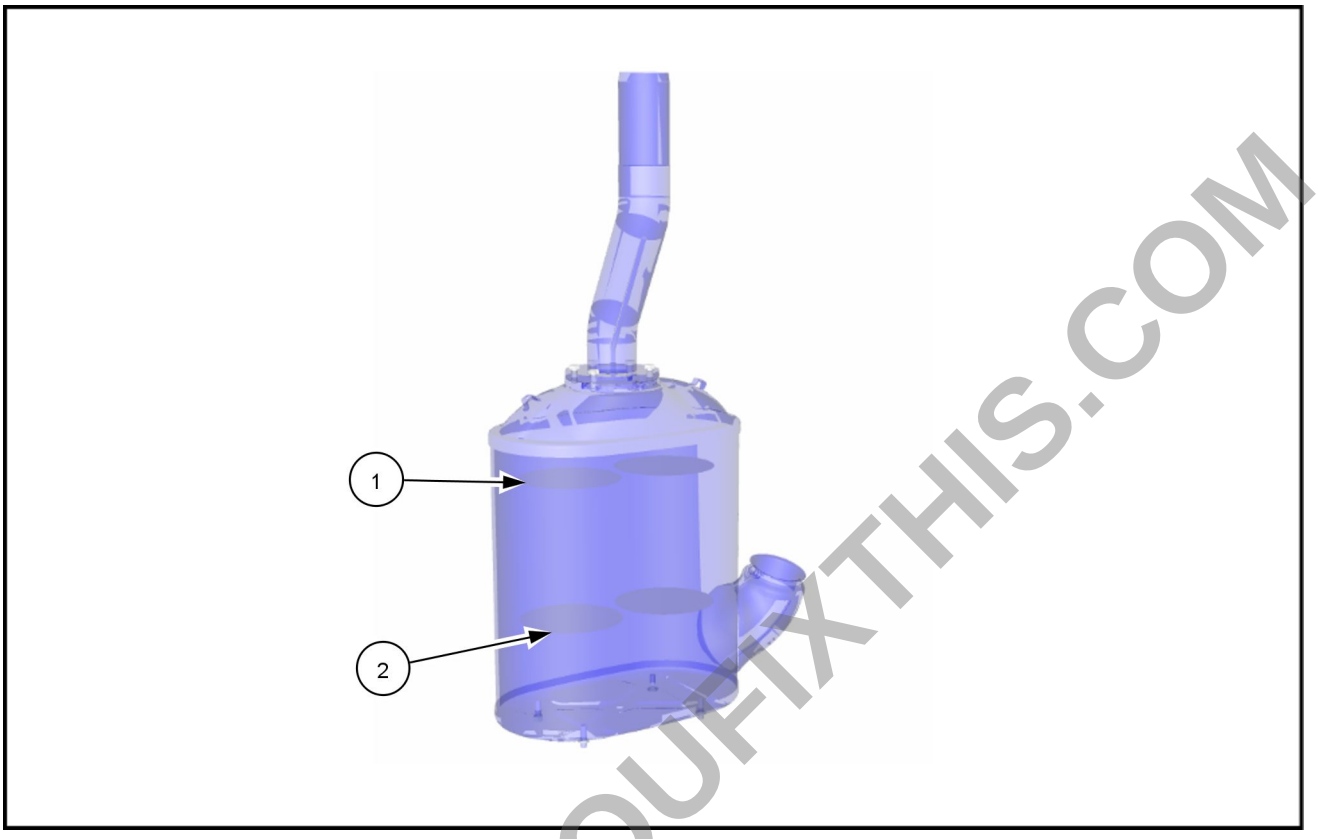
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| Problem | Possible Cause | Correction |
|---|---|---|
| | Excessive main or connecting rod bearing clearances | Replace bearings or shaft if necessary |
| | Oil pump axial clearance not properly set | Check pump clearance and shim as needed to proper tolerance. |
| | Faulty oil pressure sensor/oil pressure switch or electrical circuit | Check for fault codes, and testing procedures to check electrical circuits. |

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# Selective Catalytic Reduction (SCR) muffler and catalyst - Dynamic description - Clean Up Catalyst (CUC)




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The Clean Up Catalyst (CUC) **(1)** is located inside the Selective Catalytic Reduction (SCR) muffler **(2)**.

The CUC is required to eliminate residual ammonia (NH3) for legislation implications.

It is possible to have too much ammonia in the SCR catalyst. In this case we lose ammonia through the exhaust pipe. The target to lose is less than **10 ppm** out of the exhaust pipe.

The excess ammonia reacts with the CUC and oxygen, and then is converted to nitrogen and water vapors out of the exhaust.

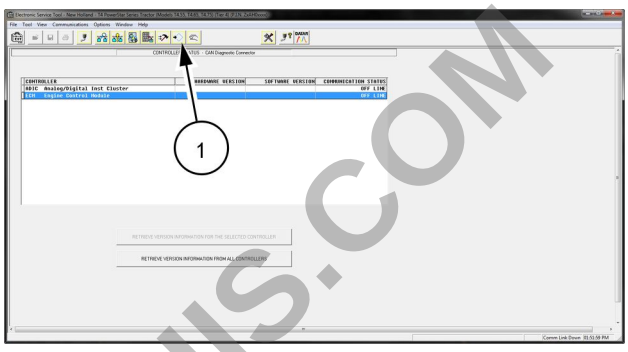
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# Engine oil system - Configure - Replacement of the Engine Oil/Filter – Reset Change Reminder

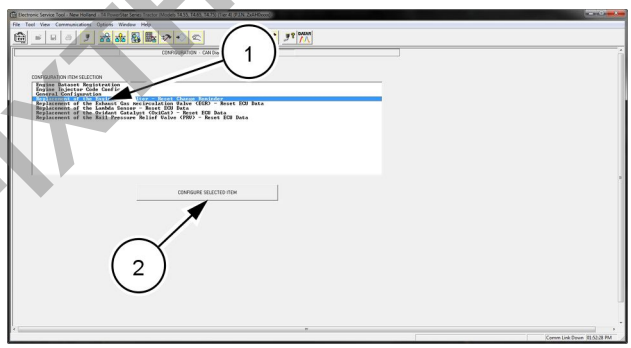
## Using the Electronic Service Tool (EST)

1. Connect the Electronic Service Tool (EST) to a diagnostic port on your machine.
2. Click the “CONFIGURE” button **(1)**.



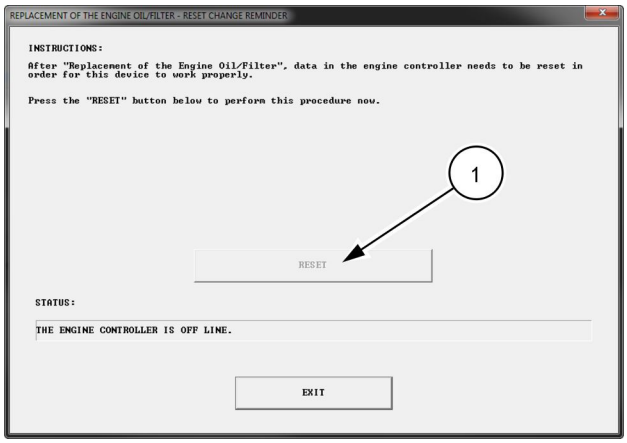

NHIL14ENG0787AA 1

3. Select “Replacement of the Engine Oil/Filter - Reset Change Reminder” **(1)** from the menu.
4. Click “CONFIGURE SELECTED ITEM” **(2)**.




NHIL14ENG0788AA 2

5. Click the “RESET” button **(1)** to perform the oil filter reset change reminder.




NHIL14ENG0789AA 3

## Machines equipped with a foot throttle

1. Turn the key switch to the ON position but do not start the engine.
2. Press the foot throttle greater than **90 %** of its travel and hold for **15 s**.
3. Fully release the foot throttle for **15 s**.
4. Press the foot throttle greater than **90 %** of its travel and hold for **15 s**.
5. Fully release the foot throttle for **15 s**.

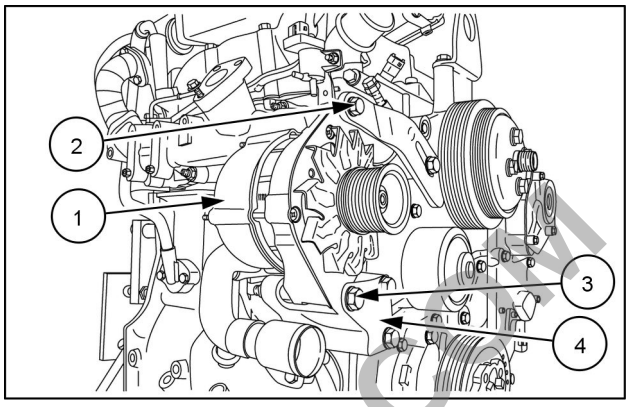
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# Alternator - Install

1. Install the alternator **(1)** on the support bracket **(4)** and install the bottom bolt **(3)**.
2. Roll the alternator towards the engine and install the top bolt **(2)** through the tensioner bracket.
3. Connect the electrical connection.
4. Torque the B+ post nut to **8 N·m** (**6 lb ft**).

***NOTICE:*** *Do not overtighten the nut. Damage to the alternator will occur.*




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