

SERVICE MANUAL

Cursor[®] 16 SST Tier 4B (final) and Stage IV Engine

See the following page for engine model numbers

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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.

Contents

Engine - 10

Engine and crankcase - 001

TECHNICAL DATA

Engine	
Service limits	3

SERVICE

Engine	
Service instruction - Finding Top Dead Center (TDC)	7
Crankcase	
Liner - Remove	8
Liner - Measure	9
Liner - Install	13
Liner - Measure – Protrusion	14
Under block - Remove	15
Under block - Install	16

DIAGNOSTIC

Engine	
Troubleshooting	20

Index

Engine - 10

Engine and crankcase - 001

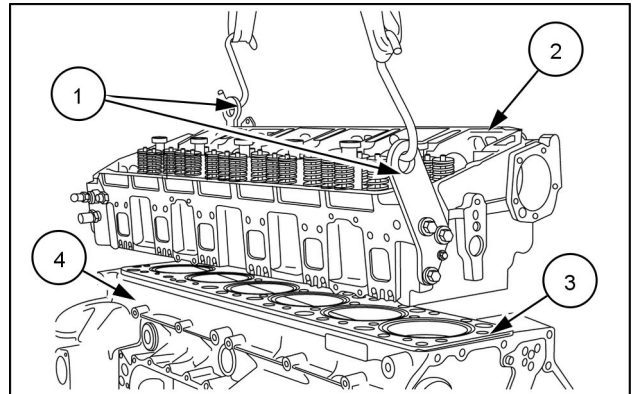
Crankcase Liner - Install	13
Crankcase Liner - Measure	9
Crankcase Liner - Measure – Protrusion	14
Crankcase Liner - Remove	8
Crankcase Under block - Install	16
Crankcase Under block - Remove	15
Engine - Service instruction - Finding Top Dead Center (TDC)	7
Engine - Service limits	3
Engine - Troubleshooting	20

Cylinder head - Install

Prior operation:

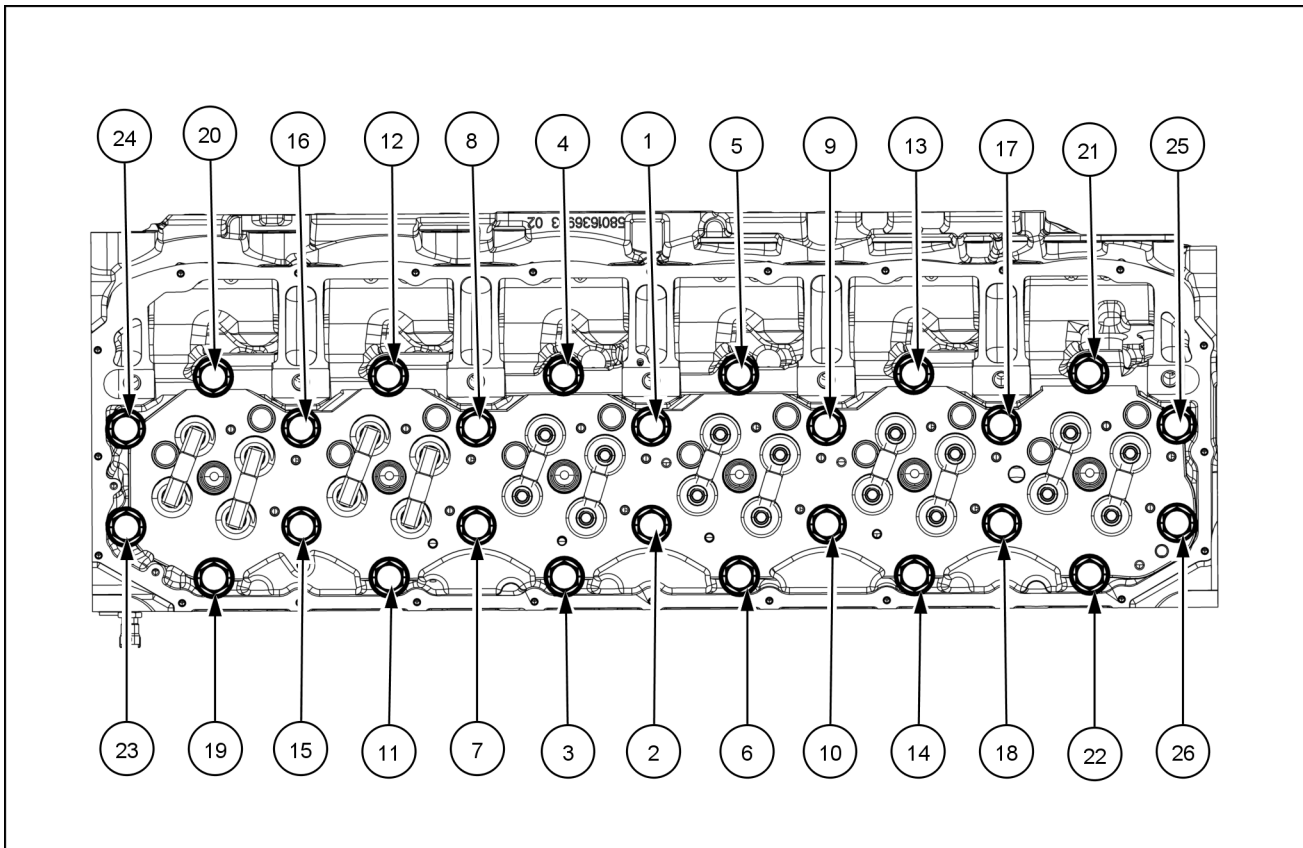
Cylinder head - Check (10.101)

1. Verify pistons 1 and 6 are at Top Dead Center (TDC).
2. Clean the mating surfaces on both the cylinder head (2) and the engine block (3).
3. Place the gasket (3) on the engine block (4).
4. Use the hoist with lifting hooks (1) to install the cylinder head (2).
5. Lubricate the threads of the head bolts with clean engine oil.



NHIL13ENG1166AA 1

6. Install the cylinder head bolts and follow the torque sequence that follows.



NHIL14ENG1048FA 2

Contents

Engine - 10

Pan and covers - 102

SERVICE

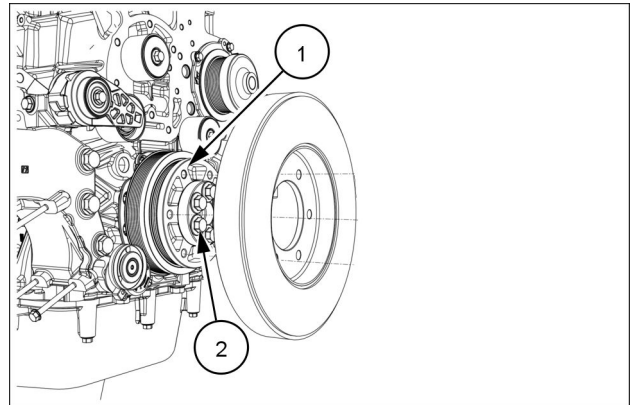
Engine oil pan	
Remove	3
Install	4

Crankshaft pulley - Remove

Prior operation:

Crankshaft damper - Remove (10.110)

1. Remove the bolts (2).
2. Remove the crankshaft pulley (1).



NHIL14ENG0352FA 1

Next operation:

Crankshaft oil seal Front seal - Remove (10.103)

Next operation:

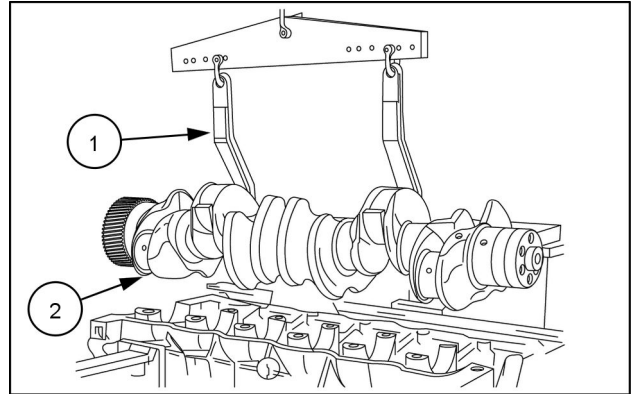
Crankshaft pulley - Install (10.103)

Crankshaft - Remove

Prior operation:

Crankcase Under block - Remove (10.001)

1. Use a hoist and tool **380000362 (1)** to remove the crankshaft **(2)**.



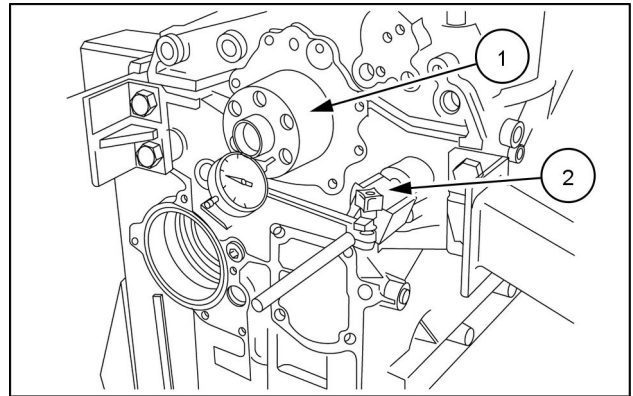
NHIL13ENG1163AA 1

Next operation:

Crankshaft - Measure (10.103)

Crankshaft - End play

1. The end play is checked by setting a dial gauge **380001004 (1)** with a magnetic base on the crankshaft **(2)** as shown in the figure. If you find the end play to be greater than the **0.10 - 0.30 mm (0.0039 - 0.0118 in)**, the bearing shells with the thrust bearing must be replaced. Repeat the check.



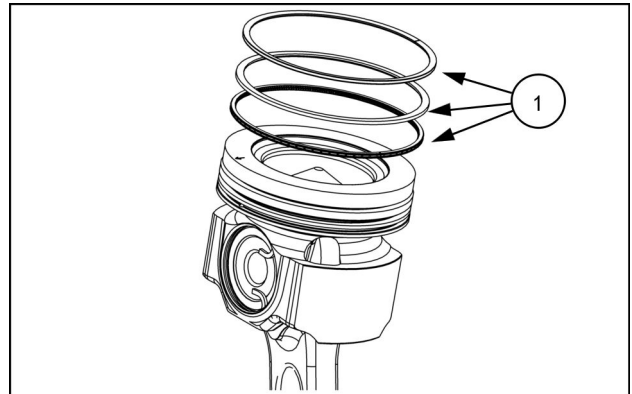
NHIL13ENG1159AA 1

Connecting rod and piston - Disassemble

Prior operation:

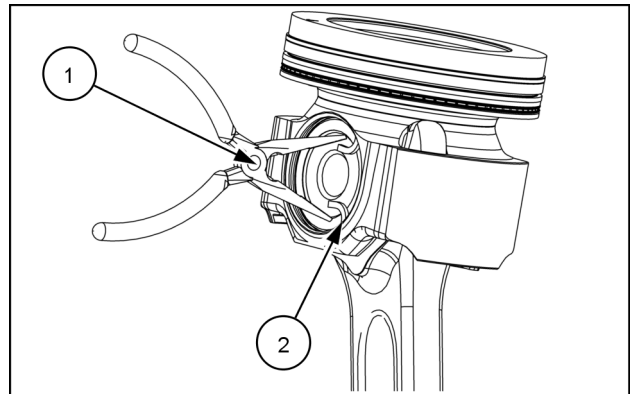
Connecting rod and piston - Remove (10.105)

1. Verify the piston does not show any signs of seizing, scoring or cracking. Replace if necessary.
2. Use the piston ring tool **380000324** to remove the piston rings (**1**).



NHIL14ENG1029AA 1

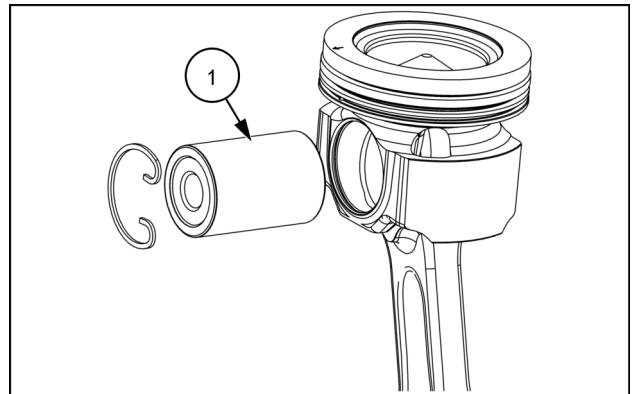
3. Use needle nose pliers (**1**) to remove the circlip (**2**) that hold the piston pin in place.



NHIL14ENG1030AA 2

4. Remove the piston pin (**1**).

NOTE: It may be necessary to use hammer and wooden dowel to remove the pin.



NHIL14ENG1028AA 3

Next operation:

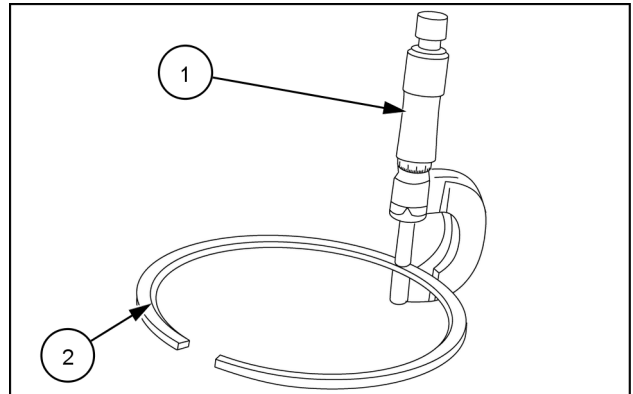
Connecting rod and piston - Assemble (10.105)

Piston Ring - Measure

Prior operation:

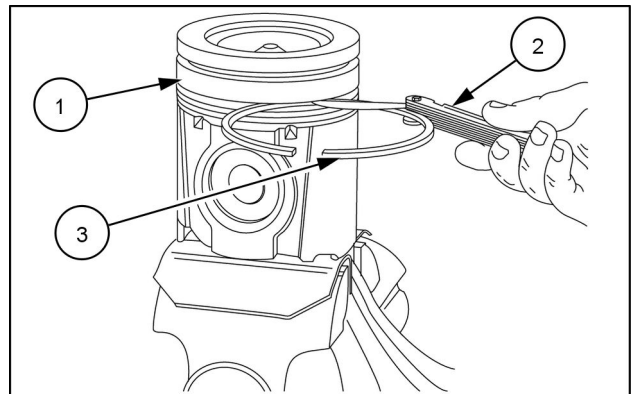
Connecting rod and piston - Disassemble (10.105)

1. Check the thickness of the piston ring (2) with a micrometer (1).



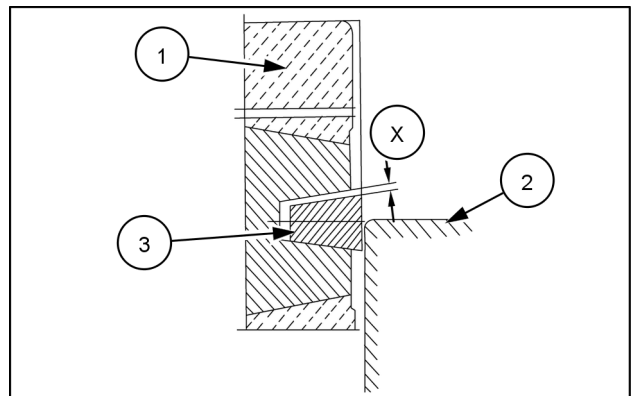
NHIL13ENG1213AA 1

2. Check the clearance between the rings (3) and their landings on the piston (1) with a feeler gauge (2).



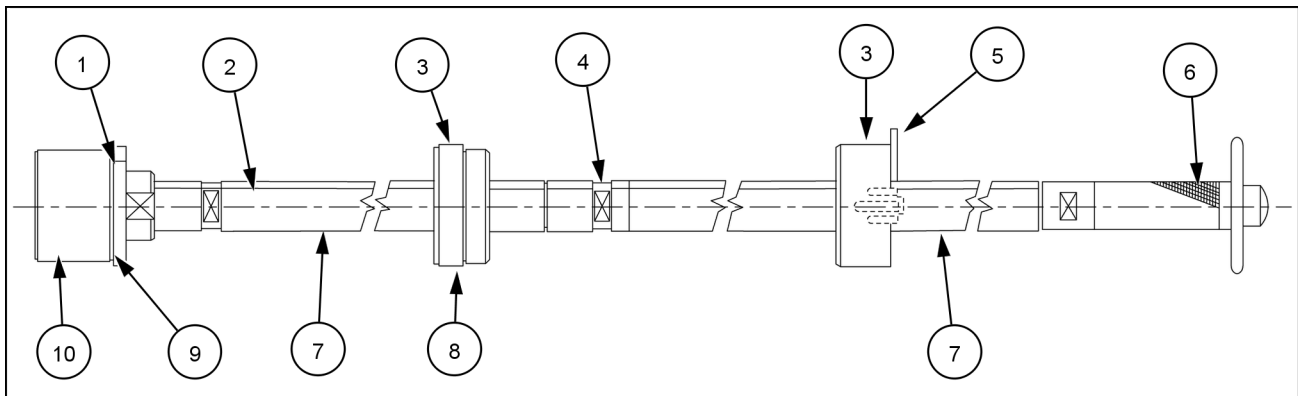
NHIL13ENG1214AA 2

3. The ring (3) of the first landing has a "V" shape. The clearance (X) between the ring and landing is measured by setting the piston (1) with the ring in the cylinder liner (2) so that the ring is exposed half way out of the cylinder liner.



NHIL13ENG1130AA 3

Camshaft bushings - Detailed view



NHIL13ENG1272EA 1

Camshaft bushing install tool 380000146

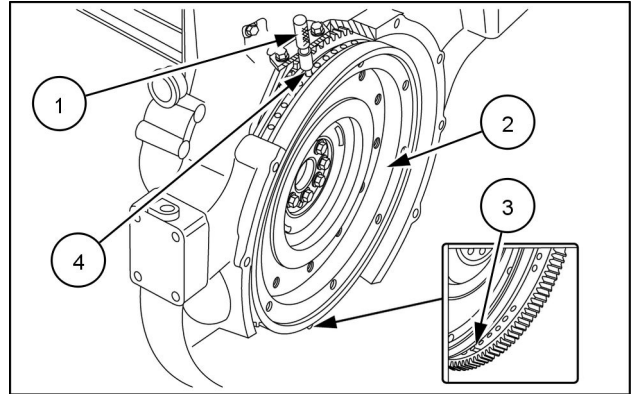
- (1) Grub screw for positioning bushings
- (2) Guide line
- (3) Guide bushing to secure the seventh bushing mount
- (4) Extension coupling
- (5) Plate securing the yellow bushing to the cylinder head
- (6) Grip
- (7) Reference marks (red) to insert bushings 1 - 6
- (8) Guide bushing
- (9) Reference mark to insert bushing 7 correctly
- (10) Drift with seat for removal and installation of bushings

Camshaft - Install

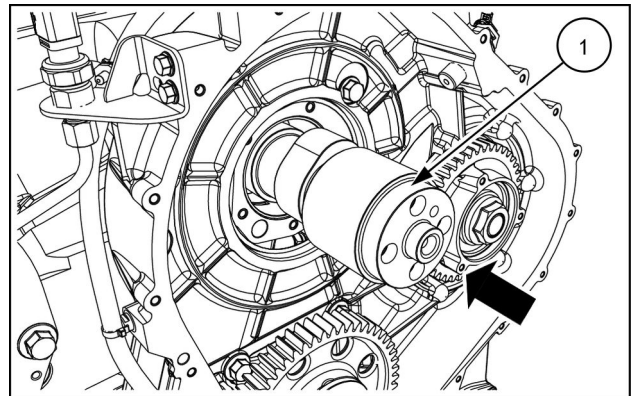
Prior operation:

Camshaft - Remove (10.106)

1. Position the crankshaft with pistons 1 and 6 at Top Dead Center (TDC). Refer to **Engine - Service instruction (10.001)** for the procedure.
2. This situation occurs when:
 - The hole with reference mark **(3)** of the engine flywheel **(2)** can be seen through the inspection window.
 - The tool **380000150 (1)** through the seat of the engine speed sensor, enters the hole **(4)** in the engine flywheel **(2)**.
3. If this condition does not occur, turn the flywheel appropriately.
4. Remove the tool **380000150 (1)**.
5. Install the camshaft **(1)** through the flywheel housing.

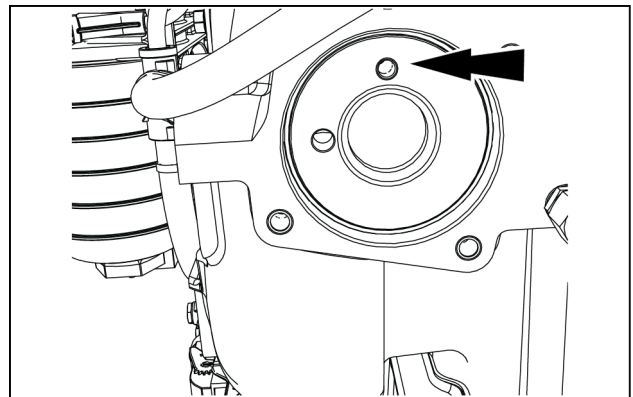


NHIL13ENG1232AA 1



NHIL14ENG0448AA 2

6. From the front of the engine, position the camshaft hole as shown.



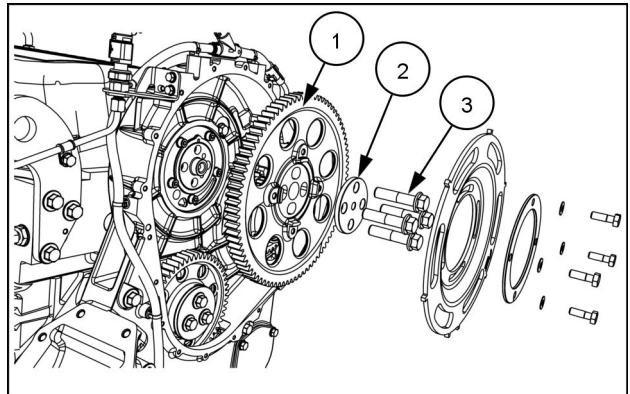
NHIL15ENG0092AA 3

Camshaft gear - Install

Prior operation:

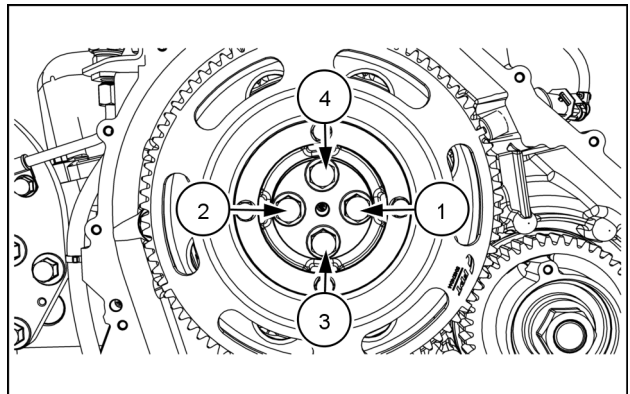
Camshaft - Install (10.106)

1. Install the camshaft gear (1) onto the camshaft.
2. Install the spacer (2) to the camshaft gear.
3. Apply clean engine oil to the threads of the bolts (3).
4. Install the four M14 x 60 bolts (3).



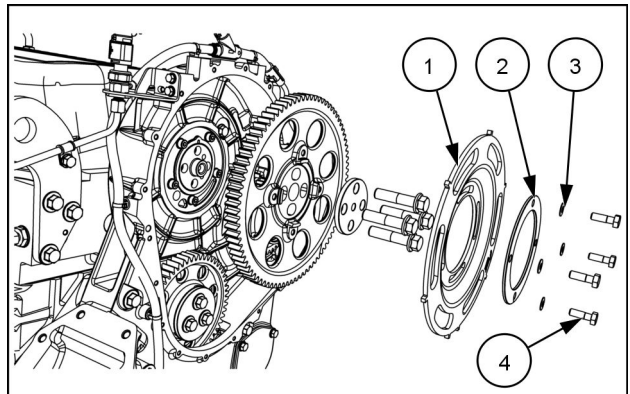
NHIL14ENG0505AA 1

5. Follow the sequence and torque the M14 bolts (3) in two stages:
 1. Stage 1: (1), (2), (3), (4) 60 N·m (44 lb ft)
 2. Stage 2: (1), (3), (2), (4) 60 N·m (44 lb ft)



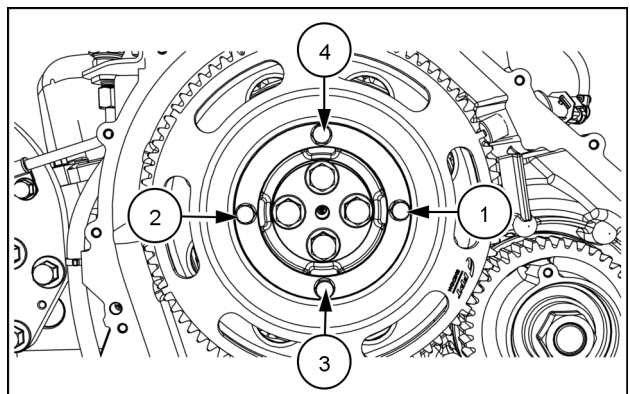
NHIL14ENG0506AA 2

6. Install the phonic wheel (1) to the camshaft gear.
7. Install the spacer (2) over the phonic wheel.
8. Apply **LOCTITE® 243™** to the threads of the M8 x 25 bolts (4).
9. Install the M8 x 25 bolts (4) with M8 washers (3) to secure the spacer and phonic wheel to the camshaft gear.



NHIL14ENG0505AA 3

10. Follow the sequence and torque the M8 bolts (4) in two stages:
 1. Stage 1: (1), (2), (3), (4) 25 - 32 N·m (18 - 24 lb ft)
 2. Stage 2: (1), (3), (2), (4) 25 - 32 N·m (18 - 24 lb ft)



NHIL14ENG0506AA 4

Contents

Engine - 10

Pump drives - 114

FUNCTIONAL DATA

Crankcase gears

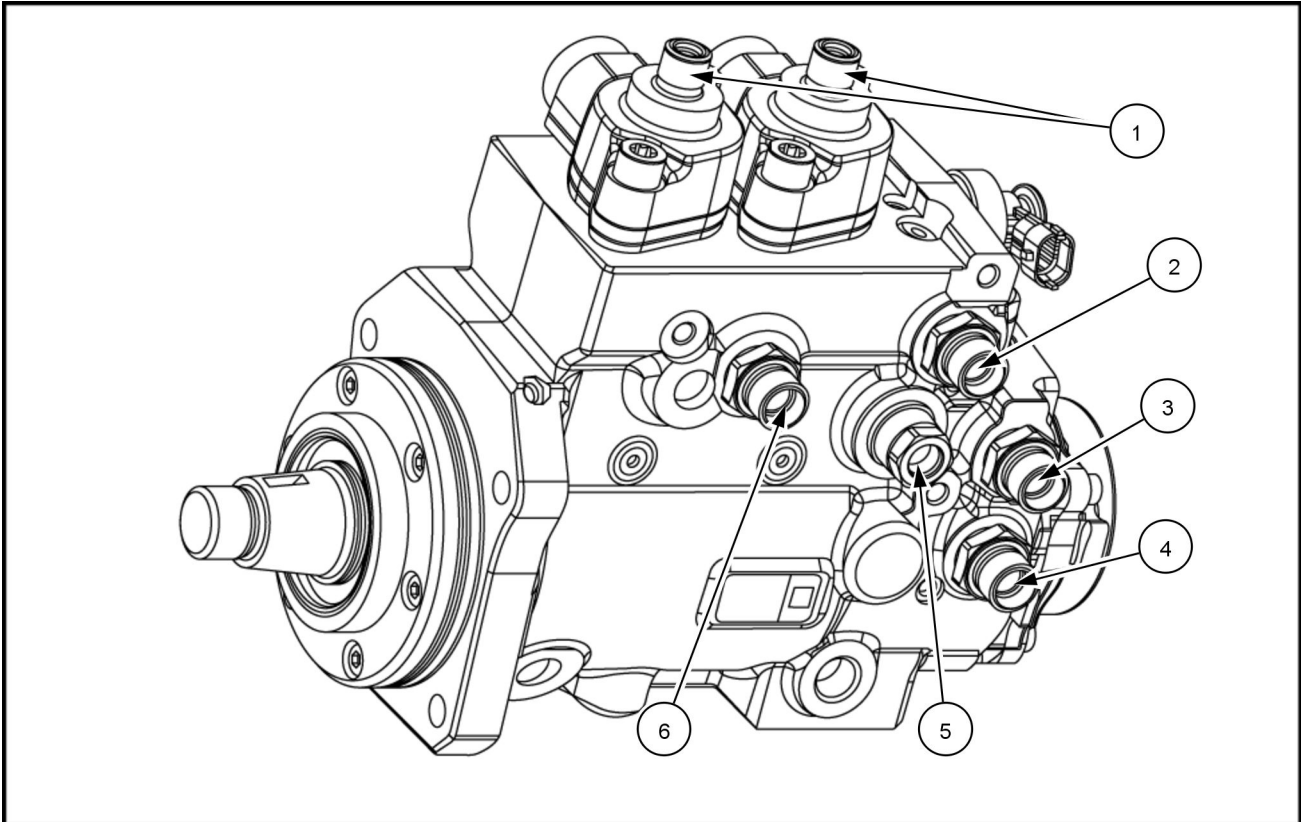
Overview 3

Injection pump - Overview

High pressure common rail pump driven by the timing gear; no adjustments required. Installed on the rear of the high-pressure pump is a mechanical feed pump controlled by the high-pressure pump shaft.

The high pressure pump is serviced as an assembly, except for the following parts:

- Drive gear
- Pressure regulator



83111736 1

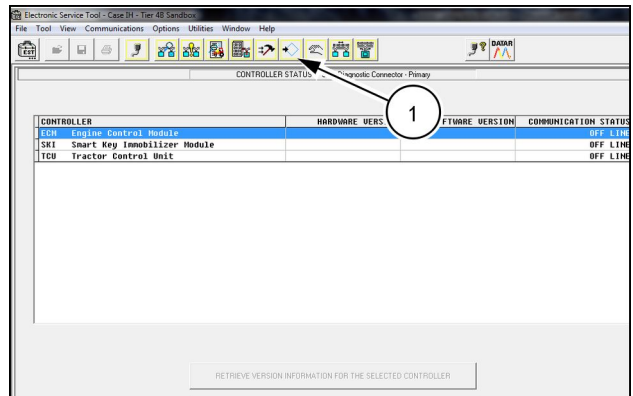
High pressure pump

- | | |
|-----------------------------|---------------------------|
| (1) Fuel to rail | (4) Fuel outlet to filter |
| (2) Fuel intake from filter | (5) Cap |
| (3) Fuel intake from tank | (6) Fuel outlet to tank |

Pressure regulating valve - Configure - Reset ECU data

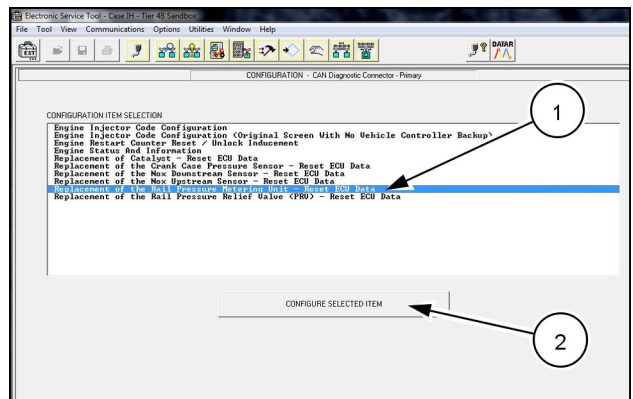
NOTE: Active dosing faults require additional key cycles in order for the Engine Control Unit (ECU) to determine the fault has been repaired. Afterrun must be completed between each key cycle.

1. Connect the Electronic Service Tool (EST) and turn the key switch ON without starting the engine.
2. Click the "Configuration" icon (1).



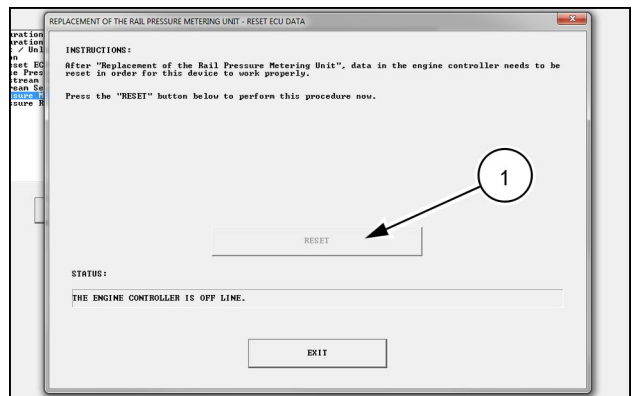
NHPH14ENG0006AA 1

3. Select "Replacement of the Rail Pressure Metering Unit – Reset ECU Data" (1).
4. Click the "CONFIGURE SELECTED ITEM" button (2).



NHPH14ENG0018AA 2

5. Click the "RESET" button (1).

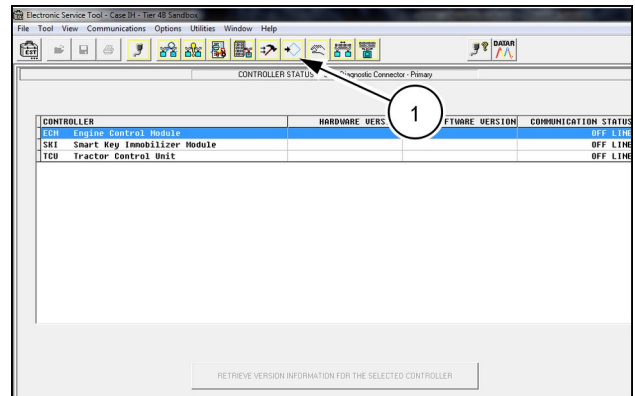


NHPH14ENG0019AA 3

Fuel injectors - Configure - Injector code configuration

NOTE: Active dosing faults require additional key cycles in order for the Engine Control Unit (ECU) to determine the fault has been repaired. Afterrun must be completed between each key cycle.

1. Connect the Electronic Service Tool (EST) and turn the key switch ON without starting the engine.
2. Click the “Configuration” icon (1).

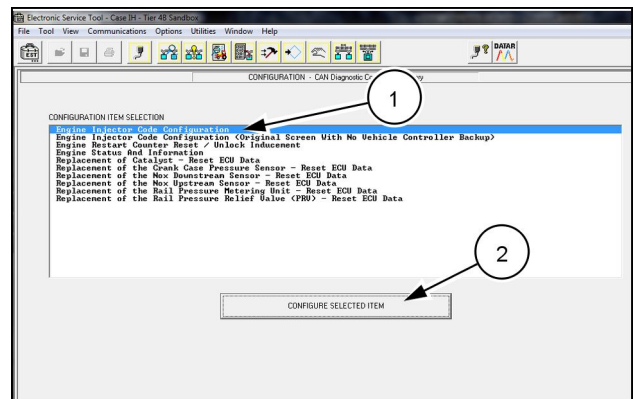


NHPH14ENG0006AA 1

3. Select “Engine Injector Code Configuration” (1).
4. Click “CONFIGURE SELECTED ITEM” (2).
5. Write down the code for the new injector on a piece of paper.

NOTE: It is suggested to wait to install the injector until after performing the following process to avoid the possibility of mistakes when copying the code to paper.

NOTE: Click the “INSTRUCTIONS” button (1) for examples of injector codes and their location on the injector body.

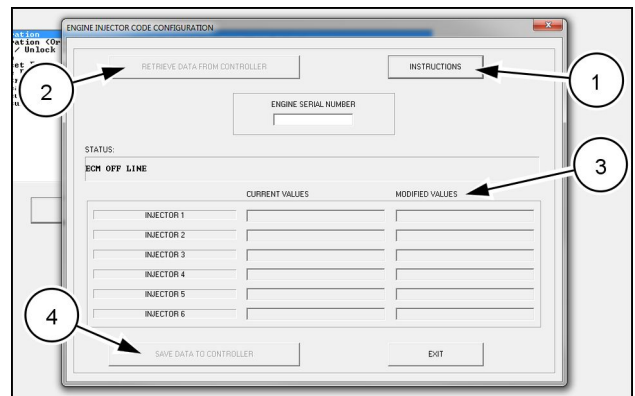


NHPH14ENG0007AA 2

6. Press the “RETRIEVE DATA FROM CONTROLLER” button (2) to read the current data.
7. In the “MODIFIED VALUES” column (3), enter the code for the new injector into the box for the appropriate cylinder number that will be replaced.

NOTE: If you are installing more than one injector, then be sure to note which injector code is assigned to which cylinder number so that you remember when you are installing the injectors.

8. Click the “SAVE DATA TO CONTROLLER” button (4) once the code(s) are entered.
9. Click “OK” to store the data in the Engine Control Unit (ECU).



NHPH14ENG0008AA 3

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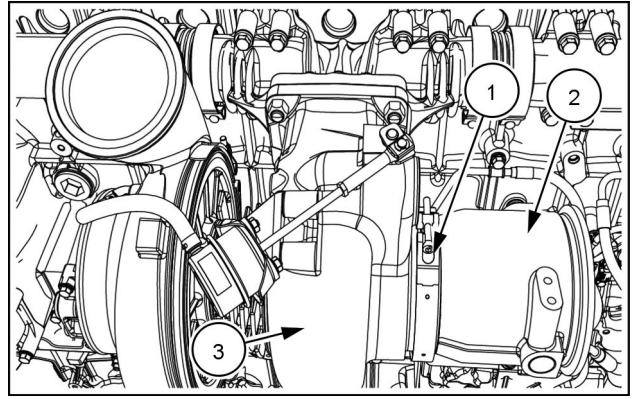
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9. Install the exhaust flap **(2)** to the turbocharger **(3)**.
10. Tighten the hose clamp **(1)** to secure.



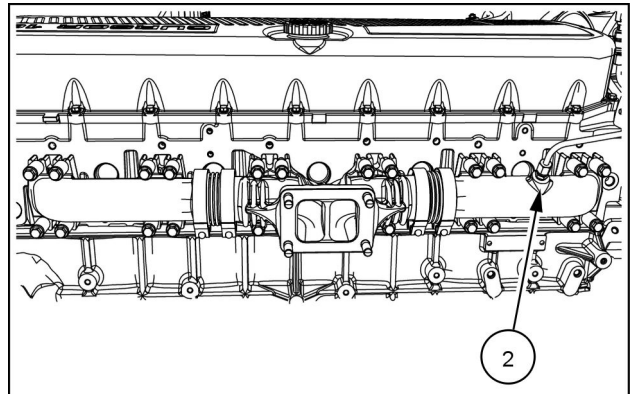
NHIL14ENG0368AA 5

Exhaust manifold - Remove

Prior operation:

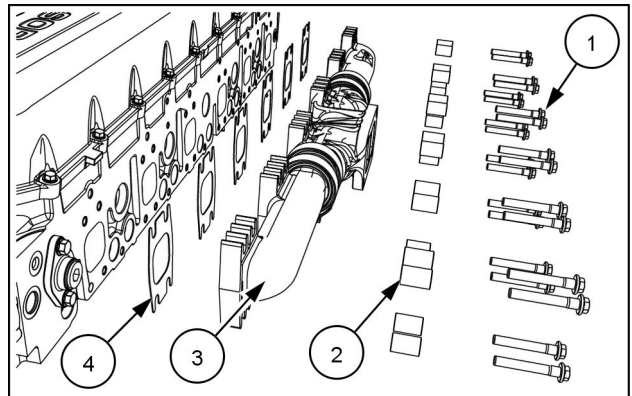
Turbocharger - Remove (10.250)

1. Remove the exhaust gas pressure sensor (2) from the exhaust manifold.



NHIL14ENG0373AA 1

2. Remove the bolts (1) and spacers (2) that secure the exhaust manifold (3) to the cylinder head.
3. Remove the exhaust manifold (3) from the cylinder head.
4. Remove the exhaust manifold gaskets (4).



NHIL14ENG0374AA 2

Next operation:

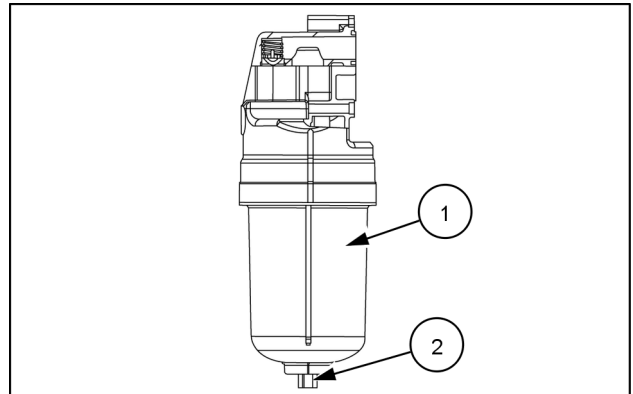
Exhaust manifold - Install (10.254)

Engine oil filter - Technical Data

Maximum operating pressure	13 bar (188 psi)
Operating temperature	-30 - 120 °C (-22 - 248 °F)
By-pass valve opening pressure	3.1 - 3.7 bar (45.0 - 53.7 psi)

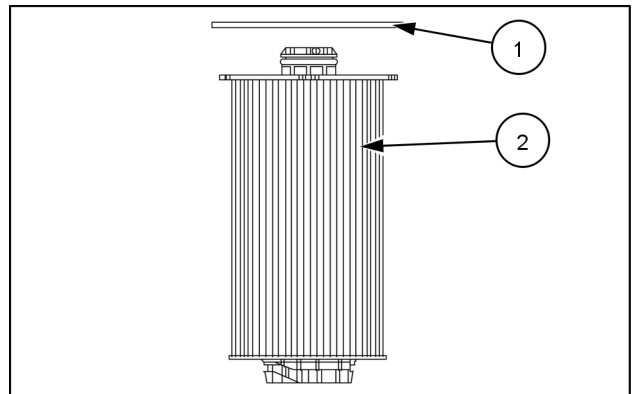
Engine oil filter - Replace

1. Place a drain pan under the filter casing (1).
2. Remove the drain plug (2).
3. Use a oil filter wrench **34591-00100** to loosen the casing a couple turns and allow the oil to fully drain.
4. Remove the casing (1).



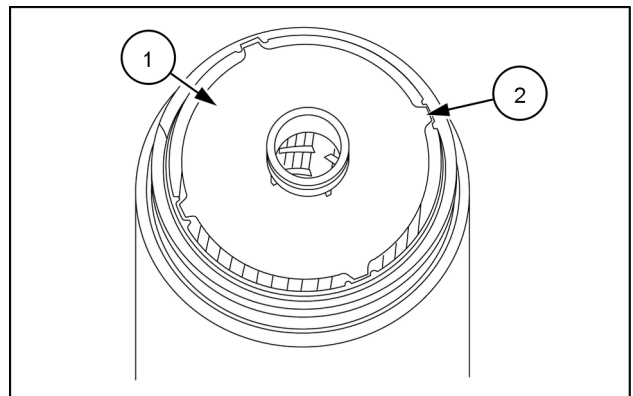
83115052 1

5. Discard the O-ring (1) and filter cartridge (2).



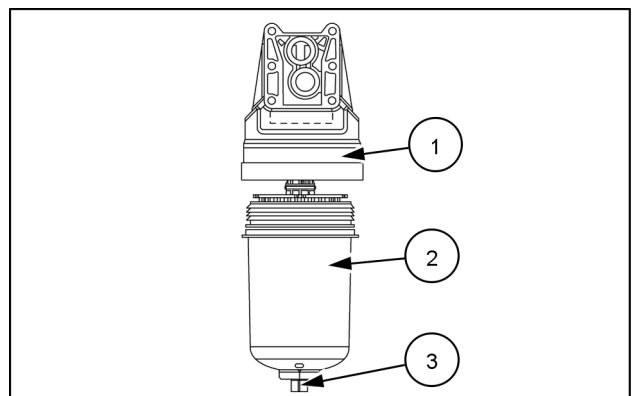
83115054 2

6. Insert a new cartridge into the casing while aligning the centering tabs (2) on the top plate (1) of the cartridge, with the seats in the casing.
7. Push the cartridge into the casing until the detent is overcome.



83115053 3

8. Install the casing (2) onto the filter base (1).
9. Torque the casing to **55 - 65 N·m (41 - 48 lb ft)**.
10. Tighten the drain plug (3).



83115055 4

Index

Engine - 10

Engine lubrication system - 304

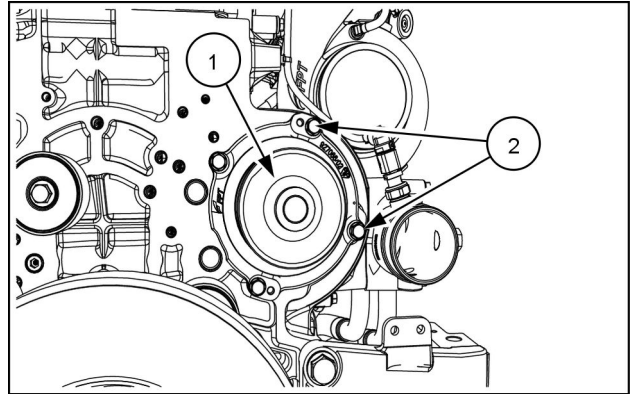
Crankcase ventilation system - Exploded view	13
Crankcase ventilation system - Install	20
Crankcase ventilation system - Overview	12
Crankcase ventilation system - Remove	19
Engine oil filter - Overview	7
Engine oil filter - Replace	14
Engine oil filter - Technical Data	4
Engine oil pump - Install	18
Engine oil pump - Overview	10
Engine oil pump - Remove	17
Engine oil pump - Sectional view	11
Oil pressure valve - General specification – Overpressure valve	5
Oil pressure valve - General specification – Regulator valve	6
Oil pressure valve - Install – Regulator valve	16
Oil pressure valve - Overview - Regulator valve	9
Oil pressure valve - Overview – Overpressure valve	8
Oil pressure valve - Remove – Regulator valve	15
Piston cooling Spray nozzle - Install	23
Piston cooling Spray nozzle - Remove	22

Water pump - Remove

Prior operation:

Belt - Remove (10.414)

1. Remove the four bolts (2) from the water pump (1).
2. Remove the water pump (1) from the engine block.

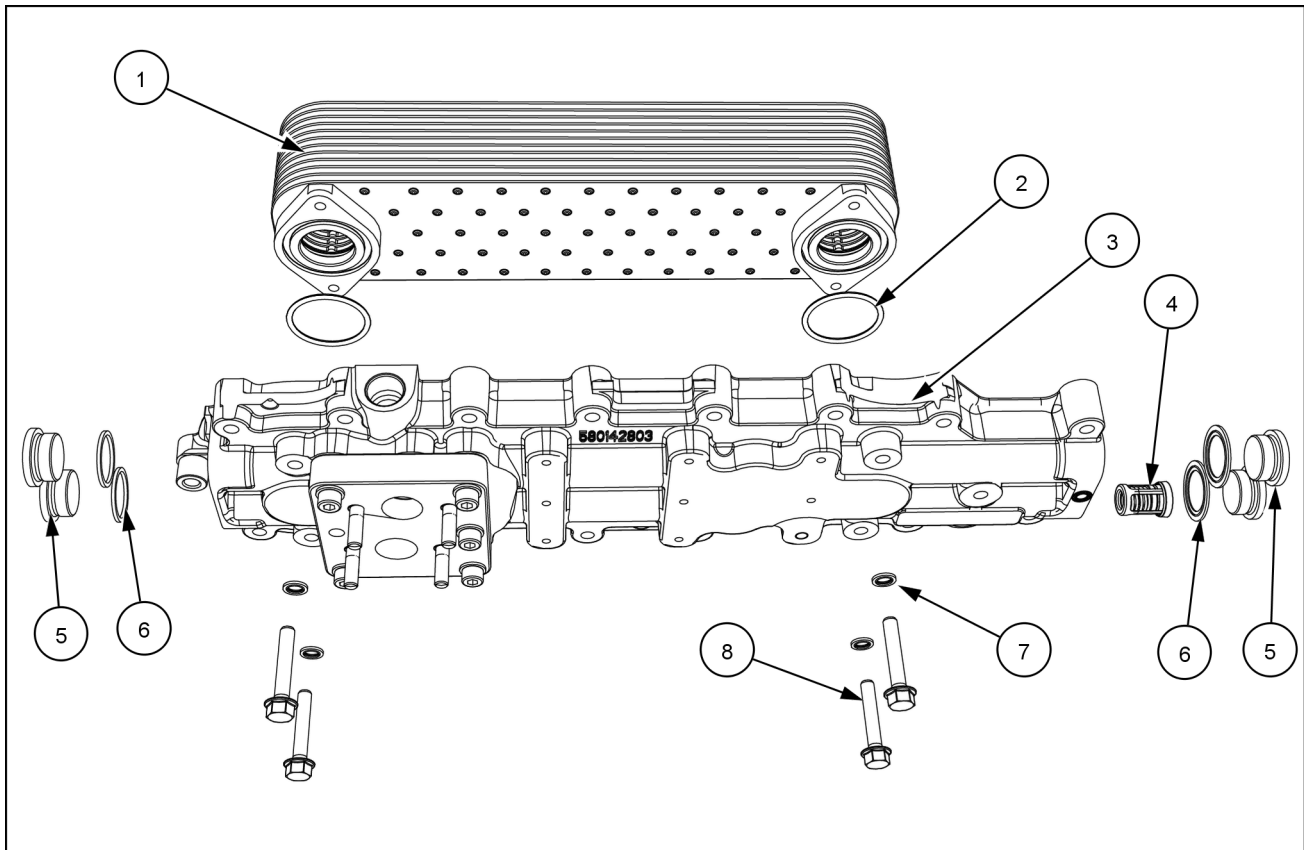


NHIL14ENG0378AA 1

Next operation:

Water pump - Install (10.400)

Engine oil cooler - Exploded view



NHIL14ENG0426FA 1

- (1) Oil cooler
- (2) O-rings
- (3) Heat exchanger body
- (4) Oil cooler bypass valve

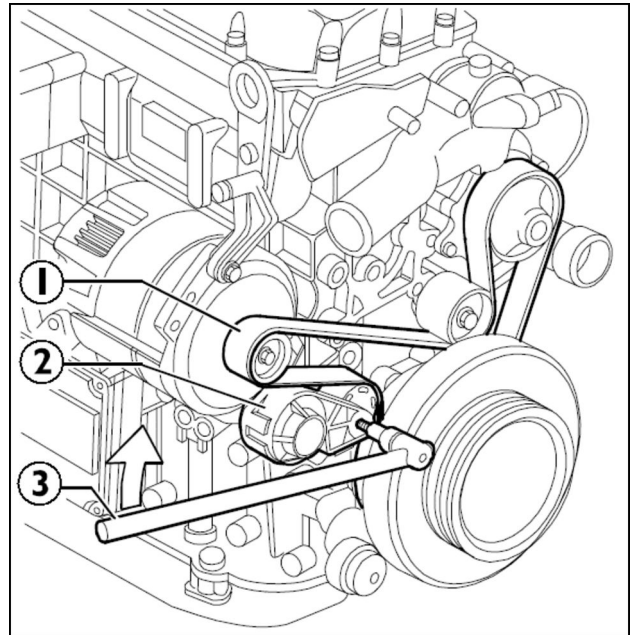
- (5) Lock plug
- (6) Seal washer
- (7) M8 washers
- (8) M8 x 45 bolts

Belt - Install

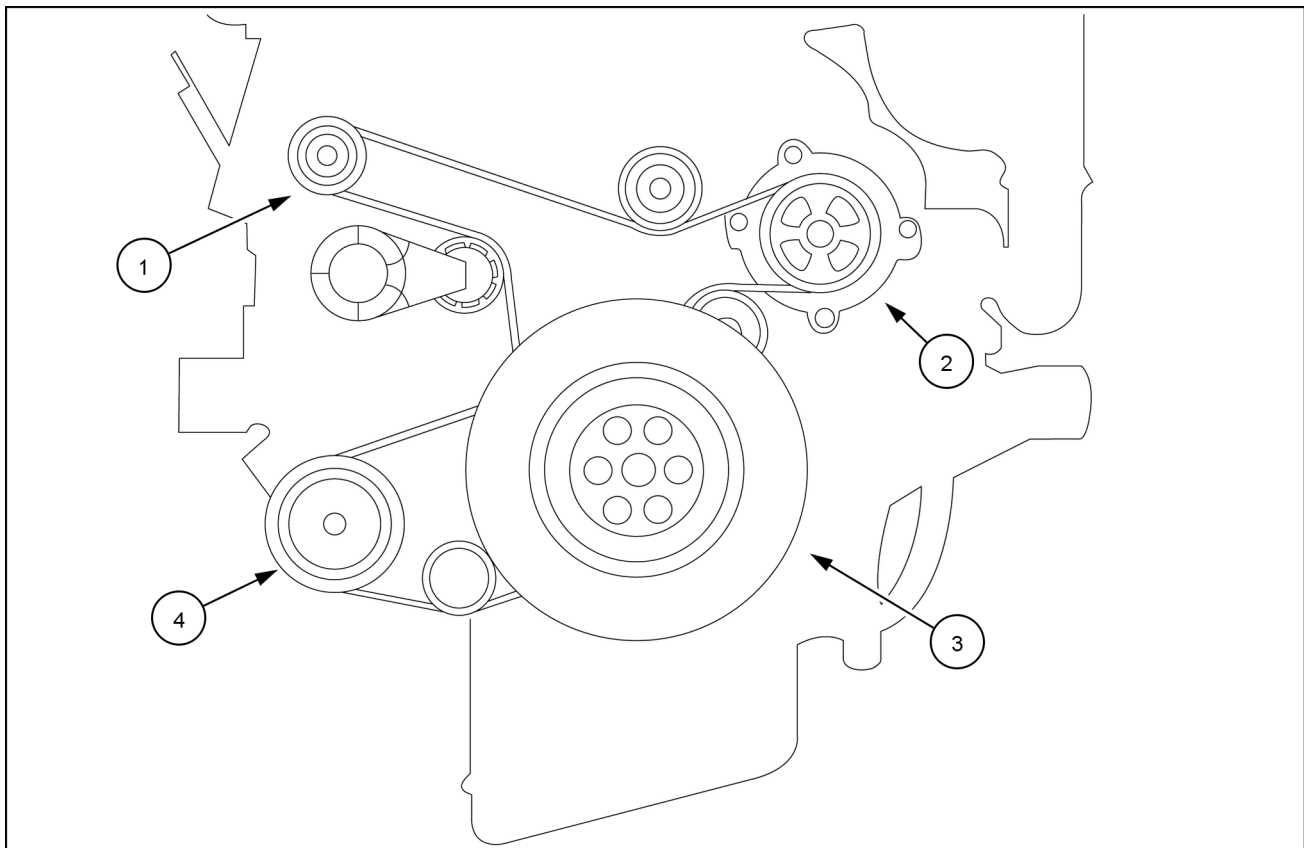
Prior operation:

Belt - Remove (10.414)

1. Use a suitable tool (3) to rotate the belt tensioner (2) in the direction of the arrow.
2. Install the belt (1) around the pulleys.



BELTF3C(A) 1



NHIL13ENG1290FA 2

(1) Alternator

(2) Water pump

(3) Crankshaft

(4) A/C compressor

Contents

Engine - 10

Selective Catalytic Reduction (SCR) exhaust treatment - 500

TECHNICAL DATA

Selective Catalytic Reduction (SCR) exhaust treatment Technical Data - Nitrogen Oxides (NOx) and Ammonia (NH3) vs Temperature	4
--	---

FUNCTIONAL DATA

Selective Catalytic Reduction (SCR) exhaust treatment	
Dynamic description	5
Overview - Emission Standard	7
Component identification	8
Dynamic description Diesel Oxidation Catalyst (DOC)	9
Dynamic description - Reduction of NOx	10
Overview – Thermal Management	11
Overview - Hydraulic	14
Selective Catalytic Reduction (SCR) muffler and catalyst	
Overview	17
Dynamic description - Clean Up Catalyst (CUC)	18
Sectional view	19
Diesel Exhaust Fluid (DEF)/AdBlue® tank	
Overview	20
Coolant control valve	
Overview	21
Dynamic description	22
Diesel Oxidation Catalyst (DOC)	
Overview	26
Dynamic description	27

SERVICE

Selective Catalytic Reduction (SCR) exhaust treatment	
Service instruction - SCR fault repair verification test	28
Configure - Engine restart counter reset	29
Selective Catalytic Reduction (SCR) muffler and catalyst	
Configure - Reset ECU data	30

- At **245.0 °C (473.0 °F)** efficiency temperature hold mode to normal mode, when the SCR temperature reaches **250.0 °C (482.0 °F)**, or after **15 min** in low-load conditions where power is less than **10 %** of rated power

Normal Mode

Activation / exit conditions:

- The exhaust flap is deactivated due to either one of the following conditions:
 - A. The exhaust temperature has reached its target value. At this time, no flap is necessary for maintaining high SCR efficiency. This is the normal operating mode for most vehicle missions.
 - B. When the SCR light off temperatures cannot be reached in a practical manner even with the use of the flap, and within minimum operating temperatures of the system. At these very low loads there is not enough energy in the exhaust gas to maintain a good SCR efficiency and hydrolysis of the required Diesel Exhaust Fluid (DEF)/AdBlue® injection. If the engine remains at this low power level for **15 min**, then continuous thermal management is switched off. As soon as engine load increases, the flap will be reactivated. In this temporarily deactivated state, the flap will still be used intermittently for preventing other issues, such as DEF/AdBlue® deposits formation or hydrocarbon (HC) accumulation as required.

Description / features:

- Flap is deactivated.
- The required SCR efficiency is around **95 - 98 %** in all of the engine maps, for engine speed lower than **1100 - 1200 RPM**. The target efficiency is set at **90 %**.

Hydrocarbon Accumulation Protection

Background

- If the engine is at very low load or left in idling conditions for long periods, then continuous thermal management is switched off. When thermal management is switched off, the temperature will fall well below **200.0 °C (392.0 °F)**. In this situation the DOC will not oxidize hydrocarbons (HC) produced by the engine, and these will gradually pass towards the SCR system. Some of the hydrocarbons will be absorbed in the SCR, thus occupying cells that cannot any longer collect ammonia (NH₃) to reduce NO_x emissions. In some cases customers will leave engine at low idle for an entire night and total HC accumulation can be significant.
- If the absorbed hydrocarbons in the SCR is too high, the increase load on the engine can be enough to create a significant thermal event. This can cause severe damage to the SCR. Cells that are occupied by hydrocarbons cannot physically collect ammonia any longer. This will cause the SCR efficiency to decrease, and risk the emission system to not be compliant.

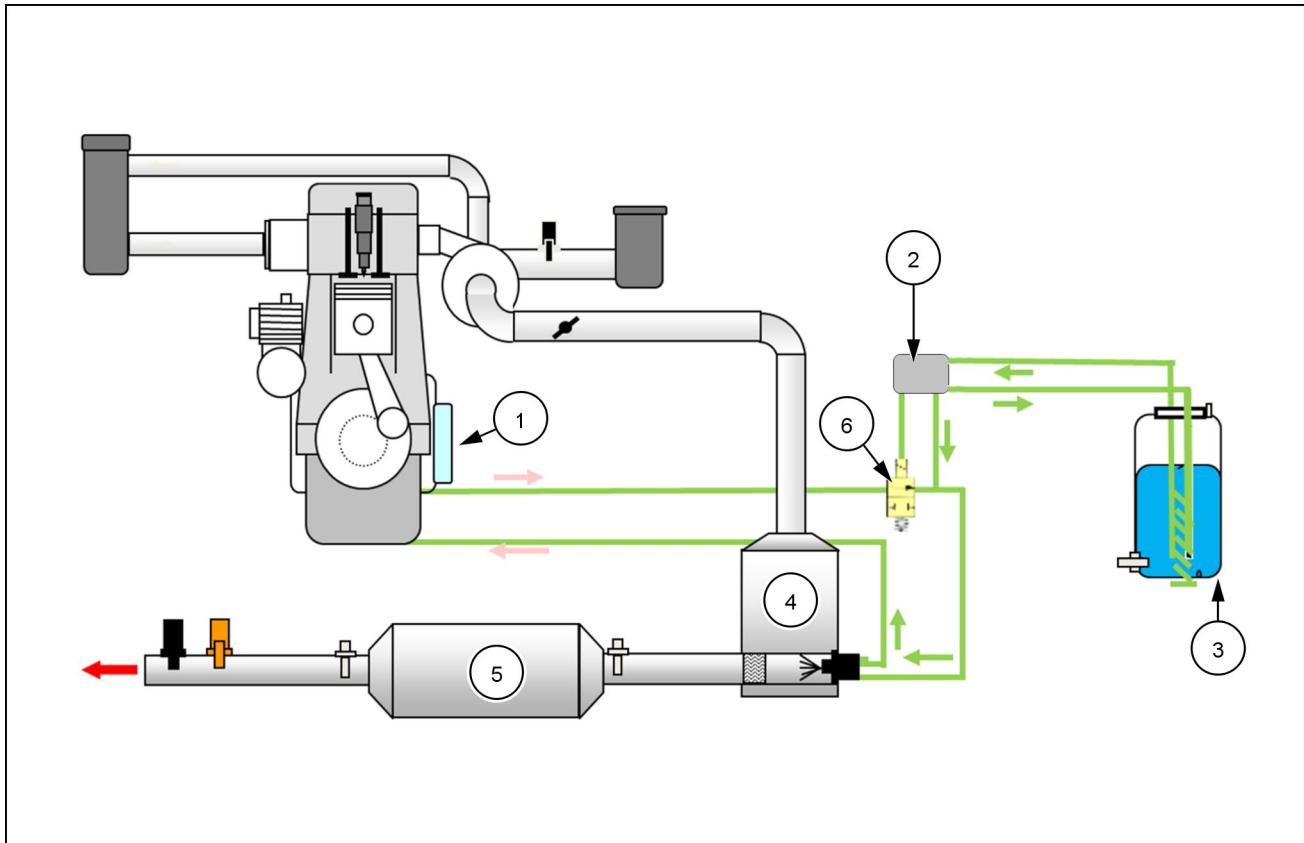
Countermeasures with thermal management

- To eliminate this risk an intermittent use of thermal management is foreseen. After a few hours, but long before the total HCs accumulated can reach dangerous levels, the exhaust flap is used. Two different strategies are possible, depending on application requirements (machine configurations, safety conditions, etc..)
 - One strategy is hydrocarbon regeneration control. This strategy can be used to keep HCs under control indefinitely by intermittently raising the SCR temperatures. The SCR system temperatures will be raised to approximately **300.0 °C (572.0 °F)**, whenever the HC model reaches a critical level. To reach this target temperature, the low idle speed must be increased during the intermittent regeneration phases.
 - On some applications the customer needs to be able to leave the normal low idle speed alone. So rather than intermittently raising temperatures to around **300.0 °C (572.0 °F)** to remove HCs, we will use strategy two which is hydrocarbon oxidation control. This strategy keeps the DOC inlet temperature at around **250.0 °C (482.0 °F)** to avoid further accumulation. The critical level for strategy two is lower than strategy one, and average flap use is higher, but climatic chamber results demonstrate that this condition can be achieved under all normal operating conditions without engine speed increase.

The hydrocarbon accumulation rate is dependent on After-Treatment System (ATS) temperature, engine speed, coolant temperature.

- The lower the ATS temperature, the higher the accumulation rate.
- The faster the engine, the higher the flow of HC reaching the SCR.
- The lower the coolant temperature, the higher HC emission from the engine.

Coolant control valve - Dynamic description



NHPP14ENG1109FA 1

Engine Control Unit (ECU) (1)

Supply module (2)

Diesel Exhaust Fluid (DEF)/AdBlue® tank (3)

Diesel Oxidation Catalyst (DOC) (4)

Selective Catalytic Reduction (SCR) muffler (5)

Coolant control valve (6)

The control software contain a heating strategy.

- This heating strategy provides defrosting of the SCR system components.
- To heat the system after defrosting was completed, this is to avoid that the system freezes again during driving.

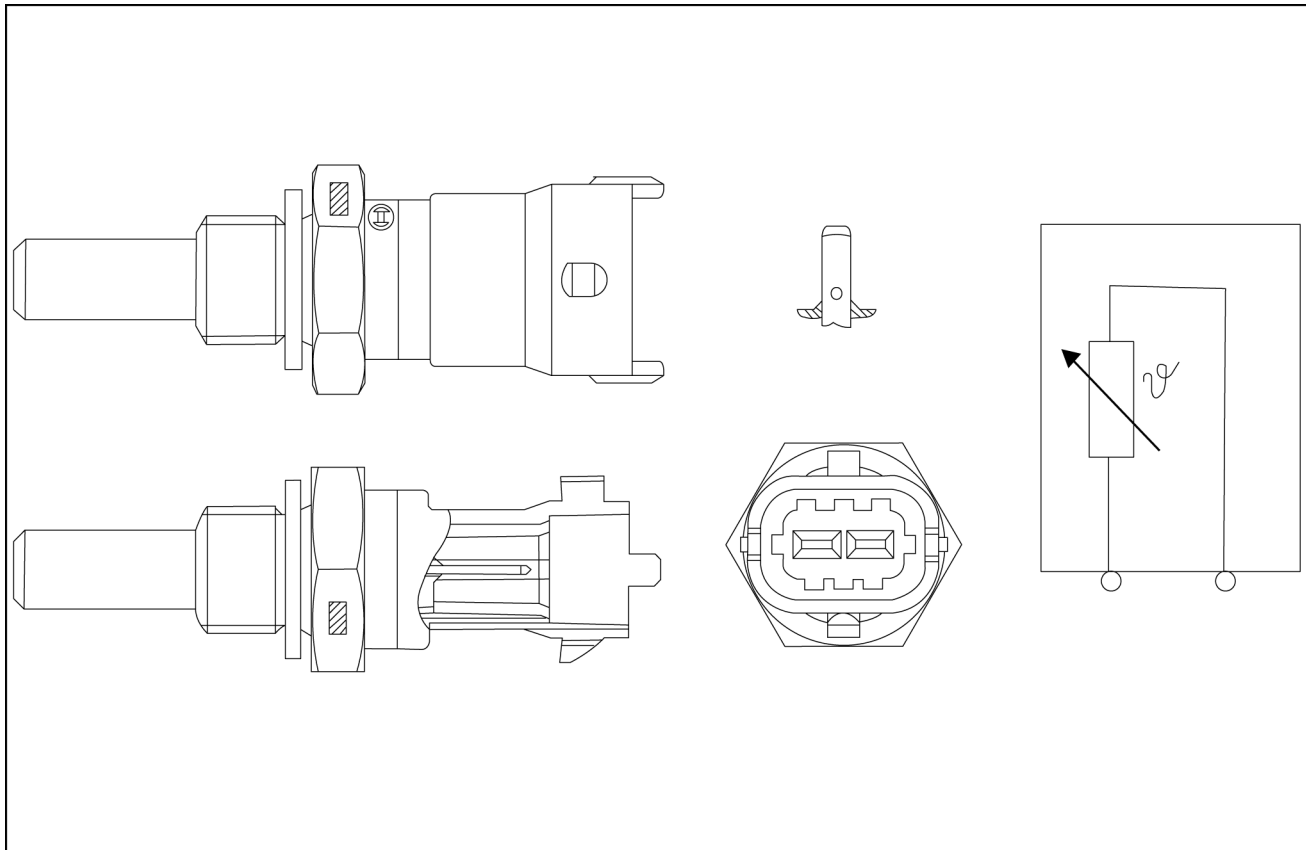
Index

Engine - 10

Selective Catalytic Reduction (SCR) exhaust treatment - 500

Coolant control valve - Dynamic description	22
Coolant control valve - Overview	21
Diesel Exhaust Fluid (DEF)/AdBlue® tank - Cleaning	31
Diesel Exhaust Fluid (DEF)/AdBlue® tank - Overview	20
Diesel Oxidation Catalyst (DOC) - Dynamic description	27
Diesel Oxidation Catalyst (DOC) - Overview	26
Selective Catalytic Reduction (SCR) exhaust treatment - Component identification	8
Selective Catalytic Reduction (SCR) exhaust treatment - Configure - Engine restart counter reset	29
Selective Catalytic Reduction (SCR) exhaust treatment - Dynamic description	5
Selective Catalytic Reduction (SCR) exhaust treatment - Dynamic description - Reduction of NOx	10
Selective Catalytic Reduction (SCR) exhaust treatment - Dynamic description Diesel Oxidation Catalyst (DOC)	9
Selective Catalytic Reduction (SCR) exhaust treatment - Overview - Emission Standard	7
Selective Catalytic Reduction (SCR) exhaust treatment - Overview - Hydraulic	14
Selective Catalytic Reduction (SCR) exhaust treatment - Overview – Thermal Management	11
Selective Catalytic Reduction (SCR) exhaust treatment - Service instruction - SCR fault repair verification test	28
Selective Catalytic Reduction (SCR) exhaust treatment - Technical Data - Nitrogen Oxides (NOx) and Ammonia (NH3) vs Temperature	4
Selective Catalytic Reduction (SCR) muffler and catalyst - Configure - Reset ECU data	30
Selective Catalytic Reduction (SCR) muffler and catalyst - Dynamic description - Clean Up Catalyst (CUC)	18
Selective Catalytic Reduction (SCR) muffler and catalyst - Overview	17
Selective Catalytic Reduction (SCR) muffler and catalyst - Sectional view	19

Fuel temperature sensor - Overview



NHIL13ENG1326FA 1

The fuel temperature sensor senses the temperature of the fuel to determine how much fuel must be sent in so that the emissions and fuel economy are kept in control.

Contents

Electrical systems - 55

Engine cooling system - 012

TECHNICAL DATA

Engine coolant temperature sensor	
General specification	3

FUNCTIONAL DATA

Engine coolant temperature sensor	
Overview	4

Contents

Electrical systems - 55

Engine intake and exhaust system - 014

TECHNICAL DATA

Intake air pressure and temperature sensor	
General specification	3
Exhaust flap actuator	
General specification	4

FUNCTIONAL DATA

Intake air pressure and temperature sensor	
Overview	5
Exhaust flap actuator	
Overview	6

De-rating

In the event of engine overheating, the control module will decrease the power of the engine proportionally to the temperature reached by the coolant.

Injection lead electronic control

Injection lead, or the start of fuel delivery expressed in degrees, can differ from one injection to the next, even from one cylinder to another. It is calculated similarly to delivery according to engine load, accelerator position, engine RPM and air admitted.

Lead is corrected as required:

- During acceleration
- According to water temperature

and to obtain:

- Reduced emissions, noise abatement, and no overload
- Better vehicle acceleration

High injection lead is set at start, based on water temperature.

Delivery start feedback is given by the variance in impedance by the electro valve.

Engine start

The accelerator pedal position signal is ignored at start. Start delivery is set exclusively based on water temperature, via a specific map. The control module enables the accelerator pedal, when it detects flywheel acceleration and RPM above what the starter can turn.

Cold start

Pre-post heating is activated when even only one of the three water, air or engine oil temperature sensors record a temperature below **10 °C (50 °F)**. The preheat warning light goes on when the ignition key is turned on. The light stays on for a variable period of time according to temperature, while the intake air heater raises the intake temperature, then the light starts blinking, at which point the engine can be started.

The warning light switches off with the engine running, while heater continues being fed for a variable period of time to complete post-heating. The operation is cancelled to avoid useless discharging of the batteries if the engine is not started within 20 - 25 seconds with the warning light blinking. The preheat curve is also variable based on battery voltage.

Hot start

When the key is turned on, the warning light will go on for about 2 seconds for a short test then turn off when all the temperature sensors read values above **10 °C (50 °F)**. The engine can be started at this point.

Run up

When the ignition key is turned on, the control unit transfers data stored from the engine stop to the main memory and diagnoses the system.

After run

At each engine stop, with the ignition key off, the control unit still remains fed by the main relay for a few seconds to enable the microprocessor to transfer data from the main volatile memory to a nonvolatile, cancelable and re-writable (eeprom) memory to make the information available for the next start.

This data essentially consists of:

- Miscellaneous settings, such as engine idling, etc.
- Settings of some components

Index

Electrical systems - 55

Engine control system - 015

Engine Control Unit (ECU) - Component identification	6
Engine Control Unit (ECU) - Overview	3
Engine speed/RPM sensor Camshaft - Install	13
Engine speed/RPM sensor Camshaft - Overview	9
Engine speed/RPM sensor Camshaft - Remove	12
Engine speed/RPM sensor Flywheel - Install	11
Engine speed/RPM sensor Flywheel - Overview	8
Engine speed/RPM sensor Flywheel - Remove	10

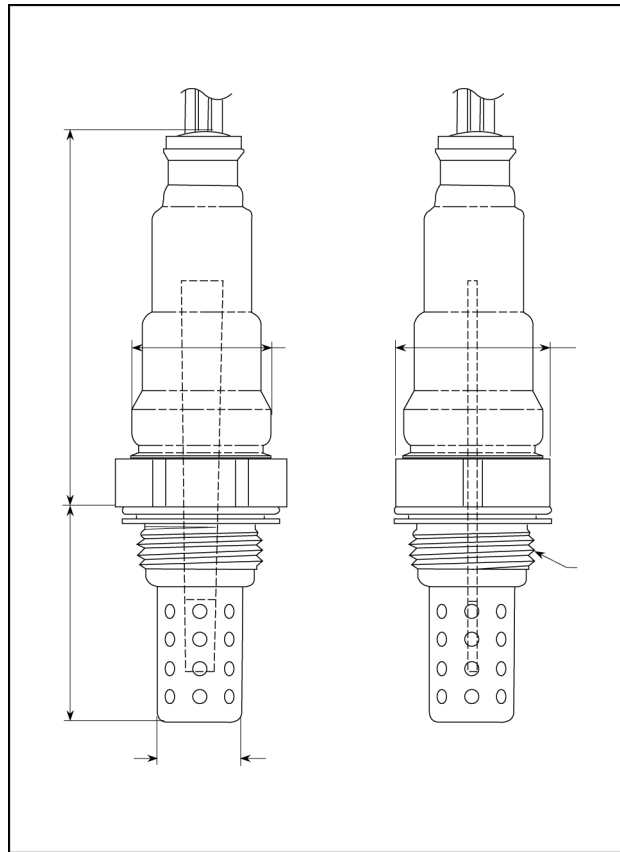
Index

Electrical systems - 55

Cold start aid - 202

Grid heater - Overview	3
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Ammonia (NH3) sensor - General specification

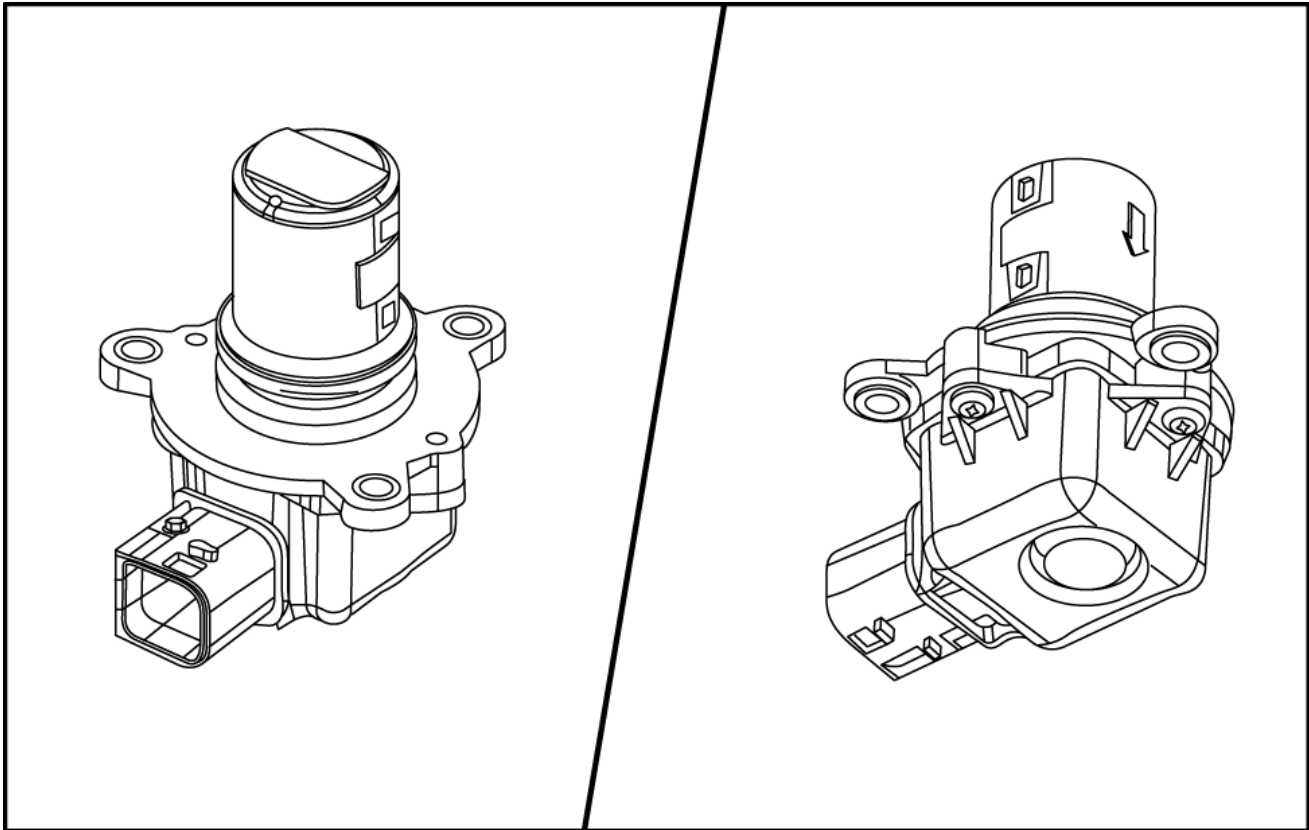


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Heater resistance at 21 °C (70 °F)	2.8 - 4.0 Ω
Heater control frequencies	100 - 600 Hz
Isolation between sensor circuit and housing at 21 °C (70 °F)	30 MΩ
Isolation between heating element and sensor housing at 21 °C (70 °F)	30 MΩ
Internal leak at 344.7 kPa (50.0 psi) measured at 21 °C (70 °F)	2.0 mL

NH3 sensor side wire colors	
Purple	Heater (+)
White	Heater (-)
Black	EMF_2
Tan	Trim resistor ground
Gray	EMF_1
Yellow	Trim resistor
Green	Temperature cell (+)
Brown	Signal ground

Diesel Exhaust Fluid (DEF)/AdBlue® quality sensor - Overview



NHIL13ENG1383AA 1

The quality of the Diesel Exhaust Fluid (DEF)/AdBlue® fluid is important to the proper function of the Selective Catalytic Reduction (SCR) system. The quality sensor monitors the quality of the fluid and reports this information to the Engine Control Unit (ECU) via the engine CAN data bus. The quality sensor is mounted to the bottom of the tank.

The sensor has two small sensing holes. The fluid enters one hole, and exits the other hole.

- By using two measuring modes, liquids that have similar heat conductivity can be distinguished.
- Measurements are taken approximately every twenty seconds.

If diesel is accidentally put into the DEF/AdBlue® tank, the sensor will detect bad concentration, once the diesel that is floating in the tank gets to the level of the quality sensor. If diesel enters the quality sensor, then the sensor must be replaced.

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