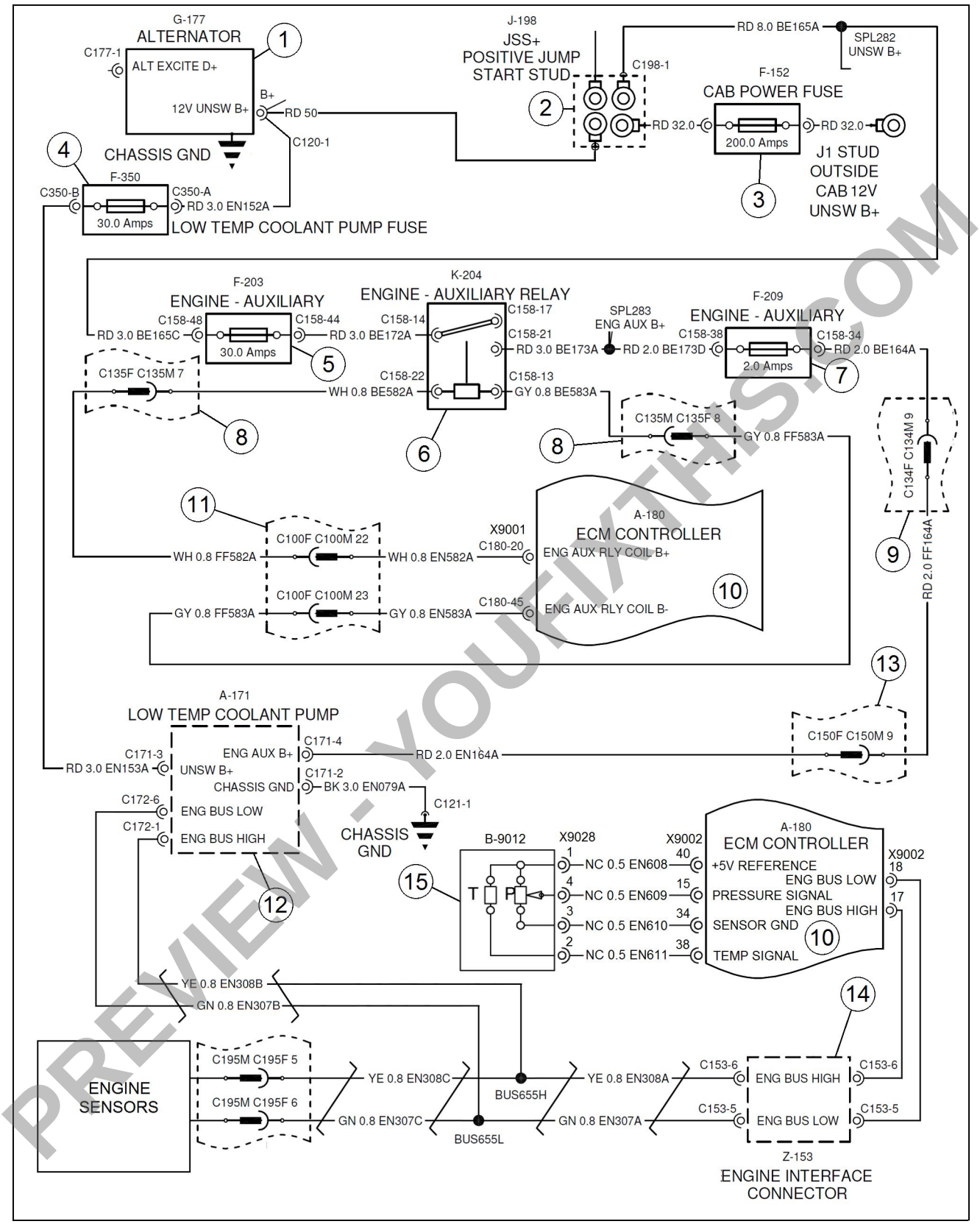
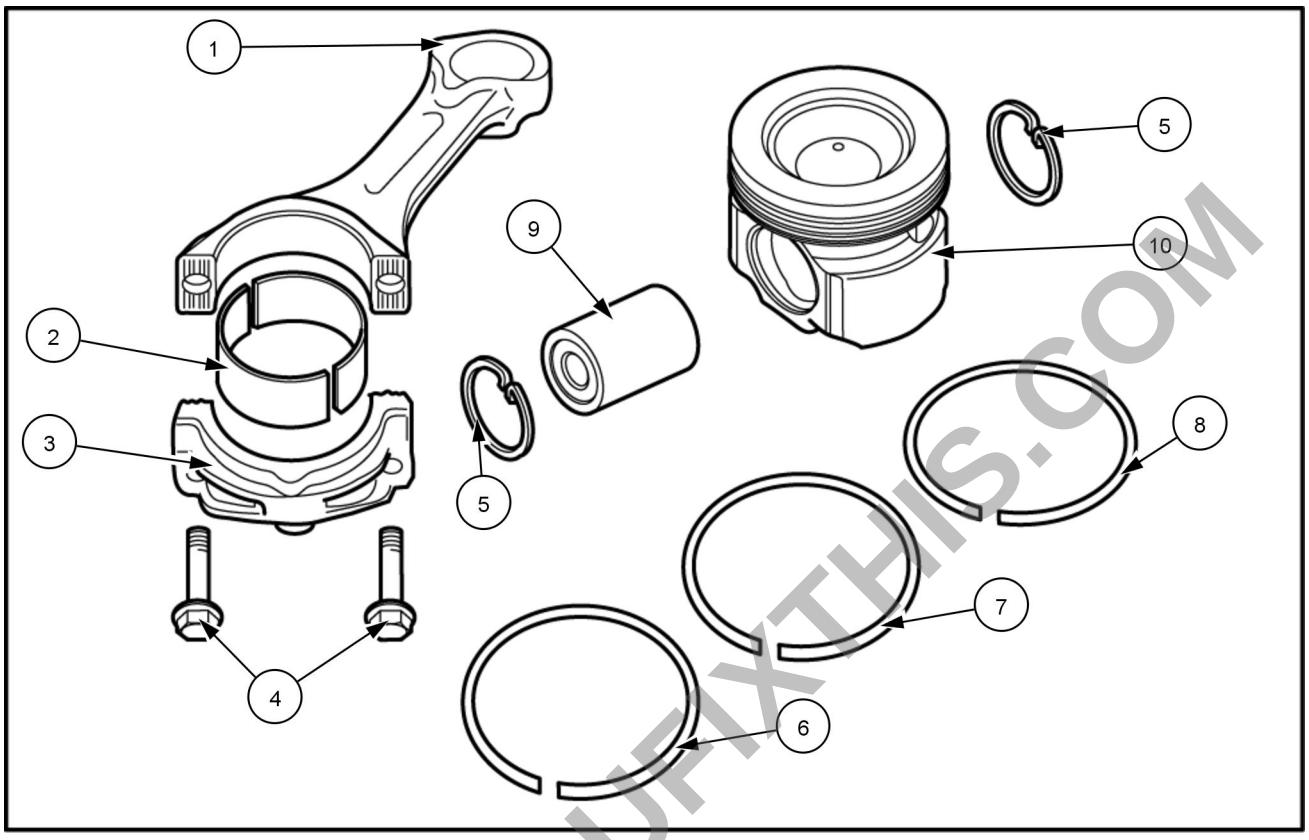


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Connecting rod and piston - Overview



83113624 1

(1) Connecting rod
(2) Half bearings
(3) Connecting rod cap
(4) Cap bolts
(5) Snap ring
(6) Oil control ring
(7) Bevel cut intermediate ring
(8) Trapazoidal combustion ring
(9) Piston pin
(10) Piston

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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.*

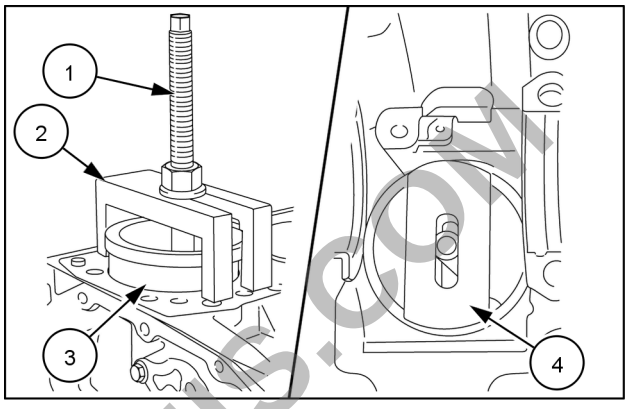
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Crankcase Liner - Remove

Prior operation:
Connecting rod and piston - Remove (10.105)

1. Use tool **380000366 (2)** in conjunction with tool **380000116 (4)** as shown in the figure.
2. Check to make sure the plate **(4)** rests on the cylinder liner correctly.
3. Screw down the nut of the screw **(1)** and extract the cylinder liner **(3)** from the crankcase.



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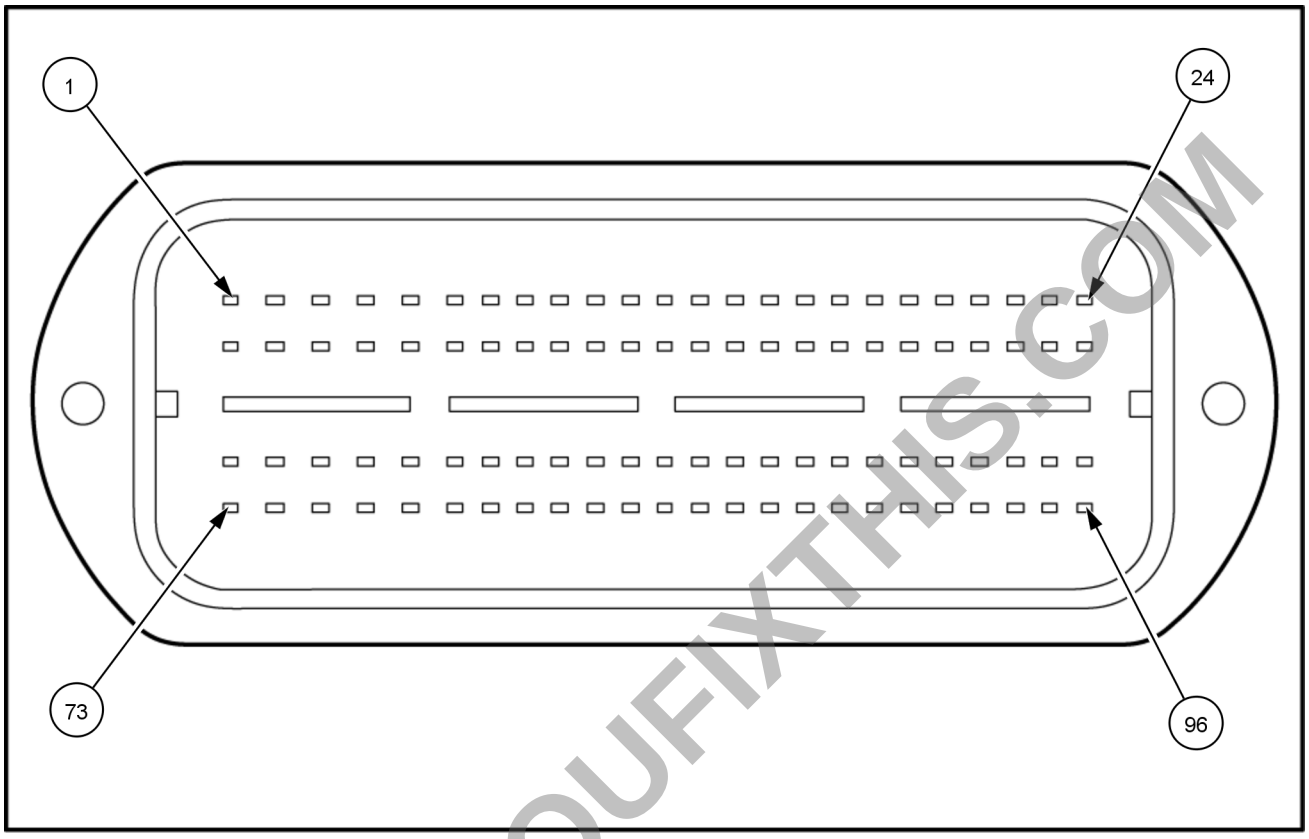
Next operation:
Crankcase Liner - Measure (10.001)

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EDC control unit Pin Out

Sensor and injector connector “B”



83113604 2

Connector side

ECU Pin	Function
01	Injector 4
02	Injector 6
03	Injector 5
06	Oil pressure/temperature sensor
07	Charge air pressure and temperature sensor
11	Rail pressure sensor
12	Fuel temperature sensor
13	Oil pressure/temperature sensor
17	Controller area network
18	Controller area network
25	Injector 4
26	Injector 6
27	Injector 5
31	Oil pressure/temperature sensor
32	Crankcase pressure sensor
35	Oil pressure/temperature sensor
36	Rail pressure sensor
37	Charge air pressure and temperature sensor
39	Coolant temperature sensor
42	Crankcase pressure sensor
49	Injector 1
50	Injector 2
51	Injector 3
58	High-pressure fuel pump
59	Fuel temperature sensor/coolant temperature sensor

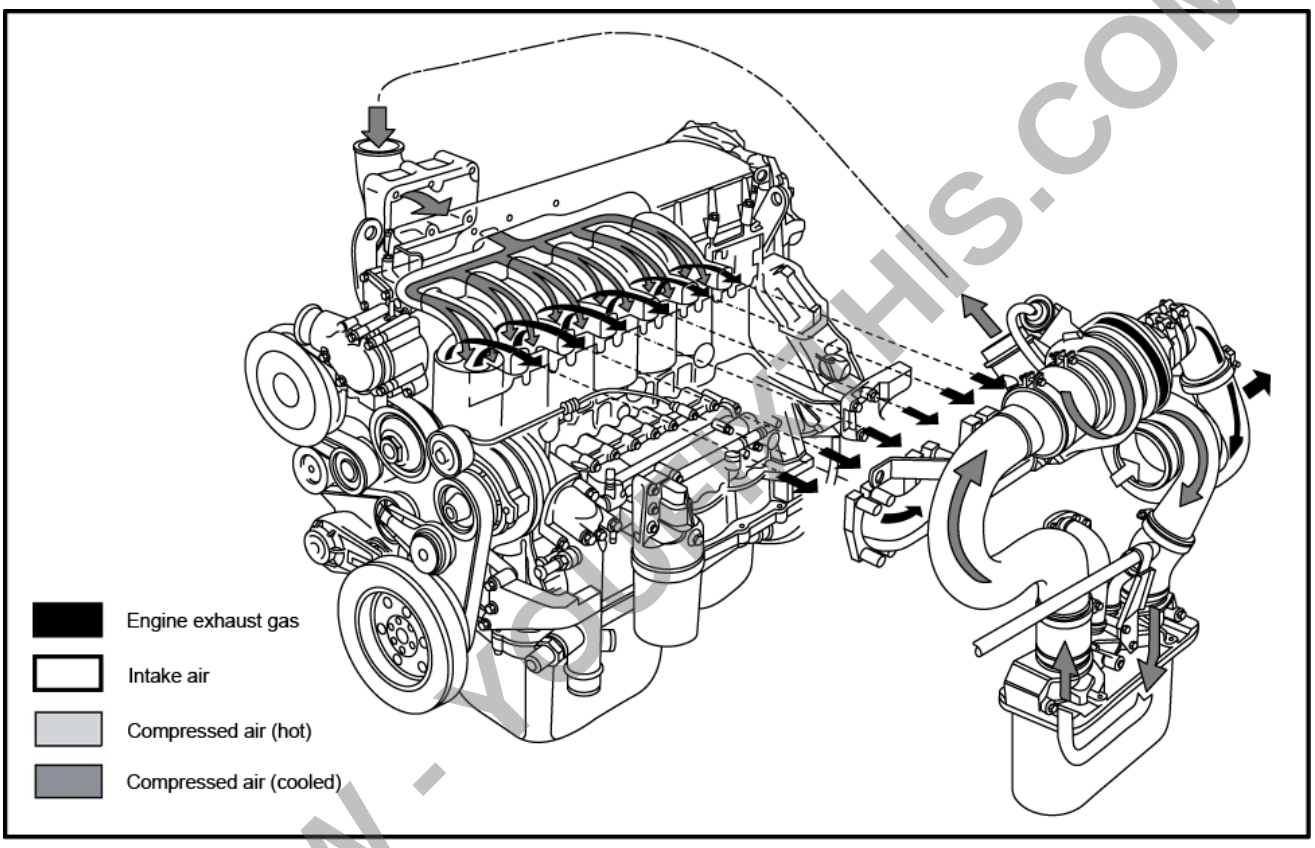
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Turbocharger - Overview

The turbocharger system comprises:

- air filter
- fixed geometry turbocharger;
- intercooler radiator.
- wastegated turbocharger
- air to water cooler



83111718A 1

Turbocharger diagram

Working principle

Turbocharging makes it possible to increase the air flow rate during the intake stroke of the combustion cycle. The supply of a greater amount of air improves combustion, increasing engine efficiency. The exhaust gases are conveyed towards the turbine of the high-pressure turbocharger and, giving up some of their energy, set the turbine in rotation. In this phase, the temperature of the exhaust gases drops to approximately **600 °C** (**1112 °F**).

Subsequently, the exhaust gases move the low-pressure turbocharger. On leaving the compressor, the temperature of the air increases so that it is cooled through a cooler (inter-stage intercooler) before being sent to the high-pressure turbocharger. On leaving the high-pressure compressor, the air is again cooled through the intercooler before it reaches the cylinders.

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Engine - Troubleshooting

Problem	Possible Cause	Correction
Engine does not develop full power	Clogged air cleaner	Inspect and replace air cleaner if necessary
	Fuel line obstructed	Check for crimped fuel line. Inspect fuel lifter for cleanliness
	Low cylinder compression	Check engine compression
	Insufficient fuel injection	Repair at authorized shop
	Improper valve lash adjustment	Adjust valves to correct tolerances
	Burned, worn or sticking valves	Inspect and replace as necessary
	Blown head gasket	Replace head gasket
	Worn or sticking piston rings	Overhaul as necessary
Low oil pressure	Engine oil level low	Fill to proper level
	Wrong grade of oil	Replace with correct grade oil
	Clogged oil pump filter	Change oil and filter
	Faulty oil pressure relief valve	Replace relief valve
	Worn oil pump drive shaft gears, or broken oil pipe	Inspect oil system and components. Replace defective components
	Excessive main or connecting rod bearing clearances	Replace bearings or shaft if necessary
Engine will not stop	Faulty starter switch	Replace starter switch
Low cylinder compression	Burned, worn or sticking valves	Replace valves
	Bent valve stem	Replace valves
	Broken or weak valve spring	Replace valve spring
	Blown cylinder head gasket	Replace head gasket
	Worn or sticking piston rings	Replace piston rings
	Scored piston	Replace piston
Poor engine idling	Air in injection pump	Purge air from the system
Oil pressure warning light fails to operate	Bulb burnt out	Replace the bulb
	Oil pressure sensor is faulty	Replace oil pressure sensor
	Warning light circuit faulty	Replace warning light circuit
Engine knocks	Diluted or thin oil	Change engine oil and filter. Check for fuel in oil
	Insufficient oil supply	Check engine oil level
	Low oil pressure	Inspect lube system for restrictions
	Worn crankshaft thrust bearing	Replace thrust bearing
	Excessive flywheel runout	Replace flywheel
	Excessive connecting rod or main bearing clearance	Replace bearings
	Seized bearing	Replace bearing and affected component if necessary
	Clogged oil passage	Clean out oil passages
	Bent or twisted connecting rod	Replace connecting rod
	Crankshaft journals out of round	Rework or replace crankshaft
	Excessive piston to cylinder bore clearance	Replace piston with correct oversized piston
	Excessive piston ring side clearance	Replace piston rings
	Broken or damaged ring	Replace piston ring
	Excessive piston pin clearance	Replace piston pin or bushing
	Seized piston	Replace piston and, if necessary, engine block
	Piston pin retainer loose or missing	Replace retainer
	Improper valve lash adjustment	Adjust valve lash to specification
	Worn valve lifter	Replace valve lifter
	Excessive timing gear backlash	Replace all timing gears
Excessive oil consumption	Engine oil level too high	Remove excess oil
	Leakage in cylinder head gasket	Replace head gasket

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Engine - Service limits

Engine specifications	
Compression Ratio	15.5 : 1
Bore	**135 mm** (**5.3 in**)
Stroke	**150 mm** (**5.9 in**)
Displacement	**12880 cm³**
Turbocharging	Inter-cooled, Direct injection
Turbocharger type	HONEYWELL HP Twin Stage Turbo (TST) T4
Lubrication	Forced by gear pump, relief valve single action
Oil Pressure (Warm engine) - Idling - Peak RPM	 **3 bar** (**43.5 psi**) **4.5 bar** (**65.3 psi**)
Cooling	Liquid cooled
Water pump control	Belt driven
Thermostat (Start of opening)	**82 - 86 °C** (**180 - 187 °F**)
Intake valve timing - Opens before TDC - Closes after BDC Exhaust valve timing - Opens before BDC - Closes after TDC	 **17 °** **6 °** **50 °** **9 °**
Valve lash setting (when engine is cold) - Intake - Exhaust	 **0.4 mm** (**0.016 in**) **0.6 mm** (**0.024 in**)
Firing Order	1 - 4 - 2 - 6 - 3 - 5
Injection pressure	-
Injector calibration	**290 - 302 bar** (**4205 - 4379 psi**)
Cylinder block and piston	
Bores for cylinder liners: - Upper - Lower	 **153.500 - 153.525 mm** (**6.043 - 6.044 in**) **152.000 - 152.025 mm** (**5.984 - 5.985 in**)
Cylinder liners external diameter: - Upper - Lower	 **153.461 - 153.486 mm** (**6.042 - 6.043 in**) **151.890 - 151.915 mm** (**5.980 - 5.981 in**)
Cylinder liner length	**252.2 mm** (**9.9 in**)
Clearance between the OD of liners and ID of bores - Upper - Lower	 **0.014 - 0.064 mm** (**0.001 - 0.003 in**) **0.085 - 0.135 mm** (**0.003 - 0.005 in**)
Cylinder liner - inside diameter - Protrusion	 **135.000 - 135.020 mm** (**5.315 - 5.316 in**) **0.045 - 0.075 mm** (**0.002 - 0.003 in**)
Pistons - Measuring dimension - External diameter - Pin bore	 **50 mm** (**2.0 in**) **134.903 - 134.933 mm** (**5.311 - 5.312 in**) **59.063 - 59.093 mm** (**2.325 - 2.326 in**)
Piston - cylinder liner	**0.0675 - 0.117 mm** (**0.003 - 0.005 in**)
Piston pin diameter	**58.993 - 59.000 mm** (**2.323 - 2.323 in**)
Piston pin - pin housing	**0.063 - 0.100 mm** (**0.002 - 0.004 in**)
Piston ring grooves - Top - Middle - Bottom	 **2.480 - 2.510 mm** (**0.098 - 0.099 in**) **2.580 - 2.610 mm** (**0.102 - 0.103 in**) **4.050 - 4.080 mm** (**0.159 - 0.161 in**)
Piston rings - Combustion ring	 **2.296 - 2.330 mm** (**0.090 - 0.092 in**)

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Voltage output			
Relative humidity	Minimum	Nominal	Maximum
10 %	**1145 mV**	**1205 mV**	**1265 mV**
15 %	**1294 mV**	**1355 mV**	**1416 mV**
20 %	**1440 mV**	**1500 mV**	**1560 mV**
25 %	**1583 mV**	**1640 mV**	**1697 mV**
30 %	**1717 mV**	**1770 mV**	**1823 mV**
35 %	**1848 mV**	**1905 mV**	**1962 mV**
40 %	**1969 mV**	**2030 mV**	**2091 mV**
45 %	**2090 mV**	**2155 mV**	**2220 mV**
50 %	**2207 mV**	**2275 mV**	**2343 mV**
55 %	**2328 mV**	**2400 mV**	**2472 mV**
60 %	**2444 mV**	**2520 mV**	**2596 mV**
65 %	**2561 mV**	**2640 mV**	**2719 mV**
70 %	**2687 mV**	**2770 mV**	**2853 mV**
75 %	**2808 mV**	**2895 mV**	**2982 mV**
80 %	**2914 mV**	**3020 mV**	**3126 mV**
85 %	**3024 mV**	**3150 mV**	**3276 mV**
90 %	**3137 mV**	**3285 mV**	**3433 mV**
95 %	**3240 mV**	**3410 mV**	**3581 mV**

Temperature dependent resistor (Ohms)			
Temperature	Minimum	Nominal	Maximum
-40.0 °C (-40.0 °F)	**39714 Ω**	**42172 Ω**	**44742 Ω**
-30 °C (-22 °F)	**23441 Ω**	**24760 Ω**	**26129 Ω**
-20 °C (-4 °F)	**14268 Ω**	**14995 Ω**	**15745 Ω**
-10 °C (14 °F)	**8937 Ω**	**9348 Ω**	**9770 Ω**
0 °C (32 °F)	**5750 Ω**	**5988 Ω**	**6230 Ω**
10 °C (50 °F)	**3792 Ω**	**3933 Ω**	**4074 Ω**
20 °C (68 °F)	**2560 Ω**	**2644 Ω**	**2729 Ω**
25 °C (77 °F)	**2116 Ω**	**2186 Ω**	**2256 Ω**
30 °C (86 °F)	**1759 Ω**	**1817 Ω**	**1875 Ω**
40 °C (104 °F)	**1229 Ω**	**1274 Ω**	**1319 Ω**
50 °C (122 °F)	**875 Ω**	**910 Ω**	**946 Ω**
60 °C (140 °F)	**634 Ω**	**662 Ω**	**690 Ω**
70 °C (158 °F)	**467 Ω**	**489 Ω**	**511 Ω**
80 °C (176 °F)	**349 Ω**	**367 Ω**	**385 Ω**
90 °C (194 °F)	**265 Ω**	**279 Ω**	**293 Ω**

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- Intermediate ring	**2.470 - 2.500 mm** (**0.097 - 0.098 in**)
- Oil control ring	**3.970 - 3.990 mm** (**0.156 - 0.157 in**)
Clearance between piston rings and grooves	
- Combustion ring	**0.150 - 0.214 mm** (**0.006 - 0.008 in**)
- Intermediate ring	**0.080 - 0.140 mm** (**0.003 - 0.006 in**)
- Oil control ring	**0.060 - 0.110 mm** (**0.002 - 0.004 in**)
Piston ring end gap in cylinder liners	
- Combustion ring	**0.35 - 0.45 mm** (**0.014 - 0.018 in**)
- Intermediate ring	**0.65 - 0.80 mm** (**0.026 - 0.031 in**)
- Oil control ring	**0.40 - 0.75 mm** (**0.016 - 0.030 in**)
Connecting rod	
Small end bush housing	
- Nominal	**63.000 - 63.030 mm** (**2.480 - 2.481 in**)
Big end bearing housing	
- Nominal	**100.000 - 100.030 mm** (**3.937 - 3.938 in**)
- Class 1	**100.000 - 100.010 mm** (**3.937 - 3.937 in**)
- Class 2	**100.011 - 100.020 mm** (**3.937 - 3.938 in**)
- Class 3	**100.021 - 100.030 mm** (**3.938 - 3.938 in**)
Small end bush diameter	
- Outside	**63.120 - 63.160 mm** (**2.485 - 2.487 in**)
- Inside	**59.060 - 59.076 mm** (**2.325 - 2.326 in**)
Big end bearing shell thickness	
- Red	**1.960 - 1.970 mm** (**0.077 - 0.078 in**)
- Green	**1.971 - 1.980 mm** (**0.078 - 0.078 in**)
- Yellow	**1.981 - 1.990 mm** (**0.078 - 0.078 in**)
Interference between small end bushing and housing	**0.090 - 0.160 mm** (**0.004 - 0.006 in**)
Clearance between piston pin and bushing	**0.060 - 0.073 mm** (**0.002 - 0.003 in**)
Connecting rod weight	
- Class A	**5537 - 5570 g** (**195.3 - 196.5 oz**)
- Class B	**5571 - 5604 g** (**196.5 - 197.7 oz**)
- Class C	**5605 - 5637 g** (**197.7 - 198.8 oz**)
Maximum connecting rod axis misalignment tolerance at **125 mm** (**4.9 in**) distance from connecting rod	**0.08 mm** (**0.003 in**)
Crankshaft	
Main journals	
- Rated value	**109.970 - 110.000 mm** (**4.330 - 4.331 in**)
- Class 1	**109.970 - 109.930 mm** (**4.330 - 4.328 in**)
- Class 2	**109.981 - 109.990 mm** (**4.330 - 4.330 in**)
- Class 3	**109.991 - 110.000 mm** (**4.330 - 4.331 in**)
Crank pins	
- Rated value	**95.970 - 96.000 mm** (**3.778 - 3.780 in**)
- Class 1	**95.970 - 95.980 mm** (**3.778 - 3.779 in**)
- Class 2	**95.981 - 95.990 mm** (**3.779 - 3.779 in**)
- Class 3	**95.991 - 96.000 mm** (**3.779 - 3.780 in**)
Main bearing shells	
- Red	**2.960 - 2.970 mm** (**0.117 - 0.117 in**)
- Green	**2.971 - 2.980 mm** (**0.117 - 0.117 in**)
- Yellow	**2.981 - 2.990 mm** (**0.117 - 0.118 in**)
Main bearing housings	
- Rated value	**116.000 - 116.030 mm** (**4.567 - 4.568 in**)
- Class 1	**116.000 - 116.010 mm** (**4.567 - 4.567 in**)
- Class 2	**116.011 - 116.020 mm** (**4.567 - 4.568 in**)
- Class 3	**116.021 - 116.030 mm** (**4.568 - 4.568 in**)
Clearance between bearing shells and main journals	**0.060 - 0.100 mm** (**0.0024 - 0.0039 in**)
Clearance between bearing shells and big ends	**0.060 - 0.100 mm** (**0.002 - 0.004 in**)

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Contents

INTRODUCTION

Engine 10

[10.001] Engine and crankcase 10.1

[10.101] Cylinder heads 10.2

[10.102] Pan and covers 10.3

[10.103] Crankshaft and flywheel 10.4

[10.105] Connecting rods and pistons 10.5

[10.106] Valve drive and gears 10.6

[10.110] Balancer and damper 10.7

[10.114] Pump drives 10.8

[10.206] Fuel filters 10.9

[10.218] Fuel injection system 10.10

[10.250] Turbocharger and lines 10.11

[10.254] Intake and exhaust manifolds and muffler 10.12

[10.304] Engine lubrication system 10.13

[10.310] Aftercooler 10.14

[10.400] Engine cooling system 10.15

[10.408] Oil cooler and lines 10.16

[10.414] Fan and drive 10.17

[10.500] Selective Catalytic Reduction (SCR) exhaust treatment 10.18

Electrical systems 55

[55.010] Fuel injection system 55.1

[55.012] Engine cooling system 55.2

[55.013] Engine oil system 55.3

[55.014] Engine intake and exhaust system 55.4

[55.015] Engine control system 55.5

[55.201] Engine starting system 55.6

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Index

Engine - 10

Engine and crankcase - 001

Crankcase - Install 16
Crankcase - Measure Protrusion 17
Crankcase Liner - Measure 12
Crankcase Liner - Remove 15
Crankcase Under block - Install 19
Crankcase Under block - Remove 18
Engine - Overview 7
Engine - Service instruction - Finding Top Dead Center (TDC) 10
Engine - Service limits 3
Engine - Troubleshooting 26
Engine - Troubleshooting 28
Engine support and mounts - Install 25
Engine support and mounts - Remove 24

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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 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 that, if not avoided, will result in death or serious injury.

WARNING indicates a hazardous situation that, if not avoided, could result in death or serious injury.

CAUTION indicates a hazardous situation that, if not avoided, could result in minor or moderate injury.

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

Machine safety

NOTICE: *Notice indicates a situation that, if not avoided, could result in machine or property damage.*

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 that 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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[55.202] Cold start aid 55.7
[55.301] Alternator 55.8
[55.988] Selective Catalytic Reduction (SCR) electrical system 55.9

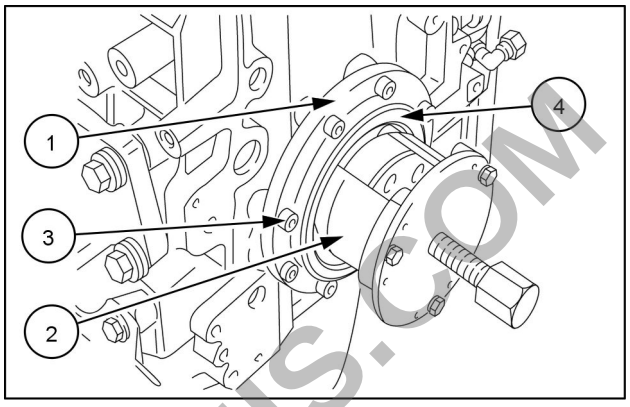
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Crankshaft oil seal Front seal - Remove

Prior operation:
Crankshaft damper - Remove (10.110)

1. Remove the seal **(4)** using tool **380000120 (2)** applied as shown in the figure.
2. Remove the bolts **(3)** and remove the cover **(1)**.



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Next operation:
Crankshaft oil seal Front seal - Install (10.103)

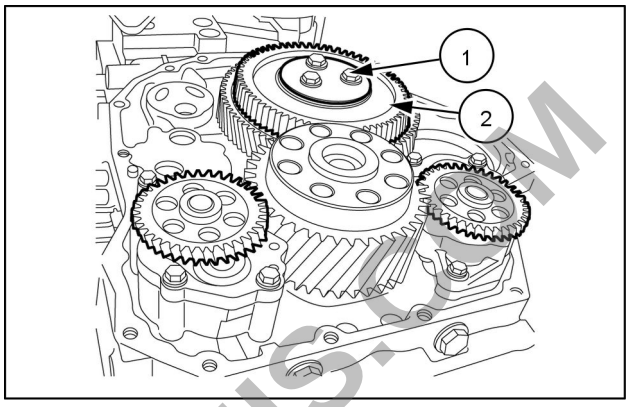
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Crankcase gears - Install

Prior operation:
Crankcase gears - Remove (10.114)

1. Install the idler gear **(2)**, stub shaft and retaining plate as an assembly.
2. Install the bolts **(1)** and torque to **30 N·m** (**22 lb ft**) then **90 °**.



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Next operation:
Crankcase ventilation system - Install (10.304)

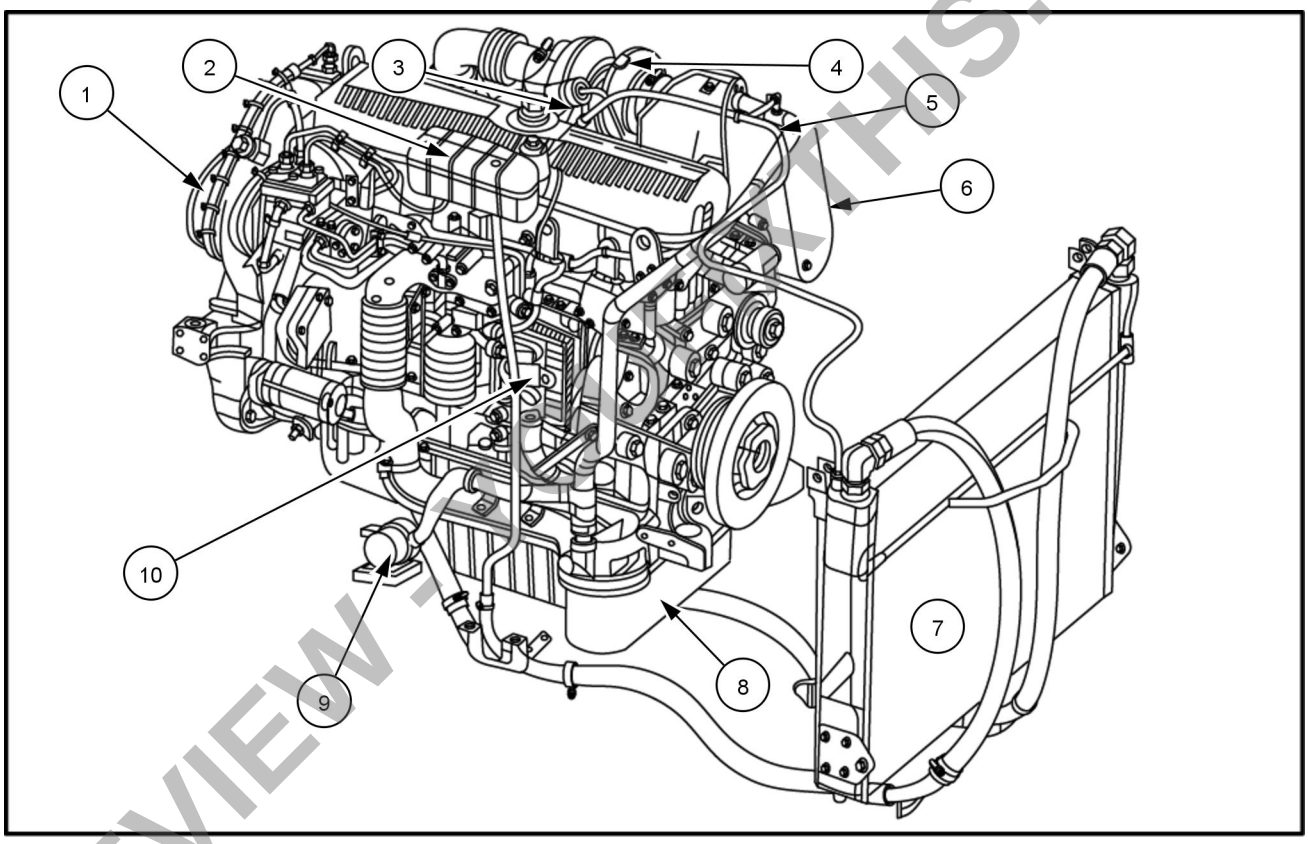
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Aftercooler - Overview

The Tier4B (final) emissions level Cursor 12.9L 2 stage turbo (TST) engine **(1)** employs a secondary Low Temperature Cooling (LTC) system to cool the intake air. Instead of using an air-to-air charge air cooler, there are two air-to-water intercoolers on the engine (one after the first turbocharger **(6)** located on the left hand side of the engine, and the other after the second turbocharger **(8)** located on the front the oil pan of the engine). These air-to-water coolers are cooled by a closed loop low temperature coolant system that is completely separate from the main engine cooling system. There is a separate LTC radiator **(7)** located on the front of the cooling package which cools this circuit.

This system is considered low temperature because it operates at less than **100.0 °C** (**212.0 °F**). Flow rate through this system is approximately **66.0 - 84.0 L/min** (**17.4 - 22.2 US gpm**). The secondary cooling system is comprised of the following components – electronically controlled and electrically powered water LTC coolant pump **(9)**, low temperature radiator **(7)**, clear LTC coolant reservoir **(2)**, LTC water temperature and pressure sensor located in the plumbing at the outlet of the first turbocharger cooler, and plumbing. The system uses the same Organic Acid Technology (OAT) coolant as the main engine cooling circuit. The LTC coolant pump is controlled by an engine CAN network signal from the Engine Control Unit (ECU).



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(1) Engine with secondary cooling system
(2) LTC coolant reservoir
(3) LTC system vent line shutoff valve
(4) Second turbocharger
(5) LTC system vent lines
(6) First turbocharger intercooler
(7) LTC radiator
(8) Second turbocharger intercooler
(9) LTC coolant pump
(10) Engine Control Unit (ECU)

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Electrical systems - 55

Fuel injection system - 010

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