



Disassembly and Assembly

C7 On-Highway Engine

YPG1-Up (Engine)
NPH1-Up (Engine)
KAL1-Up (Engine)
LBM1-Up (Engine)
SAP1-Up (Engine)
C7T1-Up (Engine)
WAX1-Up (Engine)

Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the "Safety Alert Symbol" and followed by a "Signal Word" such as "DANGER", "WARNING" or "CAUTION". The Safety Alert "WARNING" label is shown below.



The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning explains the hazard and can be either written or pictorially presented.

Operations that may cause product damage are identified by "NOTICE" labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. If a tool, procedure, work method or operating technique that is not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that the product will not be damaged or be made unsafe by the operation, lubrication, maintenance or repair procedures that you choose.

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Caterpillar dealers have the most current information available.



When replacement parts are required for this product Caterpillar recommends using Caterpillar replacement parts or parts with equivalent specifications including, but not limited to, physical dimensions, type, strength and material.

Failure to heed this warning can lead to premature failures, product damage, personal injury or death.

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Disassembly and Assembly Section

i02581591

Fuel Priming Pump - Remove and Install

SMCS Code: 1258-010

Removal Procedure

WARNING

Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire. To help prevent possible injury, turn the start switch off when changing fuel filters or water separator elements. Clean up fuel spills immediately.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

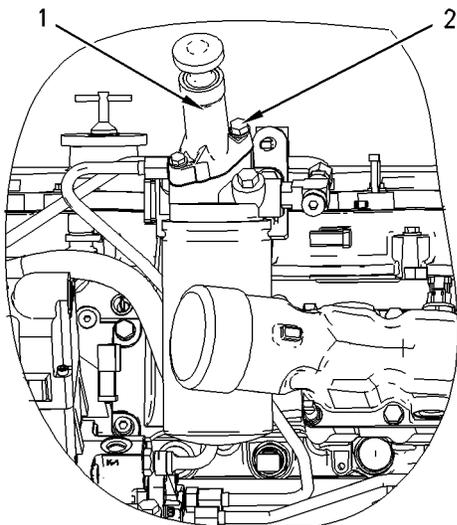


Illustration 1

g00987651

1. Remove bolts (2).

2. Remove fuel priming pump (1) and the gasket.

Installation Procedure

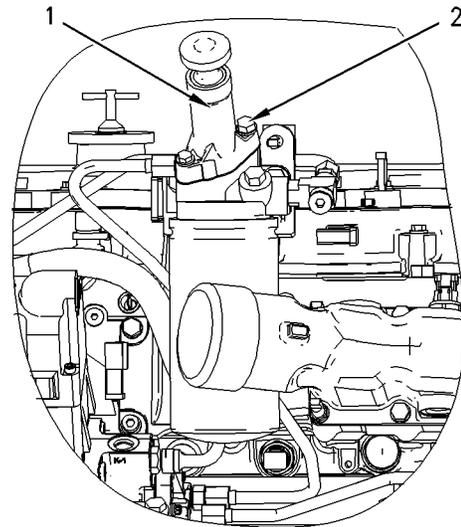


Illustration 2

g00987651

1. Position the gasket and fuel priming pump (1) on the fuel filter base.
2. Install bolts (2). Tighten bolts (2) to a torque of 25 ± 6 N·m (18 ± 4 lb ft).

i01921666

Fuel Filter Base - Remove and Install

SMCS Code: 1262-010

Removal Procedure

WARNING

Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire. To help prevent possible injury, turn the start switch off when changing fuel filters or water separator elements. Clean up fuel spills immediately.

NOTICE

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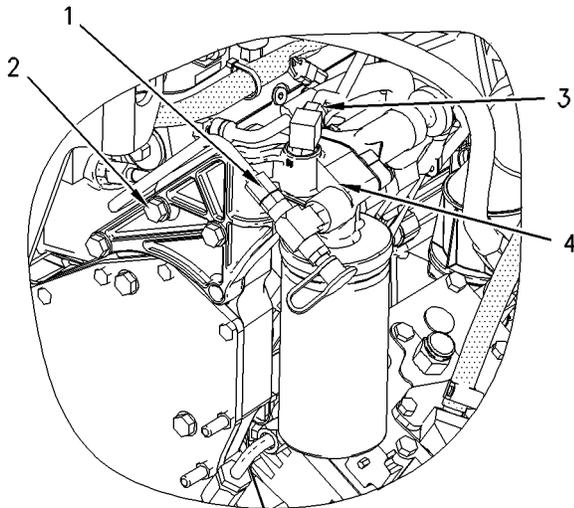


Illustration 3

g00987754

1. Disconnect tube assembly (1) and tube assembly (3).
2. Remove bolts (2).
3. Remove fuel filter base (4).

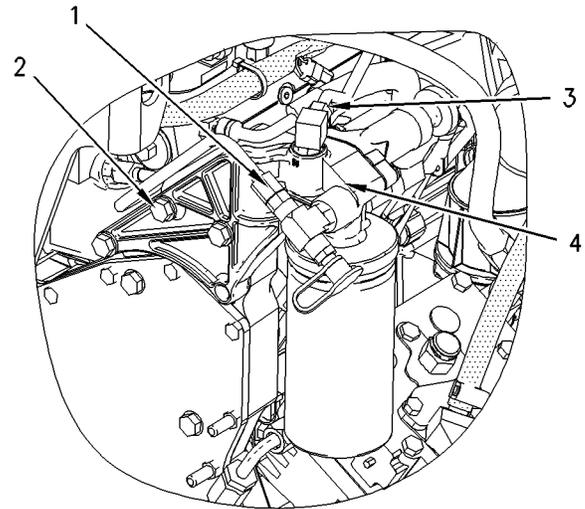
Installation Procedure

Illustration 4

g00987754

1. Position fuel filter base (4) on the engine.
2. Install bolts (2).
3. Connect tube assembly (1) and tube assembly (3).

i02226208

Fuel Transfer Pump - Remove

SMCS Code: 1256-011

Removal Procedure

Table 1

Required Tools			
Tool	Part Number	Part Description	Qty
A	218-8171	Bolt	1

Start By:

- a. Remove the unit injector hydraulic pump. Refer to Disassembly and Assembly, "Unit Injector Hydraulic Pump - Remove".

Note: Tooling (A) is required for replacement of the fuel transfer pump.

NOTICE

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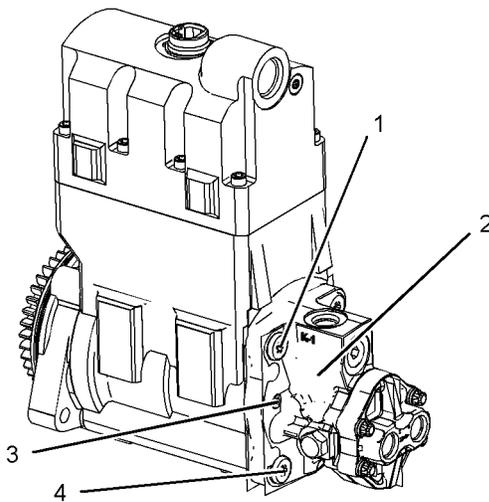


Illustration 5

g01123057

1. Mount the unit injector hydraulic pump in a vertical position on a work bench.

Note: Failure to maintain a vertical position results in misalignment of the internal components.

2. Remove bolts (3).
3. Remove tie bolt (1) that is located in the top left corner of the pump first.
4. Replace tie bolt (1) with Tooling (A).

Note: Tooling (A) has an undersized bolt head. Tooling (A) will prevent the body of the unit injector hydraulic pump from separating during service.

5. Tighten Tooling (A) to a torque of 10 N·m (89 lb in).
6. Start with tie bolt (4) in the lower left corner and remove the remainder of the bolts from fuel transfer pump (2).

7. Remove fuel transfer pump (2).

i02226252

Fuel Transfer Pump - Install

SMCS Code: 1256-012

Installation Procedure

Table 2

Required Tools			
Tool	Part Number	Part Description	Qty
A	218-8171	Bolt	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

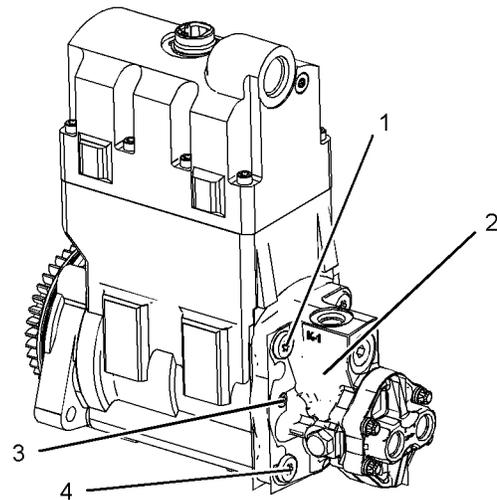


Illustration 6

g01123057

1. Position fuel transfer pump (2) on the unit injector hydraulic pump. Be sure to align the drive tang of the fuel transfer pump to the drive slot in the end of the pump shaft.
2. Install tie bolts (4). Tighten the bolts to a snug fit.
3. Remove Tooling (A) that is located in the upper left hole and install remaining tie bolt (1) to a snug fit.
4. Install bolts (3) for fuel transfer pump (2). Tighten the bolts to a snug fit.

5. Start in the lower left corner of the unit injector hydraulic pump and tighten tie bolts (4) to a torque of 28 ± 2 N·m (21 ± 1 lb ft) in a crisscross pattern. Torque the bolts again.
6. Tighten bolts (3) to a torque of 8.0 ± 0.4 N·m (71 ± 4 lb in).

End By:

- a. Install the unit injector hydraulic pump. Refer to Disassembly and Assembly, "Unit Injector Hydraulic Pump - Install".

i02325874

Unit Injector - Remove

SMCS Code: 1290-011

Removal Procedure

Table 3

Required Tools			
Tool	Part Number	Part Description	Qty
A	152-1057	Fuel Injector Installer As	1
B	274-9198	Leg	2

Start By:

- a. Remove the valve mechanism cover. Refer to Disassembly and Assembly, "Valve Mechanism Cover - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

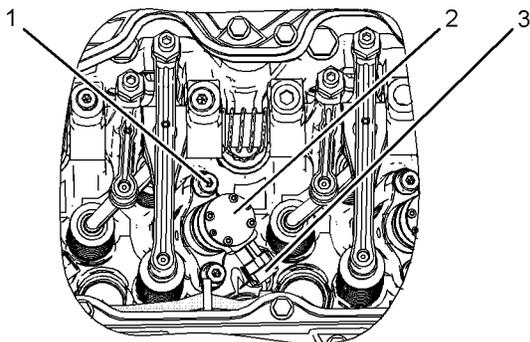


Illustration 7

g01123748

1. Disconnect harness assembly (3).

2. Remove socket head bolts (1) from unit injector (2).

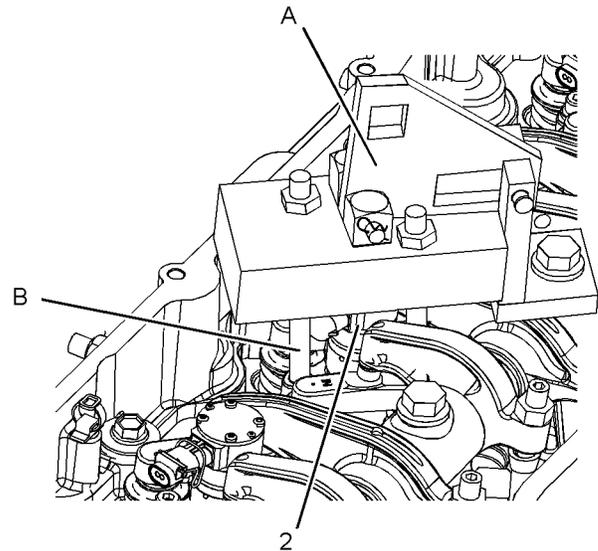


Illustration 8

g01161909

3. Use Tooling (A) and Tooling (B) to remove unit injector (2) from the cylinder head.

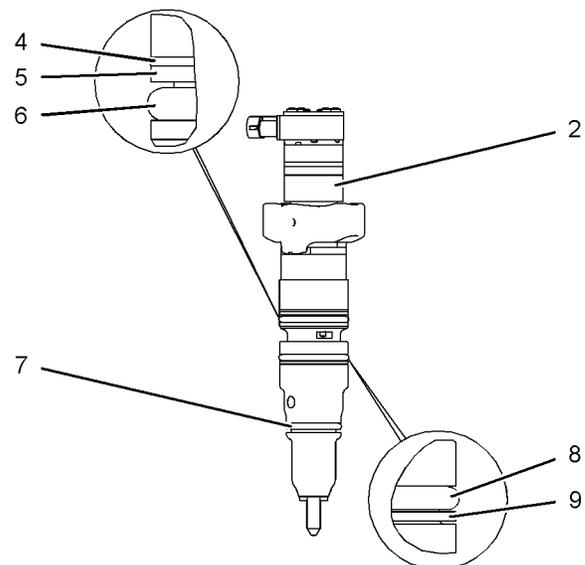
Note: Do not use a wire brush on the tip of the unit injector. Damage to the unit injector will occur.

Illustration 9

g01123753

4. Remove O-ring seal (6), O-ring seal (7), and O-ring seal (8) from unit injector (2).
5. Remove backup ring (4), backup ring (5), and backup ring (9).

i02325908

Unit Injector - Install

SMCS Code: 1290-012

Installation Procedure

Table 4

Required Tools			
Tool	Part Number	Part Description	Qty
A	152-1057	Fuel Injector Installer As	1
C	272-1149	Leg	2
D	-	Scotch Brite	1
E	149-2955	Seal Protector	1
F	149-2956	Seal Installer	1
G	1U-5718	Vacuum Pump	1
	4C-4057	Bottle Assembly	1
	169-7372	Clear Plastic Tubing	1
H	9U-5470	Reamer	1
J	4C-6161	Tube Brush	1
K	9U-6862	Tapered Brush	1
L	4C-6774	Vacuum Gun Kit	1
M	4C-5027	Tap Wrench	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Evacuate as much fuel and oil as possible from the cylinder head before installing the unit injector. Several evacuations may be necessary. Use Tooling (G) to remove the fuel and oil from the cylinder.

Note: Tooling (L) is available to clean loose material from the sleeve bore and the cylinder.

2. Clean the carbon from the sleeve, the sleeve bore and the end of the unit injector. Clean the carbon from the seat area that is inside of the cylinder head. A fine grade of Tooling (D) is preferred. Clean the carbon from the cylinder head. If the sleeve of the unit injector has been removed from the engine, use Tooling (H) to remove only carbon from the surface of the sleeve. If the sleeve of the unit injector is installed in the engine, use Tooling (J) to clean the carbon deposit from the inside of the sleeve.

The following procedure is the preferred method of cleaning the sleeve bore.

Place a 38 mm (1.5 inch) square piece of Scotch Brite material on the end of Tooling (K). Twist Tooling (K) with Tooling (M) against the lower surface of the sleeve bore.

The surface should be cleaned until the surface is smooth and shiny. The entire sleeve bore should be cleaned in order to remove any loose carbon particles.

Note: Tooling (L) is available to clean loose material from the sleeve bore and the cylinder.

NOTICE

The correct procedures and tooling specifications must always be used. Failure to follow any of the procedures may result in damage, malfunction, or possible engine failure.

NOTICE

The O-ring seals and the backup rings must be installed in the correct orientation. Damaged seals will result in excessive oil consumption or excessive leakage under the valve cover. Use care to prevent nicks or damage to the seals.

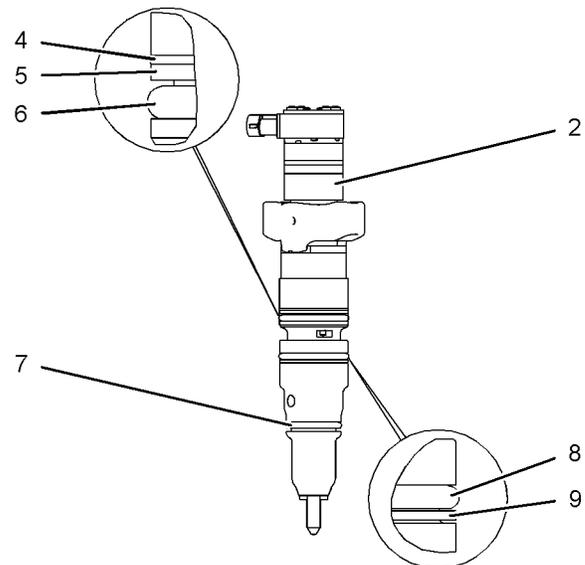


Illustration 10

g01123753

3. Lubricate O-ring seal (6), O-ring seal (7), O-ring seal (8), and the sleeve bore of the unit injector sparingly with clean engine oil.
4. Use Tooling (E) and Tooling (F) to install backup ring (4), backup ring (5), O-ring seal (6), backup ring (9), and O-ring seal (8).
5. Install O-ring seal (7).

6. Lubricate the O-ring seals and the backup rings on the unit injector with clean engine oil before installation.

Note: Proper installation of the unit injector is very important. Damage to the upper high pressure seals can cause excessive oil leakage under the valve cover. This may cause the engine not to start due to a low actuation pressure. Damage to the lower high pressure seals may allow high pressure oil to leak into the fuel supply passage. This will result in excessive oil consumption.

Note: Do not hit or strike the unit injector during installation.

7. Record the serial number for the injector and the injector confirmation code. When you install a new unit injector the E-Trim value must be programmed into the Engine Control Module. For more information, refer to Troubleshooting, "Injector Code - Calibrate".

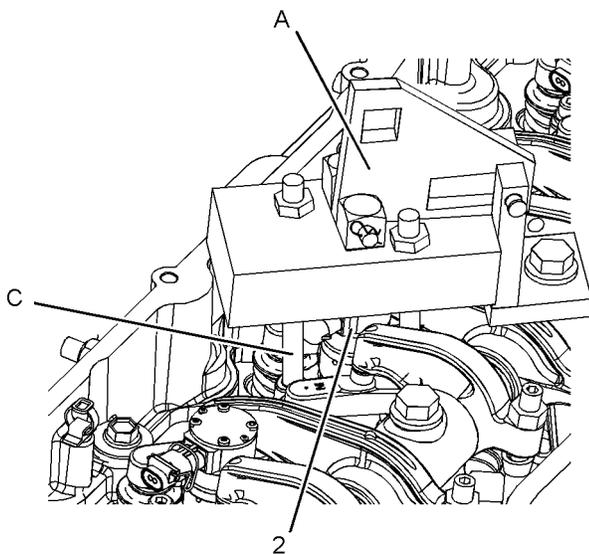


Illustration 11

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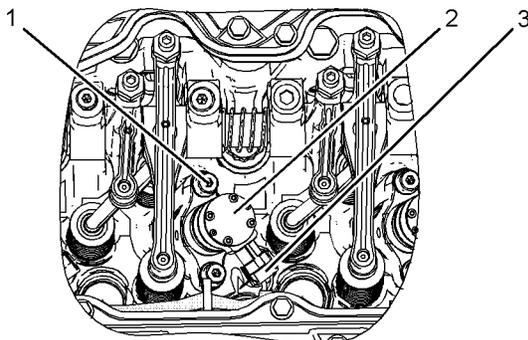


Illustration 12

g01123748

8. Use Tooling (A) and Tooling (C) to install unit injector (2) into the cylinder head.

9. Install socket head bolt (1) on the exhaust side of the bracket. Tighten the exhaust side of socket head bolt (1) until the bolt is seated. Tighten the inlet side of socket head bolt (1) to a torque of 12 ± 1 N·m (9 ± 1 lb ft).

10. Connect harness assembly (3).

End By:

- a. Install the valve mechanism cover. Refer to Disassembly and Assembly, "Valve Mechanism Cover - Remove and Install".

i02300862

Unit Injector Sleeve - Remove

SMCS Code: 1713-011

Removal Procedure

Table 5

Required Tools			
Tool	Part Number	Part Description	Qty
A	1P-3042	Plug Tap	1
B	9U-6858	Bridge Plate	1
	221-9778	Puller Stud	1
	4K-0367	Full Nut	1
	5P-8247	Hard Washer	1
	9U-6877	Thrust Bearing	1
C	221-9803	Rubber Stopper	1

Start By:

- a. Remove the unit injectors. Refer to Disassembly and Assembly, "Unit Injector - Remove".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Drain the coolant from the cooling system into a suitable container for storage or disposal. Refer to Operation and Maintenance Manual, "Cooling System Coolant - Change".
2. Position Tooling (C) at the bottom of the unit injector sleeve.

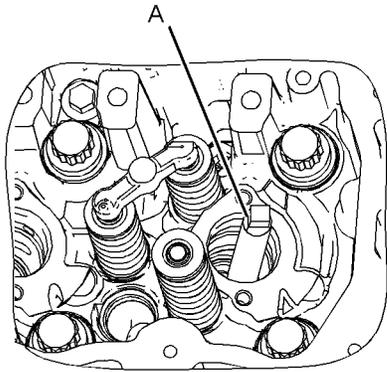


Illustration 13

g01123847

3. Coat Tooling (A) with clean grease. Use Tooling (A) to cut threads into the unit injector sleeve.

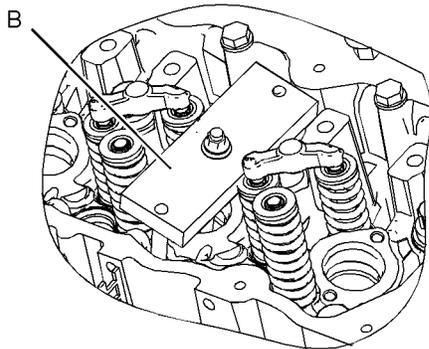


Illustration 14

g01123850

4. Use Tooling (B) to remove the unit injector sleeve.

i03145071

Unit Injector Sleeve - Install

SMCS Code: 1713-012

Installation Procedure

Table 6

Required Tools			
Tool	Part Number	Part Description	Qty
D	221-9777	Sleeve Installer	1
E	4C-9506	Retaining Compound	1
F	4C-5552	Large Bore Brush	1
G	6V-6640	Sealant	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Thoroughly clean the unit injector sleeves and the bores for the unit injectors. Tooling (F) may be used on the bores.

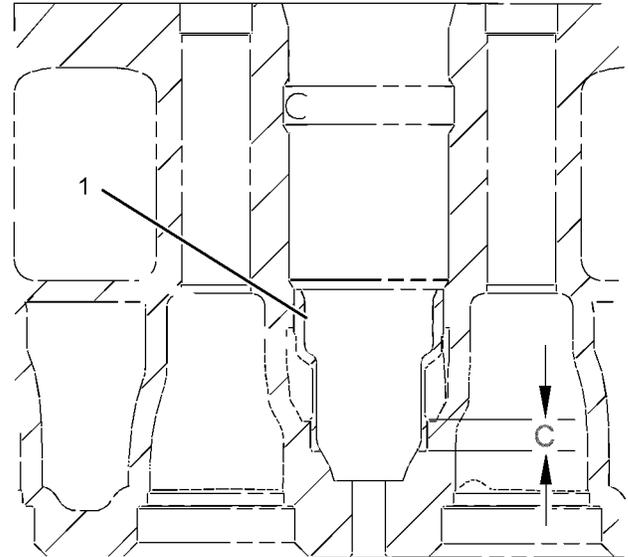


Illustration 15

g01618682

2. Apply Tooling (G) to bores prior to installation.
3. Apply a thin coating of Tooling (E) around the outer circumference of unit injector sleeve (1) at Area (C).
4. Use Tooling (D) and a hammer to position the unit injector sleeve in the cylinder head.

Note: Allow Tooling (E) to cure for two hours at 21 °C (70 °F) before filling the engine with fuel or coolant. Longer curing time is required for lower temperatures.

5. Fill the cooling system. Refer to Operation and Maintenance Manual, "Cooling System Coolant - Change".

End By:

- a. Install the unit injectors. Refer to Disassembly and Assembly, "Unit Injector - Install".

i02227961

Unit Injector Hydraulic Pump - Remove

SMCS Code: 1714-011

Removal Procedure

Table 7

Required Tools			
Tool	Part Number	Part Description	Qty
A	192-5092	Removal Tool	1

NOTICE

Keep all parts clean from contaminants.

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NOTICE

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Dispose of all fluids according to local regulations and mandates.

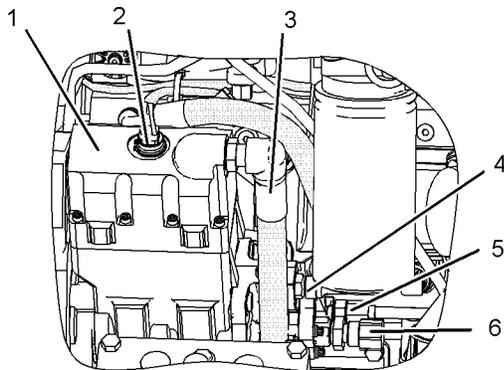


Illustration 16

g01127843

1. Disconnect tube assembly (4), tube assembly (5), and tube assembly (6).
2. Use Tooling (A) in order to disconnect hose assembly (3).

3. Disconnect harness assembly (2) from unit injector hydraulic pump (1).

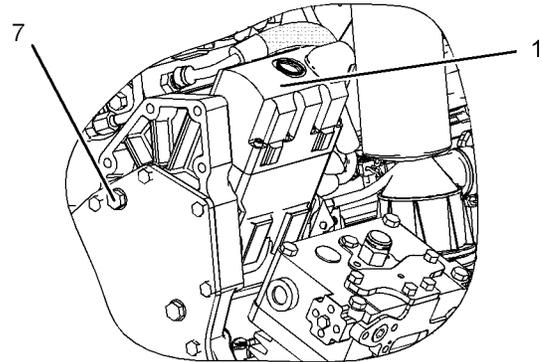


Illustration 17

g01127845

4. Remove bolts (7). Remove unit injector hydraulic pump (1).

i02227969

Unit Injector Hydraulic Pump - Install

SMCS Code: 1714-012

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

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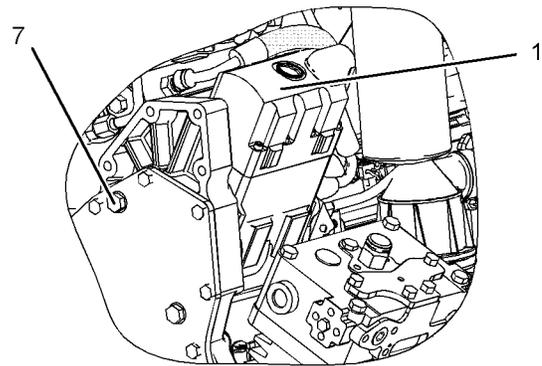


Illustration 18

g01127845

1. Position unit injector hydraulic pump (1) in the front housing.
2. Install bolts (7).

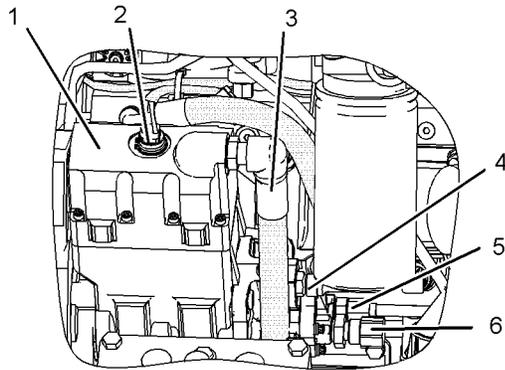


Illustration 19

g01127843

3. Connect hose assembly (3).
4. Connect tube assembly (4), tube assembly (5), and tube assembly (6).
5. Connect harness assembly (2) to unit injector hydraulic pump (1).

i02228143

Modulating Valve - Remove and Install

SMCS Code: 3139-010

Removal Procedure

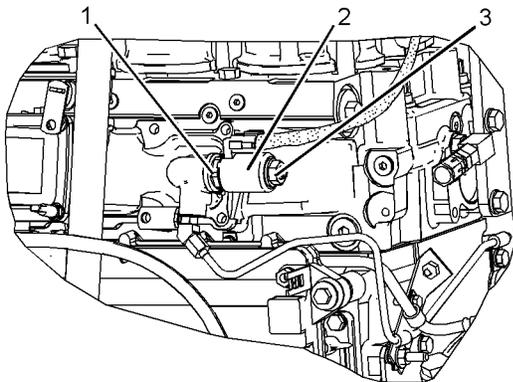


Illustration 20

g01124071

1. Disconnect the harness assembly from solenoid assembly (2).
2. Loosen nut (3) in order to allow solenoid assembly (2) to rotate around valve assembly (1) during the removal procedure.
3. Loosen valve assembly (1). Remove valve assembly (1) and solenoid assembly (2).

Installation Procedure

Table 8

Required Tools			
Tool	Part Number	Part Description	Qty
A	5P-3975	Rubber Lubricant	1

1. Apply a small amount of Tooling (A) to the O-ring seals prior to installation of the solenoid.

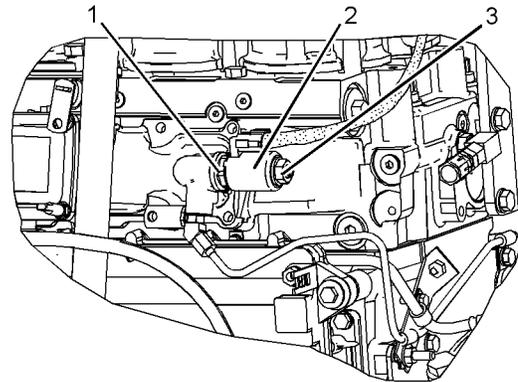


Illustration 21

g01124071

Note: Make sure that nut (3) is loose prior to installation.

2. Install valve assembly (1) and solenoid assembly (2). Tighten the valve assembly to a torque of 50 ± 5 N·m (37 ± 4 lb ft).
3. Tighten nut (3) to a torque of 13 ± 2 N·m (115 ± 18 lb in).
4. Connect the harness assembly to solenoid assembly (2).

i02236344

Turbocharger - Remove

SMCS Code: 1052-011

Removal Procedure

NOTICE

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NOTICE

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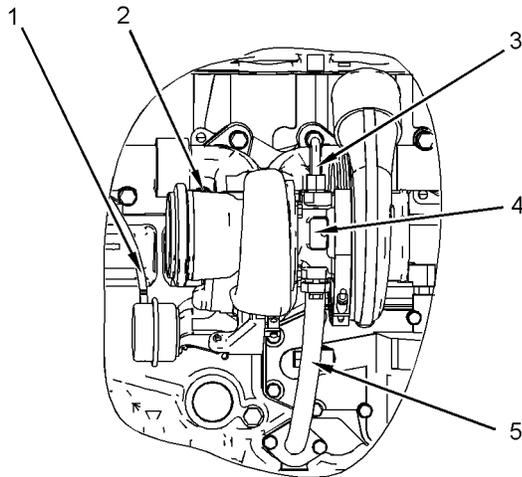


Illustration 22

g01031231

1. Disconnect hose assembly (1), if necessary.
2. Disconnect tube assembly (3) and tube assembly (5).
3. Remove nuts (2), turbocharger (4), and the gasket from the exhaust manifold.

i02228177

Turbocharger - Install

SMCS Code: 1052-012

Installation Procedure

Table 9

Required Tools			
Tool	Part Number	Part Description	Qty
A	5P-3931	Anti-Seize Compound	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Apply Tooling (A) on the threads of the mounting studs for the turbocharger.

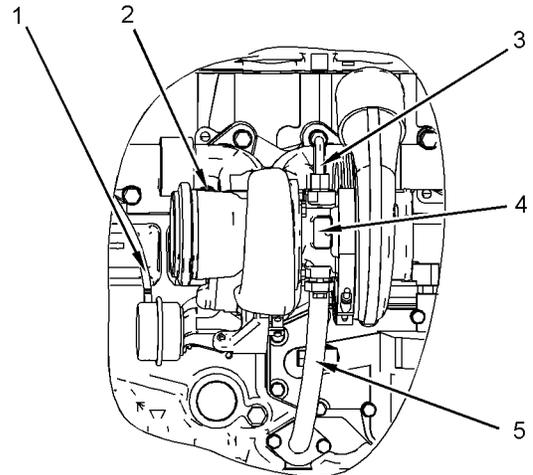


Illustration 23

g01031231

2. Position the turbocharger gasket and turbocharger (4) on the exhaust manifold. Install nuts (2).
3. Tighten nuts (2) to a torque of 54 ± 5 N·m (40 ± 4 lb ft).
4. Connect tube assembly (3) and tube assembly (5).
5. Connect hose assembly (1).

i02228217

Exhaust Manifold - Remove and Install

SMCS Code: 1059-010

Removal Procedure

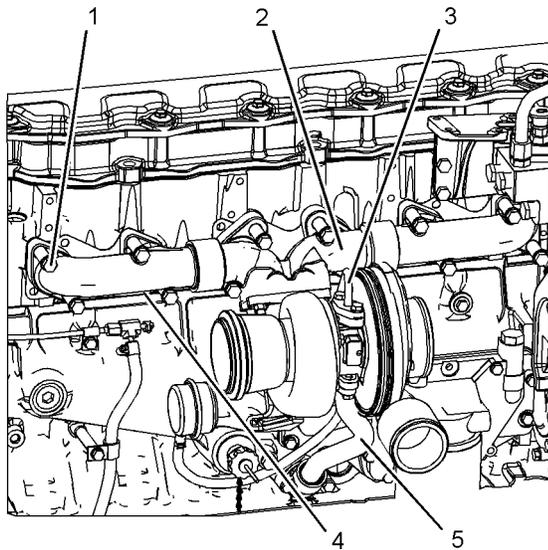


Illustration 24

g01124147

1. Disconnect tube assembly (3) and tube assembly (5).
2. Attach a suitable lifting device to exhaust manifold (2) and the turbocharger. The weight of exhaust manifold (2) and the turbocharger is approximately 40 kg (88 lb).
3. Remove bolts (1) and locks (4).
4. Remove exhaust manifold (2), the turbocharger, and the gaskets from the cylinder head assembly.

Installation Procedure

Table 10

Required Tools			
Tool	Part Number	Part Description	Qty
A	2P-2333	High Temperature Sealer	1
B	5P-3931	Anti-Seize Compound	1

NOTICE

Excessive use of sealant can cause damage to components.

To avoid component damage use only the amount of sealant necessary for the application.

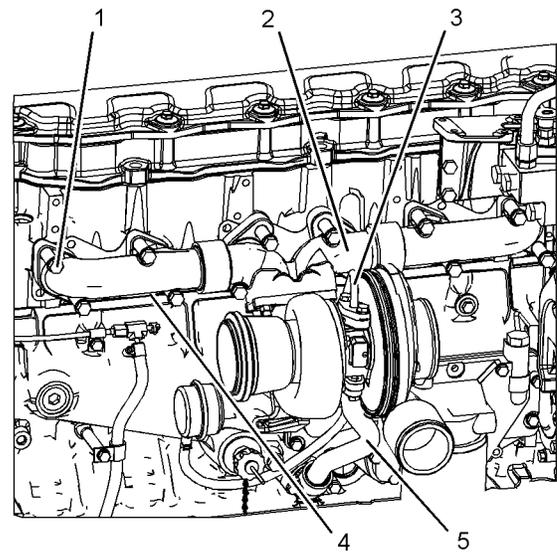


Illustration 25

g01124147

1. Apply Tooling (A) to the outside diameter of the male ends of exhaust manifold (2). Assemble exhaust manifold (2) and remove the excess sealer from the joints.
2. Apply Tooling (B) to the threads of bolts (1). Attach a suitable lifting device to exhaust manifold (2) and the turbocharger. The weight of exhaust manifold (2) and the turbocharger is approximately 40 kg (88 lb). Position the gaskets, exhaust manifold (2), and the turbocharger on the cylinder head assembly. Install locks (4) and bolts (1).
3. Connect tube assembly (3) and tube assembly (5).

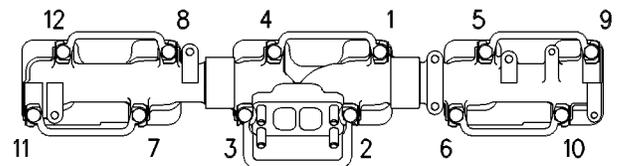


Illustration 26

g00617739

4. Tighten Bolt (1) through Bolt (12) in a numerical sequence.

Tighten bolts to the following torque. 4 ± 1 N·m
(35 ± 9 lb in)

5. Tighten Bolt (1) through Bolt (12) in a numerical sequence.

Tighten bolts to the following torque. .. 45 ± 5 N·m
(33 ± 4 lb ft)

6. Bend the locking tab over the flat of each bolt head.

Note: Prior to starting or running the engine, allow the sealant in the exhaust manifold joints to air dry for 24 hours.

i02228257

Air Inlet Heater Solenoid - Remove and Install

SMCS Code: 1090-010-OD

Removal Procedure

WARNING

Disconnect batteries before performance of any service work.

1. Disconnect the battery. Refer to Operation and Maintenance Manual, "Battery or Battery Cable - Disconnect".

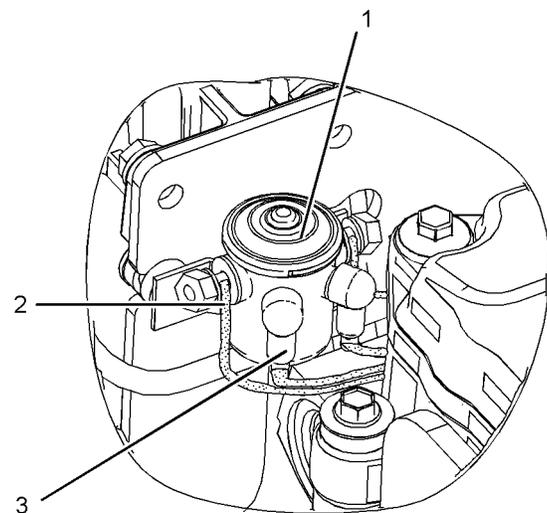


Illustration 27

g01124203

2. Disconnect harness assemblies (2) and harness assemblies (3).
3. Remove solenoid (1).

Installation Procedure

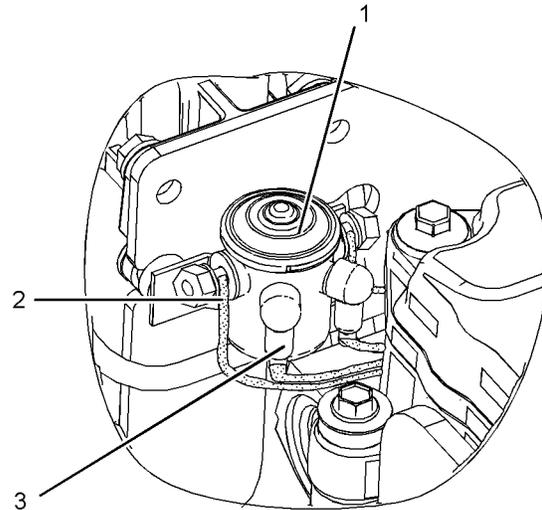


Illustration 28

g01124203

1. Position solenoid (1) on the engine.
2. Connect harness assemblies (2) and harness assemblies (3).
3. Connect the battery. Refer to Operation and Maintenance Manual, "Battery or Battery Cable - Disconnect".

i02228289

Inlet and Exhaust Valves - Remove and Install

SMCS Code: 1105-010

Removal Procedure

Table 11

Required Tools			
Tool	Part Number	Part Description	Qty
A	5S-1330	Valve Spring Compressor	1

Start By:

- a. Remove the cylinder head assembly. Refer to Disassembly and Assembly, "Cylinder Head - Remove".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

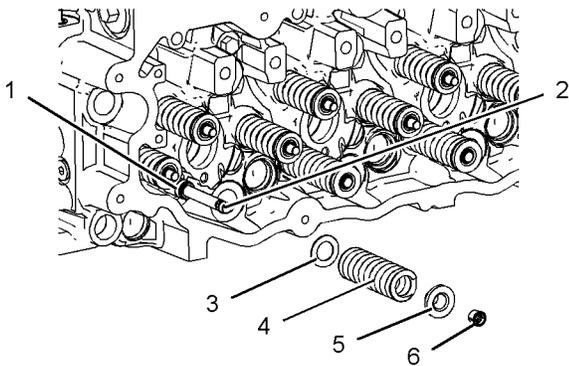


Illustration 29

g01127720

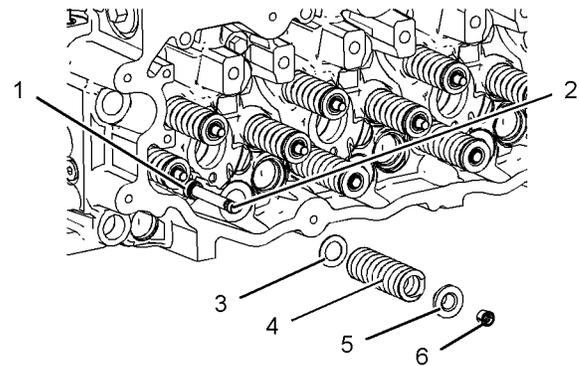


Illustration 30

g01127720

⚠ WARNING

The valve spring keepers can be thrown from the valve when the valve spring compressor is released. Ensure that the valve spring keepers are properly installed on the valve stem. To help prevent personal injury, keep away from the front of the valve spring keepers and valve springs during the installation of the valves.

Note: The following components of the exhaust valves are different from the components of the inlet valves: spring retainer (5), valve spring (4), and valve (2).

1. Use Tooling (A) to compress valve spring (4). Remove retainer locks (6).
2. Remove Tooling (A). Remove spring retainer (5), valve spring (4), and washer (3).
3. Remove valve seal (1) and valve (2).

Installation Procedure

Table 12

Required Tools			
Tool	Part Number	Part Description	Qty
A	5S-1330	Valve Spring Compressor	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

⚠ WARNING

Improper assembly of parts that are spring loaded can cause bodily injury.

To prevent possible injury, follow the established assembly procedure and wear protective equipment.

1. Lubricate valve (2) with clean engine oil. Install valve (2) in the cylinder head assembly. Install new valve seal (1) against the valve guide.
2. Place the following items on the valve stem: washer (3), valve spring (4), and spring retainer (5).

Note: A small amount of grease can be used to hold the retainer locks in position during installation.

3. Use Tooling (A) to compress valve spring (4). Install retainer locks (6).

End By:

- a. Install the cylinder head assembly. Refer to Disassembly and Assembly, "Cylinder Head - Install".

i02228414

Inlet and Exhaust Valve Guides - Remove and Install

SMCS Code: 1104-010

Removal Procedure

Table 13

Required Tools			
Tool	Part Number	Part Description	Qty
A	1U-7793	Valve Guide Driver	1
B	9U-6895	Valve Guide Driver	1

Start By:

- a. Remove the inlet and exhaust valves. Refer to Disassembly and Assembly, "Inlet and Exhaust Valves - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

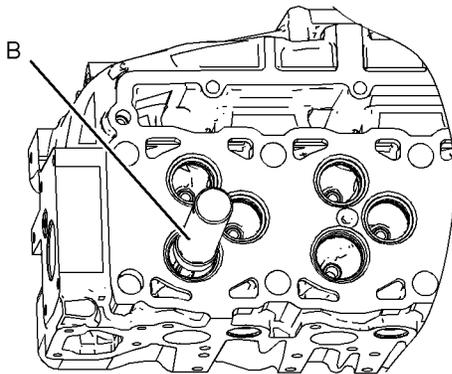


Illustration 31

g01124395

1. Use Tooling (A) to remove the inlet valve guides from the cylinder head assembly. Use Tooling (B) to remove the exhaust valve guides from the cylinder head assembly.

Installation Procedure

Table 14

Required Tools			
Tool	Part Number	Part Description	Qty
A	1U-7793	Valve Guide Driver	1
B	9U-6895	Valve Guide Driver	1
C	1U-7792	Guide Collar	1
D	149-4008	Guide Collar	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

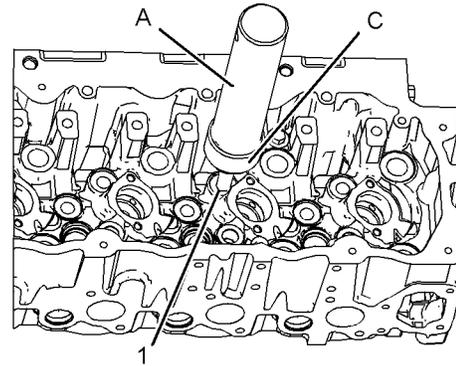


Illustration 32

g01124397

Note: Position the valve guides and tap on the top of the valve guides. This is done in order to start the valve guides into the cylinder head assembly.

1. Use Tooling (A) and Tooling (C) to install inlet valve guides (1). Install inlet valve guides (1) until the protrusion is 23.0 ± 0.50 mm (0.90 ± 0.020 inch) above the cylinder head assembly.
2. Use Tooling (B) and Tooling (D) to install the exhaust valve guides. Install the exhaust valve guides until the protrusion is 17.8 ± 0.50 mm (0.70 ± 0.020 inch) above the cylinder head assembly.

End By:

- a. Install the inlet and exhaust valves. Refer to Disassembly and Assembly, "Inlet and Exhaust Valves - Remove and Install".

i02954230

Inlet and Exhaust Valve Seat Inserts - Remove and Install

SMCS Code: 1103-010

Removal Procedure

Table 15

Required Tools			
Tool	Part Number	Part Description	Qty
A ⁽¹⁾	6V - 4194	Valve Seat Extractor ⁽²⁾	1
	165 - 5647	Valve Seat Extractor ⁽³⁾	1
	6V - 4804	Handle	1
	6V - 4192	Shaft	1
	6V - 4199	Lifting Bracket	1

- (1) Part of the 166 - 7441 Valve Seat Extractor Tool Group
- (2) Use for removal of the exhaust valve seats
- (3) Use for removal of the inlet valve seats

Start By:

- a. Remove the inlet and exhaust valves. Refer to Disassembly and Assembly, "Inlet and Exhaust Valves - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

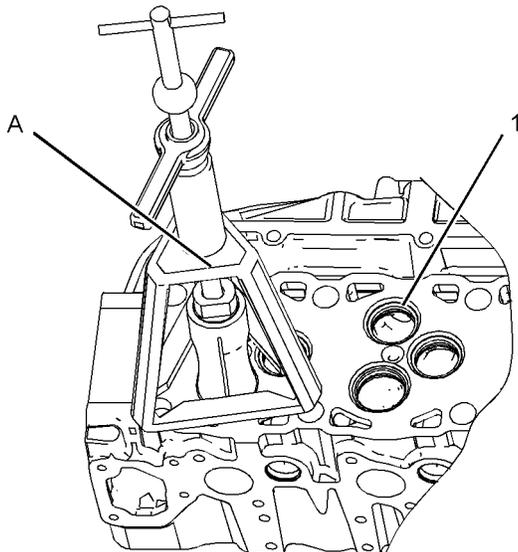


Illustration 33

g01124436

1. Use Tooling (A) to remove valve seat inserts (1).

Installation Procedure

Table 16

Required Tools			
Tool	Part Number	Part Description	Qty
B	149 - 6115	Installer	1
	133 - 9306	Valve Guide	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

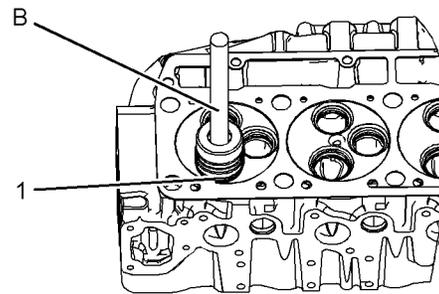


Illustration 34

g01475612

1. Lower the temperature of new valve seat inserts (1).
2. Use Tooling (B) and a suitable press to install the new valve seat inserts in the cylinder head.

Note: Do not machine the prefinished valve seat inserts in order to correct the valve stem projection. An excessive valve stem projection indicates that the valve seat insert is not seated or material was not cleaned from the bottom of the counterbore.

End By:

- a. Install the inlet valves and exhaust valves. Refer to Disassembly and Assembly, "Inlet and Exhaust Valves - Remove and Install".

i02519791

Engine Oil Filter Base and Oil Cooler - Remove

SMCS Code: 1306-011; 1378-012

Removal Procedure

Table 17

Required Tools			
Tool	Part Number	Part Description	Qty
A	185-3630	Strap Wrench Assembly	1

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

1. Drain the coolant system. Refer to Operation and Maintenance Manual, "Refill Capacities and Recommendations".

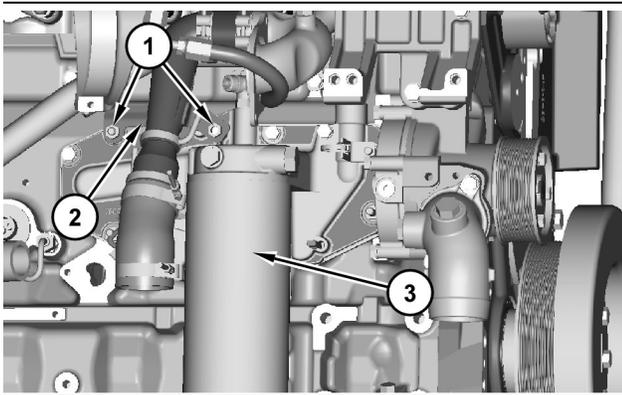


Illustration 35

g01261004

2. Remove nuts (1). Remove bracket (2) and the hose assembly. Use Tooling (A) and remove oil filter (3).

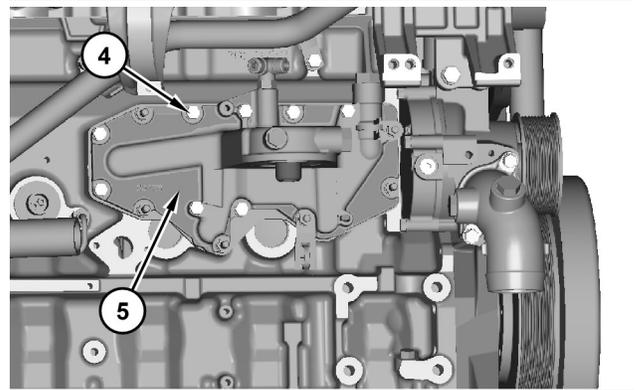


Illustration 36

g01261010

3. Remove bolts (4). Remove engine oil filter base (5) and the gasket.

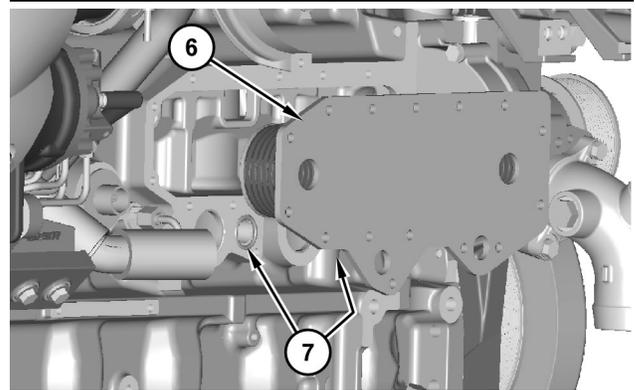


Illustration 37

g01261014

4. Remove oil cooler (6) and the gasket. Remove O-ring seals (7).

i02229026

Engine Oil Filter Base - Disassemble

SMCS Code: 1306-015

Disassembly Procedure

Start By:

- a. Remove the engine oil filter base and the oil cooler. Refer to Disassembly and Assembly, "Engine Oil Filter Base and Oil Cooler - Remove".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

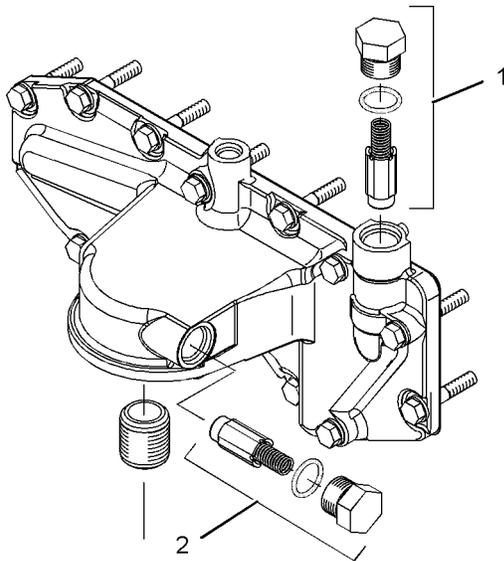


Illustration 38

g01124604

⚠ WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

- (1) Oil cooler bypass valve
- (2) Oil filter bypass valve

i02229174

Engine Oil Filter Base - Assemble

SMCS Code: 1306-016

Assembly Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

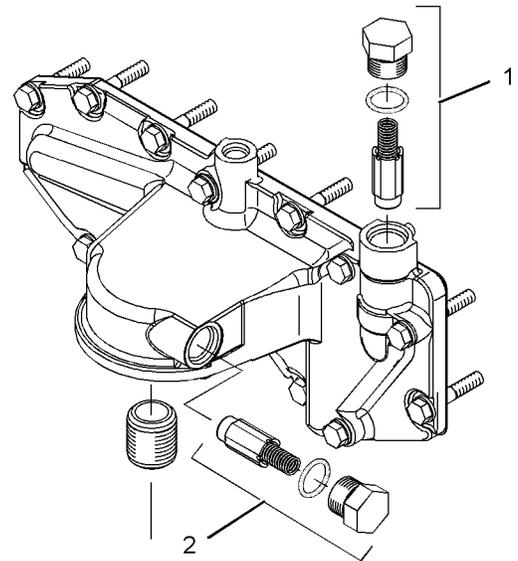


Illustration 39

g01124604

⚠ WARNING

Improper assembly of parts that are spring loaded can cause bodily injury.

To prevent possible injury, follow the established assembly procedure and wear protective equipment.

- (1) Oil cooler bypass valve
- (2) Oil filter bypass valve

End By:

- a. Install the engine oil filter base and the oil cooler. Refer to Disassembly and Assembly, "Engine Oil Filter Base and Oil Cooler - Install".

i02519800

Engine Oil Filter Base and Oil Cooler - Install

SMCS Code: 1306-012; 1378-012

Installation Procedure

Table 18

Required Tools			
Tool	Part Number	Part Description	Qty
A	185-3630	Strap Wrench Assembly	1

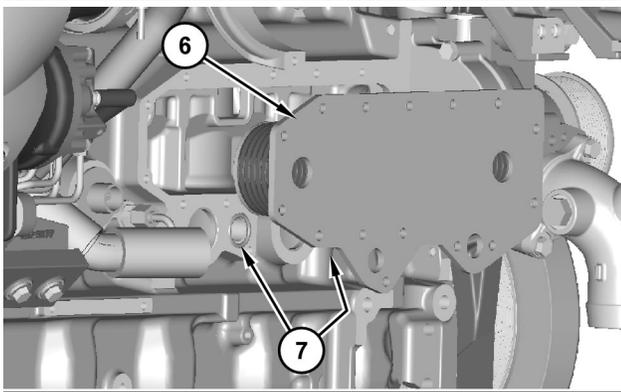


Illustration 40

g01261018

Note: Check O-ring seals for wear or for damage. If necessary, replace the O-ring seals.

1. Install O-ring seals (7). Install oil cooler (6) and the gasket.

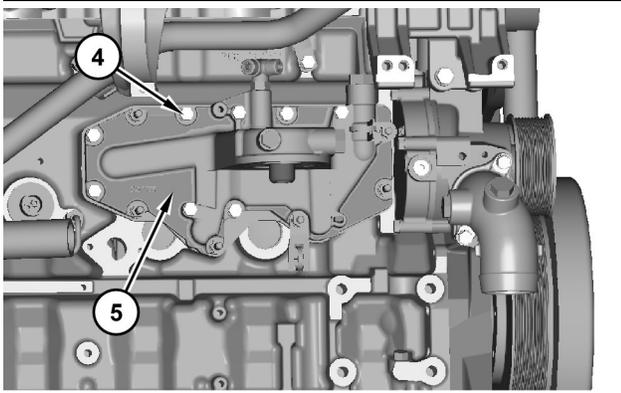


Illustration 41

g01261019

2. Install the gasket and engine oil filter base (5). Install bolts (4).

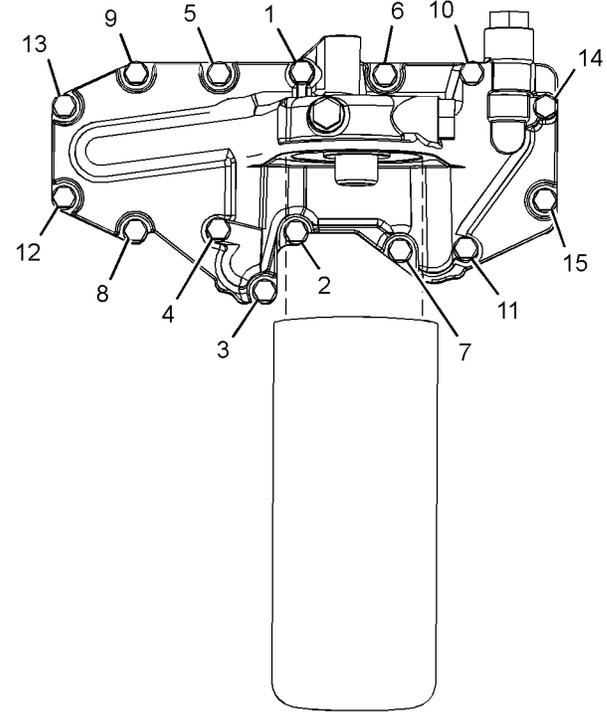


Illustration 42

g01261020

3. Tighten bolts (4) in a numerical sequence to a torque of 15 N·m (11 lb ft). Tighten bolts (4) in a numerical sequence to a torque of 28 N·m (21 lb ft).

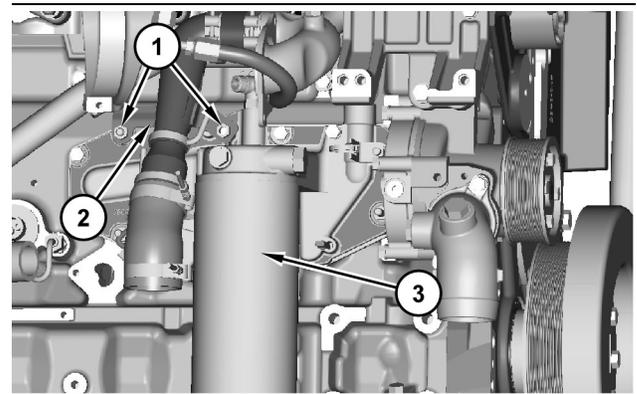


Illustration 43

g01261022

4. Install oil filter (3) with Tooling (A). Install the hose assembly and bracket (2). Install nuts (1).
5. Fill the coolant system. Refer to Operation and Maintenance Manual, "Refill Capacities and Recommendations".

i02229240

i02229280

Engine Oil Pump - Remove

SMCS Code: 1304-011

Removal Procedure

Start By:

- a. Remove the engine oil pan. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

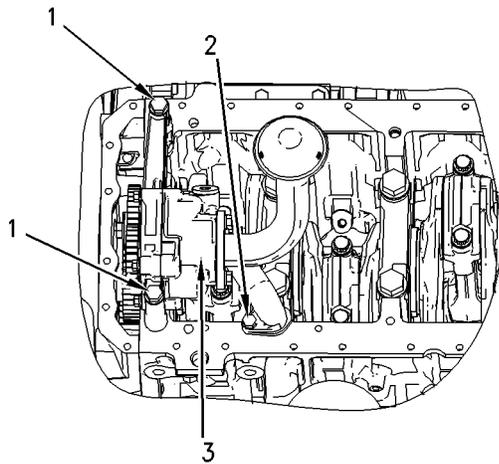


Illustration 44

g00987795

1. Remove bolts (1) and bolt (2).
2. Remove engine oil pump (3).
3. Remove the O-ring seals.

Engine Oil Pump - Disassemble

SMCS Code: 1304-015

Disassembly Procedure

Table 19

Required Tools			
Tool	Part Number	Part Description	Qty
A	8B-7554	Bearing Cup Puller Gp	1
B	1P-0510	Driver Gp	1

Start By:

- a. Remove the engine oil pump. Refer to Disassembly and Assembly, "Engine Oil Pump - Remove".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

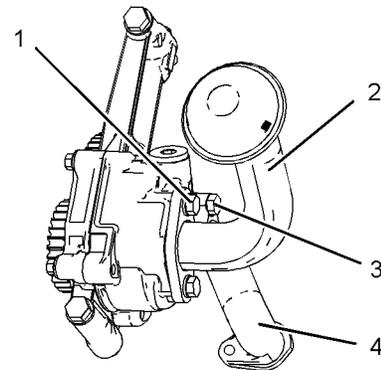


Illustration 45

g01127669

1. Remove bolts (1), oil pickup tube (2), and the gasket from the engine oil pump. Remove bolt (3) and outlet elbow (4) from the engine oil pump.

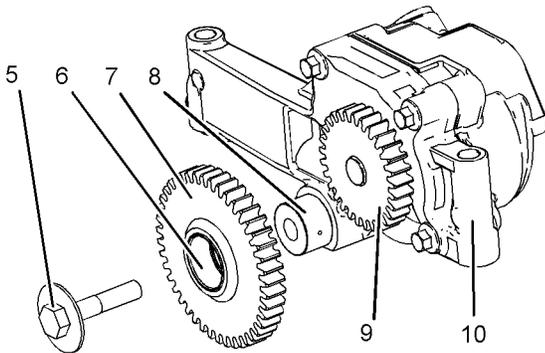


Illustration 46

g01127673

2. Remove bolt (5).
3. Remove idler gear (7) from shaft (8).
4. Use Tooling (B) and remove bearing (6) from idler gear (7).
5. Use Tooling (A) to remove drive gear (9) from engine oil pump (10).

i02229316

Engine Oil Pump - Assemble

SMCS Code: 1304-016

Assembly Procedure

Table 20

Required Tools			
Tool	Part Number	Part Description	Qty
B	1P-0510	Driver Gp	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

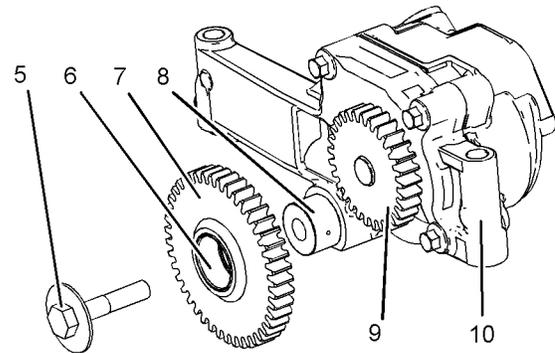


Illustration 47

g01127673

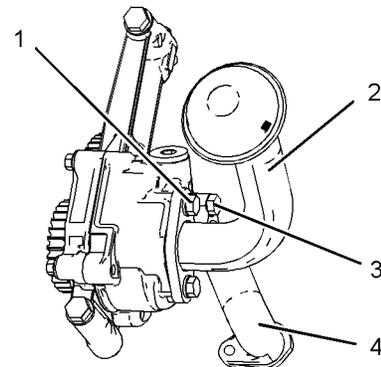


Illustration 48

g01127669

1. Use Tooling (B) and press drive gear (9) on the shaft assembly until drive gear (9) is flush with the end of the shaft assembly.
2. Install bearing (6) in idler gear (7). Install bearing (6) so the distance between the hub bolt face of idler gear and bearing (6) is 0.75 ± 0.25 mm (0.030 ± 0.010 inch).
3. Install idler gear (7) on shaft (8). Install bolt (5). Tighten bolt (5) to a torque of 70 ± 15 N·m (52 ± 11 lb ft).
4. Position the gasket and oil pickup tube (2) onto engine oil pump (10). Install bolts (1).
5. Position the O-ring seal and outlet elbow (4) onto engine oil pump (10). Install bolt (3).

End By:

- a. Install the engine oil pump. Refer to Disassembly and Assembly, "Engine Oil Pump - Install".

i02229347

Engine Oil Pump - Install

SMCS Code: 1304-012

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

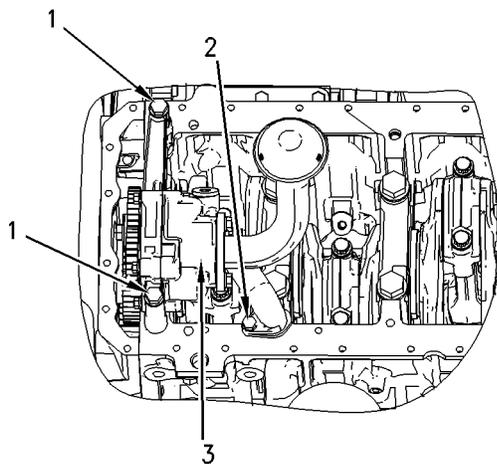


Illustration 49

g00987795

1. Install the O-ring seals. Position engine oil pump (3) on the cylinder block.
2. Install bolts (1) and bolt (2).

End By:

- a. Install the engine oil pan. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".

i02229479

Water Pump - Remove

SMCS Code: 1361-011

Removal Procedure

Start By:

- a. Remove the alternator. Refer to Disassembly and Assembly, "Alternator - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

1. Drain the coolant system. Refer to Operation and Maintenance Manual, "Refill Capacities and Recommendations".

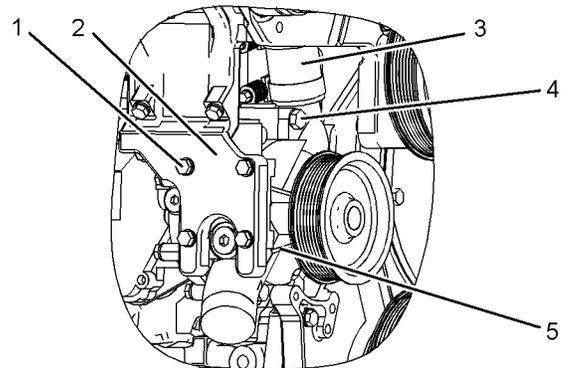


Illustration 50

g01124776

2. Remove bolts (1). Remove support bracket (2).
3. Disconnect hose (3).
4. Remove bolts (4). Remove water pump (5).

i02229484

i02229489

Water Pump - Disassemble

SMCS Code: 1361-015

Disassembly Procedure

Table 21

Required Tools			
Tool	Part Number	Part Description	Qty
A	1P-0510	Driver Group	1

Start By:

- a. Remove the water pump. Refer to Disassembly and Assembly, "Water Pump - Remove".

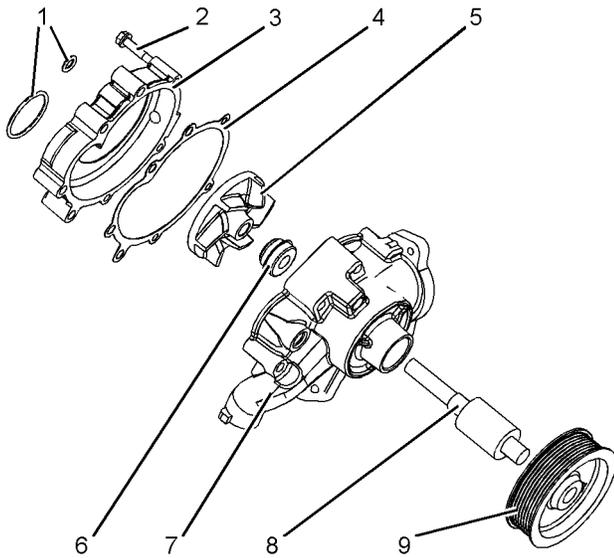


Illustration 51

g01124833

1. Remove O-ring seals (1). Remove bolts (2) and cover (3).
2. Remove gasket (4).
3. Use Tooling (A) and a suitable press to remove shaft assembly (8) from impeller (5) and housing (7).
4. Use Tooling (A) and a suitable press to remove seal assembly (6) from housing (7).
5. Use Tooling (A) and a suitable press to remove pulley (9) from shaft assembly (8).

Water Pump - Assemble

SMCS Code: 1361-016

Assembly Procedure

Table 22

Required Tools			
Tool	Part Number	Part Description	Qty
A	1P-0510	Driver Gp	1
B	5P-9722	Seal Driver	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

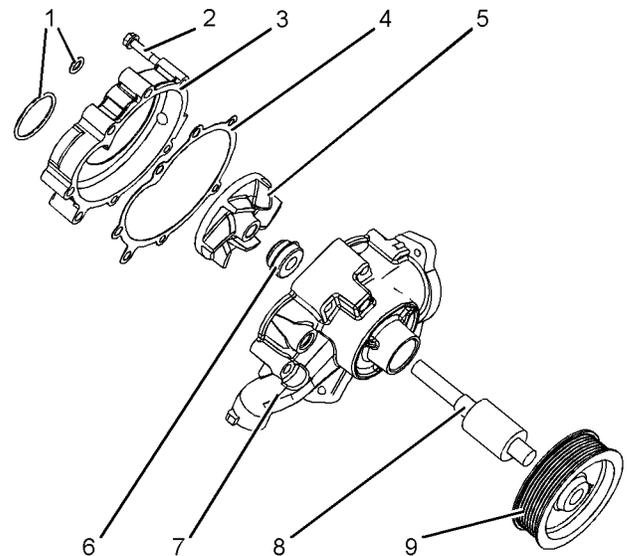


Illustration 52

g01124833

1. Use Tooling (A) and a suitable press to install pulley (9) on shaft assembly (8).
2. Use Tooling (B) and a suitable press to install seal assembly (6) in housing (7).
3. Use Tooling (A) and a suitable press to install shaft assembly (8) into housing (7). Install the shaft assembly until the bearing is flush with the housing.
4. Use Tooling (A) and a suitable press to install impeller (5) on shaft assembly (8). Install the impeller until the distance between the impeller and the machined surface of the water pump is 0.75 ± 0.25 mm (0.030 ± 0.010 inch).

5. Install new gasket (4).
6. Position cover (3) and install bolts (2). Install new O-ring seals (1).

End By:

- a. Install the water pump. Refer to Disassembly and Assembly, "Water Pump - Install".

i02229490

Water Pump - Install

SMCS Code: 1361-012

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

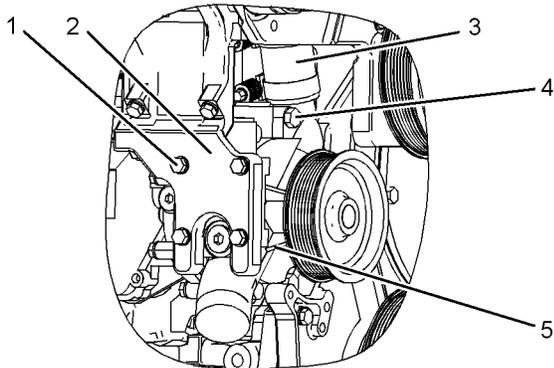


Illustration 53

g01124776

1. Position water pump (5) on the front of the engine. Install bolts (4).
2. Connect hose (3).
3. Position support bracket (2). Install bolts (1).
4. Refill the cooling system. Refer to Operation and Maintenance Manual, "Refill Capacities and Recommendations".

End By:

- a. Install the alternator. Refer to Disassembly and Assembly, "Alternator - Remove and Install".

i02301675

Water Temperature Regulator - Remove and Install

SMCS Code: 1355-010

Removal Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

1. Drain the coolant from the cooling system into a suitable container for storage or disposal. Refer to Operation and Maintenance Manual, "Cooling System Coolant - Change".

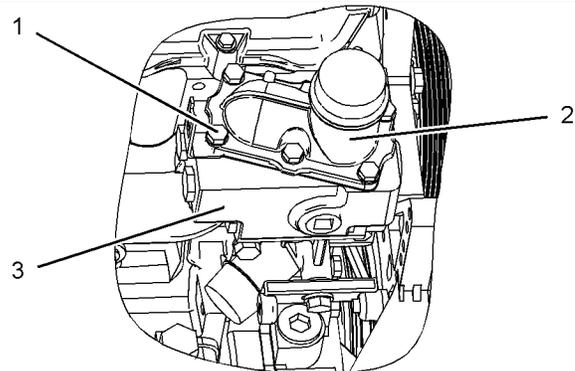


Illustration 54

g01152619

2. Remove bolts (1), pipe (2), and the gasket from water temperature regulator housing (3).
3. Remove the water temperature regulators.

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

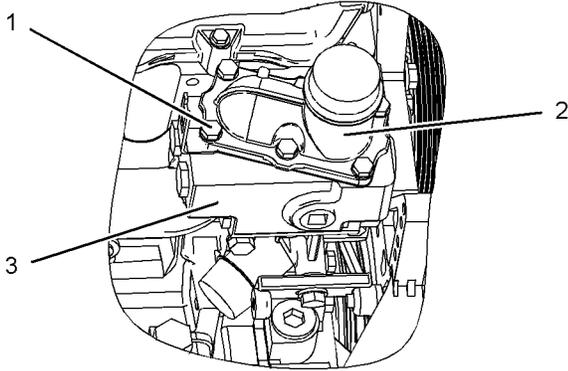


Illustration 55

g01152619

1. Position the water temperature regulators in water temperature regulator housing (3).
2. Install a gasket and pipe (2) on water temperature regulator housing (3).
3. Install bolts (1).
4. Fill the cooling system. Refer to Operation and Maintenance Manual, "Cooling System Coolant - Change".

i02230441

Flywheel - Remove

SMCS Code: 1156-011

Removal Procedure

Table 23

Required Tools			
Tool	Part Number	Part Description	Qty
A	138-7573	Link Bracket	2
B	-	Guide Bolt (M12 X 1.75 by 120 mm)	1

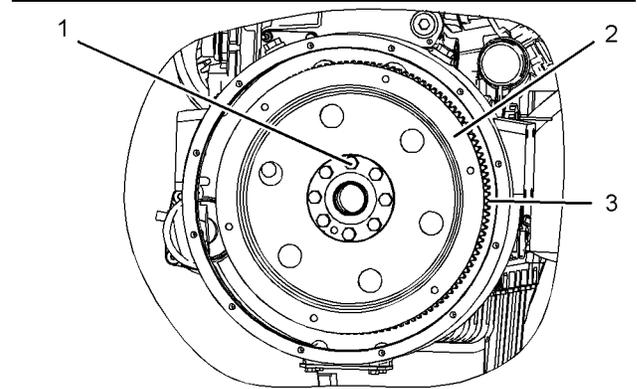


Illustration 56

g01125043

1. Install Tooling (A) and a suitable lifting device on flywheel (2). The weight of flywheel (2) is approximately 23 kg (50 lb).
2. Remove top bolt (1). Install Tooling (B). Remove remaining bolts (1).
3. Remove flywheel (2) from Tooling (B).
4. Replace ring gear (3), if necessary. Use a hammer and a punch in order to remove the flywheel ring gear.

i02230456

Flywheel - Install

SMCS Code: 1156-012

Installation Procedure

Table 24

Required Tools			
Tool	Part Number	Part Description	Qty
A	138-7573	Link Bracket	2
B	-	Guide Bolt (M12 X 1.75 by 120 mm)	1
C	9S-3263	Thread Lock Compound	1

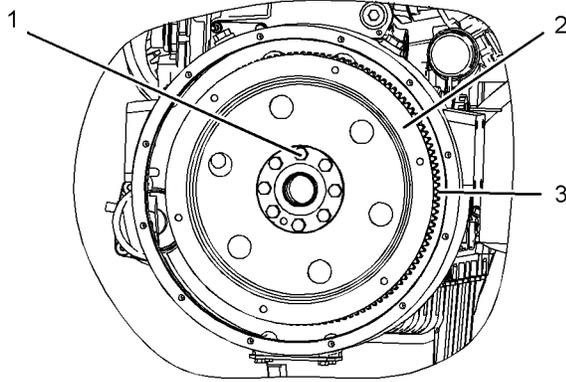


Illustration 57

g01125043

1. Raise the temperature of ring gear (3).

Note: Do not use a torch to heat the ring gear.

2. Position ring gear (3) on flywheel (2) with the part number toward the crankshaft. Use a soft hammer in order to seat the ring gear against the shoulder of the flywheel. Allow the ring gear to cool.
3. Install Tooling (A) and a suitable lifting device on flywheel (2). The weight of flywheel (2) is approximately 23 kg (50 lb).
4. Position flywheel (2) on Tooling (B).
5. Apply Tooling (C) to the threads of bolts (1).
6. Install bolts (1). Remove Tooling (B) and install remaining bolt (1). Tighten the bolts evenly to a torque of 120 ± 20 N·m (90 ± 15 lb ft).
7. Check the flywheel runout. Refer to Testing and Adjusting, "Flywheel - Inspect".

i02230478

Crankshaft Rear Seal - Remove

SMCS Code: 1161-011

Removal Procedure

Table 25

Required Tools			
Tool	Part Number	Part Description	Qty
A	1U-8145	Drill Bit	1
B	1U-7600	Slide Hammer Puller	1

Start By:

- a. Remove the flywheel. Refer to Disassembly and Assembly, "Flywheel - Remove".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Use Tooling (A) to drill three evenly spaced holes in the crankshaft rear seal.

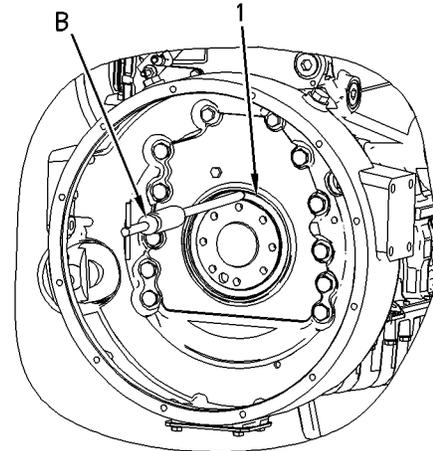


Illustration 58

g00989088

2. Use Tooling (B) to remove crankshaft rear seal (1).

i03171818

Crankshaft Rear Seal - Install

SMCS Code: 1161-012

Installation Procedure

Table 26

Required Tools			
Tool	Part Number	Part Description	Qty
C	1U-7598	Seal Installer Gp	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Replacement rear seals are supplied with a wear sleeve. This wear sleeve must be installed with the rear seal. New engines from the factory do not have a wear sleeve. Do not install the rear seal if any of the following conditions exist:

- The crankshaft rear seal has been separated from the wear sleeve.
- The rear seal group appears to be damaged.
- The crankshaft rear seal has been lubricated. The seal is designed to be installed dry.

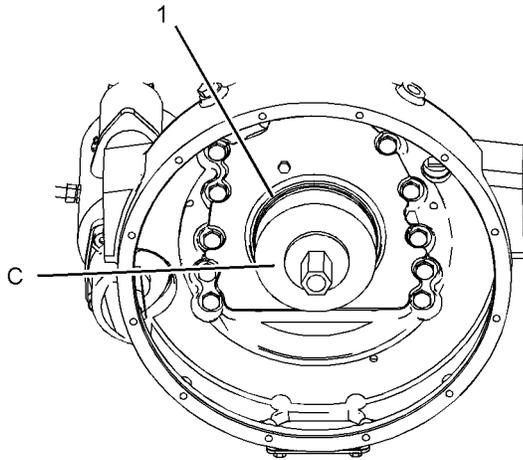


Illustration 59

g01125095

1. Use Tooling (C) to install crankshaft rear seal (1).

End By:

- Install the flywheel. Refer to Disassembly and Assembly, "Flywheel - Install".

i02230508

Flywheel Housing - Remove and Install

SMCS Code: 1157-010

Removal Procedure

Table 27

Required Tools			
Tool	Part Number	Part Description	Qty
A	138-7573	Link Bracket	2

Start By:

- Remove the flywheel. Refer to Disassembly and Assembly, "Flywheel - Remove".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

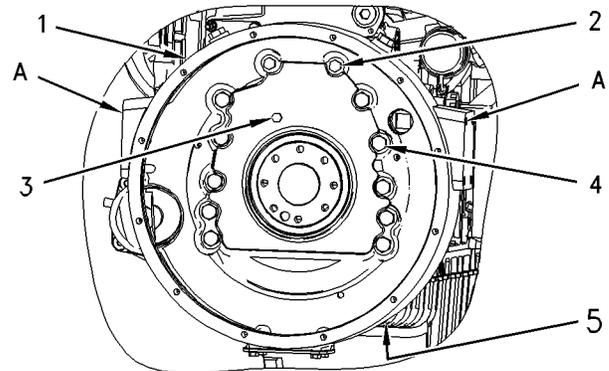


Illustration 60

g00987190

1. Fasten Tooling (A) and a suitable lifting device to flywheel housing (1). The weight of flywheel housing (1) is approximately 25 kg (55 lb).
2. Remove bolts (2) and bolt (3). Remove bolts (4).
3. Remove bolts (5) that fasten the engine oil pan to flywheel housing (1). Remove flywheel housing (1).

Installation Procedure

Table 28

Required Tools			
Tool	Part Number	Part Description	Qty
A	138-7573	Link Bracket	2
B	1U-8846	Sealant	-

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Apply Tooling (B) to the entire mounting face of the flywheel housing prior to installation.

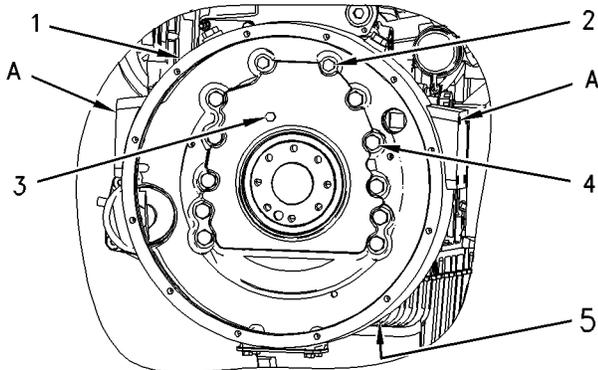


Illustration 61

g00987190

2. Fasten Tooling (A) and a suitable lifting device to flywheel housing (1). The weight of flywheel housing (1) is approximately 25 kg (55 lb). Position the flywheel housing on the cylinder block. Install bolts (5) that fasten the engine oil pan to the flywheel housing.
3. Install bolts (2) and bolt (3). Install bolts (4).
4. Check the flywheel housing runout. Refer to the Testing and Adjusting, "Flywheel Housing - Inspect".

End By:

- a. Install the flywheel. Refer to Disassembly and Assembly, "Flywheel - Install".

i02230536

Vibration Damper and Pulley - Remove and Install

SMCS Code: 1205-010

Removal Procedure

1. Remove the belts.

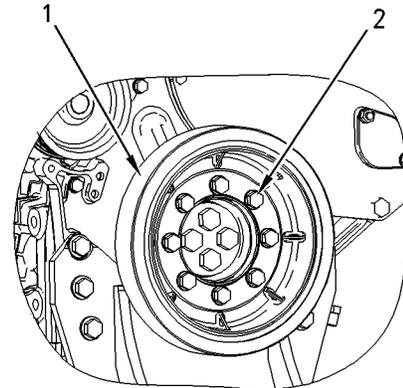


Illustration 62

g00991061

2. Remove bolts (2) and crankshaft vibration damper (1) from the crankshaft pulley.

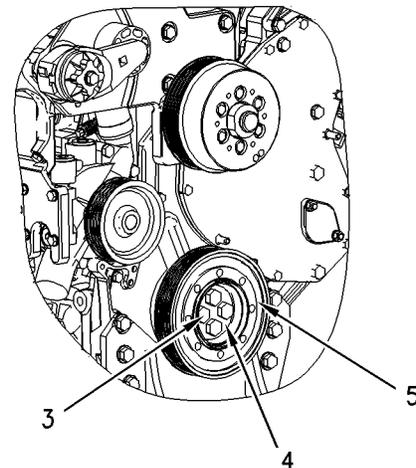


Illustration 63

g00991062

3. Remove bolts (3) and plate (4).
4. Remove crankshaft pulley (5).