



Disassembly and Assembly

C27 and C32 Generator Sets Engines

DWB1-Up (Generator Set)
SXC1-Up (Generator Set)
MED1-Up (Power Module)
WDR1-Up (Generator Set)

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

i02747487

Engine - Remove

SMCS Code: 1000-011

Removal Procedure

Table 1

Required Tools			
Tool	Part Number	Part Description	Qty
A	138-7573	Link Bracket	2
B	238-9586	Engine Turning Tool	1
C	1U-9200	Lever Puller Hoist	1
D	189-0411	Shackle As	2
E	6V-6146	Load Leveling Beam	1

Start By:

- a. Remove the cooling package. Refer to Disassembly and Assembly, "Cooling System Package (Radiator, Aftercooler, Fuel Cooler) - Remove".

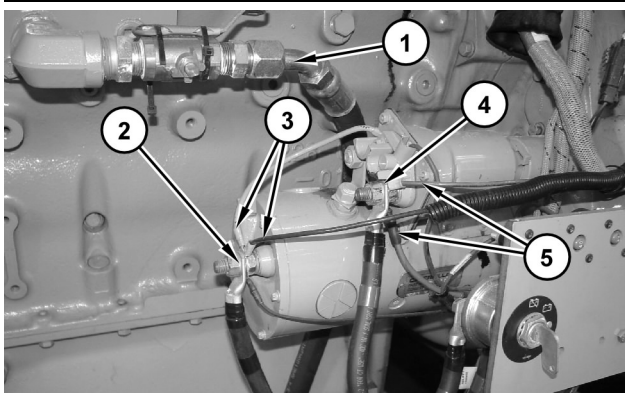


Illustration 1

g01291159

1. Disconnect hose assembly (1). Disconnect cable assembly (2). Disconnect harness assemblies (3). Disconnect cable assembly (4). Disconnect harness assemblies (5).



Illustration 2

g01291160

2. Disconnect harness assembly (6).

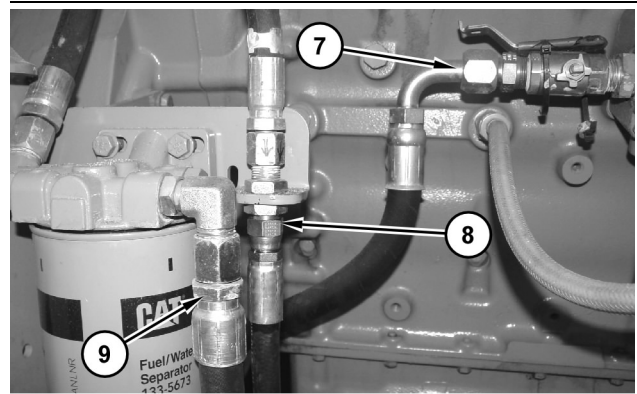


Illustration 3

g01291161

3. Disconnect hose assemblies (7), (8), and (9).

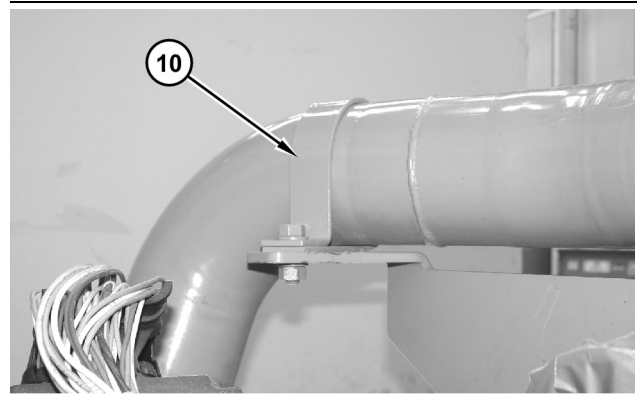


Illustration 4

g01291162

4. Disconnect clamp (10).

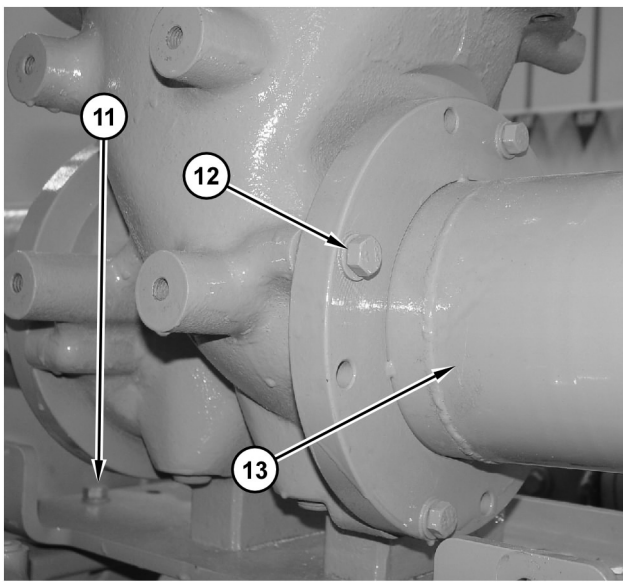


Illustration 5 g01291179

5. Remove bolts (11). Remove bolts (12). Repeat for the opposite side. Disconnect tube assembly (13). Repeat for the opposite side.

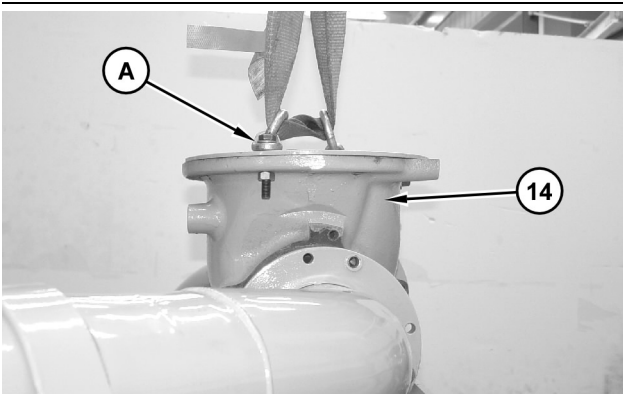


Illustration 6 g01291183

6. Attach Tooling (A) and a suitable lifting device onto exhaust elbow (14). The weight of exhaust elbow (14) is approximately 34 kg (75 lb). Remove exhaust elbow (14).

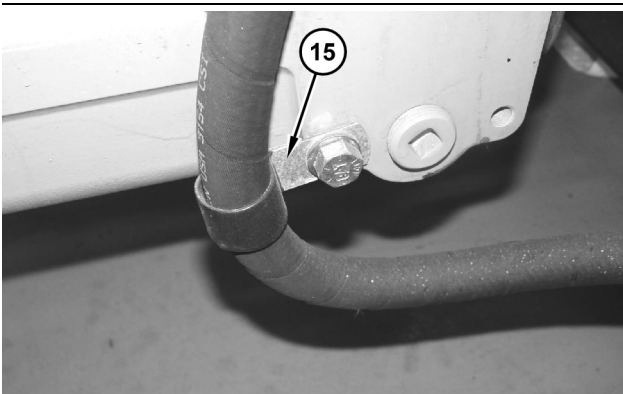


Illustration 7 g01291186

7. Disconnect clamp (15).

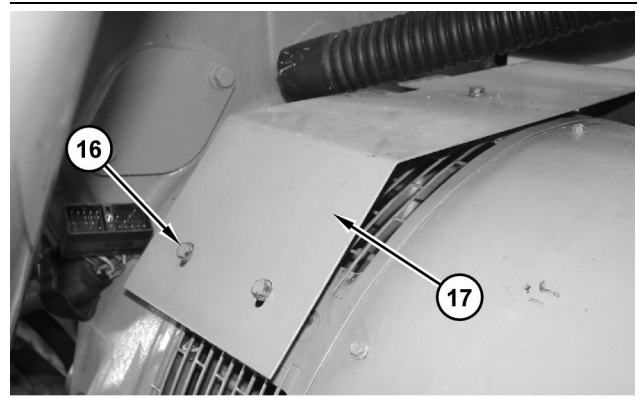


Illustration 8 g01291225

8. Remove bolts (16). Remove guard (17).

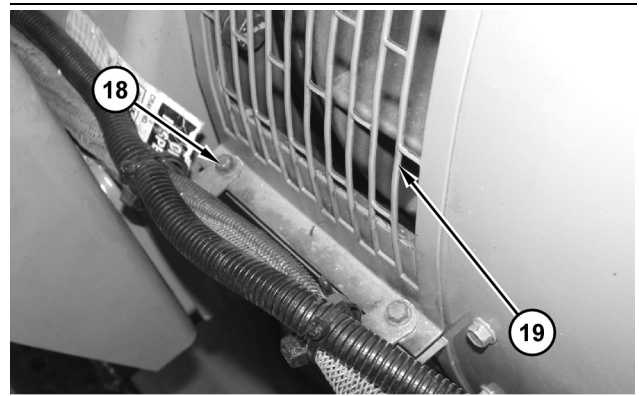


Illustration 9 g01291227

9. Remove bolts (18). Remove guard (19).

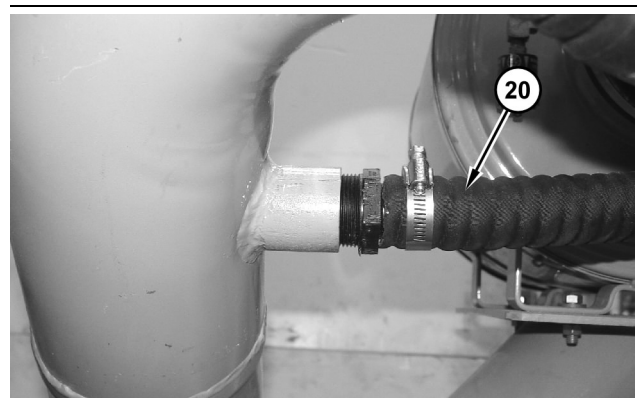


Illustration 10 g01291228

10. Disconnect hose (20).

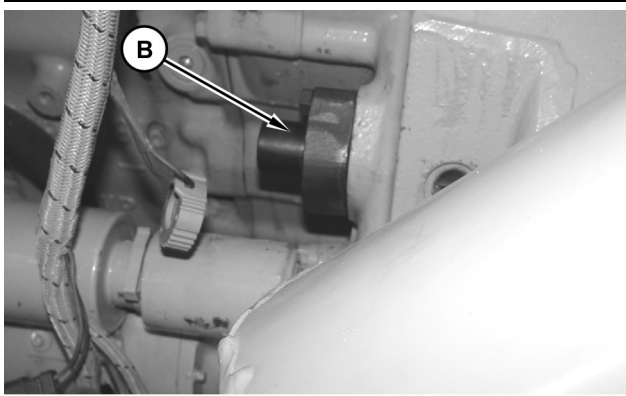


Illustration 11 g01291232

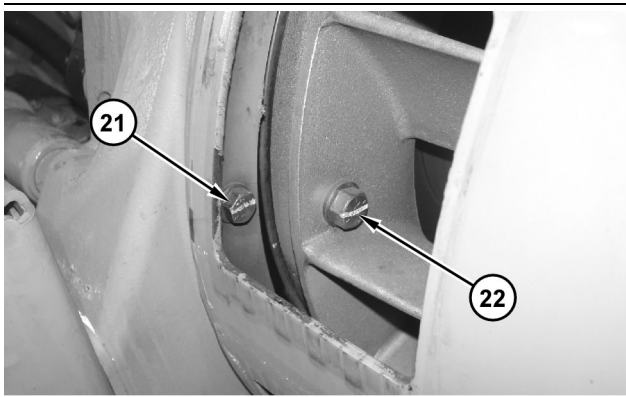


Illustration 12 g01291243

11. Install Tooling (B). Use Tooling (B) in order to rotate the engine. Rotate the engine in order to gain access to bolts (22). Remove bolts (22). Remove bolts (21).

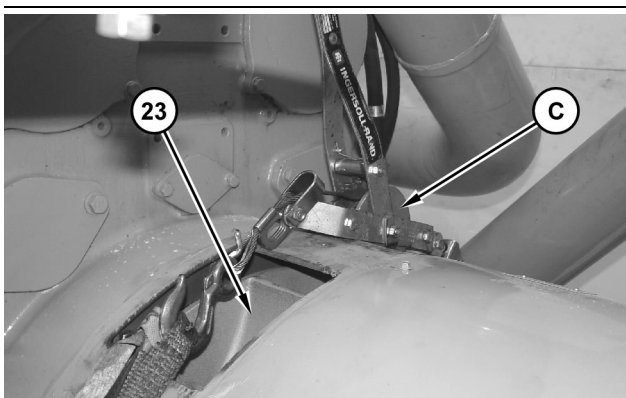


Illustration 13 g01376223

12. Use Tooling (C) in order to support generator rotor (23).

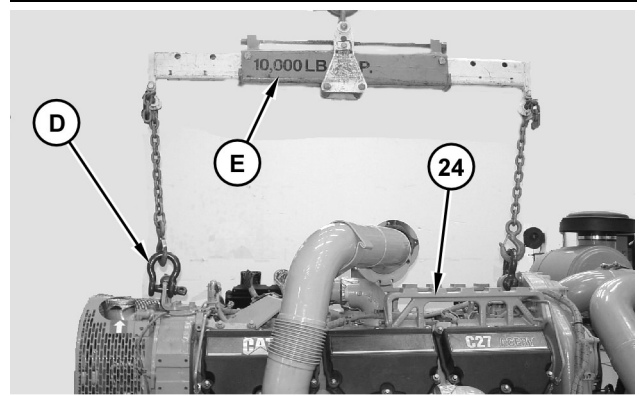


Illustration 14 g01291246

13. Attach Tooling (D) onto engine (24). Attach Tooling (E) and a suitable lifting device onto Tooling (D). The weight of engine (24) is approximately 3527 kg (7775 lb).

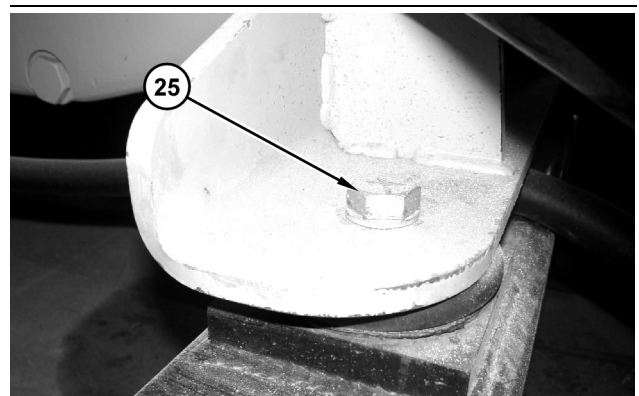


Illustration 15 g01291247

14. Remove mounting bolts (25). Remove engine (24) from the generator.

102747534

Engine - Install

SMCS Code: 1000-012

Installation Procedure

Table 2

Required Tools			
Tool	Part Number	Part Description	Qty
A	138 - 7573	Link Bracket	2
B	238 - 9586	Engine Turning Tool	1
C	1U - 9200	Lever Puller Hoist	1
D	189 - 0411	Shackle As	2
E	6V - 6146	Load Leveling Beam	1

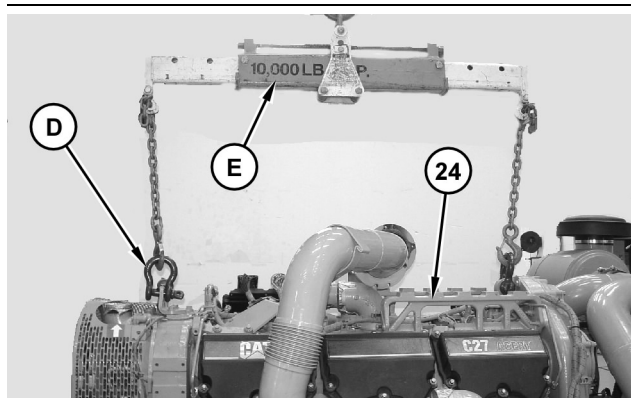


Illustration 16

g01291246

1. Attach Tooling (D) onto engine (24). Attach Tooling (E) and a suitable lifting device onto Tooling (D). The weight of engine (24) is approximately 3527 kg (7775 lb). Install engine (24).

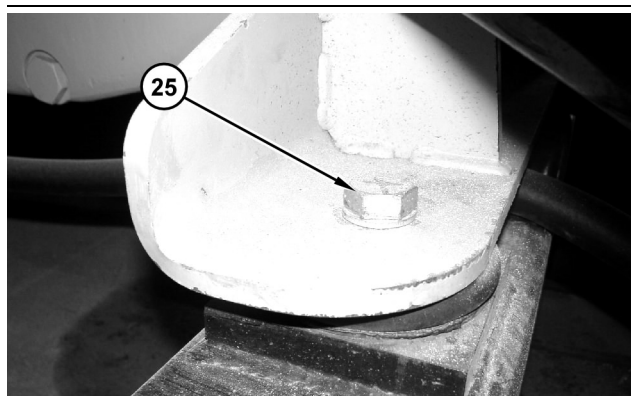


Illustration 17

g01291247

2. Install mounting bolts (25).

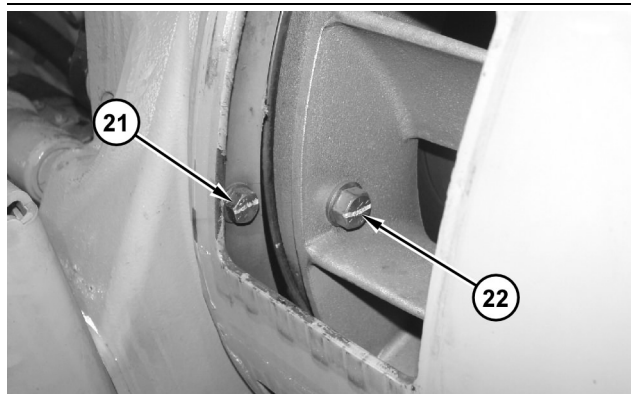


Illustration 18

g01291243

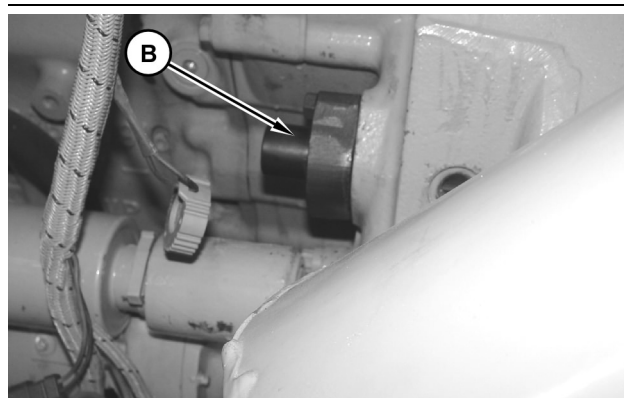


Illustration 19

g01291232

3. Install bolts (21). Use Tooling (B) in order to rotate the engine. Install bolts (22).



Illustration 20

g01291245

4. Remove Tooling (C).

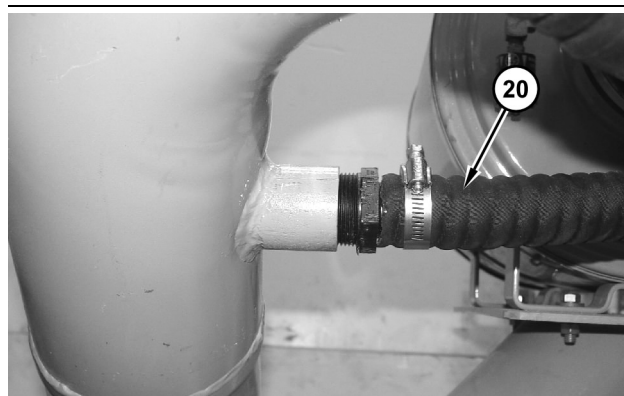


Illustration 21

g01291228

5. Connect hose (20).

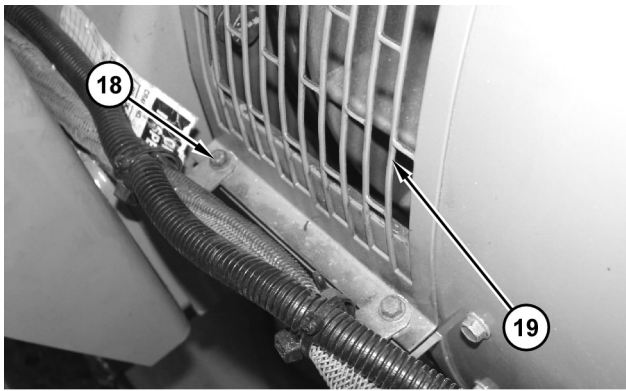


Illustration 22 g01291227

6. Install guard (19). Install bolts (18).

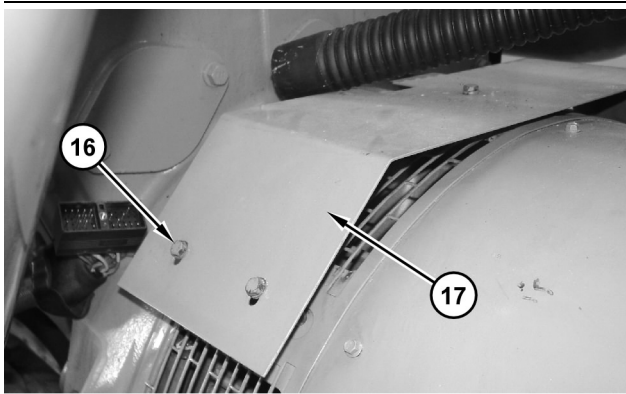


Illustration 23 g01291225

7. Install guard (17). Install bolts (16).

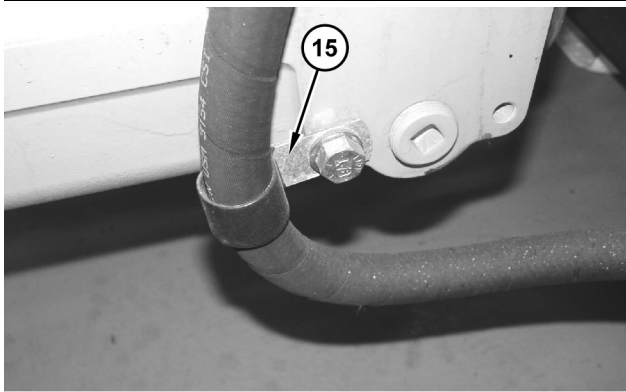


Illustration 24 g01291186

8. Connect clamp (15).

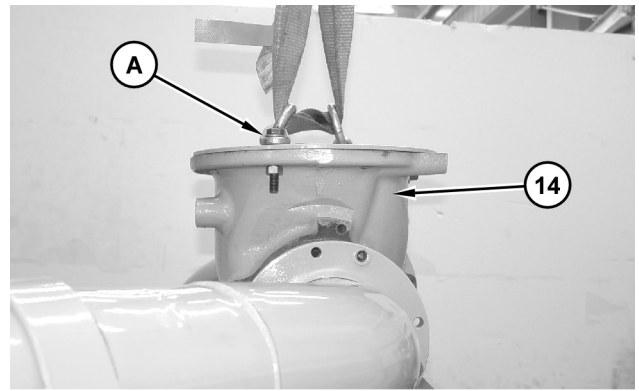


Illustration 25 g01291183

9. Attach Tooling (A) and a suitable lifting device onto exhaust elbow (14). The weight of exhaust elbow (14) is approximately 34 kg (75 lb). Install exhaust elbow (14).

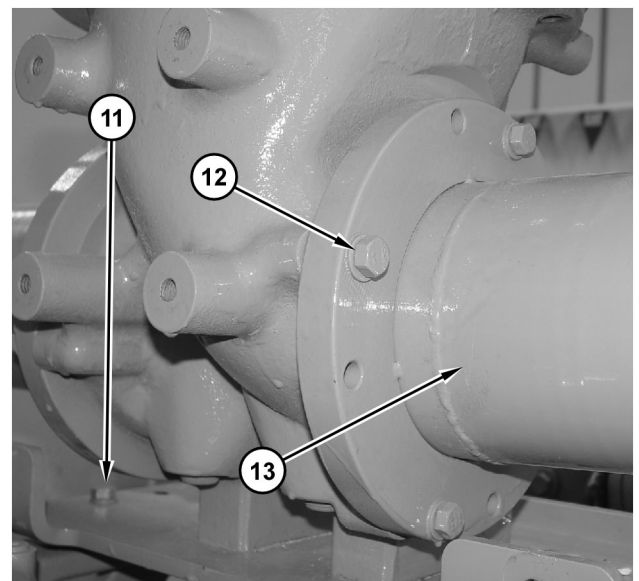


Illustration 26 g01291179

10. Connect tube assembly (13). Install bolts (12). Repeat for the opposite side. Install bolts (11).

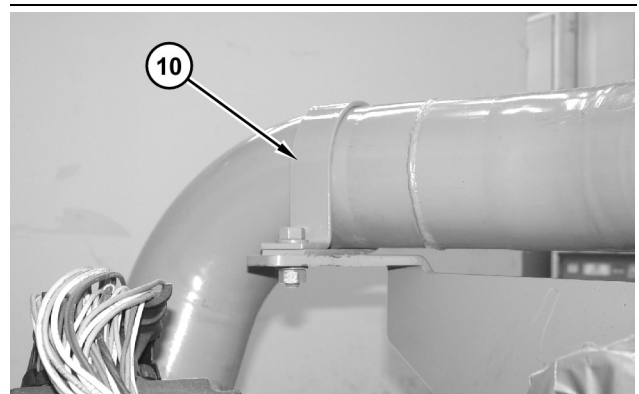


Illustration 27 g01291162

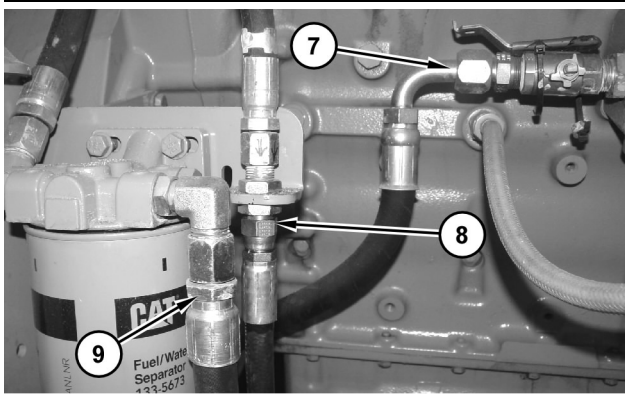
11. Connect clamp (10).

Illustration 28

g01291161

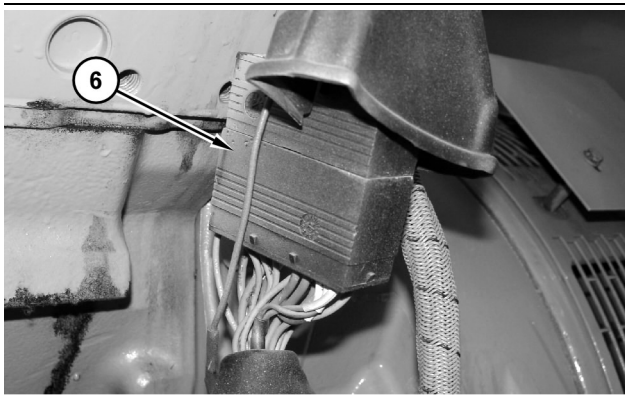
12. Connect hose assemblies (7), (8), and (9).

Illustration 29

g01291160

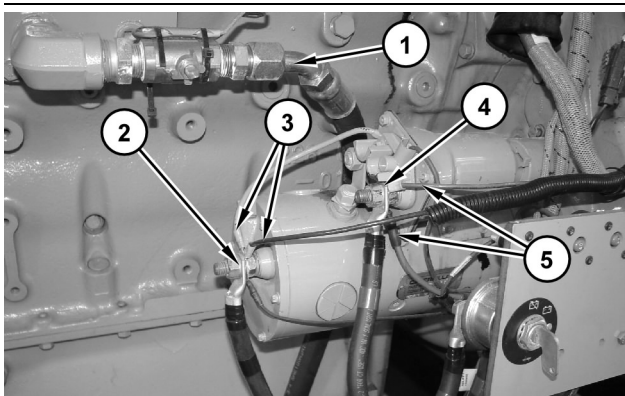
13. Connect harness assembly (6).

Illustration 30

g01291159

14. Connect harness assemblies (5). Connect cable assembly (4). Connect harness assemblies (3). Connect cable assembly (2). Connect hose assembly (1).**End By:**

- a. Install the cooling package. Refer to Disassembly and Assembly, "Cooling System Package (Radiator, Aftercooler, Fuel Cooler) - Install".

i02580978

Fuel Priming Pump - Remove and Install

SMCS Code: 1258-010

Removal Procedure**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.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

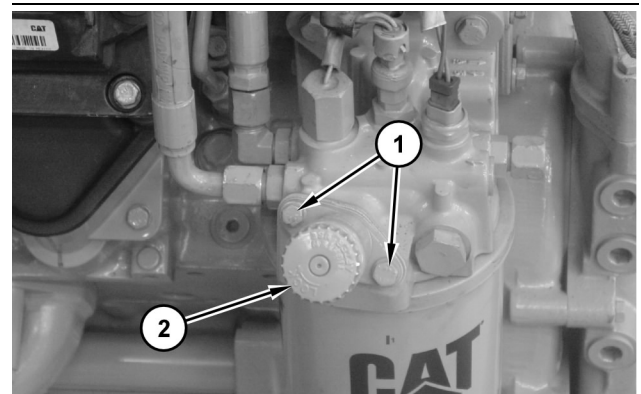


Illustration 31

g01292755

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

Installation Procedure

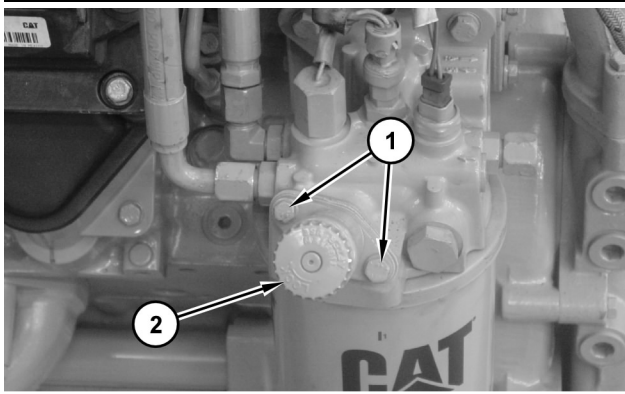


Illustration 32

g01292755

1. Position the gasket and fuel priming pump (2) on the fuel filter base.
2. Install bolts (1).

i02580993

Fuel Filter Base - Remove

SMCS Code: 1262-011

Removal Procedure

Table 3

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

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Turn the fuel supply to the OFF position.

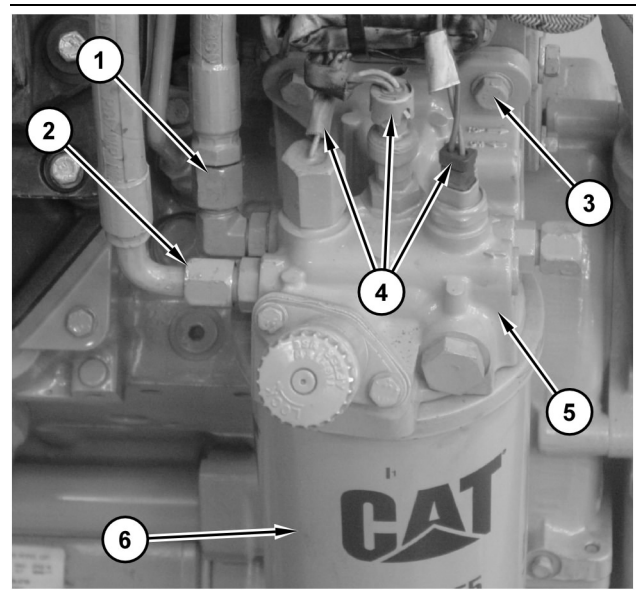


Illustration 33

g01292764

2. Use Tooling (A) to remove fuel filter (6) from fuel filter base (5).
3. Disconnect harness assemblies (4).
4. Disconnect hose assembly (1) and hose assembly (2).
5. Remove bolts (3) and fuel filter base (5).

i02581008

Fuel Filter Base - Install

SMCS Code: 1262-012

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

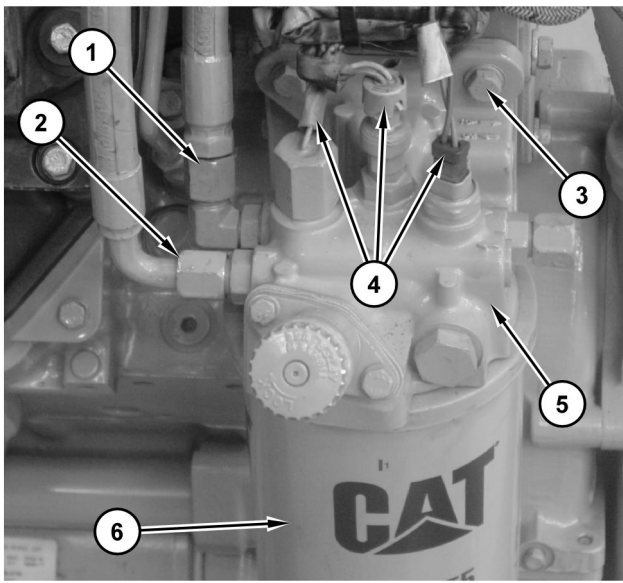


Illustration 34 g01292764

1. Position fuel filter base (5) on the engine. Install bolts (3).
2. Connect hose assembly (1) and hose assembly (2).
3. Connect harness assemblies (4).
4. Install fuel filter (6) on fuel filter base (5).
5. Turn the fuel supply to the ON position.

i02581074

Fuel Filter and Water Separator - Remove and Install

SMCS Code: 1261-010; 1263-010

Removal Procedure

Table 4

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

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 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.

1. Turn the fuel supply to the OFF position.

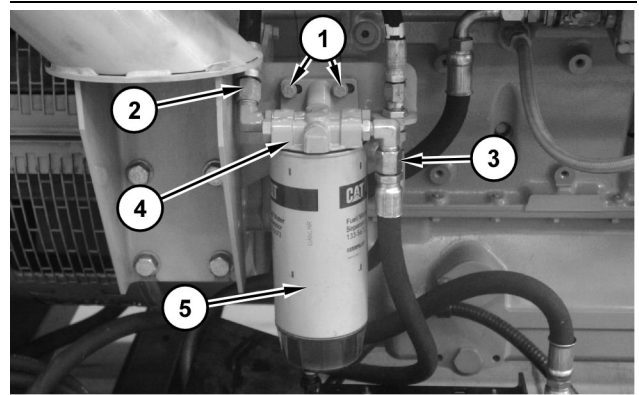


Illustration 35 g01292832

2. Use Tooling (A) to remove the fuel filter and water separator (5) from base assembly (4).
3. Disconnect hose assemblies (2) and (3).
4. Remove bolts (1) and base assembly (4).

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

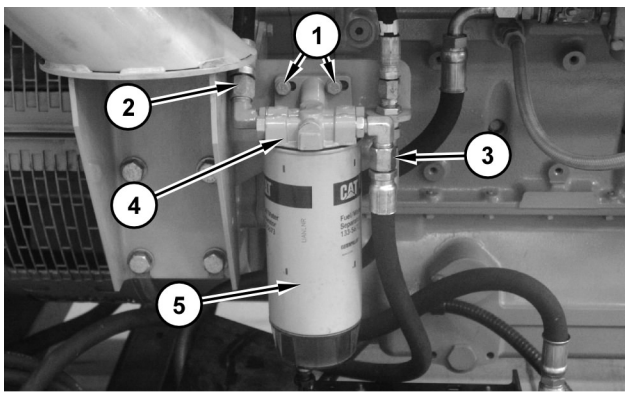


Illustration 36 g01292832

1. Position base assembly (4) on the cylinder block and install bolts (1).
2. Connect hose assemblies (2) and (3).
3. Install a new fuel filter and water separator (5) on base assembly (4).
4. Turn the fuel supply to the ON position.

i02285574

Fuel Transfer Pump - Remove

SMCS Code: 1256-011

Removal Procedure

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.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Turn the fuel supply to the "OFF" position.

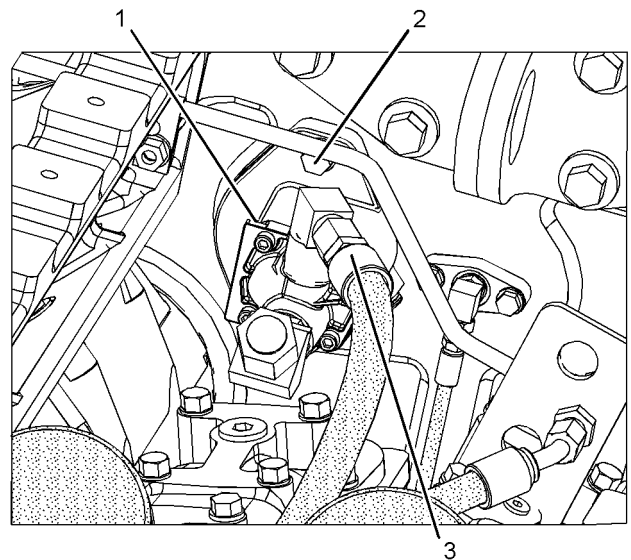


Illustration 37 g01143748

2. Disconnect hose assemblies (3).
3. Remove bolts (2).
4. Remove fuel transfer pump (1) and the O-ring seal.

i02287501

Fuel Transfer Pump - Install

SMCS Code: 1256-012

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

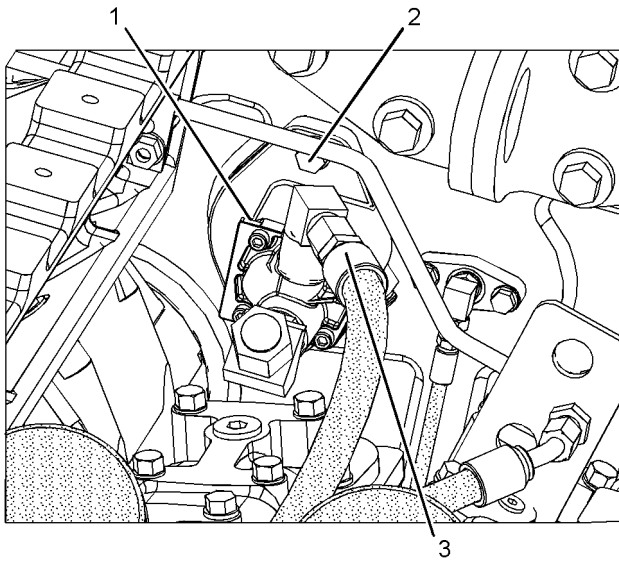


Illustration 38 g01143748

1. Install the O-ring seal on fuel transfer pump (1). Lubricate the O-ring seal with clean engine oil.
2. Position fuel transfer pump (1) on the engine. Install bolts (2).
3. Connect hose assemblies (3).
4. Turn the fuel supply to the "ON" position.

i02208070

Electronic Unit Injector - Remove

SMCS Code: 1290-011

Removal Procedure

Table 5

Required Tools			
Tool	Part Number	Part Description	Qty
A	5F-4764	Pry Bar	1

Start By:

- a. Remove the rocker arms and the rocker arm shaft. Refer to Disassembly and Assembly, "Rocker Arm and Shaft - Remove".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

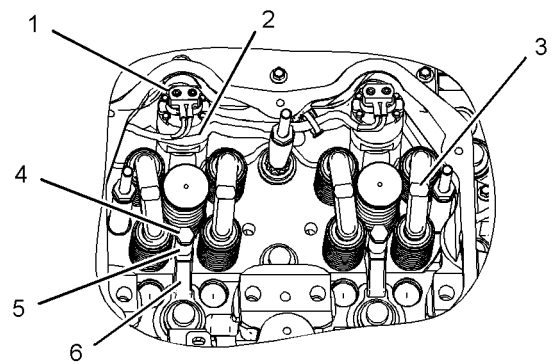


Illustration 39 g01114892

1. Disconnect harness assembly (1).
2. Remove bridge assemblies (3).

NOTICE

If the injector hold down bolt is loose during the removal procedure, inspect the injector bore for wear and debris. Replace the clamp and spacer.

3. Remove bolt (4), spacer (5), and clamp (6).
4. Place an identification mark on electronic unit injectors (2) for installation purposes. Each electronic unit injector must be reinstalled in the original location in the cylinder head.

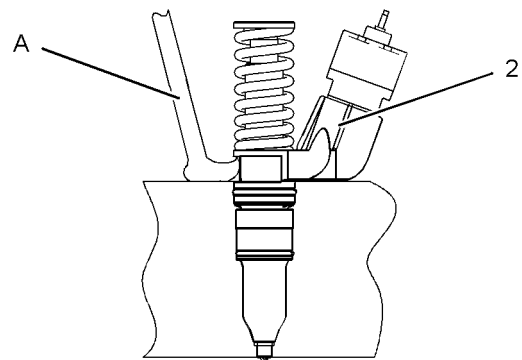


Illustration 40 g01073439

5. Use Tooling (A) to pry beneath the base and free electronic unit injector (2).
6. Remove electronic unit injector (2) from the cylinder head.

i03143340

Electronic Unit Injector - Install

SMCS Code: 1290-012

Installation Procedure

Table 6

Required Tools			
Tool	Part Number	Part Description	Qty
B	8T-2998	Lubricant	1
C	1U-5718	Vacuum Pump	1
	169-7372	Fluid Sampling Bottle	1
	4C-4057	Tube 7.9 mm (0.31 inch) OD	1
D	4C-5552	Large Bore Brush	1
E	4C-6774	Vacuum Gun Kit	1
F	8T-7765	Surface Reconditioning Pad	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Use Tooling (C) to remove the fuel and oil from the cylinder. Evacuate as much fuel and oil as possible from the cylinder before installing the electronic unit injector. Several evacuations may be necessary.
2. Use Tooling (D) to clean the carbon deposit from the inside of the electronic unit injector sleeve. Tooling (E) is available to clean loose material from the bore of the electronic unit injector sleeve and the cylinder.
3. Use Tooling (F) to clean the carbon from the seat area that is inside of the electronic unit injector sleeve.
4. Install the O-ring seals on the electronic unit injector. Lubricate the top two O-ring seals with a 50/50 mixture of clean engine oil and Tooling (B).

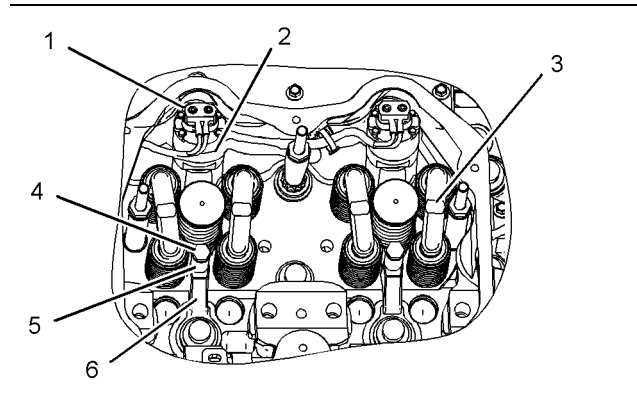


Illustration 41

g01114892

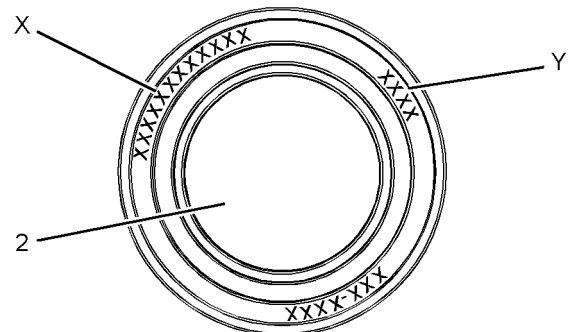


Illustration 42

g01135876

5. When you install a new injector the E-Trim value must be programmed into the engine control module. The injector confirmation code may need to be programmed into the engine control module. E-Trim Value (X) is a twelve digit alphanumeric code that is supplied with the data sheet that comes with the new injectors. Injector Confirmation Code (Y) is a four digit numeric code. Both of the codes are located on the top of electronic unit injector (2). Use the following menu to program the E-Trim value.

- ECM Summary Screen
- Service Menu
- Calibration
- Injector Code Calibration

NOTICE

When an electronic unit injector is replaced, the new electronic injector code must be programmed into the engine's personality module software by using the calibration menu on the Electronic Service Tool. If the new electronic injector code is not entered, the characteristics of the previous electronic unit injector is assumed.

If it is not possible to immediately reprogram the electronic injector code into the personality module software, the engine will not be severely harmed. The new electronic injector code should be reprogrammed as quickly as possible in order to optimize engine performance.

6. Position electronic unit injector (2) in the cylinder head.
7. Install spacer (5), clamp (6), and bolt (4). Tighten the bolt to a torque of $55 \pm 10 \text{ N}\cdot\text{m}$ ($41 \pm 7 \text{ lb ft}$).
8. Install bridge assemblies (3).
9. Connect harness assembly (1). Tighten the nuts to a torque of $2.5 \pm 0.25 \text{ N}\cdot\text{m}$ ($22 \pm 2 \text{ lb in}$).

End By:

- a. Install the rocker arms and the rocker arm shaft. Refer to Disassembly and Assembly, "Rocker Arm and Shaft - Install".

i02300212

Electronic Unit Injector Sleeve - Remove

SMCS Code: 1713-011

Removal Procedure

Table 7

Required Tools			
Tool	Part Number	Part Description	Qty
A	9U-6891	Injector Tool Group	1

Start By:

- a. Remove the electronic unit injectors. Refer to Disassembly and Assembly, "Electronic 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".

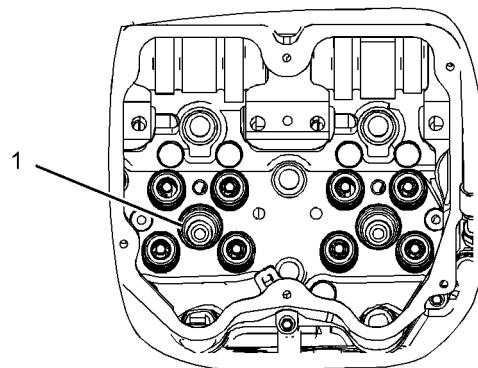


Illustration 43

g01043124

2. Install Tooling (A) in electronic unit injector sleeve (1).
3. Tighten the nut on Tooling (A) until the electronic unit injector sleeve is pulled free of the cylinder head.

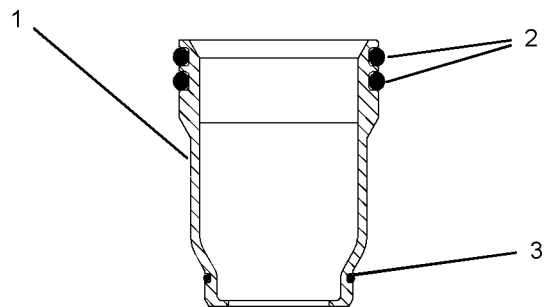


Illustration 44

g01073635

4. Remove O-ring seals (2) and O-ring seal (3) from electronic unit injector sleeve (1).

i02287628

Electronic Unit Injector Sleeve - Install

SMCS Code: 1713-012

Installation Procedure

Table 8

Required Tools			
Tool	Part Number	Part Description	Qty
A	9U-6891	Injector Tool Group	1
B	9U-6862	Tapered Brush	1
	9U-6863	Small Bore Brush	1
	9U-7244	End Brush	1
	9U-7237	Brush Extension	1
	4C-5552	Large Bore Brush	1
C	4C-9507	Retaining Compound	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Use Tooling (B) to clean the bore in the cylinder head for the electronic unit injector sleeve.

NOTICE

Ensure that the electronic unit injector sleeve and the cylinder head bore are completely free of oil, dirt, and sealant debris.

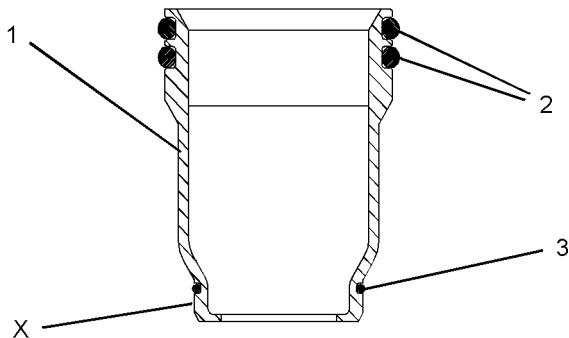


Illustration 45

g01043165

2. Install new O-ring seals (2) and O-ring seal (3) on electronic unit injector sleeve (1).
3. Apply Tooling (C) to the contact surface of electronic unit injector sleeve (1) on the surface that is Marked "X".

Note: Do not apply Tooling (C) to the cylinder head surfaces. Apply Tooling (C) on the electronic unit injector sleeve only.

4. Lubricate O-ring seals (2) with clean engine oil.

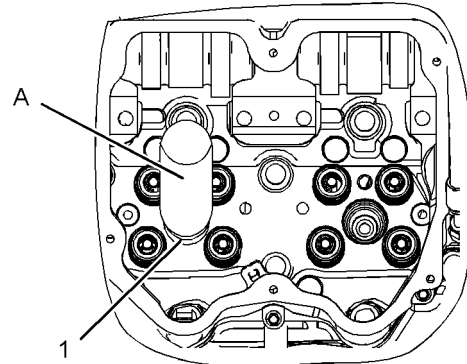


Illustration 46

g01099549

5. Install electronic unit injector sleeve (1) on Tooling (A). Position the electronic unit injector sleeve in the cylinder head. Use care not to damage the O-ring seals on the electronic unit injector sleeve. Use Tooling (A) and a hammer to install the electronic unit injector sleeve in the cylinder head.

NOTICE

Ensure that the electronic unit injector sleeve is properly seated in the cylinder head. The Tooling will "RING" when the electronic unit injector sleeve is fully seated in the bore of the cylinder head.

6. Remove Tooling (A). Remove excess Tooling (C).
7. Fill the cooling system with coolant. Refer to Operation and Maintenance Manual, "Cooling System Coolant - Change".

End By:

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

i02287744

Turbocharger - Remove

SMCS Code: 1052-011

Removal Procedure

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.

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".

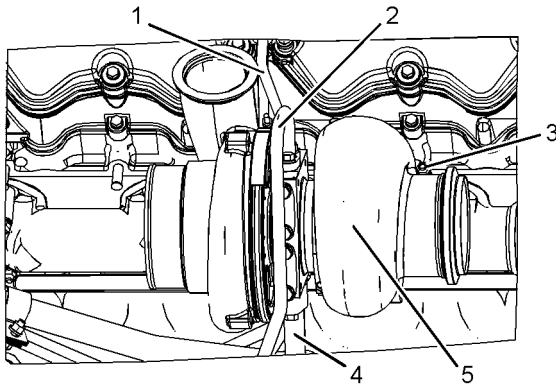


Illustration 47

g01145002

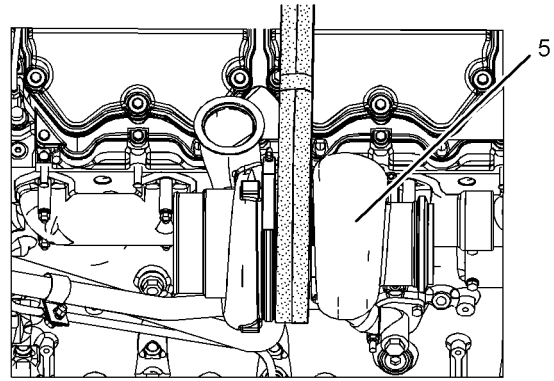


Illustration 48

g01148173

2. Remove tube assembly (2).
3. Disconnect tube assemblies (1) and tube assembly (4).
4. Attach a suitable lifting device to turbocharger (5). The weight of turbocharger (5) is approximately 45 kg (100 lb).
5. Remove nuts (3). Remove turbocharger (5) and the gasket.

i02287870

Turbocharger - Disassemble

SMCS Code: 1052-015

Disassembly Procedure

Start By:

- a. Remove the turbocharger. Refer to Disassembly and Assembly, "Turbocharger - Remove".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

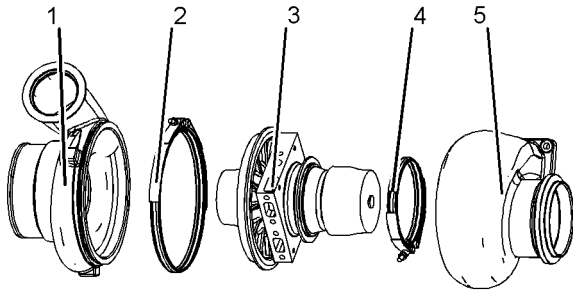


Illustration 49

g01145263

1. Loosen V-band clamp (2) and V-band clamp (4).
2. Separate compressor housing (1) from turbocharger cartridge (3).
3. Separate turbine housing (5) from turbocharger cartridge (3).

i02451256

Turbocharger - Assemble

SMCS Code: 1052-016

Assembly Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

The compressor housing must remain straight with the turbocharger cartridge during disassembly and assembly. Tilting may cause damage to the tips of the compressor wheel and the compressor shaft.

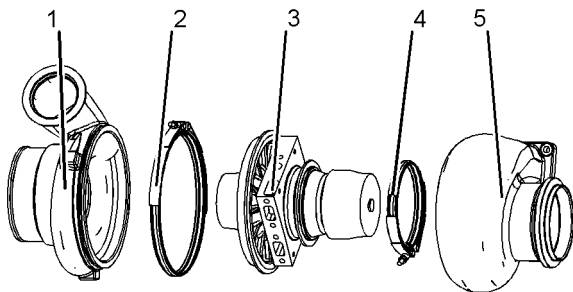


Illustration 50

g01145263

1. Position compressor housing (1) and turbine housing (5) on turbocharger cartridge (3).

Note: Ensure that the mating surfaces are flush.

2. Tighten the nuts on V-band clamp (2) to a torque of 14 ± 1 N·m (10 ± 1 lb ft). Use a soft hammer to lightly hit around the diameter of the band clamp. Tighten the nuts again to a torque of 14 ± 1 N·m (10 ± 1 lb ft).
3. Tighten the nuts on V-band clamp (4) to a torque of 14 ± 1 N·m (10 ± 1 lb ft). Use a soft hammer to lightly hit around the diameter of the band clamp. Tighten the nuts again to a torque of 14 ± 1 N·m (10 ± 1 lb ft).

4. Ensure that the impeller spins freely.

End By:

- a. Install the turbocharger. Refer to Disassembly and Assembly, "Turbocharger - Install".

i02288273

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.

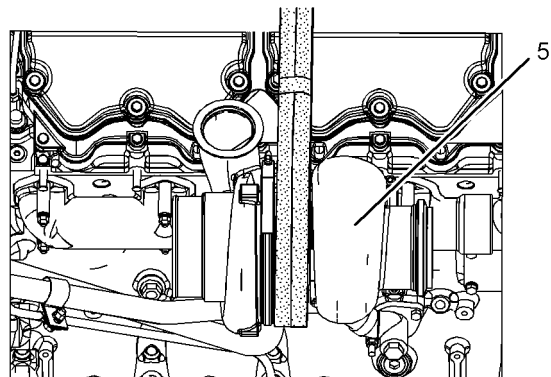


Illustration 51

g01148173

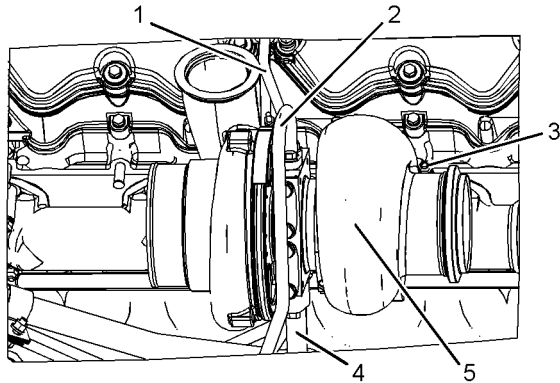


Illustration 52

g01145002

1. Position the gasket on the exhaust manifold.
2. Apply Tooling (A) to the threads of the exhaust manifold studs.
3. Attach a suitable lifting device to turbocharger (5). The weight of turbocharger (5) is approximately 45 kg (100 lb). Position turbocharger (5) on the exhaust manifold.
4. Install nuts (3) and tighten to a torque of 55 ± 9 N·m (41 ± 7 lb ft).
5. Connect tube assemblies (1) and tube assembly (4).
6. Install tube assembly (2).
7. Fill the cooling system. Refer to Operation and Maintenance Manual, "Cooling System Coolant - Change".

i02617122

Exhaust Manifold - Remove and Install

SMCS Code: 1059-010

Removal Procedure

Start By:

- a. Remove the turbocharger. Refer to Disassembly and Assembly, "Turbocharger - Remove".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Remove the shield assemblies from the exhaust manifolds.

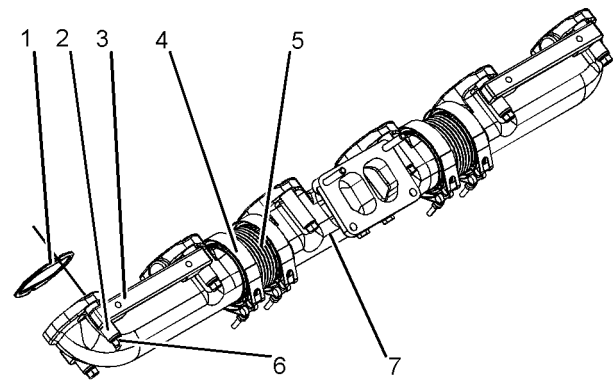


Illustration 53

g01218139

2. Remove locknuts (6) from exhaust manifold (7).
3. Remove spacers (2) and (3) from exhaust manifold (7).
4. Remove exhaust manifold (7) and gaskets (1) from the cylinder head.
5. If necessary, remove clamps (4) and expansion joints (5).

Installation Procedure

Table 10

Required Tools			
Tool	Part Number	Part Description	Qty
A	5P-3931	Anti-Seize Compound	-
B	165-4638	Guide	3

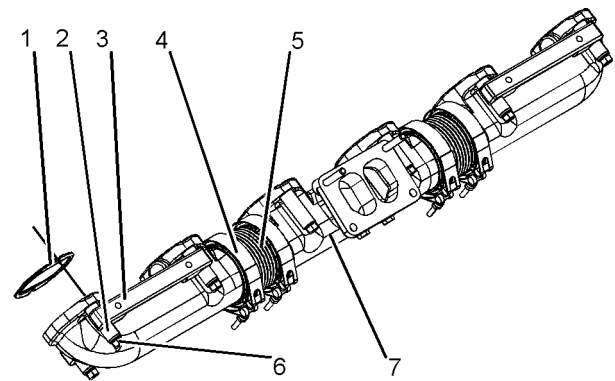


Illustration 54

g01218139

i02300073

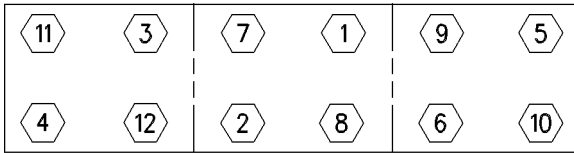


Illustration 55

g00566145

1. If necessary, install expansion joints (5) and clamps (4). Tighten the clamps to a torque of $8.5 \pm 1.0 \text{ N}\cdot\text{m}$ ($75 \pm 9 \text{ lb in}$).
2. Apply Tooling (A) to the studs prior to assembly. If necessary, install the studs and tighten to a torque of $35 \pm 5 \text{ N}\cdot\text{m}$ ($26 \pm 4 \text{ lb ft}$).
3. Position gaskets (1) and exhaust manifold (7) on the cylinder head.
4. Install spacers (2) and (3) on exhaust manifold (7).

Note: Use Tooling (B) in at least one oversize hole per manifold section in order to align the exhaust manifolds. Do not remove Tooling (B) until removal is required to tighten the locknuts.

5. Install locknuts (6) on exhaust manifold (7). Tighten locknuts (6) in a numerical sequence to a torque of $20 \pm 3 \text{ N}\cdot\text{m}$ ($15 \pm 2 \text{ lb ft}$). Tighten locknuts (6) again in a numerical sequence to a torque of $38 \pm 5 \text{ N}\cdot\text{m}$ ($28 \pm 4 \text{ lb ft}$).
6. Install the shield assemblies on the exhaust manifolds.

End By:

- a. Install the turbocharger. Refer to Disassembly and Assembly, "Turbocharger - Install".

Inlet and Exhaust Valve Springs - Remove and Install

SMCS Code: 1108-010

Removal Procedure

Table 11

Required Tools			
Tool	Part Number	Part Description	Qty
A	9U-7241	Valve Spring Compressor	1
B	8S-2263	Spring Tester	1

Start By:

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

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Place the piston at the top of the compression stroke (TC). Remove the valve springs for that cylinder. If the valves fall into the cylinder liner, then the cylinder head must be removed.

1. Position the No. 1 piston at the top center of the compression stroke. Refer to Testing and Adjusting, "Finding Top Center Position for No. 1 Piston".

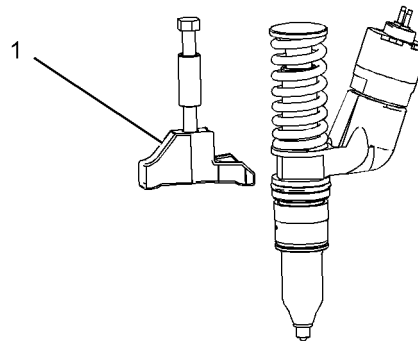


Illustration 56

g01073852

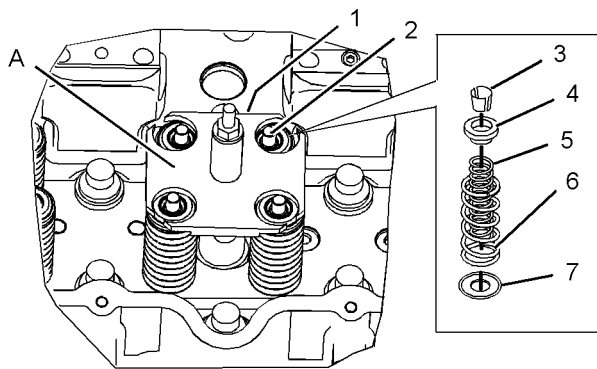


Illustration 57

g01043625

⚠ 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.

2. Install Tooling (A) in the electronic unit injector sleeve. Secure Tooling (A) with unit injector clamp (1).
3. Tighten the full nut until valve spring keepers (3) are loose on valve (2).
4. Remove valve spring keepers (3) from the valve.
5. Carefully remove Tooling (A).
6. Remove valve rotator (4).
7. Remove outer valve spring (6) and inner valve spring (5) from the valve.
8. Remove washer (7) from the valve guide.
9. Use Tooling (B) to check the valve springs (spring force). Refer to Specifications, "Cylinder Head Valves" for additional information on the valve springs.

Installation Procedure

Table 12

Required Tools			
Tool	Part Number	Part Description	Qty
A	9U-7241	Valve Spring Compressor	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Lubricate the valve stems with clean engine oil.

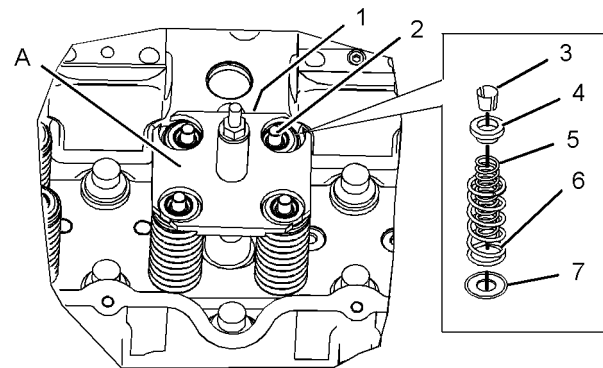


Illustration 58

g01043625

⚠ 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.

2. Ensure that washer (7) is installed on the valve guide.
3. Install inner valve spring (5) and outer valve spring (6) on valve (2).
4. Install valve rotator (4) on valve (2).

⚠ 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.

5. Use Tooling (A) to compress inner valve spring (5) and outer valve spring (6). Install valve spring keepers (3) on valve (2). Remove unit injector clamp (1) and Tooling (A).

End By:

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

i02642655

Inlet and Exhaust Valves - Remove and Install

SMCS Code: 1105-010

Removal Procedure

Table 13

Required Tools			
Tool	Part Number	Part Description	Qty
A	5S-1330	Valve Spring Compressor	1
B	8S-2263	Spring Tester	1

Start By:

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

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

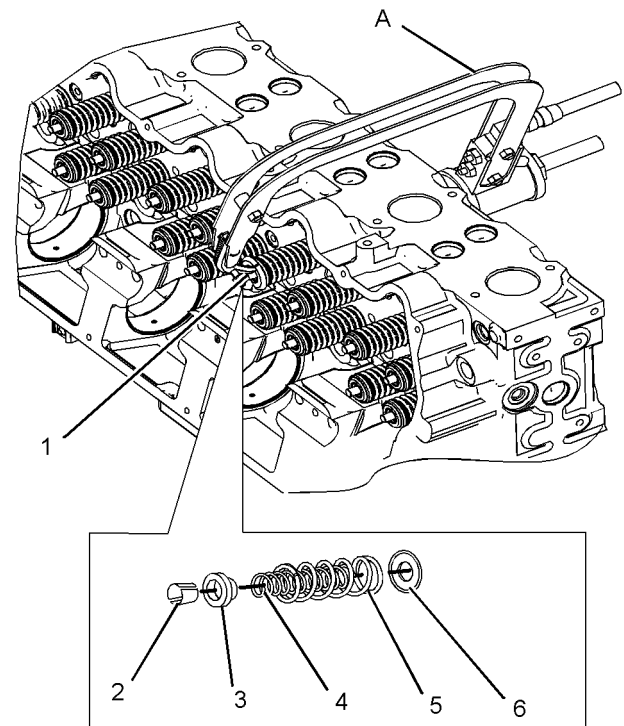


Illustration 59

g01015263

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. Install Tooling (A) and compress the valve springs. Remove valve spring keepers (2) from valve (1).
2. Carefully remove Tooling (A) from valve (1).
3. Remove valve rotator (3).
4. Remove outer valve spring (5) and inner valve spring (4) from valve (1).
5. Remove washer (6) and valve (1) from the valve guide.
6. Use Tooling (B) to check the valve springs (spring force). Refer to Specifications, "Cylinder Head Valves" for additional information on the valve springs.
7. Inspect the valves. Refer to Specifications, "Cylinder Head Valves" for additional information on the inlet and exhaust valves.

Installation Procedure

Table 14

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.

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

1. Lubricate the valves with clean engine oil. Install the valves in the cylinder head.

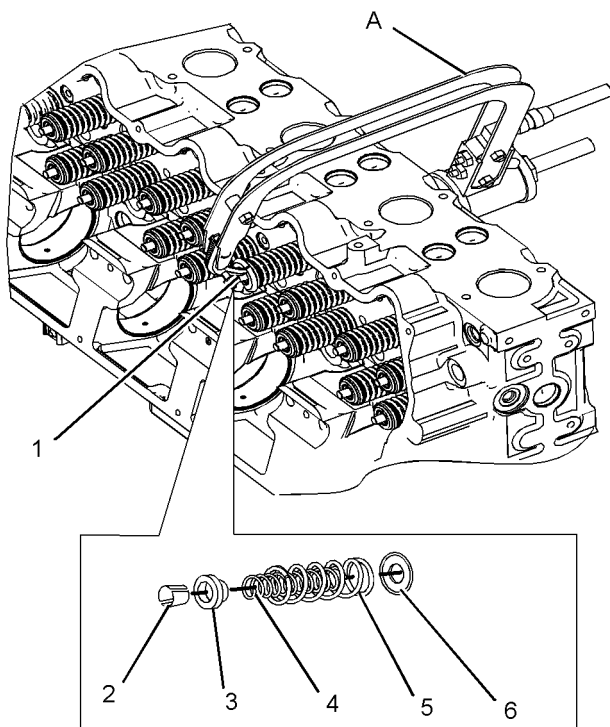


Illustration 60

g01015263

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.

2. Install washer (6) on the valve guide.

3. Install inner valve spring (4) and outer valve spring (5) on valve (1).

4. Install valve rotator (3) on valve (1).

5. Use Tooling (A) to compress inner valve spring (4) and outer valve spring (5). Install valve spring keepers (2) on valve (1).

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.

6. Carefully remove Tooling (A).

End By:

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

i02109151

Inlet and Exhaust Valve Guides - Remove and Install

SMCS Code: 1104-010

Removal Procedure

Table 15

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

⁽¹⁾ Part of 9U-7530 Engine Tool Group

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.

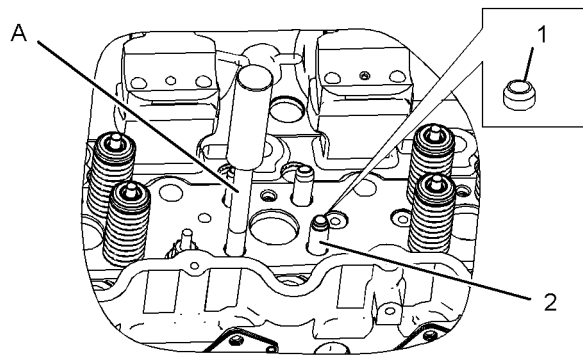


Illustration 61

g01073841

1. Remove valve stem seal (1) from valve guide (2).
2. Use Tooling (A) and a hammer to remove the valve guide from the cylinder head.

Installation Procedure

Table 16

Required Tools			
Tool	Part Number	Part Description	Qty
A ⁽¹⁾	9U-6895	Valve Guide Driver	1
B ⁽¹⁾	9U-6894	Guide Collar	1

(1) Part of 9U-7530 Engine Tool Group

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

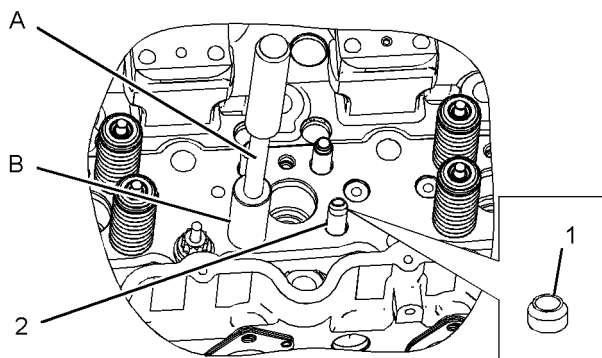


Illustration 62

g01073842

1. Lubricate the bores for the valve guides with clean engine oil.
2. Install valve guide (2) in the cylinder head with Tooling (A) and Tooling (B).

Note: Tooling (B) must be used in order to install the valve guide to the correct height.

Height to top of valve guide from cylinder head surface 35.00 ± 0.50 mm (1.378 ± 0.020 inch)

Note: For more information, refer to Specifications, "Cylinder Head Valves".

3. Install valve stem seal (1) on the valve guide.

End By:

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

i02288478

Inlet and Exhaust Valve Seat Inserts - Remove and Install

SMCS Code: 1103-010

Removal Procedure

Table 17

Required Tools			
Tool	Part Number	Part Description	Qty
A	166-7441	Valve Seat Extractor Tool Group	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.

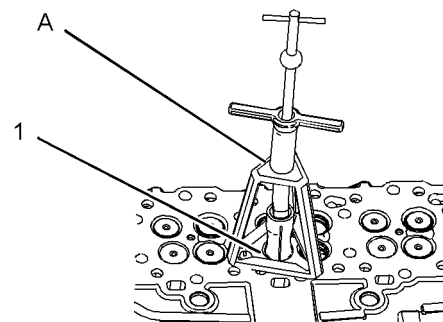


Illustration 63

g01145463

i02438648

1. Use Tooling (A) to remove valve seat insert (1) from the cylinder head.
2. Clean the bores in the cylinder head for the valve seat inserts. Remove any rough areas from the bores.

Installation Procedure

Table 18

Required Tools			
Tool	Part Number	Part Description	Qty
B ⁽¹⁾	9U-6898	Valve Seat Driver (Exhaust)	1
	9U-6897	Valve Seat Driver (Inlet)	1

⁽¹⁾ Part of 9U-7530 Engine Tool Group

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

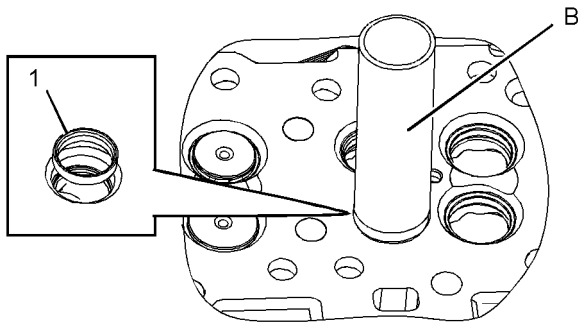


Illustration 64

g01079028

1. Lower the temperature of new valve seat insert (1).
2. Use Tooling (B) to install the new valve seat insert 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 and exhaust valves. Refer to Disassembly and Assembly, "Inlet and Exhaust Valves - Remove and Install".

Engine Oil Filter Base - Remove

SMCS Code: 1306-011

Removal Procedure

Table 19

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

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 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.

1. Drain the engine oil into a suitable container for storage or disposal. Refer to Operation and Maintenance Manual, "Engine Oil and Filter - Change".

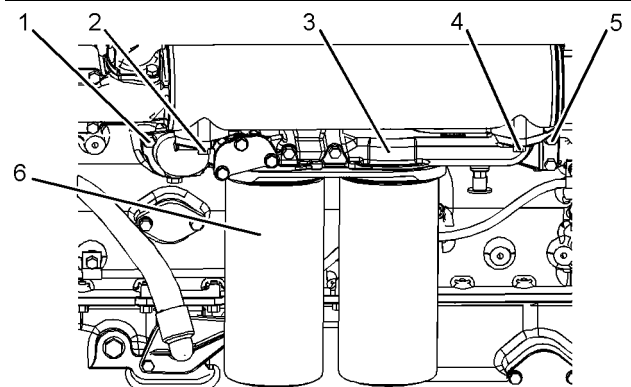


Illustration 65

g01218560

2. Use Tooling (A) in order to remove engine oil filters (6).
3. Remove bolts (1), (2), (4), and (5).
4. Remove engine oil filter base (3).

i02127750

Engine Oil Filter Base - Disassemble

SMCS Code: 1306-015

Disassembly Procedure

Start By:

- a. Remove the engine oil filter base. Refer to Disassembly and Assembly, "Engine Oil Filter Base - Remove".
1. Remove the O-ring seals.

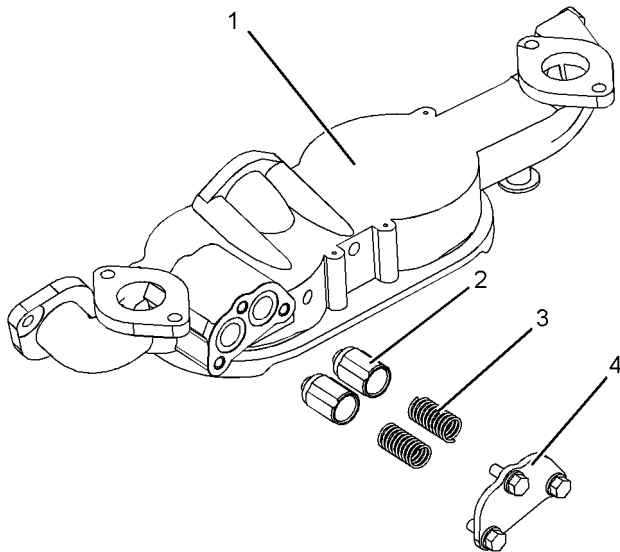


Illustration 66

g01083088

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.

2. Remove cover (4).

3. Remove springs (3) and plungers (2) from oil filter base assembly (1).

i02127824

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.

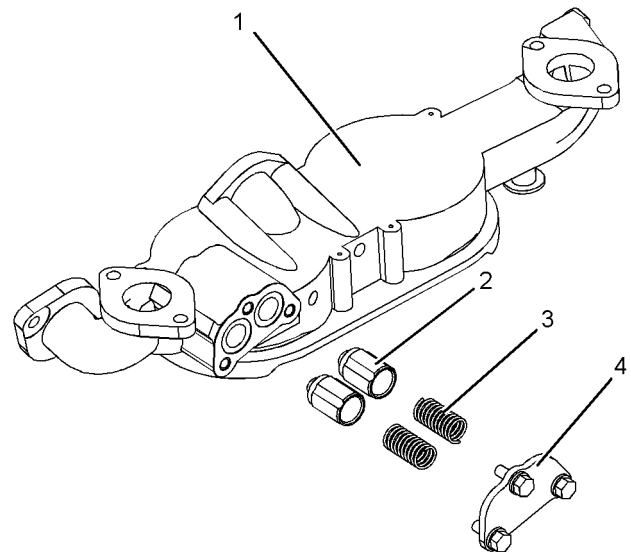


Illustration 67

g01083088

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. Install plungers (2) and springs (3) in oil filter base assembly (1).
2. Install cover (4).
3. Install the O-ring seals.

End By:

i02438849

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

i02438813

Engine Oil Filter Base - Install

SMCS Code: 1306-012

Installation Procedure

Table 20

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

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

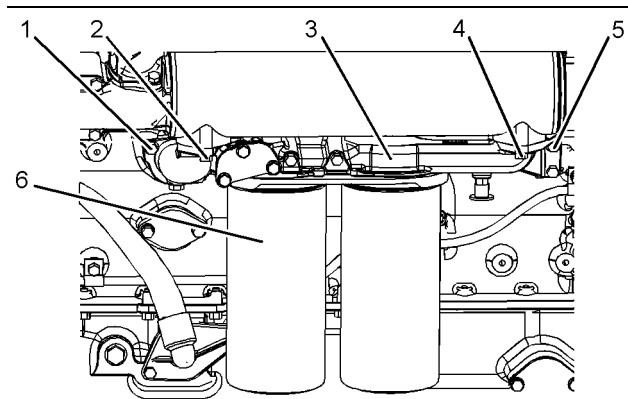


Illustration 68

g01218560

1. Position engine oil filter base (3) on the engine oil cooler.
2. Install bolts (1), (2), (4), and (5).
3. Use Tooling (A) to install engine oil filters (6).
4. Refill the engine with engine oil. Refer to Operation and Maintenance Manual, "Engine Oil and Filter - Change".

Engine Oil Cooler - Remove

SMCS Code: 1378-011

Removal Procedure**Start By:**

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

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".

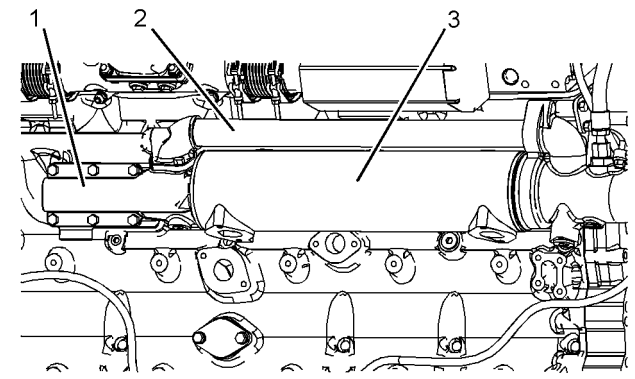


Illustration 69

g01218689

2. Remove tube assembly (2).
3. Remove bonnet (1) and the gasket.

4. Remove engine oil cooler (3).
5. Remove the O-ring seals from engine oil cooler (3).

i02439263

Engine Oil Cooler - Install

i02438914

SMCS Code: 1378-012

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

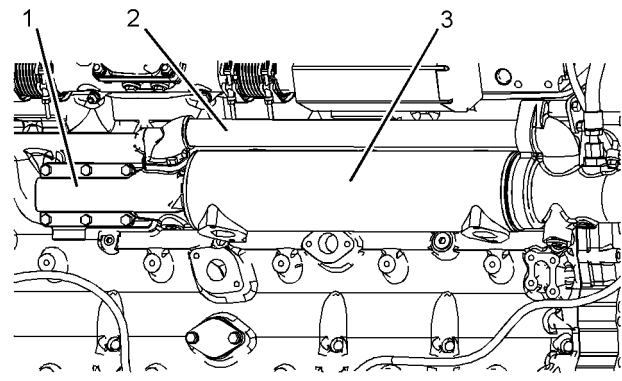


Illustration 70

g01218689

1. Install the O-ring seals on engine oil cooler (3).
2. Lubricate the O-ring seals with clean engine oil or glycerin.
3. Install engine oil cooler (3).
4. Install the gasket and bonnet (1).
5. Install tube assembly (2).
6. Refill the cooling system with coolant. Refer to Operation and Maintenance Manual, "Cooling System Coolant - Change".

End By:

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

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

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.

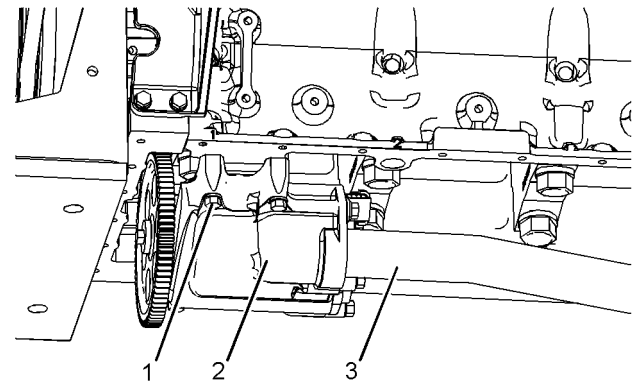


Illustration 71

g01218847

1. Remove tube assemblies (3) from engine oil pump (2).
2. Remove bolts (1) and engine oil pump (2).

i02439652

Engine Oil Pump - Disassemble

SMCS Code: 1304-015

Disassembly Procedure

Table 21

Required Tools			
Tool	Part Number	Part Description	Qty
A	1P-0510	Driver Group	1
B	1P-2320	Puller Assembly	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.

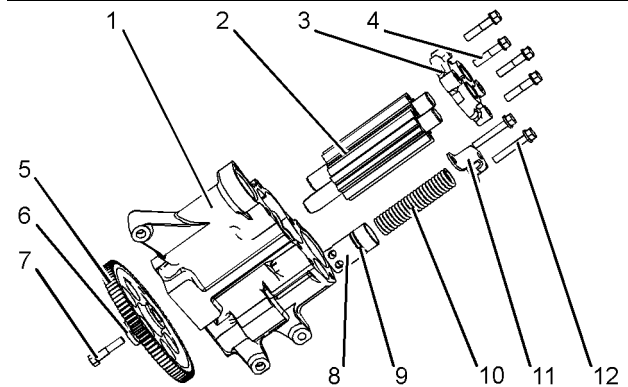


Illustration 72

g01218982

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. Remove bolt (7) and washer (6).
2. Use Tooling (B) to remove drive gear (5) from body assembly (1). Remove the key from the pump shaft.

3. Remove bolts (4) and separate cover assembly (3) from body assembly (1).
4. Use Tooling (A) and a suitable press in order to remove the bearings from cover assembly (3).
5. Remove shaft assemblies (2).
6. Remove bolts (12) and retainer (11).
7. Remove spring (10), plunger ring (9), and plunger (8).
8. Use Tooling (A) and a suitable press in order to remove the bearings from body assembly (1).

i02439997

Engine Oil Pump - Assemble

SMCS Code: 1304-016

Assembly Procedure

Table 22

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

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

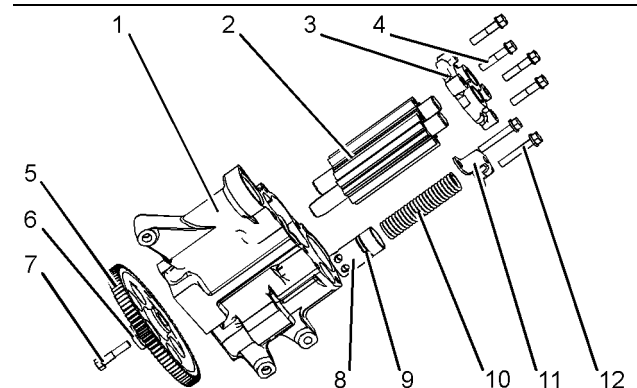


Illustration 73

g01218982

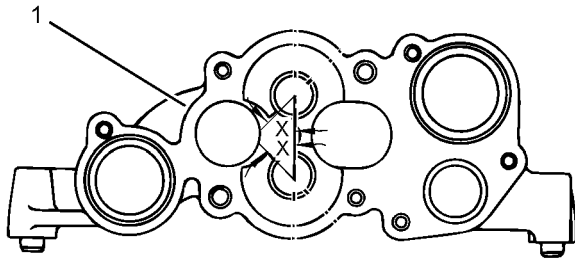


Illustration 74

g01219045

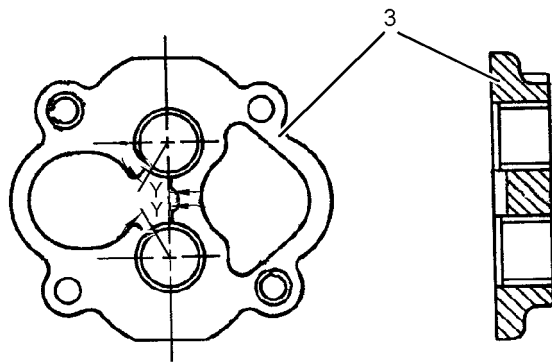


Illustration 75

g01219048

⚠ 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. Use Tooling (A) to install the bearings in body assembly (1) until the bearings are even with the outside surface of body assembly (1). Install the bearings so the junctions in the bearings are Angle (X). Angle (X) is 30 ± 15 degrees from the center line of the bearing bores and toward the outlet passage in the engine oil pump.
2. Install plunger (8), plunger ring (9), and spring (10).
3. Install retainer (11) and bolts (12).
4. Install shaft assemblies (2).

5. Use Tooling (A) to install the bearings in cover assembly (3) until the bearings are even with the outside surface of cover assembly (3). Install the bearings so the junctions in the bearings are Angle (Y). Angle (Y) is 30 ± 15 degrees from the center line of the bearing bores, and toward the outlet passage. The outlet passage has a cavity between the bearing bores.
6. Install cover assembly (3) on body assembly (1). Install bolts (4).
7. Install the key into the pump shaft. Install drive gear (5). Install washer (6) and bolt (7). Tighten bolt (7) to a torque of 55 ± 10 N·m (41 ± 7 lb ft).

End By:

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

i02440080

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.

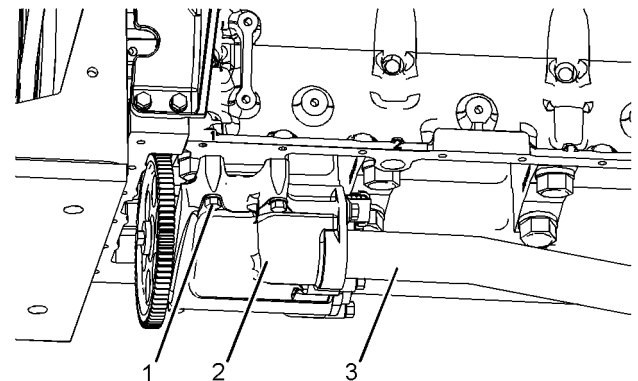


Illustration 76

g01218847

1. Position engine oil pump (2) and install bolts (1).
2. Install tube assemblies (3) on engine oil pump (2).

End By:

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

i02440626

Water Pump - Remove

SMCS Code: 1361-011

Removal Procedure

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.

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".

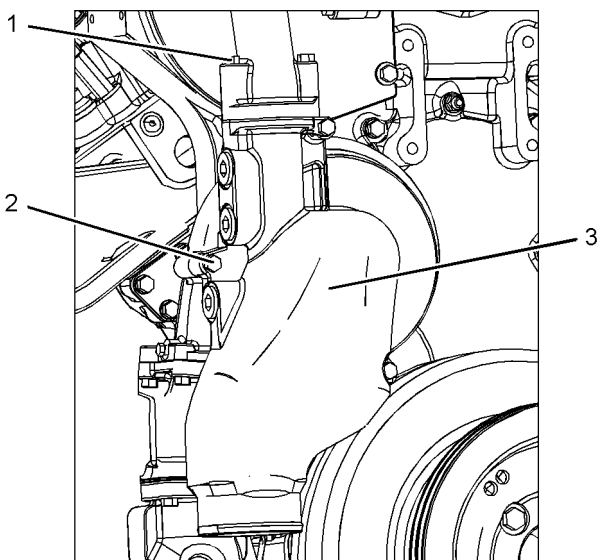


Illustration 77

g01219274

2. Remove bolts (1) and bolts (2).
3. Remove cover (3).

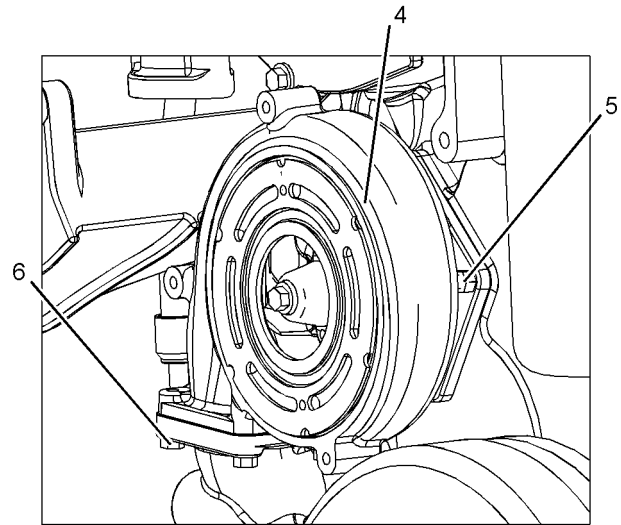


Illustration 78

g01219275

4. Remove bolts (6) and nuts (5).
5. Remove water pump (4).

i02451192

Water Pump - Disassemble

SMCS Code: 1361-015

Disassembly Procedure

Table 23

Required Tools			
Tool	Part Number	Part Description	Qty
A	8S-2264	Puller Group	1
	4B-3903	Bolt 5/16 - 18 NC by 4 inch	2
	1P-0456	Plate	1
	4B-4277	Washer	2
B	1P-0510	Driver Group	1

Start By:

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

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

i02394663

Note: The water pump seal can be replaced without removing the water pump from the engine.

Note: An intermittent leakage of a small amount of coolant from the hole in the water pump housing is not an indication of a water pump seal failure. This is required to provide lubrication for the seal. Do not replace the water pump seal unless a large amount of leakage or a constant flow of coolant is draining from the water pump housing.

Water Pump - Assemble

SMCS Code: 1361-016

Assembly Procedure

Table 24

Required Tools			
Tool	Part Number	Part Description	Qty
B	1P-0510	Driver Group	1
C	7N-7843	Seal Installation Tool	1
D	6V-1541	Quick Cure Primer	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

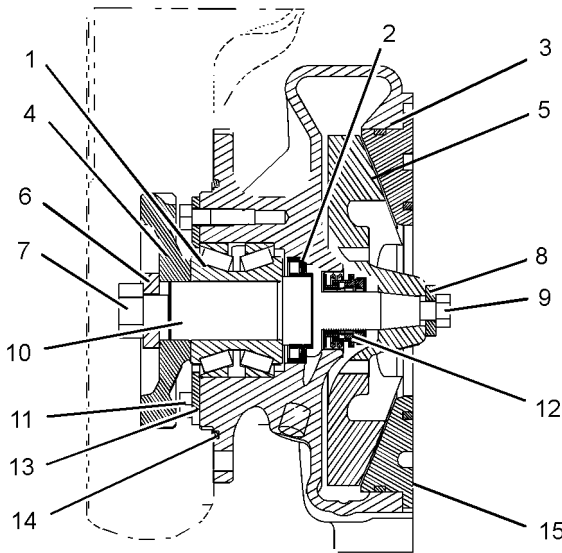


Illustration 79

g01195730

1. Remove adapter (15).
2. Remove bolt (9) and washer (8).
3. Use Tooling (A) to remove impeller (5) from shaft (10).
4. Remove bolt (7), washer (6), and gear (4) from shaft (10).
5. Remove bolts (11) and retainer (13).
6. Remove O-ring seal (14) from housing (3).
7. Use a suitable press to remove shaft (10) and bearing assembly (1) from housing (3).
8. Use a suitable press to remove bearing assembly (1) from shaft (10).
9. Remove seal assembly (12) from housing (3).
10. Use Tooling (B) to remove lip seal (2) from the housing.

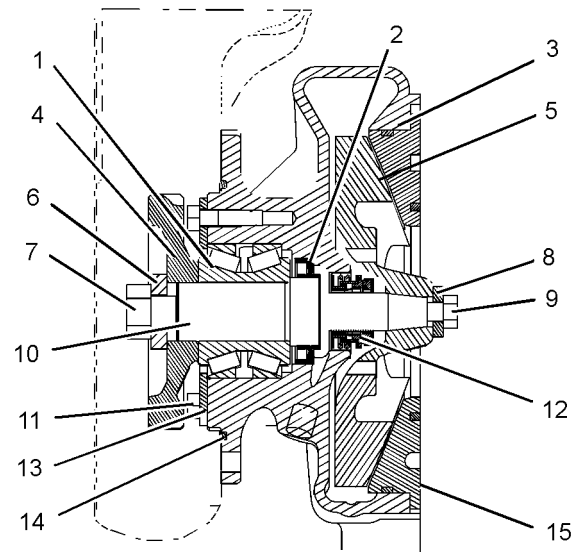


Illustration 80

g01195730

1. Use Tooling (B) to install lip seal (2) into the housing.
2. Apply Tooling (D) to shaft (10). Use a suitable press to install bearing assembly (1) on shaft (10).
3. Install shaft (10) and bearing assembly (1) in housing (3).
4. Install O-ring seal (14) on housing (3).
5. Install retainer (13) and bolts (11).
6. Position gear (4) on shaft (10). Install washer (6) and bolt (7).

7. Use Tooling (C) to install seal assembly (12) onto shaft (10) until the stationary cup is fully seated into housing (3).
8. Install impeller (5) on shaft (10). Install washer (8) and bolt (9). Tighten bolt (9) to a torque of 39 ± 3 N·m (29 ± 2 lb ft).
9. Install adapter (15).

End By:

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

i02440675

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.

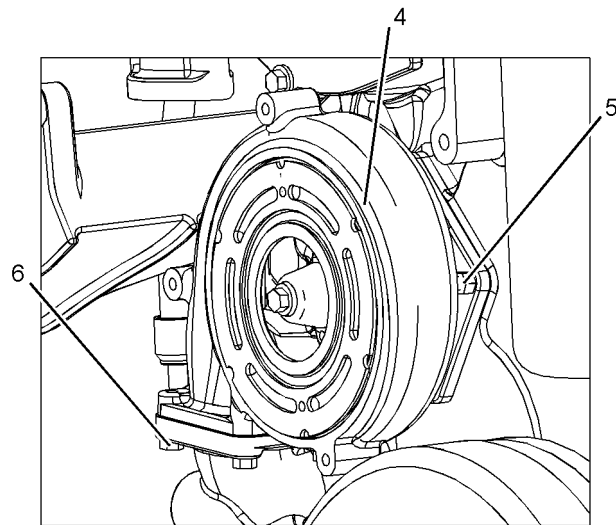


Illustration 81

g01219275

1. Position water pump (4) in the front housing.
2. Install nuts (5) and bolts (6).

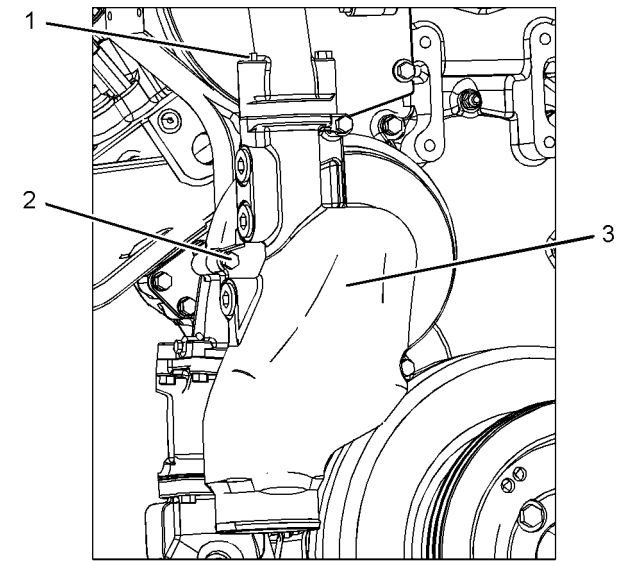


Illustration 82

g01219274

3. Position cover (3) on the water pump.
4. Install bolts (2) and bolts (1).
5. Fill the cooling system. Refer to Operation and Maintenance Manual, "Cooling System Coolant - Change".

i02440754

Water Temperature Regulator Housing - Remove and Install

SMCS Code: 1393-010

Removal Procedure

1. Drain the coolant from the cooling system into a suitable container for storage or disposal until the coolant is below the level of the water temperature regulator housing. Refer to Operation and Maintenance Manual, "Cooling System Coolant - Change".

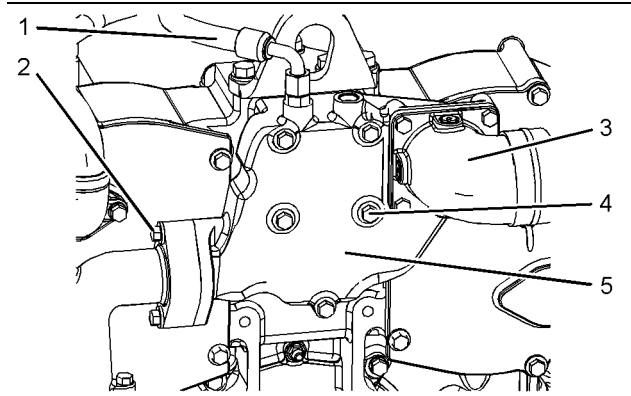


Illustration 83 g01219336

2. Disconnect hose assembly (1) and elbow (3).
3. Remove bolts (2) and bolts (4). Remove water temperature regulator housing (5).

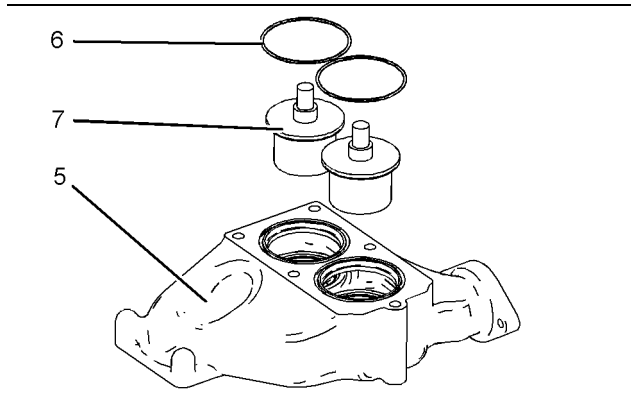


Illustration 84 g01223744

4. Remove O-ring seals (6) and water temperature regulators (7) from water temperature regulator housing (5).
5. If necessary, remove the lip seals.

Installation Procedure

Table 25

Required Tools			
Tool	Part Number	Part Description	Qty
A	221 - 8647	Seal Installer Gp	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. If necessary, use Tooling (A) to install the lip seals.

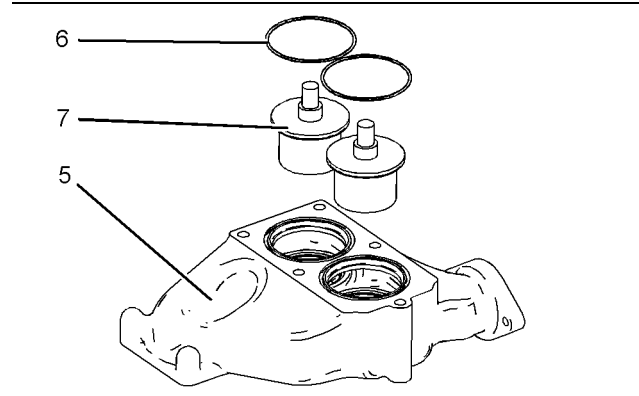


Illustration 85 g01223744

2. Install water temperature regulators (7) and O-ring seals (6) in water temperature regulator housing (5).

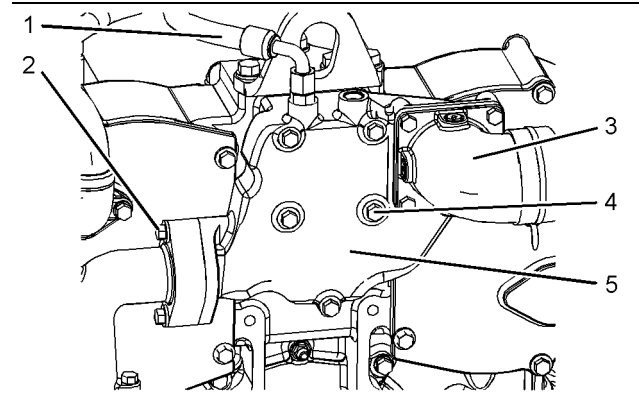


Illustration 86 g01219336

3. Position water temperature regulator housing (5) on the engine. Install bolts (4) and bolts (2).
4. Connect elbow (3) and hose assembly (1).
5. Fill the cooling system. Refer to Operation and Maintenance Manual, "Cooling System Coolant - Change".

i02576096

Cooling System Package (Radiator, Aftercooler, Fuel Cooler) - Remove

SMCS Code: 1063-011; 1353-011; 1712-011

Removal Procedure

Table 26

Required Tools			
Tool	Part Number	Part Description	Qty
A	189-0410	Shackle As	2

Start By:

- a. Remove the fan. Refer to Disassembly and Assembly, "Fan - Remove and Install".

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 for disposal. Refer to Operation and Maintenance Manual, "Cooling System Coolant (ELC) - Change".



Illustration 87

g01290908

2. Remove clamp (1). Repeat for the opposite side.

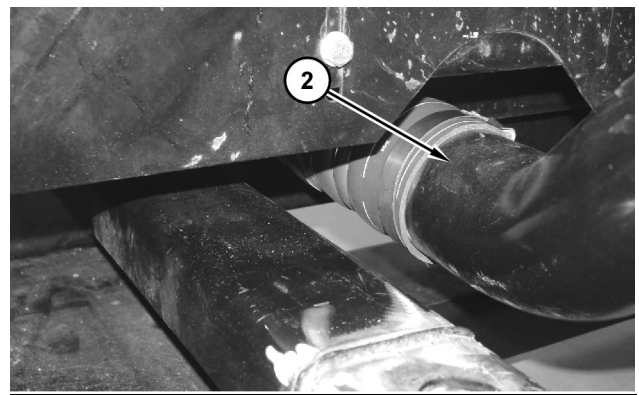


Illustration 88

g01290915

3. Disconnect bottom aftercooler tube (2).

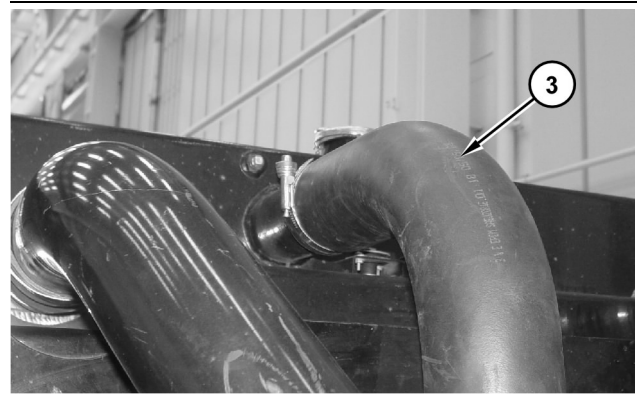


Illustration 89

g01290916

4. Disconnect top radiator hose (3).

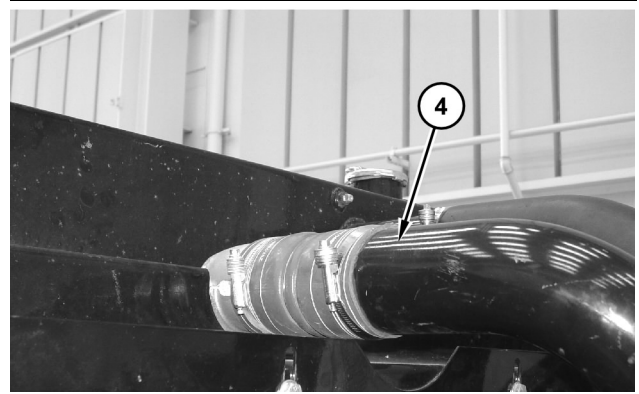


Illustration 90

g01290917

5. Disconnect top aftercooler tube (4).

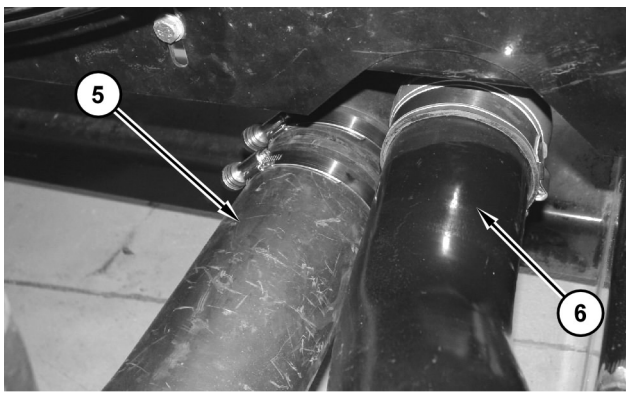


Illustration 91 g01290930

6. Disconnect bottom radiator hose (5). Disconnect bottom aftercooler tube (6).

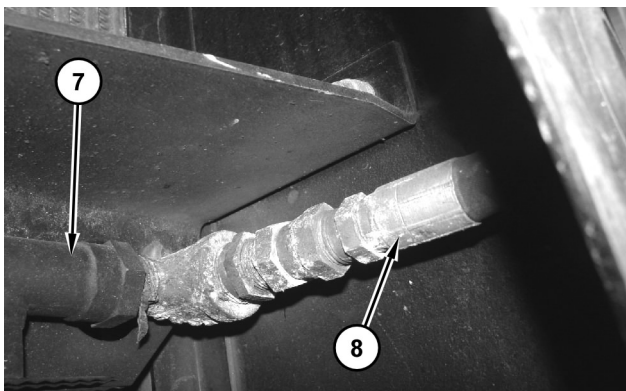


Illustration 92 g01290934

7. Disconnect hose assembly (8) from fuel cooler (7).

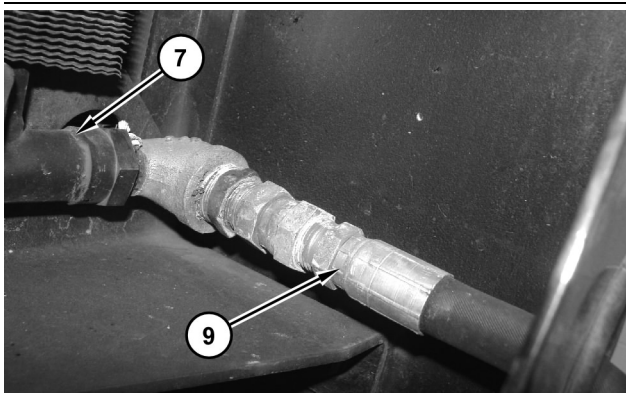


Illustration 93 g01290939

8. Disconnect hose assembly (9) from fuel cooler (7).

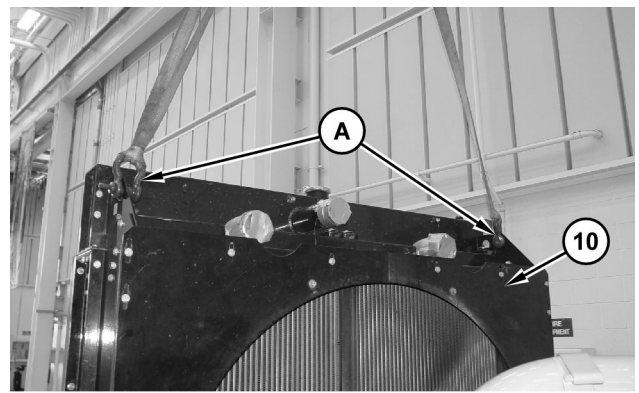


Illustration 94 g01290940

9. Attach Tooling (A) and a suitable lifting device onto cooling package (10). The weight of cooling package (10) is approximately 544 kg (1200 lb).

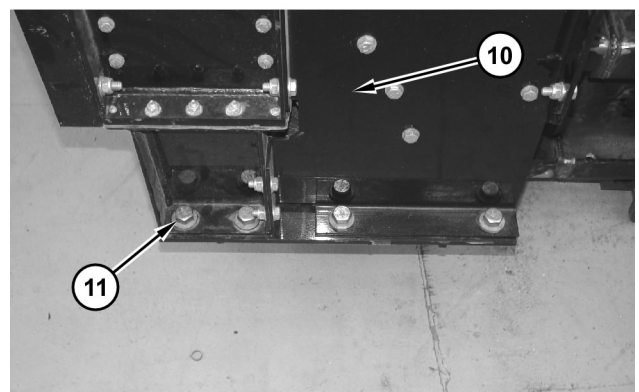


Illustration 95 g01290941

10. Remove bolts (11). Repeat for the opposite side. Remove cooling package (10).

i02576308

Cooling System Package (Radiator, Aftercooler, Fuel Cooler) - Install

SMCS Code: 1063-012; 1353-012; 1712-012

Installation Procedure

Table 27

Required Tools			
Tool	Part Number	Part Description	Qty
A	189-0410	Shackle As	2

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.

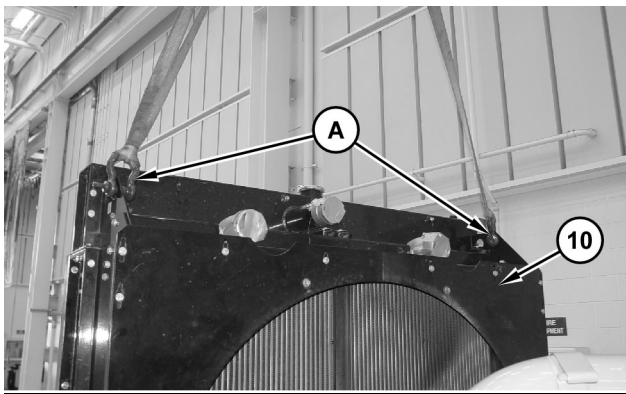


Illustration 96

g01290940

1. Attach Tooling (A) and a suitable lifting device onto cooling package (10). The weight of cooling package (10) is approximately 544 kg (1200 lb).

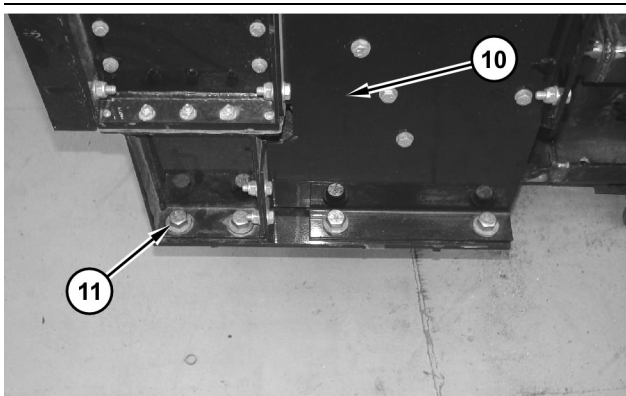


Illustration 97

g01290941

2. Install cooling package (10). Install bolts (11). Repeat for the opposite side.

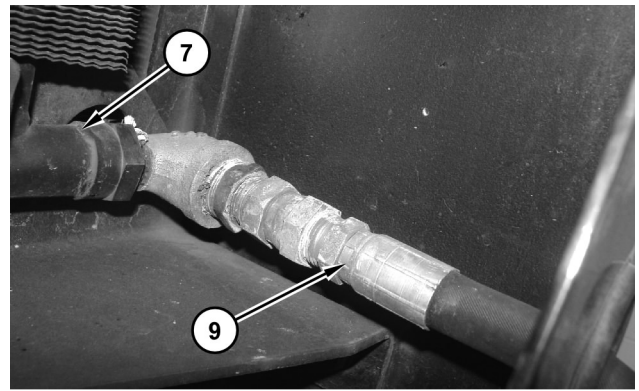


Illustration 98

g01290939

3. Connect hose assembly (9) onto fuel cooler (7).

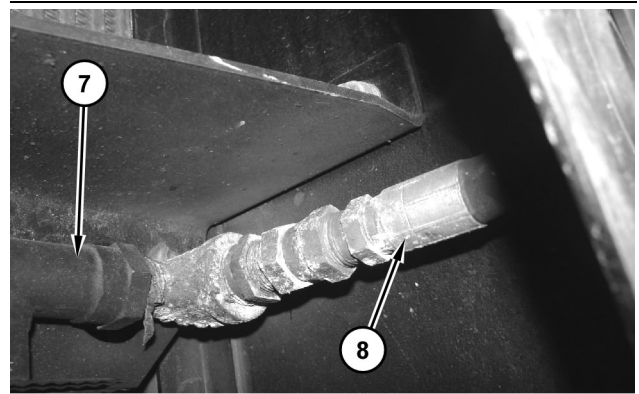


Illustration 99

g01290934

4. Connect hose assembly (8) onto fuel cooler (7).

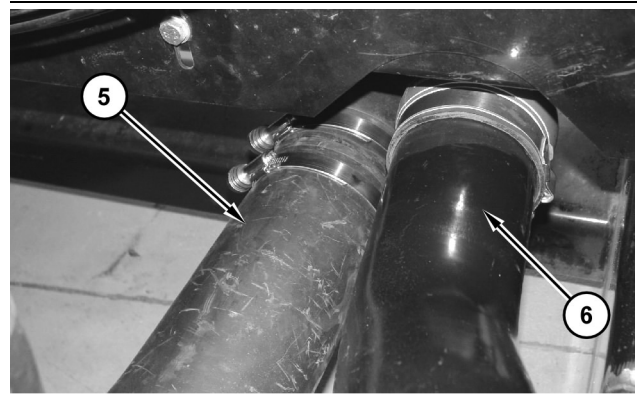


Illustration 100

g01290930

5. Connect bottom aftercooler tube (6). Connect bottom radiator hose (5).

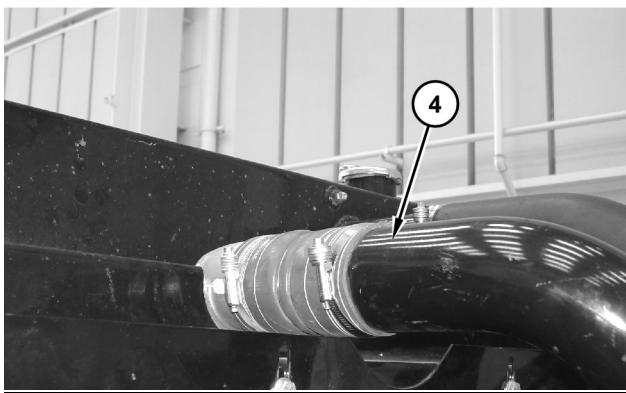


Illustration 101 g01290917

6. Connect top aftercooler tube (4).

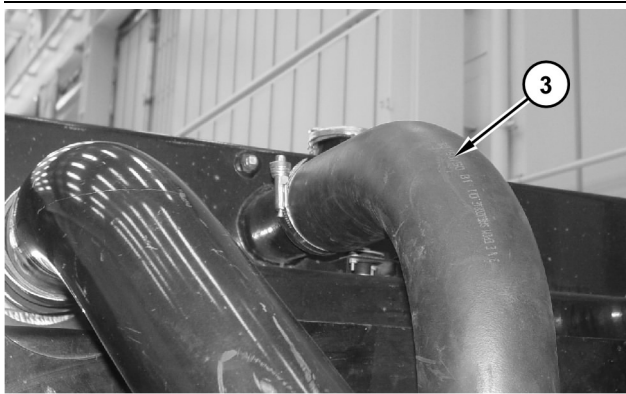


Illustration 102 g01290916

7. Connect top radiator hose (3).

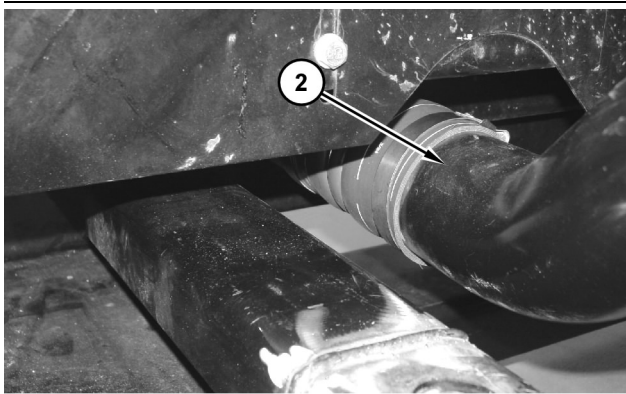


Illustration 103 g01290915

8. Connect bottom aftercooler tube (2).



Illustration 104 g01290908

9. Install clamp (1). Repeat for the opposite side.

10. Fill the cooling system with coolant. Refer to Operation and Maintenance Manual, "Cooling System Coolant (ELC) - Change".

End By:

- a. Install the fan. Refer to Disassembly and Assembly, "Fan - Remove and Install".

i02584900

Aftercooler - Remove

SMCS Code: 1063-011

Removal Procedure

Table 28

Required Tools			
Tool	Part Number	Part Description	Qty
A	189-0410	Shackle As	2

Start By:

- a. Remove the fan. Refer to Disassembly and Assembly, "Fan - Remove and Install".

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 for disposal. Refer to Operation and Maintenance Manual, "Cooling System Coolant (ELC) - Change".



Illustration 105

g01290908

2. Remove clamp (1). Repeat for the opposite side.

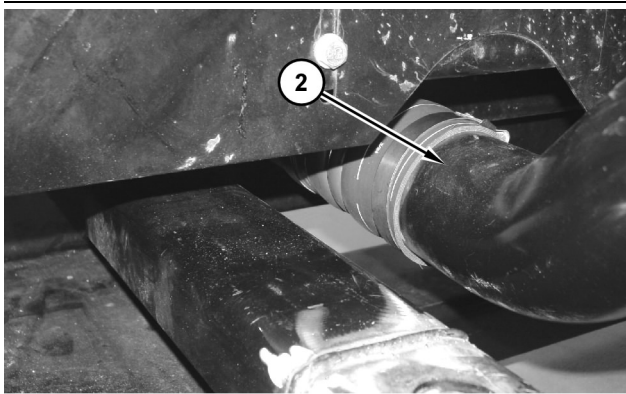


Illustration 106

g01290915

3. Disconnect bottom aftercooler tube (2).

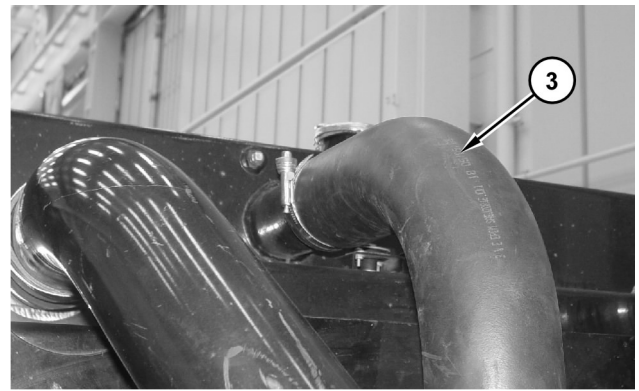


Illustration 107

g01290916

4. Disconnect top radiator hose (3).

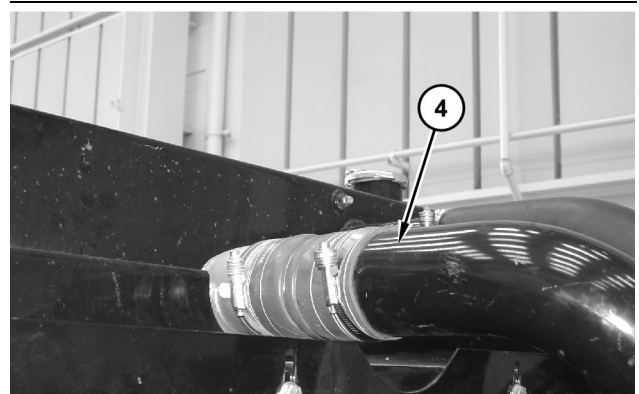


Illustration 108

g01290917

5. Disconnect top aftercooler tube (4).

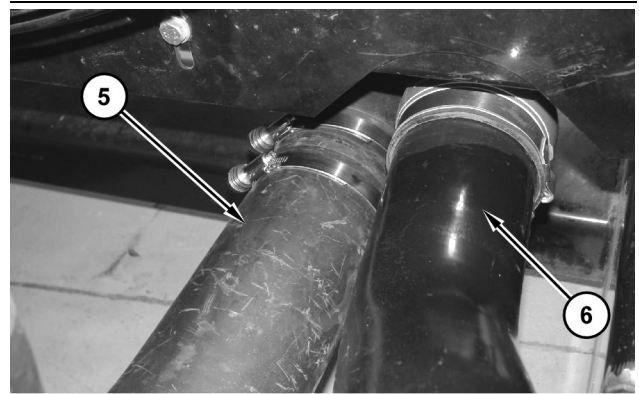


Illustration 109

g01290930

6. Disconnect bottom radiator hose (5). Disconnect bottom aftercooler tube (6).

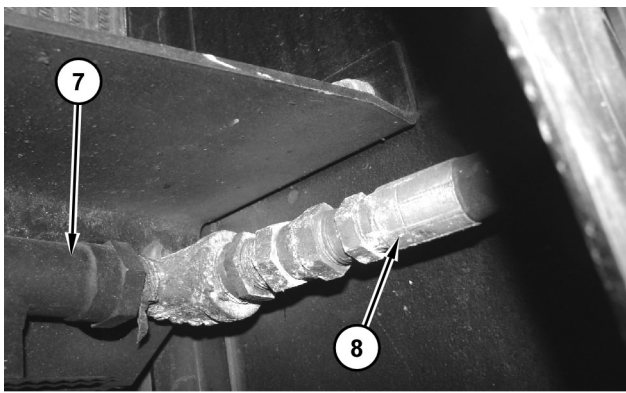


Illustration 110 g01290934

7. Disconnect hose assembly (8) from fuel cooler (7).

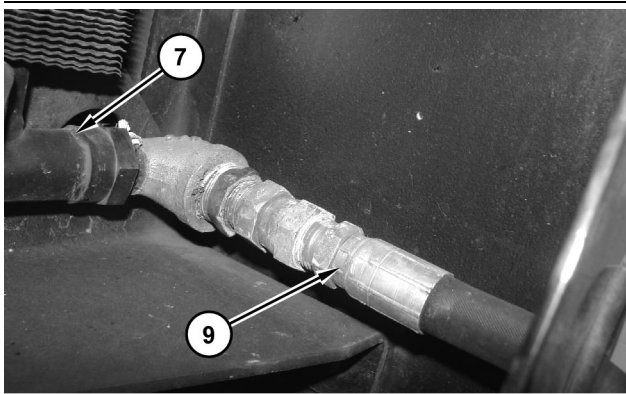


Illustration 111 g01290939

8. Disconnect hose assembly (9) from fuel cooler (7).

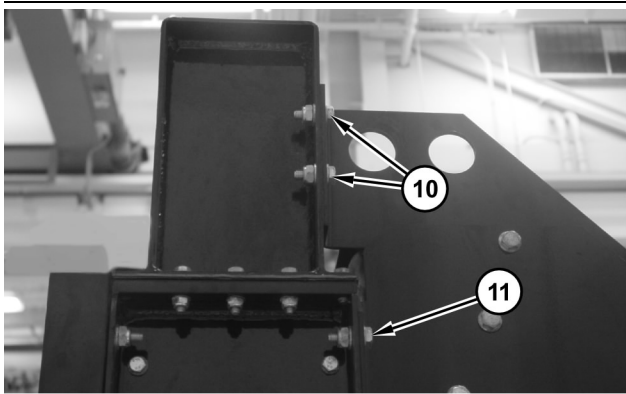


Illustration 112 g01294215

9. Remove bolts (10). Remove bolt (11).

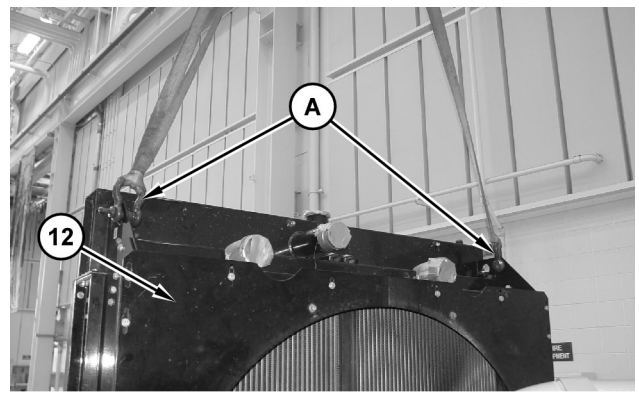


Illustration 113 g01294232

10. Attach Tooling (A) and a suitable lifting device onto aftercooler (12). The weight of aftercooler (12) is approximately 227 kg (500 lb).

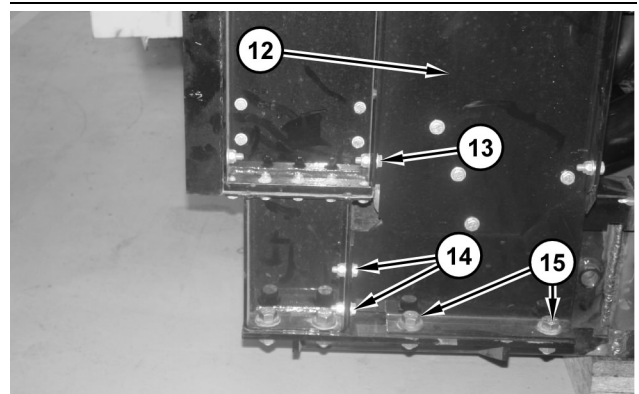


Illustration 114 g01294234

11. Remove bolt (13). Remove bolts (14) and bolts (15) from aftercooler (12).

12. Repeat Step 9 through Step 11 for the opposite side.

13. Remove aftercooler (12).

i02585968

Aftercooler - Install

SMCS Code: 1063-012

Installation Procedure

Table 29

Required Tools			
Tool	Part Number	Part Description	Qty
A	189-0410	Shackle As	2

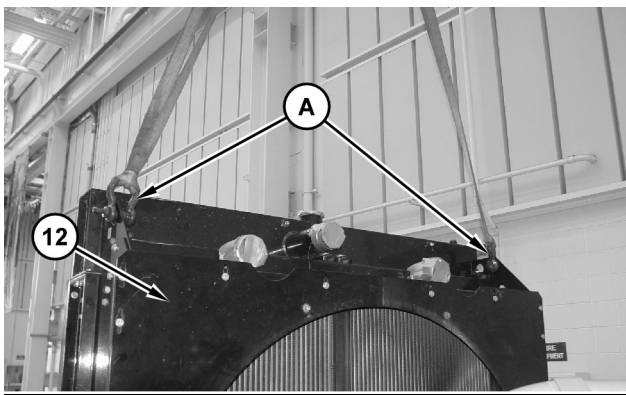


Illustration 115

g01294232

1. Attach Tooling (A) and a suitable lifting device onto aftercooler (12). The weight of aftercooler (12) is approximately 227 kg (500 lb). Install aftercooler (12).

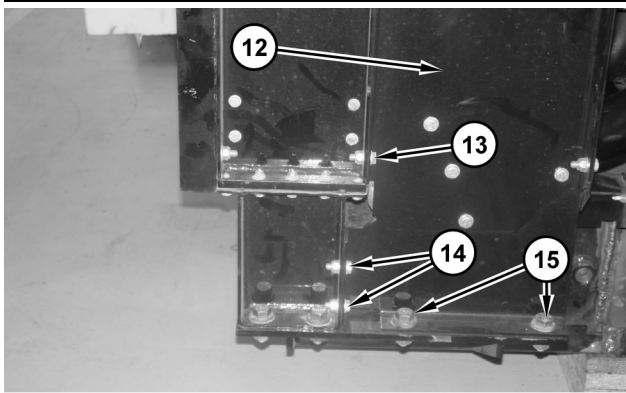


Illustration 116

g01294234

2. Install bolts (14) and bolts (15) into aftercooler (12). Install bolt (13).

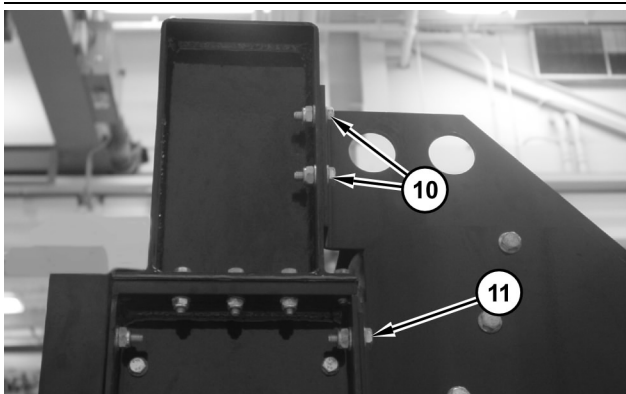


Illustration 117

g01294215

3. Install bolt (11). Install bolts (10).

4. Repeat Step 2 and Step 3 for the opposite side.

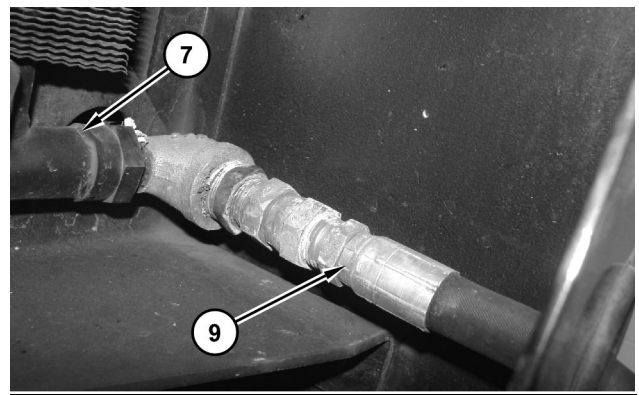


Illustration 118

g01290939

5. Connect hose assembly (9) onto fuel cooler (7).

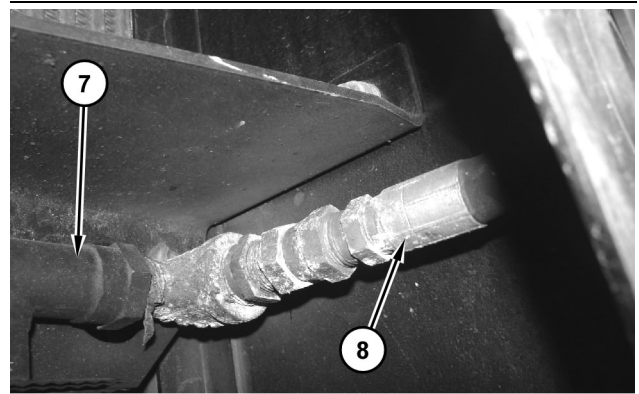


Illustration 119

g01290934

6. Connect hose assembly (8) onto fuel cooler (7).

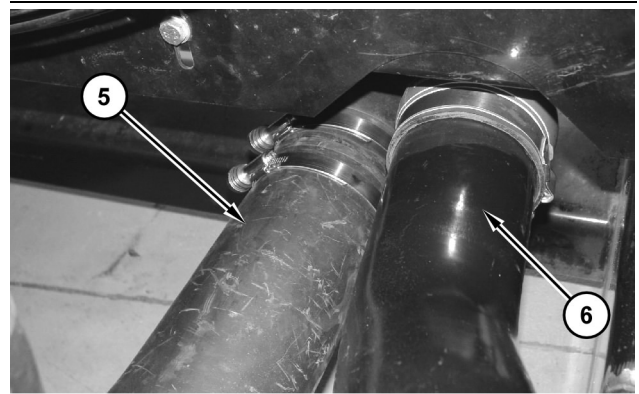


Illustration 120

g01290930

7. Connect bottom aftercooler tube (6). Connect bottom radiator hose (5).

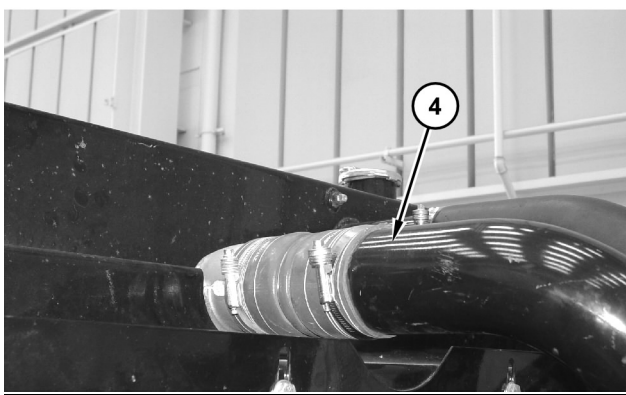


Illustration 121 g01290917

8. Connect top aftercooler tube (4).

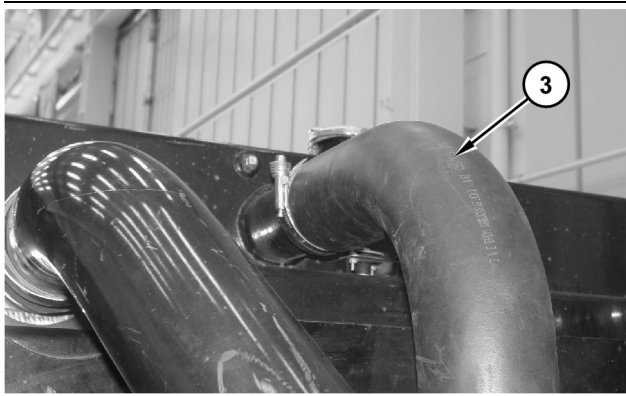


Illustration 122 g01290916

9. Connect top radiator hose (3).

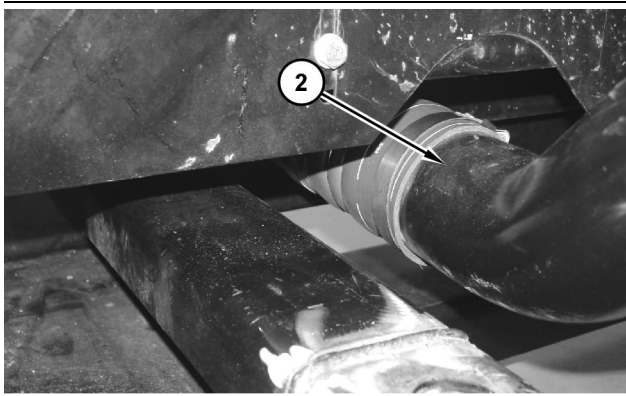


Illustration 123 g01290915

10. Connect bottom aftercooler tube (2).



Illustration 124 g01290908

11. Install clamp (1). Repeat for the opposite side.

12. Fill the cooling system with coolant. Refer to Operation and Maintenance Manual, "Cooling System Coolant (ELC) - Change".

End By:

- a. Install the fan. Refer to Disassembly and Assembly, "Fan - Remove and Install".

i02581106

Radiator Core - Remove

SMCS Code: 1353-011; 1353-011-KO

Removal Procedure

Table 30

Required Tools			
Tool	Part Number	Part Description	Qty
A	138-7575	Link Bracket	2

Start By:

- a. Remove the aftercooler. Refer to Disassembly and Assembly, "Aftercooler - Remove".

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.

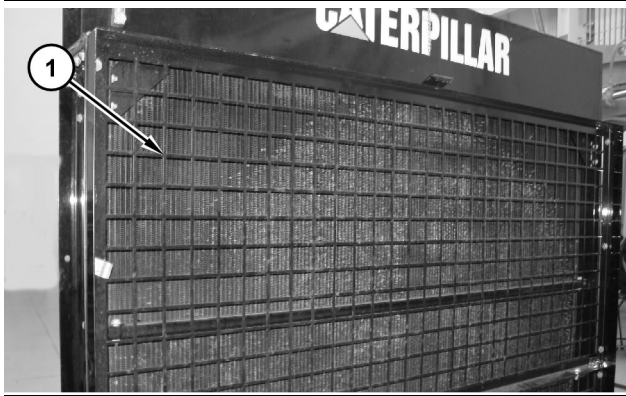


Illustration 125 g01292911

1. Remove the upper and the lower radiator guards (1).

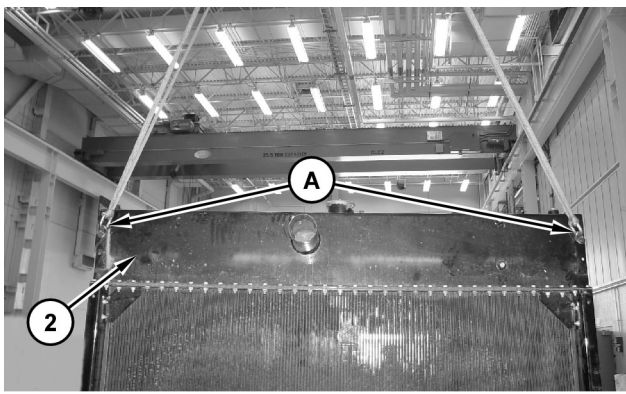


Illustration 126 g01292912

2. Attach Tooling (A) and a suitable lifting device onto radiator top tank (2). The weight of the radiator is approximately 227 kg (500 lb).

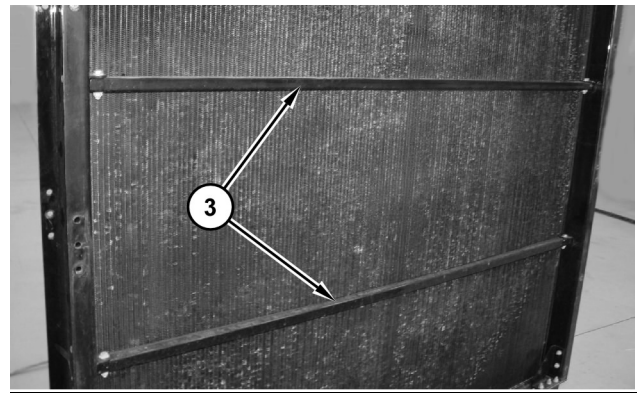


Illustration 127 g01294577

3. Remove the upper and the lower braces (3).

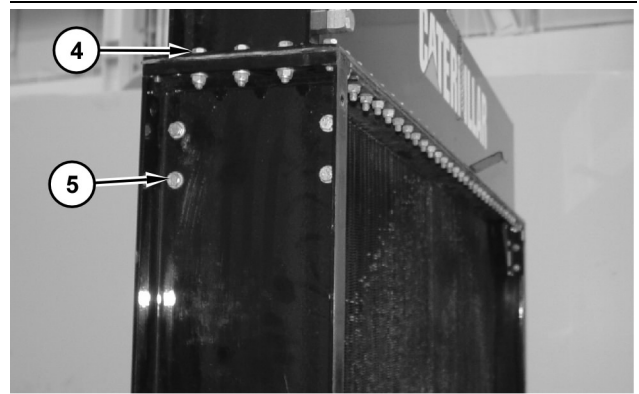


Illustration 128 g01294578

4. Remove bolts (4) and remove bolts (5).

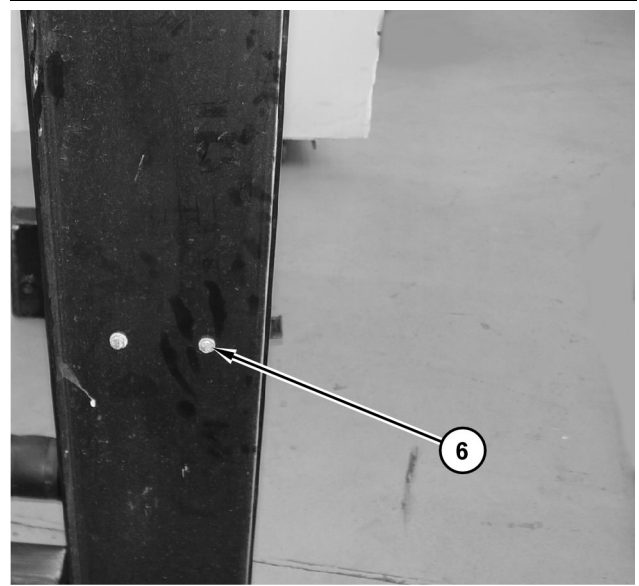


Illustration 129 g01294579

5. Remove bolts (6).

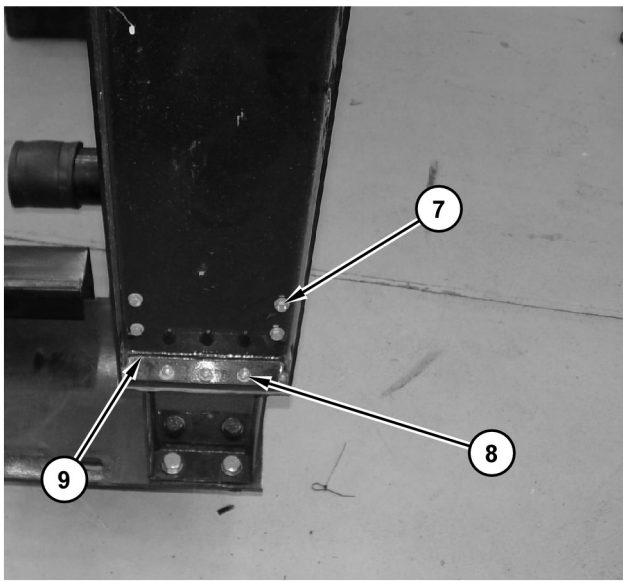


Illustration 130 g01294580

6. Remove bolts (7). Remove bolts (8). Remove support (9).
7. Repeat Steps 4 through 6 for the opposite side.

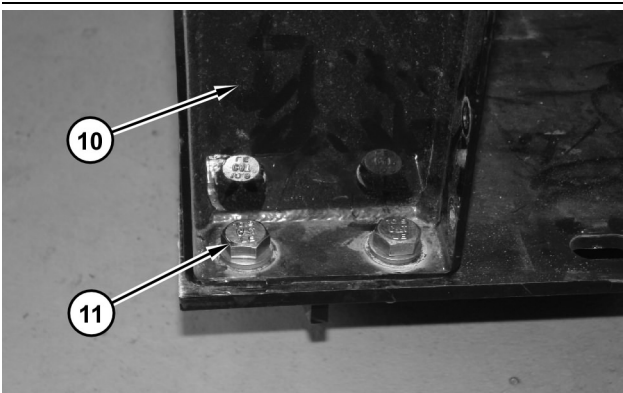


Illustration 131 g01294602

8. Remove bolts (11). Repeat for the opposite side. Remove radiator (10).

i02585957

Radiator Core - Install

SMCS Code: 1353-012-KO; 1353-012

Installation Procedure

Table 31

Required Tools			
Tool	Part Number	Part Description	Qty
A	138-7575	Link Bracket	2

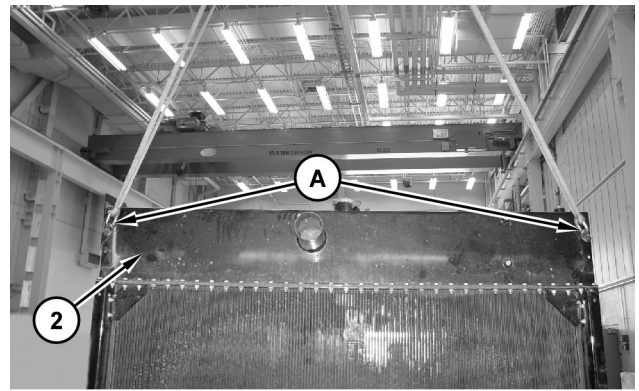


Illustration 132 g01292912

1. Attach Tooling (A) and a suitable lifting device onto radiator top tank (2). The weight of the radiator is approximately 227 kg (500 lb).

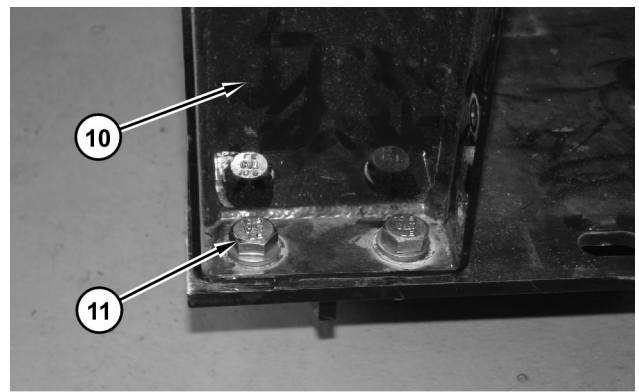


Illustration 133 g01294602

2. Install radiator (10). Install bolts (11). Repeat for the opposite side.

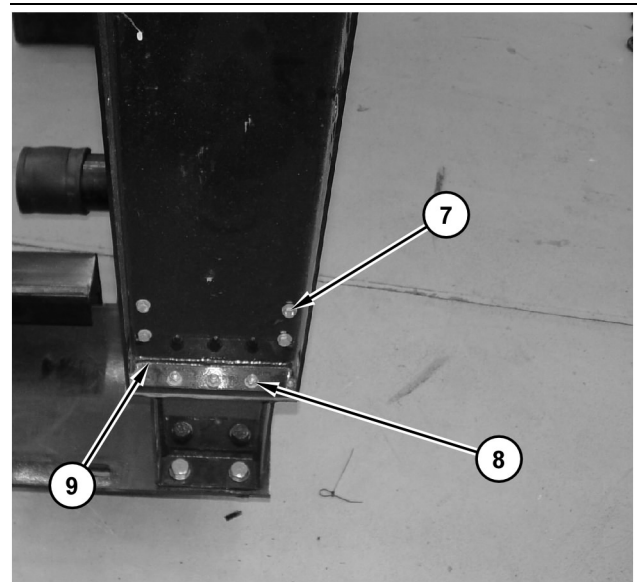


Illustration 134 g01294580

3. Install support (9). Install bolts (8). Install bolts (7).

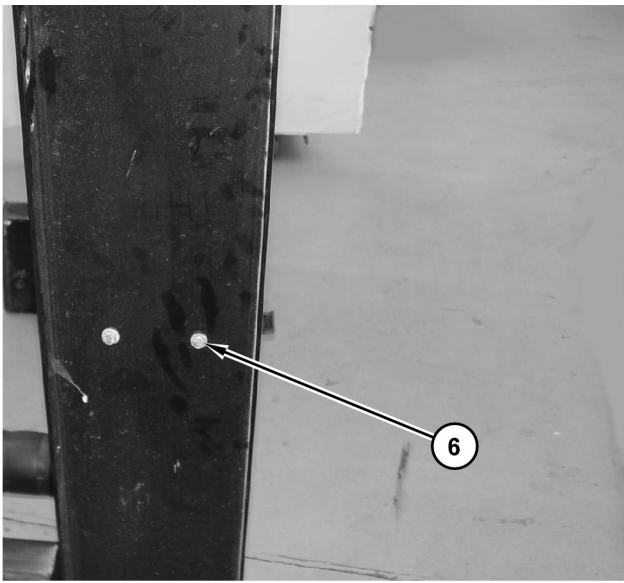


Illustration 135 g01294579

4. Install bolts (6).

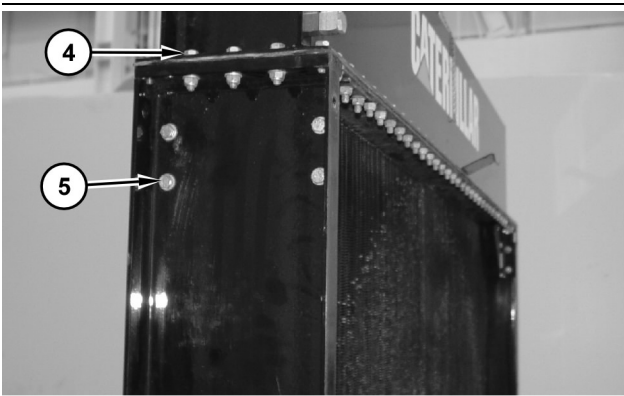


Illustration 136 g01294578

5. Install bolts (4) and bolts (5).

6. Repeat Steps 3 through 5 for the opposite side.

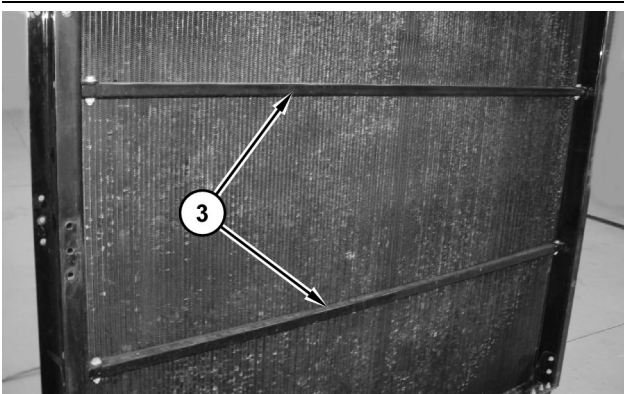


Illustration 137 g01294577

7. Install the upper and the lower braces (3).

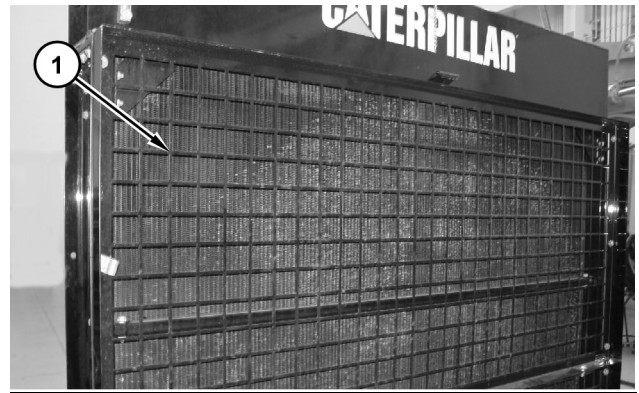


Illustration 138 g01292911

8. Install the upper and the lower radiator guards (1).

End By:

- a. Install the aftercooler. Refer to Disassembly and Assembly, "Aftercooler - Install".

i02444868

Engine Support (Front) - Remove and Install

SMCS Code: 1154-010-FR

Removal Procedure (Type 1)

Start By:

- a. Remove the vibration damper and the pulley. Refer to Disassembly and Assembly, "Vibration Damper and Pulley - Remove and Install".

1. Support the front of the engine.

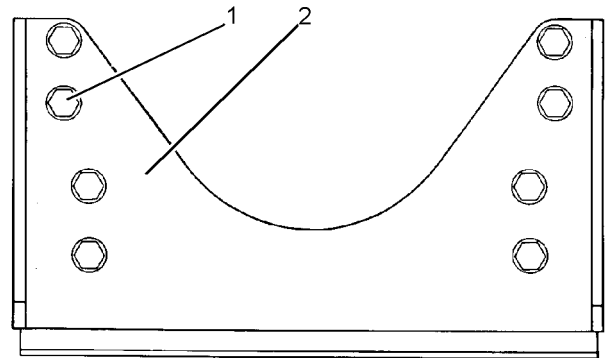


Illustration 139 g01221659

2. Remove bolts (1).

3. Remove engine support (2).

Installation Procedure (Type 1)

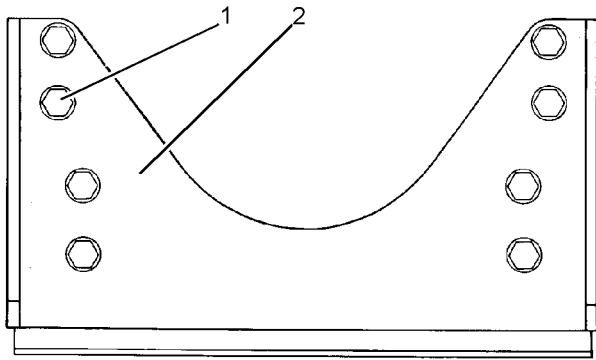


Illustration 140

g01221659

1. Position engine support (2) on the engine.
2. Install bolts (1).

End By:

- a. Install the vibration damper and the pulley. Refer to Disassembly and Assembly, "Vibration Damper and Pulley - Remove and Install".

Removal Procedure (Type 2)

Start By:

- a. Remove the vibration damper and the pulley. Refer to Disassembly and Assembly, "Vibration Damper and Pulley - Remove and Install".

1. Support the front of the engine.

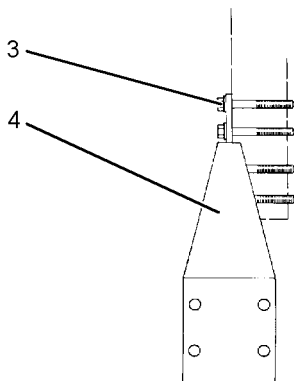


Illustration 141

g01221663

2. Remove bolts (3).
3. Use a suitable lifting device to remove engine support (4). The weight of engine support (4) is approximately 35 kg (77 lb).

Installation Procedure (Type 2)

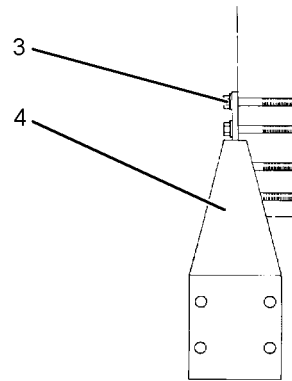


Illustration 142

g01221663

1. Use a suitable lifting device to position engine support (4) on the engine. The weight of engine support (4) is approximately 35 kg (77 lb).

2. Install bolts (3).

End By:

- a. Install the vibration damper and the pulley. Refer to Disassembly and Assembly, "Vibration Damper and Pulley - Remove and Install".

i02440962

Gear Group (Rear) - Remove

SMCS Code: 1206-011; 1212-011

Removal Procedure

Table 32

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

Start By:

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

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.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

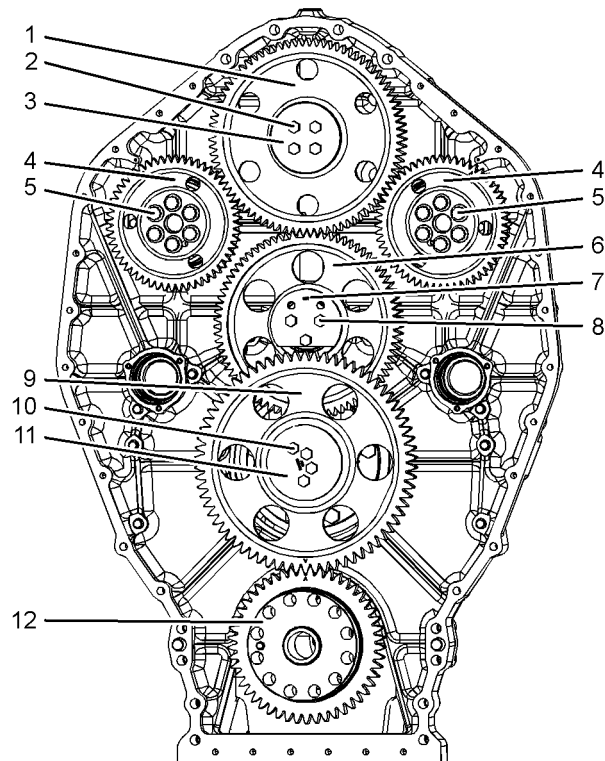


Illustration 143

g01219485

1. Remove bolts (10), thrust plate (11), and gear assembly (9).
2. Use Tooling (A) and a suitable press to remove the bearing from gear assembly (9).
3. Remove bolts (8), gear assembly (6), and shaft assembly (7).

4. Use Tooling (A) and a suitable press to remove the bearing from gear assembly (6).
5. Remove bolts (2), gear assembly (1), and shaft assembly (3).
6. Use Tooling (A) and a suitable press to remove the bearing from gear assembly (1).
7. Remove gear assembly (12).
8. Remove bolts (5) and gear assemblies (4).

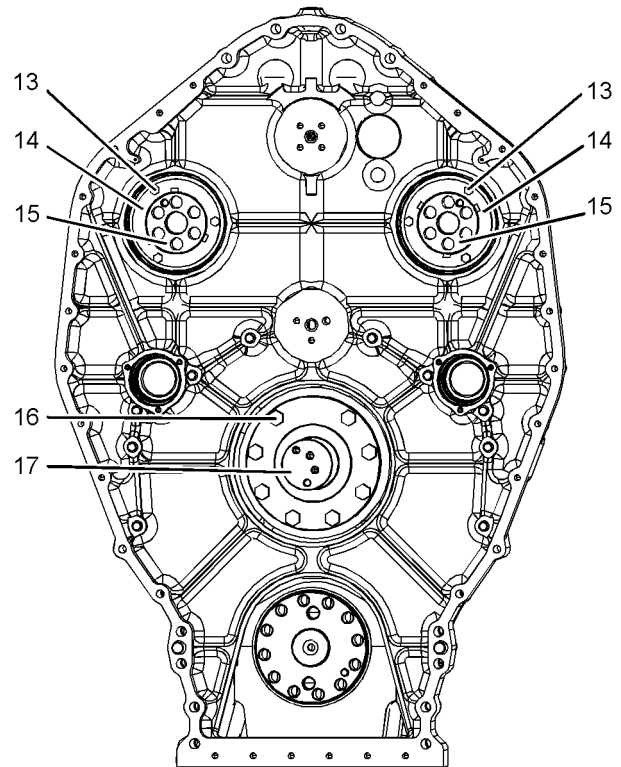


Illustration 144

g01219500

9. Remove bolts (16) and shaft assembly (17).
10. Remove bolts (13), thrust plates (14), and adapter assemblies (15).
11. Use bolt (13) in order to remove the sealing plates. Remove the O-ring seals.

i02442469

Gear Group (Rear) - Install

SMCS Code: 1206-012; 1212-012

Installation Procedure

Table 33

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

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Apply clean engine oil to the bearings and the shaft assemblies prior to installation on the engine.

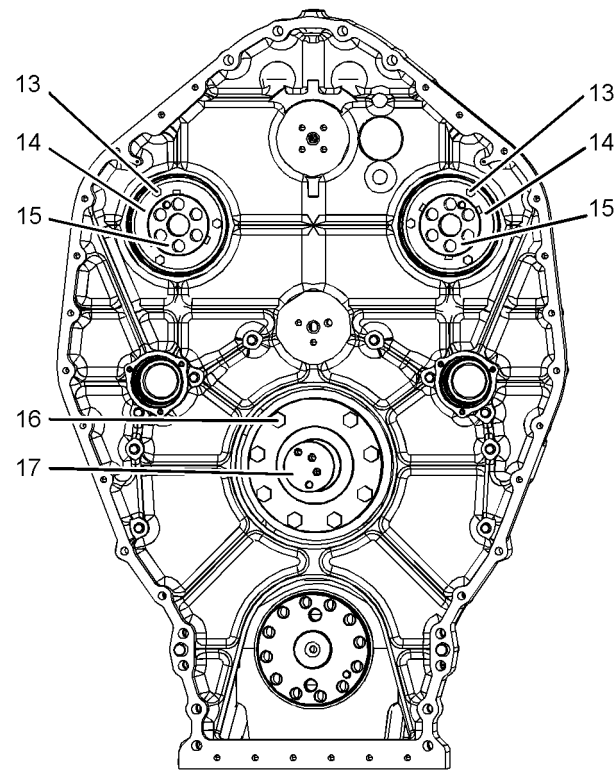


Illustration 145

g01219500

1. Install the O-ring seals and the sealing plates on the cylinder head.
2. Install adapter assemblies (15), thrust plates (14), and bolts (13).
3. Position shaft assembly (17) and install bolts (16).

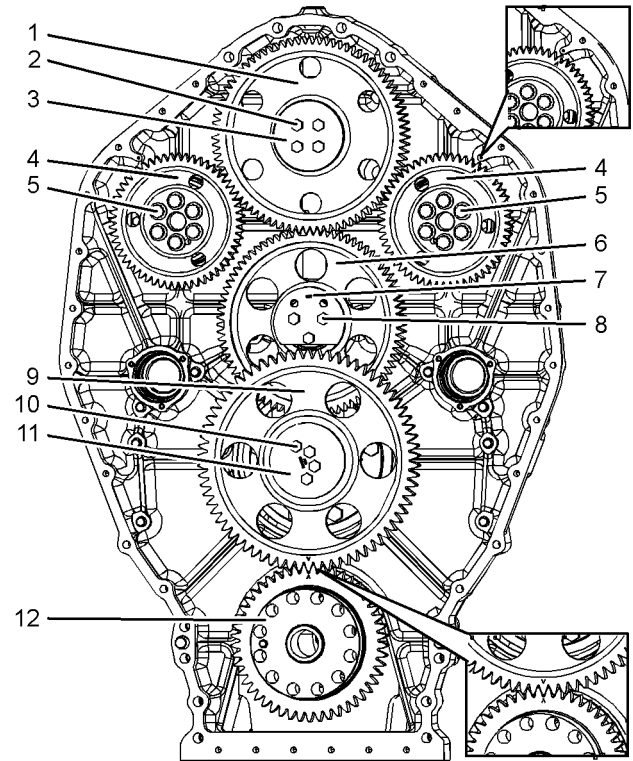


Illustration 146

g01220275

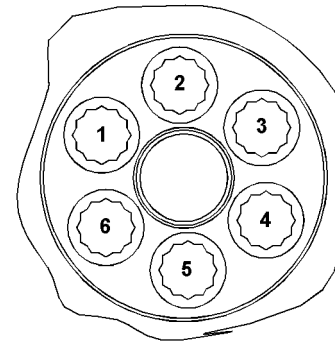


Illustration 147

g01151468

4. Refer to Testing and Adjusting, "Rear Gear Group - Time" for additional information.

Note: Align the Timing Marks on gear assemblies (4) with the Timing Marks on the rear housing and align the dowels on gear assemblies (4) with the adapter assemblies.

5. Position gear assemblies (4) and install bolts (5).
6. Install gear assembly (12).
7. Use Tooling (A) and a suitable press to install the bearing in gear assembly (1). Install the bearing to a depth of 2.6 ± 0.5 mm (0.10 ± 0.02 inch).

- 8. Install shaft assembly (3), gear assembly (1), and bolts (2).
- 9. Use Tooling (A) and a suitable press to install the bearing in gear assembly (6). Install the bearing to a depth of 2.6 ± 0.5 mm (0.10 ± 0.02 inch).
- 10. Install shaft assembly (7), gear assembly (6), and bolts (8).
- 11. Use Tooling (A) and a suitable press to install the bearing in gear assembly (9). Install the bearing to a depth of 2.5 ± 0.5 mm (0.10 ± 0.02 inch).

Note: Align the Timing Mark on gear assembly (9) with the Timing Mark on gear assembly (12).

- 12. Install gear assembly (9), thrust plate (11), and bolts (10).
- 13. Tighten the bolts on gear assemblies (4) to a torque of 240 ± 40 N·m (177 ± 30 lb ft). Tighten the bolts in the following sequence: 1, 4, 2, 5, 3, 6, 1, 4.

End By:

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

i02752668

Flywheel - Remove and Install

SMCS Code: 1156-010

Removal Procedure

Table 34

Required Tools			
Tool	Part Number	Part Description	Qty
A	-	Guide Stud 5/8 - 18 UNF by 11 inch	2

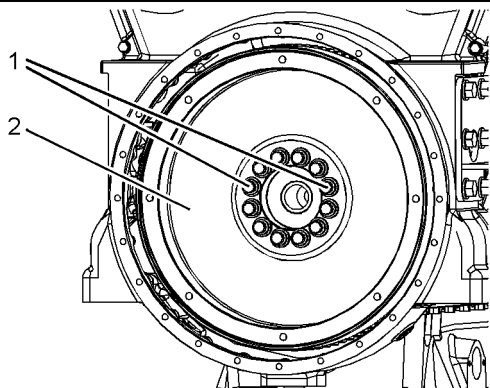


Illustration 148

g01220437

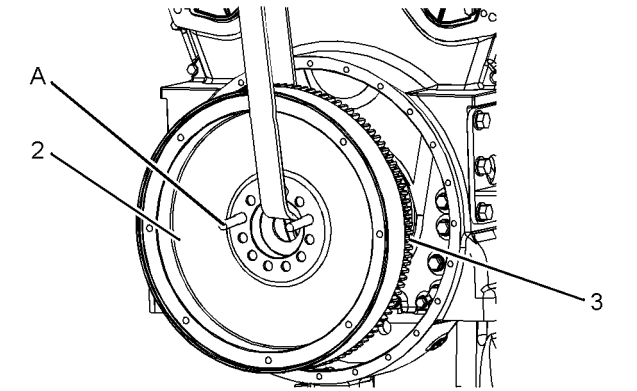


Illustration 149

g01220438

- 1. Remove two bolts (1). Install Tooling (A) in the crankshaft.
- 2. Remove remaining bolts (1). Slide flywheel (2) away from the engine on Tooling (A).
- 3. Attach a suitable lifting device to flywheel (2). The weight of flywheel (2) is approximately 130 kg (285 lb). Remove flywheel (2).
- 4. If necessary, use a hammer and a punch in order to remove ring gear (3) from flywheel (2).

Installation Procedure

Table 35

Required Tools			
Tool	Part Number	Part Description	Qty
A	-	Guide Stud 5/8 - 18 UNF by 11 inch	2
B	6V-4876	Lubricant	-

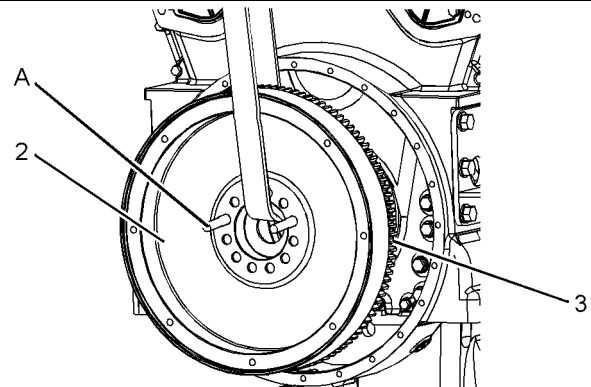


Illustration 150

g01220438

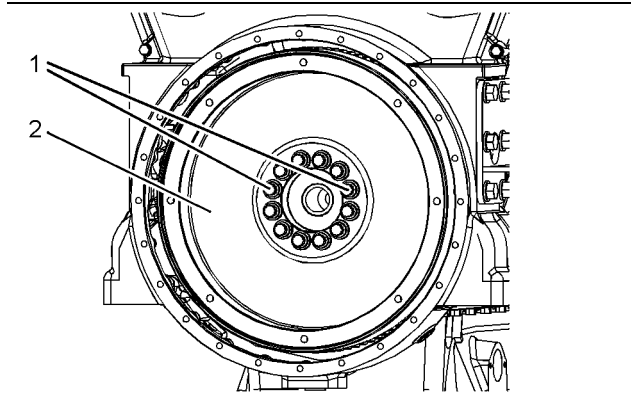


Illustration 151

g01220437

Note: Ring gear (3) must be installed with the chamfered side of the teeth upward. The chamfered side of the gear teeth will be facing toward the starting motor when the flywheel is installed.

1. Raise the temperature of ring gear (3). Install ring gear (3) on flywheel (2).
2. Install Tooling (A) in the crankshaft.
3. Attach a suitable lifting device to flywheel (2). The weight of flywheel (2) is approximately 130 kg (285 lb). Position flywheel (2) on the crankshaft.
4. Apply Tooling (B) to the threads of bolts (1).
5. Install bolts (1). Remove Tooling (A). Install remaining bolts (1).
6. Tighten bolts (1) to a torque of 100 ± 5 N·m (75 ± 4 lb ft). Turn the bolts for an additional 180 ± 5 degrees.
7. Check the flywheel runout. Refer to Testing and Adjusting, "Flywheel - Inspect".

i02442878

Crankshaft Rear Seal - Remove

SMCS Code: 1161-011

Removal Procedure

Table 36

Required Tools			
Tool	Part Number	Part Description	Qty
A	1U-7600	Slide Hammer Puller	1

Start By:

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

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

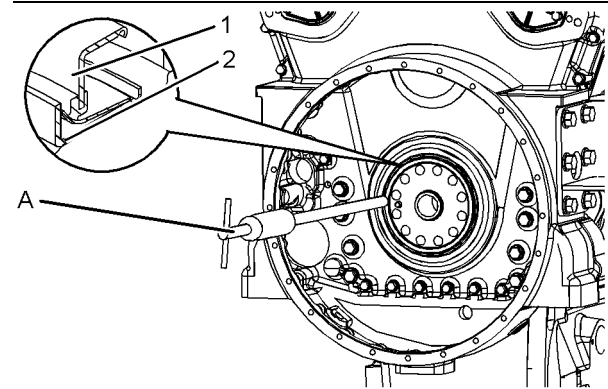


Illustration 152

g01220531

1. Use Tooling (A) or a punch and hammer in order to puncture three or more holes in crankshaft rear seal (1).
2. Use Tooling (A) to remove crankshaft rear seal (1) and crankshaft wear sleeve (2).

i02442921

Crankshaft Rear Seal - Install

SMCS Code: 1161-012

Installation Procedure

Table 37

Required Tools			
Tool	Part Number	Part Description	Qty
B	249-2937 ⁽¹⁾	Seal Locator As	1
	5P-7310 ⁽¹⁾	Bolt	3
	9S-8858 ⁽¹⁾	Nut (Seal Installer)	1
	6V-6143 ⁽¹⁾	Seal Installer	1
	5P-1733 ⁽²⁾	Seal Locator As	1
	5P-7309 ⁽²⁾	Bolt	3
	9S-8858 ⁽²⁾	Nut (Seal Installer)	1
	6V-6142 ⁽²⁾	Seal Installer	1

⁽¹⁾ Large crankshaft gear

⁽²⁾ Small crankshaft gear

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

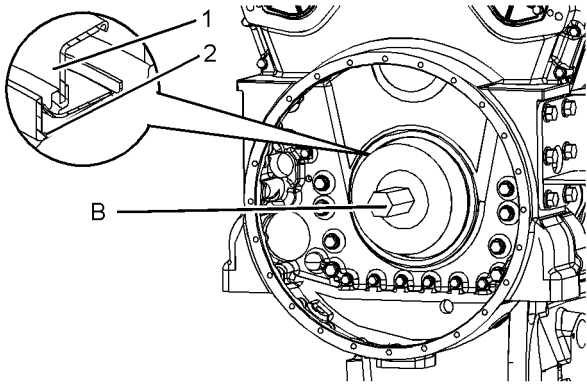


Illustration 153

g01220558

1. Clean the outside diameter of the crankshaft.

Note: Install the crankshaft rear seal with the arrow that shows the direction of crankshaft rotation toward the rear of the engine.

2. Use Tooling (B) to install crankshaft wear sleeve (2) and crankshaft rear seal (1) as a unit.

End By:

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

i02752908

Flywheel Housing - Remove and Install

SMCS Code: 1157-010

Removal Procedure

Table 38

Required Tools			
Tool	Part Number	Part Description	Qty
A	138-7574	Link Bracket	2
B	-	Guide Stud 1/2 - 13 NC by 7 inch	2

Start By:

- a. Remove the crankshaft rear seal. Refer to Disassembly and Assembly, "Crankshaft Rear Seal - Remove".

- b. Remove the electric starting motor. Refer to Disassembly and Assembly, "Electric Starting Motor - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

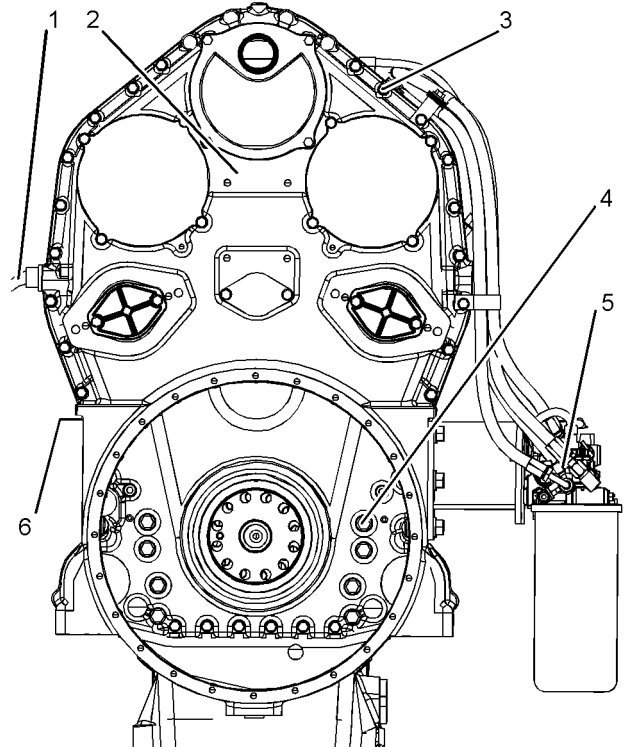


Illustration 154

g01220951

1. Disconnect hose assemblies (1) from flywheel housing (2).
2. Disconnect fuel filter base (5) from flywheel housing (2). Reposition fuel filter base (5) and the hose assemblies.
3. Remove two bolts (4) and install Tooling (B).
4. Attach Tooling (A) and a suitable lifting device to flywheel housing (2). The weight of flywheel housing (2) is approximately 110 kg (245 lb).
5. Remove remaining bolts (4), bolts (6), and bolts (3). Remove flywheel housing (2) and the gasket from the rear housing.

Installation Procedure

Table 39

Required Tools			
Tool	Part Number	Part Description	Qty
A	138-7574	Link Bracket	2
B	-	Guide Stud 1/2 - 13 NC by 7 inch	2

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

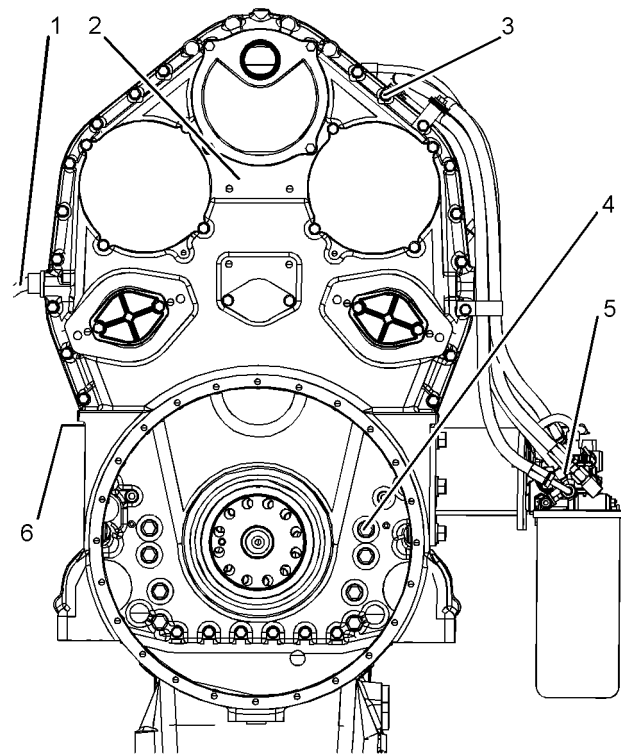


Illustration 155

g01220951

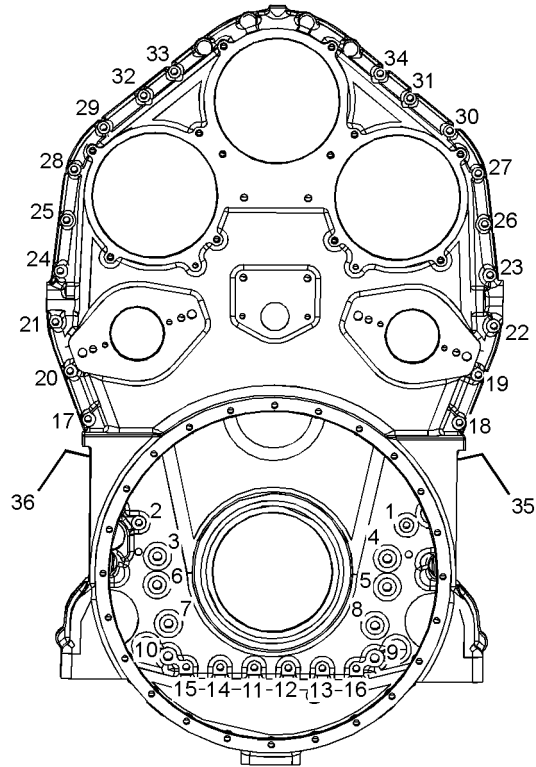


Illustration 156

g01221009

1. Install Tooling (B) in the cylinder block.
2. Attach Tooling (A) and a suitable lifting device to flywheel housing (2). The weight of flywheel housing (2) is approximately 110 kg (245 lb).
3. Position the gasket and flywheel housing (2) on the rear housing. Install bolts (3), bolts (6), and bolts (4).
4. Remove Tooling (B) and install remaining bolts (4).
5. Tighten the bolts, as follows:
 - a. In a numerical sequence, tighten Bolt 1 through Bolt 2 to a torque of 55 ± 10 N·m (41 ± 7 lb ft).
 - b. In a numerical sequence, tighten Bolt 3 through Bolt 10 to a torque of 135 ± 20 N·m (100 ± 15 lb ft).
 - c. In a numerical sequence, tighten Bolt 11 through Bolt 36 to a torque of 47 ± 9 N·m (35 ± 7 lb ft).
6. Reposition fuel filter base (5) and the hose assemblies. Connect fuel filter base (5) to flywheel housing (2).
7. Connect hose assemblies (1) to flywheel housing (2).

End By:

- a. Install the electric starting motor. Refer to Disassembly and Assembly, "Electric Starting Motor - Remove and Install".
- b. Install the crankshaft rear seal. Refer to Disassembly and Assembly, "Crankshaft Rear Seal - Install".

i02443805

Vibration Damper and Pulley - Remove and Install

SMCS Code: 1205-010

Removal Procedure

Table 40

Required Tools			
Tool	Part Number	Part Description	Qty
A	-	Guide Stud 1/2 - 13 NC by 5 inch	2

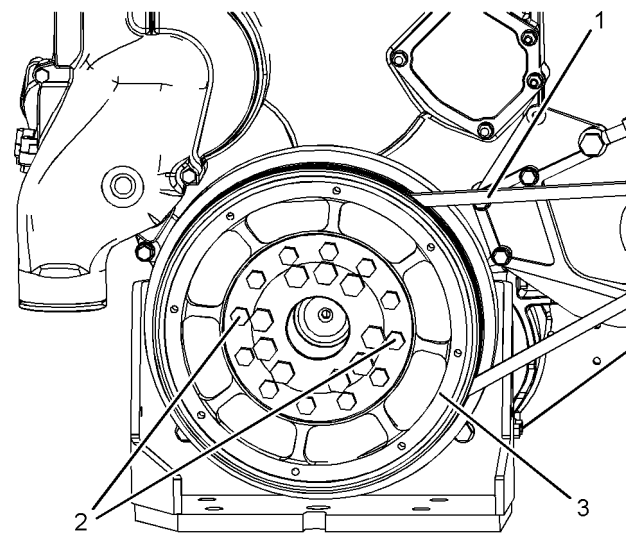


Illustration 157

g01221066

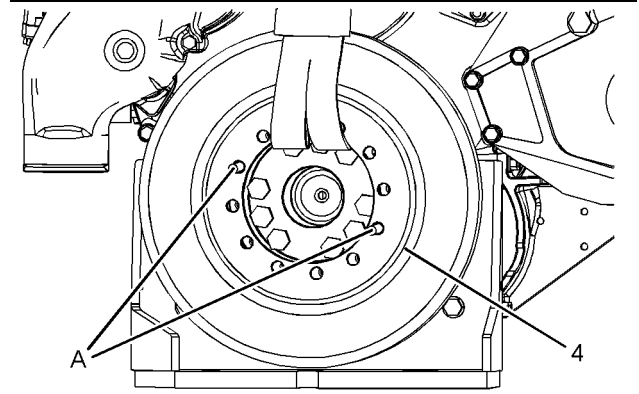


Illustration 158

g01221078

1. Remove V-belt (1) from the engine.
2. Remove two bolts (2) and install Tooling (A).
3. Remove remaining bolts (2) and pulley (3).
4. Slide vibration damper (4) along Tooling (A).
5. Attach a suitable lifting device onto vibration damper (4). The weight of vibration damper (4) is approximately 34 kg (75 lb). Remove vibration damper (4) from the adapter.

Installation Procedure

Table 41

Required Tools			
Tool	Part Number	Part Description	Qty
A	-	Guide Stud 1/2 - 13 NC by 5 inch	2

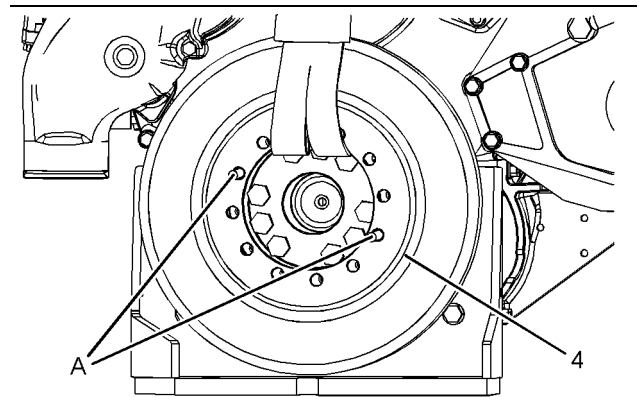


Illustration 159

g01221078

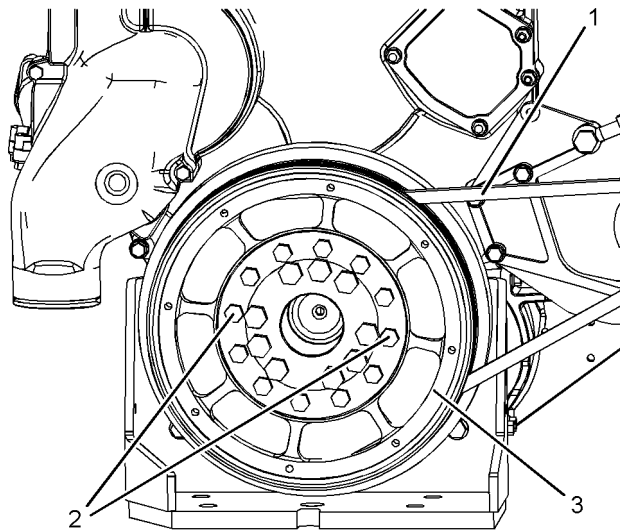


Illustration 160

g01221066

1. Install Tooling (A) in the adapter.
2. Attach a suitable lifting device onto vibration damper (4). The weight of vibration damper (4) is approximately 34 kg (75 lb). Position vibration damper (4) on the adapter.
3. Install pulley (3) and bolts (2).
4. Remove Tooling (A). Install remaining bolts (2). Tighten bolts (2) to a torque of 135 ± 20 N·m (100 ± 15 lb ft).
5. Install V-belt (1) on the engine.

i02444403

Crankshaft Front Seal - Remove

SMCS Code: 1160-011

Removal Procedure

Table 42

Required Tools			
Tool	Part Number	Part Description	Qty
A	1U-7600	Slide Hammer Puller	1

Start By:

- a. Remove the crankshaft vibration damper and pulley. Refer to Disassembly and Assembly, "Vibration Damper and Pulley - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

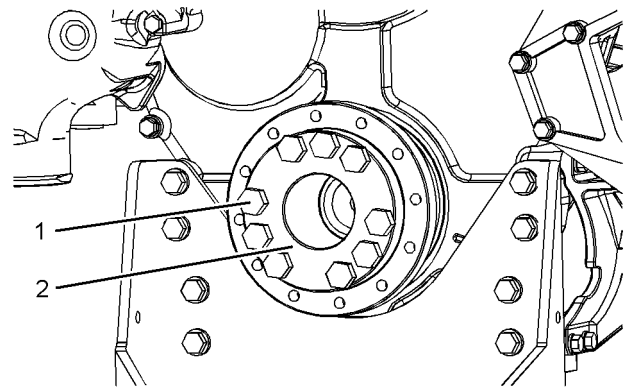


Illustration 161

g01221272

1. Remove bolts (1) and adapter (2).

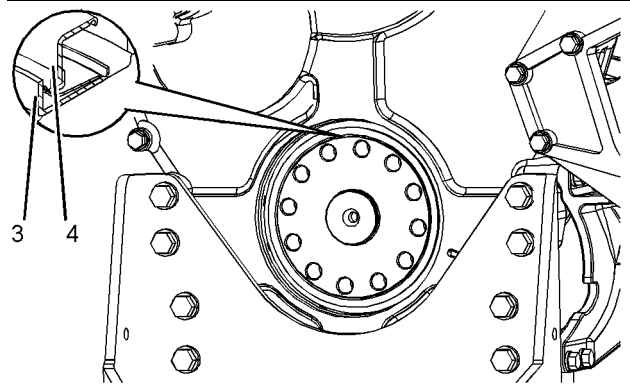


Illustration 162

g01221276

2. Use Tooling (A) or a punch and hammer in order to puncture three or more holes in crankshaft front seal (4).
3. Use Tooling (A) to remove crankshaft front seal (4).
4. If necessary, use Tooling (A) or a punch and hammer in order to puncture three or more holes in crankshaft wear sleeve (3). Use Tooling (A) to remove crankshaft wear sleeve (3).

i02444556

Crankshaft Front Seal - Install

SMCS Code: 1160-012

Installation Procedure

Table 43

Required Tools			
Tool	Part Number	Part Description	Qty
B	5P - 1733	Seal Locator	1
	5P - 1737	Bolt	3
	9S - 8858	Nut (Seal Installer)	1
	6V - 6142	Seal Installer	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Clean the outside diameter of the crankshaft.

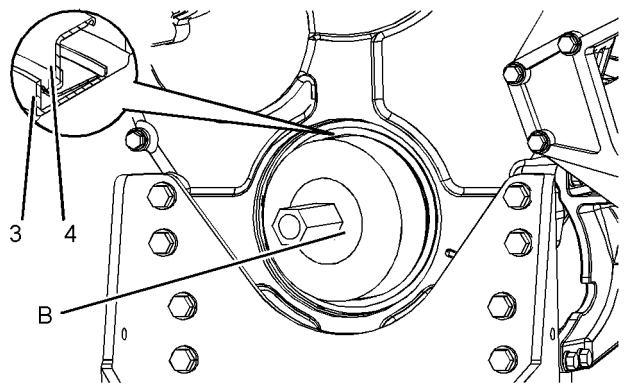


Illustration 163

g01221389

2. Use Tooling (B) to install crankshaft front seal (4) and crankshaft wear sleeve (3) as a unit.

Note: Install the crankshaft front seal with the arrow that shows the direction of crankshaft rotation toward the front of the engine.

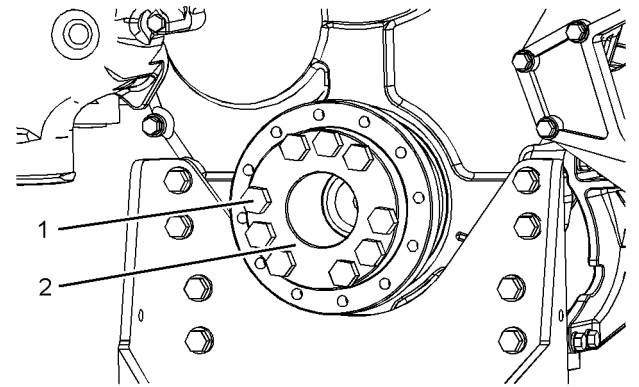


Illustration 164

g01221272

3. Install adapter (2) and bolts (1).

End By:

- a. Install the crankshaft vibration damper and pulley. Refer to Disassembly and Assembly, "Vibration Damper and Pulley - Remove and Install".

i02292422

Gear Group (Front) - Remove

SMCS Code: 1206-011

Removal Procedure

Start By:

- a. Remove the front housing. Refer to Disassembly and Assembly, "Housing (Front) - Remove".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

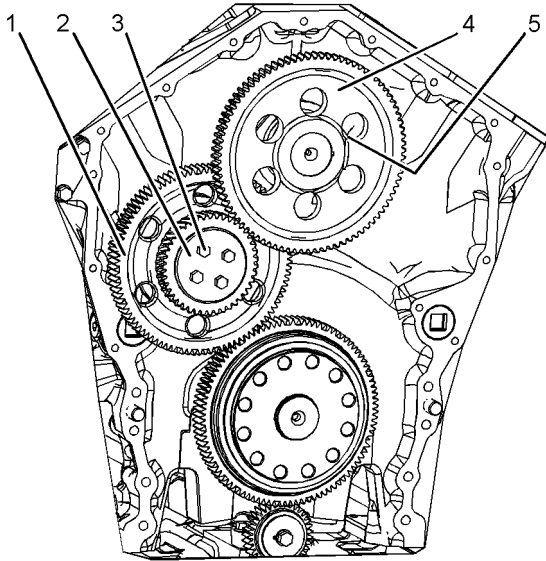


Illustration 165 g01147593

1. Remove bolts (5) and gear assembly (4).
2. Remove bolts (3) and plate (2). Remove gear assembly (1).

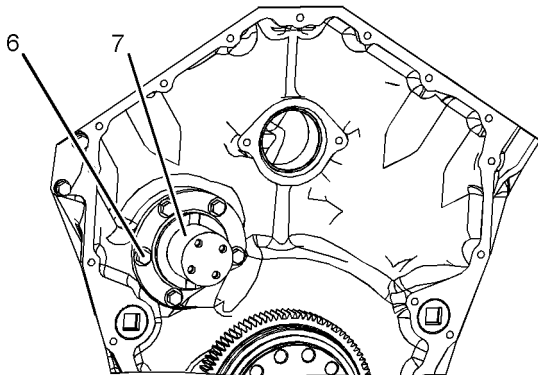


Illustration 166 g01147620

3. Remove bolts (6) and shaft (7).

i02691256

Gear Group (Front) - Install

SMCS Code: 1206-012

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

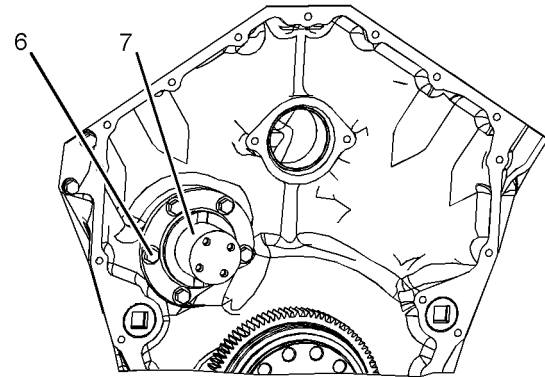


Illustration 167 g01147620

1. Apply clean engine oil to shaft (7), the bearing bore, and the thrust faces prior to installation. Install shaft (7) and bolts (6). Tighten bolts (6) to a torque of 55 ± 10 N·m (41 ± 7 lb ft).

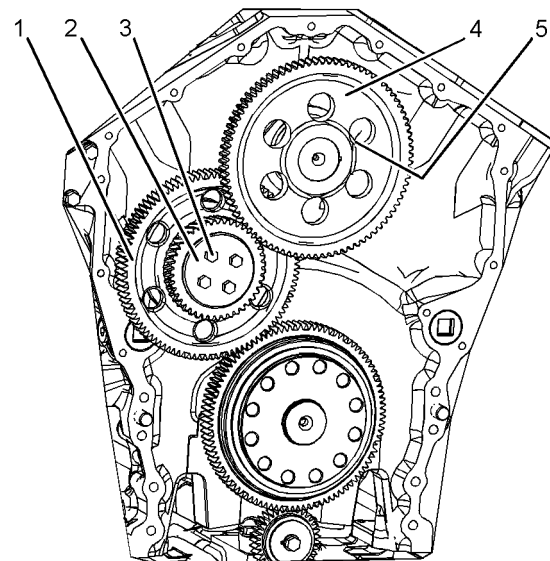


Illustration 168 g01147593

2. Position gear assembly (1) on the shaft. Install plate (2) and bolts (3).
3. Install gear assembly (4) and bolts (5).

End By:

- a. Install the front housing. Refer to Disassembly and Assembly, "Housing (Front) - Install".

i02445219

Housing (Front) - Remove

SMCS Code: 1151-011

Removal Procedure

Start By:

- a. Remove the water temperature regulator housing. Refer to Disassembly and Assembly, "Water Temperature Regulator Housing - Remove and Install".
- b. Remove the water pump. Refer to Disassembly and Assembly, "Water Pump - Remove".
- c. Remove the crankshaft front seal. Refer to Disassembly and Assembly, "Crankshaft Front Seal - Remove".
- d. Remove the front engine support. Refer to Disassembly and Assembly, "Engine Support (Front) - Remove and Install".
- e. Remove the alternator. Refer to Disassembly and Assembly, "Alternator - Remove and Install".
- f. Remove the crankshaft position sensor. Refer to Disassembly and Assembly, "Crankshaft Position Sensor - Remove and Install".
- g. Remove the camshaft position sensor. Refer to Disassembly and Assembly, "Camshaft Position Sensor - Remove and Install".

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.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

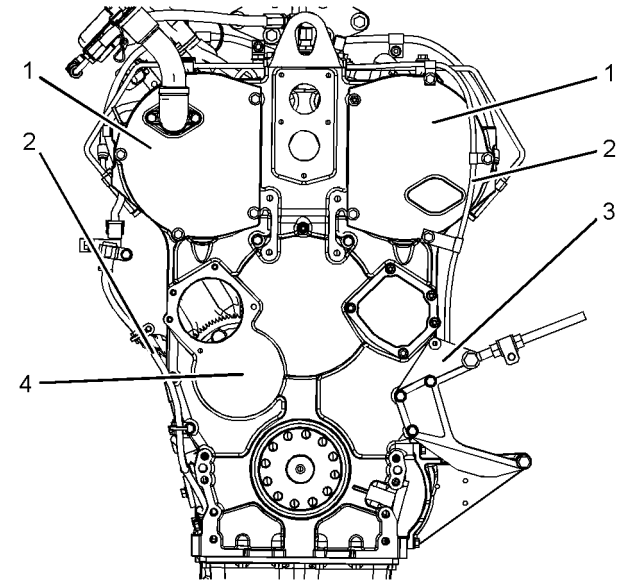


Illustration 169

g01221893

1. Disconnect hose assemblies (2) from front housing (4).
2. Remove covers (1).
3. Remove alternator bracket (3) from front housing (4).

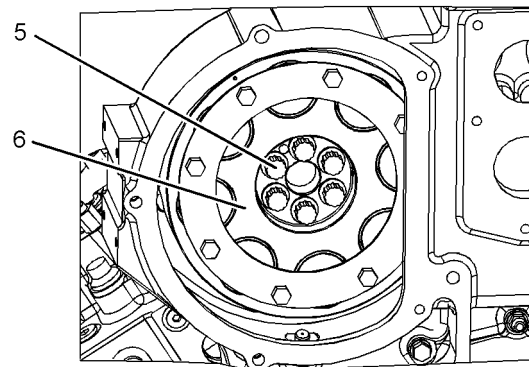


Illustration 170

g01221941

4. Remove bolts (5) and dampers (6).

i02445708

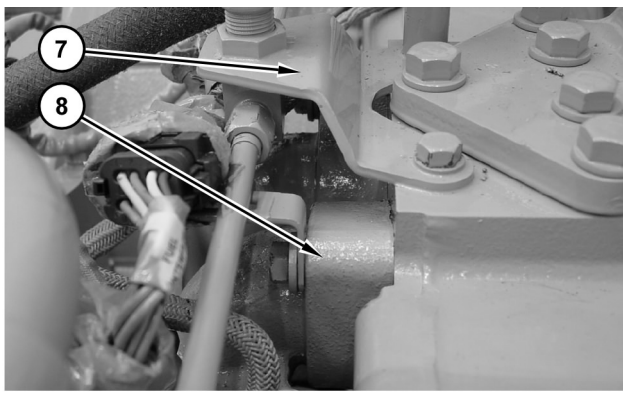


Illustration 171

g01221953

5. Disconnect bracket (7) and elbows (8).

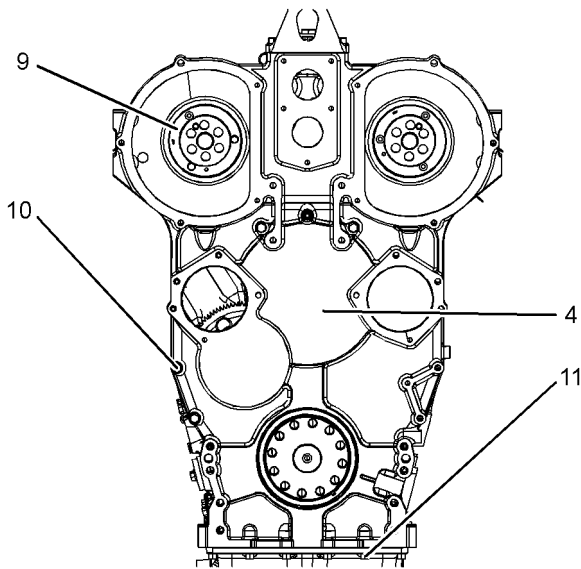


Illustration 172

g01221955

6. Remove adapters (9).
7. Attach a suitable lifting device to front housing (4). The weight of front housing (4) is approximately 70 kg (155 lb).
8. Remove bolts (10) and bolts (11).
9. Remove front housing (4) and the gasket.

Housing (Front) - Install

SMCS Code: 1151-012

Installation Procedure

Table 44

Required Tools			
Tool	Part Number	Part Description	Qty
A	4C-9612	Silicone Sealant	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

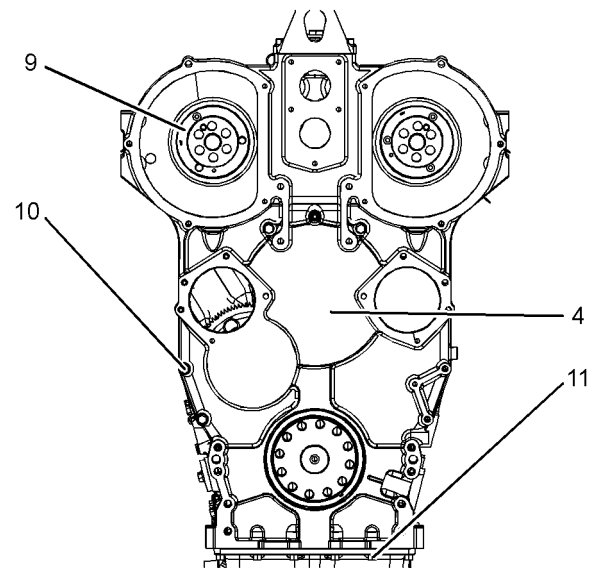


Illustration 173

g01221955

1. Apply Tooling (A) to the bottom of front housing (4) at the junction of the cylinder block and the engine oil pan.
2. Attach a suitable lifting device to front housing (4). The weight of front housing (4) is approximately 70 kg (155 lb). Position the gasket and front housing (4) on the dowel pins on the cylinder block.
3. Install bolts (10) and bolts (11).
4. Trim the gasket between the front housing and the cylinder block even with the bottom of the front housing.
5. Install adapters (9).

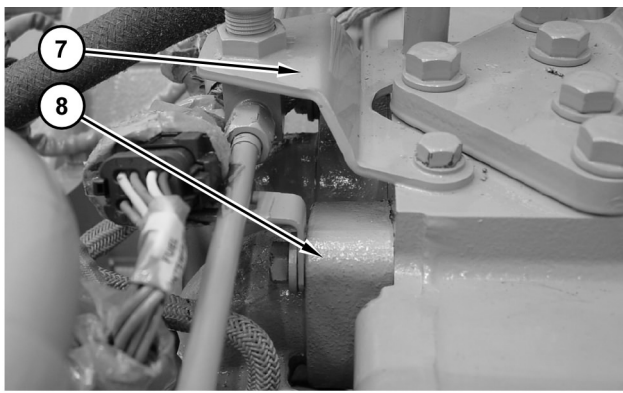


Illustration 174

g01221953

6. Connect elbows (8) and bracket (7).

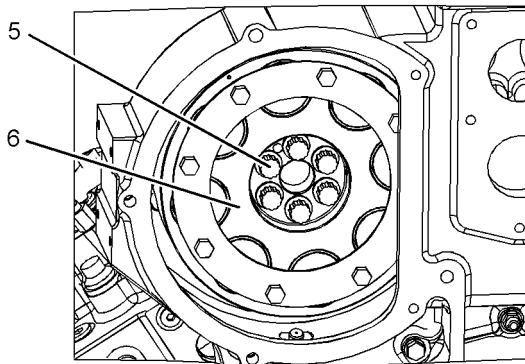


Illustration 175

g01221941

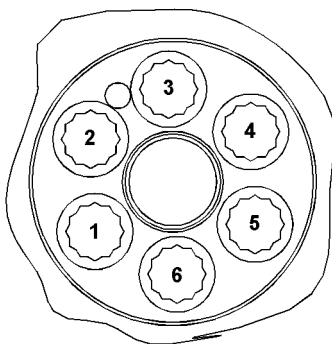


Illustration 176

g01151441

7. Install dampers (6) and bolts (5).

8. Tighten the bolts to a torque of 240 ± 40 N·m (177 ± 30 lb ft). Tighten the bolts in the following sequence: 1, 4, 2, 5, 3, 6, 1, 4.

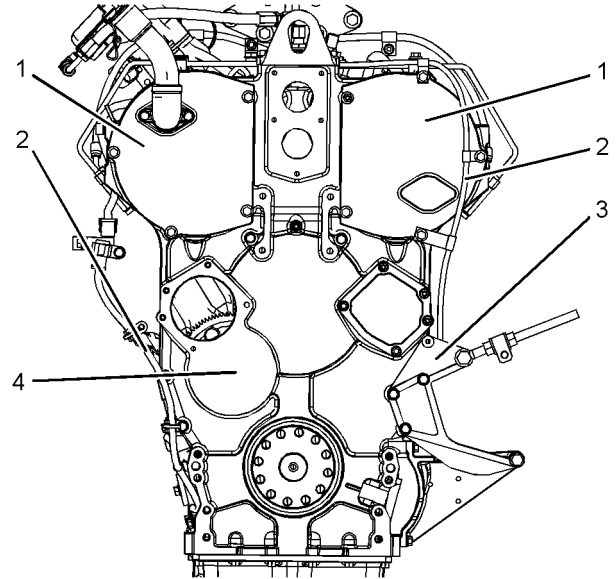


Illustration 177

g01221893

- 9. Install alternator bracket (3) on front housing (4).
- 10. Install covers (1).
- 11. Connect hose assemblies (2) to front housing (4).

End By:

- a. Install the camshaft position sensor. Refer to Disassembly and Assembly, "Camshaft Position Sensor - Remove and Install".
- b. Install the crankshaft position sensor. Refer to Disassembly and Assembly, "Crankshaft Position Sensor - Remove and Install".
- c. Install the alternator. Refer to Disassembly and Assembly, "Alternator - Remove and Install".
- d. Install the front engine support. Refer to Disassembly and Assembly, "Engine Support (Front) - Remove and Install".
- e. Install the crankshaft front seal. Refer to Disassembly and Assembly, "Crankshaft Front Seal - Install".
- f. Install the water pump. Refer to Disassembly and Assembly, "Water Pump - Install".
- g. Install the water temperature regulator housing. Refer to Disassembly and Assembly, "Water Temperature Regulator Housing - Remove and Install".

i02290579

Housing (Rear) - Remove

SMCS Code: 1157-011

Removal Procedure

Start By:

- a. Remove the rear gear group. Refer to Disassembly and Assembly, "Gear Group (Rear) - Remove".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Remove the bolts that hold the engine oil pan to the rear housing.
-

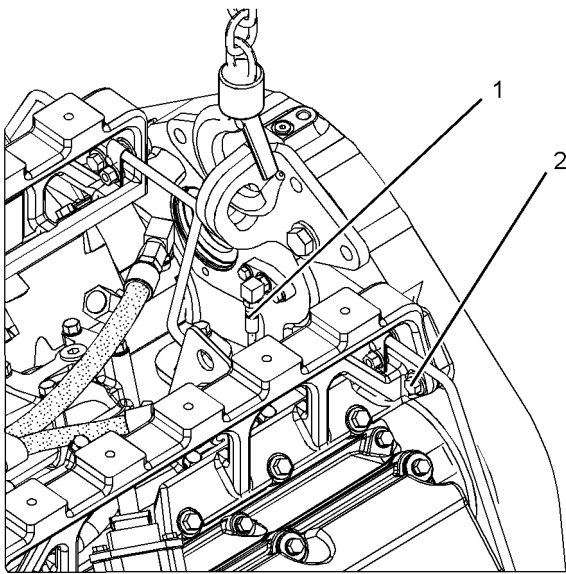


Illustration 178

g01147132

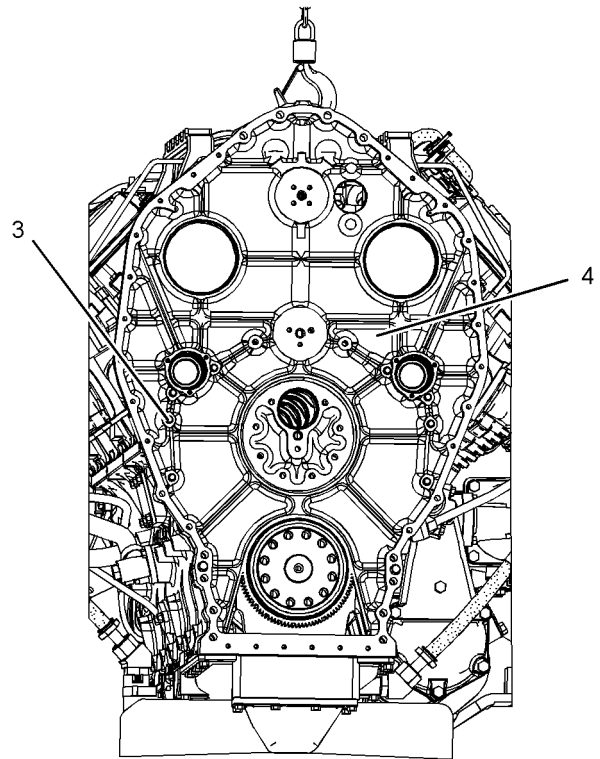


Illustration 179

g01147138

2. Disconnect hose assembly (1).
3. Remove bolts (2).
4. Attach a suitable lifting device to rear housing (4). The weight of rear housing (4) is approximately 84 kg (185 lb).
5. Remove bolts (3).
6. Remove rear housing (4) and the gasket.

i02291566

Housing (Rear) - Install

SMCS Code: 1157-012

Installation Procedure

Table 45

Required Tools			
Tool	Part Number	Part Description	Qty
A	4C-9612	Silicone Sealant	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Apply Tooling (A) to the bottom of the rear housing at the junction of the cylinder block and the engine oil pan.

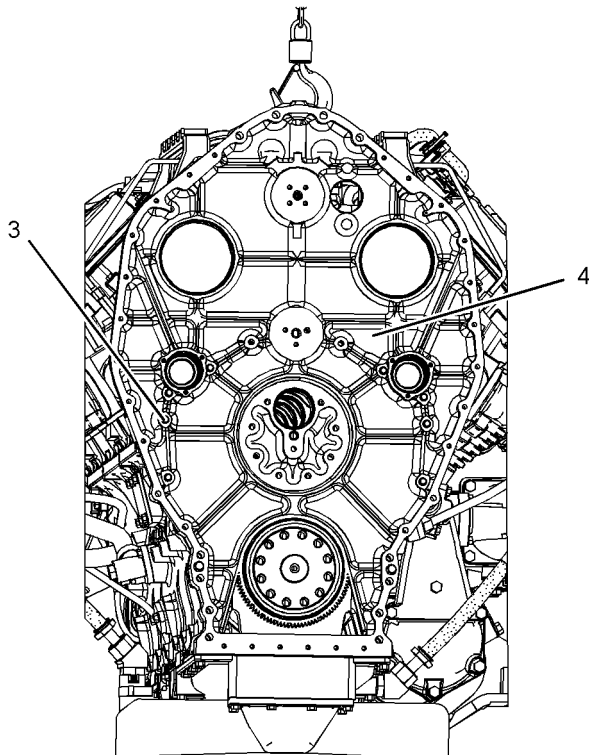


Illustration 180

g01147138

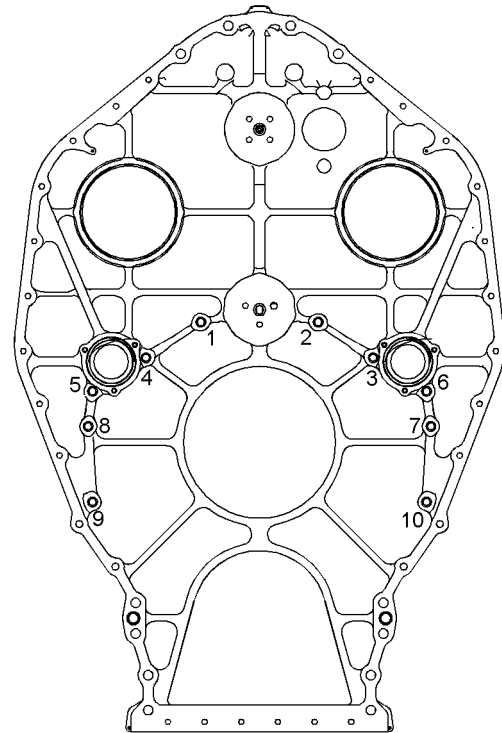


Illustration 181

g01147149

2. Attach a suitable lifting device to rear housing (4). The weight of rear housing (4) is approximately 84 kg (185 lb).
3. Position the gasket on rear housing (4).
4. Position rear housing (4) on the cylinder block. Install bolts (3). Tighten bolts (3) in a numerical sequence to a torque of 55 ± 10 N·m (41 ± 7 lb ft).
5. Trim the gasket between the rear housing and the cylinder block even with the bottom of the rear housing.

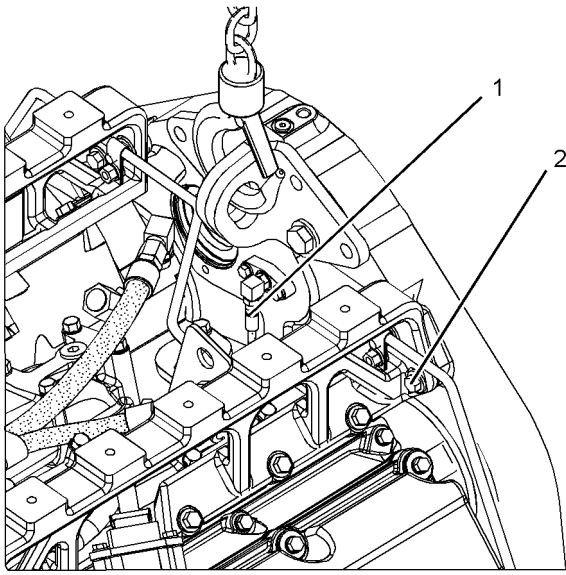


Illustration 182

g01147132

6. Install bolts (2).
7. Connect hose assembly (1).
8. Install the bolts that hold the engine oil pan to the rear housing.
9. Tighten all the bolts that hold the engine oil pan evenly in order to raise the engine oil pan into position.

End By:

- a. Install the rear gear group. Refer to Disassembly and Assembly, "Gear Group (Rear) - Install".

i02293132

Valve Mechanism Cover - Remove and Install

SMCS Code: 1107-010

Removal Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

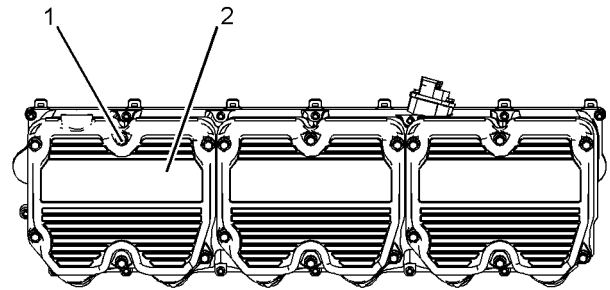


Illustration 183

g01147941

1. Remove bolts (1) and valve mechanism covers (2).

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

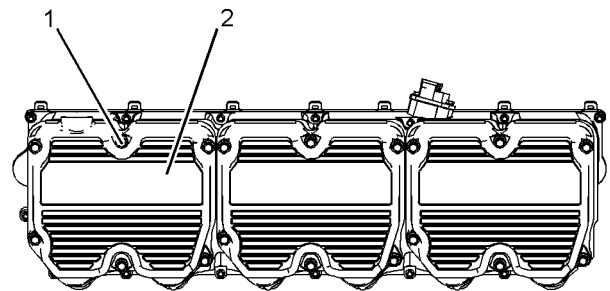


Illustration 184

g01147941

1. Position valve mechanism covers (2) on the valve mechanism cover base. Install bolts (1).

i02293148

Valve Mechanism Cover Base - Remove and Install

SMCS Code: 1120-010

Removal Procedure

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.

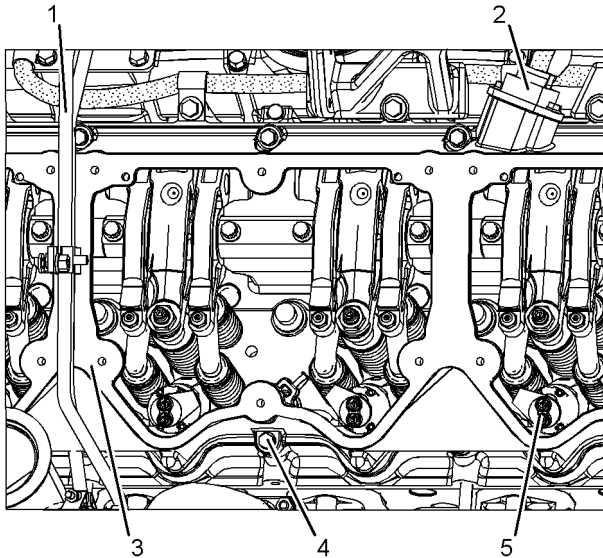


Illustration 185

g01147965

1. Remove tube assemblies (1).
2. Disconnect harness assemblies (5) and harness assembly (2).
3. Remove bolts (4).
4. Remove valve mechanism cover base (3) and the seal from the cylinder head.

Installation Procedure**NOTICE**

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

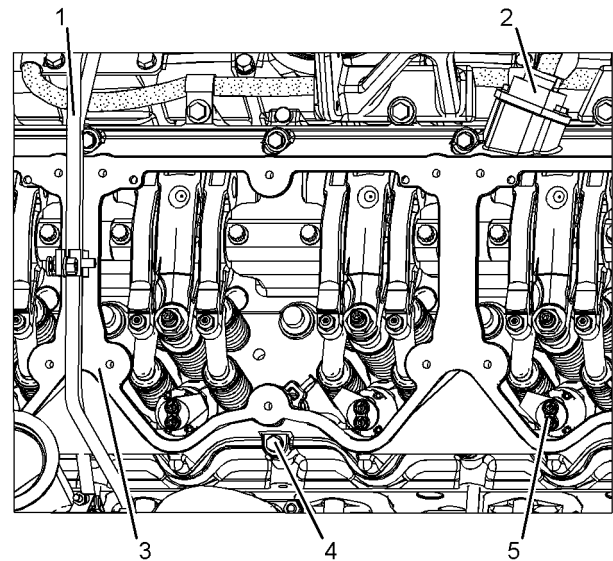


Illustration 186

g01147965

1. Install the seal on valve mechanism cover base (3).
2. Position valve mechanism cover base (3) on the cylinder head and install bolts (4).
3. Position harness assemblies (5) on the electronic unit injectors. Tighten the cap nuts to a torque of 1.70 ± 0.25 N·m (15 ± 2 lb in).
4. Connect harness assembly (2).
5. Install tube assemblies (1).

End By:

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

i02293245

Rocker Arm and Shaft - Remove

SMCS Code: 1102-011

Removal Procedure

Table 46

Required Tools			
Tool	Part Number	Part Description	Qty
A	124 - 2946	Lifting Bracket	1

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.

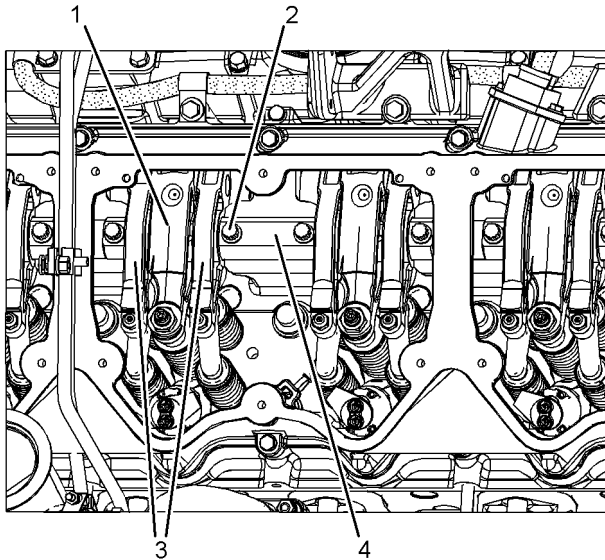


Illustration 187

g01148045

1. Remove bolts (2).
2. Use Tooling (A) to remove rocker arm shaft assembly (4), valve rocker arms (3), and electronic unit injector rocker arms (1) as a unit.

i02451112

Rocker Arm - Disassemble

SMCS Code: 1123-015

Disassembly Procedure

Start By:

- a. Remove the rocker arms and the rocker shaft. Refer to Disassembly and Assembly, "Rocker Arm and Shaft - Remove".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

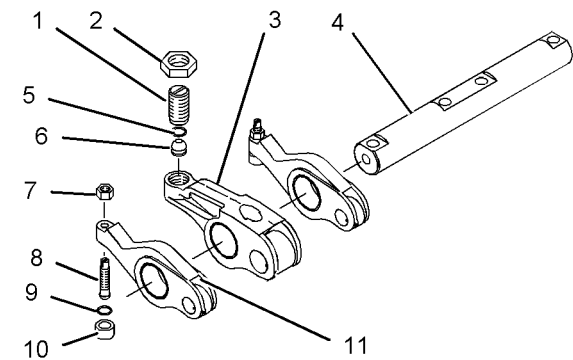


Illustration 188

g01047557

1. Remove valve rocker arms (11) and electronic unit injector rocker arm (3) from rocker shaft assembly (4).
2. Remove jam nut (7) from adjustment screw (8).
3. Remove adjustment screw (8) from valve rocker arms (11).
4. Remove button (10) from adjustment screw (8). Remove O-ring seal (9) from the adjustment screw.
5. Remove jam nut (2) from unit injector adjustment screw (1).
6. Remove unit injector adjustment screw (1) from electronic unit injector rocker arm (3).
7. Remove button (6) from unit injector adjustment screw (1). Remove O-ring seal (5) from the unit injector adjustment screw.

i02451120

Rocker Arm - Assemble

SMCS Code: 1123-016

Assembly Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

i03203773

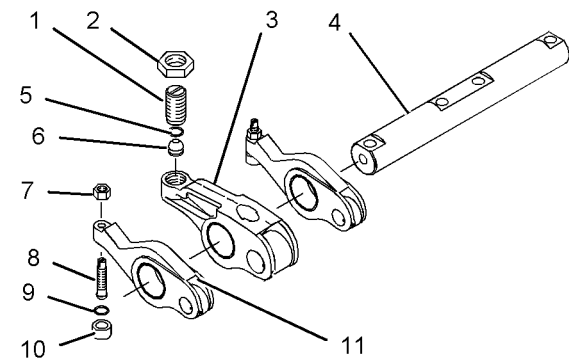


Illustration 189

g01047557

Note: Do not reuse the O-ring seal on the adjustment screw if the button is removed from the adjustment screw.

1. Install O-ring seal (9) in button (10).
2. Use a soft hammer to seat button (10) on adjustment screw (8).
3. Install adjustment screw (8) in valve rocker arms (11). Install jam nut (7) on the adjustment screw.
4. Install O-ring seal (5) in button (6).
5. Use a soft hammer to seat button (6) on unit injector adjustment screw (1).
6. Install unit injector adjustment screw (1) in electronic unit injector rocker arm (3). Install jam nut (2) on the unit injector adjustment screw.
7. Lubricate rocker shaft assembly (4) with clean engine oil.
8. Install valve rocker arms (11) and electronic unit injector rocker arm (3) on rocker shaft assembly (4).

End By:

- a. Install the rocker arms and the rocker shaft. Refer to Disassembly and Assembly, "Rocker Arm and Shaft - Install".

Rocker Arm and Shaft - Install

SMCS Code: 1102-012

Installation Procedure

Table 47

Required Tools			
Tool	Part Number	Part Description	Qty
A	124-2946	Lifting Bracket	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

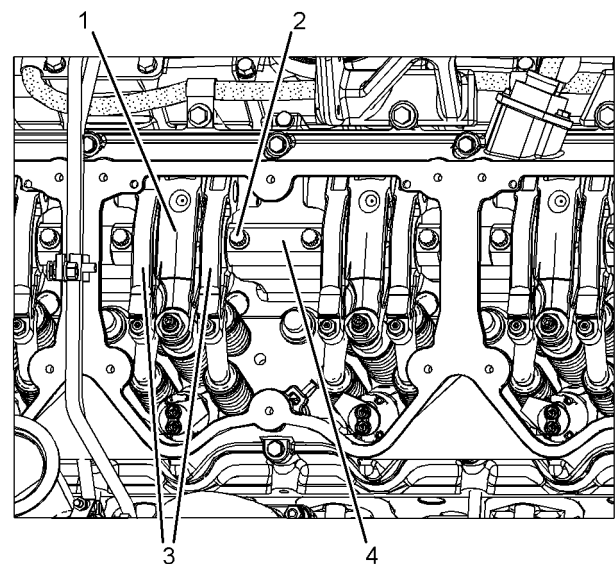


Illustration 190

g01148045

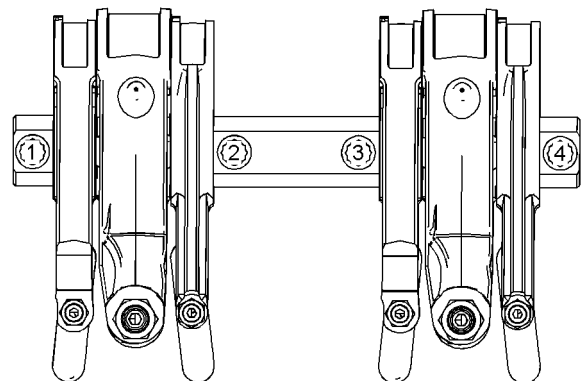


Illustration 191

g01325993

1. Position rocker arm shaft assembly (4), valve rocker arms (3), and electronic unit injector rocker arms (1) as a unit with Tooling (A) on the cylinder head.
2. Install bolts (2) and tighten to a torque of 50 ± 5 N·m (37 ± 4 lb ft) plus 45 ± 5 degree turn. Tighten the bolts in the following sequence: 2, 3, 4, 1.
3. Adjust the valve lash for the inlet valves and the exhaust valves. Refer to Testing and Adjusting, "Engine Valve Lash - Inspect/Adjust".
4. Adjust the electronic unit injectors. Refer to Testing and Adjusting, "Electronic Unit Injector - Adjust".

End By:

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

i02446003

Cylinder Head - Remove

SMCS Code: 1100-011

Removal Procedure

Table 48

Required Tools			
Tool	Part Number	Part Description	Qty
A	138-7573	Link Bracket	3
B	1U-9200	Lever Puller Hoist	1

Start By:

- a. Remove the electronic unit injectors. Refer to Disassembly and Assembly, "Electronic Unit Injector - Remove".
- b. Remove the valve mechanism cover base. Refer to Disassembly and Assembly, "Valve Mechanism Cover Base - Remove and Install".
- c. Remove the fuel transfer pump. Refer to Disassembly and Assembly, "Fuel Transfer Pump - Remove".

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.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Do not turn the crankshaft or the camshaft while the camshaft gear is removed. If the rear gear group is not correctly timed during installation, interference can occur between the pistons and the valves, resulting in damage to the engine.

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".

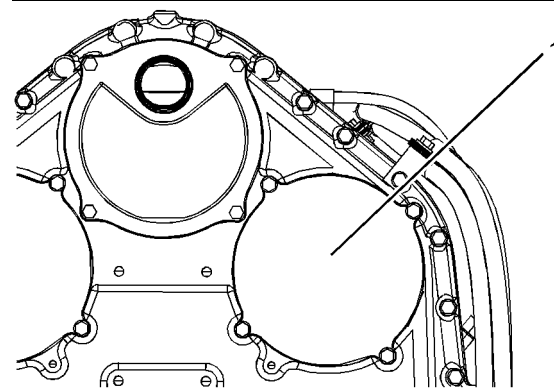


Illustration 192

g01222228

2. Remove cover (1).

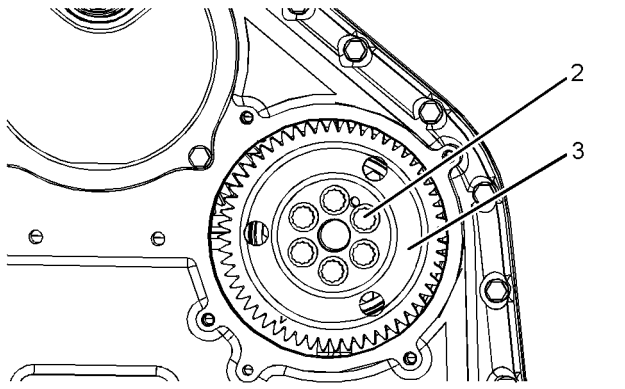


Illustration 193 g01222230

3. Remove bolts (2) and gear (3).

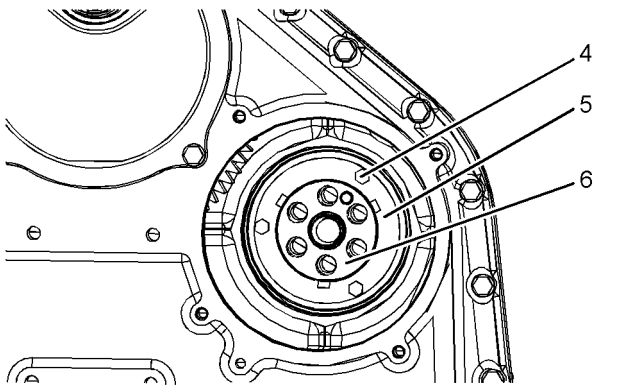


Illustration 194 g01222233

4. Remove bolts (4), thrust plate (5), and adapter assembly (6).

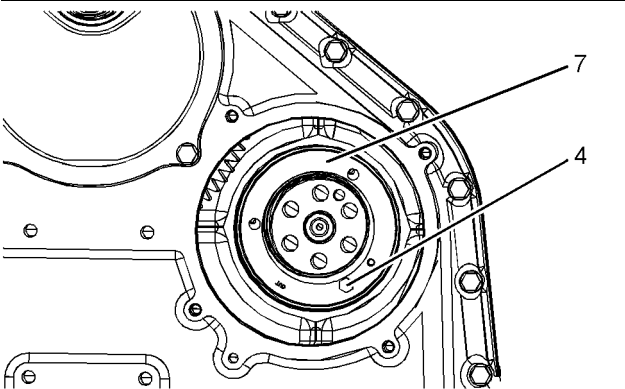


Illustration 195 g01222234

5. Use bolt (4) in order to remove sealing plate (7). Remove the O-ring seals.

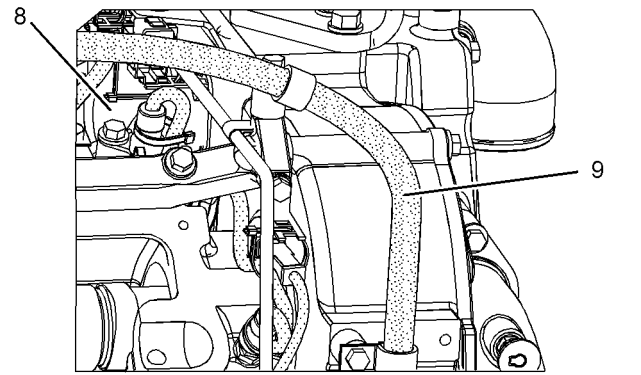


Illustration 196 g01148246

6. Remove elbow (8). Disconnect hose assembly (9).

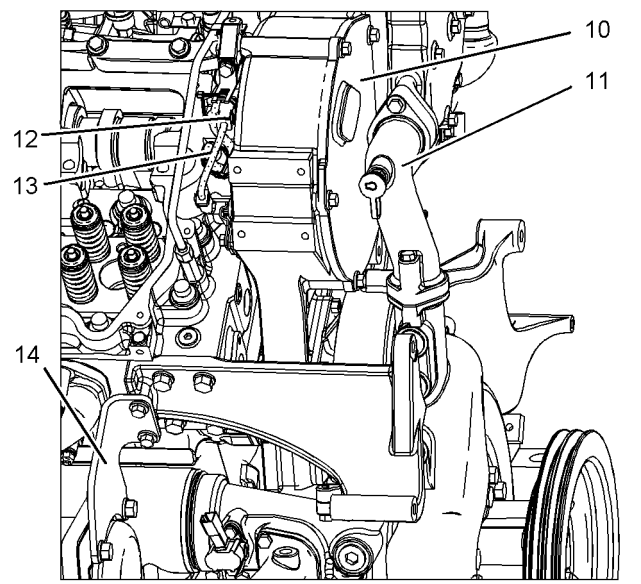


Illustration 197 g01148489

7. Remove elbow (11) and cover (10).

8. Disconnect harness assembly (12) and harness assembly (13).

9. Remove bracket (14).

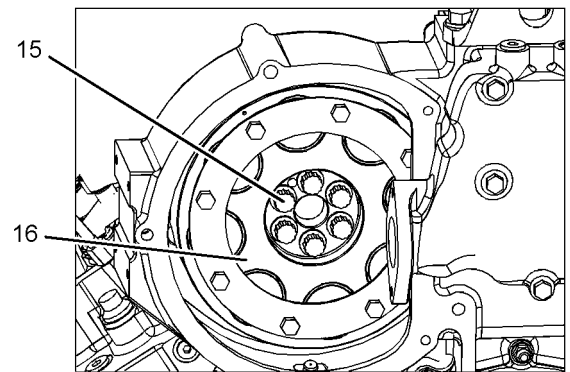


Illustration 198 g01148492

10. Remove bolts (15) and damper (16).

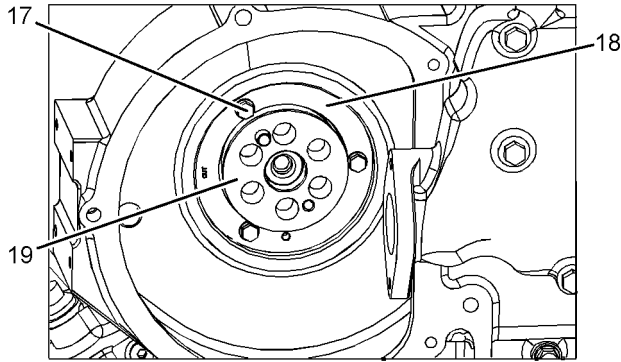


Illustration 199

g01148516

11. Remove bolts (17). Remove sealing plate (18) and adapter assembly (19).

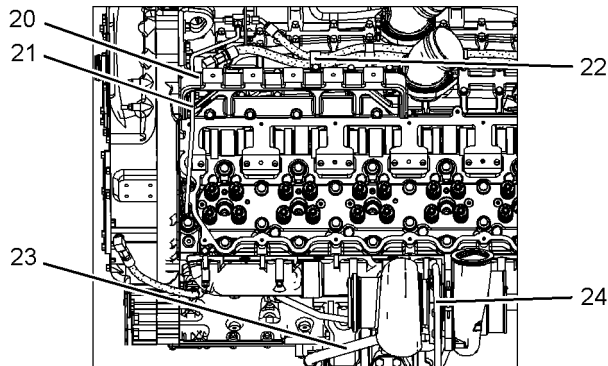


Illustration 200

g01148522

12. Disconnect clip assembly (22) from the cylinder head. Remove tube assemblies (21).

13. Remove bracket (20).

14. Disconnect tube assembly (23) and remove tube assembly (24).

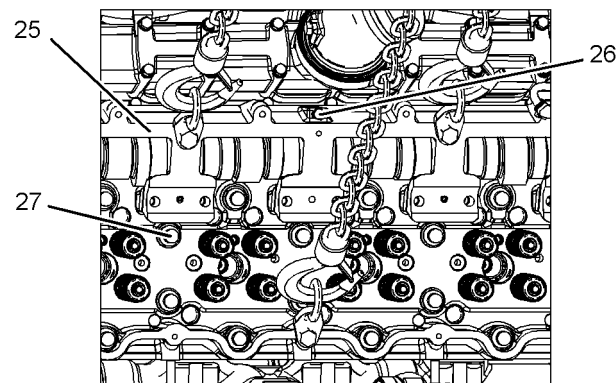


Illustration 201

g01148568

15. Attach Tooling (A) and a suitable lifting device to cylinder head (25). Attach Tooling (B) to the side of cylinder head (25) that is near the turbocharger. The weight of cylinder head (25) is approximately 365 kg (800 lb).

16. Remove bolts (26) and bolts (27).

17. Remove cylinder head (25). Remove the gaskets, O-ring seals, and the spacer plate.

i02446286

Cylinder Head - Install

SMCS Code: 1100-012

Installation Procedure

Table 49

Required Tools			
Tool	Part Number	Part Description	Qty
A	138 - 7573	Link Bracket	3
B	1U - 9200	Lever Puller Hoist	1
C	4c - 5593	Anti-Seize Compound	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

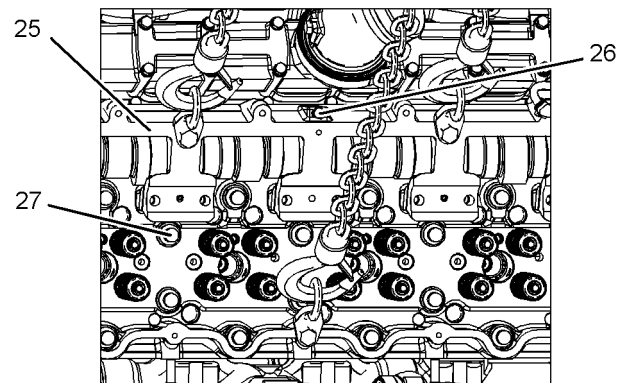


Illustration 202

g01148568

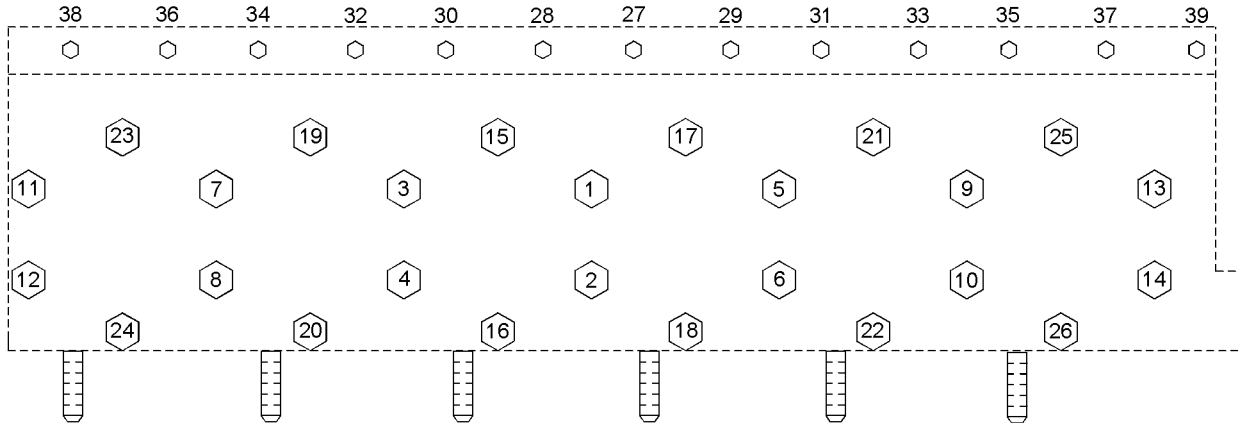


Illustration 203

g01148791

1. Install the gaskets, O-ring seals, and the spacer plate on the engine.
2. Attach Tooling (A) and a suitable lifting device to cylinder head (25). Attach Tooling (B) to the side of cylinder head (25) that is near the turbocharger. The weight of cylinder head (25) is approximately 365 kg (800 lb).
3. Position cylinder head (25) on the dowel pins in the cylinder block.

Note: Apply Tooling (C) to the bolt threads and both sides of the washers. Tighten the bolts in the following step sequence:

4. Install bolts (26) and bolts (27) according to the following procedure.
 - a. In a numerical sequence, tighten Bolt (1) through Bolt (26) to a torque of 270 ± 15 N·m (199 ± 11 lb ft).
 - b. In a numerical sequence, tighten Bolt (1) through Bolt (26) to a torque of 450 ± 15 N·m (332 ± 11 lb ft).
 - c. In a numerical sequence, again tighten Bolt (1) through Bolt (26) to a torque of 450 ± 15 N·m (332 ± 11 lb ft).
 - d. In a numerical sequence, tighten Bolt (27) through Bolt (39) to a torque of 45 ± 7 N·m (33 ± 5 lb ft).

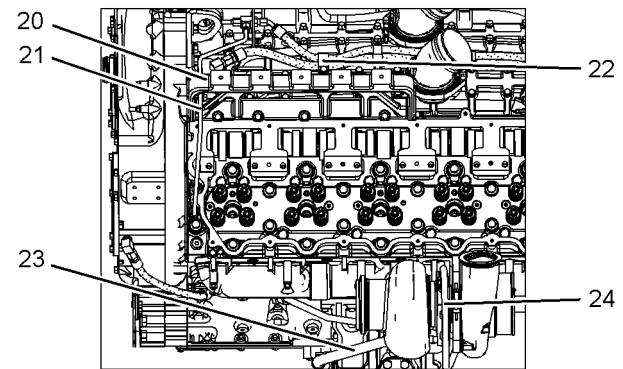


Illustration 204

g01148522

5. Connect tube assembly (23) and install tube assembly (24).
6. Install bracket (20).
7. Connect clip assembly (22). Install tube assemblies (21).

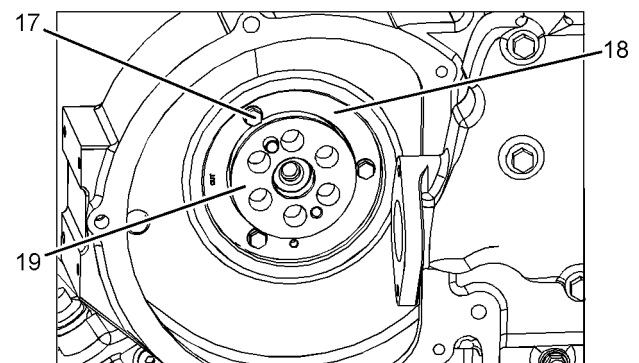


Illustration 205

g01148516

8. Install adapter assembly (19) and sealing plate (18). Install bolts (17).

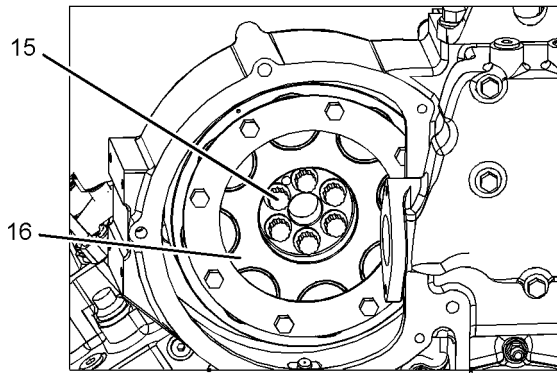


Illustration 206

g01148492

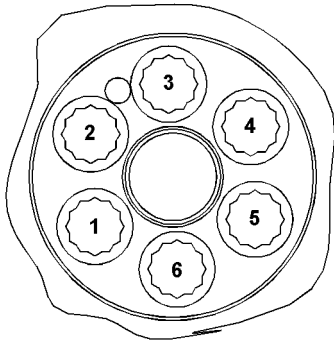


Illustration 207

g01151441

9. Install damper (16) and bolts (15).
10. Tighten the bolts to a torque of 240 ± 40 N·m (177 ± 30 lb ft). Tighten the bolts in the following sequence: 1, 4, 2, 5, 3, 6, 1, 4.

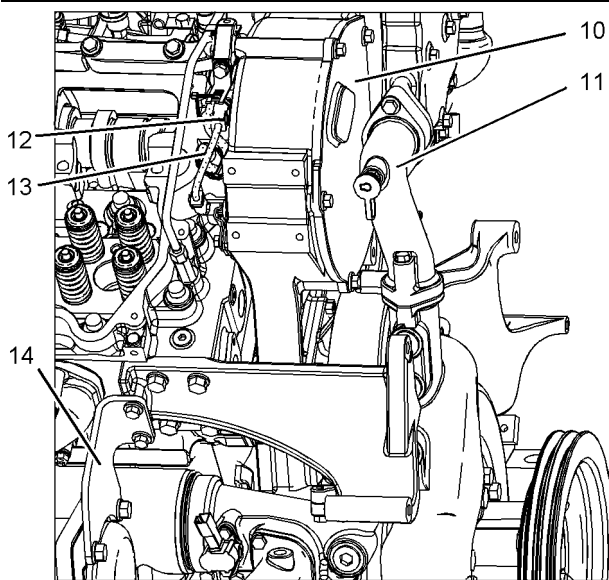


Illustration 208

g01148489

11. Install bracket (14).
12. Connect harness assembly (13) and harness assembly (12).
13. Install cover (10) and elbow (11).

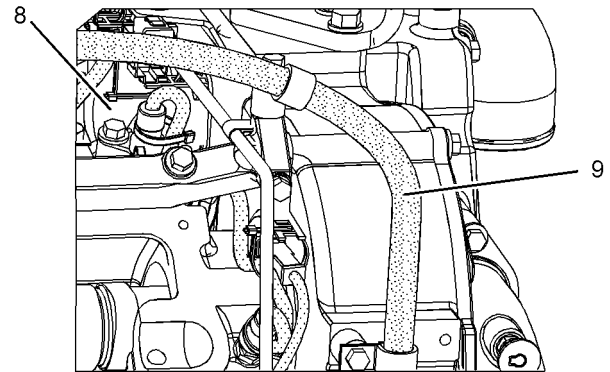


Illustration 209

g01148246

14. Connect hose assembly (9). Install elbow (8).

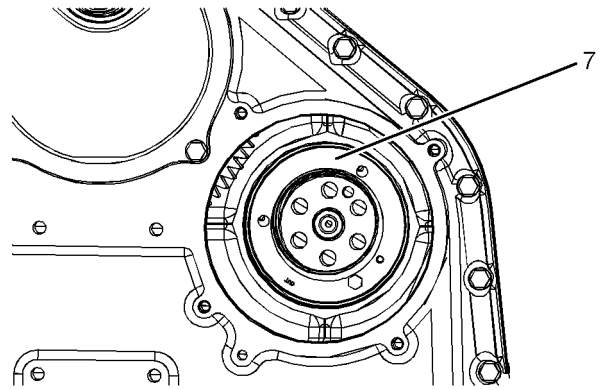


Illustration 210

g01222314

15. Install new O-ring seals and sealing plate (7).

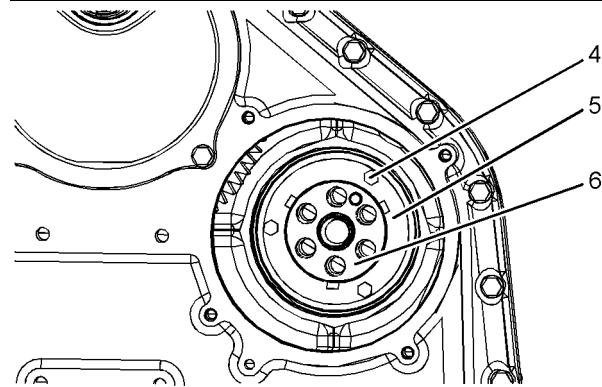


Illustration 211

g01222333

16. Install adapter assembly (6), thrust plate (5), and bolts (4).

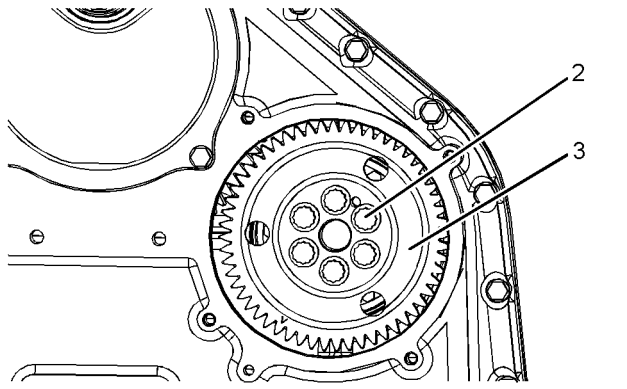


Illustration 212

g01222230

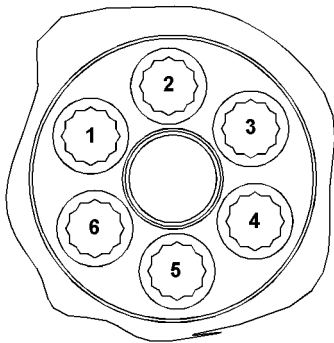


Illustration 213

g01151468

17. Install gear (3) and bolts (2).

18. Tighten the bolts to a torque of 240 ± 40 N·m (177 ± 30 lb ft). Tighten the bolts in the following sequence: 1, 4, 2, 5, 3, 6, 1, 4.

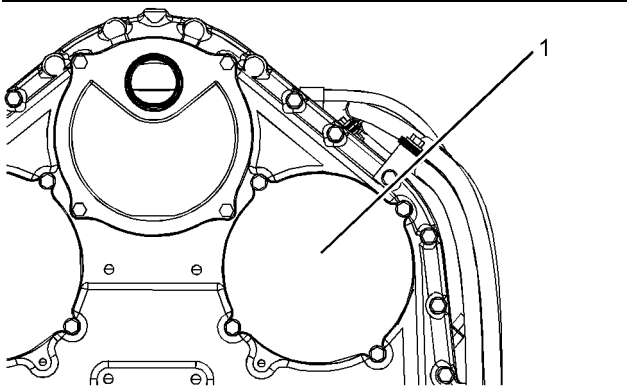


Illustration 214

g01222228

19. Install cover (1).

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

End By:

- a. Install the fuel transfer pump. Refer to Disassembly and Assembly, "Fuel Transfer Pump - Install".
- b. Install the valve mechanism cover base. Refer to Disassembly and Assembly, "Valve Mechanism Cover Base - Remove and Install".
- c. Install the electronic unit injectors. Refer to Disassembly and Assembly, "Electronic Unit Injector - Install".

i02446397

Camshaft - Remove

SMCS Code: 1210-011

Removal Procedure

Table 50

Required Tools			
Tool	Part Number	Part Description	Qty
A	177-8001	Pilot Sleeve	2
B	249-2936	Adapter	1
C	274-7932 ⁽¹⁾ or 274-7933 ⁽²⁾	Guide	1

(1) Front Removal

(2) Rear Removal

Start By:

- a. Remove the rocker arms and the rocker shafts. Refer to Disassembly and Assembly, "Rocker Arm and Shaft - Remove".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Do not turn the crankshaft or the camshaft while the camshaft gear is removed. If the rear gear group is not correctly timed during installation, interference can occur between the pistons and the valves, resulting in damage to the engine.

NOTICE

Care must be used when removing or installing the camshaft. Do not damage the finished surfaces of the camshaft or the camshaft bearings.

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".

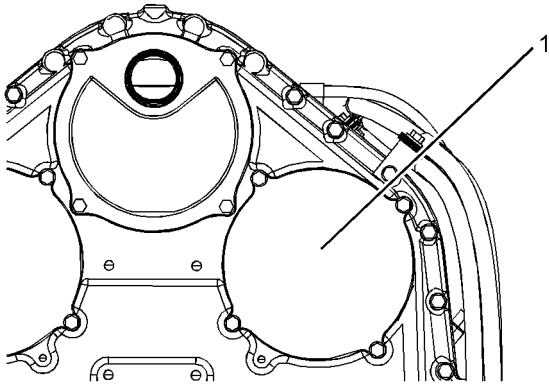


Illustration 215 g01222228

2. Remove cover (1).

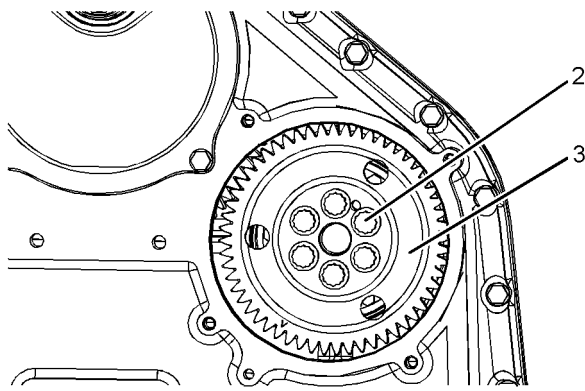


Illustration 216 g01222230

3. Remove bolts (2) and gear (3).

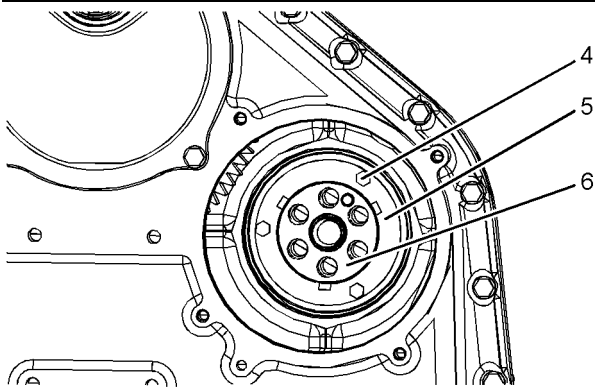


Illustration 217 g01222233

4. Remove bolts (4), thrust plate (5), and adapter assembly (6).

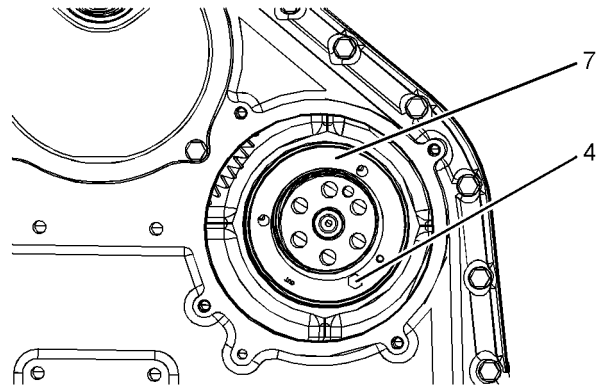


Illustration 218 g01222234

5. Use bolt (4) in order to remove sealing plate (7). Remove the O-ring seals.

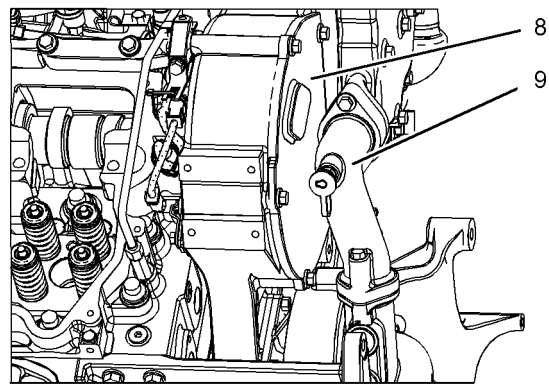


Illustration 219 g01160256

6. Remove elbow (9) and cover (8).

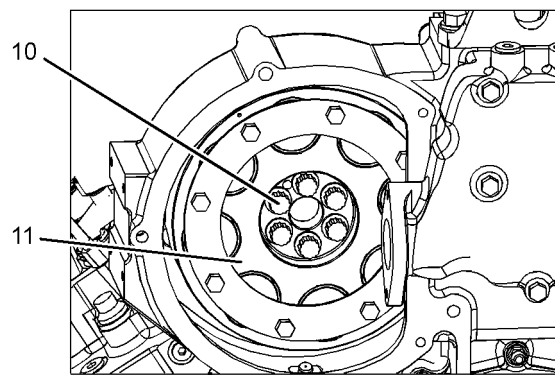


Illustration 220 g01160259

7. Remove bolts (10) and damper (11).

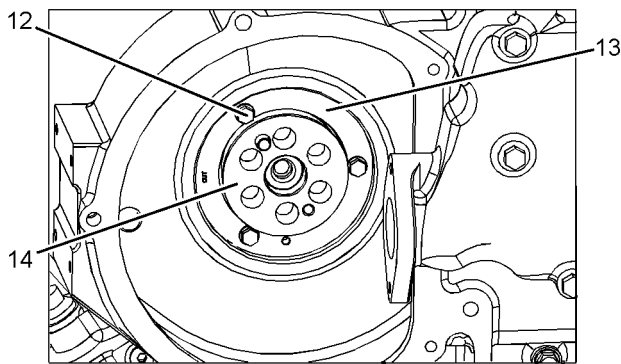


Illustration 221

g01160261

8. Remove bolts (12). Remove sealing plate (13) and adapter assembly (14).

9.

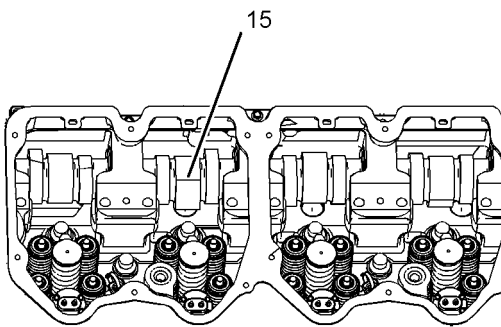


Illustration 222

g01160265

10. Install Tooling (A) and Tooling (B) on the rear of camshaft (15). Install Tooling (A) on the front of camshaft (15).

11. Install Tooling (C) on the front housing or the rear housing. Tooling (C) is used to support the camshaft.

Note: It is necessary to install Tooling (A) and Tooling (B) on the camshaft. Tooling (A) and Tooling (B) will support the camshaft as the camshaft is moved out of the cylinder head and into Tooling (C). Align the camshaft with the bore of Tooling (C).

Note: Avoid lifting the camshaft. The camshaft should rest on Tooling (A) and Tooling (B). Lifting of the camshaft can cause misalignment as the camshaft is removed, resulting in damage to the camshaft bearings.

12. Carefully slide the camshaft out of the cylinder head for removal. Use two technicians to remove the camshaft. Keep the camshaft level while the camshaft is being removed from the cylinder head. The weight of the camshaft is approximately 35 kg (77 lb).

Note: Rotate the camshaft during removal. This will prevent the camshaft from binding in the camshaft bearings.

i02446568

Camshaft - Install

SMCS Code: 1210-012

Installation Procedure

Table 51

Required Tools			
Tool	Part Number	Part Description	Qty
A	177-8001	Pilot Sleeve	2
B	249-2936	Adapter	1
C	274-7932 ⁽¹⁾ or 274-7933 ⁽²⁾	Guide	1
D	8T-2998	Lubricant	1

(1) Front Removal

(2) Rear Removal

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Do not turn the crankshaft or the camshaft while the camshaft gear is removed. If the rear gear group is not correctly timed during installation, interference can occur between the pistons and the valves, resulting in damage to the engine.

NOTICE

Care must be used when removing or installing the camshaft. Do not damage the finished surfaces of the camshaft or the camshaft bearings.

1. Ensure that the camshaft and camshaft bearings are thoroughly clean. Lubricate the camshaft lobes with a 50/50 mixture of Tooling (D) and clean engine oil. Apply a thin coat of clean engine oil on the camshaft bearings.

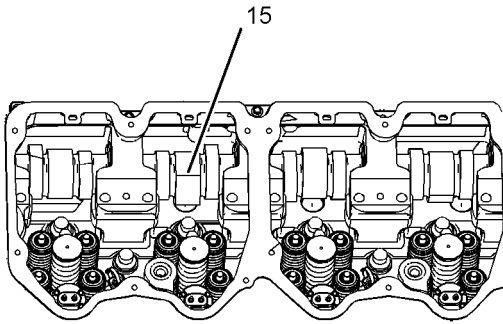


Illustration 223

g01160265

2. Install Tooling (A) and Tooling (B) on the rear of camshaft (15). Install Tooling (A) on the front of camshaft (15).
3. Install Tooling (C) on the front housing or the rear housing. Tooling (C) is used to support the camshaft.
4. Use two technicians to install the camshaft. Use Tooling (C) to assist in aligning the camshaft with the camshaft bearings. Carefully slide the camshaft into the cylinder head. Keep the camshaft level while the camshaft is being installed in the cylinder head. The weight of the camshaft is approximately 35 kg (77 lb).

Note: Rotate the camshaft during installation. This will prevent the camshaft from binding in the camshaft bearings.

5. Remove Tooling (A) and Tooling (B) from the camshaft.

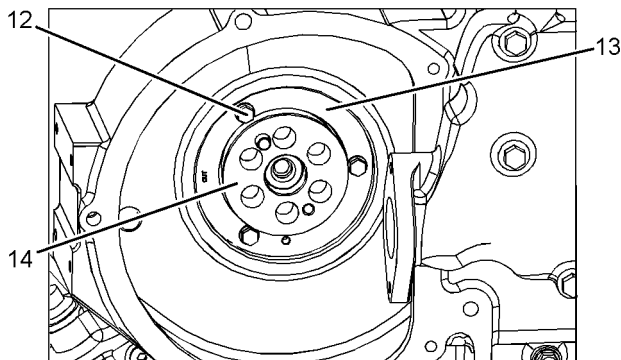


Illustration 224

g01160261

6. Install adapter assembly (14) and sealing plate (13). Install bolts (12).

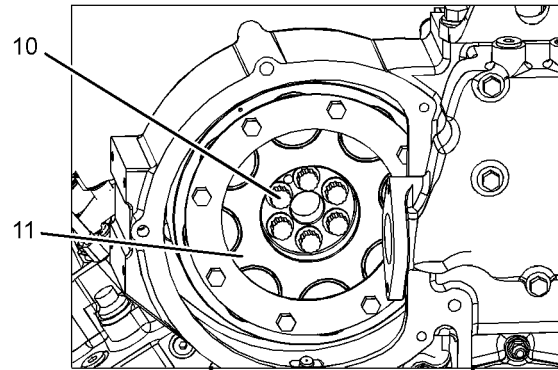


Illustration 225

g01160259

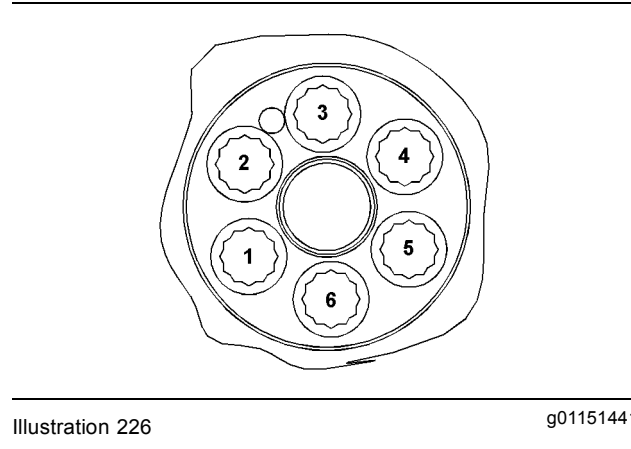


Illustration 226

g01151441

7. Install damper (11) and bolts (10).
8. Tighten the bolts to a torque of 240 ± 40 N·m (177 ± 30 lb ft). Tighten the bolts in the following sequence: 1, 4, 2, 5, 3, 6, 1, 4.

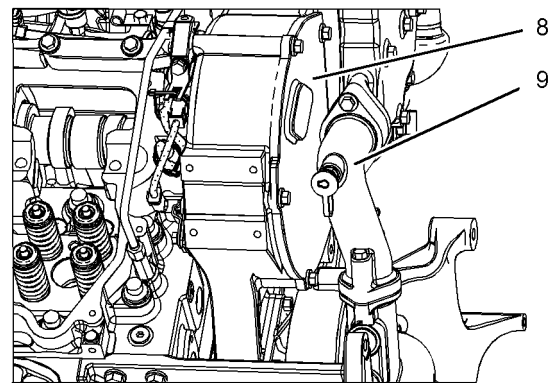


Illustration 227

g01160256

9. Install cover (8) and elbow (9).

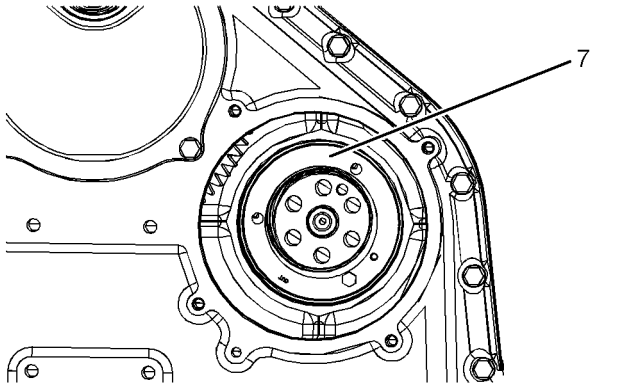


Illustration 228 g01222314

10. Install new O-ring seals and sealing plate (7).

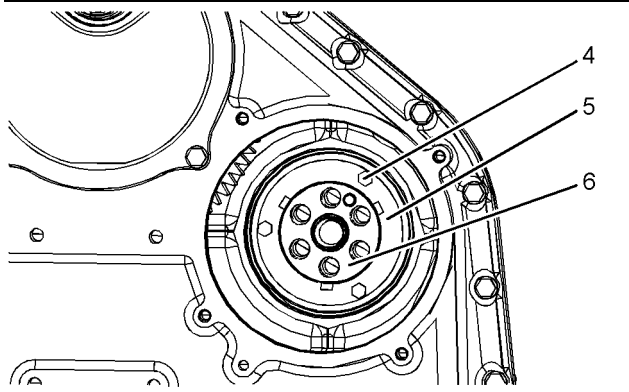


Illustration 229 g0122233

11. Install adapter assembly (6), thrust plate (5), and bolts (4).

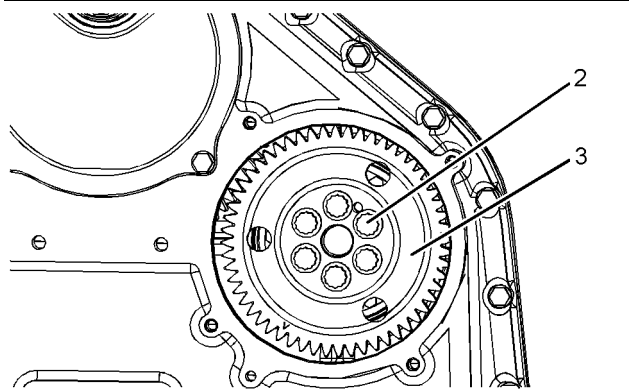


Illustration 230 g0122230

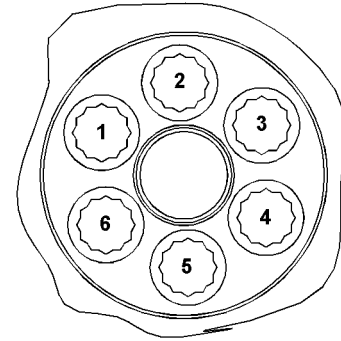


Illustration 231 g01151468

12. Install gear (3) and bolts (2).

13. Tighten the bolts to a torque of 240 ± 40 N·m (177 ± 30 lb ft). Tighten the bolts in the following sequence: 1, 4, 2, 5, 3, 6, 1, 4.

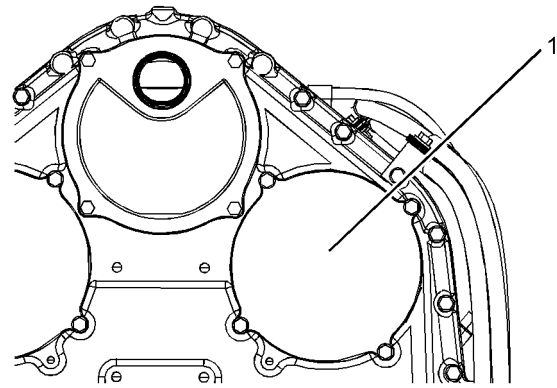


Illustration 232 g0122228

14. Install cover (1).

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

End By:

- a. Install the rocker arms and the rocker shafts. Refer to Disassembly and Assembly, "Rocker Arms and Shaft - Install".

i02451045

Camshaft Bearings - Remove

SMCS Code: 1211-011

Removal Procedure

Table 52

Required Tools			
Tool	Part Number	Part Description	Qty
A	8S-2241	Camshaft Bearing Tool Group	1
B	9U-7222	Camshaft Bearing Pilot	1
	8M-8778	Taperlock Stud 1/2 - 13 by 1 9/16 inch	1
C	9U-7210	Puller Plate	1

Start By:

- a. Remove the camshaft. Refer to Disassembly and Assembly, "Camshaft - Remove".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

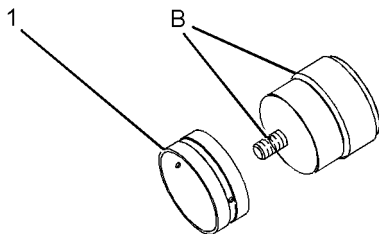


Illustration 233

g01159745

1. Remove the No. 7 camshaft bearing (rear). Work from the rear of the engine to the front of the engine.
2. Install the small end of Tooling (B) in camshaft bearing (1).
3. Position Tooling (C) over Tooling (A). Install Tooling (A) through the cylinder head on Tooling (B).

Note: Tooling (C) is installed on the outside of the cylinder head. Tooling (C) is required in order to remove all the camshaft bearings from the cylinder head.

4. Use Tooling (A) to remove camshaft bearing (1) from the cylinder head.
5. Remove Tooling (B) from Tooling (A) and remove the camshaft bearing.

i02451063

Camshaft Bearings - Install

SMCS Code: 1211-012

Installation Procedure

Table 53

Required Tools			
Tool	Part Number	Part Description	Qty
A	8S-2241	Camshaft Bearing Tool Group	1
B	9U-7222	Camshaft Bearing Pilot	1
	8M-8778	Taperlock Stud 1/2 - 13 by 1 9/16 inch	1
C	9U-7210	Puller Plate	1
D	9U-7223	Alignment Bushing	1
E	9U-7213	Backup Plate	1
	0S-1621	Bolt 1/2 - 13 by 1 inch	1
F	9U-7214	Spacer Plate	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

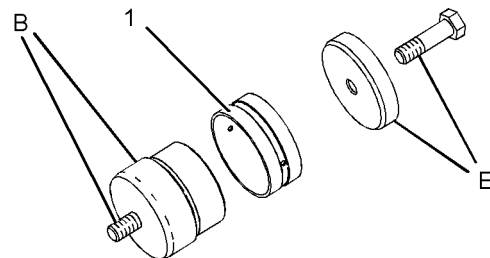


Illustration 234

g01159754

1. Install the No. 7 camshaft bearing (rear), as follows:
 - a. Insert the large end of Tooling (B) into the No. 7 camshaft bore.
 - b. Position Tooling (C) over Tooling (A). Install Tooling (A) through the cylinder head on Tooling (B).
 - c. Position camshaft bearing (1) on Tooling (B). Install Tooling (E) on Tooling (B).

Note: Refer to Specifications, "Cylinder Head" for appropriate information for the orientation of the camshaft bearings in the cylinder head.

- d. Use Tooling (A) in order to pull camshaft bearing (1) into the camshaft bore.

Note: When the chamfer of Tooling (E) contacts the face of the camshaft bore, the camshaft bearing is properly installed.

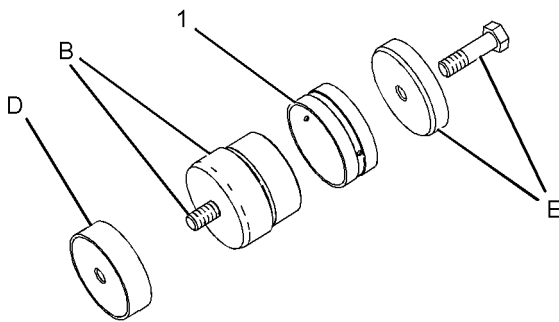


Illustration 235

g01159756

2. Install the No. 6 through No. 2 camshaft bearings, as follows:

- a. Insert the large end of Tooling (B) into the camshaft bore.

Note: Use Tooling (D) to align Tooling (A) and Tooling (B) with the camshaft bearing bores. Install Tooling (D) in the inside diameter of any installed camshaft bearing between Tooling (A) and Tooling (B).

- b. Install Tooling (A) on Tooling (B). Position camshaft bearing (1) on Tooling (B). Install Tooling (E) on Tooling (B).

Note: Refer to Specifications, "Cylinder Head" for appropriate information for the location and the orientation of the camshaft bearings in the cylinder head.

- c. Use Tooling (A) in order to pull camshaft bearing (1) into the camshaft bore.

Note: When the chamfer of Tooling (E) contacts the face of the camshaft bore, the camshaft bearing is properly installed.

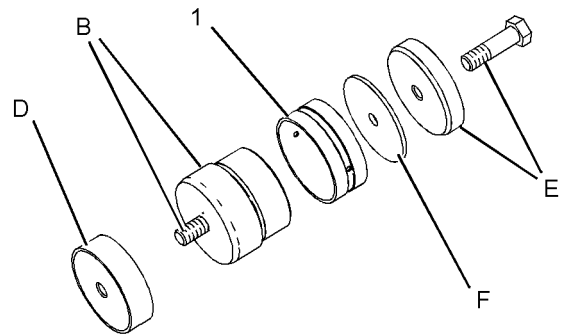


Illustration 236

g01159758

3. Install the No. 1 camshaft bearing (front), as follows:

- a. Insert the large end of Tooling (B) into the No. 1 camshaft bore. Assemble Tooling (A) and Tooling (D) on Tooling (B).
- b. Position camshaft bearing (1) on Tooling (B). Install Tooling (E) and Tooling (F) on Tooling (B).

Note: Refer to Specifications, "Cylinder Head" for appropriate information for the location and the orientation of the camshaft bearings in the cylinder head.

Note: Tooling (F) is used to seat the No. 1 camshaft bearing to the correct depth in the camshaft bore.

- c. Use Tooling (A) in order to pull the No. 1 camshaft bearing into the No. 1 camshaft bore. When the chamfer of Tooling (E) contacts the face of the camshaft bore, the camshaft bearing is properly installed.

End By:

- a. Install the camshaft. Refer to Disassembly and Assembly, "Camshaft - Install".

i02447352

Engine Oil Pan - Remove and Install

SMCS Code: 1302-010

Removal Procedure

Table 54

Required Tools			
Tool	Part Number	Part Description	Qty
A	1U-7505	Hydraulic Jack	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 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.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Drain the engine oil into a suitable container for storage or disposal. Refer to Operation and Maintenance Manual, "Engine Oil and Filter - Change".

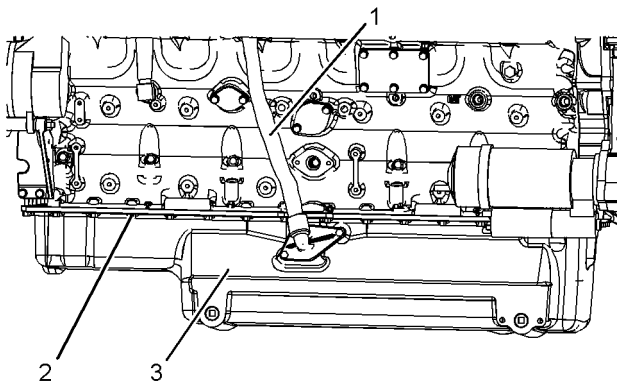


Illustration 237

g01222524

2. Remove tube assemblies (1) from engine oil pan (3).
3. Use Tooling (A) to support engine oil pan (3). The weight of engine oil pan (3) is approximately 25 kg (55 lb).
4. Remove bolts (2). Remove engine oil pan (3) and the gasket.

Installation Procedure

Table 55

Required Tools			
Tool	Part Number	Part Description	Qty
A	1U-7505	Hydraulic Jack	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

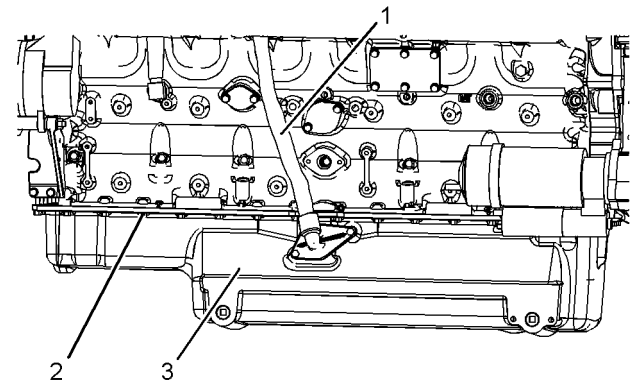


Illustration 238

g01222524

1. Use Tooling (A) to support engine oil pan (3). The weight of engine oil pan (3) is approximately 25 kg (55 lb).

2. Position the gasket and engine oil pan (3) on the engine. Install bolts (2).

Note: If the oil drain plugs were removed, install the oil drain plugs. Tighten the oil drain plugs to a torque of 80 ± 10 N·m (59 ± 7 lb ft).

3. Install tube assemblies (1) on engine oil pan (3).
4. Fill the engine with engine oil to the correct level. Refer to Operation and Maintenance Manual, "Engine Oil and Filter - Change".

i02294951

Cylinder Liner - Remove

SMCS Code: 1216-011

Removal Procedure

Table 56

Required Tools			
Tool	Part Number	Part Description	Qty
A	5P-8665 ⁽¹⁾	Cylinder Liner Puller Gp	1

⁽¹⁾ The 6V-9448 Cylinder Pack Puller is an optional Tool for removing the cylinder liner.

Start By:

- a. Remove the pistons and connecting rods. Refer to Disassembly and Assembly, "Pistons and Connecting Rods - Remove".

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.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

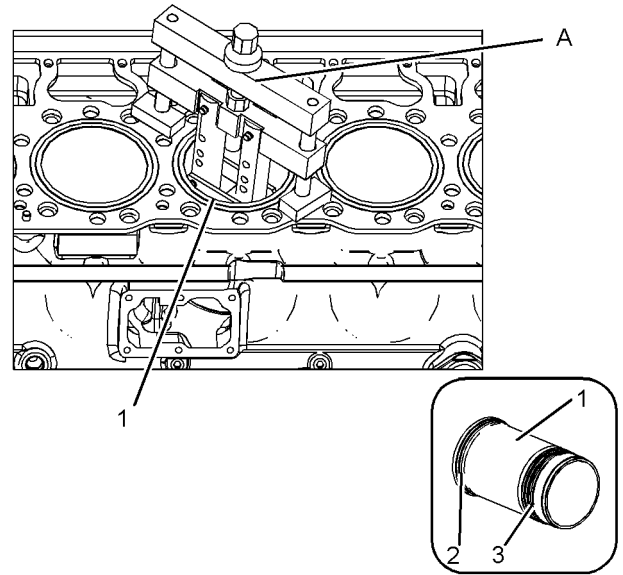


Illustration 239

g01149417

1. Use Tooling (A) to remove cylinder liner (1).
2. Remove liner seals (3) and filler band (2) from cylinder liner (1).

i02294960

Cylinder Liner - Install

SMCS Code: 1216-012

Installation Procedure

Table 57

Required Tools			
Tool	Part Number	Part Description	Qty
B	2P-8260	Cylinder Liner Installer	1
C	5P-3975	Rubber Lubricant	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Check the cylinder liner projection. Refer to Testing and Adjusting, "Cylinder Liner Projection - Inspect".

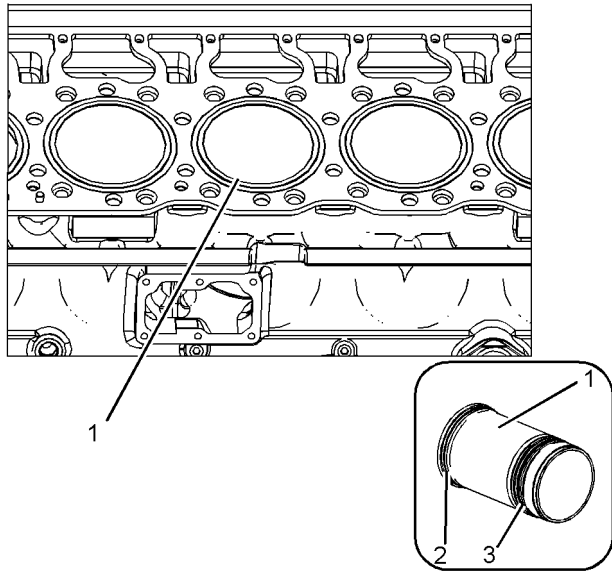


Illustration 240

g01149469

2. Install liner seals (3) on cylinder liner (1).
3. Apply Tooling (C) on the cylinder block liner bore surfaces and liner seals (3).
4. Dip filler band (2) in clean engine oil for a moment. Install the filler band on the cylinder liner immediately.
5. Use Tooling (B) to install cylinder liner (1) in the cylinder block. Ensure that any marks in relation to the cylinder liner projection are in alignment.

End By:

- a. Install the pistons and connecting rods. Refer to Disassembly and Assembly, "Pistons and Connecting Rods - Install".

i02295020

Piston Cooling Jets - Remove and Install

SMCS Code: 1331-010

Removal Procedure

Table 58

Required Tools			
Tool	Part Number	Part Description	Qty
A	9S-9082	Engine Turning Tool	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.

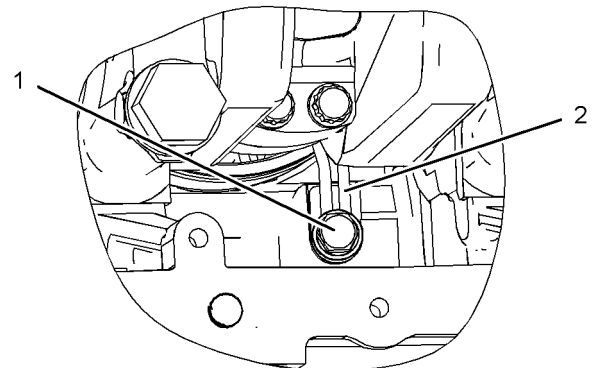


Illustration 241

g01149484

1. Use Tooling (A) to rotate the crankshaft in order to gain access to the piston cooling jet.
2. Remove bolt (1) and piston cooling jet (2).

Installation Procedure

Table 59

Required Tools			
Tool	Part Number	Part Description	Qty
A	9S-9082	Engine Turning Tool	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

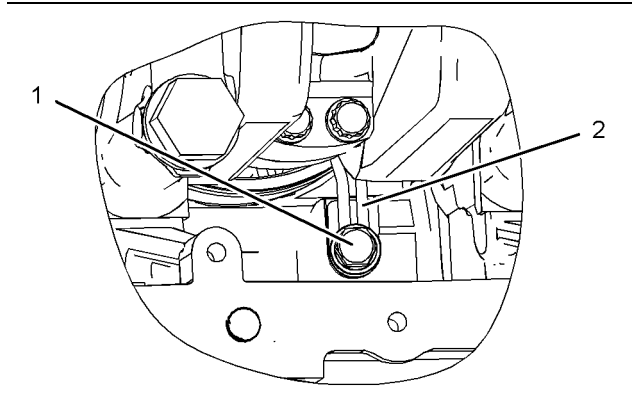


Illustration 242 g01149484

1. Use Tooling (A) to rotate the crankshaft in order to gain access to the piston cooling jet.
2. Position piston cooling jet (2) in the cylinder block. Install bolt (1). Tighten the bolt to a torque of $25 \pm 6 \text{ N}\cdot\text{m}$ ($18 \pm 4 \text{ lb ft}$).

End By:

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

i02295112

Pistons and Connecting Rods - Remove

SMCS Code: 1225-011

Removal Procedure

Table 60

Required Tools			
Tool	Part Number	Part Description	Qty
A	9S-9082	Engine Turning Tool	1

Start By:

- a. Remove the cylinder head. Refer to Disassembly and Assembly, "Cylinder Head - Remove".
- b. Remove the piston cooling jets. Refer to Disassembly and Assembly, "Piston Cooling Jets - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

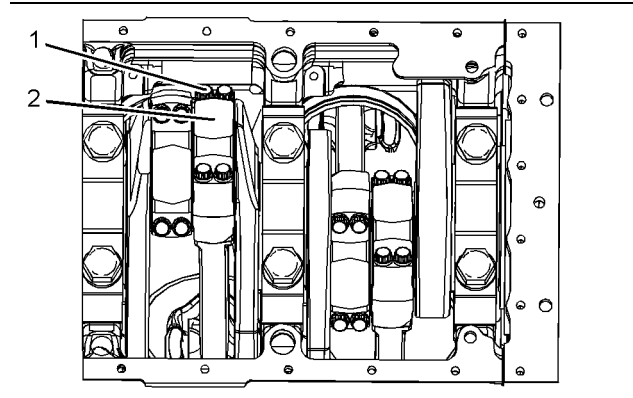


Illustration 243 g01149594

1. Use Tooling (A) to rotate the crankshaft until the piston is at the bottom center.
2. Remove the carbon ridge from the top inside surface of the cylinder liner.
3. Inspect the connecting rod and connecting rod cap for the proper identification mark. The connecting rod and the connecting rod cap should have an etched number on the side. The number should match the cylinder number. Mark the connecting rod and the connecting rod cap, if necessary.

Note: Do not stamp the connecting rod assembly. Stamping or punching the connecting rod assembly could cause the connecting rod to fracture.

4. Remove bolts (1) and connecting rod bearing cap (2).

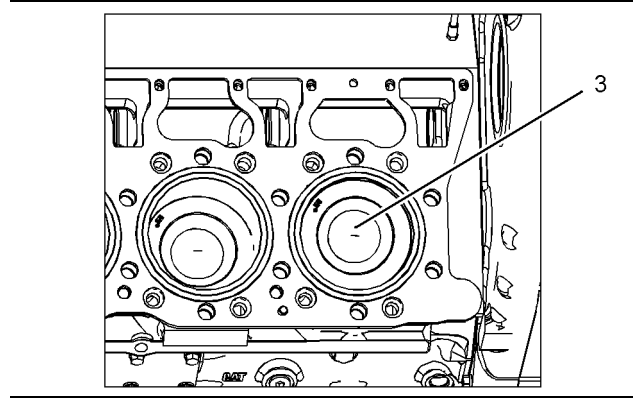


Illustration 244 g01149595

5. Remove piston (3) and the connecting rod from the cylinder liner.

i02447789

Pistons and Connecting Rods - Disassemble

SMCS Code: 1225-015

Disassembly Procedure

Table 61

Required Tools			
Tool	Part Number	Part Description	Qty
A	6V-6192	Pliers	1
B	7B-7974	Piston Ring Expander Gp	1

Start By:

- a. Remove the pistons and connecting rods. Refer to Disassembly and Assembly, "Pistons and Connecting Rods - Remove".

Note: Mark the components of each piston and connecting rod assembly. The components must be reinstalled in the original location. Do not interchange components.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

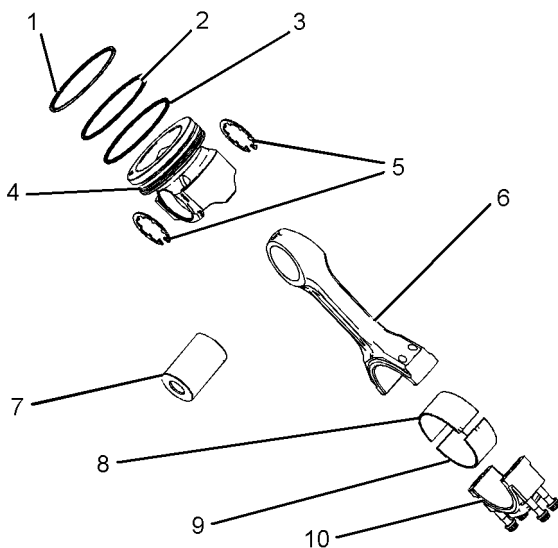


Illustration 245

g01222629

1. Remove lower connecting rod bearing (9) from connecting rod bearing cap (10).

2. Remove upper connecting rod bearing (8) from connecting rod (6).
3. Use Tooling (A) to remove pin retainers (5) from piston body assembly (4).
4. Remove connecting rod pin (7) and connecting rod (6) from the piston body assembly.
5. Use Tooling (B) to remove top piston ring (1), intermediate piston ring (2), and oil control piston ring (3) from the piston body assembly.

i02447828

Pistons and Connecting Rods - Assemble

SMCS Code: 1225-016

Assembly Procedure

Table 62

Required Tools			
Tool	Part Number	Part Description	Qty
A	6V-6192	Pliers	1
B	7B-7974	Piston Ring Expander Gp	1

Note: Prior to removal from the engine, the pistons and connecting rod assemblies were marked. The components must be reassembled together. The components must be installed in the original location in the engine. Do not interchange any of the components.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

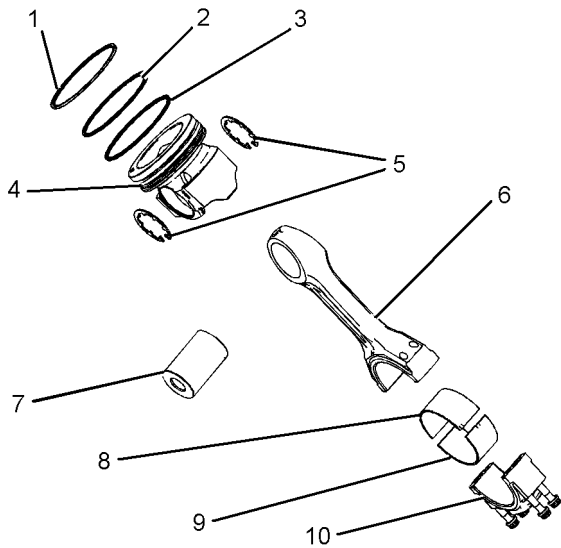


Illustration 246

g01222629

1. Position the spring for the oil control piston ring in the oil ring groove in the piston body assembly.
2. Position oil control piston ring (3) over the spring. Position the oil control piston ring so that the gap is 180 degrees from the joint in the spring. Install the oil control piston ring on the piston with Tooling (B).
3. Use Tooling (B) to install intermediate piston ring (2) with the side that has the identification "UP-2" toward the top of the piston.
4. Use Tooling (B) to install top piston ring (1) with the side that has the identification "UP-1" toward the top of the piston.
5. Position top piston ring (1), intermediate piston ring (2), and oil control piston ring (3) so the gaps are 120 degrees from each other.
6. Check the clearance between the ends of top piston ring (1), intermediate piston ring (2), and oil control piston ring (3). Refer to Specifications, "Pistons And Rings".
7. Position piston body assembly (4) on connecting rod (6). Apply clean engine oil to connecting rod pin (7) and install the connecting rod pin. Install pin retainers (5) with Tooling (A).
8. Install upper connecting rod bearing (8) in connecting rod (6).

Note: Ensure that the bearing locking tab is located in the notch of the connecting rod.

9. Install lower connecting rod bearing (9) in connecting rod bearing cap (10).

Note: Ensure that the bearing locking tab is located in the notch of the connecting rod bearing cap.

10. Ensure that the dowels are installed in the connecting rod bearing cap.

End By:

- a. Install the pistons and connecting rods. Refer to Disassembly and Assembly, "Pistons and Connecting Rods - Install".

i02630922

Pistons and Connecting Rods - Install

SMCS Code: 1225-012

Installation Procedure

Table 63

Required Tools			
Tool	Part Number	Part Description	Qty
A	9S-9082	Engine Turning Tool	1
B	200-3914	Piston Ring Compressor	1
C	8T-3052	Degree Wheel	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Install the connecting rod bearings dry when clearance checks are performed. Refer to Disassembly and Assembly, "Bearing Clearance - Check". Apply clean engine oil on the connecting rod bearings for final assembly.

1. Apply clean engine oil to the cylinder liner bore, to the piston rings, and to the outer surface of the piston.

Note: Ensure that the connecting rod and pistons are installed in the correct cylinder.

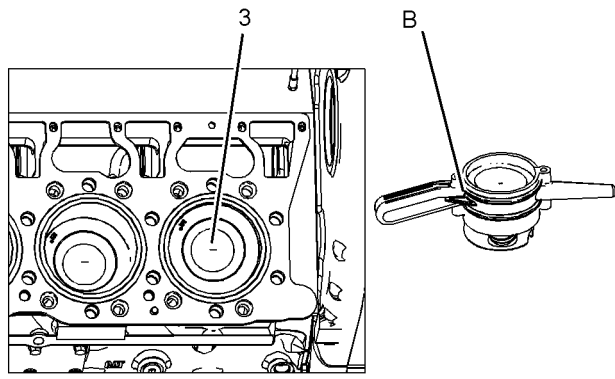


Illustration 247

g01149650

2. Use Tooling (A) to rotate the crankshaft until the connecting rod journal is at the bottom center.
3. Use Tooling (B) to install piston (3) and the connecting rod in the cylinder liner.

Note: Install the connecting rod so that the bearing tab is located on the opposite side of the piston cooling jet.

4. Install the upper connecting rod bearing in the connecting rod.

Note: Ensure that the connecting rod bearing is installed so that the bearing tab fits into the notch in the connecting rod.

5. Pull the connecting rod onto the crankshaft journal.
6. Install the lower connecting rod bearing in the connecting rod bearing cap.

Note: Ensure that the connecting rod bearing is installed so that the bearing tab fits into the notch in the connecting rod.

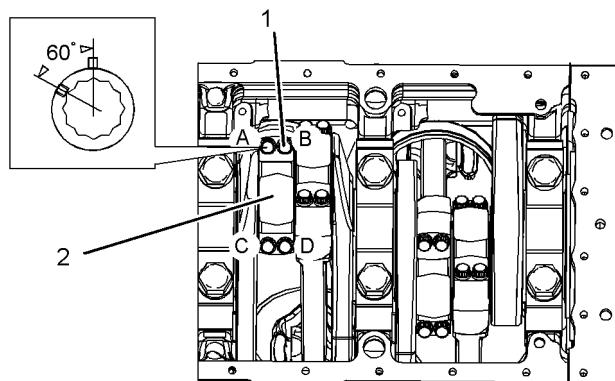


Illustration 248

g01149651

7. Position connecting rod bearing cap (2) on the connecting rod.

Note: Ensure that the number on the side of the connecting rod bearing cap is on the same side as the number on the connecting rod. The bearing tabs of the connecting rod bearing cap and the connecting rod are located on the side opposite of the piston cooling jet.

8. Lubricate the threads of bolts (1) with clean engine oil. Install the bolts.
9. Tighten bolts (1), as follows:
 - a. Tighten Bolt (A) and Bolt (C) to a torque of $70 \pm 4 \text{ N}\cdot\text{m}$ ($52 \pm 3 \text{ lb ft}$).
 - b. Tighten Bolt (B) and Bolt (D) to a torque of $70 \pm 4 \text{ N}\cdot\text{m}$ ($52 \pm 3 \text{ lb ft}$).
 - c. Turn Bolt (B) and Bolt (D) for an additional 60 ± 5 degrees ($1/6$ turn).

Note: If Tooling (C) is not used, place an index mark on each bolt.

- d. Tighten Bolt (A) and Bolt (C) again to a torque of $70 \pm 4 \text{ N}\cdot\text{m}$ ($52 \pm 3 \text{ lb ft}$).
- e. Turn Bolt (A) and Bolt (C) for an additional 60 ± 5 degrees ($1/6$ turn).

Note: If Tooling (C) is not used, place an index mark on each bolt.

- f. Rotate the crankshaft in order to ensure that the crankshaft turns freely.

End By:

- a. Install the piston cooling jets. Refer to Disassembly and Assembly, "Piston Cooling Jets - Remove and Install".
- b. Install the cylinder head. Refer to Disassembly and Assembly, "Cylinder Head - Install".

i02295567

Connecting Rod Bearings - Remove

SMCS Code: 1219-011

Removal Procedure

Table 64

Required Tools			
Tool	Part Number	Part Description	Qty
A	9S-9082	Engine Turning Tool	1

i02295910

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.

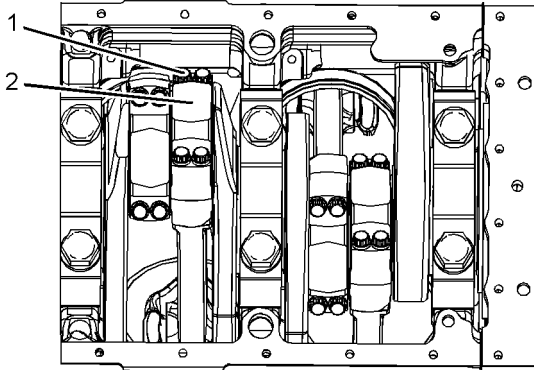


Illustration 249

g01149594

1. Use Tooling (A) to rotate the crankshaft until the connecting rod is at the bottom center.
2. Inspect the connecting rod and connecting rod cap for the proper identification mark. The connecting rod and the connecting rod cap should have an etched number on the side. The number should match the cylinder number. Mark the connecting rod and the connecting rod cap, if necessary.

Note: Do not stamp the connecting rod assembly. Stamping or punching the connecting rod assembly could cause the connecting rod to fracture.

3. Remove bolts (1) and connecting rod bearing cap (2) from the connecting rod.
4. Remove the lower half of the connecting rod bearing from the connecting rod bearing cap.
5. Push the connecting rod away from the crankshaft. Remove the upper half of the connecting rod bearing from the connecting rod.

Connecting Rod Bearings - Install

SMCS Code: 1219-012

Installation Procedure

Table 65

Required Tools			
Tool	Part Number	Part Description	Qty
A	9S-9082	Engine Turning Tool	1
B	8T-3052	Degree Wheel	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Install the connecting rod bearings dry when clearance checks are performed. Refer to Disassembly and Assembly, "Bearing Clearance - Check". Apply clean engine oil on the connecting rod bearings for final assembly.

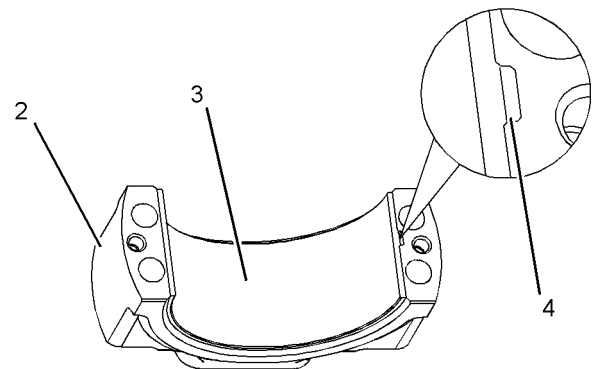


Illustration 250

g00998730

1. Use Tooling (A) to rotate the crankshaft until the connecting rod journal is at the bottom center.
2. Install a new lower half connecting rod bearing (3) in connecting rod bearing cap (2).

Note: Ensure that bearing locking tab (4) is located in the notch of the connecting rod bearing cap.

3. Install a new upper half connecting rod bearing in the connecting rod.

Note: Ensure that the bearing locking tab is located in the notch of the connecting rod.

4. Pull the connecting rod onto the crankshaft.

i02296017

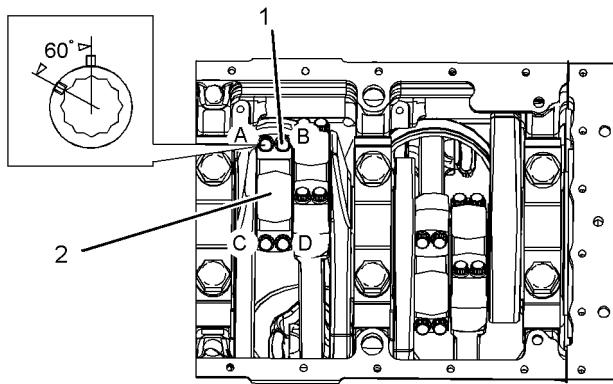


Illustration 251

g01149651

5. Position connecting rod bearing cap (2) on the connecting rod.

Note: Ensure that the number on the side of the connecting rod bearing cap is on the same side as the number on the connecting rod. The bearing tabs of the connecting rod bearing cap and the connecting rod are located on the side opposite of the piston cooling jet.

6. Lubricate the threads of bolts (1) with clean engine oil. Install the bolts.

7. Tighten bolts (1), as follows:

- a. Tighten Bolt (A) and Bolt (C) to a torque of 70 ± 4 N·m (52 ± 3 lb ft).
- b. Tighten Bolt (B) and Bolt (D) to a torque of 70 ± 4 N·m (52 ± 3 lb ft).
- c. Turn Bolt (B) and Bolt (D) for an additional 60 ± 5 degrees ($1/6$ turn).

Note: If Tooling (B) is not used, place an index mark on each bolt.

- d. Tighten Bolt (A) and Bolt (C) again to a torque of 70 ± 4 N·m (52 ± 3 lb ft).
- e. Tighten Bolt (A) and Bolt (C) for an additional 60 ± 5 degrees ($1/6$ turn).

Note: If Tooling (B) is not used, place an index mark on each bolt.

- f. Rotate the crankshaft in order to ensure that the crankshaft turns freely.

End By:

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

Crankshaft Main Bearings - Remove

SMCS Code: 1203-011

Removal Procedure

Table 66

Required Tools			
Tool	Part Number	Part Description	Qty
A	2P-5518	Bearing Tool	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.

1. Check the main bearing caps for identification of the location and check the direction of the main bearing caps in relation to the cylinder block. The main bearing caps must be installed in the original location and the original direction.

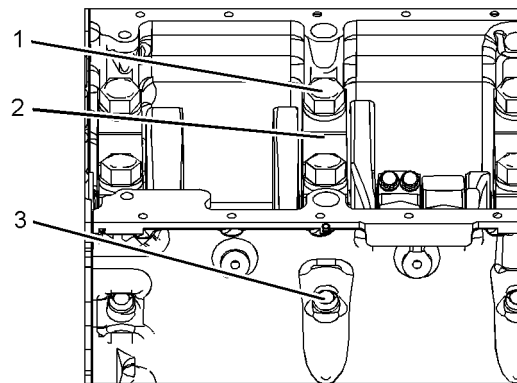


Illustration 252

g01149949

2. Remove bolts (1) and bolts (3) from No. 2 through No. 6 main bearing caps (2).

Note: Remove No. 1 and No. 7 main bearing caps (2) after No. 2 through No. 6 main bearing caps have been installed.

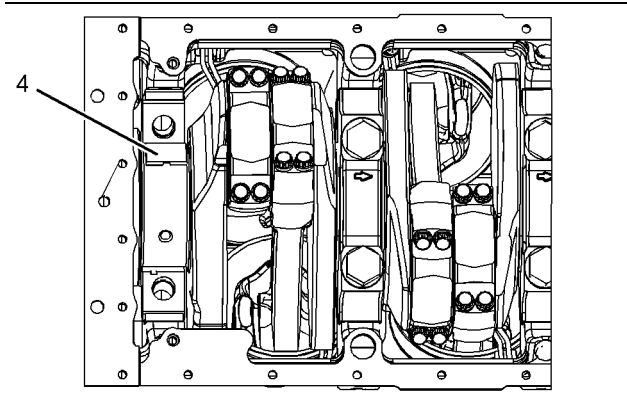


Illustration 253

g01149952

3. Install Tooling (A) in the oil hole of the crankshaft. Carefully rotate the crankshaft in order to remove upper main bearing (4) from the cylinder block.

Note: Push the upper main bearing from the opposite side of the bearing tab with Tooling (A). If the crankshaft is turned in the wrong direction, the tab on the bearing will be pushed between the crankshaft and the bearing area of the cylinder block. This can result in damage to the cylinder block and/or the crankshaft.

4. Remove the thrust plates from each side of the No. 4 main bearing.
5. Remove the lower halves of the main bearings from the main bearing caps.

i02296049

Crankshaft Main Bearings - Install

SMCS Code: 1203-012

Installation Procedure

Table 67

Required Tools			
Tool	Part Number	Part Description	Qty
A	2P-5518	Bearing Tool	1
B	8T-5096	Dial Indicator	1
C	8T-3052	Degree Wheel	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Install the main bearings dry when clearance checks are performed. Refer to Disassembly and Assembly, "Bearing Clearance - Check". Apply clean engine oil on the main bearings for final assembly.

Note: Ensure that the main bearings are installed so that bearing tabs fit into the notch in the cylinder block. The upper halves of the main bearings have the oil groove and the oil hole.

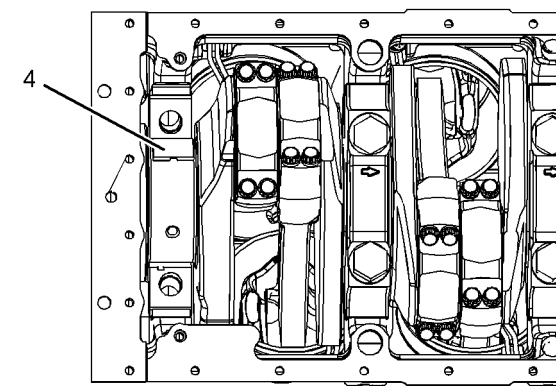


Illustration 254

g01149952

1. Position new upper main bearing (4) on the crankshaft. Insert the end of the upper main bearing that does not have the tab into the cylinder block. Install Tooling (A) in the oil hole of the crankshaft. Carefully rotate the crankshaft in order to push the upper main bearing into the cylinder block.

Note: Push the upper main bearing from the side of the bearing tab with Tooling (A). If the crankshaft is turned in the wrong direction, the tab on the bearing will be pushed between the crankshaft and the bearing area of the cylinder block. This can result in damage to the cylinder block and/or the crankshaft.

2. Install the thrust plates on each side of the No. 4 main bearing.

Note: Install the thrust plates with the words "Block Side" toward the cylinder block.

3. Install the lower halves of the crankshaft main bearings in the main bearing caps.

Note: Ensure that the main bearings are installed so that bearing tabs fit into the notch in the main bearing caps.

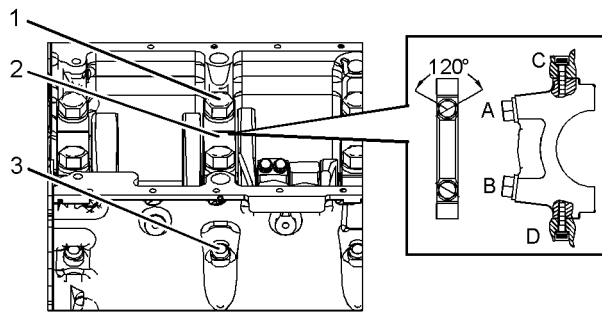


Illustration 255

g01149987

4. Position main bearing caps (2) on the crankshaft.

Note: Ensure that the numbers on the main bearing caps match the numbers on the cylinder block. Also ensure that the "FRONT" on the main bearing cap is installed toward the front of the cylinder block.

5. Lubricate the threads of bolts (1) and bolts (3) with clean engine oil. Install the bolts.

6. Tighten bolts (1) and bolts (3) for the main bearing caps, as follows:

- a. Tighten Bolt (A) to a torque of 258 ± 14 N·m (190 ± 10 lb ft).

Note: Bolt (A) is on the bearing tab side of the main bearing cap.

- b. Tighten Bolt (B) to a torque of 258 ± 14 N·m (190 ± 10 lb ft).

Note: Bolt (B) is on the opposite side of the bearing tab of the main bearing cap.

- c. Tighten Bolt (B) for an additional 120 ± 5 degrees (2 flats).

Note: If Tooling (C) is not used, place an index mark on the bolt and the main bearing cap.

- d. Tighten Bolt (A) for an additional 120 ± 5 degrees (2 flats).

Note: If Tooling (C) is not used, place an index mark on the bolt and the main bearing cap.

- e. Tighten Bolt (D) to a torque of 80 ± 10 N·m (59 ± 7 lb ft).

Note: Bolt (D) is on the opposite side of the bearing tab of the main bearing cap.

- f. Tighten Bolt (C) to a torque of 80 ± 10 N·m (59 ± 7 lb ft).

Note: Bolt (C) is on the bearing tab side of the main bearing cap.

- g. Rotate the crankshaft in order to ensure that the crankshaft turns freely.

7. Use Tooling (B) to check the crankshaft end play. Ensure that Tooling (B) is against a machined surface. The end play is controlled by the thrust plates of No. 4 main bearing (center).

Crankshaft end play (new thrust plates) 0.10 to 0.60 mm (0.004 to 0.024 inch)

End By:

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

i02296738

Crankshaft - Remove

SMCS Code: 1202-011

Removal Procedure

Table 68

Required Tools			
Tool	Part Number	Part Description	Qty
A	138-7574	Link Bracket	2
B	1H-3110	Bearing Puller	1
	8B-7560	Step Plate	1
	9U-6600	Hand Hydraulic Pump	1
	1H-3108	Push-Puller Leg	2
	1H-3107	Bearing Puller	1
	3H-0468	Puller Plate	5
	3H-0465	Push-Puller Plate	2
	1P-0820	Hydraulic Puller	1
	5B-0637	Nut	1
C	8S-6586	Forcing Screw	1
	5P-0944	Dowel Puller Group	1
	5P-0939	Dowel Extractor	1

Start By:

- a. Remove the front housing. Refer to Disassembly and Assembly, "Housing (Front) - Remove".
- b. Remove the rear housing. Refer to Disassembly and Assembly, "Housing (Rear) - Remove".

- c. Remove the piston cooling jets. Refer to Disassembly and Assembly, "Piston Cooling Jets - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Check the main bearing caps for identification for the location and the direction in the cylinder block. The identification marks on the main bearing caps must be installed in the same direction prior to removal.
2. Check the connecting rod and the connecting rod bearing caps for identification and the location in the cylinder block.

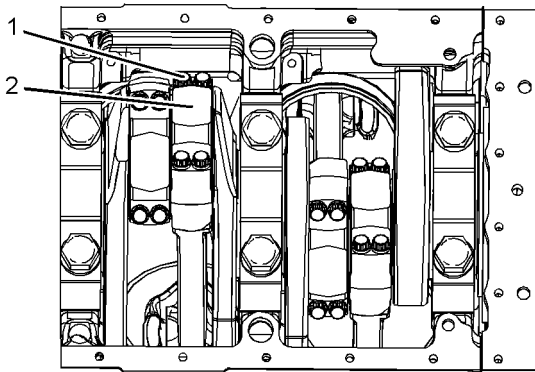


Illustration 256

g01150281

3. Remove bolts (1). Remove connecting rod bearing caps (2).

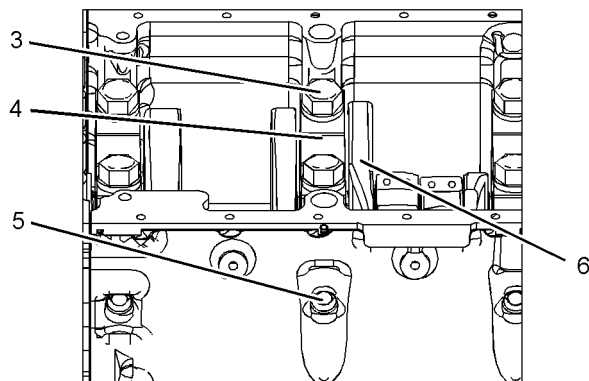


Illustration 257

g01150289

4. Remove bolts (3) and bolts (5). Remove main bearing caps (4).
5. Install Tooling (A) and a suitable lifting device on each end of crankshaft (6). The weight of crankshaft (6) is approximately 188 kg (415 lb).

6. Remove crankshaft (6) from the cylinder block.
7. Remove the thrust plates from each side of the No. 4 main bearing.
8. Remove the lower main bearings from main bearing caps (4). Remove the upper main bearings from the cylinder block.

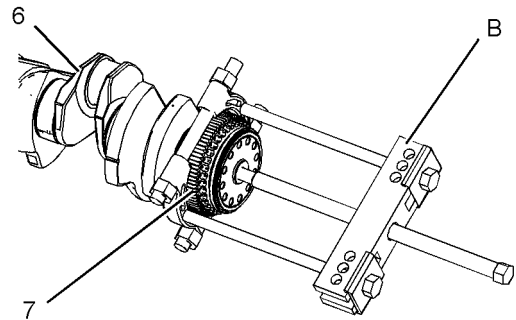


Illustration 258

g01150282

9. Use Tooling (B) to remove crankshaft gear (7) from crankshaft (6).

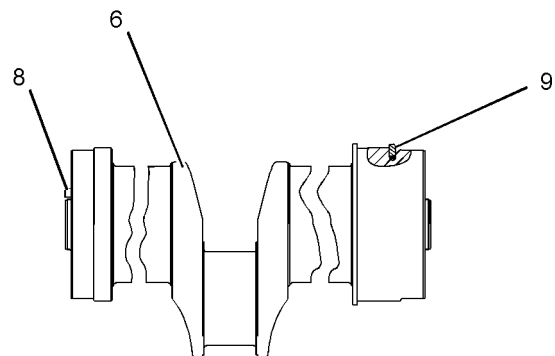


Illustration 259

g01150284

10. If necessary, use Tooling (C) to remove dowel (8) and dowel (9) from crankshaft (6).

i02296800

Crankshaft - Install

SMCS Code: 1202-012

Installation Procedure

Table 69

Required Tools			
Tool	Part Number	Part Description	Qty
A	138-7574	Link Bracket	2
D	8T-5096	Dial Indicator	1
E	8T-3052	Degree Wheel	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

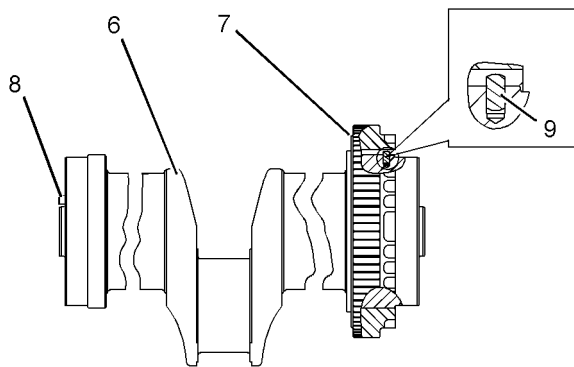


Illustration 260

g01150312

1. Install dowel (8) in the crankshaft.

Protrusion of dowel (8) from the crankshaft face 8.4 mm (0.33 inch)

2. Install dowel (9) in the crankshaft.

Protrusion of dowel (9) from the crankshaft 4.1 ± 0.5 mm (0.16 ± 0.02 inch)

3. Install crankshaft gear (7) on the crankshaft with the keyway in alignment with dowel (9). Timing Mark "V" of the gear should face away from crankshaft (6).

Note: Install the main bearings dry when clearance checks are performed. Refer to Disassembly and Assembly, "Bearing Clearance - Check". Apply clean engine oil on the main bearings for final assembly.

4. Install the upper halves of the main bearings in the cylinder block.

Note: Ensure that the main bearings are installed so that the bearing tabs fit into the notch in the cylinder block. The upper halves of the main bearings have the oil groove and the oil hole.

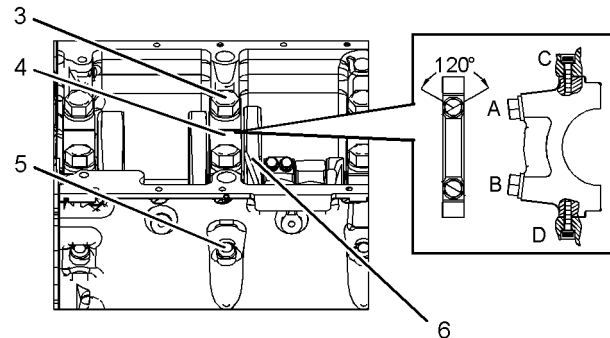


Illustration 261

g01150344

5. Install Tooling (A) and a suitable lifting device on each end of crankshaft (6). The weight of crankshaft (6) is approximately 188 kg (415 lb).
6. Install crankshaft (6) with Timing Mark "V" on the crankshaft gear in alignment with Timing Mark "V" on the cluster gear.
7. Install the thrust plates on each side of the No. 4 main bearing.

Note: Install the thrust plates with the words "Block Side" toward the cylinder block.

8. Install the lower halves of the crankshaft main bearings in the main bearing caps.

Note: Ensure that the main bearings are installed so that the bearing tabs fit into the notch in the main bearing cap.

9. Position main bearing caps (4) on the crankshaft.

Note: Ensure that the numbers on the main bearing caps match the numbers on the cylinder block. Also ensure that the "FRONT" on the main bearing cap is installed toward the front of the cylinder block.

10. Lubricate the threads of bolts (3) and bolts (5) with clean engine oil. Install the bolts.

11. Tighten bolts (3) and bolts (5) for the main bearing caps, as follows:

- a. Tighten Bolt (A) to a torque of 258 ± 14 N·m (190 ± 10 lb ft).

Note: Bolt (A) is on the bearing tab side of the main bearing cap.

- b. Tighten Bolt (B) to a torque of 258 ± 14 N·m (190 ± 10 lb ft).

Note: Bolt (B) is on the opposite side of the bearing tab of the main bearing cap.

- c. Tighten Bolt (B) for an additional 120 ± 5 degrees (2 flats).

Note: If Tooling (E) is not used, place an index mark on the bolt and the main bearing cap.

- d. Tighten Bolt (A) for an additional 120 ± 5 degrees (2 flats).

Note: If Tooling (E) is not used, place an index mark on the bolt and the main bearing cap.

- e. Tighten Bolt (D) to a torque of 80 ± 10 N·m (59 ± 7 lb ft).

Note: Bolt (D) is on the opposite side of the bearing tab of the main bearing cap.

- f. Tighten Bolt (C) to a torque of 80 ± 10 N·m (59 ± 7 lb ft).

Note: Bolt (C) is on the bearing tab side of the main bearing cap.

- g. Rotate the crankshaft in order to ensure that the crankshaft turns freely.

12. Use Tooling (D) to check the crankshaft end play. Ensure that Tooling (D) is against a machined surface. The end play is controlled by the thrust plates of No. 4 main bearing (center).

Crankshaft end play (new thrust plates) 0.10 to 0.60 mm (0.004 to 0.024 inch)

Note: Install the connecting rod bearings dry when clearance checks are performed. Refer to Disassembly and Assembly, "Bearing Clearance - Check". Apply clean engine oil on the connecting rod bearings for final assembly.

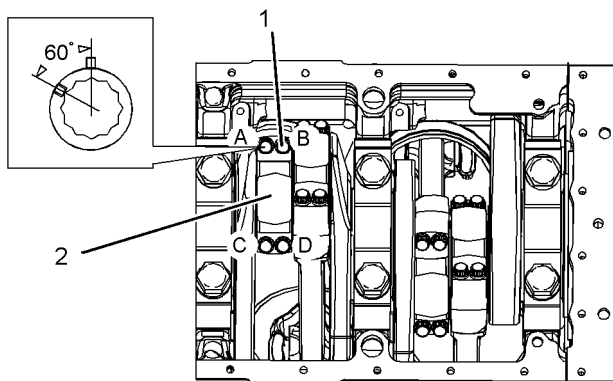


Illustration 262

g01150364

13. Position the connecting rod against the crankshaft. Install connecting rod bearing cap (2) on the connecting rod.

Note: Ensure that the number on the side of the connecting rod bearing cap is on the same side as the number on the connecting rod. The bearing tabs of the connecting rod bearing cap and the connecting rod are located on the side opposite of the piston cooling jet.

14. Lubricate the threads of bolts (1) with clean engine oil. Install the bolts.

15. Tighten bolts (1), as follows:

- a. Tighten Bolt (A) and Bolt (C) to a torque of 70 ± 4 N·m (52 ± 3 lb ft).
- b. Tighten Bolt (B) and Bolt (D) to a torque of 70 ± 4 N·m (52 ± 3 lb ft).
- c. Turn Bolt (B) and Bolt (D) for an additional 60 ± 5 degrees (1/6 turn).

Note: If Tooling (E) is not used, place an index mark on each bolt and connecting rod cap.

- d. Tighten Bolt (A) and Bolt (C) again to a torque of 70 ± 4 N·m (52 ± 3 lb ft).
- e. Turn Bolt (A) and Bolt (C) for an additional 60 ± 5 degrees (1/6 turn).

Note: If Tooling (E) is not used, place an index mark on each bolt and connecting rod cap.

- f. Rotate the crankshaft in order to ensure that the crankshaft turns freely.

End By:

- a. Install the piston cooling jets. Refer to Disassembly and Assembly, "Piston Cooling Jets - Remove and Install".
- b. Install the rear housing. Refer to Disassembly and Assembly, "Housing (Rear) - Install".
- c. Install the front housing. Refer to Disassembly and Assembly, "Housing (Front) - Install".

i02717761

Bearing Clearance - Check

SMCS Code: 1203-535; 1219-535

Measurement Procedure

Table 70

Required Tools			
Tool	Part Number	Part Description	Qty
A	198-9142	Plastic Gauge (Green) 0.025 to 0.076 mm (0.001 to 0.003 inch)	1
	198-9143	Plastic Gauge (Red) 0.051 to 0.152 mm (0.002 to 0.006 inch)	1
	198-9144	Plastic Gauge (Blue) 0.102 to 0.229 mm (0.004 to 0.009 inch)	1
	198-9145	Plastic Gauge (Yellow) 0.230 to 0.510 mm (0.009 to 0.020 inch)	1

Note: Plastic gauge may not be necessary when the engine is in the chassis.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Caterpillar does not recommend the checking of the actual bearing clearances particularly on small engines. This is because of the possibility of obtaining inaccurate results and the possibility of damaging the bearing or the journal surfaces. Each Caterpillar engine bearing is quality checked for specific wall thickness.

Note: The measurements should be within specifications and the correct bearings should be used. If the crankshaft journals and the bores for the block and the rods were measured during disassembly, no further checks are necessary. However, if the technician still wants to measure the bearing clearances, Tooling (A) is an acceptable method. Tooling (A) is less accurate on journals with small diameters if clearances are less than 0.10 mm (0.004 inch).

NOTICE

Lead wire, shim stock or a dial bore gauge can damage the bearing surfaces.

The technician must be very careful to use Tooling (A) correctly. The following points must be remembered:

- Ensure that the backs of the bearings and the bores are clean and dry.
- Ensure that the bearing locking tabs are properly seated in the tab grooves.
- The crankshaft must be free of oil at the contact points of Tooling (A).

1. Put a piece of Tooling (A) on the crown of the bearing that is in the cap.

Note: Do not allow Tooling (A) to extend over the edge of the bearing.

2. Use the correct torque-turn specifications in order to install the bearing cap. Do not use an impact wrench. Be careful not to dislodge the bearing when the cap is installed.

Note: Do not turn the crankshaft when Tooling (A) is installed.

3. Carefully remove the cap, but do not remove Tooling (A). Measure the width of Tooling (A) while Tooling (A) is in the bearing cap or on the crankshaft journal. Refer to Illustration 263.

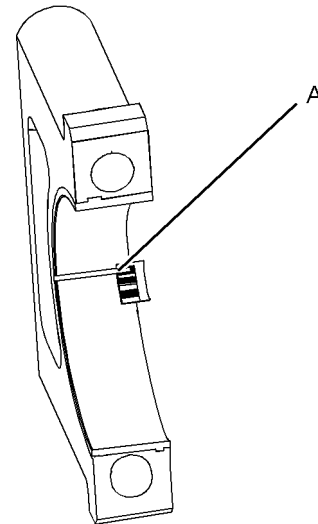


Illustration 263

g01152855

Typical Example

4. Remove all of Tooling (A) before you install the bearing cap.

Note: When Tooling (A) is used, the readings can sometimes be unclear. For example, all parts of Tooling (A) are not the same width. Measure the major width in order to ensure that the parts are within the specification range. Refer to Specifications Manual, "Connecting Rod Bearing Journal" and Specifications Manual, "Main Bearing Journal" for the correct clearances.

i02449735

Atmospheric Pressure Sensor - Remove and Install

SMCS Code: 1923-010

Removal Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

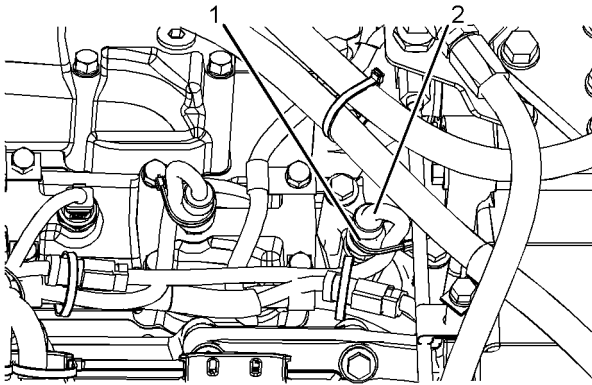


Illustration 264

g01222887

1. Disconnect harness assembly (2).
2. Remove atmospheric pressure sensor (1) from the adapter on the cylinder block.
3. Remove the O-ring seal from atmospheric pressure sensor (1).

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

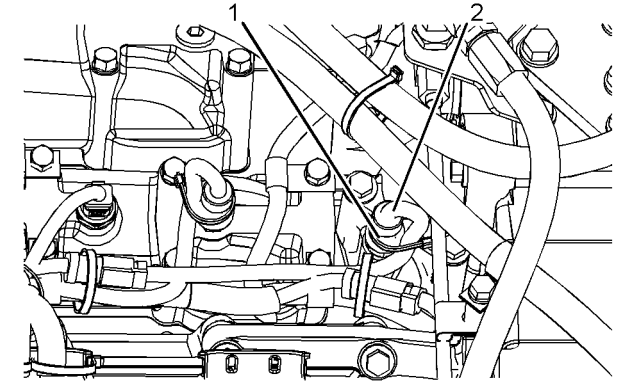


Illustration 265

g01222887

1. Install a new O-ring seal on atmospheric pressure sensor (1).
2. Install atmospheric pressure sensor (1) and tighten to a torque of $10 \pm 2 \text{ N}\cdot\text{m}$ ($90 \pm 18 \text{ lb in}$).
3. Connect harness assembly (2).

i02297743

Camshaft Position Sensor - Remove and Install

SMCS Code: 1912-010

Removal Procedure

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.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

i02297803

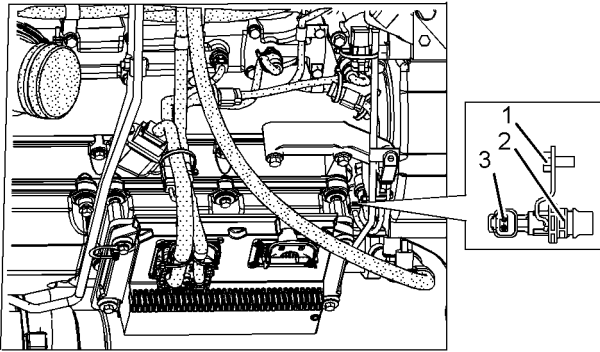


Illustration 266

g01150693

1. Disconnect harness assembly (3).
2. Remove bolt (1) and camshaft position sensor (2).
3. Remove the O-ring seal from camshaft position sensor (2).

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

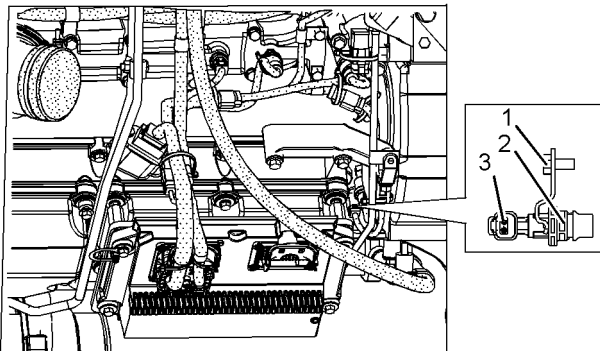


Illustration 267

g01150693

1. Install a new O-ring seal on camshaft position sensor (2). Lubricate the O-ring seal with clean engine oil.
2. Position camshaft position sensor (2) in the front housing and install bolt (1). Tighten bolt (1) to a torque of 28 ± 7 N·m (21 ± 5 lb ft).
3. Connect harness assembly (3).

Crankshaft Position Sensor - Remove and Install

SMCS Code: 1912-010

Removal Procedure

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.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

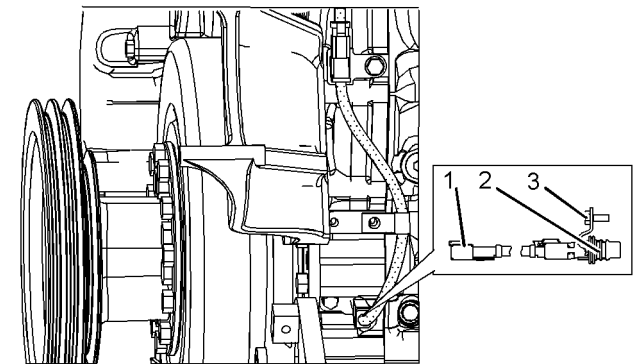


Illustration 268

g01150731

1. Disconnect harness assembly (1).
2. Remove bolt (3) and crankshaft position sensor (2).
3. Remove the O-ring seal from crankshaft position sensor (2).

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

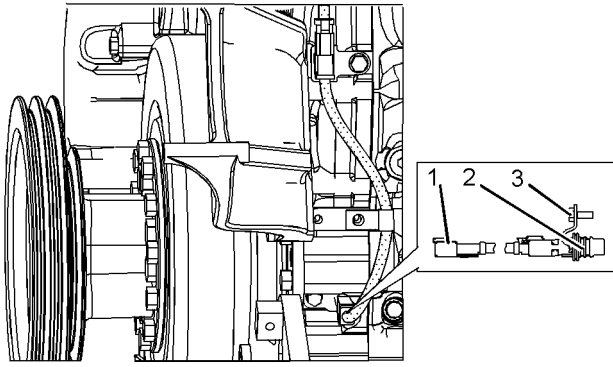


Illustration 269

g01150731

1. Install a new O-ring seal on crankshaft position sensor (2). Lubricate the O-ring seal with clean engine oil.
2. Install crankshaft position sensor (2) in the front housing. Install bolt (3). Tighten bolt (3) to a torque of 28 ± 7 N·m (21 ± 5 lb ft).
3. Connect harness assembly (1).

i02449857

Coolant Temperature Sensor - Remove and Install

SMCS Code: 1906-010

Removal Procedure

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.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

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

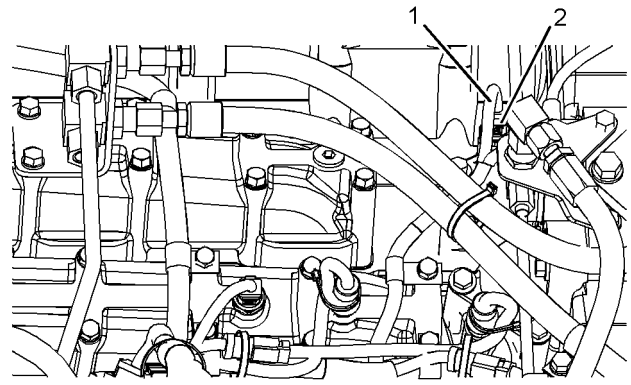


Illustration 270

g01222981

2. Disconnect harness assembly (1).
3. Remove coolant temperature sensor (2).
4. Remove the O-ring seal from coolant temperature sensor (2).

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

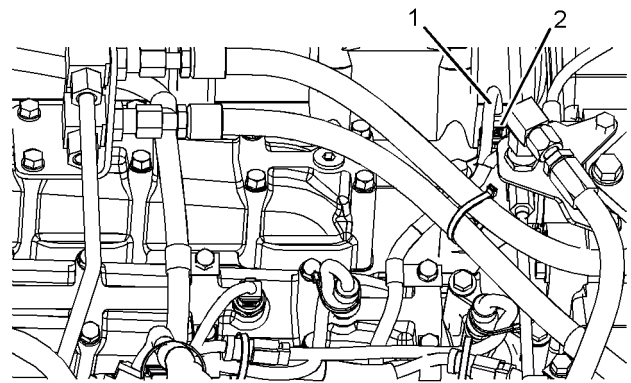


Illustration 271

g01222981

1. Install a new O-ring seal on coolant temperature sensor (2).
2. Install coolant temperature sensor (2) and tighten to a torque of 20 ± 5 N·m (15 ± 4 lb ft).
3. Connect harness assembly (1).
4. Fill the cooling system with coolant. Refer to Operation and Maintenance Manual, "Cooling System Coolant - Change".

i02298137

Engine Oil Pressure Sensor - Remove and Install

SMCS Code: 1924-010

Removal Procedure

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.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

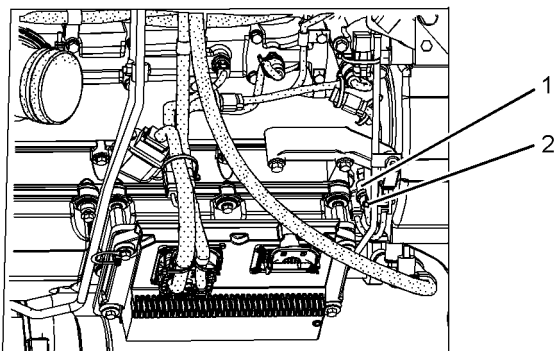


Illustration 272

g01150948

1. Disconnect harness assembly (2).

2. Remove engine oil pressure sensor (1) from the adapter on the cylinder block.
3. Remove the O-ring seal from engine oil pressure sensor (1).

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

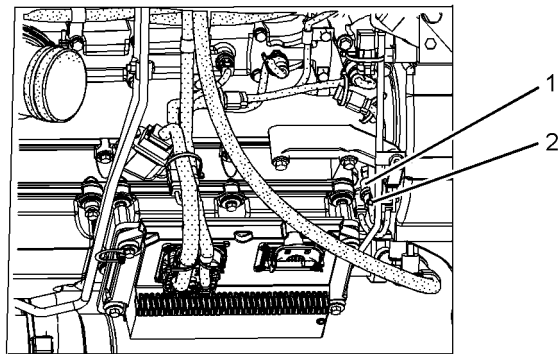


Illustration 273

g01150948

1. Install a new O-ring seal on engine oil pressure sensor (1).
2. Install engine oil pressure sensor (1) and tighten to a torque of 10 ± 2 N·m (89 ± 18 lb in).
3. Connect harness assembly (2).

i02581037

Fuel Pressure Sensor - Remove and Install

SMCS Code: 7414-010

Removal Procedure

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.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Turn the fuel supply valve to the OFF position.

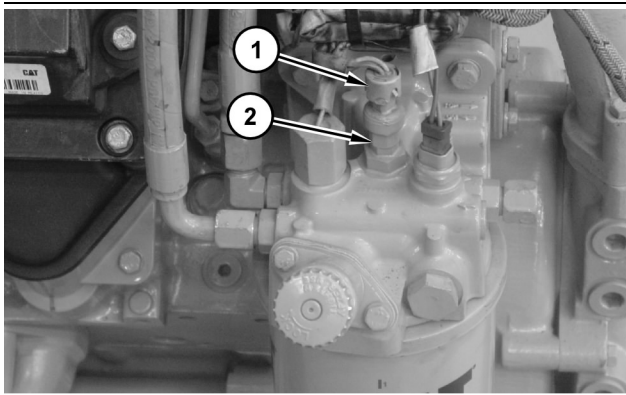


Illustration 274

g01292812

2. Disconnect harness assembly (1).
3. Remove fuel pressure sensor (2) from the fuel filter base.
4. Remove the O-ring seal from fuel pressure sensor (2).

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

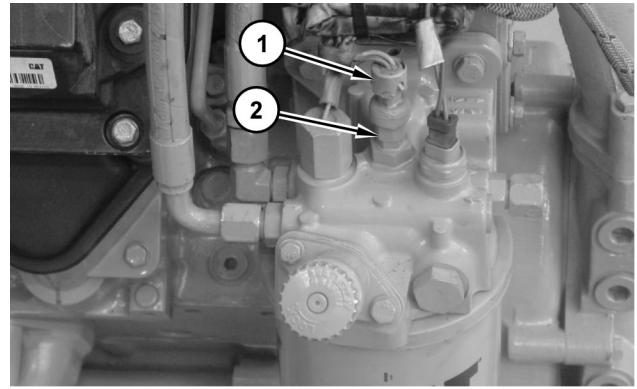


Illustration 275

g01292812

1. Install a new O-ring seal on fuel pressure sensor (2).
2. Install fuel pressure sensor (2). Tighten fuel pressure sensor (2) to a torque of 10 ± 2 N·m (90 ± 18 lb in).
3. Connect harness assembly (1).
4. Turn the fuel supply valve to the ON position.

i02581061

Fuel Temperature Sensor - Remove and Install

SMCS Code: 1922-010

Removal Procedure

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.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Turn the fuel supply valve to the OFF position.

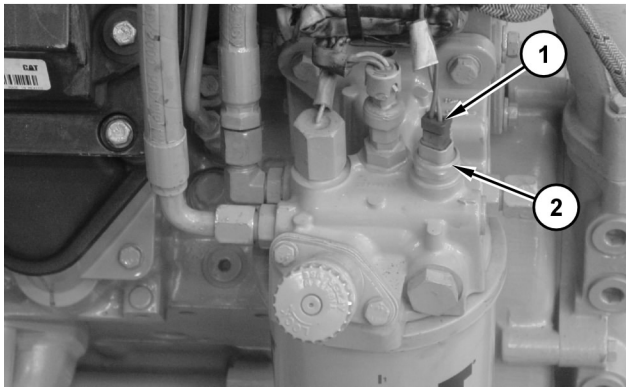


Illustration 276

g01292826

2. Disconnect harness assembly (1).
3. Remove fuel temperature sensor (2) from the fuel filter base.
4. Remove the O-ring seal from fuel temperature sensor (2).

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

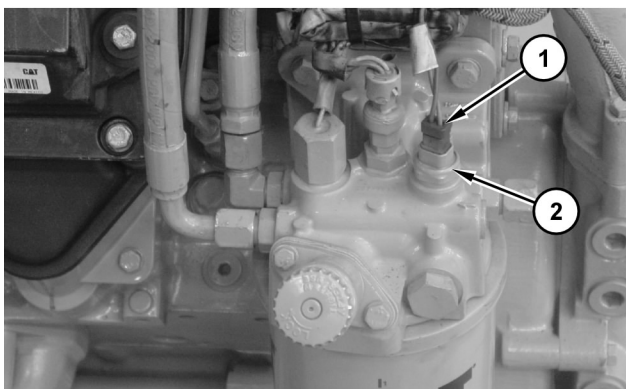


Illustration 277

g01292826

1. Install a new O-ring seal on fuel temperature sensor (2).

2. Install fuel temperature sensor (2). Tighten fuel temperature sensor (2) to a torque of $20 \pm 5 \text{ N}\cdot\text{m}$ ($15 \pm 4 \text{ lb ft}$).
3. Connect harness assembly (1).
4. Turn the fuel supply valve to the ON position.

i02449930

Turbocharger Outlet Pressure Sensor - Remove and Install

SMCS Code: 1917-010

Removal Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

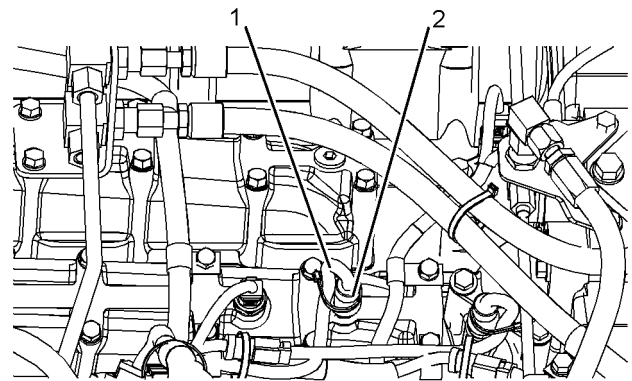


Illustration 278

g01223056

1. Disconnect harness assembly (1).
2. Remove turbocharger outlet pressure sensor (2) from the inlet manifold.
3. Remove the O-ring seal from turbocharger outlet pressure sensor (2).

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

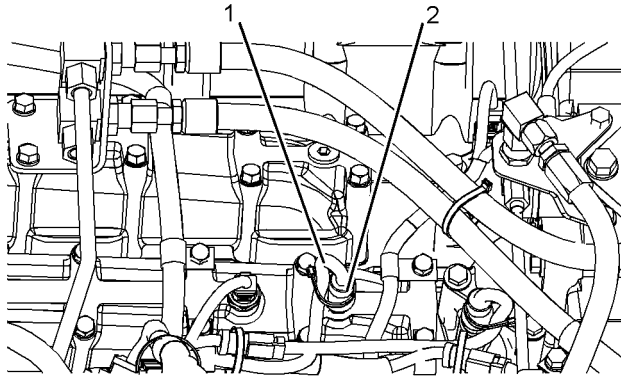


Illustration 279

g01223056

1. Install a new O-ring seal on turbocharger outlet pressure sensor (2).
2. Install turbocharger outlet pressure sensor (2) and tighten to a torque of 10 ± 2 N·m (90 ± 18 lb in).
3. Connect harness assembly (1).

i02449945

Inlet Air Temperature Sensor - Remove and Install

SMCS Code: 1921-010

Removal Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

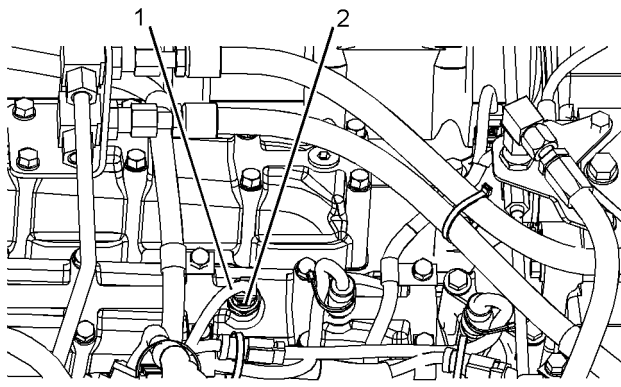


Illustration 280

g01223082

1. Disconnect harness assembly (1).
2. Remove inlet air temperature sensor (2) from the inlet manifold.

3. Remove the O-ring seal from inlet air temperature sensor (2).

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

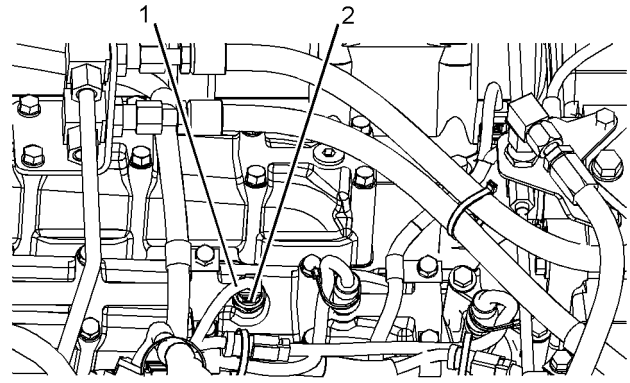


Illustration 281

g01223082

1. Install a new O-ring seal on inlet air temperature sensor (2).
2. Install inlet air temperature sensor (2) and tighten to a torque of 20 ± 5 N·m (15 ± 4 lb ft).
3. Connect harness assembly (1).

i02574366

Belt Guard - Remove and Install

SMCS Code: 1357-010-GD

Removal Procedure

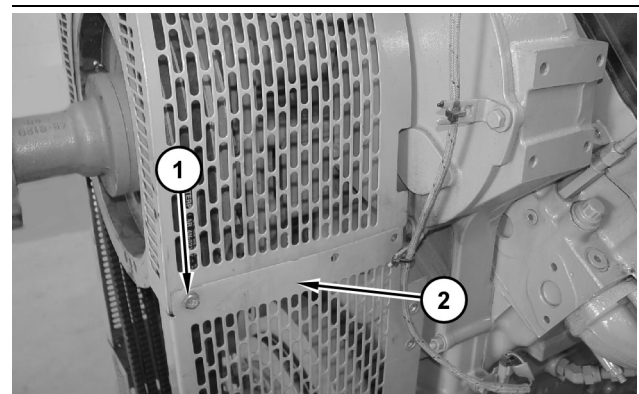


Illustration 282

g01289708

1. Remove bolts (1). Repeat for the opposite side.
Remove bottom belt guard (2).

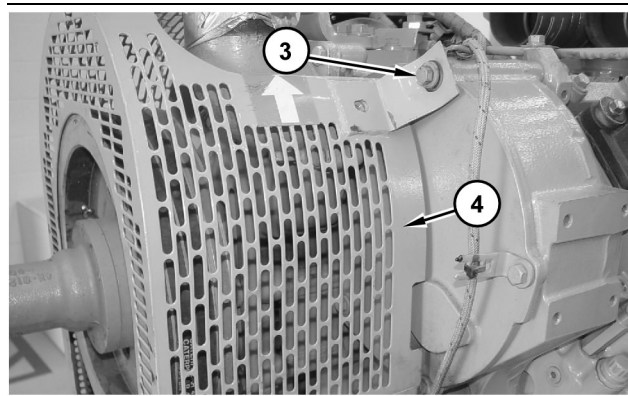


Illustration 283 g01289709

2. Remove bolt (3). Repeat for the opposite side.
Remove upper belt guard (4).

Installation Procedure

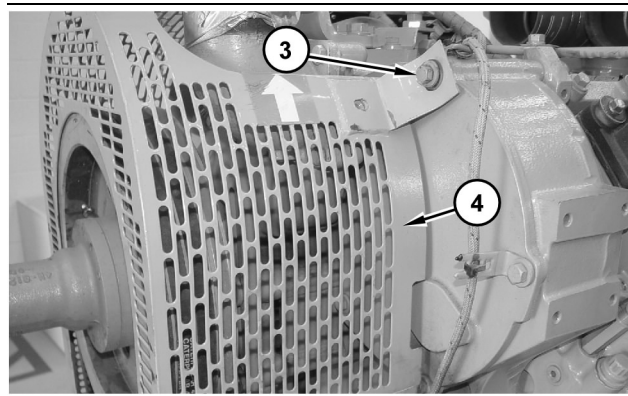


Illustration 284 g01289709

1. Install upper belt guard (4). Install bolt (3). Repeat for the opposite side.

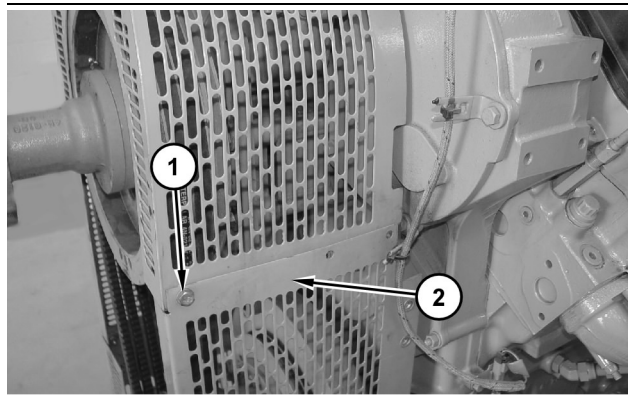


Illustration 285 g01289708

2. Install lower belt guard (2). Install bolts (1). Repeat for the opposite side.

i02755046

Fan Guard - Remove and Install

SMCS Code: 1360-010

Removal Procedure

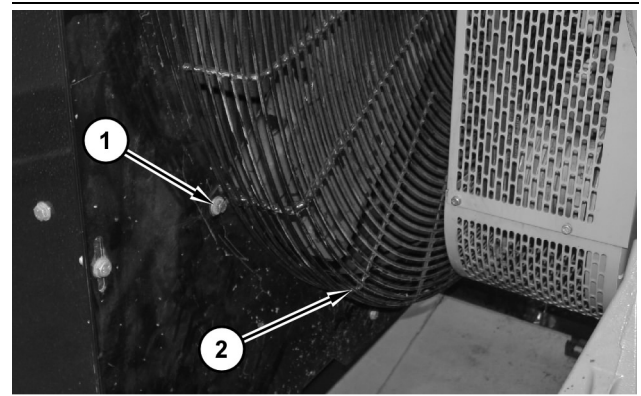


Illustration 286 g01289778

1. Remove bolts (1). Remove lower fan guard (2).

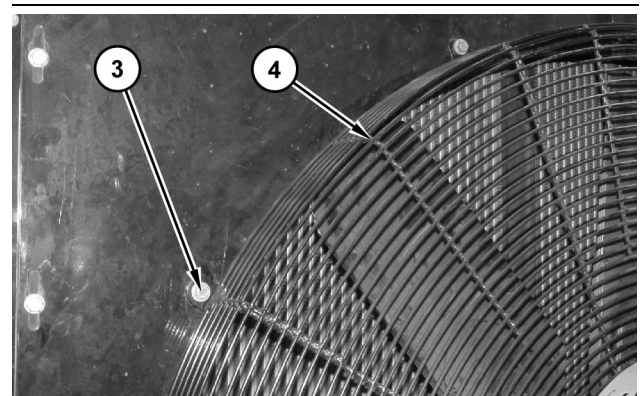


Illustration 287 g01379587

2. Remove bolts (3). Remove upper fan guard (4).

Installation Procedure

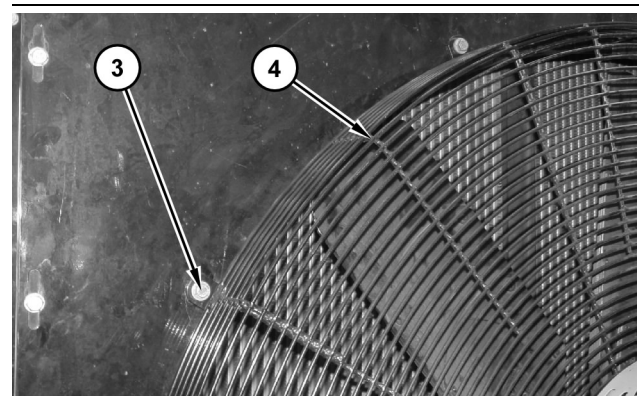


Illustration 288 g01379587

1. Install upper fan guard (4). Install bolts (3).

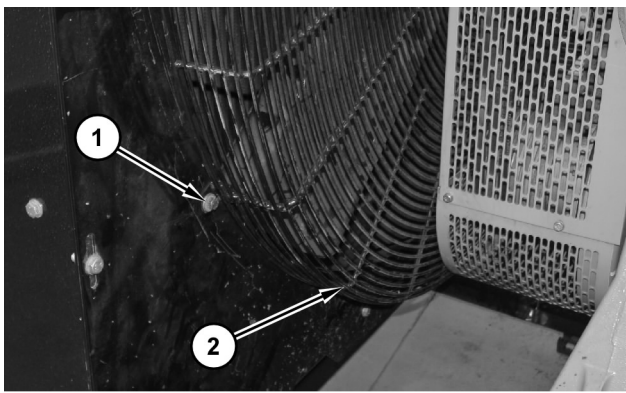


Illustration 289 g01289778

2. Install lower fan guard (2). Install bolts (1).

i02755088

Fan - Remove and Install

SMCS Code: 1356-010

Removal Procedure

Table 71

Required Tools			
Tool	Part Number	Part Description	Qty
A	140-7742	Sleeve	1

Start By:

- a. Remove the fan guard. Refer to Disassembly and Assembly, "Fan Guard - Remove and Install".

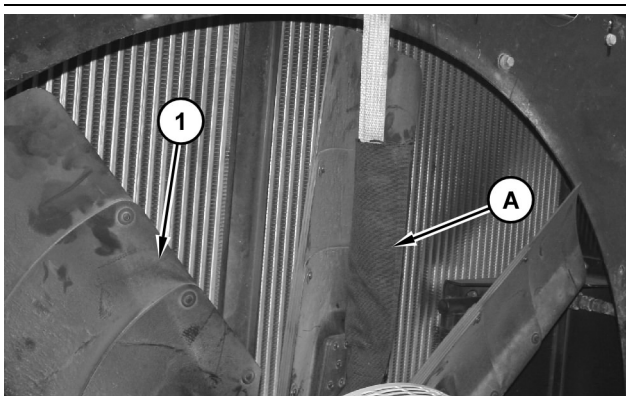


Illustration 290 g01289730

1. Attach Tooling (A) and a suitable lifting device onto fan (1). The weight of fan (1) is approximately 45 kg (100 lb).

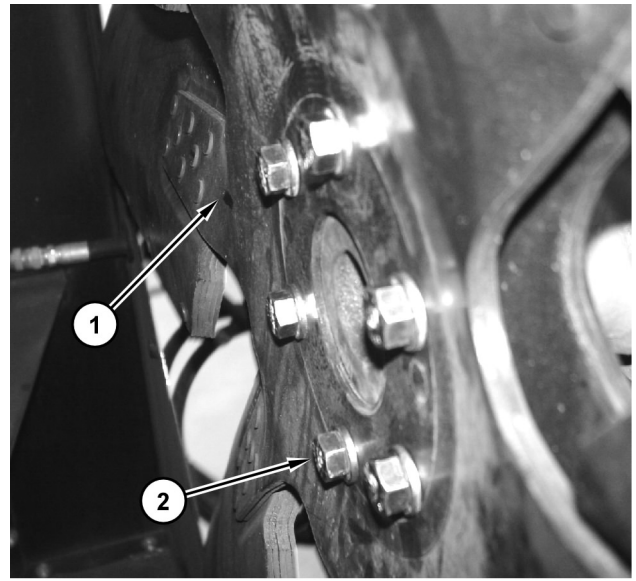


Illustration 291 g01289733

2. Remove bolts (2). Remove fan (1).

Installation Procedure

Table 72

Required Tools			
Tool	Part Number	Part Description	Qty
A	140-7742	Sleeve	1

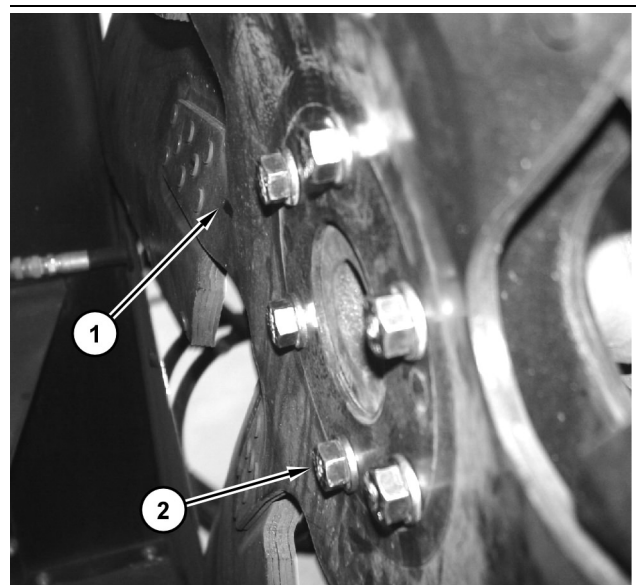


Illustration 292 g01289733

1. Attach Tooling (A) and a suitable lifting device onto fan (1). The weight of fan (1) is approximately 45 kg (100 lb). Install fan (1). Install bolts (2).

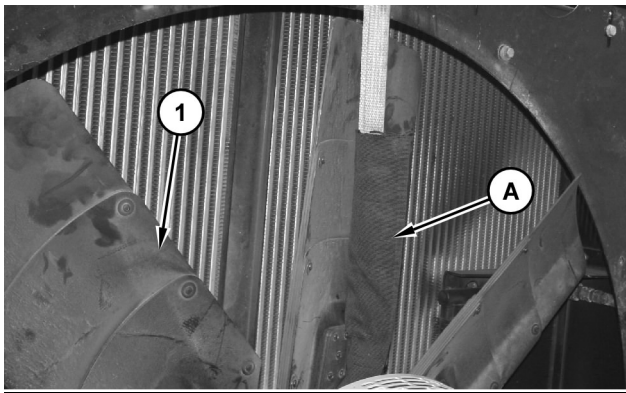


Illustration 293

g01289730

2. Remove Tooling (A) and the suitable lifting device from fan (1).

End By:

- a. Install the fan guard. Refer to Disassembly and Assembly, "Fan Guard - Remove and Install".

i02574047

Fan Drive - Remove and Install

SMCS Code: 1359-010; 1386-010

Removal Procedure

Start By:

- a. Remove the fan. Refer to Disassembly and Assembly, "Fan - Remove and Install".
- b. Remove the belt guard. Refer to Disassembly and Assembly, "Belt Guard - Remove and Install".
1. Remove the belts. Refer to Operation and Maintenance Manual, "Belts - Inspect/Adjust/Replace".

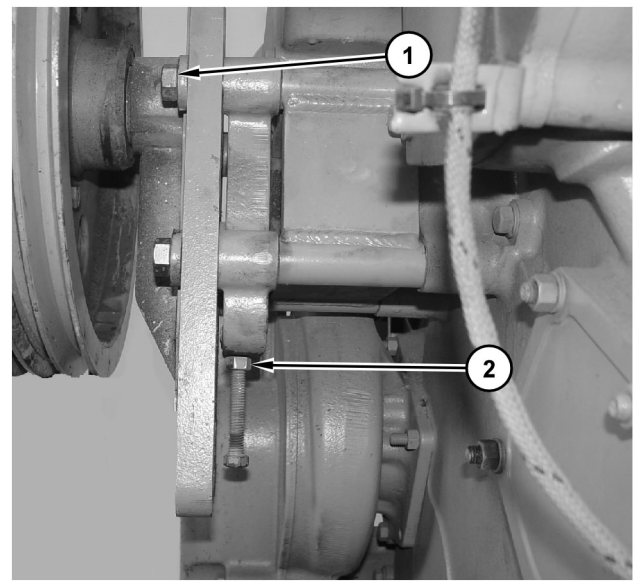


Illustration 294

g01289585

2. Loosen bolts (1). Loosen locknut (2).

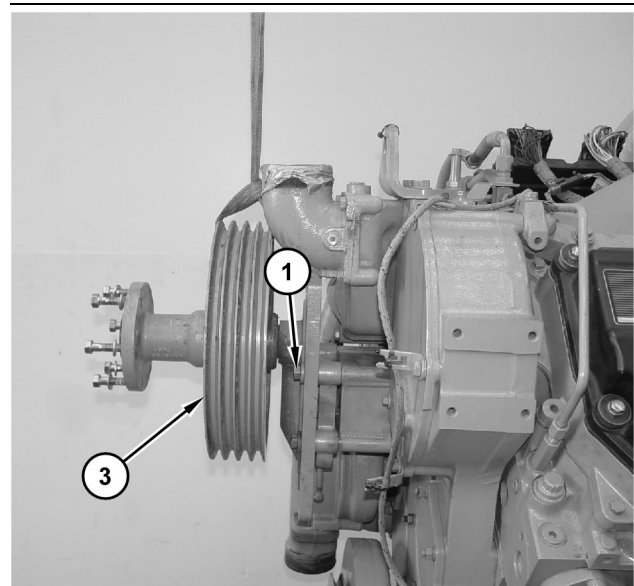


Illustration 295

g01289589

3. Attach a suitable lifting device onto fan drive (3). The weight of fan drive (3) is approximately 45 kg (100 lb). Remove bolts (1). Remove fan drive (3).

Installation Procedure

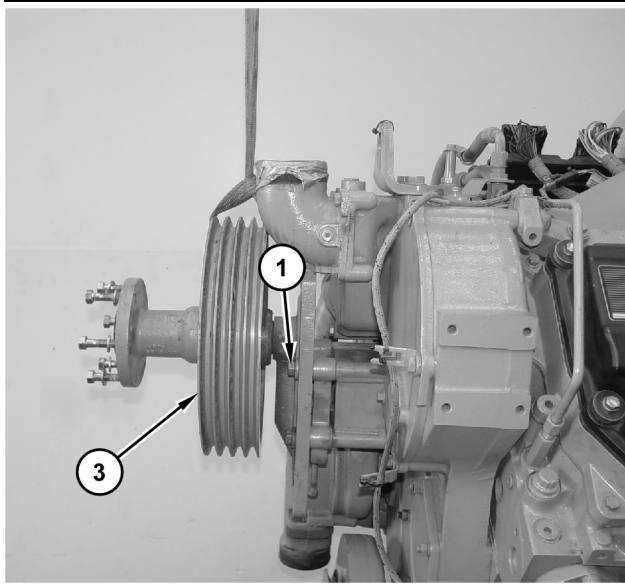


Illustration 296

g01289589

1. Attach a suitable lifting device onto fan drive (3). The weight of fan drive (3) is approximately 45 kg (100 lb). Install fan drive (3). Install bolts (1).

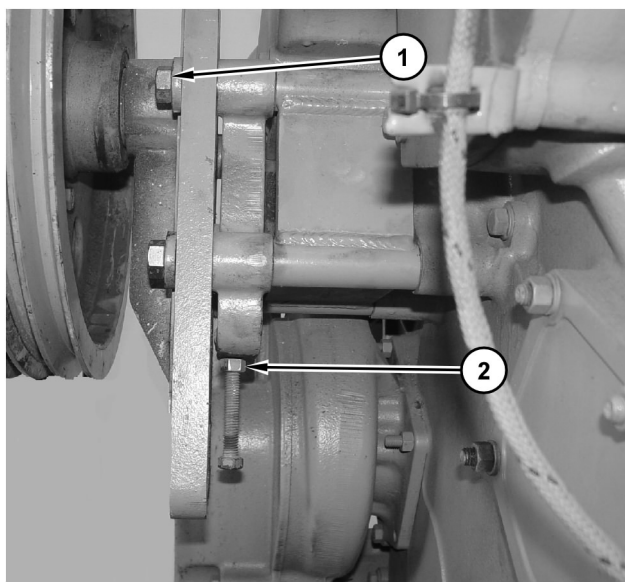


Illustration 297

g01289585

2. Install the belts. Refer to Operation and Maintenance Manual, "Belts - Inspect/Adjust/Replace".
3. Tighten bolts (1). Tighten locknut (2).

End By:

- a. Install the belt guard. Refer to Disassembly and Assembly, "Belt Guard - Remove and Install".

- b. Install the fan. Refer to Disassembly and Assembly, "Fan - Remove and Install".

i02417465

Electronic Control Module - Remove and Install

SMCS Code: 1901-010

Removal Procedure

1. Turn the battery disconnect switch to the "OFF" position.
2. Disconnect the negative battery terminal at the battery.

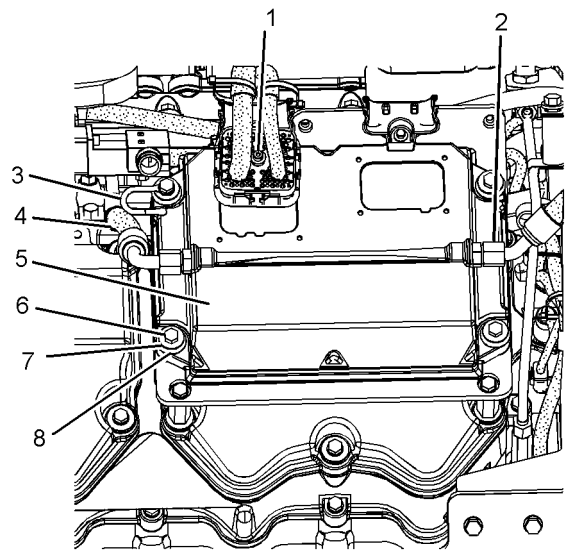


Illustration 298

g01208278

3. Loosen allen head screw (1). Disconnect the harness assembly from electronic control module (5).
4. Disconnect hose assemblies (2) and (4).
5. Remove bolts (6). Remove electronic control module (5) and ground strap (3).
6. Remove washers (7) and isolation mounts (8) from electronic control module (5).

Installation Procedure

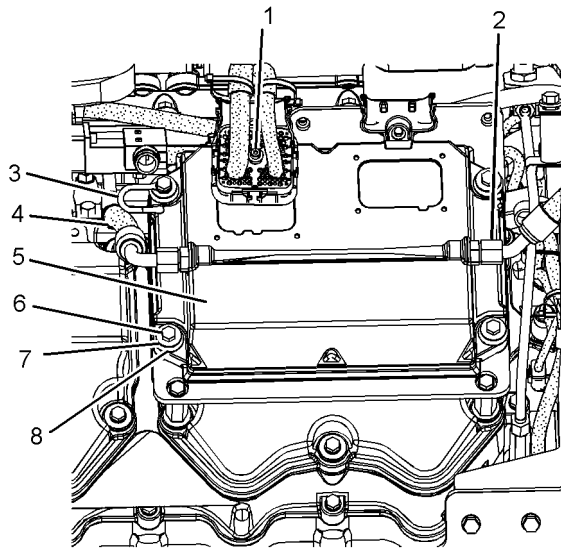


Illustration 299

g01208278

1. Position isolation mounts (8) on electronic control module (5). Position the spacers, washers (7), ground strap (3), and electronic control module (5) on the support assemblies. Install bolts (6).
2. Connect hose assemblies (4) and (2).
3. Connect the harness assembly to electronic control module (5). Tighten allen head screw (1) to a torque of 6 ± 1 N·m (53 ± 9 lb in).
4. Connect the negative battery terminal at the battery.
5. Turn the battery disconnect switch to the "ON" position.

i02450170

Alternator - Remove and Install

SMCS Code: 1405-010

Removal Procedure

1. Turn the battery disconnect switch to the OFF position.

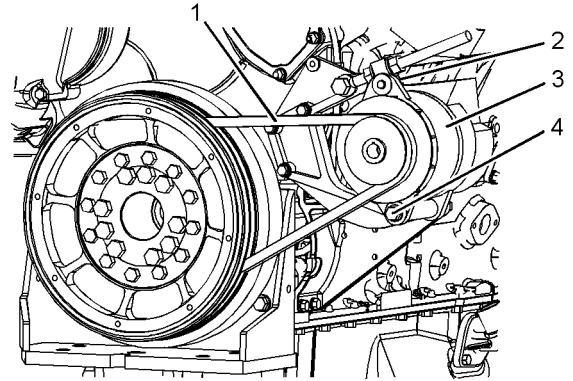


Illustration 300

g01223195

2. Remove V-belt (1) from alternator (3).
3. Disconnect the harness assemblies from alternator (3).
4. Remove bolt (2) and bolt (4).
5. Remove alternator (3) from the mounting group.

Installation Procedure

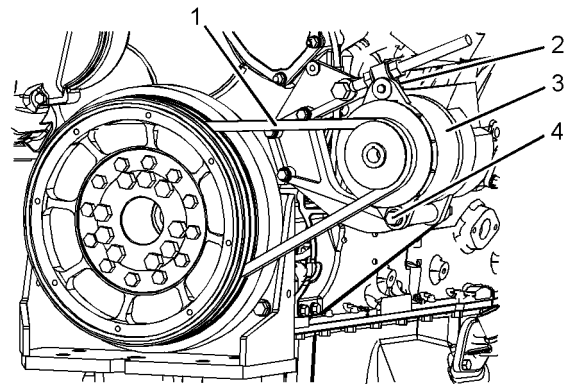


Illustration 301

g01223195

1. Position alternator (3) on the mounting group.
2. Install bolt (4) and bolt (2).
3. Connect the harness assemblies to alternator (3). Refer to Specifications, "Alternator and Regulator".
4. Install V-belt (1) on alternator (3).
5. Adjust the tension on the V-belt. Refer to Operation and Maintenance Manual, "Belt - Inspect/Adjust/Replace".
6. Turn the battery disconnect switch to the ON position.

i02419387

Electric Starting Motor - Remove and Install

SMCS Code: 1453-010

Removal Procedure

⚠ WARNING

Personal injury can result from failure to disconnect the battery.

First, disconnect the negative battery cable. Then, disconnect the positive battery cable.

A positive power lead can cause sparks if the battery is not disconnected. Sparks can possibly result in battery explosion or fire.

1. Turn the battery disconnect switch to the "OFF" position.

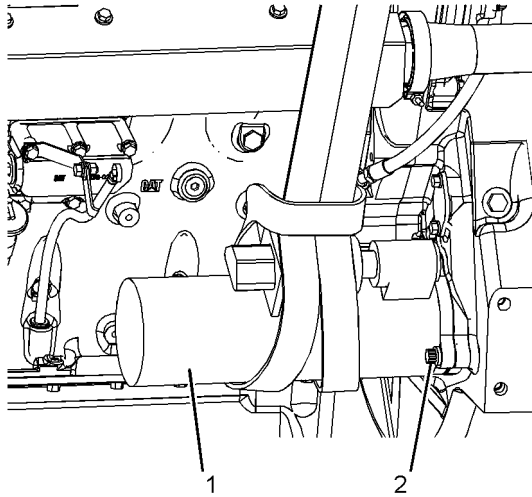


Illustration 302

g01208927

2. Place an index mark on all of the harness assemblies. Disconnect the harness assemblies from electric starting motor (1).
3. Fasten a suitable lifting device to electric starting motor (1). The weight of electric starting motor (1) is approximately 37 kg (80 lb).
4. Remove bolts (2).
5. Remove electric starting motor (1) and the gasket from the flywheel housing.

Installation Procedure

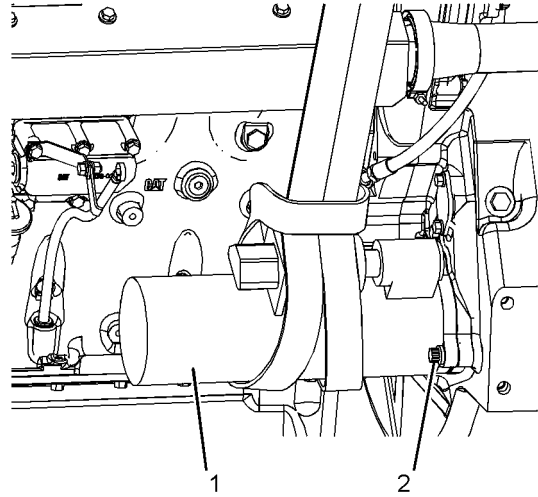


Illustration 303

g01208927

1. Fasten a suitable lifting device to electric starting motor (1). The weight of electric starting motor (1) is approximately 37 kg (80 lb).
2. Position the gasket and electric starting motor (1) in the flywheel housing. Install bolts (2).
3. Connect the harness assemblies to electric starting motor (1). Refer to Specifications, "Electric Starting Motor".
4. Turn the battery disconnect switch to the "ON" position.

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