



Disassembly and Assembly

Preliminary Information

C175-16 Generator Set Engine

WYB1-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

i02462807

Prelubrication Oil Pump - Remove and Install

SMCS Code: 1319-010

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.

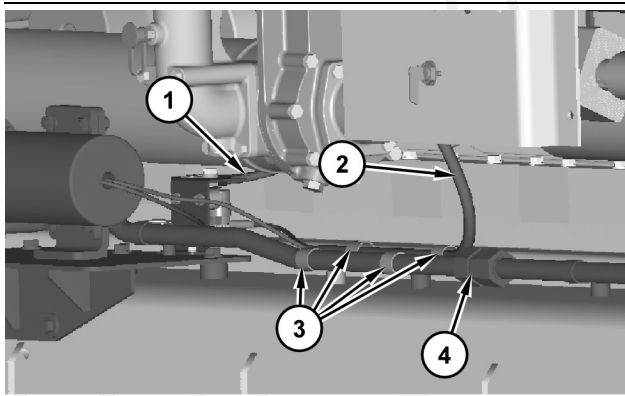


Illustration 1

g01228833

1. Disconnect harness assemblies (1). Disconnect harness assembly (2). Remove the bolts and disconnect clips (3). Disconnect tube assembly (4).

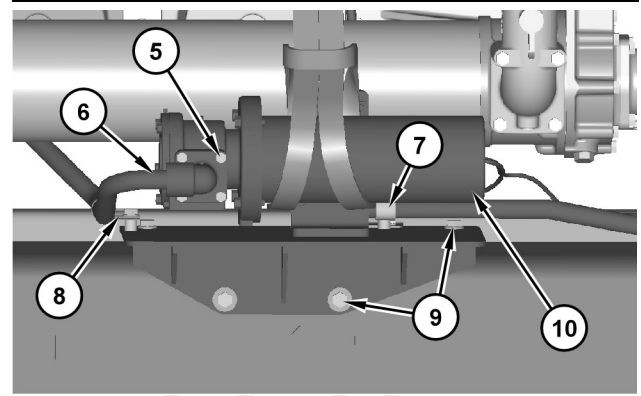


Illustration 2

g01228834

2. Attach a suitable lifting device onto prelubrication pump (10). The weight of prelubrication pump (10) is approximately 41 kg (90 lb). Remove bolts (5). Disconnect tube assembly (6). Remove the bolts and disconnect clip (7). Remove the bolts and disconnect clip (8). Remove bolts (9). Remove prelubrication pump (10).

Installation Procedure

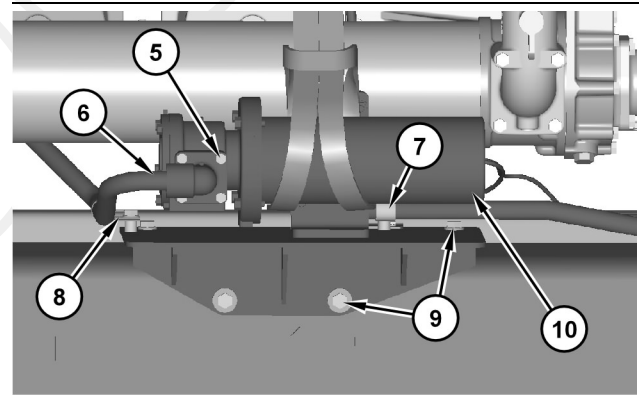


Illustration 3

g01228834

1. Attach a suitable lifting device onto prelubrication pump (10). The weight of prelubrication pump (10) is approximately 41 kg (90 lb). Install prelubrication pump (10). Install bolts (9). Connect clip (7) and the bolt. Connect tube assembly (6). Install bolts (5). Connect clip (8) and the bolt.

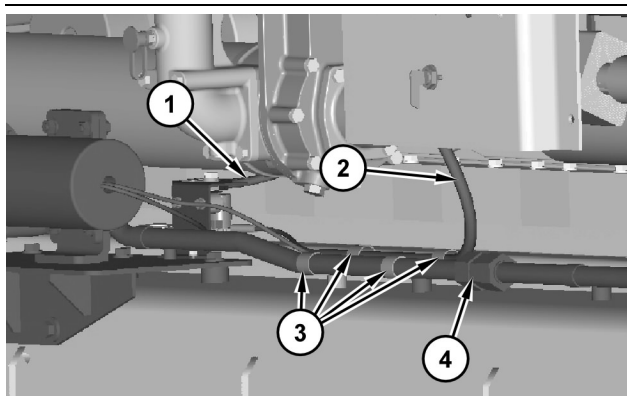


Illustration 4

g01228833

2. Connect tube assembly (4). Connect clips (3) and install the bolts. Connect harness assembly (2). Connect harness assemblies (1).

i02422161

Electronic Control Module (Engine) - Remove and Install

SMCS Code: 1900-010

Removal Procedure

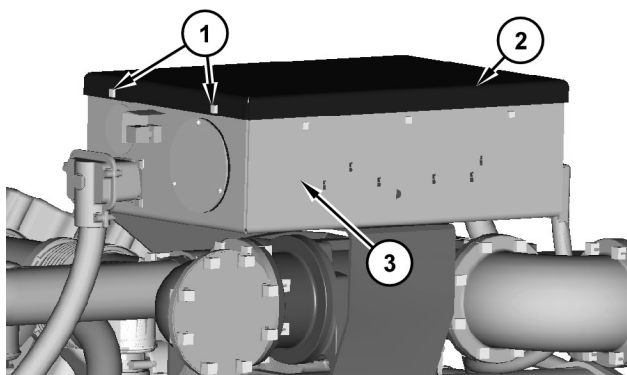


Illustration 5

g01210403

1. Remove bolts (1) from both sides of box (3). Remove cover (2).

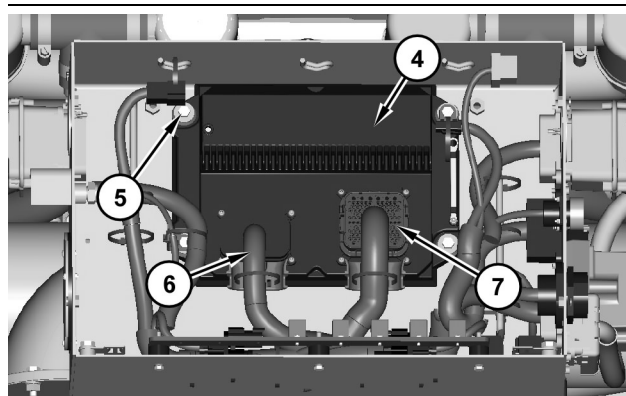


Illustration 6

g01210407

2. Disconnect harness assemblies (6) and (7). Remove bolts (5). Remove electronic control module (4).

Installation Procedure

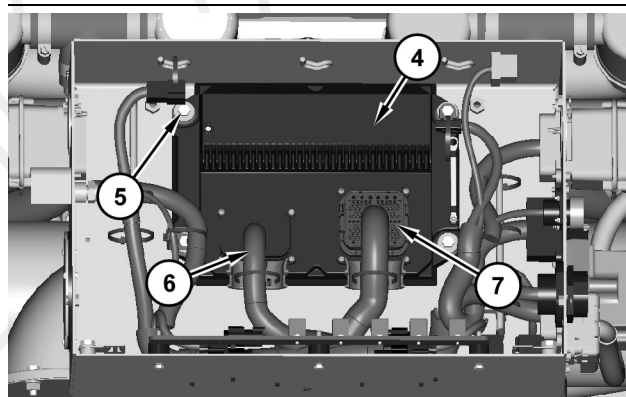


Illustration 7

g01210407

1. Position electronic control module (4). Install bolts (5). Connect harness assemblies (6) and (7). Tighten the connectors for harness assemblies (6) and (7) to a torque of 6 ± 1 N·m (53 ± 9 lb in).

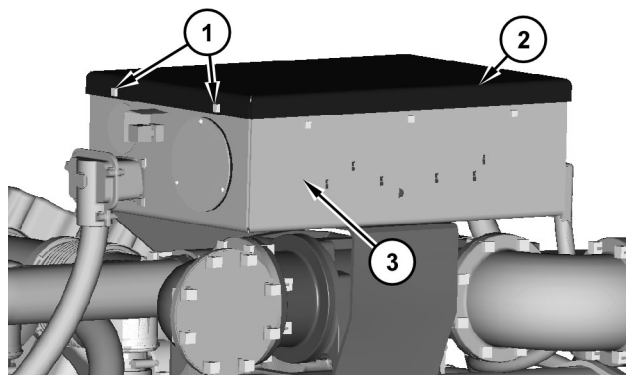


Illustration 8

g01210403

2. Install cover (2) onto box (3). Install bolts (1) on both sides of box (3).

i02438952

Fuel Filter Housing - Remove

SMCS Code: 1262-011

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.

1. Turn the fuel supply to the OFF position.

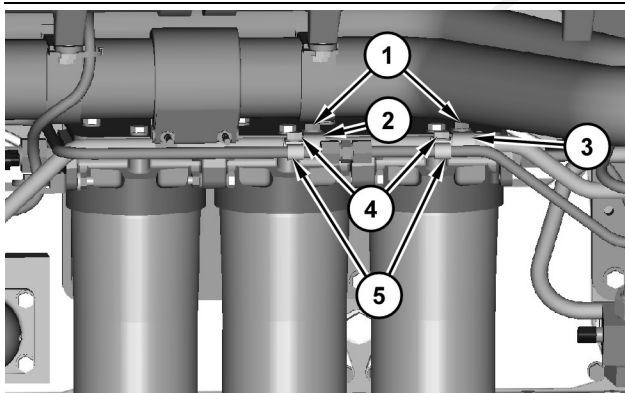


Illustration 9

g01218837

2. Remove bolts (1). Disconnect clamps (2) and (3). Remove bolts (4). Disconnect clamps (5).

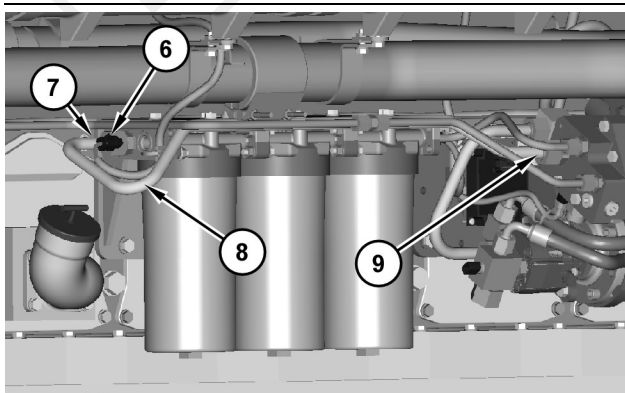


Illustration 10

g01218838

3. Disconnect harness assembly (6). Disconnect fitting (7). Disconnect fitting (9). Remove tube assembly (8).

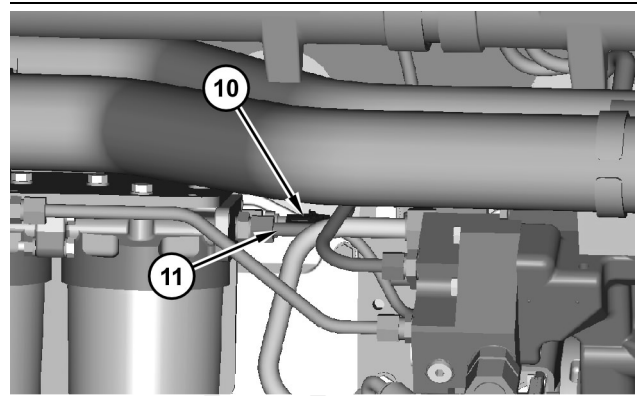


Illustration 11

g01218840

4. Disconnect harness assembly (10). Remove tube assembly (11).

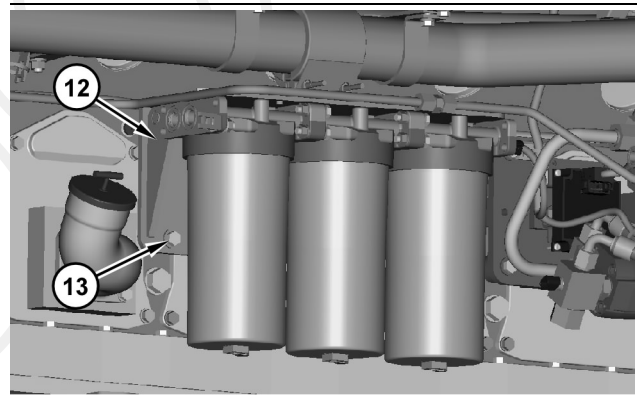


Illustration 12

g01218841

5. Remove bolts (13). Remove fuel filter housing (12). The weight of fuel filter housing (12) is approximately 23 kg (50 lb).

i02439510

Fuel Filter Housing - Install

SMCS Code: 1262-012

Installation Procedure

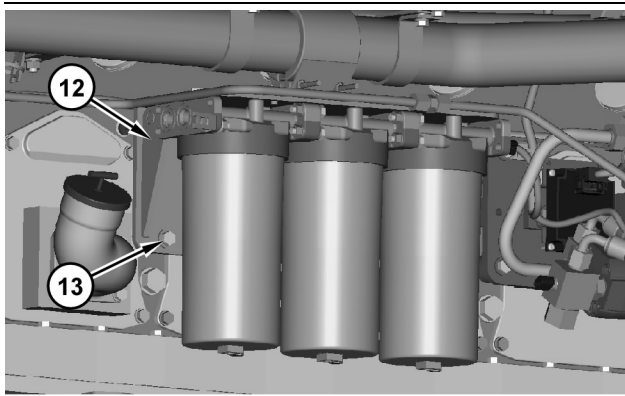


Illustration 13

g01218841

1. Install fuel filter housing (12). The weight of fuel filter housing (12) is approximately 23 kg (50 lb). Install bolts (13).

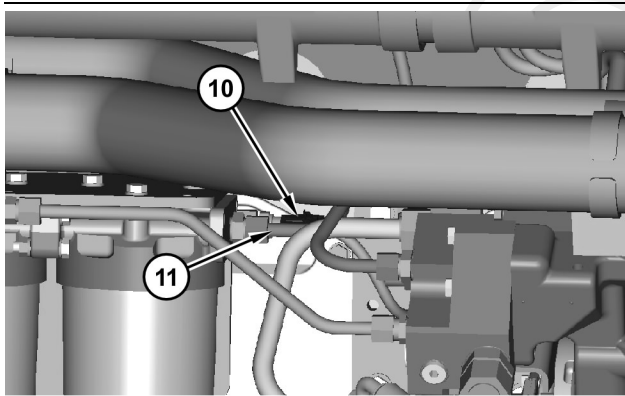


Illustration 14

g01218840

2. Install tube assembly (11). Connect harness assembly (10).

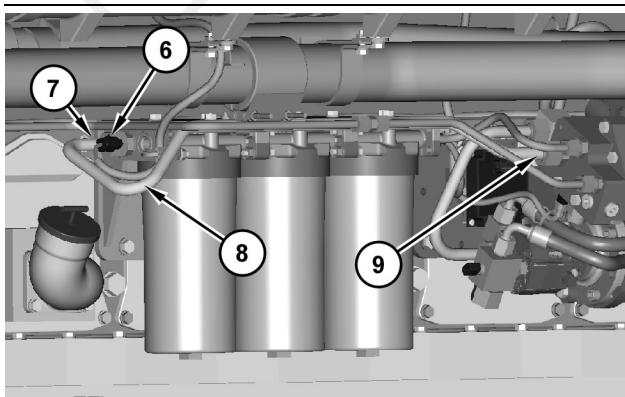


Illustration 15

g01218838

3. Position tube assembly (8). Connect fitting (9). Connect fitting (7). Connect harness assembly (6).

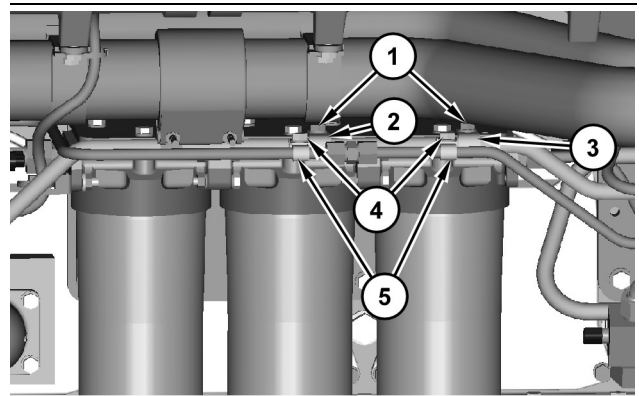


Illustration 16

g01218837

4. Connect clamps (5). Install bolts (4). Connect clamps (2) and (3). Install bolts (1).
5. Turn the fuel supply to the ON position.

i02434239

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.

1. Turn the fuel supply to the OFF position.

i02433497

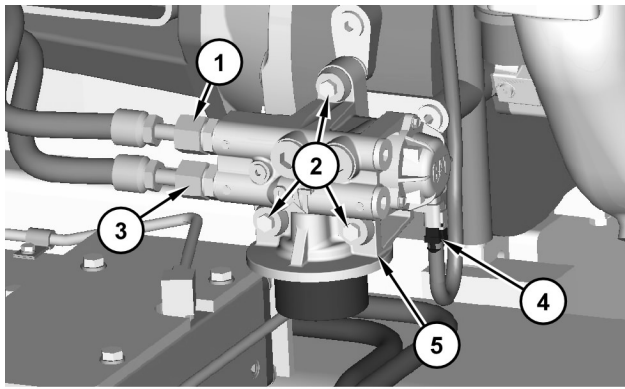


Illustration 17

g01216054

2. Disconnect hose assemblies (1) and (3). Disconnect harness assembly (4). Remove bolts (2). Remove fuel priming pump (5).

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

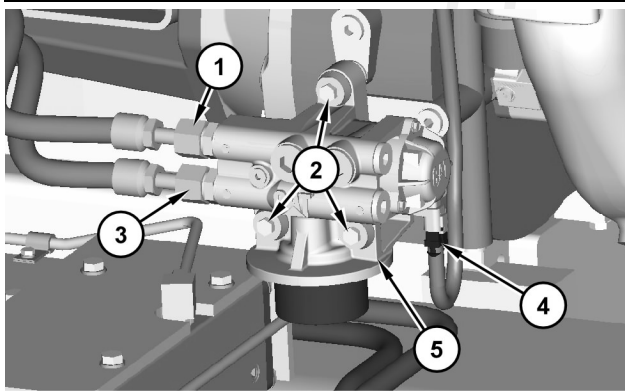


Illustration 18

g01216054

1. Install fuel priming pump (5). Install bolts (2). Connect harness assembly (4). Connect hose assemblies (1) and (3).
2. Turn the fuel supply to the ON position.

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.

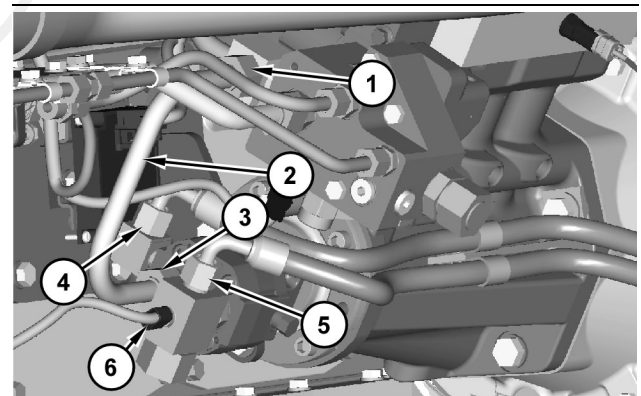


Illustration 19

g01215984

2. Disconnect fitting (3) at the bottom of tube assembly (2). Loosen fitting (1) at the top of tube assembly (2). Position tube assembly (2) out of the way. Disconnect hose assemblies (4) and (5). Disconnect harness assembly (6).

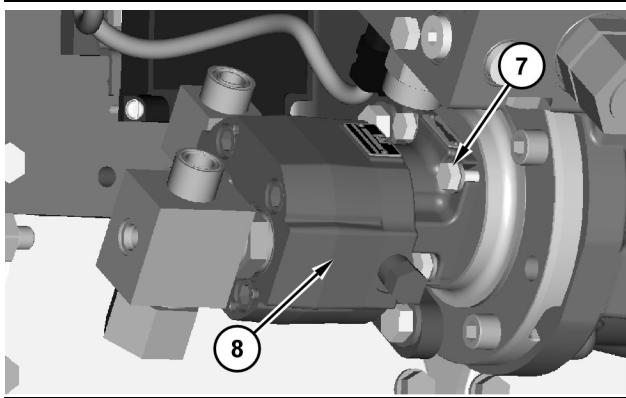


Illustration 20

g01215654

3. Remove bolts (7). Remove fuel transfer pump (8).

i02434219

Fuel Transfer Pump - Install

SMCS Code: 1256-012

Installation Procedure

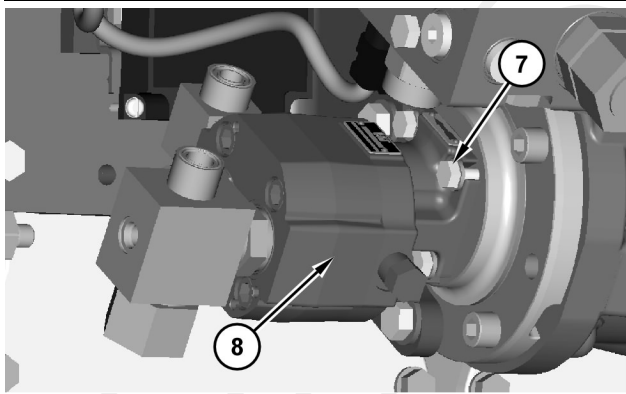


Illustration 21

g01215654

1. Install fuel transfer pump (8). Install bolts (7).

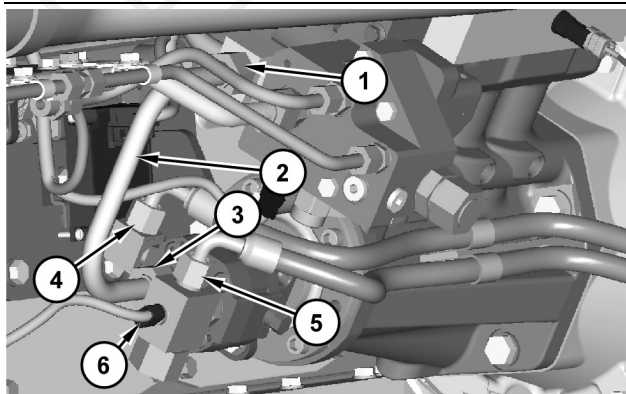


Illustration 22

g01215984

2. Connect harness assembly (6). Connect hose assemblies (4) and (5). Position tube assembly (2). Connect fitting (3) at the bottom of tube assembly (2). Tighten fitting (1) at the top of tube assembly (2).

3. Turn the fuel supply to the ON position.

i02683811

High Pressure Fuel Rails - Remove and Install

SMCS Code: 1274

Removal Procedure

Start By:

- a. Remove the air inlet manifold. Refer to Disassembly and Assembly, "Air Inlet Manifold - Remove and Install".
- b. Remove the flow limiters. Refer to Disassembly and Assembly, "Flow Limiters - 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.

WARNING

Do not open the high pressure fuel system without allowing the fuel system to purge. After the engine has shut down, allow the fuel system to purge for ten minutes. This operating fuel system contains high pressure. Exposure to high pressure fuel can result in personal injury.

Note: If necessary, cap tube assemblies, fittings, ports, and any opening in the fuel system in order to prevent contamination.

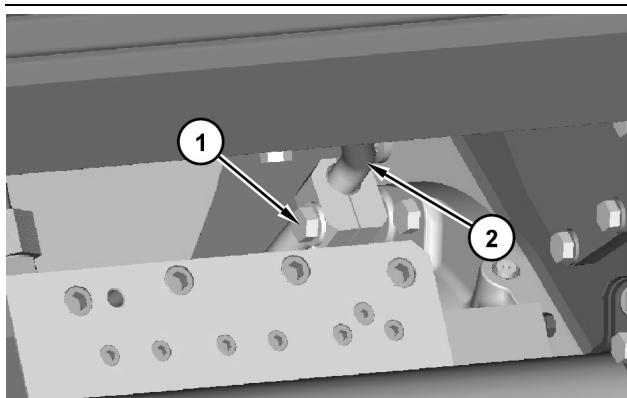


Illustration 23

g01285837

1. Remove bolt (1) and the clamp from tube assembly (2).

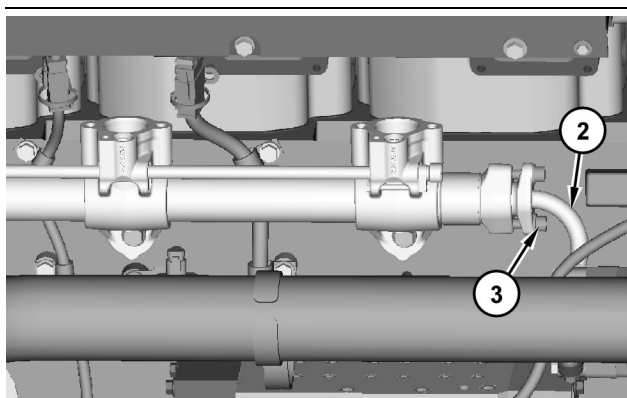


Illustration 24

g01285006

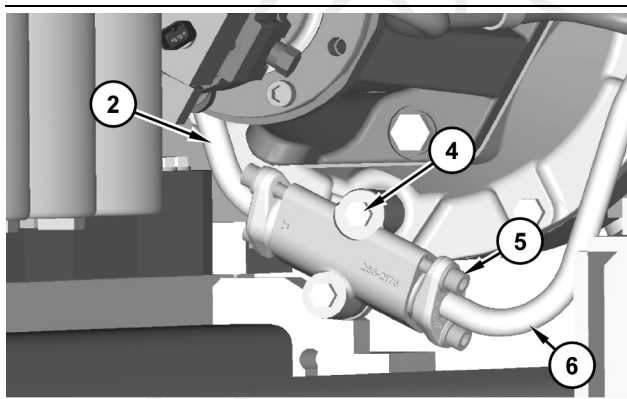


Illustration 25

g01285319

2. Remove bolts (5). Remove bolts (3). Remove bolts (4). Disconnect tube assembly (6). Remove tube assembly (2) and the O-ring seals.

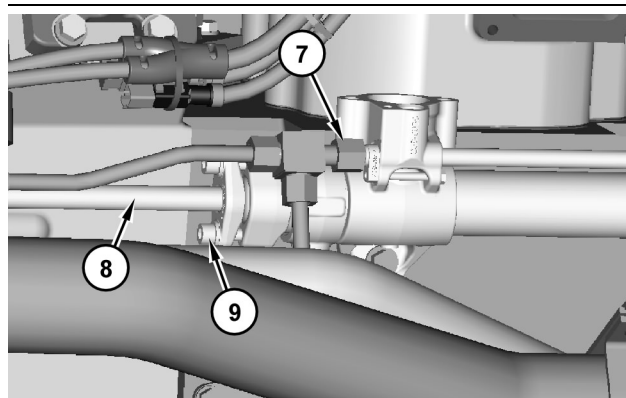


Illustration 26

g01285008

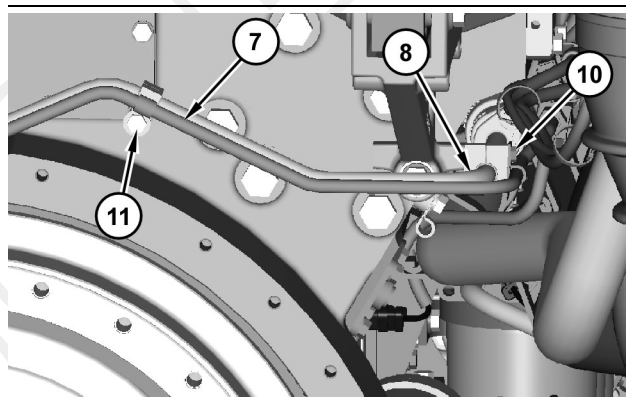


Illustration 27

g01285323

3. Remove bolts (9). Remove bolts (10) and bolts (11). Repeat for the opposite side.

4. Remove tube assembly (7). Remove tube assembly (8) and the O-ring seal.

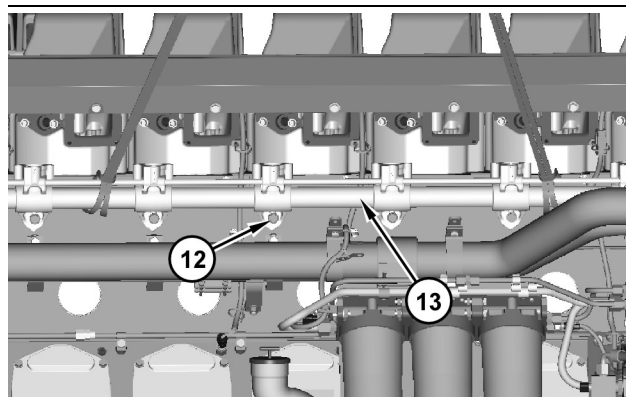


Illustration 28

g01285012

5. Attach a suitable lifting device onto fuel rail (13). The weight of fuel rail (13) is approximately (). Remove bolts (12). Remove fuel rail (13).
6. Repeat Step 5 for the opposite side.

Installation Procedure

Table 1

Required Tools			
Tool	Part Number	Part Description	Qty
A	129 - 1966	Multipurpose Grease	1

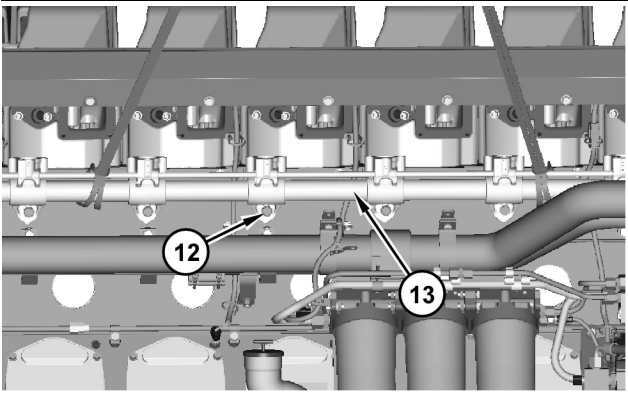


Illustration 29 g01285012

1. Attach a suitable lifting device onto fuel rail (13). The weight of fuel rail (13) is approximately (). Install fuel rail (13). Install bolts (12).

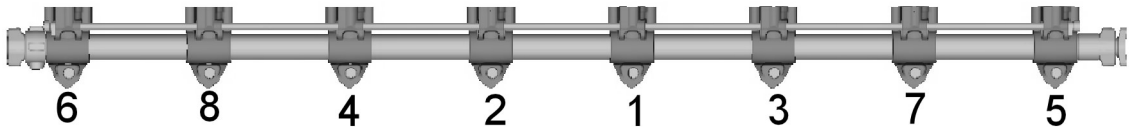


Illustration 30 g01285086

2. Tighten bolts (12) in the sequence that is shown in Illustration 30. Tighten bolts (12) to a torque of 100 ± 20 N·m (74 ± 15 lb ft).

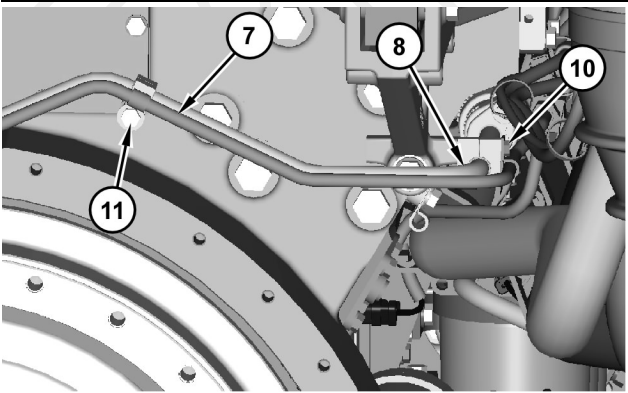


Illustration 31 g01285323

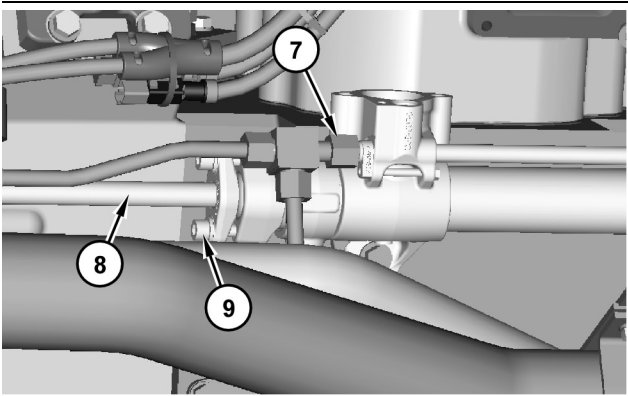


Illustration 32 g01285008

3. Lubricate the O-ring seals with clean engine oil. Lubricate the ends of tube assembly (8) with Tooling (A). Install tube assembly (8) and the O-ring seals. Install tube assembly (7). Install bolts (9) hand tight. Install bolts (10) and (11) hand tight. Evenly tighten bolts (9) to a torque of 20 N·m (15 lb ft).

Note: Bolts (9) do not rotate more than 90 degrees at a time.

4. Evenly tighten bolts (9) to a torque of 40 N·m (30 lb ft).

Note: Bolts (9) do not rotate more than 45 degrees at a time.

5. Tighten bolts (10) and (11) to a torque of 40 ± 10 N·m (30 ± 7 lb ft).

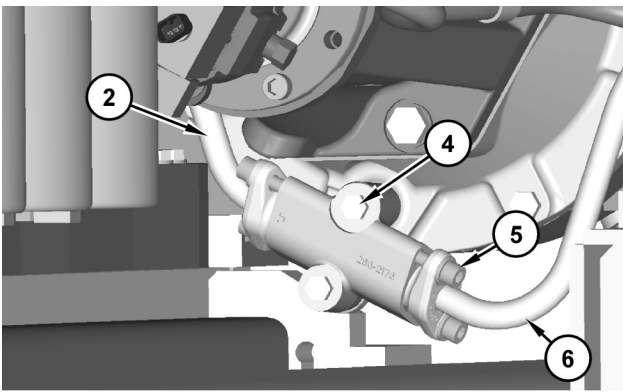


Illustration 33

g01285319

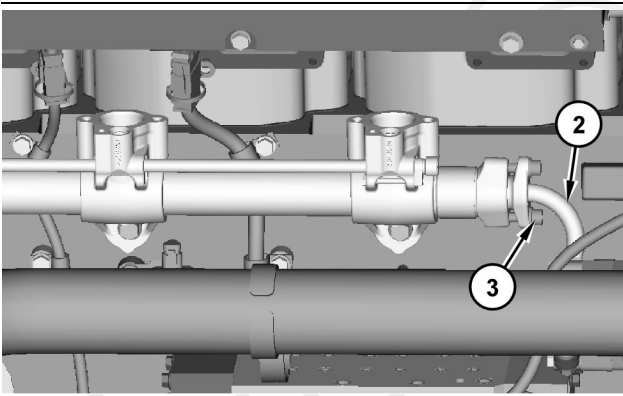


Illustration 34

g01285006

6. Lubricate the O-ring seals with clean engine oil. Apply Tooling (A) to the end of tube assembly (2) and tube assembly (6). Position tube assembly (2) into tube assembly (6) and into the fuel rail. Install bolts (3) and bolts (4) hand tight. Evenly tighten bolts (4) to a torque of 20 N·m (15 lb ft). Evenly tighten bolts (4) to a torque of 55 ± 10 N·m (41 ± 7 lb ft). Evenly tighten bolts (3) to a torque of 20 N·m (15 lb ft).

Note: Bolts (3) do not rotate more than 90 degrees at a time.

7. Evenly tighten bolts (3) to a torque of 40 N·m (30 lb ft).

Note: Bolts (3) do not rotate more than 45 degrees at a time.

8. Install bolts (5) hand tight. Evenly tighten bolts (5) to a torque of 20 N·m (15 lb ft). Evenly tighten bolts (5) to a torque of 40 ± 10 N·m (30 ± 7 lb ft).

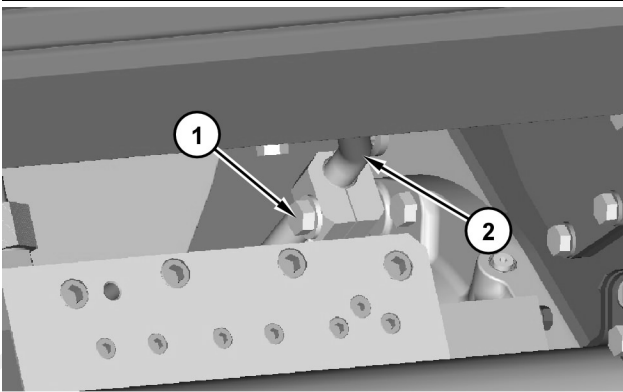


Illustration 35

g01285837

9. Install the clamp and bolt (1) onto tube assembly (2).

End By:

- a. Install the flow limiters. Refer to Disassembly and Assembly, "Flow Limiters - Remove and Install".
- b. Install the air inlet manifold. Refer to Disassembly and Assembly, "Air Inlet Manifold - Remove and Install".

i02682944

Flow Limiter - Remove and Install

SMCS Code: 1715-010

Removal Procedure

Table 2

Required Tools			
Tool	Part Number	Part Description	Qty
A	6V-6195	Interlocking Joint Pliers	1

NOTICE

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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.

 WARNING

Do not open the high pressure fuel system without allowing the fuel system to purge. After the engine has shut down, allow the fuel system to purge for ten minutes. This operating fuel system contains high pressure. Exposure to high pressure fuel can result in personal injury.

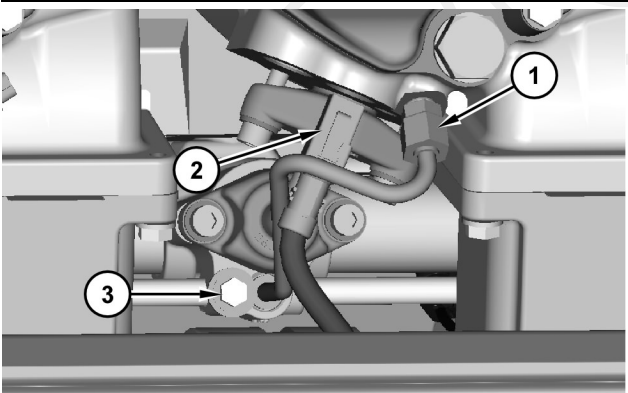


Illustration 36

g01285474

1. Remove bolt (3) and the washer. Remove tube assembly (1). Disconnect harness assembly (2).

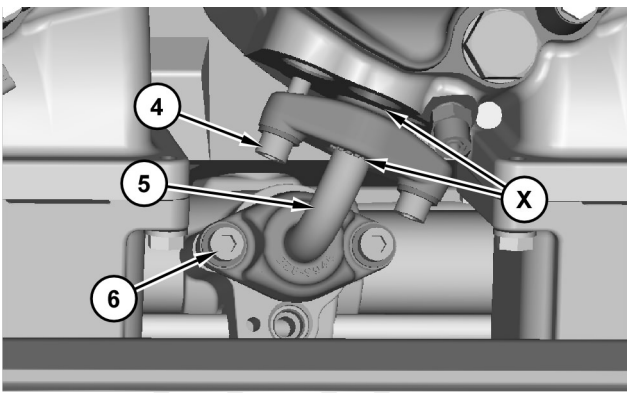


Illustration 37

g01285666

2. Apply clean engine oil to area (X). Repeat for the opposite collar. Remove bolts (4) and bolts (6). Remove tube assembly (5).

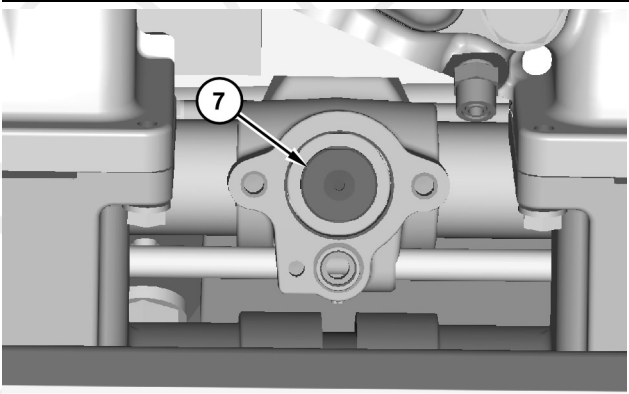


Illustration 38

g01285667

3. Use Tooling (A) to remove flow limiter (7) from the fuel rail.

Note: Clean Tooling (A) before using in order to avoid contamination in the fuel system.

Installation Procedure

Table 3

Required Tools			
Tool	Part Number	Part Description	Qty
A	6V-6195	Interlocking Joint Pliers	1
B	1P - 0808	Multipurpose Grease	1
C	129-1966	Multipurpose Grease	1

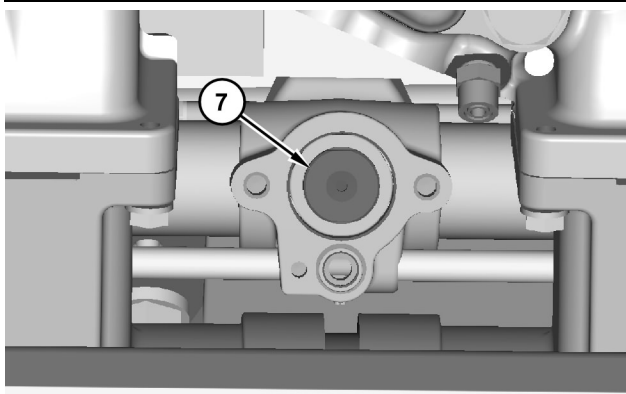


Illustration 39

g01285667

1. Apply Tooling (C) to the sealing face of the flow limiter and the fuel rail.
2. Use Tooling (A) to install flow limiter (7) into the fuel rail.

Note: Clean Tooling (A) before using in order to avoid contamination in the fuel system.

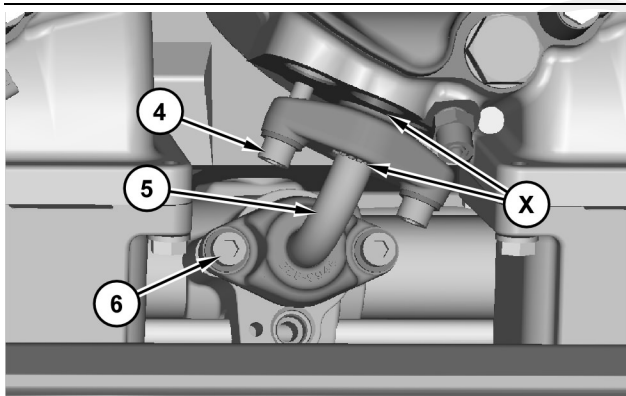


Illustration 40

g01285666

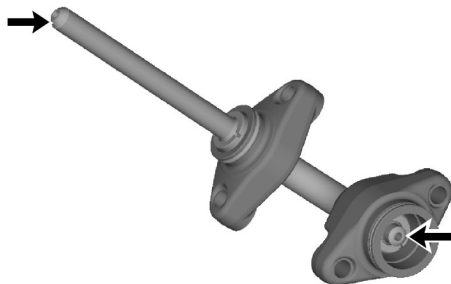


Illustration 41

g01285695

3. Apply clean engine oil to area (X). Repeat for the opposite collar. Apply Tooling (B) to the ends of tube assembly (5). Install tube assembly (5). Install bolts (4) and bolts (6) hand tight. Evenly tighten bolts (4) to a torque of 20 N·m (15 lb ft). Evenly tighten bolts (6) to a torque of 20 N·m (15 lb ft). Evenly tighten bolts (4) to a torque of 40 N·m (30 lb ft). Evenly tighten bolts (6) to a torque of 40 N·m (30 lb ft).

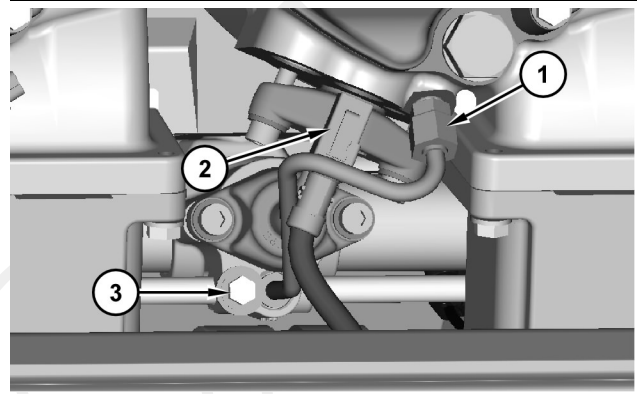


Illustration 42

g01285474

4. Connect harness assembly (2). Replace the O-ring seals on both ends of tube assembly (1). Install tube assembly (1). Install the washer and bolt (3).

i02682596

Fuel Control Valve - Remove and Install

SMCS Code: 1715-010

Removal Procedure

Start By:

- a. Remove the fuel pump (high pressure). Refer to Disassembly and assembly, "Fuel Pump (High Pressure) - 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.

 WARNING

Do not open the high pressure fuel system without allowing the fuel system to purge. After the engine has shut down, allow the fuel system to purge for ten minutes. This operating fuel system contains high pressure. Exposure to high pressure fuel can result in personal injury.

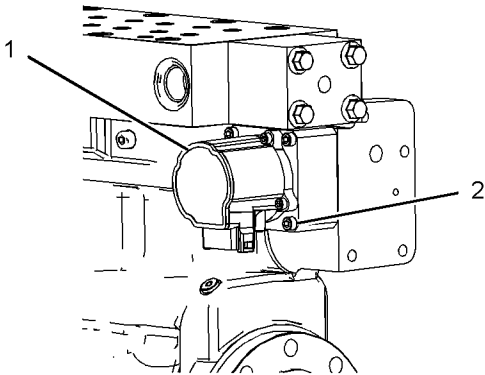


Illustration 43 g01347715

1. Remove bolts (2). Remove fuel control valve (1).

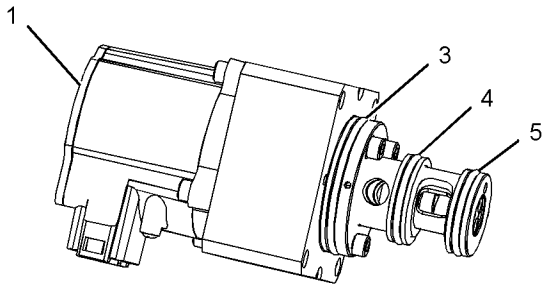


Illustration 44 g01347728

2. Check O-ring seals (3), (4), and (5) on fuel control valve (1).

Installation Procedure

Table 4

Required Tools			
Tool	Part Number	Part Description	Qty
A	5N-5561	Silicone Lubricant	1

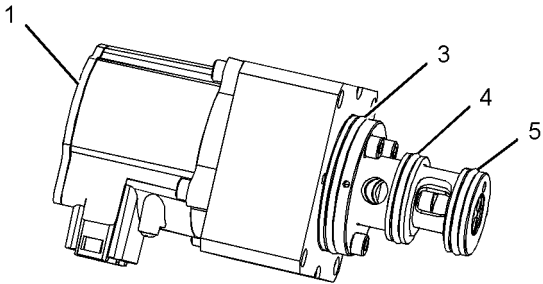


Illustration 45 g01347728

1. Lubricate O-ring seals (3), (4), and (5) with Tooling (A).

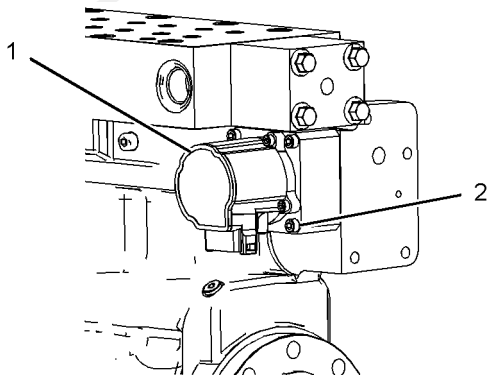


Illustration 46 g01347715

i02708156

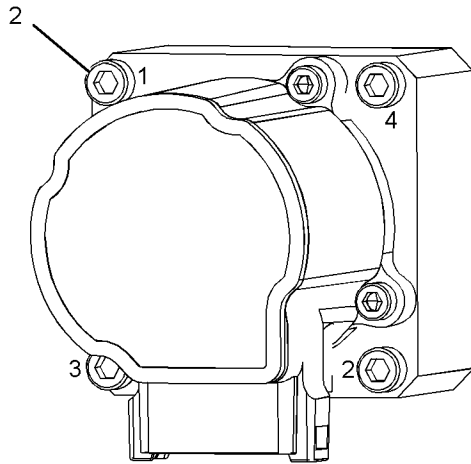


Illustration 47

g01347742

2. Position fuel control valve (1). Install bolts (2). Tighten bolts (2) in the sequence that is shown in Illustration 47. Tighten bolts (2) to a torque of 6 N·m (53 lb in). Tighten bolts (2) in the sequence that is shown in Illustration 47. Tighten bolts (2) to a torque of 12 N·m (106 lb in).

End By:

- a. Install the fuel pump (high pressure). Refer to Disassembly and assembly, "Fuel Pump (High Pressure) - Remove and Install".

Fuel Pump (High Pressure) - Remove and Install

SMCS Code: 1288-010

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.

WARNING

Do not open the high pressure fuel system without allowing the fuel system to purge. After the engine has shut down, allow the fuel system to purge for ten minutes. This operating fuel system contains high pressure. Exposure to high pressure fuel can result in personal injury.

Note: If necessary, cap tube assemblies, fittings, ports, and any openings on the fuel system in order to prevent contamination.

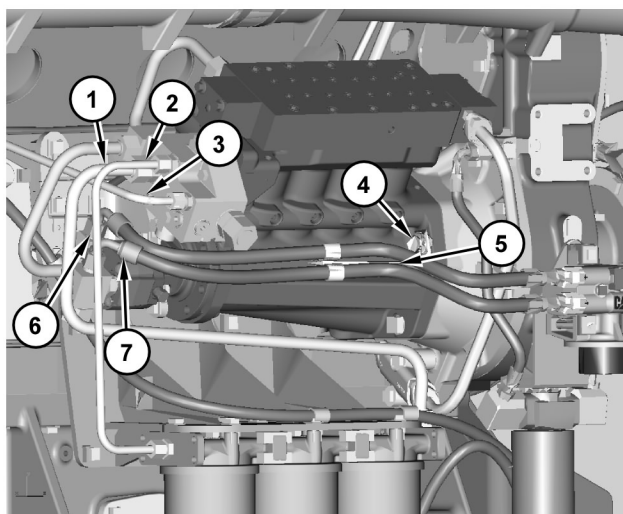


Illustration 48

g01372192

1. Remove tube assemblies (1), (2), and (3). Remove bolt (4) and disconnect bracket (5). Disconnect hose assemblies (6) and (7). Position hose assemblies (6) and (7) out of the way.

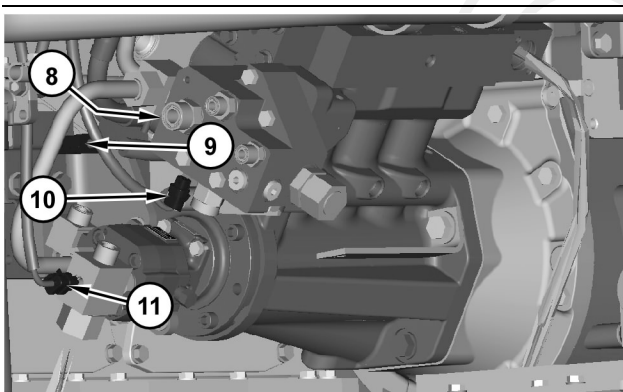


Illustration 49

g01372208

2. Disconnect harness assemblies (8), (9), (10), and (11).

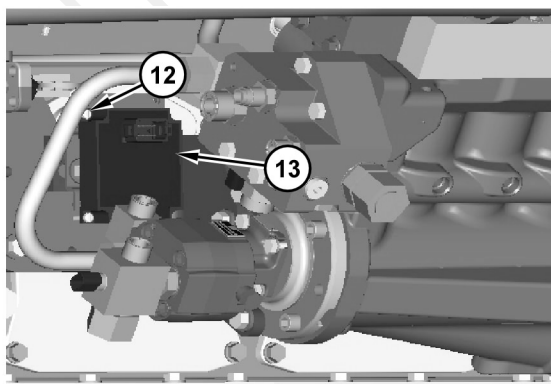


Illustration 50

g01372217

3. Remove screws (12) and remove module (13).

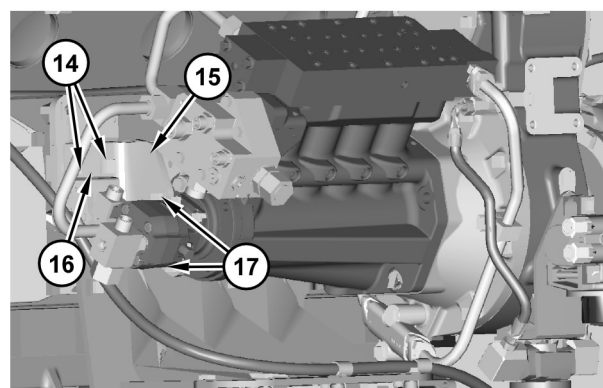


Illustration 51

g01372218

4. Remove bolts (14) and bolts (17). Remove bracket (15) and bracket (16).

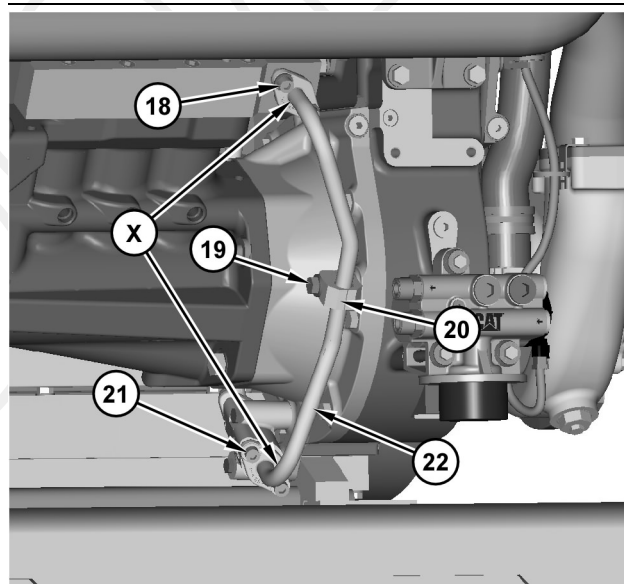


Illustration 52

g01372471

Note: When the fuel lines are removed, use clean engine oil to lubricate the outside diameter of tube assembly (22) in area (X). Remove bolts (18) and (21). If the procedure is not followed, contamination and fuel leaks may occur.

5. Remove bolt (19) and clamp (20). Remove bolts (18). Remove bolts (21). Remove tube assembly (22) and the O-ring seals.

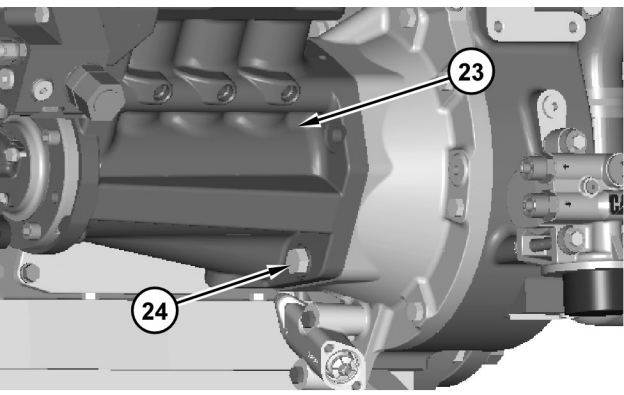


Illustration 53

g01242870

6. Attach a suitable lifting device onto fuel pump (23). The weight of fuel pump (23) is approximately 102 kg (225 lb). Remove bolts (24). Lower fuel pump (23) to the ground.

Installation Procedure

Table 5

Required Tools			
Tool	Part Number	Part Description	Qty
A	1P-0808	Multipurpose Grease	1

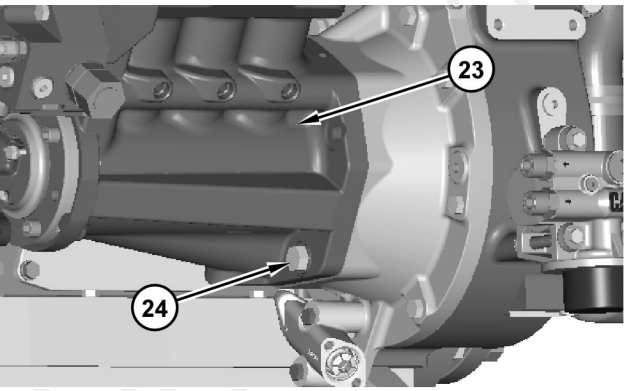


Illustration 54

g01242870

1. Attach a suitable lifting device onto fuel pump (23). The weight of fuel pump (23) is approximately 102 kg (225 lb). Raise fuel pump (23) into position on the engine. Install bolts (24).

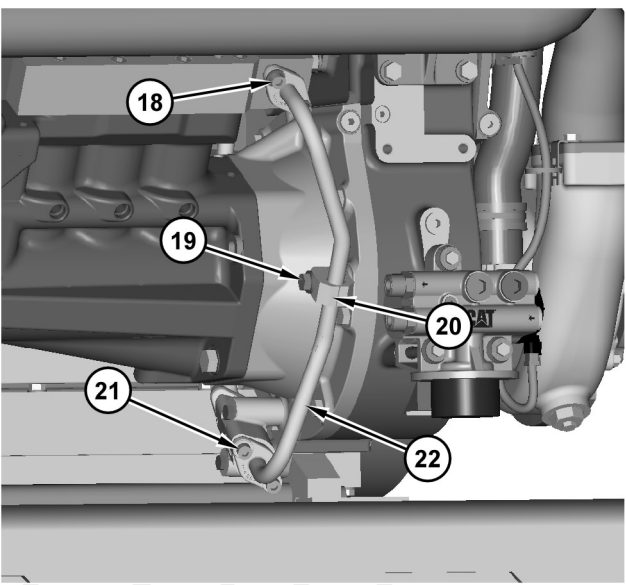


Illustration 55

g01242869

2. Lubricate the O-ring seals with clean engine oil. Lubricate the ends of tube assembly (22) with Tooling (A). Install tube assembly (22) and the O-ring seals. Install bolts (21) hand tight. Install bolts (18) hand tight. Install clamp (20) and bolt (19). Evenly tighten bolts (21) to a torque of 20 N·m (15 lb ft). Evenly tighten bolts (18) to a torque of 20 N·m (15 lb ft).

Note: Do not rotate bolts (21) and (18) more than 90 degrees at a time.

3. Evenly tighten bolts (21) to a torque of 40 N·m (30 lb ft). Evenly tighten bolts (18) to a torque of 40 N·m (30 lb ft). Tighten bolt (19).

Note: Do not rotate bolts (21) and (18) more than 45 degrees at a time.

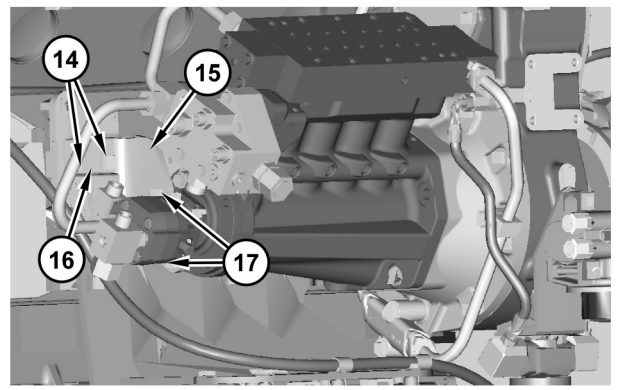


Illustration 56

g01372218

4. Install bracket (15) and bracket (16). Install bolts (14) and bolts (17).

i02412657

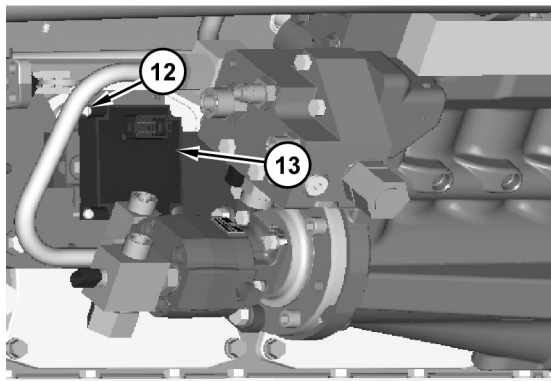


Illustration 57

g01372217

5. Install module (13). Install screws (12).

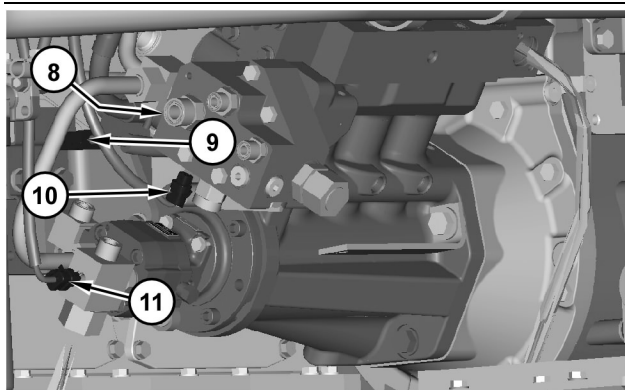


Illustration 58

g01372208

6. Connect harness assemblies (8), (9), (10), and (11).

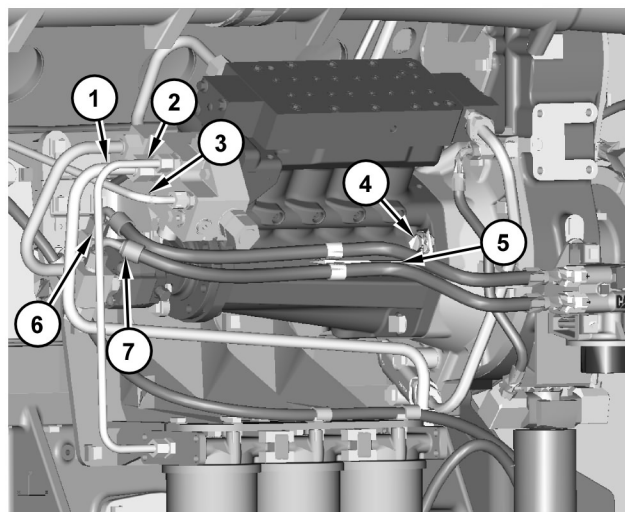


Illustration 59

g01372192

7. Install tube assemblies (1), (2), and (3). Install bracket (5) and bolt (4). Connect hose assemblies (6) and (7).

Air Cleaner - Remove and Install

SMCS Code: 1051-010

Removal Procedure

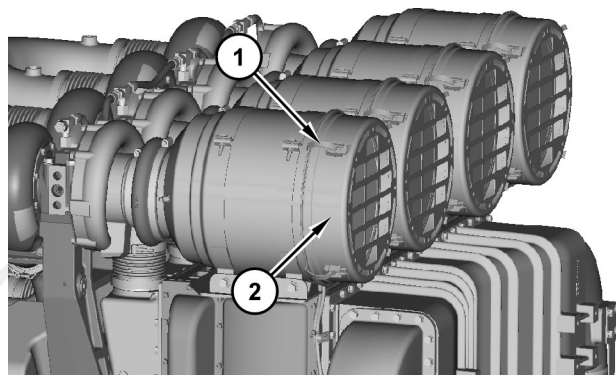


Illustration 60

g01205877

1. Release clamps (1). Remove cover (2).

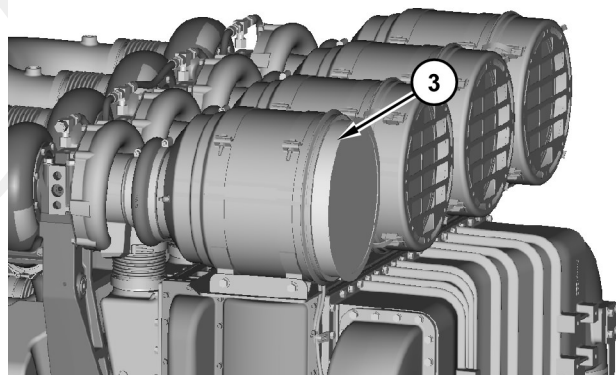


Illustration 61

g01205880

2. Remove air cleaner element (3).

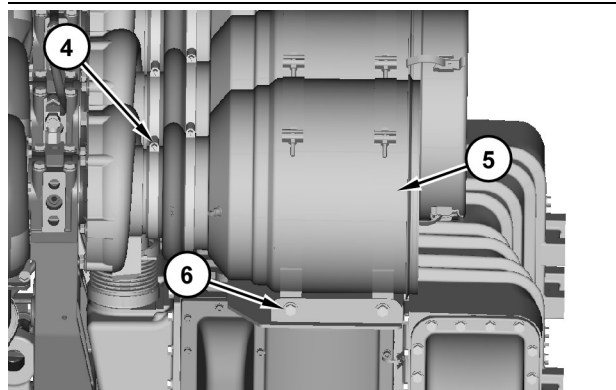


Illustration 62

g01205881

3. Loosen clamp (4). Remove bolts (6) on each side of air cleaner housing (5). Remove air cleaner housing (5).
4. Repeat Steps 1 through 3 for the remaining air cleaners.

Installation Procedure

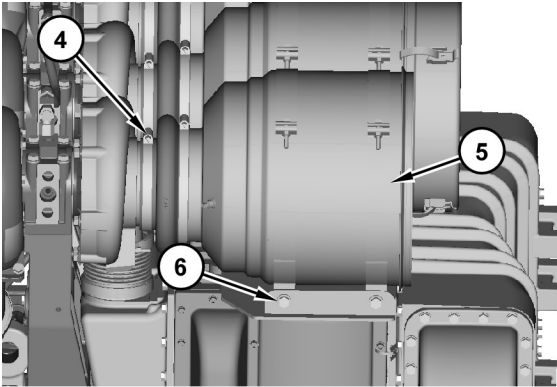


Illustration 63

g01205881

1. Position air cleaner housing (5). Install bolts (6) on each side of air cleaner housing (5). Tighten clamp (4).

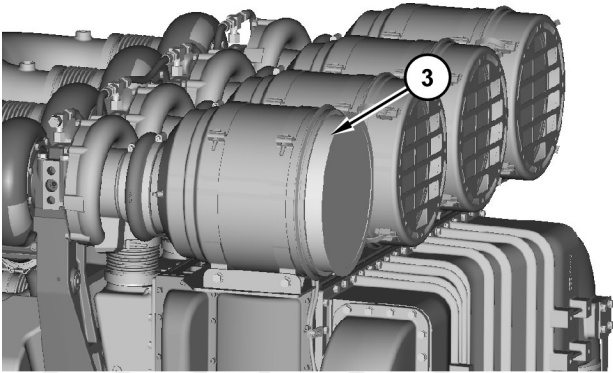


Illustration 64

g01205880

2. Install air cleaner element (3).

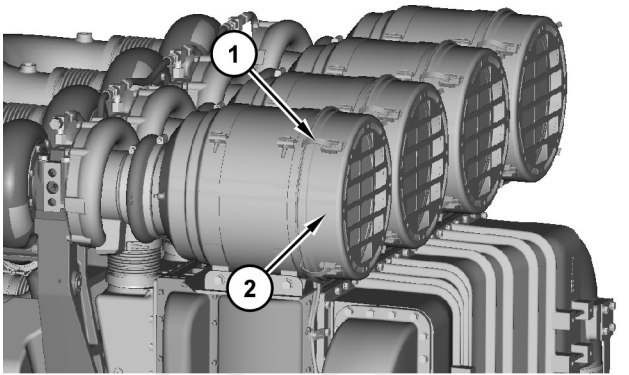


Illustration 65

g01205877

3. Install cover (2). Secure clamps (1).

i02411843

Turbocharger - Remove

SMCS Code: 1052-011

Removal Procedure

Table 6

Required Tools			
Tool	Part Number	Part Description	Qty
A	138 - 7573	Link Bracket	1

Start By:

- a. Remove the air cleaners. Refer to Disassembly and Assembly, "Air Cleaner - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

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

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

Dispose of all fluids according to local regulations and mandates.

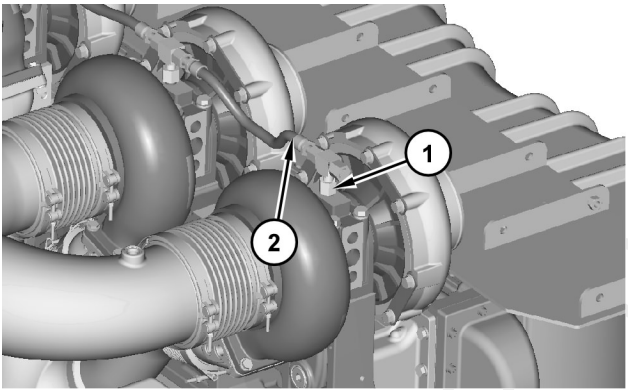


Illustration 66 g01205439

1. Disconnect fitting (1). Position fitting (1) and hose assembly (2) out of the way.

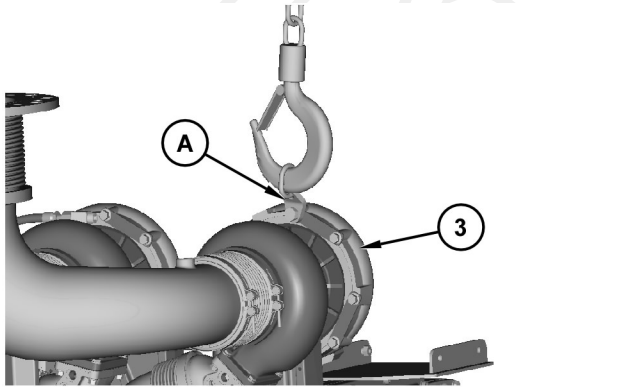


Illustration 67 g01205440

2. Attach Tooling (A) and a suitable lifting device onto turbocharger (3). The weight of turbocharger (3) is approximately 59 kg (130 lb).

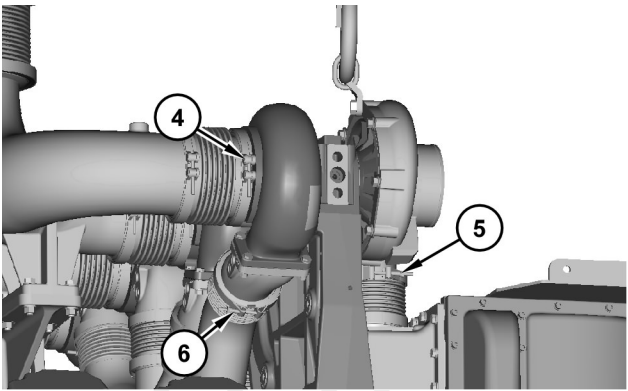


Illustration 68 g01205442

3. Disconnect clamps (4), (5), and (6).

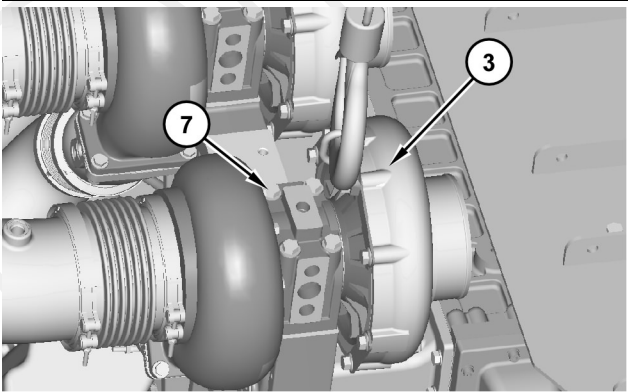


Illustration 69 g01205441

4. Remove bolts (7). Remove turbocharger (3).
5. Repeat Steps 1 through 4 for the remaining turbochargers.

i02411960

Turbocharger - Install

SMCS Code: 1052-012

Installation Procedure

Table 7

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

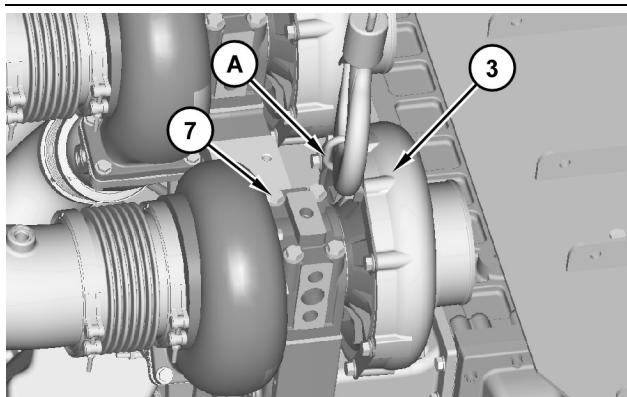


Illustration 70

g01210959

1. Attach Tooling (A) and a suitable lifting device onto turbocharger (3). The weight of turbocharger (3) is approximately 59 kg (130 lb). Position turbocharger (3). Install bolts (7).

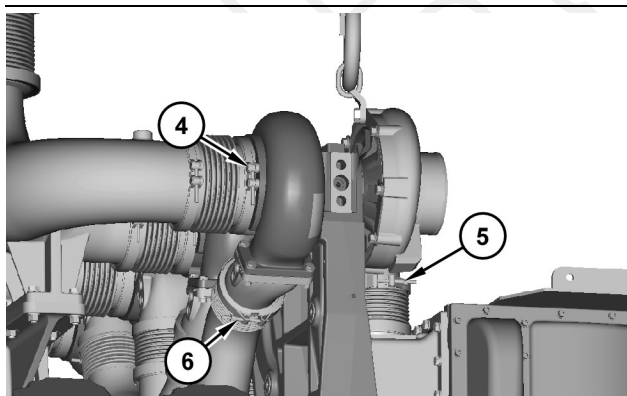


Illustration 71

g01205442

2. Tighten clamps (6), (5), and (4).

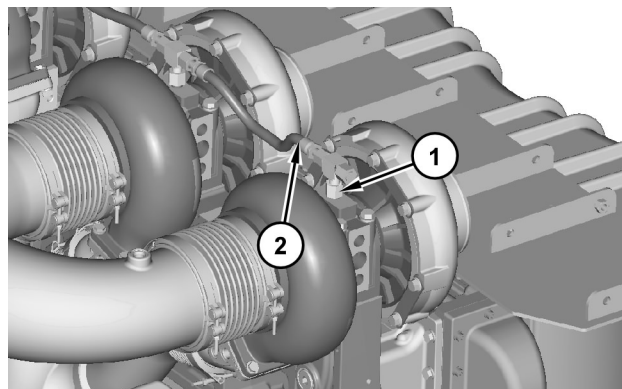


Illustration 72

g01205439

3. Position fitting (1) and hose assembly (2). Connect fitting (1).

End By:

- a. Install the air cleaners. Refer to Disassembly and Assembly, "Air Cleaner - Remove and Install".

i02399539

Aftercooler - Remove and Install

SMCS Code: 1063-010

Removal Procedure

Table 8

Required Tools			
Tool	Part Number	Part Description	Qty
A	138-7575	Link Bracket	2
B	138-7573	Link Bracket	2
C	1U-9200	Lever Puller Hoist	1
D	-	Guide Bolt M10 X 1.5 by 100 mm	2

Start By:

- a. Remove the air cleaners. Refer to Disassembly and Assembly, "Air Cleaner - Remove and Install".

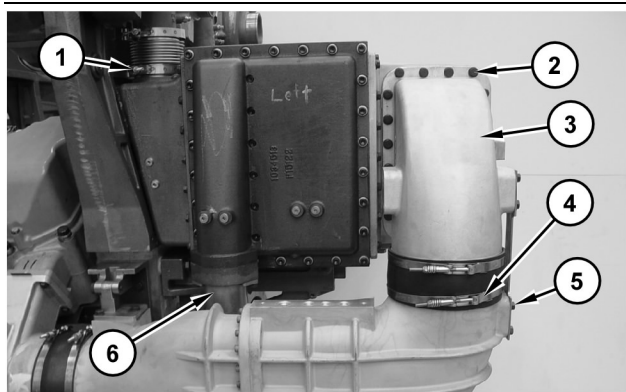


Illustration 73

g01198494

1. Remove bolts (5). Loosen clamp (4). Remove bolts (2) and remove elbow (3). Disconnect tube assembly (6). Loosen clamps (1).

2. Repeat Step 1 for the opposite side.

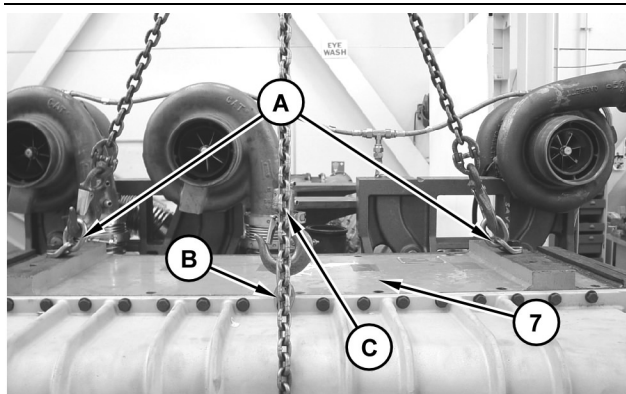


Illustration 74

g01198510

3. Attach Tooling (A) and Tooling (B) onto aftercooler (7). Attach a suitable lifting device onto Tooling (A). Attach Tooling (C) onto Tooling (B).

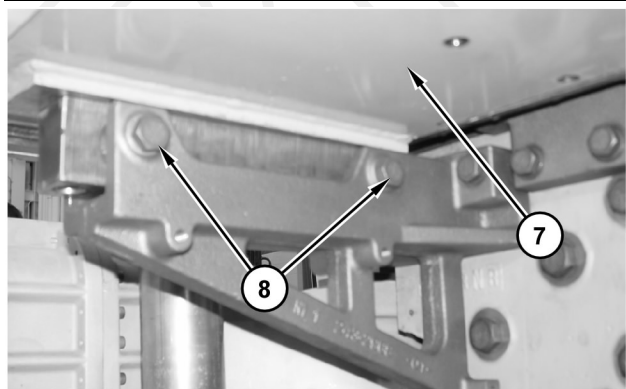


Illustration 75

g01198514

4. Remove bolts (8). Repeat for the opposite side. The weight of aftercooler (7) is approximately 590 kg (1300 lb). Use Tooling (C) in order to slightly lift the rear of aftercooler (7). Remove aftercooler (7) from the engine.

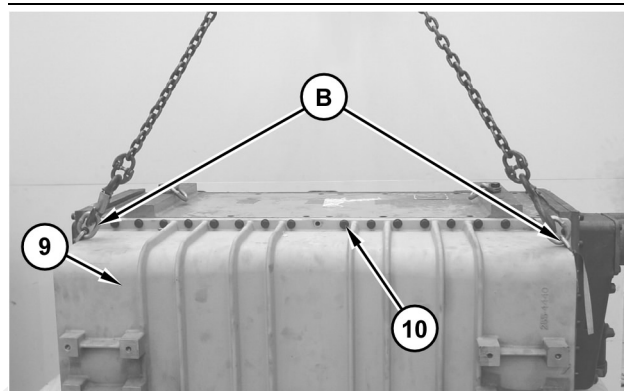


Illustration 76

g01198516

5. Attach Tooling (B) and a suitable lifting device onto housing (9). The weight of housing (9) is approximately 39 kg (85 lb). Remove bolts (10). Remove housing (9) and the gasket.

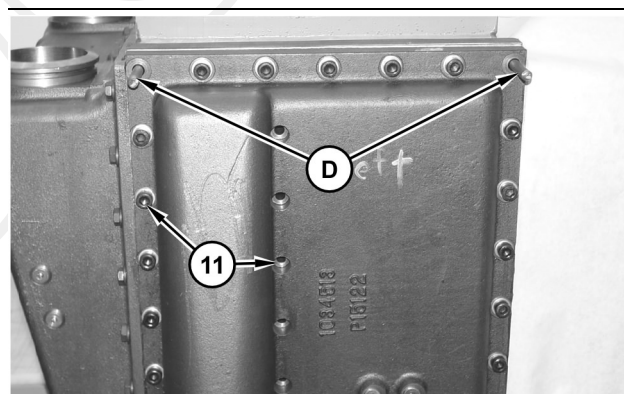


Illustration 77

g01198533

6. Remove two bolts (11). Install Tooling (D). Remove remaining bolts (11).

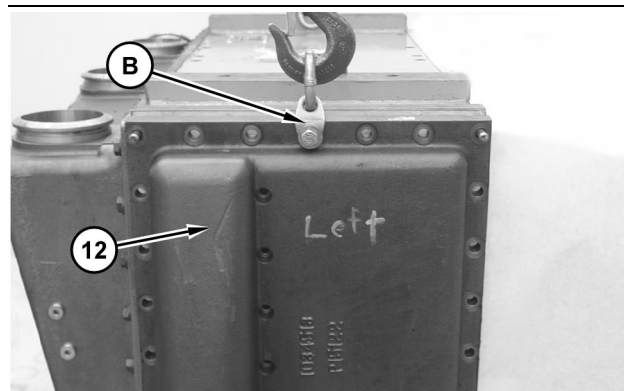


Illustration 78

g01198615

7. Slide cover (12) outward on Tooling (D). Attach Tooling (B) and a suitable lifting device onto cover (12). The weight of cover (12) is approximately 39 kg (85 lb). Remove cover (12) and the gasket.

8. Repeat Steps 6 and 7 for the opposite side.

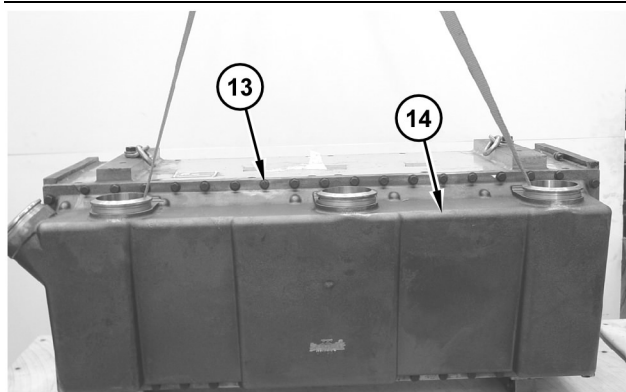


Illustration 79

g01198544

9. Attach a suitable lifting device onto cover (14). The weight of cover (14) is approximately 68 kg (150 lb). Remove bolts (13). Remove cover (14) and the gasket.

Installation Procedure

Table 9

Required Tools			
Tool	Part Number	Part Description	Qty
A	138-7575	Link Bracket	2
B	138-7573	Link Bracket	2
C	1U-9200	Lever Puller Hoist	1
D	-	Guide Bolt M10 X 1.5 by 100 mm	2

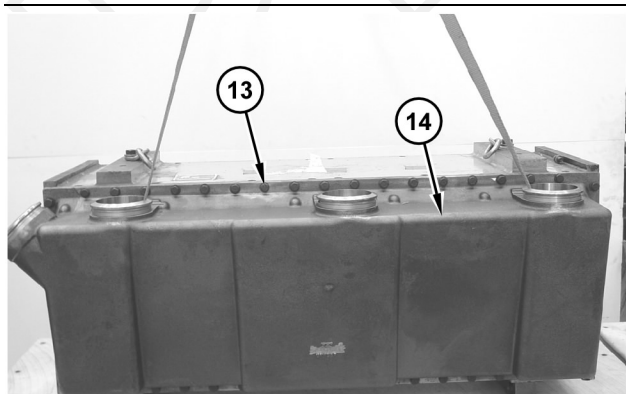


Illustration 80

g01198544

1. Attach a suitable lifting device onto cover (14). The weight of cover (14) is approximately 68 kg (150 lb). Position a new gasket and cover (14). Install bolts (13).

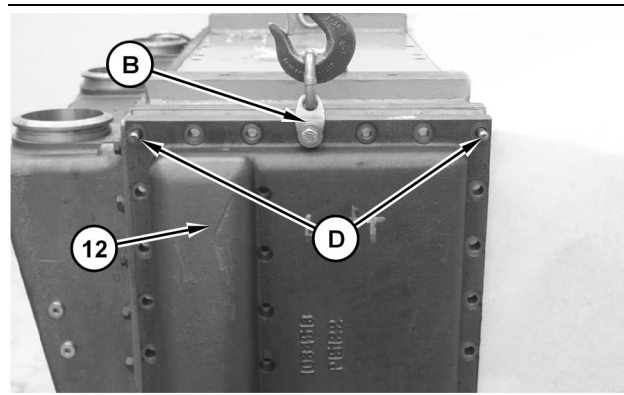


Illustration 81

g01198722

2. Attach Tooling (B) and a suitable lifting device onto cover (12). The weight of cover (12) is approximately 39 kg (85 lb). Install Tooling (D). Position a new gasket and cover (12) onto Tooling (D). Remove Tooling (B).

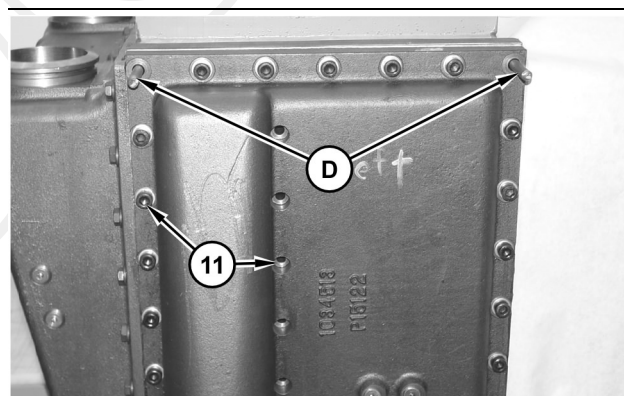


Illustration 82

g01198533

3. Slide cover (12) into position on Tooling (D). Install bolts (11). Remove Tooling (D) and install remaining bolts (11).
4. Repeat Steps 2 and 3 for the opposite side.

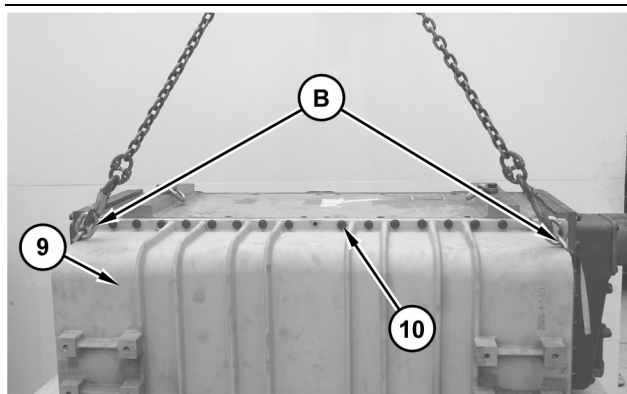


Illustration 83

g01198516

5. Attach Tooling (B) and a suitable lifting device onto housing (9). The weight of housing (9) is approximately 39 kg (85 lb). Position a new gasket and housing (9). Install bolts (10).

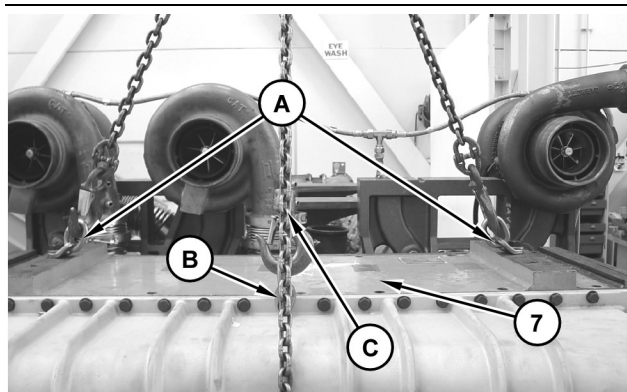


Illustration 84

g01198510

6. Attach Tooling (A) and Tooling (B) onto aftercooler (7). Attach a suitable lifting device onto Tooling (A). Attach Tooling (C) onto Tooling (B). The weight of aftercooler (7) is approximately 590 kg (1300 lb). Position aftercooler (7) onto the engine.

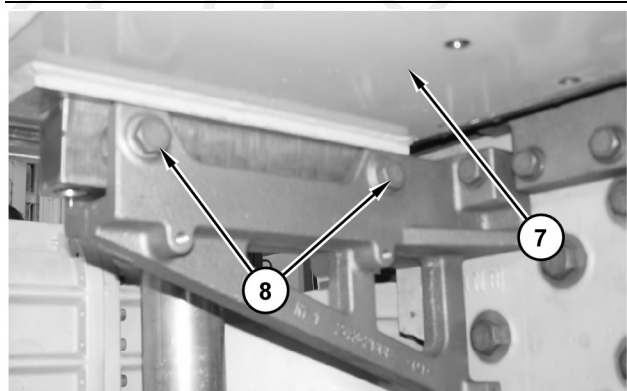


Illustration 85

g01198514

7. Install bolts (8). Repeat for the opposite side.

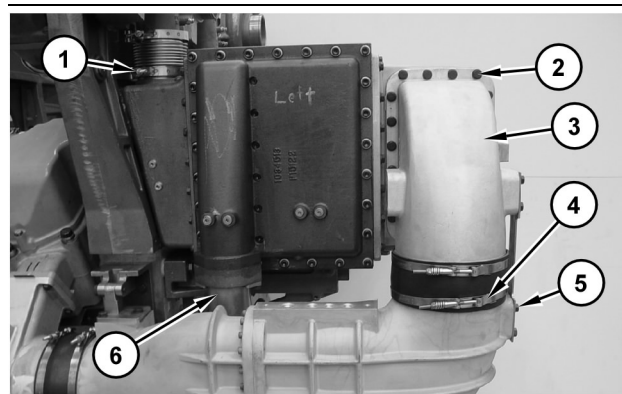


Illustration 86

g01198494

8. Tighten clamps (1). Connect tube assembly (6). Position elbow (3). Install bolts (2) and tighten clamp (4). Install bolts (5).

End By:

- a. Install the air cleaners. Refer to Disassembly and Assembly, "Air Cleaner - Remove and Install".

i02488218

Air Inlet Manifold - Remove and Install

SMCS Code: 1058-010

Removal Procedure

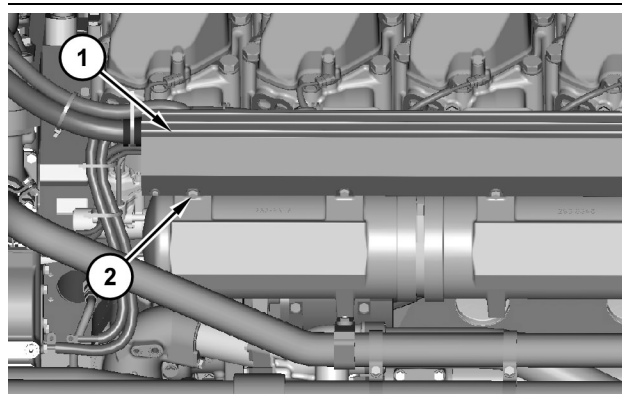


Illustration 87

g01242428

1. Remove bolts (2) from cover (1) for the harness assembly. Position cover (1) for the harness assembly out of the way.

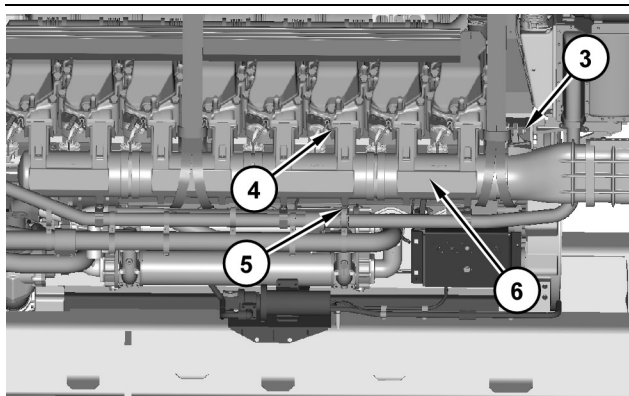


Illustration 88

g01242582

2. Attach a suitable lifting device onto air inlet manifold (6). The weight of air inlet manifold (6) is approximately 91 kg (200 lb). Remove bolt (3). Remove bolts (4) and bolts (5).

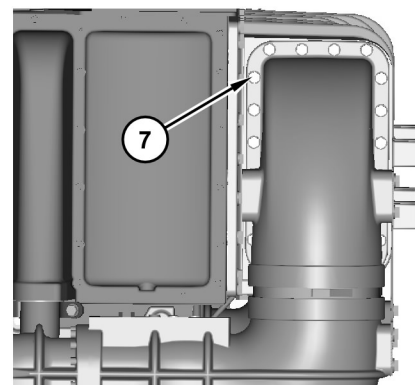


Illustration 89

g01242583

3. Remove bolts (7).

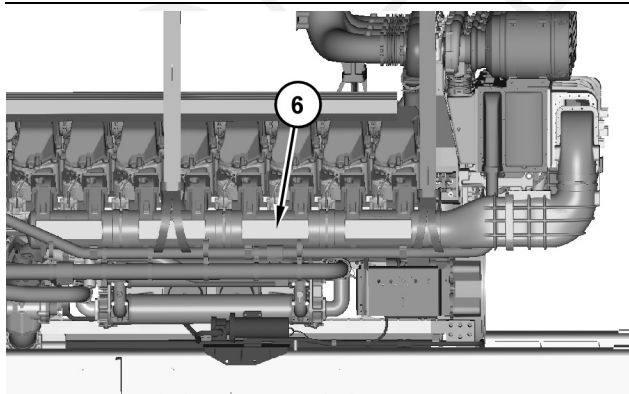


Illustration 90

g01242585

4. Remove air inlet manifold (6).

Installation Procedure

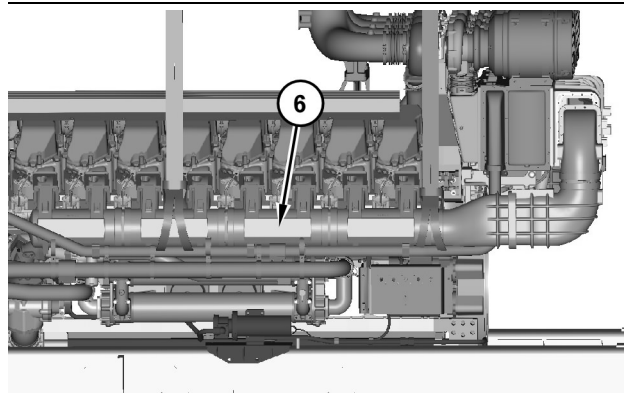


Illustration 91

g01242585

1. Attach a suitable lifting device onto air inlet manifold (6). The weight of air inlet manifold (6) is approximately 91 kg (200 lb). Position air inlet manifold (6).

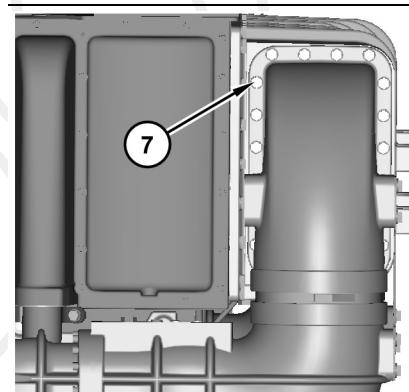


Illustration 92

g01242583

2. Install bolts (7).

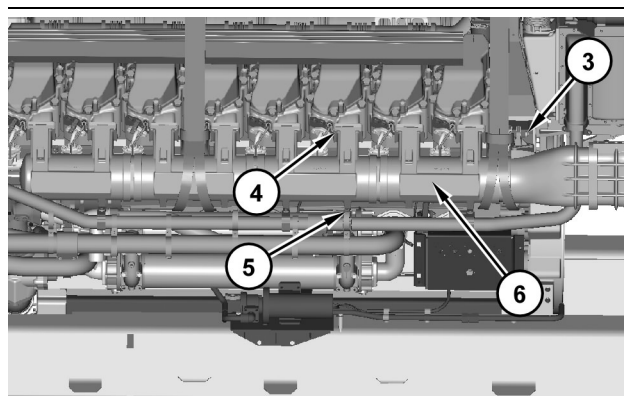


Illustration 93

g01242582

3. Install bolts (4) into air inlet manifold (6). Install bolt (3). Install bolts (5).

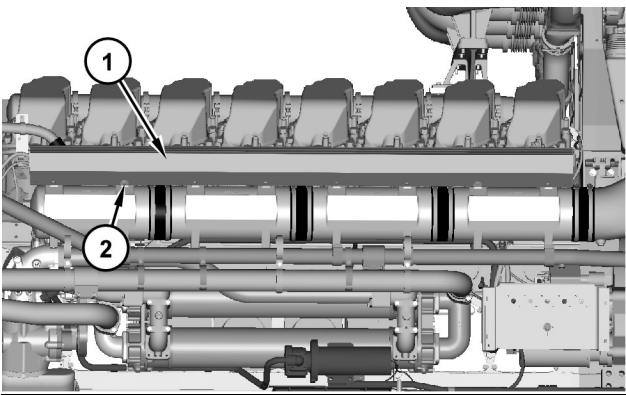


Illustration 94

g01242578

4. Position cover (1) for the harness assembly on the air inlet manifold. Install bolts (2).

i02416826

Exhaust Elbow - Remove and Install

SMCS Code: 1060-010

Removal Procedure

Table 10

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

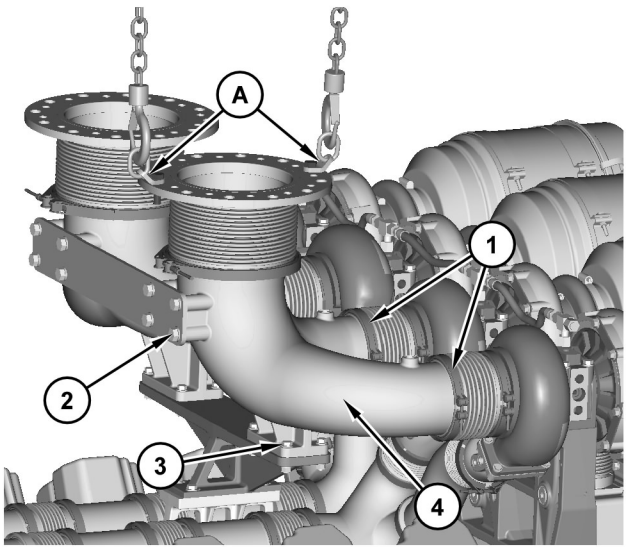


Illustration 95

g01208022

1. Attach Tooling (A) and a suitable lifting device onto exhaust elbow (4). The weight of exhaust elbow (4) is approximately 33 kg (74 lb). Loosen clamps (1). Remove bolts (2). Remove bolts (3) and the nuts. Remove exhaust elbow (4). Repeat for the opposite side.

Installation Procedure

Table 11

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

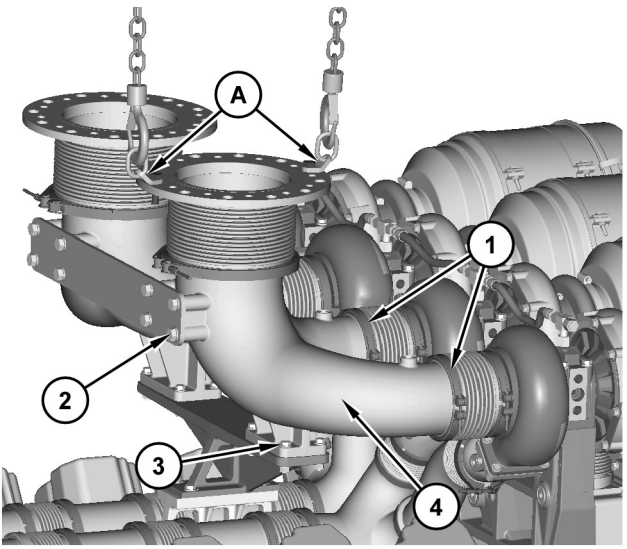


Illustration 96

g01208022

1. Attach Tooling (A) and a suitable lifting device onto exhaust elbow (4). The weight of exhaust elbow (4) is approximately 33 kg (74 lb). Position exhaust elbow (4). Install bolts (3) and the nuts. Install bolts (2). Tighten clamps (1). Repeat for the opposite side.

i02400450

Exhaust Manifold - Remove and Install

SMCS Code: 1059-010

Removal Procedure

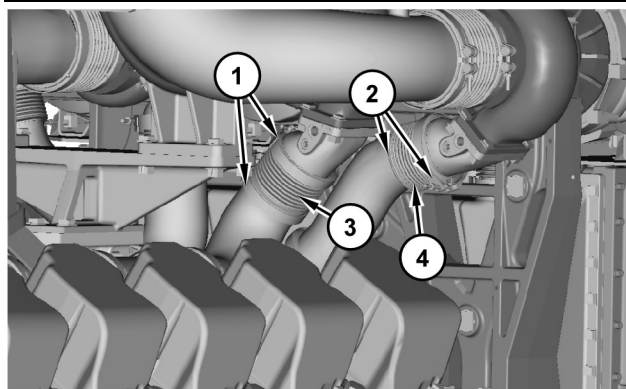


Illustration 97

g01199052

1. Remove clamps (1). Remove exhaust bellow (3). Remove clamps (2). Remove exhaust bellow (4).

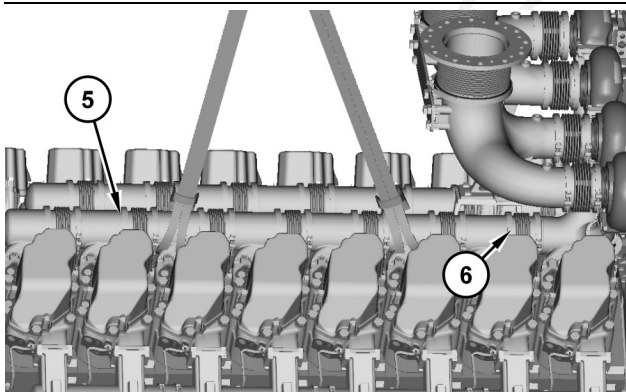


Illustration 98

g01199054

2. Attach a suitable lifting device onto exhaust manifolds (5). The weight of exhaust manifolds (5) is approximately 48 kg (105 lb). Loosen clamp (6).

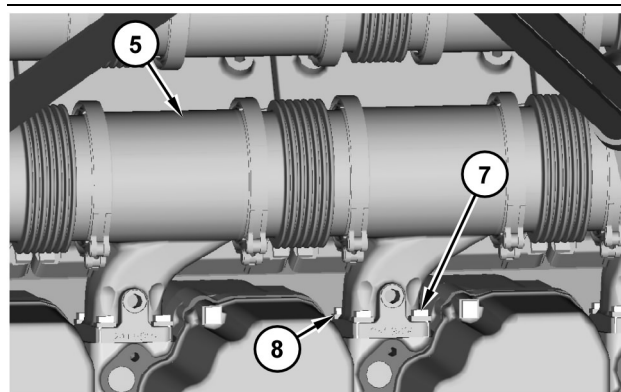


Illustration 99

g01199178

3. Remove bolts (7) from exhaust manifolds (5). Loosen bolts (8). Remove exhaust manifolds (5).

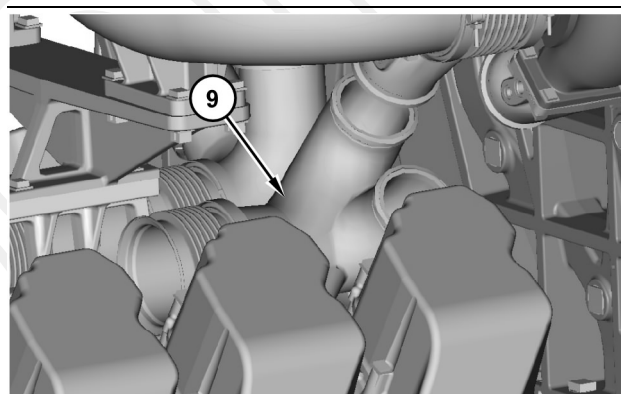


Illustration 100

g01199180

4. Remove exhaust manifold (9).
5. Repeat Steps 1 through 4 for the opposite side.

Installation Procedure

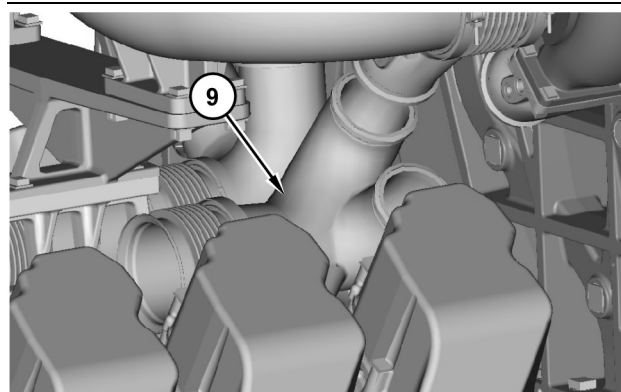


Illustration 101

g01199180

1. Position exhaust manifold (9).

i02421337

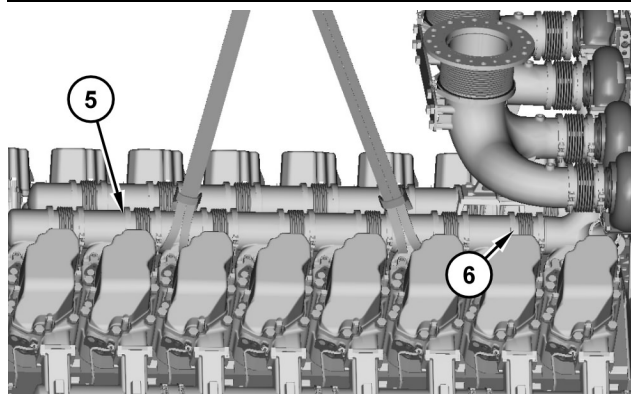


Illustration 102

g01199054

2. Attach a suitable lifting device onto exhaust manifolds (5). The weight of exhaust manifolds (5) is approximately 48 kg (105 lb). Position exhaust manifolds (5). Tighten clamp (6).

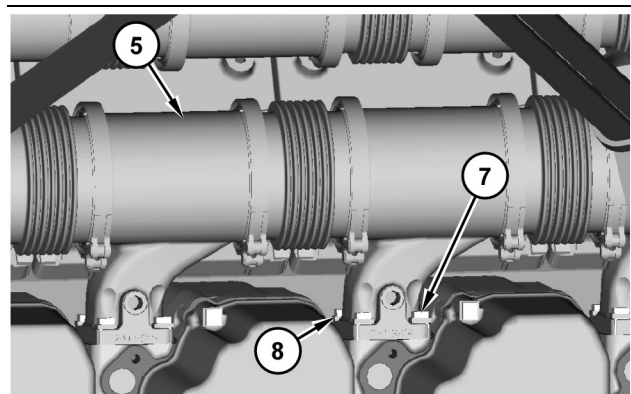


Illustration 103

g01199178

3. Install bolts (7) in exhaust manifolds (5). Tighten bolts (8).

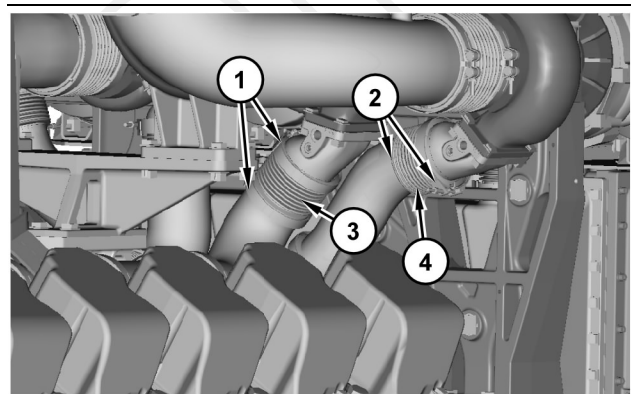


Illustration 104

g01199052

4. Install exhaust bellow (4). Install clamps (2). Install exhaust bellow (3). Install clamps (1).
5. Repeat Steps 1 through 4 for the opposite side.

Water Temperature Control Valve - Remove

SMCS Code: 1355-011

Removal Procedure

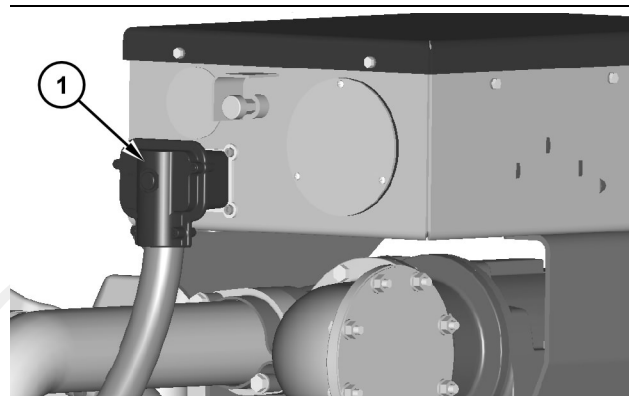


Illustration 105

g01209822

1. Disconnect harness assembly (1).

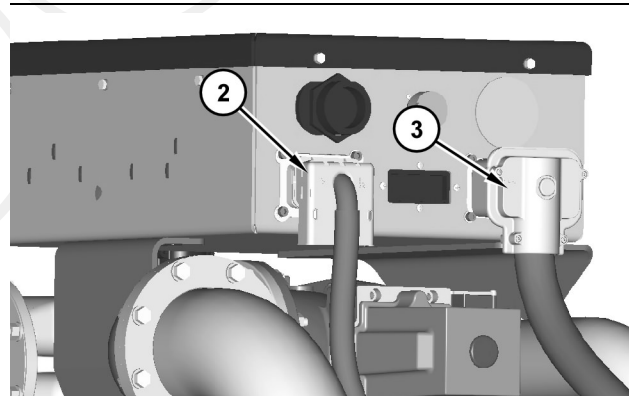


Illustration 106

g01209824

2. Disconnect harness assemblies (2) and (3).

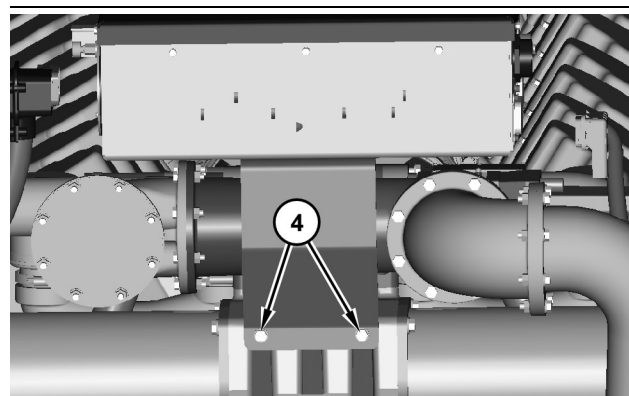


Illustration 107

g01209825

3. Remove bolts (4).

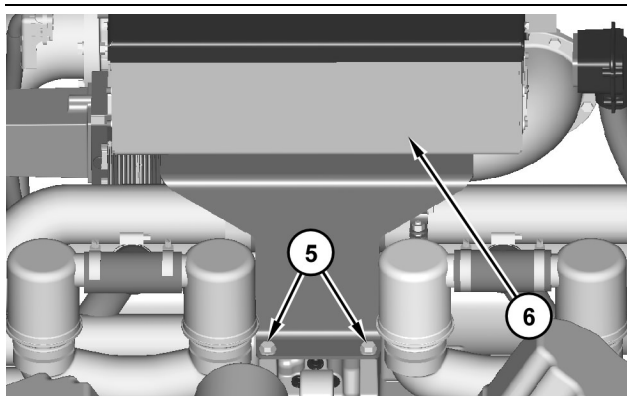


Illustration 108

g01209826

4. Remove bolts (5) and remove box (6).

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.

5. 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 - Change".

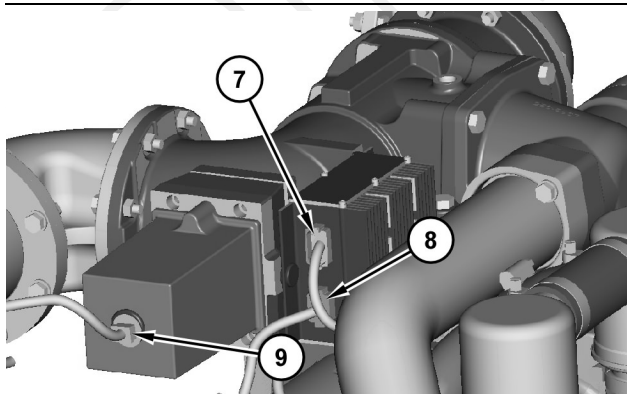


Illustration 109

g01200953

6. Disconnect harness assemblies (7), (8), and (9).

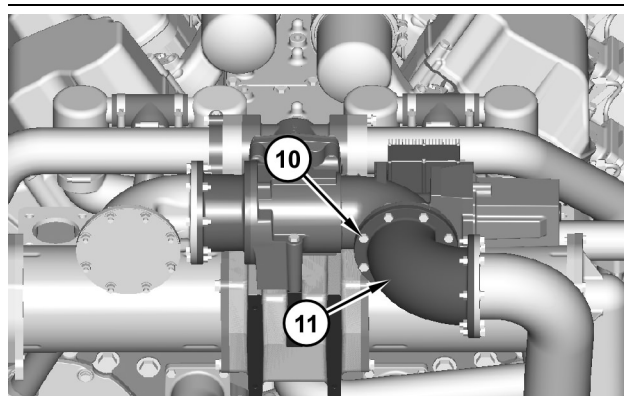


Illustration 110

g01200797

7. Remove bolts (10). Disconnect tube assembly (11).

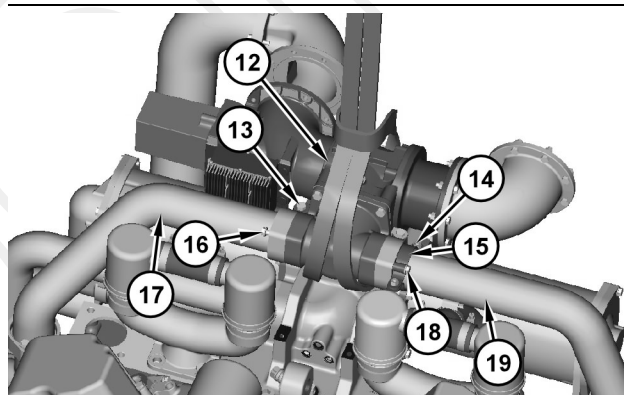


Illustration 111

g01200964

8. Attach a suitable lifting device onto water temperature control valve (12). The weight of water temperature control valve (12) is approximately 73 kg (160 lb). Loosen nuts (14) and the bolts. Slide clamp (15) out of the way. Remove bolts (18). Disconnect tube assembly (19). Remove bolts (16). Disconnect tube assembly (17). Remove bolts (13). Remove water temperature control valve (12).

i02421955

Water Temperature Control Valve - Install

SMCS Code: 1355-012

Installation Procedure

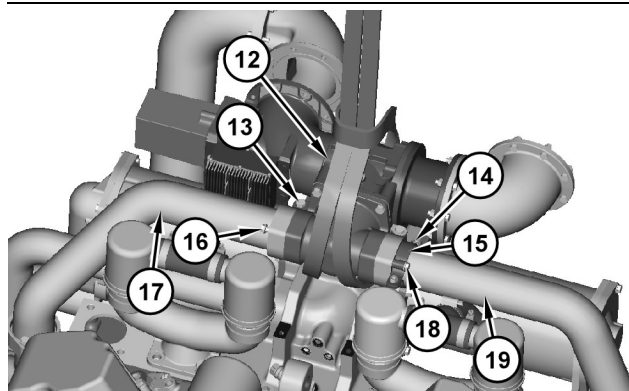


Illustration 112

g01200964

1. Attach a suitable lifting device onto water temperature control valve (12). The weight of water temperature control valve (12) is approximately 73 kg (160 lb). Position water temperature control valve (12). Install bolts (13). Position tube assembly (19). Install bolts (18). Slide clamp (15) into position and tighten nuts (14). Position tube assembly (17). Install bolts (16).

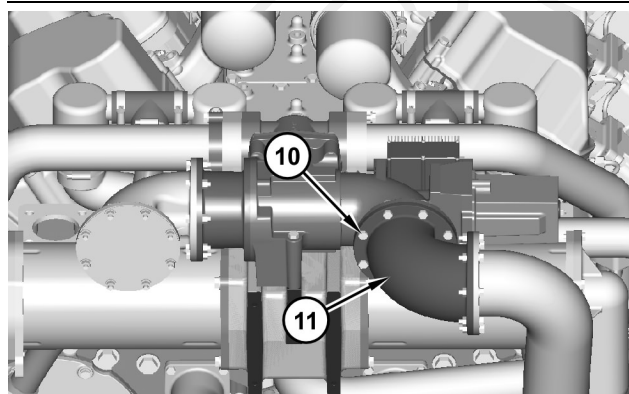


Illustration 113

g01200797

2. Position tube assembly (11). Install bolts (10).

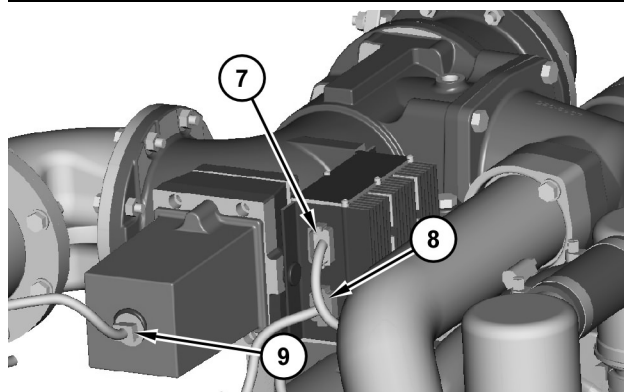


Illustration 114

g01200953

3. Connect harness assemblies (7), (8), and (9).

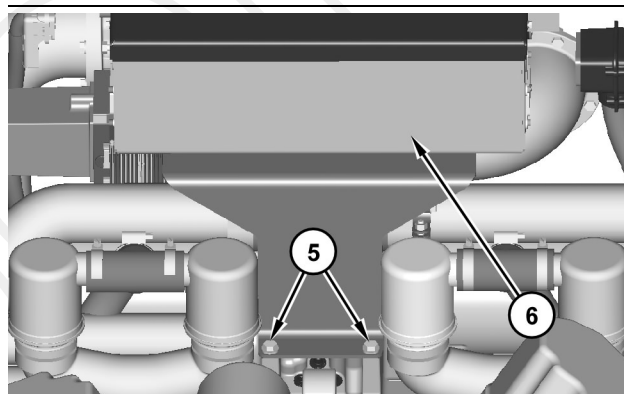


Illustration 115

g01209826

4. Position box (6). Install bolts (5).

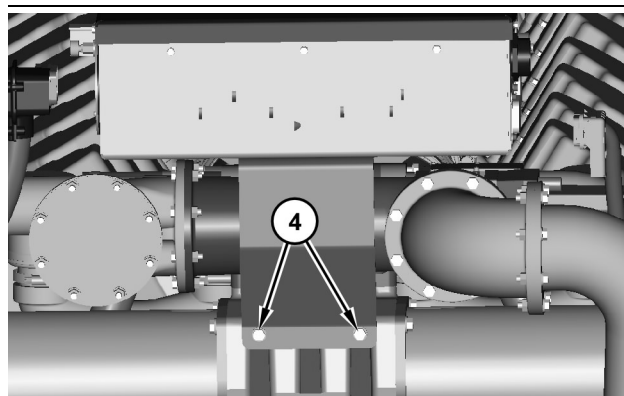


Illustration 116

g01209825

5. Install bolts (4).

i02404886

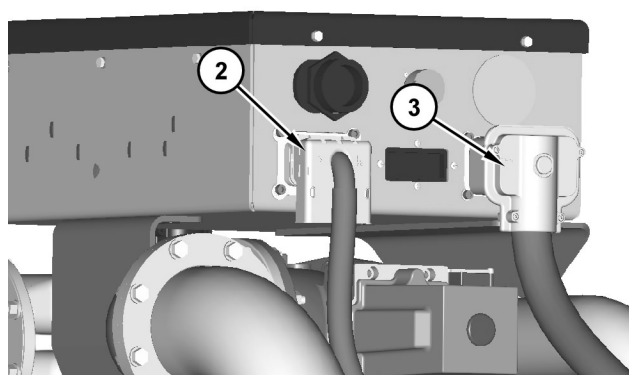


Illustration 117

g01209824

6. Connect harness assemblies (2) and (3).

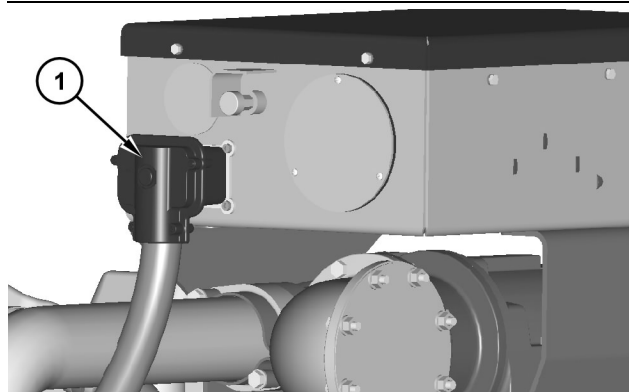


Illustration 118

g01209822

7. Connect harness assembly (1).
8. Fill the cooling system with coolant. Refer to Operation and Maintenance Manual, "Cooling System Coolant - Change".

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 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 - Change".

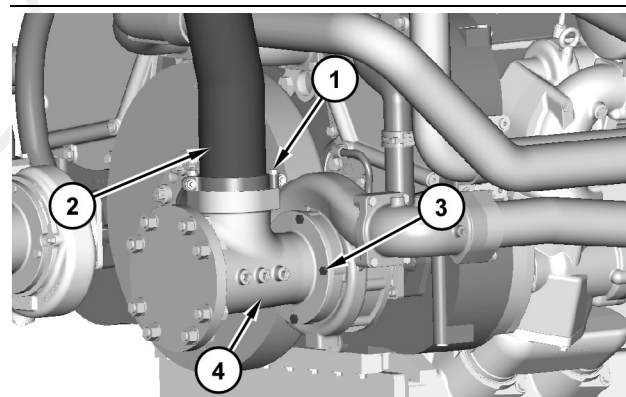


Illustration 119

g01201277

2. Remove bolts (1). Remove bolts (3). Remove elbow (4) from tube assembly (2). Remove the O-ring seal from elbow (4).

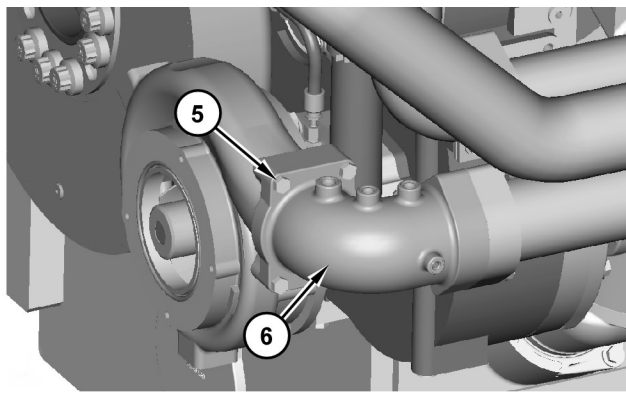


Illustration 120 g01201279

3. Remove bolts (5). Disconnect elbow (6). Remove the O-ring seal.

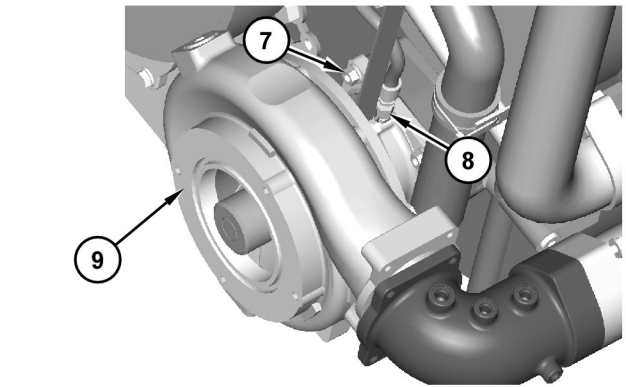


Illustration 121 g01201281

4. Attach a suitable lifting device onto water pump (9). The weight of water pump (9) is approximately 39 kg (85 lb). Disconnect hose assembly (8). Remove nuts (7) and remove water pump (7).

i02088955

Water Pump - Disassemble

SMCS Code: 1361-015

Disassembly Procedure

Table 12

Required Tools			
Tool	Part Number	Part Description	Qty
A	1P-0510	Driver Gp	1
B	-	1 inch by 4 inch steel plate	2
C	248-3311	Holding Fixture	1
D	248-3310	Locknut Wrench	1
E	8H-0663	Bearing Puller Gp	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.

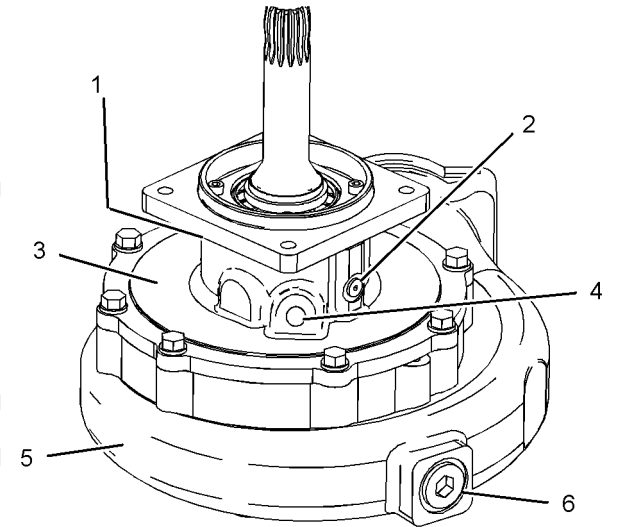


Illustration 122 g01036014

1. Remove plug (1) and plug (2) from bearing housing (3). Remove plug (6) from housing (5). Remove the O-ring seals from the plugs.
2. Remove water pump filter (4) from bearing housing (3).

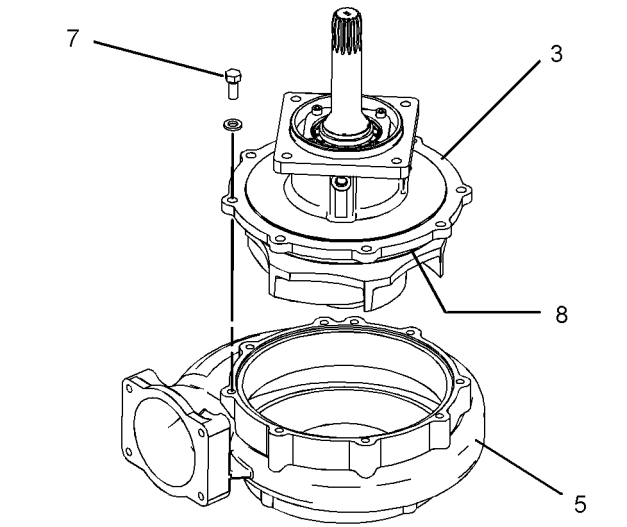


Illustration 123 g01035264

3. Remove bolts (7) and washers. Remove bearing housing (3) from housing (5). Remove O-ring seal (8) from bearing housing (3).

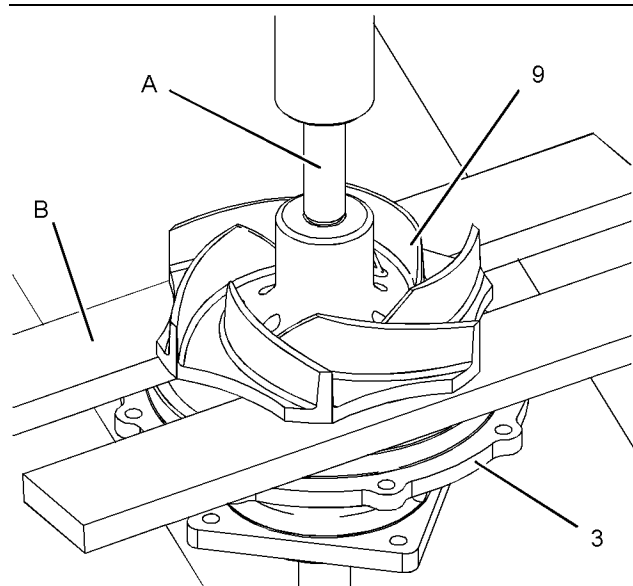


Illustration 124

g01035285

4. Install Tooling (B) under impeller (9). Use a suitable press and Tooling (A) to remove the impeller.

Note: Do not allow bearing housing (3) to fall to the floor when the impeller is removed from the pump shaft.

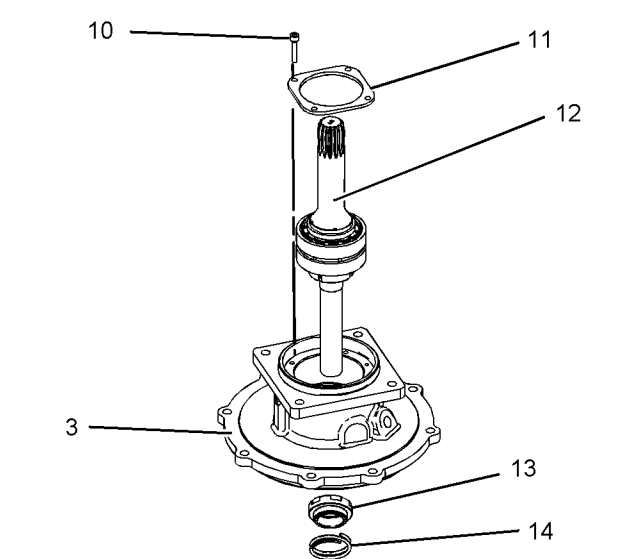


Illustration 125

g01035309

5. Remove socket head bolts (10). Remove retainer (11) and pump shaft (12) from bearing housing (3).

Note: Spring (14) and ceramic seal (13) will be removed from the shaft assembly when the pump shaft is removed from the bearing housing.

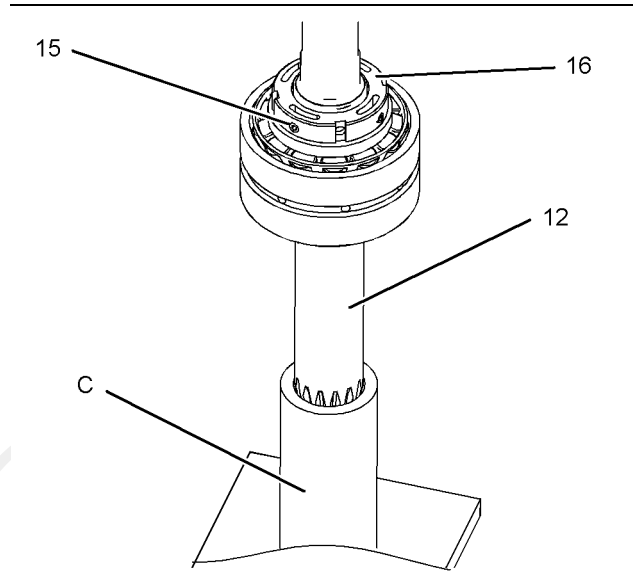


Illustration 126

g01035407

6. Install pump shaft (12) in Tooling (C). Loosen set screws (15). Use Tooling (D) to remove bearing locknut (16) from the pump shaft.

Note: The splined end of the pump shaft is marked in order to indicate either RH threads or LH threads on the pump shaft.

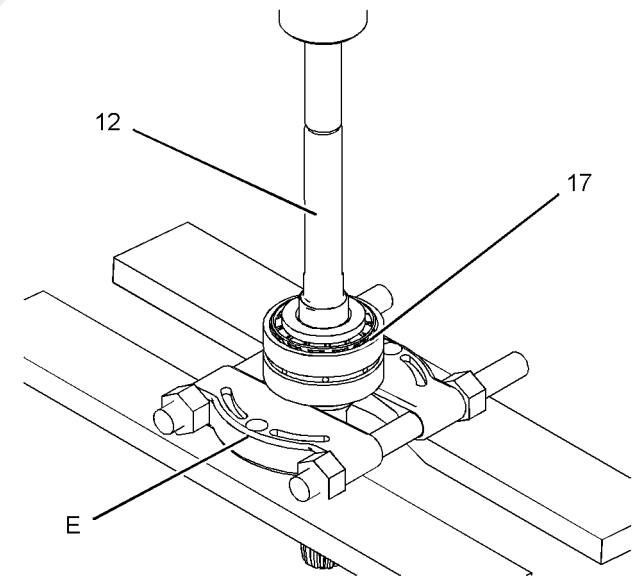


Illustration 127

g01035429

7. Use Tooling (E) to remove bearing assembly (17) from pump shaft (12).

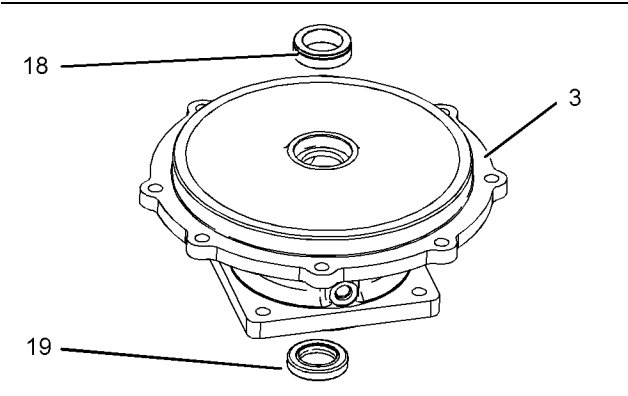


Illustration 128 g01035437

8. Remove ceramic seal (18) and lip seal (19) from bearing housing (3).

Water Pump - Assemble

SMCS Code: 1361-016

Assembly Procedure

Table 13

Required Tools			
Tool	Part Number	Part Description	Qty
A	1P-0510	Driver Gp	1
C	248-3311	Holding Fixture	1
D	248-3310	Locknut Wrench	1
E	8H-0663	Bearing Puller Gp	1
F	1U-6396	O-Ring Assembly Compound	-
G	7N-8268	Installation Tool	1
H	8H-8581	Feeler Gauge	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

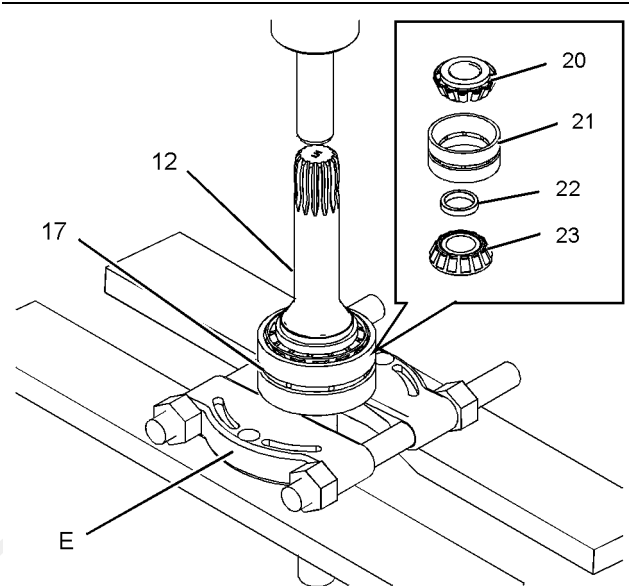


Illustration 129 g01040290

1. Use Tooling (E) and a suitable press to install bearing assembly (17) on pump shaft (12).
2. Install bearing cone (23) on the pump shaft.
3. Install spacer (22) and bearing cups (21) on the pump shaft.
4. Install bearing cone (20) on the pump shaft.

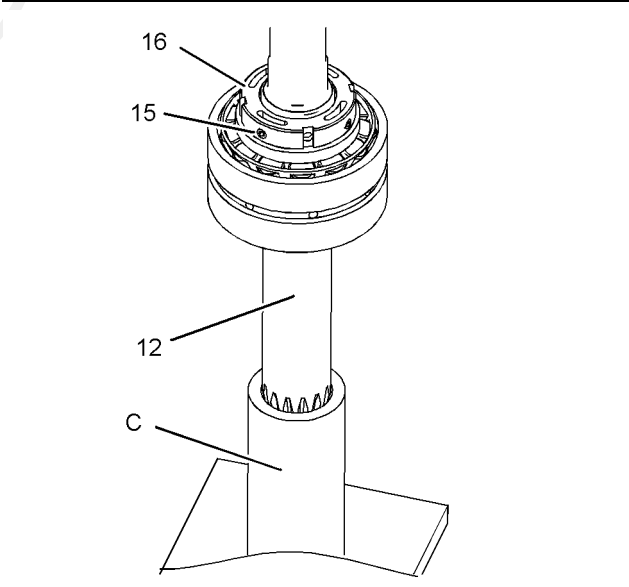


Illustration 130 g01035607

5. The splined end of the pump shaft is marked in order to indicate either RH threads or LH threads on the pump shaft. Install bearing locknut (16). Use Tooling (D) on the bearing locknut. Tighten the bearing locknut to a torque of 300 ± 30 N·m (221 ± 22 lb ft).

Note: The torque wrench must be 90 degrees to Tooling (D).

6. Install set screws (15) and tighten to a torque of $4 \pm 1 \text{ N}\cdot\text{m}$ ($35 \pm 9 \text{ lb in}$).

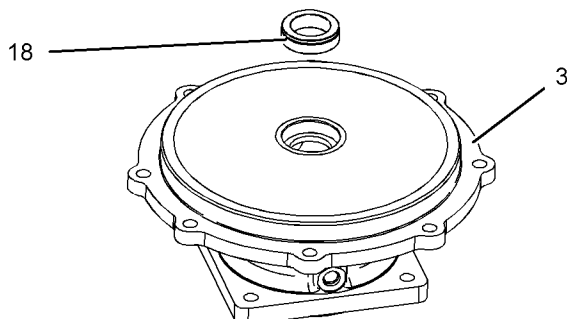


Illustration 131

g01035690

Note: Do not damage the wear surfaces of the carbon ring or the ceramic ring. Do not touch the wear surfaces of the carbon ring or the ceramic ring. Install the ceramic ring with the smoothest face of the ring toward the carbon seal.

7. Apply Tooling (F) to the outside diameter of ceramic seal (18). Use Tooling (G) and hand pressure to install ceramic seal (18) in bearing housing (3).

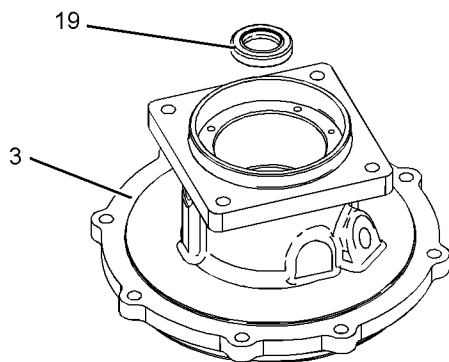


Illustration 132

g01035699

8. Use Tooling (A) and a suitable press to install lip seal (19) in bearing housing (3). Ensure that the lip is toward the outside.

Note: Install the lip seal dry. Install the lip seal within two minutes of removal from the shipping sleeve.

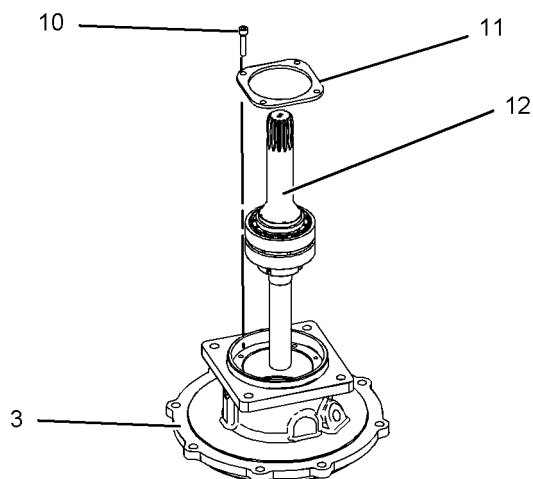


Illustration 133

g01035809

9. Lubricate pump shaft (12) with clean engine oil. Install the pump shaft in bearing housing (3). Install retainer (11). Install socket head bolts (10) and tighten to a torque of $12 \pm 3 \text{ N}\cdot\text{m}$ ($9 \pm 2 \text{ lb ft}$).

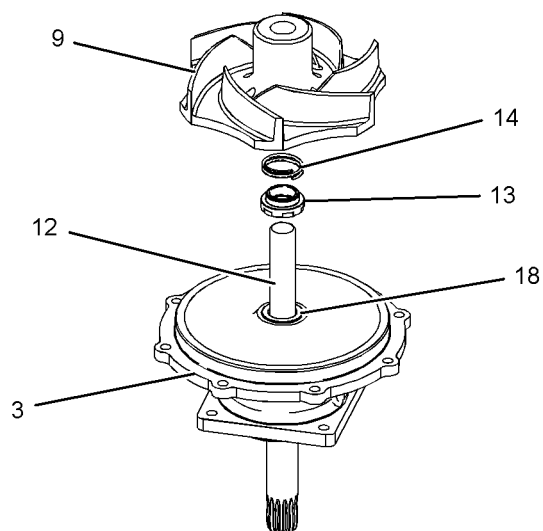


Illustration 134

g01035829

Note: Do not damage the wear surfaces of the carbon ring or the ceramic ring. Do not touch the wear surfaces of the carbon ring or the ceramic ring. Install the ceramic ring with the smoothest face of the ring toward the carbon seal.

10. Remove spring (14) from ceramic seal (13).

11. Apply Tooling (F) to the inside diameter of ceramic seal (13). Use hand pressure and the tool that is supplied with the water pump seal group to install the ceramic seal. The face of ceramic seal (13) should make light contact with ceramic seal (18).

12. Install spring (14).

13. Lubricate pump shaft (12) on bearing housing (3) with clean engine oil. Position impeller (9) on the pump shaft.

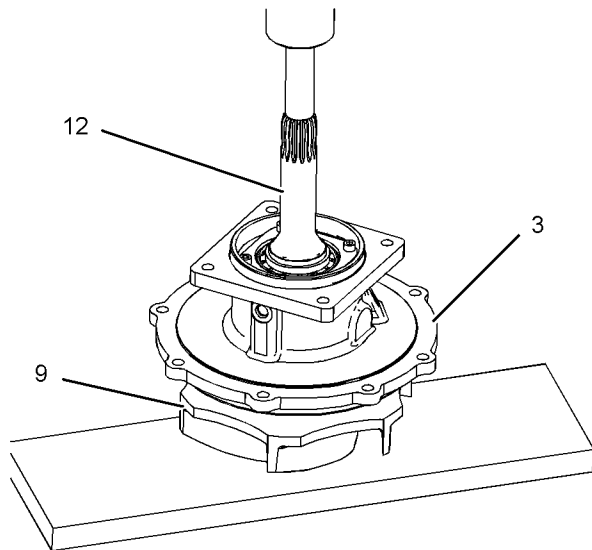


Illustration 135

g01035846

14. Place bearing housing (3) on impeller (9). Use a suitable press and press pump shaft (12) into the impeller. Install the impeller so the dimension between the impeller and the pump shaft is 0.000 ± 0.076 mm (0.0000 ± 0.0030 inch).

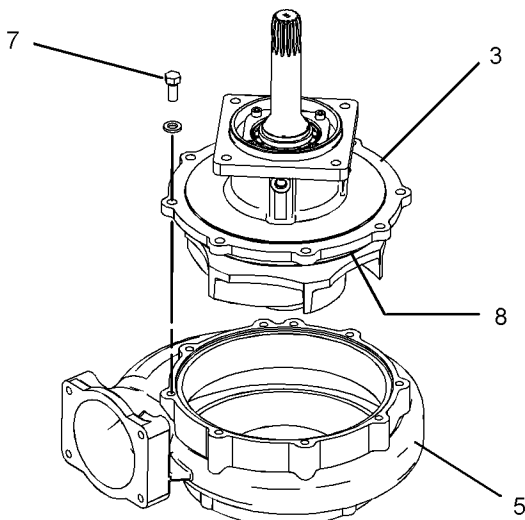


Illustration 136

g01035264

15. Install O-ring seal (8) on bearing housing (3). Lubricate the O-ring seal with clean engine oil.

16. Position bearing housing (3) in housing (5). Install washers and bolts (7) finger tight.

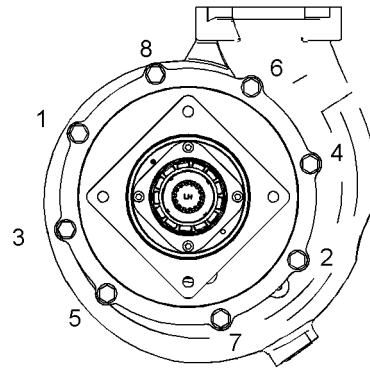


Illustration 137

g01036084

17. Tighten the bolts in a numerical sequence to a torque of 50 ± 9 N·m (35 ± 7 lb ft).

18. Use Tooling (H) and measure the gap between the impeller and the pump housing. The minimum gap between the impeller and the pump housing is 0.20 mm (0.008 inch).

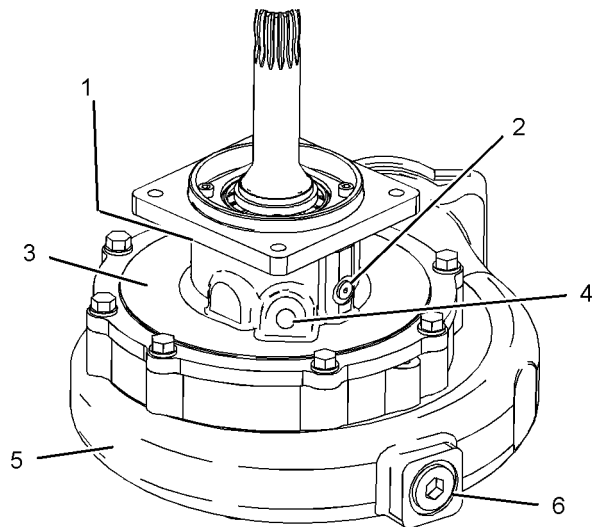


Illustration 138

g01036014

19. Install the O-ring seal on plug (6). Install the plug in housing (5). Tighten the plug to a torque of 177 ± 7 N·m (131 ± 6 lb ft).

20. Install the O-ring seal on plug (2). Install the plug in bearing housing (3). Tighten the plug to a torque of 8 ± 1 N·m (6 ± 1 lb ft).

21. Install the O-ring seal on plug (1). Install the plug in bearing housing (3). Tighten the plug to a torque of 17 ± 1 N·m (12 ± 1 lb ft).

22. Install water pump filter (4) in bearing housing (3).

End By:

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

i02404917

Water Pump - Install

SMCS Code: 1361-012

Installation Procedure

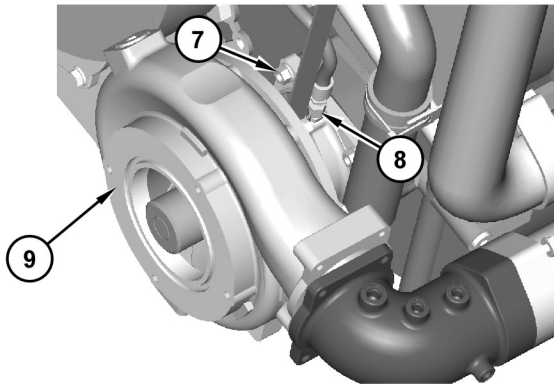


Illustration 139

g01201281

1. Attach a suitable lifting device onto water pump (9). The weight of water pump (9) is approximately 39 kg (85 lb). Position water pump (9) onto the engine and install nuts (7). Connect hose assembly (8).

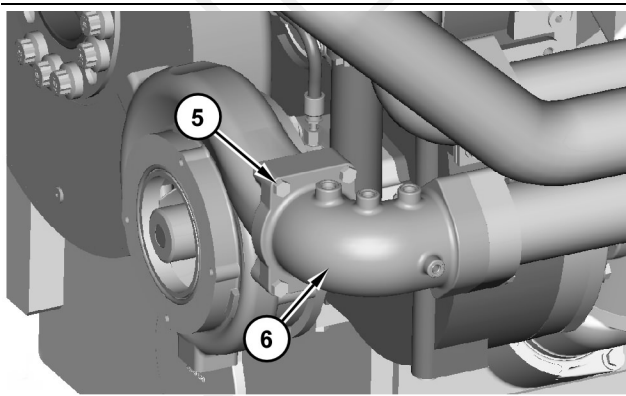


Illustration 140

g01201279

2. Position the O-ring seal and elbow (6). Install bolts (5).

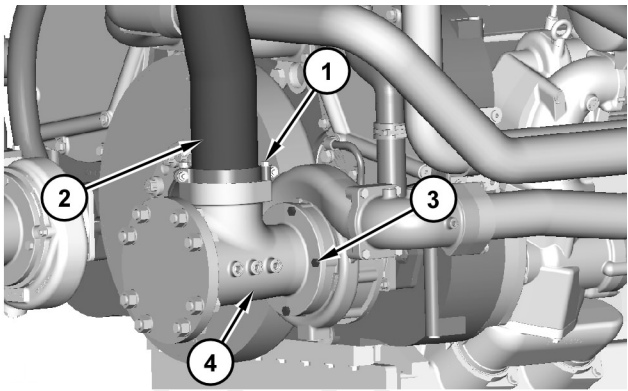


Illustration 141

g01201277

3. Position the O-ring seal onto elbow (4). Install elbow (4) into tube assembly (2). Install bolts (3). Install bolts (1).
4. Fill the cooling system with coolant. Refer to Operation and Maintenance Manual, "Cooling System Coolant - Change".

i02428493

Fuel and Auxiliary Water Pump Drive - Remove and Install

SMCS Code: 1288-010; 1371-010-DRV

Removal Procedure

Table 14

Required Tools			
Tool	Part Number	Part Description	Qty
A	138-7575	Link Bracket	1
B	1P-0520	Driver Gp	1

Start By:

- a. Remove the fuel pump. Refer to Disassembly and Assembly, "Fuel Pump (Manifold) - Remove and Install".
- b. Remove the auxiliary water pump. Refer to Disassembly and Assembly, "Auxiliary Water Pump - Remove".

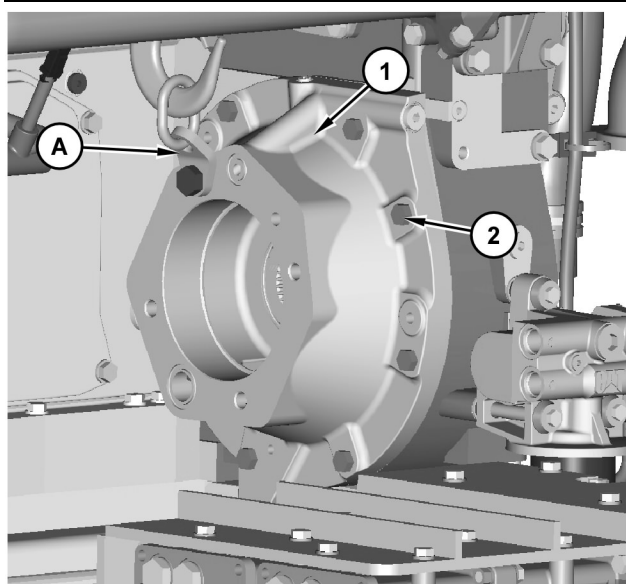


Illustration 142

g01213642

1. Attach Tooling (A) and a suitable lifting device onto housing (1). The weight of housing (1) is approximately 23 kg (50 lb). Remove bolts (2). Remove housing (1).

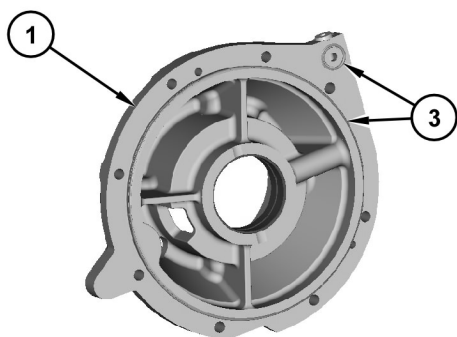


Illustration 143

g01213648

2. Remove O-ring seals (3) from housing (1).

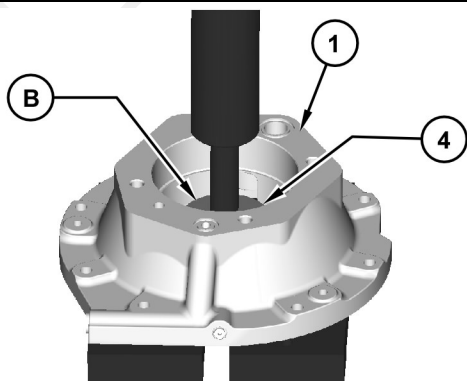


Illustration 144

g01213659

3. Use Tooling (B) and a suitable press in order to remove bearing (4) from housing (1).

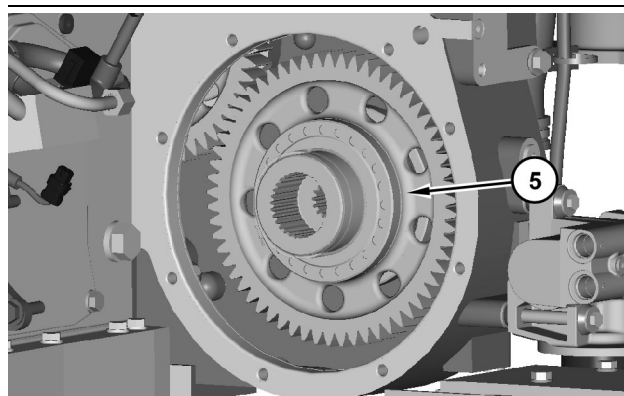


Illustration 145

g01213645

4. Remove the fuel and auxiliary water pump drive gear (5).

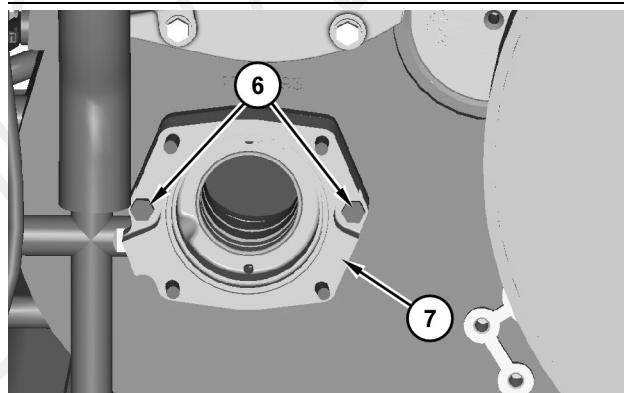


Illustration 146

g01215057

5. Remove bolts (6). Remove adapter (7).

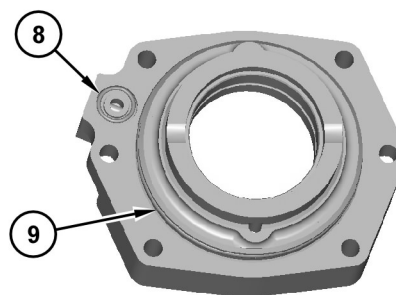


Illustration 147

g01215060

6. Remove O-ring seals (8) and (9).

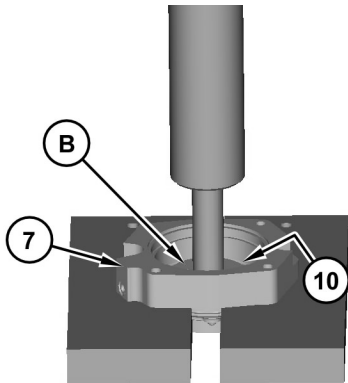


Illustration 148

g01215061

7. Use Tooling (B) and a suitable press in order to remove bearing (10) from adapter (7).

Installation Procedure

Table 15

Required Tools			
Tool	Part Number	Part Description	Qty
A	138-7575	Link Bracket	1
B	1P-0520	Driver Gp	1

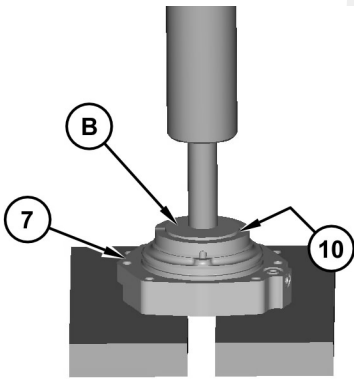


Illustration 149

g01215071

1. Use Tooling (B) and a suitable press in order to install bearing (10) into adapter (7).

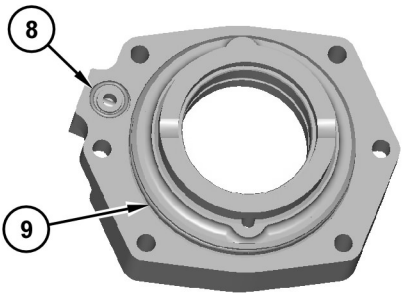


Illustration 150

g01215060

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

2. Install O-ring seals (8) and (9).

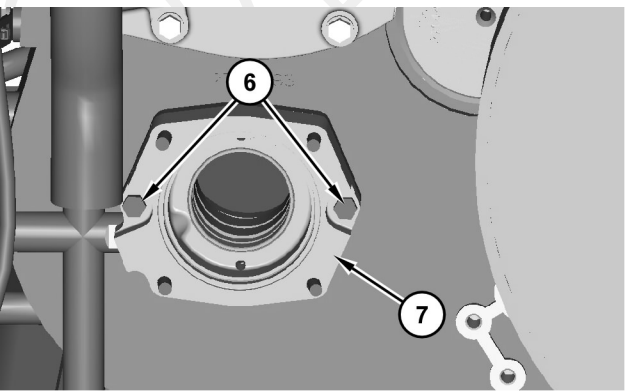


Illustration 151

g01215057

3. Install adapter (7). Install bolts (6).

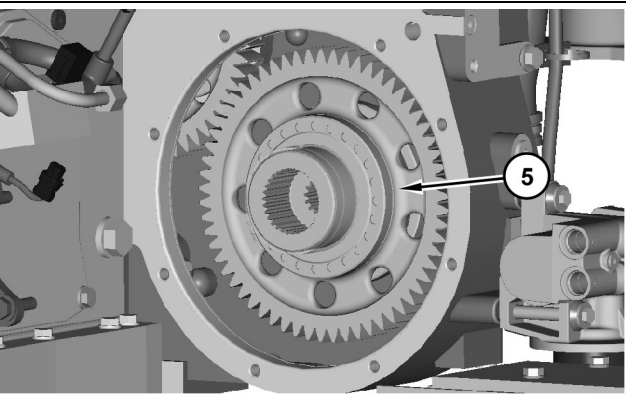


Illustration 152

g01213645

4. Install the fuel and auxiliary water pump drive gear (5).

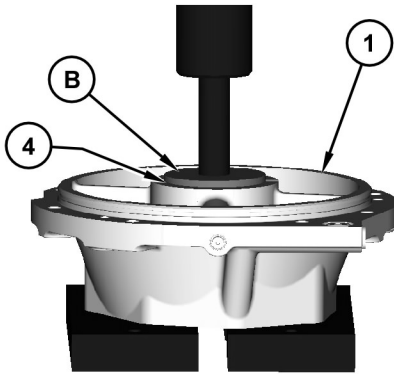


Illustration 153

g01213693

5. Use Tooling (B) and a suitable press in order to install bearing (4) into housing (1).

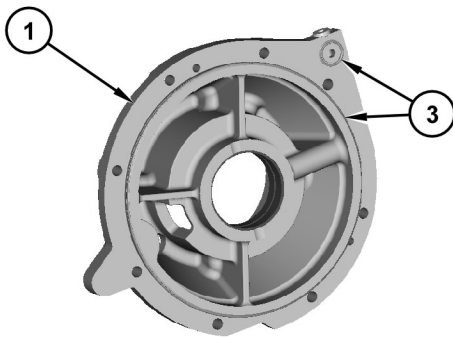


Illustration 154

g01213648

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

6. Install O-ring seals (3) into housing (1).

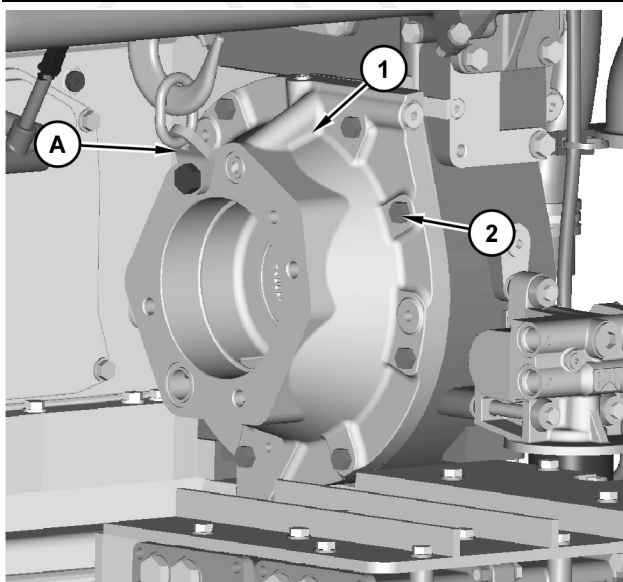


Illustration 155

g01213642

7. Attach Tooling (A) and a suitable lifting device onto housing (1). The weight of housing (1) is approximately 23 kg (50 lb). Position housing (1). Install bolts (2).

End By:

- Install the auxiliary water pump. Refer to Disassembly and Assembly, "Auxiliary Water Pump - Install".
- Install the fuel pump. Refer to Disassembly and Assembly, "Fuel Pump (Manifold) - Remove and Install".

i02412405

Auxiliary Water Pump - Remove

SMCS Code: 1371-011

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.

- 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 - Change".

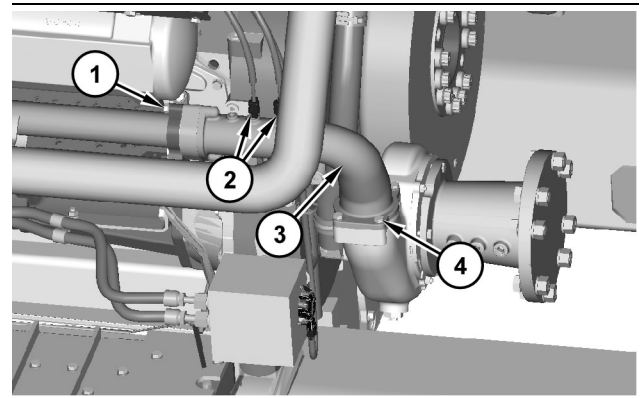


Illustration 156

g01205788

2. Disconnect harness assemblies (2). Remove bolts (1). Remove bolts (4). Remove tube assembly (3).

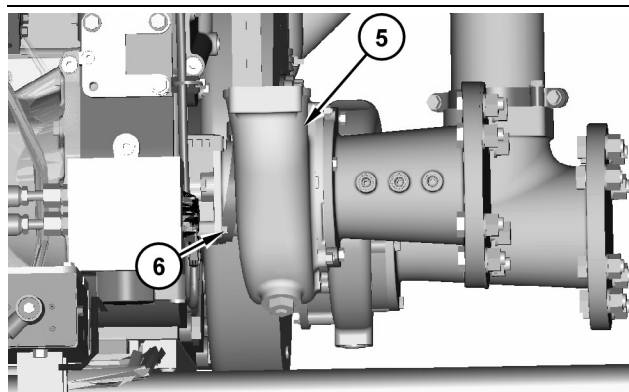


Illustration 157

g01205790

3. Attach a suitable lifting device onto auxiliary water pump (5). The weight of auxiliary water pump (5) is approximately 27 kg (60 lb). Remove bolts (6). Remove auxiliary water pump (5).

i02410903

Auxiliary Water Pump - Disassemble

SMCS Code: 1371-015

Disassembly Procedure

Table 16

Required Tools			
Tool	Part Number	Part Description	Qty
A	1U-9895	Crossblock	1
	1P-0820	Hydraulic Puller	1
	126-7181	Sliding Plate	2
	3H-0465	Push-Puller Plate	6
	2S-4680	Stud	2
	3S-6224	Electric Hydraulic Pump Gp	1
	2L-4523	Bolt	2
	5P-8244	Hard Washer	2
	6B-6682	Full Nut	2
	2J-3506	Full Nut	2

Start By:

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

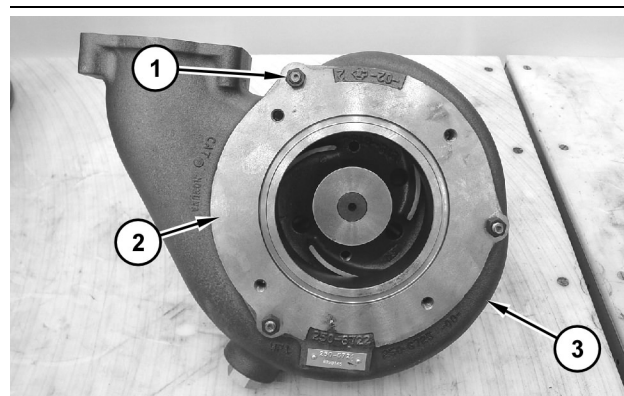


Illustration 158

g01204934

1. Remove nuts (1). Remove cover (2) from water pump (3).

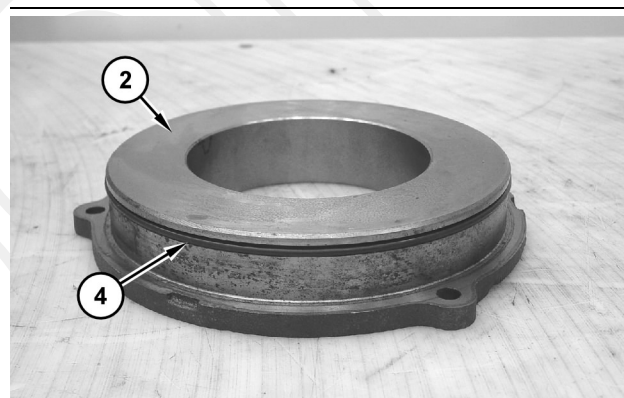


Illustration 159

g01204935

2. Remove O-ring seal (4) from cover (2).

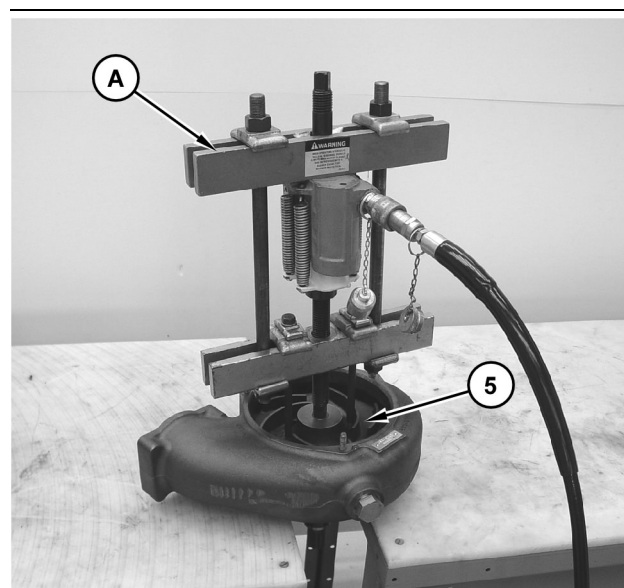


Illustration 160

g01207677

⚠ 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.

3. Use Tooling (A) in order to remove impeller (5).

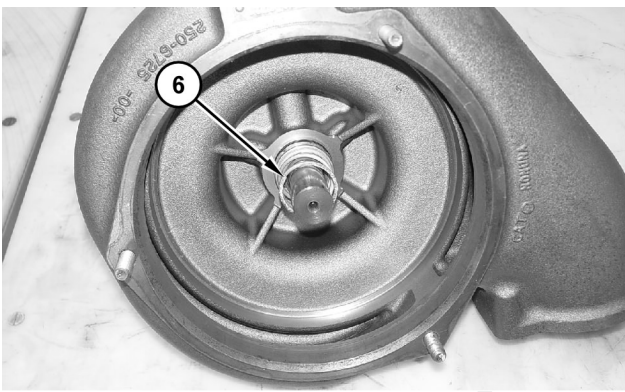


Illustration 161 g01207678

4. Remove spring (6).

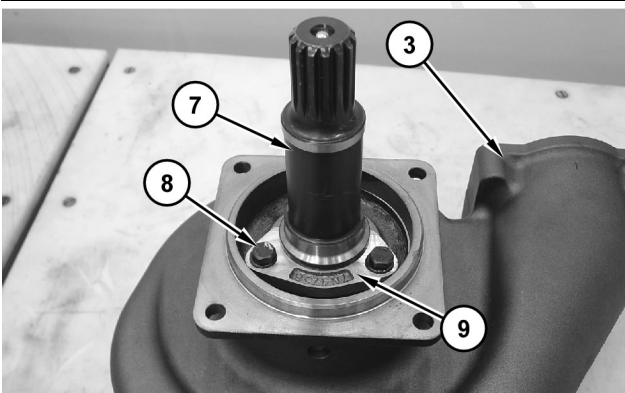


Illustration 162 g01207696

5. Turn over water pump (3). Remove bolts (8). Remove shaft (7) and thrust washer (9). When you remove shaft (7) the seal ring will be free from shaft (7).

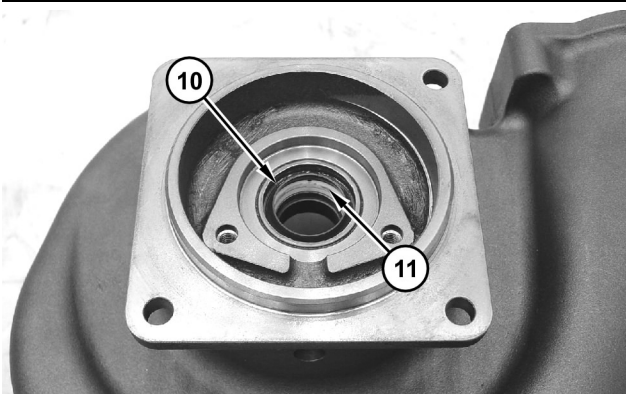


Illustration 163 g01207698

6. Remove seal (10) and ring assembly (11).

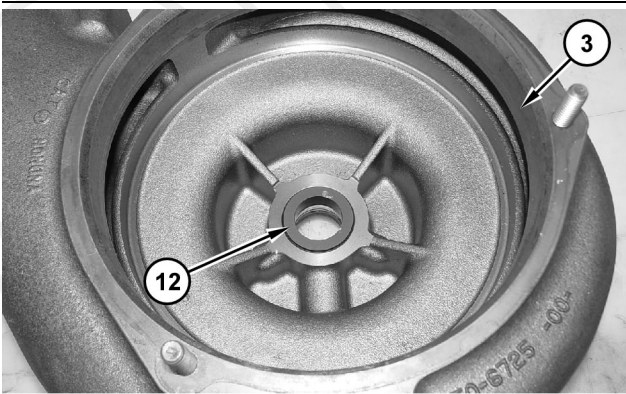


Illustration 164 g01207700

7. Turn over water pump (3). Remove the rubber seal and the ceramic ring of seal group (12).

i02416362

Auxiliary Water Pump - Assemble

SMCS Code: 1371-016

Assembly Procedure

Table 17

Required Tools			
Tool	Part Number	Part Description	Qty
B	1P - 0510	Driver Gp	1
C	207 - 1601	Rubber Lubricant	1
D	7N - 8268	Installation Tool	1

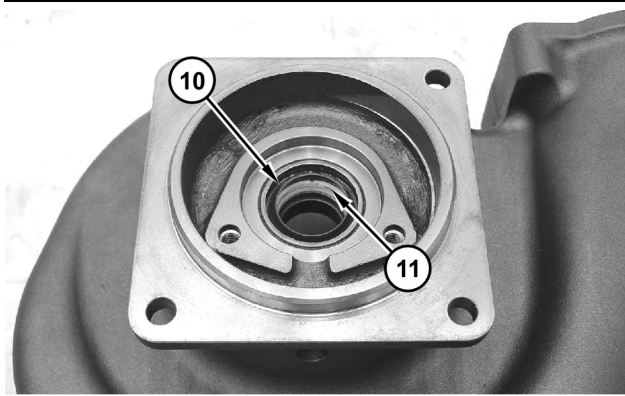


Illustration 165

g01207698

1. Do not lubricate the sealing lip of seal (10). Install ring assembly (11). Use Tooling (B) to install seal (10).

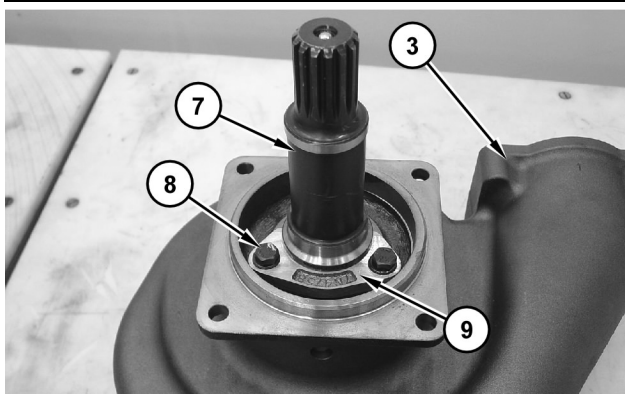


Illustration 166

g01207696

2. Install shaft (7) with thrust washer (9) into water pump (3). Install bolts (8).

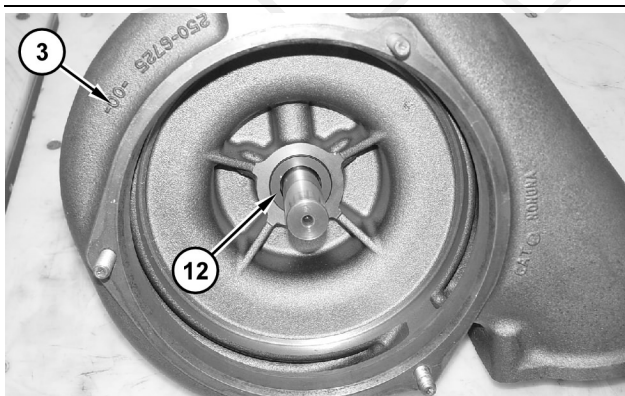


Illustration 167

g01207752

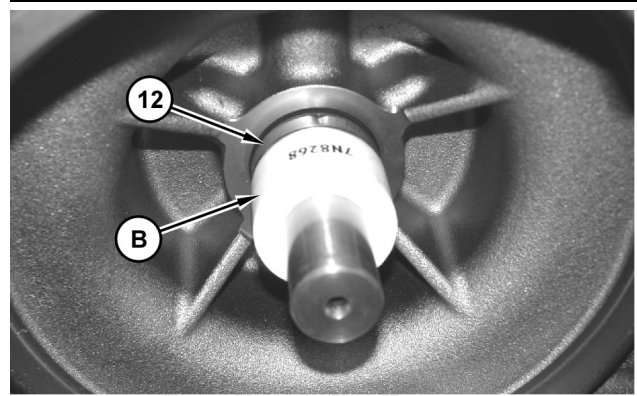


Illustration 168

g01207755

3. Turn over water pump (3). Use water or Tooling (C) to aid assembly. Use Tooling (D) and hand pressure to seat the ceramic ring and the rubber seal of seal group (12) into water pump (3). Remove the spring from the seal ring. Use Tooling (D) and hand pressure to press the seal ring of seal group (12) on the shaft until the seal faces make contact.

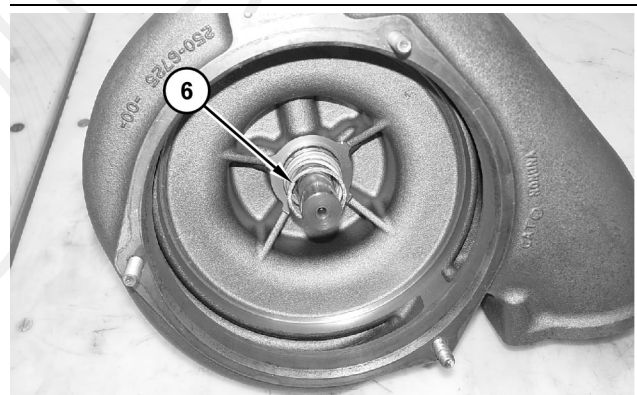


Illustration 169

g01207678

4. Install spring (6).

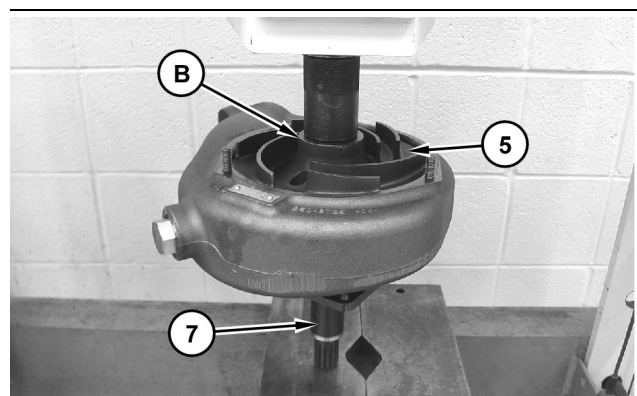


Illustration 170

g01207798

⚠ 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.

5. Lubricate shaft (7) with clean engine oil. Use Tooling (B) and a suitable press in order to install impeller (5) onto shaft (7). Install impeller (5) until impeller (5) is flush with shaft (7).

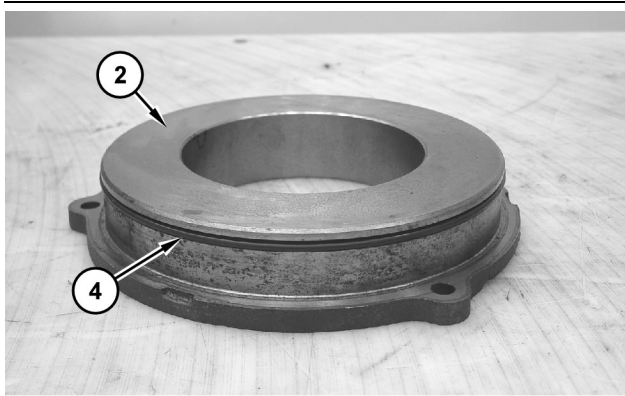


Illustration 171

g01204935

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

6. Install O-ring seal (4) onto cover (2).

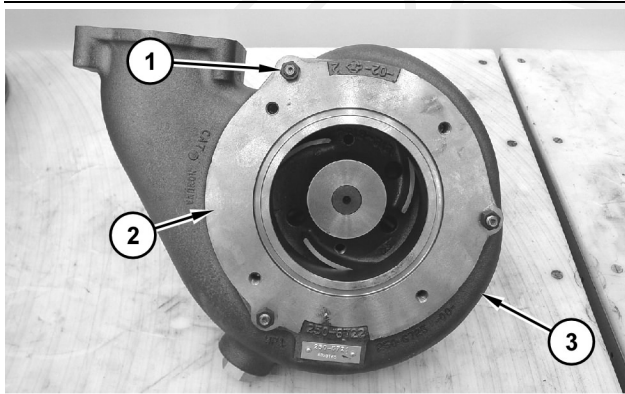


Illustration 172

g01204934

7. Install cover (2) onto water pump (3). Install nuts (1).

End By:

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

i02412497

Auxiliary Water Pump - Install

SMCS Code: 1371-012

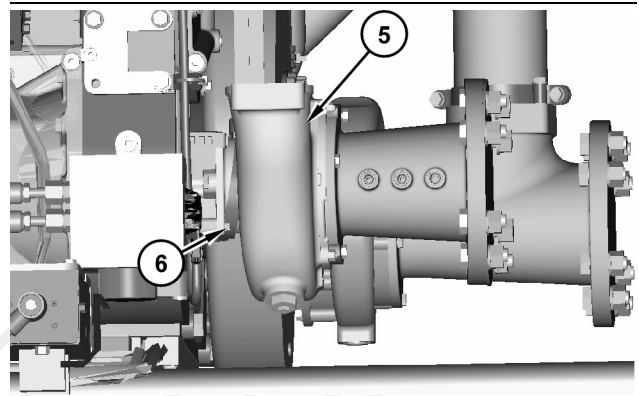
Installation Procedure

Illustration 173

g01205790

1. Attach a suitable lifting device onto auxiliary water pump (5). The weight of auxiliary water pump (5) is approximately 27 kg (60 lb). Position auxiliary water pump (5). Install bolts (6).

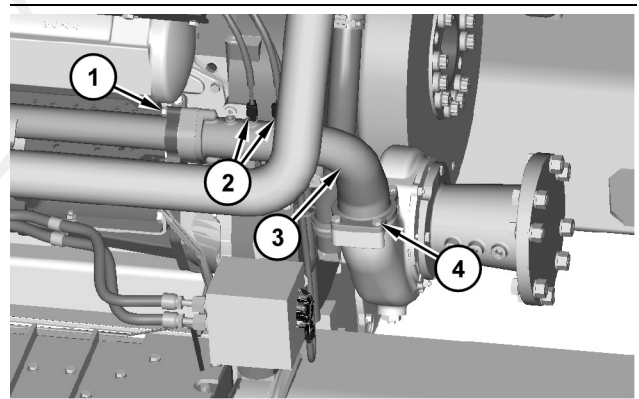


Illustration 174

g01205788

2. Install tube assembly (3). Install bolts (4). Install bolts (1). Connect harness assemblies (2).
3. Fill the cooling system with coolant. Refer to Operation and Maintenance Manual, "Cooling System Coolant - Change".

i02401974

Engine Oil Cooler - Remove

SMCS Code: 1378-011

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.

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

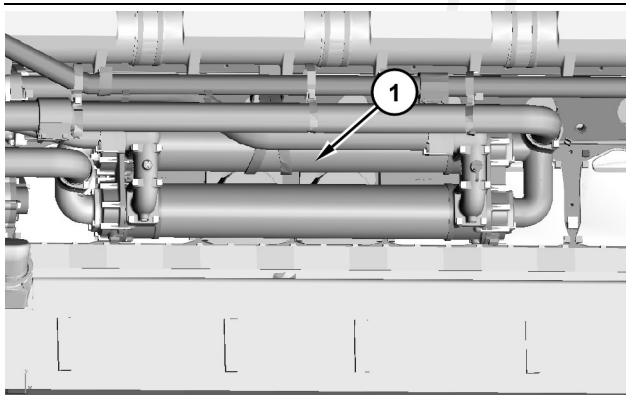


Illustration 175

g01199582

2. Attach a suitable lifting device onto engine oil cooler (1). The weight of engine oil cooler (1) is approximately 150 kg (330 lb).

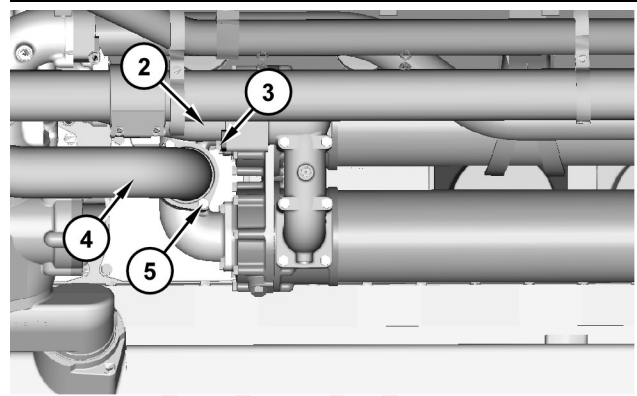


Illustration 176

g01199583

3. Remove bolts (3). Disconnect tube assembly (2). Remove bolts (5). Disconnect tube assembly (4).

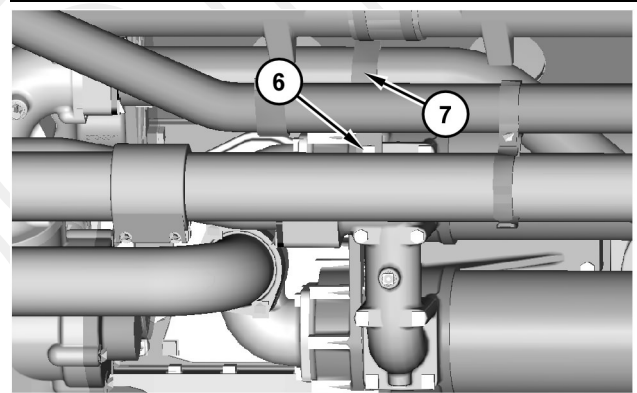


Illustration 177

g01199749

4. Remove bolt (6) in order to disconnect clamp (7).

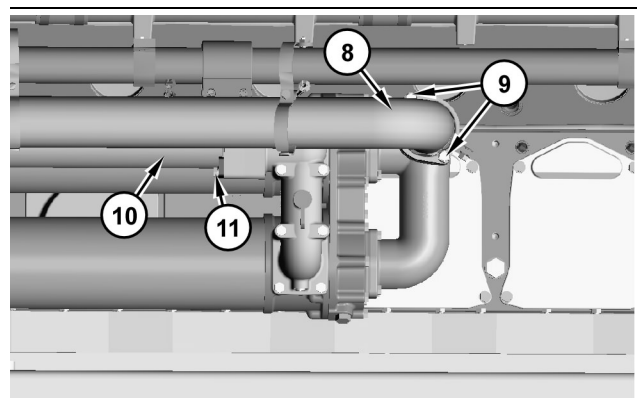


Illustration 178

g01199585

5. Remove bolts (9). Disconnect tube assembly (8). Remove bolts (11). Disconnect tube assembly (10).

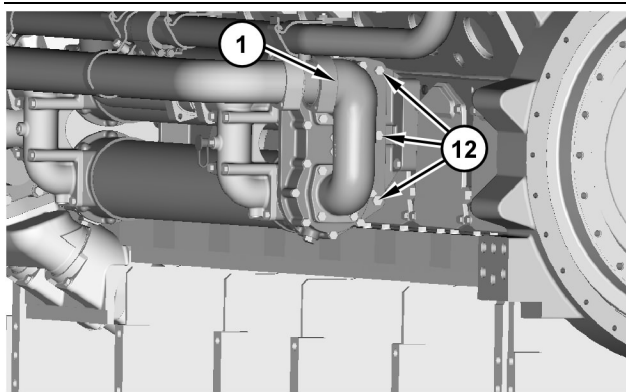


Illustration 179

g01200161

6. Remove bolts (12) from engine oil cooler (1). Repeat for the opposite side.

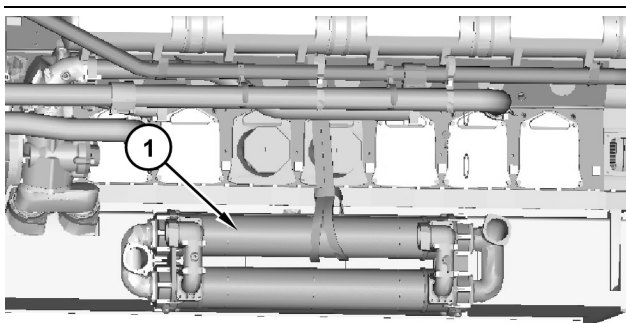


Illustration 180

g01199773

7. Lower engine oil cooler (1) to the ground.

i02402370

Engine Oil Cooler - Disassemble

SMCS Code: 1378-015

Disassembly Procedure

Start By:

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

Note: Note the orientation of the elbow for assembly purposes.

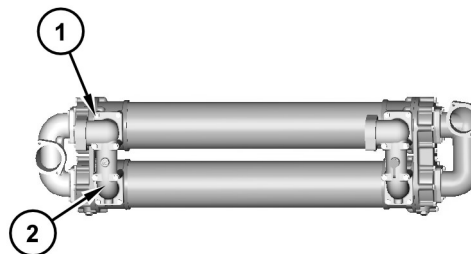


Illustration 181

g01200523

1. Remove bolts (1). Remove elbow (2) and the O-ring seals. Repeat for the opposite side.

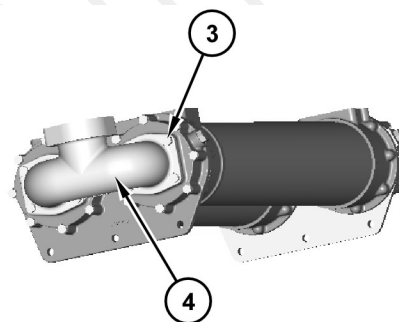


Illustration 182

g01200524

2. Remove bolts (3). Remove elbow (4) and the O-ring seals. Repeat for the opposite side.

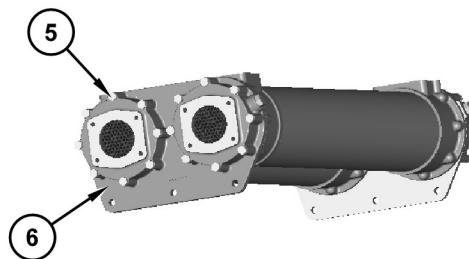


Illustration 183

g01200526

3. Remove bolts (5). Remove bonnet (6) and the gaskets. Repeat for the opposite side.

i02404098

Engine Oil Cooler - Assemble

SMCS Code: 1378-016

Assembly Procedure

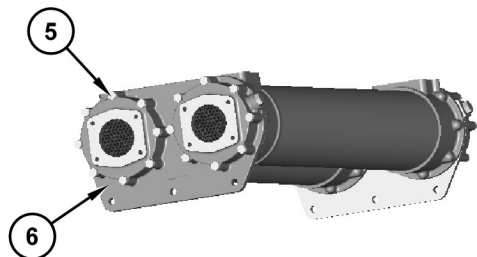


Illustration 184

g01200526

1. Position the gaskets and bonnet (6). Install bolts (5).

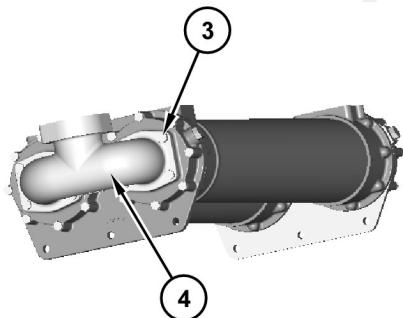


Illustration 185

g01200524

2. Position the O-ring seals and elbow (4). Install bolts (3).

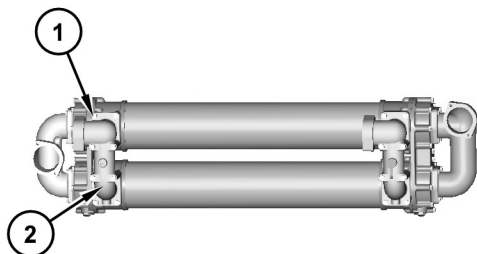


Illustration 186

g01200523

3. Position the O-ring seals and elbow (2). Install bolts (1).

End By:

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

i02402290

Engine Oil Cooler - Install

SMCS Code: 1378-012

Installation 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.

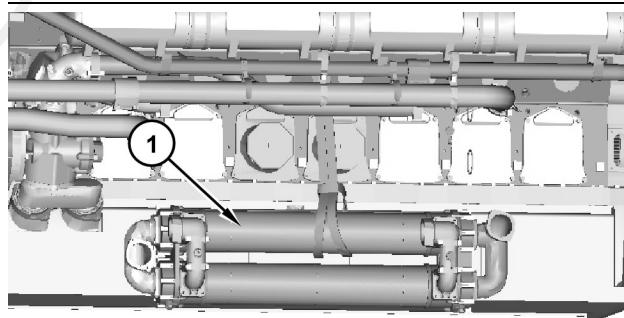


Illustration 187

g01199773

1. Attach a suitable lifting device onto engine oil cooler (1). The weight of engine oil cooler (1) is approximately 150 kg (330 lb).

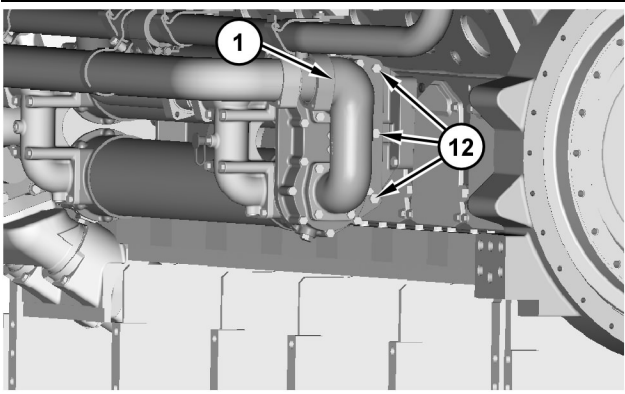


Illustration 188 g01200161

- 2. Position engine oil cooler (1). Install bolts (12). Repeat for the opposite side.

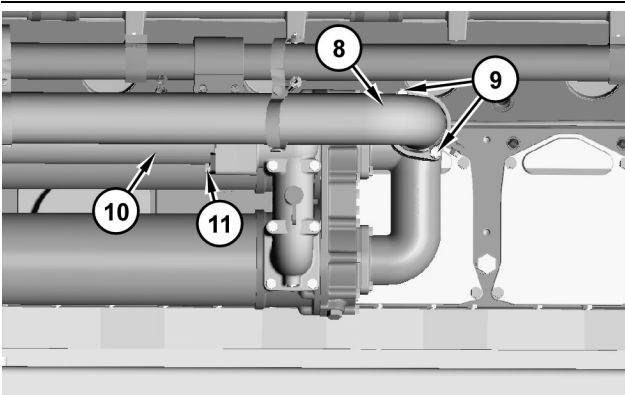


Illustration 189 g01199585

- 3. Connect tube assembly (10). Install bolts (11). Connect tube assembly (8). Install bolts (9).

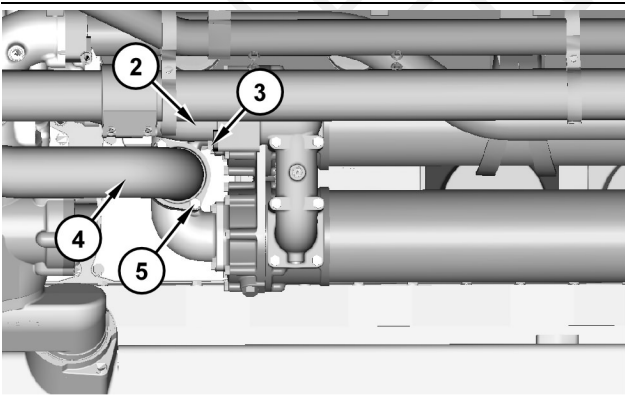


Illustration 190 g01199583

- 4. Connect tube assembly (4). Install bolts (5). Connect tube assembly (2). Install bolts (3).

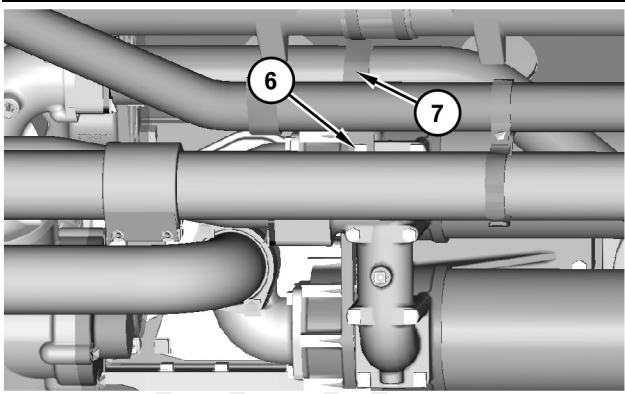


Illustration 191 g01199749

- 5. Position clamp (7) and install bolt (6).
- 6. Fill the cooling system with coolant. Refer to Operation and maintenance Manual, "Cooling System Coolant - Change".

i02487849

Engine Oil Pump - Remove

SMCS Code: 1304-011

Removal Procedure

Table 18

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

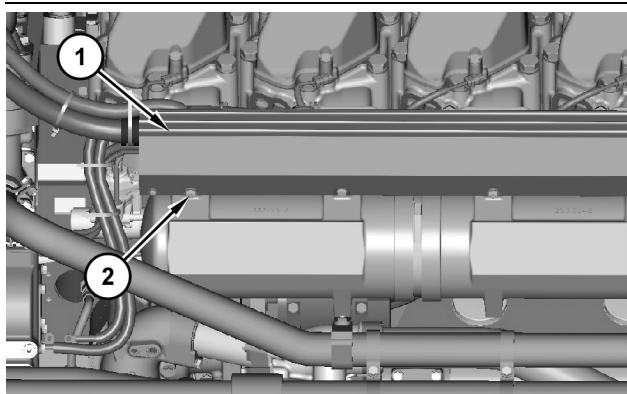


Illustration 192

g01242428

1. Remove bolts (2) from cover (1) for the harness assembly. Position cover (1) for the harness assembly out of the way.

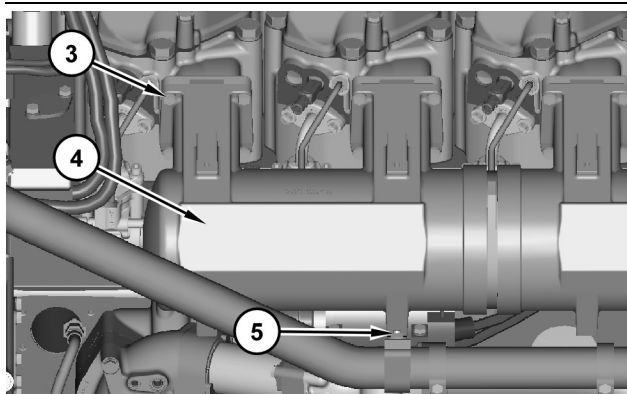


Illustration 193

g01242429

2. Remove bolts (3). Remove bolt (5). Remove the end section of air inlet manifold (4) and the gaskets.

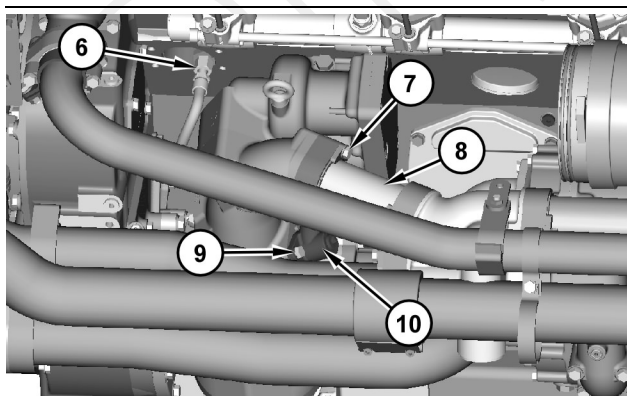


Illustration 194

g01242430

3. Remove hose assembly (6). Remove bolts (7) and disconnect tube assembly (8). Remove bolts (9) and disconnect tube assembly (10).

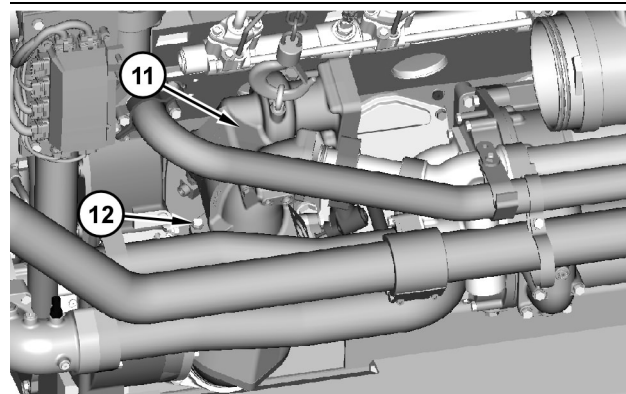


Illustration 195

g01242431

4. Attach a suitable lifting device onto regulator assembly (11). The weight of regulator assembly (11) is approximately 34 kg (75 lb). Remove bolts (12). Remove regulator assembly (11).

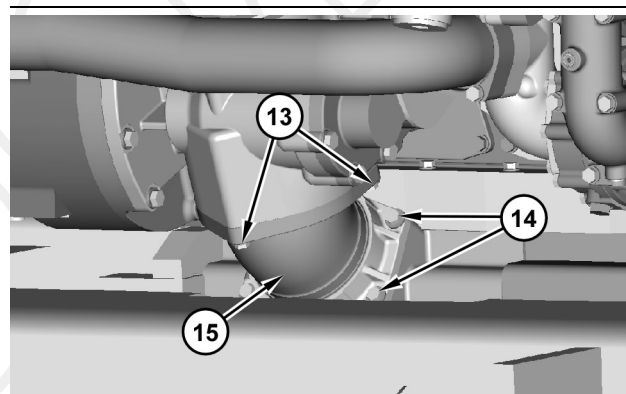


Illustration 196

g01242497

5. Remove bolts (13) and (14). Remove elbow (15).

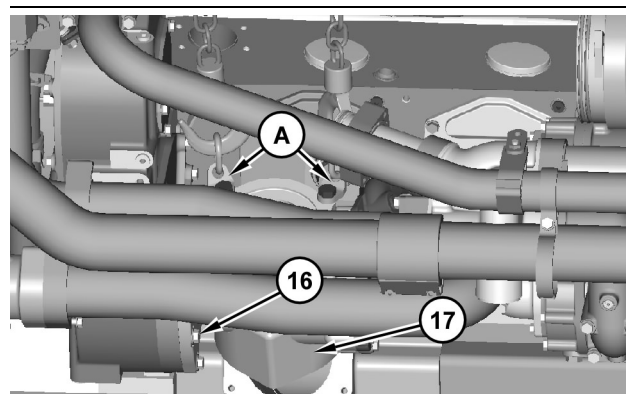


Illustration 197

g01242498

6. Attach Tooling (A) and a suitable lifting device onto engine oil pump (17). The weight of engine oil pump (17) is approximately 50 kg (110 lb). Remove bolts (16). Lower engine oil pump (17) from the engine.

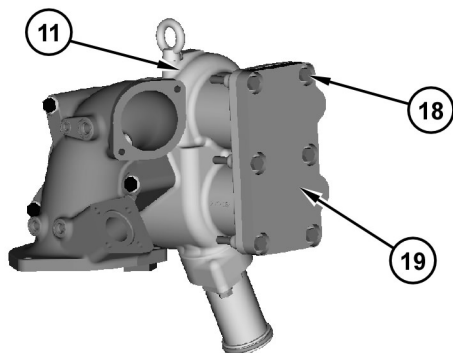


Illustration 198

g01287402

WARNING

Personal injury can result from parts and/or covers under spring pressure.

Spring force will be released when covers are removed.

Be prepared to hold spring loaded covers as the bolts are loosened.

7. Remove bolts (18). Remove cover (19) from regulator assembly (11).

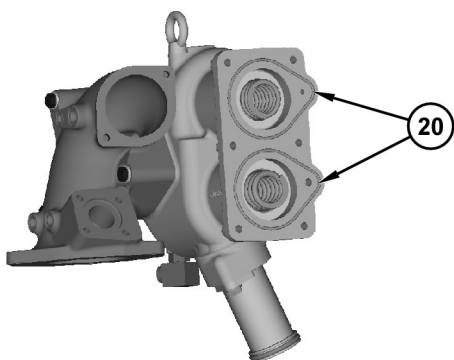


Illustration 199

g01287404

8. Remove O-ring seals (20).

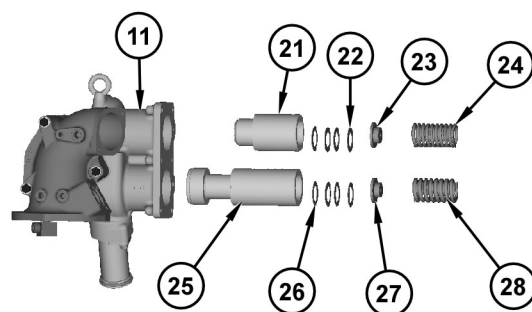


Illustration 200

g01287406

9. Remove spring (24), retainer (23), shims (22), and stem (21) for the maximum pressure relief valve from regulator assembly (11). Remove spring (28), retainer (27), shims (26), and stem (25) for the regulator valve from regulator assembly (11).

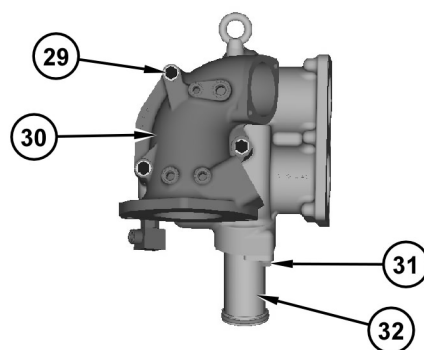


Illustration 201

g01287407

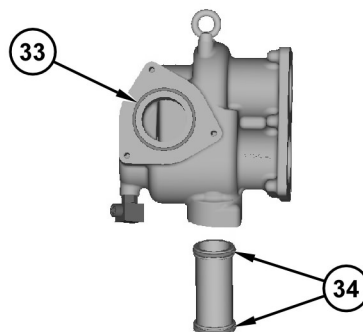


Illustration 202

g01287417

10. Remove bolts (29). Remove housing (30). Remove bolts (31). Remove tube (32). Remove O-ring seal (33). Remove O-ring seals (34).

i02402563

Engine Oil Pump - Disassemble

SMCS Code: 1304-015

Disassembly Procedure

Start By:

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

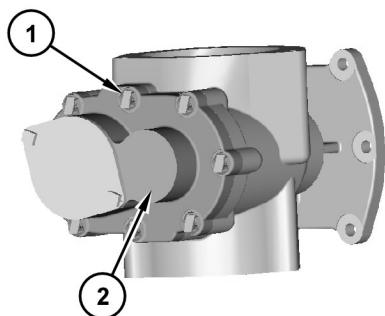


Illustration 203

g01199893

1. Remove bolts (1) and the washers. Remove cover (2).

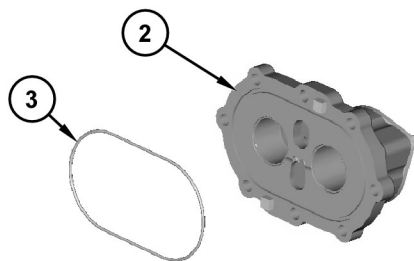


Illustration 204

g01199895

2. Remove O-ring seal (3) from cover (2).

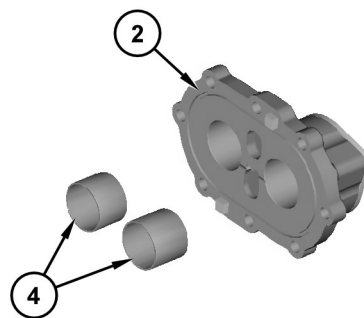


Illustration 205

g01199947

3. Remove bushings (4) from cover (2).

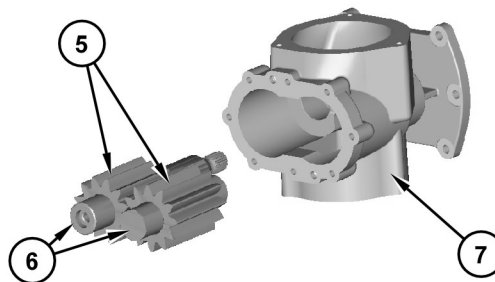


Illustration 206

g01199949

4. Remove gears (5) and shafts (6) from oil pump housing (7).

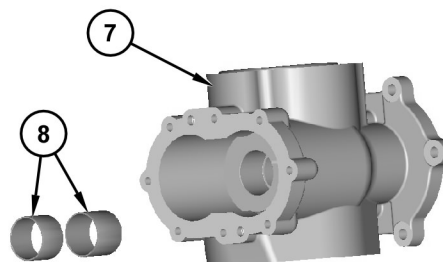


Illustration 207

g01199952

5. Remove bushings (8) from oil pump housing (7).

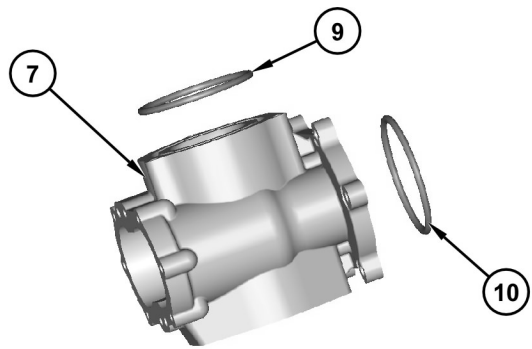


Illustration 208 g01199954

6. Remove O-ring seals (9) and (10).

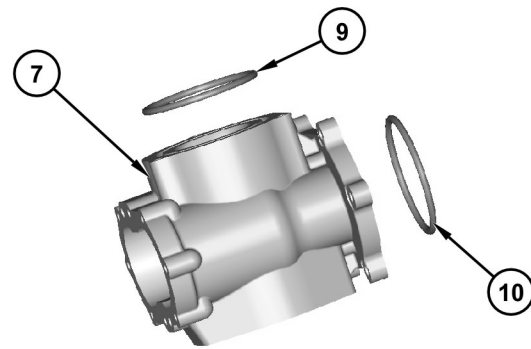


Illustration 210 g01199954

2. Install O-ring seals (9) and (10).

i02402769

Engine Oil Pump - Assemble

SMCS Code: 1304-016

Assembly Procedure

Table 19

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

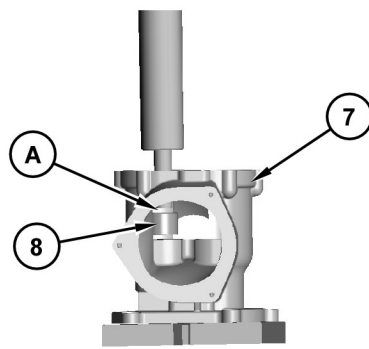


Illustration 209 g01200020

1. Use Tooling (A) and a suitable press in order to install bushings (8) into oil pump housing (7).

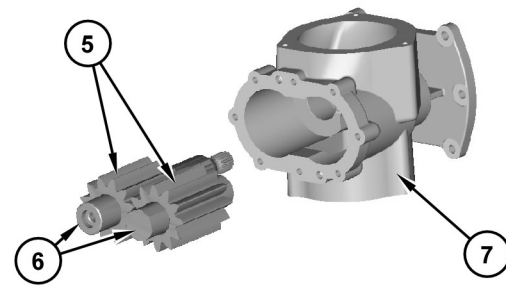


Illustration 211 g01199949

3. Install shafts (6) and gears (5) into oil pump housing (7).

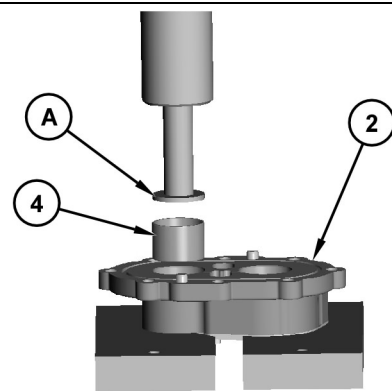


Illustration 212 g01200032

4. Use Tooling (A) and a suitable press in order to install bushings (4) into cover (2).

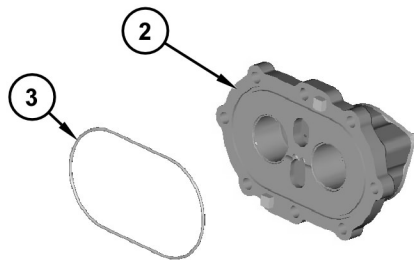


Illustration 213

g01199895

5. Install O-ring seal (3) into cover (2).

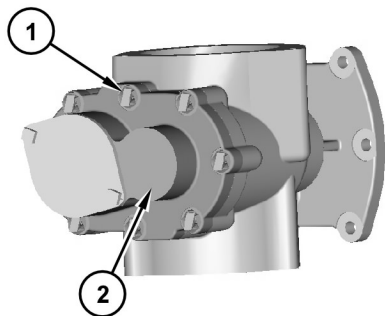


Illustration 214

g01199893

6. Position cover (2). Install the washers and bolts (1).

End By:

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

i02488133

Engine Oil Pump - Install

SMCS Code: 1304-012

Installation Procedure

Table 20

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

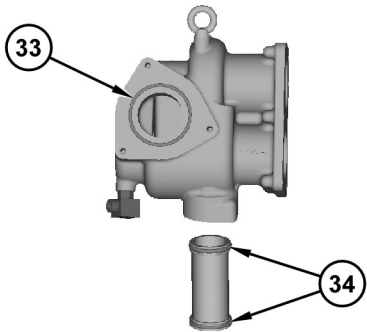


Illustration 215

g01287417

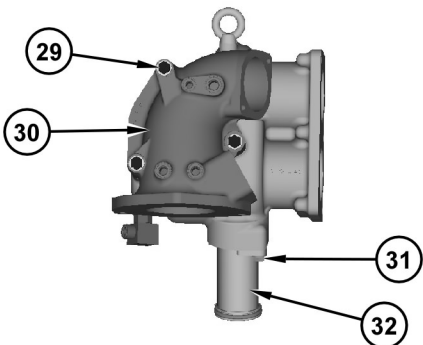


Illustration 216

g01287407

1. Install O-ring seals (34). Install O-ring seal (33). Install tube (32). Install bolts (29). Install housing (30). Install bolts (29).

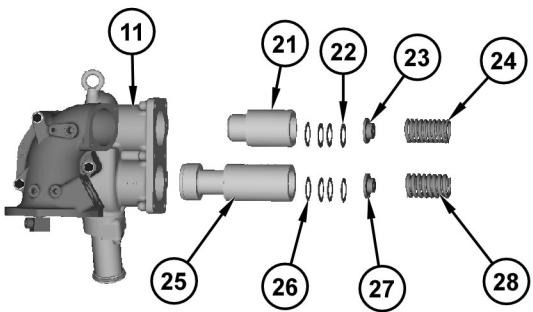


Illustration 217

g01287406

2. Install stem (25), shims (26), retainer (27), and spring (28) for the regulator valve into regulator assembly (11). Install stem (21), shims (22), retainer (23), and spring (24) for the maximum pressure relief valve into regulator assembly (11).

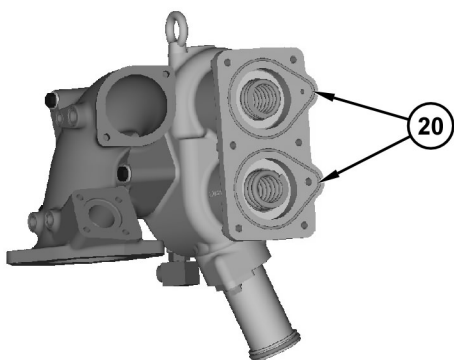


Illustration 218

g01287404

3. Install O-ring seals (20).

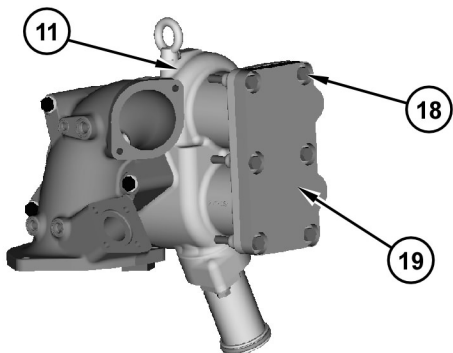


Illustration 219

g01287402

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.

4. Install cover (19) onto regulator assembly (11). Install bolts (18).

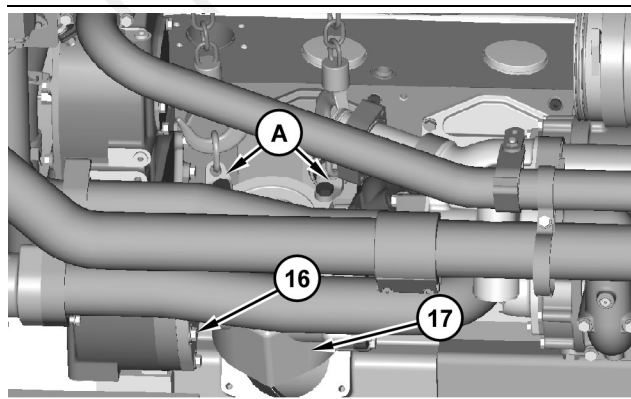


Illustration 220

g01242498

5. Attach Tooling (A) and a suitable lifting device onto engine oil pump (17). The weight of engine oil pump (17) is approximately 50 kg (110 lb). Position engine oil pump (17) onto the engine. Install bolts (16).

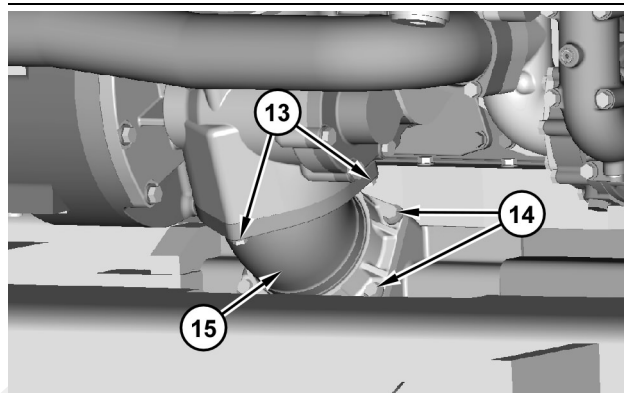


Illustration 221

g01242497

6. Install elbow (16). Install bolts (13) and (14).

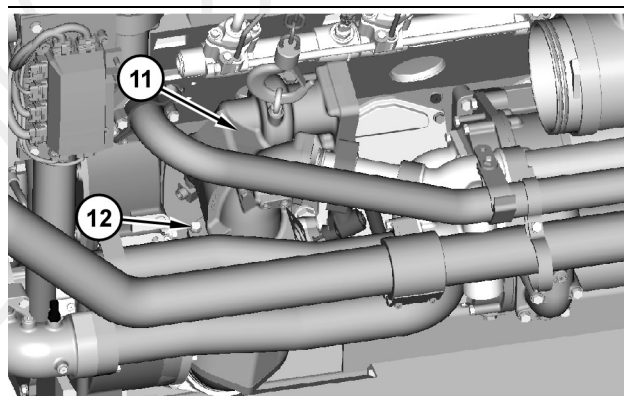


Illustration 222

g01242431

7. Attach a suitable lifting device onto manifold (11). The weight of manifold (11) is approximately 34 kg (75 lb). Position manifold (11) on the engine oil pump. Install bolts (12).

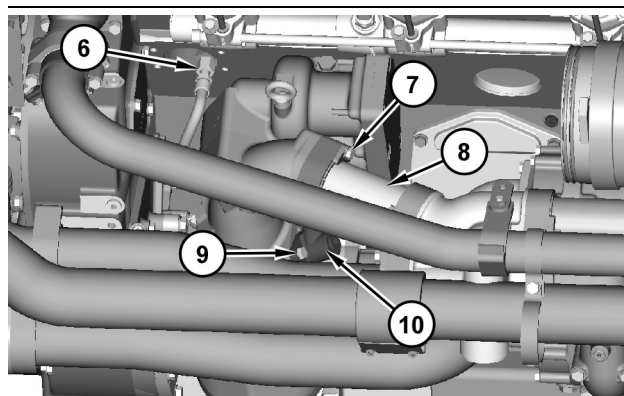


Illustration 223

g01242430

8. Connect tube assembly (10). Install bolts (9). Connect tube assembly (8). Install bolts (7). Install hose assembly (6).

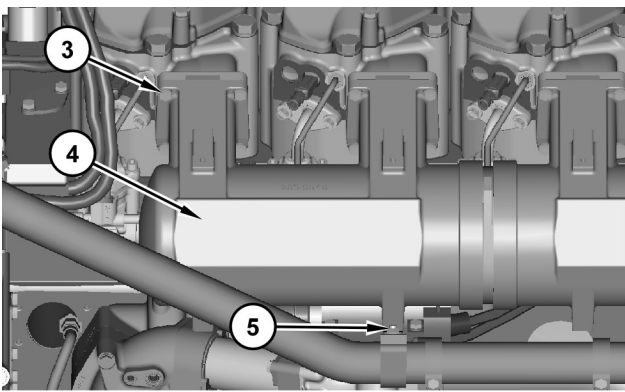


Illustration 224

g01242429

9. Install the gaskets and the end section of air inlet manifold (4). Install bolts (3). Install bolt (5).

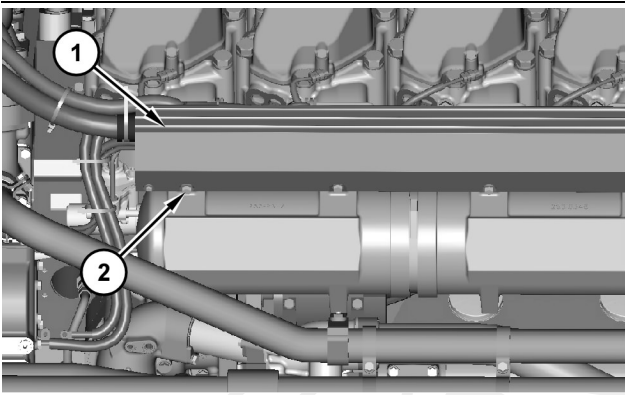


Illustration 225

g01242428

10. Position cover (1) for the harness assembly onto the air inlet manifold. Install bolts (2).

i02404179

Engine Oil Filter Housing - Remove

SMCS Code: 1306-011

Removal Procedure

Table 21

Required Tools			
Tool	Part Number	Part Description	Qty
A	138-7573	Link Bracket	3

Start By:

- a. Remove the water temperature control valve . Refer to Disassembly and Assembly, "Water Temperature Control Valve - 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.

1. Drain the oil from the engine oil filter housing into a suitable container for storage or for disposal.

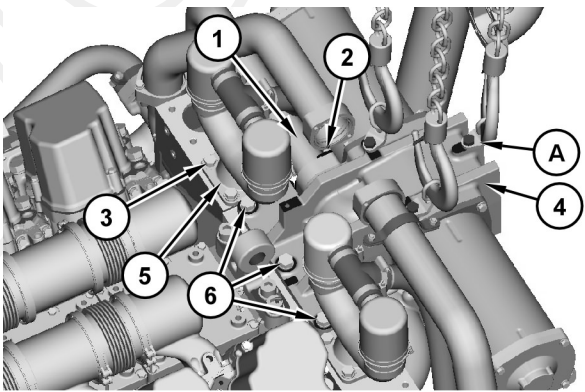


Illustration 226

g01200798

2. Attach Tooling (A) and a suitable lifting device onto engine oil filter housing (4). The weight of engine oil filter housing (4) is approximately 104 kg (230 lb). Remove bolts (3). Remove breather (5) on each side. Remove bolts (2). Disconnect tube assembly (1). Remove bolts (6).

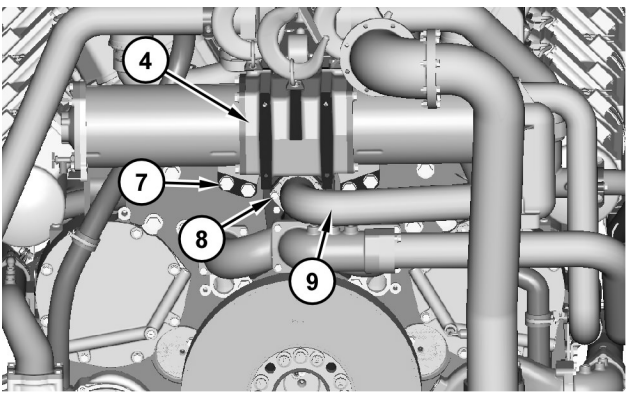


Illustration 227 g01200800

3. Remove bolts (8). Disconnect tube assembly (9). Remove bolts (7) and remove engine oil filter housing (4).

i02404488

Engine Oil Filter Housing - Install

SMCS Code: 1306-012

Installation Procedure

Table 22

Required Tools			
Tool	Part Number	Part Description	Qty
A	138-7573	Link Bracket	3

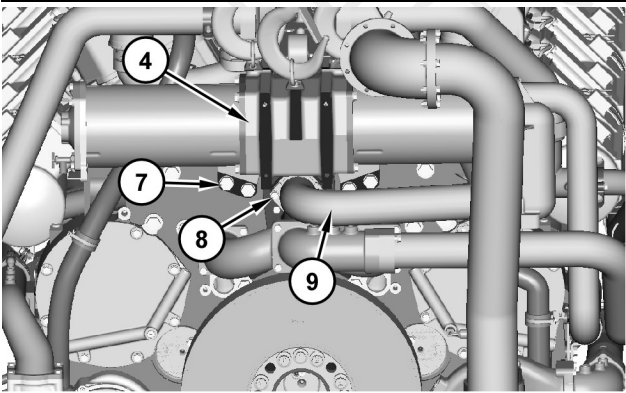


Illustration 228 g01200800

1. Attach Tooling (A) and a suitable lifting device onto engine oil filter housing (4). The weight of engine oil filter housing (4) is approximately 104 kg (230 lb). Position housing (4) onto the engine. Install bolts (7). Position tube assembly (9). Install bolts (8).

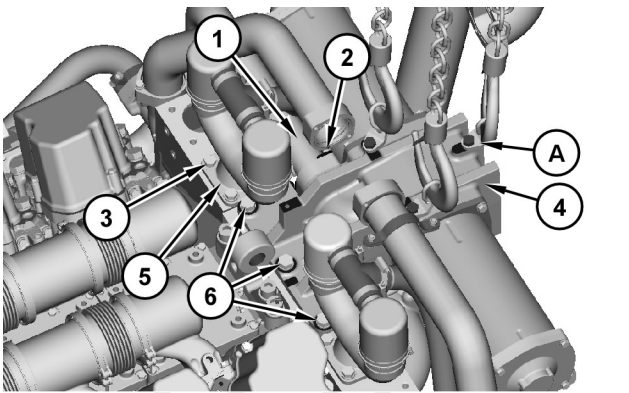


Illustration 229 g01200798

2. Install bolts (6). Position breather (5) on each side and install bolts (3) on each side. Position tube assembly (1) and install bolts (2).
3. Check the engine oil level. Refer to Operation and Maintenance Manual, "Engine Oil Level - Check".

End By:

- a. Install the water temperature control valve. Refer to Disassembly and Assembly, "Water Temperature Control Valve - Install".

i02403974

Engine Oil and Water Pump Drive - Remove

SMCS Code: 1313-011

Removal Procedure

Table 23

Required Tools			
Tool	Part Number	Part Description	Qty
A	1P-0520	Driver Gp	1

Start By:

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

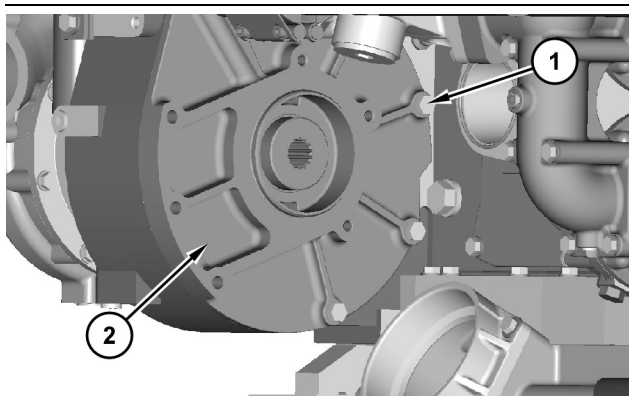


Illustration 230

g01200542

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

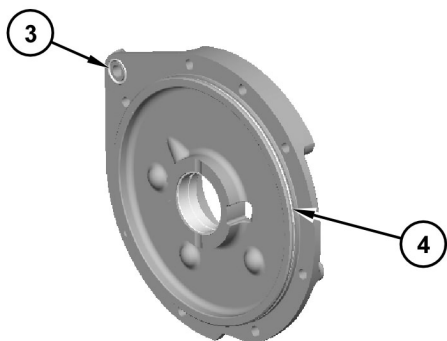


Illustration 231

g01200648

2. Remove O-ring seals (3) and (4).

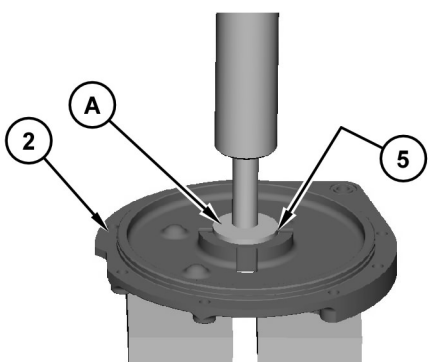


Illustration 232

g01200650

3. Use Tooling (A) and a suitable press in order to remove bearing (5) from cover (2).

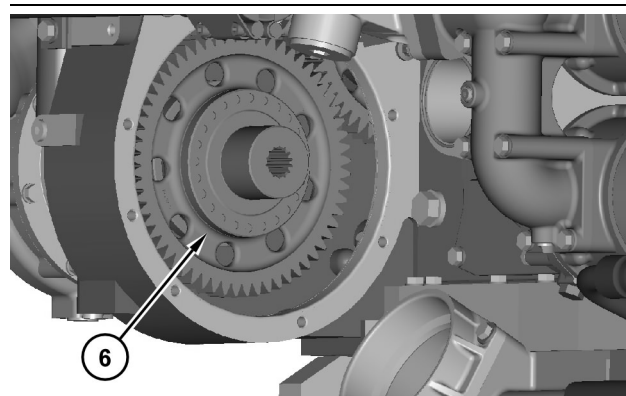


Illustration 233

g01200652

4. Remove engine oil and water pump drive (6).

i02404076

Engine Oil and Water Pump Drive - Disassemble

SMCS Code: 1313-015

Disassembly Procedure

Start By:

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

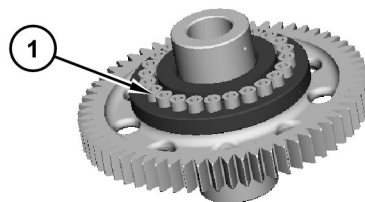


Illustration 234

g01200678

1. Remove bolts (1).

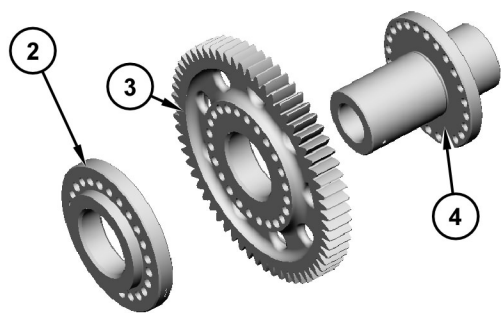


Illustration 235

g01200684

2. Remove spacer (2), gear (3), and pump drive shaft (4).

i02404086

Engine Oil and Water Pump Drive - Assemble

SMCS Code: 1313-016

Assembly Procedure

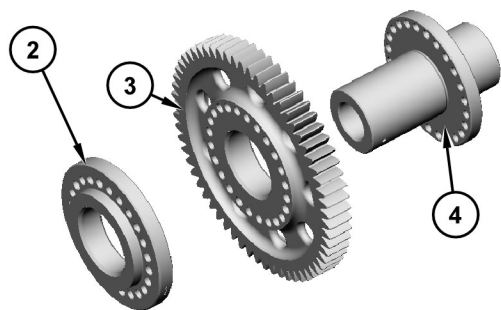


Illustration 236

g01200684

1. Position pump drive shaft (4), gear (3), and spacer (2).

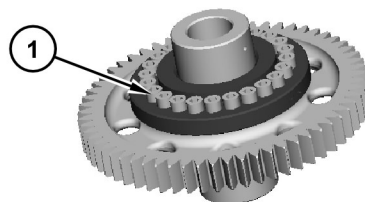


Illustration 237

g01200678

2. Install bolts (1).

End By:

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

i02404092

Engine Oil and Water Pump Drive - Install

SMCS Code: 1313-012

Installation Procedure

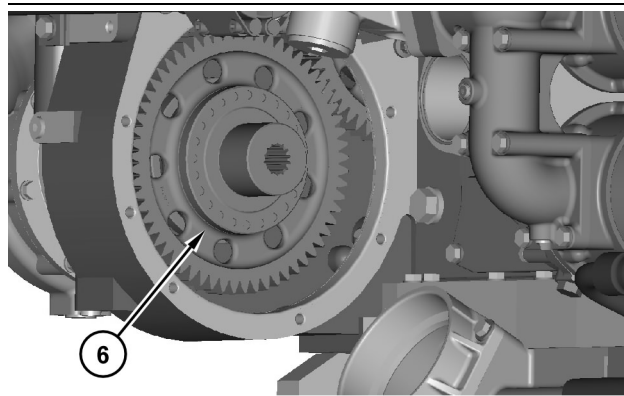


Illustration 238

g01200652

1. Install engine oil and water pump drive (6).

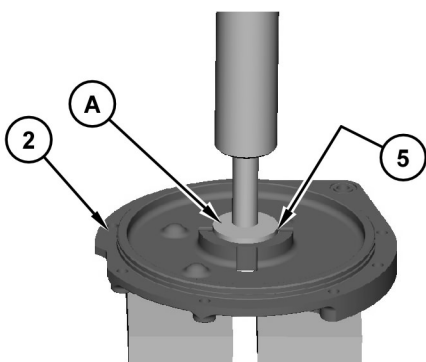


Illustration 239

g01200650

2. Use Tooling (A) and a suitable press in order to install bearing (5) into cover (2).

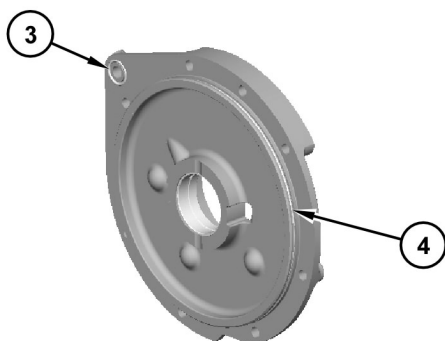


Illustration 240

g01200648

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

3. Install O-ring seals (3) and (4).

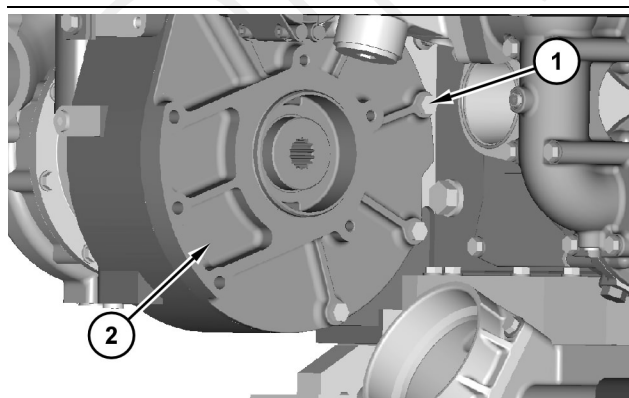


Illustration 241

g01200542

4. Position cover (2). Install bolts (1).

End By:

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

i02405003

Engine Oil Screen - Remove and Install

SMCS Code: 1308-010-Z3

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.

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

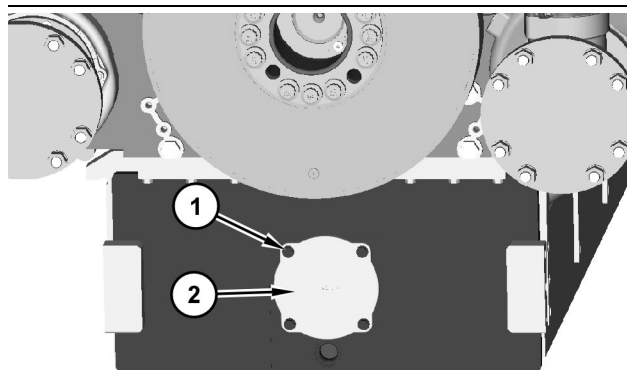


Illustration 242

g01201319

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

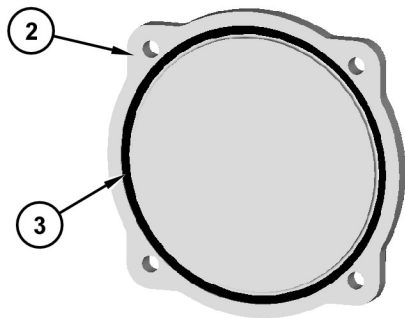


Illustration 243

g01201320

3. Remove O-ring seal (3) from cover (2).

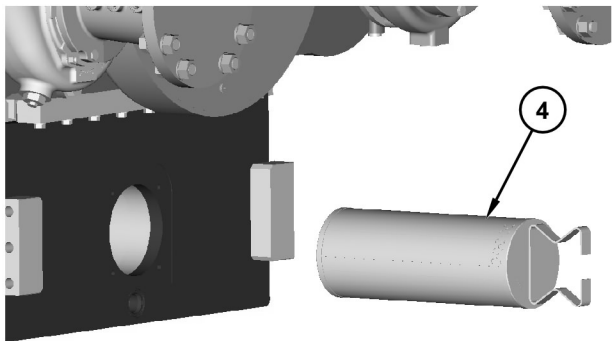


Illustration 244

g01201321

4. Remove oil screen (4).

Installation Procedure

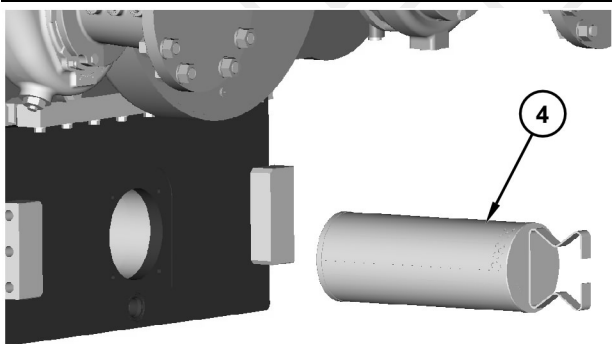


Illustration 245

g01201321

1. Install oil screen (4).

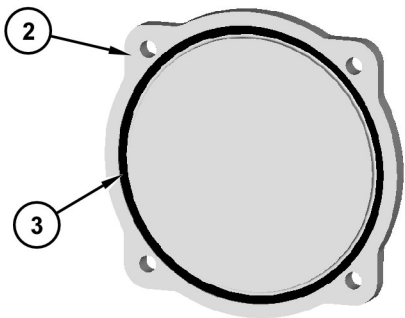


Illustration 246

g01201320

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

2. Install O-ring seal (3) onto cover (2).

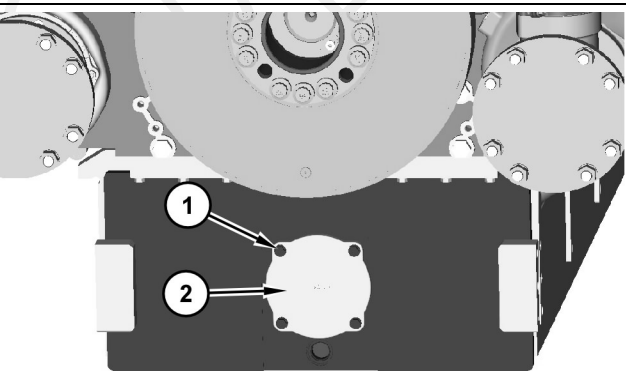


Illustration 247

g01201319

3. Position cover (2). Install bolts (1).

4. Fill the engine with oil. Refer to Operation and Maintenance Manual, “Engine Oil and Filter - Change”.

i02430901

Engine Oil Pan - Remove

SMCS Code: 1302-011

Removal Procedure

Table 24

Required Tools			
Tool	Part Number	Part Description	Qty
A	1U-7498	Support Stand As	4
	1U-7501	Extension Tube	4
B	138-7573	Link Bracket	3

1. Turn the battery disconnect switch to the OFF position.
2. Turn the fuel supply valve to the OFF position.

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.

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

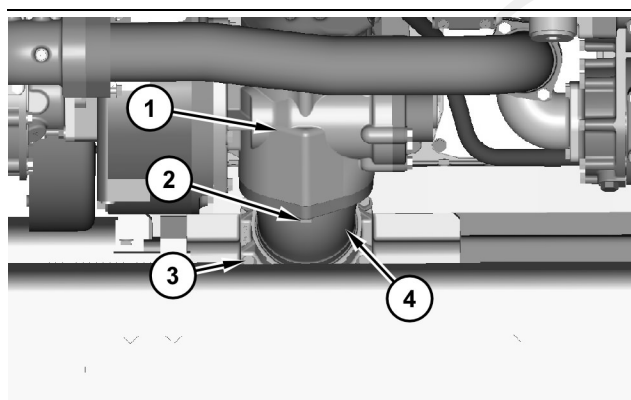


Illustration 248

g01214538

4. Remove bolts (2) and bolts (3). Remove elbow (4) from engine oil pump (1).

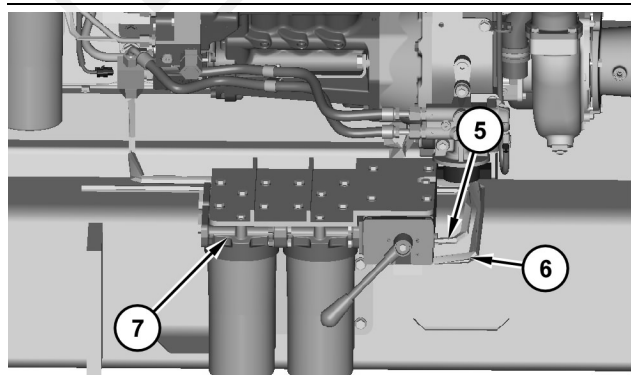


Illustration 249

g01214540

5. Disconnect tube assemblies (5) and (6) from fuel filter housing (7).

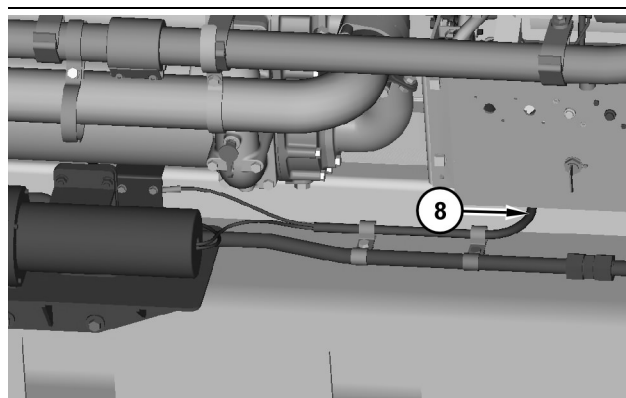


Illustration 250

g01214555

6. Disconnect harness assembly (8).

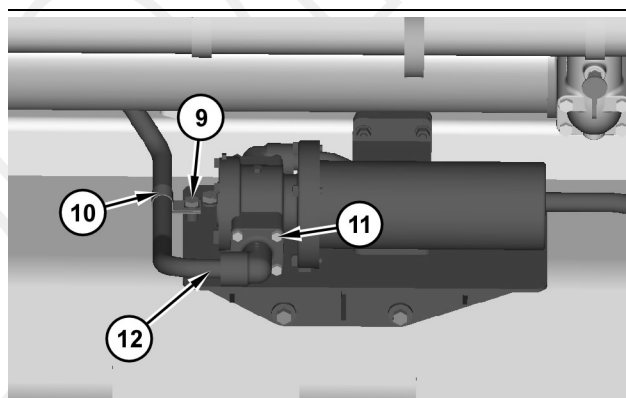


Illustration 251

g01214556

7. Remove bolt (9). Disconnect clamp (10). Remove bolts (11). Disconnect tube assembly (12).

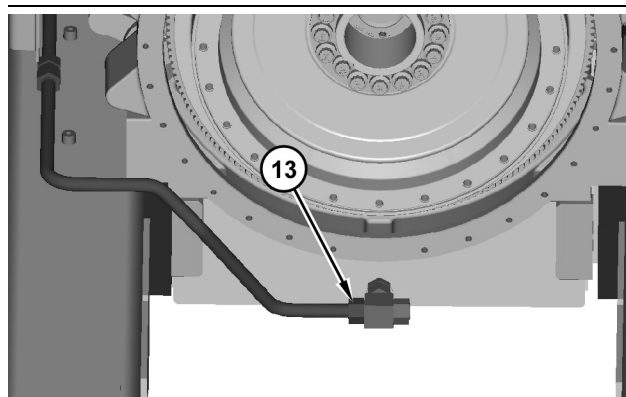


Illustration 252

g01214573

8. Disconnect tube assembly (13).

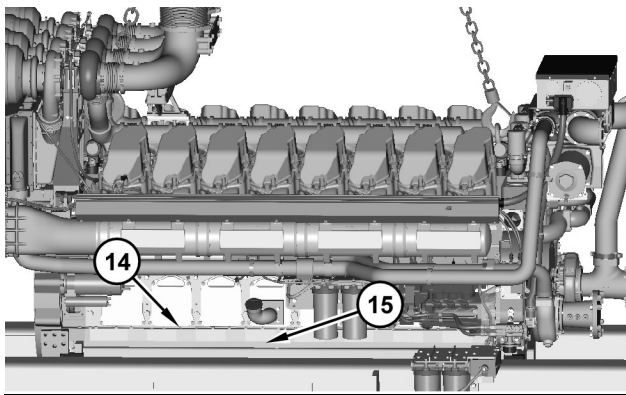


Illustration 253

g01214578

9. Attach a suitable lifting device onto the engine. The weight of the engine is approximately 567 kg (1250 lb). Remove bolts (14) on all sides of engine oil pan (15).

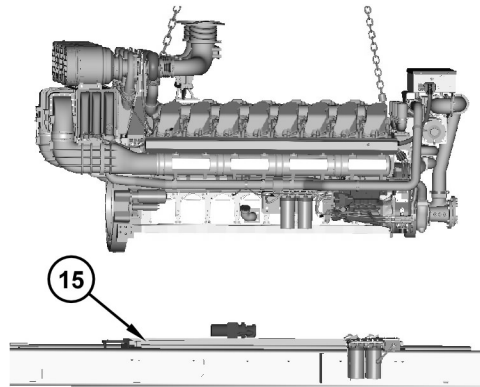


Illustration 254

g01214583

10. Raise the engine from engine oil pan (15).

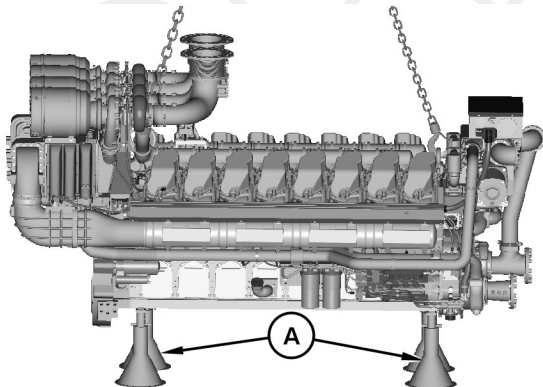


Illustration 255

g01214584

11. Position the engine on Tooling (A).

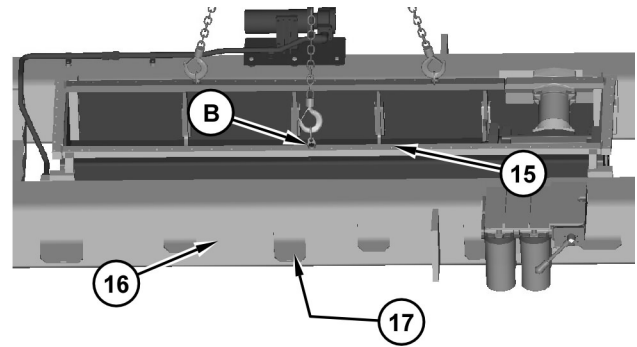


Illustration 256

g01214586

12. Attach Tooling (B) and a suitable lifting device onto engine oil pan (15). The weight of engine oil pan (15) is approximately 567 kg (1250 lb). Apply slight lifting tension on engine oil pan (15). Reach through the holes in platform (16) in order to remove bolts (17). Remove engine oil pan (15) from platform (16).

i02432028

Engine Oil Pan - Disassemble

SMCS Code: 1302-015

Disassembly Procedure

Start By:

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

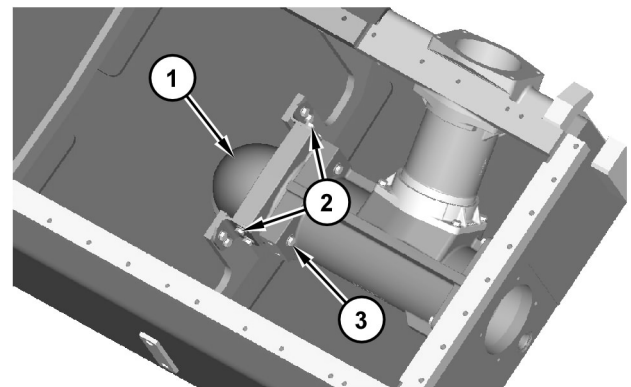


Illustration 257

g01215260

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

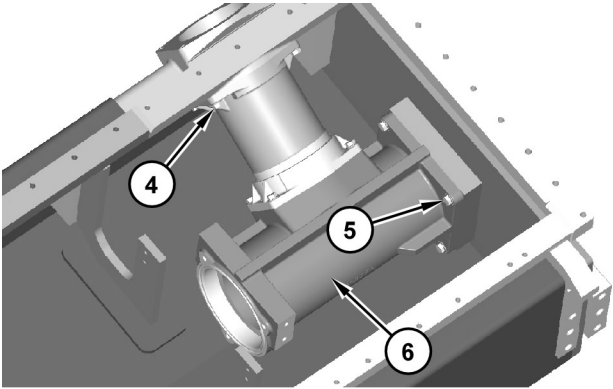


Illustration 258

g01215581

2. Remove bolts (4) and bolts (5). Remove engine oil screen housing (6).

i02433387

Engine Oil Pan - Assemble

SMCS Code: 1302-016

Assembly Procedure

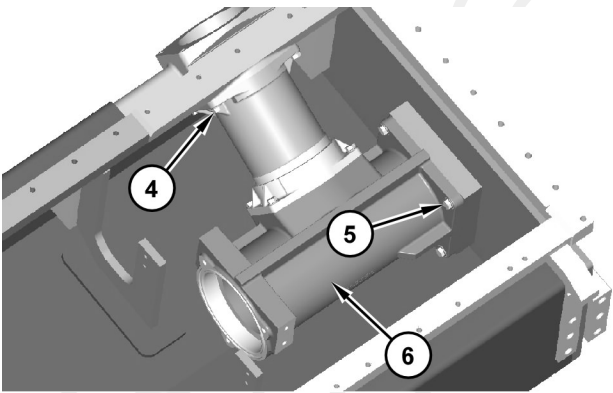


Illustration 259

g01215581

1. Install engine oil screen housing (6). Install bolts (5). Install bolts (4).

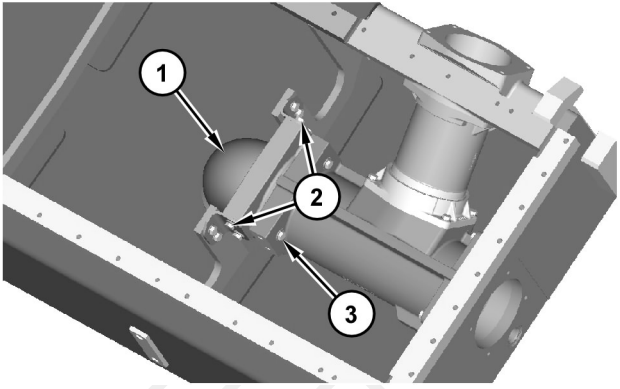


Illustration 260

g01215260

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

End By:

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

i02444292

Engine Oil Pan - Install

SMCS Code: 1302-012

Installation Procedure

Table 25

Required Tools			
Tool	Part Number	Part Description	Qty
A	1U-7498	Support Stand As	4
	1U-7501	Extension Tube	4
B	138-7573	Link Bracket	3

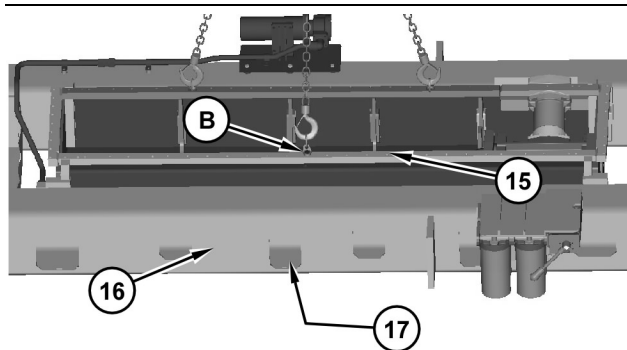


Illustration 261

g01214586

1. Attach Tooling (B) and a suitable lifting device onto engine oil pan (15). The weight of engine oil pan (15) is approximately 567 kg (1250 lb). Position engine oil pan (15) onto platform (16). Reach through the holes in platform (16) in order to install bolts (17).

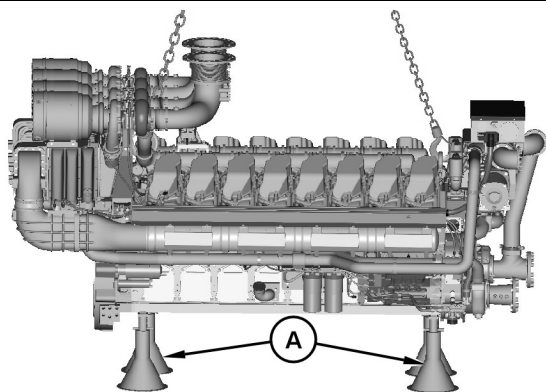


Illustration 262

g01214584

2. Attach a suitable lifting device onto the engine. The weight of the engine is approximately 567 kg (1250 lb). Remove the engine from Tooling (A).

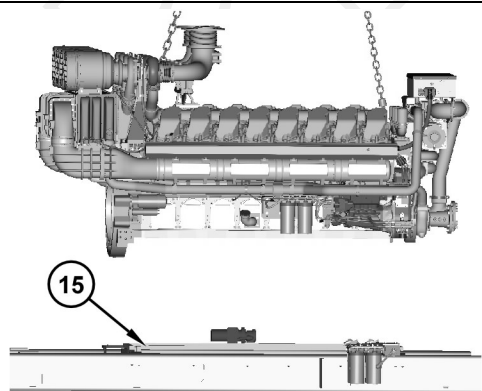


Illustration 263

g01214583

3. Lower the engine onto engine oil pan (15).

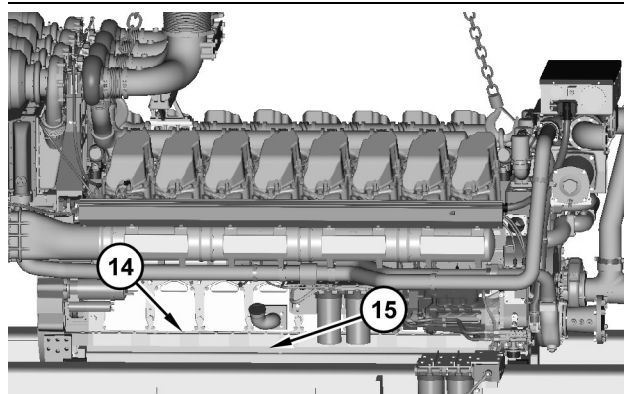


Illustration 264

g01214578

4. Install bolts (14) on all sides of engine oil pan (15).

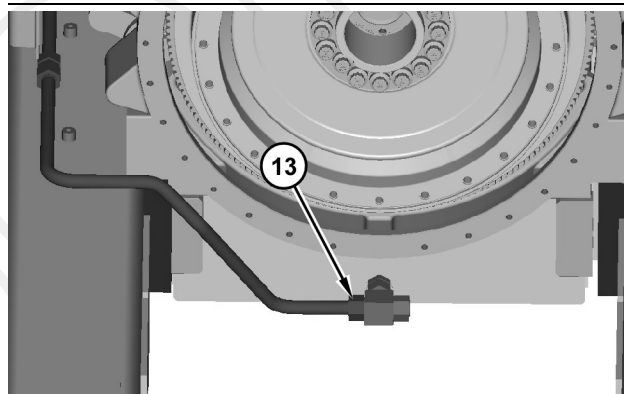


Illustration 265

g01214573

5. Connect tube assembly (13).

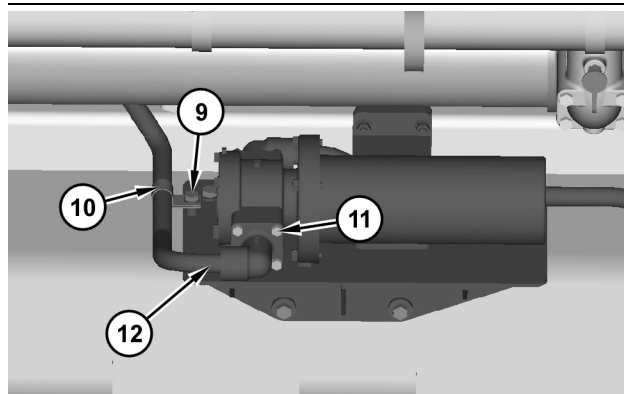


Illustration 266

g01214556

6. Connect tube assembly(12). Install bolts (11). Connect clamp (10). Install bolt (9).

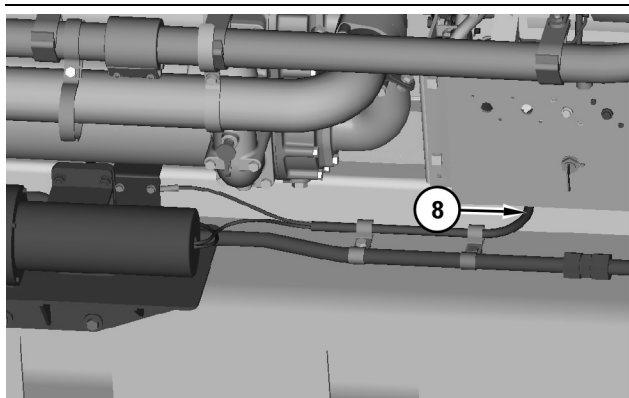


Illustration 267

g01214555

7. Connect harness assembly (8).

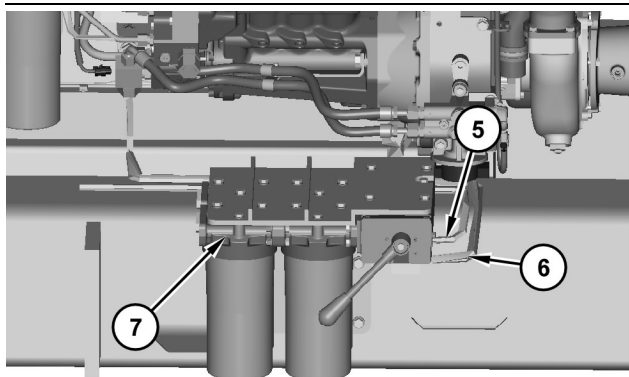


Illustration 268

g01214540

8. Connect tube assemblies (5) and (6) onto fuel filter housing (7).

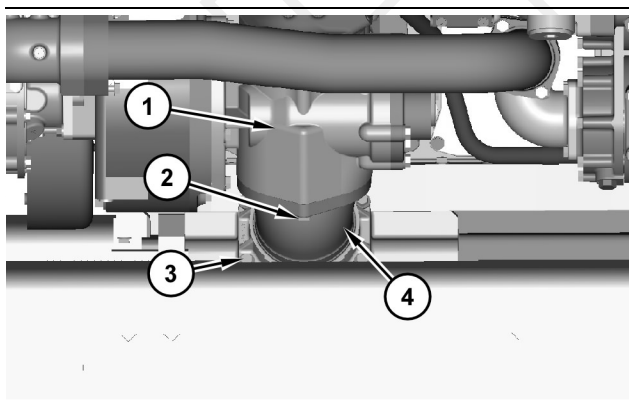


Illustration 269

g01214538

9. Install elbow (4) onto engine oil pump (1). Install bolts (2) and bolts (3).

10. Fill the engine with oil. Refer to Operation and Maintenance Manual, "Engine Oil and Filter - Change".

11. Turn the fuel supply valve to the ON position.

12. Turn the battery disconnect switch to the ON position.

i02408235

Crankcase Breather - Remove and Install

SMCS Code: 1317-010

Removal Procedure

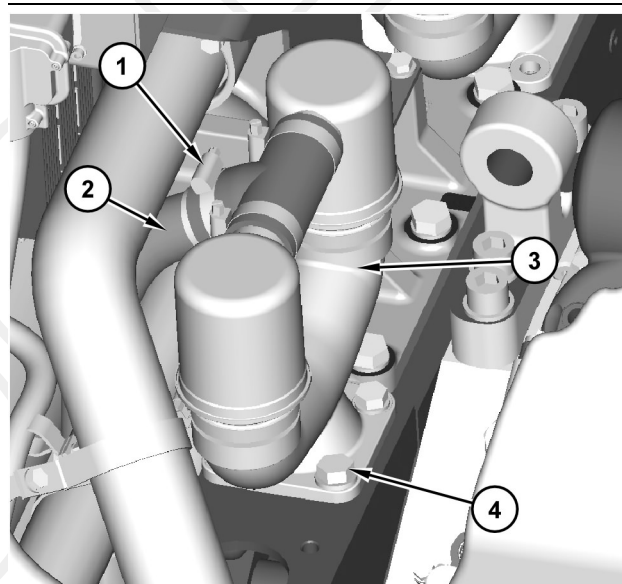


Illustration 270

g01203041

1. Loosen hose clamp (1). Disconnect hose (2). Remove bolts (4). Remove crankcase breather (3). Repeat for the opposite side.

Installation Procedure

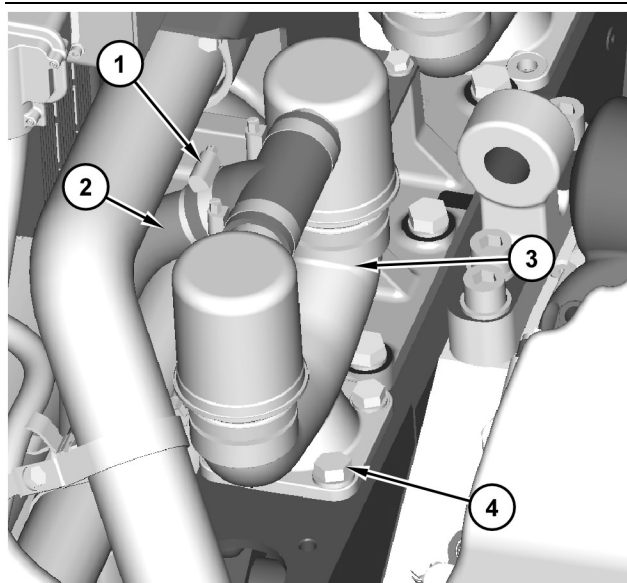


Illustration 271

g01203041

1. Position crankcase breather (3). Install bolts (4). Connect hose (2). Tighten hose clamp (1). Repeat for the opposite side.

i02405696

Valve Cover - Remove and Install

SMCS Code: 1107-010

Removal Procedure

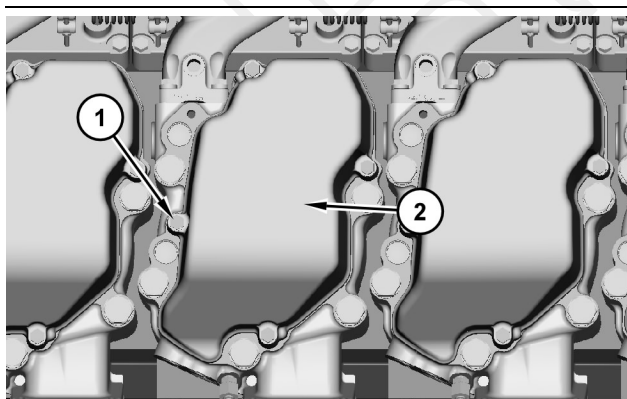


Illustration 272

g01201615

1. Remove bolts (1). Remove valve cover (2).

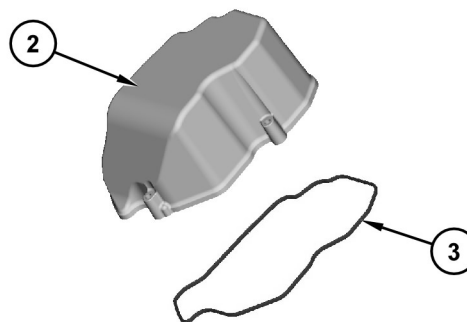


Illustration 273

g01201618

2. Remove seal (3) from valve cover (2).
3. Repeat Steps 1 and 2 for the remaining valve covers.

Installation Procedure

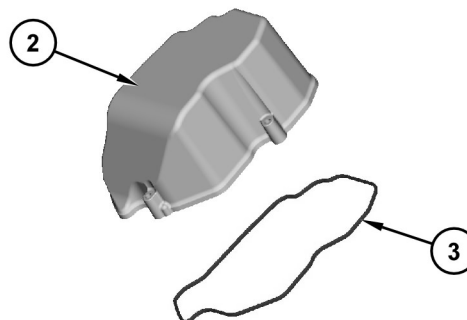


Illustration 274

g01201618

1. Install a new seal (3) onto valve cover (2).

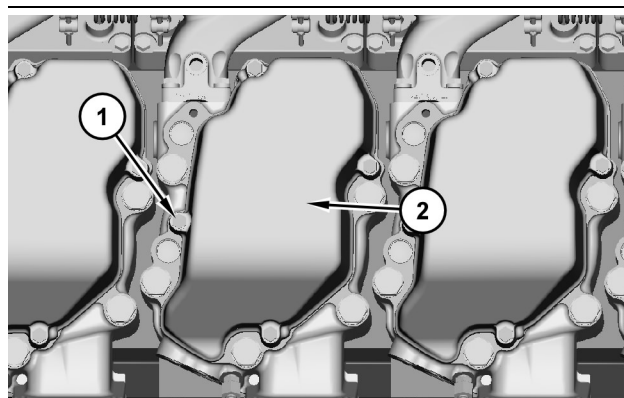


Illustration 275

g01201615

2. Position valve cover (2). Install bolts (1). Tighten bolts (1) to a torque of 55 ± 10 N·m (41 ± 7 lb ft).
3. Repeat Steps 1 and 2 for the remaining valve covers.

i02408237

Rocker Shaft and Push Rods - Remove

SMCS Code: 1102-011

Removal Procedure

Start By:

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

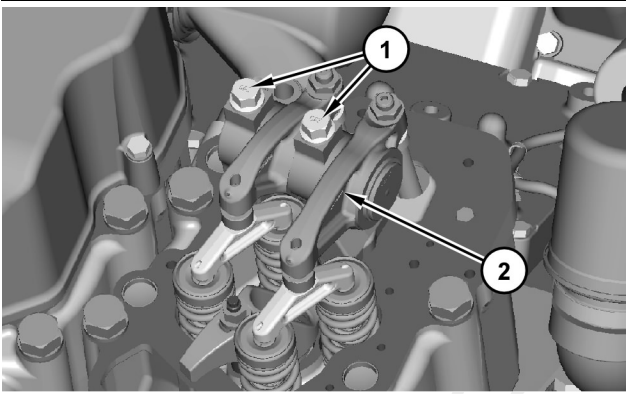


Illustration 276

g01203051

- 1. Remove bolts (1). Remove rocker shaft assembly (2).

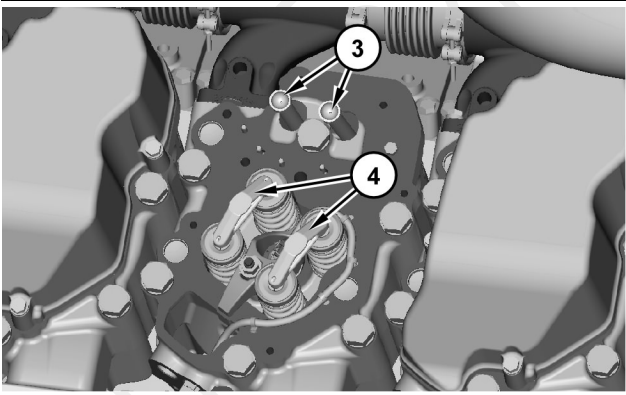


Illustration 277

g01203052

- 2. Remove pushrods (3). Remove bridges (4).

i02403294

Rocker Shaft - Disassemble

SMCS Code: 1102-015

Disassembly Procedure

Table 26

Required Tools			
Tool	Part Number	Part Description	Qty
A	1P - 1863	Retaining Ring Pliers	1
B	1P - 0510	Driver Gp	1

Start By:

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

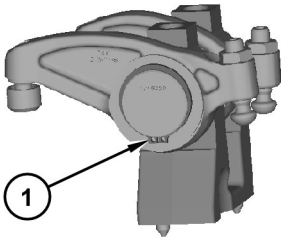


Illustration 278

g01200255

- 1. Use Tooling (A) in order to remove retaining ring (1) and the washer.

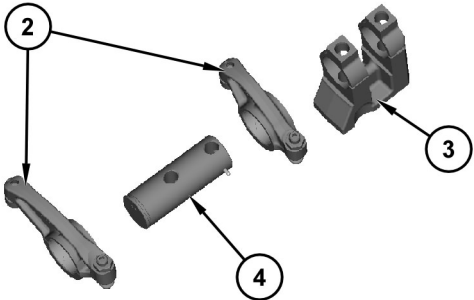


Illustration 279

g01200257

Note: Note the orientation of the rocker arms for assembly purposes.

2. Remove rocker arms (2) and shaft (4) from rocker arm pedestal (3).

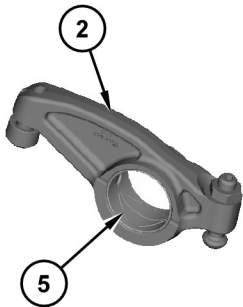


Illustration 280

g01200259

3. Use Tooling (B) and remove bushing (5) from rocker arm (2).

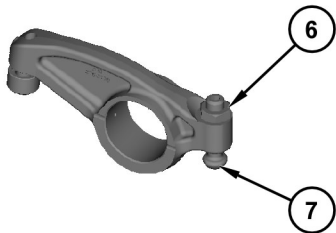


Illustration 281

g01200260

4. Remove nut (6). Remove adjusting screw (7).

i02403357

Rocker Shaft - Assemble

SMCS Code: 1102-016

Assembly Procedure

Table 27

Required Tools			
Tool	Part Number	Part Description	Qty
A	1P - 1863	Retaining Ring Pliers	1
B	1P - 0510	Driver Gp	1

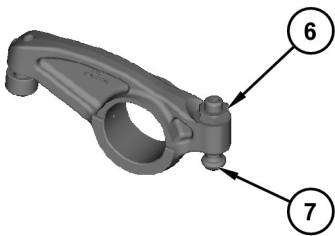


Illustration 282

g01200260

1. Install adjusting screw (7) and nut (6).

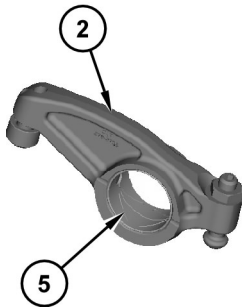


Illustration 283

g01200259

2. Use Tooling (B) and install bushing (5) into rocker arm (2). Make sure that the oil holes in bushing (5) are aligned with the oil holes in rocker arm (2). The oil holes must be aligned in the exact position.

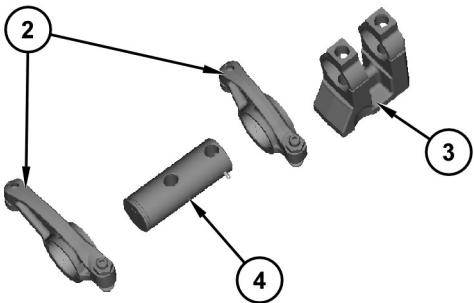


Illustration 284

g01200257

3. Install rocker arms (2) and shaft (4) onto pedestal (3).

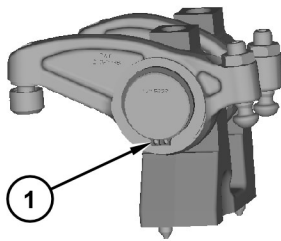


Illustration 285

g01200255

4. Install the washer. Use Tooling (A) in order to install retaining ring (1).

End By:

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

Rocker Shaft and Push Rods - Install

SMCS Code: 1102-012

Installation Procedure

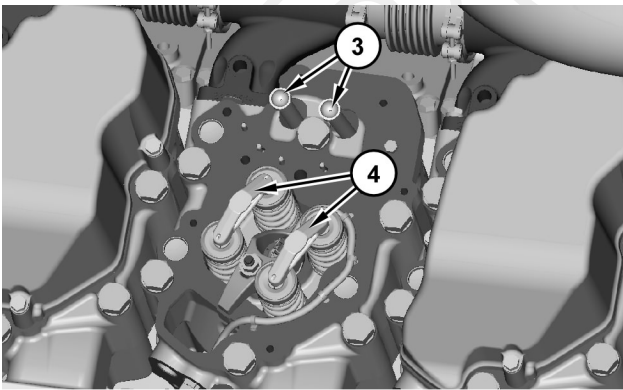


Illustration 286

g01203052

1. Lubricate bridges (4) with clean engine oil. Install bridges (4). Lubricate pushrods (3) with clean engine oil. Install pushrods (3).

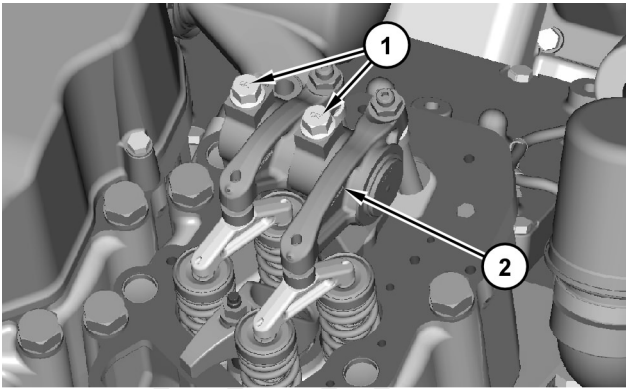


Illustration 287

g01203051

2. Install rocker shaft assembly (2). Install bolts (1). Tighten bolts (1) to a torque of 240 ± 40 N·m (177 ± 30 lb ft).

3. Adjust the valve lash. Refer to Testing and Adjusting, "Engine Valve Lash - Inspect/Adjust".

End By:

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

Valve Lifter - Remove

SMCS Code: 1209-011

Removal Procedure

Table 28

Required Tools			
Tool	Part Number	Part Description	Qty
A	3E-3879	Eyebolt	1

Start By:

- a. Remove the rocker shaft and pushrods. Refer to Disassembly and Assembly, "Rocker Shaft and Pushrods - Remove".
- b. Remove the exhaust manifolds. Refer to Disassembly and Assembly, "Exhaust Manifold - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

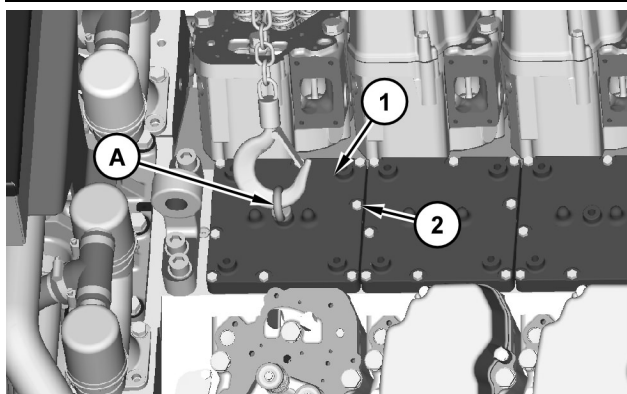


Illustration 288

g01203661

1. Attach Tooling (A) and a suitable lifting device onto valve lifter (1). Remove bolts (2). Remove valve lifter (1).

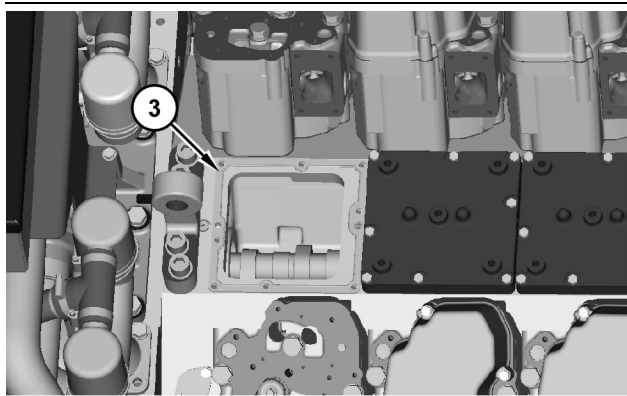


Illustration 289

g01204525

2. Remove integral seal (3).
3. Repeat Steps 1 and 2 for the remaining valve lifters.

i02410099

Valve Lifter - Disassemble

SMCS Code: 1209-015

Disassembly Procedure

Start By:

- a. Remove the valve lifter. Refer to Disassembly and Assembly, "Valve Lifter - Remove".

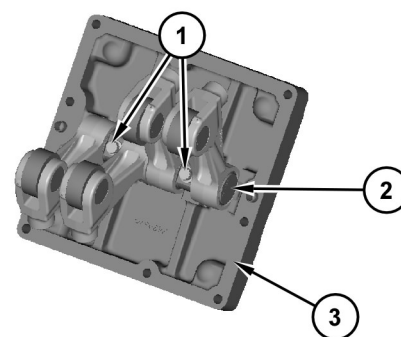


Illustration 290

g01204408

1. Remove bolts (1). Remove shaft assembly (2) from housing (3).

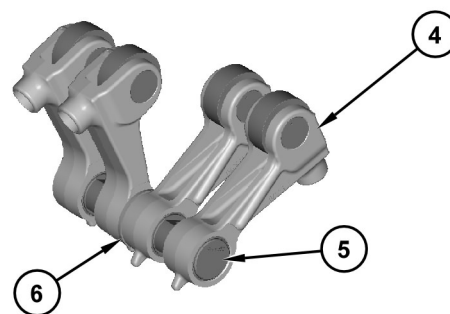


Illustration 291

g01204412

2. Remove levers (4) from shaft (5). Remove thrust washer (6) from shaft (5).

i02410168

Valve Lifter - Assemble

SMCS Code: 1209-016

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

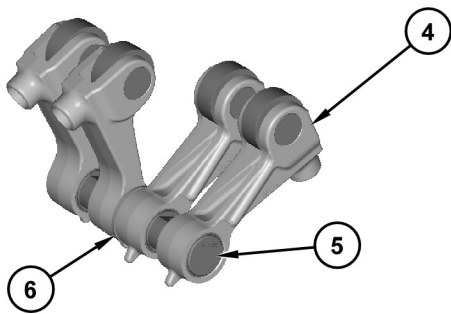


Illustration 292

g01204412

1. Install thrust washer (6) onto shaft (5). Install levers (4) onto shaft (5).

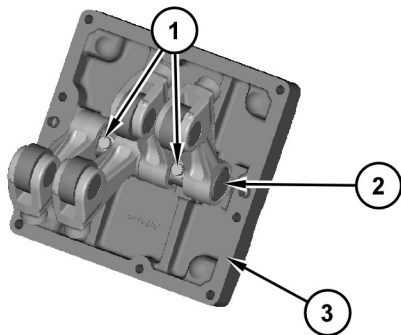


Illustration 293

g01204408

2. Install shaft assembly (2) into housing (3). Install bolts (1). Tighten bolts (1) to a torque of $55 \pm 10 \text{ N}\cdot\text{m}$ ($41 \pm 7 \text{ lb ft}$).

End By:

- a. Install the valve lifter. Refer to Disassembly and Assembly, "Valve Lifter - Install".

i02409468

Valve Lifter - Install

SMCS Code: 1209-012

Installation Procedure

Table 29

Required Tools			
Tool	Part Number	Part Description	Qty
A	3E-3879	Eyebolt	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

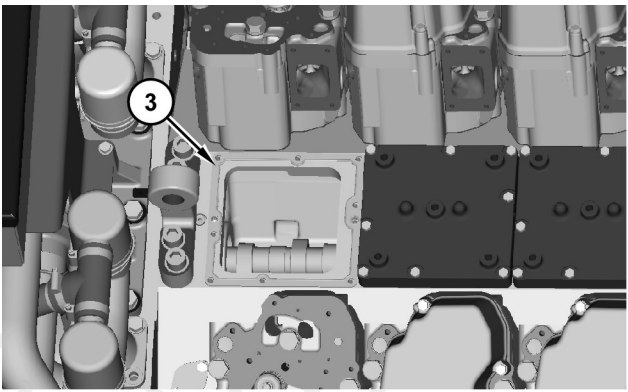


Illustration 294

g01204525

1. Install integral seal (3).

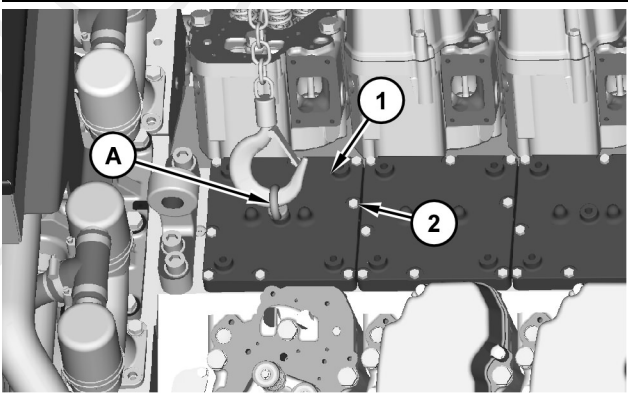


Illustration 295

g01203661

2. Attach Tooling (A) and a suitable lifting device onto valve lifter (1). Position valve lifter (1) onto the engine. Install bolts (2). Tighten bolts (2) to a torque of $55 \pm 10 \text{ N}\cdot\text{m}$ ($41 \pm 7 \text{ lb ft}$).
3. Repeat Steps 1 and 2 for the remaining valve lifters.

End By:

- a. Install the exhaust manifolds. Refer to Disassembly and Assembly, "Exhaust Manifold - Remove and Install".
- b. Install the rocker shaft and pushrods. Refer to Disassembly and Assembly, "Rocker Shaft and Pushrods - Install".

i02683440

Electronic Unit Injector - Remove

SMCS Code: 1290-011

Removal Procedure

Table 30

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

Start By:

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

⚠ WARNING

Do not open the high pressure fuel system without allowing the fuel system to purge. After the engine has shut down, allow the fuel system to purge for ten minutes. This operating fuel system contains high pressure. Exposure to high pressure fuel can result in personal injury.

Note: If necessary, cap tube assemblies, fittings, ports, and any openings in the fuel system in order to prevent contamination.

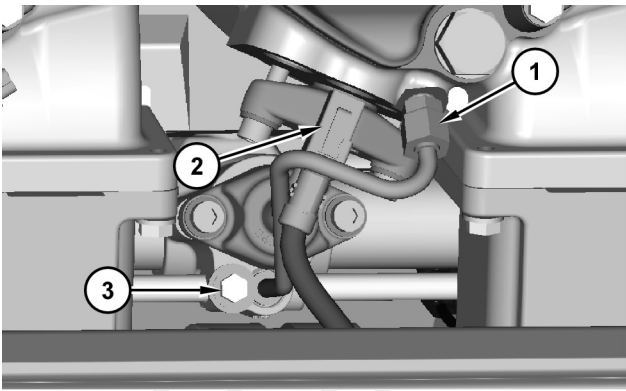


Illustration 296

g01285474

1. Remove bolt (3) and the washer. Remove tube assembly (1). Disconnect harness assembly (2).

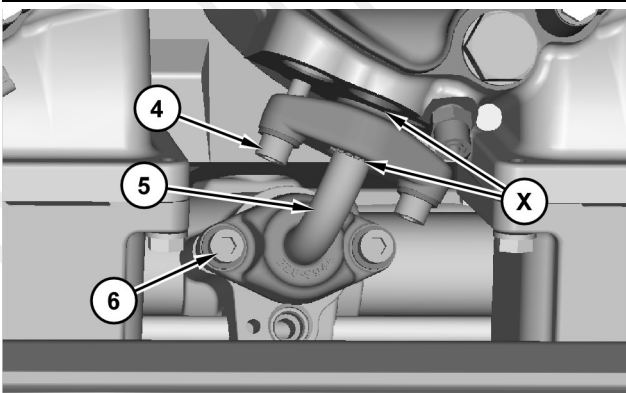


Illustration 297

g01285666

2. Apply clean engine oil to Area (X). Repeat for the opposite collar. Remove bolts (4) and bolts (6). Remove tube assembly (5).

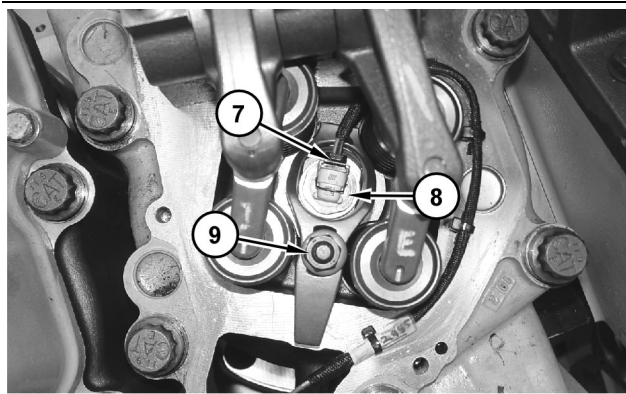


Illustration 298

g01199562

3. Disconnect harness assembly (7) from electric unit injector (8). Remove bolt (9) and the washer.

4. Place an identification mark on electronic unit injector (8) for installation purposes. Each electronic unit injector must be reinstalled in the original location. Use Tooling (A) to remove electronic unit injector (8).

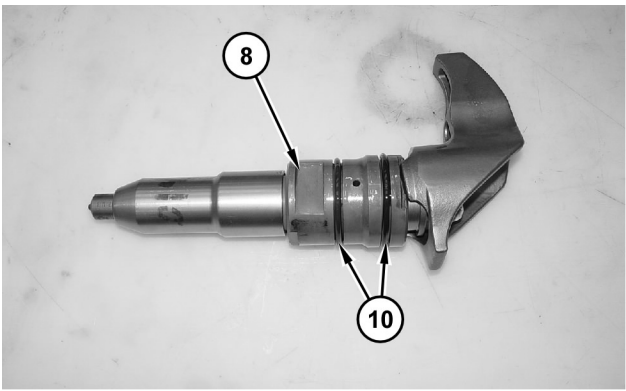


Illustration 299

g01348144

5. Check O-ring seals (10) on electronic unit injector (8).

Electronic Unit Injector - Install

SMCS Code: 1290-012

Installation Procedure

Table 31

Required Tools			
Tool	Part Number	Part Description	Qty
B	1P-0808	Multipurpose Grease	1
C	312-3204	Brush	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

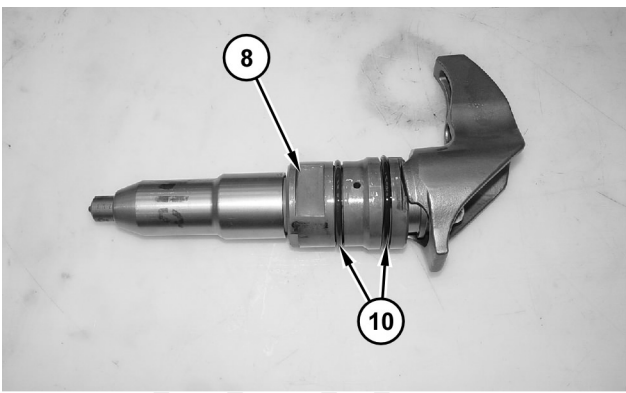


Illustration 300

g01348144

1. If necessary, install O-ring seals (10) onto electronic unit injector (8). Apply Tooling (B) to O-ring seals (11).

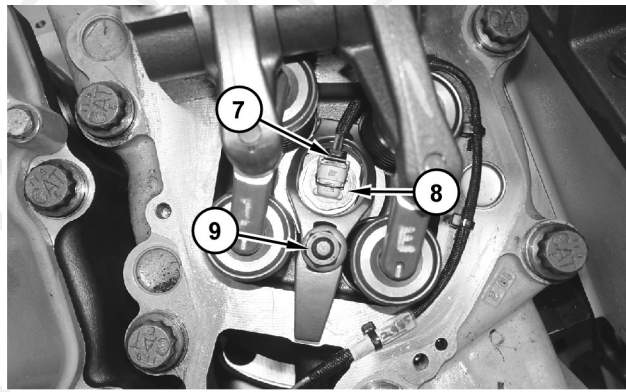


Illustration 301

g01199562

2. Check the cleanliness of the sealing surface for the unit injector in the cylinder head. If necessary, use Tooling (C) to clean the sealing cone on the unit injector.
3. Install electronic unit injector (8). Tighten bolt (9) to a torque of 60 ± 12 N·m (44 ± 9 lb ft).
4. Remove bolt (9). Hand tighten bolt (9) and the washer. Tighten bolt (9) to a torque of 10 N·m (7.5 lb ft). Connect harness assembly (7) onto electronic unit injector (8).

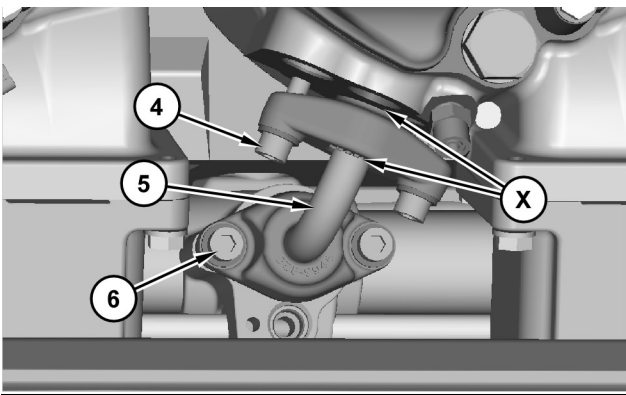


Illustration 302 g01285666

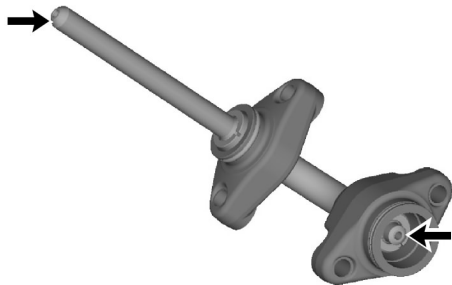


Illustration 303 g01285695

5. Apply clean engine oil to Area (X). Repeat for the opposite collar. Apply Tooling (A) to the ends of tube assembly (5). Install tube assembly (5). Install bolts (4) and bolts (6) hand tight. Evenly tighten bolts (4) to a torque of 20 N·m (15 lb ft). Evenly tighten bolts (6) to a torque of 20 N·m (15 lb ft).

Note: Do not rotate bolts (6) more than 90 degrees at a time.

6. Tighten nut (9) to a torque of 100 ± 2 N·m (74 ± 1 lb ft). Evenly tighten bolts (4) to a torque of 40 N·m (30 lb ft). Evenly tighten bolts (6) to a torque of 40 N·m (30 lb ft).

Note: Do not rotate bolts (4) and (6) more than 45 degrees at a time.

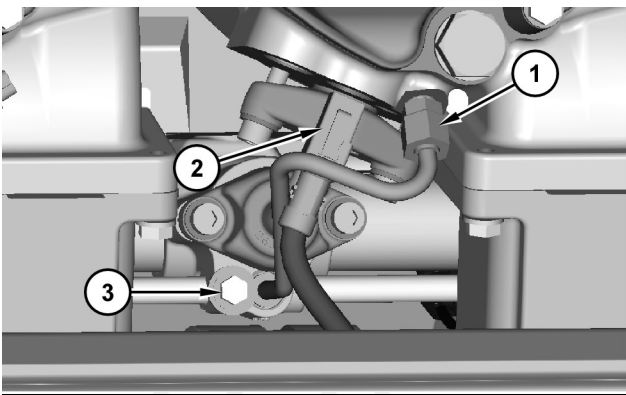


Illustration 304 g01285474

7. Connect harness assembly (2). Replace the O-ring seals on both ends of tube assembly (1). Install tube assembly (1). Install the washer and bolt (3).

End By:

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

i02462361

Electronic Unit Injector Sleeve - Remove

SMCS Code: 1713-011

Removal Procedure

Table 32

Required Tools			
Tool	Part Number	Part Description	Qty
A	249-7292	Valve Spring Compressor	1

Start By:

- a. Remove the electronic unit injector. Refer to Disassembly and Assembly, "Electronic Unit Injector - Remove".
- b. Remove the rocker shaft and pushrods. Refer to Disassembly and Assembly, "Rocker Shaft and Push 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.

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

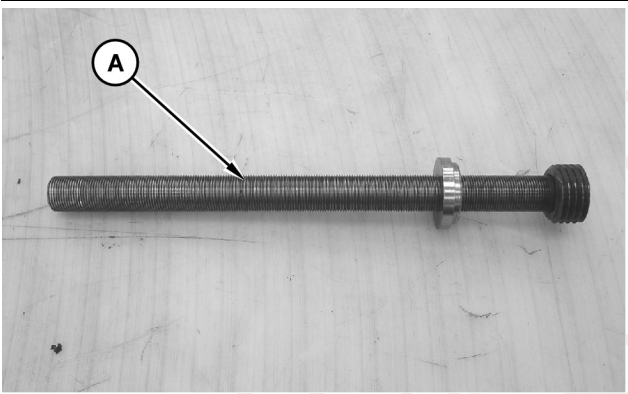


Illustration 305 g01228593

2. Install the puller of Tooling (A) into the electronic unit injector sleeve. Hand tighten the puller.



Illustration 306 g01228584

3. Install the legs of Tooling (A) onto the plate of Tooling (A).

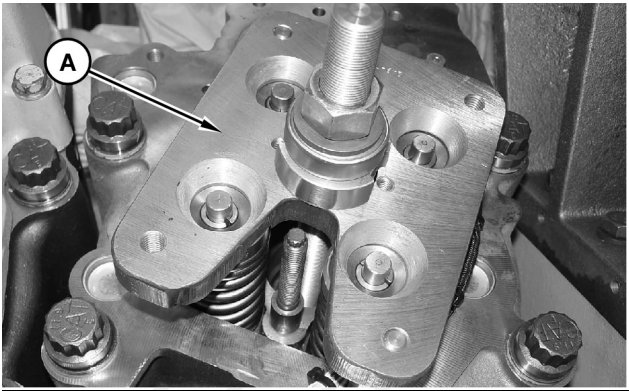


Illustration 307 g01228598

4. Install Tooling (A) onto the cylinder head. Refer to Illustration 307. Tighten the nut of Tooling (A) in order to remove the electronic unit injector sleeve.

i02462448

Electronic Unit Injector Sleeve - Install

SMCS Code: 1713-012

Installation Procedure

Table 33

Required Tools			
Tool	Part Number	Part Description	Qty
A	249-7292	Valve Spring Compressor	1
B	4C-9506	Retaining Compound	1

1. Thoroughly clean the bore in the cylinder for the electronic unit injector sleeve.

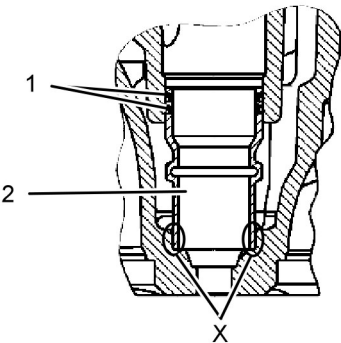


Illustration 308 g01228702

2. Install new O-ring seals (1) on electronic unit injector sleeve (2). Apply clean engine oil on O-ring seals (1). Apply Tooling (B) to Area (X).

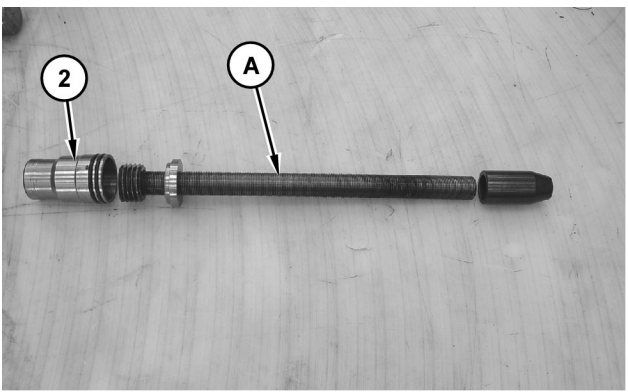


Illustration 309 g01228700

3. Install the puller of Tooling (A) into electronic unit injector sleeve (2). Tighten the collar of Tooling (A) against electronic unit injector sleeve (2).

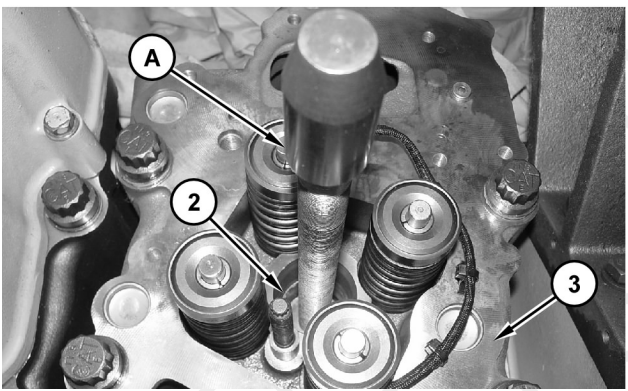


Illustration 310 g01228701

4. Install electronic unit injector sleeve (2) and Tooling (A) into cylinder head (3). Place the driver of Tooling (A) over puller of Tooling (A). Use a suitable hammer and install electronic unit injector sleeve (2). Install electronic unit injector sleeve (2) until electronic unit injector sleeve (2) is seated in cylinder head (3).

End By:

- a. Install the rocker shaft and pushrods. Refer to Disassembly and Assembly, "Rocker Shaft and Push Rods - Install".
- b. Install the electronic unit injector. Refer to Disassembly and Assembly, "Electronic Unit Injector - Install".

Cylinder Head - Remove

SMCS Code: 1100-011

Removal Procedure

Table 34

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

Start By:

- a. Remove the rocker shaft and pushrods. Refer to Disassembly and Assembly, "Rocker Shaft and Push 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 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 for disposal. Refer to Operation and Maintenance Manual, "Cooling System Coolant - Change".

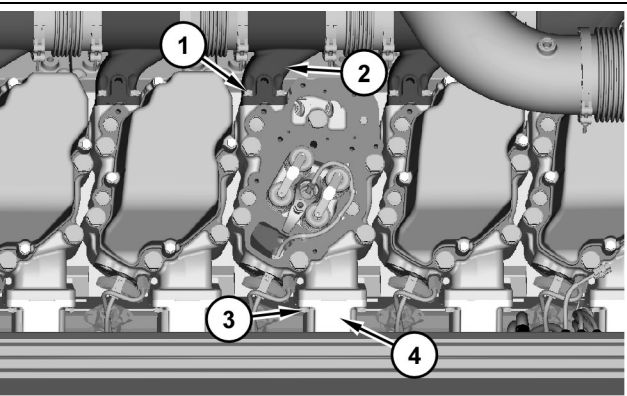


Illustration 311

g01202645

2. Remove bolts (1). Disconnect exhaust manifold (2). Remove bolts (3). Disconnect inlet manifold (4).

⚠ WARNING

Do not open the high pressure fuel system without allowing the fuel system to purge. After the engine has shut down, allow the fuel system to purge for ten minutes. This operating fuel system contains high pressure. Exposure to high pressure fuel can result in personal injury.

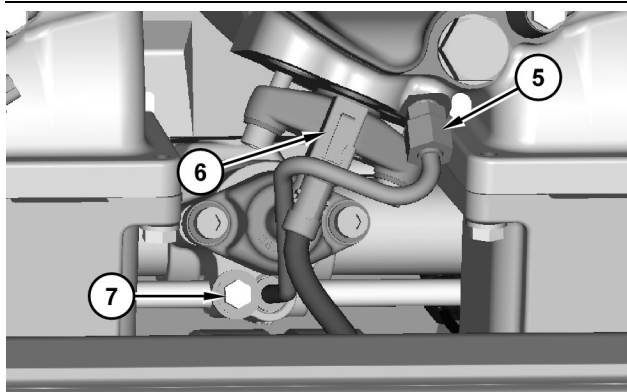


Illustration 312

g01287987

3. Remove bolt (7) and the washer. Remove tube assembly (5). Disconnect harness assembly (6).

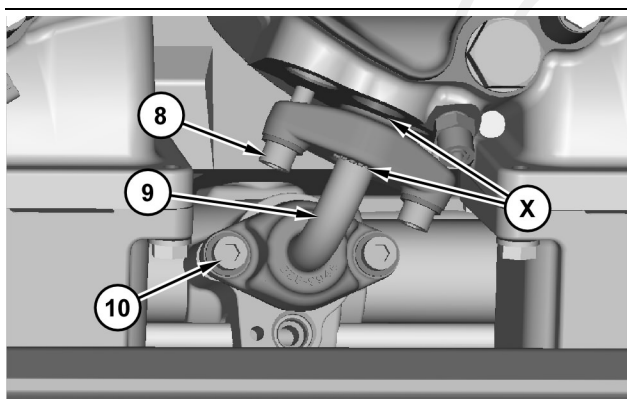


Illustration 313

g01287989

4. Apply clean engine oil to Area (X). Repeat for the opposite collar. Remove bolts (8) and bolts (10). Remove tube assembly (9).

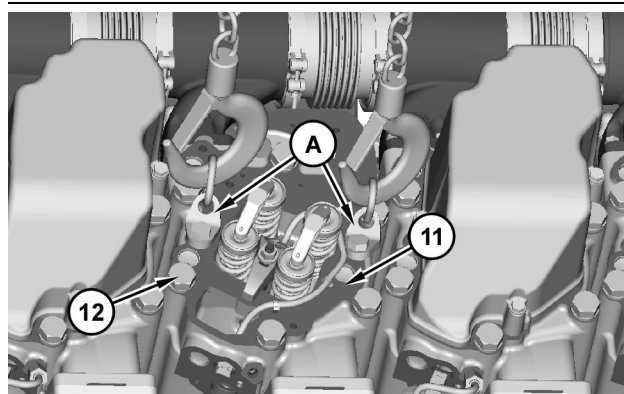


Illustration 314

g01202660

5. Attach Tooling (A) and a suitable lifting device onto cylinder head (11). Cylinder head (11) weighs approximately 68 kg (150 lb). Remove bolts (12). Remove cylinder head (11) from the engine. Position cylinder head (11) onto suitable cribbing in order to prevent damage to the electronic unit injector.

Note: The positioning dowels need to remain in the cylinder block. Remove the dowels if the dowels remain in the cylinder head. Install the new dowels in the cylinder block before installing the cylinder head.

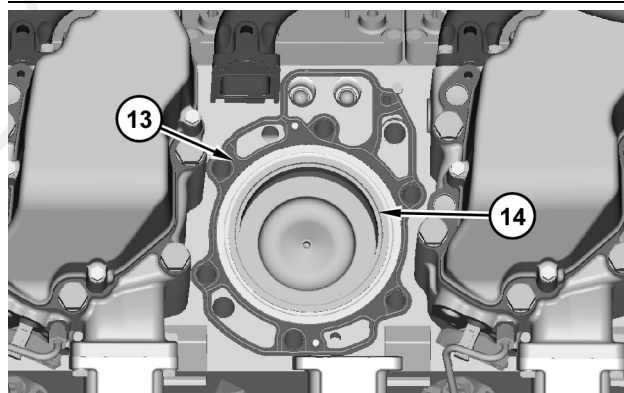


Illustration 315

g01202717

6. Remove gasket (13) from the cylinder block. Remove fire ring (14).

i02683666

Cylinder Head - Install

SMCS Code: 1100-012

Installation Procedure

Table 35

Required Tools			
Tool	Part Number	Part Description	Qty
A	138-7573	Link Bracket	2
B	1P-0808	Multipurpose Grease	1

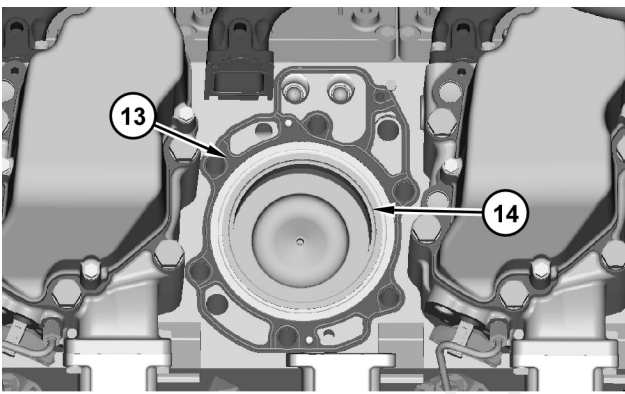


Illustration 316 g01202717

1. Install fire ring (14). Install a new gasket (13) onto the cylinder block.

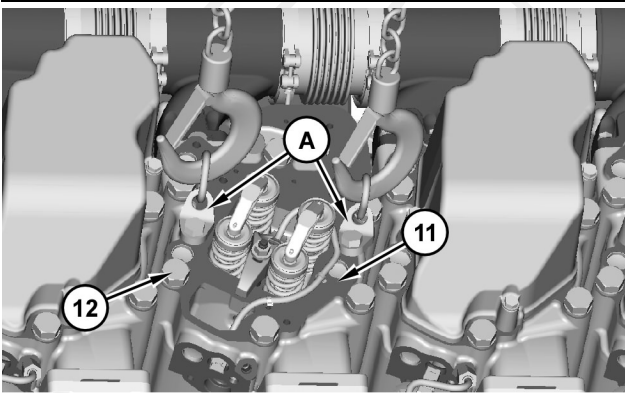


Illustration 317 g01202660

2. Attach Tooling (A) and a suitable lifting device onto cylinder head (11). Cylinder head (11) weighs approximately 68 kg (150 lb). Position cylinder head (11) onto the cylinder block. Lubricate the threads of bolts (12) with oil. Install bolts (12).

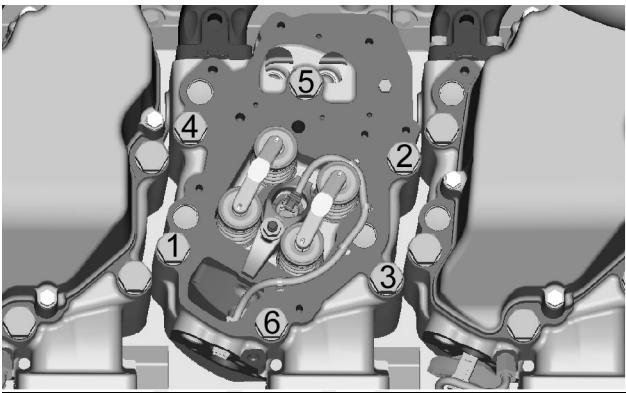


Illustration 318 g01202866

3. Tighten bolts (12) in the numerical sequence to a torque of $30 \pm 5 \text{ N}\cdot\text{m}$ ($22 \pm 7 \text{ lb ft}$). Tighten bolts (12) in the numerical sequence to a torque of $250 \pm 20 \text{ N}\cdot\text{m}$ ($184 \pm 15 \text{ lb ft}$). Tighten bolts (12) again in the numerical sequence to a torque of $250 \pm 20 \text{ N}\cdot\text{m}$ ($184 \pm 15 \text{ lb ft}$). Tighten bolts (12) in the numerical sequence for an additional 175 to 185 degrees.

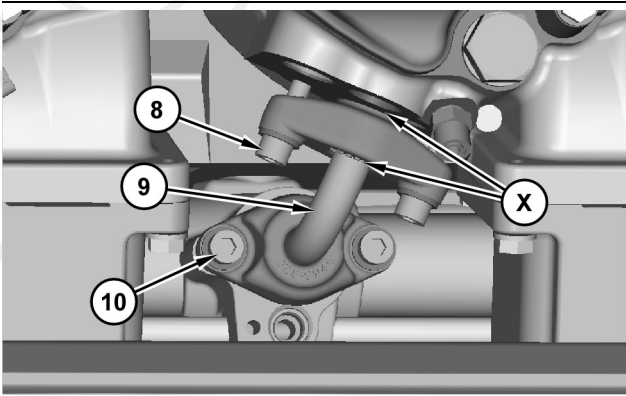


Illustration 319 g01287989

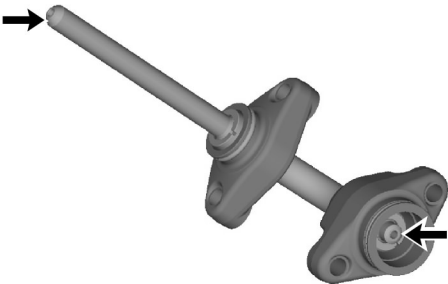


Illustration 320 g01285695

i02594527

4. Apply clean engine oil to Area (X). Repeat for the opposite collar. Apply Tooling (B) to the ends of tube assembly (9). Install tube assembly (9). Install bolts (8) and bolts (10) hand tight. Evenly tighten bolts (8) to a torque of 20 N·m (15 lb ft). Evenly tighten bolts (10) to a torque of 20 N·m (15 lb ft). Evenly tighten bolts (8) to a torque of 40 N·m (30 lb ft). Evenly tighten bolts (10) to a torque of 40 N·m (30 lb ft).

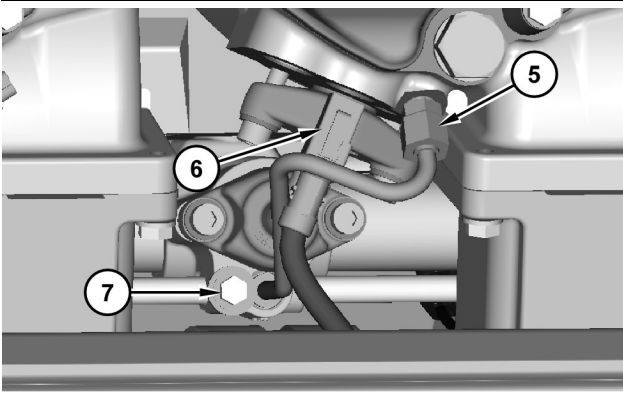


Illustration 321

g01287987

5. Connect harness assembly (6). Replace the O-ring seals on both ends of the tube assembly (5). Install tube assembly (5). Install the washer and bolt (7).

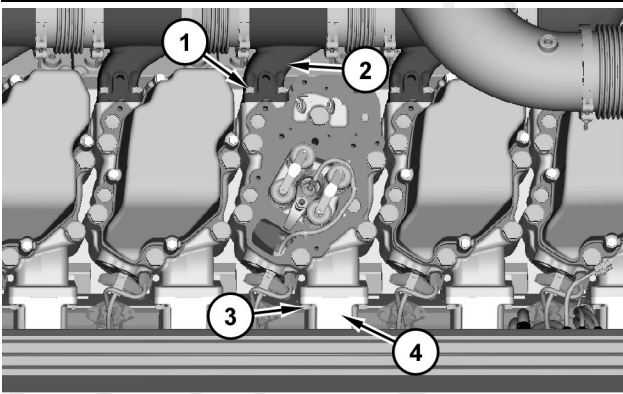


Illustration 322

g01202645

6. Position inlet manifold (4). Install bolts (3). Position exhaust manifold (2). Install bolts (1).
7. Fill the cooling system with coolant. Refer to Operation and Maintenance Manual, "Cooling System Coolant - Change".

End By:

- a. Install the rocker shaft and pushrods. Refer to Disassembly and Assembly, "Rocker Shaft and Push Rods - Install".

Inlet and Exhaust Valve Springs - Remove and Install

SMCS Code: 1108-010

Removal Procedure

Table 36

Required Tools			
Tool	Part Number	Part Description	Qty
A	283-9697	Valve Spring Compressor and Injector Sleeve Kit	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.

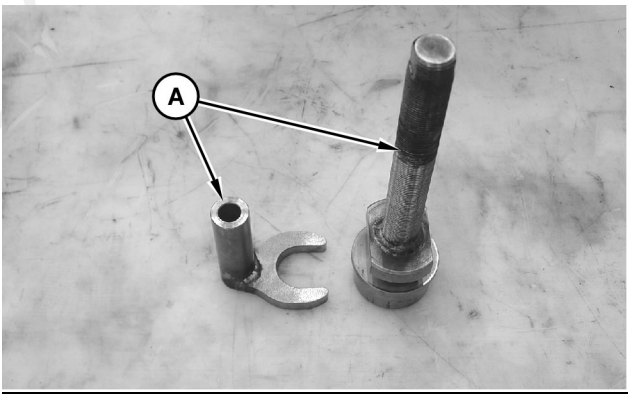


Illustration 323

g01206603

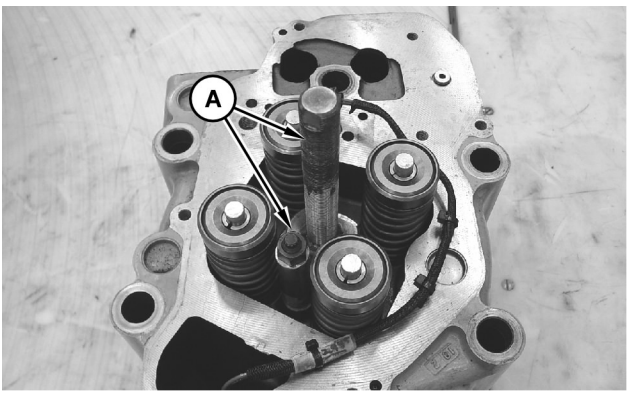


Illustration 324

g01207146

⚠ 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) into the hole for the electronic unit injector. Refer to Illustration 324.

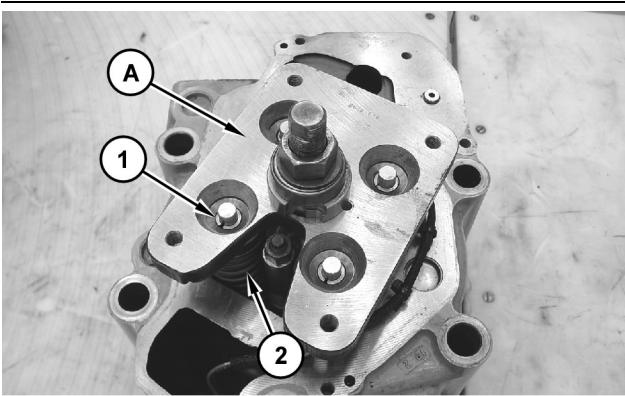


Illustration 325

g01207171

2. Install the plate of Tooling (A) onto the valve springs. Refer to Illustration 325. Install the nut onto the stud. Tighten the nut in order to compress valve springs (2). Remove retainer locks (1).

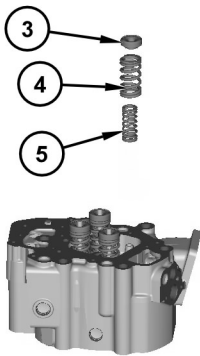


Illustration 326

g01298522

3. Remove Tooling (A). Remove rotocoil (3), outer spring (4), and inner spring (5).
4. Repeat Steps 1 through 3 for the remaining valve springs.

Installation Procedure

Table 37

Required Tools			
Tool	Part Number	Part Description	Qty
A	283-9697	Valve Spring Compressor and Injector Sleeve Kit	1

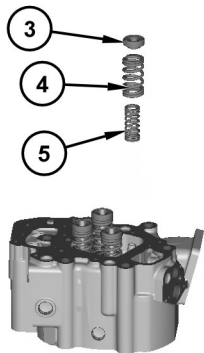


Illustration 327

g01298522

⚠ 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 inner spring (5), outer spring (4), and rotocoil (3).

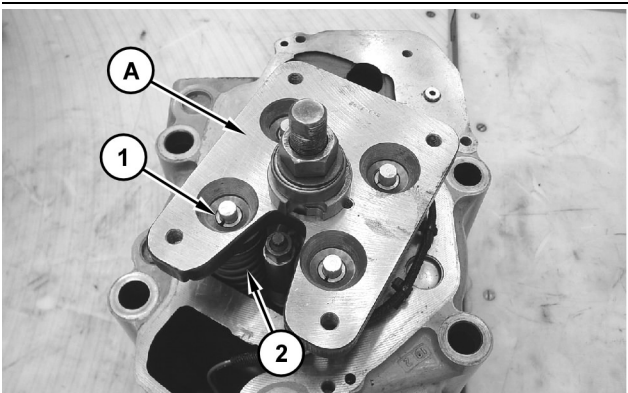


Illustration 328

g01207171

2. Use Tooling (A) in order to compress valve springs (2). Install retainer locks (1). Release the tension on valve springs (2). Remove Tooling (A).
3. Repeat Steps 1 through 2 for the remaining valve springs.

End By:

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

i02414067

Inlet and Exhaust Valves - Remove and Install

SMCS Code: 1105-010

Removal Procedure

Table 38

Required Tools			
Tool	Part Number	Part Description	Qty
A	283-9697	Valve Spring Compressor and Injector Sleeve Kit	1

Start By:

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

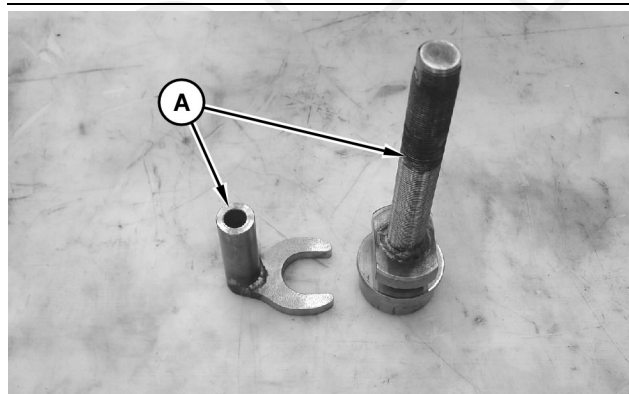


Illustration 329

g01206603

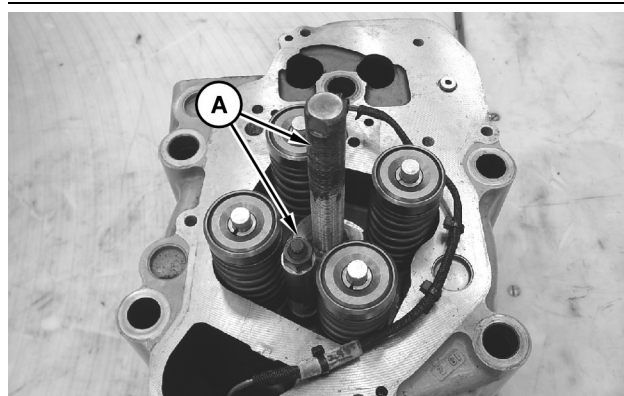


Illustration 330

g01207146

1. Install Tooling (A) into the hole for the electronic unit injector. Refer to Illustration 330.

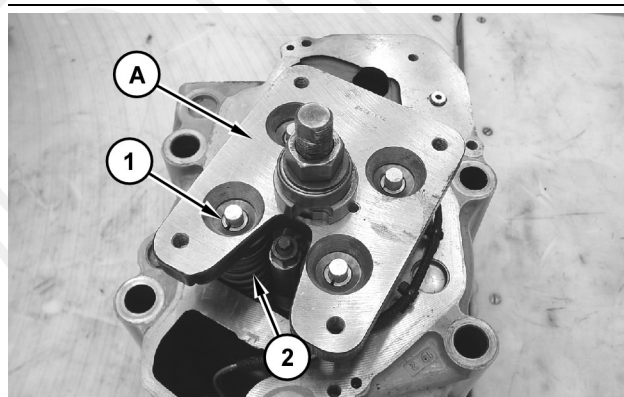


Illustration 331

g01207171

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 the plate of Tooling (A) onto the valve springs. Refer to Illustration 331. Install the nut onto the stud. Tighten the nut in order to compress valve springs (2). Remove retainer locks (1).

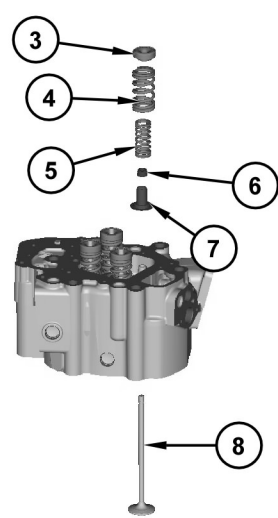


Illustration 332 g01206605

3. Remove Tooling (A). Remove rotocoil (3), outer spring (4), inner spring (5), valve seal (6), retainer (7), and valve (8).

Installation Procedure

Table 39

Required Tools			
Tool	Part Number	Part Description	Qty
A	283-9697	Valve Spring Compressor and Injector Sleeve Kit	1

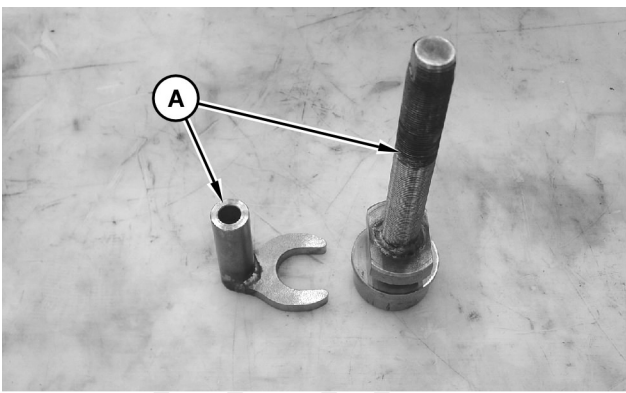


Illustration 334 g01206603

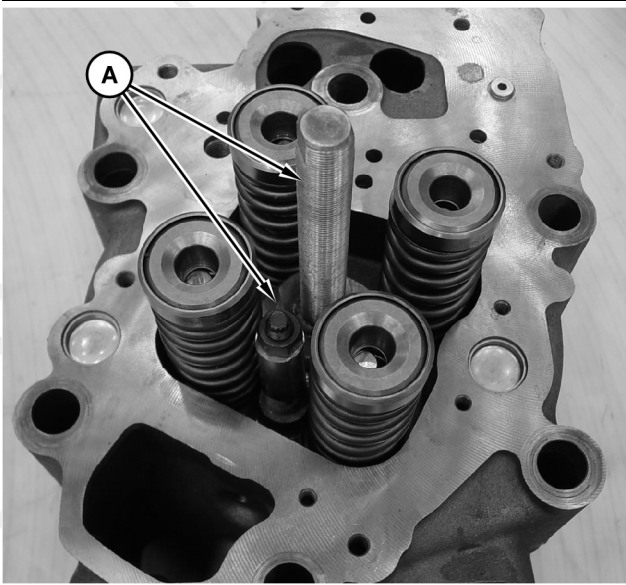


Illustration 335 g01228542

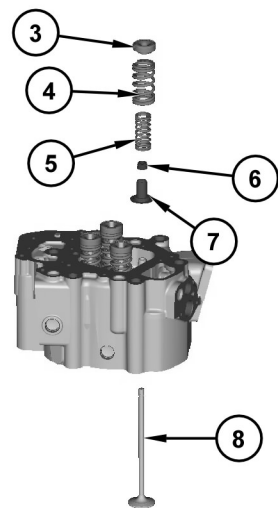


Illustration 333 g01206605

1. Install valve (8), retainer (7), valve seal (6), inner spring (5), outer spring (4), and rotocoil (3).

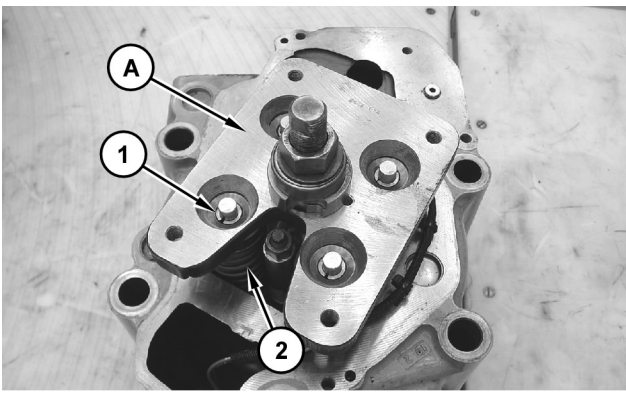


Illustration 336 g01207171

⚠ 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. Use Tooling (A) in order to compress valve springs (2). Install retainer locks (1). Release the tension on valve springs (2). Remove Tooling (A). Install a screwdriver into the hole for the injector. Slowly rotate the engine until the piston is approximately 25 mm (1.00 inch) below top dead center. Lightly strike the tops of the valves with a soft faced hammer in order to ensure that retainer locks (1) are properly seated.

End By:

- a. Install the cylinder head. Refer to Disassembly and Assembly, "Cylinder Head - Install".
- b. Install the electronic unit injector. Refer to Disassembly and Assembly, "Electronic Unit Injector - Install".

i02413949

Inlet and Exhaust Valve Guides - Remove and Install

SMCS Code: 1104-010

Removal Procedure

Table 40

Required Tools			
Tool	Part Number	Part Description	Qty
A	283-0052	Valve guide driver	1

Start By:

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

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

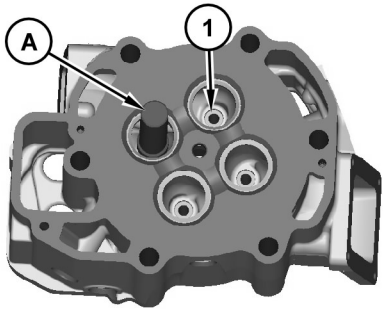


Illustration 337

g01206606

1. Turn over the cylinder head. Use Tooling (A) and a suitable hammer in order to remove valve guides (1) from the cylinder head.

Installation Procedure

Table 41

Required Tools			
Tool	Part Number	Part Description	Qty
A	283-0052	Valve guide driver	1
B	284-1503	Collar	1

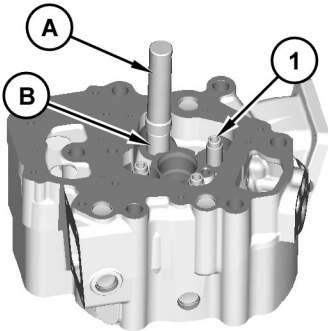


Illustration 338

g01211260

1. Coat the outside of the valve guides with clean oil prior to installation. Use Tooling (A), Tooling (B), and a suitable hammer in order to install valve guides (1) into the cylinder head. Valve guide (1) must extend 42.0 ± 0.50 mm (1.65 ± 0.020 inch) above the surface of the cylinder head.

End By:

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

i02414037

Inlet and Exhaust Valve Seat Inserts - Remove and Install

SMCS Code: 1103-010

Removal Procedure

Table 42

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

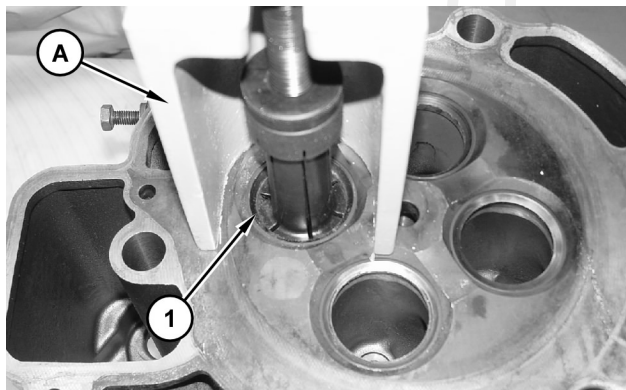


Illustration 339

g01206653

1. Turn over the cylinder head. Use Tooling (A) in order to remove valve seats (1) from the cylinder head.

Installation Procedure

Table 43

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

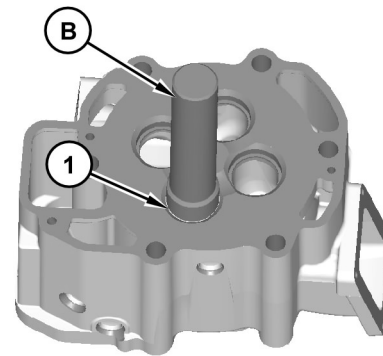


Illustration 340

g01206654

1. Lower the temperature of valve seats (1). Use Tooling (B) and a suitable hammer in order to install valve seats (1) into the cylinder head.

End By:

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

i02594613

Inlet Valve Seals - Remove and Install

SMCS Code: 1104-010-SA

Removal Procedure

Table 44

Required Tools			
Tool	Part Number	Part Description	Qty
A	283-9697	Valve Spring Compressor and Injector Sleeve Kit	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.

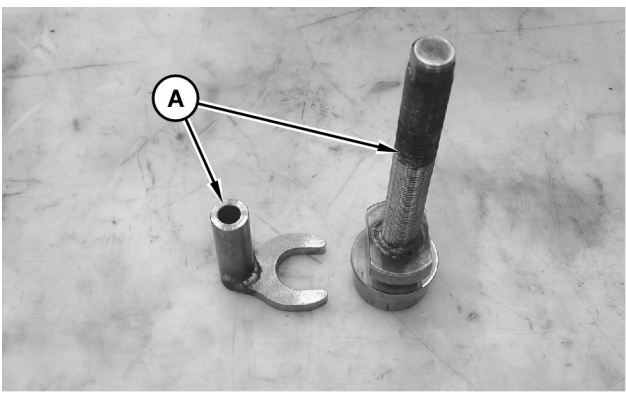


Illustration 341

g01206603

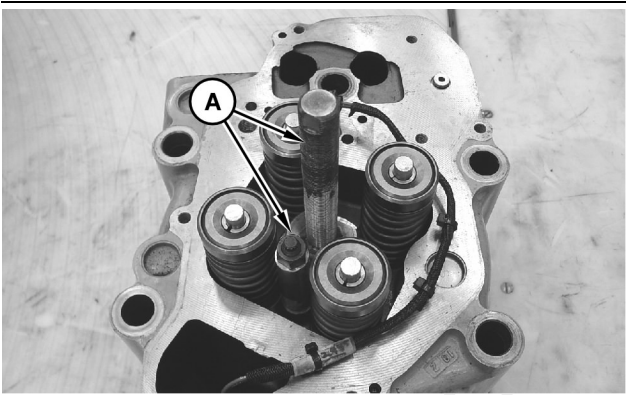


Illustration 342

g01207146

1. Install Tooling (A) into the hole for the electronic unit injector. Refer to Illustration 342.

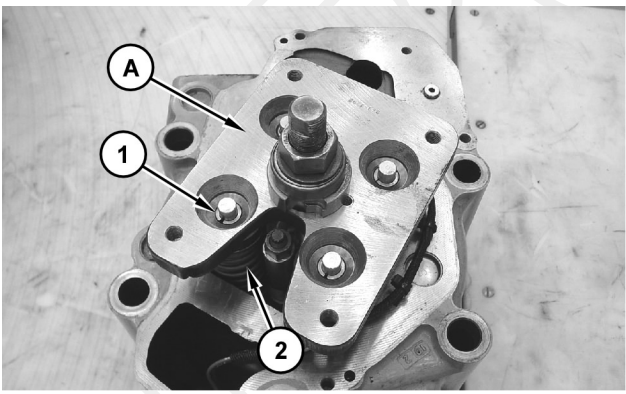


Illustration 343

g01207171

⚠ 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 the plate of Tooling (A) onto the valve springs. Refer to Illustration 343. Install the nut onto the stud. Tighten the nut in order to compress valve springs (2). Remove retainer locks (1).

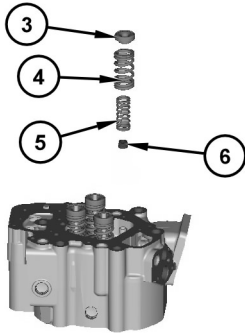


Illustration 344

g01298551

3. Remove Tooling (A). Remove rotocoil (3), outer spring (4), and inner spring (5). Remove valve seal (6).
4. Repeat Steps 1 through 3 for the remaining valve seals.

Installation Procedure

Table 45

Required Tools			
Tool	Part Number	Part Description	Qty
A	283-9697	Valve Spring Compressor and Injector Sleeve Kit	1

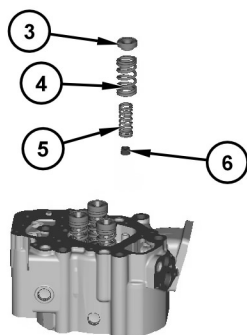


Illustration 345

g01298551

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 a new valve seal (6). Install inner spring (5), outer spring (4), and rotocoil (3).

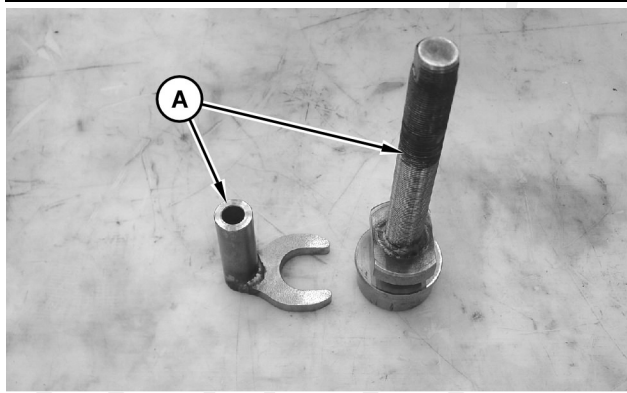


Illustration 346

g01206603

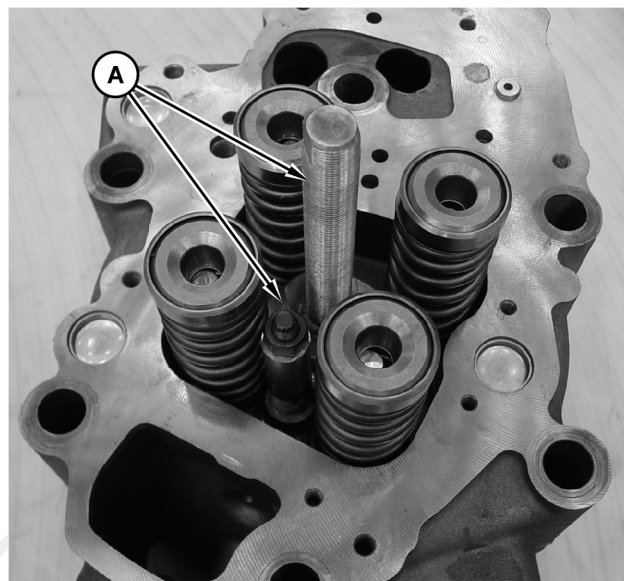


Illustration 347

g01228542

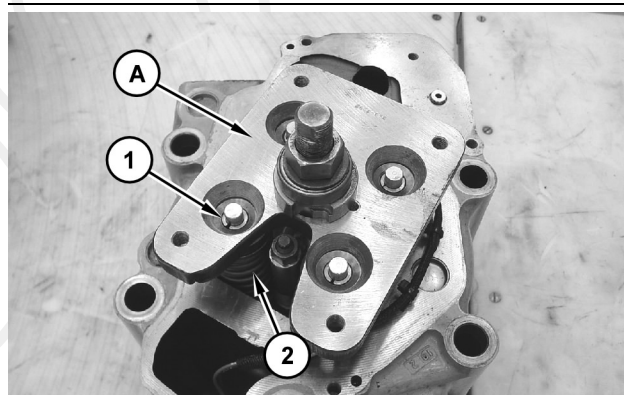


Illustration 348

g01207171

2. Use Tooling (A) in order to compress valve springs (2). Install retainer locks (1). Release the tension on valve springs (2). Remove Tooling (A).
3. Repeat Steps 1 through 2 for the remaining valve seals.

End By:

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

i02418603

Front Drive Housing - Remove and Install

SMCS Code: 1151-010

Removal Procedure

Table 46

Required Tools			
Tool	Part Number	Part Description	Qty
A	138-7574	Link Bracket	2

Start By:

- Remove the engine oil filter housing. Refer to Disassembly and Assembly, "Engine Oil Filter Housing - Remove".
- Remove the idler gears. Refer to Disassembly and Assembly, "Idler Gears (Front) - Remove and Install".
- Remove the crankshaft front seal. Refer to Disassembly and Assembly, "Crankshaft Front Seal - Remove".

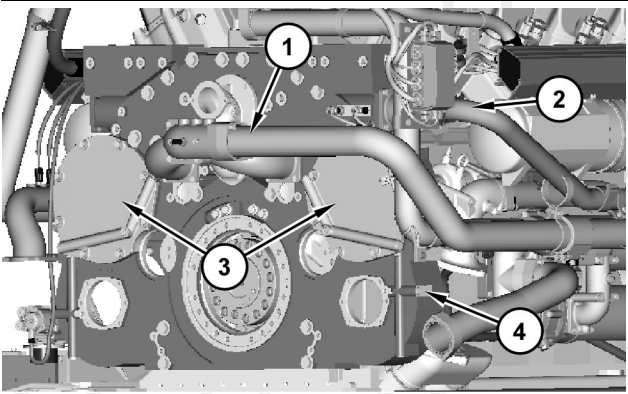


Illustration 349

g01219679

1. Disconnect tubes (1) and (2). Remove covers (3). Disconnect bracket (4).

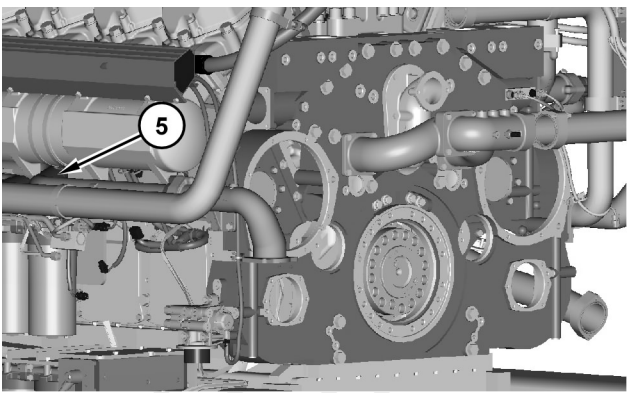


Illustration 350

g01219683

2. Disconnect tube (5).

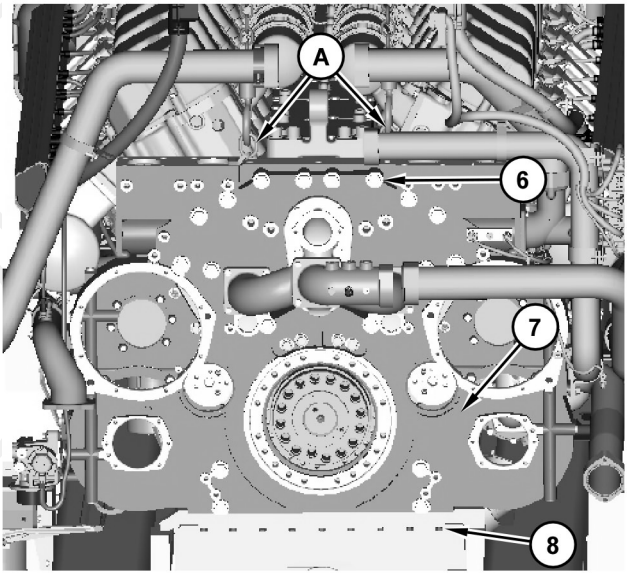


Illustration 351

g01219686

3. Remove bolts (6). Attach Tooling (A) and a suitable lifting device onto front drive housing (7). The weight of front drive housing (7) is approximately 363 kg (800 lb). Remove bolts (8). Remove front drive housing (7).

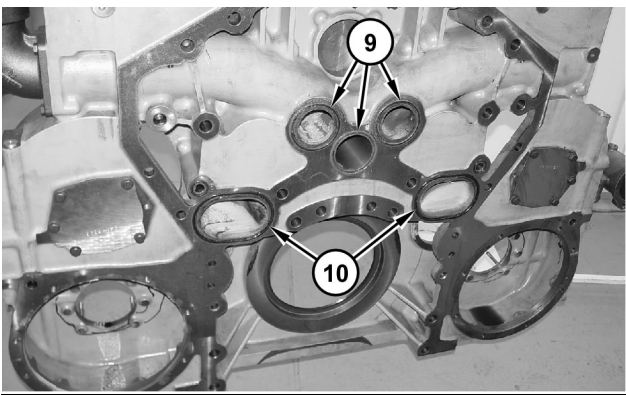


Illustration 352 g01267741

4. Remove O-ring seals (9) and (10).

Installation Procedure

Table 47

Required Tools			
Tool	Part Number	Part Description	Qty
A	138-7574	Link Bracket	2
B	1U-8846	Gasket Sealant	1

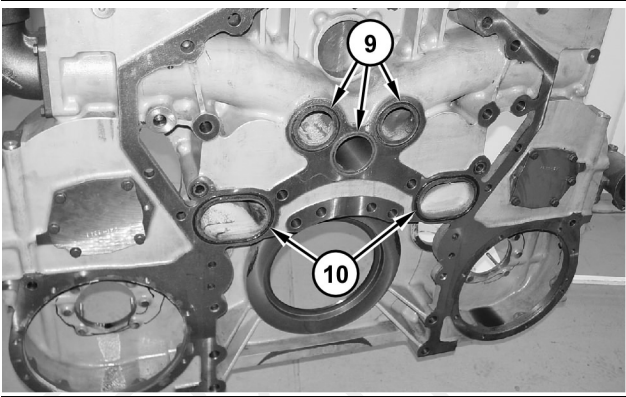


Illustration 353 g01267741

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

1. Apply Tooling (B) to the mating surface of the front drive housing. Install O-ring seals (9) and (10).

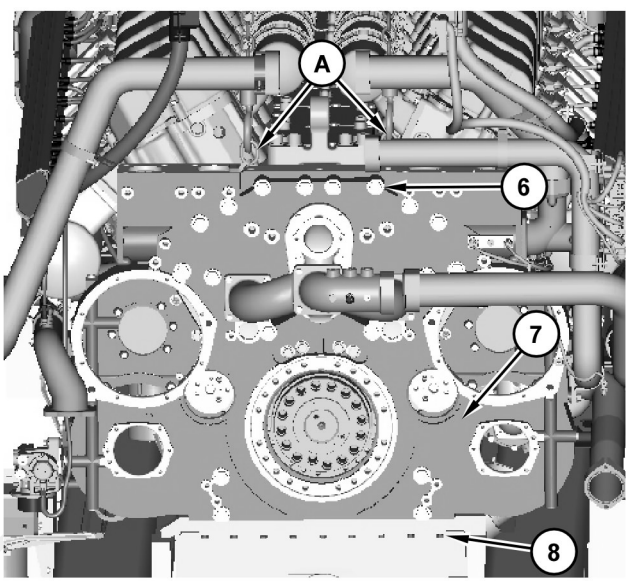


Illustration 354 g01219686

2. Attach Tooling (A) and a suitable lifting device onto front drive housing (7). The weight of front drive housing (7) is approximately 363 kg (800 lb). Install front drive housing (7). Install bolts (8). Install bolts (6).

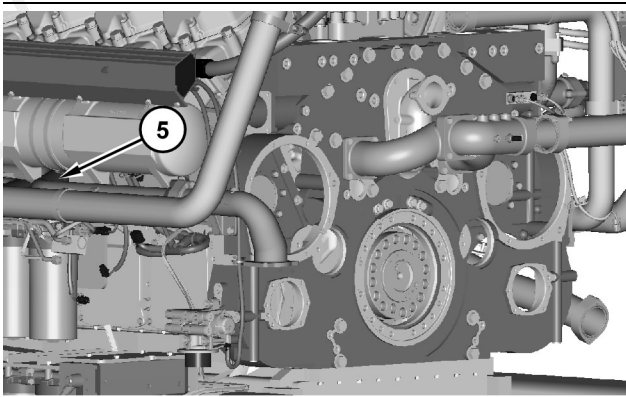


Illustration 355 g01219683

3. Connect tube (5).

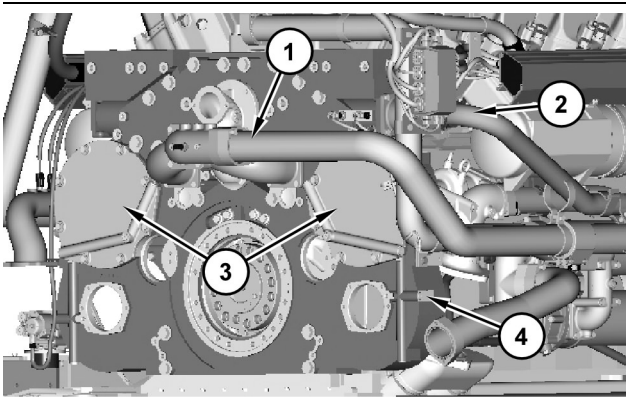


Illustration 356 g01219679

4. Connect bracket (4). Install covers (3). Connect tubes (1) and (2).

End By:

- a. Install the crankshaft front seal. Refer to Disassembly and Assembly, "Crankshaft Front Seal - Install".
- b. Install the idler gears. Refer to Disassembly and Assembly, "Idler Gears (Front) - Remove and Install".
- c. Install the engine oil filter housing. Refer to Disassembly and Assembly, "Engine Oil Filter Housing - Install".

i02410617

Vibration Damper - Remove and Install

SMCS Code: 1205-010

Removal Procedure

Table 48

Required Tools			
Tool	Part Number	Part Description	Qty
A	-	Guide Bolt M24 by 500 mm	2

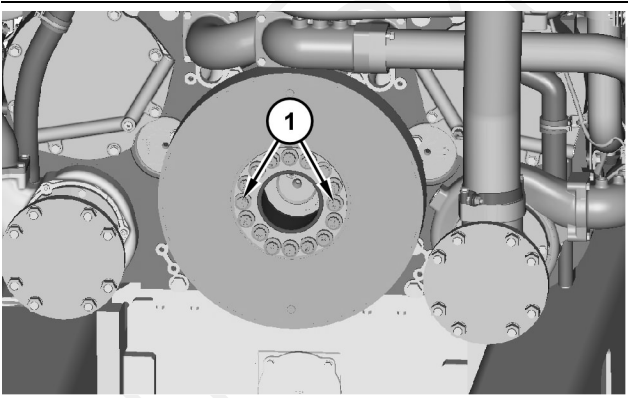


Illustration 357

g01204842

1. Remove two bolts (1).

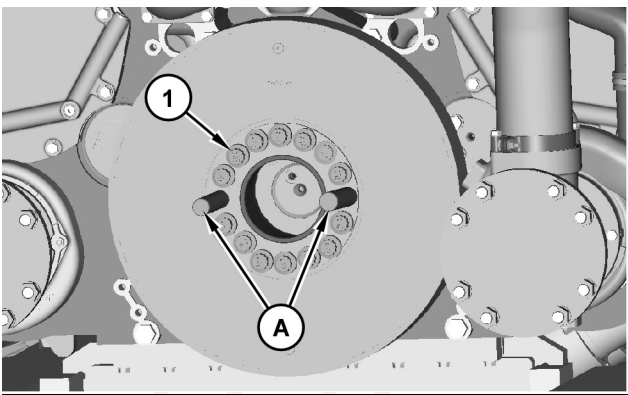


Illustration 358

g01204846

2. Install Tooling (A). Remove remaining bolts (1).

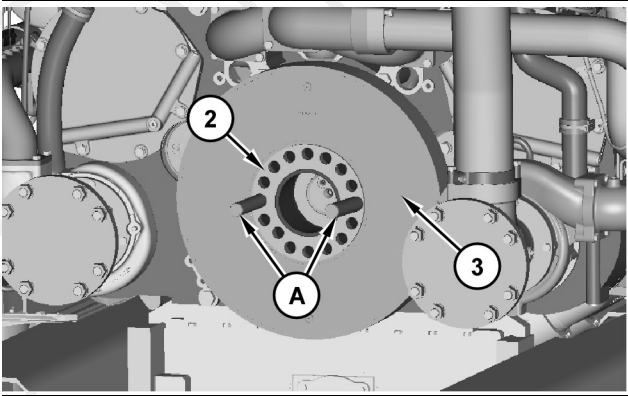


Illustration 359

g01204850

3. Remove spacer (2). Slide vibration damper (3) on Tooling (A).

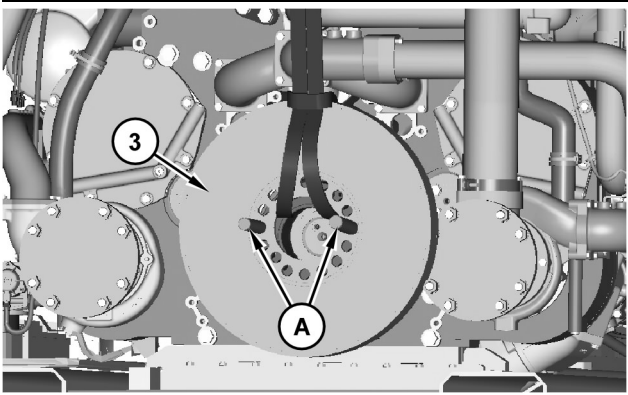


Illustration 360

g01204854

4. Attach a suitable lifting device onto vibration damper (3). The weight of vibration damper (3) is approximately 195 kg (430 lb). Slide vibration damper (3) to the end of Tooling (A). Remove vibration damper (3).

Installation Procedure

Table 49

Required Tools			
Tool	Part Number	Part Description	Qty
A	-	Guide Bolt M24 by 500 mm	2

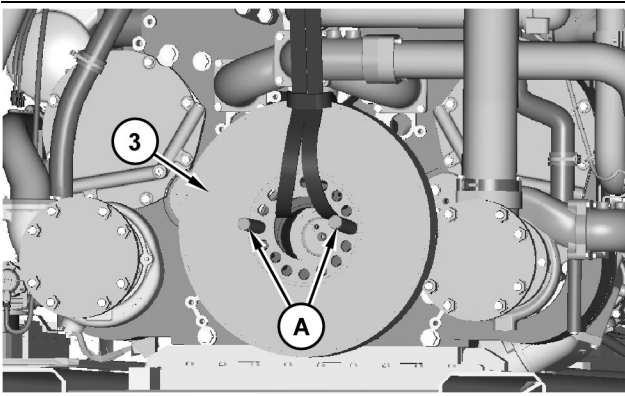


Illustration 361

g01204854

1. Attach a suitable lifting device onto vibration damper (3). The weight of vibration damper (3) is approximately 195 kg (430 lb). Install Tooling (A). Position vibration damper (3) onto Tooling (A). Slide vibration damper (3) on Tooling (A). Remove the suitable lifting device.

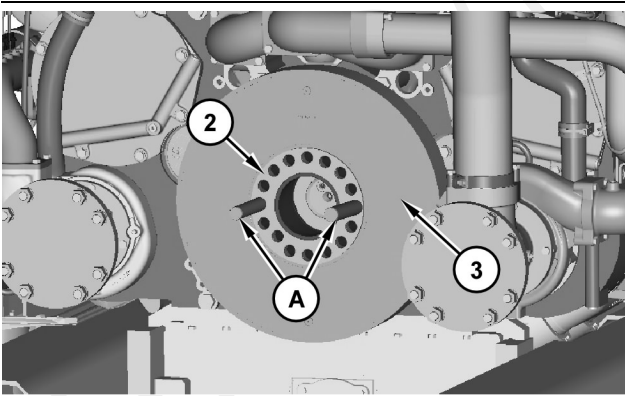


Illustration 362

g01204850

2. Position vibration damper (3). Install spacer (2) onto Tooling (A).

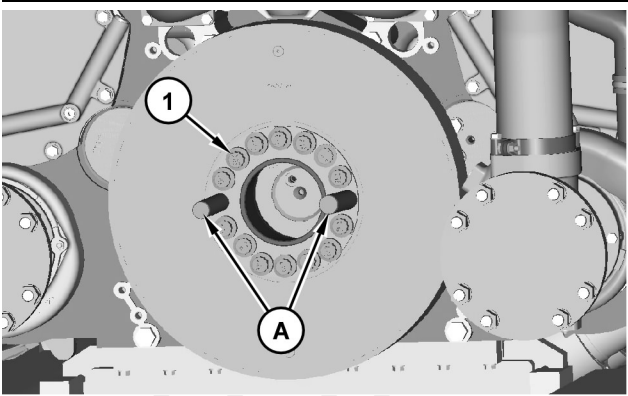


Illustration 363

g01204846

3. Install bolts (1). Remove Tooling (A).

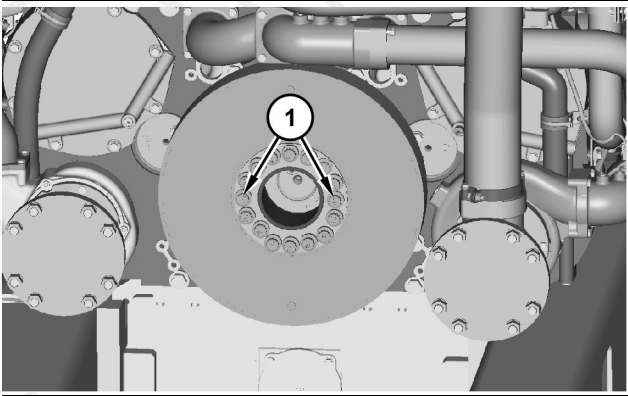


Illustration 364

g01204842

4. Install remaining bolts (1). Tighten bolts (1) to a torque of 625 ± 50 N·m (461 ± 37 lb ft).

i02416922

Crankshaft Front Seal -
Remove

SMCS Code: 1160-011

Removal Procedure

Table 50

Required Tools			
Tool	Part Number	Part Description	Qty
A	1U-5593	Drill Bit	1
B	1U-7600	Slide Hammer Puller Gp	1

Start By:

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

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

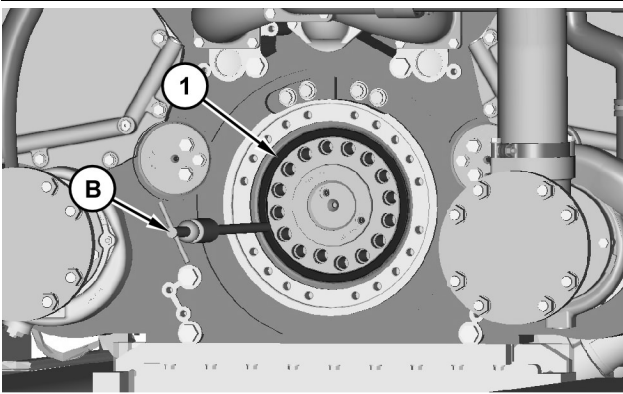


Illustration 365

g01208062

2. Use Tooling (B) in order to remove the outer half of crankshaft front seal (1).
3. Use Tooling (A) to drill three evenly spaced holes in the crankshaft front seal.

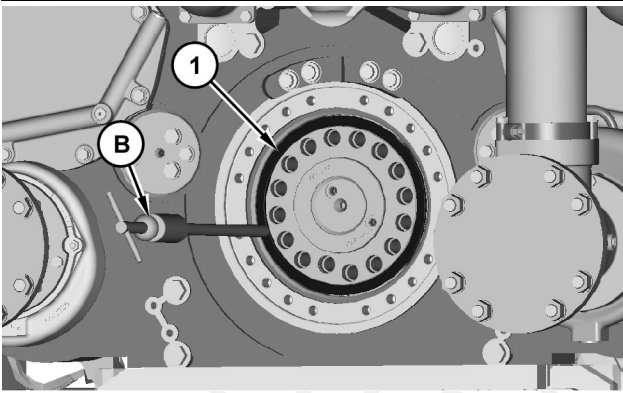


Illustration 366

g01208063

4. Use Tooling (B) in order to remove the inner half of crankshaft front seal (1).

i02417218

Crankshaft Front Seal - Install

SMCS Code: 1160-012

Installation Procedure

Table 51

Required Tools			
Tool	Part Number	Part Description	Qty
C	250 - 4587	Installer	1
	250 - 4586	Locator	1
	258 - 0933	Bolt	1

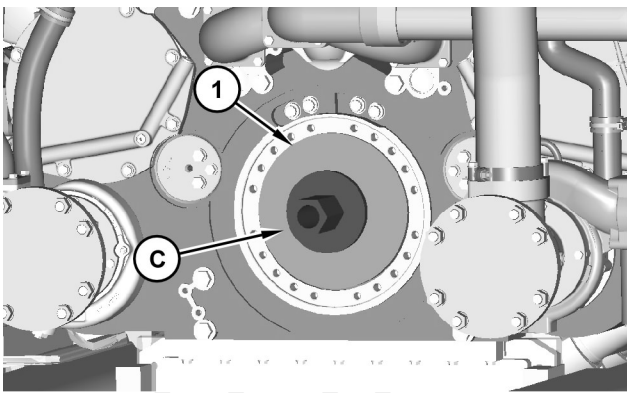


Illustration 367

g01208138

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

End By:

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

i02406835

Flywheel - Remove and Install

SMCS Code: 1156-010

Removal Procedure

Table 52

Required Tools			
Tool	Part Number	Part Description	Qty
A	-	Guide Bolt M24 X 2 by 200 mm	2
B	138 - 7575	Link Bracket	3
C	189 - 0408	Shackle As	1
D	1U - 9200	Lever Puller Hoist	1

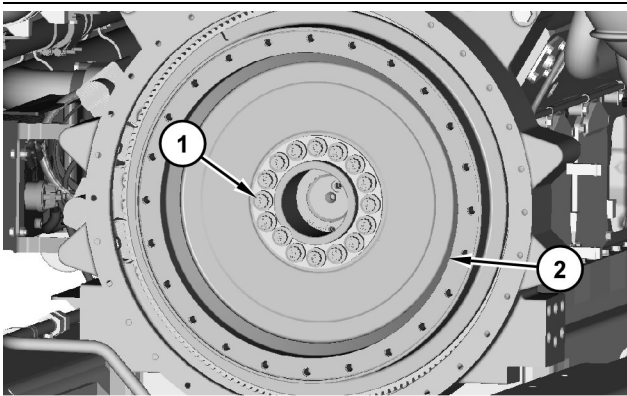


Illustration 368

g01202285

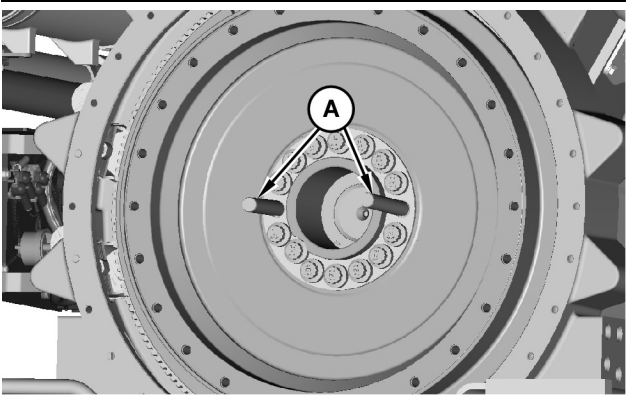


Illustration 369 g01202287

1. Remove two bolts (1) from flywheel (2). Install Tooling (A).

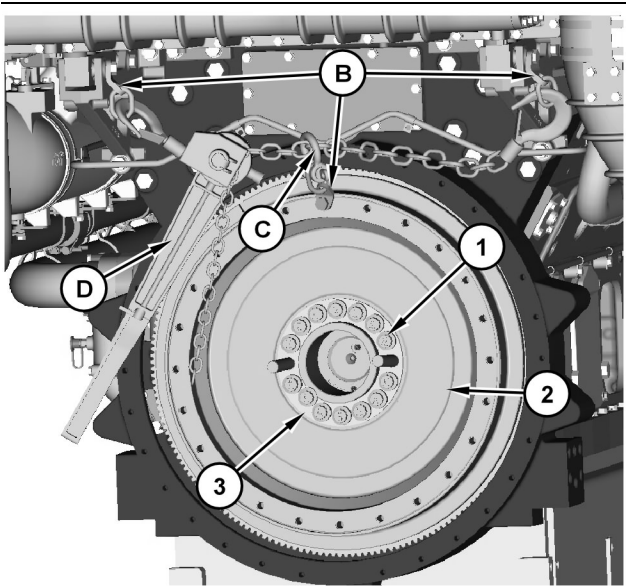


Illustration 370 g01202288

2. Install Tooling (B), Tooling (C), and Tooling (D) in order to support the weight of flywheel (2). The weight of flywheel (2) is approximately 177 kg (390 lb). Remove remaining bolts (1). Remove spacer (3). Slide flywheel (2) on Tooling (A). Remove flywheel (2).

Installation Procedure

Table 53

Required Tools			
Tool	Part Number	Part Description	Qty
A	-	Guide Bolt M24 X 2 by 200 mm	2
B	138 - 7575	Link Bracket	3
C	189 - 0408	Shackle As	1
D	1U - 9200	Lever Puller Hoist	1

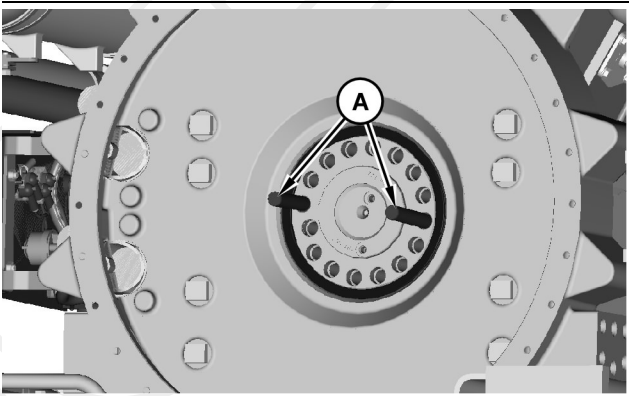


Illustration 371 g01202299

1. Install Tooling (A).

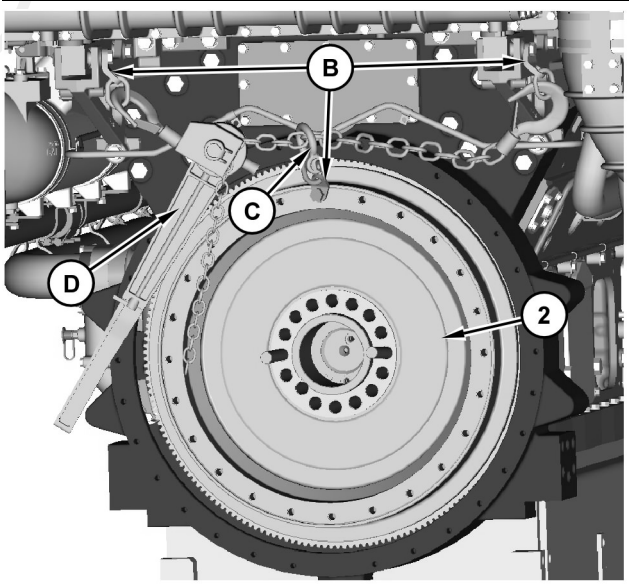


Illustration 372 g01202300

2. Use Tooling (B), Tooling (C), and Tooling (D) in order to position flywheel (2) onto Tooling (A). The weight of flywheel (2) is approximately 177 kg (390 lb).

i02403449

Crankshaft Rear Seal - Remove

SMCS Code: 1161-011

Removal Procedure

Table 54

Required Tools			
Tool	Part Number	Part Description	Qty
A	1U-5593	Drill Bit	1
B	1U-7600	Slide Hammer Puller Gp	1

Start By:

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

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

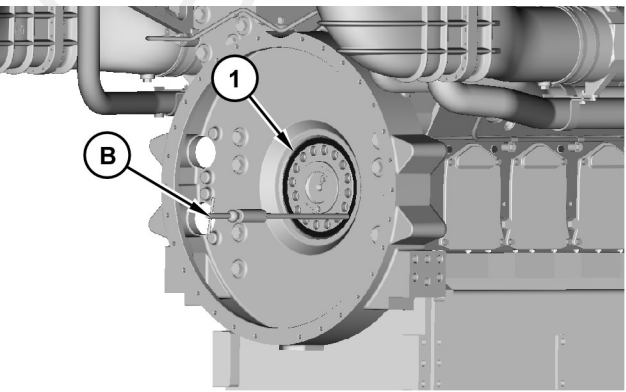


Illustration 375

g01200319

2. Use Tooling (B) in order to remove the outer half of rear crankshaft seal (1).

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

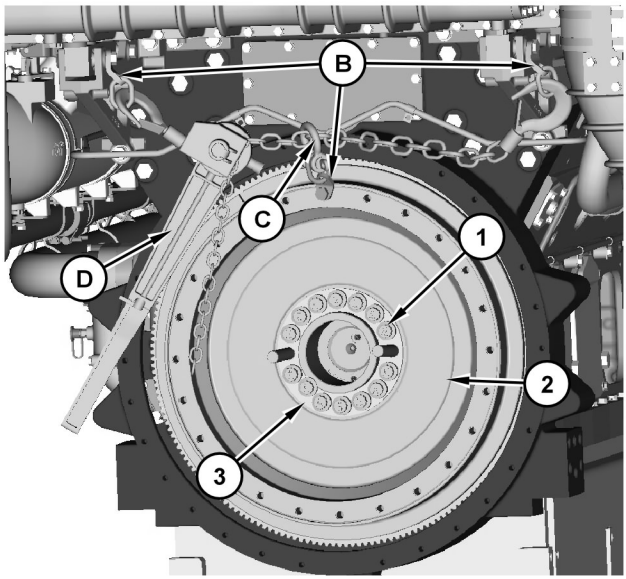


Illustration 373

g01202288

3. Install spacer (3) onto flywheel (2). Lubricate the threads of bolts (1) with oil. Install bolts (1). Remove Tooling (B), Tooling (C), and Tooling (D).

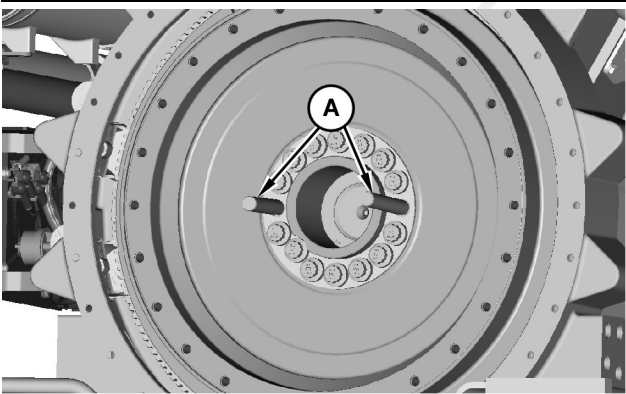


Illustration 374

g01202287

4. Remove Tooling (A) and install remaining bolts (1). Tighten bolts (1) to a torque of 550 ± 50 N·m (406 ± 37 lb ft). Tighten bolts (1) for an additional 85 to 95 degrees.

i02441306

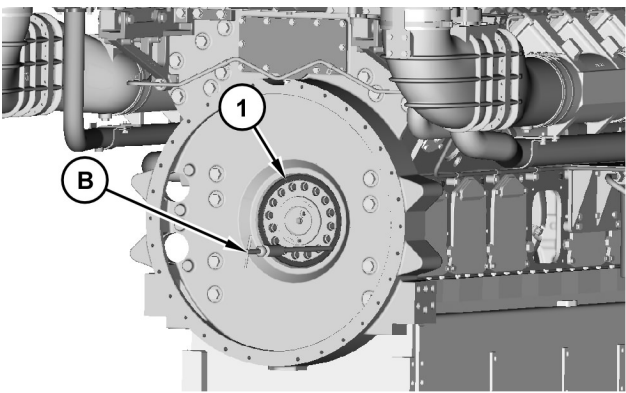


Illustration 376

g01200322

4. Use Tooling (B) in order to remove the inner half of rear crankshaft seal (1).

i02403536

Crankshaft Rear Seal - Install

SMCS Code: 1161-012

Installation Procedure

Table 55

Required Tools			
Tool	Part Number	Part Description	Qty
C	250-4587	Installer	1
	250-4586	Locator	1
	258-0933	Bolt	2

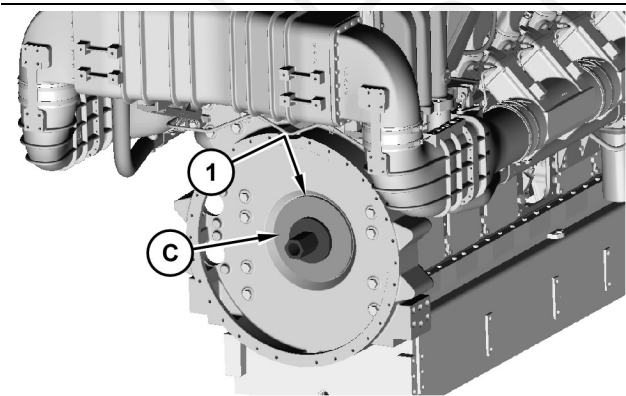


Illustration 377

g01200381

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

End By:

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

Flywheel Housing - Remove

SMCS Code: 1157-011

Removal Procedure

Table 56

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

Start By:

- a. Remove the crankshaft rear seal. Refer to Disassembly and Assembly, "Crankshaft Rear Seal - Remove".
- b. Remove the aftercooler. Refer to Disassembly and Assembly, "Aftercooler - Remove and Install".
- c. Remove the starters. Refer to Disassembly and Assembly, "Electric Starting Motor - Remove and Install" and Disassembly and Assembly, "Air Starting Motor - Remove".

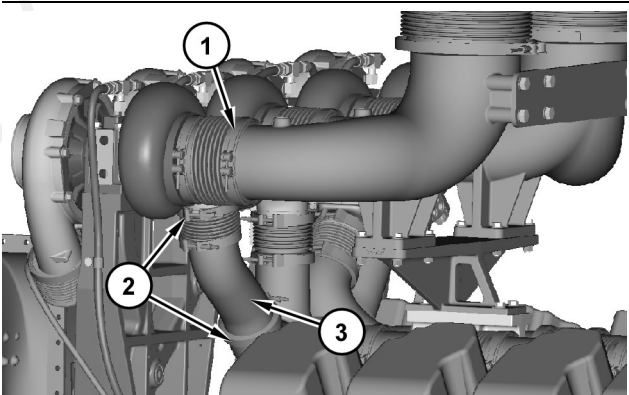


Illustration 378

g01219819

1. Disconnect clamp (1). Disconnect clamps (2). Remove tubes (3).

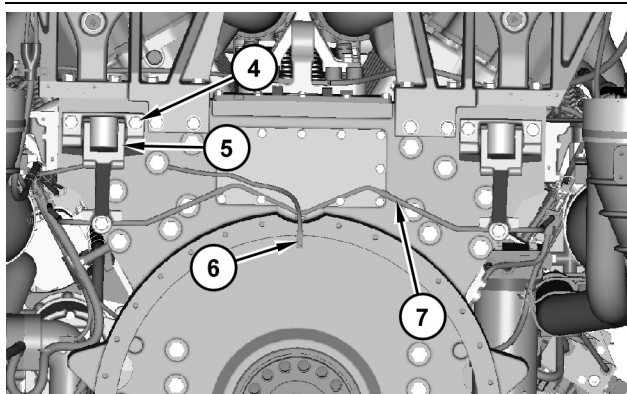


Illustration 379

g01219823

2. Remove bolts (4). Remove bracket (5). Repeat for the opposite side. Disconnect harness assembly (6). Remove tube assembly (7).

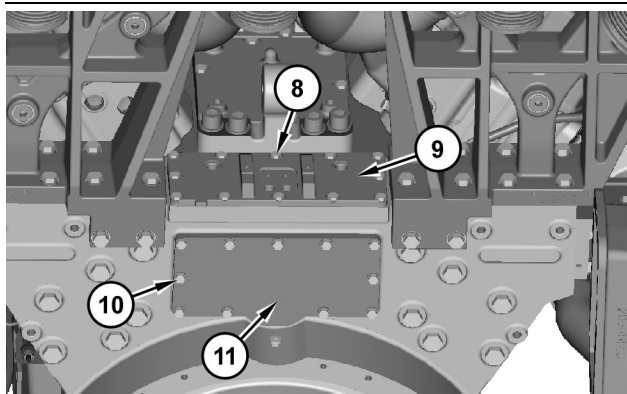


Illustration 380

g01219824

3. Remove bolts (8). Remove cover (9). Remove bolts (10). Remove cover (11).

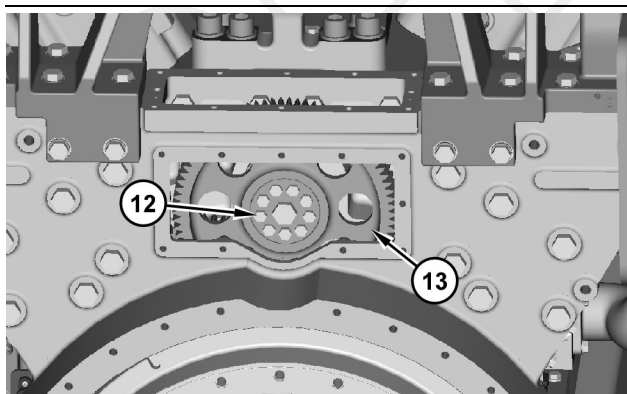


Illustration 381

g01219825

4. Remove bolts (12). Remove cam gear (13).

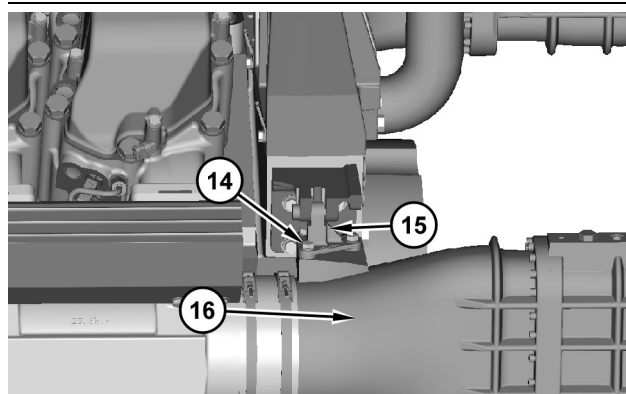


Illustration 382

g01219847

5. Remove bolts (14) in order to disconnect bracket (15) from air intake manifold (16). Repeat for the opposite side.

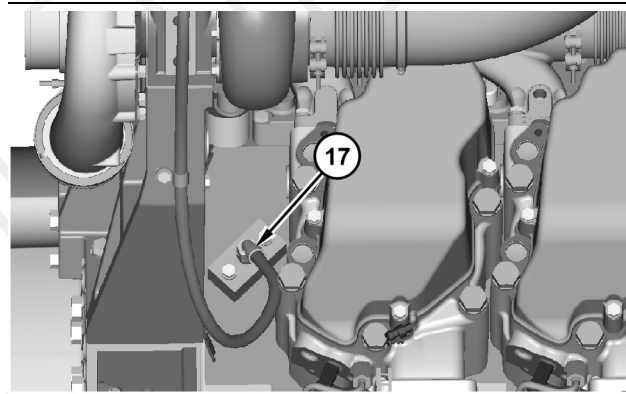


Illustration 383

g01220567

6. Disconnect hose assembly (17).

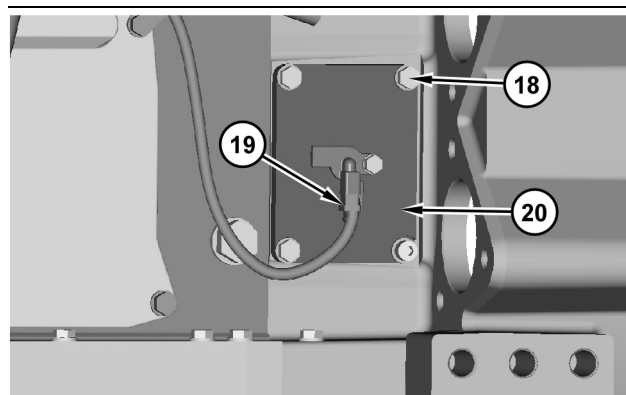


Illustration 384

g01220568

7. Disconnect harness assembly (19). Remove bolts (18). Remove cover (20).

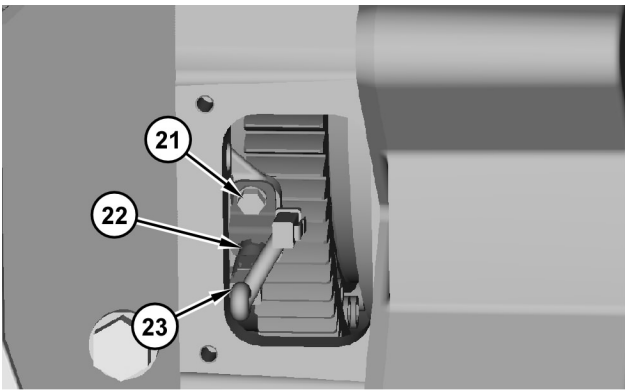


Illustration 385 g01220569

8. Disconnect harness assembly (23). Remove bolt (21). Remove crankshaft position sensor (22).

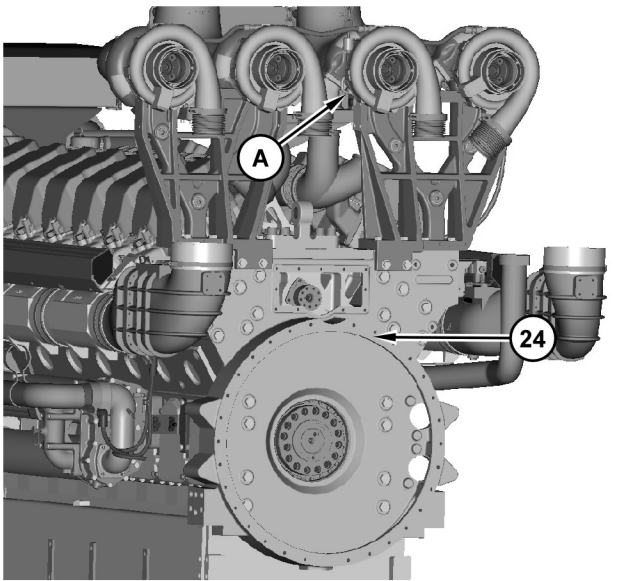


Illustration 386 g01220570

9. Attach Tooling (A) and a suitable lifting device onto flywheel housing (24). The weight of flywheel housing (24) is approximately 726 kg (1600 lb). Apply slight lifting tension on flywheel housing (24).

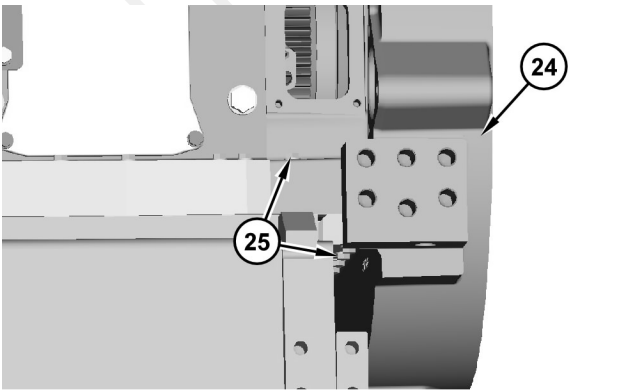


Illustration 387 g01220583

10. Remove bolts (25) that connect the oil pan to flywheel housing (24).

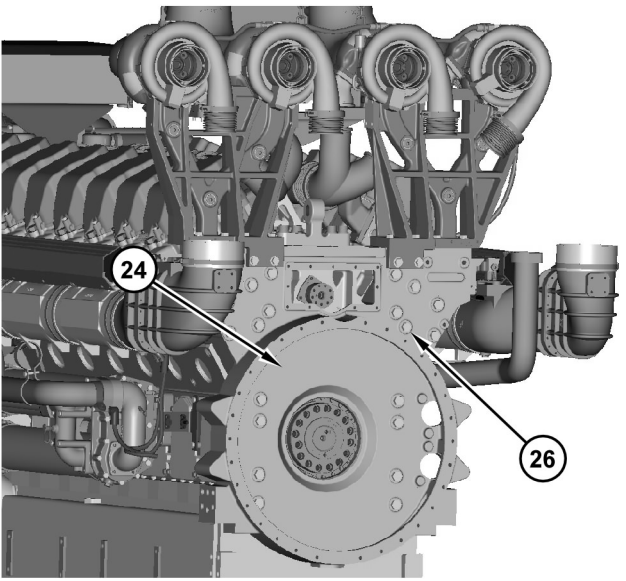


Illustration 388 g01220585

11. Remove bolts (26). Remove flywheel housing (24).

i02443799

Flywheel Housing - Install

SMCS Code: 1157-012

Installation Procedure

Table 57

Required Tools			
Tool	Part Number	Part Description	Qty
A	138-7575	Link Bracket	2
B	1U-8846	Gasket Sealant	1

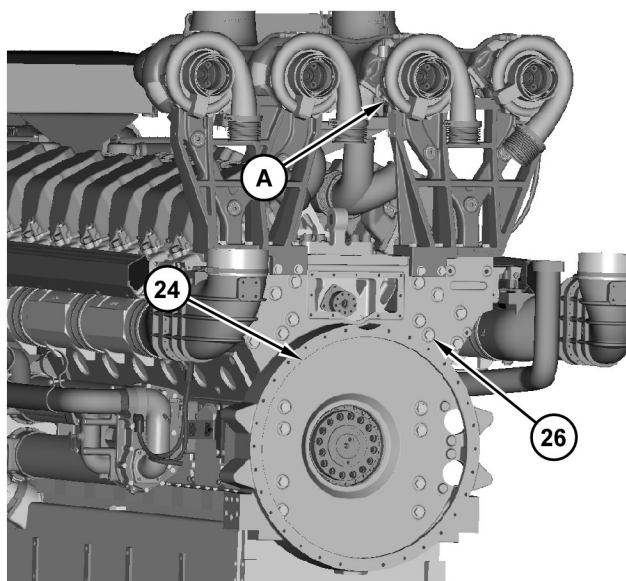


Illustration 389

g01221063

1. Attach Tooling (A) and a suitable lifting device onto flywheel housing (24). The weight of flywheel housing (24) is approximately 726 kg (1600 lb). Apply Tooling (B) to the mating surface of flywheel housing (24). Position flywheel housing (24). Install bolts (26).

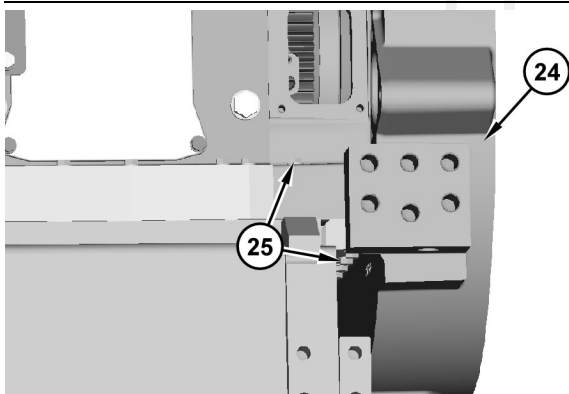


Illustration 390

g01220583

2. Install bolts (25) that connect the oil pan to flywheel housing (24).

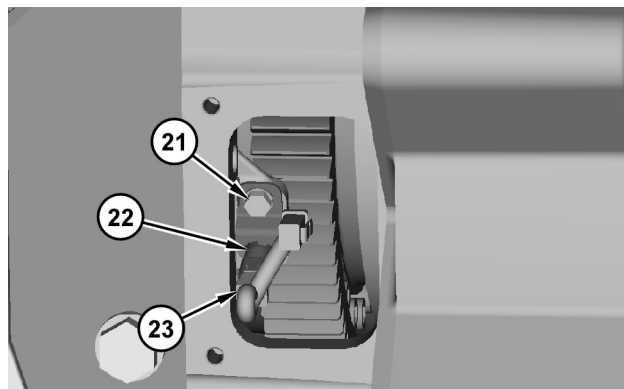


Illustration 391

g01220569

3. Install crankshaft position sensor (22). Install bolt (21). Connect harness assembly (23).

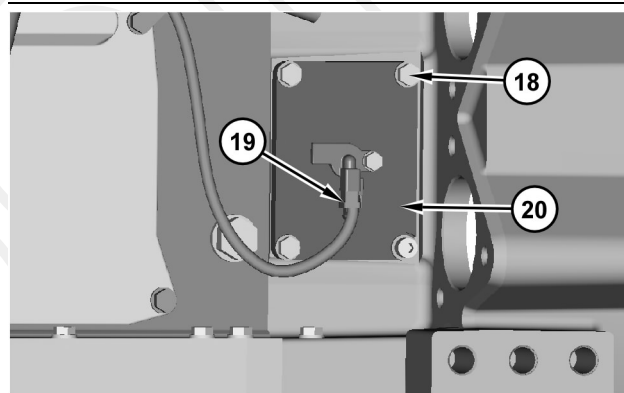


Illustration 392

g01220568

4. Install cover (20). Install bolts (18). Connect harness assembly (19).

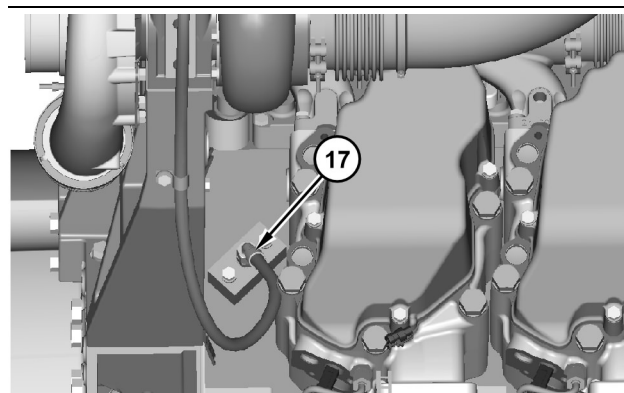


Illustration 393

g01220567

5. Connect hose assembly (17).

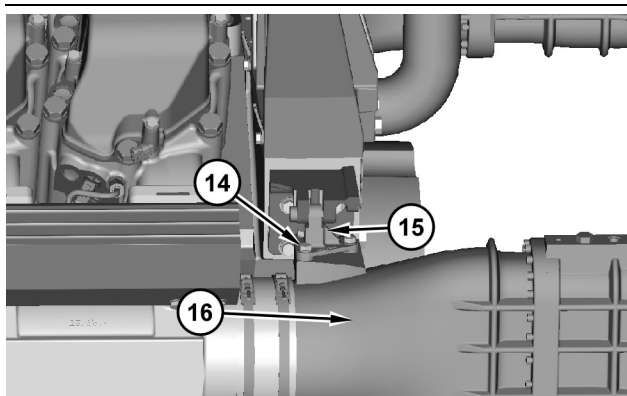


Illustration 394

g01219847

- 6.** Install bolts (14) in order to connect bracket (15) to intake manifold (16). Repeat for the opposite side.

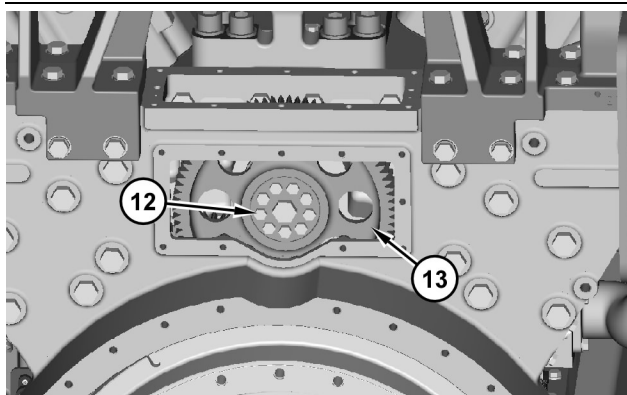


Illustration 395

g01219825

- 7.** Install cam gear (13). Install bolts (12).

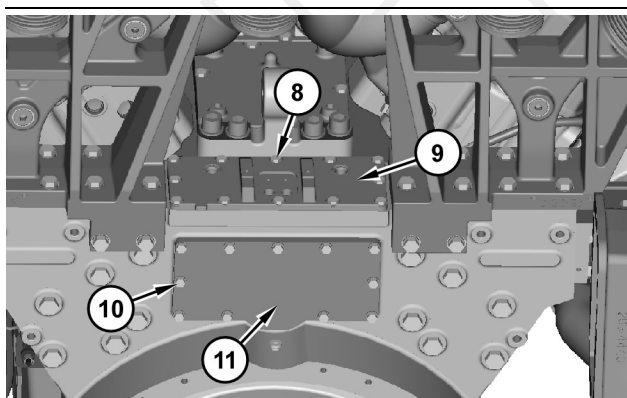


Illustration 396

g01219824

- 8.** Install cover (11). Install bolts (10). Install cover (9). Install bolts (8).

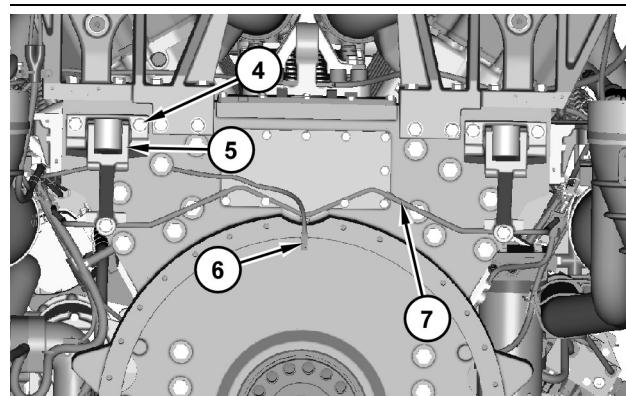


Illustration 397

g01219823

- 9.** Install tube assembly (7). Connect harness assembly (6). Install bracket (5). Install bolts (4). Repeat for the opposite side.

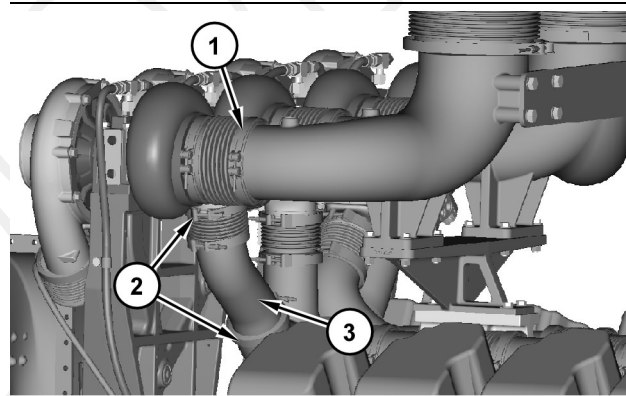


Illustration 398

g01219819

- 10.** Install tubes (3). Connect clamps (2). Connect clamp (1).

End By:

- a.** Install the starters. Refer to Disassembly and Assembly, "Electric Starting Motor - Remove and Install" and Disassembly and Assembly, "Air Starting Motor - Install".
- b.** Install the aftercooler. Refer to Disassembly and Assembly, "Aftercooler - Remove and Install".
- c.** Install the crankshaft rear seal. Refer to Disassembly and Assembly, "Crankshaft Rear Seal - Install".

i02463225

Idler Gears (Front) - Remove and Install

SMCS Code: 1206-010

Removal Procedure

Table 58

Required Tools			
Tool	Part Number	Part Description	Qty
A	1P-0520	Driver Gp	1

Start By:

- Remove the engine oil and water pump drive. Refer to Disassembly and Assembly, "Engine Oil and Water Pump Drive - Remove".
- Remove the fuel and auxiliary water pump drive. Refer to Disassembly and Assembly, "Fuel and Auxiliary Water Pump Drive - Remove".
- Remove the vibration damper. Refer to Disassembly and Assembly, "Vibration Damper - Remove and Install".

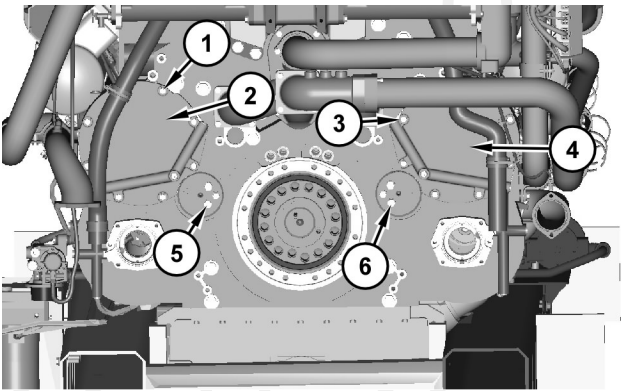


Illustration 399

g01229249

1. Remove bolts (1). Remove cover (2). Remove bolts (3). Remove cover (4). Remove bolts (5). Remove bolts (6).

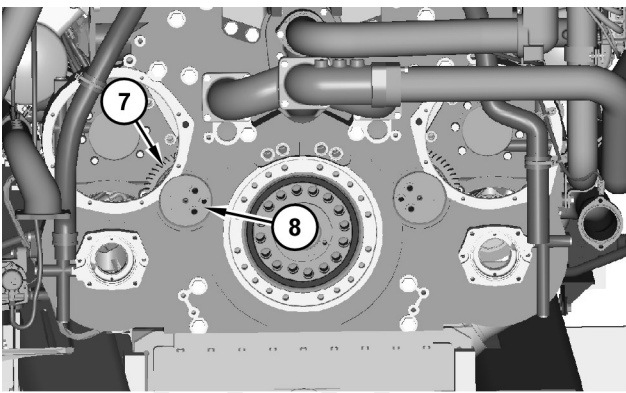


Illustration 400

g01229251

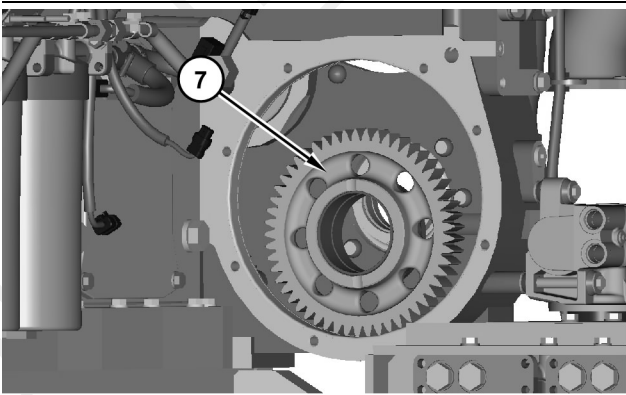


Illustration 401

g01229252

2. Support idler gear (7). Remove pin (8). Remove the O-ring seal from pin (8). Lower idler gear (7) to the bottom of the front drive housing. Remove idler gear (7) from the back side of the front drive housing.

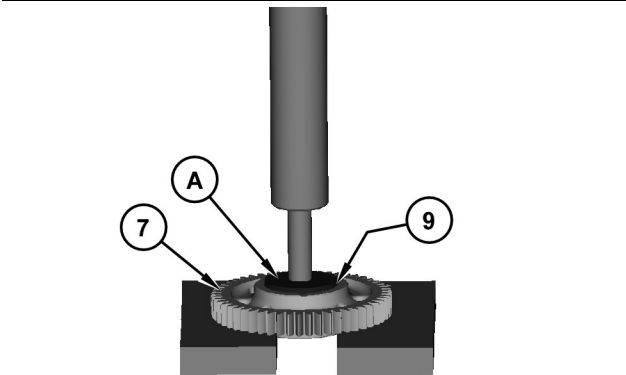


Illustration 402

g01229253

3. Use Tooling (A) and a suitable press in order to remove bearing (9) from gear (7).
4. Repeat Steps 2 through 3 for the opposite side.

Installation Procedure

Table 59

Required Tools			
Tool	Part Number	Part Description	Qty
A	1P-0520	Driver Gp	1

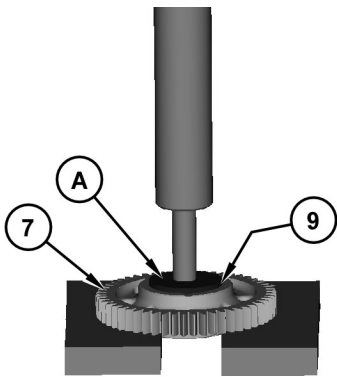


Illustration 403

g01229253

1. Use Tooling (A) and a suitable press in order to install bearing (9) into gear (7).

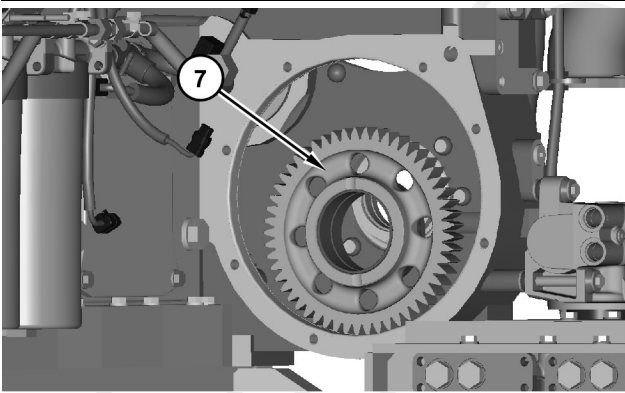


Illustration 404

g01229252

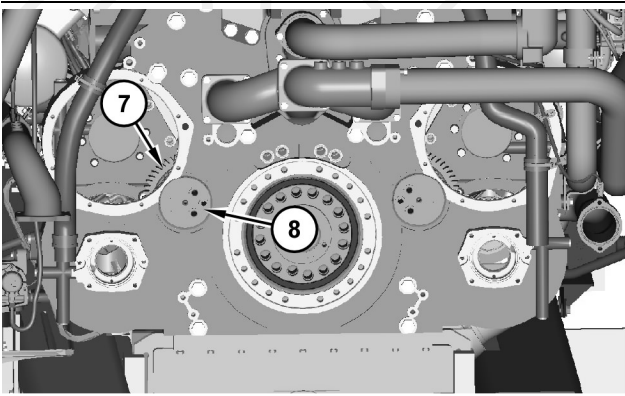


Illustration 405

g01229251

2. Position idler gear (7) into the back side of the front drive housing. Raise idler gear (7) from the bottom of the front drive housing into position. Install a new O-ring seal onto pin (8). Install pin (8) into idler gear (7).
3. Repeat Steps 1 through 2 for the opposite side.

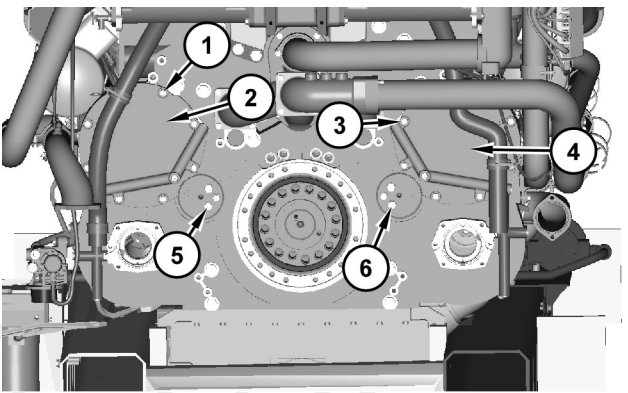


Illustration 406

g01229249

4. Install bolts (6). Install bolts (5). Install cover (4). Install bolts (3). Install cover (2). Install bolts (1).

End By:

- a. Install the vibration damper. Refer to Disassembly and Assembly, "Vibration Damper - Remove and Install".
- b. Install the fuel and auxiliary water pump drive. Refer to Disassembly and Assembly, "Fuel and Auxiliary Water Pump Drive - Install".
- c. Install the engine oil and water pump drive. Refer to Disassembly and Assembly, "Engine Oil and Water Pump Drive - Install".

i02421071

Gear Group (Rear) - Remove

SMCS Code: 1206-011; 1212-011

Removal Procedure

Start By:

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

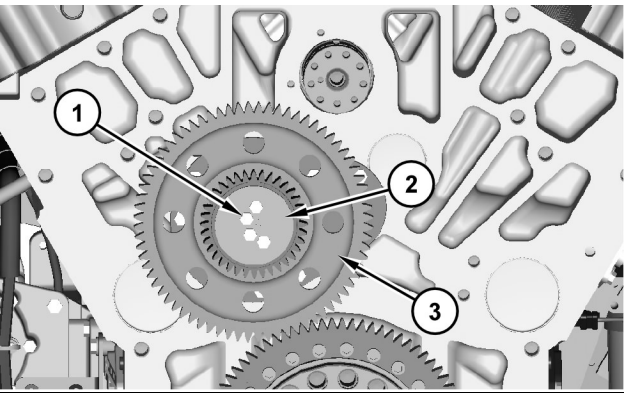


Illustration 407

g01209637

1. Remove bolts (1). Remove plate (2). Remove gear (3).

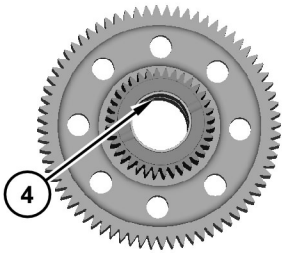


Illustration 408

g01209639

2. Remove bearing (4).

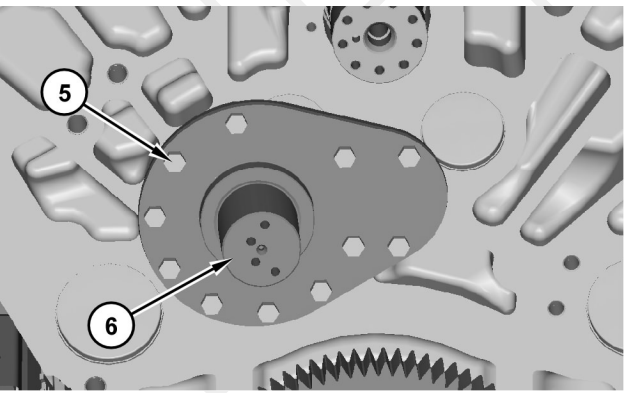


Illustration 409

g01209641

3. Remove bolts (5). Remove shaft assembly (6).

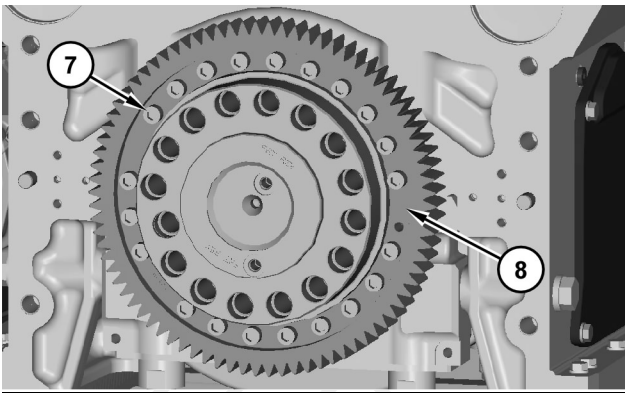


Illustration 410

g01209643

4. Remove bolts (7). Remove gear (8) from the crankshaft.

i02421100

Gear Group (Rear) - Install

SMCS Code: 1206-012; 1212-012

Installation Procedure

Table 60

Required Tools			
Tool	Part Number	Part Description	Qty
A	1P-0520	Driver Gp	1

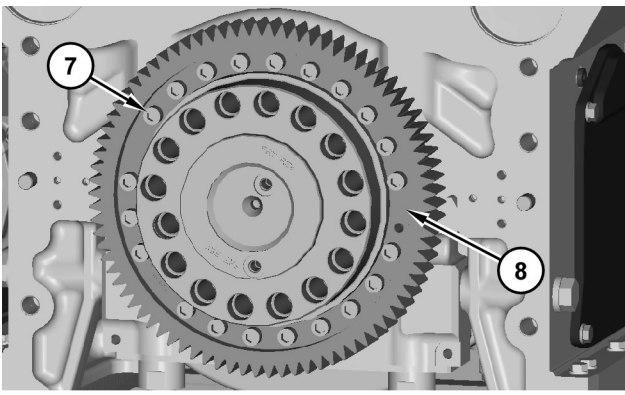


Illustration 411

g01209643

1. Install gear (8) onto the crankshaft. Install bolts (7).

i02413094

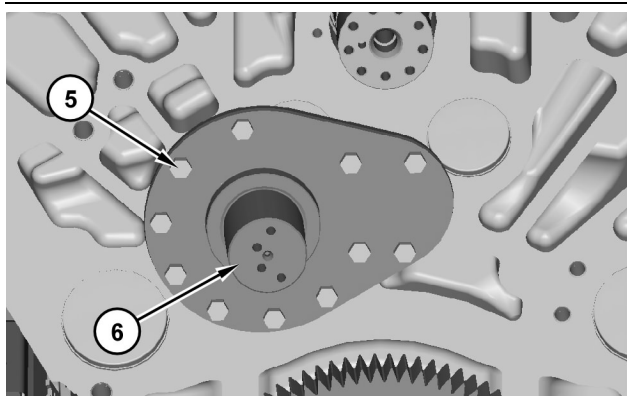


Illustration 412

g01209641

2. Install shaft assembly (6). Install bolts (5).

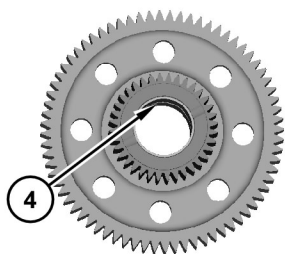


Illustration 413

g01209639

3. Use Tooling (A) to install bearing (4).

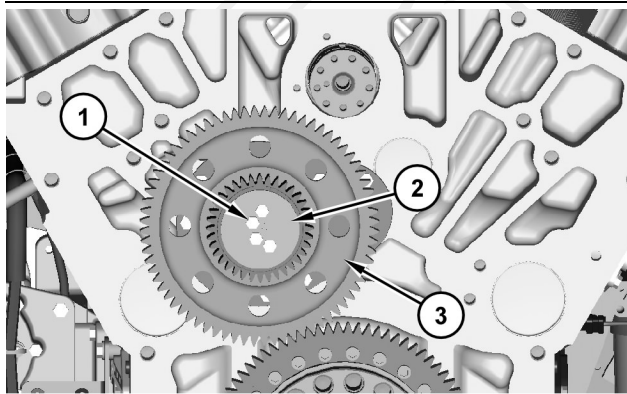


Illustration 414

g01209637

4. Install gear (3). Install plate (2). Install bolts (1).

End By:

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

Piston Cooling Jets - Remove and Install

SMCS Code: 1331

Removal Procedure

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

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

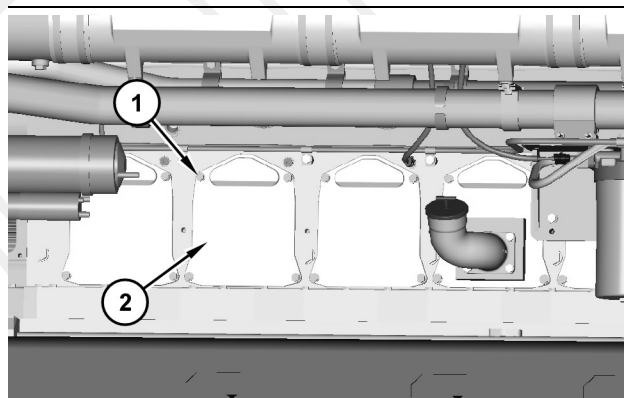


Illustration 415

g01206105

2. Remove bolts (1). Remove side cover (2).

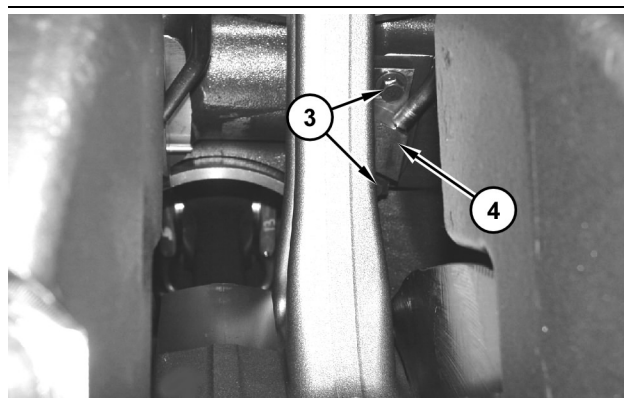


Illustration 416

g01206108

3. Remove bolts (3). Remove piston cooling jet (4).
4. Repeat Steps 2 and 3 for the remaining piston cooling jets.

Installation Procedure

i02717761

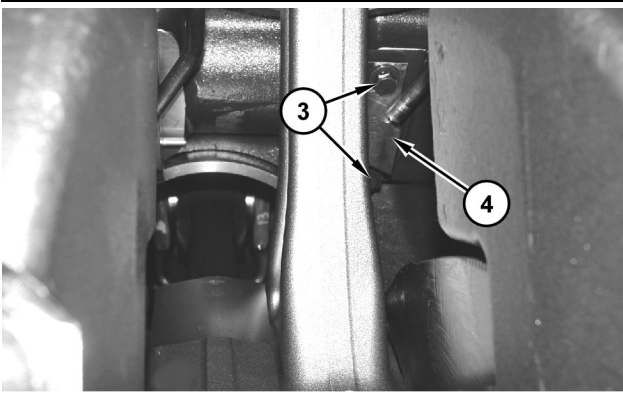


Illustration 417

g01206108

1. Install piston cooling jet (4). Install bolts (3).

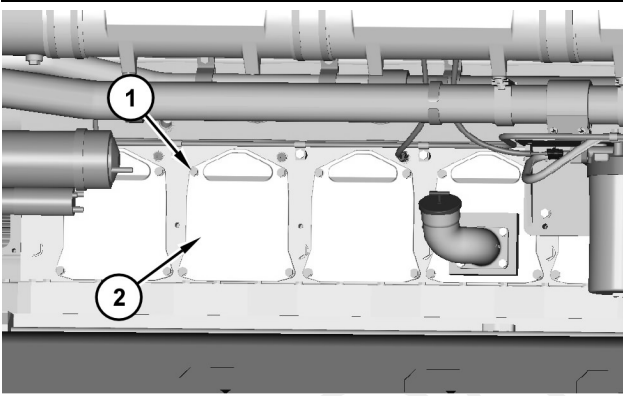


Illustration 418

g01206105

2. Install side cover (2). Install bolts (1).

3. Repeat Steps 1 and 2 for the remaining piston cooling jets.

4. Turn the battery disconnect switch to the ON position.

Bearing Clearance - Check

SMCS Code: 1203-535; 1219-535

Measurement Procedure

Table 61

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 419.

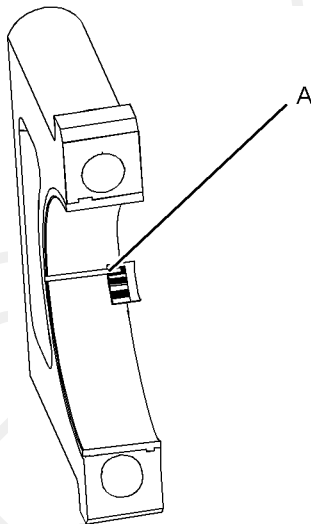


Illustration 419

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.

i02458818

Connecting Rod Bearings - Remove and Install

SMCS Code: 1219-010

Removal Procedure

Table 62

Required Tools			
Tool	Part Number	Part Description	Qty
A	275-7905	Engine Turning Tool	1

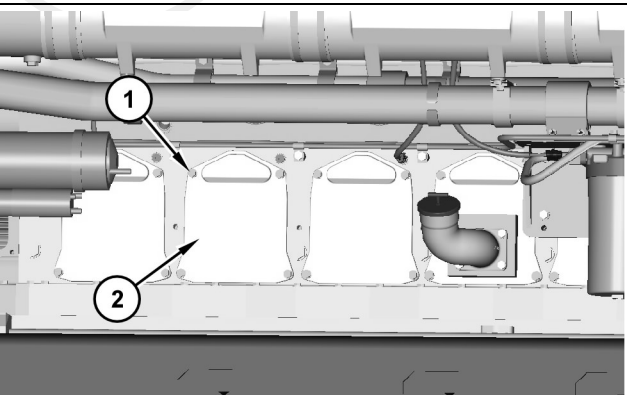


Illustration 420

g01206105

1. Remove bolts (1). Remove side cover (2).
2. Use Tooling (A) to turn the flywheel in order to access the connecting rod cap that will be removed.

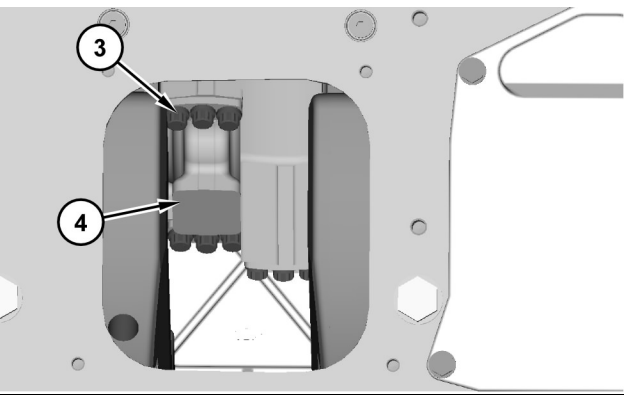


Illustration 421

g01227062

Note: 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.

3. Remove bolts (3). Remove connecting rod caps (4).
4. Push the connecting rod away from the crankshaft and remove the upper half of the connecting rod bearing.

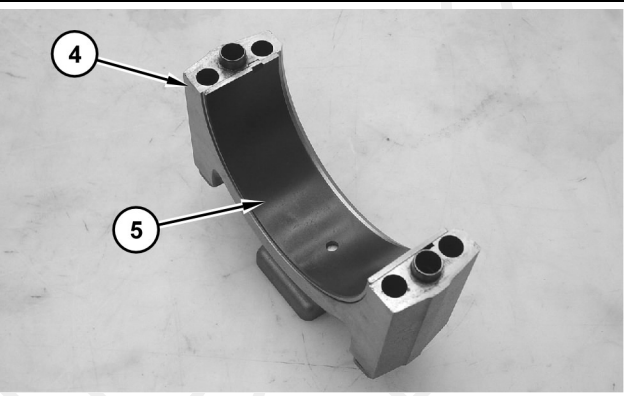


Illustration 422

g01227089

5. Remove lower half (5) of the connecting rod bearing from connecting rod cap (4).

Installation Procedure

Table 63

Required Tools			
Tool	Part Number	Part Description	Qty
B	4C-5593	Thread Lubricant	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Check the clearance of the bearings. Refer to Disassembly and Assembly, "Bearing Clearance - Check" for the correct procedure.
2. Place clean engine oil on the connecting rod bearings.

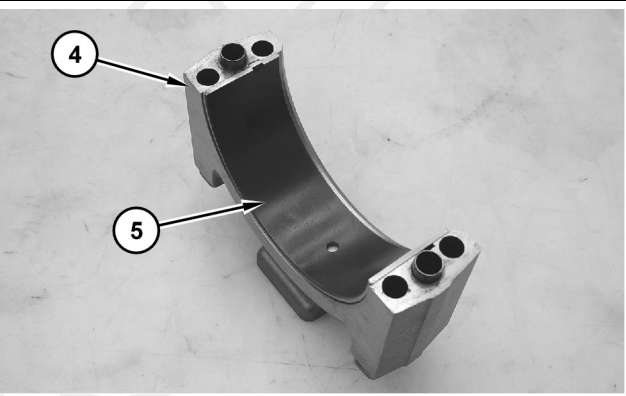


Illustration 423

g01227089

3. Install lower half (5) of the connecting rod bearing in connecting rod cap (4). Ensure that the tab on the back of the bearing is in the bearing tab groove on connecting rod cap (4).
4. Install the upper half of the connecting rod bearing in the connecting rod. Ensure that the tab on the back of the bearing is in the bearing tab groove on the connecting rod.
5. Position the connecting rod on the crankshaft.

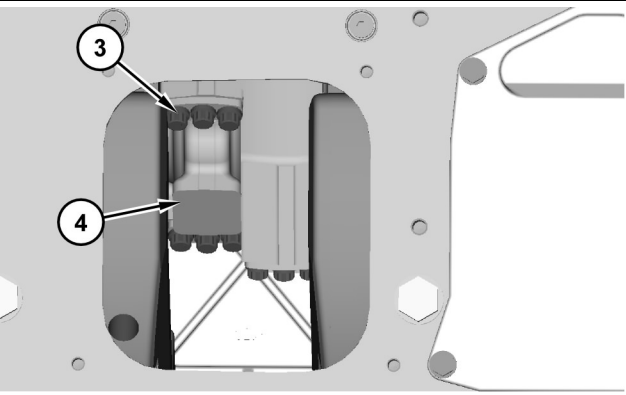


Illustration 424

g01227062

6. Position connecting rod cap (4) onto the connecting rod. Ensure that the number on the side of connecting rod cap (4) corresponds to the number that is on the connecting rod.
7. Apply Tooling (B) under the heads of bolts (3) and to the threads of bolts (3). Install bolts (3) finger tight.



Illustration 425

g01225315

8. Use the following procedure to tighten bolts (3):
 - a. Tighten bolts (1) and (2) to a torque of 120 ± 5 N·m (89 ± 4 lb ft).
 - b. Tighten bolts (3) and (4) to a torque of 120 ± 5 N·m (89 ± 4 lb ft).
 - c. Tighten bolts (5) and (6) to a torque of 120 ± 5 N·m (89 ± 4 lb ft).
 - d. Repeat Steps 8.a through 8.c.
 - e. Turn bolts (3) and (4) for an additional 180 ± 5 degrees.
 - f. Turn bolts (5) and (6) for an additional 180 ± 5 degrees.
 - g. Turn bolts (1) and (2) for an additional 180 ± 5 degrees.

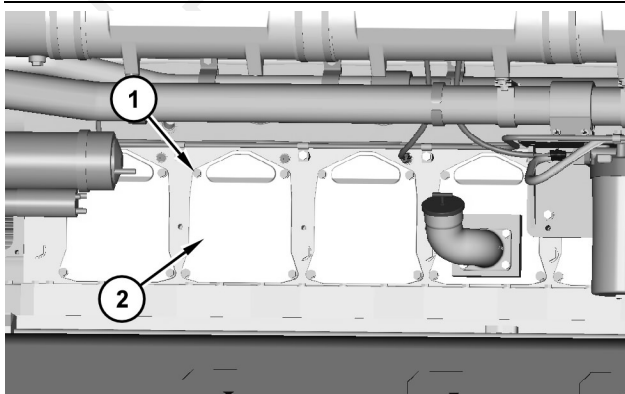


Illustration 426

g01206105

9. Position side cover (2). Install bolts (1).

i02424912

Crankshaft Main Bearings - Remove

SMCS Code: 1203-011

Removal Procedure

Table 64

Required Tools			
Tool	Part Number	Part Description	Qty
A	253-3272	Cylinder	2
B	178-9312	Hose As	2
C	253-3276	Distribution Coupler	1
D ⁽¹⁾	227-6724	Electric Hydraulic Pump Gp (120 V)	1
	227-8834	Electric Hydraulic Pump Gp (240 V)	1
	156-7166	Electric Hydraulic Pump Gp (220 V) (380 V)	1
	191-5347	Hydraulic Pump Gp	1
	156-7167	Manual Hydraulic Pump	1
E	275-7905	Engine Turning Tool	1
F	284-8228	Driver	1

⁽¹⁾ Use any of the pumps that are listed in Tooling (D) for this procedure.

Start By:

- a. Remove the starting motors. Refer to Disassembly and Assembly, "Electric Starting Motor - Remove" or Disassembly and Assembly, "Air Starting Motor - Remove".
- b. Remove the fuel filter base. Refer to Disassembly and Assembly, "Fuel Filter Base - Remove".
- c. Remove the fuel pump. Refer to Disassembly and Assembly, "Fuel Pump - Remove".
- d. Remove the engine oil pump. Refer to Disassembly and Assembly, "Engine Oil Pump - Remove".
- e. Remove the engine oil cooler. Refer to Disassembly and Assembly, "Engine Oil Cooler - Remove".

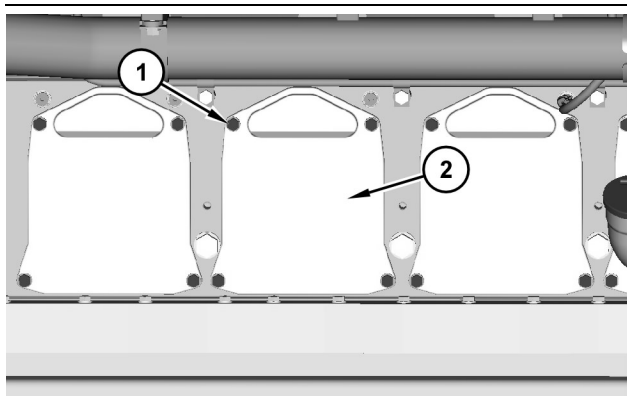


Illustration 427

g01212026

1. Remove bolts (1) and remove side cover (2). Repeat for the remaining side covers on both sides of the engine.

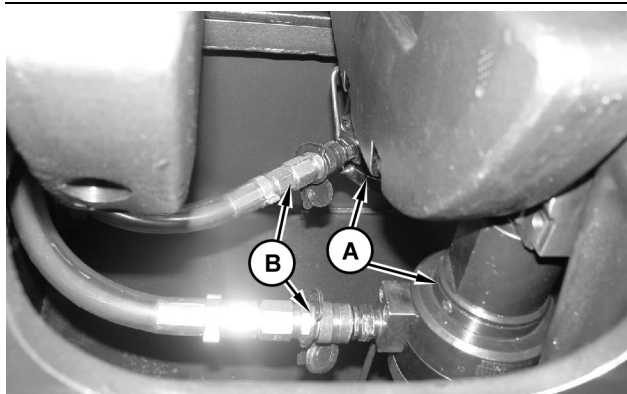


Illustration 428

g01212105

2. Install Tooling (A) onto the studs for the crankshaft main bearing cap. Tighten the threaded collar of Tooling (A). Loosen the threaded collar of Tooling (A) by 1 1/2 turns. Attach Tooling (B) onto Tooling (A). Attach Tooling (B) onto Tooling (C). Attach Tooling (C) onto Tooling (D). Apply approximately 135 MPa (19580 psi) of pressure to Tooling (A). Use the drive on Tooling (A) in order to loosen the nuts for the crankshaft main bearings. Turn the drive on Tooling (A) by approximately three turns. Release the pressure on Tooling (A). Remove Tooling (A).

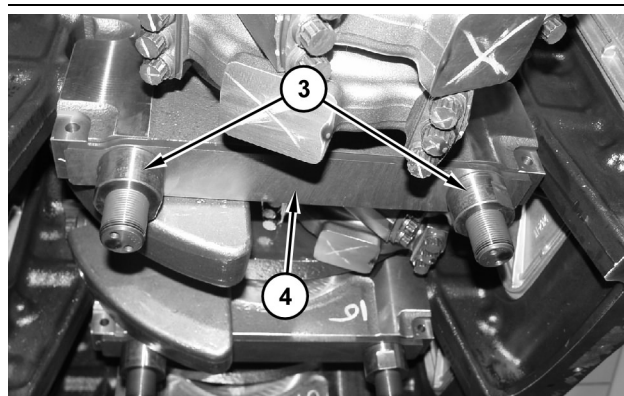


Illustration 429

g01212274

3. Remove crankshaft main bearing nuts (3). Remove plate (4).

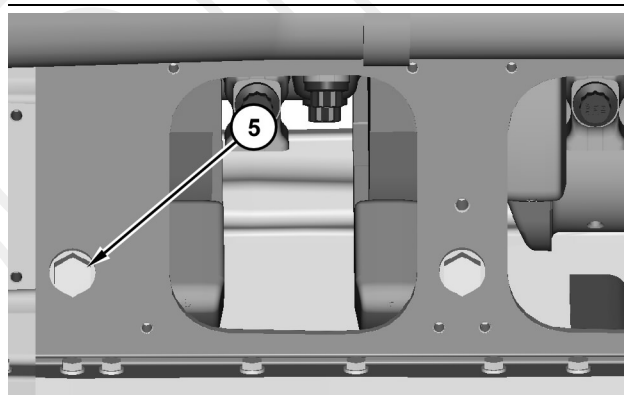


Illustration 430

g01212278

4. Remove bolt (5) from each side of the engine.

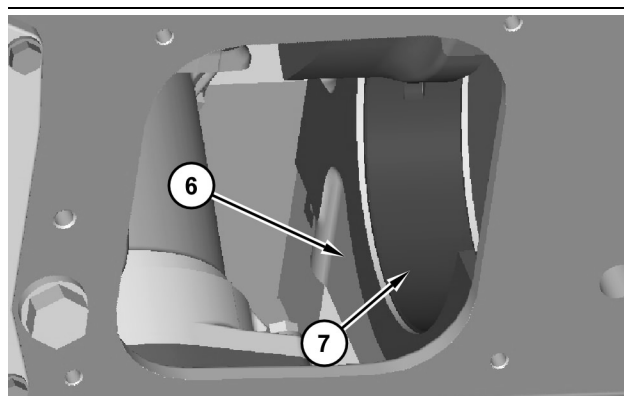


Illustration 431

g01212288

5. Slide down crankshaft main bearing cap (6) on the studs. Remove crankshaft main bearing (7) from crankshaft main bearing cap (6).

6. Use Tooling (E) in order to rotate the crankshaft until the oil hole of the crankshaft journal is just below the side of the crankshaft main bearing without the tab. Install Tooling (F). Rotate the crankshaft and remove the upper crankshaft main bearing.

i02464925

Crankshaft Main Bearings - Install

SMCS Code: 1203-012

Installation Procedure

Table 65

Required Tools			
Tool	Part Number	Part Description	Qty
A	253-3272	Cylinder	2
B	178-9312	Hose As	2
C	253-3276	Distribution Coupler	1
D ⁽¹⁾	227-6724	Electric Hydraulic Pump Gp (120 V)	1
	227-8834	Electric Hydraulic Pump Gp (240 V)	1
	156-7166	Electric Hydraulic Pump Gp (220 V) (380 V)	1
	191-5347	Hydraulic Pump Gp	1
	156-7167	Manual Hydraulic Pump	1
E	275-7905	Engine Turning Tool	1
F	284-8228	Driver	1

⁽¹⁾ Use any of the pumps that are listed in Tooling (D) for this procedure.

Note: Be sure that the back of the main bearing is clean and free from oil.

1. Lightly lubricate the upper crankshaft main bearing with clean engine oil. Use Tooling (F) and install the upper crankshaft main bearing into the cylinder block.

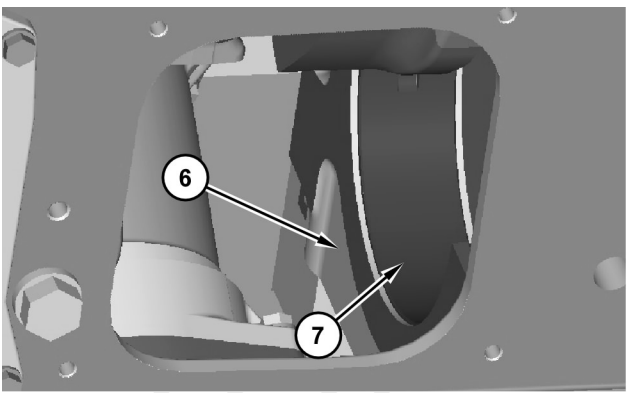


Illustration 432

g01212288

2. Lightly lubricate crankshaft main bearing (7) with clean engine oil. Install crankshaft main bearing (7) into crankshaft main bearing cap (6). Lift crankshaft main bearing cap (6) into position.

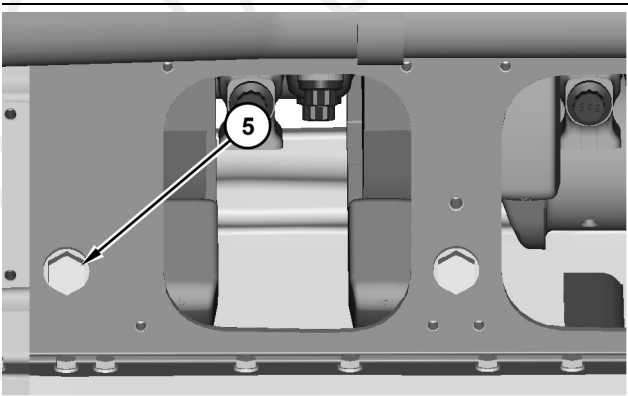


Illustration 433

g01212278

3. Lubricate bolts (5) with clean engine oil. Install bolts (5) finger tight.

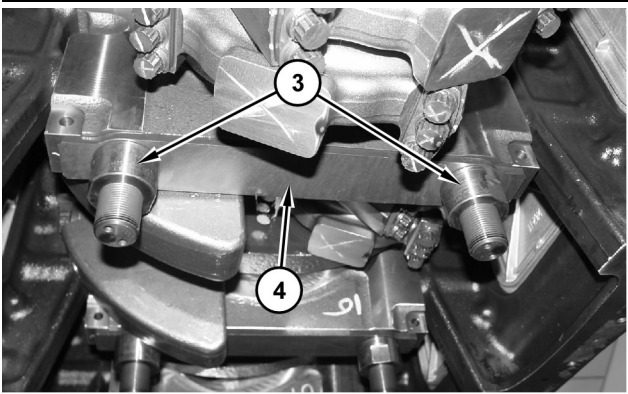


Illustration 434

g01212274

4. Lubricate the main bearing studs with clean engine oil. Install plate (4). Install nuts (3) for the crankshaft main bearings finger tight.

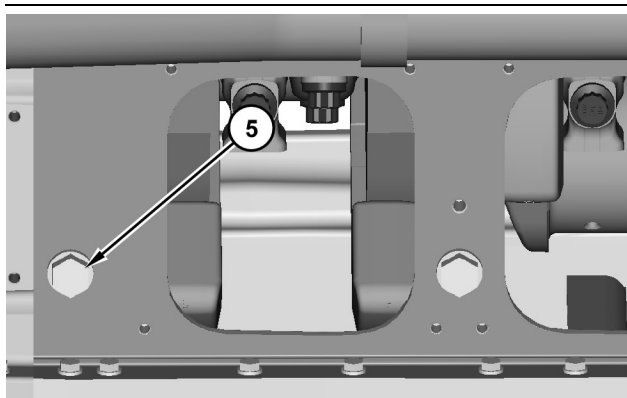


Illustration 435

g01212278

5. Start at the front of the engine and tighten bolts (5) on the right side of the cylinder block to a torque of 100 ± 20 N·m (74 ± 15 lb ft).

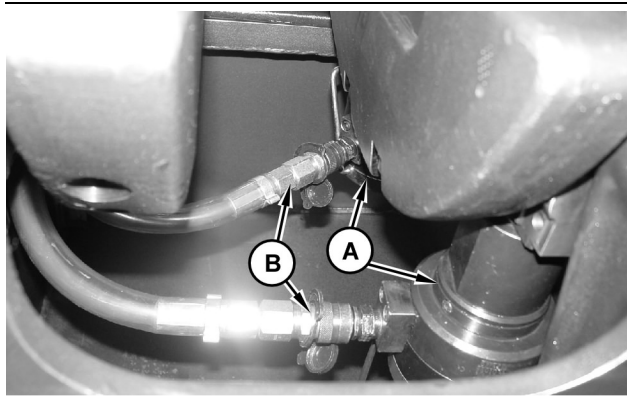


Illustration 436

g01212105

6. Install Tooling (A) onto the studs for the crankshaft main bearing cap. Tighten the threaded collar of Tooling (A). Attach Tooling (B) onto Tooling (A). Attach Tooling (C) onto Tooling (D). Apply approximately 135 MPa (19580 psi) of pressure to Tooling (B). Use the drive on Tooling (A) in order to tighten the nuts for the crankshaft main bearings. Release the pressure on Tooling (A). Reapply approximately 135 MPa (19580 psi) of pressure to Tooling (A). Recheck nuts (3) for tightness. Remove Tooling (A).

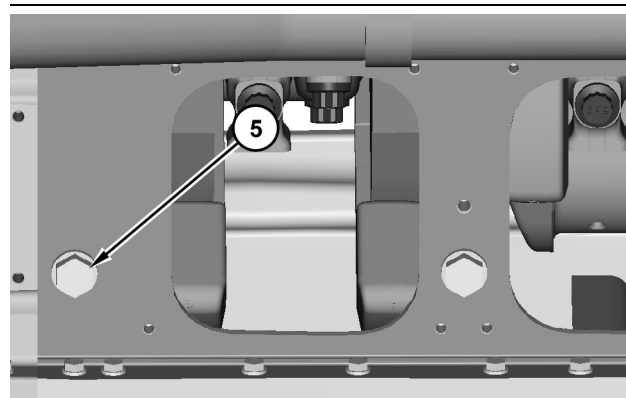


Illustration 437

g01212278

7. Start at the front of the engine and tighten bolts (5) on the right side of the cylinder block to a torque of 530 ± 70 N·m (391 ± 52 lb ft).
8. Start at the front of the engine and tighten bolts (5) on the left side of the cylinder block to a torque of 530 ± 70 N·m (391 ± 52 lb ft).

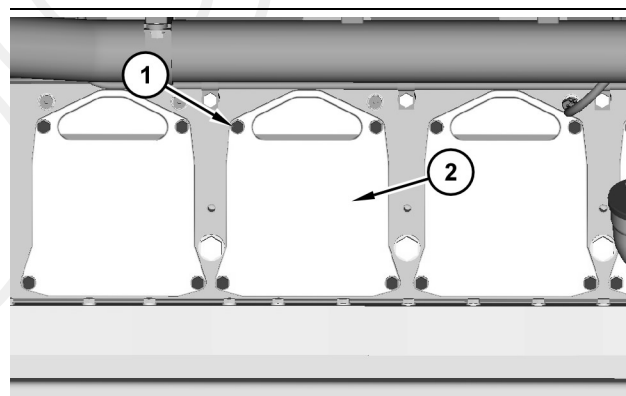


Illustration 438

g01212026

9. Install side cover (2). Install bolts (1). Repeat for the remaining side covers on both sides of the engine.

End By:

- a. Install the engine oil cooler. Refer to Disassembly and Assembly, "Engine Oil Cooler - Install".
- b. Install the engine oil pump. Refer to Disassembly and Assembly, "Engine Oil Pump - Install".
- c. Install the fuel pump. Refer to Disassembly and Assembly, "Fuel Pump - Install".
- d. Install the fuel filter base. Refer to Disassembly and Assembly, "Fuel Filter Base - Install".

- e. Install the starting motors. Refer to Disassembly and Assembly, “Electric Starting Motor - Install” or Disassembly and Assembly, “Air Starting Motor - Install”.

i02414616

Pistons, Liners, and Connecting Rods - Remove

SMCS Code: 1216-011; 1225-011

Removal Procedure

Table 66

Required Tools			
Tool	Part Number	Part Description	Qty
A	275-7905	Engine Turning Tool	1
B	274-5875	Guide	2
	276-0010	Bolt	2
C	277-3569	Puller Group	1
D	288-9171	Bridge	1
E	138-7574	Link Bracket	1

Start By:

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

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

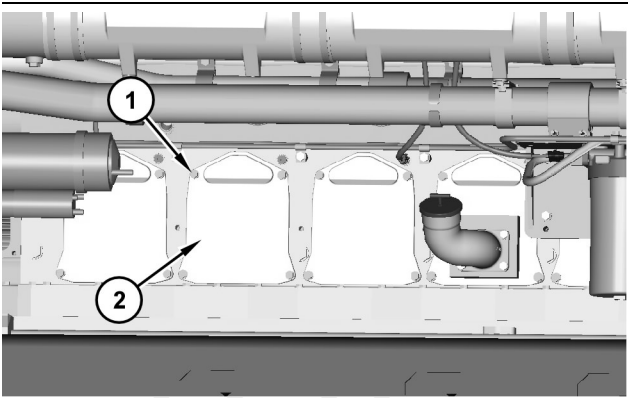


Illustration 439

g01206105

- 2. Remove bolts (1). Remove side cover (2).
- 3. Use Tooling (A) to rotate the flywheel in order to access the connecting rod cap that will be removed.

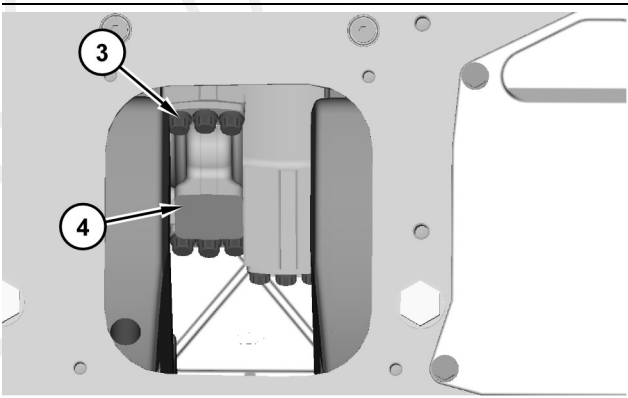


Illustration 440

g01227062

Note: 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. Careful handling is required for fractured connecting rods. The connecting rod and the rod cap should be placed on the sides in order to prevent damage. When possible, the connecting rod and the rod cap should be bolted together in order to prevent damage.

- 4. Remove bolts (3) and connecting rod cap (4). Position the crankshaft so that the piston is at the bottom dead center. Inspect the connecting rod bearing for wear or for damage. If necessary, replace the connecting rod bearing. Refer to Disassembly and Assembly, “Connecting Rod Bearings - Remove and Install” for the proper procedure.

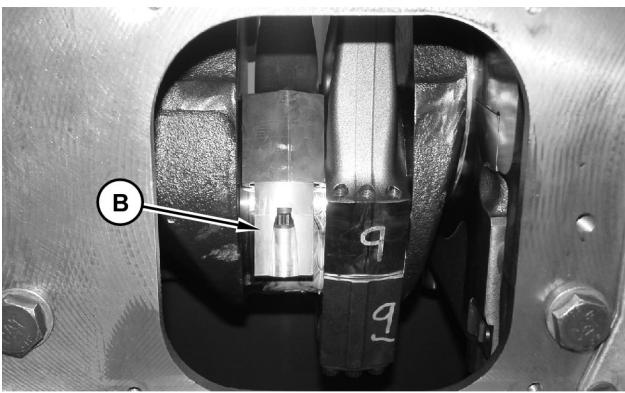


Illustration 441

g01240845

5. Install Tooling (B) onto the connecting rod.

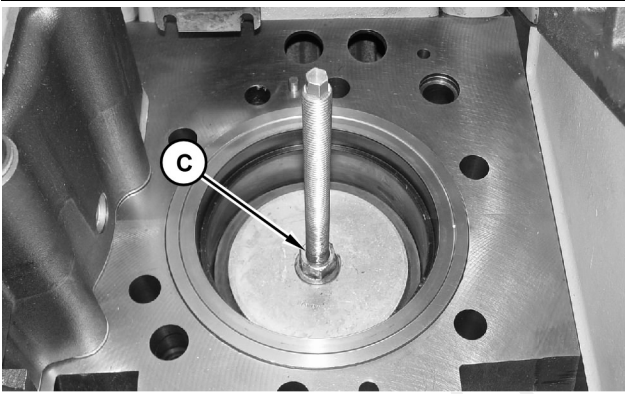


Illustration 442

g01240763

6. Install Tooling (C) onto the top of the piston. Turn Tooling (C) into the top of the piston. Turn Tooling (C) until Tooling (C) makes contact with the piston. Loosen Tooling (C) by a quarter of a turn. Hold the bolt of Tooling (C) and turn the nut. Turn the nut until the nut is tight.

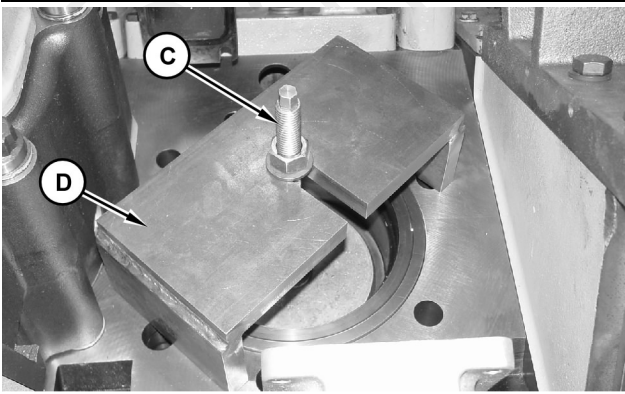


Illustration 443

g01240764

7. Slide Tooling (D) over Tooling (C) and install the washer and the nut. Tighten the nut until the piston liner assembly is loose from the cylinder block. Remove Tooling (D).

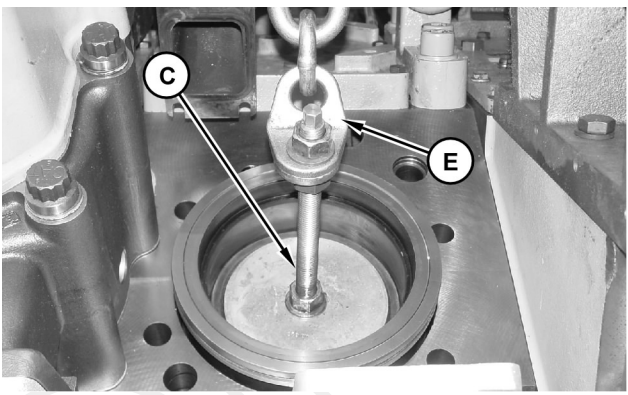


Illustration 444

g01240766

8. Attach Tooling (E) onto Tooling (C). Attach a suitable lifting device onto Tooling (E). The weight of the piston, the liner, and the connecting rod is approximately 50 kg (110 lb). Remove the piston, the liner, and the connecting rod as a unit.

9. Remove Tooling (B) from the connecting rod.

i02464418

Pistons and Connecting Rods - Disassemble

SMCS Code: 1225-015

Disassembly Procedure

Table 67

Required Tools			
Tool	Part Number	Part Description	Qty
A	138 - 7575	Link Bracket	2
B	1P - 1861	Retaining Ring Pliers	1
C	271 - 0504	Ring Expander	1

Start By:

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

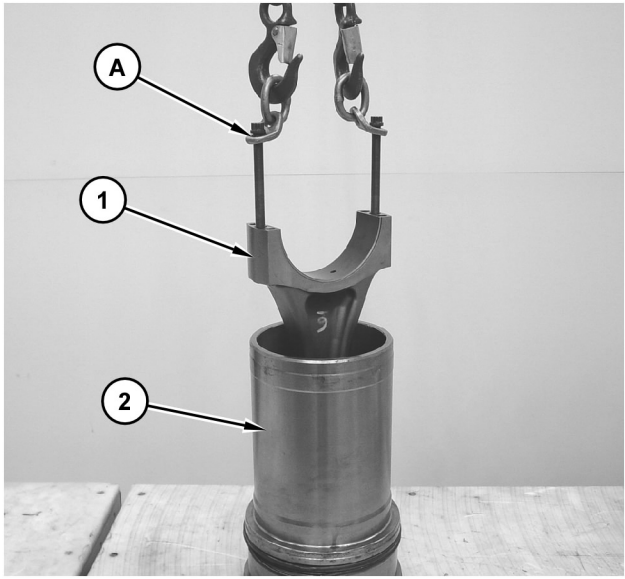


Illustration 445 g01229376

1. Attach Tooling (A) and a suitable lifting device onto connecting rod (1). The weight of connecting rod (1) and the piston is approximately 23 kg (50 lb). Remove connecting rod (1) and the piston from liner (2).

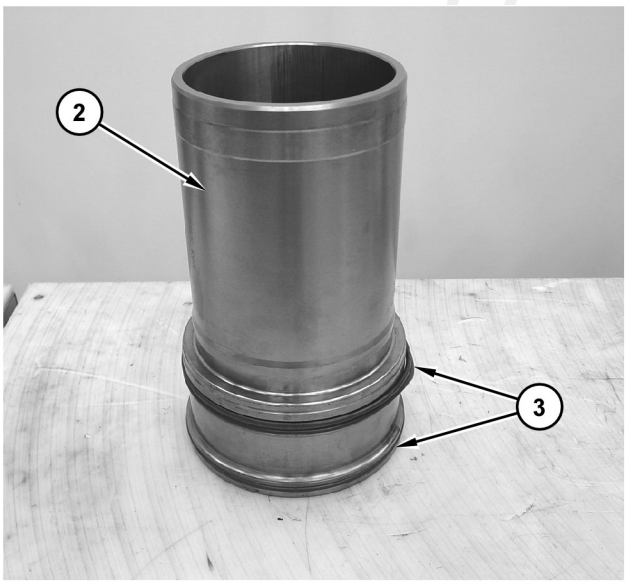


Illustration 446 g01229379

2. Remove O-ring seals (3) from liner (2).

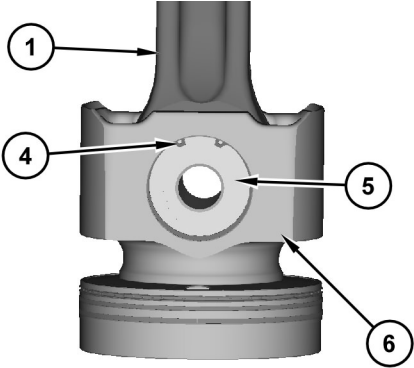


Illustration 447 g01229403

3. Use Tooling (B) in order to remove retaining ring (4). Remove wrist pin (5) and remove connecting rod (1) from piston (6).

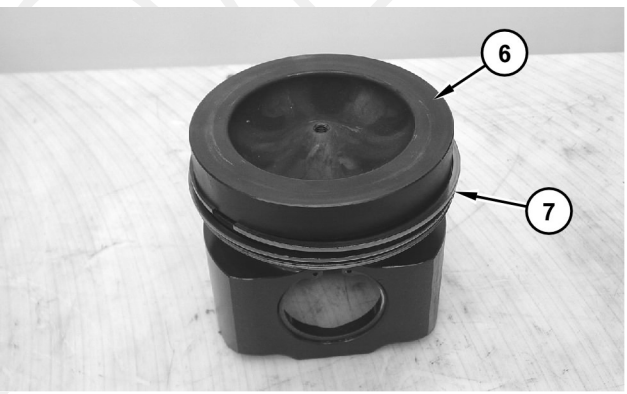


Illustration 448 i02485181

4. Use Tooling (C) and remove piston rings (7) from piston (6).

Pistons and Connecting Rods - Assemble

SMCS Code: 1225-016

Assembly Procedure

Table 68

Required Tools			
Tool	Part Number	Part Description	Qty
A	138 - 7575	Link Bracket	2
B	1P - 1861	Retaining Ring Pliers	1
C	271 - 0504	Ring Expander	1
D	255 - 8897	Ring Compressor	1

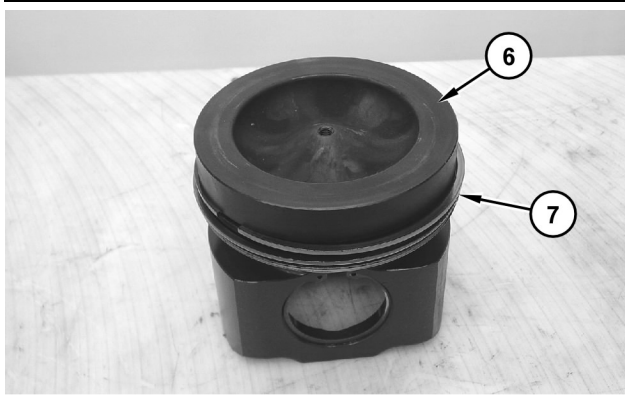


Illustration 449

g01229404

1. Use Tooling (C) and install piston rings (7) onto piston (6). Install the top ring with the side that is marked UP 1 toward the top of the piston. Install the intermediate ring with the side that is marked UP 2 toward the top of the piston. The oil ring spring ends must be assembled 180 degrees from the ring end gap. After the rings have been installed, rotate the rings so that the end gaps are located 120 degrees from each other. Oil ring end gap must be in the pin bore plane.

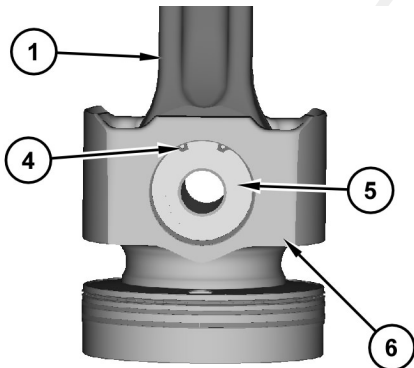


Illustration 450

g01229403

2. Coat connecting rod (1) and wrist pin (5) with clean engine oil. Install connecting rod (1) into piston (6). Install wrist pin (5) into piston (6) and connecting rod (1). Use Tooling (B) in order to install retaining ring (4). Position retaining ring (4) with the opening toward the bottom of the piston.

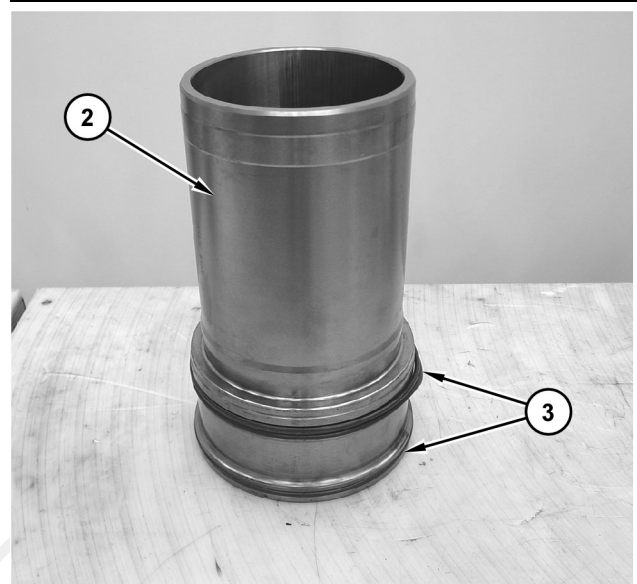


Illustration 451

g01229379

3. Install O-ring seals (3) onto liner (2).

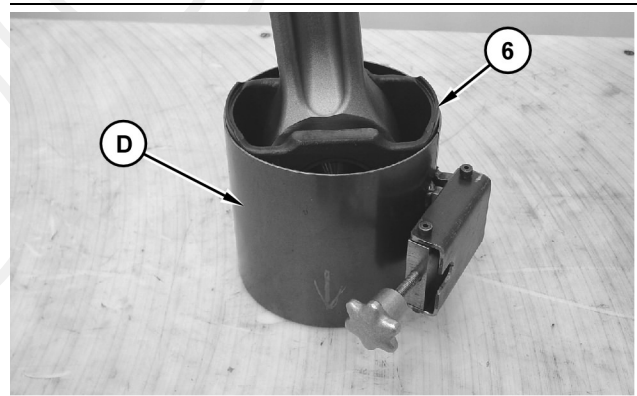


Illustration 452

g01240871

4. Coat piston (6) and the piston rings with clean engine oil. Install Tooling (D) onto piston (6). Tighten Tooling (D) in order to compress the piston rings.

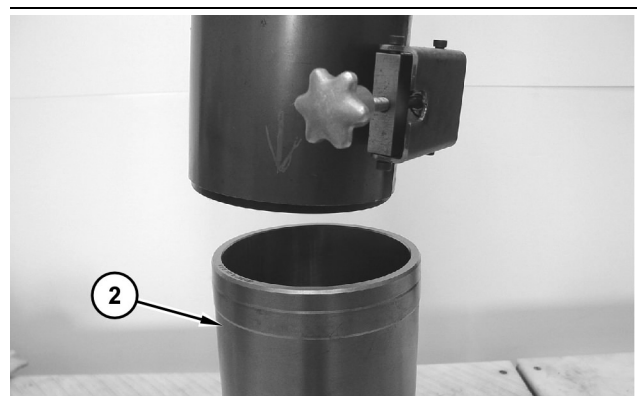


Illustration 453

g01240872

5. Coat the inside of liner (2) with clean engine oil. Attach Tooling (A) and a suitable lifting device onto the connecting rod. The weight of the connecting rod and the piston assembly is approximately 23 kg (50 lb). Install the connecting rod and the piston assembly into the bottom side of liner (2).

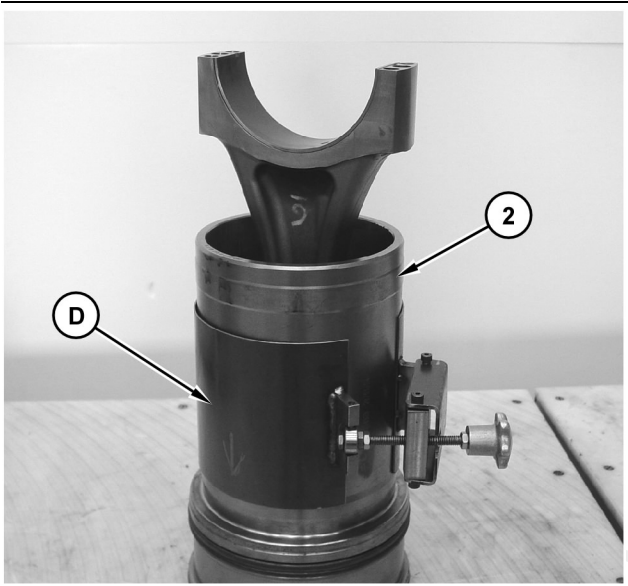


Illustration 454 g01240878

6. Remove Tooling (D) from liner (2).

Note: Do not permit the piston to go past the top dead center position. If the piston goes past the top dead center position, the piston rings will lock into the cuff ring bore.

End By:

- a. Install the pistons, liners, and connecting rods. Refer to Disassembly and Assembly, “Pistons, Liners, and Connecting Rods - Install”.

Pistons, Liners, and Connecting Rods - Install

SMCS Code: 1216-012; 1225-012

Installation Procedure

Table 69

Required Tools			
Tool	Part Number	Part Description	Qty
B	274 -5875	Guide	2
	276 -0010	Bolt	2
C	277 -3569	Puller Group	1
E	138 -7574	Link Bracket	1
F	288 -9169	Cylinder Liner Installer	1
G	4C -5593	Thread Lubricant	1

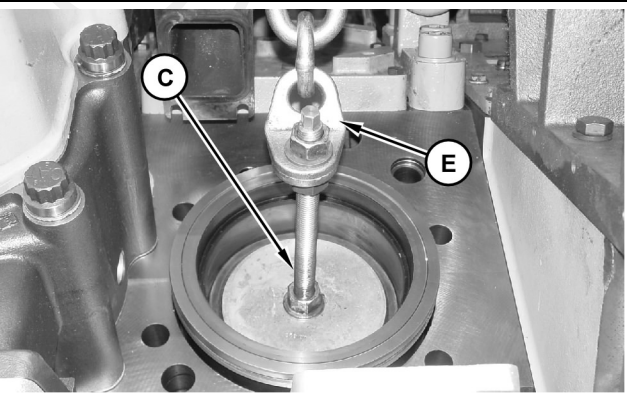


Illustration 455 g01240766

1. Install Tooling (B) onto the connecting rod. Coat the liner bore of the cylinder block and the outside of the cylinder liner with liquid soap. Attach Tooling (E) onto Tooling (C). Attach a suitable lifting device onto Tooling (E). The weight of the piston, the liner, and the connecting rod is approximately 50 kg (110 lb). Inspect the connecting rod bearing for wear or for damage. If necessary, replace the connecting rod bearing. Refer to Disassembly and Assembly, “Connecting Rod Bearings - Remove and Install” for the proper procedure. Position the connecting rod so that the chamfer is toward the crankshaft. Install the piston, the liner, and the connecting rod as a unit. Remove Tooling (C) and Tooling (E).

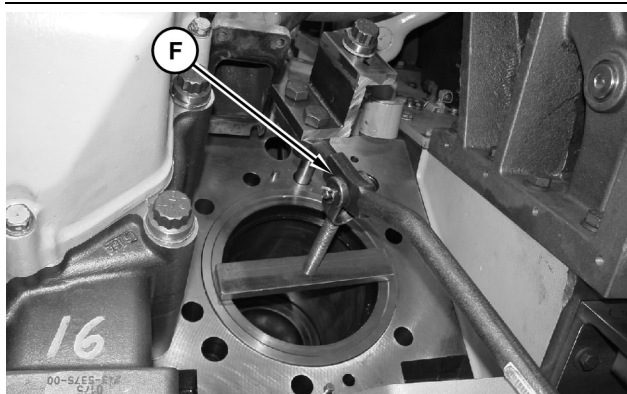


Illustration 456

g01241628

2. Install Tooling (F). Use Tooling (F) in order to seat the liner into the cylinder block. Position the cuff ring bore to 5 ± 1 mm (0.1969 ± 0.0394 inch) above the top of the cylinder liner in order to hold on the fire ring.

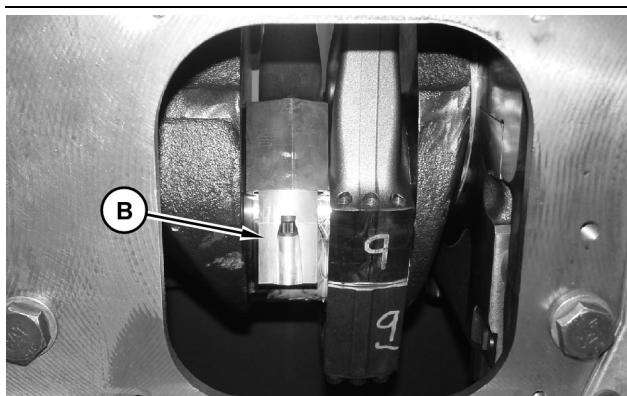


Illustration 457

g01240845

3. Remove Tooling (B) from the connecting rod.

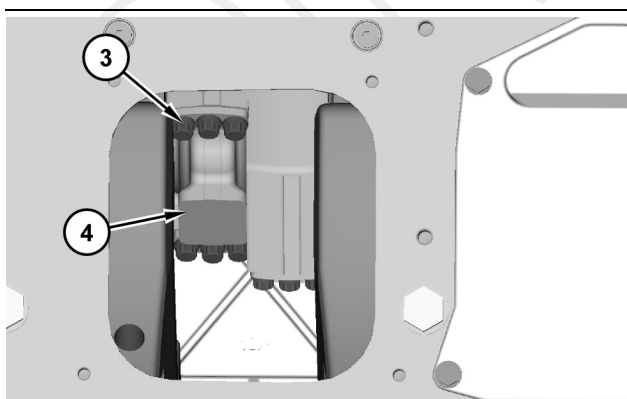


Illustration 458

g01227062

4. Install connecting rod cap (4). Apply Tooling (G) under the heads of bolts (3) and to the threads of bolts (3). Install bolts (3).



Illustration 459

g01225315

5. Use the following procedure to tighten bolts (3):
 - a. Tighten bolts (1) and (2) to a torque of 105 ± 5 N·m (77 ± 4 lb ft).
 - b. Tighten bolts (3) and (4) to a torque of 105 ± 5 N·m (77 ± 4 lb ft).
 - c. Tighten bolts (5) and (6) to a torque of 105 ± 5 N·m (77 ± 4 lb ft).
 - d. Repeat Steps 5.a through 5.c.
 - e. Turn bolts (3) and (4) for an additional 90 ± 5 degrees.
 - f. Turn bolts (5) and (6) for an additional 90 ± 5 degrees.
 - g. Turn bolts (1) and (2) for an additional 90 ± 5 degrees.

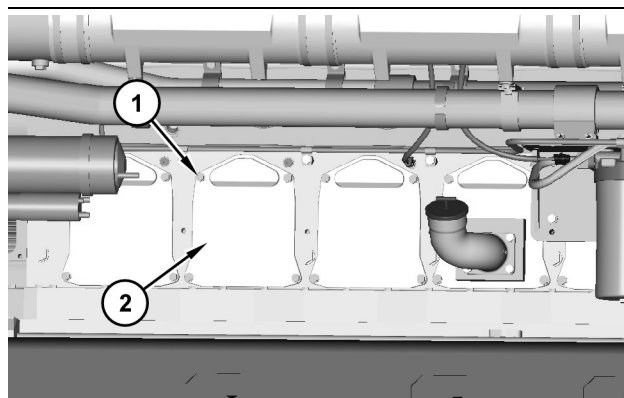


Illustration 460

g01206105

6. Install side cover (2) and install bolts (1).
7. Fill the engine with oil. Refer to Operation and Maintenance Manual, "Engine Oil and Filter - Change".

End By:

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

i02400890

Camshaft - Remove

SMCS Code: 1210-011

Removal Procedure

Table 70

Required Tools			
Tool	Part Number	Part Description	Qty
A	282 - 9962	Guide	2
B	255 - 2820	Camshaft Pilot	2
C	8T - 3169	Crank As	1

Start By:

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

- 1. Drain the coolant from the cooling system. Refer to Operation and Maintenance Manual, "Cooling System Coolant - Change".

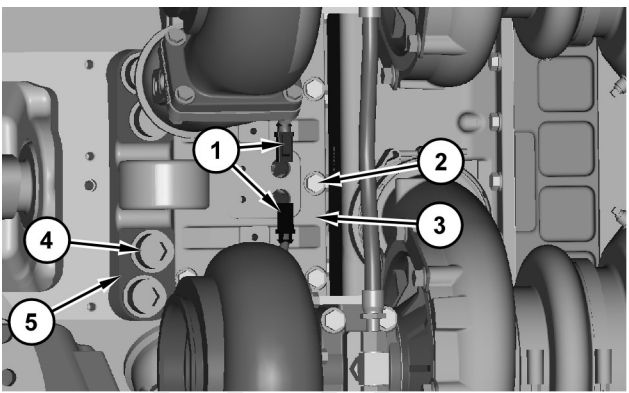


Illustration 461

g01228199

- 2. Disconnect harness assemblies (1). Remove bolts (2). Remove cover (3). Remove bolts (4). Remove lifting bracket (5).

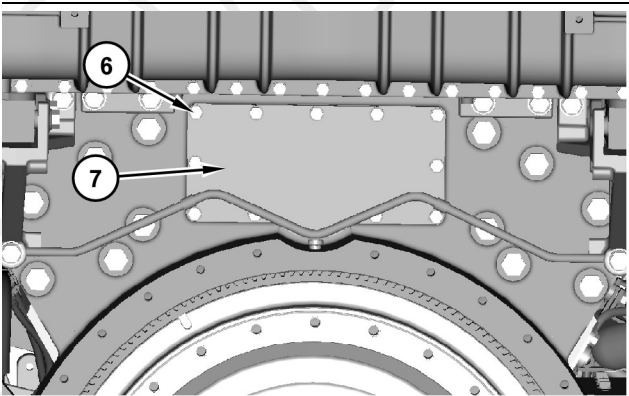


Illustration 462

g01228201

- 3. Remove bolts (6). Remove cover (7).

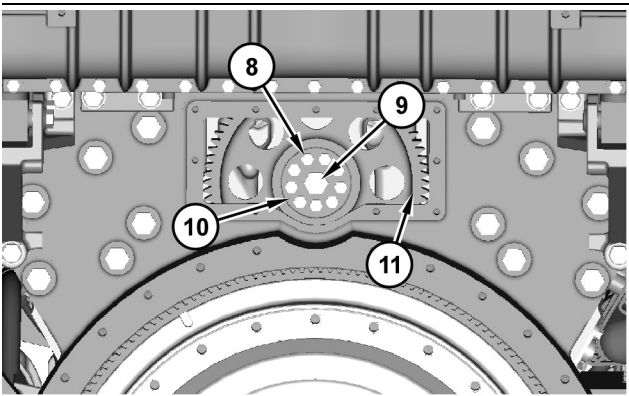


Illustration 463

g01228235

- 4. Remove bolts (8). Remove bolt (9). Remove spacer (10). Remove cam gear (11).

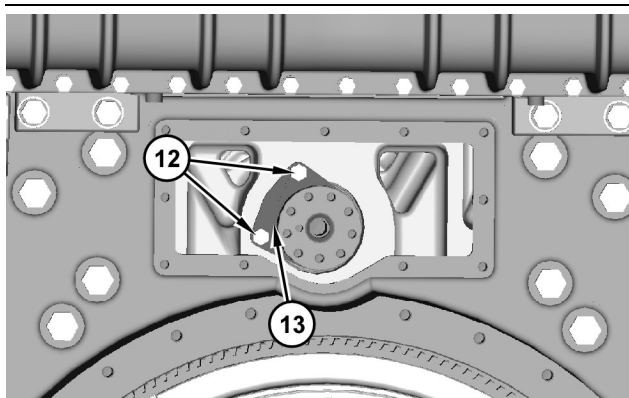


Illustration 464

g01228236

5. Remove bolts (12) and the washers. Remove retainer (13).

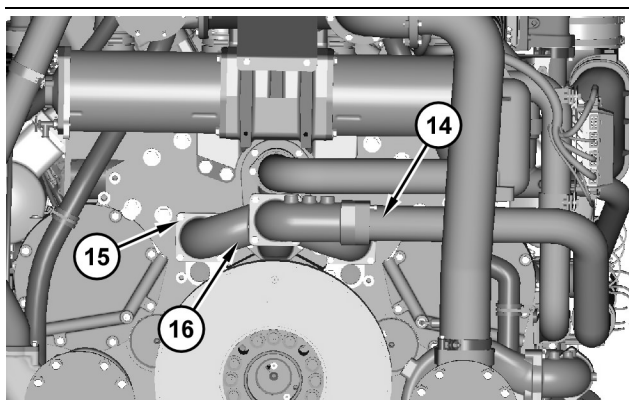


Illustration 465

g01228238

6. Disconnect tube assembly (14). Remove bolts (15). Remove housing (16).

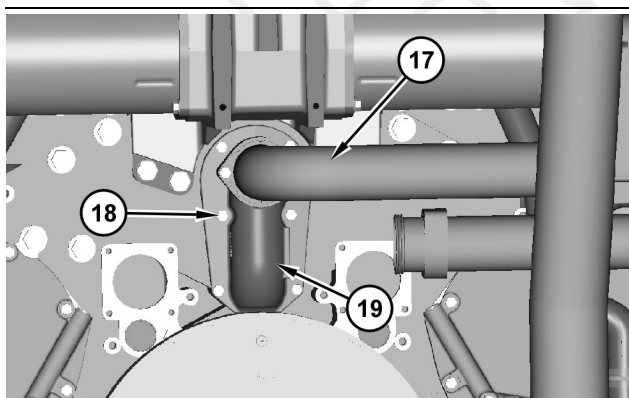


Illustration 466

g01228240

7. Remove tube assembly (17). Remove bolts (18). Remove housing (19).

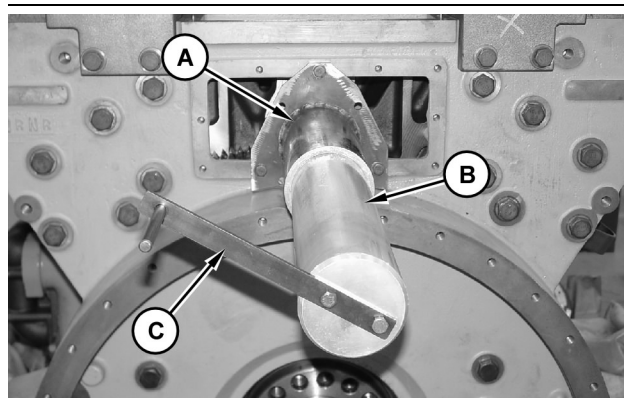


Illustration 467

g01228274

Typical Example

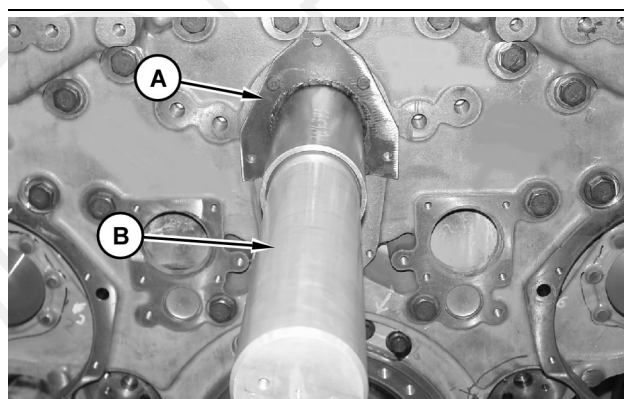


Illustration 468

g01228276

Typical Example

8. Apply a thin coat of oil to Tooling (A) and Tooling (B). Install Tooling (A) and leave the bolts loose. Install Tooling (B). Tighten the bolts for Tooling (A). Install Tooling (C). Use Tooling (C) in order to rotate the camshaft. Rotate the camshaft in order to remove the camshaft.

Note: The camshaft can be removed from either end of the engine.

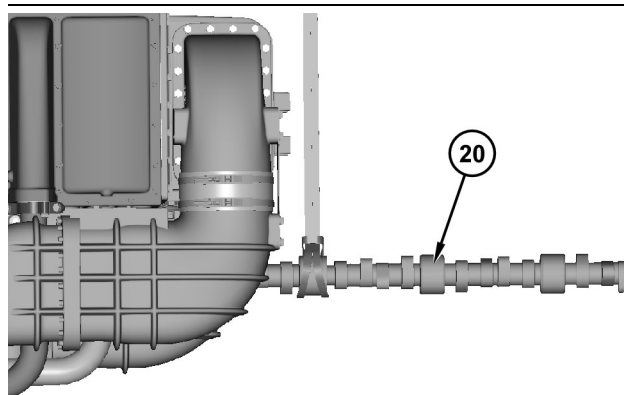


Illustration 469

g01228315

9. Remove camshaft (20) halfway from the engine. Use a suitable lifting device in order to support camshaft (20). The weight of camshaft (20) is approximately 95 kg (210 lb). Remove the remaining portion of camshaft (20).

i02408347

Camshaft Bearings - Remove

SMCS Code: 1211-011

Removal Procedure

Start By:

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

Manual Removal

Table 71

Required Tools			
Tool	Part Number	Part Description	Qty
A	125 - 2739	Bearing Pilot	1
	125 - 2740	Back Up Plate	1
	125 - 2741	Bearing Sleeve	1
B	6V - 4013	Screw	1
	6V - 4010	Puller Plate	1
	8M - 8778	Taperlock Stud	1
	2J - 3506	Full Nut	1
	5P - 8248	Hard Washer	1

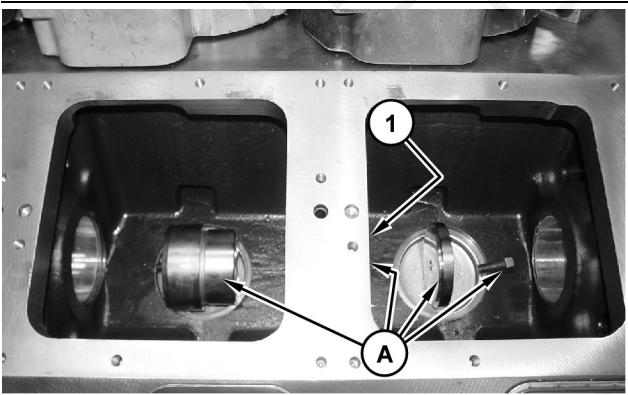


Illustration 470
205

1. Install the sleeve of Tooling (A) into camshaft bearing (1). Install the remainder of Tooling (A).

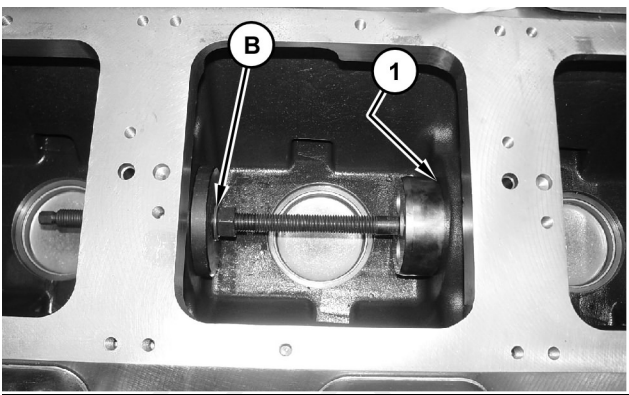


Illustration 471

g01203308

2. Install Tooling (B). Remove camshaft bearing (1).

Hydraulic Removal

Table 72

Required Tools			
Tool	Part Number	Part Description	Qty
A	125 - 2739	Bearing Pilot	1
	125 - 2740	Back Up Plate	1
	125 - 2741	Bearing Sleeve	1
B	6V - 4013	Screw	1
	6V - 4010	Puller Plate	1
	8M - 8778	Taperlock Stud	1
	2J - 3506	Full Nut	1
	5P - 8248	Hard Washer	1
C	5P - 5247	Hydraulic Puller	1
	3S - 6224	Electric Hydraulic Pump Gp	1

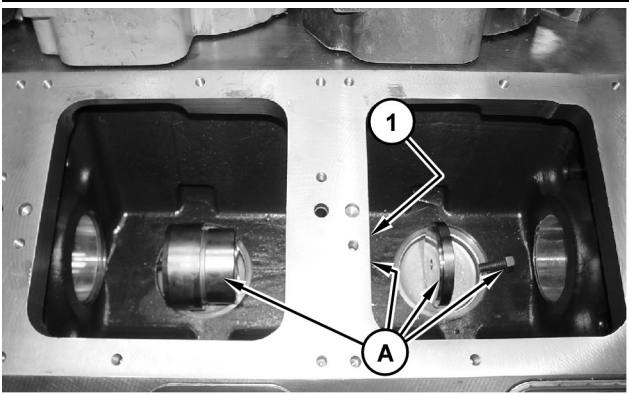


Illustration 472

g01203149

1. Install the sleeve of Tooling (A) into camshaft bearing (1). Install the remainder of Tooling (A).

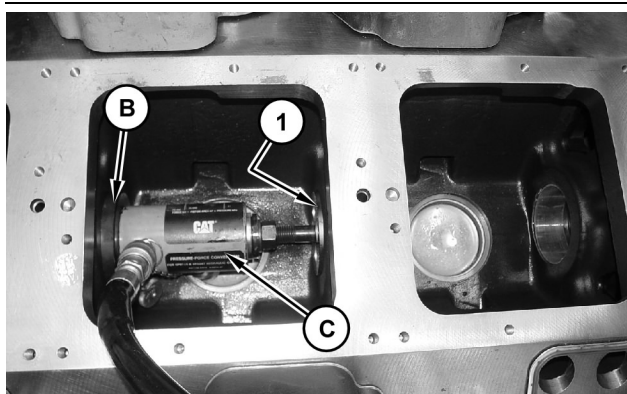


Illustration 473

g01203225

2. Install Tooling (B) and Tooling (C). Remove camshaft bearing (1).

i02408535

Camshaft Bearings - Install

SMCS Code: 1211-012

Installation Procedure

Manual Procedure

Table 73

Required Tools			
Tool	Part Number	Part Description	Qty
A	125 - 2739	Bearing Pilot	1
	125 - 2740	Back Up Plate	1
	125 - 2741	Bearing Sleeve	1
B	6V - 4013	Screw	1
	6V - 4010	Puller Plate	1
	8M - 8778	Taperlock Stud	1
	2J - 3506	Full Nut	1
	5P - 8248	Hard Washer	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

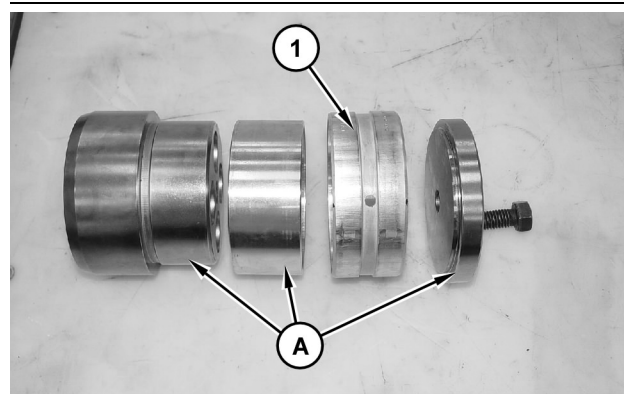


Illustration 474

g01203522

1. Install camshaft bearing (1) onto Tooling (A).

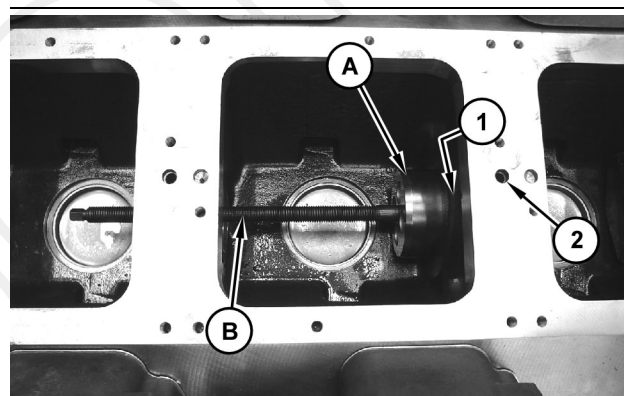


Illustration 475

g01203523

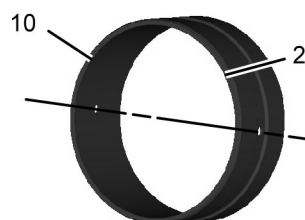


Illustration 476

g01204034

Note: The camshaft bearing joint must be in the 2 O'clock or the 10 O'clock position. The oil hole must be located on the centerline of the bore.

2. Position Tooling (A) and camshaft bearing (1) into the bearing bore. Make sure that the groove in the back of camshaft bearing (1) is aligned with oil hole (2) in the cylinder block. Install Tooling (B). Install camshaft bearing (1).

Hydraulic Procedure

Table 74

Required Tools			
Tool	Part Number	Part Description	Qty
A	125 - 2739	Bearing Pilot	1
	125 - 2740	Back Up Plate	1
	125 - 2741	Bearing Sleeve	1
B	6V - 4013	Screw	1
	6V - 4010	Puller Plate	1
	8M - 8778	Taperlock Stud	1
	2J - 3506	Full Nut	1
	5P - 8248	Hard Washer	1
C	5P - 5247	Hydraulic Puller	1
	3S - 6224	Electric Hydraulic Pump Gp	1
	8S - 8292	Extension	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

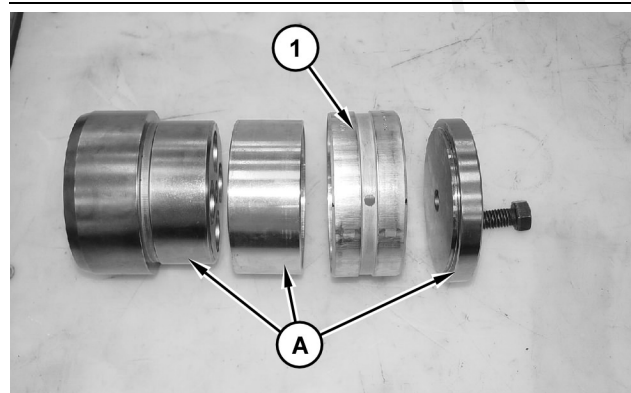


Illustration 477

g01203522

1. Install camshaft bearing (1) onto Tooling (A).

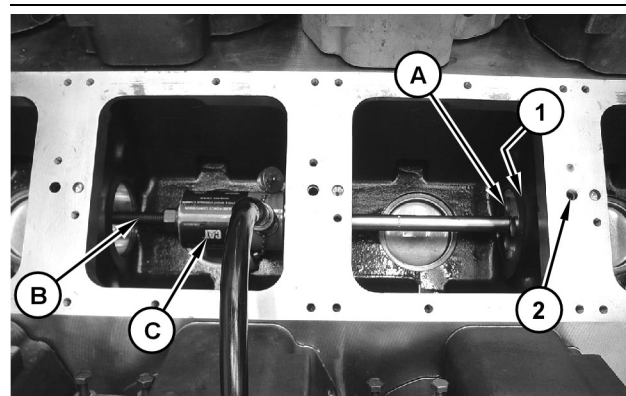


Illustration 478

g01203527

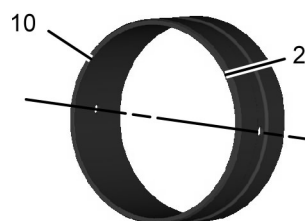


Illustration 479

g01204034

Note: The camshaft bearing joint must be in the 2 O'clock or the 10 O'clock position. The oil hole must be located on the centerline of the bore.

2. Position Tooling (A) and camshaft bearing (1) into the bearing bore. Make sure that the groove in the back of camshaft bearing (1) is aligned with oil hole (2) in the cylinder block. Install Tooling (B) and Tooling (C). Install camshaft bearing (1).

End By:

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

i02461650

Camshaft - Install

SMCS Code: 1210-012

Installation Procedure

Table 75

Required Tools			
Tool	Part Number	Part Description	Qty
A	282-9962	Guide	2
B	255-2820	Camshaft Pilot	2
C	8T-3169	Crank As	1

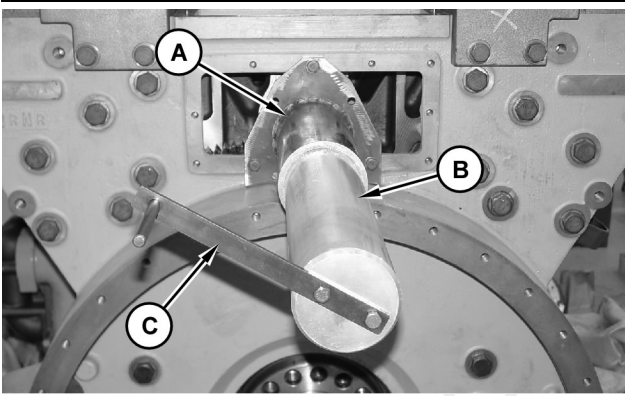


Illustration 480

g01228274

Typical Example

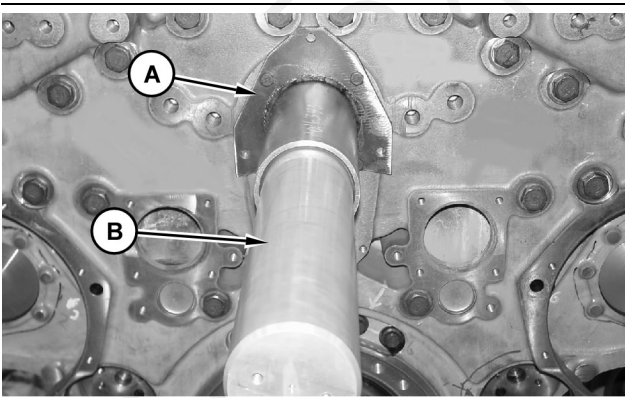


Illustration 481

g01228276

Typical Example

Note: The camshaft can be installed from either end of the engine.

1. Apply a thin coat of oil to Tooling (A) and Tooling (B). Install Tooling (B) into the ends of the camshaft. Install Tooling (C).

Note: If Tooling (A) was removed use the following Steps in order to install Tooling (A).

- a. Install Tooling (B) into the engine until Tooling (B) is through the second camshaft bearing.
- b. Slide Tooling (A) over Tooling (B).
- c. Tighten the bolts for Tooling (A).
- d. Remove Tooling (B).

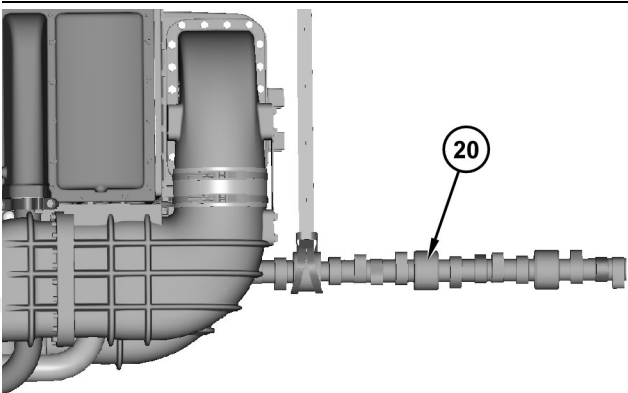


Illustration 482

g01228315

2. Attach a suitable lifting device to the middle of camshaft (20). The weight of camshaft (20) is approximately 95 kg (210 lb). Install camshaft (20) halfway into the engine. Remove the suitable lifting device. Install camshaft (20). Use Tooling (C) in order to rotate camshaft (20). Rotate camshaft (20) in order to install camshaft (20).

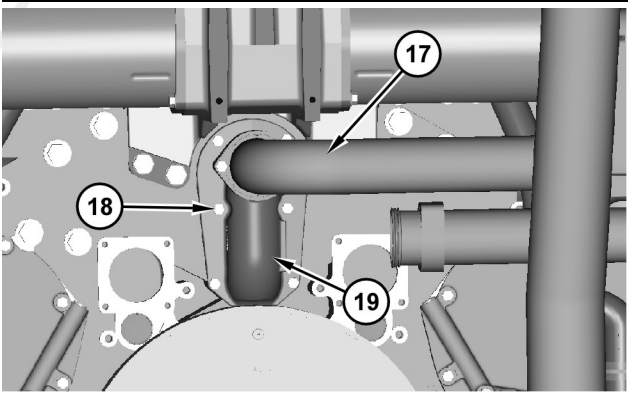


Illustration 483

g01228240

3. Install housing (19). Install bolts (18). Install tube assembly (17).

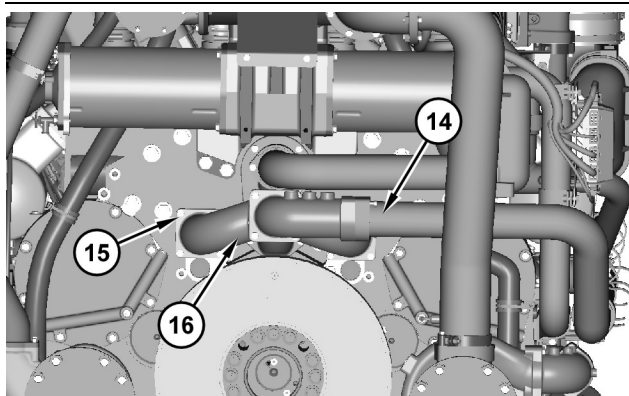


Illustration 484

g01228238

4. Install housing (16). Install bolts (15). Connect tube assembly (14).

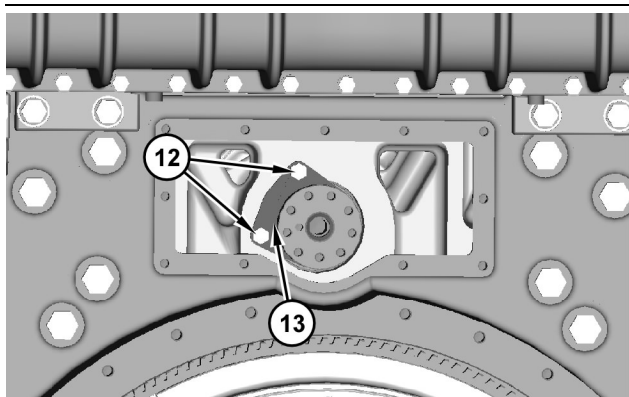


Illustration 485

g01228236

5. Install retainer (13). Install the washers and bolts (12).

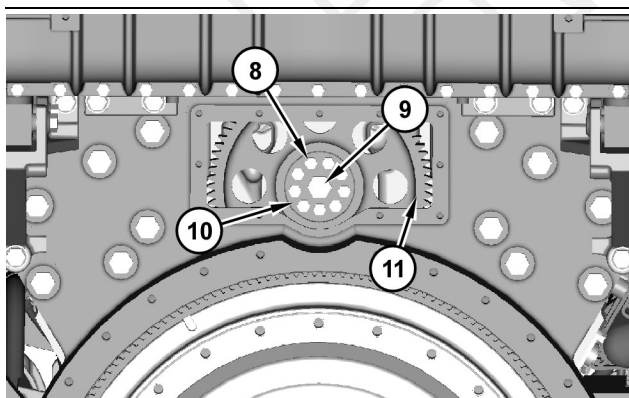


Illustration 486

g01228235

6. Rotate the engine so that the number one piston is at top dead center on the compression stroke. Refer to Testing and Adjusting, "Finding Top Center Position for No. 1 Piston". Install cam gear (11). Install spacer (10). Install bolt (9). Install bolts (8).

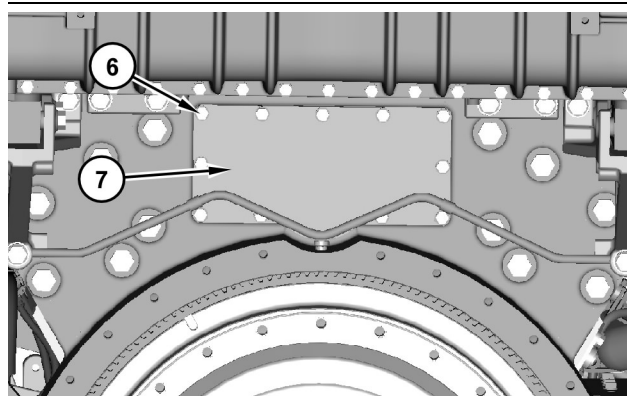


Illustration 487

g01228201

7. Install cover (7). Install bolts (6).

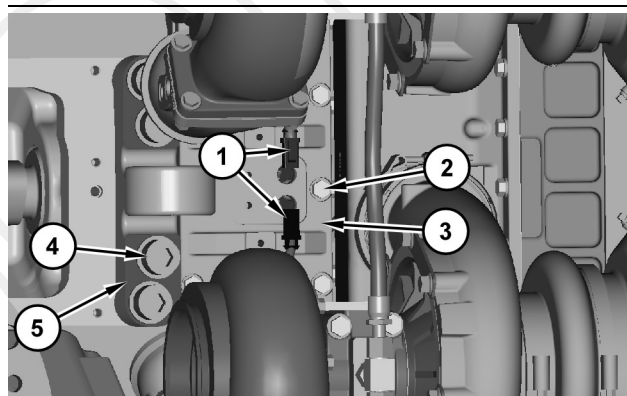


Illustration 488

g01228199

8. Install lifting bracket (5). Install bolts (4). Install cover (3). Install bolts (2). Connect harness assemblies (1).
9. Fill the cooling system with coolant. Refer to Operation and Maintenance Manual, "Cooling System Coolant - Change".

End By:

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

i02453072

Crankshaft - Remove

SMCS Code: 1202-011

Removal Procedure

Table 76

Required Tools			
Tool	Part Number	Part Description	Qty
A	4C-9832	Engine Rollover Stand	1
	284-8777	Adapter Plate (Rear)	1
	284-8766	Adapter Plate (Front)	1
B	253-3272	Cylinder	2
C	178-9312	Hose As	2
D	253-3276	Distribution Coupler	1
E ⁽¹⁾	227-6724	Electric Hydraulic Pump Gp (120 V)	1
	227-8834	Electric Hydraulic Pump Gp (240 V)	1
	156-7166	Electric Hydraulic Pump Gp (220/380 V)	1
	191-5347	Hydraulic Pump Gp	1
	156-7167	Manual Hydraulic Pump	1
F	284-5266	Spanner Wrench	1

⁽¹⁾ Use any of the pumps that are listed in Tooling (D) for this procedure.

Start By:

- Remove rocker arm shaft assemblies. Refer to Disassembly and Assembly, "Rocker Shaft and Push Rods - Remove".
 - Remove the engine oil pan. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove".
 - Remove the front housing. Refer to Disassembly and Assembly, "Front Drive Housing - Remove and Install".
 - Remove the flywheel housing. Refer to Disassembly and Assembly, "Flywheel Housing - Remove".
 - Remove the engine oil cooler. Refer to Disassembly and Assembly, "Engine Oil Cooler - Remove".
- Use Tooling (A) in order to rotate the engine to approximately 120 degrees.

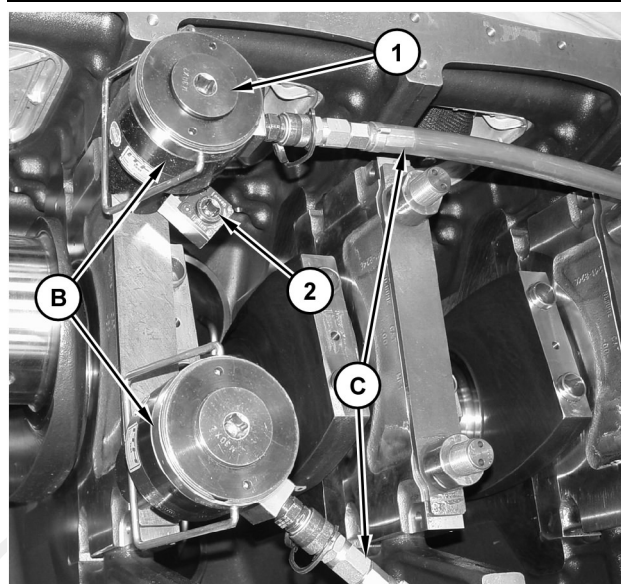


Illustration 489

g01224384

- Install Tooling (B) onto the studs for the crankshaft main bearing cap. Tighten threaded collar (1) of Tooling (B). Loosen threaded collar (1) of Tooling (B) by 1 1/2 turns. Attach Tooling (C) onto Tooling (B). Attach Tooling (C) onto Tooling (D). Attach Tooling (D) onto Tooling (E). Apply approximately 135 MPa (19580 psi) of pressure to Tooling (B). Use drive (2) on Tooling (B) in order to loosen the nuts for the crankshaft main bearings. Turn drive (2) on Tooling (B) by approximately three turns. Release the pressure on Tooling (B). Remove Tooling (B). Repeat for the remaining main bearing caps.

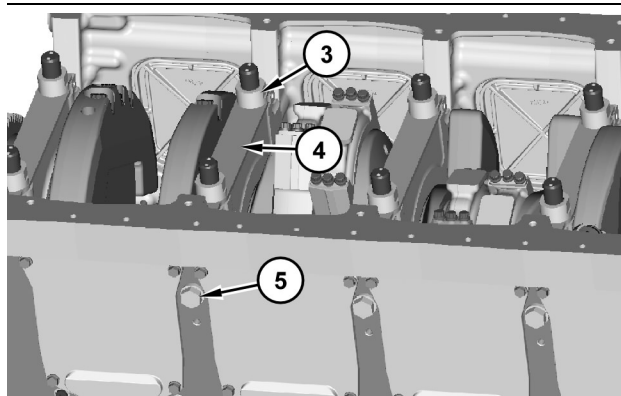


Illustration 490

g01224394

- Remove nuts (3) for the crankshaft main bearings. Remove plate (4). Remove bolts (5) from each side of the engine.

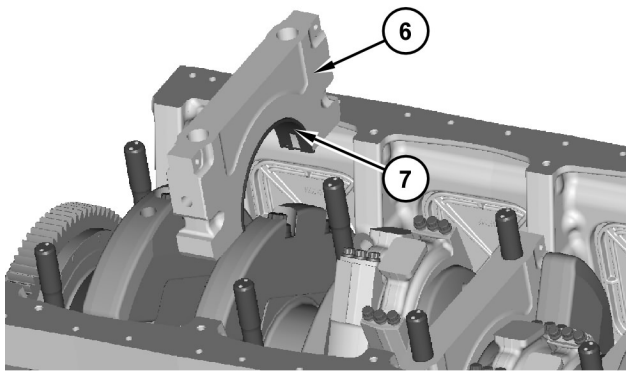


Illustration 491

g01224386

4. Remove main bearing cap (6) and lower main bearing (7).
5. Use Tooling (A) in order to rotate the engine to approximately 180 degrees so that the crankshaft is on top.

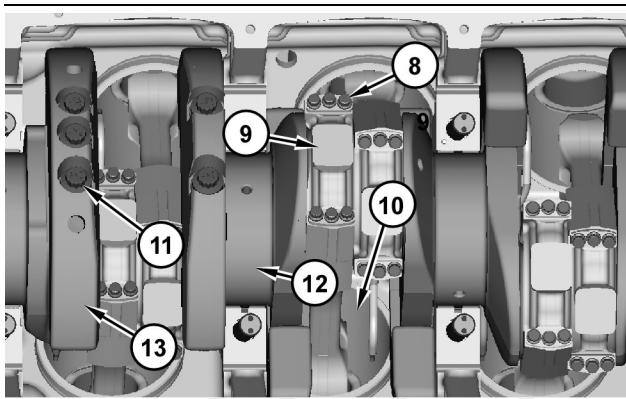


Illustration 492

g01224397

6. Number counterweights (13) for assembly purposes. Remove bolts (11). Remove counterweights (13). The weight of counterweights (13) is approximately 18 kg (40 lb). Number the rod caps and the connecting rods for assembly purposes. Remove bolts (8). Remove rod caps (9). Lay rod caps (9) on the side in order to prevent damage. Position pistons (10) away from crankshaft (12).

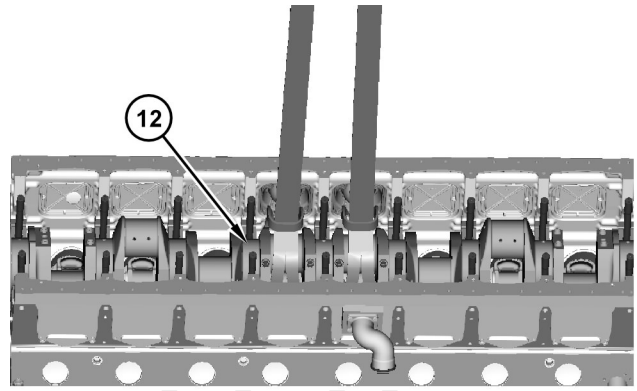


Illustration 493

g01224401

Note: If the counterweights are installed on the crankshaft, the weight of the crankshaft is approximately 1043 kg (2300 lb).

7. Attach a suitable lifting device onto crankshaft (12). The weight of crankshaft (12) is approximately 748 kg (1650 lb). Remove crankshaft (12).

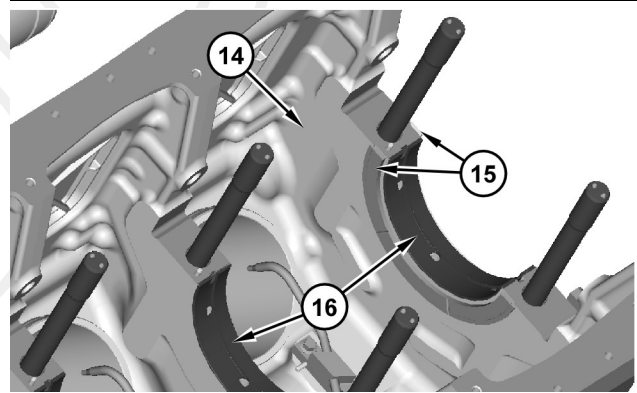


Illustration 494

g01224408

8. Remove upper main bearings (16) from cylinder block (14). Remove thrust bearing (15) from cylinder block (14).

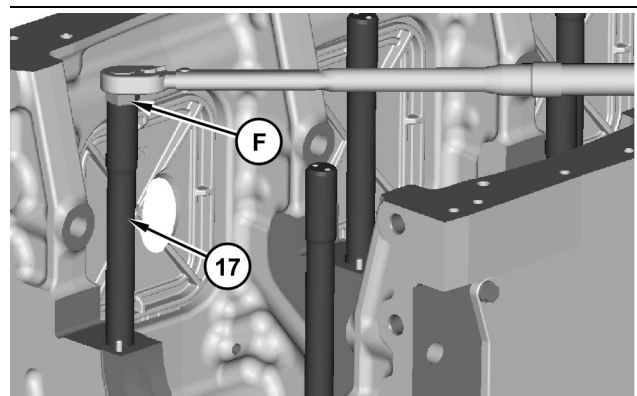


Illustration 495

g01224414

9. Install Tooling (F) onto main bearing stud (17).
Use a suitable ratchet and Tooling (F) in order to remove main bearing stud (17).

i02454293

Crankshaft - Install

SMCS Code: 1202-012

Installation Procedure

Table 77

Required Tools			
Tool	Part Number	Part Description	Qty
A	4C-9832	Engine Rollover Stand	1
	284-8777	Adapter Plate (Rear)	1
	284-8766	Adapter Plate (Front)	1
B	253-3272	Cylinder	2
C	178-9312	Hose As	2
D	253-3276	Distribution Coupler	1
E ⁽¹⁾	227-6724	Electric Hydraulic Pump Gp (120 V)	1
	227-8834	Electric Hydraulic Pump Gp (240 V)	1
	156-7166	Electric Hydraulic Pump Gp (220/380 V)	1
	191-5347	Hydraulic Pump Gp	1
	156-7167	Manual Hydraulic Pump	1
F	284-5266	Spanner Wrench	1
E	4C-5593	Anti-Seize Compound	1

⁽¹⁾ Use any of the pumps that are listed in Tooling (D) for this procedure.

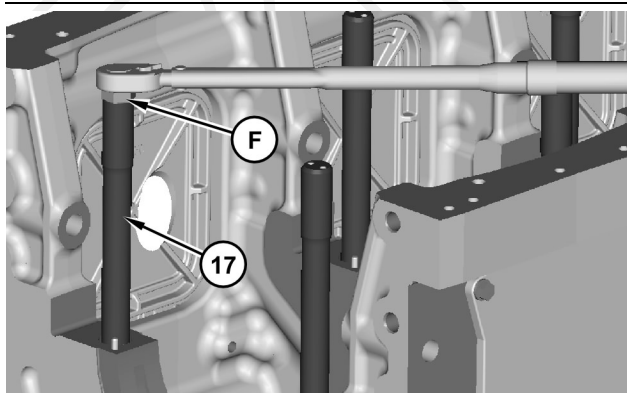


Illustration 496

g01224414

1. Lubricate main bearing studs (17) with clean engine oil. Install main bearing stud (17). Use Tooling (F) and a suitable torque wrench in order to tighten main bearing stud (17). Tighten main bearing stud (17) to a torque of 100 ± 20 N·m (74 ± 15 lb ft).

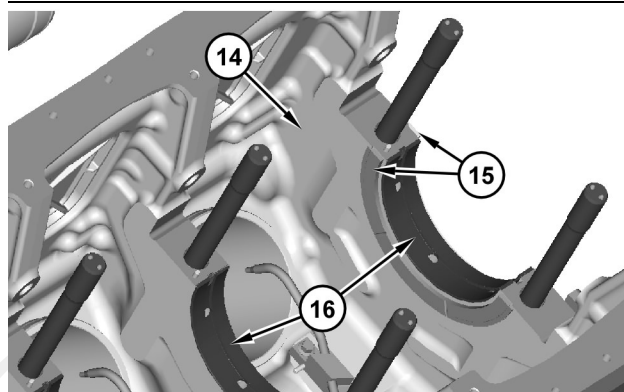


Illustration 497

g01224408

2. Install thrust bearing (15) into the rear of cylinder block (14). Lightly lubricate upper main bearings (16) and the upper connecting rod bearings with clean engine oil. Install upper main bearings (16) into cylinder block (14).

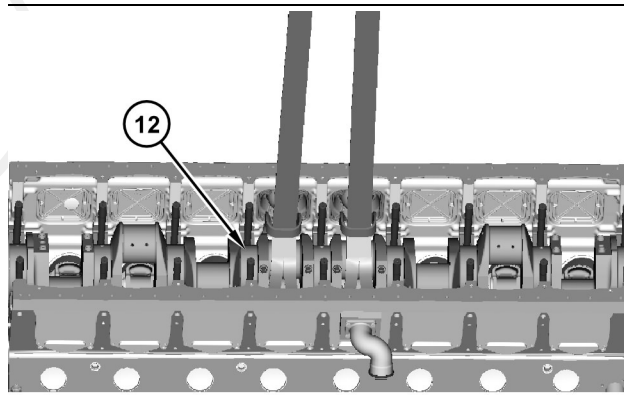


Illustration 498

g01224401

3. Attach a suitable lifting device onto crankshaft (12). The weight of crankshaft (12) is approximately 748 kg (1650 lb). Install crankshaft (12).
4. Use Tooling (A) to rotate the engine slightly above the horizontal position.

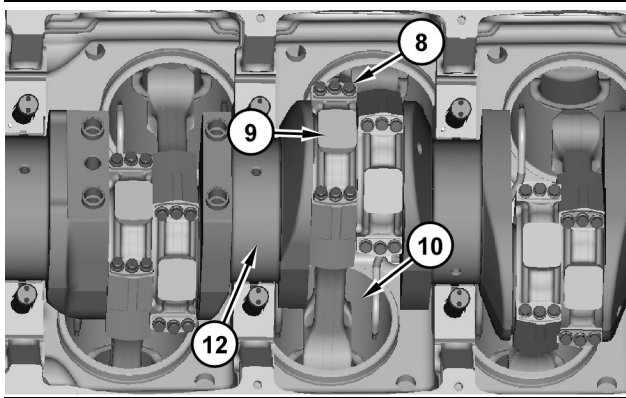


Illustration 499

g01225418

5. Position pistons (10) toward crankshaft (12). Lubricate the bearings for rod caps (9) with clean engine oil. Install rod caps (9). Apply Tooling (E) under the heads of bolts (8) and to the threads of bolts (3). Install bolts (8) finger tight.

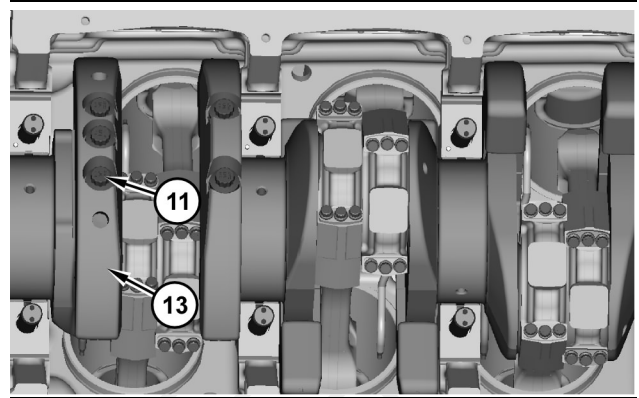


Illustration 501

g01225316

7. Install counterweights (13). The weight of counterweights (13) is approximately 18 kg (40 lb). Lubricate the threads, the shank, the washer, and the seat of bolts (11) with Tooling (E). Install bolts (11). Tighten bolts (11) to a torque of 220 ± 20 N·m (162 ± 15 lb ft). Turn bolts (11) and additional 90 ± 5 degrees.



Illustration 500

g01225315

6. Use the following procedure to tighten bolts (8):

- Tighten bolts (1) and (2) to a torque of 120 ± 5 N·m (89 ± 4 lb ft).
- Tighten bolts (3) and (4) to a torque of 120 ± 5 N·m (89 ± 4 lb ft).
- Tighten bolts (5) and (6) to a torque of 120 ± 5 N·m (89 ± 4 lb ft).
- Repeat Steps 6.a through 6.c.
- Turn bolts (3) and (4) for an additional 180 ± 5 degrees.
- Turn bolts (5) and (6) for an additional 180 ± 5 degrees.
- Turn bolts (1) and (2) for an additional 180 ± 5 degrees.

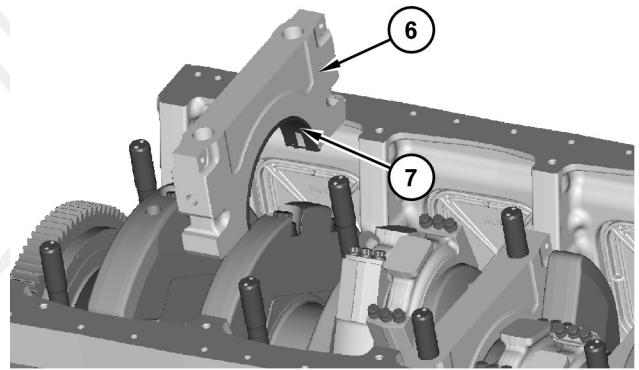


Illustration 502

g01224386

8. Lubricate lower main bearing (7) with clean engine oil. Install lower main bearing (7) into main bearing cap (6). Install main bearing cap (6).

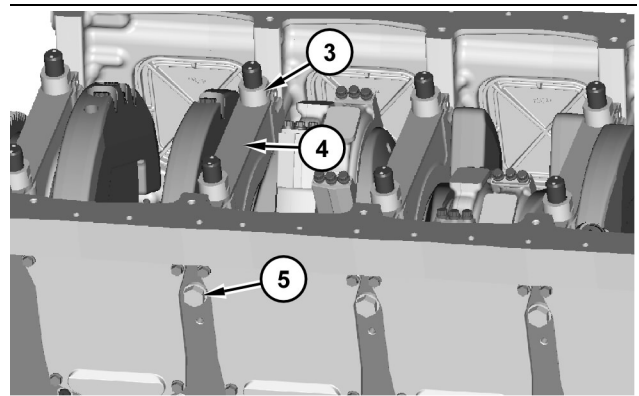


Illustration 503

g01224394

9. Lubricate the main bearing studs with clean engine oil. Install plate (4). Install nuts (3) for the crankshaft main bearings finger tight. Lubricate bolts (5) with clean engine oil. Install bolts (5) finger tight.

10. Start at the front of the engine and tighten bolts (5) on the right side of the cylinder block to a torque of $100 \pm 20 \text{ N}\cdot\text{m}$ ($74 \pm 15 \text{ lb ft}$).

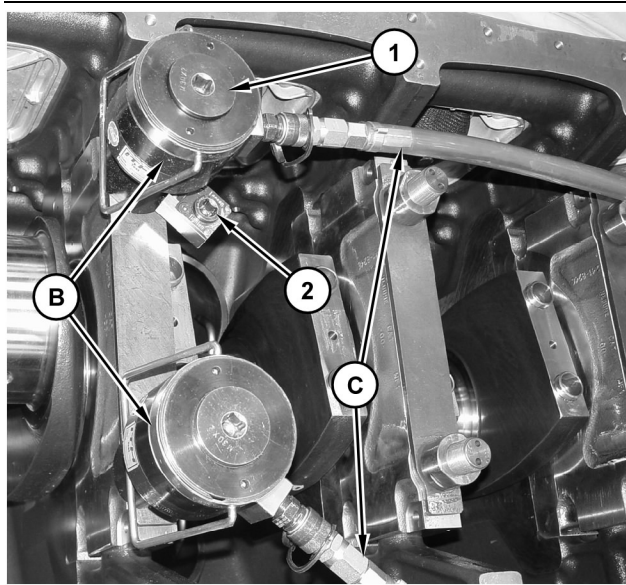


Illustration 504

g01224384

11. Install Tooling (B) onto the studs for the crankshaft main bearing cap. Tighten threaded collar (1) of Tooling (B). Attach Tooling (C) onto Tooling (B). Attach Tooling (C) onto Tooling (D). Attach Tooling (D) onto Tooling (E). Apply approximately 135 MPa (19580 psi) of pressure to Tooling (B). Use drive (2) on Tooling (B) in order to tighten the nuts for the crankshaft main bearings. Release the pressure on Tooling (B). Reapply approximately 135 MPa (19580 psi) of pressure to Tooling (B). Recheck nuts (2) for tightness. Remove Tooling (B).

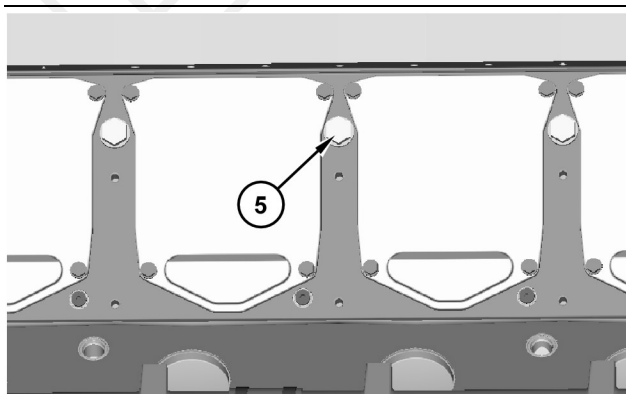


Illustration 505

g01225172

12. Start at the front of the engine and tighten bolts (5) on the right side of the cylinder block to a torque of $530 \pm 70 \text{ N}\cdot\text{m}$ ($391 \pm 52 \text{ lb ft}$).

13. Start at the front of the engine and tighten bolts (5) on the left side of the cylinder block to a torque of $530 \pm 70 \text{ N}\cdot\text{m}$ ($391 \pm 52 \text{ lb ft}$).

End By:

- a. Install the engine oil cooler. Refer to Disassembly and Assembly, "Engine Oil Cooler - Install".
- b. Install the flywheel housing. Refer to Disassembly and Assembly, "Flywheel Housing - Install".
- c. Install the front housing. Refer to Disassembly and Assembly, "Front Drive Housing - Remove and Install".
- d. Install the engine oil pan. Refer to Disassembly and Assembly, "Engine Oil Pan - Install".
- e. Install rocker arm shaft assemblies. Refer to Disassembly and Assembly, "Rocker Shaft and Push Rods - Install".

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PROOF