M0107642 (en-us)
September 2019

Specifications

C3.6 Industrial Engine

J37 1-UP (Engine)

Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards, including human factors that can affect safety. 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 verify that you are authorized to perform this work, and 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.

⚠ WARNING

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.

A non-exhaustive list of 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. You must not use this product in any manner different from that considered by this manual without first satisfying yourself that you have considered all safety rules and precautions applicable to the operation of the product in the location of use, including site-specific rules and precautions applicable to the worksite. 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 you are authorized to perform this work, and that the product will not be damaged or become unsafe by the operation, lubrication, maintenance or repair procedures that you intend to use.

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. Cat dealers have the most current information available.

⚠ WARNING

When replacement parts are required for this product Caterpillar recommends using Cat replacement parts.

Failure to follow this warning may lead to premature failures, product damage, personal injury or death.

In the United States, the maintenance, replacement, or repair of the emission control devices and systems may be performed by any repair establishment or individual of the owner's choosing.

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i06849506

Engine Design

SMCS Code: 1201

Part No.: 584-1947

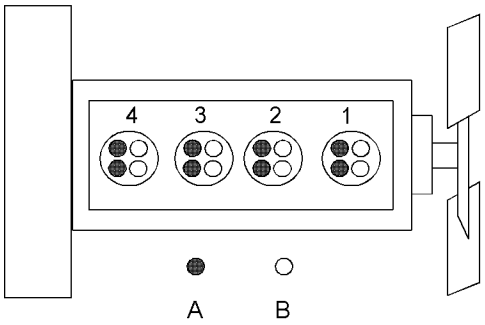

Illustration 1 g03692044

Cylinder and valve location

(A) Exhaust valves
(B) Inlet valves

Bore . . . . . 98 mm ((3.86 inch))

Stroke . . . . . 120 mm ((4.72 inch))

Displacement . . . . . .3.6 L ((220 in^3))

Cylinder arrangement . . . . . In-line

Type of combustion . . . . . Direct injection

Compression ratio

Turbocharged aftercooled 17:1

Number of cylinders 4

Valves per cylinder 4

Firing order 1, 3, 4, 2

When the crankshaft is viewed from the flywheel end of the engine, the crankshaft rotates in the following direction: . . . . . .Counterclockwise

When the camshaft is viewed from the flywheel end of the engine, the camshaft rotates in the following direction: . . . . . Clockwise

Note: The left side and the right side of the engine are viewed from the flywheel end. The No. 1 cylinder is the front cylinder.

i06867793

Fuel Injection Lines

SMCS Code: 1252

Part No.: 541-6388, 566-3805

⚠ WARNING

Contact with high pressure fuel may cause fluid penetration and burn hazards. High pressure fuel spray may cause a fire hazard. Failure to follow these inspection, maintenance and service instructions may cause personal injury or death.

Refer to Operation and Maintenance Manual, “General Hazard Information and High-Pressure Fuel Lines” before adjustments and repairs are performed.

NOTICE

Refer to Systems Operation, Testing, and Adjusting, “Cleanliness of Fuel System Components” for detailed information on the standards of cleanliness that must be observed during ALL work on the fuel system.

Ensure that all adjustments and repairs are performed by authorized personnel that have had the correct training.

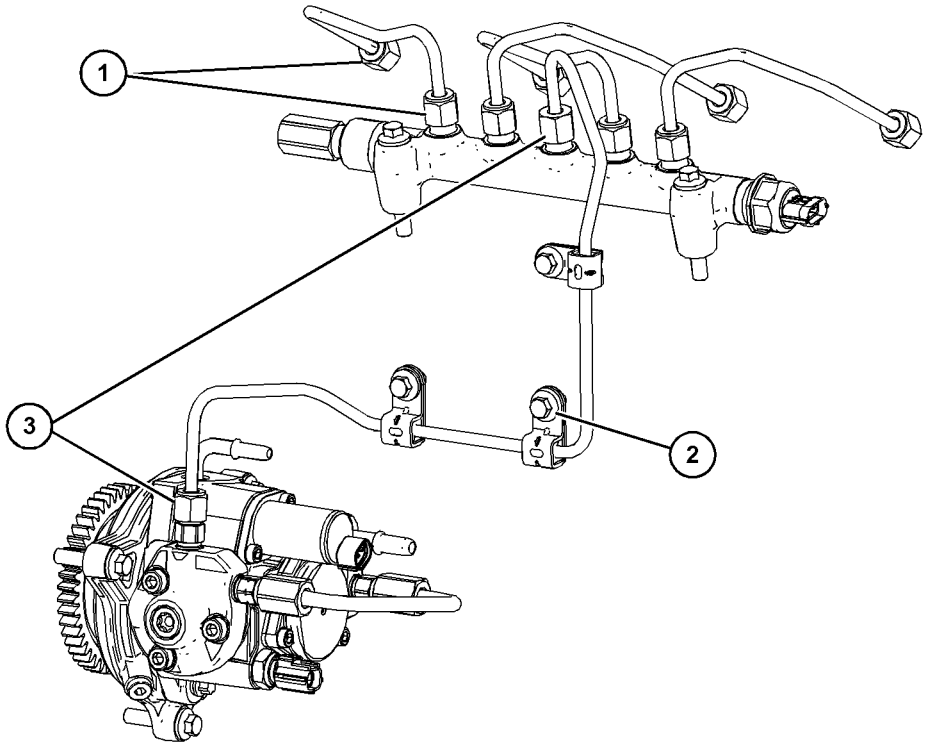

Illustration 2 g06147120

Typical example

(1) (3) High-pressure fuel lines

Initial torque . . . . . 10 N·m ((89 lb in))
Tighten an additional angle. . . . . 60 degrees

(2) Tighten the clamp bolts to the following torque
. . . . . 10 N·m ((89 lb in))

i06867674

Fuel Injection Pump

SMCS Code: 1251; 1290

Part No.: 498-7944

Note: The timing of the fuel injection pump will need to be checked by trained personnel. To check the timing of the fuel injection pump, refer to Systems Operation, Testing, and Adjusting, “Fuel Injection Pump Timing - Check”.

NOTICE
Refer to Systems Operation, Testing, and Adjusting, “Cleanliness of Fuel System Components” for detailed information on the standards of cleanliness that must be observed during ALL work on the fuel system.

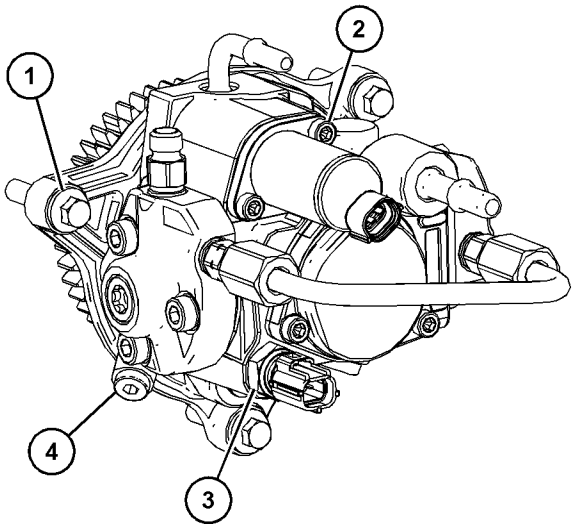

Illustration 3 g06147001

Typical example

(1) Tighten the setscrews to the following torque.
. . . . . 22 N·m ((195 lb in))

(2) Tighten the screws for the suction control valve to the following torque.. . . . . 9 N·m ((80 lb in))

(3) Tighten the fuel temperature sensor to the following torque. . . . . 22 N·m ((195 lb in))

(4) Tighten the plug to the following torque. . . 14 N·m ((124 lb in))

i06867745

Fuel Injection Nozzles

SMCS Code: 1254

Part No.: 498-7941

Refer to Operation and Maintenance Manual, “General Hazard Information and High Pressure Fuel Lines” before adjustments and repairs are performed.

NOTICE
Refer to Systems Operation, Testing and Adjusting, “Cleanliness of Fuel System Components” for detailed information on the standards of cleanliness that must be observed during ALL work on the fuel system.

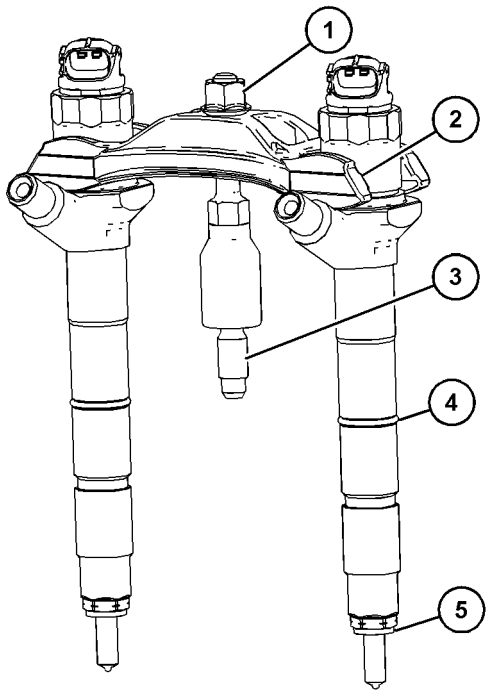

Illustration 4 g06147075

Typical example

(2) Clamp
(4) Washer
(5) O ring seal

(1) Tighten the nut to an initial torque . . . . . 10 N·m ((89 lb in))

(3) Tighten the stud to the following torque . . 44 N·m ((32 lb ft))

i06867834

Fuel Filter Base
(Fuel Filter Base with Electric Fuel Priming Pump)

SMCS Code: 1261; 1262

Part No.: 514-0681

NOTICE
Refer to Systems Operation, Testing and Adjusting, “Cleanliness of Fuel System Components” for detailed information on the standards of cleanliness that must be observed during ALL work on the fuel system.

Note: The fuel filter base is mounted to the application.

If necessary, install a new fuel filter element (1) to canister (2). Refer to Operation and Maintenance Manual, “Fuel System Primary Filter (Water Separator) Element - Replace” for the correct procedure.

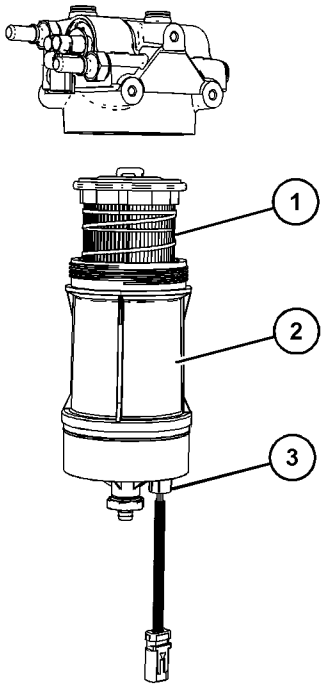

Illustration 5 g06367081

Typical example

Tighten the recommended M8 fasteners that secure the fuel filter base to the following torque. . . . 22 N·m ((195 lb in))

(3) Tighten the water in fuel sensor to the following torque.. . . . . 2.5 N·m ((22 lb in))

i07572933

Fuel Filter Base
(Secondary Fuel Filter Base)

SMCS Code: 1261; 1262

Part No.: 565-7315

NOTICE
Refer to Systems Operation, Testing and Adjusting, “Cleanliness of Fuel System Components” for detailed information on the standards of cleanliness that must be observed during ALL work on the fuel system.

Note: The secondary fuel filter base is mounted to the application.

If necessary, install a new fuel filter (1) to canister (2). Refer to Operation and Maintenance Manual, “Fuel System Secondary Filter - Replace” for the correct procedure.

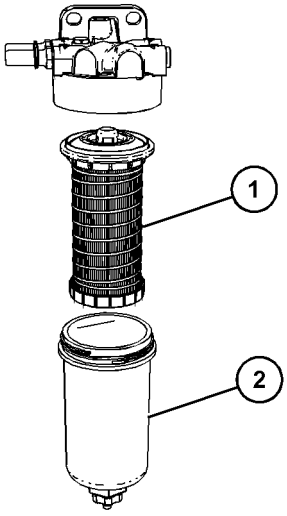

Illustration 6 g06364724
Typical example

Tighten the recommended M8 fasteners that secure the fuel filter base to the following torque. . . . 22 N·m ((195 lb in))

i07573202

Fuel Filter Base
(Fuel Filter Base with a Manual Fuel Priming Pump)

SMCS Code: 1261; 1262

Part No.: 524-2270

NOTICE
Refer to Systems Operation, Testing, and Adjusting, “Cleanliness of Fuel System Components” for detailed information on the standards of cleanliness that must be observed during ALL work on the fuel system.

Note: The fuel filter base is mounted to the application.

If necessary, install a new fuel filter element (1) to canister (2). Refer to Operation and Maintenance Manual, “Fuel System Primary Filter (Water Separator) Element - Replace” for the correct procedure.

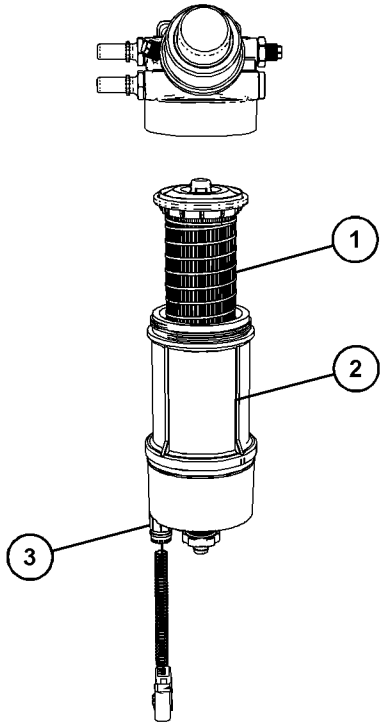

Illustration 7 g06367135
Typical example

Tighten the recommended M10 fasteners that secure the fuel filter base to the following torque. . . . 44 N·m ((32 lb ft))

(3) Tighten the water in fuel sensor to the following torque.. . . . . 2.5 N·m ((22 lb in))

i06867728

Fuel Manifold (Rail)

SMCS Code: 1702

Part No.: 553-8166

Refer to Operation and Maintenance Manual, “General Hazard Information and High Pressure Fuel Lines” before adjustments and repairs are performed.

NOTICE
Refer to Systems Operation, Testing and Adjusting, “Cleanliness of Fuel System Components” for detailed information on the standards of cleanliness that must be observed during ALL work on the fuel system.

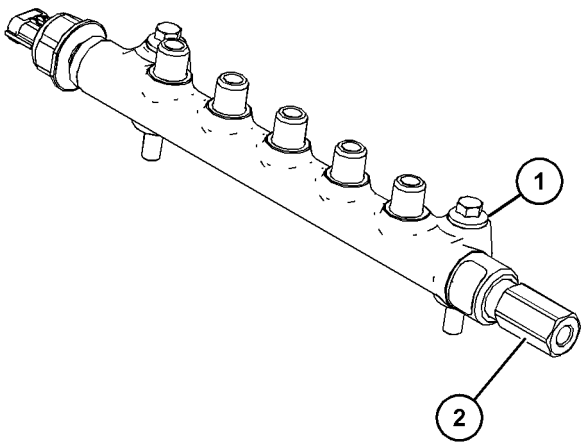

Illustration 8 g06147060
Typical example

(1) Tighten the bolts to the following torque. . 22 N·m ((195 lb in))

(2) Tighten the fuel pressure relief valve to the following torque. . . . . 30 N·m ((266 lb in))

Note: The fuel pressure relief valve (2) should be tightened an extra 24 degrees.

i07105874

Lifter Group

SMCS Code: 1209

Part No.: 486-6599

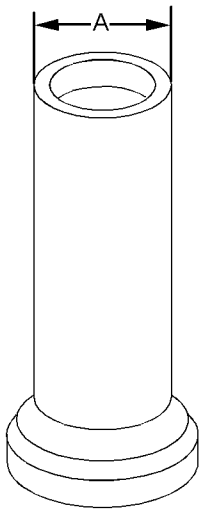

Illustration 9 g01344742
Typical example

(A) Diameter of the lifter body
. . .15.951 to 15.975 mm ((0.62799 to 0.62894 inch))

Bore diameter in the cylinder block
. . .16.009 to 16.037 mm ((0.63027 to 0.63138 inch))

Clearance

Clearance of the lifter . . . . . 0.038 to 0.095 mm ((0.0015 to 0.0037 inch))

i06851870

Rocker Shaft

SMCS Code: 1102

Part No.: 566-6794

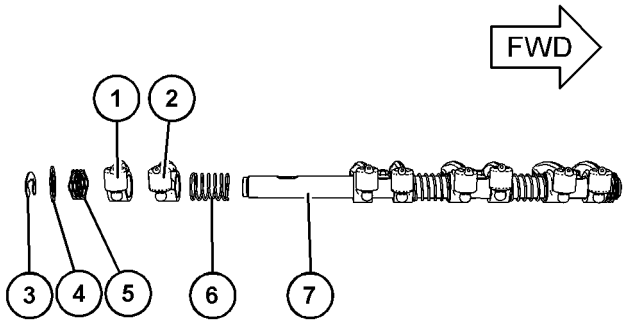

Illustration 10 g06228178

Typical example

(1) Inlet rocker arm

Diameter of the rocker arm bore
. . . . . .25.013 to 25.051 mm
((0.98476 to 0.98626 inch))

(2) Exhaust rocker arm

Diameter of the rocker arm bore
. . . . . .25.013 to 25.051 mm
((0.98476 to 0.98626 inch))

Clearance

Maximum clearance of both the rocker arm bores
. . . . . 0.089 mm ((0.0035 inch))
The service limit for both rocker arm bores
. . . . . 0.17 mm ((0.0067 inch))

(3) Clip

(4) Shim

(5) Spring

(6) Spring

(7) Diameter of the rocker shaft
. . .24.963 to 24.987 mm ((0.98279 to 0.98374 inch))

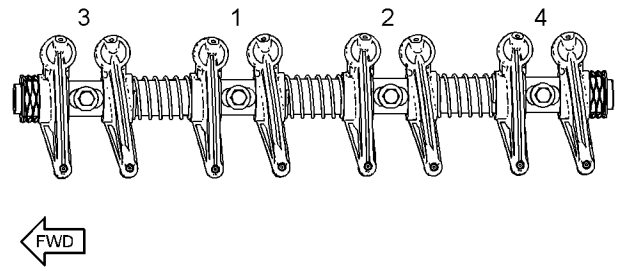

Illustration 11 g06141891

Tightening sequence

Tighten the fasteners in the sequence that is in illustration 11 . Tighten the fasteners to the following torque.. . . . . 35 N·m ((310 lb in))

i06850326

Valve Mechanism Cover

SMCS Code: 1107

Part No.: 539-5502

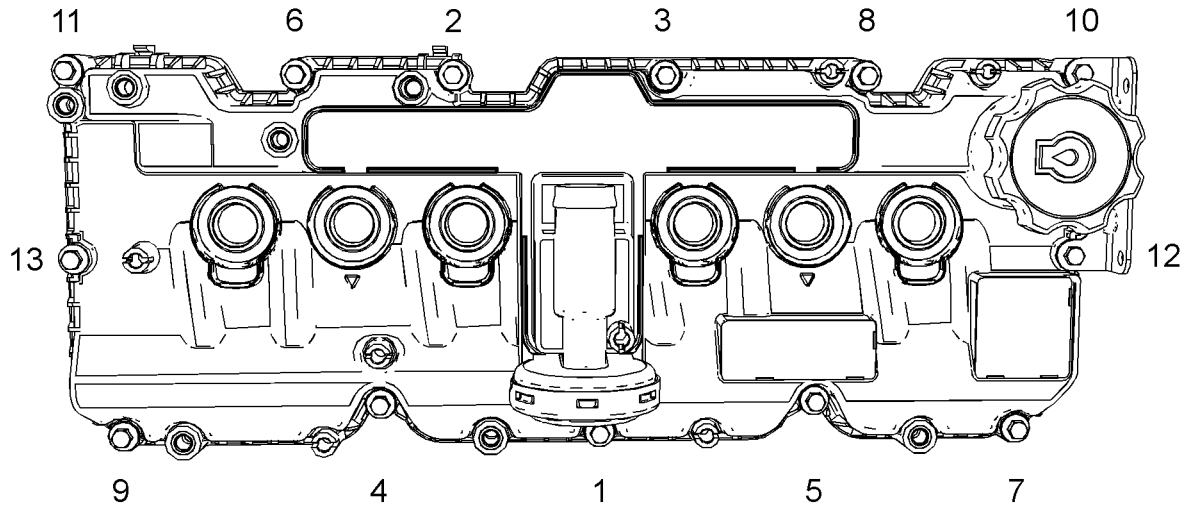

Illustration 12 g06140969

Typical example

Tighten the fasteners for the valve mechanism cover in the sequence that is shown in illustration 12 to the following torque. . . . . 9 N·m ((80 lb in))

i07106846

Cylinder Head Valves

SMCS Code: 1105

Part No.: 488-1433, 488-1434

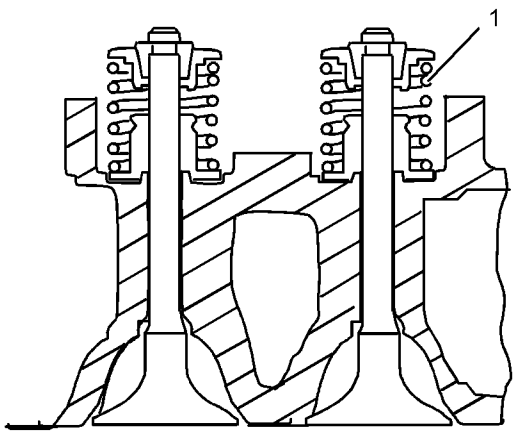

Illustration 13 g01335203

Typical example

When the valve springs (1) are replaced the valve springs must be replaced in pairs.

Table 1

The load for the inlet valve spring	The length of the inlet valve spring
161.5 to 178.5 N (36.3 to 40.1 lb)	31.5 mm (1.2402 inch)
337.9 to 373.5 N (75.96330 to 83.96654 lb)	21.5 mm (0.8465 inch)

Table 2

The load for the exhaust valve spring	The length of the exhaust valve spring
251.8 to 278.3 N (56.60716 to 62.56462 lb)	31 mm (1.2205 inch)
412.5 to 455.9 N (92.73413 to 102.49088 lb)	22 mm (0.8661 inch)

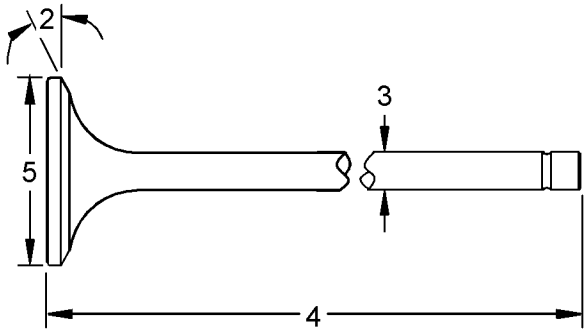

Illustration 14 g01335204

(2) Valve face angle

Inlet . . . . . 30 degrees
Exhaust . . . . . 45 degrees

(3) Valve stem diameter

Inlet . . . . . 5.942 to 5.957 mm ((0.23394 to 0.23453 inch))
Exhaust . . . . . 5.927 to 5.942 mm ((0.23335 to 0.23394 inch))

Clearance

Maximum clearance of the inlet valve stem . . . . . 0.05 mm ((0.0020 inch))
The service limit for the inlet valve stem . . . . . 0.08 mm ((0.0031 inch))

Clearance

Maximum clearance of the exhaust valve stem . . . . . 0.075 mm ((0.00295 inch))
The service limit for the exhaust valve stem . . . . . 0.10 mm ((0.00394 inch))

(4) Length of valve

Inlet valve. . . . . 105.4 mm ((4.14960 inch))
Exhaust valve . . . . . 105.15 mm ((4.13976 inch))

(5) Valve head

Diameter of inlet valve head . . 32.08 to 32.32 mm ((1.26299 to 1.27244 inch))
Diameter of exhaust valve head . . 29.88 to 30.12 mm ((1.17638 to 1.18582 inch))

i07107303

Cylinder Head

SMCS Code: 1100

Part No.: 539-5489

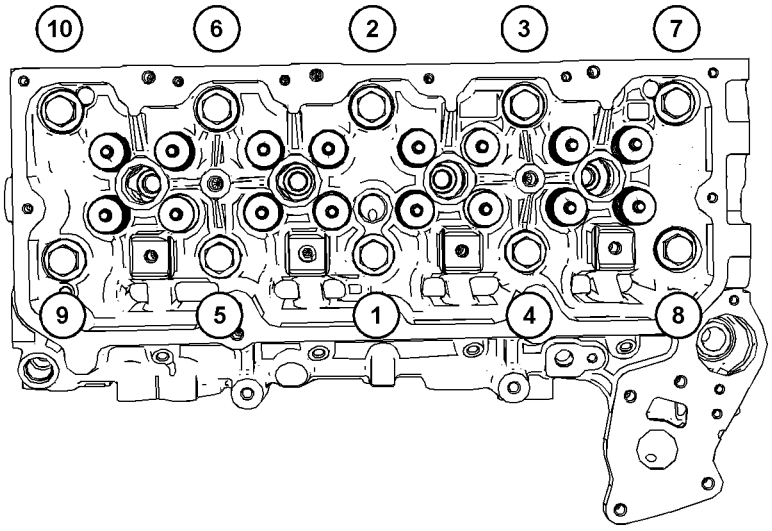

Illustration 15 g06227960

Typical example

Lubricate the threads and the underside of the head bolts with clean engine oil.

Tighten the bolts in the sequence that is shown in illustration 15 to the following torque. . . . . 50 N·m ((37 lb ft))
Tighten the bolts again to the following torque. . . . . 100 N·m ((74 lb ft))
Tighten the head bolts to the additional amount. . . . . 250 degrees

Minimum thickness of cylinder head . . . . . 120 mm ((4.72440 inch))

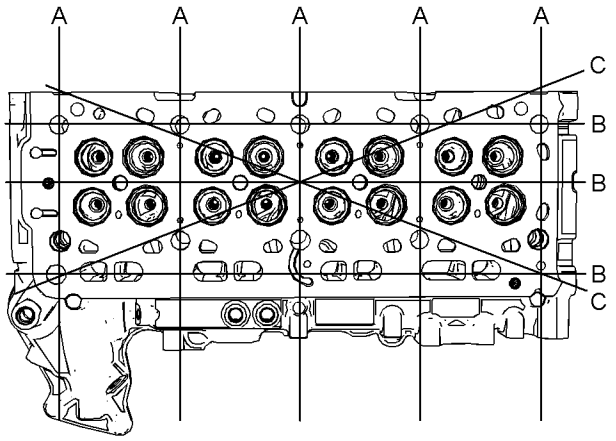

Illustration 16 g06227964

Note: The maximum distortion of the bottom face of the cylinder head is given in table 3 .

Table 3

Dimension	Maximum Permissible Distortion
Width (A)	0.08 mm (0.0032 inch)
Length (B)	0.08 mm (0.0032 inch)
Diagonal Line (C)	0.08 mm (0.0032 inch)

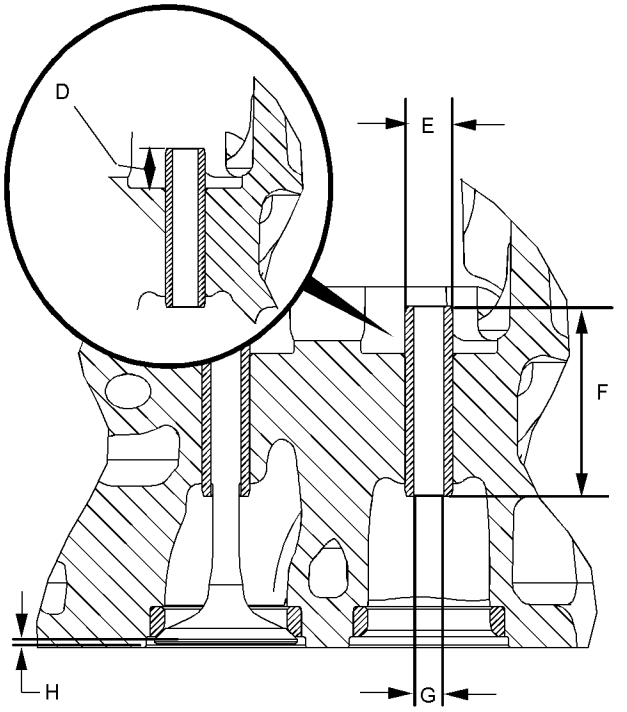

Illustration 17 g02328933

Typical example

(D) Valve guide height from the top of the valve guide to the valve spring seat . . . . . 9.25 to 9.75 mm ((0.36417 to 0.38386 inch))

(E) Outside diameter of the valve guides . . .10.025 to 10.034 mm ((0.39468 to 0.39504 inch))

(F) Length of the valve guides. . . . . 41.7 to 42.3 mm ((1.64173 to 1.66535 inch))

(G) Internal diameter of the valve guides . . . . .5.979 to 5.992 mm ((0.23539 to 0.23591 inch))

(H) Valve depths

Inlet . . . . . 0.47 to 0.73 mm ((0.01850 to 0.02874 inch))
The service limit for the depth of the inlet valve . . . . . 1.41 mm ((0.0555 inch))
Exhaust . . . . . 0.71 to 0.98 mm ((0.02795 to 0.03858 inch))
The service limit for the exhaust valve depth . . . . . 1.38 mm ((0.0543 inch))

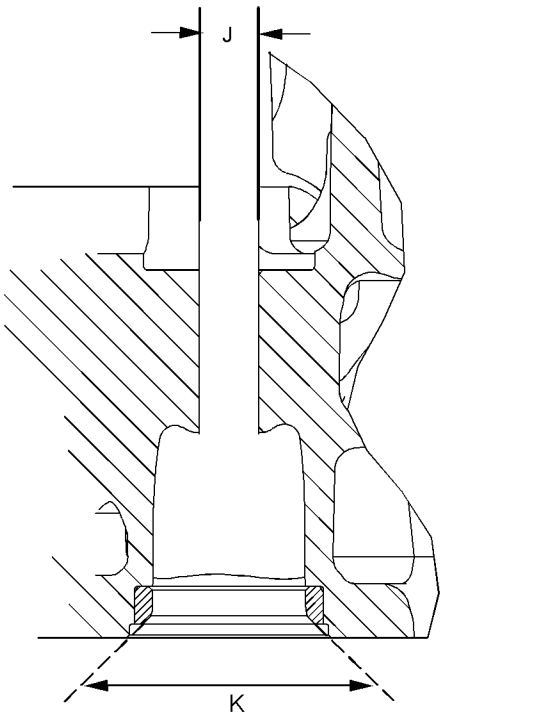

Illustration 18 g02474819

Typical example

(J) Diameter of the parent bore in the cylinder head . . .10.000 to 10.022 mm ((0.39370 to 0.39457 inch))

(K) Seat angle

Inlet . . . . . .119.7 degrees
Exhaust . . . . . 89.5 degrees

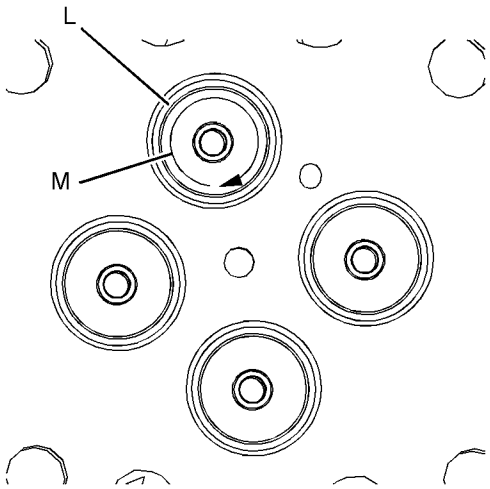

Illustration 19 g02475018

Typical example

(L) Seat surface finish . . . . . Ra 0.8 microns

(M) Concentricity of valve seat to valve guide parent bore Maximum Total Indicated Reading (TIR) . . . . . 0.1 mm ((0.00394 inch))

i06867682

Turbocharger

SMCS Code: 1052

Part No.: 514-7399

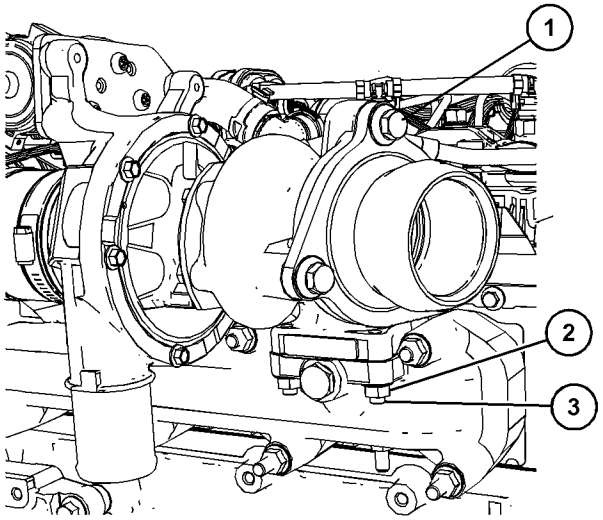

Illustration 20 g06147017

Typical example

(1) Tighten the bolts to the following torque. . 44 N·m ((32 lb ft))

(2) Tighten the nuts to the following torque. . . 28 N·m ((248 lb in))

(3) Tighten the studs to the following torque. . . . . 11 N·m ((97 lb in))

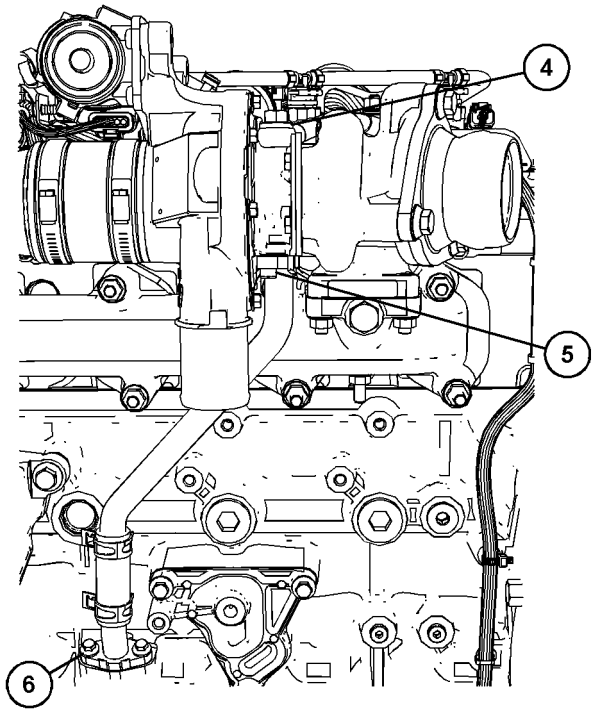

Illustration 21 g06147021
Typical example

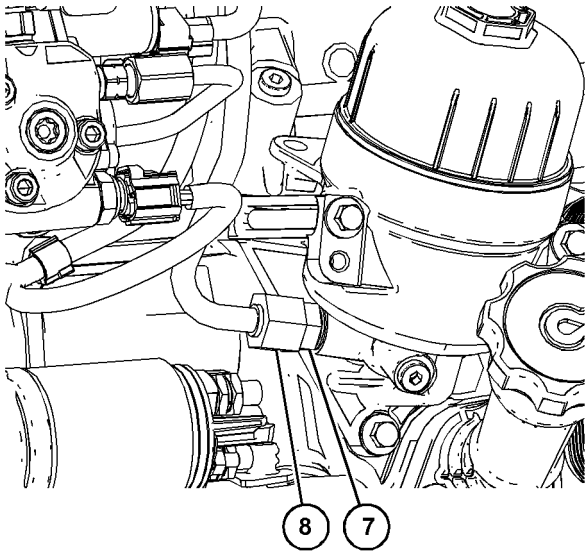

Illustration 22 g06147023
Typical example

(4) Tighten the bolt to the following torque. . . 15 N·m ((133 lb in))

(5) Tighten the bolts to the following torque. . . 9 N·m ((80 lb in))

(6) Tighten the bolts to the following torque. . . 9 N·m ((80 lb in))

(7) Tighten the adaptor to the following torque. . . . . 24 N·m ((212 lb in))

(8) Tighten the nut to the following torque. . . . 45 N·m ((33 lb ft))

i06851715

Injector (Diesel Exhaust Fluid)

SMCS Code: 108l

Part No.: 529-7539

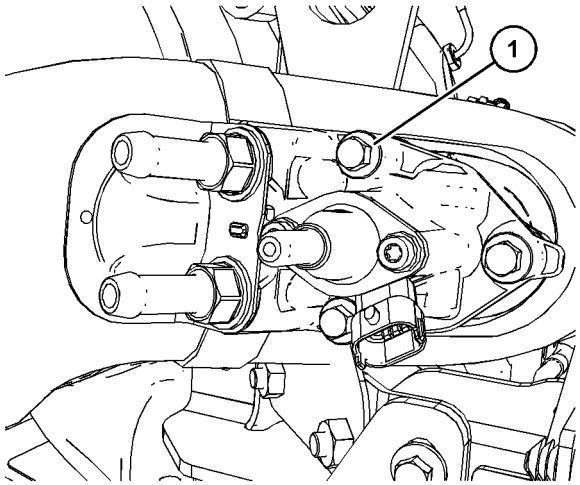

Illustration 23 g06141768

Typical example

(1) Tighten the bolts to an initial torque. . . . . 5 N·m ((44 lb in))

(1) Tighten the bolts to a final torque. . . . . 8 N·m ((71 lb in))

i07576376

Manifold (Diesel Exhaust Fluid)

SMCS Code: 108K-M9; 3206-DE2

Part No.: 535-6924

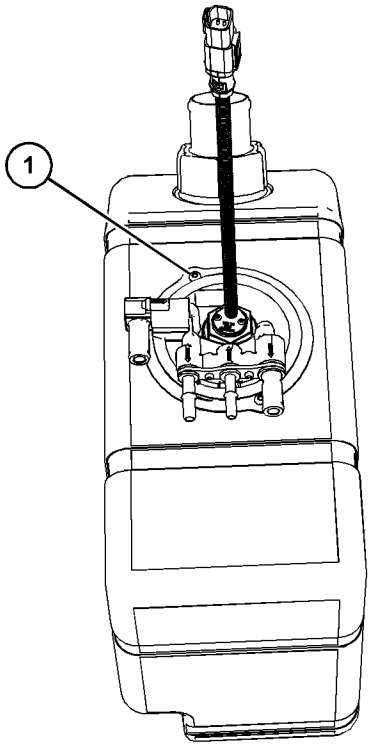

Illustration 24 g06366821

Typical example

(1) Tighten the screws to the following torque. . . . . 3 N·m ((27 lb in))

i05882407

Diesel Exhaust Fluid Tank

SMCS Code: 108K-TNK

Part No.: 466-9613

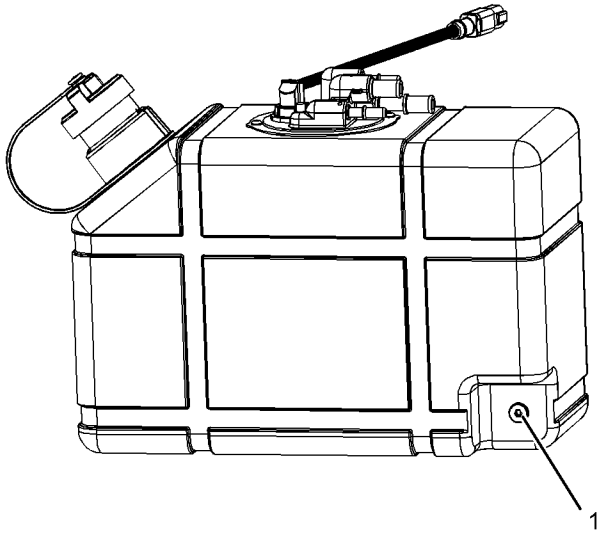

Illustration 25 g03719679

Typical example

(1) Tighten the plug to the following torque. . . 6 N·m ((53 lb in))

Note: The Original Equipment Manufacturer (OEM) may supply the Diesel Exhaust Fluid (DEF) tank. Refer to the OEM for more information if the DEF tank has been supplied by the OEM.

i06852385

Diesel Exhaust Fluid Pump

SMCS Code: 108J

Part No.: 398-4746

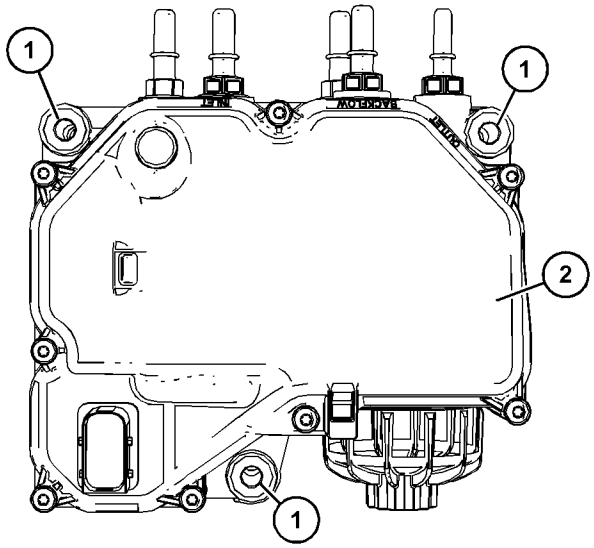

Illustration 26 g06146523

Typical example

(1) M8 mounting holes

Note: The diesel exhaust fluid pump (2) is mounted to the application.

Tighten the M8 bolts of the following torque. . . . . 19 N·m ((168 lb in))

i06851863

Solenoid Valve (DEF Heater Coolant)

SMCS Code: 5479-CLT

Part No.: 536-3567

Note: The coolant diverter valve is mounted to the application. The coolant diverter valve must be mounted with four M6 bolts.

Tighten the recommended M6 fasteners to the following torque. . . . . 10 N·m ((89 lb in))

i06865895

Exhaust Gas Valve (NRS)
(Throttle Valve)

SMCS Code: 3139; 5137; 5479

Part No.: 523-6556

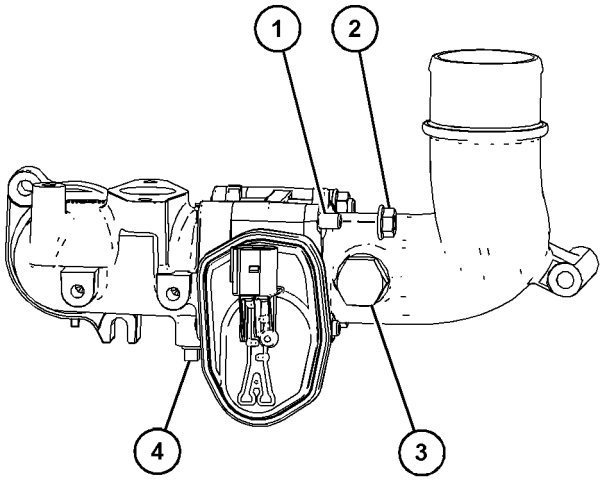

Illustration 27 g06146586
Typical example

(1) Tighten the studs to the following torque. . . 6 N·m ((53 lb in))

(2) Tighten the nuts to the following torque. . . 22 N·m ((195 lb in))

(3) Tighten the plug to the following torque. . . 35 N·m ((310 lb in))

(4) Tighten the plug to the following torque. . . . 6 N·m ((53 lb in))

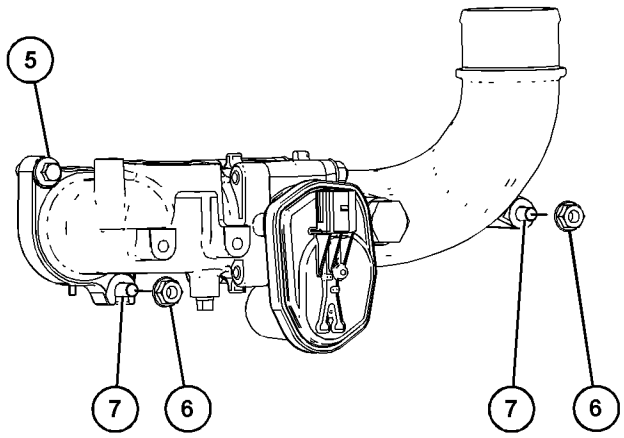

Illustration 28 g06146591
Typical example

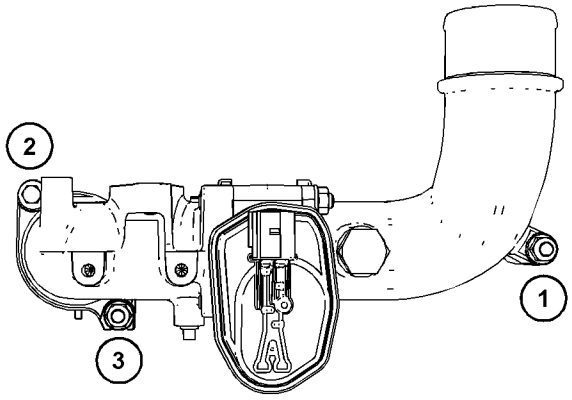

Illustration 29 g06146608
Tightening sequence

Note: Bolt (5), and nuts (6) for the throttle valve should be tightened after the fasteners for the exhaust cooler (NRS). Tighten the fasteners in the sequence that is shown in Illustration 29 .

(5) Tighten the bolt to the following torque. . . 22 N·m ((195 lb in))

(6) Tighten the nuts to the following torque. . . 22 N·m ((195 lb in))

(7) Tighten the studs to the following torque.
. . . . . 11 N·m ((97 lb in))

i06866183

Exhaust Gas Valve (NRS)

SMCS Code: 3139; 5137; 5479

Part No.: 551-5102

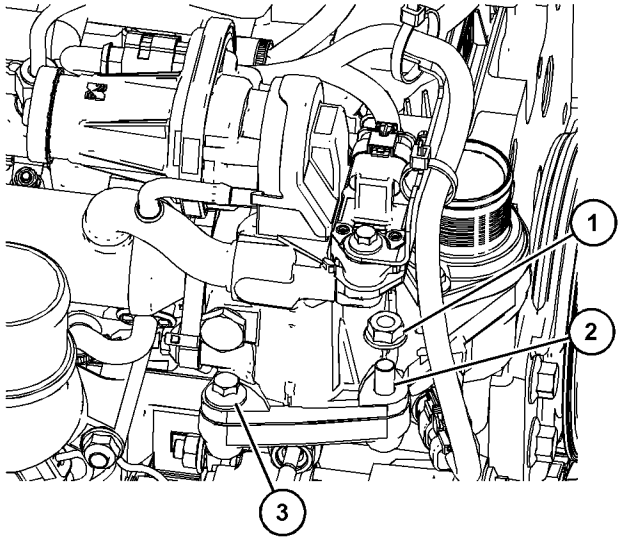

Illustration 30 g06146711
Typical example

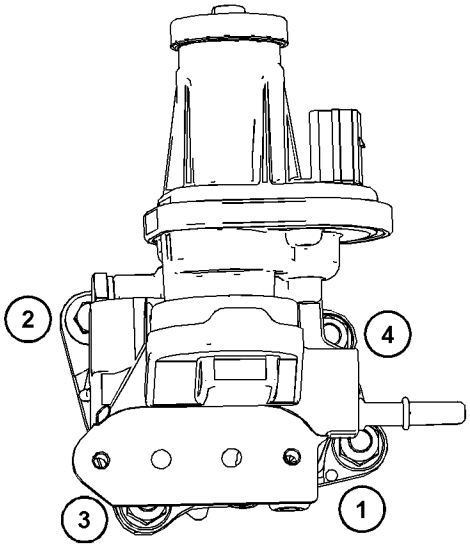

Illustration 31 g06146718
Tightening sequence

(1) Tighten the nuts to the following torque. . . . 22 N·m ((195 lb in))

(2) Tighten the studs to the following torque. . . . . 22 N·m ((195 lb in))

(3) Tighten the bolt to the following torque. . . . 22 N·m ((195 lb in))

Tighten nuts (1) and bolt (3) in the sequence that is shown in Illustration 31 .

i06865800

Exhaust Cooler (NRS)

SMCS Code: 1079; 108C

Part No.: 540-0580

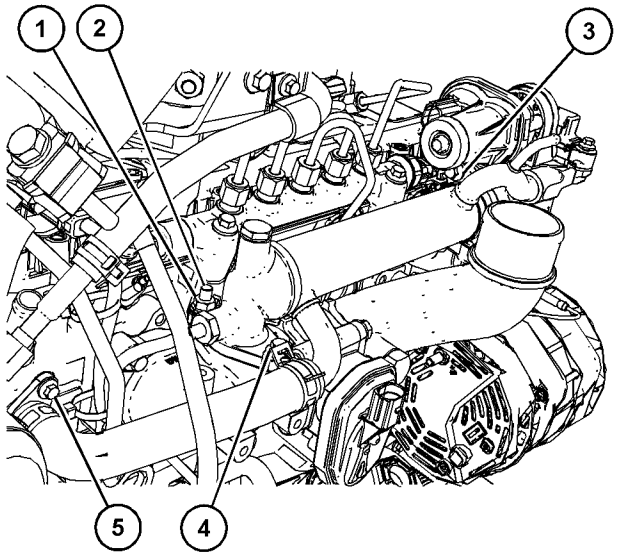

Illustration 32 g06146546

Typical example

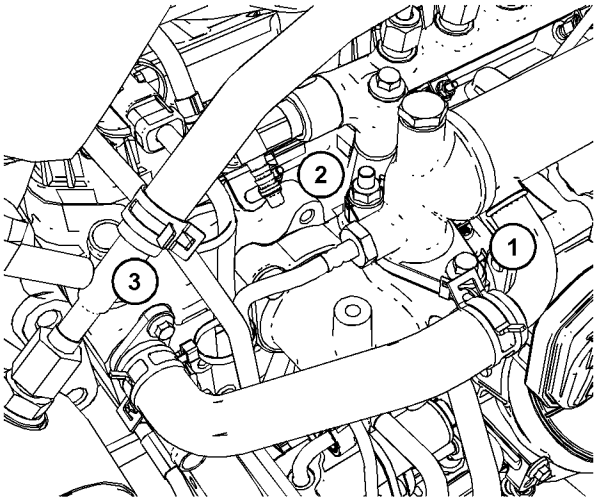

Illustration 33 g06146579

Tightening sequence

Note: Nut (1), bolt (4), and bolt (5) for the exhaust cooler (NRS) should be tightened after the fasteners for the exhaust gas valve (NRS). Tighten the fasteners in the sequence that is shown in Illustration 33 .

(1) Tighten the nut to the following torque. . . . 22 N·m ((195 lb in))

(2) Tighten the stud to the following torque. . . 22 N·m ((195 lb in))

(3) Tighten the bolts to the following torque. . 22 N·m ((195 lb in))

(4) Tighten the bolt to the following torque. . . 22 N·m ((195 lb in))

(5) Tighten the bolt to the following torque. . . . 9 N·m ((80 lb in))

i06867653

Exhaust Manifold

SMCS Code: 1059

Part No.: 512-8095

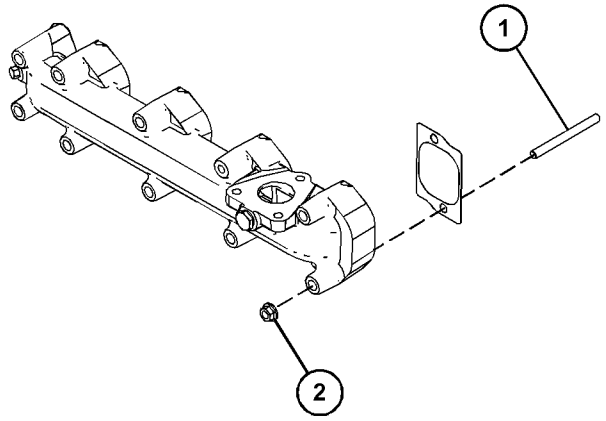

Illustration 34 g06146973

Typical example

(1) Tighten the studs to the following torque. . . . . 11 N·m ((97 lb in))

(2) Tighten the nuts in the sequence that is shown in Illustration 35 to the following torque. . . . . 28 N·m ((248 lb in))

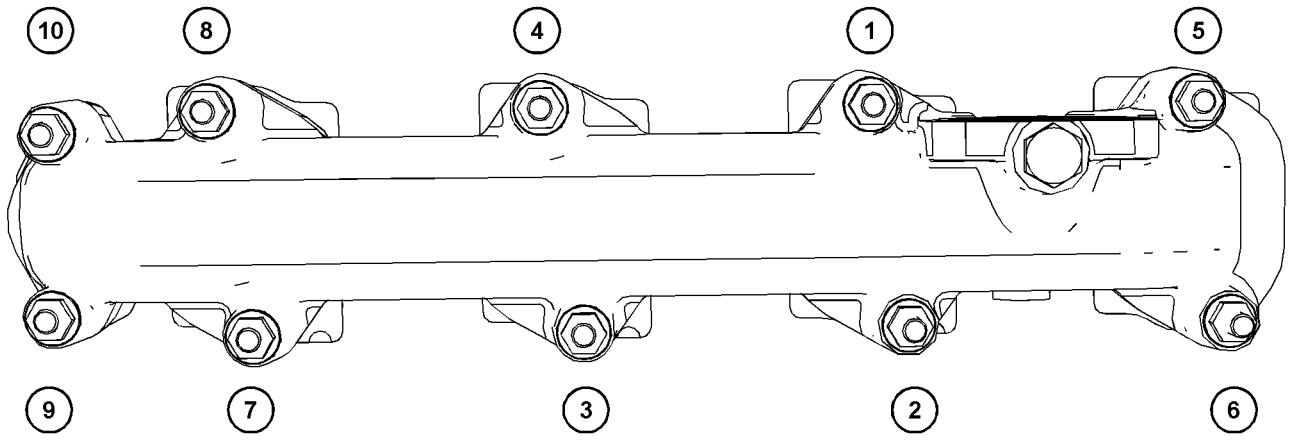

Illustration 35 g06146979

Tightening sequence

i07107375

Camshaft

SMCS Code: 1210

Part No.: 548-8391

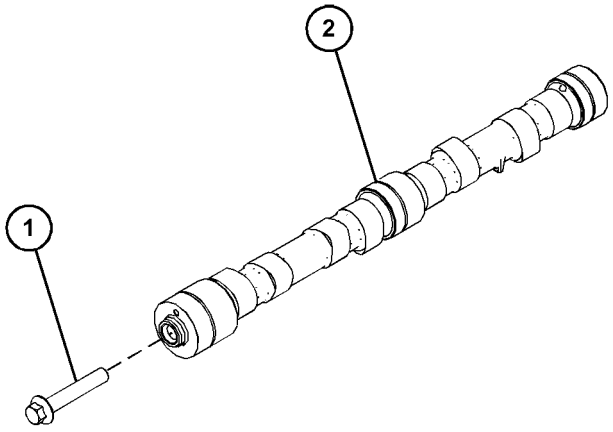

Illustration 36 g06227353

Typical example

End play of a camshaft . . . . . 0.1 to 0.6 mm ((0.004 to 0.024 inch))

Maximum permissible end play of a worn camshaft . . . . . 0.62 mm ((0.0244 inch))

(1) Tighten the bolt to the following torque. . . 95 N·m ((70 lb ft))

(2) The diameters of the camshaft journals are given in table 4 .

Table 4

Camshaft Journals from the Front End of the Engine	Standard Diameter
1 Front	44.957 to 44.983 mm (1.76996 to 1.77098 inch)
2	45.957 to 45.983 mm (1.80933 to 1.81035 inch)
3 Rear	50.711 to 50.737 mm (1.99649 to 1.99752 inch)

Maximum wear on the camshaft journals . . . 0.05 mm ((0.0021 inch))

Check the camshaft lobes for visible damage. If a new camshaft is installed, you must install new lifters.

i06849440

Engine Oil Filter Base

SMCS Code: 1306

Part No.: 559-7823

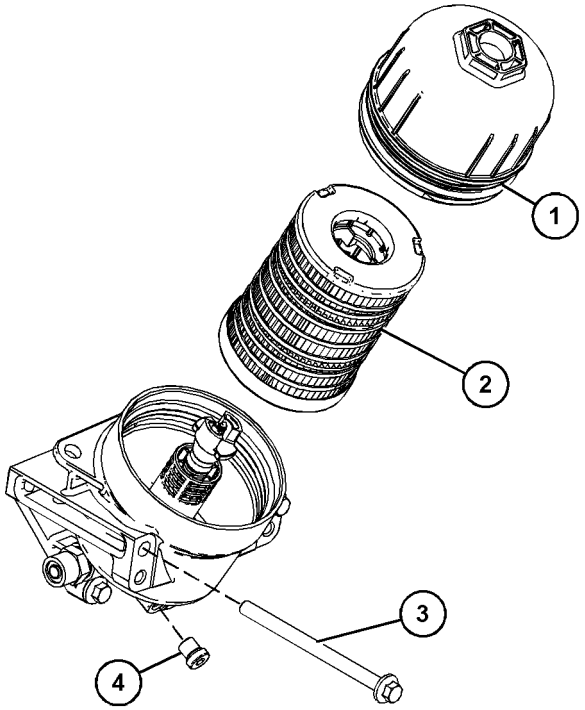

Illustration 37 g06140427

Typical example

(1) Tighten the cap to the following torque. . . 24 N·m ((212 lb in))

(2) Engine oil filter element

(3) Tighten the bolts to the following torque. . 22 N·m ((195 lb in))

(4) Tighten the plug to the following torque. . . 12 N·m ((106 lb in))

i07573811

Engine Oil Relief Valve

SMCS Code: 1315

Part No.: 513-9222

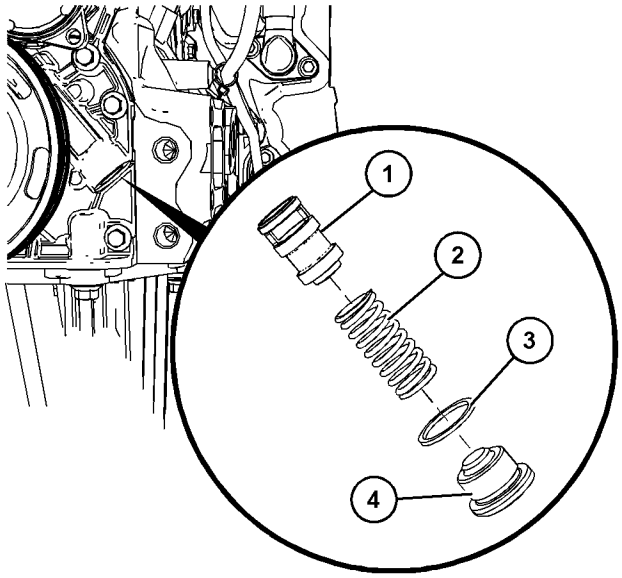

Illustration 38 g06365214

Typical example

(1) Valve
(2) Spring
(3) Washer

(4) Tighten the plug to the following torque. . . . . 100 N·m ((74 lb ft))

i06849417

Engine Oil Cooler

SMCS Code: 1378

Part No.: 514-7381

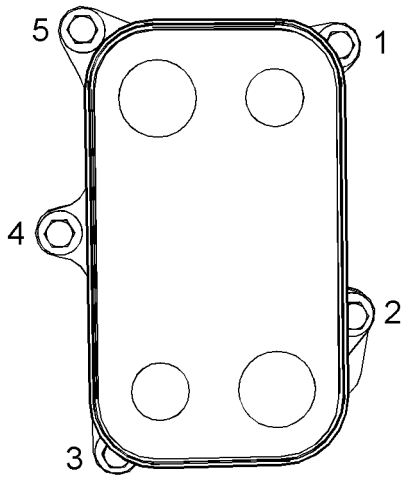

Illustration 39 g06140412

Typical example

Tighten the bolts in the sequence that is in illustration 39 to the following torque. . . . . 9 N·m ((80 lb in))

i07109965

Engine Oil Pressure

SMCS Code: 1924

Part No.: 513-9222

The minimum oil pressure at an operating speed of between 1800 rpm and 2400 rpm and at normal operating temperature is the following value.
. . . . . .375 kPa ((54 psi))

i06891477

Engine Oil Pan
(Composite Engine Oil Pan)

SMCS Code: 1302

Part No.: 509-6445

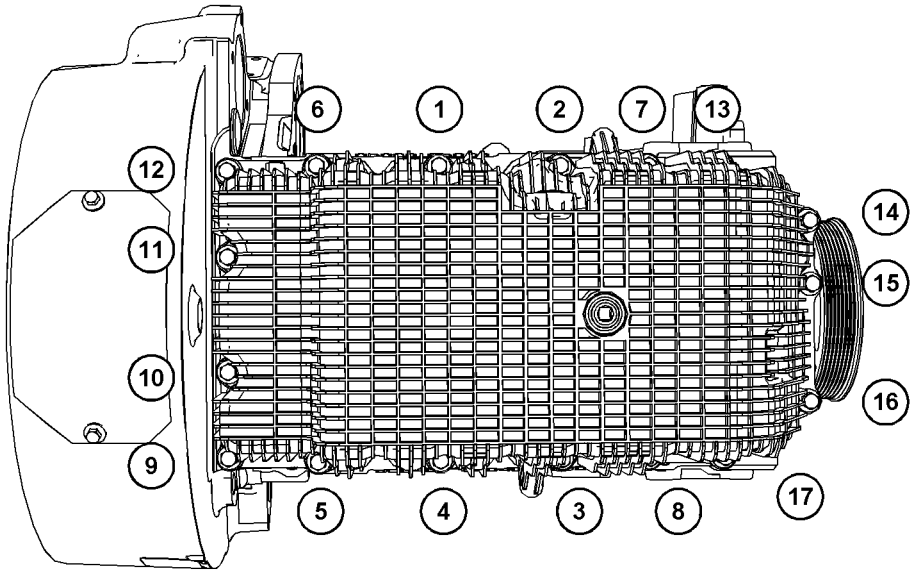

Illustration 40 g06156407

Tightening sequence

Tighten the bolts in sequence that is in illustration 40 to the following torque. . . . . 44 N·m ((32 lb ft))

Tighten the oil drain plug to the following torque. . . . . 24 N·m ((212 lb in))

Tighten the oil drain adaptor and valve to the following torque. . . . . 24 N·m ((212 lb in))

i06851224

Crankcase Breather

SMCS Code: 1317

Part No.: 539-5492

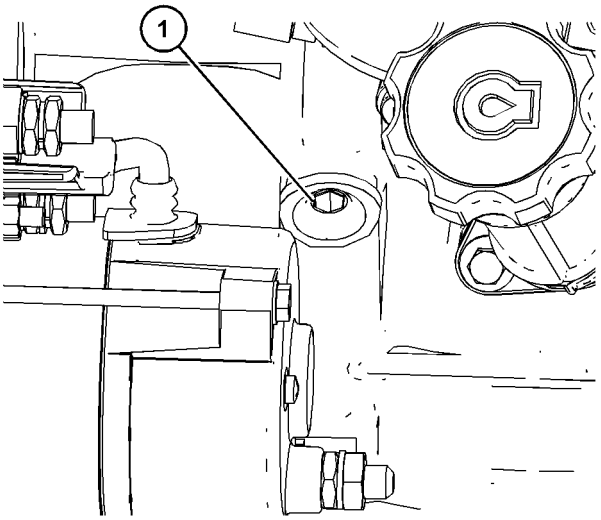

Illustration 41 g06141395

Typical example

(1) Tighten the drain valve to the following torque. . . . . 5 N·m ((44 lb in))

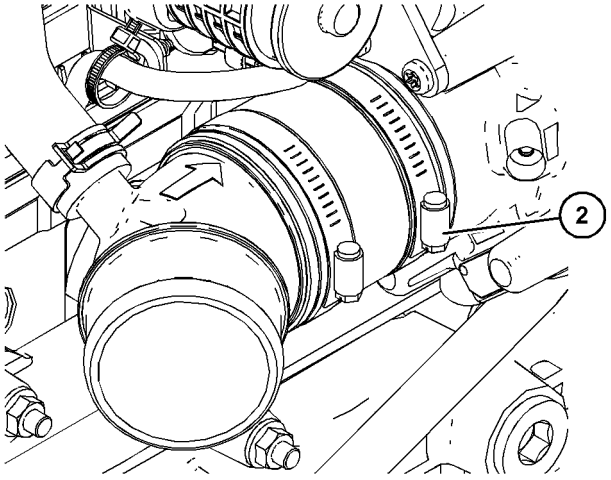

Illustration 42 g06141416

Typical example

(2) Tighten the clips to the following torque. . . . . 5.5 N·m ((48.7 lb in))

i06885831

Water Temperature Regulator and Housing

SMCS Code: 1355; 1393

Part No.: 487-4342

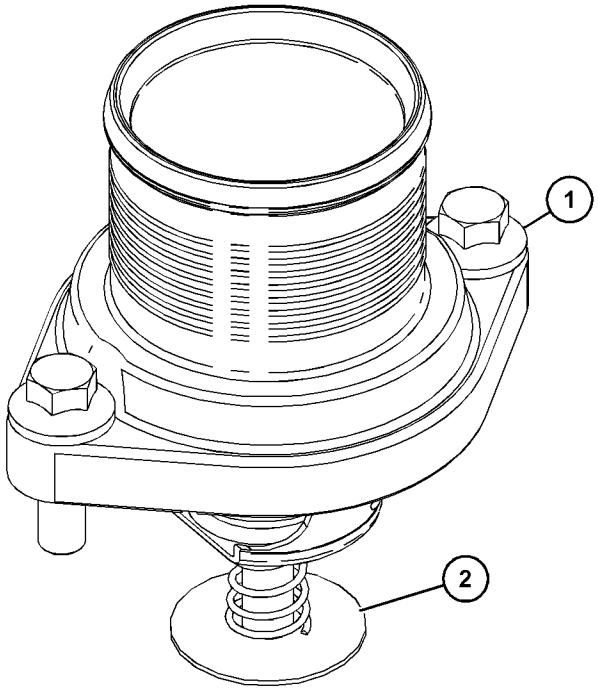

Illustration 43 g06227342

Typical example

(1) Torque for the bolts that fasten the housing to the cylinder head . . . . . 9 N·m ((80 lb in))

(2) Water temperature regulator

Opening temperature . . . . . 82° to 86°C ((148° to 155°F))

Minimum open length of 7 mm (0.276 inch) is achieved at the following temperature. . . . . 95° C ((203° F))

i07111295

Water Pump

SMCS Code: 1361

Part No.: 533-5882

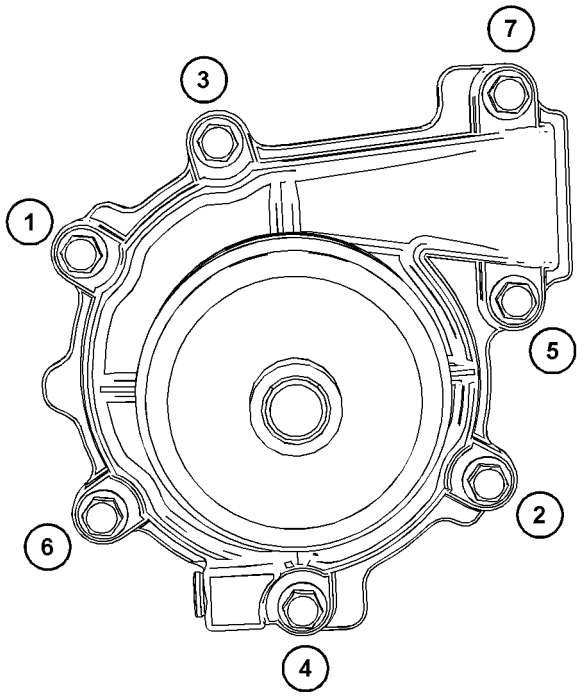

Illustration 44 g06228581

Tightening sequence

Tighten the bolts in the numerical sequence that is shown in illustration 44 to the following torque.

. . . . . 10 N·m ((89 lb in))

i07108603

Cylinder Block

SMCS Code: 1201

Part No.: 574-7806

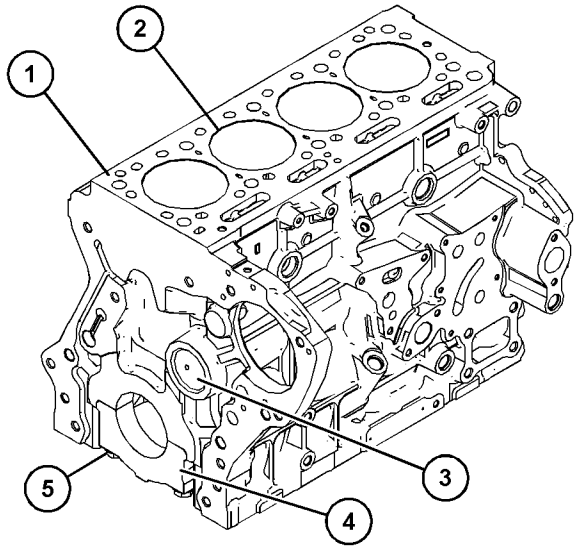

Illustration 45 g06227425

Typical example

(1) Cylinder block

(2) Cylinder bore . . . . . 98.000 to 98.025 mm ((3.85826 to 3.85924 inch))

(3) Camshaft bores

Diameter of the bore in the cylinder block for the number 1 camshaft journal . . . . . 50.787 to 50.831 mm ((1.99948 to 2.00122 inch))

Diameter of the bore in the cylinder block for the number 2 camshaft journal . . . . . 46.033 to 46.077 mm ((1.81232 to 1.81405 inch))

Diameter of the bore in the cylinder block for the number 3 camshaft journal . . . . . 45.033 to 45.077 mm ((1.77295 to 1.77468 inch))

(4) Main bearings

Bore in the cylinder block for the main bearings . . . . . 82.277 to 82.303 mm ((3.23925 to 3.24027 inch))

(5) Main bearing cap bolts

Use the following procedure to install the main bearing cap bolts:

1. Put the main bearing caps in the correct position that is indicated by a number on the top of the main bearing cap. Install the main bearing caps with the locating tabs in correct alignment with the recess in the cylinder block.
2. Evenly tighten the main bearing cap bolts.

Torque for the main bearing cap bolts. . . . . 80 N·m ((59 lb ft))

Tighten the main bearing cap bolts to an extra amount. . . . . 90 degrees

Note: Ensure that the crankshaft can rotate freely.

i07107323

Crankshaft

SMCS Code: 1202

Part No.: 514-3901

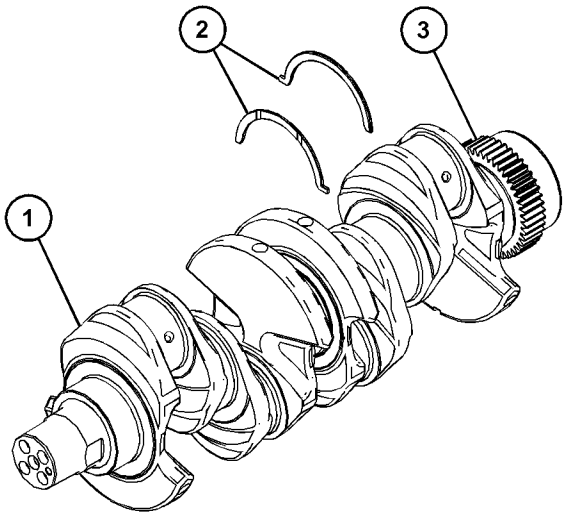

Illustration 46 g06227007

Typical example

(1) Crankshaft
(2) Crankshaft thrust washers
(3) Crankshaft gear

The end play of a new crankshaft . . . . 0.1 to 0.41 mm ((0.00394 to 0.01614 inch))

Thickness of thrust washer . . . . . 2.58 to 2.64 mm ((0.10157 to 0.10394 inch))

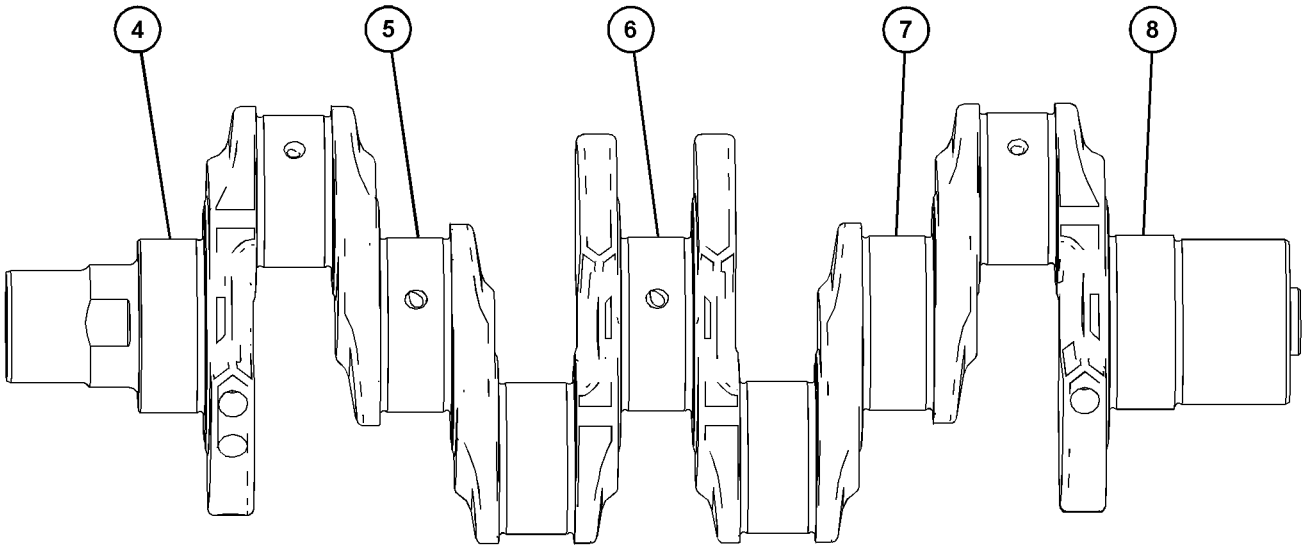

Illustration 47 g06227012

Typical example

(4) Journal 1
(5) Journal 2
(6) Journal 3
(7) Journal 4
(8) Journal 5

Refer to table 5 for the run out of the crankshaft journals.

Table 5

Journal	Run out of the Journals
(1)	Mounting
(2)	0.08 mm (0.0031 inch)
(3)	0.08 mm (0.0031 inch)
(4)	0.08 mm (0.0031 inch)
(5)	Mounting

Refer to Specifications, “Connecting Rod Bearing Journal” for more information on the connecting rod bearing journals and connecting rod bearings.

Refer to Specifications, “Main Bearing Journal” for information on the main bearing journals and for information on the main bearings.

i07109809

Connecting Rod Bearing Journal

SMCS Code: 1202; 1219; 1225

Part No.: 574-2670

The original size of the connecting rod bearing journal on the crankshaft . . . . . 68.00 to 68.02 mm ((2.67716 to 2.67795 inch))

Maximum permissible wear of a bearing journal on the crankshaft when a new connecting rod is installed . . . . . 0.04 mm ((0.0016 inch))

Width of the connecting rod bearing journals on the crankshaft . . . . . 33.9 to 34.1 mm ((1.33464 to 1.34252 inch))

Surface finish of connecting rod bearing journals . . . . . Ra 0.25 microns

i07109863

Main Bearing Journal

SMCS Code: 1202; 1203

Part No.: 577-5945

The original size of the main bearing journal . . . . . 78.00 to 78.02 mm ((3.07086 to 3.07165 inch))

Maximum permissible wear of the main bearing journals . . . . . 0.040 mm ((0.0016 inch))

Surface finish of bearing journals and crank pins . . . . . Ra 0.25 microns

Width of new main bearing journal where the thrust washer is installed . . . . . 32.465 to 32.535 mm ((1.27815 to 1.28090 inch))

Width of new main bearing journal where the thrust washer is not installed . . . . . 31.9 to 32.1 mm ((1.25590 to 1.26378 inch))

The shell for the main bearings

Width of the main bearing shells . . . . . 26.15 to 26.40 mm ((1.02953 to 1.03937 inch))

Clearance between the bearing shell and the main bearing journals . . . . . 0.036 to 0.094 mm ((0.00142 to 0.00370 inch))

Thickness at center of the shells of oversize bearing shell 0.25 mm (0.010 inch) . . . . . 2.226 to 2.232 mm ((0.08764 to 0.08787 inch))

Thickness at center of the shells of oversize bearing shell 0.50 mm (0.020 inch) . . . . . 2.353 to 2.359 mm ((0.09264 to 0.09287 inch))

i07109775

Connecting Rod

SMCS Code: 1218

Part No.: 517-1970

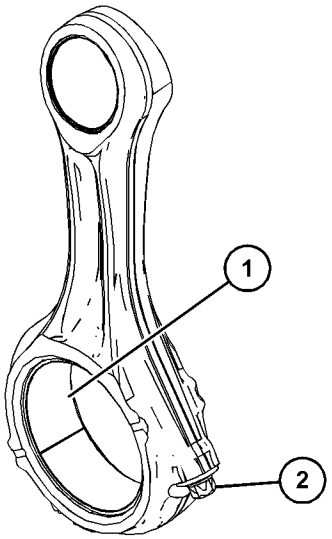

Illustration 48 g06228016

Typical example

(1) The bearing shell for the connecting rod

Table 6

Thickness of Connecting Rod Bearing at the Center	2.10 to 2.11 mm (0.08268 to 0.08307 inch)
Bearing Clearance	0.031 to 0.078 mm (0.00122 to 0.00307 inch)

For the correct procedure to install the bearing shell for the connecting rod, refer to Disassembly and Assembly, “Pistons and Connecting Rods - Assemble”.

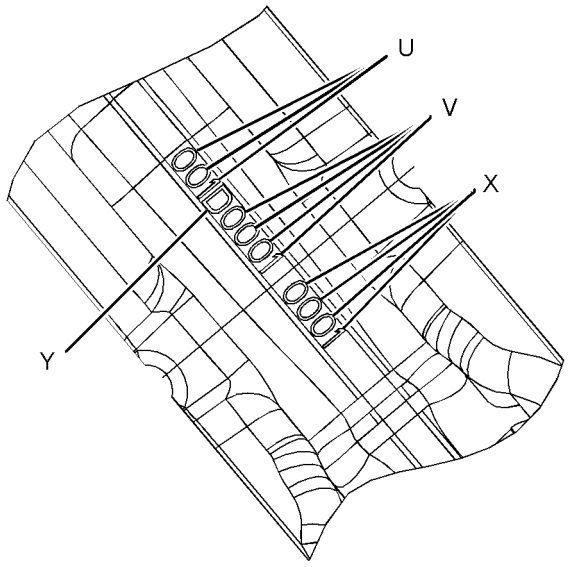

Illustration 49 g06228022

Typical example

(U) Day code
(V) Code for the connecting rod
(X) Code for the Connecting rod cap
(Y) Year code

Note: The day code is from the first day in the year. For example, “001” will be the first day of the appropriate year.

The mating surfaces of the connecting rod are produced by hydraulically fracturing the forged connecting rod. Ensure that the correct cap for the connecting rod is installed with the correct connecting rod. Ensure that the serial numbers for both components match.

(2) Torque of the setscrews for the connecting rod . . . . . .40 N·m ((30 lb ft))

Tighten the setscrews for the connecting rod for an extra 120 degrees. The setscrews for the connecting rod (2) must be replaced after this procedure.

Note: Always tighten the connecting rod cap to the connecting rod, when the assembly is out of the engine. Tighten the assembly to the following torque 20 N·m (14 lb ft).

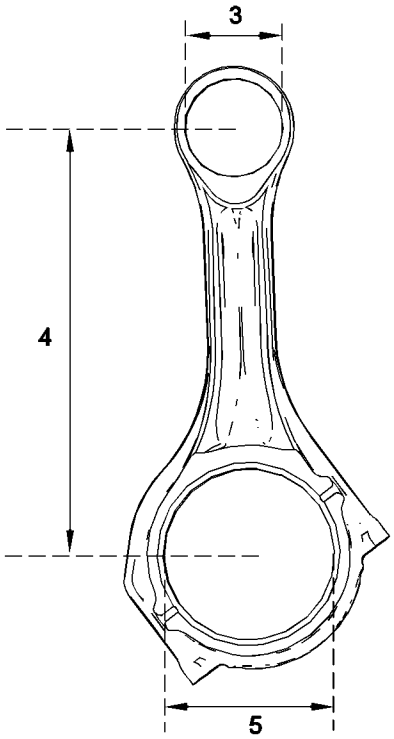

Illustration 50 g06228030

Typical example

(3) Diameter of the finished bore for the piston pin . . .38.024 to 38.038 mm ((1.49700 to 1.49756 inch))

(4) Distance between the parent bores . . . . . .179.975 to 180.025 mm ((7.08562 to 7.08758 inch))

(5) Diameter for the finished bore for the connecting rod bearing . . . . . .72.273 to 72.285 mm ((2.84539 to 2.84586 inch))

Length of connecting rod . . . . . .124.8335 to 124.8665 mm ((4.91469 to 4.91599 inch))

i07107428

Piston and Rings

SMCS Code: 1214; 1215

Part No.: 565-1428

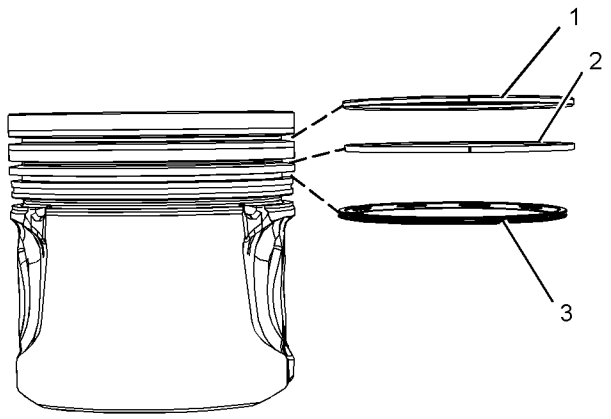

Illustration 51 g03120776
Typical example

(1) Top compression ring

The shape of the top compression ring . . . . . Half keystone

Ring gap. . . . . 0.25 to 0.40 mm ((0.00984 to 0.01575 inch))

Note: When you install a new top compression ring, make sure that the word “TOP” is facing the top of the piston. New top piston rings have a blue identification mark. The identification mark must be on the left of the ring end gap when the top piston ring is installed on an upright piston.

(2) Intermediate compression ring

The shape of the intermediate compression ring . . . . Rectangular internal bevel in the bottom edge with a tapered face

Width of intermediate compression ring . . . . 1.97 to 1.99 mm ((0.07756 to 0.07835 inch))

The clearance between a new intermediate compression ring and the piston groove in a new piston . . . . . 0.07 to 0.11 mm ((0.00276 to 0.00433 inch))

Ring gap. . . . . 0.80 to 1.00 mm ((0.03150 to 0.03937 inch))

Note: When you install a new intermediate compression ring, make sure that the word “TOP” is facing the top of the piston. New intermediate rings have a blue identification mark. The identification mark must be on the left of the ring end gap when the top piston ring is installed on an upright piston.

(3) The oil control ring

Width of oil control ring . . . . . 2.47 to 2.49 mm ((0.09724 to 0.09803 inch))

The clearance between a new oil control ring and the groove in a new piston . . . . . 0.05 to 0.09 mm ((0.00197 to 0.00354 inch))

Ring gap. . . . . 0.25 to 0.45 mm ((0.00984 to 0.01772 inch))

Note: The oil control ring is a two-piece ring that is spring loaded. A pin is used to hold both ends of the spring of the oil control ring in position. The ends of the spring of the oil control ring must be installed opposite the end gap of the oil control ring.

Note: Ensure that the ring end gaps of the piston rings are spaced 120 degrees from each other.

Piston

Note: An arrow which is marked on the piston crown must be toward the front of the engine.

Piston height above cylinder block . . 0.06 to 0.41 mm ((0.00236 to 0.01614 inch))

Width of top groove in the piston. . . . . Tapered

Width of second groove in new piston . . . . . 2.06 to 2.08 mm ((0.08110 to 0.08189 inch))

Width of third groove in new piston . . . . . 2.54 to 2.56 mm ((0.10000 to 0.10079 inch))

Piston pin

Diameter of a new piston pin . . . . . 37.994 to 38.000 mm ((1.49582 to 1.49606 inch))

i06915742

Piston Cooling Jet

SMCS Code: 1331

Part No.: 486-8897

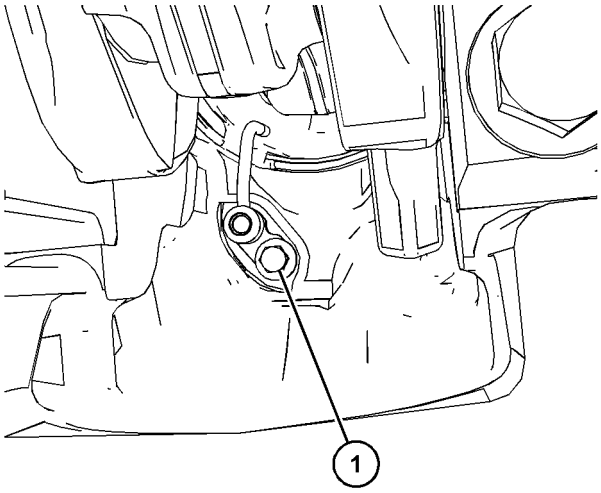

Illustration 52 g06166101

Typical example

Note: The valve must move freely.

(1) Tighten the bolt to the following torque. . . . 9 N·m ((7 lb ft))

Piston Cooling Jet Alignment

Use the following procedure to check the alignment of the piston cooling jet.

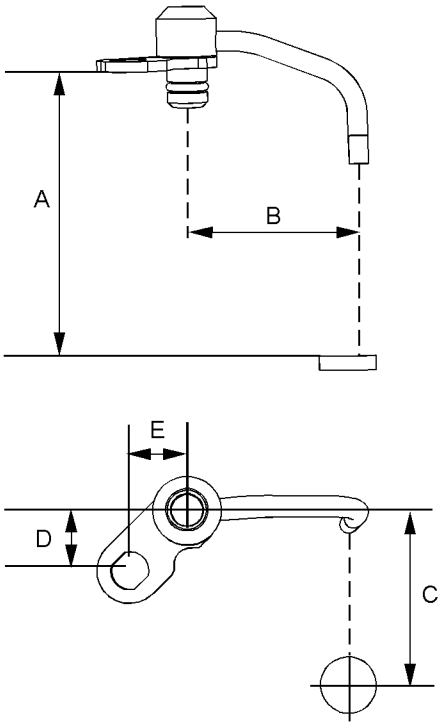

Illustration 53 g06365779

Typical example

1. Insert a suitable rod with a diameter that fits snugly in each piston jet orifice. The inside diameter of piston jet orifice is 1.5 mm (0.059 inch). The rod simulates the stream of oil under normal operating pressure.

Note: Ensure that the rod cannot damage the piston cooling jet when the alignment is checked. The piston cooling jets cannot be adjusted. If a piston cooling jet is not in alignment, the piston cooling jet should be replaced.

2. Use the following dimensions to check the alignment of the piston cooling jet.

Dimension (A). . . . . 165 mm ((6.496 inch))

Dimension (B). . . . . 34 mm ((1.339 inch))

Dimension (C) . . . . . 26.93 mm ((1.060 inch))

Dimension (D) . . . . . 9.64 mm ((0.380 inch))

Dimension (E). . . . . .11.49 mm ((0.452 inch))

i06915757

Accessory Drive

SMCS Code: 1207

Part No.: 499-2389

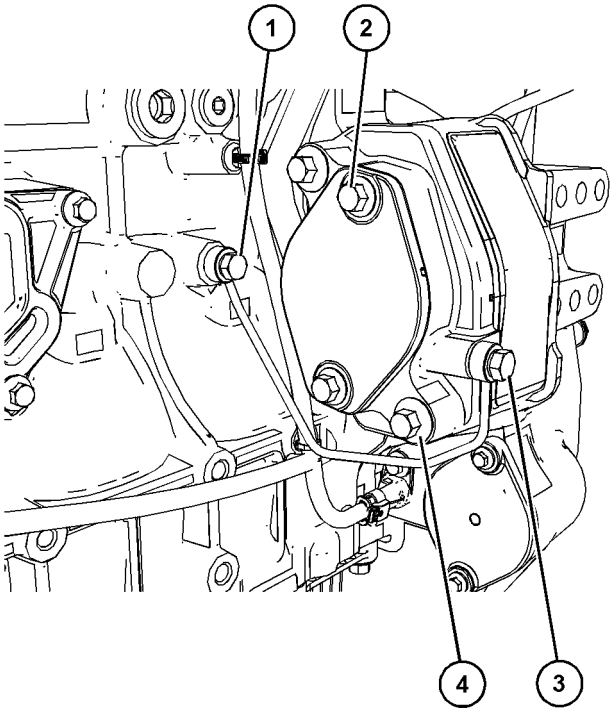

Illustration 54 g06166116

Typical example

(1) (3) Tighten the banjo bolts to the following torque. . . . . 17 N·m ((150 lb in))

(2) Tighten the bolts to the following torque. . 44 N·m ((32 lb ft))

(4) Tighten the bolts to the following torque. . 78 N·m ((58 lb ft))

i06885841

Housing (Front)

SMCS Code: 1151

Part No.: 542-1070

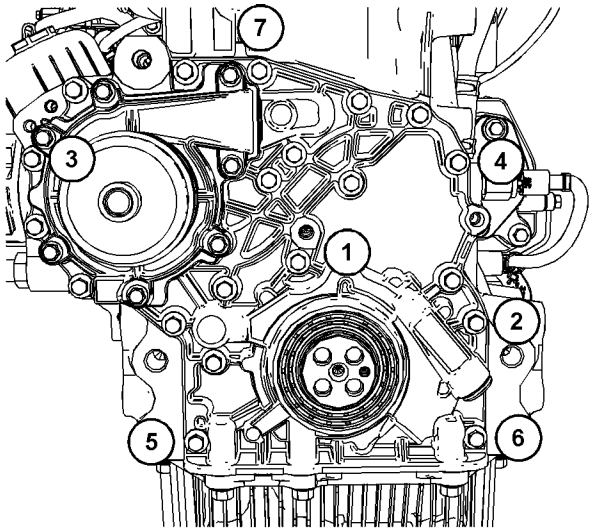

Illustration 55 g06154172

Typical example

Tighten the bolts in the sequence that is in illustration 55 to the following torque. . . . . 9 N·m ((80 lb in))

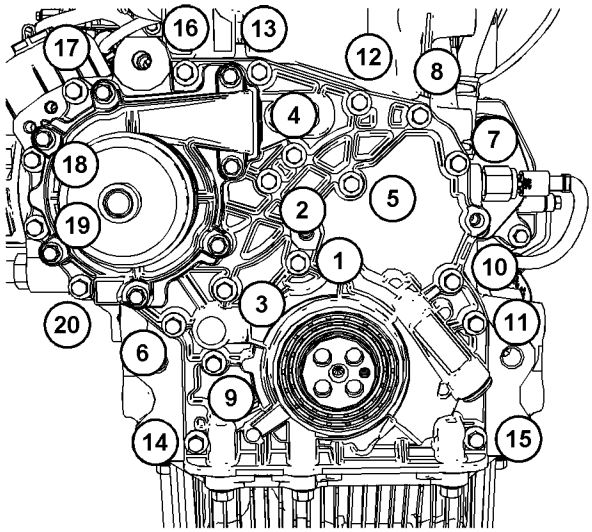

Illustration 56 g06154215

Typical example

Tighten the bolts in the sequence that is in illustration 56 to the following torque. . . . . 22 N·m ((195 lb in))

i06867647

Gear Group (Rear)

SMCS Code: 1204; 1206

Part No.: 496-0025

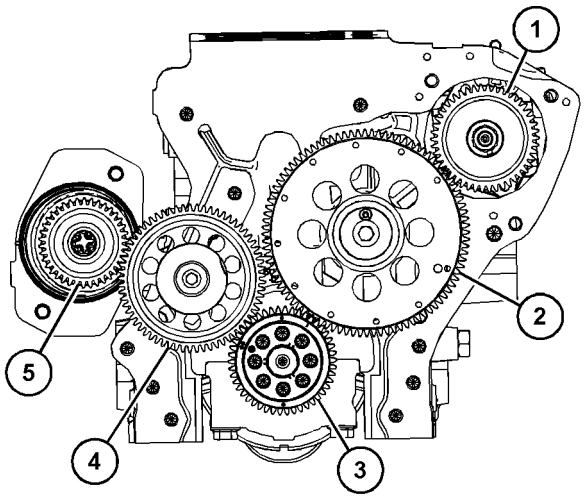

Illustration 57 g06148329

Typical example of the rear gear train

(5) Accessory drive gear (if equipped)

(1) Fuel injection pump drive gear

Torque for the nut . . . . . 64 N·m ((47 lb ft))
Number of teeth. 46

(2) Camshaft gear

Torque for securing bolt for the camshaft gear . . . . . 95 N·m ((70 lb ft))
Number of teeth. 92

(3) Crankshaft gear

Bore diameter of crankshaft gear . . 74.00 to 74.03 mm ((2.91338 to 2.91456 inch))
Installation limits of the crankshaft gear on crankshaft . . . . . -0.047 to -0.096 mm ((-0.00185 to -0.00378 inch))
Number of teeth. 46

(4) Idler gear

Torque for the bolt for the idler gear . . . . . 30 N·m ((266 lb in))
Number of teeth. 65
Width of idler gear bush . . . . . 15.18 mm ((0.59764 inch))
Inside diameter of idler gear bush . . . . . 38.000 to 38.030 mm ((1.49606 to 1.49724 inch))
Outside diameter of idler gear bush . . . . . 42.09 to 42.14 mm ((1.657 to 1.659 inch))

Backlash values

Backlash between the crankshaft gear and the camshaft gear . . . . . 0.020 to 0.188 mm ((0.0008 to 0.0074 inch))
Backlash between the camshaft gear and the fuel injection pump gear . . . . . 0.020 to 0.181 mm ((0.0008 to 0.0071 inch))
Backlash between the crankshaft gear and the idler gear . . . . . 0.020 to 0.217 mm ((0.0008 to 0.0085 inch))
Backlash between the idler gear and the accessory drive gear (SAE “A”) . . . . 0.021 to 0.221 mm ((0.0008 to 0.0087 inch))
Backlash between the idler gear and the accessory drive gear (SAE “B”) . . . . 0.021 to 0.217 mm ((0.0008 to 0.0085 inch))

i06849523

Flywheel

SMCS Code: 1156

Part No.: 502-6310

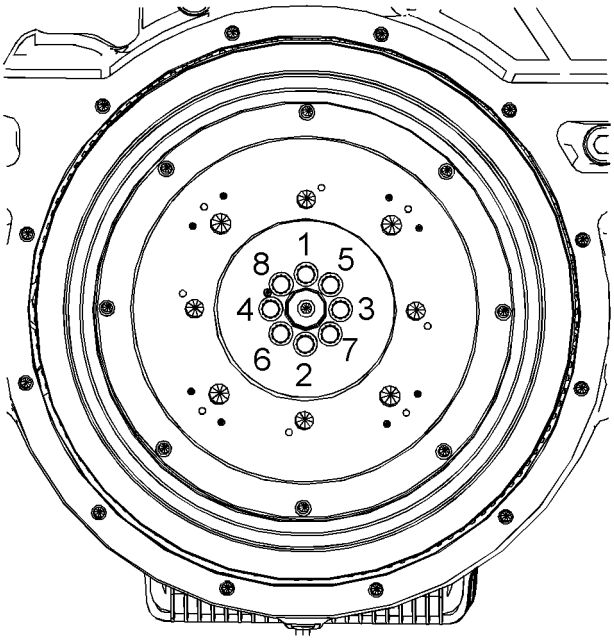

Illustration 58 g06140465

Typical example

Heat the flywheel ring gear to the following temperature. . . . . 250 °C ((480 °F))

Note: Do not use an oxyacetylene torch to heat the flywheel ring gear.

Tighten the bolts in the sequence that is shown in illustration 58 to the following torque. . . . . 97 N·m ((72 lb ft))

i06867937

Flywheel Housing

SMCS Code: 1157

Part No.: 490-1304

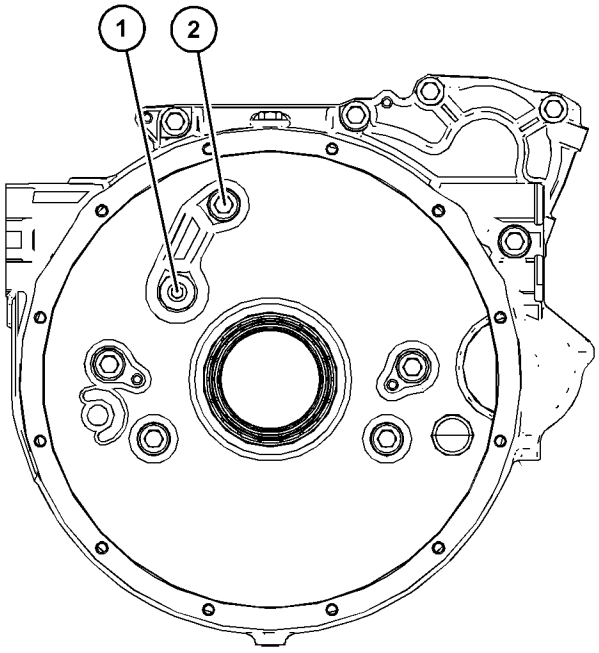

Illustration 59 g06403088

Typical example

(1) M8 x 1.25 bolt
(2) M12 x 1.75 bolts

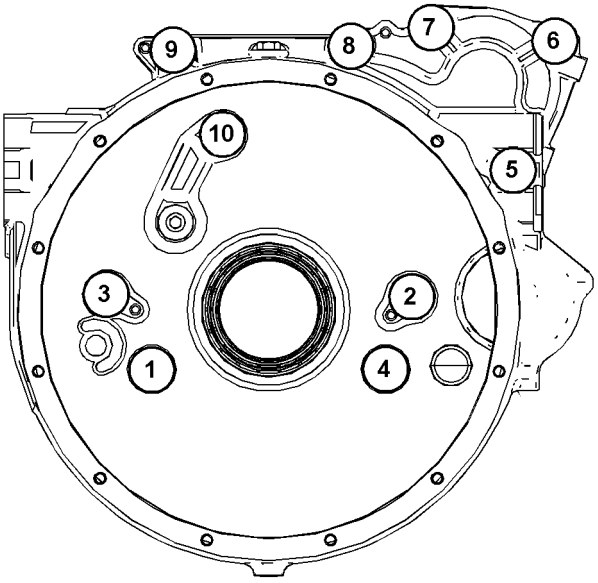

Illustration 60 g06403083

Tightening sequence

Tighten the M12 bolts in the sequence that is shown in illustration 60 to an initial torque.. . . . . 60 N·m ((44 lb ft))

Tighten the M12 bolts in the sequence that is shown in illustration 60 to a final torque.. . . . . 125 N·m ((92 lb ft))

Tighten the M8 bolt to the following torque. . . 60 N·m ((44 lb ft))

i06849425

Crankshaft Pulley

SMCS Code: 1205

Part No.: 506-5468

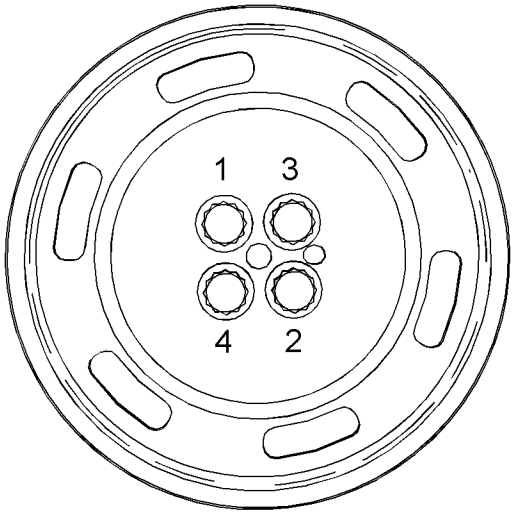

Illustration 61 g06140415

Typical example

Tighten the bolts in the sequence that is shown in illustration 61 to the following torque. . . . . 18 N·m ((159 lb in))

Tighten the bolts in the sequence that is shown in illustration 61 to the additional amount. . . 45 degrees

i06849574

Belt Tensioner

SMCS Code: 1358

Part No.: 536-3596

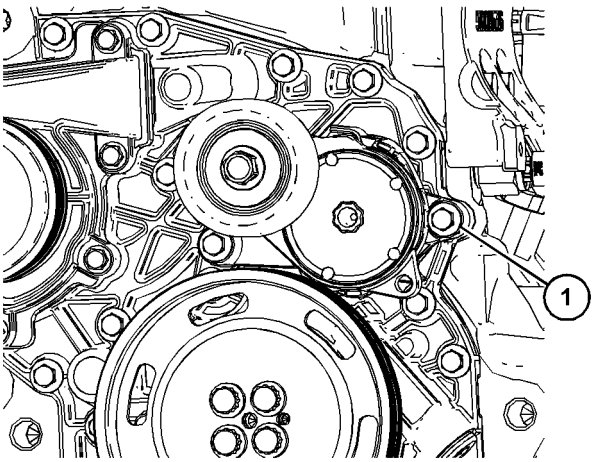

Illustration 62 g06140512

Typical example

(1) Tighten the bolts to the following torque. . 22 N·m ((195 lb in))

Note: To install the belt tensioner, refer to Disassembly and Assembly, “Belt Tensioner - Remove and Install” for the correct procedure.

i07575208

Refrigerant Compressor

SMCS Code: 1802

Part No.: 510-3721

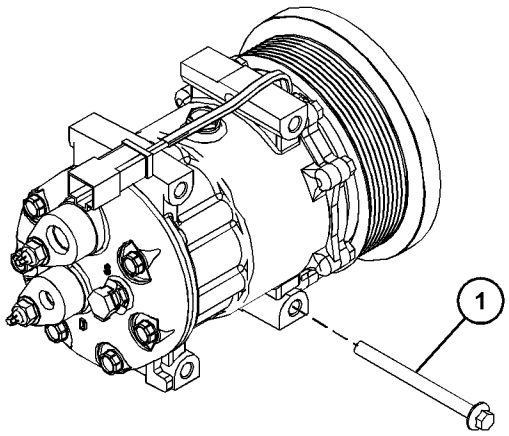

Illustration 63 g06366410

Typical example

(1) Tighten the bolts to the following torque. . 22 N·m ((195 lb in))

i06851002

Fan Drive

SMCS Code: 1359

Part No.: 527-7238

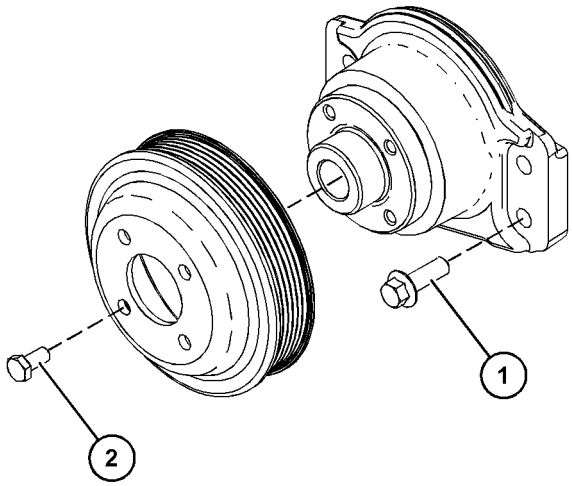

Illustration 64 g06141215

Typical example

(1) Tighten the bolts to the following torque. . 44 N·m ((32 lb ft))

(2) Tighten the bolts to the following torque. . 22 N·m ((195 lb in))

i06950247

Engine Lifting Bracket

SMCS Code: 1122

Part No.: 560-2128

All engines are equipped engine lifting brackets. Some lifting brackets require two bolts and some lifting brackets may require four bolts.

Tighten the bolts on the front engine lifting brackets to the following torque.. . . . . 44 N·m ((32 lb ft))

Tighten the bolts on the rear engine lifting brackets to the following torque.. . . . . 78 N·m ((58 lb ft))

i06849395

Alternator

SMCS Code: 1405

Part No.: 515-4385

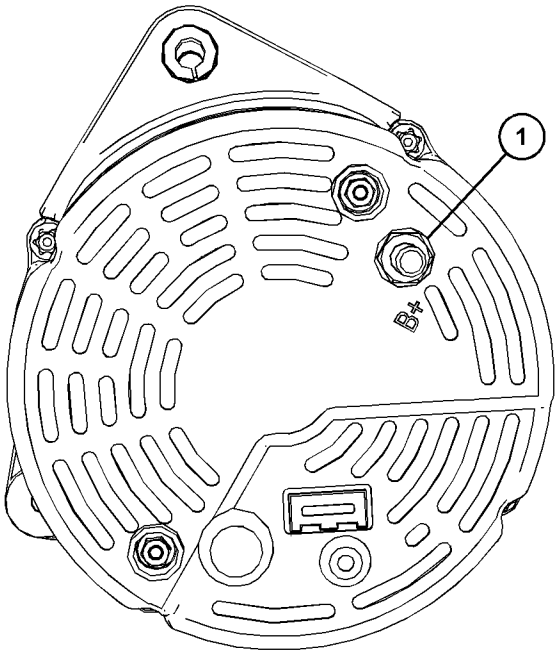

Illustration 65 g06140401

Typical example

(1) Terminal “B+”

Tighten the nut on the terminal to the following torque. . . . . 11 N·m ((97 lb in))

Tighten the nut for the alternator pulley to the following torque. . . . . 95 N·m ((70 lb ft))

Output

The output of the alternator . . . 100, 140 and 150 Amp

i07113200

Alternator

SMCS Code: 1405

Part No.: 515-4385

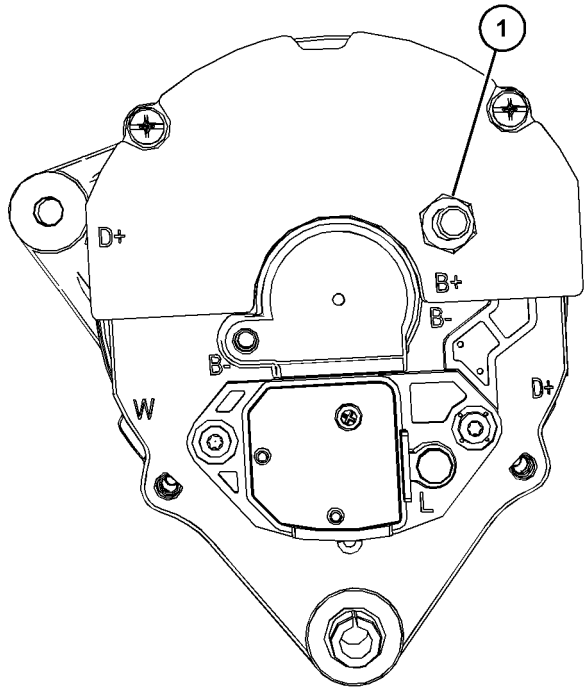

Illustration 66 g06229048

Typical example

(1) Terminal “B+”

Tighten the nut on the terminal to the following torque. . . . . 11 N·m ((97 lb in))

Tighten the nut for the alternator pulley to the following torque. . . . . 95 N·m ((70 lb ft))

Output

The output of the alternator . . . . . 100 Amp

i07113462

Alternator

SMCS Code: 1405

Part No.: 383-2557

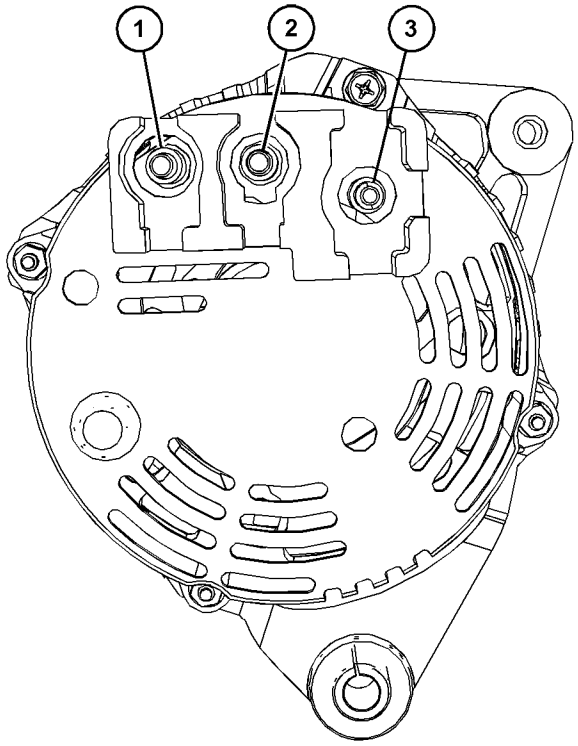

Illustration 67 g06229053

Typical example

(1) Terminal “W”

Tighten the nut on the terminal to the following torque. . . . . 3.7 N·m ((33 lb in))

(2) Terminal “D+”

Tighten the nut on the terminal to the following torque. . . . . 3.7 N·m ((33 lb in))

(3) Terminal “B+”

Tighten the nut on the terminal to the following torque. . . . . 7 N·m ((62 lb in))

Tighten the nut for the alternator pulley to the following torque. . . . . 80 N·m ((59 lb ft))

Output

The output of the alternator . . . . 85, 100 and 120 Amp

i06849392

Starter Motor

SMCS Code: 1451; 1453

Part No.: 451-0011

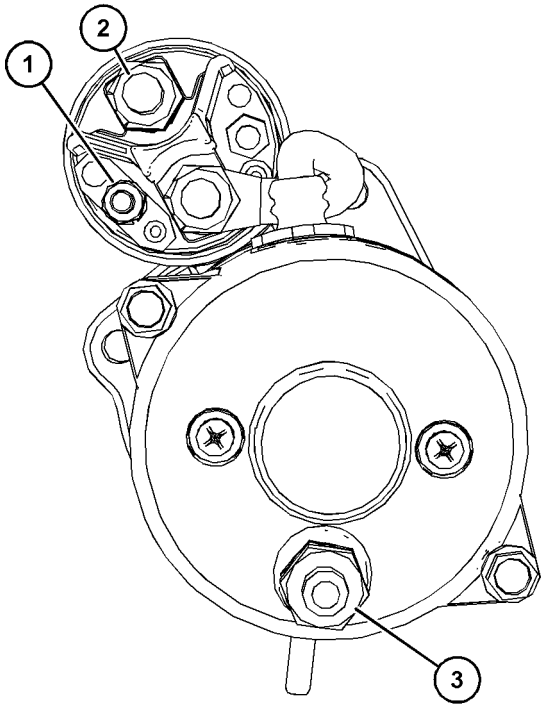

Illustration 68 g06140397

Typical example

(1) Tighten “terminal 50” to the following torque. . . . . 5.8 N·m ((51 lb in))

(2) Tighten “terminal 30” to the following torque. . . . . 15 N·m ((133 lb in))

(3) Tighten the ground terminal nut to the following torque.. . . . . 18 N·m ((159 lb in))

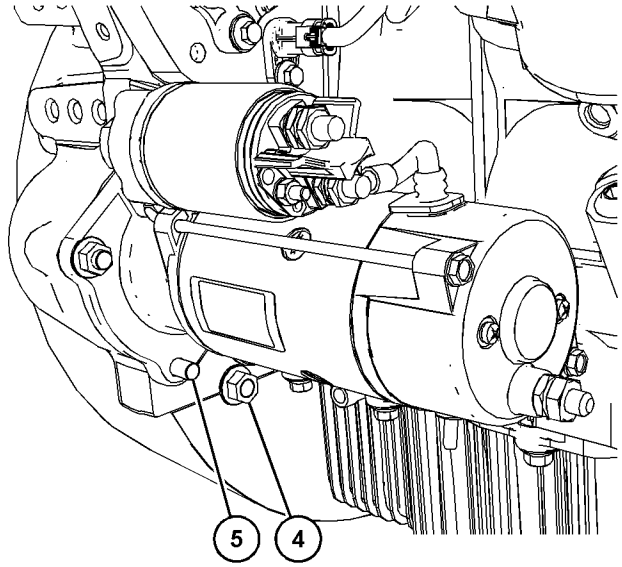

Illustration 69 g06228663

Typical example

(4) Tighten the nuts to the following torque. . . . 44 N·m ((32 lb ft))

(5) Tighten the studs to the following torque. . . . . 18 N·m ((159 lb in))

Rated voltage . . . . . 12 V or 24 V

i06848212

Nitrogen Oxide Sensor

SMCS Code: 191N

Part No.: 514-1719

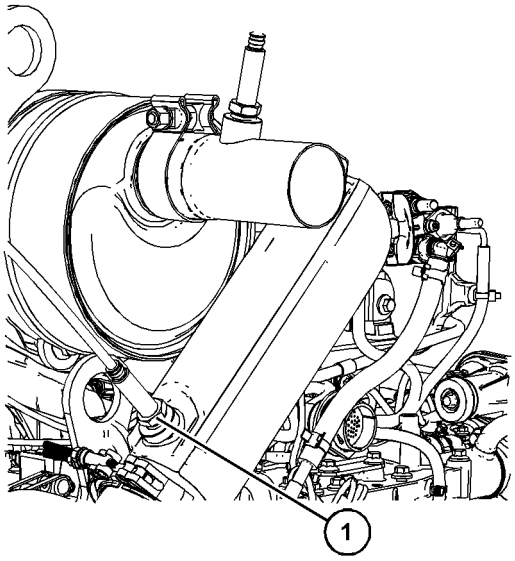

Illustration 70 g06365105

Typical example

(1) Tighten the sensor to the following torque. . . . . 50 N·m ((37 lb ft))

i06848150

Coolant Temperature Sensor

SMCS Code: 1906

Part No.: 256-6454

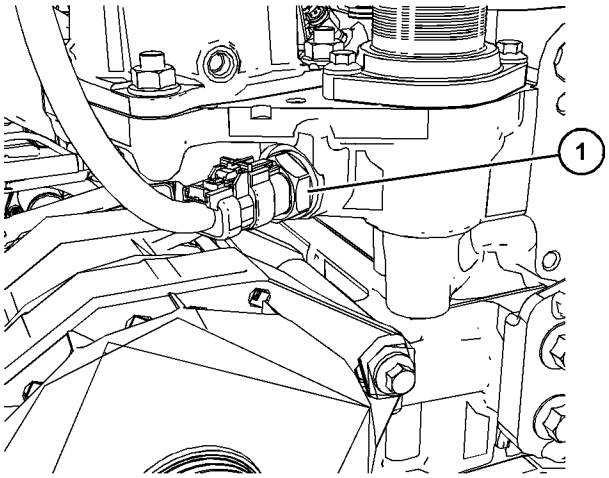

Illustration 71 g06139888

Typical example

(1) Tighten the coolant temperature sensor to the following torque. . . . . 20 N·m ((177 lb in))

i06848158

Engine Oil Pressure Switch

SMCS Code: 1924

Part No.: 529-8053

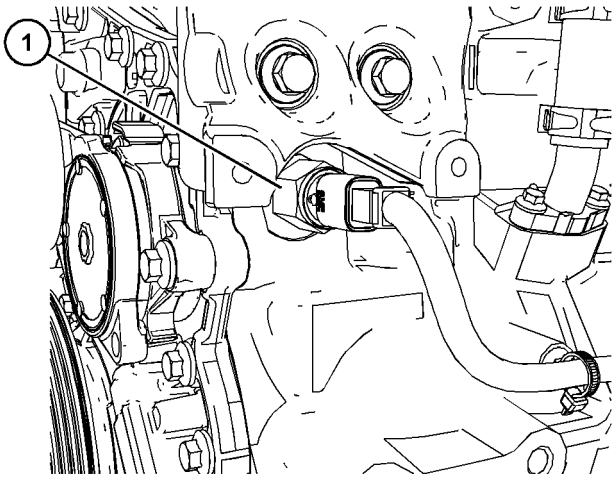

Illustration 72 g06139891

Typical example

(1) Tighten the engine oil pressure switch to the following torque. . . . . 17 N·m ((150 lb in))

i06848161

Inlet Manifold Temperature and Pressure Sensor

SMCS Code: 1058-NS; 1439-TMS; 1439-PXS

Part No.: 500-3341

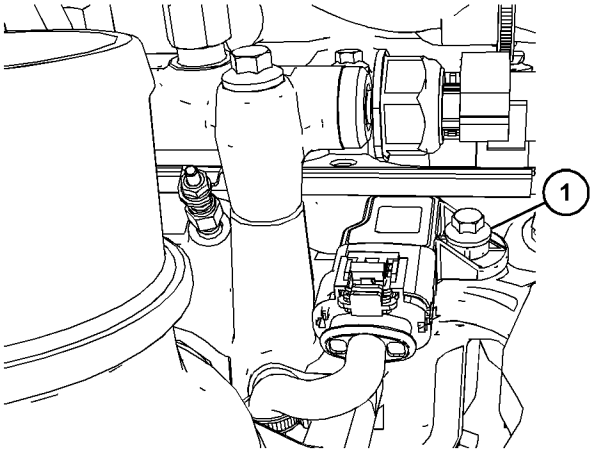

Illustration 73 g06139916

Typical example

(1) Tighten the bolt for the inlet manifold air pressure and temperature sensor to the following torque. . . . . 8 N·m ((71 lb in))

i06851092

Temperature Sensor (DPF Inlet)

SMCS Code: 1439

Part No.: 486-9076

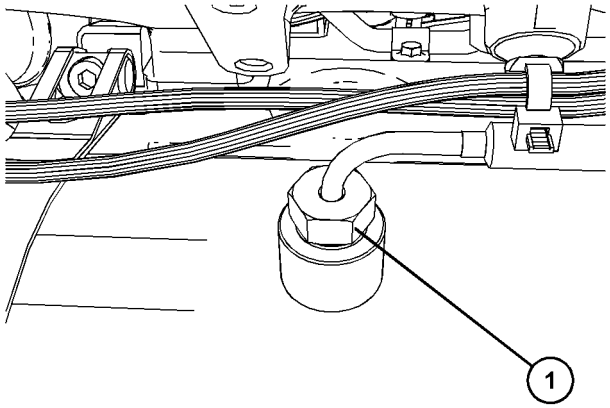

Illustration 74 g06141266

Typical example

(1) Tighten the temperature sensor to the following torque.. . . . . .45 N·m ((33 lb ft))

i06851042

Temperature Sensor (DOC Inlet)

SMCS Code: 1439; 1919

Part No.: 486-9076

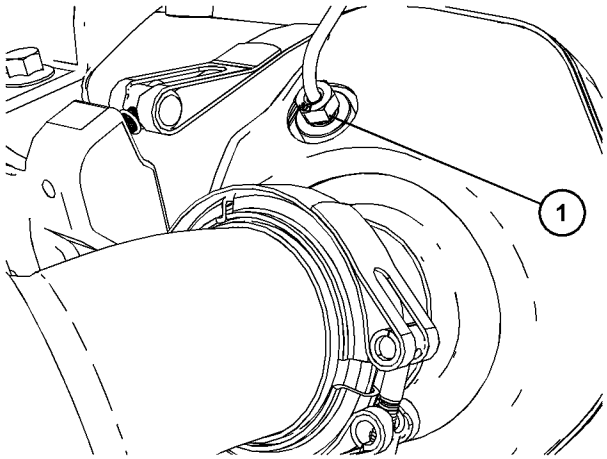

Illustration 75 g06141264

Typical example

(1) Tighten the temperature sensor to the following torque.. . . . . 35 N·m ((310 lb in))

i06851111

Temperature Sensor (Exhaust) (Selective Catalytic Reduction (SCR) Temperature Sensor)

SMCS Code: 1919

Part No.: 486-9076

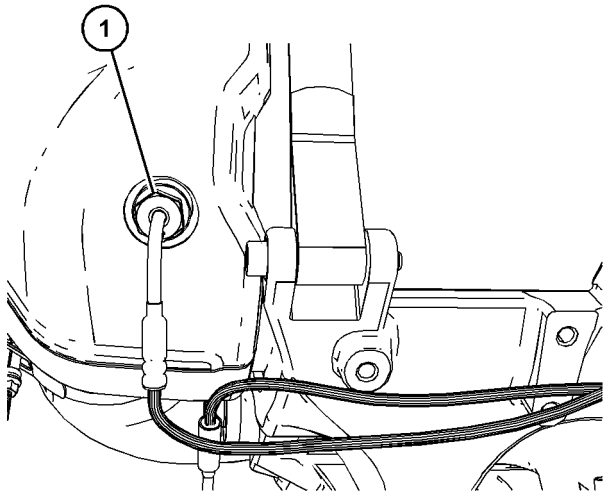

Illustration 76 g06141268

Typical example

(1) Tighten the temperature sensor to the following torque.. . . . . .45 N·m ((33 lb ft))

i06848541

Pressure Sensor (NOx Reduction System) (Differential Pressure Sensor)

SMCS Code: 1439

Part No.: 513-0267

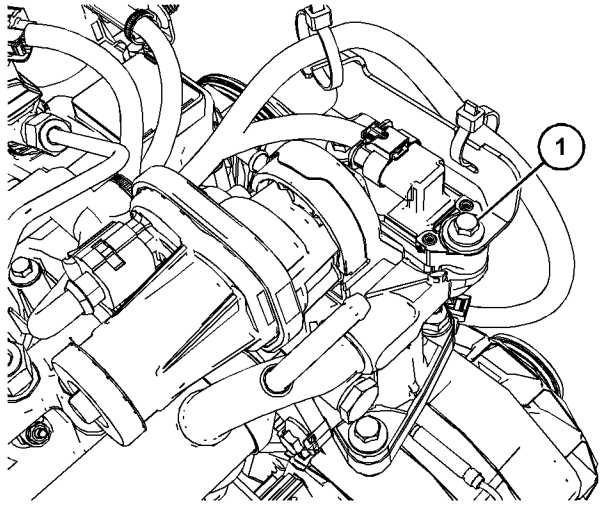

Illustration 77 g06139989

Typical example

(1) Tighten the bolts to the following torque. . 12 N·m ((106 lb in))

i06848547

Temperature Sensor (NOx Reduction System)

SMCS Code: 1439

Part No.: 474-3231, 542-4656

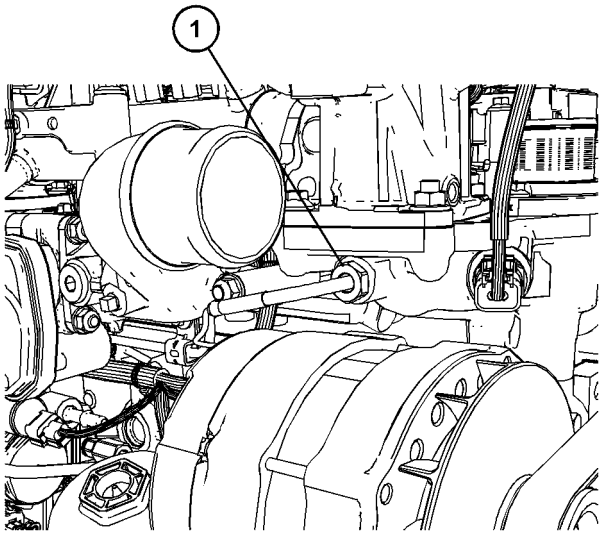

Illustration 78 g06140004
Typical example

(1) Tighten the sensor to the following torque.
. . . . . 27 N·m ((239 lb in))

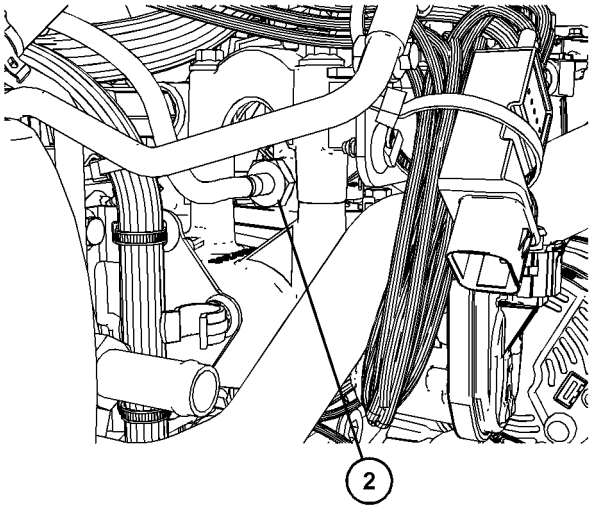

Illustration 79 g06140023
Typical example

(2) Tighten the sensor to the following torque.
. . . . . 27 N·m ((239 lb in))

i06915755

Pressure Sensor (Exhaust Differential)

SMCS Code: 1439

Part No.: 501-2207

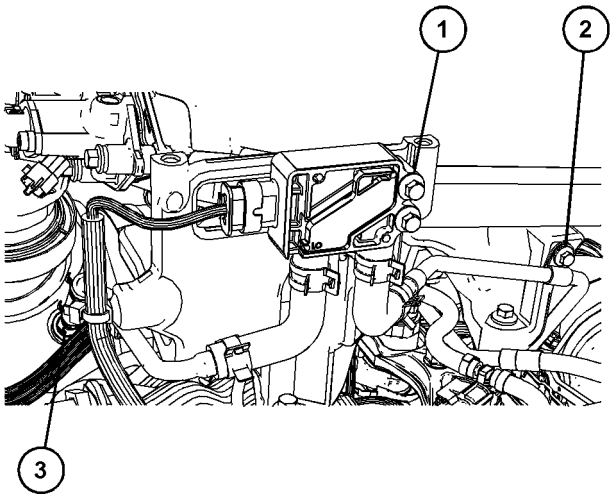

Illustration 80 g06166114

Typical example

(1) Tighten the bolts to the following torque. . 12 N·m ((106 lb in))

(2) Tighten the bolts to the following torque. . . 9 N·m ((80 lb in))

(3) Tighten the tube nuts to the following torque. . . . . 35 N·m ((310 lb in))

i06848139

Speed/Timing Sensor

SMCS Code: 1907; 1912

Part No.: 481-5928

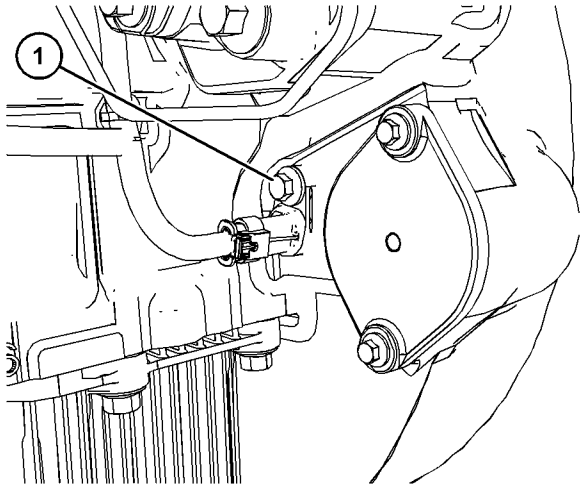

Illustration 81 g06139882

Typical example

(1) Tighten the bolt for the crankshaft position sensor to the following torque. . . . . 14 N·m ((124 lb in))

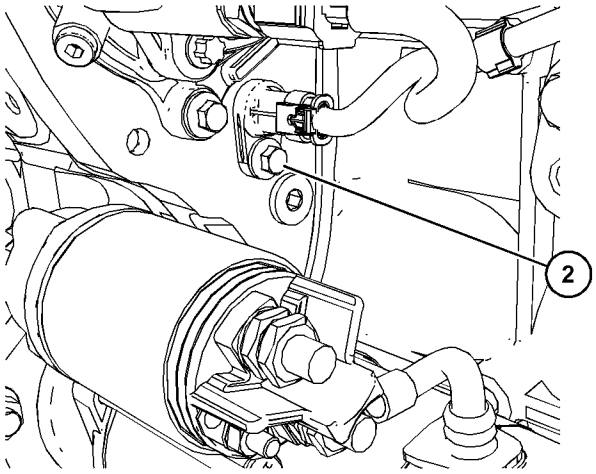

Illustration 82 g06139887

Typical example

(2) Tighten the bolt for the camshaft position sensor to the following torque.. . . . . 14 N·m ((124 lb in))

i06852366

Electronic Control Module

SMCS Code: 1901

Part No.: 540-1539

Note: The Electronic Control Module (ECM) is mounted to the application. The ECM must be mounted with four M6 bolts.

Tighten the M6 fasteners to the following torque . . . . . 10.5 N·m ((93 lb in))

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Glow Plugs

SMCS Code: 1412

Part No.: 519-7383

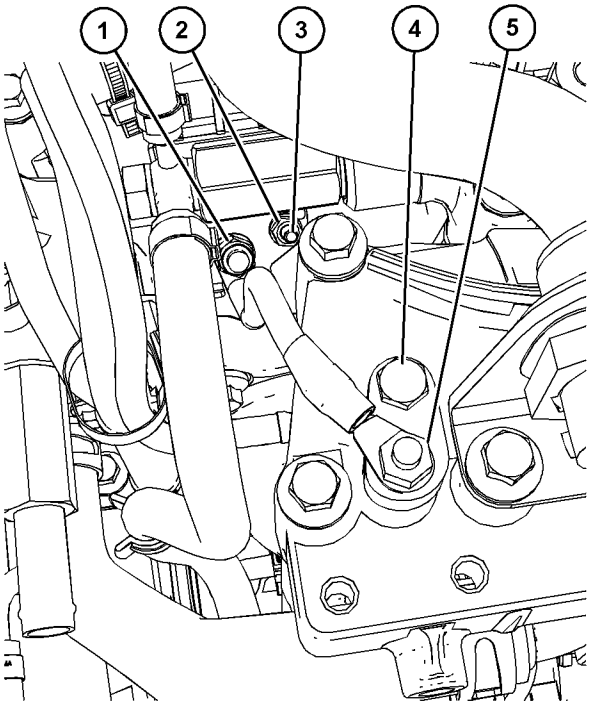

Illustration 83 g06366292

Typical example

(1) Tighten the nut to the following torque. . . . 3.5 N·m ((31 lb in))

(2) Tighten the nuts for the bus bar that is installed on top of the glow plugs to the following torque. . . 2 N·m ((18 lb in))

(3) Tighten the glow plugs in the cylinder head to the following torque. . . . . 9 N·m ((80 lb in))

(4) Tighten the bolt to the following torque. . . . 9 N·m ((80 lb in))

(5) Tighten the nut to the following torque. . . . 3.5 N·m ((31 lb in))

Voltage . . . . . 12 V or 24 V

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