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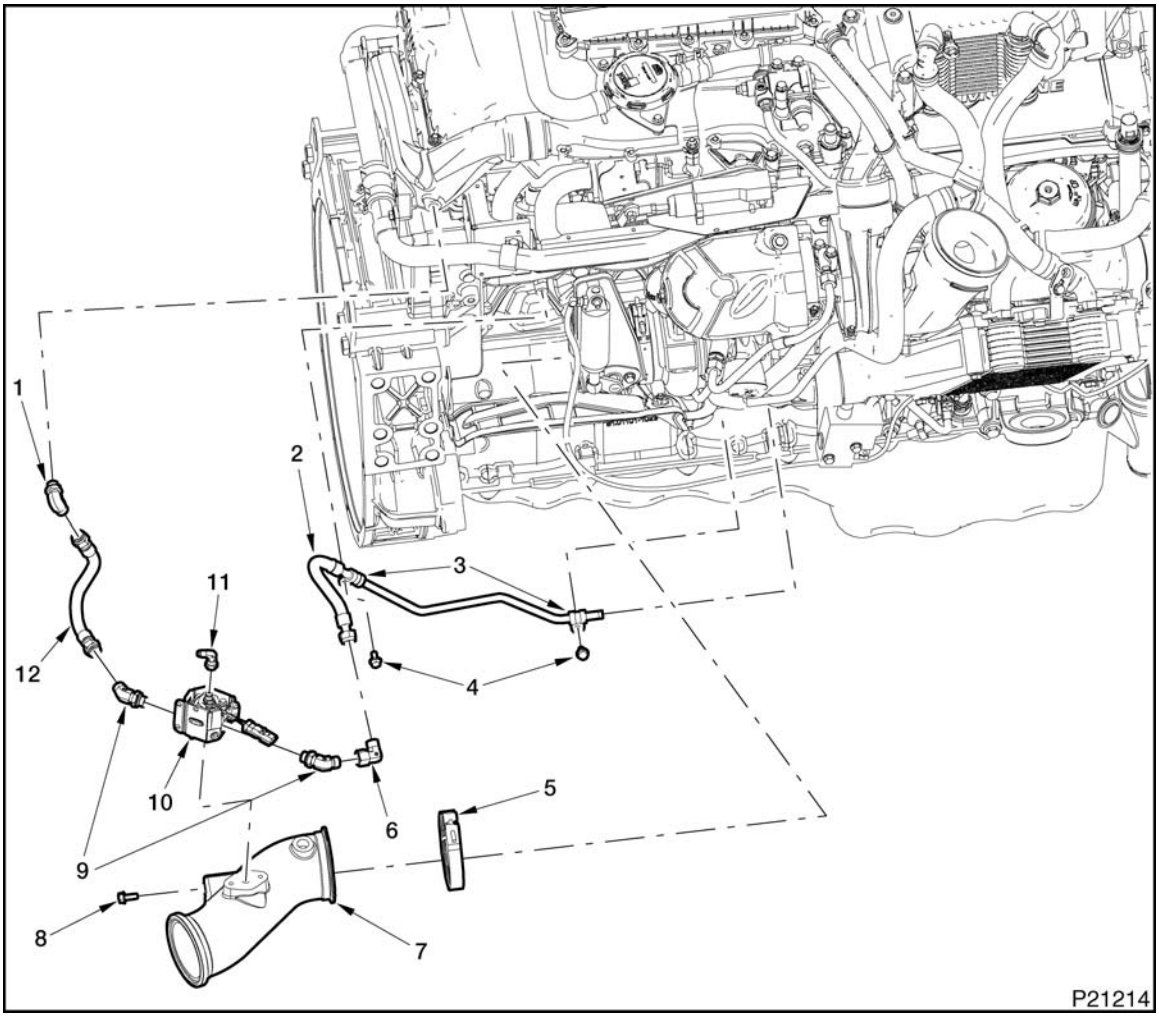

Figure 119 Aftertreatment system components

1. Parker® wee 12
2. Coolant return assembly
3. P-clamp (2)
4. M8 x 16 hex bolt (2)
5. Profiled clamp
6. Parker® ew12
7. Turbo exhaust pipe
8. M8 x 20 hex bolt
9. Parker® vee 12 (2)
10. Aftertreatment Fuel Injector (AFI)
11. Parker® 4C6MXSS
12. Coolant supply line

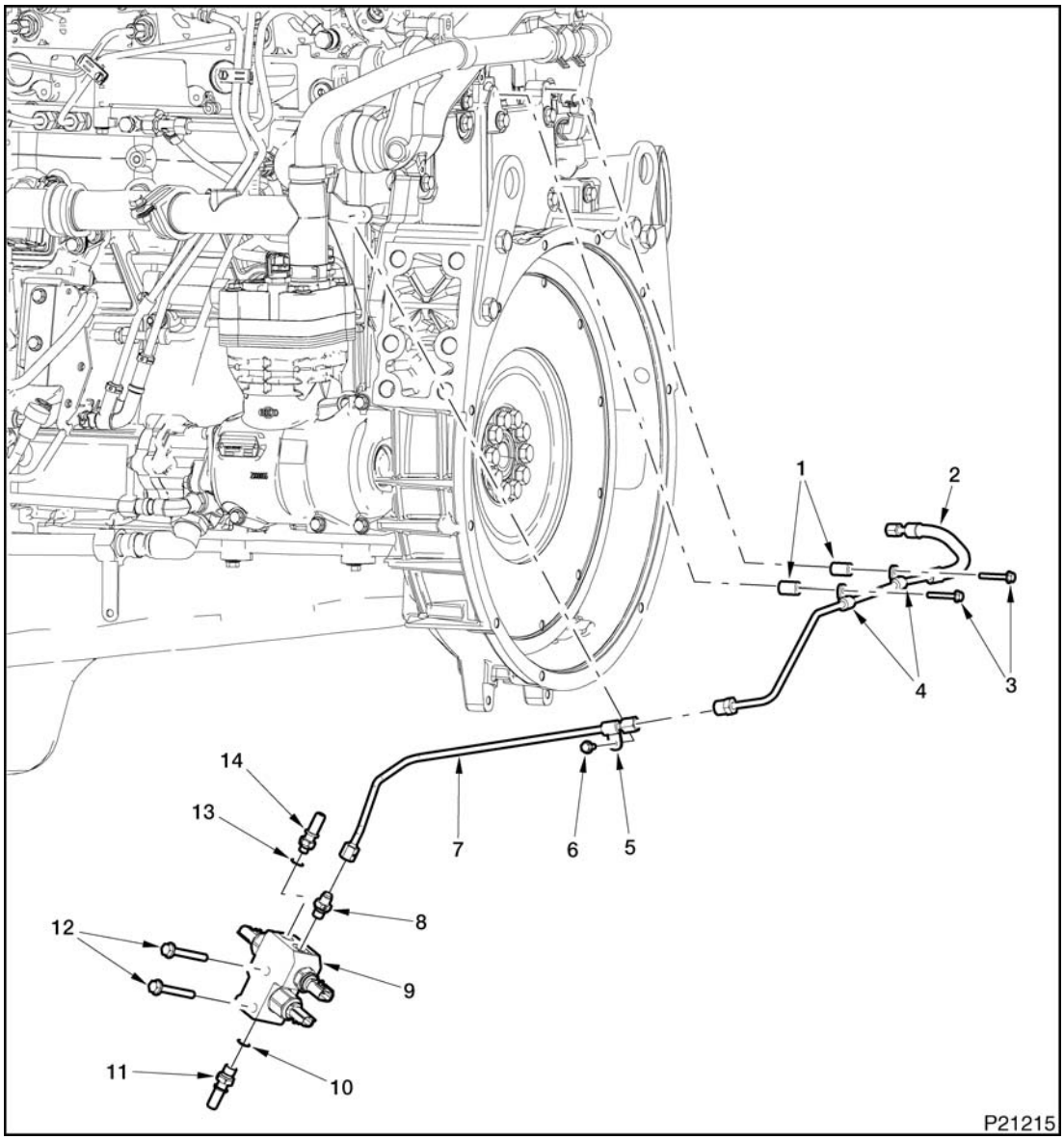

Figure 120 Aftertreatment system fuel supply

1. 6 x 15 x 23 bushing (2)
2. Fuel supply assembly (upper line)
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11. M14 x 1.5 threaded union
12. M8 x 55 hex bolt (2)
13. 9 x 2 O-ring
14. M10 x 1 threaded union

Removal

WARNING: To prevent personal injury or death, read all safety instructions in the "Safety Information" section of this manual.

WARNING: To prevent personal injury or death, shift transmission to park or neutral, set parking brake, and block wheels before doing diagnostic or service procedures.

WARNING: To prevent personal injury or death, make sure that the engine has cooled before removing components.

WARNING: To prevent personal injury or death, do not let engine fluids stay on your skin. Clean skin and nails using hand cleaner and wash with soap and water. Wash or discard clothing and rags contaminated with engine fluids.

GOVERNMENT REGULATION: Engine fluids (oil, fuel, and coolant) may be a threat to the environment. Recycle or dispose of engine fluids according to applicable regulations. Never put engine fluids in the trash, on the ground, in sewers or bodies of water.

Fuel Supply Assembly

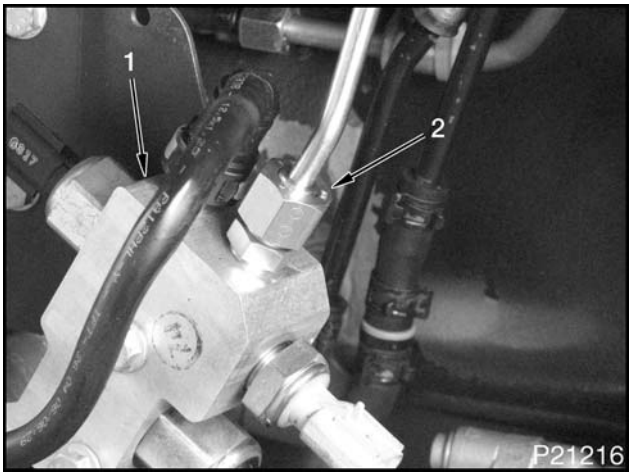

Figure 121 Fuel supply assembly (lower line)

1. Hydrocarbon (HC) cut-off valve
2. Fuel supply assembly (lower line) fitting nut

WARNING: To prevent personal injury or death, dispose of fuel in a container marked DIESEL FUEL, according to applicable regulations.

1. Place suitable container clearly marked DIESEL FUEL under HC cut-off valve.
2. Loosen fuel supply assembly (lower line) fitting nut and disconnect assembly from straight fitting at HC cut-off valve.

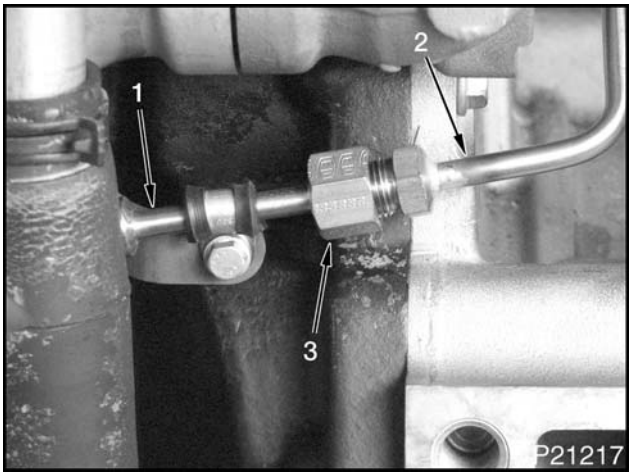

Figure 122 Fuel supply assembly (connection)

1. Fuel supply assembly (lower line)
2. Fuel supply assembly (upper line)
3. Fuel supply assembly fitting nut

3. Loosen fuel supply assembly (lower line) fitting nut and disconnect fuel supply assembly (lower line) from fuel supply assembly (upper line).

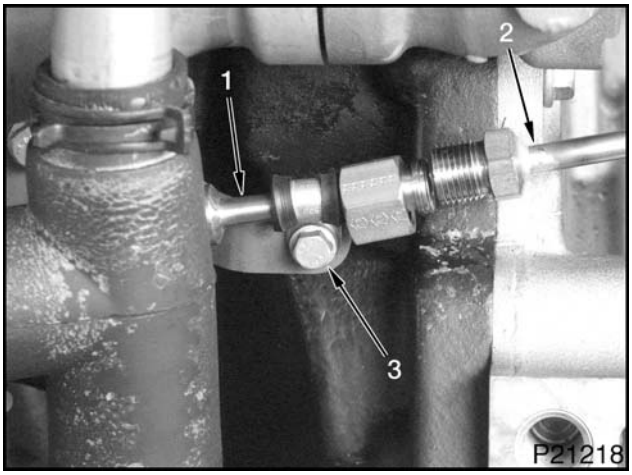

Figure 123 Fuel supply assembly (lower line)

1. Fuel supply assembly (lower line)
2. Fuel supply assembly (upper line)
3. M8 x 16 hex bolt

4. Remove M8 x 16 hex bolt and fuel supply assembly (lower line).

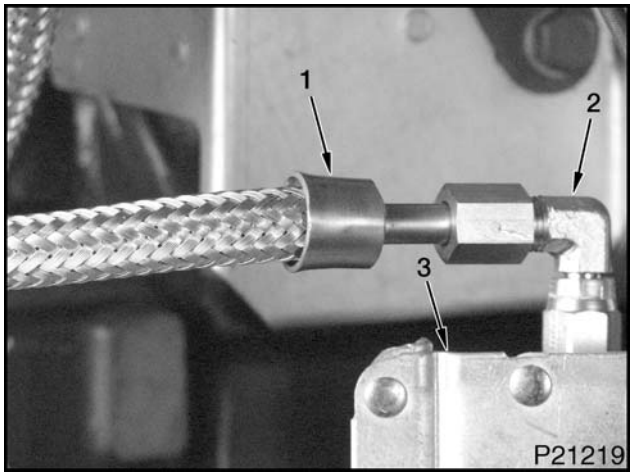

Figure 124 Fuel supply assembly (upper line connection)

1. Fuel supply assembly (upper line)
2. Parker® 4C6MXSS
3. Aftertreatment Fuel Injector (AFI)

5. Loosen fuel supply assembly (upper line) fitting nut and disconnect assembly from Parker® 4C6MXSS at AFI.

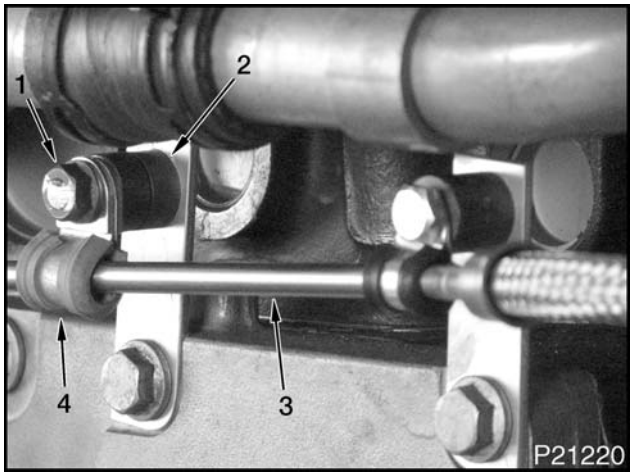

Figure 125 Fuel supply assembly (upper line)

1. M6 x 40 hex bolt (2)
2. 6 x 15 x 23 bushing (2)
3. Fuel supply assembly (upper line)
4. P-clamp (2)

6. Remove two M6 x 40 hex bolts, two 6 x 15 x 23 bushings and fuel supply assembly (upper line).

Hydrocarbon (HC) Cut-Off Valve

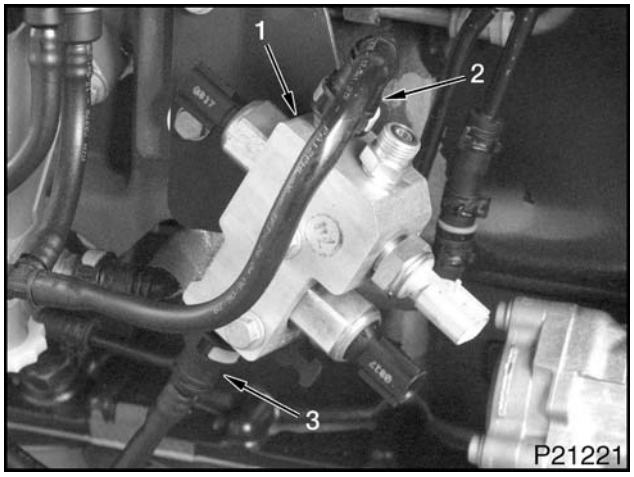

Figure 126 HC cut-off valve connections

1. HC cut-off valve
2. Fuel line assembly
3. Fuel line assembly

WARNING: To prevent personal injury or death, dispose of fuel in a container marked DIESEL FUEL, according to applicable regulations.

1. Place suitable container clearly marked DIESEL FUEL under HC cut-off valve.

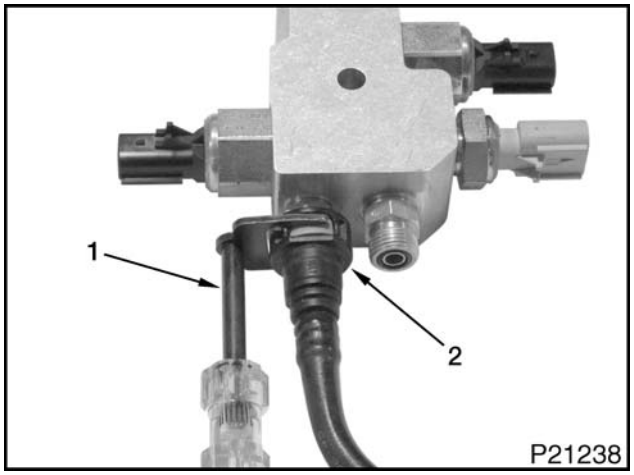

Figure 127 Fuel line disconnect tool on fuel line assembly

1. Fuel line disconnect tool 11.8 mm
2. Fuel line assembly (2)

2. Using Fuel Line Disconnect Tool 11.8 mm (page 118) disconnect two fuel line assemblies from HC cut-off valve.

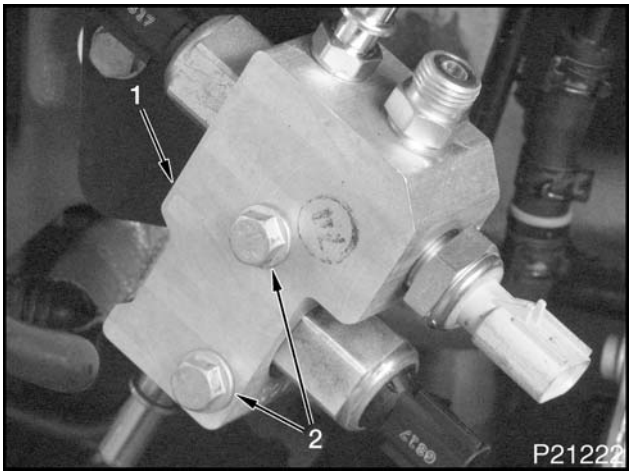

Figure 128 HC cut-off valve

1. HC cut-off valve
2. M8 x 55 hex bolt (2)

3. Remove two M8 x 55 hex bolts and HC cut-off valve.

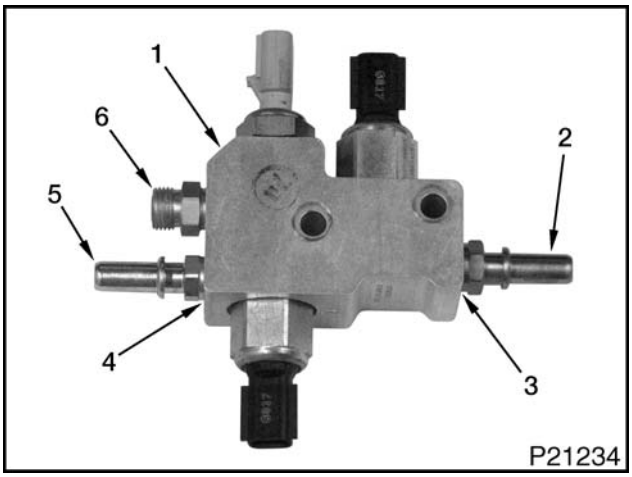

Figure 129 HC cut-off valve (fitting/unions)

1. HC cut-off valve
2. M14 x 1.5 threaded union
3. A14 x 18 seal ring
4. 9 x 2 O-ring
5. M10 x 1 threaded union
6. Straight fitting

NOTE: Proceed with steps 4, 5, and 6 only if HC cut-off valve fittings are found to be leaking or if HC cut-off valve is being replaced.

4. Remove M14 x 1.5 threaded union from HC cut-off valve. Remove and discard A14 x 18 seal ring.
5. Remove M10 x 1 threaded union from HC cut-off valve. Remove and discard 9 x 2 O-ring.
6. Remove and discard straight fitting from HC cut-off valve.

Coolant Supply Line

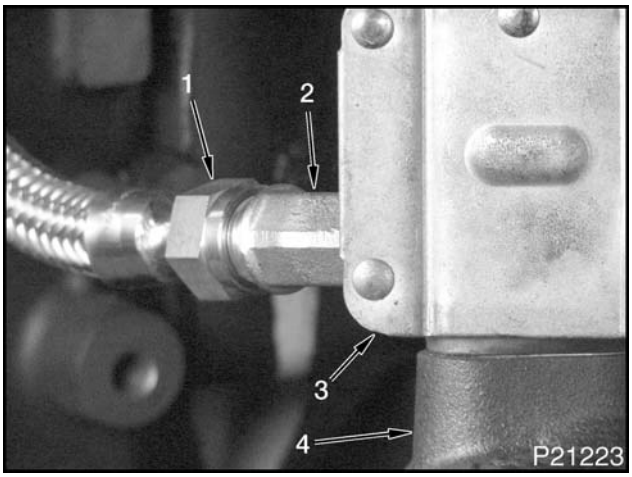

Figure 130 Coolant supply line

1. Coolant supply line fitting nut
2. Parker® vee 12
3. Aftertreatment Fuel Injector (AFI)
4. Turbo exhaust pipe

1. Loosen the coolant supply line fitting nut and disconnect line from Parker® vee 12 at AFI.

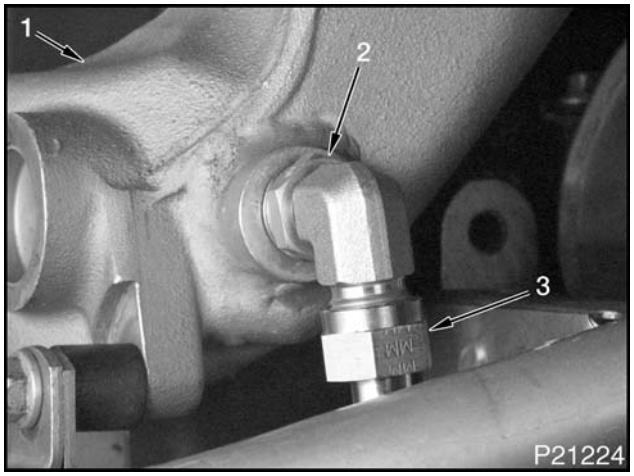

Figure 131 Coolant supply line

1. Coolant elbow
2. Parker® wee 12
3. Coolant supply line

2. Loosen coolant supply line fitting nut and disconnect line from Parker® wee 12 at coolant elbow. Remove coolant supply line.

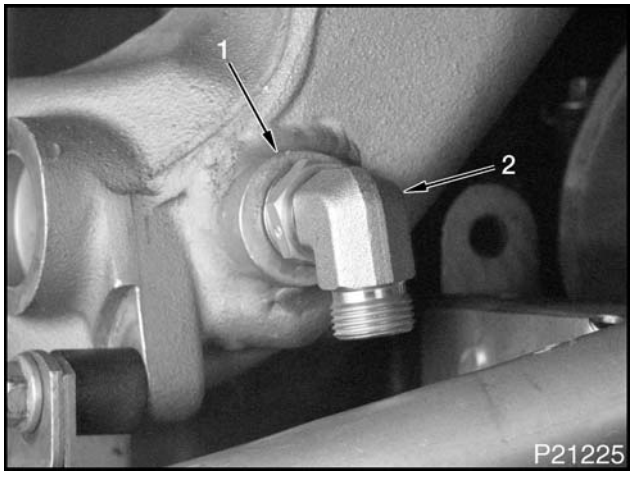

Figure 132 Coolant elbow connection

1. Coolant elbow
2. Parker® wee 12

NOTE: Proceed with step 3 only if Parker® wee 12 is found to be leaking or if coolant elbow is being replaced.

3. Remove Parker® wee 12 from coolant elbow.

Coolant Return Assembly

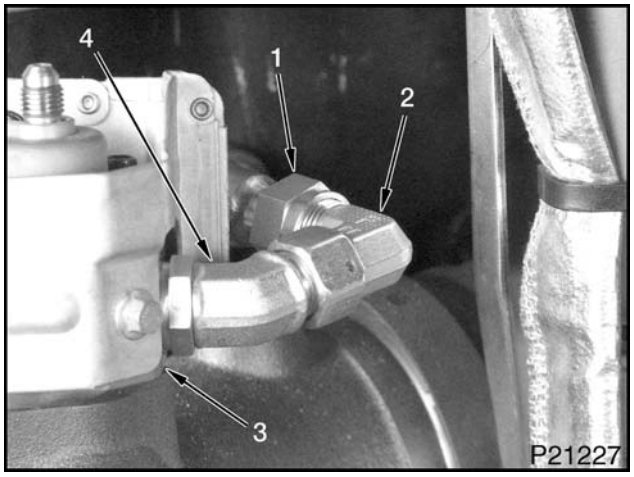

Figure 133 Coolant return assembly (upper connection)

1. Coolant return assembly fitting nut
2. Parker® ew12
3. Aftertreatment Fuel Injector (AFI)
4. Parker® vee 12

1. Loosen coolant return assembly fitting nut and disconnect assembly from Parker® ew12.

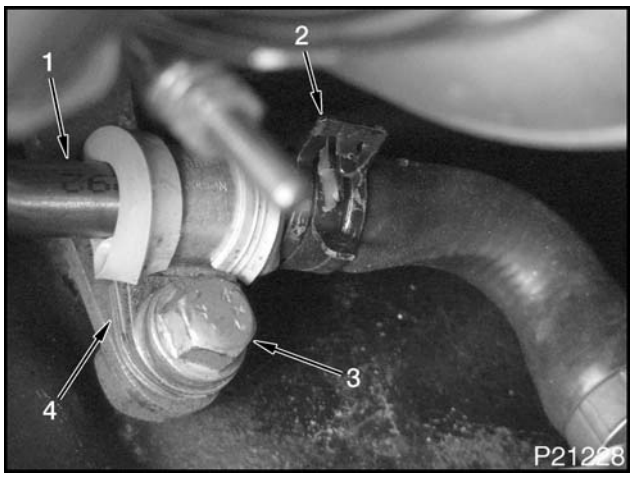

Figure 134 Coolant return assembly (lower connection)

1. Coolant return assembly
2. Clamp
3. M8 x 16 hex bolt
4. P-clamp

2. Release clamp and disconnect coolant return assembly from Charge Air Cooler (CAC) return coolant pipe.
3. Remove M8 x 16 hex bolt from P-clamp.

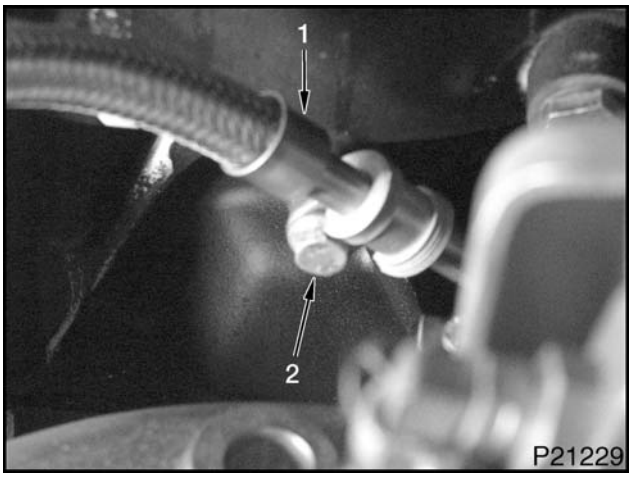

Figure 135 Coolant return assembly

1. Coolant return assembly
2. M8 x 16 hex bolt

4. Remove M8 x 16 hex bolt and remove the coolant return assembly.

Aftertreatment Fuel Injector (AFI)

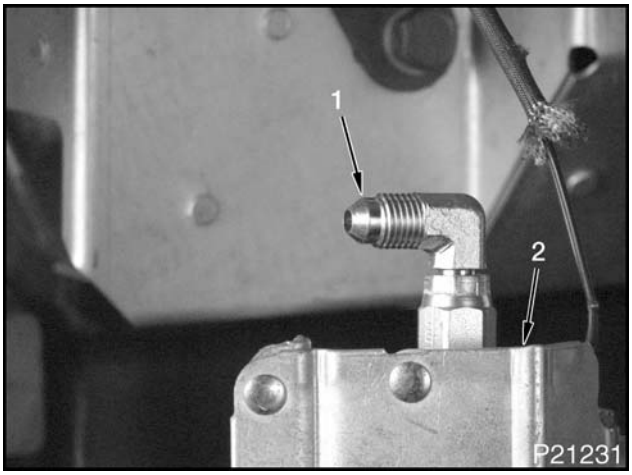

Figure 136 Parker® 4C6MXSS connection at Aftertreatment Fuel Injector (AFI)

1. Parker® 4C6MXSS
2. AFI

NOTE: Proceed with steps 1 through 4 only if fittings are found to be leaking or if AFI is being replaced.

1. Remove Parker® 4C6MXSS from AFI.

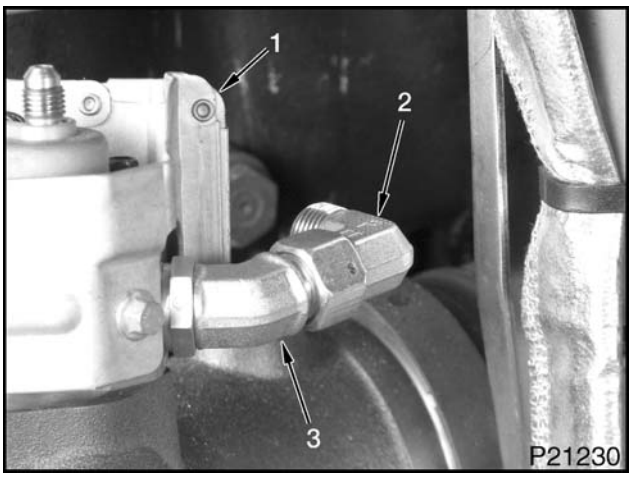

Figure 137 Aftertreatment Fuel Injector (AFI) connection

1. AFI
2. Parker® ew12
3. Parker® vee 12

2. Remove Parker® ew12 from Parker® vee 12.
3. Remove Parker® vee 12 from AFI.

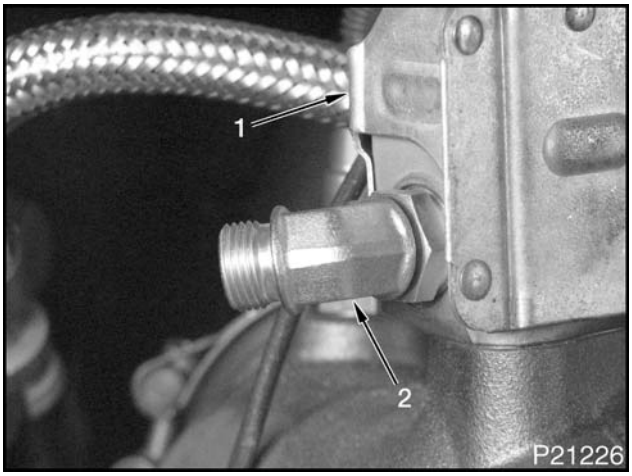

Figure 138 Parker® vee 12 connection at Aftertreatment Fuel Injector (AFI)

1. AFI
2. Parker® vee 12

4. Remove Parker® vee 12 from AFI.

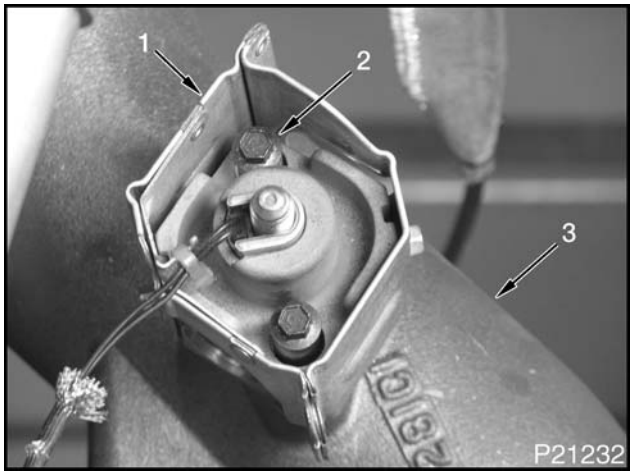

Figure 139 Aftertreatment Fuel Injector (AFI)

1. AFI
2. AFI hex bolt (2)
3. Turbo exhaust pipe

NOTE: Do not lose spacer between AFI and gasket.

5. Remove two hex bolts, two spacers, and AFI from turbo exhaust pipe.
6. Discard gasket.

Turbo Exhaust Pipe

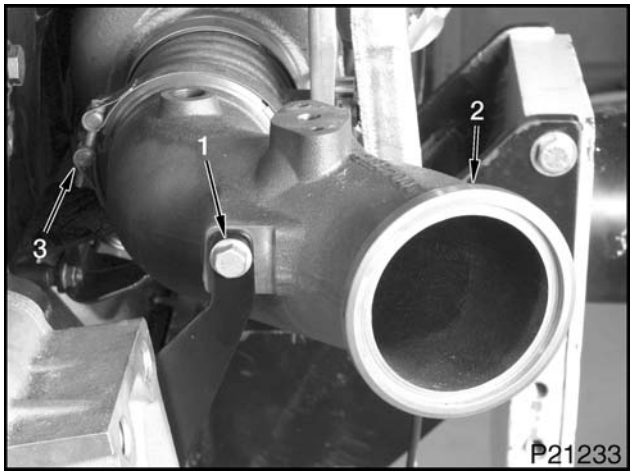

Figure 140 Turbo exhaust pipe

1. M8 x 20 hex bolt
2. Turbo exhaust pipe
3. Profiled clamp

1. Remove M8 x 20 hex bolt from turbo exhaust pipe.
2. Loosen profiled clamp and remove turbo exhaust pipe.

Installation

Turbo Exhaust Pipe

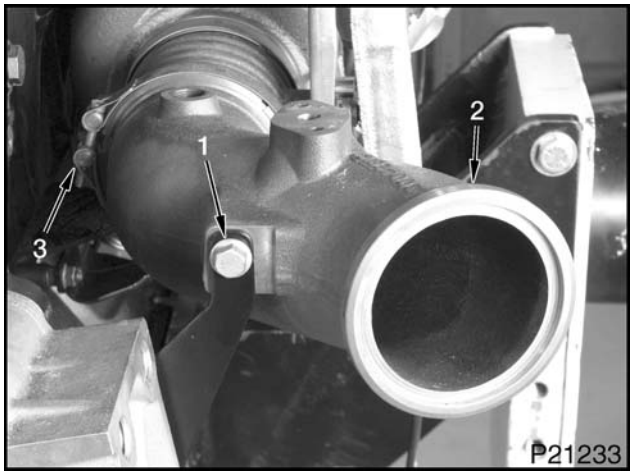

Figure 141 Turbo exhaust pipe

1. M8 x 20 hex bolt
2. Turbo exhaust pipe
3. Profiled clamp

1. Install turbo exhaust pipe and profiled clamp.
2. Install M8 x 20 hex bolt into turbo exhaust pipe. Tighten bolt to special torque (page 118).
3. Tighten profiled clamp to special torque (page 118).

Aftertreatment Fuel Injector (AFI)

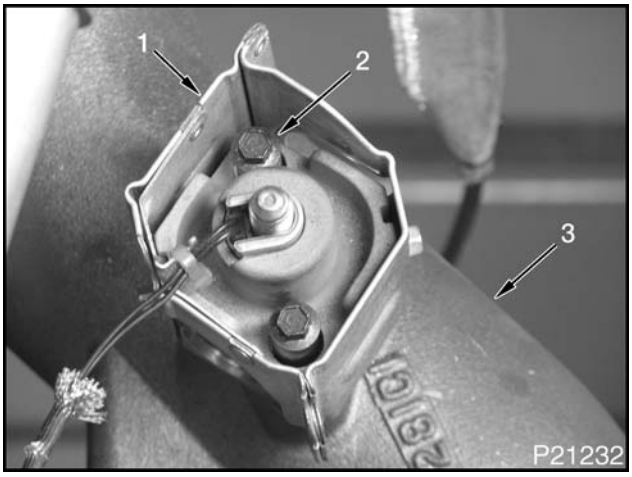

Figure 142 Aftertreatment Fuel Injector (AFI)

1. AFI
2. AFI hex bolt (2)
3. Turbo exhaust pipe

1. Apply a light coating of high-temperature nickel-graphite anti-seize compound (page 118) to AFI hex bolt threads.
2. Apply a light coating of clean engine oil to AFI hex bolt head bearing surfaces.

NOTE: Remember to install spacer between gasket and AFI.

3. Install new gasket on AFI.
4. Install AFI onto turbo exhaust pipe. Tighten hex bolts as follows.
   a. Pre-tighten hex bolts to 8 N·m (75 lbf-in)
   b. Tighten hex bolts to 14 N·m (125 lbf-in)
5. Apply Parker® ThreadMate™ (page 118) to Parker® vee 12, Parker® ew12, and Parker® 4C6MXSS threads.

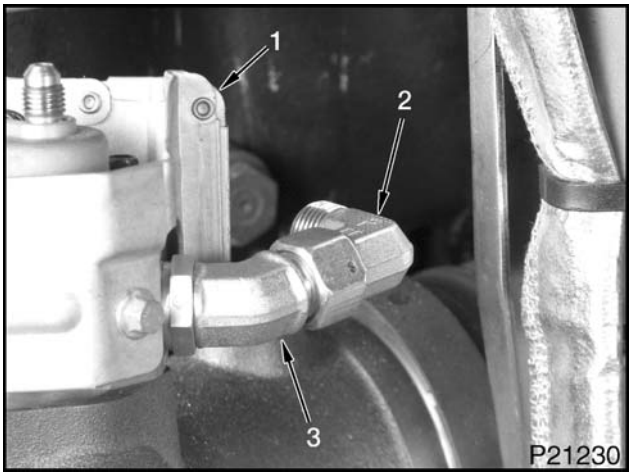

Figure 143 Aftertreatment Fuel Injector (AFI) connection

1. AFI
2. Parker® ew12
3. Parker® vee 12

NOTE: Proceed with steps 6 through 9 only if fittings were found to be leaking or if AFI was replaced.

6. Install Parker® vee 12 into AFI and hand tighten.
7. Install Parker® ew12 onto Parker® vee 12 and hand tighten.

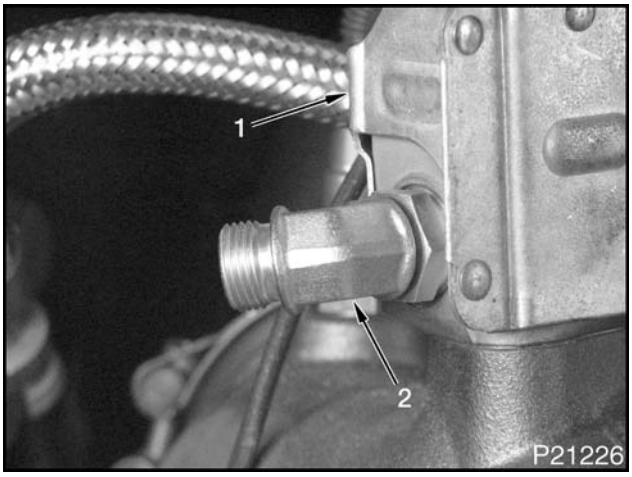

Figure 144 Parker® vee 12 connection at Aftertreatment Fuel Injector (AFI)

1. AFI
2. Parker® vee 12

8. Install Parker® vee 12 onto AFI and hand tighten.

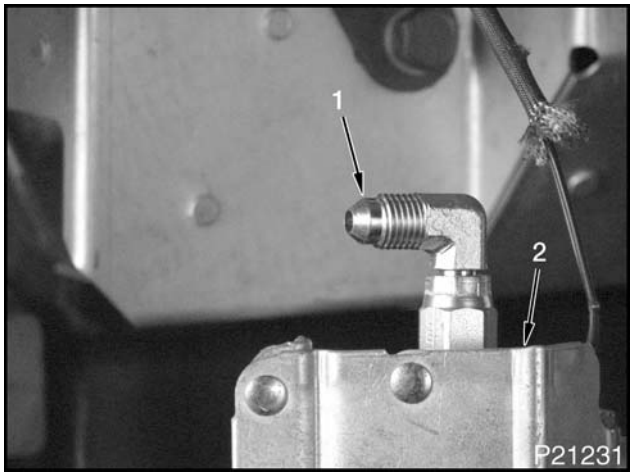

Figure 145 Parker® 4C6MXSS at Aftertreatment Fuel Injector (AFI)

1. Parker® 4C6MXSS
2. AFI

9. Install Parker® 4C6MXSS onto AFI and hand tighten.

Coolant Return Assembly

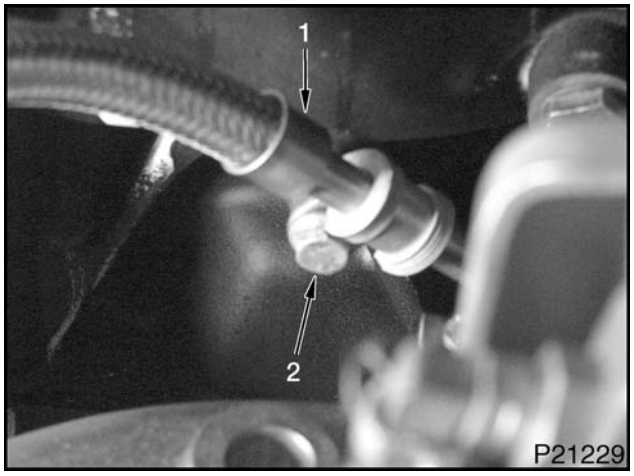

Figure 146 Coolant return assembly

1. Coolant return assembly
2. M8 x 20 hex bolt

1. Position coolant return assembly and install M8 x 20 hex bolt through P-clamp. Tighten hex bolt to special torque (page 118).

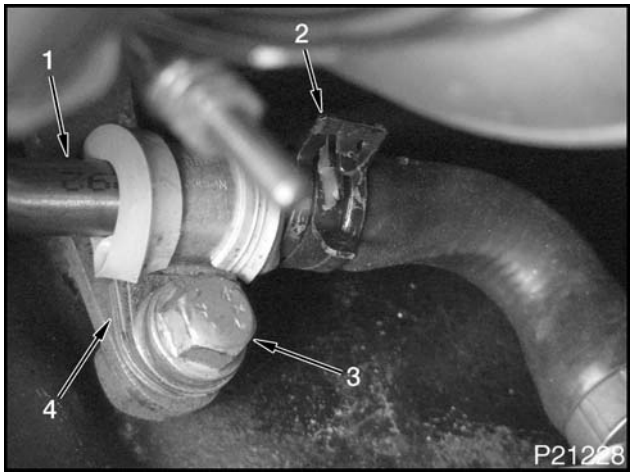

Figure 147 Coolant return assembly (lower connection)

1. Coolant return assembly
2. Clamp
3. M8 x 20 hex bolt
4. P-clamp

2. Install M8 x 20 hex bolt into P-clamp. Tighten hex bolt to special torque (page 118).
3. Connect coolant return assembly to Charge Air Cooler (CAC) return coolant pipe and install clamp.

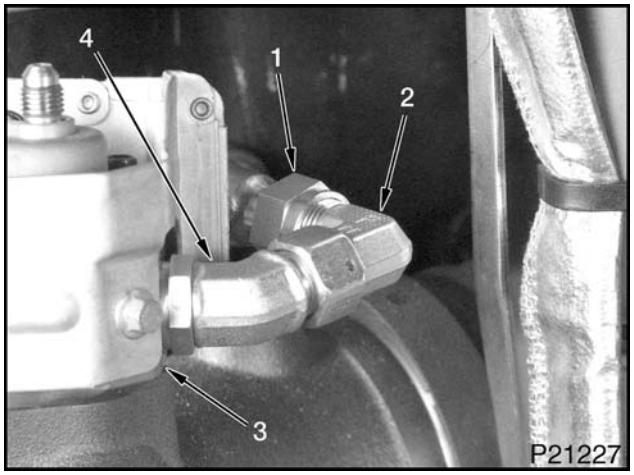

Figure 148 Coolant return assembly (upper connection)

1. Coolant return assembly fitting nut
2. Parker® ew12
3. Aftertreatment Fuel Injector (AFI)
4. Parker® vee 12

4. Connect and hand tighten coolant return assembly fitting nut to Parker® ew12 at AFI.

NOTE: Proceed with steps 5 through 7 only if fittings were removed or if AFI was replaced.

5. Align Parker® vee 12 and Parker® ew12 to maintain coolant return assembly clearance.
6. Tighten Parker® vee 12 fitting at AFI to special torque (page 118).
7. Tighten Parker® ew12 fitting at Parker® vee 12 to special torque (page 118).
8. Tighten coolant return assembly fitting nut to Parker® ew12 as follows.
   a. Hand tighten.
   b. Turn an additional 90°.

Coolant Supply Line

1. Apply Parker® ThreadMate™ (page 118) to threads of Parker® wee 12.

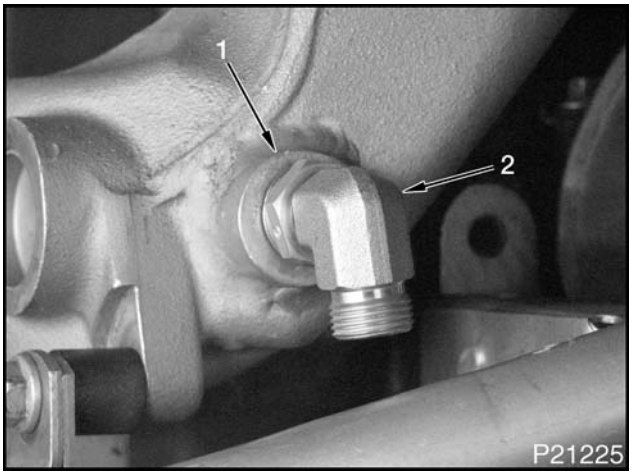

Figure 149 Coolant elbow connection

1. Coolant elbow
2. Parker® wee 12

NOTE: Proceed with step 2 only if fitting was removed or if coolant elbow was replaced.

2. Install Parker® wee 12 into coolant elbow and hand tighten.

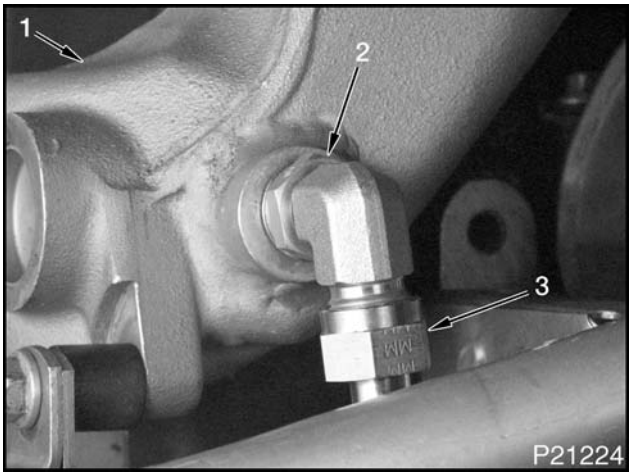

Figure 150 Coolant supply line connection at coolant elbow

1. Coolant elbow
2. Parker® wee 12
3. Coolant supply line

3. Connect and hand tighten coolant supply line fitting nut onto Parker® wee 12 at coolant elbow.

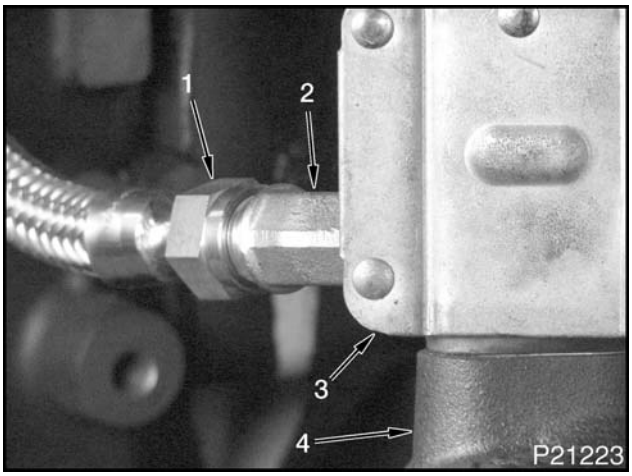

Figure 151 Coolant supply line connection at AFI

1. Coolant supply line
2. Parker® vee 12
3. AFI
4. Turbo exhaust pipe

4. Connect coolant supply line fitting nut onto Parker® vee 12 at AFI.

NOTE: Proceed with steps 5, 6, and 7 only if fittings were removed, or if the AFI or coolant elbow was replaced.

5. Align Parker® vee 12 and Parker® wee 12 to maintain coolant supply line clearance.
6. Tighten Parker® vee 12 at AFI to special torque (page 118).
7. Tighten Parker® wee 12 at coolant elbow to special torque (page 118).
8. Tighten coolant supply line fitting nuts onto Parker® vee 12 at AFI and at Parker® wee 12 at the coolant elbow as follows:
   a. Hand tighten.
   b. Turn an additional 90°.

Hydrocarbon (HC) Cut-Off Valve

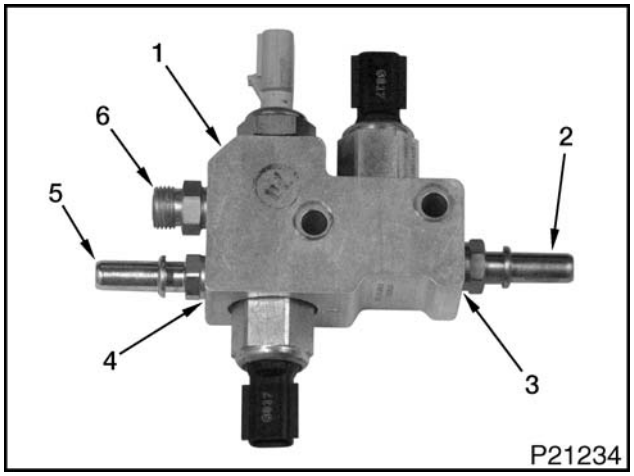

Figure 152 HC cut-off valve (fitting/unions)

1. HC cut-off valve
2. M14 x 1.5 threaded union
3. A14 x 18 seal ring
4. 9 x 2 O-ring
5. M10 x 1 threaded union
6. Straight fitting

NOTE: Proceed with steps 1, 2 and 3 only if fittings were removed or the HC cut-off valve was replaced.

1. Install new straight fitting to HC cut-off valve. Tighten to special torque (page 118).

2. Install a new 9 x 2 O-ring. Install M10 x 1 threaded union to HC cut-off valve. Tighten to special torque (page 118).
3. Install a new A14 x 18 seal ring. Install M14 x 1.5 threaded union to HC cut-off valve. Tighten to special torque (page 118).

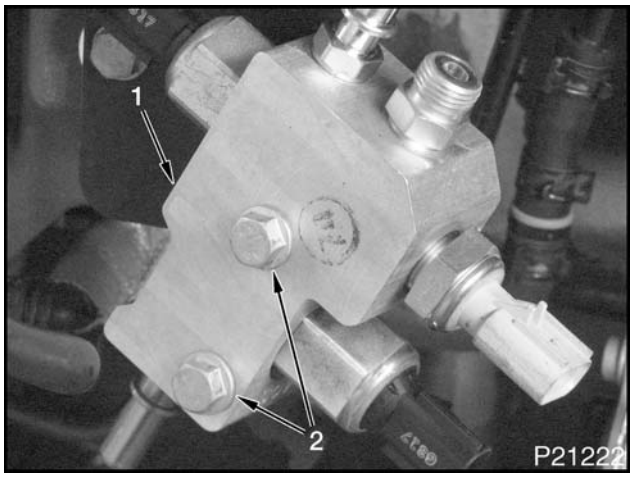

Figure 153 HC cut-off valve

1. HC cut-off valve
2. M8 x 55 hex bolts (2)

4. Install HC cut-off valve and two M8 x 55 hex bolts. Tighten two hex bolts to special torque (page 118).

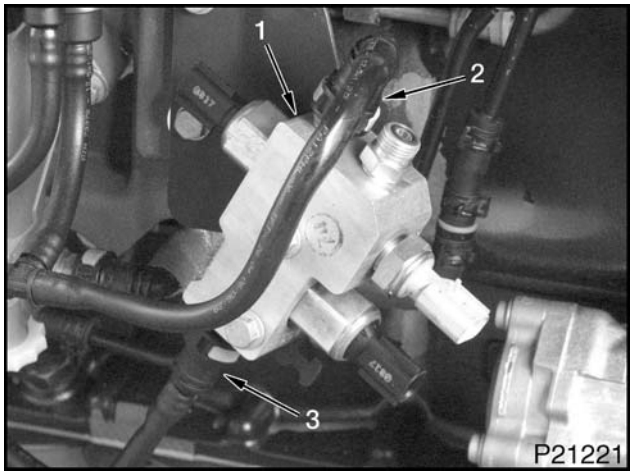

Figure 154 HC cut-off valve

1. HC cut-off valve
2. Fuel line assembly
3. Fuel line assembly

5. Position fuel line assemblies onto unions and push on to connect to HC cut-off valve until an audible click is heard.

Fuel Supply Assembly

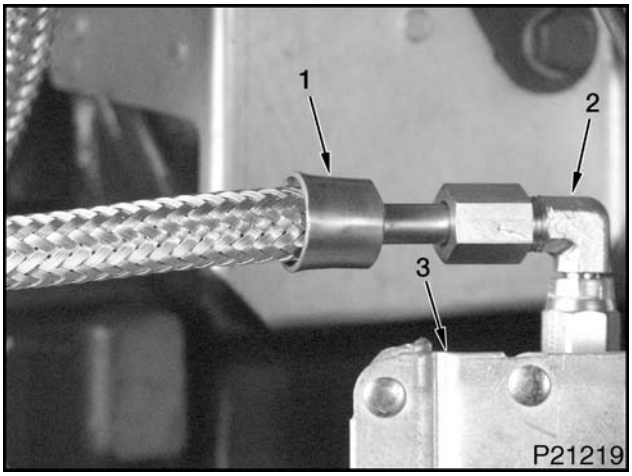

Figure 155 Fuel supply assembly (upper line connection)

1. Fuel supply assembly (upper line)
2. Parker® 4C6MXSS
3. Aftertreatment fuel injector (AFI)

1. Position fuel supply assembly (upper line) into correct location.
2. Connect and hand tighten fuel supply assembly (upper line) onto Parker® 4C6MXSS at AFI.

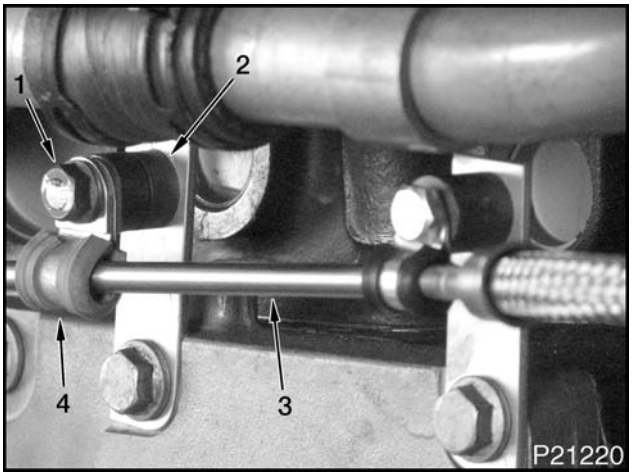

Figure 156 Fuel supply assembly (upper line)

1. M6 x 40 hex bolt (2)
2. 6 x 15 x 23 bushing (2)
3. Fuel supply assembly (upper line)
4. P-clamp (2)

3. Install two M6 x 40 hex bolts, two 6 x 15 x 23 bushings for fuel supply assembly (upper line). Tighten hex bolts to special torque (page 118).

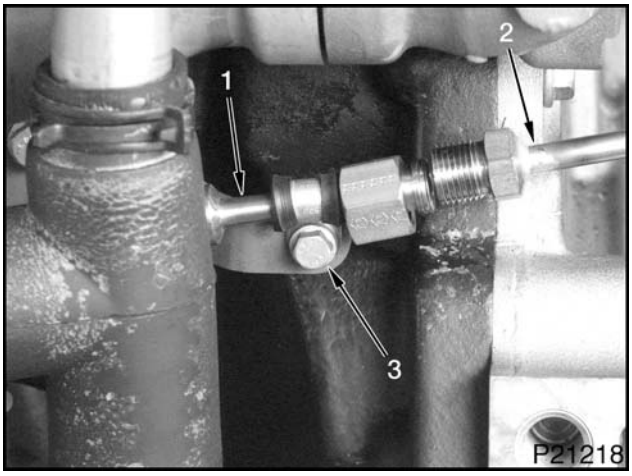

Figure 157 Fuel supply assembly (lower line)

1. Fuel supply assembly (lower line)
2. Fuel supply assembly (upper line)
3. M8 x 16 hex bolt

4. Position fuel supply assembly (lower line) and install M8 x 16 hex bolt. Tighten hex bolt to special torque (page 118).

5. Apply Parker® ThreadMate™ (page 118) to threads of fuel supply assembly (upper line).

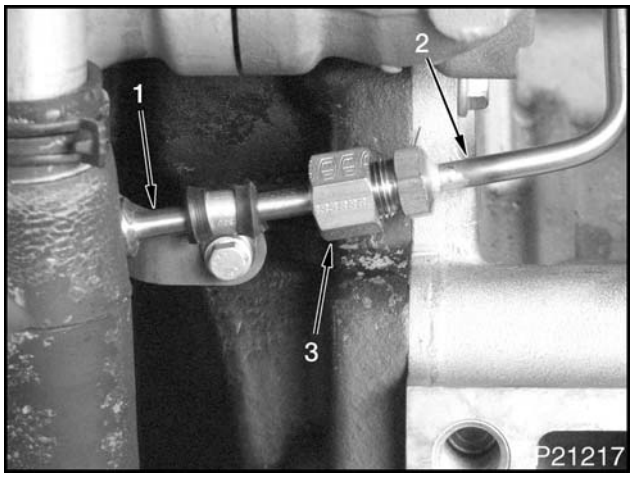

Figure 158 Fuel supply assembly (connection)

1. Fuel supply assembly (lower line)
2. Fuel supply assembly (upper line)
3. Fuel supply assembly fitting nut

6. Connect fuel supply assembly (upper line) onto fuel supply assembly (lower line). Tighten fitting nut to special torque (page 118).

7. Apply Parker® ThreadMate™ (page 118) to threads of straight fitting on HC cut-off valve.

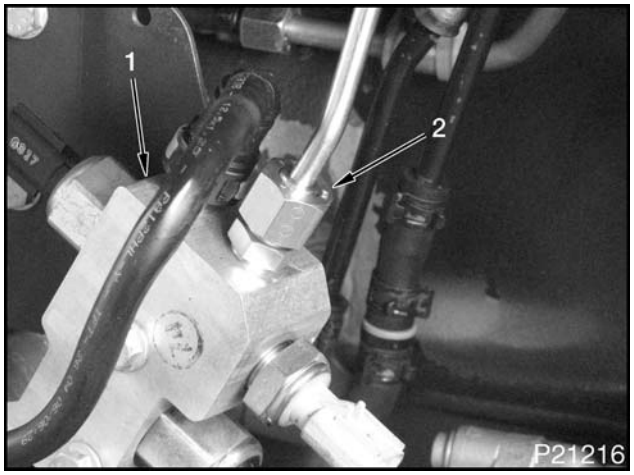

Figure 159 Fuel supply assembly (lower line)

1. Hydrocarbon (HC) cut-off valve
2. Fuel supply assembly (lower line)

8. Connect fuel supply assembly (lower line) onto HC cut-off valve. Tighten fitting nut to special torque (page 118).
9. Tighten fuel supply assembly (upper line) fitting nut to Parker® 4C6MXSS to special torque (page 118).

NOTE: Proceed with steps 10 and 11 only if fitting was removed or if AFI was replaced.

10. Align Parker® 4C6MXSS to maintain fuel supply assembly (upper line) clearance.
11. Tighten Parker® 4C6MXSS onto AFI to special torque (page 118).

Special Torque

Table 6 Aftertreatment System (in order of installation)

Turbo exhaust pipe hex bolt	31 N·m (23 lbf·ft)
Profiled clamp	6 N·m (44 lbf·in)
Aftertreatment fuel injector (AFI) hex bolts	See tightening steps in procedure.
Coolant return assembly P-clamp hex bolts	31 N·m (23 lbf·ft)
Parker® vee 12 onto AFI	41 N·m (30 lbf·ft)
Parker® ew12 onto Parker® vee 12	41 N·m (30 lbf·ft)
Coolant return assembly fitting nut to Parker® ew12	See tightening steps in procedure.
Parker® wee 12 into coolant elbow	41 N·m (30 lbf·ft)
Coolant supply line fitting nuts	See tightening steps in procedure.
Straight fitting into HC cut-off valve	24 N·m (18 lbf·ft)
M10 x 1 threaded union into HC cut-off valve	23 N·m (11 lbf·ft)
M14 x 1.5 threaded union into HC cut-off valve	35 N·m (26 lbf·ft)
Hydrocarbon (HC) cut-off valve hex bolts	31 N·m (23 lbf·ft)
M6 x 40 fuel supply assembly (upper line) P-clamp hex bolts	13 N·m (11 lbf·ft)
M8 x 16 fuel supply assembly (lower line) P-clamp hex bolt	31 N·m (23 lbf·ft)
Fuel supply assembly (upper line) fitting nut at connection of upper and lower lines	40 N·m (30 lbf·ft)
Fuel supply assembly (lower line) fitting nut at HC cut-off valve	27 N·m (20 lbf·ft)
Fuel supply assembly fitting nut (upper line) at Parker® 4C6MXSS	27 N·m (20 lbf·ft)
Parker® 4C6MXSS into AFI	15 N·m (11 lbf·ft)

Special Service Tools

Table 7 Aftertreatment System

Description	Tool Number
Parker® ThreadMate™	Obtain locally
High-Temperature Nickel-Graphite Anti-Seize Compound	Obtain locally
Fuel Line Disconnect Tool 11.8 mm	ZTSE4773

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Exploded View

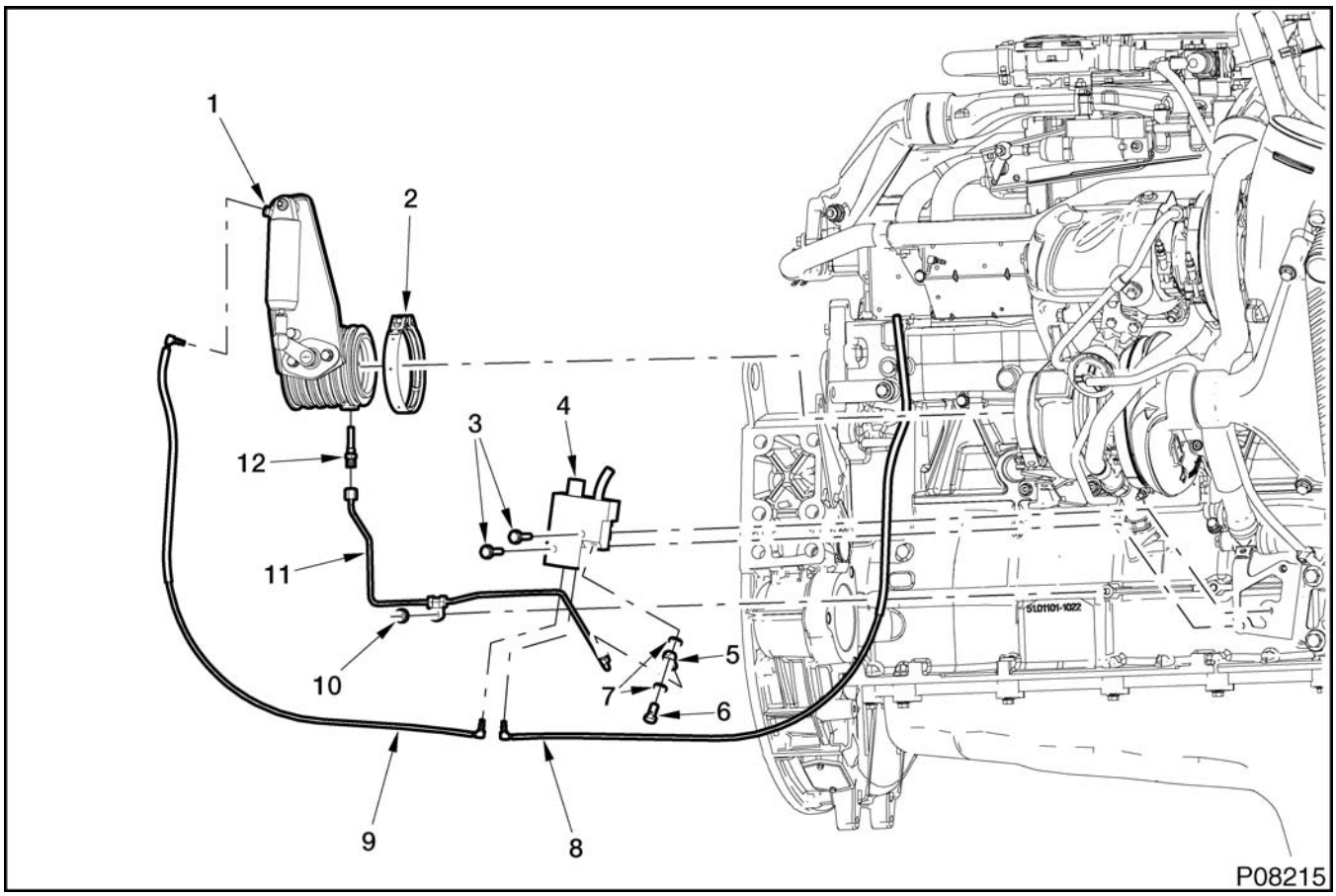

Figure 160 Retarder control system

1. Exhaust manifold with butterfly
2. DMR 114 profiled clamp
3. M8 x 55 hex bolt (2)
4. Retarder control
5. Ring union
6. Size 6 hollow screw
7. 10 x 1.35 seal (2)
8. Air supply line assembly
9. Pressure air line
10. M8 x 16 x 20 stud bolt
11. Pressure line
12. Straight union

Removal

WARNING: To prevent personal injury or death, read all safety instructions in the "Safety Information" section of this manual.

WARNING: To prevent personal injury or death, shift transmission to park or neutral, set parking brake, and block wheels before doing diagnostic or service procedures.

WARNING: To prevent personal injury or death, make sure that the engine has cooled before removing components.

WARNING: To prevent personal injury or death, do not let engine fluids stay on your skin. Clean skin and nails using hand cleaner and wash with soap and water. Wash or discard clothing and rags contaminated with engine fluids.

GOVERNMENT REGULATION: Engine fluids (oil, fuel, and coolant) may be a threat to the environment. Recycle or dispose of engine fluids according to applicable regulations. Never put engine fluids in the trash, on the ground, in sewers or bodies of water.

NOTE: Refer to the following service sections for information on removal of components prior to this section:

- Engine Electrical
- Aftertreatment System

Pressure Line

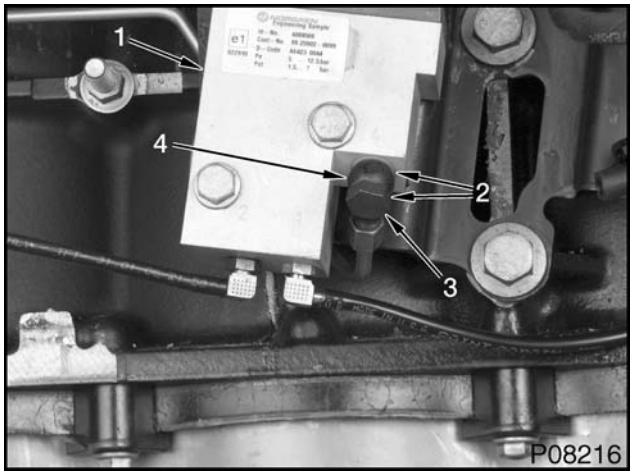

Figure 161 Pressure line connection at retarder control

1. Retarder control
2. 10 x 1.35 seal (2)
3. Size 6 hollow screw
4. Ring union

1. Remove size 6 hollow screw and disconnect ring union from retarder control. Discard two 10 x 1.35 seals.

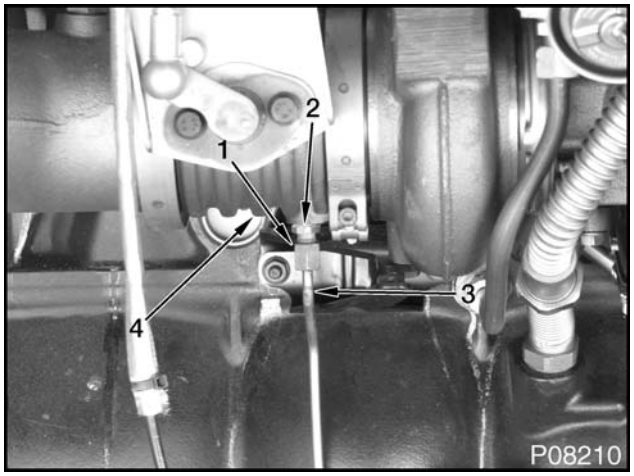

Figure 162 Pressure line connection at exhaust manifold with butterfly

1. Pressure line fitting nut
2. Straight union
3. Pressure line
4. Exhaust manifold with butterfly

2. Loosen pressure line fitting nut from straight union.

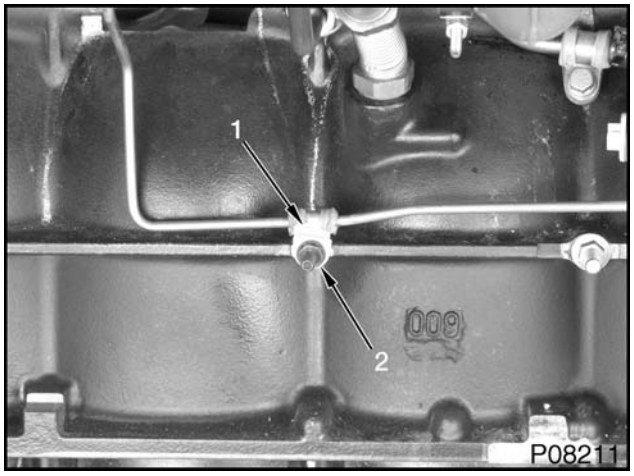

Figure 163 Pressure line P-clamp

1. Pressure line P-clamp
2. M8 x 16 x 20 stud bolt

3. Remove M8 x 16 x 20 stud bolt from pressure line P-clamp and remove pressure line.

NOTE: Do next step only if replacing ring union or pressure line due to leakage.

4. Remove ring union from pressure line.

Pressure Air Line

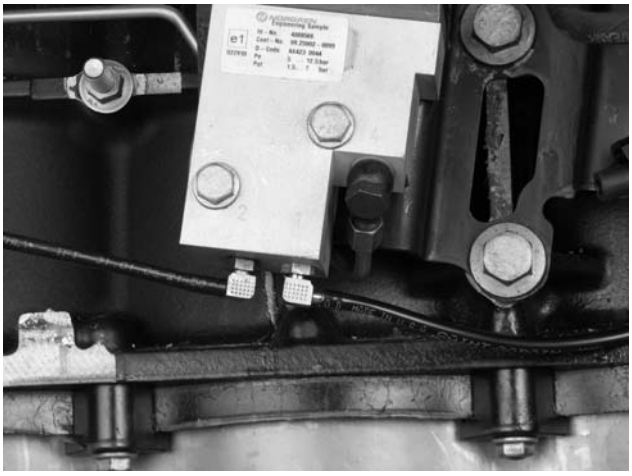

Figure 164 Pressure air line connection to retarder control

1. Retarder control
2. Pressure air line threaded fitting

1. Loosen pressure air line threaded fitting at retarder control and disconnect pressure air line.

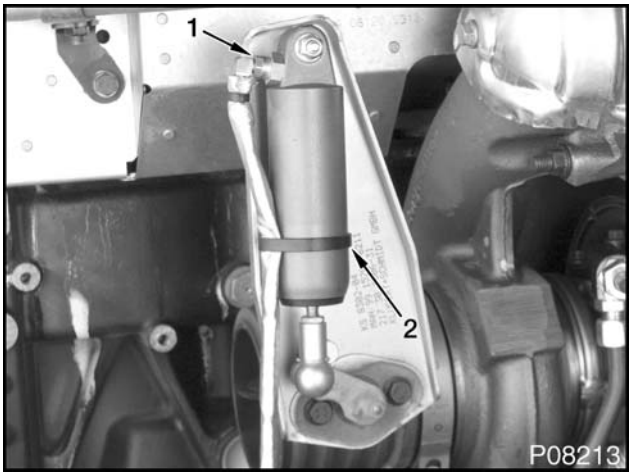

Figure 165 Pressure air line connection to exhaust manifold with butterfly

1. Pressure air line threaded fitting
2. Tie strap

2. Loosen pressure air line threaded fitting at exhaust manifold with butterfly and disconnect pressure air line.

3. Remove tie strap and remove pressure air line.

Retarder Control

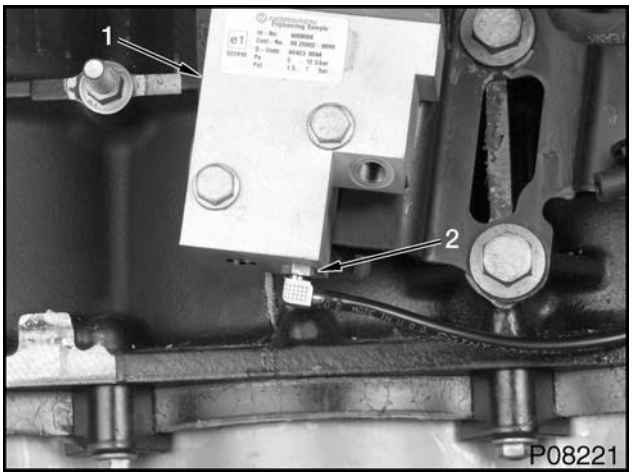

Figure 166 Air supply line assembly connection to retarder control

1. Retarder control
2. Air supply line assembly threaded fitting

1. Loosen air supply line assembly threaded fitting at retarder control and disconnect air supply line assembly.

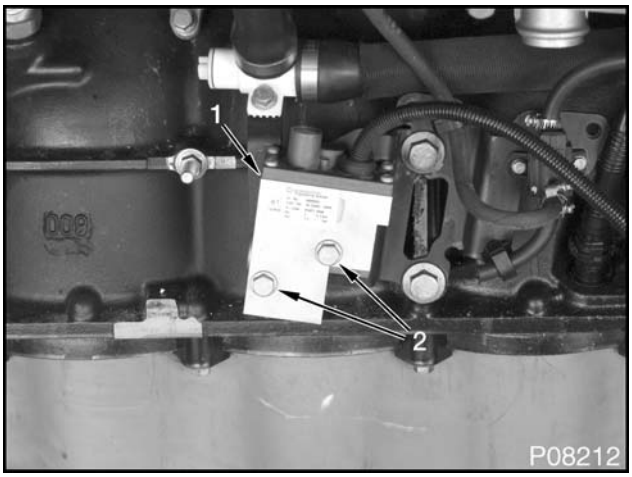

Figure 167 Retarder control

1. Retarder control
2. M8 x 55 hex bolt (2)

2. Remove two M8 x 55 hex bolts and retarder control.

Exhaust Manifold with Butterfly

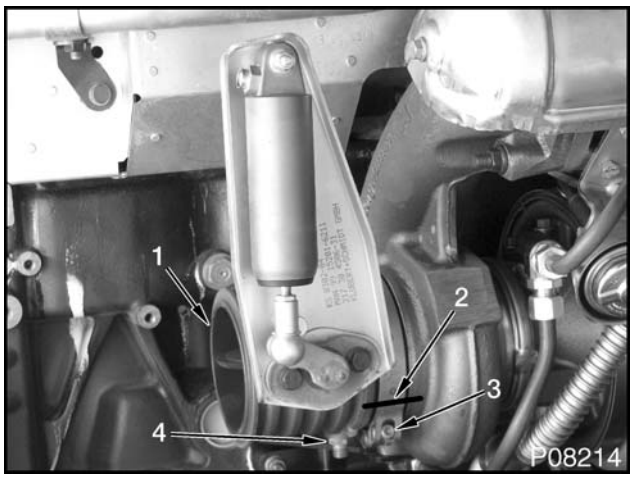

Figure 168 Exhaust manifold with butterfly

1. Exhaust manifold with butterfly
2. Orientation mark
3. DMR 114 profiled clamp
4. Straight union

1. Mark location of exhaust manifold with butterfly for correct orientation in relation to turbine housing.
2. Loosen DMR 114 profiled clamp and remove exhaust manifold with butterfly.

NOTE: Perform next step only if replacing exhaust manifold with butterfly or if straight union is leaking.

3. Remove straight union from exhaust manifold with butterfly.

Installation

Exhaust Manifold with Butterfly

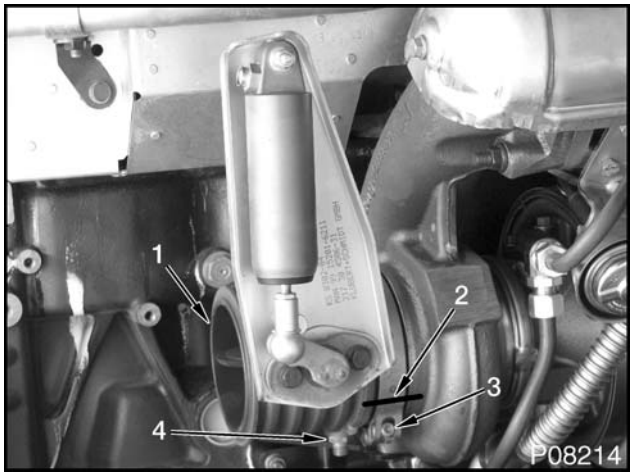

Figure 169 Exhaust manifold with butterfly

1. Exhaust manifold with butterfly
2. Orientation mark
3. DMR 114 profiled clamp
4. Straight union

NOTE: If replacing exhaust manifold with butterfly, transfer orientation mark to new exhaust manifold with butterfly for correct orientation.

1. Position DMR 114 profiled clamp and install exhaust manifold with butterfly to correct location as marked. Tighten profiled clamp to special torque (page 130).

NOTE: Perform next step only if exhaust manifold with butterfly was replaced or if straight union was replaced.

2. Tighten straight union as follows:
   a. Hand tighten straight union.
   b. Turn an additional 90°.

Retarder Control

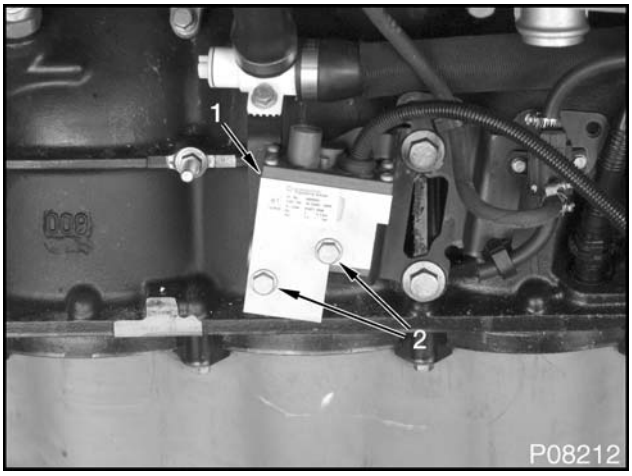

Figure 170 Retarder control

1. Retarder control
2. M8 x 55 hex bolt (2)

1. Install retarder control and two M8 x 55 hex bolts. Tighten hex bolts to special torque (page 130).

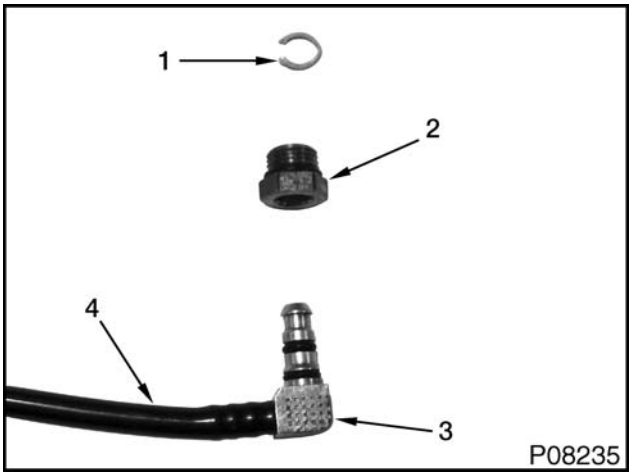

Figure 171 Air supply line assembly connections

1. Clip
2. Threaded fitting (with O-ring)
3. Male end (part of air supply line assembly)
4. Air supply line assembly

NOTE: If retarder control was replaced, perform steps 2 through 4. If retarder control was not replaced, perform steps 5 and 6.

NOTE: If air supply line assembly was replaced or was found to be leaking, perform steps 7 and 8. If air supply line assembly was not replaced, perform steps 5 and 6.

2. Remove old clip and threaded fitting from existing air supply line assembly.

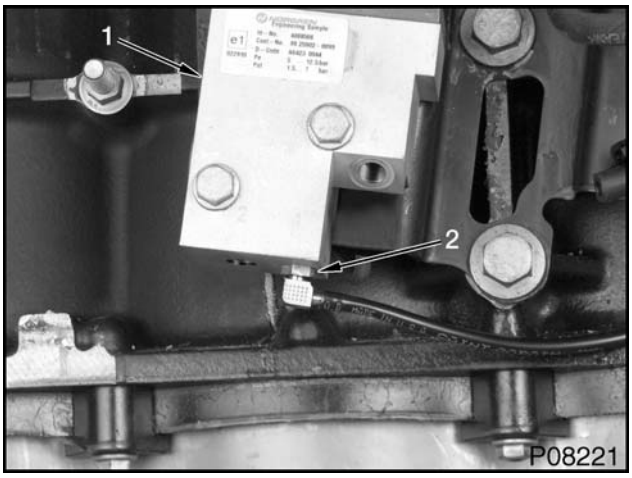

Figure 172 Air supply line assembly connection to retarder control

1. Retarder control
2. Threaded fitting

3. Lubricate existing air supply line assembly O-rings with P-80® Rubber Lubricant or equivalent(page 130).
4. Install and push air supply line assembly into new threaded fitting (mounted on new retarder control) until a click is heard. This ensures the air supply line assembly has locked into the clip and is properly installed.
5. Lubricate existing air supply line assembly threaded fitting O-ring with P-80® Rubber Lubricant or equivalent (page 130).
6. Position existing air supply line assembly and install threaded fitting into retarder control. Tighten threaded fitting to special torque (page 130).
7. Lubricate new air supply line assembly threaded fitting O-ring with P-80® Rubber Lubricant or equivalent (page 130). Install new clip and new threaded fitting into retarder control. Tighten threaded fitting to special torque (page 130).
8. Install and push new air supply line assembly into threaded fitting until a click is heard. This ensures the air supply line assembly has locked into the clip and is properly installed.

Pressure Air Line

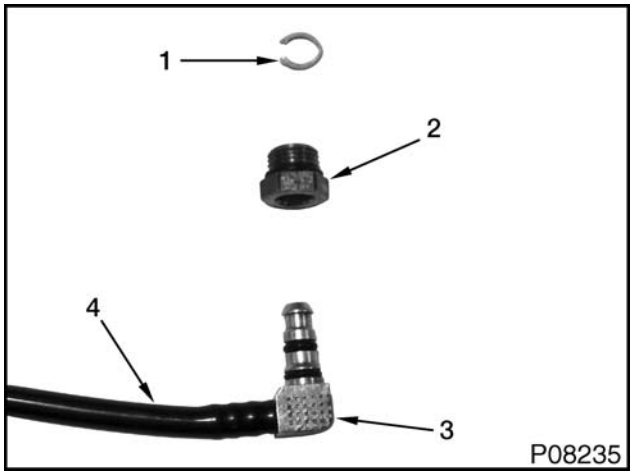

Figure 173 Pressure air line connections

1. Clip
2. Threaded fitting (with O-ring)
3. Male end (part of pressure air line)
4. Pressure air line

NOTE: If retarder control was replaced, perform steps 1 through 3. If retarder control was not replaced, perform steps 4 and 5.

NOTE: If pressure air line was replaced or was found to be leaking, perform steps 6 and 7. If pressure air line was not replaced, perform steps 4 and 5.

1. Remove old clip and threaded fitting from pressure air line.

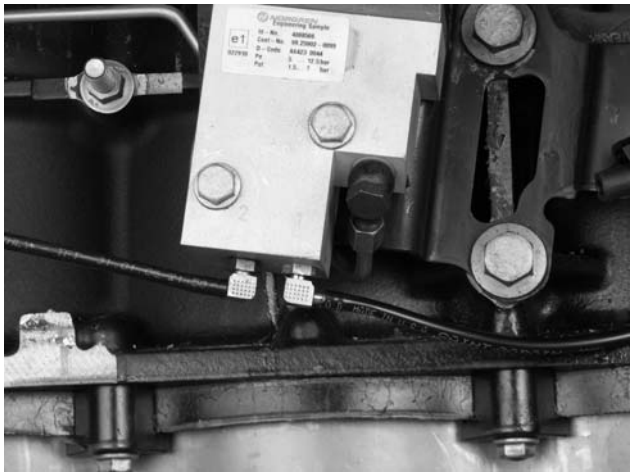

Figure 174 Pressure air line connection to retarder control

1. Retarder control
2. Pressure air line threaded fitting

2. Lubricate existing pressure air line O-rings with P-80® Rubber Lubricant or equivalent (page 130).
3. Install and push pressure air line into new threaded fitting (mounted on new retarder control) until a click is heard. This ensures the pressure air line has locked into place and is properly installed.
4. Lubricate existing pressure air line threaded fitting O-ring with P-80® Rubber Lubricant or equivalent (page 130).
5. Position existing pressure air line and install threaded fitting into retarder control. Tighten threaded fitting to special torque (page 130).
6. Lubricate new pressure air line threaded fitting O-ring with P-80® Rubber Lubricant or equivalent(page 130). Install new clip and new threaded fitting into retarder control. Tighten threaded fitting to special torque (page 130).
7. Install and push new pressure air line into threaded fitting until a click is heard. This ensures the pressure air line has locked into place and is properly installed.

NOTE: If exhaust manifold with butterfly was replaced, perform steps 8 through 10. If exhaust manifold with butterfly was not replaced, perform steps 11 and 12.

NOTE: If pressure air line was replaced or was found to be leaking, perform steps 13 and 14. If pressure air line was not replaced, perform steps 11 and 12.

8. Remove old clip and threaded fitting from pressure air line.
9. Lubricate existing pressure air line O-rings with P-80® Rubber Lubricant or equivalent (page 130).
10. Install and push existing pressure air line into new threaded fitting (mounted on new exhaust manifold with butterfly) until a click is heard. This ensures the pressure air line has locked into place and is properly installed.
11. Lubricate existing pressure air line threaded fitting O-ring with P-80® Rubber Lubricant or equivalent (page 130).
12. Position existing pressure air line and install fitting nut into exhaust manifold with butterfly. Tighten fitting nut to special torque (page 130).
13. Lubricate new pressure air line O-rings with P-80® Rubber Lubricant or equivalent (page 130). Install new clip and new threaded fitting into exhaust manifold with butterfly. Tighten threaded fitting to special torque (page 130).
14. Install and push new pressure air line into threaded fitting until a click is heard. This ensures the pressure air line had locked into place and is properly installed.

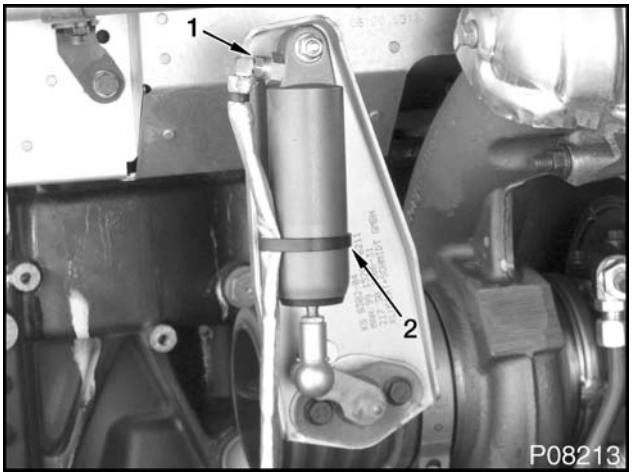

Figure 175 Exhaust manifold with butterfly connection

1. Pressure air line fitting nut
2. Tie strap

NOTE: Make sure installing tie strap does not kink air line.

15. Install new tie strap as shown in figure above.

Pressure Line

NOTE: Do step 1 only if ring union was previously removed from pressure line, otherwise begin with step 2.

1. Install ring union onto pressure line. Do not tighten at this time.

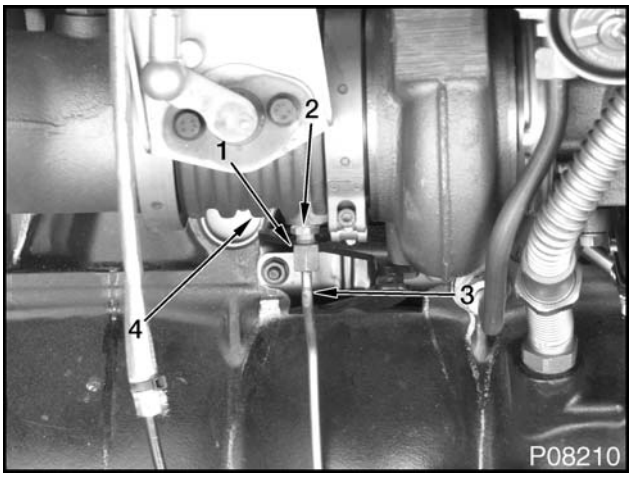

Figure 176 Pressure line connection at exhaust manifold with butterfly

1. Pressure line fitting nut
2. Straight union
3. Pressure line
4. Exhaust manifold with butterfly

2. Position pressure line and fitting nut and install into straight union. Hand tighten fitting nut.

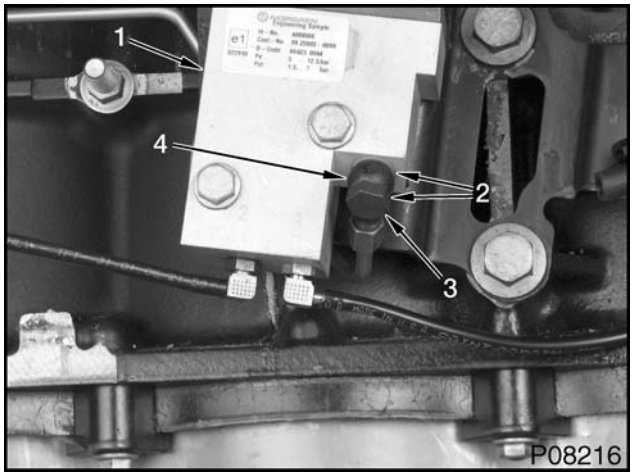

Figure 177 Pressure line connection at retarder control

1. Retarder control
2. 10 x 1.35 seal (2)
3. Size 6 hollow screw
4. Ring union

3. Position ring union and two new 10 x 1.35 seals into retarder control. Install size 6 hollow screw. Hand tighten size 6 hollow screw.

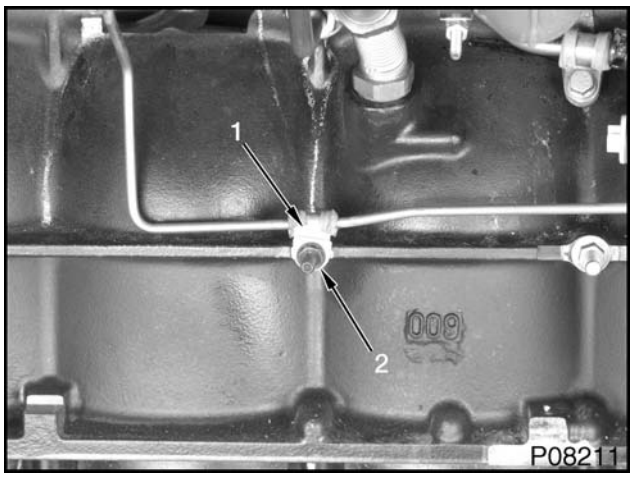

Figure 178 Pressure line P-clamp

1. Pressure line P-clamp
2. M8 x 16 x 20 stud bolt

4. Install M8 x 16 x 20 stud bolt through pressure line P-clamp and into crankcase. Tighten stud bolt to special torque (page 130).

5. Tighten size 6 hollow screw at retarder control to special torque (page 130).
6. If loosened in step 1, tighten pressure line fitting nut at ring union to special torque (page 130).
7. Tighten pressure line fitting nut at straight union to special torque (page 130).

Special Torque

Table 8 Retarder Control System Components

DMR 114 profiled clamp	10 N·m (89 lbf·in)
Pressure line P-clamp stud bolt	35 N·m (26 lbf·ft)
Retarder control hex bolts	35 N·m (26 lbf·ft)
Size 6 hollow screw	20 N·m (15 lbf-ft)
Pressure line fitting nut to straight union	30 N·m (22 lbf·ft)
Pressure line fitting nut to ring union	30 N·m (22 lbf·ft)
Straight union	See tightening steps in procedure.
Pressure air line fitting nut to retarder control	12 N·m (106 lbf·in)
Pressure air line fitting nut to exhaust manifold with butterfly	12 N·m (106 lbf·in)
Air supply line assembly fitting nut to retarder control	12 N·m (106 lbf·in)

Special Service Tools

Table 9 Engine Retarder Control

Description	Tool Number
P-80®Rubber Lubricant or equivalent	Obtain locally

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Exploded Views

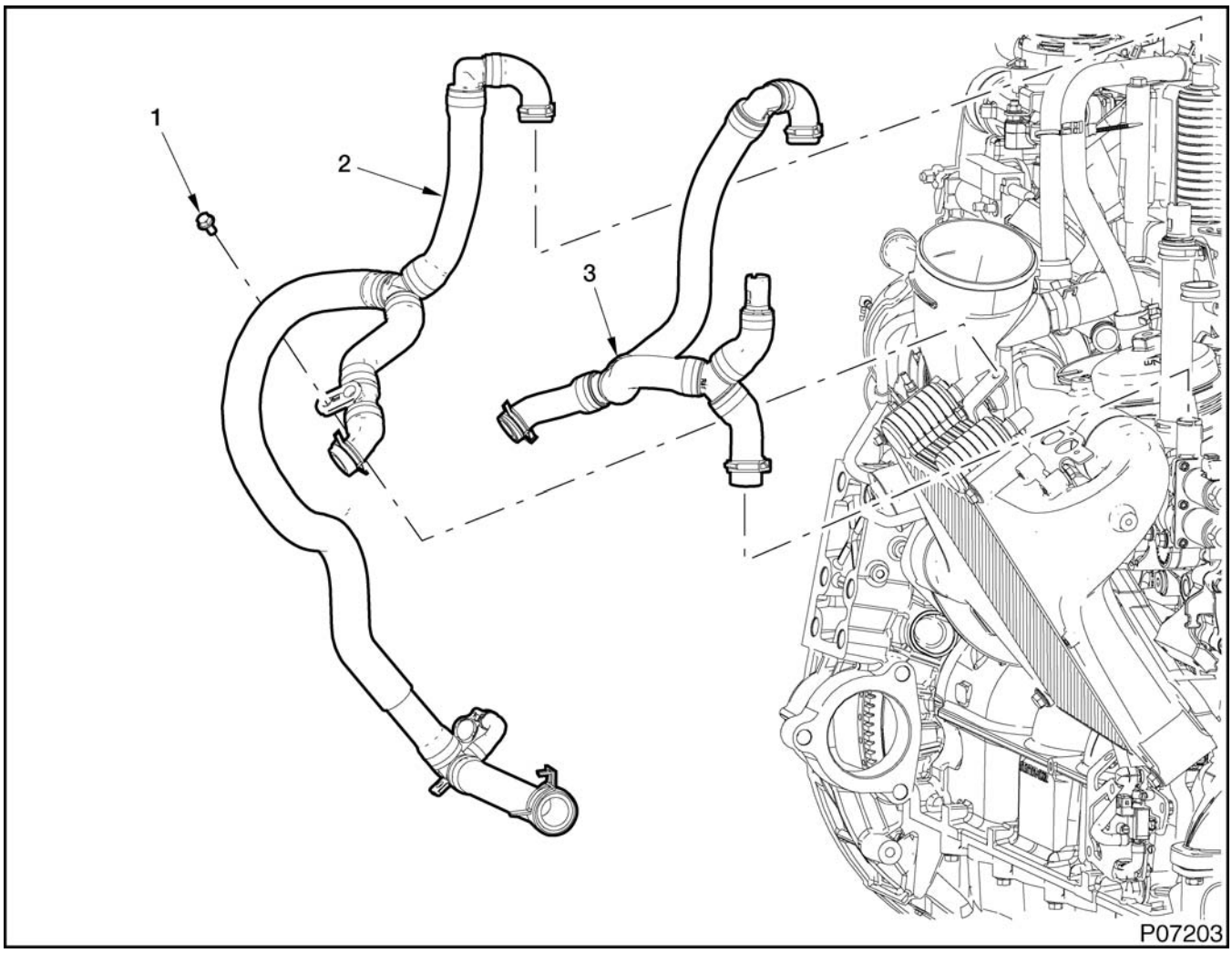

Figure 179 Coolant pipes

1. M8 x 16 hex bolt
2. Charge Air Cooler (CAC) return coolant pipe
3. CAC supply coolant pipe

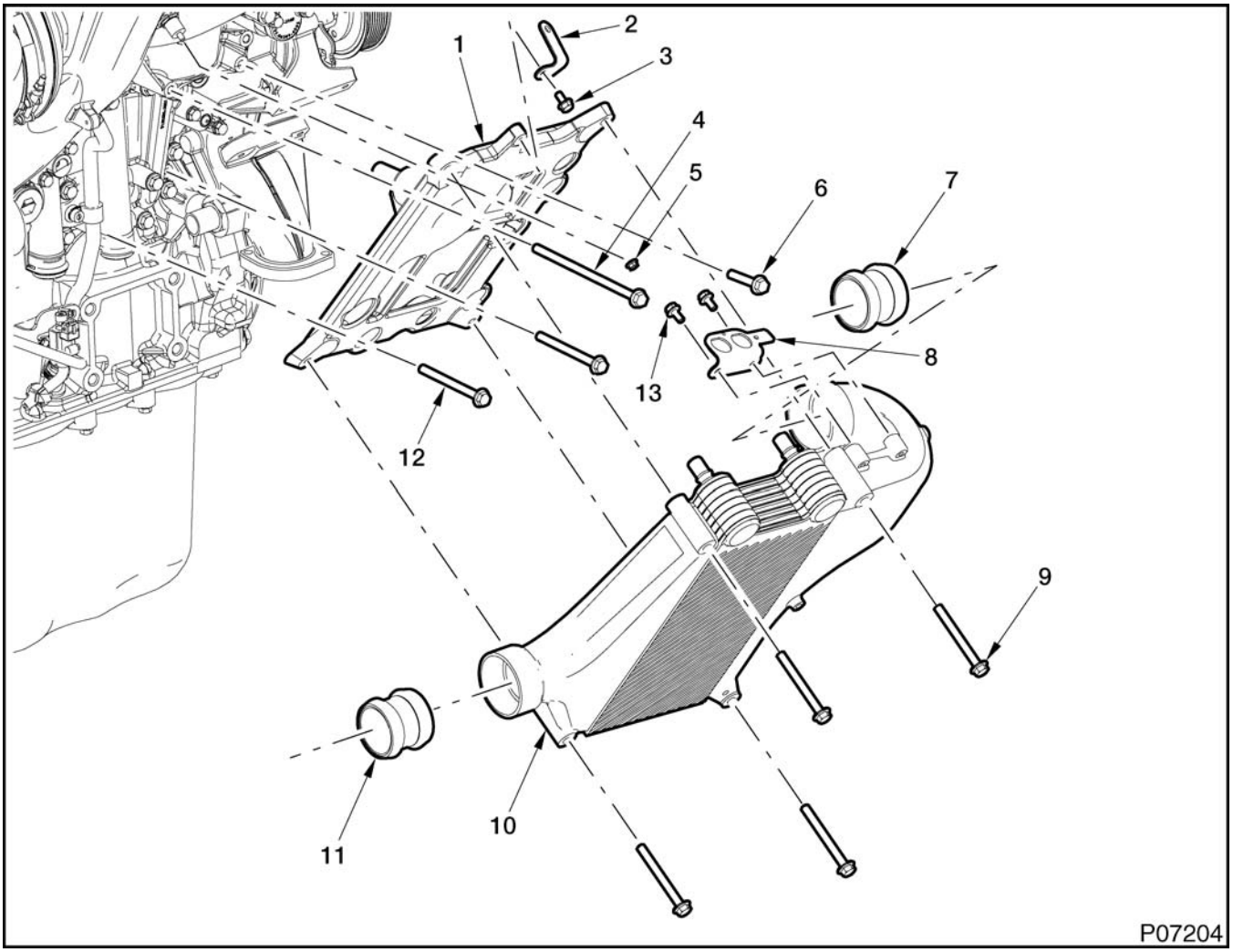

Figure 180 Low Pressure Charge Air Cooler (LPCAC)

1. LPCAC bracket
2. Temperature sensor bracket
3. M8 x 16 hex bolt
4. M10 x 190 hex bolt
5. M6 hexagon nut
6. M10 x 50 hex bolt
7. DMR70 extension tube
8. Adapter line bracket
9. M10 x 90 hex bolt (4)
10. LPCAC
11. DMR70 extension tube
12. M10 x 110 hex bolt (2)
13. M8 x 16 hex bolt (2)

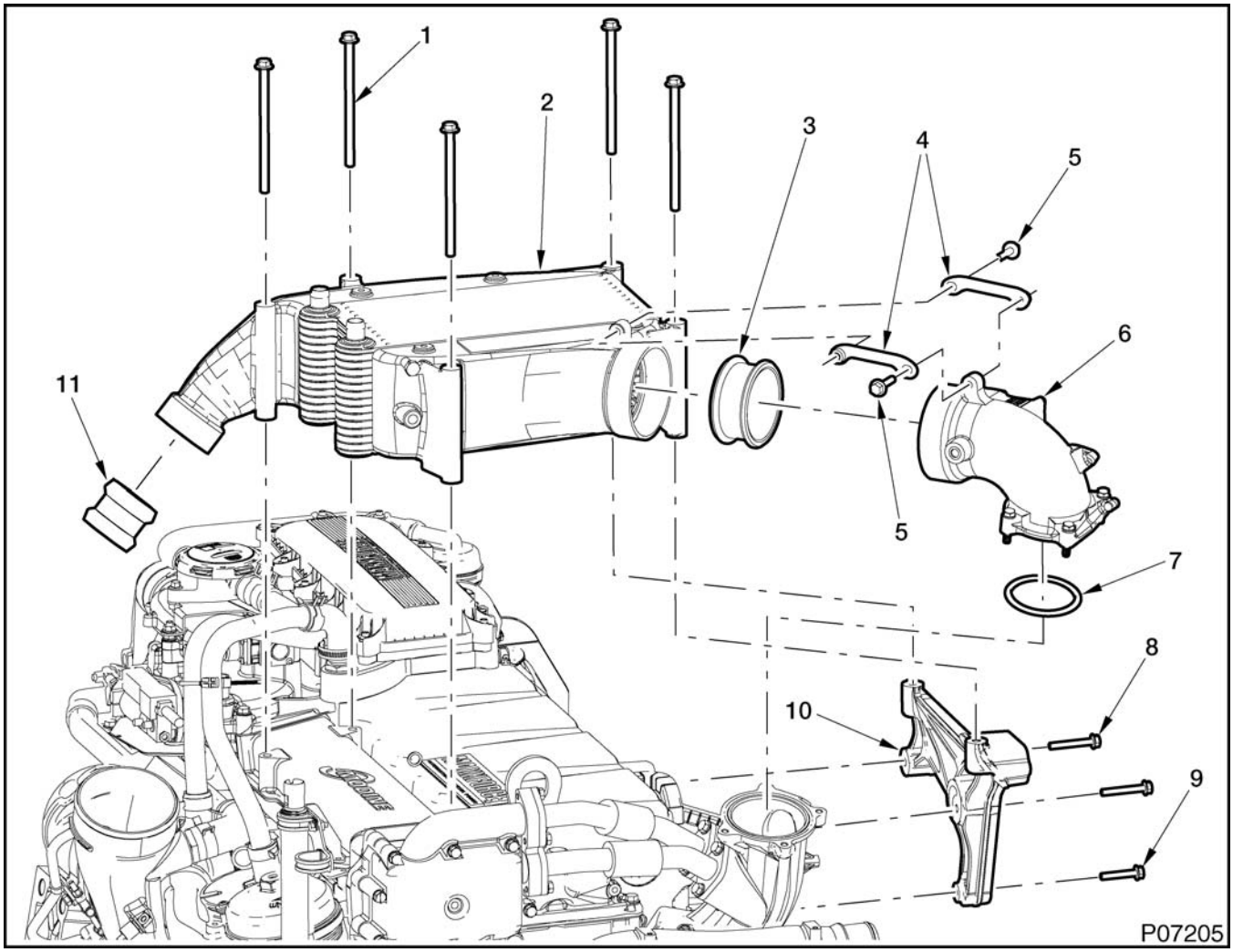

Figure 181 High Pressure Charge Air Cooler (HPCAC)

1. M10 x 160 hex bolt (5)
2. HPCAC
3. DMR110/92 extension tube
4. Latch arm (2)
5. M10 x 30 hex bolt (2)
6. Intake Throttle Valve (ITV)
7. O-ring
8. M8 x 55 hex bolt (2)
9. M8 x 45 hex bolt
10. HPCAC bracket
11. DMR70 extension tube

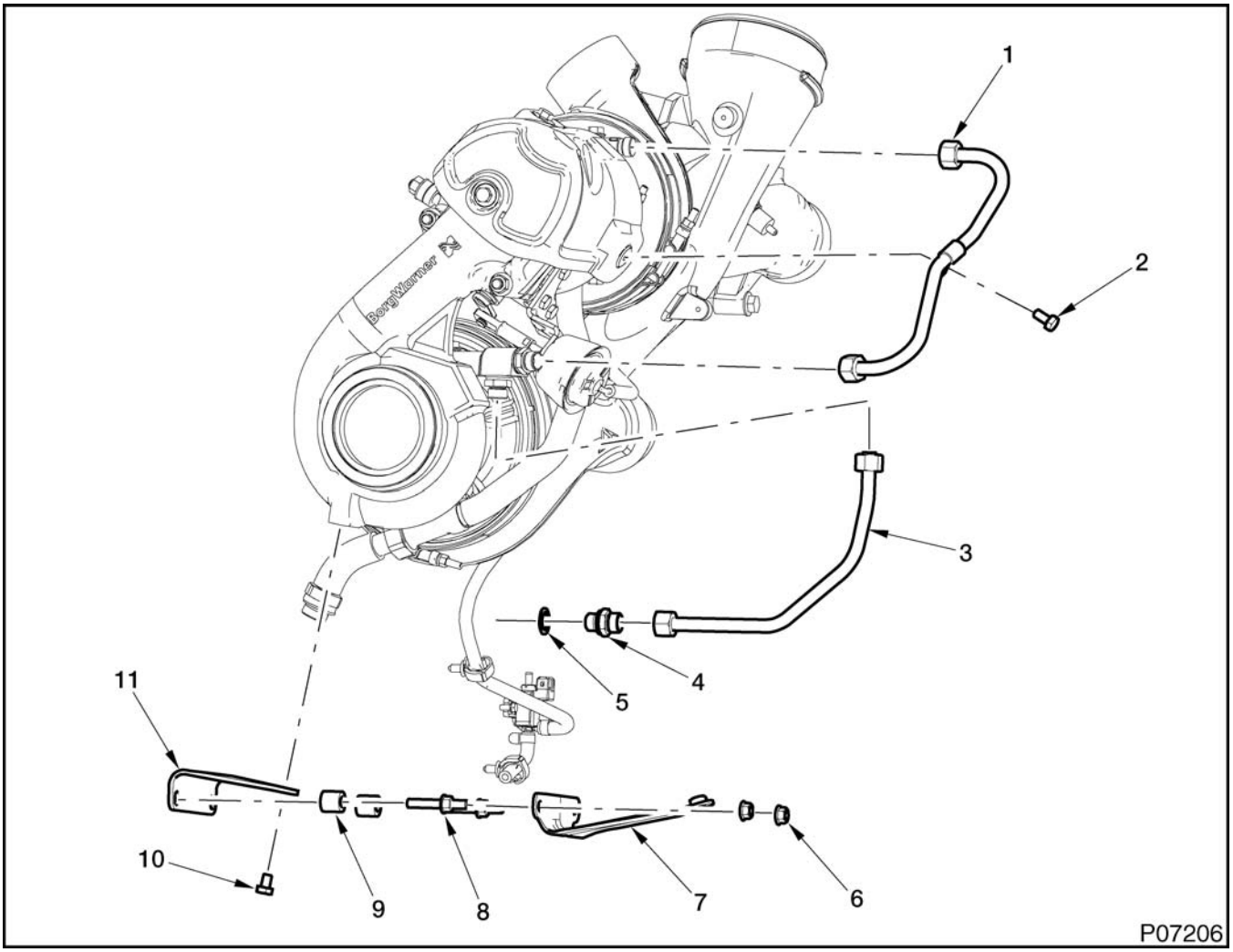

Figure 182 Oil pressure pipes and bracket

1. High pressure turbocharger oil pressure pipe
2. M8 x 16 hex bolt
3. Low pressure turbocharger oil pressure pipe
4. L12A straight union
5. BS-24.7 x 32 seal
6. M8 hex nut (2)
7. Starter heat shield bracket
8. M8 x 35 stud bolt (2)
9. Bushing (2)
10. M8 x 12 hex bolt
11. Bracket (turbocharger support)

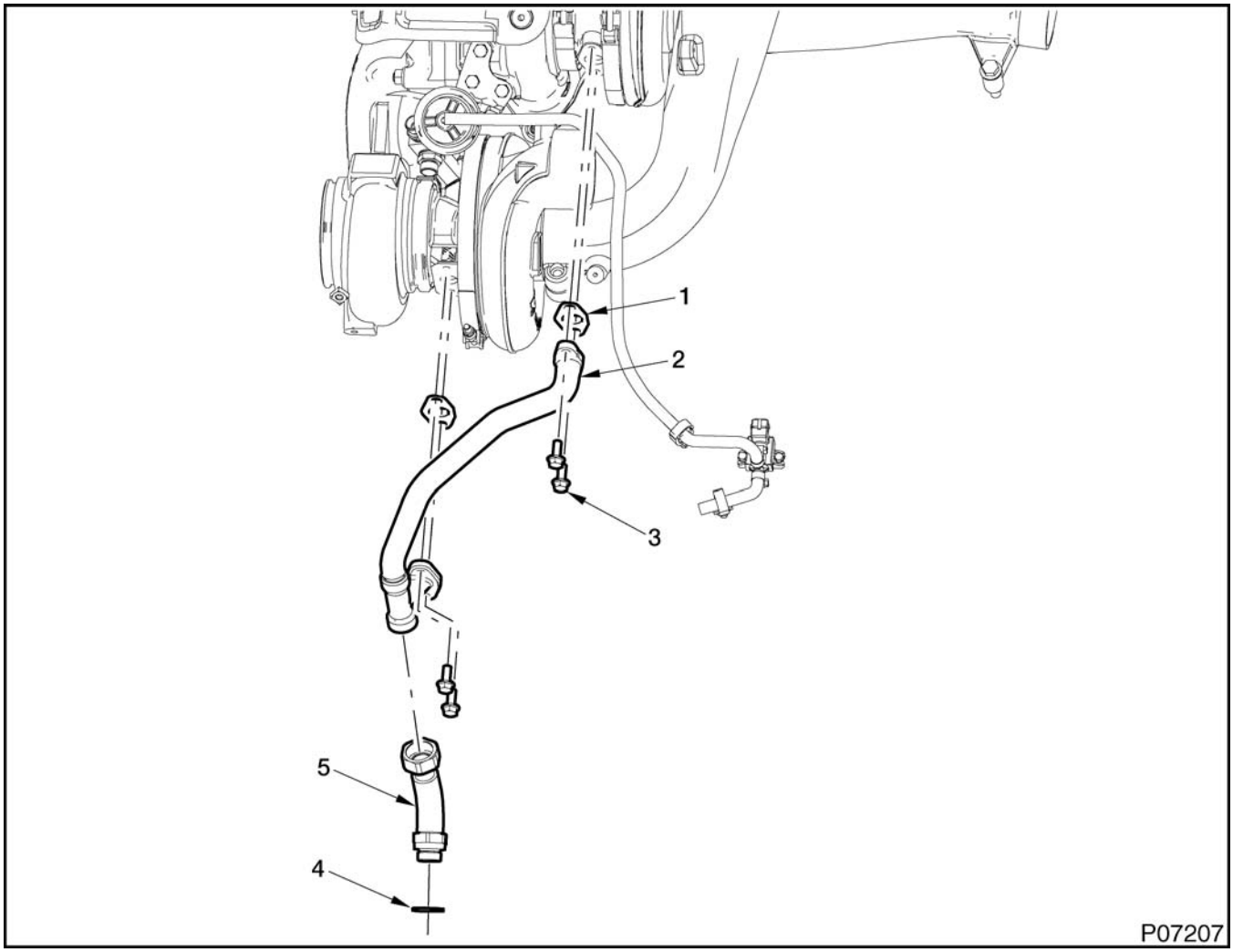

Figure 183 Oil return pipe

1. Gasket (2)
2. High pressure turbocharger oil return pipe
3. M8 x 20 hex bolt (4)
4. BS-16.7 x 24 seal
5. Low pressure turbocharger oil return pipe

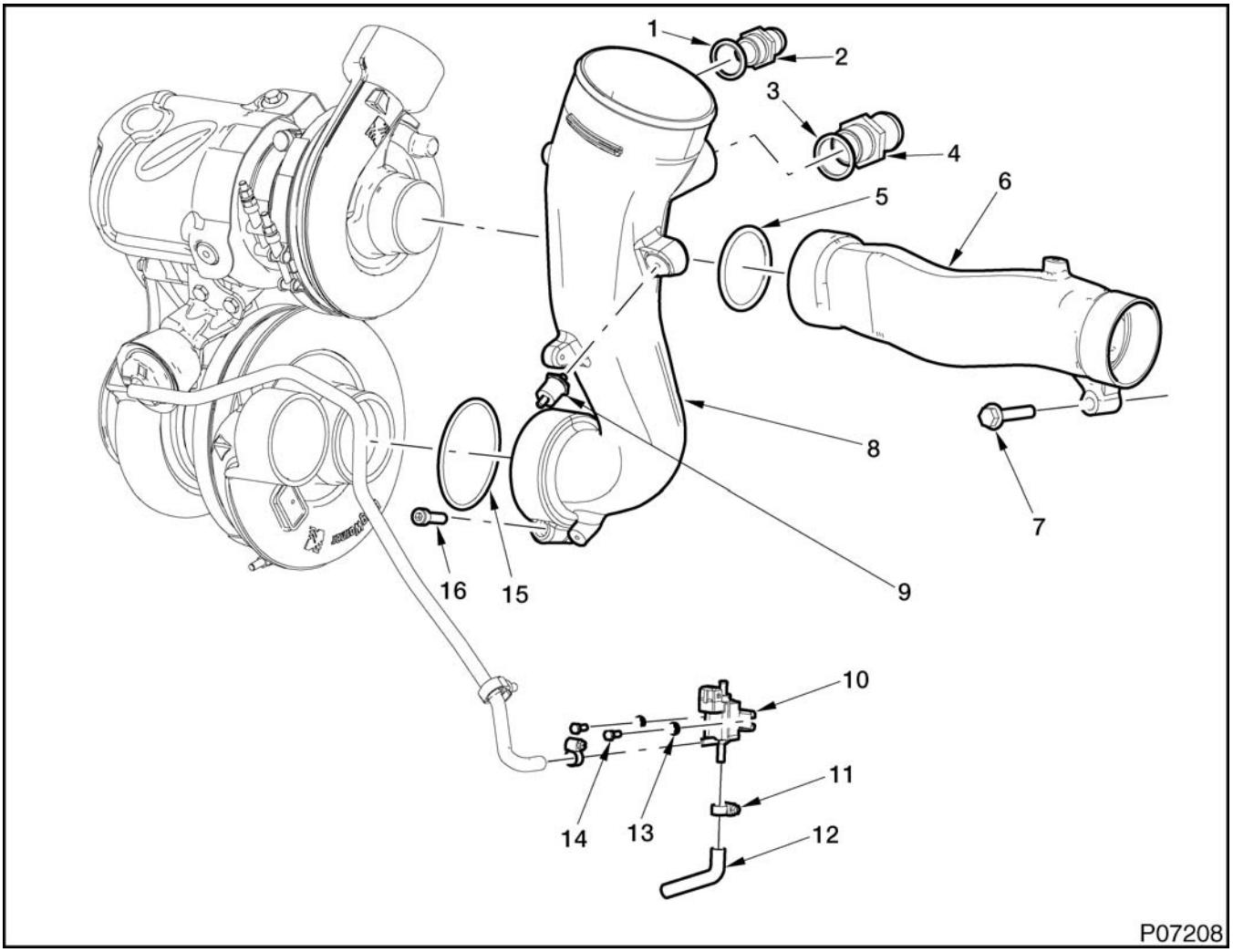

Figure 184 Air intake and boost control

1. BS-26.7 x 34 seal
2. M26 x 1.5 threaded union
3. BS-32.7 x 40 seal
4. M32 x 1.5 threaded union
5. 62.87 x 5.33 O-ring
6. Intercooler elbow
7. M10 x 50 hex bolt
8. Air intake manifold
9. Rubber pad
10. Boost Control Solenoid (BCS) valve
11. Hose clamp (2)
12. Hose
13. M5 washer (2)
14. M5 x 12 hex bolt (2)
15. BS-32.7 x 40 seal
16. M8 x 30 cylinder screw

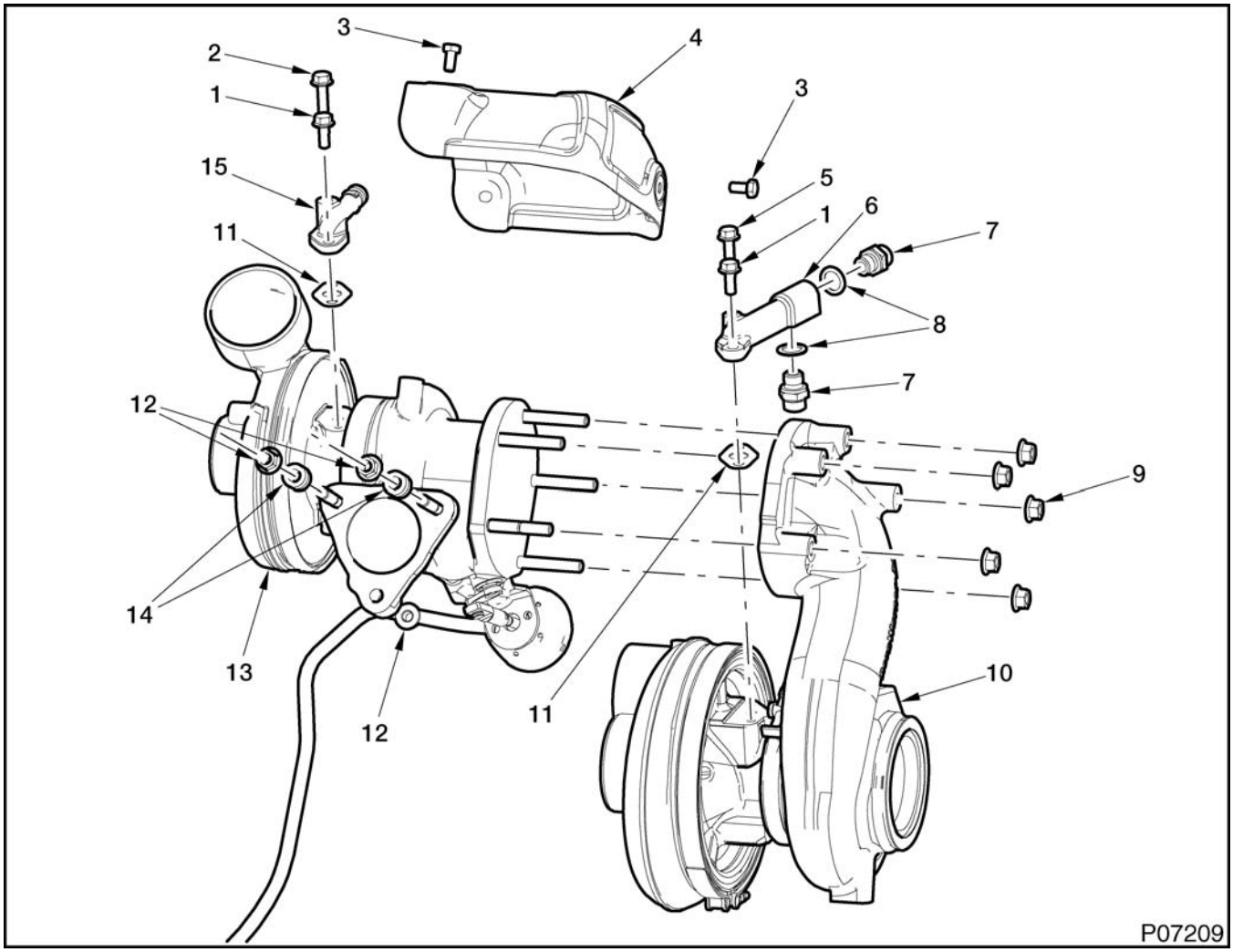

Figure 185 Turbochargers

1. M8 x 20 hex bolt (2)
2. M8 x 45 hex bolt
3. M8 x 16 hex bolt (2)
4. Heat shield
5. M8 x 35 hex bolt
6. Low pressure turbocharger oil pressure connection flange
7. Straight union (2)
8. Seal (2)
9. M10 hexagon nut (5)
10. Low pressure turbocharger
11. Gasket (2)
12. M10 hexagon nut (3)
13. High pressure turbocharger
14. High temperature spacing bushing (2)
15. High pressure turbocharger oil pressure connection flange

Removal

WARNING: To prevent personal injury or death, read all safety instructions in the "Safety Information" section of this manual.

WARNING: To prevent personal injury or death, shift the transmission to park or neutral, set the parking brake, and block the wheels before doing diagnostic or service procedures.

WARNING: To prevent personal injury or death, make sure the engine and turbocharger have cooled before removing the turbocharger.

WARNING: To prevent personal injury or death, remove the ground cable from the negative terminal of the main battery before disconnecting or connecting electrical components. Always connect the ground cable last.

WARNING: To prevent personal injury or death, do not let engine fluids stay on your skin. Clean skin and nails using hand cleaner and wash with soap and water. Wash or discard clothing and rags contaminated with engine fluids.

GOVERNMENT REGULATION: Engine fluids (oil, fuel, and coolant) may be a threat to the environment. Recycle or dispose of engine fluids according to applicable regulations. Never put engine fluids in the trash, on the ground, in sewers or bodies of water.

NOTE: Refer to the following service sections for information on removal of components prior to this section.

- Engine Electrical
- Aftertreatment System
- Engine Retarder Control

Boost Control Solenoid (BCS) Valve

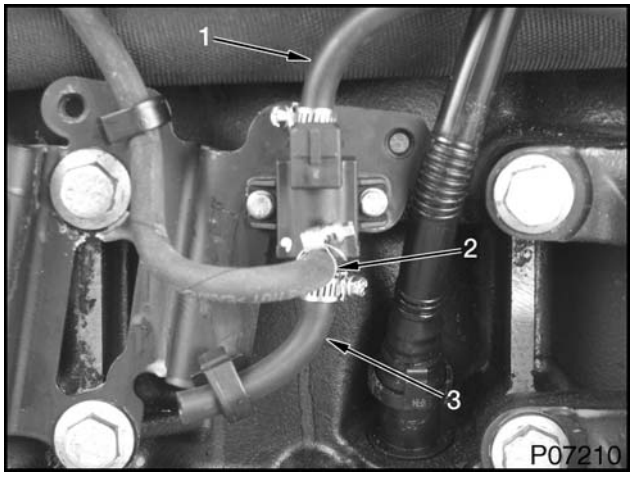

Figure 186 BCS valve hoses

1. BCS valve supply line
2. BCS valve output line
3. Hose

1. Loosen three hose clamps and disconnect three hoses from BCS valve.

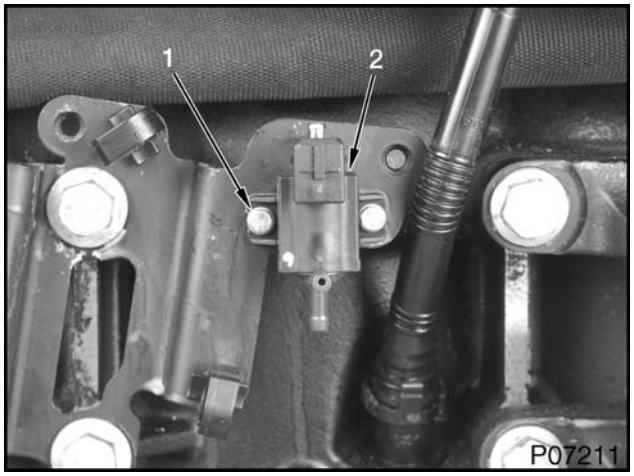

Figure 187 BCS valve

1. M5 x 12 hex bolt (2)
2. BCS valve

2. Remove two M5 x 12 hex bolts and two M5 washers.
3. Remove BCS valve.

Boost Control Solenoid (BCS) Valve Supply Line

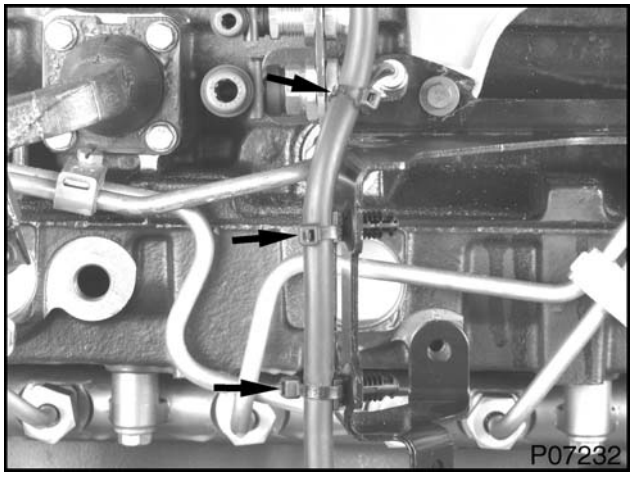

Figure 188 Tie straps

1. Remove three tie straps retaining BCS valve supply line to bracket.

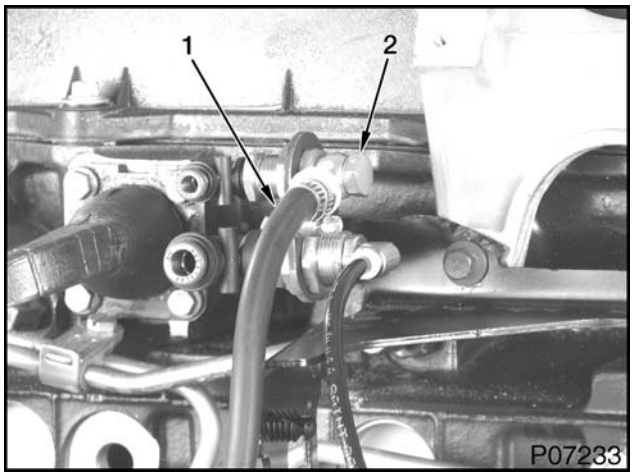

Figure 189 BCS valve supply line

1. BCS valve supply line
2. Banjo bolt

2. Remove banjo bolt and disconnect BCS valve supply line from air fitting. Discard washers.
3. Note routing of BCS valve supply line for later reassembly. Remove line.

Low Pressure Charge Air Cooler (LPCAC)

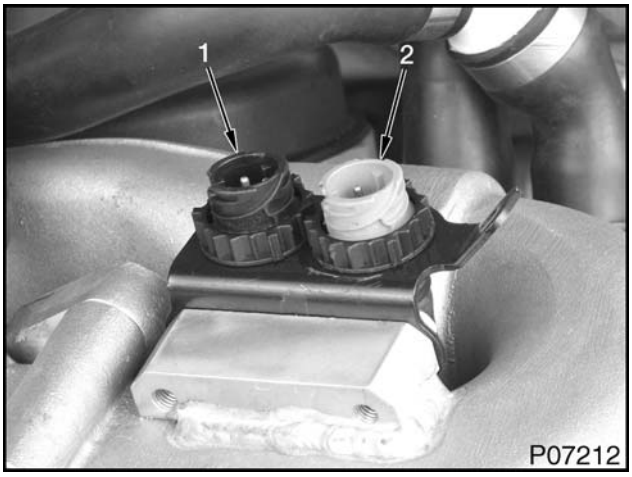

Figure 190 Adapter lines (electrical connections)

1. Engine Oil Pressure (EOP) sensor adapter line
2. Engine Oil Temperature (EOT) sensor adapter line

1. Remove retaining ring by turning counterclockwise and release EOP sensor adapter line from adapter line bracket on LPCAC.
2. Remove retaining ring by turning counterclockwise and release EOT sensor adapter line from adapter line bracket on LPCAC.

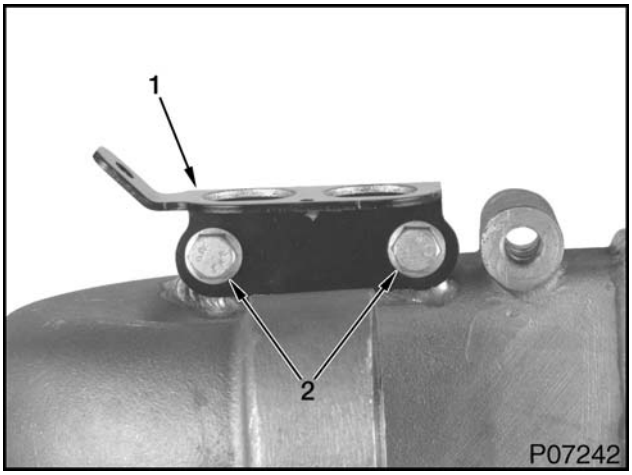

Figure 191 Adapter line bracket

1. Adapter line bracket
2. M8 x 16 hex bolt (2)

3. Remove two M8 x 16 hex bolts and adapter line bracket.

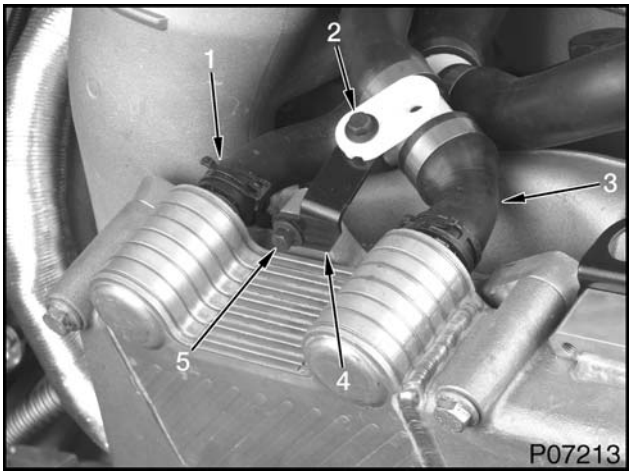

Figure 192 Low Pressure Charge Air Cooler (LPCAC) coolant pipe connections

1. CAC supply coolant pipe
2. M8 x 16 hex bolt
3. CAC return coolant pipe
4. Temperature sensor bracket
5. M8 x 16 hex bolt

4. Release hose clamp and disconnect CAC supply coolant pipe from LPCAC.
5. Remove M8 x 16 hex bolt from bracket on LPCAC.
6. Release hose clamp and disconnect CAC return coolant pipe from LPCAC.
7. Remove M8 x 16 hex bolt and temperature sensor bracket.

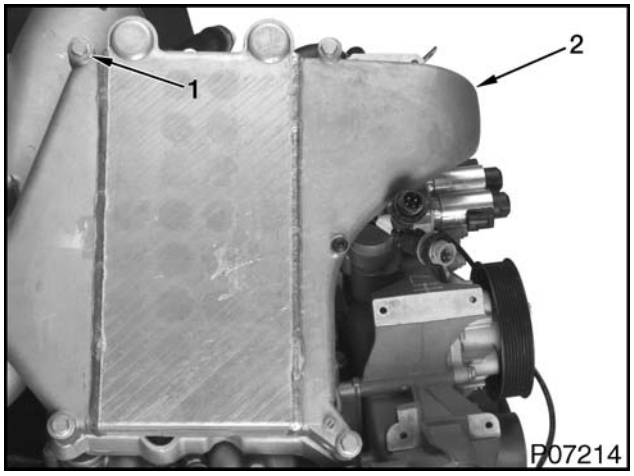

Figure 193 Low Pressure Charge Air Cooler (LPCAC)

1. M10 x 90 hex bolt (4)
2. LPCAC

8. Remove four M10 x 90 hex bolts.
9. Remove LPCAC from engine.

CAUTION: To prevent engine damage, do not remove extension tubes by grabbing sealing surface.

10. Remove two DMR70 extension tubes from LPCAC. Inspect sealing surfaces of DMR70 extension tubes. Discard if damaged.

Low Pressure Charge Air Cooler (LPCAC) Bracket

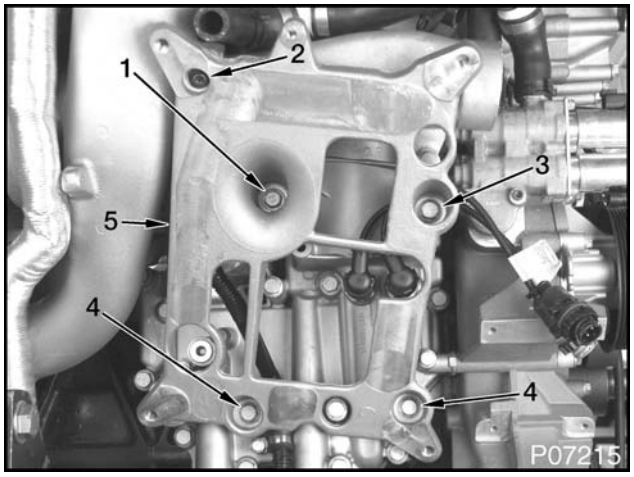

Figure 194 Low Pressure Charge Air Cooler (LPCAC) bracket

1. M10 x 190 hex bolt
2. M6 hexagon nut
3. M10 x 50 hex bolt
4. M10 x 110 hex bolt (2)
5. LPCAC bracket

1. Remove M10 x 190 hex bolt, M6 hexagon nut, M10 x 50 hex bolt, and two M10 x 110 hex bolts from LPCAC bracket.
2. Remove LPCAC bracket.

High Pressure Charge Air Cooler (HPCAC)

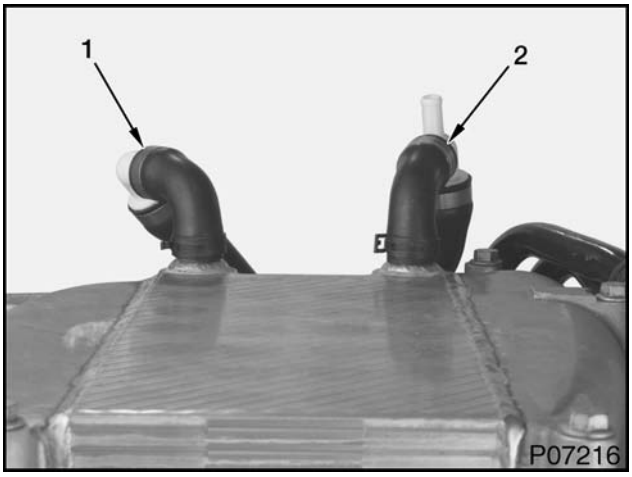

Figure 195 High Pressure Charge Air Cooler (HPCAC) coolant pipe connections

1. CAC supply coolant pipe
2. CAC return coolant pipe

1. Release hose clamp and disconnect CAC supply coolant pipe from HPCAC.
2. Release hose clamp and disconnect CAC return coolant pipe from HPCAC.

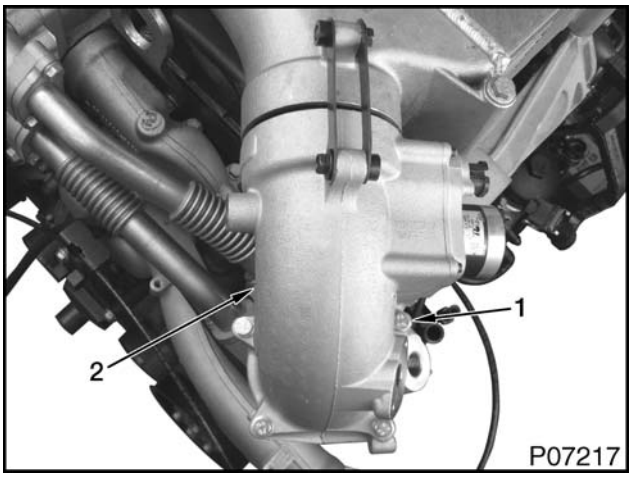

Figure 196 Intake Throttle Valve (ITV)

1. ITV bolt (4)
2. ITV

NOTE: The captive ITV bolts can be locked in a raised position by pulling up and turning counterclockwise.

3. Unscrew four captive ITV bolts.

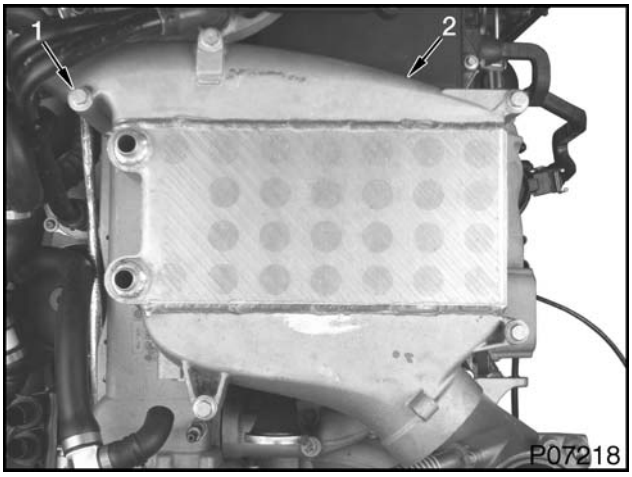

Figure 197 High Pressure Charge Air Cooler (HPCAC)

1. M10 x 160 hex bolt (5)
2. HPCAC

4. Remove five M10 x 160 hex bolts.
5. Remove HPCAC and ITV as an assembly.

CAUTION: To prevent engine damage, do not remove extension tube by grabbing sealing surface.

6. Remove DMR70 extension tube from HPCAC. Inspect sealing surfaces of DMR70 extension tube. Discard if damaged.
7. Remove and discard ITV O-ring.

NOTE: If the HPCAC pressure test is to be performed, it must be done now before proceeding to ITV removal. See High Pressure Charge Air Cooler (HPCAC) Pressure Test (page 152).

Intake Throttle Valve (ITV)

NOTE: It is not necessary to remove the ITV from the High Pressure Charge Air Cooler (HPCAC) unless the HPCAC is to be replaced due to damage or a failed pressure test.

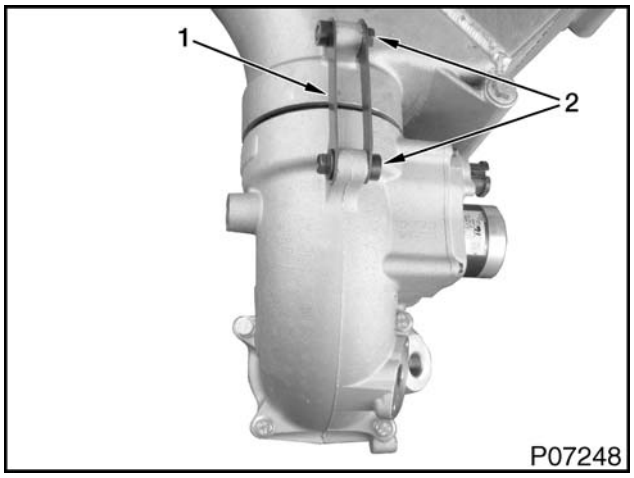

Figure 198 Intake Throttle Valve (ITV)

1. Latch arm (2)
2. M10 x 30 hex bolt (2)

1. Remove two M10 x 30 hex bolts and two latch arms from ITV and HPCAC.
2. Remove ITV from HPCAC.

CAUTION: To prevent engine damage, do not remove extension tube by grabbing sealing surface.

3. Remove DMR110/92 extension tube from ITV. Inspect sealing surfaces of DMR110/92 extension tube for damage. Discard if damaged.

High Pressure Charge Air Cooler (HPCAC) Bracket

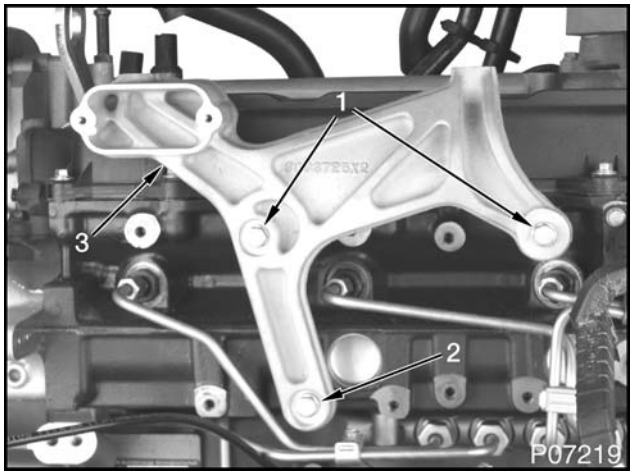

Figure 199 High Pressure Charge Air Cooler (HPCAC) bracket

1. M8 x 55 hex bolt (2)
2. M8 x 45 hex bolt
3. HPCAC bracket

1. Remove two M8 x 55 hex bolts and M8 x 45 hex bolt.
2. Remove HPCAC bracket.

Coolant Pipes

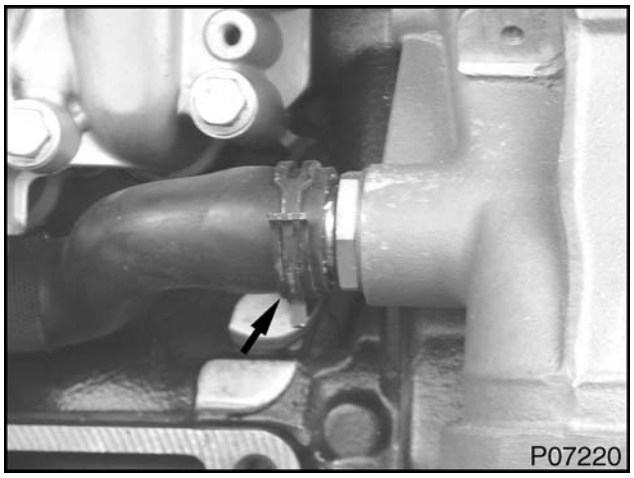

Figure 200 Charge Air Cooler (CAC) return coolant pipe

1. Release hose clamp and disconnect CAC return coolant pipe from front cover and remove from engine.

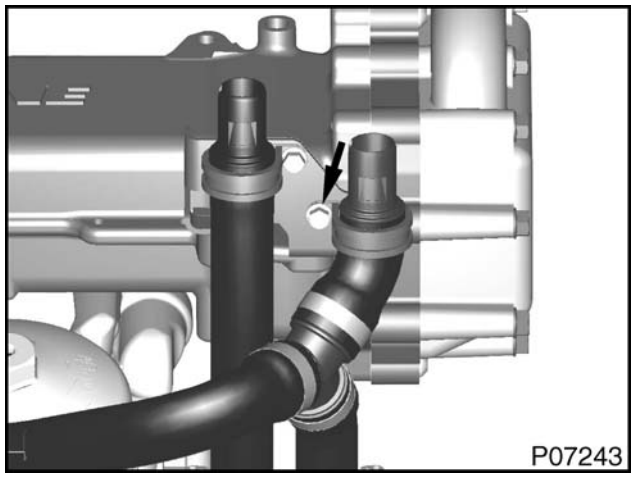

Figure 201 Charge Air Cooler (CAC) supply coolant pipe to bracket connection

2. Remove M6 x 16 hex bolt and remove CAC supply coolant pipe from bracket.

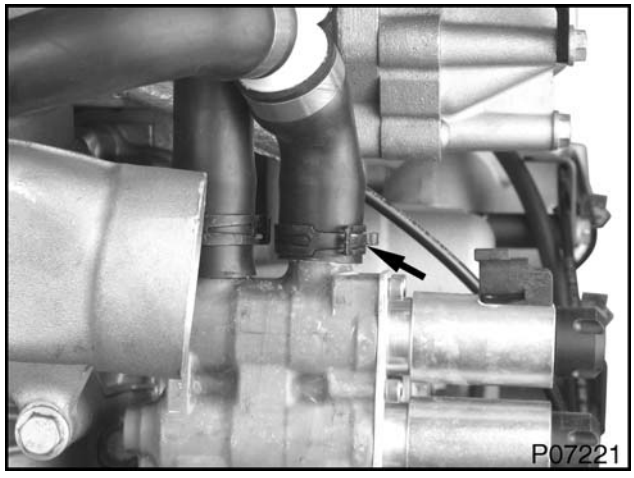

Figure 202 Charge Air Cooler (CAC) supply coolant pipe

3. Release hose clamp and disconnect CAC supply coolant pipe from Coolant Control Valve (CCV) and remove from engine.

Air Intake Manifold

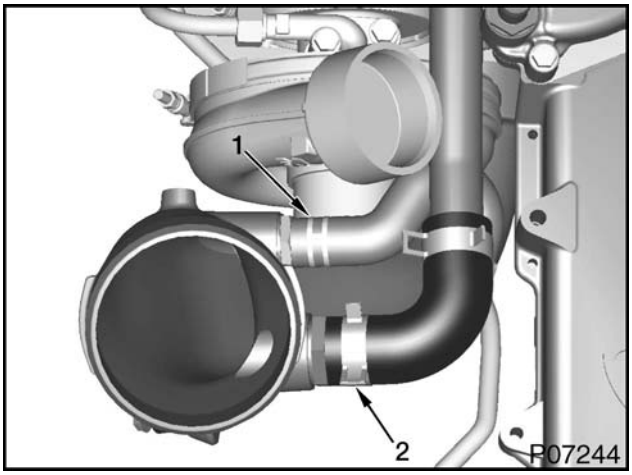

Figure 203 Breather and air compressor connections

1. 29/12 spring clip
2. 44/15 spring clip

1. Release 29/12 spring clip and disconnect breather outlet tube assembly from air intake manifold.
2. Release 44/15 spring clip and disconnect DMR32 shaped hose from air intake manifold.

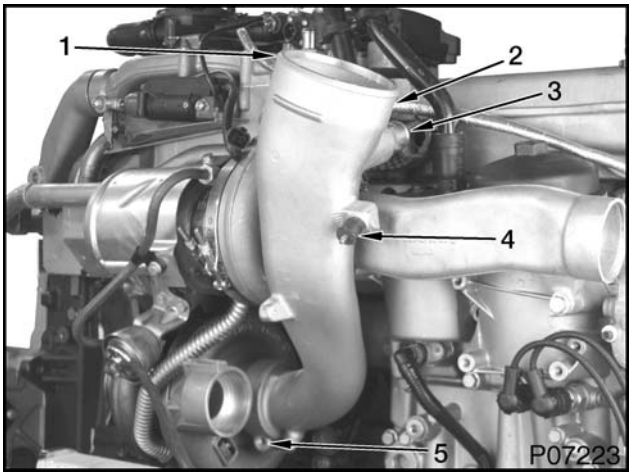

Figure 204 Air intake manifold

1. Air intake manifold
2. M26 x 1.5 threaded union
3. M32 x 1.5 threaded union
4. Rubber pad
5. M8 x 30 cylinder screw

3. Remove M8 x 30 cylinder screw and remove air intake manifold from low pressure turbocharger.

NOTE: Complete steps 4, 5, and 6 if air intake manifold is being replaced or the unions are found to be leaking.

4. Unscrew rubber pad from air intake manifold.
5. Remove M32 x 1.5 and/or M26 x 1.5 threaded unions and seals.
6. Remove and inspect BS-32.7 x 40 seal sealing surfaces. Discard seal if damaged.

Intercooler Elbow

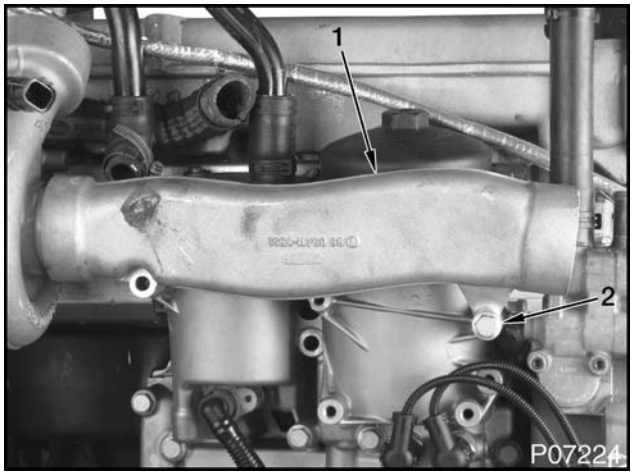

Figure 205 Intercooler elbow

1. Intercooler elbow
2. M10 x 50 hex bolt

1. Remove M10 x 50 hex bolt and intercooler elbow from high pressure turbocharger. Inspect 62.87 x 5.33 O-ring. Discard if damaged.

Turbochargers

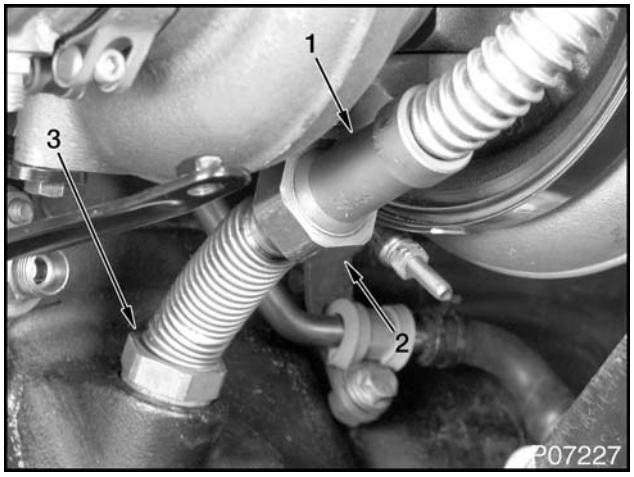

Figure 206 Low pressure turbocharger oil return pipe

1. High pressure turbocharger oil return pipe
2. Low pressure turbocharger oil return pipe fitting nut
3. Low pressure turbocharger oil return pipe

1. Loosen low pressure turbocharger oil return pipe fitting nut from high pressure turbocharger oil return pipe fitting nut and disconnect pipe from low pressure turbocharger oil return pipe.
2. Remove low pressure turbocharger oil return pipe from crankcase and discard BS-16.7 x 24 seal.

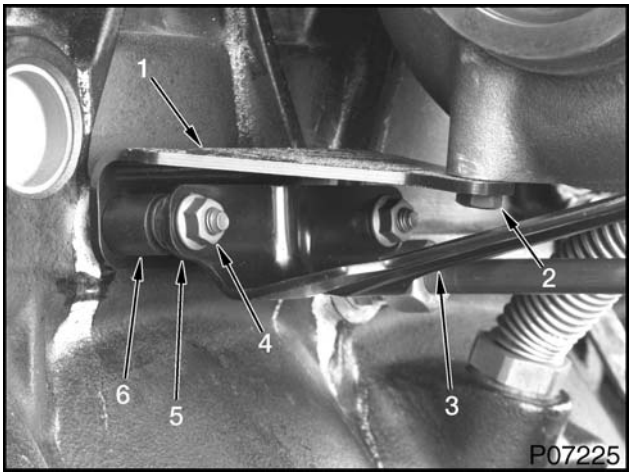

Figure 207 Starter heat shield bracket and bracket

1. Bracket (turbocharger support)
2. M8 x 12 hex bolt
3. Starter heat shield bracket
4. M8 hex nut (2)
5. M8 x 35 stud bolt (2)
6. Bushing (2)

3. Remove two M8 hex nuts and starter heat shield bracket.
4. Remove M8 x 12 hex bolt.
5. Remove two M8 x 35 stud bolts, two bushings, and bracket supporting the turbocharger.

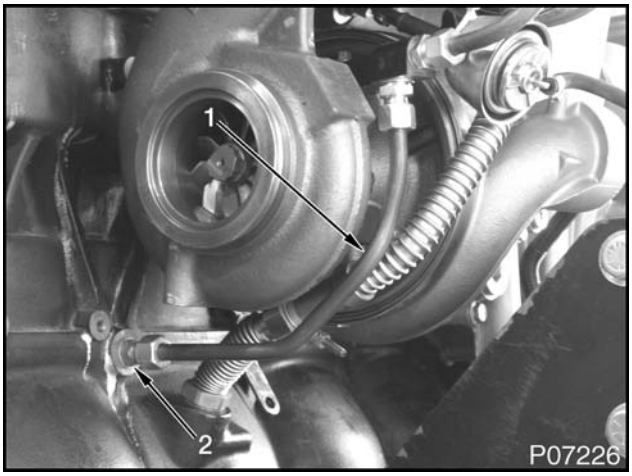

Figure 208 Low pressure turbocharger oil pressure pipe

1. Low pressure turbocharger oil pressure pipe
2. L12A straight union

6. Loosen low pressure turbocharger oil pressure pipe fitting nuts and remove pipe.
7. Remove L12A straight union from right side of crankcase and discard BS-24.7 x 32 seal.

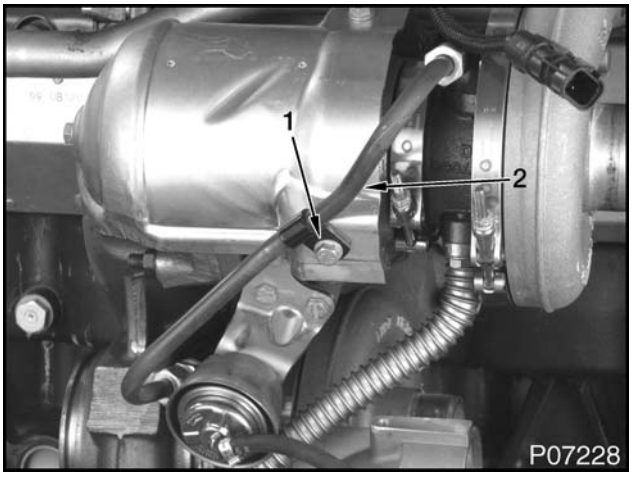

Figure 209 High pressure turbocharger oil pressure pipe

1. M8 x 16 hex bolt
2. High pressure turbocharger oil pressure pipe

8. Remove M8 x 16 hex bolt.
9. Loosen two high pressure turbocharger oil pressure pipe fitting nuts and remove pipe.

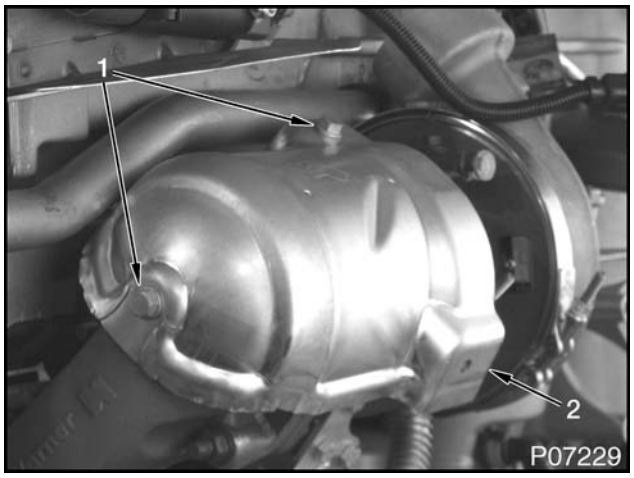

Figure 210 Heat shield

1. M8 x 16 hex bolt (2)
2. Heat shield

10. Remove two M8 x 16 hex bolts and heat shield.

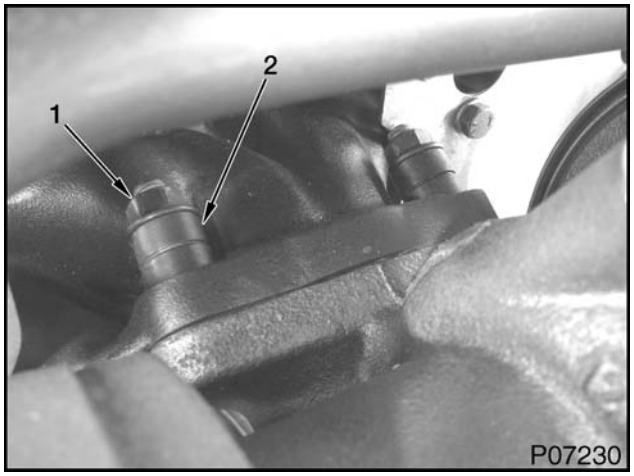

Figure 211 High pressure turbocharger connection (upper nuts)

1. M10 hexagon nut (2)
2. High temperature spacing bushing (2)

11. Remove two M10 hexagon nuts and high temperature spacing bushings.

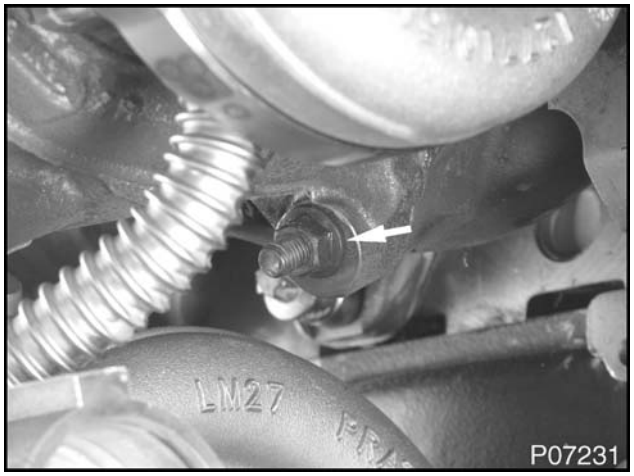

Figure 212 High pressure turbocharger connection (lower nut)

WARNING: To prevent personal injury or death, get help to remove or install the turbochargers.

12. Remove one M10 hexagon nut and turbochargers. Use an assistant to support turbochargers during removal.

Disassembly

Turbochargers

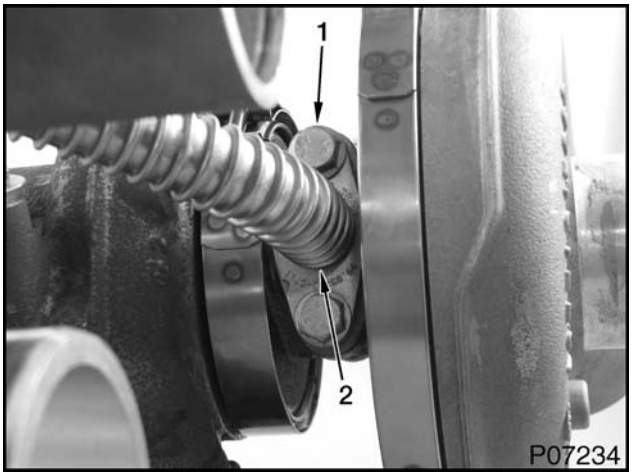

Figure 213 High pressure turbocharger oil return pipe (upper connection)

1. M8 x 20 hex bolt (2)
2. High pressure turbocharger oil return pipe

1. Remove two M8 x 20 hex bolts.
2. Disconnect high pressure turbocharger oil return pipe from high pressure turbocharger and discard gasket.

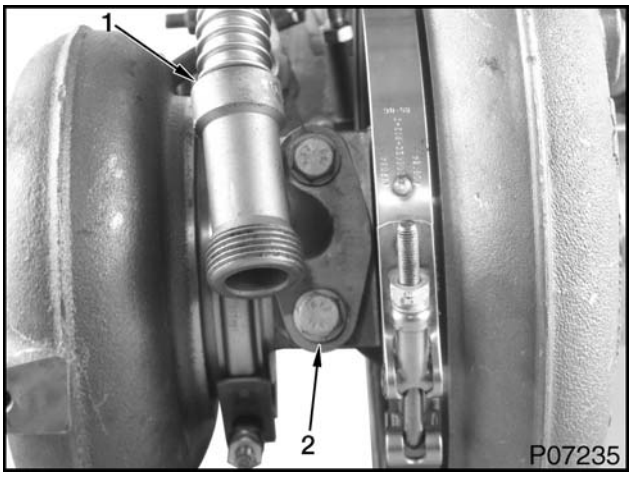

Figure 214 High pressure turbocharger oil return pipe (lower connection)

1. High pressure turbocharger oil return pipe
2. M8 x 20 hex bolt (2)

3. Remove two M8 x 20 hex bolts.
4. Disconnect and remove high pressure turbocharger oil return pipe from low pressure turbocharger. Discard gasket.

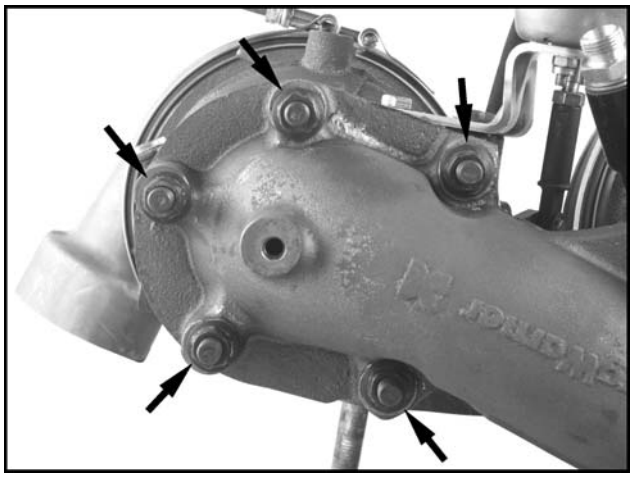

Figure 215 Turbocharger connection

5. Remove five M10 hexagon nuts and separate high pressure turbocharger from low pressure turbocharger.

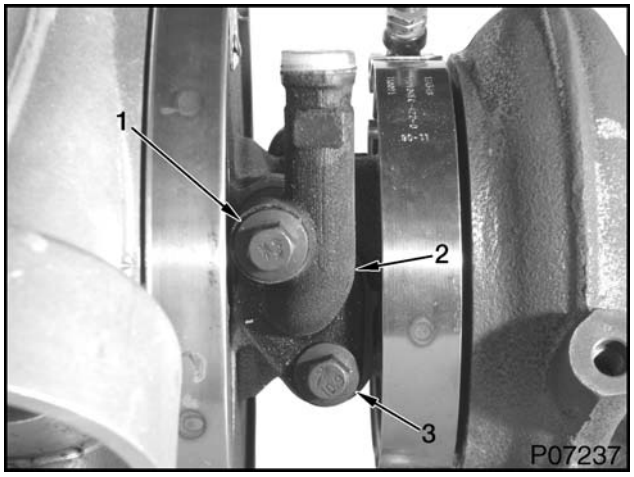

Figure 216 High pressure turbocharger oil pressure connection flange

1. M8 x 45 hex bolt
2. High pressure turbocharger oil pressure connection flange
3. M8 x 20 hex bolt

6. Remove M8 x 20 and M8 x 45 hex bolts.

7. Remove high pressure turbocharger oil pressure connection flange and discard gasket.

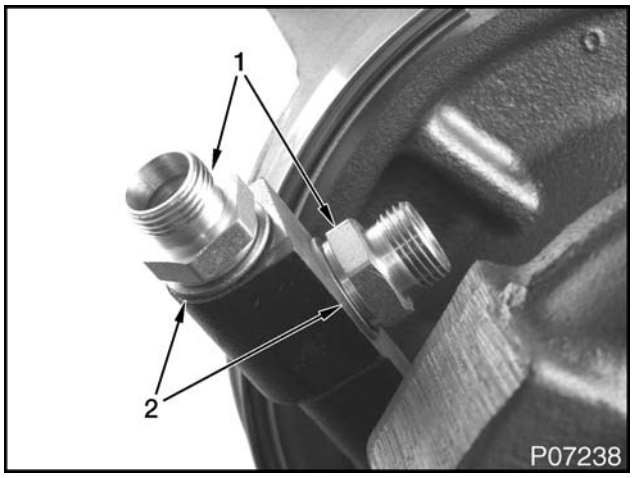

Figure 217 Straight unions

1. Straight union (2)
2. Seal (2)

NOTE: Complete next step only if straight unions are found to be leaking.

8. Remove two straight unions and discard seals.

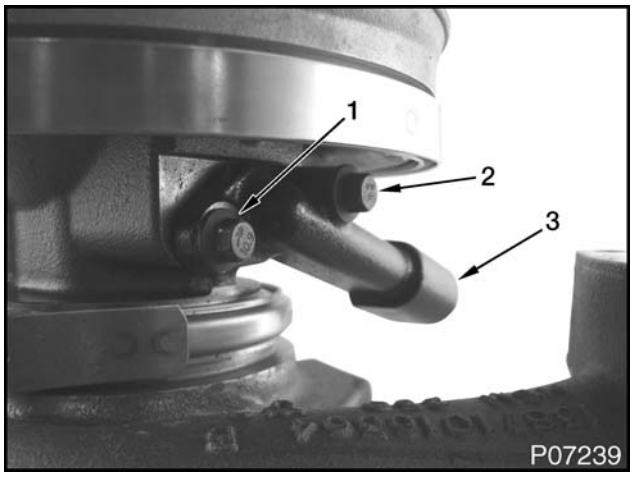

Figure 218 Low pressure turbocharger oil pressure connection flange

1. M8 x 20 hex bolt
2. M8 x 35 hex bolt
3. Low pressure turbocharger oil pressure connection flange

9. Remove M8 x 20 and M8 x 35 hex bolts.
10. Remove low pressure turbocharger oil pressure connection flange and discard gasket.

Cleaning and Inspection

Turbochargers and Related Parts Cleaning

WARNING: To prevent personal injury or death, wear safety glasses with side shields. Limit compressed air pressure to 207 kPa (30 psi).

NOTE: Do not use a caustic solution on turbochargers and related components.

1. Clean piping between air intake manifold and air cleaner assembly with soap and steam clean. Dry all piping with filtered compressed air.
2. Clean High Pressure Charge Air Cooler (HPCAC), Low Pressure Charge Air Cooler (LPCAC), air intake manifold, and intercooler elbow with filtered compressed air.
3. Clean oil pressure pipes and oil return pipes with suitable solvent and a nylon brush. Dry pipes with filtered compressed air. Replace any damaged pipes.
4. Clean all gasket surfaces.

Turbochargers Inspection

1. Inspect turbochargers for cracks and leaks. Replace if necessary.
2. Inspect compressor impellers and turbine wheels for blade erosion, bending, breakage or deposits. Replace turbochargers if damaged.

NOTE: Replace turbochargers if blades are bent. Do not attempt to straighten bent wheel blades.

3. Place turbochargers on a bench with the shafts in a horizontal position.

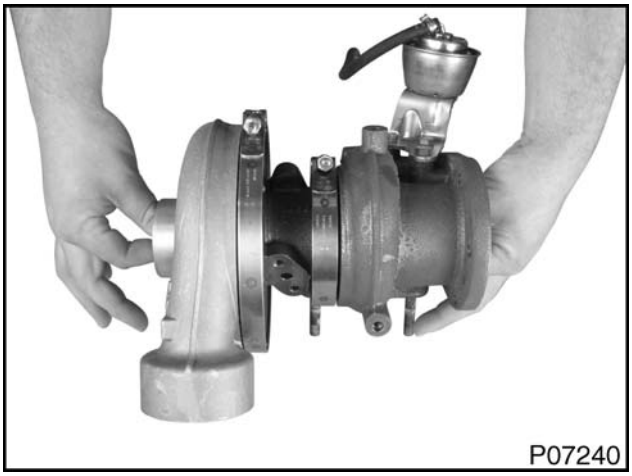

Figure 219 Free rotation of turbocharger assembly shaft (typical)

4. Turn turbine shafts by hand and check for wheel rub in each housing.

   The wheels must rotate freely. If there is any rubbing or interference, replace turbocharger.

Low Pressure Charge Air Cooler (LPCAC) Pressure Test

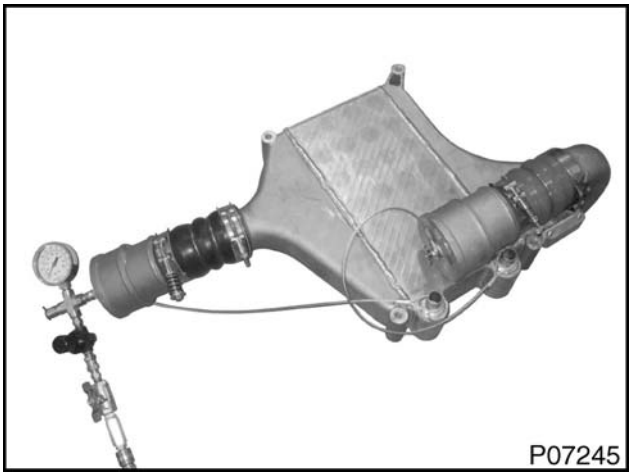

Figure 220 LPCAC pressure test

1. Attach Charge Air Cooler Tester Kit (page 165) to LPCAC using instructions supplied with tool and three inch couplers and clamps (obtain locally).
2. Pressurize LPCAC to 30 psi (205 kPa).
3. Spray a soapy water solution on LPCAC and tester components. Verify there are no leaks from hose connections or tester components.
4. If a leak is visually detected on LPCAC or tester gauge pressure drops, replace LPCAC.
5. Remove Charge Air Cooler Tester from LPCAC.

High Pressure Charge Air Cooler (HPCAC) Pressure Test

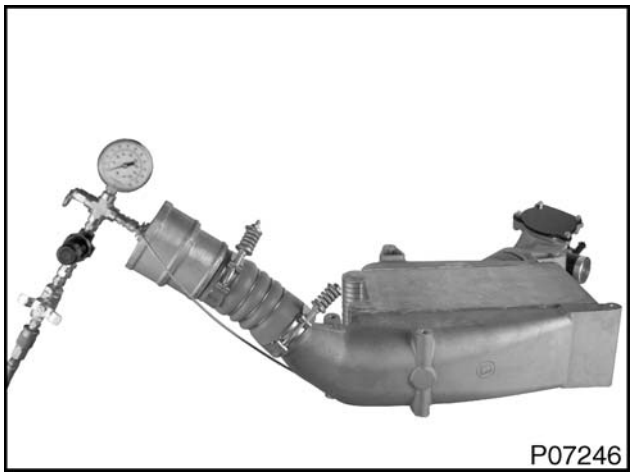

Figure 221 HPCAC pressure test

1. Install Manifold Absolute Pressure/Intake Air Temperature 2 (MAP/IAT2) sensor.
2. Attach High Pressure CAC Test Plate (page 165) and Charge Air Cooler Tester Kit (page 165) to HPCAC using instructions supplied with tool and three inch couplers and clamps (obtain locally).
3. Pressurize HPCAC to 30 psi (205 kPa).
4. Spray a soapy water solution on HPCAC and tester components. Verify there are no leaks from hose connections or tester components.
5. If a leak is visually detected on HPCAC or tester gauge pressure drops, replace HPCAC.
6. Remove MAP/IAT2 sensor.

Assembly

Turbochargers

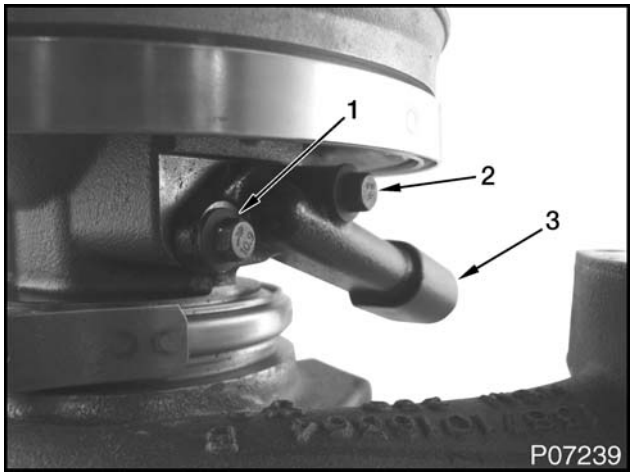

Figure 222 Low pressure turbocharger oil pressure connection flange

1. M8 x 20 hex bolt
2. M8 x 35 hex bolt
3. Low pressure turbocharger oil pressure connection flange

1. Install low pressure turbocharger oil pressure connection flange with new gasket.
2. Install M8 x 20 and M8 x 35 hex bolts. Tighten hex bolts to standard torque (page 455).

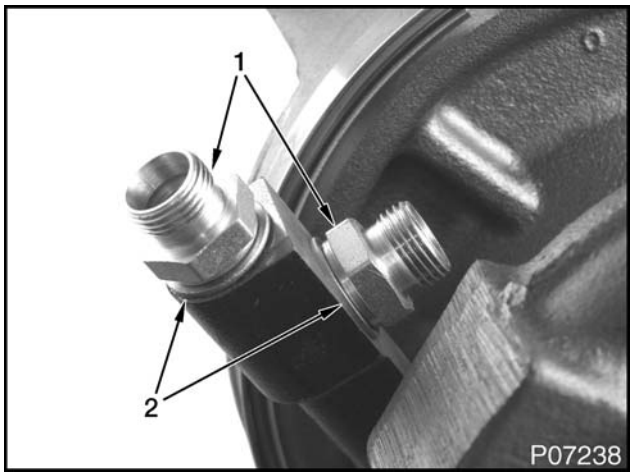

Figure 223 Straight unions

1. Straight union (2)
2. Seal (2)

NOTE: Complete steps 3 and 4 if straight unions were removed.

3. Install two straight unions with new seals.
4. Tighten straight unions as follows:
   a. Hand tighten straight unions.
   b. Turn an additional 90°.

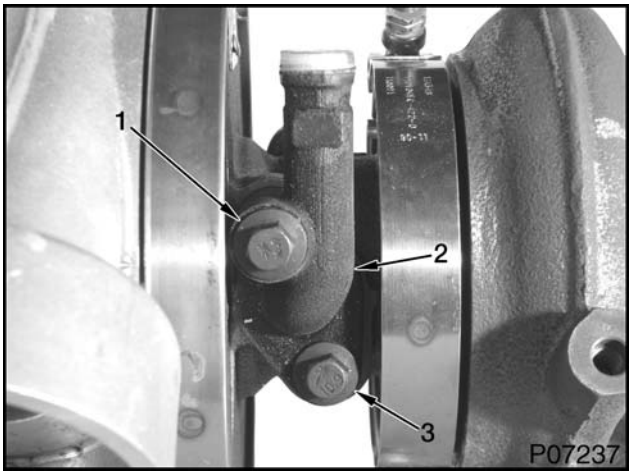

Figure 224 High pressure turbocharger oil pressure connection flange

1. M8 x 45 hex bolt
2. High pressure turbocharger oil pressure connection flange
3. M8 x 20 hex bolt

5. Install high pressure turbocharger oil pressure connection flange with new gasket.
6. Install M8 x 20 and M8 x 45 hex bolts. Tighten hex bolts to standard torque (page 455).

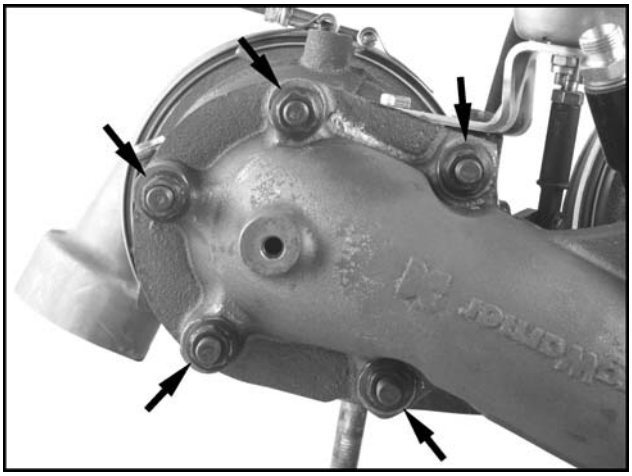

Figure 225 Turbocharger connection

7. Connect high pressure turbocharger to low pressure turbocharger. Install five M10 hexagon nuts and tighten as follows:
   a. Tighten nuts to 10 N·m (89 lbf·in).
   b. Turn nuts an additional 90°.

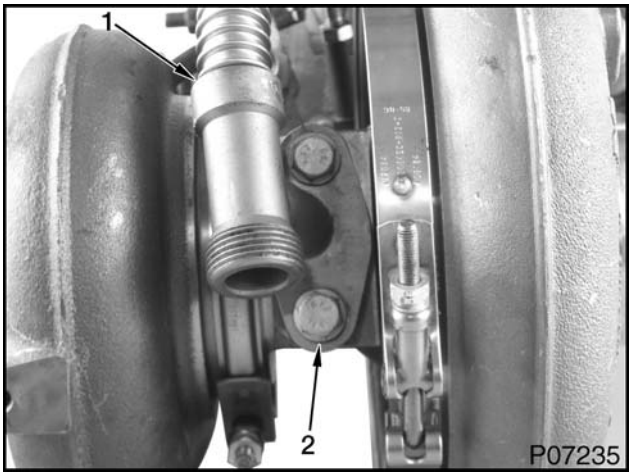

Figure 226 High pressure turbocharger oil return pipe (lower connection)

1. High pressure turbocharger oil return pipe
2. M8 x 20 hex bolt (2)

8. Position high pressure turbocharger oil return pipe to low pressure turbocharger with new gasket.
9. Install two M8 x 20 hex bolts. Tighten hex bolts to standard torque (page 455).

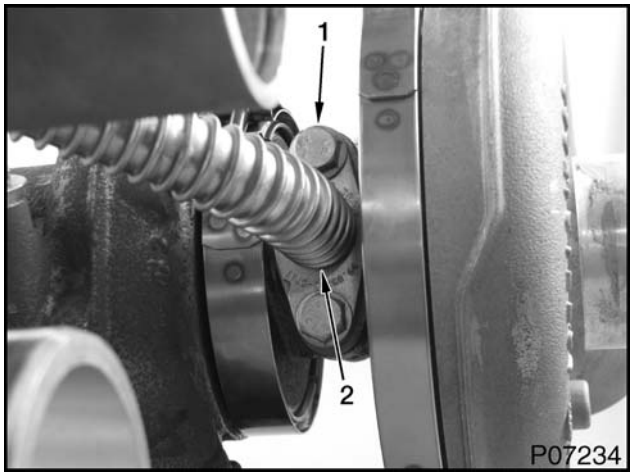

Figure 227 High pressure turbocharger oil return pipe (upper connection)

1. M8 x 20 hex bolt (2)
2. High pressure turbocharger oil return pipe

10. Position high pressure turbocharger oil return pipe to high pressure turbocharger with new gasket.
11. Install two M8 x 20 hex bolts. Tighten hex bolts to standard torque (page 455).

Installation

Turbochargers

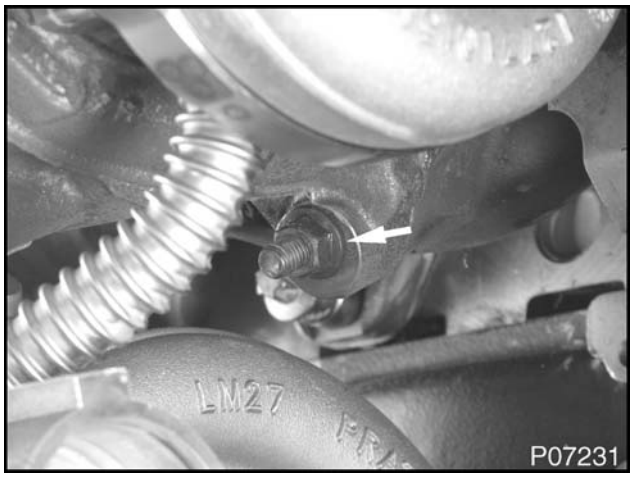

Figure 228 High pressure turbocharger connection (lower nut)

WARNING: To prevent personal injury or death, get help to remove or install the turbochargers.

1. Install turbochargers and one M10 hexagon nut with help from an assistant to support turbochargers. Tighten hexagon nut to standard torque (page 455).

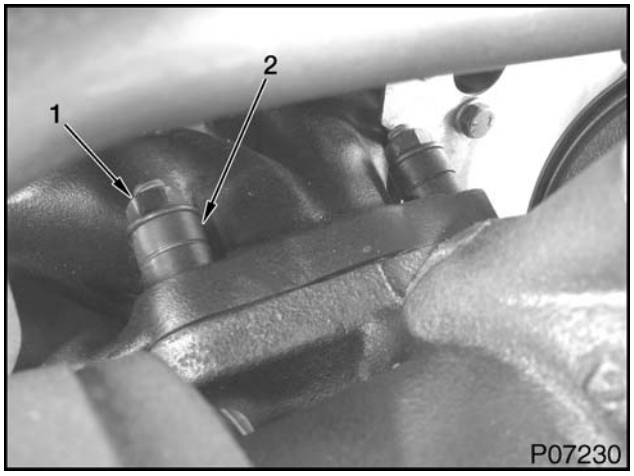

Figure 229 High pressure turbocharger connection (upper nuts)

1. M10 hexagon nut (2)
2. High temperature spacing bushing (2)

2. Install two M10 hexagon nuts and high temperature spacing bushings. Tighten hexagon nuts to standard torque (page 455).

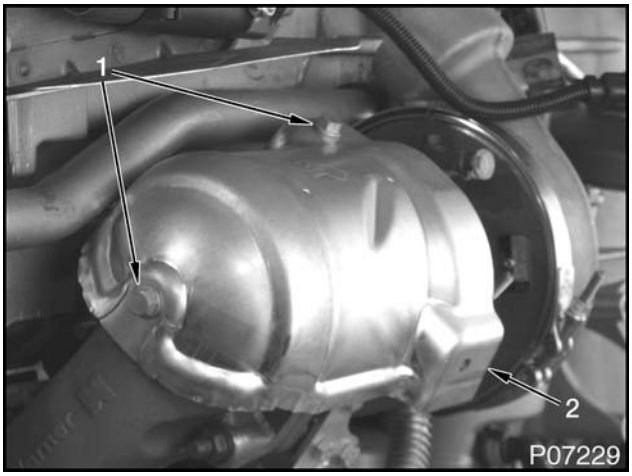

Figure 230 Heat shield

1. M8 x 16 hex bolt (2)
2. Heat shield

3. Install heat shield and two M8 x 16 hex bolts. Tighten hex bolts to standard torque (page 455).

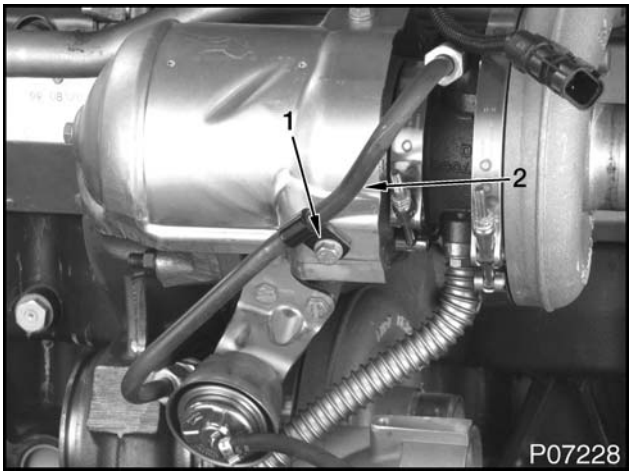

Figure 231 High pressure turbocharger oil pressure pipe

1. M8 x 16 hex bolt
2. High pressure turbocharger oil pressure pipe

4. Position high pressure turbocharger oil pressure pipe and tighten fitting nuts as follows:
   a. Tighten fitting nuts to 10 N·m (89 lbf·in).
   b. Turn nuts an additional 90°.

5. Install M8 x 16 hex bolt. Tighten hex bolt to standard torque (page 455).

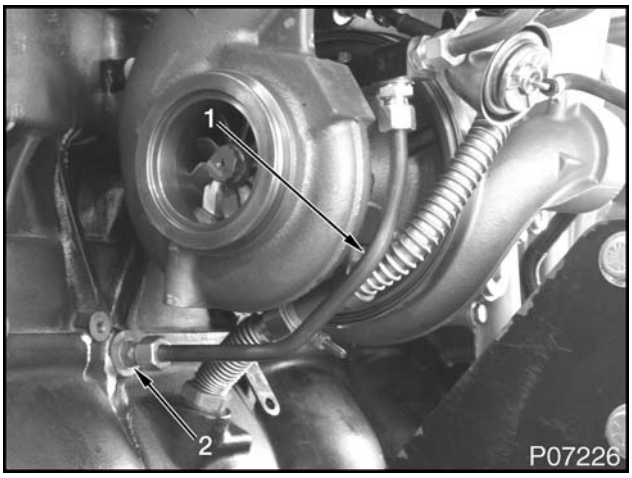

Figure 232 Low pressure turbocharger oil pressure pipe

1. Low pressure turbocharger oil pressure pipe
2. L12A straight union

6. Install L12A straight union and new BS-24.7 x 32 seal into right side of crankcase. Tighten straight union as follows:
   a. Hand tighten straight union.
   b. Turn an additional 90°.
7. Install low pressure turbocharger oil pressure pipe. Tighten fitting nuts as follows:
   a. Tighten fitting nuts to 10 N·m (89 lbf·in).
   b. Turn nuts an additional 90°.

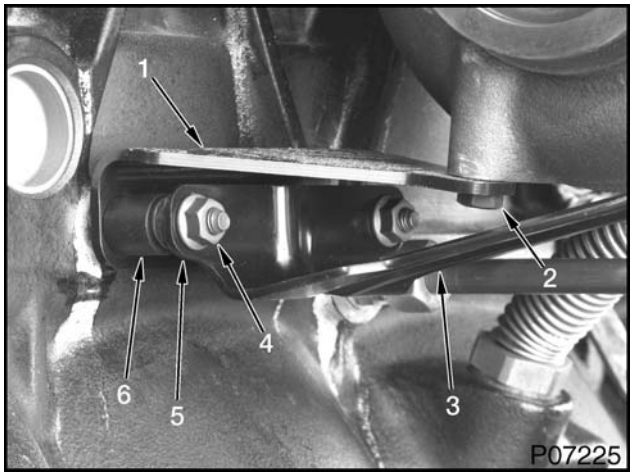

Figure 233 Starter heat shield bracket and bracket

1. Bracket (turbocharger support)
2. M8 x 12 hex bolt
3. Starter heat shield bracket
4. M8 hex nut (2)
5. M8 x 35 stud bolt (2)
6. Bushing (2)

8. Install bracket supporting turbocharger, two bushings, and two M8 x 35 stud bolts. Tighten stud bolts to standard torque (page 455).
9. Install M8 x 12 hex bolt. Tighten hex bolt to standard torque (page 455).
10. Install starter heat shield bracket and two M8 hex nuts. Tighten hex nuts to standard torque (page 455).

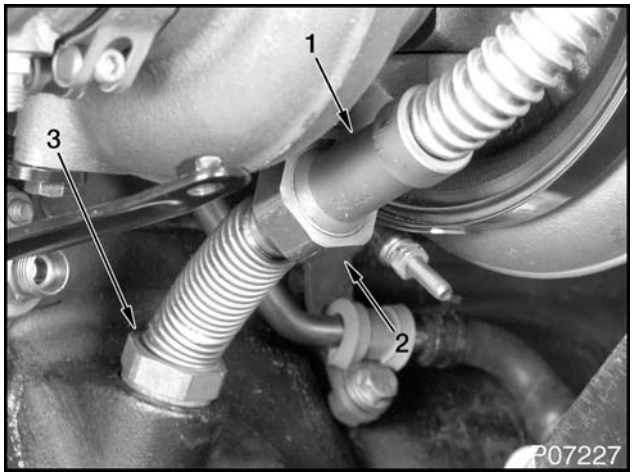

Figure 234 Low pressure turbocharger oil return pipe

1. High pressure turbocharger oil return pipe
2. Low pressure turbocharger oil return pipe fitting nut
3. Low pressure turbocharger oil return pipe

11. Install low pressure turbocharger oil return pipe with new seal into crankcase. Tighten fitting nut as follows:
    a. Tighten nut to 10 N·m (89 lbf·in).
    b. Turn nut an additional 90°.
12. Connect low pressure turbocharger oil return pipe to high pressure turbocharger oil return pipe. Tighten fitting nut as follows:
    a. Tighten nut to 10 N·m (89 lbf·in).
    b. Turn nut an additional 90°.

Intercooler Elbow

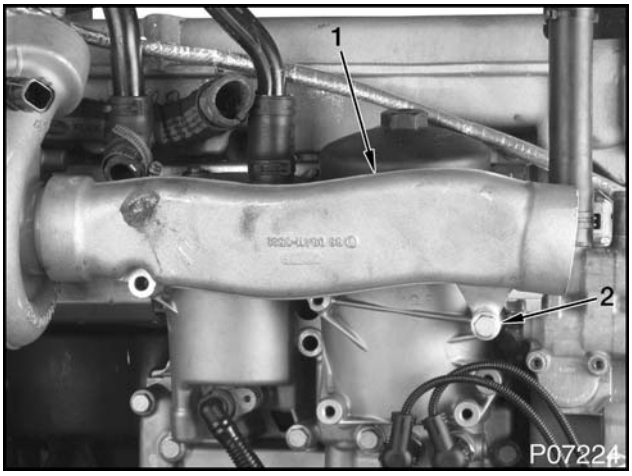

Figure 235 Intercooler elbow

1. Intercooler elbow
2. M10 x 50 hex bolt

NOTE: Install new 62.87 x 5.33 O-ring if old O-ring was found to be defective.

1. Lubricate 62.87 x 5.33 O-ring with P-80® Rubber Lubricant or equivalent (page 165) and install into intercooler elbow.
2. Install intercooler elbow to high pressure turbocharger with M10 x 50 hex bolt. Tighten hex bolt to standard torque (page 455).

Air Intake Manifold

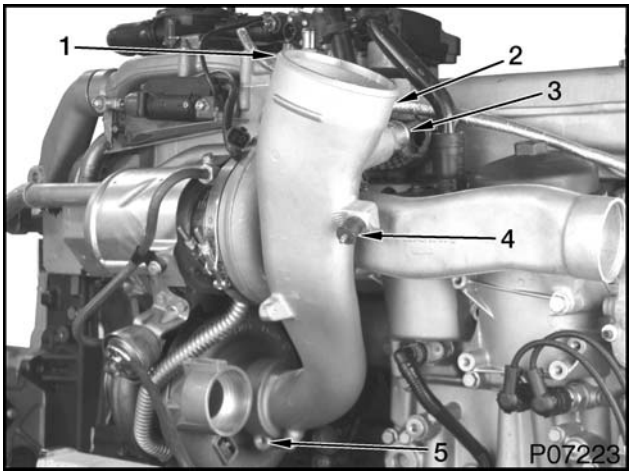

Figure 236 Air intake manifold

1. Air intake manifold
2. M26 x 1.5 threaded union
3. M32 x 1.5 threaded union
4. Rubber pad
5. M8 x 30 cylinder screw

NOTE: Complete steps 1 and 2 if air intake manifold was replaced or if unions were removed.

1. Install rubber pad into air intake manifold. Tighten rubber pad to special torque (page 165).
2. Install M32 x 1.5 and/or M26 x 1.5 threaded union and BS-26.7 x 34 and BS-32.7 x 40 seals.

   Tighten straight unions as follows:

   a. Hand tighten straight unions.

   b. Turn an additional 90°.

NOTE: Install new BS-32.7 x 40 seal if old seal was found to be defective.

3. Lubricate BS-32.7 x 40 seal with P-80® Rubber Lubricant or equivalent (page 165) and install into air intake manifold.
4. Install air intake manifold to low pressure turbocharger. Install M8 x 30 cylinder screw. Do not tighten at this time.

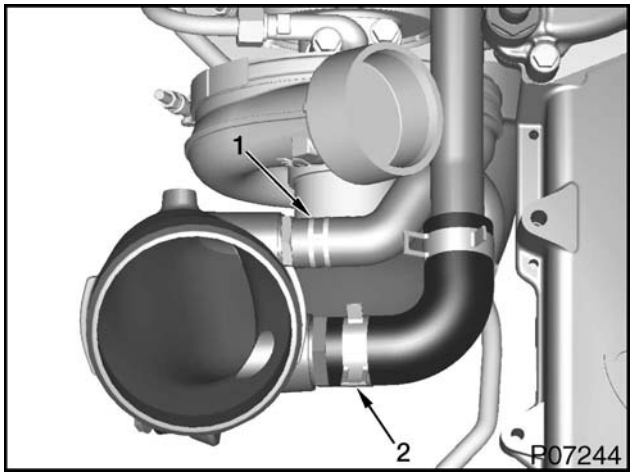

Figure 237 Breather and air compressor connections

1. 29/12 spring clip
2. 44/15 spring clip

5. Connect breather outlet tube assembly to air intake manifold and install 29/12 spring clip.
6. Connect DMR32 shaped hose to air intake manifold and install 44/15 spring clip.

Coolant Pipes

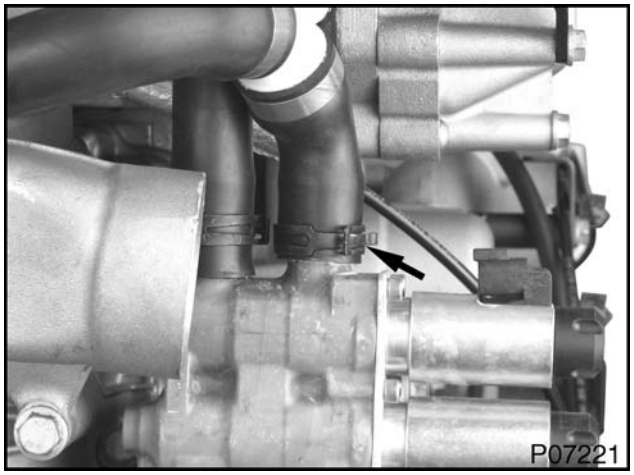

Figure 238 Charge Air Cooler (CAC) supply coolant pipe

1. Install CAC supply coolant pipe to engine and connect to Coolant Control Valve (CCV). Install hose clamp.

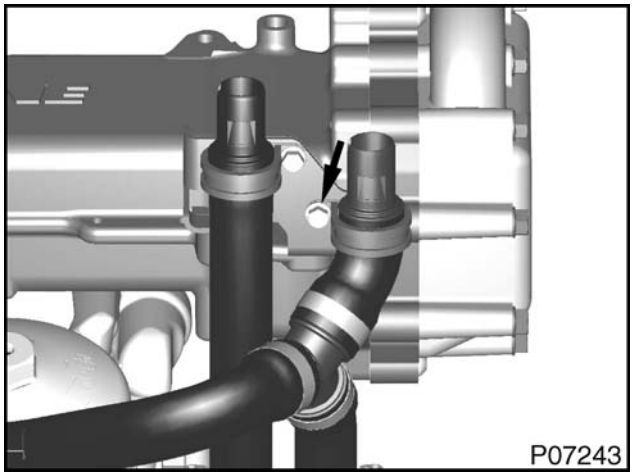

Figure 239 Charge Air Cooler (CAC) supply coolant pipe to bracket connection

2. Install CAC supply coolant pipe to bracket and install M6 x 16 hex bolt. Tighten hex bolt to standard torque (page 455).

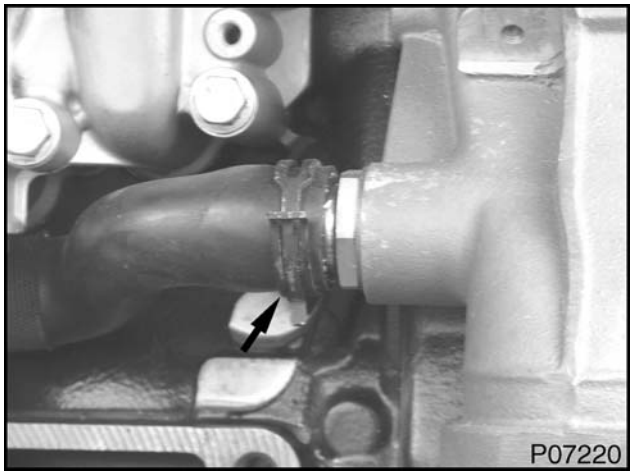

Figure 240 CAC return coolant pipe

3. Install CAC return coolant pipe to engine and connect to front cover. Install hose clamp.

High Pressure Charge Air Cooler (HPCAC) Bracket

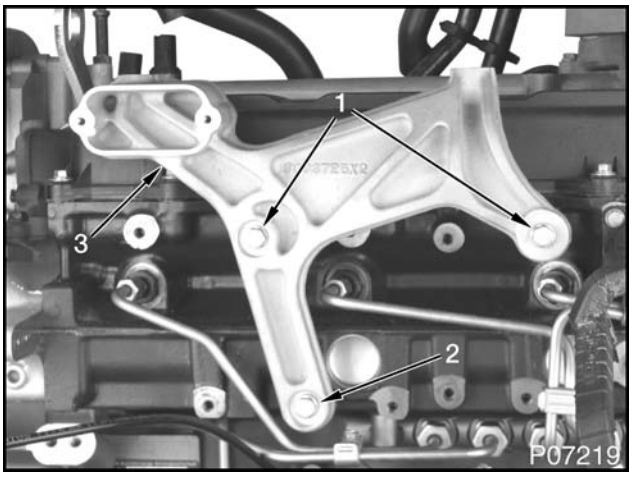

Figure 241 High Pressure Charge Air Cooler (HPCAC) bracket

1. M8 x 55 hex bolt (2)
2. M8 x 45 hex bolt
3. HPCAC bracket

1. Install HPCAC bracket.
2. Install two M8 x 55 and M8 x 45 hex bolts. Tighten hex bolts to standard torque (page 455).

Intake Throttle Valve (ITV)

NOTE: Complete this procedure if ITV was previously removed from High Pressure Charge Air Cooler (HPCAC).

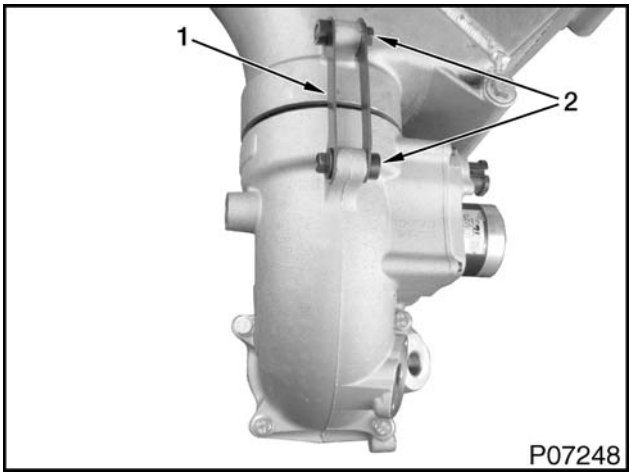

Figure 242 Intake Throttle Valve (ITV)

1. Latch arm (2)
2. M10 x 30 hex bolt (2)

1. Lubricate both ends of DMR110/92 extension tube sealing surfaces with P-80® Rubber Lubricant or equivalent (page 165) and install one end into HPCAC. Install ITV to HPCAC.
2. Install two latch arms and two M10 x 30 hex bolts to ITV and HPCAC. Do not tighten at this time.

High Pressure Charge Air Cooler (HPCAC)

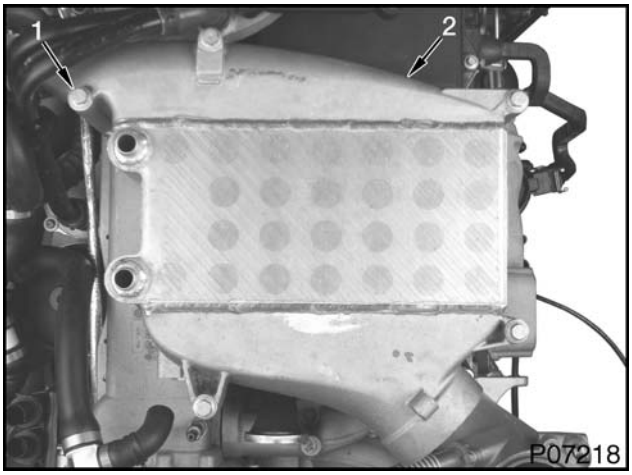

Figure 243 High Pressure Charge Air Cooler (HPCAC)

1. M10 x 160 hex bolt (5)
2. HPCAC

1. Lubricate both ends of DMR70 extension tube sealing surfaces with P-80® Rubber Lubricant or equivalent (page 165) and install one end into HPCAC.
2. Install new ITV O-ring.
3. Install HPCAC.
4. Install five M10 x 160 hex bolts. Tighten hex bolts to standard torque (page 455).

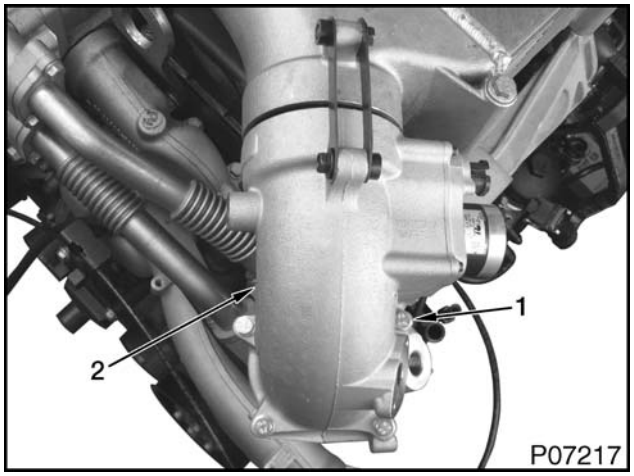

Figure 244 Intake Throttle Valve (ITV)

1. ITV bolt (4)
2. ITV

NOTE: The captive ITV bolts can be locked in a raised position by pulling up and turning counterclockwise.

5. Screw in four captive ITV bolts. Tighten bolts to standard torque (page 455).
6. Tighten two latch arm M10 x 30 hex bolts to standard torque (page 455).

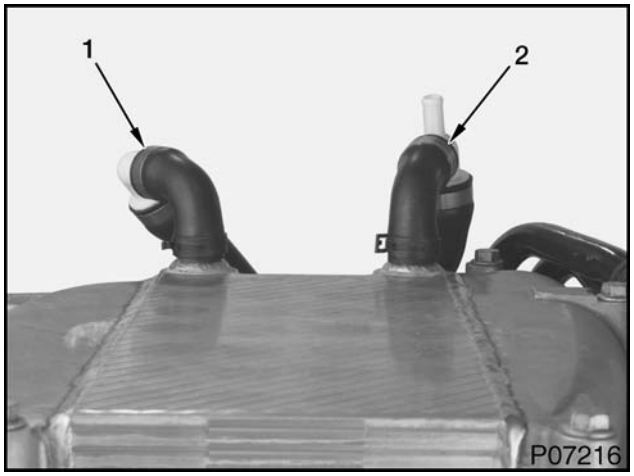

Figure 245 High Pressure Charge Air Coolant (HPCAC) coolant pipe connections

1. CAC supply coolant pipe
2. CAC return coolant pipe

7. Connect CAC return coolant pipe to HPCAC and install hose clamp.
8. Connect CAC supply coolant pipe to HPCAC and install hose clamp.

Low Pressure Charge Air Cooler (LPCAC) Bracket

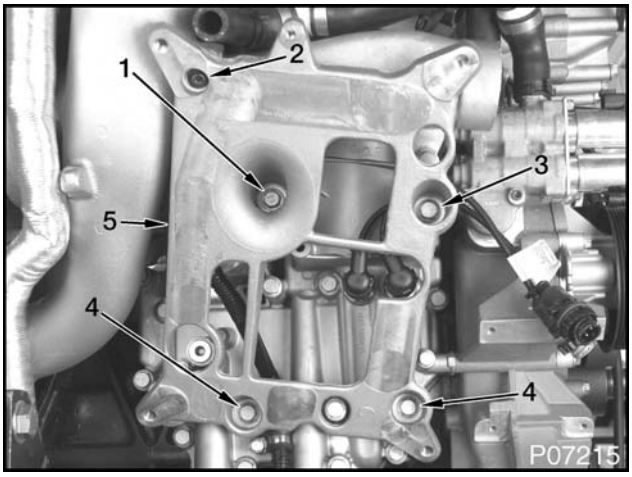

Figure 246 Low Pressure Charge Air Cooler (LPCAC) bracket

1. M10 x 190 hex bolt
2. M6 hexagon nut
3. M10 x 50 hex bolt
4. M10 x 110 hex bolt (2)
5. LPCAC bracket

1. Install LPCAC bracket.
2. Install M10 x 190 hex bolt, M6 hexagon nut, M10 x 50 hex bolt, and two M10 x 110 hex bolts to LPCAC bracket. Tighten hexagon nut and hex bolts to standard torque (page 455).
3. Tighten air intake manifold M8 x 30 cylinder screw to special torque (page 165).

Low Pressure Charge Air Cooler (LPCAC)

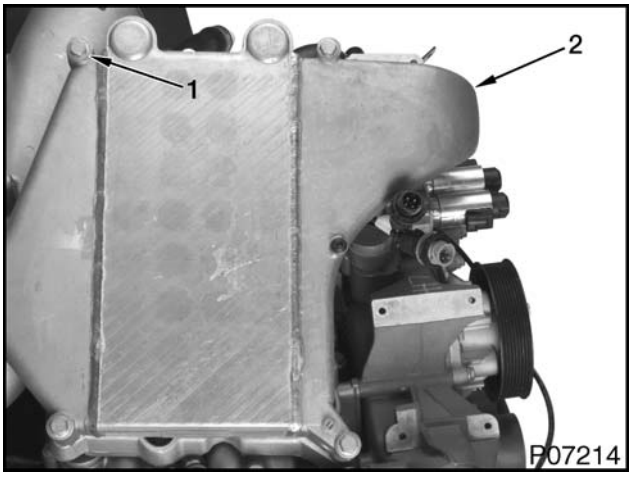

Figure 247 Low Pressure Charge Air Cooler (LPCAC)

1. M10 x 90 hex bolt (4)
2. LPCAC

1. Lubricate both DMR70 extension tube sealing surfaces with P-80® Rubber Lubricant or equivalent (page 165) and install into LPCAC.
2. Install LPCAC to engine until both DMR70 extension tubes seat in intercooler elbow and low pressure turbocharger.
3. Install four M10 x 90 hex bolts. Tighten hex bolts to standard torque (page 455).

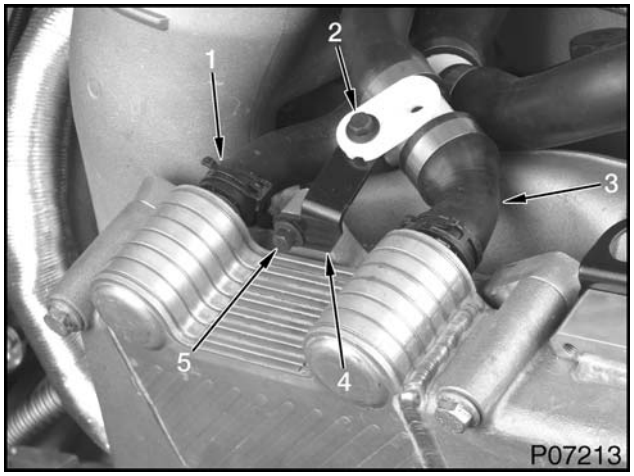

Figure 248 Low Pressure Charge Air Cooler (LPCAC) coolant pipe connections

1. CAC supply coolant pipe
2. M8 x 16 hex bolt
3. CAC return coolant pipe
4. Temperature sensor bracket
5. M8 x 16 hex bolt.

4. Connect CAC return coolant pipe to LPCAC and install hose clamp.
5. Install M8 x 16 hex bolt to bracket on LPCAC. Tighten hex bolt to standard torque (page 455).
6. Connect CAC supply coolant pipe to LPCAC and install hose clamp.
7. Install temperature sensor bracket and M8 x 16 bolt. Tighten bolt to standard torque (page 455).

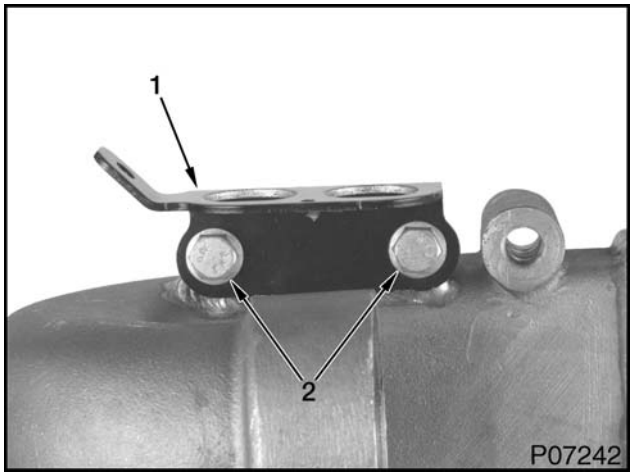

Figure 249 Adapter line bracket

1. Adapter line bracket
2. M8 x 16 hex bolt (2)

8. Install adapter line bracket and two M8 x 16 hex bolts. Tighten hex bolts to standard torque (page 455).

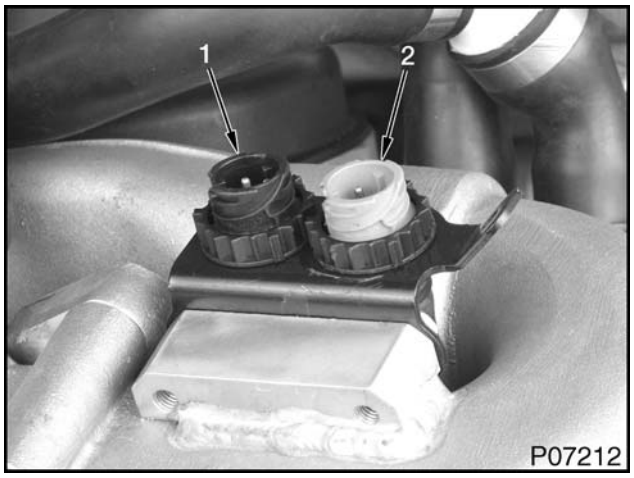

Figure 250 Adapter lines (electrical connections)

1. Engine Oil Pressure (EOP) sensor adapter line
2. Engine Oil Temperature (EOT) sensor adapter line

NOTE: Be sure to align flat spots on adapter line connectors with flat spots in adapter line bracket holes.

9. Install EOT sensor adapter line and retaining ring to adapter line bracket on LPCAC and turn adapter line retaining ring clockwise until tight.

10. Install EOP sensor adapter line and retaining ring to adapter line bracket on LPCAC and turn adapter line retaining ring clockwise until tight.

Boost Control Solenoid (BCS) Valve Supply Line

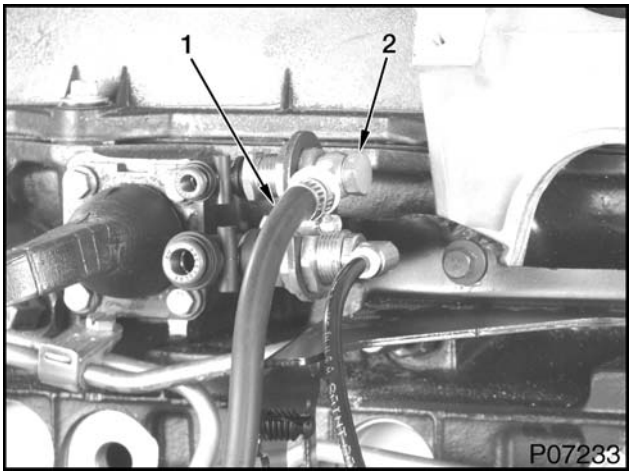

Figure 251 BCS valve supply line

1. BCS valve supply line
2. Banjo bolt

1. Connect BCS valve supply line to air fitting and install banjo bolt with new washers. Tighten banjo bolt to special torque(page 165).

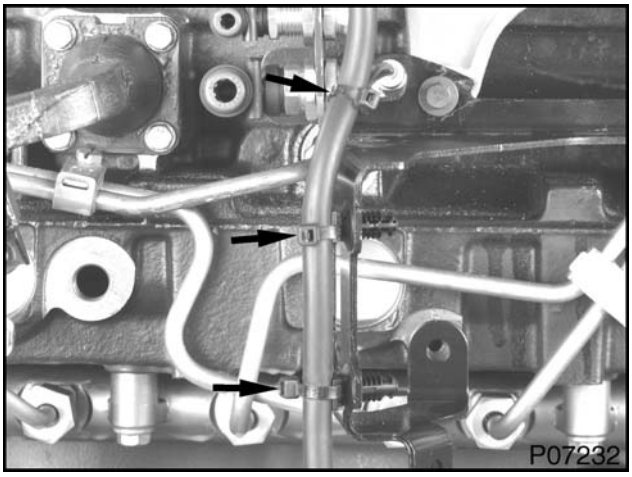

Figure 252 Tie straps

2. Install three new tie straps retaining BCS valve supply line to bracket.

Boost Control Solenoid (BCS) Valve

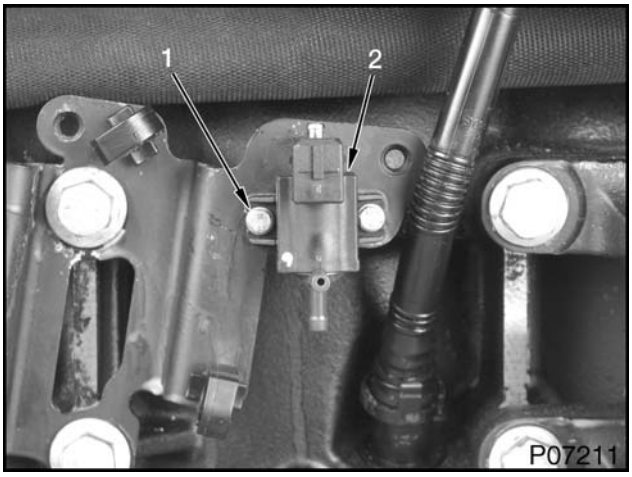

Figure 253 BCS valve

1. M5 x 12 hex bolt (2)
2. BCS valve

1. Install BCS valve.
2. Install two M5 x 12 hex bolts and two M5 washers. Tighten hex bolts to standard torque (page 455).

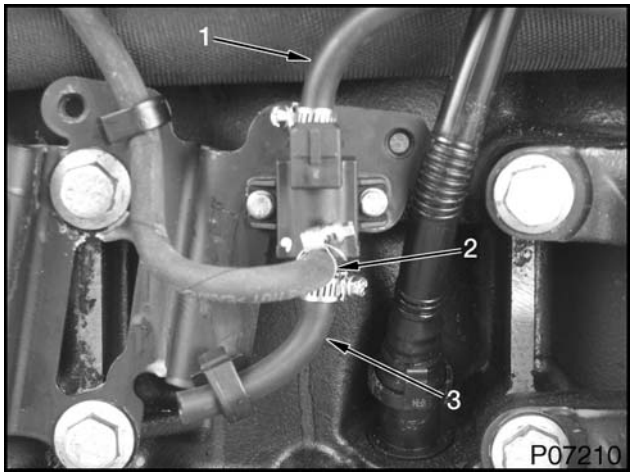

Figure 254 BCS valve hoses

1. BCS valve supply line
2. BCS valve output line
3. Hose

3. Connect hoses to BCS valve and tighten hose clamps.

Special Torque

Table 10 Turbochargers

High pressure turbocharger to low pressure turbocharger hexagon nuts	See tightening steps in procedure.
Banjo bolt	10 N·m (89 lbf·in)
Air intake manifold cylinder screw	10 N·m (89 lbf·in)
M32 x 1.5 threaded union (air intake duct)	See tightening steps in procedure.
M26 x 1.5 threaded union (air intake duct)	See tightening steps in procedure.
Rubber pad	10 N·m (89 lbf·in)
Straight union (for low pressure turbocharger oil pressure connection flange)	See tightening steps in procedure.
L12A straight union	See tightening steps in procedure.
Low pressure turbocharger oil pressure pipe fitting nuts	See tightening steps in procedure.
High pressure turbocharger oil pressure pipe fitting nuts	See tightening steps in procedure.
Low pressure turbocharger oil return pipe fitting nut	See tightening steps in procedure.
Low pressure turbocharger oil return pipe (to crankcase)	See tightening steps in procedure.

Special Service Tools

Table 11 Turbochargers

Description	Tool Number
Charge Air Cooler Tester Kit	ZTSE4341
High Pressure CAC Test Plate	ZTSE4909
P-80® Rubber Lubricant or equivalent	Obtain locally

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Exploded Views

Power Steering

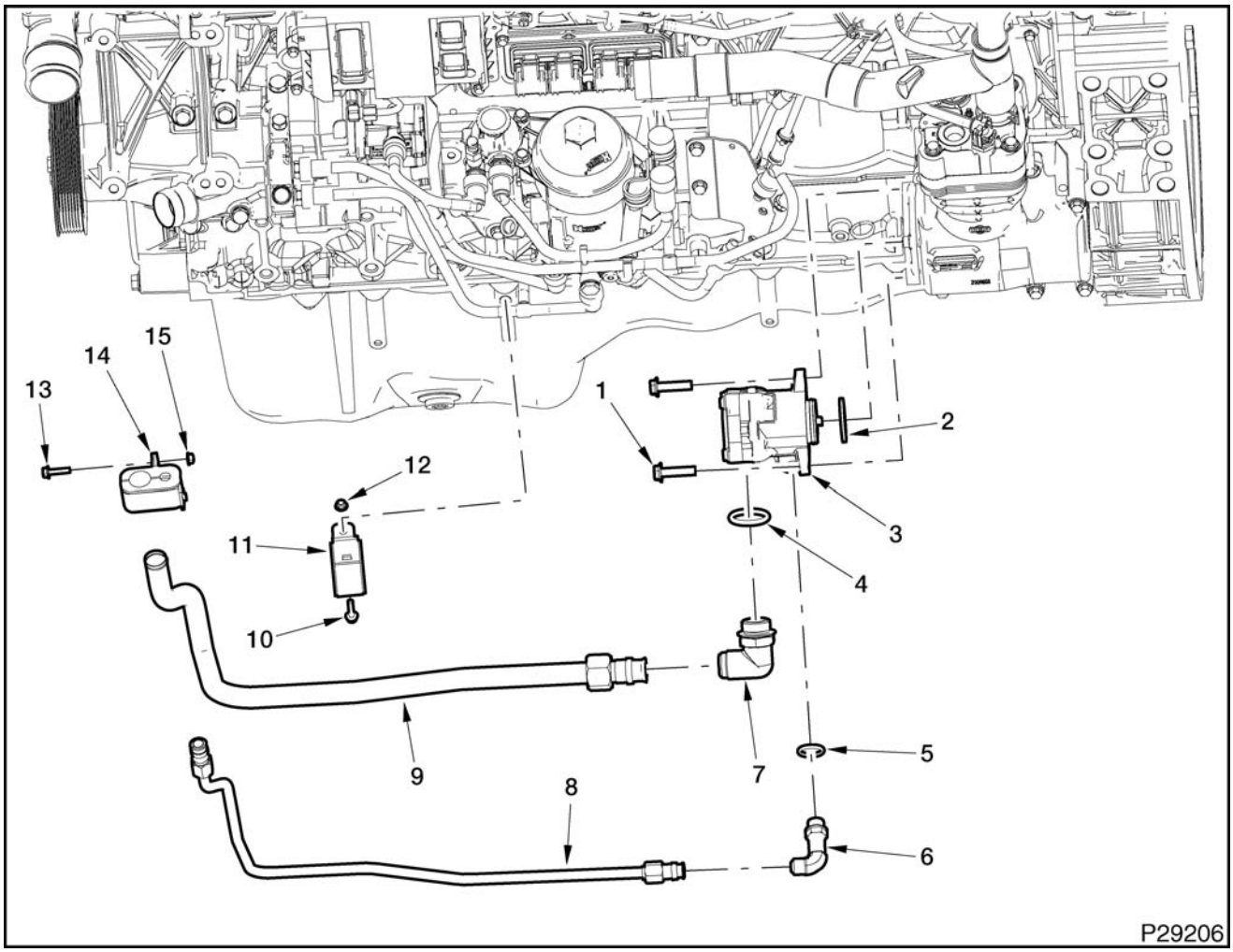

Figure 255 Power steering system (typical)

1. M10 x 40 heavy bolt (2)
2. Power steering pump adapter
3. Power steering pump
4. 0.087 x 0.644 O-ring
5. 1 1/16-12 STD O-ring
6. 1/2” 90 degree tube elbow
7. 1-1/16” 90 degree elbow
8. High pressure tube
9. Low pressure tube
10. M6 x 25 bolt
11. Support bracket
12. M6 nut
13. M6 x 25 bolt
14. Support bracket
15. M6 nut

Air Compressor

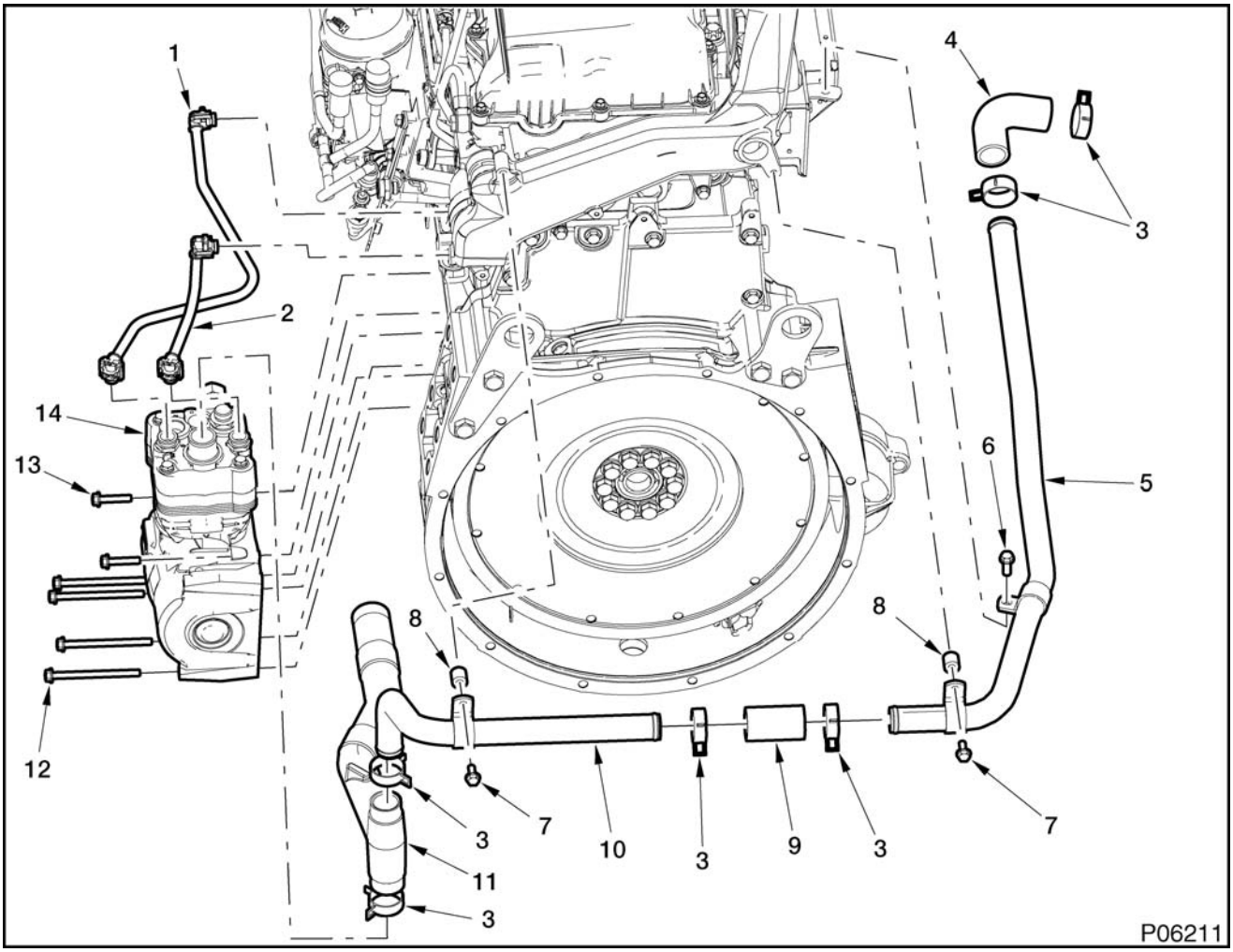

Figure 256 Air compressor system (typical)

1. Air compressor coolant pipe (supply)
2. Air compressor coolant pipe (return)
3. 44/15 spring clip (6)
4. DMR32 shaped hose
5. Air compressor suction pipe
6. M8 x 25 hex bolt
7. M8 x 65 hex bolt (2)
8. Bushing (2)
9. Hose
10. Air compressor suction pipe
11. Air compressor shaped hose
12. M8 x 110 hex bolt (4)
13. M8 x 40 hex bolt (2)
14. Air compressor

Removal

WARNING: To prevent personal injury or death, read all safety instructions in the "Safety Information" section of this manual.

WARNING: To prevent personal injury or death, make sure the engine has cooled before removing components.

WARNING: To prevent personal injury or death, do not let engine fluids stay on your skin. Clean skin and nails using hand cleaner and wash with soap and water. Wash or discard clothing and rags contaminated with engine fluids.

GOVERNMENT REGULATION: Engine fluids (oil, fuel, and coolant) may be a threat to the environment. Recycle or dispose of engine fluids according to applicable regulations. Never put engine fluids in the trash, on the ground, in sewers or bodies of water.

Power Steering Pressure Tubes

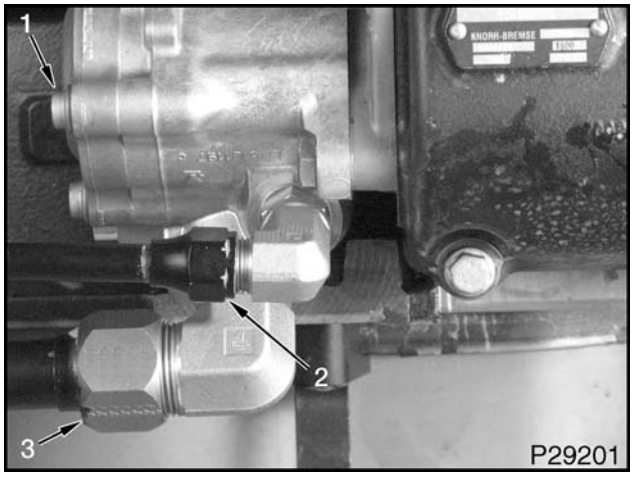

Figure 257 Pressure tubes

1. Power steering pump
2. High pressure tube fitting nut
3. Low pressure tube fitting nut

1. Loosen high pressure tube fitting nut and disconnect tube from 1/2" 90 degree tube elbow.
2. Loosen low pressure tube fitting nut and disconnect tube from 1-1/16" 90 degree elbow.

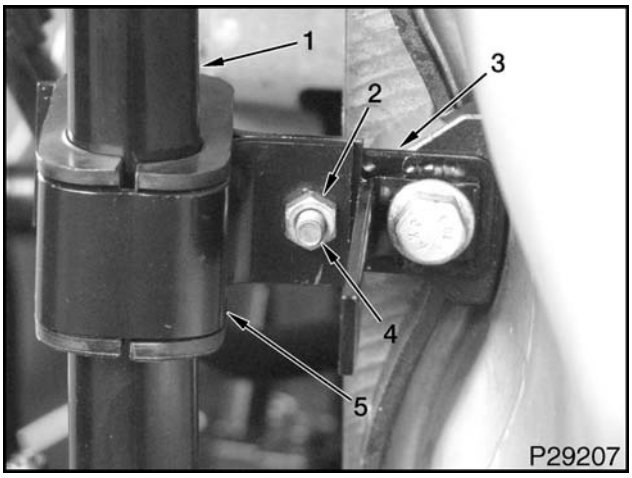

Figure 258 Pressure tubes support bracket

1. High and low pressure tube assembly
2. M6 nut
3. T-bracket
4. M6 x 25 hex bolt
5. Support bracket

3. Remove rear support bracket M6 nut and M6 x 25 hex bolt from T-bracket at the oil pan.
4. If equipped, remove front support bracket M6 nut and M6 x 25 hex bolt from T-bracket on front engine support.
5. Remove high and low pressure tube as an assembly.

NOTE: If replacing high or low pressure tubes, do steps 6 and 7.

6. Remove the rear support brackets and rubber isolator from the high and low pressure tubes.
7. Remove M6 nut, M6 x 25 hex bolt, front support brackets and rubber isolator from the high and low pressure tubes.

Power Steering Elbows

NOTE: This procedure should be completed only if replacing power steering pump, or if one or both of the elbows are leaking.

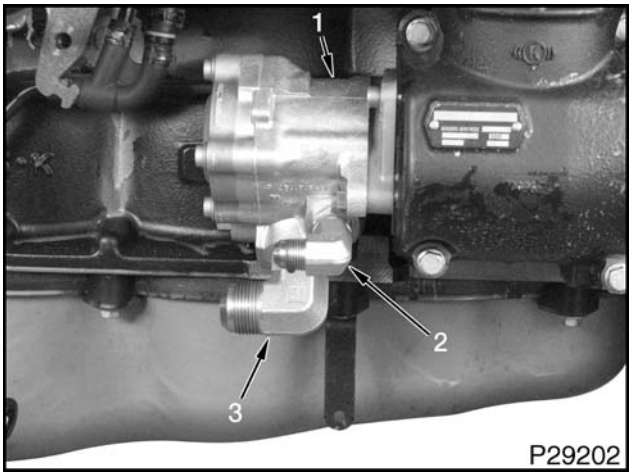

Figure 259 Power steering elbows

1. Power steering pump
2. 1/2” 90 degree tube elbow
3. 1-1/16” 90 degree elbow

1. Loosen the lock nut and rotate the 1/2” 90 degree tube elbow counterclockwise to remove from power steering pump.
2. Loosen the lock nut and rotate the 1-1/16” 90 degree elbow counterclockwise to remove from power steering pump.

Power Steering Pump

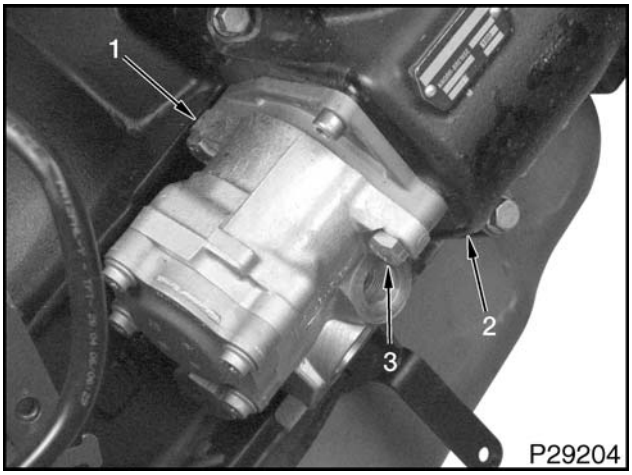

Figure 260 Power steering pump

1. Power steering pump
2. Air compressor
3. M10 x 40 heavy bolt (2)

1. Remove two M10 x 40 heavy bolts and power steering pump.
2. Check O-ring for damage and replace as necessary.

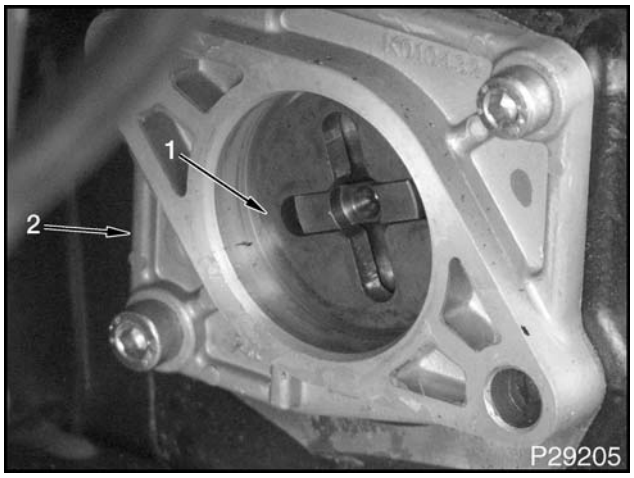

Figure 261 Power steering pump adapter

1. Power steering pump adapter
2. Air compressor

3. Remove power steering pump adapter from air compressor bore.

Air Compressor Suction Pipes

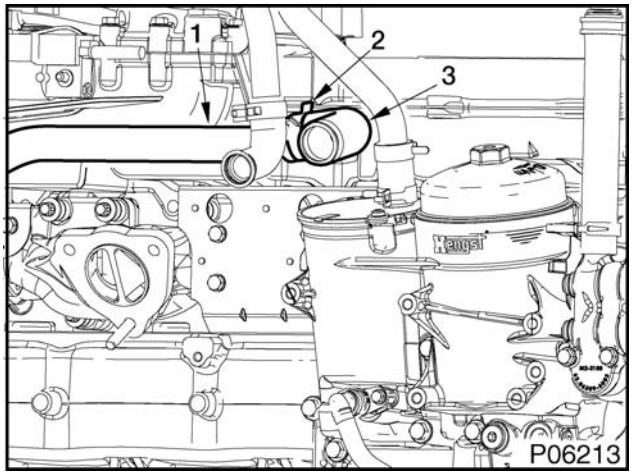

Figure 262 Air compressor suction pipe

1. Air compressor suction pipe
2. 44/15 spring clip
3. DMR32 shaped hose

1. Loosen 44/15 spring clips and remove DMR32 shaped hose from air compressor suction pipe.

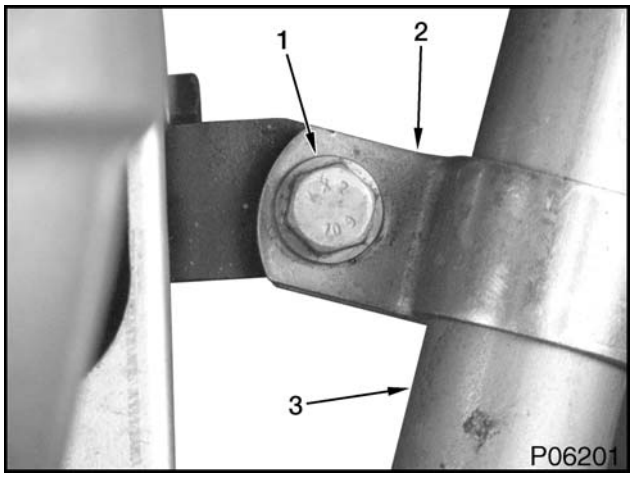

Figure 263 Air compressor suction pipe

1. M8 x 25 hex bolt
2. Bracket
3. Air compressor suction pipe

2. Remove M8 x 25 hex bolt from bracket.

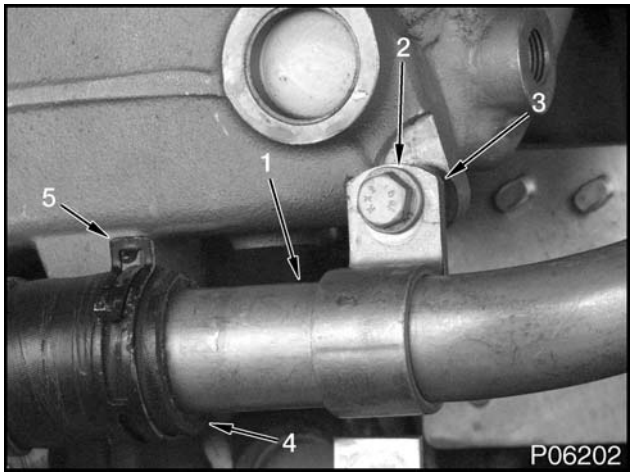

Figure 264 Air compressor suction pipe bolt

1. Air compressor suction pipe
2. M8 x 65 hex bolt
3. Bushing
4. Hose
5. 44/15 spring clip

3. Remove M8 x 65 hex bolt from coolant elbow.

4. Loosen 44/15 spring clip at hose and remove air compressor suction pipe.

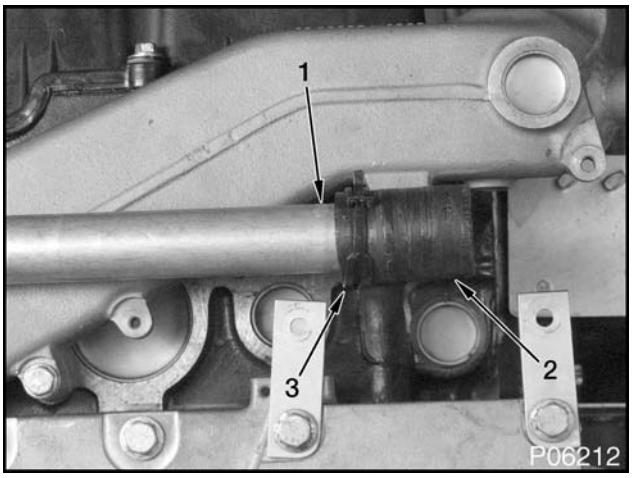

Figure 265 Hose

1. Air compressor suction pipe
2. Hose
3. 44/15 spring clip

5. Loosen 44/15 spring clip and remove hose from air compressor suction pipe.

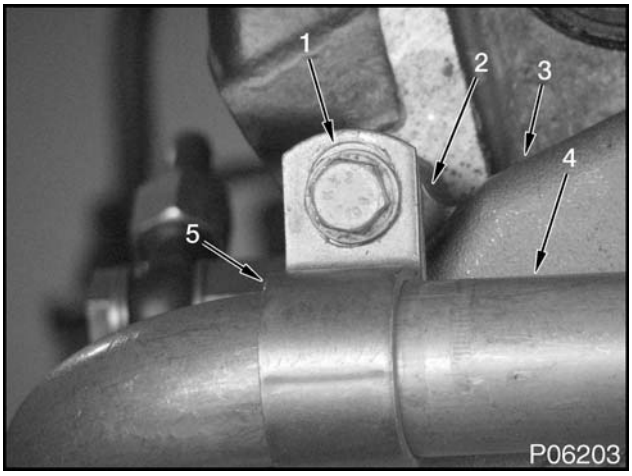

Figure 266 Air compressor suction pipe

1. M8 x 65 hex bolt
2. Bushing
3. Coolant elbow
4. Air compressor suction pipe
5. Bracket

6. Remove M8 x 65 hex bolt and bushing from cylinder head.

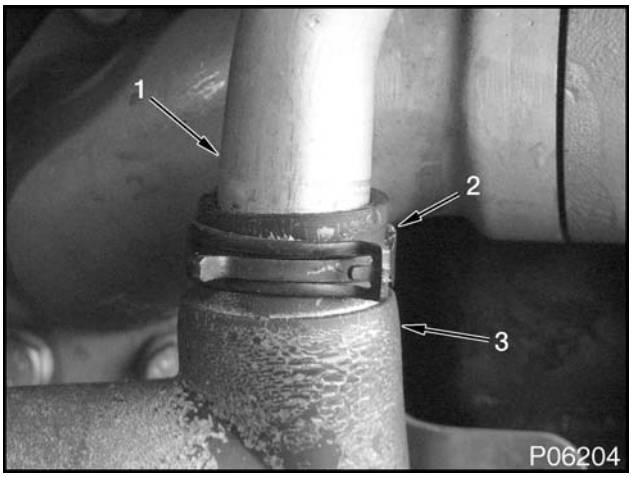

Figure 267 Air compressor suction pipe

1. Air compressor suction pipe
2. 44/15 spring clip
3. Air compressor shaped hose

7. Loosen 44/15 spring clip at air compressor shaped hose and remove air compressor suction pipe.

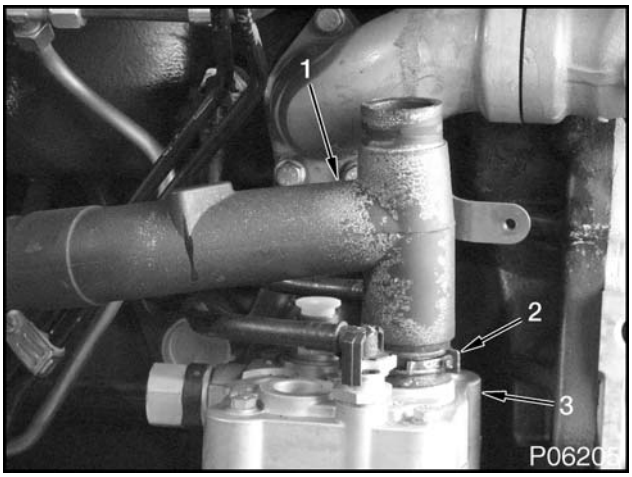

Figure 268 Air compressor shaped hose

1. Air compressor shaped hose
2. 44/15 spring clip
3. Air compressor

8. Loosen 44/15 spring clip and remove air compressor shaped hose from air compressor.

Air Compressor Coolant Pipe (Supply)

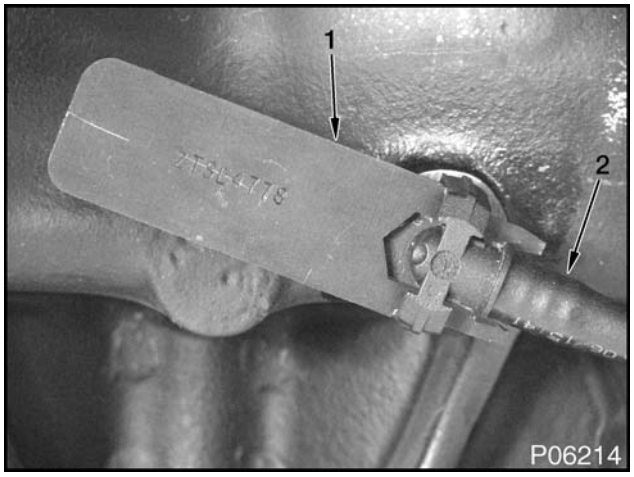

Figure 269 Air compressor coolant pipe (supply)

1. Coolant Line Release Tool
2. Air compressor coolant pipe (supply)

1. Place suitable container under air compressor to collect any residual coolant.
2. Insert Coolant Line Release Tool (page 183), into retaining clips of air compressor coolant pipe (supply) and remove from crankcase.

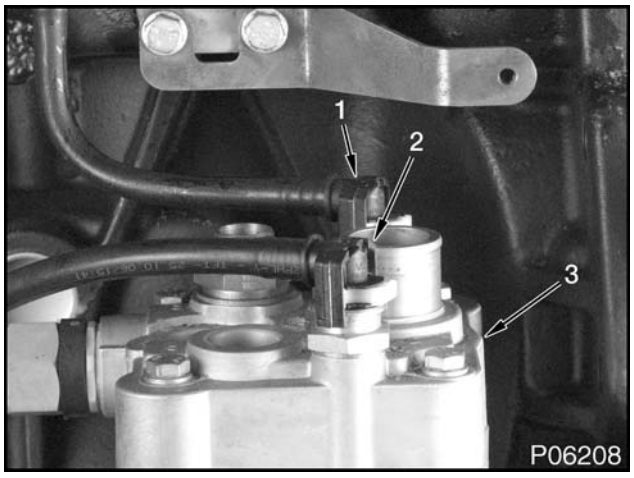

Figure 270 Air compressor coolant pipe (supply)

1. Air compressor coolant pipe (return)
2. Air compressor coolant pipe (supply)
3. Air compressor

3. Using Coolant Line Release Tool (page 183), release and remove air compressor coolant pipe (supply) from air compressor.

Air Compressor Coolant Pipe (Return)

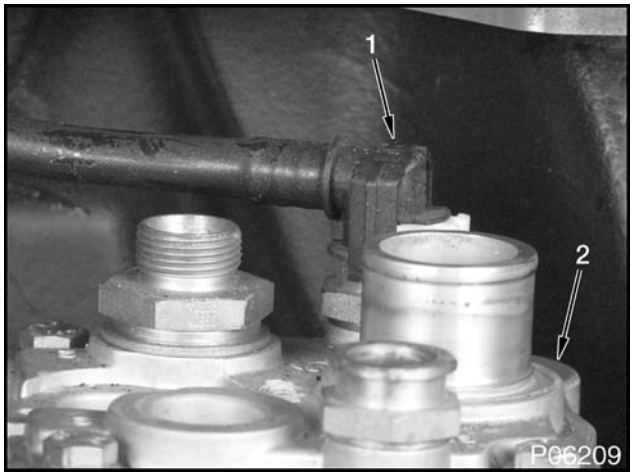

Figure 271 Air compressor coolant pipe (return)

1. Air compressor coolant pipe (return)
2. Air compressor

1. Place suitable container under air compressor to collect any residual coolant.
2. Using Coolant Line Release Tool (page 183), release air compressor coolant pipe (return) from air compressor.

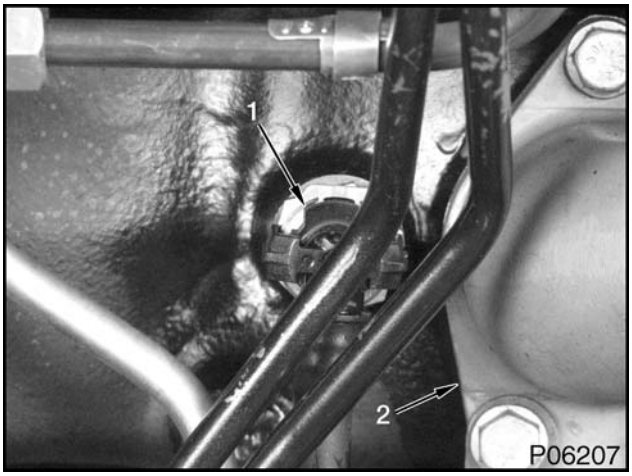

Figure 272 Air compressor coolant pipe (return)

1. Air compressor coolant pipe (return)
2. Coolant elbow

3. Using Coolant Line Release Tool (page 183), release and remove air compressor coolant pipe (return) from crankcase.

Air Compressor

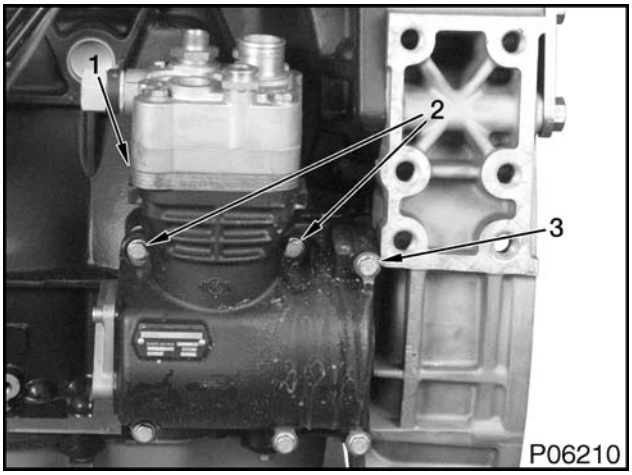

Figure 273 Air compressor (typical)

1. Air compressor
2. M8 x 40 hex bolt (2)
3. M8 x 110 hex bolt (4)

WARNING: To prevent personal injury or death, get help when removing or installing the air compressor.

1. Remove two M8 x 40 hex bolts and four M8 x 110 hex bolts.
2. Remove air compressor from alignment dowels.

Cleaning

All Components

1. Cover coolant, fluid and air openings to ensure dirt does not enter air compressor and power steering pump.
2. Clean foreign material from gasket surfaces of air compressor. Use a scraper to remove gasket from gasket surfaces.
3. Use only hot water to clean all hoses and tubes.

Installation

Air Compressor

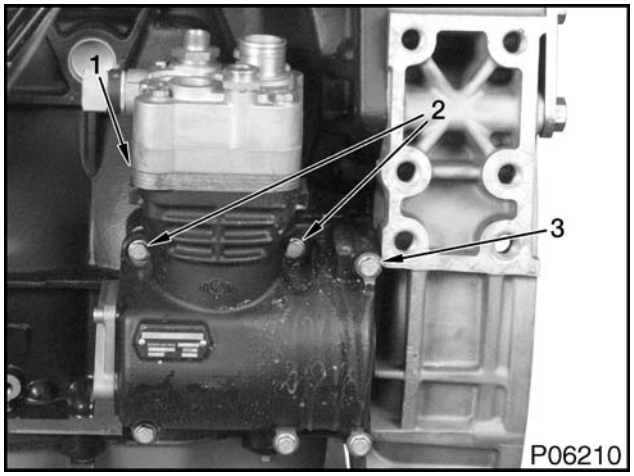

Figure 274 Air compressor (typical)

1. Air compressor
2. M8 x 40 hex bolt (2)
3. M8 x 110 hex bolt (4)

WARNING: To prevent personal injury or death, get help when removing or installing the air compressor.

CAUTION: To prevent engine damage, apply Liquid Gasket and component within 5 minutes of application to inhibit the formation of a skin and ensure a leak proof joint.

1. Apply Loctite® 5900 sealant or equivalent (page 183) to crankcase and air compressor mating surface.
2. Position air compressor and install two M8 x 40 hex bolts and four M8 x 110 hex bolts. Tighten hex bolts to special torque (page 183).

Air Compressor Coolant Pipe (Return)

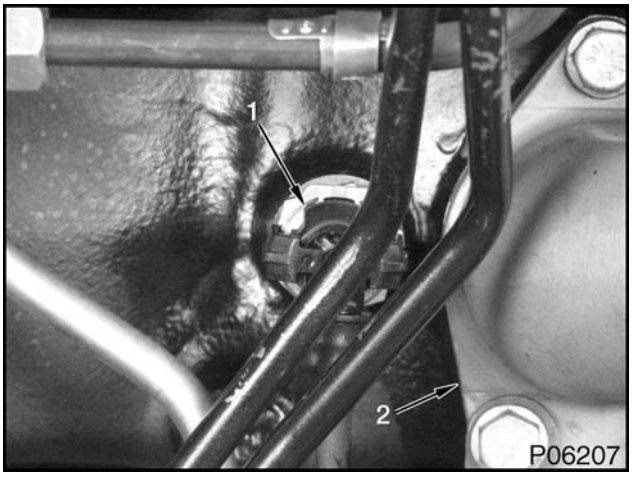

Figure 275 Air compressor coolant pipe (return)

1. Air compressor coolant pipe (return)
2. Coolant elbow

1. Check coolant pipe O-ring before reassembly. Replace O-ring as needed.
2. Position air compressor coolant pipe (return) and press against crankcase until a click is heard.

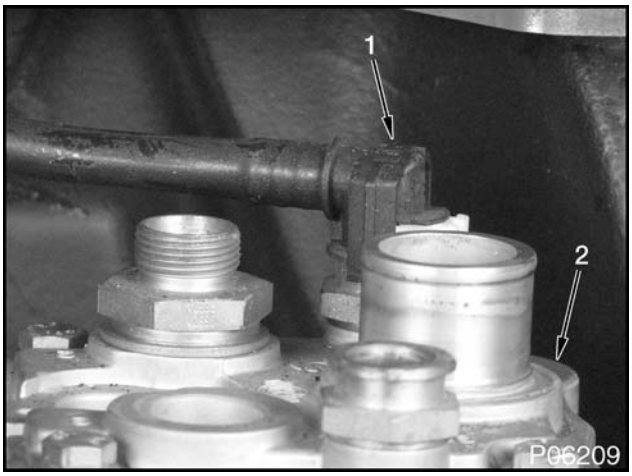

Figure 276 Air compressor coolant pipe (return)

1. Air compressor coolant pipe (return)
2. Air compressor

3. Press on air compressor coolant pipe (return) to air compressor until a click is heard.

Air Compressor Coolant Pipe (Supply)

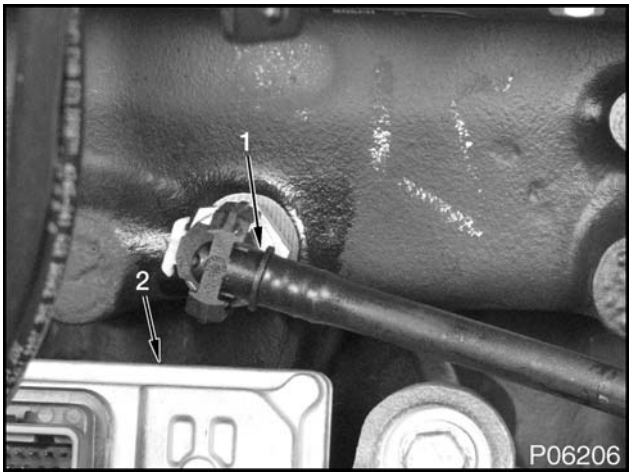

Figure 277 Air compressor coolant pipe (supply)

1. Air compressor coolant pipe (supply)
2. Engine Interface Module (EIM)

1. Check coolant pipe O-ring before reassembly. Replace O-ring as needed.
2. Position air compressor coolant pipe (supply) and press against crankcase until a click is heard.

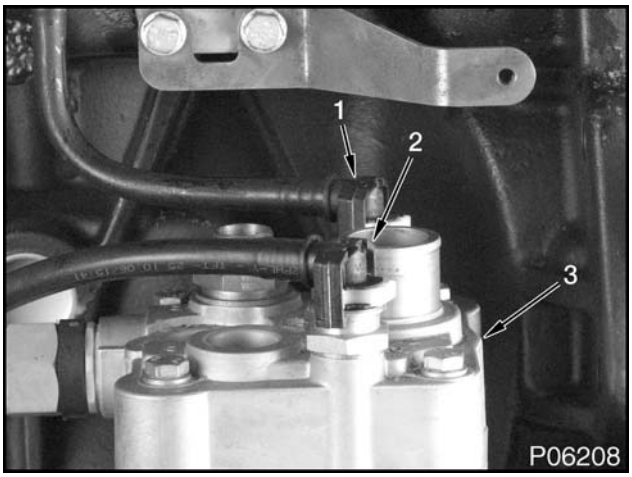

Figure 278 Air compressor coolant pipe (supply)

1. Air compressor coolant pipe (return)
2. Air compressor coolant pipe (supply)
3. Air compressor

3. Press on air compressor coolant pipe (supply) to air compressor until a click is heard.

Air Compressor Suction Pipes

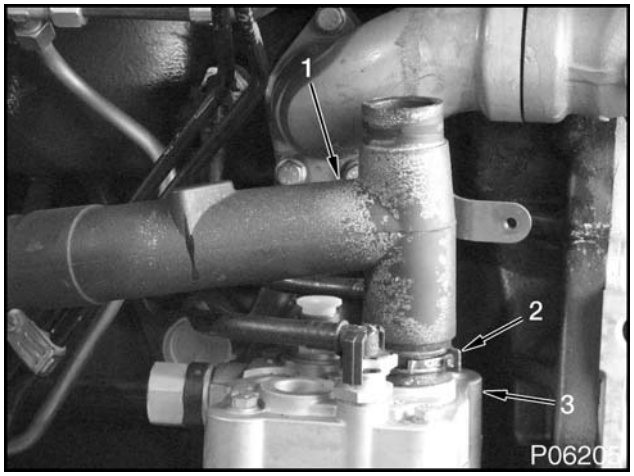

Figure 279 Air compressor shaped hose

1. Air compressor shaped hose
2. 44/15 spring clip
3. Air compressor

1. Install air compressor shaped hose to air compressor and release 44/15 spring clip.

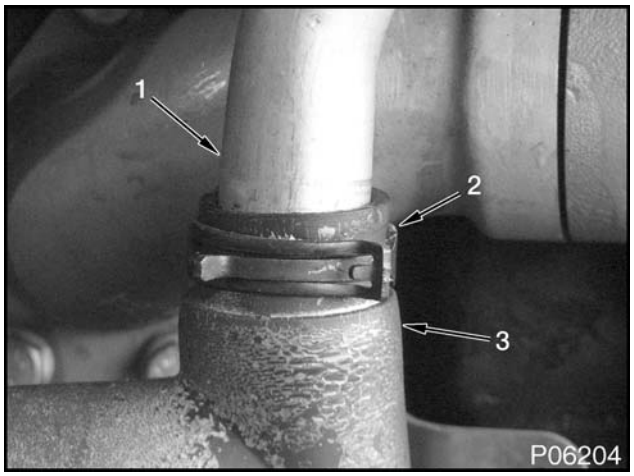

Figure 280 Air compressor suction pipe

1. Air compressor suction pipe
2. 44/15 spring clip
3. Air compressor shaped hose

2. Install air compressor suction pipe and release 44/15 spring clip at air compressor shaped hose.

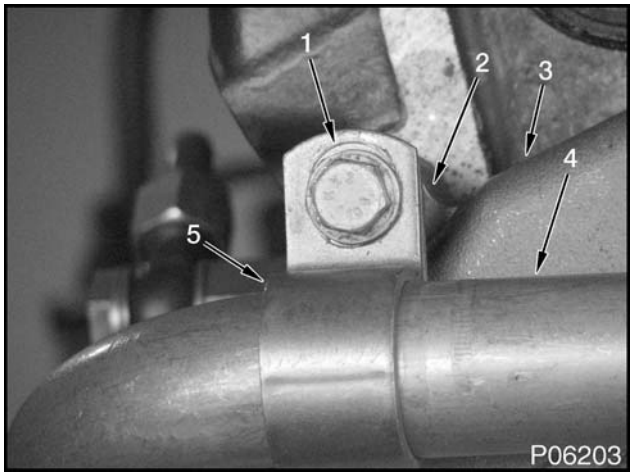

Figure 281 Air compressor suction pipe

1. M8 x 65 hex bolt
2. Bushing
3. Coolant elbow
4. Air compressor suction pipe
5. Bracket

3. Position air compressor suction pipe and install M8 x 65 hex bolt though pipe bracket and bushing to cylinder head. Tighten hex bolt to special torque (page 183).

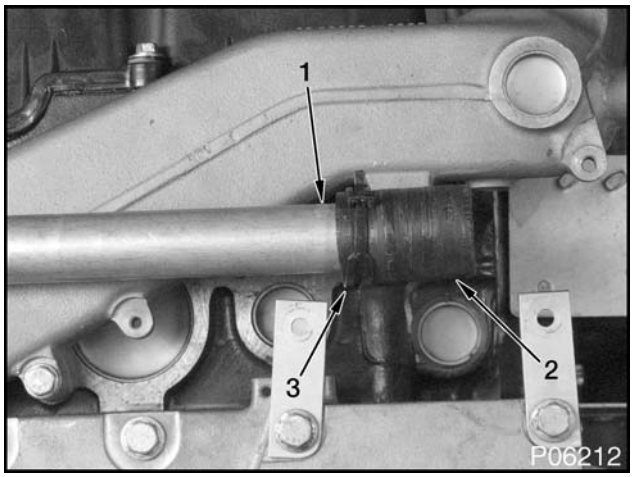

Figure 282 Hose

1. Air compressor suction pipe
2. Hose
3. 44/15 spring clip

4. Install hose to air compressor suction pipe and release 44/15 spring clip.

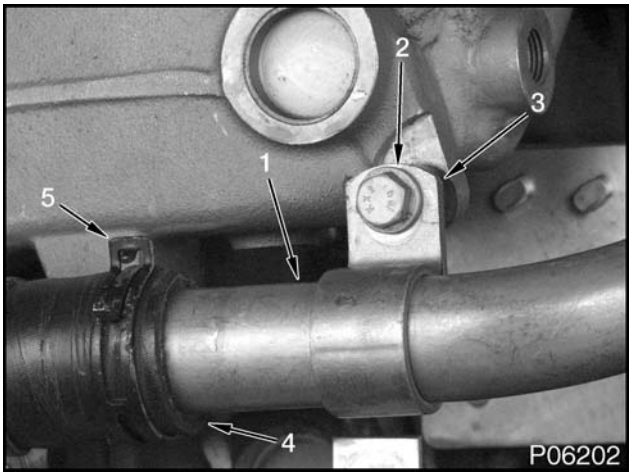

Figure 283 Air compressor suction pipe

1. Air compressor suction pipe
2. M8 x 65 hex bolt
3. Bushing
4. Hose
5. 44/15 spring clip

5. Install air compressor suction pipe to hose and release 44/15 spring clip.

6. Position air compressor suction pipe and install M8 x 65 hex bolt though pipe bracket and bushing to coolant elbow. Tighten hex bolt to special torque (page 183).

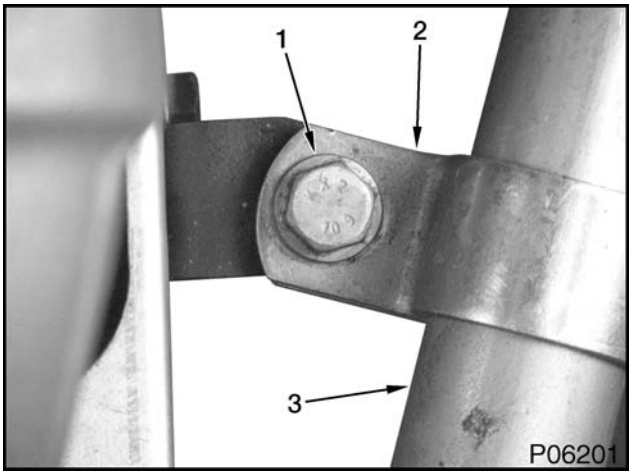

Figure 284 Air compressor suction pipe

1. M8 x 25 hex bolt
2. Bracket
3. Air compressor suction pipe

7. Install M8 x 25 hex bolt to bracket. Tighten hex bolt to standard torque (page 455).

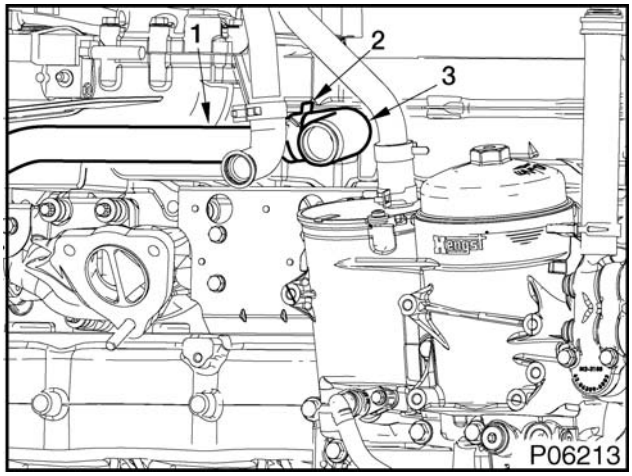

Figure 285 Air compressor suction pipe

1. Air compressor suction pipe
2. 44/15 spring clip
3. DMR32 shaped hose

8. Install DMR32 shaped hose to air compressor suction pipe and release 44/15 spring clip.

Power Steering Pump

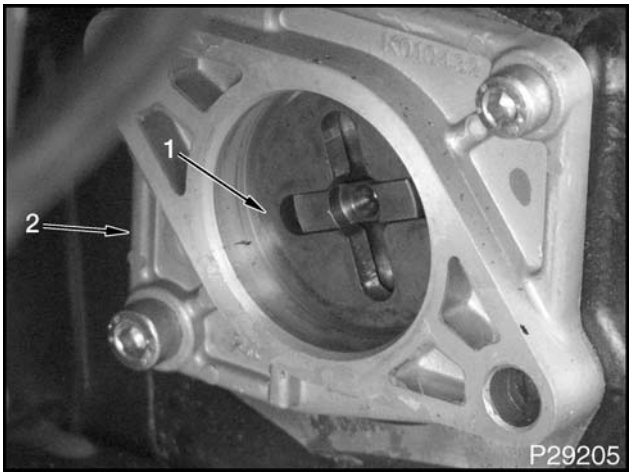

Figure 286 Power steering pump adapter

1. Power steering pump adapter
2. Air compressor

1. Install power steering pump adapter to air compressor bore.

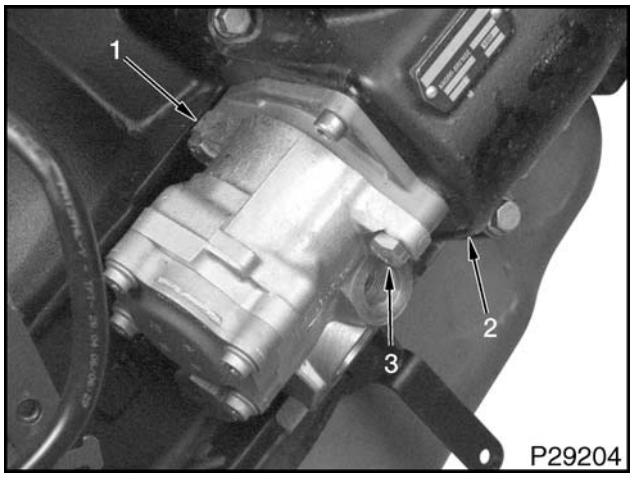

Figure 287 Power steering pump (typical)

1. Power steering pump
2. Air compressor
3. M10 x 40 heavy bolt (2)

2. If O-ring was removed or is damaged, install a new O-ring.
3. Install power steering pump and two M10 x 40 heavy bolts. Tighten bolts to special torque (page 183).

Power Steering Elbow

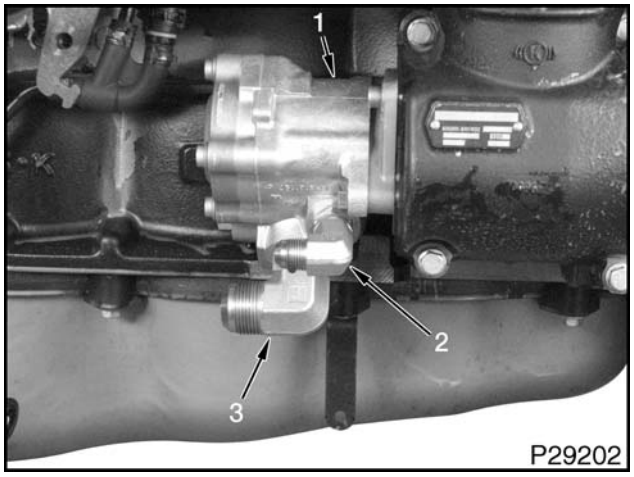

Figure 288 Power steering elbow

1. Power steering pump
2. 1/2” 90 degree tube elbow
3. 1-1/16” 90 degree elbow

NOTE: This procedure should be completed only if replacing power steering pump, or if one or both of the elbows were removed.

1. Check seals on elbow for damage. Replace as necessary.
2. Install 1/2” 90 degree tube elbow to power steering pump. Lock nuts should not be tightened until power steering lines are installed for proper orientation.
3. Install 1-1/16” 90 degree elbow to power steering pump. Lock nuts should not be tightened until power steering lines are installed for proper orientation.

Power Steering Pressure Tubes

NOTE: If high or low pressure tubes were replaced, do steps 1 and 2.

1. Install front support brackets, isolator, M6 x25 hex bolt and M6 nut onto the high and low pressure tubes.
2. Install the rear support brackets and rubber isolator onto the high and low pressure tubes.

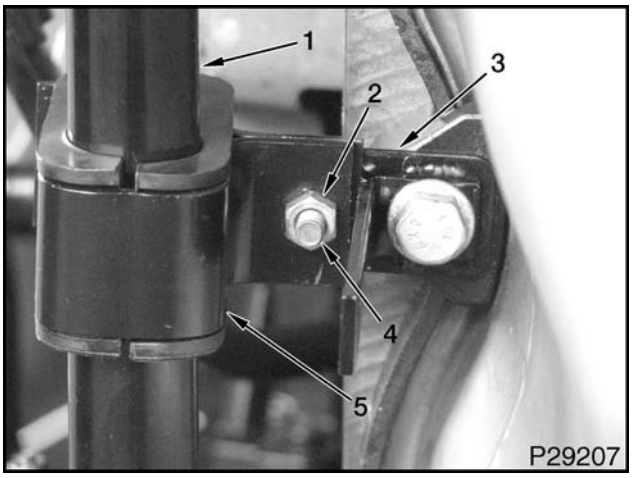

Figure 289 Pressure tubes support bracket

1. High and low pressure tube assembly
2. M6 nut
3. T-bracket
4. M6 x 25 hex bolt
5. Support bracket

3. Position high and low pressure tube as an assembly. Install M6 x 25 hex bolt and M6 nut onto rear support brackets and t-bracket at the oil pan. Tighten nut to standard torque (page 455).
4. If equipped, install front support bracket to T-bracket on front engine support and secure with M6 nut. Tighten nut to standard torque (page 455).

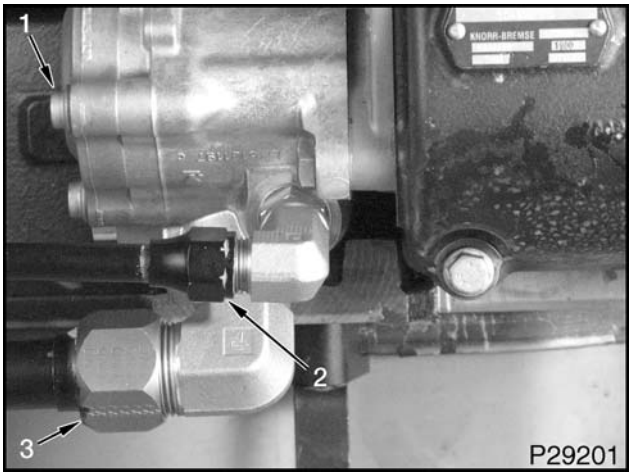

Figure 290 Pressure tube(s)

1. Power steering pump
2. High pressure tube
3. Low pressure tube

5. Install high and low pressure tubes to elbows. Tighten pressure tube fitting nuts to special torque (page 183).

NOTE: Proceed with steps 5 and 6 only if fitting was removed or if power steering pump was replaced.

6. Using a appropriate size wrench to hold the elbow. Tighten 1/2" 90 degree tube elbow lock nut to special torque (page 183).
7. Using a appropriate size wrench to hold the elbow. Tighten 1-1/16" 90 degree elbow lock nut to special torque (page 183).

Special Torque

Table 12 Air Compressor and Power Steering/Fuel Pump

1-1/16" 90 degree elbow lock nut	55 N·m (40 lbf·ft)
1/2" 90 degree tube elbow lock nut	45 N·m (33 lbf·ft)
Air compressor hex bolts	35 N·m (26 lbf·ft)
Air compressor suction pipe M8 x 65 hex bolts	35 N·m (26 lbf·ft)
High pressure tube fitting nut	62 N·m (45 lbf·ft)
Low pressure tube fitting nut	164 N·m (120 lbf·ft)
Power steering pump heavy bolts	67 N·m (49 lbf·ft)

Special Service Tools

Table 13 Air Compressor

Description	Tool Number
Coolant Line Release Tool	ZTSE4778
Loctite® 5900 Sealant or equivalent	Obtain locally