

EXHAUST SYSTEM

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EXHAUST SYSTEM

DESCRIPTION

DESCRIPTION

CAUTION: Avoid application of rust prevention compounds or undercoating materials to exhaust system floor pan exhaust heat shields. Light overspray near the edges is permitted. Application of coating will result in excessive floor pan temperatures and objectionable fumes.

The federal gasoline engine exhaust system consists of engine exhaust manifolds, exhaust pipes, catalytic converter(s), extension pipe (if needed), exhaust heat shields, muffler and exhaust tailpipe.

The California emission vehicles exhaust system also contains the above components as well as mini catalytic converters added to the exhaust pipe.

The exhaust system must be properly aligned to prevent stress, leakage and body contact. Minimum clearance between any exhaust component and the body or frame is 25.4 mm (1.0 in.). If the system contacts any body panel, it may amplify objectionable noises from the engine or body.

EXHAUST SYSTEM (Continued)

DESCRIPTION – 5.9L DIESEL

CAUTION: Avoid application of rust prevention compounds or undercoating materials to exhaust system floor pan exhaust heat shields. Light overspray near the edges is permitted. Application of coating will result in excessive floor pan temperatures and objectionable fumes.

The diesel engine exhaust system consists of an engine exhaust manifold, turbocharger, exhaust pipe,

resonator, extension pipe (if needed), muffler and exhaust tailpipe.

California emission vehicles include a catalytic converter.

The exhaust system must be properly aligned to prevent stress, leakage and body contact. The exhaust components should be kept a minimum of 25.4 mm (1.0 in.) away from the body and frame. If the system contacts any body panel, it may amplify objectionable noises from the engine or body.

DIAGNOSIS AND TESTING**DIAGNOSIS AND TESTING - GAS ENGINE***EXHAUST SYSTEM DIAGNOSIS CHART*

CONDITION	POSSIBLE CAUSE	CORRECTION
EXCESSIVE EXHAUST NOISE OR LEAKING EXHAUST GASES	1. Leaks at pipe joints. 2. Rusted or blown out muffler. 3. Broken or rusted out exhaust pipe. 4. Exhaust pipe leaking at manifold flange. 5. Exhaust manifold cracked or broken. 6. Leak between exhaust manifold and cylinder head. 7. Catalytic converter rusted or blown out. 8. Restriction in exhaust system.	1. Tighten clamps/bolts at leaking joints. 2. Replace muffler. Inspect exhaust system. 3. Replace exhaust pipe. 4. Tighten/replace flange attaching nuts/bolts. 5. Replace exhaust manifold. 6. Tighten exhaust manifold to cylinder head bolts. 7. Replace catalytic converter assy. 8. Remove restriction, if possible. Replace restricted part if necessary.

CAUTION:

When servicing and replacing exhaust system components, disconnect the oxygen sensor connector(s). Allowing the exhaust to hang by the oxygen sensor wires will damage the harness and/or sensor.

EXHAUST SYSTEM (Continued)**DIAGNOSIS AND TESTING - DIESEL ENGINE***EXHAUST SYSTEM DIAGNOSIS CHART*

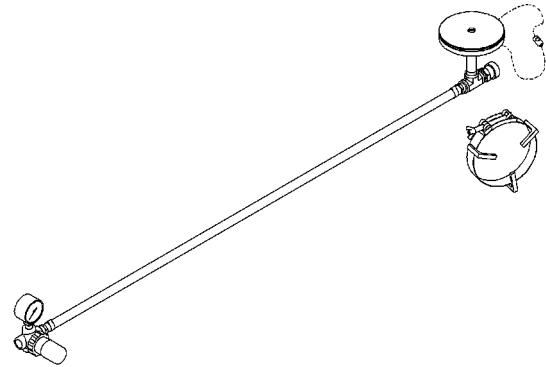
CONDITION	POSSIBLE CAUSE	CORRECTION
EXCESSIVE EXHAUST NOISE OR LEAKING EXHAUST GASES	1. Leaks at pipe joints. 2. Rusted or blown out muffler. 3. Broken or rusted out exhaust pipe. 4. Exhaust pipe leaking at manifold flange. 5. Exhaust manifold cracked or broken. 6. Leak between exhaust manifold and cylinder head. 7. Turbocharger mounting flange cracked. 8. Restriction in exhaust system.	1. Tighten clamps/bolts at leaking joints. 2. Replace muffler. Inspect exhaust system. 3. Replace exhaust pipe. 4. Tighten/replace flange attaching nuts/bolts. 5. Replace exhaust manifold. 6. Tighten exhaust manifold to cylinder head bolts. Replace gasket if necessary. 7. Remove turbocharger and inspect. (Refer to 11 - EXHAUST SYSTEM/TURBOCHARGER SYSTEM/TURBOCHARGER - REMOVAL). 8. Remove restriction, if possible. Replace restricted part if necessary.

EXHAUST SYSTEM (Continued)

SPECIFICATIONS - TORQUE

DESCRIPTION	N·m	Ft. Lbs.	In. Lbs.
Adjusting Strap—Bolt	23	—	200
Air Heater Power Supply—Nuts	14	—	124
Air Inlet Housing—Bolts	24	18	—
Cab Heater Supply/Return Line—Nuts	24	18	—
Exhaust Clamp—Nuts	48	35	—
Exhaust Manifold to Cylinder Head—Bolts (Diesel Engine)	43	32	—
Exhaust Manifold to Cylinder Head—Bolts (5.9L)	31	23	—
Exhaust Manifold to Cylinder Head—Bolts (8.0L)	22	—	195
Exhaust Pipe to Manifold—Bolts	31	23	—
Generator Mounting—Bolts	41	30	—
Charge Air Cooler Mounting—Bolts	2	—	17
Charge Air Cooler Duct—Nuts	11	—	95
Heat Shield—Nuts and Bolts	11	—	95
Turbocharger flange studs	24	18	—
Turbocharger Mounting—Nuts	43	32	—
Turbocharger Oil Drain Tube—Bolts	24	18	—
Turbocharger Oil Supply Line—Fitting	24	18	—
Turbocharger V-Band Clamp—Nut	9	—	75
Turbocharger Oil Supply fitting (at Turbocharger)	36	27	—
Turbocharger Oil Supply fitting (at lube filter head)	24	18	—
Turbocharger Drain Hose Clamps	8	—	71

SPECIAL TOOLS



TURBOCHARGER TESTER 9022

CATALYTIC CONVERTER

DESCRIPTION - CATALYTIC CONVERTER

WARNING: THE NORMAL OPERATING TEMPERATURE OF THE EXHAUST SYSTEM IS VERY HIGH. THEREFORE, NEVER WORK AROUND OR ATTEMPT TO SERVICE ANY PART OF THE EXHAUST SYSTEM UNTIL IT IS COOLED. SPECIAL CARE SHOULD BE TAKEN WHEN WORKING NEAR THE CATALYTIC CONVERTER. THE TEMPERATURE OF THE CONVERTER RISES TO A HIGH LEVEL AFTER A SHORT PERIOD OF ENGINE OPERATION TIME.

CAUTION: DO NOT remove spark plug wires from plugs or by any other means short out cylinders. Failure of the catalytic converter can occur due to a temperature increase caused by unburned fuel passing through the converter.

The stainless steel catalytic converter body is designed to last the life of the vehicle. Excessive heat can result in bulging or other distortion, but excessive heat will not be the fault of the converter. If unburned fuel enters the converter, overheating may occur. If a converter is heat-damaged, correct the cause of the damage at the same time the converter is replaced. Also, inspect all other components of the exhaust system for heat damage.

Unleaded gasoline must be used to avoid contaminating the catalyst core.

50 State emission vehicles incorporate two mini catalytic converters located after the exhaust manifold and before the inline catalytic converter.

OPERATION

The catalytic converter captures and burns any unburned fuel mixture exiting the combustion chambers during the exhaust stroke of the engine. This process aids in reducing emissions output.

CATALYTIC CONVERTER (Continued)

REMOVAL

REMOVAL

WARNING: IF TORCHES ARE USED WHEN WORKING ON THE EXHAUST SYSTEM, DO NOT ALLOW THE FLAME NEAR THE FUEL LINES.

- (1) Raise and support the vehicle.
- (2) Saturate the bolts and nuts with heat valve lubricant. Allow 5 minutes for penetration.
- (3) Remove the bolts from the crossover pipe to the catalytic converter connection.
- (4) Disconnect oxygen sensor wiring.
- (5) Loosen the nuts from the clamp that hold the catalytic converter to the exhaust pipe flange connection.

NOTE: Do not remove nut from T-Bolt. Only remove nut far enough, so that the T end can be removed from the clamp.

- (6) Remove the T bolt end of the fastener, from the clamp.
- (7) Spread the clamp, and remove the catalytic converter from the vehicle.
- (8) Discard the clamp.

NOTE: The catalytic converter to exhaust manifold clamp is not reusable. Always use a new clamp when reinstalling the catalytic converter.

REMOVAL

- (1) Raise and support vehicle.
- (2) Saturate the bolts and nuts with heat valve lubricant. Allow 5 minutes for penetration.
- (3) Remove clamps and nuts.
- (4) Remove the catalytic converter.

INSPECTION

Look at the stainless steel body of the converter, inspect for bulging or other distortion that could be a result of overheating. If the converter has a heat shield attached make sure it is not bent or loose.

If you suspect internal damage to the catalyst, tapping the bottom of the catalyst with a rubber mallet may indicate a damaged core.

INSTALLATION

INSTALLATION

NOTE: The catalytic converter to exhaust manifold clamp is not reusable. Always use a new clamp when reinstalling the catalytic converter.

(1) Position the catalytic converter onto the exhaust pipe flange connection. Tighten the nuts to 28 N·m (250 in. lbs.) torque.

(2) Install the muffler onto the catalytic converter until the alignment tab is inserted into the alignment slot.

(3) Install the exhaust clamp at the muffler and catalytic converter connection. Tighten the clamp nuts to 47 N·m (35 ft. lbs.) torque.

(4) Connect oxygen sensor wiring.

(5) Lower the vehicle.

(6) Start the engine and inspect for exhaust leaks and exhaust system contact with the body panels. Adjust the alignment, if needed.

INSTALLATION

(1) Assemble converter and clamps loosely in place.

(2) Install the exhaust pipe onto exhaust manifolds, tighten 31 N·m (23 ft. lbs.).

(3) Tighten all clamp nuts to 48 N·m (35 ft. lbs.) torque.

(4) Lower the vehicle.

(5) Start the engine and inspect for exhaust leaks and exhaust system contact with the body panels. A minimum of 25.4 mm (1.0 in.) is required between exhaust system components and body/frame parts. Adjust the alignment, if needed.

EXHAUST PIPE

REMOVAL

REMOVAL — 5.9L

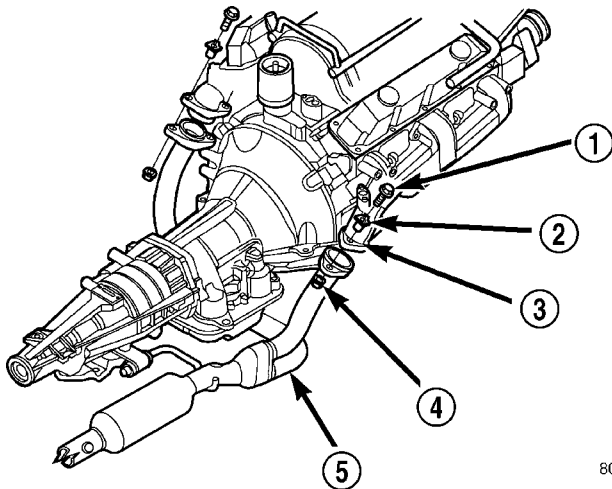
- (1) Raise and support the vehicle.
- (2) Saturate the bolts and nuts with heat valve lubricant. Allow 5 minutes for penetration.
- (3) Remove exhaust pipe to manifold bolts, retainers and nuts.
- (4) Remove the clamp nuts.
- (5) Remove the exhaust pipe (Fig. 1).

REMOVAL

CAUTION: When servicing or replacing exhaust system components, disconnect the oxygen sensor connector(s). Allowing the exhaust to hang by the oxygen sensor wires will damage the harness and/or sensor.

- (1) Raise and support the vehicle.
- (2) Saturate the bolts and nuts with Mopar® Rust Penetrant. Allow 5 minutes for penetration.
- (3) Disconnect the oxygen sensor(s).

EXHAUST PIPE (Continued)



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Fig. 1 Exhaust Pipe to Manifold Connection - 5.9L

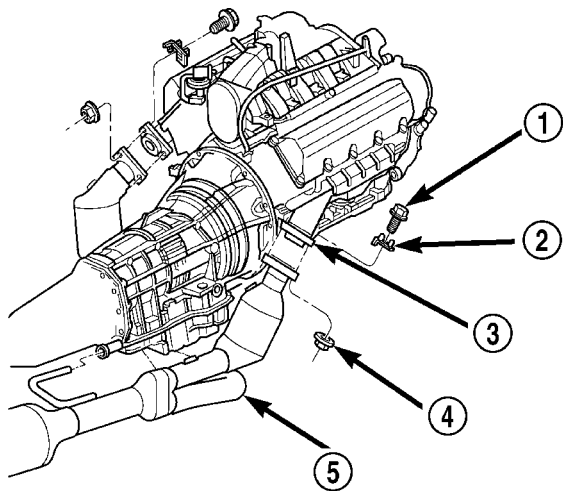
- 1 - BOLT
- 2 - RETAINER
- 3 - EXHAUST MANIFOLD
- 4 - NUT
- 5 - EXHAUST PIPE

(4) Remove the exhaust manifold-to-exhaust pipe nuts (Fig. 2).

(5) Remove exhaust pipe to converter exhaust clamp.

(6) Disconnect the exhaust pipe from the catalytic converter front flange.

(7) Remove the exhaust pipe.



80bbc378

Fig. 2 Exhaust Pipe(s) to Manifold Connection

- 1 - BOLT
- 2 - RETAINER
- 3 - EXHAUST MANIFOLD
- 4 - NUT
- 5 - EXHAUST PIPE

INSPECTION

Discard rusted clamps, broken or worn supports and attaching parts. Replace a component with original equipment parts, or equivalent. This will assure proper alignment with other parts in the system and provide acceptable exhaust noise levels.

INSTALLATION**INSTALLATION — 5.9L**

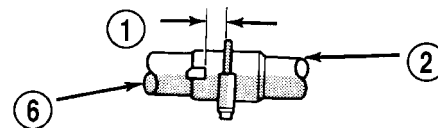
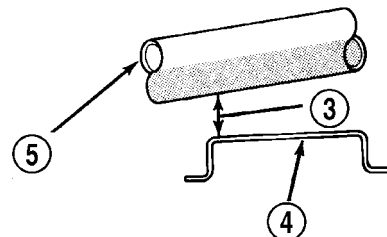
(1) Position the exhaust pipe for proper clearance with the frame and underbody parts. A minimum clearance of 25.4 mm (1.0 in.) is required.

(2) Position the exhaust pipe to manifold. Install the bolts, retainers and nuts. Tighten the nuts to 31 N·m (23 ft. lbs.) torque.

(3) Tighten the clamp nuts to 48 N·m (35 ft. lbs.) torque.

(4) Lower the vehicle.

(5) Start the engine and inspect for exhaust leaks and exhaust system contact with the body panels. Adjust the alignment, if needed (Fig. 1) and (Fig. 3).

**TYPICAL VIEW OF PIPE SLIP JOINT
(MUST BE FULLY ENGAGED)**

J9311-18

Fig. 3 Exhaust Pipe-to-Catalytic Converter Flange Alignment — Typical

- 1 - 7.874-17.526 mm (0.31-0.69 in.)
- 2 - CATALYTIC CONVERTER FLANGE
- 3 - 20 mm (0.79 in.) MIN.
- 4 - CROSSMEMBER
- 5 - EXHAUST PIPE
- 6 - EXHAUST PIPE

EXHAUST PIPE (Continued)

INSTALLATION

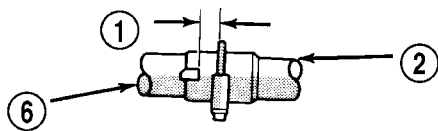
(1) Connect the exhaust pipe(s) to the exhaust manifold. Tighten the nuts to 34 N·m (25 ft. lbs.) torque.

(2) Align and connect the exhaust pipe to the catalytic converter flange (Fig. 4). Install exhaust clamp and tighten clamp nuts to 47 N·m (35 ft. lbs.) torque.

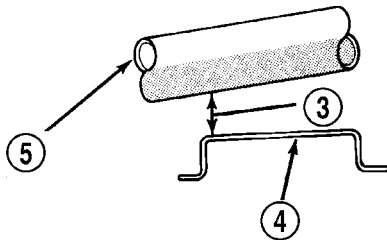
(3) Connect oxygen sensor connector(s).

(4) Lower the vehicle.

(5) Start the engine and inspect for exhaust leaks and exhaust system contact with the body panels. Adjust the alignment, if needed.



TYPICAL VIEW OF PIPE SLIP JOINT
(MUST BE FULLY ENGAGED)



J9311-18

Fig. 4 Exhaust Pipe-to-Catalytic Converter Flange Alignment—Typical

- 1 - 7.874–17.526 mm (0.31–0.69 in.)
- 2 - CATALYTIC CONVERTER FLANGE
- 3 - 20 mm (0.79 in.) MIN.
- 4 - CROSSMEMBER
- 5 - EXHAUST PIPE
- 6 - EXHAUST PIPE

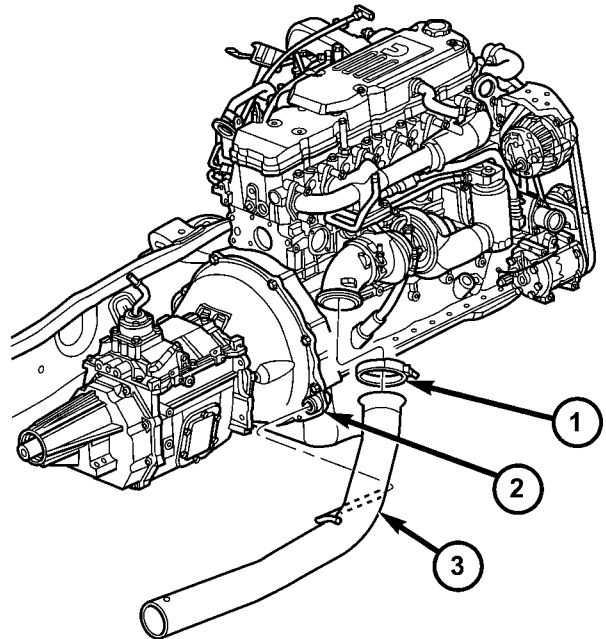
EXHAUST PIPE

REMOVAL

- (1) Disconnect the battery negative cables.
- (2) Raise and support the vehicle on a hoist.
- (3) Saturate the bolts and nuts with heat valve lubricant. Allow 5 minutes for penetration.
- (4) Remove the exhaust pipe-to-extension pipe clamp. Separate the exhaust pipe and extension pipe.
- (5) Remove the exhaust pipe-to-turbocharger elbow clamp (Fig. 5).
- (6) Remove the exhaust pipe from the transmission support (Fig. 5).

INSPECTION

Discard rusted clamps, broken or worn supports and attaching parts. Replace a component with original equipment parts, or equivalent. This will assure proper alignment with other parts in the system and provide acceptable exhaust noise levels.



80ff320c

Fig. 5 Exhaust Pipe

- 1 - Clamp
- 2 - Support
- 3 - EXHAUST PIPE

INSTALLATION

- (1) Install the exhaust pipe into the transmission support and onto the turbocharger flange.
- (2) Install the exhaust pipe-to-turbocharger elbow clamp and tighten to 31 N·m (23 ft. lbs.) torque.
- (3) Install the extension pipe and clamp to the exhaust pipe using a new clamp and tighten the clamp nuts to 48 N·m (35 ft. lbs.) torque.
- (4) Lower the vehicle.
- (5) Connect the battery negative cables.
- (6) Start the engine and inspect for exhaust leaks and exhaust system contact with the body panels. A minimum of 25.4 mm (1.0 in.) is required. Adjust the alignment, if needed.

HEAT SHIELDS

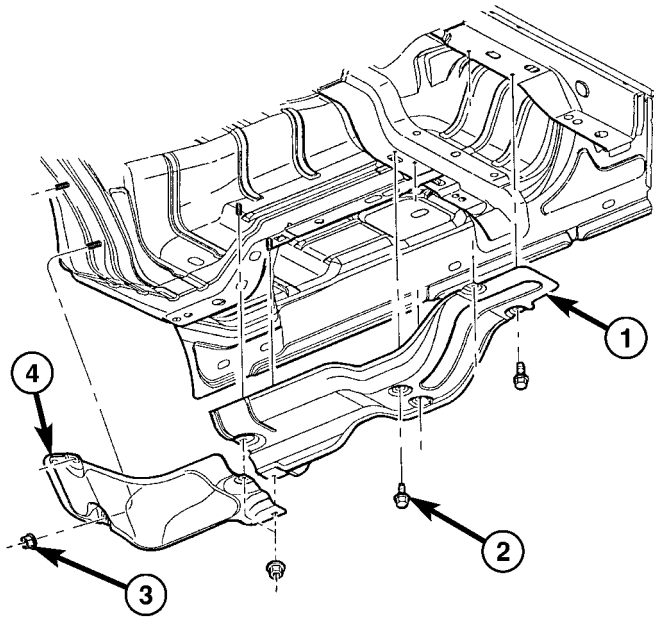
DESCRIPTION

There are two types of heat shields used. One is stamped steel the other is molded foil sheets. The shields attach to the vehicle around the exhaust system to prevent heat from the exhaust system from entering the passenger area and other areas where the heat can cause damage to other components.

REMOVAL

- (1) Raise and support the vehicle.
- (2) Remove the nuts or bolts holding the exhaust heat shield to the floor pan (Fig. 6) (Fig. 7) (Fig. 8), crossmember or bracket.

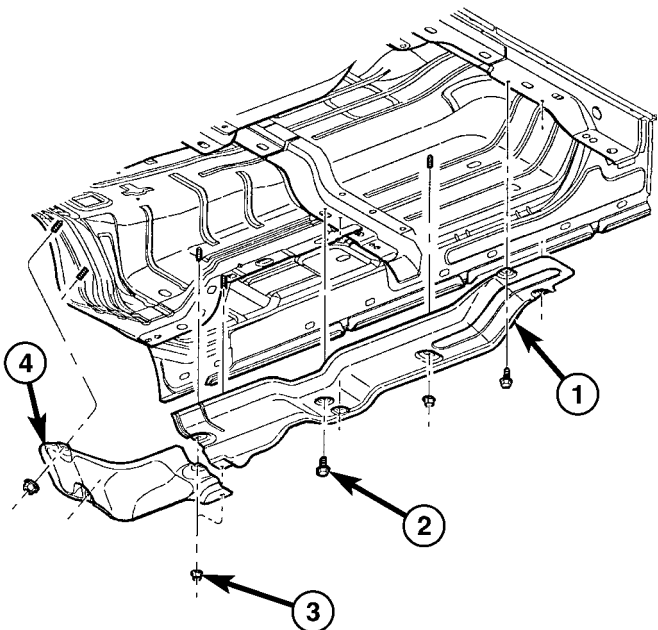
HEAT SHIELDS (Continued)



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Fig. 6 HEAT SHIELDS - RH - REG CAB

- 1 - HEAT SHIELD
- 2 - FASTENER
- 3 - NUT
- 4 - HEAT SHIELD

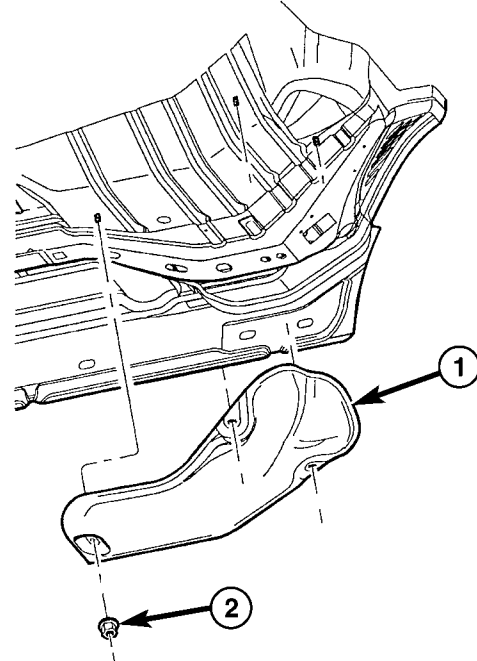


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Fig. 7 HEAT SHIELDS - RH - QUAD CAB

- 1 - HEAT SHIELD
- 2 - FASTENER
- 3 - NUT
- 4 - HEAT SHIELD

(3) Slide the shield out around the exhaust system.



80dd676c

Fig. 8 HEAT SHIELD LH

- 1 - HEAT SHIELD
- 2 - NUT

INSTALLATION

(1) Position the exhaust heat shield to the floor pan, crossmember or bracket and install the nuts or bolts.

(2) Tighten the nuts and bolts 11 N·m (100 in. lbs.).

(3) Lower the vehicle.

MUFFLER**REMOVAL**

(1) Raise and support the vehicle.

(2) Saturate the clamp nuts with heat valve lubricant. Allow 5 minutes for penetration.

(3) Disconnect the muffler hangers (Fig. 9).

(4) Remove clamps and nuts.

(5) Remove the muffler.

INSTALLATION

(1) Assemble muffler and clamps loosely to permit proper alignment of all parts.

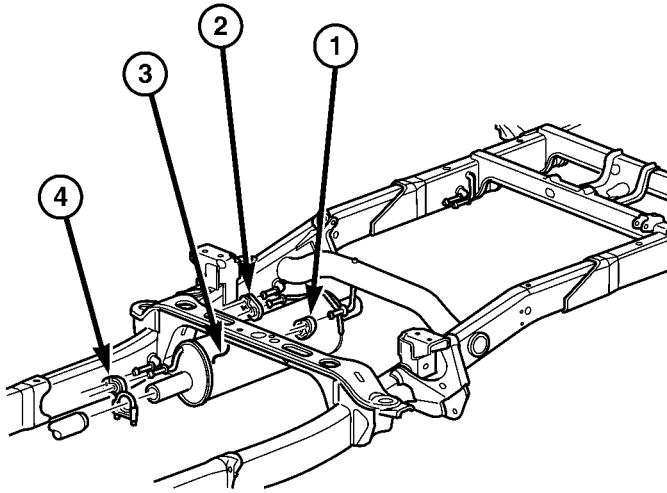
(2) Connect the muffler hangers.

(3) Tighten the clamp nuts to 48 N·m (35 ft. lbs.) torque.

(4) Lower the vehicle.

(5) Start the engine and inspect for exhaust leaks and exhaust system contact with the body panels. A minimum of 25.4 mm (1.0 in.) is required between exhaust system components and body/frame parts. Adjust the alignment, if needed.

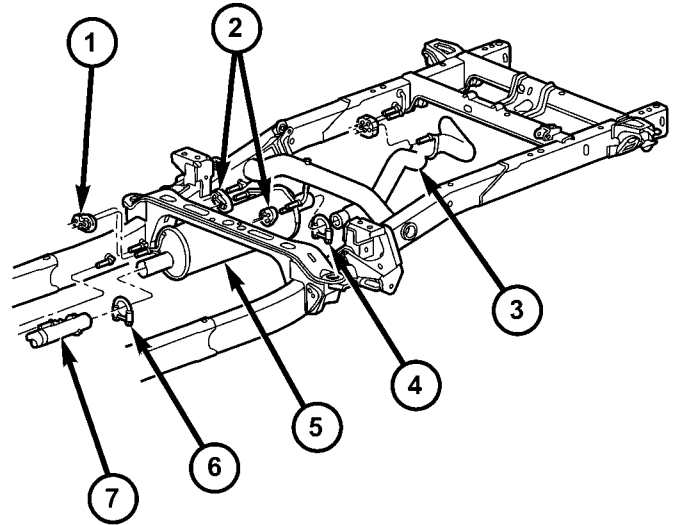
MUFFLER (Continued)



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Fig. 9 MUFFLER

- 1 - INSULATOR
- 2 - INSULATOR
- 3 - MUFFLER
- 4 - INSULATOR



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Fig. 10 Muffler Removal/Installation

- 1 - INSULATOR
- 2 - ISOLATOR
- 3 - TAILPIPE
- 4 - CLAMP
- 5 - MUFFLER
- 6 - CLAMP
- 7 - EXTENSION PIPE

MUFFLER - 5.9L DIESEL

REMOVAL

- (1) Disconnect the battery negative cables.
- (2) Raise and support the vehicle.
- (3) Remove the muffler to tail pipe and extension pipe clamps (Fig. 10).
- (4) Disconnect the muffler from the hanger isolators (Fig. 10).
- (5) Disconnect the muffler from the tailpipe.
- (6) Disconnect the muffler from the extension pipe and remove from the vehicle.

INSTALLATION

- (1) Install the muffler hanger rods into the isolators (Fig. 10).
- (2) Install the muffler into the extension pipe.
- (3) Install the muffler into the tail pipe.
- (4) Install the exhaust clamps, align the exhaust system, and tighten the exhaust clamps to 48 N·m (35 ft. lbs.) torque.
- (5) Lower the vehicle.
- (6) Connect the battery negative cables.
- (7) Start the engine and inspect for exhaust leaks and exhaust system contact with the body panels. A minimum of 25.4 mm (1.0 in.) is required between exhaust system components and body/frame parts. Adjust the alignment, if needed.

TAILPIPE - 5.9L DIESEL

REMOVAL

- (1) Disconnect the battery negative cables.
- (2) Raise and support the vehicle.
- (3) Saturate the clamp nuts with heat valve lubricant. Allow 5 minutes for penetration.
- (4) Disconnect the exhaust tailpipe support hanger isolators (Fig. 11).
- (5) Remove the muffler-to-tailpipe clamps (Fig. 11).
- (6) Remove the tailpipe from the vehicle.

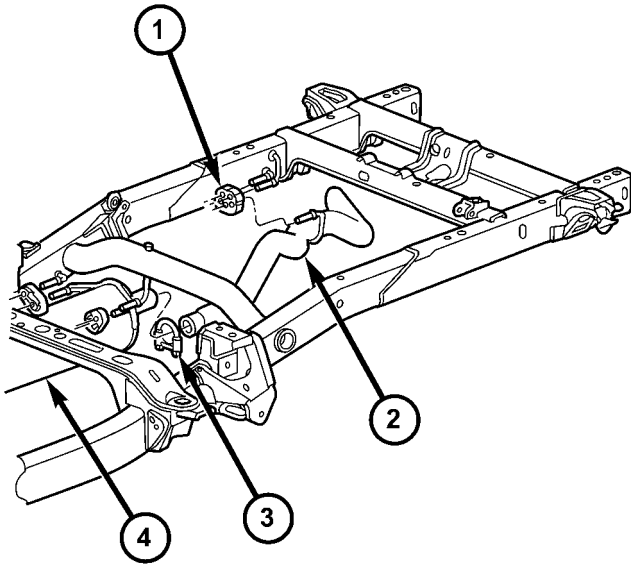
INSPECTION

Discard rusted clamps, broken or worn supports and attaching parts. Replace a component with original equipment parts, or equivalent. This will assure proper alignment with other parts in the system and provide acceptable exhaust noise levels.

INSTALLATION

- (1) Install the tailpipe into the muffler.
- (2) Install the tailpipe hanger rods into the isolators (Fig. 11)
- (3) Install the exhaust clamp, align the exhaust system, and tighten the clamp 48 N·m (35 ft. lbs.) torque.

TAILPIPE - 5.9L DIESEL (Continued)



8087ef25

Fig. 11 Tailpipe Removal/Installation

- 1 - ISOLATOR
- 2 - TAILPIPE
- 3 - CLAMP
- 4 - MUFFLER

- (4) Lower the vehicle.
- (5) Connect the battery negative cables.
- (6) Start the engine and inspect for exhaust leaks and exhaust system contact with the body panels. Adjust the alignment, if needed.

TAILPIPE**REMOVAL**

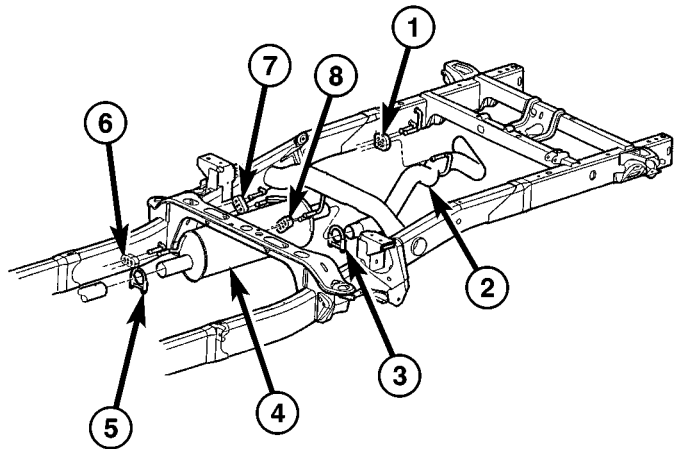
- (1) Raise and support the vehicle.
- (2) Saturate the clamp nuts with heat valve lubricant. Allow 5 minutes for penetration.
- (3) Disconnect the exhaust tailpipe support hanger (Fig. 12).
- (4) Remove clamps and nuts.
- (5) Remove the exhaust tailpipe.

INSPECTION

Discard rusted clamps, broken or worn supports and attaching parts. Replace a component with original equipment parts, or equivalent. This will assure proper alignment with other parts in the system and provide acceptable exhaust noise levels.

INSTALLATION

- (1) Loosely assemble exhaust tailpipe to permit proper alignment of all parts.
- (2) Connect the support hangers.



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Fig. 12 TAILPIPE

- 1 - INSULATOR
- 2 - TAILPIPE
- 3 - CLAMP
- 4 - MUFFLER
- 5 - CLAMP
- 6 - INSULATOR
- 7 - INSULATOR
- 8 - INSULATOR

- (3) Position the exhaust tailpipe for proper clearance with the underbody parts.

- (4) Tighten all clamp nuts to 48 N·m (35 ft. lbs.) torque.

- (5) Lower the vehicle.

- (6) Start the engine and inspect for exhaust leaks and exhaust system contact with the body panels. A minimum of 25.4 mm (1.0 in.) is required between the exhaust system components and body/frame parts. Adjust the alignment, if needed.

TURBOCHARGER SYSTEM**DIAGNOSIS AND TESTING - TURBOCHARGER BOOST PRESSURE**

NOTE: This diagnostic procedure is to be used with the DRB III® while test driving the vehicle under normal load and driving conditions.

Low turbocharger boost pressure can cause poor engine performance and driveability concerns. The following procedure will test the turbocharger boost pressure.

TURBOCHARGER SYSTEM (Continued)

(1) Loosen clamps holding air inlet duct rubber sleeve to the intake manifold and air inlet duct. Remove rubber sleeve (Fig. 13).

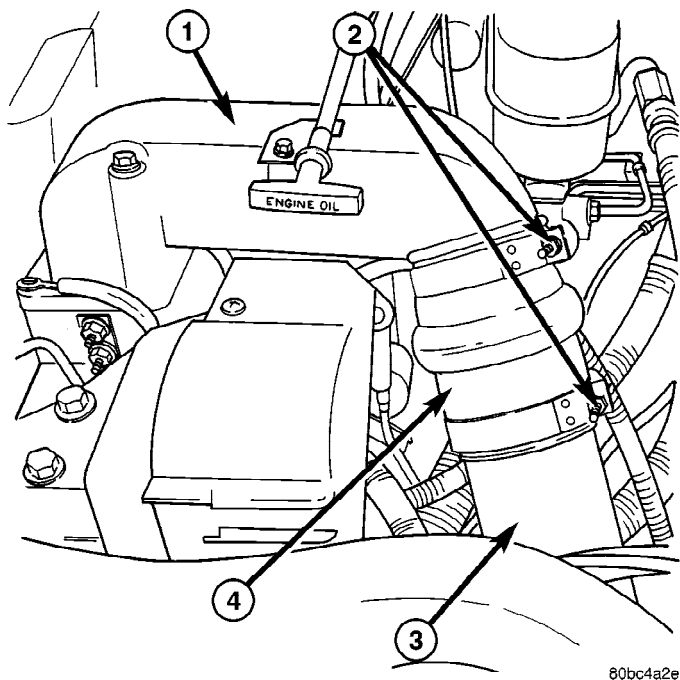


Fig. 13 INTAKE MANIFOLD TO AIR INLET DUCT RUBBER SLEEVE

- 1 - INTAKE MANIFOLD AIR INLET
- 2 - CLAMPS
- 3 - AIR INLET DUCT
- 4 - AIR INLET DUCT RUBBER SLEEVE

(2) Position Special Tool 8462 onto air inlet duct and intake manifold. Using the existing clamps tighten to 8 N·m (72 in. lbs.).

(3) Install the 3447.5 kPa 500 psi (gray) Pressure Transducer (part of OT-CH8520 Transducer Kit) into Special Tool 8462.

(4) Connect the DRB III® to the pressure transducer following the instructions supplied with the DRB III®.

(5) Enter DRB III® into pressure reading mode and test drive vehicle.

(6) Full load boost pressure at rated speed will be 158 - 186 kPa (23 - 27 psi.) depending on engine hp rating.. If pressure readings are not within this range inspect for the following:

- Restricted air inlet system
- Leak in the charge air cooler system (Refer to 11 - EXHAUST SYSTEM/TURBOCHARGER SYSTEM/CHARGE AIR COOLER AND PLUMBING - DIAGNOSIS AND TESTING)
- Turbocharger wastegate broken or misadjusted
- Restricted/high pressure drop across charge air cooler

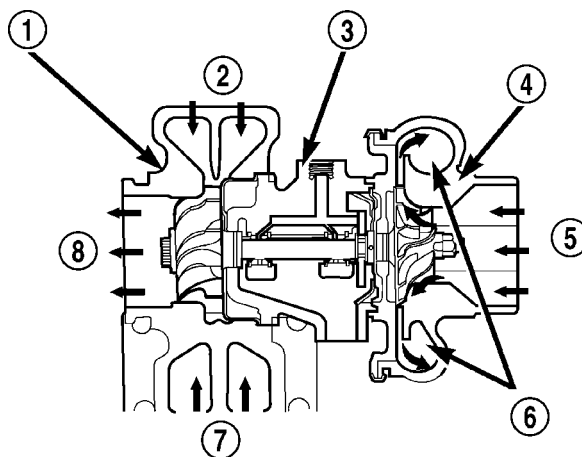
• Turbocharger damaged (Refer to 11 - EXHAUST SYSTEM/TURBOCHARGER SYSTEM/TURBOCHARGER - INSPECTION)

TURBOCHARGER**DESCRIPTION**

The turbocharger is an exhaust-driven supercharger which increases the pressure and density of the air entering the engine. With the increase of air entering the engine, more fuel can be injected into the cylinders, which creates more power during combustion.

The turbocharger assembly consists of four (4) major component systems (Fig. 14) (Fig. 15) :

- Turbine section
- Compressor section
- Bearing housing
- Wastegate



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Fig. 14 Turbocharger Operation

- 1 - TURBINE SECTION
- 2 - EXHAUST GAS
- 3 - BEARING HOUSING
- 4 - COMPRESSOR SECTION
- 5 - INLET AIR
- 6 - COMPRESSED AIR TO ENGINE
- 7 - EXHAUST GAS
- 8 - EXHAUST GAS TO EXHAUST PIPE

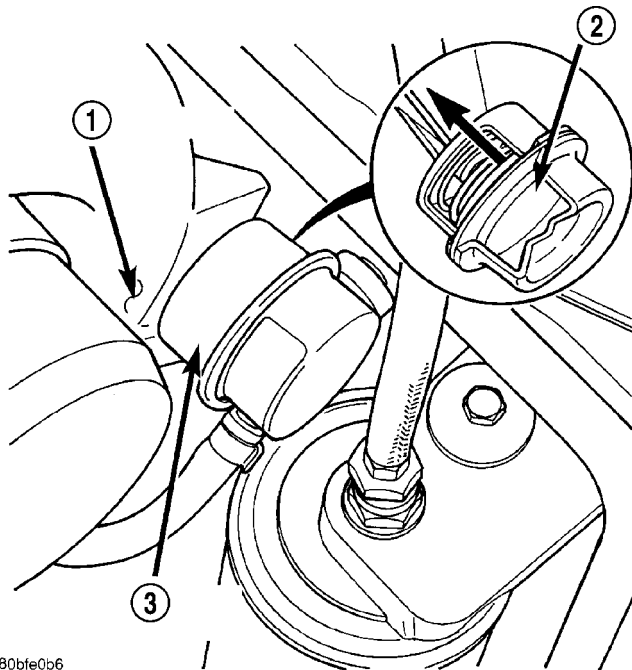
OPERATION

Exhaust gas pressure and energy drive the turbine, which in turn drives a centrifugal compressor that compresses the inlet air, and forces the air into the engine through the charge air cooler and plumbing. Since heat is a by-product of this compression, the air must pass through a charge air cooler to cool the incoming air and maintain power and efficiency.

Increasing air flow to the engine provides:

- Improved engine performance
- Lower exhaust smoke density

TURBOCHARGER (Continued)



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Fig. 15 Turbocharger Wastegate Actuator

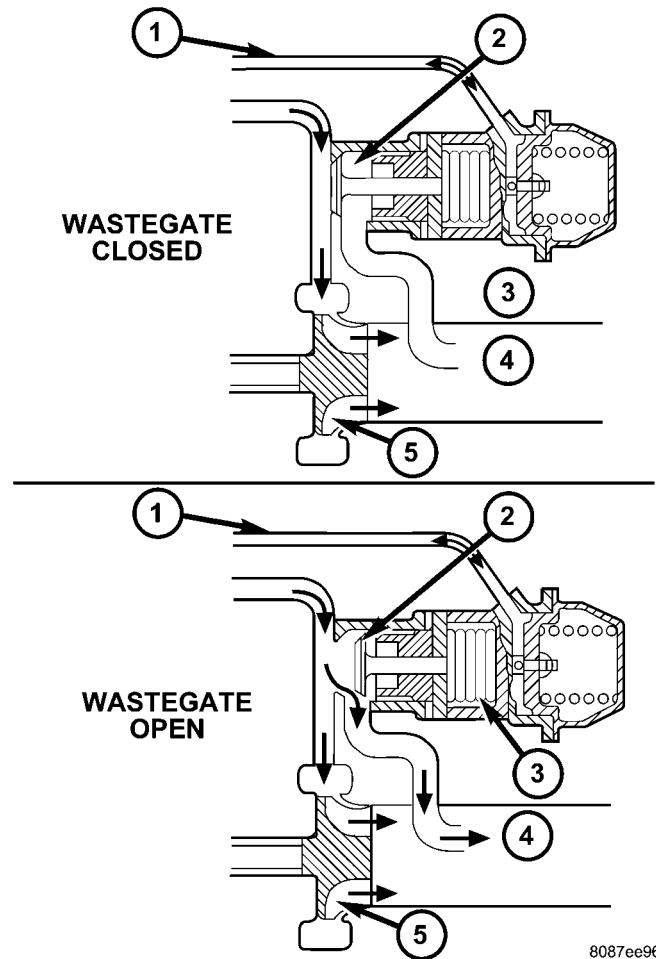
- 1 - TURBOCHARGER
- 2 - DIAPHRAGM
- 3 - WASTE GATE ACTUATOR

- Improved operating economy
- Altitude compensation
- Noise reduction.

The turbocharger also uses a wastegate (Fig. 16), which regulates intake manifold air pressure and prevents over boosting at high engine speeds. When the wastegate valve is closed, all of the exhaust gases flow through the turbine wheel. As the intake manifold pressure increases, the wastegate actuator opens the valve, diverting some of the exhaust gases away from the turbine wheel. This limits turbine shaft speed and air output from the impeller.

The turbocharger is lubricated by engine oil that is pressurized, cooled, and filtered. The oil is delivered to the turbocharger by a supply line that is tapped into the oil filter head. The oil travels into the bearing housing, where it lubricates the shaft and bearings (Fig. 17). A return pipe at the bottom of the bearing housing, routes the engine oil back to the crankcase.

The most common turbocharger failure is bearing failure related to repeated hot shutdowns with inadequate "cool-down" periods. A sudden engine shut down



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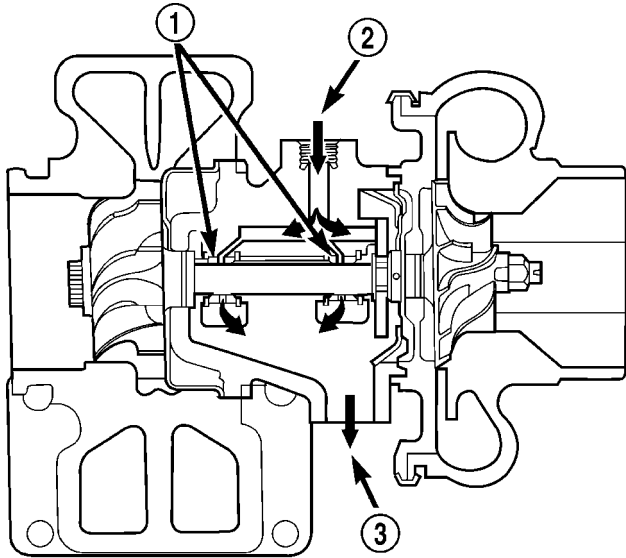
Fig. 16 Wastegate Operation

- 1 - SIGNAL LINE
- 2 - EXHAUST BYPASS VALVE
- 3 - WASTEGATE
- 4 - EXHAUST
- 5 - TURBINE

after prolonged operation will result in the transfer of heat from the turbine section of the turbocharger to the bearing housing. This causes the oil to overheat and break down, which causes bearing and shaft damage the next time the vehicle is started.

Letting the engine idle after extended operation allows the turbine housing to cool to normal operating temperature. The following chart should be used as a guide in determining the amount of engine idle time required to sufficiently cool down the turbocharger before shut down, depending upon the type of driving and the amount of cargo.

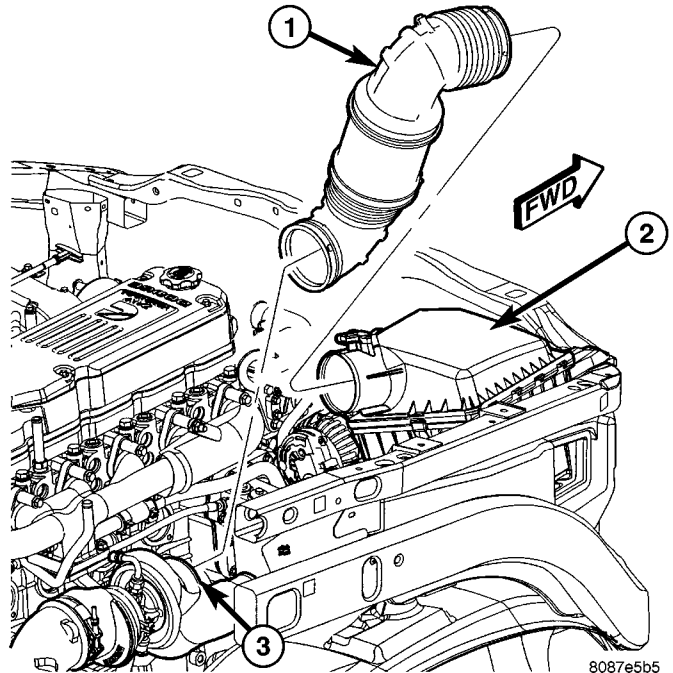
TURBOCHARGER (Continued)



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Fig. 17 Turbocharger Oil Supply and Drain

- 1 - BEARINGS
 2 - OIL SUPPLY (FROM FILTER HEAD)
 3 - OIL RETURN (TO SUMP)



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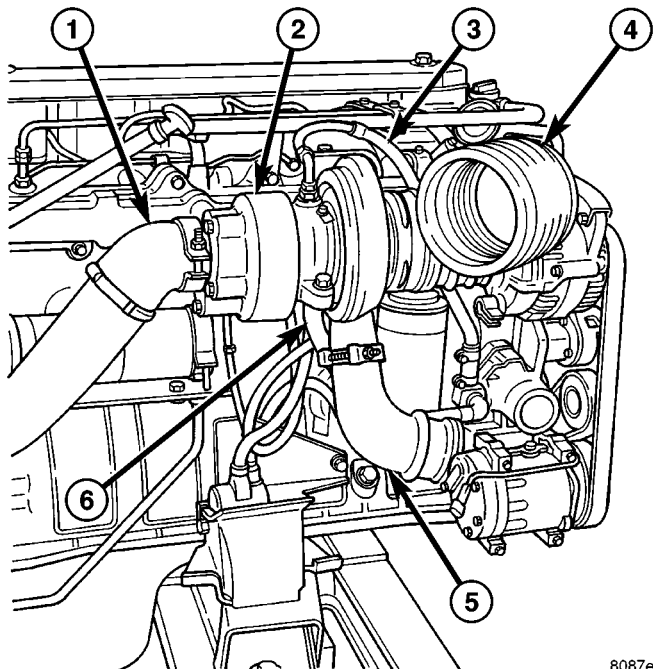
Fig. 18 Turbocharger Air Inlet Hose

- 1 - AIR INLET TUBE
 2 - AIR FILTER HOUSING
 3 - TURBOCHARGER

TURBOCHARGER "COOL DOWN" CHART			
Driving Condition	Load	Turbocharger Temperature	Idle Time (in minutes) Before Shut Down
Stop & Go	Empty	Cool	Less than 1
Stop & Go	Medium	Warm	1
Highway Speeds	Medium	Warm	2
City Traffic	Max. GCWR	Warm	3
Highway Speeds	Max. GCWR	Warm	4
Uphill Grade	Max. GCWR	Hot	5

REMOVAL

- (1) Disconnect the battery negative cables.
- (2) Raise vehicle on hoist.
- (3) Disconnect the exhaust pipe from the turbocharger elbow (Refer to 11 - EXHAUST SYSTEM/EXHAUST PIPE - REMOVAL).
- (4) Lower vehicle.
- (5) Disconnect the turbocharger air inlet hose (Fig. 18).
- (6) Disconnect the turbocharger oil supply line and the oil drain tube from the turbocharger (Fig. 19).
- (7) Disconnect the charge air cooler inlet pipe from the turbocharger compressor outlet (Fig. 19).
- (8) Remove the turbocharger and gasket from the exhaust manifold.



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Fig. 19 Oil Supply Line and Charge Air Cooler Inlet Duct

- 1 - TURBOCHARGER EXHAUST ELBOW
 2 - TURBOCHARGER
 3 - OIL SUPPLY LINE
 4 - AIR INLET TUBE
 5 - TURBOCHARGER COMPRESSOR OUTLET
 6 - OIL DRAIN LINE

TURBOCHARGER (Continued)

(9) If the turbocharger is not to be installed immediately, cover the opening to prevent material from entering into the manifold.

(10) If replacing the turbocharger, transfer the compressor outlet and clamp to the new assembly.

(11) Clean and inspect the sealing surface.

CAUTION: The turbocharger is only serviced as an assembly. Do not attempt to repair the turbocharger as turbocharger and/or engine damage can result.

CLEANING

Clean the turbocharger and exhaust manifold mounting surfaces with a suitable scraper.

INSPECTION

Visually inspect the turbocharger and exhaust manifold gasket surfaces. Replace stripped or eroded mounting studs.

(1) Visually inspect the turbocharger for cracks. The following cracks are NOT acceptable:

- Cracks in the turbine and compressor housing that go completely through.
- Cracks in the mounting flange that are longer than 15 mm (0.6 in.).
- Cracks in the mounting flange that intersect bolt through-holes.
- Two (2) Cracks in the mounting flange that are closer than 6.4 mm (0.25 in.) together.

(2) Visually inspect the impeller and compressor wheel fins for nicks, cracks, or chips. Note: Some impellers may have a factory placed paint mark which, after normal operation, appears to be a crack. Remove this mark with a suitable solvent to verify that it is not a crack.

(3) Visually inspect the turbocharger compressor housing for an impeller rubbing condition (Fig. 20). Replace the turbocharger if the condition exists.

(4) Measure the turbocharger axial end play:

(a) Install a dial indicator as shown in (Fig. 21). Zero the indicator at one end of travel.

(b) Move the impeller shaft fore and aft and record the measurement. Allowable end play is 0.026 mm (0.0001 in.) MIN. and 0.127 mm (0.005 in.) MAX. If the recorded measurement falls outside these parameters, replace the turbocharger assembly.

(5) Measure the turbocharger bearing radial clearance:

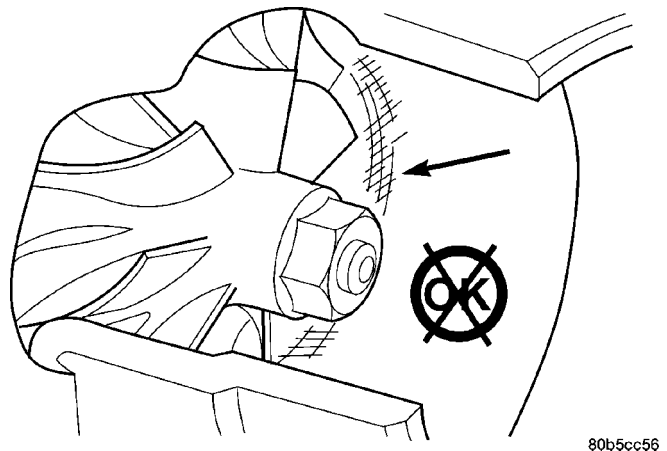
(a) Insert a narrow blade or wire style feeler gauge between the compressor wheel and the housing (Fig. 22).

(b) Gently push the compressor wheel toward the housing and record the clearance.

(c) With the feeler gauge in the same location, gently push the compressor wheel away from the housing and again record the clearance.

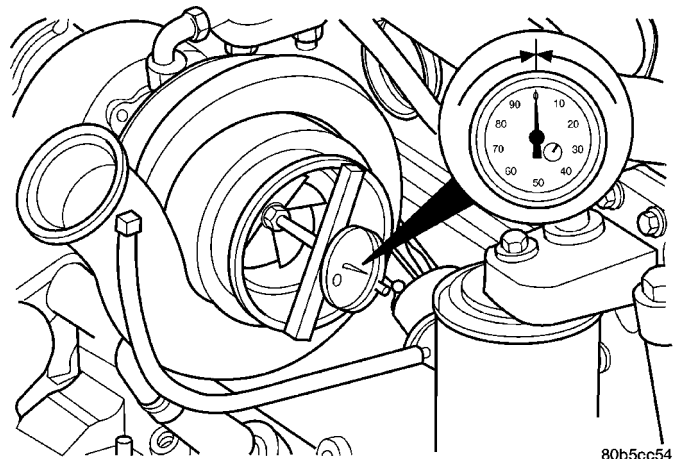
(d) Subtract the smaller clearance from the larger clearance. This is the radial bearing clearance.

(e) Allowable radial bearing clearance is 0.33 mm (0.013 in.) MIN. and 0.50 mm (0.020 in.) MAX. If the recorded measurement falls outside these specifications, replace the turbocharger assembly.



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Fig. 20 Inspect Compressor Housing for Impeller Rubbing Condition



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Fig. 21 Measure Turbocharger Axial End Play

INSTALLATION

(1) Install the turbocharger. Apply anti-seize to the studs and then tighten the turbocharger mounting nuts to 43 N·m (32 ft. lbs.) torque.

(2) Install the oil drain tube to the turbocharger (Fig. 19). Tighten the drain tube bolts to 24 N·m (18 ft. lbs.) torque.

TURBOCHARGER (Continued)

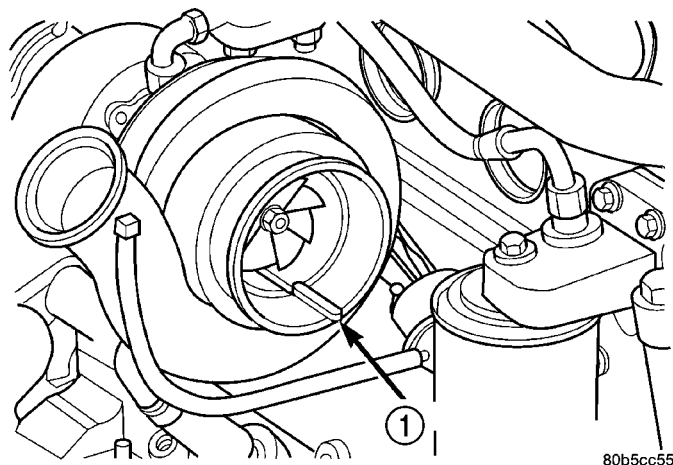


Fig. 22 Measure Turbocharger Bearing Radial Clearance

1 - FEELER GAUGE

(3) **Pre-lube the turbocharger.** Pour 50 to 60 cc (2 to 3 oz.) clean engine oil in the oil supply line fitting. Carefully rotate the turbocharger impeller by hand to distribute the oil thoroughly.

(4) Install and tighten the oil supply line to 24 N·m (18 ft. lbs.) torque.

(5) Position the charge air cooler inlet pipe to the turbocharger. With the clamp in position, tighten the clamp nut to 11 N·m (95 in. lbs.) torque.

(6) Position the air inlet hose to the turbocharger (Fig. 18). Tighten the clamp to 11 N·m (95 in. lbs.) torque.

(7) Raise vehicle on hoist.

(8) Connect the exhaust pipe to the turbocharger and tighten the bolts to 34 N·m (25 ft. lbs.) torque.

(9) Lower the vehicle.

(10) Connect the battery negative cables.

(11) Start the engine to check for leaks.

CHARGE AIR COOLER AND PLUMBING

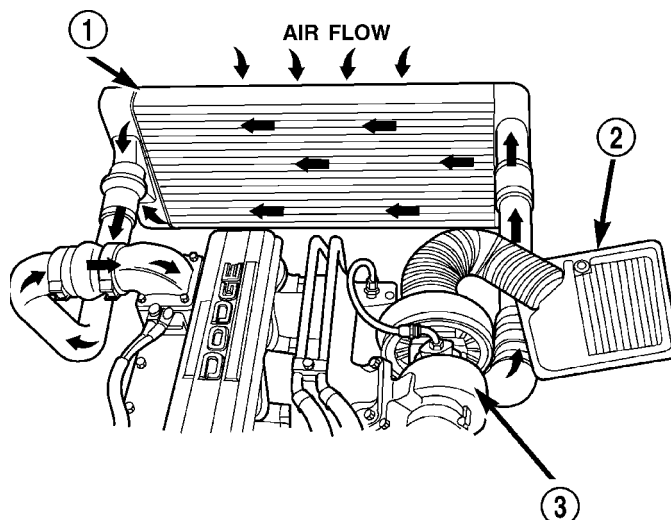
DESCRIPTION

The charge air system (Fig. 23) consists of the charge air cooler piping, charge air cooler and intake air grid heater.

The charge air cooler is a heat exchanger that uses air flow from vehicle motion to dissipate heat from the intake air. As the turbocharger increases air pressure, the air temperature increases. Lowering the intake air temperature increases engine efficiency and power.

OPERATION

Intake air is drawn through the air cleaner and into the turbocharger compressor housing. Pressur-



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Fig. 23 Intake Air Circulation

- 1 - CHARGE AIR COOLER
- 2 - AIRFILTER
- 3 - TURBOCHARGER

ized air from the turbocharger then flows forward through the charge air cooler located in front of the radiator. From the charge air cooler the air flows back into the intake manifold.

DIAGNOSIS AND TESTING - CHARGE AIR COOLER SYSTEM - LEAKS

Low turbocharger boost pressure and low engine performance can be caused by leaks in the charge air cooler or it's plumbing. Fuel staining on the exhaust manifold can also be an indication that there are leaks in the air system. The following procedure outlines how to check for leaks in the charge air cooler system.

(1) Loosen clamp and remove air inlet hose from turbocharger.

(2) Insert Special Tool 9022 Adapter into the turbocharger inlet. Tighten tool clamp to 8 N·m (72 in. lbs.).

CAUTION: Do not apply more than 138 kPa (20 psi) air pressure to the charge air cooler system, sever damage to the charge air cooler system may occur.

(3) Connect a regulated air supply to air fitting on Special Tool 9022 Adapter. Set air pressure to a Maximum of 138 kPa (20 psi).

(4) Using soapy water check the rubber sleeves, charge air cooler and intake manifold for leaks.

REMOVAL

WARNING: IF THE ENGINE WAS JUST TURNED OFF, THE AIR INTAKE SYSTEM TUBES MAY BE HOT.

CHARGE AIR COOLER AND PLUMBING (Continued)

- (1) Disconnect the battery negative cables.
- (2) Discharge the A/C system (Refer to 24 - HEATING & AIR CONDITIONING/PLUMBING - STANDARD PROCEDURE) and remove the A/C condenser (Refer to 24 - HEATING & AIR CONDITIONING/PLUMBING/A/C CONDENSER - REMOVAL) (if A/C equipped).
- (3) Remove the transmission auxiliary cooler (Refer to 7 - COOLING/TRANSMISSION/TRANS COOLER - REMOVAL).
- (4) Remove the boost tubes from the charge air cooler (Fig. 24).
- (5) Remove the charge air cooler bolts. Pivot the charge air cooler forward and up to remove.

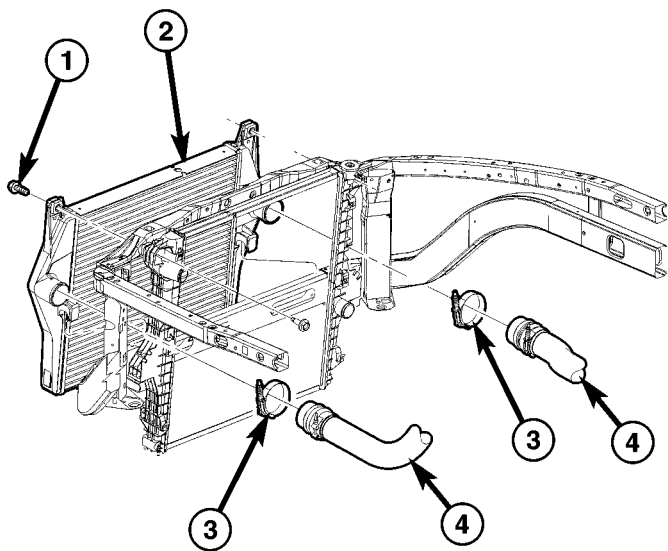


Fig. 24 Air Intake System Tubes

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- 1 - BOLT
- 2 - CHARGE AIR COOLER
- 3 - CLAMP
- 4 - BOOST TUBE

CLEANING

CAUTION: Do not use caustic cleaners to clean the charge air cooler. Damage to the charge air cooler will result.

NOTE: If internal debris cannot be removed from the cooler, the charge air cooler **MUST** be replaced.

(1) If the engine experiences a turbocharger failure or any other situation where oil or debris get into the charge air cooler, the charge air cooler must be cleaned internally.

(2) Position the charge air cooler so the inlet and outlet tubes are vertical.

(3) Flush the cooler internally with solvent in the direction opposite of normal air flow.

(4) Shake the cooler and lightly tap on the end tanks with a rubber mallet to dislodge trapped debris.

(5) Continue flushing until all debris or oil are removed.

(6) Rinse the cooler with hot soapy water to remove any remaining solvent.

(7) Rinse thoroughly with clean water and blow dry with compressed air.

INSPECTION

Visually inspect the charge air cooler for cracks, holes, or damage. Inspect the tubes, fins, and welds for tears, breaks, or other damage. Replace the charge air cooler if damage is found.

Pressure test the charge air cooler, using Charge Air Cooler Tester Kit #3824556. This kit is available through Cummins® Service Products. Instructions are provided with the kit.

INSTALLATION

(1) Position the charge air cooler. Install the bolts and tighten to 2 N·m (17 in. lbs.) torque.

(2) Install the air intake system tubes to the charge air cooler. With the clamps in position, tighten the clamps to 11 N·m (95 in. lbs.) torque.

(3) Install the transmission auxiliary cooler (if equipped) (Refer to 7 - COOLING/TRANSMISSION/TRANS COOLER - INSTALLATION).

(4) Install the A/C condenser (if A/C equipped) (Refer to 24 - HEATING & AIR CONDITIONING/PLUMBING/A/C CONDENSER - INSTALLATION). Recharge A/C system (Refer to 24 - HEATING & AIR CONDITIONING/PLUMBING - STANDARD PROCEDURE).

(5) Connect the battery negative cables.

(6) Start engine and check for boost system leaks.