Group Index, Alphabetical

Section	Section Number
Air Cleaner	09.01
Air Intake Ducting	09.00
Charge Air Cooler	09.02

Contents

Subject	Subject Number
Service Operations	
Air Intake Ducting Replacement	100

Air Intake Ducting Replacement

Replacement

1. Turn off the engine, apply the brakes, and chock the tires.
2. Open the hood.

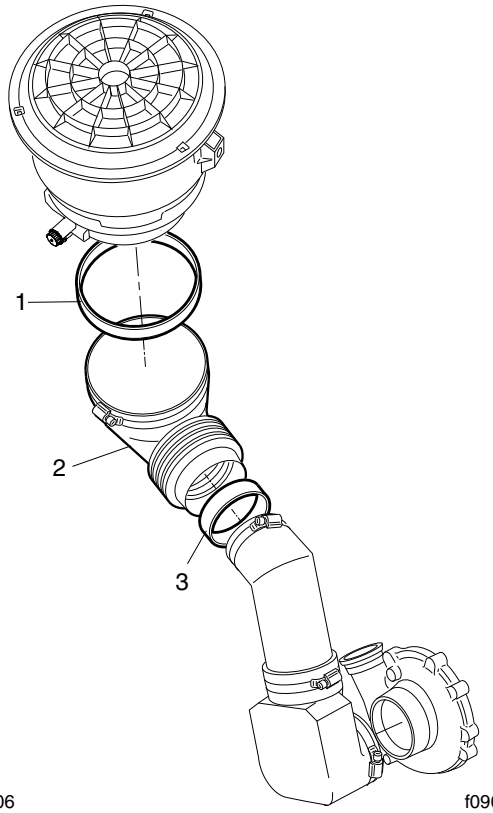
⚠ WARNING

Do not operate the engine with any component of the air intake system removed. Serious physical injury can occur if the turbocharger impeller is touched when it is rotating.

NOTICE

All air intake components and connections must be air- and water-tight. Dirt or dust entering the engine can cause internal engine damage. Most of the dirt and dust particles are silicates, which fuse into abrasive glass-like particles when exposed to engine combustion. These particles can grind piston rings, pistons, and cylinder liners.

3. Remove the hose clamps that attach the air intake duct assembly to the air cleaner and the turbocharger. If the duct assembly consists of more than one piece, remove the clamps that secure the elbows. See **Fig. 1** and **Fig. 2**.
4. Remove the air intake duct assembly.
5. Determine which new air intake duct assembly to install. Use PartsPro® to determine specific part numbers.
   - Vehicles built before November 26, 2003 with MBE900 or C7 engines require the installation of smaller clamps and rubber seals on the plastic duct connections.
   - Vehicles built between November 26, 2003 and November 1, 2004 with MBE900 or C7 engines require the installation of rubber seals only.
   - Vehicles built after November 1, 2004 have the correct clamps and seals already installed.
6. Inspect the new air intake duct assembly for debris that may have collected during shipping. Remove any debris or dirt before installation.
7. Install the new air intake duct assembly between the air cleaner and turbocharger.



1. Air Cleaner-to-Elbow Seal
2. Elbow
3. Elbow-to-Duct Seal

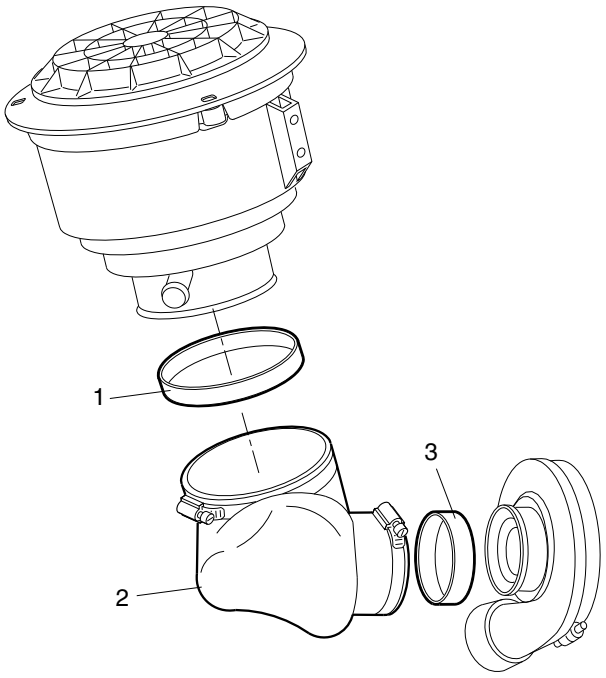
Fig. 1, Typical Elbow-to-Duct Configuration (MBE906 engine shown)

7.1 Apply P-80® Rubber Lubricant Emulsion to the overlapping areas of all seals, elbows, and tubes, and the air cleaner housing outlet and turbocharger inlet.

NOTE: P-80 Emulsion eases installation of tight-fitting rubber and plastic parts by reducing the force needed for assembly. Once assembly is complete, P-80 Emulsion dries and the part returns to its original condition. Use P-80 Emulsion when a thin film of lubricant is desired.

7.2 Install all parts so that each connection overlaps at least 1.18 inch (30 mm). The rubber seal, duct, and clamp of each connection should be fitted as shown in **Fig. 3**.

Air Intake Ducting Replacement



06/19/2006 f090435

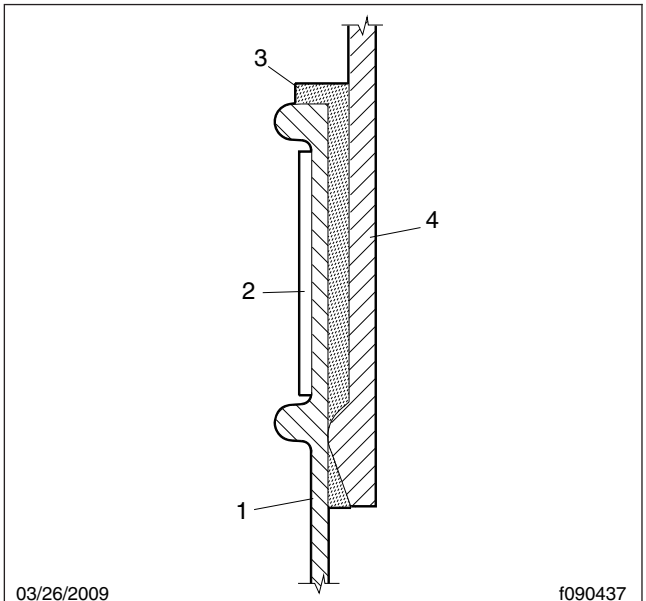
1. Air Cleaner-to-Elbow Seal
2. Elbow
3. Elbow-to-Turbocharger Seal

Fig. 2, Typical Elbow-to-Turbocharger Configuration (CAT C7 engine shown)

7.3 Check the installed assembly for any interference or contact with adjacent components. Loosen and adjust as necessary to avoid chafing.

NOTE: Be sure all hose connections are square and have proper overlap before tightening the hose clamps.

8. Tighten the clamps on the air intake duct assembly 40 lbf·in (452 N·cm).
9. Lower the hood.



03/26/2009 f090437

1. Duct
2. Clamp
3. Seal
4. Air Cleaner Housing

Fig. 3, Cross-Section of Air Intake Ducting

Contents

Subject	Subject Number
Service Operations	
Element Replacement	100
Housing Removal and Installation	110
Air Cleaner Restriction Checking	120

Replacement

NOTICE

Do not use aftermarket air-cleaner elements. Aftermarket air-cleaner elements may not seal the housing correctly, which can lead to engine damage and potentially the loss of warranty. When replacing an air-cleaner element, use only the part listed in PartsPro for the serial number of the vehicle.

IMPORTANT: Do not modify, or use modified air cleaners or duct components.

1. Park the vehicle on a level surface, shut down the engine, and set the parking brake.
2. Chock the tires and open the hood.

NOTICE

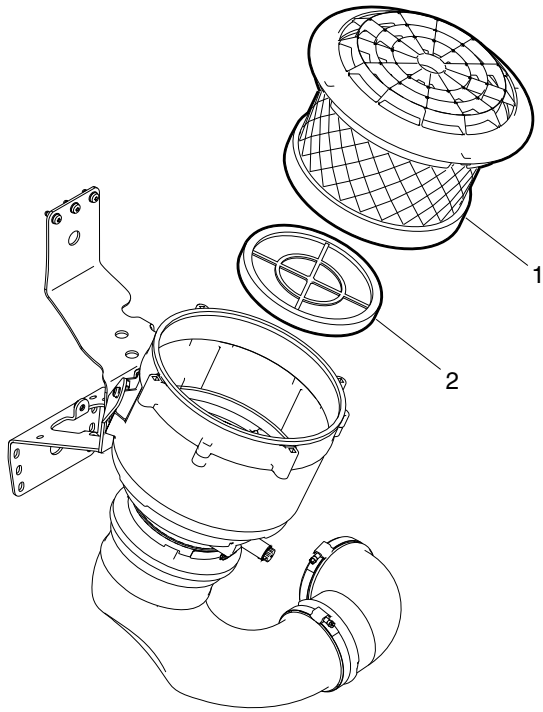
All air intake components and connections must be air- and water-tight. Dirt or dust entering the engine can cause internal engine damage. Most of the dirt and dust particles are silicates, which fuse into abrasive glass-like particles when exposed to engine combustion. These particles can grind piston rings, pistons, and cylinder liners. Do not operate the engine with the air cleaner element or any air intake component removed.

3. Check the air cleaner housing for damage, and check all ducts and connections for leakage. Adjust or replace parts as necessary.
4. Remove the capscrews that secure the primary air cleaner element in the air cleaner housing.

   Remove the primary air cleaner element. See **Fig. 1**.

NOTE: The vehicle is equipped with either a stainless steel safety screen or a safety air cleaner element. Replace the safety screen or the safety element with every third primary air cleaner element replacement.

5. Remove the safety screen or element from the air cleaner and wipe the inside of the air cleaner with a clean, damp cloth. Check the housing and sealing surfaces for damage, dust, or foreign matter that could cause sealing problems. Clean surfaces or replace parts as necessary.



07/01/2011 f090489

1. Primary Air Cleaner Element
2. Stainless Steel Safety Screen or Safety Air Cleaner Element

Fig. 1, Air Cleaner Elements

NOTICE

Do not clean or reuse air filter elements. Cleaning and reusing elements increases the chances of dirt entering the engine. Always replace with a new one.

6. Inspect the safety screen or element for damage. Replace if necessary, or according to the recommended maintenance interval (see the NOTE before step 5).
7. Install the safety screen or element in the air cleaner housing.
8. Inspect the new primary air cleaner element for damage or holes.
9. Using capscrews, install the air cleaner element in the air cleaner housing. Tighten the capscrews 25 to 35 lbf·in (280 to 400 N·cm).
10. Check all connections for tightness.

Removal

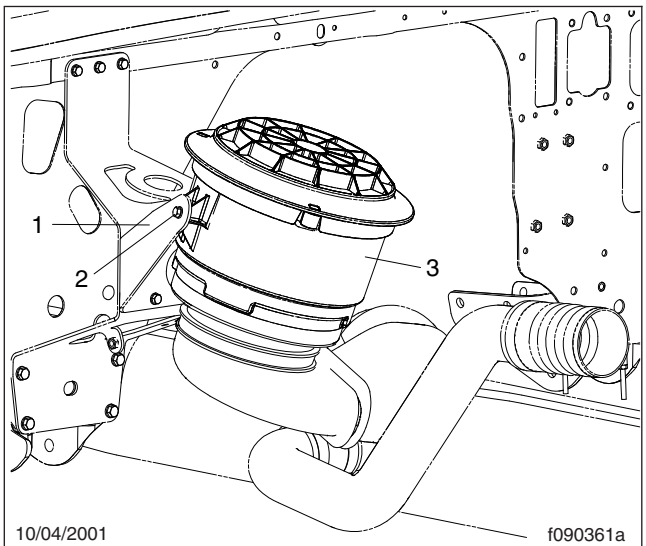
IMPORTANT: Do not modify, or use modified air cleaners or duct components.

1. Park the vehicle on a level surface, shut down the engine, and set the parking brake.
2. Chock the tires and open the hood.

NOTICE

All air intake components and connections must be air- and water-tight. Dirt or dust entering the engine can cause internal engine damage. Most of the dirt and dust particles are silicates, which fuse into abrasive glass-like particles when exposed to engine combustion. These particles can grind piston rings, pistons, and cylinder liners. Do not operate the engine with the air cleaner element or any air intake component removed.

3. Remove the air restriction indicator or sensor, if equipped.
4. Loosen the hose clamp that attaches the air intake duct to the air cleaner outlet port, then pull the duct off the port. See **Fig. 1**.



1. Mounting Bracket
2. Capscrew
3. Air Cleaner

Fig. 1, Air Cleaner Installation

5. Remove the three capscrews that attach the air cleaner to the air cleaner mounting bracket.

Installation

NOTICE

Do not clean or reuse air filter elements. Cleaning and reusing the elements increases the chances of dirt entering the engine. Always replace with a new one.

1. Check the air cleaner housing for damage, and check all ducts and connections for leakage. Adjust or replace parts as necessary.
2. Using three capscrews, install the air cleaner housing on the mounting bracket.
3. Install the air intake duct on the air cleaner outlet port so that it overlaps by at least 1 inch (25 mm). P80® Rubber Lubricant Emulsion, or equivalent rubber lubricant, can be used to ease assembly.

NOTE: To locate your local International Products Corporation distributor, call 1-609-386-877 or visit **www.ipcol.com**.

4. Check the duct for any interference or contact with adjacent components. Loosen and adust as necessary.
5. Tighten the hose clamp at the air cleaner outlet 40 lbf·in (450 N·cm).
6. Install the air restriction indicator on the air cleaner, if equipped.

Restriction Checking

Restriction of air flow through the air cleaner element is measured at the tap in the air cleaner outlet. Check the restriction indicator at the air cleaner or in the cab if the vehicle is equipped with a dash-mounted restriction gauge.

NOTICE

Use the air intake restriction gauge rather than visual inspection to determine if servicing the air filter element is necessary. Removal of the air filter element can cause damage to the primary seal, which may allow contaminants into the engine, potentially causing engine damage.

Vehicles may be equipped with either a manual-reset restriction indicator with graduations (**Fig. 1**), or a go/no-go restriction indicator without graduations (**Fig. 2**).

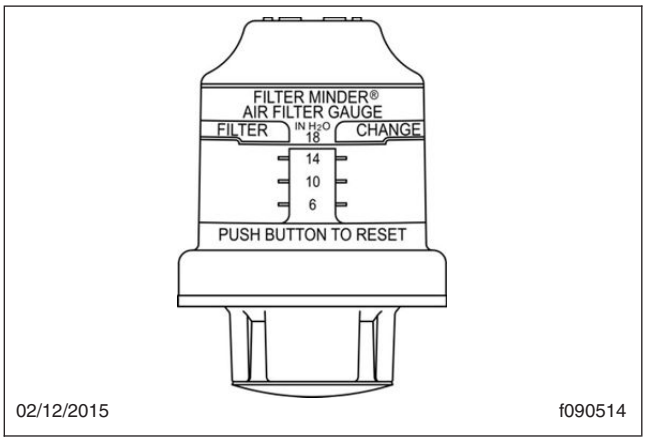


Fig. 1, Manual-Reset Air Restriction Indicator, Graduated

1. For vehicles equipped with a manual-reset indicator with graduations, check the indicator with the engine off to see if air restriction equals or exceeds the value shown in **Table 1** for maximum air restriction.

   For vehicles equipped with a go/no-go restriction indicator without graduations, check the indicator with the engine off to see if the colored bar shows through the clear window.

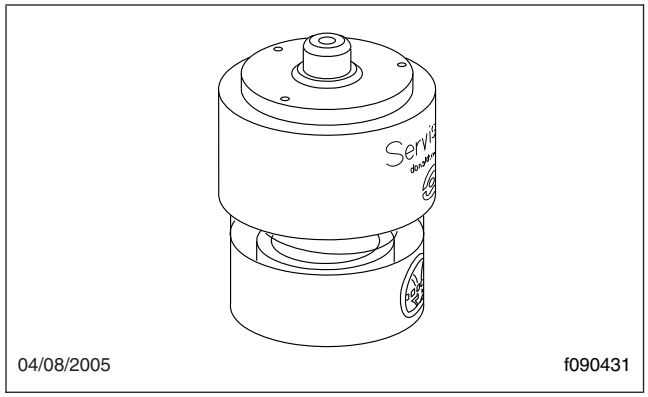


Fig. 2, Manual-Reset Air Restriction Indicator, Go/No-Go

Air Intake Maximum Restriction Values (inH_2O)			
Engine Make	**Pre-EPA07 Engines**	**EPA07 and EPA10 Engines**	**GHG14 Engines**
Detroit	20	22	18
Cummins	25	25	25
Mercedes-Benz	22	22	–
Caterpillar	25	–	–

Table 1, Air Intake Maximum Restriction Values

2. If air restriction is below the maximum, no further work is necessary.

   If air restriction is at or above the maximum, push the reset button on the indicator.

3. Operate the engine to see if air restriction exceeds recommended values again. This can be done by running the vehicle on a dynamometer at **full-load and rated rpm**, or by driving the vehicle for one day in the vehicle's typical operating environment while not exceeding the rated rpm. See the engine manufacturer's service literature for information on rated rpm for your engine.
4. Check the indicator again. If air restriction continues to equal or exceed the maximum air restriction value in **Table 1** on an indicator with graduations, or if the colored bar shows through the clear window on a go/no-go indicator, replace the air cleaner element, then reset the indicator.

   For air cleaner element replacement instructions, see **Subject 100** for instructions.

Contents

Subject	Subject Number
General Information	050
Service Operations	
CAC Removal and Installation	100
CAC Inspection and Leakage Test	110
CAC Flushing	120
CAC Restriction Test	130

General Information

The charge air cooler (CAC) is attached to the front of the radiator. The function of the CAC is to cool the hot, compressed air that exits the turbocharger. The CAC reduces the temperature of this air to the engine manufacturers' specified air intake temperature before the air reaches the engine intake manifold. The lower temperature reduces exhaust emissions, improves fuel economy, and increases horsepower.

Removal

NOTE: This procedure covers vehicles that have the charge air cooler (CAC) mounted above the condenser.

1. Apply the parking brakes and chock the tires.
2. Disconnect the batteries.
3. Remove the four Torx® fasteners that attach the grille to the hood.
4. Loosen the constant tension hose clamps at both ends of the flex tubes that attach the inlet and outlet air piping to the CAC. Remove the flex tubes and the CAC pipes from the CAC.
5. Standing in the grille opening of the hood, remove the nuts that attach the CAC to the mounting brackets. Remove the CAC.
6. For a CAC that is mounted on a 1350-square-inch radiator that has aluminum CAC baffles attached to the radiator support channels, remove the six Torx fasteners that secure the baffles to the radiator. Discard the aluminum CAC baffles.

Installation

1. Using nuts, attach the right side of the CAC to the mounting bracket, then attach the left side of the CAC to the mounting bracket. After all four nuts are installed, tighten them 25 to 31 lbf·ft (34 to 42 N·m).
2. Install the flex tubes between the CAC and the CAC inlet and outlet air pipes. Place the constant tension hose clamps over the flex tubes.
3. Turn the constant tension hose clamps so their tightening screws are under the hoses or facing inboard. Tighten the clamps 45 lbf·in (500 N·cm).

IMPORTANT: Vehicles built on or after February 26, 2007, have modified constant tension clamps that adjust to changes in diameter at the hose connection. When installing a new clamp or reinstalling a modified clamp, tighten the fastener 98 lbf·in (1100 N·cm). Do not retighten the clamp unless the measured torque drops below 50 lbf·in (560 N·cm), at which time it should be tightened again 98 lbf·in (1100 N·cm).

4. Using four Torx fasteners, attach the grille to the hood.
5. Connect the batteries.

Inspection

1. Apply the parking brakes and chock the tires.
2. Check the charge air cooler (CAC) flex tubes and the inlet and outlet piping for holes or other damage. Also check for loose or damaged constant tension hose clamps. Replace damaged parts. If hose clamps are loose, turn them so their tightening screws are under the hoses or facing inboard. Tighten the screws 45 lbf·in (500 N·cm).

IMPORTANT: Vehicles built on or after February 26, 2007, have modified constant tension clamps that adjust to changes in diameter at the hose connection. When installing a new clamp or reinstalling a modified clamp, tighten the fastener 98 lbf·in (1100 N·cm). Do not retighten the clamp unless the measured torque drops below 50 lbf·in (560 N·cm), at which time it should be tightened again 98 lbf·in (1100 N·cm).

3. Check the CAC core fins. If the fins are bent, use a small pair of needlenose pliers or a small screwdriver to straighten them.
4. Check the CAC core for clogged fins. Use compressed air or water to dislodge any material restricting airflow through the core.
5. Perform the "CAC Core Leakage Test."

CAC Core Leakage Test

Charge air coolers are designed in such a way that they may leak an insignificant amount of air. The allowable leakage mentioned in **Table 1** represents a loss of less than 0.1 percent of charge airflow. Based on this rate, there should be no measurable loss of performance.

Leakage Rate Specifications		
Engine	**Pressure Drop in 15 Seconds: psi (kPa)**	**Start Pressure: psi (kPa)**
Caterpillar	5 (34)	30 (207)
Cummins	7 (48)	30 (207)
Mercedes-Benz	5 (34)	30 (207)

Table 1, Leakage Rate Specifications

The CAC core leakage test should be performed using a CAC test kit, part number 5039, which can be purchased from SPX Kent-Moore at 1-800-328-6657.

1. Apply the parking brakes and chock the tires.
2. Connect the test equipment to the CAC core, as follows. See **Fig. 1**.
   - 2.1 Remove the inlet and outlet air piping from the flex tubes that attach them to the CAC air inlet and air outlet.
   - 2.2 Slip a safety ring with thumbscrew over each flex tube and onto the CAC air inlet and air outlet. Turn the rings so the thumbscrews are facing outboard and the safety chains are inboard. Tighten the thumbscrews securely.
   - 2.3 Install an additional constant tension hose clamp on each flex tube.
   - 2.4 Install the test plug without an adapter in the CAC air inlet and turn the plug so the safety chain is inboard. Tighten each constant tension hose clamp 72 lbf·in (810 N·cm).
   - 2.5 Install the test plug with adapter in the CAC air outlet and turn the plug so the safety chain is inboard. Tighten each constant tension hose clamp 72 lbf·in (810 N·cm).

⚠ WARNING

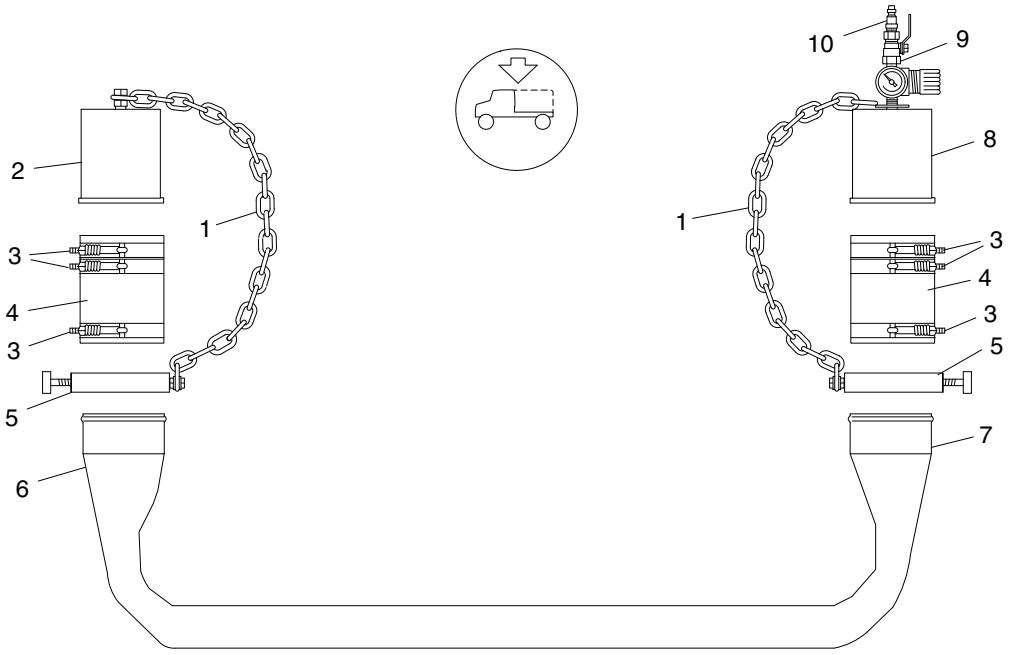
Always secure the test plugs with the safety rings. Test pressures could blow out an unsecured test plug at high speed, possibly causing eye injury or other serious personal injury.

   - 2.6 If not already installed, install a test valve/gauge assembly and air chuck in the test plug with adapter.
   - 2.7 Attach a pressurized air line to the air chuck on the pressure regulator valve.
3. Test the CAC core as follows.

⚠ WARNING

Always wear safety glasses and hearing protection when doing this procedure. Do not stand in front of the test plugs while the core is pressur-

CAC Inspection and Leakage Test



1. Safety Chain
2. Test Plug
3. Constant Tension Hose Clamp
4. Flex Tube
5. Safety Ring
6. CAC Air Inlet
7. CAC Air Outlet
8. Test Plug with Adapter
9. Test Valve/Gauge Assembly
10. Air Chuck

Fig. 1, CAC Core Testing

ized. A plug could suddenly release debris at high speed, possibly resulting in eye injury or other serious personal injury.

3.1 Open the test valve, then slowly open the pressure regulator valve and allow the CAC to gradually fill with air to the start pressure. See **Table 1**.

3.2 Close the test valve and watch the gauge for 15 seconds. If there is more than the specified drop in the CAC pressure in 15 seconds, replace the CAC. See **Table 1**.

IMPORTANT: Do not attempt to repair the CAC.

3.3 When testing is completed, reduce the pressure on the pressure regulator valve to bleed air from the CAC.

4. Remove the test equipment (and the additional constant tension hose clamps) from the flex tubes.
5. Pull the flex tubes and constant tension hose clamps rearward until the hoses cover about 1-1/2 inches (38 mm) of the CAC air inlet and air outlet piping.
6. Turn the clamps so their tightening screws are under the hoses or facing inboard. Tighten the screws 45 lbf·in (500 N·cm).

IMPORTANT: Vehicles built on or after February 26, 2007, have modified constant tension clamps that adjust to changes in diameter at the hose connection. When installing a new clamp or reinstalling a modified clamp, tighten the fastener 98 lbf·in (1100 N·cm). Do not retighten the clamp unless the measured torque drops below 50 lbf·in (560 N·cm), at which time it should be tightened again 98 lbf·in (1100 N·cm).

Flushing

If the charge air cooler (CAC) is suspected of being contaminated, flush the CAC.

1. Apply the brakes and chock the tires.
2. Remove the CAC. For instructions, see **Subject 100**.
3. Set the CAC in a horizontal position with the inlet and outlet ports facing up.

IMPORTANT: Use only naphtha or mineral spirits to clean the charge air cooler. Do not use caustic solutions such as those that are commonly used in radiator shops. Do not use steam or high-temperature cleaning operations. Caustic solutions, steam, and high-temperature cleaning operations will damage the RTV that seals the charge air cooler tubes to the headers, which may result in leaking.

4. Pour a filtered naphtha or mineral spirits solution into the CAC until it is 40 percent full.
5. Cap the inlet and outlet ports on the CAC.
6. Rock the CAC back and forth so that the solvent travels from one tank, through the tubes, to the other tank and back. Repeat this process ten times.

NOTE: Do not leave the solvent in the CAC for more than 10 minutes.

7. Remove the caps from the inlet and outlet ports.
8. Drain the CAC and properly dispose of the solvent.
9. Leave the caps off and allow the residual solvent to evaporate.
10. Install the CAC. For instructions, see **Subject 100**.

Restriction Test

After flushing the charge air cooler (CAC) because of turbocharger or engine damage, test the pressure drop across the CAC and air piping as follows:

1. Remove the pipe plug from the tapped hole in the turbocharger air outlet elbow.

   Remove the pipe plug or the nylon tube and atomizer for the ether start system if so equipped, or the air line to the turbocharger air-pressure gauge if so equipped from the tapped hole in the rear-left side of the intake manifold.

   Install an air pressure gauge in each tapped hole.

2. Operate the engine at rated speed and horsepower. There is no need to operate the engine at its peak torque rating. While operating the engine, read both air pressure gauges.

   Because of air turbulence at the turbocharger outlet, subtract 0.3 inHg (1 kPa) from the pressure measurement taken at this point to make it a true reading.

   From that reading, subtract the reading taken at the intake manifold. This is the pressure drop of the CAC.

   If the pressure drop is more than 4 inHg (14 kPa), flush or replace the CAC as needed.