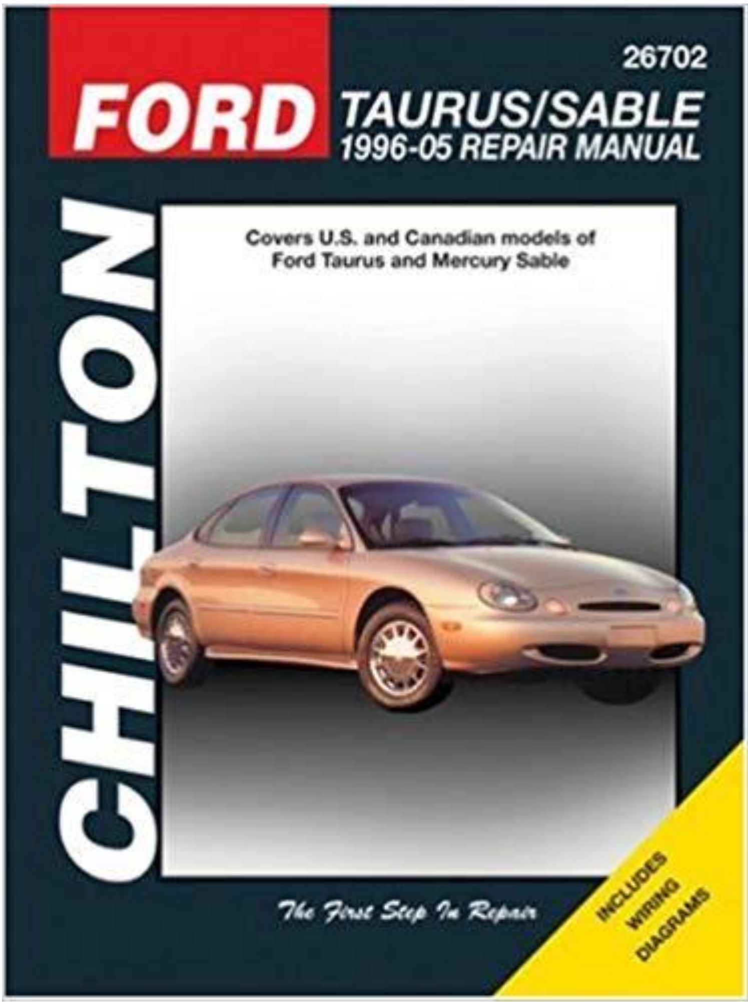
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Automotive Repair Information

performing steps in the wrong order usually just costs you extra time; however, it CAN break something. Read the entire procedure before beginning disassembly. Perform everything in the order in which the instructions say you should, even if you can't immediately see a reason for it. When you're taking apart something that is very intricate, you might want to draw a picture of how it looks when assembled at one point in order to make sure you get everything back in its proper position. We will supply exploded views whenever possible. When making adjustments, perform them in the proper order. One adjustment possibly will affect another.

2. Overtorquing (or undertorquing). While it is more common for overtorquing to cause damage, undertorquing may allow a fastener to vibrate loose causing serious damage. Especially when dealing with aluminum parts, pay attention to torque specifications and utilize a torque wrench in assembly. If a torque figure is not available, remember that if you are using the right tool to perform the job, you will probably not have to strain yourself to get a fastener tight enough. The pitch of most threads is so slight that the tension you put on the wrench will be multiplied many times in actual force on what you are tightening. A good example of how critical torque is can be seen in the case of spark plug installation, especially where you are putting the plug into an aluminum cylinder head. Too little torque can fail to seat the plug properly in its hole (or crush the spark plug gasket, if equipped) causing leakage of combustion gases and perhaps even allow the plug to fall out of the spark plug hole. Too much torque can damage the spark plug hole threads, which will then require expensive repairs to the engine cylinder head to correct.

There are many commercial chemical products available, generally referred to as threadlockers, for ensuring that fasteners won't come loose, even if they are not torqued just right (a very common brand is Loctite®). If you're worried about getting something together tight enough to hold, but not over tightened to the point of mechanical damage during assembly, one of these products might offer substantial insurance. Before applying a threadlocking compound, or any chemical compound to a fastener, read the label on the package and make sure the product is appropriate for the intended use, and compatible with the materials, fluids, etc. involved. Incorrect use of chemical products can have unintended, and sometimes undesirable, results.

3. Crossthreading. This occurs when a part such as a bolt is screwed into a nut or casting at the wrong angle and forced. Crossthreading is more likely to occur if access is difficult. It helps to clean and lubricate fasteners, then to start threading the bolt, spark plug, etc. with your fingers. If you encounter resistance, unscrew the part and start over again at a different angle until it can be inserted and turned several times without much effort. Keep in mind that many parts, especially spark plugs, have tapered threads, so that gentle turning will automatically bring the part you're threading to the proper angle. Don't put a wrench on the part until it's been tightened a couple of turns by hand. If you suddenly encounter resistance, and the part has not seated fully, don't force it. Pull it back out to make sure it's clean and threading properly.

Be sure to take your time and be patient, and always plan ahead. Allow yourself ample time to perform repairs and maintenance. You may find maintaining your car a satisfying and enjoyable experience.

TOOLS AND EQUIPMENT

Introduction

Naturally, without the proper tools and equipment it is impossible to properly service your vehicle. It would also be virtually impossible to catalog every tool that you would need to perform all of the operations in this book. Of course, It would be unwise for the amateur to rush out and buy an expensive set of tools on the theory that he/she may need one or more of them at some time.

The best approach is to proceed slowly, gathering a good quality set of those tools that are used most frequently. Don't be misled by the low cost of bargain tools. It is far better to spend a little more for better quality. Forged wrenches, 6 or 12-point sockets and fine tooth ratchets are by far preferable to their less expensive counterparts. As any good mechanic can tell you, there are few worse experiences than trying to work on a vehicle with bad tools. Your monetary savings will be far outweighed by frustration and mangled knuckles.

Begin accumulating those tools that are used most frequently: those associated with routine maintenance and tune-up. In addition to the normal assortment of screwdrivers and pliers, you should have the following tools:

- Wrenches/sockets and combination open end/box end wrenches in sizes from 1/8-3/4 in. or 3-19mm, as well as a 13/16 in. or 5/8 in. spark plug socket (depending on plug type).

If possible, buy various length socket drive extensions. Universal-jointand wobble extensions can be extremely useful, but be careful when using them,as they can change the amount of torque applied to the fastener.

- Jack stands for supporting a lifted vehicle.
- Oil filter wrench.
- Spout or funnel for pouring fluids.
- Grease gun for chassis lubrication (unless your vehicle is not equipped with any grease fittings-for details, please refer to information on Fluids and Lubricants, later in this section).
- Hydrometer for checking the battery (unless equipped with a sealed, maintenance-free battery).
- Coolant hydrometer or chemical test strips for checking engine coolant.
- A container or drain pan for draining oil and other fluids.
- Rags for wiping up the inevitable mess.

All but the most basic procedures will require an assortment of ratchets and sockets

In addition to ratchets, a good set of wrenches and hex keys will be necessary

A hydraulic floor jack and a set of jack stands are essential for lifting and supporting the vehicle

An assortment of pliers, grippers and cutters will be handy for old rusted parts and stripped bolt heads

Various drivers, chisels and pry bars are great tools to have in your toolbox

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Many repairs will require the use of a torque wrench to assure the components are properly fastened

In addition to the above items there are several others that are not absolutely necessary, but handy to have around. These include Oil Dry® (or an equivalent oil absorbent gravel-such as cat litter) and the usual supply of lubricants, antifreeze and fluids, although these can be purchased as needed. This is a basic list for routine maintenance, but only your personal needs and desire can accurately determine your list of tools.

After performing a few projects on the vehicle, you'll be amazed at the other tools and non-tools on your workbench. Some useful household items are: a large turkey baster or siphon, empty coffee cans and ice trays (to store parts), ball of twine, electrical tape for wiring, small rolls of colored tape for tagging lines or hoses, markers and pens, a note pad, golf tees (for plugging vacuum lines), metal coat hangers or a roll of mechanic's wire (to hold things out of the way), dental pick or similar long, pointed probe, a strong magnet, and a small mirror (to see into recesses and under manifolds).

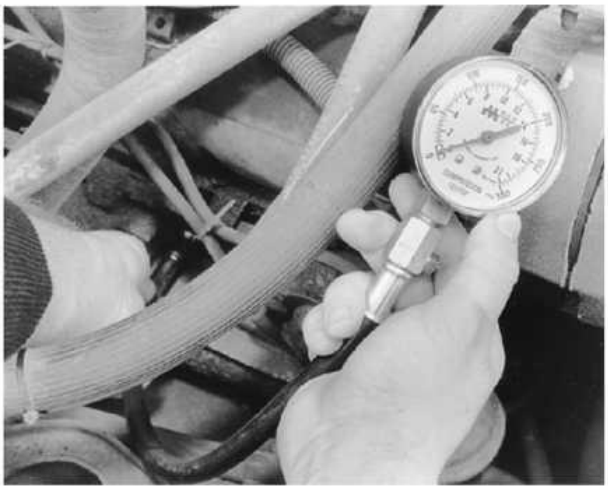
Although not always necessary, using specialized brake tools will save time

A few inexpensive lubrication tools will make maintenance easier

Various pullers, clamps and separator tools are needed for many larger, more complicated repairs

A variety of tools and gauges should be used for spark plug gapping and installation

Inductive type timing light



A screw-in type compression gauge is recommended for compression testing

A vacuum/pressure tester is necessary for many testing procedures

Most modern automotive multimeters incorporate many helpful features

Proper information is vital, so always have a Chilton Total Car Care manual handy

A more advanced set of tools, suitable for tune-up work, can be drawn up easily. While the tools are slightly more sophisticated, they need not be outrageously expensive. There are several inexpensive electrical multimeters on the market that are every bit as good for the average mechanic as a professional model. A typical automotive multimeter will have the ability to measure DC voltage, resistance (ohms), engine rpm, dwell/duty cycle, and possibly other features as well. The key to these purchases is to make them with an eye towards adaptability and wide range. A basic list of tune-up tools could include:

- Automotive multimeter.
- Spark plug wrench and gapping tool.
- Feeler gauges for valve adjustment.
- Timing light (unless the ignition timing is not adjustable ! for details, please refer to information on Routine Maintenance and Tune-up, later in this section).

The choice of a timing light should be made carefully. A light which works on the DC current supplied by the vehicle's battery is the best choice; it should have a xenon tube for brightness. A timing light has an inductive pickup that clamps around the No. 1 spark plug cable so the cable need not be disconnected.

In addition to these basic tools, there are several other tools and gauges you may find useful. These include:

- Compression gauge. The screw-in type is slower to use, but eliminates the possibility of a faulty reading due to escaping pressure.
- Vacuum/pressure gauge for measuring manifold vacuum.
- 12V test light.
- Fuel pressure test gauge. A typical fuel pressure gauge for a fuel-injected vehicle should read up to 60 psi, and should have an appropriate adapter for connection to your vehicle.

As a final note, you will probably find a torque wrench necessary for all but the most basic work. Torque wrenches are commonly of the beam type, dial type, or click type. The beam or dial type models are perfectly adequate, although the click types (sometimes called `breakaway' types) are easier to use. The click type torque wrenches tend to be more expensive. Also keep in mind that all types of torque wrenches should be periodically checked and/or recalibrated. You will have to decide for yourself which better fits your pocketbook, and purpose.

Special Tools

Normally, the use of special factory tools is avoided for repair procedures, since these are not readily available for the do-it-yourself mechanic. When it is possible to perform the job with more commonly available tools, it will be pointed out, but occasionally, a special tool was designed to perform a specific function and should be used. Before substituting another tool, you should be convinced that neither your safety nor the performance of the vehicle will be compromised.

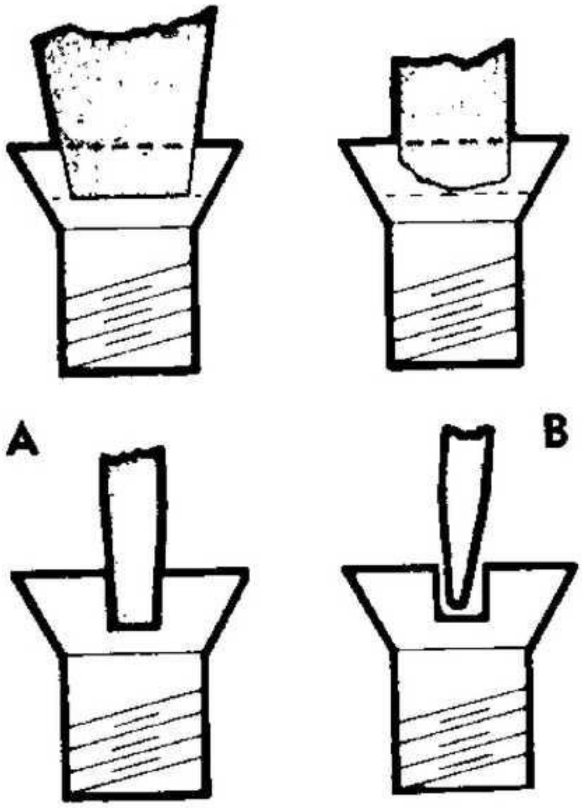
Special tools can usually be purchased from an automotive parts store or from your dealer. In some cases special tools may be available directly from the tool manufacturer.

SERVICING YOUR VEHICLE SAFELY

Introduction

It is virtually impossible to anticipate all of the hazards involved with automotive maintenance and service, but care and common sense will prevent most accidents.

The rules of safety for mechanics range from "don't smoke around gasoline" to "use the proper tool(s) for the job." The trick to avoiding injuries is to develop safe work habits and to take every possible safety precaution.



Screwdrivers should be kept in good condition to prevent injury or damage which could result if the blade slips from the screw

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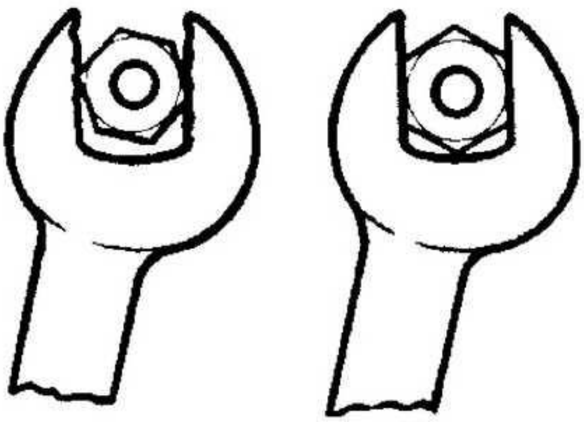
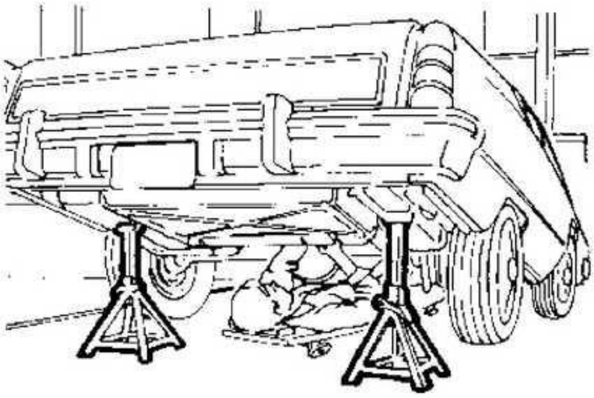
Power tools should always be properly grounded



Using the correct size wrench will help prevent the possibility of rounding off a nut



NEVER work under a vehicle unless it is supported using safety stands (jack stands)

Do's

- Do keep a fire extinguisher and first aid kit handy.
- Do wear safety glasses or goggles when cutting, drilling, grinding or prying. If you wear glasses for the sake of vision, wear safety goggles over your regular glasses.
- Do shield your eyes whenever you work around the battery. Batteries contain sulfuric acid. In case of contact with the eyes or skin, flush the area with water or a mixture of water and baking soda, then seek immediate medical attention.
- Do use safety stands (jack stands) for any under vehicle service. Jacks are for raising vehicles; jack stands are for making sure the vehicle stays raised until you want it to come down. Whenever the vehicle is raised, block the wheels remaining on the ground and set the parking brake.
- Do use adequate ventilation and follow manufacturer's directions when working with any chemicals or hazardous materials, or when working on the vehicle with the engine running. Carbon monoxide in the vehicle's exhaust, asbestos dust resulting from some brake lining wear, new or used automotive fluids and chemicals are just a few examples of materials that can be hazardous in sufficient quantities.
- Do disconnect the negative battery cable when working on the electrical system to avoid electrical arcing and the possibility of fire, bodily harm or damage to the vehicle.
- Use extreme caution when working on the ignition system. The secondary ignition system contains EXTREMELY HIGH VOLTAGE. In some cases it can even exceed 50,000 volts.
- Do follow manufacturer's directions whenever working with potentially hazardous materials. Most chemicals and fluids are poisonous if taken internally.
- Do properly maintain your tools. Loose hammer heads, mushroomed punches and chisels, frayed or poorly grounded electrical cords, excessively worn screwdrivers, spread wrenches (open end), cracked sockets, slipping ratchets, or faulty droplight sockets can cause accidents.
- Likewise, keep your tools clean; a greasy wrench can slip off a bolt head, ruining the bolt and often harming your knuckles in the process.
- Do use the proper size and type of tool for the job at hand. Do select a wrench or socket that fits the nut or bolt. The wrench or socket should sit straight, not cocked.
- Do, when possible, pull on a wrench handle rather than push on it, and adjust your stance to prevent a fall.
- Do be sure that adjustable wrenches are tightly closed on the nut or bolt and pulled so that the force is on the side of the fixed jaw.
- Do strike squarely with a hammer; avoid glancing blows.
- Do set the parking brake and block the drive wheels if the work requires a running engine.

Don'ts

- Don't run the engine in a garage or anywhere else without proper ventilation-EVER! Carbon monoxide in a vehicle's exhaust stream is poisonous; it takes a long time to leave the human body and you can build up a deadly supply of it in your system by simply breathing in a little every day. You may not realize you are slowly poisoning yourself. Always use power vents, windows, fans and/or open the garage door.
- Don't work around moving parts while wearing loose clothing. Short sleeves are much safer than long, loose sleeves. Hard-toed shoes with neoprene soles protect your toes and give a better grip on slippery surfaces. Jewelry such as watches, fancy belt buckles, beads or body adornment of any kind is not safe working around a vehicle. Long hair should be tied back under a hat or cap.
- Don't use pockets for toolboxes. A fall or bump can drive a screwdriver deep into your body. Even a rag hanging from your back pocket can wrap around a spinning shaft or fan.

- Don't smoke when working around gasoline, cleaning solvent or other flammable material.
- Don't smoke when working around the battery. When the battery is being charged, it gives off explosive hydrogen gas.
- Don't use gasoline to wash your hands; there are excellent soaps available. Gasoline contains dangerous additives which can enter the body through a cut or through your pores. Gasoline also removes all the natural oils from the skin so that bone-dry hands will more easily absorb oil and grease.
- Don't service the air conditioning system unless you are equipped with the necessary tools, training and certification. When liquid or compressed gas refrigerant is released to atmospheric pressure it will absorb heat from whatever it contacts. This will chill or freeze anything it touches - including any body parts it contacts. Additionally, automobile refrigerant is a regulated substance ! certification is required to service the air conditioning system.
- Don't use screwdrivers for anything other than driving screws! A screwdriver used as a prying tool can snap when you least expect it, causing injuries. At the very least, you'll ruin a good screwdriver.
- Don't use an emergency jack (that little ratchet, scissors, or pantograph jack supplied with the vehicle) for anything other than changing a flat! These jacks are only intended for emergency use out on the road; they are NOT designed as a maintenance tool. If you are serious about maintaining your vehicle yourself, invest in a hydraulic floor jack of at least 11/2 ton capacity, and at least two sturdy jack stands.

FASTENERS, MEASUREMENTS AND CONVERSIONS

Bolts, Nuts and Other Threaded Retainers

Although there are a great variety of fasteners found in the modern car or truck, the most commonly used retainer is the threaded fastener (nuts, bolts, screws, studs, etc.). Most threaded retainers may be reused, provided that they are not damaged in use or during the repair. Some retainers (such as stretch bolts or torque prevailing nuts) are designed to deform when tightened or in use and should not be reinstalled.

Click on icon to view fullsize printable image.

Click to Enlarge

Here are a few of the most common screw/bolt driver styles

Whenever possible, we will note any special retainers which should be replaced during a procedure, but you should always inspect the condition of a retainer when it is removed and replace any that show signs of damage. Check all threads for rust or corrosion that can increase the torque necessary to achieve the desired clamp load for which that fastener was originally selected. Additionally, be sure that the driver surface of the fastener has not been compromised by rounding or other damage. In some cases a driver surface may become only partially rounded, allowing the driver to catch in only one direction. In many of these occurrences, a fastener may be installed and tightened, but the driver would not be able to grip and loosen the fastener again (this could lead to frustration down the line should that component ever need to be disassembled again).

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There are many different types of threaded retainers found on vehicles

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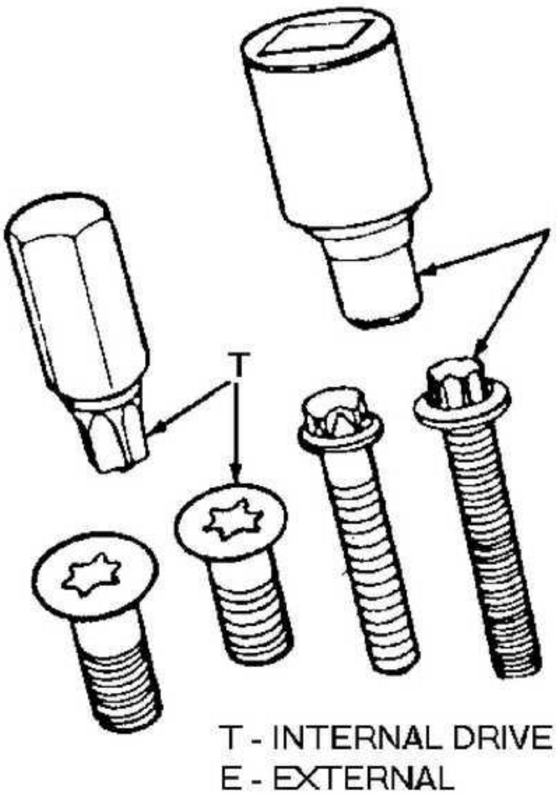
Threaded retainer sizes are determined using these measurements



Special fasteners such as these Torx® head bolts are used by manufacturers to discourage people from working on vehicles without the proper tools

If you must replace a fastener, whether due to design or damage, you must ALWAYS be sure to use the proper replacement. In all cases, a retainer of the same design, material and strength should be used. Markings on the heads of most bolts will help determine the proper strength of the fastener. The same material, thread and pitch must be selected to assure proper installation and safe operation of the vehicle afterwards.

Thread gauges are available to help measure a bolt or stud's thread. Most automotive and hardware stores keep gauges available to help you select the proper size. In a pinch, you can use another nut or bolt for a thread gauge. If the bolt you are replacing is not too badly damaged, you can select a match by finding another bolt which will thread in its place. If you find a nut which threads properly onto the damaged bolt, then use that nut to help select the replacement bolt. If however, the bolt you are replacing is so badly damaged (broken or drilled out) that its threads cannot be used as a gauge, you might start by looking for another bolt (from the same assembly or a similar location on your vehicle) which will thread into the damaged bolt's mounting. If so, the other bolt can be used to select a nut; the nut can then be used to select the replacement bolt.

In all cases, be absolutely sure you have selected the proper replacement. Don't be shy, you can always ask the store clerk for help.

Be aware that when you find a bolt with damaged threads, you may also findthe nut or drilled hole it was threaded into has also been damaged. If this isthe case, you may have to drill and tap the hole, replace the nut or otherwiserepair the threads. NEVER try to force a replacement bolt to fit into thedamaged threads.

Torque

Torque is defined as the measurement of resistance to turning or rotating. It tends to twist a body about an axis of rotation. A common example of this would be tightening a threaded retainer such as a nut, bolt or screw. Measuring torque is one of the most common ways to help assure that a threaded retainer has been properly fastened.

When tightening a threaded fastener, torque is applied in three distinct areas, the head, the bearing surface and the clamp load. About 50 percent of the measured torque is used in overcoming bearing friction. This is the friction between the bearing surface of the bolt head, screw head or nut face and the base material or washer (the surface on which the fastener is rotating). Approximately 40 percent of the applied torque is used in overcoming thread friction. This leaves only about 10 percent of the applied torque to develop a useful clamp load (the force which holds a joint together). This means that friction can account for as much as 90 percent of the applied torque on a fastener.

TORQUE WRENCHES

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Various styles of torque wrenches are usually available at your local automotive supply store

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Standard and metric bolt torque specifications based on bolt strengths. WARNING: use only as a guide

In most applications, a torque wrench can be used to assure proper installation of a fastener. Torque wrenches come in various designs and most automotive supply stores will carry a variety to suit your needs. A torque wrench should be used any time we supply a specific torque value for a fastener. A torque wrench can also be used if you are following the general guidelines in the accompanying charts. Keep in mind that because there is no worldwide standardization of fasteners, the charts are a general guideline and should be used with caution. Again, the general rule of "if you are using the right tool for the job, you should not have to strain to tighten a fastener" applies here.

Beam Type

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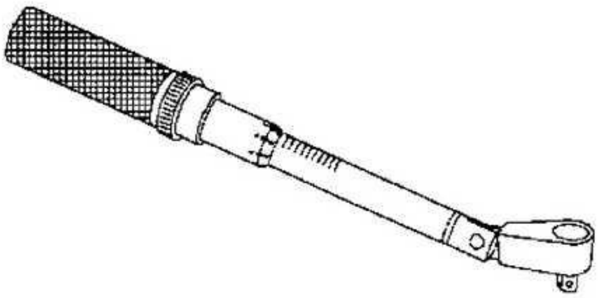
Example of a beam type torque wrench

The beam type torque wrench is one of the most popular types. It consists of a pointer attached to the head that runs the length of the flexible beam (shaft) to a scale located near the handle. As the wrench is pulled, the beam bends and the pointer indicates the torque using the scale.

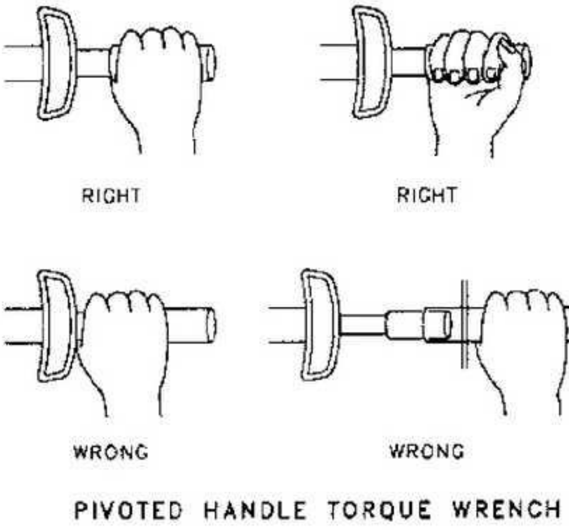
Click (Breakaway) Type



A click type or breakaway torque wrench-note that this one has a pivoting head

Another popular design of torque wrench is the click type. To use the click type wrench you pre-adjust it to a torque setting. Once the torque is reached, the wrench has a reflex signaling feature that causes a momentary breakaway of the torque wrench body, sending an impulse to the operator's hand.

Pivot Head Type

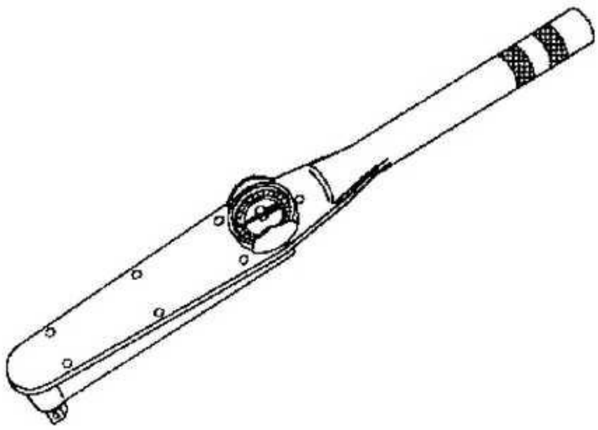


Torque wrenches with pivoting heads must be grasped and used properly to prevent an incorrect reading

Some torque wrenches (usually of the click type) may be equipped with a pivot head which can allow it to be used in areas of limited access, BUT it must be used properly. To hold a pivot head wrench, grasp the handle lightly, and as you pull on the handle, it should be floated on the pivot point. If the handle comes in contact with the yoke extension during the process of pulling, there is a very good chance the torque readings will be inaccurate because this could alter the wrench loading point. The design of the handle is usually such as to make it inconvenient to deliberately misuse the wrench.

It should be mentioned that the use of any U-joint, wobble or extensionwill have an effect on the torque readings, no matter what type of wrench youare using. For the most accurate readings, install the socket directly on thewrench driver. If necessary, straight extensions (which hold a socket directlyunder the wrench driver) will have the least effect on the torque reading.Avoid any extension that alters the length of the wrench from the handle to thehead/driving point (such as a crow's foot). U-joint or wobble extensions cangreatly affect the readings; avoid their use at all times.

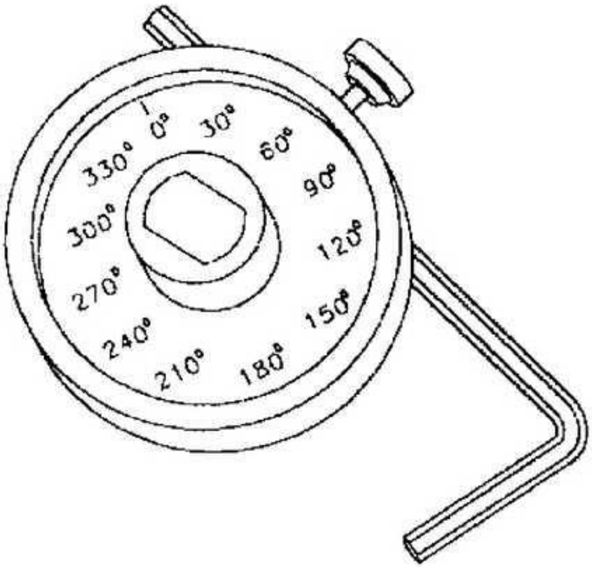
Rigid Case (Direct Reading)



The rigid case (direct reading) torque wrench uses a dial indicator to show torque

A rigid case or direct reading torque wrench is equipped with a dial indicator to show torque values. One advantage of these wrenches is that they can be held at any position on the wrench without affecting accuracy. These wrenches are often preferred because they tend to be compact, easy to read and have a great degree of accuracy.

TORQUE ANGLE METERS



Some specifications require the use of a torque angle meter (mechanical protractor)

Because the frictional characteristics of each fastener or threaded hole will vary, clamp loads which are based strictly on torque will vary as well. In most applications, this variance is not significant enough to cause worry. But, in certain applications, a manufacturer's engineers may determine that more precise clamp loads are necessary (such is the case with many aluminum cylinder heads). In these cases, a torque angle method of installation would be specified. When installing fasteners which are torque angle tightened, a predetermined seating torque and standard torque wrench are usually used first to remove any compliance from the joint. The fastener is then tightened the specified additional portion of a turn measured in degrees. A torque angle gauge (mechanical protractor) is used for these applications.

Standard and Metric Measurements

Throughout this manual, specifications are given to help you determine the condition of various components on your vehicle, or to assist you in their installation. Some of the most common measurements include length (in. or cm/mm), torque (ft. lbs., inch lbs. or Nm) and pressure (psi, in. Hg, kPa or mm Hg). In most cases, we strive to provide the proper measurement as determined by the manufacturer's engineers.

Though, in some cases, that value may not be conveniently measured with what is available in your toolbox. Luckily, many of the measuring devices which are available today will have two scales so the Standard or Metric measurements may easily be taken. If any of the various measuring tools which are available to you do not contain the same scale as listed in the specifications, use the accompanying conversion factors to determine the proper value.

The conversion factor chart is used by taking the given specification and multiplying it by the necessary conversion factor. For instance, looking at the first line, if you have a measurement in inches such as "free-play should be 2 in." but your ruler reads only in millimeters, multiply 2 in. by the conversion factor of 25.4 to get the metric equivalent of 50.8mm. Likewise, if the specification was given only in a Metric measurement, for example in Newton Meters (Nm), then look at the center column first. If the measurement is 100 Nm, multiply it by the conversion factor of 0.738 to get 73.8 ft. lbs.

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Standard and metric conversion factors chart

SERIAL NUMBER IDENTIFICATION

Vehicle Identification Number (VIN)

The VIN plate as viewed through the windshield

The Vehicle Identification Number (VIN) is located on the dashboard, close to the windshield on the driver's side of the vehicle. It is visible from outside the vehicle.

The 17-character label contains the following information:

- Digits 1, 2 and 3: World manufacturer identifier
- Digit 4: Restraint system type
- Digit 5: Manufacturer's specification
- Digits 6 and 7: Line, series and body type
- Digit 8: Engine type
- Digit 9: Check digit
- Digit 10: Vehicle model year
- Digit 11: Assembly plant
- Digits 12 through 17: Production sequence number

Vehicle Certification Number

A Vehicle Certification Label (VCL) is also affixed on the left front door jamb or door pillar. The VCL also contains a 17-digit Vehicle Identification Number (VIN). This VIN is used for warranty identification.

This label contains the following information:

- Name of manufacturer
- Month of the year manufacture
- Gross Vehicle Weight Rating (GVWR)
- Gross Axle Weight Rating (GAWR)
- Certification statement
- Body type
- Color
- Radio type
- Brake type
- Molding
- Tape stripe or paint stripe
- Interior trim
- Axle ratio
- Transaxle
- Spring
- District sales office
- Series order codes

Engine

The 8th character of the VIN designates the engine type installed in the vehicle. An engine identification label may also be attached to the engine valve cover.

The codes are as follows:

- Code 1: 3.0L (OHV) gasoline/methanol engine
- Code 2: 3.0L (OHV) gasoline/ethanol engine
- Code U: 3.0L (OHV) gasoline engine
- Code S: 3.0L (DOHC) gasoline engine
- Code N: 3.4L (DOHC) gasoline engine

Transaxle

The transaxle code is found on the Vehicle Certification Label (VCL), affixed on the left front door jamb or door pillar. The code is located in the lower right-hand corner of the VCL. This code designates the transaxle type installed in the vehicle. A transaxle identification tag is also affixed to the transaxle assembly, usually located on top of the converter housing.

The codes are as follows:

- Code L: AX4S 4-speed automatic transaxle
- Code X: AX4N 4-speed automatic transaxle

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Typical transaxle identification code which is usually located on top of the converter housing-AX4S and AX4N transaxles

ROUTINE MAINTENANCE AND TUNE-UP

Introduction

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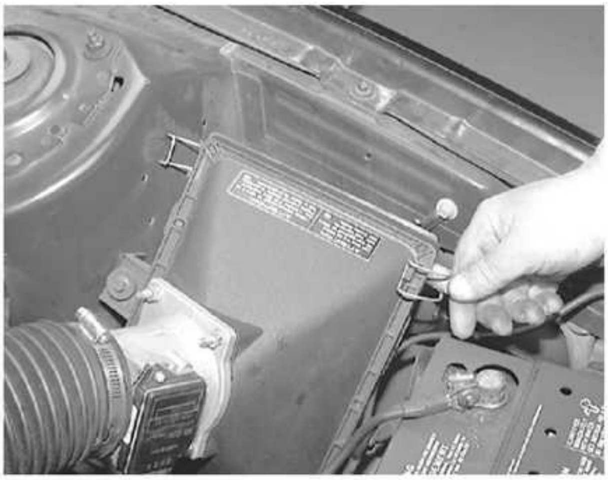
Proper maintenance and tune-up is the key to long and trouble-free vehicle life, and the work can yield its own rewards. Studies have shown that a properly tuned and maintained vehicle can achieve better gas mileage than an out-of-tune vehicle. As a conscientious owner and driver, set aside a Saturday morning, say once a month, to check or replace items which could cause major problems later. Keep your own personal log to jot down which services you performed, how much the parts cost you, the date, and the exact odometer reading at the time. Keep all receipts for such items as engine oil and filters, so that they may be referred to in case of related problems or to determine operating expenses. As a do-it-yourselfer, these receipts are the only proof you have that the required maintenance was performed. In the event of a warranty problem, these receipts will be invaluable.

The literature provided with your vehicle when it was originally delivered includes the factory recommended maintenance schedule. If you no longer have this literature, replacement copies are usually available from the dealer. A maintenance schedule is provided later in this section, in case you do not have the factory literature.

Air Cleaner (Element)

REMOVAL & INSTALLATION



Release the retaining clips and...

... lift the air cleaner housing cover to access the filter element

Remove the element from the housing

Refer to the maintenance interval chart located at the end of this section for frequency of the element replacement.

1. Release the air cleaner housing cover retaining clips.
2. Position the cover aside.
3. Remove the air cleaner element.
4. Inspect the element and clean or replace as necessary.

To install:

5. Using a clean rag or shop towel, wipe the inside of the cleaner housing and remove all dirt and debris.
6. Place the element in position.
7. Place the air cleaner housing cover into position and fasten the retaining clips.

Cabin Air Filter

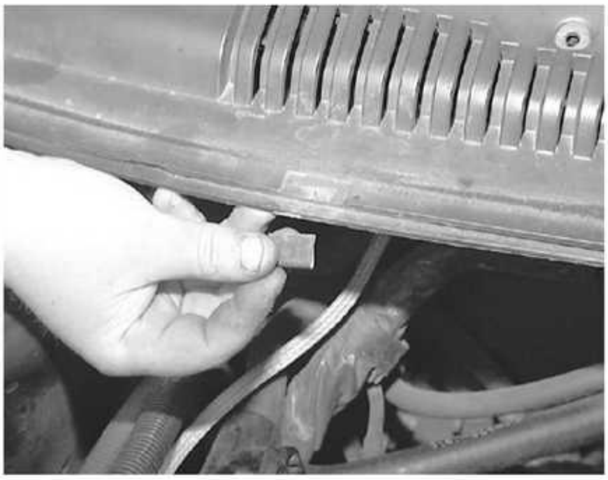
Some vehicles may be equipped with a cabin air filter. This filter restricts the entry of airborne dust and pollen particles. The filter is usually located just in front of the windshield under the cowl vent screen on the passenger side of the vehicle.

REMOVAL & INSTALLATION

1. Open the hood.
2. Tag and disconnect any necessary vacuum hoses.
3. Rotate and remove the four push pins located on the cowl vent screen.
4. Remove the three push-on clips and remove the cowl vent screen.
5. Unfasten the two screws attaching the cowl top inner panel shield and remove the shield.
6. Remove the filter by sliding it forward out of the housing and then towards the center of the vehicle.
7. Installation of the remaining components is the reverse of removal.

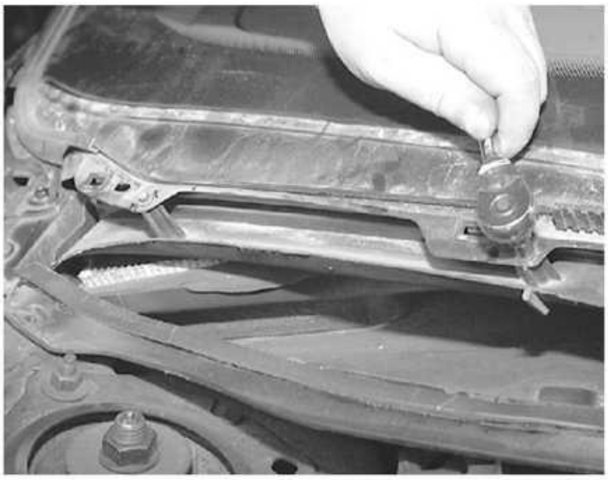
Turn the wipers on and turn the ignition to OFF to position the wiper arms in the upright position as shown

Rotate and remove the four push pins located on the cowl vent screen.

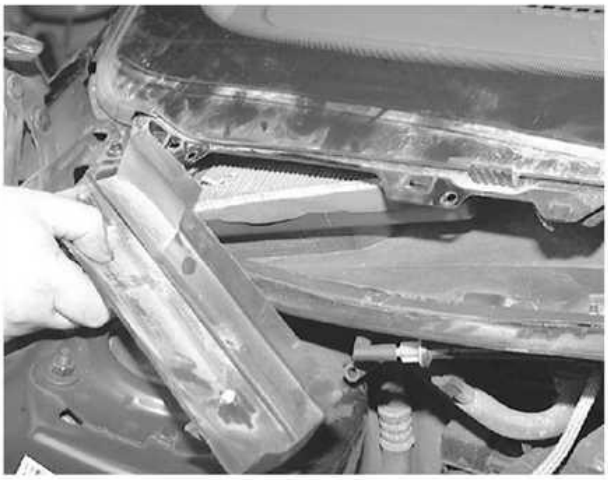


Remove the three push-on clips and...

... remove the screen



Unfasten the two screws attaching the cowl top inner panel shield and...



... remove the shield

Remove the filter and install a new one

Fuel Filter

REMOVAL & INSTALLATION

The in-line fuel filter provides filtration to protect the small metering orifices of the fuel injectors. The filter is located upstream of the fuel pump and is usually mounted to the rear right hand frame rail adjacent to the right hand front cover of the fuel tank underneath the vehicle. The filter and base is a one-piece unit that is non-serviceable and must be replaced if it is defective.

The flexible-fuel filter is compatible with either fuel Methanol or fuelEthanol. The use of a gasoline fuel filter on these models will result in thefailure of the filter.

Click on icon to view fullsize printable image.

Click to Enlarge

Exploded view of the fuel system mounting and its related components

Remove the clips from the push connect fittings

1. Relieve the fuel system pressure. Refer to Section 5 of this manual for the proper procedure.
2. Raise the vehicle and support it with jack stands.
3. Disconnect the push connect fittings from the ends of the filter. Refer to Section 5 of this manual for the fuel line disconnect procedure.
4. Loosen the filter clamp mounting clamp just enough so that the filter can be removed.
5. Once the clamp is loosened, remove the filter from the vehicle.

To install:

The flow direction arrow on the filter should be pointing forward toensure proper flow of fuel through the filter.

6. Install the fuel filter in the mounting clamp. Make sure the flow arrow is properly positioned. Locate the base of the filter against the tab at the lower end of the bracket.
7. Attach the push connect fittings to the filter. Refer to Section 5 of this manual for the fuel line connect procedure.
8. Tighten the filter mounting clamp nut to 15-24 inch lbs. (1.7-2.8 Nm).
9. Start the engine and check for leaks.
10. Remove the jack stands and lower the vehicle.

Positive Crankcase Ventilation (PCV) Valve

REMOVAL & INSTALLATION

The Positive Crankcase Ventilation (PCV) valve cycles crankcase gasses back through the engine where they are burned. The PCV valve regulates the amount of ventilating air and blow-by fuel vapor to the intake manifold. The valve also prevents backfire from entering the crankcase.

Do not remove the PCV valve from the engine. If you operate the enginewithout the valve it will reduce fuel economy and engine ventilation. This willweaken the engine performance and shorten engine life.

Click on icon to view fullsize printable image.

Click to Enlarge

View of a typical PCV system air flow schematic

3.0L (OHV) Engine

1. Pull the PCV valve out of the valve grommet in the right hand valve cover.
2. Disconnect the crankcase ventilation hose from the PCV valve.
3. Inspect the PCV valve, grommet and hose for damage and replace as necessary. For PCV valve testing, refer to Section 4 of this manual.

To install:

4. Connect the PCV valve to the crankcase ventilation hose.
5. Push the PCV valve into the grommet on the valve cover. Make sure the valve is fully seated.

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Click to Enlarge

PCV components-3.0L (OHV) engine

The PCV valve is located in the right hand (rear) valve cover-3.0L (OHV) engine

Remove the PCV valve from the valve cover grommet and ventilation hose ! 3.0L (OHV) engine

3.0L (DOHC) Engine

1. Disconnect the crankcase vent connector and hose from the PCV valve.
2. Disconnect the valve from the oil separator tube.
3. Inspect the PCV valve and oil separator tube sleeve for damage and replace as necessary. For PCV valve testing, refer to Section 4 of this manual.

To install:

4. Connect the PCV valve to the oil separator tube.
5. Connect the PCV valve to the crankcase vent connector and hose.

Click on icon to view fullsize printable image.

Click to Enlarge

PCV components-3.0L (DOHC) engine

3.4L (DOHC) Engine

1. Disconnect the oil separator hose from the PCV valve.
2. Loosen the spring clamp and remove the PCV valve from the oil separator tube.
3. Inspect the PCV valve, hose and oil separator tube for damage and replace as necessary. For PCV valve testing, refer to Section 4 of this manual.

To install:

4. Attach the PCV valve to the oil separator tube and install the spring clamp.
5. Connect the oil separator hose to the PCV valve.

Click on icon to view fullsize printable image.

Click to Enlarge

PCV components-3.4L (DOHC) engine

Evaporative Canister

SERVICING

The evaporative emission canister should be inspected for damage or leaks at the hose fittings. Repair or replace any old or cracked hoses. Replace the canister if it is damaged in any way. The evaporative emission canister is located on the underside of the vehicle, rearward of the fuel tank. Refer to the accompanying illustrations for the canister location.

Click on icon to view fullsize printable image.

Click to Enlarge

Location of evaporative emission canister and its related components-3.0L (OHV) flexible-fuel vehicles

Location of evaporative emission canister and its related components - 3.0L (OHV) non-flexible-fuel, 3.0L (DOHC) and 3.4L (DOHC) vehicles

Battery

PRECAUTIONS

Always use caution when working on or near the battery. Never allow a tool to bridge the gap between the negative and positive battery terminals. Also, be careful not to allow a tool to provide a ground between the positive cable/terminal and any metal component on the vehicle. Either of these conditions will cause a short circuit, leading to sparks and possible personal injury.

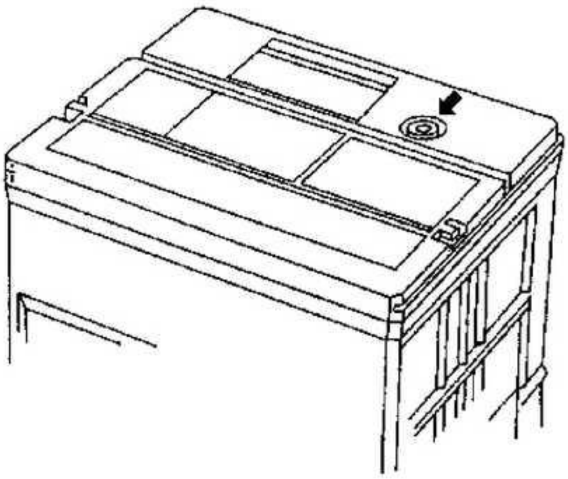
Do not smoke, have an open flame or create sparks near a battery; the gases contained in and emitted from the battery are very explosive and, if ignited, could cause severe injury or death.

All batteries, regardless of type, should be carefully secured by a battery hold-down device. If this is not done, the battery terminals or casing may crack from stress applied to the battery during vehicle operation. A battery which is not secured may allow acid to leak out, making it discharge faster; such leaking corrosive acid can also eat away at components under the hood.

Always visually inspect the battery case for cracks, leakage and corrosion. A white corrosive substance on the battery case or on nearby components could indicate a leaking or cracked battery. If the battery is cracked, it should be replaced immediately.

GENERAL MAINTENANCE

A battery that is not sealed must be checked periodically for electrolyte level. You cannot add water to a sealed maintenance-free battery (though not all maintenance-free batteries are sealed); however, a sealed battery must be checked for proper electrolyte condition, as indicated by the color of the built-in hydrometer "eye."



A typical location for the built-in hydrometer #

Always keep the battery cables and terminals free of corrosion. Check these components about once a year. Refer to the removal, installation and cleaning procedures outlined in this section.

Keep the top of the battery clean, as a film of dirt can help completely discharge a battery that is not used for long periods. A solution of baking soda and water may be used for cleaning, but be careful to flush this off with clear water. Do NOT let any of the solution into the filler holes. Baking soda neutralizes battery acid and will de-activate a battery cell.

Batteries in vehicles which are not operated on a regular basis can fall victim to parasitic loads (small current drains which are constantly drawing current from the battery). Normal parasitic loads may drain a battery on a vehicle that is in storage and not used for 6-8 weeks. Vehicles that have additional accessories such as a cellular phone, an alarm system or other devices that increase parasitic load may discharge a battery sooner. If the vehicle is to be stored for 6-8 weeks in a secure area and the alarm system, if present, is not necessary, the negative battery cable should be disconnected at the onset of storage to protect the battery charge.

Remember that constantly discharging and recharging will shorten battery life. Take care not to allow a battery to be needlessly discharged.

BATTERY FLUID

Check the battery electrolyte level at least once a month, or more often in hot weather or during periods of extended vehicle operation. On non-sealed batteries, the level can be checked either through the case on translucent batteries or by removing the cell caps on opaque-cased types. The electrolyte level in each cell should be kept filled to the split ring inside each cell, or the line marked on the outside of the case.

If the level is low, add only distilled water through the opening until the level is correct. Each cell is separate from the others, so each must be checked and filled individually. Distilled water should be used, because the chemicals and minerals found in most drinking water are harmful to the battery and could significantly shorten its life.

If water is added in freezing weather, the vehicle should be driven several miles to allow the water to mix with the electrolyte. Otherwise, the battery could freeze.

Although some maintenance-free batteries have removable cell caps for access to the electrolyte, the electrolyte condition and level on all sealed maintenance-free batteries must be checked using the built-in hydrometer "eye." The exact type of eye varies between battery manufacturers, but most apply a sticker to the battery itself explaining the possible readings. When in doubt, refer to the battery manufacturer's instructions to interpret battery condition using the built-in hydrometer.

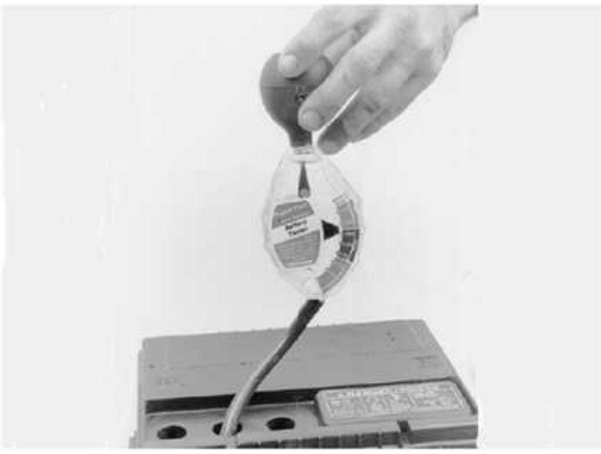
Although the readings from built-in hydrometers found in sealed batteriesmay vary, a green eye usually indicates a properly charged battery withsufficient fluid level. A dark eye is normally an indicator of a battery withsufficient fluid, but one which may be low in charge. And a light or yellow eyeis usually an indication that electrolyte supply has dropped below thenecessary level for battery (and hydrometer) operation. In this last case,sealed batteries with an insufficient electrolyte level must usually be discarded.

Checking the Specific Gravity

A hydrometer is required to check the specific gravity on all batteries that are not maintenance-free. On batteries that are maintenance-free, the specific gravity is checked by observing the built-in hydrometer "eye" on the top of the battery case. Check with your battery's manufacturer for proper interpretation of its built-in hydrometer readings.

On non-maintenance-free batteries, the fluid level can be checked through the case on translucent models; the cell caps must be removed on other models

If the fluid level is low, add only distilled water through the opening until the level is correct



Check the specific gravity of the battery's electrolyte with a hydrometer

Battery electrolyte contains sulfuric acid. If you should splash any on yourskin or in your eyes, flush the affected area with plenty of clear water. If itlands in your eyes, get medical help immediately.

The fluid (sulfuric acid solution) contained in the battery cells will tell you many things about the condition of the battery. Because the cell plates must be kept submerged below the fluid level in order to operate, maintaining the fluid level is extremely important. And, because the specific gravity of the acid is an indication of electrical charge, testing the fluid can be an aid in determining if the battery must be replaced. A battery in a vehicle with a properly operating charging system should require little maintenance, but careful, periodic inspection should reveal problems before they leave you stranded.

As stated earlier, the specific gravity of a battery's electrolyte level can be used as an indication of battery charge. At least once a year, check the specific gravity of the battery. It should be between 1.20 and 1.26 on the gravity scale. Most auto supply stores carry a variety of inexpensive battery testing hydrometers. These can be used on any non-sealed battery to test the specific gravity in each cell.

The battery testing hydrometer has a squeeze bulb at one end and a nozzle at the other. Battery electrolyte is sucked into the hydrometer until the float is lifted from its seat. The specific gravity is then read by noting the position of the float. If gravity is low in one or more cells, the battery should be slowly charged and checked again to see if the gravity has come up. Generally, if after charging, the specific gravity between any two cells varies more than 50 points (0.50), the battery should be replaced, as it can no longer produce sufficient voltage to guarantee proper operation.

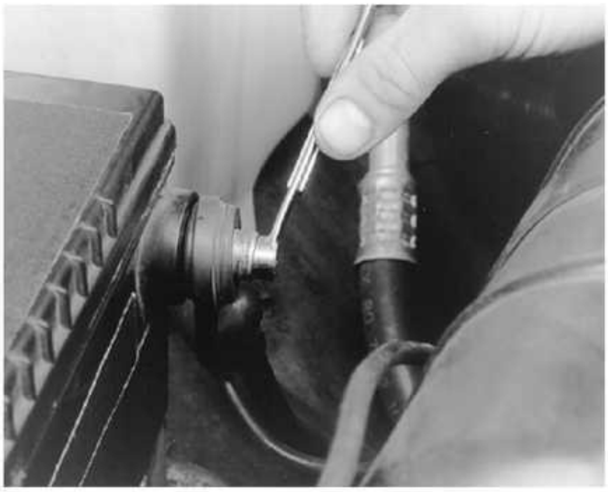
CABLES

Once a year (or as necessary), the battery terminals and the cable clamps should be cleaned. Loosen the clamps and remove the cables, negative cable first. On batteries with posts on top, the use of a puller specially made for this purpose is recommended. These are inexpensive and available in most auto parts stores. Side terminal battery cables are secured with a small bolt.

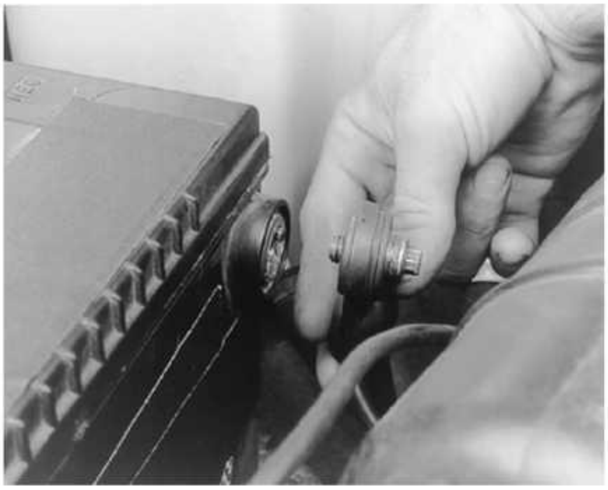
Clean the cable clamps and the battery terminal with a wire brush, until all corrosion, grease, etc., is removed and the metal is shiny. It is especially important to clean the inside of the clamp thoroughly (an old knife is useful here), since a small deposit of foreign material or oxidation there will prevent a sound electrical connection and inhibit either starting or charging. Special tools are available for cleaning these parts, one type for conventional top post batteries and another type for side terminal batteries. It is also a good idea to apply some dielectric grease to the terminal, as this will aid in the prevention of corrosion.

After the clamps and terminals are clean, reinstall the cables, negative cable last; DO NOT hammer the clamps onto battery posts. Tighten the clamps securely, but do not distort them. Give the clamps and terminals a thin external coating of grease after installation, to retard corrosion.

Check the cables at the same time that the terminals are cleaned. If the cable insulation is cracked or broken, or if the ends are frayed, the cable should be replaced with a new cable of the same length and gauge.



Loosen the battery cable retaining nut...



... then disconnect the cable from the battery

A wire brush may be used to clean any corrosion or foreign material from the cable

The wire brush can also be used to remove any corrosion or dirt from the battery terminal

The battery terminal can also be cleaned using a solution of baking soda and water

Before connecting the cables, it's a good idea to coat the terminals with a small amount of dielectric grease

CHARGING

The chemical reaction which takes place in all batteries generates explosivehydrogen gas. A spark can cause the battery to explode and splash acid. Toavoid serious personal injury, be sure there is proper ventilation and takeappropriate fire safety precautions when connecting, disconnecting, or charginga battery and when using jumper cables.

A battery should be charged at a slow rate to keep the plates inside from getting too hot. However, if some maintenance-free batteries are allowed to discharge until they are almost "dead," they may have to be charged at a high rate to bring them back to "life." Always follow the charger manufacturer's instructions on charging the battery.

REPLACEMENT

When it becomes necessary to replace the battery, select one with an amperage rating equal to or greater than the battery originally installed. Deterioration and just plain aging of the battery cables, starter motor, and associated wires makes the battery's job harder in successive years. The slow increase in electrical resistance over time makes it prudent to install a new battery with a greater capacity than the old.

Belts

ROUTING

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Click to Enlarge

Serpentine drive belt routing-3.0L (OHV) engines

Click on icon to view fullsize printable image.

Click to Enlarge

Serpentine drive belt routing-3.0L (DOHC) engines

Click on icon to view fullsize printable image.

Click to Enlarge

Serpentine drive belt routing-3.4L (DOHC) engines

Click on icon to view fullsize printable image.

Click to Enlarge

Water pump drive belt routing-3.4L (DOHC) engines

INSPECTION

Inspect the belts for signs of excessive glazing or cracking. A glazed belt will be perfectly smooth from slippage, while a good belt will have a slight texture of fabric visible. Cracks will usually start at the inner edge of the belt and run outward. All worn or damaged drive belts should be replaced immediately. It is best to replace all drive belts at one time, as a preventive maintenance measure, during this service operation.

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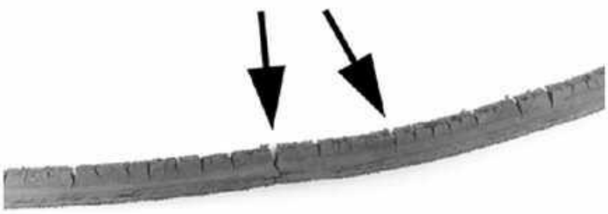
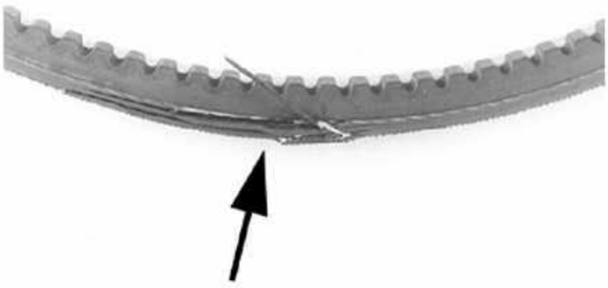
There are typically 3 types of accessory drive belts found on vehicles today

An example of a healthy drive belt



Deep cracks in this belt will cause flex, building up heat that will eventually lead to belt failure



The cover of this belt is worn, exposing the critical reinforcing cords to excessive wear

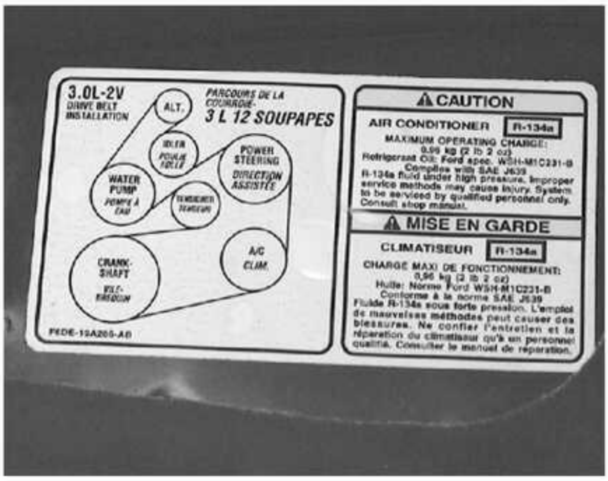
Installing too wide a belt can result in serious belt wear and/or breakage

Adjustment

The drive belt tension is maintained by an automatic belt tensioner and does not require adjustment.

REMOVAL & INSTALLATION

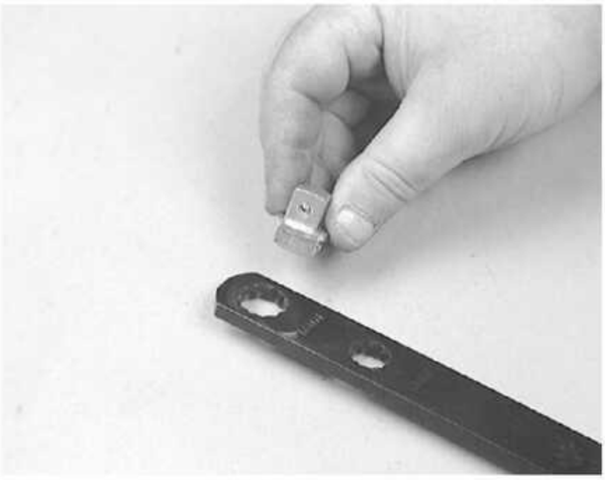
When installing the drive belt on the pulleys, make sure all theV-grooves make proper contact with the pulleys.



This label, usually affixed in the engine compartment, will give a diagram of the belt routing

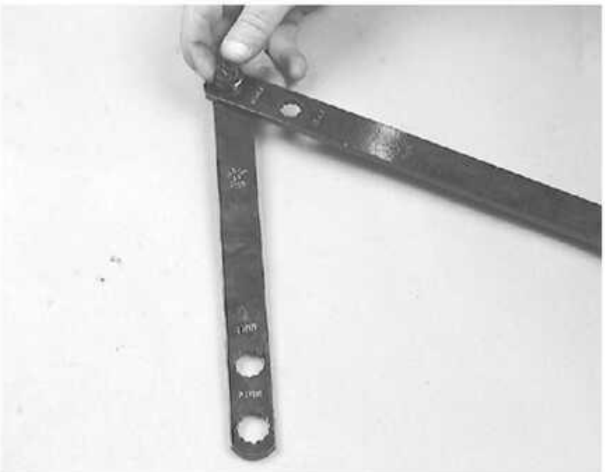
A very useful tool kit is available to use for releasing the spring loaded belt tensioner

Place the proper size socket into the release bar



Some vehicles use a 3/8 or 1/2 drive opening on the tensioner

An extension is available, if needed, to avoid components obstructing the path to the tensioner



Just place the extension on the end of the release bar and tighten the retaining bolt

Except 3.4L (DOHC) Models

Rotate the belt tensioner and...

... remove the belt from around one of the pulleys to remove the belt

Use caution when removing or installing the belt and make sure the tool doesnot slip from the drive belt tensioner or personal injury or damage to the belttensioner and the belt may occur.

1. Attach a 15mm socket or wrench to the bolt attaching the tensioner pulley.
2. On all 3.0L (OHV) engines, rotate the drive belt tensioner clockwise to relieve belt tension and slide the belt off the pulleys.
3. On 3.0L (DOHC) engines, rotate the tensioner counterclockwise to relieve belt tension and slide the belt off the pulleys.

To install:

4. Install the drive belt on all the pulleys except the tensioner pulley.
5. Rotate the belt tensioner as outlined in the removal procedure to relieve belt tension and install the belt onto the tensioner pulley. Make sure the V-grooves make proper contact with the pulleys. Make sure the spring keeper releases or improper belt tension will occur.

3.4L (DOHC) Models

SERPENTINE DRIVE BELT

1. Raise the front of the vehicle and support it with jack stands.

Use caution when removing or installing the belt and make sure the tool doesnot slip from the drive belt tensioner or personal injury or damage to the belttensioner and the belt may occur.

2. Attach a 3/8 inch ratchet on the tensioner lifting lug and rotate the belt tensioner counterclockwise (upwards) to relieve belt tension and slide the belt off the pulleys.

To install:

3. Install the drive belt on all the pulleys except the tensioner pulley.
4. Rotate the belt tensioner as outlined in the removal procedure to relieve belt tension and install the belt onto the tensioner pulley. Make sure the V-grooves make proper contact with the pulleys. Make sure the sponge keeper releases or improper belt tension will occur.

WATER PUMP DRIVE BELT

If removal of the water pump drive pulley is required, refer to

Section 3 of this manual for the procedure.

1. Rotate the drive belt tensioner clockwise by hand and remove the belt from the belt tensioner.
2. Remove the belt from the water pump and crankshaft pulleys.

To install:

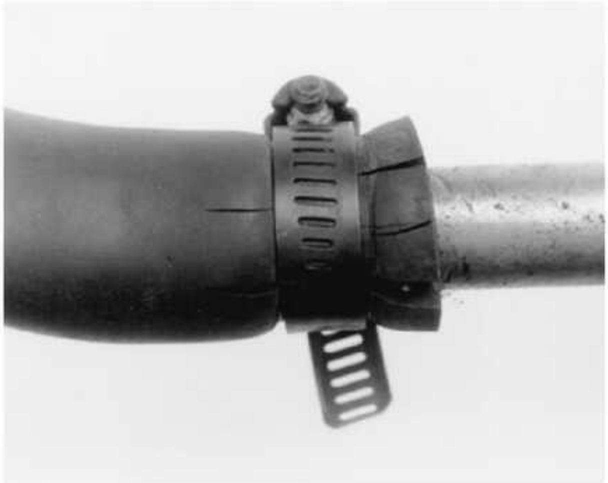
3. Position the belt onto the water pump and crankshaft pulleys.
4. Rotate the drive belt tensioner clockwise by hand and install the belt over the top of the belt tensioner. Make sure the pulley V-grooves make proper contact with the belt.

Hoses

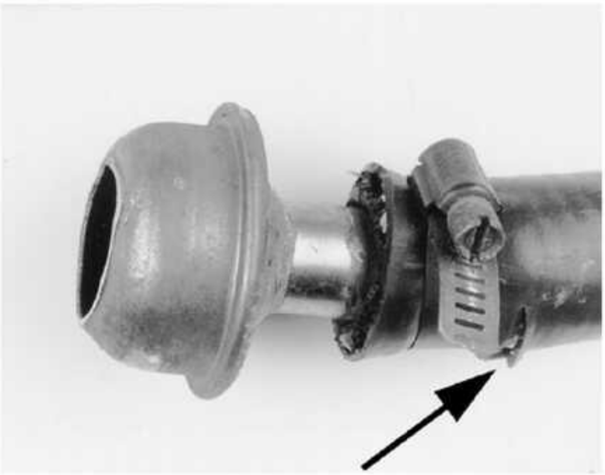
INSPECTION

Upper and lower radiator hoses, along with the heater hoses, should be checked for deterioration, leaks and loose hose clamps at least every 15,000 miles (24,000 km). It is also wise to check the hoses periodically in early spring and at the beginning of the fall or winter when you are performing other maintenance. A quick visual inspection could discover a weakened hose which might have left you stranded if it had remained unrepaired.

Whenever you are checking the hoses, make sure the engine and cooling system are cold. Visually inspect for cracking, rotting or collapsed hoses, and replace as necessary. Run your hand along the length of the hose. If a weak or swollen spot is noted when squeezing the hose wall, the hose should be replaced.



The cracks developing along this hose are a result of age-related hardening



A hose clamp that is too tight can cause older hoses to separate and tear on either side of the clamp

A soft spongy hose (identifiable by the swollen section) will eventually burst and should be replaced

Hoses are likely to deteriorate from the inside if the cooling system is not periodically flushed

REMOVAL & INSTALLATION

1. Remove the radiator pressure cap.

NEVER remove the pressure cap while the engine is running, or personal injury from scalding hot coolant or steam may result. If possible, wait untilthe engine has cooled to remove the pressure cap. If this is not possible, wrapa thick cloth around the pressure cap and turn it slowly to the stop. Step backwhile the pressure is released from the cooling system. When you are sure allthe pressure has been released, use the cloth to turn and remove the cap.

2. Position a clean container under the radiator and/or engine draincock or plug, then open the drain and allow the cooling system to drain to an appropriate level. For some upper hoses, only a little coolant must be drained. To remove hoses positioned lower on the engine, such as a lower radiator hose, the entire cooling system must be emptied.

When draining coolant, keep in mind that cats and dogs are attracted by thetaste of ethylene glycol antifreeze, and are quite likely to drink any that isleft in an uncovered container or in puddles on the ground. This will provefatal in sufficient quantity. Always drain coolant into a sealable container. if necessary, clean coolant may be reused unless it is contaminated or more thantwo years old.

3. Loosen the hose clamps at each end of the hose requiring replacement. Clamps are usually either of the spring tension type (which require pliers to squeeze the tabs and loosen) or of the screw tension type (which require screw or hex drivers to loosen). Pull the clamps back on the hose away from the connection.
4. Twist, pull and slide the hose off the fitting, taking care not to damage the neck of the component from which the hose is being removed.

If the hose is stuck at the connection, do NOT try to insert ascrewdriver or other sharp tool under the hose end in an effort to free it, asthe connection and/or hose may become damaged. Heater connections especiallymay be easily damaged by such a procedure. If the hose is to be replaced, use asingle-edged razor blade to make a slice along the portion of the hose which isstuck on the connection, perpendicular to the end of the hose. Do NOT cut so deepas to damage the connection. The hose can then be peeled from the connectionand discarded.

5. Clean both hose mounting connections. Inspect the condition of the hose clamps and replace them, if necessary.

To install:

6. Dip the ends of the new hose into clean engine coolant to ease installation.
7. Slide the clamps over the replacement hose, then slide the hose ends over the connections and into position.
8. Position and secure the clamps at least 1/4 in. (6.35mm) from the ends of the hose. Make sure they are located beyond the raised bead of the connector.
9. Close the radiator or engine drains and properly refill the cooling system with the clean drained engine coolant or a suitable mixture of ethylene glycol coolant and water.
10. If available, install a pressure tester and check for leaks. If a pressure tester is not available, run the engine until normal operating temperature is reached (allowing the system to naturally pressurize), then check for leaks.

If you are checking for leaks with the system at normal operatingtemperature BE EXTREMELY CAREFUL not to touch any moving or hot engine parts.Once temperature has been reached, shut the engine OFF, and check for leaksaround the hose fittings and connections.

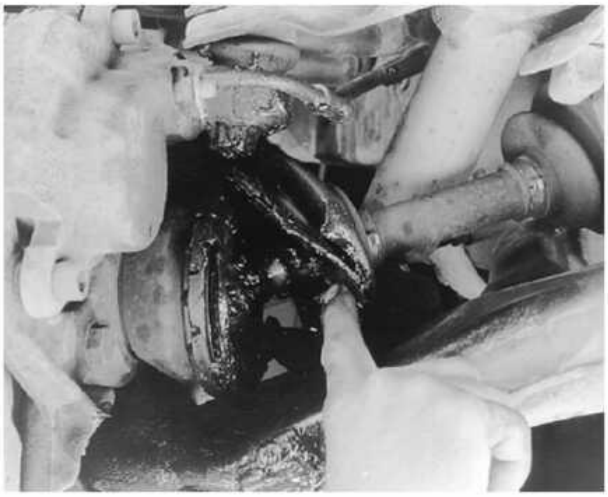
CV-Boots

INSPECTION

The CV (Constant Velocity) boots should be checked for damage each time the oil is changed and any other time the vehicle is raised for service. These boots keep water, grime, dirt and other damaging matter from entering the CV-joints. Any of these could cause early CV-joint failure which can be expensive to repair. Heavy grease thrown around the inside of the front wheel(s) and on the brake caliper/drum can be an indication of a torn boot. Thoroughly check the boots for missing clamps and tears. If the boot is damaged, it should be replaced immediately. Please refer to

Section 7 for procedures.

CV-boots must be inspected periodically for damage



A torn boot should be replaced immediately

Spark Plugs

A typical spark plug consists of a metal shell surrounding a ceramic insulator. A metal electrode extends downward through the center of the insulator and protrudes a small distance. Located at the end of the plug and attached to the side of the outer metal shell is the side electrode. The side electrode bends in at a 90° angle so that its tip is just past and parallel to the tip of the center electrode. The distance between these two electrodes (measured in thousandths of an inch or hundredths of a millimeter) is called the spark plug gap.

The spark plug does not produce a spark, but instead provides a gap across which the current can arc. The coil produces anywhere from 20,000 to 50,000 volts (depending on the type and application) which travels through the wires to the spark plugs. The current passes along the center electrode and jumps the gap to the side electrode, and in doing so, ignites the air/fuel mixture in the combustion chamber.

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Cross-section of a spark plug

SPARK PLUG HEAT RANGE

Spark plug heat range is the ability of the plug to dissipate heat. The longer the insulator (or the farther it extends into the engine), the hotter the plug will operate; the shorter the insulator (the closer the electrode is to the block's cooling passages) the cooler it will operate. A plug that absorbs little heat and remains too cool will quickly accumulate deposits of oil and carbon since it is not hot enough to burn them off. This leads to plug fouling and consequently to misfiring. A plug that absorbs too much heat will have no deposits but, due to the excessive heat, the electrodes will burn away quickly and might possibly lead to preignition or other ignition problems. Preignition takes place when plug tips get so hot that they glow sufficiently to ignite the air/fuel mixture before the actual spark occurs. This early ignition will usually cause a pinging during low speeds and heavy loads.

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Spark plug heat range

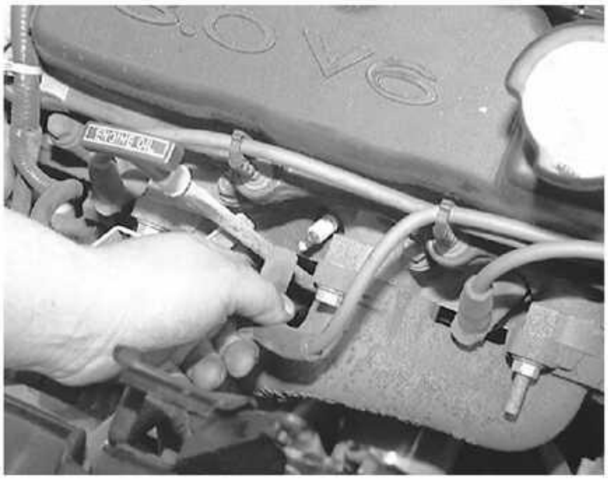
The general rule of thumb for choosing the correct heat range when picking a spark plug is: if most of your driving is long distance, high speed travel, use a colder plug; if most of your driving is stop and go, use a hotter plug. Original equipment plugs are generally a good compromise between the 2 styles and most people never have the need to change their plugs from the factory-recommended heat range.

REMOVAL & INSTALLATION

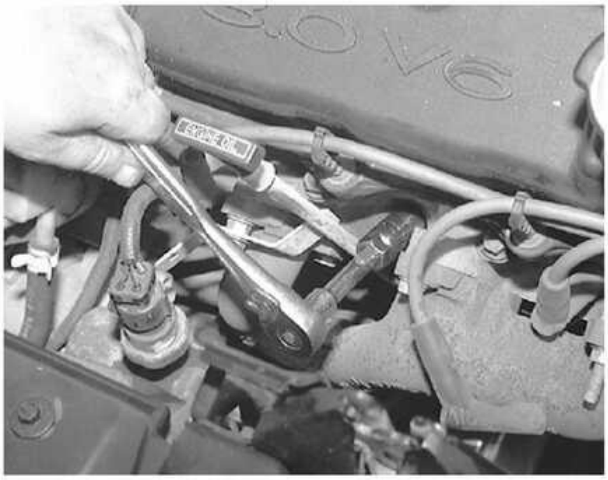
A set of spark plugs usually requires replacement after about 30,000 miles (48,000 km) on Flexible Fuel Vehicles (FFV) and about 100,000 miles (160,000 Km) on all gasoline engine models, depending on your style of driving. In normal operation plug gap increases about 0.001 in. (0.025mm) for every 2500 miles (4000 km). As the gap increases, the plug's voltage requirement also increases. It requires a greater voltage to jump the wider gap and about two to three times as much voltage to fire the plug at high speeds than at idle. The improved air/fuel ratio control of modern fuel injection combined with the higher voltage output of modern ignition systems will often allow an engine to run significantly longer on a set of standard spark plugs, but keep in mind that efficiency will drop as the gap widens (along with fuel economy and power).

When you're removing spark plugs, work on one at a time. Don't start by removing the plug wires all at once, because, unless you number them, they may become mixed up. Take a minute before you begin and number the wires with tape.

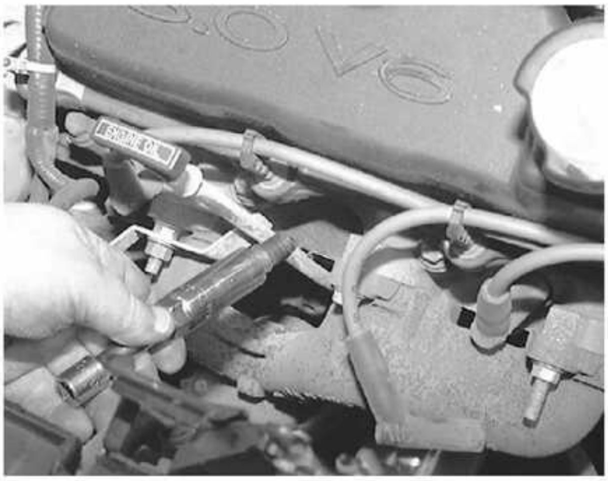
3.0L Engines



Carefully twist the spark plug wire to remove the wire from the spark plug



Use a spark plug socket and the proper drive tools to remove the plug from the engine. The spark plug on the 3.0L OHV engine requires a 5/8 socket



After sufficiently loosened, remove the plug from the engine by hand

Apply a small quality of anti-seize to the threads of the spark plug before installing it into the engine

On 3.0L OHV engines, if a spark plug is removed for inspection, it must be reinstalled in the same cylinder. Cylinders 1, 2 and 3 have a PG suffix and cylinders 4, 5 and 6 have a P suffix. If a spark plug has to be replaced, use only plugs with the service part number suffix letter PP as shown on the engine decal.

1. Disconnect the negative battery cable, and if the vehicle has been run recently, allow the engine to thoroughly cool.
2. Remove the right hand side of the cowl vent screen and the right hand cowl top extension.
3. Unplug the engine control sensor wiring from the ignition coil, then unfasten the four ignition coil hold-down screws and remove the coil so that access to the spark plugs located at cylinder 1, 2 and 3 is possible.
4. Unplug the electrical connection from the Intake Manifold Runner Control (IMRC) actuator, unfasten the actuator retaining screws and lay the actuator to one side so that access to the sparks plugs at cylinders 4, 5 and 6 is possible.
5. Carefully twist the spark plug wire boot to loosen it, then pull upward and remove the boot from the plug. Be sure to pull on the boot and not on the wire, otherwise the connector located inside the boot may become separated.
6. Loosen the spark plugs 1/4 turn, then using compressed air, blow any water or debris from the spark plug well to assure that no harmful contaminants are allowed to enter the combustion chamber when the spark plug is removed. If compressed air is not available, use a rag or a brush to clean the area.

Remove the spark plugs when the engine is cold, if possible, to preventdamage to the threads. If removal of the plugs is difficult, apply a few dropsof penetrating oil or silicone spray to the area around the base of the plug,and allow it a few minutes to work.

7. Using a spark plug socket that is equipped with a rubber insert to properly hold the plug, turn the spark plug counterclockwise to loosen and remove the spark plug from the bore.

Be sure not to use a flexible extension on the socket. Use of a flexibleextension may allow a shear force to be applied to the plug. A shear forcecould break the plug off in the cylinder head, leading to costly andfrustrating repairs.

To install:

8. Inspect the spark plug boot for tears or damage. If a damaged boot is found, the spark plug wire must be replaced.
9. Using a wire feeler gauge, check and adjust the spark plug gap. When using a gauge, the proper size should pass between the electrodes with a slight drag. The next larger size should not be able to pass while the next smaller size should pass freely.
10. Carefully thread the plug into the bore by hand. If resistance is felt before the plug is almost completely threaded, back the plug out and begin threading again. In small, hard to reach areas, an old spark plug wire and boot could be used as a threading tool. The boot will hold the plug while you twist the end of the wire and the wire is supple enough to twist before it would allow the plug to crossthread.

Do not use the spark plug socket to thread the plugs. Always carefullythread the plug by hand or using an old plug wire to prevent the possibility ofcrossthreading and damaging the cylinder head bore.

11. Carefully tighten the spark plug to 80-177 inch lbs. (9-20 Nm).
12. Apply a small amount of silicone dielectric compound to the end of the spark plug lead or inside the spark plug boot to prevent sticking, then install the boot to the spark plug and push until it clicks into place. The click may be felt or heard, then gently pull back on the boot to assure proper contact.
13. Place the IMRC actuator into position and install its retaining screws, then attach the electrical connection to the actuator.
14. Place the ignition coil in position and install its retaining screws, then attach the engine control sensor wiring to the ignition coil.
15. Install the right hand cowl top extension and the cowl vent screen.
16. Connect the negative battery cable.

3.4L Engines

Click on icon to view fullsize printable image.

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Exploded view of the appearance cover and Intake Manifold Runner Control (IMRC) deactivation motor-3.4L engines

1. Loosen the spark plugs 1/4 turn, then using compressed air, blow any water or debris from the spark plug well to assure that no harmful contaminants are allowed to enter the combustion chamber when the spark plug is removed. If compressed air is not available, use a rag or a brush to clean the area.

Remove the spark plugs when the engine is cold, if possible, to preventdamage to the threads. If removal of the plugs is difficult, apply a few dropsof penetrating oil or silicone spray to the area around the base of the plug,and allow it a few minutes to work.

5. Using a spark plug socket that is equipped with a rubber insert to properly hold the plug, turn the spark plug counterclockwise to loosen and remove the spark plug from the bore.

Be sure not to use a flexible extension on the socket. Use of a flexibleextension may allow a shear force to be applied to the plug. A shear forcecould break the plug off in the cylinder head, leading to costly andfrustrating repairs.

To install:

6. Using a wire feeler gauge, check and adjust the spark plug gap. When using a gauge, the proper size should pass between the electrodes with a slight drag. The next larger size should not be able to pass while the next smaller size should pass freely.
7. Carefully thread the plug into the bore by hand. If resistance is felt before the plug is almost completely threaded, back the plug out and begin threading again. In small, hard to reach areas, an old spark plug wire and boot could be used as a threading tool. The boot will hold the plug while you twist the end of the wire and the wire is supple enough to twist before it would allow the plug to crossthread.

Do not use the spark plug socket to thread the plugs. Always carefullythread the plug by hand or using an old plug wire to prevent the possibility ofcrossthreading and damaging the cylinder head bore.

8. Connect the negative battery cable.

INSPECTION & GAPPING

Check the plugs for deposits and wear. If they are not going to be replaced, clean the plugs thoroughly. Remember that any kind of deposit will decrease the efficiency of the plug. Plugs can be cleaned on a spark plug cleaning machine, which can sometimes be found in service stations, or you can do an acceptable job of cleaning with a stiff brush. If the plugs are cleaned, the electrodes must be filed flat. Use an ignition points file, not an emery board or the like, which will leave deposits. The electrodes must be filed perfectly flat with sharp edges; rounded edges reduce the spark plug voltage by as much as 50%.

Check spark plug gap before installation. The ground electrode (the L-shaped one connected to the body of the plug) must be parallel to the center electrode and the specified size wire gauge (please refer to the Tune-Up Specifications chart for details) must pass between the electrodes with a slight drag.

NEVER adjust the gap on a used platinum type spark plug.

Always check the gap on new plugs as they are not always set correctly at the factory. Do not use a flat feeler gauge when measuring the gap on a used plug, because the reading may be inaccurate. A round-wire type gapping tool is the best way to check the gap. The correct gauge should pass through the electrode gap with a slight drag. If you're in doubt, try one size smaller and one larger. The smaller gauge should go through easily, while the larger one shouldn't go through at all. Wire gapping tools usually have a bending tool attached. Use that to adjust the side electrode until the proper distance is obtained. Absolutely never attempt to bend the center electrode. Also, be careful not to bend the side electrode too far or too often as it may weaken and break off within the engine, requiring removal of the cylinder head to retrieve it.

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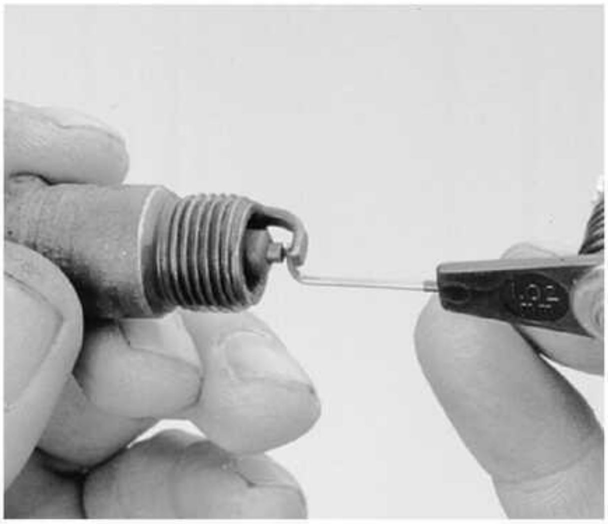
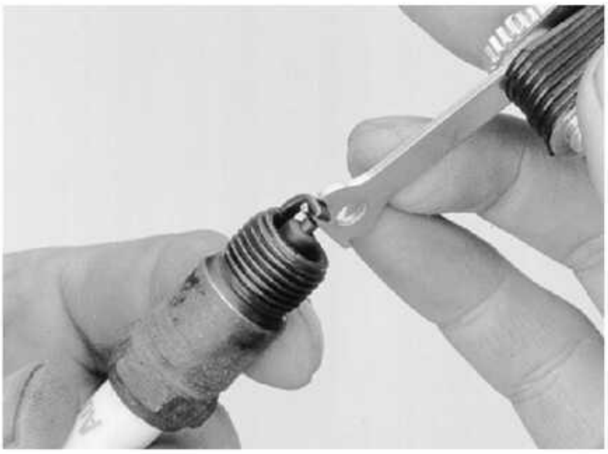
Inspect the spark plug to determine engine running conditions

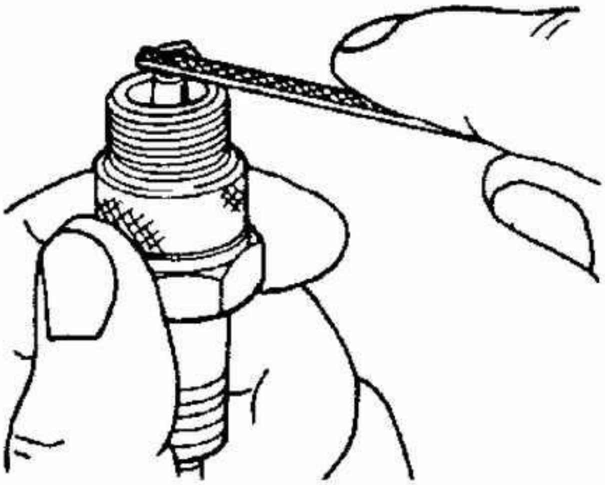
A variety of tools and gauges are needed for spark plug service



Checking the spark plug gap with a wire feeler gauge



Adjusting the spark plug gap



If the standard plug is in good condition, the electrode may be filed flat-WARNING: do not file platinum plugs

Spark Plug Wires

TESTING

Checking individual plug wire resistance with a digital ohmmeter

At every tune-up/inspection, visually check the spark plug cables for burns cuts, or breaks in the insulation. Check the boots and the nipples on the coil. Replace any damaged wiring.

Every 50,000 miles (80,000 km) or 60 months, the resistance of the wires should be checked with an ohmmeter. Wires with excessive resistance will cause misfiring, and may make the engine difficult to start in damp weather.

To check resistance, an ohmmeter should be used on each wire to test resistance between the end connectors. Remove and install/replace the wires in order, one-by-one.

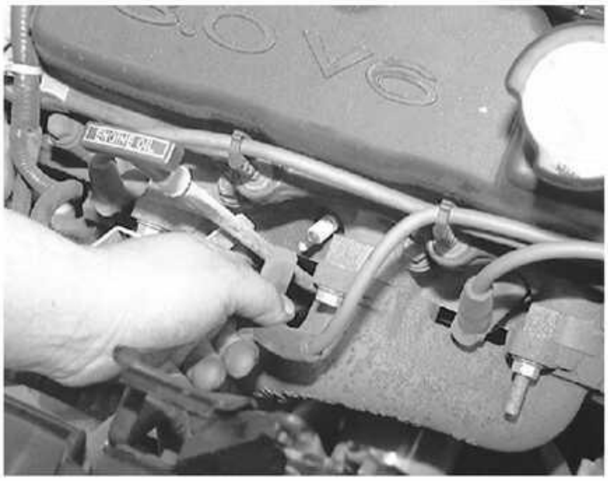
Resistance on these wires must not exceed 7,000 ohms per foot. To properly measure this, remove the wires from the plugs and coil. Do not pierce any ignition wire for any reason. Measure only from the two ends.

Whenever the high tension wires are removed from the plugs or coil,silicone grease must be applied to the boot before reconnection. Coat theentire interior surface with Ford silicone grease D7AZ-19A331-A or itsequivalent.

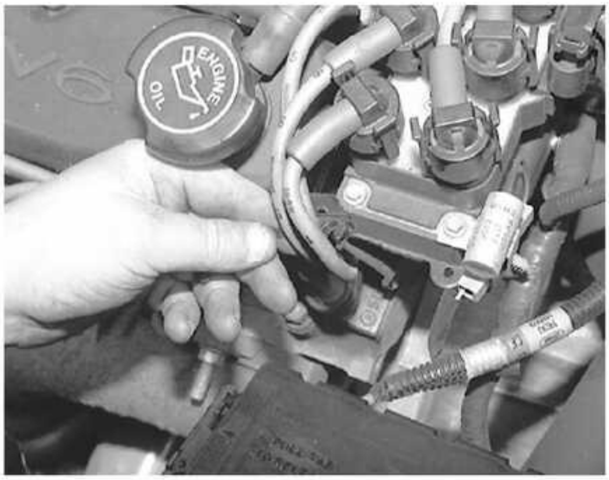
REMOVAL & INSTALLATION

When you're removing spark plug wires, work on one at a time. Don't start by removing the plug wires all at once, because, unless you number them, they may become mixed up. Take a minute before you begin and number the wires with tape.

1. Disconnect the negative battery cable, and if the vehicle has been run recently, allow the engine to thoroughly cool.
2. Using spark plug wire removal tool T74P-6666-A or its equivalent, grasp and carefully twist the spark plug wire boot to loosen it, then pull upward and remove the boot from the plug. Be sure to pull on the boot and not on the wire, otherwise the connector located inside the boot may become separated.
3. Disconnect the spark plug wire from the coil by squeezing the locking tabs and using a twisting motion, gently pull the wire from the coil.
4. If necessary, remove the spark plug wire separator from the throttle body stud bolts.
5. Open the spark plug wire separators and remove the wires.



Carefully twist the spark plug wire boot to remove the wire from the spark plug



Remove the spark plug wire separator/retainers

Squeeze the retaining tabs to remove the plug wires from the coil pack

To install:

6. Apply a small amount of silicone dielectric compound such as Ford silicone grease D7AZ-19A331-A or its equivalent to the end of the spark plug lead or inside the spark plug boot to prevent sticking, then install the boot to the spark plug and push until it clicks into place. The click may be felt or heard, then gently pull back on the boot to assure proper contact.
7. Connect the wires to the proper coil pack tower and make sure the locking tabs engage.
8. Route the wires through the wire separators and close the separators.
9. If removed, attach the spark wire separator to the throttle body stud bolts. Tighten the nuts to 45-61 inch lbs. (7-7 Nm).
10. Connect the negative battery cable.

Ignition Timing

GENERAL INFORMATION

Ignition timing is the measurement, in degrees of crankshaft rotation, of the point at which the spark plugs fire in each of the cylinders. It is measured in degrees before or after Top Dead Center (TDC) of the compression stroke.

Ideally, the air/fuel mixture in the cylinder will be ignited by the spark plug just as the piston passes TDC of the compression stroke. If this happens, the piston will be beginning the power stroke just as the compressed and ignited air/fuel mixture starts to expand. The expansion of the air/fuel mixture then forces the piston down on the power stroke and turns the crankshaft.

Because it takes a fraction of a second for the spark plug to ignite the mixture in the cylinder, the spark plug must fire a little before the piston reaches TDC. Otherwise, the mixture will not be completely ignited as the piston passes TDC and the full power of the explosion will not be used by the engine.

The timing measurement is given in degrees of crankshaft rotation before the piston reaches TDC (BTDC, or Before Top Dead Center). If the setting for the ignition timing is 10°BTDC, each spark plug must fire 10° before each piston reaches TDC. This only holds true, however, when the engine is at idle speed.

As the engine speed increases, the piston goes faster. The spark plugs have to ignite the fuel even sooner if it is to be completely ignited when the piston reaches TDC.

If the ignition is set too far advanced (BTDC), the ignition and expansion of the fuel in the cylinder will occur too soon and tend to force the piston down while it is still traveling up. This causes engine ping. If the ignition spark is set too far retarded after TDC (ATDC), the piston will have already passed TDC and started on its way down when the fuel is ignited. This will cause the piston to be forced down for only a portion of its travel. This will result in poor engine performance and lack of power.

Timing marks consist of `zero' marks or scales which can be found on the rim of the crankshaft pulley and/or on the timing cover. The mark(s) on the pulley correspond(s) to the position of the piston in the number 1 cylinder. A stroboscopic (dynamic) timing light is attached to the circuit of the No. 1 cylinder spark plug.

Every time the spark plug fires, the timing light flashes. By aiming the timing light at the timing marks while the engine is running, the exact position of the piston within the cylinder can be easily read since the stroboscopic flash makes the pulley appear to be standing still. Proper timing is indicated when the mark and scale are in proper alignment.

Because these vehicles utilize high voltage, electronic ignition systems, only a timing light with an inductive pickup should be used. The pickup simply clamps to the No. 1 spark plug wire, eliminating the adapter. It is not susceptible to cross-firing or false triggering, which may occur with a conventional light, due to the greater voltages produced by electronic ignition.

ADJUSTMENT

Ignition timing on the vehicles covered in this manual is controlled by the Powertrain Control Module (PCM). No adjustment is necessary or possible.

Valve Lash

ADJUSTMENT

3.0L Engines

The 3.0L engines used in these vehicles utilize hydraulic lifters. No periodic adjustment is necessary or possible.

3.4L Engines

The valve lash should be checked and if necessary, adjusted every 100,000 miles (160,000 Km).

Tappet compressor tool T89P-6500-A and tappet holder tool T96P-6500-AH or their equivalents are required to perform this procedure.

1. Disconnect the negative battery cable.
2. Remove the valve cover. Refer to Section 3 of this manual for the valve cover removal procedure.

Camshaft lobes must be directed 90° or more away from the valve tappet.

3. Insert a feeler gauge under a camshaft lobe between the lobe and a tappet at a 90° degree angle to the camshaft. The intake valve clearance (cold) should be 0.006-0.010 inch (0.15-0.25mm) and the exhaust valve clearance (cold) should be 0.010-0.014 inch (0.25-0.35mm).
4. If the clearance has to be adjusted, insert tappet compressor tool T89P-6500-A or its equivalent under the camshaft next to the lobe and rotate it down to depress the bucket valve tappet.
5. Insert tappet holder tool T96P-6500-AH or its equivalent and remove the compressor tool.

Eye protection should be worn when using compressed air. Failure to wear theeye protection could result in personal injury.

6. Direct a jet of compressed air towards the hole in the face of the valve adjusting spacer to lift the spacer off the tappet.
7. Determine the size of the adjusting spacer by the numbers on the bottom face of the spacer or by measuring the spacer with a micrometer.
8. If the spacer being used will not permit the specified clearance, discard the old spacer and replace it with a spacer that will permit the specified clearance. Make sure to install the spacer with the numbers facing down and that it is properly seated.
9. Insert the tappet compressor tool and release the tappet holder.
10. Repeat the procedure at each valve by rotating the engine crankshaft to position the valve as necessary.
11. After all the valve clearances have been checked and/or adjusted, inspect all the valve adjusting spacers to make sure they are fully seated in their bucket valve tappets.
12. Install the valve covers.
13. Connect the negative battery cable. Refer to Section 3 of this manual for the valve cover installation procedure.

Click on icon to view fullsize printable image. Click to Enlarge *Insert a feeler gauge under a camshaft lobe between the lobe and a tappet at a 90° degree angle to the camshaft and measure the valve clearance*
Click on icon to view fullsize printable image. Click to Enlarge *Insert tappet compressor tool T89P-6500-A or its equivalent under the camshaft next to the lobe and rotate it down to depress the bucket valve tappet*
Click on icon to view fullsize printable image. Click to Enlarge *Insert tappet holder tool T96P-6500-AH or its equivalent and remove the compressor tool*
Click on icon to view fullsize printable image. Click to Enlarge *Make sure to wear eye protection , then direct a jet of compressed air towards the hole in the face of the valve adjusting spacer to lift the spacer off the tappet*

Idle Speed and Mixture Adjustments

ADJUSTMENT

The idle speed and mixture adjustments on the vehicles covered in this manual are controlled by the Powertrain Control Module (PCM). No adjustment is necessary or possible.

Air Conditioning System

SYSTEM SERVICE & REPAIR

It is recommended that the A/C system be serviced by an EPA Section 609certified automotive technician utilizing a refrigerant recovery/recyclingmachine.

The do-it-yourselfer should not service his/her own vehicle's A/C system for many reasons, including legal concerns, personal injury, environmental damage and cost. The following are some of the reasons why you may decide not to service your own vehicle's A/C system.

According to the U.S. Clean Air Act, it is a federal crime to service or repair (involving the refrigerant) a Motor Vehicle Air Conditioning (MVAC) system for money without being EPA certified. It is also illegal to vent R-134a refrigerant into the atmosphere.

State and/or local laws may be more strict than the federal regulations, so be sure to check with your state and/or local authorities for further information. For further federal information on the legality of servicing your A/C system, call the EPA Stratospheric Ozone Hotline.

Federal law dictates that a fine of up to $25,000 may be levied on peopleconvicted of venting refrigerant into the atmosphere. Additionally, the EPA maypay up to $10,000 for information or services leading to a criminal convictionof the violation of these laws.

When servicing an A/C system you run the risk of handling or coming in contact with refrigerant, which may result in skin or eye irritation or frostbite. Although low in toxicity (due to chemical stability), inhalation of concentrated refrigerant fumes is dangerous and can result in death; cases of fatal cardiac arrhythmia have been reported in people accidentally subjected to high levels of refrigerant. Some early symptoms include loss of concentration and drowsiness.

Also, refrigerants can decompose at high temperatures (near gas heaters or open flame), which may result in formation of hydrofluoric acid, hydrochloric acid and phosgene (a fatal nerve gas).

R-134a refrigerant is a greenhouse gas which, if allowed to vent into the atmosphere, will contribute to global warming (the Greenhouse Effect).

It is usually more economically feasible to have a certified MVAC automotive technician perform A/C system service to your vehicle. While it is illegal to service an A/C system without the proper equipment, the home mechanic would also have to purchase an expensive refrigerant recovery/recycling machine to service his/her own vehicle.

PREVENTIVE MAINTENANCE

Although the A/C system should not be serviced by the do-it-yourselfer, preventive maintenance can be practiced and A/C system inspections can be performed to help maintain the efficiency of the vehicle's A/C system. For preventive maintenance, perform the following:

- The easiest and most important preventive maintenance for your A/C system is to be sure that it is used on a regular basis. Running the system for five minutes each month (no matter what the season) will help ensure that the seals and all internal components remain lubricated.

Some newer vehicles automatically operate the A/C system compressorwhenever the windshield defroster is activated. When running, the compressorlubricates the A/C system components; therefore, the A/C system would not needto be operated each month.

- In order to prevent heater core freeze-up during A/C operation, it is necessary to maintain a proper antifreeze protection. Use a hand-held coolant tester (hydrometer) to periodically check the condition of the antifreeze in your engine's cooling system.

Antifreeze should not be used longer than the manufacturer specifies.

- For efficient operation of an air conditioned vehicle's cooling system, the radiator cap should have a holding pressure which meets manufacturer's specifications. A cap which fails to hold these pressures should be replaced.
- Any obstruction of or damage to the condenser configuration will restrict air flow which is essential to its efficient operation. It is, therefore, a good rule to keep this unit clean and in proper physical shape.

Bug screens which are mounted in front of the condenser (unless they areoriginal equipment) are regarded as obstructions.

- The condensation drain tube expels any water, which accumulates on the bottom of the evaporator housing, into the engine compartment. If this tube is obstructed, the air conditioning performance can be restricted and condensation buildup can spill over onto the vehicle's floor.

SYSTEM INSPECTION

Although the A/C system should not be serviced by the do-it-yourselfer, preventive maintenance can be practiced and A/C system inspections can be performed to help maintain the efficiency of the vehicle's A/C system. For A/C system inspection, perform the following:

The easiest and often most important check for the air conditioning system consists of a visual inspection of the system components. Visually inspect the air conditioning system for refrigerant leaks, damaged compressor clutch, abnormal compressor drive belt tension and/or condition, plugged evaporator drain tube, blocked condenser fins, disconnected or broken wires, blown fuses, corroded connections and poor insulation.

A refrigerant leak will usually appear as an oily residue at the leakage point in the system. The oily residue soon picks up dust or dirt particles from the surrounding air and appears greasy. Through time, this will build up and appear to be a heavy dirt-impregnated grease.

For a thorough visual and operational inspection, check the following:

- Check the surface of the radiator and condenser for dirt, leaves or other material which might block air flow.
- Check for kinks in hoses and lines. Check the system for leaks.
- Make sure the drive belt is properly tensioned. When the air conditioning is operating, make sure the drive belt is free of noise or slippage.
- Make sure the blower motor operates at all appropriate positions, then check for distribution of the air from all outlets with the blower on ***HIGH*** or ***MAX***.

Keep in mind that under conditions of high humidity, air discharged fromthe A/C vents may not feel as cold as expected, even if the system is workingproperly. This is because vaporized moisture in humid air retains heat moreeffectively than dry air, thereby making humid air more difficult to cool.

- Make sure the air passage selection lever is operating correctly. Start the engine and warm it to normal operating temperature, then make sure the temperature selection lever is operating correctly.

Windshield Wipers

ELEMENT (REFILL) CARE & REPLACEMENT

For maximum effectiveness and longest element life, the windshield and wiper blades should be kept clean. Dirt, tree sap, road tar and so on will cause streaking, smearing and blade deterioration if left on the glass. It is advisable to wash the windshield carefully with a commercial glass cleaner at least once a month. Wipe off the rubber blades with the wet rag afterwards. Do not attempt to move wipers across the windshield by hand; damage to the motor and drive mechanism will result.

To inspect and/or replace the wiper blade elements, place the wiper switch in the ***LOW*** speed position and the ignition switch in the ***ACC*** position. When the wiper blades are approximately vertical on the windshield, turn the ignition switch to ***OFF***.

Examine the wiper blade elements. If they are found to be cracked, broken or torn, they should be replaced immediately. Replacement intervals will vary with usage, although ozone deterioration usually limits element life to about one year. If the wiper pattern is smeared or streaked, or if the blade chatters across the glass, the elements should be replaced. It is easiest and most sensible to replace the elements in pairs.

If your vehicle is equipped with aftermarket blades, there are several different types of refills and your vehicle might have any kind. Aftermarket blades and arms rarely use the exact same type blade or refill as the original equipment. Here are some typical aftermarket blades; not all may be available for your vehicle:

The Anco® type uses a release button that is pushed down to allow the refill to slide out of the yoke jaws. The new refill slides back into the frame and locks in place.

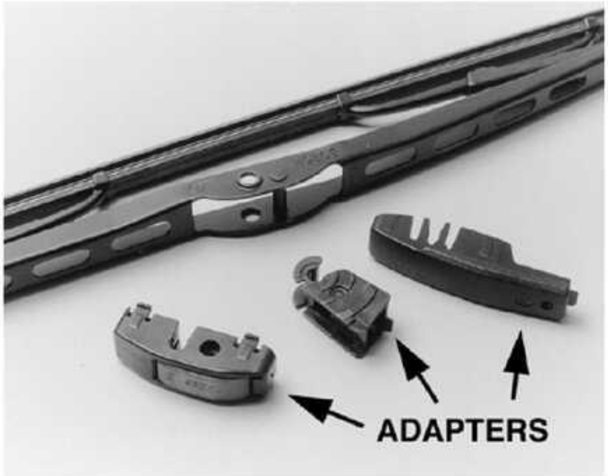
Some Trico® refills are removed by locating where the metal backing strip or the refill is wider. Insert a small screwdriver blade between the frame and metal backing strip. Press down to release the refill from the retaining tab.

Other types of Trico® refills have two metal tabs which are unlocked by squeezing them together. The rubber filler can then be withdrawn from the frame jaws. A new refill is installed by inserting the refill into the front frame jaws and sliding it rearward to engage the remaining frame jaws. There are usually four jaws; be certain when installing that the refill is engaged in all of them. At the end of its travel, the tabs will lock into place on the front jaws of the wiper blade frame.

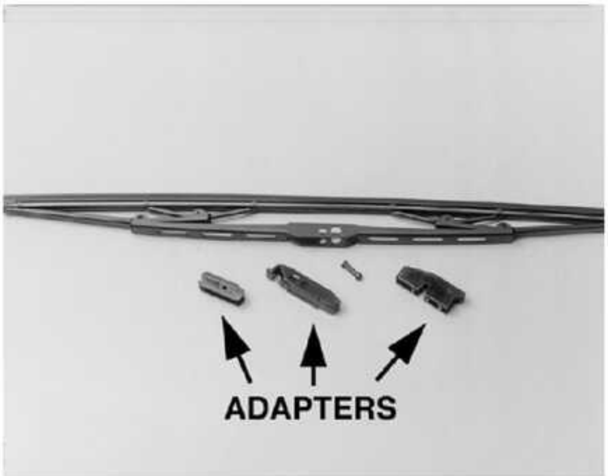
Another type of refill is made from polycarbonate. The refill has a simple locking device at one end which flexes downward out of the groove into which the jaws of the holder fit, allowing easy release. By sliding the new refill through all the jaws and pushing through the slight resistance when it reaches the end of its travel, the refill will lock into position.

To replace the Tridon® refill, it is necessary to remove the wiper blade. This refill has a plastic backing strip with a notch about 1 in. (25mm) from the end. Hold the blade (frame) on a hard surface so that the frame is tightly bowed. Grip the tip of the backing strip and pull up while twisting counterclockwise. The backing strip will snap out of the retaining tab. Do this for the remaining tabs until the refill is free of the blade. The length of these refills is molded into the end and they should be replaced with identical types.

Regardless of the type of refill used, be sure to follow the part manufacturer's instructions closely. Make sure that all of the frame jaws are engaged as the refill is pushed into place and locked. If the metal blade holder and frame are allowed to touch the glass during wiper operation, the glass will be scratched.



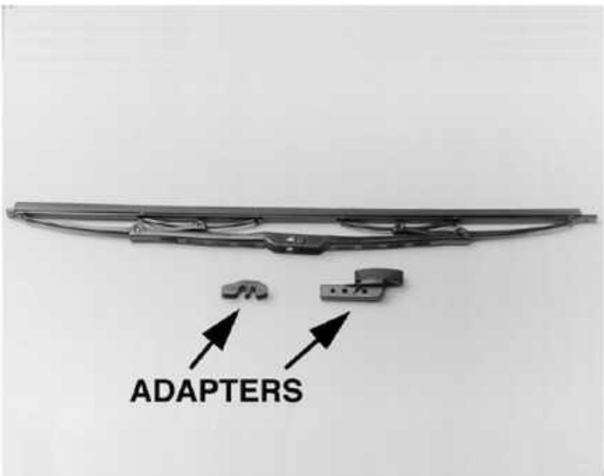
Bosch® wiper blade and fit kit



Lexor® wiper blade and fit kit

Pylon® wiper blade and adapter

Trico® wiper blade and fit kit

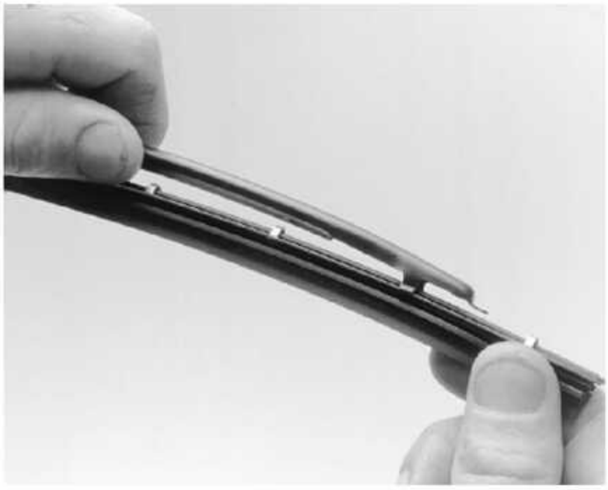


Tripledge® wiper blade and fit kit

To remove and install a Lexor® wiper blade refill, slip out the old insert and slide in a new one

On Pylon® inserts, the clip at the end has to be removed prior to sliding the insert off

On Trico® wiper blades, the tab at the end of the blade must be turned up...



... then the insert can be removed. After installing the replacement insert, bend the tab back

The Tripledge® wiper blade insert is removed and installed using a securing clip

Tires and Wheels

Common sense and good driving habits will afford maximum tire life. Fast starts, sudden stops and hard cornering are hard on tires and will shorten their useful life span. Make sure that you don't overload the vehicle or run with incorrect pressure in the tires. Both of these practices will increase tread wear.

For optimum tire life, keep the tires properly inflated, rotate themoften and have the wheel alignment checked periodically.

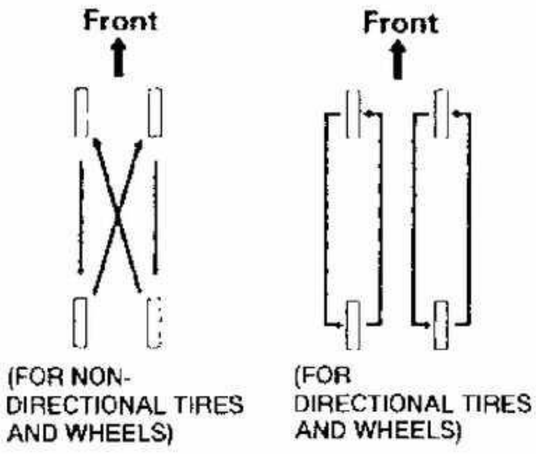
Inspect your tires frequently. Be especially careful to watch for bubbles in the tread or sidewall, deep cuts or underinflation. Replace any tires with bubbles in the sidewall. If cuts are so deep that they penetrate to the cords, discard the tire. Any cut in the sidewall of a radial tire renders it unsafe. Also look for uneven tread wear patterns that may indicate the front end is out of alignment or that the tires are out of balance.

TIRE ROTATION

Tires must be rotated periodically to equalize wear patterns that vary with a tire's position on the vehicle. Tires will also wear in an uneven way as the front steering/suspension system wears to the point where the alignment should be reset.

Rotating the tires will ensure maximum life for the tires as a set, so you will not have to discard a tire early due to wear on only part of the tread. Regular rotation is required to equalize wear.

When rotating "unidirectional tires," make sure that they always roll in the same direction. This means that a tire used on the left side of the vehicle must not be switched to the right side and vice-versa. Such tires should only be rotated front-to-rear or rear-to-front, while always remaining on the same side of the vehicle. These tires are marked on the sidewall as to the direction of rotation; observe the marks when reinstalling the tire(s).



Compact spare tires must NEVER be used in the rotation pattern

Unidirectional tires are identifiable by sidewall arrows and/or the word "rotation"

Some styled or "mag" wheels may have different offsets front to rear. In these cases, the rear wheels must not be used up front and vice-versa. Furthermore, if these wheels are equipped with unidirectional tires, they cannot be rotated unless the tire is remounted for the proper direction of rotation.

The compact or space-saver spare is strictly for emergency use. It mustnever be included in the tire rotation or placed on the vehicle for everydayuse.

TIRE DESIGN

For maximum satisfaction, tires should be used in sets of four. Mixing of different types (radial, bias-belted, fiberglass belted) must be avoided. In most cases, the vehicle manufacturer has designated a type of tire on which the vehicle will perform best. Your first choice when replacing tires should be to use the same type of tire that the manufacturer recommends.

When radial tires are used, tire sizes and wheel diameters should be selected to maintain ground clearance and tire load capacity equivalent to the original specified tire. Radial tires should always be used in sets of four.

Click on icon to view fullsize printable image.

Click to Enlarge

P-Metric tire coding

Radial tires should never be used on only the front axle.

When selecting tires, pay attention to the original size as marked on the tire. Most tires are described using an industry size code sometimes referred to as P-Metric. This allows the exact identification of the tire specifications, regardless of the manufacturer. If selecting a different tire size or brand, remember to check the installed tire for any sign of interference with the body or suspension while the vehicle is stopping, turning sharply or heavily loaded.

Snow Tires

Good radial tires can produce a big advantage in slippery weather, but in snow, a street radial tire does not have sufficient tread to provide traction and control. The small grooves of a street tire quickly pack with snow and the tire behaves like a billiard ball on a marble floor. The more open, chunky tread of a snow tire will self-clean as the tire turns, providing much better grip on snowy surfaces.

To satisfy municipalities requiring snow tires during weather emergencies, most snow tires carry either an M + S designation after the tire size stamped on the sidewall, or the designation "all-season." In general, no change in tire size is necessary when buying snow tires.

Most manufacturers strongly recommend the use of 4 snow tires on their vehicles for reasons of stability. If snow tires are fitted only to the drive wheels, the opposite end of the vehicle may become very unstable when braking or turning on slippery surfaces. This instability can lead to unpleasant endings if the driver can't counteract the slide in time.

Note that snow tires, whether 2 or 4, will affect vehicle handling in all non-snow situations. The stiffer, heavier snow tires will noticeably change the turning and braking characteristics of the vehicle. Once the snow tires are installed, you must re-learn the behavior of the vehicle and drive accordingly.

Consider buying extra wheels on which to mount the snow tires. Once done,the "snow wheels" can be installed and removed as needed. Thiseliminates the potential damage to tires or wheels from seasonal removal and installation.Even if your vehicle has styled wheels, see if inexpensive steel wheels areavailable. Although the look of the vehicle will change, the expensive wheelswill be protected from salt, curb hits and pothole damage.

TIRE STORAGE

If they are mounted on wheels, store the tires at proper inflation pressure. All tires should be kept in a cool, dry place. If they are stored in the garage or basement, do not let them stand on a concrete floor; set them on strips of wood, a mat or a large stack of newspaper. Keeping them away from direct moisture is of paramount importance. Tires should not be stored upright, but in a flat position.

INFLATION & INSPECTION

The importance of proper tire inflation cannot be overemphasized. A tire employs air as part of its structure. It is designed around the supporting strength of the air at a specified pressure. For this reason, improper inflation drastically reduces the tire's ability to perform as intended. A tire will lose some air in day-to-day use; having to add a few pounds of air periodically is not necessarily a sign of a leaking tire.

Two items should be a permanent fixture in every glove compartment: an accurate tire pressure gauge and a tread depth gauge. Check the tire pressure (including the spare) regularly with a pocket type gauge. Too often, the gauge on the end of the air hose at your corner garage is not accurate because it suffers too much abuse. Always check tire pressure when the tires are cold, as pressure increases with temperature. If you must move the vehicle to check the tire inflation, do not drive more than a mile before checking. A cold tire is generally one that has not been driven for more than three hours.

Tires should be checked frequently for any sign of puncture or damage

Tires with deep cuts, or cuts which bulge, should be replaced immediately

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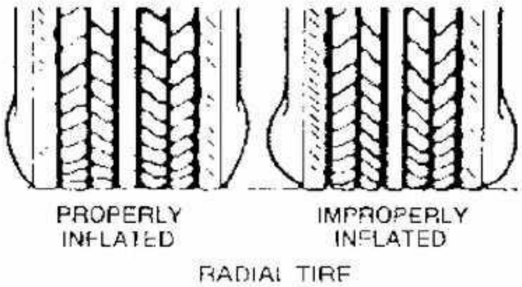
Examples of inflation-related tire wear patterns



Radial tires have a characteristic sidewall bulge; don't try to measure pressure by looking at the tire. Use a quality air pressure gauge

Click on icon to view fullsize printable image.

Click to Enlarge

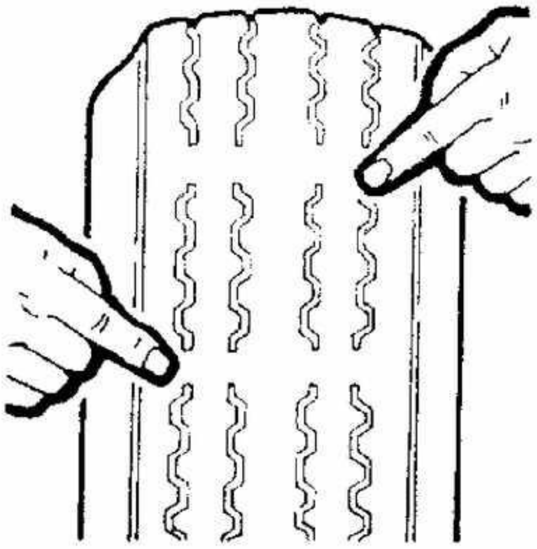
Common tire wear patterns and causes

A plate or sticker is normally provided somewhere in the vehicle (door post, hood, tailgate or trunk lid) which shows the proper pressure for the tires. Never counteract excessive pressure build-up by bleeding off air pressure (letting some air out). This will cause the tire to run hotter and wear quicker.

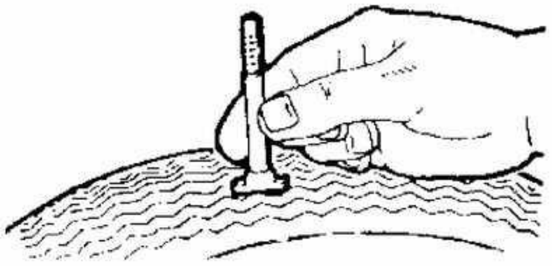
Never exceed the maximum tire pressure embossed on the tire! This is thepressure to be used when the tire is at maximum loading, but it is rarely thecorrect pressure for everyday driving. Consult the owner's manual or the tirepressure sticker for the correct tire pressure.

Once you've maintained the correct tire pressures for several weeks, you'll be familiar with the vehicle's braking and handling personality. Slight adjustments in tire pressures can fine-tune these characteristics, but never change the cold pressure specification by more than 2 psi. A slightly softer tire pressure will give a softer ride but also yield lower fuel mileage. A slightly harder tire will give crisper dry road handling but can cause skidding on wet surfaces. Unless you're fully attuned to the vehicle, stick to the recommended inflation pressures.

All tires made since 1968 have built-in tread wear indicator bars that show up as 1/2 in. (13mm) wide smooth bands across the tire when 1/16 in. (1.5mm) of tread remains. The appearance of tread wear indicators means that the tires should be replaced. In fact, many states have laws prohibiting the use of tires with less than this amount of tread.

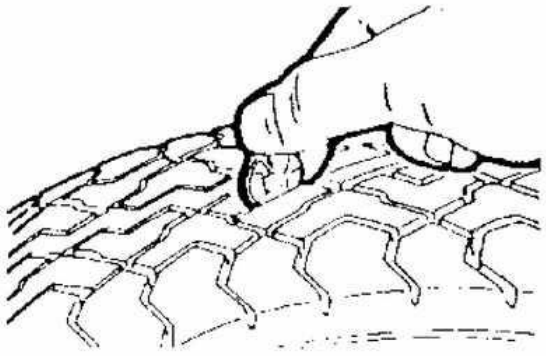


Tread wear indicators will appear when the tire is worn



Accurate tread depth indicators are inexpensive and handy

You can check your own tread depth with an inexpensive gauge or by using a Lincoln head penny. Slip the Lincoln penny (with Lincoln's head upside-down) into several tread grooves. If you can see the top of Lincoln's head in 2 adjacent grooves, the tire has less than 1/16 in. (1.5mm) tread left and should be replaced. You can measure snow tires in the same manner by using the "tails" side of the Lincoln penny. If you can see the top of the Lincoln memorial, it's time to replace the snow tire(s).



A penny works well for a quick check of tread depth

CARE OF SPECIAL WHEELS

If you have invested money in magnesium, aluminum alloy or sport wheels, special precautions should be taken to make sure your investment is not wasted and that your special wheels look good for the life of the vehicle.

Special wheels are easily damaged and/or scratched. Occasionally check the rims for cracking, impact damage or air leaks. If any of these are found, replace the wheel. But in order to prevent this type of damage and the costly replacement of a special wheel, observe the following precautions:

- Use extra care not to damage the wheels during removal, installation, balancing, etc. After removal of the wheels from the vehicle, place them on a mat or other protective surface. If they are to be stored for any length of time, support them on strips of wood. Never store tires and wheels upright; the tread may develop flat spots.
- When driving, watch for hazards; it doesn't take much to crack a wheel.
- When washing, use a mild soap or non-abrasive dish detergent (keeping in mind that detergent tends to remove wax). Avoid cleansers with abrasives or the use of hard brushes. There are many cleaners and polishes for special wheels.
- If possible, remove the wheels during the winter. Salt and sand used for snow removal can severely damage the finish of a wheel.
- Make certain the recommended lug nut torque is never exceeded or the wheel may crack. Never use snow chains on special wheels; severe scratching will occur.

FLUIDS AND LUBRICANTS

Fluid Disposal

Used fluids such as engine oil, transmission fluid, antifreeze and brake fluid are hazardous wastes and must be disposed of properly. Before draining any fluids, consult with your local authorities; in many areas, waste oil, antifreeze, etc. is being accepted as a part of recycling programs. A number of service stations and auto parts stores are also accepting waste fluids for recycling.

Be sure of the recycling center's policies before draining any fluids, as many will not accept different fluids that have been mixed together.

Fuel and Engine Oil Recommendations

ENGINE OIL

On models equipped with gasoline engines, Ford recommends that SAE 5W-30viscosity engine oil should be used for all climate conditions, however, SAE 10W-30is acceptable for vehicles operated in moderate-to-hot climates.

On models equipped with Flexible Fuel Vehicles (FFV), Ford recommendsthat SAE 10W-30 viscosity flexible fuel vehicle engine oil should be used.

When adding oil to the crankcase or changing the oil or filter, it is important that oil of an equal quality to original equipment be used in your car. The use of inferior oils may void the warranty, damage your engine, or both.

The SAE (Society of Automotive Engineers) grade number of oil indicates the viscosity of the oil (its ability to lubricate at a given temperature). The lower the SAE number, the lighter the oil; the lower the viscosity, the easier it is to crank the engine in cold weather but the less the oil will lubricate and protect the engine in high temperatures. This number is marked on every oil container.

Oil viscosities should be chosen from those oils recommended for the lowest anticipated temperatures during the oil change interval. Due to the need for an oil that embodies both good lubrication at high temperatures and easy cranking in cold weather, multigrade oils have been developed. Basically, a multigrade oil is thinner at low temperatures and thicker at high temperatures. For example, a 10W-40 oil (the W stands for winter) exhibits the characteristics of a 10 weight (SAE 10) oil when the car is first started and the oil is cold. Its lighter weight allows it to travel to the lubricating surfaces quicker and offer less resistance to starter motor cranking than, say, a straight 30 weight (SAE 30) oil. But after the engine reaches operating temperature, the 10W-40 oil begins acting like straight 40 weight (SAE 40) oil, its heavier weight providing greater lubrication with less chance of foaming than a straight 30 weight oil.

Look for the API oil identification label when choosing your engine oil

This label, usually affixed under the hood, will reveal the engine's oil viscosity requirement

The API (American Petroleum Institute) designations, also found on the oil container, indicate the classification of engine oil used under certain given operating conditions. Only oils designated for use Service SG, or latest superceding grade, heavy duty detergent should be used in your car. Oils of the SG type perform many functions inside the engine besides their basic lubrication. Through a balanced system of metallic detergents and polymeric dispersants, the oil prevents high and low temperature deposits and also keeps sludge and dirt particles in suspension. Acids, particularly sulfuric acid, as well as other by-products of engine combustion are neutralized by the oil. If these acids are allowed to concentrate, they can cause corrosion and rapid wear of the internal engine parts.

Non-detergent motor oils or straight mineral oils should NOT be used in yourFord gasoline engine.

Synthetic Oil

There are many excellent synthetic and fuel-efficient oils currently available that can provide better gas mileage, longer service life and, in some cases, better engine protection. These benefits do not come without a few hitches, however; the main one being the price of synthetic oil, which can be significantly more expensive than conventional oil.

Synthetic oil is not for every car and every type of driving, so you should consider your engine's condition and your type of driving. Also, check your vehicles warranty conditions regarding the use of synthetic oils.

FUEL

The 3.0L (VIN U) and 3.0L (VIN S) vehicles covered by this manual are designed to operate using regular unleaded fuel with a minimum of 87 octane. The 3.4L (VIN N) vehicles covered by this manual are designed to operate using premium unleaded fuel with an octane rating of 91 or higher. Ford warns that using gasoline with an octane rating lower than specified can cause persistent and heavy knocking, and may cause internal engine damage.

If your vehicle is having problems with rough idle or hesitation when the engine is cold, it may be caused by low volatility fuel. If this occurs, try a different grade or brand of fuel.

The Taurus Flexible Fuel Vehicle (FFV) has two versions, one for fuel methanol (3.0L VIN 1) and the other for fuel ethanol (3.0L VIN 2). Unleaded gasoline may be used in either vehicle. However, fuel methanol is not to be used in a fuel ethanol vehicle, and vice-versa. These models will operate well on ordinary unleaded regular gasoline, but only the highest quality fuel methanol or fuel ethanol should be used. To ensure proper operation of your Flexible Fuel Vehicle (FFV) only refuel at stations certified by the American Automobile Manufacturers Association (AAMA).

Use only fuels which meet the specifications issued by the AAMA and the typespecified for the calibration number printed on the decal. Use of other fuelsmay cause damage to the vehicles powertrain, cause a loss of vehicleperformance and may even void your vehicles warranty.

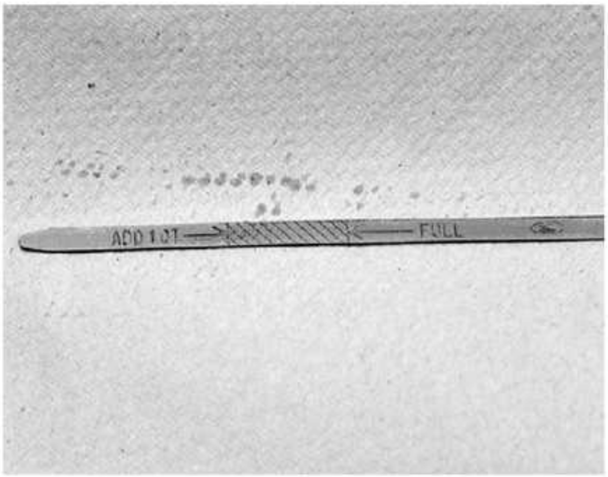
OPERATION IN FOREIGN COUNTRIES

If you plan to drive your car outside the United States or Canada, there is a possibility that fuels will be too low in anti-knock quality and could produce engine damage. It is wise to consult with local authorities upon arrival in a foreign country to determine the best fuels available.

Engine

OIL LEVEL CHECK

The oil level dipstick is located in front of the left-hand valve cover directly behind the radiator



If the oil level is in the crosshatched area of the dipstick, the level is OK, if it is below the crosshatched area, add oil as necessary

The oil fill cap is located on the left-hand valve cover (front)

Use a funnel to add the oil to the engine to avoid spillage

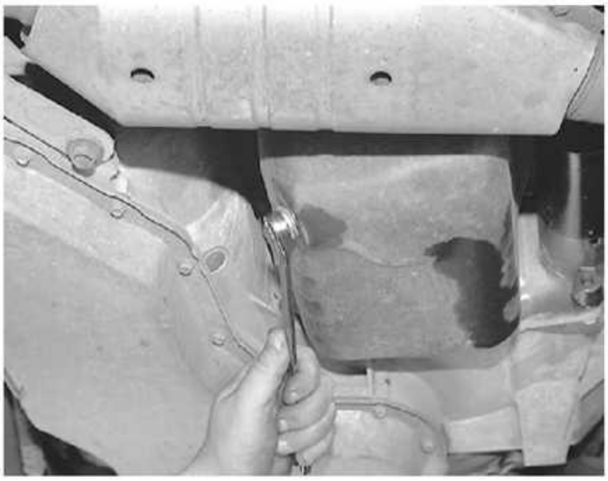
The EPA warns that prolonged contact with used engine oil may cause a numberof skin disorders, including cancer! You should make every effort to minimize your exposure to used engine oil. Protective gloves should be worn when changing the oil. Wash your hands and any other exposed skin areas as soon as possible after exposure to used engine oil. Soap and water, or waterless handcleaner should be used.

Operating the engine without the proper amount and type of engine oil will resultin severe engine damage.

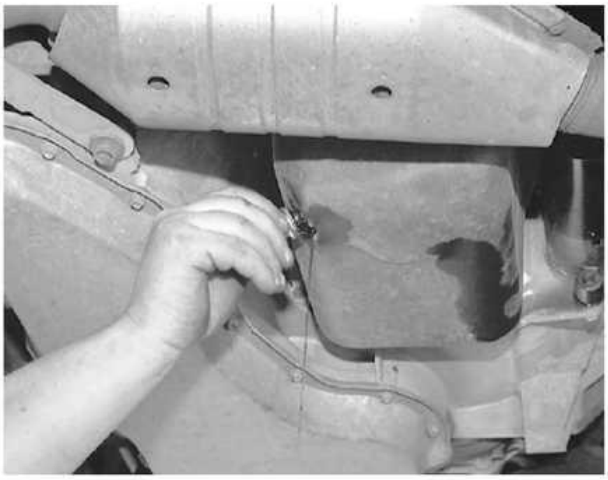
Check the engine oil level every time you fill the fuel tank. The car should be on level ground when checking the oil.

1. Turn the engine ***OFF*** and wait several minutes.
2. Locate the engine oil dipstick and withdraw it from the tube.
3. Wipe the dipstick with a clean rag and reinsert it in the dipstick tube. Make sure the dipstick is fully seated.
4. Remove the dipstick again, hold the dipstick horizontal and observe the level of the oil.
5. The oil level should be at or near the ***FULL*** line on the dipstick.
6. If the level is at or near the ***ADD*** line, replace the dipstick and add fresh oil to bring the level up to the ***FULL*** line. Do NOT overfill.
7. Recheck the oil level and close the hood.

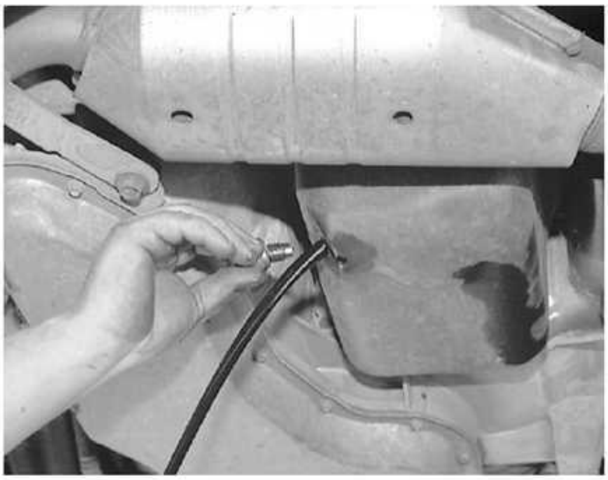
OIL & FILTER CHANGE



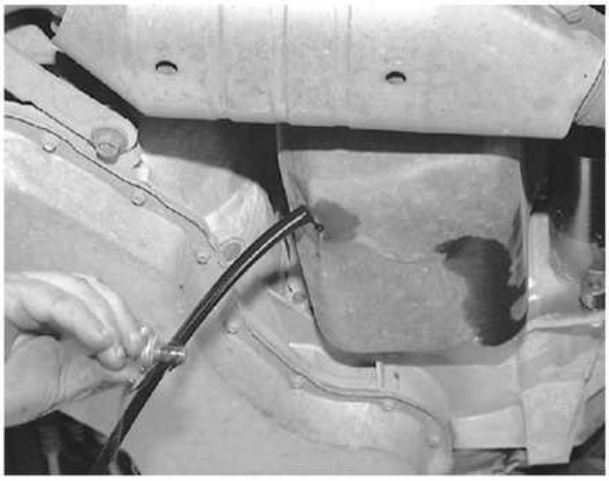
Use an appropriate size tool to loosen the oil pan drain plug. Typically the drain plug requires a 16mm wrench



Carefully loosen the drain plug by hand, but keep constant light inward pressure on the drain plug

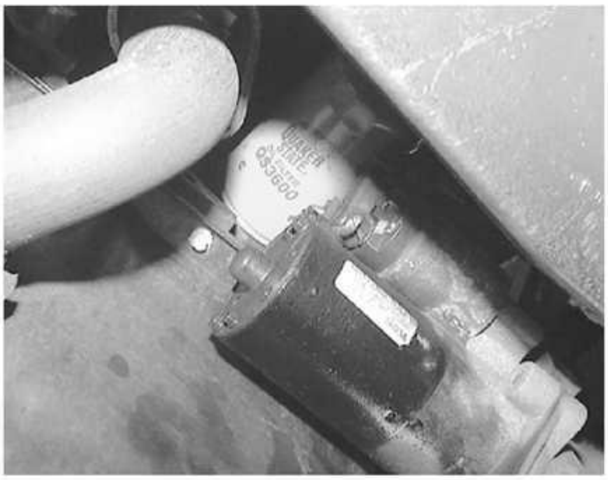


Make sure the drain pan is in position and remove the drain plug from the oil pan

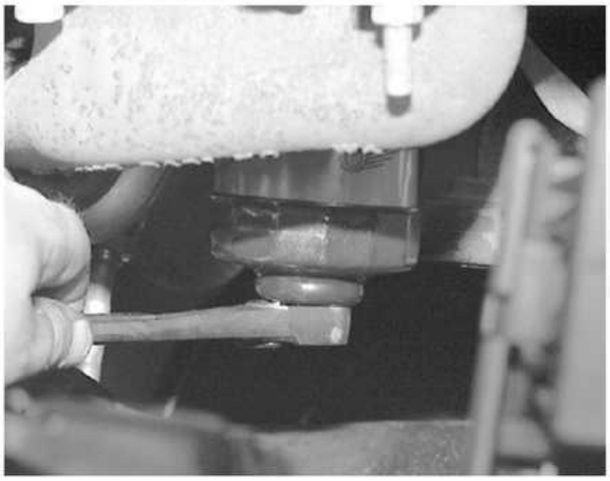


Quickly move your hand away as the oil will flow out rapidly and could be quite hot

Inspect the threads on the drain plug as well as the gasket and replace either if necessary



The oil filter is located on the engine, just above the starter-3.0L OHV



Use an appropriate size oil filter wrench to loosen the oil filter

CHILTON

Remove the filter from the engine. Try to keep it upright to avoid spilling oil

The engine oil and oil filter should be changed at the recommendedintervals on the Maintenance Chart. Though some manufacturers have at times recommended changing the filter only at every other oil change, we at Chilton recommend that you always change the filter with the oil. The benefit of fresh oil is quickly lost if the old filter is clogged and unable to do its job.Also, leaving the old filter in place leaves a significant amount of dirty oil in the system.

The oil should be changed more frequently if the vehicle is being operated in a very dusty area. Before draining the oil, make sure that the engine is at operating temperature. Hot oil will hold more impurities in suspension and will flow better, allowing the removal of more oil and dirt.

It is usually a good idea to place your ignition key in the box or bagwith the bottles of fresh engine oil. In this way, it will be VERY HARD to forget to refill the engine crankcase before you go to start the engine.

1. Raise and support the vehicle safely on jack stands.
2. Before you crawl under the car, take a look at where you will be working and gather all the necessary tools such as: a few wrenches or a ratchet and strip of sockets, a drain pan and clean rags. If the oil filter is more accessible from underneath the vehicle, you will also want to grab a bottle of oil, the new filter and a filter wrench at this time.

The EPA warns that prolonged contact with used engine oil may cause a numberof skin disorders, including cancer! You should make every effort to minimize your exposure to used engine oil. Protective gloves should be worn when changing the oil. Wash your hands and any other exposed skin areas as soon as possible after exposure to used engine oil. Soap and water, or waterless handcleaner should be used.

Operating the engine without the proper amount and type of engine oil will result in severe engine damage.

3. Position the drain pan beneath the oil pan drain plug. Keep in mind that the fast flowing oil, which will spill out as you pull the plug from the pan, will flow with enough force that it could miss the pan. Position the drain pan accordingly and be ready to move the pan more directly beneath the plug as the oil flow lessens to a trickle.
4. Loosen the 16mm drain plug with a wrench (or socket and driver), then carefully unscrew the plug with your fingers. Use a rag to shield your fingers from the heat. Push in on the plug as you unscrew it so you can feel when all of the screw threads are out of the hole (and so you will keep the oil from seeping past the threads until you are ready to remove the plug). You can then remove the plug quickly to avoid having hot oil run down your arm. This will also help assure that have the plug in your hand, not in the bottom of a pan of hot oil.

Be careful of the oil; when at operating temperature, it is hot enough tocause a severe burn.

5. Allow the oil to drain until nothing but a few drops come out of the drain hole. Check the drain plug to make sure the threads and sealing surface are not damaged. Clean the plug and install a new seal if it is missing or damaged.
6. Carefully thread the plug into position and tighten it with a torque wrench to 9-11 ft. lbs. (11-16 Nm) on 3.0L (OHV) engines, 16-22 ft. lbs. (22-30 Nm) on 3.0L (DOHC) engines or 15-25 ft. lbs. (20-34 Nm) on 3.4L (DOHC) engines.
7. If a torque wrench is not available, snug the drain plug and give a slight additional turn. You don't want the plug to fall out (as you would quickly become stranded), but the pan threads are EASILY stripped from overtightening (and this can be time consuming and/or costly to fix).
8. Position the drain pan beneath the filter. To remove the filter, you may need an oil filter wrench, since the filter may have been fitted too tightly and/or the heat from the engine may have made it even tighter. A filter wrench can be obtained at any auto parts store and is well worth the investment. Loosen the filter with the filter wrench. With a rag wrapped around the filter, unscrew the filter from the boss on the engine. Be careful of hot oil that will run down the side of the filter. Make sure that your drain pan is under the filter before you start to remove it from the engine; should some of the hot oil happen to get on you, there will be a place to dump the filter in a hurry and the filter will usually spill a good bit of dirty oil as it is removed.

Before installing a new oil filter, lightly coat the rubber gasket with clean engine oil

9. Wipe the base of the mounting boss with a clean, dry cloth. When you install the new filter, smear a small amount of fresh oil on the gasket with your finger, just enough to coat the entire contact surface. When you tighten the filter, rotate it about a half-turn after it contacts the mounting boss (or follow any instructions which are provided on the filter or parts box).

Operating the engine without the proper amount and type of engine oil will result in severe engine damage.

10. Remove the jack stands and carefully lower the vehicle, then IMMEDIATELY refill the engine crankcase with the proper amount of oil. DO NOT WAIT TO DO THIS because if you forget and someone tries to start the car severe engine damage will occur.
11. Refill the engine crankcase slowly, checking the level often. You may notice that it usually takes less than the amount of oil listed in the capacity chart to refill the crankcase. But, that is only until the engine is run and the oil filter is filled with oil. To make sure the proper level is obtained, run the engine to normal operating temperature. While the engine is warming, look under the vehicle for any oil leakage; if any leakage is found, shut the engine ***OFF*** immediately, then fix the leak.
12. Shut the engine ***OFF***, allow the oil to drain back into the oil pan, and recheck the level. Top off the oil at this time to the FULL mark.

If the vehicle is not resting on level ground, the oil level reading onthe dipstick may be slightly off. Be sure to check the level only when the caris sitting level.

13. Drain your used oil in a suitable container for recycling and clean up your tools, as you will be needing them again in a few thousand more miles (kilometers).

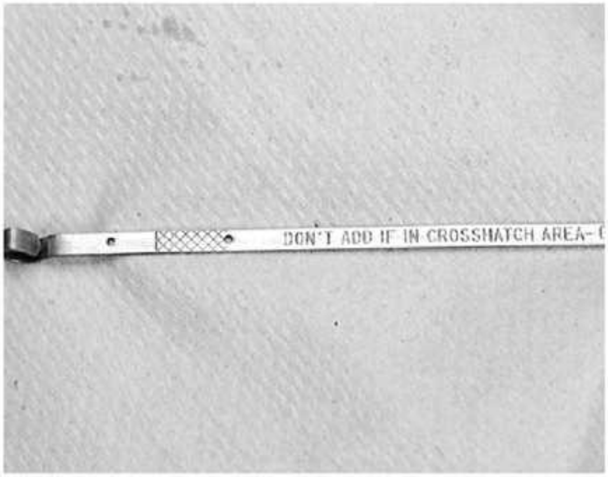
Automatic Transaxle

FLUID RECOMMENDATIONS

Ford recommends that you use Mercon® automatic transmission fluid in your transaxle.

LEVEL CHECK

Remove the transaxle dipstick from the tube



Check the fluid level on the dipstick. The fluid level should be between the crosshatched area, if it is below the crosshatches, add transmission fluid as necessary

Place a funnel into the transaxle dipstick tube and add the fluid as necessary

It is very important to maintain the proper fluid level in an automatic transaxle. If the level is either too high or too low, poor shifting operation and internal damage are likely to occur. For this reason, a regular check of the fluid level is essential.

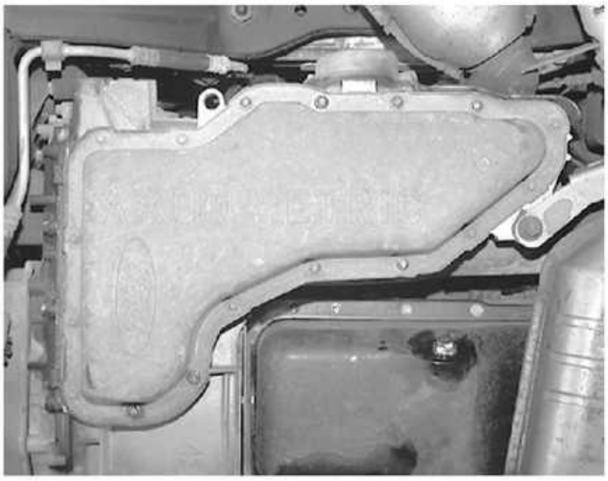
It is best to check fluid at normal operating temperature.

There are LOW and FULL marks on the dipstick with a crosshatched area inbetween.

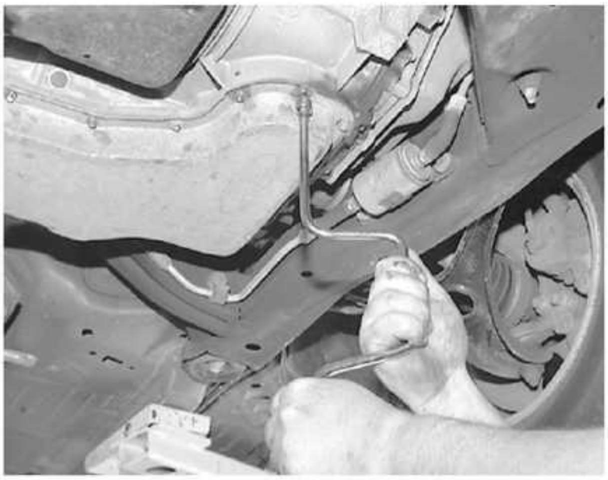
1. Drive the vehicle for 15-20 minutes or idle it at a fast idle speed (about 1200 rpm), allowing the transaxle to reach operating temperature. When the fluid is warm, allow the engine to idle normally.
2. Park the car on a level surface, apply the parking brake and leave the engine idling. Make sure the parking brake is FIRMLY ENGAGED.
3. Depress the brake pedal and shift the transaxle engaging each gear, then place the selector in ***P*** (PARK) position.
4. Keep the engine running and open the hood. Locate the transaxle dipstick. Wipe away any dirt in the area of the dipstick to prevent it from falling into the filler tube. Withdraw the dipstick, wipe it with a clean, lint-free rag and reinsert it until it fully seats.
5. Withdraw the dipstick and hold it horizontally while noting the fluid level. It should be between the ***LOW*** and ***FULL*** marks (in the crosshatched area) of the dipstick when the temperature of the fluid is at normal operating temperature.
6. If the level is below the ***LOW*** mark, use a funnel and add fluid in small quantities through the dipstick filler neck. Keep the engine running while adding fluid and check the level after each small amount. Do NOT overfill, as this could lead to foaming and transaxle damage or seal leaks.

Since the transaxle fluid is added through the dipstick tube, if youcheck the fluid too soon after adding fluid, an incorrect reading may occur.After adding fluid, wait a few minutes to allow it to fully drain into the transaxle.

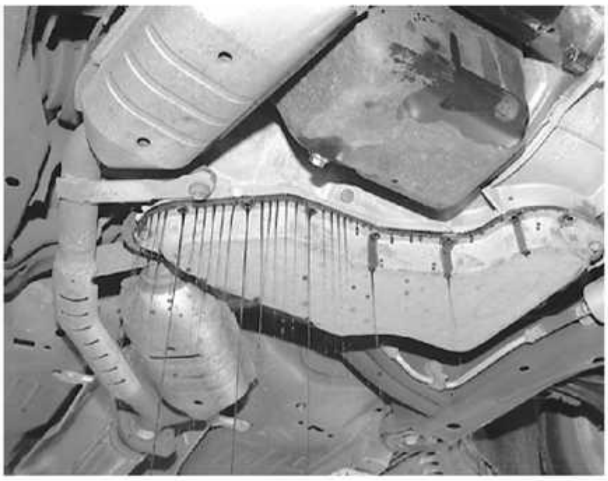
Pan & Filter Service



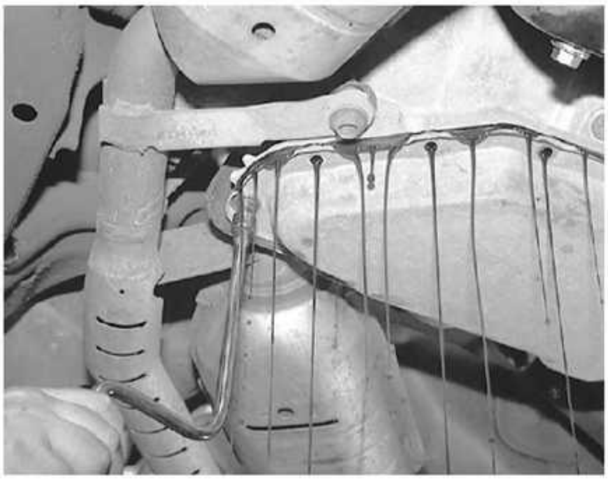
The transaxle fluid pan is retained by 17 bolts



Using the proper tools remove the 10mm transaxle fluid pan bolts except...



... for two bolts on each end of the pan. Carefully loosen the remaining bolts, but do not remove them, and fluid will begin to drain from the pan

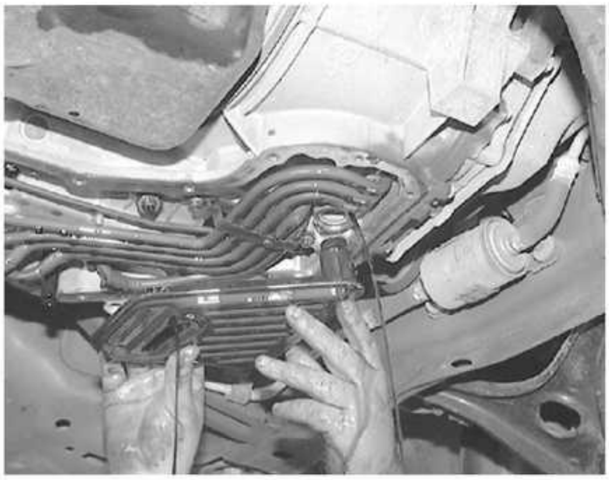


Slowly loosen the remaining bolts until the fluid stops flowing out

Remove the remaining bolts and...

... remove the pan from the transaxle

Carefully lower the pan and dump the remaining fluid in the pan into a suitable drain pan



Remove the filter from the transaxle. Make sure that the filter O-ring is removed and replaced also

1. Raise the car and support it securely on jack stands.
2. Place a large drain pan under the transaxle.
3. Loosen all the pan bolts except the bolts at the four corners.
4. Loosen the front two bolts about three turns and the rear two bolts about six turns.

Do NOT force the pan while breaking the gasket seal. Do NOT allow the panflange to become bent or otherwise damaged.

5. Use a prying tool to gently separate the pan from the transaxle.
6. As the fluid drains from the pan, keep loosening the bolts in the same two-to-one ratio allowing all the fluid to completely drain.
7. When fluid has drained, remove the pan bolts and the pan, doing your best to drain the rest of the fluid into the drain pan.
8. Remove the filter by pulling it down and off of the valve body. Make sure any gaskets or seals are removed with the old filter.

If the filter seal did not come off with the filter, remove the sealusing the large end of a 3/8 inch socket extension.

9. Clean and inspect the oil pan gasket. If the gasket is not damaged it may be reused. If the gasket is damaged, discard it.
10. Clean the transaxle pan-to-transaxle mounting surface. Remove the magnet from the bottom of the pan and clean the pan with solvent and dry it using air or a clean lint-free cloth.

To install:

11. Re-install the magnet in the pan.
12. Install the new oil filter, making sure all gaskets or seals are in place.
13. If the old gasket was damaged, place a new gasket on the fluid pan, then install the pan to the transaxle. Tighten the attaching bolts to 80-106 inch lbs. (9-12 Nm).
14. Remove the jack stands and lower the vehicle.
15. Add 10 quarts (9.1L) of fluid through the dipstick tube.
16. The level should always be just below the ***F*** mark.
17. Start the engine and move the gear selector through all gears in the shift pattern. Allow the engine to reach normal operating temperature.
18. Add an additional 2 quarts (1.9L) of transaxle fluid through the dipstick tube.
19. Check the transaxle fluid level. Add fluid, as necessary, to obtain the correct level.

Cooling System

FLUID RECOMMENDATIONS

NEVER remove the radiator cap under any conditions while the engine isrunning! Failure to follow these instructions could result in damage to thecooling system and/or personal injury. To avoid having scalding hot coolant orsteam blow out of the radiator, use extreme care when removing the radiator capfrom a hot radiator. Wait until the engine has cooled, then wrap a thick clotharound the radiator cap and turn it slowly to the first stop. Step back whilethe pressure is released from the cooling system. When you are sure thepressure has been released, press down on the radiator cap (with the clothstill in position), turn and remove the cap.

The recommended coolant for all vehicles covered by this manual is a 50/50 mixture of ethylene glycol and water for year-round use. Choose an aluminum-compatible, good quality antifreeze with water pump lubricants, rust inhibitors and other corrosion inhibitors, along with acid neutralizers.

INSPECTION

The coolant level should be between the COLD FILL levels on the coolant recovery tank

Any time you have the hood open, glance at the coolant recovery tank to make sure it is properly filled. Top off the cooling system using the recovery tank and its markings as a guideline. If you top off the system, make a note of it to check again soon. A coolant level that consistently drops is usually a sign of a small, hard to detect leak, although in the worst case it could be a sign of an internal engine leak (blown head gasket/cracked block?... check the engine oil for coolant contamination). In most cases, you will be able to trace the leak to a loose fitting or damaged hose (and you might solve a problem before it leaves you stranded). Evaporating ethylene glycol antifreeze will leave small, white (salt-like) deposits, which can be helpful in tracing a leak.

At least annually or every 15,000 miles (25,000 km), all hoses, fittings and cooling system connections should be inspected for damage, wear or leaks. Hose clamps should be checked for tightness, and soft or cracked hoses should be replaced. Damp spots, or accumulations of rust or dye near hoses or fittings indicate possible leakage. These must be corrected before filling the system with fresh coolant. The pressure cap should be examined for signs of deterioration and aging. The water pump drive belt(s) should be inspected and adjusted to the proper tension. Refer to the information on drive belts found earlier in this section. Finally, if everything looks good, obtain an antifreeze/coolant testing hydrometer in order to check the freeze and boil-over protection capabilities of the coolant currently in your engine. Old or improperly mixed coolant should be replaced.

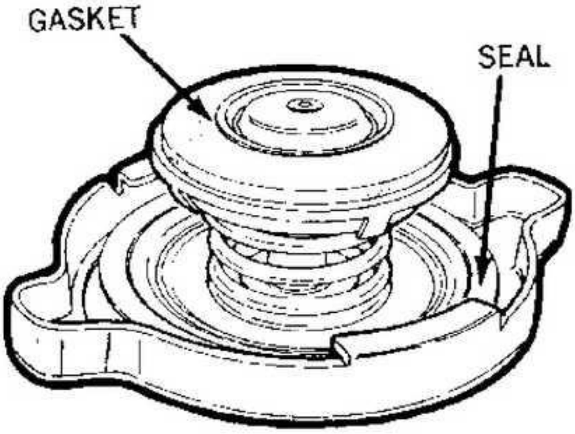
NEVER open, service or drain the radiator or cooling system when hot; serious burns can occur from the steam and hot coolant. Also, when draining engine coolant, keep in mind that cats and dogs are attracted to ethylene glycol antifreeze and could drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantities.Always drain coolant into a sealable container. If necessary, clean coolant maybe reused unless it is contaminated or more than two years old.

The engine cooling system should be inspected, flushed and refilled with fresh coolant. The engine coolant should be changed initially at 50,000 miles (80,000 km), then change the coolant at least once every 2 years or 30,000 miles (48,000 km). If the coolant is left in the system too long, it loses its ability to prevent rust and corrosion. If the coolant has too much water, it won't protect against freezing.

If you experience problems with your cooling system, such as overheating or boiling over, check for a simple cause before expecting the complicated. Make sure the system can fully pressurize (are all the connections tight/is the radiator cap on properly, is the cap seal intact?). Ideally, a pressure tester should be connected to the radiator opening and the system should be pressurized and inspected for leaks. If no obvious problems are found, use a hydrometer antifreeze/coolant tester (available at most automotive supply stores) to check the condition and concentration of the antifreeze in your cooling system. Excessively old coolant or the wrong proportions of water and coolant will adversely affect the coolant's boiling and freezing points.

Check the Radiator Cap

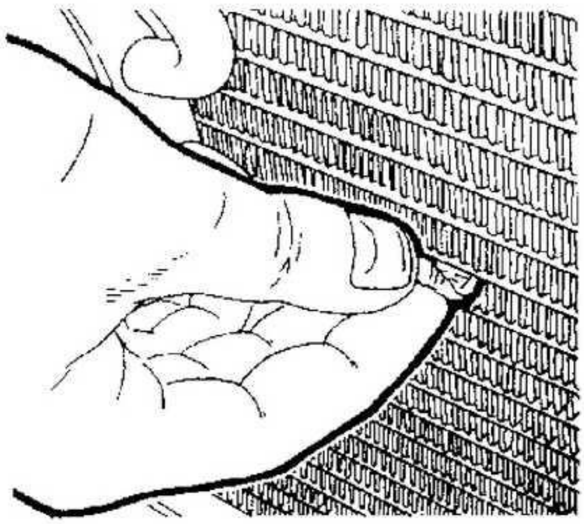
While you are checking the coolant level, check the radiator cap for a worn or cracked gasket. If the cap doesn't seal properly, fluid will be lost and the engine will overheat. Worn caps should be replaced with new ones.



Check the radiator cap for a worn or cracked gasket

Clean Radiator of Debris

Periodically, clean any debris-leaves, paper, insects, etc. from the radiator fins. Pick the large pieces off by hand. The smaller pieces can be washed away with water pressure from a hose.



Periodically remove all debris from the radiator fins

Carefully straighten any bent radiator fins with a pair of needle-nosed pliers. Be careful; the fins are very soft. Don't wiggle the fins back and forth too much. Straighten them once and try not to move them again.

DRAIN & REFILL

Remove the cap from the coolant recovery tank

Pour the proper 50/50coolant-to-water ratio directly into the coolant recovery tank

NEVER open, service or drain the radiator or cooling system when hot; serious burns can occur from the steam and hot coolant. Also, when draining engine coolant, keep in mind that cats and dogs are attracted to ethylene glycol antifreeze and could drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantities. Alwaysdrain coolant into a sealable container. If necessary, clean coolant may be reused unless it is contaminated or more than two years old.

A complete drain and refill of the cooling system at 50,000 miles (80,000 km) and afterwards at least every 30,000 miles (48,000 km) or 2 years will remove the accumulated rust, scale and other deposits. The recommended coolant is a 50/50 mixture of ethylene glycol and water for year-round use. Choose a good quality antifreeze with water pump lubricants, rust inhibitors and other corrosion inhibitors, along with acid neutralizers.

1. Raise the vehicle and support it with jack stands.
2. Remove the splash shield from the front of the front sub frame and body.

Before opening the radiator petcock, spray it with some penetratinglubricant.

3. Place a suitable container under the petcock.

If you are checking for leaks with the system at normal operatingtemperature, BE EXTREMELY CAREFUL not to touch any moving or hot engine parts.Once the temperature has been reached, shut the engine OFF, and check for leaksaround the hose fittings and connections which were removed earlier.

14. Check the level of protection with an antifreeze/coolant hydrometer.

FLUSHING & CLEANING THE SYSTEM

1. Remove the radiator and turn it upside down.
2. Using a garden hose inserted in the lower hose location, backflush the radiator making sure the radiator internal pressure does not exceed 20 psi (138 kPa).

The radiator internal pressure must not exceed 20 psi (138 kPa) or damagemay occur.

3. Remove the thermostat, insert the hose into the thermostat opening.
4. Turn the hose on high and let the water backflush the engine block.
5. Tag and disconnect the heater core outlet hose from the water pump fitting and connect a female garden hose-end adapter in the end of the hose and hold it in place with a hose clamp.
6. Connect the garden hose to the hose-end adapter attached to the heater core hose.
7. Tag and disconnect the heater core inlet hose from the block and position it so a container to catch the coolant and water can be placed under it.
8. Place a suitable sized container under the inlet hose.
9. If equipped with a water valve on the heater core inlet hose, make sure the valve is open (no vacuum).
10. Turn the water supply on and off several times to loosen sludge and deposits, then turn the full water pressure on and let it run for about five minutes.
11. If a water valve is installed in the heater core inlet hose, apply vacuum to the valve vacuum motor to check for proper operation of the valve with proper closure with no water leakage. If there is water leakage, replace the valve.
12. Remove the garden hose and the adapter from the outlet hose.
13. Connect the heater core inlet and outlet hoses.
14. Install the thermostat and radiator.
15. Properly fill the cooling system.
16. Start the engine and allow it to reach normal operating temperature, then check for leaks.

Brake Master Cylinder

The brake master cylinder reservoir is located under the hood, attached to the firewall on the driver's side of the engine compartment.

FLUID RECOMMENDATIONS

BRAKE FLUID EATS PAINT. Take great care not to splash or spill brake fluid on painted surfaces. Should you spill a small amount on the cars finish, don't panic, just flush the area with plenty of water.

When adding fluid to the system, ONLY use fresh DOT 3 brake fluid from a sealed container. DOT 3 brake fluid will absorb moisture when it is exposed to the atmosphere, which will lower its boiling point. A container that has been opened once, closed and placed on a shelf will allow enough moisture to enter over time to contaminate the fluid within. If your brake fluid is contaminated with water, you could boil the brake fluid under hard braking conditions and lose all or some braking ability. Don't take the risk, buy fresh brake fluid whenever you must add to the system.

LEVEL CHECK

The fluid level should be between the MAX and MIN lines; if the fluid level is low, be sure to check the brakes

Wipe the master cylinder reservoir clean before opening the cap to ensure that no contamination enters the brake fluid

Unscrew the master cylinder cap and...

... carefully pour fresh, approved brake fluid directly into the reservoir

Observe the fluid level indicators on the master cylinder; the fluid level should be 0.16 inch (4mm) below the ***MAX*** line.

Before removing the master cylinder reservoir cap, make sure the vehicle is resting on level ground and clean all dirt away from the top of the master cylinder. Unscrew the cap and fill the master cylinder until the level is between the ***MIN*** and ***MAX*** lines.

If the level of the brake fluid is less than half the volume of the reservoir, it is advised that you check the brake system for leaks. Leaks in a hydraulic brake system most commonly occur at the wheel cylinder.

Power Steering Pump

FLUID RECOMMENDATIONS

Fill the power steering pump reservoir with Mercon® Automatic Transmission Fluid (ATF).

LEVEL CHECK

3.0L OHV Engines

1. Position the vehicle on level ground.
2. Run the engine until the fluid is at normal operating temperature.
3. Turn the steering wheel all the way to the left and right several times.
4. Position the wheels in the straight ahead position, then shut off the engine.
5. To check the level in the reservoir, turn the reservoir cap until the locking tabs disengage and withdraw the cap/dipstick from the reservoir.
6. The fluid level should be between the arrows at the ***FULL HOT*** mark. If fluid is required, add fluid in small amounts until it reaches the ***FULL HOT*** mark and replace the cap/dipstick.
7. If the level is checked with the engine not at operating temperature, remove the dipstick and check the fluid level at the ***FULL COLD*** mark. If necessary, add fluid until the level is correct and replace the cap.

The power steering reservoir is located on the power steering pump-3.0L OHV engines

Click on icon to view fullsize printable image.

Click to Enlarge

The power steering pump reservoir cap/dipstick must be removed to observe the fluid level and to add fluid if necessary-3.0L OHV engines

The power steering fluid level dipstick has a FULL COLD side and ...

... a FULL HOT side

Carefully pour the power steering fluid directly into the reservoir

3.0L and 3.4L (DOHC) Engines

1. Position the vehicle on level ground.
2. Run the engine until the fluid is at normal operating temperature.
3. Turn the steering wheel all the way to the left and right several times.
4. Position the wheels in the straight ahead position, then shut off the engine.
5. Check the fluid level in the reservoir by observing the ***MIN*** and ***MAX*** marks on the side of the reservoir. The fluid level should be between the ***MIN*** and ***MAX*** marks.
6. If the fluid level is low, remove the reservoir cap and add small amounts of the specified fluid until the fluid level is between the ***MIN*** and ***MAX*** marks, then replace the cap.
7. If the level is checked with the engine not at operating temperature, observe the fluid level ***MIN*** and ***MAX*** marks on the side of the reservoir. The fluid level should be at the ***MIN*** mark. If necessary, add fluid until the level is correct and replace the cap.

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The power steering pump reservoir fluid level cap be checked by observing the marks fluid level marks on the side of the reservoir-3.0L and 3.4L DOHC engines

Steering Gear

The steering gear is factory-filled with steering gear grease. Changing of this lubricant should not be performed and the housing should not be drained; periodic lubrication is not required for the steering gear.

Body Lubrication

The body lubrication should be performed at least once a year or more, depending on the conditions under which the vehicle is operated. It is advisable that you walk around the vehicle and give attention to a number of other surfaces which require a variety of lubrication/protection.

Lubricate the door and luggage hinges, door locks, door latches, and the hood latch when they become noisy or difficult to operate. Use a high quality multi-purpose grease spray that meets Ford's F5AZ-19G209-AA specification.

HOOD/DOOR LATCH & HINGES

Wipe clean any exposed surfaces of the door latches and hinges and hood latch, liftgate hinges and latches. Then, treat the surfaces using a multi-purpose grease spray that meets Ford's F5AZ-19G209-AA specification.

LOCK CYLINDERS

Lock cylinders should be treated with Ford penetrating lubricant, part no. E8AZ-19A501-B or equivalent. Consult your local parts supplier for equivalent lubricants.

DOOR WEATHERSTRIPPING

Spray or wipe the door weatherstripping using a silicone lubricant to help preserve the rubber.

Wheel Bearings

The wheel bearings used on these models are pre-greased, sealed bearings and are part of the hub assembly. These bearings require no periodic maintenance. If the bearing is defective, the bearing assembly needs to be replaced.

TRAILER TOWING

General Recommendations

Your vehicle was primarily designed to carry passengers and cargo. It is important to remember that towing a trailer will place additional loads on your vehicle's engine, drive train, steering, braking and other systems. However, if you decide to tow a trailer, using the prior equipment is a must.

Local laws may require specific equipment such as trailer brakes or fender-mounted mirrors. Check your local laws.

Trailer Weight

The weight of the trailer is the most important factor. A good weight-to-horsepower ratio is about 35:1, 35 lbs. of Gross Combined Weight (GCW) for every horsepower your engine develops. Multiply the engine's rated horsepower by 35 and subtract the weight of the vehicle passengers and luggage. The number remaining is the approximate ideal maximum weight you should tow, although a numerically higher axle ratio can help compensate for heavier weight.

Hitch (Tongue) Weight

Calculate the hitch weight in order to select a proper hitch. The weight of the hitch is usually 9-11% of the trailer gross weight and should be measured with the trailer loaded. Hitches fall into various categories: those that mount on the frame and rear bumper, the bolt-on type, or the weld-on distribution type used for larger trailers. Axle mounted or clamp-on bumper hitches should never be used.

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Calculating proper tongue weight for your trailer

Check the gross weight rating of your trailer. Tongue weight is usually figured as 10% of gross trailer weight. Therefore, a trailer with a maximum gross weight of 2000 lbs. will have a maximum tongue weight of 200 lbs. Class I trailers fall into this category. Class II trailers are those with a gross weight rating of 2000-3000 lbs., while Class III trailers fall into the 3500-6000 lbs. category. Class IV trailers are those over 6000 lbs. and are for use with fifth-wheel trucks only.

When you've determined the hitch that you'll need, follow the manufacturer's installation instructions, exactly, especially when it comes to fastener torques. The hitch will subjected to a lot of stress and good hitches come with hardened bolts. Never substitute an inferior bolt for a hardened bolt.

Engine

One of the most common, if not THE most common, problems associated with trailer towing is engine overheating. If you have a cooling system without an expansion tank, you'll definitely need to get an aftermarket expansion tank kit, preferably one with at least a 2 quart capacity. These kits are easily installed on the radiator's overflow hose, and come with a pressure cap designed for expansion tanks.

Aftermarket engine oil coolers are helpful for prolonging engine oil life and reducing overall engine temperatures. Both of these factors increase engine life. While not absolutely necessary in towing Class I and some Class II trailers, they are recommended for heavier Class II and all Class III towing. Engine oil cooler systems usually consist of an adapter, screwed on in place of the oil filter, a remote filter mounting and a multi-tube, finned heat exchanger, which is mounted in front of the radiator or air conditioning condenser.

Transaxle

An automatic transaxle is usually recommended for trailer towing. Modern automatics have proven reliable and, of course, easy to operate in trailer towing. The increased load of a trailer, however, causes an increase in the temperature of the automatic transaxle fluid. Heat is the worst enemy of an automatic transaxle. As the temperature of the fluid increases, the life of the fluid decreases.

It is essential, therefore, that you install an automatic transaxle cooler. The cooler, which consists of a multi-tube, finned heat exchanger, is usually installed in front of the radiator or air conditioning compressor, and hooked in-line with the transaxle cooler tank inlet line. Follow the cooler manufacturer's installation instructions.

Select a cooler of at least adequate capacity, based upon the combined gross weights of the vehicle and trailer.

Cooler manufacturers recommend that you use an aftermarket cooler in addition to, and not instead of, the present cooling tank in your radiator. If you do want to use it in place of the radiator cooling tank, get a cooler at least two sizes larger than normally necessary.

A transaxle cooler can, sometimes, cause slow or harsh shifting in the transaxle during cold weather, until the fluid has a chance to come up tonormal operating temperature. Some coolers can be purchased with or retrofittedwith a temperature bypass valve which will allow fluid flow through the cooleronly when the fluid is above a certain operating temperature.

Handling a Trailer

Towing a trailer with ease and safety requires a certain amount of experience. It's a good idea to learn the feel of a trailer by practicing turning, stopping and backing in an open area such as an empty parking lot.

JUMP STARTING A DEAD BATTERY

Introduction

Whenever a vehicle is jump started, precautions must be followed in order to prevent the possibility of personal injury. Remember that batteries contain a small amount of explosive hydrogen gas which is a by-product of battery charging. Sparks should always be avoided when working around batteries, especially when attaching jumper cables. To minimize the possibility of accidental sparks, follow the procedure carefully.

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Connect the jumper cables to the batteries and engine in the order shown

NEVER hook the batteries up in a series circuit or the entire electrical system will go up in smoke, including the starter!

Vehicles equipped with a diesel engine may utilize two 12 volt batteries. If so, the batteries are connected in a parallel circuit (positive terminal to positive terminal, negative terminal to negative terminal). Hooking the batteries up in parallel circuit increases battery cranking power without increasing total battery voltage output. Output remains at 12 volts. On the other hand, hooking two 12 volt batteries up in a series circuit (positive terminal to negative terminal, positive terminal to negative terminal) increases total battery output to 24 volts (12 volts plus 12 volts).

Jump Starting Precautions

- Be sure that both batteries are of the same voltage. Vehicles covered by this manual and most vehicles on the road today utilize a 12 volt charging system.
- Be sure that both batteries are of the same polarity (have the same terminal, in most cases NEGATIVE grounded).
- Be sure that the vehicles are not touching or a short could occur.
- On serviceable batteries, be sure the vent cap holes are not obstructed.

- Do not smoke or allow sparks anywhere near the batteries.
- In cold weather, make sure the battery electrolyte is not frozen. This can occur more readily in a battery that has been in a state of discharge.
- Do not allow electrolyte to contact your skin or clothing.

Jump Starting Procedure

1. Make sure that the voltages of the 2 batteries are the same. Most batteries and charging systems are of the 12 volt variety.
2. Pull the donor vehicle (with the good battery) into a position so the jumper cables can reach the dead battery and that vehicle's engine. Make sure that the vehicles do NOT touch.
3. Place the transmissions/transaxles of both vehicles in ***Neutral*** (MT) or ***P*** (AT), as applicable, then firmly set their parking brakes.

If necessary for safety reasons, the hazard lights on both vehicles maybe operated throughout the entire procedure without significantly increasingthe difficulty of jumping the dead battery.

4. Turn all lights and accessories OFF on both vehicles. Make sure the ignition switches on both vehicles are turned to the ***OFF*** position.
5. Cover the battery cell caps with a rag, but do not cover the terminals.
6. Make sure the terminals on both batteries are clean and free of corrosion or proper electrical connection will be impeded. If necessary, clean the battery terminals before proceeding.
7. Identify the positive (+) and negative (-) terminals on both batteries.
8. Connect the first jumper cable to the positive (+) terminal of the dead battery, then connect the other end of that cable to the positive (+) terminal of the donor (good) battery.
9. Connect one end of the other jumper cable to the negative (-) terminal on the donor battery and the final cable clamp to an engine bolt head, alternator bracket or other solid, metallic point on the engine with the dead battery. Try to pick a ground on the engine that is positioned away from the battery in order to minimize the possibility of the 2 clamps touching should one loosen during the procedure. Do NOT connect this clamp to the negative (-) terminal of the dead battery.

Be very careful to keep the jumper cables away from moving parts (coolingfan, belts, etc.) on both engines.

10. Check to make sure that the cables are routed away from any moving parts, then start the donor vehicle's engine. Run the engine at moderate speed for several minutes to allow the dead battery a chance to receive some initial charge.
11. With the donor vehicle's engine still running slightly above idle, try to start the vehicle with the dead battery. Crank the engine for no more than 10 seconds at a time and let the starter cool for at least 20 seconds between tries. If the vehicle does not start in 3 tries, it is likely that something else is also wrong or that the battery needs additional time to charge.
12. Once the vehicle is started, allow it to run at idle for a few seconds to make sure that it is operating properly.
13. Turn ON the headlights, heater blower and, if equipped, the rear defroster of both vehicles in order to reduce the severity of voltage spikes and subsequent risk of damage to the vehicles' electrical systems when the cables are disconnected. This step is especially important to any vehicle equipped with computer control modules.
14. Carefully disconnect the cables in the reverse order of connection. Start with the negative cable that is attached to the engine ground, then the negative cable on the donor battery. Disconnect the positive cable from the donor battery and finally, disconnect the positive cable from the formerly dead battery. Be careful when disconnecting the cables from the positive terminals not to allow the alligator clips to touch any metal on either vehicle or a short and sparks will occur.

JACKING

Introduction

Place the jack under the frame rails to lift the front of the vehicle

Also place the jack stand under the frame rails to support the front of the vehicle

Place the jack under the body seam to lift the rear of the vehicle

Also place the jack stand under the body seam to support the rear of the vehicle

Always chock the opposite end's wheel when lifting one side of the vehicle (if lifting passenger side front, chock driver's side rear)

Slide the chock under the wheel and tight up against the tire

Your vehicle was supplied with a jack for emergency road repairs. This jack is fine for changing a flat tire or other short-term procedures not requiring you to go beneath the vehicle. If it is used in an emergency situation, carefully follow the instructions provided either with the jack or in your owner's manual. Do not attempt to use the jack on any portions of the vehicle other than specified by the vehicle manufacturer. Always block the diagonally opposite wheel when using a jack.

A more convenient way of jacking is the use of a garage or floor jack. You may use the floor jack to raise the car in the positions indicated in the accompanying photographs.

Never place the jack under the radiator, engine or transmission components. Severe and expensive damage will result when the jack is raised. Additionally, never jack under the floorpan or bodywork; the metal will deform.

Whenever you plan to work under the vehicle, you must support it on jack stands or ramps. Never use cinder blocks or stacks of wood to support the vehicle, even if you're only going to be under it for a few minutes. Never crawl under the vehicle when it is supported only by the tire-changing jack or other floor jack.

Always position a block of wood or small rubber pad on top of the jack orjack stand to protect the lifting point's finish when lifting or supporting thevehicle.

Small hydraulic, screw, or scissors jacks are satisfactory for raising the vehicle. Drive-on trestles or ramps are also a handy and safe way to both raise and support the vehicle. Be careful though, some ramps may be too steep to drive your vehicle onto without scraping the front bottom panels. Never support the vehicle on any suspension member (unless specifically instructed to do so by a repair manual) or by an underbody panel.

Jacking Precautions

The following safety points cannot be overemphasized:

- Always block the opposite wheel or wheels to keep the vehicle from rolling off the jack.
- When raising the front of the vehicle, firmly apply the parking brake.
- When the drive wheels are to remain on the ground, leave the vehicle in gear to help prevent it from rolling.
- Always use jack stands to support the vehicle when you are working underneath. Place the stands beneath the vehicle's jacking brackets. Before climbing underneath, rock the vehicle a bit to make sure it is firmly supported.

SPECIFICATIONS CHARTS

Click on icon to view fullsize printable image. **Click to Enlarge** *Standard and Metric Conversion Factors Chart*
Click on icon to view fullsize printable image. **Click to Enlarge** *Vehicle Identification Chart*
Click on icon to view fullsize printable image. **Click to Enlarge** *General Engine Specifications*
Click on icon to view fullsize printable image. **Click to Enlarge** *Engine Tune-up Specifications*
Click on icon to view fullsize printable image. **Click to Enlarge** *Normal Scheduled Maintenance Intervals*
Click on icon to view fullsize printable image. **Click to Enlarge** *Severe Scheduled Maintenance Intervals*

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ENGINE ELECTRICAL

ELECTRONIC IGNITION SYSTEM-3.0L OHV ENGINES

Electronic Ignition System-3.0L OHV Engines

For information on understanding electricity and troubleshooting electrical circuits, please refer to Section 6 *of this manual.*

General Information

The Electronic Ignition (EI) system is used for both the 3.0L OHV gasoline and Flexible Fuel (FF) engines. The system consists of the following components:

- Crankshaft Position (CKP) sensor
- Ignition coil
- Desired spark angle from the Powertrain Control Module (PCM)
- Related wiring

The Crankshaft Position (CKP) sensor is a variable reluctance sensor triggered by a 36 minus 1 tooth trigger wheel located on the crankshaft pulley and damper. The signal generated from the CKP sensor is known as the CKP sensor signal. This signal provides base timing and crankshaft speed (rpm) information to the Powertrain Control Module (PCM). The PCM will use this information along with the spark advance information to determine when to turn the ignition coil on or off.

The ignition coil, which is mounted to the rear of the left-hand cylinder head, contains three separate coils. Each coil is controlled by the PCM through three coil leads. Each coil activates two spark plugs simultaneously.

One spark plug is activated on the compression stroke. This spark plug uses the majority of the ignition coil's stored energy. The other plug is activated simultaneously on the exhaust stroke. This plug will use very little of the coil's stored energy. These two spark plugs are connected in series so that the firing voltage of one spark plug will be negative with respect to ground and the other spark plug will be positive with respect to ground.

Diagnosis and Testing

PRELIMINARY CHECKS

1. Visually inspect the engine compartment to ensure that all vacuum lines and spark plug wires are properly routed and securely connected.
2. Be certain that the battery is fully charged and that all accessories are ***OFF*** during the diagnosis.
3. Measure the spark plug wire resistance. Refer to Section 1 for this procedure.

A simple way to check for proper ignition system operation is the secondary spark test. However, if this test fails to show a spark, the individual components of the system must be tested. Refer to the different components in this section for their testing procedures.

SERVICE PRECAUTIONS

Always turn the key ***OFF*** and isolate both ends of a circuit whenever testing for short or continuity.

Always disconnect solenoids and switches from the harness before measuring for continuity, resistance or energizing by way of a 12 volt source.

Electronic modules are sensitive to static electrical charges. If the moduleis exposed to these charges, damage may result.

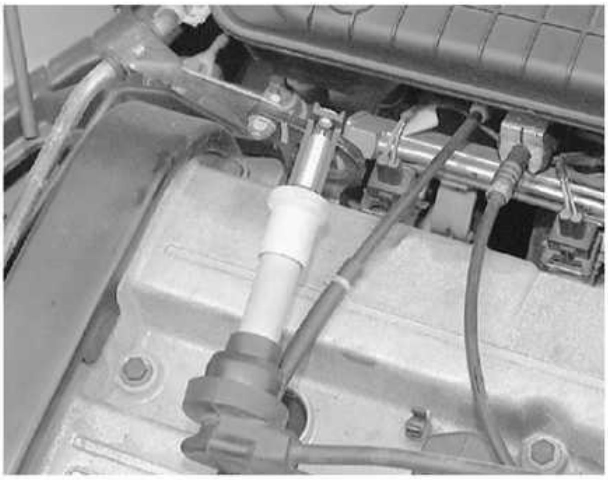
Before performing any component testing, check for and, if necessary, repair the following:

- Damaged, fouled, improperly seated or improperly gapped spark plugs
- Damaged or improperly engaged electrical connections, spark plug wires, etc.
- Discharged battery
- Blown fuses

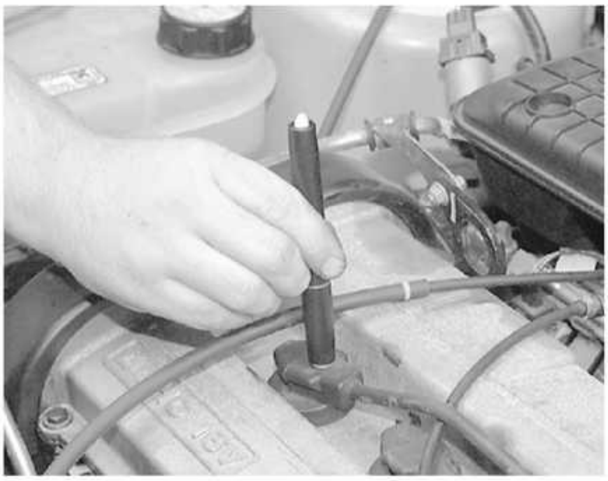
SECONDARY SPARK TEST

This spark tester looks just like a spark plug. Attach the clip to ground and crank the engine to check for spark

This spark tester has an adjustable air gap for measuring spark strength and testing different voltage ignition systems



Attach the clip to ground and crank the engine to check for spark



This spark tester is the easiest to use - just place it on a plug wire and the spark voltage is detected and the bulb on the top will flash with each pulse

The best way to perform this procedure is to use a spark tester (available at most automotive parts stores). Two types of spark testers are commonly available. The Neon Bulb type is connected to the spark plug wire and flashes with each ignition pulse. The Air Gap type must be adjusted to the individual spark plug gap specified for the engine. This type of tester allows the user to not only detect the presence of spark, but also the intensity (orange/yellow is weak, blue is strong).

1. Disconnect a spark plug wire at the spark plug end.
2. Connect the plug wire to the spark tester and ground the tester to an appropriate location on the engine.
3. Crank the engine and check for spark at the tester.
4. If spark exists at the tester, the ignition system is functioning properly.
5. If spark does not exist at the wire, test the ignition coil, and other ignition system related components or wiring. Repair or replace components as necessary.

Adjustments

The ignition system functions are controlled by the PCM, so no adjustment is necessary.

Ignition Coil

TESTING

Click to Enlarge

Coil pack pin location and coil towers-3.0L engines

PRIMARY WINDING RESISTANCE

Testing the coil primary resistance using a multimeter

1. Turn the ignition ***OFF***.
2. Disconnect the negative battery cable.
3. Disconnect the wiring harness from the ignition coil.
4. Check for dirt, corrosion or damage on the terminals and repair as necessary.
5. Measure coil primary resistance between ignition coil pin 4 (B+) and pins 1 (coil 2), 2 (coil 3) and 3 (coil 1).
6. Resistance should be 0.3-1.0 ohms. If resistance is out of specifications, replace the coil pack. If resistance is within specifications, proceed to secondary winding resistance testing.

SECONDARY WINDING RESISTANCE

Testing the coil secondary resistance between the ignition wire terminals

REMOVAL & INSTALLATION

1. Disconnect the negative battery cable.
2. Unplug the wiring connectors from the ignition coil and the radio ignition interference capacitor.
3. Tag and disconnect the spark plug wires from the coil by squeezing the locking tabs, then twist the tab and pull upwards.
4. Unfasten the four ignition coil retaining screws and remove the coil and the radio ignition interference capacitor as an assembly.
5. If you are replacing the coil, unfasten the radio ignition interference capacitor retaining screw and remove the capacitor.
6. Wipe the coil towers with a clean cloth dampened with soap and water. Remove any soap film and dry with compressed air. Inspect the coil for cracks, carbon tracking, dirt or damage and replace as necessary.

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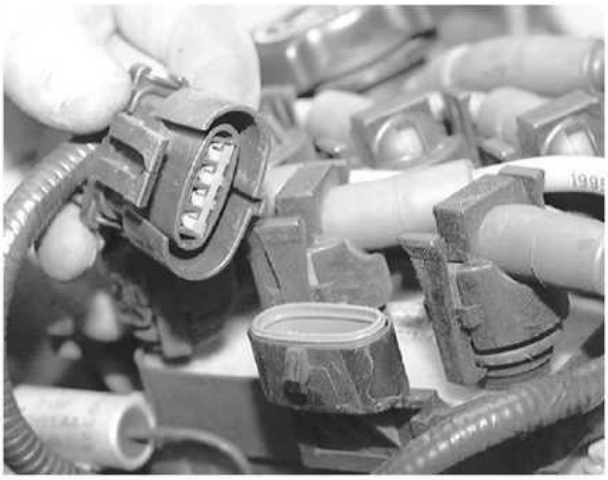
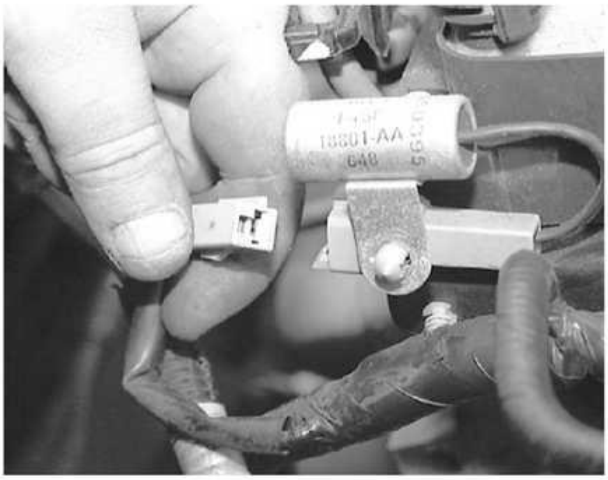
Ignition coil and bracket mounting-3.0L OHV engines

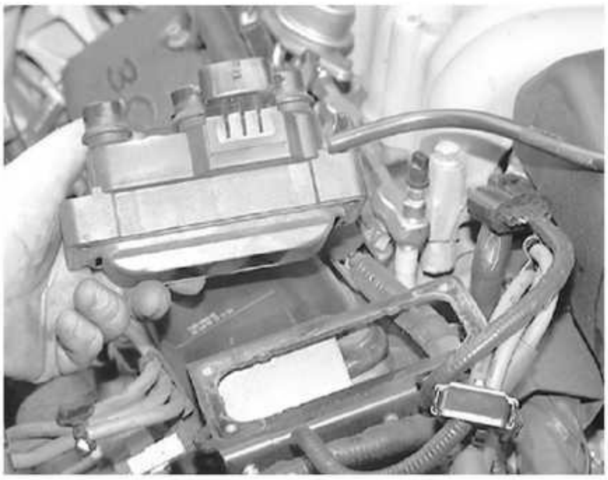


Detach the coil pack connector and the...

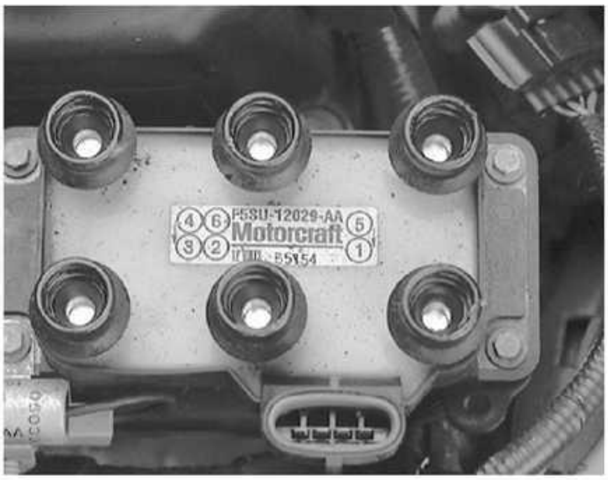


... ignition capacitor connector

Remove the spark plug wires from the coil pack by depressing the retaining tabs and lifting the wires from the coil pack towers. Remember to label the wires before removal



Loosen the coil pack retaining bolts and remove the coil pack from the vehicle



The coils are numbered on a label on the coil pack to help you on reinstallation

To install:

7. If removed, place the capacitor in position and install its retaining screw. Tighten the screw to 45-61 inch lbs. (5-7 Nm).
8. Place the coil and capacitor assembly into position on the bracket.
9. Install the coil assembly retaining screws and tighten to 45-61 inch lbs. (5-7 Nm).
10. Apply dielectric compound D7AZ-19A331-A or its equivalent to the spark plug wire boots.
11. Attach the spark plug wires to their proper terminals on the coil and make sure the boots are firmly seated so that the locking tabs engage.
12. Attach the wiring connectors to the ignition coil and the radio ignition interference capacitor.
13. Connect the negative battery cable, start the vehicle and check for proper operation.

Camshaft and Crankshaft Position Sensors

For position sensor procedures, please refer to Section 4 in this manual.

ELECTRONIC IGNITION (EI– HIGH DATA RATE) IGNITION SYSTEM-3.0L DOHC ENGINES

General Information

The Electronic Ignition (EI High Data Rate) system is used on the 3.0L DOHC engines. The system consists of the following components:

- Crankshaft Position (CKP) sensor
- Ignition coil
- Desired spark angle from the Powertrain Control Module (PCM)
- Related wiring

The Crankshaft Position (CKP) sensor is a variable reluctance sensor triggered by a 36 minus 1 tooth trigger wheel located inside the engine front cover. The sine wave signal generated from the CKP sensor is known as the CKP sensor signal. This signal provides two types of information to the Powertrain Control Module (PCM): the position of the crankshaft in 10 degree increments and crankshaft speed (rpm). The PCM will use this information along with the spark advance information to determine when to turn the ignition coil on or off.

The ignition coil contains separate coils. Each coil is controlled by the PCM through two coil leads. Each coil activates two spark plugs simultaneously.

One spark plug is activated on the compression stroke. This spark plug uses the majority of the ignition coil's stored energy. The other plug is activated simultaneously on the exhaust stroke. This plug will use very little of the coil's stored energy. These two spark plugs are connected in series so that the firing voltage of one spark plug will be negative with respect to ground and the other spark plug will be positive with respect to ground.

Diagnosis and Testing

PRELIMINARY CHECKS

1. Visually inspect the engine compartment to ensure that all vacuum lines and spark plug wires are properly routed and securely connected.
2. Be certain that the battery is fully charged and that all accessories are ***OFF*** during the diagnosis.
3. Measure the spark plug wire resistance. Refer to Section 1 for this procedure.

A simple way to check for proper ignition system operation is the secondary spark test. However, if this test fails to show a spark, the individual components of the system must be tested. Refer to the different components in this section for their testing procedures.

SERVICE PRECAUTIONS

Always turn the key ***OFF*** and isolate both ends of a circuit whenever testing for short or continuity.

Always disconnect solenoids and switches from the harness before measuring for continuity, resistance or energizing by way of a 12 volt source.

Electronic modules are sensitive to static electrical charges. If the moduleis exposed to these charges, damage may result.

Before performing any component testing, check for and, if necessary, repair the following:

- Damaged, fouled, improperly seated or improperly gapped spark plugs
- Damaged or improperly engaged electrical connections, spark plug wires, etc.
- Discharged battery
- Blown fuses

SECONDARY SPARK TEST

The best way to perform this procedure is to use a spark tester (available at most automotive parts stores). Two types of spark testers are commonly available. The Neon Bulb type is connected to the spark plug wire and flashes with each ignition pulse. The Air Gap type must be adjusted to the individual spark plug gap specified for the engine. This type of tester allows the user to not only detect the presence of spark, but also the intensity (orange/yellow is weak, blue is strong).

1. Disconnect a spark plug wire at the spark plug end.
2. Connect the plug wire to the spark tester and ground the tester to an appropriate location on the engine.
3. Crank the engine and check for spark at the tester.
4. If spark exists at the tester, the ignition system is functioning properly.
5. If spark does not exist at the wire, test the ignition coil, and other ignition system related components or wiring.

Repair or replace components as necessary.

Adjustments

The ignition system functions are controlled by the PCM, so no adjustment is necessary.

Ignition Coil

TESTING

PRIMARY WINDING RESISTANCE

1. Turn the ignition ***OFF***.
2. Disconnect the negative battery cable.
3. Disconnect the wiring harness from the ignition coil.
4. Check for dirt, corrosion or damage on the terminals and repair as necessary.
5. Measure coil primary resistance between ignition coil pin 4 (B+) and pins 1 (coil 2), 2 (coil 3) and 3 (coil 1).
6. Resistance should be 0.3-1.0 ohms. If resistance is out of specifications, replace the coil pack. If resistance is within specifications, proceed to secondary winding resistance testing.

SECONDARY WINDING RESISTANCE

REMOVAL & INSTALLATION

1. Disconnect the negative battery cable.
2. Unplug the wiring connectors from the ignition coil and the radio ignition interference capacitor.
3. Tag and disconnect the spark plug wires from the coil by squeezing the locking tabs, then twist the tab and pull upwards.
4. Unfasten the four ignition coil retainers and remove the coil and the coil ground wire the radio ignition interference capacitor. Save the capacitor and coil ground wire for re-installation of the coil assembly.
5. Wipe the coil towers with a clean cloth dampened with soap and water. Remove any soap film and dry with compressed air. Inspect the coil for cracks, carbon tracking, dirt or damage and replace as necessary.

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Ignition coil assembly mounting-3.0L DOHC engines

To install:

6. Place the coil, capacitor and the coil ground wire onto its mounting location on the right hand valve cover.
7. Install the coil assembly retainers and tighten to 45-61 inch lbs. (5-7 Nm)..
8. Apply dielectric compound D7AZ-19A331-A or its equivalent to the spark plug wire boots.
9. Attach the spark plug wires to their proper terminals on the coil and make sure the boots are firmly seated so that the locking tabs engage.
10. Attach the wiring connectors to the ignition coil and the radio ignition interference capacitor.
11. Connect the negative battery cable, start the vehicle and check for proper operation.

Camshaft and Crankshaft Position Sensors

For position sensor procedures, please refer to Section4 in this manual.

ELECTRONIC IGNITION (EI) SYSTEM-3.4L DOHC ENGINES

General Information

The Electronic Ignition (EI) system is used on the 3.4 DOHC engines. The system consists of the following components:

- Crankshaft Position (CKP) sensor
- Camshaft Position (CMP) sensor
- Coil-on-plug units
- Spark control portion of the Powertrain Control Module (PCM)
- Related wiring

The Crankshaft Position (CKP) sensor is a variable reluctance sensor triggered by a 36 minus 1 tooth trigger wheel located inside the engine front cover. The sine wave signal generated from the CKP sensor is known as the CKP sensor signal. This signal provides two types of information to the Powertrain Control Module (PCM): the position of the crankshaft in 10 degree increments and crankshaft speed (rpm).

The Camshaft Position (CMP) sensor is a variable reluctance sensor. The sensor is triggered by the high point mark on the left hand exhaust camshaft. The CMP sensor provides camshaft rotational location to the Powertrain Control Module (PCM). The PCM uses the CMP sensor signal for the ignition coil firing sequence and also for fuel injector synchronization.

The 3.4L engine uses eight separate coil-on-plug units. Each coil-on-plug unit is controlled by the PCM. Each coil-on-plug unit is mounted directly above each spark plug and activates its own spark plug in the proper sequence as controlled by the PCM.

During some ignition system concerns the failure mode effects management portion of the PCM will maintain vehicle operation as follows:

- If the spark plug output signal is interrupted, the PCM will automatically turn the coil-on-plug unit on and off using the CKP sensor signal input. This will result in a fixed spark timing and fixed dwell time.
- If the PCM does not receive the CMP sensor input during engine cranking, the PCM will revert to the double coil fire mode. One coil will fire on the compression stroke while its cylinder pair fires on the exhaust stroke. The engine will start normally.
- If the PCM loses CMP input while the engine is running, the PCM will retain the proper firing sequence and will continue to fire the coil-on-plug units to maintain engine operation.

Diagnosis and Testing

PRELIMINARY CHECKS

1. Visually inspect the engine compartment to ensure that all vacuum lines and electrical connections are properly routed and securely attached.
2. Be certain that the battery is fully charged and that all accessories are ***OFF*** during the diagnosis.

A simple way to check for proper ignition system operation is the secondary spark test. However, if this test fails to show a spark, the individual components of the system must be tested. Refer to the different components in this section for their testing procedures.

SERVICE PRECAUTIONS

Always turn the key ***OFF*** and isolate both ends of a circuit whenever testing for short or continuity.

Always disconnect solenoids and switches from the harness before measuring for continuity, resistance or energizing by way of a 12 volt source.

Electronic modules are sensitive to static electrical charges. If the moduleis exposed to these charges, damage may result.

Before performing any component testing, check for and if necessary repair the following:

- Damaged, fouled, improperly seated or improperly gapped spark plugs
- Damaged or improperly engaged electrical connections, spark plug wires, etc.
- Discharged battery
- Blown fuses

SECONDARY SPARK TEST

The best way to perform this procedure is to use an air gap spark tester (available at most automotive parts stores). The Air Gap type must be adjusted to the individual spark plug gap specified for the engine. This type of tester allows the user to not only detect the presence of spark, but also the intensity (orange/yellow is weak, blue is strong).

1. Remove the coil from the plug.

2. Connect the spark tester to a coil and ground the tester to an appropriate location on the engine.
3. Crank the engine and check for spark at the tester.
4. If spark exists at the tester, the ignition system is functioning properly.
5. If spark does not exist at the wire, test the ignition coil, and other ignition system related components or wiring. Repair or replace components as necessary.

Adjustments

The ignition system functions are controlled by the PCM, so no adjustment is necessary.

Coil-On-Plug Unit

TESTING

1. Unplug the coil-on-plug wiring harness.
2. Turn the ignition key ***ON***.
3. Using a Digital Volt Ohmmeter (DVOM) set to read voltage, measure the voltage between the IGN start/run terminal of the harness and ground.
4. The Voltage reading should be greater than 10.5 volts. If the voltage is less than specified, check the condition of related fuses and fuse links and repair as necessary. If a fuse or fuse link is damaged, check the ignition start/run circuit for a short to ground and repair as necessary. Check the voltage reading again and verify that it meets specifications.
5. Perform the spark test as outlined in this section. If spark is present, the coil is functioning properly. Check the condition of the spark plugs and repair as necessary. If spark is not present, the coil is probably defective and should be replaced.

REMOVAL & INSTALLATION

To install:

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The coil-on-plug assembly is attached directly to the spark plug-3.4L DOHC engines

Camshaft and Crankshaft Position Sensors

For position sensor procedures, please refer to Section 4 in this manual.

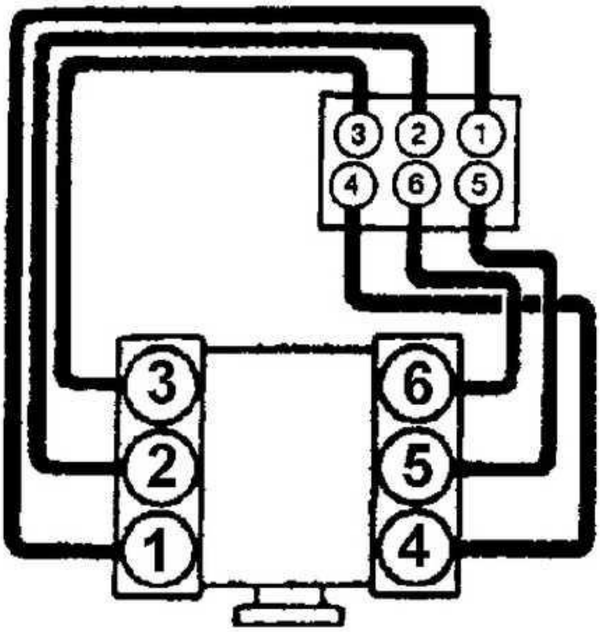
FIRING ORDERS

To avoid confusion, remove and tag the spark plug wires one at a time.

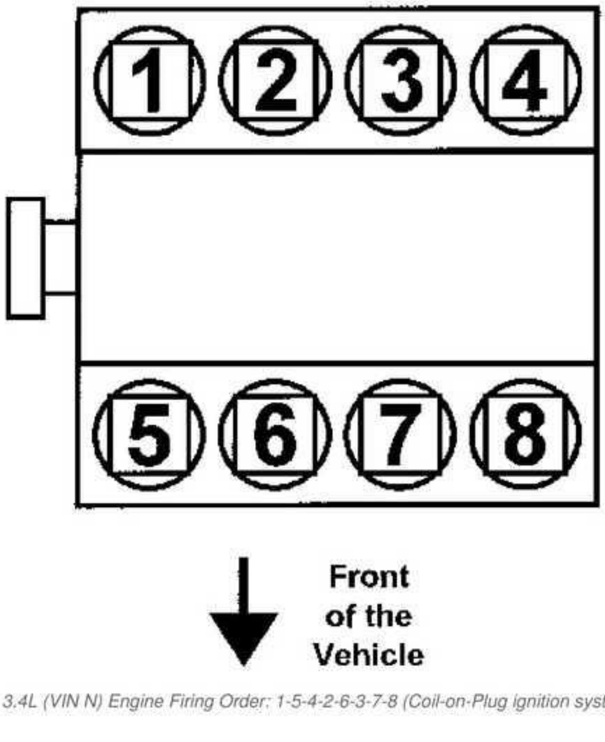
If a distributor is not keyed for installation with only one orientation, it could have been removed previously and rewired. The resultant wiring would hold the correct firing order, but could change the relative placement of the plug towers in relation to the engine. For this reason it is imperative that you label all wires before disconnecting any of them.

For vehicles equipped with distributorless ignition systems, it is difficult or impossible to wire the ignition system incorrectly and still have a running engine when you are done.

Before removal, compare the current wiring with the accompanying illustrations. If the current wiring does not match, make notes in your book to reflect how your engine is wired.



3.0L (VINS 1, 2 and U) Engines Firing Order: 1-4-2-5-3-6 (Distributorless ignition system)



3.4L (VIN N) Engine Firing Order: 1-5-4-2-6-3-7-8 (Coil-on-Plug ignition system)

CHARGING SYSTEM

General Information

The charging system is a negative (-) ground system which consists of an alternator, a regulator, a charge indicator lamp, a storage battery, circuit protection and wiring connecting the components.

The alternator is belt-driven from the engine. Energy is supplied from the alternator (with integral regulator) to the rotating field through brushes to slip-rings. The slip-rings are mounted on the rotor shaft and are connected to the field coil. This energy supplied to the rotating field from the battery is called excitation current and is used to initially energize the field to begin the generation of electricity. Once the alternator starts to generate electricity, the excitation current comes from its own output rather than the battery.

The alternator produces power in the form of alternating current. The alternating current is rectified by diodes into direct current. The direct current is used to charge the battery and power the rest of the electrical system. When the ignition key is turned on, current flows from the battery, through the charging system indicator light on the instrument panel, to the voltage regulator, and to the alternator. Since the alternator is not producing any current, the alternator warning light comes on. When the engine is started, the alternator begins to produce current and turns the alternator light off.

As the alternator turns and produces current, the current is divided in two ways: charging the battery and powering the electrical components of the vehicle. Part of the current is returned to the alternator to enable it to increase its output. In this situation, the alternator is receiving current from the battery and from itself. A voltage regulator is wired into the current supply to the alternator to prevent it from receiving too much current, which would cause it to overproduce current. Conversely, if the voltage regulator does not allow the alternator to receive enough current, the battery will not be fully charged and will eventually go dead.

The battery is connected to the alternator at all times, whether the ignition key is turned on or off. If the battery were shorted to ground, the alternator would also be shorted. This would damage the alternator. To prevent this, circuit protection (usually in the form of a fuse link) is installed in the wiring between the battery and the alternator. If the battery is shorted, the circuit protection will protect the alternator.

Alternator Precautions

To prevent damage to the alternator and voltage regulator, the following precautionary measures must be taken when working with the electrical system:

- NEVER ground or short out the alternator or regulator terminals.
- NEVER operate the alternator with any of its or the battery's lead wires disconnected.
- NEVER use a fast battery charger to jump start a dead battery.
- NEVER attempt to polarize an alternator.
- NEVER subject the alternator to excessive heat or dampness (for instance, steam cleaning the engine).
- NEVER use arc welding equipment on the car with the alternator connected.
- ALWAYS observe proper polarity of the battery connections; be especially careful when jump starting the car.
- ALWAYS remove the battery or at least disconnect the ground cable while charging.
- ALWAYS disconnect the battery ground cable while repairing or replacing electrical components.

Alternator

TESTING

Voltage Test

1. Make sure the engine is ***OFF***, and turn the headlights on for 15-20 seconds to remove any surface charge from the battery.
2. Using a DVOM set to volts DC, probe across the battery terminals.
3. Measure the battery voltage.
4. Write down the voltage reading and proceed to the next test.

No-Load Test

1. Connect a tachometer to the engine.

Ensure that the transmission is in Park and the emergency brake is set.Blocking a wheel is optional and an added safety measure.

2. Turn off all electrical loads (radio, blower motor, wipers, etc.).
3. Start the engine and increase engine speed to approximately 1500 rpm.
4. Measure the voltage reading at the battery with the engine holding a steady 1500 rpm. Voltage should have raised at least 0.5 volts, but no more than 2.5 volts.

5. If the voltage does not go up more than 0.5 volts, the alternator is not charging. If the voltage goes up more than 2.5 volts, the alternator is overcharging.

Usually under and overcharging is caused by a defective alternator, orits related parts (regulator), and replacement will fix the problem; however,faulty wiring and other problems can cause the charging system to malfunction.Further testing, which is not covered by this book, will reveal the exactcomponent failure. Many automotive parts stores have alternator bench testersavailable for use by customers. An alternator bench test is the most definitiveway to determine the condition of your alternator.

6. If the voltage is within specifications, proceed to the next test.

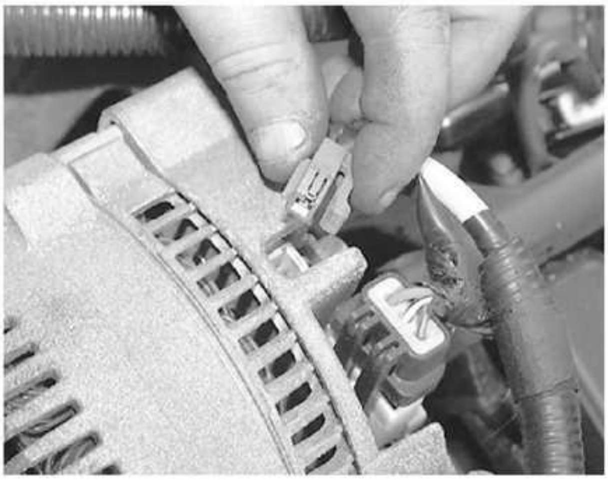
Load Test

1. With the engine running, turn on the blower motor and the high beams (or other electrical accessories to place a load on the charging system).
2. Increase and hold engine speed to 2000 rpm.
3. Measure the voltage reading at the battery.
4. The voltage should increase at least 0.5 volts from the voltage test. If the voltage does not meet specifications, the charging system is malfunctioning.

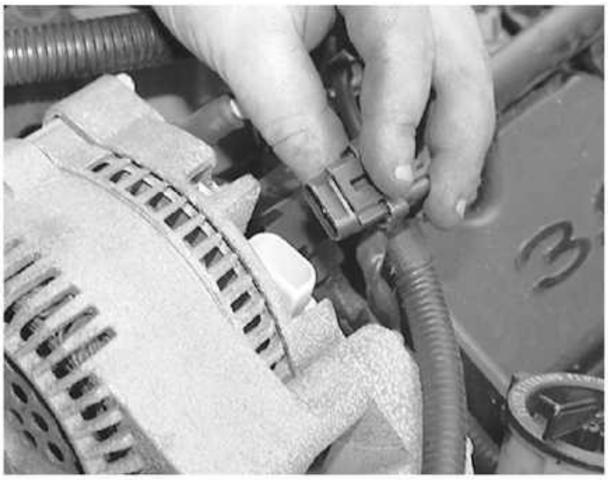
Usually under and overcharging is caused by a defective alternator, orits related parts (regulator), and replacement will fix the problem; however,faulty wiring and other problems can cause the charging system to malfunction.Further testing, which is not covered by this book, will reveal the exactcomponent failure. Many automotive parts stores have alternator bench testersavailable for use by customers. An alternator bench test is the most definitiveway to determine the condition of your alternator.

REMOVAL & INSTALLATION

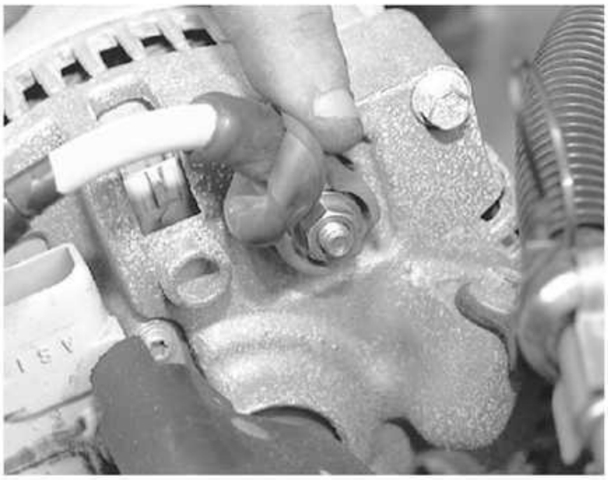
3.0L OHV Engines



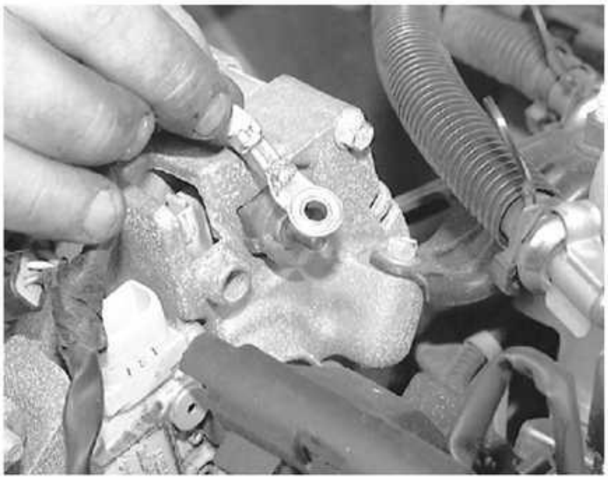
Detach the small electrical connector and...



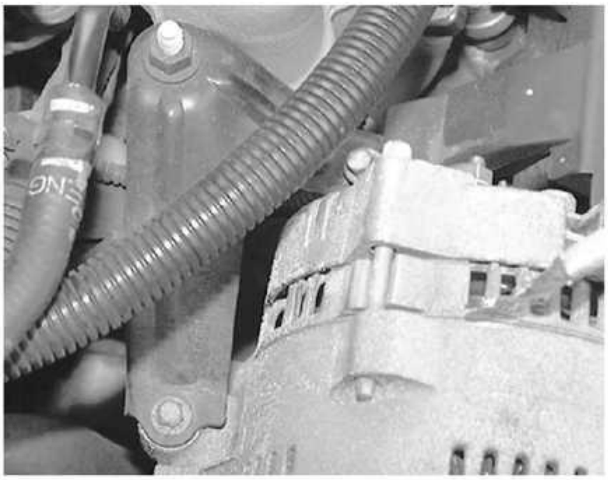
... the regulator connector from the alternator



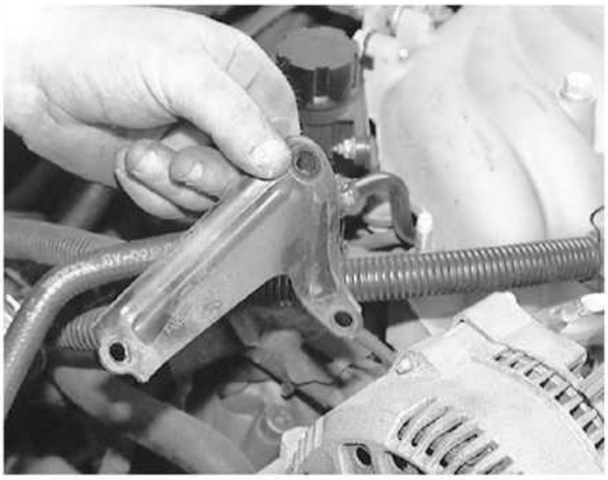
Slide the rubber boot back to access the output cable retaining nut



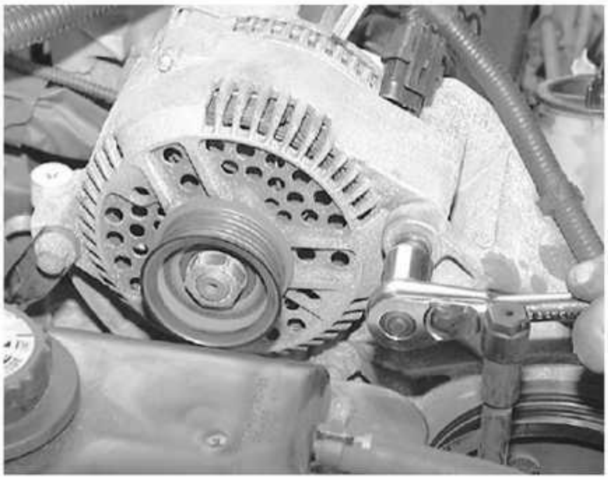
Remove the retaining nut and remove the cable from the alternator



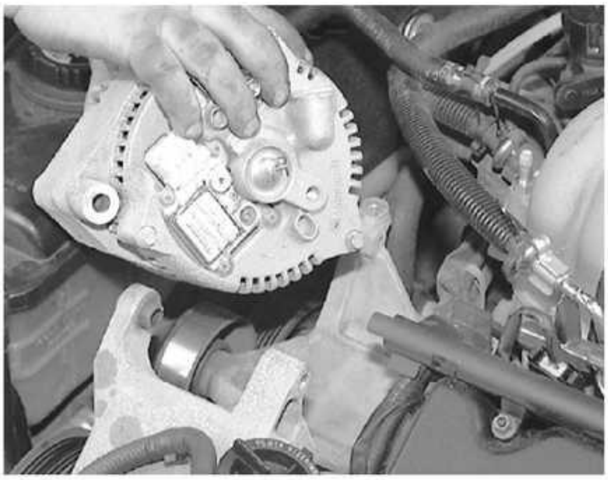
Remove the two mounting brace retaining nuts and one bolt and...



... remove the mounting brace



Remove the two alternator retaining bolts and...



... remove the alternator from the vehicle

The alternator is not internally serviceable.

1. Disconnect the negative battery cable.
2. Unplug the wiring harness electrical connectors from alternator/voltage regulator.
3. Unfasten the alternator output nut (B+) and remove the wire from the stud.
4. Loosen the alternator pivot bolt, then remove the mounting brace bolt from the alternator.
5. Remove the accessory drive belt from the alternator pulley. Refer to Section 1 of this manual for drive belt removal.
6. Unfasten the alternator brace retainers and remove the brace.
7. Unfasten the alternator pivot bolt and remove the alternator from the vehicle.

Click on icon to view fullsize printable image.

Click to Enlarge

Exploded view of the alternator mounting-3.0L OHV engines

To install:

8. Place the alternator into position.
9. Install the alternator pivot and mounting brace bolts. Do not tighten the bolts until the drive belt is properly tensioned.
10. Place the alternator brace into position. Tighten the brace retaining nut to 15-22 ft. lbs. (20-30 Nm) and the brace bolts to 76-97 inch lbs. (8.5-11 Nm).
11. Install the drive belt over the alternator pulley. Refer to Section 1 of this manual for drive belt installation.
12. Tighten the mounting brace bolt to 15-22 ft. lbs. (20-30 Nm) and the pivot bolt to 30-40 ft. lbs. (40-55 Nm).
13. Attach the wiring harness electrical connector to the alternator/voltage regulator.
14. Place the eyelet of the battery output wire onto the stud and install the nut. Tighten the nut to 62-80 inch lbs. (7-9 Nm).
15. Connect the negative battery cable.

3.0L DOHC Engines

1. Disconnect the negative battery cable.
2. Remove the accessory drive belt. Refer to Section 1 for this procedure.
3. Disengage the electrical harness connector and output terminal wiring.
4. Remove the engine control sensor nut and position the nut aside.
5. Unfasten the two alternator bolts and one alternator stud bolt.
6. Remove the alternator from the vehicle.

To install:

7. Place the alternator into position and install the two mounting bolts and bolt stud. Tighten the bolts and stud bolt to 15-22 ft. lbs. (20-30 Nm).
8. Place the engine control sensor in position and install its retaining nut. Tighten the nut to 11-14 ft. lbs. (15-20 Nm).

9. Attach the electrical harness connector and output terminal wiring. Tighten the output wiring terminal retaining nut to 80-106 inch lbs. (9-12 Nm).
10. Install the accessory drive belt. Refer to Section 1 for this procedure.
11. Connect the negative battery cable.

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Click to Enlarge

Exploded view of the alternator mounting-3.0L and DOHC engines (3.4L DOHC engines similar)

3.4L DOHC Engines

1. Disconnect the negative battery cable.
2. Remove the right side cowl vent screen.
3. Raise the vehicle and support it with jack stands.
4. Remove the right front wheel assembly.
5. Remove the right tie-rod. Refer to Section 8 for this procedure.
6. Remove the accessory drive belt. Refer to Section 1 for this procedure.
7. Disengage the electrical harness connector and output terminal wiring.
8. Remove the engine control sensor nut and position the nut aside.
9. Unfasten the two alternator bolts and one alternator stud bolt.
10. Remove the alternator from the vehicle.

To install:

11. Place the alternator into position and install the two mounting bolts and bolt stud. Tighten the bolts and stud bolt to 15-22 ft. lbs. (20-30 Nm).
12. Place the engine control sensor in position and install its retaining nut. Tighten the nut to 11-14 ft. lbs. (15-20 Nm).
13. Attach the electrical harness connector and output terminal wiring. Tighten the output wiring terminal retaining nut to 80-106 inch lbs. (9-12 Nm).
14. Install the accessory drive belt. Refer to Section 1 for this procedure.
15. Install the right tie-rod. Refer to Section 8 for this procedure.
16. Install the right front wheel assembly and lower the vehicle.
17. Install the right side cowl vent screen.
18. Connect the negative battery cable.

Regulator

3.0L OHV Engines

1. Disconnect the negative battery cable.
2. Disconnect the wiring harness from the alternator/regulator assembly.
3. Remove the four T20 Torx® head type screws attaching the regulator to the alternator rear housing.
4. Remove the regulator, with the brush and terminal holder attached, from the alternator.
5. Pry the cap off the ***A*** terminal screw with a prying tool.
6. Unfasten the brush and terminal holder-to-voltage regulator T20 Torx® head type screws, then separate the regulator from the brush and terminal holder.

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Click to Enlarge

The voltage regulator is mounted on the back of the alternator and is retained by four T20 Torx® head screws

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Click to Enlarge

The voltage regulator is attached to brush and terminal holder and is retained by two T20 Torx® head screws

To install:

7. Engage the voltage regulator to the brush and terminal holder and tighten the two screws to 25-35 inch lbs. (2.8-4 Nm)
8. Install the cap on the ***A*** terminal screw.
9. Depress the brushes into the brush holder and hold the brushes in position by inserting a standard size paper clip or its equivalent through both the location holes in the regulator and the holes in the brushes.
10. Fit the regulator and brush holder assemblies to the alternator rear housing and install the retaining screws. Tighten the screws to 21-30 inch lbs. (2.3-3.4 Nm).
11. Remove the paper clip or equivalent from the alternator.
12. Connect the alternator wiring harness.
13. Connect the negative battery cable.

3.0L and 3.4L DOHC Engines

The voltage regulator on these models is an integral part of the alternator. If the regulator is defective, replace the alternator assembly.

STARTING SYSTEM

General Information

The starting system includes the battery, starter motor, solenoid, ignition switch, circuit protection and wiring connecting the components. An inhibitor switch located in the Transmission Range (TR) sensor is included in the starting system to prevent the vehicle from being started with the vehicle in gear.

When the ignition key is turned to the ***START*** position, current flows and energizes the starter's solenoid. The starter solenoid is energized directly from the ignition circuitry. A magnetic field is created in the solenoid coil. The iron plunger core is drawn into the solenoid coil. The lever connected to the starter drive engages the drive pinion gear to the ring gear on the flywheel or the offset gear (depending on application). When the iron plunger core is completely into the coil, its contact disc closes the circuit between the battery and starter motor terminals. The current travels to the starter which cranks the engine until it starts or the ignition switch is released from the ***START*** position.

To prevent damage caused by excessive starter armature rotation when the engine starts, the starter incorporates an over-running clutch in the pinion gear.

Starter

TESTING

Voltage Drop Testing

MOTOR FEED CIRCUIT

The battery must be in good condition and fully charged prior toperforming these tests.

1. Make sure the battery terminals are clean and tight.
2. Check the starter motor electrical wires for insulation damage, and that the connections are properly engaged and have no dirt or corrosion.
3. Disengage the electrical connections from the ignition coil to prevent the engine from starting.
4. Using a Digital Volt Ohmmeter (DVOM) set on the voltage scale, connect the DVOM positive lead to the battery positive terminal and the negative lead to the starter solenoid ***M*** terminal.
5. Use a remote starter (connected between the battery positive terminal and the starter motor ***S*** terminal) or with the help an assistant, crank the engine and observe the voltage reading.
6. If the voltage at the ***M*** Terminal is higher than 0.5 volts, move the DVOM negative lead to the solenoid ***B*** terminal and repeat the test.
7. If the voltage reading is higher than 0.5 volts there may be a problem with the solenoid or the wires.
8. Disengage, clean and reinstall the ***B***, ***S*** and ***M*** terminals. Repeat Steps 4-6.
9. If the voltage readings are still the same the solenoid is defective and must be replaced.

Many automotive parts stores have starter bench testers available for useby customers. A starter bench test is the most definitive way to determine thecondition of your starter.

Click on icon to view fullsize printable image.

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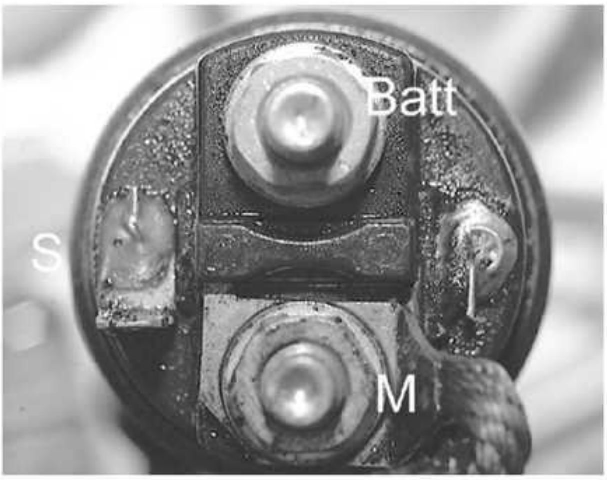
Wiring schematic of the remote starter and DVOM connections required when performing a voltage drop test of the motor feed circuit



The location of the starter motor terminals on the solenoid

MOTOR GROUND CIRCUIT

If the voltage reading is too high, clean the terminal ends and retest. If the reading is still too high, replace the cable.

Many automotive parts stores have starter bench testers available for useby customers. A starter bench test is the most definitive way to determine thecondition of your starter.

Click on icon to view fullsize printable image.

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Wiring schematic of the remote starter and DVOM connections required when performing a voltage drop test of the motor ground circuit

REMOVAL & INSTALLATION

When performing any work on or near the starter motor, note that the heavy gauge input lead connected to the starter solenoid is electrically hot atall times. Make sure the protective cap is installed over the terminal and isreplaced after service.

1. Disconnect the negative battery cable.
2. Raise the vehicle and support it with jack stands.

When disengaging the plastic hard shell connector at the solenoid S terminal, grasp the connector and depress the plastic tab, then pull off the lead assembly. Do not pull on the lead.

3. Disengage the starter motor solenoid electrical connector and starter battery cable from the starter solenoid.
4. Unfasten the upper and lower starter motor mounting bolts.
5. Remove the starter from the vehicle.

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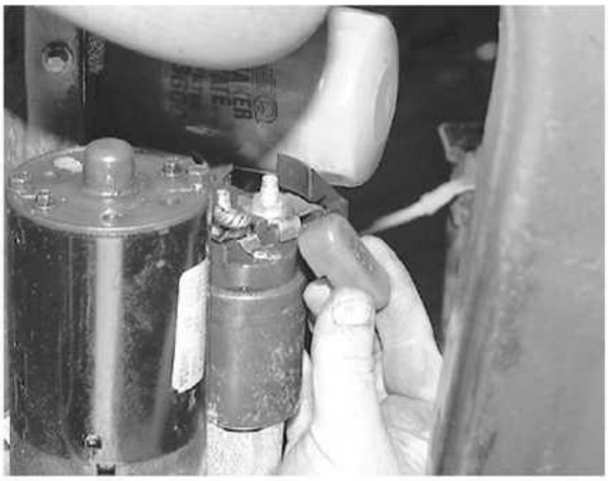
Click to Enlarge

Starter motor mounting and related components-3.0L OHV engines

Click on icon to view fullsize printable image.

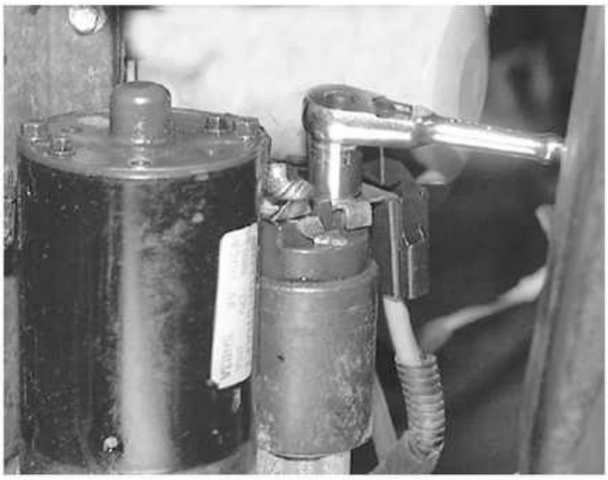
Click to Enlarge

Starter motor mounting and related components-3.0L DOHC and 3.4L DOHC engines



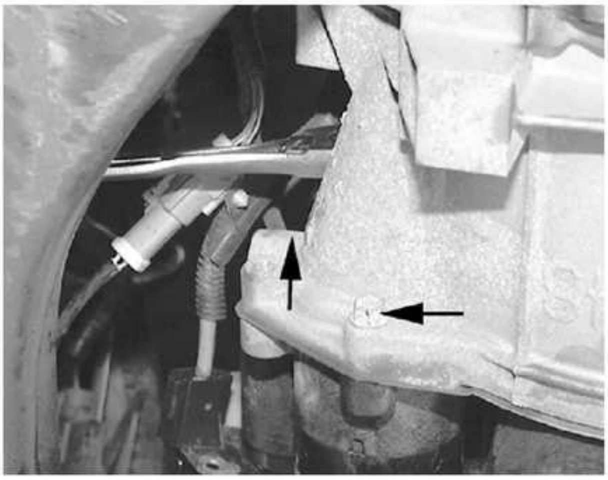
Remove the protective cap from the starter motor terminals

Remove the starter motor solenoid terminal connector by depressing the retaining tab and pulling the connector off



Remove the nut retaining the battery cable and...

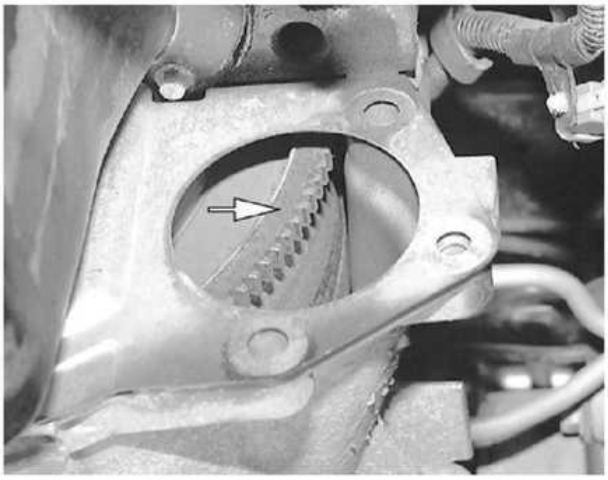
... remove the battery cable from the starter



Remove the two starter retaining bolts and...

... carefully remove the starter from the bellhousing and...

... remove the starter from the vehicle



Inspect the flexplate for damage before installing the starter

To install:

6. Place the starter motor in position and install the mounting bolts finger-tight. Tighten the upper and lower mounting bolts to 16-21 ft. lbs. (21-29 Nm).
7. Attach the starter battery cable and install its retaining nut. Tighten the nut to 80-123 inch lbs. (9-14 Nm).
8. Attach the starter motor connector. Make sure to be careful to push straight on the connector and make sure it locks into position with a notable click or detent.
9. Install the solenoid terminal cover.
10. Lower the vehicle and connect the negative battery cable.

SOLENOID REPLACEMENT

1. Remove the starter motor, as described in this section.
2. Remove the positive brush connector from the solenoid motor "M" terminal.
3. Unfasten the solenoid retaining screws and remove the solenoid.

To install:

4. Correctly position the solenoid to the drive end housing, making sure the solenoid plunger is attached through the drive lever and pin (the bottom ***M*** solenoid should have a metal strip attached to it).
5. Install and tighten the solenoid screw(s) to 45-88 inch lbs. (5-10 Nm).
6. Attach the positive brush connector nut to the solenoid ***M*** terminal and tighten the brush connector nut to 80-123 inch lbs. (9-14 Nm).
7. Install the starter motor.

SENDING UNITS

Sending Units

This section describes the operating principles of sending units, warning lights and gauges. Sensors that provide information to the Electronic Control Module (ECM) are covered in Section 4 ***of this manual.***

Instrument panels contain a number of indicating devices (gauges and warning lights). These devices are composed of two separate components. One is the sending unit, mounted on the engine or other remote part of the vehicle, and the other is the actual gauge or light in the instrument panel.

Several types of sending units exist, however most can be characterized as being either a pressure type or a resistance type. Pressure type sending units convert liquid pressure into an electrical signal which is sent to the gauge. Resistance type sending units are most often used to measure temperature and use variable resistance to control the current flow back to the indicating device. Both types of sending units are connected in series by a wire to the battery (through the ignition switch). When the ignition is turned ***ON***, current flows from the battery through the indicating device and on to the sending unit.

Temperature Gauge Sending Unit

The sending unit is located in the engine block or cylinder head.

TESTING

1. Locate the sending unit and unplug sending unit electrical harness.

Connect instrument gauge system tester 014-R1063 or its equivalent to the sending unit connector.

2. Set the tester to 275 ohms, turn the ignition key to the ***RUN*** position, wait 60 seconds and read the temperature gauge in the instrument cluster. It should read ***C***.
3. If the gauge does not read as specified there may be a problem with either the cluster gauge wiring or the cluster printed circuit board.
4. Set the tester to 18.3 ohms, wait 60 seconds and read the temperature gauge in the instrument cluster. If the gauge is now in the ***H*** position and was in the ***C*** position at 275 ohms, the sender is defective and should be replaced.

REMOVAL & INSTALLATION

The temperature gauge sending unit is located on the bypass tube next to the ECT sensor just above the bellhousing-3.0L OHV engine

Remove the temperature gauge sending unit using a suitable tool

Before installing the temperature gauge sending, coat the threads with a suitable thread sealant

NEVER open, service or drain the radiator or cooling system when hot; serious burns can occur from the steam and hot coolant. Also when draining engine coolant, keep in mind that cats and dogs are attracted to ethylene glycol antifreeze and could drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantities.Always drain coolant into a sealable container. If necessary, clean coolant maybe reused unless it is contaminated or more than two years old.

1. Disconnect the negative battery cable.
2. Disconnect the sending unit electrical harness.
3. Drain the engine coolant below the level of the switch.
4. Remove the sending unit from the engine using the proper size socket.

To install:

5. Coat the new sending unit with Teflon® tape or electrically conductive sealer.
6. Install the sending unit and tighten until it is snug.
7. Attach the sending unit's electrical connector.
8. Fill the engine with coolant.
9. Start the engine, allow it to reach operating temperature, bleed the cooling system and check for leaks.
10. Check for proper sending unit operation.

Oil Pressure Sensor

On 3.0L OHV engines, the oil pressure sensor is located on the left side of the engine block above the flywheel. On 3.0L DOHC engines the sensor is located on the left side of the engine block above the oil filter. On 3.4L DOHC engines the sensor is screwed into the oil filter adapter. The oil pressure sensor operates the oil pressure warning lamp.

Click on icon to view fullsize printable image.

Click to Enlarge

Location of the oil pressure sensor-3.0L OHV engines

Click on icon to view fullsize printable image.

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Location of the oil pressure sensor-3.0L DOHC engines

Click on icon to view fullsize printable image.

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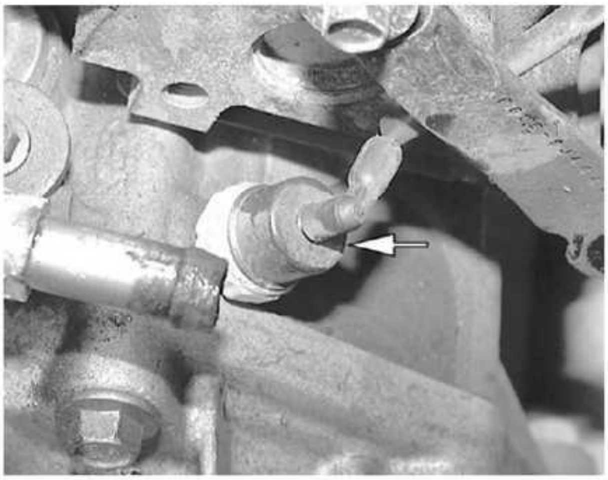
Location of the oil pressure sensor-3.4L DOHC engines

TESTING

1. Test and verify the engine oil pressure. See Section 3 for more information. If no or insufficient pressure exists, oil pressure problem exists and gauge and sensor are operational, repair oil pressure problem.
2. Start the engine and observe the oil pressure warning lamp.
3. If the lamp stays on continuously, turn the engine off, then turn the ignition key to the run position.
4. Unplug the sensor electrical harness and observe the oil pressure warning lamp. If the lamp does not illuminate, the sensor is defective and should be replaced.

REMOVAL & INSTALLATION



The oil pressure sensor-3.0L OHV engine

The EPA warns that prolonged contact with used engine oil may cause a number of skin disorders, including cancer! You should make every effort to minimize your exposure to used engine oil. Protective gloves should be worn when changing the oil. Wash your hands and any other exposed skin areas as soon as possible after exposure to used engine oil. Soap and water, or waterless hand cleaner should be used.

1. Locate the oil pressure sensor on the engine.
2. Disconnect the sensor electrical harness.
3. Unfasten and remove the sensor from the engine.

To install:

4. Coat the new sensor with Teflon® tape or electrically conductive sealer.
5. Install the sensor and tighten to 12-16 ft. lbs. (16-22 Nm) on 3.0L OHV engines, 9-12 ft. lbs. (12-16 Nm) on 3.0L DOHC and 3.4L DOHC engines.
6. Attach the sensor's electrical connector.
7. Start the engine, allow it to reach operating temperature and check for leaks.
8. Check for proper sensor operation.

TROUBLESHOOTING CHARTS

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Click to Enlarge

Troubleshooting Basic Starting System Problems

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Troubleshooting Basic Charging System Problems

ENGINE & ENGINE OVERHAUL

ENGINE MECHANICAL

Engine

REMOVAL & INSTALLATION

In the process of removing the engine, you will come across a number of steps which call for the removal of a separate component or system, such as "disconnect the exhaust system" or "remove the radiator." In most instances, a detailed removal procedure can be found elsewhere in this manual.

It is virtually impossible to list each individual wire and hose which must be disconnected, simply because so many different model and engine combinations have been manufactured. Careful observation and common sense are the best possible approaches to any repair procedure.

Removal and installation of the engine can be made easier if you follow these basic points:

- If you have to drain any of the fluids, use a suitable container.
- Always tag any wires or hoses and, if possible, the components they came from before disconnecting them.
- Because there are so many bolts and fasteners involved, store and label the retainers from components separately in muffin pans, jars or coffee cans. This will prevent confusion during installation.
- After unbolting the transaxle, always make sure it is properly supported.
- If it is necessary to disconnect the air conditioning system, have this service performed by a qualified technician using a recovery/recycling station. If the system does not have to be disconnected, unbolt the compressor and set it aside.
- When unbolting the engine mounts, always make sure the engine is properly supported. When removing the engine, make sure that any lifting devices are properly attached to the engine. It is recommended that if your engine is supplied with lifting hooks, your lifting apparatus be attached to them.
- Lift the engine from its compartment slowly, checking that no hoses, wires or other components are still connected.
- After the engine is clear of the compartment, place it on an engine stand or workbench.
- After the engine has been removed, you can perform a partial or full teardown of the engine using the procedures outlined in this manual.

Except 3.4L DOHC Engines

If your vehicle is equipped with air conditioning, refer to Section 1 for information regarding the implications of servicing your A/C system yourself. Only a MVAC-trained, EPA-certified, automotive technician should service the A/C system or its components.

1. If your vehicle is equipped with A/C have the system evacuated by a qualified technician using a recovery/recycling station.
2. Disconnect the battery cables, negative cable first.

NEVER open, service or drain the radiator or cooling system when hot; serious burns can occur from the steam and hot coolant. Also, when draining engine coolant, keep in mind that cats and dogs are attracted to ethylene glycol antifreeze and could drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantities.Always drain coolant into a sealable container. If necessary, clean coolant maybe reused unless it is contaminated or more than two years old.

3. Drain the cooling system.
4. Mark the position of the hood on the hinges and remove the hood.
5. Disconnect the steering coupling at the pinch bolt joint inside the passenger compartment.
6. On 3.0L DOHC engines, remove the cowl extension and windshield wiper, then disconnect the main emission vacuum control connector at the two connectors located at the right hand side of the dash panel.
7. Disconnect the wiring from the Mass Air Flow (MAF) sensor, and the Intake Air Temperature (IAT) sensor.

Label all electrical connectors and vacuum hoses prior to removal so they can be reinstalled in their proper locations.

8. Remove the air cleaner outlet tube.
9. Remove the air cleaner retaining bolts at the air cleaner body.
10. Disconnect the engine intake air resonator by pushing in the top and bottom tube surfaces at the engine air cleaner and pulling the air cleaner outward. Lift the air cleaner up and out of the engine compartment.

Observe all applicable safety precautions when working around fuel. Whenever servicing the fuel system, always work in a well ventilated area. Do not allow fuel spray or vapors to come in contact with a spark or open flame. Keep a dry chemical fire extinguisher near the work area. Always keep fuel in a container specifically designed for fuel storage; also, always properly seal fuel containers to avoid the possibility of fire or explosion.

11. Properly relieve the fuel system pressure.
12. Disconnect the fuel lines from the fuel injection supply manifold.
13. Disconnect the chassis vacuum supply hose at the connection on the intake manifold. Position the hose aside.
14. Remove the ground straps from the dash panel.
15. Disconnect the control sensor wiring from the Powertrain Control Module (PCM) and position aside.
16. Remove the connectors for the engine control sensor wiring from the retaining bracket on the power brake booster. Disconnect the engine control sensor wiring at the two connectors.
17. Disconnect engine control sensor wiring from the evaporative emission canister purge valve.
18. Disconnect the evaporative emission hose at the crankcase vent connector and hose. Position the hose aside.
19. Remove the shield and disconnect the accelerator cable and the speed control actuator from the throttle body and from the accelerator cable bracket. Position the cables aside.
20. Remove the retaining nut and disconnect the manual control lever from the manual control lever shaft at the Transmission Range (TR) sensor.
21. Remove the connectors for the engine control sensor wiring from the retaining bracket on top of the transaxle. Disconnect the engine control sensor wiring at the two connectors.
22. Disconnect the wiring connector from the secondary air injection pump relay located on the retaining bracket on top of the transaxle.
23. Disconnect the main emission vacuum control connector at the connection near the fan shroud.
24. Disconnect the oil cooler inlet tube from the transaxle.
25. Disconnect the heater water hose from the water pump and water hose connection.
26. Disconnect the upper radiator hose and coolant recovery tank tube from the water hose connection.
27. Remove the power steering return hose from the power steering oil reservoir and drain.
28. Disconnect the alternator wiring harness from the alternator at the BAT terminal and stator connector plug. Remove the wiring harness retaining clip from the alternator mounting bracket.
29. On 3.0L OHV engines, disconnect the retaining clips and the A/C compressor lines from the compressor. On 3.0L DOHC engines, disconnect the A/C compressor line from the heater core inlet tube. Cap all openings to prevent the entrance of dirt or moisture.
30. Raise and safely support the vehicle. Remove the front wheel and tire assemblies.
31. Remove both front stabilizer bar links from the front stabilizer bar.
32. Remove both axle halfshafts using the procedure in this manual.
33. Remove the splash shield from the radiator support and front bumper.

The EPA warns that prolonged contact with used engine oil may cause a number of skin disorders, including cancer! You should make every effort to minimize your exposure to used engine oil. Protective gloves should be worn when changing the oil. Wash your hands and any other exposed skin areas as soon as possible after exposure to used engine oil. Soap and water, or waterless handcleaner should be used.

34. Drain the engine oil.
35. Remove the exhaust catalytic converter Y-pipe.
36. Disconnect the power steering pressure hose from the power steering/transaxle oil cooler connection. Position the

hose aside.

37. Disconnect the lower radiator hose at the radiator and at the radiator overflow hose.
38. Disconnect the wiring at the starter motor, and remove the starter motor.
39. Disconnect the lower cooler line from the transaxle.
40. Support the front subframe and engine/transaxle assembly using Powertrain Lift 014-00765 and Universal Powertrain Removal Bracket 014-00766 or equivalents.
41. Remove the four subframe retaining bolts.
42. Lower the engine/transaxle and front subframe from the vehicle.
43. Disconnect the power steering pressure hose from the power steering pump.
44. Install suitable engine lifting brackets on the engine and transaxle assembly.
45. Remove the front engine support insulator, rear engine support insulator and engine and transaxle support.
46. Lift the engine and transaxle from the subframe.
47. Lower the engine and transaxle. Support the transaxle on a level, stationary surface for transaxle storage.
48. Remove the transaxle-to-cylinder block mounting bolts and separate the engine from the transaxle/torque converter assembly.
49. Place the engine on a safe, suitable work stand.

To install:

50. Installation is the reverse of removal but please note the following important steps.
51. Install the transaxle/torque converter assembly to the engine. Tighten the mounting bolts to 30-44 ft. lbs. (40-60 Nm) on 3.0L OHV engines or 25-33 ft. lbs. (34-46 Nm) on 3.0L DOHC engines. Tighten the torque converter nuts to 20-33 ft. lbs. (27-46 Nm).
52. Raise the engine, transaxle and subframe into position using the powertrain lifting tool.
53. Align the front subframe to the body and install the subframe-to-body bolts. Tighten the bolts to 57-76 ft. lbs. (77-103 Nm).

Operating the engine without the proper amount and type of engine oil will result in severe engine damage.

54. Fill the cooling system. Fill the crankcase with the proper type of motor oil to the required level.
55. Connect the battery cables, negative cable last. Run the engine and check for leaks.
56. Install and align the hood.

Whenever the vehicle's subframe is removed or lowered, the wheel alignment should be checked.

57. Check the front wheel alignment. Road test the vehicle and check the engine and transaxle for proper operation.
58. Have the A/C system evacuated and recharged by a qualified technician using a recovery/recycling station.

3.4L DOHC Engines

If your vehicle is equipped with air conditioning, refer to Section 1 for information regarding the implications of servicing your A/C system yourself. Only an MVAC-trained, EPA-certified, automotive technician should service the A/C system or its components.

1. If your vehicle is equipped with A/C have the system evacuated by a qualified technician using a recovery/recycling station.
2. Disconnect the battery cables, negative cable first.
3. Mark the position of the hood on the hinges and remove the hood.
4. Remove the battery and battery tray.
5. Remove the oil fill cap, unfasten the two bolts and four nuts attaching the engine appearance cover, then remove the cover.
6. Disconnect the engine control sensor wiring from the engine air fuel ratio bracket.
7. Tag and unplug the engine control sensor wiring from the Mass Air Flow (MAF) sensor.
8. Disconnect the air cleaner outlet tube from the throttle body.
9. Release the air cleaner cover and disconnect the crankcase ventilation hose from the air cleaner outlet tube.
10. Remove the wiper module.
11. Unfasten the retaining nuts from the main vacuum connector and remove the intake manifold from the vacuum connector.
12. Remove the wiper motor and connector and grommet from the cowl top extension, then remove the cowl top extension.

13. Remove the accelerator control splash shield and disconnect the speed control actuator cable from the throttle body.
14. Unfasten the bolts attaching the speed control actuator cable and the accelerator cable to the accelerator cable bracket. Position the cables out of the way.
15. Unfasten the main engine control harness screw and unplug the main harness.
16. Unplug the Transmission Range (TR) sensor connector and remove the transmission shift cable-to-shift cable bracket nut. Position the shift cable and bracket aside.
17. Remove the power steering reservoir cap.

NEVER open, service or drain the radiator or cooling system when hot; serious burns can occur from the steam and hot coolant. Also, when draining engine coolant, keep in mind that cats and dogs are attracted to ethylene glycol antifreeze and could drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantities.Always drain coolant into a sealable container. If necessary, clean coolant maybe reused unless it is contaminated or more than two years old.

18. Drain the cooling system.
19. Disconnect the power steering return hose from the left end of the power steering fluid cooler and allow it to drain. Once drained, cap all openings to prevent contamination.
20. Disconnect the lower fluid cooler tube at the left rubber line.
21. Disconnect the heater water hose from the heater water tubes.
22. Tag and disconnect all necessary vacuum hoses.
23. Unfasten the bolt attaching the engine control sensor wiring to the Powertrain Control Module (PCM) bracket and separate the wiring from the bracket.
24. Unfasten the engine ground strap bolt and position the strap to one side.
25. Tag and unplug the electrical connection from the canister purge valve solenoid.

Observe all applicable safety precautions when working around fuel. Whenever servicing the fuel system, always work in a well ventilated area. Do not allow fuel spray or vapors to come in contact with a spark or open flame. Keep a dry chemical fire extinguisher near the work area. Always keep fuel in a container specifically designed for fuel storage; also, always properly seal fuel containers to avoid the possibility of fire or explosion.

26. Properly relieve the fuel system pressure.
27. Disconnect the fuel lines from the fuel injection supply manifold.
28. Disconnect the power steering pump-to-power steering reservoir hose at the pump.
29. Tag and disconnect all tubes from the coolant recovery reservoir.
30. Tag and unplug the electrical connection from the A/C pressure cut-off switch.
31. Loosen the A/C manifold-to-compressor bolt.
32. Disconnect the A/C pressure cut-off switch from the compressor and position it aside.
33. Disconnect the upper and lower radiator hoses from the water pump.
34. Disconnect the battery-to-starter relay cable at the starter motor.
35. Unfasten the nut that attaches the battery-to-starter relay cable to the cylinder block and position the cable aside.
36. Raise the vehicle and support it with jack stands.
37. Remove the both front wheel and tire assemblies.
38. Disconnect the catalyst monitor sensors and unplug the heated oxygen sensor electrical connector.
39. Remove the dual three-way converter and pipe.
40. Disconnect the wiring from the alternator.
41. Disconnect the ride level sensors at the front suspension lower arm.
42. Unfasten the stabilizer bar link-to-front suspension lower arm retaining nuts.
43. Disconnect the tie rod end from the wheel knuckle assembly.
44. Remove the front hub retaining nuts.
45. Disconnect the ball joints from the front suspension lower arm.
46. Position the wheel knuckle and shock absorber assemblies out of the way.

47. Secure the drive axle halfshafts to the subframe.
48. Unfasten the four flywheel-to-torque converter nuts.
49. Unfasten the four lower transaxle-to-engine retaining bolts.
50. Unfasten the steering column pinch bolt from the steering column intermediate shaft coupling at the steering gear and separate the intermediate shaft from the steering gear.
51. Support the front subframe and engine/transaxle assembly using Powertrain Lift 014-00765 and Universal Powertrain Removal Bracket 014-00766 or equivalents.
52. Remove the four subframe retaining bolts.
53. Lower the engine/transaxle and front subframe from the vehicle.
54. Install engine lift brackets 014-00793 or equivalent to the engine.
55. Attach engine lifting spreader bar 014-00793 or equivalent to the lifting eyes. Support the engine and transaxle.
56. Tag and disconnect the engine wiring from the secondary air injection pump and the transaxle.
57. Tag and unplug the wiring from the transmission speed sensor and the power steering pressure switch.
58. Unfasten the nut on the power steering left turn pressure hose, then disconnect the hose from the power steering pump and position the hose aside.
59. Unfasten the four upper engine-to-transaxle bolts.
60. Remove the right drive axle halfshaft.
61. Unfasten the seven right hand front engine support insulator bracket retaining bolts.
62. Unfasten the two left hand front upper engine support insulator-to-engine support insulator bracket bolts.
63. Separate the engine from the transaxle/torque converter assembly.
64. Unfasten the flywheel retaining bolts and remove the flywheel.
65. Place the engine on a safe, suitable work stand.

To install:

66. Installation is the reverse of removal but please note the following important steps.
67. Tighten the flywheel-to-engine bolts in an alternating pattern (across from each other) to 54-64 ft. lbs. (73-87 Nm).
68. Tighten the two left hand front upper engine support insulator-to-engine support insulator bracket bolts to 44-59 ft. lbs. (60-80 Nm).
69. Install the seven right hand front engine support insulator bracket retaining bolts and tighten to 44-59 ft. lbs. (60-80 Nm).
70. Tighten the four upper engine-to-transaxle bolts to 30-44 ft. lbs. (40-60 Nm).
71. Connect the power steering left turn pressure hose to the pump and tighten the fitting to 25-30 ft. lbs. (33-41 Nm).
72. Tighten the power steering left turn pressure hose-to-surge tank nut to 71-106 inch lbs. (8-12 Nm).
73. Raise the engine, transaxle and subframe into position using the powertrain lifting tool.
74. Align the front subframe to the body and install the subframe-to-body bolts. Tighten the bolts to 57-75 ft. lbs. (77-103 Nm).
75. Tighten the steering gear-to-steering column shaft coupling pinch bolt to 30-37 ft. lbs. (41-51 Nm).
76. Tighten the lower engine-to-transaxle bolts to 30-44 ft. lbs. (40-60 Nm).
77. Tighten the four torque converter-to-flywheel nuts to 20-33 ft. lbs. (27-46 Nm).
78. Tighten the wheel hub retaining bolts to 170-202 ft. lbs. (230-275 Nm).
79. Tighten the A/C pressure cut-off switch-to-compressor retainer to 13-16 ft. lbs. (17-23 Nm).
80. Tighten the engine control sensor wiring-to-PCM bracket bolt to 32 inch lbs. (3.7 Nm).
81. Install the shift cable and bracket on the manual control lever and tighten the retaining nut to 15-19 ft. lbs. (20-26 Nm).
82. Tighten the speed control actuator cable and accelerator cable to the accelerator cable bracket retaining bolts to 45-62 ft. lbs. (5-7 Nm).

Operating the engine without the proper amount and type of engine oil will resultin severe engine damage.

83. Fill the cooling system. Fill the crankcase with the proper type of motor oil to the required level.
84. Fill the power steering system.
85. Check the transaxle fluid level and replenish as necessary
86. Connect the battery cables, negative cable last. Run the engine and check for leaks.
87. Install and align the hood.

Whenever the vehicle's subframe is removed or lowered, the wheel alignment should be checked.

88. Check the front wheel alignment. Road test the vehicle and check the engine and transaxle for proper operation.
89. Have the A/C system evacuated and recharged by a qualified technician using a recovery/recycling station.

Valve Cover

REMOVAL & INSTALLATION

3.0L OHV Engine

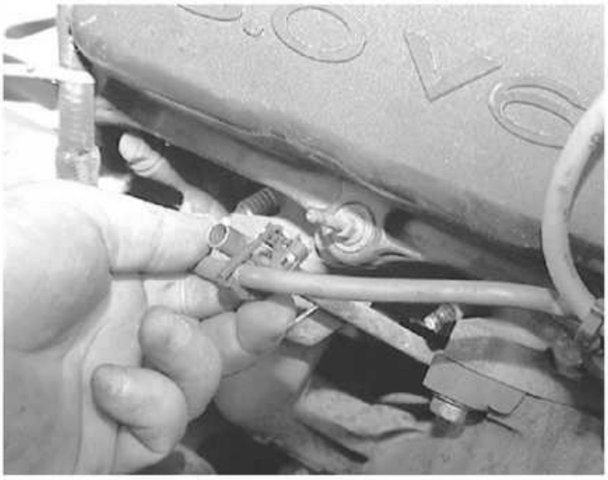
To install:

6. Lightly oil the valve cover retaining bolts and studs before installation.
7. Check the valve cover gasket for correct installation. The new valve cover gasket will lay flat to the valve cover in both the channel and fastener areas. If the gasket is installed incorrectly oil leakage will occur.
8. While aligning the fastener holes, lay the new gasket into the cover channel.
9. Install the valve cover gasket to each fastener by securing the fastener head with a nut driver or with a socket. Seat the fastener against the valve cover and at the same time, roll the gasket around the fastener collar. If the gasket is installed correctly, the fasteners will be secured by the gasket and not fall out.

Prior to installing sealer, clean the sealing surfaces using metalsurface cleaner F4AZ-19A536-RA or its equivalent to remove all residues thatwould interfere with the sealer's ability to adhere.

10. Apply a 1/4 inch (6mm) bead of silicone gasket and sealant F6AZ-19562-AA or its equivalent at the cylinder head-to-intake manifold step (two places per side) as shown in Figures 8 and 10.

Use a straight down approach when installing the valve cover. Anyadjustments made after the sealer has made contact may roll over the gasketfrom the cover channel, which will result in a leak.

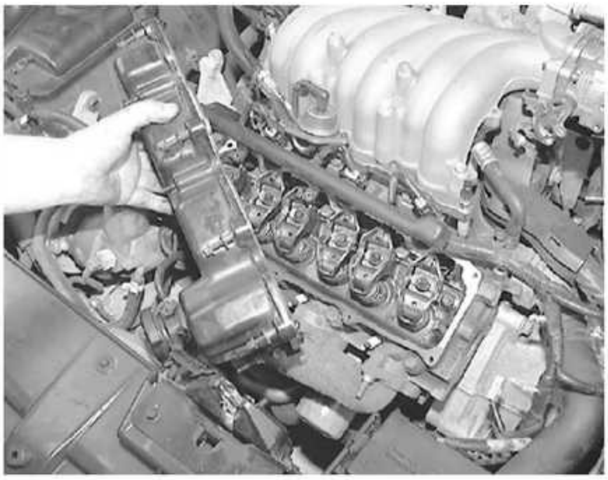


Remove the spark plug wire retainers from the valve cover retaining studs

Remove the oil separator hose from the oil fill cap opening (LH valve cover only)

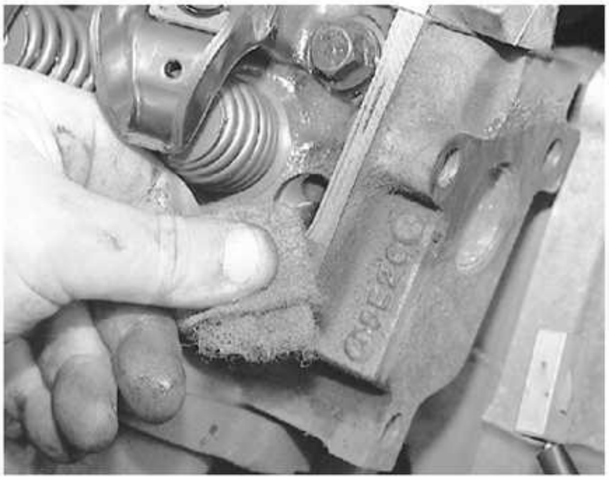
Remove the fuel injector harness retaining nuts and...

... remove the harness from the valve cover retaining studs

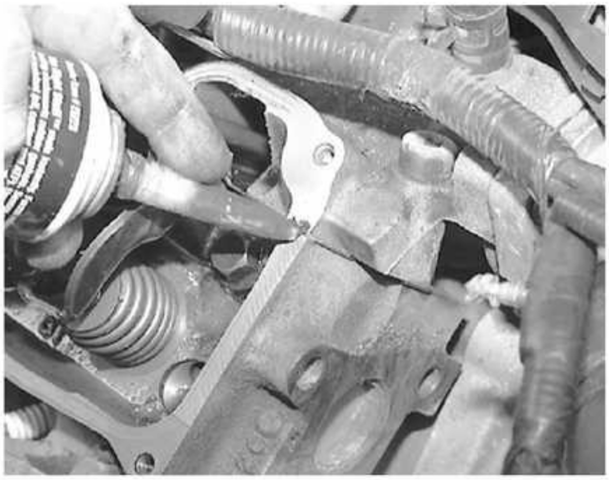


Remove the retaining bolts/studs and remove the valve cover from the cylinder head

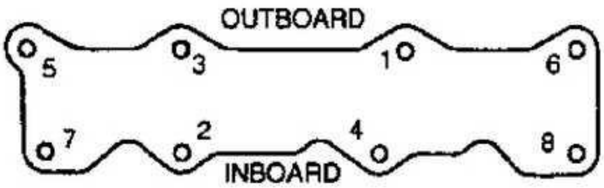
Remove the valve cover gasket from the valve cover



Thoroughly clean the cylinder head-to-valve cover mating surface before installing the valve cover



Apply silicone sealant to the ends of the cylinder head



Valve cover tightening sequence-3.0L OHV engines

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Exploded view of the valve cover assembly and valve cover sealer application location-3.0L OHV engines

3.0L DOHC Engine

RIGHT SIDE

1. Disconnect the negative battery cable.
2. Remove the upper intake manifold.
3. Tag and disconnect the spark plug wires from the spark plugs and the ignition coil.
4. Remove the ignition coil.
5. Remove the crankcase ventilation tube from the vehicle.
6. Unfasten the nuts that attach the engine wiring and the evaporative emission return tube to the studs on the valve cover. Position wiring and tube aside.
7. Unfasten the valve cover retainers in the sequence shown.
8. Remove the valve cover from the cylinder head, then remove the gasket from the valve cover.

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Click to Enlarge

Remove the right hand valve cover retainers in the sequence shown-3.0L DOHC engines

To install:

9. Clean the valve cover sealing surfaces using a clean shop towel and metal surface cleaner F4AZ-19A536-RA or its equivalent to remove all residues that would interfere with the sealer's ability to adhere.
10. Apply a 0.31 inch (8mm) bead of silicone gasket and sealant F6AZ-19562-AA or its equivalent at the two places on the valve cover sealing surfaces where the engine front cover and the cylinder head contact. Refer to Figure 12.

11. Install the valve cover gaskets onto the valve cover.
12. Place the valve cover into position and install the cover retainers. Tighten the retainers to 71-106 inch lbs. (8-12 Nm) within 6 minutes of applying the sealer.
13. Place the return tube and wiring in position and install the retaining nuts.
14. Install the crankcase ventilation tube.
15. Install the ignition coil and connect the spark plug wires.
16. Install the upper intake manifold.
17. Connect the negative battery cable.

Click on icon to view fullsize printable image.

Click to Enlarge

Apply a bead of silicone sealant at the two places on the valve cover sealing surfaces where the engine front cover and the cylinder head contact-3.0L DOHC engines

Click on icon to view fullsize printable image.

Click to Enlarge

Tighten the right hand valve cover retainers in the sequence shown-3.0L DOHC engines

LEFT SIDE

1. Disconnect the negative battery cable.
2. Remove the crankcase ventilation tube from the vehicle.
3. Unfasten the nuts that attach the engine wiring to the studs on the valve cover. Position wiring aside.
4. Tag and disconnect the spark plug wires from the spark plugs and valve cover.
5. Unfasten the valve cover retainers in the sequence shown.
6. Remove the valve cover from the cylinder head, then remove the gasket from the valve cover.

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Click to Enlarge

Remove the left hand valve cover retainers in the sequence shown-3.0L DOHC engines

To install:

7. Clean the valve cover sealing surfaces using a clean shop towel and metal surface cleaner F4AZ-19A536-RA or its equivalent to remove all residues that would interfere with the sealer's ability to adhere.
8. Apply a 0.31 inch (8mm) bead of silicone gasket and sealant F6AZ-19562-AA or its equivalent at the two places on the valve cover sealing surfaces where the engine front cover and the cylinder head contact. Refer to Figure 12.
9. Install the valve cover gaskets onto the valve cover.
10. Place the valve cover into position and install the cover retainers. Tighten the retainers to 71-106 inch lbs. (8-12 Nm) within 6 minutes of applying the sealer.
11. Connect the spark plug wires to the plugs and position the wires on the valve cover.
12. Place the wiring in position and install the retaining nuts.
13. Install the crankcase ventilation tube.
14. Connect the negative battery cable.

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Tighten the left hand valve cover retainers in the sequence shown-3.0L DOHC engines

3.4L (DOHC) Engine

RIGHT SIDE

1. Disconnect the negative battery cable.

2. Temporarily remove the oil filler cap.
3. Unfasten the two flange bolts and four cap nuts attaching the appearance cover to the engine and remove the cover. Install the oil fill cap.
4. Remove the right half cowl vent screen.
5. Tag and disconnect the main emission vacuum supply hose from the surge tank vacuum fitting and the EGR valve. Position the hose out of the way.

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Tag and disconnect the main emission vacuum supply hose from the surge tank vacuum fitting and the EGR valve-3.4L DOHC engines

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Click to Enlarge

Exploded view of the transducer mounting bracket and intake manifold support assemblies-3.4L DOHC engines

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Exploded view of the intake manifold components-3.4L DOHC engines

6. Tag and disconnect the vacuum hose from the intake manifold vacuum union.
7. Tag and disconnect the EGR valve-to-exhaust manifold tube from the bottom of the EGR valve.
8. Unfasten the power steering left turn pressure hose bracket nut and position the hose aside.
9. Unfasten the bolts attaching the transducer to the surge tank and position the bracket aside.
10. Remove the two intake manifold supports from the surge tank and cylinder head.
11. Remove the two bolts and the surge tank stay from the front of the surge tank.
12. Unfasten the bolts, nuts and surge tank stay from the rear of the surge tank.
13. Tag and disconnect the crankcase ventilation hose.
14. Tag and disconnect the intake manifold-to-surge tank ventilation tube.
15. Tag and disconnect the vacuum tube from the fuel pressure regulator.
16. Loosen the intake air connector hose clamps and remove the surge tank from the engine.
17. Tag and unplug the ignition coil wiring, then remove the coil(s).
18. Unfasten the two wiring harness guide retaining bolts and the two wiring bracket bolts.
19. Unfasten the radio interference capacitor bracket retaining nut.
20. Tag and disconnect the crankcase ventilation tube from the valve cover.
21. Position any necessary engine wiring aside.

The valve cover gasket is reusable if it is not damaged.

22. Loosen the valve cover retainers and remove the valve cover.
23. If necessary, remove and inspect the valve cover gasket(s). Replace as necessary.

To install:

24. Clean the valve cover sealing surfaces using a clean shop towel and metal surface cleaner F4AZ-19A536-RA or its equivalent to remove all residues that would interfere with the sealer's ability to adhere.
25. Apply a 0.31 inch (8mm) bead of silicone gasket and sealant F6AZ-19562-AA or its equivalent at the two places on the valve cover sealing surfaces where the engine front cover and the cylinder head contact. Refer to Figure 20.
26. Install the valve cover gasket(s) onto the valve cover.
27. Place the valve cover into position and install the cover retainers. Tighten the retainers to 71-106 inch lbs. (8-12 Nm) within 6 minutes of applying the sealer.
28. Position the intake air connector hose clamps as shown in the accompanying illustration.
29. Connect the crankcase ventilation tube to the valve cover.
30. Install the radio interference capacitor and tighten the bracket retaining nut to 71-106 inch lbs. (8-12 Nm).
31. Position the wiring on the valve cover and install the wiring brackets. Tighten the bracket retaining bolts to 71-106 inch lbs. (8-12 Nm).
32. Install the coils removed and tighten the retaining bolts to 71-106 inch lbs. (8-12 Nm). Attach the wiring to the coils.
33. Position the surge tank on the engine. Align and tighten the clamps as outlined in the intake manifold removal and

installation procedure later in this section.

34. Attach the intake manifold ventilation tube to the surge tank and the crankcase ventilation hose to the valve cover.
35. Place the rear and front surge tank stays in position and install its retainers. Tighten the retainers to 14-20 ft. lbs. (18-28 Nm).
36. Position the two intake manifold supports on the surge tank and cylinder head. Tighten the retainers to 71-106 inch lbs. (8-12 Nm).
37. Position the transducer mounting bracket to the surge tank and install the retainers. Tighten the retainers to71-106 inch lbs. (8-12 Nm).
38. Position the power steering left turn hose on the surge tank stud bolt and install the retaining nut. Tighten the nut to 71-106 inch lbs. (8-12 Nm).
39. Connect the EGR valve-to-exhaust manifold tube to the EGR valve. Tighten the fitting to 19-25 ft. lbs. (25-35 Nm).
40. Connect the vacuum tube to the intake manifold vacuum union.
41. Connect the main emission hose to the surge tank vacuum fitting and EGR valve.
42. Connect the fuel pressure regulator vacuum hose.
43. Install the cowl vent screen.
44. Remove the oil filler cap.
45. Install the engine appearance cover and its retainers. Tighten the retainers to 71-106 inch lbs. (8-12 Nm). Install the oil filler cap.
46. Connect the negative battery cable.

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Right hand valve cover and gaskets-3.4L DOHC engines

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Apply a 0.31 inch (8mm) bead of silicone gasket sealant at the two places on the valve cover where the engine front cover and the cylinder head contact-3.4L DOHC engines

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Align and tighten the intake air connector hose clamps as shown and as outlined in the intake manifold removal and installation procedure later in this section-3.4L DOHC engines

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Appearance cover mounting-3.4L DOHC engines

LEFT SIDE

1. Disconnect the negative battery cable.
2. Temporarily remove the oil filler cap.
3. Unfasten the two flange bolts and four cap nuts attaching the appearance cover to the engine and remove the cover. Install the oil fill cap.
4. Tag and unplug the electrical connection from the Intake Manifold Runner Control (IMRC) deactivation motor.
5. Remove the engine sensor control wiring from the wire harness bracket and clamp.
6. Unfasten the bolts that attach the IMRC motor to the left-hand valve cover and move the motor out of the way.
7. Unplug the electrical connections from the ignition coils, then remove the coils.
8. Unplug the ignition capacitor electrical connection.
9. Disconnect the crankcase ventilation tube from the valve cover.
10. Raise the vehicle and support it with jack stands.
11. Unfasten the retainers that attach the radiator air deflector to the lower radiator support and the front bumper, then remove the deflector.
12. Tag and unplug the electrical connections from the A/C pressure control switch, Crankshaft Position (CKP) sensor, A/C compressor clutch field coil and the Heated Oxygen (HO2S) electrical connectors.
13. Slide the HO2S connector off the retainer.

14. Unfasten the engine wiring-to-front cover retaining nuts and move the wiring aside.
15. Lower the vehicle and remove the right hand wiring harness guide retaining nut. Position the wiring aside.
16. Remove the coolant reservoir tube bracket retaining bolt and bracket.
17. Unfasten the two-wire harness clip retaining bolts and remove the clip.

The valve cover gasket is reusable if it is not damaged.

18. Loosen the valve cover retainers and remove the valve cover.
19. If necessary, remove and inspect the valve cover gasket(s). Replace as necessary.

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Exploded view of the Intake Manifold Runner Control (IMRC) and coil-on-plug mounting-3.4L DOHC engines

Click on icon to view fullsize printable image.

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View of the left hand valve cover and gaskets-3.4L DOHC engines

To install:

20. Clean the valve cover sealing surfaces using a clean shop towel and metal surface cleaner F4AZ-19A536-RA or its equivalent to remove all residues that would interfere with the sealer's ability to adhere.
21. Apply a 0.31 inch (8mm) bead of silicone gasket and sealant F6AZ-19562-AA or its equivalent at the two places on the valve cover sealing surfaces where the cylinder heads contact and at the two places on the rear of the cylinder head where the camshaft seal retainer contacts the cylinder head. Refer to Figure 25.

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Apply a suitable silicone sealant to the points illustrated-3.4L DOHC engines

22. Install the valve cover gasket(s) onto the valve cover.
23. Place the valve cover into position and install the cover retainers. Tighten the retainers to 71-106 inch lbs. (8-12 Nm) within 6 minutes of applying the sealer.
24. Install the wire harness clip and its retaining bolts. Tighten the retainers to 71-106 inch lbs. (8-12 Nm).
25. Install the coolant reservoir tube bracket and retaining bolt. Tighten the bolt to 71-106 inch lbs. (8-12 Nm).
26. Position the wiring harness on the valve cover. Install the right hand wiring harness guide nut. Tighten the nut to 71-106 inch lbs. (8-12 Nm).
27. Raise the vehicle and support it with jack stands.
28. Position the wiring harness on the front cover studs and install the retaining nuts. Tighten the retaining nuts to71-106 inch lbs. (8-12 Nm).
29. Slide the HO2S connector onto the retainer.
30. Attach the electrical connections to the A/C pressure control switch, Crankshaft Position (CKP) sensor, A/C compressor clutch field coil and the Heated Oxygen (HO2S) electrical connectors.
31. Install the radiator air deflector and lower the vehicle.
32. Connect the crankcase ventilation tube to the valve cover.
33. Attach the electrical connection to the ignition capacitor.
34. Install the ignition coils and attach the coil electrical connections.
35. Place the IMRC motor into position, install its retaining bolts and tighten them to71-106 inch lbs. (8-12 Nm).
36. Position the wiring harness bracket on the valve cover and install its retaining bolts. Tighten the bolts to 71-106 inch lbs. (8-12 Nm).
37. Install the engine control sensor wiring in the wiring bracket and wire harness clamp.
38. Connect the engine control sensor wiring to the IMRC motor.
39. Remove the oil filler cap.
40. Install the engine appearance cover and its retainers. Tighten the retainers to 71-106 inch lbs. (8-12 Nm). Install the oil filler cap.
41. Connect the negative battery cable.

Rocker Arms/Shafts

REMOVAL & INSTALLATION

3.0L OHV Engine

1. Disconnect the negative battery cable.
2. Remove the upper intake manifold.
3. Remove the valve covers.

Make a note of the rocker arm assembly component locations as they must be installed in their original positions.

4. Remove the rocker arm bolts, seats, rocker arms and if necessary the pushrods. Keep all parts in order so they can be reinstalled to their original positions.
5. Inspect the rocker arms, fulcrums and pushrods for wear and/or damage. Replace as necessary.

To install:

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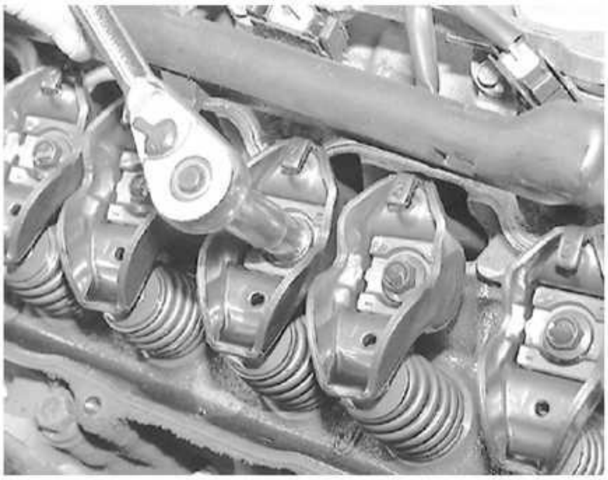
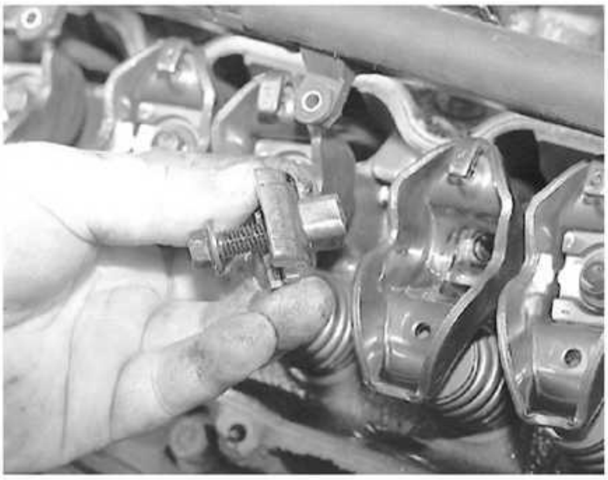
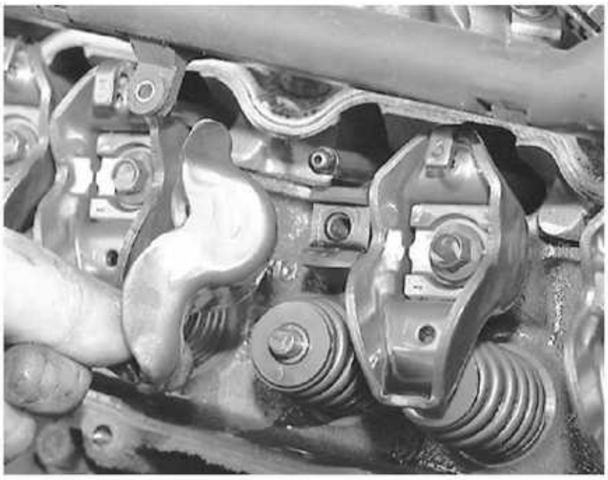
Exploded view of the rocker arm components-3.0L OHV engine



Loosen the rocker arm retaining bolts and...



... remove the seat and retaining bolt from each rocker arm



Lift the rocker arm off of the cylinder head and remove it from the engine

Remove the push rods from the engine if necessary

Be sure to number and separate the rocker arms and pushrods for installation

Aluminum components gouge easily which can cause gasket leaks. Always use caution when using a scraper to clean any aluminum gasket surfaces.

6. Clean the upper-to-lower intake manifold gasket surfaces. Make sure to remove all gasket particles to prevent them from entering the lower intake manifold. Use a suitable solvent to remove any old silicone sealant.

Rocker arm seats must be fully seated into the cylinder head and the pushrods must be fully seated in the rocker arm and valve tappet sockets prior to final tightening.

7. Install the pushrods, if removed, making sure they seat in the lifters.
8. Coat the valve and pushrod tips, rocker arm and fulcrum contact areas with Lubriplate® or equivalent. Lightly oil all the bolt and stud threads before installation.
9. Rotate the engine using the crankshaft to position the camshaft lobes straight down and away from the rocker arm.
10. Install the rocker arm and components and tighten the rocker arm fulcrum bolts in two steps: the first to 6-11 ft. lbs. (7-15 Nm) and the final to 20-28 ft. lbs. (26-38 Nm).
11. Install the valve cover.
12. Install the intake manifold.
13. Connect the negative battery cable.

3.0L DOHC Engine

1. Disconnect the negative battery cable.
2. Remove the upper intake manifold(s).
3. Remove the valve covers.
4. Remove the crankshaft pulley.
5. Remove the crankshaft damper retaining bolt from the front of the crankshaft allowing the key-way to be referenced.
6. Rotate the crankshaft clockwise to position the key-way to the 11 o'clock position and the engine to Top Dead Center (TDC) for the No. 1 cylinder prior to the removal and installation of camshafts and rocker arms or you may damage the camshafts.
7. Verify that the alignment flags (arrows) on the camshafts (marked RFF) are aligned. If not, rotate the crankshaft one complete revolution and recheck.
8. Rotate the crankshaft clockwise so the crankshaft key-way is at the 3 o'clock position. This positions the right cylinder head camshafts to the neutral position (base circle).

Cylinder head camshaft journal caps and the cylinder heads should be given an identification mark to make sure they are assembled in their original position. When removed, keep the camshaft journal caps from each cylinder head with the head they were removed from. Do not mix the caps with those from another cylinder head.

Remove the cylinder head camshaft journal thrust cap first to make sure that damage to the camshaft journal thrust cap does not occur.

9. Remove the right cylinder head camshaft journal thrust cap retaining bolts and thrust caps.
10. Loosen the remaining camshaft journal cap bolts in the sequence illustrated, releasing the bolts several revolutions at a time by making several passes to allow the camshaft to be raised from the cylinder head evenly. Do not remove the retaining bolts completely.

If the lash adjusters (tappets) and roller rocker arms are to be reused, mark the positions of the lash adjusters and rocker arms so they are reassembled into their original positions.

11. With the camshafts loose, remove the rocker arms, keeping them in the order that they were removed.
12. If required, remove the lash adjusters from the cylinder head.
13. Rotate the crankshaft and locate the crankshaft key-way at the 11 o'clock position. This will position the left cylinder head camshafts to their neutral position (base circle).
14. Verify that the alignment arrows (flags) on the camshafts (marked RFF) are aligned.

The camshaft journal caps and cylinder heads are numbered to ensure that they are assembled in their original positions. If removed, keep the camshaft journal caps together with the cylinder head that they were removed from.

15. Remove the camshaft journal thrust cap retaining bolts and thrust caps from the left cylinder head.
16. Loosen the remaining camshaft journal cap bolts in the sequence illustrated, releasing the bolts several revolutions at a time by making several passes to allow the camshaft to be raised from the cylinder head evenly. Do not remove the retaining bolts completely.

If the lash adjusters (tappets) and roller rocker arms are to be reused, mark the positions of the lash adjusters and rocker arms so they are reassembled into their original positions.

17. With the camshafts loose, remove the rocker arms, keeping them in the order that they were removed.
18. If required, remove the lash adjusters from the cylinder head.
19. Inspect the rocker arms and lash adjusters for wear and/or damage and replace as necessary.

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Right hand cylinder head camshaft journal cap removal sequence-3.0L DOHC engine

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Click to Enlarge

Left hand cylinder head camshaft journal cap removal sequence-3.0L DOHC engine

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Click to Enlarge

Exploded view of the rocker arm removal (camshaft removed for clarity)-3.0L DOHC engine

To install:

20. Be sure the crankshaft key-way is at the 11 o'clock position.
21. If removed, lubricate the left cylinder head lash adjusters with engine assembly lubricant and install into their correct positions in the cylinder head.
22. If the lash adjusters are being replaced with new units, soak the adjusters in a container of clean engine oil, then manually pump up the adjusters before installing into the cylinder head.
23. Lubricate the left cylinder head rocker arms with engine assembly lubricant and install the left cylinder head rocker arms into their original locations.

Do not install the camshaft journal thrust caps until the camshaft journal caps are tightened into position.

24. Tighten the left cylinder head camshaft journal cap bolts in the sequence illustrated making several passes to pull the camshafts down evenly. Tighten the bolts to 71-106 inch lbs. (8-12 Nm).

Click on icon to view fullsize printable image.

Click to Enlarge

Tighten the journal caps gradually in the sequence shown to prevent possible camshaft warpage- 3.0L (DOHC) left cylinder head

25. Install the left-hand cylinder head thrust caps and bolts. Tighten to 71-106 inch lbs. (8-12 Nm).
26. Rotate the crankshaft and position the crankshaft key-way to the 3 o'clock location. This will position the right cylinder head camshafts to the neutral position (base circle).
27. Lubricate the right cylinder head lash adjusters with engine assembly lubricant and install into their original positions in the cylinder head.
28. If the lash adjusters are being replaced with new units, soak the adjusters in a container of clean engine oil and manually pump the adjusters up before installing them into the cylinder head.
29. Lubricate the right cylinder head rocker arms with engine assembly lubricant and install the right cylinder head rocker arms into their original locations.

Do not install the camshaft journal thrust caps until the camshaft journal caps are tightened into position.

30. Tighten the right cylinder head camshaft journal cap bolts in sequence making several passes to pull the camshafts down evenly. Tighten the bolts to 71-106 inch lbs. (8-12 Nm).

Click on icon to view fullsize printable image.

Click to Enlarge

Camshaft journal cap tightening sequence-3.0L (DOHC) right cylinder head

31. Install the right-hand cylinder head thrust caps and bolts. Tighten to 71-106 inch lbs. (8-12 Nm).
32. Install the crankshaft damper retaining bolt and tighten as follows:

    1. Tighten to 89 ft. lbs. (120 Nm).
    2. Loosen the bolt at least one full turn.
    3. Tighten the bolt to 35-39 ft. lbs. (47-53 Nm).
    4. Rotate the bolt 85-95 degrees.

33. Install the valve covers.
34. Install the upper intake manifold(s).
35. Connect the negative battery cable.
36. Run the engine and check for leaks and proper operation.

3.4L (DOHC) Engine

The 3.4L (DOHC) engine does not have rocker arms. The camshaft lobes work directly on the valves.

Thermostat

REMOVAL & INSTALLATION

3.0L OHV Engine

NEVER open, service or drain the radiator or cooling system when hot; serious burns can occur from the steam and hot coolant. Also, when draining engine coolant, keep in mind that cats and dogs are attracted to ethylene glycol antifreeze and could drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantities.Always drain coolant into a sealable container. If necessary, clean coolant maybe reused unless it is contaminated or more than two years old.

1. Drain the coolant until the level of the coolant is below the level of the thermostat.
2. Disconnect the upper radiator hose from the water hose connection.
3. Unfasten the three water inlet connection retaining bolts and remove the water hose connection.
4. Remove the gasket and thermostat from the water hose connection. Discard the gasket.

To install:

5. Clean the water inlet connection mating surfaces.

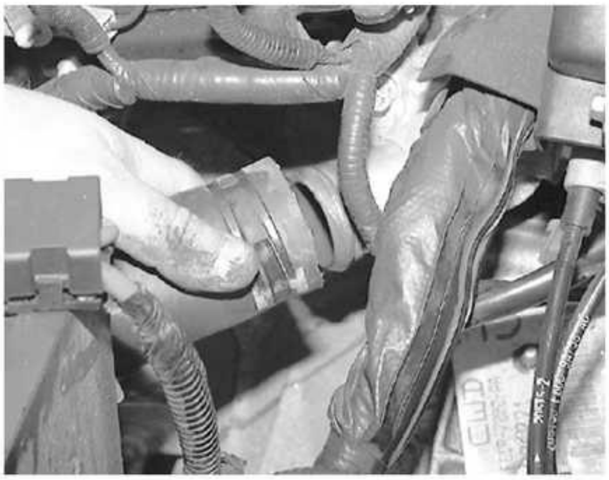
The jiggle valve on the thermostat must be in the up position.

6. Place the thermostat in the water hose connection making sure the thermostat jiggle valve is facing up.
7. Install the new gasket and place the water hose connection assembly into position.
8. Install the water hose connection assembly retainers and tighten them to 89-124 inch lbs. (10-14 Nm).
9. Connect the upper radiator hose to the water hose connection.
10. Fill the engine with coolant, start the engine and check for leaks.
11. Stop the engine and top off the coolant recovery reservoir as necessary.

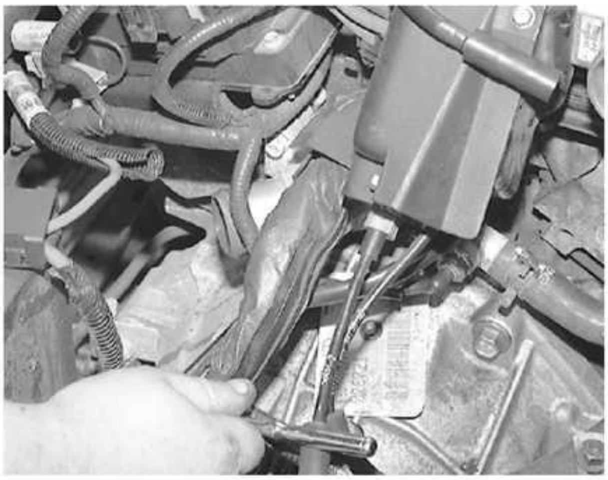
Click on icon to view fullsize printable image.

Click to Enlarge

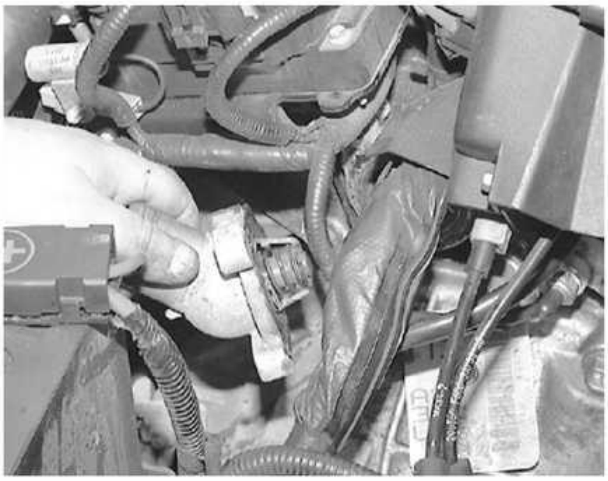
Exploded view of the water hose connection and the thermostat assembly-3.0L OHV engines



Remove the upper radiator hose from the water outlet



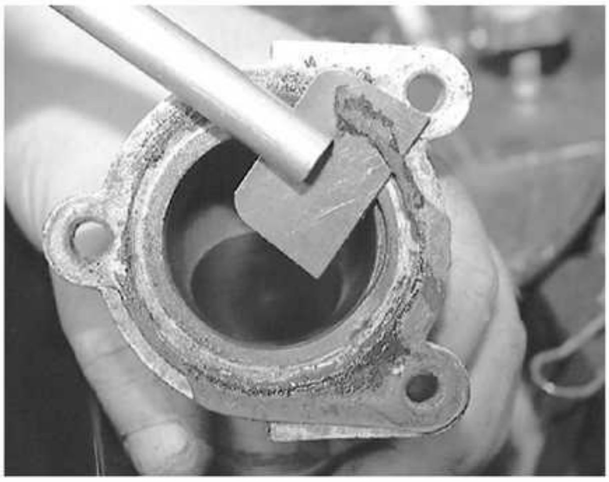
Remove the water outlet retaining bolts and...



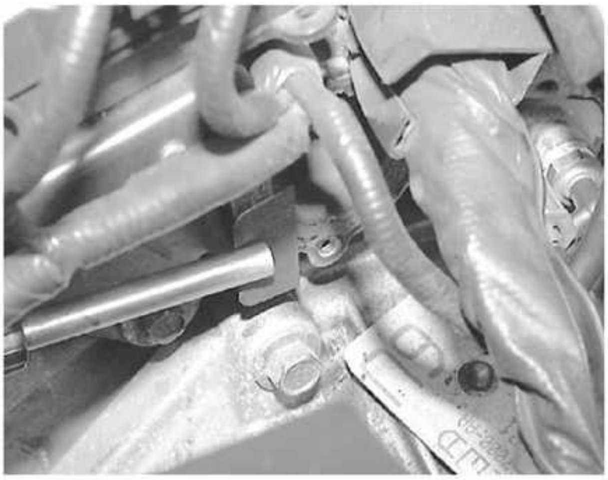
... remove the outlet from the engine

Remove the thermostat from the water outlet

Inspect the water outlet connection for cracks or damage



Thoroughly clean the mating surfaces of the water outlet and...



... the engine before installing a new gasket

The jiggle valve must be in the up (12 o'clock) position after installation into the water outlet

3.0L DOHC Engine

NEVER open, service or drain the radiator or cooling system when hot; serious burns can occur from the steam and hot coolant. Also, when draining engine coolant, keep in mind that cats and dogs are attracted to ethylene glycol antifreeze and could drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantities.Always drain coolant into a sealable container. If necessary, clean coolant maybe reused unless it is contaminated or more than two years old.

1. Drain the coolant until the level of the coolant is below the level of the thermostat.
2. Raise the vehicle and support it with jack stands.
3. Disconnect the lower radiator hose from the water inlet connection.
4. Unfasten the two water inlet connection retaining bolts and remove the water inlet connection.
5. Remove the O-ring seal and thermostat from the water inlet connection. Inspect the O-ring for damage and replace as necessary.

To install:

6. Clean the water inlet connection mating surfaces.
7. Install the O-ring, thermostat and the water inlet connection. Refer to Figure 10 if you can't remember how the O-ring and thermostat are positioned.
8. Install the water inlet connection assembly retainers and tighten them to 71-106 inch lbs. (8-12 Nm).
9. Connect the lower radiator hose to the water inlet connection.
10. Fill the engine with coolant, start the engine and check for leaks.
11. Stop the engine and top off the coolant recovery reservoir as necessary.

Click on icon to view fullsize printable image.

Click to Enlarge

Exploded view of the water inlet connection and the thermostat assembly-3.0L DOHC engines

3.4L DOHC Engine

NEVER open, service or drain the radiator or cooling system when hot; serious burns can occur from the steam and hot coolant. Also, when draining engine coolant, keep in mind that cats and dogs are attracted to ethylene glycol antifreeze and could drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantities.Always drain coolant into a sealable container. If necessary, clean coolant maybe reused unless it is contaminated or more than two years old.

1. Drain the coolant until the level of the coolant is below the level of the thermostat.
2. Disconnect the battery cables (negative cable first).
3. Remove the battery from the vehicle.
4. Remove the power distribution box.
5. Remove the battery tray.
6. Disconnect the upper radiator hose and position it out of the way.
7. Disconnect the lower radiator hose from the water inlet connection.
8. Unfasten the two water inlet connection retaining bolts and remove the water inlet connection.
9. Remove the O-ring seal and thermostat from the water pump. Inspect the O-ring for damage and replace as necessary.

To install:

10. Clean the water inlet connection mating surfaces.
11. Install the O-ring, thermostat and the water inlet connection. Refer to Figure 11 if you can't remember how the O-ring and thermostat are positioned.
12. Install the water inlet connection assembly retainers and tighten them alternately to 71-106 inch lbs. (8-12 Nm).
13. Connect the lower radiator hose to the water inlet connection.
14. Install the upper radiator hose.
15. Install the battery tray, power distribution box ad the battery.
16. Connect the battery cables.
17. Fill the engine with coolant, start the engine and check for leaks.
18. Stop the engine and top off the coolant recovery reservoir as necessary.

Click on icon to view fullsize printable image.

Click to Enlarge

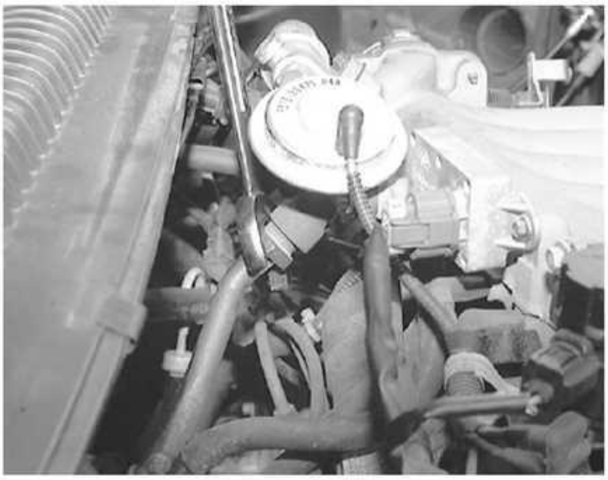
The water inlet connection, O-ring and the thermostat are mounted on the water pump assembly-3.4L DOHC engines

Intake Manifold

REMOVAL & INSTALLATION

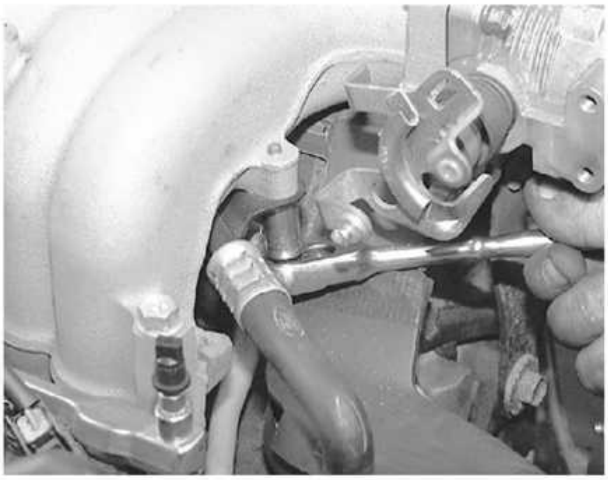
3.0L OHV Engine

UPPER INTAKE

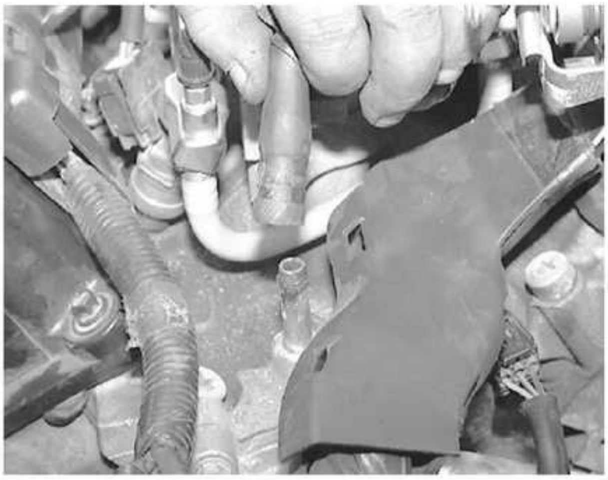


Remove the EGR tube from the EGR valve

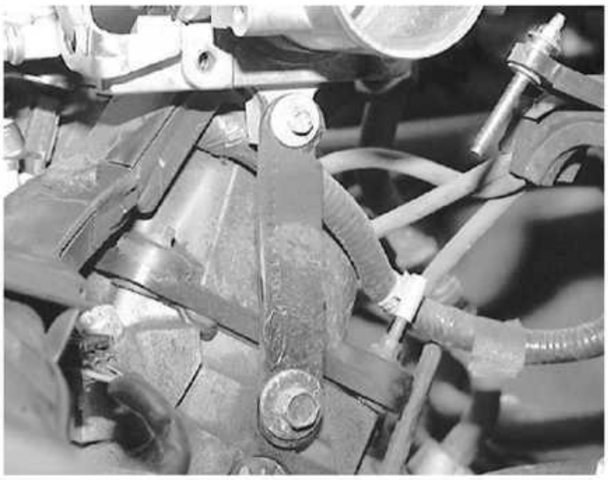
Tag and disconnect the EGR vacuum hose



Remove the wiring harness support bolt from the bottom of the intake manifold



Remove the coolant bypass hose from the lower intake manifold

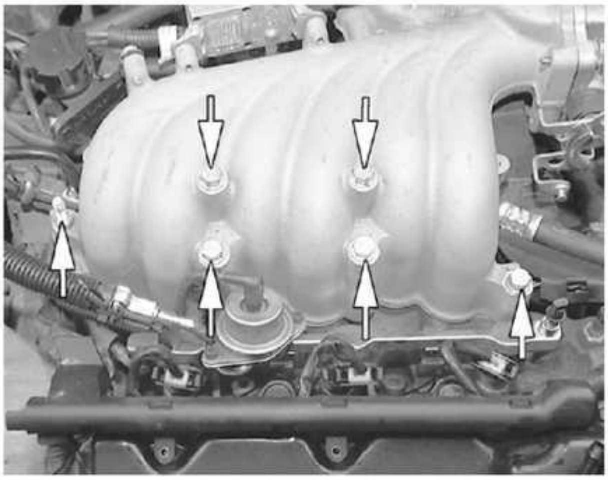


Remove the intake manifold support from the throttle body and right cylinder head

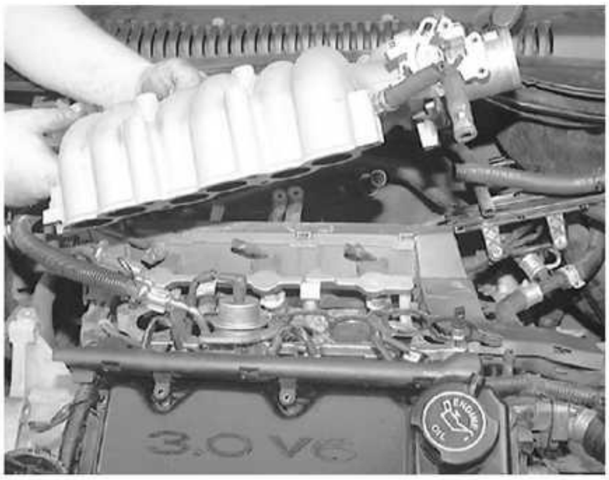
Remove the throttle body coolant hose clamp and...

... remove the hose from the tube

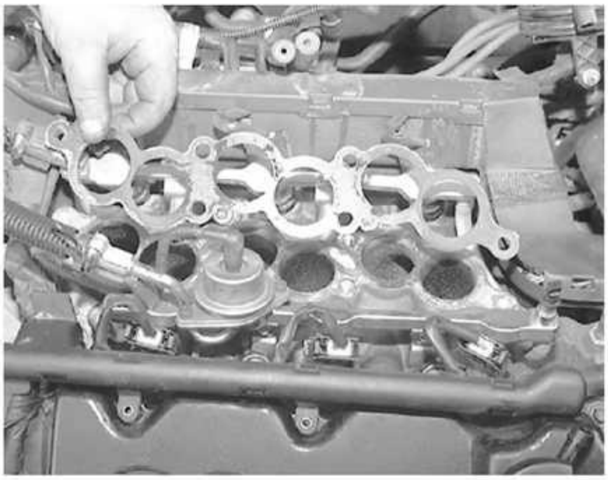
Tag and disconnect the booster vacuum hose from the vacuum fitting on the upper intake manifold



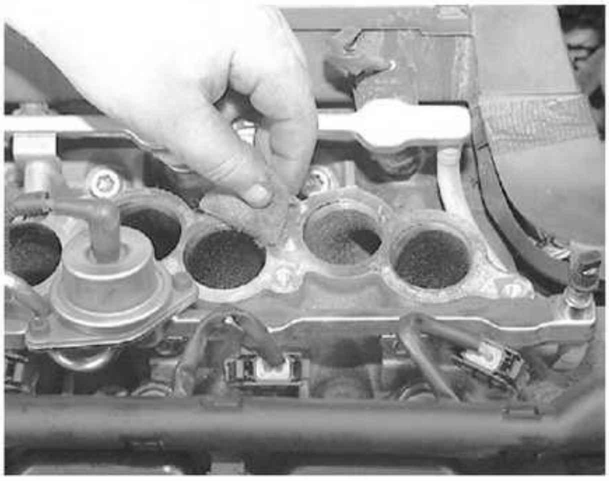
The valve cover is retained by 5 bolts and one stud, remove them and...



... carefully lift the upper intake manifold and remove it from the engine



Remove the upper intake manifold gasket from the lower intake manifold



thoroughly clean the mating surfaces of the upper and lower intake manifolds

It is a good idea to place paper towels or rags into the manifold runners while the upper intake is removed to avoid items falling into the engine and possibly causing severe damage

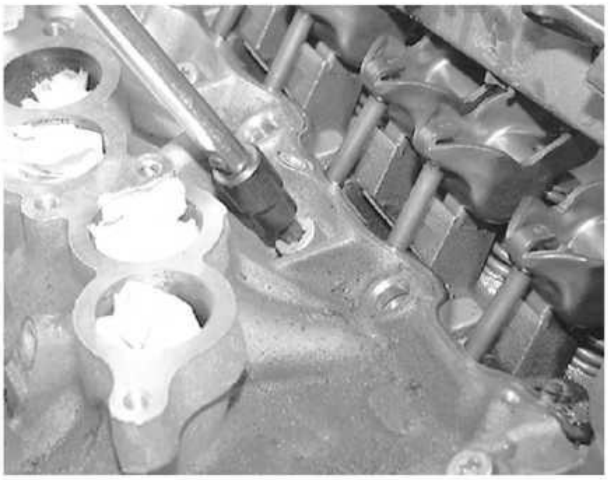
1. Disconnect the negative battery cable.
2. Remove the air cleaner outlet tube.
3. Remove the accelerator cable shield from the from the cable bracket.
4. Remove the accelerator retracting spring. Disconnect the accelerator and speed control cables from the throttle body lever.
5. Remove the two accelerator cable bracket retaining bolts from the side of the throttle body and position the cable bracket aside.
6. Label and disconnect the vacuum hose from the fuel pressure regulator.
7. Loosen the EGR tube nut at the EGR valve and disconnect the EGR backpressure transducer hoses from the EGR valve to exhaust manifold tube.
8. Tag and disconnect the PCV hose, aspirator vacuum supply hose and evaporative emission return tube from the fittings underneath the upper intake manifold.
9. Tag and unplug the electrical connectors to the Throttle Position Sensor (TPS), Idle Air Control (IAC) valve, EGR backpressure transducer and EGR vacuum regulator solenoid.
10. Disconnect the degas tube from the radiator coolant recovery tank and lower intake manifold fitting.
11. Unfasten the retaining nut and bolts for the upper alternator brace and remove the brace.
12. Remove the sensor wiring bracket from the throttle body retaining stud bolt and position the wiring aside.
13. On models equipped, remove the intake manifold support from the throttle body and right cylinder head.
14. Remove the upper intake manifold retaining bolts and stud bolts and note their location for installation. Remove the upper intake manifold.
15. Remove the manifold gaskets and discard.

To install:

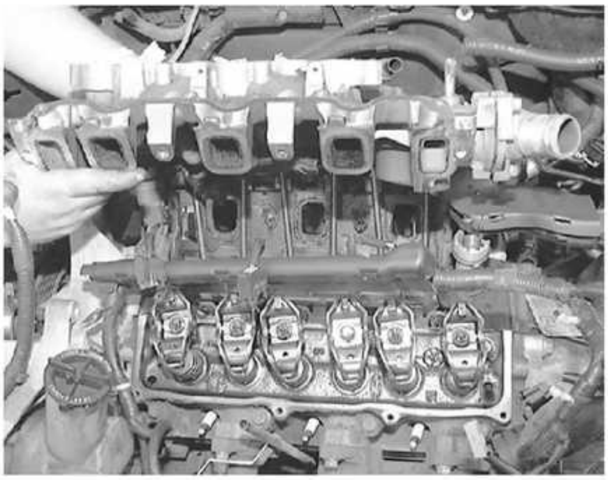
16. Clean and inspect the gasket sealing surfaces and install the new intake manifold gaskets using locating pins as necessary to aid in gasket alignment.
17. Lightly oil all attaching bolt and stud threads before installation.
18. Position the upper intake gasket and manifold on top of the lower intake manifold. Use locating pins to secure the position of gasket between manifolds.
19. Install the retaining bolts and studs in their original locations. Tighten the stud bolts and bolts to 15-22 ft. lbs. (20-30 Nm).
20. Install the alternator brace to the upper intake manifold mounting stud and alternator mounting bracket. Tighten the nut and bolts to 9-15 ft. lbs. (12-20 Nm).
21. Install the intake manifold support to the throttle body and the right cylinder head. Tighten the top retaining bolt to 71-106 inch lbs. (8-12 Nm). Tighten the bottom bolt to 30-40 ft. lbs. (40-55 Nm).
22. Install the engine sensor wiring bracket onto the throttle body stud bolts.
23. Connect the PCV hose, aspirator vacuum supply hose and evaporative emission return tube to the fittings underneath the upper intake manifold.
24. Install the EGR tube nut to the EGR valve and tighten to 26-48 ft. lbs. (35-65 Nm).
25. Connect the vacuum hose to the fuel pressure regulator.
26. Attach the electrical connectors to the TPS, IAC, EGR backpressure transducer and EGR vacuum regulator solenoid.
27. Install the accelerator cable bracket to the side of the throttle body and install the two retaining bolts. Tighten the bolts to 13 ft. lbs. (17 Nm).

28. Connect the accelerator cable and speed control cable to the throttle body. Install the throttle retracting spring.
29. Install the accelerator cable shield and tighten the bolts to 13 inch lbs. (1.4 Nm).
30. Install the air cleaner outlet tube. Connect the negative battery cable.
31. Fill the cooling system.
32. Start the engine and check for leaks and proper operation.

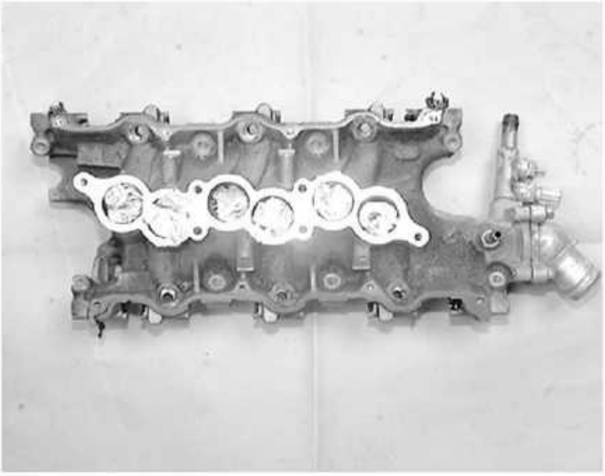
LOWER INTAKE



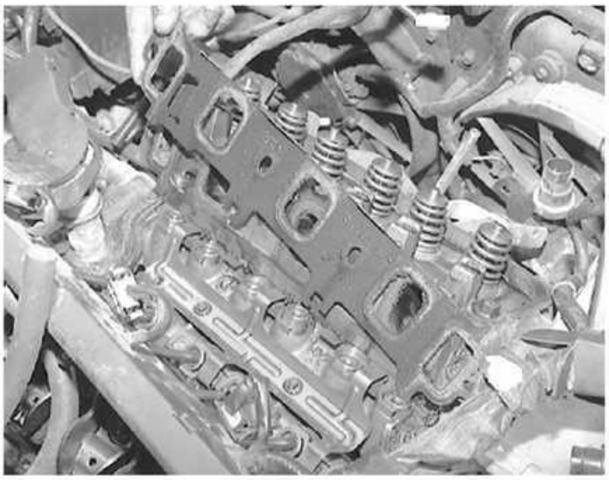
Remove the lower intake manifold retaining bolts



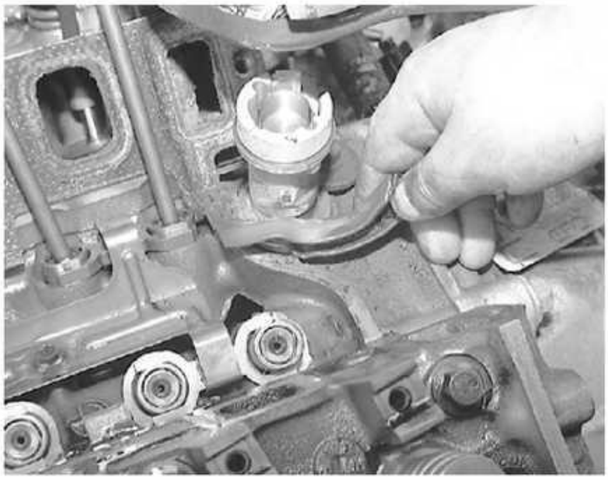
Carefully lift and remove the lower intake manifold from the engine



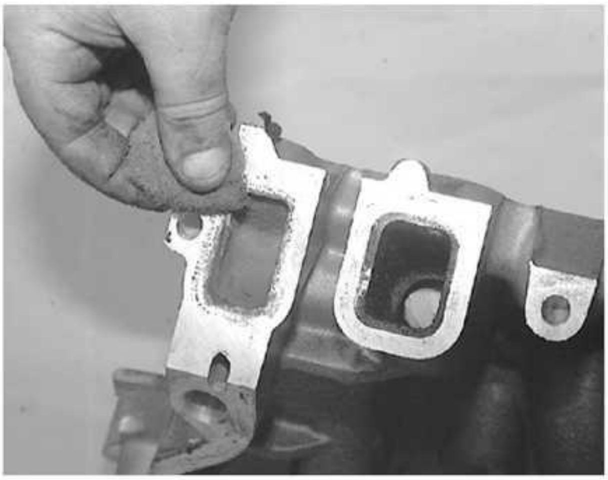
The lower intake manifold assembly-removed from the vehicle



Remove the lower intake-to-cylinder head port gaskets



Remove the lower intake manifold end gaskets



Thoroughly clean the lower intake manifold gasket mating surfaces

1. Disconnect the negative battery cable. Relieve the fuel system pressure.

NEVER open, service or drain the radiator or cooling system when hot; seriousburns can occur from the steam and hot coolant. Also, when draining enginecoolant, keep in mind that cats and dogs are attracted to ethylene glycolantifreeze and could drink any that is left in an uncovered container or inpuddles on the ground. This will prove fatal in sufficient quantities. Alwaysdrain coolant into a sealable container. If necessary, clean coolant may be reused unless it is contaminated or more than two years old.

2. Drain the cooling system.
3. Tag and unplug the wiring from the Mass Air Flow (MAF) sensor and the Intake Air Temperature (IAT) sensor.
4. Remove the air cleaner outlet tube. Remove the air cleaner bolts at the air cleaner body.
5. Disconnect the engine intake air resonator by pushing in the top and bottom tube surfaces at the engine air cleaner and pulling the air cleaner outward. Lift the air cleaner up and out of the engine compartment.
6. Remove the fuel line safely clips. Disconnect the fuel supply and return lines from the fuel supply manifold using the proper disconnect tools.
7. Tag and unplug the remaining engine wire connectors from the Camshaft Position (CMP) sensor, Throttle Position (TP) sensor, Idle Air Control (IAC) valve, Engine Coolant Temperature (ECT) sensor, ignition coil, water temperature sensor, EGR backpressure transducer and EGR vacuum regulator solenoid connector.

Note the position of the CMP sensor electrical connector. Theinstallation requires that the connector be located in the same location.

8. With suitable pliers, slide back the upper radiator hose clamp and with a twisting motion loosen the hose from the hose connection.
9. Remove the upper intake manifold.
10. Loosen the EGR tube nut and remove the EGR valve to exhaust manifold tube from the EGR valve tube to manifold connector.
11. Disconnect the sensor wiring from the valve cover stud bolts. Carefully tag and unplug the electrical connectors to each fuel injector and position the sensor wiring harness aside.
12. Disconnect the heater water hoses.
13. Label and disconnect the spark plug wires.

Before removing the CMP sensor, position No. 1 cylinder to TDC of itscompression stroke.

14. Unfasten the retaining screws from the CMP sensor and remove the sensor from the sensor housing.
15. Remove the hold-down clamp and remove the CMP housing from the cylinder block.
16. Remove the ignition coil from the rear of the left cylinder head.
17. Remove the cylinder head covers.
18. Loosen the intake valve rocker arm retaining bolt from cylinder No. 3 and rotate the rocker arm away from the valve

stem and pushrod. Remove the pushrod.

The lower intake manifold may be removed with the fuel injection supplymanifold and fuel injectors in place.

19. Remove the intake manifold attaching bolts using a Torx® head socket. Use a suitable prybar to loosen the intake manifold. Pry upward using the area between the thermostat and transaxle as a leverage point. Remove the manifold and old gaskets and seals.

To install:

Click on icon to view fullsize printable image.

Click to Enlarge

Exploded views showing lower intake manifold gasket and seal installation and points where sealant should be used-3.0L OHV engines

20. Clean the gasket mating surfaces of the intake manifold and the cylinder heads. Lay a shop rag in the lifter valley to catch any gasket material. After scraping, carefully lift the shop rag from the lifter valley, being careful not to let any particles enter the oil drain holes or cylinder head. If necessary, use a suitable solvent to remove old rubber sealant.
21. Lightly oil all the attaching bolts and stud threads before installation. When using a silicone rubber sealer, assembly must occur within 15 minutes after the sealer has been applied. After this time, the sealer may start to set-up and its sealing quality may be reduced. In high temperature and/or humidity conditions, the sealant will start to set up in approximately five minutes.
22. Apply a 1/4 inch (5-6mm) bead of a suitable silicone rubber sealer to the intersection of the cylinder block end rails and cylinder heads. Be careful not to let sealer that may block oil passages fall into the engine.
23. Install the front and rear intake manifold end seals in place and secure. Install the intake manifold gaskets, aligning the locking tabs to the provisions on the cylinder head gaskets.
24. Carefully lower the intake manifold into position on the cylinder block and cylinder heads to prevent smearing the silicone sealer and causing gasket voids.
25. Install bolts 1, 2, 3 and 4 and hand tighten.
26. Install the bolts and tighten in the sequence illustrated in two steps. On the first pass tighten to 15-22 lbs. (20-30 Nm). On the second pass tighten the bolts in sequence to 20-23 ft. lbs. (26-32 Nm).

Click on icon to view fullsize printable image.

Click to Enlarge

Tighten the lower intake manifold bolts to specification, in two steps, using the sequence shown-3.0L OHV engine

27. Install the fuel supply manifold and injectors, if removed. Apply a small amount of clean engine oil to the injector holes in the intake manifold and fuel supply manifold prior to injector installation. Install the fuel supply manifold retaining bolts and tighten to 7 ft. lbs. (10 Nm).

A special Synchro Positioning tool T95T-12200-A on 1996-97 models or tool303-589 on 1998 and later models or their equivalents must be used beforeinstalling the CMP sensor. If the special tool is not used the fuel system willbe out of time possibly causing engine damage.

Be sure the CMP connector is installed in the same position as it wasremoved for correct operation.

43. Install engine air cleaner and air cleaner outlet tube.
44. Connect the negative battery cable.
45. Cycle the ignition switch to the ***RUN*** position several times without starting the engine to pressurize the fuel system and check for fuel leaks.
46. Fill the cooling system.
47. Start the engine and check for leaks and proper operation.

3.0L DOHC Engine

UPPER INTAKE

1. Disconnect the negative battery cable. Relieve the fuel system pressure.
2. Remove the cowl vent screen and windshield wiper motor (if necessary).
3. Remove the air cleaner outlet tube.
4. Remove the accelerator cable shield.
5. Remove the accelerator cable and speed control actuator cable from the throttle body lever.
6. Remove the accelerator cable bracket from the throttle body and move aside.
7. Tag and unplug the wiring harnesses from the Throttle Position (TP) sensor and the Idle Air Control (IAC) valve.
8. Remove the evaporative emission hose from the upper intake manifold.
9. Remove the crankcase vent connector and hose from the upper intake manifold to the PCV valve at the upper intake manifold.
10. Disconnect the main emission vacuum control connector from the upper intake manifold and the secondary air injection diverter valve.
11. Remove the EGR valve.
12. Remove the secondary air injection diverter valve bracket retaining bolt and stud bolt from the upper intake manifold. Position the bracket aside.
13. Remove the upper intake manifold retaining bolts in the sequence illustrated.

When removing engine components such as manifolds and cylinder heads, always remove the retaining bolts in a reverse order of their tightening sequence to prevent warpage to the component.

14. Remove the upper intake manifold and gaskets from the engine.

Click on icon to view fullsize printable image.

Click to Enlarge

Upper intake manifold bolt loosening sequence-3.0L DOHC engine

To install:

15. Clean the upper intake manifold gasket mating surfaces.
16. Install the upper intake manifold using two new gaskets onto the lower intake manifold. Install the upper manifold retaining bolts and tighten following the sequence illustrated to 71-106 inch lbs. (8-12 Nm).

Click on icon to view fullsize printable image.

Click to Enlarge

Upper intake manifold bolt tightening sequence-3.0L DOHC engine

17. Install the EGR valve. Tighten the EGR valve-to-exhaust manifold tube nut to 26-33 ft. lbs. (35-45 Nm).
18. Attach all hoses and wiring that were tagged and unplugged during removal.
19. Attach the accelerator cable bracket to the throttle body.
20. Attach the accelerator cable and speed control actuator cable to the throttle body lever.
21. Install the accelerator cable shield.
22. Install the air cleaner outlet tube.
23. Install the wiper motor (if removed) and the cowl vent screen.
24. Connect the negative battery cable. Run the engine and check for leaks and proper engine operation.

LOWER INTAKE

1. Disconnect the negative battery cable.
2. Relieve the fuel system pressure.
3. Remove the upper intake manifold.
4. Remove the spring lock coupling retainer clips from the fuel supply and return fittings.
5. Use spring lock coupling disconnect tools (3/8 inch and 1/2 inch) to disconnect the fuel supply and return hoses from the fuel injection supply manifold.
6. Tag and unplug the fuel injector wiring harness and move aside.
7. Disconnect the vacuum line from the fuel pressure regulator.

Use care when removing the actuator cable from the Intake Manifold Runner Control (IMRC) lever.

8. Disconnect the Intake Manifold Runner Control (IMRC) actuator control cable from the intake manifold. Be careful not to loosen or bend the cable bracket, alignment is critical.

9. Tag and disconnect the ignition wires from the left cylinder head and position the wires aside.
10. If the lower intake manifold is to be replaced or machined, remove the fuel injector supply manifold (fuel rail) and the fuel injectors.
11. Remove the eight lower intake manifold to cylinder head retaining bolts in the sequence illustrated.
12. Be careful not to damage the IMRC actuator cable retainer bracket.
13. Remove the lower intake manifold and gaskets from the vehicle.

Click on icon to view fullsize printable image.

Click to Enlarge

Lower intake manifold bolt loosening sequence-3.0L DOHC engine

To install:

14. Install the fuel injectors and the fuel supply manifold onto the lower intake manifold if removed. Verify the operation of the manifold runner control plate.
15. Thoroughly clean the gasket sealing areas and place two new intake-to-cylinder head gaskets into position.
16. Carefully install the lower intake manifold and install the intake manifold to cylinder head retaining bolts. Tighten the retaining bolts in the sequence illustrated to 71-106 inch lbs. (8-12 Nm).

Click on icon to view fullsize printable image.

Click to Enlarge

Exploded view of the lower intake manifold gasket and manifold mounting-3.0L DOHC engine

Click on icon to view fullsize printable image.

Click to Enlarge

Lower intake manifold bolt tightening sequence-3.0L DOHC engine

17. Install the fuel supply and return hoses to the fuel supply manifold and ensure that the spring lock couplings are correctly installed.
18. Install the retaining clips onto the spring lock couplings.
19. Connect the vacuum line to the fuel pressure regulator.
20. Temporarily connect the negative battery cable.
21. Connect the fuel pressure gauge to the fuel pressure relief valve located on the fuel injection supply manifold.
22. Cycle the ignition key several times to the ***RUN*** position to pressurize the fuel system.
23. Watch the fuel pressure gauge for signs of leakage. If the gauge holds pressure, remove the gauge and continue with the installation of the upper intake manifold. If the pressure gauge loses pressure, remove the fuel injection supply manifold and replace the leaking O-ring(s) before continuing.
24. Disconnect the negative battery cable.
25. Reposition and install the fuel injector wiring harness.
26. Connect the ignition wires to the left cylinder head.
27. Connect the intake manifold runner actuator control cable to the intake manifold. Be careful not to loosen or bend the cable bracket, alignment is critical.
28. Install the upper intake manifold.
29. Connect the negative battery cable.

3.4L DOHC Engine

UPPER INTAKE

1. Disconnect the negative battery cable. Relieve the fuel system pressure.
2. Tmporarily remove the oil filler cap.
3. Unfasten the two flange bolts and four cap nuts attaching the appearance cover to the engine and remove the cover. Install the oil fill cap.
4. Remove the right half of the cowl vent screen.
5. Remove the throttle body.
6. Tag and disconnect the main emission vacuum supply hose from the surge tank vacuum fitting and EGR valve and move out of the way.
7. Tag and disconnect the vacuum tube from the intake manifold vacuum union.

8. Remove the two transducer mounting bracket-to-surge tank retaining bolts and position the bracket out of the way.
9. Remove the two intake manifold supports from the surge tank and cylinder head.
10. Remove the EGR valve.
11. Remove the retaining bolts and surge tank stay from the front of the surge tank.
12. Remove the bolt, nuts and surge tank stay from the rear of the surge tank.
13. Disconnect the crankcase ventilation tube from the valve cover.
14. Disconnect the crankcase ventilation tube from the surge tank.
15. Disconnect the vacuum tube to the pressure regulator.
16. Disconnect the right side crankcase ventilation hose and move aside.
17. Loosen the intake air connector hose clamps and remove the surge tank from the engine.
18. Remove the radio ignition interference capacitor bracket retaining bolt and position the radio ignition interference capacitor out of the way.
19. Remove the upper intake manifold retaining bolts in the proper sequence.

When removing engine components such as manifolds and cylinder heads, always remove the retaining bolts in a reverse order of their tightening sequence to prevent warpage to the component.

20. Remove the upper intake manifold and gaskets from the lower intake manifold.

To install:

21. Install the upper intake manifold using new gaskets onto the lower intake manifold. Install the upper manifold retaining bolts and tighten starting inward, and working outward in a criss-cross pattern to 14-20 ft. lbs. (18-28 Nm).
22. Install the radio ignition interference capacitor bracket and retaining bolt and tighten to 71-106 inch lbs. (8-12 Nm).
23. Install the surge tank and align and tighten the intake air connector hose clamps.
24. Connect the right side crankcase ventilation hose.
25. Connect the vacuum tube to the pressure regulator.
26. Connect the crankcase ventilation tube to the surge tank.
27. Connect the crankcase ventilation tube to the valve cover.
28. Install the rear surge tank stay and tighten the retaining bolts to and nuts to 14-20 ft. lbs. (18-28 Nm).
29. Install the front surge tank stay and tighten the retaining bolts to and nuts to 14-20 ft. lbs. (18-28 Nm).
30. Install the EGR valve.
31. Install the two intake manifold supports to the surge tank and cylinder head and tighten the retaining bolts to 14-20 ft. lbs. (18-28 Nm).
32. Position the transducer mounting bracket to surge tank and tighten the retaining bolts to 14-20 ft. lbs. (18-28 Nm).
33. Connect the vacuum tube to the intake manifold vacuum union.
34. Connect the main emission vacuum supply hose to the surge tank vacuum fitting and EGR valve.
35. Install the throttle body.
36. Install the right half of the cowl vent screen.
37. Install the engine appearance cover.
38. Connect the negative battery cable. Run the engine and check for leaks and proper engine operation.

LOWER INTAKE

1. Disconnect the negative battery cable. Relieve the fuel system pressure.
2. Remove the upper intake manifold.
3. Remove the fuel supply and return lines from the fuel injection supply manifold (fuel rail).
4. Disconnect the Intake Manifold Runner Control (IMRC) deactivation cable from the lower intake manifold. Remove the cable from the bracket and position aside.
5. Tag and disconnect the engine control sensor wiring from the fuel injectors and wiring retainers, then position the sensor wiring out of the way.
6. Remove the lower intake manifold to cylinder head retaining bolts and remove the intake manifold and gaskets. Discard the gaskets.

To install:

7. Thoroughly clean the gasket sealing areas and place new intake to cylinder head gaskets into position.
8. Carefully install the lower intake manifold and install the intake manifold to cylinder head retaining bolts. Tighten the

retaining bolts to 14-20 ft. lbs. (18-28 Nm).

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Exploded view of the lower intake manifold mounting-3.4L engine

9. Attach the engine control sensor wiring to the fuel injectors.
10. Connect the IMRC deactivation cable to the lower intake manifold.
11. Connect the fuel supply and return lines to the fuel injection supply manifold (fuel rail).
12. Install the upper intake manifold.
13. Connect the negative battery cable.

Exhaust Manifold

REMOVAL & INSTALLATION

3.0L OHV Engine

Left Side

1. Disconnect the negative battery cable.
2. Unfasten the oil level indicator tube support bracket retaining nut. Remove the oil level indicator tube and move engine control sensor wiring aside.
3. Raise and safely support the vehicle using jack stands.
4. Remove the exhaust manifold-to-exhaust pipe retaining nuts.
5. Lower the vehicle.

Mark the location of the manifold stud bolts prior to removal.

6. Unfasten the exhaust manifold retaining bolts and exhaust manifold stud bolts. Remove the exhaust manifold and gasket from the vehicle.

To install:

7. Clean all mating surfaces and lightly oil all bolt and stud threads prior to installation.
8. Place the exhaust manifold into position on the cylinder head using a new gasket. Tighten the four exhaust manifold retaining bolts and two stud bolts to 15-18 ft. lbs. (20-25 Nm).
9. Install the exhaust pipe to the exhaust manifold and tighten the exhaust pipe attaching nuts to 25-34 ft. lbs. (34-47 Nm).
10. Install the oil level indicator tube. Tighten the bracket nut to 12-15 ft. lbs. (16-20 Nm). Reposition the engine control sensor wiring.
11. Connect negative battery cable.
12. Run the engine and check for exhaust leaks and proper operation.

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Click to Enlarge

Exploded view of the left hand exhaust manifold mounting-3.0L OHV gasoline engines

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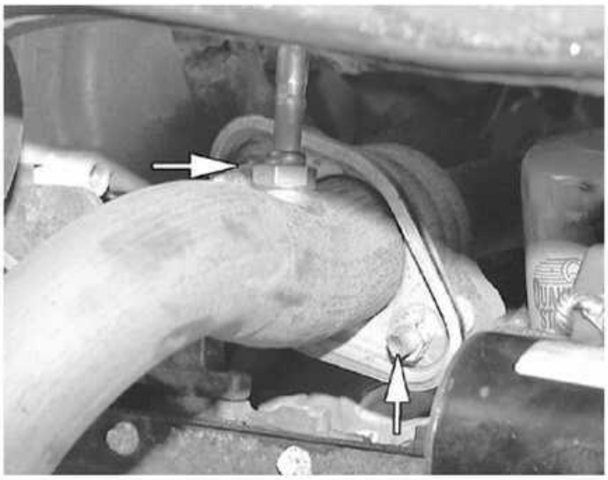
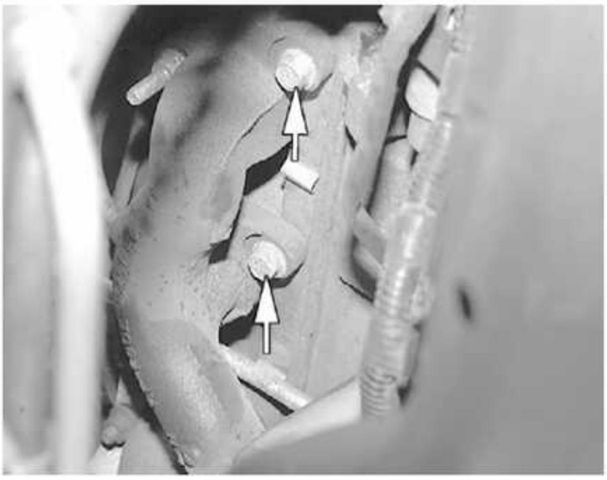
Exploded view of the left hand exhaust manifold mounting-3.0L OHV flexible fuel engines (California only)

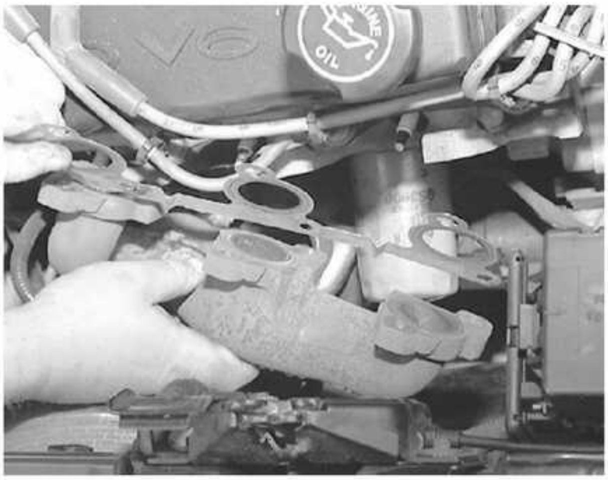
Remove oil level indicator tube



From underneath the vehicle, remove the two exhaust manifold-to-exhaust pipe retaining nuts

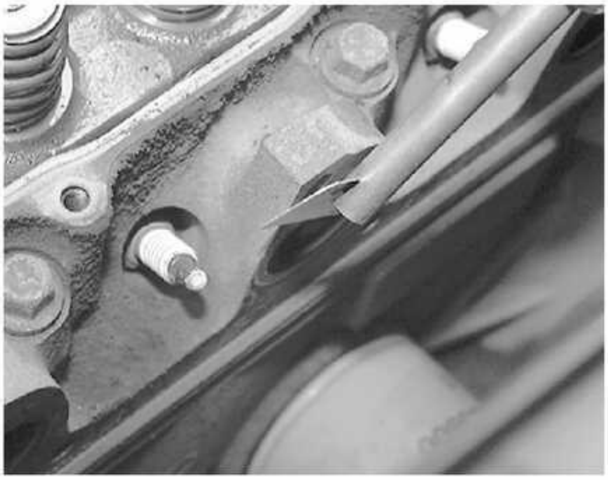


While underneath the vehicle, remove the two lower exhaust manifold retaining bolts



Remove the upper retaining bolts and remove the exhaust manifold from the vehicle

The exhaust manifold-removed from the vehicle



Thoroughly clean the manifold and cylinder head mating surfaces

RIGHT SIDE

1. Disconnect the negative battery cable.
2. Remove the EGR backpressure transducer hoses from the EGR valve-to-exhaust manifold tube.
3. Remove the EGR valve-to-exhaust manifold from the exhaust manifold. Use a back-up wrench on the EGR valve tube-to-manifold connector.
4. Unfasten the three retaining bolts from the exhaust manifold heat shield and remove the shield.
5. Raise and safely support the vehicle with jack stands.
6. Unfasten the exhaust manifold-to-exhaust pipe retaining nuts and separate the exhaust pipe from the exhaust manifold.
7. Lower the vehicle.
8. Unfasten the exhaust manifold retaining bolts and remove the exhaust manifold and gasket from the vehicle.

To install:

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Right hand exhaust manifold mounting-gasoline engines and flexible fuel engines-3.0L DOHC engines

9. Clean all mating surfaces and lightly oil all bolt threads prior to installation.
10. Install a new gasket.
11. Place the exhaust manifold into position on the cylinder head. Tighten the six exhaust manifold retaining bolts to 15-18 ft. lbs. (20-25 Nm).
12. Raise and safely support the vehicle with jack stands.
13. Position the exhaust pipe and install the retaining nuts. Tighten the retaining nuts to 25-34 ft. lbs. (34-47 Nm).
14. Install the exhaust manifold heat shield and install the retaining bolts. Tighten the retaining bolts to 71-106 inch lbs. (8-12 Nm).
15. Lower the vehicle.
16. Install the EGR tube to the exhaust manifold. Tighten the tube nut to 26-47 ft. lbs. (35-65 Nm). Connect the EGR valve hoses.
17. Connect the negative battery cable.
18. Run the engine and check for exhaust leaks and proper operation.

3.0L DOHC Engine

RIGHT SIDE

1. Disconnect the negative battery cable.
2. Remove the upper intake manifold assembly.
3. Remove the ignition coil assembly.
4. Loosen the EGR valve-to-exhaust manifold tube nuts and remove the tube from the right hand manifold.
5. Raise and safely support the vehicle with jack stands.
6. Remove the dual converter Y-pipe.
7. Remove the lower exhaust manifold retaining nuts from the cylinder head studs and lower the vehicle.
8. Remove the upper exhaust manifold retaining nuts from the cylinder head studs.
9. Remove the exhaust manifold and gasket from the engine.
10. Clean all gasket mating surfaces.

To install:

11. Install the exhaust manifold with a new exhaust manifold gasket.
12. Install the exhaust manifold retaining studs and tighten to 13-16 ft. lbs. (18-22 Nm) in the sequence illustrated.

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Right side exhaust manifold mounting bolt tightening sequence-3.0L DOHC engine

13. Position the Y-pipe assembly using a new flange gasket and install all the retaining nuts and bolts loosely.
14. Starting at the front of the system tighten the Y-pipe to exhaust manifold nuts to 26-34 ft. lbs. (34-46 Nm). Tighten the converter to transaxle nut and bolt to 30 ft. lbs. (40.3 Nm). Tighten the converter outlet bolts to 26-34 ft. lbs. (34-46 Nm).

15. Lower the vehicle.
16. Install the oxygen sensor and tighten to 26-34 ft. lbs. (35-46 Nm). Attach the electrical connector.
17. Install the EGR valve to exhaust manifold tube and tighten the nuts to 26-33 ft. lbs. (35-45 Nm).
18. Install the ignition coil assembly.
19. Install the upper intake manifold assembly.
20. Connect the negative battery cable.
21. Run the engine and check for exhaust leaks and proper operation.

LEFT SIDE

1. Disconnect the negative battery cable.
2. Raise and safely support the vehicle with jack stands.
3. Remove the dual converter Y-pipe.
4. Remove the exhaust manifold retaining nuts from the cylinder head studs.
5. Remove the exhaust manifold and gasket from the engine.
6. Clean all gasket mating surfaces.

To install:

7. Install the exhaust manifold with a new exhaust manifold gasket.
8. Install the exhaust manifold retaining studs and tighten to 13-16 ft. lbs. (18-22 Nm) in the sequence illustrated.

Click on icon to view fullsize printable image.

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Left side exhaust manifold mounting bolt tightening sequence-3.0L DOHC engine

9. Position the Y-pipe assembly using a new flange gasket and install all the retaining nuts and bolts loosely.
10. Starting at the front of the system tighten the Y-pipe to exhaust manifold nuts to 26-34 ft. lbs. (34-46 Nm). Tighten the converter to transaxle nut and bolt to 30 ft. lbs. (40.3 Nm). Tighten the converter outlet bolts to 26-34 ft. lbs. (34-46 Nm).
11. Lower the vehicle.
12. Install the oxygen sensor and tighten to 26-34 ft. lbs. (35-46 Nm). Attach the electrical connector.
13. Connect the negative battery cable.
14. Run the engine and check for exhaust leaks and proper operation.

3.4L DOHC Engine

LEFT SIDE

1. Disconnect the negative battery cable.
2. Raise and safely support the vehicle with jack stands.
3. Remove the dual converter Y-pipe.
4. Remove the lower exhaust manifold retaining nuts.
5. Lower the vehicle.
6. Remove the secondary air injection manifold tube from the exhaust manifold.
7. Remove the bolts and exhaust manifold shield from the exhaust manifold.
8. Remove the oil level indicator tube retaining bolt.
9. Remove the upper exhaust manifold retaining nuts.
10. Remove the left side exhaust manifold and gasket.

To install:

11. Clean the gasket mating surfaces.
12. Position the exhaust manifold to the engine, using a new gasket.
13. Install the upper exhaust manifold retaining nuts and tighten to 30-44 ft. lbs. (40-60 Nm).
14. Install the oil level indicator tube retaining bolt.
15. Install the bolts and exhaust manifold shield to the exhaust manifold and tighten to 12-16 ft. lbs. (16-23 Nm).
16. Install the secondary air injection manifold tube to the exhaust manifold and tighten the nut to 29-33 ft. lbs. (40-45 Nm).
17. Raise and safely support the vehicle.

18. Install the lower exhaust manifold retaining nuts and tighten to 30-44 ft. lbs. (40-60 Nm).
19. Install the dual converter Y-pipe.
20. Lower the vehicle.
21. Connect the negative battery cable.

RIGHT SIDE

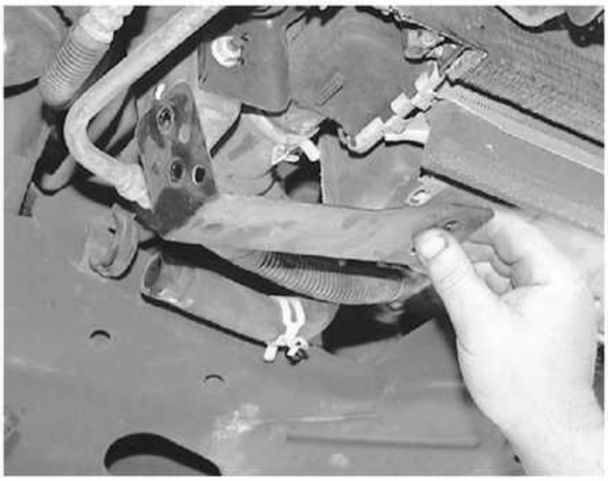
1. Disconnect the negative battery cable.
2. Remove the secondary air injection manifold tube from the exhaust manifold.
3. Remove the three bolts from the exhaust manifold shield.
4. Raise and safely support the vehicle with jack stands.
5. Remove the EGR valve-to-exhaust manifold tube from the exhaust manifold.
6. Disconnect the EGR valve to exhaust manifold tube from the EGR transducer.
7. Remove the dual converter Y-pipe.
8. Remove the two lower exhaust manifold retaining nuts.
9. Lower the vehicle.
10. Remove the exhaust manifold shield.
11. Remove the four upper exhaust manifold retaining nuts.
12. Raise and safely support the vehicle with jack stands.
13. Remove the right side exhaust manifold and gasket.

To install:

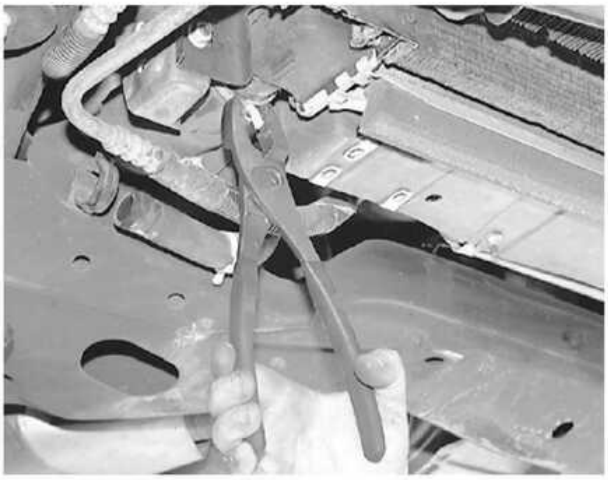
14. Clean the exhaust manifold gasket mating surfaces.
15. Position the exhaust manifold to the engine, using a new gasket.
16. Install the four upper exhaust manifold retaining nuts and tighten to 30-44 ft. lbs. (40-60 Nm).
17. Raise and safely support the vehicle with jack stands.
18. Install the two lower exhaust manifold retaining nuts and tighten to 30-44 ft. lbs. (40-60 Nm).
19. Install the dual converter Y-pipe.
20. Connect the EGR valve to exhaust manifold tube to the EGR transducer.
21. Install the EGR valve to exhaust manifold tube to the exhaust manifold.
22. Lower the vehicle.
23. Install the three bolts that attach the exhaust manifold shield to the exhaust manifold and tighten to 12-16 ft. lbs. (16-23 Nm).
24. Install the secondary air injection manifold tube to the exhaust manifold.
25. Connect the negative battery cable.

Radiator

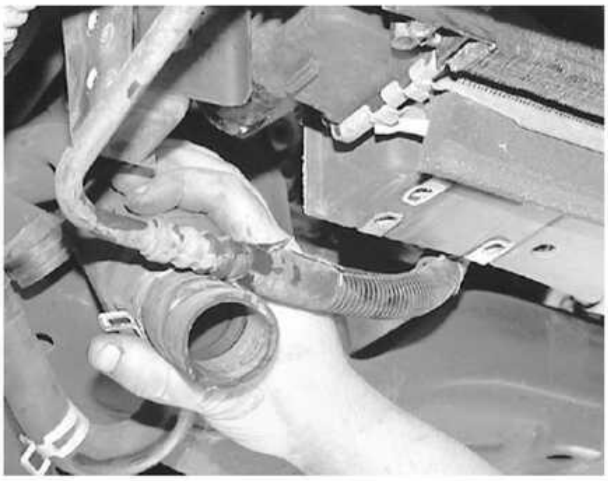
REMOVAL & INSTALLATION



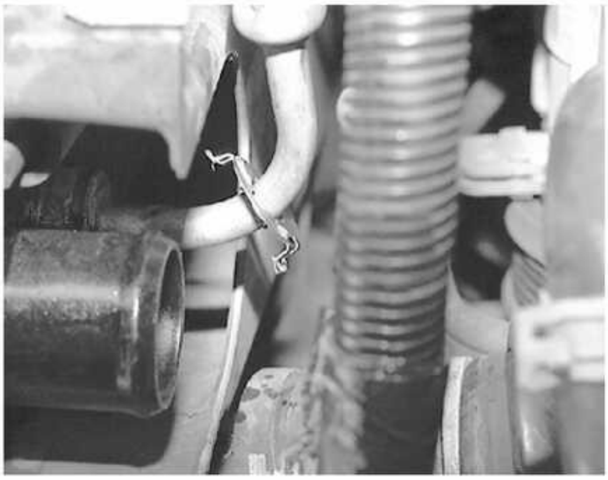
Remove the lower mounting bracket to access the lower radiator hose



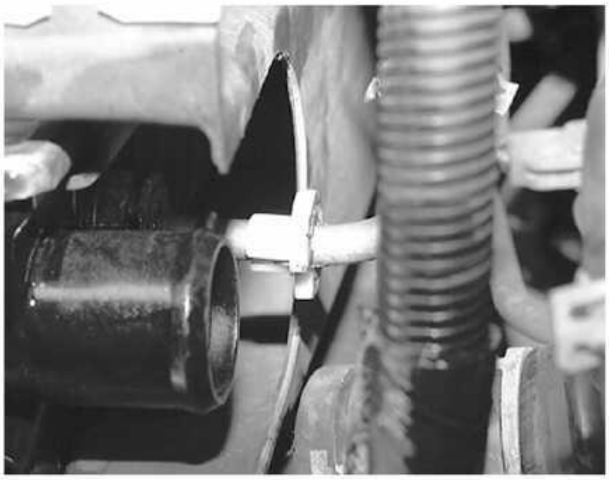
Remove the clamp from the lower radiator hose and...



... remove the hose from the radiator

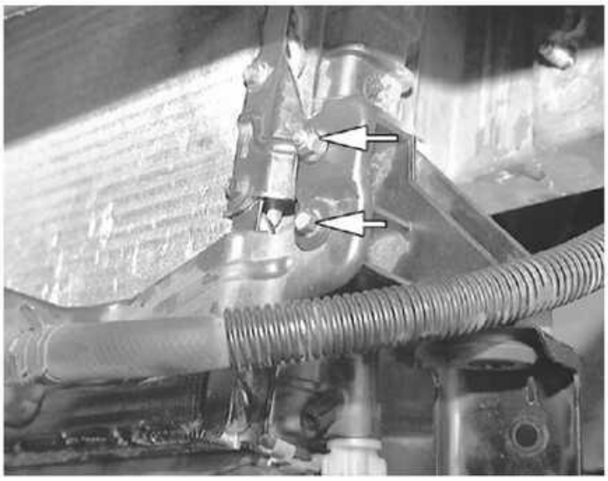


Remove the transmission cooler line retaining clips

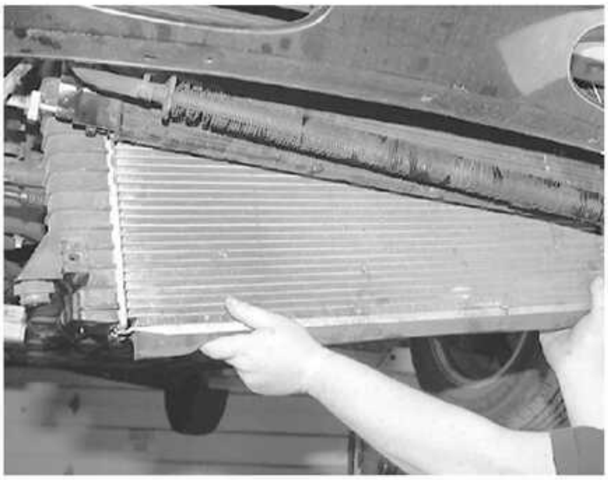


Install the release tool onto the cooler line and release the fitting

The upper radiator retaining screws are accessible through a hole, remove them from the radiator



Remove the lower radiator retaining screws and...



... remove the radiator from the vehicle

Fuel line disconnect tool set T90T-9550-S or equivalent is required toperform this procedure.

1. Disconnect the battery cables, negative cable first.
2. Remove the battery and the battery tray.
3. Unclip the constant control relay module and position it aside.
4. Remove the radiator cap.
5. Raise the vehicle and support it with jack stands.
6. Remove the radiator splash shields.

NEVER open, service or drain the radiator or cooling system when hot; serious burns can occur from the steam and hot coolant. Also, when draining engine coolant, keep in mind that cats and dogs are attracted to ethylene glycol antifreeze and could drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantities.Always drain coolant into a sealable container. If necessary, clean coolant maybe reused unless it is contaminated or more than two years old.

7. Drain the cooling system into a suitable container.
8. Remove the radiator mounting bracket assembly.
9. Disconnect the lower and upper radiator hoses and the overflow hose from the radiator.
10. Remove the A/C condenser retaining bolts.
11. Remove the transaxle cooler line clips.
12. Using a 3/8 inch fuel line disconnect tool T90T-9550-S or its equivalent, disconnect the transaxle oil cooler tubes from the radiator.
13. Remove the transaxle oil cooler line bracket and position the oil cooler aside.
14. Remove the A/C condenser bracket and position the A/C condenser core aside.
15. Remove the retaining bolts and radiator support bracket.
16. Remove the radiator.

To install:

17. Place the radiator in position.
18. Install the radiator support bracket and the retaining nuts. Tighten the nuts to 71-106 inch lbs. (8-12 Nm).
19. Place the A/C condenser core into position, install the condenser bracket and the retaining bolts. Tighten the bolts to 45-61 inch lbs. (5-7 Nm).
20. Place the transaxle oil cooler in position and install the oil cooler tube bracket. Tighten the retainers to 45-61 inch lbs. (5-7 Nm).
21. Install the transaxle cooler line tubes and the cooler line clips.
22. Place the A/C condenser retaining bracket and install the retainers. Tighten the retainers to 45-61 inch lbs. (5-7 Nm).

23. Attach the radiator overflow hose and the radiator hoses to the radiator. Tighten the hose clamps securely.
24. Install the radiator mounting bracket and its retainers. Tighten the retainers to 81-106 inch lbs. (8-12 Nm).
25. Install the radiator splash shields and lower the vehicle.
26. Place the constant control relay module in position and install the retaining clip.
27. Install the battery tray and battery.
28. Connect the battery cables, negative cable last.
29. Fill and bleed the cooling system.
30. Start the engine and check for coolant and transmission fluid leaks.

Engine Fan

REMOVAL & INSTALLATION

If your vehicle is equipped with air conditioning, refer to Section 1 for information regarding the implications of servicing your A/C system yourself. Only an MVAC-trained, EPA-certified, automotive technician should service the A/C system or its components.

Fuel line disconnect tool set T90T-9550-S or equivalent is required toperform this procedure.

1. If your vehicle is equipped with A/C have the system evacuated by a qualified technician using a recovery/recycling station.
2. Remove the engine air cleaner assembly.
3. Disconnect the battery cables, negative cable first.
4. Remove the battery and battery tray.
5. Raise the vehicle and support it with jack stands.

NEVER open, service or drain the radiator or cooling system when hot; serious burns can occur from the steam and hot coolant. Also, when draining engine coolant, keep in mind that cats and dogs are attracted to ethylene glycol antifreeze and could drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantities.Always drain coolant into a sealable container. If necessary, clean coolant maybe reused unless it is contaminated or more than two years old.

6. Drain the cooling system into a suitable container.
7. Unfasten the bolts retaining the lower radiator hose shield and remove the shield.
8. Disconnect the lower radiator hose from the radiator.
9. Disconnect the A/C evaporator muffler and hoses from the A/C condenser core. Cap all openings immediately to avoid system contamination.
10. Using a 3/8 inch fuel line disconnect tool T90T-9550-S or its equivalent, disconnect the lower transaxle oil cooler tube from the radiator.
11. Unfasten the two screws from the lower transaxle oil cooler tube and allow the transaxle oil cooler tube to hang.
12. Remove both of the transaxle oil cooler tubes from the left end of the power steering/transaxle oil cooler.
13. Remove the lower radiator mounts and lower the vehicle.
14. Unfasten the four bolts retaining the hood latch support and position the latch support to one side.
15. Remove the front bumper cover and the upper radiator support.
16. Disconnect the radiator overflow hose from the radiator.
17. Remove the power distribution box, harness and bracket, then position the box and harness aside.
18. Tag and unplug the wiring from the fan motor.
19. Unfasten the screws retaining the engine control sensor wiring and position the wiring aside.
20. Disconnect the power steering fluid cooler from the power steering pump.
21. Support the fan blade and fan shroud assembly.
22. Unfasten the fan assembly brackets-to-sub-frame bolts.
23. Remove the cooling fan assembly from the vehicle.

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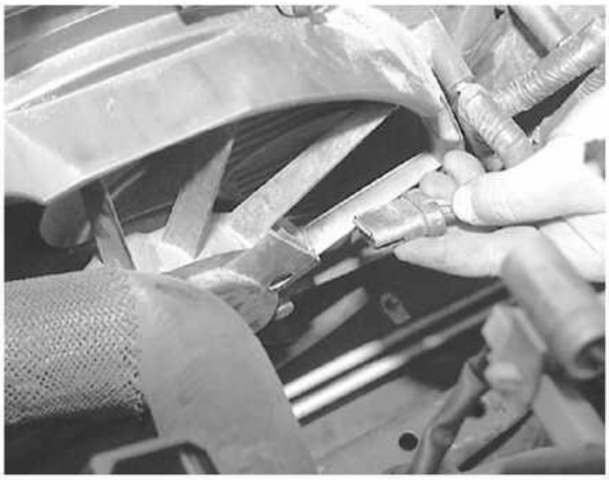
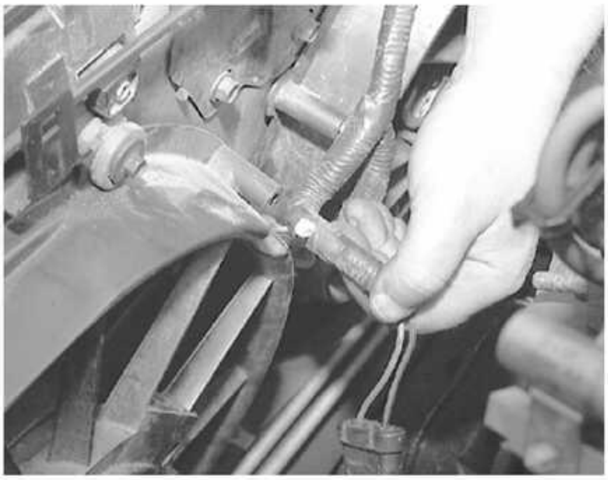
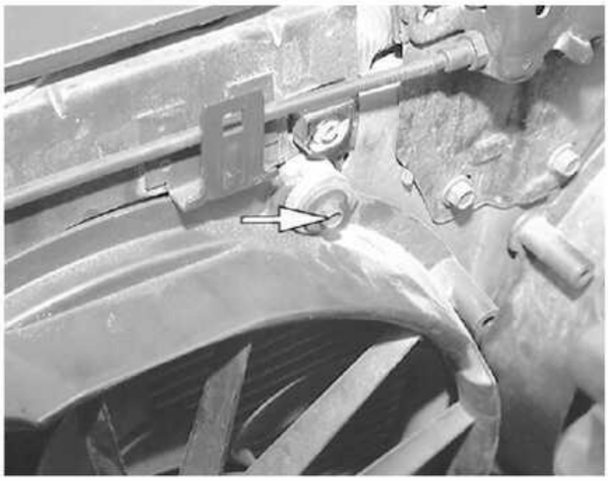
View of the fan assembly



Detach the connector for the engine fan

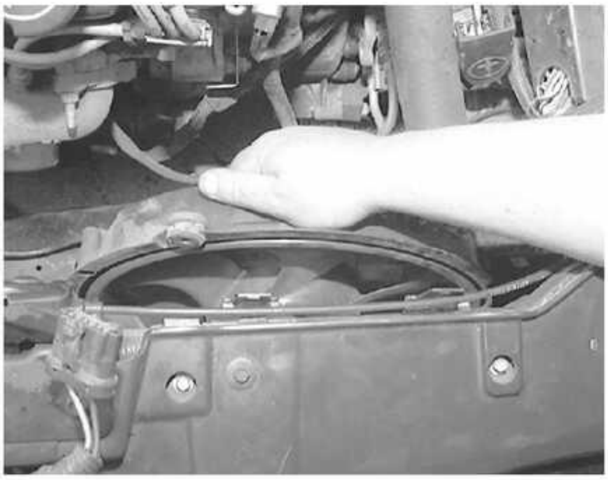


Remove the harness from the fan assembly



Remove the fan retaining bolts and...

CHILTON



... remove the fan from the vehicle

To install:

24. Place the fan assembly in position and install the fan assembly-to-frame rail retainers. Tighten the retainers to 15-22 ft. lbs. (20-30 Nm).
25. Connect the power steering fluid cooler to the power steering pump.
26. Place the engine wiring into position and install the retaining screws.
27. Attach the wiring to the power steering pump.
28. Place the power distribution box and bracket in position and install the retainers to 18-25 ft. lbs. (25-35 Nm).
29. Connect the upper radiator hose and the overflow hose to the radiator and tighten the hose clamps.
30. Install the upper radiator support and the front bumper cover.
31. Place the hood latch support assembly in position and install the retaining bolts. Tighten the bolts to 18-25 ft. lbs. (25-35 Nm).
32. Raise the vehicle and support it with jack stands.
33. Connect both of the transaxle oil cooler tubes to the left end of the power steering/transaxle oil cooler.
34. Install the power steering transaxle cooler and its retaining bolt and nut. Tighten the bolt and nut to 45-61 ft. lbs. (5-7 Nm).
35. Connect the lower transaxle oil cooler tube.
36. Connect the A/C evaporator muffler and hoses to the condenser core.
37. Connect the lower radiator hose to the radiator and tighten the clamp.
38. Install the lower radiator hose shield and its retainers. Tighten the retainers to 45-61 inch lbs. (5-7 Nm).
39. Lower the vehicle and install the battery tray and battery.
40. Install the engine air cleaner assembly.
41. Connect the battery cables, negative cable last.
42. Fill and bleed the power steering reservoir.
43. Fill and bleed the cooling system.
44. Have the A/C system evacuated and recharged by a qualified technician using a recovery/recycling station.

Water Pump

REMOVAL & INSTALLATION

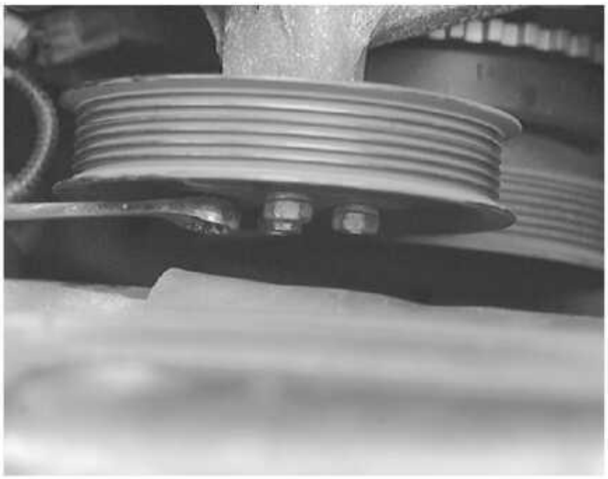
NEVER open, service or drain the radiator or cooling system when hot; serious burns can occur from the steam and hot coolant. Also, when draining engine coolant, keep in mind that cats and dogs are attracted to ethylene glycol antifreeze and could drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantities.Always drain coolant into a sealable container. If necessary, clean coolant maybe reused unless it is contaminated or more than two years old.

3.0L OHV Engine

1. Disconnect the negative battery cable. Allow the engine to cool.
2. Remove the radiator cap and drain the cooling system.
3. Loosen four retaining bolts securing the water pump pulley to the water pump hub.
4. Remove the accessory drive belts.
5. Remove the automatic belt tensioner.
6. Disconnect and remove the heater hose from the water pump.
7. Remove the engine control sensor wiring from the locating stud bolt, if equipped.
8. Remove the water pump-to-engine retaining bolts and lift the water pump and pulley up and out of the vehicle.

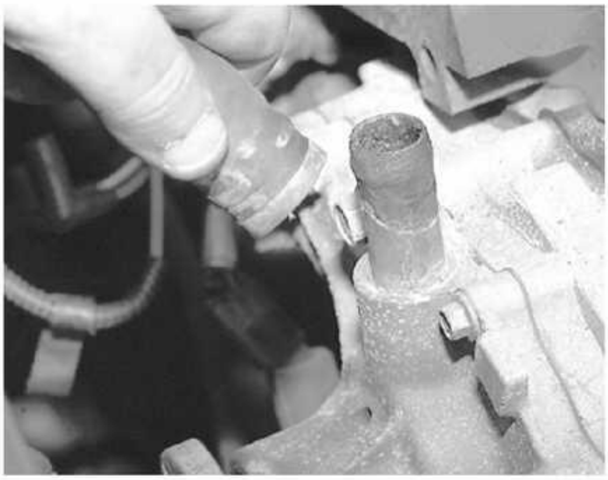
To install:

It is recommended to loosen the water pump pulley bolts while the belt is still connected

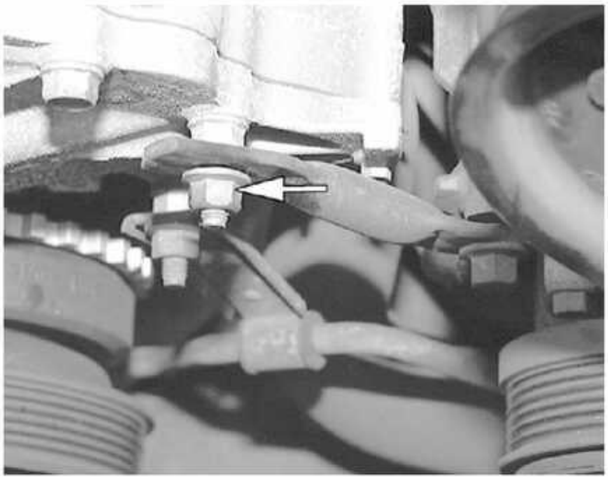


After the belt is removed, remove the pulley bolts and...

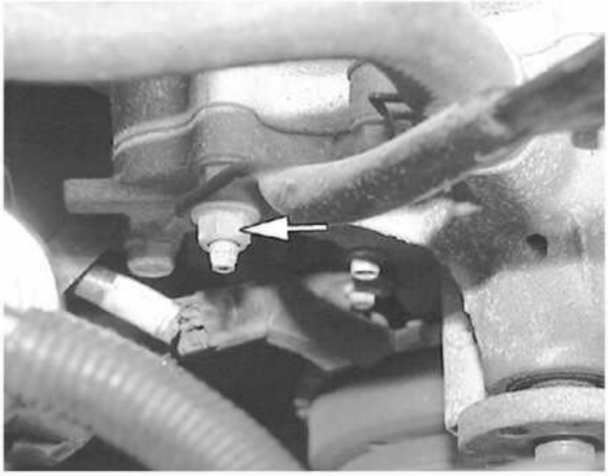
Remove the pulley from the water pump



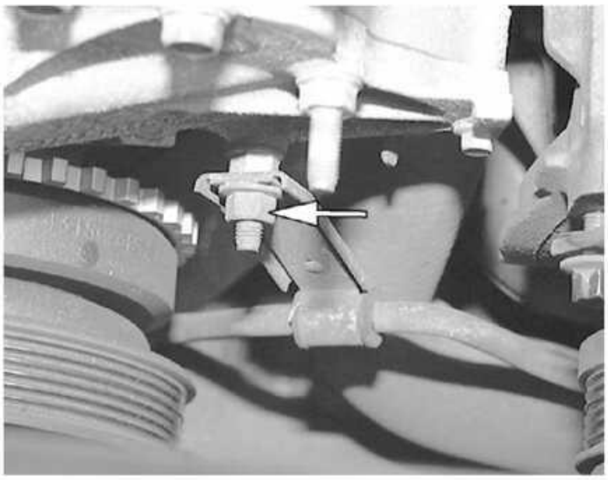
Remove the heater hose from the top of the water pump



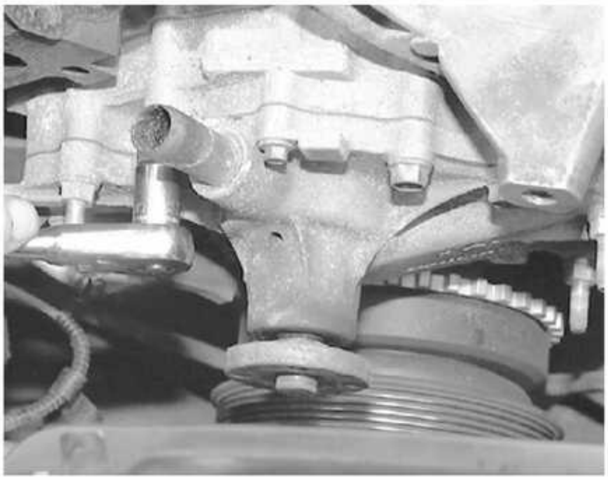
Remove the A/C compressor support bracket



Remove the alternator support bracket also



Remove the power steering line support bracket nut and remove the bracket from the water pump



Remove the water pump retaining bolts and...

... remove the water pump from the engine

Thoroughly clean the water pump mounting surfaces

Click on icon to view fullsize printable image.

Click to Enlarge

Location, size and torque specification for the water pump bolts-3.0L OHV engine

Use care when using a scraper to clean any aluminum parts. Aluminum gouges easily which may cause the component to leak.

9. Clean the gasket surfaces on the water pump and engine front cover. Install a new gasket on the water pump using gasket adhesive.
10. Place the water pump in position on the engine with the pulley and four retaining bolts loosely installed on the hub.
11. Apply pipe sealant to bolt No. 3. Refer to the accompanying illustration for bolt location.
12. Install the bolts in the water pump housing.
13. Tighten bolts Nos. 4, 5, 6, 7, 8, 9 and 10 to 15-22 ft. lbs. (20-30 Nm). Tighten bolts Nos. 11, 12, 13, 14 and 15 to 71-106 inch lbs. (8-12 Nm).

The bolts are of different lengths and must be installed in the correctlocations.

14. If equipped, attach the engine control sensor wiring to the locating stud bolt.
15. Hand-tighten the water pump pulley retaining bolts.
16. Install the accessory drive belts.
17. Tighten the water pump pulley bolts to 15-22 ft. lbs. (20-30 Nm).
18. Connect the heater hose to the water pump.
19. Fill the cooling system. Connect the negative battery cable.
20. Start the engine and allow it to reach normal operating temperature. Check for leaks and proper operation.

3.0L DOHC Engine

1. Disconnect the negative battery cable. Drain the engine cooling system.
2. Remove the water pump drive belt.
3. Disconnect the radiator and heater hoses from the water pump.
4. If equipped, remove the A/C compressor-to-water pump brace.
5. Unfasten the four nuts securing the water pump to the engine and remove the water pump.

To install:

Click on icon to view fullsize printable image.

Click to Enlarge

Water pump mounting-3.0L DOHC engine

6. Clean the water pump to engine gasket sealing surfaces.
7. Install the water pump using a new gasket and install the four retaining nuts. Tighten the retaining nuts to 15-22 ft. lbs. (20-30 Nm).
8. Connect the radiator and heater hoses to the water pump. Make sure the clamps are securely tightened.
9. If equipped, install the A/C compressor-to-water pump brace. Tighten the brace bolts to 15-22 ft. lbs. (20-30 Nm).
10. Install the water pump drive belt.
11. Fill the engine cooling system, then connect the negative battery cable.
12. Start the engine and allow it to reach normal operating temperature, then check for coolant leaks and proper engine operation.

3.4L Engine

1. Disconnect the negative battery cable.
2. Drain the engine cooling system.
3. Remove the two flange bolts and four cap nuts and remove the engine appearance cover.
4. Remove the battery and battery tray.
5. Remove the water pump drive belt.
6. Disconnect the throttle body return and supply hoses, heater core return hose and the oil cooler return hose from the water pump.
7. Remove the two water hose connection (thermostat housing) retaining bolts and remove the thermostat.
8. Remove the bolts and collar retaining the water pump housing to the left side cylinder head.
9. Disconnect the water outlet and inlet hoses from the water pump and remove the water pump from the engine.
10. Unfasten the belt idler pulley retaining nut and remove the pulley from the water pump.

To install:

Click on icon to view fullsize printable image.

Click to Enlarge

Exploded view of the water pump and its related components-3.4L DOHC engine

11. Clean the water pump to engine and housing gasket sealing surfaces.
12. Install the belt idler pulley and retaining nut and tighten the retaining bolt to 89-141 inch lbs. (10-16 Nm).
13. Apply a silicone lubricant to the water pump inlet and outlet hoses, install them on the water pump housing and clamp securely.

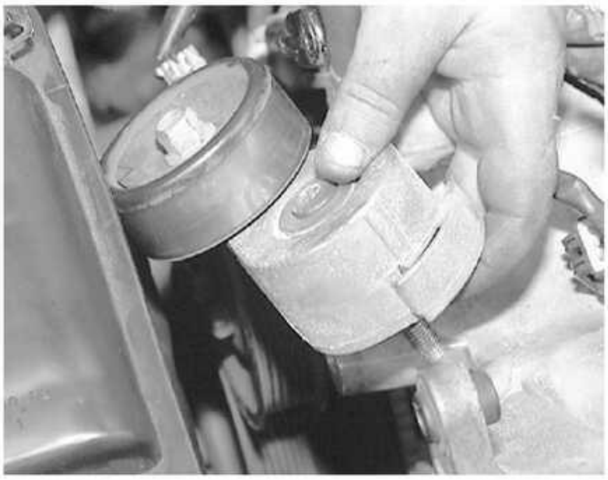
14. Apply a silicone lubricant to the O-ring and install it between the water pump housing and left side cylinder head.
15. Install the bolts retaining the water pump housing to the left side cylinder head. Tighten the two retaining bolts at the water inlet to 71-106 inch lbs. (8-12 Nm). Tighten the two remaining retaining bolts to 14-20 ft. lbs. (18-28 Nm).
16. Install the water thermostat, oil cooler return tube gasket and water hose connection to the water pump housing and tighten the two retaining bolts to 71-106 inch lbs. (8-12 Nm).
17. Connect the throttle body return and supply hoses, heater core return hose and the oil cooler return hose to the water pump.
18. Install the water pump drive belt.
19. Install the engine appearance cover and tighten the two flange bolts and four cap nuts to 71-106 inch lbs. (8-12 Nm).
20. Fill the engine cooling system, then connect the negative battery cable.
21. Start the engine and allow it to reach normal operating temperature, then check for coolant leaks and proper engine operation.

Cylinder Head

REMOVAL & INSTALLATION

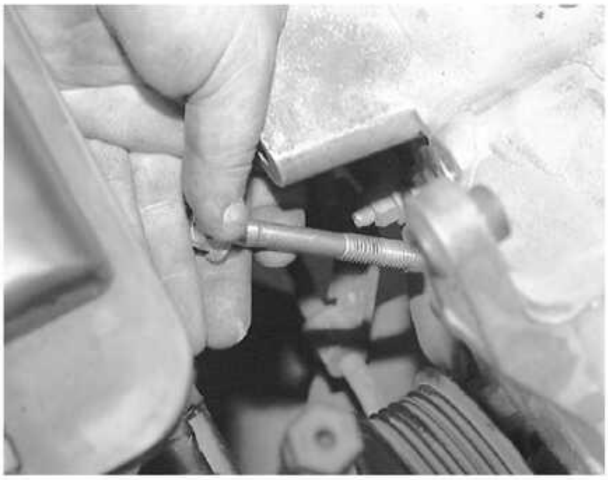
3.0L OHV Engines

Remove the drive belt tensioner retaining bolt and...

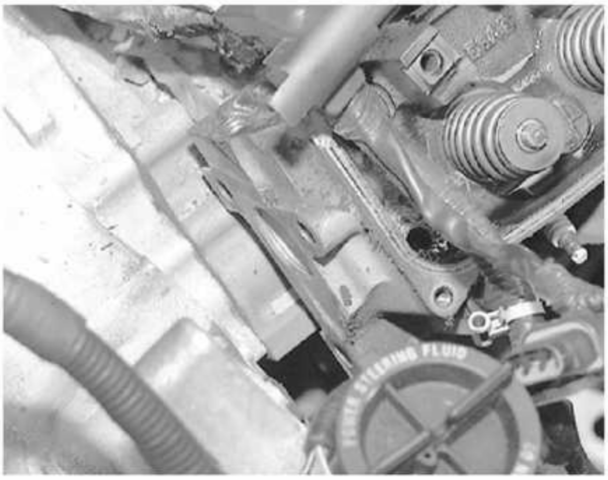


... remove the drive belt tensioner

Loosen and...

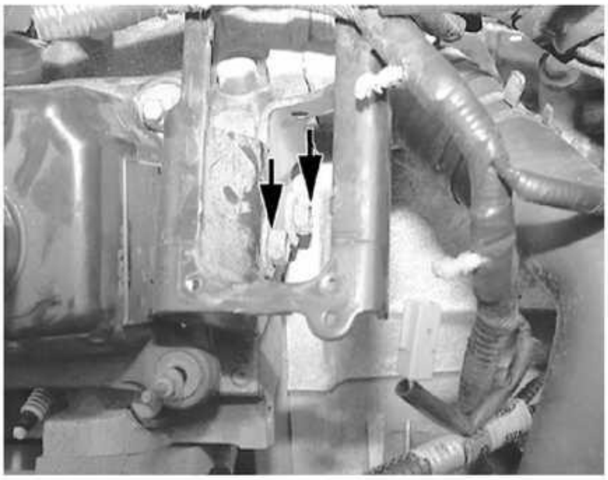


... remove the power steering pump bracket mounting bolts

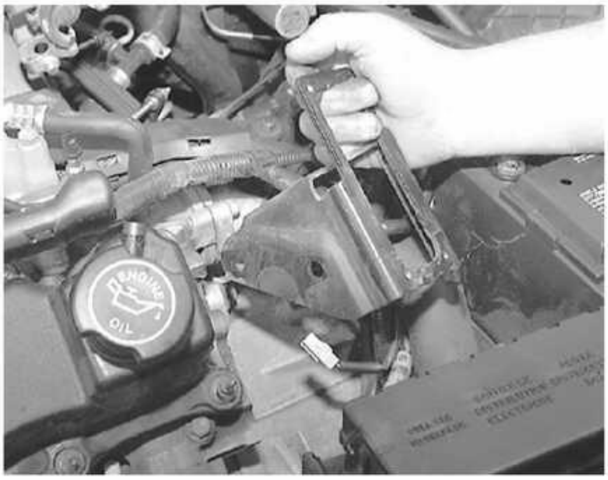


Carefully position the power steering pump assembly out of the way

Remove the heater hose from the bypass tube

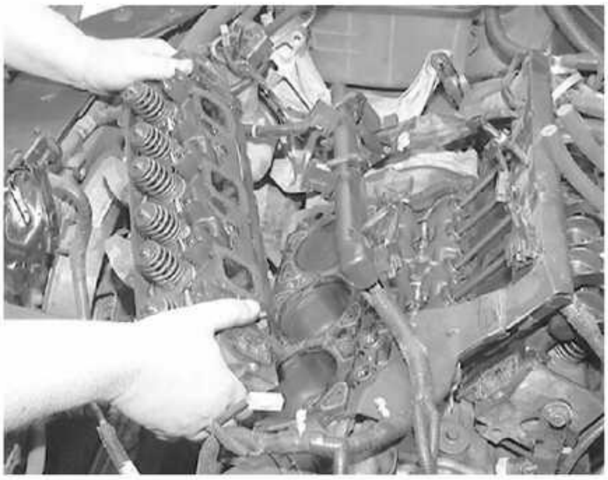


Remove the two ignition coil bracket mounting bolts and...

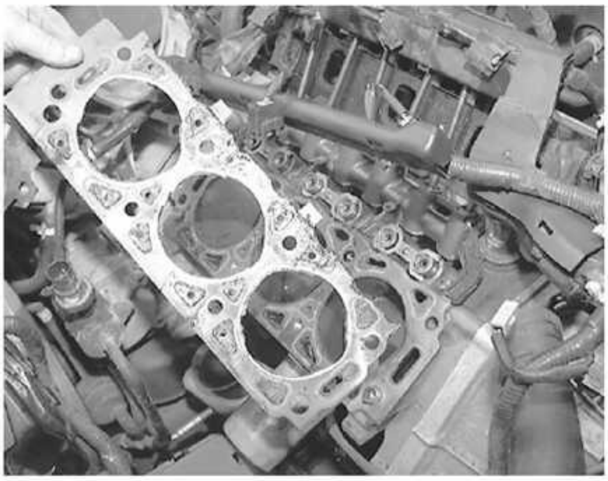


... remove the bracket from the engine

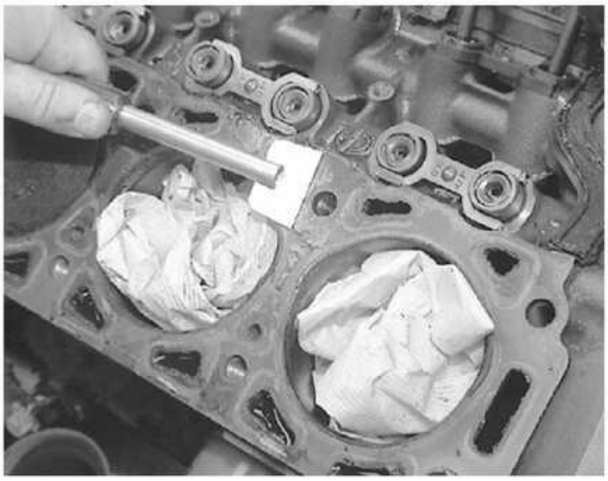
CHILTON



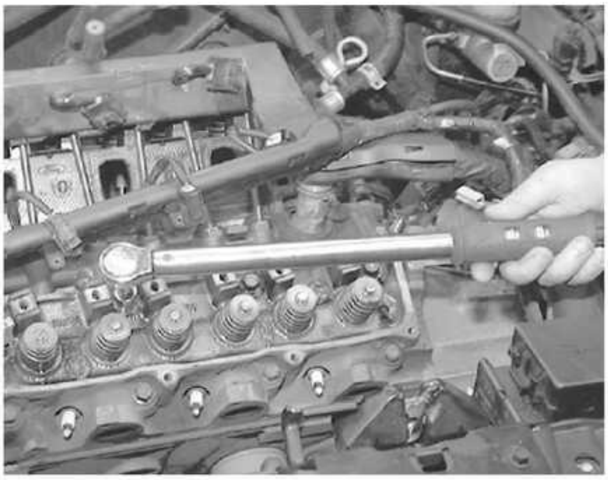
Lift the head from the engine



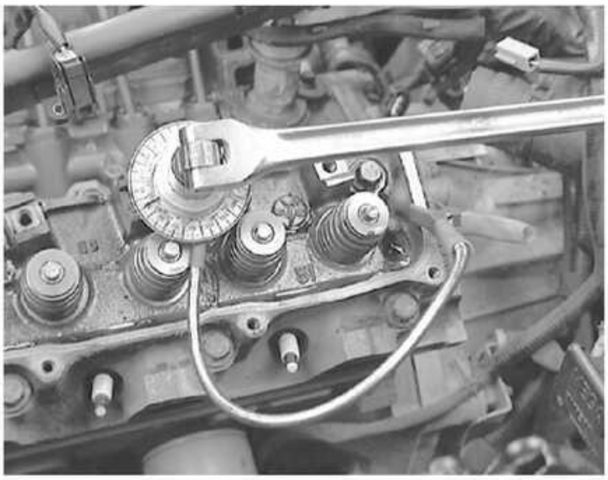
Remove the old head gasket from the block and...



Thoroughly clean the block-to-cylinder head mating surfaces



ALWAYS tighten the cylinder head bolts using a torque wrench and...



... torque angle gauge (if necessary)

The cylinder head bolts are a torque-to-yield design and cannot be reused. Be sure new cylinder head bolts are available before beginning this procedure.

1. Rotate the crankshaft until the piston in No. 1 cylinder is at TDC on the compression stroke.
2. Disconnect the negative battery cable. Properly relieve the fuel system pressure.

NEVER open, service or drain the radiator or cooling system when hot; serious burns can occur from the steam and hot coolant. Also, when draining engine coolant, keep in mind that cats and dogs are attracted to ethylene glycol antifreeze and could drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantities.Always drain coolant into a sealable container. If necessary, clean coolant maybe reused unless it is contaminated or more than two years old.

3. Drain the cooling system into a suitable container.
4. Remove the air cleaner outlet hose to throttle body.
5. Label and disconnect the vacuum lines to the upper intake manifold.
6. Disconnect the transducer hose from the EGR valve. Loosen the lower EGR valve-to-exhaust manifold tube nut and

Regardless of the cylinder head being removed, the No. 3 cylinder intakevalve pushrod must be removed to allow removal of the intake manifold.

19. Loosen the rocker arm fulcrum bolts and remove the rocker arms, fulcrums and bolts. Keep the assemblies in order so they can be reinstalled in their original locations.
20. Remove the pushrods and label their positions. The pushrods must be installed in their original position during reassembly.
21. Remove the lower intake manifold.
22. Remove the spark plugs.
23. Remove the exhaust manifolds.
24. Unfasten and discard the cylinder head bolts and remove the cylinder heads from the engine.
25. Remove and discard the old cylinder head gaskets.

To install:

The cylinder head should be cleaned and inspected before installation. Refer to the appropriate portion of the engine reconditioning procedure later in this section.

If the cylinder heads were removed for cylinder head gasket replacement, check the flatness of the cylinder heads and the cylinder block gasket sealing surfaces.

Use care when using a scraper to clean any aluminum parts. Aluminum gouges easily which may cause the component to leak.

26. Place a shop rag in the valve tappet valley to catch any dirt or gasket material. Clean the cylinder head bolts holes in the block with a tap. Clean the cylinder head, intake manifold, rocker arm cover and cylinder head gasket contact surfaces.
27. Position new head gaskets on the cylinder block using the dowels in the block for alignment. If the dowels are damaged, they must be replaced.

Click on icon to view fullsize printable image.

Click to Enlarge

The cylinder head dowels must be fully seated to install gasket and head properly-3.0L OHV engines

Click on icon to view fullsize printable image.

Click to Enlarge

Cylinder head bolt tightening sequence-3.0L OHV engines

Click on icon to view fullsize printable image.

Click to Enlarge

Camshaft position during rocker arm installation and valve clearance check-3.0L OHV engines

29. Install the intake manifold.
30. Attach the ECT and coolant temperature sending unit connectors.
31. Dip each pushrod end in oil conditioner or heavy engine oil. Install the pushrods in their original position.
32. Before installation, coat the valve tips, rocker arm and fulcrum contact areas with Lubriplate® or equivalent.
33. Rotate the crankshaft one full turn (360 degrees) until the lifter is on the base circle of the cam as shown in the accompanying illustration (camshaft position A).
34. Install the rocker arm assemblies and tighten the rocker arm fulcrum bolts to 6-11 ft. lbs. (7-17 Nm) to position the rocker arm seats.
35. Rotate the crankshaft clockwise 120 degrees to camshaft position B as shown in the accompanying illustration. Tighten the rocker arm fulcrum bolts to 6-11 ft. lbs. (7-17 Nm) to position the rocker arm seats.

The fulcrums must be fully seated in the cylinder head and the pushrodsmust be seated in the rocker arm sockets prior to the final tightening.

36. Final tighten the rocker arm fulcrum bolts to 20-28 ft. lbs. (26-38 Nm).

If the same valve train components are used a valve train check is not required.If new components were installed, measure the clearance with the valve tappetfully collapsed on the base circle of the camshaft lobe. The measurement should be 0.085-0.185 inch (2.15-4.69mm). Refer to the accompanying illustration if necessary for the valve clearance measurement.

3.0L DOHC Engines

The cylinder head bolts are a torque-to-yield design and cannot be reused. Be sure new cylinder head bolts are available before beginning this procedure.

1. Disconnect the negative battery cable.

NEVER open, service or drain the radiator or cooling system when hot; serious burns can occur from the steam and hot coolant. Also, when draining engine coolant, keep in mind that cats and dogs are attracted to ethylene glycol antifreeze and could drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantities.Always drain coolant into a sealable container. If necessary, clean coolant maybe reused unless it is contaminated or more than two years old.

2. Drain the engine coolant from the radiator and cylinder block drain plugs.
3. Remove the engine from the vehicle and position on a suitable workstand.
4. Remove the upper and lower intake manifolds.
5. Remove the exhaust manifolds.
6. Drain the engine oil and remove the oil pan.
7. Remove the engine front cover.
8. Remove the timing chains, camshafts and lash adjusters from both cylinder heads.
9. Remove the EGR backpressure transducer and its mounting bracket from the rear of the right hand cylinder head.
10. Remove the cylinder head retaining bolts from the cylinder heads in the sequence illustrated.
11. Remove the cylinder heads and gaskets.

Click on icon to view fullsize printable image.

Click to Enlarge

Cylinder head bolt loosening sequence-3.0L DOHC engine

To install:

The cylinder head should be cleaned and inspected before installation. Refer to the appropriate portion of the engine reconditioning procedure later in this section.

If the cylinder heads were removed for cylinder head gasket replacement, check the flatness of the cylinder heads and the cylinder block gasket sealing surfaces.

The right hand and left hand cylinder head gaskets are notinterchangeable.

Use care when using a scraper to clean any aluminum parts. Aluminum gouges easily which may cause the component to leak.

Click on icon to view fullsize printable image.

Click to Enlarge

Cylinder head bolt tightening sequence-3.0L DOHC engine

16. Install the lash adjusters, camshafts and timing chains to both cylinder heads.
17. Install the EGR backpressure transducer and bracket to the rear of the right cylinder head. Tighten the retaining bolts to 71-106 inch lbs. (8-12 Nm).
18. Install the lash adjusters, camshafts and timing chains.
19. Install the engine front cover and the engine oil pan.
20. Install the exhaust manifolds.
21. Install the lower and upper intake manifolds. Replace the engine oil filter.
22. Install the engine assembly into the vehicle.
23. Fill the engine with the proper amount and grade of engine oil.
24. Fill the engine cooling system.
25. Connect the negative battery cable. Run the engine and check for leaks. Road test the vehicle and check for proper engine operation.

3.4L DOHC Engines

The cylinder head bolts are a tighten-to-yield design and cannot be reused. Be sure new cylinder head bolts are available before beginning this procedure.

1. Disconnect the negative battery cable.

NEVER open, service or drain the radiator or cooling system when hot; serious burns can occur from the steam and hot coolant. Also, when draining engine coolant, keep in mind that cats and dogs are attracted to ethylene glycol antifreeze and could drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantities.Always drain coolant into a sealable container. If necessary, clean coolant maybe reused unless it is contaminated or more than two years old.

2. Drain the engine coolant from the radiator and cylinder block drain plugs.
3. Remove the engine from the vehicle and position on a suitable workstand.
4. Remove the upper and lower intake manifolds.
5. Remove the exhaust manifolds.
6. Drain the engine oil and remove the oil pan.
7. Remove the engine front cover.
8. Remove the timing chains and camshafts.
9. Remove the cylinder head retaining bolts from the cylinder heads in the removal sequence illustrated.
10. Remove the cylinder heads and gaskets.

Click on icon to view fullsize printable image.

Click to Enlarge

Cylinder head bolt loosening sequence-3.4L DOHC engine

To install:

The cylinder head should be cleaned and inspected before installation. Refer to the appropriate portion of the engine reconditioning procedure later in this section.

If the cylinder heads were removed for cylinder head gasket replacement, check the flatness of the cylinder heads and the cylinder block gasket sealing surfaces.

The right hand and left hand cylinder head gaskets are notinterchangeable.

Use care when using a scraper to clean any aluminum parts. Aluminum gouges easily which may cause the component to leak.

11. Clean the cylinder heads, intake manifolds, valve covers and the cylinder head gasket sealing surfaces on the cylinder block.
12. Install new cylinder head gaskets onto the dowels of the cylinder block.

Click on icon to view fullsize printable image.

Click to Enlarge

Cylinder head bolt tightening sequence-3.4L (DOHC) engine

16. Install the camshafts and timing chains.
17. Install the engine front cover.
18. Install the engine oil pan.
19. Install the exhaust manifolds.
20. Install the lower and upper intake manifolds.
21. Replace the engine oil filter.
22. Install the engine assembly into the vehicle.
23. Fill the engine with the proper amount and grade of engine oil. Fill the engine cooling system.
24. Connect the negative battery cable. Run the engine and check for leaks. Road test the vehicle and check for proper engine operation.

Oil Pan

REMOVAL & INSTALLATION

3.0L OHV Engines

1. Disconnect the negative battery cable.
2. Remove the engine oil level dipstick.
3. Raise and safely support the vehicle with jack stands.
4. Drain the engine oil.
5. If equipped with a low oil level sensor, remove the retainer clip at the sensor. Unplug the electrical connector from the sensor.
6. Remove the starter motor and brace.
7. Unplug the connector from the O2 sensor(s).
8. Remove the dual converter Y-pipe assembly.
9. Remove the engine rear plate from the torque converter housing.
10. Unfasten the oil pan retaining bolts and carefully remove the engine oil pan from the cylinder block making sure the internal oil pan baffle does not snag the oil pump screen cover and tube.
11. Remove the oil pan gasket.

To install:

12. Clean the gasket sealing surfaces on the cylinder block and the engine oil pan.
13. Clean the oil sealing surfaces using a clean shop towel and metal surface cleaner F4AZ-19A536-RA or its equivalent to remove all residues that would interfere with the sealers ability to adhere.
14. Apply a 1/4 inch (6mm) bead of silicone sealer to the junction of the front cover assembly and the cylinder block and to the junction of the rear crankshaft main bearing cap and cylinder block.

When using a silicone sealer, the assembly process should occur withinfive minutes after the sealer has been applied. Be sure the sealer does notfall into the engine and form plugs that could block oil passages.

15. Place the oil pan gasket on the engine oil pan and secure with a suitable contact adhesive.
16. Place the engine oil pan into position on the cylinder block. Install the engine oil pan retaining bolts. Tighten the retaining bolts to 89-123 inch lbs. (10-14 Nm). Back off all bolts and retighten.
17. Install the engine rear plate from the torque converter housing.
18. Install the dual converter Y-pipe assembly.
19. Attach the connector to the O2 sensor(s).
20. If equipped with a low oil level sensor, attach the electrical connector to the sensor and install the retainer clip at the sensor.
21. Lower the vehicle.
22. Install the engine oil dipstick.
23. Connect the negative battery cable.
24. Fill the crankcase with the proper type and quantity of engine oil, then start the engine and check for leaks and proper operation.

Operating the engine without the proper amount and type of engine oil will result in severe engine damage.

Click on icon to view fullsize printable image.

Click to Enlarge

Oil pan mounting and sealer application location-3.0L OHV engine

3.0L DOHC Engines

1. Disconnect the negative battery cable.
2. Raise and safely support the vehicle with jack stands.
3. Drain the engine oil.
4. Remove the dual catalytic converter Y-pipe retaining nuts from the exhaust manifolds.
5. Remove the bolt and nut retainers from the transaxle.
6. Remove the two remaining nuts and bolts from the dual converter Y-pipe connection. Remove the Y-pipe from the vehicle.
7. Reinstall the oil pan drain plug using a new gasket and tighten to 16-22 ft. lbs. (22-30 Nm).
8. Remove the oil pan retaining bolts from the transaxle housing.
9. Remove the access plug from the engine rear plate.
10. Remove the support bracket from the oil pan and transaxle.
11. Remove the oil pan retaining bolts and studs from the lower cylinder block following the sequence illustrated.
12. Remove the oil pan and the oil pan gasket from the vehicle.
13. If required, remove the oil pump screen and tube assembly from the oil pump.

Click on icon to view fullsize printable image.

Click to Enlarge

Loosen the oil pan retainers in the sequence illustrated-3.0L DOHC engines

To install:

14. Clean the oil pan to lower cylinder block gasket sealing surfaces.
15. Thoroughly clean the oil pan and mating surfaces with soap and water and dry completely with compressed air.
16. Clean the mating surfaces with Metal Surface Cleaner F4AZ9A536-RA or equivalent to remove all the residues that may cause oil leakage.
17. If removed, install the oil pump screen and tube assembly to the oil pump using a new O-ring. Tighten the retaining bolts to 15-22 ft. lbs. (20-30 Nm). Install a new self-locking nut and tighten to 71-106 inch lbs. (8-12 Nm).
18. Install a new oil pan gasket into the groove of the oil pan. Apply a 0.31 inch (3mm) bead of silicone sealer on the gasket at the places where the engine front cover meets the engine block.
19. Carefully install the oil pan with gasket to the lower cylinder block. Install the bolts and studs but do not tighten.
20. Push the oil pan against the transaxle case and tighten the oil pan bolts and studs, finger-tight.
21. Tighten the oil pan retaining bolts and studs in the sequence illustrated to 15-22 ft. lbs. (20-30 Nm).

Click on icon to view fullsize printable image.

Click to Enlarge

Oil pan bolt tightening sequence and location where the sealer should be applied (inset)-3.0L DOHC engines

22. Tighten the oil pan to transaxle case bolts to 25-33 ft. lbs. (34-46 Nm).
23. Install the transaxle support bracket to the oil pan retaining stud bolts and transaxle. Tighten the retaining nuts to 71-106 inch lbs. (8-12 Nm). Tighten the retaining bolts to 15-22 ft. lbs. (20-30 Nm).
24. Install the access plug into the engine rear plate.
25. Position the Y-pipe assembly using a new flange gasket and install all the retaining nuts and bolts loosely.
26. Starting at the front of the system tighten the Y-pipe to exhaust manifold nuts to 26-34 ft. lbs. (34-46 Nm). Tighten the converter to transaxle nut and bolt to 30 ft. lbs. (40.3 Nm). Tighten the converter outlet bolts to 26-34 ft. lbs. (34-46 Nm).
27. Replace the engine oil filter.

28. Lower the vehicle.
29. Fill the crankcase with the correct amount and grade of engine oil.

Operating the engine without the proper amount and type of engine oil will result in severe engine damage.

30. Connect the negative battery cable. Run the engine and check for leaks and proper operation.

3.4L DOHC Engines

1. Disconnect the negative battery cable.
2. Raise and safely support the vehicle with jack stands.
3. Drain the engine oil.
4. Remove the dual catalytic converter Y-pipe.
5. Reinstall the oil pan drain plug using a new gasket and tighten to 15-25 ft. lbs. (20-34 Nm).
6. Remove the oil pan retaining bolts from the transaxle housing.
7. Remove the oil pan retaining bolts from the lower cylinder block.
8. Remove the oil pan and the oil pan gasket from the vehicle.

To install:

9. Clean the oil pan to lower cylinder block gasket sealing surfaces.
10. Thoroughly clean the oil pan and mating surfaces with soap and water and dry completely with compressed air.
11. Clean the mating surfaces with Metal Surface Cleaner F4AZ9A536-RA or equivalent to remove all the residues that may cause oil leakage.
12. Apply a 0.16 inch (4mm) bead of silicone sealer on the oil pan sealing surface where the oil pan, the engine front cover and cylinder block contact.
13. Carefully install the oil pan with gasket to the lower cylinder block in the locations shown in the accompanying illustration and tighten in the sequence shown to 14-20 ft. lbs. (18-28 Nm). Tighten the oil pan-to-transaxle bolts to 25-33 ft. lbs. (34-46 Nm).

Click on icon to view fullsize printable image.

Click to Enlarge

Apply sealer to the oil pan bolt mating surface where indicated-3.4L DOHC engines

Click on icon to view fullsize printable image.

Click to Enlarge

Oil pan bolt tightening sequence-3.4L DOHC engines

14. Install the dual converter Y-pipe assembly.
15. Replace the engine oil filter.
16. Lower the vehicle.
17. Fill the crankcase with the correct amount and grade of engine oil.

Operating the engine without the proper amount and type of engine oil will result in severe engine damage.

18. Connect the negative battery cable. Run the engine and check for leaks and proper operation.

Oil Pump

REMOVAL & INSTALLATION

3.0L OHV Engines

1. Disconnect the negative battery cable.
2. Raise and safely support the vehicle with jack stands.
3. Drain the engine oil.
4. Remove the engine oil pan.
5. Remove the oil pump retaining bolt and remove the oil pump and the oil pump intermediate shaft from the engine.
6. If replacing the engine oil pump, separate the intermediate shaft from the oil pump.

To install:

Click on icon to view fullsize printable image.

Click to Enlarge

Oil pump mounting. Make sure the retaining ring is positioned on the oil pump intermediate shaft (insert)-3.0L DOHC engines

7. If replacing the engine oil pump, insert the oil pump intermediate shaft into the hex drive hole in the new oil pump assembly until the intermediate shaft retaining ring clicks into place.
8. Prime the new oil pump by filling either the inlet or the outlet port with engine oil. Rotate the pump shaft to distribute the oil within the oil pump body cavity.
9. Insert the oil pump intermediate shaft assembly through the hole in the rear main bearing cap and place the oil pump onto the locating pins.
10. Install the oil pump retaining bolt and tighten the retaining bolt to 30-40 ft. lbs. (40-55 Nm).
11. Install the engine oil pan.
12. Lower the vehicle. Fill the crankcase with the proper type and quantity of engine oil.
13. Connect the negative battery cable. Start engine and check for leaks, proper oil pressure and proper engine operation.

3.0L DOHC Engine

1. Disconnect the negative battery cable. Remove the engine from the vehicle.
2. Remove the engine oil pan.
3. Remove the engine front cover.
4. Remove the timing chains and the crankshaft sprockets.
5. Remove the oil pump screen cover/tube nut/bolts and the tube from the engine.
6. Remove the oil pump retaining bolts in sequence illustrated.
7. Remove the oil pump from the vehicle.

Click on icon to view fullsize printable image.

Click to Enlarge

Loosen the oil pump retaining bolts in the sequence illustrated-3.0L and 3.4L DOHC engines

To install:

8. Rotate the inner rotor of the oil pump to align with the flats on the crankshaft. Install the oil pump flush to the cylinder block.
9. Install the oil pump retaining bolts and tighten in the sequence illustrated to 80-115 inch lbs. (9-13 Nm).

Click on icon to view fullsize printable image.

Click to Enlarge

Tighten the oil pump retaining bolts in the sequence illustrated to ensure sealing to the engine block-3.0L and 3.4L DOHC engines

10. Inspect the oil pump screen and tube O-ring and replace if needed.
11. Position the oil pump screen and tube with the O-ring to the oil pump. Tighten the retaining bolts to 71-106 inch lbs. (8-12 Nm).
12. Install a new self-locking tube support nut to the lower cylinder block stud. Tighten the nut to 15-22 ft. lbs. (20-30 Nm).
13. Install the crankshaft sprockets and the timing chains.
14. Install the oil pan and the engine front cover.
15. Install the engine in the vehicle. Fill the crankcase with the correct amount of engine oil.
16. Connect the negative battery cable. Run the engine and check for leaks and proper operation.

3.4L DOHC Engine

1. Disconnect the negative battery cable. Remove the engine from the vehicle.
2. Remove the engine oil pan and the engine front cover.
3. Remove the timing chains and the crankshaft sprockets.
4. Remove the oil pump screen cover/tube nut/bolts and the tube from the engine.
5. Remove the four oil pump retaining bolts in the sequence illustrated.
6. Remove the oil pump from the vehicle.

To install:

7. Rotate the inner rotor of the oil pump to align with the flats on the crankshaft. Install the oil pump flush to the cylinder block.
8. Install the oil pump retaining bolts and tighten in the sequence illustrated to 80-115 inch lbs. (9-13 Nm).
9. Inspect the oil pump screen and tube O-ring and replace if needed.
10. Position the oil pump screen and tube with the O-ring to the oil pump. Tighten the retaining bolts to 71-123 inch lbs. (8-14 Nm).
11. Install the crankshaft sprockets and the timing chains.
12. Install the oil pan and the engine front cover.
13. Install the engine in the vehicle. Fill the crankcase with the correct amount of engine oil.
14. Connect the negative battery cable. Run the engine and check for leaks and proper operation.

Crankshaft Damper

REMOVAL & INSTALLATION

3.0L OHV Engine

1. Disconnect the negative battery cable.
2. Remove the accessory drive belt.
3. Raise the vehicle and support it with jack stands.
4. Remove the right hand wheel assembly.
5. Unfasten the four crankshaft pulley-to-damper retaining bolts and remove the pulley.
6. Remove the crankshaft damper retaining bolt and washer.

Use caution when removing the damper so as not to damage the damper orcreate burrs.

7. Using crankshaft damper removal tool T58P-6316-D and vibration damper T82L-6316-B or their equivalents, remove the damper from the crankshaft.

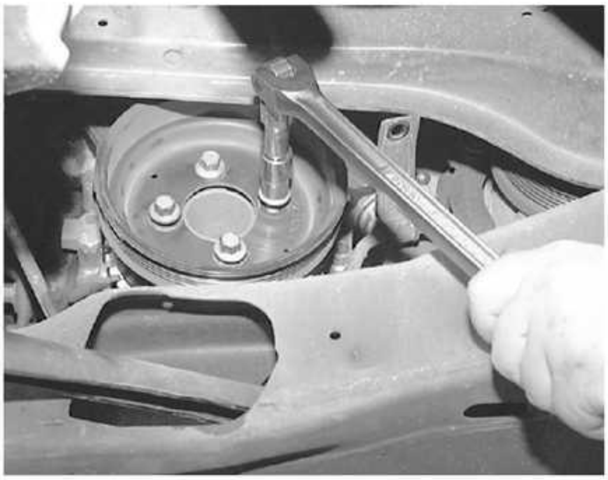
Use care when removing the damper not to damage the engine front cover or the Crankshaft Position (CKP) sensor.

To install:

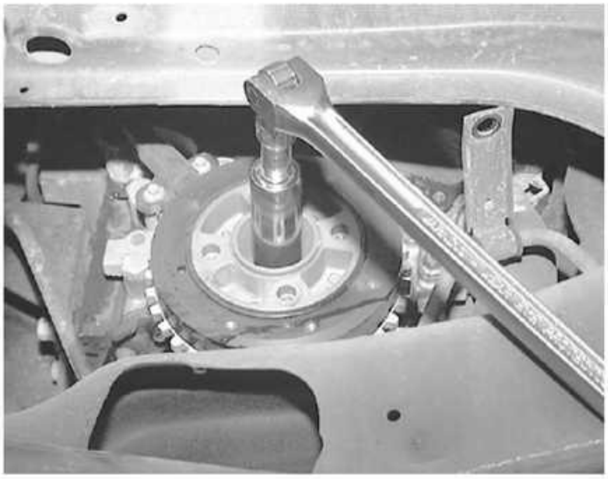
Click on icon to view fullsize printable image.

Click to Enlarge

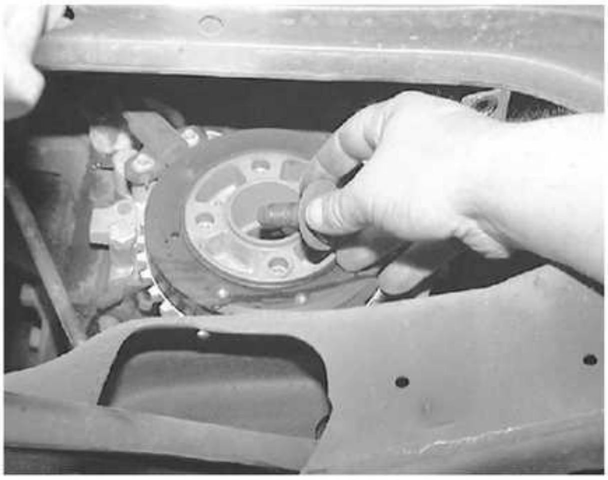
The crankshaft damper is attached to the crankshaft through an opening in the front cover and is retained by a bolt and washer-3.0L OHV engine



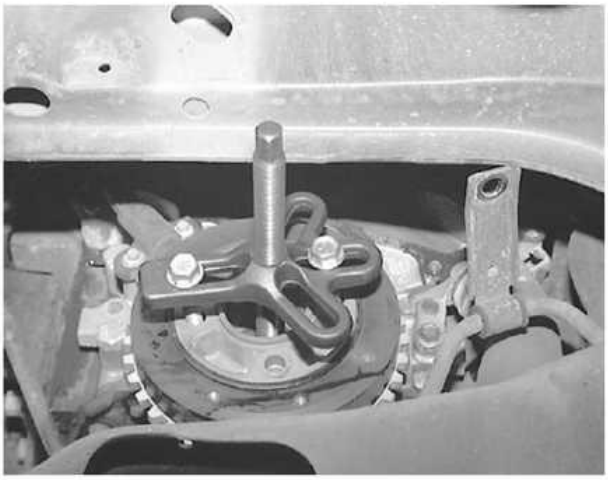
Remove the crankshaft pulley from the damper



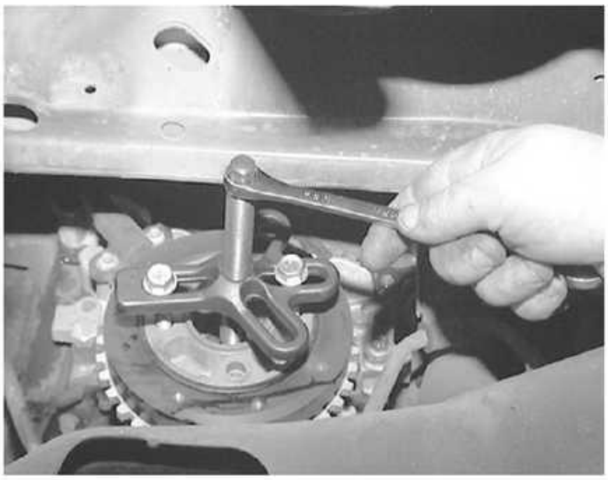
Loosen the crankshaft damper retaining bolt and...



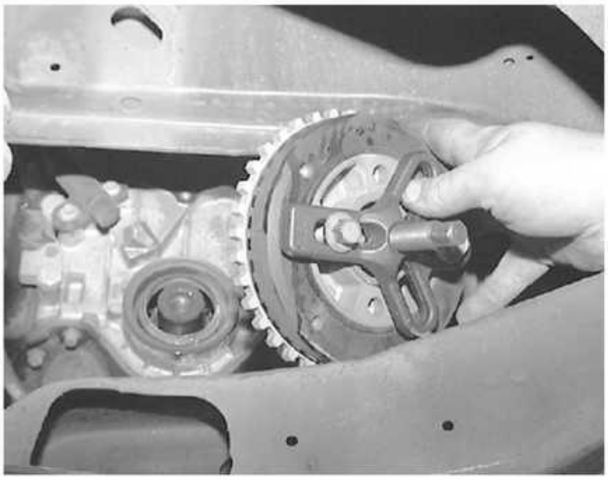
... remove the retaining bolt from the damper



Install a suitable puller onto the damper



Tighten the forcing screw on the puller and...



... remove the damper from the engine

to bind, which would cause engine damage.

6. Install a flywheel holding tool T96P-6375-A or its equivalent to the transaxle case and engage the flywheel.

The crankshaft drive pulley uses left hand threading. Rotate the pulley clockwise to remove.

7. Remove the crankshaft pulley bracket retaining nuts from the engine front cover.
8. Remove the crankshaft pulley and bracket.
9. Remove the flywheel holding tool.

The crankshaft damper bolt is a right hand thread.

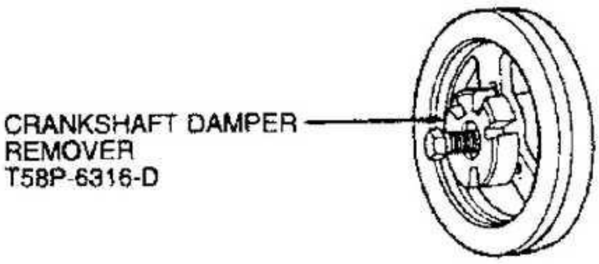
10. Remove the damper retaining bolt and washer.
11. Using front damper removal tool T58P-6316-D or its equivalent, remove the damper from the crankshaft.

To install:

Click on icon to view fullsize printable image.

Click to Enlarge

Crankshaft pulley mounting-3.0L DOHC engine

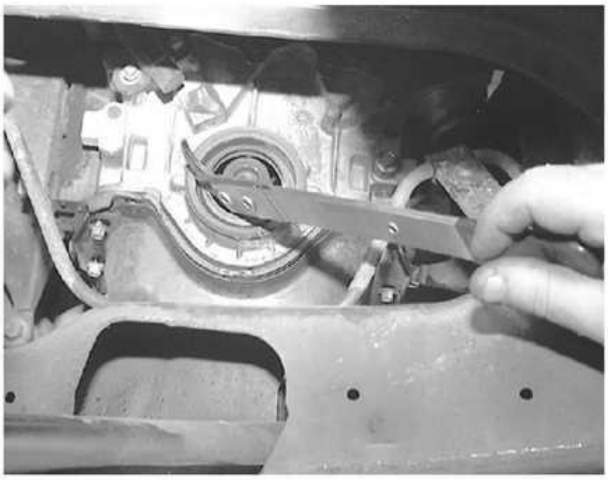


Use a suitable crankshaft damper removal tool such as the one illustrated to remove the damper-3.0L DOHC engine

3.4L DOHC Engine

1. Disconnect the negative battery cable.
2. Raise the vehicle and support it with jack stands.
3. Remove the right hand wheel assembly.
4. Remove the right hand splash shield from the front fender apron to access the crankshaft pulley.
5. Remove the accessory drive belt.
6. Remove the damper retaining bolt and washer.
7. Using steering wheel puller tool T67L-3600-A or its equivalent, remove the damper from the crankshaft.

To install:



If necessary, remove the front crank seal with a suitable puller and replace the seal

Apply a suitable sealant to the key-way of the crankshaft damper

8. Inspect the crankshaft damper and the seal for signs of damage and repair as necessary.
9. Coat the crankshaft damper sealing surface with clean engine oil.
10. Apply a suitable sealant to the crankshaft damper key-way.
11. Using damper and seal replacer tool T82L-6316-A or its equivalent, install the damper onto the crankshaft.
12. Install the damper retaining bolt and washer. Tighten the bolt to 93-121 ft. lbs. (125-165 Nm).
13. Place the crankshaft pulley in position and install the four bolts. Tighten the bolts to 30-40 ft. lbs. (40-55 Nm)
14. Install the right hand wheel assembly and lower the vehicle.
15. Install the accessory drive belt.
16. Connect the negative battery cable.
17. Start the vehicle and check for leaks.

3.0L DOHC Engine

1. Disconnect the negative battery cable.
2. Raise the vehicle and support it with jack stands.
3. Remove the right hand wheel assembly.
4. Remove the right hand splash shield from the front fender apron to access the crankshaft pulley.
5. Remove the accessory drive belt.

Rotating the crankshaft in a counterclockwise direction may cause the timing chains

to bind, which would cause engine damage.

6. Install a flywheel holding tool T96P-6375-A or its equivalent to the transaxle case and engage the flywheel.

The crankshaft drive pulley uses left hand threading. Rotate the pulley clockwise to remove.

7. Remove the crankshaft pulley bracket retaining nuts from the engine front cover.
8. Remove the crankshaft pulley and bracket.
9. Remove the flywheel holding tool.

The crankshaft damper bolt is a right hand thread.

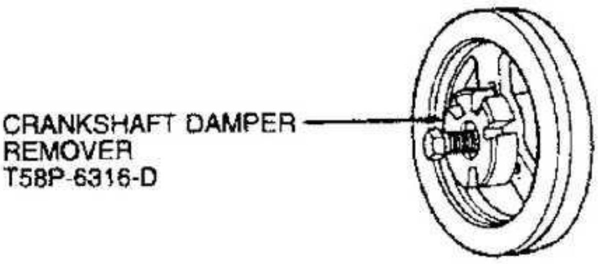
10. Remove the damper retaining bolt and washer.
11. Using front damper removal tool T58P-6316-D or its equivalent, remove the damper from the crankshaft.

To install:

Click on icon to view fullsize printable image.

Click to Enlarge

Crankshaft pulley mounting-3.0L DOHC engine

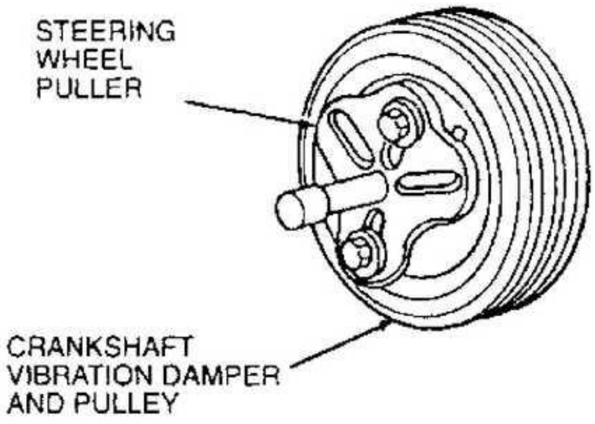


Use a suitable crankshaft damper removal tool such as the one illustrated to remove the damper-3.0L DOHC engine

3.4L DOHC Engine

1. Disconnect the negative battery cable.
2. Raise the vehicle and support it with jack stands.
3. Remove the right hand wheel assembly.
4. Remove the right hand splash shield from the front fender apron to access the crankshaft pulley.
5. Remove the accessory drive belt.
6. Remove the damper retaining bolt and washer.
7. Using steering wheel puller tool T67L-3600-A or its equivalent, remove the damper from the crankshaft.

To install:

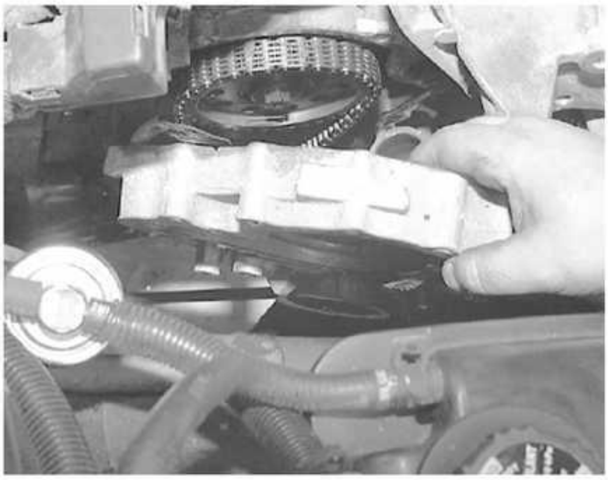


Steering wheel puller tool T67L-3600-A or its equivalent can be used to remove the crankshaft pulley-3.4L DOHC engine

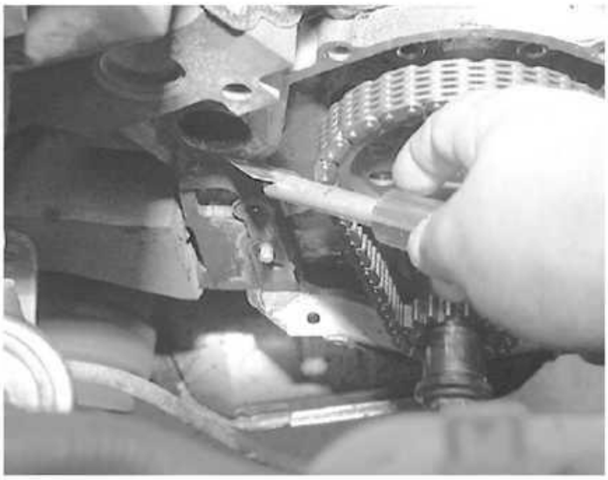
Timing Chain, Sprockets, Front Cover and Seal

REMOVAL & INSTALLATION

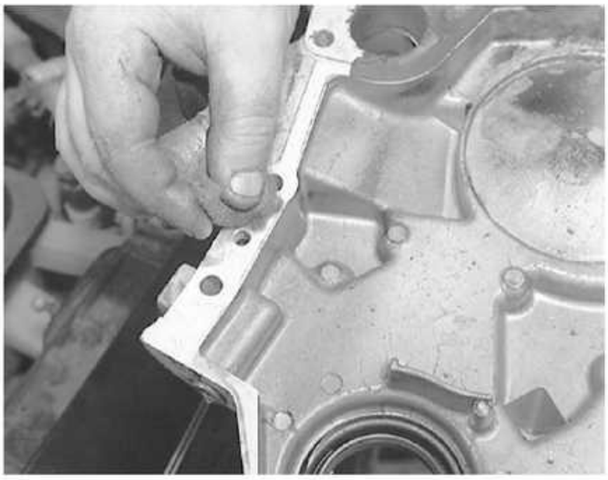
3.0L OHV Engines



Remove the cover from the engine



Thoroughly clean the gasket mating surfaces of the engine and...



... the timing chain cover

1. Disconnect the negative battery cable.
2. Drain the engine cooling system.

NEVER open, service or drain the radiator or cooling system when hot; serious burns can occur from the steam and hot coolant. Also, when draining engine coolant, keep in mind that cats and dogs are attracted to ethylene glycol antifreeze and could drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantities.Always drain coolant into a sealable container. If necessary, clean coolant maybe reused unless it is contaminated or more than two years old.

3. Loosen four water pump pulley bolts while the accessory drive belt is in place.
4. Remove the accessory drive belts.
5. Remove the belt tensioner.
6. Remove the lower radiator hose and the heater hose from the water pump and front cover.
7. Remove the crankshaft pulley and damper.
8. Unplug the Crankshaft Position (CKP) sensor wiring and disconnect the wiring from the locating stud bolt.

9. Drain the engine oil and remove the oil pan. Discard the old gasket.

The engine front cover and water pump may be removed as an assembly by not removing bolt numbers 11 through 15 as shown in the accompanying illustration.

10. If necessary, unfasten the water pump pulley retaining bolts, then remove the pulley.
11. Remove the retaining bolts from the timing cover to the cylinder block and remove the timing cover.
12. Tap the seal out of the cover with a seal driver.

To install:

13. Clean all the gasket residue from the timing cover and the cylinder block.
14. Prior to applying sealer, clean the sealing surfaces using a clean shop towel and metal surface cleaner F4AZ-19A536-RA or its equivalent to remove all residues that would interfere with the sealers ability to adhere.
15. Lightly oil all bolt and stud threads except bolts 1, 2 and 3 that require a suitable pipe sealant.
16. Install the crankshaft front oil seal protector onto the crankshaft if available.
17. Install a new seal in the timing cover using a suitable seal driver/installer.
18. Install a new timing cover gasket over the cylinder block dowels.
19. Install the timing cover/water pump assembly onto the cylinder block with the water pump pulley loosely attached to the water pump hub.
20. Apply a non-hardening sealant to bolt numbers 1, 2 and 3 and hand start them along with the rest of the cover retaining bolts. Tighten bolts 1-10 to 18 ft. lbs. (25 Nm) on 1996-97 models and 15-22 ft. lbs. (20-30 Nm) on 1998-99 models. Tighten bolts 11-15 to 88 inch lbs. (10 Nm) on 1996-97 models and 71-106 inch lbs. (8-12 Nm) on 1998-99 models.

Click on icon to view fullsize printable image.

Click to Enlarge

Timing chain front cover bolt location and identification-3.0L OHV engines

21. Install the engine oil pan.
22. Hand-tighten the water pump pulley retaining bolts.
23. Install the crankshaft damper and pulley.
24. If the CKP sensor was removed from the front cover, install the sensor and tighten its retainers to 45-61 inch lbs. (5-7 Nm).
25. Install the belt tensioner.
26. Install the accessory drive belt. Tighten the water pump pulley retaining bolts to 15-22 ft. lbs. (20-30 Nm).
27. Install the lower radiator hose and the heater hose and tighten the clamps.
28. Fill the crankcase with the correct amount and type of engine oil. Fill and bleed the engine cooling system.
29. Connect the negative battery cable. Start the engine and check for coolant and oil leaks. Road test the vehicle and check for proper operation.

3.0L DOHC Engine

1. Disconnect the negative battery cable.
2. Remove the engine from vehicle and position on a suitable workstand.
3. Remove the upper and lower intake manifolds.
4. Remove the cylinder head covers, then remove the drive belt.
5. Remove the wire connector from the water temperature sender.
6. Remove the heater water hose from the bypass tube.
7. Remove the bypass tube bolts and the tube.
8. Remove the power steering pump bolts and the pump.
9. Remove the A/C compressor bracket to water pump brace, the mounting bolts, the compressor and bracket.

The A/C mounting bracket bolts are torque-to-yield bolts and must be replaced when removed.

10. Remove the alternator and the water pump.
11. Install a suitable damper puller and remove the crankshaft damper from the crankshaft.
12. If necessary, remove the Crankshaft Position (CKP) sensor and the Camshaft Position (CMP) sensors.
13. If necessary, remove the drive belt tensioner from the right side of the engine front cover.
14. Remove the engine oil pan.
15. Remove the engine front cover bolts in the sequence illustrated.
16. Remove the front cover and gasket.

17. If necessary, remove the crankshaft oil seal using a suitable puller.

Click on icon to view fullsize printable image.

Click to Enlarge

Unfasten the engine front cover in the sequence illustrated-3.0L DOHC engine

To install:

18. Clean the engine front cover and the front cover to cylinder block and head gasket sealing surfaces using a clean shop towel and metal surface cleaner F4AZ-19A536-RA or its equivalent to remove all residues that would interfere with the sealer's ability to adhere.

The front cover must be installed and properly tightened within six minutes of the application of the sealer.

19. Apply a 0.118 inch (3mm) diameter bead approximately 0.472 inch (12mm) long of silicone sealer to the six critical areas of the cylinder block as shown in the accompanying illustration to prevent oil seepage.

Click on icon to view fullsize printable image.

Click to Enlarge

Apply a bead of silicone sealer to the six critical areas of the cylinder block to the points illustrated-3.0L DOHC engine

Click on icon to view fullsize printable image.

Click to Enlarge

Install and tighten in the sequence illustrated, the front cover retaining bolts and stud bolts where the silicone sealer was applied -3.0L DOHC engine

Click on icon to view fullsize printable image.

Click to Enlarge

Install the remaining bolts and studs, then tighten all the bolts and studs and tighten in the sequence illustrated-3.0L DOHC engine

20. Place new front cover gaskets onto the dowel pins on the cylinder block and heads.
21. Place the front cover into position by placing the front cover onto the dowel pins at the cylinder block.
22. Install the front cover retaining bolts and stud bolts where the silicone sealer was applied.
23. Tighten the bolts and stud bolts until the front cover contacts the cylinder block and heads, then, turn the bolts and stud bolts an additional 1/4 turn.
24. Install the remaining front cover retaining bolts and stud bolts. Tighten all of the front cover retaining bolts and stud bolts in the sequence illustrated to 15-22 ft. lbs. (20-30 Nm).
25. If removed, install the belt tensioner onto the right side of the engine front cover. Tighten the bolt to 15-22 ft. lbs. (20-30 Nm).
26. If removed, coat the new crankshaft oil seal bore with engine assembly lubricant and install the seal using crankshaft seal replacer/cover aligner tool T88T-6701-A or its equivalent.
27. Install the oil pan and install the retaining bolts loosely.
28. Aligned the oil pan to the rear of the cylinder block using a straightedge to 0.0-0.010 inch (0.0-0.025mm). Install or remove shims to the rear of the oil pan as necessary. Tighten the oil pan bolts and studs.
29. If removed, install the CKP and CMP sensors.
30. Install the power steering pump and tighten the bolts to 15-22 ft. lbs. (20-30 Nm).
31. Install the crankshaft damper.
32. Install the accessory drive crankshaft pulley and bracket.
33. Install the water pump.
34. Install the alternator.

The A/C compressor mounting bracket must engage in the front cover dowels or an engine vibration may occur. New torque-to-yield retaining bolts must beused.

35. Install the A/C compressor mounting bracket and tighten the nuts to 18 ft. lbs. (22 Nm), then tighten the bolts an additional 90 degrees.
36. Install the A/C compressor and retaining bolts and tighten the nuts to 15-22 ft. lbs. (20-30 Nm).
37. Install the A/C compressor mounting bracket to the water pump brace and tighten the nuts to 15-22 ft. lbs. (20-30 Nm).
38. Replace the water bypass tube O-ring and lubricate with clean coolant. Install the bypass tube onto the right cylinder head and install the stud and bolt. Tighten the stud and bolt to 71-106 inch lbs. (8-12 Nm).
39. Install the heater water hose and position the hose clamp. Install the wire connector to the water temperature sender.
40. Install both cylinder head covers.

The cylinder head covers must be installed and properly tightened withinsix minutes of applying the silicone sealant.

41. Install the lower and upper intake manifolds.
42. Release the accessory drive belt tension by rotating the tensioner clockwise and installing the drive belt.
43. Install the engine assembly into the vehicle. Restore all fluid levels. Connect the negative battery cable.
44. Run the engine and check for leaks. Road test the vehicle and check for proper operation.

3.4L Engine

1. Disconnect the negative battery cable.
2. Remove the engine from vehicle and position on a suitable workstand.
3. Remove the accessory drive belt.
4. Remove the A/C compressor mounting bolts from the cylinder blocks and remove the A/C compressor.
5. If necessary, remove the alternator and bracket.
6. Release the water pump drive belt tension by rotating the tensioner clockwise and remove the belt.
7. Remove the three water pump drive pulley retaining bolts from the left side camshaft.
8. Disconnect the main emission vacuum supply hose from the surge tank vacuum fitting. secondary air injection diverter valve and EGR valve.
9. Disconnect the engine control sensor wiring from the EGR backpressure transducer, EGR vacuum regulator solenoid and secondary air injection control solenoid vacuum valve.
10. Disconnect the EGR pressure sensor valve hoses from the EGR valve to exhaust manifold tube and remove the transducer mounting bracket from the engine.
11. Remove the EGR valve-to-exhaust manifold tube.
12. Remove the two intake manifold supports from the surge tank and cylinder head.
13. Remove the retaining bolts and surge tank stay from the front of the surge tank.
14. Remove the bolt, nuts and surge tank stay from the rear of the surge tank.
15. Loosen the intake air connector hose clamps and remove the surge tank from the engine.
16. Unplug the engine control sensor wiring connections from the Idle Air Control (IAC) valve and the throttle position sensor.
17. Remove the right and left intake manifolds from the lower intake manifold.
18. Tag and unplug the engine control sensor wiring connections to components, as necessary.
19. Remove the exhaust air supply tube from the exhaust manifolds and secondary air injection diverter valve.
20. Remove the secondary air injection diverter valve, as necessary.
21. Remove the water pump and hoses.
22. Remove the left and right valve covers.
23. Remove the power steering pump and pump support.
24. Remove the crankshaft pulley.
25. Remove the Camshaft Position (CMP) sensor from the left cylinder head and the Crankshaft Position (CKP) sensor from the engine front cover, as necessary.
26. Drain the engine oil and remove the oil pan.
27. Remove the drive belt idler pulleys from the engine front cover.
28. Unfasten the engine front cover retainers and remove the cover.
29. If necessary, remove the crankshaft oil seal using a suitable puller.

Click on icon to view fullsize printable image.

Click to Enlarge

Exploded view of the engine front cover assembly mounting-3.4L DOHC engines

To install:

30. Clean the engine front cover and the front cover to cylinder block and head gasket sealing surfaces using a clean shop towel and metal surface cleaner F4AZ-19A536-RA or its equivalent to remove all residues that would interfere

with the sealers ability to adhere.

The front cover must be installed and properly tightened within six minutes of the application of the sealer.

31. Apply a 0.118 inch (3mm) diameter bead approximately 0.472 inch (12mm) long of silicone sealer to the eight gasket surface joints and five mounting bosses on the cylinder block as shown in the accompanying illustration to prevent oil seepage.
32. Place new front cover gaskets onto the dowel pins on the cylinder block and heads.
33. Place the front cover into position by placing the front cover onto the dowel pins at the cylinder block.
34. Install the front cover retaining bolts and stud bolts and tighten to 14-20 ft. lbs. (18-28 Nm).
35. If removed, coat the new crankshaft oil seal bore with engine assembly lubricant and install the seal using crankshaft seal replacer/cover aligner tool T88T-6701-A or its equivalent.
36. Install the oil pan.
37. With the oil pan aligned to the rear of the cylinder block, tighten the oil pan bolts and studs, in sequence, to 14-20 ft. lbs. (18-28 Nm) no more than six minutes after applying the silicone sealer.

Click on icon to view fullsize printable image.

Click to Enlarge

Apply silicone sealer to the gasket surface joints and mounting bosses on the block as illustrated-3.4L DOHC engines

Click on icon to view fullsize printable image.

Click to Enlarge

Tighten the engine front cover retainers in the sequence illustrated-3.4L DOHC engines

38. Install the CMP sensor to the left cylinder head and the CKP sensor to the engine front cover, as necessary and tighten to 71-106 inch lbs. (8-12 Nm).
39. Install the crankshaft damper pulley.
40. Install the power steering pump pulley, plain washer, split washer and retaining nut and tighten to 41-50 ft. lbs. (55-69 Nm).
41. Install the drive belt idler pulleys to the engine front cover and tighten to 27-38 ft. lbs. (36-52 Nm).
42. Install both cylinder head covers
43. Install the water pump and hoses.
44. Install the secondary air injection diverter valve, as necessary.
45. Install the exhaust air supply tube to the exhaust manifolds and secondary air injection diverter valve.
46. Attach the engine control sensor wiring connections to components, as necessary.
47. Install the right and left intake manifolds to the lower intake manifold.
48. Attach the engine control sensor wiring connections to the Idle Air Control (IAC) valve and the throttle position sensor.
49. Install the surge tank to the engine.
50. Connect the EGR pressure sensor valve hoses, manifold tube and the transducer mounting bracket to the engine.
51. Connect the engine control sensor wiring to the EGR backpressure transducer, EGR vacuum regulator solenoid and secondary air injection control solenoid vacuum valve.
52. Connect the main emission vacuum supply hose to the surge tank vacuum fitting. secondary air injection diverter valve and EGR valve.
53. If removed, install the alternator and bracket.
54. Install the A/C compressor and mounting bolts to the cylinder blocks and tighten to 17-27 ft. lbs. (23-37 Nm).
55. Rotate the drive belt tensioner clockwise and install the belt.
56. Install the engine and connect the negative battery cable.

Timing Chain and Gears

REMOVAL & INSTALLATION

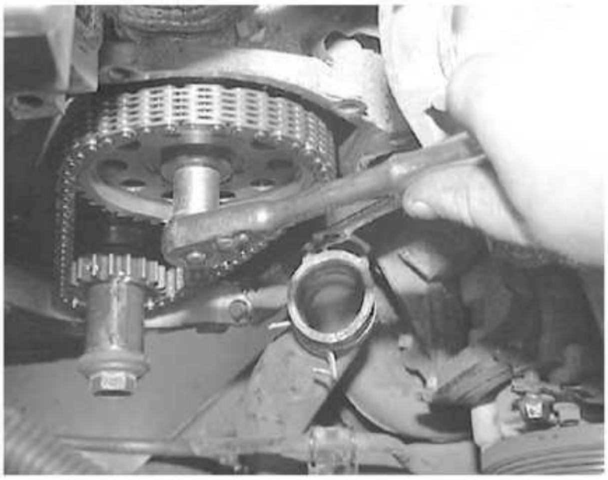
3.0L OHV Engines

NEVER open, service or drain the radiator or cooling system when hot; serious burns can occur from the steam and hot coolant. Also, when draining engine coolant, keep in mind that cats and dogs are attracted to ethylene glycol antifreeze and could drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantities.Always drain coolant into a sealable container. If

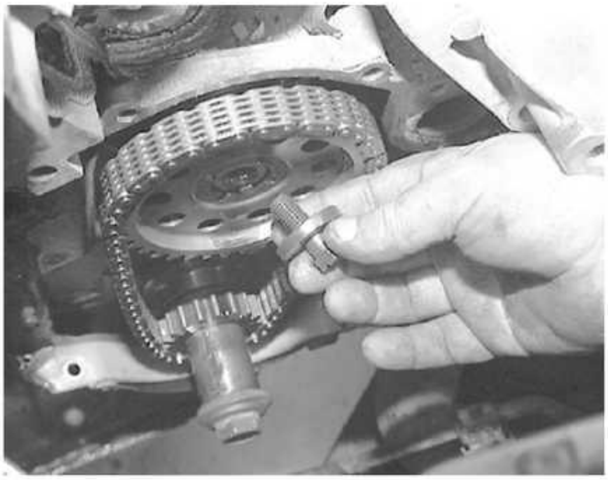
necessary, clean coolant maybe reused unless it is contaminated or more than two years old.

1. Disconnect the negative battery cable, then drain the engine cooling system.
2. Remove the timing cover.
3. Tap the seal out of the cover with a seal driver.
4. Remove the crankshaft damper and timing chain front cover.
5. Rotate the crankshaft until the No. 1 piston is at TDC on its compression stroke and the timing marks are aligned as shown in the accompanying illustration.

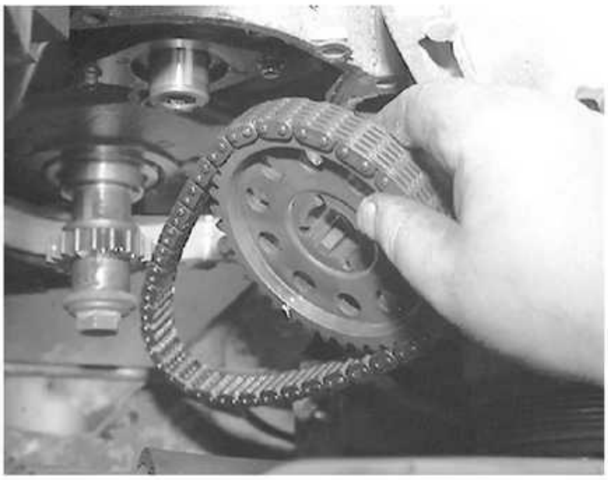
Rotate the timing marks into alignment



Loosen the camshaft sprocket retaining bolt and...



... remove the bolt from the sprocket



Carefully remove the timing chain and camshaft sprocket from the engine

Click on icon to view fullsize printable image.

Click to Enlarge

Make sure the timing marks are facing each and the marks are aligned as illustrated-3.0L OHV engines

6. Remove the camshaft sprocket attaching bolt and washer. Slide both sprockets and timing chain forward and remove as an assembly.
7. Check the timing chain and sprockets for excessive wear. Replace if necessary.

To install:

8. Before installation, clean and inspect all parts. Clean the gasket material and dirt from the oil pan, cylinder block and front cover.
9. Slide both sprockets and timing chain onto the camshaft and crankshaft with the timing marks aligned.

The camshaft bolt has a drilled oil passage in it for timing chain lubrication. Prior to installation, clean the passage and be sure it is clear. Never replace the camshaft bolt with a standard bolt.

10. Install the camshaft bolt and washer and tighten to 37-51 ft. lbs. (50-70 Nm). Apply clean engine oil to the timing chain and sprockets after installation.

11. Install a new seal in the timing cover using a suitable driver/installation tool..
12. Install the timing cover.
13. Fill the crankcase with the correct amount and type of engine oil. Fill and bleed the engine cooling system.
14. Connect the negative battery cable. Start the engine and check for coolant and oil leaks. Road test the vehicle and check for proper operation.

3.0L DOHC Engines

1. Remove the engine front cover.

Rotating the crankshaft in a counterclockwise direction may cause the timing chains to bind, which would cause engine damage.

2. Rotate the crankshaft clockwise so the key-way is at the 11 o'clock position to locate the crankshaft at TDC for No. 1 cylinder.
3. Verify that the alignment arrows (marked RFF) on the back of the camshaft sprockets are aligned. If not, rotate the crankshaft clockwise one complete revolution and recheck.
4. Rotate the crankshaft 120 degrees so the crankshaft key-way is at the 3 o'clock position. This positions the right cylinder head camshafts to the neutral position (base circle).
5. If the right hand timing chain tensioner and guide are to be reused, mark the position of the tensioner arm and guide to make sure they are reinstalled in their original positions.
6. Remove the right hand timing chain tensioner arm the timing chain.
7. Remove the right cylinder head timing chain guide bolts and guide; if worn, replace the timing chain guide.

Click on icon to view fullsize printable image.

Click to Enlarge

Exploded view of the right side timing chain and related components (left side is similar)-3.0L DOHC engine

8. Remove the right crankshaft timing chain sprocket.
9. Remove the right cylinder head camshaft timing chain sprockets, if being replaced.
10. Rotate the crankshaft clockwise two revolutions and locate the crankshaft key-way at the 11 o'clock position. This will position the left cylinder head camshafts to their neutral position (base circle).
11. Verify that the alignment arrows on the camshafts are aligned.
12. Remove the left cylinder head timing chain tensioner retaining bolts and the timing chain tensioner.

If the left cylinder head timing chain tensioner arm and timing chainguide are to be reused, mark the position of the timing chain tensioner arm andthe timing chain guide so they are reassembled into their original positions.

13. Remove the left cylinder head timing chain tensioner arm and the timing chain.
14. Remove the left cylinder head timing chain guide bolts and guide; if worn, replace the timing chain guide.
15. Remove the left crankshaft timing chain sprocket.
16. If required, the left cylinder head camshaft sprockets may be removed at this time.

To install:

Inspect the timing chains, tensioners, tensioner arms, guides and sprockets for wear or damage. If any components are to be replaced for premature wear or damage, the camshaft damper should also be replaced.

17. Reinstall or replace the camshaft sprockets, if removed.
18. Be sure the crankshaft key-way is still at the 11 o'clock position.
19. Install the left timing chain crankshaft sprocket onto the crankshaft.
20. Install the left timing chain guide and retaining bolts to the engine. Tighten the retaining bolts to 15-22 ft. lbs. (20-30 Nm).
21. Verify that the arrows on the left cylinder head camshafts are aligned (facing each other as shown in the accompanying illustration).
22. Install the left timing chain over the left crankshaft sprocket and the left camshaft sprockets.
23. Align the timing marks on the left cylinder head timing chain with the timing marks on the crankshaft sprocket and the camshaft sprockets.

Do not release the ratchet stem until the tensioner is fully bottomed in its bore, or damage to the ratchet stem can occur.

Compress the timing chain slowly or damage to the tensioner may occur. The piston should retract using minimal force. Reposition the tensioner to eliminate side loading if binding occurs.

The wire must remain in the tensioner until the tensioner is installed with the piston bottomed in the bore.

Click on icon to view fullsize printable image. **Click to Enlarge** *Using a small pick, hold the timing chain tensioner ratchet lock mechanism away from the ratchet stem-3.0L DOHC engine*
Click on icon to view fullsize printable image. **Click to Enlarge** *Retain the piston using a 0.040-0.065 inch piece of wire such as a paper clip inserted into the small hole above the ratchet-3.0L DOHC engine*

26. Install the compressed and locked left cylinder head timing chain tensioner and retaining bolts onto the cylinder block. Tighten the retaining bolts to 15-22 ft. lbs. (20-30 Nm).
27. Verify that the timing marks on the left timing chain are in alignment with the timing marks on the crankshaft sprocket and the camshaft sprockets.
28. Reinstall or replace the camshaft sprockets, if removed.
29. Install the right timing chain crankshaft sprocket onto the crankshaft. Align the crankshaft key-way on the crankshaft sprocket.
30. Install the right timing chain guide and retaining bolts to the engine. Tighten the retaining bolts to 15-22 ft. lbs. (20-30 Nm).
31. Verify that the arrows on the right cylinder head camshafts are aligned (facing each other as shown in the accompanying illustration).
32. Install the right timing chain over the right crankshaft sprocket and the right camshaft sprockets.
33. Align the timing marks on the right cylinder head timing chain with the timing marks on the crankshaft sprocket and the camshaft sprockets.
34. Install the right timing chain tensioner arm over the alignment dowel on the right cylinder head.
35. Before installing the timing chain tensioner, it must be properly bled down as follows:

Do not release the ratchet stem until the tensioner is fully bottomed in its bore, or damage to the ratchet stem can occur.

Compress the timing chain slowly or damage to the tensioner may occur. The piston should retract using minimal force. Reposition the tensioner to eliminate side loading if binding occurs.

The wire must remain in the tensioner until the tensioner is installed with the piston bottomed in the bore.

Click on icon to view fullsize printable image. **Click to Enlarge** *The left hand timing chain index marks and camshaft marks should be aligned as illustrated-3.0L DOHC engine*
Click on icon to view fullsize printable image. **Click to Enlarge** *The right hand timing chain index marks and camshaft marks should be aligned as illustrated-3.0L DOHC engine*

39. Rotate the crankshaft two revolutions and position the crankshaft key-way to the 3 o'clock location. This will position the right cylinder head camshafts to the neutral position.
40. Remove the lock pins from the timing chain tensioners.
41. Verify that the timing marks on the timing chains are aligned with the timing marks on the crankshaft sprocket and the camshaft sprockets.
42. Install the engine front cover.

3.4L DOHC Engines

1. Remove the engine front cover.
2. Remove the crankshaft position sensor pulse ring from the crankshaft.
3. Rotate the crankshaft to position the No. 1 piston at Top-Dead-Center (TDC) by aligning the crankshaft key-way groove with the oil pump mark. Refer to the accompanying illustration.
4. Verify that the alignment on the camshafts sprockets are on top. If not, rotate the crankshaft one complete revolution and recheck.
5. Remove the timing chain guides, tensioner arm and tensioner retaining bolts and remove the timing chain from the engine.
6. Using a small screwdriver, release the timing chain tensioner ratchet/pawl mechanism through the access hole in the timing chain tensioner. Compress the timing chain tensioner rack and piston into the tensioner housing by inserting a small wire into the top of the piston and gently unseat the oil check ball. Compress the timing chain tensioner by hand.

Failure to compress and lock the timing chain tensioner prior to installation may cause damage to the engine.

7. With the tensioner compressed, install a 0.060 inch (1.5mm) drill bit or wire into the small hole above the ratchet, engaging the lock groove in the rack of the timing chain tensioner.
8. Remove the camshaft timing chain sprockets, if being replaced.

Click on icon to view fullsize printable image.

Click to Enlarge

Align the crankshaft key-way groove with the oil pump mark to set the engine at TDC-3.4L DOHC engines

Click on icon to view fullsize printable image.

Click to Enlarge

Exploded view of the timing chain guide and tensioner assemblies-3.4L DOHC engines

Click on icon to view fullsize printable image.

Click to Enlarge

Make sure the timing marks are aligned as shown after the chains have been installed-3.4L DOHC engine

Click on icon to view fullsize printable image.

Click to Enlarge

Locate the dowel pin in the hole illustrated and tighten the camshaft sprocket bolt to specification-3.4L DOHC engine

To install:

Inspect the timing chains, tensioners, tensioner arms, guides and sprocketsfor wear or damage and replace as necessary.

9. Rotate the crankshaft to position the No. 1 piston at top-dead-center TDC by aligning the crankshaft key-way groove with the oil pump mark.

Do not rotate the crankshaft more than 45 degrees counterclockwise or morethan 90 degrees clockwise from the previously set No. 1 cylindertop-dead-center position or valve to piston contact could occur.

10. Match the sprocket and chain timing marks and install the timing chain with the crankshaft, camshaft and balance shaft correctly aligned as illustrated.
11. Reinstall or replace the camshaft sprockets, if removed making sure the dowel pin is located in the hole shown the accompanying illustration. Tighten the sprocket retaining bolt to 48-70 ft. lbs. (64-95 Nm).
12. Install the compressed timing chain guides, tensioner arm and tensioner. Tighten the timing chain tensioner pivot bolt to 25-39 ft. lbs. (34-53 Nm). Tighten the timing chain tensioner retaining bolts to 14-20 ft. lbs. (18-27 Nm).
13. Verify the timing index marks on the timing chain are in alignment with the index marks on the crankshaft sprocket, camshaft sprocket and balance shaft driven gear.
14. Install the crankshaft position sensor pulse ring onto the crankshaft aligning the crankshaft key with the key-way on the sensor ring.
15. Install the engine front cover.

Camshaft, Bearings and Lifters

REMOVAL & INSTALLATION

The fuel injection system remains under pressure, even after the engine has been turned OFF. The fuel system pressure must be relieved before disconnecting any fuel lines. Failure to do so may result in fire and/or personal injury.

3.0L OHV Engine

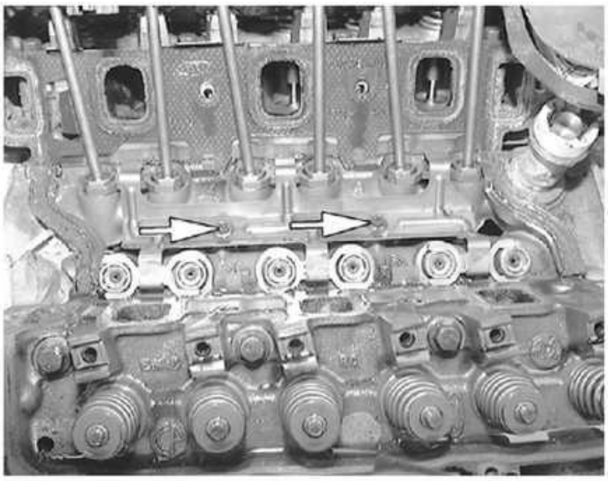
1. Remove the engine from the vehicle and position on a suitable holding fixture.
2. Rotate the crankshaft to Top Dead Center (TDC) for No. 1 cylinder on its compression stroke.
3. Remove the upper intake manifold.
4. Disconnect the engine wiring harness connectors from the cylinder head cover stud bolts. Tag and carefully unplug the fuel injector harness connectors from each fuel injector and position engine wiring harness aside.
5. Label and disconnect the ignition wires from the spark plugs. Remove the ignition wire separators from the cylinder head cover stud bolts.
6. Remove the Camshaft Position (CMP) sensor housing retainer bolt and washer and remove the CMP sensor housing.
7. Remove the ignition coil from the rear of the left cylinder head.
8. Remove the valve head covers.
9. Loosen the No. 3 intake valve rocker arm seat retaining bolt and rotate the rocker arm off the pushrod. Remove the pushrod.
10. Remove the accessory drive belt.
11. Remove the drive belt tensioner, alternator and alternator brackets.
12. Remove the lower intake manifold leaving the fuel supply manifold (fuel rail) and fuel injectors in place.
13. Loosen the remaining rocker arm fulcrum nuts enough to allow the rocker arms to be lifted off the pushrods. Remove the remaining pushrods, identifying each pushrod for installation as the pushrods must be installed in their original positions.
14. Remove the valve lifter guide plate retainer bolts and the valve lifter guide plate.
15. Using a suitable magnet or lifter removal tool, remove the hydraulic valve lifters and keep them in order so they can be installed in their original positions. If the valve lifters are stuck in the bores by excessive varnish, use a hydraulic lifter puller to remove the lifters.
16. Remove the crankshaft pulley retaining bolts and the crankshaft pulley.
17. Remove the crankshaft damper retaining bolt and washer. Remove the crankshaft damper using remover T58P-6316-D or equivalent puller and adapter T82L-6316-B or equivalent.
18. Remove the engine oil pan.
19. Unfasten the engine front cover retaining bolts leaving the water pump attached. Remove the engine front cover.
20. Align the timing marks on the camshaft and crankshaft sprockets. Check the camshaft end-play as follows:

If replacing the camshaft, the valve lifters must also be replaced.

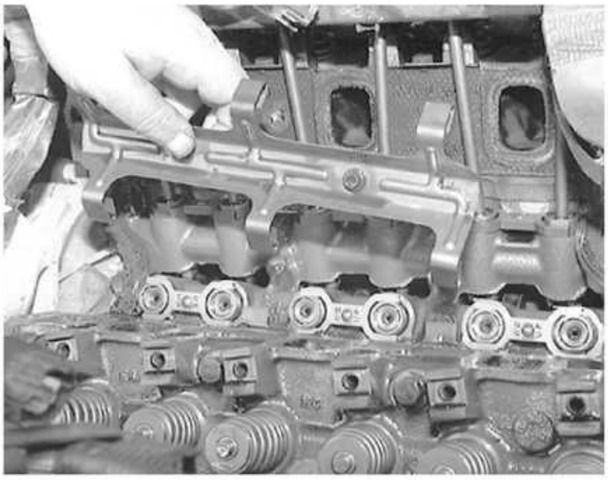
Click on icon to view fullsize printable image.

Click to Enlarge

Exploded view of camshaft bearing removal/installation using a suitable camshaft bearing set-3.0L OHV engines

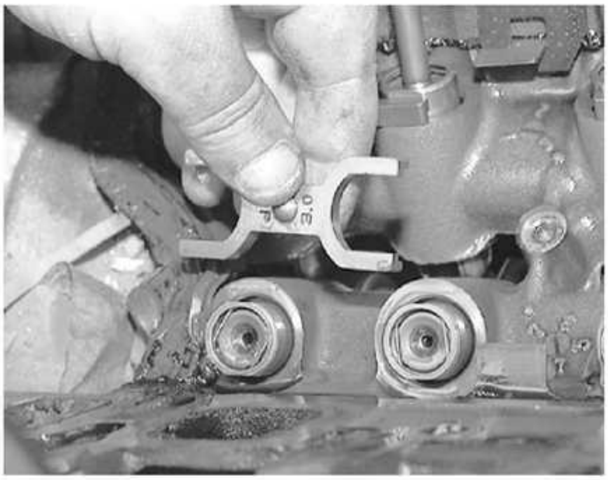


The guide plate is held by two retaining bolts, remove the bolts and...

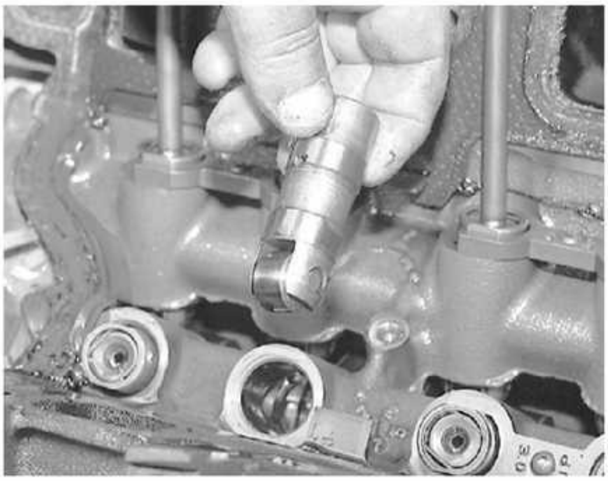


... remove the guide plate

The lifters are held by a retainer



Remove the retainer and...



... remove the lifters from the engine

To install:

Failure to use the correct expanding collet may cause damage to the camshaft bearings.

The camshaft bearings are available pre-finished to size and require noreaming for standard and 0.015 (0.38mm) undersize journal diameters.

28. Install the camshaft bearings as follows:
29. Place the bearings at the bearing bores, align the oil holes in the camshaft bearings with the oil holes in the cylinder block before pressing the bearing into place.
30. Using camshaft bearing set T65L-6250-A or its equivalent, press the bearings into place. Make sure the pulling plate and puller screw are centered to prevent damage to the bearing.

Make sure the front camshaft bearing isinstalled 0.020-0.035 in. (0.51-0.89mm) below the front face of the cylinder block

31. If removed, install the camshaft rear bearing cover using a suitable driver/installer tool.
32. Clean all gasket mating surfaces.
33. Lubricate the camshaft lobes, journals, drive gear and bearing surfaces with engine assembly lubricant or equivalent. Carefully insert the camshaft through the bearings into the cylinder block.
34. Lubricate the camshaft thrust plate on both sides with engine assembly lubricant. Install the thrust plate and the two retaining bolts. Tighten the retaining bolts to 88 inch lbs. (10 Nm).

If installing a new camshaft, check the camshaftend-play.

35. Lubricate the timing chain and sprockets with engine assembly lubricant or equivalent and align the timing marks on the sprockets before installation.
36. Install the timing chain and sprocket assembly. Install the camshaft sprocket bolt. Tighten the camshaft sprocket bolt to 37-51 ft. lbs. (50-70 Nm).

The camshaft bolt has a drilled oil passage in it for timing chain lubrication. Be sure the passage is clean prior to bolt installation. If the bolt is damaged, do not replace the camshaft bolt with a standard bolt or engine damage will result.

37. Lubricate the valve lifters and lifter bores with engine assembly lubricant or equivalent. Install the valve lifters into their original bores.
38. Align the flat surfaces on the valve lifters and install the valve lifter guide plate. The plate must be installed with the word ***UP*** and/or a dimple on the plate visible. Install the two retaining bolts and tighten to 8-10 ft. lbs. (10-14 Nm).
39. Install the lower intake manifold.
40. Install the CMP sensor.
41. Lubricate the pushrods and rocker arms with engine assembly lubricant or equivalent. Install the pushrods into their original positions. Position each rocker arm onto its related pushrod.
42. Before installation, coat the valve tips, rocker arm and fulcrum contact areas with Lubriplate® or equivalent.
43. Rotate the crankshaft one full turn (360 degrees) until the lifter is on the base circle of the cam as shown in the accompanying illustration (camshaft position A).
44. Install the rocker arm assemblies and tighten the rocker arm fulcrum bolts to 6-11 ft. lbs. (7-17 Nm) to position the rocker arm seats.
45. Rotate the crankshaft clockwise 120 degrees to camshaft position B as shown in the accompanying illustration. Tighten the rocker arm fulcrum bolts to 6-11 ft. lbs. (7-17 Nm) to position the rocker arm seats.

The fulcrums must be fully seated in thecylinder head and the pushrods must be seated in the rocker arm sockets priorto the final tightening.

Click on icon to view fullsize printable image.

Click to Enlarge

Camshaft position during rocker arm installation and valve clearance check-3.0L OHV engines

46. Final tighten the rocker arm fulcrum bolts to 20-28 ft. lbs. (26-38 Nm).

If the same valve train components are used a valve train check is not required. If new components were installed, measure the clearance with the valve tappet fully collapsed on the base circle of the camshaft lobe. The measurement should be 0.085-0.185 inch (2.15-4.69mm). refer to the accompanying illustration if necessary for the valve clearance measurement.

47. Install the engine front cover and the engine oil pan.
48. Install the crankshaft damper and pulley.
49. Install the alternator and brackets.
50. Install the drive belt tensioner and the accessory drive belt.
51. Install the valve covers.
52. Attach the fuel injector harness to each fuel injector. Secure the harness to the cylinder head cover stud bolts.
53. Install the ignition coil to the left cylinder head.
54. Install the upper intake manifold.
55. Install the ignition wiring harness retainers to the cylinder head cover stud bolts and connect the ignition wires to the spark plugs and ignition coil.
56. Install the engine assembly into the vehicle.
57. Fill the engine cooling system.
58. Fill the crankcase with the correct amount and type of engine oil.
59. Connect the negative battery cable.
60. Start the engine and check for leaks and proper engine operation.

3.0L DOHC Engine

1. Remove the engine from the vehicle and place it on a suitable work stand.
2. Remove the upper intake manifold.
3. Remove the valve covers.
4. Remove the engine front cover.
5. Remove the timing chains.
6. Rotate the crankshaft clockwise to position the crankshaft key-way to the 11 o'clock position and the engine to Top Dead Center (TDC) for the No. 1 cylinder prior to the removal and installation of camshafts and rocker arms or you may damage the camshafts.
7. Verify that the alignment flags (arrows) on the camshafts (marked RFF) are aligned. If not, rotate the crankshaft one complete revolution and recheck.
8. Rotate the crankshaft clockwise so the crankshaft key-way is at the 3 o'clock position. This positions the right cylinder head camshafts to the neutral position (base circle).

Cylinder head camshaft journal caps and the cylinder heads should be given an identification mark to make sure they are assembled in their original position. When removed, keep the camshaft journal caps from each cylinder head with the head they were removed from. Do not mix the caps with those from another cylinder head.

Remove the cylinder head camshaft journal thrust cap first to make sure that damage to the camshaft journal thrust cap does not occur.

9. Remove the right cylinder head camshaft journal thrust cap retaining bolts and thrust caps.
10. Loosen the remaining camshaft journal cap bolts in the sequence illustrated, releasing the bolts several revolutions at a time by making several passes to allow the camshaft to be raised from the cylinder head evenly. Do not remove the retaining bolts completely.

If the lash adjusters (tappets) and roller rocker arms are to be reused,mark the positions of the lash adjusters and rocker arms so they are reassembled into their original positions.

11. Remove the camshaft journal caps with the retaining bolts installed.
12. Remove the camshafts from the cylinder head, then repeat the procedure for both cylinder heads.
13. Pull the valve lifters out of their bores. Mark them so they can be installed in their original locations.
14. Inspect the camshafts and cylinder heads for wear or damage.

To install:

The crankshaft key-way must be at the 11 o'clock position before reassembly. Failure to do so may lead to engine damage.

15. Rotate the crankshaft so the key-way is at the 11 o'clock position for installation of the camshafts.
16. Lubricate the camshaft lobes and journals with engine assembly lubricant.
17. Install the valve lifters in their original positions.
18. Install the camshafts into their correct positions into each cylinder head with the timing marks on the camshaft sprockets aligned.
19. Loosely install the camshaft journal caps and retaining bolts into their correct positions.

Do not install the camshaft journal thrust caps until the rocker arms and timing chains have been installed and the camshaft journal caps are tightened into position.

20. Install the timing chains.
21. Tighten the camshaft journal cap bolts, in sequences illustrated, to 71-106 inch lbs. (8-12 Nm). Install the thrust caps and tighten the retaining bolts to 71-106 inch lbs. (8-12 Nm).
22. Install the engine front cover.
23. Install both cylinder head covers.
24. Install the upper intake manifold.
25. Install the engine assembly into the vehicle.
26. Fill the engine cooling system.
27. Fill the crankcase with the correct amount and type of engine oil.
28. Connect the negative battery cable.
29. Start the engine and check for leaks and proper engine operation.

3.4L DOHC Engine

1. Remove the engine from the vehicle and place it on a suitable work stand.
2. Remove the valve covers as outlined earlier in this section.
3. Remove the timing chain, sprockets and front cover, as outlined earlier in this section.
4. Remove the timing chain sprocket tensioners from the cylinder heads.
5. Remove the camshaft timing chain sprocket tensioners from the cylinder heads.

The camshaft journal caps and the cylinder heads are numbered to make sure they are assembled in their original positions. Make sure to keep the journal caps from each cylinder head together. Do not mix the caps from each head.

Make sure to remove camshaft journal thrust caps first to ensure that damage to thrust caps does not occur.

6. Loosen the camshaft journal thrust caps in the sequence illustrated 7-8 revolutions in several passes to allow the camshafts to be raised from the head. Do not remove the retaining bolts completely.
7. Inspect the camshafts for wear and/or damage and replace, as necessary.
8. Pull the valve lifters out of their bores. Mark them so they can be installed in their original locations.

To install:

9. Apply a thin coat of clean engine oil to the valve lifters and install the valve lifters in their original positions.
10. Apply a thin coat of clean engine oil to the camshaft bearing surfaces on the cylinder head and camshaft journal caps.

Click on icon to view fullsize printable image.

Click to Enlarge

Camshaft journal thrust cap retaining bolt removal sequence-3.4L DOHC engine

11. Rotate the crankshaft to position the No. 1 piston at top-dead-center TDC by aligning the crankshaft key-way groove with the oil pump mark.
12. Install the timing chain on the intake and exhaust camshafts. Match the sprocket and chain timing marks and install the camshafts into the cylinder heads with the timing marks pointing up.
13. Apply a 0.08-0.11 inch (2-3mm) bead of silicone gasket and sealant to the left side cylinder head camshaft journal cap.

Be sure the camshaft journal caps are installed in their original positions.

Click on icon to view fullsize printable image.

Click to Enlarge

Tighten the camshaft journal caps in the sequence shown to avoid damaging the camshafts-3.4L DOHC engine

INSPECTION

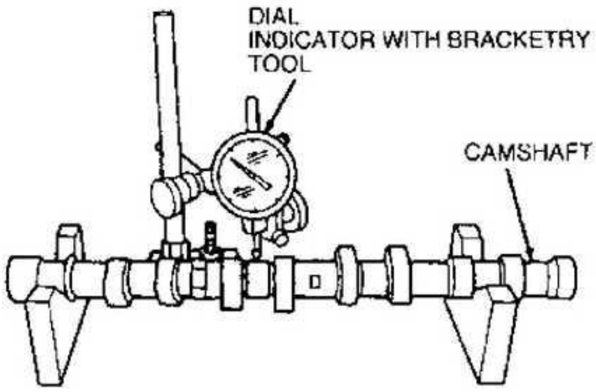
Camshaft

Degrease the camshaft using safe solvent, clean all oil grooves. Visually inspect the cam lobes and bearing journals for excessive wear. If a lobe is questionable, check all lobes and journals with a micrometer.

Measure the lobes from nose to base and again at 90°. The lift is determined by subtracting the second measurement from the first. If all exhaust lobes and all intake lobes are not identical, the camshaft must be reground or replaced. Measure the bearing journals and compare to the specifications. If a journal is worn there is a good chance that the cam bearings are worn too, requiring replacement.

If the lobes and journals appear intact, place the front and rear camshaft journals in V-blocks and rest a dial indicator on the center journal. Rotate the camshaft to check for run-out, if deviation exceeds specification, replace the camshaft.

Measure the camshaft journal diameter at the points shown in the accompanying illustration. If the diameters do not conform to specifications, replace the camshaft.



Checking the camshaft run-out

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Checking the camshaft lobe lift

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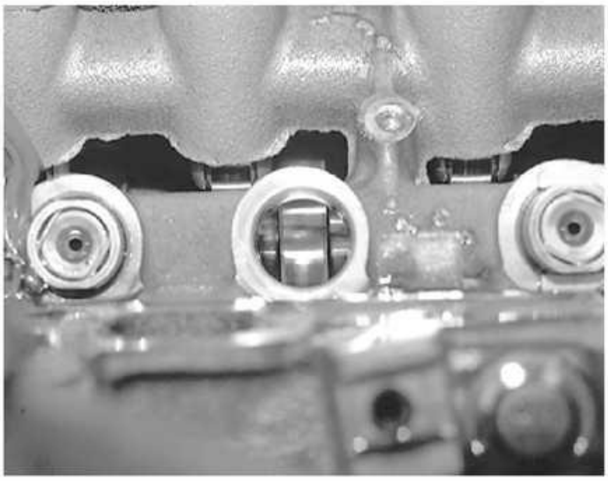
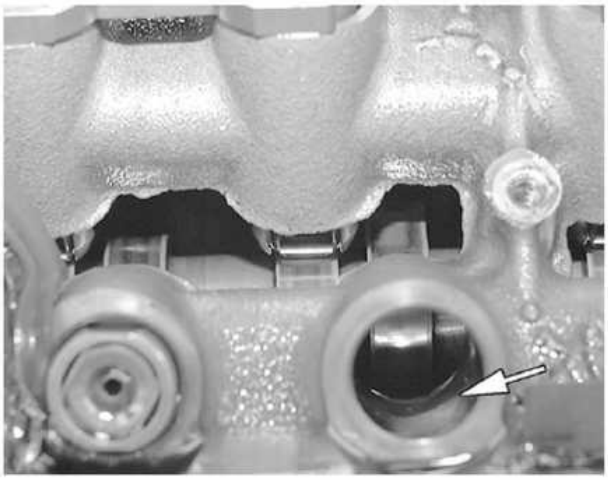
Checking the camshaft journal diameter



Inspect the lobes of the camshaft and...



... the lifter bores for scoring or other damage

Bearings and Journals

Check the camshaft bores for size, taper, roundness, alignment and finish. If any of these exceed the specifications given in the engine rebuilding chart at the end of this section, install new bearings or cylinder heads.

Lifters

Inspect the rollers on the lifters for wear

1. Thoroughly clean the lifter and its bore, then check for pitting, scoring or excessive wear.
2. On flat lifters, the bottom should be flat and not concave.
3. If equipped with a roller, the roller should rotate freely without excessive play.

Balance Shaft

REMOVAL & INSTALLATION

3.4L DOHC Engine

Click on icon to view fullsize printable image.

Click to Enlarge

Remove the balance shaft driven gear bolt, gear and sprocket key-3.4L DOHC engines
Click on icon to view fullsize printable image. **Click to Enlarge** *Remove the balance shaft thrust plate-3.4L DOHC engines*
Click on icon to view fullsize printable image. **Click to Enlarge** *Removing the balance shaft using the slide hammer and remover/installer tools-3.4L DOHC engines*
Click on icon to view fullsize printable image. **Click to Enlarge** *Remove the balance shaft rear bearing-3.4L DOHC engines*
Click on icon to view fullsize printable image. **Click to Enlarge** *Remove the balance shaft rear bearing bore core plug from the rear of the block-3.4L DOHC engines*

1. Remove the engine from the vehicle and place it on a suitable work stand.
2. Remove the valve covers as outlined earlier in this section.
3. Remove the timing chain, sprockets and front cover, as outlined earlier in this section.
4. Remove the timing chain tensioners.
5. Unfasten the engine balance shaft driven gear retaining bolt, then remove the bolt, the gear and the balance shaft sprocket key from the shaft.
6. Unfasten the three balance shaft thrust plate bolts and remove the thrust plate.
7. Thread balance shaft remover/installer tool T96P-6A333-AH or it's equivalent into the balance shaft. Thread impact slide hammer T50T-100-A or its equivalent into the remover/installer tool. Pull the balance shaft and front bearing out of the block using the slide hammer.
8. If necessary, thread balance shaft rear bearing remover tool T96P-6A333-BH or its equivalent onto the balance shaft remover/installer tool. Insert the bearing remover through the inside diameter of the rear bearing. Seat the tool into the bearing inside diameter before pulling, then pull out the rear bearing using the slide hammer.

To install:

9. If the rear bearing was removed, remove the balance shaft rear bearing bore core plug from the rear face of the block. Install balance shaft rear bearing locator tool T96P-6A333-GH or its equivalent into the core plug bore using the bolts provided with the tool.
10. Install balance shaft rear bearing onto balance shaft rear bearing replacer tool T96P-6A333-CH or its equivalent. Slide balance shaft rear bearing aligner tool T96P-6A333-DH onto the replacer shaft. Position the bearing at the rear bearing bore and the aligner into the front bearing bore.
11. Install balance shaft bearing replacer adapter tool T96P-6A333-FH or its equivalent onto the front of the engine block using the bolts provided with the tool. Assemble front hub remover/installer tool T81P-11940-C or its equivalent to the adapter. Push the rear bearing into the bore until it is seated against the rear bearing locator tool. Once the bearing is seated, remove the bearing locator and front hub remover/installer from the balance shaft replacer adapter

Use the impact slide hammer tool only as a handle to assist you when installing the balance shaft. Do not hammer on the balance shaft.

12. Thread balance shaft remover/installer tool and the slide hammer into the balance shaft. Carefully install the balance shaft into the rear bearing until it is fully seated, then remove the installer and slide hammer tools.
13. Slide the front balance shaft bearing over the nose of the shaft. Position balance shaft front bearing replacer tool T96P-6A333-EH or its equivalent against the bearing making sure to position the flat on the tool upward to clear the flange on the block. Attach the front hub remover/replacer to the adapter. Push the bearing into its bore until it is fully seated.
14. Install the balance shaft thrust plate and its retaining screws. Tighten the bolts to 16-22 ft. lbs. (21-30 Nm). Make sure the balance shaft rotates freely, then install the shaft key into the shaft.
15. Install the balance shaft driven gear over the shaft key onto the shaft and install its retaining bolt. Tighten the bolt to

34-42 ft. lbs. (46-58 Nm).

16. Install the core plug in the rear face of the block.
17. Install the timing chain tensioners.
18. Install the timing chain, sprockets and the front cover.
19. Install the valve covers.
20. Install the engine in the vehicle.

Click on icon to view fullsize printable image.

Click to Enlarge

Install the balance shaft rear bearing locator into the core plug bore-3.4L DOHC engines

Click on icon to view fullsize printable image.

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Installing the balance shaft rear bearing-3.4L DOHC engines

Rear Main Seal

REMOVAL & INSTALLATION

3.0L OHV Engines

1. Disconnect the negative battery cable.
2. Raise and safely support the vehicle.
3. Remove the transaxle assembly.
4. Remove the flywheel.

Use care to avoid damaging the crankshaft oil seal surface.

5. Using a sharp pick or similar tool, punch a hole in the rear crankshaft seal between the seal lip and the cylinder block.
6. Screw in the threaded end of a jet plug remover tool such as T77L-9533-B or its equivalent and remove the rear crankshaft seal.

To install:

7. Inspect the crankshaft seal area for any damage which may cause the seal to leak. If damage is evident, service or replace the crankshaft as necessary.
8. Coat the crankshaft seal area and the seal lip with clean engine oil.
9. Place the rear crankshaft seal on seal replacer T88L-6701-A or equivalent, and position the tool and seal to the rear of the cylinder block with three bolts. Alternately tighten the bolts to properly seat the seal. The seal must be flush or within 0.020 inch (0.50mm) of the cylinder block surface. Do not bottom the seal.
10. Install the flywheel.
11. Install the transaxle assembly.
12. Lower the vehicle.
13. Connect the negative battery cable.
14. Run the engine and check for leaks.
15. Road test the vehicle and check for proper engine and transaxle operation.

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Installing the rear main oil seal-3.0L OHV engines

3.0L and 3.4L DOHC Engines

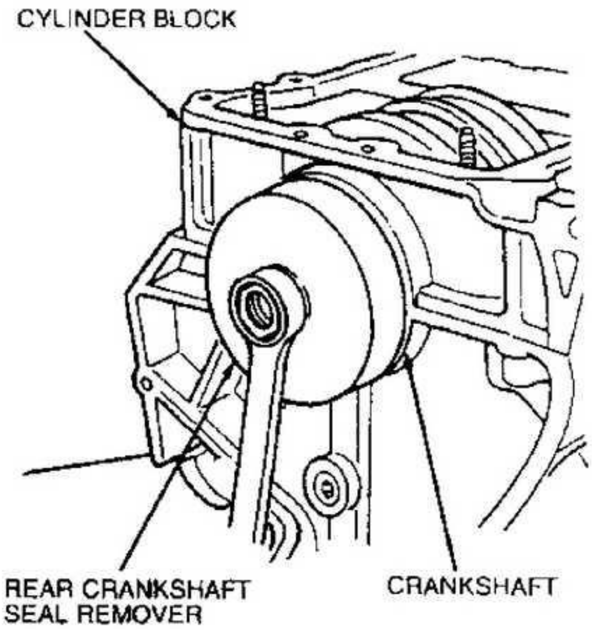
1. Disconnect the negative battery cable.
2. Raise and safely support the vehicle.
3. Remove the transaxle assembly.

4. Remove the flywheel.

Use care not to scratch the crankshaft or the crankshaft retainer oil sealing surfaces when removing the rear crankshaft seal.

5. Use seal remover tool T95P-6700-EH or equivalent, to remove the rear crankshaft seal.

If the removal tool is going to rest against the back of the crankshaft, place a piece of thin copper or other soft metal 0.010 inch (0.25mm) thick, between the tool and the rear face of the crankshaft to protect the surface of the crankshaft.



Removing the rear main oil seal-3.0L and 3.4L OHC engines

To install:

6. Clean and inspect the rear crankshaft seal sealing surfaces on the crankshaft and the cylinder block.
7. Lubricate the crankshaft flange and the rear crankshaft seal bore with engine assembly lubricant.
8. Install the rear main oil seal using rear seal replacer tool T82L-6701-A and adapter T91P-6701-A or equivalents.
9. Alternate tightening the bolts to pull the rear crankshaft seal in evenly. Seat the rear crankshaft seal flush to the rear of the cylinder block.
10. Install the flywheel.
11. Install the transaxle.
12. Connect the negative battery cable.
13. Run the engine and check for leaks and proper operation.

Flywheel

REMOVAL & INSTALLATION

1. Disconnect the negative battery cable.
2. Raise and safely support the vehicle.
3. Remove the transaxle assembly.
4. Mark the location of the flywheel to the crankshaft.
5. Unfasten the flywheel retaining bolts and remove the flywheel.
6. Inspect the flywheel for damage and replace as necessary.

To install:

7. Place the flywheel into position aligning the marks made during removal and install the retaining bolts. Tighten the

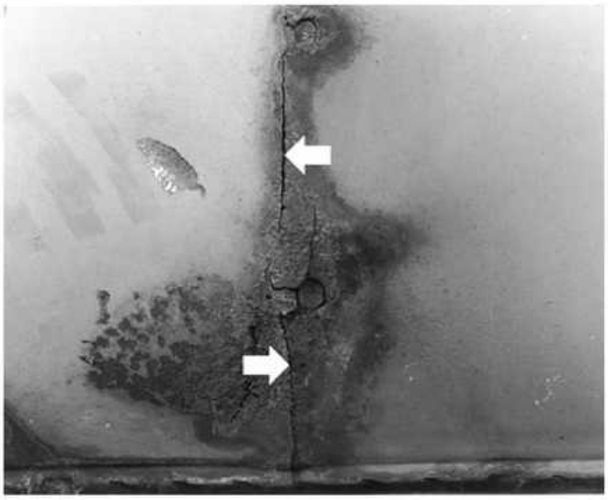
bolts to 54-64 ft. lbs. (73-87 Nm) using a criss-cross tightening sequence.

8. Install the transaxle.
9. Connect the negative battery cable.
10. Run the engine and check for leaks and proper operation.

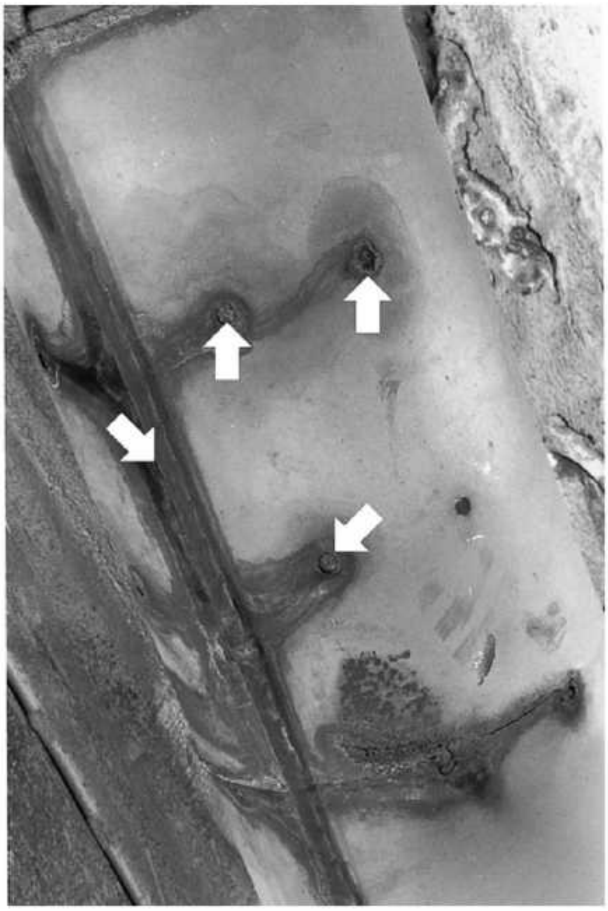
EXHAUST SYSTEM

Safety glasses should be worn at all times when working on or near the exhaust system. Older exhaust systems will almost always be covered with loose rust particles which will shower you when disturbed. These particles are more than a nuisance and could injure your eyes.

Do NOT perform exhaust repairs or inspection with the engine or exhaust hot. Allow the system to cool completely before attempting any work. Exhaust systems are noted for sharp edges, flaking metal and rusted bolts. Gloves and eye protection are required. A healthy supply of penetrating oil and rags is highly recommended.

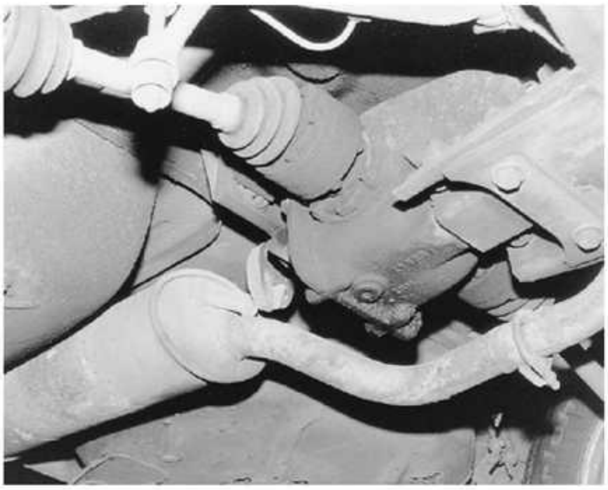


Cracks in the muffler are a guaranteed leak



Check the muffler for rotted spot welds and seams

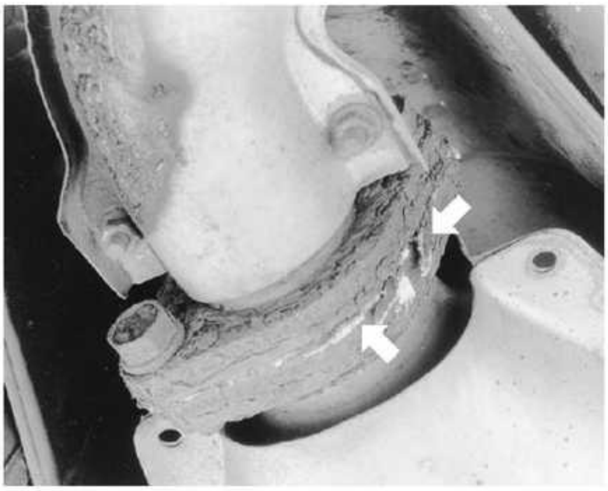
Your vehicle must be raised and supported safely to inspect the exhaust system properly. Placing four safety stands under the vehicle for support should provide enough room for you to slide under the vehicle and inspect the system completely. Start the inspection at the exhaust manifold or turbocharger pipe where the header pipe is attached and work your way to the back of the vehicle. On dual exhaust systems, remember to inspect both sides of the vehicle. Check the complete exhaust system for open seams, holes loose connections, or other deterioration which could permit exhaust fumes to seep into the passenger compartment. Inspect all mounting brackets and hangers for deterioration, some models may have rubber O-rings that can be overstretched and non-supportive. These components will need to be replaced if found. It has always been a practice to use a pointed tool to poke up into the exhaust system where the deterioration spots are to see whether or not they crumble. Some models may have heat shield covering certain parts of the exhaust system, so it will also be necessary to remove these shields to have the exhaust visible for inspection.



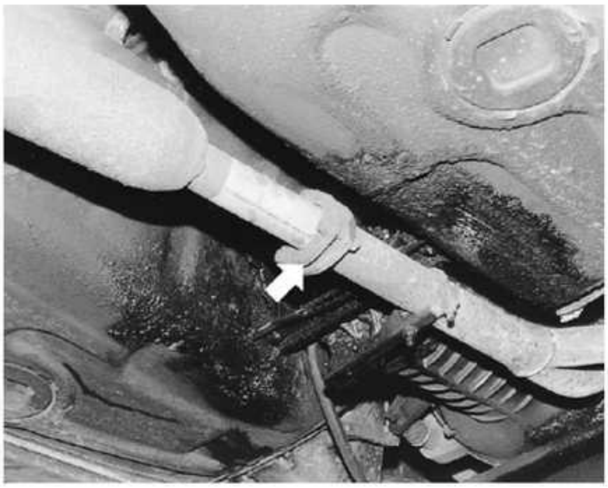
Make sure the exhaust components are not contacting the body or suspension

Check for overstretched or torn exhaust hangers

Example of a badly deteriorated exhaust pipe



Inspect flanges for gaskets that have deteriorated and need replacement



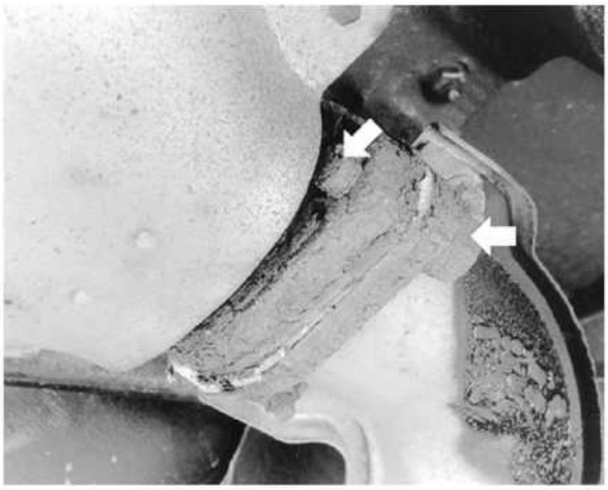
Some systems, like this one, use large O-rings (doughnuts) in between the flanges

REPLACEMENT

There are basically two types of exhaust systems. One is the flange type where the component ends are attached with bolts and a gasket in-between. The other exhaust system is the slip joint type. These components slip into one another using clamps to retain them together.

Allow the exhaust system to cool sufficiently before spraying a solvent on exhaust fasteners. Some solvents are highly flammable and could ignite when sprayed on hot exhaust components.

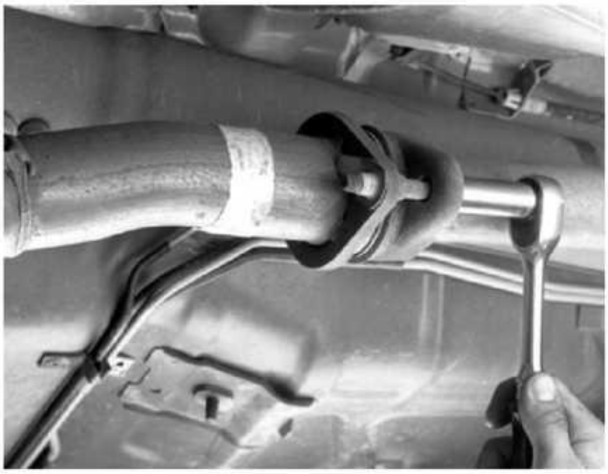
Before removing any component of the exhaust system, ALWAYS squirt a liquid rust dissolving agent onto the fasteners for ease of removal. A lot of knuckle skin will be saved by following this rule. It may even be wise to spray the fasteners and allow them to sit overnight.



Nuts and bolts will be extremely difficult to remove when deteriorated with rust

Flange Type

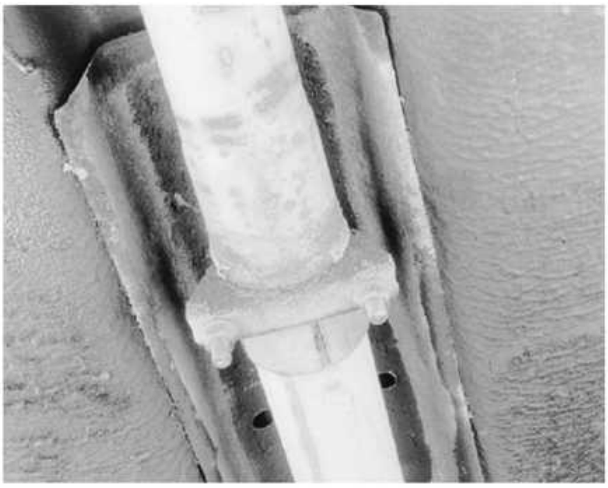
Do NOT perform exhaust repairs or inspection with the engine or exhaust hot.Allow the system to cool completely before attempting any work. Exhaust systems are noted for sharp edges, flaking metal and rusted bolts. Gloves and eyeprotection are required. A healthy supply of penetrating oil and rags is highly recommended. Never spray liquid rust dissolving agent onto a hot exhaust component.



Example of a flange type exhaust system joint

Before removing any component on a flange type system, ALWAYS squirt a liquid rust dissolving agent onto the fasteners for ease of removal. Start by unbolting the exhaust piece at both ends (if required). When unbolting the headpipe from the manifold, make sure that the bolts are free before trying to remove them. if you snap a stud in the exhaust manifold, the stud will have to be removed with a bolt extractor, which often means removal of the manifold itself. Next, disconnect the component from the mounting; slight twisting and turning may be required to remove the component completely from the vehicle. You may need to tap on the component with a rubber mallet to loosen the component. If all else fails, use a hacksaw to separate the parts. An oxy-acetylene cutting torch may be faster but the sparks are DANGEROUS near the fuel tank, and at the very least, accidents could happen, resulting in damage to the under-car parts, not to mention yourself.

Slip Joint Type



Example of a common slip joint type system

Before removing any component on the slip joint type exhaust system, ALWAYS squirt a liquid rust dissolving agent onto the fasteners for ease of removal. Start by unbolting the exhaust piece at both ends (if required). When unbolting the headpipe from the manifold, make sure that the bolts are free before trying to remove them. if you snap a stud in the exhaust manifold, the stud will have to be removed with a bolt extractor, which often means removal of the manifold itself. Next, remove the mounting U-bolts from around the exhaust pipe you are extracting from the vehicle. Don't be surprised if the U-bolts break while removing the nuts. Loosen the exhaust pipe from any mounting brackets retaining it to the floor pan and separate the components.

ENGINE RECONDITIONING

Determining Engine Condition

Anything that generates heat and/or friction will eventually burn or wear out (for example, a light bulb generates heat, therefore its life span is limited). A running engine generates tremendous amounts of both; friction is encountered by the moving and rotating parts inside the engine and heat is created by friction and combustion of the fuel. However, the engine has systems designed to help reduce the effects of heat and friction and provide added longevity. The oiling system reduces the amount of friction encountered by the moving parts inside the engine, while the cooling system reduces heat created by friction and combustion. If either system is not maintained, a break-down will be inevitable. Therefore, you can see how regular maintenance can affect the service life of your vehicle. If you do not drain, flush and refill your cooling system at the proper intervals, deposits will begin to accumulate in the radiator, thereby reducing the amount of heat it can extract from the coolant. The same applies to your oil and filter; if it is not changed often enough it becomes laden with contaminates and is unable to properly lubricate the engine. This increases friction and wear.

There are a number of methods for evaluating the condition of your engine. A compression test can reveal the condition of your pistons, piston rings, cylinder bores, head gasket(s), valves and valve seats. An oil pressure test can warn you of possible engine bearing, or oil pump failures. Excessive oil consumption, evidence of oil in the engine air intake area and/or bluish smoke from the tailpipe may indicate worn piston rings, worn valve guides and/or valve seals. As a general rule, an engine that uses no more than one quart of oil every 1000 miles is in good condition. Engines that use one quart of oil or more in less than 1000 miles should first be checked for oil leaks. If any oil leaks are present, have them fixed before determining how much oil is consumed by the engine, especially if blue smoke is not visible at the tailpipe.

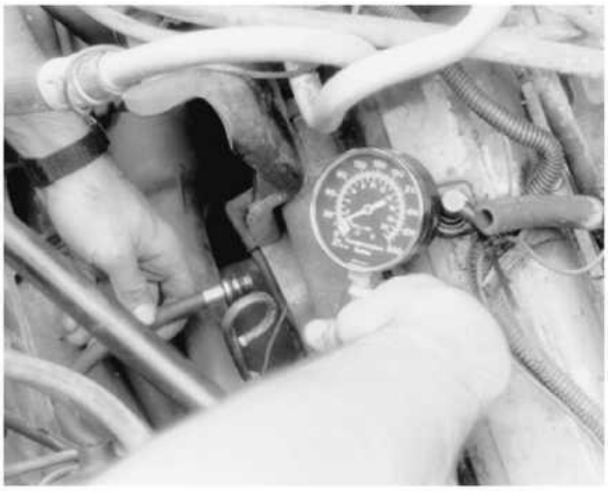
COMPRESSION TEST

A noticeable lack of engine power, excessive oil consumption and/or poor fuel mileage measured over an extended period are all indicators of internal engine wear. Worn piston rings, scored or worn cylinder bores, blown head gaskets, sticking or burnt valves, and worn valve seats are all possible culprits. A check of each cylinder's compression will help locate the problem.

A screw-in type compression gauge is more accurate than the type you simply hold against the spark plug hole.

Although it takes slightly longer to use, it's worth the effort to obtain a more accurate reading.

1. Make sure that the proper amount and viscosity of engine oil is in the crankcase, then ensure the battery is fully charged.
2. Warm-up the engine to normal operating temperature, then shut the engine ***OFF***.
3. Disable the ignition system.
4. Label and disconnect all of the spark plug wires from the plugs.
5. Thoroughly clean the cylinder head area around the spark plug ports, then remove the spark plugs.
6. Set the throttle plate to the fully open (wide-open throttle) position. You can block the accelerator linkage open for this, or you can have an assistant fully depress the accelerator pedal.



A screw-in type compression gauge is more accurate and easier to use without an assistant

7. Install a screw-in type compression gauge into the No. 1 spark plug hole until the fitting is snug.

Be careful not to crossthread the spark plug hole.

8. According to the tool manufacturer's instructions, connect a remote starting switch to the starting circuit.
9. With the ignition switch in the ***OFF*** position, use the remote starting switch to crank the engine through at least five compression strokes (approximately 5 seconds of cranking) and record the highest reading on the gauge.
10. Repeat the test on each cylinder, cranking the engine approximately the same number of compression strokes and/or time as the first.
11. Compare the highest readings from each cylinder to that of the others. The indicated compression pressures are considered within specifications if the lowest reading cylinder is within 75 percent of the pressure recorded for the highest reading cylinder. For example, if your highest reading cylinder pressure was 150 psi (1034 kPa), then 75 percent of that would be 113 psi (779 kPa). So the lowest reading cylinder should be no less than 113 psi (779 kPa).
12. If a cylinder exhibits an unusually low compression reading, pour a tablespoon of clean engine oil into the cylinder through the spark plug hole and repeat the compression test. If the compression rises after adding oil, it means that the cylinder's piston rings and/or cylinder bore are damaged or worn. If the pressure remains low, the valves may not be seating properly (a valve job is needed), or the head gasket may be blown near that cylinder. If compression in any two adjacent cylinders is low, and if the addition of oil doesn't help raise compression, there is leakage past the head gasket. Oil and coolant in the combustion chamber, combined with blue or constant white smoke from the tailpipe, are symptoms of this problem. However, don't be alarmed by the normal white smoke emitted from the tailpipe during engine warm-up or from cold weather driving. There may be evidence of water droplets on the engine dipstick and/or oil droplets in the cooling system if a head gasket is blown.

OIL PRESSURE TEST

Check for proper oil pressure at the sending unit passage with an externally mounted mechanical oil pressure gauge (as opposed to relying on a factory installed dash-mounted gauge). A tachometer may also be needed, as some specifications may require running the engine at a specific rpm.

1. With the engine cold, locate and remove the oil pressure sending unit.
2. Following the manufacturer's instructions, connect a mechanical oil pressure gauge and, if necessary, a tachometer to the engine.
3. Start the engine and allow it to idle.
4. Check the oil pressure reading when cold and record the number. You may need to run the engine at a specified rpm, so check the specifications.
5. Run the engine until normal operating temperature is reached (upper radiator hose will feel warm).
6. Check the oil pressure reading again with the engine hot and record the number. Turn the engine ***OFF***.
7. Compare your hot oil pressure reading to that given in the chart. If the reading is low, check the cold pressure

reading against the chart. If the cold pressure is well above the specification, and the hot reading was lower than the specification, you may have the wrong viscosity oil in the engine. Change the oil, making sure to use the proper grade and quantity, then repeat the test.

Low oil pressure readings could be attributed to internal component wear, pump related problems, a low oil level, or oil viscosity that is too low. High oil pressure readings could be caused by a lubrication system restriction, too high of an oil viscosity or a faulty pressure relief valve.

Buy or Rebuild?

Now that you have determined that your engine is worn out, you must make some decisions. The question of whether or not an engine is worth rebuilding is largely a subjective matter and one of personal worth. Is the engine a popular one, or is it an obsolete model? Are parts available? Will it get acceptable gas mileage once it is rebuilt? Is the car it's being put into worth keeping? Would it be less expensive to buy a new engine, have your engine rebuilt by a pro, rebuild it yourself or buy a used engine from a salvage yard? Or would it be simpler and less expensive to buy another car? If you have considered all these matters and more, and have still decided to rebuild the engine, then it is time to decide how you will rebuild it.

The editors at Chilton feel that most engine machining should be performed by a professional machine shop. Don't think of it as wasting money, rather, as an assurance that the job has been done right the first time. There are many expensive and specialized tools required to perform such tasks as boring and honing an engine block or having a valve job done on a cylinder head. Even inspecting the parts requires expensive micrometers and gauges to properly measure wear and clearances. Also, a machine shop can deliver to you clean, and ready to assemble parts, saving you time and aggravation. Your maximum savings will come from performing the removal, disassembly, assembly and installation of the engine and purchasing or renting only the tools required to perform the above tasks. Depending on the particular circumstances, you may save 40 to 60 percent of the cost doing these yourself.

A complete rebuild or overhaul of an engine involves replacing all of the moving parts (pistons, rods, crankshaft, camshaft, etc.) with new ones and machining the non-moving wearing surfaces of the block and heads. Unfortunately, this may not be cost effective. For instance, your crankshaft may have been damaged or worn, but it can be machined undersize for a minimal fee.

So, as you can see, you can replace everything inside the engine, but, it is wiser to replace only those parts which are really needed, and, if possible, repair the more expensive ones. Later in this section, we will break the engine down into its two main components: the cylinder head and the engine block. We will discuss each component, and the recommended parts to replace during a rebuild on each.

Engine Overhaul Tips

Most engine overhaul procedures are fairly standard. In addition to specific parts replacement procedures and specifications for your individual engine, this section is also a guide to acceptable rebuilding procedures. Examples of standard rebuilding practice are given and should be used along with specific details concerning your particular engine.

Competent and accurate machine shop services will ensure maximum performance, reliability and engine life. In most instances it is more profitable for the do-it-yourself mechanic to remove, clean and inspect the component, buy the necessary parts and deliver these to a shop for actual machine work.

Much of the assembly work (crankshaft, bearings, piston rods, and other components) is well within the scope of the do-it-yourself mechanic's tools and abilities. You will have to decide for yourself the depth of involvement you desire in an engine repair or rebuild.

TOOLS

The tools required for an engine overhaul or parts replacement will depend on the depth of your involvement. With a few exceptions, they will be the tools found in a mechanic's tool kit (see Section 1 of this manual). More in-depth work will require some or all of the following:

- A dial indicator (reading in thousandths) mounted on a universal base
- Micrometers and telescope gauges
- Jaw and screw-type pullers
- Scraper
- Valve spring compressor
- Ring groove cleaner
- Piston ring expander and compressor
- Ridge reamer
- Cylinder hone or glaze breaker
- Plastigage®
- Engine stand

The use of most of these tools is illustrated in this section. Many can be rented for a one-time use from a local parts jobber or tool supply house specializing in automotive work.

Occasionally, the use of special tools is called for. See the information on Special Tools and the Safety Notice in the front of this book before substituting another tool.

OVERHAUL TIPS

Aluminum has become extremely popular for use in engines, due to its low weight. Observe the following precautions when handling aluminum parts:

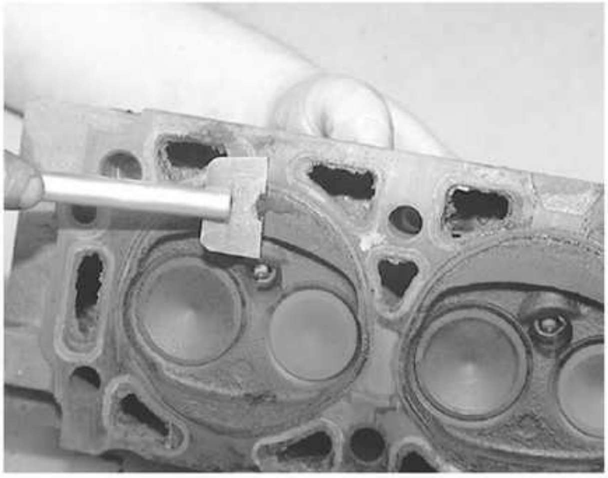
- Never hot-tank aluminum parts (the caustic hot-tank solution will eat the aluminum).
- Remove all aluminum parts (identification tags, etc.) from engine parts prior to hot-tanking.
- Always coat threads lightly with engine oil or anti-seize compounds before installation, to prevent seizure.
- Never overtighten bolts or spark plugs, especially in aluminum threads.

When assembling the engine, any parts that will be exposed to frictional contact must be prelubed to provide lubrication at initial start-up. Any product specifically formulated for this purpose can be used, but engine oil is not recommended as a prelube in most cases.

When semi-permanent (locked, but removable) installation of bolts or nuts is desired, threads should be cleaned and coated with Loctite® or another similar, commercial threadlocker.

CLEANING

Before the engine and its components are inspected, they must be thoroughly cleaned. You will need to remove any engine varnish, oil sludge and/or carbon deposits from all of the components to insure an accurate inspection. A crack in the engine block or cylinder head can easily be overlooked if hidden by a layer of sludge or carbon.

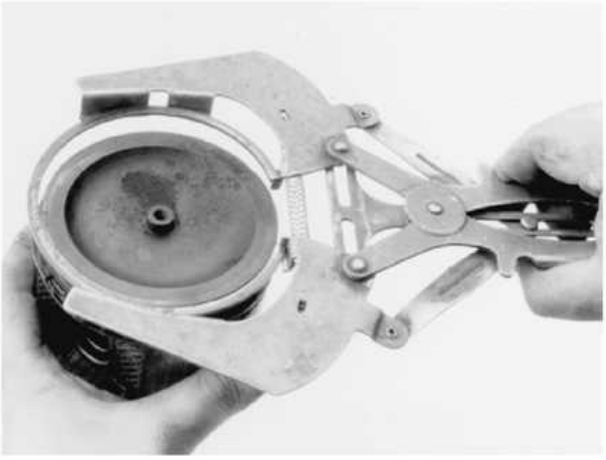


Use a gasket scraper to remove the old gasket material from the mating surfaces

Most of the cleaning process can be carried out with common hand tools and readily available solvents or solutions. Carbon deposits can be chipped away using a hammer and a hard wooden chisel. Old gasket material and varnish or sludge can usually be removed using a scraper and/or cleaning solvent. Extremely stubborn deposits may require the use of a power drill with a wire brush. If using a wire brush, use extreme care around any critical machined surfaces (such as the gasket surfaces, bearing saddles, cylinder bores, etc.). Use of a wire brush is NOT RECOMMENDED on any aluminum components. Always follow any safety recommendations given by the manufacturer of the tool and/or solvent. You should always wear eye protection during any cleaning process involving scraping, chipping or spraying of solvents.

An alternative to the mess and hassle of cleaning the parts yourself is to drop them off at a local garage or machine shop. They will, more than likely, have the necessary equipment to properly clean all of the parts for a nominal fee.

Always wear eye protection during any cleaning process involving scraping, chipping or spraying of solvents.



Use a ring expander tool to remove the piston rings

Remove any oil galley plugs, freeze plugs and/or pressed-in bearings and carefully wash and degrease all of the engine components including the fasteners and bolts. Small parts such as the valves, springs, etc., should be placed in a metal basket and allowed to soak. Use pipe cleaner type brushes, and clean all passageways in the components. Use a ring expander and remove the rings from the pistons. Clean the piston ring grooves with a special tool or a piece of broken ring. Scrape the carbon off of the top of the piston. You should never use a wire brush on the pistons. After preparing all of the piston assemblies in this manner, wash and degrease them again.

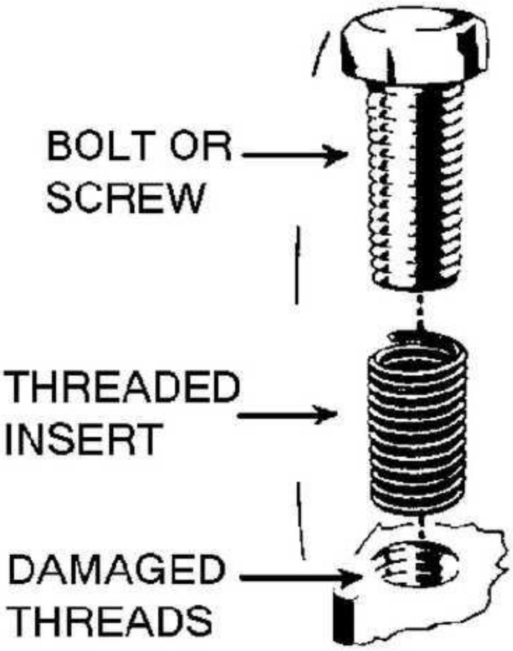
Clean the piston ring grooves using a ring groove cleaner tool, or...

... use a piece of an old ring to clean the grooves. Be careful, the ring can be quite sharp

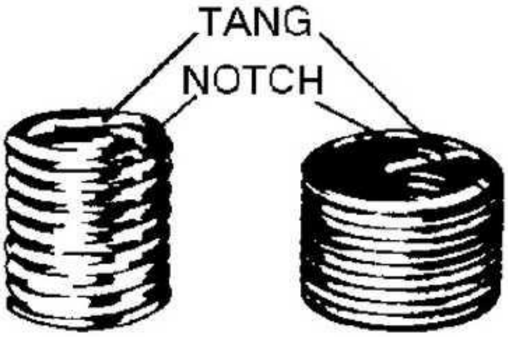
Use extreme care when cleaning around the cylinder head valve seats. A mistake or slip may cost you a new seat.

When cleaning the cylinder head, remove carbon from the combustion chamber with the valves installed. This will avoid damaging the valve seats.

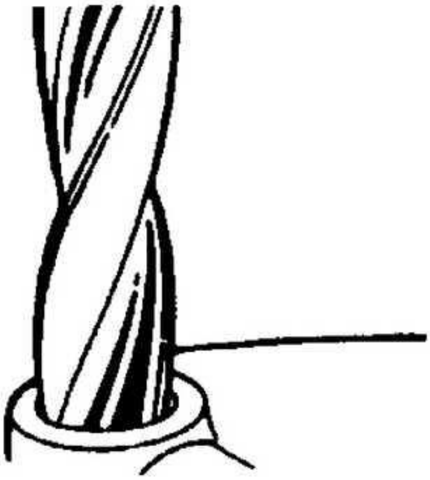
REPAIRING DAMAGED THREADS



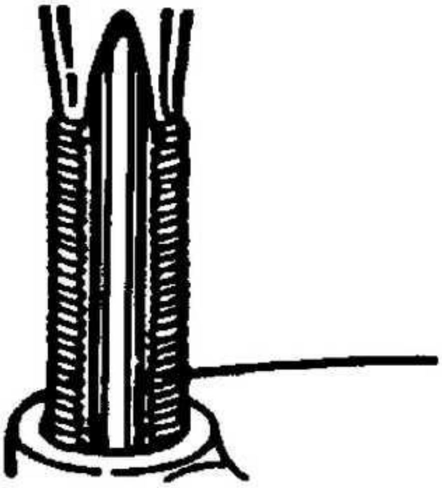
Damaged bolt hole threads can be replaced with thread repair inserts



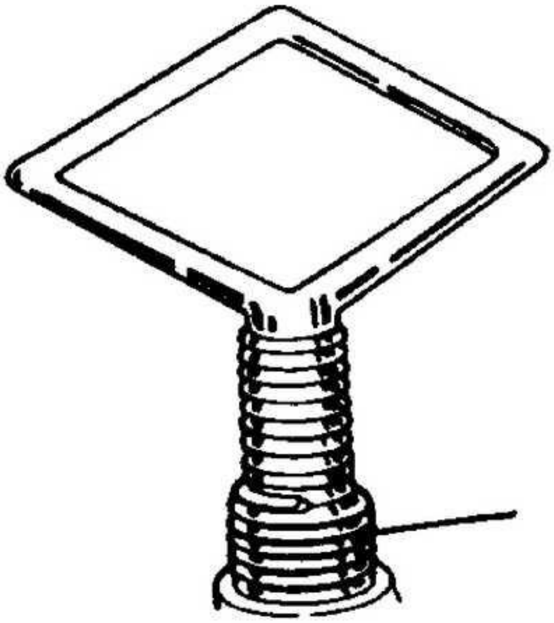
Standard thread repair insert (left), and spark plug thread insert



Drill out the damaged threads with the specified size bit. Be sure to drill completely through the hole or to the bottom of a blind hole



Using the kit, tap the hole in order to receive the thread insert. Keep the tap well oiled and back it out frequently to avoid clogging the threads



Screw the insert onto the installer tool until the tang engages the slot. Thread the insert into the hole until it is 1/4-1/2 turn below the top surface, then remove the tool and break off the tang using a punch

Several methods of repairing damaged threads are available. Heli-Coil® (shown here), Keenserts® and Microdot® are among the most widely used. All involve basically the same principle-drilling out stripped threads, tapping the hole and installing a pre-wound insert-making welding, plugging and oversize fasteners unnecessary.

Two types of thread repair inserts are usually supplied: a standard type for most inch coarse, inch fine, metric course and metric fine thread sizes and a spark lug type to fit most spark plug port sizes. Consult the individual tool manufacturer's catalog to determine exact applications. Typical thread repair kits will contain a selection of pre-wound threaded inserts, a tap (corresponding to the outside diameter threads of the insert) and an installation tool. Spark plug inserts usually differ because they require a tap equipped with pilot threads and a combined reamer/tap section. Most manufacturers also supply blister-packed thread repair inserts separately in addition to a master kit containing a variety of taps and inserts plus installation tools.

Before attempting to repair a threaded hole, remove any snapped, broken or damaged bolts or studs. Penetrating oil can be used to free frozen threads. The offending item can usually be removed with locking pliers or using a screw/stud extractor. After the hole is clear, the thread can be repaired, as shown in the series of accompanying illustrations and in the kit manufacturer's instructions.

Engine Preparation

To properly rebuild an engine, you must first remove it from the vehicle, then disassemble and diagnose it. Ideally, you should place your engine on an engine stand. This affords you the best access to the engine components. Follow the manufacturer's directions for using the stand with your particular engine. Remove the flywheel or flexplate before installing the engine to the stand.

Now that you have the engine on a stand, and assuming that you have drained the oil and coolant from the engine, it's time to strip it of all but the necessary components. Before you start disassembling the engine, you may want to take a moment to draw some pictures, or fabricate some labels or containers to mark the locations of various components and the bolts and/or studs which fasten them. Modern-day engines use a lot of little brackets and clips which hold wiring harnesses and such, and these holders are often mounted on studs and/or bolts that can be easily mixed up. The manufacturer spent a lot of time and money designing your vehicle, and they wouldn't have wasted any of it by haphazardly placing unnecessary brackets, clips or fasteners on the vehicle. If it's present when you disassemble it, put it back when you assemble, or you will regret not remembering that little bracket which holds a wire harness out of the path of a rotating part.

You should begin by unbolting any accessories still attached to the engine, such as the water pump, power steering pump, alternator, etc. Then, unfasten any manifolds (intake or exhaust) which were not removed during the engine removal procedure. Finally, remove any covers remaining on the engine such as the rocker arm, front or timing cover and oil pan. Some front covers may require the vibration damper and/or crank pulley to be removed beforehand. The idea is to reduce the engine to the bare necessities (cylinder head(s), valve train, engine block, crankshaft, pistons and connecting rods), plus any other 'in block' components such as oil pumps, balance shafts and auxiliary shafts.

Finally, remove the cylinder head(s) from the engine block and carefully place on a bench. Disassembly instructions for each component follow later in this section.

Cylinder Head

There are two basic types of cylinder heads used on today's automobiles: the Overhead Valve (OHV) and the Overhead

Camshaft (OHC). The latter can also be broken down into two subgroups: the Single Overhead Camshaft (SOHC) and the Dual Overhead Camshaft (DOHC). Generally, if there is only a single camshaft on a head, it is just referred to as an OHC head. Also, an engine with an OHV cylinder head is also known as a pushrod engine.

Most cylinder heads these days are made of an aluminum alloy due to its light weight, durability and heat transfer qualities. However, cast iron was the material of choice in the past, and is still used on many vehicles today. Whether made from aluminum or iron, all cylinder heads have valves and seats. Some use two valves per cylinder, while the more hi-tech engines will utilize a multi-valve configuration using 3, 4 and even 5 valves per cylinder. When the valve contacts the seat, it does so on precision machined surfaces, which seals the combustion chamber. All cylinder heads have a valve guide for each valve. The guide centers the valve to the seat and allows it to move up and down within it. The clearance between the valve and guide can be critical. Too much clearance and the engine may consume oil, lose vacuum and/or damage the seat. Too little, and the valve can stick in the guide causing the engine to run poorly if at all, and possibly causing severe damage. The last component all cylinder heads have are valve springs. The spring holds the valve against its seat. It also returns the valve to this position when the valve has been opened by the valve train or camshaft. The spring is fastened to the valve by a retainer and valve locks (sometimes called keepers). Aluminum heads will also have a valve spring shim to keep the spring from wearing away the aluminum.

An ideal method of rebuilding the cylinder head would involve replacing all of the valves, guides, seats, springs, etc. with new ones. However, depending on how the engine was maintained, often this is not necessary. A major cause of valve, guide and seat wear is an improperly tuned engine. An engine that is running too rich, will often wash the lubricating oil out of the guide with gasoline, causing it to wear rapidly. Conversely, an engine which is running too lean will place higher combustion temperatures on the valves and seats allowing them to wear or even burn. Springs fall victim to the driving habits of the individual. A driver who often runs the engine rpm to the redline will wear out or break the springs faster then one that stays well below it. Unfortunately, mileage takes it toll on all of the parts. Generally, the valves, guides, springs and seats in a cylinder head can be machined and re-used, saving you money. However, if a valve is burnt, it may be wise to replace all of the valves, since they were all operating in the same environment. The same goes for any other component on the cylinder head. Think of it as an insurance policy against future problems related to that component.

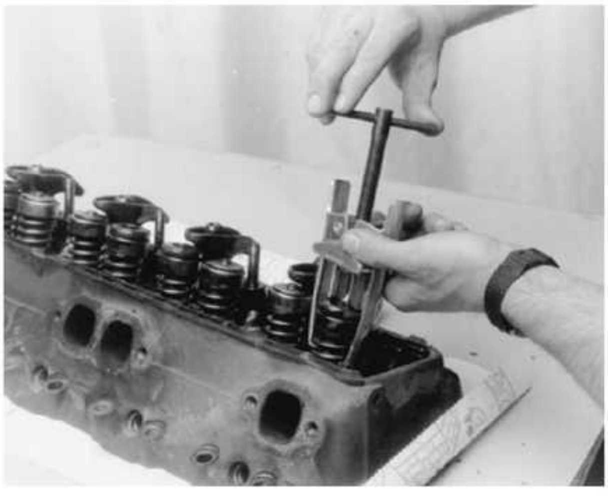
Unfortunately, the only way to find out which components need replacing is to disassemble and carefully check each piece. After the cylinder head(s) are disassembled, thoroughly clean all of the components.

DISASSEMBLY

OHV Heads

Before disassembling the cylinder head, you may want to fabricate some containers to hold the various parts, as some of them can be quite small (such as keepers) and easily lost. Also keeping yourself and the components organized will aid in assembly and reduce confusion. Where possible, try to maintain a components original location; this is especially important if there is not going to be any machine work performed on the components.

1. If you haven't already removed the rocker arms and/or shafts, do so now.
2. Position the head so that the springs are easily accessed.

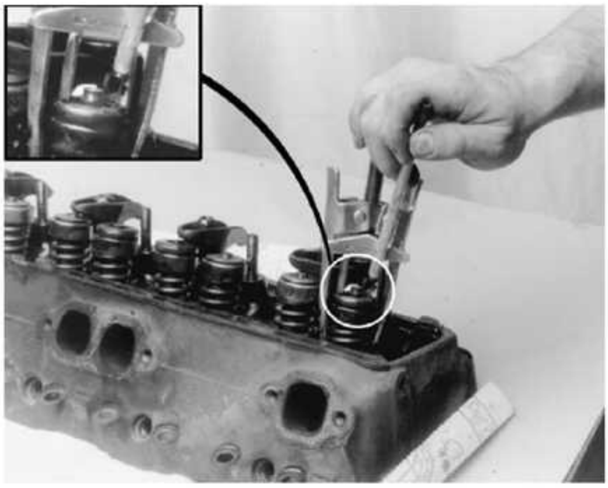


When removing an OHV valve spring, use a compressor tool to relieve the tension from the retainer

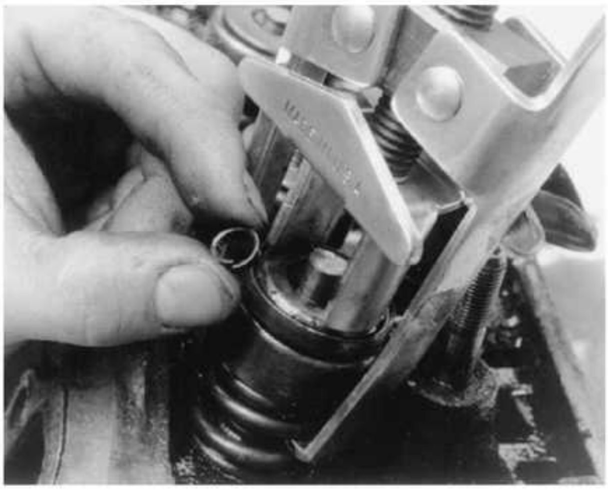
3. Use a valve spring compressor tool, and relieve spring tension from the retainer.

Due to engine varnish, the retainer may stick to the valve locks. a gentle tap with a hammer may help to break it loose.

CHILTON



A small magnet will help in removal of the valve locks



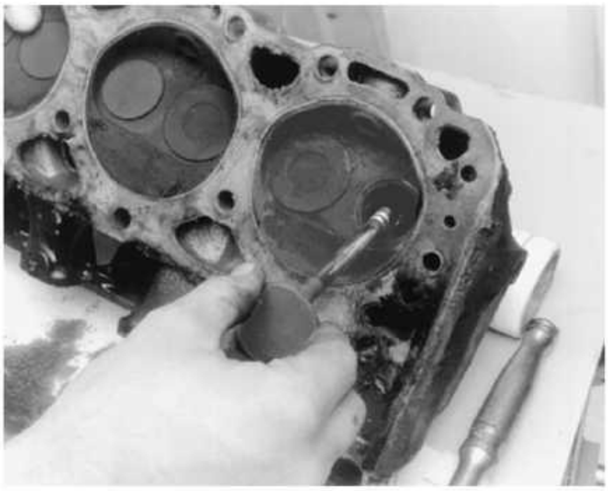
Be careful not to lose the small valve locks (keepers)

4. Remove the valve locks from the valve tip and/or retainer. A small magnet may help in removing the locks.
5. Lift the valve spring, tool and all, off of the valve stem.

Remove the valve seal from the valve stem-O-ring type seal shown

Removing an umbrella/positive type seal

6. If equipped, remove the valve seal. If the seal is difficult to remove with the valve in place, try removing the valve first, then the seal. Follow the steps below for valve removal.



Invert the cylinder head and withdraw the valve from the valve guide bore

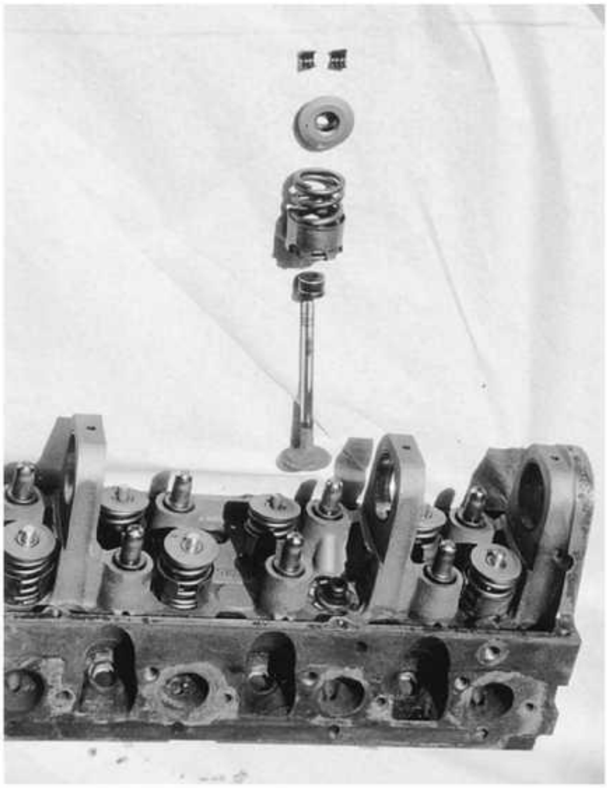
7. Position the head to allow access for withdrawing the valve.

Cylinder heads that have seen a lot of miles and/or abuse may have mushroomed the valve lock grove and/or tip, causing difficulty in removal of the valve. If this has happened, use a metal file to carefully remove the high spots around the lock grooves and/or tip. Only file it enough to allow removal.

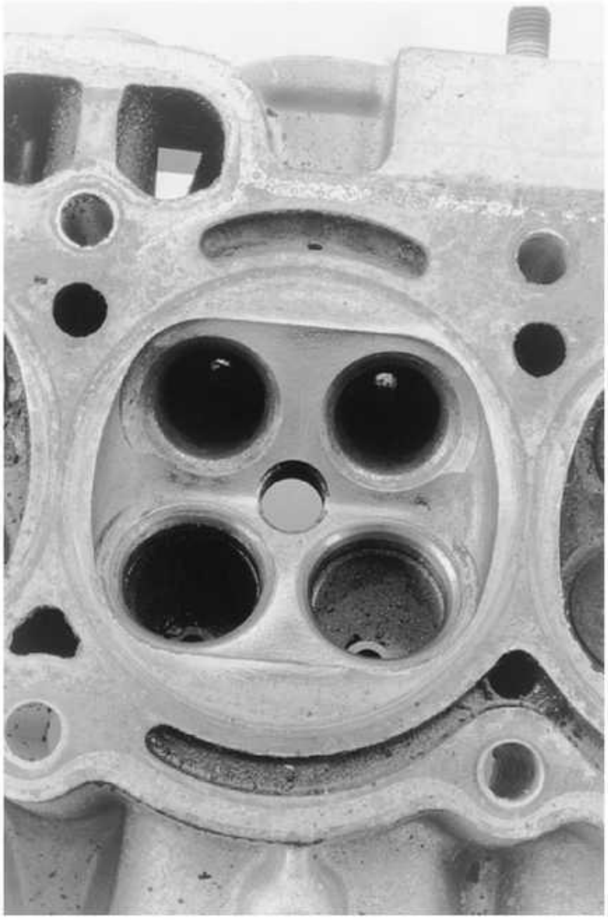
8. Remove the valve from the cylinder head.
9. If equipped, remove the valve spring shim. A small magnetic tool or screwdriver will aid in removal.
10. Repeat Steps 3 though 9 until all of the valves have been removed.

OHC Heads

Whether it is a single or dual overhead camshaft cylinder head, the disassembly procedure is relatively unchanged. One aspect to pay attention to is careful labeling of the parts on the dual camshaft cylinder head. There will be an intake camshaft and followers as well as an exhaust camshaft and followers and they must be labeled as such. In some cases, the components are identical and could easily be installed incorrectly. DO NOT MIX THEM UP! Determining which is which is very simple; the intake camshaft and components are on the same side of the head as was the intake manifold. Conversely, the exhaust camshaft and components are on the same side of the head as was the exhaust manifold.



Exploded view of a valve, seal, spring, retainer and locks from an OHC cylinder head



Example of a multi-valve cylinder head. Note how it has 2 intake and 2 exhaust valve ports

CUP TYPE CAMSHAFT FOLLOWERS

Most cylinder heads with cup type camshaft followers will have the valve spring, retainer and locks recessed within the follower's bore. You will need a C-clamp style valve spring compressor tool, an OHC spring removal tool (or equivalent) and a small magnet to disassemble the head.

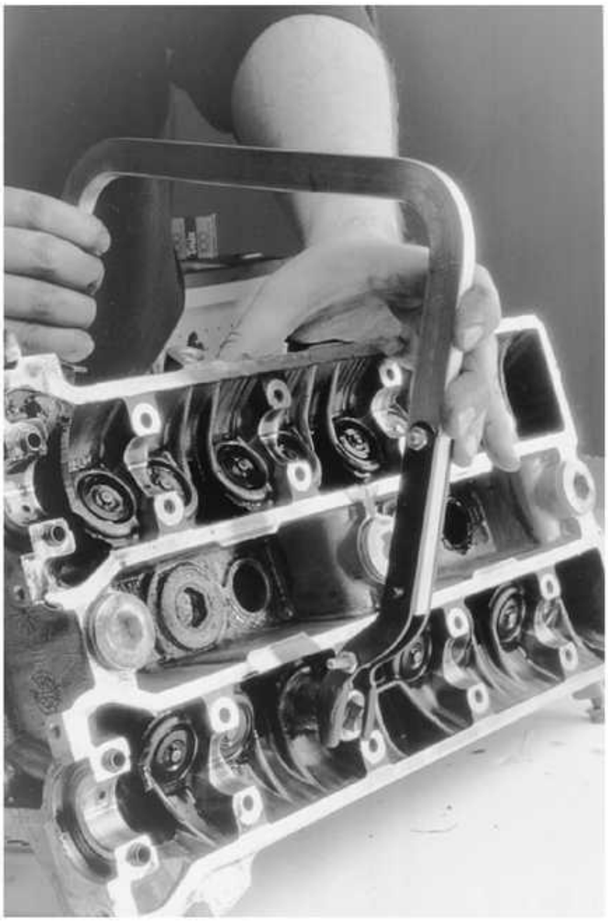
C-clamp type spring compressor and an OHC spring removal tool (center) for cup type followers

1. If not already removed, remove the camshaft(s) and/or followers. Mark their positions for assembly.

Most cup type follower cylinder heads retain the camshaft using bolt-on bearing caps

2. Position the cylinder head to allow use of a C-clamp style valve spring compressor tool.

It is preferred to position the cylinder head gasket surface facing you with the valve springs facing the opposite direction and the head laying horizontal.



Position the OHC spring tool in the follower bore, then compress the spring with a C-clamp type tool

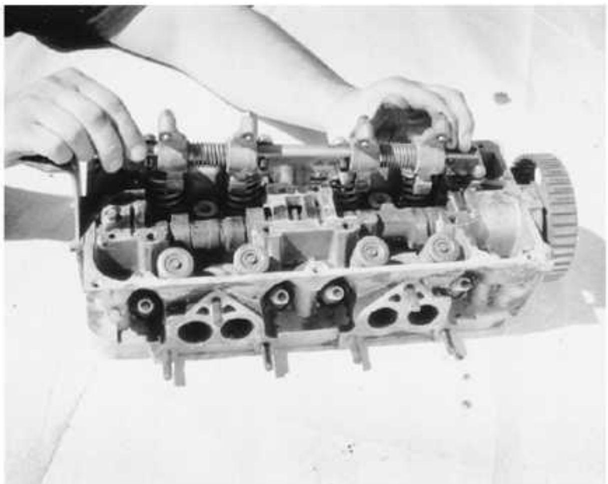
3. With the OHC spring removal adapter tool positioned inside of the follower bore, compress the valve spring using the C-clamp style valve spring compressor.
4. Remove the valve locks. A small magnetic tool or screwdriver will aid in removal.
5. Release the compressor tool and remove the spring assembly.
6. Withdraw the valve from the cylinder head.
7. If equipped, remove the valve seal.

Special valve seal removal tools are available. Regular or needlenose-type pliers, if used with care, will work just as well. If using ordinary pliers, be sure not to damage the follower bore. The follower and its bore are machined to close tolerances and any damage to the bore will effect this relationship.

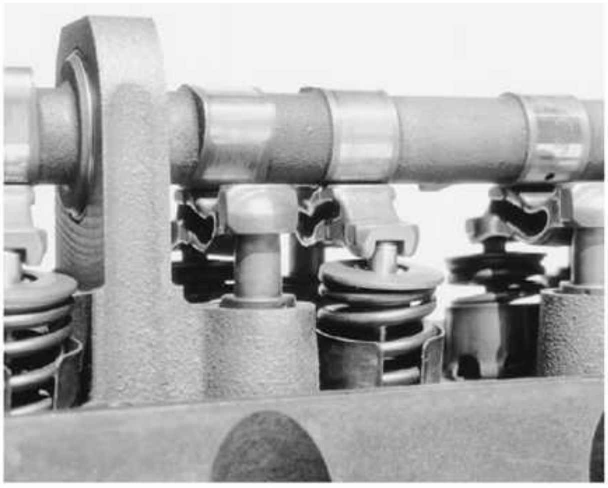
8. If equipped, remove the valve spring shim. A small magnetic tool or screwdriver will aid in removal.
9. Repeat Steps 3 through 8 until all of the valves have been removed.

ROCKER ARM TYPE CAMSHAFT FOLLOWERS

Most cylinder heads with rocker arm-type camshaft followers are easily disassembled using a standard valve spring compressor. However, certain models may not have enough open space around the spring for the standard tool and may require you to use a C-clamp style compressor tool instead.

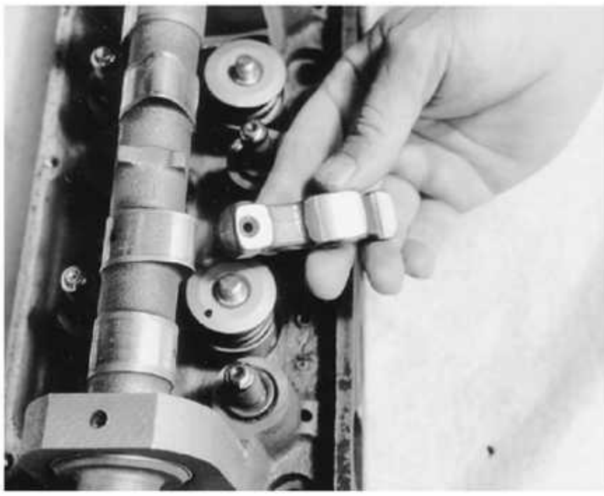


Example of the shaft mounted rocker arms on some OHC heads

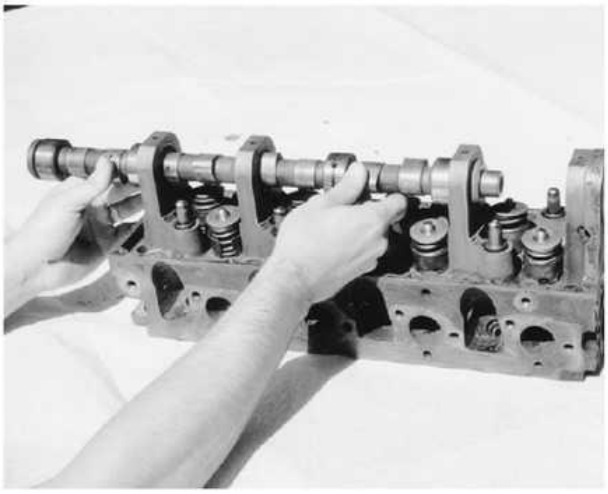


Another example of the rocker arm type OHC head. This model uses a follower under the camshaft

1. If not already removed, remove the rocker arms and/or shafts and the camshaft. If applicable, also remove the hydraulic lash adjusters. Mark their positions for assembly.

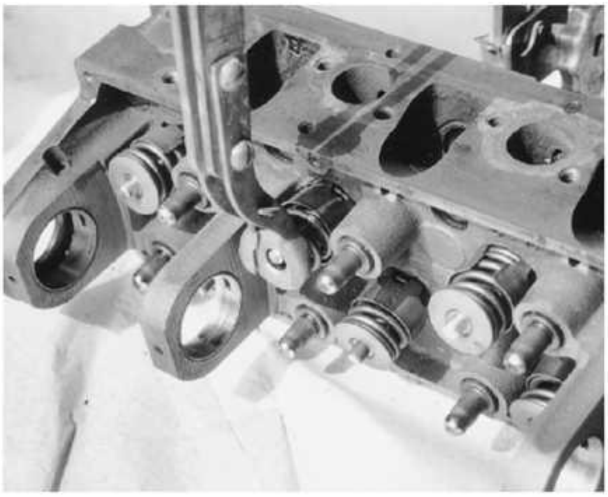


Before the camshaft can be removed, all of the followers must first be removed...



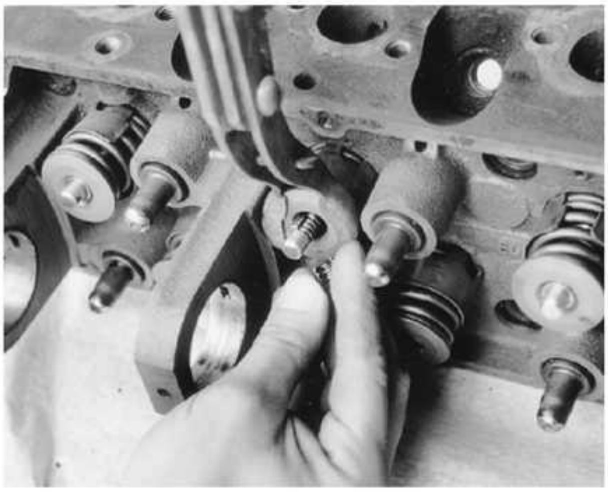
... then the camshaft can be removed by sliding it out (shown), or unbolting a bearing cap (not shown)

2. Position the cylinder head to allow access to the valve spring.
3. Use a valve spring compressor tool to relieve the spring tension from the retainer.



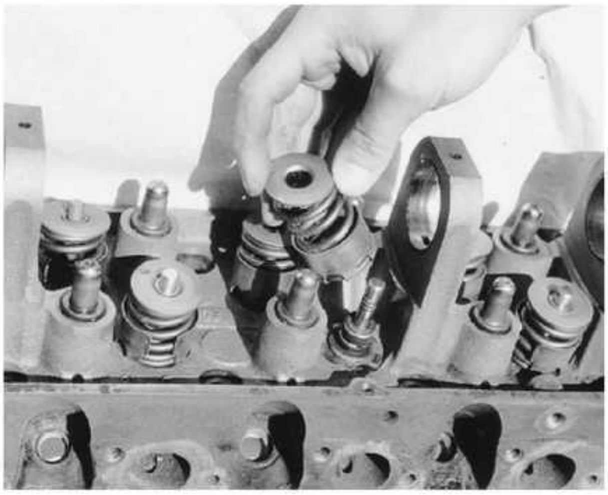
Compress the valve spring...

Due to engine varnish, the retainer may stick to the valve locks. a gentle tap with a hammer may help to break it loose.



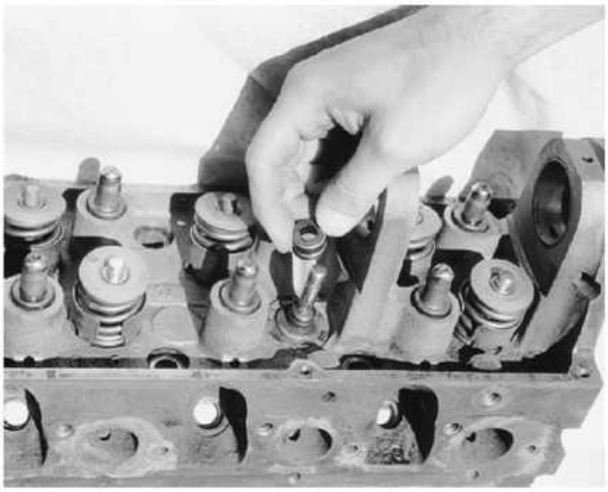
... then remove the valve locks from the valve stem and spring retainer

4. Remove the valve locks from the valve tip and/or retainer. A small magnet may help in removing the small locks.
5. Lift the valve spring, tool and all, off of the valve stem.



Remove the valve spring and retainer from the cylinder head

6. If equipped, remove the valve seal. If the seal is difficult to remove with the valve in place, try removing the valve first, then the seal. Follow the steps below for valve removal.

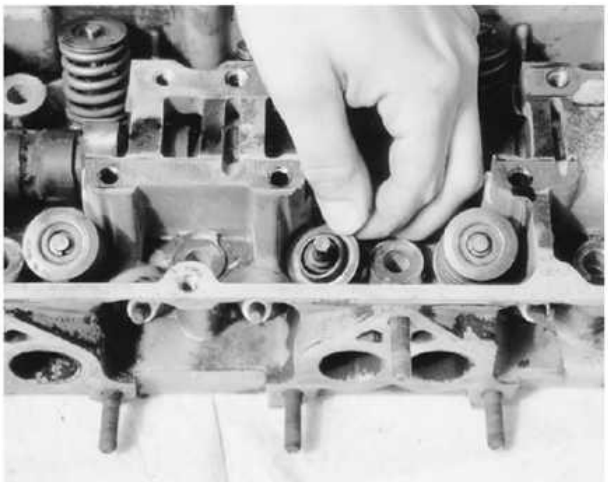


Remove the valve seal from the guide. Some gentle prying or pliers may help to remove stubborn ones

7. Position the head to allow access for withdrawing the valve.

Cylinder heads that have seen a lot of miles and/or abuse may have mushroomed the valve lock grove and/or tip, causing difficulty in removal of the valve. If this has happened, use a metal file to carefully remove the high spots around the lock grooves and/or tip. Only file it enough to allow removal.

8. Remove the valve from the cylinder head.



All aluminum and some cast iron heads will have these valve spring shims. Remove all of them as well

9. If equipped, remove the valve spring shim. A small magnetic tool or screwdriver will aid in removal.
10. Repeat Steps 3 though 9 until all of the valves have been removed.

INSPECTION

Now that all of the cylinder head components are clean, it's time to inspect them for wear and/or damage. To accurately inspect them, you will need some specialized tools:

- A 0-1 in. micrometer for the valves
- A dial indicator or inside diameter gauge for the valve guides
- A spring pressure test gauge

If you do not have access to the proper tools, you may want to bring the components to a shop that does.

Valves

The first thing to inspect are the valve heads. Look closely at the head, margin and face for any cracks, excessive wear or burning. The margin is the best place to look for burning. It should have a squared edge with an even width all around the diameter. When a valve burns, the margin will look melted and the edges rounded. Also inspect the valve head for any signs of tulipping. This will show as a lifting of the edges or dishing in the center of the head and will usually not occur to all of the valves. All of the heads should look the same, any that seem dished more than others are probably bad. Next, inspect the valve lock grooves and valve tips. Check for any burrs around the lock grooves, especially if you had to file them to remove the valve. Valve tips should appear flat, although slight rounding with high mileage engines is normal. Slightly worn valve tips will need to be machined flat. Last, measure the valve stem diameter with the micrometer. Measure the area that rides within the guide, especially towards the tip where most of the wear occurs. Take several measurements along its length and compare them to each other. Wear should be even along the length with little to no taper. If no minimum diameter is given in the specifications, then the stem should not read more than 0.001 in. (0.025mm) below the unworn area of the valve stem. Any valves that fail these inspections should be replaced.

Valve stems may be rolled on a flat surface to check for bends

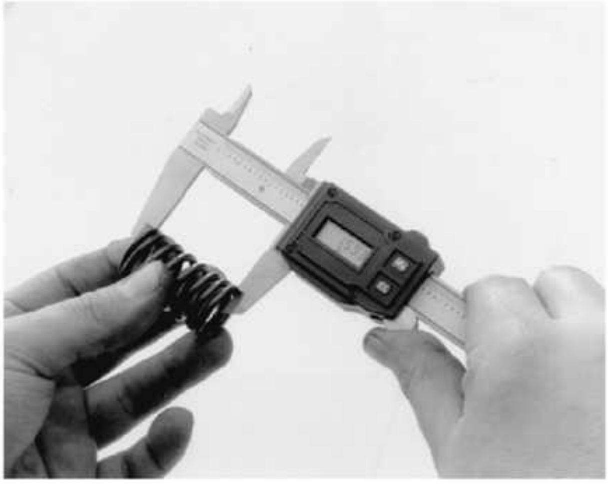
Use a micrometer to check the valve stem diameter

Springs, Retainers and Valve Locks

The first thing to check is the most obvious, broken springs. Next check the free length and squareness of each spring. If applicable, insure to distinguish between intake and exhaust springs. Use a ruler and/or carpenter's square to measure the length. A carpenter's square should be used to check the springs for squareness. If a spring pressure test gauge is available, check each springs rating and compare to the specifications chart. Check the readings against the specifications given. Any springs that fail these inspections should be replaced.

The spring retainers rarely need replacing, however they should still be checked as a precaution. Inspect the spring mating surface and the valve lock retention area for any signs of excessive wear. Also check for any signs of cracking. Replace any retainers that are questionable.

Valve locks should be inspected for excessive wear on the outside contact area as well as on the inner notched surface. Any locks which appear worn or broken and its respective valve should be replaced.



Use a caliper to check the valve spring free-length

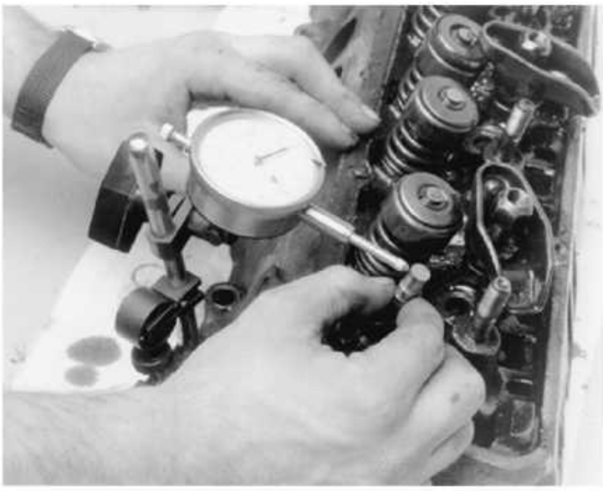
Check the valve spring for squareness on a flat surface; a carpenter's square can be used

Cylinder Head

There are several things to check on the cylinder head: valve guides, seats, cylinder head surface flatness, cracks and physical damage.

VALVE GUIDES

Now that you know the valves are good, you can use them to check the guides, although a new valve, if available, is preferred. Before you measure anything, look at the guides carefully and inspect them for any cracks, chips or breakage. Also if the guide is a removable style (as in most aluminum heads), check them for any looseness or evidence of movement. All of the guides should appear to be at the same height from the spring seat. If any seem lower (or higher) from another, the guide has moved. Mount a dial indicator onto the spring side of the cylinder head. Lightly oil the valve stem and insert it into the cylinder head. Position the dial indicator against the valve stem near the tip and zero the gauge. Grasp the valve stem and wiggle towards and away from the dial indicator and observe the readings. Mount the dial indicator 90 degrees from the initial point and zero the gauge and again take a reading. Compare the two readings for a out of round condition. Check the readings against the specifications given. An Inside Diameter (I.D.) gauge designed for valve guides will give you an accurate valve guide bore measurement. If the I.D. gauge is used, compare the readings with the specifications given. Any guides that fail these inspections should be replaced or machined.



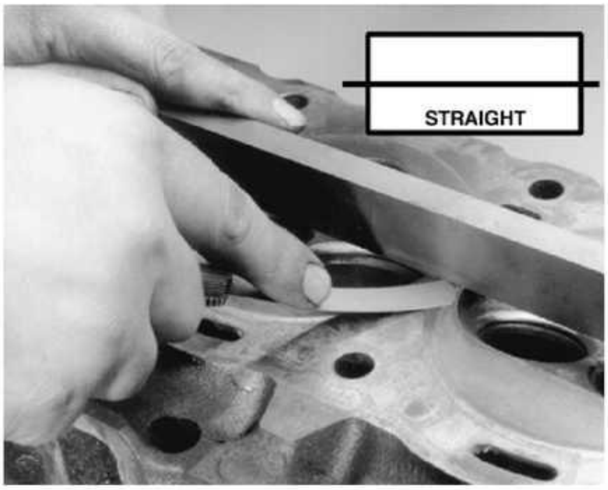
A dial gauge may be used to check valve stem-to-guide clearance; read the gauge while moving the valve stem

VALVE SEATS

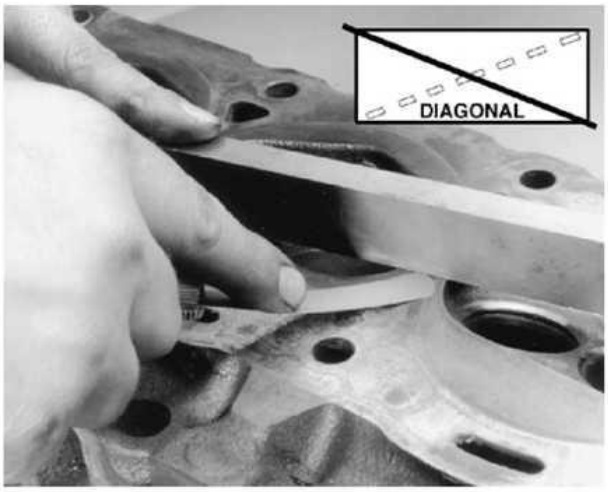
A visual inspection of the valve seats should show a slightly worn and pitted surface where the valve face contacts the seat. Inspect the seat carefully for severe pitting or cracks. Also, a seat that is badly worn will be recessed into the cylinder head. A severely worn or recessed seat may need to be replaced. All cracked seats must be replaced. A seat concentricity gauge, if available, should be used to check the seat run-out. If run-out exceeds specifications the seat must be machined (if no specification is given use 0.002 in. or 0.051mm).

CYLINDER HEAD SURFACE FLATNESS

After you have cleaned the gasket surface of the cylinder head of any old gasket material, check the head for flatness.



Check the head for flatness across the center of the head surface using a straightedge and feeler gauge



Checks should also be made along both diagonals of the head surface

Place a straightedge across the gasket surface. Using feeler gauges, determine the clearance at the center of the straightedge and across the cylinder head at several points. Check along the centerline and diagonally on the head surface. If the warpage exceeds 0.003 in. (0.076mm) within a 6.0 in. (15.2cm) span, or 0.006 in. (0.152mm) over the total length of the head, the cylinder head must be resurfaced. After resurfacing the heads of a V-type engine, the intake manifold flange surface should be checked, and if necessary, milled proportionally to allow for the change in its mounting position.

CRACKS AND PHYSICAL DAMAGE

Generally, cracks are limited to the combustion chamber, however, it is not uncommon for the head to crack in a spark plug hole, port, outside of the head or in the valve spring/rocker arm area. The first area to inspect is always the hottest: the exhaust seat/port area.

A visual inspection should be performed, but just because you don't see a crack does not mean it is not there. Some more reliable methods for inspecting for cracks include Magnaflux®, a magnetic process, or Zyglo®, a dye penetrant. Magnaflux® is used only on ferrous metal (cast iron) heads. Zyglo® uses a spray on fluorescent mixture along with a black light to reveal the cracks. It is strongly recommended to have your cylinder head checked professionally for cracks, especially if the engine was known to have overheated and/or leaked or consumed coolant. Contact a local shop for availability and pricing of these services.

Physical damage is usually very evident. For example, a broken mounting ear from dropping the head or a bent or broken stud and/or bolt. All of these defects should be fixed or, if unrepairable, the head should be replaced.

Camshaft and Followers

Inspect the camshaft(s) and followers as described earlier in this section.

REFINISHING & REPAIRING

Many of the procedures given for refinishing and repairing the cylinder head components must be performed by a machine shop. Certain steps, if the inspected part is not worn, can be performed yourself inexpensively. However, you spent a lot of time and effort so far, why risk trying to save a couple bucks if you might have to do it all over again?

Valves

Any valves that were not replaced should be refaced and the tips ground flat. Unless you have access to a valve grinding machine, this should be done by a machine shop. If the valves are in extremely good condition, as well as the valve seats and guides, they may be lapped in without performing machine work.

It is a recommended practice to lap the valves even after machine work has been performed and/or new valves have been purchased. This insures a positive seal between the valve and seat.

LAPPING THE VALVES

Before lapping the valves to the seats, read the rest of the cylinder head section to insure that any related parts are in acceptable enough condition to continue.

Before any valve seat machining and/or lapping can be performed, the guides must be within factory recommended specifications.

1. Invert the cylinder head.
2. Lightly lubricate the valve stems and insert them into the cylinder head in their numbered order.
3. Raise the valve from the seat and apply a small amount of fine lapping compound to the seat.
4. Moisten the suction head of a hand-lapping tool and attach it to the head of the valve.
5. Rotate the tool between the palms of both hands, changing the position of the valve on the valve seat and lifting the tool often to prevent grooving.
6. Lap the valve until a smooth, polished circle is evident on the valve and seat.
7. Remove the tool and the valve. Wipe away all traces of the grinding compound and store the valve to maintain its

lapped location.

Do not get the valves out of order after they have been lapped. They must be put back with the same valve seat with which they were lapped.

Springs, Retainers and Valve Locks

There is no repair or refinishing possible with the springs, retainers and valve locks. If they are found to be worn or defective, they must be replaced with new (or known good) parts.

Cylinder Head

Most refinishing procedures dealing with the cylinder head must be performed by a machine shop. Read the sections below and review your inspection data to determine whether or not machining is necessary.

VALVE GUIDE

If any machining or replacements are made to the valve guides, the seats must be machined.

Unless the valve guides need machining or replacing, the only service to perform is to thoroughly clean them of any dirt or oil residue.

There are only two types of valve guides used on automobile engines: the replaceable-type (all aluminum heads) and the cast-in integral-type (most cast iron heads). There are four recommended methods for repairing worn guides.

- Knurling
- Inserts
- Reaming oversize
- Replacing

Knurling is a process in which metal is displaced and raised, thereby reducing clearance, giving a true center, and providing oil control. It is the least expensive way of repairing the valve guides. However, it is not necessarily the best, and in some cases, a knurled valve guide will not stand up for more than a short time. It requires a special knurling tool and precision reaming tools to obtain proper clearances. It would not be cost effective to purchase these tools, unless you plan on rebuilding several of the same cylinder head.

Installing a guide insert involves machining the guide to accept a bronze insert. One style is the coil-type which is installed into a threaded guide. Another is the thin-walled insert where the guide is reamed oversize to accept a split-sleeve insert. After the insert is installed, a special tool is then run through the guide to expand the insert, locking it to the guide. The insert is then reamed to the standard size for proper valve clearance.

Reaming for oversize valves restores normal clearances and provides a true valve seat. Most cast-in type guides can be reamed to accept an oversize valve with an oversize stem. The cost factor for this can become quite high as you will need to purchase the reamer and new, oversize stem valves for all guides which were reamed. Oversizes are generally 0.003 to 0.030 in. (0.076 to 0.762mm), with 0.015 in. (0.381mm) being the most common.

To replace cast-in type valve guides, they must be drilled out, then reamed to accept replacement guides. This must be done on a fixture which will allow centering and leveling off of the original valve seat or guide, otherwise a serious guide-to-seat misalignment may occur making it impossible to properly machine the seat.

Replaceable-type guides are pressed into the cylinder head. A hammer and a stepped drift or punch may be used to install and remove the guides. Before removing the guides, measure the protrusion on the spring side of the head and record it for installation. Use the stepped drift to hammer out the old guide from the combustion chamber side of the head. When installing, determine whether or not the guide also seals a water jacket in the head, and if it does, use the recommended sealing agent. If there is no water jacket, grease the valve guide and its bore. Use the stepped drift, and hammer the new guide into the cylinder head from the spring side of the cylinder head. A stack of washers the same thickness as the measured protrusion may help the installation process.

VALVE SEATS

Before any valve seat machining can be performed, the guides must be within factory recommended specifications.

If any machining or replacements were made to the valve guides, the seats must be machined.

If the seats are in good condition, the valves can be lapped to the seats, and the cylinder head assembled. See the ***Valves*** section for instructions on lapping.

If the valve seats are worn, cracked or damaged, they must be serviced by a machine shop. The valve seat must be perfectly centered to the valve guide, which requires very accurate machining.

CYLINDER HEAD SURFACE

If the cylinder head is warped, it must be machined flat. If the warpage is extremely severe, the head may need to be replaced. In some instances, it may be possible to straighten a warped head enough to allow machining. In either case, contact a professional machine shop for service.

Any OHC cylinder head that shows excessive warpage should have the camshaft bearing journals align bored after the cylinder head has been resurfaced.

Failure to align bore the camshaft bearing journals could result in severe engine damage including but not limited to: valve and piston damage, connecting rod damage, camshaft and/or crankshaft breakage.

CRACKS AND PHYSICAL DAMAGE

Certain cracks can be repaired in both cast iron and aluminum heads. For cast iron, a tapered threaded insert is installed along the length of the crack. Aluminum can also use the tapered inserts, however welding is the preferred method. Some physical damage can be repaired through brazing or welding. Contact a machine shop to get expert advice for your particular dilemma.

ASSEMBLY

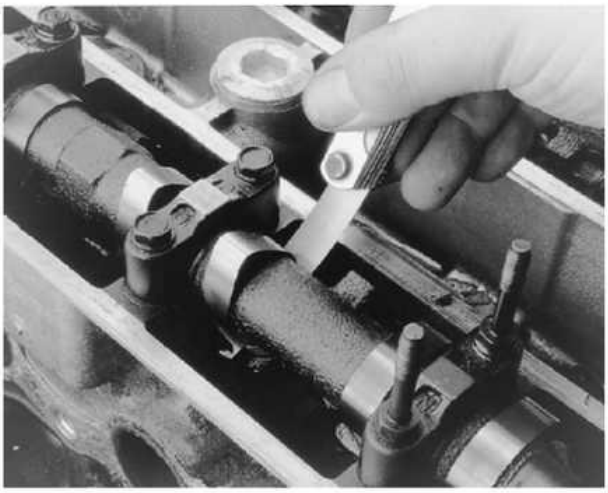
The first step for any assembly job is to have a clean area in which to work. Next, thoroughly clean all of the parts and components that are to be assembled. Finally, place all of the components onto a suitable work space and, if necessary, arrange the parts to their respective positions.

OHV Engines

OHC Engines

CUP TYPE CAMSHAFT FOLLOWERS

To install the springs, retainers and valve locks on heads which have these components recessed into the camshaft follower's bore, you will need a small screwdriver-type tool, some clean white grease and a lot of patience. You will also need the C-clamp style spring compressor and the OHC tool used to disassemble the head.



Once assembled, check the valve clearance and correct as needed

ROCKER ARM TYPE CAMSHAFT FOLLOWERS

Engine Block

GENERAL INFORMATION

A thorough overhaul or rebuild of an engine block would include replacing the pistons, rings, bearings, timing belt/chain assembly and oil pump. For OHV engines also include a new camshaft and lifters. The block would then have the cylinders bored and honed oversize (or if using removable cylinder sleeves, new sleeves installed) and the crankshaft would be cut undersize to provide new wearing surfaces and perfect clearances. However, your particular engine may not have everything worn out. What if only the piston rings have worn out and the clearances on everything else are still within factory specifications? Well, you could just replace the rings and put it back together, but this would be a very rare example. Chances are, if one component in your engine is worn, other components are sure to follow, and soon. At the very least, you should always replace the rings, bearings and oil pump. This is what is commonly called a "freshen up".

Cylinder Ridge Removal

Because the top piston ring does not travel to the very top of the cylinder, a ridge is built up between the end of the travel and the top of the cylinder bore.

Pushing the piston and connecting rod assembly past the ridge can be difficult, and damage to the piston ring lands could occur. If the ridge is not removed before installing a new piston or not removed at all, piston ring breakage and piston damage may occur.

It is always recommended that you remove any cylinder ridges before removing the piston and connecting rod assemblies. If you know that new pistons are going to be installed and the engine block will be bored oversize, you maybe able to forego this step. However, some ridges may actually prevent the assemblies from being removed, necessitating its removal.

There are several different types of ridge reamers on the market, none of which are inexpensive. Unless a great deal of engine rebuilding is anticipated, borrow or rent a reamer.

1. Turn the crankshaft until the piston is at the bottom of its travel.
2. Cover the head of the piston with a rag.
3. Follow the tool manufacturers instructions and cut away the ridge, exercising extreme care to avoid cutting too deeply.
4. Remove the ridge reamer, the rag and as many of the cuttings as possible. Continue until all of the cylinder ridges have been removed.

DISASSEMBLY

The engine disassembly instructions following assume that you have the engine mounted on an engine stand. If not, it is easiest to disassemble the engine on a bench or the floor with it resting on the bell housing or transmission mounting surface. You must be able to access the connecting rod fasteners and turn the crankshaft during disassembly. Also, all engine covers (timing, front, side, oil pan, whatever) should have already been removed. Engines which are seized or locked up may not be able to be completely disassembled, and a core (salvage yard) engine should be purchased.

Pushrod Engines

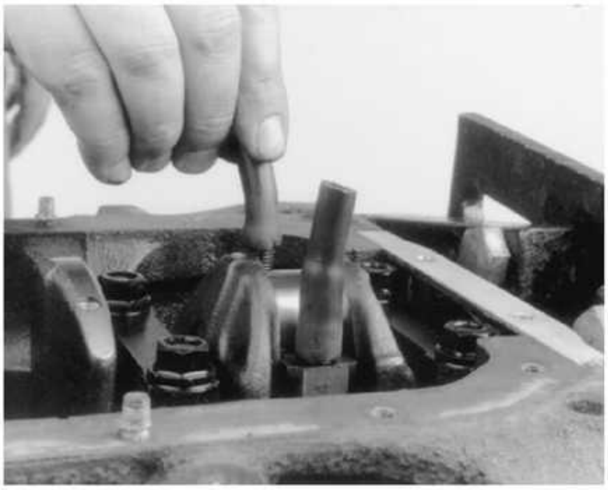
If not done during the cylinder head removal, remove the pushrods and lifters, keeping them in order for assembly. Remove the timing gears and/or timing chain assembly, then remove the oil pump drive assembly and withdraw the camshaft from the engine block. Remove the oil pick-up and pump assembly. If equipped, remove any balance or auxiliary shafts. If necessary, remove the cylinder ridge from the top of the bore. See the cylinder ridge removal procedure earlier in this section.

OHC Engines

If not done during the cylinder head removal, remove the timing chain/belt and/or gear/sprocket assembly. Remove the oil pick-up and pump assembly and, if necessary, the pump drive. If equipped, remove any balance or auxiliary shafts. If necessary, remove the cylinder ridge from the top of the bore. See the cylinder ridge removal procedure earlier in this section.

All Engines

Rotate the engine over so that the crankshaft is exposed. Use a number punch or scribe and mark each connecting rod with its respective cylinder number. The cylinder closest to the front of the engine is always number 1. However, depending on the engine placement, the front of the engine could either be the flywheel or damper/pulley end. Generally the front of the engine faces the front of the vehicle. Use a number punch or scribe and also mark the main bearing caps from front to rear with the front most cap being number 1 (if there are five caps, mark them 1 through 5, front to rear).



Place rubber hose over the connecting rod studs to protect the crankshaft and cylinder bores from damage

Take special care when pushing the connecting rod up from the crankshaft because the sharp threads of the rod bolts/studs will score the crankshaft journal. Insure that special plastic caps are installed over them, or cut two pieces of rubber hose to do the same.

Carefully tap the piston out of the bore using a wooden dowel

Again, rotate the engine, this time to position the number one cylinder bore (head surface) up. Turn the crankshaft until the number one piston is at the bottom of its travel, this should allow the maximum access to its connecting rod. Remove the number one connecting rods fasteners and cap and place two lengths of rubber hose over the rod bolts/studs to protect the crankshaft from damage. Using a sturdy wooden dowel and a hammer, push the connecting rod up about 1 in. (25mm) from the crankshaft and remove the upper bearing insert. Continue pushing or tapping the connecting rod up until the piston rings are out of the cylinder bore. Remove the piston and rod by hand, put the upper half of the bearing insert back into the rod, install the cap with its bearing insert installed, and hand-tighten the cap fasteners. If the parts are kept in order in this manner, they will not get lost and you will be able to tell which bearings came form what cylinder if any problems are discovered and diagnosis is necessary. Remove all the other piston assemblies in the same manner. On V-style engines, remove all of the pistons from one bank, then reposition the engine with the other cylinder bank head surface up, and remove that banks piston assemblies.

The only remaining component in the engine block should now be the crankshaft. Loosen the main bearing caps evenly until the fasteners can be turned by hand, then remove them and the caps. Remove the crankshaft from the engine block. Thoroughly clean all of the components.

INSPECTION

Now that the engine block and all of its components are clean, it's time to inspect them for wear and/or damage. To accurately inspect them, you will need some specialized tools:

- Two or three separate micrometers to measure the pistons and crankshaft journals
- A dial indicator
- Telescoping gauges for the cylinder bores
- A rod alignment fixture to check for bent connecting rods

If you do not have access to the proper tools, you may want to bring the components to a shop that does.

Generally, you shouldn't expect cracks in the engine block or its components unless it was known to leak, consume or mix engine fluids, it was severely overheated, or there was evidence of bad bearings and/or crankshaft damage. A visual inspection should be performed on all of the components, but just because you don't see a crack does not mean it is not there. Some more reliable methods for inspecting for cracks include Magnaflux®, a magnetic process or Zyglo®, a dye penetrant. Magnaflux® is used only on ferrous metal (cast iron). Zyglo® uses a spray on fluorescent mixture along with a black light to reveal the cracks. It is strongly recommended to have your engine block checked professionally for cracks, especially if the engine was known to have overheated and/or leaked or consumed coolant. Contact a local shop for availability and pricing of these services.

Engine Block

ENGINE BLOCK BEARING ALIGNMENT

Remove the main bearing caps and, if still installed, the main bearing inserts. Inspect all of the main bearing saddles and caps for damage, burrs or high spots. If damage is found, and it is caused from a spun main bearing, the block will need to be align-bored or, if severe enough, replacement. Any burrs or high spots should be carefully removed with a metal file.

Place a straightedge on the bearing saddles, in the engine block, along the centerline of the crankshaft. If any clearance exists between the straightedge and the saddles, the block must be align-bored.

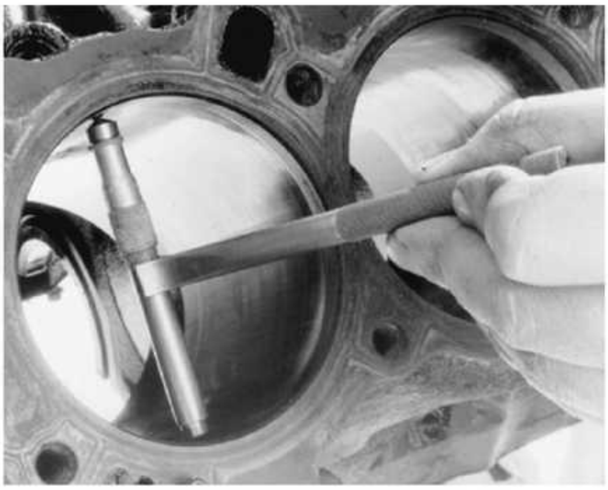
Align-boring consists of machining the main bearing saddles and caps by means of a flycutter that runs through the bearing saddles.

DECK FLATNESS

The top of the engine block where the cylinder head mounts is called the deck. Insure that the deck surface is clean of dirt, carbon deposits and old gasket material. Place a straightedge across the surface of the deck along its centerline and, using feeler gauges, check the clearance along several points. Repeat the checking procedure with the straightedge placed along both diagonals of the deck surface. If the reading exceeds 0.003 in. (0.076mm) within a 6.0 in. (15.2cm) span, or 0.006 in. (0.152mm) over the total length of the deck, it must be machined.

CYLINDER BORES

The cylinder bores house the pistons and are slightly larger than the pistons themselves. A common piston-to-bore clearance is 0.0015-0.0025 in. (0.0381mm-0.0635mm). Inspect and measure the cylinder bores. The bore should be checked for out-of-roundness, taper and size. The results of this inspection will determine whether the cylinder can be used in its existing size and condition, or a rebore to the next oversize is required (or in the case of removable sleeves, have replacements installed).



Use a telescoping gauge to measure the cylinder bore diameter-take several readings within the same bore

The amount of cylinder wall wear is always greater at the top of the cylinder than at the bottom. This wear is known as taper. Any cylinder that has a taper of 0.0012 in. (0.0305mm) or more, must be rebored. Measurements are taken at a number of positions in each cylinder: at the top, middle and bottom and at two points at each position; that is, at a point 90 degrees from the crankshaft centerline, as well as a point parallel to the crankshaft centerline. The measurements are made with either a special dial indicator or a telescopic gauge and micrometer. If the necessary precision tools to check the bore are not available, take the block to a machine shop and have them mike it. Also if you don't have the tools to check the cylinder bores, chances are you will not have the necessary devices to check the pistons, connecting rods and crankshaft. Take these components with you and save yourself an extra trip.

For our procedures, we will use a telescopic gauge and a micrometer. You will need one of each, with a measuring range which covers your cylinder bore size.

1. Position the telescopic gauge in the cylinder bore, loosen the gauges lock and allow it to expand.

Your first two readings will be at the top of the cylinder bore, then proceed to the middle and finally the bottom, making a total of sixmeasurements.

2. Hold the gauge square in the bore, 90 degrees from the crankshaft centerline, and gently tighten the lock. Tilt the gauge back to remove it from the bore.

3. Measure the gauge with the micrometer and record the reading.
4. Again, hold the gauge square in the bore, this time parallel to the crankshaft centerline, and gently tighten the lock. Again, you will tilt the gauge back to remove it from the bore.
5. Measure the gauge with the micrometer and record this reading. The difference between these two readings is the out-of-round measurement of the cylinder.
6. Repeat steps 1 through 5, each time going to the next lower position, until you reach the bottom of the cylinder. Then go to the next cylinder, and continue until all of the cylinders have been measured.

The difference between these measurements will tell you all about the wear in your cylinders. The measurements which were taken 90 degrees from the crankshaft centerline will always reflect the most wear. That is because at this position is where the engine power presses the piston against the cylinder bore the hardest. This is known as thrust wear. Take your top, 90 degree measurement and compare it to your bottom, 90 degree measurement. The difference between them is the taper. When you measure your pistons, you will compare these readings to your piston sizes and determine piston-to-wall clearance.

Crankshaft

Inspect the crankshaft for visible signs of wear or damage. All of the journals should be perfectly round and smooth. Slight scores are normal for a used crankshaft, but you should hardly feel them with your fingernail. When measuring the crankshaft with a micrometer, you will take readings at the front and rear of each journal, then turn the micrometer 90 degrees and take two more readings, front and rear. The difference between the front-to-rear readings is the journal taper and the first-to-90 degree reading is the out-of-round measurement. Generally, there should be no taper or out-of-roundness found, however, up to 0.0005 in. (0.0127mm) for either can be overlooked. Also, the readings should fall within the factory specifications for journal diameters.

If the crankshaft journals fall within specifications, it is recommended that it be polished before being returned to service. Polishing the crankshaft insures that any minor burrs or high spots are smoothed, thereby reducing the chance of scoring the new bearings.

Pistons and Connecting Rods

PISTONS

The piston should be visually inspected for any signs of cracking or burning (caused by hot spots or detonation), and scuffing or excessive wear on the skirts. The wrist pin attaches the piston to the connecting rod. The piston should move freely on the wrist pin, both sliding and pivoting. Grasp the connecting rod securely, or mount it in a vise, and try to rock the piston back and forth along the centerline of the wrist pin. There should not be any excessive play evident between the piston and the pin. If there are C-clips retaining the pin in the piston then you have wrist pin bushings in the rods. There should not be any excessive play between the wrist pin and the rod bushing. Normal clearance for the wrist pin is approx. 0.001-0.002 in. (0.025mm-0.051mm).

Measure the piston's outer diameter, perpendicular to the wrist pin, with a micrometer

Use a micrometer and measure the diameter of the piston, perpendicular to the wrist pin, on the skirt. Compare the reading to its original cylinder measurement obtained earlier. The difference between the two readings is the piston-to-wall clearance. If the clearance is within specifications, the piston may be used as is. If the piston is out of specification, but the bore is not, you will need a new piston. If both are out of specification, you will need the cylinder rebored and oversize pistons installed. Generally if two or more pistons/bores are out of specification, it is best to rebore the entire block and purchase a complete set of oversize pistons.

CONNECTING ROD

You should have the connecting rod checked for straightness at a machine shop. If the connecting rod is bent, it will unevenly wear the bearing and piston, as well as place greater stress on these components. Any bent or twisted connecting rods must be replaced. If the rods are straight and the wrist pin clearance is within specifications, then only the bearing end of the rod need be checked. Place the connecting rod into a vice, with the bearing inserts in place, install the cap to the rod and torque the fasteners to specifications. Use a telescoping gauge and carefully measure the inside diameter of the bearings. Compare this reading to the rods original crankshaft journal diameter measurement. The difference is the oil clearance. If the oil clearance is not within specifications, install new bearings in the rod and take another measurement. If the clearance is still out of specifications, and the crankshaft is not, the rod will need to be reconditioned by a machine shop.

You can also use Plastigage® to check the bearing clearances. The assembling section has complete instructions on its use.

Camshaft

Inspect the camshaft and lifters/followers as described earlier in this section.

Bearings

All of the engine bearings should be visually inspected for wear and/or damage. The bearing should look evenly worn all around with no deep scores or pits. If the bearing is severely worn, scored, pitted or heat blued, then the bearing, and the components that use it, should be brought to a machine shop for inspection. Full-circle bearings (used on most camshafts, auxiliary shafts, balance shafts, etc.) require specialized tools for removal and installation, and should be brought to a machine shop for service.

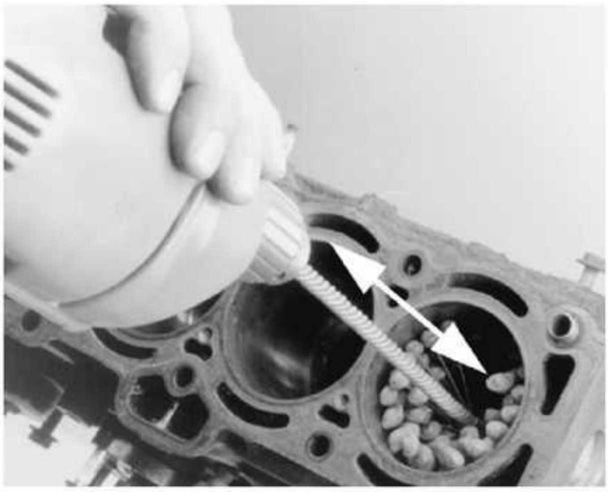
Oil Pump

The oil pump is responsible for providing constant lubrication to the whole engine and so it is recommended that a new oil pump be installed when rebuilding the engine.

Completely disassemble the oil pump and thoroughly clean all of the components. Inspect the oil pump gears and housing for wear and/or damage. Insure that the pressure relief valve operates properly and there is no binding or sticking due to varnish or debris. If all of the parts are in proper working condition, lubricate the gears and relief valve, and assemble the pump.

REFINISHING

Almost all engine block refinishing must be performed by a machine shop. If the cylinders are not to be rebored, then the cylinder glaze can be removed with a ball hone. When removing cylinder glaze with a ball hone, use a light or penetrating type oil to lubricate the hone. Do not allow the hone to run dry as this may cause excessive scoring of the cylinder bores and wear on the hone. If new pistons are required, they will need to be installed to the connecting rods. This should be performed by a machine shop as the pistons must be installed in the correct relationship to the rod or engine damage can occur.



Use a ball type cylinder hone to remove any glaze and provide a new surface for seating the piston rings

Pistons and Connecting Rods

Only pistons with the wrist pin retained by C-clips are serviceable by the home-mechanic. Press fit pistons require special presses and/or heaters to remove/install the connecting rod and should only be performed by a machine shop.

All pistons will have a mark indicating the direction to the front of the engine and the must be installed into the engine in that manner. Usually it is a notch or arrow on the top of the piston, or it may be the letter F cast or stamped into the piston.

Most pistons are marked to indicate positioning in the engine (usually a mark means the side facing the front)

C-CLIP TYPE PISTONS

1. Note the location of the forward mark on the piston and mark the connecting rod in relation.
2. Remove the C-clips from the piston and withdraw the wrist pin.

Varnish build-up or C-clip groove burrs may increase the difficulty of removing the wrist pin. If necessary, use a punch or drift to carefully tap the wrist pin out.

3. Insure that the wrist pin bushing in the connecting rod is usable, and lubricate it with assembly lube.
4. Remove the wrist pin from the new piston and lubricate the pin bores on the piston.
5. Align the forward marks on the piston and the connecting rod and install the wrist pin.
6. The new C-clips will have a flat and a rounded side to them. Install both C-clips with the flat side facing out.
7. Repeat all of the steps for each piston being replaced.

ASSEMBLY

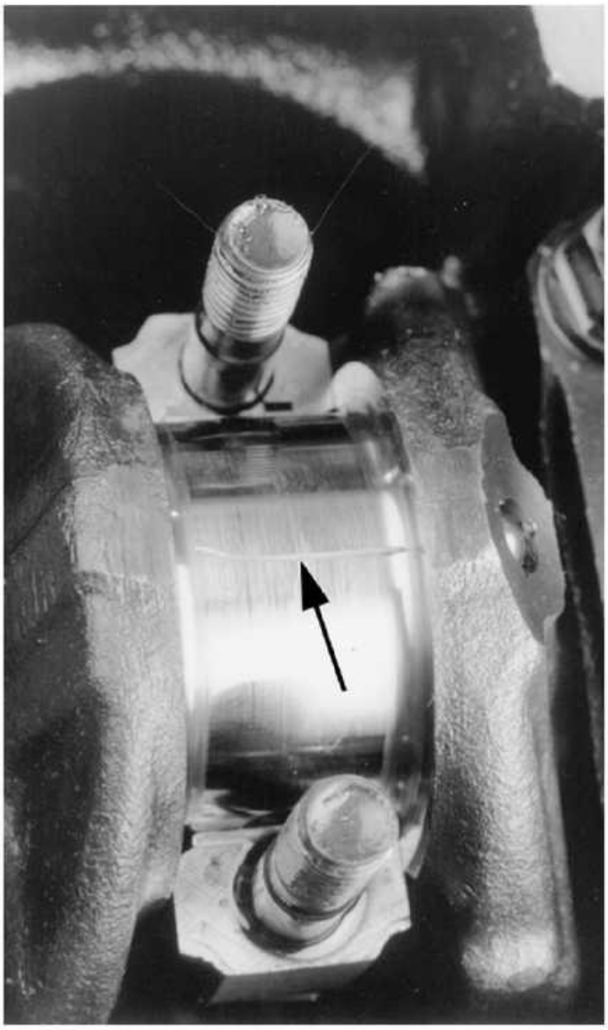
Before you begin assembling the engine, first give yourself a clean, dirt free work area. Next, clean every engine component again. The key to a good assembly is cleanliness.

Mount the engine block into the engine stand and wash it one last time using water and detergent (dishwashing detergent works well). While washing it, scrub the cylinder bores with a soft bristle brush and thoroughly clean all of the oil passages. Completely dry the engine and spray the entire assembly down with an anti-rust solution such as WD-40® or similar product. Take a clean lint-free rag and wipe up any excess anti-rust solution from the bores, bearing saddles, etc. Repeat the final cleaning process on the crankshaft. Replace any freeze or oil galley plugs which were removed during disassembly.

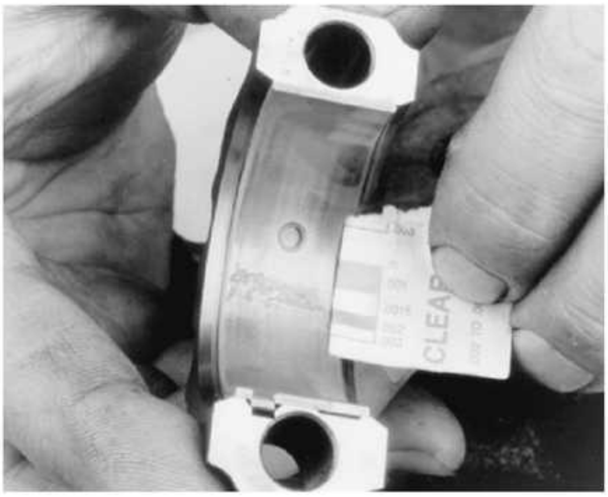
Crankshaft

1. Remove the main bearing inserts from the block and bearing caps.
2. If the crankshaft main bearing journals have been refinished to a definite undersize, install the correct undersize bearing. Be sure that the bearing inserts and bearing bores are clean. Foreign material under inserts will distort bearing and cause failure.
3. Place the upper main bearing inserts in bores with tang in slot.

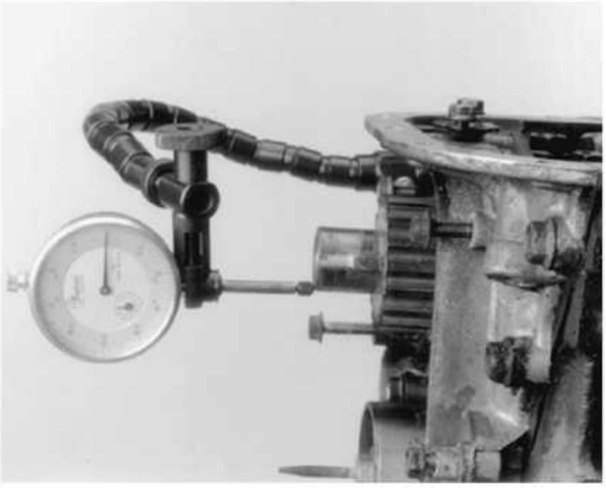
The oil holes in the bearing inserts must be aligned with the oil holes in the cylinder block.



Apply a strip of gauging material to the bearing journal, then install and torque the cap



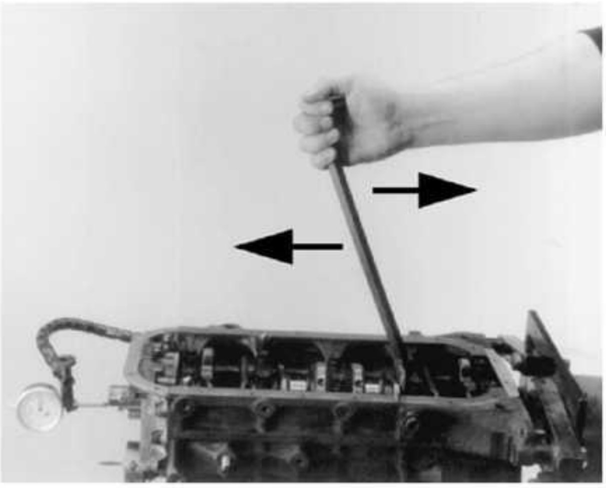
After the cap is removed again, use the scale supplied with the gauging material to check the clearance



A dial gauge may be used to check crankshaft end-play

a. Mount a dial gauge to the engine block and position the tip of the gauge to read from the crankshaft end.

b. Carefully pry the crankshaft toward the rear of the engine and hold it there while you zero the gauge.



Carefully pry the crankshaft back and forth while reading the dial gauge for end-play

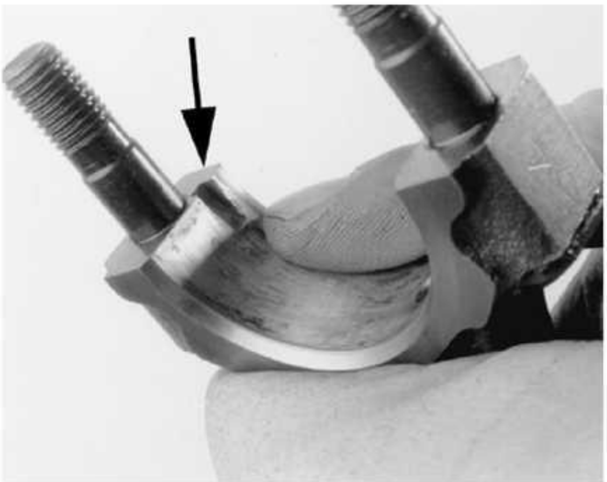
c. Carefully pry the crankshaft toward the front of the engine and read the gauge.

d. Confirm that the reading is within specifications. If not, install a new thrust bearing and repeat the procedure. If the reading is still out of specifications with a new bearing, have a machine shop inspect the thrust surfaces of the crankshaft, and if possible, repair it.

15. Rotate the crankshaft so as to position the first rod journal to the bottom of its stroke.

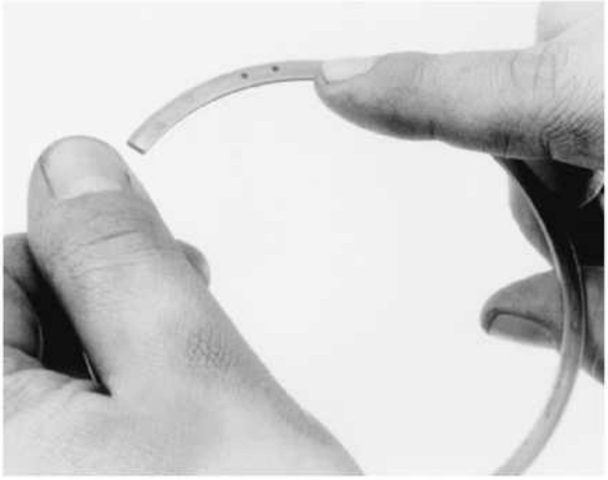
Pistons and Connecting Rods

Checking the piston ring-to-ring groove side clearance using the ring and a feeler gauge



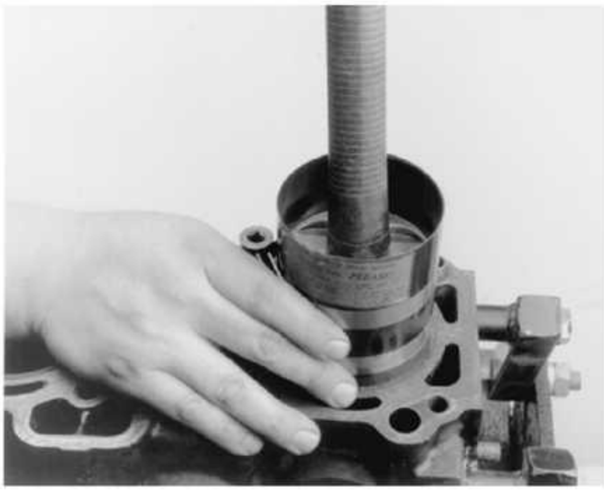
The notch on the side of the bearing cap matches the tang on the bearing insert

2. Unless new pistons are installed, be sure to install the pistons in the cylinders from which they were removed. The numbers on the connecting rod and bearing cap must be on the same side when installed in the cylinder bore. If a connecting rod is ever transposed from one engine or cylinder to another, new bearings should be fitted and the connecting rod should be numbered to correspond with the new cylinder number. The notch on the piston head goes toward the front of the engine.
3. Install all of the rod bearing inserts into the rods and caps.



Most rings are marked to show which side of the ring should face up when installed to the piston

4. Install the rings to the pistons. Install the oil control ring first, then the second compression ring and finally the top compression ring. Use a piston ring expander tool to aid in installation and to help reduce the chance of breakage.



Install the piston and rod assembly into the block using a ring compressor and the handle of a hammer

5. Make sure the ring gaps are properly spaced around the circumference of the piston. Fit a piston ring compressor around the piston and slide the piston and connecting rod assembly down into the cylinder bore, pushing it in with the wooden hammer handle. Push the piston down until it is only slightly below the top of the cylinder bore. Guide the connecting rod onto the crankshaft bearing journal carefully, to avoid damaging the crankshaft.
6. Check the bearing clearance of all the rod bearings, fitting them to the crankshaft bearing journals. Follow the procedure in the crankshaft installation above.
7. After the bearings have been fitted, apply a light coating of assembly oil to the journals and bearings.
8. Turn the crankshaft until the appropriate bearing journal is at the bottom of its stroke, then push the piston assembly all the way down until the connecting rod bearing seats on the crankshaft journal. Be careful not to allow the bearing cap screws to strike the crankshaft bearing journals and damage them.
9. After the piston and connecting rod assemblies have been installed, check the connecting rod side clearance on each crankshaft journal.
10. Prime and install the oil pump and the oil pump intake tube.
11. Install the auxiliary/balance shaft(s)/assembly(ies).

OHV Engines

CAMSHAFT, LIFTERS AND TIMING ASSEMBLY

1. Install the camshaft.
2. Install the lifters/followers into their bores.
3. Install the timing gears/chain assembly.

CYLINDER HEAD(S)

1. Install the cylinder head(s) using new gaskets.
2. Assemble the rest of the valve train (pushrods and rocker arms and/or shafts).

OHC Engines

CYLINDER HEAD(S)

1. Install the cylinder head(s) using new gaskets.
2. Install the timing sprockets/gears and the belt/chain assemblies.

Engine Covers and Components

Install the timing cover(s) and oil pan. Refer to your notes and drawings made prior to disassembly and install all of the components that were removed. Install the engine into the vehicle.

Engine Start-up and Break-in

STARTING THE ENGINE

Now that the engine is installed and every wire and hose is properly connected, go back and double check that all coolant and vacuum hoses are connected. Check that your oil drain plug is installed and properly tightened. If not already done, install a new oil filter onto the engine. Fill the crankcase with the proper amount and grade of engine oil. Fill the cooling system with a 50/50 mixture of coolant/water.

1. Connect the vehicle battery.
2. Start the engine. Keep your eye on your oil pressure indicator; if it does not indicate oil pressure within 10 seconds of starting, turn the vehicle off.

Damage to the engine can result if it is allowed to run with no oil pressure. Check the engine oil level to make sure that it is full. Check for any leaks and if found, repair the leaks before continuing. If there is still no indication of oil pressure, you may need to prime the system.

3. Confirm that there are no fluid leaks (oil or other).
4. Allow the engine to reach normal operating temperature (the upper radiator hose will be hot to the touch).
5. At this point you can perform any necessary checks or adjustments, such as checking the ignition timing.
6. Install any remaining components or body panels which were removed.

BREAKING IT IN

Make the first miles on the new engine, easy ones. Vary the speed but do not accelerate hard. Most importantly, do not lug the engine, and avoid sustained high speeds until at least 100 miles. Check the engine oil and coolant levels frequently. Expect the engine to use a little oil until the rings seat. Change the oil and filter at 500 miles, 1500 miles, then every 3000 miles past that.

KEEP IT MAINTAINED

Now that you have just gone through all of that hard work, keep yourself from doing it all over again by thoroughly maintaining it. Not that you may not have maintained it before, heck you could have had one to two hundred thousand miles on it before doing this. However, you may have bought the vehicle used, and the previous owner did not keep up on maintenance. Which is why you just went through all of that hard work. See?

SPECIFICATIONS CHARTS

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Engine Mechanical Specifications

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TROUBLESHOOTING CHARTS

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Troubleshooting the Serpentine Drive Belt

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Troubleshooting the Cooling System

DRIVEABILITY & EMISSIONS CONTROLS

AIR POLLUTION

Introduction

The earth's atmosphere, at or near sea level, consists approximately of 78 percent nitrogen, 21 percent oxygen and 1 percent other gases. If it were possible to remain in this state, 100 percent clean air would result. However, many varied sources allow other gases and particulates to mix with the clean air, causing our atmosphere to become unclean or polluted.

Some of these pollutants are visible while others are invisible, with each having the capability of causing distress to the eyes, ears, throat, skin and respiratory system. Should these pollutants become concentrated in a specific area and under certain conditions, death could result due to the displacement or chemical change of the oxygen content in the air. These pollutants can also cause great damage to the environment and to the many man made objects that are exposed to the elements.

To better understand the causes of air pollution, the pollutants can be categorized into 3 separate types, natural, industrial and automotive.

Natural Pollutants

Natural pollution has been present on earth since before man appeared and continues to be a factor when discussing air pollution, although it causes only a small percentage of the overall pollution problem. It is the direct result of decaying organic matter, wind born smoke and particulates from such natural events as plain and forest fires (ignited by heat or lightning), volcanic ash, sand and dust which can spread over a large area of the countryside.

Such a phenomenon of natural pollution has been seen in the form of volcanic eruptions, with the resulting plume of smoke, steam and volcanic ash blotting out the sun's rays as it spreads and rises higher into the atmosphere. As it travels into the atmosphere the upper air currents catch and carry the smoke and ash, while condensing the steam back into water vapor. As the water vapor, smoke and ash travel on their journey, the smoke dissipates into the atmosphere while the ash and moisture settle back to earth in a trail hundreds of miles long. In some cases, lives are lost and millions of dollars of property damage result.

Industrial Pollutants

Industrial pollution is caused primarily by industrial processes, the burning of coal, oil and natural gas, which in turn produce smoke and fumes. Because the burning fuels contain large amounts of sulfur, the principal ingredients of smoke and fumes are sulfur dioxide and particulate matter. This type of pollutant occurs most severely during still, damp and cool weather, such as at night. Even in its less severe form, this pollutant is not confined to just cities. Because of air movements, the pollutants move for miles over the surrounding countryside, leaving in its path a barren and unhealthy environment for all living things.

Working with Federal, State and Local mandated regulations and by carefully monitoring emissions, big business has greatly reduced the amount of pollutant introduced from its industrial sources, striving to obtain an acceptable level. Because of the mandated industrial emission clean up, many land areas and streams in and around the cities that were formerly barren of vegetation and life, have now begun to move back in the direction of nature's intended balance.

Automotive Pollutants

The third major source of air pollution is automotive emissions. The emissions from the internal combustion engines were not an appreciable problem years ago because of the small number of registered vehicles and the nation's small highway system. However, during the early 1950's, the trend of the American people was to move from the cities to the surrounding suburbs. This caused an immediate problem in transportation because the majority of suburbs were not afforded mass transit conveniences. This lack of transportation created an attractive market for the automobile manufacturers, which resulted in a dramatic increase in the number of vehicles produced and sold, along with a marked increase in highway construction between cities and the suburbs. Multi-vehicle families emerged with a growing emphasis placed on an individual vehicle per family member. As the increase in vehicle ownership and usage occurred, so did pollutant levels in and around the cities, as suburbanites drove daily to their businesses and employment, returning at the end of the day to their homes in the suburbs.

It was noted that a smoke and fog type haze was being formed and at times, remained in suspension over the cities, taking time to dissipate. At first this "smog," derived from the words "smoke" and "fog," was thought to result from industrial pollution but it was determined that automobile emissions shared the blame. It was discovered that when normal automobile emissions were exposed to sunlight for a period of time, complex chemical reactions would take place.

It is now known that smog is a photo chemical layer which develops when certain oxides of nitrogen (NOx) and unburned hydrocarbons (HC) from automobile emissions are exposed to sunlight. Pollution was more severe when smog would become stagnant over an area in which a warm layer of air settled over the top of the cooler air mass, trapping and holding the cooler mass at ground level. The trapped cooler air would keep the emissions from being dispersed and diluted through normal air flows. This type of air stagnation was given the name "Temperature Inversion."

TEMPERATURE INVERSION

In normal weather situations, surface air is warmed by heat radiating from the earth's surface and the sun's rays. This causes it to rise upward, into the atmosphere. Upon rising it will cool through a convection type heat exchange with the cooler upper air. As warm air rises, the surface pollutants are carried upward and dissipated into the atmosphere.

When a temperature inversion occurs, we find the higher air is no longer cooler, but is warmer than the surface air, causing the cooler surface air to become trapped. This warm air blanket can extend from above ground level to a few hundred or even a few thousand feet into the air. As the surface air is trapped, so are the pollutants, causing a severe smog condition. Should this stagnant air mass extend to a few thousand feet high, enough air movement with the inversion takes place to allow the smog layer to rise above ground level but the pollutants still cannot dissipate. This inversion can remain for days over an area, with the smog level only rising or lowering from ground level to a few hundred feet high. Meanwhile, the pollutant levels increase, causing eye irritation, respiratory problems, reduced visibility, plant damage and in some cases, even disease.

This inversion phenomenon was first noted in the Los Angeles, California area. The city lies in terrain resembling a basin and with certain weather conditions, a cold air mass is held in the basin while a warmer air mass covers it like a lid.

Because this type of condition was first documented as prevalent in the Los Angeles area, this type of trapped pollution was named Los Angeles Smog, although it occurs in other areas where a large concentration of automobiles are used and the air remains stagnant for any length of time.

HEAT TRANSFER

Consider the internal combustion engine as a machine in which raw materials must be placed so a finished product comes out. As in any machine operation, a certain amount of wasted material is formed. When we relate this to the internal combustion engine, we find that through the input of air and fuel, we obtain power during the combustion process to drive the vehicle. The by-product or waste of this power is, in part, heat and exhaust gases with which we must dispose.

The heat from the combustion process can rise to over 4000°F (2204°C). The dissipation of this heat is controlled by a ram air effect, the use of cooling fans to cause air flow and a liquid coolant solution surrounding the combustion area to transfer the heat of combustion through the cylinder walls and into the coolant. The coolant is then directed to a thin-finned, multi-tubed radiator, from which the excess heat is transferred to the atmosphere by 1 of the 3 heat transfer methods, conduction, convection or radiation.

The cooling of the combustion area is an important part in the control of exhaust emissions. To understand the behavior of the combustion and transfer of its heat, consider the air/fuel charge. It is ignited and the flame front burns progressively across the combustion chamber until the burning charge reaches the cylinder walls. Some of the fuel in contact with the walls is not hot enough to burn, thereby snuffing out or quenching the combustion process. This leaves unburned fuel in the combustion chamber. This unburned fuel is then forced out of the cylinder and into the exhaust system, along with the exhaust gases.

Many attempts have been made to minimize the amount of unburned fuel in the combustion chambers due to quenching, by increasing the coolant temperature and lessening the contact area of the coolant around the combustion area. However, design limitations within the combustion chambers prevent the complete burning of the air/fuel charge, so a certain amount of the unburned fuel is still expelled into the exhaust system, regardless of modifications to the engine.

AUTOMOTIVE EMISSIONS

Introduction

Before emission controls were mandated on internal combustion engines, other sources of engine pollutants were discovered along with the exhaust emissions. It was determined that engine combustion exhaust produced approximately 60 percent of the total emission pollutants, fuel evaporation from the fuel tank and carburetor vents produced 20 percent, with the final 20 percent being produced through the crankcase as a by-product of the combustion process.

Exhaust Gases

The exhaust gases emitted into the atmosphere are a combination of burned and unburned fuel. To understand the exhaust emission and its composition, we must review some basic chemistry.

When the air/fuel mixture is introduced into the engine, we are mixing air, composed of nitrogen (78 percent), oxygen (21 percent) and other gases (1 percent) with the fuel, which is 100 percent hydrocarbons (HC), in a semi-controlled ratio. As the combustion process is accomplished, power is produced to move the vehicle while the heat of combustion is transferred to the cooling system. The exhaust gases are then composed of nitrogen, a diatomic gas (N2), the same as was introduced in the engine, carbon dioxide (CO2), the same gas that is used in beverage carbonation, and water vapor (H2O). The nitrogen (N2), for the most part, passes through the engine unchanged, while the oxygen (O2) reacts (burns) with the hydrocarbons (HC) and produces the carbon dioxide (CO2) and the water vapors (H2O). If this chemical process would be the only process to take place, the exhaust emissions would be harmless. However, during the combustion process, other compounds are formed which are considered dangerous. These pollutants are hydrocarbons (HC), carbon monoxide (CO), oxides of nitrogen (NOx), oxides of sulfur (SOx), and engine particulates.

HYDROCARBONS

Hydrocarbons (HC) are essentially fuel which was not burned during the combustion process or which has escaped into the atmosphere through fuel evaporation. The main sources of incomplete combustion are rich air/fuel mixtures, low engine temperatures and improper spark timing. The main sources of hydrocarbon emission through fuel evaporation on most vehicles used to be the vehicle's fuel tank and carburetor float bowl.

To reduce combustion hydrocarbon emission, engine modifications were made to minimize dead space and surface area in the combustion chamber. In addition, the air/fuel mixture was made more lean through the improved control which feedback carburetion and fuel injection offers and by the addition of external controls to aid in further combustion of the hydrocarbons outside the engine. Two such methods were the addition of air injection systems, to inject fresh air into the exhaust manifolds and the installation of catalytic converters, units that are able to burn traces of hydrocarbons without affecting the internal combustion process or fuel economy.

To control hydrocarbon emissions through fuel evaporation, modifications were made to the fuel tank to allow storage of the fuel vapors during periods of engine shut-down. Modifications were also made to the air intake system so that at specific times during engine operation, these vapors may be purged and burned by blending them with the air/fuel mixture.

CARBON MONOXIDE

Carbon monoxide is formed when not enough oxygen is present during the combustion process to convert carbon (C) to carbon dioxide (CO2). An increase in the carbon monoxide (CO) emission is normally accompanied by an increase in the hydrocarbon (HC) emission because of the lack of oxygen to completely burn all of the fuel mixture.

Carbon monoxide (CO) also increases the rate at which the photo chemical smog is formed by speeding up the conversion of nitric oxide (NO) to nitrogen dioxide (NO2). To accomplish this, carbon monoxide (CO) combines with oxygen (O2) and nitric oxide (NO) to produce carbon dioxide (CO2) and nitrogen dioxide (NO2). (CO + O2 + NO = CO2 + NO2).

The dangers of carbon monoxide, which is an odorless and colorless toxic gas are many. When carbon monoxide is inhaled into the lungs and passed into the blood stream, oxygen is replaced by the carbon monoxide in the red blood cells, causing a reduction in the amount of oxygen supplied to the many parts of the body. This lack of oxygen causes headaches, lack of coordination, reduced mental alertness and, should the carbon monoxide concentration be high enough, death could result.

NITROGEN

Normally, nitrogen is an inert gas. When heated to approximately 2500°F (1371°C) through the combustion process, this gas becomes active and causes an increase in the nitric oxide (NO) emission.

Oxides of nitrogen (NOx) are composed of approximately 97-98 percent nitric oxide (NO). Nitric oxide is a colorless gas but when it is passed into the atmosphere, it combines with oxygen and forms nitrogen dioxide (NO2). The nitrogen dioxide then combines with chemically active hydrocarbons (HC) and when in the presence of sunlight, causes the formation of photo-chemical smog.

Ozone

To further complicate matters, some of the nitrogen dioxide (NO2) is broken apart by the sunlight to form nitric oxide and oxygen. (NO2 + sunlight = NO + O). This single atom of oxygen then combines with diatomic (meaning 2 atoms) oxygen (O2) to form ozone (O3). Ozone is one of the smells associated with smog. It has a pungent and offensive odor, irritates the eyes and lung tissues, affects the growth of plant life and causes rapid deterioration of rubber products. Ozone can be formed by sunlight as well as electrical discharge into the air.

The most common discharge area on the automobile engine is the secondary ignition electrical system, especially when inferior quality spark plug cables are used. As the surge of high voltage is routed through the secondary cable, the circuit builds up an electrical field around the wire, which acts upon the oxygen in the surrounding air to form the ozone. The faint glow along the cable with the engine running that may be visible on a dark night, is called the "corona discharge." It is the result of the electrical field passing from a high along the cable, to a low in the surrounding air, which forms the ozone gas. The combination of corona and ozone has been a major cause of cable deterioration. Recently, different and better quality insulating materials have lengthened the life of the electrical cables.

Although ozone at ground level can be harmful, ozone is beneficial to the earth's inhabitants. By having a concentrated ozone layer called the "ozonosphere," between 10 and 20 miles (16-32 km) up in the atmosphere, much of the ultra violet radiation from the sun's rays are absorbed and screened. If this ozone layer were not present, much of the earth's surface would be burned, dried and unfit for human life.

OXIDES OF SULFUR

Oxides of sulfur (SOx) were initially ignored in the exhaust system emissions, since the sulfur content of gasoline as a fuel is less than 1/10 of 1 percent. Because of this small amount, it was felt that it contributed very little to the overall pollution problem. However, because of the difficulty in solving the sulfur emissions in industrial pollution and the introduction of catalytic converters to automobile exhaust systems, a change was mandated. The automobile exhaust system, when equipped with a catalytic converter, changes the sulfur dioxide (SO2) into sulfur trioxide (SO3).

When this combines with water vapors (H2O), a sulfuric acid mist (H2SO4) is formed and is a very difficult pollutant to handle since it is extremely corrosive. This sulfuric acid mist that is formed, is the same mist that rises from the vents of an automobile battery when an active chemical reaction takes place within the battery cells.

When a large concentration of vehicles equipped with catalytic converters are operating in an area, this acid mist may rise and be distributed over a large ground area causing land, plant, crop, paint and building damage.

PARTICULATE MATTER

A certain amount of particulate matter is present in the burning of any fuel, with carbon constituting the largest percentage of the particulates. In gasoline, the remaining particulates are the burned remains of the various other compounds used in its manufacture. When a gasoline engine is in good internal condition, the particulate emissions are low but as the engine wears internally, the particulate emissions increase. By visually inspecting the tail pipe emissions, a determination can be made as to where an engine defect may exist. An engine with light gray or blue smoke emitting from the tail pipe normally indicates an increase in the oil consumption through burning due to internal engine wear. Black smoke would indicate a defective fuel delivery system, causing the engine to operate in a rich mode. Regardless of the color of the smoke, the internal part of the engine or the fuel delivery system should be repaired to prevent excess particulate emissions.

Diesel and turbine engines emit a darkened plume of smoke from the exhaust system because of the type of fuel used. Emission control regulations are mandated for this type of emission and more stringent measures are being used to prevent excess emission of the particulate matter. Electronic components are being introduced to control the injection of the fuel at precisely the proper time of piston travel, to achieve the optimum in fuel ignition and fuel usage. Other particulate after-burning components are being tested to achieve a cleaner emission.

Good grades of engine lubricating oils should be used, which meet the manufacturer's specification. Cut-rate oils can contribute to the particulate emission problem because of their low flash or ignition temperature point. Such oils burn prematurely during the combustion process causing emission of particulate matter.

The cooling system is an important factor in the reduction of particulate matter. The optimum combustion will occur, with the cooling system operating at a temperature specified by the manufacturer. The cooling system must be maintained in the same manner as the engine oiling system, as each system is required to perform properly in order for the engine to operate efficiently for a long time.

Crankcase Emissions

Crankcase emissions are made up of water, acids, unburned fuel, oil fumes and particulates. These emissions are classified as hydrocarbons (HC) and are formed by the small amount of unburned, compressed air/fuel mixture entering the crankcase from the combustion area (between the cylinder walls and piston rings) during the compression and power strokes. The heat of the compression and combustion help to form the remaining crankcase emissions.

Since the first engines, crankcase emissions were allowed into the atmosphere through a road draft tube, mounted on the lower side of the engine block. Fresh air came in through an open oil filler cap or breather. The air passed through the crankcase mixing with blow-by gases. The motion of the vehicle and the air blowing past the open end of the road draft tube caused a low pressure area (vacuum) at the end of the tube. Crankcase emissions were simply drawn out of the road draft tube into the air.

To control the crankcase emission, the road draft tube was deleted. A hose and/or tubing was routed from the crankcase to the intake manifold so the blow-by emission could be burned with the air/fuel mixture. However, it was found that intake manifold vacuum, used to draw the crankcase emissions into the manifold, would vary in strength at the wrong time and not allow the proper emission flow. A regulating valve was needed to control the flow of air through the crankcase.

Testing, showed the removal of the blow-by gases from the crankcase as quickly as possible, was most important to the longevity of the engine. Should large accumulations of blow-by gases remain and condense, dilution of the engine oil would occur to form water, soots, resins, acids and lead salts, resulting in the formation of sludge and varnishes. This condensation of the blow-by gases occurs more frequently on vehicles used in numerous starting and stopping conditions, excessive idling and when the engine is not allowed to attain normal operating temperature through short runs.

Evaporative Emissions

Gasoline fuel is a major source of pollution, before and after it is burned in the automobile engine. From the time the fuel is refined, stored, pumped and transported, again stored until it is pumped into the fuel tank of the vehicle, the gasoline gives off unburned hydrocarbons (HC) into the atmosphere. Through the redesign of storage areas and venting systems, the pollution factor was diminished, but not eliminated, from the refinery standpoint. However, the automobile still remained the primary source of vaporized, unburned hydrocarbon (HC) emissions.

Fuel pumped from an underground storage tank is cool but when exposed to a warmer ambient temperature, will expand. Before controls were mandated, an owner might fill the fuel tank with fuel from an underground storage tank and park the vehicle for some time in warm area, such as a parking lot. As the fuel would warm, it would expand and should no provisions or area be provided for the expansion, the fuel would spill out of the filler neck and onto the ground, causing hydrocarbon (HC) pollution and creating a severe fire hazard. To correct this condition, the vehicle manufacturers added overflow plumbing and/or gasoline tanks with built in expansion areas or domes.

However, this did not control the fuel vapor emission from the fuel tank. It was determined that most of the fuel evaporation occurred when the vehicle was stationary and the engine not operating. Most vehicles carry 5-25 gallons (19-95 liters) of gasoline. Should a large concentration of vehicles be parked in one area, such as a large parking lot, excessive fuel vapor emissions would take place, increasing as the temperature increases.

To prevent the vapor emission from escaping into the atmosphere, the fuel systems were designed to trap the vapors while the vehicle is stationary, by sealing the system from the atmosphere. A storage system is used to collect and hold the fuel vapors from the carburetor (if equipped) and the fuel tank when the engine is not operating. When the engine is started, the storage system is then purged of the fuel vapors, which are drawn into the engine and burned with the air/fuel mixture.

EMISSION CONTROLS

Crankcase Ventilation System

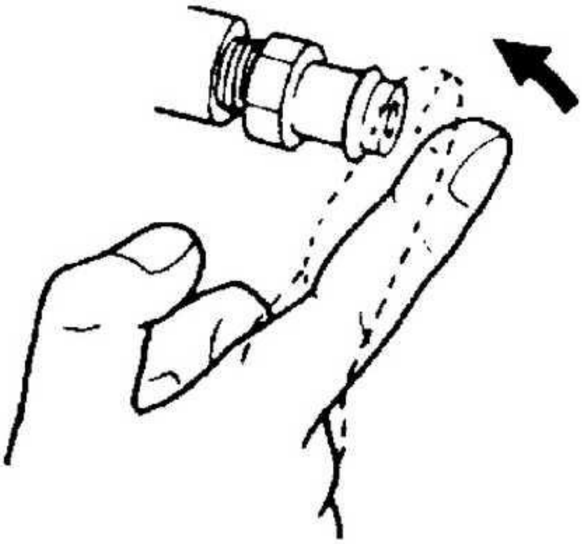
OPERATION

When the engine is running, a small portion of the gases which are formed in the combustion chamber leak by the piston rings and enter the crankcase. Since these gases are under pressure they tend to escape from the crankcase and enter into the atmosphere. If these gases are allowed to remain in the crankcase for any length of time, they would contaminate the engine oil and cause sludge to build up. If the gases are allowed to escape into the atmosphere, they would pollute the air, as they contain unburned hydrocarbons. The crankcase ventilation system recycles these gases back into the engine combustion chamber, where they are burned.

Crankcase gases are recycled in the following manner. While the engine is running, clean filtered air is drawn into the crankcase through the intake air filter and then through a hose leading to the oil filler cap or the valve cover . As the air passes through the crankcase it picks up the combustion gases and carries them out of the crankcase, up through the PCV valve, and into the intake manifold. After they enter the intake manifold they are drawn into the combustion chamber and are burned.

The most critical component of the system is the PCV valve. This vacuum-controlled valve regulates the amount of gases which are recycled into the combustion chamber. At low engine speeds the valve is partially closed, limiting the flow of gases into the intake manifold. As engine speed increases, the valve opens to admit greater quantities of the gases into the intake manifold. If the valve should become blocked or plugged, the gases will be prevented from escaping the crankcase by the normal route. Since these gases are under pressure, they will find their own way out of the crankcase. This alternate route is usually a weak oil seal or gasket in the engine. As the gas escapes by the gasket, it also creates an oil leak. Besides causing oil leaks, a clogged PCV valve also allows these gases to remain in the crankcase for an extended period of time, promoting the formation of sludge in the engine.

COMPONENT TESTING



Check the PCV valve for vacuum at idle

1. Remove the PCV valve from the valve cover grommet.
2. Shake the PCV valve.
    1. If the valve rattles when shaken, reinstall it and proceed to Step 3.
    2. If the valve does not rattle, it is sticking and must be replaced.
3. Start the engine and allow it to reach normal operating temperature.
4. Check the PCV valve for vacuum by placing your finger over the end of the valve.
    1. If vacuum exists, proceed to Step 5.
    2. If vacuum does not exist, check for loose hose connections, vacuum leaks or blockage. Correct as necessary.
5. Disconnect the fresh air intake hose from the air inlet tube (connects the air cleaner housing to the throttle body).
6. Place a stiff piece of paper over the hose end and wait 1 minute.
    1. If vacuum holds the paper in place, the system is OK; reconnect the hose.
    2. If the paper is not held in place, check for loose hose connections, vacuum leaks or blockage. Correct as necessary.

REMOVAL & INSTALLATION

Refer to Section 1 for removal and installation of the PCV valve.

Evaporative Emission Controls

OPERATION

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Typical EVAP system canister purge valve

Changes in atmospheric temperature cause fuel tanks to breathe, that is, the air within the tank expands and contracts with outside temperature changes. If an unsealed system was used, when the temperature rises, air would escape through the tank vent tube or the vent in the tank cap. The air which escapes contains gasoline vapors.

The Evaporative Emission Control System provides a sealed fuel system with the capability to store and condense fuel vapors. When the fuel evaporates in the fuel tank, the vapor passes through the EVAP emission valve, through vent hoses or tubes to a carbon filled evaporative canister. When the engine is operating the vapors are drawn into the intake manifold and burned during combustion..

A sealed, maintenance free evaporative canister is used. The canister is filled with granules of an activated carbon mixture. Fuel vapors entering the canister are absorbed by the charcoal granules. A vent cap is located on the top of the canister to provide fresh air to the canister when it is being purged. The vent cap opens to provide fresh air into the canister, which circulates through the charcoal, releasing trapped vapors and carrying them to the engine to be burned.

Fuel tank pressure vents fuel vapors into the canister. They are held in the canister until they can be drawn into the intake manifold. The canister purge valve allows the canister to be purged at a pre-determined time and engine operating conditions.

Vacuum to the canister is controlled by the canister purge valve. The valve is operated by the PCM. The PCM regulates the valve by switching the ground circuit on and off based on engine operating conditions. When energized, the valve prevents vacuum from reaching the canister. When not energized the valve allows vacuum to purge the vapors from the canister.

During warm up and for a specified time after hot starts, the PCM energizes (grounds) the valve preventing vacuum from reaching the canister. When the engine temperature reaches the operating level of about 120°F (49°C), the PCM removes the ground from the valve allowing vacuum to flow through the canister and purges vapors through the throttle body. During certain idle conditions, the purge valve may be grounded to control fuel mixture calibrations.

The fuel tank is sealed with a pressure-vacuum relief filler cap. The relief valve in the cap is a safety feature, preventing excessive pressure or vacuum in the fuel tank. If the cap is malfunctioning, and needs to be replaced, ensure that the replacement is the identical cap to ensure correct system operation.

OBD-II EVAP System Monitor

The 1997-99 models have added system components due to the EVAP system monitor incorporated in the OBD-II engine control system. A pressure sensor is mounted on the fuel tank which measures pressure inside the tank, and a purge flow sensor measures the flow of the gases from the canister into the engine. The purge valve is now called the Vapor Management Valve (VMV). It performs the same functions as the purge valve, however it looks slightly different. A canister vent solenoid is mounted on the canister, taking the place of the vent cap, providing a source of fresh air to the canister.

The PCM can store trouble codes for EVAP system performance, a list of the codes is provided later in this section. Normal testing procedure can be used, see EVAP System Component Testing in this Section.

COMPONENT TESTING

Evaporative Emissions Canister

Generally, the only testing done to the canister is a visual inspection. Look the canister over and replace it with a new one if there is any evidence of cracks or other damage.

Evaporative Hoses and Tubes

Inspect all system hoses and tubes for signs of damage or cracks. Any damage or leakage must be repaired.

Evaporative Emissions Valve

Inspect the valve for open air passage through the orifice. The valve is molded directly to the fuel tank and is not serviceable separately. If the orifice is blocked, replace the fuel tank.

Canister Purge Valve/Vapor Management Valve

1. Remove the canister purge valve.
2. Measure the resistance between the two valve terminals.
    1. If the resistance is between 30-36 ohms, proceed to the Step 3.
    2. If the resistance is not between 30-36 ohms, replace the valve.
3. Attach a hand-held vacuum pump to the intake manifold vacuum side of the valve, then apply 16 in. Hg (53 kPa) of vacuum to the valve.
    1. If the valve will not hold vacuum for at least 20 seconds replace it with a new one.
    2. If the valve holds vacuum, proceed to Step 4. Keep the vacuum applied to the valve.
4. Using an external voltage source, apply 9-14 DC volts to the valve electrical terminals.
    1. If the valve opens and the vacuum drops, the valve is working properly. Check power and ground circuits.
    2. If the valve does not open and the vacuum remains, replace the valve is faulty.

REMOVAL & INSTALLATION

Evaporative Emissions Canister

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EVAP canister mounting

1. Raise and support the vehicle.
2. Remove the vent tube from the vent hose at the fuel filler neck.

3. Unplug the canister vent solenoid connector.
4. Remove the canister retaining bolts.
5. Lower the canister and remove the vapor tube connector from the canister.
6. Remove the canister from the vehicle.

To install:

7. Installation is the reverse of removal. Tighten the retaining bolts to 54-61 inch lbs. (6-7 Nm).

Pressure Sensor

1. Raise and support the vehicle.
2. Remove the fuel tank. See Section 5.
3. Detach the connector from the sensor.
4. Twist and remove the sensor.
5. Installation is the reverse of removal.

Evaporative Emissions Valve

1. Raise and support the vehicle.
2. Remove the fuel tank. See Section 5.
3. Disconnect the vapor hose from the valve.
4. Twist and remove the valve.
5. Installation is the reverse of removal.

Canister Purge Valve/Vapor Management Valve

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Typical EVAP canister purge valve mounting

1. Disconnect the negative battery cable.
2. Label and disconnect all the vacuum hoses to the valve.
3. Disconnect the electrical harness from the valve.
4. Remove the valve retaining nuts.
5. Label and disconnect the vacuum and vapor hoses from the valve.
6. Remove the valve.
7. Installation is the reverse of removal.

Exhaust Gas Recirculation System

OPERATION

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Differential pressure feedback EGR system schematic

The Exhaust Gas Recirculation (EGR) system is designed to reintroduce exhaust gas into the combustion chambers, thereby lowering combustion temperatures and reducing the formation of Oxides of Nitrogen (NOx).

The amount of exhaust gas that is reintroduced into the combustion cycle is determined by several factors, such as: engine speed, engine vacuum, exhaust system backpressure, coolant temperature, throttle position. All EGR valves are vacuum operated. The EGR vacuum diagram for your particular vehicle is displayed on the Vehicle Emission Control Information (VECI) label.

The EGR system is Differential Pressure Feedback EGR (DPFE) system, controlled by the Powertrain Control Module (PCM) and composed of the following components: DPFE sensor (also referred to as the backpressure transducer), EGR Vacuum Regulator (EVR) solenoid, EGR valve, and assorted hoses.

COMPONENT TESTING

DPFE Sensor

Apply vacuum to the DPFE and verify the signal return voltage is greater than 4.0 volts D/C

1. Disconnect the pressure hoses at the DPFE sensor.
2. Connect a hand vacuum pump to the downstream pickup marked ***REF*** on the sensor.
3. Using a multimeter, backprobe the SIG RTN circuit at the DPFE connector.
4. With the ignition ***ON***, voltage should be 0.20-0.70 volts.
5. Apply 8-9 in. Hg of vacuum to the sensor. Voltage should be greater than 4 volts.
6. Quickly release the vacuum from the sensor. Voltage should drop to less than 1 volt in 3 seconds.
7. If the sensor does not respond as specified, check the power and ground circuits.
8. If power and ground circuits are functional, the sensor is faulty.

EVR Solenoid

EGR Valve

1. Install a tachometer on the engine, following the manufacturer's instructions.
2. Detach the engine wiring harness connector from the Idle Air Control (IAC) solenoid.
3. Disconnect and plug the vacuum supply hose from the EGR valve.
4. Start the engine, then apply the parking brake, block the rear wheels and position the transmission in Neutral.
5. Observe and note the idle speed.

If the engine will not idle with the IAC solenoid disconnected, provide an air bypass to the engine by slightly opening the throttle plate or by creating an intake vacuum leak. Do not allow the idle speed to exceed typical idle rpm.

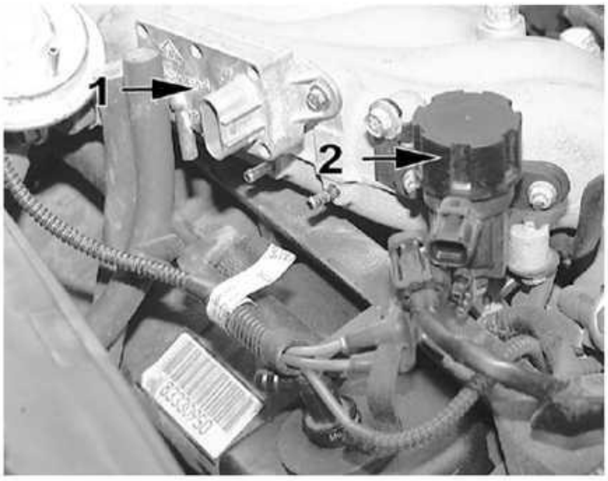
REMOVAL & INSTALLATION

DPFE Sensor

Click on icon to view fullsize printable image. Click to Enlarge *DPFE sensor and related components mounting-3.0L OHV engine*
Click on icon to view fullsize printable image. Click to Enlarge *DPFE sensor and related components mounting-3.0L DOHC engine*

Click to Enlarge

DPFE sensor and related components mounting-3.4L DOHC engine



The DPFE (1) and EVR solenoid (2)-3.0L OHV engine

1. Disconnect the negative battery cable.
2. Detach the wiring harness from the DPFE sensor.
3. Label and disconnect the vacuum hoses.
4. Remove the mounting screws and remove the DPFE sensor.

To install:

5. Position the DPFE sensor and tighten the mounting screws.
6. Attach all necessary hoses and wiring to the sensor.
7. Connect the negative battery cable.

EVR Solenoid

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Typical EVR solenoid and related components mounting

1. Disconnect the negative battery cable.
2. Label and detach the wiring harness connector from the EVR solenoid.
3. Detach the main emission vacuum control connector from the solenoid.
4. Remove the retaining bolts, and remove the solenoid.

To install:

5. Position the solenoid and install the retaining bolts.
6. Attach the main emission vacuum control connector and the wiring harness connector to the EVR solenoid.
7. Connect the negative battery cable.

EGR Valve

3.0L OHV AND 3.4L DOHC ENGINE

Click on icon to view fullsize printable image.

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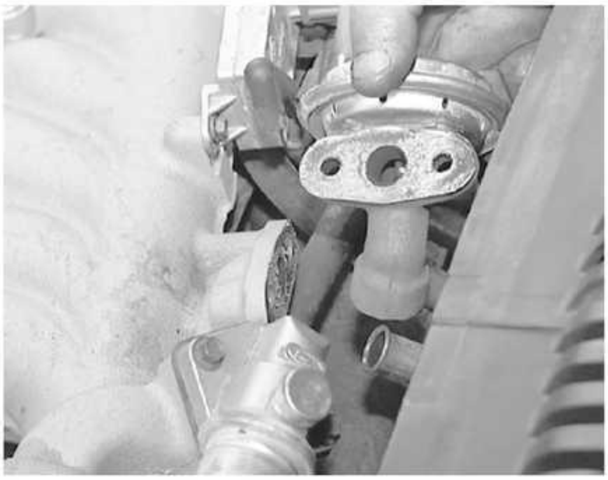
EGR mounting-3.0L OHV engine

Click on icon to view fullsize printable image.

Click to Enlarge

EGR mounting-3.4L DOHC engine

Remove the two retaining bolts and...



... remove the valve from the intake manifold

Thoroughly clean the mating surfaces of the manifold and the EGR valve (if being reused)

1. Disconnect the negative battery cable.
2. Remove the vacuum hose from the EGR valve.
3. Using a 22mm wrench or crowfoot, disconnect the EGR valve-to-exhaust manifold tube from the EGR valve.
4. Remove the EGR valve mounting fasteners, then separate the valve from the intake manifold.
5. Remove and discard the old EGR valve gasket, and clean the gasket mating surfaces on the valve and the intake manifold.

To install:

6. Install the EGR valve, along with a new gasket, on the upper intake manifold, then install and tighten the mounting bolts to 15-22 ft. lbs. (20-30 Nm).
7. Connect the EGR valve-to-exhaust manifold tube to the valve, then tighten the tube nut to 26-47 ft. lbs. (35-65 Nm).
8. Connect the vacuum hose to the EGR valve.
9. Connect the negative battery cable.

3.0L DOHC ENGINE

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EGR mounting-3.0L DOHC engine

1. Disconnect the negative battery cable.
2. Remove the vacuum hose from the EGR valve.
3. Remove the two EGR tube-to-EGR valve retaining nuts.
4. Remove the EGR valve mounting fasteners, then separate the valve from the intake manifold.
5. Remove and discard the old EGR valve gasket, and clean the gasket mating surfaces on the valve and the intake manifold.

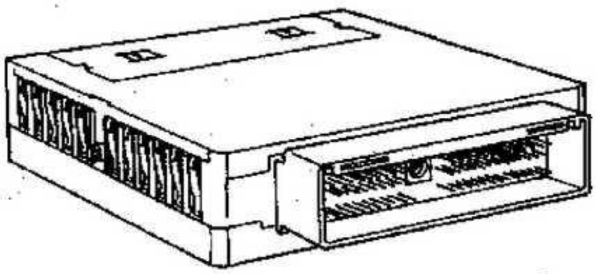
To install:

6. Install the EGR valve, along with a new gasket, on the upper intake manifold, then install and tighten the mounting bolts to 15-22 ft. lbs. (20-30 Nm).
7. Connect the EGR valve-to-EGR tube, then tighten the retaining nuts.
8. Connect the vacuum hose to the EGR valve.
9. Connect the negative battery cable.

ELECTRONIC ENGINE CONTROLS

Powertrain Control Module (PCM)

OPERATION



PCM assembly

The Powertrain Control Module (PCM) performs many functions on your vehicle. The module accepts information from various engine sensors and computes the required fuel flow rate necessary to maintain the correct amount of air/fuel ratio throughout the entire engine operational range.

Based on the information that is received and programmed into the PCM's memory, the PCM generates output signals to control relays, actuators and solenoids. The PCM also sends out a command to the fuel injectors that meters the appropriate quantity of fuel. The module automatically senses and compensates for any changes in altitude when driving your vehicle.

REMOVAL & INSTALLATION

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PCM and related hardware mounting

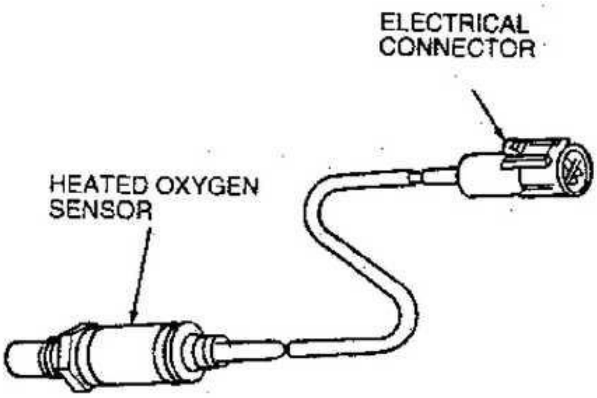
1. Disconnect the negative battery cable.
2. Remove the cowl deflector.
3. Remove the screw securing the ground cable of the engine control harness to the dash panel.
4. Loosen the engine control wiring harness-to-PCM retaining bolt.
5. Remove the engine control wiring harness from the PCM.
6. Remove the retaining nuts from the PCM insulator and remove the PCM insulator.
7. Remove the PCM.

To install:

8. The installation is the reverse of removal.

Heated Oxygen Sensor

OPERATION



Heated oxygen sensor assembly

The oxygen (O2) sensor is a device which produces an electrical voltage when exposed to the oxygen present in the exhaust gases. The sensor is mounted in the exhaust system, usually in the manifold or a boss located on the down pipe before the catalyst.. The oxygen sensors used on the Ford Contour/Mercury Mystique/Mercury Cougar are electrically heated internally for faster switching when the engine is started cold. The oxygen sensor produces a voltage within 0 and 1 volt. When there is a large amount of oxygen present (lean mixture), the sensor produces a low voltage (less than 0.4v). When there is a lesser amount present (rich mixture) it produces a higher voltage (0.6-1.0v).The stoichiometric or correct fuel to air ratio will read between 0.4 and 0.6v. By monitoring the oxygen content and converting it to electrical voltage, the sensor acts as a rich-lean switch. The voltage is transmitted to the PCM.

Some models have two sensors, one before the catalyst and one after. This is done for a catalyst efficiency monitor that is a part of the OBD-II engine controls. The one before the catalyst measures the exhaust emissions right out of the engine, and sends the signal to the PCM about the state of the mixture as previously talked about. The second sensor reports the difference in the emissions after the exhaust gases have gone through the catalyst. This sensor reports to the PCM the amount of emissions reduction the catalyst is performing.

The oxygen sensor will not work until a predetermined temperature is reached, until this time the PCM is running in what as known as OPEN LOOP operation. OPEN LOOP means that the PCM has not yet begun to correct the air-to-fuel ratio by reading the oxygen sensor. After the engine comes to operating temperature, the PCM will monitor the oxygen sensor and correct the air/fuel ratio from the sensor's readings. This is what is known as CLOSED LOOP operation.

A heated oxygen sensor (HO2S) has a heating element that keeps the sensor at proper operating temperature during all operating modes. Maintaining correct sensor temperature at all times allows the system to enter into CLOSED LOOP operation sooner.

In CLOSED LOOP operation the PCM monitors the sensor input (along with other inputs) and adjusts the injector pulse width accordingly. During OPEN LOOP operation the PCM ignores the sensor input and adjusts the injector pulse to a preprogrammed value based on other inputs.

TESTING

The voltage of the HO2S should be between 0.1 and 1.0 volts DC with the engine running

The HO2S can be monitored with an appropriate and Data-stream capable scan tool

Do not pierce the wires when testing this sensor; this can lead to wiring harness damage. Backprobe the connector to properly read the voltage of theHO2S.

1. Disconnect the HO2S.
2. Measure the resistance between PWR and GND terminals of the sensor. Resistance should be approximately 6 ohms at 68°F (20°C). If resistance is not within specification, the sensor's heater element is faulty.
3. With the HO2S connected and engine running, measure the voltage with a Digital Volt-Ohmmeter (DVOM) between terminals ***HO2S*** and ***SIG RTN*** (GND) of the oxygen sensor connector. Voltage should fluctuate between 0.01-1.0 volts. If voltage fluctuation is slow or voltage is not within specification, the sensor may be faulty.

REMOVAL & INSTALLATION

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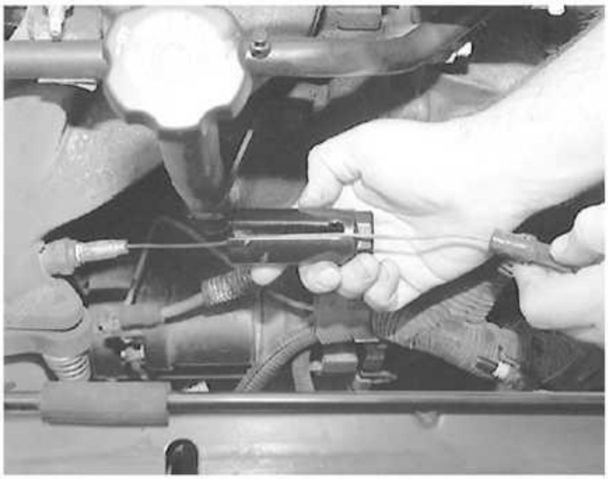
Typical oxygen sensor locations-3.0L DOHC engine



A special socket is available to remove the oxygen sensor. The socket contains a slot that the wire slides out of

An appropriate sized wrench can be used if an oxygen sensor socket is unavailable

Carefully loosen the sensor and remove it from the exhaust pipe

An oxygen sensor socket/wrench is available from Ford or aftermarket manufacturersto ease the removal and installation of the oxygen sensor(s). If one is notavailable, an open end wrench can be used.

The sensor uses a permanently attached pigtail and connector. This pigtail should not be removed from the sensor. Damage or removal of the pigtail or connector will affect the proper operation of the sensor. Keep the electricalconnector and louvered end of the sensor clean and free of grease. NEVER use cleaning solvents of any type on the sensor! The oxygen sensor may be difficult to remove when the temperature of the engine is below 120°F (49°C). Excessive force may damage the threads in the exhaust manifold or exhaust pipe.

1. Disconnect the negative battery cable.
2. Raise and support the vehicle.
3. Unplug the electrical connector and any attaching hardware.

Lubricate the sensor with penetrating oil prior to removal.

4. Remove the sensor using an appropriate tool. Special oxygen sensor sockets are available to remove the sensor and can be purchased at many parts stores or where automotive tools are sold. The proper size wrench can be used,

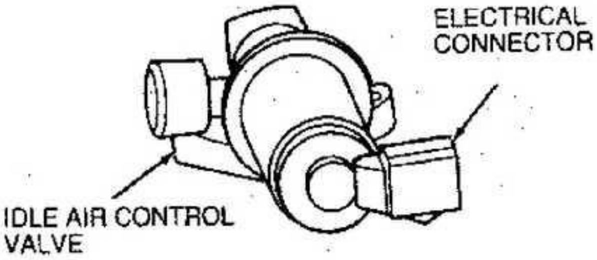
most sensors are 7/8 inch or 22mm sizes.

To install:

5. Coat the threads of the sensor with a suitable anti-seize compound before installation. New sensors are pre-coated with this compound.
6. Install the sensor and tighten it. Use care in making sure the silicone boot is in the correct position to avoid melting it during operation.
7. Attach the electrical connector.
8. Lower the vehicle.
9. Connect the negative battery cable.

Idle Air Control Valve

OPERATION



IAC valve assembly

The Idle Air Control (IAC) valve adjusts the engine idle speed. The valve is located on the side of the throttle body. The valve is controlled by a duty cycle signal from the PCM and allows air to bypass the throttle plate in order to maintain the proper idle speed.

Do not attempt to clean the IAC valve. Carburetor tune-up cleaners or any type of solvent cleaners will damage the internal components of the valve.

TESTING

The IAC can be monitored with an appropriate and Data-stream capable scan tool

1. Turn the ignition switch to the ***OFF*** position.
2. Disconnect the wiring harness from the IAC valve.
3. Measure the resistance between the terminals of the valve.

Due to the diode in the solenoid, place the ohmmeter positive lead on theVPWR terminal and the negative lead on the ISC terminal.

4. Resistance should be 6-13 ohms.
5. If resistance is not within specification, the valve may be faulty.

REMOVAL & INSTALLATION

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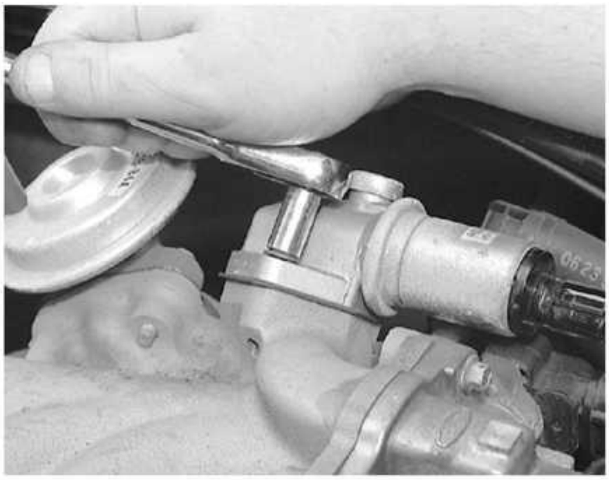
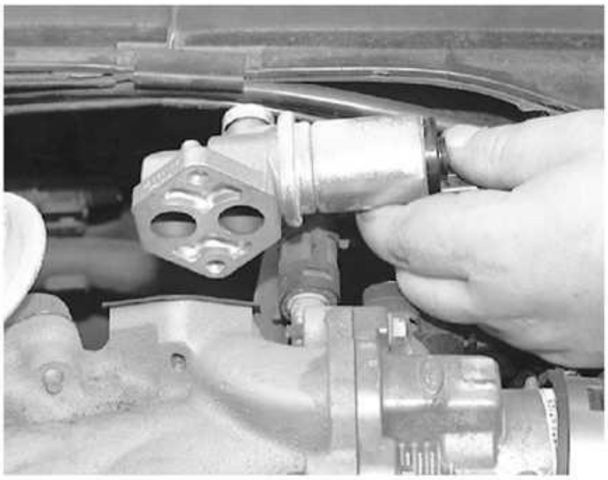
IAC valve mounting-3.0L DOHC engine

Detach the IAC valve connector

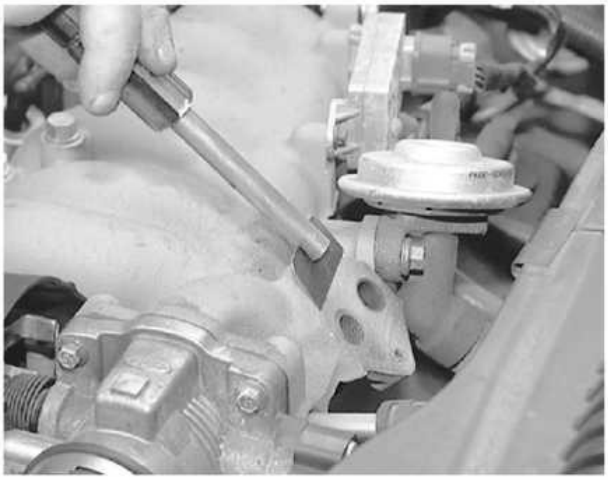
The IAC valve is retained by two bolts



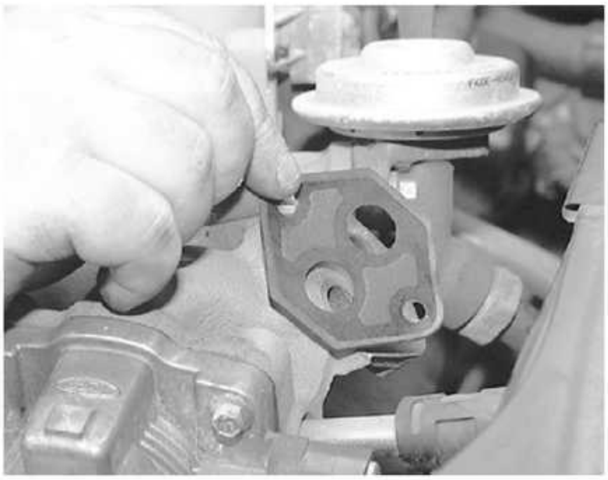
Remove the two IAC valve retaining bolts and...



... remove the IAC valve from the intake manifold



Thoroughly clean the IAC valve mounting surfaces



Always use a new IAC valve gasket when installing the IAC valve onto the intake manifold

1. Disconnect the negative battery cable.
2. Remove the air cleaner inlet tube and the throttle cover, if necessary.
3. Disconnnect the wiring harness from the IAC valve.
4. Remove the two retaining bolts.
5. Remove the IAC valve and discard the old gasket.

To install:

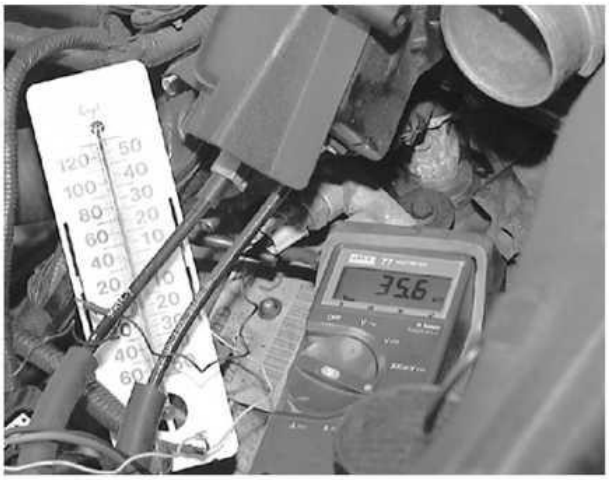
6. Clean the gasket mating surfaces thoroughly.
7. Using a new gasket, position the IAC valve on the throttle body.
8. Install and tighten the retaining bolts to 71-106 inch lbs. (8-12 Nm).
9. Connect the wiring harness to the IAC valve.
10. If removed, install the air cleaner tube and throttle cover.
11. Connect the negative battery cable.

Engine Coolant Temperature Sensor

OPERATION

The Engine Coolant Temperature (ECT) sensor resistance changes in response to engine coolant temperature. The sensor resistance decreases as the coolant temperature increases, and increases as the coolant temperature decreases. This provides a reference signal to the PCM, which indicates engine coolant temperature. The signal sent to the PCM by the ECT sensor helps the PCM to determine spark advance, EGR flow rate, air/fuel ratio, and engine temperature. The ECT is a two wire sensor, a 5-volt reference signal is sent to the sensor and the signal return is based upon the change in the measured resistance due to temperature.

TESTING



Measure the resistance of the ECT sensor across the two sensor terminals using a suitable DVOM. Compare the readings to the temp/resistance chart in this Section

Another method of testing the ECT is to submerge it in cold or hot water and check resistance

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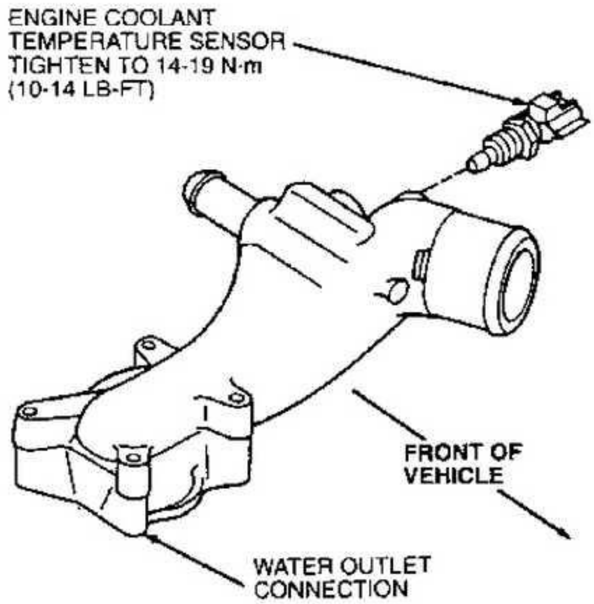
ECT resistance-to-temperature specifications

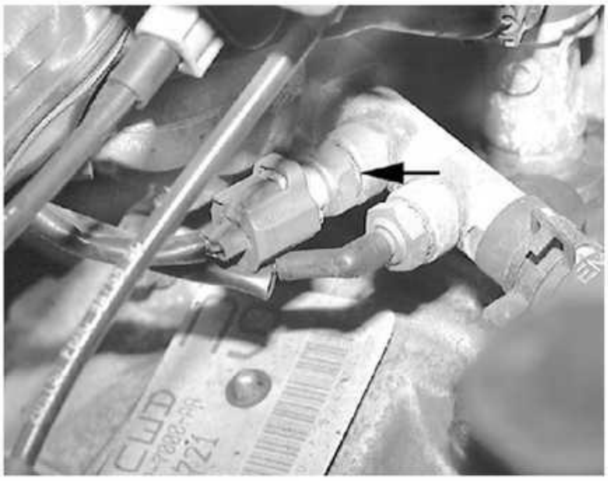
1. Disconnect the engine wiring harness from the ECT sensor.
2. Connect an ohmmeter between the ECT sensor terminals.
3. With the engine cold and the ignition switch in the ***OFF*** position, measure and note the ECT sensor resistance.
4. Connect the engine wiring harness to the sensor.
5. Start the engine and allow the engine to reach normal operating temperature.
6. Once the engine has reached normal operating temperature, turn the engine ***OFF***.
7. Once again, disconnect the engine wiring harness from the ECT sensor.
8. Measure and note the ECT sensor resistance with the engine hot.
9. Compare the cold and hot ECT sensor resistance measurements with the accompanying chart.
10. If readings do not approximate those in the chart, the sensor may be faulty.

REMOVAL & INSTALLATION

Click on icon to view fullsize printable image. Click to Enlarge *ECT sensor mounting-3.0L OHV engine*
Click on icon to view fullsize printable image. Click to Enlarge *ECT sensor mounting-3.0L DOHC engine*

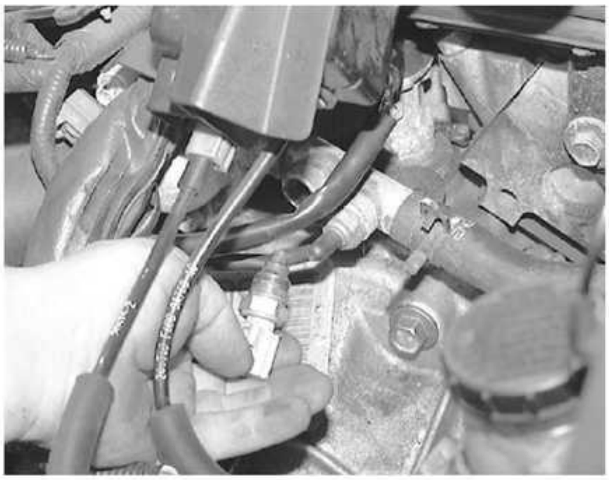


ECT sensor mounting-3.4L DOHC engine



The ECT sensor is located on a bypass tube adjacent to the temperature gauge sending unit

Loosen the ECT sensor using a proper size socket and drive tool and...



... remove the ECT sensor from the bypass tube

Always apply a suitable thread sealant to the threads of the ECT sensor before installing it onto the engine

1. Disconnect the negative battery cable.
2. Drain the engine coolant.

NEVER open, service or drain the radiator or cooling system when hot; serious burns can occur from the steam and hot coolant. Also, when draining engine coolant, keep in mind that cats and dogs are attracted to ethylene glycol antifreeze and could drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantities.Always drain coolant into a sealable container. If necessary, clean coolant maybe reused unless it is contaminated or more than two years old.

3. On the 3.4L engine, remove the air intake resonator.
4. Detach the ECT sensor connector.
5. Loosen the ECT sensor using an appropriate size socket and drive tool.
6. Remove the ECT sensor from the vehicle.

To install:

7. Coat the sensor threads with Teflon® sealant.
8. Thread the sensor into position and tighten to 11-14 ft lbs. (14-19 Nm).
9. Attach the ECT sensor connector.
10. On the 3.4L engine, install the air intake resonator.
11. Connect the negative battery cable.
12. Refill the engine cooling system.
13. Start the engine and check for coolant leaks.
14. Bleed the cooling system.

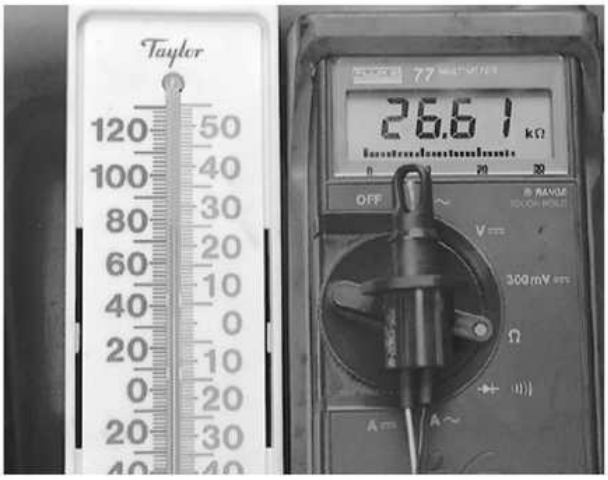
Intake Air Temperature Sensor

OPERATION

The tip of the IAT sensor has an exposed thermistor that changes the resistance of the sensor based upon the force of the air rushing past it

The Intake Air Temperature (IAT) sensor determines the air temperature inside the intake manifold. Resistance changes in response to the ambient air temperature. The sensor has a negative temperature coefficient. As the temperature of the sensor rises the resistance across the sensor decreases. This provides a signal to the PCM indicating the temperature of the incoming air charge. This sensor helps the PCM to determine spark timing and air/fuel ratio. Information from this sensor is added to the pressure sensor information to calculate the air mass being sent to the cylinders. The IAT is a two wire sensor. A 5-volt reference signal is sent to the sensor and the signal return is based upon the change in the measured resistance due to temperature.

TESTING



Measure the resistance of the IAT sensor across the two sensor terminals using a suitable DVOM. Compare the readings to the temp/resistance chart in this Section

The IAT sensor can be monitored with an appropriate and Data-stream capable scan tool

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ECT/IAT resistance-to-temperature specifications

1. Turn the ignition switch ***OFF***.
2. Disconnect the wiring harness from the IAT sensor.
3. Measure the resistance between the sensor terminals.
4. Compare the resistance reading with the accompanying chart.
5. If the resistance is not within specification, the IAT may be faulty.
6. Connect the wiring harness to the sensor.

REMOVAL & INSTALLATION

3.0L OHV

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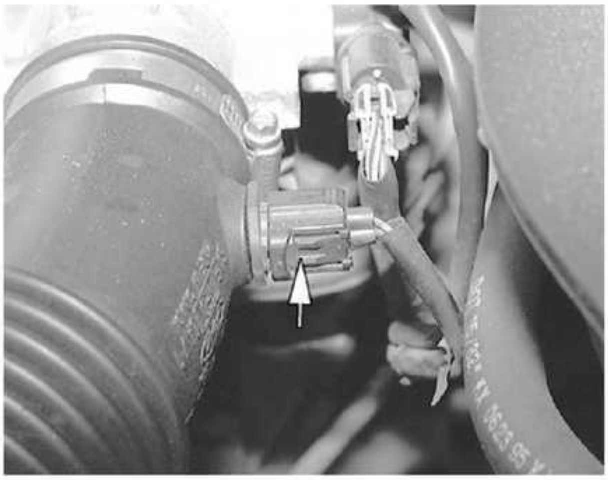
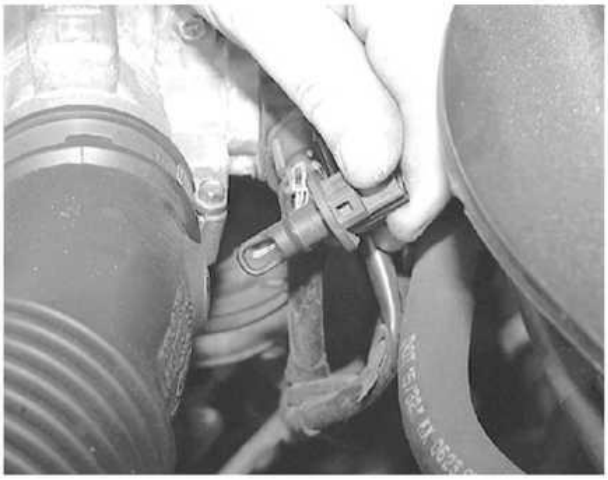
IAT sensor mounting-3.0L OHV engine



The IAT sensor is located in the air intake hose on the 3.0L OHV engine. Detach the connector for the IAT sensor and...



... carefully twist the sensor from the tube and remove the sensor

1. Disconnect the negative battery cable.
2. Detach the IAT sensor connector.
3. Twist the IAT sensor and carefully remove from the air cleaner outlet tube.

To install:

4. The installation is the reverse of removal.

3.0L DOHC

Click on icon to view fullsize printable image.

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IAT sensor mounting-3.0L DOHC engine

1. Disconnect the negative battery cable.

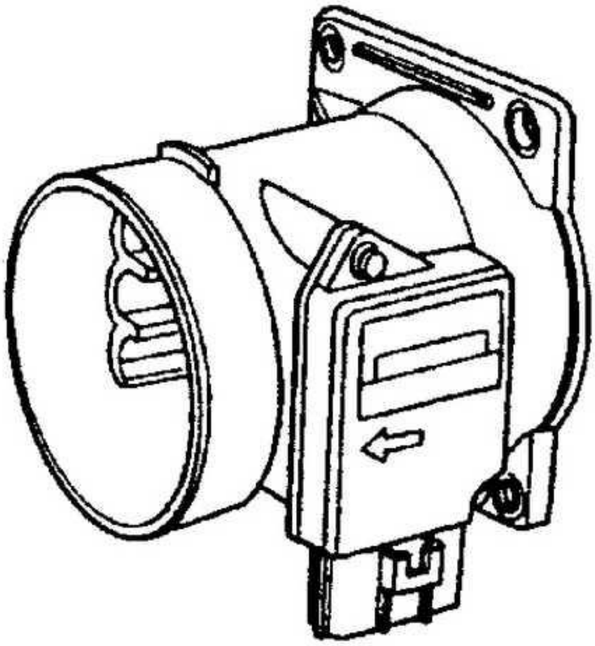
2. Detach the IAT sensor connector.
3. Turn the IAT sensor 90° counterclockwise and carefully remove from the air cleaner element cover.
4. Inspect the IAT sensor O-ring and replace as necessary.

To install:

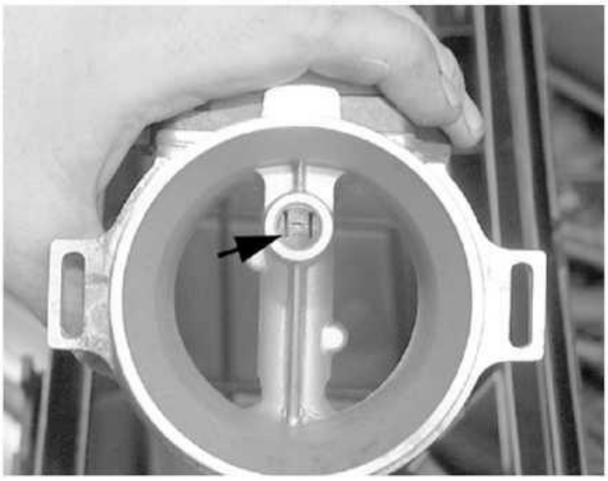
5. The installation is the reverse of removal.

Mass Airflow Sensor

OPERATION



Typical MAF sensor assembly

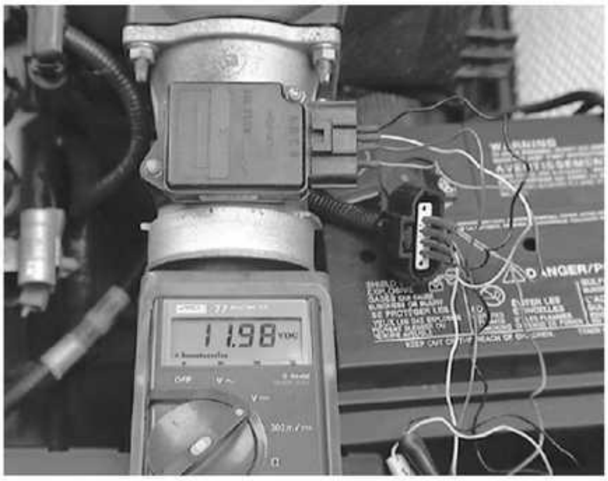


The exposed "hot wire" of the MAF sensor

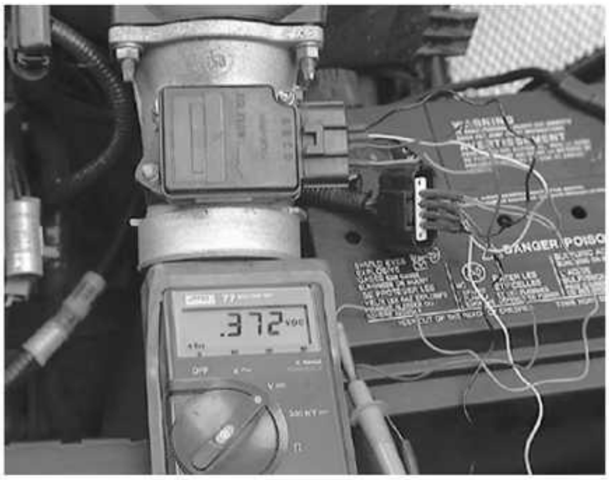
The Mass Air Flow (MAF) sensor directly measures the mass of air being drawn into the engine. The sensor output is used to calculate injector pulse width. The MAF sensor is what is referred to as a "hot-wire sensor". The sensor uses a thin platinum wire filament, wound on a ceramic bobbin and coated with glass, that is heated to 200°C (417°F) above the ambient air temperature and subjected to the intake airflow stream. A "cold-wire" is used inside the MAF sensor to determine the ambient air temperature.

Battery voltage from the EEC power relay, and a reference signal and a ground signal from the PCM are supplied to the MAF sensor. The sensor returns a signal proportionate to the current flow required to keep the "hot-wire" at the required temperature. The increased airflow across the "hot-wire" acts as a cooling fan, lowering the resistance and requiring more current to maintain the temperature of the wire. The increased current is measured by the voltage in the circuit, as current increases, voltage increases. As the airflow increases the signal return voltage of a normally operating MAF sensor will increase.

TESTING



Testing the VPWR circuit of the MAF sensor



Testing the SIG RTN circuit of the MAF sensor

1. Using a multimeter, check for voltage by backprobing the MAF sensor connector.
2. With the key **ON**, and the engine **OFF**, verify that there is at least 10.5 volts between the VPWR and GND terminals of the MAF sensor connector. If voltage is not within specification, check power and ground circuits and repair as necessary.
3. With the key **ON**, and the engine **ON**, verify that there is at least 4.5 volts between the SIG and GND terminals of the MAF sensor connector. If voltage is not within specification, check power and ground circuits and repair as necessary.
4. With the key **ON**, and the engine **ON**, check voltage between GND and SIG RTN terminals. Voltage should be approximately 0.34-1.96 volts. If voltage is not within specification, the sensor may be faulty.

REMOVAL & INSTALLATION

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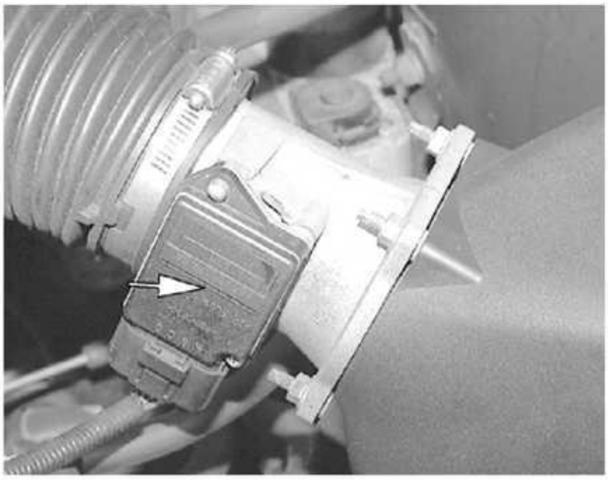
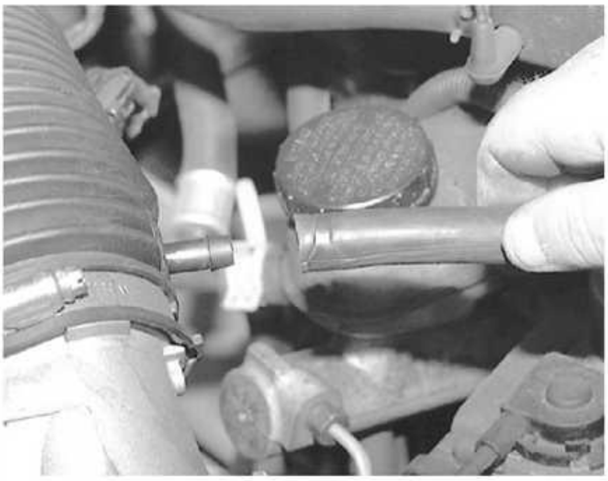
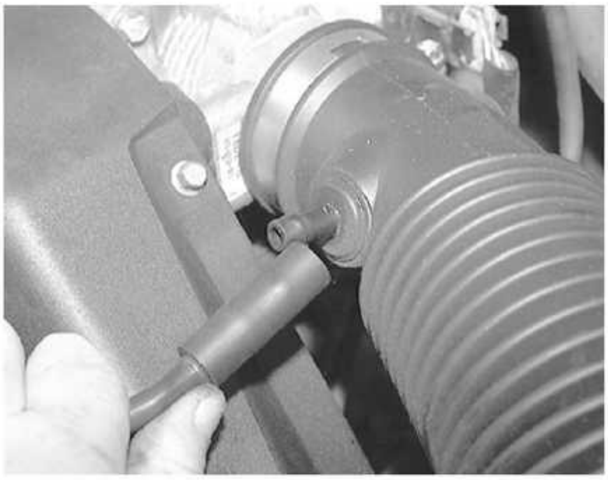
Typical MAF sensor mounting



The MAF sensor is mounted to the air cleaner housing-3.0L OHV engine



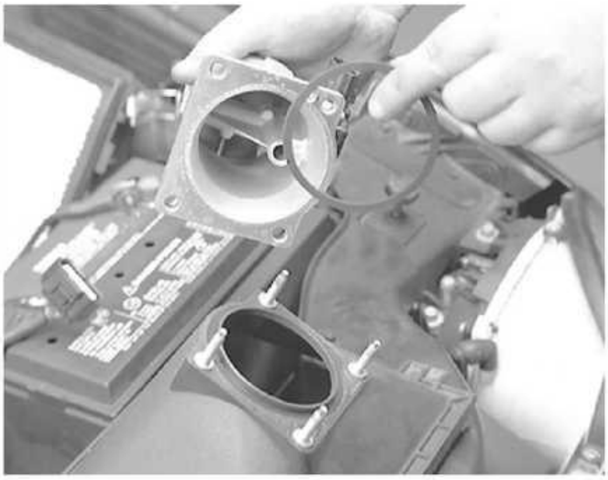
Remove the rear hose and...



... the crankcase ventilation hose from the air cleaner outlet tube and...

... loosen the hose clamps and remove the hose from the engine

Remove the MAF sensor retaining bolts and...



... remove the sensor and the gasket from the air cleaner cover

1. Disconnect the negative battery cable.
2. Remove the air cleaner outlet tube.
3. Detach the MAF sensor connector.
4. Remove the four MAF sensor-to-air cleaner cover retaining screws.
5. Remove the MAF sensor from the air cleaner cover.
6. Discard the MAF sensor gasket.

To install:

7. Install a new gasket onto the air cleaner cover.
8. Install the MAF sensor onto the air cleaner cover and tighten the retaining screws to 71-106 inch lbs. (8-12 Nm).
9. Install the air cleaner outlet tube.
10. Attach the MAF sensor connector.
11. Connect the negative battery cable.

Throttle Position Sensor

OPERATION

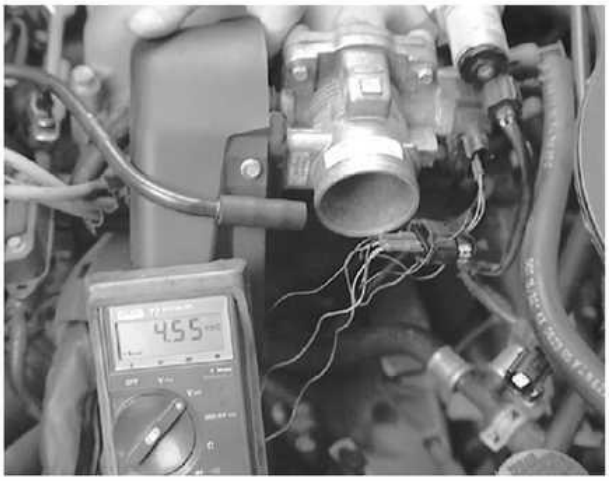
The Throttle Position (TP) sensor is a potentiometer that provides a signal to the PCM that is directly proportional to the throttle plate position. The TP sensor is mounted on the side of the throttle body and is connected to the throttle plate shaft. The TP sensor monitors throttle plate movement and position, and transmits an appropriate electrical signal to the PCM. These signals are used by the PCM to adjust the air/fuel mixture, spark timing and EGR operation according to engine load at idle, part throttle, or full throttle. The TP sensor is not adjustable.

The TP sensor receives a 5 volt reference signal and a ground circuit from the PCM. A return signal circuit is connected to wiper that runs on a resistor internally on the sensor. The further the throttle is opened, the wiper moves along the resistor, at wide open throttle, the wiper essentially creates a loop between the reference signal and the signal return returning the full or nearly full 5 volt signal back to the PCM. At idle the signal return should be approximately 0.9 volts.

TESTING

Testing the SIG circuit to the TP sensor

Testing the SIG RTN circuit of the TP sensor



Testing the operation of the potentiometer inside the TP sensor while slowly opening the throttle

The TP sensor can be monitored with an appropriate and Data-stream capable scan tool

1. With the engine **OFF** and the ignition **ON**, check the voltage at the signal return circuit of the TP sensor by carefully backprobing the connector using a DVOM.
2. Voltage should be between 0.2 and 1.4 volts at idle.
3. Slowly move the throttle pulley to the wide open throttle (WOT) position and watch the voltage on the DVOM. The voltage should slowly rise to slightly less than 4.8v at Wide Open Throttle (WOT).
4. If no voltage is present, check the wiring harness for supply voltage (5.0v) and ground (0.3v or less), by referring to your corresponding wiring guide. If supply voltage and ground are present, but no output voltage from TP, replace the TP sensor. If supply voltage and ground do not meet specifications, make necessary repairs to the harness or PCM.

REMOVAL & INSTALLATION

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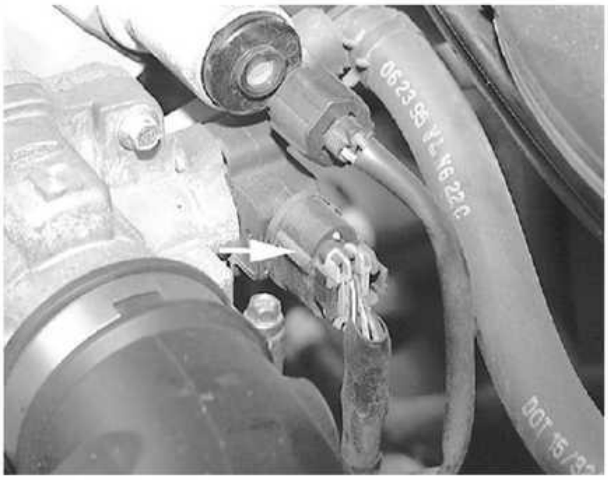
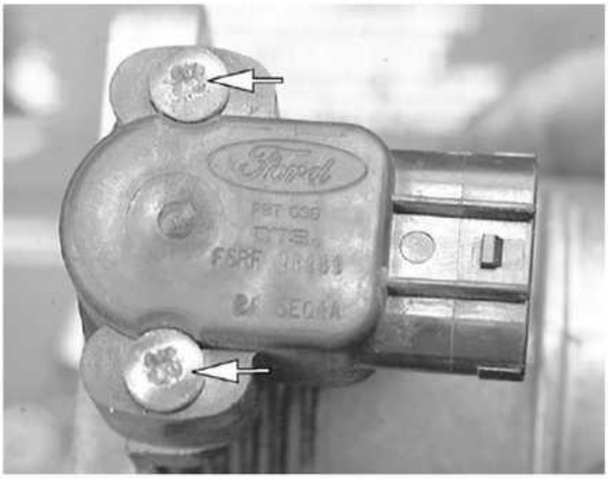
Click to Enlarge

Typical TP sensor mounting



Detach the connector for the TP sensor and...



... remove the two retaining screws to remove the sensor from the throttle body

1. Disconnect the negative battery cable.
2. Remove the air intake resonator.
3. Disconnect the wiring harness from the TP sensor.
4. Remove the two sensor mounting screws, then pull the TP sensor off of the throttle shaft.

To install:

5. Carefully slide the rotary tangs on the sensor into position over the throttle shaft, then rotate the sensor clockwise to the installed position..

> **Failure to install the TP sensor in this manner may result in sensor damage or high idle speeds.**

The TP sensor is not adjustable.

6. Install and tighten the sensor mounting screws to 25-33 inch lbs. (3-4 Nm).
7. Connect the wiring harness to the sensor.
8. Install the air intake resonator.
9. Connect the negative battery cable.

Camshaft Position Sensor

OPERATION

The camshaft position sensor (CMP) on the 3.0L DOHC and 3.4L DOHC engines is a variable reluctance sensor that is triggered by a high point on the left-hand exhaust camshaft sprocket. The CMP sends a signal relating camshaft position back to the PCM which is used by the PCM to control engine timing.

The camshaft position sensor (CMP) on the 3.0L OHV engine is a single hall-effect magnetic switch that is triggered by a single vane which is driven by the camshaft. The CMP sends a signal relating camshaft position back to the PCM which is used by the PCM to control engine timing.

TESTING

Testing the CMP sensor for voltage as the engine is running

Testing the VPWR circuit of the CMP sensor

1. Check voltage between the camshaft position sensor terminals PWR GND and CID.
2. With engine running, voltage should be greater than 0.1 volt AC and vary with engine speed.
3. If voltage is not within specification, check for proper voltage at the VPWR terminal.
4. If VPWR voltage is greater than 10.5 volts, sensor may be faulty.

REMOVAL & INSTALLATION

3.0L OHV

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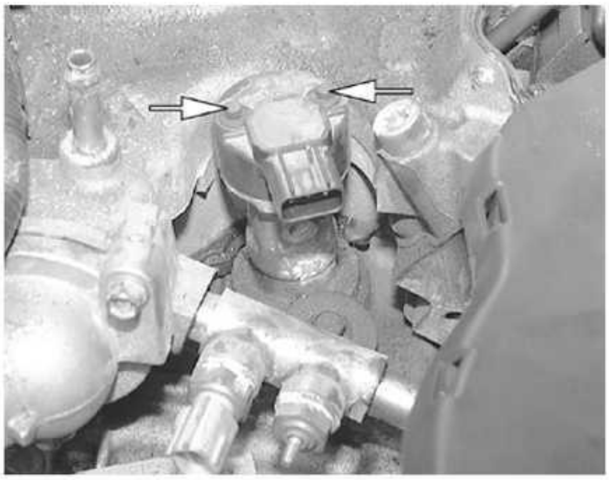
CMP sensor mounting and installation-3.0L OHV engine



The CMP sensor is retained by two retaining screws-3.0L OHV engine

Remove the two retaining screws and remove the sensor from the housing

1. Disconnect the negative battery cable.
2. Detach the CMP sensor connector. Note the position of the connector in relation to the sensor.
3. Remove the CMP sensor retaining bolts and remove the CMP sensor from the sensor housing.
4. Remove the CMP sensor housing hold-down clamp.
5. Remove the housing from the engine.

To install:

6. Attach syncro positioning tool T95T-12200-A or equivalent and position the sensor housing vane into the radial slot of the tool.
7. Rotate the tool on the CMP sensor housing until the tool boss engages the notch in the housing.
8. Pre-lubricate the synchronizer gear with engine oil prior to assembly.
9. Install the CMP sensor so that drive gear engagement occurs.
10. Locate the CMP sensor electrical connector in it's pre-removal position.

If the CMP sensor connector is not positioned properly, do not reposition the connector by rotating the CMP sensor housing. This could result in engine damage. Remove the housing and repeat the installation procedure.

11. Install the hold-down clamp and tighten it to 14-22 ft. lbs. (19-30 Nm).
12. Remove the syncro positioning tool T95T-12200-A or equivalent.
13. Install the CMP sensor and tighten the retaining bolts to 14-35 inch lbs. (2-4 Nm).
14. Attach the CMP sensor connector.
15. Connect the negative battery cable.

3.0L and 3.4L DOHC

Click on icon to view fullsize printable image. Click to Enlarge *CMP sensor mounting-3.0L DOHC engine*
Click on icon to view fullsize printable image. Click to Enlarge *CMP sensor mounting-3.4L DOHC engine*

1. Disconnect the negative battery cable.
2. Detach the CMP sensor connector.
3. Remove the CMP sensor retaining bolt and remove the CMP sensor.

To install:

4. Thoroughly clean the CMP sensor surface and ensure that the O-ring is in place.
5. Position the CMP sensor into the engine and tighten the retaining bolt to 71-106 inch lbs. (8-12 Nm).

Do not overtighten the retaining bolt or damage to the sensor will occur.

6. Attach the CMP sensor connector.
7. Connect the negative battery cable.

Crankshaft Position Sensor

OPERATION

The Crankshaft Position (CKP) sensor is a variable reluctance sensor that uses a trigger wheel to induce voltage. The CKP sensor is a fixed magnetic sensor mounted to the engine block and monitors the trigger or "pulse" wheel which is attached to the crank pulley/damper. As the pulse wheel rotates by the CKP sensor, teeth on the pulse wheel induce voltage inside the sensor through magnetism. The pulse wheel has a missing tooth that changes the reading of the sensor. This is used for the Cylinder Identification (CID) function to properly monitor and adjust engine timing by locating the number 1 cylinder. The voltage created by the CKP sensor is alternating current (A/C). This voltage reading is sent to the PCM and is used to determine engine RPM, engine timing, and is used to fire the ignition coils.

TESTING

Test the CKP sensor for output voltage while the engine is cranked or running. Voltage should be more than 0.1 volts A/C

1. Measure the voltage between the sensor CKP sensor terminals by backprobing the sensor connector.

If the connector cannot be backprobed, fabricate or purchase a test harness.

2. Sensor voltage should be more than 0.1 volt AC with the engine running and should vary with engine RPM.
3. If voltage is not within specification, the sensor may be faulty.

REMOVAL & INSTALLATION

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CKP sensor mounting-3.0L OHV engine

Click on icon to view fullsize printable image.

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CKP sensor mounting-3.0L DOHC engine

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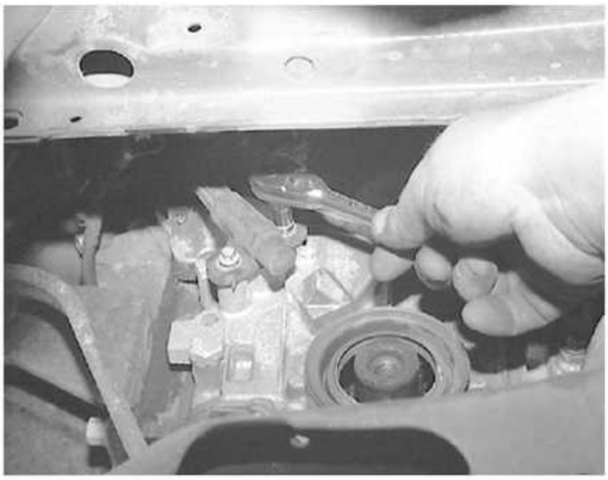
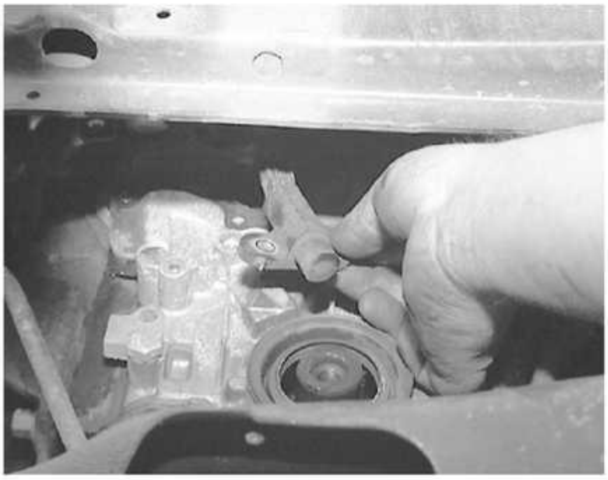
CKP sensor mounting-3.4L DOHC engine



Remove the two CKP sensor retaining screws and...

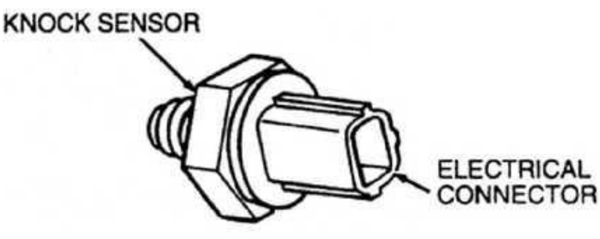


... remove the CKP sensor from the engine

1. Disconnect the negative battery cable.
2. Raise and safely support the vehicle.
3. Remove the passenger side inner fender splash shield.
4. Detach the electrical connector for the CKP sensor.
5. Remove the CKP sensor retaining bolts and remove the CKP sensor.
6. The installation is the reverse of removal.

Knock Sensor

OPERATION



Knock sensor assembly

The operation of the Knock Sensor (KS) is to monitor preignition or "engine knocks" and send the signal to the PCM. The PCM responds by adjusting ignition timing until the "knocks" stop. The sensor works by generating a signal produced by the frequency of the knock as recorded by the piezoelectric ceramic disc inside the KS. The disc absorbs the shock waves from the knocks and exerts a pressure on the metal diaphragm inside the KS. This compresses the crystals inside the disc and the disc generates a voltage signal proportional to the frequency of the knocks ranging from zero to 1 volt.

TESTING

There is real no test for this sensor, the sensor produces it's own signal based on information gathered while the engine is running. The sensors also are usually inaccessible without major component removal. The sensors can be monitored with an appropriate scan tool using a data display or other data stream information. Follow the instructions included with the scan tool for information on accessing the data. The only test available is to test the continuity of the harness from the PCM to the sensor.

REMOVAL & INSTALLATION

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The knock sensor is threaded right into the engine block

The sensor is most easily accessed from underneath the vehicle.

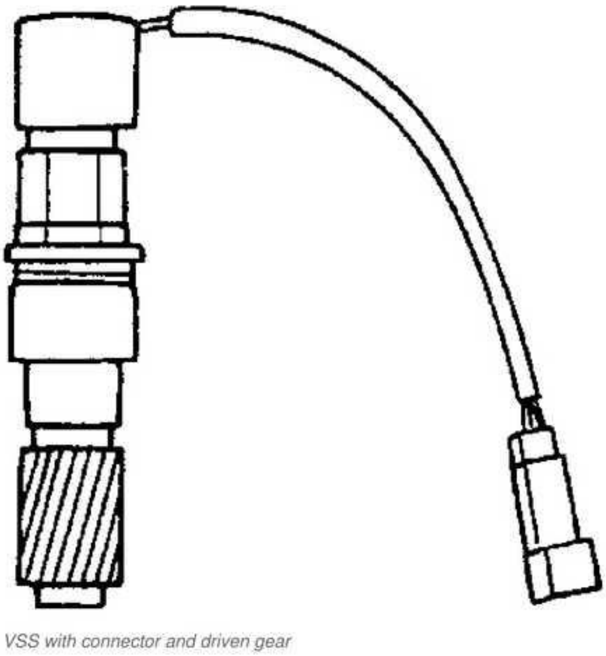
1. Disconnect the negative battery cable.
2. Raise and safely support the vehicle securely on jackstands.
3. Unplug the sensor connector.
4. Using the proper size socket, loosen and remove the knock sensor.

To install:

5. Carefully thread the sensor into the engine block.
6. Tighten the sensor to 11-14 ft lbs. (15-20 Nm).
7. Attach the sensor connector.
8. Lower the vehicle.
9. Connect the negative battery cable.

Vehicle Speed Sensor

OPERATION



VSS with connector and driven gear

The Vehicle Speed Sensor (VSS) is a magnetic pick-up sensor that sends a signal to the Powertrain Control Module (PCM) and the speedometer. The sensor measures the rotation of the output shaft on the transaxle and sends an AC voltage signal to the PCM which determines the corresponding vehicle speed.

TESTING

1. Disconnect the negative battery cable.
2. Disengage the wiring harness connector from the VSS.
3. Using a Digital Volt-Ohmmeter (DVOM), measure the resistance (ohmmeter function) between the sensor terminals. If the resistance is 190-250 ohms, the sensor is okay.

REMOVAL & INSTALLATION

1. Disconnect the negative battery cable.
2. Raise and support the vehicle.
3. Remove the catalytic converter Y-pipe.
4. Unplug the VSS electrical connector.
5. Remove the VSS protective heat shield.
6. Remove the retaining bolt from the VSS.
7. Lift the VSS out of the transaxle.
8. Remove the driven gear retainer and the drive gear.

To install:

9. Inspect the O-ring on the sensor and replace if necessary.
10. Install the driven gear and the retainer.
11. Place the VSS into the transaxle.
12. Tighten the retaining bolt to 36-53 inch lbs. (4-6 Nm).
13. Install the VSS protective heat shield.
14. Attach the VSS electrical connector.
15. Install the catalytic converter Y-pipe.
16. Lower the vehicle.
17. Connect the negative battery cable.

COMPONENT LOCATIONS

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3.0L OHV (2 valve) engine component locations (1 of 2)

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3.0L OHV (2 valve) engine component locations (2 of 2)

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3.0L OHC (4 valve) engine component locations (1 of 2)

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3.0L OHC (4 valve) engine component locations (2 of 2)
Click on icon to view fullsize printable image. Click to Enlarge 3.0L OHV (2 valve) flexible fuel engine component locations (1 of 2)
Click on icon to view fullsize printable image. Click to Enlarge 3.0L OHV (2 valve) flexible fuel engine component locations (2 of 2)
Click on icon to view fullsize printable image. Click to Enlarge 3.4L OHC (SHO) engine component locations (1 of 2)
Click on icon to view fullsize printable image. Click to Enlarge 3.4L OHC (SHO) engine component locations (2 of 2)

TROUBLE CODES

EEC-V System

GENERAL INFORMATION

The Powertrain Control Module (PCM) is given responsibility for the operation of the emission control devices, cooling fans, ignition and advance and in some cases, automatic transmission functions. Because the EEC-V oversees both the ignition timing and the fuel injector operation, a precise air/fuel ratio will be maintained under all operating conditions. The PCM is a microprocessor or small computer which receives electrical inputs from several sensors, switches and relays on and around the engine.

Based on combinations of these inputs, the PCM controls outputs to various devices concerned with engine operation and emissions. The control module relies on the signals to form a correct picture of current vehicle operation. If any of the input signals is incorrect, the PCM reacts to whatever picture is painted for it. For example, if the coolant temperature sensor is inaccurate and reads too low, the PCM may see a picture of the engine never warming up. Consequently, the engine settings will be maintained as if the engine were cold. Because so many inputs can affect one output, correct diagnostic procedures are essential on these systems.

One part of the PCM is devoted to monitoring both input and output functions within the system. This ability forms the core of the self-diagnostic system. If a problem is detected within a circuit, the control module will recognize the fault, assign it an Diagnostic Trouble Code (DTC), and store the code in memory. The stored code(s) may be retrieved during diagnosis.

While the EEC-V system is capable of recognizing many internal faults, certain faults will not be recognized. Because the control module sees only electrical signals, it cannot sense or react to mechanical or vacuum faults affecting engine operation. Some of these faults may affect another component which will set a code. For example, the PCM monitors the output signal to the fuel injectors, but cannot detect a partially clogged injector. As long as the output driver responds correctly, the computer will read the system as functioning correctly. However, the improper flow of fuel may result in a lean mixture. This would, in turn, be detected by the oxygen sensor and noticed as a constantly lean signal by the PCM. Once the signal falls outside the pre-programmed limits, the control module would notice the fault and set an trouble code.

Additionally, the EEC-V system employs adaptive fuel logic. This process is used to compensate for normal wear and variability within the fuel system. Once the engine enters steady-state operation, the control module watches the oxygen sensor signal for a bias or tendency to run slightly rich or lean. If such a bias is detected, the adaptive logic corrects the fuel delivery to bring the air/fuel mixture towards a centered or 14.7:1 ratio. This compensating shift is stored in a non-volatile memory which is retained by battery power even with the ignition switched ***OFF***. The correction factor is then available the next time the vehicle is operated.

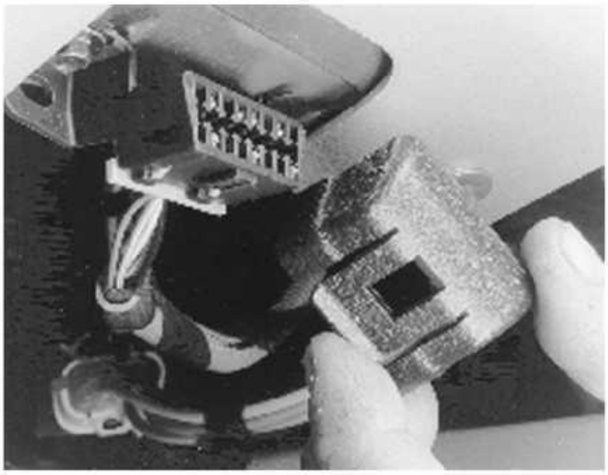
MALFUNCTION INDICATOR LAMP

The Malfunction Indicator Lamp (MIL) is located on the instrument panel. The lamp is connected to the PCM and will alert the driver to certain malfunctions within the EEC-V system. When the lamp is illuminated, the PCM has detected a fault and stored an DTC in memory.

The light will stay illuminated as long as the fault is present. Should the fault self-correct, the MIL will extinguish but the stored code will remain in memory.

Under normal operating conditions, the MIL should illuminate briefly when the ignition key is turned **ON**. This is commonly known as a prove-out. As soon as the PCM receives a signal that the engine is cranking, the lamp should extinguish. The lamp should remain extinguished during the normal operating cycle.

Data Link Connector



The diagnostic link connector is covered by a protective cap

The Data Link Connector (DLC) may be found in the following location:

- Under the driver's side dash , near the steering column.

The DLC is rectangular in design and capable of allowing access to 16 terminals. The connector has keying features that allow easy connection. The test equipment and the DLC have a latching feature to ensure a good mated connection.

ELECTRICAL TOOLS

The most commonly required electrical diagnostic tool is the Digital Multimeter, allowing voltage, resistance, and amperage to be read by one instrument. Many of the diagnostic charts require the use of a volt or ohmmeter during diagnosis.

The multimeter must be a high impedance unit, with 10 megaohms of impedance in the voltmeter. This type of meter will not place an additional load on the circuit it is testing; this is extremely important in low voltage circuits. The multimeter must be of high quality in all respects. It should be handled carefully and protected from impact or damage. Replace the batteries frequently in the unit.

Reading Codes

When using a scan tool, make sure to follow all of the manufacturer's instructions carefully to ensure proper diagnosis

The EEC-V equipped engines utilize On Board Diagnostic II (OBD-II) DTC's, which are alpha-numeric (they use letters and numbers). The letters in the OBD-II DTC's make it highly difficult to convey the codes through the use of anything but a scan tool. Therefore, to read the codes on these vehicles it is necessary to utilize an OBD-II compatible scan tool.

Since each manufacturers scan tool is different, please follow the manufacturer's instructions for connecting the tool and obtaining code information.

Clearing Codes

CONTINUOUS MEMORY CODES

These codes are retained in memory for 40 warm-up cycles. To clear the codes for the purposes of testing or confirming repair, perform the code reading procedure. When the fault codes begin to be displayed, de-activate the test by either disconnecting the jumper wire (meter, MIL or message center) or releasing the test button on the hand scanner. Stopping the test during code transmission will erase the Continuous Memory. Do not disconnect the negative battery cable to clear these codes; the Keep Alive memory will be cleared and a new code, 19, will be stored for loss of PCM power.

KEEP ALIVE MEMORY

The Keep Alive Memory (KAM) contains the adaptive factors used by the processor to compensate for component tolerances and wear. It should not be routinely cleared during diagnosis. If an emissions related part is replaced during repair, the KAM must be cleared. Failure to clear the KAM may cause severe driveability problems since the correction factor for the old component will be applied to the new component.

To clear the Keep Alive Memory, disconnect the negative battery cable for at least 5 minutes. After the memory is cleared and the battery reconnected, the vehicle must be driven at least 10 miles so that the processor may relearn the needed correction factors. The distance to be driven depends on the engine and vehicle, but all drives should include steady-throttle cruise on open roads. Certain driveability problems may be noted during the drive because the adaptive factors are not yet functioning.

EEC-V Diagnostic Trouble Codes (DTC's)

P0000 No Failures

P0100 Mass or Volume Air Flow Circuit Malfunction

P0101 Mass or Volume Air Flow Circuit Range/Performance Problem

P0102 Mass or Volume Air Flow Circuit Low Input

P0103 Mass or Volume Air Flow Circuit High Input

P0104 Mass or Volume Air Flow Circuit Intermittent

P0105 Manifold Absolute Pressure/Barometric Pressure Circuit Malfunction

P0106 Manifold Absolute Pressure/Barometric Pressure Circuit Range/Performance Problem

P0107 Manifold Absolute Pressure/Barometric Pressure Circuit Low Input

P0108 Manifold Absolute Pressure/Barometric Pressure Circuit High Input

P0109 Manifold Absolute Pressure/Barometric Pressure Circuit Intermittent

P0110 Intake Air Temperature Circuit Malfunction

P0111 Intake Air Temperature Circuit Range/Performance Problem

P0112 Intake Air Temperature Circuit Low Input

P0113 Intake Air Temperature Circuit High Input

P0114 Intake Air Temperature Circuit Intermittent

P0115 Engine Coolant Temperature Circuit Malfunction

P0116 Engine Coolant Temperature Circuit Range/Performance Problem

P0117 Engine Coolant Temperature Circuit Low Input

P0118 Engine Coolant Temperature Circuit High Input

P0119 Engine Coolant Temperature Circuit Intermittent

P0120 Throttle/Pedal Position Sensor/Switch "A" Circuit Malfunction

P0121 Throttle/Pedal Position Sensor/Switch "A" Circuit Range/Performance Problem

P0122 Throttle/Pedal Position Sensor/Switch "A" Circuit Low Input

P0123 Throttle/Pedal Position Sensor/Switch "A" Circuit High Input

P0124 Throttle/Pedal Position Sensor/Switch "A" Circuit Intermittent

P0125 Insufficient Coolant Temperature For Closed Loop Fuel Control

P0126 Insufficient Coolant Temperature For Stable Operation

P0130 O2 Circuit Malfunction (Bank no. 1 Sensor no. 1)

P0131 O2 Sensor Circuit Low Voltage (Bank no. 1 Sensor no. 1)

P0132 O2 Sensor Circuit High Voltage (Bank no. 1 Sensor no. 1)

P0133 O2 Sensor Circuit Slow Response (Bank no. 1 Sensor no. 1)

P0134 O2 Sensor Circuit No Activity Detected (Bank no. 1 Sensor no. 1)

P0135 O2 Sensor Heater Circuit Malfunction (Bank no. 1 Sensor no. 1)

P0136 O2 Sensor Circuit Malfunction (Bank no. 1 Sensor no. 2)

P0137 O2 Sensor Circuit Low Voltage (Bank no. 1 Sensor no. 2)

P0138 O2 Sensor Circuit High Voltage (Bank no. 1 Sensor no. 2)

P0139 O2 Sensor Circuit Slow Response (Bank no. 1 Sensor no. 2)

P0140 O2 Sensor Circuit No Activity Detected (Bank no. 1 Sensor no. 2)

P0141 O2 Sensor Heater Circuit Malfunction (Bank no. 1 Sensor no. 2)
P0142 O2 Sensor Circuit Malfunction (Bank no. 1 Sensor no. 3)
P0143 O2 Sensor Circuit Low Voltage (Bank no. 1 Sensor no. 3)
P0144 O2 Sensor Circuit High Voltage (Bank no. 1 Sensor no. 3)
P0145 O2 Sensor Circuit Slow Response (Bank no. 1 Sensor no. 3)
P0146 O2 Sensor Circuit No Activity Detected (Bank no. 1 Sensor no. 3)
P0147 O2 Sensor Heater Circuit Malfunction (Bank no. 1 Sensor no. 3)
P0150 O2 Sensor Circuit Malfunction (Bank no. 2 Sensor no. 1)
P0151 O2 Sensor Circuit Low Voltage (Bank no. 2 Sensor no. 1)
P0152 O2 Sensor Circuit High Voltage (Bank no. 2 Sensor no. 1)
P0153 O2 Sensor Circuit Slow Response (Bank no. 2 Sensor no. 1)
P0154 O2 Sensor Circuit No Activity Detected (Bank no. 2 Sensor no. 1)
P0155 O2 Sensor Heater Circuit Malfunction (Bank no. 2 Sensor no. 1)
P0156 O2 Sensor Circuit Malfunction (Bank no. 2 Sensor no. 2)
P0157 O2 Sensor Circuit Low Voltage (Bank no. 2 Sensor no. 2)
P0158 O2 Sensor Circuit High Voltage (Bank no. 2 Sensor no. 2)
P0159 O2 Sensor Circuit Slow Response (Bank no. 2 Sensor no. 2)
P0160 O2 Sensor Circuit No Activity Detected (Bank no. 2 Sensor no. 2)
P0161 O2 Sensor Heater Circuit Malfunction (Bank no. 2 Sensor no. 2)
P0162 O2Sensor Circuit Malfunction (Bank no. 2 Sensor no. 3)
P0163 O2Sensor Circuit Low Voltage (Bank no. 2 Sensor no. 3)
P0164 O2Sensor Circuit High Voltage (Bank no. 2 Sensor no. 3)
P0165 O2Sensor Circuit Slow Response (Bank no. 2 Sensor no. 3)
P0166 O2Sensor Circuit No Activity Detected (Bank no. 2 Sensor no. 3)
P0167 O2Sensor Heater Circuit Malfunction (Bank no. 2 Sensor no. 3)
P0170 Fuel Trim Malfunction (Bank no. 1)
P0171 System Too Lean (Bank no. 1)
P0172 System Too Rich (Bank no. 1)
P0173 Fuel Trim Malfunction (Bank no. 2)
P0174 System Too Lean (Bank no. 2)
P0175 System Too Rich (Bank no. 2)
P0176 Fuel Composition Sensor Circuit Malfunction
P0177 Fuel Composition Sensor Circuit Range/Performance
P0178 Fuel Composition Sensor Circuit Low Input
P0179 Fuel Composition Sensor Circuit High Input
P0180 Fuel Temperature Sensor "A" Circuit Malfunction
P0181 Fuel Temperature Sensor "A" Circuit Range/Performance
P0182 Fuel Temperature Sensor "A" Circuit Low Input
P0183 Fuel Temperature Sensor "A" Circuit High Input
P0184 Fuel Temperature Sensor "A" Circuit Intermittent
P0185 Fuel Temperature Sensor "B" Circuit Malfunction
P0186 Fuel Temperature Sensor "B" Circuit Range/Performance
P0187 Fuel Temperature Sensor "B" Circuit Low Input
P0188 Fuel Temperature Sensor "B" Circuit High Input
P0189 Fuel Temperature Sensor "B" Circuit Intermittent
P0190 Fuel Rail Pressure Sensor Circuit Malfunction
P0191 Fuel Rail Pressure Sensor Circuit Range/Performance
P0192 Fuel Rail Pressure Sensor Circuit Low Input
P0193 Fuel Rail Pressure Sensor Circuit High Input
P0194 Fuel Rail Pressure Sensor Circuit Intermittent
P0195 Engine Oil Temperature Sensor Malfunction
P0196 Engine Oil Temperature Sensor Range/Performance
P0197 Engine Oil Temperature Sensor Low
P0198 Engine Oil Temperature Sensor High
P0199 Engine Oil Temperature Sensor Intermittent
P0200 Injector Circuit Malfunction
P0201 Injector Circuit Malfunction-Cylinder no. 1
P0202 Injector Circuit Malfunction-Cylinder no. 2
P0203 Injector Circuit Malfunction-Cylinder no. 3
P0204 Injector Circuit Malfunction-Cylinder no. 4
P0205 Injector Circuit Malfunction-Cylinder no. 5
P0206 Injector Circuit Malfunction-Cylinder no. 6
P0207 Injector Circuit Malfunction-Cylinder no. 7

P0208 Injector Circuit Malfunction-Cylinder no. 8
P0209 Injector Circuit Malfunction-Cylinder no. 9
P0210 Injector Circuit Malfunction-Cylinder no. 10
P0211 Injector Circuit Malfunction-Cylinder no. 11
P0212 Injector Circuit Malfunction-Cylinder no. 12
P0213 Cold Start Injector no. 1 Malfunction
P0214 Cold Start Injector no. 2 Malfunction
P0215 Engine Shutoff Solenoid Malfunction
P0216 Injection Timing Control Circuit Malfunction
P0217 Engine Over Temperature Condition
P0218 Transmission Over Temperature Condition
P0219 Engine Over Speed Condition
P0220 Throttle/Pedal Position Sensor/Switch "B" Circuit Malfunction
P0221 Throttle/Pedal Position Sensor/Switch "B" Circuit Range/Performance Problem
P0222 Throttle/Pedal Position Sensor/Switch "B" Circuit Low Input
P0223 Throttle/Pedal Position Sensor/Switch "B" Circuit High Input
P0224 Throttle/Pedal Position Sensor/Switch "B" Circuit Intermittent
P0225 Throttle/Pedal Position Sensor/Switch "C" Circuit Malfunction
P0226 Throttle/Pedal Position Sensor/Switch "C" Circuit Range/Performance Problem
P0227 Throttle/Pedal Position Sensor/Switch "C" Circuit Low Input
P0228 Throttle/Pedal Position Sensor/Switch "C" Circuit High Input
P0229 Throttle/Pedal Position Sensor/Switch "C" Circuit Intermittent
P0230 Fuel Pump Primary Circuit Malfunction
P0231 Fuel Pump Secondary Circuit Low
P0232 Fuel Pump Secondary Circuit High
P0233 Fuel Pump Secondary Circuit Intermittent
P0234 Engine Over Boost Condition
P0261 Cylinder no. 1 Injector Circuit Low
P0262 Cylinder no. 1 Injector Circuit High
P0263 Cylinder no. 1 Contribution/Balance Fault
P0264 Cylinder no. 2 Injector Circuit Low
P0265 Cylinder no. 2 Injector Circuit High
P0266 Cylinder no. 2 Contribution/Balance Fault
P0267 Cylinder no. 3 Injector Circuit Low
P0268 Cylinder no. 3 Injector Circuit High
P0269 Cylinder no. 3 Contribution/Balance Fault
P0270 Cylinder no. 4 Injector Circuit Low
P0271 Cylinder no. 4 Injector Circuit High
P0272 Cylinder no. 4 Contribution/Balance Fault
P0273 Cylinder no. 5 Injector Circuit Low
P0274 Cylinder no. 5 Injector Circuit High
P0275 Cylinder no. 5 Contribution/Balance Fault
P0276 Cylinder no. 6 Injector Circuit Low
P0277 Cylinder no. 6 Injector Circuit High
P0278 Cylinder no. 6 Contribution/Balance Fault
P0279 Cylinder no. 7 Injector Circuit Low
P0280 Cylinder no. 7 Injector Circuit High
P0281 Cylinder no. 7 Contribution/Balance Fault
P0282 Cylinder no. 8 Injector Circuit Low
P0283 Cylinder no. 8 Injector Circuit High
P0284 Cylinder no. 8 Contribution/Balance Fault
P0285 Cylinder no. 9 Injector Circuit Low
P0286 Cylinder no. 9 Injector Circuit High
P0287 Cylinder no. 9 Contribution/Balance Fault
P0288 Cylinder no. 10 Injector Circuit Low
P0289 Cylinder no. 10 Injector Circuit High
P0290 Cylinder no. 10 Contribution/Balance Fault
P0291 Cylinder no. 11 Injector Circuit Low
P0292 Cylinder no. 11 Injector Circuit High
P0293 Cylinder no. 11 Contribution/Balance Fault
P0294 Cylinder no. 12 Injector Circuit Low
P0295 Cylinder no. 12 Injector Circuit High
P0296 Cylinder no. 12 Contribution/Balance Fault

P0300 Random/Multiple Cylinder Misfire Detected
P0301 Cylinder no. 1-Misfire Detected
P0302 Cylinder no. 2-Misfire Detected
P0303 Cylinder no. 3-Misfire Detected
P0304 Cylinder no. 4-Misfire Detected
P0305 Cylinder no. 5-Misfire Detected
P0306 Cylinder no. 6-Misfire Detected
P0307 Cylinder no. 7-Misfire Detected
P0308 Cylinder no. 8-Misfire Detected
P0309 Cylinder no. 9-Misfire Detected
P0310 Cylinder no. 10-Misfire Detected
P0311 Cylinder no. 11-Misfire Detected
P0312 Cylinder no. 12-Misfire Detected
P0320 Ignition/Distributor Engine Speed Input Circuit Malfunction
P0321 Ignition/Distributor Engine Speed Input Circuit Range/Performance
P0322 Ignition/Distributor Engine Speed Input Circuit No Signal
P0323 Ignition/Distributor Engine Speed Input Circuit Intermittent
P0325 Knock Sensor no. 1-Circuit Malfunction (Bank no. 1 or Single Sensor)
P0326 Knock Sensor no. 1-Circuit Range/Performance (Bank no. 1 or Single Sensor)
P0327 Knock Sensor no. 1-Circuit Low Input (Bank no. 1 or Single Sensor)
P0328 Knock Sensor no. 1-Circuit High Input (Bank no. 1 or Single Sensor)
P0329 Knock Sensor no. 1-Circuit Input Intermittent (Bank no. 1 or Single Sensor)
P0330 Knock Sensor no. 2-Circuit Malfunction (Bank no. 2)
P0331 Knock Sensor no. 2-Circuit Range/Performance (Bank no. 2)
P0332 Knock Sensor no. 2-Circuit Low Input (Bank no. 2)
P0333 Knock Sensor no. 2-Circuit High Input (Bank no. 2)
P0334 Knock Sensor no. 2-Circuit Input Intermittent (Bank no. 2)
P0335 Crankshaft Position Sensor "A" Circuit Malfunction
P0336 Crankshaft Position Sensor "A" Circuit Range/Performance
P0337 Crankshaft Position Sensor "A" Circuit Low Input
P0338 Crankshaft Position Sensor "A" Circuit High Input
P0339 Crankshaft Position Sensor "A" Circuit Intermittent
P0340 Camshaft Position Sensor Circuit Malfunction
P0341 Camshaft Position Sensor Circuit Range/Performance
P0342 Camshaft Position Sensor Circuit Low Input
P0343 Camshaft Position Sensor Circuit High Input
P0344 Camshaft Position Sensor Circuit Intermittent
P0350 Ignition Coil Primary/Secondary Circuit Malfunction
P0351 Ignition Coil "A" Primary/Secondary Circuit Malfunction
P0352 Ignition Coil "B" Primary/Secondary Circuit Malfunction
P0353 Ignition Coil "C" Primary/Secondary Circuit Malfunction
P0354 Ignition Coil "D" Primary/Secondary Circuit Malfunction
P0355 Ignition Coil "E" Primary/Secondary Circuit Malfunction
P0356 Ignition Coil "F" Primary/Secondary Circuit Malfunction
P0357 Ignition Coil "G" Primary/Secondary Circuit Malfunction
P0358 Ignition Coil "H" Primary/Secondary Circuit Malfunction
P0359 Ignition Coil "I" Primary/Secondary Circuit Malfunction
P0360 Ignition Coil "J" Primary/Secondary Circuit Malfunction
P0361 Ignition Coil "K" Primary/Secondary Circuit Malfunction
P0362 Ignition Coil "L" Primary/Secondary Circuit Malfunction
P0370 Timing Reference High Resolution Signal "A" Malfunction
P0371 Timing Reference High Resolution Signal "A" Too Many Pulses
P0372 Timing Reference High Resolution Signal "A" Too Few Pulses
P0373 Timing Reference High Resolution Signal "A" Intermittent/Erratic Pulses
P0374 Timing Reference High Resolution Signal "A" No Pulses
P0375 Timing Reference High Resolution Signal "B" Malfunction
P0376 Timing Reference High Resolution Signal "B" Too Many Pulses
P0377 Timing Reference High Resolution Signal "B" Too Few Pulses
P0378 Timing Reference High Resolution Signal "B" Intermittent/Erratic Pulses
P0379 Timing Reference High Resolution Signal "B" No Pulses
P0380 Glow Plug/Heater Circuit "A" Malfunction
P0381 Glow Plug/Heater Indicator Circuit Malfunction
P0382 Glow Plug/Heater Circuit "B" Malfunction

P0385 Crankshaft Position Sensor "B" Circuit Malfunction
P0386 Crankshaft Position Sensor "B" Circuit Range/Performance
P0387 Crankshaft Position Sensor "B" Circuit Low Input
P0388 Crankshaft Position Sensor "B" Circuit High Input
P0389 Crankshaft Position Sensor "B" Circuit Intermittent
P0400 Exhaust Gas Recirculation Flow Malfunction
P0401 Exhaust Gas Recirculation Flow Insufficient Detected
P0402 Exhaust Gas Recirculation Flow Excessive Detected
P0403 Exhaust Gas Recirculation Circuit Malfunction
P0404 Exhaust Gas Recirculation Circuit Range/Performance
P0405 Exhaust Gas Recirculation Sensor "A" Circuit Low
P0406 Exhaust Gas Recirculation Sensor "A" Circuit High
P0407 Exhaust Gas Recirculation Sensor "B" Circuit Low
P0408 Exhaust Gas Recirculation Sensor "B" Circuit High
P0410 Secondary Air Injection System Malfunction
P0411 Secondary Air Injection System Incorrect Flow Detected
P0412 Secondary Air Injection System Switching Valve "A" Circuit Malfunction
P0413 Secondary Air Injection System Switching Valve "A" Circuit Open
P0414 Secondary Air Injection System Switching Valve "A" Circuit Shorted
P0415 Secondary Air Injection System Switching Valve "B" Circuit Malfunction
P0416 Secondary Air Injection System Switching Valve "B" Circuit Open
P0417 Secondary Air Injection System Switching Valve "B" Circuit Shorted
P0418 Secondary Air Injection System Relay "A" Circuit Malfunction
P0419 Secondary Air Injection System Relay "B" Circuit Malfunction
P0420 Catalyst System Efficiency Below Threshold (Bank no. 1)
P0421 Warm Up Catalyst Efficiency Below Threshold (Bank no. 1)
P0422 Main Catalyst Efficiency Below Threshold (Bank no. 1)
P0423 Heated Catalyst Efficiency Below Threshold (Bank no. 1)
P0424 Heated Catalyst Temperature Below Threshold (Bank no. 1)
P0430 Catalyst System Efficiency Below Threshold (Bank no. 2)
P0431 Warm Up Catalyst Efficiency Below Threshold (Bank no. 2)
P0432 Main Catalyst Efficiency Below Threshold (Bank no. 2)
P0433 Heated Catalyst Efficiency Below Threshold (Bank no. 2)
P0434 Heated Catalyst Temperature Below Threshold (Bank no. 2)
P0440 Evaporative Emission Control System Malfunction
P0441 Evaporative Emission Control System Incorrect Purge Flow
P0442 Evaporative Emission Control System Leak Detected (Small Leak)
P0443 Evaporative Emission Control System Purge Control Valve Circuit Malfunction
P0444 Evaporative Emission Control System Purge Control Valve Circuit Open
P0445 Evaporative Emission Control System Purge Control Valve Circuit Shorted
P0446 Evaporative Emission Control System Vent Control Circuit Malfunction
P0447 Evaporative Emission Control System Vent Control Circuit Open
P0448 Evaporative Emission Control System Vent Control Circuit Shorted
P0449 Evaporative Emission Control System Vent Valve/Solenoid Circuit Malfunction
P0450 Evaporative Emission Control System Pressure Sensor Malfunction
P0451 Evaporative Emission Control System Pressure Sensor Range/Performance
P0452 Evaporative Emission Control System Pressure Sensor Low Input
P0453 Evaporative Emission Control System Pressure Sensor High Input
P0454 Evaporative Emission Control System Pressure Sensor Intermittent
P0455 Evaporative Emission Control System Leak Detected (Gross Leak)
P0460 Fuel Level Sensor Circuit Malfunction
P0461 Fuel Level Sensor Circuit Range/Performance
P0462 Fuel Level Sensor Circuit Low Input
P0463 Fuel Level Sensor Circuit High Input
P0464 Fuel Level Sensor Circuit Intermittent
P0465 Purge Flow Sensor Circuit Malfunction
P0466 Purge Flow Sensor Circuit Range/Performance
P0467 Purge Flow Sensor Circuit Low Input
P0468 Purge Flow Sensor Circuit High Input
P0469 Purge Flow Sensor Circuit Intermittent
P0470 Exhaust Pressure Sensor Malfunction
P0471 Exhaust Pressure Sensor Range/Performance
P0472 Exhaust Pressure Sensor Low

P0473 Exhaust Pressure Sensor High
P0474 Exhaust Pressure Sensor Intermittent
P0475 Exhaust Pressure Control Valve Malfunction
P0476 Exhaust Pressure Control Valve Range/Performance
P0477 Exhaust Pressure Control Valve Low
P0478 Exhaust Pressure Control Valve High
P0479 Exhaust Pressure Control Valve Intermittent
P0480 Cooling Fan no. 1 Control Circuit Malfunction
P0481 Cooling Fan no. 2 Control Circuit Malfunction
P0482 Cooling Fan no. 3 Control Circuit Malfunction
P0483 Cooling Fan Rationality Check Malfunction
P0484 Cooling Fan Circuit Over Current
P0485 Cooling Fan Power/Ground Circuit Malfunction
P0500 Vehicle Speed Sensor Malfunction
P0501 Vehicle Speed Sensor Range/Performance
P0502 Vehicle Speed Sensor Circuit Low Input
P0503 Vehicle Speed Sensor Intermittent/Erratic/High
P0505 Idle Control System Malfunction
P0506 Idle Control System RPM Lower Than Expected
P0507 Idle Control System RPM Higher Than Expected
P0510 Closed Throttle Position Switch Malfunction
P0520 Engine Oil Pressure Sensor/Switch Circuit Malfunction
P0521 Engine Oil Pressure Sensor/Switch Range/Performance
P0522 Engine Oil Pressure Sensor/Switch Low Voltage
P0523 Engine Oil Pressure Sensor/Switch High Voltage
P0530 A/C Refrigerant Pressure Sensor Circuit Malfunction
P0531 A/C Refrigerant Pressure Sensor Circuit Range/Performance
P0532 A/C Refrigerant Pressure Sensor Circuit Low Input
P0533 A/C Refrigerant Pressure Sensor Circuit High Input
P0534 A/C Refrigerant Charge Loss
P0550 Power Steering Pressure Sensor Circuit Malfunction
P0551 Power Steering Pressure Sensor Circuit Range/Performance
P0552 Power Steering Pressure Sensor Circuit Low Input
P0553 Power Steering Pressure Sensor Circuit High Input
P0554 Power Steering Pressure Sensor Circuit Intermittent
P0560 System Voltage Malfunction
P0561 System Voltage Unstable
P0562 System Voltage Low
P0563 System Voltage High
P0565 Cruise Control On Signal Malfunction
P0566 Cruise Control Off Signal Malfunction
P0567 Cruise Control Resume Signal Malfunction
P0568 Cruise Control Set Signal Malfunction
P0569 Cruise Control Coast Signal Malfunction
P0570 Cruise Control Accel Signal Malfunction
P0571 Cruise Control/Brake Switch "A" Circuit Malfunction
P0572 Cruise Control/Brake Switch "A" Circuit Low
P0573 Cruise Control/Brake Switch "A" Circuit High
P0574 Through P0580 Reserved for Cruise Codes
P0600 Serial Communication Link Malfunction
P0601 Internal Control Module Memory Check Sum Error
P0602 Control Module Programming Error
P0603 Internal Control Module Keep Alive Memory (KAM) Error
P0604 Internal Control Module Random Access Memory (RAM) Error
P0605 Internal Control Module Read Only Memory (ROM) Error
P0606 PCM Processor Fault
P0608 Control Module VSS Output "A" Malfunction
P0609 Control Module VSS Output "B" Malfunction
P0620 Generator Control Circuit Malfunction
P0621 Generator Lamp "L" Control Circuit Malfunction
P0622 Generator Field "F" Control Circuit Malfunction
P0650 Malfunction Indicator Lamp (MIL) Control Circuit Malfunction
P0654 Engine RPM Output Circuit Malfunction

P0655 Engine Hot Lamp Output Control Circuit Malfunction
P0656 Fuel Level Output Circuit Malfunction
P0700 Transmission Control System Malfunction
P0701 Transmission Control System Range/Performance
P0702 Transmission Control System Electrical
P0703 Torque Converter/Brake Switch "B" Circuit Malfunction
P0704 Clutch Switch Input Circuit Malfunction
P0705 Transmission Range Sensor Circuit Malfunction (PRNDL Input)
P0706 Transmission Range Sensor Circuit Range/Performance
P0707 Transmission Range Sensor Circuit Low Input
P0708 Transmission Range Sensor Circuit High Input
P0709 Transmission Range Sensor Circuit Intermittent
P0710 Transmission Fluid Temperature Sensor Circuit Malfunction
P0711 Transmission Fluid Temperature Sensor Circuit Range/Performance
P0712 Transmission Fluid Temperature Sensor Circuit Low Input
P0713 Transmission Fluid Temperature Sensor Circuit High Input
P0714 Transmission Fluid Temperature Sensor Circuit Intermittent
P0715 Input/Turbine Speed Sensor Circuit Malfunction
P0716 Input/Turbine Speed Sensor Circuit Range/Performance
P0717 Input/Turbine Speed Sensor Circuit No Signal
P0718 Input/Turbine Speed Sensor Circuit Intermittent
P0719 Torque Converter/Brake Switch "B" Circuit Low
P0720 Output Speed Sensor Circuit Malfunction
P0721 Output Speed Sensor Circuit Range/Performance
P0722 Output Speed Sensor Circuit No Signal
P0723 Output Speed Sensor Circuit Intermittent
P0724 Torque Converter/Brake Switch "B" Circuit High
P0725 Engine Speed Input Circuit Malfunction
P0726 Engine Speed Input Circuit Range/Performance
P0727 Engine Speed Input Circuit No Signal
P0728 Engine Speed Input Circuit Intermittent
P0730 Incorrect Gear Ratio
P0731 Gear no. 1 Incorrect Ratio
P0732 Gear no. 2 Incorrect Ratio
P0733 Gear no. 3 Incorrect Ratio
P0734 Gear no. 4 Incorrect Ratio
P0735 Gear no. 5 Incorrect Ratio
P0736 Reverse Incorrect Ratio
P0740 Torque Converter Clutch Circuit Malfunction
P0741 Torque Converter Clutch Circuit Performance or Stuck Off
P0742 Torque Converter Clutch Circuit Stuck On
P0743 Torque Converter Clutch Circuit Electrical
P0744 Torque Converter Clutch Circuit Intermittent
P0745 Pressure Control Solenoid Malfunction
P0746 Pressure Control Solenoid Performance or Stuck Off
P0747 Pressure Control Solenoid Stuck On
P0748 Pressure Control Solenoid Electrical
P0749 Pressure Control Solenoid Intermittent
P0750 Shift Solenoid "A" Malfunction
P0751 Shift Solenoid "A" Performance or Stuck Off
P0752 Shift Solenoid "A" Stuck On
P0753 Shift Solenoid "A" Electrical
P0754 Shift Solenoid "A" Intermittent
P0755 Shift Solenoid "B" Malfunction
P0756 Shift Solenoid "B" Performance or Stuck Oft
P0757 Shift Solenoid "B" Stuck On
P0758 Shift Solenoid "B" Electrical
P0759 Shift Solenoid "B" Intermittent
P0760 Shift Solenoid "C" Malfunction
P0761 Shift Solenoid "C" Performance Or Stuck Oft
P0762 Shift Solenoid "C" Stuck On
P0763 Shift Solenoid "C" Electrical
P0764 Shift Solenoid "C" Intermittent

P0765 Shift Solenoid "D" Malfunction
P0766 Shift Solenoid "D" Performance Or Stuck Oft
P0767 Shift Solenoid "D" Stuck On
P0768 Shift Solenoid "D" Electrical
P0769 Shift Solenoid "D" Intermittent
P0770 Shift Solenoid "E" Malfunction
P0771 Shift Solenoid "E" Performance Or Stuck Oft
P0772 Shift Solenoid "E" Stuck On
P0773 Shift Solenoid "E" Electrical
P0774 Shift Solenoid "E" Intermittent
P0780 Shift Malfunction
P0781 1-2 Shift Malfunction
P0782 2-3 Shift Malfunction
P0783 3-4 Shift Malfunction
P0784 4-5 Shift Malfunction
P0785 Shift/Timing Solenoid Malfunction
P0786 Shift/Timing Solenoid Range/Performance
P0787 Shift/Timing Solenoid Low
P0788 Shift/Timing Solenoid High
P0789 Shift/Timing Solenoid Intermittent
P0790 Normal/Performance Switch Circuit Malfunction
P0801 Reverse Inhibit Control Circuit Malfunction
P0803 1-4 Upshift (Skip Shift) Solenoid Control Circuit Malfunction
P0804 1-4 Upshift (Skip Shift) Lamp Control Circuit Malfunction
P1000 OBD II Monitor Testing Not Complete More Driving Required
P1001 Key On Engine Running (KOER) Self-Test Not Able To Complete, KOER Aborted
P1100 Mass Air Flow (MAF) Sensor Intermittent
P1101 Mass Air Flow (MAF) Sensor Out Of Self-Test Range
P1111 System Pass 49 State Except Econoline
P1112 Intake Air Temperature (IAT) Sensor Intermittent
P1116 Engine Coolant Temperature (ECT) Sensor Out Of Self-Test Range
P1117 Engine Coolant Temperature (ECT) Sensor Intermittent
P1120 Throttle Position (TP) Sensor Out Of Range (Low)
P1121 Throttle Position (TP) Sensor Inconsistent With MAF Sensor
P1124 Throttle Position (TP) Sensor Out Of Self-Test Range
P1125 Throttle Position (TP) Sensor Circuit Intermittent
P1127 Exhaust Not Warm Enough, Downstream Heated Oxygen Sensors (HO2S) Not Tested
P1128 Upstream Heated Oxygen Sensors (HO2S) Swapped From Bank To Bank
P1129 Downstream Heated Oxygen Sensors (HO2S) Swapped From Bank To Bank
P1130 Lack Of Upstream Heated Oxygen Sensor (HO2S 11) Switch, Adaptive Fuel At Limit (Bank #1)
P1131 Lack Of Upstream Heated Oxygen Sensor (HO2S 11) Switch, Sensor Indicates Lean (Bank #1)
P1132 Lack Of Upstream Heated Oxygen Sensor (HO2S 11) Switch, Sensor Indicates Rich (Bank#1)
P1137 Lack Of Downstream Heated Oxygen Sensor (HO2S 12) Switch, Sensor Indicates Lean (Bank#1)
P1138 Lack Of Downstream Heated Oxygen Sensor (HO2S 12) Switch, Sensor Indicates Rich (Bank#1)
P1150 Lack Of Upstream Heated Oxygen Sensor (HO2S 21) Switch, Adaptive Fuel At Limit (Bank #2)
P1151 Lack Of Upstream Heated Oxygen Sensor (HO2S 21) Switch, Sensor Indicates Lean (Bank#2)
P1152 Lack Of Upstream Heated Oxygen Sensor (HO2S 21) Switch, Sensor Indicates Rich (Bank #2)
P1157 Lack Of Downstream Heated Oxygen Sensor (HO2S 22) Switch, Sensor Indicates Lean (Bank #2)
P1158 Lack Of Downstream Heated Oxygen Sensor (HO2S 22) Switch, Sensor Indicates Rich (Bank#2)
P1169 (HO2S 12) Signal Remained Unchanged For More Than 20 Seconds After Closed Loop
P1170 (HO2S 11) Signal Remained Unchanged For More Than 20 Seconds After Closed Loop
P1173 Feedback A/F Mixture Control (HO2S 21) Signal Remained Unchanged For More Than 20 Seconds After Closed Loop
P1184 Engine Oil Temp Sensor Circuit Performance
P1195 Barometric (BARO) Pressure Sensor Circuit Malfunction (Signal Is From EGR Boost Sensor)
P1196 Starter Switch Circuit Malfunction
P1209 Injection Control Pressure (ICP) Peak Fault
P1210 Injection Control Pressure (ICP) Above Expected Level
P1211 Injection Control Pressure (ICP) Not Controllable-Pressure Above/Below Desired
P1212 Injection Control Pressure (ICP) Voltage Not At Expected Level
P1218 Cylinder Identification (CID) Stuck High
P1219 Cylinder Identification (CID) Stuck Low
P1220 Series Throttle Control Malfunction (Traction Control System)
P1224 Throttle Position Sensor "B" (TP-B) Out Of Self-Test Range (Traction Control System)

P1230 Fuel Pump Low Speed Malfunction
P1231 Fuel Pump Secondary Circuit Low With High Speed Pump On
P1232 Low Speed Fuel Pump Primary Circuit Malfunction
P1233 Fuel Pump Driver Module Off-line (MIL DTC)
P1234 Fuel Pump Driver Module Disabled Or Off-line (No MIL)
P1235 Fuel Pump Control Out Of Range (MIL DTC)
P1236 Fuel Pump Control Out Of Range (No MIL)
P1237 Fuel Pump Secondary Circuit Malfunction (MIL DTC)
P1238 Fuel Pump Secondary Circuit Malfunction (No DMIL)
P1250 Fuel Pressure Regulator Control (FPRC) Solenoid Malfunction
P1260 THEFT Detected-Engine Disabled
P1261 High To Low Side Short-Cylinder #1 (Indicates Low side Circuit Is Shorted To B+ Or To The High Side Between The IDM And The Injector)
P1262 High To Low Side Short-Cylinder #2 (Indicates Low side Circuit Is Shorted To B+ Or To The High Side Between The IDM And The Injector)
P1263 High To Low Side Short-Cylinder #3 (Indicates Low side Circuit Is Shorted To B+ Or To The High Side Between The IDM And The Injector)
P1264 High To Low Side Short-Cylinder #4 (Indicates Low side Circuit Is Shorted To B+ Or To The High Side Between The IDM And The Injector)
P1265 High To Low Side Short-Cylinder #5 (Indicates Low side Circuit Is Shorted To B+ Or To The High Side Between The IDM And The Injector)
P1266 High To Low Side Short-Cylinder #6 (Indicates Low side Circuit Is Shorted To B+ Or To The High Side Between The IDM And The Injector)
P1267 High To Low Side Short-Cylinder #7 (Indicates Low side Circuit Is Shorted To B+ Or To The High Side Between The IDM And The Injector)
P1268 High To Low Side Short-Cylinder #8 (Indicates Low side Circuit Is Shorted To B+ Or To The High Side Between The IDM And The Injector)
P1270 Engine RPM Or Vehicle Speed Limiter Reached
P1271 High To Low Side Open-Cylinder #1 (Indicates A High To Low Side Open Between The Injector And The IDM)
P1272 High To Low Side Open-Cylinder #2 (Indicates A High To Low Side Open Between The Injector And The IDM)
P1273 High To Low Side Open-Cylinder #3 (Indicates A High To Low Side Open Between The Injector And The IDM)
P1274 High To Low Side Open-Cylinder #4 (Indicates A High To Low Side Open Between The Injector And The IDM)
P1275 High To Low Side Open-Cylinder #5 (Indicates A High To Low Side Open Between The Injector And The IDM)
P1276 High To Low Side Open-Cylinder #6 (Indicates A High To Low Side Open Between The Injector And The IDM)
P1277 High To Low Side Open-Cylinder #7 (Indicates A High To Low Side Open Between The Injector And The IDM)
P1278 High To Low Side Open-Cylinder #8 (Indicates A High To Low Side Open Between The Injector And The IDM)
P1280 Injection Control Pressure (ICP) Circuit Out Of Range Low
P1281 Injection Control Pressure (ICP) Circuit Out Of Range High
P1282 Injection Control Pressure (ICP) Excessive
P1283 Injection Pressure Regulator (IPR) Circuit Failure
P1284 Injection Control Pressure (ICP) Failure-Aborts KOER Or CCT Test
P1285 Cylinder Head Temperature (CHT) Over Temperature Sensed
P1288 Cylinder Head Temperature (CHT) Sensor Out Of Self-Test Range
P1289 Cylinder Head Temperature (CHT) Sensor Circuit Low Input
P1290 Cylinder Head Temperature (CHT) Sensor Circuit High Input
P1291 IDM To Injector High Side Circuit #1 (Right Bank) Short To GND Or B+
P1292 IDM To Injector High Side Circuit #2 (Right Bank) Short To GND Or B+
P1293 IDM To Injector High Side Circuit Open Bank #1 (Right Bank)
P1294 IDM To Injector High Side Circuit Open Bank #2 (Left Bank)
P1295 Multiple IDM/Injector Circuit Faults On Bank #1 (Right)
P1296 Multiple IDM/Injector Circuit Faults On Bank#2 (Left)
P1297 High Sides Shorted Together
P1298 IDM Failure
P1299 Engine Over Temperature Condition
P1309 Misfire Detection Monitor Is Not Enabled
P1316 Injector Circuit/IDM Codes Detected
P1320 Distributor Signal Interrupt
P1336 Crankshaft Position Sensor (Gear)
P1345 No Camshaft Position Sensor Signal
P1351 Ignition Diagnostic Monitor (IDM) Circuit Input Malfunction
P1351 Indicates Ignition System Malfunction
P1352 Indicates Ignition System Malfunction
P1353 Indicates Ignition System Malfunction
P1354 Indicates Ignition System Malfunction
P1355 Indicates Ignition System Malfunction

P1356 PIPs Occurred While IDM Pulse width Indicates Engine Not Turning
P1357 Ignition Diagnostic Monitor (IDM) Pulse width Not Defined
P1358 Ignition Diagnostic Monitor (IDM) Signal Out Of Self-Test Range
P1359 Spark Output Circuit Malfunction
P1364 Spark Output Circuit Malfunction
P1390 Octane Adjust (OCT ADJ) Out Of Self-Test Range
P1391 Glow Plug Circuit Low Input Bank #1 (Right)
P1392 Glow Plug Circuit High Input Bank #1 (Right)
P1393 Glow Plug Circuit Low Input Bank #2 (Left)
P1394 Glow Plug Circuit High Input Bank #2 (Left)
P1395 Glow Plug Monitor Fault Bank #1
P1396 Glow Plug Monitor Fault Bank #2
P1397 System Voltage Out Of Self Test Range
P1400 Differential Pressure Feedback EGR (DPFE) Sensor Circuit Low Voltage Detected
P1401 Differential Pressure Feedback EGR (DPFE) Sensor Circuit High Voltage Detected/EGR Temperature Sensor
P1402 EGR Valve Position Sensor Open Or Short
P1403 Differential Pressure Feedback EGR (DPFE) Sensor Hoses Reversed
P1405 Differential Pressure Feedback EGR (DPFE) Sensor Upstream Hose Off Or Plugged
P1406 Differential Pressure Feedback EGR (DPFE) Sensor Downstream Hose Off Or Plugged
P1407 Exhaust Gas Recirculation (EGR) No Flow Detected (Valve Stuck Closed Or Inoperative)
P1408 Exhaust Gas Recirculation (EGR) Flow Out Of Self-Test Range
P1409 Electronic Vacuum Regulator (EVR) Control Circuit Malfunction
P1410 Check That Fuel Pressure Regulator Control Solenoid And The EGR Check Solenoid Connectors Are Not Swapped
P1411 Secondary Air Injection System Incorrect Downstream Flow Detected
P1413 Secondary Air Injection System Monitor Circuit Low Voltage
P1414 Secondary Air Injection System Monitor Circuit High Voltage
P1442 Evaporative Emission Control System Small Leak Detected
P1443 Evaporative Emission Control System-Vacuum System, Purge Control Solenoid Or Purge Control Valve Malfunction
P1444 Purge Flow Sensor (PFS) Circuit Low Input
P1445 Purge Flow Sensor (PFS) Circuit High Input
P1449 Evaporative Emission Control System Unable To Hold Vacuum
P1450 Unable To Bleed Up Fuel Tank Vacuum
P1455 Evaporative Emission Control System Control Leak Detected (Gross Leak)
P1460 Wide Open Throttle Air Conditioning Cut-Off Circuit Malfunction
P1461 Air Conditioning Pressure (ACP) Sensor Circuit Low Input
P1462 Air Conditioning Pressure (ACP) Sensor Circuit High Input
P1463 Air Conditioning Pressure (ACP) Sensor Insufficient Pressure Change
P1464 Air Conditioning (A/C) Demand Out Of Self-Test Range/A/C On During KOER Or CCT Test
P1469 Low Air Conditioning Cycling Period
P1473 Fan Secondary High, With Fan(s) Off
P1474 Low Fan Control Primary Circuit Malfunction
P1479 High Fan Control Primary Circuit Malfunction
P1480 Fan Secondary Low, With Low Fan On
P1481 Fan Secondary Low, With High Fan On
P1483 Power To Fan Circuit Over current
P1484 Open Power/Ground To Variable Load Control Module (VLCM)
P1485 EGR Control Solenoid Open Or Short
P1486 EGR Vent Solenoid Open Or Short
P1487 EGR Boost Check Solenoid Open Or Short
P1500 Vehicle Speed Sensor (VSS) Circuit Intermittent
P1501 Vehicle Speed Sensor (VSS) Out Of Self-Test Range/Vehicle Moved During Test
P1502 Invalid Self Test-Auxiliary Powertrain Control Module (APCM) Functioning
P1504 Idle Air Control (IAC) Circuit Malfunction
P1505 Idle Air Control (IAC) System At Adaptive Clip
P1506 Idle Air Control (IAC) Overspeed Error
P1507 Idle Air Control (IAC) Underspeed Error
P1512 Intake Manifold Runner Control (IMRC) Malfunction (Bank#1 Stuck Closed)
P1513 Intake Manifold Runner Control (IMRC) Malfunction (Bank#2 Stuck Closed)
P1516 Intake Manifold Runner Control (IMRC) Input Error (Bank #1)
P1517 Intake Manifold Runner Control (IMRC) Input Error (Bank #2)
P1518 Intake Manifold Runner Control (IMRC) Malfunction (Stuck Open)
P1519 Intake Manifold Runner Control (IMRC) Malfunction (Stuck Closed)
P1520 Intake Manifold Runner Control (IMRC) Circuit Malfunction

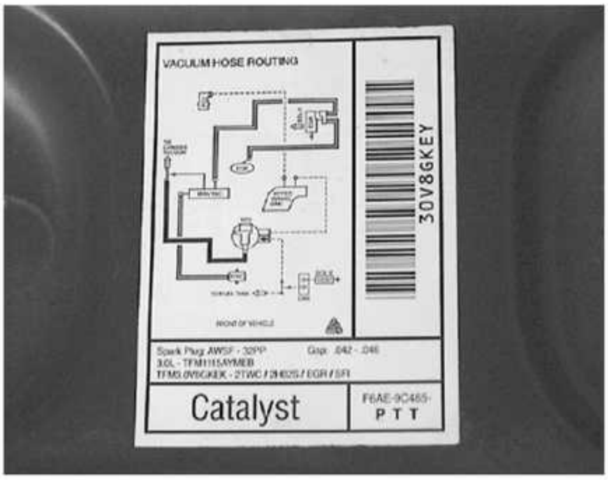
P1521 Variable Resonance Induction System (VRIS) Solenoid #1 Open Or Short
P1522 Variable Resonance Induction System (VRIS) Solenoid#2 Open Or Short
P1523 High Speed Inlet Air (HSIA) Solenoid Open Or Short
P1530 Air Condition (A/C) Clutch Circuit Malfunction
P1531 Invalid Test-Accelerator Pedal Movement
P1536 Parking Brake Applied Failure
P1537 Intake Manifold Runner Control (IMRC) Malfunction (Bank#1 Stuck Open)
P1538 Intake Manifold Runner Control (IMRC) Malfunction (Bank#2 Stuck Open)
P1539 Power To Air Condition (A/C) Clutch Circuit Overcurrent
P1549 Problem In Intake Manifold Tuning (IMT) Valve System
P1550 Power Steering Pressure (PSP) Sensor Out Of Self-Test Range
P1601 Serial Communication Error
P1605 Powertrain Control Module (PCM)-Keep Alive Memory (KAM) Test Error
P1608 PCM Internal Circuit Malfunction
P1609 PCM Internal Circuit Malfunction (2.5L Only)
P1625 B+ Supply To Variable Load Control Module (VLCM) Fan Circuit Malfunction
P1626 B+ Supply To Variable Load Control Module (VLCM) Air Conditioning (A/C) Circuit
P1650 Power Steering Pressure (PSP) Switch Out Of Self-Test Range
P1651 Power Steering Pressure (PSP) Switch Input Malfunction
P1660 Output Circuit Check Signal High
P1661 Output Circuit Check Signal Low
P1662 Injection Driver Module Enable (IDM EN) Circuit Failure
P1663 Fuel Delivery Command Signal (FDCS) Circuit Failure
P1667 Cylinder Identification (CID) Circuit Failure
P1668 PCM-IDM Diagnostic Communication Error
P1670 EF Feedback Signal Not Detected
P1701 Reverse Engagement Error
P1701 Fuel Trim Malfunction (Villager)
P1703 Brake On/Off (BOO) Switch Out Of Self-Test Range
P1704 Digital Transmission Range (TR) Sensor Failed To Transition State
P1705 Transmission Range (TR) Sensor Out Of Self-Test Range
P1705 TP Sensor (AT) Villager
P1705 Clutch Pedal Position (CPP) Or Park Neutral Position (PNP) Problem
P1706 High Vehicle Speed In Park
P1709 Park Or Neutral Position (PNP) Or Clutch Pedal Position (CPP) Switch Out Of Self-Test Range
P1709 Throttle Position (TP) Sensor Malfunction (Aspire 1.3L, Escort/ Tracer 1.8L, Probe 2.5L)
P1711 Transmission Fluid Temperature (TFT) Sensor Out Of Self-Test Range
P1714 Shift Solenoid "A" Inductive Signature Malfunction
P1715 Shift Solenoid "B" Inductive Signature Malfunction
P1716 Transmission Malfunction
P1717 Transmission Malfunction
P1719 Transmission Malfunction
P1720 Vehicle Speed Sensor (VSS) Circuit Malfunction
P1727 Coast Clutch Solenoid Inductive Signature Malfunction
P1728 Transmission Slip Error-Converter Clutch Failed
P1729 4x4 Low Switch Error
P1731 Improper 1-2 Shift
P1732 Improper 2-3 Shift
P1733 Improper 3-4 Shift
P1734 Improper 4-5 Shift
P1740 Torque Converter Clutch (TCC) Inductive Signature Malfunction
P1741 Torque Converter Clutch (TCC) Control Error
P1742 Torque Converter Clutch (TCC) Solenoid Failed On (Turns On MIL)
P1743 Torque Converter Clutch (TCC) Solenoid Failed On (Turns On TCIL)
P1744 Torque Converter Clutch (TCC) System Mechanically Stuck In Off Position
P1744 Torque Converter Clutch (TCC) Solenoid Malfunction (2.5L Only)
P1746 Electronic Pressure Control (EPC) Solenoid Open Circuit (Low Input)
P1747 Electronic Pressure Control (EPC) Solenoid Short Circuit (High Input)
P1748 Electronic Pressure Control (EPC) Malfunction
P1749 Electronic Pressure Control (EPC) Solenoid Failed Low
P1751 Shift Solenoid#1 (SS1) Performance
P1754 Coast Clutch Solenoid (CCS) Circuit Malfunction
P1756 Shift Solenoid#2 (SS2) Performance

P1760 Overrun Clutch SN
P1761 Shift Solenoid #(SS2) Performance
P1762 Transmission Malfunction
P1765 3-2 Timing Solenoid Malfunction (2.5L Only)
P1779 TCIL Circuit Malfunction
P1780 Transmission Control Switch (TCS) Circuit Out Of Self-Test Range
P1781 4x4 Low Switch, Out Of Self-Test Range
P1783 Transmission Over Temperature Condition
P1784 Transmission Malfunction
P1785 Transmission Malfunction
P1786 Transmission Malfunction
P1787 Transmission Malfunction
P1788 3-2 Timing/Coast Clutch Solenoid (3-2/CCS) Circuit Open
P1789 3-2 Timing/Coast Clutch Solenoid (3-2/CCS) Circuit Shorted
P1792 Idle (IDL) Switch (Closed Throttle Position Switch) Malfunction
P1794 Loss Of Battery Voltage Input
P1795 EGR Boost Sensor Malfunction
P1797 Clutch Pedal Position (CPP) Switch Or Neutral Switch Circuit Malfunction
P1900 Cooling Fan
U1021 SCP Indicating The Lack Of Air Conditioning (A/C) Clutch Status Response
U1039 Vehicle Speed Signal (VSS) Missing Or Incorrect
U1051 Brake Switch Signal Missing Or Incorrect
U1073 SCP Indicating The Lack Of Engine Coolant Fan Status Response
U1131 SCP Indicating The Lack Of Fuel Pump Status Response
U1135 SCP Indicating The Ignition Switch Signal Missing Or Incorrect
U1256 SCP Indicating A Communications Error
U1451 Lack Of Response From Passive Anti-Theft System (PATS) Module-Engine Disabled

VACUUM DIAGRAMS

Following are vacuum diagrams for most of the engine and emissions package combinations covered by this manual. Because vacuum circuits will vary based on various engine and vehicle options, always refer first to the vehicle emission control information label, if present. Should the label be missing, or should vehicle be equipped with a different engine from the vehicle's original equipment, refer to the diagrams below for the same or similar configuration.

If you wish to obtain a replacement emissions label, most manufacturers make the labels available for purchase. The labels can usually be ordered from a local dealer.



The emissions control label is usually affixed to the underside of the hood and contains vacuum diagrams of the engine equipped on the vehicle

The calibration code label is usually affixed to the door pillar on the driver's side. The calibration code will be required for ordering parts for most electronic engine controlled components and emissions equipment

Click on icon to view fullsize printable image. Click to Enlarge *1996-97 3.0L OHV (2 valve) engine*
Click on icon to view fullsize printable image. Click to Enlarge *1996 3.0L OHC (4 valve) engine*
Click on icon to view fullsize printable image. Click to Enlarge *1996-99 3.0L OHV (2 valve) flexible fuel engine*
Click on icon to view fullsize printable image. Click to Enlarge *1996-99 3.4L OHC (SHO) engine*
Click on icon to view fullsize printable image. Click to Enlarge *1997 3.0L OHC (4 valve) engine*
Click on icon to view fullsize printable image. Click to Enlarge *1998-99 3.0L OHV (2 valve) engine*
Click on icon to view fullsize printable image. Click to Enlarge *1998-99 3.0L OHV (2 valve) engine with California emissions*
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1998-99 3.0L OHC (4 valve) engine

SPECIFICATIONS CHARTS

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ECT/IAT resistance-to-temperature specifications

FUEL SYSTEM

BASIC FUEL SYSTEM DIAGNOSIS

When there is a problem starting or driving a vehicle, two of the most important checks involve the ignition and the fuel systems. The questions most mechanics attempt to answer first, "is there spark?" and "is there fuel?" will often lead to solving most basic problems. For ignition system diagnosis and testing, please refer to the information on engine electrical components and ignition systems found earlier in this manual. If the ignition system checks out (there is spark), then you must determine if the fuel system is operating properly (is there fuel?).

FUEL LINES AND FITTINGS

Hairpin Clip Fitting

REMOVAL & INSTALLATION

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Cutaway view of the hairpin clip fitting

Click on icon to view fullsize printable image.

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When assembling the fitting, push the pipe into the fitting until a click is heard

Observe all applicable safety precautions when working around fuel. Whenever servicing the fuel system, always work in a well ventilated area. Do not allow fuel spray or vapors to come in contact with a spark or open flame. Keep a dry chemical fire extinguisher near the work area. Always keep fuel in a container specifically designed for fuel storage; also, always properly seal fuel containers to avoid the possibility of fire or explosion.

1. Clean all dirt and grease from the fitting. Spread the two clip legs about 1/8 in. (3mm) each to disengage from the fitting and pull the clip outward from the fitting. Use finger pressure only; do not use any tools.
2. Grasp the fitting and hose assembly and pull away from the steel line. Twist the fitting and hose assembly slightly while pulling, if the assembly sticks.
3. Inspect the hairpin clip for damage, replacing the clip if necessary. Reinstall the clip in position on the fitting.
4. Inspect the fitting and inside of the connector to ensure freedom from dirt or obstruction. Install the fitting into the connector and push together. A click will be heard when the hairpin snaps into the proper connection. Pull on the line to insure full engagement.

Duckbill Clip Fitting

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Click on icon to view fullsize printable image.

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A fuel line disconnect tool is required to properly separate a duckbill clip fitting

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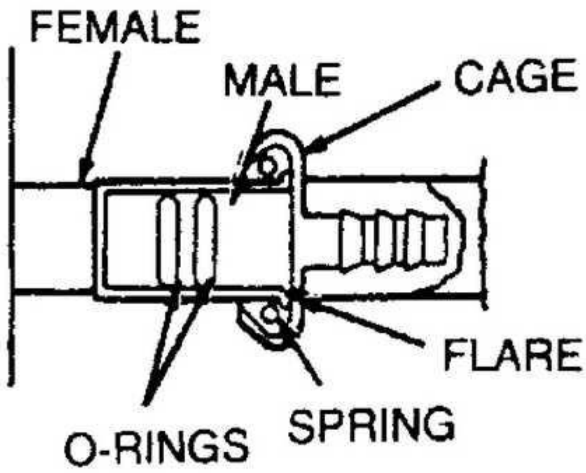
1. A special tool is available from Ford and other manufacturers for removing the retaining clips. Use Ford Tool T90T-9550-B or C or equivalent. If the tool is not on hand, go onto step 2. Align the slot on the push connector disconnect tool with either tab on the retaining clip. Pull the line from the connector.
2. If the special clip tool is not available, use a pair of narrow 6-inch slip-jaw pliers with a jaw width of 0.2 in (5mm) or less. Align the jaws of the pliers with the openings of the fitting case and compress the part of the retaining clip that engages the case. Compressing the retaining clip will release the fitting, which may be pulled from the connector. Both sides of the clip must be compressed at the same time to disengage.
3. Inspect the retaining clip, fitting end and connector. Replace the clip if any damage is apparent.
4. Push the line into the steel connector until a click is heard, indicating the clip is in place. Pull on the line to check engagement.

Spring Lock Coupling

REMOVAL & INSTALLATION



Cutaway view of a spring lock coupling

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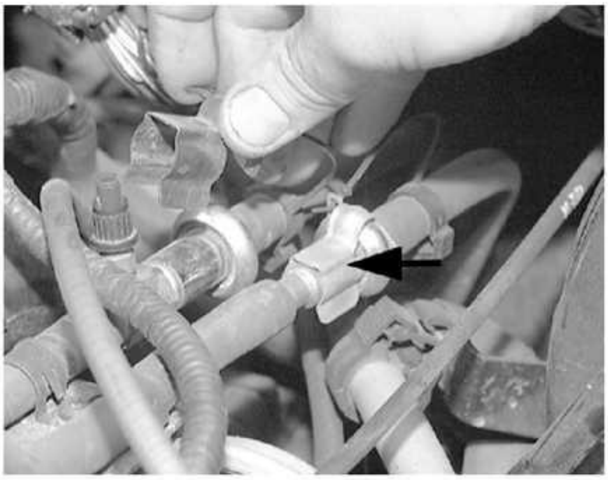
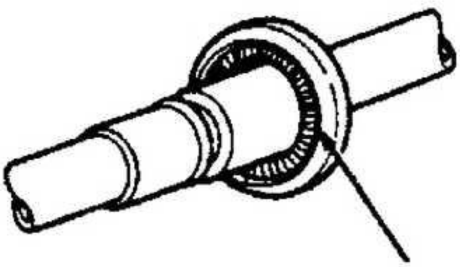
The spring lock coupling is held together by a garter spring inside a circular cage. When the coupling is connected together, the flared end of the female fitting slips behind the garter spring inside the cage of the male fitting. The garter spring and cage then prevent the flared end of the female fitting from pulling out of the cage. As an additional locking feature, most vehicles have a horseshoe-shaped retaining clip that improves the retaining reliability of the spring lock coupling.

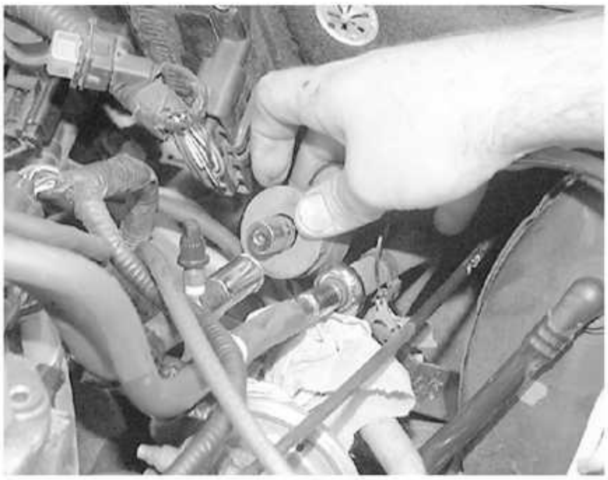


Remove the safety clip from the fuel lines, the clip is attached to a small wire that keeps it from getting lost

This type of removal tool has a hinged center section that allows you to fit it around the fuel line



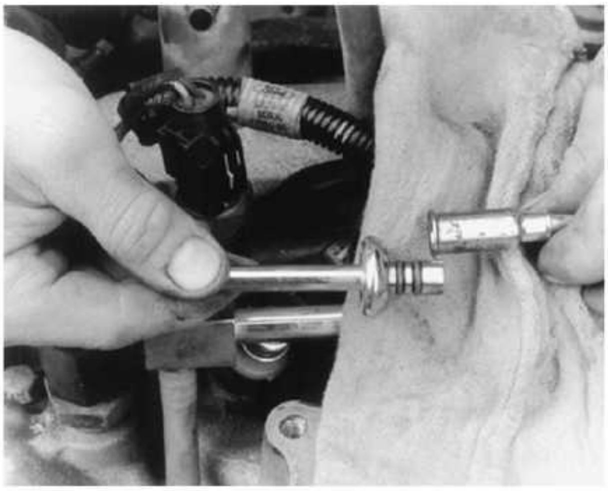
The garter spring is located inside the fitting and holds the fitting together



Slide the tool back to unseat the garter spring on the fitting, and pull back on the fuel line to separate them

This type of removal tool snaps over the line

Slide the tool back to unseat the garter spring on the fitting, and pull back on the fuel line to separate them



Be sure to check the O-rings for damage; replace them if necessary

Use a small hook or pick to remove the O-rings from the fuel line quick-connect fittings

The O-rings should be replaced if necessary with the specific ones used for the fuel system, a non-specific O-ring could leak

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The fitting should be inspected after assembly

SEQUENTIAL ELECTRONIC FUEL INJECTION

Introduction

The Sequential Fuel Injection (SFI) system includes a high pressure electric fuel pump mounted in the fuel tank, a fuel supply manifold, a throttle body (meters the incoming air charge for the correct mixture with the fuel), a pressure regulator, fuel filters and both solid and flexible fuel lines. The fuel supply manifold includes 6 or 8 electronically-controlled fuel injectors, each mounted directly above an intake port in the intake manifold. Each injector fires once every other crankshaft revolution, in sequence with the engine firing order.

The fuel pressure regulator maintains a constant pressure drop across the injector nozzles. The regulator is referenced to intake manifold vacuum and is connected in parallel to the fuel injectors; it is positioned on the far end of the fuel rail. Any excess fuel supplied by the fuel pump passes through the regulator and is returned to the fuel tank via a return line.

The pressure regulator reduces fuel pressure to 30-45 psi under normaloperating conditions. At idle or high manifold vacuum condition, fuel PRESSURE IS further reduced to approximately 30 psi.

The fuel pressure regulator is a diaphragm-operated relief valve, in which the inside of the diaphragm senses fuel pressure and the other side senses manifold vacuum. Normal fuel pressure is established by a spring preload applied to the diaphragm. Control of the fuel system is maintained through the Powertrain Control Module (PCM), although electrical power is routed through the fuel pump relay and an inertia switch. The fuel pump relay is normally located in the power distribution box, under the hood, and the inertia switch is located in the trunk. The inline fuel pump is mounted in the fuel tank.

The inertia switch opens the power circuit to the fuel pump in the event of a collision or roll over. Once tripped, the switch must be reset manually by pushing the reset button on the assembly.

Check that the inertia switch is reset before diagnosing power SUPPLY PROBLEMS to the fuel pump.

The fuel injectors used with SFI system are electro-mechanical (solenoid) type, designed to meter and atomize fuel delivered to the intake ports of the engine. The injectors are mounted in the intake manifold and positioned so that their spray nozzles direct the fuel charge in front of the intake valves. The injector body consists of a solenoid-actuated pintle and needle-valve assembly. The control unit sends an electrical impulse that activates the solenoid, causing the pintle to move inward off the seat and allow the fuel to flow. The amount of fuel delivered is controlled by the length of time the injector is energized (pulse width), since the fuel flow orifice is fixed and the fuel pressure drop across the injector tip is constant. Correct atomization is achieved by contouring the pintle at the point where the fuel enters the pintle chamber.

Exercise care when handling fuel injectors during service. Be careful notto lose the pintle cap and always replace O-rings to assure a tight seal.

The injectors receive high-pressure fuel from the fuel supply manifold (fuel rail) assembly. The complete assembly includes a single, pre-formed tube with four or six connectors, the mounting flange for the pressure regulator, and mounting attachments to locate the manifold and provide the fuel injector retainers.

The fuel manifold is normally removed with the fuel injectors and pressure regulator attached. Fuel injector electrical connectors are plastic and have locking tabs that must be released when disconnecting the wiring harness.

FUEL SYSTEM SERVICE PRECAUTIONS

Observe all applicable safety precautions when working around fuel. Whenever servicing the fuel system, always work in a well ventilated area. Do not allow fuel spray or vapors to come in contact with a spark or open flame. Keep a dry chemical fire extinguisher near the work area. Always keep fuel in a container specifically designed for fuel storage; also, always properly seal fuel containers to avoid the possibility of fire or explosion.

Safety is the most important factor when performing not only fuel system maintenance, but any type of maintenance. Failure to conduct maintenance and repairs in a safe manner may result in serious personal injury or death. Work on a vehicle's fuel system components can be accomplished safely and effectively by adhering to the following rules and guidelines.

- To avoid the possibility of fire and personal injury, always disconnect the negative battery cable unless the repair or test procedure requires that battery voltage be applied.
- Always relieve the fuel system pressure prior to disconnecting any fuel system component (injector, fuel rail, pressure regulator, etc.) fitting or fuel line connection. Exercise extreme caution whenever relieving fuel system pressure to avoid exposing skin, face and eyes to fuel spray. Please be advised that fuel under pressure may penetrate the skin or any part of the body that it contacts.
- Always place a shop towel or cloth around the fitting or connection prior to loosening to absorb any excess fuel due to

spillage. Ensure that all fuel spillage is quickly remove from engine surfaces. Ensure that all fuel-soaked cloths or towels are deposited into a flame-proof waste container with a lid.

- Always keep a dry chemical (Class B) fire extinguisher near the work area.
- Do not allow fuel spray or fuel vapors to come into contact with a spark or open flame.
- Always use a second wrench when loosening or tightening fuel line connections fittings. This will prevent unnecessary stress and torsion to fuel piping. Always follow the proper torque specifications.
- Always replace worn fuel fitting O-rings with new ones. Do not substitute fuel hose where rigid pipe is installed.

Relieving Fuel System Pressure

Depressing the pressure relief valve is one method to relieve the fuel pressure

Observe all applicable safety precautions when working around fuel. Whenever servicing the fuel system, always work in a well ventilated area. Do not allow fuel spray or vapors to come in contact with a spark or open flame. Keep a dry chemical fire extinguisher near the work area. Always keep fuel in a container specifically designed for fuel storage; also, always properly seal fuel containers to avoid the possibility of fire or explosion.

All SFI fuel injected engines are equipped with a pressure relief valve located on the fuel supply manifold. Remove the fuel tank cap and attach fuel pressure gauge T80L-9974-B, or equivalent, to the valve to release the fuel pressure. Be sure to drain the fuel into a suitable container and to avoid gasoline spillage. You may also relieve the fuel pressure at the relief valve by depressing the valve with a small screwdriver.

If a pressure gauge is not available, disconnect the vacuum hose from the fuel pressure regulator and attach a hand-held vacuum pump. Apply about 25 in. Hg (84 kPa) of vacuum to the regulator to vent the fuel system pressure into the fuel tank through the fuel return hose. Note that this procedure will remove most of the fuel pressure from the lines, but not the fuel. Take precautions to avoid the risk of fire and use clean rags to soak up any spilled fuel when the lines are disconnected.

An alternate method of relieving the fuel system pressure involves disconnecting the inertia switch with the engine running and waiting for the engine to stall. This procedure works, however it is not recommended and will set a DTC in the PCM but will not illuminate the MIL lamp.

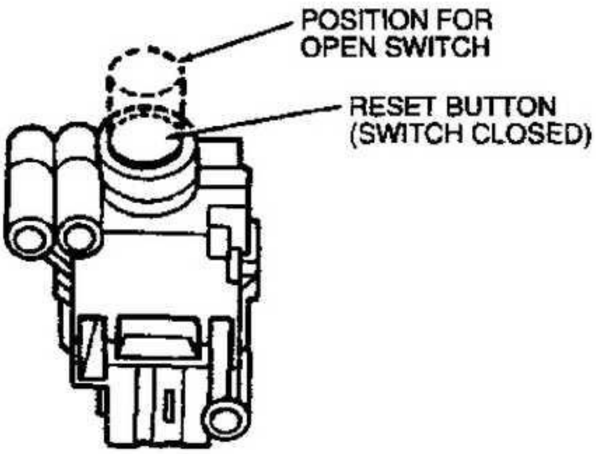
Inertia Switch

GENERAL INFORMATION

This switch shuts off the fuel pump in the event of a collision. Once the switch has been tripped, it must be reset manually in order to start the engine.

The inertia switch is located in the luggage compartment near the passenger side inner fender well on the sedan and in the luggage compartment on the passenger side behind an access door on wagon models.

RESETTING THE SWITCH



The inertia switch reset button is located on the top of the switch

This label is usually attached to the underside of the hood. It is a reminder that the inertia switch could have been opened if the vehicle was involved in an accident

1. Turn the ignition switch ***OFF***.
2. Ensure that there is no fuel leaking in the engine compartment, along any of the lines or at the tank. There should be no odor of fuel as well.
3. If no leakage and/or odor is apparent, reset the switch by pushing the reset button on the top of the switch.
4. Cycle the ignition switch from the ***ON*** to ***OFF*** positions several times, allowing five seconds at each position, to build fuel pressure within the system.
5. Again, check the fuel system for leaks. There should be no odor of fuel as well.
6. If there is no leakage and/or odor of fuel, it is safe to operate the vehicle. However, it is recommended that the entire system be checked by a professional, especially if the vehicle was in an accident severe enough to trip the inertia switch.

REMOVAL & INSTALLATION

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Inertia switch mounting-sedan

Click on icon to view fullsize printable image.

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Inertia switch mounting-wagon

1. Disconnect the negative battery cable.
2. Remove the any necessary trim to access the switch.
3. Unplug the connector on the inertia switch.
4. Remove the retaining bolts and remove the switch.

To install:

5. Installation is the reverse of removal.

Fuel Pump

TESTING

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Fuel pump connector pin locations

Observe all applicable safety precautions when working around fuel. Whenever servicing the fuel system, always work in a well ventilated area. Do not allow fuel spray or vapors to come in contact with a spark or open flame. Keep a dry chemical fire extinguisher near the work area. Always keep fuel in a container specifically designed for fuel storage; also, always properly seal fuel containers to avoid the possibility of fire or explosion.

1. Check all hoses and lines for kinks and leaking. Repair as necessary.
2. Check all electrical connections for looseness and corrosion. Repair as necessary.
3. Turn the ignition key from the ***OFF*** position to the ***RUN*** position several times (do not start the engine) and verify that the pump runs briefly each time (you will hear a low humming sound from the fuel tank).

Check that the inertia switch is reset before diagnosing power SUPPLY PROBLEMS to the fuel pump.

The use of a scan tool is required to perform these tests.

4. Turn the ignition key ***OFF***.
5. Connect a suitable fuel pressure gauge to the fuel test port (Schrader valve) on the fuel rail.
6. Connect the scan tool and turn the ignition key ***ON*** but do not start the engine.
7. Following the scan tool manufacturer's instructions, enter the output test mode and run the fuel pump to obtain the maximum fuel pressure.
8. The fuel pressure should be between 30-40 psi (310-415 kPa).
9. If the fuel pressure is within specification the pump is working properly. If not, continue with the test.
10. Check the pump ground connection and service as necessary.
11. Turn the ignition key ***ON***.
12. Using the scan tool, enter output test mode and turn on the fuel pump circuit.
13. Using a Digital Volt Ohmmeter (DVOM), check for voltage (approximately 10.5 volts) at the fuel pump electrical connector.
14. If the pump is getting a good voltage supply and the ground connection is good, but the fuel pressure is not within specification, then replace the pump.

REMOVAL & INSTALLATION

Click on icon to view fullsize printable image.

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Exploded view of fuel pump assembly

Observe all applicable safety precautions when working around fuel. Whenever servicing the fuel system, always work in a well ventilated area. Do not allow fuel spray or vapors to come in contact with a spark or open flame. Keep a dry chemical fire extinguisher near the work area. Always keep fuel in a container specifically designed for fuel storage; also, always properly seal fuel containers to avoid the possibility of fire or explosion.

1. Disconnect the negative battery cable.
2. Properly relieve the fuel system pressure.
3. Raise and safely support the vehicle.
4. Remove the fuel tank and place on a suitable work bench.
5. Remove any dirt that has accumulated around the fuel pump retaining flange so it will not enter the tank during pump removal and installation.
6. Turn the fuel pump locking ring counterclockwise and remove the locking ring using Fuel Tank Sender Wrench T74P-9275-A, or equivalent.
7. Pull the fuel pump module up and out of the fuel tank until the locking tabs for the fuel pump module are accessible. Squeeze both locking tabs together and remove the fuel pump module from the fuel tank. Remove and discard the O-ring seal.

To install:

8. Clean the fuel pump mounting flange, fuel tank mounting surface and O-ring seal groove.
9. Apply a light coating of grease on a new O-ring seal to hold it in place during assembly and install the O-ring seal.
10. Install the fuel pump module carefully to ensure the filter, hoses and float rod are not damaged.
11. Align the fuel pump module and the fuel tank retainer axially and push the fuel pump module into the fuel tank retainer. When the fuel pump module is properly engaged, a definite click will be heard engaging 2 locking tabs on the outside of the fuel pump.
12. Pull on the fuel pump module to ensure that both locking tabs are properly engaged.
13. Make sure the locating keys are in the keyways and the seal ring remains in the groove.
14. Hold the fuel pump module in place and install the locking ring finger-tight. Make sure all the locking tabs are under the tank lock ring tabs.
15. Using the sender wrench or equivalent, rotate the locking ring clockwise until the ring is against the stops.
16. Install the fuel tank in the vehicle. Lower the vehicle.
17. Add a minimum of 10 gallons (38 liters) of clean fuel to the tank. Connect the negative battery cable.
18. Install a suitable fuel pressure gauge to the Schrader valve on the fuel supply manifold.
19. Cycle the ignition switch from ***OFF*** to ***ON*** for 3 seconds. Repeat this procedure 5-10 times until the pressure gauge reads at least 30 psi (207 kPa). Check for fuel leaks.
20. Remove the fuel pressure gauge. Start the engine and again, check for fuel leaks. Road test the vehicle and check for proper operation.

Throttle Body

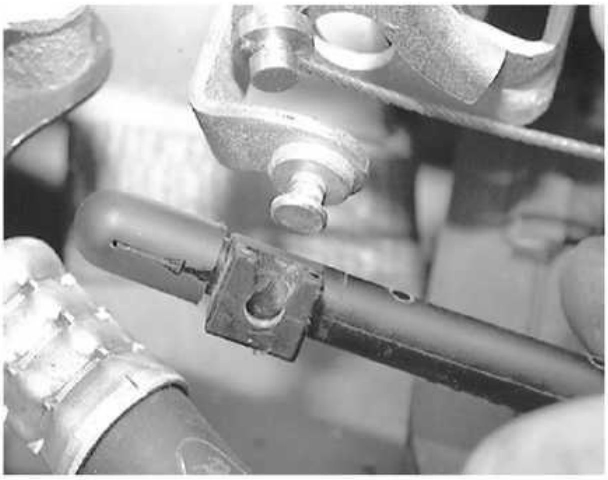
REMOVAL & INSTALLATION

3.0L OHV Engine

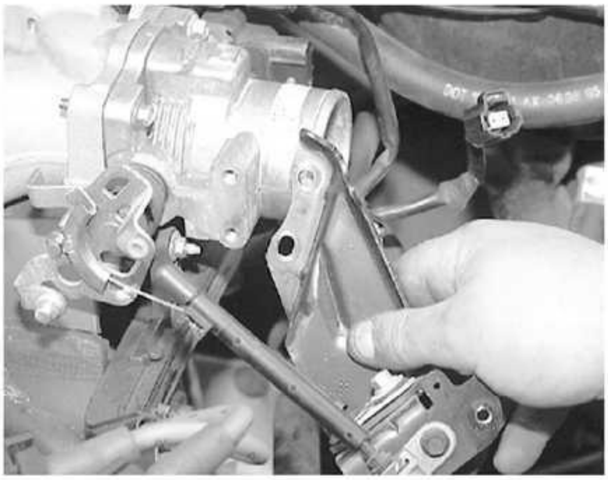
The throttle body should never be cleaned. A special protective coating is placed on the throttle plate that could be removed by some solvents

Remove the retaining screws and remove the accelerator cable shield from the throttle body

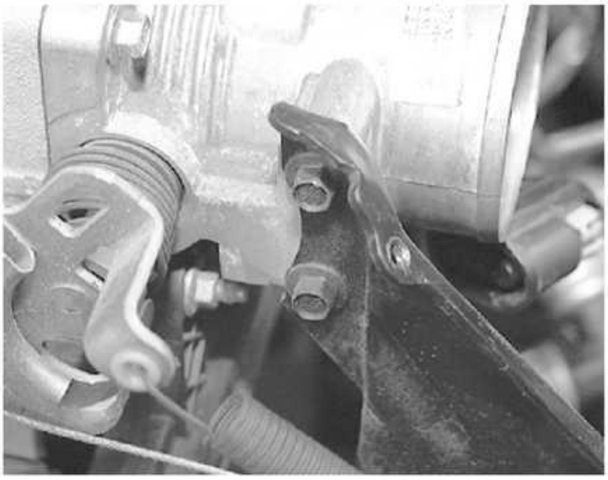
Disconnect the accelerator cable from the throttle lever



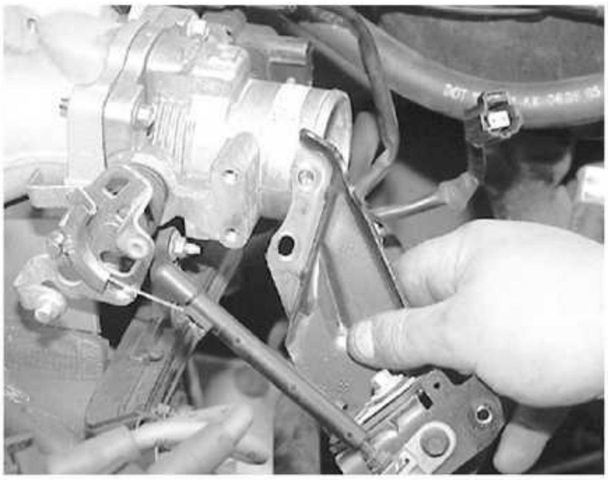
Remove the speed control cable (if equipped) from the throttle lever by sliding it off of the small stud



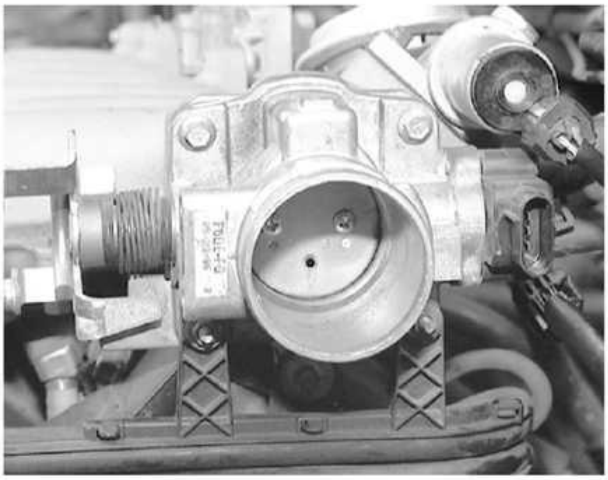
Remove the return spring from the throttle shaft



Remove the two retaining bolts for the accelerator cable bracket

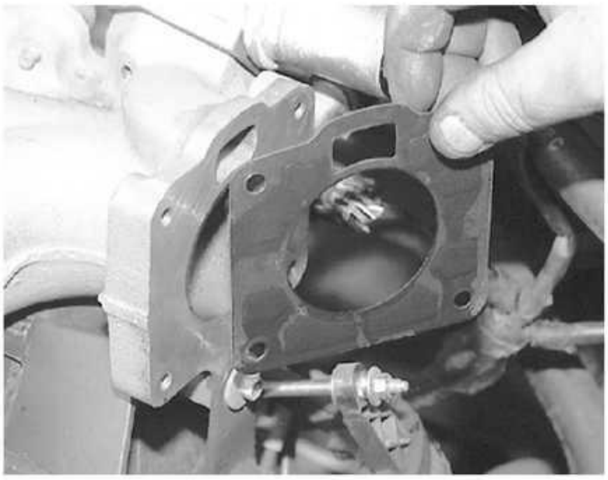


Position the accelerator bracket out of the way



Remove the four throttle body mounting bolts and...

... remove the throttle body from the engine



Replace the gasket anytime the throttle body is removed

1. Disconnect the negative battery cable.
2. Remove the air cleaner outlet tube.
3. Remove the accelerator cable shield from the throttle body.
4. Disconnect the accelerator cable from the throttle lever.
5. If equipped with speed control, disconnect the speed control actuator from the throttle lever.
6. Disengage the throttle return spring from the throttle shaft and the accelerator cable bracket.
7. Remove the two accelerator cable bracket retaining bolts and position the bracket with the accelerator and speed control cable attached to the side.
8. Unplug the Throttle Position (TP) sensor electrical connection.
9. Remove the retaining nuts for the ignition wire separators and position the separators and ignition wires out of the way.
10. Unfasten the throttle body retaining bolts and remove the throttle body.

If scraping is necessary to remove any gasket material, be careful not TO DAMAGE the gasket mating surfaces or allow any foreign material to enter THE INTAKE manifold.

11. Remove the old gasket and clean any gasket residue from both mating surfaces.

To install:

12. Install a new gasket and the throttle body.
13. Install the throttle body retaining bolts and tighten them to 15-22 ft. lbs. (20-30 Nm).
14. Position the ignition wire separators onto the throttle body retaining studs and tighten the retaining nuts.
15. Attach the Throttle Position (TP) sensor electrical connection.
16. Install the accelerator cable bracket to the throttle body and tighten the retaining bolts.
17. Attach the throttle return spring to the throttle shaft.
18. Connect the accelerator cable to the throttle lever.
19. If equipped with speed control, connect the speed control actuator.
20. Install the accelerator cable shield.
21. Install the air cleaner outlet hose.
22. Connect the negative battery cable.
23. Start the engine and check for vacuum leaks.

3.0L DOHC Engine

Click on icon to view fullsize printable image.

Click to Enlarge

Throttle body mounting-3.0L DOHC Engine

1. Disconnect the negative battery cable.

2. Remove the air cleaner outlet tube.
3. Remove the accelerator cable shield from the throttle body.
4. Unplug the Throttle Position (TP) sensor electrical connection.
5. Disconnect the accelerator cable from the throttle lever.
6. If equipped with speed control, disconnect the speed control actuator from the throttle lever.
7. Remove the two accelerator cable bracket retaining bolts and position the bracket with the accelerator and speed control cable attached to the side.
8. Unfasten the throttle body retaining bolts and remove the throttle body.

If scraping is necessary to remove any gasket material, be careful not TO DAMAGE the gasket mating surfaces or allow any foreign material to enter THE INTAKE manifold.

9. Remove the old gasket and clean any gasket residue from both mating surfaces.

To install:

10. Install a new gasket and the throttle body.
11. Install the throttle body retaining bolts and tighten them to 71-106 inch lbs. (8-12 Nm).
12. Install the accelerator cable bracket to the throttle body and tighten the retaining bolts.
13. Attach the Throttle Position (TP) sensor electrical connection.
14. Connect the accelerator cable to the throttle lever.
15. If equipped with speed control, connect the speed control actuator.
16. Install the accelerator cable shield.
17. Install the air cleaner outlet hose.
18. Connect the negative battery cable.
19. Start the engine and check for vacuum leaks.

3.4L DOHC Engine

Click on icon to view fullsize printable image.

Click to Enlarge

Throttle body mounting-3.4L DOHC engine

1. Disconnect the negative battery cable.
2. Remove the air cleaner outlet tube.
3. Remove the accelerator cable shield from the throttle body.
4. Disconnect the accelerator cable from the throttle lever.
5. If equipped with speed control, disconnect the speed control actuator from the throttle lever.
6. Remove the two accelerator cable bracket retaining bolts and position the bracket with the accelerator and speed control cable attached to the side.
7. Unplug the Throttle Position (TP) sensor and Idle Air Control (IAC) valve electrical connections.
8. Remove the water bypass hose from the throttle body.
9. If required, remove the IAC valve and gasket from the surge tank connector.
10. Unfasten the throttle body retaining bolts and remove the throttle body.

If scraping is necessary to remove any gasket material, be careful not TO DAMAGE the gasket mating surfaces or allow any foreign material to enter THE INTAKE manifold.

11. Remove the old gasket and clean any gasket residue from both mating surfaces.

To install:

12. Install a new gasket and the throttle body.
13. Install the throttle body retaining bolts and tighten them to 12-16 ft. lbs. (16-23 Nm).
14. If removed, install the IAC valve and a new gasket onto the surge tank and tighten the retaining bolts to 84 inch lbs. (10 Nm).
15. Connect the water bypass hose to the throttle body.
16. Attach the TP sensor and IAC valve electrical connections.
17. Install the accelerator cable bracket to the throttle body and tighten the retaining bolts.
18. Connect the accelerator cable to the throttle lever.
19. If equipped with speed control, connect the speed control actuator.
20. Install the accelerator cable shield.

21. Install the air cleaner outlet hose.
22. Connect the negative battery cable.
23. Start the engine and check for vacuum leaks.
24. Refill the cooling system if necessary.

Fuel Injector(s)

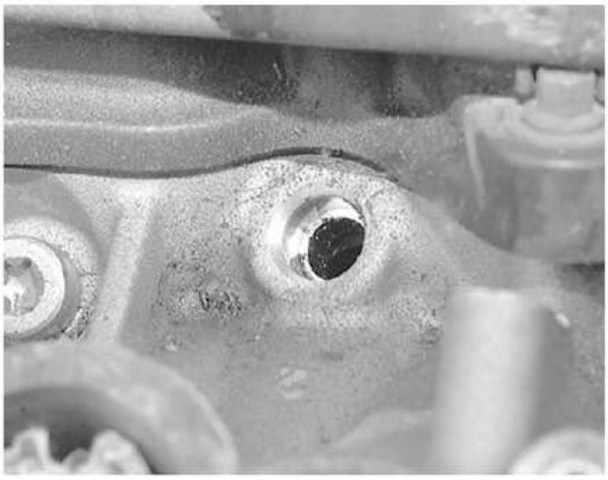
REMOVAL & INSTALLATION

Carefully twist the injector from the fuel rail

Inspect the injector tip for deposits and dirt build-up and replace if necessary

Remove the top and...

... the bottom O-rings and replace them with new ones



Inspect the injector bore in the lower intake manifold, clean if necessary

Click on icon to view fullsize printable image.

Click to Enlarge

Fuel injector mounting-3.4L DOHC engine

Observe all applicable safety precautions when working around fuel. Whenever servicing the fuel system, always work in a well ventilated area. Do not allow fuel spray or vapors to come in contact with a spark or open flame. Keep a dry chemical fire extinguisher near the work area. Always keep fuel in a container specifically designed for fuel storage; also, always properly seal fuel containers to avoid the possibility of fire or explosion.

Do not modify flexible fuel configuration or components with parts notspecially designed for use with fuel methanol and fuel ethanol. The use ofdifferent parts or materials could produce an untested configuration that couldresult in fire, personal injury or could cause engine damage.

1. Disconnect the negative battery cable.
2. Properly relieve the fuel system pressure.
3. Remove the fuel rail as described in this Section.
4. Remove the fuel injector(s) from the fuel rail using a rocking side-to-side motion while pulling up gently.
5. Remove and discard the fuel injector O-rings. Inspect the fuel injector end caps for signs of dirt and deterioration. Replace as needed.

To install:

6. Place new O-rings onto each injector and lightly coat with clean engine oil.

On flexible fuel engines use an oil with an API designation of multi-fuel vehicles.

7. Install the fuel injector(s) into the fuel injection supply manifold using a light twisting/pushing motion.
8. Install the fuel injection supply manifold as described in this Section.
9. Connect the negative battery cable.
10. Run the engine and check for leaks and proper operation.

TESTING

The easiest way to test the operation of the fuel injectors is to listen for a clicking sound coming from the injectors while the engine is running. This is accomplished using a mechanic's stethoscope, or a long screwdriver. Place the end of the stethoscope or the screwdriver (tip end, not handle) onto the body of the injector. Place the ear pieces of the stethoscope in your ears, or if using a screwdriver, place your ear on top of the handle. An audible clicking noise should be heard; this is the solenoid operating. If the injector makes this noise, the injector driver circuit and computer are operating as designed. Continue testing all the injectors this way.

Be extremely careful while working on an operating engine, make sure you have no dangling jewelry, extremely loose clothes, power tool cords or other items that might get caught in a moving part of the engine.

All Injectors Clicking

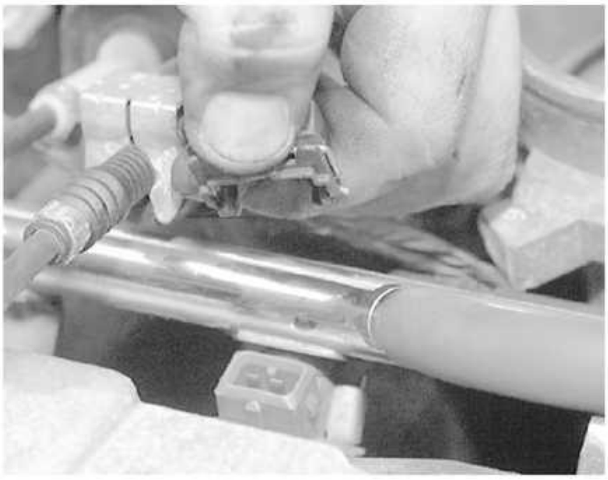
If all the injectors are clicking, but you have determined that the fuel system is the cause of your driveability problem, continue diagnostics. Make sure that you have checked fuel pump pressure as outlined earlier in this section.

Observe all applicable safety precautions when working around fuel. Whenever servicing the fuel system, always work in a well ventilated area. Do not allow fuel spray or vapors to come in contact with a spark or open flame. Keep a dry chemical fire extinguisher near the work area. Always keep fuel in a container specifically

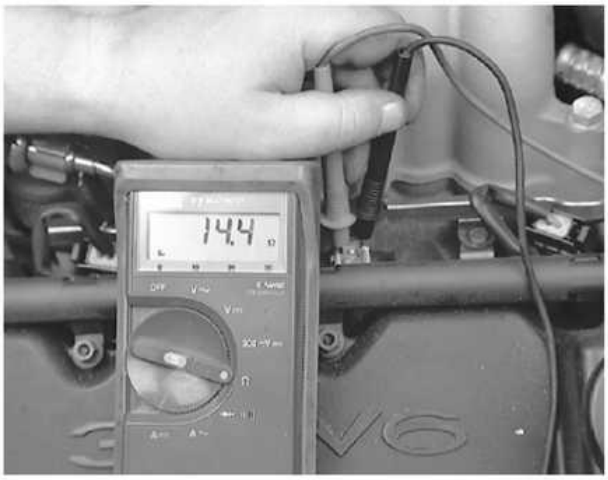
designed for fuel storage; also, always properly seal fuel containers to avoid the possibility of fire or explosion.

If the injectors were all clicking and the ignition system is functioning properly, remove the injector of the suspect cylinder and bench test it. This is accomplished by checking for a spray pattern from the injector itself. Install a fuel supply line to the injector (or rail if the injector is left attached to the rail) and momentarily apply 12 volts DC and a ground to the injector itself; a visible fuel spray should appear. If no spray is achieved, replace the injector and check the running condition of the engine.

One or More Injectors Are Not Clicking

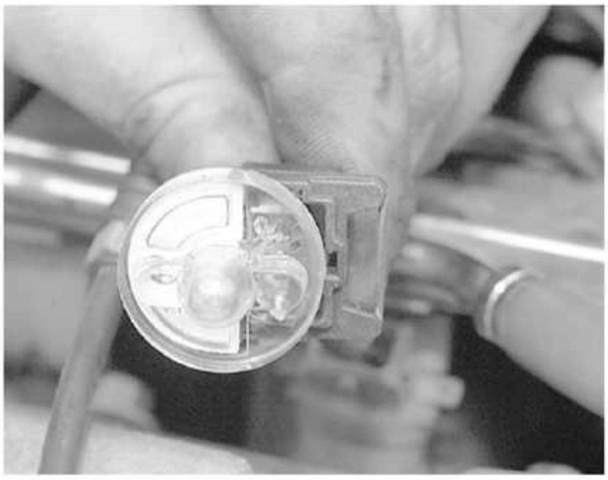


Unplug the fuel injector connector



Probe the two terminals of a fuel injector to check it's resistance

Plug the correct "noid" light directly into the injector harness connector



If the correct "noid" light flashes while the engine is running, the injector driver circuit inside the PCM is working

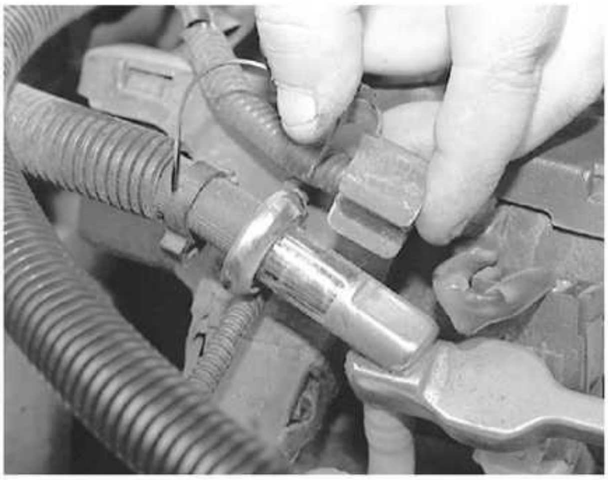
If one or more injectors are found to be not operating, testing the injector driver circuit and computer can be accomplished using a "noid" light. First, with the engine not running and the ignition key in the **OFF** position, remove the connector from the injector you plan to test, then plug the "noid" light tool into the injector connector. Start the engine and the "noid" light should flash, signaling that the injector driver circuit is working. If the "noid" light flashes, but the injector does not click when plugged in, test the injector's resistance. Resistance should be between 11-18 ohms.

If the "noid" light does not flash, the injector driver circuit is faulty. Disconnect the negative battery cable. Unplug the "noid" light from the injector connector and also unplug the PCM. Check the harness between the appropriate pins on the harness side of the PCM connector and the injector connector. Resistance should be less than 5.0 ohms; if not, repair the circuit. If resistance is within specifications, the injector driver inside the PCM is faulty and replacement of the PCM will be necessary.

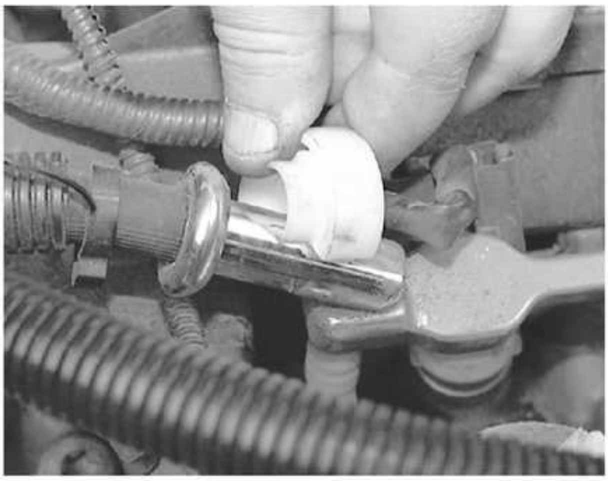
Fuel Charging Assembly (Fuel Rail)

REMOVAL & INSTALLATION

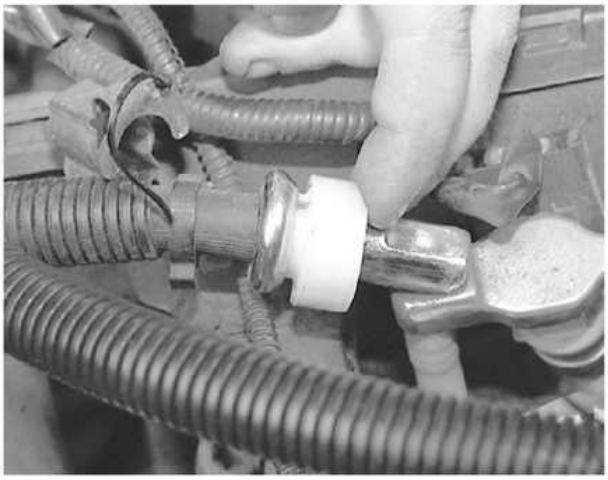
3.0L OHV Engine



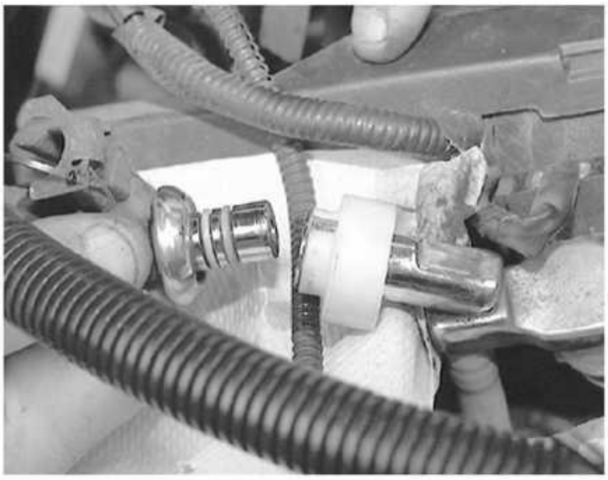
Remove the fuel line retaining clip



Insert a suitable quick-connect fitting removal tool

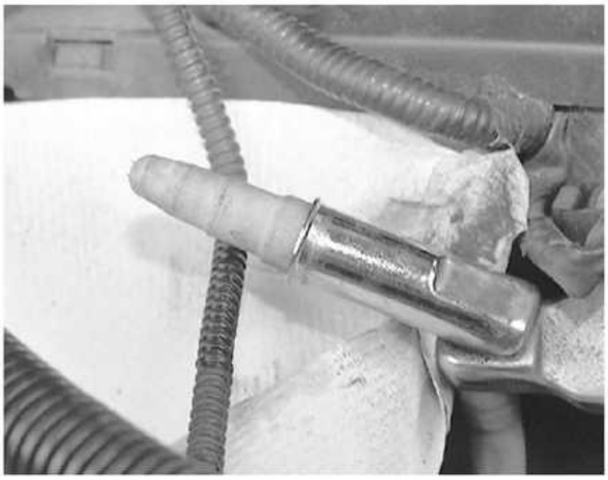


Push the tool towards the fitting releasing the retaining spring and...

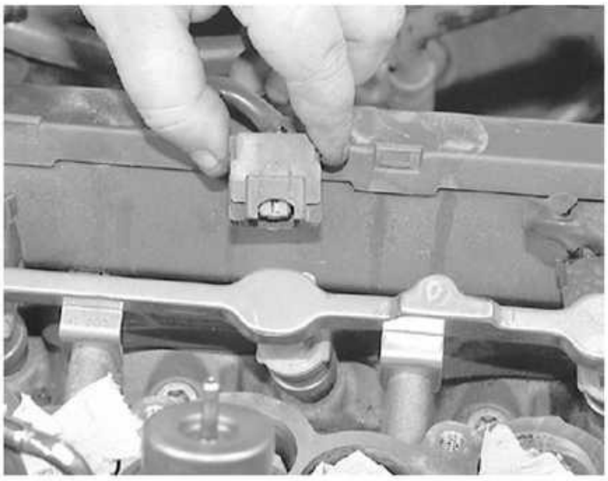


disconnect the fitting

Plug the opening on the line and...



the inlet on the fuel rail to prevent contamination of the fuel system

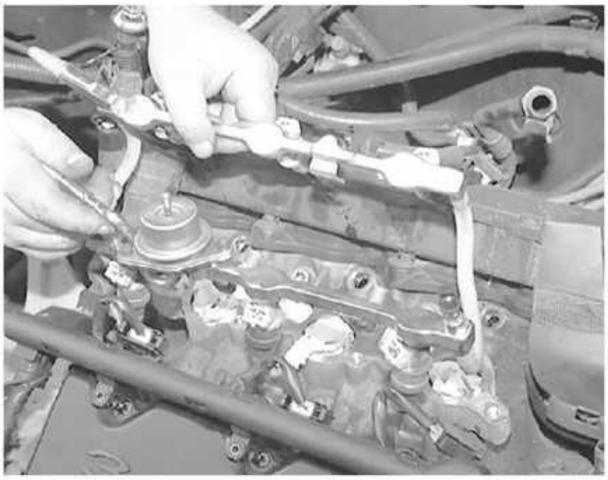


Detach the fuel injector connectors

Remove the fuel rail retaining bolts from the front and the...

... rear of the lower intake manifold and...

CHILTON



... carefully lift the fuel rail from the engine

Observe all applicable safety precautions when working around fuel. Whenever servicing the fuel system, always work in a well ventilated area. Do not allow fuel spray or vapors to come in contact with a spark or open flame. Keep a dry chemical fire extinguisher near the work area. Always keep fuel in a container specifically designed for fuel storage; also, always properly seal fuel containers to avoid the possibility of fire or explosion.

Do not modify flexible fuel configuration or components with parts not specially designed for use with fuel methanol and fuel ethanol. The use of different parts or materials could produce an untested configuration that could result in fire, personal injury or could cause engine damage.

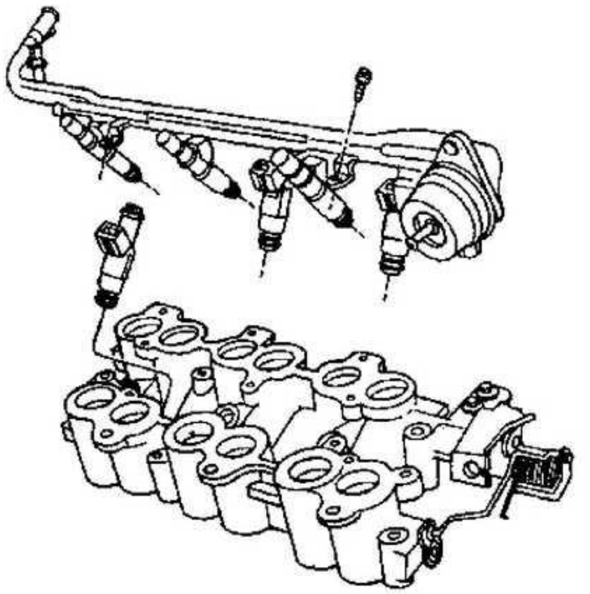
1. Disconnect the negative battery cable.
2. Properly relieve the fuel system pressure.
3. Remove the upper intake manifold.
4. Disconnect the fuel injector wiring harness and move aside.
5. Disconnect the vacuum line at the fuel pressure regulator.
6. If required, remove the fuel pressure regulator and the pressure relief valve from the supply manifold.
7. Remove the spring lock coupling retainer clips from the fuel supply and return fittings.
8. Use spring lock coupling disconnect tools (3/8 inch and 1/2 inch) to disconnect the fuel supply and return hoses from the fuel injection supply manifold (fuel rail).
9. Remove the 4 fuel injection supply manifold retaining bolts.
10. Carefully disengage the fuel injection supply manifold with the fuel injectors and remove as an assembly.

To install:

11. If replacing the fuel rail, remove and install the fuel injectors as described in this Section.
12. Lubricate new O-rings on the injectors with engine oil and install them on the fuel injectors.
13. While holding down on the fuel injection supply manifold, install the retaining bolts and tighten to 71-106 inch lbs. (8-12 Nm).
14. Install the fuel supply and return hoses to the fuel supply manifold. Ensure that the spring lock couplings are correctly installed.
15. Install the retaining clips on the spring lock couplings. Connect the vacuum line to the fuel pressure regulator. Temporarily connect the negative battery cable.
16. With the fuel injector wiring disconnected, cycle the ignition key several times to the ***RUN*** position to pressurize the fuel system.

17. Using a clean paper towel while wearing rubber gloves, check for leaks where the fuel injectors connect to the fuel injection supply manifold and intake manifold. If a leak is found, disconnect the negative battery cable and relieve the fuel system pressure. Remove the fuel injection supply manifold and replace the leaking O-ring(s) before continuing. If no leaks are found, continue with the next step.
18. Connect the fuel injector wiring harness.
19. Install the upper intake manifold as described in Section 3.
20. Connect the negative battery cable.
21. Start the vehicle and check for leaks.

3.0L DOHC Engine



Fuel injection supply manifold mounting-3.0L DOHC engine

Observe all applicable safety precautions when working around fuel. Whenever servicing the fuel system, always work in a well ventilated area. Do not allow fuel spray or vapors to come in contact with a spark or open flame. Keep a dry chemical fire extinguisher near the work area. Always keep fuel in a container specifically designed for fuel storage; also, always properly seal fuel containers to avoid the possibility of fire or explosion.

1. Disconnect the negative battery cable.
2. Properly relieve the fuel system pressure.
3. Remove the upper intake manifold.
4. Disconnect the fuel injector wiring harness and move aside.
5. Disconnect the vacuum line at the fuel pressure regulator.
6. If required, remove the fuel pressure regulator and the pressure relief valve from the supply manifold.
7. Remove the spring lock coupling retainer clips from the fuel supply and return fittings.
8. Use spring lock coupling disconnect tools (3/8 inch and 1/2 inch) to disconnect the fuel supply and return hoses from the fuel injection supply manifold (fuel rail).
9. Remove the 4 fuel injection supply manifold retaining bolts.
10. Carefully disengage the fuel injection supply manifold with the fuel injectors and remove as an assembly.

To install:

11. If replacing the fuel rail, remove and install the fuel injectors as described in this Section.
12. Lubricate new O-rings on the injectors with engine oil and install them on the fuel injectors.

13. While holding down on the fuel injection supply manifold, install the retaining bolts and tighten to 71-106 inch lbs. (8-12 Nm).
14. Install the fuel supply and return hoses to the fuel supply manifold. Ensure that the spring lock couplings are correctly installed.
15. Install the retaining clips on the spring lock couplings. Connect the vacuum line to the fuel pressure regulator. Temporarily connect the negative battery cable.
16. With the fuel injector wiring disconnected, cycle the ignition key several times to the ***RUN*** position to pressurize the fuel system.
17. Using a clean paper towel while wearing rubber gloves, check for leaks where the fuel injectors connect to the fuel injection supply manifold and intake manifold. If a leak is found, disconnect the negative battery cable and relieve the fuel system pressure. Remove the fuel injection supply manifold and replace the leaking O-ring(s) before continuing. If no leaks are found, continue with the next step.
18. Connect the fuel injector wiring harness.
19. Install the upper intake manifold.
20. Connect the negative battery cable.
21. Start the vehicle and check for leaks.

3.4L DOHC Engines

Click on icon to view fullsize printable image.

Click to Enlarge

Fuel supply manifold mounting-3.4L DOHC engine

Observe all applicable safety precautions when working around fuel. Whenever servicing the fuel system, always work in a well ventilated area. Do not allow fuel spray or vapors to come in contact with a spark or open flame. Keep a dry chemical fire extinguisher near the work area. Always keep fuel in a container specifically designed for fuel storage; also, always properly seal fuel containers to avoid the possibility of fire or explosion.

1. Disconnect the negative battery cable.
2. Properly relieve the fuel system pressure.
3. Remove the intake manifold as described in Section 3.
4. Detach the electrical connectors at the fuel injectors.
5. Remove the fuel rail retaining bolts, then raise and slightly rotate the fuel rail assembly and remove it from the engine.

To install:

6. Lubricate new O-rings on the injectors with engine oil and install them on the fuel injectors.
7. Install the fuel rail, making sure the injectors seat properly in the cylinder head. Install the fuel rail retaining bolts and tighten to 11-17 ft. lbs. (15-23 Nm).
8. Attach the connectors at the injectors.
9. Install the intake manifold as described in Section 3.
10. Connect the negative battery cable.
11. Start the engine and check for leaks.

Fuel Pressure Regulator

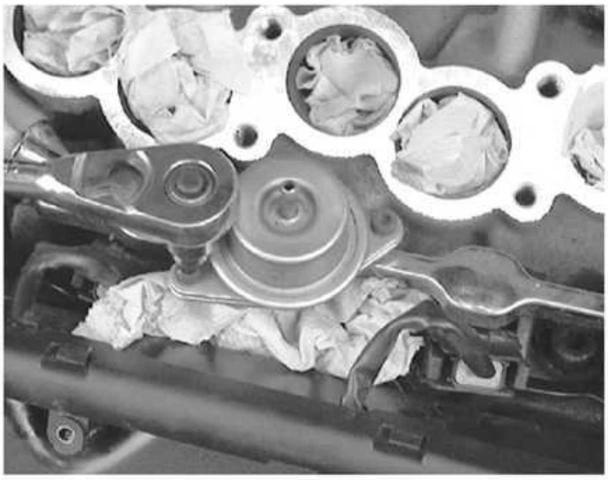
REMOVAL & INSTALLATION

Click on icon to view fullsize printable image.

Click to Enlarge

Fuel pressure regulator exploded view

Disconnect the vacuum hose from the pressure regulator



Remove the two pressure regulator retaining bolts and...

... remove the regulator from the injector rail

Replace the O-rings on the pressure regulator and...

... the rail with new O-rings

Observe all applicable safety precautions when working around fuel. Whenever servicing the fuel system, always work in a well ventilated area. Do not allow fuel spray or vapors to come in contact with a spark or open flame. Keep a dry chemical fire extinguisher near the work area. Always keep fuel in a container specifically designed for fuel storage; also, always properly seal fuel containers to avoid the possibility of fire or explosion.

1. Disconnect the negative battery cable.
2. Properly relieve the fuel system pressure.
3. Remove the air cleaner outlet tube(s).
4. Remove any necessary components to access the pressure regulator.
5. Disconnect the vacuum hose from the pressure regulator.
6. Remove the pressure regulator attaching screws.
7. Remove the pressure regulator from the fuel rail.

To install:

8. Discard the O-rings on the pressure regulator and replace them with new ones.
9. Lubricate the O-rings with clean engine oil.
10. Install the regulator into the fuel rail and tighten the retaining screws.
11. Connect the vacuum hose to the regulator.
12. Install any components removed to access the regulator.
13. Install the air cleaner outlet tube(s).
14. Connect the negative battery cable.
15. Start the engine and check for leaks.

Pressure Relief Valve

REMOVAL & INSTALLATION

Click on icon to view fullsize printable image.

Click to Enlarge

Pressure relief valve mounting-3.0L DOHC engine

Click on icon to view fullsize printable image.

Click to Enlarge

Pressure relief valve mounting-3.4L DOHC engine

Observe all applicable safety precautions when working around fuel. Whenever servicing the fuel system, always work in a well ventilated area. Do not allow fuel spray or vapors to come in contact with a spark or open flame. Keep a dry chemical fire extinguisher near the work area. Always keep fuel in a container specifically designed for fuel storage; also, always properly seal fuel containers to avoid the possibility of fire or explosion.

1. Properly relieve the fuel system pressure.
2. Disconnect the negative battery cable.
3. Remove the protective cap for the pressure relief valve.
4. Unscrew the fuel pressure relief valve.

To install:

5. Install the valve and tighten it to 68 inch lbs. (8 Nm).
6. Install the protective cap for the pressure relief valve.
7. Connect the negative battery cable.
8. Run the engine at idle for 2 minutes, then turn the engine ***OFF*** and check for fuel leaks and proper operation.

Flexible Fuel Sensor

REMOVAL & INSTALLATION

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Flexible fuel sensor and components

Observe all applicable safety precautions when working around fuel. Whenever servicing the fuel system, always work in a well ventilated area. Do not allow fuel spray or vapors to come in contact with a spark or open flame. Keep a dry chemical fire extinguisher near the work area. Always keep fuel in a container specifically designed for fuel storage; also, always properly seal fuel containers to avoid the possibility of fire or explosion.

The flexible fuel sensor is only equipped on 3.0L OHV flexible fuel engines. It applies to no other models.

1. Disconnect the negative battery cable.
2. Properly relieve the fuel system pressure.
3. Detach the flexible fuel sensor connector.
4. Raise and safely support the vehicle securely on jack stands.
5. Remove the passenger side front tire assembly.
6. Remove the fuel line retaining clip from the fuel mixer at the inlet hose and using a suitable disconnect tool, remove the fuel line. Label the hose.
7. Remove the fuel line retaining clip from the fuel mixer at the outlet hose and using a suitable disconnect tool, remove the fuel line. Label the hose.
8. Remove the supply and return hoses from the sensor bracket retaining clip.
9. Remove the bracket-to-frame rail retaining bolts and remove the bracket assembly from the vehicle.
10. Remove the retaining bolts and remove the sensor from the bracket.

To install:

11. The installation is the reverse of the removal.
12. Start the engine and check for leaks.

FUEL TANK

REMOVAL & INSTALLATION

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Click to Enlarge

Fuel tank removal and installation procedures

Click on icon to view fullsize printable image.

Click to Enlarge

Fuel tank components keylist

1. Disconnect the negative battery cable.

Observe all applicable safety precautions when working around fuel. Whenever servicing the fuel system, always work in a well ventilated area. Do not allow fuel spray or vapors to come in contact with a spark or open flame. Keep a dry chemical fire extinguisher near the work area. Always keep fuel in a container specifically designed for fuel storage; also, always properly seal fuel containers to avoid the possibility of fire or explosion.

2. Properly relieve the fuel system pressure.
3. Drain the fuel from the tank.
4. Raise and safely support the vehicle securely on jack stands.
5. Loosen the fuel tank filler pipe and vent hose clamps at the metal tubes and remove the hoses.
6. Label and disconnect the fuel lines from the fuel pump. Refer to Fuel Lines in this Section.
7. Detach the electrical connector from the fuel pump.
8. Label and disconnect the white plastic push connect fitting for the EVAP system at the right rear upper corner of the fuel tank.
9. Place a transmission jack or other suitable support device under the fuel tank, but do not obstruct the tank holding straps.
10. Remove the fuel tank holding strap retaining bolts. The tank holding straps are hinged at the front and will swing down after the retaining bolts are removed.

11. Carefully lower the tank from the vehicle and place the tank in a secure spot.

To install:

If you find it necessary, you may want to tape the lines and hoses on the top of the fuel tank to ensure the proper routing and that no lines are pinched between the tank and the body.

CHASSIS ELECTRICAL

UNDERSTANDING AND TROUBLESHOOTING ELECTRICAL SYSTEMS

Basic Electrical Theory

For any 12 volt, negative ground, electrical system to operate, the electricity must travel in a complete circuit. This simply means that current (power) from the positive (+) terminal of the battery must eventually return to the negative (-) terminal of the battery. Along the way, this current will travel through wires, fuses, switches and components. If, for any reason, the flow of current through the circuit is interrupted, the component fed by that circuit will cease to function properly.

Perhaps the easiest way to visualize a circuit is to think of connecting a light bulb (with two wires attached to it) to the battery-one wire attached to the negative (-) terminal of the battery and the other wire to the positive (+) terminal. With the two wires touching the battery terminals, the circuit would be complete and the light bulb would illuminate. Electricity would follow a path from the battery to the bulb and back to the battery. It's easy to see that with longer wires on our light bulb, it could be mounted anywhere. Further, one wire could be fitted with a switch so that the light could be turned on and off.

Click on icon to view fullsize printable image.

Click to Enlarge

This example illustrates a simple circuit. When the switch is closed, power from the positive (+) battery terminal flows through the fuse and the switch, and then to the light bulb. The light illuminates and the circuit is completed through the ground wire back to the negative (-) battery terminal. In reality, the two ground points shown in the illustration are attached to the metal frame of the vehicle, which completes the circuit back to the battery

The normal automotive circuit differs from this simple example in two ways. First, instead of having a return wire from the bulb to the battery, the current travels through the frame of the vehicle. Since the negative (-) battery cable is attached to the frame (made of electrically conductive metal), the frame of the vehicle can serve as a ground wire to complete the circuit. Secondly, most automotive circuits contain multiple components which receive power from a single circuit. This lessens the amount of wire needed to power components on the vehicle.

HOW ELECTRICITY WORKS: THE WATER ANALOGY

Electricity is the flow of electrons-the subatomic particles that constitute the outer shell of an atom. Electrons spin in an orbit around the center core of an atom. The center core is comprised of protons (positive charge) and neutrons (neutral charge). Electrons have a negative charge and balance out the positive charge of the protons. When an outside force causes the number of electrons to unbalance the charge of the protons, the electrons will split off the atom and look for another atom to balance out. If this imbalance is kept up, electrons will continue to move and an electrical flow will exist.

Many people have been taught electrical theory using an analogy with water. In a comparison with water flowing through a pipe, the electrons would be the water and the wire is the pipe.

The flow of electricity can be measured much like the flow of water through a pipe. The unit of measurement used is amperes, frequently abbreviated as amps (A). You can compare amperage to the volume of water flowing through a pipe. When connected to a circuit, an ammeter will measure the actual amount of current flowing through the circuit. When relatively few electrons flow through a circuit, the amperage is low. When many electrons flow, the amperage is high.

Water pressure is measured in units such as pounds per square inch (psi). The electrical pressure is measured in units called volts (V). When a voltmeter is connected to a circuit, it is measuring the electrical pressure.

The actual flow of electricity depends not only on voltage and amperage, but also on the resistance of the circuit. The higher the resistance, the higher the force necessary to push the current through the circuit. The standard unit for measuring resistance is an ohm. Resistance in a circuit varies depending on the amount and type of components used in the circuit. The main factors which determine resistance are:

- Material-some materials have more resistance than others. Those with high resistance are said to be insulators. Rubber materials (or rubber-like plastics) are some of the most common insulators used in vehicles as they have a very high resistance to electricity. Very low resistance materials are said to be conductors. Copper wire is among the best conductors. Silver is actually a superior conductor to copper and is used in some relay contacts, but its high cost prohibits its use as common wiring. Most automotive wiring is made of copper.
- Size-the larger the wire size being used, the less resistance the wire will have. This is why components which use large amounts of electricity usually have large wires supplying current to them.
- Length-for a given thickness of wire, the longer the wire, the greater the resistance. The shorter the wire, the less the resistance. When determining the proper wire for a circuit, both size and length must be considered to design a circuit that can handle the current needs of the component.

- Temperature-with many materials, the higher the temperature, the greater the resistance (positive temperature coefficient). Some materials exhibit the opposite trait of lower resistance with higher temperatures (negative temperature coefficient). These principles are used in many of the sensors on the engine.

OHM'S LAW

There is a direct relationship between current, voltage and resistance. The relationship between current, voltage and resistance can be summed up by a statement known as Ohm's Law.

Voltage (E) is equal to amperage (I) times resistance (R): E=I x R Other forms of the formula are R=E/I and I=E/R

In each of these formulas, E (which stands for Electromotive Force) is the voltage in volts, I (which stands for Intensity) is the current in amps and R (which stands for Resistance) is the resistance in ohms. The basic point to remember is that as the resistance of a circuit goes up, the amount of current that flows in the circuit will go down, if voltage remains the same.

The amount of work that the electricity can perform is expressed as power. The unit of power is the watt (W). The relationship between power, voltage and current is expressed as:

Power (W) is equal to amperage (I) times voltage (E): W=I x E

This is only true for direct current (DC) circuits. The alternating current formula is a tad different, but since the electrical circuits in most vehicles are DC type, we need not get into AC circuit theory.

Electrical Components

POWER SOURCE

Power is supplied to the vehicle by two devices: The battery and the alternator. The battery supplies electrical power during starting or during periods when the current demand of the vehicle's electrical system exceeds the output capacity of the alternator. The alternator supplies electrical current when the engine is running. The alternator supplies the electrical current needs of the vehicle, but it also recharges the battery.

The Battery

In most modern vehicles, the battery is a lead/acid electrochemical device consisting of six 2-volt subsections (cells) connected in series, so that the unit is capable of producing approximately 12 volts of electrical pressure. Each subsection consists of a series of positive and negative plates held a short distance apart in a solution of sulfuric acid and water.

The two types of plates are of dissimilar metals. This sets up a chemical reaction, and it is this reaction which produces current flow from the battery when its positive and negative terminals are connected to an electrical load. The power removed from the battery is replaced by the alternator, restoring the battery to its original chemical state.

The Alternator

On some vehicles there isn't an alternator, but a generator. The difference is that an alternator supplies alternating current which is then changed to direct current for use on the vehicle, while a generator produces direct current. Alternators tend to be more efficient and that is why they are used.

Alternators and generators are devices that consist of coils of wires wound together making big electromagnets. One group of coils spins within another set and the interaction of the magnetic fields causes a current to flow. This current is then drawn off the coils and fed into the vehicle's electrical system.

GROUND

Two types of grounds are used in automotive electric circuits. Direct ground components are grounded to the frame through their mounting points. All other components use some sort of ground wire which is attached to the frame or chassis of the vehicle. The electrical current runs through the chassis of the vehicle and returns to the battery through the ground (-) cable; if you look, you'll see that the battery ground cable connects between the battery and the frame or chassis of the vehicle.

It should be noted that a good percentage of electrical problems can BE TRACED to bad grounds.

PROTECTIVE DEVICES

It is possible for large surges of current to pass through the electrical system of your vehicle. If this surge of current were to reach the load device in the circuit, the surge could burn it out or severely damage it. It can also overload the wiring, causing the harness to get hot and melt the insulation. To prevent this, fuses, circuit breakers and/or fusible links are connected into the supply wires of the electrical system. These items are nothing more than a built-in weak spot in the system. When an abnormal amount of current flows through the system, these protective devices work as follows to protect the circuit:

- Fuse-when an excessive electrical current passes through a fuse, the fuse "blows" (the conductor melts) and opens the circuit, preventing the passage of current.

Most vehicles use one or more fuse panels. This one is located on the driver's side kick panel

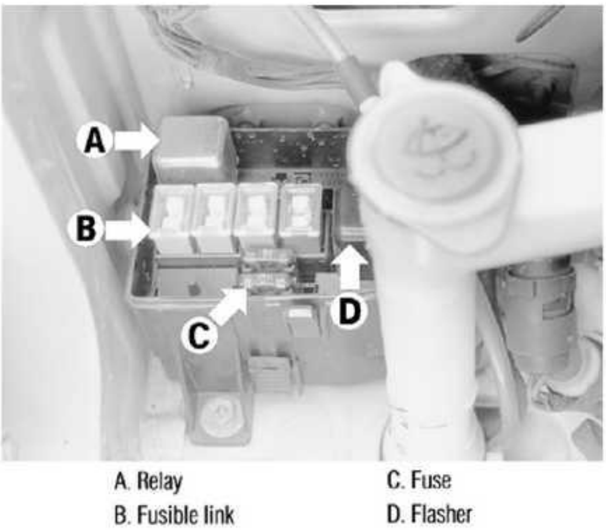
- Circuit Breaker-a circuit breaker is basically a self-repairing fuse. It will open the circuit in the same fashion as a fuse, but when the surge subsides, the circuit breaker can be reset and does not need replacement.

- Fusible Link-a fusible link (fuse link or main link) is a short length of special, high temperature insulated wire that acts as a fuse. When an excessive electrical current passes through a fusible link, the thin gauge wire inside the link melts, creating an intentional open to protect the circuit. To repair the circuit, the link must be replaced. Some newer type fusible links are housed in plug-in modules, which are simply replaced like a fuse, while older type fusible links must be cut and spliced if they melt. Since this link is very early in the electrical path, it's the first place to look if nothing on the vehicle works, yet the battery seems to be charged and is properly connected.

Always replace fuses, circuit breakers and fusible links with identically rated components. Under no circumstances should a component of higher or lower amperage rating be substituted.

SWITCHES & RELAYS

Switches are used in electrical circuits to control the passage of current. The most common use is to open and close circuits between the battery and the various electric devices in the system. Switches are rated according to the amount of amperage they can handle. If a sufficient amperage rated switch is not used in a circuit, the switch could overload and cause damage.



The underhood fuse and relay panel usually contains fuses, relays, flashers and fusible links

Some electrical components which require a large amount of current to operate use a special switch called a relay. Since these circuits carry a large amount of current, the thickness of the wire in the circuit is also greater. If this large wire were connected from the load to the control switch, the switch would have to carry the high amperage load and the fairing or dashboard would be twice as large to accommodate the increased size of the wiring harness. To prevent these problems, a relay is used.

Relays are composed of a coil and a set of contacts. When the coil has a current passed though it, a magnetic field is formed and this field causes the contacts to move together, completing the circuit. Most relays are normally open, preventing current from passing through the circuit, but they can take any electrical form depending on the job they are intended to do. Relays can be considered "remote control switches." They allow a smaller current to operate devices that require higher amperages. When a small current operates the coil, a larger current is allowed to pass by the contacts. Some common circuits which may use relays are the horn, headlights, starter, electric fuel pump and other high amperage circuits.

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Relays are composed of a coil and a switch. These two components are linked together so that when one operates, the other operates at the same time. The large wires in the circuit are connected from the battery to one side of the relay switch (B+) and from the opposite side of the relay switch to the load (component). Smaller wires are connected from the relay coil to the control switch for the circuit and from the opposite side of the relay coil to ground

LOAD

Every electrical circuit must include a "load" (something to use the electricity coming from the source). Without this load, the battery would attempt to deliver its entire power supply from one pole to another. This is called a "short circuit." All this electricity would take a short cut to ground and cause a great amount of damage to other components in the circuit by developing a tremendous amount of heat. This condition could develop sufficient heat to melt the insulation on all the surrounding wires and reduce a multiple wire cable to a lump of plastic and copper.

WIRING & HARNESSES

The average vehicle contains meters and meters of wiring, with hundreds of individual connections. To protect the many wires from damage and to keep them from becoming a confusing tangle, they are organized into bundles, enclosed in plastic or taped together and called wiring harnesses. Different harnesses serve different parts of the vehicle. Individual wires are color coded to help trace them through a harness where sections are hidden from view.

Automotive wiring or circuit conductors can be either single strand wire, multi-strand wire or printed circuitry. Single strand wire has a solid metal core and is usually used inside such components as alternators, motors, relays and other devices. Multi-strand wire has a core made of many small strands of wire twisted together into a single conductor. Most of the wiring in an automotive electrical system is made up of multi-strand wire, either as a single conductor or grouped together in a harness. All wiring is color coded on the insulator, either as a solid color or as a colored wire with an identification stripe. A printed circuit is a thin film of copper or other conductor that is printed on an insulator backing. Occasionally, a printed circuit is sandwiched between two sheets of plastic for more protection and flexibility. A complete printed circuit, consisting of conductors, insulating material and connectors for lamps or other components is called a printed circuit board. Printed circuitry is used in place of individual wires or harnesses in places where space is limited, such as behind instrument panels.

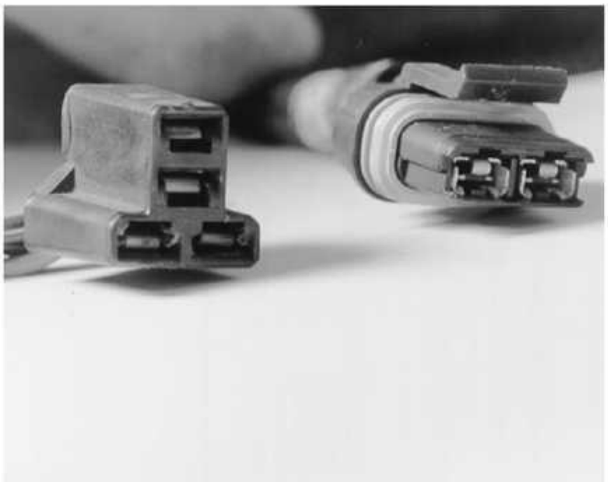
Since automotive electrical systems are very sensitive to changes in resistance, the selection of properly sized wires is critical when systems are repaired. A loose or corroded connection or a replacement wire that is too small for the circuit will add extra resistance and an additional voltage drop to the circuit.

The wire gauge number is an expression of the cross-section area of the conductor. Vehicles from countries that use the metric system will typically describe the wire size as its cross-sectional area in square millimeters. In this method, the larger the wire, the greater the number. Another common system for expressing wire size is the American Wire Gauge (AWG) system. As gauge number increases, area decreases and the wire becomes smaller. An 18 gauge wire is smaller than a 4 gauge wire. A wire with a higher gauge number will carry less current than a wire with a lower gauge number. Gauge wire size refers to the size of the strands of the conductor, not the size of the complete wire with insulator. It is possible, therefore, to have two wires of the same gauge with different diameters because one may have thicker insulation than the other.

It is essential to understand how a circuit works before trying to figure out why it doesn't. An electrical schematic shows the electrical current paths when a circuit is operating properly. Schematics break the entire electrical system down into individual circuits. In a schematic, usually no attempt is made to represent wiring and components as they physically appear on the vehicle; switches and other components are shown as simply as possible. Face views of harness connectors show the cavity or terminal locations in all multi-pin connectors to help locate test points.

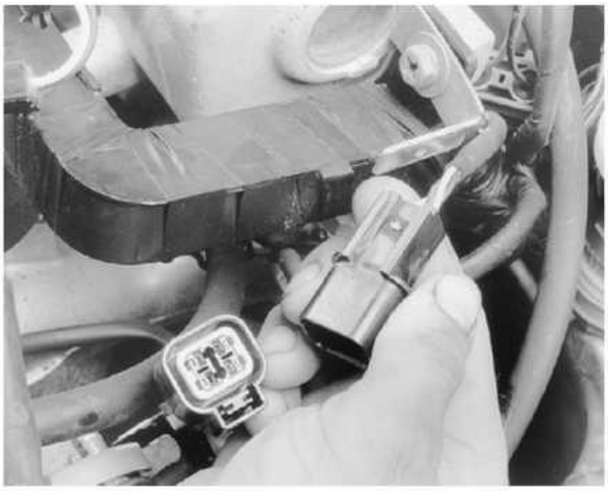
CONNECTORS

Three types of connectors are commonly used in automotive applications-weatherproof, molded and hard shell.



Hard shell (left) and weatherproof (right) connectors have replaceable terminals

- Weatherproof-these connectors are most commonly used where the connector is exposed to the elements. Terminals are protected against moisture and dirt by sealing rings which provide a weathertight seal. All repairs require the use of a special terminal and the tool required to service it. Unlike standard blade type terminals, these weatherproof terminals cannot be straightened once they are bent. Make certain that the connectors are properly seated and all of the sealing rings are in place when connecting leads.
- Molded-these connectors require complete replacement of the connector if found to be defective. This means splicing a new connector assembly into the harness. All splices should be soldered to insure proper contact. Use care when probing the connections or replacing terminals in them, as it is possible to create a short circuit between opposite terminals. If this happens to the wrong terminal pair, it is possible to damage certain components. Always use jumper wires between connectors for circuit checking and NEVER probe through weatherproof seals.
- Hard Shell-unlike molded connectors, the terminal contacts in hard-shell connectors can be replaced. Replacement usually involves the use of a special terminal removal tool that depresses the locking tangs (barbs) on the connector terminal and allows the connector to be removed from the rear of the shell. The connector shell should be replaced if it shows any evidence of burning, melting, cracks, or breaks. Replace individual terminals that are burnt, corroded, distorted or loose.



Weatherproof connectors are most commonly used in the engine compartment or where the connector is exposed to the elements

Test Equipment

Pinpointing the exact cause of trouble in an electrical circuit is most times accomplished by the use of special test equipment. The following describes different types of commonly used test equipment and briefly explains how to use them in diagnosis. In addition to the information covered below, the tool manufacturer's instructions booklet (provided with the tester) should be read and clearly understood before attempting any test procedures.

JUMPER WIRES

Never use jumper wires made from a thinner gauge wire than the circuit being tested. If the jumper wire is of too small a gauge, it may overheat and possibly melt. Never use jumpers to bypass high resistance loads in a circuit. Bypassing resistances, in effect, creates a short circuit. This may, in turn, cause damage and fire. Jumper wires should only be used to bypass lengths of wire or to simulate switches.

Jumper wires are simple, yet extremely valuable, pieces of test equipment. They are basically test wires which are used to bypass sections of a circuit. Although jumper wires can be purchased, they are usually fabricated from lengths of standard automotive wire and whatever type of connector (alligator clip, spade connector or pin connector) that is required for the particular application being tested. In cramped, hard-to-reach areas, it is advisable to have insulated boots over the jumper wire terminals in order to prevent accidental grounding. It is also advisable to include a standard automotive fuse in any jumper wire. This is commonly referred to as a "fused jumper". By inserting an in-line fuse holder between a set of test leads, a fused jumper wire can be used for bypassing open circuits. Use a 5 amp fuse to provide protection against voltage spikes.

Jumper wires are used primarily to locate open electrical circuits, on either the ground (-) side of the circuit or on the power (+) side. If an electrical component fails to operate, connect the jumper wire between the component and a good ground. If the component operates only with the jumper installed, the ground circuit is open. If the ground circuit is good, but the component does not operate, the circuit between the power feed and component may be open. By moving the jumper wire successively back from the component toward the power source, you can isolate the area of the circuit where the open is located. When the component stops functioning, or the power is cut off, the open is in the segment of wire between the jumper and the point previously tested.

You can sometimes connect the jumper wire directly from the battery to the "hot" terminal of the component, but first make sure the component uses 12 volts in operation. Some electrical components, such as fuel injectors or sensors, are designed to operate on about 4 to 5 volts, and running 12 volts directly to these components will cause damage.

TEST LIGHTS

A 12 volt test light is used to detect the presence of voltage in a circuit

The test light is used to check circuits and components while electrical current is flowing through them. It is used for voltage and ground tests. To use a 12 volt test light, connect the ground clip to a good ground and probe wherever necessary with the pick. The test light will illuminate when voltage is detected. This does not necessarily mean that 12 volts (or any particular amount of voltage) is present; it only means that some voltage is present. It is advisable before using the test light to touch its ground clip and probe across the battery posts or terminals to make sure the light is operating properly.

Do not use a test light to probe electronic ignition, spark plug or coil wires. Never use a pick-type test light to probe wiring on computer controlled systems unless specifically instructed to do so. Any wire insulation that is pierced by the test light probe should be taped and sealed with silicone after testing.

Like the jumper wire, the 12 volt test light is used to isolate opens in circuits. But, whereas the jumper wire is used to bypass the open to operate the load, the 12 volt test light is used to locate the presence of voltage in a circuit. If the test light illuminates, there is power up to that point in the circuit; if the test light does not illuminate, there is an open circuit (no power). Move the test light in successive steps back toward the power source until the light in the handle illuminates. The open is between the probe and a point which was previously probed.

The self-powered test light is similar in design to the 12 volt test light, but contains a 1.5 volt penlight battery in the handle. It is most often used in place of a multimeter to check for open or short circuits when power is isolated from the circuit (continuity test).

The battery in a self-powered test light does not provide much current. A weak battery may not provide enough power to illuminate the test light even when a complete circuit is made (especially if there is high resistance in the circuit). Always make sure that the test battery is strong. To check the battery, briefly touch the ground clip to the probe; if the light glows brightly, the battery is strong enough for testing.

A self-powered test light should not be used on any computer controlled system or component. The small amount of electricity transmitted by the test light is enough to damage many electronic automotive components.

MULTIMETERS

Multimeters are an extremely useful tool for troubleshooting electrical problems. They can be purchased in either analog or digital form and have a price range to suit any budget. A multimeter is a voltmeter, ammeter and ohmmeter (along with other features) combined into one instrument. It is often used when testing solid state circuits because of its high input impedance (usually 10 megaohms or more). A brief description of the multimeter main test functions follows:

- Voltmeter-the voltmeter is used to measure voltage at any point in a circuit, or to measure the voltage drop across any part of a circuit. Voltmeters usually have various scales and a selector switch to allow the reading of different voltage ranges. The voltmeter has a positive and a negative lead. To avoid damage to the meter, always connect the negative lead to the negative (-) side of the circuit (to ground or nearest the ground side of the circuit) and connect the positive lead to the positive (+) side of the circuit (to the power source or the nearest power source). Note that the negative voltmeter lead will always be black and that the positive voltmeter will always be some color other than black (usually red).
- Ohmmeter-the ohmmeter is designed to read resistance (measured in ohms) in a circuit or component. Most ohmmeters will have a selector switch which permits the measurement of different ranges of resistance (usually the selector switch allows the multiplication of the meter reading by 10, 100, 1,000 and 10,000). Some ohmmeters are "auto-ranging" which means the meter itself will determine which scale to use. Since the meters are powered by an internal battery, the ohmmeter can be used like a self-powered test light. When the ohmmeter is connected, current from the ohmmeter flows through the circuit or component being tested. Since the ohmmeter's internal resistance and

voltage are known values, the amount of current flow through the meter depends on the resistance of the circuit or component being tested. The ohmmeter can also be used to perform a continuity test for suspected open circuits. In using the meter for making continuity checks, do not be concerned with the actual resistance readings. Zero resistance, or any ohm reading, indicates continuity in the circuit. Infinite resistance indicates an opening in the circuit. A high resistance reading where there should be none indicates a problem in the circuit. Checks for short circuits are made in the same manner as checks for open circuits, except that the circuit must be isolated from both power and normal ground. Infinite resistance indicates no continuity, while zero resistance indicates a dead short.

Never use an ohmmeter to check the resistance of a component or wire while there is voltage applied to the circuit.

- Ammeter-an ammeter measures the amount of current flowing through a circuit in units called amperes or amps. At normal operating voltage, most circuits have a characteristic amount of amperes, called "current draw" which can be measured using an ammeter. By referring to a specified current draw rating, then measuring the amperes and comparing the two values, one can determine what is happening within the circuit to aid in diagnosis. An open circuit, for example, will not allow any current to flow, so the ammeter reading will be zero. A damaged component or circuit will have an increased current draw, so the reading will be high. The ammeter is always connected in series with the circuit being tested. All of the current that normally flows through the circuit must also flow through the ammeter; if there is any other path for the current to follow, the ammeter reading will not be accurate. The ammeter itself has very little resistance to current flow and, therefore, will not affect the circuit, but it will measure current draw only when the circuit is closed and electricity is flowing. Excessive current draw can blow fuses and drain the battery, while a reduced current draw can cause motors to run slowly, lights to dim and other components to not operate properly.

Troubleshooting Electrical Systems

When diagnosing a specific problem, organized troubleshooting is a must. The complexity of a modern automotive vehicle demands that you approach any problem in a logical, organized manner. There are certain troubleshooting techniques, however, which are standard:

- Establish when the problem occurs. Does the problem appear only under certain conditions? Were there any noises, odors or other unusual symptoms? Isolate the problem area. To do this, make some simple tests and observations, then eliminate the systems that are working properly. Check for obvious problems, such as broken wires and loose or dirty connections. Always check the obvious before assuming something complicated is the cause.
- Test for problems systematically to determine the cause once the problem area is isolated. Are all the components functioning properly? Is there power going to electrical switches and motors. Performing careful, systematic checks will often turn up most causes on the first inspection, without wasting time checking components that have little or no relationship to the problem.
- Test all repairs after the work is done to make sure that the problem is fixed. Some causes can be traced to more than one component, so a careful verification of repair work is important in order to pick up additional malfunctions that may cause a problem to reappear or a different problem to arise. A blown fuse, for example, is a simple problem that may require more than another fuse to repair. If you don't look for a problem that caused a fuse to blow, a shorted wire (for example) may go undetected.

Experience has shown that most problems tend to be the result of a fairly simple and obvious cause, such as loose or corroded connectors, bad grounds or damaged wire insulation which causes a short. This makes careful visual inspection of components during testing essential to quick and accurate troubleshooting.

Testing

OPEN CIRCUITS

The infinite reading on this multimeter indicates that the circuit is open

This test already assumes the existence of an open in the circuit and it is used to help locate the open portion.

1. Isolate the circuit from power and ground.
2. Connect the self-powered test light or ohmmeter ground clip to the ground side of the circuit and probe sections of the circuit sequentially.
3. If the light is out or there is infinite resistance, the open is between the probe and the circuit ground.
4. If the light is on or the meter shows continuity, the open is between the probe and the end of the circuit toward the power source.

SHORT CIRCUITS

Never use a self-powered test light to perform checks for opens or shortswhen power is applied to the circuit under test. The test light can be damagedby outside power.

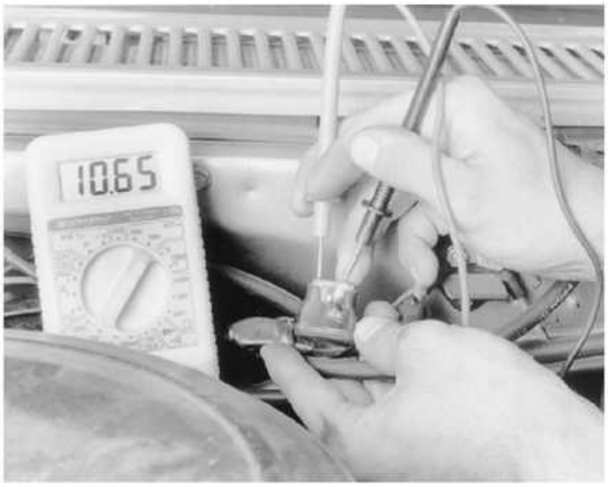
1. Isolate the circuit from power and ground.
2. Connect the self-powered test light or ohmmeter ground clip to a good ground and probe any easy-to-reach point in the circuit.
3. If the light comes on or there is continuity, there is a short somewhere in the circuit.
4. To isolate the short, probe a test point at either end of the isolated circuit (the light should be on or the meter should indicate continuity).
5. Leave the test light probe engaged and sequentially open connectors or switches, remove parts, etc. until the light goes out or continuity is broken.
6. When the light goes out, the short is between the last two circuit components which were opened.

VOLTAGE

This test determines voltage available from the battery and should be the first step in any electrical troubleshooting procedure after visual inspection. Many electrical problems, especially on computer controlled systems, can be caused by a low state of charge in the battery. Excessive corrosion at the battery cable terminals can cause poor contact that will prevent proper charging and full battery current flow.

1. Set the voltmeter selector switch to the 20V position.
2. Connect the multimeter negative lead to the battery's negative (-) post or terminal and the positive lead to the battery's positive (+) post or terminal.
3. Turn the ignition switch ***ON*** to provide a load.
4. A well charged battery should register over 12 volts. If the meter reads below 11.5 volts, the battery power may be insufficient to operate the electrical system properly.

VOLTAGE DROP



This voltage drop test revealed high resistance (low voltage) in the circuit

When current flows through a load, the voltage beyond the load drops. This voltage drop is due to the resistance created by the load and also by small resistances created by corrosion at the connectors and damaged insulation on the wires. The maximum allowable voltage drop under load is critical, especially if there is more than one load in the circuit, since all voltage drops are cumulative.

1. Set the voltmeter selector switch to the 20 volt position.
2. Connect the multimeter negative lead to a good ground.
3. Operate the circuit and check the voltage prior to the first component (load).
4. There should be little or no voltage drop in the circuit prior to the first component. If a voltage drop exists, the wire or connectors in the circuit are suspect.
5. While operating the first component in the circuit, probe the ground side of the component with the positive meter lead and observe the voltage readings. A small voltage drop should be noticed. This voltage drop is caused by the resistance of the component.
6. Repeat the test for each component (load) down the circuit.
7. If a large voltage drop is noticed, the preceding component, wire or connector is suspect.

RESISTANCE

Checking the resistance of a coolant temperature sensor with an ohmmeter. Reading is 1.04 kilo ohms (1040 ohms)

Spark plug wires can be checked for excessive resistance using an ohmmeter

Never use an ohmmeter with power applied to the circuit. The ohmmeter is designed to operate on its own power supply. The normal 12 volt electrical system voltage could damage the meter!

1. Isolate the circuit from the vehicle's power source.
2. Ensure that the ignition key is ***OFF*** when disconnecting any components or the battery.
3. Where necessary, also isolate at least one side of the circuit to be checked, in order to avoid reading parallel resistances. Parallel circuit resistances will always give a lower reading than the actual resistance of either of the branches.
4. Connect the meter leads to both sides of the circuit (wire or component) and read the actual measured ohms on the meter scale. Make sure the selector switch is set to the proper ohm scale for the circuit being tested, to avoid misreading the ohmmeter test value.

Wire and Connector Repair

Almost anyone can replace damaged wires, as long as the proper tools and parts are available. Wire and terminals are available to fit almost any need. Even the specialized weatherproof, molded and hard shell connectors are now available from aftermarket suppliers.

Be sure the ends of all the wires are fitted with the proper terminal hardware and connectors. Wrapping a wire around a stud is never a permanent solution and will only cause trouble later. Replace wires one at a time to avoid confusion. Always route wires exactly the same as the factory.

If connector repair is necessary, only attempt it if you have the proper tools. Weatherproof and hard shell connectors require special tools to release the pins inside the connector. Attempting to repair these connectors with conventional

hand tools will damage them.

BATTERY CABLES

When working on any electrical component on the vehicle, it is always a good idea to disconnect the negative (-) battery cable. This will prevent potential damage to many sensitive electrical components such as the Engine Control Module (ECM), radio, alternator, etc.

Any time you disengage the battery cables, it is recommended that you disconnect the negative (-) battery cable first. This will prevent accidentally grounding the positive (+) terminal to the body of the vehicle when disconnecting it, possibly causing damage to the above mentioned components.

Before you disconnect the cable(s), first turn the ignition to the ***OFF*** position. This will prevent a draw on the battery which could cause arcing (electricity trying to ground itself to the body of a vehicle, just like a spark plug jumping the gap) and, of course, damaging some components such as the alternator diodes.

When the battery cable(s) are reconnected (negative cable last), be sure to check that your lights, windshield wipers and other electrically operated safety components are all working correctly. If your vehicle contains an Electronically Tuned Radio (ETR), don't forget to also reset your radio stations. Reset the clock, if equipped, as well.

AIR BAG (SUPPLEMENTAL RESTRAINT SYSTEM)

General Information

Always follow the instructions on any safety labels regarding the air bag system

The Air Bag system or Supplemental Restraint System (SRS) is designed to provide additional protection for front seat occupants when used in conjunction with a seat belt. The system is an electronically controlled, mechanically operated system. The system contains two basic subsytems: the air bag module(s) (the actual air bag(s) themselves), and the electrical system. The system consists of:

- The crash sensors
- The safing sensor
- The air bag module(s)
- The diagnostic monitor
- The instrument cluster indicator
- The sliding contacts (clock spring assembly)

The system operates as follows: the system remains out of sight until activated in an accident that is determined to be the equivalent of hitting a parked car of the same size and weight at 28 mph (40 km/h) with the vehicle receiving severe front end damage. This determination is made by crash and safing sensors mounted on the vehicle which, when a sufficient impact occurs, close their contacts, completing the electrical circuit and inflating the air bags. When not activated the system is monitored by the air bag diagnostic monitor and system readiness is indicated by the lamp located on the instrument cluster. Any fault detected by the diagnostic monitor will illuminate the lamp and store a Diagnostic Trouble Code (DTC).

Air Bag Module(s)

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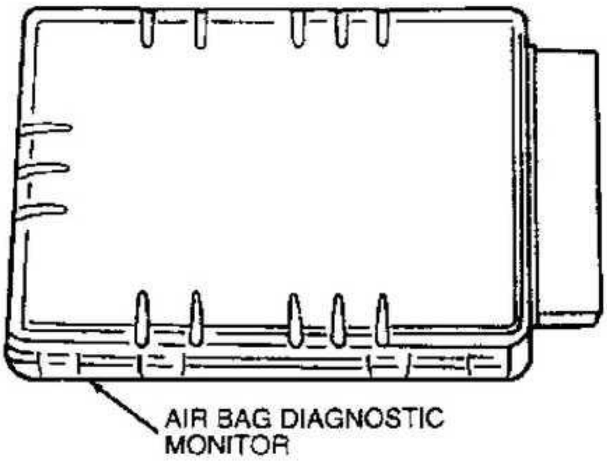
Passenger side air bag module assembly

The air bag module(s) are located in the steering wheel and the passenger side of the instrument panel. The modules are molded to fit into their designated areas. The driver's side is located in the center of the steering wheel. The passenger side module is molded to fit into the instrument panel and is located above the glove box, where it is generally unnoticeable until inflated.

The module contains four parts: an inflator, a bag, a container, and the cover. The purpose of the inflator is to generate the gas needed to fill the air bag. It consists of a high strength steel casing containing a propellant that is activated by an igniter. The igniter is fired by the electrical signal received when the safing sensor closes. When the igniter is fired, the propellant discharge is ignited and fills the bag. As the bag fills, invisible "split seams" in the cover tear open allowing the bag to inflate and cushion the forward motion of the occupant and protect against serious injury.

Diagnostic Monitor



The air bag diagnostic monitor assembly

The diagnostic monitor is located behind the center of the instrument panel, under the radio. The diagnostic monitor serves no purpose in the firing of the air bag(s). The main purpose of the diagnostic monitor is to monitor the operational status of the system through continual checks of the system's circuits. In the event of a fault detected, the diagnostic monitor will illuminate the air bag indicator and flash out a Diagnostic Trouble Code (DTC). All codes are double digit and if a code is flashed, it can be read as follows: a flash-flash-flash, one-second pause, flash-flash, three-second pause, is a code 32. If numerous codes are stored, they will flash after the three second pause. If only one code is stored, the same flash sequence will begin again. In the event of a air bag indicator bulb failure, an audible tone will be emitted from the diagnostic monitor. This tone is a series of five sets of five beeps, this is code 55 indicating the indicator bulb is out and, in addition, the air bag system may require service.

The diagnostic monitor also contains the back-up power supply. In the event of an impact severing the battery or other electrical sources to the air bag system, the back up power supply contains enough power to deploy the air bag(s). The diagnostic monitor contains several small capacitors that store power. The back-up power supply must be discharged before air bag service can be performed.

Crash Sensors

Click on icon to view fullsize printable image.

Click to Enlarge

Crash sensor mounting-driver's side shown, passenger side similar

The crash sensors are located in the front of the vehicle on either side of the front radiator support. In the event of a head-on impact (or at least a 3/4 frontal impact), the sensing mass inside the sensor breaks away from the bias magnet. The sensor mass rolls along a cylinder toward two electrical contacts, if the deceleration is sufficient, the sensing mass will bridge the contacts and complete the primary deployment circuit to the air bag module.

The mounting and orientation of the sensors is vital to system operation. The sensors should be inspected by a qualified individual after any impact where the sensors could have been damaged. If any structural damage is evident, the area must be repaired to its original condition, otherwise the sensor orientation could be compromised. If the sensor(s) have received damage, they must be replaced.

Safing Sensor

The safing sensor is located behind the kick panel on the passenger side, below the instrument panel. The safing sensor operates identically to the crash sensor, except for the calibration. This is accomplished using a slightly weaker bias magnet. If the safing sensor contacts close simultaneously with the crash sensor, the air bag(s) will be deployed.

The safing sensor is essentially a safety for the air bag system. It protects the bag(s) from deploying due to an electrical short. The safing sensor is used to verify the force of a collision and complete the air bag(s) deployment. The sensor is located inside the passenger compartment so that a forceful enough impact could be detected, and a false signal from the crash sensor would not deploy the air bag(s) at an inappropriate time.

Air Bag Indicator

The air bag indicator is located on the instrument cluster and illuminates when activated by the diagnostic monitor. The indicator illuminates when the key is placed in the ignition and turned to ***RUN***. This is the bulb `prove-out'. The indicator will stay illuminated after the vehicle is started while the diagnostic monitor checks the system for faults and, if no faults are detected, the indicator will go out after about 6 seconds. If the indicator does not go out after 6 seconds, a fault has been detected in the system and a Diagnostic Trouble Code (DTC) will be flashed using the indicator.

Sliding Contact

The clock spring assembly is located in the steering column, behind the steering wheel. The function of the clock spring assembly is to keep the electrical connection intact while the steering wheel is rotated during steering.

System Service

SERVICE PRECAUTIONS

Whenever working around, or on, the air bag supplemental restraint system, ALWAYS adhere to the following warnings and cautions.

- Always wear safety glasses when servicing an air bag vehicle and when handling an air bag module.
- Carry a live air bag module with the bag and trim cover facing away from your body, so that an accidental deployment of the air bag will have a small chance of personal injury.
- Place an air bag module on a table or other flat surface with the bag and trim cover pointing up.
- Wear gloves, a dust mask and safety glasses whenever handling a deployed air bag module. The air bag surface may contain traces of sodium hydroxide, a by-product of the gas that inflates the air bag and which can cause skin irritation.
- Always wash your hands with mild soap and water after handling a deployed air bag.
- All air bag modules with discolored or damaged cover trim must be replaced, not repainted.
- All component replacement and wiring service must be made with the negative and positive battery cables disconnected from the battery for a minimum of one minute prior to attempting service or replacement.
- NEVER probe the air bag electrical terminals. Doing so could result in air bag deployment, which can cause serious physical injury.
- If the vehicle is involved in a fender-bender which results in a damaged front bumper or grille, have the air bag sensors inspected by a qualified automotive technician to ensure that they were not damaged.
- If at any time, the air bag light indicates that the computer has noted a problem, have your vehicle's SRS serviced immediately by a qualified automotive technician. A faulty SRS can cause severe physical injury or death.

DISARMING THE SYSTEM

The air bag system must be disarmed before performing service around air bag components or wiring. Failure to do so may cause accidental deployment of theair bag, resulting in costly repairs and/or personal injury.

1. Position the vehicle with the front wheels in a straight ahead position.
2. Disconnect the negative battery cable.
3. Disconnect the positive battery cable.
4. Wait at least one minute for the air bag back-up power supply to drain before continuing.
5. Proceed with the repair.
6. Once complete, connect the battery cables, negative cable last.
7. Check the functioning of the air bag system by turning the ignition key to the ***RUN*** position and visually monitoring the air bag indicator lamp in the instrument cluster. The indicator lamp should illuminate for approximately six seconds, then turn ***OFF***. If the indicator lamp does not illuminate, stays on, or flashes at any time, a fault has been detected by the air bag diagnostic monitor.

ARMING THE SYSTEM

1. Connect the positive battery cable.
2. Connect the negative battery cable.
3. Stand outside the vehicle and carefully turn the ignition to the ***RUN*** position. Be sure that no part of your body is in front of the air bag module on the steering wheel, to prevent injury in case of an accidental air bag deployment.
4. Ensure the air bag indicator light turns off after approximately 6 seconds. If the light does not illuminate at all, does not turn off, or starts to flash, have the system tested by a qualified automotive technician. If the light does turn off after 6 seconds and does not flash, the SRS is working properly.

HEATING AND AIR CONDITIONING

Blower Motor

REMOVAL & INSTALLATION

1996 Models

1. Disconnect the negative battery cable.
2. Disengage the instrument panel insulator from the instrument panel.
3. Detach the wiring connector at the blower motor.
4. Remove the 3 screws retaining the blower motor to the evaporator housing and remove the blower motor and wheel assembly.
5. If required, separate the blower motor wheel from the blower motor by removing the retainer from the blower motor shaft and sliding the blower motor wheel off the blower motor shaft.

To install:

6. If the blower motor wheel was removed, align the flats on the inside diameter of the wheel hub with the flat surface on the blower motor shaft and slide the blower motor wheel onto the blower motor shaft. Install a new blower motor wheel retainer onto the shaft.
7. Install the blower motor and wheel assembly into the evaporator housing and firmly tighten the 3 retaining screws.
8. Attach the connector to the blower motor. Install the insulator panel to the instrument panel.
9. Connect the negative battery cable. Check for proper blower motor operation.

1997-99 Models

Click on icon to view fullsize printable image.

Click to Enlarge

The blower motor-to-evaporator housing mounting

Click on icon to view fullsize printable image.

Click to Enlarge

The blower wheel is held to the motor by a retaining clip

1. Disconnect the negative battery cable.
2. Disengage the instrument panel insulator from the instrument panel.
3. Detach the wiring connector at the blower motor.
4. Unsnap the instrument panel upper finish panel from the instrument panel.
5. On vehicles equipped with autolamp, detach the electrical connector from the light sensor amplifier.
6. Unsnap and remove the instrument panel finish end panel from the right side of the instrument panel.
7. Remove the 3 screws retaining the instrument panel to the upper cowl top panel.
8. Remove the 2 screws at each right side of the instrument panel.
9. Remove the 3 screws retaining the blower motor to the evaporator housing.

10. Pull the instrument panel away from the cowl and remove the blower motor from the A/C evaporator housing.
11. If required, separate the blower motor wheel from the blower motor by removing the retainer from the blower motor shaft and sliding the blower motor wheel off the blower motor shaft.

To install:

12. If the blower motor wheel was removed, align the flats on the inside diameter of the wheel hub with the flat surface on the blower motor shaft and slide the blower motor wheel onto the blower motor shaft. Install a new blower motor wheel retainer onto the shaft.
13. Install the blower motor and wheel assembly into the evaporator housing and firmly tighten the 3 retaining screws.
14. Reposition the instrument panel and install the 2 screws at each right side of the instrument panel.
15. Install the 3 screws retaining the instrument panel to the upper cowl top panel.
16. Install the instrument panel finish end panel to the right side of the instrument panel.
17. On vehicles equipped with autolamp, Attach the electrical connector to the light sensor amplifier.
18. Snap the instrument panel upper finish panel to the instrument panel.
19. Attach the wiring connector at the blower motor.
20. Engage the instrument panel insulator to the instrument panel.
21. Connect the negative battery cable. Check for proper blower motor operation.

Heater Core

REMOVAL & INSTALLATION

Click on icon to view fullsize printable image.

Click to Enlarge

Remove the four blend door actuator retaining screws

Click on icon to view fullsize printable image.

Click to Enlarge

Secondary air temperature door connections

1. Disconnect the negative battery cable.

NEVER open, service or drain the radiator or cooling system when hot; serious burns can occur from the steam and hot coolant. Also, when draining engine coolant, keep in mind that cats and dogs are attracted to ethylene glycol antifreeze and could drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantities.Always drain coolant into a sealable container. If necessary, clean coolant maybe reused unless it is contaminated or more than two years old.

2. Drain the engine coolant.
3. Remove the instrument panel. Refer to Section 10.
4. In the engine compartment, label and disconnect the heater hoses from the heater core.
5. Plug the opening on the heater core inlet and outlet tubes to prevent coolant from flowing out into the passenger compartment.
6. Remove the four retaining screws and remove the blend door actuator from the evaporator housing.
7. Remove the metal cover and disengage the spring from the heater core cover and remove the spring from the lever.
8. Gently depress the locking ramp and remove the lever from the secondary A/C air temperature control door.
9. Rotate the primary A/C temperature control door shaft down, then swing the metal link and remove the pin.
10. Remove the three heater core cover retaining screws and remove the heater core cover and seal from the evaporator housing.
11. Remove the heater core from the evaporator housing by pushing on the heater core tubes.

To install:

12. Transfer the foam seal to the new heater core.
13. Install the new core with seal into the evaporator housing.
14. Position the heater core cover and seal into position and install the three retaining screws.
15. Install the metal link over the pin on the primary A/C air temperature door lever.
16. Install the secondary A/C air temperature control door lever-to-secondary A/C air temperature control door end.
17. Engage the spring on the heater core cover and secondary A/C air temperature control door lever.
18. Install the blend door actuator.
19. Connect the heater hoses to the heater core.
20. Install the instrument panel. Refer to Section 10.
21. Connect the negative battery cable.
22. Fill and bleed the cooling system.

Air Conditioning Components

REMOVAL & INSTALLATION

Repair or service of air conditioning components is not covered by this manual, because of the risk of personal injury or death, and because of the legal ramifications of servicing these components without the proper EPA certification and experience. Cost, personal injury or death, environmental damage, and legal considerations (such as the fact that it is a federal crime to vent refrigerant into the atmosphere), dictate that the A/C components on your vehicle should be serviced only by a Motor Vehicle Air Conditioning (MVAC) trained, and EPA certified automotive technician.

If your vehicle's A/C system uses R-12 refrigerant and is in need of recharging, the A/C system can be converted over to R-134a refrigerant (less environmentally harmful and expensive). Refer to Section 1 ***for additional information on R-12 to R-134a conversions, and for additional considerations dealing with your vehicle's A/C system.***

Vacuum Actuator Motors

REMOVAL & INSTALLATION

Heater Air Damper Door

Click on icon to view fullsize printable image.

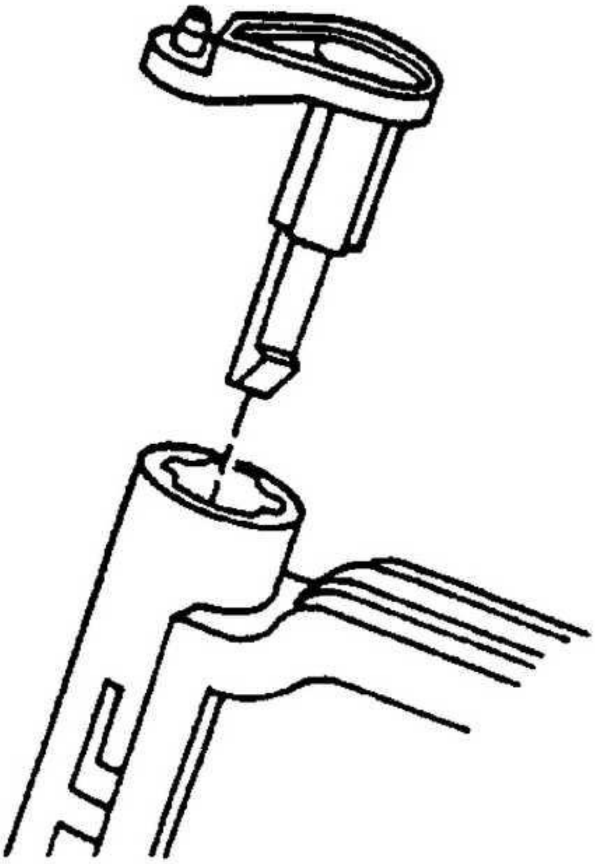
Click to Enlarge

The air bag diagnostic monitor assembly mounting

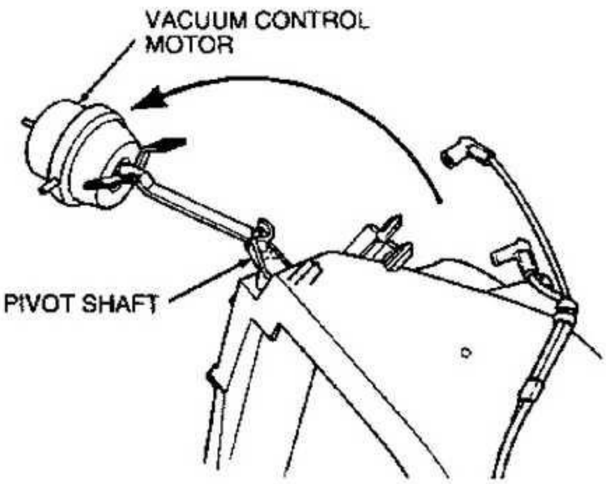
Click on icon to view fullsize printable image.

Click to Enlarge

Remove the two retaining screws and remove the metal cover from the evaporator housing



Rotate the pivot shaft to remove it from the vacuum motor



The air damper door vacuum motor mounting

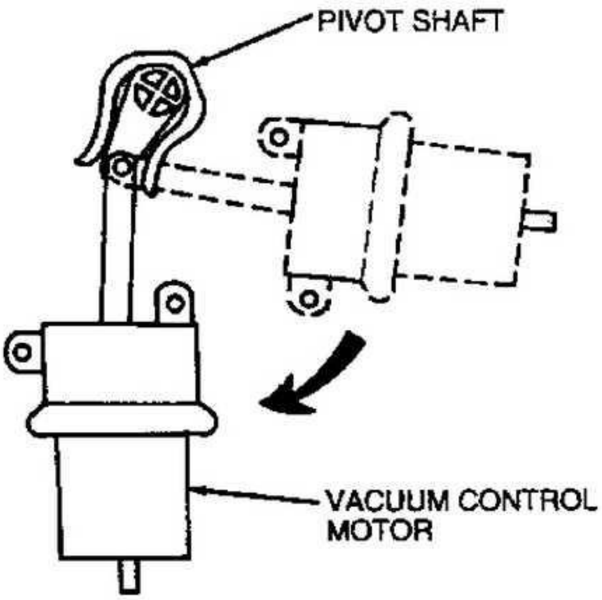
1. Disconnect the negative battery cable.
2. Remove the instrument panel. Refer to Section 10.
3. Detach the air bag diagnostic monitor connectors.
4. Remove the two air bag diagnostic monitor bracket lower retaining bolts. Loosen the bolt to the right of the diagnostic monitor connector and remove the monitor from the vehicle.

5. Remove the two retaining screws and remove the metal cover from the evaporator housing.
6. Gently depress the locking ramp on the pivot shaft and remove the pivot shaft from the heater air damper door.
7. Rotate the pivot shaft and remove the arm from the vacuum motor.
8. Remove the vacuum motor retaining screws.
9. Disconnect the vacuum harness from the vacuum motor and remove the vacuum motor from the vehicle.
10. The installation is the reverse of the removal.

A/C Damper Door

1. Disconnect the negative battery cable.
2. Remove the lower trim panel from the passenger side of the instrument panel.
3. Disengage the trim panel from the passenger side of the center console.
4. Remove the two vacuum motor-to-heater air plenum chamber retaining nuts.
5. Rotate the vacuum motor and disconnect the arm from the pivot shaft.
6. The installation is the reverse of the removal.

Windshield Defroster Door

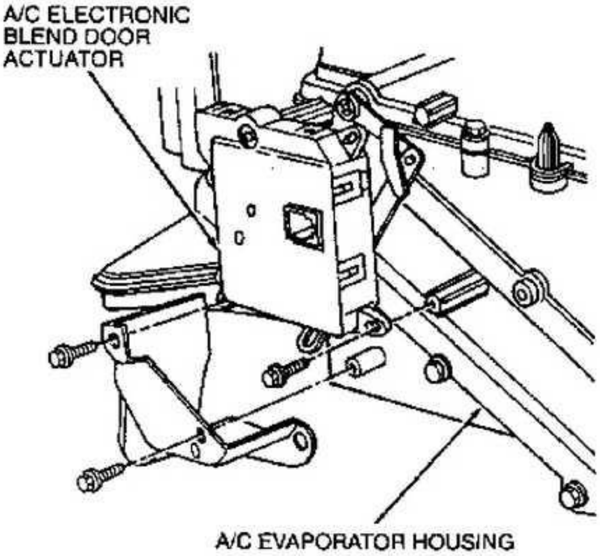


The windshield defroster door vacuum motor mounting

1. Disconnect the negative battery cable.
2. Disarm the air bag system.
3. Remove the passenger side air bag module trim cover.
4. Open the glove box door, release the door cable, and lower the door to the floor.
5. Remove the two air bag module retaining screws through the glove box opening.
6. Detach the air bag module connections and remove the passenger side air bag module.
7. Remove the two vacuum motor-to-heater air plenum chamber retaining nuts.
8. Rotate the vacuum motor and disconnect the arm from the pivot shaft.
9. Remove the vacuum motor.
10. The installation is the reverse of the removal.

Blend Door Actuator

REMOVAL & INSTALLATION



Remove the four blend door actuator retaining screws

1. Disconnect the negative battery cable.
2. Remove the lower trim panel from the passenger side of the instrument panel.
3. Disengage the trim panel from the passenger side of the center console.
4. Unplug the wire harness connector from the blend door actuator.
5. Remove the four retaining screws from the blend door actuator.
6. Remove the blend door actuator from the evaporator housing.
7. The installation is the reverse of the removal.

Control Panel

REMOVAL & INSTALLATION

The control panel for the heating and air conditioning is integrated into one large panel that includes the radio control as well. This panel is referred to as the Integrated Control Panel (ICP). Refer to Radio in this section for removal and installation procedures.

CRUISE CONTROL

All models covered by this vehicle have an available speed control system. This system automatically controls the speed of the vehicle when cruising at a stable highway speed. The speed control system consists of the following:

- Speed control amplifier/servo assembly
- Speed control cable
- Vehicle Speed Sensor (VSS)
- Speed control actuator switch
- Stop light switch
- Deactivator switch

The speed control system operates independently of engine vacuum and, therefore, does not utilize any vacuum lines.

The speed control amplifier integrates the system electronics, thereby eliminating any other electronic control modules in the vehicle. The amplifier controls the vehicle's speed via a cable attached to the throttle body lever.

The speed control actuator switch assembly is mounted on the steering wheel and allows the driver to control the system's operation. The switch assembly contains five control buttons for system functioning, namely: ON, OFF, RESUME, SET ACCEL, COAST.

The system will continue to control the vehicle's speed until the OFF button is used, or the brake pedal or clutch pedal (manual transmissions only) is depressed.

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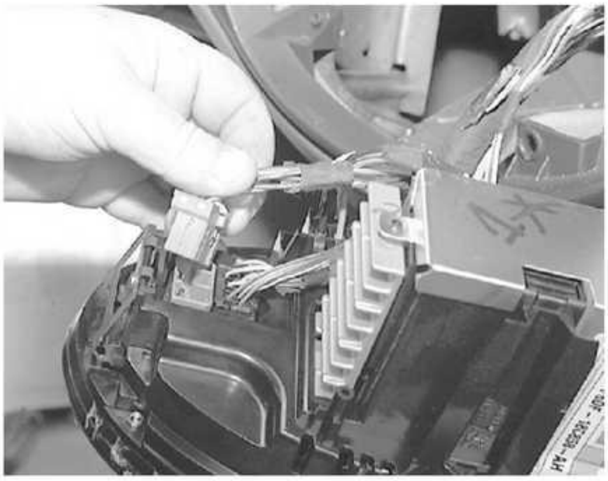
Cruise Control Troubleshooting

ENTERTAINMENT SYSTEMS

Integrated Control Panel (ICP)

REMOVAL & INSTALLATION

Insert the radio removal tools and release the retaining clips. Carefully pull the control panel chassis out of the instrument panel



Detach the connectors on the back of the control panel

1. Disconnect the negative battery cable.

Do not use excessive force when installing the radio removal tool. This will damage the retaining clips, making the Integrated Control Panel (ICP) chassis removal difficult and may cause other internal damage.

2. Install Radio Removal Tool (T87P-19061-A) or equivalent into the ICP. Push the tool in approximately 1 in. (25mm) to release the retaining clips.
3. Apply a slight outward force on both sides and pull the chassis out of the instrument panel.
4. Detach the any connectors, vacuum hoses or necessary cables.
5. Remove the ICP from the vehicle.

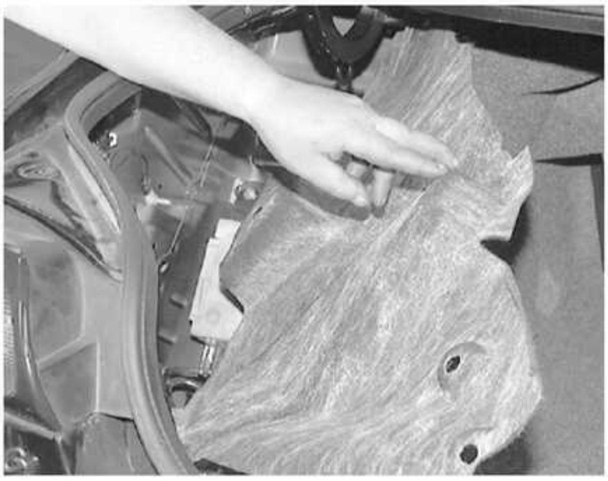
To install:

6. Position the ICP chassis in the vehicle.
7. Attach and removed connectors, hoses or cables to the ICP.
8. Push the ICP chassis inward until the retaining clips are fully engaged.
9. Connect the negative battery cable.

Rear Chassis Unit

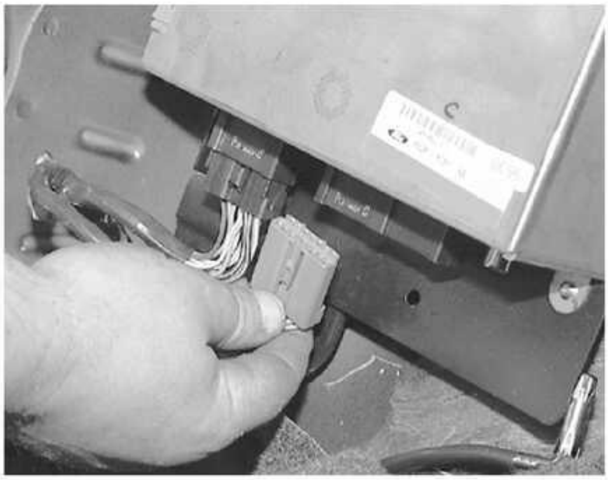
REMOVAL & INSTALLATION

Sedan



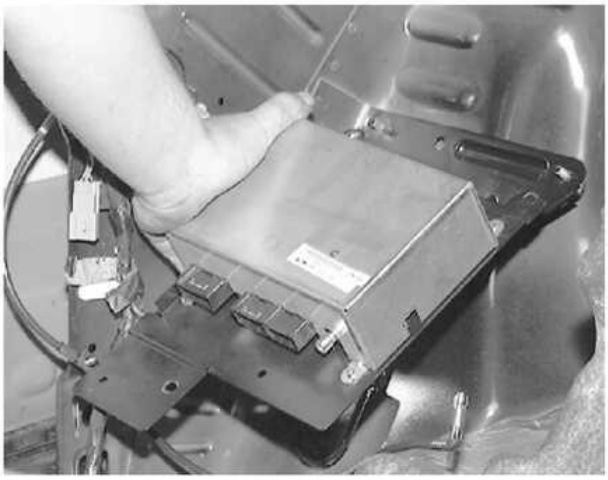
Remove the trim to access the rear chassis unit

Disconnect the antenna from the rear chassis unit



Detach the electrical connectors from the rear chassis unit

Remove the three retaining nuts...



... and remove the rear chassis unit from the vehicle

1. Disconnect the negative battery cable.
2. Open the trunklid and remove the driver's side trim panel pushpins and the panel.
3. Detach the electrical connectors and the antenna cable from the rear chassis unit.
4. Remove the three retaining nuts from the rear chassis unit and remove the unit from the vehicle.

To install:

5. The installation is the reverse of the removal.

Wagon

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Click to Enlarge

Rear chassis unit mounting-wagon

1. Disconnect the negative battery cable.
2. Open the liftgate and remove the spare tire from the vehicle.
3. Remove the spare tire well trim.
4. Detach the electrical connectors and the antenna cable from the rear chassis unit.
5. Remove the one retaining nut and the two retaining screws from the rear chassis unit and remove the unit from the vehicle.
6. The installation is the reverse of the removal.

Compact Disc Changer

REMOVAL & INSTALLATION

Sedan

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Compact disc changer mounting-sedan

1. Disconnect the negative battery cable.
2. Open the trunklid and remove the driver's side trim panel pushpins and remove the panel.
3. Detach the electrical connectors from the CD changer unit.
4. Remove the three retaining screws from the CD changer unit and remove the unit from the vehicle.

To install:

5. The installation is the reverse of the removal.

Wagon

Click on icon to view fullsize printable image.

Click to Enlarge

Compact disc changer mounting-wagon

1. Disconnect the negative battery cable.
2. Open the liftgate and remove the rear quarter trim from the vehicle.
3. Detach the electrical connectors from the CD changer unit.
4. Remove the two retaining bolts from the CD changer unit and remove the unit from the vehicle.

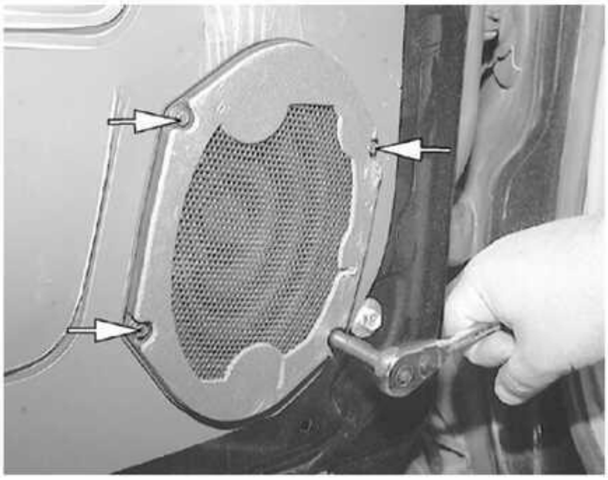
To install:

5. The installation is the reverse of the removal.

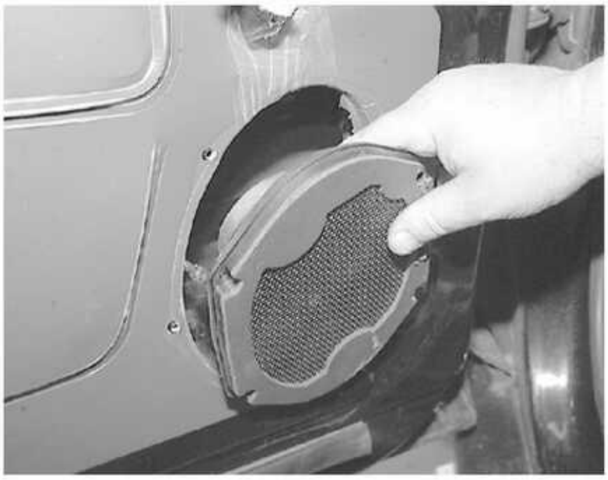
Speakers

REMOVAL & INSTALLATION

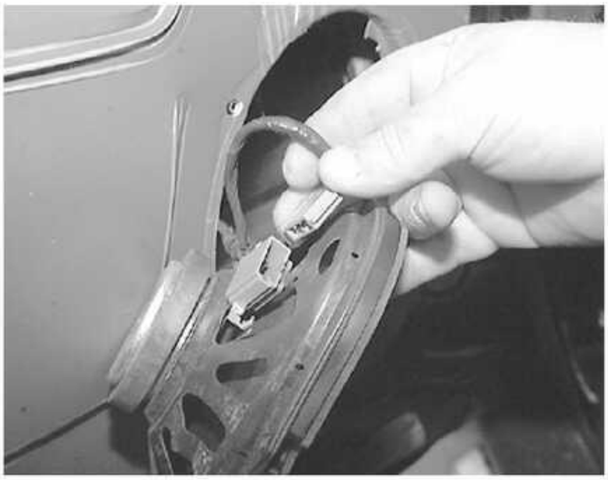
Door Speakers



Remove the four speaker retaining screws and...



... pull the speaker out of the door to...



... detach the connector from the speaker and remove the speaker from the vehicle

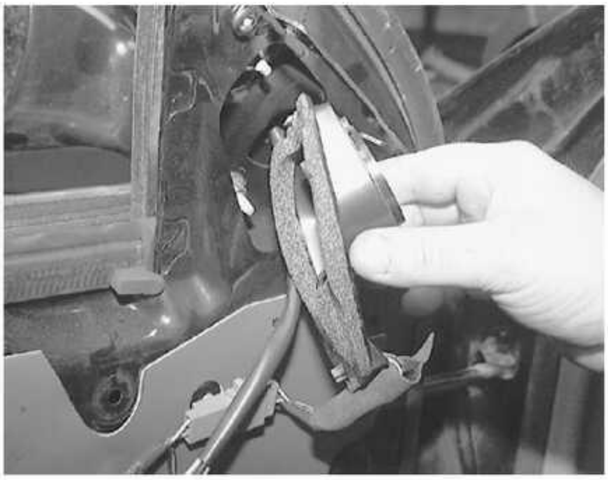
1. Disconnect the negative battery cable.
2. Remove the door trim panel.
3. Remove the four screws attaching the speaker to the door.
4. Lift the speaker from the door and disconnect the electrical harness.
5. Remove the speaker.

To install:

6. The installation is the reverse of the removal.

Sail Panel Speakers

Remove the sail panel from the door



Remove the speaker retaining screws and remove the speaker from the door

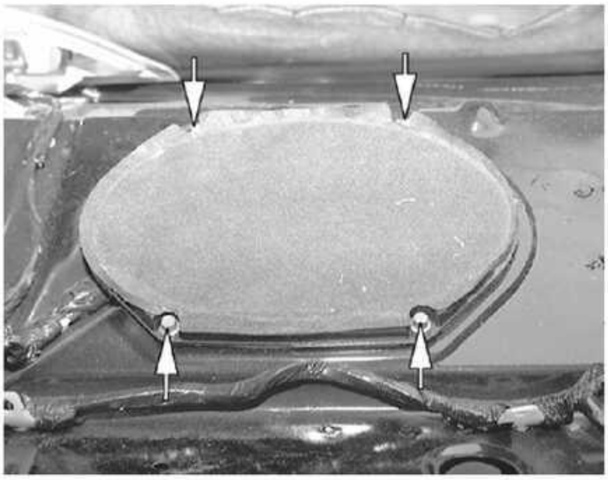
1. Disconnect the negative battery cable.
2. Remove the sail panel from the door.
3. Remove the speaker retaining screws.
4. Pull the speaker out, detach the speaker connector and remove the speaker from the vehicle.

To install:

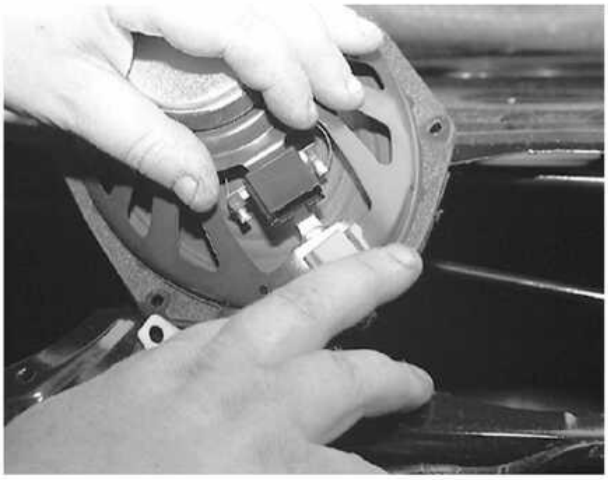
5. The installation is the reverse of the removal.

Package Shelf Speakers (Sedan Only)

Remove the package shelf trim panel from the vehicle



Remove the four speaker retaining screws and...



Lift the speaker out of the rear package shelf, detach the connector and remove the speaker

1. Disconnect the negative battery cable.
2. Remove the package shelf trim panel.
3. Remove the four screws attaching the speaker to the package shelf.
4. Lift the speaker from the package shelf and disconnect the electrical harness.

To install:

5. The installation is the reverse of the removal.

Liftgate Speakers (Wagon Only)

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Click to Enlarge

Liftgate speaker mounting-sedan

1. Disconnect the negative battery cable.
2. Remove the liftgate trim panel.
3. Remove the four screws attaching the speaker to the liftgate.
4. Lift the speaker from the liftgate and disconnect the electrical harness.

To install:

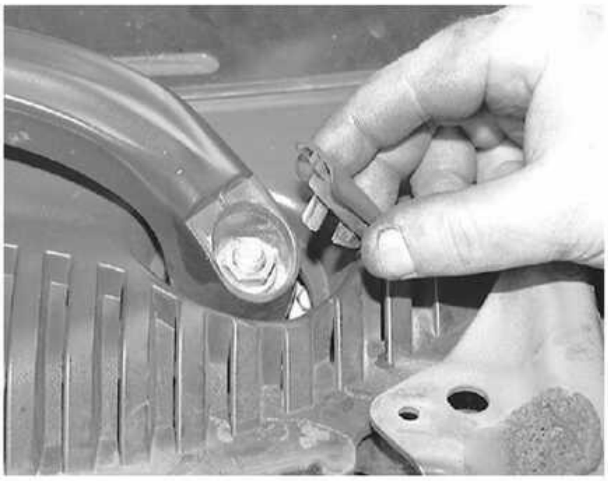
5. The installation is the reverse of the removal.

WINDSHIELD WIPERS AND WASHERS

Windshield Wiper Blade and Arm

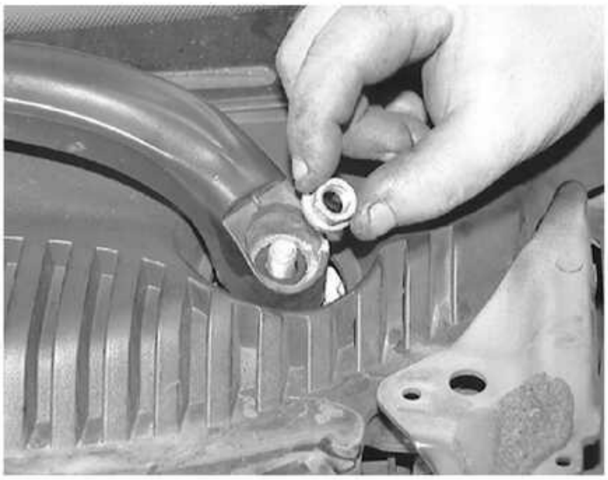
REMOVAL & INSTALLATION

Front

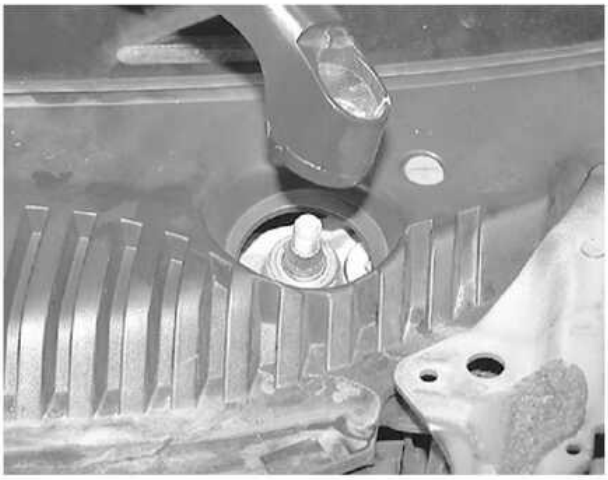


Remove the wiper arm retaining nut cover

Matchmark the wiper arm-to-pivot



Remove the wiper arm retaining nut and...



... remove the arm from the pivot

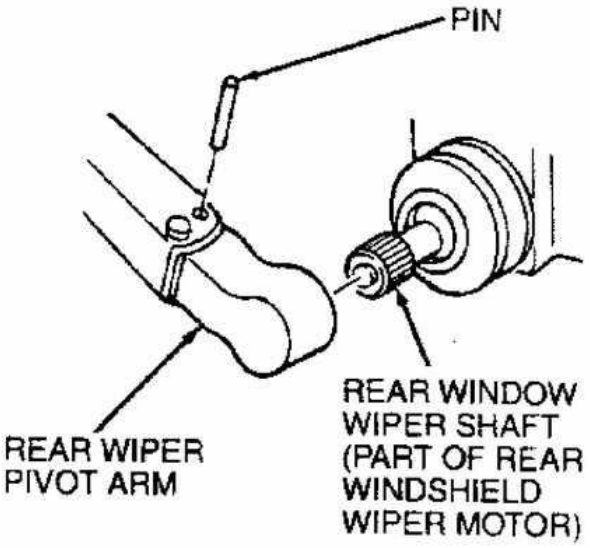
1. Raise the covers over the wiper arm retaining nuts.
2. Remove the retaining nuts on the wiper arm pivots.
3. Matchmark the wiper arms to the pivot for reinstallation.
4. Lift each wiper arm and free it from the pivot shafts.

The wiper arms will most likely be stuck. A useful tool for removal of the wiper arms is a battery terminal puller. The battery terminal puller exerts force on the pivot and raises the arm. Prying and other techniques could do damage to the wiper arms, trim, windshield, or painted surfaces of the vehicle.

To install:

5. Place the wiper arm onto the pivot aligning the matchmarks.
6. Tighten the wiper arm retaining nuts.
7. Fasten the retaining nut covers.

Rear (Wagon Only)



Insert the required pin into the hole in the wiper arm and...

Click on icon to view fullsize printable image.

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... remove the arm from the pivot shaft

To avoid scratching the glass and/or paint, do not pry the wiper mounting arm and pivot shaft from the pivot arm with a metal or sharp tool.

1. Raise the arm away from the back window glass, then insert a 0.062 in. (1.6mm) pin into the hole in the wiper arm.
2. Lower the arm to the glass to relieve arm spring tension.
3. Lift the arm assembly off of the pivot shaft.

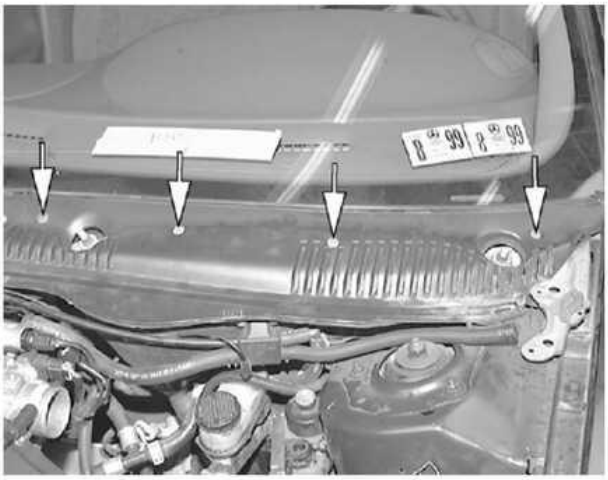
To install:

4. Place the arm over the pivot shaft.
5. Position the arm onto the pivot shaft, ensuring the placement is aligned. Remove the pin.

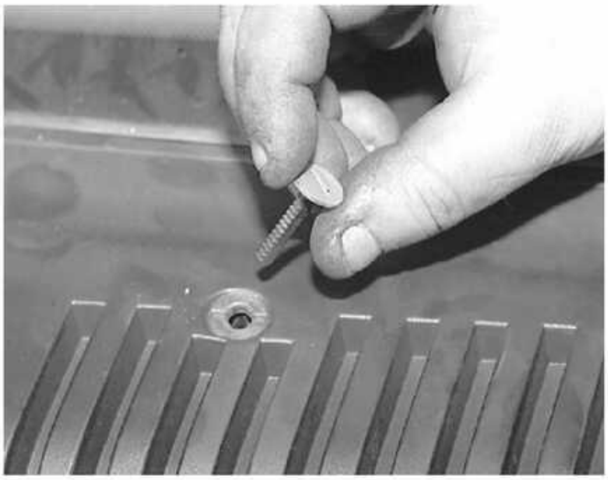
Windshield Wiper Motor

REMOVAL & INSTALLATION

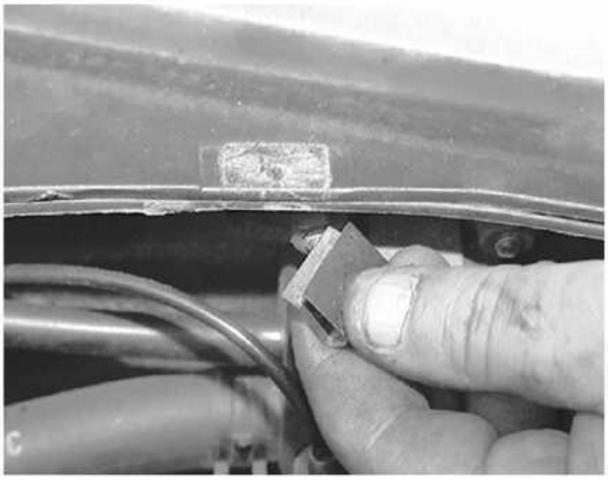
Front



The cowl vent screens are held by 8 plastic retainers (4 on each screen)

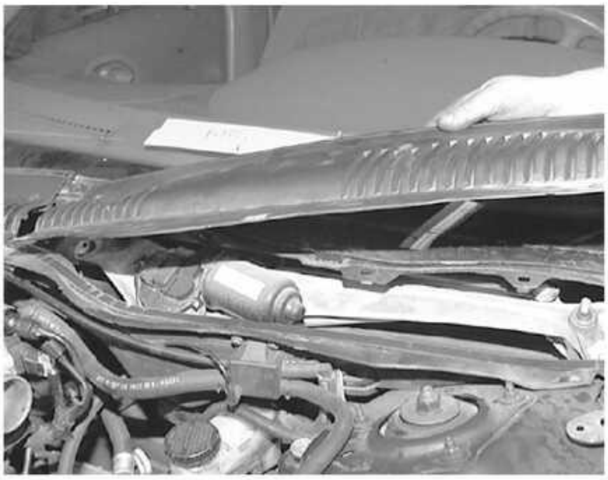


Remove the retainers and the...



... screen-to-inner panel retaining clips from the cowl vent screens

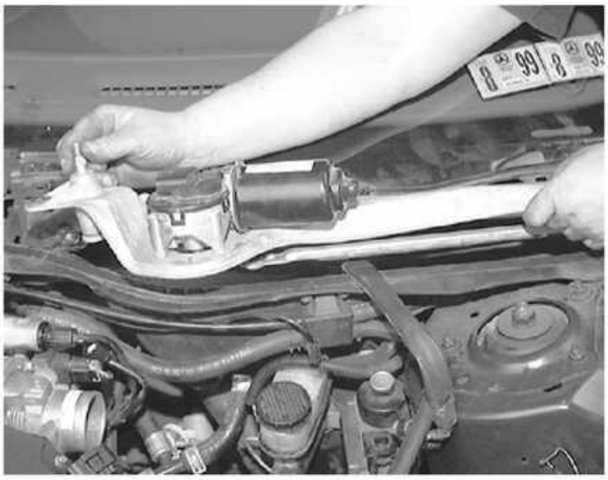
CHILTON



Carefully lift the cowl vent screen up and remove it from the vehicle

Detach the connector for the wiper motor

Remove the four wiper module retaining bolts and...

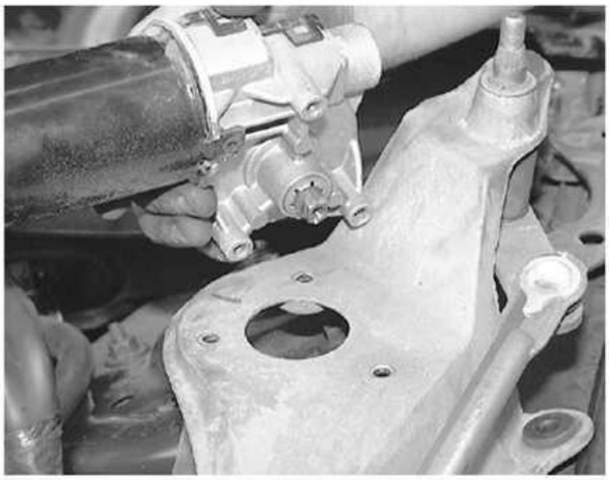


... lift the module from the vehicle

Remove the wiper pivot arm retaining bolt

Matchmark the wiper pivot arm-to-motor connection and...

...disconnect the pivot from the motor



Remove the three motor retaining bolts and remove the motor from the module assembly

1. Disconnect the negative battery cable.
2. Remove the wiper arms.
3. Remove the 8 plastic retainers and the 6 clips holding the cowl vent screens to the to the inner panels. Turn the retainers 1/4 turn counterclockwise to remove.
4. Remove the cowl vent screens.
5. Detach the electrical connector from the wiper motor and remove the 4 bolts retaining the module assembly to the cowl.
6. Remove the windshield wiper module from the vehicle.
7. Rotate the wiper operating arm in a clockwise direction to gain access to the bolt retaining the arm to the motor.

Always rotate the wiper operating arm in a clockwise motion or damage to the motor could occur.

8. Remove the nut retaining the wiper operating arm to the wiper motor.
9. Remove the three wiper motor-to-wiper module assembly retaining bolts and remove the motor from the vehicle.
10. The installation is the reverse of the removal.

Rear (Wagon Only)

Click on icon to view fullsize printable image.

Click to Enlarge

Rear wiper motor and washer connections

Click on icon to view fullsize printable image.

Click to Enlarge

Rear wiper motor mounting

1. Disconnect the negative battery cable.
2. Open the liftgate.
3. Remove the wiper motor cover.
4. Detach the electrical connector from the motor.
5. Release the wiper output arm cover and remove.
6. Remove the retaining nut, washer and plastic bezel.
7. Remove the wiper motor-to-rear window retaining nut and remove the wiper motor.
8. The installation is the reverse of the removal.

Windshield Washer Reservoir

REMOVAL & INSTALLATION

Click on icon to view fullsize printable image.

Click to Enlarge

Windshield washer reservoir mounting

1. Disconnect the negative battery cable.
2. Remove the radiator recovery tank.
3. Detach washer pump electrical connector.
4. Remove the two nuts near the A/C accumulator retaining the reservoir to the body.
5. Raise and support the vehicle.
6. Working through the passenger side front wheel opening, remove the front half of the lower splash shield.
7. Remove the screw retaining reservoir to the inner fender.
8. Disconnect the washer pump hose and drain the washer solvent into a suitable container.
9. Remove the washer reservoir from the vehicle.
10. The installation is the reverse of the removal.

Windshield Washer Pump

REMOVAL & INSTALLATION

Click on icon to view fullsize printable image.

Click to Enlarge

Windshield washer pump mounting

1. Disconnect the negative battery cable.
2. Remove the reservoir from the vehicle, then disengage the electrical connector and hoses.
3. Using a small suitable prying tool, pry out the windshield washer pump, being careful not to damage the plastic housing.
4. Remove the one piece seal and filter, then inspect for damage and replace if necessary. Flush out the reservoir and clean any foreign material from the wiper motor cavity or washer reservoir.

To install:

5. Insert the seal. Lubricate the inside of the seal with soapy solution, then insert the pump into the reservoir cavity until it is firmly seated in the seal.
6. Engage the electrical connector, connect the hose, then install the reservoir in the vehicle.

Do not operate the pump until fluid has been added to the reservoir.

7. Connect the negative battery cable, then add fluid to the windshield washer reservoir.

INSTRUMENTS AND SWITCHES

Instrument Cluster

REMOVAL & INSTALLATION

Floor Shift Models Only

1. Disconnect the negative battery cable.
2. Remove the ignition lock cylinder to allow removal of the steering column shrouds.
3. Remove the steering column upper and lower shrouds.
4. Remove the instrument cluster finish panel retaining screw covers.
5. Remove the instrument cluster finish panel.
6. Remove the four instrument cluster retaining screws.
7. Pull the cluster out to access the connectors on back and unplug them.
8. Remove the cluster from the vehicle.

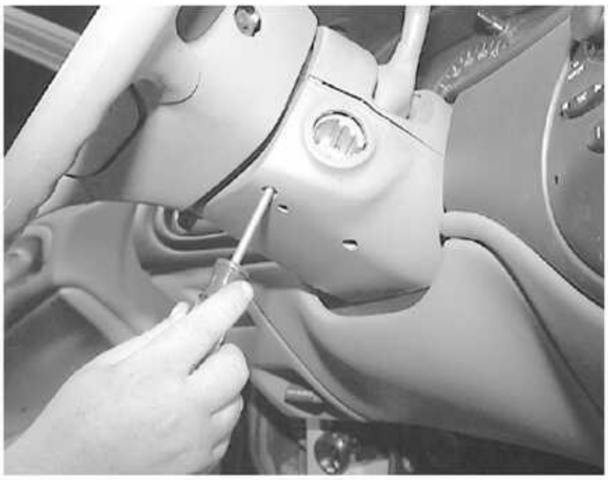
To install:

9. The installation is the reverse of the removal.
10. Tighten the cluster retaining bolts to 18-26 inch lbs. (2-3 Nm).

Column Shift Models Only

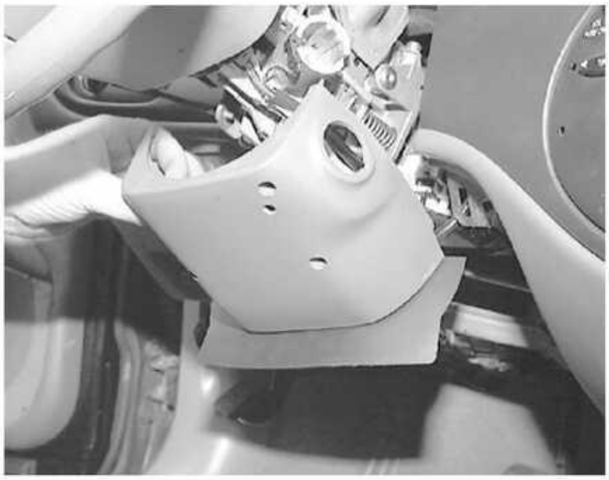
Remove the knee bolster panel retaining screws and...

... remove the knee bolster panel from the vehicle



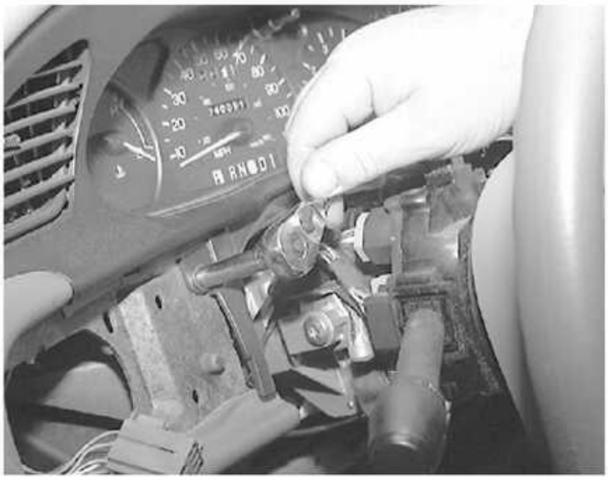
Remove the column shroud retaining screws and...

... remove the upper and the...



... lower column shrouds from the steering column

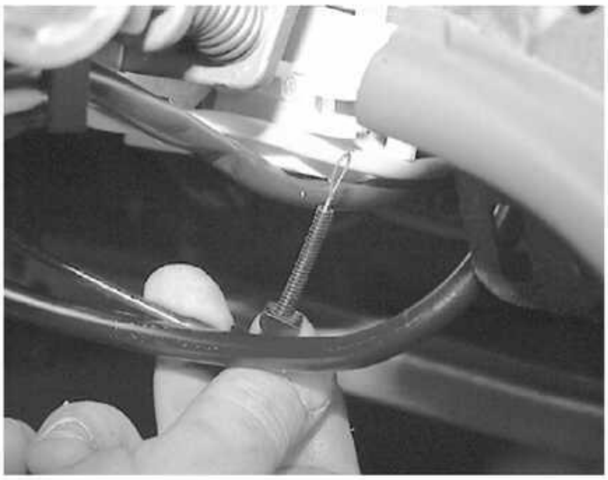
Remove the cluster finish panel upper retaining screws and...



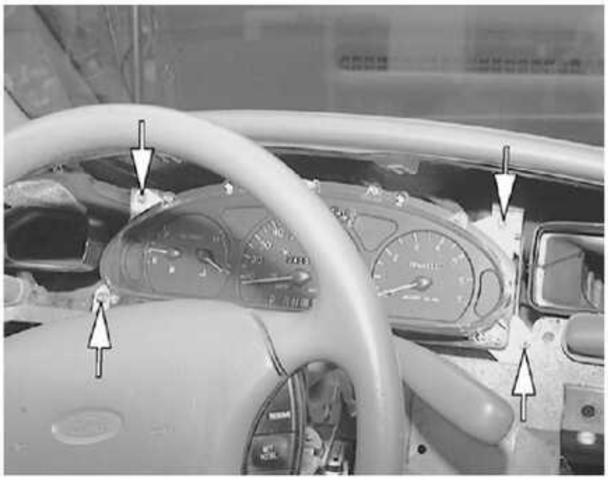
... the lower retaining screws behind the headlight switch panel, then...

CHILTON

... remove the cluster finish panel from the vehicle

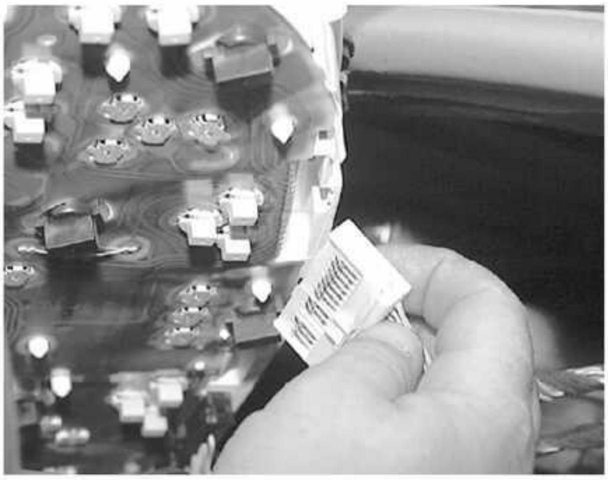


Disconnect the column shifter cable loop from the transmission range indicator



Remove the cluster retaining screws and...

CHILTON



... carefully slide the cluster out of the instrument panel and detach the connectors and remove the cluster from the vehicle

1. Disconnect the negative battery cable.
2. Remove the ignition lock cylinder to allow removal of the steering column shrouds.
3. Remove the knee bolster panel (steering column cover).
4. Remove the steering column upper and lower shrouds.
5. Remove the integrated control panel from the instrument panel.
6. Remove the instrument cluster finish panel retaining screw covers.
7. Remove the instrument cluster finish panel.
8. Tilt the steering column to it's lowest position.
9. Detach the column shifter cable loop from the transmission shift indicator.
10. Remove the four instrument cluster retaining screws.
11. Pull the cluster out to access the connectors on back and unplug them.
12. Remove the cluster from the vehicle.

To install:

13. The installation is the reverse of the removal.
14. Tighten the cluster retaining bolts to 18-26 inch lbs. (2-3 Nm).

Gauges

REMOVAL & INSTALLATION

Click on icon to view fullsize printable image.

Click to Enlarge

Remove the instrument cluster lens and...

Click on icon to view fullsize printable image.

Click to Enlarge

... mask assembly from the cluster to access the gauges

Click on icon to view fullsize printable image.

Click to Enlarge

The fuel/temperature gauge assembly

Click to Enlarge

The speedometer/odometer assembly

Click on icon to view fullsize printable image.

Click to Enlarge

The tachometer assembly

1. Disconnect the negative battery cable.
2. Remove the instrument cluster.
3. Remove the retaining screws for the instrument cluster lens and mask assembly.
4. Remove the cover and lens.
5. Remove the retaining screws for the gauge or warning lamp to be replaced and remove the gauge or warning lamp.

To install:

6. Place the gauge or warning lamp into place and tighten the retaining screws.
7. Install the instrument cluster lens and cover assembly.
8. Install the instrument cluster.
9. Connect the negative battery cable.

Rear Window Wiper Switch

REMOVAL & INSTALLATION

Click on icon to view fullsize printable image.

Click to Enlarge

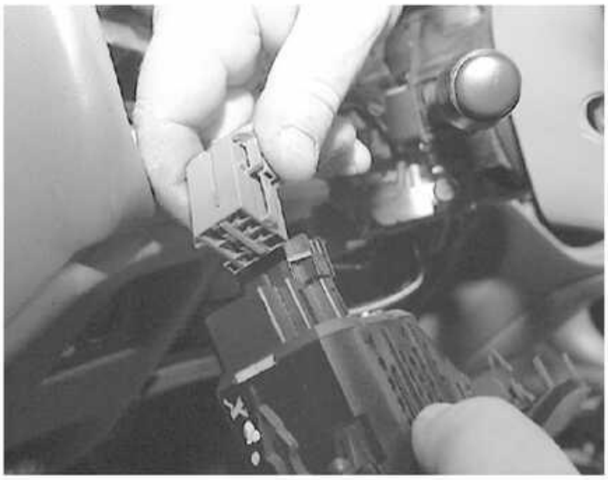
The rear wiper/washer switch mounting

1. Disconnect the negative battery cable.
2. Grasp the switch and gently pull the switch from the instrument panel. If necessary, use a small screwdriver or other suitable tool to gently pry the switch from the instrument panel.
3. Detach the electrical connector from the switch.
4. The installation is the reverse of the removal.

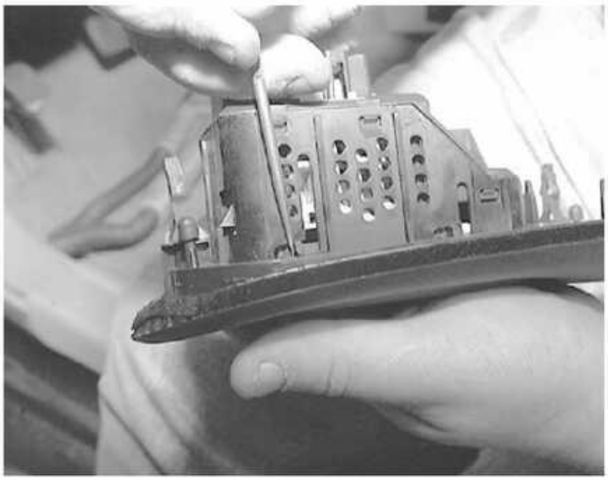
Headlight Switch

REMOVAL & INSTALLATION

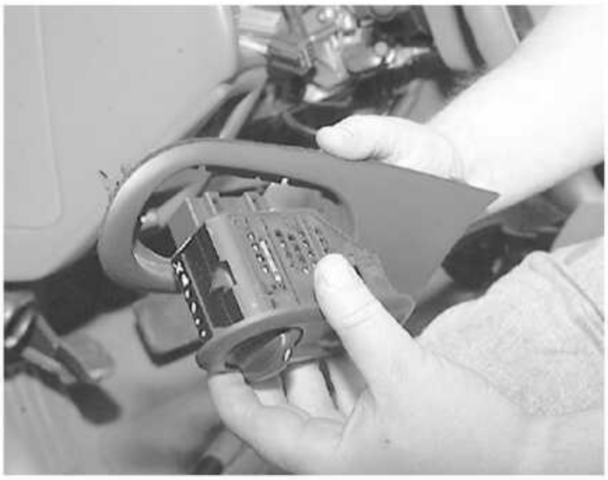
Carefully pry the headlight switch and finish panel away from the instrument panel



Detach the electrical connectors from the switch



Release the switch retaining tabs and...



... remove the switch from the finish panel

1. Disconnect the negative battery cable.
2. Carefully pry the headlight switch and finish panel away from the instrument panel.
3. Push the release button down on the headlight switch and pull the switch assembly and finish panel away from the instrument panel.

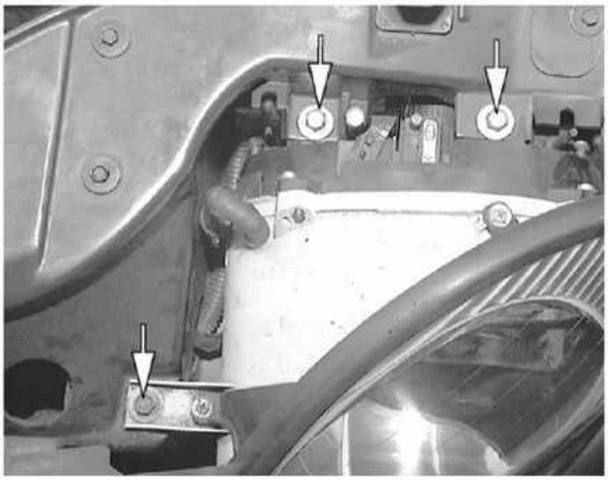
If equipped with autolamps there will be 3 wire connectors on the headlight switch. If not equipped with autolamps, it will have 2 connectors.

4. Detach the wire connectors from the headlight switch
5. Release the retaining tabs and remove the switch.
6. Installation is the reverse of the removal procedure.

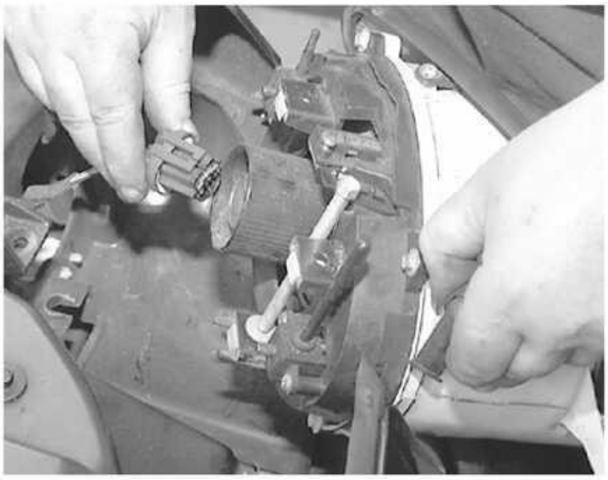
LIGHTING

Headlights

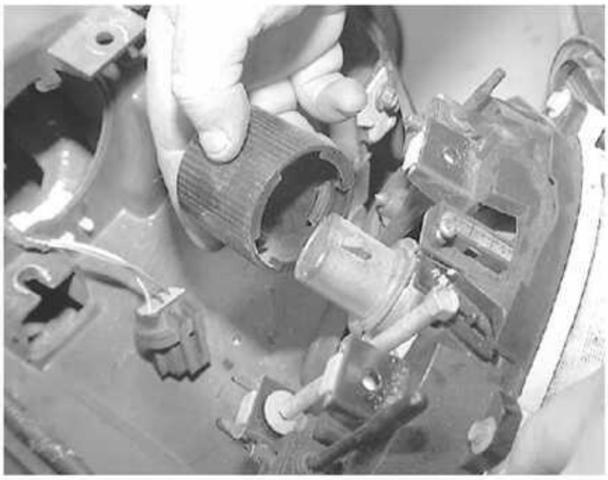
REMOVAL & INSTALLATION



Remove the three headlight retaining bolts and carefully pull the headlight forward to access the bulbs



Detach the headlight electrical connector from the bulb



Remove the headlight bulb retainer and...

... remove the headlight bulb from the lens assembly

1. Disconnect the negative battery cable.
2. Open the vehicle's hood and secure it in an upright position.
3. Remove the headlight retaining bolts and carefully pull the headlamp forward to access the bulbs.
4. Unplug the wiring connector from the bulb
5. Rotate the bulb retainer counterclockwise approximately 1/8 of a turn and remove the bulb retainer.
6. Remove the bulb from the vehicle by gently pulling the bulb straight out of the headlamp assembly.

Do not touch the glass bulb with your fingers. Oil from your fingers can severely shorten the life of the bulb. If necessary, wipe off any dirt or oil from the bulb with rubbing alcohol before completing installation.

To install:

7. The installation is the reverse of the removal.
8. To ensure that the replacement bulb functions properly, activate the applicable switch to illuminate the bulb which was just replaced. (If this is a combination low and high beam bulb, be sure to check both intensities.) If the replacement light bulb does not illuminate, either it too is faulty or there is a problem in the bulb circuit or switch. Correct if necessary.

AIMING THE HEADLIGHTS

The headlights must be properly aimed to provide the best, safest road illumination. The lights should be checked for proper aim and adjusted as necessary. Certain state and local authorities have requirements for headlight aiming; these should be checked before adjustment is made.

About once a year, when the headlights are replaced or any time front end work is performed on your vehicle, the headlight should be accurately aimed by a reputable repair shop using the proper equipment. Headlights not properly aimed can make it virtually impossible to see and may blind other drivers on the road, possibly causing an accident. Note that the following procedure is a temporary fix, until you can take your vehicle to a repair shop for a proper adjustment.

Headlight adjustment may be temporarily made using a wall, as described below, or on the rear of another vehicle. When adjusted, the lights should not glare in oncoming car or truck windshields, nor should they illuminate the passenger compartment of vehicles driving in front of you. These adjustments are rough and should always be fine-tuned by a repair shop which is equipped with headlight aiming tools. Improper adjustments may be both dangerous and illegal.

For most of the vehicles covered by this manual, horizontal and vertical aiming of each sealed beam unit is provided by two adjusting screws which move the retaining ring and adjusting plate against the tension of a coil spring. There is no adjustment for focus; this is done during headlight manufacturing.

Because the composite headlight assembly is bolted into position, no adjustment should be necessary or possible. Some applications, however, may be bolted to an adjuster plate or may be retained by adjusting screws. If so, follow this procedure when adjusting the lights, BUT always have the adjustment checked by a reputable shop.

Before removing the headlight bulb or disturbing the headlamp in any way, note the current settings in order to ease headlight adjustment upon reassembly. If the high or low beam setting of the old lamp still works, this can be done using the wall of a garage or a building:

1. Park the vehicle on a level surface, with the fuel tank about 1/2 full and with the vehicle empty of all extra cargo (unless normally carried). The vehicle should be facing a wall which is no less than 6 feet (1.8m) high and 12 feet (3.7m) wide. The front of the vehicle should be about 25 feet from the wall.
2. If aiming is to be performed outdoors, it is advisable to wait until dusk in order to properly see the headlight beams on the wall. If done in a garage, darken the area around the wall as much as possible by closing shades or hanging cloth over the windows.
3. Turn the headlights ***ON*** and mark the wall at the center of each light's low beam, then switch on the bright lights and mark the center of each light's high beam. A short length of masking tape which is visible from the front of the vehicle may be used. Although marking all four positions is advisable, marking one position from each light should be sufficient.

Click on icon to view fullsize printable image.

Click to Enlarge

Low-beam headlight pattern alignment

Click on icon to view fullsize printable image.

Click to Enlarge

High-beam headlight pattern alignment

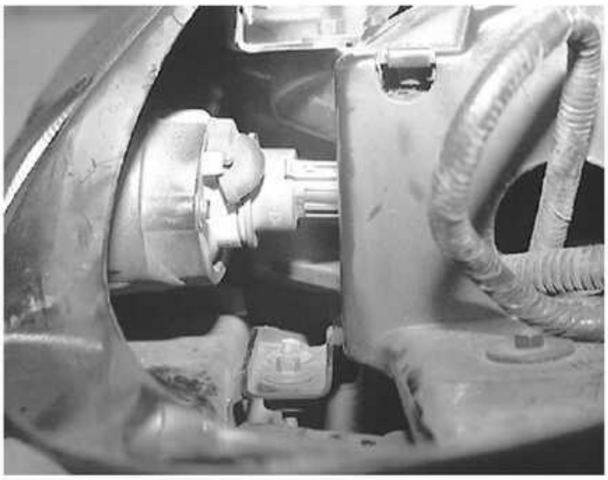
4. If neither beam on one side is working, and if another like-sized vehicle is available, park the second one in the exact spot where the vehicle was and mark the beams using the same-side light. Then switch the vehicles so the one to be aimed is back in the original spot. It must be parked no closer to or farther away from the wall than the second vehicle.
5. Perform any necessary repairs, but make sure the vehicle is not moved, or is returned to the exact spot from which the lights were marked. Turn the headlights ***ON*** and adjust the beams to match the marks on the wall.
6. Have the headlight adjustment checked as soon as possible by a reputable repair shop.

Signal and Marker Lights

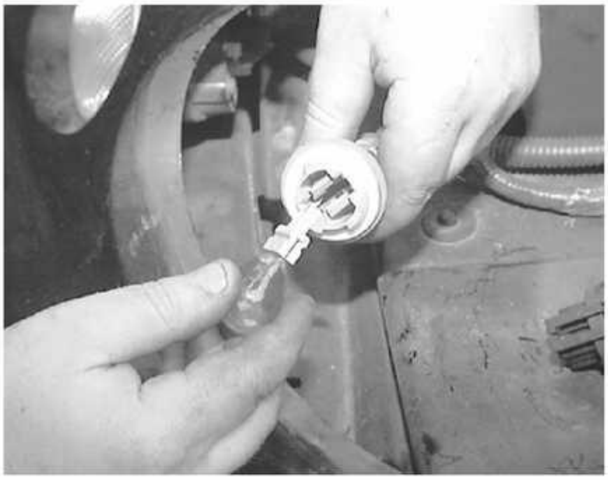
REMOVAL & INSTALLATION

Front Turn Signal and Parking Lights

TAURUS



The parking/turn signal lamp is accessible after the headlamp is removed



Rotate the socket to remove and pull the bulb straight out to replace the bulb

1. Disconnect the negative battery cable.
2. Remove the headlamp assembly from the vehicle
3. Grasp the bulb socket and turn the socket 1/2 of a turn counterclockwise and remove the socket from the headlamp assembly.
4. Pull the bulb straight out to remove it from the socket.
5. The installation is the reverse of the removal.

SABLE

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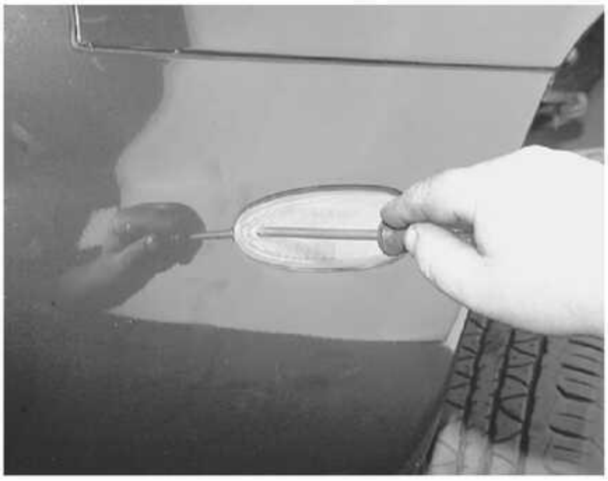
Click to Enlarge

Parking lamp assembly mounting-Sable models only

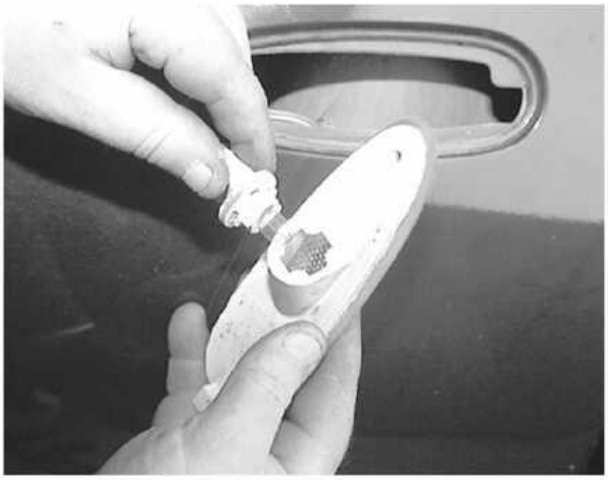
1. Disconnect the negative battery cable.
2. Remove the retaining screw from the parking lamp assembly.
3. Remove the front parking lamp from the grille opening.
4. Detach the connector from the bulb socket.
5. Grasp the bulb socket and turn the socket 1/2 of a turn counterclockwise and remove the socket from the headlamp assembly.
6. Pull the bulb straight out to remove it from the socket.
7. The installation is the reverse of the removal.

Side Marker Light

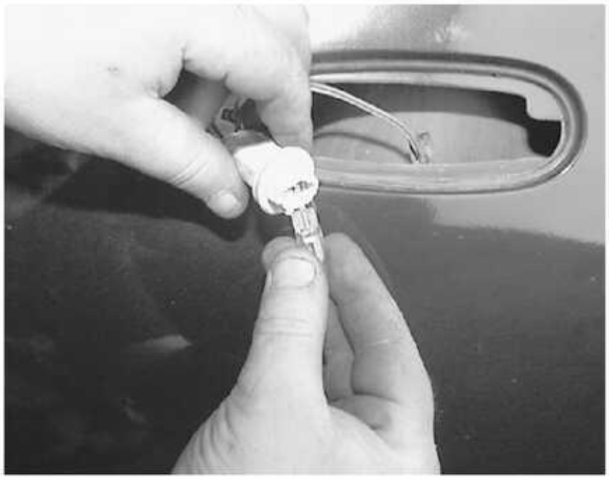


Remove the retaining screw and...

... remove the lens from the side of the vehicle



Rotate the socket to remove it from the lens and...

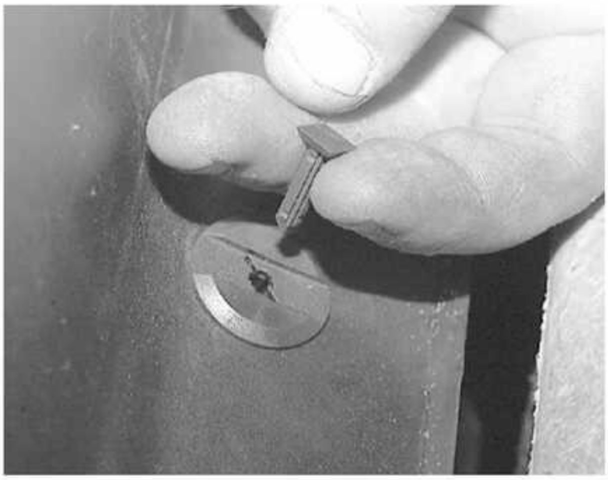


... pull the bulb straight out to remove it from the socket

1. Disconnect the negative battery cable.
2. Remove the retaining screw for the side marker lamp.
3. Starting at the end where the retaining screw was, pull outward on the lamp lens.
4. Grasp the bulb socket and turn the socket 1/2 of a turn counterclockwise and remove the socket from the lens.
5. Pull the bulb straight out to remove it from the socket.
6. The installation is the reverse of the removal.

Rear Turn Signal and Brake Lights

SEDAN

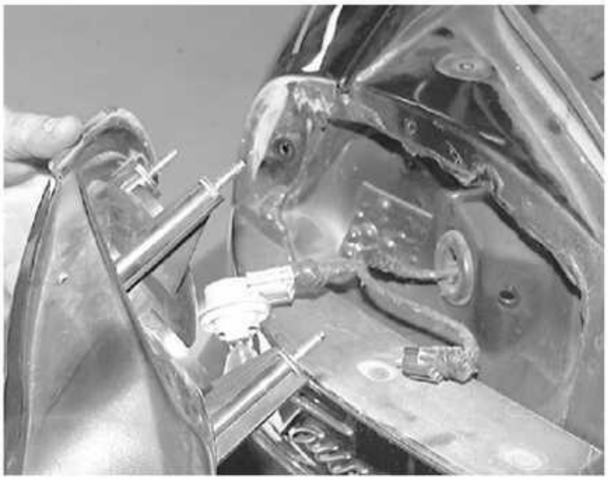


Remove the trim clip center retainer and...

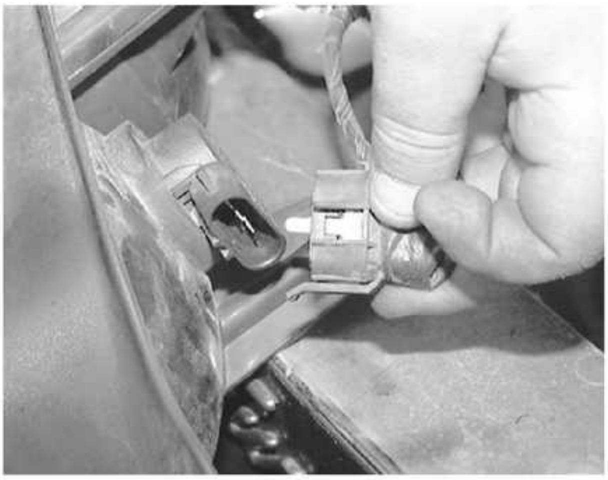
... remove the clip from the trim

Remove the trim from the trunk

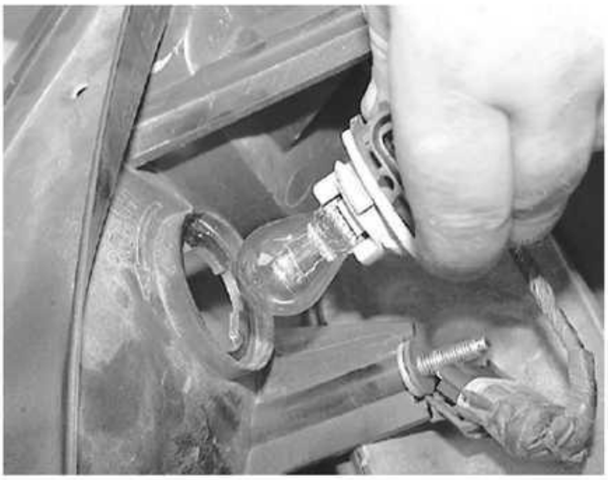
Carefully pull back the trim to access the taillamp retaining nuts. Remove the retaining nuts and...



... pull the taillamp away from the body to...



... detach the connectors for the taillamp bulbs and...



... rotate the bulb sockets from the taillamp assembly

Pull the bulb straight out to remove it from the socket

1. Disconnect the negative battery cable.
2. Open the trunklid.
3. Remove the quarter trim panel.
4. Remove the three retaining nuts for the taillamp assembly.
5. Carefully pull the rear lamp assembly away from the vehicle.
6. Detach the bulb(s) socket electrical connector.
7. Rotate the bulb(s) socket counterclockwise approximately 1/4 of a turn and remove the socket from the lamp assembly.
8. Remove the bulb(s) from the socket by pulling the bulb straight out.
9. The installation is the reverse of the removal.

WAGON

Click on icon to view fullsize printable image.

Click to Enlarge

Rear taillamp assembly mounting-Wagon

1. Disconnect the negative battery cable.
2. Open liftgate.
3. Remove the two retaining screws for the taillamp assembly.
4. Carefully pull the rear lamp assembly away from the vehicle.
5. Detach the bulb(s) socket electrical connector.
6. Rotate the bulb(s) socket counterclockwise approximately 1/4 of a turn and remove the socket from the lamp assembly.
7. Remove the bulb(s) from the socket by pulling the bulb straight out.
8. The installation is the reverse of the removal.

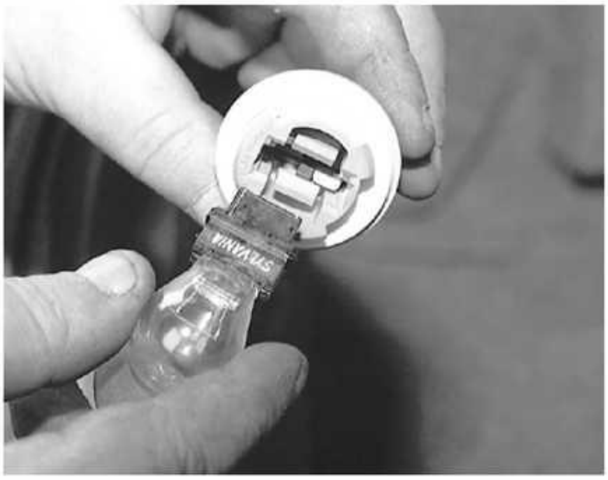
Back-up Lamp

SEDAN

Remove the trim from the underside of the trunklid

Detach the connector for the back-up lamp bulbs

Rotate the bulb socket from the lens



Pull the bulb straight out to remove it from the socket

1. Disconnect the negative battery cable.
2. Open trunklid.
3. If equipped, remove the trim on the underside of the trunklid.
4. Unplug the connector for the lamp.
5. Turn the socket counterclockwise 1/4 of a turn to release it from the lens.
6. Turn the bulb counterclockwise 1/4 of a turn to release it from the socket.
7. The installation is the reverse of the removal.

WAGON

Click on icon to view fullsize printable image.

Click to Enlarge

Back-up lamp mounting-wagon

1. Disconnect the negative battery cable.
2. Open the liftgate.
3. Remove the liftgate trim panel.
4. Reach through the openings on the end of the liftgate and rotate the bulb(s) socket counterclockwise approximately 1/4 of a turn and remove the socket from the lamp assembly and out of the opening.
5. Detach the electrical connector for the socket.
6. Remove the bulb(s) from the socket by pulling the bulb straight out.
7. The installation is the reverse of the removal.

High-Mount Brake Light

SEDAN

Click on icon to view fullsize printable image.

Click to Enlarge

High mount brake light mounting-sedan

1. Disconnect the negative battery cable.
2. Open the trunk and remove the rear luggage compartment door trim panel.
3. From inside the trunk, rotate the high mount brake light bulb socket(s) and rotate them a 1/2 turn counterclockwise and remove the socket(s) from the lamp assembly.
4. Remove the bulb(s) from the socket by pulling the bulb straight out.
5. The installation is the reverse of the removal.

WAGON

Click on icon to view fullsize printable image.

Click to Enlarge

High mount brake light mounting-wagon

1. Disconnect the negative battery cable.
2. Open the liftgate.
3. Remove the liftgate upper finish panel.
4. Remove the rubber plug from the liftgate.
5. Remove the four nuts from the high mount brake light mounting studs.
6. Close the liftgate and pull the brake light away from the liftgate.
7. Rotate the high mount brake light bulb socket(s) and rotate them a 1/2 turn counterclockwise and remove the socket(s) from the lamp assembly.
8. Remove the bulb(s) from the socket by pulling the bulb straight out.
9. The installation is the reverse of the removal.

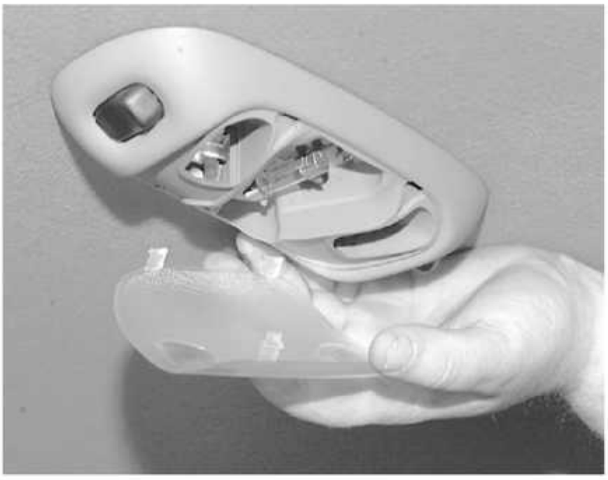
Dome/Cargo Light

1. Disconnect the negative battery cable.

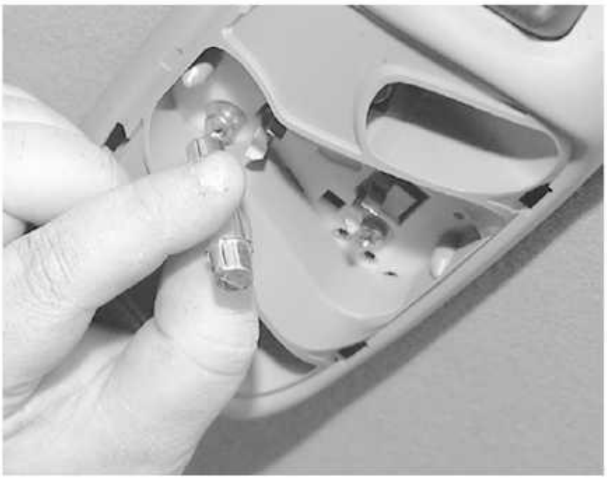
2. Using a small screwdriver or other suitable prying tool to remove the lens from the lamp assembly.
3. Grasp the bulb and remove the bulb from the contacts in the lamp assembly.
4. The installation is the reverse of the removal.

Dome/Map Light Assembly

DOME LIGHT



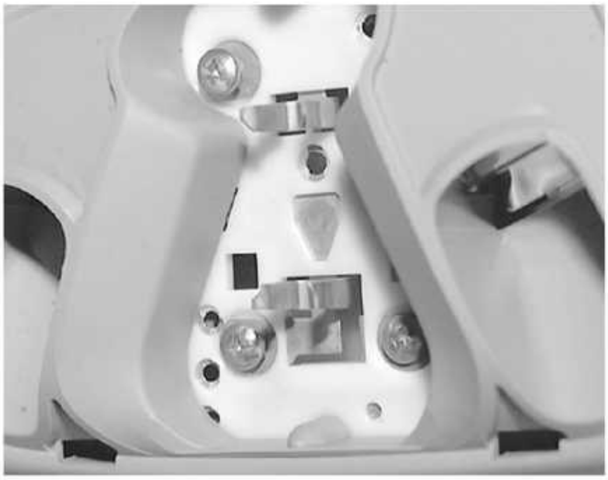
Carefully pry the dome light cover from the dome light assembly



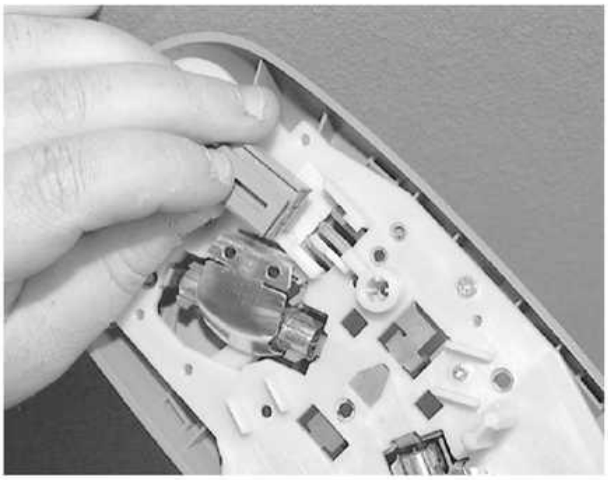
Pull the bulb straight down to remove it from the sockets

1. Disconnect the negative battery cable.
2. Using a small screwdriver or other suitable prying tool to remove the lens from the lamp assembly.
3. Grasp the bulb and remove the bulb from the contacts in the lamp assembly.
4. The installation is the reverse of the removal.

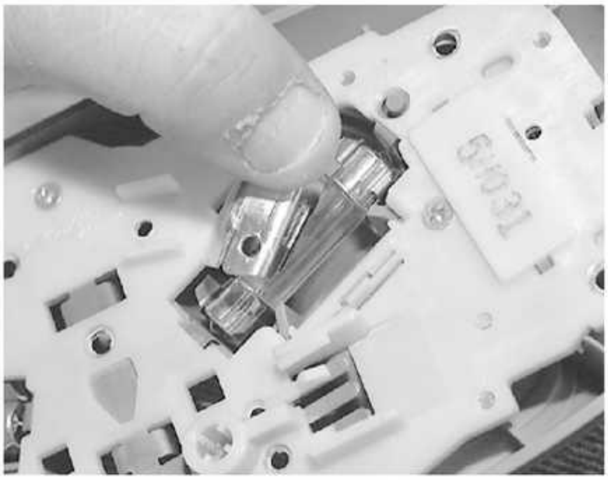
MAP LIGHT



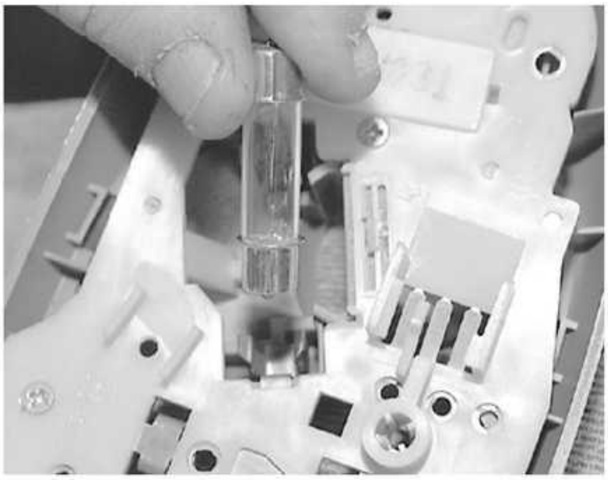
Remove the three light retaining screws and lower the light assembly from the roof



Depress the locking tab that retains the map light reflector and...



... remove the reflector from the light



Pull the bulb straight out to remove it from the socket

1. Disconnect the negative battery cable.
2. Using a small screwdriver or other suitable prying tool to remove the lens from the lamp assembly.
3. Remove the three retaining screws from the lamp assembly and remove the lamp from the vehicle.
4. From the back of the lamp, use a small screwdriver or other suitable prying tool to depress the locking tab that retains the map lamp reflector and remove the reflector.
5. Grasp the bulb(s) and remove the bulb from the contacts in the lamp assembly.
6. The installation is the reverse of the removal.

License Plate Lights

Click on icon to view fullsize printable image.

Click to Enlarge

License plate light bulb mounting-sedan

Click on icon to view fullsize printable image.

Click to Enlarge

License plate light bulb mounting-wagon

1. Disconnect the negative battery cable.
2. Remove the two retaining screws and the plastic rivets from the lamp on the sedan. The wagon is equipped with only one screw and rivet.
3. Pull the lamp assembly down away from the license plate housing.
4. Grasp the bulb socket and turn the socket 1/2 of a turn counterclockwise and remove the socket from the lens.
5. Pull the bulb straight out to remove it from the socket.
6. The installation is the reverse of the removal.

Fog/Driving Lights

INSTALLING AFTERMARKET AUXILIARY LIGHTS

Before installing any aftermarket light, make sure it is legal for road use. Most acceptable lights will have a DOT approval number. Also check your local and regional inspection regulations. In certain areas, aftermarket lights must be installed in a particular manner or they may not be legal for inspection.

1. Disconnect the negative battery cable.
2. Unpack the contents of the light kit purchased. Place the contents in an open space where you can easily retrieve a piece if needed.
3. Choose a location for the lights. If you are installing fog lights, below the bumper and apart from each other is desirable. Most fog lights are mounted below or very close to the headlights. If you are installing driving lights, above

the bumper and close together is desirable. Most driving lights are mounted between the headlights.

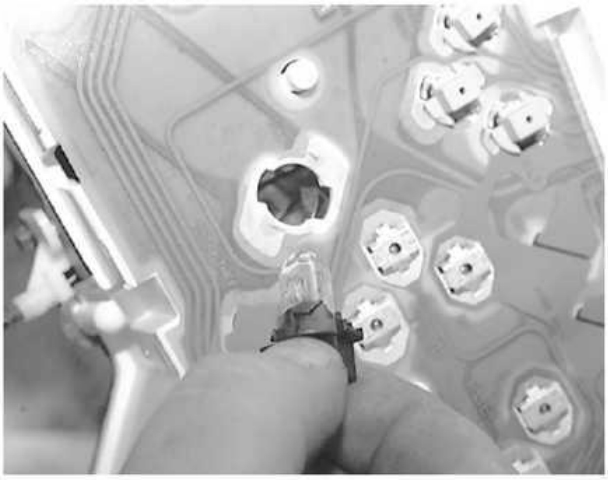
4. Drill the needed hole(s) to mount the light. Install the light, and secure using the supplied retainer nut and washer. Tighten the light mounting hardware, but not the light adjustment nut or bolt.
5. Install the relay that came with the light kit in the engine compartment, in a rigid area, such as a fender. Always install the relay with the terminals facing down. This will prevent water from entering the relay assembly.
6. Using the wire supplied, locate the ground terminal on the relay, and connect a length of wire from this terminal to a good ground source. You can drill a hole and screw this wire to an inside piece of metal; just scrape the paint away from the hole to ensure a good connection.
7. Locate the light terminal on the relay; and attach a length of wire between this terminal and the fog/driving lamps.
8. Locate the ignition terminal on the relay, and connect a length of wire between this terminal and the light switch.
9. Find a suitable mounting location for the light switch and install. Some examples of mounting areas are a location close to the main light switch, auxiliary light position in the dash panel, if equipped, or in the center of the dash panel.
10. Depending on local and regional regulations, the other end of the switch can be connected to a constant power source such as the battery, an ignition opening in the fuse panel, or a parking or headlight wire.
11. Locate the power terminal on the relay, and connect a wire with an in-line fuse of at least 10 amperes between the terminal and the battery.
12. With all the wires connected and tied up neatly, connect the negative battery cable.
13. Turn the lights ON and adjust the light pattern, if necessary.

AIMING

1. Park the vehicle on level ground, so it is perpendicular to and, facing a flat wall about 25 ft. (7.6m) away.
2. Remove any stone shields, if equipped, and switch ON the lights.
3. Loosen the mounting hardware of the lights so you can aim them as follows:
    1. The horizontal distance between the light beams on the wall should be the same as between the lights themselves.
    2. The vertical height of the light beams above the ground should be 4 in. (10cm) less than the distance between the ground and the center of the lamp lenses for fog lights. For driving lights, the vertical height should be even with the distance between the ground and the center of the lamp.
4. Tighten the mounting hardware.
5. Test to make sure the lights work correctly, and the light pattern is even.

Instrument Cluster Light bulbs

REMOVAL & INSTALLATION



Rotate the sockets to remove the instrument cluster socket and bulb assembly

Pull the bulb straight out to remove it from the socket

1. Disconnect the negative battery cable.
2. Remove the instrument cluster as outlined in this section.
3. Turn the desired bulb socket counter clockwise to remove it from the cluster.
4. Grasp the bulb and pull it straight out to remove it from the socket.

To install:

5. Place a new bulb into the socket and lightly press it into place.
6. Place the socket into the cluster and turn the socket clockwise to engage it into the cluster.
7. Install the instrument cluster.
8. Connect the negative battery cable.

Specifications Charts

Click on icon to view fullsize printable image.

Click to Enlarge

Light bulb application chart-all models

TRAILER WIRING

Wiring the vehicle for towing is fairly easy. There are a number of good wiring kits available and these should be used, rather than trying to design your own.

All trailers will need brake lights and turn signals as well as tail lights and side marker lights. Most areas require extra marker lights for overwide trailers. Also, most areas have recently required back-up lights for trailers, and most trailer manufacturers have been building trailers with back-up lights for several years.

Additionally, some Class I, most Class II and just about all Class III and IV trailers will have electric brakes. Add to this number an accessories wire, to operate trailer internal equipment or to charge the trailer's battery, and you can have as many as seven wires in the harness.

Determine the equipment on your trailer and buy the wiring kit necessary. The kit will contain all the wires needed, plus a plug adapter set which includes the female plug, mounted on the bumper or hitch, and the male plug, wired into, or plugged into the trailer harness.

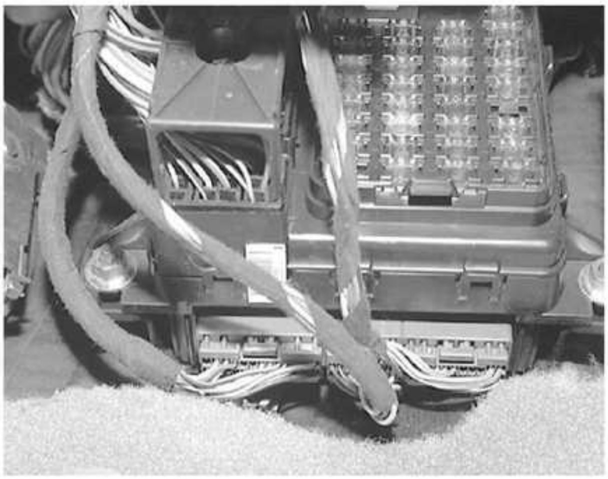
When installing the kit, follow the manufacturer's instructions. The color coding of the wires is usually standard throughout the industry. One point to note: some domestic vehicles, and most imported vehicles, have separate turn signals. On most domestic vehicles, the brake lights and rear turn signals operate with the same bulb. For those vehicles without separate turn signals, you can purchase an isolation unit so that the brake lights won't blink whenever the turn signals are operated.

One, final point, the best kits are those with a spring loaded cover on the vehicle mounted socket. This cover prevents dirt and moisture from corroding the terminals. Never let the vehicle socket hang loosely; always mount it securely to the bumper or hitch.

CIRCUIT PROTECTION

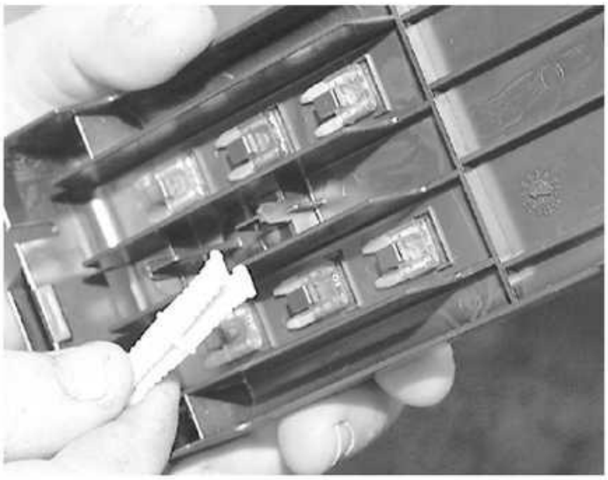
Fuses

REPLACEMENT



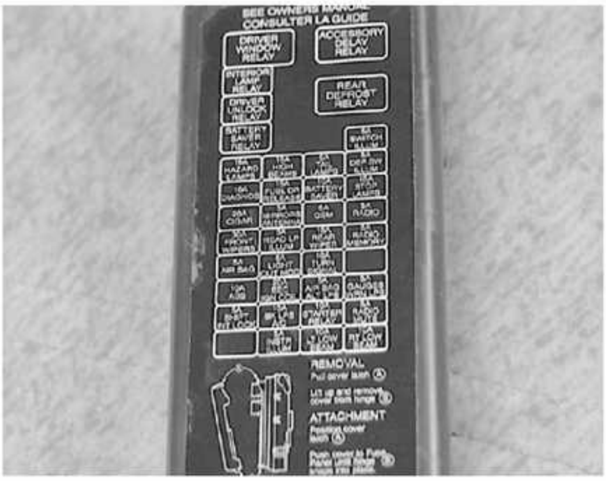
The interior fuse panel is located under the instrument panel on the driver's side

Remove the fuse panel cover



Under the fuse panel cover is a fuse removal/installation tool as well as...

... replacement fuses



the fuse panel cover has the fuse locations marked on it as well as the amperage ratings of the fuses

Fuses are located either in the engine compartment or passenger compartment fuse and relay panels. If a fuse blows, a single component or single circuit will not function properly.

1. Remove the fuse or relay box cover.
2. Inspect the fuses to determine which is faulty.
3. Unplug and discard the fuse.
4. Inspect the box terminals and clean if corroded. If any terminals are damaged, replace the terminals.
5. Plug in a new fuse of the same amperage rating.

Never exceed the amperage rating of a blown fuse. If the replacement fuse also blows, check for a problem in the circuit.

6. Check for proper operation of the affected component or circuit.

Maxi-Fuses (Fusible Links)

Maxi-fuses are located in the engine compartment relay box. If a maxi-fuse blows, an entire circuit or several circuits will not function properly.

REPLACEMENT

1. Remove the fuse and relay box cover.
2. Inspect the fusible links to determine which is faulty.
3. Unplug and discard the fusible link.
4. Inspect the box terminals and clean if corroded. If any terminals are damaged, replace the terminals.
5. Plug in a new fusible link of the same amperage rating.

Never exceed the amperage rating of a blown maxi-fuse. If the replacement fuse also blows, check for a problem in the circuit(s).

6. Check for proper operation of the affected circuit(s).

Circuit Breakers

RESETTING AND/OR REPLACEMENT

Circuit breakers are located inside the fuse panel. They are automatically reset when the problem corrects itself, is repaired, or the circuit cools down to allow operation again.

Flashers

REPLACEMENT

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Flasher assembly mounting

1. Disconnect the negative battery cable.
2. Locate the flasher assembly under the driver's side of the instrument panel and remove the flasher retaining screw.
3. Detach the flasher from the connector and remove the flasher from the vehicle.

To install:

4. The installation is the reverse of the removal.

WIRING DIAGRAMS

Click on icon to view fullsize printable image.

Click to Enlarge

Wiring Diagrams Index

Fig. 2: Sample Diagram: How to Read & Interpret Wiring Diagrams

Click on icon to view fullsize printable image.

Click to Enlarge

Sample Diagram: Wiring Diagram Symbols

Fig. 4: 1996-99 3.0L OHV (VIN 1, 2 & U) Engine Schematic

Click on icon to view fullsize printable image.

Click to Enlarge

1996-99 3.0L DOHC Engine Schematic

Fig. 6: 1996-99 3.4L DOHC Engine Schematic

Click on icon to view fullsize printable image.

Click to Enlarge

1996-99 Starting & Charging Chassis Schematics

Fig. 8: 1996-99 Charging, Horn and Fuel Pump Chassis Schematics

Click on icon to view fullsize printable image.

Click to Enlarge

1996-99 Cooling Fan and Headlight w/o DRL Chassis Schematics

Fig. 10: 1996-99 Front and Rear Wiper Motor Chassis Schematics

Click on icon to view fullsize printable image.

Click to Enlarge

1996-99 Turn Signal Lights Chassis Schematics

Fig. 12: 1996-99 Marker Lights Chassis Schematics

Click on icon to view fullsize printable image.

Click to Enlarge

1996-99 Brake and Back-up Lights Chassis Schematics

Fig. 14: 1996-99 Power Window Chassis Schematics

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1996-99 Power Door Lock Chassis Schematics

Fig. 16: 1996-99 Headlight w/DRL Chassis Schematics

SPECIFICATION CHARTS

Click on icon to view fullsize printable image. **Click to Enlarge** *Typical interior fuse panel*
Click on icon to view fullsize printable image. **Click to Enlarge** *Typical interior fuse identification*
Click on icon to view fullsize printable image. **Click to Enlarge** *Typical interior fuse identification-continued*
Click on icon to view fullsize printable image. **Click to Enlarge** *Typical power distribution box*
Click on icon to view fullsize printable image. **Click to Enlarge** *Typical power distribution box fuse identification*
Click on icon to view fullsize printable image. **Click to Enlarge** *Typical power distribution box fuse identification-continued*
Click on icon to view fullsize printable image. **Click to Enlarge** *Fuse color and amperage ratings*

DRIVE TRAIN: AUTOMATIC TRANSAXLE

Understanding the Automatic Transaxle

The automatic transaxle allows engine torque and power to be transmitted to the front wheels within a narrow range of engine operating speeds. It will allow the engine to turn fast enough to produce plenty of power and torque at very low speeds, while keeping it at a sensible rpm at high vehicle speeds (and it does this job without driver assistance). The transaxle uses a light fluid as the medium for the transmission of power. This fluid also works in the operation of various hydraulic control circuits and as a lubricant. Because the transaxle fluid performs all of these functions, trouble within the unit can easily travel from one part to another. For this reason, and because of the complexity and unusual operating principles of the transaxle, a very sound understanding of the basic principles of operation will simplify troubleshooting.

Fluid Pan

REMOVAL & INSTALLATION

For removal of the transaxle fluid pan and replacement of the filter, refer to Section 1.

Transmission Range Sensor (TR Sensor)

REMOVAL & INSTALLATION

Click on icon to view fullsize printable image.

Click to Enlarge

Remove the two TR sensor retaining bolts

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Click to Enlarge

Align the TR sensor slots using TR sensor alignment tool T92-70010-AH or equivalent

1. Disconnect the negative battery cable.
2. Place the shift selector into ***NEUTRAL***.
3. Remove the air cleaner outlet tube and the air cleaner housing from the vehicle.
4. Detach the electrical connector from the TR sensor.
5. Remove the retaining nut and detach the manual control lever from the TR sensor.
6. Remove the two TR sensor retaining bolts and remove the TR sensor from the transaxle.

To install:

7. Make sure that the shift selector is in ***NEUTRAL***.
8. Place the TR sensor onto the transaxle and loosely install the retaining bolts.
9. Align the TR sensor slots using TR sensor alignment tool T92-70010-AH or equivalent.
10. Tighten the TR sensor retaining bolts to 80-106 inch lbs. (9-12 Nm).
11. Attach the electrical connector to the TR sensor.
12. Attach the manual control lever to the TR sensor and tighten the nut to 98-141 inch lbs. (11-16 Nm).
13. Install the air cleaner housing and the outlet tube.
14. Connect the negative battery cable.
15. Verify that the engine will only start in ***NEUTRAL*** or ***PARK***.

ADJUSTMENT

1. Disconnect the negative battery cable.

2. Place the shift selector into ***NEUTRAL***.
3. Remove the air cleaner outlet tube and the air cleaner housing from the vehicle.
4. Make sure that the shift selector is in ***NEUTRAL***.
5. Loosen, but do not remove the TR sensor retaining bolts.
6. Align the TR sensor slots using TR sensor alignment tool T92-70010-AH or equivalent.
7. Tighten the TR sensor retaining bolts to 80-106 inch lbs. (9-12 Nm).
8. Install the air cleaner housing and the outlet tube.
9. Connect the negative battery cable.
10. Verify that the engine will only start in ***NEUTRAL*** or ***PARK***.

Automatic Transaxle Assembly

REMOVAL & INSTALLATION

Click on icon to view fullsize printable image. Click to Enlarge *Transaxle removal-3.0L OHV engine only*
Click on icon to view fullsize printable image. Click to Enlarge *Transaxle removal-3.0L and 3.4L DOHC engines only*
Click on icon to view fullsize printable image. Click to Enlarge *Install a suitable engine support device before removing the transaxle*
Click on icon to view fullsize printable image. Click to Enlarge *Rear engine mount-to-transaxle mounting points*

1. Disconnect both battery cables, negative cable first.
2. Remove the battery and battery tray. Remove the engine air cleaner assembly.
3. Detach the transaxle harness and the Transmission Range (TR) sensor connectors.
4. Remove the shift cable actuator fitting (cable retaining clip) and one retaining nut and disconnect the shift cable from the shift cable bracket on the transaxle.
5. Disconnect the transaxle cooler lines.
6. For the 3.0L OHV engines, remove the four upper transaxle-to-engine retaining bolts and one transaxle-to-engine stud.
7. For the 3.0L and 3.4L DOHC engines, remove five transaxle-to-engine retaining bolts.
8. Install two engine lifting brackets on the engine assembly.
9. Install a suitable engine support device.
10. Raise and safely support the vehicle.
11. Loosen the transaxle oil pan retaining bolts and drain the transaxle fluid into a suitable container.
12. Remove both front wheel and tire assemblies.
13. Remove both halfshafts.
14. Detach the four Heated Oxygen Sensor (HO2S) electrical connectors.
15. Remove three bolts and seven nuts securing the converter Y-pipe assembly and remove from the vehicle.
16. Detach the two starter motor connectors, then remove the starter.
17. Remove one bolt and one stud securing the starter motor and remove the starter motor from the transaxle.
18. For the OHV engine, remove one bolt and the transaxle housing cover.
19. Support the rack and pinion assembly using wire attached to the strut and spring assembly to hold it in position. Remove two rack and pinion assembly retaining nuts from the subframe.
20. Remove two lower control arm-to-ball joint retaining nuts and separate the lower control arms from the steering knuckles and ball joints.
21. Remove the retaining nuts from the front engine support insulators (mounts) at the subframe.

22. Remove the sway bar (stabilizer bar) link retaining nuts at each end of the sway bar and separate the links from the sway bar.
23. Remove the engine and transaxle support insulator through-bolts from the subframe.
24. Place a suitable transmission jack, using a suitable subframe adapter under the subframe and support the subframe.
25. Remove the four subframe-to-body retaining bolts. Carefully lower the subframe and set aside.
26. Place a suitable transmission jack using Adapter 014-00461 or equivalent, under the transaxle and support the transaxle assembly. Secure the transaxle to the transaxle adapter using a strap or chain.
27. For the OHV engine, remove one lower engine-to-transaxle bolt.
28. For the DOHC engines, remove the four lower engine-to-transaxle bolts.
29. Remove the four flywheel-to-torque converter nuts.
30. Remove three bolts and two nuts securing the rear engine support to the transaxle and remove the rear engine support.
31. Remove one bolt from the right engine mount brace, then slowly lower the transaxle from the vehicle.

To install:
Flush the transaxle cooler lines thoroughly before installing the transaxle assembly.

Whenever the vehicle's subframe is removed or lowered, the wheel alignment should be checked.

49. Check the front end alignment.
50. Road test the vehicle and check the transaxle for proper operation.

ADJUSTMENTS

There are no adjustments to the automatic transaxle in the Ford Taurus or Mercury Sable. The transaxle is electronically controlled by the PCM.

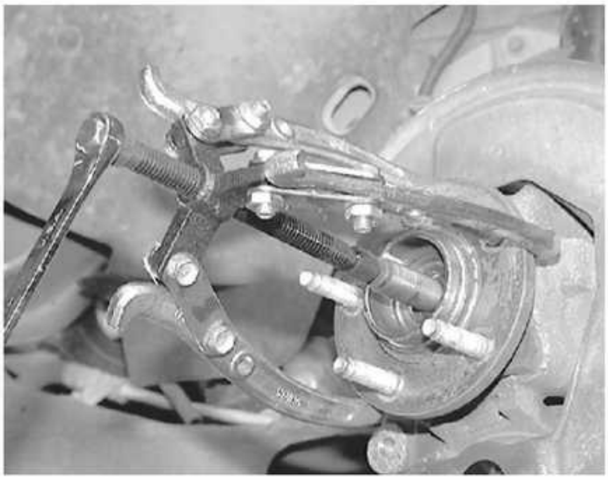
Halfshafts

REMOVAL & INSTALLATION

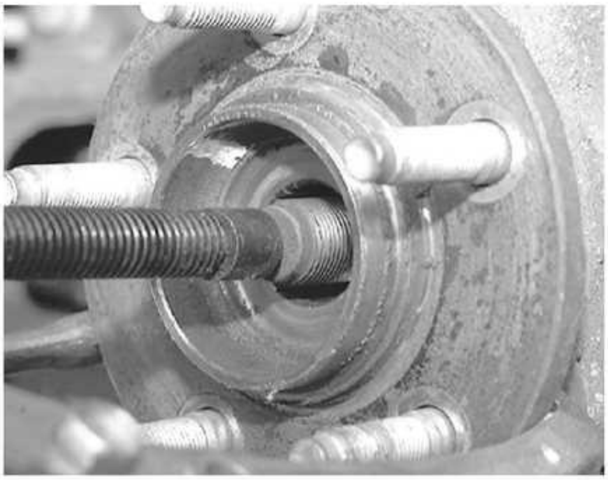
Loosen the hub retaining nut

Using a pry bar or other suitable tool, remove the lower ball joint from the knuckle

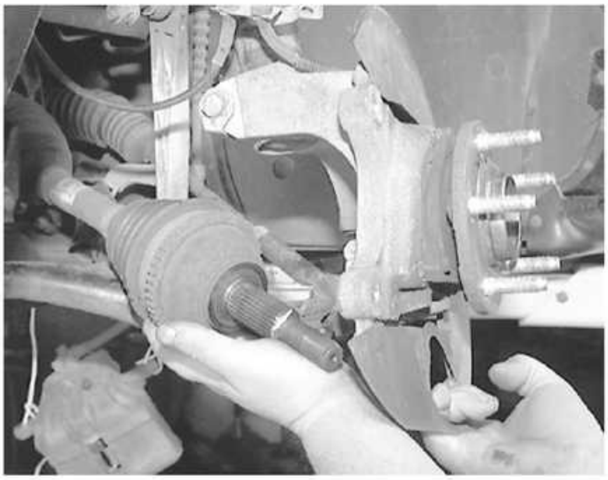
Remove the hub nut and washer from the halfshaft



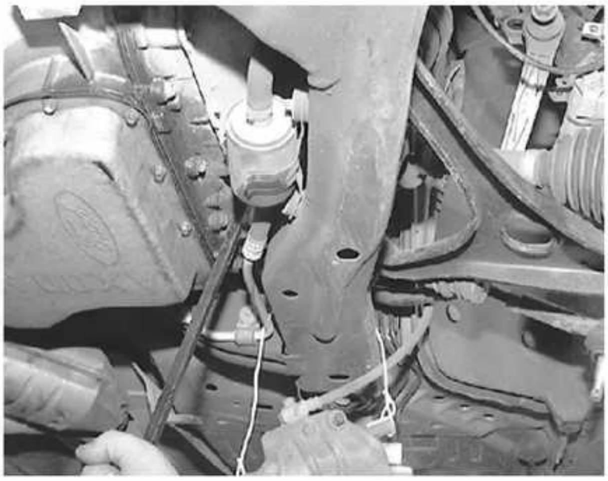
If necessary, a suitable puller can be installed to aid in the removal of the halfshaft from the hub assembly



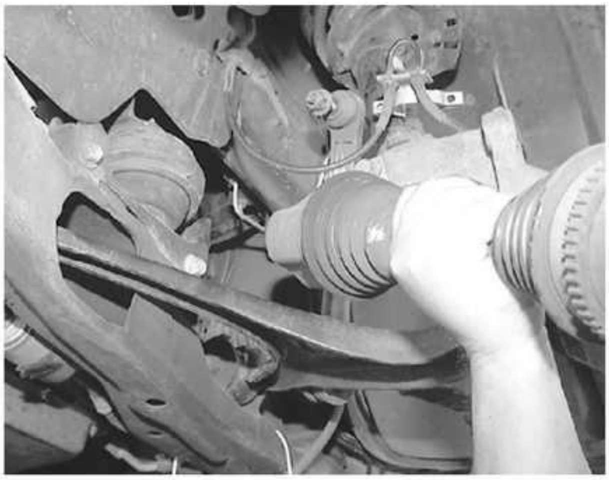
Tighten the forcing screw of the puller to push the halfshaft out of the hub



Remove the halfshaft from the hub and knuckle assembly



Using a pry bar or other suitable device, release the halfshaft from the transaxle and...



... remove the halfshaft from the vehicle

Replace the circlip on the transaxle differential stub shaft before installing a new halfshaft

Do NOT begin this procedure unless the following parts are available:

- New hub retainer nut
- New lower control arm-to-steering knuckle bolt and nut
- New halfshaft circlip

Once removed, these parts must not be reused during assembly. Their torque holding ability or retention capability is diminished during removal.

1. Remove the wheel cover/hub cover from the wheel and tire assembly. Loosen the hub retainer nut and the lug nuts.
2. Raise the vehicle and support safely.
3. Remove the wheel and tire assembly. Remove the hub retainer nut and washer and discard the hub nut.
4. Remove the nut from the ball joint-to-steering knuckle attaching bolts. Drive the bolt out of the steering knuckle using a punch and hammer. Discard the bolt and nut.
5. If equipped with ABS, remove the anti-lock brake sensor and position aside.
6. Separate the ball joint from the steering knuckle using a suitable pry bar. Position the end of the pry bar outside of the bushing pocket to avoid damage to the bushing. Use care to prevent damage to the ball joint boot. Remove the stabilizer bar link at the stabilizer bar.
7. Remove the shaft from the hub assembly.

Never use a hammer to separate the outer CV-joint stub shaft from the hub.Damage to the CV-joint threads and internal components may result.

8. Support the end of the shaft by suspending it from a convenient underbody component with a piece of wire. Do not allow the shaft to hang unsupported; damage to the outboard CV-joint may occur.
9. Using a suitable prying tool, release the inboard joint from the transaxle by carefully prying the shaft away and releasing the retaining circlip.
10. Remove the halfshaft assembly from the vehicle.

To install:

11. Install a new circlip on the transaxle end of the halfshaft. When installing the circlip, start one end in the groove and work the circlip over the shaft end into the groove. This will avoid over-expanding the circlip.

The circlip must not be re-used. A new circlip must be installed each time the inboard CV-joint is installed into the transaxle differential.

12. Carefully align the splines of the inboard CV-joint stub shaft with the splines in the differential. Exerting some force, push the CV-joint into the differential until the circlip is felt to seat in the differential side gear. Use care to prevent damage to the differential oil seal.

A non-metallic mallet may be used to aid in seating the circlip into the differential side gear groove. If a mallet is necessary, tap only on the outboard CV-joint stub shaft.

CV-JOINTS OVERHAUL

These vehicles use several different types of joints. Engine size, transaxle type, whether the joint is an inboard or outboard joint, even which side of the vehicle is being serviced could make a difference in joint type. Be sure to properly identify the joint before attempting joint or boot replacement. Look for identification numbers at the large end of the boots and/or on the end of the metal retainer bands.

The 3 types of joints used are the Birfield Joint, (B.J.), the Tripod Joint (T.J.) and the Double Offset Joint (D.O.J.).

Do not disassemble a Birfield joint. Service with a new joint or clean and repack using a new boot kit.

The distance between the large and small boot bands is important and should be checked prior to and after boot service. This is so the boot will not be installed either too loose or too tight, which could cause early wear and cracking, allowing the grease to get out and water and dirt in, leading to early joint failure.

The halfshaft joints use special grease; do not add any grease other than that supplied with the kit.

Double Offset Joint

The Double Offset Joint (D.O.J.) is bigger than other joints and, in these applications, is normally used as an inboard joint.

1. Remove the halfshaft from the vehicle.
2. Side cutter pliers can be used to cut the metal retaining bands. Remove the boot from the joint outer race.
3. Locate and remove the large circlip at the base of the joint. Remove the outer race (the body of the joint).
4. Remove the small snap-ring and take off the inner race, cage and balls as an assembly. Clean the inner race, cage and balls without disassembling.
5. If the boot is to be reused, wipe the grease from the splines and wrap the splines in vinyl tape before sliding the boot from the shaft.
6. Remove the inner (D.O.J.) boot from the shaft. If the outer (B.J.) boot is to be replaced, remove the boot retainer rings and slide the boot down and off of the shaft at this time.

To install:

7. Be sure to tape the shaft splines before installing the boots. Fill the inside of the boot with the specified grease. Often the grease supplied in the replacement parts kit is meant to be divided in half, with half being used to lubricate the joint and half being used inside the boot.
8. Install the cage onto the halfshaft so the small diameter side of the cage is installed first. With a brass drift pin, tap lightly and evenly around the inner race to install the race until it comes into contact with the rib of the shaft. Apply the specified grease to the inner race and cage and fit them together. Insert the balls into the cage.
9. Install the outer race (the body of the joint) after filling with the specified grease. The outer race should be filled with this grease.
10. Tighten the boot bands securely. Make sure the distance between the boot bands is correct.
11. Install the halfshaft to the vehicle.

Except Double Offset Joint

1. Disconnect the negative battery cable. Remove the halfshaft.
2. Use side cutter pliers to remove the metal retaining bands from the boot(s) that will be removed. Slide the boot from the joint case.
3. Remove the snap-ring and the tripod joint spider assembly from the halfshaft. Do not disassemble the spider and use care in handling.

4. If the boot is be reused, wrap vinyl tape around the splined part of the shaft so the boot(s) will not be damaged when removed. Remove the dynamic damper, if used, and the boots from the shaft.

To install:

5. Double check that the correct replacement parts are being installed. Wrap vinyl tape around the splines to protect the boot and install the boots and damper, if used, in the correct order.
6. Install the joint spider assembly to the shaft and install the snap-ring.
7. Fill the inside of the boot with the specified grease. Often the grease supplied in the replacement parts kit is meant to be divided in half, with half being used to lubricate the joint and half being used inside the boot. Keep grease off the rubber part of the dynamic damper (if used).
8. Secure the boot bands with the halfshaft in a horizontal position. Make sure distance between boot bands is correct.
9. Install the halfshaft to the vehicle.

Axle Seals

REMOVAL & INSTALLATION

The axle seal is easily accessed once the halfshaft is removed

Using a suitable seal puller, remove the axle seal from the transaxle

In place of a proper seal driver, a large socket can be used to install the seal

1. Remove the halfshaft(s) as outlined in this Section.
2. Using a suitable seal puller, remove the seal from the transaxle.
3. Thoroughly clean the sealing surface of the axle seal.

To install:

4. Using a suitable seal driver, or a large socket that is the same circumference as the seal, drive the new seal into the transaxle.
5. Install the halfshaft(s).

Specifications Charts

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Torque Specifications

SUSPENSION & STEERING

WHEELS

Wheel Assembly

REMOVAL & INSTALLATION

1. Park the vehicle on a level surface.
2. Remove the jack, tire iron and, if necessary, the spare tire from their storage compartments.
3. Check the owner's manual or refer to Section 1 of this manual for the jacking points on your vehicle. Then, place the jack in the proper position.
4. If equipped with lug nut trim caps, remove them by either unscrewing or pulling them off the lug nuts, as appropriate. Consult the owner's manual, if necessary.
5. If equipped with a wheel cover or hub cap, insert the tapered end of the tire iron in the groove and pry off the cover.
6. Apply the parking brake and block the diagonally opposite wheel with a wheel chock or two.

Wheel chocks may be purchased at your local auto parts store, or a block of wood cut into wedges may be used. If possible, keep one or two of the chocks in your tire storage compartment, in case any of the tires has to be removed on the side of the road.

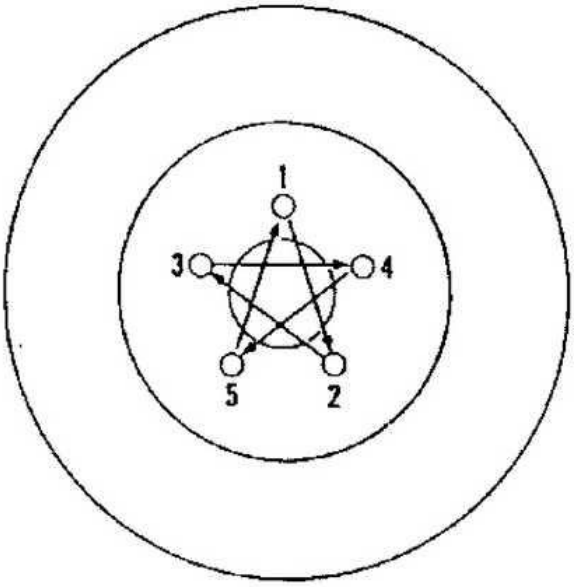
7. If equipped with an automatic transaxle, place the selector lever in ***P*** or Park; with a manual transmission/transaxle, place the shifter in Reverse.
8. With the tires still on the ground, use the tire iron/wrench to break the lug nuts loose.

If a nut is stuck, never use heat to loosen it or damage to the wheel and bearings may occur. If the nuts are seized, one or two heavy hammer blows directly on the end of the bolt usually loosens the rust. Be careful, as continued pounding will likely damage the brake drum or rotor.

9. Using the jack, raise the vehicle until the tire is clear of the ground. Support the vehicle safely using jack stands.
10. Remove the lug nuts, then remove the tire and wheel assembly.

To install:

11. Make sure the wheel and hub mating surfaces, as well as the wheel lug studs, are clean and free of all foreign material. Always remove rust from the wheel mounting surface and the brake rotor or drum. Failure to do so may cause the lug nuts to loosen in service.
12. Install the tire and wheel assembly and hand-tighten the lug nuts.
13. Using the tire wrench, tighten all the lug nuts, in a crisscross pattern, until they are snug.
14. Raise the vehicle and withdraw the jack stand, then lower the vehicle.
15. Using a torque wrench, tighten the lug nuts in a crisscross pattern to 85-105 ft. lbs. (115-142 Nm). Check your owner's manual or refer to Section 1 of this manual for the proper tightening sequence.



Typical wheel lug tightening sequence

Tighten the wheel lug nuts using a torque wrench

Do not overtighten the lug nuts, as this may cause the wheel studs to stretch or the brake disc (rotor) to warp.

16. If so equipped, install the wheel cover or hub cap. Make sure the valve stem protrudes through the proper opening before tapping the wheel cover into position.
17. If equipped, install the lug nut trim caps by pushing them or screwing them on, as applicable.
18. Remove the jack from under the vehicle, and place the jack and tire iron/wrench in their storage compartments. Remove the wheel chock(s).
19. If you have removed a flat or damaged tire, place it in the storage compartment of the vehicle and take it to your local repair station to have it fixed or replaced as soon as possible.

INSPECTION

Inspect the tires for lacerations, puncture marks, nails and other sharp objects. Repair or replace as necessary. Also check the tires for treadwear and air pressure as outlined in Section 1 of this manual.

Check the wheel assemblies for dents, cracks, rust and metal fatigue. Repair or replace as necessary.

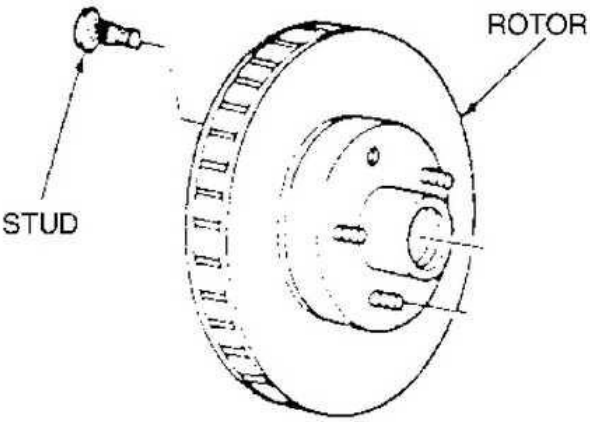
Wheel Lug Studs

REMOVAL & INSTALLATION

With Disc Brakes

1. Raise and support the appropriate end of the vehicle safely using jack stands, then remove the wheel.
2. Remove the brake pads and caliper. Support the caliper aside using wire or a coat hanger. For details, please refer to Section 9 of this manual.
3. Remove the outer wheel bearing and lift off the rotor. For details on wheel bearing removal, installation and adjustment, please refer to Section 1 of this manual.
4. Properly support the rotor using press bars, then drive the stud out using an arbor press.

If a press is not available, CAREFULLY drive the old stud out using a blunt drift. MAKE SURE the rotor is properly and evenly supported or it may be damaged.



View of the rotor and stud assembly

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Pressing the stud from the rotor

To install:

5. Clean the stud hole with a wire brush and start the new stud with a hammer and drift pin. Do not use any lubricant or thread sealer.
6. Finish installing the stud with the press.

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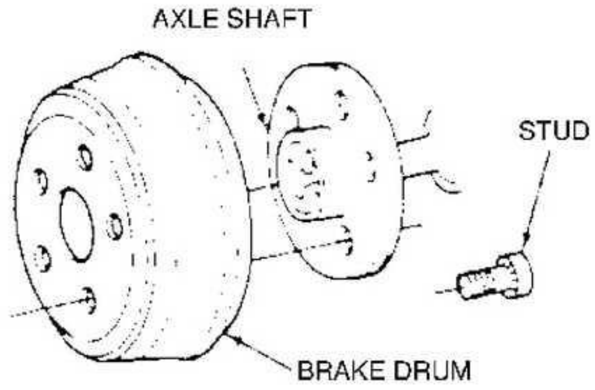
Use a press to install the stud into the rotor

If a press is not available, start the lug stud through the bore in the hub, then position about 4 flat washers over the stud and thread the lug nut. Hold the hub/rotor while tightening the lug nut, and the stud should be drawn into position. MAKE SURE THE STUD IS FULLY SEATED, then remove the lug nut and washers.

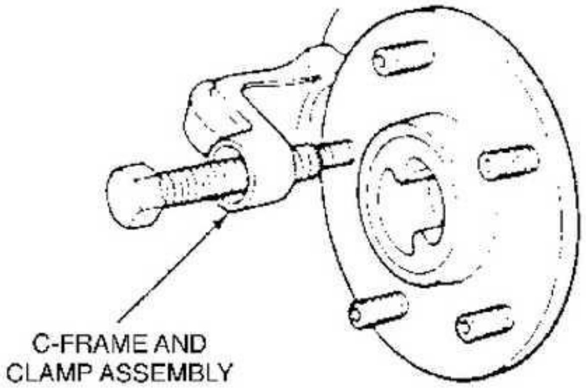
7. Install the rotor and adjust the wheel bearings.
8. Install the brake caliper and pads.
9. Install the wheel, then remove the jack stands and carefully lower the vehicle.
10. Tighten the lug nuts in sequence to the proper torque.

With Drum Brakes

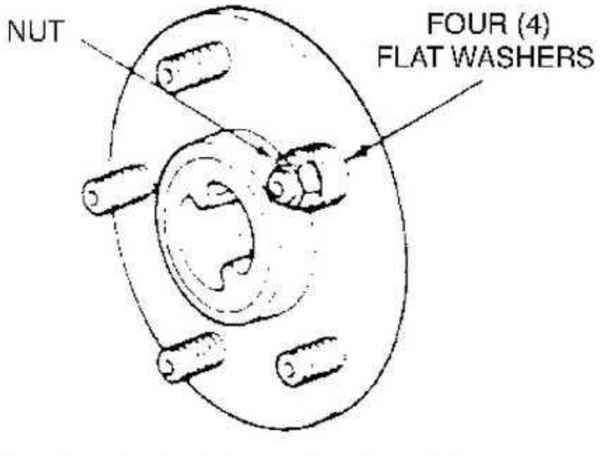
1. Raise the vehicle and safely support it with jack stands, then remove the wheel.
2. Remove the brake drum.
3. If necessary to provide clearance, remove the brake shoes, as outlined in Section 9 of this manual.



Exploded view of the drum, axle flange and stud



Use a C-clamp and socket to press out the stud



Force the stud onto the axle flange using washers and a lug nut

4. Using a large C-clamp and socket, press the stud from the axle flange.

5. Coat the serrated part of the stud with liquid soap and place it into the hole.

To install:

6. Position about 4 flat washers over the stud and thread the lug nut. Hold the flange while tightening the lug nut, and the stud should be drawn into position. MAKE SURE THE STUD IS FULLY SEATED, then remove the lug nut and washers.
7. If applicable, install the brake shoes.
8. Install the brake drum.
9. Install the wheel, then remove the jack stands and carefully lower the vehicle.
10. Tighten the lug nuts in sequence to the proper torque.

FRONT SUSPENSION

Introduction

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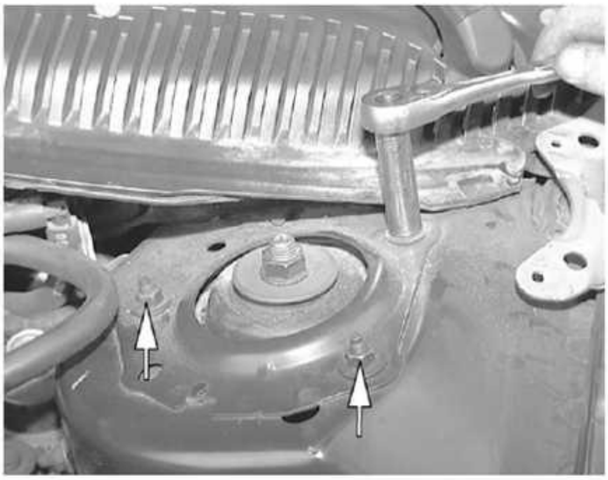
Front Suspension Components

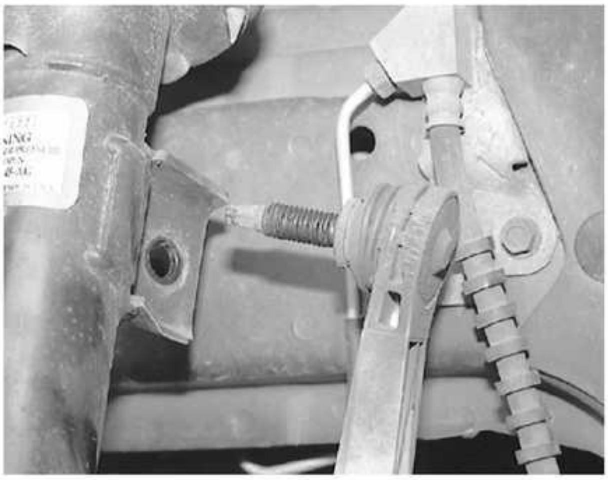
Macpherson Struts

REMOVAL & INSTALLATION

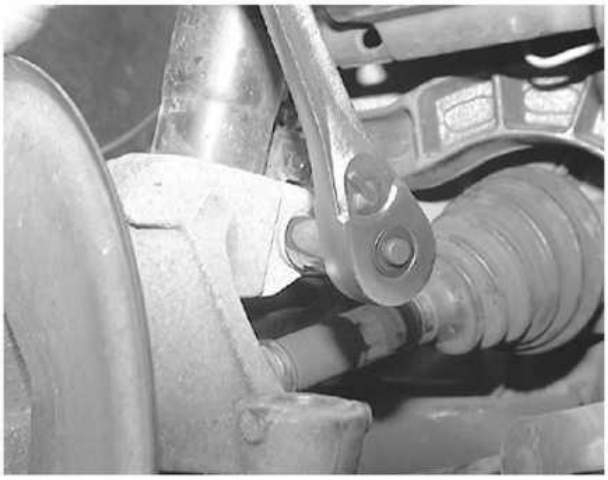


Loosen the three top mount-to-strut tower nuts

Remove the stabilizer bar link-to-strut retaining nut and...



... remove the stabilizer bar link from the strut



Remove the strut-to-knuckle retaining bolt and...

... remove the strut from the knuckle

Remove the strut out the bottom to remove it from the vehicle

Be sure new wheel hub retainer nuts, tie rod end castellated nuts, stabilizer bar link nuts and knuckle-to-strut pinch bolt/nuts are available. These parts lose their torque holding/retention capabilities during removal and must not be reused.

1. Turn the ignition switch to the ***OFF*** position. Leave the steering column in the UNLOCKED position.
2. With all four wheels on the ground, remove the wheel hub retainer nut. Discard the nut.
3. On the SHO vehicles:

   1. Detach the height sensor wiring connector.
   2. Remove the wiring harness from the routing clip on the front shock absorber.
   3. Remove air suspension height sensor from the height sensor ball studs.

4. Loosen the three top mount-to-strut tower nuts, but do not remove the nuts at this time.
5. Raise and safely support the vehicle.
6. Remove the wheel and tire assembly.

When raising the vehicle, do not lift by using the lower control arms.

7. Remove the disc brake caliper. Hang the caliper out of the work area with wire to prevent damage to the brake hose.
8. Remove the disc brake rotor.
9. Remove the anti-lock brake sensor wiring harness clip and the mounting screw from the brake hose bracket on the strut assembly. Move the anti-lock brake sensor aside.

10. Remove the cotter pin and the castellated nut from the tie rod end. Discard the cotter pin and nut.
11. Using Removal tool 3290-D, or equivalent and Adapter tool T81P-3504-W or equivalent, separate the tie rod end from the steering knuckle.
12. On SHO vehicles, remove the vinyl cover from the upper link stud.
13. Remove the sway bar (stabilizer bar) link nut and link from the strut. Discard the link nut.
14. Remove and discard the lower ball joint retaining nut. Using Ball Joint Remover T96P-3010-A or equivalent, separate the ball joint from the lower control arm.
15. Using Spring Compressor 164-R-3571 or equivalent, compress the coil spring until the ball joint clears the lower arm.
16. Remove the pinch bolt and nut from the bottom of the steering knuckle. It may be necessary to use a drift punch to remove the bolt. Discard the pinch bolt and nut.
17. Separate the halfshaft from the wheel hub using Front Hub Remover/Replacer T81P-1104-C or equivalent and the required adapters.
18. Support the halfshaft with wire in a level position to prevent it from hanging by the inner CV-joint.

Do not let the halfshaft hang by the inner CV-joint or move too far outward. The internal parts of the tripod CV-joint could be pulled apart.

19. Remove the three top mount-to-strut tower nuts while supporting the strut. Lower the strut assembly from the vehicle.

To install:

20. Install the strut assembly with the spring compressor installed to the vehicle and install the three top mount-to-strut tower nuts loosely.

Further compress the coil spring if added clearance is required for installation.

21. Install the steering knuckle and hub assembly to the strut. Install a new pinch bolt and nut. Tighten to 73-97 ft. lbs. (98-132 Nm).
22. Install the halfshaft into the hub using care to align the splines.
23. Install the sway bar link to the strut and install a new sway bar link nut. Tighten to 55-75 ft. lbs. (75-101 Nm).
24. On SHO vehicles, install the vinyl cover to the upper link stud.
25. Install the tie rod end onto the steering knuckle using a new castellated nut. Tighten the nut to 35-46 ft. lbs. (47-63 Nm). Continue to tighten the nut until a slot lines up with the opening in the tie rod end stud and install a new cotter pin.
26. Install the anti-lock brake sensor wiring routing clip and tighten the brake hose bracket mounting screw.
27. On the SHO vehicles:

    1. Install air suspension height sensor to the height sensor ball studs.
    2. Install the wiring harness to the routing clip on the front shock absorber.
    3. Attach the height sensor wiring connector.

28. Install the disc brake rotor and caliper. Tighten the caliper anchor bracket bolts to 65-87 ft. lbs. (88-118 Nm).
29. Install the wheel and tire assembly. Tighten the lug nuts to 85-105 ft. lbs. (115-142 Nm).
30. Tighten the three top mount-to-shock tower nuts to 22-29 ft. lbs. (30-40 Nm).
31. Lower the vehicle.
32. Install a new wheel hub retainer nut. Tighten the nut to 170-202 ft. lbs. (230-275 Nm).
33. Pump the brake pedal several times prior to moving the vehicle, to position the brake pads.
34. Road test the vehicle and check for proper operation.

OVERHAUL

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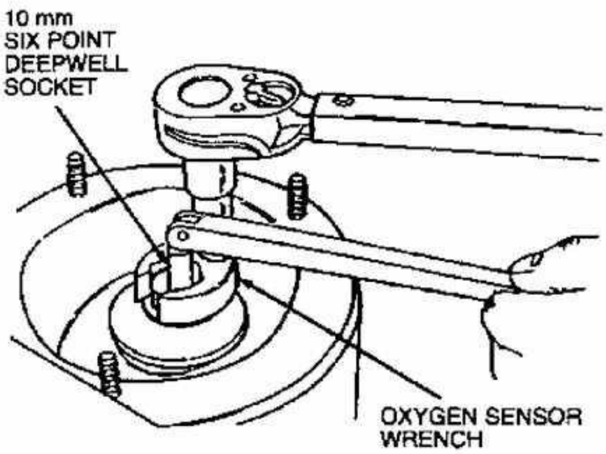
Exploded view of the front strut and coil spring assembly

Do not remove the strut rod nut until the spring has been compressed until it comes away from the seat.

1. Remove the strut from the vehicle.
2. Compress the coil spring using a suitable spring compressor until the spring comes away from the seat.
3. Remove the large center nut and slowly release the spring compressor.
4. Remove the upper bearing from the strut assembly.
5. Remove the spring from the strut assembly.
6. Remove the lower spring insulator from the strut.

To install:

7. If replacing the strut, transfer any necessary components from the old strut.
8. Install the lower spring insulator onto the strut.
9. Compress the spring and install it on the strut.
10. Install the lower washer and upper bearing assembly.
11. Install the upper washer and a new nut. Tighten the nut to 39-53 ft. lbs. (53-72 Nm) while holding the rod with a T-50 size Torx® socket.
12. Install the strut assembly in the vehicle.



Hold the strut rod while loosening or tightening the nut

Lower Ball Joint

INSPECTION

1. Raise and safely support the vehicles on jack stands. Allow the suspension to hang free.
2. Grasp the tire at the top and the bottom and move the top of the tire in and out.
3. Observe for any horizontal movement of the steering knuckle relative to the front lower control arm. If any movement is detected, replace the ball joint.
4. If the ball stud is disconnected from the steering knuckle and any looseness is detected, or if the ball stud can be twisted in its socket using finger pressure, replace the ball joint.

REMOVAL & INSTALLATION

The lower ball joint is an integral part of the steering knuckle. If the lower ball joint is found to be defective, the entire steering knuckle must be replaced.

Stabilizer (Sway) Bar

REMOVAL & INSTALLATION

Click on icon to view fullsize printable image.

Click to Enlarge

Remove the stabilizer bar link from the stabilizer bar

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Click to Enlarge

The stabilizer bar bracket and bushing location

Make sure 4 new sway bar link retaining nuts, 2 sway bar insulators, 4sway bar U-bracket bolts and 2 subframe to body retaining bolts are available.These parts lose their torque holding/retention capabilities during removal and must not be reused.

Do not raise the vehicle on the lower control arms or subframe.

4. Remove the sway bar (stabilizer bar) link-to-sway bar nuts at each strut assembly by holding the link stud with an 8 mm box wrench while removing the retaining nut with an 18mm open end wrench. Discard the sway bar link nuts.
5. Remove the sway bar link-to-strut nuts and the links; discard the nuts.

Use care not to damage the boot seals on the sway bar links. Do not use power tools for removal or installation.

6. Remove the rack and pinion-to-subframe nuts and move the rack and pinion assembly off the subframe to allow for removal of the sway bar.
7. Place a set of jack stands under the rear of the subframe and remove the rear subframe-to-body bolts.
8. Lower the rear of the subframe enough to gain access to the sway bar brackets.
9. Remove the sway bar U-bracket bolts, 2 per side and remove the U-brackets. Discard the 4 U-bracket bolts.
10. Remove the sway bar from the vehicle.
11. Remove the 2 sway bar insulators and discard.

To install:

12. Clean the sway bar of contamination in the areas that the sway bar insulators are positioned.
13. Lubricate the inside diameter of the new sway bar insulators with a lubricant designed for rubber suspension insulators.
14. Install the new sway bar insulators onto the sway bar and position the insulators in their approximate locations. Make sure the slits are positioned towards the front of the vehicle.
15. Install the sway bar onto the vehicle.
16. Install the U-brackets and 4 new retaining bolts securing the sway bar to the subframe. Tighten the bolts to 22-29 ft. lbs. (30-40 Nm).
17. Raise the subframe and install 2 new subframe to body retaining bolts. Tighten the bolts to 57-76 ft. lbs. (77-103 Nm).
18. Place the rack and pinion assembly in position on the subframe and install 2 retaining nuts. Tighten the retaining nuts to 85-99 ft. lbs. (115-135 Nm).
19. Install the sway bar links to the sway bar and struts. Note the letters TOP LH and TOP RH on each link for correct positioning. Install new nuts. Hold each link stud with an 8 mm box wrench while installing the new retaining nut with an 18mm open end wrench. Tighten the nuts at the strut to 57-75 ft. lbs. (77-103 Nm) and the nuts at the sway bar to 35-46 (47-63 Nm).

Use care not to damage the boot seals on the sway bar links. Do not use power tools for removal or installation.

Whenever the vehicle's subframe is removed or lowered, the wheel alignment should be checked.

24. Road test the vehicle and check for proper operation.

Lower Control Arm

REMOVAL & INSTALLATION

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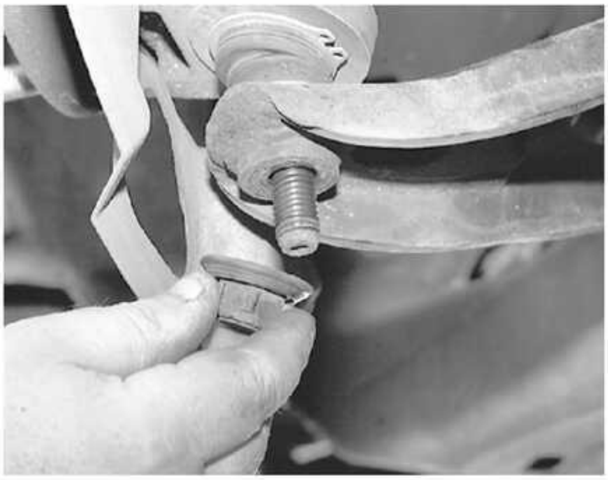
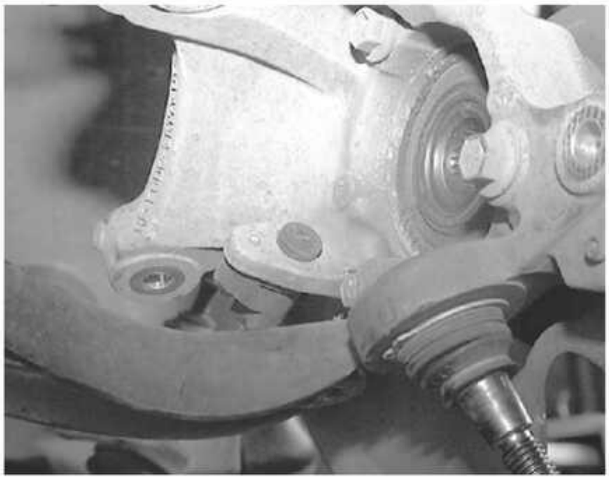
Lower control arm mounting

Loosen the ball joint nut and...



... remove the nut from the ball joint stud



Separate the ball joint from the lower control arm

1. Leave the steering column in the UNLOCKED position.
2. Raise and safely support the vehicle. Remove the wheel and tire assembly.
3. On the SHO vehicles:
    1. Detach the height sensor wiring connector.
    2. Remove the wiring harness from the routing clip on the front shock absorber.
    3. Remove air suspension height sensor from the height sensor ball studs.
4. Remove and discard the lower ball joint nut. Separate the lower ball joint from the lower control arm using Ball Joint tool T96P-3010-A or equivalent and Tie Rod End Adapter T881P-3504-W or equivalent.
5. Using Rotunda Spring Compressor 164-R-3571 or equivalent, compress the coil spring until the ball joint clears the lower arm.
6. Remove the front and rear lower control arm mounting nuts and bolts. Remove the lower control arm from the vehicle.

To install:

7. Place the lower control arm into position and install the front and rear mounting nuts and bolts. Tighten the rear nut and bolt to 72-97 ft. lbs. (98-132 Nm). Tighten the front nut and bolt to 57-75 ft. lbs. (77-103 Nm).
8. Slowly release the spring compressor while guiding the ball joint into the lower control arm. Remove the spring compressor.
9. Install a new ball joint retaining nut and tighten to 50-67 ft. lbs. (68-92 Nm).
10. On the SHO vehicles:
    1. Install air suspension height sensor to the height sensor ball studs.
    2. Install the wiring harness to the routing clip on the front shock absorber.
    3. Attach the height sensor wiring connector.
11. Install the wheel and tire assembly. Tighten the lug nuts to 85-104 ft. lbs. (115-142 Nm).
12. Lower the vehicle.
13. Road test the vehicle and check for proper operation.

CONTROL ARM BUSHING REPLACEMENT

The control arm bushings are part of the control arm assembly and are only replaceable by replacing the entire control arm assembly.

Knuckle Assembly

REMOVAL & INSTALLATION

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Front steering knuckle assembly and related components

Be sure new wheel hub retainer nuts, tie rod end castellated nuts, hub-to-knuckle retaining bolts, knuckle-to-strut pinch bolt/nut and inboard halfshaft circlips are available. These parts lose their torque holding/retention capabilities during removal and must not be reused.

1. Turn the ignition switch to the ***OFF*** position. Place the steering column in the UNLOCKED position.
2. Remove the wheel hub retainer nut before raising the vehicle off the ground. Discard the wheel hub retainer nut.
3. Raise and safely support the vehicle. Remove the wheel and tire assembly.

When raising the vehicle, do not lift by using the lower control arms.

4. Remove the wheel and tire assembly.
5. Remove the cotter pin and the castellated nut from the tie rod end. Discard the cotter pin and nut.
6. Separate the tie rod end from the steering knuckle using Remover tool 3290-D and adapter T81P-3504-W, or equivalents.
7. On SHO vehicles, remove the vinyl cover from the upper link stud.
8. Remove the stabilizer link from the strut. Remove the disc brake caliper and hang it aside.
9. Remove the disc brake rotor.
10. Remove the anti-lock sensor and move it aside.
11. Remove and discard the lower ball joint retaining nut. Using Ball Joint Remover T96P-3010-A or equivalent, separate

the ball joint from the lower control arm.

12. Using Rotunda Spring Compressor 164-R-3571 or equivalent, compress the coil spring until the ball joint clears the lower control arm.
13. Remove and discard the steering knuckle-to-strut pinch bolt and nut.
14. Separate the halfshaft from the wheel hub using Front Hub Remover/Replacer T81P-1104-C or equivalent and adapters.
15. Support the halfshaft with wire in a level position to prevent it from hanging by the inner CV-joint.

Do not let the halfshaft hang by the inner CV-joint or move too far outward. The internal parts of the tripod CV-joint could be pulled apart.

16. Separate the steering knuckle from the strut assembly and remove it from the vehicle.

To install:

17. Install the disc brake rotor shield using new rivets, if removed.
18. Position the steering knuckle assembly to the vehicle.
19. Place the halfshaft into the hub assembly.
20. Install the steering knuckle to the strut and loosely install a new pinch bolt.
21. Install the steering knuckle and hub assembly onto the halfshaft. Be sure the splines are properly aligned.
22. Slowly release Rotunda Spring Compressor 164-R-3571 or equivalent, while guiding the lower ball joint into the lower control arm.
23. Remove the spring compressor.
24. Install a new nut on the lower ball joint stud and tighten to 50-67 ft. lbs. (68-92 Nm).
25. Install a new nut on the steering knuckle-to-strut pinch bolt. Tighten the pinch bolt nut to 72-97 ft. lbs. (98-132 Nm)
26. Position the tie rod end to the steering knuckle. Install a new castellated nut and tighten to 35-46 ft. lbs. (47-63 Nm). Install a new cotter pin.
27. Install the sway bar link and tighten the nut to 57-75 ft. lbs. (77-103 Nm).
28. On SHO vehicles, install the vinyl cover to the upper link stud.

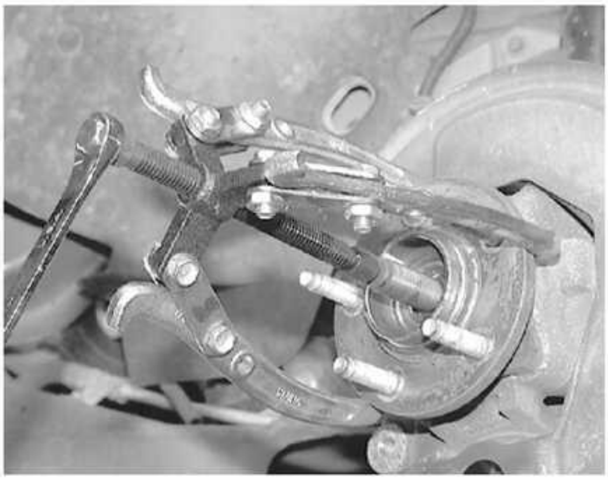
Use care not to damage the sway bar link boot seals. Do not use power tools to tighten the nuts or seal damage will result.

29. Install the disc brake rotor and disc brake caliper. Tighten the caliper anchor bracket bolts to 65-87 ft. lbs. (88-118 Nm).
30. Install the wheel and tire assembly.
31. Lower the vehicle.
32. Install a new wheel hub retainer nut. Tighten the nut to 170-202 ft. lbs. (230-275 Nm).
33. Pump the brake pedal several times prior to moving the vehicle, to position the brake pads.
34. Road test the vehicle and check for proper operation.

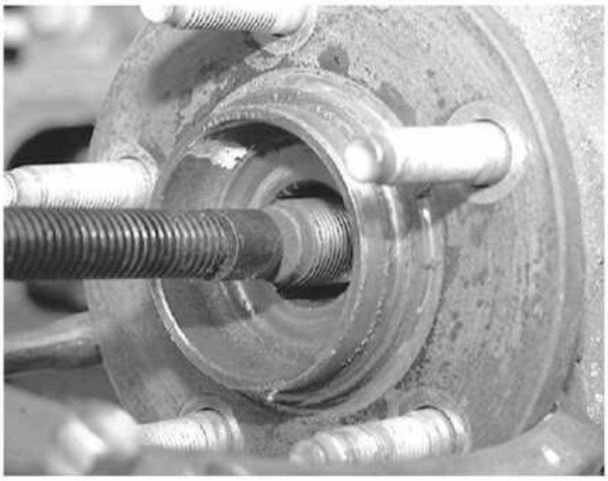
Front Hub and Bearing

REMOVAL & INSTALLATION

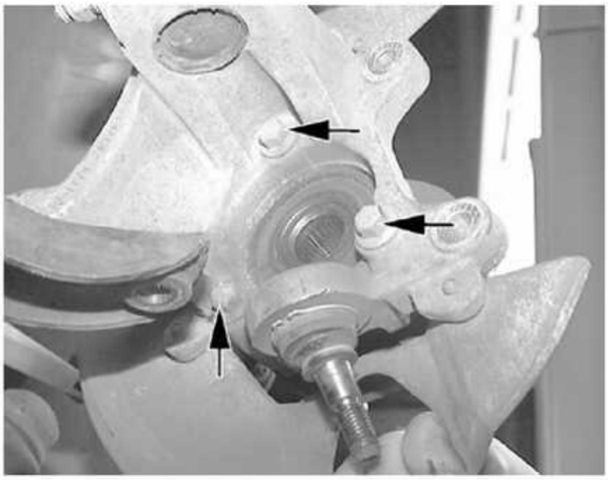
Remove the wheel hub retainer nut from the halfshaft



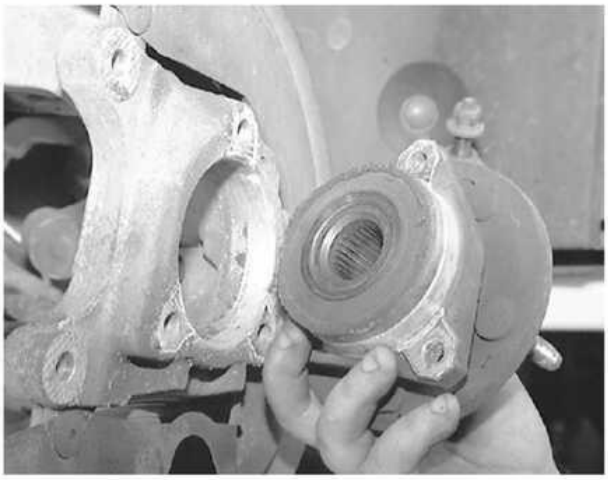
Install a suitable puller onto the hub assembly



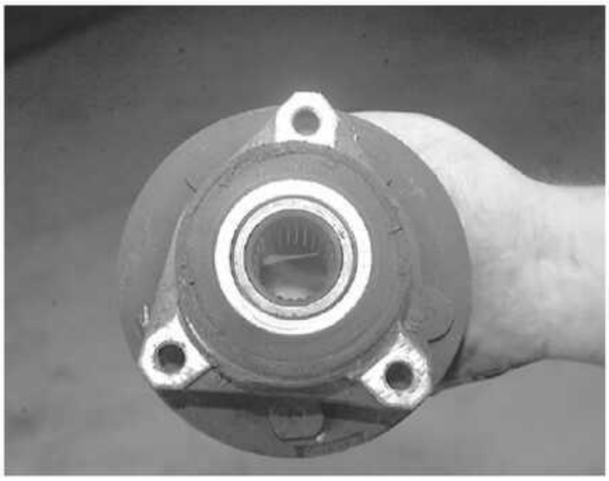
Place the forcing screw on the halfshaft end and tighten the forcing screw to remove the halfshaft from the hub



Remove the three hub retaining bolts and...

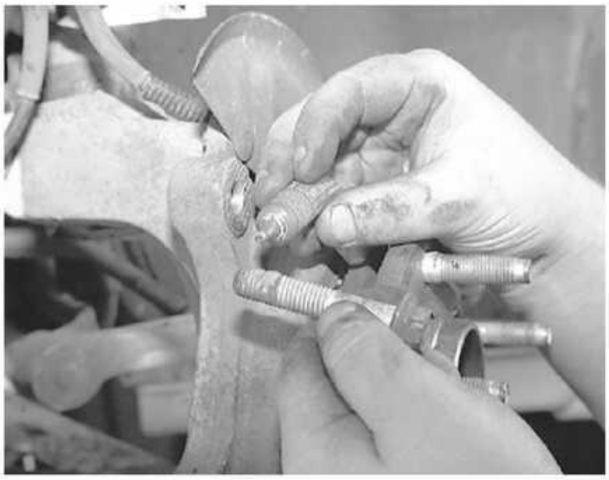


... remove the hub assembly from the knuckle



Inspect the bearings for damage and replace as necessary

CHILTON



Coat the threads of the hub retaining bolts with a quality thread locking compound before installing them

Be sure new wheel hub retainer nuts, tie rod end castellated nuts, hub-to-knuckle retaining bolts, knuckle-to-strut pinch bolt/nut and inboard halfshaft circlips are available. These parts lose their torque holding/retention capabilities during removal and must not be reused.

1. Turn the ignition switch to the ***OFF*** position. Place the steering column in the UNLOCKED position.
2. Remove the wheel hub retainer nut before raising the vehicle off the ground. Discard the wheel hub retainer nut.
3. Raise and safely support the vehicle. Remove the wheel and tire assembly.

When raising the vehicle, do not lift by using the lower control arms.

4. Remove the wheel and tire assembly.
5. Remove the disc brake rotor.
6. Separate the halfshaft from the wheel hub using Front Hub Remover/Replacer T81P-1104-C or equivalent and adapters.
7. Support the halfshaft with wire in a level position to prevent it from hanging by the inner CV-joint.

Do not let the halfshaft hang by the inner CV-joint or move too faroutward. The internal parts of the tripod CV-joint could be pulled apart.

The wheel hub is not pressed into the front wheel knuckle. DO NOT USE a slide hammer to remove a stuck wheel hub. Do not strike the back of the inner bearing race.

8. Remove the three hub and bearing retainer bolts from the back of the steering knuckle while using a prybar to steady the assembly. Discard the three hub and bearing retainer bolts.
9. Remove the wheel hub from the steering knuckle using a suitable pry bar.
10. Inspect all components and replace as necessary. The wheel bearings are not serviceable and must be replaced with a new wheel hub assembly.

To install:

If the hub bearing journal is scored or damaged, replace the steering knuckle. If the wheel hub is damaged or any end-play is detectable, replace the wheel hub.

11. Remove all foreign material from the knuckle bearing bore and hub bearing journal to ensure correct seating of the new hub.

The knuckle must be clean enough to allow the wheel hub to be completely seated by hand. Do not press or draw the wheel hub into place.

12. Place the wheel hub to the steering knuckle using light oil. Push the wheel hub assembly into the steering knuckle. Install bolts and tighten to 61-78 ft. lbs. (83-107 Nm).

13. Place the halfshaft into the hub assembly.
14. Install the disc brake rotor and disc brake caliper. Tighten the caliper anchor bracket bolts to 65-87 ft. lbs. (88-118 Nm).
15. Install the wheel and tire assembly.
16. Lower the vehicle.
17. Install a new wheel hub retainer nut. Tighten the nut to 170-202 ft. lbs. (230-275 Nm).
18. Pump the brake pedal several times prior to moving the vehicle, to position the brake pads.
19. Road test the vehicle and check for proper operation.

Wheel Alignment

If the tires are worn unevenly, if the vehicle is not stable on the highway or if the handling seems uneven in spirited driving, the wheel alignment should be checked. If an alignment problem is suspected, first check for improper tire inflation and other possible causes. These can be worn suspension or steering components, accident damage or even unmatched tires. If any worn or damaged components are found, they must be replaced before the wheels can be properly aligned. Wheel alignment requires very expensive equipment and involves minute adjustments which must be accurate; it should only be performed by a trained technician. Take your vehicle to a properly equipped shop.

Following is a description of the alignment angles which are adjustable on most vehicles and how they affect vehicle handling. Although these angles can apply to both the front and rear wheels, usually only the front suspension is adjustable.

CASTER

Looking at a vehicle from the side, caster angle describes the steering axis rather than a wheel angle. The steering knuckle is attached to a control arm or strut at the top and a control arm at the bottom. The wheel pivots around the line between these points to steer the vehicle. When the upper point is tilted back, this is described as positive caster. Having a positive caster tends to make the wheels self-centering, increasing directional stability. Excessive positive caster makes the wheels hard to steer, while an uneven caster will cause a pull to one side. Overloading the vehicle or sagging rear springs will affect caster, as will raising the rear of the vehicle. If the rear of the vehicle is lower than normal, the caster becomes more positive.

Click on icon to view fullsize printable image.

Click to Enlarge

Caster affects straight-line stability. Caster wheels used on shopping carts, for example, employ positive caster

CAMBER

Looking from the front of the vehicle, camber is the inward or outward tilt of the top of wheels. When the tops of the wheels are tilted in, this is negative camber; if they are tilted out, it is positive. In a turn, a slight amount of negative camber helps maximize contact of the tire with the road. However, too much negative camber compromises straight-line stability, increases bump steer and torque steer.

Click on icon to view fullsize printable image.

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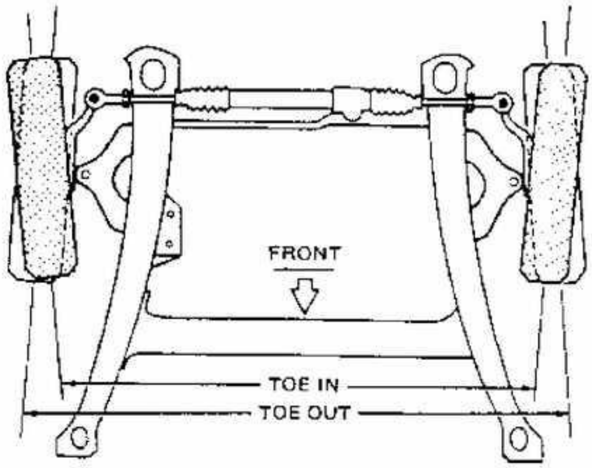
Camber influences tire contact with the road

TOE

Looking down at the wheels from above the vehicle, toe angle is the distance between the front of the wheels, relative to the distance between the back of the wheels. If the wheels are closer at the front, they are said to be toed-in or to have negative toe. A small amount of negative toe enhances directional stability and provides a smoother ride on the highway.



With toe-in, the distance between the wheels is closer at the front than at the rear

REAR SUSPENSION

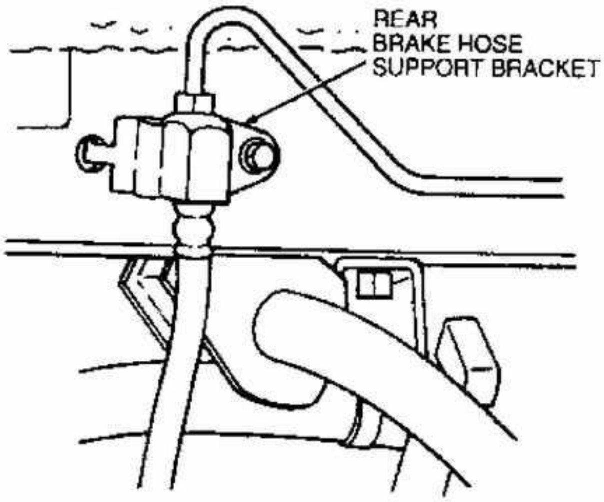
Introduction

Click on icon to view fullsize printable image. Click to Enlarge *Rear suspension components-sedan*
Click on icon to view fullsize printable image. Click to Enlarge *Rear suspension components-wagon*

Coil Springs

REMOVAL & INSTALLATION

Wagons Only



Remove the bolt retaining the rear brake hose bracket to the body

Click on icon to view fullsize printable image. **Click to Enlarge** *Rear coil spring assembly mounting-wagon only*
Click on icon to view fullsize printable image. **Click to Enlarge** *Position the spring insulators on installation before compressing the spring*

1. Raise and safely support the vehicle.
2. Remove the wheel and tire assembly
3. Position a floor jack under the lower suspension control arm.

The lower control arm must be supported before removal of the upper or lower shock absorber mounts to prevent injury or damage to the related components due to tension applied by the coil spring.

4. Remove the bolt retaining the rear brake hose bracket to the body.
5. Remove the shock absorber. Refer to the procedure in this Section.
6. Remove the stabilizer bar and bracket from the lower control arm.
7. Using the floor jack, slowly raise the lower control arm to normal curb height.
8. Install Spring Cage 164-R3555 or equivalent, on the coil spring.
9. Remove and discard the upper ball joint nut. Separate the upper ball joint from the wheel spindle.
10. Slowly lower the lower control arm using the floor jack until the tension is relaxed on the coil spring. Remove the coil spring and the upper and lower spring insulators.

To install:

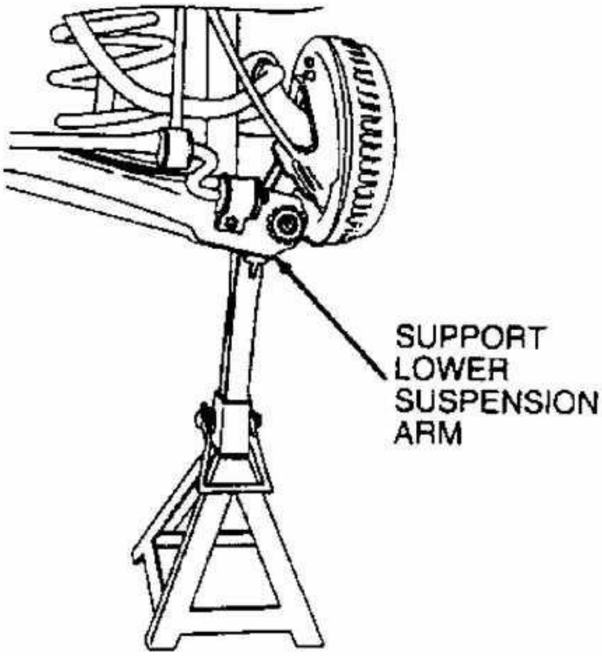
11. Place the lower spring insulator on the lower control arm. Press the insulator downward into place, making certain that the insulator is properly seated.
12. Position the upper insulator on top of the coil spring. Install the coil spring on the lower control arm. Make certain the spring is properly seated.
13. Using the floor jack, slowly raise the lower control arm. Guide the upper spring insulator onto the upper spring seat on the underbody.
14. Position the upper ball joint into the upper control arm. Install a new nut and tighten to 50-68 ft. lbs. (68-92 Nm).

15. Position the shock absorber into the tower opening with a new washer and insulator installed. Push on the lower end of the shock until the lower bracket is lined up with the mounting holes in the lower control arm. Install a new lower retaining bolt and nut. Tighten to 50-68 ft. lbs. (68-92 Nm).
16. From inside the vehicle, install a new upper shock absorber insulator and washer. Tighten the nut to 19-25 ft. lbs. (25-34 Nm).
17. Install the rear compartment access panel.
18. Install the stabilizer bar and bracket to the lower control arm. Tighten to 15-19 ft. lbs. (19-26 Nm).
19. Install the brake hose support bracket to the body and install the retaining bolt.
20. Install the wheel and tire assembly. Tighten the lug nuts to 85-105 ft. lbs. (115-142 Nm).
21. Remove the floor jack.
22. Lower the vehicle.
23. Check the rear wheel alignment and adjust if necessary.
24. Road test the vehicle and check for proper operation.

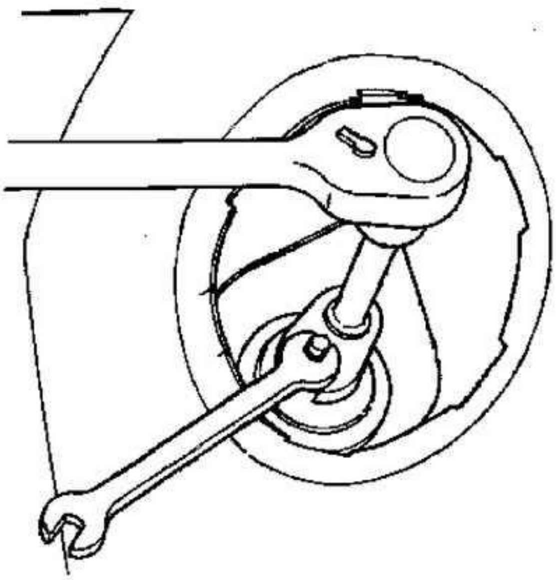
Shock Absorber

REMOVAL & INSTALLATION

Wagons Only



Support under the lower control arm using a jack stand or other suitable device



Remove the upper shock retaining nut using suitable tools

Before continuing, be sure new mounting bolts and nuts and shock absorber insulator bushings are available.

1. Raise and safely support the vehicle securely on jack stands.
2. Remove the wheel and tire assembly.

The lower control arm must be supported before removal of the upper or lower shock absorber attachments to prevent injury or damage to attached components.

3. From inside the vehicle, remove the rear compartment access panel.
4. Remove the top shock absorber retaining nut using a crow foot wrench and ratchet while holding the shock absorber shaft stationary with an open-end wrench. Do not grip the shaft of the shock absorber if it is to be reused. Discard the retaining nut.
5. Remove the upper washer and insulator from the shock absorber.

The shock absorbers are gas filled. It will require an effort to collapsethe shock to remove it from the lower control arm.

6. Remove the lower shock absorber mounting nut and bolt.
7. Remove the shock absorber from the vehicle. Discard the nut and bolt.

To install:

8. Install a new washer and insulator on the upper shock absorber rod.
9. Maneuver the upper part of the shock absorber into the shock tower opening in the body. Push slowly on the lower part of the shock absorber until the lower bracket is aligned with the mounting holes in the lower control arm.
10. Install a new retaining bolt and nut, then tighten to 50-68 ft. lbs. (68-92 Nm).
11. From inside the vehicle, install a new insulator, washer and nut on top of the shock absorber shaft. Tighten the nut to 19-25 ft. lbs. (26-34 Nm.).
12. Install the rear compartment access panel.
13. Install the wheel and tire assembly.
14. Lower the vehicle.
15. Road test the vehicle and check for proper operation.

TESTING

The purpose of the shock absorber is simply to limit the motion of the spring during compression and rebound cycles. If the vehicle is not equipped with these motion dampers, the up and down motion would multiply until the vehicle was alternately trying to leap off the ground and to pound itself into the pavement.

Contrary to popular rumor, the shocks do not affect the ride height of the vehicle. This is controlled by other suspension components such as springs and tires. Worn shock absorbers can affect handling; if the front of the vehicle is rising or falling excessively, the "footprint" of the tires changes on the pavement and steering is affected.

The simplest test of the shock absorber is simply push down on one corner of the unladen vehicle and release it. Observe the motion of the body as it is released. In most cases, it will come up beyond it original rest position, dip back below it and settle quickly to rest. This shows that the damper is controlling the spring action. Any tendency to excessive pitch (up-and-down) motion or failure to return to rest within 2-3 cycles is a sign of poor function within the shock absorber. Oil-filled shocks may have a light film of oil around the seal, resulting from normal breathing and air exchange. This should NOT be taken as a sign of failure, but any sign of thick or running oil definitely indicates failure. Gas filled shocks may also show some film at the shaft; if the gas has leaked out, the shock will have almost no resistance to motion.

When fluid is seeping out of the shock absorber, it's time to replace it

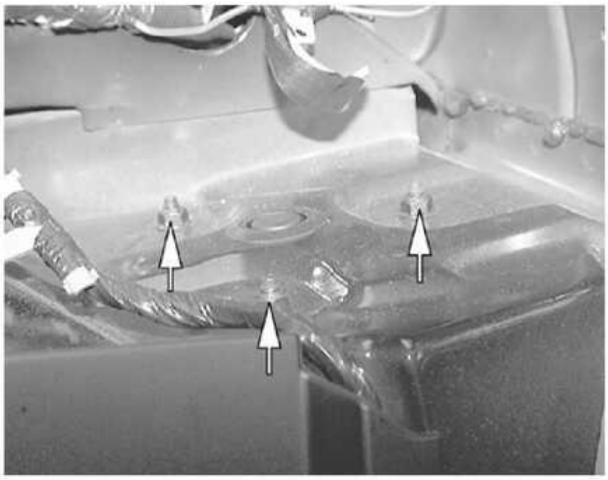
While each shock absorber can be replaced individually, it is recommended that they be changed as a pair (both front or both rear) to maintain equal response on both sides of the vehicle. Chances are quite good that if one has failed, its mate is weak also.

MacPherson Struts

REMOVAL & INSTALLATION

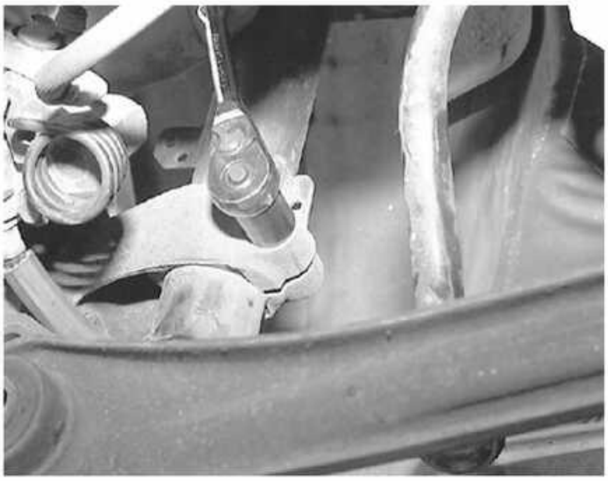
Sedan Only

Remove the trim to access the strut upper mounting bolts

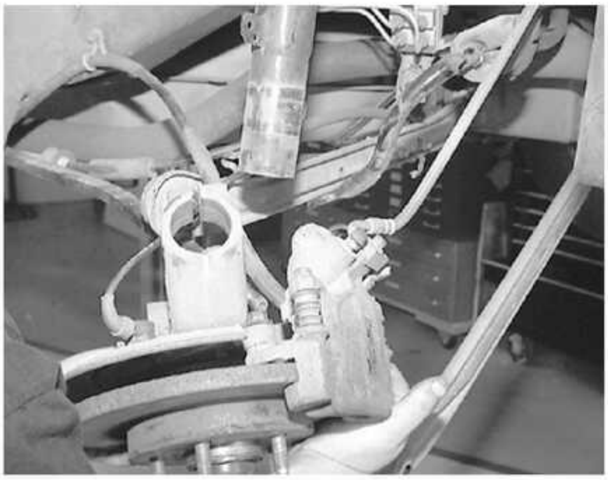


Loosen the three strut upper mounting bolts

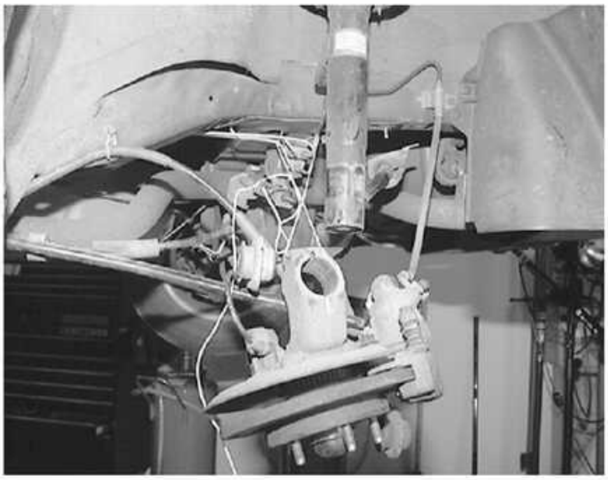
Loosen the tension strut-to-spindle retaining bolt and remove the tension strut from the spindle



Remove the strut-to-spindle attaching bolt and...



... separate the strut from the spindle



Support the spindle assembly using mechanic's wire or another suitable device

Remove the strut from the vehicle

1. Remove the package tray trim panel and loosen the three nuts attaching the strut to the body.
2. Raise the vehicle and remove the rear wheel.
3. Remove the brake load sensor from the rear suspension arm.
4. Remove the clip holding the brake hose to the strut and position the hose out of the way.
5. Remove the stabilizer bar bracket from the body.
6. Separate the stabilizer bar from the link.
7. Remove the tension strut from the front of the rear wheel spindle. Pull the spindle back to remove the tension strut.
8. If required, remove the stabilizer link from the strut.
9. Support the spindle with a jack and remove the pinchbolt securing the strut to the spindle. Do not let the assembly hang by the brake line.
10. Remove the nuts securing the strut to the body and remove the strut.

To install:

11. If removed, install the stabilizer link on the strut. Tighten the nut to 62-79 inch lbs. (7-9 Nm).
12. Position the strut in the vehicle and install the three upper mounting nuts. Do not tighten the nuts at this time.
13. Install the lower end of the strut in the spindle. Use a new pinch bolt tightened to 50-67 ft. lbs. (68-92 Nm).
14. Pull the spindle back and install the tension strut. Tighten the nut to 35-46 ft. lbs. (68-92 Nm).
15. Connect the link to the stabilizer bar. Tighten the nut to 62-79 inch lbs. (7-9 Nm).
16. Install the stabilizer bar bracket on the body. Tighten the bolts to 25 -33 ft. lbs. (34-46 Nm).
17. Install the brake hose on the strut.
18. Connect the load sensor to the suspension arm.
19. Tighten the three upper mounting nuts to 19-25 ft. lbs. (25-34 Nm).
20. Install the rear wheel and lower the vehicle.

OVERHAUL

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Rear strut components exploded view

Do not remove the strut rod nut until the spring has been compressed until it comes away from the seat.

1. Remove the strut from the vehicle.
2. Compress the coil spring using a suitable spring compressor until the spring comes away from the seat.
3. Remove the large center nut and slowly release the spring compressor.
4. Remove the upper bearing from the strut assembly.
5. Remove the spring from the strut assembly.
6. Remove the lower spring insulator from the strut.

To install:

7. If replacing the strut, transfer any necessary components from the old strut.
8. Install the lower spring insulator onto the strut.
9. Compress the spring and install it on the strut.
10. Install the lower washer and upper bearing assembly.
11. Install the upper washer and a new nut. Tighten the nut to 39-53 ft. lbs. (53-72 Nm) while holding the rod with a T-50 size Torx® socket.
12. Install the strut assembly in the vehicle.

Upper Control Arm

REMOVAL & INSTALLATION

Wagon Only

Make sure a new upper ball joint nut is available.

1. Raise and safely support the vehicle.
2. Place a jack stand under the lower control arm and raise the lower control arm to normal curb height.
3. Remove the wheel and tire assembly.
4. Remove the brake hose bracket retaining bolt and separate the bracket from the body.
5. Remove and discard the upper ball joint nut. Separate the ball joint from the wheel spindle.
6. Remove the upper control arm-to-body nuts and bolts. Remove the upper control arm.
7. Inspect the upper control arm and bushings. The bushings are not serviceable.

To install:

8. Place the upper control arm in position and install the upper control arm-to-body nuts and bolts. Do not tighten at this time.
9. Install the ball joint stud into the upper control arm and install a new nut. Tighten the nut to 50-68 ft. lbs. (68-92 Nm).
10. Tighten the upper control arm-to-body nuts and bolts to 73-97 ft. lbs. (98-132 Nm).
11. Install the brake line bracket and retaining bolt to the body.
12. Install the wheel and tire assembly. Tighten the lug nuts to 85-105 ft. lbs. (115-142 Nm).
13. Remove the jack stand.
14. Lower the vehicle.
15. Check the rear wheel alignment.
16. Road test the vehicle and check for proper operation.

Lower Control Arms

REMOVAL AND INSTALLATION

Sedans

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The lower control arm-to-spindle connection also is the adjusting point for rear camber

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The lower control arm-to-body bracket mounting

Make sure to have available a new rear control arm-to-spindle bolt, washer and nut and a new rear control arm-to-body bolt and nut, per control arm.

1. Raise and safely support the vehicle.

Do not raise the vehicle by the tension strut.

2. Disconnect the brake load sensor proportioning valve from the left front control arm, if that control arm is being replaced.
3. Disconnect the parking brake rear cable from the control arm being removed.
4. Remove and discard the control arm-to-spindle bolt, washer and nut.
5. Remove and discard the control arm-to-body bolt and nut. Remove the control arm from the vehicle.
6. Inspect the control arm bushings. If worn or damaged, the control arm must be replaced as an assembly.

To install:

When installing new control arms, the offset on all arms must face up. The arms are stamped BOTTOM on the lower edge. The flange edge of the right rear arm stamping must face the front of the vehicle. The other 3 control arms must face the rear of the vehicle. The rear control arms have 2 adjustment cams that fit inside the bushings at the control arm-to-body attachment points.

7. Position the control arm and if equipped, the adjustment cam. Insert a new bolt and install a new nut, but do not tighten at this time.
8. Move the control arm end up to the spindle and insert a new bolt, washer and nut. Tighten the nut to 50-68 ft. lbs. (68-92 Nm).
9. Tighten the control arm-to-body nut to 50-68 ft. lbs. (68-92 Nm) while preventing the bolt from turning.

10. If a front control arm was removed, attach the parking brake cable.
11. If the left front control arm was removed, install the brake load sensor proportioning valve. Lower the vehicle.
12. Check the rear wheel alignment and adjust as necessary. Road test the vehicle and check for proper operation.

Wagons

Make sure to have available a new lower control arm-to-body bolt and nut.

1. Raise and safely support the vehicle.

If using a twin-post lift, floor jacks must be placed under the lifting pads on the underbody forward of the tension strut body bracket and the rear lift post lowered aside.

2. Remove the wheel and tire assembly.
3. Properly remove the shock absorber and coil spring.
4. Remove the control arm-to-spindle bolt and nut. Discard the bolt and nut.
5. Remove the wheel spindle.
6. Remove and discard the lower control arm-to-body bolt and nut.
7. Remove the lower control arm from the vehicle.
8. Inspect the lower control arm and bushings for damage or wear. The bushings are not serviceable and if worn, the control arm must be replaced as an assembly.

To install:

9. Place the lower control arm to the body bracket and install a new retaining bolt and nut with the bolt head toward the front of the vehicle. Do not tighten at this time.
10. Properly install the coil spring and shock absorber. Install the wheel spindle. Install a new lower control arm-to-spindle bolt and nut. Do not tighten at this time.
11. Using a floor jack or equivalent, raise the lower control arm to normal curb height.
12. Tighten the lower control arm-to-body bolt/nut to 40-52 ft. lbs. (54-71 Nm) and the lower control arm-to-spindle bolt/nut to 50-68 ft. lbs. (68-92 Nm).
13. Remove the floor jack from underneath the vehicle. Lower the vehicle.
14. Check the rear wheel alignment and adjust as necessary. Road test the vehicle and check for proper operation.

CONTROL ARM BUSHING REPLACEMENT

The control arm bushings are part of the control arm assembly and are only replaceable by replacing the entire control arm assembly.

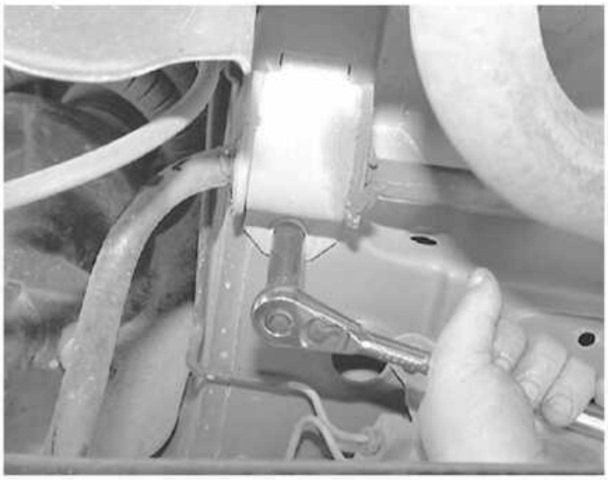
Sway Bar

REMOVAL & INSTALLATION

Make sure new sway bar (stabilizer bar) link nuts and sway bar bracket bolts and nuts are available.

Sedan

Remove the sway bar link-to-sway bar nuts



Remove the sway bar bracket retaining nuts and remove the sway bar

1. Raise and safely support the vehicle.
2. Remove the sway bar-to-link nuts, washers and insulators; discard the nuts.
3. Remove the 2 bolts attaching the sway bar brackets to the body and remove the sway bar. Discard the bolts.
4. Inspect the bracket insulators and replace if damaged or worn.
5. If required, remove the nut, washer and insulator retaining each sway bar link to the strut brackets and remove the sway bar links. Check the link insulators and replace if damaged or worn.

To install:

6. Apply a rubber suspension lubricant to the inside of the insulators. Install the insulators to the sway bar.
7. If removed, position each sway bar link to the strut brackets and install the insulator, washer and a new nut. Tighten the nuts to 62-79 inch lbs. (7-9 Nm).
8. Place the sway bar with the insulators and brackets into position on the body. Install 2 new bolts and tighten to 25-33 ft. lbs. (34-46 Nm).
9. Position the sway bar links on the sway bar ends. Install the insulators, washers and new nuts. Tighten the nuts to 62-79 inch lbs. (7-9 Nm).
10. Lower the vehicle. Check for proper operation.

Station Wagon

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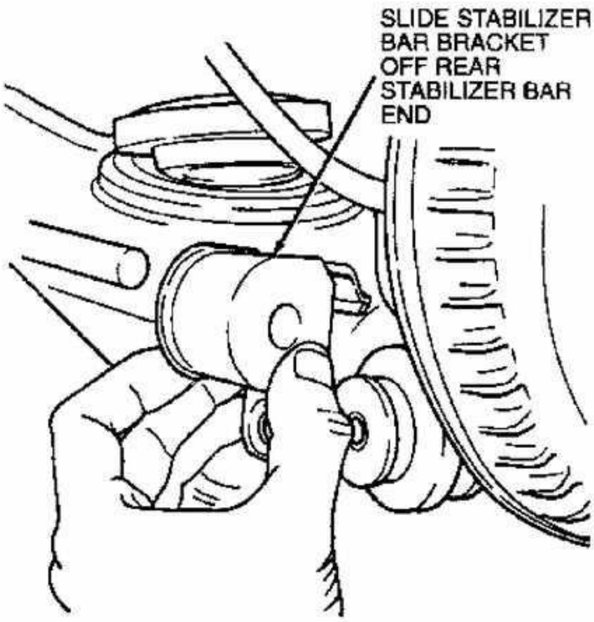
Stabilizer bar mounting



Remove the stabilizer bar bracket bolts and slide the bracket off of the stabilizer bar

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Remove the stabilizer bar link-to-body retaining bolt and remove the stabilizer bar from the vehicle

1. Raise and safely support the vehicle.
2. Support the vehicle with jack stands under the lower control arm to unload the sway bar link insulators.
3. Remove the 2 bolts and nuts retaining the sway bar brackets and insulators to the lower control arms. Discard the bolts and nuts.
4. Clean the sway bar of any contamination and slide the sway bar bracket and insulator off the sway bar end.
5. Inspect the brackets and insulators. Replace if damaged or worn.
6. Remove the 2 bolts and nuts attaching the sway bar link assemblies to the body brackets. Discard the bolts and nuts.
7. Remove the sway bar and link assemblies from the vehicle.
8. Inspect the sway bar link assemblies and replace if damaged or worn.

To install:

9. Lubricate the sway bar link bushings with a suitable rubber suspension lubricant. Install the sway bar and link assemblies to the body brackets using 2 new nuts and bolts. Tighten to 44-59 ft. lbs. (60-80 Nm).
10. Clean the sway bar insulator inside diameter and apply a suitable rubber suspension lubricant. Slide the insulators on both ends of the sway bar into their approximate positions and install the brackets.
11. Position the sway bar brackets on the lower control arms and install 2 new bolts and nuts. Tighten to 14-19 ft. lbs. (19-26 Nm).
12. Lower the vehicle. Check for proper operation.

Spindle Assembly

REMOVAL & INSTALLATION

Sedan

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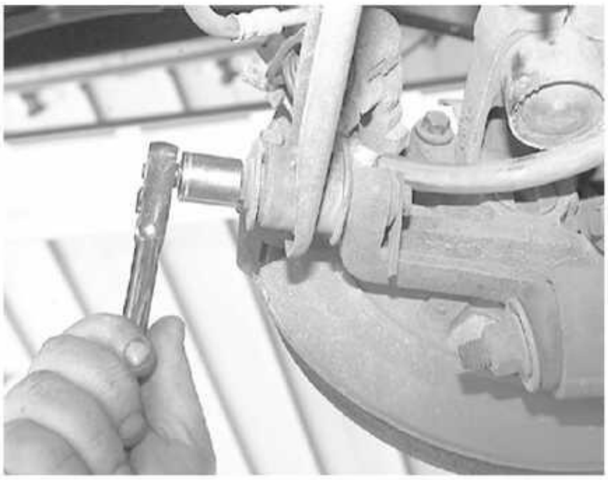
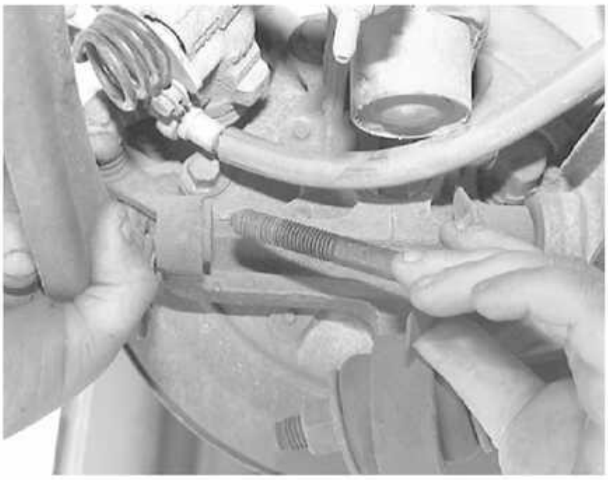
Rear wheel spindle and related components mounting-sedan



Loosen the lower control arm-to-spindle retaining bolt and...



... remove the lower control arm from the spindle

Loosen the tension strut-to-spindle retaining bolt and remove the tension strut from the spindle

To install:

Wagons

To install:

10. Place the spindle into position and loosely install the lower control arm-to-spindle retaining bolt.
11. Position the tension strut onto the spindle and loosely install the retaining nut.
12. Position the upper ball joint into the spindle and tighten the retaining nut to 50-67 ft. lbs. (68-92 Nm).
13. Tighten the lower control arm-to-spindle retaining bolts to 50-67 ft. lbs. (68-92Nm).
14. Install the tie rod bushing washer and nut. Tighten the nut to 50-67 ft. lbs. (68-92 Nm).
15. Install the brake components.
16. Install the bolt retaining the brake hose to the strut bracket.
17. Install the wheel and tire assembly.
18. Lower the vehicle.
19. Check the alignment and correct as necessary.

Hub and Bearing Assembly

REMOVAL & INSTALLATION

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Click to Enlarge

Wheel bearing and hub assembly-disc brakes

Click on icon to view fullsize printable image.

Click to Enlarge

Wheel bearing and hub assembly-drum brakes

1. Raise and safely support the vehicle.
2. Remove the wheel and tire assembly.
3. Remove the bolt retaining the brake hose to the strut bracket.
4. If equipped with disc brakes, remove the rear caliper and rotor.
5. If equipped with drum brakes, remove the brake drum.
6. Remove the grease cap from the bearing and hub assembly and discard the grease cap.
7. Remove the bearing and hub assembly retaining nut and discard. Remove the bearing and hub assembly from the spindle.

To install:

8. Position the wheel hub and bearing on the rear spindle.
9. Install a new wheel hub retainer nut and tighten to 188-254 ft. lbs. (255-345 Nm).
10. Install a new hub cap grease seal using Shaft Protector T89P-19623-FH, or equivalent. Tap on the tool until the hub cap grease seal is fully seated.
11. Install the rear disc/drum brake assembly.
12. Install the wheel and tire assembly.
13. Lower the vehicle.
14. Check the front end alignment. Road test the vehicle and check for proper operation.

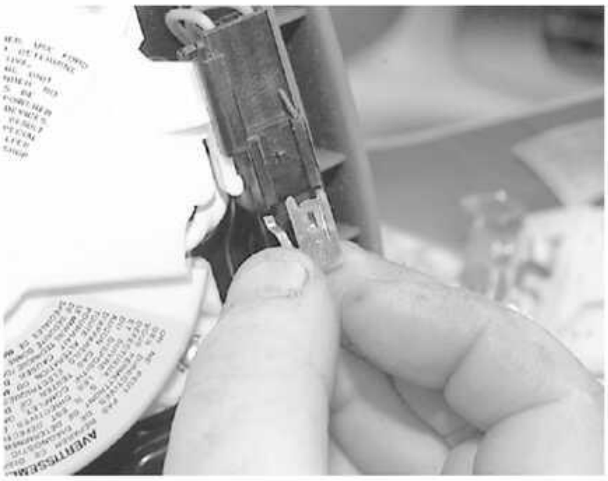
Steering Wheel

REMOVAL & INSTALLATION

Remove the access covers for the air bag module retaining bolts

Remove the air bag retaining bolts and...

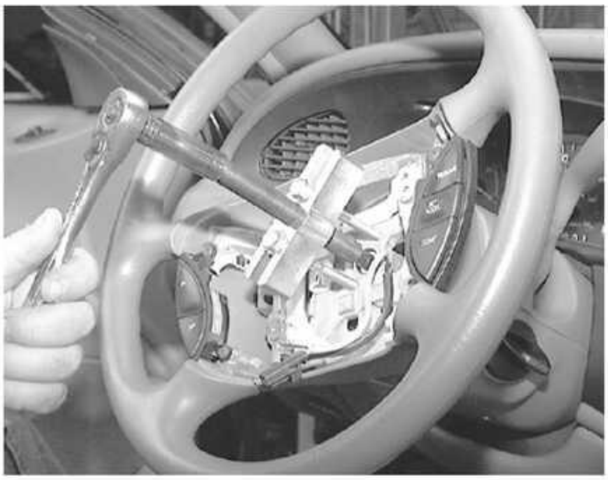
Carefully remove the air bag from the steering wheel to access the wiring connectors



Detach the connectors...

... from the air bag module

Remove the center bolt from the steering wheel



Install a suitable puller and tighten the forcing screw to...

... remove the steering wheel

The Supplemental Restraint System (SRS) system must be disarmed before performing service around SRS system components or SRS system wiring. failure to do so may cause accidental deployment of the air bag, resulting in unnecessary SRS system repairs and/or personal injury.

Before proceeding, make sure a new steering wheel retaining bolt is available as the bolt removed must not be reused.

1. Make sure the front wheels are in the straight-ahead position.
2. If equipped, properly disarm the SSR (air bag) system.
3. Remove the steering wheel spoke covers, if equipped.
4. Remove the air bag module retaining nuts or bolts. Lift the air bag module from the steering wheel and detach the air bag wiring connector from the air bag module. Remove the air bag module from the steering wheel and properly place aside.

When carrying a live air bag, make sure the air bag and trim cover are pointed away from the body. In the unlikely event of an accidental deployment, the bag will then deploy with minimal chance if injury. When placing a live airbag on a bench or other surface, always face the bag and trim cover up, away from the surface. This will reduce the motion of the module if it isaccidentally deployed.

5. Detach the cruise control wiring connector from the steering wheel. Remove and discard the steering wheel retaining bolt.
6. Install Steering Wheel Puller T67L-3600-A, or equivalent and remove the steering wheel. Route the contact assembly wiring harness through the steering wheel as the wheel is lifted off the shaft.

To install:

7. Make sure the vehicle's front wheels are in the straight-ahead position. Route the contact assembly wire harness through the steering wheel opening at the 3 o'clock position and install the steering wheel on the shaft. The steering wheel and shaft alignment marks should be aligned.
8. Install a new steering wheel retaining bolt and tighten to 25-34 ft. lbs. (34-46 Nm).
9. Attach the cruise control wiring harness to the steering wheel and snap the connector assembly into the steering wheel clip.
10. Attach the air bag wiring connector to the air bag module, install the air bag module to the steering wheel. Install and tighten the 2 bolts to 89-124 inch lbs. (10-14 Nm).
11. Install the steering wheel spoke covers, if equipped. Connect the battery cables, negative cable last.
12. Prove out the air bag system by turning the ignition key to the ***RUN*** position and visually monitoring the air bag indicator lamp in the instrument cluster. The indicator lamp should illuminate for approximately 6 seconds and then turn OFF. If the indicator lamp does not illuminate, stays ON, or flashes at any time, a fault has been detected by the air bag diagnostic monitor.
13. Check the steering wheel, horn and steering column for proper operation. Road test the vehicle and check the speed control for proper operation.

Multi-Function (Turn/Wiper) Switch

REMOVAL & INSTALLATION

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Multi-function switch and related components mounting

1. Disconnect the negative battery cable.
2. If equipped with a tilt steering column, set the tilt column to its lowest position and remove the tilt lever.
3. Remove the ignition lock cylinder. Remove the steering column shroud screws and remove the upper and lower shrouds.
4. Remove 2 self tapping screws attaching the combination switch to the steering column and disengage the switch from the steering column tube casting.

5. Remove the wiring harness retainer, if equipped and detach the electrical connectors.

To install:

6. Attach the electrical connectors. Install the wiring harness retainer, if equipped.
7. Align the combination switch mounting holes with the corresponding holes in the steering column tube casting and install 2 self-tapping screws.
8. Install the upper and lower steering column shroud and shroud retaining screws.
9. Install the ignition lock cylinder and attach the tilt lever, if removed.
10. Connect the negative battery cable. Check the combination switch and the steering column for proper operation.

Ignition Switch

REMOVAL & INSTALLATION

1. Disconnect the negative battery cable. Remove the I/P lower steering column cover.
2. Detach the ignition switch electrical connector.
3. Turn the ignition key lock cylinder to the ***RUN*** position.
4. Remove the 2 screws attaching the ignition switch and disengage the switch from the actuator pin.

To install:

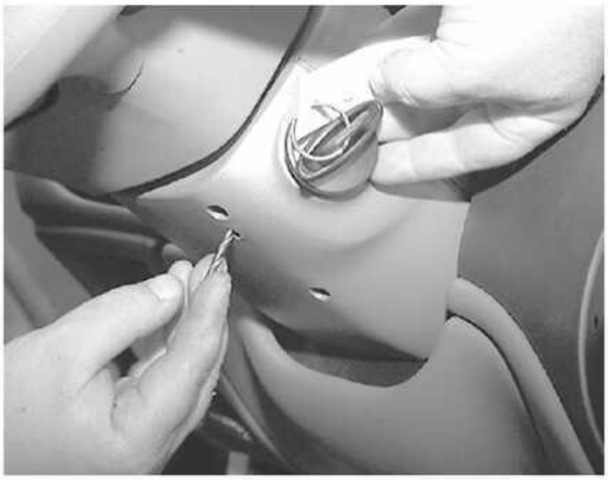
5. Adjust the ignition switch by sliding the carrier to the switch ***RUN*** position. A new replacement switch assembly will already be set in the ***RUN*** position.
6. Make sure the ignition key lock cylinder is in the ***RUN*** position. The ***RUN*** position is achieved by rotating the key lock cylinder approximately 90 degrees from the lock position.
7. Install the ignition switch into the actuator pin. It may be necessary to move the switch slightly back and forth to align the switch mounting holes with the column lock housing threaded holes.
8. Install and tighten the attaching screws.
9. Attach the switch connector.
10. Connect the negative battery cable. Check the ignition switch for proper function, including ***START*** and ***ACCESSORY*** positions. Make sure the column is locked with the switch in the ***LOCK*** position.
11. Install the instrument panel lower steering column cover.

Ignition Lock Cylinder

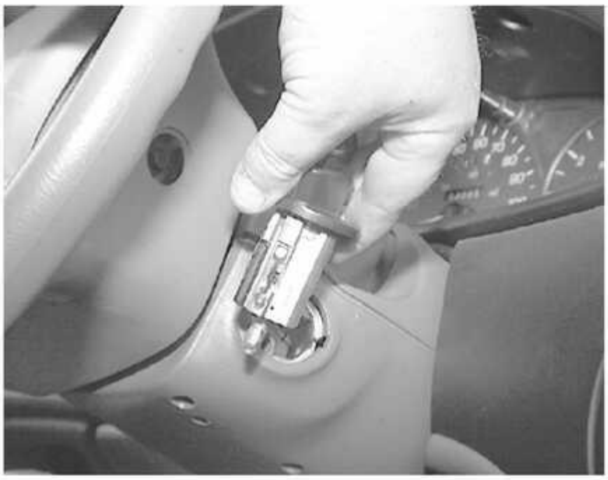
REMOVAL & INSTALLATION

Functional Lock Cylinder

1. Disconnect the negative battery cable.
2. Remove the upper and lower steering column covers.
3. Turn the ignition lock to the accessory position.
4. Insert a 0.125 (3.17mm) wire pin or small drift punch in the hole at the top of the cylinder housing and depress the retaining pin while pulling out the lock cylinder.



Turn the ignition to the RUN position and release the lock cylinder retaining pin



Carefully remove the lock cylinder from the steering column

To install:

5. Turn the new lock cylinder to accessory position and while pressing the retaining pin in, insert the lock cylinder into the housing.
6. Turn the key to the ***OFF*** position the release the retaining pin.
7. Try the lock cylinder operation in all positions.
8. Reinstall the steering column covers.
9. Reconnect the negative battery cable.

Non-Functional Lock Cylinder

1. Disconnect the negative battery cable.
2. Remove the upper and lower steering column covers.
3. Insert a 0.125 (3.17mm) drill bit in the hole at the top of the cylinder housing and drill out the retaining pin.

Be careful not to drill into the lock cylinder housing.

4. Pull out the lock cylinder.
5. Clean out all the metal shavings and check the tube for damage. If damaged, the housing must be replaced.

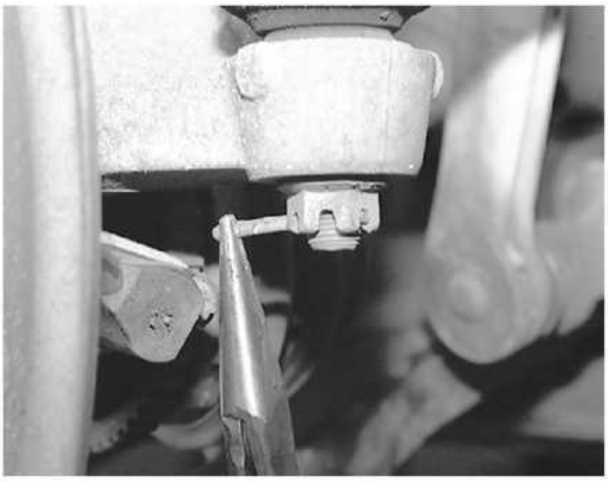
To install:

6. Turn the new lock cylinder to accessory position and while pressing the retaining pin in, insert the lock cylinder into the housing.
7. Turn the key to the ***OFF*** position the release the retaining pin.
8. Try the lock cylinder operation in all positions.
9. Reinstall the steering column covers.
10. Reconnect the negative battery cable.

Steering Linkage

REMOVAL & INSTALLATION

Tie Rod Ends

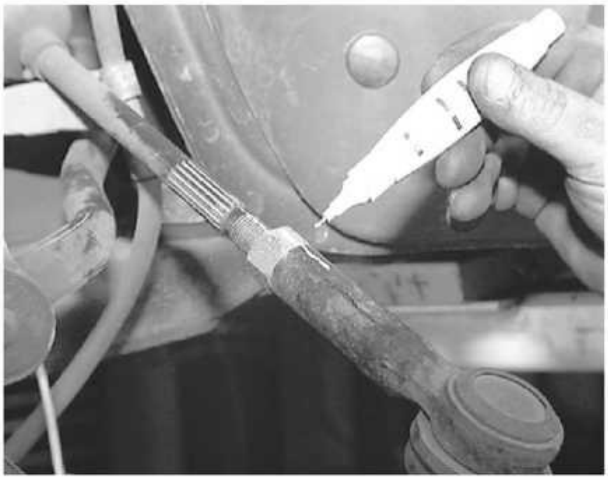


Remove the cotter pin from the tie rod end and...

... remove the retaining nut from the tie rod end

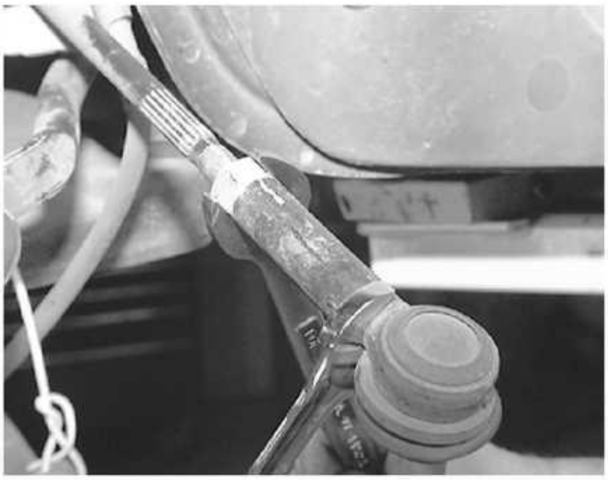
A special puller is recommended for removing the tie rod end from the knuckle

Remove the tie rod end from the steering knuckle



Mark the outer tie rod jam nut on one side with a reference line for installation

CHILTON



Use two wrenches, one to hold the inner tie rod, and one to loosen the jam nut

Back the jam nut off ONE TURN ONLY and then unthread the tie rod end from the inner tie rod and...

... remove the tie rod end from the inner tie rod.

1. Disconnect the negative battery cable.
2. Remove the wheel and tire assembly.
3. Remove the cotter pin and the castellated nut from the outer tie rod end. Discard the cotter pin.
4. Separate the outer tie rod end from the steering knuckle using an appropriate tie rod end remover.
5. Mark the outer tie rod jam nut on one side with a reference line for installation.
6. Hold the outer tie rod end with a wrench and loosen the tie rod end jam nut.
7. Back the tie rod end jam nut off ONE FULL TURN ONLY.
8. Remove the outer tie rod end from the inner tie rod spindle.

To install:

9. Clean the threads on the inner tie rod spindle (front wheel spindle connecting rod).
10. Thread the new outer tie rod end onto the inner tie rod until it bottoms on the jam nut.
11. Back the tie rod and jam nut out one full turn until the reference line is in the same position as before.
12. Place the outer tie rod end stud into the steering knuckle. Set the front wheels in a straight ahead position.
13. Install a new castellated nut onto the outer tie rod end stud.
14. Tighten the nut to 35-46 ft. lbs. (47-63 Nm).
15. Continue to tighten the castellated nut until a new cotter pin can be inserted through the hole in the stud. Install a new cotter pin.
16. If required, repeat the procedure for the opposite side.
17. Reinstall the wheel and tire assembly.
18. Reconnect the negative battery cable.
19. Check the alignment and set the toe adjustment to specification.
20. Torque the outer tie rod end jam nut to 35-46 ft. lbs. (47-63 Nm).

Power Steering Rack and Pinion

REMOVAL & INSTALLATION

1. Disconnect the negative battery cable.
2. From inside the vehicle, remove the boot covering the shaft at the cowl panel.
3. Remove the bolts retaining the intermediate shaft to the steering column shaft. Set the weather boot aside.
4. Remove the pinch bolt at the steering gear input shaft and remove the intermediate shaft. Raise the vehicle and support safely.
5. Safely raise and support the vehicle.
6. Remove the front wheels.
7. Remove the exhaust system flex tube, then remove the dual converter Y-pipe from the vehicle.
8. Support the rear end of the front subframe with tall jackstands.
9. Disconnect the tie rod ends from the steering knuckle tie rods. Mark the position of the jam nuts for correct installation.
10. Remove the nuts securing the steering gear to the subframe.
11. Remove the bolts securing the rear of the subframe to the body.
12. Carefully raise the lift until the subframe separates from the body approximately 4 inches (102mm).
13. Remove the push-pin retainers from the power steering hose bracket, then remove the shield.
14. Remove the left turn pressure hose from the bracket, then remove the bracket.
15. Disconnect the left stabilizer link from the strut assembly.
16. Disconnect the power steering auxiliary actuator.
17. Rotate the steering gear to clear the mounting bolts and move the gear to the left to gain access to the hose fittings.
18. Position a drain pan under the steering gear and disconnect the pressure and return hoses.
19. Remove the steering gear assembly through the left wheel opening.

To install:

20. Install new Teflon® seals on the hydraulic line fittings on the gear assembly. Install the mounting bolts in the steering gear housing, then insert the steering gear through the left fender apron.
21. Install the remaining components in the reverse order of removal.
22. Align the steering gear bolts, install the nuts and tighten to 85-100 ft. lbs. (115-135 Nm). Lower the vehicle.
23. Tighten the hydraulic pressure line and return line to 15-25 ft. lbs. (20-35 Nm).
24. Tighten the tie rod end castle nuts to 35-46 ft. lbs. (47-63 Nm). If necessary, tighten the nuts a little bit more to align the slot in the nut for the cotter pin. Install the cotter pin.
25. Fill and bleed the power steering system. Check the system for leaks and proper operation. Adjust the toe setting as necessary.

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Disconnect the exhaust system flex tube, then remove the dual converter Y-pipe from the vehicle

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Support the rear of the subframe with two tall jack stands while removing the steering gear

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Disconnect the sway bar link and the tie rod end from the knuckle

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Power steering gear connections

Power Steering Pump

REMOVAL & INSTALLATION

3.0L OHV Engine

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Power steering system-3.0L OHV

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A few special tools are required to remove and install the pulley on the power steering pump

1. Disconnect the negative battery cable.
2. Remove the accessory drive belt.
3. Remove the alternator.
4. Drain and remove the radiator coolant recovery reservoir.
5. Position a drain pan under the power steering pump underneath the vehicle. Disconnect the hydraulic pressure and return lines and allow to drain.
6. Remove the idler pulley from the power steering pump support.
7. Remove the bracket mounting bolt located under the belt tensioner mounting.
8. Remove 2 retaining nuts from the bracket mounting studs. Remove both mounting studs, and pull off the power steering pump support with the pump attached.
9. Clamp the pump support bracket in a suitable vise.
10. Remove the power steering pump pulley from the pump shaft using Pump Pulley Remover T69L-10300-B, or equivalent. Remove the 3 bolts retaining the power steering pump to the power steering pump support and remove the power steering pump.

To install:

11. Install the power steering pump to the power steering pump support.
12. Install the power steering pump pulley using Steering Pump Pulley Replacer T65P-3A733-C, or equivalent; the pulley face must be flush within 0.010 inch (0.25mm) of the pump shaft.

13. Install the power steering pump/pump support and torque nuts/bolt to 17-24 ft. lbs. (23-32 Nm).
14. Complete the installation by reversing the removal procedure.
15. Fill the power steering reservoir with power steering fluid.
16. Connect the negative battery cable.
17. Run the engine and check for leaks and proper operation. Bleed the power steering system if needed.

3.0L and 3.4L DOHC Engine

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Power steering system-3.0L DOHC

Click on icon to view fullsize printable image.

Click to Enlarge

Power steering system-3.4L DOHC

1. Disconnect the negative battery cable.
2. Remove the accessory drive belt.
3. Drain and remove the radiator coolant recovery reservoir.
4. Position a drain pan under the power steering pump. Disconnect the power steering pump reservoir hose and allow it to drain.
5. Using Pulley Remover T69L-10300-B, or equivalent, remove the pulley from the power steering pump shaft.
6. Disconnect the left turn pressure hose from the power steering pump and allow it to drain.
7. Remove the power steering pump retaining bolts and the pump.

To install:

8. Install the power steering pump and tighten bolts to 15-22 ft. lbs. (20-30 Nm).
9. Connect the left turn pressure hose and secure clamp.
10. Using a Steering Pump Pulley Replacer T65P-3A733-C, or equivalent, install the power steering pump pulley: the pulley face must be flush with the pump shaft or within 0.010 inch (0.25mm).
11. Fill the power steering reservoir with power steering fluid. Connect the negative battery cable.
12. Start the engine and check for leaks and proper operation. Bleed the power steering system if needed.

BLEEDING

1. Disable the ignition by disconnecting the ignition module or disconnecting the camshaft position sensor.
2. Raise and safely support the vehicle so the front wheels are off the floor.
3. Place jack stands under the front of the vehicle.
4. Fill the power steering fluid reservoir.
5. Crank the engine with the starter motor and add fluid until the level remains constant.
6. While cranking the engine, rotate the steering wheel from lock-to-lock.

The front wheels must be off the floor during lock-to-lock rotation of the steering wheel. Do not hold the steering wheel on the stops.

SPECIFICATIONS CHARTS

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Torque Specifications

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Torque Specifications

BRAKES

BRAKE OPERATING SYSTEM

Basic Operating Principles

Hydraulic systems are used to actuate the brakes of all modern automobiles. The system transports the power required to force the frictional surfaces of the braking system together from the pedal to the individual brake units at each wheel. A hydraulic system is used for two reasons.

First, fluid under pressure can be carried to all parts of an automobile by small pipes and flexible hoses without taking up a significant amount of room or posing routing problems.

Second, a great mechanical advantage can be given to the brake pedal end of the system, and the foot pressure required to actuate the brakes can be reduced by making the surface area of the master cylinder pistons smaller than that of any of the pistons in the wheel cylinders or calipers.

The master cylinder consists of a fluid reservoir along with a double cylinder and piston assembly. Double type master cylinders are designed to separate the front and rear braking systems hydraulically in case of a leak. The master cylinder coverts mechanical motion from the pedal into hydraulic pressure within the lines. This pressure is translated back into mechanical motion at the wheels by either the wheel cylinder (drum brakes) or the caliper (disc brakes).

Steel lines carry the brake fluid to a point on the vehicle's frame near each of the vehicle's wheels. The fluid is then carried to the calipers and wheel cylinders by flexible tubes in order to allow for suspension and steering movements.

In drum brake systems, each wheel cylinder contains two pistons, one at either end, which push outward in opposite directions and force the brake shoe into contact with the drum.

In disc brake systems, the cylinders are part of the calipers. At least one cylinder in each caliper is used to force the brake pads against the disc.

All pistons employ some type of seal, usually made of rubber, to minimize fluid leakage. A rubber dust boot seals the outer end of the cylinder against dust and dirt. The boot fits around the outer end of the piston on disc brake calipers, and around the brake actuating rod on wheel cylinders.

The hydraulic system operates as follows: When at rest, the entire system, from the piston(s) in the master cylinder to those in the wheel cylinders or calipers, is full of brake fluid. Upon application of the brake pedal, fluid trapped in front of the master cylinder piston(s) is forced through the lines to the wheel cylinders. Here, it forces the pistons outward, in the case of drum brakes, and inward toward the disc, in the case of disc brakes. The motion of the pistons is opposed by return springs mounted outside the cylinders in drum brakes, and by spring seals, in disc brakes.

Upon release of the brake pedal, a spring located inside the master cylinder immediately returns the master cylinder pistons to the normal position. The pistons contain check valves and the master cylinder has compensating ports drilled in it. These are uncovered as the pistons reach their normal position. The piston check valves allow fluid to flow toward the wheel cylinders or calipers as the pistons withdraw. Then, as the return springs force the brake pads or shoes into the released position, the excess fluid reservoir through the compensating ports. It is during the time the pedal is in the released position that any fluid that has leaked out of the system will be replaced through the compensating ports.

Dual circuit master cylinders employ two pistons, located one behind the other, in the same cylinder. The primary piston is actuated directly by mechanical linkage from the brake pedal through the power booster. The secondary piston is actuated by fluid trapped between the two pistons. If a leak develops in front of the secondary piston, it moves forward until it bottoms against the front of the master cylinder, and the fluid trapped between the pistons will operate the rear brakes. If the rear brakes develop a leak, the primary piston will move forward until direct contact with the secondary piston takes place, and it will force the secondary piston to actuate the front brakes. In either case, the brake pedal moves farther when the brakes are applied, and less braking power is available.

All dual circuit systems use a switch to warn the driver when only half of the brake system is operational. This switch is usually located in a valve body which is mounted on the firewall or the frame below the master cylinder. A hydraulic piston receives pressure from both circuits, each circuit's pressure being applied to one end of the piston. When the pressures are in balance, the piston remains stationary. When one circuit has a leak, however, the greater pressure in that circuit during application of the brakes will push the piston to one side, closing the switch and activating the brake warning light.

In disc brake systems, this valve body also contains a metering valve and, in some cases, a proportioning valve. The metering valve keeps pressure from traveling to the disc brakes on the front wheels until the brake shoes on the rear wheels have contacted the drums, ensuring that the front brakes will never be used alone. The proportioning valve controls the pressure to the rear brakes to lessen the chance of rear wheel lock-up during very hard braking.

Warning lights may be tested by depressing the brake pedal and holding it while opening one of the wheel cylinder bleeder screws. If this does not cause the light to go on, substitute a new lamp, make continuity checks, and, finally, replace the switch as necessary.

The hydraulic system may be checked for leaks by applying pressure to the pedal gradually and steadily. If the pedal sinks very slowly to the floor, the system has a leak. This is not to be confused with a springy or spongy feel due to the compression of air within the lines. If the system leaks, there will be a gradual change in the position of the pedal with a constant pressure.

Check for leaks along all lines and at wheel cylinders. If no external leaks are apparent, the problem is inside the master cylinder.

DISC BRAKES

Instead of the traditional expanding brakes that press outward against a circular drum, disc brake systems utilize a disc (rotor) with brake pads positioned on either side of it. An easily-seen analogy is the hand brake arrangement on a bicycle. The pads squeeze onto the rim of the bike wheel, slowing its motion. Automobile disc brakes use the identical principle but apply the braking effort to a separate disc instead of the wheel.

The disc (rotor) is a casting, usually equipped with cooling fins between the two braking surfaces. This enables air to circulate between the braking surfaces making them less sensitive to heat buildup and more resistant to fade. Dirt and water do not drastically affect braking action since contaminants are thrown off by the centrifugal action of the rotor or scraped off the by the pads. Also, the equal clamping action of the two brake pads tends to ensure uniform, straight line stops. Disc brakes are inherently self-adjusting. There are three general types of disc brake:

- A fixed caliper.
- A floating caliper.
- A sliding caliper.

The fixed caliper design uses two pistons mounted on either side of the rotor (in each side of the caliper). The caliper is mounted rigidly and does not move.

The sliding and floating designs are quite similar. In fact, these two types are often lumped together. In both designs, the pad on the inside of the rotor is moved into contact with the rotor by hydraulic force. The caliper, which is not held in a fixed position, moves slightly, bringing the outside pad into contact with the rotor. There are various methods of attaching floating calipers. Some pivot at the bottom or top, and some slide on mounting bolts. In any event, the end result is the same.

DRUM BRAKES

Drum brakes employ two brake shoes mounted on a stationary backing plate. These shoes are positioned inside a circular drum which rotates with the wheel assembly. The shoes are held in place by springs. This allows them to slide toward the drums (when they are applied) while keeping the linings and drums in alignment. The shoes are actuated by a wheel cylinder which is mounted at the top of the backing plate. When the brakes are applied, hydraulic pressure forces the wheel cylinder's actuating links outward. Since these links bear directly against the top of the brake shoes, the tops of the shoes are then forced against the inner side of the drum. This action forces the bottoms of the two shoes to contact the brake drum by rotating the entire assembly slightly (known as servo action). When pressure within the wheel cylinder is relaxed, return springs pull the shoes back away from the drum.

Most modern drum brakes are designed to self-adjust themselves during application when the vehicle is moving in reverse. This motion causes both shoes to rotate very slightly with the drum, rocking an adjusting lever, thereby causing rotation of the adjusting screw. Some drum brake systems are designed to self-adjust during application whenever the brakes are applied. This on-board adjustment system reduces the need for maintenance adjustments and keeps both the brake function and pedal feel satisfactory.

POWER BOOSTERS

Virtually all modern vehicles use a vacuum assisted power brake system to multiply the braking force and reduce pedal effort. Since vacuum is always available when the engine is operating, the system is simple and efficient. A vacuum diaphragm is located on the front of the master cylinder and assists the driver in applying the brakes, reducing both the effort and travel he must put into moving the brake pedal.

The vacuum diaphragm housing is normally connected to the intake manifold by a vacuum hose. A check valve is placed at the point where the hose enters the diaphragm housing, so that during periods of low manifold vacuum brakes assist will not be lost.

Depressing the brake pedal closes off the vacuum source and allows atmospheric pressure to enter on one side of the diaphragm. This causes the master cylinder pistons to move and apply the brakes. When the brake pedal is released, vacuum is applied to both sides of the diaphragm and springs return the diaphragm and master cylinder pistons to the released position.

If the vacuum supply fails, the brake pedal rod will contact the end of the master cylinder actuator rod and the system will apply the brakes without any power assistance. The driver will notice that much higher pedal effort is needed to stop the car and that the pedal feels harder than usual.

Vacuum Leak Test

1. Operate the engine at idle without touching the brake pedal for at least one minute.
2. Turn off the engine and wait one minute.
3. Test for the presence of assist vacuum by depressing the brake pedal and releasing it several times. If vacuum is present in the system, light application will produce less and less pedal travel. If there is no vacuum, air is leaking into the system.

System Operation Test

1. With the engine ***OFF***, pump the brake pedal until the supply vacuum is entirely gone.
2. Put light, steady pressure on the brake pedal.
3. Start the engine and let it idle. If the system is operating correctly, the brake pedal should fall toward the floor if the constant pressure is maintained.

   Power brake systems may be tested for hydraulic leaks just as ordinary systems are tested.

Brake Light Switch

REMOVAL & INSTALLATION

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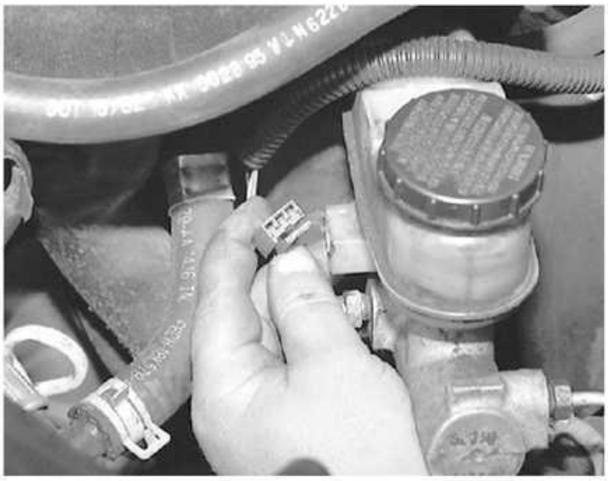
Brake light switch mounting

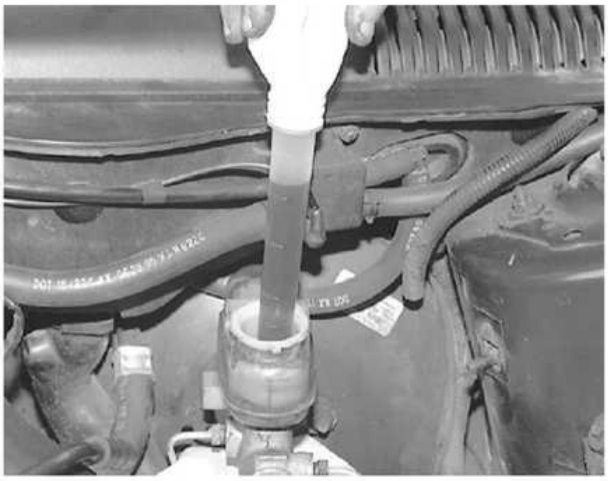
1. Disconnect the negative battery cable.
2. Detach the connector from the stoplight switch.
3. Remove the hairpin retainer and the white nylon washer.
4. Slide the switch and pushrod away from the pedal.
5. Remove the stoplight switch by sliding it down.
6. The installation is the reverse of removal.

Master Cylinder

REMOVAL & INSTALLATION

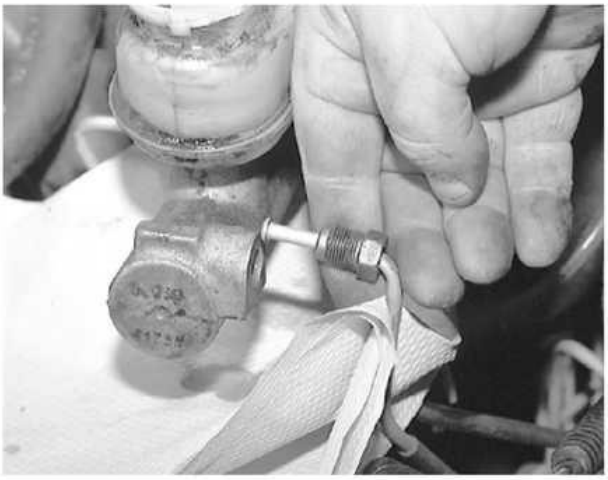


Detach the brake warning lamp indicator wire connector

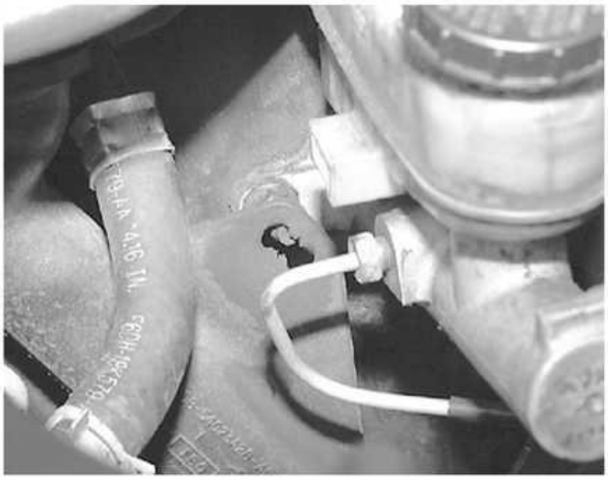


Remove the fluid from the master cylinder reservoir

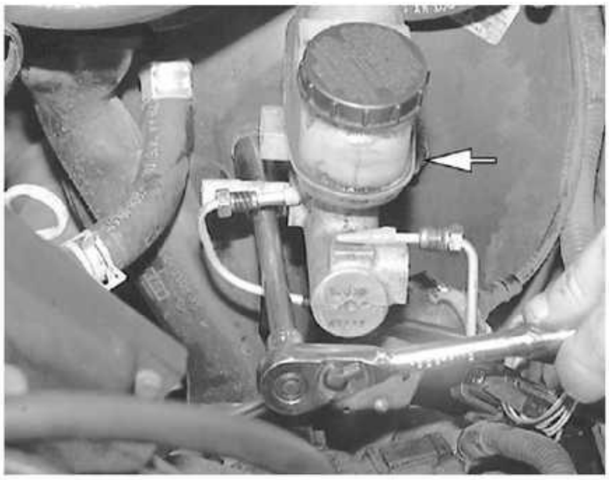
Use a flare nut wrench to...



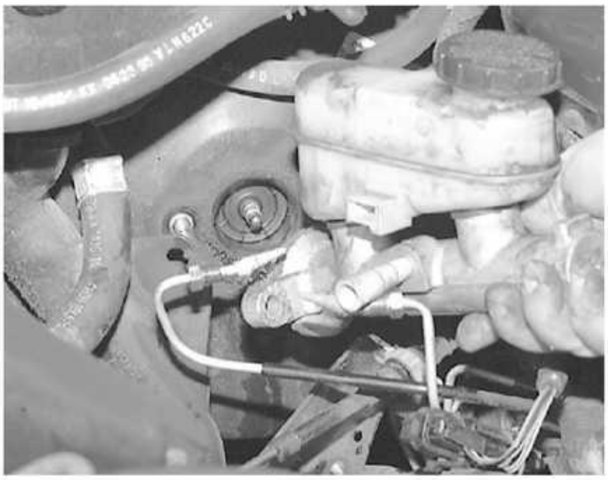
... disconnect the brake lines from the master cylinder



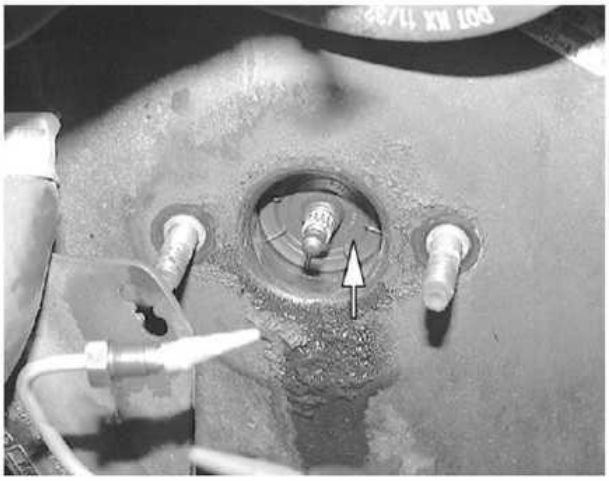
Remove the retaining nut for the HCU bracket and slide the bracket off of the master cylinder retaining stud



Remove the retaining nuts for the master cylinder and...



... and remove the master cylinder from the booster



Replace the groove seal in the booster assembly before installing the new master cylinder

1. Disconnect the negative battery cable.
2. Apply the brake pedal several times to exhaust all vacuum in the brake booster.
3. Detach the brake warning lamp indicator wire connector.
4. Disconnect the brake lines from the primary and secondary outlet ports of the master cylinder. Plug the brake lines.
5. Remove the retaining nut for the HCU bracket and slide the bracket off of the master cylinder retaining stud .
6. Remove 2 nuts retaining the master cylinder to the brake booster.
7. Slide the master cylinder forward and upward from the vehicle.

To install:

8. Install a new seal in the groove in the brake master cylinder mounting face.
9. Bench bleed the new master cylinder.
10. Mount the master cylinder on the booster. Tighten the nuts to 20-28 ft. lbs. (26-39 Nm).
11. Position the HCU bracket on the brake master cylinder mounting stud and install the retaining nut.
12. Unplug and connect the brake lines to the master cylinder and tighten to 12-14 ft. lbs. (16-20 Nm.
13. Connect the brake warning light or fluid level indicator switch wire connector.
14. Connect the negative battery cable.
15. Fill the master cylinder reservoir.
16. Bleed the system and check for leaks.
17. Road test the vehicle and check the brake system for proper operation.

BENCH BLEEDING

All new master cylinders should be bench bled prior to installation. Bleeding a new master cylinder on the vehicle is not a good idea. With air trapped inside, the master cylinder piston may bottom in the bore and possibly cause internal damage.

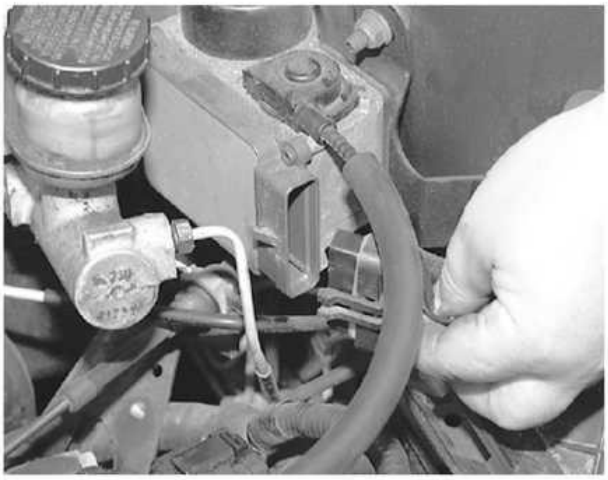
1. Secure the master cylinder in a bench vise using soft jaws.
2. Remove the master cylinder reservoir cap.
3. Manufacture or purchase bleeding tubes and install them on the master cylinder as illustrated.
4. Fill the master cylinder reservoir with clean, fresh brake fluid until the level is within 0.25 in. of the reservoir top.

Ensure the bleeding tubes are below the level of the brake fluid, otherwise air may get into the system making your bleeding efforts ineffective.

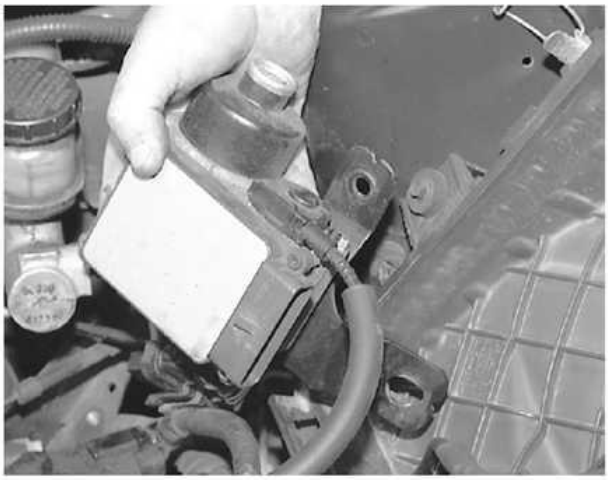
5. Use a blunt tipped rod (a long socket extension works well) to slowly depress the master cylinder piston. Make sure the piston travels full its full stroke.
6. As the piston is depressed, bubbles will come out of the bleeding tubes. Continue depressing and releasing the piston until all bubbles cease.
7. Refill the master cylinder with fluid.
8. Remove the bleeding tubes.
9. Install the master cylinder reservoir cap.
10. Install the master cylinder on the vehicle.

Power Brake Booster

REMOVAL & INSTALLATION



Detach the connector for the speed control actuator



Remove the actuator retaining nuts and position the actuator out of the way

Click on icon to view fullsize printable image.

Click to Enlarge

Brake booster assembly and related components

1. Disconnect the negative battery cable.
2. Disconnect the vacuum hose from the booster.
3. Unclip the air cleaner cover and position it out of the way.
4. Disconnect the speed control actuator, remove the retaining nuts, and position the actuator out of the way.
5. Remove the master cylinder. Refer to the procedure in this section.
6. Remove the stoplight switch. Refer to the procedure in this section.
7. Remove the booster-to-dash panel retaining nuts.
8. Slide the push rod and bushing off of the brake pedal pin.
9. Move the booster forward until it clears the studs on the cowl and remove the booster from the vehicle.

To install:

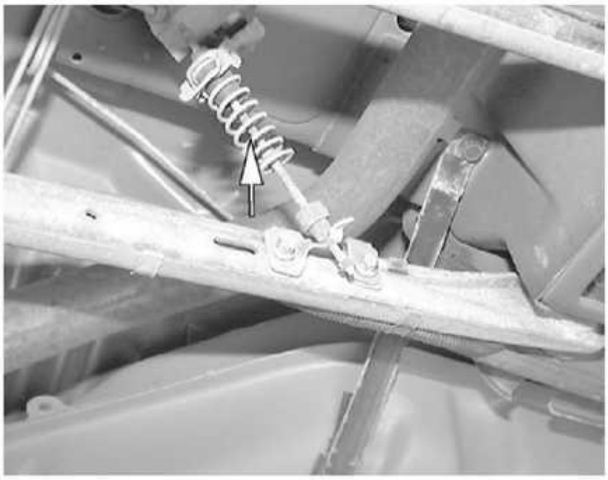
10. Align the pedal support bracket inside the vehicle and place the booster onto the retaining studs. Hand start the retaining nuts.
11. Working inside the vehicle, install the push rod spacer, push rod and bushing onto the booster.

The head of the bushing should be on the side of the push rod away from the pedal arm.

12. Tighten the booster retaining nuts to 16-21 ft. lbs. (21-29 Nm).
13. Install the stoplight switch.
14. Install the master cylinder.
15. Install the speed control actuator.
16. Install the air cleaner cover.
17. Connect the vacuum hose to the booster.
18. Fill and bleed the brakes.
19. Connect the negative battery cable.

Proportioning Valve

REMOVAL & INSTALLATION



The load sensing proportioning valve is mounted between the body and the forward driver's side lower control arm in the rear suspension

Click on icon to view fullsize printable image.

Click to Enlarge

Proportioning valve assembly

1. Disconnect the negative battery cable.
2. Raise and safely support the vehicle securely on jack stands.
3. Label and disconnect the four brake lines from the proportioning valve.
4. Remove the screw retaining the proportioning valve bracket to the rear suspension arm and bushing.
5. Remove the two screws retaining the proportioning valve bracket to the body and remove the valve and bracket assembly.

To install:

6. Ensure the rear suspension is in full rebound.

A replacement valve assembly comes with a red plastic gauge clip on the valve and the operator rod lower adjustment screw is loose. The gauge clip must not be removed until the valve is installed onto the vehicle.

7. Position the proportioning valve assembly onto the vehicle and tighten the retaining screws to 89-123 inch lbs. (10-14 Nm).
8. Connect the four brake lines.
9. Bleed the brakes.
10. Remove the red plastic gauge clip.
11. Lower the vehicle.

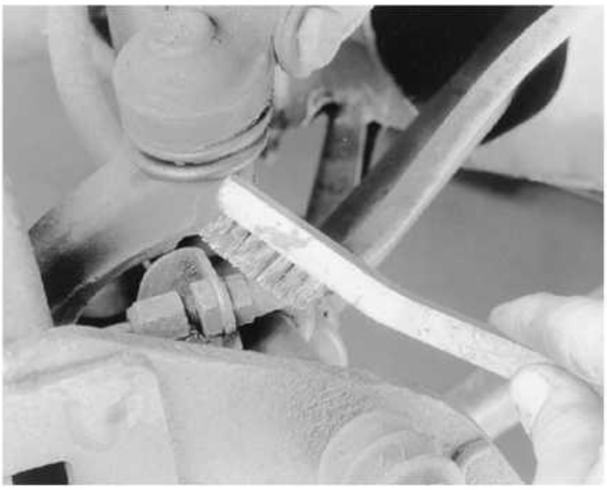
Brake Hoses and Lines

Metal lines and rubber brake hoses should be checked frequently for leaks and external damage. Metal lines are particularly prone to crushing and kinking under the vehicle. Any such deformation can restrict the proper flow of fluid and therefore impair braking at the wheels. Rubber hoses should be checked for cracking or scraping; such damage can create a weak spot in the hose and it could fail under pressure.

Any time the lines are removed or disconnected, extreme cleanliness must be observed. Clean all joints and connections before disassembly (use a stiff bristle brush and clean brake fluid); be sure to plug the lines and ports as soon as they are opened. New lines and hoses should be flushed clean with brake fluid before installation to remove any contamination.

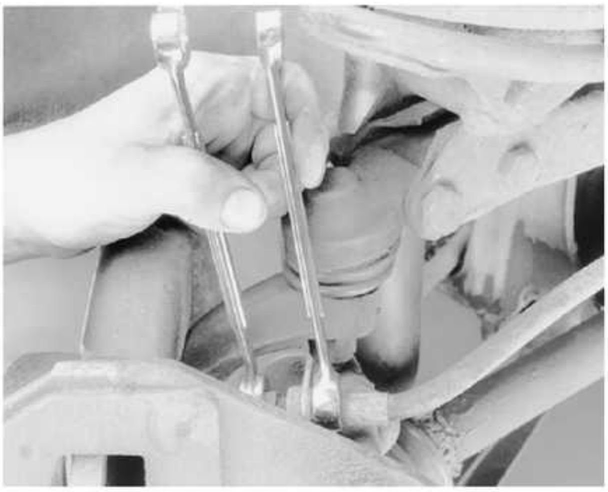
REMOVAL & INSTALLATION

1. Disconnect the negative battery cable.
2. Raise and safely support the vehicle on jack stands.
3. Remove any wheel and tire assemblies necessary for access to the particular line you are removing.
4. Thoroughly clean the surrounding area at the joints to be disconnected.



Use a brush to clean the fittings of any debris

5. Place a suitable catch pan under the joint to be disconnected.
6. Using two wrenches (one to hold the joint and one to turn the fitting), disconnect the hose or line to be replaced.



Use two wrenches to loosen the fitting. If available, use flare nut type wrenches

7. Disconnect the other end of the line or hose, moving the drain pan if necessary. Always use a back-up wrench to avoid damaging the fitting.
8. Disconnect any retaining clips or brackets holding the line and remove the line from the vehicle.

If the brake system is to remain open for more time than it takes to swap lines, tape or plug each remaining clip and port to keep contaminants out andfluid in.

Any gaskets/crush washers should be replaced with new ones during installation

Tape or plug the line to prevent contamination

To install:

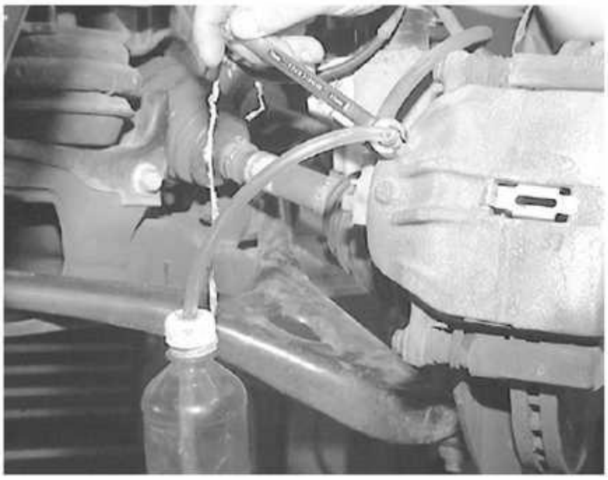
9. Install the new line or hose, starting with the end farthest from the master cylinder. Connect the other end, then confirm that both fittings are correctly threaded and turn smoothly using finger pressure. Make sure the new line will not rub against any other part. Brake lines must be at least 1/2 in. (13mm) from the steering column and other moving parts. Any protective shielding or insulators must be reinstalled in the original location.

Make sure the hose is NOT kinked or touching any part of the frame or suspension after installation. These conditions may cause the hose to fail prematurely.

10. Using two wrenches as before, tighten each fitting.
11. Install any retaining clips or brackets on the lines.
12. If removed, install the wheel and tire assemblies, then carefully lower the vehicle to the ground.
13. Refill the brake master cylinder reservoir with clean, fresh brake fluid, meeting DOT 3 specifications. Properly bleed the brake system.
14. Connect the negative battery cable.

Bleeding Brake System

Remove the bleed valve protective cap and...



... connect a hose and jar to collect the fluid onto the bleed valve and open the valve while an assistant depresses the brake pedal

Brake fluid contains polyglycol ethers and polyglycols. Avoid contact with the eyes and wash your hands thoroughly after handling brake fluid. If you do get brake fluid in your eyes, flush your eyes with clean, running water for 15 minutes. If eye irritation persists, or if you have taken brake fluid internally, IMMEDIATELY seek medical assistance.

When any part of the hydraulic system has been disconnected for repair or replacement, air may get into the lines and cause spongy pedal action (because air can be compressed and brake fluid cannot). To correct this condition, it is necessary to bleed the hydraulic system so to be sure all air is purged.

When bleeding the brake system, bleed one brake cylinder at a time, beginning at the cylinder with the longest hydraulic line (farthest from the master cylinder) first. ALWAYS Keep the master cylinder reservoir filled with brake fluid during the bleeding operation. Never use brake fluid that has been drained from the hydraulic system, no matter how clean it is.

The primary and secondary hydraulic brake systems are separate and are bled independently. During the bleeding operation, do not allow the reservoir to run dry. Keep the master cylinder reservoir filled with brake fluid.

1. Clean all dirt from around the master cylinder fill cap, remove the cap and fill the master cylinder with brake fluid until the level is within 1/4 in. (6mm) of the top edge of the reservoir.
2. Clean the bleeder screws at all 4 wheels. The bleeder screws are located on the back of the brake backing plate (drum brakes) and on the top of the brake calipers (disc brakes).
3. Attach a length of rubber hose over the bleeder screw and place the other end of the hose in a glass jar, submerged in brake fluid.
4. Open the bleeder screw 1/2-3/4 turn. Have an assistant slowly depress the brake pedal.
5. Close the bleeder screw and tell your assistant to allow the brake pedal to return slowly. Continue this process to purge all air from the system.
6. When bubbles cease to appear at the end of the bleeder hose, close the bleeder screw and remove the hose.
7. Check the master cylinder fluid level and add fluid accordingly. Do this after bleeding each wheel.

Clean, high quality brake fluid is essential to the safe and proper operation of the brake system. You should always buy the highest quality brake fluid that is available. If the brake fluid becomes contaminated, drain andflush the system, then refill the master cylinder with new fluid. Never reuse any brake fluid. Any brake fluid that is removed from the system should be discarded. Also, do not allow any brake fluid to come in contact with a painted surface; it will damage the paint.

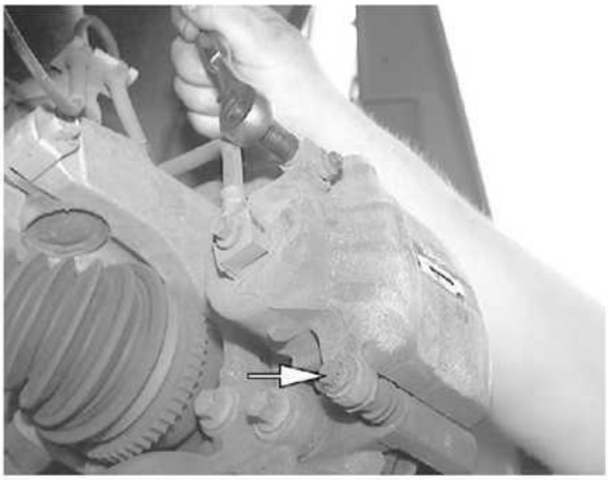
8. Repeat the bleeding operation at the remaining 3 wheels, ending with the one closest to the master cylinder.
9. Fill the master cylinder reservoir to the proper level.

DISC BRAKES

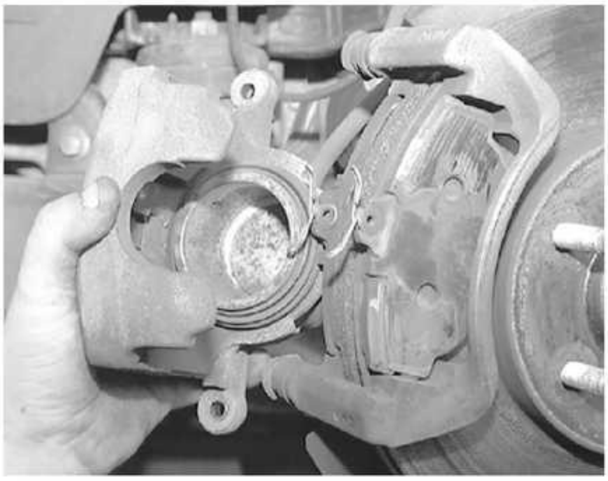
Brake Pads

REMOVAL & INSTALLATION

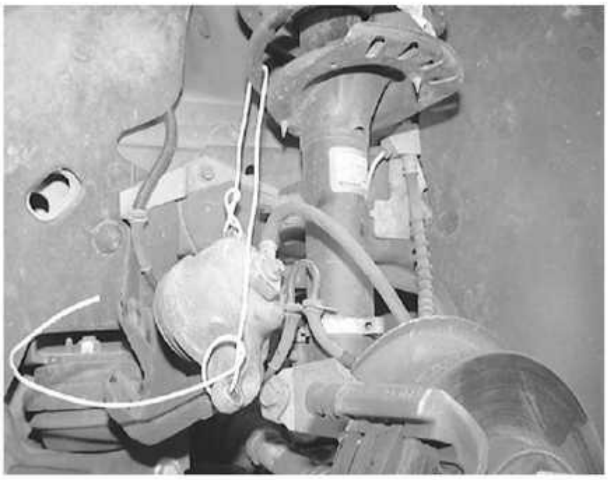
Front



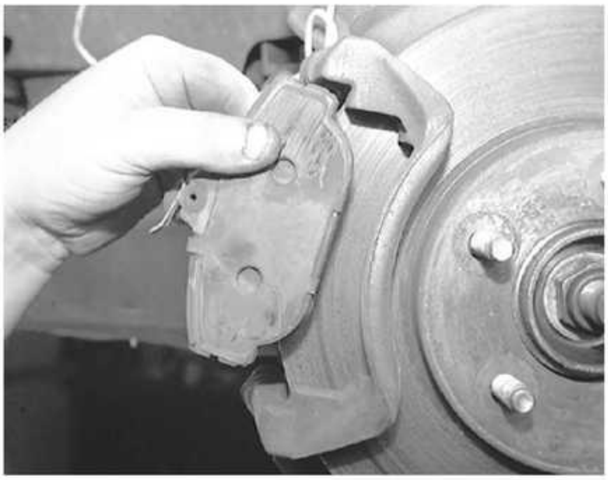
Remove the caliper locating pins and...



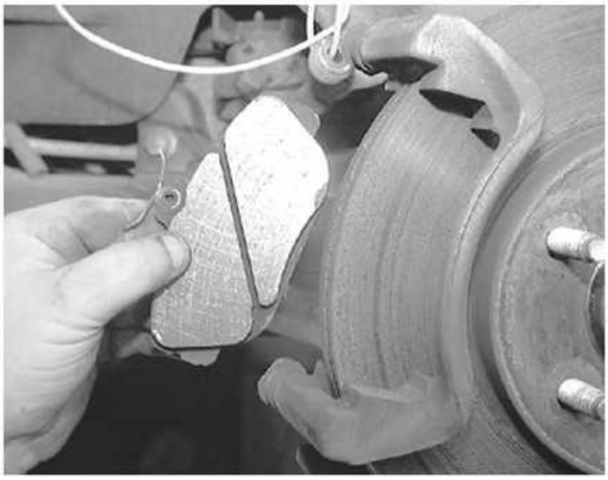
... remove the caliper from the bracket and rotor



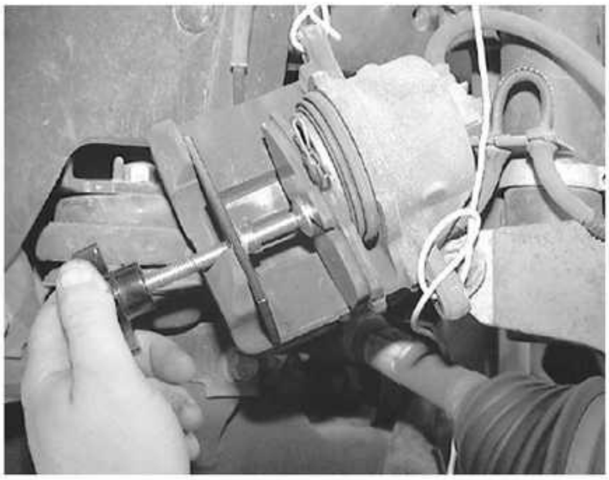
Support the caliper using a piece of mechanic's wire



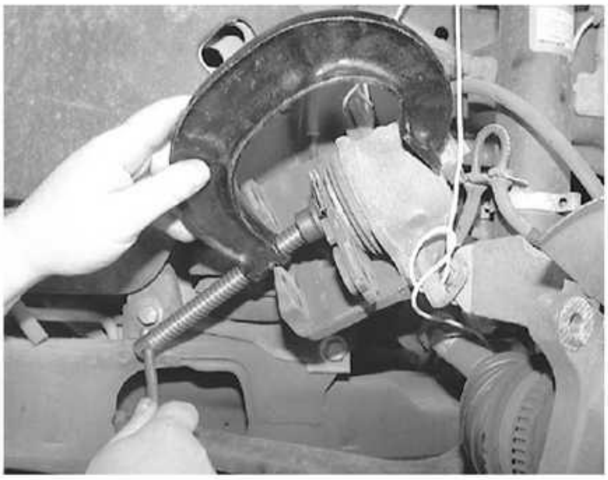
Remove the outer and...



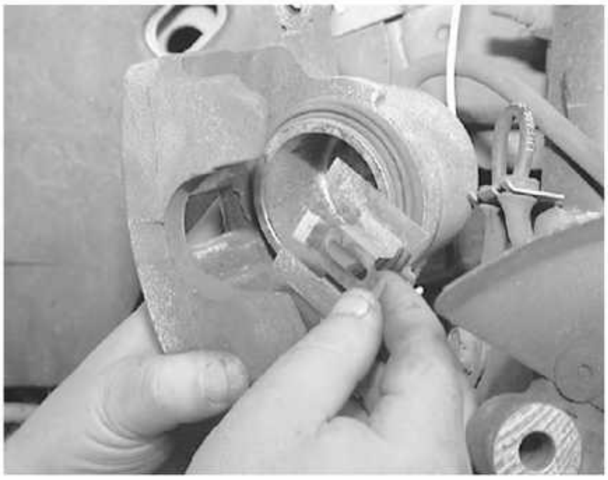
... inner brake pads from the caliper bracket



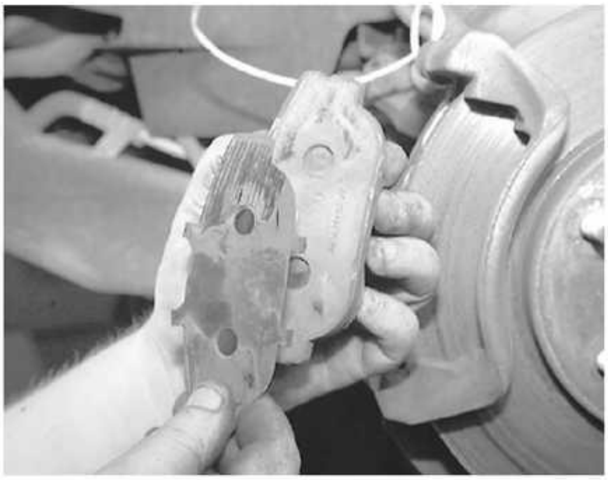
Special tools, such as this one from Lisle®, are available to compress the caliper pistons, however...



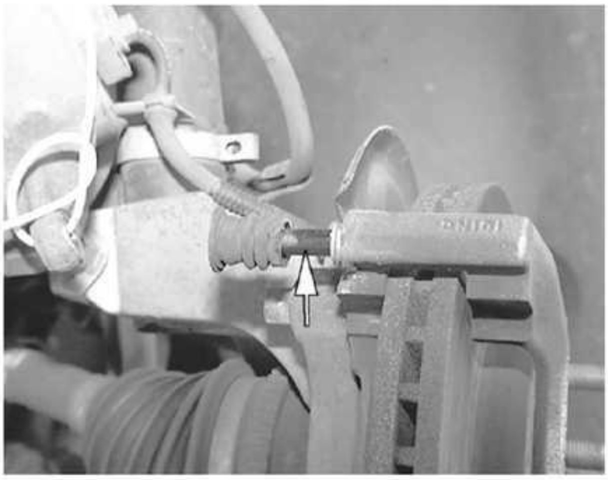
... if they are not available, a large C-clamp works well also



Remember to install the spring into the caliper if removed



Remember to transfer the shims and retaining clips if new ones are not provided with your new pads



Lubricate the caliper locating pin slides before installing the caliper onto the bracket

Older brake pads or shoes may contain asbestos, which has been determined tobe a cancer-causing agent. Never clean the brake surfaces with compressed air! Avoid inhaling any dust from any brake surface! When cleaning brake surfaces,use a commercially available brake cleaning fluid.

1. Remove the master cylinder reservoir cap and check the fluid level in the reservoir. Remove brake fluid until the reservoir is 1/2 full. Discard the removed fluid.
2. Raise and safely support the vehicle.
3. Remove the wheel and tire assembly.
4. Remove the disc brake caliper locating pins. Lift the caliper assembly from the anchor plate and rotor using a rotating motion.

Do not pry directly against the metal caliper piston or damage will occur.

5. Suspend the caliper inside the fender housing with wire. Do not allow the caliper to hang from the brake hose.
6. Remove the inner and outer brake pads. Inspect the rotor braking surfaces for scoring and machine as necessary.

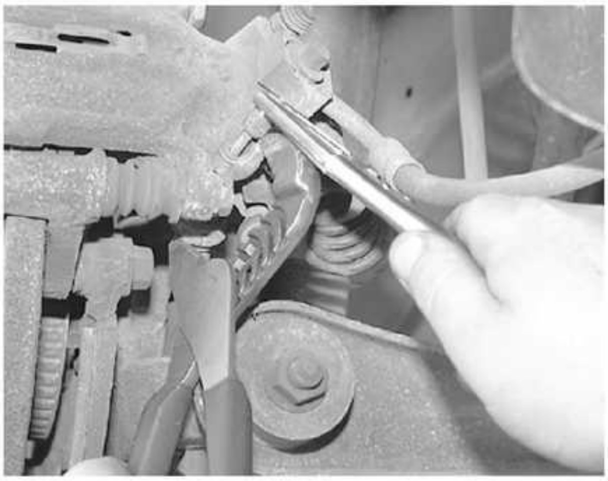
To install:

7. Use a C-clamp and an old brake pad or block of wood to seat the caliper piston in its bore.
8. Remove any rust buildup from the inside of the caliper in the brake pad contact area.
9. Install the inner pad in the caliper piston. Install the outer pad. Make sure the clips are properly seated.

Make sure the insulators are installed on the brake pads.

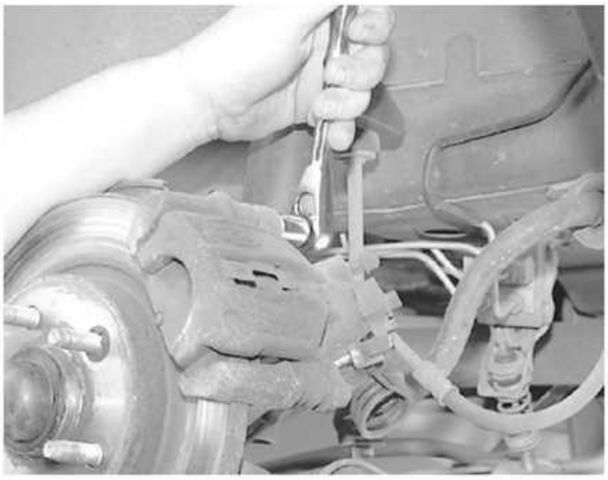
10. Install the disc brake caliper over the rotor and install the wheel. Lower the vehicle.
11. Pump the brake pedal several times prior to moving the vehicle to position the brake pads to the rotor.
12. Refill the master cylinder reservoir as necessary, using only clean DOT 3 or equivalent brake fluid from a closed container.
13. Road test the vehicle and check the brake system for proper operation.

Rear



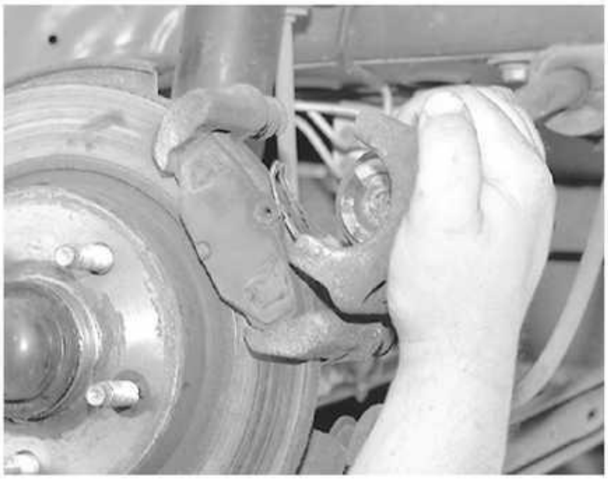
Remove the retaining clip from the parking brake cable and...

... remove the cable from the caliper

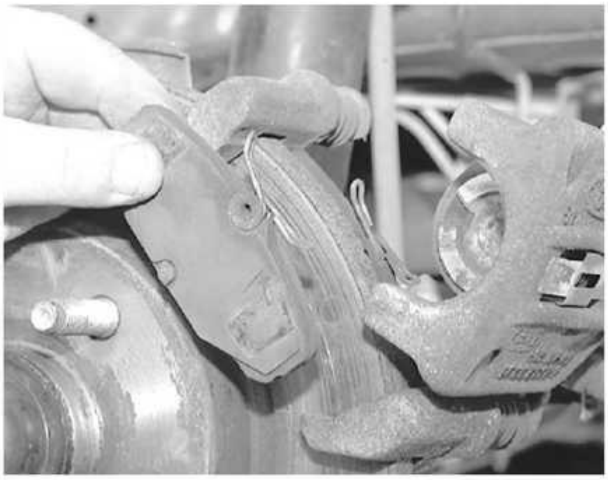


Remove the top and...

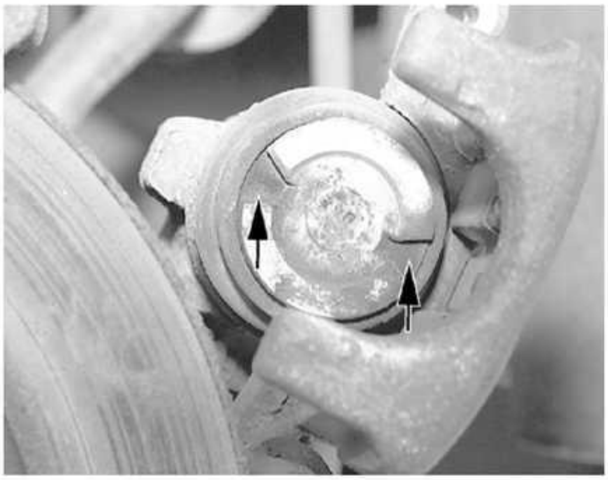
... lower caliper locating pins. The lower locating pin must be removed using a wrench to clear the parking brake actuator spring



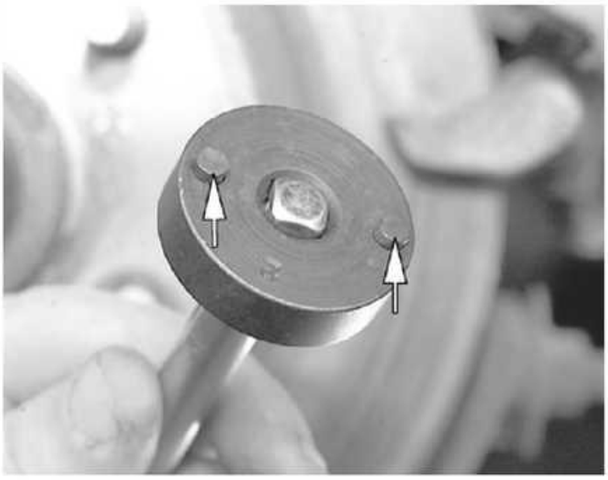
Carefully slide the caliper from the caliper bracket and off of the rotor



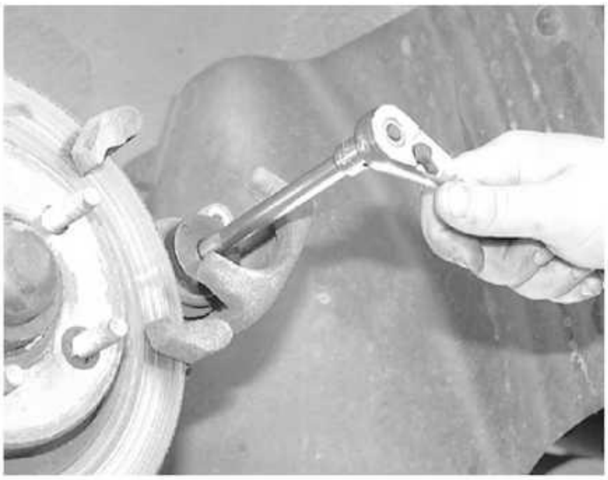
Remove the brake pads from the caliper bracket



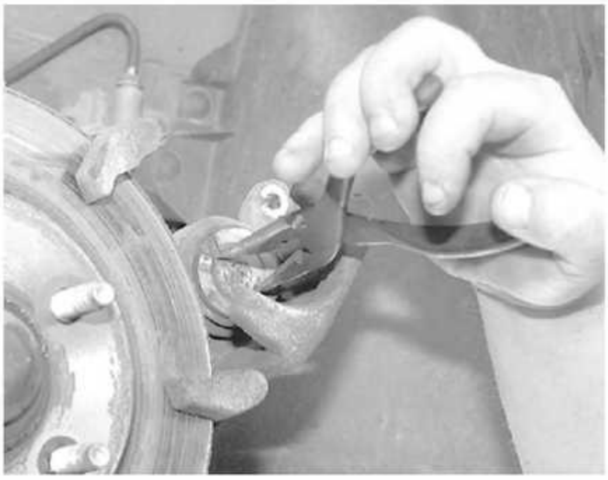
The piston on the rear calipers requires that it be rotated in to compress it



The caliper piston shown is used to rotate the piston and compress it. Align the small pins with...



... the small holes in the piston and turn using a suitable tool until the piston is fully compressed and seated



If the special piston is unavailable, a pair of needle nose pliers may be used to rotate the piston in, however, it is considerably more difficult

Remember to transfer the shims and retaining clips if new ones are not provided with your new pads

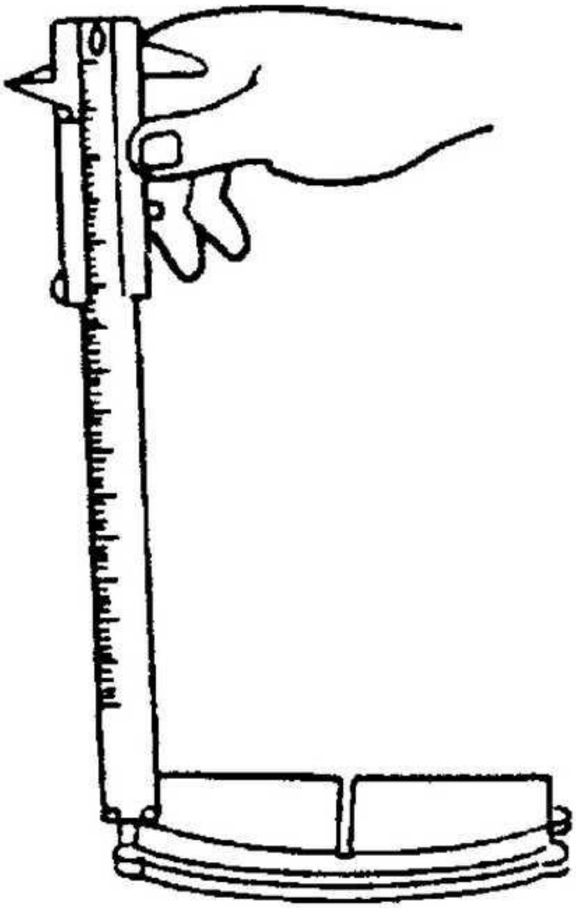
Older brake pads or shoes may contain asbestos, which has been determined tobe a cancer-causing agent. Never clean the brake surfaces with compressed air! Avoid inhaling any dust from any brake surface! When cleaning brake surfaces,use a commercially available brake cleaning fluid.

1. Remove the master cylinder reservoir cap and check the fluid level in the reservoir. Remove brake fluid until the reservoir is 1/2 full. Discard the removed fluid.
2. Raise and safely support the vehicle.
3. Remove the wheel and tire assembly.
4. Remove the screw retaining the brake hose bracket to the frame side rail.
5. Remove the retaining clip from the parking brake cable at the disc brake caliper. Remove the cable end from the parking brake lever.
6. Remove the upper disc brake caliper locating pin at the support bracket. Rotate the caliper away from the rotor.
7. Remove the disc brake pads.
8. Inspect the rotor braking surfaces for scoring and machine as necessary.

To install:

9. Using Rear Caliper Piston Adjuster T87P-2588-A or equivalent, rotate the piston clockwise until it is fully seated. Make sure one of the slots in the piston face is positioned so it will engage the nib on the brake pad.
10. Install the brake pads in the support bracket. Rotate the caliper assembly over the rotor into position on the support bracket. Make sure the brake pads are installed correctly.
11. Remove the residue from the rear brake pin retainer bolt threads and apply one drop of a suitable threadlock sealer. Install and tighten the disc brake caliper locating pin to 23-25 ft. lbs. (31-34 Nm).
12. Attach the cable end to the parking brake lever. Install the cable retaining clip on the caliper assembly. Position the brake flex hose and bracket assembly to the side rail, and install the retaining screw. Tighten to 8-11 ft. lbs. (11-16 Nm).
13. Install the wheel and tire, then lower the vehicle. Pump the brake pedal several times prior to moving the vehicle, to position the brake pads to the rotor.
14. Refill the master cylinder reservoir if necessary, using only clean DOT 3 or equivalent brake fluid from a closed container.
15. Road test the vehicle and check the brake system for proper operation.

INSPECTION



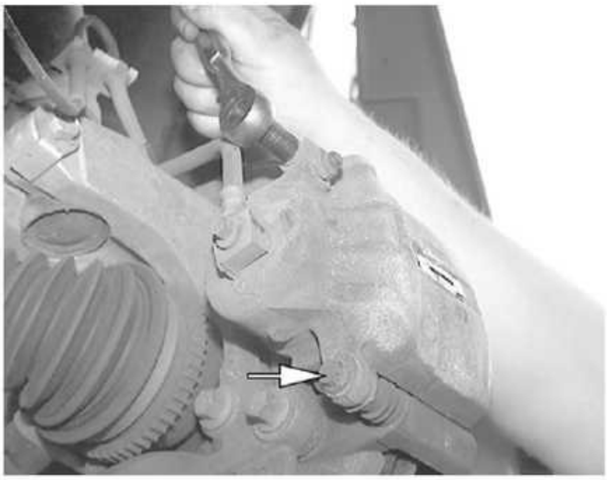
Measure brake pad thickness in several places around the pad with a ruler or Vernier caliper

Inspect the brake pads for wear using a ruler or Vernier caliper. Compare measurements to the brake specifications chart. If the lining is thinner than specification or there is evidence of the lining being contaminated by brake fluid or oil, make the necessary repairs and replace all brake pad assemblies (a complete axle set).

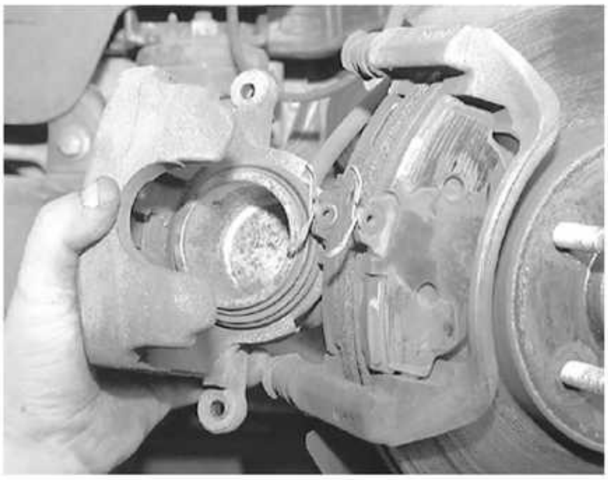
Brake Caliper

REMOVAL & INSTALLATION

Front



Remove the caliper locating pins and...



... remove the caliper from the bracket and rotor

1. Remove brake fluid from the brake master cylinder reservoir until the reservoir is 1/2 full.
2. Raise and safely support the vehicle.
3. Remove the wheel and tire assembly.
4. Mark the disc brake caliper to ensure that it is reinstalled in the correct location.
5. Remove the hollow bolt connecting the brake hose to the disc brake caliper and plug the brake hose. Discard the 2 copper sealing washers.

Do not pry directly against the piston or damage to the piston will result.

6. Remove the caliper locating pins and lift the caliper off the rotor using a rotating motion.

To install:

7. Retract the disc brake caliper piston fully in the piston bore, using an old brake pad or block of wood and a C-clamp or equivalent.

Be sure to clean all dirt from the mating surfaces of the caliper locating pins and housing ears. Also, make sure the

clip-on insulators are attached to the brake pads.

8. Install the disc brake pads to the caliper. Make sure the brake pad insulators are correctly attached to the brake pad plate.
9. Position the disc brake caliper and pad assembly above the rotor and install it with a rotating motion. Make sure the inner and outer pads are properly positioned and the outer anti-rattle spring is properly positioned.
10. Lubricate the locating pins and the inside of the insulators with silicone grease. Tighten the locating pins to 23-28 ft. lbs. (31-38 Nm).
11. Remove the plug and install the brake hose to the disc brake caliper. Use 2 new copper washers and torque the hollow bolt to 30-40 ft. lbs. (41-54 Nm).
12. Bleed the brake system, filling the master cylinder as required.
13. Install the wheel and tire assembly; tighten the nuts to 85-104 ft. lbs. (115-142 Nm).
14. Lower the vehicle.
15. Pump the brake pedal several times to position the brake pads prior to moving the vehicle.
16. Road test the vehicle and check for proper brake system operation.

Rear

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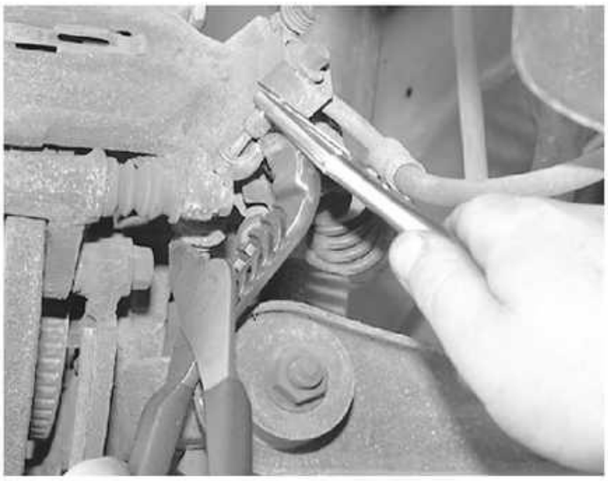
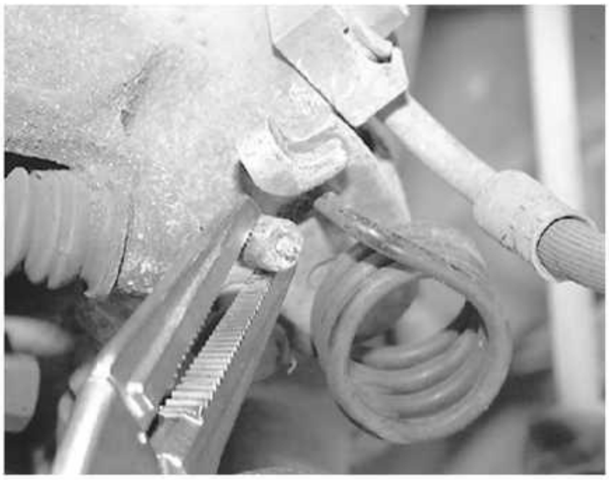
Click to Enlarge

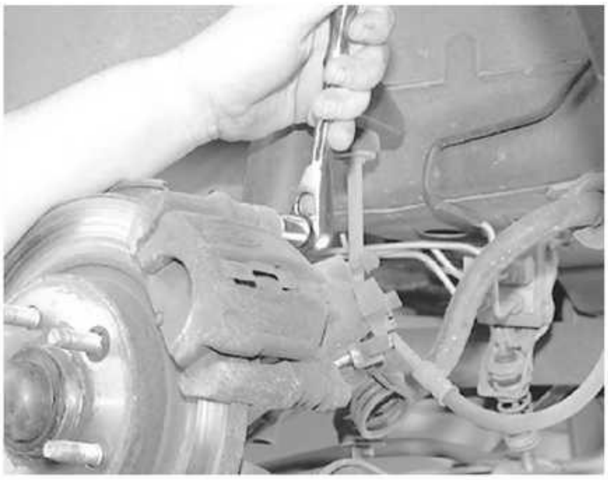
Rear caliper brake hose connection



Remove the retaining clip from the parking brake cable and...

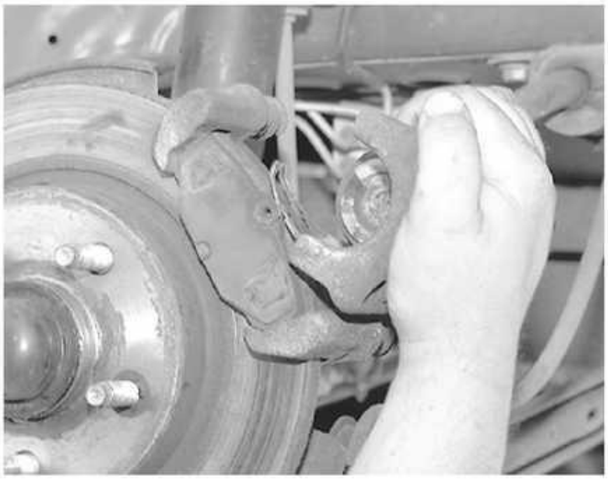


... remove the cable from the caliper



Remove the top and...

... lower caliper locating pins. The lower locating pin must be removed using a wrench to clear the parking brake actuator spring



Carefully slide the caliper from the caliper bracket and off of the rotor

1. Remove brake fluid from the brake master cylinder reservoir until the reservoir is 1/2 full.
2. Raise and safely support the vehicle.
3. Remove the wheel and tire assembly.
4. Remove the retaining bolt and disconnect the brake hose from the caliper assembly. Discard the copper sealing washers.
5. Remove the retaining clip from the parking brake at the caliper. Disengage the parking brake cable end from the lever arm.
6. Lift the rear disc brake caliper away from the rear disc support bracket.
7. Remove the disc brake caliper locating pins and boots from the rear disc support bracket.

To install:

8. Using rear caliper piston adjuster tool T87P-2588-A or equivalent, rotate the rear disc brake piston and adjuster clockwise until fully seated.

Make sure one of the 2 slots in the rear disc brake piston and adjuster face is positioned so it will engage the nib on the disc brake pad.

9. Apply silicone dielectric compound or equivalent, to the inside of the slider pin boots and the slider pins.
10. Position the slider pins and boots in the support bracket. Position the caliper assembly on the support bracket. Make sure the brake pads are installed correctly.
11. Remove the residue from the pin retainer threads and apply 1 drop of threadlock and sealer. Install the pin retainers and tighten to 23-25 ft. lbs. (31-35 Nm).
12. Attach the cable end to the parking brake lever. Install the cable retaining clip on the caliper assembly.
13. Using new washers, connect the brake flex hose to the caliper. Tighten the retaining bolt to 40 ft. lbs. (54 Nm).
14. Bleed the brake system, filling the master cylinder as required.
15. Install the wheel and tire assembly; tighten the nuts to 85-104 ft. lbs. (115-142 Nm).
16. Lower the vehicle.
17. Pump the brake pedal several times to position the brake pads prior to moving the vehicle.
18. Road test the vehicle and check for proper brake system operation.

OVERHAUL

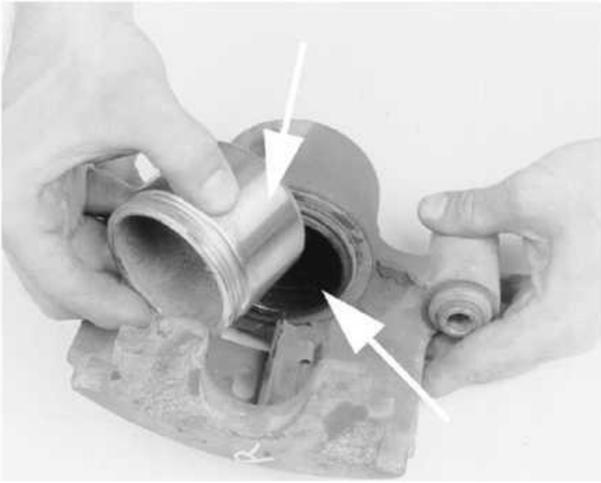
Some vehicles may be equipped dual piston calipers. The procedure to overhaul the caliper is essentially the same with the exception of multiple pistons, O-rings and dust boots.

1. Remove the caliper from the vehicle and place on a clean workbench.

NEVER place your fingers in front of the pistons in an attempt to catch or protect the pistons when applying compressed air. This could result in personal injury!

Depending upon the vehicle, there are two different ways to remove the piston from the caliper. Refer to the brake pad replacement procedure to make sure you have the correct procedure for your vehicle.

For some types of calipers, use compressed air to drive the piston out of the caliper, but make sure to keep your fingers clear

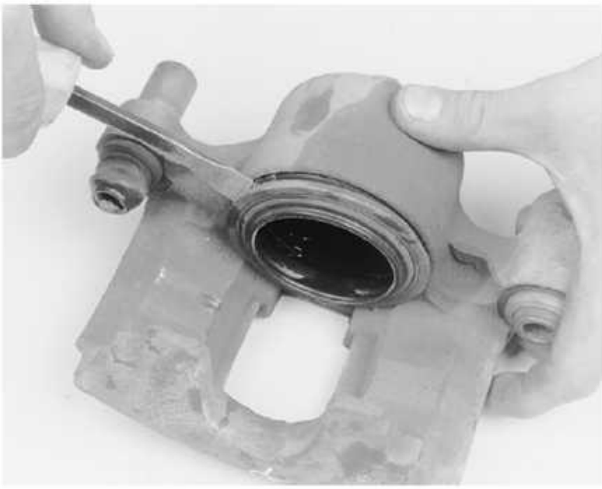


Withdraw the piston from the caliper bore

3. For the second method, you must rotate the piston to retract it from the caliper.
4. If equipped, remove the anti-rattle clip.

On some vehicles, you must remove the anti-rattle clip

5. Use a prying tool to remove the caliper boot, being careful not to scratch the housing bore.



Use a prying tool to carefully pry around the edge of the boot...

... then remove the boot from the caliper housing, taking care not to score or damage the bore

6. Remove the piston seals from the groove in the caliper bore.

Use extreme caution when removing the piston seal; DO NOT scratch the caliper bore

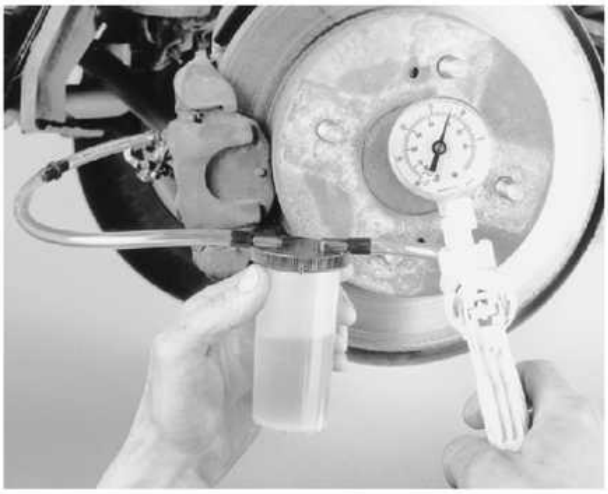
7. Carefully loosen the brake bleeder valve cap and valve from the caliper housing.
8. Inspect the caliper bores, pistons and mounting threads for scoring or excessive wear.
9. Use crocus cloth to polish out light corrosion from the piston and bore.
10. Clean all parts with denatured alcohol and dry with compressed air.

To assemble:

11. Lubricate and install the bleeder valve and cap.
12. Install the new seals into the caliper bore grooves, making sure they are not twisted.
13. Lubricate the piston bore.
14. Install the pistons and boots into the bores of the calipers and push to the bottom of the bores.
15. Use a suitable driving tool to seat the boots in the housing.

Use the proper size driving tool and a mallet to properly seal the boots in the caliper housing

16. Install the caliper in the vehicle.
17. Install the wheel and tire assembly, then carefully lower the vehicle.
18. Properly bleed the brake system.

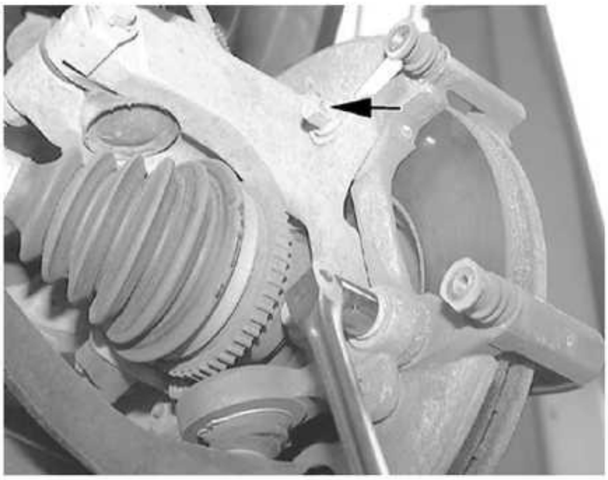


There are tools, such as this Mighty-Vac, available to assist in proper brake system bleeding

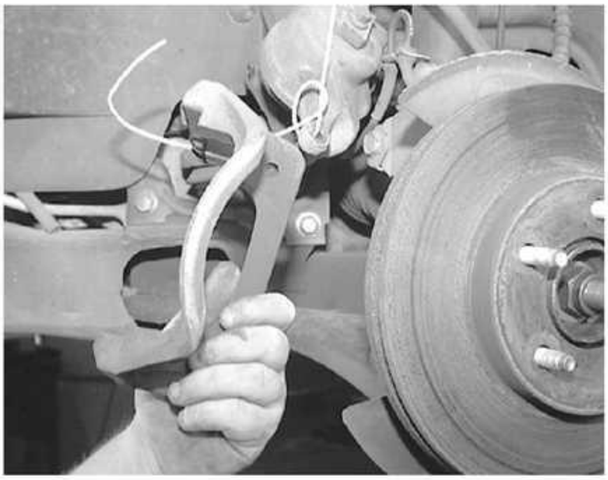
Brake Disc (Rotor)

REMOVAL & INSTALLATION

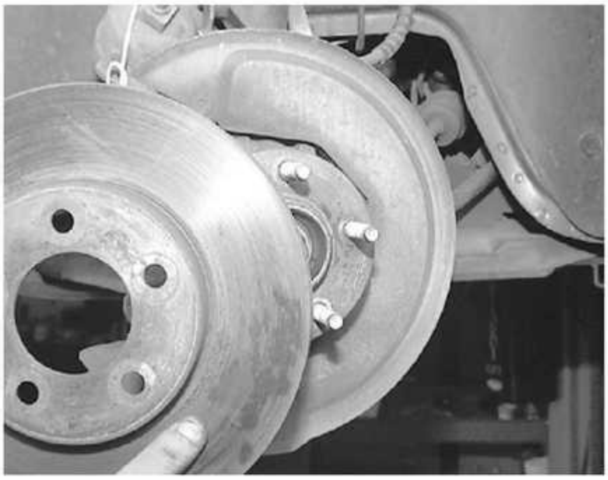
Front



Remove the caliper bracket retaining bolts and...



... remove the bracket from the vehicle



Carefully remove the rotor from the hub assembly

1. Raise and safely support the vehicle.
2. Remove the wheel and tire assembly.
3. Remove the disc brake caliper and the caliper anchor bracket as an assembly. Discard the bracket retaining bolts. Position the caliper aside and support it with a length of wire. Do not allow the caliper to hang by the brake hose.

To prevent contamination of the disc brake caliper guide pin journals, do not separate the disc brake caliper from the caliper anchor bracket.

4. Separate the disc brake rotor from the hub assembly by pulling it off the hub studs. If additional force is required to remove the rotor, apply rust penetrate on the front and rear rotor/hub mating surfaces and then strike the rotor between the studs with a plastic hammer. If this does not work, attach a suitable 3-jaw puller and remove the rotor.

If excessive force must be used to remove the rotor, it should be checked for lateral run-out before installation.

5. Check the rotor for scoring and/or other wear. Machine or replace, as necessary.

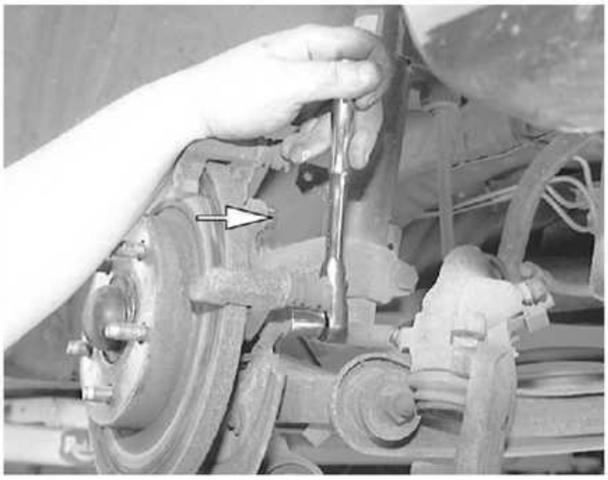
To install:

6. If the disc brake rotor is being replaced, remove the protective coating from the new rotor. If the original rotor is being installed, make sure the rotor braking surfaces are clean.
7. Apply a small amount of silicone dielectric compound or equivalent, to the pilot diameter of the disc brake rotor. Install the rotor on the hub assembly.
8. Install remaining components in the reverse order of removal. Torque the following

- Caliper anchor bracket bolts to 65-87 ft. lbs. (88-118 Nm)
- Lug nuts to 85-105 ft. lbs. (115-142 Nm)

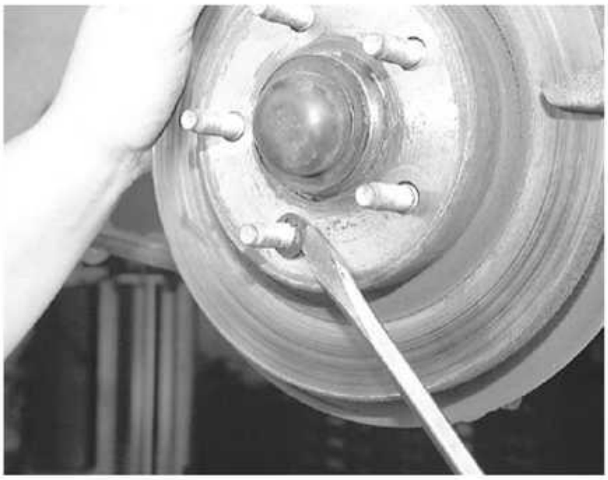
9. Pump the brake pedal several times prior to moving the vehicle to seat the disc brake pads to the rotor.
10. Road test the vehicle and check the brake system for proper operation.

Rear



Remove the caliper bracket retaining bolts and...

... remove the bracket from the vehicle



If equipped, pry or cut off the...

... retainer nuts placed on the rotors from the assembly line

Carefully remove the rotor from the hub assembly

1. Raise and safely support the vehicle.
2. Remove the wheel and tire assembly.
3. Remove the caliper assembly from the disc brake rotor and support it with a length of wire. Do not let the caliper hang from the brake line.
4. Remove the upper and lower support bracket retaining bolts. Remove the support bracket.
5. Remove 2 retainer nuts and remove the disc brake rotor from the hub. Check the rotor for scoring and/or other wear. Machine or replace, as necessary.

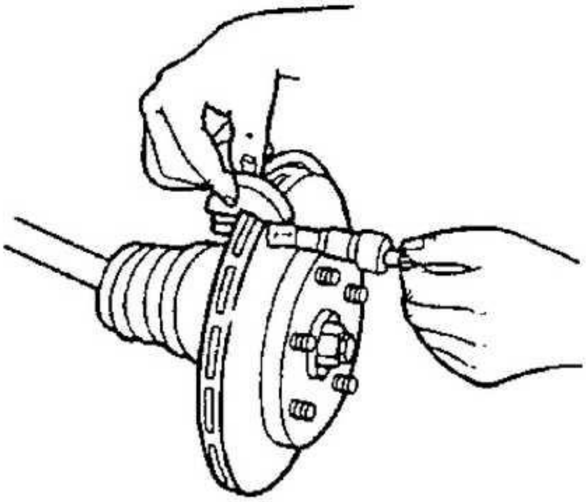
To install:

6. If the disc brake rotor is being replaced, remove the protective coating from the new rotor. If the original rotor is being installed, make sure the rotor braking surfaces are clean.
7. Install the disc brake rotor on the hub assembly.

Lubricate the hub pilot with a suitable caliper slide grease to ease future rotor removal.

8. Install 2 retainer nuts to hold the disc brake rotor in position.
9. Install the disc brake caliper support bracket and tighten the support bracket retaining bolts to 65-87 ft. lbs. (88-118 Nm).
10. Install the brake pads and disc brake caliper assembly.
11. Install the wheel and tire assembly. Install the lug nuts and torque to 85-105 ft. lbs. (115-142 Nm).
12. Pump the brake pedal several times prior to moving the vehicle to seat the brake pads to the rotor.
13. Road test the vehicle and check the brake system for proper operation.

INSPECTION



Check brake rotor thickness in several places around the rotor

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Click to Enlarge

Mount the dial indicator and zero the indicator

Rotor thickness should be measured any time a brake inspection is done. Rotor thickness can be measured using a brake rotor micrometer or Vernier caliper. Measure the rotor thickness in several places around the rotor. Compare the thickness to the specifications chart found at the end of this section.

The run-out of the brake rotor should be checked any time a vibration during braking occurs. Excessive run-out can be caused by a build-up of rust scale or other particles on the rotor or hub surfaces. Remove the rotor and thoroughly clean the hub and rotor-to-hub mounting surface on the back of the rotor. Mount a dial indicator to a suspension member and zero the indicator stylus on the face of the rotor. Rotate the rotor 360 degrees by hand and record the run-out.

Compare measurements to the brake specifications chart. If the thickness and run-out do not meet specifications, replace the rotor.

DRUM BRAKES

Introduction

Click on icon to view fullsize printable image.

Click to Enlarge

Drum brake components-exploded view

Click on icon to view fullsize printable image.

Click to Enlarge

Drum brake components-assembled view

Brake Drums

REMOVAL & INSTALLATION

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Click to Enlarge

If the brake shoes need to be backed off, remove the rubber plug to access the brake shoe adjusting screw
Click on icon to view fullsize printable image. Click to Enlarge *Brake drum mounting*

Older brake pads or shoes may contain asbestos, which has been determined tobe a cancer-causing agent. Never clean the brake surfaces with compressed air! Avoid inhaling any dust from any brake surface! When cleaning brake surfaces,use a commercially available brake cleaning fluid.

1. Raise and safely support the vehicle.
2. Remove the wheel and tire assembly.
3. Remove the brake drum.

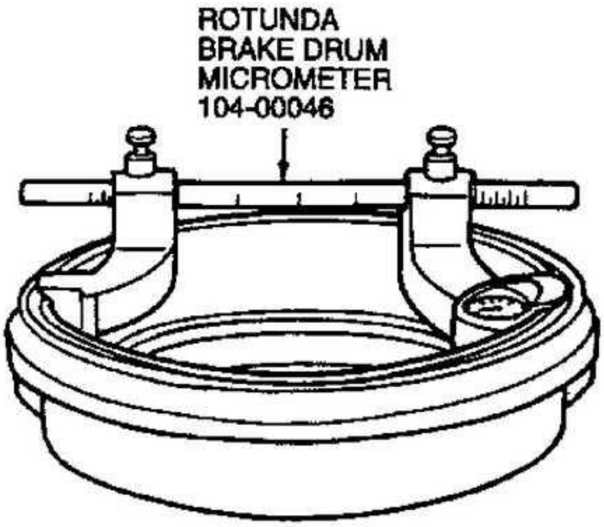
If the drum will not come off, pry the rubber plug from the backing plate inspection hole. Remove the brake line-to-axle retention bracket. This willallow sufficient room to insert suitable brake tools through the inspection hole to disengage the adjusting lever and back off the adjusting screw.

4. Inspect the drum for scoring and/or other wear. Machine or replace, as necessary.

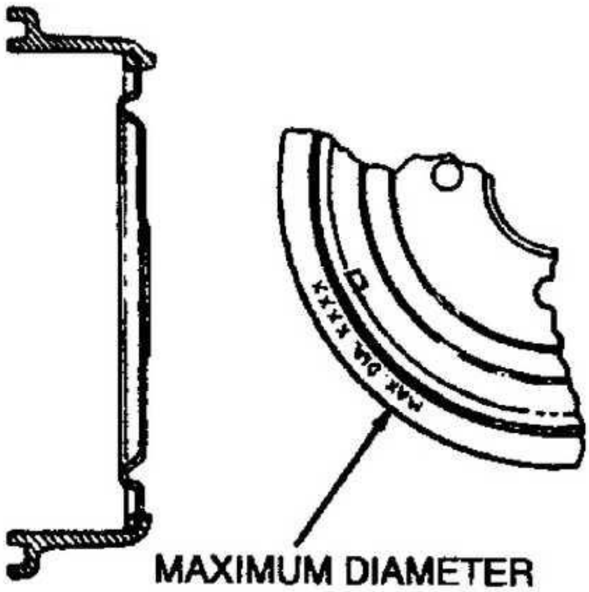
To install:

5. Measure the brake drum inside diameter using D81L-1103-A or equivalent brake adjustment gauge.
6. Using the brake adjustment gauge, adjust the brake shoes to the same dimensions as the brake drum.
7. Position the brake drum over the brake shoes on the axle hub.
8. Install the wheel and tire assembly. Tighten the lug nuts to 85-104 ft. lbs. (115-141 Nm).
9. Lower the vehicle.
10. Pump the brake pedal several times to position the brake shoes and complete the adjustment.
11. Road test the vehicle and check for proper brake system operation.

INSPECTION



A micrometer is needed to check the diameter and run-put of the brake drum



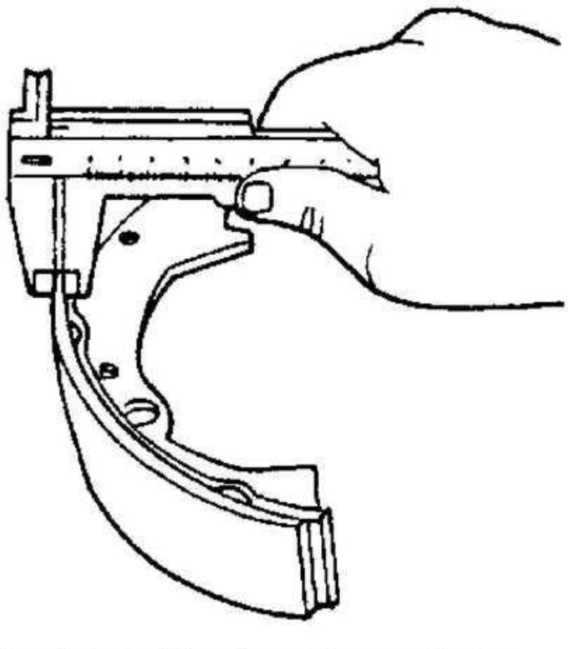
Typically the drum maximum diameter is stamped onto the drum ridge

Check that there are no cracks or chips in the braking surface. Excessive bluing indicates overheating and a replacement drum is needed. The drum can be machined to remove minor damage and to establish a rounded braking surface on a warped drum. Never exceed the maximum oversize of the drum when machining the braking surface.

The brake drum inside diameter and run-out can be measured using a brake drum micrometer. The drum should be measured every time a brake inspection is performed. Take the inside diameter readings at points 90° apart from each other on the drum to measure the run-out. The maximum inside diameter is stamped on the rim of the drum or on the inside above the lug nut stud holes and is also contained in the brake specifications chart at the end of this section.

Brake Shoes

INSPECTION



Measure brake shoe thickness in several places around the shoe

Inspect the brake shoes for wear using a ruler or Vernier caliper. Compare measurements to the brake specifications chart. If the lining is thinner than specification or there is evidence of the lining being contaminated by brake fluid or oil, repair the leak and replace all brake shoe assemblies (a complete axle set). In addition to the shoes inspect all springs and brake shoe hardware for wear and replace as necessary.

REMOVAL & INSTALLATION

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Click to Enlarge

Brake shoe adjusting screw assembly

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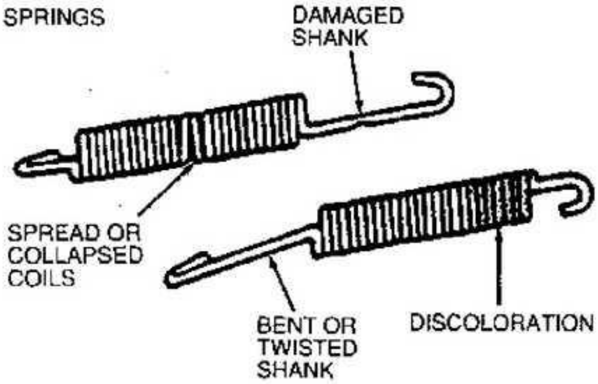
Click to Enlarge

Remove the brake shoe adjusting screw from the brake shoes



Inspect all springs and hardware and replace as necessary before reassembling the brakes

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Ensure that the adjusting screw slots are aligned in the proper positions

1. Raise and safely support the vehicle.
2. Remove the wheel and tire assembly.
3. Remove the brake drum.
4. Remove the parking brake cable from the parking brake lever.
5. Remove the 2 brake shoe hold-down springs and pins.
6. Lift the brake shoes, springs and adjuster assembly off the backing plate and wheel cylinder assembly. When removing the assembly, be careful not to bend the adjusting lever.
7. Remove the retracting springs from the lower brake attachments and upper shoe-to-adjusting lever attachment points.
8. Remove the horse shoe retaining clip and spring washer and slide the lever off the parking brake lever pin on the trailing shoe. Discard the horseshoe clip.

To install:

9. Apply a light coating of disc brake caliper slide grease at the points where the brake shoes contact the backing plate.
10. Apply a thin coat of lubricant to the adjuster screw threads and socket end of the adjusting screw. Install the stainless steel washer over the socket end of the adjusting screw and install the socket. Turn the adjusting screw into the adjusting pivot nut to the limit of the threads and then back off 1/2 turn.
11. Assemble the parking brake lever to the trailing shoe by installing the spring washer and a new horse shoe retaining clip. Crimp the clip until it retains the lever to the shoe securely.
12. Position the trailing shoe on the backing plate and attach the rear parking brake cable.
13. Position the leading shoe on the backing plate and attach the lower brake shoe adjusting spring to the brake shoes.
14. Install the adjuster assembly in the slots on the brake shoes. The wide slot on the dual slotted end must fit into the leading shoe. The narrow slot on the dual slotted end fits into the shoe adjusting lever. The single slotted side of the adjuster assembly must fit into the slots on the trailing shoe and the rear parking brake cable bracket.

The adjuster socket blade is marked R for the right or L for the left brake assemblies. The adjuster blade must be installed with the letter R or L in the upright position, facing the wheel cylinder. Make sure the adjuster socket fits into the parking brake lever.

15. Complete the installation by reversing the removal procedures.
16. Pump the brake pedal several times to position the brake shoes and finish the brake shoe adjustment.
17. Road test the vehicle and check the brake system for proper operation.

ADJUSTMENTS

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Click to Enlarge

Install an alignment gauge on the brake shoes and the drum before rotating the adjusting screw assembly

The rear brakes are automatically adjusted while driving the vehicle. The brakes are also adjusted each time the parking brake is applied. Manual brake adjustment is only required after the brake shoes or hardware has been replaced, or the adjuster has been replaced.

1. Remove the brake drum as described in this section..
2. Remove any excessive dust and dirt present on the brakes using the appropriate methods.
3. Using a brake adjustment gauge, measure the inside diameter of the brake drum.
4. Line up the brake shoes vertically so the flats on the bottom of the brake shoes are aligned approximately 0.05 inch (1.5mm) above the bottom of the abutment plate.
5. Adjust the brake shoes to the same diameter as the drum by placing the brake adjustment gauge on the shoes and holding the adjusting lever out of engagement of the adjusting screw.

If the adjusting screw does not rotate freely, remove it, lubricate the threads, reinstall it and repeat the adjustment procedure.

6. Install the brake drum as described in this section.

Wheel Cylinders

REMOVAL & INSTALLATION

1. Raise and safely support the vehicle.
2. Remove the wheel and tire assembly.
3. Remove the brake drum.
4. Remove the brake shoes, retainers and springs from the backing plate.
5. Disconnect and plug the brake line at the rear of the wheel cylinder.
6. Remove the 2 bolts securing the wheel cylinder to the backing plate and remove the wheel cylinder.

To install:

Wipe the end of the brake line to remove any foreign matter before connecting to the wheel cylinder.

7. Install the wheel cylinder and tighten the bolts to 8-10 ft. lbs. (10-14 Nm).
8. Tighten the brake line fitting, using a tube nut wrench, to 12-14 ft. lbs. (16-20 Nm).
9. Complete the installation by reversing the removal procedures.
10. Bleed the rear brakes.
11. Road test the vehicle and check for leaks and proper brake system operation.

OVERHAUL

Wheel cylinder overhaul kits may be available, but often at little or no savings over a reconditioned wheel cylinder. It often makes sense with these components to substitute a new or reconditioned part instead of attempting an overhaul.

If no replacement is available, or you would prefer to overhaul your wheel cylinders, the following procedure may be used. When rebuilding and installing wheel cylinders, avoid getting any contaminants into the system. Always use clean, new, high quality brake fluid. If dirty or improper fluid has been used, it will be necessary to drain the entire system, flush the system with proper brake fluid, replace all rubber components, then refill and bleed the system.

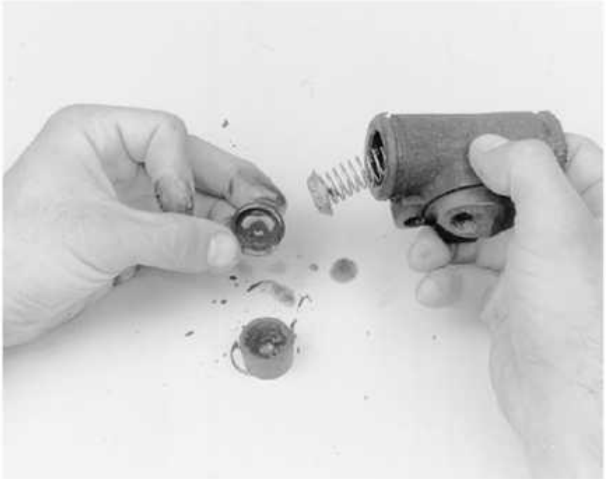
1. Remove the wheel cylinder from the vehicle and place on a clean workbench.

2. First remove and discard the old rubber boots, then withdraw the pistons. Piston cylinders are equipped with seals and a spring assembly, all located behind the pistons in the cylinder bore.

Remove the outer boots from the wheel cylinder

3. Remove the remaining inner components, seals and spring assembly. Compressed air may be useful in removing these components. If no compressed air is available, be VERY careful not to score the wheel cylinder bore when removing parts from it. Discard all components for which replacements were supplied in the rebuild kit.

Compressed air can be used to remove the pistons and seals



Remove the pistons, cup seals and spring from the cylinder

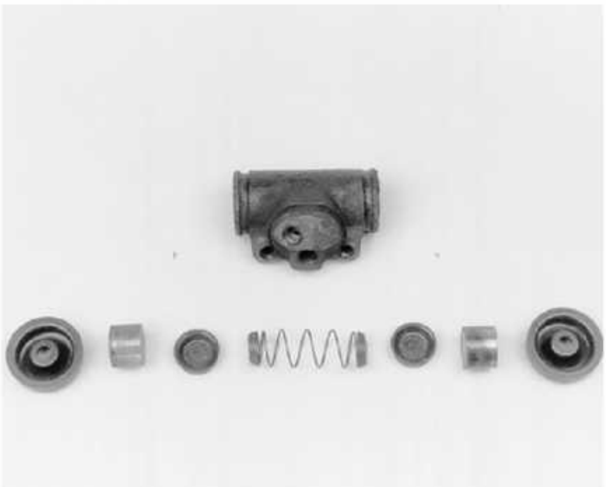
4. Wash the cylinder and metal parts in denatured alcohol or clean brake fluid.

Use brake fluid and a soft brush to clean the pistons...

... and the bore of the wheel cylinder

Never use a mineral-based solvent such as gasoline, kerosene or paint thinner for cleaning purposes. These solvents will swell rubber components and quickly deteriorate them.

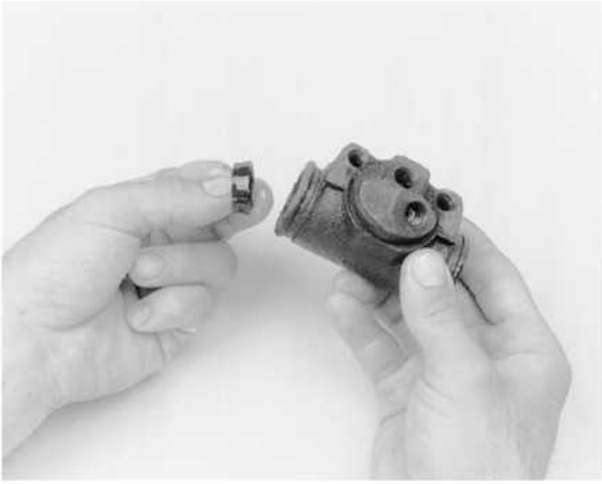
5. Allow the parts to air dry or use compressed air. Do not use rags for cleaning, since lint will remain in the cylinder bore.
6. Inspect the piston and replace it if it shows scratches.



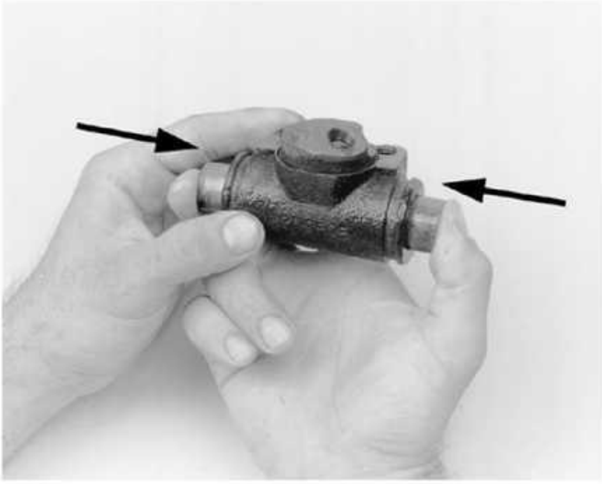
Once cleaned and inspected, the wheel cylinder is ready for assembly

7. Lubricate the cylinder bore and seals using clean brake fluid.
8. Position the spring assembly.
9. Install the inner seals, then the pistons.

Lubricate the cup seals with brake fluid



Install the spring, then the cup seals in the bore



Lightly lubricate the pistons, then install them

10. Insert the new boots into the counterbores by hand. Do not lubricate the boots.

The boots can now be installed over the wheel cylinder ends

11. Install the wheel cylinder.

PARKING BRAKE

REMOVAL & INSTALLATION

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Click to Enlarge

Parking brake system

Front Cable

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Front parking brake cable-to-lever connection

1. Raise and safely support the vehicle.
2. Loosen the adjuster nut at the cable adjuster bracket.
3. Remove the grommet from the floor.
4. Remove the cable and push-in prong retainer from the cable bracket, using a 1/2 inch or 13 mm box end wrench to depress the retaining prongs.
5. Lower the vehicle.
6. Remove the floor scuff plate (cowl trim panel) and position the carpeting aside.
7. From inside the vehicle, remove the cable end from the clevis using a 1/2 inch or 13 mm box end wrench to press the retaining prongs and remove the conduit from the parking brake control.
8. Raise and safely support the vehicle.
9. Pull the cable assembly through the floorpan hole and remove.

To install:

10. Position the cable assembly through the floorpan hole and secure the rubber grommet.
11. Position the cable through the bracket at the inner floor side member. Push the prong into the bracket.

12. Install the cable adjusting nut and adjuster.
13. Complete the installation by reversing the removal procedures.
14. Adjust the parking brake.
15. Check the parking brake for proper operation.

Rear Cable-Driver Side

To install:

Rear Cable-Passenger Side

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Passenger side rear parking brake cable-to-equalizer connection

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Remove the retaining clip and remove the brake cable from the caliper on disc brake equipped models

To install:

ADJUSTMENT

1. Make sure the parking brake is fully released.
2. Place the transaxle in *N*.
3. Partially raise and safely support the vehicle.
4. Place jack stands under the rear suspension.
5. Using Cable Tension Gauge 021-00018 or equivalent, tighten the adjusting nut against the rear parking brake cable adjuster until the cable tension is 18-26 lbs. for 1996 (8.1-11.7 Kg) and 34-46 lbs. (15.8-20.8 Kg) for 1997-98
6. Apply the parking brake control fully and then release.
7. Verify the cable tension is still as specified and no drag is present on the rear brakes.
8. Remove the jack stands.
9. Lower the vehicle.
10. Check the parking brake for proper operation.

ANTI-LOCK BRAKE SYSTEM

General Information

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Anti-lock hydraulic system schematic

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Anti-lock brake system component locations

The 4-Wheel Anti-lock Brake System (ABS) is an electronically operated, all wheel brake control system. Major components include the vacuum power brake booster, master cylinder, the wheel speed sensors, and the Hydraulic Control Unit (HCU) which contains the control module, a relay, and the pressure control valves.

The system is designed to retard wheel lockup during periods of high wheel slip when braking. Retarding wheel lockup is accomplished by modulating fluid pressure to the wheel brake units. When the control module detects a variation in voltage across the wheel speed sensors, the ABS is activated. The control module opens and closes various valves located inside the HCU. These valves, called dump and isolation valves, modulate the hydraulic pressure to the wheels by applying and venting the pressure to the brake fluid circuits.

PRECAUTIONS

- Certain components within the ABS system are not intended to be serviced or repaired individually.
- Do not use rubber hoses or other parts not specifically specified for and ABS system. When using repair kits, replace all parts included in the kit. Partial or incorrect repair may lead to functional problems and require the replacement of components.
- Lubricate rubber parts with clean, fresh brake fluid to ease assembly. Do not use shop air to clean parts; damage to rubber components may result.
- Use only DOT 3 brake fluid from an unopened container.
- If any hydraulic component or line is removed or replaced, it may be necessary to bleed the entire system.
- A clean repair area is essential. Always clean the reservoir and cap thoroughly before removing the cap. The slightest amount of dirt in the fluid may plug an orifice and impair the system function. Perform repairs after components have been thoroughly cleaned; use only denatured alcohol to clean components. Do not allow ABS components to come into contact with any substance containing mineral oil; this includes used shop rags.
- The Anti-Lock control unit is a microprocessor similar to other computer units in the vehicle. Ensure that the ignition switch is ***OFF*** before removing or installing controller harnesses. Avoid static electricity discharge at or near the controller.
- If any arc welding is to be done on the vehicle, the control unit should be unplugged before welding operations begin.

TESTING

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Anti-lock brake system trouble codes

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Anti-lock brake system trouble codes-continued

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Anti-lock brake system parameter identification

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Anti-lock brake system parameter identification-continued

The ABS module performs system tests and self-tests during startup and normal operation. The valves, wheel sensors and fluid level circuits are monitored for proper operation. If a fault is found, the ABS will be deactivated and the amber ANTI LOCK light will be lit until the ignition is turned OFF. When the light is lit, the Diagnostic Trouble Code (DTC) may be obtained. Under normal operation, the light will stay on for about 2 seconds while the ignition switch is in the ON position and will go out shortly after.

The Diagnostic Trouble Codes (DTC) are an alphanumeric code and a scan tool, such as Rotunda NGS Tester 007-00500 or its equivalent, is required to retrieve the codes. Refer to the manufacturer's instructions for operating the tool and retrieving the codes.

The data link connector (DLC) for the ABS is the OBDII connector located under the driver's side of the instrument panel, underneath the steering column.

Anti-Lock Control Assembly

REMOVAL & INSTALLATION

The anti-lock control assembly consists of the HCU and the anti-lock control module.

1. Disconnect the battery cables and remove the battery and battery tray from the vehicle.
2. Remove the connector retaining bolt and detach the electrical connector from the control module.
3. Label and remove the two tubes from the inlet ports and the four tubes from the outlet ports of the HCU. Plug each port to prevent contamination.
4. Remove the pump motor ground retaining screw and remove the ground wire from the body.
5. Remove the three control assembly-to-bracket retaining bolts and remove the control assembly from the vehicle.
6. Remove the five control module-to-HCU retaining screws and separate the control module from the HCU.

To install:

7. Position the control module to the HCU and tighten the five retaining bolts.
8. Install the control assembly into the bracket and tighten the three retaining bolts to 20-25 ft. lbs. (26-34 Nm).
9. Position the pump motor ground strap and tighten the retaining screw.
10. Install the inlet and outlet tubes to the HCU and tighten the tube nuts to 11-17 ft. lbs. (14-24 Nm).
11. Attach the electrical connector to the control module and tighten the connector retaining bolt.
12. Install the battery tray, battery and connect the battery cables.
13. Bleed the brakes using the anti-lock brake bleeding procedure.

Speed Sensors

REMOVAL & INSTALLATION

Front Sensor

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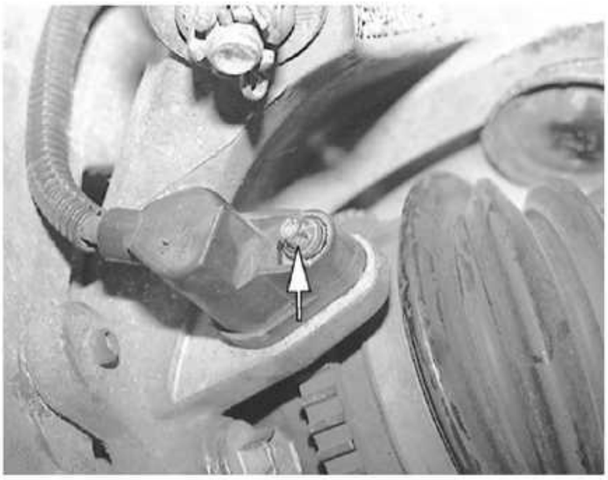
Front anti-lock brake wheel speed sensor mounting



Remove the speed sensor retaining bolt and...

... remove the sensor from the front steering knuckle

Apply a quality thread locking compound to the retaining bolt before installation

1. Disconnect the negative battery cable. Detach the anti-lock speed sensor wire located in the engine compartment.
2. Raise and safely support the vehicle.
3. Remove the plastic studs to loosen the front fender splash shield.
4. Remove the anti-lock speed sensor wire grommets at the rail bracket and from the retainer on the strut housing just above the steering knuckle.
5. Remove the anti-lock speed sensor retaining bolt and the sensor from the steering knuckle.

To install:

6. Install the anti-lock speed sensor and the retaining bolt. Tighten the retaining bolt to 90-120 inch lbs. (10.2-13.8 Nm).
7. Install the grommets at the rail bracket and the retainer at the strut housing.
8. Install the plastic studs in the front fender splash shield.
9. Lower the vehicle.
10. Connect the sensor wire to the wire harness in the wheel opening at the frame rail.
11. Connect the negative battery cable. Road test the vehicle and check for proper operation.

Rear Sensor

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Rear anti-lock brake wheel speed sensor mounting

1. Disconnect the negative battery cable. Raise and safely support the vehicle.
2. Disconnect the anti-lock speed sensor from the mating body connector located in the center of the crossmember.
3. Disconnect the clips from the suspension arm and crossmember.
4. On station wagons, remove the sensor retaining bolt from the brake adapter and on sedans remove the bolt from the spindle.
5. Remove the anti-lock speed sensor assembly.

To install:

6. Install the anti-lock speed sensor and retaining bolt. Tighten the retaining bolt 62-98 inch. lbs. (7.6-10.4 Nm).
7. Install the sensor wiring clips to the suspension arm and crossmember.
8. Connect the anti-lock speed sensor to the mating body connector in the center of the crossmember.
9. Lower the vehicle.
10. Connect the negative battery.
11. Road test the vehicle and check for proper operation.
12. If the amber or red brake indicator lamps illuminate at any time during the road test, check the brake system for possible faults.

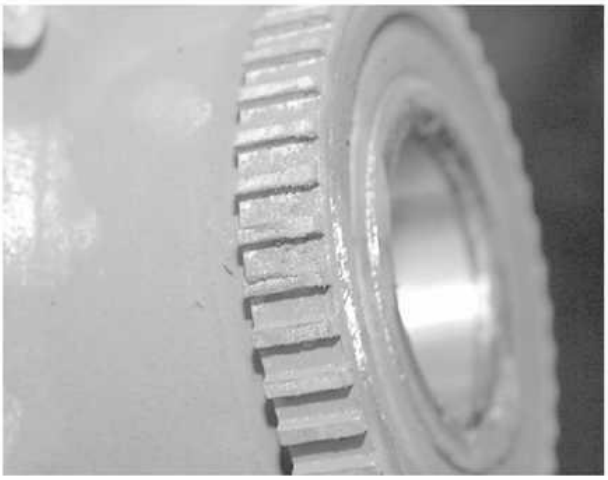
Tone (Exciter) Ring

REMOVAL & INSTALLATION

Front

The front exciter rings are located on the outer CV-joints. Refer to Section 7 for halfshaft removal.

Rear



The rear exciter ring is located on the back of the hub assembly

The rear exciter rings are located on the hubs. Refer to Section 8 for hub removal.

Bleeding the ABS System

If a spongy brake pedal is present and air in the hydraulic control unit is suspected, use the following procedure to bleed the brake system:

1. Connect a New Generation Star (NGS) tester or equivalent scan tool, to the serial data link connector below the instrument panel as though retrieving codes.
2. Make sure the ignition switch is in the ***RUN*** position.
3. Follow the instructions on the NGS screen. Verify correct vehicle and model year go to the "Diagnostic Data Link"

SPECIFICATIONS CHARTS

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Brake Specifications

BODY & TRIM

EXTERIOR

Doors

REMOVAL & INSTALLATION

Click on icon to view fullsize printable image.

Click to Enlarge

The door-to-body mounting

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Click to Enlarge

Detach the door wiring from the connector

This is a two person operation.

1. Remove the two door check-to-body retaining screws.

Cover the end of the check strap to prevent possible paint damage.

2. On the rear doors, remove the rear door trim panel, detach the electrical connectors from the components (if equipped) and remove the wiring harness from rear door.
3. On the driver's side front door, disconnect the window regulator wiring, if so equipped, by removing the wire connector cover, loosening the screw and separating the connector halves.
4. On the passenger side front door, remove the rubber harness protector from the body to reveal the electrical connectors. Detach the two electrical connectors.
5. If the door is to be replaced, transfer the following components to the new door if in usable condition:

- Door trim panel
- Watershield
- Outside mouldings
- Trim clips
- Window regulator
- Door latch components.

6. Remove the hinge retaining screws and nuts from the door and remove the door.

To install:

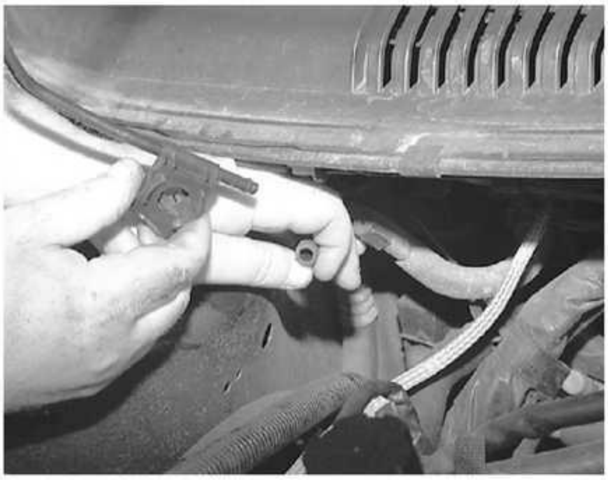
7. Position the door onto the hinges and hand tighten the screws.
8. Align the door and tighten the screws to 19-25 ft. lbs. (25-35 Nm).
9. If removed, install the wiring harness to the rear doors.
10. Attach the electrical connectors to the door panel.
11. Install the door panel(s).

ADJUSTMENT

1. Determine which hinge bolts and nuts must be loosened to move door in desired direction.
2. Loosen the hinge bolts and nuts enough to permit movement of the door with a padded pry bar.
3. Move the door the estimated necessary distance. Tighten the hinge bolts and nuts to 19-25 ft. lbs. (25-35 Nm) and check door fit to make sure there is no bind or interference with the adjacent panel.
4. Repeat the operation until desired fit is obtained.

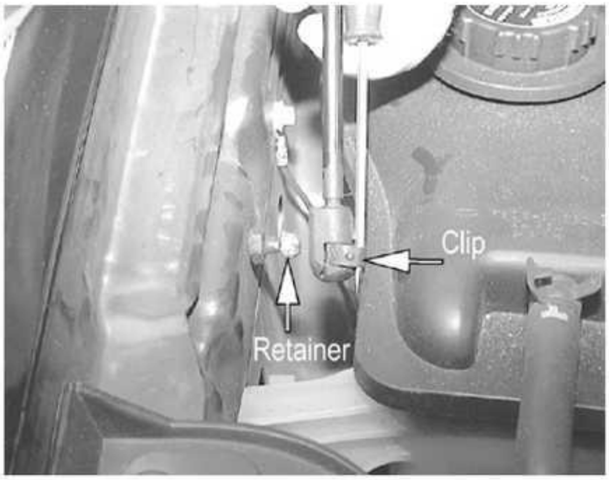
Hood

REMOVAL & INSTALLATION



Disconnect the washer fluid hoses

Peel back the weatherstripping protecting the bottom of the hood-to-cowl junction point, so that it clears the hood hinges



Detach the hood hydraulic lift by prying the retaining clip out and carefully pulling the hydraulic lift from the retainer

Matchmark the hood hinge location on the hood

Remove the hood hinge-to-hood retaining bolts

The help of an assistant is recommended when removing or installing the hood.

1. Disconnect the negative battery cable.
2. Open and support the hood.
3. Protect the body with covers to prevent damage to the paint.
4. Unplug any electrical connections and windshield washer hoses that would interfere with the hood removal.
5. Use a marker or scribe marks around the hinge locations for reference during installation.
6. While an assistant helps secure the hood, unfasten the attaching bolts, then remove the hood from the vehicle.

To install:

7. Place the hood into position. Install and partially tighten attaching bolts.
8. Adjust the hood with the reference marks and tighten the attaching bolts to 18 ft. lbs. (24 Nm).
9. Check the hood for an even fit between the fenders and for flush fit with the front of the fenders. Also, check for a flush fit with the top of the cowl and fenders. If necessary, adjust the hood latch.
10. Attach any electrical connections or windshield washer hoses removed to facilitate hood removal.
11. Connect the negative battery cable.

ALIGNMENT

1. The hood can be adjusted fore-and-aft and side-to-side by loosening the two hood-to-hood hinge retaining bolts at each hood hinge.
2. Position the hood as required and tighten the hood-to-hood hinge retaining bolts. A 0.10-0.22 inch (2.5-5.5 mm) margin should be maintained between the hood and front fenders.

Luggage Compartment Door (Trunklid)

REMOVAL & INSTALLATION

Removal of the luggage compartment door is a two-person operation.

1. Remove the four hinge-to-luggage compartment door screws and remove the luggage compartment door.

To install:

2. Follow removal procedure in reverse order.
3. Tighten the four hinge-to-luggage compartment door retaining screws to 89-123 inch lbs. (10-14 Nm).
4. Adjust as outlined in this section.

ALIGNMENT

1. Loosen the hinge-to-luggage door retaining screws.
2. Shift the luggage compartment door to desired proper location.
3. Tighten the retaining screws to 89-123 inch lbs. (10-14 Nm).

Liftgate

REMOVAL & INSTALLATION

Liftgate removal and installation is a two-person operation.

1. Before removing the hinge-to-roof frame attachments at both liftgate hinges, use a felt marker or equivalent to mark the location of each liftgate hinge on the roof frame being careful not to scratch the paint.
2. Disconnect the negative battery cable.
3. Open the liftgate.
4. Remove the rear corner upper finish panel.
5. Detach the wiring harness connectors at the top left and right D pillar posts.
6. Remove the liftgate harness and rubber harness protectors from the body.
7. Remove the luggage compartment door hydraulic lifts.

Do not remove the Torx® head bolt and nut. They are used to locate the hinge to the body during installation.

8. Remove the screw and nut retaining the liftgate hinge-to-body.
9. Remove the liftgate from vehicle.

To install:

10. The installation is the reverse of the removal.
11. Tighten screw and nut to 19-25 ft. lbs. (25-35 Nm)

ALIGNMENT

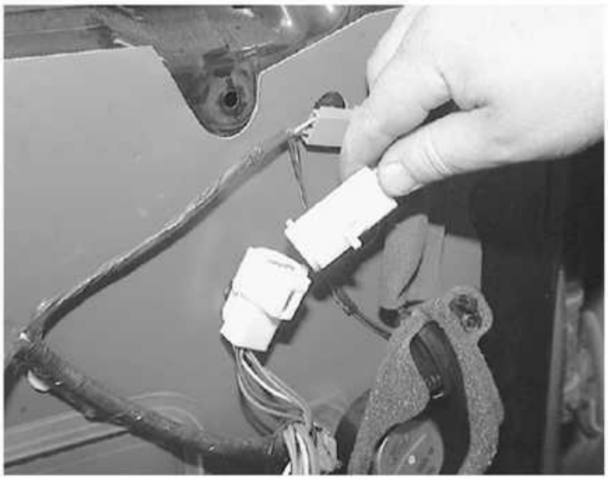
The liftgate can be adjusted:

- Up and down by loosening the bolts retaining the liftgate hinge-to-liftgate.
- In and out by loosening the screw, nut and through-bolt retaining liftgate hinge-to-body.
- Side-to-side (minimum adjustment available) by a combination of the above methods or by adjusting the striker on the body.

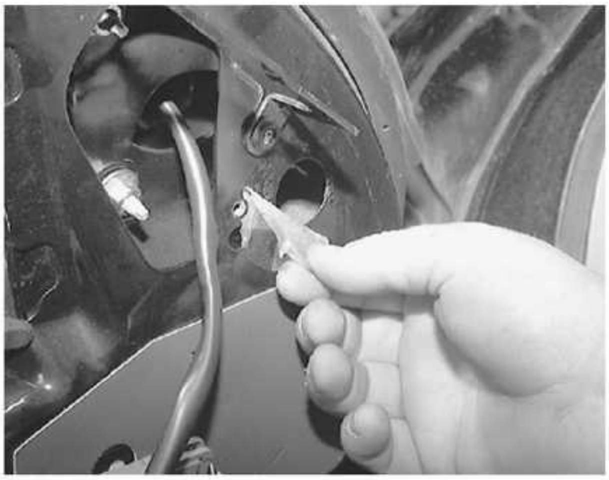
1. Shift or shim the liftgate hinge as required.
2. Seal the liftgate hinge to the body with Silicone Rubber D6AZ-19562-AA or equivalent meeting Ford specifications ESB-M4G92-A and ESE-M4G195-A.
3. Tighten the through-bolt and nut to 71-88 inch lbs. (8-10 Nm) using a Torx® T-25 bit and 10 mm wrench. Tighten the remaining screw and nut to 19-25 ft. lbs. (25-35 Nm).
4. Install the rear corner upper finish panel after the alignment is complete.

Outside Mirrors

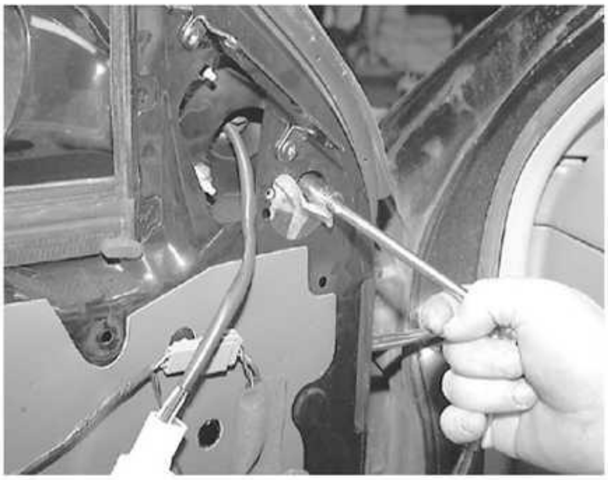
REMOVAL & INSTALLATION



Detach the connector for the mirror



If necessary, peel back any watershields to...



... access the mirror retaining bolts and remove them

As the bolts are removed, carefully support the mirror assembly then remove it from the vehicle

1. Disconnect the negative battery cable.
2. Remove the front door panel.
3. Detach the outside rearview mirror wiring connector.
4. Remove the wiring guides as necessary.
5. Remove the three outside rear view mirror retaining nuts.
6. Remove the outside rear view mirror while guiding the wiring through the hole in the door.

To install:

7. Install the outside rear view mirror by routing the wiring through the hole in the front door.
8. Install the three retaining nuts and tighten the retaining nuts to 54-70 inch lbs.(6-8 Nm).
9. Connect the mirror wiring.
10. Replace the front door trim panel.
11. Connect the negative battery cable.

Antenna

REPLACEMENT

Fixed Mount Antenna

1. Open the luggage compartment door and remove trim panel on the driver's side.
2. Remove the antenna nut and the antenna stanchion from the antenna base.
3. Remove the one nut and one bolt retaining the antenna base and cable inside the luggage compartment.
4. Remove the antenna base and disconnect the antenna lead-in cable from the antenna base.

To install:

5. Connect the antenna lead-in cable to the antenna base but do not tighten nuts at this time.
6. Install the antenna base with the retaining nut and bolt.
7. Install the antenna stanchion and antenna nut to the antenna base. Tighten the antenna nut to 53-71 inch lbs. (6-8 Nm).
8. Tighten the previously installed retaining nut and bolt to 8-9 ft. lbs. (11-13 Nm).
9. Install the trim panel in the luggage compartment.

Power Antenna

1. Remove the cover and the spare tire.
2. Remove the antenna nut and the antenna stanchion from the electric antenna.
3. Remove the one nut and one bolt retaining the electric antenna inside the luggage compartment.
4. Detach the wire harness connector and the antenna lead-in cable from the electric antenna and remove the electric antenna from the vehicle.

To install:

5. Attach the wire harness connector and antenna lead-in cable to the electric antenna.
6. Install the electric antenna and the retaining bolt and nut but do not tighten the nut at this time.
7. Install the antenna stanchion and antenna nut to the electric antenna. Tighten the antenna nut to 53-71 inch lbs. (6-8 Nm).
8. Tighten the previously installed bolt and nut to 8-9 ft. lbs. (11-13 Nm).
9. Install the spare tire and cover.

Fenders

REMOVAL & INSTALLATION

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Click to Enlarge

The front fender splash shield mounting

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The front fender mounting-exploded view

1. Remove the cowl vent screens.
2. Remove the hood hinge and hood.
3. Remove the front bumper cover.
4. Remove the four upper front fender-to-body retaining screws.
5. Remove the front fender splash shield.
6. Remove the floor side member moulding.
7. Remove the two screws retaining the lower rear of the front fender to the body side.
8. Remove the two retaining bolts from the catwalk area of the front fender retaining it to the front fender apron.
9. Remove the front fender.

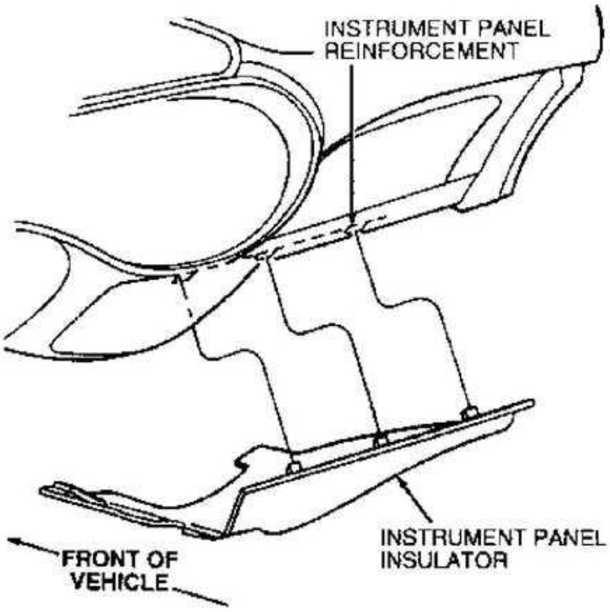
To install:

10. The installation is the reverse of removal.
11. Tighten the fender attaching screws to 71-88 inch lbs. (8-10 Nm).

INTERIOR

Instrument Panel

REMOVAL & INSTALLATION



Remove the instrument panel insulator from the instrument panel reinforcement

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Manual A/C-heater equipped vehicles disconnection points

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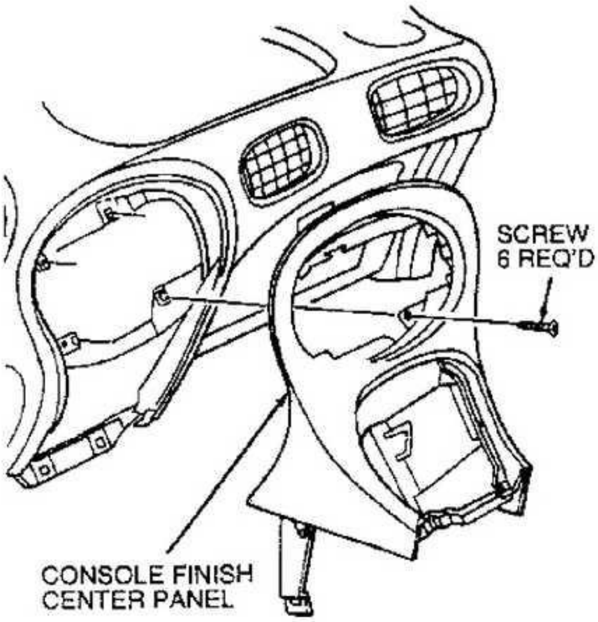
EATC equipped vehicles disconnection points



On floor shift vehicles, remove the console center finish panel

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On floor shift vehicles, remove the finish panel from around the integrated control panel

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If equipped with autolamps, detach the light sensor amplifier

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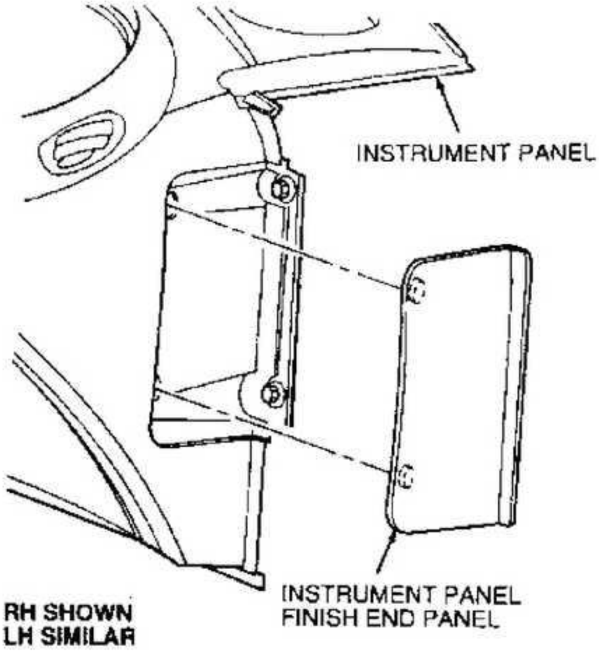
Unsnap the instrument panel upper finish panel from the instrument panel



Remove the instrument panel finish end panel

Click on icon to view fullsize printable image. **Click to Enlarge** *Detach the electrical connectors*
Click on icon to view fullsize printable image. **Click to Enlarge** *Instrument panel-to-cowl panel mounting*

Removal and installation of the instrument panel is best accomplished by two people.

Position the front wheels in the straight-ahead position.

1. Disconnect the negative battery cable.
2. Remove the pushpins and remove the instrument panel insulator from the instrument panel reinforcement .
3. On floor shift models, remove the console panel.
4. On vehicles equipped with manual A/C-heater, remove the main wiring electrical connectors and vacuum hose harness from A/C evaporator housing and blower motor.
5. On vehicles equipped with electronic automatic temperature control (EATC), remove the automatic temperature control sensor hose and elbow, the two main wiring harness electrical connectors and the vacuum hose harness from the A/C evaporator housing.
6. On floor shift vehicles, remove the integrated control panel as outlined in Section 6.
7. On floor shift vehicles, remove the six screws and console center finish panel.
8. On floor shift models, remove the four screws and remove the finish panel from around the integrated control panel.

Do not remove the steering column from the vehicle unless the steering column is locked to prevent rotation or lower end of steering shaft is wired in such a way to prevent the steering wheel from being rotated.

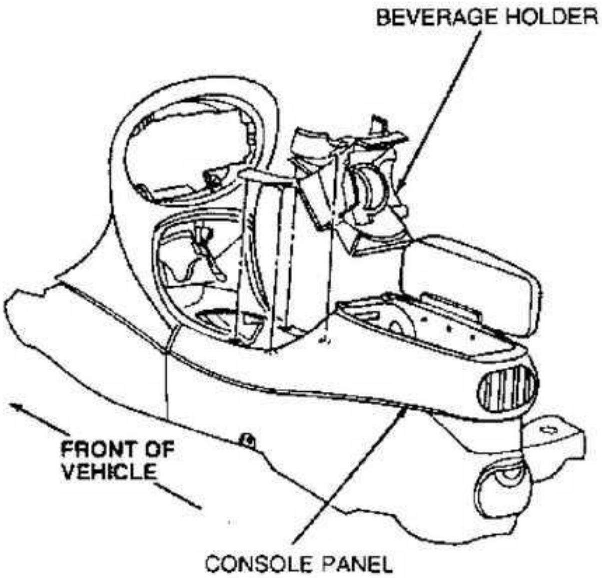
9. Remove the steering column assembly.
10. On autolamp equipped vehicles, detach the connector from the light sensor amplifier.
11. Unsnap the instrument panel upper finish panel from the instrument panel .
12. Unsnap and remove the instrument panel finish end panel from both sides of the instrument panel.
13. Remove the front scuff plates and pull the door weatherstrip away from the instrument panel.
14. Remove the three screws retaining the instrument panel-to-upper cowl top panel.
15. Working with an assistant, remove the two screws at each end of the instrument panel.
16. Detach the instrument panel-to-dash panel electrical connectors.
17. Remove the parking brake cable and detach the parking brake switch connector.
18. With an assistant, remove the instrument panel from the vehicle.

To install:

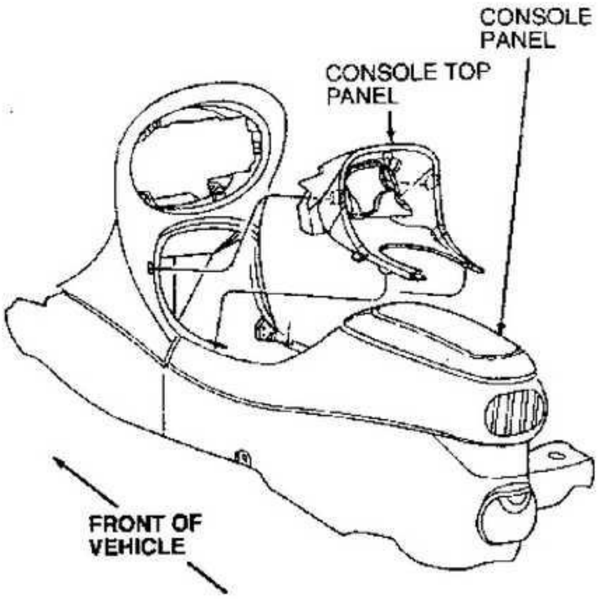
19. If the instrument panel is being replaced, transfer all components, wiring and hardware to the new instrument panel .
20. With an assistant, place the instrument panel in the vehicle. Attach the instrument panel-to-dash panel electrical connectors. Tighten the connector retaining screws.
21. With an assistant, install the instrument panel to the cowl and install the two screws at each end of the instrument panel. Tighten the screws to 15-18 ft. lbs. (19-25 Nm).
22. Install the three screws retaining the instrument panel-to-upper cowl top panel. Tighten the screws to 62-79 inch lbs.(7-9 Nm).
23. Install the parking brake cable and attach the brake switch connector.
24. Install the instrument panel finish end panel to each end of the instrument panel by snapping in place.
25. Install the door weatherstrips and scuff plates.
26. Snap the instrument panel upper finish panel into place in the instrument panel .
27. Install the steering column assembly.
28. On floor shift models, install console center finish panel with six retaining screws.
29. Install the integrated control panel.
30. On vehicles equipped with electronic automatic temperature control (EATC), install the automatic temperature control sensor hose and elbow, two main wiring electrical connectors and the vacuum hose harness to the A/C evaporator housing.
31. On vehicles equipped with manual A/C-heater, install the main wiring electrical connectors and vacuum hose harness to the A/C evaporator housing and blower motor.
32. Reattach any other electrical connectors or hoses detached for removal of the instrument panel.
33. On floor shift models, install the console panel.
34. Install the instrument panel insulator-to-instrument panel reinforcement .
35. Connect the negative battery cable.
36. Install/attach any other components removed/disconnected for removal of the instrument panel.
37. Test all instrument panel gauges and controls for proper operation.
38. Verify the air bag warning indicator operation.

Center Console

REMOVAL & INSTALLATION



Remove the beverage holder from the center console



Grasp the console top panel and pull rearward to unsnap from the console center finish panel

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Remove the two screws retaining console panel-to-console center finish panel

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Remove the two screws retaining the console finish panel-to-console panel and remove the console finish panel

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Remove the four bolts retaining the console panel to the floor mounting bracket

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Remove the two bolts retaining the console panel to the rear bracket

1. Remove the beverage holder by carefully unsnapping the front portion using a flat-blade screwdriver. Grasp the beverage holder and unsnap from console panel.
2. Open the ash receptacle and move the gearshift lever to the ***Park*** position.
3. Grasp the console top panel and pull rearward to unsnap from the console center finish panel. Remove the electrical connectors from the cigar lighter socket and lamp assembly.
4. Remove the two screws retaining the console finish panel-to-console panel and remove the console finish panel.
5. Remove the two screws retaining console panel-to-console center finish panel.
6. Pull the two carpet-covered kick panels at lower front of console panel to disengage the clips from the bracket.
7. Remove the four bolts retaining the console panel to the floor mounting bracket.
8. Remove the two bolts retaining the console panel to the rear bracket.
9. Remove the console panel from the vehicle.

To install:

10. The installation is the reverse of the removal.
11. Tighten the side mounting bolts to 80-106 inch lbs. (9-12 Nm).

Door Panels

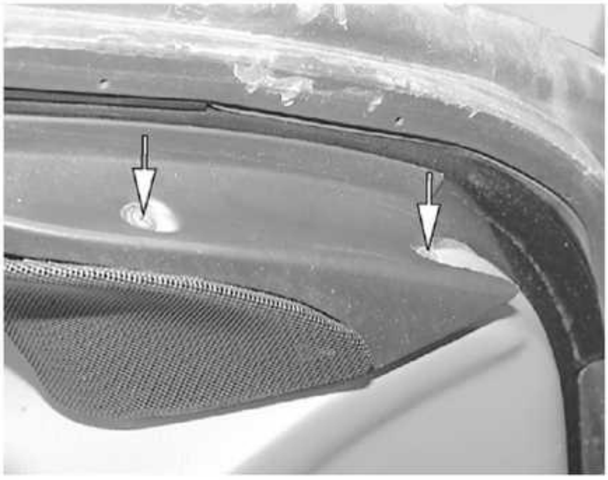
REMOVAL & INSTALLATION

This procedure applies to both the front and rear door panels.

Remove the cover from behind the inside door handle by gently pulling it out to release the retaining tabs

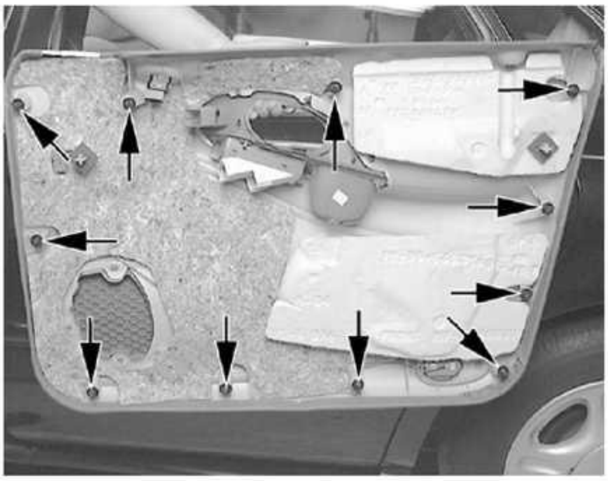
Remove the pull cup retaining screw cover and...

... remove the retaining screw from the cup and lift the cup straight up out of the door panel



Remove the two sail panel/speaker grille retaining screws and...

... remove the panel/grille from the door



The door panel is retained to the door by 11 retaining clips

Carefully lift the door panel off of the door and...

... detach the electrical connectors from the switches and remove the panel from the vehicle

1. Remove the cover behind the inside door handle.
2. Remove the screw from the bottom of the pull cup retaining the front door trim panel to the front door.
3. Remove the two screws retaining the sail panel/speaker grille assembly and remove the panel/grille from the door.
4. Remove the three screws retaining the front door trim panel to the front door.

Do not attempt to remove more than one pushpin at a time.

5. Use a suitable tool to remove the pushpins from the door.
6. Carefully lift the door panel away from the door.
7. Detach the electrical connectors as necessary and remove the panel from the door.

To install:

8. Installation is the reverse of removal.

Door Locks

REMOVAL & INSTALLATION

Lock Cylinders

DOOR

Click on icon to view fullsize printable image.

Click to Enlarge

Door wiring harness disconnection points

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Door lock cylinder mounting

1. Remove the door trim panel and watershield.
2. Remove the outside door handle.
3. Detach the anti-theft switch connector and pull out the two harness retaining clips from the inner door.
4. Remove the door lock cylinder retainer retaining the door lock cylinder to the front door and remove the door lock cylinder.

To install:

5. Installation is the reverse of removal.

LUGGAGE COMPARTMENT DOOR

1. Unsnap and remove the luggage compartment door inside cover from the luggage compartment door.
2. Disconnect the anti-tamper switch from the luggage compartment lock cylinder.
3. On Taurus models, remove the two retaining nuts, and remove the luggage compartment lock cylinder from the luggage compartment door.
4. On Sable models, drill out and remove the two rivets retaining the luggage compartment lock cylinder retainer clip assembly, and remove the retainer clip assembly.
5. Remove the luggage compartment lock cylinder from the liftgate.

To install:

6. Installation is the reverse of removal.

LIFTGATE

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Liftgate lock cylinder mounting

1. Remove the liftgate inside trim panel.
2. Remove the 12 nuts retaining the rear reflector and socket to the liftgate. Remove the rear reflector and socket.
3. Release the door latch rod retainer and remove from the rear license plate housing and bracket.
4. Remove the two retaining nuts and remove the liftgate lock cylinder from the liftgate.

To install:

5. Installation is the reverse of removal.
6. Tighten the lock cylinder retaining nuts to 54-70 inch lbs. (6-8 Nm).

Latch Assembly

FRONT DOOR

1. Position the door glass in the up position.
2. Remove the front door trim panel and watershield.
3. Unbolt the window regulator support bar from the door, and slide the bar out of the way to gain access to the door latch.
4. Remove the upper end of the front door key cylinder rod from the key cylinder lever.
5. Remove the retainer attaching the outside door handle control rod-to-front door latch.
6. Detach the electrical connector for the door ajar switch (attached to door latch).
7. Detach the electrical connector for the power door latch actuator (if equipped).
8. Remove the three screws attaching the front door latch to the front door.
9. Remove the front door latch from the front door.
10. Remove the cable watershield and the cable from the door latch.
11. To remove door ajar switch, use a flat-blade screwdriver to gently pry apart the inner latch casing while twisting the door ajar switch clockwise (for passenger side door latch) or counterclockwise (for driver's side door latch) until switch releases. Remove the door ajar switch.
12. To remove the door latch actuator, release the retaining tab on the actuator and slide the actuator off of the door latch.
13. Transfer the components to the new front door latch as necessary.

To install:

14. Installation is the reverse of removal. Tighten the front door latch retaining screws to 89-123 inch lbs. (10-14 Nm).

REAR DOOR

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Rear door latch mounting

1. Position the window glass in the up position.
2. Remove the rear door trim panel and watershield.
3. Remove the rear door pushbutton rod.

Do not drive out the center of the bell crank rivet, or the door sheet metal may be damaged. Drill the rivet or cut the head of the rivet to remove it.

4. Remove the one rivet retaining the rear door latch bellcrank to the rear door.
5. Remove the rear door latch control rod retainer from the door by twisting it with a flat-blade screwdriver.
6. Detach the electrical connector for the door ajar switch.
7. Detach the electrical connector for the power door latch actuator (if equipped).
8. Remove the retainer attaching the outside door handle control rod to the front door latch.
9. Remove the three screws retaining the rear door latch to the rear door.
10. Feed the latch and link rod forward in the door far enough to twist and remove the latch from the link rod. Leave the link rod in this position in vehicle. Remove the door latch from the vehicle.
11. Remove the cable watershield and cable from the door latch.
12. To remove the door ajar switch, use a flat-blade screwdriver to gently pry apart the inner latch casing while twisting the door ajar switch clockwise (for passenger side door latch) or counterclockwise (for driver's side door latch) until the switch releases. Remove the door ajar switch.
13. To remove the door latch actuator, release the tab on the actuator and slide the actuator off the door latch.

To install:

14. Transfer the components to the new door latch as required.
15. Installation is the reverse of removal. Tighten the rear door latch retaining screws to 89-123 inch lbs.(10-14 Nm).

LUGGAGE COMPARTMENT DOOR

1. Remove the luggage compartment door trim panel from the luggage compartment door.
2. Detach the anti-tamper switch connector from the luggage compartment lock cylinder.
3. Detach the wiring connector from the luggage compartment door latch assembly.
4. Remove the three screws retaining luggage compartment door latch assembly and remove from the luggage compartment door.

To install:

5. Installation is the reverse of removal. Tighten the latch retaining screws to 89-123 inch lbs.(10-14 Nm).

LIFTGATE

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Liftgate latch mounting

1. Remove the liftgate inside trim panel.
2. Detach the anti-theft switch connector.
3. Unsnap and release the liftgate latch release rod from rear license plate housing and bracket.
4. Pry out and remove the two push-pin retainers and remove the liftgate latch cover.
5. Remove the three retaining screws and remove the luggage compartment door latch from the liftgate.
6. Transfer the liftgate latch release rod to the new luggage compartment door latch.

To install:

7. Installation is the reverse of removal. Tighten the liftgate latch retaining screws to 89-123 inch lbs.(10-14 Nm).

Power Door Lock Actuator

DOOR

Click on icon to view fullsize printable image.

Click to Enlarge

Power lock actuator mounting-front door

Click on icon to view fullsize printable image.

Click to Enlarge

Power lock actuator mounting-rear door

1. Position the window glass in the up position.
2. Remove the front or rear door latch assembly.
3. Remove the door ajar switch from the door latch assembly.
4. Using a flat-blade screwdriver, gently pry up the locking tab and slide the power door latch actuator off the door latch.

To install:

The power door latch actuator must be installed BEFORE the door ajar switch is installed.

5. Engage one end of the adjunct power door latch actuator to the channel on the door latch.
6. Press down on the actuator to engage the other end of the actuator to its channel on the door latch.
7. Slide the actuator onto the door latch, while making sure that the pin on the actuator engages through the yellow bushing on the arm of the latch properly, until the actuator clicks into place.
8. The balance of the installation is the reverse of removal. Tighten the door latch retaining screws to 89-123 inch lbs.(10-14 Nm).

LIFTGATE

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Rear reflector assembly-to-liftgate mounting

1. Remove the liftgate inside trim panel.
2. Remove the 12 nuts retaining the rear reflector and socket to the liftgate. Remove the rear reflector and socket.
3. Release the door latch rod retainer and remove the liftgate lock cylinder to release the rod from the rear license plate housing and bracket.
4. Remove the two retaining nuts and remove the liftgate lock cylinder from the liftgate.
5. Release the door latch rod retainer to free and remove the back window latch rod from the rear license plate housing and bracket.
6. Release the door latch rod retainer to free and remove the liftgate latch release rod from the rear license plate housing and bracket.
7. Remove the license plate light sockets from the rear license plate housing and bracket by twisting 1/4 of a turn and lift the bulb and socket out of the rear license plate housing and bracket.
8. Detach the electrical connectors for the lock actuator and liftgate ajar switch at the rear license plate housing and bracket.
9. Remove the three nuts retaining the rear license plate housing and bracket to the liftgate.
10. Remove the three retaining nuts and remove the actuator mounting bracket from the rear license plate housing and bracket.
11. Remove the two retaining screws and remove the rear liftgate actuator from the actuator mounting bracket.

To install:

12. Installation is the reverse of removal.

Door Window

REMOVAL & INSTALLATION

Glass

FRONT

Click to Enlarge

Door glass mounting-front door

1. Remove the front door trim panel and the front door watershield.
2. Remove the window garnish moulding.
3. Remove the front door belt line inside weatherstrip.
4. Lower the front door window glass to access the holes in the front door inner panel. Remove the two rivets retaining the front door window glass to the front door window channel bracket.
5. Loosen the nut and washer retaining the door window glass inner stabilizer.
6. Remove the rear mounting bolt from the front door glass run.
7. Remove the front door window glass by tipping it forward and then removing it from between the door belt opening and outboard side of the front door.

To install:

8. Install the front door window glass into door. Make sure that the front door window glass is set within the front door glass top run
9. Position the front door window glass to the front door window channel bracket. Install the two rivets, door window glass bracket spacers and door window glass channel bracket retainers to secure the front door window glass to the front door window channel bracket.
10. Install the front door belt line inside weatherstrip
11. Raise the front door window glass to within 3 inches (75 mm) of the full-up position and adjust the front door window glass. Adjust and tighten the door window glass inner stabilizer.
12. Install the window garnish moulding.
13. Lower the window to the full-down position and install the rear mounting bolt of the front door glass run. Tighten the bolt to 62-88 inch lbs.(7-10 Nm).
14. Install the front door watershield and front door trim panel.

REAR

Click on icon to view fullsize printable image.

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Door glass mounting-rear door

1. Remove the rear door trim panel and watershield.
2. Remove the window garnish moulding.
3. Remove the rear door glass inside weatherstrip by gently pulling the weatherstrip from the door flange.

Prior to removing the rivet center pins, insert a suitable block support between the door outer panel and glass to stabilize the glass during the rivet pin removal. Use a 1/4 inch diameter drill to drill out the remainder of rivet, using care not to enlarge the sheet metal holes or damage the plastic retainer and spacer.

4. Remove the rear door window glass-to-rear door glass channel front bracket attaching rivets.
5. Remove the rear door window stabilizer.
6. Lift the rear door window glass up between the door belt opening and remove from the rear door.

To install:

7. Install the door window glass channel bracket retainer and the door window glass bracket spacers into the rear door window glass. Install the rear door window glass into the door.
8. Secure the rear door window glass to the rear door glass channel front bracket and install the two rivets.
9. Install the rear door glass inside weatherstrip, using hand pressure to push the weatherstrip onto the rear door flange.
10. Install the window garnish moulding.
11. Install the rear door window stabilizer with the glass in the full down position. Secure with the retaining nut. Tighten the retaining nut to 62-97 inch lbs. (7-11 Nm).

12. Cycle the rear door window glass to verify smooth operation.
13. Install the rear door watershield and rear door trim panel.

Door Window Regulator

FRONT

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Window regulator mounting-front door

If the front door power window regulator counterbalance spring must be removed or replaced for any reason, make sure that the front door power window regulator arms are in a fixed position prior to removal to prevent possible injury during c-spring unwind.

1. Remove the front door trim panel and watershield.
2. Remove the front door window glass as outlined in this section.
3. Remove the two rivets attaching the window regulator equalizer arm bracket.
4. Remove the four rivets attaching the front door power window regulator base plate to the door inner panel.
5. Detach the window motor harness connector.
6. Remove the front door window regulator and front door window channel bracket as an assembly from the front door.
7. Working on a bench, carefully bend the tab flat to remove the window regulator arm rollers from the front door window channel bracket.
8. Install the new window regulator arm rollers into the front door window channel bracket and bend the tab back to 90 °. (Use care not to break tab. If tab is cracked or broken, replace front door window channel bracket .)
9. Remove the bolts retaining window motor to the front door window regulator.

To install:

10. Install the front door window channel bracket onto the front door window regulator.
11. Install the window motor onto the front door window regulator.
12. Install the front door window channel bracket, front door window regulator and window motor into front door. Set the regulator base plate to the front door inner panel using the base plate locator tab as a guide.
13. Install the retaining bolts.
14. Install the four rivets to attach the front door window regulator-to-front door inner panel.
15. Install the window regulator equalizer arm bracket.
16. Lower the regulator arms to access the holes in the front door inner panel. Install the front door window glass as outlined in this section.
17. Attach the window motor harness connector.
18. Adjust the front door window glass to verify proper alignment with the front door glass top run. Cycle the front door window glass for smooth operation.
19. Install the front door trim panel and watershield.

REAR

Click on icon to view fullsize printable image.

Click to Enlarge

Window regulator mounting-rear door

1. Remove the rear door trim panel and watershield..
2. Remove the rear door window glass as outlined in this section.
3. Remove the four rivets attaching the regulator mounting plate assembly to the rear door inner panel.

Use the access hole in rear door inner panel for removal and installation.

4. Slide the regulator arm plastic guides out of the rear door glass channel front bracket C-channel and detach the window motor connector.

5. Remove the rear door power window regulator from the rear door.
6. Remove the bolts retaining the window motor-to-rear door electric window regulator and remove the window motor.

To install:

7. Install the window motor to the rear door electric window regulator.
8. Install the rear door electric window regulator through the access hole in the rear door. Slide the regulator arm plastic guides into the rear door glass channel front bracket C-channel.
9. Install the rivets to secure the regulator mounting plate to the door inner panel.
10. Install the retaining bolts.
11. Attach the window motor harness connector.
12. Cycle the rear door window glass to check for smooth operation.
13. Install the watershield and rear door trim panel.

Window Motor

1. Raise the window glass to the full-up position if possible. If the glass cannot be raised and is in a partially down or full-down position, it must be supported so that it will not fall into the door well when removing the window motor.
2. Disconnect the negative battery cable.
3. Remove the door trim panel and watershield.
4. Detach the window motor harness connector.

If the front door power window regulator counterbalance spring must be removed or replaced for any reason, make sure that the front door power window regulator arms are in a fixed position prior to removal to prevent possible injury during c-spring unwind.

5. Remove the three window motor mounting screws.
6. Remove the window motor.

To install:

7. Position the window motor to the power window regulator. Install the three screws snugly but do not tighten all the way.
8. Attach the window regulator electric drive wires at the connector and cycle the door window glass to make sure the motor gear engages. After the gears are engaged, tighten the three window motor retaining screws to 54-88 inch lbs.(6-10 Nm).
9. Connect the negative battery cable.
10. Check the power window for proper operation.
11. Install the door trim panel and watershield.

Windshield and Fixed Glass

REMOVAL & INSTALLATION

If your windshield, or other fixed window, is cracked or chipped, you may decide to replace it with a new one yourself. However, there are two main reasons why replacement windshields and other window glass should be installed only by a professional automotive glass technician: safety and cost.

The most important reason a professional should install automotive glass is for safety. The glass in the vehicle, especially the windshield, is designed with safety in mind in case of a collision. The windshield is specially manufactured from two panes of specially-tempered glass with a thin layer of transparent plastic between them. This construction allows the glass to "give" in the event that a part of your body hits the windshield during the collision, and prevents the glass from shattering, which could cause lacerations, blinding and other harm to passengers of the vehicle. The other fixed windows are designed to be tempered so that if they break during a collision, they shatter in such a way that there are no large pointed glass pieces. The professional automotive glass technician knows how to install the glass in a vehicle so that it will function optimally during a collision. Without the proper experience, knowledge and tools, installing a piece of automotive glass yourself could lead to additional harm if an accident should ever occur.

Cost is also a factor when deciding to install automotive glass yourself. Performing this could cost you much more than a professional may charge for the same job. Since the windshield is designed to break under stress, an often life saving characteristic, windshields tend to break VERY easily when an inexperienced person attempts to install one. Do-it-yourselfers buying two, three or even four windshields from a salvage yard because they have broken them during installation are common stories. Also, since the automotive glass is designed to prevent the outside elements from entering your vehicle, improper installation can lead to water and air leaks. Annoying whining noises at highway speeds from air leaks or inside body panel rusting from water leaks can add to your stress level and subtract from your wallet. After buying two or three windshields, installing them and ending up with a leak that produces a noise while driving and water damage during rainstorms, the cost of having a professional do it correctly the first time may be much more alluring. We here at Chilton, therefore, advise that you have a professional automotive glass technician service any broken glass on your vehicle.

WINDSHIELD CHIP REPAIR

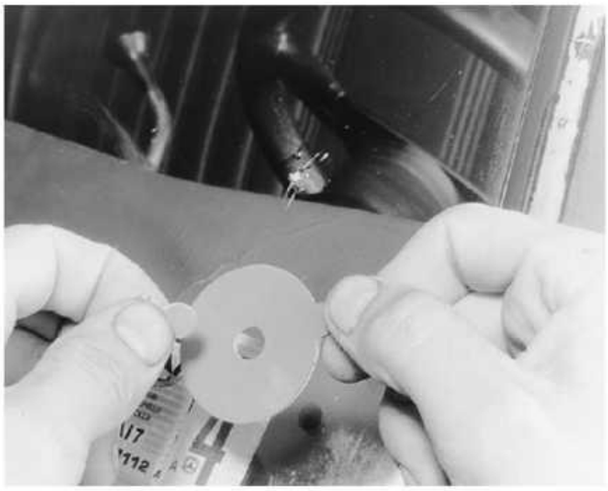
Check with your state and local authorities on the laws for state safety inspection. Some states or municipalities may not allow chip repair as a viable option for correcting stone damage to your windshield.

Although severely cracked or damaged windshields must be replaced, there is something that you can do to prolong or even prevent the need for replacement of a chipped windshield. There are many companies which offer windshield chip repair products, such as Loctite's® Bullseye™ windshield repair kit. These kits usually consist of a syringe, pedestal and a sealing adhesive. The syringe is mounted on the pedestal and is used to create a vacuum which pulls the plastic layer against the glass. This helps make the chip transparent. The adhesive is then injected which seals the chip and helps to prevent further stress cracks from developing. Refer to the sequence of photos to get a general idea of what windshield chip repair involves.

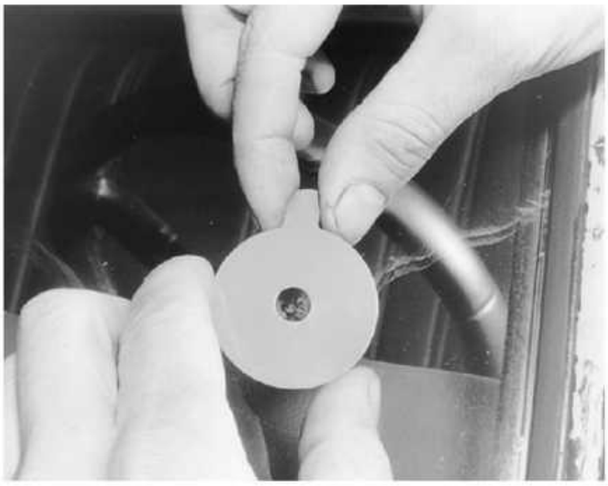
Always follow the specific manufacturer's instructions.

Small chips on your windshield can be fixed with an aftermarket repair kit, such as the one from Loctite®(

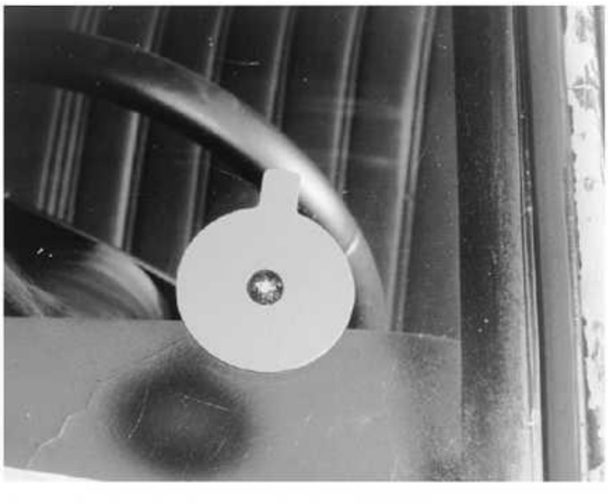
To repair a chip, clean the windshield with glass cleaner and dry it completely



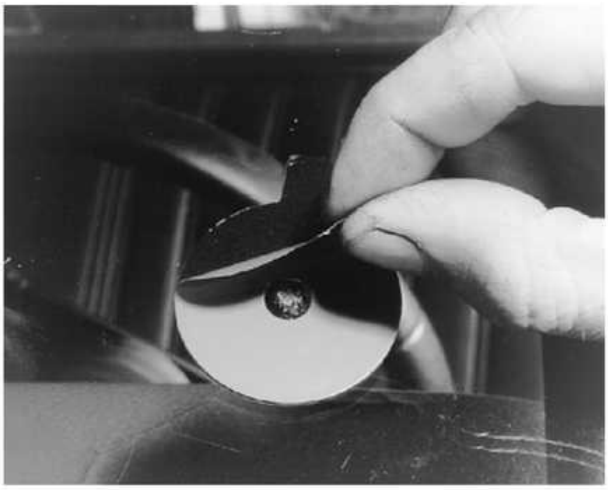
Remove the center from the adhesive disc and peel off the backing from one side of the disc...



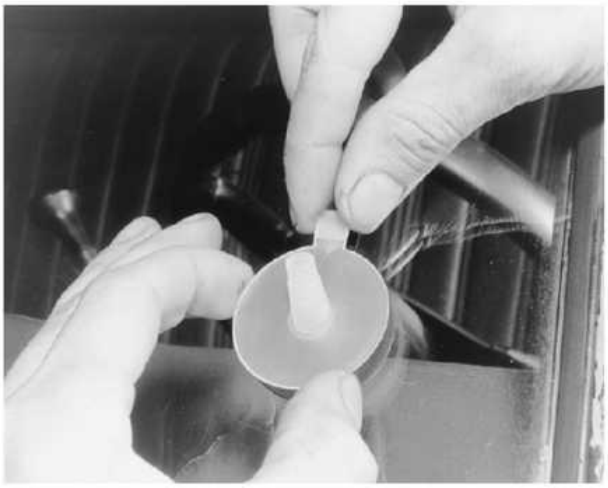
... then press it on the windshield so that the chip is centered in the hole



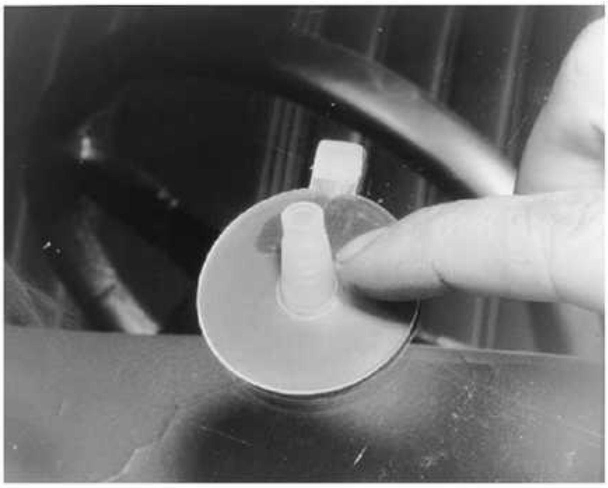
Be sure that the tab points upward on the windshield



Peel the backing off the exposed side of the adhesive disc...



... then position the plastic pedestal on the adhesive disc, ensuring that the tabs are aligned

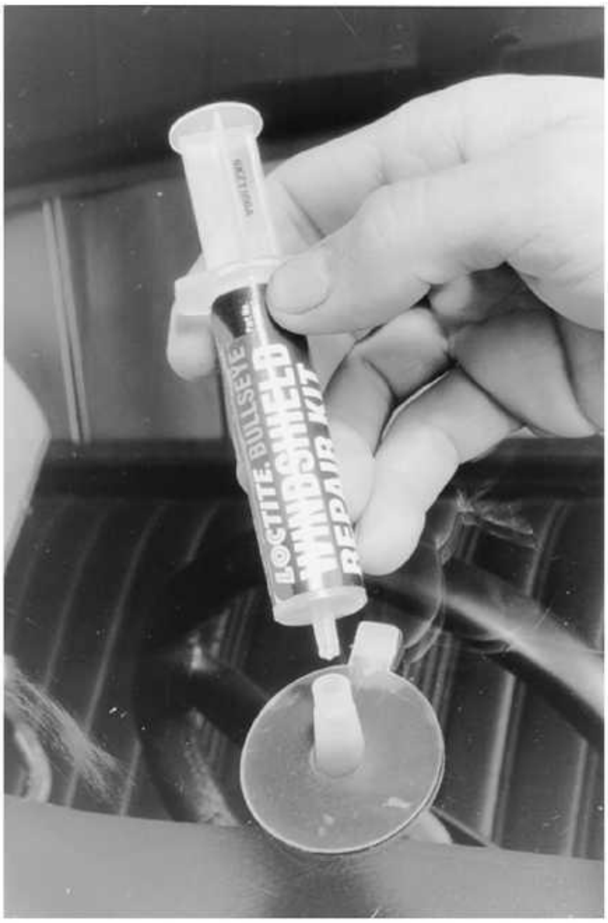


Press the pedestal firmly on the adhesive disc to create an adequate seal...

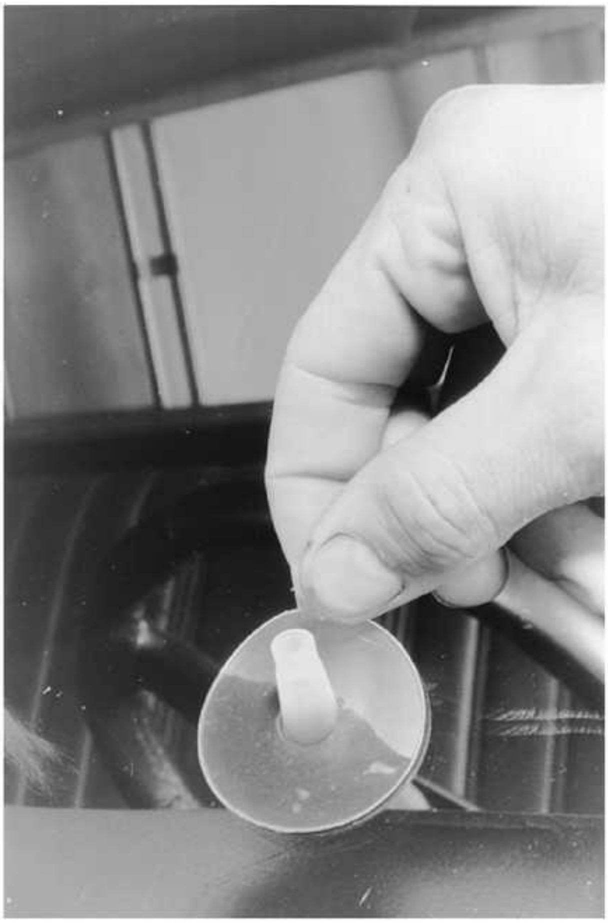
... then install the applicator syringe nipple in the pedestal's hole

Hold the syringe with one hand while pulling the plunger back with the other hand

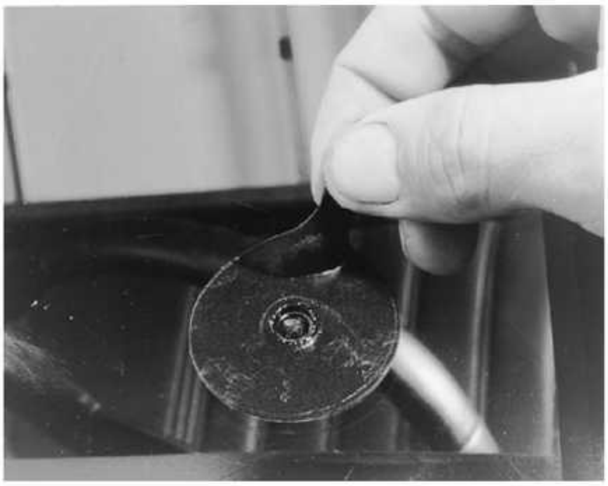
After applying the solution, allow the entire assembly to sit until it has set completely



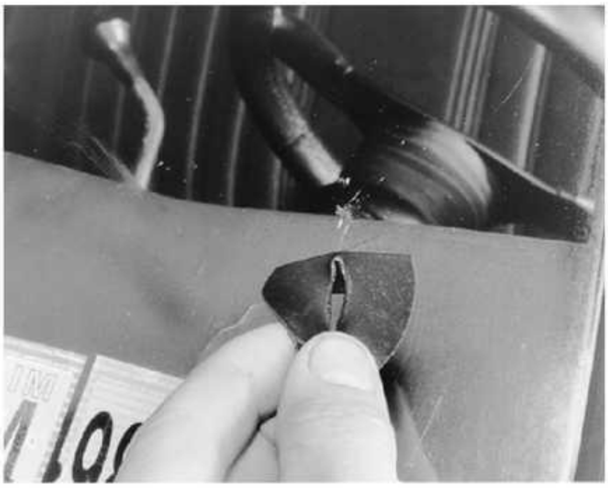
After the solution has set, remove the syringe from the pedestal...



... then peel the pedestal off of the adhesive disc...



... and peel the adhesive disc off of the windshield

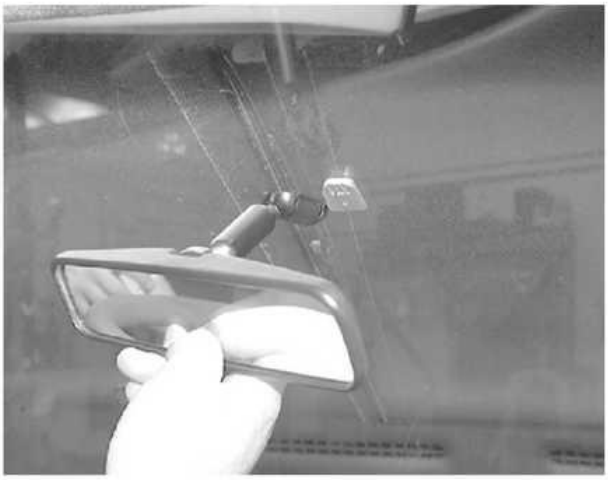


The chip will still be slightly visible, but it should be filled with the hardened solution

Inside Rear View Mirror

REPLACEMENT

Insert a small flatblade screwdriver into the bottom of the mirror mounting bracket and twist to...



... remove the mirror from the bracket

1. Grasp the rear view mirror firmly.
2. Insert a small flatblade screwdriver into the slot on the bottom of the mirror mounting pad.
3. Using a twisting motion on the shank of the mirror while gently prying with the screwdriver..
4. Pull the screwdriver rearward until the mirror snaps off of the mounting bracket.

To install:

5. Install the mirror onto the mounting bracket until it firmly fits in place.

Seats

REMOVAL & INSTALLATION

Front Seat Assembly

Click on icon to view fullsize printable image. Click to Enlarge *Front seat mounting-manual*
Click on icon to view fullsize printable image. Click to Enlarge *Front seat mounting-power*

1. Disconnect the negative battery cable.
2. Remove the four seat track-to-floor insulators by disengaging the spring clips and carefully pulling outward.
3. Remove the seat track-to-floor retaining bolts and nuts.
4. If the vehicle is equipped with power seats, detach the connector for the power seat track.
5. Remove the seat from the vehicle.

To install:

6. The installation is the reverse of the removal.
7. Tighten the seat track-to-floor bolts to 14-19 ft. lbs. (19-26 Nm).
8. Tighten the seat track-to-floor retaining nuts to 51-67 ft. lbs. (68-92 Nm).

Rear Seat Cushion

SEDAN AND WAGON

Lift directly up on the seat cushion to disengage the cushion retaining hooks (inset photo) from the retainers on the floor pan

1. Apply knee pressure to the lower front portion of the rear seat cushion. Push rearward to disengage the rear seat cushion pad and frame from rear seat cushion front retainers.
2. Remove the rear seat cushion from vehicle.

To install:

3. Position the rear seat cushion assembly into the vehicle.
4. Place the safety belts and buckles on top of the rear seat cushion.
5. Apply knee pressure to the lower portion of rear seat cushion pad and frame. Push rearward and down to lock the rear seat cushion pad and frame into position.
6. Pull the rear seat cushion pad and frame forward to make sure it is secured into the rear seat cushion front retainer.
7. Check the seat belts for proper operation.

AUXILIARY SEAT (WAGON ONLY)

1. Position the auxiliary seat back into the latched position.
2. Remove the retaining nuts.
3. Lift the auxiliary seat cushion assembly out of the vehicle.

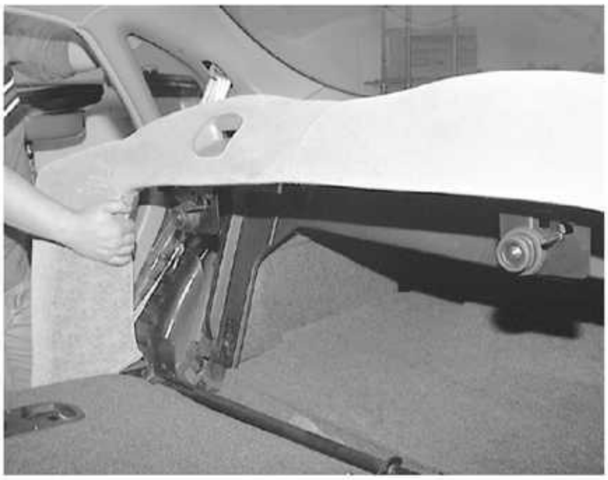
To install:

4. Installation is the reverse of removal. Tighten the nuts to 51-67 ft. lbs.(68-92 Nm).

Rear Seat Back

SEDAN AND WAGON

Remove the seat back retaining bolts and...



... carefully remove the seatback from the vehicle

The safety belt bolts do not secure seat back to vehicle.

1. Fold down the back seat and remove the two bolts in the center of each seat back striker plate.
2. Remove the two bolts from the outboard rear seat back frame retaining brackets.
3. Lift the seat back up and pull forward to remove from the vehicle.

To install:

4. The installation is the reverse of the removal.
5. Tighten the bolts to 14-19 ft. lbs. (19-26 Nm).

AUXILIARY SEAT (WAGON ONLY)

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Click to Enlarge

Auxiliary seat back mounting

1. Fold the stowage compartment door up.
2. Disengage the four retainers at top of the back panel between the load floor and the auxiliary seat back pad.
3. Pull the auxiliary seat back pad up to remove.

To install:

4. Installation is the reverse of removal.

Power Seat Motor

REMOVAL & INSTALLATION

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Click to Enlarge

Power seat motor assembly

The power seat motor is part of the seat track assembly.

1. Remove the seat assembly from the vehicle.
2. Place the seat upside down on a clean bench.
3. Remove the front safety belt buckle end from the front seat track.
4. Detach the seat regulator control switch from the seat regulator motor harness connector.
5. If equipped, disconnect the front seat back pad adjusting tubes.
6. Remove the front seat cushion side shield from the seat assembly.
7. Remove the two screws retaining the front seat back latch to the front seat track.
8. Remove the four bolts retaining the front seat track to the front seat cushion frame and spring . Remove the front seat track.

To install:

9. Position the front seat tracks to the front seat cushion frame and spring.
10. Secure the front seat back covers to the front seat cushion frame and spring using the four retaining bolts. Tighten the bolts to 107-212 inch lbs. (12-24 Nm).
11. Install the front seat back latch and seat back-to-latch screws to the front seat track. Tighten the screws to 33-44 ft. lbs. (44-60 Nm).
12. Transfer the motor harness to the new front seat track.
13. Connect the front seat adjusting motor drive tube, if equipped.
14. Install the front seat cushion side shield to the front seat track.
15. Attach the seat regulator control switch to the seat regulator motor harness connector.
16. Install the front safety belt buckle end to the front seat track.
17. Position the seat and track assembly in the vehicle.
18. Install the seat assembly.
19. Connect the negative battery cable.
20. Check the front seat tracks for proper operation.

Specifications Chart

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