{ewc MVIMAGE,MVIMAGE, !fp.BMP}

Save time and money by doing it yourself, with the confidence only a Chilton Repair Disc can provide.

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Essential Notes To Use This Disc

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About Total Car Care

{ewl MVIMAGE,MVIMAGE, !total.bmp}

Total Car Care is the most complete, step-by-step automotive repair disc you'll ever use. All repair procedures are supported by detailed specifications, exploded views, and photographs.

Here are just a few of the items in this disc that make your repair jobs easier:

- **Expanded index to quickly locate information**
- **Vacuum diagrams**
- **Wiring diagrams**
- **Diagnostic charts**
- **Troubleshooting charts**
- **A glossary to identify those unfamiliar terms**

From the simplest repair procedure to the most complex, trust Chilton's Total Car Care to give you everything you need to do the job.

Essential Notes To Use This Disc

SAFETY NOTICE

Proper service and repair procedures are vital to the safe, reliable operation of all motor vehicles, as well as the personal safety of those performing repairs. This disc outlines procedures for servicing and repairing vehicles using safe, effective methods. The procedures contain many NOTES, CAUTIONS and WARNINGS which should be followed, along with standard procedures, to eliminate the possibility of personal injury or improper service which could damage the vehicle or compromise its safety.

It is important to note that repair procedures and techniques, tools and parts for servicing motor vehicles, as well as the skill and experience of the individual performing the work, vary widely. It is not possible to anticipate all of the conceivable ways or conditions under which vehicles may be serviced, or to provide cautions as to all possible hazards that may result. Standard and accepted safety precautions and equipment should be used during cutting, grinding, chiseling, prying, or any other process that can cause material removal or projectiles.

Some procedures require the use of tools specially designed for a specific purpose. Before substituting another tool or procedure, you must be completely satisfied that neither your personal safety, nor the performance of the vehicle, will be endangered.

Although information in this disc is based on industry sources and is complete as possible at the time of publication, the possibility exists that some vehicle manufacturers made later changes which could not be included here. While striving for total accuracy, Nichols Publishing cannot assume responsibility for any errors, changes or omissions that may occur in the compilation of this data.

PART NUMBERS

Part numbers listed in this reference are not recommendations by Nichols Publishing for any product brand name. They are references that can be used with interchange manuals and aftermarket supplier catalogs to locate each brand supplier's discrete part number.

SPECIAL TOOLS

Special tools are recommended by the vehicle manufacturer to perform their specific job. Use has been kept to a minimum, but, where absolutely necessary, they are referred to in the text by the part number of the tool manufacturer. These tools can be purchased, under the appropriate part number, from your local dealer or regional distributor, or an equivalent tool can be purchased locally from a tool supplier or parts outlet. Before substituting any tool for the one recommended, read the SAFETY NOTICE at the top of this page.

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Table of Contents

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contents.bmp}

ROUTINE MAINTENANCE AND TUNE-UP

{ewc MVIMAGE,MVIMAGE, ! routine.bmp}

HOW TO USE THIS BOOK {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

HOW TO USE THIS BOOK

Chilton's Repair & Tune-Up Guide for the Chevrolet Astro and GMC Safari Vans is intended to help you learn more about the inner working of your vehicle and save you money in it's upkeep and operation.

The beginning of the book will likely be referred to the most, since that is where you will find information for maintenance and tune-up. The other sections deal with the more complex systems of your vehicle. Operating systems from engine through brakes are covered to the extent that the average do-it-yourselfer becomes mechanically involved. This book will not explain such things as rebuilding a differential for the simple reason that the expertise required and the investment in special tools make this task uneconomical. It will, however, give you detailed instructions to help you change your own brake pads and shoes, replace spark plugs, and perform many more jobs that can save you money, give you personal satisfaction and help you avoid expensive problems.

A secondary purpose of this book is a reference for owners who want to understand their vehicle and/or their mechanics better. In this case, no tools at all are required.

Where to Begin {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Where to Begin

Before removing any bolts, read through the entire procedure. This will give you the overall view of what tools and supplies will be required. There is nothing more frustrating than having to walk to the bus stop on Monday morning because you were short 1 bolt on Sunday afternoon. So read ahead and plan ahead. Each operation should be approached logically and all procedures thoroughly understood before attempting any work.

All sections contain adjustments, maintenance, removal and installation procedures, and in some cases, repair or overhaul procedures. When repair is not considered practical, we tell you how to remove the part and then how to install the new or rebuilt replacement. In this way, you at least save the labor costs. Backyard repair of some components is just not practical.

Avoiding Trouble {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Avoiding Trouble

Many procedures in this book require you to "label and disconnect . . . “ a group of lines, hoses or wires. Don't be lulled into thinking you can remember where everything goes—you won't. If you hook up vacuum or fuel lines incorrectly, the vehicle will run poorly, if at all. If you hook up electrical wiring incorrectly, you may instantly learn a very expensive lesson.

You don't need to know the official or engineering name for each hose or line. A piece of masking tape on the hose and a piece on its fitting will allow you to assign your own label such as the letter A or a short name. As long as you remember your own code, the lines can be reconnected by matching similar letters or names. Do remember that tape will dissolve in gasoline or other fluids; if a component is to be washed or cleaned, use another method of identification. A permanent felt-tipped marker can be very handy for marking metal parts. Remove any tape or paper labels after assembly.

Maintenance or Repair? {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Maintenance or Repair?

It's necessary to mention the difference between maintenance and repair. Maintenance includes routine inspections, adjustments, and replacement of parts which show signs of normal wear. Maintenance compensates for wear or deterioration. Repair implies that something has broken or is not working. A need for repair is often caused by lack of maintenance. Example: draining and refilling the automatic transmission fluid is maintenance recommended by the manufacturer at specific mileage intervals. Failure to do this can ruin the transmission/transaxle, requiring very expensive repairs. While no maintenance program can prevent items from breaking or wearing out, a general rule can be stated: MAINTENANCE IS CHEAPER THAN REPAIR.

Two basic mechanic's rules should be mentioned here. First, whenever the left side of the vehicle or engine is referred to, it is meant to specify the driver's side. Conversely, the right side of the vehicle means the passenger's side. Second, most screws and bolts are removed by turning counterclockwise, and tightened by turning clockwise.

Safety is always the most important rule. Constantly be aware of the dangers involved in working on an automobile and take the proper precautions. See the information in this section regarding SERVICING YOUR VEHICLE SAFELY and the SAFETY NOTICE in Essential Notes To Use This Disc.

Avoiding the Most Common Mistakes {ewc MVIMAGE, MVIMAGE, ! nexttopicarrow.bmp}

Avoiding the Most Common Mistakes

Pay attention to the instructions provided. There are 3 common mistakes in mechanical work:

1. Incorrect order of assembly, disassembly or adjustment. When taking something apart or putting it together, 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 1 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; often, 1 adjustment affects another, and you cannot expect even satisfactory results unless each adjustment is made only when it cannot be changed by any other.
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 crush the gasket, causing leakage of combustion gases and consequent overheating of the plug and engine parts. Too much torque can damage the threads or distort the plug, changing the spark gap.

There are many commercial products available 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 loose enough to avoid mechanical damage during assembly, one of these products might offer substantial insurance. Before choosing a threadlocking compound, read the label on the package and make sure the product is compatible with the materials, fluids, etc. involved.

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 with the part to be installed positioned straight in. Then, start 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 gentle turning will automatically bring the part you're threading to the proper angle, but only if you don't force it or resist a change in 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.

Always take your time and be patient; once you have some experience, working on your vehicle may well become an enjoyable hobby.

TOOLS AND EQUIPMENT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Routine Maintenance And Tune-up

TOOLS AND EQUIPMENT

Ü See figures 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13

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 1 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 3mm–19mm (depending on whether your vehicle uses standard or metric fasteners) and a 13/16 in. or 5/8 in. spark plug socket (depending on plug type).

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

- Jackstands for support.
- 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 found later in this section).
- Hydrometer for checking the battery (unless equipped with a sealed, maintenance-free battery).
- A container for draining oil and other fluids.
- Rags for wiping up the inevitable mess.

Figure 1.
All but the most basic procedures will require an assortment of ratchets and sockets

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tccs1200

Figure 2.
In addition to ratchets, a good set of wrenches and hex keys will be necessary

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tccs1201

Figure 3.
A hydraulic floor jack and a set of jackstands are essential for lifting and supporting the vehicle

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tccs1202

Figure 4.
An assortment of pliers, grippers and cutters will be handy for old rusted parts and stripped bolt heads

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tccs1203

Figure 5.
Various drivers, chisels and prybars are great tools to have in your toolbox

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tccs1204

Figure 6.
Many repairs will require the use of a torque wrench to assure the components are properly fastened

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tccs1205

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).

Figure 7.
Tools from specialty manufacturers such as Lisle® are designed to make your job easier . . .

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tccs101a

Figure 8.
. . . these Torx drivers and magnetic socket holders are just 2 examples of their handy products

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tccs101b

Figure 9.
Although not always necessary, using specialized brake tools will save time

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tccs1209

Figure 10.
A few inexpensive lubrication tools will make maintenance easier

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tccs1210

Figure 11.
Various pullers, clamps and separator tools are needed for many larger, more complicated repairs

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tccs1211

Figure 12.
A variety of tools and gauges should be used for spark plug gapping and installation

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tccs1212

Figure 13.
Proper information is vital, so always have a Chilton Total Car Care manual handy

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tccs1213

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 tach/dwell meters on the market that are every bit as good for the average mechanic as a professional model. Just be sure it goes to a least 1200–1500 rpm on the tach scale and that it works on 4, 6 and 8-cylinder engines. (If you have 1 or more vehicles with a diesel engine, a special tachometer is required since diesels don't use spark plug ignition systems). 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:

- Tach/dwell meter.
- Spark plug wrench and gapping tool.
- Feeler gauges for valve or point adjustment. (Even if your vehicle does not use points or require valve adjustments, a feeler gauge is helpful for many repair/overhaul procedures).

A tachometer/dwell meter will ensure accurate tune-up work on vehicles without electronic ignition. 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. On any vehicle with an electronic ignition system, a timing light with an inductive pickup that clamps around the No. 1 spark plug cable is preferred.

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.
- Manifold vacuum gauge.
- 12V test light.
- A combination volt/ohmmeter
- Induction Ammeter. This is used for determining whether or not there is current in a wire. These are handy for use if a wire is broken somewhere in a wiring harness.

As a final note, you will probably find a torque wrench necessary for all but the most basic work. The beam type models are perfectly adequate, although the newer click types (breakaway) 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 purpose.

Special Tools {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

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.

In the United States, contact:

Service Tool Division
Kent-Moore Corporation
29784 Little Mack
Roseville, MI 48066-2298

In Canada, contact:

Kent-Moore of Canada, Ltd.
2395 Cawthra Mississauga
Ontario, Canada L5A 3P2.

SERVICING YOUR VEHICLE SAFELY {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SERVICING YOUR VEHICLE SAFELY

Ü See figures 14, 15, 16, 17

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 precaution.

Figure 14.
Screwdrivers should be kept in good condition to prevent injury or damage which could result if the blade slips from the screw

{ewc GSMVIMG,GSMVIMG, !tccs1020.bmp}

tccs1020

Figure 15.
Power tools should always be properly grounded

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tccs1021

Figure 16.
Using the correct size wrench will help prevent the possibility of rounding off a nut

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tccs1022

Figure 17.
NEVER work under a vehicle unless it is supported using safety stands (jackstands)

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Do's {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Do's

- Do keep a fire extinguisher and first aid kit handy.
- Do wear safety glasses or goggles when cutting, drilling, grinding or prying, even if you have 20–20 vision. 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 (jackstands) for any undervehicle service. Jacks are for raising vehicles; jackstands 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 when working with any chemicals or hazardous materials. Like carbon monoxide, the asbestos dust resulting from some brake lining wear can be hazardous in sufficient quantities.
- Do disconnect the negative battery cable when working on the electrical 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 hammerheads, 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 adjustable wrenches are tightly closed on the nut or bolt and pulled so 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 {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Don'ts

- Don't run the engine in a garage or anywhere else without proper ventilation—EVER! Carbon monoxide 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 bone dry hands will suck up oil and grease.
- Don't service the air conditioning system unless you are equipped with the necessary tools and training. 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. Although refrigerant is normally non-toxic, R-12 becomes a deadly poisonous gas in the presence of an open flame. One good whiff of the vapors from burning refrigerant can be fatal.
- Don't use screwdrivers for anything other than driving screws! A screwdriver used as an prying tool can snap when you least expect it, causing injuries. At the very least, you'll ruin a good screwdriver.
- Don't use a bumper or 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 a $1^1/2$ ton capacity, and at least 2 sturdy jackstands.

FASTENERS, MEASUREMENTS AND CONVERSIONS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

FASTENERS, MEASUREMENTS AND CONVERSIONS

Bolts, Nuts and Other Threaded Retainers

Ü See figures 18, 19, 20, 21

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.

Figure 18.
Here are a few of the most common screw/bolt driver styles

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tccs1037

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 which can increase the torque necessary to achieve the desired clamp load for which that fastener was originally selected. Additionally, be sure 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 1 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).

Figure 19.
There are many different types of threaded retainers found on vehicles

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tccs1036

Figure 20.
Threaded retainer sizes are determined using these measurements

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tccs1038

Figure 21.
Special fasteners such as these Torx® head bolts are used by manufacturers to discourage people from working on vehicles without the proper tools

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tccs1016

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.

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

Torque {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

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 3 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 {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TORQUE WRENCHES

Ü See figures 22, 23, 24

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.

Figure 22.
Various styles of torque wrenches are usually available at your local automotive supply store

{ewc GSMVIMG,GSMVIMG, !tccs1015.bmp}

tccs1015

Figure 23.
Determining bolt strength of metric fasteners—NOTE: this is a typical bolt marking system, but there is not a worldwide standard

{ewc GSMVIMG,GSMVIMG, !tccs1240.bmp}

tccs1240

Figure 24.
Standard bolt torque for metric fasteners—WARNING: use only as a guide

{ewc GSMVIMG,GSMVIMG, !tccs1241.bmp}

tccs1241

Beam Type {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Beam Type

Ü See figure 25

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.

Figure 25.
Example of a beam type torque wrench

{ewc GSMVIMG,GSMVIMG, !tccs1039.bmp}

tccs1039

Click (Breakaway) Type {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Click (Breakaway) Type

Ü See figure 26

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.

Figure 26.
A click type or breakaway torque wrench—note this one has a pivoting head
{ewc GSMVIMG,GSMVIMG, !tccs1040.bmp}

tccs1040

Pivot Head Type {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Pivot Head Type

Ü See figures 26, 27

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.

Figure 27.
Torque wrenches with pivoting heads must be grasped and used properly to prevent an incorrect reading

{ewc GSMVIMG,GSMVIMG, !tccs1041.bmp}

tccs1041

Ä It should be mentioned that the use of any U-joint, wobble or extension will have an effect on the torque readings, no matter what type of wrench you are using. For the most accurate readings, install the socket directly on the wrench driver. If necessary, straight extensions (which hold a socket directly under 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 the head/driving point (such as a crow's foot). U-joint or Wobble extensions can greatly affect the readings; avoid their use at all times.

Rigid Case (Direct Reading) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Rigid Case (Direct Reading)

Ü See figure 28

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.

Figure 28.
The rigid case (direct reading) torque wrench uses a dial indicator to show torque

{ewc GSMVIMG,GSMVIMG, !tccs1042.bmp}

tccs1042

TORQUE ANGLE METERS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TORQUE ANGLE METERS

Ü See figure 29

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.

Figure 29.
Some specifications require the use of a torque angle meter (mechanical protractor)

{ewc GSMVIMG,GSMVIMG, !tccs1043.bmp}

tccs1043

Standard and Metric Measurements

Ü See figure 30

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 2 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.

Figure 30.
Standard and metric conversion factors chart

{ewc GSMVIMG,GSMVIMG, !tccs1044.bmp}

tccs1044

HISTORY {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

HISTORY

In 1985, the Astro and Safari Vans were born, it is an in-between Van; smaller than the conventional Chevy/GMC Vans but larger than the minivans. It is a rear wheel drive vehicle with a wide range of power trains available. The 1990 model year saw the introduction of All Wheel Drive version as an option which continues to be available right on through 1996.

Due to the vast array of the state-of-the-art design, engineering, manufacturing and assembly technologies, this model makes available one of the widest varieties of window, seating and equipment options ever offered on compact vans.

MODEL IDENTIFICATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

MODEL IDENTIFICATION

Essentially, 2 engine configurations have been available in these vehicles, an inline 4 cylinder with Throttle Body Injection, and a V6 which has developed over the years from a 4-barrel carburetor, through Throttle Body Injection to Central Multi-Port and finally, Central Sequential Fuel Injection. The various fuel systems available on the V6 raise the number of engines actually available on these models to 6:

- 2.5L (151 cu. in.) L4, TBI (Throttle Body Injection) (1985–90)
- 4.3L (262 cu. in.) V6, 4-bbl. carburetor (1985)
- 4.3L (262 cu. in.) V6, TBI (Throttle Body Injection) (1986–94)
- 4.3L HO (262 cu. in.) V6, TBI (Throttle Body Injection) (1991)
- 4.3L (262 cu. in.) V6, CMFI (Central Multi-Port Fuel Injection) (1992–95)
- 4.3L (262 cu. in.) V6, CSFI (Central Sequential Fuel Injection) (1996)

In 1987, the 2.5L and 4.3L engines were redesigned to incorporate a single serpentine drivebelt, replacing the conventional multiple V-belts. This new system features an automatic belt tensioner, which eliminates the need for belt adjustment throughout the life of the vehicle and increases the expected belt life to as-much-as 100,000 miles (161,000 km).

Two models are offered: One designed for cargo hauling and the other for passengers. Both are distinguished by a wind tunnel tuned shape which producing a low aerodynamic drag coefficient, when compared to many full-size or more box-like trucks and vans.

The independent front suspension incorporates unequal length A-arms with coil springs. The rear suspension features the first truck use of corrosion free, single leaf fiberglass springs, which are 54 lbs. lighter than a pair of conventional steel springs.

A choice of transmissions was available up through 1989: The MR2, 76mm 4-speed manual (base-only available 1985–86), the MH3/ML3, 77mm 5-speed manual (optional until 1987) and the MD8, Turbo Hydra-Matic 700-R4 4-speed automatic.

Your choice of transmissions went away in 1990 when the first major new design of these models now offered the option of full-time All Wheel Drive (AWD). From 1990 on, driveline work was performed solely by the THM 700-R4 (1990–92), which was now known as the 4L60, or by the 4L60-E (1993–96) 4-speed automatic transmissions. The power is transmitted through a planetary gear set in the transfer case to the rear axle.

Two fuel tanks are available: A 17 gal. (standard) and a 27 gal. (optional). The fuel economy is expected to be low-to-mid 20's for city driving and low-to-mid 30's for highway driving. The combination of a 4-cyl. engine and a 27 gal. tank may approach the 900 mile driving range.

The manufacturing time is reduced by the introduction of the Single Piece construction approach, whereby, a few large stampings to replace the many small ones. The Astro and Safari boasts of the most extensive corrosion protection of any Chevy truck EVER, which includes: The widest use of 2-sided galvanized steel, a full underbody hot-melt wax spray and 7 layers of exterior finish.

GM's innovative Central Multi-Port Fuel Injection (CMFI) system was made available on the 4.3L engine in 1992 bringing the increased power and performance of a multi-port system without as much of the cost. By 1995 this was the only fuel system and engine available for the Astro/Safari model line. And by 1996, the Central Sequential Fuel Injection (CSFI) had supplanted its earlier cousin as standard equipment with yet another increase in performance.

In the area of occupant protection, the 1994 model year saw the introduction of side-door impact protection beams and a driver's side air bag along with environmentally responsible R-134a refrigerant. By 1996, dual (driver and passenger) front air bags were standard equipment.

Rear wheel anti-lock brakes were introduced in 1989 and 4 wheel anti-lock brakes were introduced in 1990. Both systems are electronically controlled to help prevent tire skid under various road conditions.

Depending upon the equipment, the Astro and Safari's capable of towing up to 5000–6000 lbs. (depending on the model and year).

SERIAL NUMBER IDENTIFICATION {ewc MVIMAGE, MVIMAGE, ! nexttopicarrow.bmp}

SERIAL NUMBER IDENTIFICATION

Vehicle

Ü See figures 31, 32

The Vehicle Identification Number (VIN) is found on various anti-theft labels, but the most important is the vehicle serial number plate located on the top left side of the instrument panel (it can be viewed through the windshield). The VIN identifies the body style, model year, assembly plant, engine usage and production number.

Figure 31.
The VIN is on a plate attached to the dash and visible through the driver's side of the windshield

{ewc GSMVIMG,GSMVIMG, !88261P01.bmp}

88261P01

Figure 32.
Description of the Vehicle Identification Number (VIN)

{ewc GSMVIMG,GSMVIMG, !88261G01.bmp}

88261G01

Engine {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Engine

Ü See figures 33, 34, 35

Your first stop in engine identification is the VIN which will supply you with a code to identify the engine with which the vehicle was originally equipped. If you believe the engine is not original equipment for your vehicle, identification can be a little more difficult. Check the labels found on about the engine compartment (radiator shroud, power steering pump reservoir, air cleaner) for more clues. Your last resort is the often difficult to interpret engine codes.

All engines will have some engine build code attached on a label and usually stamped or laser cut into a portion of the block. The 2.5L engine identification numbers are stamped on the left side of the rear engine block flange. All of the early-model (1985–89) and many of the later (1990–93) 4.3L engine identification numbers are stamped on a pad of the engine block which is located at the lower front edge of the right side cylinder head. On these vehicles the eighth digit of the serial number identifies the engine used in the vehicle.

Figure 33.
Engine identification number location—early-model engines (2.5L top, 4.3L bottom)

{ewc GSMVIMG,GSMVIMG, !88261G02.bmp}

88261G02

Figure 34.
Engine identification number locations—1990–93 4.3L engines

{ewc GSMVIMG,GSMVIMG, !88261G03.bmp}

88261G03

Figure 35.
Engine identification number locations—1994–96 4.3L engines

{ewc GSMVIMG,GSMVIMG, !88261G04.bmp}

88261G04

{ewc GSMVIMG,GSMVIMG, !88261c01.bmp}

88261c01

{ewc GSMVIMG,GSMVIMG, !88261c02.bmp}

88261c02

Many of the later model engines relocated the identification numbers. On some 1990–93 4.3L engines, the number can be found at the rear left of the block, just above the oil filter adapter. The left rear location is also used on many of the 1994–96 engines covered by this manual. The balance of late-model engine codes are found on the upper right, rear of the block. On late-model 4.3L engines, the number is a 8 digit code which includes, a source code, month of build, date of build and broadcast code. See your dealer's parts department for translation of these codes.

Manual Transmission

Ü See figure 36

The transmission serial numbers are located on the front right side of the main housing.

Figure 36.
Manual transmission serial number location

{ewc GSMVIMG,GSMVIMG, !88261G05.bmp}

88261G05

Automatic Transmission {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Automatic Transmission

Ü See figures 37, 38

The Turbo Hydra-Matic 700-R4 (also known as the 4L60 on models through 1992) and their electronically controlled cousin the 4L60-E (1993–96) 4-spd automatic transmission serial numbers are located on the rear right side of the transmission case, above the oil pan.

Figure 37.
Location and description of the THM-R4 (4L60) transmission serial number—early-model vehicles (1985–92)

{ewc GSMVIMG,GSMVIMG, !88261G06.bmp}

88261G06

Figure 38.
Location and description of the 4L60-E transmission serial number—late-model vehicles (1993–96)

{ewc GSMVIMG,GSMVIMG, !88261G07.bmp}

88261G07

Drive Axle {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Drive Axle

Ü See figure 39

All Astro and Safari Vans have the drive axle serial number located on the forward side of the right axle tube. The 2 or 3 letter prefix in the serial number identifies the drive axle gear ratio.

Figure 39.
Location and description of the drive axle serial number

{ewc GSMVIMG,GSMVIMG, !88261G08.bmp}

88261G08

Transfer Case {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Transfer Case

Ü See figure 40

The All Wheel Drive transfer case identification is located on a tag bolted to the bottom of the front output flange.

Figure 40.
The Astro/Safari BW-4472 transfer case identification tag is held by a lower center case bolt

{ewc GSMVIMG,GSMVIMG, !88261G09.bmp}

88261G09

{ewc GSMVIMG,GSMVIMG, !88261c01.bmp}

88261c01

{ewc GSMVIMG,GSMVIMG, !88261c02.bmp}

88261c02

{ewc GSMVIMG,GSMVIMG, !88261c03.bmp}

88261c03

ROUTINE MAINTENANCE AND TUNE-UP

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 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.

Engine Cover {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

{ewc GSMVIMG,GSMVIMG, !88261P02.bmp}

88261P02

{ewc GSMVIMG,GSMVIMG, !88261P03.bmp}

88261P03

Engine Cover

Many of the components on your van are serviced in the same way that most conventional passenger cars or trucks are repaired. Raising the hood (to expose the engine compartment), or raising and supporting the vehicle (to expose the underbody) will allow you access to most of the components. However, because of the inherent space-saving design of a van (which moves the dash forward in the chassis (over the motor), some parts of the engine simply cannot be accessed from underhood or under the engine. Many of the mid-to-rear mounted engine components such as the distributor, spark plugs and even the air cleaner (on all carbureted and TBI models) must be accessed in a different way. Some components can be reached through access panels in the wheel wells, but in most cases your will have to remove the Engine Cover from the center of the dash in the passenger compartment. A procedure is provided for engine cover removal in this section, as it is assumed that if you are to properly maintain your vehicle, it is something you will become quite familiar with over time.

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REMOVAL & INSTALLATION

1985–89 Vehicles

Ü See figures 41, 42, 43, 44

1. Open the hood and disconnect the negative battery cable for safety.
2. With a long-handled screwdriver, loosen the upper left and upper right cover retaining screws at the rear of the engine compartment. Turn the screws counterclockwise until they release the cover, but keep in mind that the screws are not designed to come out of the bracket assembly which is attached to the engine compartment opening.

   Ä On some vehicles, the air cleaner intake snorkel will interfere with access to the cover retaining screws. On these vehicles, remove the snorkel buy carefully, but firmly, grasping it and pulling it away from the air cleaner, then by pulling it from the front air intake duct.
3. Walk around the vehicle to the passenger compartment, then slide both front seats to their furthest back positions in order to give yourself more working space.
4. Remove the instrument panel extension housing retainers. There are 2 bolts at the top of the housing (which are accessed by opening the glove box) and there are 2 nuts at the bottom of the housing.
5. Carefully pull the extension housing outward and disengage any wiring connectors, such as the cigarette lighter. Remove the extension housing and position aside, being careful not to scratch the plastic trim.
6. Release the 2 latches at the bottom of the engine cover, then pull the straps off the studs.
7. Remove the engine cover by carefully sliding it backwards, then rotating the top of the cover to the rear and upward. Again, be careful not to damage any of the decorative plastic trim pieces and be careful not to catch any edges on the interior fabric.
8. Inspect the engine cover rubber seal for wear or damage. The seal MUST be replaced if there are any sings of damage which would prevent a proper seal between the engine and passenger compartments.

Figure 41.
On some vehicles, the air intake snorkel must be removed for access to the engine cover retaining screws

{ewc GSMVIMG,GSMVIMG, !88261G10.bmp}

88261G10

Figure 42.
A long-handled screwdriver will be necessary to access the 2 upper engine compartment-to-engine cover retaining screws

{ewc GSMVIMG,GSMVIMG, !88261G11.bmp}

88261G11

Figure 43.
The extension housing is freed by removing the upper bolts and lower nuts, then the cover latches can be released

{ewc GSMVIMG,GSMVIMG, !88261G12.bmp}

88261G12

Figure 44.
Upon installation make sure the cover and rubber seal are properly positioned to isolate the engine compartment

{ewc GSMVIMG,GSMVIMG, !88261G13.bmp}

88261G13

To install:

9. Lift the engine cover into the vehicle, rotate it backwards and then carefully slide it all the way forward making sure to keep the straps attached to the upper instrument panel bracket clear.
10. Place the cover between the engine cover locators (as shown in the accompanying illustration), then install the 2 screws from the engine compartment.

****Warning**
Before tightening the engine compartment screws or setting the cover latches, make sure the cover's rubber seal is in place. The seal is necessary to keep harmful fumes (as well as engine heat) from the passenger compartment. It should be replaced if any signs of damage or improper sealing are evident.

11. With the rubber seal in position over the latches, secure latches at the base of the cover.
12. Install the 2 straps that are attached to the upper instrument panel bracket. Be sure to pull each strap tight before attaching the bracket to the engine cover stud.
13. Position the instrument panel extension, then engage any necessary electrical connectors.
14. Install the extension by carefully spreading and holding the sides while sliding it into position on the 4 locators. Secure the extension using the nuts and bolts removed earlier.
15. If removed earlier, install the air cleaner intake snorkel.
16. Connect the negative battery cable.

1990-96 Vehicles {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Routine Maintenance And Tune-up

1990–96 Vehicles

Ü See figures 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61

1. Open the hood and disconnect the negative battery cable for safety.
2. Slide both front seats to their furthest back positions in order to give yourself more working space.
3. Remove the instrument panel extension housing retainers. There are 2 bolts at the top sides of the housing and there are 2 nuts at the bottom of the housing.
4. Carefully grasp the extension housing at the bottom, then rotate it upward and outward for access. Disengage any wiring connectors, such as the cigarette lighter, then remove the extension housing and position aside, being careful not to scratch the plastic trim.
5. Remove the engine cover heating and air duct:
    a. For 1990–95 vehicles, grasp the duct at the top and firmly, but gently, pull downward to release it from the dash and the engine cover studs.
    b. Disconnect the engine cover heating and air duct from the air distributor (at the top of the duct). If equipped, remove the nuts retaining the duct to the floor studs and/or disconnect the air outlet from the rear seat ducts. Position the cover heater and air duct aside.
6. Remove the bolt and loosen the nut on each of the 2 engine cover brackets, then rotate the brackets out of the way.
7. Release the 2 latches at the bottom of the engine cover.
8. Using a long-handled screwdriver to loosen the 2 engine cover-to-cowl screws (at the sides of the engine cover).

    Ä The screw on each side of the engine cover is NOT designed to come out of the engine cover. Simply loosen the screw until the cover is free from the cowl.

9. Remove the engine cover by grasping the bottom and carefully sliding it backwards, then rotating the top of the cover to the rear and upward. Again, be careful not to damage any of the decorative plastic trim pieces and be careful not to catch any edges on the interior fabric.

    ****Warning**
    Because the engine cover-to-cowl screws remain attached to the engine cover, take extra care during cover removal to make sure they do not scratch and damage the rest of the instrument panel.

10. Inspect the engine cover rubber seal for wear or damage. The seal MUST be replaced if there are any sings of damage which would prevent a proper seal between the engine and passenger compartments.

Figure 45.
The instrument panel extension housing is retained by 2 nuts and 2 bolts—1990–95 shown (1996 similar)

{ewc GSMVIMG,GSMVIMG, !88261G14.bmp}

88261G14

Figure 46.
Exploded view of the instrument panel extension housing—1990–95 vehicles

{ewc GSMVIMG,GSMVIMG, !88261G15.bmp}

88261G15

Figure 47.
Exploded view of the instrument panel extension housing—1996 vehicles

{ewc GSMVIMG,GSMVIMG, !88261G16.bmp}

88261G16

Figure 48.
Loosen and remove the instrument panel extension housing upper retaining bolts . . .

{ewc GSMVIMG,GSMVIMG, !88261P04.bmp}

88261P04

Figure 49.
. . . then remove the extension housing lower retaining nuts

{ewc GSMVIMG,GSMVIMG, !88261P05.bmp}

88261P05

Figure 50.
Carefully pull the extension housing forward, disengage the wiring and remove it from the vehicle

{ewc GSMVIMG,GSMVIMG, !88261P06.bmp}

88261P06

Figure 51.
Engine cover heater and air duct mounting—1990–95 vehicles

{ewc GSMVIMG,GSMVIMG, !88261G17.bmp}

88261G17

Figure 52.
Engine cover heater and air duct mounting—1996 vehicles

{ewc GSMVIMG,GSMVIMG, !88261G18.bmp}

88261G18

Figure 53.
On 1990–95 vehicles, the cover heater and air duct is removed by pulling it gently downward

{ewc GSMVIMG,GSMVIMG, !88261P07.bmp}

88261P07

Figure 54.
All 1990–96 engine covers are retained by upper brackets

{ewc GSMVIMG,GSMVIMG, !88261G19.bmp}

88261G19

Figure 55.
Remove the bolt and loosen the nut from each cover bracket, then rotate the brackets out of the way

{ewc GSMVIMG,GSMVIMG, !88261P08.bmp}

88261P08

Figure 56.
The upper cover-to-cowl screws and latches are the final retainers securing the engine cover

{ewc GSMVIMG,GSMVIMG, !88261G20.bmp}

88261G20

Figure 57.
Release the engine cover latches

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88261P09

Figure 58.
Loosen the captive engine cover-to-cowl retaining screws . . .

{ewc GSMVIMG,GSMVIMG, !88261P10.bmp}

88261P10

Figure 59.
Exploded view of the engine cover mounting

{ewc GSMVIMG,GSMVIMG, !88261G21.bmp}

88261G21

Figure 60.
. . . then carefully pull the cover back and remove it from the vehicle

{ewc GSMVIMG,GSMVIMG, !88261P11.bmp}

88261P11

Figure 61.
With the cover removed you have access to almost all of the upper engine components

{ewc GSMVIMG,GSMVIMG, !88261P12.bmp}

88261P12

To install:

11. Lift the engine cover into the vehicle, then carefully slide it all the way forward making sure the rubber seal is positioned over the latches.

    ****Warning**
    Before tightening the cowl screws or setting the cover latches, make sure the cover's rubber seal is in place. The seal is necessary to keep harmful fumes (as well as engine heat) from the passenger compartment. It should be replaced if any signs of damage or improper sealing are evident.

12. Thread the 2 engine cover-to-cowl retaining screws, but do not tighten fully at this time.
13. With the rubber seal in position over the latches, press downward on each of the 2 latch assemblies and secure latches at the base of the cover.
14. Tighten the engine cover-to-cowl screws.
15. At each side of the cover, turn the bracket into position, then install the bolt and tighten the nut at the other end of the bracket.
16. Install the engine cover heater and air duct.
17. Position the instrument panel extension, then engage any necessary electrical connectors.
18. Grasp the bottom of the instrument panel extension then install the top into the groove first and push the bottom into place. Secure the extension using the nuts and bolts removed earlier.
19. Connect the negative battery cable.

Air Cleaner (Element) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Air Cleaner (Element)

Ü See figures 62, 63, 64

An air cleaner is used to keep airborne dirt and dust out of the air flowing through the engine. This material, if allowed to enter the engine, would form an abrasive compound in conjunction with the engine oil and drastically shorten engine life. For this reason, you should never run the engine without the air cleaner in place (except possibly for a very brief period in when you are diagnosing a problem). You should also be sure to use the proper replacement part to avoid poor fit and consequent air leakage.

Proper maintenance is important since a clogged air filter will not allow the proper amount of air to enter the engine causing reduced power and fuel economy. It is even possible that a clogged filter could contribute to an overly rich fuel mixture on early-model vehicles equipped with a carburetor. Rich fuel mixtures can wreak havoc with the life span of a catalytic converter.

The air cleaner on carbureted or TBI engines consists of a metal housing with a replaceable paper filter and the necessary hoses connecting it to the crankcase ventilation system. The air cleaner cover is held down by 1 or 2 nuts on all models. Unfortunately, the housing is mounted directly on top of the carburetor or throttle body assembly, so access is almost always impossible without first removing the engine cover from the passenger compartment.

The air cleaner assembly on CMFI or CSFI engines is a composite plastic housing placed inline between the fresh air intake ducts and the throttle body assembly. The nice part about this setup for you is that unlike the metal housing on older engines, the plastic inline housing can be accessed by simply raising the hood.

Figure 62.
Exploded view of the air cleaner assembly—1985 2.5L engines
{ewc GSMVIMG,GSMVIMG, !88261G22.bmp}

88261G22

Figure 63.
Exploded view of the TBI air cleaner assembly—1986–87 engines
{ewc GSMVIMG,GSMVIMG, !88261G23.bmp}

88261G23

Figure 64.
Exploded view of the TBI air cleaner assembly—1988–94 engines
{ewc GSMVIMG,GSMVIMG, !88261G24.bmp}

88261G24

No matter which type of housing and filter you have, the factory recommends that the filter be replaced at least once every 30,000 miles (48,000 km). Inspection and replacement should come more often when the vehicle is operated under dusty conditions. To check the effectiveness of your paper element, remove the air cleaner assembly, if the idle speed increases noticeably, the element is restricting airflow and should be replaced.

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REMOVAL & INSTALLATION

Carbureted and TBI Engines

Ü See figures 65, 66, 67

1. Remove the engine cover from the passenger compartment for access to the air cleaner housing assembly. For details, please refer to the procedure earlier in this section.
2. Remove the air cleaner top nut(s) and lift off the top to expose the element.
3. Remove the filter from inside the filter housing.
4. Clean any accumulated dirt, dust or oil from the inside of the air cleaner housing using a rag.

To install:

5. Position the new filter element in the housing, making sure it has the proper fit.
6. Install the housing cover and secure using the retaining nut(s). Tighten the nuts firmly, but do not crack or deform the cover.
7. Install the engine cover (or, as long as it is off, perform any other necessary maintenance such as checking the distributor cap, rotor and wires).

Figure 65.
Remove the nut(s) from the top of the air cleaner housing—1992 4.3L engine shown

{ewc GSMVIMG,GSMVIMG, !88261P13.bmp}

88261P13

Figure 66.
With the nut(s) removed, lift the cover from the air cleaner housing . . .

{ewc GSMVIMG,GSMVIMG, !88261P14.bmp}

88261P14

Figure 67.
. . . then remove the element

{ewc GSMVIMG,GSMVIMG, !88261P15.bmp}

88261P15

CMFI and CSFI Engines {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CMFI and CSFI Engines

Ü See figures 68, 69, 70

1. Raise the hood (and support using the prop rod).
2. Locate the plastic air cleaner housing at the front center of the engine compartment.
3. Release the hold-down clamps at the front of the housing.
4. Lift the air cleaner cover sufficiently to expose the housing, but be careful not to damage any attached components (duct work, wiring).
5. Note the positioning of the filter element, then lift and remove the element from the housing.
6. Clean any accumulated dirt or dust from the inside of the air cleaner housing using a rag.

To install:

7. Position the new filter element in the housing as noted during removal.
8. Install the cover to the housing and secure using the hold-down clamps.
9. Close the hood.

Figure 68.
Exploded view of the CMFI and CSFI air cleaner housing assembly
{ewc GSMVIMG,GSMVIMG, !88261G25.bmp}

88261G25

Figure 69.
On these vehicles, simply release the hold-down clamps and lift up on the cover . . .
{ewc GSMVIMG,GSMVIMG, !88261P16.bmp}

88261P16

Figure 70.
. . . then remove the air cleaner element from the housing
{ewc GSMVIMG,GSMVIMG, !88261P17.bmp}

88261P17

Fuel Filter {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Fuel Filter

There are 3 types of fuel filters used: The internal (1985 4.3L carbureted models), the inline (TBI, CMFI and CSFI) and the in-tank.

> ****Caution**
> **Before removing any component of the fuel system on fuel injected models, be sure to properly release the system pressure. For details on fuel system pressure release procedures and related safety precautions, please refer to** Section 5 **of this manual.**

The internal carburetor filter and the inline fuel filter should be replaced at least every 30,000 miles (48,000 km) to help assure a clean and trouble-free fuel delivery system. The intank filter should not require replacement unless it becomes clogged. If a vehicle is purchased used and the last fuel filter service is not documented, it is probably a good idea to replace the internal or inline filter anyway to be sure of its condition.

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REMOVAL & INSTALLATION

Internal (Carbureted Models)

Ü See figure 71

1. Disconnect the negative battery cable for safety.
2. At the carburetor, disconnect the fuel line connection from the fuel inlet filter nut.
3. Remove the fuel inlet filter nut from the carburetor.
4. Remove the filter and the spring, then discard the old filter.

To install:

Ä A check valve MUST be installed in the filter to meet the Motor Vehicle Safety Standards for roll-over. When installing a new filter, pay attention to the direction the fuel must flow through it; it MUST be installed with the check valve end facing the fuel line. The new filter is equipped with ribs on the closed end to ensure that it will not be installed incorrectly unless it is forced.

5. Install the spring and the new filter/check valve assembly into the carburetor inlet, followed by the fuel inlet nut.
6. Tighten the fuel inlet nut to 18 ft. lbs. (25 Nm).
7. Install the fuel line and tighten the connection.
8. Connect the negative battery cable, then start the engine and check for leaks.

Figure 71.
Exploded view of the internal fuel filter—carbureted engines

{ewc GSMVIMG,GSMVIMG, !88261G26.bmp}

88261G26

Inline {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Inline

Ü See figures 72, 73, 74, 75, 76, 77

The location of the inline fuel filter varies depending upon the year and model of the vehicle. On most models, the filter can be found along one of the vehicle's frame rails (usually the left side, towards the front of the vehicle). But, on some later versions of the 2.5L engine, the filter may be found under the engine cover, at the rear of the engine. To save you the trouble of removing the engine cover, we recommend that no matter which engine your van uses, that you check along the frame rails first. If necessary, follow the fuel lines from the tank at the rear of the vehicle, forward until you either find the filter, or the line disappear into the engine cavity.

1. Properly relieve the fuel system pressure, then disconnect the negative battery cable.

   Ä When relieving the fuel system pressure, remember to loosen the fuel tank filler cap. If the tank pressure is not released, fuel could be forced through the lines and out the opening, as soon as the fuel fittings are loosened.

2. Locate the filter along the frame rail or under the engine cover. As necessary for access, either raise and support the vehicle using jackstands or remove the engine cover.
3. Using 2 wrenches (one for backup on the filter itself to keep it from spinning), loosen and remove the fuel lines from the filter. On models where the filter is mounted vertically along the frame rail, it may be easier to loosen the upper fitting first, then the lower fitting.

   Ä Fittings which are stuck to the filter with corrosion may be very difficult to loosen. ALWAYS use the proper size wrench (a line wrench is preferable to a standard open-end tool) or you will risk rounding off the fuel line fittings. Also, spraying the fitting with penetrating oil prior to loosening may help to loosen the corrosion and free the fitting.

4. Note the direction which the filter is mounted for installation purposes (there may still be a visible arrow on the side of the old filter, or the filter ends may be different). Loosen the filter or filter clamp-to-bracket bolt (as applicable), then remove the filter and discard it. If the filter and clamp come of the bracket as an assembly, retain the clamp for installation on the new filter.

Figure 72.
Exploded view of the late-model 2.5L engine fuel filter mounting

{ewc GSMVIMG,GSMVIMG, !88261G27.bmp}

88261G27

Figure 73.
Most vehicles covered by this manual use a fuel filter which is mounted vertically along the frame rail

{ewc GSMVIMG,GSMVIMG, !88261G28.bmp}

88261G28

Figure 74.
A backup wrench is used to keep the filter from twisting (damaging the other fuel line if still attached)

{ewc GSMVIMG,GSMVIMG, !88261P18.bmp}

88261P18

Figure 75.
Before loosening the fitting completely, position a rag to catch any remaining fuel which may spill

{ewc GSMVIMG,GSMVIMG, !88261P19.bmp}

88261P19

Figure 76.
The fuel filter on some late-model vehicles is mounted horizontally along the frame rail

{ewc GSMVIMG,GSMVIMG, !88261G29.bmp}

88261G29

Figure 77.
Once the filter and clamp assembly is removed (on late-model vehicles) the filter should be separated and discarded (but retain the clamp for the new filter)

{ewc GSMVIMG,GSMVIMG, !88261G30.bmp}

88261G30

To install:

Ä When installing a new filter, be sure to install it facing the proper direction. Normally an arrow is found on the side of the filter housing to show proper direction of flow (toward the engine). If no arrow is present, position it in the same way as you noted during removal of the old filter.

5. If the clamp was removed with the old filter, position it over the replacement.
6. Install the new filter into the bracket and thread, but do not tighten, the retaining bolt.

Ä If O-rings are used on the threaded fittings, they should be replaced to assure a proper seal.

7. Connect the fuel lines and tighten using a backup wrench to keep the filter from spinning.
8. Tighten the fuel filter retaining bolt.
9. Connect the negative battery cable, then pressurize the fuel system (by cycling the ignition or cranking the engine) and check for leaks.
10. Either remove the jackstands and carefully lower the vehicle, or install the engine cover, as applicable.

Intank {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Intank

Ü See figure 78

The intank filter (also know as the strainer) is usually constructed of woven plastic and is located on the lower end of the fuel pickup tube in the fuel tank. The filter prevents dirt and discourages water from entering the fuel system; though water will enter the system if the filter becomes completely submerged in the water. The filter is normally self cleaning and requires no periodic maintenance; should this filter become clogged, the fuel tank must be flushed.

1. Remove the fuel pump or sending unit from the vehicle, as applicable. For details, please refer to Section 5 of this manual.
2. Carefully remove the fuel filter (strainer) from the fuel pump and clean or replace it, as necessary.

   Ä When installing the intank fuel filter, be careful not to fold or twist it for this may restrict the flow.

3. Install the strainer, then install the fuel pump or sending unit.

Figure 78.
The intank fuel filter (strainer) is attached to the bottom of the pump or sending unit assembly—TBI model shown

{ewc GSMVIMG,GSMVIMG, !88261G31.bmp}

88261G31

Positive Crankcase Ventilation (PCV) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Positive Crankcase Ventilation (PCV)

Ü See figure 79

The Positive Crankcase Ventilation (PCV) system is used to vent pressure which builds in the crankcase during engine operation. Fresh air is inducted to the crankcase through the ventilation system (which may include a separate filter in the air cleaner on some models) and is then drawn to the engine intake air system so it can be burned. The PCV valve may be the most important part of the system since it regulates the flow of the vapors during engine operation. If the valve becomes stuck open it could allow vapors to enter the intake at the wrong time (causing poor driveability). If is becomes stuck closed or clogged, it could allow excessive crankcase pressure to cause gasket leaks and/or the buildup of damaging sludge in the crankcase oil. In any case, it is an inexpensive part which should NOT be overlooked for periodic inspection and replacement.

The PCV valve is usually attached to a valve cover by a rubber grommet and connected to the intake manifold through a ventilation hose. Replace the PCV valve and the PCV filter (located in the air cleaner on TBI and carbureted models so equipped) every 30,000 miles (48,000 km).

Figure 79.
Typical air and vapor flow through PCV systems

{ewc GSMVIMG,GSMVIMG, !88261G33.bmp}

88261G33

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REMOVAL & INSTALLATION

Ü See figures 80, 81

1. Open the hood to see if access is possible without removing the engine cover. Depending on your model (and the length of your arms) you may be able to reach the valve for replacement. If not, SORRY, but you will have to remove the engine cover for better access.
2. Pull the PCV from the valve cover grommet and disconnect it from the ventilation hose(s).
3. You can inspect the valve for operation: (1) Shake it to see if the valve is free; (2) Blow through it (air will pass in one direction only). If you have removed the engine cover, take this opportunity to also check the condition of the vacuum hose and, if applicable, the filter in the air cleaner housing and replace any damaged or worn component.

   Ä When replacing the PCV valve, it is recommended to use a new one. It is usually an inexpensive part, but it performs a very important function for the life of your engine's gaskets and oil.

4. Upon installation, be sure the valve seats properly in the valve cover grommet and that the vacuum hose is tight on the valve fitting.

Figure 80.
The PCV valve is normally fitted to a rubber grommet in the valve cover

{ewc GSMVIMG,GSMVIMG, !88261P20.bmp}

88261P20

Figure 81.
Once it is removed from the grommet, carefully pull it free of the vacuum hose

{ewc GSMVIMG,GSMVIMG, !88261P21.bmp}

88261P21

Evaporative Canister

Ü See figures 82, 83

To limit gasoline vapor discharge into the atmosphere, this system is designed to trap fuel vapors, which normally escape from the fuel tank and the intake manifold. Vapor arrest is accomplished through the use of the charcoal canister. This canister absorbs fuel vapors and stores them until they can be removed to be burned in the engine. Removal of the vapors from the canister to the engine is accomplished by various means, depending upon the emission systems on your van. For more details about the operation and components of the evaporative emission system, please refer to Section 4 of this manual.

In addition to the modifications necessary to the fuel system of evaporative emission equipped engines and the addition of a canister, the fuel tank requires a non-vented gas cap. The domed fuel tank positions a vent high enough above the fuel to keep the vent pipe in the vapor at all times. The single vent pipe is routed directly to the canister. From the canister, the vapors are routed to the intake system, where they will be burned during normal combustion.

Figure 82.
Schematic for a typical evaporative emission control system—2.5L engine shown

{ewc GSMVIMG,GSMVIMG, !88261G34.bmp}

88261G34

Figure 83.
Schematic for a typical evaporative emission control system—4.3L TBI engine shown

{ewc GSMVIMG,GSMVIMG, !88261G35.bmp}

88261G35

SERVICING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SERVICING

Ü See figure 84

The only maintenance necessary to this system on most vehicles covered by this manual is a periodic check to make sure the lines and components are intact and still holding (or routing) vapors. Every 30,000 miles (48,000 km) or 24 months, check all fuel, vapor lines and hoses for proper hookup, routing and condition. If equipped, check that the bowl vent and purge valves work properly. Remove the canister and check for cracks or damage, then replace (if necessary). Some early model vehicles will be equipped with a canister that uses a replaceable filter. You should be able to tell by inspecting the bottom of the canister once it is removed for your maintenance inspection. If your canister is equipped, the filter should be visible. Most vehicles covered by this manual use a sealed canister that does not utilize a replaceable filter.

Figure 84.
Periodically check the evaporative canister, lines and fittings for leaks

{ewc GSMVIMG,GSMVIMG, !88261P22.bmp}

88261P22

FILTER REPLACEMENT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

FILTER REPLACEMENT

On early model vehicles, the replaceable filter is in the bottom of the carbon canister located in the engine compartment. It should be replaced every 30,000 miles (48,000 km) or 24 months.

1. Disconnect and mark the charcoal canister vent hoses.
2. Remove the canister-to-bracket bolt.
3. Lift the canister from the bracket.
4. At the bottom of the canister, grasp the filter with your fingers and pull it out.
5. To install, use a new filter and reverse the removal procedures.

Battery {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Battery

Ä Although all Astro and Safari Vans were originally equipped with a sealed Maintenance-Free battery as standard equipment (which would limit the need for periodic fluid level checks and eliminate the possibility of specific gravity tests) you should keep in mind that if someone has already replaced the battery, the new part might not be a sealed-maintenance free unit. A careful inspection of the battery cover and any labels which are still present should help you determine the type of battery in your vehicle. Keep in mind that a built-in hydrometer eye almost always means that the battery is a sealed maintenance-free unit.

GENERAL MAINTENANCE

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 components under the hood. 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), but a sealed battery must also be checked for proper electrolyte level as indicated by the color of the built-in hydrometer "eye."

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.

****Caution**

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.

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 {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

BATTERY FLUID

Ü See figures 85, 86, 87

****Caution**
Battery electrolyte contains sulfuric acid. If you should splash any on your skin or in your eyes, flush the affected area with plenty of clear water. If it lands 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.

Figure 85.
On non-maintenance free batteries, the level can be checked through the case on translucent batteries; the cell caps must be removed on other models

{ewc GSMVIMG,GSMVIMG, !tccs1251.bmp}

tccs1251

Figure 86.
Check the specific gravity of the battery's electrolyte with a hydrometer

{ewc GSMVIMG,GSMVIMG, !tccs1252.bmp}

tccs1252

Figure 87.
A typical sealed (maintenance-free) battery with a built-in hydrometer—NOTE that the hydrometer eye may vary between battery manufacturers; always refer to the battery's label

{ewc GSMVIMG,GSMVIMG, !tccs1253.bmp}

tccs1253

Fluid Level {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Fluid Level

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.

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

Specific Gravity {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Specific Gravity

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 1 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 2 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.

On sealed batteries, the built-in hydrometer is the only way of checking specific gravity. Again, check with your battery's manufacturer for proper interpretation of its built-in hydrometer readings.

CABLES {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CABLES

Ü See figures 88, 89, 90, 91, 92, 93

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.

Figure 88.
Maintenance is performed with household items and with special tools like this post cleaner

{ewc GSMVIMG,GSMVIMG, !tccs1206.bmp}

tccs1206

Figure 89.
The underside of this special battery tool has a wire brush to clean post terminals

{ewc GSMVIMG,GSMVIMG, !tccs1207.bmp}

tccs1207

Figure 90.
Place the tool over the terminals and twist to clean the post

{ewc GSMVIMG,GSMVIMG, !tccs1208.bmp}

tccs1208

Figure 91.
A special tool is available to pull the clamp from the post

{ewc GSMVIMG,GSMVIMG, !tccs1254.bmp}

tccs1254

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 (an old knife is useful here) thoroughly, 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, 1 type for conventional top post batteries and another type for side terminal batteries.

Figure 92.
Clean the battery terminals until the metal is shiny

{ewc GSMVIMG,GSMVIMG, !tccs1255.bmp}

tccs1255

Before installing the cables, loosen the battery hold-down clamp or strap, remove the battery and check the battery tray. Clear it of any debris, and check it for soundness (the battery tray can be cleaned with a baking soda and water solution). Rust should be wire brushed away, and the metal given a couple coats of anti-rust paint. Install the battery and tighten the hold-down clamp or strap securely. Do not over tighten, as this can crack the battery case.

Figure 93.
The cable ends should be cleaned as well

{ewc GSMVIMG,GSMVIMG, !tccs1256.bmp}

tccs1256

After the clamps and terminals are clean, reinstall the cables, negative cable last; DO NOT hammer the clamps onto post batteries. 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.

CHARGING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CHARGING

****Caution**
The chemical reaction which takes place in all batteries generates explosive hydrogen gas. A spark can cause the battery to explode and splash acid. To avoid serious personal injury, be sure there is proper ventilation and take appropriate fire safety precautions when connecting, disconnecting, or charging a 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 {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REPLACEMENT

When it becomes necessary to replace the battery, select 1 with a 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 {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Belts

INSPECTION

Ü See figures 94, 95, 96, 97, 98

V-Belts

> **Ä The 1985–86 vehicles covered by this manual utilize 1 or more V-belts to drive engine accessories (such as the alternator, water pump, power steering pump or A/C compressor off the crankshaft.**

Check the drive belt(s) every 15,000 miles/12 months (heavy usage) or 30,000 miles/24 months (light usage) for evidence of wear such as cracking, fraying and incorrect tension. Determine the belt tension at a point halfway between the pulleys by pressing on the belt with moderate thumb pressure. The belt should deflect about $^{1}/4$ in. (6mm) over a 7–10 in. (178–254mm) span, or $^{1}/2$ in. (13mm) over a 13–16 in. (330–406mm) span, at this point. If the deflection is found to be too much or too little, perform the tension adjustments.

Figure 94.
There are typically 3 types of accessory drive belts found on vehicles today

{ewc GSMVIMG,GSMVIMG, !tccs1218.bmp}

tccs1218

Figure 95.
An example of a healthy drive belt

{ewc GSMVIMG,GSMVIMG, !tccs1214.bmp}

tccs1214

Figure 96.
Deep cracks in this belt will cause flex, building up heat that will eventually lead to belt failure

{ewc GSMVIMG,GSMVIMG, !tccs1215.bmp}

tccs1215

Figure 97.
The cover of this belt is worn, exposing the critical reinforcing cords to excessive wear

{ewc GSMVIMG,GSMVIMG, !tccs1216.bmp}

tccs1216

Figure 98.
Installing too wide a belt can result in serious belt wear and/or breakage

{ewc GSMVIMG,GSMVIMG, !tccs1217.bmp}

tccs1217

Serpentine Belts {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Serpentine Belts

Ü See figures 99, 100

Ä All 1987 and later vehicles covered by this manual utilize a single, ribbed, serpentine belts to drive engine accessories (such as the alternator, water pump, power steering pump or A/C compressor off the crankshaft.

The serpentine belt and pulleys should be inspected every 15,000 miles/12 months (heavy usage) or 30,000 miles/24 months (light usage) for evidence of wear such as cracking, fraying, incorrect alignment and incorrect tension. Proper maintenance of the belt and pulleys can extend normal belt life.

Figure 99.
Serpentine drive belts require little attention other than periodic inspection or replacement

{ewc GSMVIMG,GSMVIMG, !88261P23.bmp}

88261P23

Figure 100.
When checking the serpentine belt, be sure it is properly seated in each of the pulleys

{ewc GSMVIMG,GSMVIMG, !88261G36.bmp}

88261G36

****Warning**
DO NOT use belt dressings in an attempt to extend belt life. Belt dressing will soften the serpentine belt, causing deterioration. Oil or grease contamination on the belt or pulleys will have the same effect. Keep the drive belt system clear of oil, grease, coolant or other contaminants.

PULLEY INSPECTION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

PULLEY INSPECTION

Ü See figure 101

Ä Pulley inspection is most easily accomplished with the drive belt removed so you can freely turn the pulleys and to provide an unobstructed view of each pulley.

1. Visually inspect each of the pulleys for chips, nicks, cracks, tool marks, bent sidewalls, severe corrosion or other damage. Replace any pulley showing these signs as they will eventually lead to belt failure.
2. Place a straightedge or position a length of string across any 2 pulleys making sure it touches all points. When using string, be sure it is straight and not bent at one spot in order to contact all points on the pulley.

Ä An assistant is helpful to hold the straightedge or string during the next steps.

3. Turn each pulley 1/2 revolution and recheck with the straightedge or string.
4. Full contact must be made at all points checked. If contact is not made at all of the points, the pulley may be warped or the shaft may be bent. Replace any damaged parts to assure proper belt life.

Figure 101.
A straightedge should be used to check pulley alignment

{ewc GSMVIMG,GSMVIMG, !88261G38.bmp}

88261G38

BELT INSPECTION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Routine Maintenance And Tune-up

BELT INSPECTION

Ü See figure 102

1. Visually check the belt for signs of damage. Routine inspection may reveal cracks in the belt ribs. These cracks will not impair belt performance and are NOT a basis for belt replacement. HOWEVER, if your inspection reveals that sections of the belt are missing, the belt must be replaced to avoid a possible failure.
2. Visually check the belt for proper routing (when compared with the engine compartment label or the diagrams in this section). Make sure the belt is fully seated on all pulleys.
3. Check the automatic drive belt tensioner. The belt is considered serviceable if no wear or damage was found in the previous visual inspections and if the arrow on the tensioner assembly is pointing within the acceptable used belt length range on the tensioner spindle.

Figure 102.
The markings on the automatic tensioner are used to check serpentine belt wear

{ewc GSMVIMG,GSMVIMG, !88261G39.bmp}

88261G39

ADJUSTING TENSION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ADJUSTING TENSION

V-belts

Ü See figure 103

Ä The following procedures require the use of GM Belt Tension Gauge No. BT–33–95-ACBN (regular V-belts) or BT–33–97M (poly V-belts).

If a belt tension gauge is not available, you can adjust tension using the deflection measurements, but this is not as exact. Keep in mind that too tight or too loose an adjustment can damage the components which the belt drives. Too tight will increase preload on the bearings, leading to early failure, while too loose could cause slippage or jerky movements. Of the 2 possibilities, you would prefer the belt to be a little loose, rather than a little tight. The belt should deflect about $^1/4$ in. (6mm) over a 7–10 in. (178–254mm) span, or $^1/2$ in. (13mm) over a 13–16 in. (330–406mm) span, at this point.

If a belt tension gauge is available:

1. If the belt is cold, operate the engine (at idle speed) for 15 minutes; the belt will seat itself in the pulleys allowing the belt fibers to relax or stretch. If the belt is hot, allow it to cool, until it is warm to the touch.

   Ä A used belt is one that has been rotated at least one complete revolution on the pulleys. This begins the belt seating process and it must never be tensioned to the new belt specifications.

2. Disconnect the negative battery cable for safety.
3. Loosen the component-to-mounting bracket bolts.
4. Using a GM Belt Tension Gauge No. BT–33–95–ACBN (standard V–belts) or BT–33–97M (poly V-belts), place the tension gauge at the center of the belt between the longest span.
5. Applying belt tension pressure on the component, adjust the drive belt tension to the correct specifications.
6. While holding the correct tension on the component, tighten the component-to-mounting bracket bolt.
7. When the belt tension is correct, remove the tension gauge and connect the negative battery cable.

Figure 103.
A tension gauge is necessary to properly adjust tension on V-belt equipped engines

{ewc GSMVIMG,GSMVIMG, !88261G37.bmp}

88261G37

Serpentine Belts {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Serpentine Belts

All 1987–96 Astro and Safari vans are equipped with a single serpentine belt and spring loaded tensioner. The proper belt adjustment is automatically maintained by the tensioner, therefore, no periodic adjustment is needed until the pointer is past the scale on the tensioner. For more information, please refer to the information on serpentine belt and pulley inspection found earlier in this section.

DRIVE BELT ROUTING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

DRIVE BELT ROUTING

Ü See figures 104, 105, 106, 107, 108, 109, 110, 111

A label is normally provided in the engine compartment which details the proper belt routing for the original engine installed in that vehicle. Check the routing label (or vehicle emission control information label) for an illustration which resembles your motor first. If no label is present or if the label does not match your engine (perhaps an engine swap was performed on older vehicles before you were the owner) refer to the routing diagrams found in this section. In cases where engine swaps were made, determine the year or the engine using year codes, or visually match the accessories to the diagrams provided.

Figure 104.
Belt routing can be found on labels such as this one on the power steering reservoir . . .

{ewc GSMVIMG,GSMVIMG, !88261P24.bmp}

88261P24

Figure 105.
. . . or like this one on a 1996 Astro vehicle emission control information label

{ewc GSMVIMG,GSMVIMG, !88261P25.bmp}

88261P25

Figure 106.
Drive belt routing—1985–86 2.5L engines (V-belts)

{ewc GSMVIMG,GSMVIMG, !88261G40.bmp}

88261G40

Figure 107.
Drive belt routing—1985–86 4.3L engines (V-belts)

{ewc GSMVIMG,GSMVIMG, !88261G41.bmp}

88261G41

Figure 108.
Drive belt routing—1987–90 2.5L engines (Serpentine Belts)

{ewc GSMVIMG,GSMVIMG, !88261G42.bmp}

88261G42

Figure 109.
Drive belt routing—1987–91 4.3L engines (Serpentine Belts)

{ewc GSMVIMG,GSMVIMG, !88261G43.bmp}

88261G43

Figure 110.
Drive belt routing—1992–95 4.3L engines (Serpentine Belts)

{ewc GSMVIMG,GSMVIMG, !88261G44.bmp}

88261G44

Figure 111.
Drive belt routing—1996 4.3L engines (Serpentine Belts)

{ewc GSMVIMG,GSMVIMG, !88261G45.bmp}

88261G45

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REMOVAL & INSTALLATION

V-belts

Ü See figures 112, 113

1. Disconnect the negative battery cable for safety.
2. Loosen the component-to-mounting bracket bolts.
3. Rotate the component to relieve the tension on the drive belt.
4. Slip the drive belt from the component pulley and remove it from the engine.

   Ä If the engine uses more than one belt, it may be necessary to remove other belts that are in front of the one being removed.

5. To install, reverse the removal procedures. Adjust the component drive belt tension to specifications.

Figure 112.
To adjust or replace belts, first loosen the component mounting and adjusting bolts . . .

{ewc GSMVIMG,GSMVIMG, !88261G46.bmp}

88261G46

Figure 113.
. . . the pivot the component inward to remove the belt or outward to increase tension

{ewc GSMVIMG,GSMVIMG, !88261G47.bmp}

88261G47

Serpentine Belts {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Serpentine Belts

Ü See figure 114

Belt replacement is a relatively simple matter rotating the tensioner off the belt (to relieve tension) and holding the tensioner in this position as the belt is slipped from its pulley. Depending on the engine and year of production, there are various methods of rotating the tensioner, but all require a breaker bar, large ratchet or wrench. Most early models use a tensioner which has a machined receiver which directly accepts a $^{1}/2$ in. driver. Most later models (through 1995) require that you use a large socket or wrench (usually 16mm or $^{5}/8$ in.) over the tensioner pulley bolt. A change was made to the part again in 1996, so the tensioner arm contains a machined receiver for a $^{3}/8$ in. driver from a ratchet or breaker bar.

1. Before you begin, visually confirm the belt routing to the engine compartment label (if present) or to the appropriate diagram in this section (if the label is not present). If you cannot make a match (perhaps it is not the original motor for this van), scribble your own diagram on a page in this book before proceeding.
2. Disconnect the negative battery cable for safety.
3. Install the appropriate sized breaker bar, wrench, or socket to the tensioner arm or pulley, as applicable.
4. Rotate the tensioner to the left (counterclockwise) and slip the belt from the tensioner pulley.
5. Once the belt is free from the tensioner, CAREFULLY rotate the tensioner back into position. DO NOT allow the tensioner to suddenly snap into place or damage could occur to the assembly.
6. Slip the belt from the remaining pulleys (this can get difficult is there is little room between the radiator/fan assembly and the accessory pulleys. Work slowly and be patient.
7. Once the belt is free, remove it from the engine compartment.

Figure 114.
On this 4.3L engine, a large wrench (16mm) was used to pivot the belt tensioner and free the belt

{ewc GSMVIMG,GSMVIMG, !88261P26.bmp}

88261P26

To install:

8. Route the belt over all the pulleys except the water pump and/or the tensioner. Refer to the routing illustration that you identified as a match before beginning.
9. Rotate the tensioner pulley to the left (counterclockwise) and hold it while you finish slipping the belt into position. Slowly allow the tensioner into contact with the belt.
10. Check to see if the correct V-groove tracking is around each pulley.

****Warning**
Improper V-groove tracking will cause the belt to fail in a short period of time.

11. Connect the negative battery cable.

Hoses {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Hoses

INSPECTION

Ü See figures 115, 116, 117, 118

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) or 12 months. 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 both 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.

Figure 115.
The cracks developing along this hose are a result of age-related hardening

{ewc GSMVIMG,GSMVIMG, !tccs1219.bmp}

tccs1219

Figure 116.
A hose clamp that is too tight can cause older hoses to separate and tear on either side of the clamp

{ewc GSMVIMG,GSMVIMG, !tccs1220.bmp}

tccs1220

Figure 117.
A soft spongy hose (identifiable by the swollen section) will eventually burst and should be replaced

{ewc GSMVIMG,GSMVIMG, !tccs1221.bmp}

tccs1221

Figure 118.
Hoses are likely to deteriorate from the inside if the cooling system is not periodically flushed

{ewc GSMVIMG,GSMVIMG, !tccs1222.bmp}

tccs1222

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REMOVAL & INSTALLATION

1. Disconnect the negative battery cable for safety.
2. Drain the cooling system to a level below the hose which is being removed. The entire system must be drained if the lower radiator hose is being disconnected from the radiator or engine.
3. Loosen the hose clamps at each end of the hose.
4. Working the hose back and forth, slide it off its connection.

   Ä When replacing the heater hoses, maintain a 1 1/2 in. (38mm) clearance between the hose clip-to-upper control arm and between the rear overhead heater core lines-to-exhaust pipe.

5. To install, reverse the removal procedures.

   Ä Draw the hoses tight to prevent sagging or rubbing against other components; route the hoses through the clamps as installed originally. Always make sure the hose clamps are beyond the component bead and placed in the center of the clamping surface before tightening them.

CV-Boots {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CV-Boots

INSPECTION

Ü See figures 119, 120

The front halfshafts on All Wheel Drive (AWD) vehicles use CV (Constant Velocity) joints to transmit power from the differential to the front wheels, while still allowing for suspension travel. The joints are protected by CV-boots which 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.

Figure 119.
CV-boots must be inspected periodically for damage

{ewc GSMVIMG,GSMVIMG, !tccs1011.bmp}

tccs1011

Figure 120.
A torn boot should be replaced immediately

{ewc GSMVIMG,GSMVIMG, !tccs1010.bmp}

tccs1010

Spark Plugs {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Spark Plugs

Ü See figure 121

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 degrees angle so its tip is just past and parallel to the tip of the center electrode. The distance between these 2 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 20,000–50,000 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.

Figure 121.
Cross-section of a spark plug

{ewc GSMVIMG,GSMVIMG, !tccs1045.bmp}

tccs1045

SPARK PLUG HEAT RANGE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SPARK PLUG HEAT RANGE

Ü See figure 122

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.

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.

Figure 122.
Spark plug heat range

{ewc GSMVIMG,GSMVIMG, !tccs1046.bmp}

tccs1046

REMOVAL {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REMOVAL

Ü See figures 123, 124, 125, 126, 127

A set of spark plugs usually requires replacement after about 20,000–30,000 miles (32,000–48,000 km), 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 2 to 3 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).

> **Ä All 1996 models were originally equipped with platinum-tip spark plugs which can be used for as-long-as 100,000 miles (161,000 km). This holds true unless internal engine wear or damage and/or improperly operating emissions controls cause plug fouling. If you suspect this, you may wish to remove and inspect the platinum plugs before the recommended mileage. Most platinum plugs should not be cleaned or regapped. If you find their condition unsuitable, they should be replaced.**

When removing the spark plugs, work on 1 at a time. Don't start by removing the plug wires all at once because unless you number them, they're going to get mixed up. On some models though, it will be more convenient for you to remove all of the wires before you start to work on the plugs. If this is necessary, take a minute before you begin and number the wires with tape before you take them off. The time you spend here will pay off later.

Figure 123.
Access to the spark plugs is through the wheel-well on most Astro and Safari vans

{ewc GSMVIMG,GSMVIMG, !88261P27.bmp}

88261P27

Figure 124.
Disconnect the spark plug wire by pulling on the BOOT, NOT THE WIRE

{ewc GSMVIMG,GSMVIMG, !88261P28.bmp}

88261P28

Figure 125.
A spark plug wire removal tool is recommended to prevent wire damage (and to make it easier)

{ewc GSMVIMG,GSMVIMG, !88261G48.bmp}

88261G48

Figure 126.
Loosen the spark plug using a ratchet and extension . . .

{ewc GSMVIMG,GSMVIMG, !88261P29.bmp}

88261P29

Figure 127.
. . . then carefully unthread and remove the plug from the cylinder head

{ewc GSMVIMG,GSMVIMG, !88261P30.bmp}

88261P30

1. Disconnect the negative battery cable, and if the vehicle has been run recently, allow the engine to thoroughly cool. Attempting to remove plugs from a hot cylinder head could cause the plugs to seize and damage the threads in the cylinder head.

2. Check for access to the plugs on your vehicle. The wheel wells of most vans covered by this manual are designed to allow access to the sides of the engine. A rubber cover may be draped over the opening, and it may require removal of 1 or more plastic body snap-fasteners (which are carefully pried loose using a special C-shaped tool) before you can move it aside for clearance. If this is your best access point, raise and support the vehicle safely using jackstands, then remove the front tire and wheel assemblies.

   Ä On some models, the engine cover may be removed to provide additional access to the spark plugs. This will be necessary if you also plan to check the spark plug wires at this time anyway.

3. 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.

   Ä A spark plug wire removal tool is recommended as it will make removal easier and help prevent damage to the boot and wire assembly.

4. Using compressed air (and SAFETY GLASSES), 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.

   Ä Remove the spark plugs when the engine is cold, if possible, to prevent damage to the threads. If plug removal is difficult, apply a few drops of 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 (usually a $^{5}/8$ in. socket on these engines) 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.

   ****Warning**
   AVOID the use of a flexible extension on the socket. Use of a flexible extension may allow a shear force to be applied to the plug. A shear force could break the plug off in the cylinder head, leading to costly and frustrating repairs.

INSPECTION & GAPPING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

INSPECTION & GAPPING

Ü See figures 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139

> **Ä If the specifications on the underhood tune-up sticker in the engine compartment disagree with the Tune-Up Specifications chart in this Section, the figures on the sticker must be used. The sticker often reflects changes made during the production run.**

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%.

> **Ä All 1996 models were originally equipped with platinum-tip spark plugs which can be used for as-long-as 100,000 miles (161,000 km). This holds true unless internal engine wear or damage and/or improperly operating emissions controls cause plug fouling. If you suspect this, you may wish to remove and inspect the platinum plugs before the recommended mileage. Most platinum plugs should not be cleaned or regapped. If you find their condition unsuitable, they should be replaced.**

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.

> **Ä 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 1 size smaller and 1 larger. The smaller gauge should go through easily, while the larger 1 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.

Figure 128.
A normally worn spark plug should have light tan or gray deposits on the firing tip

{ewc GSMVIMG,GSMVIMG, !tccs2135.bmp}

tccs2135

Figure 129.
A carbon fouled plug, identified by soft, sooty, black deposits, may indicate an improperly tuned vehicle. Check the air cleaner, ignition components and engine control system

{ewc GSMVIMG,GSMVIMG, !tccs2136.bmp}

tccs2136

Figure 130.
A variety of tools and gauges are needed for spark plug service

{ewc GSMVIMG,GSMVIMG, !tccs1212.bmp}

tccs1212

Figure 131.
A physically damaged spark plug may be evidence of severe detonation in that cylinder. Watch that cylinder carefully between services, as a continued detonation will not only damage the plug, but could also damage the engine

{ewc GSMVIMG,GSMVIMG, !tccs2137.bmp}

tccs2137

Figure 132.
Checking the spark plug gap with a feeler gauge

{ewc GSMVIMG,GSMVIMG, !tccs2903.bmp}

tccs2903

Figure 133.
An oil fouled spark plug indicates an engine with worn piston rings and/or bad valve seals allowing excessive oil to enter the chamber

{ewc GSMVIMG,GSMVIMG, !tccs2138.bmp}

tccs2138

Figure 134.
Adjusting the spark plug gap

{ewc GSMVIMG,GSMVIMG, !tccs2904.bmp}

tccs2904

Figure 135.
This spark plug has been left in the engine too long, as evidenced by the extreme gap—Plugs with such an extreme gap can cause misfiring and stumbling accompanied by a noticeable lack of power

{ewc GSMVIMG,GSMVIMG, !tccs2139.bmp}

tccs2139

Figure 136.
A bridged or almost bridged spark plug, identified by a build-up between the electrodes caused by excessive carbon or oil build-up on the plug

{ewc GSMVIMG,GSMVIMG, !tccs2140.bmp}

tccs2140

Figure 137.
If the standard plug is in good condition, the electrode may be filed flat—WARNING: do not file platinum plugs

{ewc GSMVIMG,GSMVIMG, !tccs1141.bmp}

tccs1141

Figure 138.
Used spark plugs which show damage may indicate engine problems

{ewc GSMVIMG,GSMVIMG, !tccs2001.bmp}

tccs2001

Figure 139.
Inspect the spark plug to determine engine running conditions

{ewc GSMVIMG,GSMVIMG, !tccs2002.bmp}

tccs2002

INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

INSTALLATION

1. Inspect the spark plug boot for tears or damage. If a damaged boot is found, the spark plug wire must be replaced. As mentioned earlier, this is an excellent time to check each of the spark plug wires for proper resistance and/or for damage.
2. 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.
3. 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 cross thread.

   ****Warning**
   Do not use the spark plug socket to thread the plugs. Always carefully thread the plug by hand or using an old plug wire to prevent the possibility of Crossthreading and damaging the cylinder head bore.

4. Carefully tighten the spark plug. If the plug you are installing is equipped with a crush washer, seat the plug, then tighten about $^{1}/4$ turn to crush the washer. If you are installing a tapered seat plug, tighten the plug to 11 ft. lbs. (14 Nm) for all engines except 1996 models. On 1996 model engines, tighten the plug to 14 ft. lbs. (20 Nm) on used cylinder heads or to 22 ft. lbs. (30 Nm) on new cylinder heads.
5. 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.

Spark Plug Wires {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Spark Plug Wires

Ü See figures 140, 141

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 distributor cap and/or coil. Replace any damaged wiring.

> **Ä If the spark plug wires have become unserviceable due to time and wear, it is probably a good idea to replace the distributor cap and rotor as well.**

Every 30,000 miles (48,000 km) or so, 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. Generally, the useful life of the cables is 30,000–45,000 miles (48,000–72,000 km), though some late-model vehicles (such as 1996 Astro or Safari equipped with platinum-tip plugs) use newer long-life wires which could last up to 100,000 (161,000 km) miles in some circumstances.

Figure 140.
Checking plug wire resistance through the distributor cap with an ohmmeter

{ewc GSMVIMG,GSMVIMG, !tccs1008.bmp}

tccs1008

Figure 141.
Checking individual plug wire resistance with a digital ohmmeter

{ewc GSMVIMG,GSMVIMG, !tccs1009.bmp}

tccs1009

To check the resistance, remove the distributor cap (you'll have to remove the engine cover for access), leaving the wires in place. Connect 1 lead of an ohmmeter to an electrode within the cap; connect the other lead to the corresponding spark plug terminal (remove it from the spark plug for this test). Replace any wire which shows a resistance over 30,000 ohms or which fluctuates value if the wire is moved/bent slightly.

It should be remembered that resistance is also a function of length; the longer the wire the greater the resistance. If the wire resistance is below 30,000 ohms, then compare the ohmmeter reading to the appropriate specification for that wire's length. Replace any wire which exceeds the appropriate resistance for its length:

- 0–15 in. (0–38 cm)—3000–10,000 ohms
- 15–25 in. (38–64 cm)—4000–15,000 ohms
- 25–35 in. (64–89 cm)—6000–20,000 ohms
- Over 35 in. (89 cm)—5000–10,000 ohms per 12 in. (30 cm)

When installing a new set of spark plug wires, replace the wires 1 at a time so there will be no mix up. Start by replacing the longest cable first. Install the boot firmly over the spark plug. Route the wire exactly the same as the original. Insert the distributor end of the wire firmly into the distributor cap tower, then seat the boot over the tower. Repeat the process for each wire.

Distributor Cap and Rotor {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Distributor Cap and Rotor

At every tune-up/inspection, visually check the distributor cap and rotor for damage, burns or corrosion. Check the spark plug towers and their terminals under the cap to make sure they are free of corrosion which would inhibit proper spark distribution. Replace any damaged or worn components.

Ä If the spark plug wires have become unserviceable due to time and wear, it is probably a good idea to replace the cap and rotor as well.

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REMOVAL & INSTALLATION

Ü See figures 142, 143, 144, 145, 146

1. Disconnect the negative battery cable for safety.
2. Remove the engine cover from the passenger compartment.

   Ä Some late-model vehicles, such as 1996 engines with the HVS system, use spark plug wires and distributor caps which are already numbered for ease of service, BUT double-check this before disconnecting any wires.
3. If the cap is being completely removed (for replacement or for engine service) TAG all of the spark plug wires and matching terminals on the cap, then disconnect the wires.

   Ä If the cap is just being removed for inspection or for access to the rotor, it may be possible to remove the cap without disconnecting any/all of the wires and position it aside. Just remember that if you change your mind and disconnect 2 or more wires you MUST stop and tag them before proceeding.
4. Release the distributor cap retainers. For most vehicles covered by this manual, there should be 2 retaining screws (one on either side of the cap), though some models may use spring loaded cap retainers which are simply twisted $^1/4–^1/2$ turn to release.
5. Remove the cap from the distributor assembly.
6. If you are replacing or inspecting the rotor, check for any retaining screws and remove, if present. Most vans covered by this manual utilize keyed rotor which is mounted to the distributor shaft with a gentle interference fit. Grasp the rotor and gently pull upward to remove it from the shaft.
7. Check the distributor cap and rotor for wear or damage and replace, if necessary.

To install:

8. If removed, install the rotor to the top of the distributor shaft.
9. Install the cap to the distributor assembly. Some early models may utilize an internal-coil type distributor cap. Obviously, the old coil must be transferred to the new cap if you are replacing the cap on these models.
10. As tagged, connect any spark plug wires which were removed.
11. Install the engine cover.
12. Connect the negative battery cable.

Figure 142.
Tag all spark plug wires and matching cap terminals before removal
{ewc GSMVIMG,GSMVIMG, !88261P31.bmp}

88261P31

Figure 143.
Release the distributor cap hold-down bolts
{ewc GSMVIMG,GSMVIMG, !88261P32.bmp}

88261P32

Figure 144.
Remove the cap for inspection, replacement or access to the rotor
{ewc GSMVIMG,GSMVIMG, !88261P33.bmp}

88261P33

Figure 145.
Carefully pull the rotor from the distributor shaft—note this type does NOT use retaining screws

{ewc GSMVIMG,GSMVIMG, !88261P34.bmp}

88261P34

Figure 146.
Some early-model distributors may have the ignition coil mounted to the distributor cap.

{ewc GSMVIMG,GSMVIMG, !88261G50.bmp}

88261G50

Ignition Timing {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

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.

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). If the setting for the ignition timing is 5º BTDC, the spark plug must fire 5º before each piston reaches TDC. This only holds true, however, when the engine is at idle speed.

As the engine speed increases, the pistons go faster. The spark plugs have to ignite the fuel even sooner if it is to be completely ignited when the piston reaches TDC. To do this, distributors have various means of advancing the spark timing as the engine speed increases. On older vehicles (before the vans covered by this manual), this was accomplished by centrifugal weights within the distributor along with a vacuum diaphragm mounted on the side of the distributor. Later vehicles (such as the Astro and Safari vans are equipped with an electronic spark timing system in which no vacuum or mechanical advance is used, instead all timing changes electronically based on signals from various sensors.

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 usually consist of a notch on the rim of the crankshaft pulley and a scale of degrees attached to the front of the engine (often on the engine front cover). The notch corresponds to the position of the piston in the No. 1 cylinder. A stroboscopic (dynamic) timing light is used, which is hooked into 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 mark on the pulley appear to be standing still. Proper timing is indicated when the notch is aligned with the correct number on the scale.

Ä Never pierce a spark plug wire in order to attach a timing light or perform tests. The pierced insulation will eventually lead to an electrical arc and related ignition troubles.

Since your van has electronic ignition, you should use a timing light with an inductive pickup. This pickup simply clamps onto 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.

SERVICE PRECAUTIONS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Routine Maintenance And Tune-up

SERVICE PRECAUTIONS

****Warning**
Some electronic diagnostic equipment and service tachometers may not be compatible with the HEI system, consult your manufacturer before using such equipment.

1. Before making compression checks, disconnect the engine control switch feed wire at the distributor. To disconnect the connector from the distributor, release the locking tab and pull the connector body downward; NEVER use a metal tool to release the locking tab, for the tab may break off.
2. The distributor needs no periodic lubrication, for the engine lubrication system lubricates the lower bushing and an oil reservoir lubricates the upper bushing.
3. The tachometer (TACH) terminal is located next to the engine control switch (BAT) connector on the distributor cap.

****Warning**
NEVER allow the tachometer terminal to touch ground, for damage to the module, ECM and/or the coil may result.

4. Since there are no points in the ignition system, NO manual dwell adjustment is necessary or possible.
5. The material used in the construction of the spark plug wires is very soft and pliable. These wires can withstand high heat and carry a higher voltage. It is very important that the wires be routed correctly, for they are highly susceptible to scuffing and/or cutting.

Ä When removing a spark plug wire, be sure to twist the boot and then pull on it to remove it. Do NOT pull on the wire to remove it.

ADJUSTMENT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ADJUSTMENT

Ü See figures 147, 148, 149

Ä Ignition timing on these engines is controlled by the electronic engine control system and does NOT need to be periodically checked and adjusted. If the distributor has been removed for engine service or if all other causes of a driveability problem have been resolved and the timing is suspect, the initial (base) timing may be checked and adjusted. Also note that although the HVS ignition system used on 1996 engines utilizes a distributor assembly, it is NOT a traditional distributor ignition system (the HVS assembly is keyed for installation in ONLY one position as it is completely electronically controlled) and timing CANNOT be adjusted at all.

The following procedure requires the use of a distributor wrench and a timing light. When using a timing light, be sure to consult the manufacturer's recommendations for installation and usage.

Figure 147.
Timing marks are found on the crankshaft damper (balancer) and engine front cover—late-model 4.3L engine shown

{ewc GSMVIMG,GSMVIMG, !88261G49.bmp}

88261G49

Figure 148.
View of a typical timing mark scale

{ewc GSMVIMG,GSMVIMG, !88261G51.bmp}

88261G51

Figure 149.
Aim the timing light at the crankshaft damper timing mark, but WATCH OUT for moving engine parts

{ewc GSMVIMG,GSMVIMG, !88261P35.bmp}

88261P35

1. Refer to the ignition timing specifications, listed on the Vehicle Emissions Control Information (VECI) label, located on the radiator support panel and follow the instructions. If the label is missing you MUST obtain the correct replacement in order to assure the proper timing procedures are being followed for YOUR engine.
2. Start and run the engine until it reaches normal operating temperature.

   ****Caution**
   NEVER run the engine in a sealed garage. Open all doors and windows, and if possible, use vents or fans to provide further ventilation. Carbon Monoxide which is prevalent in exhaust gas can quickly build-up in your blood, preventing oxygen from reaching your brain. This can cause serious injury or even DEATH.

3. Disable the electronic ignition advance system (usually known as Ignition Control or IC) by disconnecting the "Set Timing” connector. This connector is in a single wire (tan/black) that breaks out of the engine wiring harness, adjacent to the distributor assembly. On early-model vehicles covered by this manual, you should be able to find the connector by tracing the wire back from the 4-terminal EST connector at the distributor assembly.
4. Connect a timing light to the motor:
   a. If using a non-inductive type, connect an adapter between the No. 1 spark plug and the spark plug wire; DO NOT puncture the spark plug wire, for this will allow arching which

will cause engine mis-firing.

b. If using an inductive type, clamp it around the No. 1 spark plug wire.

c. If using a magnetic type, place the probe in the connector located near the damper pulley; this type must be used with special electronic timing equipment.

5. Start the engine and allow it to idle at normal operating temperature. Aim the timing light at the timing mark on the damper pulley (be careful because the strobe affect of the timing light will make moving engine parts appear to be standing still); a line on the damper pulley will align the timing mark. If necessary (to adjust the timing), loosen the distributor hold-down clamp and slowly turn the distributor slightly to align the marks. When the alignment is correct, tighten the hold-down bolt, then re-check the timing with the light to make sure it did not change while you were tightening the distributor bolt.

6. Turn the engine **OFF**, remove the timing light and reconnect the "Set Timing" connector.

Valve Lash {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Valve Lash

Valve lash adjustment determines how far the valves enter the cylinder and how long they stay open and/or closed.

> **Ä While all valve adjustments must be made as accurately as possible, it is better to have the valve adjustment slightly loose than slightly tight, as a burned valve may result from overly tight adjustments.**

All of the engines covered by this manual utilize hydraulic valve lifters. The purpose of hydraulic lifters is to automatically maintain zero valve lash, therefore no periodic adjustments are required on engines equipped with them. However, many of the vehicles utilize rocker arms which are retained by adjusting nuts. If the rocker arms and nuts are loosened or removed, they must be properly adjusted upon installation in order for the lifters to work.

ADJUSTMENT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ADJUSTMENT

2.5L Engine

Ü See figure 150

Ä This engine utilizes hydraulic valve lifters which means that a valve adjustment is NOT a regular maintenance item. The valves must only be adjusted if the rockers arms have been disturbed for any reason such as cylinder head, camshaft, pushrod or lifter removal.

1. Disconnect the negative battery cable for safety.
2. Remove the engine cover from the passenger compartment for access.
3. Remove the rocker arm cover. For details, please refer to Section 3 of this manual.
4. Rotate the crankshaft until the mark on the damper pulley aligns with the **0** mark on the timing plate and the No. 1 cylinder is on the compression stroke.

Figure 150.
Valve arrangement—2.5L engines (E=Exhaust; I=Intake)

{ewc GSMVIMG,GSMVIMG, !88261G52.bmp}

88261G52

Ä To determine if the No. 1 cylinder is on the compression stroke, shake the rocker arms of the No. 1 cylinder, if they move the cylinder is on the compression stroke, if they don't move the cylinder is on the exhaust stroke. If the cylinder is on the exhaust stroke, it will be necessary to rotate the crankshaft 1 more full revolution to bring No. 1 back to top on compression.

5. With the engine on the compression stroke, adjust the exhaust valves of cylinders No. 1 and 3 and the intake valves of cylinders No. 1 and 2.
6. To adjust the valves, tighten the rocker arm studs to the specified torque:
   - 1985–86: 20 ft. lbs. (28 Nm).
   - 1987: 24 ft. lbs. (32 Nm).
   - 1988–90: 22 ft. lbs. (30 Nm).
7. Rotate the crankshaft 1 complete revolution and align the mark on the damper pulley with the **0** mark on the timing plate.
8. With the engine on the No. 4 compression stroke, tighten the retainers for the exhaust valves of cylinders No. 2 and 4 and the intake valves of cylinders No. 3 and 4.
9. Install the rocker arm cover.
10. Connect the negative battery cable, then run the engine and verify there are no leaks.
11. Shut the engine **OFF**, then install the engine cover. You may wish to allow the engine to cool first as you may be working near HOT components.

4.3L Engine {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Routine Maintenance And Tune-up

4.3L Engine

VIN Z

Ü See figures 151, 152

> **Ä This engine utilizes hydraulic valve lifters which means that a valve adjustment is NOT a regular maintenance item. The valves must only be adjusted if the rockers arms have been disturbed for any reason such as cylinder head, camshaft, pushrod or lifter removal.**

For 1993–94, the 4.3L (VIN Z) engine may be equipped with either of 2 rocker arm retaining systems. If your engine utilizes screw-in type rocker arm studs with positive stop shoulders, no valve lash adjustment is necessary or possible. If equipped, please refer to the 4.3L (VIN W) valve lash information, found later in this section. If however, your engine utilizes the pressed-in rocker arm studs, use the following procedure to tighten the rocker arm nuts and properly center the pushrod on the hydraulic lifter:

Figure 151.
Valve arrangement—4.3L engines (E=Exhaust; I=Intake)

{ewc GSMVIMG,GSMVIMG, !88261G53.bmp}

88261G53

Figure 152.
Adjust the rockers, by rotating the pushrods between your thumb and forefinger to feel for play

{ewc GSMVIMG,GSMVIMG, !88261G54.bmp}

88261G54

1. Disconnect the negative battery cable for safety.
2. Remove the engine cover from the passenger compartment for access.
3. Remove the rocker arm covers. For details, please refer to Section 3 of this manual.
4. To prepare the engine for valve adjustment, rotate the crankshaft until the mark on the damper pulley aligns with the 0º mark on the timing plate and the No. 1 cylinder is on the compression stroke. You will know when the No. 1 piston is on it's compression stroke because both the intake and exhaust valves will remain closed as the crankshaft damper mark approaches the timing scale.

   Ä Another method to tell when the piston is coming up on the compression stroke is by removing the spark plug and placing your thumb over the hole, you will feel the air being forced out of the spark plug hole. Stop turning the crankshaft when the TDC timing mark on the crankshaft pulley is directly aligned with the timing mark pointer or the zero mark on the scale.

5. With the engine on the compression stroke, adjust the exhaust valves of cylinders No. 1, 5 and 6 and the intake valves of cylinders No. 1, 2 and 3 by performing the following procedures:
   a. Back out the adjusting nut until lash can be felt at the pushrod.
   b. While rotating the pushrod, turn the adjusting nut inward until all of the lash is removed.
   c. When the play has disappeared, turn the adjusting nut inward 1 additional turn for 1988–93 engines or 1 3/4 additional turns for 1994 engines.
6. Rotate the crankshaft 1 complete revolution and align the mark on the damper pulley with the 0º mark on the timing plate; the engine is now positioned on the No. 4 firing position. This

time the No. 4 cylinder valves remain closed as the timing mark approaches the scale. Adjust the exhaust valves of cylinders No. 2, 3 and 4 and the intake valves of cylinders No. 4, 5 and 6, by performing the following procedures:

a. Back out the adjusting nut until lash can be felt at the pushrod.

b. While rotating the pushrod, turn the adjusting nut inward until all of the lash is removed.

c. When the play has disappeared, turn the adjusting nut inward 1 additional turn for 1988–93 engines or $1^{3}/4$ additional turns for 1994 engines.

7. Install the rocker arm covers.
8. Connect the negative battery cable, then run the engine and verify there are not leaks.
9. Shut the engine **OFF**, then install the engine cover. You may wish to allow the engine to cool first as you may be working near HOT components.

VIN W {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

VIN W

Ü See figure 151

The 4.3L (VIN W) engine and some of the 4.3L (VIN Z) engines are equipped with screw-in type rocker arm studs with positive stop shoulders. Because the shoulders allow the rocker arms to be torqued into proper position, no adjustments are necessary or possible. If a valve train problem is suspected, check that the rocker arm nuts are tightened to 20 ft. lbs. (27 Nm). When valve lash falls out of specification (valve tap is heard), replace the rocker arm, pushrod and hydraulic lifter on the offending cylinder.

Idle Speed and Mixture Adjustments {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Idle Speed and Mixture Adjustments

CARBURETED ENGINES

The different combinations of emission systems application on the various available engines have resulted in a great variety of tune-up specifications. All vehicles covered by this manual should have a decal conspicuously placed in the engine compartment giving tune-up specifications.

Because the 4.3L carbureted engine utilizes an electronically controlled feedback carburetor there are no periodic mixture adjustments are necessary or possible. Slow (curb) idle speed can be set using the speed screw at the throttle valve on the carburetor. When setting the curb idle speed, make sure the engine is at normal operating temperature and that all of the conditions on the vehicle emission control information label have been met.

FUEL INJECTED ENGINES {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

FUEL INJECTED ENGINES

Engines covered by this manual may be equipped with a variety of fuel injection systems including: Throttle Body Injection (TBI), Central Multi-Port Fuel Injection (CMFI) and Central Sequential Fuel Injection (CSFI). Although each of these systems contain some of their own unique engine control components, what they all share is full computer control of the idle air supply and of all fuel delivery. The fuel injection computer module regulates idle speeds and supplies the correct amount of fuel during all engine operating conditions. No periodic adjustments are necessary or possible. If the engine is suspected of maintaining an incorrect idle speed, refer to Section 4 of this manual for information regarding the self-diagnostic features of the computer engine and emission control systems and to Section 5 for information regarding the throttle body and fuel delivery systems.

Air Conditioning {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Air Conditioning

Ü See figure 153

All 1994 and later vehicles covered by this manual utilize the new CFC-free R-134a refrigerant NOT the old style R-12. Use of the incorrect type of refrigerant and oils will severely damage your A/C system.

Figure 153.
This label warns technicians to use R-134a refrigerant (R-12 would damage this system)

{ewc GSMVIMG,GSMVIMG, !88261P36.bmp}

88261P36

Ä Be sure to consult the laws in your area before servicing the air conditioning system. In most areas, it is illegal to perform repairs involving refrigerant unless the work is done by a certified technician. Also, it is quite likely that you will not be able to purchase refrigerant without proof of certification.

SAFETY PRECAUTIONS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SAFETY PRECAUTIONS

There are 2 major hazards associated with air conditioning systems and they both relate to the refrigerant gas. First, the refrigerant gas (R-12 or R-134a) is an extremely cold substance. When exposed to air, it will instantly freeze any surface it comes in contact with, including your eyes. The other hazard relates to fire (if your vehicle is equipped with R-12. Although normally non-toxic, the R-12 gas becomes highly poisonous in the presence of an open flame. One good whiff of the vapor formed by burning R-12 can be fatal. Keep all forms of fire (including cigarettes) well clear of the air conditioning system.

Because of the inherent dangers involved with working on air conditioning systems, these safety precautions must be strictly followed.

- Avoid contact with a charged refrigeration system, even when working on another part of the air conditioning system or vehicle. If a heavy tool comes into contact with a section of tubing or a heat exchanger, it can easily cause the relatively soft material to rupture.
- When it is necessary to apply force to a fitting which contains refrigerant, as when checking that all system couplings are securely tightened, use a wrench on both parts of the fitting involved, if possible. This will avoid putting torque on refrigerant tubing. (It is also advisable to use tube or line wrenches when tightening these flare nut fittings.)

Ä R-12 refrigerant is a chlorofluorocarbon which, when released into the atmosphere, can contribute to the depletion of the ozone layer in the upper atmosphere. Ozone filters out harmful radiation from the sun.

- Do not attempt to discharge the system without the proper tools. Precise control is possible only when using the service gauges and a proper A/C refrigerant recovery station. Wear protective gloves when connecting or disconnecting service gauge hoses.
- Discharge the system only in a well ventilated area, as high concentrations of the gas which might accidentally escape can exclude oxygen and act as an anesthetic. When leak testing or soldering, this is particularly important, as toxic gas is formed when R-12 contacts any flame.
- Never start a system without first verifying that both service valves are properly installed, and that all fittings throughout the system are snugly connected.
- Avoid applying heat to any refrigerant line or storage vessel. Charging may be aided by using water heated to less than 125ºF (50ºC) to warm the refrigerant container. Never allow a refrigerant storage container to sit out in the sun, or near any other source of heat, such as a radiator or heater.
- Always wear goggles to protect your eyes when working on a system. If refrigerant contacts the eyes, it is advisable in all cases to consult a physician immediately.
- Frostbite from liquid refrigerant should be treated by first gradually warming the area with cool water, and then gently applying petroleum jelly. A physician should be consulted.
- Always keep refrigerant drum fittings capped when not in use. If the container is equipped with a safety cap to protect the valve, make sure the cap is in place when the can is not being used. Avoid sudden shock to the drum, which might occur from dropping it, or from banging a heavy tool against it. Never carry a drum in the passenger compartment of a vehicle.
- Always completely discharge the system into a suitable recovery unit before painting the vehicle (if the paint is to be baked on), or before welding anywhere near refrigerant lines.
- When servicing the system, minimize the time that any refrigerant line or fitting is open to the air in order to prevent moisture or dirt from entering the system. Contaminants such as moisture or dirt can damage internal system components. Always replace O-rings on

lines or fittings which are disconnected. Prior to installation coat, but do not soak, replacement O-rings with suitable compressor oil.

GENERAL SERVICING PROCEDURES {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

GENERAL SERVICING PROCEDURES

Ü See figure 154

Ä It is recommended, and possibly required by law, that a qualified technician perform the following services.

****Warning**
Some of the vehicles covered by this manual may be equipped with R-134a refrigerant systems, rather than R-12. Be ABSOLUTELY SURE what type of system you are working on before attempting to add refrigerant. Use of the wrong refrigerant or oil will cause damage to the system.

The most important aspect of air conditioning service is the maintenance of a pure and adequate charge of refrigerant in the system. A refrigeration system cannot function properly if a significant percentage of the charge is lost. Leaks are common because the severe vibration encountered underhood in an automobile can easily cause a sufficient cracking or loosening of the air conditioning fittings; allowing, the extreme operating pressures of the system to force refrigerant out.

Figure 154.
Schematic for a typical air condition system

{ewc GSMVIMG,GSMVIMG, !88261G55.bmp}

88261G55

The problem can be understood by considering what happens to the system as it is operated with a continuous leak. Because the expansion valve regulates the flow of refrigerant to the evaporator, the level of refrigerant there is fairly constant. The receiver/drier stores any excess refrigerant, and so a loss will first appear there as a reduction in the level of liquid. As this level nears the bottom of the vessel, some refrigerant vapor bubbles will begin to appear in the stream of liquid supplied to the expansion valve. This vapor decreases the capacity of the expansion valve very little as the valve opens to compensate for its presence. As the quantity of liquid in the condenser decreases, the operating pressure will drop there and throughout the high side of the system. As the refrigerant continues to be expelled, the pressure available to force the liquid through the expansion valve will continue to decrease, and, eventually, the valve's orifice will prove to be too much of a restriction for adequate flow even with the needle fully withdrawn.

At this point, low side pressure will start to drop, and a severe reduction in cooling capacity, marked by freeze-up of the evaporator coil, will result. Eventually, the operating pressure of the evaporator will be lower than the pressure of the atmosphere surrounding it, and air will be drawn into the system wherever there are leaks in the low side.

Because all atmospheric air contains at least some moisture, water will enter the system mixing with the refrigerant and oil. Trace amounts of moisture will cause sludging of the oil, and corrosion of the system. Saturation and clogging of the filter/drier, and freezing of the expansion valve orifice will eventually result. As air fills the system to a greater and greater extent, it will interfere more and more with the normal flows of refrigerant and heat.

From this description, it should be obvious that much of the repairman's focus in on detecting leaks, repairing them, and then restoring the purity and quantity of the refrigerant charge. A list of general rules should be followed in addition to all safety precautions:

- Keep all tools as clean and dry as possible.
- Thoroughly purge the service gauges/hoses of air and moisture before connecting them to the system. Keep them capped when not in use.
- Thoroughly clean any refrigerant fitting before disconnecting it, in order to minimize the entrance of dirt into the system.

- Plan any operation that requires opening the system beforehand, in order to minimize the length of time it will be exposed to open air. Cap or seal the open ends to minimize the entrance of foreign material.
- When adding oil, pour it through an extremely clean and dry tube or funnel. Keep the oil capped whenever possible. Do not use oil that has not been kept tightly sealed.
- Purchase refrigerant intended for use only in automatic air conditioning systems.
- Completely evacuate any system that has been opened for service, or that has leaked sufficiently to draw in moisture and air. This requires evacuating air and moisture with a good vacuum pump for at least 1 hour. If a system has been open for a considerable length of time it may be advisable to evacuate the system for up to 12 hours (overnight).
- Use a wrench on both halves of a fitting that is to be disconnected, so as to avoid placing torque on any of the refrigerant lines.
- When overhauling a compressor, pour some of the oil into a clean glass and inspect it. If there is evidence of dirt, metal particles, or both, flush all refrigerant components with clean refrigerant before evacuating and recharging the system. In addition, if metal particles are present, the compressor should be replaced.
- Schrader valves may leak only when under full operating pressure. Therefore, if leakage is suspected but cannot be located, operate the system with a full charge of refrigerant and look for leaks from all Schrader valves. Replace any faulty valves.

Additional Preventive Maintenance {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Additional Preventive Maintenance

USING THE SYSTEM

The easiest and most important preventive maintenance for your A/C system is to be sure it is used on a regular basis. Running the system for 5 minutes each month (no matter what the season) will help assure that the seals and all internal components remain lubricated.

ANTIFREEZE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ANTIFREEZE

Ü See figure 155

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 antifreeze tester (hydrometer) to periodically check the condition of the antifreeze in your engine's cooling system.

Ä Antifreeze should not be used longer than the manufacturer specifies.

Figure 155.
An antifreeze tester can be use to determine the freezing and boiling points of your coolant

{ewc GSMVIMG,GSMVIMG, !tccs1233.bmp}

tccs1233

RADIATOR CAP {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

RADIATOR CAP

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.

CONDENSER {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Routine Maintenance And Tune-up

CONDENSER

Any obstruction of or damage to the condenser configuration will restrict the 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.

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

CONDENSATION DRAIN TUBE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CONDENSATION DRAIN TUBE

This single molded drain tube expels the condensation, 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 {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SYSTEM INSPECTION

Ä R-12 refrigerant is a chlorofluorocarbon which, when released into the atmosphere, can contribute to the depletion of the ozone layer in the upper atmosphere. Ozone filters out harmful radiation from the sun.

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, compressor drive belt tension and 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. Most leaks are caused by damaged or missing O-ring seals at the component connections, damaged charging valve cores or missing service gauge port caps.

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

1. Check the surface of the radiator and condenser for dirt, leaves or other material which might block air flow.
2. Check for kinks in hoses and lines. Check the system for leaks.
3. Make sure the drive belt is under the proper tension. When the air conditioning is operating, make sure the drive belt is free of noise or slippage.
4. 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**.

   Ä Keep in mind that under conditions of high humidity, air discharged from the A/C vents may not feel as cold as expected, even if the system is working properly. This is because the vaporized moisture in humid air retains heat more effectively than does dry air, making the humid air more difficult to cool.
5. Make sure the air passage selection lever is operating correctly. Start the engine and warm it to normal operating temperature, then make sure the hot/cold selection lever is operating correctly.

DISCHARGING, EVACUATING & CHARGING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

DISCHARGING, EVACUATING & CHARGING

Discharging, evacuating and charging the air conditioning system must be performed by a properly trained and certified mechanic in a facility equipped with refrigerant recovery/recycling equipment that meets SAE standards for the type of system to be serviced.

If you don't have access to the necessary equipment, we recommend that you take your vehicle to a reputable service station to have the work done. If you still wish to perform repairs on the vehicle, have them discharge the system, then take your vehicle home and perform the necessary work. When you are finished, return the vehicle to the station for evacuation and charging. Just be sure to cap ALL A/C system fittings immediately after opening them and keep them protected until the system is recharged.

Windshield Wipers {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Windshield Wipers

Ä Intense heat from the sun, snow and ice, road oils and the chemicals used in windshield washer solvents combine to deteriorate the rubber wiper refills. The refills should be replaced about twice a year or whenever the blades begin to streak or chatter.

ELEMENT (REFILL) CARE & REPLACEMENT

Ü See figures 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167

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**.

Figure 156.
Bosch® wiper blade and fit kit

{ewc GSMVIMG,GSMVIMG, !tccs1223.bmp}

tccs1223

Figure 157.
Lexor® wiper blade and fit kit

{ewc GSMVIMG,GSMVIMG, !tccs1224.bmp}

tccs1224

Figure 158.
Pylon® wiper blade and adaptor

{ewc GSMVIMG,GSMVIMG, !tccs1225.bmp}

tccs1225

Figure 159.
Trico® wiper blade and fit kit

{ewc GSMVIMG,GSMVIMG, !tccs1226.bmp}

tccs1226

Figure 160.
Tripledge® wiper blade and fit kit

{ewc GSMVIMG,GSMVIMG, !tccs1227.bmp}

tccs1227

Figure 161.
To remove and install a Lexor® wiper blade refill, slip out the old insert and slide in a new one

{ewc GSMVIMG,GSMVIMG, !tccs1228.bmp}

tccs1228

Figure 162.
On Pylon® inserts, the clip at the end has to be removed prior to sliding the insert off

{ewc GSMVIMG,GSMVIMG, !tccs1229.bmp}

tccs1229

Figure 163.
On Trico® wiper blades, the tab at the end of the blade must be turned up . . .

{ewc GSMVIMG,GSMVIMG, !tccs1230.bmp}

tccs1230

Figure 164.
. . . then the insert can be removed. After installing the replacement insert, bend the tab back

{ewc GSMVIMG,GSMVIMG, !tccs1231.bmp}

tccs1231

Figure 165.
The Tripledge® wiper blade insert is removed and installed using a securing clip

{ewc GSMVIMG,GSMVIMG, !tccs1232.bmp}

tccs1232

Figure 166.
Trico® wiper blade insert (element) replacement

{ewc GSMVIMG,GSMVIMG, !tccs1236.bmp}

tccs1236

Figure 167.
Tridon® wiper blade insert (element) replacement

{ewc GSMVIMG,GSMVIMG, !tccs1237.bmp}

tccs1237

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 1 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 2 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 4 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 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 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.

Tires and Wheels {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Tires and Wheels

Ü See figure 168

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 you don't overload the vehicle or run with incorrect pressure in the tires. Both of these practices will increase tread wear.

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

Figure 168.
This label (usually found on a door or jamb) gives the proper tire inflation pressures for your vehicle

{ewc GSMVIMG,GSMVIMG, !88261P37.bmp}

88261P37

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 {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TIRE ROTATION

Ü See figures 169, 170, 171

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 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).

Figure 169.
Common tire rotation patterns for 4 and 5-wheel rotations

{ewc GSMVIMG,GSMVIMG, !tccs1259.bmp}

tccs1259

Figure 170.
Compact spare tires must NEVER be used in the rotation pattern

{ewc GSMVIMG,GSMVIMG, !tccs1260.bmp}

tccs1260

Figure 171.
Unidirectional tires are identifiable by sidewall arrows and/or the word "rotation"

{ewc GSMVIMG,GSMVIMG, !tccs1234.bmp}

tccs1234

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.

Ä The compact or space-saver spare is strictly for emergency use. It must never be included in the tire rotation or placed on the vehicle for everyday use.

TIRE USAGE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TIRE USAGE

The tires on your van were selected to provide the best all around performance for normal operation when inflated as specified. Oversize tires (Load Range D) will not increase the maximum carrying capacity of the vehicle, although they will provide an extra margin of tread life. Be sure to check overall height before using larger size tires which may cause interference with suspension components or wheel wells. When replacing conventional tire sizes with other tire size designations, be sure to check the manufacturer's recommendations. Interchangeability is not always possible because of differences in load ratings, tire dimensions, wheel well clearances, and rim size. Also due to differences in handling characteristics, 70 Series and 60 Series tires should be used only in pairs on the same axle. Radial tires should be used only in sets of four.

The wheels must be the correct width for the tire. Tire dealers have charts of tire and rim compatibility. A mismatch can cause sloppy handling and rapid tread wear. The old rule of thumb is that the tread width should match the rim width (inside bead to inside bead) within 1 in. (25mm). For radial tires, the rim width should be 80 percent or less of the tire (not tread) width.

The height (mounted diameter) of the new tires can greatly change speedometer accuracy, engine speed at a given road speed, fuel mileage, acceleration, and ground clearance. Tire manufacturers furnish full measurement specifications. Speedometer drive gears are available for correction.

> **Ä Dimensions of tires marked the same size may vary significantly, even among tires from the same manufacturer.**

The spare tire should be usable, at least for low speed operation, with the new tires.

TIRE DESIGN {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TIRE DESIGN

Ü See figure 172

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.

Figure 172.
P-Metric tire coding

{ewc GSMVIMG,GSMVIMG, !tccs1261.bmp}

tccs1261

****Caution**
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.

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

TIRE STORAGE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

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 {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

INFLATION & INSPECTION

Ü See figures 173, 174, 175, 176, 177, 178, 179, 180

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 3 hours.

Figure 173.
Tires should be checked frequently for any sign of puncture or damage

{ewc GSMVIMG,GSMVIMG, !tccs1097.bmp}

tccs1097

Figure 174.
Tires with deep cuts, or cuts which show bulging should be replaced immediately

{ewc GSMVIMG,GSMVIMG, !tccs1095.bmp}

tccs1095

Figure 175.
Examples of inflation-related tire wear patterns

{ewc GSMVIMG,GSMVIMG, !tccs1262.bmp}

tccs1262

Figure 176.
Radial tires have a characteristic sidewall bulge; don't try to measure pressure by looking at the tire. Use a quality air pressure gauge

{ewc GSMVIMG,GSMVIMG, !tccs1263.bmp}

tccs1263

Figure 177.
Common tire wear patterns and causes

{ewc GSMVIMG,GSMVIMG, !tccs1267.bmp}

tccs1267

Figure 178.
Tread wear indicators will appear when the tire is worn

{ewc GSMVIMG,GSMVIMG, !tccs1265.bmp}

tccs1265

Figure 179.
Accurate tread depth indicators are inexpensive and handy

{ewc GSMVIMG,GSMVIMG, !tccs1264.bmp}

tccs1264

Figure 180.
A penny works well for a quick check of tread depth

{ewc GSMVIMG,GSMVIMG, !tccs1266.bmp}

tccs1266

A plate or sticker is normally provided somewhere in the vehicle (door post, hood, tailgate) which shows the proper pressure for the tires. This plate and NOT THE SIDEWALL of the tire should be your first source in determining the proper inflation pressure. The ONLY exception to this being that if you replace the stock tires with ones that have a lower MAXIMUM rating than the recommended tire pressure from the label, you SHOULD NOT exceed the rating on the sidewall. Of course, you might want to think twice about a set of tires whose listed pressure rating cannot match the van manufacturer's recommended figures. 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.

**Caution

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

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).

CARE OF SPECIAL WHEELS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

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 {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

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, 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 {ewc MVIMAGE, MVIMAGE, ! nexttopicarrow.bmp}

Fuel and Engine Oil Recommendations

FUEL

All vehicles covered by this manual are equipped with emission control systems that would be severely damaged or destroyed by the use of leaded fuels or additives. NEVER put any gasoline in your tank that could contain lead or you will likely void your warranty.

**Warning
Some fuel additives contain chemicals that can damage the catalytic converter and/or oxygen sensor. Read all of the labels carefully before using any additive in the engine or fuel system.

Fuel should be selected for the brand and octane which performs best with your engine. Judge a gasoline by its ability to prevent pinging, it's engine starting capabilities (cold and hot) and general all weather performance. As far as the octane rating is concerned, all of the engines covered by this manual are capable of running fine on a high-quality 87 octane gasoline (usually this is a mid or low grade in the U.S.). If necessary at high altitudes, most engines can also run on lower octanes, down to even 85. BUT, when you are working your van hard, such as towing or hauling a full contingent of passengers with luggage, it is recommended that higher octane will help maximize power while preventing damaging engine knock. If your van has the 4.3L (VIN W) CMFI or CSFI engine, it is recommended that you use a minimum of 91 octane gasoline whenever you are towing or hauling heavy loads.

Ä Your van's engine fuel requirement can change with time, due to carbon buildup, which changes the compression ratio. If your van's engine knocks, pings or runs on, switch to a higher grade of fuel (if possible) and check the ignition timing. Sometimes changing brands of gasoline will cure the problem. If it is necessary to retard the timing from specifications, don't change it more than a 2 degrees. Retarded timing will reduce the power output and the fuel mileage, plus it will increase the engine temperature.

The vehicles covered by manual are capable of running on various types of blended gasoline as well. Blended gas containing any ONE of the following blends are allowed if they contain no more than 15 percent MTBE (Methyl Tertiary-Butyl Ether), 10 percent Ethanol (Ethyl or grain alcohol) or 5 percent Methanol (wood alcohol).

**Warning
Gasoline that contain MORE THAN 5 PERCENT METHANOL are BAD for your engine. It can corrode metal parts in your fuel system while also damaging plastic and rubber parts. Even at 5 percent mixtures make sure there are COSOLVENTS and corrosion preventers in this fuel or AVOID IT.

OIL {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

OIL

Ü See figures 181, 182

Use ONLY SG/CC, SG/CD, SH/CC or SH/CD rated oils of the recommended viscosity. Under the classification system developed by the American Petroleum Institute (API), the SH rating (or latest superceding alpha-rating) designates the highest quality oil for use in passenger vehicles. In addition, Chevrolet recommends the use of an SH/Energy Conserving oil. Oils labeled Energy Conserving (or Saving), Fuel (Gas or Gasoline) Saving, etc. are recommended due to their superior lubricating qualities (less friction—easier engine operation) and fuel saving characteristics. Pick your oil viscosity with regard to the anticipated temperatures during the period before your next oil change. Using the accompanying chart, choose the oil viscosity for the lowest expected temperature. You will be assured of easy cold starting and sufficient engine protection.

Figure 181.
Engine oil viscosity recommendations

{ewc GSMVIMG,GSMVIMG, !88261G56.bmp}

88261G56

Figure 182.
Look for the API oil identification label when choosing your engine oil

{ewc GSMVIMG,GSMVIMG, !tccs1235.bmp}

tccs1235

Ä For the first few years of production (1985–88) GM's preferred recommendation was the use of 10W-30 in the 4.3L engine, but only if ambient temperatures did not drop below 0ºF (-18ºC). During these years 5W-30 was recommended for use, but only in ambient temperatures below 60ºF (16ºC). It does not seem like any significant changes were made to the bottom end of this engine, but for 1989 and later models, the recommendations changed to prefer 5W-30 for all ambient temperatures.

The mileage figures given in your owner's manual are the Chevrolet recommended intervals for oil and filter changes assuming average driving. If your Astro or Safari Van is being used under dusty, polluted or off-road conditions, change the oil and filter sooner than specified. The same thing goes for vehicles driven in stop-and-go traffic, used for only for short distances or used in heavy hauling such as trailering or filled with passengers and luggage.

Always drain the oil after the engine has been running long enough to bring it to operating temperature. Hot oil will flow easier and more contaminants will be removed along with the oil than if it were drained cold. You will need a large capacity drain pan, which you can purchase at any store that sells automotive parts. Another necessity is a container for the used oil. You will find that plastic bottles, such as those used for bleach or fabric softener, make excellent storage jugs.

Ä Dispose of used oil ONLY by finding a service station or facility which accepts used oil for recycling.

Although GM recommends changing both the oil and filter during the first oil change, they then usually permit that the filter be replaced only every other oil change thereafter. For the small price of an oil filter, its cheap insurance to replace the filter at every oil change. Chilton recommends that you change both the oil and filter together at each service. One of the larger filter manufacturers points out in it's advertisements that not changing the filter leaves 1 quart of dirty oil in the engine. This claim is true and should be kept in mind when changing your oil.

Synthetic Oils {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Synthetic Oils

There are excellent synthetic and fuel-efficient oils available that, under the right circumstances, can help provide better fuel mileage and better engine protection. However, these advantages come at a price, which can be 3 or 4 times the cost per quart of conventional motor oils.

Before pouring any synthetic oils into your vehicle's engine, you should consider the condition of the engine and the type of driving you do. Also, check the manufacturer's warranty conditions regarding the use of synthetics.

Generally, it is best to avoid the use of synthetic oil in both brand new and older, high mileage engines. New engines require a proper break-in, and the synthetics are so slippery that they can prevent this. Most manufacturers recommend that you wait at least 5000 miles (8000 km) before switching to a synthetic oil. Conversely, older engines are looser and tend to loose more oil. Synthetics will slip past worn parts more readily than regular oil. If your van already leaks oil (due to bad seals or gaskets), it will probably leak more with a slippery synthetic inside.

Consider your type of driving. If most of your accumulated mileage is on the highway at higher, steadier speeds, a synthetic oil will reduce friction and probably help deliver fuel mileage. Under such ideal highway conditions, the oil change interval can be extended, as long as the oil filter will operate effectively for the extended life of the oil. If the filter can't do its job for this extended period, dirt and sludge will build up in your engine's crankcase, sump, oil pump and lines, no matter what type of oil is used. If using synthetic oil in this manner, you should continue to change the oil filter at the recommended intervals.

Vans used under harder, stop-and-go, short hop circumstances should always be serviced more frequently, and for these trucks, synthetic oil may not be a wise investment. Because of the necessary shorter change interval needed for this type of driving, you cannot take advantage of the long recommended change interval of most synthetic oils.

Engine {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Engine

OIL LEVEL CHECK

Ü See figures 183, 184, 185, 186, 187, 188

Every time you stop for fuel, check the engine oil making sure the engine has fully warmed and the vehicle is parked on a level surface. If the van is used for trailer towing or for heavy-duty use, it is recommended to check the oil more frequently. Because it takes a few minutes for all the oil to drain back to the oil pan, you should wait a few minutes before checking your oil. If you are doing this at a fuel stop, first fill the fuel tank, then open the hood and check the oil, but don't get so carried away as to forget to pay for the fuel. Most station attendants won't believe that you forgot.

Figure 183.
To check engine oil, start by locating and withdrawing the oil dipstick

{ewc GSMVIMG,GSMVIMG, !88261P38.bmp}

88261P38

Figure 184.
On late-model vans with automatics, the engine dipstick is usually right below the A/T dipstick

{ewc GSMVIMG,GSMVIMG, !88261P39.bmp}

88261P39

Figure 185.
After the dipstick is cleaned, inserted and withdrawn, read the level using the stick's markings

{ewc GSMVIMG,GSMVIMG, !88261P40.bmp}

88261P40

Figure 186.
If additional oil is necessary, remove the cap from the filler tube . . .

{ewc GSMVIMG,GSMVIMG, !88261P41.bmp}

88261P41

Figure 187.
. . . the recommended viscosity oil may be found on many of the tube caps

{ewc GSMVIMG,GSMVIMG, !88261P42.bmp}

88261P42

Figure 188.
A funnel will help prevent a mess when you are pouring oil into the filler tube

{ewc GSMVIMG,GSMVIMG, !88261P43.bmp}

88261P43

1. Make sure the van is parked on level ground.
2. When checking the oil level it is best for the engine to be a normal operating temperature, although checking the oil immediately after stopping will lead to a false reading. Wait a few minutes after turning OFF the engine to allow the oil to drain back into the crankcase.
3. Open the hood and locate the dipstick which will be in a guide tube mounted in the upper engine block, just below the cylinder head mating surface. On most Astro and Safari vans, the dipstick is found on the passenger side of the engine, about mid-way back in the engine compartment. On late-model vehicles with automatic transmissions, it will probably be right below the A/T dipstick.

4. Pull the dipstick from its tube, wipe all traces of oil from it (using a clean, lint free rag) and then reinsert it into the guide tube. To make sure you get a correct reading, be sure the dipstick is fully seated in the tube and pause for a second.
5. Pull the dipstick out again and, holding it horizontally, read the oil level. The oil should be in the cross-hatched area that represents the OPERATING RANGE (above the ADD mark) on the dipstick. If the oil is below the ADD mark, add oil of the proper viscosity through the capped opening in the oil filler tube. See the fuel and oil recommendations listed earlier in this section for the proper viscosity and rating of oil to use.
6. Insert the dipstick and check the oil level again after adding any oil. Approximately 1 quart of oil will raise the level from the ADD mark to the FULL mark. Be sure not to overfill the crankcase and waste the oil. Excess oil will generally be consumed at an accelerated rate.

****Caution**
DO NOT overfill the crankcase. It may result in oil-fouled spark plugs, oil leaks caused by oil seal failure or engine damage due to foaming of the oil.

OIL & FILTER CHANGE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

OIL & FILTER CHANGE

Ü See figures 189, 190, 191, 192, 193

If the vehicle is operated on a daily or semi-daily basis and most trips are for several miles (allowing the engine to properly warm-up), the oil should be changed a minimum of every 12 months or 7500 miles (12,000 km) whichever comes first.

If however, the vehicle is used to tow a trailer, is made to idle for extended periods of time such as in heavy daily traffic or if used as a service vehicle (delivery) or the vehicle is used for only short trips in below freezing temperature, the oil change interval should be shortened. Likewise, if your vehicle is used under dusty, polluted or off-road conditions, the oil should be changed more frequently. Under these circumstances oil has a greater chance of building up sludge and contaminants which could damage your engine. If your vehicle use fits into these circumstance, as most do, it is suggested that the oil and filter be changed every 3000 miles (5000 km) or 3 months, whichever comes first.

Under certain circumstances, Chevrolet and GMC recommend changing both the oil and filter during the first oil change and then only replacing the filter every other oil change thereafter. For the small price of an oil filter, it's cheap insurance to replace the filter at every oil change.

Oil should always be changed after the engine has been running long enough to bring it up to normal operating temperature. Hot oil will flow easier and more contaminants will be removed along with the oil than if it were drained cold. The oil drain plug is located on the bottom of the oil pan (bottom of the engine, underneath the van). The oil filter is usually located on the left side of the engine and in some cases may be easier to reach through the plastic access flap in the wheel well.

Figure 189.
Loosen the drain plug using a ratchet and socket (shown) or a box wrench

{ewc GSMVIMG,GSMVIMG, !88261P44.bmp}

88261P44

Figure 190.
Unthread the plug, then withdraw it (and your hand) quickly to keep from getting burned by hot oil

{ewc GSMVIMG,GSMVIMG, !88261P45.bmp}

88261P45

Figure 191.
A filter strap wrench is helpful, but it can be tricky in tight places . . .

{ewc GSMVIMG,GSMVIMG, !88261P46.bmp}

88261P46

Figure 192.
. . . be sure to maneuver the wrench so your hand stays clear of the HOT exhaust pipe

{ewc GSMVIMG,GSMVIMG, !88261P47.bmp}

88261P47

Figure 193.
Before installing a new oil filter, lightly coat the rubber gasket with clean oil

{ewc GSMVIMG,GSMVIMG, !tccs1901.bmp}

tccs1901

You should have available a container that will hold a minimum of 6 quarts of liquid (to help prevent spilling the oil even after it is drained), a wrench to fit the drain plug, a spout for pouring in new oil and a rag or two, which you will always need. If the filter is being replaced, you will also need a band wrench or a filter wrench that fits the end of the filter.

Ä If the engine is equipped with an oil cooler, this should be drained also, if it is equipped with a drain plug. Be sure to add enough oil to fill the cooler in addition to the engine.

1. Run the engine until it reaches normal operating temperature, then shut the engine **OFF**, make sure the parking brake is firmly set and block the drive wheels.
2. Clearance may be sufficient to access the drain plug without raising the vehicle. If the van must be lifted, be sure to support it safely with jackstands and be sure to position the drain plug at a low point under the vehicle (this will help assure fast and complete draining of the old oil.
3. Slide a drain pan of a least 6 quarts capacity under the oil pan. Wipe the drain plug and surrounding area clean using an old rag.

****Caution**
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.

4. Loosen the drain plug using a ratchet, short extension and socket or a box-wrench. Turn the plug out by hand, using a rag to shield your fingers from the hot oil. By keeping an inward pressure on the plug as you unscrew it, oil won't escape past the threads and you can remove it without being burned by hot oil.
5. Quickly withdraw the plug and move your hands out of the way, but be careful not to drop the plug into the drain pan as fishing it out can be an unpleasant mess. Allow the oil to drain completely in the pan, then install and carefully tighten the drain plug. Be careful not to over tighten the drain plug, otherwise you'll be buying a new pan or a trick replacement plug for stripped threads.

Ä Although some manufacturers have at times recommended changing the oil filter every other oil change, we recommend the filter be changed each time you change your oil. The added benefit of clean oil is quickly lost if the old filter is clogged and the added protection to the heart of your engine far outweighs the few dollars saved by using a old filter.

6. Move the drain pan under the oil filter. Use a strap-type or cap-type filter wrench to loosen the oil filter. Cover your hand with a rag and spin the filter off by hand; turn it slowly. Keep in mind that it's holding about 1 quart of dirty, hot oil.

****Caution**
On many Chevrolet/GMC engines, especially the V6s, the oil filter is next to the exhaust pipes. Stay clear of these, since even a passing contact can result in a painful burn. ALSO, since all of these vans are equipped with catalytic converters, it advisable to remind you to stay clear of the converter. The outside temperature of a hot catalytic converter can approach 1200ºF.

7. Empty the old filter into the drain pan and properly dispose of the filter.
8. Using a clean rag, wipe off the filter adapter on the engine block. Be sure the rag doesn't leave any lint which could clog an oil passage.

Ä To help prevent oil leaks, always check to make sure the threaded nipple or the adapter base bolt(s) are properly tightened.

9. Coat the rubber gasket on the filter with fresh oil, then spin it onto the engine by hand; when the gasket touches the adapter surface, give it another $^{1}/2$–1 turn. No more, or you might squash the gasket causing it to leak.
10. If raised for access, remove the jackstands and carefully lower the van.
11. IMMEDIATELY refill the engine with the correct amount of fresh oil. Don't risk someone trying to start a dry motor, fill it up right away. For approximate capacities, please refer to the chart at the end of this section.
12. If you fill the engine the first time according to the chart, it is normal for the level to be a bit above the full mark. This is fine, if after having warmed the engine and filled the empty oil filter, the level comes down to normal. It is probably a better idea to fill the engine to a point within 1 quart of total capacity, then check the oil level on the dipstick. The engine can then be run to normal operating temperature, shut OFF, then rechecked and topped off.
13. Start the engine and allow it to idle for a few minutes.

    ****Warning**

    Do not run the engine above idle speed until it has built up oil pressure, as indicated when the oil light goes out.

14. Shut OFF the engine and allow the oil to flow back to the crankcase for a minute, then recheck the oil level. Check around the filter and drain plug for any leaks, and correct as necessary.

When you have finished this job, you will notice that you now possess 4–5 quarts of dirty oil. The best thing to do with it is to pour it into plastic jugs, such as milk or antifreeze containers. Then, locate a service station or automotive parts store where you can pour it into their used oil tank for recycling.

Manual Transmission {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Manual Transmission

FLUID RECOMMENDATIONS

Fill the main transmission housing with API GL5 SAE-80W90 Multipurpose Gear Oil for the 4-speed transmission. All of the 5-speed transmissions require the use of Dexron®II (or latest superceding) automatic transmission fluid.

LEVEL CHECK {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

LEVEL CHECK

Ü See figure 194

Remove the filler plug from the passenger's side of the transmission (the upper plug if the transmission has 2 plugs). The oil should be level with the bottom edge of the filler hole. This should be checked at least once every 6000 miles (9700 km) and more often if any leakage or seepage is observed.

Ä When checking the fluid, the vehicle must be level. If it was necessary to raise and support the vehicle to access the filler plug, the vehicle must be supported at sufficient points (all wheels or 4 points on the frame) so it is sitting level and is not tilted forward/backward or to one side.

Figure 194.
The filler plug is normally found about mid-way up the side of the transmission, while drain plugs are found towards the bottom of the housing (for hopefully obvious reasons)

{ewc GSMVIMG,GSMVIMG, !88261G57.bmp}

88261G57

DRAIN & REFILL {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

DRAIN & REFILL

Ü See figure 194

Under normal conditions, the transmission fluid should not need to be changed. However, if you purchase a used vehicle, it is usually a good idea to get a clean start with all of the fluids. Also, if the vehicle is operated in high water (up to the level of the transmission) it is definitely a good idea to change the fluid.

1. Drive the vehicle for a few miles to warm the fluid (so it will flow better).
2. Raise and support the vehicle safely using jackstands.
3. Place a fluid catch pan under the transmission.
4. Remove the bottom plug and drain the fluid.
5. Install the bottom plug and refill the transmission housing.

Automatic Transmission {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Automatic Transmission

FLUID RECOMMENDATIONS

When adding fluid or refilling the transmission, use Dexron®II (or the latest superceding) automatic transmission fluid for 1985–95 models or Dexron®III for 1996 models. The newer Dexron®III supersedes Dexron®II and may be used in all automatic transmissions covered by this manual.

LEVEL CHECK {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

LEVEL CHECK

Ü See figures 195, 196, 197, 198, 199

Before checking the fluid level of the transmission, drive the vehicle for at least 15 miles to warm the fluid. Conversely, if the vehicle has just been driven at high speed for at least the past 1/2 hour, or was just pulling a trailer, let the fluid cool down (back toward the center of normal operating range) before checking the fluid.

1. Place the vehicle on a level surface, then firmly apply the parking brake.
2. Start the engine and move the selector through each range, then place it in **P**.

   Ä When moving the selector through each range, DO NOT race the engine.

3. With the engine running at a low idle (and the GEAR SELECTOR STILL IN **P**), remove the transmission's dipstick to check the fluid level.

   Ä Some late-model vehicles utilize a locking, hinged dipstick. To remove these, simply pull upward on the outer portion of the hinge (straightening out the handle). This will release the dipstick from the guide/filler tube.

4. The level should be at the Full Hot mark of the dipstick. If not, add fluid using a funnel (to prevent a real mess and possible fire hazard) through the dipstick guide/filler tube. One pint raises the level from Add to Full.

   ****Caution**
   Add fluid SLOWLY. DO NOT overfill the transmission, damage to the seals could occur. Overfilling the transmission could also cause small amounts of fluid to be forced back up and out of the tube. Automatic transmission fluid could then be expelled onto hot engine parts, possibly even causing a fire.

   Ä The dipstick on some vehicles may have 2 cross-hatched zones (one for HOT and the other for COLD). It is still advisable to check the transmission hot most of the time (it more accurately reflects the level when it matters most), but the COLD zone can be used for an early morning check or as the first refill level during a fluid change.

Figure 195.
Most transmission fluid dipsticks on later-model vehicles are labeled . . .
{ewc GSMVIMG,GSMVIMG, !88261P48.bmp}

88261P48

Figure 196.
. . . and a few are hinged (locking into place to seal the guide/filler tube)
{ewc GSMVIMG,GSMVIMG, !88261P49.bmp}

88261P49

Figure 197.
As with any dipstick, make sure the fluid level is within the given range(s)
{ewc GSMVIMG,GSMVIMG, !88261P52.bmp}

88261P52

Figure 198.
Fluid is added through the dipstick guide/filler tube . . .
{ewc GSMVIMG,GSMVIMG, !88261P50.bmp}

88261P50

Figure 199.
. . . making a funnel mandatory on most models
{ewc GSMVIMG,GSMVIMG, !88261P51.bmp}

88261P51

DRAIN & REFILL {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

DRAIN & REFILL

Ü See figures 200, 201, 202, 203, 204, 205, 206

The vehicle should be driven 15 miles to warm the transmission fluid before the pan is removed.

Ä The fluid should be drained while the transmission is warm. Fluid which is at normal operating temperature will flow better, removing more contaminants or impurities than cold fluid.

1. Raise and support the front of vehicle using jackstands.
2. Place a drain pan under the transmission pan.
3. If necessary, remove the crossmember from the rear of the transmission.
4. Remove the pan bolts from the front and the sides, then loosen the rear bolts 4 turns.
5. Using a small prybar, carefully separate the front of the pan from the transmission. This will allow the pan to partially drain. DO NOT use excessive force when attempting to break the gasket seal. DO NOT bend or otherwise damage the pan and the gasket mating surfaces. If necessary, loosen the bolts a few more turns to allow the pan more play without stressing the flange.
6. Remove the remaining pan bolts and lower the pan from the transmission. Again, be CAREFUL as the pan still contains a decent amount of HOT and MESSY transmission fluid. This is very slimy stuff and if you spill it on yourself (besides possibly being burned) you will feel slimy for days no matter how much you wash.

   Ä If the transmission fluid is dark or has a burnt smell, transmission damage is indicated. Have the transmission checked professionally.

7. Empty the pan, remove the gasket material and clean with a solvent. If you use putty knife to clean the gasket surfaces, be very careful not to score or damage them. Most late-model vehicles utilize a rubber-seal that comes off the pan, with relative ease.
8. As-long-as you've gone through the trouble to drop the pan, you might as well replace the filter. Changing the automatic transmission fluid and filter are the MOST important things you can do to help assure a long, trouble-free transmission life. Well, that and avoiding trying to pull tree stumps on a regular basis.
9. To install the oil pan, use a new gasket and sealant, then reverse the removal procedures. GM recommends that you use Transjel® sealant on the new gasket. Tighten the pan bolts to 97 inch lbs. (11 Nm) in a crisscross pattern.
10. Refill the transmission through the dipstick guide/filler tube. Please refer to the capacities chart later in this section to determine the proper amount of fluid to be added.

Figure 200.
Loosen all of the transmission pan retaining bolts . . .

{ewc GSMVIMG,GSMVIMG, !88261P53.bmp}

88261P53

Figure 201.
. . . then remove all but a few at the very rear of the pan

{ewc GSMVIMG,GSMVIMG, !88261P54.bmp}

88261P54

Figure 202.
Once most of the fluid has drained, carefully lower the pan from the transmission

{ewc GSMVIMG,GSMVIMG, !88261P55.bmp}

88261P55

Figure 203.
Remove the filter for inspection and replacement

{ewc GSMVIMG,GSMVIMG, !88261P56.bmp}

88261P56

Figure 204.
The gasket (or rubber seal, depending on the application) must be replaced no matter how good it looks

{ewc GSMVIMG,GSMVIMG, !88261P57.bmp}

88261P57

Figure 205.
The magnet at the bottom of the pan should be thoroughly cleaned of all metal particles

{ewc GSMVIMG,GSMVIMG, !88261P58.bmp}

88261P58

Figure 206.
Exploded view of the automatic transmission fluid pan and filter

{ewc GSMVIMG,GSMVIMG, !88261G58.bmp}

88261G58

**Caution
Add fluid SLOWLY. DO NOT overfill the transmission, damage to the seals could occur. Overfilling the transmission could also cause small amounts of fluid to be forced back up and out of the tube. Automatic transmission fluid could then be expelled onto hot engine parts, possibly even causing a fire.

11. With the gearshift lever in **P**, start the engine and let it idle. DO NOT race the engine.
12. Apply the parking brake and move the gearshift lever through each position. Return the lever to **P** and check the fluid level with the engine idling. The level should be between the 2 dimples on the dipstick, about $^1/4$ in. (6mm) below the ADD mark. On dipsticks that are so marked, the fluid should remain in the COLD zone until the transmission has fully warmed. Add fluid, if necessary.
13. Check the fluid level after the vehicle has been driven enough to thoroughly warm the transmission.

PAN & FILTER SERVICE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

PAN & FILTER SERVICE

Ü See figures 200, 201, 202, 203, 204, 205, 206

1. Remove the transmission oil pan. For details, refer to the drain and refill procedures in this section.
2. Remove the screen and the filter from the valve body.

   Ä When removing the filter from the valve body, be sure the old O-ring is removed with the filter. Sometimes it remains stuck in the pump.
3. Install a new filter using a new gasket or O-ring.

   Ä If the transmission uses a filter having a fully exposed screen, it may be cleaned and reused.
4. To install the oil pan, use a new gasket and sealant, then reverse the removal procedures. Tighten the pan bolts to 87 inch lbs. (11 Nm) in a crisscross pattern. Refill the transmission.

Drive Axle (Front and Rear) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Drive Axle (Front and Rear)

Several axle ratios are available with the various powertrain applications.

FLUID RECOMMENDATIONS

Standard Axle

GM recommends you use SAE 80W–90 GL5 gear or an equivalent lubricant that meets the standards of their part No. 1052271. In cold climates, GM recommends the use of SAE 80W gear oil for some applications. Refer to your owners manual for more details.

You should drain and refill the rear differential at first oil change, then it should be checked at every other oil change. Periodic fluid replacement should not be necessary under normal service, but the fluid should be changed if the vehicle is operated in water which is as deep as the axles. Change the fluid at every other engine oil change if the van is used in severe service, such as trailer towing or severely dusty conditions.

Changing the front drive axle fluid on these vehicles usually requires its removal and partial disassembly. The fluid in the front drive axle should not need to be changed unless the axle is removed for repair. It should however, be checked at each engine oil change.

Locking Axle {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Locking Axle

Always use GM Rear Axle Fluid No. 1052271 or equivalent SAE 80W–90 GL5 lubricant. Check with your owners manual or parts supplier, on a few earlier models covered by this manual it may be necessary to add 4 ounces of GM Fluid No. 1052358 (limit-slip additive) before refilling. BUT GM SPECIFICALLY WARNS AGAINST using limited slip additive on 1996 locking differentials and does not mention its use for many of the late-model vehicles covered by this manual.

You should drain and refill the rear differential at first oil change, then it should be checked at every other oil change. Periodic fluid replacement should not be necessary under normal service, but the fluid should be changed if the vehicle is operated in water which is as deep as the axles. Change the fluid at every other engine oil change if the van is used in severe service, such as trailer towing or severely dusty conditions.

Changing the front drive axle fluid on these vehicles usually requires its removal and partial disassembly. The fluid in the front drive axle should not need to be changed unless the axle is removed for repair. It should however, be checked at each engine oil change.

LEVEL CHECK {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

LEVEL CHECK

Ü See figures 207, 208

Ä When checking the fluid, the vehicle must be level. If it was necessary to raise and support the vehicle to access the filler plug, the vehicle must be supported at sufficient points (all wheels or 4 points on the frame) so it is sitting level and is not tilted forward/backward or to one side.

The lubricant level should be checked at each chassis lubrication and maintained at the bottom of the filler plug hole.

1. If necessary for access, raise and support the vehicle on jackstands; BUT be sure the vehicle is level.
2. Remove the filler plug, located at the passenger side of the differential carrier. Most plugs are designed to accept the driver from a $^{3}/8$ in. ratchet, breaker bar or extension.
3. Check the fluid level, it should be level with the bottom of the filler plug hole, add fluid (if necessary).

****Caution**
Watch for sharp threads in the filler plug opening. When present, they can give you a nasty cut.

4. When you are finished, install the filler plug and tighten to 26 ft. lbs. (35 Nm).

Figure 207.
Use a ratchet and extension to remove the filler plug and check the axle fluid
{ewc GSMVIMG,GSMVIMG, !88261P59.bmp}

88261P59

Figure 208.
Gear oil can be added using a pump or a squeeze bottle
{ewc GSMVIMG,GSMVIMG, !88261P60.bmp}

88261P60

DRAIN & REFILL {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

DRAIN & REFILL

Rear Axle Assembly

Ü See figures 209, 210, 211, 212, 213, 214, 215

Refer to Fluid Recommendations in this section for information on when to change the fluid.

1. Drive the vehicle until the lubricant reaches operating temperature. Warm fluid flows better, removing more impurities with the oil.
2. Raise and support the rear of the vehicle on jackstands; BUT be sure the vehicle is level (for refilling purposes and to help assure proper draining of the axle housing).
3. Use a wire brush to clean the area around the differential. This will help prevent dirt from contaminating the differential housing while the cover is removed.
4. Position a drain pan under the rear axle.
5. Unscrew the retaining bolts and remove the rear cover. When removing the cover, a small prytool may be used at the base of the cover to gently pry it back from the axle housing, breaking the gasket seal and allowing the lubricant to drain out into the container. You may wish to leave 1 of the cover bolts, loosely installed, to keep the cover from falling suddenly (creating quite a mess) once the seal is broken. Be careful not to use excessive force and damage the cover or housing.

To install:

6. Carefully clean the gasket mating surfaces of the cover and axle housing of any remaining gasket or sealer. A putty knife is a good tool to use for this.
7. Install the rear cover using a new gasket and sealant. Tighten the retaining bolts using a crosswise pattern to 20 ft. lbs. (27 Nm).

   Ä Make sure the vehicle is level before attempting to add fluid to the rear axle or an incorrect fluid level will result.

8. Refill the rear axle housing using the proper grade and quantity of lubricant as detailed earlier in this section. Install the filler plug, operate the vehicle and check for any leaks.

Figure 209.
Because there is usually no drain plug, the rear axle cover must be removed to change the fluid

{ewc GSMVIMG,GSMVIMG, !88261P61.bmp}

88261P61

Figure 210.
Begin by cleaning loose dirt from around the cover to prevent contamination when it is removed

{ewc GSMVIMG,GSMVIMG, !88261P62.bmp}

88261P62

Figure 211.
Loosen and remove the cover bolts, then . . .

{ewc GSMVIMG,GSMVIMG, !88261P63.bmp}

88261P63

Figure 212.
. . . carefully break the gasket seal at the housing (DO NOT damage the cover/housing)

{ewc GSMVIMG,GSMVIMG, !88261P64.bmp}

88261P64

Figure 213.
With the gasket seal broken, pull the cover back at the bottom allowing the fluid to drain

{ewc GSMVIMG,GSMVIMG, !88261P65.bmp}

88261P65

Figure 214.
Once most of the fluid has been emptied into the drain pan, remove the cover from the housing

{ewc GSMVIMG,GSMVIMG, !88261P66.bmp}

88261P66

Figure 215.
If equipped, the magnet should be cleaned of metal particles

{ewc GSMVIMG,GSMVIMG, !88261P67.bmp}

88261P67

Transfer Case {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Transfer Case

FLUID RECOMMENDATIONS

When adding fluid to the transfer case, use Dexron®II (or the latest superceding) automatic transmission fluid for 1985–95 models or Dexron®III for 1996 models. The newer Dexron®III us the supersedes Dexron®II and may be used in all transfer cases covered by this manual. Inspect the transfer case level at your first oil change, then at every other oil change.

LEVEL CHECK {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

LEVEL CHECK

Ü See figure 216

The fluid level should be checked at least annually and more often if any leakage or seepage is observed.

Ä When checking the fluid, the vehicle must be level. If it was necessary to raise and support the vehicle to access the filler plug, the vehicle must be supported at sufficient points (all wheels or 4 points on the frame) so it is sitting level and is not tilted forward/backward or to one side.

1. If necessary for access to the filler plug, raise and support the vehicle safely using jackstands, but make sure the vehicle is level.
2. Remove the filler plug (upper plug of the 2) from the rear-side of the transfer case.
3. Using your finger, check the fluid level, it should be level with the bottom of the filler hole.

****Caution**
Watch for sharp threads in the filler plug opening. When present, they can give you a nasty cut.

4. If the fluid level is low, add fluid to bring the level up to the filler hole. Most parts stores will carry a small, hand operated pump which will greatly ease the task of adding fluid to the transfer case.
5. Install and tighten the filler plug.

Figure 216.
Transfer case fluid plugs

{ewc GSMVIMG,GSMVIMG, !88261G59.bmp}

88261G59

DRAIN & REFILL {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

DRAIN & REFILL

Ü See figure 216

Under normal conditions, the transfer case fluid should not need to be changed. However, if you purchase a used vehicle, it is usually a good idea to get a clean start with all of the fluids. Also, if the vehicle is operated in high water (up to the level of the transmission) it is definitely a good idea to change the fluid.

1. Operate the vehicle in 4 wheel drive in order to warm the fluid to normal operating temperature.
2. If necessary for access to the drain and filler plugs, raise and support the vehicle safely using jackstands. Support the truck so it is level; this is necessary to assure the proper fluid level is maintained when the case is refilled.
3. Position drain pan under transfer case.
4. Remove drain and fill plugs, then drain the lubricant into the drain pan.
5. Install and tighten the drain plug.
6. Remove the drain pan and dump the fluid into a used transmission fluid storage tank, for recycling purposes.
7. Fill transfer case to the edge of fill plug opening. Refer to the fluid recommendations found earlier in this section to determine the proper type of fluid.
8. Install and tighten the fill plug.
9. Remove the jackstands and carefully lower the vehicle, then check for proper operation of the transfer case.

Cooling System {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Cooling System

Ü See figure 217

For most of the vehicles covered by this manual (except 1996 which use a different type of coolant) you should inspect, flush and refill the engine cooling system with fresh coolant (antifreeze) 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 and it can boil-over in the summer.

The cooling systems on all 1996 vehicles were originally filled with silicate-free DEX-COOL® coolant meeting GM specification 6277M. The fluid is easily identified because of its orange color (instead of the green we have come to expect from most types of ethylene glycol antifreeze). If your cooling system is filled with DEX-COOL®, then no periodic service is required, other than fluid level checks, for 100,000 miles (161,000 km) or 5 years, whichever comes first. BUT if you add a silicated coolant to the system (even in small amounts) premature engine, heater core or radiator corrosion may result. In addition, the coolant will have to be changed sooner (30,000 miles/48,000 km or 2 years, just like other vehicles not using DEX-COOL®).

Figure 217.
Cutaway view of a typical cooling system flow

{ewc GSMVIMG,GSMVIMG, !tccs1082.bmp}

tccs1082

FLUID RECOMMENDATIONS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

FLUID RECOMMENDATIONS

Ü See figure 218

For 1985–95 vehicles use a good quality ethylene glycol antifreeze (one that will not effect aluminum), mixed with water until a 50–50 antifreeze solution is attained. Colder climates require more antifreeze to prevent freezing. Refer to the chart on the back of the antifreeze container.

Ä In addition to the coolant, 1995 vehicles require the addition of 2 sealant pellets (GMSPO No. 3634621) whenever the entire system has been drained and is being refilled with fresh coolant.

As mentioned earlier in this manual, 1996 vehicles were originally equipped with GM DEX-COOL® silicate-free coolant. GM does not recommended any other type of coolant for these vehicles. It is easily identified by its orange color.

Figure 218.
On 1996 models, labels in the engine compartment warn you that special coolant is used

{ewc GSMVIMG,GSMVIMG, !88261P68.bmp}

88261P68

Ä In all instances, you should premix your coolant and water solution, to be sure you will get the proper ratio of coolant to water. Also, distilled water is preferred as tap water may contain minerals or additives that could be harmful to the cooling system.

LEVEL CHECK {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

LEVEL CHECK

Ü See figures 219, 220

The coolant level should be checked EVERY TIME you open the hood.

Ä When checking the coolant level, the radiator cap does not have to be removed, simply check the coolant recovery tank (normally found on the passenger's side of the engine compartment, next to the windshield wiper/washer fluid bottle).

Check the coolant recovery bottle (see through plastic bottle). With the engine Cold, the coolant should be at the ADD or COLD mark (recovery tank about $^{1}/4$ full). With the engine warm, the coolant should be at the FULL or HOT mark (recovery tank about $^{1}/2$ full). If necessary, add fluid to the recovery bottle.

Figure 219.
On all models, the coolant level should be checked through the coolant recovery tank . . .

{ewc GSMVIMG,GSMVIMG, !88261P69.bmp}

88261P69

Figure 220.
. . . and if coolant is needed, it should be added to the tank

{ewc GSMVIMG,GSMVIMG, !88261P70.bmp}

88261P70

COOLING SYSTEM INSPECTION {ewc MVIMAGE, MVIMAGE, ! nexttopicarrow.bmp}

COOLING SYSTEM INSPECTION

Ü See figures 221, 222

****Caution**
Never remove the radiator cap under any conditions while the engine is hot! Failure to follow these instructions could result in damage to the cooling system, engine and/or personal injury. To avoid having scalding hot coolant or steam blow out of the radiator, use extreme care whenever you are removing the radiator cap. Wait until the engine has cooled, then wrap a thick cloth around the radiator cap and turn it slowly to the first stop. Step back while the pressure is released from the cooling system. When you are sure the pressure has been released, press down on the radiator cap (still have the cloth in position) turn and remove the radiator cap.

Dealing with the cooling system can be a dangerous matter unless the proper precautions are observed. It is best to check the coolant level in the radiator when the engine is cold. All vehicles covered by this manual should be equipped with a coolant recovery tank which can be checked hot or cold (refer to the level check information earlier in this section). Always be certain that the filler caps on both the radiator and the recovery tank are closed tightly.

****Warning**
Never add coolant to a hot engine unless it is running. If it is not running you run the risk of cracking the engine block.

It is wise to pressure check the cooling system at least once per year. If the coolant level is chronically low or rusty, the system should be thoroughly checked for leaks.

A simple and inexpensive hydrometer should be available in most parts stores to help you test the antifreeze in your system. It will tell you the boiling and freezing points of ethylene glycol antifreeze based on specific gravity. Although this is good in helping to determine the temperature protection it will give your engine, it does NOT tell you how old the coolant it. Even if it tests good for temperature protection, the coolant may no longer be providing corrosion protection and should be changed if you are unsure of its age. Again, the rules on DEX-COOL® are a little different (considering how much longer it lasts and that the ethylene glycol hydrometer readings may not apply) BUT, the principle is the same. If you suspect the coolant in a 1996 vehicle is older than the manufacturer recommends, OR if you think silicate-based coolant may have been added to it, you should probably drain, flush and refill the system.

Figure 221.
Cooling systems should be pressure tested for leaks periodically

{ewc GSMVIMG,GSMVIMG, !tccs1083.bmp}

tccs1083

Figure 222.
The freezing/boiling points of your coolant can be checked using a simple, inexpensive antifreeze hydrometer

{ewc GSMVIMG,GSMVIMG, !88261G60.bmp}

88261G60

The pressure cap should be examined for signs of age or deterioration. The fan belt and other drive belts (if equipped) should be inspected and adjusted to the proper tension. (See the information on drive belts earlier in this section.)

Hose clamps should be tightened, and soft or cracked hoses replaced. Damp spots, or accumulations of rust or dye near hoses, water pump or other areas, indicate possible leakage, which must be corrected before filling the system with fresh coolant. (For more information, please refer to Hoses, earlier in this section.)

Checking the Radiator Cap Seal {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Checking the Radiator Cap Seal

Ü See figure 223

While you are checking the cooling system, check the radiator cap for a worn or cracked gasket. It the cap doesn't seal properly, fluid will be lost and the engine will overheat.

Worn caps should be replaced with a new one.

Figure 223.
Be sure the rubber gasket on the radiator cap has a tight seal

{ewc GSMVIMG,GSMVIMG, !tccs1079.bmp}

tccs1079

Checking the Radiator for Debris {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Checking the Radiator for Debris

Ü See figure 224

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.

Carefully straighten any bent radiator fins with a pair of needle-nose 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.

Figure 224.
Periodically remove all debris from the radiator fins

{ewc GSMVIMG,GSMVIMG, !tccs1081.bmp}

tccs1081

DRAIN & REFILL {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

DRAIN & REFILL

Ü See figures 225, 226, 227

****Caution**
When draining the coolant, keep in mind that cats and dogs are attracted by ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old. To avoid injuries from scalding fluid and steam, DO NOT remove the radiator cap while the engine and radiator are still HOT.

1. When the engine is cool, remove the radiator cap using the following procedures.
   a. Slowly rotate the cap counterclockwise to the detent.
   b. If any residual pressure is present, WAIT until the hissing noise stops.
   c. After the hissing noise has ceased, press down on the cap and continue rotating it counterclockwise to remove it.
2. Place a fluid catch pan under the radiator, open the radiator drain valve and, if access is possible, remove the engine drain plugs, then drain the coolant.

   Ä To help prevent a mess when coolant splashes over everything and drips from all points at the front of the vehicle, try placing a short rubber tube over the radiator petcock before opening it. The route the tube down from the vehicle to the drain pan.
3. Close the drain valve and, if removed, install the engine drain plugs.
4. Empty the coolant reservoir and flush it.
5. Using the correct mixture (AND TYPE, refer to the fluid recommendations earlier in this section if you are unsure) of antifreeze, fill the radiator to about $^1/2$ in. (13mm) from the bottom of the filler neck.
6. Start the engine and allow it to idle as the engine warms-up. As the thermostat is opened, air which was trapped in the engine should be expelled, causing the fluid level in the radiator to drop. Add fresh coolant/water mixture until the level reaches the at the bottom of the filler neck.
7. For 1995 vehicles, add 2 sealant pellets (GMSPO part No. 3634621) to coolant mixture in the radiator. This MUST be done to prevent premature water pump leakage. DO NOT add the pellets to the recovery bottle since this might prevent the coolant system from operating properly.
8. Add some of the coolant/water mixture to the coolant tank, but don't go above the ADD or COLD mark at this time.
9. Install the radiator cap (make sure the arrows align with the overflow tube).
10. Run the engine until it reaches the operating temperatures, then check the recovery tank and add fluid (if necessary).

Figure 225.
To prevent a mess when draining the radiator, place a plastic tube over the radiator petcock

{ewc GSMVIMG,GSMVIMG, !88261P71.bmp}

88261P71

Figure 226.
When refilling the system, pour coolant directly into the radiator, then . . .

{ewc GSMVIMG,GSMVIMG, !88261P72.bmp}

88261P72

Figure 227.
. . . top off using the recovery tank (once the sealed radiator is at normal operating temperature)

{ewc GSMVIMG,GSMVIMG, !88261P73.bmp}

88261P73

FLUSHING & CLEANING THE SYSTEM {ewc MVIMAGE, MVIMAGE, ! nexttopicarrow.bmp}

FLUSHING & CLEANING THE SYSTEM

There are various methods to flush the cooling system, including power flushing equipment or adapters to attach your garden hose. If special equipment is to be used (such as a back flusher), follow the equipment manufacturer's instructions closely. Also, carefully read the bottle of any flushing solution, to make sure it is compatible with your cooling system components and the type of antifreeze used.

Most flushing compounds attack metals and SHOULD NOT remain in the cooling system for more than a few minutes. Be sure to use a neutralizer in the cooling system IMMEDIATELY after a descaling solvent has been used. Keep in mind that for extremely hard, stubborn coatings, such as lime scale, a stronger solution may be necessary. BUT, the corrosive action of the stronger solution will affect the thin metals of the radiator, thereby reducing its operating life. A COMPLETE flushing and rinsing is mandatory if this is attempted.

1. Refer to the Drain and Refill procedures in this section, then drain the cooling system.
2. Close the drain valve and install the engine drain plugs, then add sufficient water to the cooling system.
3. Run the engine, then drain and refill the system. Perform this procedure several times, until the fluid (drained from the system) is clear.
4. Empty the coolant reservoir and flush it.
5. Properly refill the engine cooling system with the correct type and mixture of coolant for your vehicle. Refer to the fluid recommendations and the fluid refill procedures found earlier in this section.

Master Cylinder {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Master Cylinder

Ü See figures 228, 229, 230, 231, 232

FLUID RECOMMENDATIONS

****Warning**
BRAKE FLUID EATS PAINT. Do not allow it to spill, splash or otherwise contact painted surfaces of your vehicle (or at least ones that you care about). If an accident should occur, don't panic, just immediately flush the area with plenty of clean water.

Use only heavy-duty DOT-3 brake fluid. BUT JUST AS IMPORTANTLY, use ONLY fresh fluid from a sealed container. Brake fluid attracts and absorbs moisture from the atmosphere, which can significantly lower its boiling point. Should fluid boil during heavy use (towing a trailer or hauling passengers and luggage) the fluid will turn to a gas and all/most braking ability could be lost almost instantly. Although the most manufacturers do not require a periodic fluid change for their brake systems, it is a good idea to fill the system with fresh fluid, bleeding out all of the old brake fluid through the wheel bleeders, at least every few years. Keep in mind that over time moisture will even enter a sealed system lowering the brake fluid's boiling point and causing internal corrosion to brake components.

Figure 228.
Many of the earlier models covered by this manual utilize 2 completely separate reservoirs . . .

{ewc GSMVIMG,GSMVIMG, !88261P74.bmp}

88261P74

Figure 229.
. . . remove the cover ONLY from the side that requires fluid

{ewc GSMVIMG,GSMVIMG, !88261P75.bmp}

88261P75

Figure 230.
If there are no markings on the reservoir, keep the fluid approximately $^{1}/4$ in. (6mm) from the top

{ewc GSMVIMG,GSMVIMG, !88261G61.bmp}

88261G61

Figure 231.
Late-model vehicle, such as this 1996 Astro, use a 1-piece reservoir assembly . . .

{ewc GSMVIMG,GSMVIMG, !88261P76.bmp}

88261P76

Figure 232.
. . . but fluid is added in the same manner, clean the cover, remove and pour

{ewc GSMVIMG,GSMVIMG, !88261P77.bmp}

88261P77

Ä If you decide to change the brake fluid, you will save a LOT of time by removing MOST of the old fluid from the master cylinder reservoirs, before you begin. Replacing the old fluid with fresh before you begin the bleeding procedure will simply require you to bleed a smaller amount of fluid completely through the system before the fresh fluid reaches all bleeding points. For more details on brake bleeding procedures, please refer to Section 9 of this manual.

LEVEL CHECK {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

LEVEL CHECK

The brake fluid level should be checked EVERY TIME YOU OPEN THE HOOD. At the very minimum, a thorough inspection of all fluid level and all components should be conducted every 6 months.

****Caution**
Before opening the master cylinder reservoir ALWAYS use a clean rag thoroughly clean the reservoir cover and immediate surrounding area. Failure to do this could allow contaminants to fall into the fluid when the cover is removed. These contaminants, if forced through the system by the master cylinder, could destroy seals, leaking to leaks, repairs and possibly even brake failures.

1. Most vehicles covered by this manual use translucent plastic reservoirs, so the cover does NOT need to be removed in order to check the level. Also, most reservoirs will have fill marks or lines on the plastic. The fluid should be about $^{1}/4$ in. (6mm) from top of the reservoir.
2. If the level is low, thoroughly clean the reservoir and cap(s), then remove the caps to add fluid. Some early-models may have a separate rubber diaphragm seal under the cap. If it is not removed with the cap, it should be carefully removed before fluid is added.

   Ä Remember to ONLY use fresh fluid from a sealed container.
3. When you are finished, be sure the cap (and separate rubber seal on some early-models) is properly seated.

Hydraulic Clutch {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Hydraulic Clutch

Ä The clutch master cylinder is mounted on the firewall next to the brake master cylinder.

FLUID RECOMMENDATIONS

****Caution**

Before opening the clutch master cylinder reservoir ALWAYS use a clean rag thoroughly clean the reservoir cover and immediate surrounding area. Failure to do this could allow contaminants to fall into the fluid when the cover is removed. These contaminants, if forced through the system by the master cylinder, could destroy seals, leaking to leaks, repairs and possibly even hydraulic clutch failures.

Use only FRESH heavy duty DOT-3 brake fluid from a SEALED container. For more information on DOT-3 fluid and for tips on safe handling, please refer to the brake master cylinder information earlier in this section. Information there includes, the tendency for DOT-3 fluid to absorb moisture and the ability of it to EAT PAINT. Proper care must be used in handling the fluid to prevent vehicle or system damage.

LEVEL CHECK {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

LEVEL CHECK

The hydraulic clutch reservoir should be checked at least every 6 months. As with the brake master cylinder reservoir, you normally check the fluid level through the translucent plastic body of the reservoir. Fill to the line on the reservoir.

> **Ä Although the level should drop slowly with clutch wear, the need to constantly add large amounts of fluid points to the probability of a leak. If a leak is suspected the system should be thoroughly inspected to prevent a hydraulic failure which would leave you stranded.**

Power Steering Pump {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Power Steering Pump

Ü See figures 233, 234, 235, 236, 237

The power steering pump reservoir is located at the front left or right side of the engine (depending on the year and model. The reservoir is usually mounted to the top of the cowl, remote from the power steering pump, for ease of service.

Figure 233.
The power steering fluid level is checked using the reservoir cap/dipstick . . .

{ewc GSMVIMG,GSMVIMG, !88261P78.bmp}

88261P78

Figure 234.
. . . hold the cap sideways, making sure the fluid level is within the operating range

{ewc GSMVIMG,GSMVIMG, !88261P79.bmp}

88261P79

Figure 235.
Although 2 operating ranges are provided, it is preferable to check the level HOT

{ewc GSMVIMG,GSMVIMG, !88261G62.bmp}

88261G62

Figure 236.
If necessary, fluid should be added (and as usual, a funnel is handy)

{ewc GSMVIMG,GSMVIMG, !88261P80.bmp}

88261P80

Figure 237.
Late model reservoirs are also mounted to the cowl, just on the other side of the engine

{ewc GSMVIMG,GSMVIMG, !88261P81.bmp}

88261P81

FLUID RECOMMENDATIONS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

FLUID RECOMMENDATIONS

Use GM Power Steering Fluid No. 1050017 (1985–95 vehicles), No. 1052884 (1996 vehicles), or a suitable equivalent.

> **Ä Avoid using automatic transmission fluid in the power steering unit, it is not usually a directly compatible substitute any more.**

LEVEL CHECK {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

LEVEL CHECK

The power steering fluid should be checked at least every 6 months. There is a Cold and a Hot mark on the dipstick. The fluid should be checked when the engine is warm and turned **OFF**. If necessary, add fluid to the power steering pump reservoir.

Chassis Greasing {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Chassis Greasing

Ü See figure 238

Chassis greasing should be performed every 6 months or 7500 miles (12,000 km), it can be performed with a commercial pressurized grease gun or at home by using a hand operated grease gun. Wipe the grease fittings clean before greasing in order to prevent the possibility of forcing any dirt into the component. Just add enough fresh grease to fill (and thereby swell the rubber seal). DO NOT add grease until it pours from the seal, as this means the SEAL can no longer properly protect the grease from moisture or dirt.

Figure 238.
Grease fittings, such as the one pictured, should be cleaned before the grease gun is attached

{ewc GSMVIMG,GSMVIMG, !88261P82.bmp}

88261P82

Body Lubrication {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Body Lubrication

HOOD LATCH & HINGES

Clean the latch surfaces and apply clean engine oil to the latch pilot bolts and the spring anchor. Use the engine oil to lubricate the hood hinges as well. Use a chassis grease to lubricate all the pivot points in the latch release mechanism.

DOOR HINGES & LOCKS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

DOOR HINGES & LOCKS

The gas tank filler door, the front doors and rear door hinges should be wiped clean and lubricated with clean engine oil. Silicone spray also works well on these parts but must be applied more often. The door lock cylinders can be lubricated easily with a shot of GM silicone spray No. 1052276 or 1 of the many dry penetrating lubricants commercially available.

PARKING BRAKE LINKAGE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

PARKING BRAKE LINKAGE

Use chassis grease on the parking brake cable where it contacts the guides, links, levers and pulleys. The grease should be a water resistant one for durability under the vehicle.

ACCELERATOR LINKAGE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ACCELERATOR LINKAGE

Lubricate the throttle body lever, the cable and the accelerator pedal lever (at the support inside the vehicle) with clean engine oil.

TRANSMISSION SHIFT LINKAGE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TRANSMISSION SHIFT LINKAGE

Lubricate the manual transmission shift linkage with water resistant chassis grease which meets GM specification No. 6031M or equivalent. Automatic transmission shift linkage should be lubricated with clean engine oil.

Wheel Bearings {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Wheel Bearings

Once every 30,000 miles (48,000 km) the non-sealed front wheel bearings of rear wheel drive vehicles should be cleaned and repacked with a GM Wheel Bearing Grease No. 1051344 or equivalent. Use only enough grease to completely coat the rollers. Remove any excess grease from the exposed surface of the hub and seal.

REPACKING & ADJUSTMENT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REPACKING & ADJUSTMENT

2-Wheel Drive

Ü See figures 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258

Before handling the bearings, there are a few things that you should remember to do and not to do.

Remember to DO the following:

- Remove all outside dirt from the housing before exposing the bearing.
- Treat a used bearing as gently as you would a new one.
- Work with clean tools in clean surroundings.
- Use clean, dry canvas or plastic gloves.
- Clean solvents and flushing fluids are a must.
- Use clean paper when laying out the bearings to dry.
- Protect disassembled bearings from rust and dirt. Cover them up.
- Use clean rags to wipe bearings.
- Keep the bearings in oil-proof paper when they are to be stored or are not in use.
- Clean the inside of the housing before replacing the bearing.

Do NOT do the following:

- Don't work in dirty surroundings.
- Don't use dirty, chipped or damaged tools.
- Try not to work on wooden work benches or use wooden mallets.
- Don't handle bearings with dirty or moist hands.
- Do not use gasoline for cleaning; use a safe solvent.
- Do not spin-dry bearings with compressed air. They will be damaged.
- Do not spin dirty bearings.
- Avoid using cotton waste or dirty cloths to wipe bearings.
- Try not to scratch or nick bearing surfaces.
- Do not allow the bearing to come in contact with dirt or rust at any time.

Ä The following procedures are made easier with the use of GM tools No. J–29117, J–8092, J–8850, J–8457 and J–9746–02 or their equivalents. Although the job can be done using a prybar, some a few LARGE sockets and some assorted drivers.

1. Loosen the lug nuts on the front wheels.
2. Raise and support the front of the vehicle safely using jackstands.
3. Remove the front tire and wheel assemblies.
4. Remove the caliper-to-steering knuckle bolts and the caliper from the steering knuckle. Using a wire, support the caliper from the vehicle; DO NOT disconnect the brake line.
5. Remove the dust cap at the center of the hub and disc assembly.
6. Remove the cotter pin, the spindle nut, the thrust washer and the outer bearing.

7. Grasping the hub and disc assembly firmly, pull the assembly from the axle spindle.
8. Using a small prybar or an inexpensive seal removal tool, pry the grease seal from the rear of the hub/disc assembly, then remove the inner bearing.

   Ä DO NOT remove the bearing races from the hub, unless they show signs of damage.

9. If it is necessary to remove the wheel bearing races, use the GM front bearing race removal tool No. J–29117 to drive the races from the hub and disc assembly. If the tool is not available, you can use a prybar (if you take care not to damage the hub and disc assembly) or you can use a blunt drift from behind (the other side of the assembly).

   Ä Wheel bearings and races which have been in service MUST remain together as matched sets. DO NOT switch bearings from side-to-side. ALSO, if the bearings are replaced, new races MUST be installed to insure the proper bearing operating life of the replacement parts.

10. Using solvent, clean the grease from all of the parts, then blow them dry with compressed air.

    Ä DO NOT spin the dry bearings with the compressed air or damage will likely occur. If compressed air is not available, place the bearings on a clean, dry surface (clean, lint free rag or a plastic bag) and allow them to air dry.

11. Inspect all of the parts for scoring, pitting or cracking, replace the parts (if necessary).

To install:

12. If the bearing races were removed, perform the following procedures to the install the replacements:
    a. Using grease, lightly lubricate the inside of the hub/disc assembly.
    b. Using the GM seal installation tools No. J–8092 and J–8850, drive the inner bearing race into the hub/disc assembly until it seats.

    Ä When installing the bearing races, be sure to support the hub/disc assembly with GM tool No. J–9746–02.

    c. Using the GM seal installation tools No. J–8092 and J–8457, drive the outer race into the hub/disc assembly until it seats.
13. Using wheel bearing grease, lubricate the bearings, the races and the spindle; be sure to place a gob of grease (inside the hub/disc assembly) between the races to provide an ample supply of lubricant.

Figure 239.
Exploded view of the front wheel hub and bearing assembly—2-wheel drive without ABS shown (ABS similar but with a speed sensor assembly on the shield and a reluctor ring on the back of the hub)

{ewc GSMVIMG,GSMVIMG, !88261G63.bmp}

88261G63

Figure 240.
Remove the dust cap from the center of the hub and disc assembly

{ewc GSMVIMG,GSMVIMG, !88261P83.bmp}

88261P83

Figure 241.
If the cap is stuck use a thin chisel to drive it away from the disc . . .

{ewc GSMVIMG,GSMVIMG, !88261P84.bmp}

88261P84

Figure 242.
. . . then pry the cap free, but be careful not to deform and ruin the cap

{ewc GSMVIMG,GSMVIMG, !88261P85.bmp}

88261P85

Figure 243.
Once loosened, remove the cap for access to the bearing retainer (cotter pin, washer and nut)

{ewc GSMVIMG,GSMVIMG, !88261P86.bmp}

88261P86

Figure 244.
Bend the ends outward and pull or lever the cotter pin from the spindle . . .

{ewc GSMVIMG,GSMVIMG, !88261P87.bmp}

88261P87

Figure 245.
If difficulty is encountered, gently tap on the pliers with a hammer to help free the cotter pin

{ewc GSMVIMG,GSMVIMG, !tccS8026.bmp}

TCCS8026

Figure 246.
. . . then loosen and remove the castellated spindle nut

{ewc GSMVIMG,GSMVIMG, !88261P88.bmp}

88261P88

Figure 247.
Withdraw the thrust washer . . .

{ewc GSMVIMG,GSMVIMG, !88261P89.bmp}

88261P89

Figure 248.
. . . then remove the outer bearing, freeing the hub and disc assembly

{ewc GSMVIMG,GSMVIMG, !88261P90.bmp}

88261P90

Figure 249.
Pull the hub/disc assembly from the spindle and face downward on a clean working surface

{ewc GSMVIMG,GSMVIMG, !88261P91.bmp}

88261P91

Figure 250.
Remove the inner wheel bearing seal using a seal puller (this really makes the job easier) . . .

{ewc GSMVIMG,GSMVIMG, !88261P92.bmp}

88261P92

Figure 251.
On ABS equipped vehicles a puller removes the seal WITHOUT damaging the reluctor ring (the visible teeth)

{ewc GSMVIMG,GSMVIMG, !88261P93.bmp}

88261P93

Figure 252.
With the seal removed, the inner wheel bearing may be lifted from the back of the hub

{ewc GSMVIMG,GSMVIMG, !88261P94.bmp}

88261P94

Figure 253.
Removing the bearings races from the hub and disc assembly

{ewc GSMVIMG,GSMVIMG, !88261G64.bmp}

88261G64

Figure 254.
Installing the inner wheel bearing race to the hub and disc

{ewc GSMVIMG,GSMVIMG, !88261G65.bmp}

88261G65

Figure 255.
Installing the outer wheel bearing race to the hub and disc

{ewc GSMVIMG,GSMVIMG, !88261G66.bmp}

88261G66

Figure 256.
Thoroughly pack the bearing with fresh, high temperature wheel-bearing grease before installation

{ewc GSMVIMG,GSMVIMG, !tccS8033.bmp}

TCCS8033

Figure 257.
Apply a thin coat of fresh grease to the new inner bearing seal lip

{ewc GSMVIMG,GSMVIMG, !tccS8034.bmp}

TCCS8034

Figure 258.
Though a driver is preferred, any circular tool (pipe or socket) of similar size can install the seal

{ewc GSMVIMG,GSMVIMG, !88261P95.bmp}

88261P95

Ä To lubricate each bearing, place a gob of grease in the palm of the hand, then scoop the bearing through the grease to force grease between the rollers and cage. Be sure to thoroughly fill the bearing around the entire circumference from the top and bottom of the assembly, then roll the bearing through the grease to assure it is well lubricated.

14. Place the inner wheel bearing into the hub/disc assembly. Using a smooth flat driver, length of pipe or a large socket, drive the new grease seal into the rear of the hub and disc assembly until it is flush with the outer surface.
15. Position the hub and disc assembly onto the spindle, then install the outer bearing, thrust washer and the hub nut.
16. While turning the wheel, torque the hub nut to 12 ft. lbs. (16 Nm) until the bearings seat. Back off the nut to the "just loose" position, then retighten it by hand. Back the nut off until the nearest nut slot aligns with the spindle hole. The nut should not be turned back more than $^1/2$ of a nut flat.
17. Install a new cotter pin through the nut and the spindle, then bend the ends and cut off the

excess pin (one outward over the end of the spindle, and the other downward around the spindle). Install the grease cap.

18. If possible, use a dial indicator to the check the rotor end-play. The end-play should be 0.001–0.005 in. (0.03–0.13mm) when the bearings are properly adjusted. If not, readjust the hub/disc assembly.
19. Install the caliper onto the steering knuckle.
20. Install the tire and wheel assembly.
21. Remove the jackstands, then carefully lower the vehicle.
22. Tighten the lug nuts, then road test the vehicle.

All Wheel Drive {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

All Wheel Drive

The all wheel drive front wheel bearings are the sealed type that require no periodic adjusting or repacking. The bearing and hub is a 1 piece assembly requiring replacement if the bearings are defective. Refer to the "Front Wheel Bearing" section in Section 8 for bearing procedures.

TRAILER TOWING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TRAILER TOWING

Ü See figure 259

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 proper equipment is a must.

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

Figure 259.
Calculating proper tongue weight for your trailer

{ewc GSMVIMG,GSMVIMG, !tccs1005.bmp}

tccs1005

Trailer Weight {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

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 {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

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.

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.

Cooling {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Cooling

ENGINE

Overflow Tank

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.

Flex Fan {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Flex Fan

Another helpful accessory for vehicles using a belt-driven radiator fan is a flex fan. These fans are large diameter units designed to provide more airflow at low speeds, by using fan blades that have deeply cupped surfaces. The blades then flex, or flatten out, at high speed, when less cooling air is needed. These fans are far lighter in weight than stock fans, requiring less horsepower to drive them. Also, they are far quieter than stock fans. If you do decide to replace your stock fan with a flex fan, note that if your vehicle has a fan clutch, a spacer will be needed between the flex fan and water pump hub.

Oil Cooler {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Oil Cooler

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.

Ä Depending on the model and accessories originally installed on your vehicle, an integral oil cooler may already be installed in your radiator with lines leading back to your oil filter adapter.

TRANSMISSION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TRANSMISSION

An automatic transmission 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 transmission fluid. Heat is the worst enemy of an automatic transmission. As the temperature of the fluid increases, the life of the fluid decreases.

It is essential, therefore, that you install an automatic transmission 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 transmission 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 2 sizes larger than normally necessary.

Ä A transmission cooler can, sometimes, cause slow or harsh shifting in the transmission during cold weather, until the fluid has a chance to come up to normal operating temperature. Some coolers can be purchased with or retrofitted with a temperature bypass valve which will allow fluid flow through the cooler only when the fluid has reached above a certain operating temperature.

Handling A Trailer {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

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.

TOWING THE VEHICLE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TOWING THE VEHICLE

DO NOT push or tow your Astro or Safari Van to start it. Unusually high catalytic converter and exhaust system temperatures may result, which under extreme conditions may ignite the interior floor covering material above the converter.

Astro and Safari Vans may be towed at speeds up to 35 mph and distances not over 50 miles with the driveshaft in place, if no engine/driveline damage is present. If engine/driveline damage is known or suspected, the driveshaft should be disconnected before towing.

If your vehicle is equipped with fog lamps, it SHOULD NOT be towed from the front using sling-type equipment. Also, All Wheel Drive (AWD) vehicles MUST be towed with all 4 wheels OFF the ground on a flatbed, dolly or trailer.

> **Ä During towing the ignition should be OFF and the steering wheel should be clamped in the straight-ahead position using a device designed for this purpose. DO NOT use the steering column lock to hold the wheels in position. The transmission should be in Neutral and the parking brake should be released. The vehicle must be COMPLETELY secured using multiple steel chains or cables, DO NOT use ropes, canvas webbing or leather straps.**

To be sure no damage will occur to your vehicle, consult any GM dealer or professional tow truck service for towing instructions.

> **Ä To avoid damage to the fiberglass springs when raising the vehicle, DO NOT allow the lifting equipment to come into contact with the springs.**

JUMP STARTING A DEAD BATTERY {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

JUMP STARTING A DEAD BATTERY

Ü See figure 260

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.

Figure 260.
Connect the jumper cables to the batteries and engine in the order shown

{ewc GSMVIMG,GSMVIMG, !tccs1080.bmp}

tccs1080

****Caution**
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 {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Jump Starting Precautions

- Be sure 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 both batteries are of the same polarity (have the same terminal, in most cases NEGATIVE grounded).
- Be sure 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 {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Jump Starting Procedure

1. Make sure the voltages of the 2 batteries are the same. Most batteries and charging systems are of the 12 volt variety.
2. Pull the jumping vehicle (with the good battery) into a position so the jumper cables can reach the dead battery and that vehicle's engine. Make sure 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.

   Ä If necessary for safety reasons, the hazard lights on both vehicles may be operated throughout the entire procedure without significantly increasing the 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 booster (good) battery.
9. Connect 1 end of the other jumper cable to the negative (-) terminal on the booster 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 1 loosen during the procedure. DO NOT connect this clamp to the negative (–) terminal of the bad battery.

   ****Caution**
   Be very careful to keep the jumper cables away from moving parts (cooling fan, belts, etc.) on both engines.
10. Check to make sure 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 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 {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

JACKING

Ü See figures 261, 262, 263, 264, 265, 266, 267

The jack supplied with the Astro and Safari van is meant for changing tires during emergency roadside operations. No jack is not meant to support a vehicle while you crawl under it and work. Whenever it is necessary to get under a vehicle to perform service operations, always be sure it is adequately supported, preferably by jackstands at the proper points. Always block the wheels when changing tires.

If the van is equipped with a Positraction® (locking differential) rear axle, DO NOT run the engine for any reason with 1 rear wheel off the ground. Power will be transmitted through the rear wheel remaining on the ground, possibly causing the vehicle to drive itself off the jack.

Some of the service operations in this book require that 1 or both ends of the vehicle be raised and supported safely. The best arrangement for this, of course, is a grease pit or a vehicle lift but these items are seldom found in the home garage. However, small hydraulic, screw or scissors jacks are satisfactory for raising the vehicle. If you are serious about home maintenance and repair, do yourself a favor and buy a quality floor jack, the convenience will pay for itself in the long run.

Figure 261.
Floor jacks can be used on frame rails (such as this front crossmember) to raise the vehicle . . .

{ewc GSMVIMG,GSMVIMG, !88261P96.bmp}

88261P96

Figure 262.
. . . but jackstands must be used to support it (note this stand is placed under a frame pad)

{ewc GSMVIMG,GSMVIMG, !88261P97.bmp}

88261P97

Figure 263.
The rear differential is another jacking point (you can get both rear wheels off the ground at once)

{ewc GSMVIMG,GSMVIMG, !88261P98.bmp}

88261P98

Figure 264.
You can use the crossmember to lift the front of the vehicle

{ewc GSMVIMG,GSMVIMG, !88261G67.bmp}

88261G67

Figure 265.
The front frame pads may be used to lift 1 side of the vehicle

{ewc GSMVIMG,GSMVIMG, !88261G68.bmp}

88261G68

Figure 266.
The rear axle can be used to lift (floor jack pictured) or support (jackstands) the vehicle

{ewc GSMVIMG,GSMVIMG, !88261G69.bmp}

88261G69

Figure 267.
The rear spring bracket can be used to lift 1 side of the vehicle

{ewc GSMVIMG,GSMVIMG, !88261G70.bmp}

88261G70

Heavy wooden blocks or adjustable jackstands should be used to support the vehicle while it is being worked on. Drive-on trestles or ramps are also a handy and a safe way to raise the vehicle, assuming their capacity is adequate and that there are no clearance problems with low body panels/skirts or air dams. These can be bought or constructed from suitable heavy timbers or steel.

In any case, it is always best to spend a little extra time to make sure your van is lifted and supported safely.

****Caution**
Concrete blocks are not recommended. They may crumble if the load is not evenly distributed. Boxes and milk crates of any description MUST not be used. WE ARE TALKING ABOUT YOUR LIFE HERE! Once the vehicle is on the ramps or jackstands, shake it a few times to make sure the jackstands/ramps are securely supporting the weight before crawling under.

Before using any jack, read the manufacturer's instructions. This includes the emergency jack provided with your vehicle. When using floor jacks and jackstands, be sure they are positioned on structural components and not on body or floor panels which were not designed to support the vehicle weight (and which will just deform or break once this force is applied). Generally frame rails, differential housings and certain specified suspension components are good jacking points. For more detail, please refer to the accompanying illustrations.

Jacking Precautions {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Routine Maintenance And Tune-up

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 jackstands 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.

{ewc GSMVIMG,GSMVIMG, !tccs1c02.bmp}

tccs1c02

{ewc GSMVIMG,GSMVIMG, !tccs1c03.bmp}

tccs1c03

{ewc GSMVIMG,GSMVIMG, !tccs1c04.bmp}

tccs1c04

{ewc GSMVIMG,GSMVIMG, !tccs1c05.bmp}

tccs1c05

{ewc GSMVIMG,GSMVIMG, !tccs1c06.bmp}

tccs1c06

{ewc GSMVIMG,GSMVIMG, !tccs1c07.bmp}

tccs1c07

ENGINE ELECTRICAL

{ewc MVIMAGE,MVIMAGE, !engine_ele.bmp}

BASIC ELECTRICAL THEORY {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

BASIC ELECTRICAL THEORY

Understanding Electricity

For any electrical system to operate, there must be a complete circuit. This simply means that the power flow from the battery must make a full circle. When an electrical component is operating, power flows from the battery to the components, passes through the component (load) causing it to function, and returns to the battery through the ground path of the circuit. This ground may be either another wire or a metal part of the vehicle (depending upon how the component is designed).

BASIC CIRCUITS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

BASIC CIRCUITS

Ü See figures 1, 2

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. If one of the two wires was attached to the negative post (-) of the battery and the other wire to the positive post (+), the circuit would be complete and the light bulb would illuminate. Electricity could follow a path from the battery to the bulb and back to the battery. It's not hard to see that with longer wires on our light bulb, it could be mounted anywhere on the vehicle. Further, one wire could be fitted with a switch so that the light could be turned on and off. Various other items could be added to our primitive circuit to make the light flash, become brighter or dimmer under certain conditions, or advise the user that it's burned out.

Figure 1.
Here is an example of a simple automotive circuit. When the switch is closed, power from the positive battery terminal flows through the fuse, then the switch and to the load (light bulb), the light illuminates and then, the circuit is completed through the return conductor and the vehicle ground. If the light did not work, the tests could be made with a voltmeter or test light at the battery, fuse, switch or bulb socket

{ewc GSMVIMG,GSMVIMG, !tccs2004.bmp}

tccs2004

Figure 2.
Damaged insulation can allow wires to break (causing an open circuit) or touch (causing a short)

{ewc GSMVIMG,GSMVIMG, !tccs2003.bmp}

tccs2003

Ground {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Engine Electrical

Ground

Some automotive components are grounded through their mounting points. 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 body of the vehicle.

Load {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Load

Every complete circuit must include a "load” (something to use the electricity coming from the source). If you were to connect a wire between the two terminals of the battery (DON'T do this, but take our word for it) without the light bulb, the battery would attempt to deliver its entire power supply from one pole to another almost instantly. This is a short circuit. The electricity is taking a short cut to get to ground and is not being used by any load in the circuit. This sudden and uncontrolled electrical flow can cause great damage to other components in the circuit and can develop a tremendous amount of heat. A short in an automotive wiring harness can develop sufficient heat to melt the insulation on all the surrounding wires and reduce a multiple wire cable to one sad lump of plastic and copper. Two common causes of shorts are broken insulation (thereby exposing the wire to contact with surrounding metal surfaces or other wires) or a failed switch (the pins inside the switch come out of place and touch each other).

Switches and Relays {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Switches and Relays

Some electrical components which require a large amount of current to operate also have a relay in their circuit. Since these circuits carry a large amount of current (amperage or amps), the thickness of the wire in the circuit (wire gauge) is also greater. If this large wire were connected from the load to the control switch on the dash, the switch would have to carry the high amperage load and the dash would be twice as large to accommodate wiring harnesses as thick as your wrist. To prevent these problems, a relay is used. The large wires in the circuit are connected from the battery to one side of the relay and from the opposite side of the relay to the load. The relay is normally open, preventing current from passing through the circuit. An additional, smaller wire is connected from the relay to the control switch for the circuit. When the control switch is turned on, it grounds the smaller wire to the relay and completes its circuit. The main switch inside the relay closes, sending power to the component without routing the main power through the inside of the vehicle. Some common circuits which may use relays are the horn, headlights, starter and rear window defogger systems.

Protective Devices {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Engine Electrical

Protective Devices

It is possible for larger surges of current to pass through the electrical system of your vehicle. If this surge of current were to reach the load in the circuit, it could burn it out or severely damage it. 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. It's much easier to go to a known location (the fuse box) to see why a circuit is inoperative than to dissect 15 feet of wiring under the dashboard, looking for what happened.

When an electrical current of excessive power passes through the fuse, the fuse blows (the conductor melts) and breaks the circuit, preventing the passage of current and protecting the components.

A circuit breaker is basically a self repairing fuse. It will open the circuit in the same fashion as a fuse, but when either the short is removed or the surge subsides, the circuit breaker resets itself and does not need replacement.

A fuse link (fusible link or main link) is a wire that acts as a fuse. One of these is normally connected between the starter relay and the main wiring harness under the hood. Since the starter is usually the highest electrical draw on the vehicle, an internal short during starting could direct about 130 amps into the wrong places. Consider the damage potential of introducing this current into a system whose wiring is rated at 15 amps and you'll understand the need for protection. Since this link is very early in the electrical path, it's the first place to look if nothing on the vehicle works, but the battery seems to be charged and is properly connected.

TROUBLESHOOTING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Engine Electrical

TROUBLESHOOTING

Ü See figures 3, 4, 5

Electrical problems generally fall into one of three areas:

- The component that is not functioning is not receiving current.
- The component is receiving power but is not using it or is using it incorrectly (component failure).
- The component is improperly grounded.

The circuit can be can be checked with a test light and a jumper wire. The test light is a device that looks like a pointed screwdriver with a wire on one end and a bulb in its handle. A jumper wire is simply a piece of wire with alligator clips or special terminals on each end. If a component is not working, you must follow a systematic plan to determine which of the three causes is the villain.

1. Turn ON the switch that controls the item not working.

   Ä Some items work only when the ignition switch is turned ON.

2. Disconnect the power supply wire from the component.
3. Attach the ground wire of a test light or a voltmeter to a good metal ground.
4. Touch the end probe of the test light (or the positive lead of the voltmeter) to the power wire; if there is current in the wire, the light in the test light will come on (or the voltmeter will indicate the amount of voltage). You have now established that current is getting to the component.

Figure 3.
A 12 volt test light is useful when checking parts of a circuit for power

{ewc GSMVIMG,GSMVIMG, !tccs2006.bmp}

tccs2006

Figure 4.
Here, someone is checking a circuit by making sure there is power to the component's fuse

{ewc GSMVIMG,GSMVIMG, !tccs2007.bmp}

tccs2007

Figure 5.
Jumper wires with various connectors are handy for quick electrical testing

{ewc GSMVIMG,GSMVIMG, !tccs2005.bmp}

tccs2005

5. Turn the ignition or dash switch **OFF** and reconnect the wire to the component.

If there was no power, then the problem is between the battery and the component. This includes all the switches, fuses, relays and the battery itself. The next place to look is the fuse box; check carefully either by eye or by using the test light across the fuse clips. The easiest way to check is to simply replace the fuse. If the fuse is blown, and upon replacement, immediately blows again, there is a short between the fuse and the component. This is generally (not always) a sign of an internal short in the component. Disconnect the power wire at the component again and replace the fuse; if the fuse holds, the component is the problem.

****Warning**
DO NOT test a component by running a jumper wire from the battery UNLESS you are certain that it operates on 12 volts. Many electronic

components are designed to operate with less voltage and connecting them to 12 volts could destroy them. Jumper wires are best used to bypass a portion of the circuit (such as a stretch of wire or a switch) that DOES NOT contain a resistor and is suspected to be bad.

If all the fuses are good and the component is not receiving power, find the switch for the circuit. Bypass the switch with the jumper wire. This is done by connecting one end of the jumper to the power wire coming into the switch and the other end to the wire leaving the switch. If the component comes to life, the switch has failed.

****Warning**
Never substitute the jumper for the component. The circuit needs the electrical load of the component. If you bypass it, you will cause a short circuit.

Checking the ground for any circuit can mean tracing wires to the body, cleaning connections or tightening mounting bolts for the component itself. If the jumper wire can be connected to the case of the component or the ground connector, you can ground the other end to a piece of clean, solid metal on the vehicle. Again, if the component starts working, you've found the problem.

A systematic search through the fuse, connectors, switches and the component itself will almost always yield an answer. Loose and/or corroded connectors, particularly in ground circuits, are becoming a larger problem in modern vehicles. The computers and on-board electronic (solid state) systems are highly sensitive to improper grounds and will change their function drastically if one occurs.

Remember that for any electrical circuit to work, ALL the connections must be clean and tight.

ELECTRONIC DISTRIBUTOR IGNITION SYSTEMS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Engine Electrical

ELECTRONIC DISTRIBUTOR IGNITION SYSTEMS

General Information

There are three general ignition systems used on these vehicles: High Energy Ignition (HEI), Electronic Spark Timing (EST) and High Voltage Switch (HVS). The HEI and EST systems are very similar to each other and differ more in nomenclature than anything else. These systems use distributors that contain pickups and electronic modules. The HVS system uses a distributor that contains nothing but a rotor and cap. All the HVS does is to distribute the spark to the appropriate cylinder; the engine control module (ECM) takes care of the rest of the timing parameters. The HVS distributor does contain a camshaft position sensor, but it is not used for timing determination.

HIGH ENERGY IGNITION (HEI) AND ELECTRONIC SPARK TIMING (EST) SYSTEMS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

HIGH ENERGY IGNITION (HEI) AND ELECTRONIC SPARK TIMING (EST) SYSTEMS

Ü See figures 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20

The HEI/EST system operates in basically the same manner as the conventional points type ignition system, with the exception of the type of switching device used. A toothed iron timer core is mounted on the distributor shaft which rotates inside of an electronic pole piece. The pole piece has internal teeth (corresponding to those on the timer core) which contains a permanent magnet and pick-up coil (not to be confused with the ignition coil). The pole piece senses the magnetic field of the timer core teeth and sends a signal to the ignition module which electronically controls the primary coil voltage. The ignition coil operates in basically the same manner as a conventional ignition coil (though the ignition coils DO NOT interchange).

Some distributors use a Hall Effect device to act as the switching device. This type of distributor uses a slotted vane that passes between a magnet and the Hall Effect device to signal when to initiate a spark. The Hall Effect device is a solid state sensor that acts as a magnetic activated switch. The slots in the vane effectively change the magnetic field set up by the magnet, causing the Hall Effect device to switch on and off. This signal is sent to the ignition module and processed in the same way that the above mentioned pick-up coil type distributor does.

The 4.3L engines up to 1995 use a knock sensor to retard the timing when knock is sensed. The knock sensor is located on the block and it sends a signal to the Electronic Spark Control (ESC) module located on a bracket at the back of the engine. The ESC module in turn sends a signal to the ECM to retard the timing.

Ä The HEI/EST systems uses a capacitor within the distributor which is primarily used for radio interference suppression purposes.

None of the electrical components used in the HEI systems are adjustable. If a component is found to be defective, it must be replaced.

Figure 6.
ST distributor at home nestled at the back of the 4.3L engine
{ewc GSMVIMG,GSMVIMG, !88262p9a.bmp}

88262p9a

Figure 7.
EI distributor with the coil mounted in the cap
{ewc GSMVIMG,GSMVIMG, !88262g01.bmp}

88262g01

Figure 8.
ST distributor with the coil mounted externally
{ewc GSMVIMG,GSMVIMG, !88262g14.bmp}

88262g14

Figure 9.
Electronic Spark Control components
{ewc GSMVIMG,GSMVIMG, !88262g13.bmp}

88262g13

Figure 10.
Distributor testing—HEI with "coil in cap”
{ewc GSMVIMG,GSMVIMG, !88262g05.bmp}

88262g05

Figure 11.

Distributor testing—HEI with "coil in cap," continued

{ewc GSMVIMG,GSMVIMG, !88262g06.bmp}

88262g06

Figure 12.
Distributor testing—HEI with "coil in cap," continued

{ewc GSMVIMG,GSMVIMG, !88262g07.bmp}

88262g07

Figure 13.
Distributor testing—HEI with remote coil

{ewc GSMVIMG,GSMVIMG, !88262g08.bmp}

88262g08

Figure 14.
Distributor testing—HEI with remote coil, continued

{ewc GSMVIMG,GSMVIMG, !88262g09.bmp}

88262g09

Figure 15.
Ignition system check—2.5L engine

{ewc GSMVIMG,GSMVIMG, !88262c37.bmp}

88262c37

Figure 16.
Ignition system check—2.5L engine, continued

{ewc GSMVIMG,GSMVIMG, !88262c38.bmp}

88262c38

Figure 17.
Ignition system check—4.3L engine except with HVS

{ewc GSMVIMG,GSMVIMG, !88262c39.bmp}

88262c39

Figure 18.
Ignition system check—4.3L engine except with HVS, continued

{ewc GSMVIMG,GSMVIMG, !88262c40.bmp}

88262c40

Figure 19.
Ignition system check—4.3L engine except with HVS, continued

{ewc GSMVIMG,GSMVIMG, !88262c41.bmp}

88262c41

Figure 20.
Ignition system check—4.3L engine except with HVS, continued

{ewc GSMVIMG,GSMVIMG, !88262c42.bmp}

88262c42

HIGH VOLTAGE SWITCH (HVS) SYSTEM {ewc MVIMAGE, MVIMAGE, ! nexttopicarrow.bmp}

HIGH VOLTAGE SWITCH (HVS) SYSTEM

Ü See figures 21, 22

The High Voltage Switch (HVS) system is the highest evolution in distributor based ignition systems. The only purpose the distributor has in the systems is to distribute the spark to the cylinders. It contains no ignition pickup coils, no ignition high voltage coils, no weights or springs, nor does it contain any ignition modules. It does contain a camshaft position sensor, but that sensor does not effect the operation of the vehicle. The camshaft position sensor is utilized to determine which cylinder is misfiring, under misfire conditions. The Powertrain Control Module (PCM) controls the ignition coil based on inputs from the various engine sensors. It sends a signal to the Ignition Control Module which uses the low voltage control signal (approximately 4 volts) to ground the ignition coil, thus completing the circuit. When the ICM switches off, the ignition coil fires. The ICM module is attached to the same bracket as the ignition coil.

Figure 21.
HVS distributors are easily identified by their flat appearance and side mounted ignition wire towers

{ewc GSMVIMG,GSMVIMG, !88262g18.bmp}

88262g18

Figure 22.
HVS ignition systems have the ICM module mounted to the same bracket as the coil

{ewc GSMVIMG,GSMVIMG, !88262g19.bmp}

88262g19

PRECAUTIONS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Engine Electrical

PRECAUTIONS

Before troubleshooting the systems, it might be a good idea to take note of the following precautions:

Timing Light Use

Inductive pick-up timing lights are the best kind to use. Timing lights which connect between the spark plug and the spark plug wire occasionally give false readings.

Some engines incorporate a magnetic timing probe terminal (at the damper pulley) for use of special electronic timing equipment. Refer to the manufacturer's instructions when using this equipment.

Spark Plug Wires {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Engine Electrical

Spark Plug Wires

The plug wires are of a different construction than conventional wires. When replacing them, make sure to use the correct wires, since conventional wires won't carry the higher voltage. Also, handle them carefully to avoid cracking or splitting them and never pierce them.

Tachometer Use {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Tachometer Use

Not all tachometers will operate or indicate correctly. While some tachometers may give a reading, this does not necessarily mean the reading is correct. In addition, some tachometers connect differently than others. If you can't figure out whether or not your tachometer will work on your vehicle, check with the tachometer manufacturer.

System Testers {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Engine Electrical

System Testers

Instruments designed specifically for testing the HEI system are available from several tool manufacturers. Some of these will even test the module.

Ignition Coil {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Ignition Coil

Ü See figures 23, 24, 25

The ignition coil on the 2.5L engine, is located on the right rear side of the engine; on the 4.3L (1985) engine, it is located in the top of the distributor cap; on the 1986 and later 4.3L engine, it is located on intake manifold to the right side of the engine.

Figure 23.
Ignition component mounting points on early 4-cylinder engines

{ewc GSMVIMG,GSMVIMG, !88262g02.bmp}

88262g02

Figure 24.
Ignition component mounting points on late 4-cylinder engines

{ewc GSMVIMG,GSMVIMG, !88262g15.bmp}

88262g15

Figure 25.
Ignition component mounting points on HVS equipped 6-cylinder engines

{ewc GSMVIMG,GSMVIMG, !88262g20.bmp}

88262g20

TESTING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TESTING

Ü See figures 26, 27

Ä The following procedures require the use of an ohmmeter.

2.5L Engine

For this procedure, the ignition coil may be removed from the engine or simply remove the electrical connectors and test it on the engine.

1. Using an ohmmeter (on the high scale), connect the probes between the primary (low voltage) terminal and coil ground; the reading should be very high or infinity, if not, replace the coil.
2. Using an ohmmeter (on the low scale), connect the probes between both primary (low voltage) terminals; the reading should be very low or zero, if not, replace the coil.
3. Using an ohmmeter (on the high scale), connect the probes between a primary (low voltage) terminal and the secondary (high voltage) terminal; the reading should be high (not infinite), if not, replace the coil.

Figure 26.
Ignition coil testing points—HEI/EST coil

{ewc GSMVIMG,GSMVIMG, !88262g12.bmp}

88262g12

Figure 27.
Ignition coil testing points—HVS coil

{ewc GSMVIMG,GSMVIMG, !88262g16.bmp}

88262g16

4.3L Engine {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Engine Electrical

4.3L Engine

CARBURETED

Ü See figures 26, 27

To test the ignition coil, the distributor cap must be removed from the distributor.

1. Remove the electrical connector from the distributor cap and the distributor cap from the distributor. Place the distributor cap on a workbench in the inverted position.
2. Using an ohmmeter (on the low scale), connect the probes between the primary (low voltage) terminals; the reading should be low or nearly zero, if not, replace the coil.
3. Using an ohmmeter (on the high scale), connect the probes between a primary (low voltage) terminal and the secondary (center terminal or high voltage) terminal; the reading should be high (not infinite), if not, replace the coil.

FUEL INJECTED {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Engine Electrical

FUEL INJECTED

Ü See figures 26, 27

For this procedure, the ignition coil may be removed from the engine or simply remove the electrical connectors and test it on the engine.

1. Using an ohmmeter (on the high scale), connect the probes between the primary (low voltage) terminal and coil ground; the reading should be very high or infinity, if not, replace the coil.
2. Using an ohmmeter (on the low scale), connect the probes between both primary (low voltage) terminals; the reading should be very low or zero, if not, replace the coil.
3. Using an ohmmeter (on the high scale), connect the probes between a primary (low voltage) terminal and the secondary (high voltage) terminal; the reading should be high (not infinite), if not, replace the coil.

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REMOVAL & INSTALLATION

Ü See figures 28, 29, 30, 31, 32

2.5L Engine

The ignition coil is located near the cylinder head at the right rear side of the engine. The coil is located under the intake manifold on the later model 2.5L engines.

1. Disconnect the negative battery terminal and remove the console cover.
2. At the ignition coil, disconnect the ignition switch-to-coil wire and the distributor-to-coil wires.
3. Remove the coil-to-engine nuts/bolts and the coil from the engine.
4. If necessary, test or replace the ignition coil.
5. To install, mount the coil onto the engine, torque the nuts to 20 ft. lbs. (27 Nm) and reconnect all coil and battery connectors.

Figure 28.
Terminal identification for coil and distributor

{ewc GSMVIMG,GSMVIMG, !88262g25.bmp}

88262g25

Figure 29.
Always pull on the boot to remove the ignition wires, never the wire itself

{ewc GSMVIMG,GSMVIMG, !88262p73.bmp}

88262p73

Figure 30.
Depress the tabs to release the connector from the coil

{ewc GSMVIMG,GSMVIMG, !88262p74.bmp}

88262p74

Figure 31.
The coil will be mounted to the manifold directly or to a bracket which is bolted to the manifold

{ewc GSMVIMG,GSMVIMG, !88262p75.bmp}

88262p75

Figure 32.
Check the coil for cracks and other signs of damage before installation

{ewc GSMVIMG,GSMVIMG, !88262p76.bmp}

88262p76

4.3L Engine {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

4.3L Engine

CARBURETED

Ü See figures 26, 27, 28, 29, 30, 31, 32

The ignition coil is located in the top of the distributor which is positioned at the top rear of the engine.

1. Disconnect the negative battery terminal and remove the console cover from inside the vehicle.
2. At the ignition coil, on top of the distributor, disconnect the electrical connector and remove the spark plug wire retainer.
3. Remove the coil cover-to-distributor cap screws and the cover. Mark the coil terminals for installation purposes.
4. Remove the coil-to-distributor cap screws and the coil from the cap.
5. If necessary, test or replace the coil.
6. To install, position the high tension button and seal and coil into the cap.
7. Insert the terminals into the proper cap locations. Install the coil cover and spark plug retainer. Reconnect the coil and battery terminals.

FUEL INJECTED {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Engine Electrical

FUEL INJECTED

Ü See figures 26, 27, 28, 29, 30, 31, 32

The ignition coil is located, on top of the intake manifold, next to the distributor or midway along the valve cover.

1. Disconnect the negative battery terminal and remove the console cover inside the vehicle.
2. Disconnect the engine control switch and tachometer terminals from the ignition coil.
3. Disconnect the ignition coil-to-distributor lead wire from the coil.
4. Remove the coil bracket/coil assembly-to-engine bracket nuts and the assembly from the engine.
5. If necessary, test or replace the coil.
6. If necessary to remove the coil from the bracket, perform the following procedures:
   a. Using a drill, drill out the coil-to-bracket rivets.
   b. Using a center punch, drive the rivets from the coil-to-bracket assembly.
   c. Remove the coil from the coil bracket.

To install:

7. Install the coil on the bracket with two screws, position the coil on the engine and torque the nuts to 20 ft. lbs. (27 Nm).
8. Connect the coil connectors and negative battery cable. Install the console cover.

Ignition Module {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Ignition Module

The ignition module on the 2.5L and non-HVS 4.3L engine is located inside the distributor; it may be replaced without removing the distributor from the engine. The ignition control module (ICM) on 1995 and later VIN W 4.3L engines is just an electronic switch and does no controlling of the ignition system. It is attached to the ignition coil bracket.

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REMOVAL & INSTALLATION

1985–94 (non-HVS) Engines

Ü See figures 33, 34, 35, 36

1. Disconnect the negative battery terminal and remove the console cover.
2. Remove the distributor cap and the rotor.
3. If the flange, of the distributor shaft is positioned above the module, place a socket on the crankshaft pulley bolt and rotate the crankshaft (turning the distributor shaft) to provide clearance to the ignition module.
4. Remove the ignition module-to-distributor bolts, lift the module and disconnect the electrical connectors from it.
5. If the module is suspected as being defective, take it to a module testing machine and have it tested.

   Ä When replacing the module, be sure to coat the module-to-distributor surface with silicone lubricant (dielectric compound) that will provide heat dissipation.

To install:

6. Apply silicone heat sink compound to the module mounting area of the distributor. Install the rotor, the distributor cap and connect the negative battery cable.

Figure 33.
Module and pick-up coil for EST distributor

{ewc GSMVIMG,GSMVIMG, !88262g27.bmp}

88262g27

Figure 34.
The module easily unbolts without disassembling the distributor on EST equipped engines

{ewc GSMVIMG,GSMVIMG, !88262p78.bmp}

88262p78

Figure 35.
Unplug the internal connections before trying to remove the module

{ewc GSMVIMG,GSMVIMG, !88262p78.bmp}

88262p78

Figure 36.
Heat sink grease must be applied when installing the module or it may fail due to overheating

{ewc GSMVIMG,GSMVIMG, !88262p79.bmp}

88262p79

1995-96 (HVS) Engines {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

1995–96 (HVS) Engines

1. Disconnect the negative battery terminal and remove the console cover inside the vehicle.
2. Disconnect the engine control switch and tachometer terminals from the ignition coil and module.
3. Disconnect the ignition coil-to-distributor lead wire from the coil.
4. Remove the coil bracket/module assembly-to-engine bracket nuts and lift the assembly from the engine.
5. If necessary to remove the module from the bracket, perform the following procedures:
    a. Using a drill, drill out the module-to-bracket rivets.
    b. Using a center punch, drive the rivets from the module-to-bracket assembly.
    c. Remove the module from the coil bracket.

To install:

6. Install the module on the bracket with two screws, position the coil on the engine and torque the nuts to 20 ft. lbs. (27 Nm).
7. Connect the coil connectors and negative battery cable. Install the console cover.

Pickup Coil {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Pickup Coil

Ü See figure 37

TESTING

1. With the ignition key **OFF**, remove the console cover, distributor cap, rotor and disconnect the pickup coil-to-module wire harness.
2. Connect an ohmmeter from the distributor housing to one pickup lead. The reading should be infinite at all times.
3. Connect an ohmmeter to both pickup coil wire terminals. The reading should be steady at one value within 500–1500 ohms. If not replace the pickup coil.

Figure 37.
Pick-up coil testing points

{ewc GSMVIMG,GSMVIMG, !88262g17.bmp}

88262g17

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REMOVAL & INSTALLATION

Ü See figures 38, 39, 40, 41

1. Disconnect the negative battery cable.
2. Remove the distributor cap and rotor. Do NOT remove the spark plug wires from the cap.
3. Mark the distributor housing, position of rotor and relationship from the distributor housing-to-engine block for installation purposes.
4. Remove the distributor clamp and remove the distributor from the engine.
5. Place the distributor in a vise and mark the distributor shaft and gear so they can be reassembled in the same position.
6. Drive out the roll pin and remove the gear and shaft from the distributor. Remove the retainer clip by cutting it off.
7. Remove the attaching screws, magnetic shield, retaining ring, pickup coil and pole piece.

To install:

8. Install the pole piece, pickup coil, retaining ring, magnetic shield and retaining screws. Install a new retainer clip using a socket as a driver.
9. Install the gear and shaft to the distributor. Drive in the roll pin.
10. Install the distributor and clamp to the marked position.
11. Install the distributor cap and rotor.
12. Connect the negative battery cable.
13. Adjust the timing to specifications.

Figure 38.
Exploded view of the distributor components—2.5L engine

{ewc GSMVIMG,GSMVIMG, !88262g21.bmp}

88262g21

Figure 39.
Exploded view of the distributor components—4.3L engine, non-HVS distributor

{ewc GSMVIMG,GSMVIMG, !88262g22.bmp}

88262g22

Figure 40.
Support the distributor shaft while driving out the roll pin

{ewc GSMVIMG,GSMVIMG, !88262g23.bmp}

88262g23

Figure 41.
Use a socket to press the retainer clip over the shaft. Use a new retainer clip each time it is removed

{ewc GSMVIMG,GSMVIMG, !88262g24.bmp}

88262g24

Distributor

REMOVAL & INSTALLATION

Ü See figures 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54

Engine Not Rotated

This procedure applies if the engine has not been rotated with the distributor removed.

1. Disconnect the negative battery terminal from the battery and remove the console cover.
2. Tag and disconnect the electrical connector(s) from the distributor.
3. Remove the distributor cap (DO NOT remove the spark plug wires) from the distributor and move it aside.
4. Using a crayon or chalk, make locating marks (for installation purposes) on the rotor, the ignition module, the distributor housing and the engine block.
5. Loosen and remove the distributor clamp bolt and clamp, then lift the distributor from the engine.

   Ä Noting the relative position of the rotor and the module alignment marks, make a second mark on the rotor to align it with the one mark on the module.

Figure 42.
Connector identification for distributor—2.5L engine

{ewc GSMVIMG,GSMVIMG, !88262g26.bmp}

88262g26

Figure 43.
The HVS distributor mounts only one way. Do not try to rotate the distributor to change the timing

{ewc GSMVIMG,GSMVIMG, !88262g28.bmp}

88262g28

Figure 44.
Align the indent hole on the drive gear with the cast-in arrow before installation on the HVS distributor

{ewc GSMVIMG,GSMVIMG, !88262g29.bmp}

88262g29

Figure 45.
With the indent hole and cast-in arrow aligned, the rotor should point in this direction

{ewc GSMVIMG,GSMVIMG, !88262g31.bmp}

88262g31

Figure 46.
Connector locations on the HVS distributor

{ewc GSMVIMG,GSMVIMG, !88262g30.bmp}

88262g30

Figure 47.
With the HVS distributor properly aligned and installed, the rotor should point to the mark

{ewc GSMVIMG,GSMVIMG, !88262g32.bmp}

88262g32

Figure 48.
Tag all the ignition wires before removing them from the cap or the spark plugs

{ewc GSMVIMG,GSMVIMG, !88262p80.bmp}

88262p80

Figure 49.
Disconnect the harnesses from the module

{ewc GSMVIMG,GSMVIMG, !88262p81.bmp}

88262p81

Figure 50.
Mark the alignment of the rotor before removing the distributor

{ewc GSMVIMG,GSMVIMG, !88262p82.bmp}

88262p82

Figure 51.
Mark the distributor base-to-block alignment before removing the distributor

{ewc GSMVIMG,GSMVIMG, !88262p86.bmp}

88262p86

Figure 52.
The distributor hold-down bolt must be removed to be able to draw out the distributor

{ewc GSMVIMG,GSMVIMG, !88262p87.bmp}

88262p87

Figure 53.
Depending on the hold-down's shape, there may be a correct orientation, so note how it is mounted

{ewc GSMVIMG,GSMVIMG, !88262p88.bmp}

88262p88

Figure 54.
Draw the distributor body straight up and out

{ewc GSMVIMG,GSMVIMG, !88262p89.bmp}

88262p89

To install:

6. Install a new O-ring on the distributor housing.
7. Align the second mark on the rotor with the mark on the module, then install the distributor, taking care to align the mark on the housing with the one on the engine.

   Ä It may be necessary to lift the distributor and turn the rotor slightly to align the gears and the oil pump driveshaft. The crankshaft may have to moved very slightly to engage the oil pump driveshaft with the distributor. Do NOT force the distributor into the engine with the distributor clamp.
8. With the respective marks aligned, install the clamp and bolt finger tight.
9. Install and secure the distributor cap.
10. Connect the electrical connector(s) to the distributor.
11. Connect a timing light to the engine (following the manufacturer's instructions). Start the engine, then check and/or adjust the timing.

12. Turn the engine **OFF**, tighten the distributor clamp bolt and remove the timing light.

Engine Rotated {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Engine Rotated

This procedure applies when the engine has been rotated with the distributor removed.

1. Disconnect the negative battery terminal from the battery and remove the console cover.
2. Tag and disconnect the electrical connector(s) from the distributor.
3. Remove the distributor cap (DO NOT remove the ignition wires) from the distributor and move it aside.
4. Using a crayon or chalk, make locating marks (for installation purposes) on the rotor, the ignition module, the distributor housing and the engine.
5. Loosen and remove the distributor clamp bolt and clamp, then lift the distributor from the engine.

   Ä Noting the relative position of the rotor and the module alignment marks, make a second mark on the rotor to align it with the one mark on the module.

To install:

6. Install a new O-ring on the distributor housing.
7. Rotate the crankshaft to position the No. 1 cylinder on the TDC of compression stroke. This may be determined by inserting a rag into the No. 1 spark plug hole and slowly turning the engine crankshaft. When the timing mark on the crankshaft pulley aligns with the **0** mark on the timing scale and the rag is blown out by the compression, the No. 1 piston is at top-dead-center (TDC).
8. Turn the rotor so that it will point to the No. 1 terminal of the distributor cap.
9. Install the distributor into the engine block. It may be necessary to turn the rotor, a little in either direction, in order to engage the gears.
10. Tap the starter a few times to ensure that the oil pump shaft is mated to the distributor shaft.
11. Bring the engine to No. 1 TDC again and check to see that the rotor is indeed pointing toward the No. 1 terminal of the cap.
12. With the respective marks aligned, install the clamp and bolt finger tight.
13. Install and secure the distributor cap.
14. Connect the electrical connector(s) to the distributor.
15. Connect a timing light to the engine (following the manufacturer's instructions). Start the engine, then check and/or adjust the timing.
16. Turn the engine **OFF**, tighten the distributor clamp bolt and remove the timing light.

Crankshaft and Camshaft Position Sensors {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Engine Electrical

Crankshaft and Camshaft Position Sensors

Refer to Section 5 for information on the crankshaft and camshaft sensors.

FIRING ORDERS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

FIRING ORDERS

Ü See figures 55, 56, 57, 58, 59, 60, 61, 62

Ä To avoid confusion, remove and tag the wires, one at a time, for replacement

Figure 55.
2.5L Engine
Firing Order: 1–3–4–2
Distributor Rotation: Clockwise

{ewc GSMVIMG,GSMVIMG, !88262G35.bmp}

88262G35

Figure 56.
4.3L Engine, non-HVS
Firing Order: 1–6–5–4–3–2
Distributor Rotation: Clockwise

{ewc GSMVIMG,GSMVIMG, !88262G36.bmp}

88262G36

Figure 57.
Ignition wire routing—early-model 2.5L engine

{ewc GSMVIMG,GSMVIMG, !88262g04.bmp}

88262g04

Figure 58.
Ignition wire routing—late-model 2.5L engine

{ewc GSMVIMG,GSMVIMG, !88262g11.bmp}

88262g11

Figure 59.
Ignition wire routing—4.3L engine with HEI (coil in cap)

{ewc GSMVIMG,GSMVIMG, !88262g03.bmp}

88262g03

Figure 60.
Ignition wire routing—4.3L engine with HEI (remote coil)

{ewc GSMVIMG,GSMVIMG, !88262g10.bmp}

88262g10

Figure 61.
Ignition wire routing—4.3L engine with HVS, right side

{ewc GSMVIMG,GSMVIMG, !88262g33.bmp}

88262g33

Figure 62.
Ignition wire routing—4.3L engine with HVS, left side

{ewc GSMVIMG,GSMVIMG, !88262g34.bmp}

88262g34

CHARGING AND STARTING SYSTEMS {ewc MVIMAGE, MVIMAGE, ! nexttopicarrow.bmp}

Engine Electrical

CHARGING AND STARTING SYSTEM

General Information

Basic Operating Principles

The battery is the first link in the chain of mechanisms which work together to provide cranking of the automobile engine. In most modern vans, the battery is a lead/acid electrochemical device consisting of six 2v subsections connected in series so the unit is capable of producing approximately 12v of electrical pressure. Each subsection, or cell, 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 causes a chemical reaction to be set up, and it is this reaction which produces current flow from the battery when its positive and negative terminals are connected to an electrical appliance such as a lamp or motor. The continued transfer of electrons would eventually convert the sulfuric acid in the electrolyte to water, and make the two plates identical in chemical composition. As electrical energy is removed from the battery, its voltage output tends to drop. Thus, measuring battery voltage and battery electrolyte composition are two ways of checking the ability of the unit to supply power. During the starting of the engine, electrical energy is removed from the battery. However, if the charging circuit is in good condition and the operating conditions are normal, the power removed from the battery will be replaced by the generator (or alternator) which will force electrons back through the battery, reversing the normal flow, and restoring the battery to its original chemical state.

The battery and starting motor are linked by very heavy electrical cables designed to minimize resistance to the flow of current. Generally, the major power supply cable that leaves the battery goes directly to the starter, while other electrical system needs are supplied by a smaller cable. During starter operation, power flows from the battery to the starter and is grounded through the van's frame and the battery's negative ground strap.

The automobile charging system provides electrical power for operation of the vehicle's ignition and starting systems and all the electrical accessories. The battery services as an electrical surge or storage tank, storing (in chemical form) the energy originally produced by the engine driven generator. The system also provides a means of regulating generator output to protect the battery from being overcharged and to avoid excessive voltage to the accessories.

The storage battery is a chemical device incorporating parallel lead plates in a tank containing a sulfuric acid/water solution. Adjacent plates are slightly dissimilar, and the chemical reaction of the two dissimilar plates produces electrical energy when the battery is connected to a load such as the starter motor. The chemical reaction is reversible, so that when the generator is producing a voltage (electrical pressure) greater than that produced by the battery, electricity is forced into the battery, and the battery is returned to its fully charged state.

The vehicle's generator is driven mechanically, through V-belts, by the engine crankshaft. It consists of two coils of fine wire, one stationary (the stator), and one movable (the rotor). The rotor may also be known as the armature, and consists of fine wire wrapped around an iron core which is mounted on a shaft. The electricity which flows through the two coils of wire (provided initially by the battery in some cases) creates an intense magnetic field around both rotor and stator, and the interaction between the two fields creates voltage, allowing the generator to power the accessories and charge the battery.

There are two types of generators: the earlier is the direct current (DC) type. The current produced by the DC generator is generated in the armature and carried off the spinning armature by stationary brushes contacting the commutator. The commutator is a series of smooth metal contact plates on the end of the armature. The commutator plates, which are separated from one another by a very short gap, are connected to the armature circuits so that current will flow in one directions only in the wires carrying the generator output. The generator stator consists of two stationary coils of wire which draw some of the output current of the generator to form a powerful magnetic field and create the interaction of fields which generates the voltage. The generator field is wired in series with the regulator.

Newer automobiles use alternating current generators or alternators, because they are more efficient, can be rotated at higher speeds, and have fewer brush problems. In an alternator, the field rotates while all the current produced passes only through the stator winding. The brushes bear against continuous slip rings rather than a commutator. This causes the current produced to periodically reverse the direction of its flow. Diodes (electrical one-way switches) block the flow of current from traveling in the wrong direction. A series of diodes is wired together to permit the alternating flow of the stator to be converted to a pulsating, but unidirectional flow at the alternator output. The alternator's field is wired in series with the voltage regulator.

The regulator consists of several circuits. Each circuit has a core, or magnetic coil of wire, which operates a switch. Each switch is connected to ground through one or more resistors. The coil of wire responds directly to system voltage. When the voltage reaches the required level, the magnetic field created by the winding of wire closes the switch and inserts a resistance into the generator field circuit, thus reducing the output. The contacts of the switch cycle open and close many times each second to precisely control voltage.

While alternators are self-limiting as far as maximum current is concerned, DC generators employ a current regulating circuit which responds directly to the total amount of current flowing through the generator circuit rather than to the output voltage. The current regulator is similar to the voltage regulator except that all system current must flow through the energizing coil on its way to the various accessories.

Alternator {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Alternator

Ü See figures 63, 64, 65, 66, 67

The alternator charging system is a negative ground system which consists of an alternator, a regulator, a charge indicator, a storage battery and wiring connecting the components, and fuse link wire.

The alternator is belt-driven from the engine. Energy is supplied from the alternator/regulator system to the rotating field through two brushes to two 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 6 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: part to the battery to charge the battery and power the electrical components of the vehicle, and part 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 put out too much 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.

Figure 63.
The CS Series alternator is one of General Motors most commonly used units

{ewc GSMVIMG,GSMVIMG, !88262g51.bmp}

88262g51

Figure 64.
The SI Series alternator was used in 1985 and was the last to use a diode trio

{ewc GSMVIMG,GSMVIMG, !88262g52.bmp}

88262g52

Figure 65.
Alternator wiring—1985 2.5L engine

{ewc GSMVIMG,GSMVIMG, !88262g53.bmp}

88262g53

Figure 66.
Alternator wiring—1986 and on 2.5L engine

{ewc GSMVIMG,GSMVIMG, !88262g49.bmp}

88262g49

Figure 67.
Alternator wiring—4.3L engine

{ewc GSMVIMG,GSMVIMG, !88262g50.bmp}

88262g50

The battery is connected to the alternator at all times, whether the ignition key is turned on or not. If the battery were shorted to ground, the alternator would also be shorted. This would damage the alternator. To prevent this, a fuse link is installed in the wiring between the battery and the alternator. If the battery is shorted, the fuse link is melted, protecting the alternator.

In 1986, the alternators experienced engineering changes, which are: The elimination of the diode trio and the reduction of the external wiring connectors from three-to-two wires.

Ä The new alternators are not serviceable and no periodic maintenance is required.

ALTERNATOR PRECAUTIONS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ALTERNATOR PRECAUTIONS

Observing these precautions will ensure safe handling of the electrical system components and will avoid damage to the vehicle's electrical system:

1. Be absolutely sure of the polarity of a booster battery before making connections. Connect the cables positive-to-positive and negative-to-negative. If jump starting, connect the positive cables first and the last connection to a ground on the body of the booster vehicle, so that arcing cannot ignite the hydrogen gas that may have accumulated near the battery. Even a momentary connection of a booster battery with polarity reversed may damage the alternator diodes.
2. Disconnect both vehicle battery cables before attempting to charge the battery.
3. Never ground the alternator output or battery terminal. Be cautious when using metal tools around a battery to avoid creating a short circuit between the terminals.
4. Never run an alternator without a load unless the field circuit (1985) is disconnected.
5. Never attempt to polarize an alternator.
6. Never disconnect any electrical components with the ignition switch turned **ON.**

CHARGING SYSTEM TROUBLESHOOTING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Engine Electrical

CHARGING SYSTEM TROUBLESHOOTING

Ü See figures 68, 69

There are many possible ways in which the charging system can malfunction. Often the source of a problem is difficult to diagnose, requiring special equipment and a good deal of experience. This is usually not the case, however, where the charging system fails completely and causes the dash board warning light to come on or the battery to become dead. To troubleshoot a complete system failure, only two pieces of equipment are needed: a test light, to determine that current is reaching a certain point; and a current indicator (ammeter), to determine the direction of the current flow and its measurement in amps.

This test works under three assumptions:

1. The battery is known to be good and fully charged.
2. The alternator belt is in good condition and adjusted to the proper tension.
3. All connections in the system are clean and tight.

   Ä In order for the current indicator to give a valid reading, the truck must be equipped with battery cables which are of the same gauge size and quality as original equipment battery cables.
4. Turn off all electrical components on the truck.
5. Make sure the doors of the truck are closed.
6. If the truck is equipped with a clock, disconnect the clock by removing the lead wire from the rear of the clock.
7. Disconnect the positive battery cable from the battery and connect the ground wire on a test light to the disconnected positive battery cable.
8. Touch the probe end of the test light to the positive battery post. The test light should not light. If the test light does light, there is a short or open circuit on the truck.
9. Disconnect the voltage regulator wiring harness connector at the voltage regulator.
10. Turn on the ignition key.
11. Connect the wire on a test light to a good ground (engine bolt).
12. Touch the probe end of a test light to the ignition wire connector into the voltage regulator wiring connector. This wire corresponds to the **I** terminal on the regulator. If the test light goes on, the charging system warning light circuit is complete. If the test light does not come on and the warning light on the instrument panel is on, either the resistor wire, which is parallel with the warning light, or the wiring to the voltage regulator, is defective. If the test light does not come on and the warning light is not on, either the bulb is defective or the power supply wire form the battery through the ignition switch to the bulb has an open circuit. Connect the wiring harness to the regulator.
13. Examine the fuse link wire in the wiring harness from the starter relay to the alternator. If the insulation on the wire is cracked or split, the fuse link may be melted.
14. Connect a test light to the fuse link by attaching the ground wire on the test light to an engine bolt and touching the probe end of the light to the bottom of the fuse link wire where it splices into the alternator output wire. If the bulb in the test light does not light, the fuse link is melted.
15. Start the engine and place a current indicator on the positive battery cable.
16. Turn off all electrical accessories and make sure the doors are closed. If the charging system is working properly, the gauge will show a draw of less than 5 amps. If the system is not

working properly, the gauge will show a draw of more than 5 amps. A charge moves the needle toward the battery, a draw moves the needle away from the battery. Turn the engine off.

17. Disconnect the wiring harness from the voltage regulator at the regulator at the regulator connector.
18. Connect a male spade terminal (solderless connector) to each end of a jumper wire.
19. Insert one end of the wire into the wiring harness connector which corresponds to the **A** terminal on the regulator.
20. Insert the other end of the wire into the wiring harness connector which corresponds to the **F** terminal on the regulator.
21. Position the connector with the jumper wire installed so that it cannot contact any metal surface under the hood.
22. Position a current indicator gauge on the positive battery cable. Have an assistant start the engine. Observe the reading on the current indicator. Have your assistant slowly raise the speed of the engine to about 2,000 rpm or until the current indicator needle stops moving, whichever comes first. Do not run the engine for more than a short period of time in this condition. If the wiring harness connector or jumper wire becomes excessively hot during this test, turn off the engine and check for a grounded wire in the regulator wiring harness. If the current indicator shows a charge of about three amps less than the output of the alternator, the alternator is working properly. If the previous tests showed a draw, the voltage regulator is defective. If the gauge does not show the proper charging rate, the alternator is defective.

Figure 68.
Alternator ground tab location—1985

{ewc GSMVIMG,GSMVIMG, !88262g58.bmp}

88262g58

Figure 69.
Alternator testing—1985

{ewc GSMVIMG,GSMVIMG, !88262g57.bmp}

88262g57

{ewc GSMVIMG,GSMVIMG, !tccs2c02.bmp}

tccs2c02

PRELIMINARY CHARGING SYSTEM TESTS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

PRELIMINARY CHARGING SYSTEM TESTS

1. If you suspect a defect in your charging system, first perform these general checks before going on to more specific tests.
2. Check the condition of the alternator belt and tighten it if necessary.
3. Clean the battery cable connections at the battery. Make sure the connections between the battery wires and the battery clamps are good. Reconnect the negative terminal only and proceed to the next step.
4. With the key off, insert a test light between the positive terminal on the battery and the disconnected positive battery terminal clamp. If the test light comes on, there is a short in the electrical system of the truck. The short must be repaired before proceeding. If the light does not come on, proceed to the next step.

   Ä If the truck is equipped with an electric clock, the clock must be disconnected.
5. Check the charging system wiring for any obvious breaks or shorts.
6. Check the battery to make sure it is fully charged and in good condition.

CHARGING SYSTEM OPERATIONAL TEST {ewc MVIMAGE, MVIMAGE, ! nexttopicarrow.bmp}

CHARGING SYSTEM OPERATIONAL TEST

Ä You will need a current indicator to perform this test. If the current indicator is to give an accurate reading, the battery cables must be the same gauge and length as the original equipment.

1. With the engine running and all electrical systems turned off, place a current indicator over the positive battery cable.
2. If a charge of roughly 5 amps is recorded, the charging system is working. If a draw of about 5 amps is recorded, the system is not working. The needle moves toward the battery when a charge condition is indicated, and away from the battery when a draw condition is indicated.
3. If a draw is indicated, proceed with further testing. If an excessive charge (10–15 amps) is indicated, the regulator may be at fault.

OUTPUT TEST {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

OUTPUT TEST

1. You will need an ammeter for this test.
2. Disconnect the battery ground cable.
3. Disconnect the wire from the battery terminal on the alternator.
4. Connect the ammeter negative lead to the battery terminal wire removed in step three, and connect the ammeter positive lead to the battery terminal on the alternator.
5. Reconnect the battery ground cable and turn on all electrical accessories. If the battery is fully charged, disconnect the coil wire and bump the starter a few times to partially discharge it.
6. Start the engine and run it until you obtain a maximum current reading on the ammeter.
7. If the current is not within 10 amps of the rated output of the alternator, the alternator is working properly. If the current is not within 10 amps, insert a screwdriver in the test hole in the end frame of the alternator and ground the tab in the test hole against the side of the hole.
8. If the current is now within 10 amps of the rated output, remove the alternator and have the voltage regulator replaced. If it is still below 10 amps of rated output, have the alternator repaired.

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REMOVAL & INSTALLATION

1985–90 Models

Ü See figures 70, 71, 72, 73

Ä The following procedures require the use of GM Belt Tension Gauge No. BT–33–95–ACBN for regular V-belts, or BT–33–97M for serpentine belts. The belt should deflect about 6mm (1/4 in.) over a 178–254mm (7–10 in.) span, or 13mm (1/2 in.) over a 330–406mm (13–16 in.) span at this point.

1. Disconnect the negative battery terminal from the battery.
2. Remove the top radiator hose bracket from the radiator.
3. Remove the wiring harness that is clamped to the radiator core support.
4. Remove the upper fan support-to-radiator support bolts and the fan support.
5. Label and disconnect the alternator's electrical connectors.
6. Remove the alternator brace bolt and the drive belt.
7. Support the alternator, then remove the mounting bolts and the unit from the vehicle.

Figure 70.
Alternator mounting—1985–86 2.5L engine
{ewc GSMVIMG,GSMVIMG, !88262g43.bmp}

88262g43

Figure 71.
Alternator mounting—1985–86 4.3L engine
{ewc GSMVIMG,GSMVIMG, !88262g44.bmp}

88262g44

Figure 72.
Alternator mounting—1987–90 2.5L engine
{ewc GSMVIMG,GSMVIMG, !88262g45.bmp}

88262g45

Figure 73.
Alternator mounting—1987–90 4.3L engine
{ewc GSMVIMG,GSMVIMG, !88262g46.bmp}

88262g46

To install:

8. Install the alternator and adjust the drive belt tension. Torque the top mounting bolt as follows:
   - 2.5L to 20 ft. lbs. (27 Nm)
   - 4.3L to 18.4 ft. lbs. (25 Nm)
9. Lower mounting bolt as follows:
   - 2.5L to 37 ft. lbs. (50 Nm)
   - 4.3L to 35 ft. lbs. (47 Nm)
10. Reconnect the negative battery terminal.
11. To adjust the drive belt, perform the following procedures:

a. If the belt is cold, operate the engine (at idle speed) for 15 minutes; the belt will seat itself in the pulleys allowing the belt fibers to relax or stretch. If the belt is hot, allow it to cool, until it is warm to the touch.

Ä A used belt is one that has been rotated at least one complete revolution on the pulleys. This begins the belt seating process and it must never be tensioned to the new belt specifications.

b. Loosen the component-to-mounting bracket bolts.

c. Using a GM Belt Tension Gauge No. BT–33–95–ACBN (standard V-belts) or BT–33–97M (poly V-belts), place the tension gauge at the center of the belt between the longest span.

d. Applying belt tension pressure on the component, adjust the drive belt tension to the correct specifications.

e. While holding the correct tension on the component, tighten the component-to-mounting bracket bolt.

f. When the belt tension is correct, remove the tension gauge.

1991-96 Models {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Engine Electrical

1991–96 Models

Ü See figures 74, 75, 76, 77, 78, 79, 80, 81

1. Disconnect the negative battery cable.
2. Disconnect the terminal plug and battery lead from the alternator.
3. Remove the drive belt.
4. Remove the alternator brace.
5. Remove the mounting bolts.
6. Remove the alternator from the alternator mounting bracket.

To install:

7. Install the alternator in the alternator mounting bracket.
8. Install the mounting bolts. Tighten the front mounting bolts to 36 ft. lbs. (50 Nm).
9. Install the alternator brace. Tighten the brace to alternator bracket bolt to 36 ft. lbs. (50 Nm).
10. Tighten the brace-to-alternator bolt to 18 ft. lbs. (25 Nm).
11. Install the drive belt.
12. Connect the terminal plug and battery lead to the alternator.
13. Connect the negative battery cable.
13. Start the engine and check for proper charging system operation.

Figure 74.
Alternator mounting—1991–95 4.3L engine

{ewc GSMVIMG,GSMVIMG, !88262g47.bmp}

88262g47

Figure 75.
Alternator mounting—1996 4.3L engine

{ewc GSMVIMG,GSMVIMG, !88262g48.bmp}

88262g48

Figure 76.
Before removing the positive lead from the alternator, DISCONNECT the battery ground cable

{ewc GSMVIMG,GSMVIMG, !88262p90.bmp}

88262p90

Figure 77.
Be careful when removing the locknut as sometimes the terminal stud likes to rotate with the nut

{ewc GSMVIMG,GSMVIMG, !88262p91.bmp}

88262p91

Figure 78.
Remove the mounting bolts after removing the belt

{ewc GSMVIMG,GSMVIMG, !88262p92.bmp}

88262p92

Figure 79.

This mounting stud holds a bracket in addition to mounting the alternator

{ewc GSMVIMG,GSMVIMG, !88262p93.bmp}

88262p93

Figure 80.
Once the bracket is removed, the mounting stud can be removed

{ewc GSMVIMG,GSMVIMG, !88262p94.bmp}

88262p94

Figure 81.
Do not replace this stud with a regular bolt or the bracket will not have a mounting location

{ewc GSMVIMG,GSMVIMG, !88262p95.bmp}

88262p95

Regulator {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Regulator

The voltage regulators are sealed units mounted within the alternator body and are nonadjustable.

REMOVAL & INSTALLATION

1985 Models

Ü See figures 82, 83, 84, 85

Ä This procedure is to be performed with the alternator removed from the vehicle. The new alternators, 1986 and later models, are non-serviceable.

1. Mark scribe lines on the end-frames to make the reassembly easier.
2. Remove the 4 through-bolts and separate the drive end-frame assembly from the rectifier end-frame assembly.
3. Remove the 3 diode trio attaching nuts and the 3 regulator attaching screws.
4. Remove the diode trio and the regulator from the end frame.

Ä Before installing the regulator, push the brushes into the brush holder and install a brush retainer or a tooth pick to hold the brushes in place.

5. To install the regulator, reverse the removal procedures. After the alternator is assembled, remove the brush retainer.

Figure 82.
With the regulator hooked up as shown, the light should extinguish between 13.5 and 16.0 volts—1985 models

{ewc GSMVIMG,GSMVIMG, !88262g59.bmp}

88262g59

Figure 83.
Alternator service—1985 models

{ewc GSMVIMG,GSMVIMG, !88262g54.bmp}

88262g54

Figure 84.
Alternator service—1985 models, continued

{ewc GSMVIMG,GSMVIMG, !88262g55.bmp}

88262g55

Figure 85.
Alternator service—1985 models, continued

{ewc GSMVIMG,GSMVIMG, !88262g56.bmp}

88262g56

VOLTAGE ADJUSTMENT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

VOLTAGE ADJUSTMENT

The voltage regulator is electronic and is housed within the alternator. Adjustment of the regulator is not possible. Should replacement of the regulator become necessary, the alternator must be disassembled.

Battery {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Battery

The battery is mounted in front, left side of the engine compartment. It is a non-tamperable type with side mounted terminals.

REMOVAL & INSTALLATION

Ü See figures 86, 87, 88, 89

1. Disconnect the negative battery terminal, then the positive battery terminal.
2. Remove the battery hold-down retainer.
3. Remove the battery from the vehicle.

To install:

4. Inspect the battery, the cables and the battery carrier for damage.
5. Clean any rust or corrosion from the terminals, tray or body with baking soda and water. Remove the rust and repaint with a rust preventative paint.
6. Place the battery in the tray using a battery carrying strap. Torque the battery retainer to 11 ft. lbs. (15 Nm) and the top bar to 8 ft. lbs. (11 Nm).

Figure 86.
The battery relies on this one mount to hold it in place

{ewc GSMVIMG,GSMVIMG, !88262g60.bmp}

88262g60

Figure 87.
Battery tray mounting points. Keep the tray clean to prevent corrosion due to acid attack

{ewc GSMVIMG,GSMVIMG, !88262g61.bmp}

88262g61

Figure 88.
This is representative battery cable routing on a 4-cylinder engine equipped truck

{ewc GSMVIMG,GSMVIMG, !88262g62.bmp}

88262g62

Figure 89.
This is representative battery cable routing on a 6-cylinder engine equipped truck

{ewc GSMVIMG,GSMVIMG, !88262g63.bmp}

88262g63

ADJUSTMENTS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Engine Electrical

ADJUSTMENTS

No adjustments are necessary or possible. If the battery is determined to be defective (other than charging), replace it and return the old battery to a recycling center.

Starter {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Starter

Ü See figures 90, 91, 92

The starter is located on the left side (2.5L) or right side (4.3L) of the engine. The 1985–87 2.5L is equipped with a 5MT starter. The 4.3L is equipped with a 10MT. In the model year 1988, the names of the 5MT changed to SD–200 and the 10MT changed to the SD–300. The starters are basically still the same.

The starting motor is a specially designed, direct current electric motor capable of producing a very great amount of power for its size. One thing that allows the motor to produce a great deal of power is its tremendous rotating speed. It drives the engine through a tiny pinion gear (attached to the starter's armature), which drives the very large flywheel ring gear at a greatly reduced speed. Another factor allowing it to produce so much power is that only intermittent operation is required of it. This (little allowance for air circulation is required) and the windings can be built into a very small space.

Figure 90.
This is the basic starter electrical circuit

{ewc GSMVIMG,GSMVIMG, !88262g66.bmp}

88262g66

Figure 91.
Cutaway view of the 5MT (SD–200) starter

{ewc GSMVIMG,GSMVIMG, !88262g64.bmp}

88262g64

Figure 92.
Cutaway view of the 10MT (SD–300) starter

{ewc GSMVIMG,GSMVIMG, !88262g65.bmp}

88262g65

The starter solenoid is a magnetic device which employs the small current supplied by the starting switch circuit of the ignition switch. This magnetic action moves a plunger which mechanically engages the starter and electrically closes the heavy switch which connects it to the battery. The starting switch circuit consists of the starting switch contained within the ignition switch, a transmission neutral safety switch or clutch pedal switch, and the wiring necessary to connect these in series with the starter solenoid or relay.

A pinion, which is a small gear, is mounted to a one-way drive clutch. This clutch is splined to the starter armature shaft. When the ignition switch is moved to the **start** position, the solenoid plunger slides the pinion toward the flywheel ring gear via a collar and spring. If the teeth on the pinion and flywheel match properly, the pinion will engage the flywheel immediately. If the gear teeth butt one another, the spring will be compressed and will force the gears to mesh as soon as the starter turns far enough to allow them to do so. As the solenoid plunger reaches the end of its travel, it closes the contacts that connect the battery and starter and then the engine is cranked.

As soon as the engine starts, the flywheel ring gear begins turning fast enough to drive the pinion at an extremely high rate of speed. At this point, the one-way clutch begins allowing the pinion to spin faster than the starter shaft so that the starter will not operate at excessive speed. When the ignition switch is released from the starter position, the solenoid is de-energized, and a spring contained within the solenoid assembly pulls the gear out of mesh and interrupts the current flow to the starter.

Some starter employ a separate relay, mounted away from the starter, to switch the motor and solenoid current on and off. The relay thus replaces the solenoid electrical switch, buy does not eliminate the need for a solenoid mounted on the starter used to mechanically engage the starter drive gears. The relay is used to reduce the amount of current the starting switch must carry.

DIAGNOSIS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Engine Electrical

DIAGNOSIS

Starter Won't Crank The Engine

1. Dead battery.
2. Open starter circuit, such as:
    a. Broken or loose battery cables.
    b. Inoperative starter motor solenoid.
    c. Broken or loose wire from ignition switch to solenoid.
    d. Poor solenoid or starter ground.
    e. Bad ignition switch.
3. Defective starter internal circuit, such as:
    a. Dirty or burnt commutator.
    b. Stuck, worn or broken brushes.
    c. Open or shorted armature.
    d. Open or grounded fields.
4. Starter motor mechanical faults, such as:
    a. Jammed armature end bearings.
    b. Bad bearings, allowing armature to rub fields.
    c. Bent shaft.
    d. Broken starter housing.
    e. Bad starter drive mechanism.
    f. Bad starter drive or flywheel-driven gear.
5. Engine hard or impossible to crank, such as:
    a. Hydrostatic lock, water in combustion chamber.
    b. Crankshaft seizing in bearings.
    c. Piston or ring seizing.
    d. Bent or broken connecting rod.
    e. Seizing of connecting rod bearings.
    f. Flywheel jammed or broken.

Starter Spins Freely, Won't Engage

1. Sticking or broken drive mechanism.
2. Damaged ring gear.

{ewc GSMVIMG,GSMVIMG, !tccs2c01.bmp}

tccs2c01

SHIMMING THE STARTER {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SHIMMING THE STARTER

Ü See figures 93, 94

Starter noise during cranking and after the engine fires is often a result of too much or too little distance between the starter pinion gear and the flywheel. A high pitched whine during cranking (before the engine fires) can be caused by the pinion and flywheel being too far apart. Likewise, a whine after the engine starts (as the key is released) is often a result of the pinion-flywheel relationship being too close. In both cases flywheel damage can occur. Shims are available in 0.015 in. sizes to properly adjust the starter on its mount. You will also need a flywheel turning tool, available at most auto parts stores or from any auto tool store or salesperson.

If your truck's starter emits the above noises, follow the shimming procedure below:

1. Disconnect the negative battery cable.
2. Remove the flywheel inspection cover on the bottom of the bellhousing.
3. Using the flywheel turning tool, turn the flywheel and examine the flywheel teeth. If damage is evident, the flywheel should be replaced.
4. Insert a screwdriver into the small hole in the bottom of the starter and move the starter pinion and clutch assembly so the pinion and flywheel teeth mesh. If necessary, rotate the flywheel so that a pinion tooth is directly in the center of the two flywheel teeth and on the centerline of the two gears, as shown in the accompanying illustration.
5. Check the pinion-to-flywheel clearance by using a 0.5mm (0.020 in.) wire gauge (a spark plug wire gauge may work here, or you can make your own). Make sure you center the pinion tooth between the flywheel teeth and the gauge not in the corners, as you may get a false reading. If the clearance is under this minimum, shim the starter away from the flywheel by adding shim(s) one at a time to the starter mount. Check clearance after adding each shim.
6. If the clearance is a good deal over 0.5mm (0.020 in.), in the vicinity of 1.3mm (0.050 in.) plus, shim the starter towards the flywheel. Broken or severely mangled flywheel teeth are also a good indicator that the clearance here is too great. Shimming the starter towards the flywheel is done by adding shims to the outboard starter mounting pad only. Check the clearance after each shim is added. A shim of 0.015 in. at this location will decrease the clearance about 0.010 in.

Figure 93.
Insert a tool into the hole and push the pinion out until it engages the ring gear. This allows the pinion clearance to be measured

{ewc GSMVIMG,GSMVIMG, !88262g72.bmp}

88262g72

Figure 94.
Make sure that you measure at the tip of the gear to get an accurate pinion clearance measurement

{ewc GSMVIMG,GSMVIMG, !88262g69.bmp}

88262g69

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Engine Electrical

REMOVAL & INSTALLATION

Ü See figures 95, 96, 97, 98, 99, 100

1. Disconnect the negative battery cable.
2. Raise and support the front of the vehicle on jackstands.
3. If equipped, remove any starter braces or shields that may be in the way.
4. Disconnect the electrical connectors from the starter solenoid.
5. Remove the starter-to-engine bolts, nuts, washers and shims. Allow the starter to drop, then remove it from the engine.

   Ä Be sure to keep the shims in order so that they may be reinstalled in the same order.

To install:

6. Install the starter, shims and bolts. Torque the starter-to-engine bolts to 31 ft. lbs. (42 Nm) for the 2.5L and 28 ft. lbs. (38 Nm) for the 4.3L. Connect the wires to the starter solenoid and the negative battery cable.
7. Install any braces or shields if so equipped. Start the engine and check for proper operation.

Figure 95.
Starter mounting—2.5L engine

{ewc GSMVIMG,GSMVIMG, !88262g67.bmp}

88262g67

Figure 96.
Starter mounting—4.3L engine

{ewc GSMVIMG,GSMVIMG, !88262g68.bmp}

88262g68

Figure 97.
Disconnect the negative battery cable before removing the starter cables

{ewc GSMVIMG,GSMVIMG, !88262p96.bmp}

88262p96

Figure 98.
The torque converter cover may need to be removed on some versions to withdraw the starter

{ewc GSMVIMG,GSMVIMG, !88262p97.bmp}

88262p97

Figure 99.
Support the starter when removing the mounting bolts

{ewc GSMVIMG,GSMVIMG, !88262p98.bmp}

88262p98

Figure 100.
The starter can be heavy, so be ready for its heft once the final mounting bolt is removed

{ewc GSMVIMG,GSMVIMG, !88262p99.bmp}

88262p99

SOLENOID REPLACEMENT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SOLENOID REPLACEMENT

Ü See figures 101, 102

1. Remove the starter, then place it on a workbench.
2. Remove the screw and the washer from the motor connector strap terminal.
3. Remove the two solenoid retaining screws.
4. Twist the solenoid housing clockwise to remove the flange key from the keyway in the housing, then remove the housing.

To install:

5. Place the return spring on the plunger and place the solenoid body on the drive housing. Turn it counterclockwise to engage the flange key.
6. Place the two retaining screws in position, then install the screw and washer which secures the strap terminal. Install the unit on the starter.

Figure 101.
Exploded view of the 5MT (SD–200) starter

{ewc GSMVIMG,GSMVIMG, !88262g70.bmp}

88262g70

Figure 102.
Cutaway view of the 10MT (SD–300) starter

{ewc GSMVIMG,GSMVIMG, !88262g71.bmp}

88262g71

OVERHAUL {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

OVERHAUL

Drive Replacement

1. Disconnect the field coil straps from the solenoid.
2. Remove the through-bolts, then separate the commutator end-frame, the field frame assembly, the drive housing and the armature assembly, from each other.
3. Slide the two piece thrust collar off the end of the armature shaft.
4. Slide a suitably sized metal cylinder, such as a standard $^{1}/2$ in. (12.7mm) pipe coupling or an old pinion, onto the shaft so that the end of the coupling or pinion butts against the edge of the pinion retainer.
5. Support the lower end of the armature securely on a soft surface, such as a wooden block and tap the end of the coupling or pinion, driving the retainer towards the armature end of the snapring.
6. Using a pair of pliers, remove the snapring from the groove in the armature shaft. Then, slide the retainer and the starter drive from the shaft.
7. To assemble, lubricate the drive end of the armature shaft with silicone lubricant and slide the starter drive onto the shaft with the pinion facing outward. Slide the retainer onto the shaft with the cupped surface facing outward.
8. Again, support the armature on a soft surface, with the pinion at the upper end. Center the snapring on top of the shaft (use a new snapring if the original was damaged during removal). Gently place a block of wood flat on top of the snapring, so as not to move it from a centered position. Tap the wooden block with a hammer in order to force the snapring around the shaft. Then, slide the ring down into the snapring groove.
9. Lay the armature down flat on the surface you're working on. Slide the retainer close, up on the shaft, then position it and the thrust collar next to the snapring. Using two pairs of pliers, on opposite sides of the shaft, squeeze the thrust collar and the retainer together until the snapring is forced into the retainer.
10. Lubricate the drive housing bushing with a silicone lubricant. Then, install the armature and the clutch assembly into the drive housing, engaging the solenoid shift lever yoke with the clutch and positioning the front of the armature shaft into the bushing.
11. Apply a sealing compound, approved for this application onto the drive housing, then, position the field frame around the armature's shaft and against the drive housing. Work slowly and carefully to prevent damaging the starter brushes.
12. Lubricate the bushing in the commutator end-frame with a silicone lubricant, place the leather brake washer onto the armature shaft and then slide the commutator end-frame over the shaft and into position against the field frame. Line up the bolt holes, then install and tighten the through-bolts.
13. Reconnect the field coil straps to the **Motor** terminal of the solenoid.

    Ä If replacement of the starter drive fails to cure the improper engagement of the starter pinion to flywheel, there are probably defective parts in the solenoid and/or the shift lever. The best procedure would probably be to take the assembly to a shop where a pinion clearance check can be made by energizing the solenoid on a test bench. If the pinion clearance is incorrect, disassemble the solenoid and the shift lever, then inspect and replace the worn parts.

Brush Replacement {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Brush Replacement

1. Disassemble the starter by following Steps 1 and 2 of the Drive Replacement procedure, above.
2. Replace the brushes, one at a time, to avoid having to mark the wiring. For each brush, remove the brush holding screw and the old brush, then position the new brush in the same direction (large end toward the center of the field frame), position the wire connector on top of the brush, line up the holes and reinstall the screw. Make sure the screw is snug enough to ensure good contact.
3. Reassemble the starter according to Steps 10–13, above.

SENDING UNITS AND SENSORS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SENDING UNITS AND SENSORS

The sensors covered in this section are not related to engine control. They are for gauges and warning lights only. For sensors related to engine control refer to Electronic Engine Controls in Section 4.

Coolant Temperature Sensor {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Coolant Temperature Sensor

OPERATION

The coolant temperature sensor changes resistance as the coolant temperature increases and decreases. The sensor is located on the left side of the engine on both the V6 and I4 engines. On the V6 it is screwed into the head between the rear two exhaust ports. On the I4 engine, it is screwed into the rear of the head just in front of the lifting eye.

TESTING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TESTING

1. Turn the ignition switch to **ON**, but do not start the engine.
2. Disconnect the sensor lead at the sensor. Connect a test lamp to the lead; The lamp should glow. If not, check the wiring, fuses and connections.
3. Disconnect the test lamp and ground the connector. The gauge should read at the **HOT** mark.
4. Remove the connector from ground. The gauge should read at the **COLD** mark.
5. At 104ºF (40ºC) the resistance of the sensor should be 1365 ohms.
6. At 257ºF (125ºC) the resistance of the sensor should be 55 ohms.

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Engine Electrical

REMOVAL & INSTALLATION

Ü See figure 103

1. Disconnect the negative battery cable and drain the engine coolant. Remove the engine cover.
2. Disconnect the sensor electrical lead and unscrew the sensor.

To install:

3. Install the sensor and tighten it to 17 ft. lbs. (23 Nm). Connect the electrical lead.
4. Connect the battery cable and fill the engine with coolant. Install the engine cover.

Figure 103.
Coolant temperature and oil pressure senders—2.5L and 4.3L engines
{ewc GSMVIMG,GSMVIMG, !88262g73.bmp}

88262g73

Oil Pressure Sender {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Engine Electrical

Oil Pressure Sender

OPERATION

The oil pressure sender relays to the dash gauge the oil pressure in the engine.

TESTING

1. Check the oil level and correct as necessary. Turn the ignition switch on, but do not start the engine.
2. Disconnect the sensor lead at the sensor. The gauge should read full scale.
3. Ground the connector. The gauge should read at the bottom of the scale.
4. At 0 psi (0 kPa) the resistance of the sensor should be 1 ohm.
5. At 40 psi (275 kPa) the resistance of the sensor should be 44 ohms.

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Engine Electrical

REMOVAL & INSTALLATION

Ü See figures 104, 105, 106, 107

1. Disconnect the negative battery cable. Remove the engine cover.
2. Disconnect the sensor electrical lead and unscrew the sensor. The sensor can be found on the top side of the engine, near the distributor.

To install:

3. Coat the first 2 or 3 threads with sealer. Install the sensor and tighten until snug. Engage the electrical lead.
4. Connect the battery cable and install the engine cover.

Figure 104.
The oil pressure sender can be reached after removing the engine cover

{ewc GSMVIMG,GSMVIMG, !88262pa0.bmp}

88262pa0

Figure 105.
Do not put too much sideways force on the sender or you can damage the adapter

{ewc GSMVIMG,GSMVIMG, !88262pa1.bmp}

88262pa1

Figure 106.
You can use some pipe sealer to make sure oil doesn't leak past the sender threads

{ewc GSMVIMG,GSMVIMG, !88262pa2.bmp}

88262pa2

Figure 107.
Do not crossthread the sender into the adapter or you will definitely have a leak to contend with

{ewc GSMVIMG,GSMVIMG, !88262pa3.bmp}

88262pa3

ENGINE AND ENGINE OVERHAUL

{ewc MVIMAGE,MVIMAGE, !
engine_over.bmp}

ENGINE MECHANICAL {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ENGINE MECHANICAL

Description

Two engines and four fuel systems types are used to power your Astro/Safari Van. Depending on the year and model, your van could be equipped with a 2.5L (151 cu. in.) engine (1985–90) or a 4.3L (262 cu. in.) engine (1985–96). The 2.5L engine was only produced with a Throttle Body Injection (TBI) fuel system, while the 4.3L engine varied from a 4-bbl carburetor for 1985, TBI for 1986–91 (as-well-as some models from 1992–94), a Central Multi-port Fuel Injection (CMFI) system for some 1992–94 and all 1995 vehicles or a Central Sequential Fuel Injection (CSFI) system for 1996 models.

On the 1985, 2.5L TBI engine, the cylinder head and engine block are both constructed of cast iron. The valve guides are integral with the cylinder head and the rocker arms are retained by individual threaded shoulder bolts. Hydraulic roller lifters are incorporated to reduce the friction between the valve lifters and the camshaft lobes.

On the 1986–90, 2.5L TBI engine, a few changes appeared, such as: (1) the pistons were replaced with hypereutectic types (pistons embedded with silicone nodules in the walls to reduce the cylinder wall friction), (2) a reduced weight, high efficiency alternator and (3) a variable ratio air conditioning compressor.

Although there are different versions of the 4.3L engine, depending on the VIN and fuel system, the main design is the same. All are 90 degree, V6, overhead valve, liquid cooled engines with cast iron block and cylinder heads. Many of the early 4.3L engines use swirl chamber heads (to increase power and fuel efficiency). The engine block and cylinder heads are constructed of cast iron. Other major features are: a wider oil pan flange, raised rails inside the cylinder heads (to improve oil return control), machined rocker cover seal surfaces, a trough along the rocker cover rails (to channel oil away from the gasket) and even distribution of the clamping loads, to make this engine one of the most leak-resistant on the road today.

In 1986, the 4.3L TBI engine began using a new one-piece rear crankshaft seal, lighter engine oil, remachined camshaft lobes and new poly-vee alternator drive belts.

In 1987, the 4.3L TBI engine began using roller valve lifters instead of the standard flat bottom lifters. The roller lifter is still hydraulic requiring no valve adjustment. The roller lifter incorporates a roller that rides along the cam lobe reducing friction and component wear. A roller lifter restrictor and retainer is needed to keep the lifter from turning in the bore while the engine is running. All 2.5L TBI engines incorporate the roller lifter configuration.

In 1992, the introduction of the VIN W (CMFI or CSFI) motor saw the latest improvements in the 4.3L engine family. The VIN W motors are equipped with a cast iron balance shaft mounted in the crankcase, above the and inline with the camshaft. A camshaft gear drives a gear which is attached to the balance shaft. The VIN W's unique fuel system requires the use of a two piece manifold, with integral throttle body. These cast aluminum pieces house the central injection system (injector or injectors, depending on the model). For more details on the CMFI and CSFI fuel systems, please refer to Section 5 of this manual.

Engine Overhaul Tips {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

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.

On the other hand, much of the rebuilding work (crankshaft, block, 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 {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Engine And Engine Overhaul

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 chapter. 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.

INSPECTION TECHNIQUES {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

INSPECTION TECHNIQUES

Procedures and specifications are given in this chapter for inspecting, cleaning and assessing the wear limits of most major components. Other procedures such as Magnaflux® and Zyglo® can be used to locate material flaws and stress cracks. Magnaflux® is a magnetic process applicable only to ferrous materials. The Zyglo® process coats the material with a fluorescent dye penetrant and can be used on any material.

Checking for suspected surface cracks can be more readily made using spot check dye. The dye is sprayed onto the suspected area, wiped off and the area sprayed with a developer. Cracks will show up brightly.

OVERHAUL TIPS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

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 tag, etc.) from engine parts prior to the tanking.
- Always coat threads lightly with engine oil or anti-seize compounds before installation, to prevent seizure.
- Never overtorque bolts or spark plugs especially in aluminum threads.

Stripped threads in any component can be repaired using any of several commercial repair kits (Heli-Coil®, Microdot®, Keenserts®, etc.).

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 non-hardening sealant.

REPAIRING DAMAGED THREADS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REPAIRING DAMAGED THREADS

Ü See figures 1, 2, 3, 4, 5

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 prewound 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 prewound 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.

Figure 1.
Damaged bolt hole threads can be replaced with thread repair inserts

{ewc GSMVIMG,GSMVIMG, !tccs3039.bmp}

tccs3039

Figure 2.
Standard thread repair insert (left), and spark plug thread insert

{ewc GSMVIMG,GSMVIMG, !tccs3040.bmp}

tccs3040

Figure 3.
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

{ewc GSMVIMG,GSMVIMG, !tccs3041.bmp}

tccs3041

Figure 4.
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

{ewc GSMVIMG,GSMVIMG, !tccs3042.bmp}

tccs3042

Figure 5.
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

{ewc GSMVIMG,GSMVIMG, !tccs3043.bmp}

tccs3043

Checking Engine Compression {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Checking Engine Compression

Ü See figure 6

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 here. A check of each cylinder's compression will help you locate the problems.

As mentioned in the Tools and Equipment part of Section 1, a screw-in type compression gauge is more accurate that the type you simply hold against the spark plug hole, although it takes slightly longer to use. It's worth it to obtain a more accurate reading.

Figure 6.
A screw-in type compression gauge is more accurate and easier to use without an assistant

{ewc GSMVIMG,GSMVIMG, !tccs3801.bmp}

tccs3801

1. Make sure the battery is fully charged.
2. Warm up the engine to normal operating temperature, then shut the engine **OFF**.
3. Disable the ignition system by disconnecting the primary ignition wiring from the coil. On early models equipped with an external ignition coil it is also possible to disconnect the secondary wiring (coil-to-distributor lead).
4. Remove all spark plugs.
5. Block open the throttle linkage in the fully open position.
6. Screw the compression gauge into the No. 1 spark plug hole until the fitting is snug.

   Ä Be careful not to crossthread the plug hole. Use extra care, as the spark plug threads are easily ruined.

7. Set the compression gauge to zero, then use the ignition switch to crank the engine through 4 compression strokes (four "puffs” on the compression gauge).
8. Record the highest reading, clear the compression gauge and repeat to be sure of your results. Record the highest obtained reading from both tests, then remove the compression gauge and repeat at each of the cylinders.
9. Compare the highest reading of each cylinder to the readings of the other cylinders. No cylinder should be less than 70 percent of the highest reading. For example, if the highest reading was 150 psi (1035 kPa), then the lowest cylinder should not be below 105 psi (725 kPa).

   Ä A cylinder's compression pressure should not be below 100 psi (689 kPa) and the lowest cylinder should NOT be any lower than 70 percent of the highest cylinders reading.

10. If a cylinder is unusually low, 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 the oil, it is likely that the cylinder's piston rings or bore are damaged or worn. If the pressure remains low, the valves may not be seating properly (a valve job would be 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 does not help the compression, there is probably leakage past the head gasket. Oil and coolant water in the combustion chamber can result from this problem. There may be evidence of water droplets on the engine dipstick when a head gasket has blown.

Different engine conditions should yield appropriate compression test results:

NORMAL - Compression builds up quickly and evenly to the specified compression on each cylinder.

PISTON RINGS - Compression low on the first stroke, then tends to build up on the following strokes, but does not reach normal. This reading should be tested with the addition of a few shots of engine oil into the cylinder. If the compression increases considerably, the rings are leaking compression.

VALVES - Low on the first stroke, does not tend to build up on following strokes. This reading will stay around the same with a few shots of engine oil in the cylinder.

HEAD GASKET - The compression reading is low between two adjacent cylinders. The head gasket between the two cylinders may be blown. If there is signs of white smoke coming from the exhaust while the engine is running may indicate water leaking into the cylinder and being converted into steam. Check around the cylinder head-to-cylinder block area for signs of coolant and oil leakage, indicating a leaking head gasket.

Engine {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Engine

REMOVAL & INSTALLATION

2.5L Engine

Caution
Before removing any component of the fuel system, be sure to reduce the fuel pressure in the system.

1. From inside the vehicle, remove the engine cover. For details, please refer to Section 1 of this manual.
2. Properly relieve the fuel system pressure, then disconnect the negative battery cable.
3. Place a drain pan under the radiator, open the drain cock and drain the cooling system; be sure to save the cooling fluid for reuse.

Caution
When draining the coolant, keep in mind that cats and dogs are attracted by ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.

4. Remove the headlight bezel and grille.
5. Remove the lower radiator close out panel and the radiator support brace.
6. Remove the lower tie bar, the cross braces and the hood latch assembly.
7. If equipped, remove the upper radiator core support.
8. Remove the radiator hoses, then disconnect and plug the transmission-to-radiator oil cooler lines (if equipped).
9. Remove the radiator filler panels, then the radiator and the fan shroud as an assembly.
10. At the bulkhead connector, disconnect the engine electrical harness. Disconnect the electrical harness from the Electronic Control Module (ECM) and pull it through the bulkhead.
11. Remove the heater hoses from the heater core.
12. Disconnect the accelerator, the cruise control and the detent (if equipped) cables. Disconnect the ground cable from the cylinder head.
13. Remove the oil filler neck and the thermostat housing from the engine.
14. Remove the purge hose from the charcoal canister, then the air cleaner and adapter from throttle body. Disconnect the fuel hoses from the throttle body.
15. Raise and support the front of the vehicle on jackstands.
16. Disconnect the exhaust pipe from the exhaust manifold. Remove the flywheel cover from the bellhousing.
17. Disconnect the electrical harness from the transmission and the frame, then the electrical connectors from the starter.
18. Remove the starter-to-engine bolts and the starter from the engine.
19. Remove the through-bolts from the engine mounts and install an engine lifting device to the engine.

20. Remove the bellhousing-to-engine bolts, then lower the vehicle. Using a floor jack, support the transmission.
21. Using an engine lifting device, lift the engine, separate it from the transmission and remove it from the vehicle.

To install:

22. Using an engine lifting device, lift the engine, connect it to the transmission and install it in the vehicle.
23. Install the bellhousing-to-engine bolts, torque to 32 ft. lbs. (44 Nm) then lower the vehicle. Using a floor jack, support the transmission.
24. Install the through-bolts to the engine mounts and remove the engine lifting device from the engine.
25. Install the starter and starter-to-engine bolts.
26. Connect the electrical harness to the transmission and the frame, then the electrical connectors to the starter.
27. Connect the exhaust pipe to the exhaust manifold. Install the flywheel cover to the bellhousing.
28. Raise and support the front of the vehicle on jackstands.
29. Install the purge hose to the charcoal canister, then the air cleaner and adapter to the throttle body. Connect the fuel hoses to the throttle body.
30. Install the oil filler neck and the thermostat housing to the engine.
31. Connect the accelerator, the cruise control and the detent (if equipped) cables. Connect the ground cable to the cylinder head.
32. Install the heater hoses to the heater core.
33. At the bulkhead connector, connect the engine electrical harness. Connect the electrical harness to the Electronic Control Module (ECM).
34. Install the radiator, filler panels and the fan shroud as an assembly.
35. Install the radiator hoses, then connect the transmission-to-radiator oil cooler lines (if equipped).
36. If equipped, install the upper radiator core support.
37. Install the lower tie bar, the cross braces and the hood latch assembly.
38. Install the lower radiator close out panel and the radiator support brace.
39. Install the headlight grille and bezel.
40. Refill the cooling system.
41. From inside the vehicle, install the engine cover.
42. Connect the negative battery cable to the battery.
43. Start the engine and check for fluid leaks and proper operation.

    Ä All engine fasteners are important parts that may affect the performance of the components and systems. If replacement becomes necessary, they MUST BE replaced with the same part number or equivalent part. Use specific torque values when assembling the parts, to assure proper retention.

4.3L Engine {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Engine And Engine Overhaul

4.3L Engine

Ü See figure 7

****Caution**
To reduce the risk of fire and personal injury, it is necessary to relieve the fuel system pressure before servicing any fuel system component. If this procedure is not performed, fuel may be sprayed out of the connection under pressure. Always keep a dry chemical (Class B) fire extinguisher near the work area. Relieve the pressure on the fuel system before disconnecting any fuel line connection.

Figure 7.
Typical 4.3L engine mounting on All Wheel Drive (AWD) and rear wheel drive Astro and Safari vans

{ewc GSMVIMG,GSMVIMG, !88263g01.bmp}

88263g01

1985-90 MODELS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Engine And Engine Overhaul

1985–90 MODELS

1. If equipped, properly discharge and recover the air conditioning refrigerant. If you do not have access to a recovery/recycling station, take the vehicle to a reputable repair facility that has the proper and have them recover the refrigerant.
2. Properly relieve the fuel system pressure and disconnect the negative battery cable.
3. Place a pan under the radiator, open the drain cock and drain the engine coolant.

   Caution
   When draining the coolant, keep in mind that cats and dogs are attracted by ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.

4. Raise and support the front of the vehicle on jackstands.
5. Disconnect the exhaust pipes from the exhaust manifolds.
6. At the flywheel cover, remove the strut rods, then the flywheel cover from the bellhousing. If equipped with an automatic transmission, mark the torque converter-to-flywheel position, then disconnect the torque converter from the flywheel.
7. Disengage the electrical connectors from the starter, then remove the starter from the engine. Disconnect the electrical harness and connectors from the transmission and the frame.
8. Remove the oil filter and the lower fan shroud bolts. Disconnect the fuel hoses from the frame.
9. From the radiator, disconnect the lower transmission oil cooler line (if used) and the lower engine oil cooler line (if used).
10. Remove the through-bolts of the engine-to-frame mounts, then remove the jackstands and lower the vehicle.
11. Remove the headlight bezels and the grille. At the radiator, remove the lower close-out panel, the support brace and the core support cross brace, then remove the lower tie-bar and the hood latch mechanism.
12. At the firewall, remove the master cylinder.
13. From the radiator, remove the upper fan shroud, the upper radiator core support, the filler panels and the radiator.

    Ä Before removing the radiator, be sure to discharge the air conditioning system (if equipped).

14. From inside the vehicle, remove the engine cover (for details, please refer to Section 1 of this manual) and the right side kick panel.
15. From the air conditioning system, remove the rear compressor brace, the hose from the accumulator, then the compressor (with the bracket) and the accumulator.
16. Remove the power steering pump (DO NOT disconnect the pressure hoses) and move it aside.
17. Disconnect the vacuum hoses from the intake manifold. Disconnect the electrical harness connector from the bulkhead and the Electronic Control Module (ECM); push the electrical

harness connector through the bulkhead.

18. Remove the distributor cap, the fuel line(s) from the carburetor or throttle body and the diverter valve (if equipped).
19. Remove the transmission dipstick tube, the heater hose(s) from the heater core, the horn and the Air Injector Reactor (AIR) check valves.
20. Using and engine lifting device, attach it to the engine.
21. Using a floor jack, raise and support the transmission, then remove the bellhousing-to-engine bolts.
22. Raise the engine, disconnect it from the bellhousing and remove it from the vehicle.

To install:

Ä All engine fasteners are important parts that may affect the performance of the components and systems. If replacement becomes necessary, they MUST BE replaced with the same part number or equivalent part. Use specific torque values when assembling the parts, to assure proper retention.

23. Place the engine on a lifting device and lower the engine into the vehicle. Connect it to the bellhousing.
24. Using a floor jack, raise and support the transmission, then install the bellhousing-to-engine bolts.
25. Remove the engine lifting device.
26. Install the transmission dipstick tube. Connect the heater hose(s) to the heater core.
27. Install the horn and the Air Injector Reactor (AIR) check valves.
28. Install the distributor cap. Connect the fuel line(s) to the carburetor or throttle body and install the diverter valve (if equipped).
29. Connect the vacuum hoses to the intake manifold. Connect the electrical harness connector to the bulkhead and the Electronic Control Module (ECM).
30. Install the power steering pump.
31. To the air conditioning system, install the rear compressor brace, the hose to the accumulator, then the compressor (with the bracket) and the accumulator.
32. From inside the vehicle, install the engine cover and the right side kick panel.
33. To the radiator, install the upper fan shroud, the upper radiator core support, the filler panels and the radiator.
34. At the firewall, install the master cylinder.
35. Install the grille and the headlight bezels. At the radiator, install the lower close-out panel, the support brace and the core support cross brace, then install the lower tie-bar and the hood latch mechanism.
36. Install the through-bolts to the engine-to-frame mounts, then and lower the vehicle.
37. To the radiator, connect the lower transmission oil cooler line (if used) and the lower engine oil cooler line (if used).
38. Install a new oil filter and the lower fan shroud bolts. Connect the fuel hoses to the frame.
39. Engage the electrical connectors to the starter after installing the starter to the engine. Connect the electrical harness and connectors to the transmission and the frame.
40. If equipped with an automatic transmission, note the torque converter-to-flywheel position, then connect the torque converter to the flywheel at the marked position. At the flywheel

cover, install the strut rods, then the flywheel cover to the bellhousing.

41. Connect the exhaust pipes to the exhaust manifolds.
42. Refill the engine with coolant and oil.
43. Connect the negative battery cable to the battery.
44. Start the engine and check for leaks and proper operation.
45. If the A/C system was discharged, take the van to a reputable repair facility to have the system evacuated, recharged and leak tested. DO NOT WAIT LONG to do this or moisture which entered the system while it was discharged will cause corrosion and internal system damage. ALSO, DO NOT run the compressor until the system has been properly recharged. Depending on how your model is equipped this may mean you CANNOT use the defogger (this automatically turns the compressor on in some vehicles).

1991-95 MODELS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Engine And Engine Overhaul

1991–95 MODELS

Ü See figures 8, 9, 10

1. If equipped, properly discharge and recover the air conditioning refrigerant. If you do not have access to a recovery/recycling station, take the vehicle to a reputable repair facility that has the proper equipment and have them recover the refrigerant.
2. Properly relieve the fuel system pressure and disconnect the negative battery cable.
3. Drain the cooling system.
4. Raise and safely support the vehicle. Disconnect the exhaust pipes at the manifolds.
5. If applicable, disconnect the strut rods at the flywheel housing.
6. Remove the torque converter cover, then remove the torque converter bolts.
7. Remove the starter assembly, then drain the oil and remove the and oil filter. Disconnect the wires at the transmission. Disconnect the fuel lines.
8. Tag and disengage the wires at the engine and frame. Disconnect the fuel lines at the frame.
9. Disconnect the transmission and engine oil cooler lines at the radiator.
10. Remove the lower fan shroud retainers, then remove the motor mount bolts.
11. Lower the vehicle. Remove the headlight bezels and/or grille, as necessary. On 1994–95 vehicles, remove the horns.
12. Remove the radiator close out panel and the radiator support brace.
13. Remove the hood latch mechanism. If necessary on vehicles through 1992, remove the master cylinder.
14. Remove the air cleaner assembly and ducts.
15. Remove the upper fan shroud.
16. For 1991–93 vehicles:
    a. Remove the upper radiator core support, then if equipped, remove the A/C condenser.
    b. Remove the radiator filler panels, then remove the radiator.
    c. Remove the lower radiator shroud, then remove the engine cover (for details, please refer to Section 1 of this manual).
    d. If equipped, disconnect the A/C hose at the accumulator.
    e. Remove the multi-ribbed accessory drive belt, then remove the fan.
17. For 1994–95 vehicles:
    a. If equipped, remove the A/C condenser.
    b. Remove the fan and clutch assembly, then remove the lower fan shroud.
    c. If not done already, disconnect the remaining oil cooler-to-radiator lines.
    d. Remove the radiator.
    e. Remove the engine cover (for details, please refer to Section 1 of this manual).
    f. If equipped, remove the A/C accumulator.
    g. If not done already, remove the multi-ribbed engine accessory drive belt.

18. Disconnect the power steering pump lines at the gearbox (1991–93) or from the hydro-boost, oil cooler and reservoir (1994–95).
19. If equipped, remove the A/C compressor pencil braces at the engine block.
20. Remove the power steering pump, bracket and A/C compressor as an assembly.
21. Disengage the alternator wiring, then remove the alternator and bracket assembly.
22. Disengage the wiring harness at the bulkhead. Except for 1995 vehicles, remove the right kick panel.
23. Disengage the wiring from the knock sensor module.
24. Disconnect the upper and lower radiator hoses, then disconnect the heater hose from the water pump.
25. Remove the oil filler tube, then remove the transmission filler tube (top bolt only).
26. Tag and disconnect the vacuum hoses at the intake manifold.
27. If equipped, remove the cruise control servo and bracket.
28. Match-mark and remove the distributor assembly or the High Voltage Switch (HVS) assembly, as applicable.
29. If equipped with the 4.3L (VIN W) engine, remove the upper intake manifold assembly, then disconnect the fuel lines and remove the lower intake manifold.
30. If equipped with the 4.3L (VIN B or Z) engine, disconnect the fuel lines from the TBI unit, tag and disengage all cables, wiring and hoses, then remove the TBI unit from the engine. Remove the MAP sensor bracket, then disconnect the heater hose from the engine block with bracket from the exhaust manifold.
31. Raise and support the vehicle safely, then If equipped, remove the transfer case brace.
32. For 1994–95 vehicles, remove the fuel line bracket and ground wire from the back of the left cylinder head.
33. Remove the transmission oil level indicator tube.
34. Disengage the necessary wiring from the transmission.
35. Remove the bellhousing bolts, then lower the vehicle.
36. For 1995 vehicles the tie bar must be cut from the vehicle in order to create sufficient clearance for engine removal:
    a. Remove the master cylinder retaining nuts, then reposition the cylinder assembly out of the way.
    b. Scribe marks for cutting the tie bar assembly. The marks should be made at the centerline between the indentations on the right and left side of the bar assembly.
    c. Using the replacement brackets from the service kit as a template over the indentations, center punch the holes for drilling.
    d. Drill out 8mm holes for the brace bolts.
    e. Carefully cut the tie bar cross section using a reciprocating power saw or hack saw.

    Ä Extreme care must be taken when cutting out the tie bar cross section. The tie bar will be attached using brackets from the service kit. The cut out portion of the bar and the brackets must be treated with anti-corrosion materials and painted. Care taken during cutting will help save time on surface preparation and installation.

Figure 8.
Scribing marks for cutting the tie bar—1995 models

{ewc GSMVIMG,GSMVIMG, !88263g02.bmp}

88263g02

Figure 9.
Drilling out holes for tie bar replacement brackets—1995 models

{ewc GSMVIMG,GSMVIMG, !88263g03.bmp}

88263g03

Figure 10.
Tie bar bracket positioning—1995 models

{ewc GSMVIMG,GSMVIMG, !88263g04.bmp}

88263g04

37. Attach a suitable lifting device to the engine and support the transmission, then carefully remove the engine.

To install:

38. Carefully lower the engine into position and engage it to the transmission assembly. If possible, thread the bellhousing bolts to secure the engine to the transmission.
39. Remove the engine lifting device, then raise and support the vehicle safely. Install any remaining bellhousing bolts, then tighten the bolts and remove the transmission support.
40. Engage the wiring to the transmission assembly.
41. Install the transmission oil level indicator tube.
42. On 1994–95 vehicles install the fuel line bracket and ground wire to the back of the left cylinder head.
43. If equipped, install the transfer case brace.
44. Lower the vehicle.
45. If equipped with the 4.3L (VIN B or Z) engine, connect the heater hose to the engine block with the exhaust manifold bracket, then install the MAP sensor bracket. Install the TBI unit, connecting all wiring, cables and hoses. Connect the fuel lines.
46. If equipped with the 4.3L (VIN W) engine, install the lower intake manifold assembly, then connect the fuel lines and install the upper intake manifold assembly.
47. Align and install the distributor or the HVS assembly, as equipped.
48. If equipped, install the cruise control servo and bracket.
49. Connect the vacuum hoses to the intake manifold.
50. Install the transmission filler tube (upper bolt) and the oil filler tube.
51. If removed and applicable, install the ignition coil.
52. Except for 1995 vehicles, the air cleaner and ducts may be installed at this time.
53. Connect the heater and radiator hoses.
54. Connect the wiring harness to the knock sensor module, then for vehicles 1991–94 install the kick panel.
55. Engage the wiring harness at the bulkhead.
56. Install the alternator and bracket as an assembly, then engage the wiring.
57. Install the power steering pump, bracket and A/C compressor assembly. Connect the compressor pencil braces to the block and connect the hoses to the power steering pump, oil cooler and reservoir. Make sure all components are secure.

58. For 1991–93 vehicles, install the fan.
59. Position the multi-ribbed drive belt.
60. Install the accumulator and/or connect the refrigerant hoses to the accumulator assembly, as applicable.
61. Install the lower radiator shroud, then for 1994–95 vehicles, install the fan and clutch.
62. For 1995 vehicles install the tie bar assembly:
    a. File the rough edges of the tie bar and removed cross section.
    b. Clean the assembly, cross section and brackets using a wax and grease remover.
    c. Treat all bare metal surfaces with an anticorrosion primer.
    d. Apply primer surfaces to the tie bar assembly, cross section and brackets.
    e. Paint the components and allow to dry.
    f. Install the front brackets to the tie bar cross section and to the bar assembly using the 2 bolts and nuts facing the front of the vehicle.
    g. Install the U-nuts to the rear tie bar cross section and tie bar assembly.
    h. Install the rear bracket and remaining nuts and bolts, then tighten to 24 ft. lbs. (31 Nm)
    i. Reposition and secure the master cylinder assembly. If necessary, cut out indication hole in the air cleaner snorkel.
63. Install the radiator and connect the hoses.
64. If equipped, install the A/C condenser.
65. Install the upper fan shroud and, if applicable, the upper radiator core support.
66. Install the hood latch mechanism, then install the core support brace.
67. On vehicles 1991–94 install the radiator lower close out panel.
68. On 1994–95 vehicles, install the horns.
69. Install the grille and, if applicable, the headlight bezels.
70. If not done earlier, install the air cleaner and intake ducts at this time.
71. If not done earlier, connect the fuel lines at the engine.
72. Raise and support the vehicle safely, then install the motor mount fasteners.
73. If not done earlier, install the lower fan shroud retainers.
74. Connect the engine and transmission oil cooler lines.
75. Secure the fuel line bracket at the frame.
76. Engage the wiring to the engine and frame, as necessary.
77. Install the oil filter, then install the starter assembly.
78. Install the torque converter bolts, then install the cover.
79. Connect the exhaust pipes, then lower the vehicle.
80. Refill the engine crankcase with engine oil, then connect the negative battery cable.
81. Properly refill the engine cooling system.
82. If the A/C system was discharged, take the van to a reputable repair facility to have the system evacuated, recharged and leak tested. DO NOT WAIT LONG to do this or moisture which entered the system while it was discharged will cause corrosion and internal system

damage. ALSO, DO NOT run the compressor until the system has been properly recharged. Depending on how your model is equipped this may mean you CANNOT use the defogger (this automatically turns the compressor on in some vehicles).

1996 MODELS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Engine And Engine Overhaul

1996 MODELS

Ü See figures 11, 12, 13, 14

For the 1996 model year, the manufacturer determined that lifting the engine from the van's engine compartment was no longer a viable option (especially if it involved cutting pieces of the radiator support in order to provide sufficient clearance). Although it still may be possible to remove the engine as outlined for similar late-model vehicles (under the 1991–95 procedures), IT IS NOT recommended.

Ä Because there is insufficient clearance to remove the engine from the van through the engine compartment, the body must be lifted off the frame assembly for access. This requires great care and patience to prevent unnecessary damage to the vehicle's body. ALSO, this procedure requires the use of a side lift or twin post hoist. If a suitable hoist is not available, it is recommended that you do NOT attempt this procedure, but instead have the work done by a reputable repair facility.

1. If equipped, properly discharge and recover the air conditioning refrigerant. If you do not have access to a recovery/recycling station, take the vehicle to a reputable repair facility that has the proper and have them recover the refrigerant.
2. Properly relieve the fuel system pressure.
3. Drain the engine cooling system.
4. Disconnect the negative battery, followed by the positive cable, then remove the battery from the engine compartment.
5. Remove the air cleaner assembly.
6. Disconnect the throttle cable, and cruise control cable (if equipped), from the throttle body bracket.
7. If equipped, disengage the cruise control stepper motor wiring.
8. If equipped, disconnect the air conditioning lines at the accumulator and condenser. Immediately plug all openings to prevent system contamination.
9. Remove the radiator assembly.
10. Remove the power steering reservoir and drain the fluid.
11. If equipped, disconnect the lines from the brake hydro-boost unit.
12. Remove the master cylinder from the hydro-boost unit, then tie it to the oil fill tube for support.
13. Match-mark, then disconnect the steering shaft from the gear. Make sure the steering wheel is locked in position and remains so to prevent possible damage to the Supplemental Inflatable Restraint (SIR or air bag) coil in the steering column).
14. Disconnect the heater hoses from the engine.
15. Disconnect the vacuum line from the vacuum tank.
16. Disengage the fuse box and wiring harness from the bulkhead connector and all related electrical connectors. Position the wiring harness over the engine.
17. Drain the engine crankcase.
18. Match-mark and remove the rear driveshaft.
19. Remove the starter and starter opening shield.
20. Match-mark the torque converter to the flywheel (flexplate), then remove the torque converter bolts through the starter opening.

21. Disconnect the shift linkage from the transmission.
22. Disconnect the exhaust system at the main flange behind the catalytic converter.
23. Disconnect the parking brake bracket from the frame.
24. Disconnect the brake line from the BMPV assembly.
25. Remove the front bumper.
26. Remove the power steering cooler from the front air deflector.
27. Disengage the SIR (air bag) sensor connector.
28. Remove the wheel housing splash shield's chassis-to-frame retainers.
29. If equipped, disconnect the rear air conditioning lines at the rear crossmember. Leave the A/C lines attached to the powertrain assembly.
30. Disconnect the fuel lines at the fuel filter. Carefully pull the lines through the crossmember (forward) and position them on the transmission.
31. Disengage the fuel tank electrical connector.

    Ä Make sure that there are no connections between the chassis and frame.

32. On All Wheel Drive (AWD) vehicles, remove the transfer case vent hose.

    ****Caution**
    When working on a vehicle that is supported by a hoist, add extra support to the opposite end of the vehicle, from where the work is occurring to prevent the possibility of the vehicle falling from the lift. A sudden jarring motion that causes the vehicle to fall could also cause SEVERE personal injury or even death.

33. If a side lift hoist is being used:
    a. Install a body protection hoist adapter set such as J-41602, or equivalent, to the pinch weld area on both sides of the vehicle. A suitable replacement for this tool may be fabricated from blocks of wood, but be sure that they spread the weight across a sufficiently large area of the body around the weld point.
    b. If raised, lower the vehicle.
    c. Position the front hoist arms under the body protection adapter set, making sure the rear of the vehicle is slightly higher than the front.
    d. Support the rear crossmember with jackstands.
    e. Remove the 6 frame bolts.
    f. Raise the hoist to separate the body from the frame assembly.
    g. Install supports under the rear axle.
34. If a twin post hoist is being used:
    a. Install a body protection hoist adapter set such as J-41602, or equivalent, to the pinch weld area on both sides of the vehicle. A suitable replacement for this tool may be fabricated from blocks of wood, but be sure that they spread the weight across a sufficiently large area of the body around the weld point.
    b. Install jackstands under the body protection set and under the rear of the van to support the vehicle.
    c. Lower the front post of the hoist, then install J-41617 or an equivalent twin post hoist frame assembly support bar to the hoist. Raise the front part of the hoist with the tool

attached.

d. Remove the 6 frame bolts.

e. CAREFULLY lower the powertrain/frame assembly from the vehicle.

35. Install J-41427, or equivalent universal lift brackets, to the engine:

    a. Tag and disconnect the spark plug wires, then remove the distributor cap from the top of the HVS assembly.

    b. Remove the 2 rear right lower intake manifold bolts, then install the engine lift bracket marked RIGHT REAR. Tighten the bracket retaining bolts to 11 ft. lbs. (15 Nm).

    c. Remove the air conditioning compressor and accessory drive bracket.

    d. Disconnect the EGR tube from the intake manifold.

    e. Remove the 2 left front lower intake manifold bolts, then install the engine lift bracket marked LEFT FRONT, with the arrow pointing to the front of the engine. Tighten the retaining bolts to 11 ft. lbs. (15 Nm).

36. Remove the engine mount through-bolts.

37. Disconnect the fuel line bracket from the rear of the left cylinder head.

38. Disconnect the fuel lines from the fuel rail.

39. Disengage the electrical harness at the transmission connectors and ALL of the emission sensors.

40. On All Wheel Drive (AWD) vehicles, remove the transfer case-to-engine support brace. Raise the engine slightly and support the transmission with jackstands and a block of wood. DO NOT support the transmission under the oil pan.

41. Disconnect the exhaust "Y” pipe from the manifolds.

42. Disconnect the engine from the transmission, then remove the engine from the frame.

Figure 11.
A body protection hoist adapter set must be used to spread the weight evenly and prevent damage—1996 models

{ewc GSMVIMG,GSMVIMG, !88263g05.bmp}

88263g05

Figure 12.
A twin post hoist frame assembly support bar is necessary unless you are using a side lift hoist

{ewc GSMVIMG,GSMVIMG, !88263g06.bmp}

88263g06

Figure 13.
Universal lift brackets should be installed in place of the proper intake manifold bolts

{ewc GSMVIMG,GSMVIMG, !88263g07.bmp}

88263g07

Figure 14.
The proper frame bolt tightening sequence MUST BE OBSERVED to assure proper chassis-to-frame alignment

{ewc GSMVIMG,GSMVIMG, !88263g08.bmp}

88263g08

To install:

Ä If you are installing a new motor, make sure that any remaining components, brackets or accessories are transferred from the old engine.

43. Carefully position the engine to the frame, then install it to the transmission and tighten the retaining bolts. Remove the transmission jack, then lower the assembly onto the engine mountings.
44. Install and tighten the engine mount through-bolts.
45. Connect the exhaust pipe to the manifolds.
46. Install the fuel line bracket to the rear of the left cylinder head, then connect the fuel lines to the rail.
47. Engage the wiring harness to the transmission connectors and to the emission sensors.
48. If equipped, install the transfer case-to-engine block support brace.
49. Remove the universal lift brackets from the engine.
50. Install the intake manifold bolts where

the lift hooks were installed.

51. Install the A/C compressor and accessory drive bracket.
52. Connect the EGR pipe to the intake manifold.
53. CAREFULLY lower the vehicle onto the frame (if using a side post hoist) OR raise the engine/frame assembly up and into the vehicle (if using a twin post hoist). As the body is assembled to the frame, use a prybar or dowel pin to properly align the components using the 2 alignment holes provided in each.
54. Loosely install the 6 frame mounting bolts, then tighten the bolts to specification using THE PROPER SEQUENCE:
    a. First, tighten the right center bolt to 114 ft. lbs. (155 Nm).
    b. Then, tighten the left center bolt to 114 ft. lbs. (155 Nm).
    c. Next, tighten the right front bolt, followed by the left rear bolt each to 66 ft. lbs. (90 Nm).
    d. Finally, tighten left front bolt, followed by the right rear bolt each to 66 ft. lbs. (90 Nm).
55. Remove the body protection hoist adapters and, if raised, lower the vehicle.
56. Engage the engine wiring harness connectors.
57. Secure the wheel housing splash shields.
58. Align and install the steering shaft to the gear.
59. Install the cooler line to the power steering pump and to the gear.
60. Connect the lines to the hydro-boost unit.
61. Connect the hose to the power steering reservoir.
62. Connect the heater hoses to the engine.
63. Engage the SIR (air bag) sensor connector.
64. If e quipped, engage the wiring to the cruise control stepper motor.
65. Connect the throttle and, if equipped, cruise control cables.
66. If equipped, remove the plugs, then connect the A/C lines to the accumulator and condenser.
67. Install the distributor cap and plug wires to the HVS assembly, as tagged during removal.

68. Install the radiator assembly. Connect the transmission and engine oil cooler lines, replacing the retaining clips.
69. Install the air cleaner.
70. Reposition and secure the master cylinder.
71. Raise and support the vehicle safely for access.
72. Connect the rear brake line to the BMPV.
73. Install the parking brake bracket to the frame.
74. Connect the fuel lines at the fuel filter.
75. If equipped, secure the rear A/C lines to the rear crossmember.
76. On All Wheel Drive (AWD) vehicles, install the transfer case vent tube.
77. Install the power steering cooler.
78. Install the front bumper.
79. Connect the shift linkage to the transmission.
80. Align the torque converter and flexplate match-marks made earlier, then install and tighten the converter bolts. Tighten the bolts evenly to specification. For details, please refer to Section 7.
81. Install the starter shield and the starter motor assembly.
82. Align and install the rear driveshaft.
83. Connect the exhaust system at the center flange, behind the catalytic converter.
84. Remove the jackstands and carefully lower the vehicle.
85. Refill the engine crankcase, then install and connect the battery (negative cable last).
86. Fill and bleed the hydraulic brake system.
87. Check and fill the transmission assembly, as necessary.
88. Refill the power steering system.
89. Fill and bleed the engine cooling system.
90. Properly refill the engine cooling system, then check for leaks.
91. Once the engine has cooled sufficiently, install the engine cover to the passenger compartment.
92. If the A/C system was discharged, take the van to a reputable repair facility to have the system evacuated, recharged and leak tested. DO NOT WAIT LONG to do this or moisture which entered the system while it was discharged will cause corrosion and internal system damage. ALSO DO NOT run the compressor until the system has been properly recharged, depending on how your model is equipped this may mean you CANNOT use the defogger (this automatically turns the compressor on in some vehicles).

Pushrod Side Cover {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Pushrod Side Cover

REMOVAL & INSTALLATION

2.5L Engine

Ü See figures 15, 16

The pushrod side cover is located on the right side of the engine and must be removed to service the valve lifters.

1. Disconnect the negative battery cable for safety.
2. For access, remove the engine cover from the passenger compartment. For details, please refer to Section 1 of this manual.
3. If necessary, remove the alternator and the bracket from the engine.
4. Place a pan under the radiator, open the drain cock and drain the cooling system.

   ****Caution**
   When draining the coolant, keep in mind that cats and dogs are attracted by ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.

5. If necessary on early models, remove the intake manifold-to-engine brace, then remove the lower radiator and heater hoses.
6. Disengage the ignition coil wires, then remove the spark plug wires and bracket from the intake manifold.
7. Remove the fuel pipes and clips from the pushrod cover.
8. Remove the oil pressure gage sender or wiring (if equipped), then remove the wiring harness brackets from the pushrod cover.
9. Unscrew the nuts from the cover attaching studs, reverse 2 of the nuts so the washers face outward and screw them back onto the 2 inner studs.
10. Assemble the 2 remaining nuts to the same 2 inner studs with the washers facing inward, then using a small wrench on the inner nut (on each stud) jam the nuts slightly together.
11. Again using the wrench on the inner stud, unscrew the studs until the cover breaks loose, then remove the nuts from the studs and remove the cover from the engine. Remove the studs from the cover and reinstall them to the engine. Tighten the studs to 90 inch lbs. (10 Nm).
12. Using a plastic scraper, clean the gasket mounting surfaces.

   Ä Use a solvent to clean the oil and grease from the gasket mounting surfaces.

Figure 15.
Exploded view of the pushrod side cover mounting—2.5L engine

{ewc GSMVIMG,GSMVIMG, !88263g09.bmp}

88263g09

Figure 16.
A thin bead of RTV sealant is used on both the pushrod and rocker arm covers on the 2.5L engine

{ewc GSMVIMG,GSMVIMG, !88263g10.bmp}

88263g10

To install:

13. Apply a $^{3}/16$ (5mm) bead of RTV sealant to the gasket mating surface of the pushrod cover.
14. Install the side cover to the engine and tighten the nuts to 90 inch lbs. (10 Nm).
15. Engage the electrical connector to the oil sender (or install the sender if removed or if the cover is being replaced) and the wiring harness to the pushrod side cover.
16. Install the fuel pipes and clips to the pushrod cover.
17. Install the spark plug wires and bracket along with the coil wiring.
18. If removed, install the lower radiator and heater hoses. Install the intake manifold-to-engine brace.
19. If removed, install the alternator and the bracket to the engine.
20. Connect the negative battery cable, then properly refill and bleed the cooling system.
21. Start the engine and check for leaks.
22. Once the engine has cooled sufficiently, install the engine cover to the passenger compartment.

Rocker Arm (Valve) Cover {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Rocker Arm (Valve) Cover

REMOVAL & INSTALLATION

2.5L Engine

Ü See figures 16, 17

1. Disconnect the negative battery cable for safety.
2. From inside the vehicle, remove the engine cover. For details, please refer to Section 1 of this manual.
3. Remove the air cleaner.
4. Disconnect the Positive Crankcase Ventilation (PCV) valve hose, the ignition wires from the rocker arm cover.
5. Remove the Exhaust Gas Recirculation (EGR) valve.
6. From the intake stud, label and disconnect the vacuum hoses.
7. Remove the rocker arm cover-to-cylinder head bolts and the cover.
8. Using a plastic scraper, clean the gasket mounting surface.

   Ä Be sure to use solvent to remove any oil or grease that may remain on the sealing surfaces.

Figure 17.
Exploded view of the rocker arm cover mounting—2.5L engine

{ewc GSMVIMG,GSMVIMG, !88263g11.bmp}

88263g11

To install:

9. Apply a $^{3}/16$ in. (5mm) continuous bead of RTV sealant to the cylinder head, inboard of the bolts holes. While the sealant is still wet (within about 10 minutes of applications), install the rocker arm cover, then tighten the retainers to 90 inch lbs. (10 Nm).
10. Connect the vacuum hoses to the intake stud as labeled.
11. Install the Exhaust Gas Recirculation (EGR) valve.
12. Connect the Positive Crankcase Ventilation (PCV) valve hose, the ignition wires to the rocker arm cover.
13. Install the air cleaner.
14. Connect the negative battery cable.
15. Start the engine and check for leaks.
16. Once the engine has cooled sufficiently, install the engine cover to the passenger compartment.

4.3L Engine {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Engine And Engine Overhaul

4.3L Engine

RIGHT SIDE (1985–92)

Ü See figures 18, 19, 20, 21, 22

1. Disconnect the negative battery cable for safety.
2. From inside the vehicle, remove the engine cover. For details, please refer to Section 1 of this manual.
3. Remove the air cleaner. Disconnect the Air Injection Reaction (AIR) hoses from the diverter valve, then the diverter valve bracket from the intake manifold.
4. From the alternator bracket, remove the engine oil filler tube and the transmission (if equipped with an automatic transmission) oil filler tube.
5. From the valve cover, remove the Positive Crankcase Ventilation (PCV) valve.
6. From the back side of the right cylinder head, remove the AIR pipe-to-cylinder head bolts and move the pipe (hose) out of the way.
7. Remove the ignition wires from the valve cover and the distributor cap (with the wires attached), then move the cap out of the way.
8. Remove the rocker arm cover-to-cylinder head bolts and the cover.
9. Using a plastic scraper, clean the gasket mounting surfaces.

Figure 18.
Exploded view of a typical 4.3L rocker arm cover mounting
{ewc GSMVIMG,GSMVIMG, !88263g12.bmp}

88263g12

Figure 19.
Loosen the rocker arm retaining bolts using a wrench or ratchet and suitable driver . . .
{ewc GSMVIMG,GSMVIMG, !88263p01.bmp}

88263p01

Figure 20.
. . . then remove the bolts from the cylinder head and valve cover
{ewc GSMVIMG,GSMVIMG, !88263p02.bmp}

88263p02

Figure 21.
Lift and remove the valve cover from the cylinder head . . .
{ewc GSMVIMG,GSMVIMG, !88263p03.bmp}

88263p03

Figure 22.
. . . then remove and discard the old gasket
{ewc GSMVIMG,GSMVIMG, !88263p04.bmp}

88263p04

To install:

10. Using a new gasket, install the rocker cover and tighten the retainers to 90 inch lbs. (10 Nm).
11. Install the ignition wires to the valve cover and the distributor cap.

12. To the back side of the right cylinder head, install the AIR pipe-to-cylinder head bolts.
13. To the rocker cover, install the Positive Crankcase Ventilation (PCV) valve.
14. To the alternator bracket, install the engine oil filler tube and the transmission (if equipped with an automatic transmission) oil filler tube.
15. Install the air cleaner. Connect the Air Injection Reaction (AIR) hoses to the diverter valve.
16. Connect the negative battery cable.
17. Start the engine and check for leaks.
18. Once the engine has cooled sufficiently, install the engine cover to the passenger compartment.

RIGHT SIDE (1993-95) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Engine And Engine Overhaul

RIGHT SIDE (1993–95)

Ü See figures 18, 19, 20, 21, 22

1. Disconnect the negative battery cable for safety.
2. From inside the vehicle, remove the engine cover. For details, please refer to Section 1 of this manual.
3. Remove the air cleaner, adapter and heat stove tube.
4. Disconnect the spark plug wire bracket at the side of the cylinder head, then remove the wires from the clip at the rear of the cylinder head.
5. Remove the Positive Crankcase Ventilation (PCV) valve and vacuum tube.
6. Disengage the wiring harness at the rocker arm cover including the connections for:
    a. Air conditioning compressor clutch (if equipped).
    b. Coolant temperature sensor.
    c. Manifold Absolute Pressure (MAP) sensor.
    d. Throttle Position (TP) sensor.
    e. Exhaust Gas Recirculation (EGR) solenoid.
    f. Fuel injector(s).
    g. Ignition coil.
    h. Knock sensor module.
    i. Wiring harness ground at the coolant outlet.
7. Tag and disconnect the vacuum tubes from the MAP sensor and EGR solenoid. Remove the sensor bracket.
8. Remove the rocker arm cover-to-cylinder head bolts, then remove the cover and gasket.
9. Using a plastic scraper, clean the gasket mounting surfaces.

To install:

10. Using a new gasket, install the rocker cover and tighten the retainers to 90 inch lbs. (10 Nm).
11. Install the sensor bracket, then connect the vacuum tubes to the MAP sensor and EGR solenoid, as tagged during removal.
12. Engage the wiring harness connectors to the components disengaged earlier.
13. Install the PCV valve and vacuum tube.
14. Connect the spark plug wires to the clip at the rear of the cylinder head and to the side of the cylinder head.
15. Install the air cleaner, adapter and heat stove tube.
16. Connect the negative battery cable.
17. Start the engine and check for leaks.
18. Once the engine has cooled sufficiently, install the engine cover to the passenger compartment.

RIGHT SIDE (1996) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

RIGHT SIDE (1996)

Ü See figures 18, 19, 20, 21, 22, 23

1. Disconnect the negative battery cable for safety.
2. From inside the vehicle, remove the engine cover. For details, please refer to Section 1 of this manual.
3. Disconnect the spark plug wires from the brackets. If any of the wires will interfere with cover removal, they should be TAGGED and disconnected from the spark plugs for additional clearance.
4. Disconnect the vent tube.
5. Remove the purge solenoid and bracket from the engine.
6. Disengage the wiring harness at the rocker arm cover, then remove the bracket.
7. Remove the rocker arm cover-to-cylinder head bolts, then remove the cover and gasket.
8. Using a plastic scraper, clean the gasket mounting surfaces.

Figure 23.
Exploded view of the late-model 4.3L Vortec engine rocker arm cover mounting—1996 shown

{ewc GSMVIMG,GSMVIMG, !88263g13.bmp}

88263g13

To install:

9. Using a new gasket, install the rocker cover and tighten the retainers to 90 inch lbs. (10 Nm).
10. Install the bracket and engage the wiring harness connectors at the valve cover.
11. Install the purge solenoid and bracket.
12. Connect the vent tube.
13. Connect the spark plug wires. If any wires were removed from the plugs, be sure to connect them as tagged during removal.
14. Connect the negative battery cable.
15. Start the engine and check for leaks.
16. Once the engine has cooled sufficiently, install the engine cover to the passenger compartment.

LEFT SIDE (1985-92) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

LEFT SIDE (1985–92)

Ü See figures 18, 19, 20, 21, 22, 23

1. Disconnect the negative battery cable for safety.
2. From inside the vehicle, remove the engine cover. For details, please refer to Section 1 of this manual.
3. Remove the air cleaner.

   Ä If equipped with a carburetor, remove the vacuum pipe from the carburetor.

4. Disconnect the electrical harness from the rocker arm cover and any vacuum hoses (if necessary).
5. On late-model vehicles, remove the oil fill tube if necessary for clearance.
6. If necessary, disconnect the accelerator and the detent cables from the carburetor/throttle body, then remove the mounting brackets from the intake manifold.
7. Remove the rocker arm cover-to-cylinder head bolts and the cover.
8. Using a plastic scraper, clean the gasket mounting surfaces.

To install:

9. Install the cover using a new gasket, then tighten the rocker cover-to-cylinder head bolts to 90 inch lbs. (10 Nm).
10. If removed, connect and install the mounting bracket, accelerator and the detent cables to the carburetor/throttle body.
11. If removed, install the oil fill tube.
12. Connect the electrical harness to the rocker arm cover and any vacuum hoses (if necessary).
13. Install the air cleaner.
14. Connect the negative battery cable.
15. Start the engine and check for leaks.
16. Once the engine has cooled sufficiently, install the engine cover to the passenger compartment.

LEFT SIDE (1993-95) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

LEFT SIDE (1993–95)

Ü See figures 18, 19, 20, 21, 22

1. Disconnect the negative battery cable for safety.
2. From inside the vehicle, remove the engine cover. For details, please refer to Section 1 of this manual.
3. Remove the air cleaner, adapter and heat stove tube.
4. Remove the multiple ribbed serpentine drive belt.
5. If equipped, remove the air conditioning compressor pencil braces at the rear of the compressor, then remove the compressor mounting bolts. Pull the compressor forward without disconnecting or damaging the refrigerant lines.
6. If equipped, disconnect the vacuum tube and disengage the wiring harness connector from the cruise control servo.
7. Remove the oil fill tube.
8. Disconnect the spark plug wire bracket from the side of the cylinder head.
9. Remove the rocker arm cover-to-cylinder head bolts, then remove the cover and gasket.
10. Using a plastic scraper, clean the gasket mounting surfaces.

To install:

11. Using a new gasket, install the rocker cover and tighten the retainers to 90 inch lbs. (10 Nm).
12. Install the oil fill tube.
13. If equipped, engage the wiring harness and connect the vacuum tube to the cruise control servo.
14. If equipped, reposition the air conditioning compressor, then install and tighten the mounting bolts and the pencil braces.
15. Install the serpentine drive belt.
16. Install the air cleaner, adapter and heat stove tube.
17. Connect the negative battery cable.
18. Start the engine and check for leaks.
19. Once the engine has cooled sufficiently, install the engine cover to the passenger compartment.

LEFT SIDE (1996) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Engine And Engine Overhaul

LEFT SIDE (1996)

Ü See figures 18, 19, 20, 21, 22, 23

1. Disconnect the negative battery cable for safety.
2. From inside the vehicle, remove the engine cover. For details, please refer to Section 1 of this manual.
3. Remove the air cleaner box and intake duct.
4. Remove the PCV valve and oil fill tube.
5. Remove the serpentine drive belt.
6. If equipped, unbolt the air conditioning compressor and bracket, then slide the assembly forward without disconnecting or damaging the refrigerant lines.
7. Remove the EGR tube.
8. Disconnect the spark plug wires from the brackets. If any of the wires will interfere with cover removal, they should be TAGGED and disconnected from the spark plugs for additional clearance.
9. Remove the rocker arm cover-to-cylinder head bolts, then remove the cover and gasket.
10. Using a plastic scraper, clean the gasket mounting surfaces.

To install:

11. Using a new gasket, install the rocker cover and tighten the retainers to 90 inch lbs. (10 Nm).
12. Connect the spark plug wires. If any wires were removed from the plugs, be sure to connect them as tagged during removal.
13. Install the EGR tube.
14. If equipped, reposition the air conditioning compressor and bracket, then secure using the retainers.
15. Install the serpentine drive belt.
16. Install the PCV valve and the oil fill tube.
17. Install the air cleaner box and intake duct.
18. Connect the negative battery cable.
19. Start the engine and check for leaks.
20. Once the engine has cooled sufficiently, install the engine cover to the passenger compartment.

Rocker Arms {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Rocker Arms

The rocker arms open and close the valves through a very simple ball pivot type operation.

REMOVAL & INSTALLATION

2.5L Engine

Ü See figure 24

1. Refer to the rocker arm (valve) cover, removal and installation procedures in this section and remove the valve cover.
2. Using a socket wrench, remove the rocker arm bolts, the ball washer and the rocker arm.

   Ä If only the pushrod is to be removed, back off the rocker arm bolt, swing the rocker arm aside and remove the pushrod. When removing more than assembly, at the same time, be sure to keep them in order for reassembly purposes.

3. Inspect the rocker arms and ball washers for scoring and/or other damage, replace them (if necessary).

Figure 24.
Exploded view of the rocker arm assembly—2.5L engine

{ewc GSMVIMG,GSMVIMG, !88263g14.bmp}

88263g14

To install:

Ä If replacing worn components with new ones, be sure to coat the new parts with Molykote® or an equivalent engine assembly pre-lube, before installation.

4. Install the pushrod and pushrod guide, if removed.
5. Loosely install the ball washer, rocker arms and bolts.
6. Adjust the valves:
   a. Rotate the crankshaft until the mark on the damper pulley aligns with the **0** mark on the timing plate and the No. 1 cylinder is on the compression stroke.

   Ä To determine if the No. 1 cylinder is on the compression stroke, shake the rocker arms of the No. 1 cylinder, if they move the cylinder is on the compression stroke, if they don't move the cylinder is on the exhaust stroke. If the cylinder is on the exhaust stroke, it will be necessary to rotate the crankshaft one more full revolution to bring No. 1 back to top on compression.

   b. With the engine on the compression stroke, adjust the exhaust valves of cylinders No. 1 & 3 and the intake valves of cylinders No. 1 & 2.
   c. To adjust the valves, tighten the rocker arm studs to the specified torque:
      - 1985–86: 20 ft. lbs. (28 Nm).
      - 1987: 24 ft. lbs. (32 Nm).
      - 1988–90: 22 ft. lbs. (30 Nm).
   d. Rotate the crankshaft one complete revolution and align the mark on the damper pulley with the **0** mark on the timing plate.
   e. With the engine on the No. 4 compression stroke, tighten the retainers for the exhaust valves of cylinders No. 2 & 4 and the intake valves of cylinders No. 3 & 4.
7. Install the rocker arm cover. For details, please refer to the procedure found earlier in this section.

4.3L Engine {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Engine And Engine Overhaul

4.3L Engine

Ü See figures 25, 26, 27, 28, 29, 30

1. Refer to the Valve Cover, Removal and Installation procedures in this section and remove the valve covers.
2. Using a socket wrench remove the rocker arm-to-cylinder head nuts, the ball washers, the rocker arms and the pushrods (if necessary).

   Ä If you are removing more than one rocker arm, nut, washer and pushrod at a time, keep each assembly tagged, arranged and/or sorted to assure installation in their original locations.

3. Inspect the parts for excessive wear and/or damage, then replace any parts (if necessary).

Figure 25.
Exploded view of a 4.3L engine rocker arm assembly

{ewc GSMVIMG,GSMVIMG, !88263g15.bmp}

88263g15

Figure 26.
To remove the rocker arm, loosen and remove the nut and ball washer (pivot) . . .

{ewc GSMVIMG,GSMVIMG, !88263p05.bmp}

88263p05

Figure 27.
. . . then lift the rocker arm from the stud

{ewc GSMVIMG,GSMVIMG, !88263p06.bmp}

88263p06

Figure 28.
If necessary, remove the pushrod for replacement or inspection

{ewc GSMVIMG,GSMVIMG, !88263p07.bmp}

88263p07

Figure 29.
Keep ALL PARTS sorted or tagged for installation in their original locations

{ewc GSMVIMG,GSMVIMG, !88263p08.bmp}

88263p08

Figure 30.
Most 4.3L engines (except VIN W and some 1993–94 VIN Z models) will require valve lash adjustment during installation

{ewc GSMVIMG,GSMVIMG, !88263g16.bmp}

88263g16

To install:

Ä If replacing any parts with new ones, coat the new parts with Molykote® or an equivalent engine assembly pre-lube.

4. If removed, install the pushrod.
5. Loosely install the rocker arm, ball pivot and nut.
6. For the 4.3L (VIN W) engine and any 1993–94 4.3L (VIN Z) engines which are equipped with screw-in type rocker arm studs with positive stop shoulders, Tighten the rocker arm adjusting

nuts against the stop shoulders to 20 ft. lbs. (27 Nm). No further adjustment is necessary, or possible.

7. For all 1985–92 and most later 4.3L (VIN B or Z) engines (which are not equipped with screw-in type rocker arm studs and positive stop shoulders), properly adjust the valve lash. For details on valve lash adjustment, please refer to Section 1 of this manual.
8. Install the rocker arm cover(s) to the cylinder head.

Thermostat {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Thermostat

The thermostat is located inside a housing, which is attached to the front of the cylinder head (2.5L) or to the front of the intake manifold (4.3L).

REMOVAL & INSTALLATION

Ü See figures 31, 32, 33, 34, 35, 36, 37, 38, 39

1. Disconnect the negative battery cable for safety.
2. Place a catch pan under the radiator, open the drain cock and drain the cooling system to a level below the thermostat housing.

****Caution**
When draining the coolant, keep in mind that cats and dogs are attracted by ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.

3. Remove the thermostat housing-to-engine bolts or bolt and stud, as applicable,
4. Separate the housing from the cylinder head (2.5L) or manifold (4.3L) and carefully remove the thermostat.
5. Using a plastic scraper, clean the gasket mounting surfaces.

To install:

6. Except for 1996 vehicles, place a $^{1}/8$ in. (3mm) bead of RTV sealant in the groove of the water outlet mating surface.
7. Place the thermostat in position, then install and secure the housing using a new gasket on all but 1996 vehicles.
8. Tighten the thermostat housing-to-engine bolts or bolt and nut to 21 ft. lbs. (28 Nm) for 1985–94 vehicles, 15 ft. lbs. (20 Nm) for 1995 vehicles or to 18 ft. lbs. (25 Nm) for 1996 vehicles.
9. Connect the battery cable, the properly refill and bleed the cooling system.
10. Run the engine and check for leaks.

Figure 31.
Exploded view of the thermostat and housing assembly—2.5L engine

{ewc GSMVIMG,GSMVIMG, !88263g17.bmp}

88263g17

Figure 32.
Exploded view of the thermostat and housing assembly—carbureted and TBI 4.3L engines

{ewc GSMVIMG,GSMVIMG, !88263g18.bmp}

88263g18

Figure 33.
If access is difficult with the hose attached . . .

{ewc GSMVIMG,GSMVIMG, !88263p09.bmp}

88263p09

Figure 34.
. . . remove the hose, then loosen and remove the housing retainers

{ewc GSMVIMG,GSMVIMG, !88263p10.bmp}

88263p10

Figure 35.
Once the housing is free, carefully lift it from the engine to expose the thermostat

{ewc GSMVIMG,GSMVIMG, !88263p11.bmp}

88263p11

Figure 36.
Sometimes, the thermostat will lift from the engine with the housing . . .

{ewc GSMVIMG,GSMVIMG, !88263p12.bmp}

88263p12

Figure 37.
. . . but if not, note the direction it is installed, then lift if from the engine for replacement

{ewc GSMVIMG,GSMVIMG, !88263p13.bmp}

88263p13

Figure 38.
Exploded view of the thermostat and housing assembly—4.3L (1992–95 VIN W) CMFI engine

{ewc GSMVIMG,GSMVIMG, !88263g19.bmp}

88263g19

Figure 39.
Exploded view of the thermostat and housing assembly—4.3L (1996 VIN W) CSFI engine

{ewc GSMVIMG,GSMVIMG, !88263g20.bmp}

88263g20

Intake Manifold {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Intake Manifold

REMOVAL & INSTALLATION

2.5L Engine

Ü See figure 40

The intake manifold is located on the right side of the cylinder head.

****Caution**
Relieve the pressure on the fuel system before disconnecting any fuel line connection!

1. From inside the vehicle, remove the engine cover. For details, please refer to Section 1 of this manual.
2. Properly relieve the fuel system pressure, then disconnect the negative battery cable.
3. Place a catch pan under the radiator, open the drain cock and drain the cooling system.

****Caution**
When draining the coolant, keep in mind that cats and dogs are attracted by ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.

4. Remove the air cleaner assembly.
5. Label and disengage the wiring harnesses and connectors at the intake manifold.
6. Disconnect the accelerator, TVS, and cruise control cables (as equipped) with brackets.
7. If equipped, remove the cruise control transducer.
8. Disconnect the EGR vacuum line.
9. Remove the emission sensor bracket at the manifold.
10. Tag and disconnect the fuel lines, vacuum lines and wiring from the TBI unit.
11. Disconnect the water pump bypass hose and, if applicable, the heater hoses at the intake manifold.
12. Remove the alternator rear bracket.
13. Tag and disconnect the vacuum hoses and pipes from the intake manifold and the vacuum line clips at the thermostat and manifold.
14. If necessary, tag and disconnect the spark plug wires and the bracket at the manifold. Depending on how the wires are run it may be possible to leave them attached to

the spark plugs, but if you disconnect them BE SURE TO LABEL THEM BEFORE REMOVAL.

15. Disconnect the coil wires.
16. Remove the intake manifold bolts, then remove the manifold from the engine.

Figure 40.
Exploded view of the intake manifold mounting—early-model 2.5L engines (NOTE that torque values apply ONLY to models retained by bolts and STUDS)

{ewc GSMVIMG,GSMVIMG, !88263g21.bmp}

88263g21

To install:

17. Using a plastic scraper, clean the gasket mounting surfaces.
18. Install the intake manifold to the engine using a new gasket and carefully thread the retainers.
19. Early-model 2.5L engines use a manifold retained by bolts and studs. For these engines (used through the mid-1980's) tighten the retainers slowly and evenly (starting at the middle and working outward) to 25–37 ft. lbs. (34–50 Nm) using the torque values for each specific fastener as shown in the accompanying illustration. For late-model engines which are retained only by bolts, slowly and evenly tighten all of the retainers to 25 ft. lbs. (34 Nm).
20. Engage the coil wires.
21. Install the spark plug wires and bracket.
22. Connect the vacuum hoses and pipes to the manifold and the vacuum line clips at the thermostat as noted during removal.
23. Install the alternator rear bracket, then connect the coolant bypass hose.
24. If applicable, connect the heater hose at the intake.
25. Connect the fuel lines, vacuum lines and the wiring to the TBI unit.
26. Install the emissions sensor bracket, then connect the EGR valve hose.
27. If equipped, install the cruise control transducer.
28. Connect the accelerator, TVS and cruise control cables (as equipped) with brackets.
29. Engage and secure the wiring harness connectors at the intake, as noted during removal.
30. Install the air cleaner assembly, then connect the negative battery cable.
31. Properly refill the engine cooling system, then check for leaks.
32. Once the engine has cooled sufficiently, install the engine cover to the passenger compartment.

4.3L Engine {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Engine And Engine Overhaul

4.3L Engine

VIN B, N AND Z MODELS

Ü See figures 41, 42, 43, 44, 45, 46, 47, 48, 49, 50

The intake manifold is located between the cylinder heads.

**Caution
If equipped with a TBI system, relieve the pressure on the fuel system before disconnecting any fuel line connection!

1. From inside the vehicle, remove the engine cover. For details, please refer to Section 1 of this manual.
2. Properly relieve the fuel system pressure, then disconnect the negative battery cable.
3. Remove the air cleaner assembly and the heat stove tube.
4. Place a catch pan under the radiator, open the drain cock and drain the cooling system.

**Caution
When draining the coolant, keep in mind that cats and dogs are attracted by ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.

5. Match-mark and remove the distributor assembly.
6. If equipped, remove the cruise control transducer.
7. Disconnect the throttle linkage (accelerator, cruise control and the transmission detent cables, as equipped).
8. Remove the air conditioning compressor from the engine and support aside, leaving the refrigerant lines connected. Be sure not to stretch, stress or otherwise damage the A/C lines.
9. Disconnect the engine oil filler tube (at the manifold bracket) and the transmission dipstick/oil filler tube (if equipped) at the manifold or alternator brackets (as applicable).
10. If applicable on early-model vehicles, remove the air conditioning compressor belt idler (if equipped) from the alternator bracket, then the alternator bracket.
11. Tag and disconnect the fuel hoses, the vacuum lines and the electrical connectors from the carburetor or the throttle body, as applicable.
12. On early-model vehicles so equipped, remove the Air Injection Reactor (AIR) hoses and brackets.
13. Disconnect the heater hose and the upper radiator hose.
14. If used, remove the power brake vacuum pipe.
15. If equipped with an external ignition coil, disengage the wiring, then remove the coil.
16. Disconnect the EGR vacuum line.
17. Remove the sensors and bracket from the right side of the engine.

Ä When removing the intake manifold retainers, take careful note of the locations for all bolts and studs. The stud locations will vary based on production year and emission packages, but the studs must be installed in their original locations is all

engine accessories and controls are to be properly reinstalled.

18. Remove the intake manifold-to-cylinder head bolts, then carefully lift and remove the intake manifold from the engine.
19. Using a plastic scraper, clean the gasket mounting surfaces, the carbon deposits from the exhaust/EGR passages and the scale/deposits from the coolant passages.
20. Inspect the intake manifold for cracks.

Figure 41.
Disconnect all lines, hoses . . .

{ewc GSMVIMG,GSMVIMG, !88263p14.bmp}

88263p14

Figure 42.
. . . and wiring from the intake manifold or from manifold mounted support brackets

{ewc GSMVIMG,GSMVIMG, !88263p15.bmp}

88263p15

Figure 43.
Loosen and remove the intake manifold retaining bolts . . .

{ewc GSMVIMG,GSMVIMG, !88263p16.bmp}

88263p16

Figure 44.
. . . a ratchet with various extensions will be very helpful for this, then carefully . . .

{ewc GSMVIMG,GSMVIMG, !88263p17.bmp}

88263p17

Figure 45.
. . . remove the manifold—NOTE the TBI unit or carb need not be removed on VIN B, N or Z engines

{ewc GSMVIMG,GSMVIMG, !88263p18.bmp}

88263p18

Figure 46.
Once the manifold has been removed you have free access to the lifter valley

{ewc GSMVIMG,GSMVIMG, !88263p19.bmp}

88263p19

Figure 47.
To keep debris out of the engine, cover all openings before cleaning the gasket surfaces

{ewc GSMVIMG,GSMVIMG, !88263p20.bmp}

88263p20

Figure 48.
Exploded view of the 4.3L (VIN B, N and Z) engine intake manifold mounting and RTV sealant application—NOTE that bolt/stud locations will vary based on model year and emission packages

{ewc GSMVIMG,GSMVIMG, !88263g22.bmp}

88263g22

Figure 49.
Intake manifold bolt torque sequence—1985–90 4.3L (VIN B, N and Z) engines

{ewc GSMVIMG,GSMVIMG, !88263g23.bmp}

88263g23

Figure 50.
Intake manifold bolt torque sequence—1991–94 4.3L (VIN B or Z) engines

{ewc GSMVIMG,GSMVIMG, !88263g24.bmp}

88263g24

To install:

21. Use new gaskets and RTV sealant (apply a $^{3}/16$ in. (5mm) bead to the front and rear manifold seals, extend the bead approximately $^{1}/2$ in. (13mm) up each cylinder head to seal and retain the gaskets). Tighten the intake manifold-to-cylinder head bolts/studs using 2 passes of the proper sequence to 35 ft. lbs. (48 Nm). On 1991–94 vehicles, then tighten bolt 9 to 41 ft. lbs. (56 Nm)
22. Install the emission sensors and bracket.
23. Connect the EGR vacuum line.
24. If equipped with an external ignition coil, install the coil and engage the wiring.
25. If used, install the power brake vacuum pipe.
26. Connect the upper radiator hose and the heater hose.
27. If equipped, install the Air Injection Reactor (AIR) hoses and brackets.
28. Install the fuel hoses, the vacuum lines and the electrical connectors to the carburetor or throttle body, as tagged during removal.
29. If applicable on early-model vehicles, install the air conditioning compressor belt idler (if equipped) to the alternator bracket, then the alternator bracket.
30. Reposition and secure the engine oil filler tube and the transmission dipstick/filler tube (as applicable).
31. If equipped, reposition and secure the A/C compressor.
32. Connect the throttle linkage (accelerator, cruise control and transmission detent cables, as equipped).
33. Align and install the distributor assembly.
34. If equipped, install the cruise control transducer.
35. Install the air cleaner and heat stove tube assembly.
36. Connect the negative battery cable.
37. Properly refill the engine cooling system, then check for leaks.
38. Once the engine has cooled sufficiently, install the engine cover to the passenger compartment.

CMFI VIN W Models 1992-95 {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Engine And Engine Overhaul

CMFI VIN W MODELS—1992–95

Ü See figures 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53

> **Ä The manufacturer warns that it may be necessary to disconnect the refrigerant lines from the back of the compressor in order to remove the upper intake manifold assembly. If your vehicle is equipped with A/C, before beginning this procedure you must remove determine if this is necessary. If so, take the vehicle to a reputable repair facility and have the A/C system discharged and recovered using a suitable recovery station. ALSO, remember that if you are wrong and later decide that the system must be discharged, you may have to significantly reassemble the motor so the van may be driven to the repair facility.**

Unlike previous versions of the 4.3L engine, the VIN W utilizes separate upper and lower intake manifold assemblies. It is possible to remove only the upper manifold assembly for access to fuel injection components. If this is all that is necessary on your vehicle, follow only the steps up to upper intake manifold removal, then skip to that portion of the installation procedure.

1. Open the hood, then from inside the vehicle, remove the engine cover. For details, please refer to Section 1 of this manual.
2. If your vehicle is equipped with A/C determine if the compressor can be unbolted and repositioned in order to allow upper manifold removal or if the A/C refrigerant lines will have to be removed from the compressor. If you determine they must be removed from the compressor, take the vehicle to a reputable repair facility to have the system discharged and recovered.

   Ä If only the upper intake manifold is being removed, the fuel system pressure does not need to be released. ALWAYS release the pressure before disconnecting any fuel lines.

3. Unless only the upper intake manifold is being removed, properly relieve the fuel system pressure.
4. Disconnect the negative battery cable for safety.
5. Unless only the upper intake manifold is being removed, drain the engine cooling system.
6. Remove the air cleaner box and inlet duct.
7. Disengage the wiring harness from the necessary upper intake components including:
   - Throttle Position (TP) sensor
   - Idle Air Control (IAC) motor
   - Manifold Absolute Pressure (MAP) sensor
   - Communicator valve
8. Disengage the throttle linkage, and the TV linkage if applicable) from the upper intake manifold.
9. Disengage the wiring, then remove the ignition coil.
10. Disconnect the PCV hose at the rear of the upper intake manifold, then tag and disengage the vacuum hoses from both the front and rear of the upper intake.
11. If equipped with A/C, either unbolt and reposition the compressor (you will have to remove the serpentine drive belt first) or disconnect the refrigerant lines from the rear of the compressor. Remember that the A/C refrigerant must be recovered using a suitable recycling/recovery station before the lines can be disconnected.

12. Remove the upper intake manifold bolts and studs, making sure to note or mark the location of all studs to assure proper installation. Remove the upper intake manifold from the engine.
13. Disengage the wiring from the distributor (or HVS as applicable, they both perform the job of "distributing" secondary ignition voltage to the plugs and are visually very similar) and match-mark the distributor or HVS, then remove the assembly from the engine.
14. Disconnect the upper radiator hose at the thermostat housing and the heater hose at the lower intake manifold.
15. Disconnect the fuel supply and return lines at the rear of the lower intake manifold.
16. Disengage the wiring harness connectors from the necessary lower intake components including:
    - Fuel injector
    - Exhaust Gas Recirculation (EGR) valve
    - Engine Coolant Temperature (ECT) sensor
17. Remove the lower intake manifold retaining bolts, then remove the manifold from the engine.
18. Using a plastic scraper, carefully clean the gasket mounting surfaces. Be sure to inspect the manifold for warpage and/or cracks; if necessary, replace the manifold.

Figure 51.
Lower intake manifold bolt torque sequence—1992–95 4.3L (VIN W) engine

{ewc GSMVIMG,GSMVIMG, !88263g25.bmp}

88263g25

Figure 52.
Upper intake manifold bolt torque sequence—1992–95 4.3L (VIN W) engine

{ewc GSMVIMG,GSMVIMG, !88263g26.bmp}

88263g26

Figure 53.
Exploded view of the upper and lower intake manifold assembly—1992–95 4.3L (VIN W) engine

{ewc GSMVIMG,GSMVIMG, !88263g27.bmp}

88263g27

To install:

19. Position the gaskets to the cylinder heads with the port blocking plates to the rear and the "this side up" stamps facing upward, then apply a $^{3}/16$ in. (5mm) bead of RTV sealant to the front and rear of the engine block at the block-to-manifold mating surface. Extend the bead $^{1}/2$ in. (13mm) up each cylinder head to seal and retain the gaskets.
20. Install the lower intake manifold taking care not to disturb the gaskets. Apply sealer such as GM 1052080 or equivalent to the lower manifold retaining bolts, then install and tighten the manifold retainers to 35 ft. lbs. (48 Nm) using the proper torque sequence.
21. Engage the wiring harness to the lower manifold components, including the injector, EGR valve and ECT sensor.
22. Connect the fuel supply and return lines to the rear of the lower intake. Temporarily reconnect the negative battery cable, then pressurize the fuel system (by cycling the ignition without starting the engine) and check for leaks. Disconnect the negative battery cable for safety and continue installation.
23. Connect the heater hose to the lower intake and the upper radiator hose to the thermostat

housing.

24. Align the match-marks and install the distributor or HVS assembly, then engage the wiring.
25. Position a new upper intake manifold gasket on the engine, making sure the green sealing lines are facing upward.
26. Install the upper intake manifold being careful not to pinch the fuel injector wires or fuel lines between the manifolds.
27. Install the manifold retainers, making sure the studs are properly positioned, then tighten them gradually and evenly to 124 inch lbs. (14 Nm).
28. Either reposition and secure the A/C compressor or remove the plugs and reconnect the A/C refrigerant lines to the rear of the compressor.
29. Connect the PCV hose to the rear of the upper intake manifold and the vacuum hoses to both the front and rear of the manifold assembly.
30. Install the ignition coil and engage the wiring.
31. Connect the throttle linkage to the upper intake.
32. Engage the necessary wiring to the upper intake components including the TP sensor, IAC motor, MAP sensor and the communicator valve.
33. Install the air cleaner and air inlet duct.
34. Connect the negative battery cable.
35. Properly refill the engine cooling system, then check for leaks.
36. Once the engine has cooled sufficiently, install the engine cover to the passenger compartment.
37. If the A/C system was discharged, take the van to a reputable repair facility to have the system evacuated, recharged and leak tested. DO NOT WAIT LONG to do this or moisture which entered the system while it was discharged will cause corrosion and internal system damage. ALSO, DO NOT run the compressor until the system has been properly recharged. Depending on how your model is equipped this may mean you CANNOT use the defogger (this automatically turns the compressor on in some vehicles).

CSFI VIN W MODELS-1996 {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Engine And Engine Overhaul

CSFI VIN W MODELS—1996

Ü See figures 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 54, 55, 56, 57

Unlike early versions of the 4.3L engine, the VIN W utilizes separate upper and lower intake manifold assemblies. It is possible to remove only the upper manifold assembly for access to fuel injection components. If this is all that is necessary on your vehicle, follow only the steps up to upper intake manifold removal, then skip to that portion of the installation procedure.

1. From inside the vehicle, remove the engine cover. For details, please refer to Section 1 of this manual.

   Ä If only the upper intake manifold is being removed, the fuel system pressure does not need to be released. ALWAYS release the pressure before disconnecting any fuel lines.
2. Unless only the upper intake manifold assembly is being removed, properly relieve the fuel system pressure.
3. Disconnect the negative battery cable for safety.
4. Unless only the upper intake manifold is being removed, drain the engine cooling system.
5. Remove the air cleaner box and inlet duct.
6. Disengage the wiring harness from the necessary upper intake components (including brackets), then position the harness aside.
7. Disengage the throttle linkage and cruise control cable (if equipped), along with the bracket from the upper intake manifold.
8. Disconnect the fuel line bracket from the rear of the lower intake manifold.
9. Disconnect the PCV hose at the upper intake manifold.
10. Disengage the wiring, then remove the ignition coil and bracket.
11. Remove the purge solenoid and bracket.
12. Remove the upper intake manifold bolts and studs, making sure to note or mark the location of all studs to assure proper installation. Remove the upper intake manifold from the engine.
13. Match-mark the relationship of the HVS housing and rotor for proper installation, then remove the HVS distributor assembly from the engine.
14. Disconnect the upper radiator hose at the thermostat housing and the heater hose at the lower intake manifold.
15. Remove the EGR valve.
16. Disconnect the coolant bypass hose.
17. Disconnect the fuel supply and return lines at the rear of the lower intake manifold.
18. Disengage the wiring harness connectors and brackets from the necessary lower intake components.
19. Remove the throttle linkage and cable(s) with bracket from the lower intake manifold.
20. Remove the transmission fluid level indicator tube.
21. Remove the EGR tube, clamp and bolt.
22. Remove the PCV valve and vacuum hoses.
23. Remove the air conditioning compressor, bracket and accessory drive bracket. Reposition

and support the A/C compressor aside with the refrigerant lines intact.

24. If needed, remove the alternator bracket bolt next to the thermostat housing
25. Remove the lower intake manifold retaining bolts, then remove the manifold from the engine.
26. Using a plastic scraper, carefully clean the gasket mounting surfaces. Be sure to inspect the manifold for warpage and/or cracks; if necessary, replace the manifold.

Figure 54.
Exploded view of the upper intake manifold and Central Sequential Fuel Injection (CSFI) components

{ewc GSMVIMG,GSMVIMG, !88263g28.bmp}

88263g28

Figure 55.
Exploded view of the lower intake manifold mounting—1996 4.3L (VIN W) CSFI engines

{ewc GSMVIMG,GSMVIMG, !88263g29.bmp}

88263g29

Figure 56.
Lower intake manifold-to-block RTV sealer area

{ewc GSMVIMG,GSMVIMG, !88263g30.bmp}

88263g30

Figure 57.
Lower intake manifold bolt torque sequence—1996 4.3L (VIN W) CSFI engines

{ewc GSMVIMG,GSMVIMG, !88263g31.bmp}

88263g31

To install:

27. Position the gaskets to the cylinder head with the port blocking plates to the rear and the "this side up" stamps facing upward, then apply a $^3/16$ in. (5mm) bead of RTV sealant to the front and rear of the engine block at the block-to-manifold mating surface. Extend the bead $^1/2$ in. (13mm) up each cylinder head to seal and retain the gaskets.
28. Install the lower intake manifold taking care not to disturb the gaskets. Apply sealer such as GM 1052080 or equivalent to the lower manifold retaining bolts, then install and tighten the manifold retainers in 3 passes of the proper sequence.
    a. First, tighten lower manifold bolts to 26 inch lbs. (3 Nm).
    b. Then, tighten the bolts to 106 inch lbs. (12 Nm).
    c. Finally, tighten the bolts to 11 ft. lbs. (15 Nm).
29. Install the alternator bracket bolt, next to the thermostat housing.
30. Connect the coolant bypass hose, then install the EGR valve.
31. Connect the upper radiator hoses at the thermostat housing and the heater hose at the lower manifold.
32. Engage the wiring harness and brackets to the lower manifold components.
33. Connect the fuel supply and return lines at the rear of the lower intake. Temporarily reconnect the negative battery cable, then pressurize the fuel system (by cycling the ignition without starting the engine) and check for leaks. Disconnect the negative battery cable for safety and continue installation.

34. Install the throttle linkage cable(s) and bracket to the lower manifold.
35. Install the transmission fluid level indicator tube.
36. Install the EGR tube, clamp and bolt.
37. Install the PCV valve and connect the vacuum hoses.
38. If equipped, carefully reposition and secure the A/C compressor, bracket and accessory drive bracket.
39. Align the match-marks and install the HVS distributor assembly, then engage the wiring.
40. Position a new upper intake manifold gasket on the engine.
41. Install the upper intake manifold being careful not to pinch the fuel injector wires or lines between the manifolds.
42. Install the manifold retainers (starting with the 2 corner studs first to help align the 2 halves), making sure the studs are properly positioned, then tighten them using the proper sequence to 83 inch lbs. (10 Nm).
43. Install the purge solenoid and bracket.
44. Install the ignition coil and bracket, then engage the wiring.
45. Connect the PCV hose at the upper intake manifold assembly.
46. Secure the fuel lines to the intake at the rear of the block.
47. Connect the throttle linkage to the upper intake.
48. Engage the necessary wiring and brackets to the upper intake components.
49. Install the air cleaner and air inlet duct.
50. Connect the negative battery cable.
51. Properly refill the engine cooling system and check for leaks.
52. Once the engine has cooled sufficiently, install the engine cover to the passenger compartment.

Exhaust Manifold {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Exhaust Manifold

REMOVAL & INSTALLATION

Exhaust pipe and manifold fasteners suffer extreme corrosion due to the harsh operating conditions to which they are exposed. It is usually EASY to break or strip these fasteners if great care is not taken. It is usually a good idea to soak the fasteners with penetrating oil some time before the procedure is begun. Try letting the engine cool the night before and carefully spray the fasteners with a penetrating oil, then allow it to soak in and work while you sleep.

2.5L Engine {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

2.5L Engine

Ü See figure 58

The exhaust manifold is located on the left side of the engine.

1. Disconnect the negative battery cable for safety.
2. From inside the vehicle, remove the engine cover. For details, please refer to Section 1 of this manual.
3. Disconnect the Thermac heat stove pipe from the exhaust manifold.
4. Disengage the wiring from the oxygen sensor. The sensor should be removed only if the manifold or sensor requires replacement.
5. Raise and support the front of the vehicle safely using jackstands.
6. Disconnect the exhaust pipe from the exhaust manifold.
7. If equipped, remove the rear air conditioning compressor bracket.
8. Remove the exhaust manifold-to-engine bolts and the manifold from the engine.
9. Using a plastic scraper, clean the gasket mounting surfaces.

Figure 58.
Exploded view of the exhaust manifold mounting and retainer torque sequence—2.5L engine

{ewc GSMVIMG,GSMVIMG, !88263g32.bmp}

88263g32

To install:

10. Install the exhaust manifold to the cylinder head using a new gasket.
11. Tighten the exhaust manifold retaining bolts in sequence to 36 ft. lbs. (50 Nm) for the inner or center retainers and to 32 ft. lbs. (43 Nm) for the outer retainers.
12. If equipped, install the rear A/C compressor bracket.
13. Connect the exhaust pipe to the exhaust manifold, then remove the jackstands and carefully lower the vehicle.
14. Engage the oxygen sensor wiring.
15. Install the Thermac heat stove pipe to the exhaust manifold.
16. Connect the negative battery cable.
17. Start the engine and check for leaks.
18. Once the engine has cooled sufficiently, install the engine cover to the passenger compartment.

4.3L Engine {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Engine And Engine Overhaul

4.3L Engine

RIGHT SIDE

Ü See figures 59, 60, 61, 62, 63, 64, 65

1. Disconnect the negative battery cable for safety.
2. From inside the vehicle, remove the engine cover. For details, please refer to Section 1 of this manual.
3. Raise and support the front of the vehicle safely using jackstands.
4. Disconnect the right exhaust pipe from the exhaust manifold.
5. On models through 1990, disconnect the Air Injection Reactor (AIR) hose from the check valve (and, if necessary from the diverter valve). If applicable, remove the dipstick tube bracket at the manifold.
6. Except for 1996 models, disconnect the heat stove tube from the manifold.
7. Remove the exhaust manifold-to-engine bolts, washers and tab washers. Whenever tab washers are used, their edges should be straightened before you attempt to loosen the bolts.
8. If used, remove the heat shields (if removal is difficult, take them out with the manifold as an assembly).
9. Remove the manifold from the engine.
10. Using a plastic scraper, clean the gasket mounting surfaces.

Figure 59.
Exploded view of typical 4.3L engine exhaust manifold mounting

{ewc GSMVIMG,GSMVIMG, !88263g33.bmp}

88263g33

Figure 60.
Loosen the retainers and disconnect the exhaust pipe from the manifold

{ewc GSMVIMG,GSMVIMG, !88263p21.bmp}

88263p21

Figure 61.
Except for 1996 models, disconnect the heat stove tube from the exhaust manifold

{ewc GSMVIMG,GSMVIMG, !88263p22.bmp}

88263p22

Figure 62.
Once the tab washers are flattened, loosen and remove the manifold retaining bolts . . .

{ewc GSMVIMG,GSMVIMG, !88263p23.bmp}

88263p23

Figure 63.
. . . then carefully remove the manifold from the vehicle

{ewc GSMVIMG,GSMVIMG, !88263p24.bmp}

88263p24

Figure 64.
Exploded view of late-model 4.3L engine heat shield mounting

{ewc GSMVIMG,GSMVIMG, !88263g34.bmp}

88263g34

Figure 65.
Late-model 4.3L engine exhaust manifold fastener locations—1996 VIN W shown

{ewc GSMVIMG,GSMVIMG, !88263g35.bmp}

88263g35

To install:

11. Install the exhaust manifold assembly using a new gasket. Remember, that if heat shields were removed with the manifold as an assembly, it may be easier to position them at the same time you position the manifold. It also may help to be an octopus with 8 arms or to have an assistant nearby.
12. If used and not positioned already, install the heat shields.
13. Install the manifold retaining bolts, then tighten the inner (center tube) manifold bolts to 26 ft. lbs. (36 Nm), and the outer (front and rear tube) manifold bolts to 20 ft. lbs. (28 Nm). Once the bolts are tightened, bend the tab washers over the heads of the bolts in order to lock them in place and keep them from loosening in service.
14. On models through 1990, connect the Air Injection Reactor (AIR) hose to the check valve (and, if necessary, the diverter valve). If applicable, install the dipstick tube bracket to the manifold.
15. Except for 1996 models, connect the heat stove tube to the manifold.
16. Connect the right exhaust pipe to the exhaust manifold.
17. Remove the jackstands and carefully lower the vehicle.
18. Connect the negative battery cable.
19. Start the engine and check for leaks.
20. Once the engine has cooled sufficiently, install the engine cover to the passenger compartment.

LEFT SIDE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

LEFT SIDE

Ü See figures 59, 60, 61, 62, 63, 64, 65

1. Disconnect the negative battery cable for safety.
2. From inside the vehicle, remove the engine cover. For details, please refer to Section 1 of this manual.
3. Raise and support the front of the vehicle safely using jackstands.
4. Disconnect the right exhaust pipe from the exhaust manifold.
5. On models through 1990, disconnect the Air Injection Reactor (AIR) hose from the check valve (and, if necessary from the diverter valve). If applicable, remove the power steering pump and alternator brackets from the manifold.
6. Except for 1996 models, disengage the oxygen sensor wiring. The sensor should only be removed if the manifold or sensor requires replacement.
7. On 1996 models, disconnect the EGR inlet pipe.
8. Remove the exhaust manifold-to-engine bolts, washers and tab washers. Whenever tab washers are used, their edges should be straightened before you attempt to loosen the bolts.
9. If used, remove the heat shields (if removal is difficult, take them out with the manifold as an assembly).
10. Remove the manifold from the engine.
11. Using a plastic scraper, clean the gasket mounting surfaces.

To install:

12. Install the exhaust manifold assembly using a new gasket. Remember, that if heat shields were removed with the manifold as an assembly, it may be easier to position them at the same time you position the manifold. It also may help to be an octopus with 8 arms or to have an assistant nearby.
13. If used and not positioned already, install the heat shields.
14. Install the manifold retaining bolts, then tighten the inner (center tube) manifold bolts to 26 ft. lbs. (36 Nm), and the outer (front and rear tube) manifold bolts to 20 ft. lbs. (28 Nm). Once the bolts are tightened, bend the tab washers over the heads of the bolts in order to lock them in place and keep them from loosening in service.
15. On 1996 models, connect the EGR inlet pipe.
16. Except for 1996 models, engage the oxygen sensor wiring.
17. On models through 1990, connect the Air Injection Reactor (AIR) hose to the check valve (and, if necessary, the diverter valve). If applicable, install the power steering pump and alternator brackets to the manifold.
18. Connect the left exhaust pipe to the exhaust manifold.
19. Remove the jackstands and carefully lower the vehicle.
20. Connect the negative battery cable.
21. Start the engine and check for leaks.
22. Once the engine has cooled sufficiently, install the engine cover to the passenger compartment.

Radiator {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Radiator

REMOVAL & INSTALLATION

1985–95 Models

Ü See figures 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80

Ä For certain late-model vehicles (1993–94 AWD and all 1995 vehicles) you will need a special Quick-Connect fitting release tool, such as J-37088-2a or equivalent to release the transmission fluid cooler lines from the fittings at the radiator.

1. Disconnect the negative battery cable for safety.
2. Place a catch pan under the radiator, open the drain cock and drain the cooling system.

****Caution**
When draining the coolant, keep in mind that cats and dogs are attracted by ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.

3. For 1985–87 vehicles, remove the brake master cylinder from the firewall (non-power brakes) or the power booster (power brakes) and support it aside. Take care not to stress or damage the brake lines.

Ä DO NOT disconnect the brake lines from the master cylinder, unless there is not enough room to move the master cylinder to provide enough room.

4. For 1992–95 vehicles, match-mark the position of the hood latch to the radiator support, then unbolt and position the latch aside for clearance. Also, if equipped, loosen the A/C accumulator brackets.
5. Separate the upper fan shroud from the bottom half of the shroud assembly, then remove the upper shroud from the vehicle. For many mid-to-late-model vehicles (late 80's to 1995) it will be necessary to unfasten upper radiator hose and power steering pressure switch harness from the shroud. It may also be necessary to remove the upper radiator hose from the radiator in order to provide sufficient clearance.
6. Disconnect the radiator hoses and the coolant overflow hose from the radiator.

****Warning**
When working on fluid lines BE VERY CAREFUL not to strip them. Although an open-end wrench must be used, the use of a special line wrench is HIGHLY recommended. Line wrenches are open-ended wrenches with smaller openings (meaning a greater surface area to contact the line fitting) that are designed to be just large enough to fit over a line.

7. If equipped with an automatic transmission, disconnect the transmission fluid cooler lines from the radiator assembly. For most models, use the appropriate sized flare (line) wrench. For 1993–94 All Wheel Drive (AWD) models and all 1995 models, you must use J-37088-2a or an equivalent Quick-Connect Fitting tool to disengage the lines from the radiator.

Ä Once transmission or engine oil cooler lines have been disconnected, immediately cap or plug the openings to prevent excessive fluid loss or system contamination. Golf tees or specially made plastic caps work well for this, but it is sometime difficult to really seal them. If necessary, raise and support the front of the vehicle, this should

keep fluid in the lines, but will help speed up the draining process of the oils in the radiator cooler tanks.

8. If equipped, loosen and disconnect the engine oil cooler lines from the radiator assembly.
9. Check the bottom of the radiator assembly for fasteners (some early-models are retained by mounting bolts which thread through the lower shroud and radiator), and remove if any are found.
10. Carefully lift the radiator from the vehicle, keeping in mind that the coolant tank and any oil cooler tanks (transmission and/or engine) are still filled with a pretty significant amount of fluid. Take care or get wet.
11. Inspect the radiator for leaks or physical damage, then repair (if necessary).

Ä The radiator is constructed of aluminum. If repairs are necessary, it should be taken to a radiator repair shop.

Figure 66.
Drain the cooling system using the radiator drain cock—a tube on the outlet may prevent a mess

{ewc GSMVIMG,GSMVIMG, !88263p25.bmp}

88263p25

Figure 67.
On some late-model vehicles you must remove the hood latch—start by match-marking it . . .

{ewc GSMVIMG,GSMVIMG, !88263p26.bmp}

88263p26

Figure 68.
. . . then loosen the retaining bolts . . .

{ewc GSMVIMG,GSMVIMG, !88263p27.bmp}

88263p27

Figure 69.
. . . and remove the assembly from the radiator support

{ewc GSMVIMG,GSMVIMG, !88263p28.bmp}

88263p28

Figure 70.
Loosen the upper fan shroud retainers . . .

{ewc GSMVIMG,GSMVIMG, !88263p29.bmp}

88263p29

Figure 71.
. . . be careful not to miss any (a long extension is handy for the upper-to-lower shroud bolts)

{ewc GSMVIMG,GSMVIMG, !88263p30.bmp}

88263p30

Figure 72.
With the retainers removed, carefully lift the upper fan shroud from the engine compartment

{ewc GSMVIMG,GSMVIMG, !88263p31.bmp}

88263p31

Figure 73.

Loosen and disconnect any threaded transmission or engine oil cooler lines . . .

{ewc GSMVIMG,GSMVIMG, !88263p34.bmp}

88263p34

Figure 74.
. . . note the shape of this open-end wrench, it is a special line wrench just for this purpose

{ewc GSMVIMG,GSMVIMG, !88263p35.bmp}

88263p35

Figure 75.
Disengage the overflow hose from the radiator . . .

{ewc GSMVIMG,GSMVIMG, !88263p32.bmp}

88263p32

Figure 76.
. . . and finally, loosen the clamps and disconnect and remaining radiator hoses . . .

{ewc GSMVIMG,GSMVIMG, !88263p33.bmp}

88263p33

Figure 77.
. . . then CAREFULLY lift the radiator from the engine compartment

{ewc GSMVIMG,GSMVIMG, !88263p36.bmp}

88263p36

Figure 78.
Transmission and engine cooler lines are either of the threaded type (left) or the Quick-Connect type (right)

{ewc GSMVIMG,GSMVIMG, !88263g36.bmp}

88263g36

Figure 79.
Exploded view of a typical early-model Astro and Safari radiator and cooling fan mounting

{ewc GSMVIMG,GSMVIMG, !88263g37.bmp}

88263g37

Figure 80.
Exploded view of a typical late-model Astro and Safari radiator mounting

{ewc GSMVIMG,GSMVIMG, !88263g38.bmp}

88263g38

To install:

12. Carefully lower the radiator into the mounting insulators.
13. If equipped, install the retainers and tighten to 18 ft. lbs. (25 Nm).
14. If equipped, install the engine oil cooler lines to the radiator assembly.
15. If equipped, install the transmission cooler lines to the radiator assembly.

    Ä When reconnecting the Quick-Connect fittings on certain late-model transmission cooler lines, listen and feel for a distinct snap which should be heard when the line is fastened. The line must be fully inserted into the connector to assure proper seating. Check this by hand using a forceful pull on the fitting.

16. Connect the radiator and overflow hoses. Remember that if the upper radiator hose had to

be removed earlier in order to remove the upper shroud, installing it now would not be doing yourself any favors, since you would likely have to remove it again for the next step.

17. Install the upper fan shroud. If not done earlier, connect the upper radiator hose. Also, if applicable, secure the upper hose and the power steering pressure switch bracket to the shroud. If loosened, secure the A/C accumulator brackets.
18. For 1992–95 vehicles, align and install the hood latch and cable assembly to the radiator support.
19. For 1985–87 vehicles, install the brake master cylinder to the firewall (non-power brakes) or the power booster (power brakes), as applicable.
20. Connect the negative battery cable to the battery.
21. Properly refill and bleed the engine cooling system, then check for leaks.
22. If equipped with an engine oil cooler or with a transmission oil cooler, check and top-off those fluids, as necessary.

1996 Models {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Engine And Engine Overhaul

1996 Models

Ü See figures 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82

Ä To assure a proper seal upon installation you will need NEW cooler line retaining clips for the transmission and engine oil cooler line fittings for this procedure.

1. Disconnect the negative battery cable for safety.
2. Place a catch pan under the radiator, open the drain cock and drain the cooling system.

****Caution**
When draining the coolant, keep in mind that cats and dogs are attracted by ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.

3. Loosen the clamp, then remove the air cleaner assembly.
4. Remove the upper fan shroud retaining bolts, then remove the upper shroud from the vehicle.
5. Disconnect the radiator hoses and the coolant overflow hose from the radiator.

Ä To disconnect the transmission or engine oil cooler lines, use a small pick-type tool or a small screwdriver to release one of retaining clip's open ends, then remove and discard the old clip.

6. Disconnect the transmission oil cooler lines from the radiator, then discard the old retaining clips.
7. Disconnect the engine oil cooler lines from the radiator, then discard the old retaining clips.
8. Carefully lift the radiator from the vehicle, keeping in mind that the coolant tank and the engine/transmission oil cooler tanks are still filled with a pretty significant amount of fluid. Take care or get wet.
9. Inspect the radiator for leaks or physical damage, then repair (if necessary).

Ä The radiator is constructed of aluminum. If repairs are necessary, it should be taken to a radiator repair shop.

Figure 81.
Use a small pick-type tool to release and remove the retaining clips from the cooler line fittings

{ewc GSMVIMG,GSMVIMG, !88263g39.bmp}

88263g39

Figure 82.
When installing the replacement clips to the cooler line fittings, PROPER ALIGNMENT IS CRITICAL

{ewc GSMVIMG,GSMVIMG, !88263g40.bmp}

88263g40

To install:

10. Carefully lower the radiator into the mounting insulators.

****Warning**

DO NOT attempt to reuse the existing retaining clips that were removed from the cooler line connector fittings. ALSO, take care to assure that each clip engages all 3 slots in the connector fittings. Old, damaged or improperly installed clips could cause the cooler lines to loosen in service, allowing for fluid leaks which could damage the engine or transmission.

11. Install the new retaining clips into the cooler line connector fittings. For each fitting, use your thumb and forefinger to insert a new clip into one of the 3 recesses in the connector fitting. With one end of the retaining clip engaged in the connector fitting slot, use your thumb to rotate the retaining clip around the connector fitting until it snaps into place.
12. Install the engine oil cooler lines to the radiator assembly. Make sure that your hear and/or feel a click as each line is snapped into place, then pull back sharply on the pipe to assure it is tightly fastened to the fitting.
13. Install the transmission cooler lines to the radiator assembly. Make sure that your hear and/or feel a click as each line is snapped into place, then pull back sharply on the pipe to assure it is tightly fastened to the fitting.
14. Connect the radiator and overflow hoses.
15. Install the upper shroud and secure using the retaining bolts.
16. Install the air cleaner assembly and tighten the clamp.
17. Connect the negative battery cable.
18. Properly refill and bleed the engine cooling system, then check for leaks.
19. Check the engine and transmission fluids and top-off, as necessary.

Engine Oil Cooler {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Engine Oil Cooler

REMOVAL & INSTALLATION

Ü See figures 83, 84

Many of the vehicles covered by this manual are equipped with an engine oil cooler. The factory engine oil cooler assembly is part of the radiator assembly. The cooler works as the oil pump sends oil through the lines (leaving the block at the oil filter

adapter), through the cooler tank (in the radiator) and then back to the oil filter adapter and engine block cooling passages. For details on removal and installation of the cooler/radiator, please refer to the radiator removal procedure found earlier in this section.

Figure 83.
Typical Astro and Safari engine oil cooler lines and components
{ewc GSMVIMG,GSMVIMG, !88263g42.bmp}

88263g42

Figure 84.
Late-model engine oil cooler line routing—1996 model shown
{ewc GSMVIMG,GSMVIMG, !88263g43.bmp}

88263g43

Cooling Fan {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Cooling Fan

REMOVAL & INSTALLATION

**Caution
DO NOT use or repair a damaged fan assembly. An unbalanced fan assembly could fly apart causing damage or severe personal injury. Always replace a damaged fan using a NEW assembly.

1985–95 Models

Ü See figures 85, 86, 87, 88, 89, 90

1. Disconnect the negative battery cable for safety.
2. For 1992–95 vehicles, match-mark the position of the hood latch to the radiator support, then unbolt and position the latch aside for clearance. Also, if equipped, loosen the A/C accumulator brackets.
3. Remove the upper fan shroud retainers, then separate the upper fan shroud from the bottom half of the shroud assembly. Remove the upper shroud from the vehicle. For many mid-to-late-model vehicles (late 80's to 1995) it will be necessary to unfasten upper radiator hose and power steering pressure switch harness from the shroud. It may also be necessary to remove the upper radiator hose from the radiator in order to provide sufficient clearance. If the hose must be removed, first partially drain the cooling system (to a level below the upper radiator hose).
4. Remove the fan clutch-to-water pump nuts and bolts, then remove the fan and clutch assembly from the engine.

   Ä Some early-model 2.5L engines may not be equipped with a fan clutch assembly. For these models, the fan is bolted to directly to the water pump through a spacer. To remove the fan, simply unbolt and remove the blade with the spacer.

5. If necessary, remove the fan blade-to-clutch retainers, and separate the blade from the clutch assembly.

**Figure 85.
Exploded view of the cooling fan assembly for the 2.5L engine without a clutch**

{ewc GSMVIMG,GSMVIMG, !88263g44.bmp}

88263g44

**Figure 86.
Fan removal usually boils down to a simple matter of removing the retainers (without cutting your hand) . . .**

{ewc GSMVIMG,GSMVIMG, !88263p37.bmp}

88263p37

**Figure 87.
. . . then pulling the fan blade assembly from the water pump and pulley**

{ewc GSMVIMG,GSMVIMG, !88263p38.bmp}

88263p38

**Figure 88.
Exploded view of the late-model 2.5L engine fan and clutch assembly**

{ewc GSMVIMG,GSMVIMG, !88263g46.bmp}

88263g46

Figure 89.
Exploded view of an early-model 2.5L engine fan and clutch assembly
{ewc GSMVIMG,GSMVIMG, !88263g45.bmp}

88263g45

Figure 90.
Exploded view of a 4.3L engine fan and clutch assembly
{ewc GSMVIMG,GSMVIMG, !88263g47.bmp}

88263g47

To install:

6. If separated, install the fan blade to the clutch assembly and secure using the retainers. Tighten the fan-to-clutch retainers to 18 ft. lbs. (24 Nm) for 1985–92 4.3L engines or to 26 ft. lbs. (35 Nm) for 1993–95 4.3L engines. For 2.5L engines tighten the retainers to 89 inch lbs. (10 Nm) if they thread from the front of the fan, then back into the clutch, toward the engine or to 26 ft. lbs. (35 Nm) if they thread from the engine side, through the fan and THEN out toward the front of the vehicle and into the clutch.
7. Install the fan and clutch assembly (or fan and spacer on some early 2.5L engines) to the water pump pulley. Tighten the retainers to 18 ft. lbs. (24 Nm) for 2.5L engines with a clutch assembly, 20 ft. lbs. (27 Nm) for 2.5.L engines with a spacer (and no clutch) or to 22 ft. lbs. (30 Nm) for 4.3L engines.
8. Install the upper fan shroud.
9. For 1992–95 vehicles, align and install the hood latch to the radiator support using the marks made during removal. If equipped, secure the A/C accumulator brackets.
10. Connect the negative battery cable.
11. Start the engine and check operation.
12. Remember that if the upper radiator hose was removed, you should bleed and top-off the cooling system.

1996 Models {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

1996 Models

Ü See figure 91

1. Disconnect the negative battery cable for safety.
2. Place a catch pan under the radiator, open the drain cock and drain the cooling system.

****Caution**
When draining the coolant, keep in mind that cats and dogs are attracted by ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.

3. Loosen the clamp, then remove the air cleaner assembly.
4. Remove the upper fan shroud retaining bolts, then remove the upper shroud from the vehicle.
5. Remove the fan and clutch assembly retainers using J-41240, or an equivalent fan clutch wrench.
6. If necessary, remove the 4 bolts holding the fan blade to the clutch, then separate the fan from the clutch assembly.

Figure 91.
Exploded view of the fan and clutch assembly—1996 models
{ewc GSMVIMG,GSMVIMG, !88263g48.bmp}

88263g48

To install:

7. If removed, install the fan to the clutch assembly, then secure using the 4 retaining bolts. Tighten the bolts to 24 ft. lbs. (33 Nm).
8. Install the fan blade and clutch assembly to the engine using J-41240 and tighten the retainers to 41 ft. lbs. (56 Nm).
9. Install the upper shroud and secure using the retaining bolts.
10. Install the air cleaner assembly and tighten the clamp.
11. Connect the negative battery cable.
12. Start the engine and check operation.

Water Pump {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Water Pump

REMOVAL & INSTALLATION

Ü See figures 92, 93, 94, 95, 96, 97, 98

1. Disconnect the negative battery cable for safety.
2. Place a catch pan under the radiator, open the drain cock and drain the cooling system.

Caution
When draining the coolant, keep in mind that cats and dogs are attracted by ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.

3. Remove the accessory drive belt(s).
4. Remove the upper fan shroud and the engine cooling fan. For details, please refer to the procedure found earlier in this section.
5. Remove the water pump pulley.
6. Loosen the clamps, then disconnect the hoses from the water pump.
7. Remove the water pump-to-engine bolts. Because the bolt lengths and types may vary from location-to-location (some early-models may use studs in certain locations) on some models, tag or note all bolt locations as they are removed, this will help assure proper installation.
8. Carefully break the gasket seal and remove the water pump from the engine.
9. Using a plastic scraper, clean the gasket mounting surfaces.

Figure 92.
Remove the accessory drive belt(s)—on most models that means the single serpentine belt

{ewc GSMVIMG,GSMVIMG, !88263p39.bmp}

88263p39

Figure 93.
Once the shroud, fan and clutch or spacer are out of the way, remove the water pump pulley

{ewc GSMVIMG,GSMVIMG, !88263p40.bmp}

88263p40

Figure 94.
Disconnect the hoses from the water pump . . .

{ewc GSMVIMG,GSMVIMG, !88263p43.bmp}

88263p43

Figure 95.
. . . in most cases this means loosening the clamp and pulling off the hose . . .

{ewc GSMVIMG,GSMVIMG, !88263p41.bmp}

88263p41

Figure 96.
. . . but a stuck hose can be carefully cut away if you determine it should be

replaced anyway

{ewc GSMVIMG,GSMVIMG, !88263p42.bmp}

88263p42

Figure 97.
Loosen and remove the retaining bolts, then remove the water pump from the engine

{ewc GSMVIMG,GSMVIMG, !88263p44.bmp}

88263p44

Figure 98.
Exploded view of typical Astro and Safari water pump mountings—note that some early-models use studs at various locations to help mount engine accessories

{ewc GSMVIMG,GSMVIMG, !88263g49.bmp}

88263g49

To install:

10. For 2.5L engines, clean the water pump bolt threads, then apply a coating of GM 1052080 or an equivalent sealant.
11. Position the water pump to the engine using new gaskets, then install the retaining bolts. If any are of different lengths (or are bolts instead of studs) be sure they are installed in their original locations, as noted during removal.
12. Tighten the pump-to-engine bolts to 17 ft. lbs. (25 Nm) for the 2.5L, 22 ft. lbs. (29 Nm) 1985–92 4.3L engines, 30 ft. lbs. (41 Nm) 1993–95 4.3L engines, or 33 ft. lbs. (45 Nm) 1996 4.3L engines.
13. Install the hoses to the water pump and secure using the clamps.
14. Install the water pump pulley. For 1996 engines, tighten the pulley retaining bolts to 18 ft. lbs. (25 Nm).
15. Install the fan (and clutch or spacer assembly), along with the upper fan shroud. For details, please refer to the procedure found earlier in this section.
16. Install the accessory drive belt and check for proper tension. For details, please refer to the belt information in Section 1 of this manual.
17. Connect the negative battery cable.
18. Properly refill and bleed the engine cooling system, then check for leaks.

Cylinder Head {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Cylinder Head

REMOVAL & INSTALLATION

2.5L Engine

Ü See figures 99, 100

Ä Before disassembling the engine, make sure that it is overnight cold.

****Caution**
Relieve the pressure on the fuel system before disconnecting any fuel line connection!

1. From inside the vehicle, remove the engine cover. For details, please refer to Section 1 of this manual.
2. Properly relieve the fuel system pressure, then disconnect the negative battery cable for safety.
3. Place a catch pan under the radiator, open the drain cock and drain the cooling system.

****Caution**
When draining the coolant, keep in mind that cats and dogs are attracted by ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.

4. Remove the rocker arm cover. For details, please refer to the procedure found earlier in this section.
5. Disconnect the accelerator, cruise control and the TVS cables, as equipped.
6. From the intake manifold, remove the water pump bypass and heater hoses.
7. From the alternator, remove the front and rear braces, then move it aside.
8. Disconnect the air conditioning compressor brackets, then reposition and support the compressor aside. Be sure not to stress or damage the A/C refrigerant lines.
9. Remove the thermostat housing-to-cylinder head bolts and the housing from the engine.
10. Remove the ground cable and any necessary electrical connectors from the cylinder head. TAG and disconnect the ignition wires from the spark plugs and disengage the oxygen sensor lead. Disconnect and remove the ignition coil from the intake manifold and the cylinder head.
11. Tag and remove the vacuum lines and fuel hoses from the intake manifold and the TBI unit.
12. Disconnect the exhaust pipe from the exhaust manifold.
13. Remove the rocker arm nuts, the washers, the rocker arms and the pushrods from the cylinder head.

    Ä If the rocker arm and pushrod assemblies are not being replaced BE SURE TO TAG or ARRANGE them. If they are reused, they MUST be installed in their original locations.

14. Remove the cylinder head-to-engine bolts, then remove the cylinder head from the engine (with the manifolds attached).

15. Place the assembly on a workbench. If necessary, remove the intake and the exhaust manifolds from the cylinder head.
16. Using a plastic scraper, clean the gasket mounting surfaces. Using a wire brush, clean the carbon deposits from the combustion chambers.
17. Inspect the cylinder head and block for cracks, nicks, heavy scratches or other damage.

Figure 99.
Exploded view of the cylinder head mounting—2.5L engine
{ewc GSMVIMG,GSMVIMG, !88263g50.bmp}

88263g50

Figure 100.
Cylinder head bolt torque sequence—2.5L engine
{ewc GSMVIMG,GSMVIMG, !88263g51.bmp}

88263g51

To install:

18. If removed, install the intake and/or exhaust manifolds to the cylinder head using new gaskets.
19. Use new gaskets, sealant (where necessary, refer to the illustration and any instructions which came with the gasket kit) and install the cylinder head onto the block.
20. Tighten all of the cylinder head bolts (in sequence) to 18 ft. lbs. (25 Nm). Then tighten all bolts (except #9) to 26 ft. lbs. (35 Nm). Retighten the #9 bolt to 18 ft. lbs. (25 Nm). Then tighten all bolts an additional 90 degrees ($^1/4$ turn) in sequence.
21. Loosely install the pushrods, rocker arms and nuts. Adjust the valve lash and secure the rocker arm assemblies as detailed in Section 1 of this manual or earlier in this section under Rocker Arm removal and installation.
22. Connect the exhaust pipe to the exhaust manifold.
23. Install the vacuum lines and fuel hoses to the intake manifold and the TBI unit as tagged during removal.
24. Install the ground cable and any necessary electrical connectors from the cylinder head. Connect the ignition wires to the spark plugs (as tagged during removal) and engage the oxygen sensor lead. Connect the ignition coil to the intake manifold and the cylinder head.
25. Install the thermostat housing and housing-to-cylinder head bolts to the engine.
26. Connect the air conditioning compressor brackets.
27. To the alternator, install the front and rear braces.
28. To the intake manifold, install the water pump bypass and heater hoses.
29. Connect the accelerator, cruise control and TVS cables, as equipped.
30. Install the rocker arm cover.
31. Connect the negative battery cable.
32. Properly refill and bleed the engine cooling system, then check for leaks.
33. Once the engine has cooled sufficiently, install the engine cover to the passenger compartment.

4.3L Engine {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Engine And Engine Overhaul

4.3L Engine

1985–90 Models

Ü See figures 101, 102, 103, 104, 105, 106, 107, 108, 109

> ****Caution**
> **If equipped with a TBI system, relieve the pressure on the fuel system before disconnecting any fuel line connection.**

1. From inside the vehicle, remove the engine cover. For details, please refer to Section 1 of this manual.
2. Properly relieve the fuel system pressure, then disconnect the negative battery cable for safety.
3. Place a catch pan under the radiator, open the drain cock and drain the cooling system.

> ****Caution**
> **When draining the coolant, keep in mind that cats and dogs are attracted by ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.**

4. Remove the rocker arm cover.
5. Remove the intake manifold.
6. Remove the exhaust manifold.
7. Remove the AIR pipe at the rear of the head.
8. If removing the right cylinder head, remove or disconnect:
   - AIR pump mounting bolt and spacer at the head.
   - Engine accessory bracket bolts and studs at the head.
   - Wiring harness and clip at the rear of the head.
9. If removing the left cylinder head, remove or disconnect:
   - Engine accessory bracket bolts and studs at the head. It may be necessary to loosen the remaining bracket bolts to provide clearance for head removal.
   - Fuel pipes and bracket at the rear of the head.
   - Coolant sensor wire.
   - Cruise control transducer bracket, if equipped.
10. Tag and disconnect the wiring from the spark plugs. If necessary, remove the spark plugs from the cylinder head.
11. Loosen the rocker arms and remove the pushrods.

    Ä If valve train components, such as the rocker arms or pushrods, are to be reused, they must be tagged or arranged to insure installation in their original locations.
12. Remove the cylinder head bolts by loosening them in the reverse of the torque sequence, then carefully remove the cylinder head.
13. Using a plastic scraper, clean the gasket mounting surfaces.

14. Clean the carbon deposits from the combustion chambers.
15. Inspect the cylinder head and block for cracks, nicks, heavy scratches or other damage.

Figure 101.
Prepare the cylinder head by removing the rocker arm cover, intake manifold, and exhaust manifold

{ewc GSMVIMG,GSMVIMG, !88263p45.bmp}

88263p45

Figure 102.
Loosen the cylinder head bolts using the reverse of the torque sequence . . .

{ewc GSMVIMG,GSMVIMG, !88263p46.bmp}

88263p46

Figure 103.
. . . a breaker bar, socket and various length extensions are necessary to remove the bolts

{ewc GSMVIMG,GSMVIMG, !88263p47.bmp}

88263p47

Figure 104.
Once all the bolts are removed, break the gasket seal and lift the cylinder head from the block

{ewc GSMVIMG,GSMVIMG, !88263p48.bmp}

88263p48

Figure 105.
Protect the lifter valley and pistons bores using rags or a plastic cover . . .

{ewc GSMVIMG,GSMVIMG, !88263p49.bmp}

88263p49

Figure 106.
. . . then carefully clean the gasket mating surfaces of all old gasket and debris

{ewc GSMVIMG,GSMVIMG, !88263p50.bmp}

88263p50

Figure 107.
Upon installation, tighten the cylinder head bolts using the proper torque sequence

{ewc GSMVIMG,GSMVIMG, !88263p51.bmp}

88263p51

Figure 108.
Exploded view of a typical 4.3L engine cylinder head—1996 shown

{ewc GSMVIMG,GSMVIMG, !88263g52.bmp}

88263g52

Figure 109.
Cylinder head torque sequence—4.3L engines

{ewc GSMVIMG,GSMVIMG, !88263g53.bmp}

88263g53

To install:

Ä The gasket surfaces on both the head and block must be clean of any foreign matter

and free of nicks or heavy scratches. The cylinder bolt threads in the block and threads on the bolts must be cleaned (dirt will affect the bolt torque).

Ä DO NOT apply sealer to composition steel-asbestos gaskets.

16. If using a steel only gasket, apply a thin and even coat of sealer to both sides of the gaskets.
17. Place a new gasket over the dowel pins with the bead or the words "This Side Up" facing upwards (as applicable), then carefully lower the cylinder head into position over the gasket and dowels.
18. Apply a coating of GM 1052080 or an equivalent sealer to the threads of the cylinder head bolts, then thread the bolts into position until finger-tight. Using the proper torque sequence, tighten the bolts in 3 steps:
    - First, tighten the bolts to 25 ft. lbs. (34 Nm).
    - Next, tighten the bolts to 45 ft. lbs. (61 Nm).
    - Finally, tighten the bolts to 65 ft. lbs. (90 Nm).
19. Install the pushrods, secure the rocker arms and adjust the valves.
20. If removed, install the spark plugs. Engage the spark plug wires and make sure they are positioned in the wire brackets.
21. If the left cylinder head was removed, reposition and secure the engine accessory bracket bolts and studs, the fuel pipes and bracket at the rear of the head, the coolant sensor wire and, if equipped, the cruise control transducer bracket.
22. If the right cylinder head was removed, install the AIR pump mounting bolt and spacer at the head, the engine accessory bracket bolts and studs and the wiring harness and clip at the rear of the head.
23. Connect the AIR pipe at the rear of the head.
24. Install the exhaust manifold.
25. Install the intake manifold.
26. Install the rocker arm cover.
27. Connect the negative battery cable, then properly refill the engine cooling system.
28. Run the engine to check for leaks, then check and/or adjust the ignition timing.
29. Once the engine has cooled sufficiently, install the engine cover to the passenger compartment.

1991-95 Models {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Engine And Engine Overhaul

1991–95 Models

Ü See figures 101, 102, 103, 104, 105, 106, 107, 108, 109

**Caution

Relieve the pressure on the fuel system before disconnecting any fuel line connection.

1. From inside the vehicle, remove the engine cover. For details, please refer to Section 1 of this manual.
2. Properly relieve the fuel system pressure, then disconnect the negative battery cable for safety.
3. Place a catch pan under the radiator, open the drain cock and drain the cooling system.

**Caution

When draining the coolant, keep in mind that cats and dogs are attracted by ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.

4. Remove the rocker arm cover.
5. Remove the intake manifold.
6. Remove the exhaust manifold.
7. Remove the engine accessory bracket bolts and studs at the head.
8. Disconnect the wiring harness clip at the rear of the head.
9. Remove the fuel pipes and bracket from the rear of the head.
10. Disconnect the coolant sensor wire.
11. If equipped, remove the cruise control transducer bracket.
12. Tag and disconnect the wiring from the spark plugs. If necessary, remove the spark plugs from the cylinder head.
13. Loosen the rocker arms and remove the pushrods.

    Ä If valve train components, such as the rocker arms or pushrods, are to be reused, they must be tagged or arranged to insure installation in their original locations.

14. Remove the cylinder head bolts by loosening them in the reverse of the torque sequence, then carefully remove the cylinder head.
15. Using a plastic scraper, clean the gasket mounting surfaces.
16. Clean the carbon deposits from the combustion chambers.
17. Inspect the cylinder head and block for cracks, nicks, heavy scratches or other damage.

To install:

Ä The gasket surfaces on both the head and block must be clean of any foreign matter and free of nicks or heavy scratches. The cylinder bolt threads in the block and threads on the bolts must be cleaned (dirt will affect the bolt torque).

Ä DO NOT apply sealer to composition steel-asbestos gaskets.

18. If using a steel only gasket, apply a thin and even coat of sealer to both sides of the gaskets.
19. Place a new gasket over the dowel pins with the bead or the words "This Side Up” facing upwards (as applicable), then carefully lower the cylinder head into position over the gasket and dowels.
20. Apply a coating of GM 1052080 or an equivalent sealer to the threads of the cylinder head bolts, then thread the bolts into position until finger-tight. Using the proper torque sequence, tighten the bolts in 3 steps:
    - First, tighten the bolts to 25 ft. lbs. (34 Nm).
    - Next, tighten the bolts to 45 ft. lbs. (61 Nm).
    - Finally, tighten the bolts to 65 ft. lbs. (90 Nm).
21. Install the pushrods, secure the rocker arms and adjust the valves.
22. If removed, install the spark plugs. Engage the spark plug wires and make sure they are positioned in the wire brackets.
23. Install the engine accessory bracket bolts and studs at the head.
24. Secure the wiring harness and clip at the rear of the head.
25. Install the fuel pipes and bracket at the rear of the head.
26. Engage the coolant sensor wiring connector.
27. If equipped, install the cruise control transducer bracket.
28. Install the exhaust manifold.
29. Install the intake manifold.
30. Install the rocker arm cover.
31. Connect the negative battery cable, then properly refill the engine cooling system.
32. Run the engine to check for leaks, then check and/or adjust the ignition timing.
33. Once the engine has cooled sufficiently, install the engine cover to the passenger compartment.

1996 Models {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Engine And Engine Overhaul

1996 Models

Ü See figures 101, 102, 103, 104, 105, 106, 107, 108, 109

**Caution
Relieve the pressure on the fuel system before disconnecting any fuel line connection.

1. From inside the vehicle, remove the engine cover. For details, please refer to Section 1 of this manual.
2. Properly relieve the fuel system pressure, then disconnect the negative battery cable for safety.
3. Place a catch pan under the radiator, open the drain cock and drain the cooling system.

**Caution
When draining the coolant, keep in mind that cats and dogs are attracted by ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.

4. Remove the rocker arm cover.
5. Remove the intake manifold.
6. Remove the exhaust manifold.
7. Remove the alternator and bracket.
8. Disconnect the wiring harness clip at the rear of the head.
9. Disconnect the coolant sensor wire.
10. Tag and disconnect the wiring from the spark plugs. If necessary, remove the spark plugs from the cylinder head.
11. Loosen the rocker arms and remove the pushrods.

Ä If valve train components, such as the rocker arms or pushrods, are to be reused, they must be tagged or arranged to insure installation in their original locations.

12. Remove the cylinder head bolts by loosening them in the reverse of the torque sequence, then carefully remove the cylinder head.
13. Using a plastic scraper, clean the gasket mounting surfaces.
14. Clean the carbon deposits from the combustion chambers.
15. Inspect the cylinder head and block for cracks, nicks, heavy scratches or other damage.

To install:

Ä The gasket surfaces on both the head and block must be clean of any foreign matter and free of nicks or heavy scratches. The cylinder bolt threads in the block and threads on the bolts must be cleaned (dirt will affect the bolt torque).

Ä DO NOT apply sealer to composition steel-asbestos gaskets.

16. If using a steel only gasket, apply a thin and even coat of sealer to both sides of the gaskets.
17. Place a new gasket over the dowel pins with the bead or the words "This Side Up" facing

upwards (as applicable), then carefully lower the cylinder head into position over the gasket and dowels.

18. Apply a coating of GM 1052080 or an equivalent sealer to the threads of the cylinder head bolts, then thread the bolts into position until finger-tight. Using the proper torque sequence, tighten the bolts to 22 ft. lbs. (30 Nm), then using a torque angle meter, tighten the bolts the additional specified amount based on bolt size and position in the torque sequence.
    - Short length bolts (11, 7, 3, 2, 6 and 10) should be tightened an additional 55 degrees.
    - Medium length bolts (12, and 13) should be tightened an additional 65 degrees.
    - Long length bolts (1, 4, 8, 5, and 9) should be tightened an additional 75 degrees.
19. Install the pushrods and rocker arms.
20. If removed, install the spark plugs. Engage the spark plug wires and make sure they are positioned in the wire brackets.
21. Install the alternator and bracket.
22. Secure the wiring harness and clip at the rear of the head.
23. Engage the coolant sensor wiring connector.
24. Install the exhaust manifold.
25. Install the intake manifold.
26. Install the rocker arm cover.
27. Connect the negative battery cable, then properly refill the engine cooling system.
28. Run the engine to check for leaks, then check and/or adjust the ignition timing.
29. Once the engine has cooled sufficiently, install the engine cover to the passenger compartment.

CLEANING AND INSPECTION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CLEANING AND INSPECTION

Ü See figures 110, 111, 112, 113

1. With the valves installed to protect the valve seats, remove carbon deposits from the combustion chambers and valve heads using a drill-mounted wire brush. Be careful not to damage the cylinder head gasket surface. If the head is to be disassembled, proceed to Step 3. If the head is not to be disassembled, proceed to Step 2.
2. Remove all dirt, oil and old gasket material from the cylinder head with solvent. Clean the bolt holes and the oil passage. Be careful not to get solvent on the valve seals as the solvent may damage them. If available, dry the cylinder head with compressed air. Check the head for cracks or other damage, and check the gasket surface for burrs, nicks and flatness. If you are in doubt about the head's serviceability, consult a reputable automotive machine shop.
3. Remove the valves, springs and retainers, then clean the valve guide bores with a valve guide cleaning tool. Remove all dirt, oil and old gasket material from the cylinder head with solvent. Clean the bolt holes and the oil passage.

   Ä Excessive valve stem-to-bore clearance will cause excessive oil consumption and may cause valve breakage. Insufficient clearance will result in noisy and sticky functioning of the valve and disturb engine smoothness.
4. Remove all deposits from the valves with a wire brush or buffing wheel. Inspect the valves as described later in this section.
5. Check the head for cracks using a dye penetrant in the valve seat area and ports, head surface and top. Check the gasket surface for burrs, nicks and flatness. If you are in doubt about the head's serviceability, consult a reputable automotive machine shop.

   Ä If the cylinder head was removed due to an overheating condition and a crack is suspected, do not assume that the head is not cracked because a crack is not visually found. A crack can be so small that it cannot be seen by eye, but can pass coolant when the engine is at operating temperature. Consult an automotive machine shop that has pressure testing equipment to make sure the head is not cracked.

Figure 110.
Use a gasket scraper to remove the bulk of the old head gasket material from the mating surface . . .

{ewc GSMVIMG,GSMVIMG, !tccs3132.bmp}

tccs3132

Figure 111.
. . . but an electric drill equipped with a wire wheel will expedite complete gasket removal

{ewc GSMVIMG,GSMVIMG, !tccs3133.bmp}

tccs3133

Figure 112.
Clean the combustion chambers using a wire brush—if the valves are removed use care around the valve seats

{ewc GSMVIMG,GSMVIMG, !tccs3802.bmp}

tccs3802

Figure 113.
If the cylinder head is disassembled, use an expandable wire type tool to clean the valve guides

{ewc GSMVIMG,GSMVIMG, !88263g58.bmp}

88263g58

RESURFACING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

RESURFACING

Ü See figures 114, 115, 116

Whenever the cylinder head is removed, check the flatness of the cylinder head gasket surface as follows:

1. Make sure all dirt and old gasket material has been cleaned from the cylinder head. Any foreign material left on the head gasket surface can cause a false measurement.
2. Place a straightedge straight across and diagonally across the gasket surface of the cylinder head (in the positions shown in the figures). Using feeler gauges, determine the clearance at the center of the straightedge.
3. If warpage exceeds the 0.004 in. (0.10mm) then the cylinder head should likely be resurfaced or replaced. Contact a reputable machine shop for machining service and recommendations.

   Ä When resurfacing the cylinder head(s), the intake manifold mounting position is altered and must be corrected by machining a proportionate amount from the intake manifold flange.

Figure 114.
Check the cylinder head for warpage across each of these surface angles
{ewc GSMVIMG,GSMVIMG, !88263g54.bmp}

88263g54

Figure 115.
Check the cylinder head for flatness across the head surface
{ewc GSMVIMG,GSMVIMG, !tccs3918.bmp}

tccs3918

Figure 116.
Checks should be made both straight across the head and a both diagonals
{ewc GSMVIMG,GSMVIMG, !tccs3919.bmp}

tccs3919

CYLINDER BLOCK CLEANING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CYLINDER BLOCK CLEANING

While the cylinder head is removed, the top of the cylinder block and pistons should also be cleaned. Before you begin, rotate the crankshaft until one or more pistons are flush with the top of the block. Carefully stuff clean rags into the cylinders in which the pistons are down. This will help keep grit and carbon chips out during cleaning. Using care not to gouge or scratch the block-to-head mating surface and the piston top(s), clean away any old gasket material with a wire brush and/or scraper. On the piston tops, make sure you are actually removing the carbon and not merely burnishing it.

Remove the rags from the down cylinders after you have wiped the top of the block with a solvent soaked rag. Rotate the crankshaft until the other pistons come up flush with the top of the block, and clean those pistons.

> **Ä Because you have rotated the crankshaft, you may have to re-time the ignition during installation. It is probably easiest to set the engine to No. 1 TDC before installing the cylinder head. Also, make sure you wipe out each cylinder thoroughly with a solvent-soaked rag, to remove all traces of grit, before the head is reassembled to the block.**

Valves {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Valves

REMOVAL & INSTALLATION

Ü See figures 117, 118, 119, 120, 121, 122, 123

Ä If the valve springs are suspect, you may wish to measure the installed height BEFORE removing them. For details, please refer to the valve spring inspection information, later in this section.

New valve seals must be installed when the valve train is put back together. Certain seals slip over the valve stem and guide boss, while others require that the boss be machined. In some applications Teflon guide seals are available. Check with a machinist and/or automotive parts store for a suggestion on the proper seals to use.

1. Remove the cylinder head(s), and place on a clean surface.
2. Using a suitable spring compressor (either a leverage or jawed type that is designed for pushrod overhead valve engines), compress the valve spring and remove the valve spring cap keys. Carefully release the spring compressor and remove the valve spring and cap (and valve rotator on some engines).

   Ä Use care in removing the keys; they are easily lost.

3. Remove the valve seals and the spring seat (if applicable) from the valve guides. Throw these old seals away, as you'll be installing new seals during reassembly.
4. Slide the valves out of the head from the combustion chamber side.
5. Make a holder for the valves out of a piece of wood with drilled holes or cardboard. Make sure you number each hole in the holder to keep the valves in proper order; they MUST be installed in their original locations. Another method of sorting the valve components is to use numbered containers, and make sure the components from each valve is stored in a separate container.
6. Use an electric drill and rotary wire brush to clean the intake and exhaust valve ports, combustion chamber and valve seats. In some cases, the carbon build-up will have to be chipped away. Use a blunt pointed drift for carbon chipping, being careful around valve seat areas.
7. Use a valve guide cleaning brush and suitable solvent to clean the valve guides.
8. Clean the valves with a revolving wire brush. Heavy carbon deposits may be removed with a blunt drift.

   Ä When using a wire brush to remove carbon from the cylinder head or valves, make sure the deposits are actually removed and not just burnished.

9. Wash and clean all valve springs, retainers etc., in safe solvent. Remember to keep parts from each valve separate.
10. Check the cylinder head for cracks. Cracks usually start around the exhaust valve seat because it is the hottest part of the combustion chamber. If a crack is suspected but cannot be detected visually, have the area checked by pressure testing, with a dye penetrant or other method by an automotive machine shop.
11. Inspect the valves, guides, springs and seats and machine or replace parts, as necessary.

Figure 117.
Compress the valve springs, then remove the valve keys in order to free the assembly . . .

{ewc GSMVIMG,GSMVIMG, !tccs3809.bmp}

tccs3809

Figure 118.
. . . then remove the spring from the valve stem in order to access the seal

{ewc GSMVIMG,GSMVIMG, !tccs3810.bmp}

tccs3810

Figure 119.
Remove the valve stem seal from the cylinder head

{ewc GSMVIMG,GSMVIMG, !tccs3811.bmp}

tccs3811

Figure 120.
Invert the cylinder head and withdraw the valve from the cylinder head bore

{ewc GSMVIMG,GSMVIMG, !tccs3141.bmp}

tccs3141

Figure 121.
A valve spring compressor is necessary to remove the valves—this C-clamp style model can only be used with the cylinder head removed from the engine. Jawed types, such as seen in the photos can also be used with the head installed

{ewc GSMVIMG,GSMVIMG, !88263g57.bmp}

88263g57

Figure 122.
Exploded and cross-sectional view of a common valve component assembly—2.5L engine shown

{ewc GSMVIMG,GSMVIMG, !88263g55.bmp}

88263g55

Figure 123.
Exploded view of early-model 4.3L engine valves and components—late-model similar

{ewc GSMVIMG,GSMVIMG, !88263g56.bmp}

88263g56

To install:

12. Lubricate the valve stems with clean engine oil.
13. Install the valves in the cylinder head, one at a time, as numbered.
14. Lubricate and position the spring seats (if applicable), new seals and valve springs, again one valve at a time.
15. Install the spring caps, and compress the springs.
16. With the valve key groove exposed above the compressed valve spring, wipe some wheel bearing grease around the groove. This will retain the keys as you release the spring compressor.
17. Using needle-nose pliers (or your fingers), carefully place the keys in the key grooves. The grease should hold the keys in place. Slowly release the spring compressor; the valve cap or rotator will be raised as the compressor is released, retaining the key.
18. Install the cylinder head(s).

INSPECTION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

INSPECTION

Ü See figures 124, 125, 126, 127, 128, 129

> **Ä Excessive valve stem-to-bore clearance will cause excessive oil consumption and may cause valve breakage. Insufficient clearance will result in noisy and sticky functioning of the valve and disturb engine smoothness.**

Inspect the valve faces and seats (in the head) for pits, burned spots and other evidence of poor seating. Valves that are pitted must be refaced to the proper angle (45º). Valves that are warped excessively must be replaced. When a valve head that is warped excessively is refaced, a knife edge will be ground on part or all of the valve head due to the amount of material that must be removed to completely reface the valve. Knife edges lead to breakage, burning or preignition due to heat localizing on the knife edge. If the edge of the valve head is less than $^{1}/32$ in. (0.8mm) after machining, replace the valve. We recommend that all machine work be performed by a reputable machine shop.

Make sure the valve stem is not bent. The valve may be rolled on a flat surface such as a mirror or glass. An even better indication of valve stem bending can be determined by carefully chocking the stem into an electric drill. Use the drill the spin the stem while you watch the valve head. A bent stem will be obvious by the wobbling of the head. Be very careful if this method is used. If the valve stem is not properly chocked in position it could come flying out of the drill and cause injury.

Some of the engines covered in this guide are equipped with valve rotators, which double as valve spring caps. In normal operation the rotators put a certain degree of wear on the tip of the valve stem; this wear appears as concentric rings on the stem tip. However, if the rotator is not working properly, the wear may appear as straight notches or **X** patterns across the valve stem tip. Whenever the valves are removed from the cylinder head, the tips should be inspected for improper pattern, which could indicate valve rotator problems. Valve stem tips will have to be ground flat if rotator patterns are severe.

Check the valve stem for scoring and burned spots. If not noticeably scored or damaged, clean the valve stem with solvent to remove all gum and varnish. Clean the valve guides using solvent and an expanding wire type valve guide cleaner. Check the valve stem-to-guide clearance in one or more of the following manners, but do not rely on the visual inspection alone:

Figure 124.
Check the valve for damage or wear in these critical areas

{ewc GSMVIMG,GSMVIMG, !88263g59.bmp}

88263g59

Figure 125.
A valve worn out of specification should be replaced

{ewc GSMVIMG,GSMVIMG, !88263g60.bmp}

88263g60

Figure 126.
Valve stem wear patterns on engines equipped with rotator cups

{ewc GSMVIMG,GSMVIMG, !88263g61.bmp}

88263g61

Figure 127.
A dial gauge may be used to check valve stem-to-guide clearance

{ewc GSMVIMG,GSMVIMG, !tccs3142.bmp}

tccs3142

Figure 128.
Valve stems may be rolled on a flat surface to check for bends

{ewc GSMVIMG,GSMVIMG, !tccs3144.bmp}

tccs3144

Figure 129.
Use a micrometer to check the valve stem diameter

{ewc GSMVIMG,GSMVIMG, !tccs3910.bmp}

tccs3910

1. A visual inspection can give you a fairly good idea if the guide, valve stem or both are worn. Insert the valve into the guide until the valve head is slightly away from the valve seat. Wiggle the valve sideways. A small amount of wobble is normal, excessive wobble means a worn guide and/or valve stem.

   Ä If a dial indicator and micrometer are not available to you, take your cylinder head and valves to a reputable machine shop of inspection.

2. If a dial indicator is on hand, mount the indicator so that gauge stem is 90º to the valve stem as close to the top of the valve guide as possible. Move the valve from the seat, and measure the valve guide-to-stem clearance by rocking the stem back and forth to actuate the dial indicator. Measure the valve stem using a micrometer and compare to specifications to determine whether stem or guide is causing excessive clearance.
3. If both a ball gauge and a micrometer are available, first, measure the inside diameter of the valve guide bushing at three locations using the ball gauge. Second, use the micrometer to measure the stem diameter. Finally, subtract the valve stem diameter from the corresponding valve guide inside diameter to arrive at the valve clearance. If clearance is greater than specification, the valve and guide bushing must be replaced.

The valve guide, if worn, must be repaired before the valve seats can be resurfaced. A new valve guide should be installed or, in some cases, knurled. Consult an automotive machine shop.

If the valve guide is okay, measure the valve seat concentricity using a runout gauge. Follow the manufacturers instructions. If runout is excessive, reface or replace the valve and machine or replace the valve seat.

Ä Valves and seats must always be machined together. Never use a refaced valve on a valve seat that has not been machined; never use a valve that has not been refaced on a machined valve seat.

REFACING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REFACING

Valve refacing should only be handled by a reputable machine shop, as the experience and equipment needed to do the job are beyond that of the average owner/mechanic. Refacing may be necessary in order to correct seat and face wear. When the valves are reground (resurfaced), the valve seats must also be recut, again requiring special equipment and experience.

VALVE LAPPING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

VALVE LAPPING

Ü See figures 130, 131

After machine work has been performed on the valves, it may be necessary to lap the valves to assure proper contact. For this, you should first contact your machine shop to determine if lapping is necessary. Some machine shops will perform this for you as part of the service. Keep in mind that the precision machining which is available today often makes lapping unnecessary. Additionally, the hardened valves/seats used in modern automobiles may make lapping difficult or impossible. If your machine shop recommends that you lap the valves, proceed as follows:

1. Set the cylinder head on the workbench, combustion chamber side up. Rest the head on wooden blocks on either end, so there are two or three inches between the tops of the valve guides and the bench.
2. Lightly lube the valve stem with clean engine oil. Coat the valve seat completely with valve grinding compound. Use just enough compound that the full width and circumference of the seat are covered.
3. Install the valve in its proper location in the head. Attach the suction cup end of the valve lapping tool to the valve head. It usually helps to put a small amount of saliva into the suction cup to aid its sticking to the valve.
4. Rotate the tool between your palms, changing position and lifting the tool often to prevent grooving. Lap the valve in until a smooth, evenly polished seat and valve face are evident.
5. Remove the valve from the head. Wipe away all traces of grinding compound from the valve face and seat. Wipe out the port with a solvent soaked rag, and swab out the valve guide with a piece of solvent soaked rag to make sure there are no traces of compound grit inside the guide. This cleaning is important.
6. Proceed through the remaining valves, one at a time. Make sure the valve faces, seats, cylinder ports and valve guides are clean before reassembling the valve train.

Figure 130.
Lapping the valves by hand

{ewc GSMVIMG,GSMVIMG, !88263g62.bmp}

88263g62

Figure 131.
Homemade lapping tool

{ewc GSMVIMG,GSMVIMG, !88263g63.bmp}

88263g63

Valve Springs and Stem Seals {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Valve Springs and Stem Seals

REMOVAL & INSTALLATION

Ü See figures 132, 133

Ä If the valve springs are suspect, you may wish to measure the installed height BEFORE removing them. For details, please refer to the valve spring inspection information, later in this section.

Both the valve spring and stem seal must be removed if the valve is being removed from the cylinder head. If the cylinder head has been removed from the engine, then please refer to the Valve procedures found earlier in this section for details on spring or stem seal removal or installation. But unlike the valves which face into the combustion chamber (and therefore cannot be removed unless the cylinder head is off the engine) both the valve springs and the stem seals can be replaced with the cylinder head installed (if a special tool is used to keep the valves from falling into the combustion chambers).

Ä The following procedures requires the use of GM Air Adapter tool No. J–23590 or equivalent, and a jawed spring compressor or a lever style spring compressor tool such as No. J–5892 or equivalent.

1. For access, remove the engine cover from the passenger compartment. For details, please refer to Section 1 of this manual.
2. Disconnect the negative battery cable.
3. Remove the rocker arm cover.

   Ä The cylinder on whose valves you are working must have its piston at TDC of the compression stroke in order to follow this procedure. On the compression stroke, the cylinder's valves will be closed allowing the air pressure to hold the valve in position. The engine must therefore be turned slightly for each cylinder's valve springs or seals.

4. Remove the rocker arm and pushrod assemblies from the cylinders on which the valves are being serviced.
5. Remove the spark plug from the cylinder which is on its compression stroke and install a spark plug air fitting adapter with an in-line gauge set between the adapter and air compressor. Apply AT LEAST 100 psi (690 kPa) of compressed air to hold the valve in place.

   ****Warning**
   If air pressure is lost while the valve keepers are removed, the valve will drop into the cylinder. If this happens, the cylinder head must be removed in order to recover the valve.

6. Compress the valve spring using a suitable compressor tool and remove the valve key. Carefully release the spring tension, then remove the valve cap and spring.

   Ä If the air pressure has forced the piston to the bottom of the cylinder, any removal of air pressure will allow the valves to fall into the cylinder. A rubber band, tape or string wrapped around the end of the valve stem will prevent this.

7. If the seals are being replaced, remove and discard the old seal from the valve stem.

Figure 132.
With the proper tools, valve springs and stem seals can be replaced with the cylinder head installed

{ewc GSMVIMG,GSMVIMG, !88263p52.bmp}

88263p52

Figure 133.
A lever type or jawed spring compressor can be used with the head installed
{ewc GSMVIMG,GSMVIMG, !88263g64.bmp}

88263g64

To install:

8. If removed, install the new seal using a valve stem seal installer or other suitable driver.
9. Install the valve spring and cap, then compress the spring and install the valve keys.
10. When the valve springs are properly installed, release the air pressure from the cylinder using the gauge set, then remove the spark plug adapter.
11. Install the spark plug and turn the engine sufficiently to work on the next cylinder. Repeat the above steps until all seals are replaced.
12. Install the rocker arm and pushrod assemblies.
13. Install the rocker cover and connect the negative battery cable.
14. Install the engine cover to the passenger compartment.

INSPECTION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

INSPECTION

Ü See figures 134, 135, 136, 137, 138

1. Before the springs are removed, check the installed height using a precision ruler. Compare the measurement to the specification found in the Valve chart at the beginning of this section.
2. Place the valve spring on a flat, clean surface next to a square.
3. Measure the height of the spring, and rotate it against the edge of the square to measure distortion (out-of-roundness). If spring height varies between springs by more than $^{1}/16$ in. (1.6mm) or if the distortion exceeds $^{1}/16$ in (1.6mm), replace the spring.

Figure 134.
The first step in spring inspection is to measure the installed height

{ewc GSMVIMG,GSMVIMG, !88263g65.bmp}

88263g65

Figure 135.
A special tool is needed to check valve spring pressure

{ewc GSMVIMG,GSMVIMG, !88263g66.bmp}

88263g66

Figure 136.
Use a caliper gauge to check the valve spring free-length

{ewc GSMVIMG,GSMVIMG, !tccs3907.bmp}

tccs3907

Figure 137.
Check the valve spring for squareness on a flat service; a carpenter's square can be used

{ewc GSMVIMG,GSMVIMG, !tccs3908.bmp}

tccs3908

Figure 138.
The valve spring should be straight up and down when placed like this

{ewc GSMVIMG,GSMVIMG, !tccs3909.bmp}

tccs3909

A valve spring tester is needed to test spring test pressure, so the valve springs must usually be taken to a professional machine shop for this test. Spring pressure at the installed and/or compressed heights is checked, depending on the specification.

Valve Seats {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Valve Seats

Ü See figure 139

The valve seats are cast into the cylinder head(s) and cannot be replaced; the seats can be machined during a valve job to provide optimum sealing between the valve and the seat. Valve seat concentricity should be checked by the machine shop, using special dial gauge.

The seating services should be performed by a professional machine shop which has the specialized knowledge and tools necessary to perform the service.

Figure 139.
Machine shops will check valve seat concentricity using a special dial gauge
{ewc GSMVIMG,GSMVIMG, !88263g67.bmp}

88263g67

Valve Guides {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Valve Guides

Ü See figures 140, 141

The engines covered in this guide use integral valves guides; that is, they are a part of the cylinder head and cannot be replaced. The guides can, however, be reamed oversize if they are found to be worn past an acceptable limit. Occasionally, a valve guide bore will be oversize as manufactured. These are marked on the inboard side of the cylinder heads on the machined surface just above the intake manifold.

If the guides must be reamed (this service is available at most machine shops), then valves with oversize stems must be fitted. Valves are usually available in 0.001 in. (0.0254mm), 0.003 in. (0.0762mm) and 0.005 in. (0.127mm) stem oversizes. Valve guides which are not excessively worn or distorted may, in some cases, be knurled rather than reamed. Knurling is a process in which the metal on the valve guide bore is displaced and raised, thereby reducing clearance. Knurling also provides excellent oil control. The option of knurling rather than reaming valve guides should be discussed with a reputable machinist or engine specialist.

Figure 140.
Reaming the valve guide for oversize valve stems

{ewc GSMVIMG,GSMVIMG, !88263g68.bmp}

88263g68

Figure 141.
Cross-sectional view of a knurled valve guide

{ewc GSMVIMG,GSMVIMG, !88263g69.bmp}

88263g69

Valve Lifters {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Valve Lifters

In 1987, the 4.3L TBI engine began using roller valve lifters instead of the standard flat bottom lifters. The roller lifter is still hydraulic requiring no valve adjustment. The roller lifter incorporates a roller that rides along the cam lobe reducing friction and component wear. A roller lifter restrictor and retainer is needed to keep the lifter from turning in the bore while the engine is running. All 2.5L TBI engines incorporate the roller lifter configuration.

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REMOVAL & INSTALLATION

Ä Valve lifters and pushrods MUST be kept in order so they can be reinstalled in their original positions.

2.5L Engine

Ü See figures 142, 143

This engine uses hydraulic lifters that are equipped with rollers to reduce engine friction.

1. Refer to the Rocker Arm, Removal and Installation procedures in this section, then loosen the rocker arms bolts, move the rocker arms aside and remove the pushrods.
2. Refer to the Pushrod Cover, Removal and Installation procedures in this section and remove the pushrod cover.
3. Remove the hydraulic lifter retainer studs, the retainer(s) and the guides. Lift the hydraulic lifter from the engine block.
4. Inspect the hydraulic lifter for:
   - Wear or scuffing.
   - Wear or scuffing in the engine bore.
   - Freedom of the roller movement.
   - Flat spots or pitting on the roller surface.

   Ä If the hydraulic lifter is found to be defective, replace it. If installing a new lifter, be sure to remove all of the protective sealant from inside the body, then lubricate it and the roller with engine oil.

Figure 142.
Exploded view of the hydraulic lifter-to-engine mounting—2.5L engine

{ewc GSMVIMG,GSMVIMG, !88263g70.bmp}

88263g70

Figure 143.
Exploded view of a roller-type hydraulic lifter assembly—2.5L engines and 1987–96 4.3L engines

{ewc GSMVIMG,GSMVIMG, !88263g71.bmp}

88263g71

To install:

5. Install the lifters and retainers. If you are installing the old lifters, MAKE SURE they are being returned to their original positions.
6. Tighten the lifter retainer-to-engine studs to 96 inch lbs. (11 Nm).
7. Install the pushrods and reposition the rocker arms. Adjust the valve lash as detailed earlier in this section or in Section 1 of this manual.
8. Install the pushrod cover as outlined earlier in this section.
9. Install the rocker arm cover as outlined earlier in this section.

4.3L Engine {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Engine And Engine Overhaul

4.3L Engine

Ü See figures 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154

Some of the early 4.3L engines covered by this manual (1985–86 models), use a hydraulic lifter without a cam roller. All 1987 and later 4.3L engines use roller lifters. The removal procedures are basically the same except the roller lifters have retainers and guides (which are necessary to keep them from turning while the engine is running) that have to be removed to free the lifters.

1. Refer to the Intake Manifold, Removal and Installation procedures in this section and remove the intake manifold.
2. Refer to the Rocker Arm Cover, Removal and Installation procedures in this section and remove the rocker arm cover(s) from the engine.
3. Refer to the Rocker Arm, Removal and Installation procedures in this section, then loosen the rocker arm nuts, move the rocker arms aside and remove the pushrods.

   Ä Either work on only one lifter at a time, or label/arrange the pushrods to be assured that you can install them back to their original locations.

4. For 1987–93 models, remove the bolts from the lifter retainer, then remove the retainer from the lifter valley in order to access the lifter restrictors. Usually there will be 6 restrictors (one per cylinder or one per pair of lifters). Remove the restrictor for the lifter(s) you are servicing.
5. For 1994–96 models, remove the bolts from the retainer which is being removed. There is usually one on each side of the lifter valley.
6. Grasp the hydraulic lifter and remove it from the cylinder block, using a twisting action. If necessary use the GM Lifter Remover tool No. J–3049 (pliers type). In some cases, pliers can be used, but be careful not to score or damage the lifter.
7. If any lifters are stuck in the cylinder block, use the GM Lifter Removal tool No. J–9290–01 (or an equivalent slide hammer type tool) to pull the hydraulic lifter from the cylinder block.

   Ä When removing the hydraulic lifters, be sure to place them in an organizer rack so that they may be reinstalled in the same engine bore from which they were removed.

8. Inspect the lifters for:
   - Wear or scuffing.
   - Wear or scuffing in the engine bore.
   - Lifter to bore clearance; if the clearance is excessive, replace the lifter.
   - Worn spots, pitting or damage on the lifter surface; the lifter foot must be smooth and slightly convex.

   Ä If a new camshaft has been installed, install all new hydraulic lifters. If a new camshaft or new lifter(s) have been installed, add engine oil supplement to the crankcase.

Figure 144.
Using the GM pliers type lifter removal tool (J-3049) to remove a hydraulic lifter from its bore

{ewc GSMVIMG,GSMVIMG, !88263g72.bmp}

88263g72

Figure 145.
Cross-sectional view of a non-roller hydraulic lifter—roller type similar (except at base)

{ewc GSMVIMG,GSMVIMG, !88263g73.bmp}

88263g73

Figure 146.
Exploded view of the hydraulic roller lifter, retainer and restrictor mounting—1987–93 4.3L engines

{ewc GSMVIMG,GSMVIMG, !88263g74.bmp}

88263g74

Figure 147.
Exploded view of the hydraulic roller lifter and retainer mounting—1994–96 4.3L engines

{ewc GSMVIMG,GSMVIMG, !88263g75.bmp}

88263g75

Figure 148.
To remove the lifters, start by removing the intake manifold and the rocker arm cover

{ewc GSMVIMG,GSMVIMG, !88263p53.bmp}

88263p53

Figure 149.
Remove the bolts from the lifter retainer (this style was used from 1987–93) . . .

{ewc GSMVIMG,GSMVIMG, !88263p54.bmp}

88263p54

Figure 150.
. . . then remove the lifter retainer from the lifter valley

{ewc GSMVIMG,GSMVIMG, !88263p55.bmp}

88263p55

Figure 151.
Remove the restrictor for the lifter(s) you are removing . . .

{ewc GSMVIMG,GSMVIMG, !88263p56.bmp}

88263p56

Figure 152.
. . . then grasp and remove the lifter from the bore

{ewc GSMVIMG,GSMVIMG, !88263p57.bmp}

88263p57

Figure 153.
. . . a magnet is helpful to pull a well oiled lifter from the bore . . .

{ewc GSMVIMG,GSMVIMG, !tccs3812.bmp}

tccs3812

Figure 154.
. . . but a slide hammer type removal tool must be used if the lifter is stuck

{ewc GSMVIMG,GSMVIMG, !tccs3813.bmp}

tccs3813

To install:

9. When new lifters are installed they should be coated using either a high viscosity oil with zinc (such as GM 12345501) or with a suitable engine pre-lube. It's also usually a good idea to prime any hydraulic lifter by submerging it in fresh engine oil and pumping the plunger gently

a few times. This will provide lubrication to the internal components before assembly.

Ä GM recommends that whenever a new camshaft and/or a set of new lifters has been installed, that you change the engine oil and filter, and then add GM engine oil supplement 1052367 to the engine oil upon refill.

10. Install the lifters. If you are reusing the old lifters MAKE SURE each is installed in the same bore from which it was removed.
11. Install the lifter retainer (and separate restrictors on 1987–93 models), then tighten the bolts to 12 ft. lbs. (16 Nm).
12. Install the pushrods and rotate the rocker arms back into position. Adjust the valve lash.
13. Refer to the Intake Manifold, Removal and Installation procedures in this section and install the intake manifold.
14. Install the rocker arm cover(s).

Oil Pan {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Oil Pan

REMOVAL & INSTALLATION

1985–90 Models

Ü See figures 155, 156, 157, 158, 159, 160, 161

1. Disconnect the negative battery cable for safety.
2. Raise and support the front of the vehicle safely using jackstands.
3. Position a catch pan under the crankcase and drain the oil from the engine.

Caution
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.

4. Disconnect the strut rods at the flywheel/torque converter cover, then remove the cover from the bellhousing.
5. Disengage the electrical connectors from the starter, then remove the starter-to-engine bolts, the brace and the starter from the vehicle.
6. Disconnect the exhaust pipe(s) from the exhaust manifold(s) and, if necessary, at the exhaust pipe-to-catalytic converter hanger(s).
7. If necessary, remove the engine mount through-bolts, then using an engine lifting device, raise the engine (as needed) in order to make room for the oil pan removal.

Warning
If it is necessary to raise the engine, do so slowly, continually checking for possible interference with the firewall. DO NOT allow upper engine components to become damaged.

8. Remove the oil pan-to-engine bolts and nuts (as applicable), then remove the oil pan from the engine.
9. Using a plastic scraper, clean the gasket mounting surfaces. Using solvent, clean the excess oil from the mounting surfaces.

Figure 155.
Exploded view of a typical oil pan assembly—early-model 4.3L engine shown

{ewc GSMVIMG,GSMVIMG, !88263g76.bmp}

88263g76

Figure 156.
RTV sealant application for the 2.5L engine oil pan

{ewc GSMVIMG,GSMVIMG, !88263g77.bmp}

88263g77

Figure 157.
On most vehicles covered by this manual you will have to unbolt the exhaust pipe for clearance

{ewc GSMVIMG,GSMVIMG, !88263p58.bmp}

88263p58

Figure 158.
Loosen and remove the oil pan retaining bolts (a variety of ratchet extensions will be helpful)

{ewc GSMVIMG,GSMVIMG, !88263p59.bmp}

88263p59

Figure 159.
If equipped, remove the oil pan reinforcements . . .

{ewc GSMVIMG,GSMVIMG, !88263p60.bmp}

88263p60

Figure 160.
. . . then lower the pan from the engine

{ewc GSMVIMG,GSMVIMG, !88263p61.bmp}

88263p61

Figure 161.
CAREFULLY remove the old gasket (on 4.3L engines it can be reused if it is not damaged)

{ewc GSMVIMG,GSMVIMG, !88263p62.bmp}

88263p62

To install:

10. On the 2.5L engine, apply a $^1/6$ in. (4.2mm) bead of RTV sealant to the oil pan flange (keep the bead inside the bolt holes), the rear main bearing, the timing gear cover and the engine block sealing surface. On the 4.3L engine, apply a small amount of RTV sealant to the front and rear corners of the oil pan; too much sealant may prevent sealing of the gasket.

    Ä The 4.3L engine uses a one piece oil pan gasket.

11. Use a new gasket (4.3L), RTV sealant and install the oil pan.
12. Tighten the oil pan-to-engine bolts to 100 inch lbs. (11 Nm) and the oil pan-to-engine nuts to 14 ft. lbs. (20 Nm) for the 4.3L.
13. If raised, lower the engine into position and install the mount through-bolts.
14. Reposition and secure the pipe(s) to the exhaust manifold(s).
15. Install the starter motor assembly.
16. Install the flywheel/torque converter cover, then secure the strut rods.
17. Remove the jackstands and carefully lower the vehicle.
18. Immediately refill the crankcase with fresh oil. Don't risk someone accidentally trying to start a dry motor.
19. Connect the negative battery cable, then start the engine, establish normal operating temperatures and check for leaks.

1991-95 Models {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Engine And Engine Overhaul

1991–95 Models

Ü See figures 155, 157, 158, 159, 160, 161

1. Disconnect the negative battery cable for safety.
2. Raise and support the front of the vehicle safely using jackstands.
3. Position a catch pan under the crankcase and drain the oil from the engine.

   ****Caution**
   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.

4. Disconnect the exhaust pipe from the manifolds.
5. Remove the torque converter cover from the bellhousing.
6. Remove the starter assembly from the vehicle.
7. Remove the oil pan-to-engine bolts, nuts and reinforcements, then carefully lower the oil pan from the engine.

   Ä Remember that no matter how well you drained the crankcase, the oil pan will still be holding a decent amount of slimy residue.

8. Carefully remove the rubber composite gasket from the mating surface. Take care because if the gasket is free of damage it can be reused.
9. Clean the gasket mounting surfaces of sealant, dirt or other residue. Using solvent, clean the excess oil from the mounting surfaces.

To install:

10. Inspect the oil pan gasket for damage and replace, if necessary. Position the gasket on the oil pan.
11. Apply sealant such as GM 12346141, or equivalent, to the front cover-to-block joint and to the rear crankshaft seal-to-block joint. Continue the sealant about 1 in. (25mm) in both directions from the 4 corners.
12. Carefully raise the oil pan into position with the reinforcements and thread the retainers.
13. Tighten the oil pan-to-engine bolts to 100 inch lbs. (11 Nm) and the oil pan-to-engine nuts to 17 ft. lbs. (23 Nm).
14. Install the starter motor assembly.
15. Install the torque converter cover.
16. Reposition and secure the pipe to the exhaust manifolds.
17. Remove the jackstands and carefully lower the vehicle.
18. Immediately refill the crankcase with fresh oil. Don't risk someone accidentally trying to start a dry motor.
19. Connect the negative battery cable, then start the engine, establish normal operating temperatures and check for leaks.

1996 Models {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Engine And Engine Overhaul

1996 Models

Ü See figures 155, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166

Ä Any time the transmission and oil pan are off the engine at the same time, the transmission MUST be installed before the oil pan. This will allow for proper measurement of the oil pan tolerance.

1. Disconnect the negative battery cable for safety.
2. Raise and support the front of the vehicle safely using jackstands.
3. Position a catch pan under the crankcase and drain the oil from the engine.

****Caution**
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.

4. Remove the oil filter.
5. Disconnect the oil cooler lines from the oil pan and from the adapter. Immediately plug all openings to prevent system contamination or excessive fluid loss.
6. Remove the oil filter adapter.
7. Remove the starter assembly from the vehicle.
8. Remove the starter shield.
9. If necessary, remove the transmission oil cooler lines. Immediately plug all openings to prevent system contamination or excessive fluid loss.
10. On All Wheel Drive (AWD) vehicles, remove the front drive axle tube mount nuts and the left lower drive axle bushing bolt.
11. Remove the rubber bellhousing plugs.
12. Remove the oil pan-to-engine bolts and studs, then carefully lower the oil pan from the engine.

Ä Remember that no matter how well you drained the crankcase, the oil pan will still be holding a decent amount of slimy residue.

13. Carefully remove the rubber composite gasket from the mating surface. Take care because if the gasket is free of damage it can be reused.
14. Clean the gasket mounting surfaces of sealant, dirt or other residue. Using solvent, clean the excess oil from the mounting surfaces.

Figure 162.
Exploded view of the oil pan mounting—1996 4.3L engines

{ewc GSMVIMG,GSMVIMG, !88263g78.bmp}

88263g78

Figure 163.
Sealant should be applied to this area during installation—1996 4.3L engines

{ewc GSMVIMG,GSMVIMG, !88263g79.bmp}

88263g79

Figure 164.
Oil pan retainer torque sequence—1996 4.3L engines
{ewc GSMVIMG,GSMVIMG, !88263g80.bmp}

88263g80

Figure 165.
Check the oil pan tolerance (pan-to-transmission clearance) as these 3 points
{ewc GSMVIMG,GSMVIMG, !88263g81.bmp}

88263g81

Figure 166.
Exploded view of the oil filter adapter mounting
{ewc GSMVIMG,GSMVIMG, !88263g84.bmp}

88263g84

To install:

15. Inspect the oil pan gasket for damage and replace, if necessary. Position the gasket on the oil pan.
16. Apply sealant such as GM 12346141, or equivalent, to the front cover-to-block joint and to the rear crankshaft seal-to-block joint. Continue the sealant about 1 in. (25mm) in both directions from the 4 corners.
17. Carefully raise the oil pan into position and thread the retainers finger-tight.
18. Tighten the oil pan-to-engine retainers using the proper torque sequence to 18 ft. lbs. (25 Nm).
19. Use a feeler gauge to check for proper oil pan-to-transmission clearance at the points shown in the accompanying figure. If the clearance exceeds 0.010 in. (0.254) at ANY of the 3 contact points, loosen the retainers and reposition the pan until clearance is correct.
20. If removed, install the transmission oil cooler lines.
21. Install the starter shield.
22. Install the starter motor assembly.
23. Install the oil filter adapter.
24. Remove the plugs, then connect the oil cooler lines. Secure the lines to the oil pan.
25. Install a new oil filter.
26. On AWD vehicles, install the front drive axle tube mount nuts and the left lower drive axle bushing bolt.
27. Remove the jackstands and carefully lower the vehicle.
28. Immediately refill the crankcase with fresh oil. Don't risk someone accidentally trying to start a dry motor.
29. Connect the negative battery cable, then start the engine, establish normal operating temperatures and check for leaks.

Oil Pump {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Oil Pump

REMOVAL & INSTALLATION

Ü See figures 167, 168, 169, 170

1. Refer to the Oil Pan, Removal and Installation procedures in this section and remove the oil pan.
2. Remove the oil pump-to-rear main bearing cap bolt(s), the pump and the extension shaft.
3. Remove the pump pickup screen only if replacement is necessary. Because the pickup tube has a press (interference) fit to the pump cover on most models it cannot be reinstalled.

Figure 167.
Exploded view of the oil pump mounting—2.5L engine
{ewc GSMVIMG,GSMVIMG, !88263g82.bmp}

88263g82

Figure 168.
Exploded view of the oil pump mounting—4.3L engine (late-model shown)
{ewc GSMVIMG,GSMVIMG, !88263g83.bmp}

88263g83

Figure 169.
Loosen and remove the oil pump retaining bolt(s) . . .
{ewc GSMVIMG,GSMVIMG, !88263p63.bmp}

88263p63

Figure 170.
. . . then remove the pump and extension shaft from the engine
{ewc GSMVIMG,GSMVIMG, !88263p64.bmp}

88263p64

To install:

4. Install the oil pump and extension shaft to the engine, while aligning the slot (on top of the extension shaft) with the drive tang (on the lower end of the distributor driveshaft). The oil pump should slide easily in place.
5. Tighten the oil pump-to-bearing cap bolt(s) to 22 ft. lbs. (30 Nm) for the 2.5L engine or 65 ft. lbs. (88 Nm) for the 4.3L engine.
6. Install the oil pan.
7. Refill the crankcase with fresh oil.
8. When starting the motor, MAKE SURE the oil pressure light goes out, or the gauge reads pressure almost immediately after starting. If it does not, shut the engine **OFF** and determine the cause of the problem.

Crankshaft Pulley, Damper and Front Oil Seal {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Crankshaft Pulley, Damper and Front Oil Seal

REMOVAL & INSTALLATION

2.5L Engine

Ä The following procedure requires the use of the GM Seal Installer/Centering tool No. J–34995 or equivalent.

1. Disconnect the negative battery cable for safety.
2. If equipped, remove the power steering fluid reservoir from the radiator shroud.
3. Remove the upper fan shroud. Loosen and remove the accessory-to-damper pulley drive belts.
4. Remove the damper pulley/hub assembly-to-crankshaft bolt and washer, then the pulley/hub assembly from the crankshaft.

   Ä The damper pulley is connected to the damper pulley hub by 3 bolts; if necessary, remove the pulley-to-hub bolts and separate the pulley from the hub. When it becomes necessary to remove the damper pulley/hub assembly, ALWAYS replace the front oil seal with a new one.

5. Inspect the damper hub (oil seal surface) for rust or burrs; remove the roughness with fine emery cloth.

   Ä When installing the damper pulley hub to the crankshaft, be careful not to damage the front oil seal.

6. To replace the timing cover oil seal, perform the following procedures:
   a. Using a medium prybar, carefully pry the oil seal from the timing cover, making sure not to score the surface of the bore or the crankshaft.
   b. Using the GM Seal Installer/Centering tool No. J–34995 or equivalently sized driver, install the new oil seal into the timing cover, then remove the tool from the timing cover.

To install:

7. Lubricate (with clean engine oil) and install the damper hub. Align it onto the keyway and push onto crankshaft.
8. Install and tighten the damper pulley hub-to-crankshaft bolt to 160 ft. lbs. (217 Nm).
9. Install the drive belts and check or adjust the belt tension, as applicable. For details, please refer to Section 1 of this manual.
10. Install the upper fan shroud.
11. If equipped, install the power steering fluid reservoir to the radiator shroud.
12. Connect the negative battery cable.
13. Start the engine, check for leaks and proper operation.

4.3L Engine {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Engine And Engine Overhaul

4.3L Engine

Ü See figures 171, 172, 173, 174, 175, 176, 177, 178, 179, 180

Ä The following procedure requires the use of a torsional damper puller/installer tool such as GM tool no. J-23523-E (1985–92 models), J-39046 (1993–96 models) or an equivalent, and the GM seal installer tool No. J-35468 or equivalent.

****Warning**
DO NOT attempt to remove the damper using a jawed puller or the hub may be destroyed. The internal weight section of the balancer is assembled to the hub using a rubber-type material. The proper puller type tool is needed to prevent damage.

1. Disconnect the negative battery cable for safety.
2. For 1985–90 vehicles, loosen and remove the accessory-to-damper pulley drive belt(s).
3. For 1991–96 vehicles, remove the engine cooling fan, along with the upper and lower shrouds. For details, please refer to the procedure found earlier in this section.

   Ä Although fan and shroud removal is not required on many older vehicles covered by this manual, because of the tight working conditions, it is highly recommended.

4. Remove the accessory drive belt pulley-to-damper bolts, then remove the pulley. On some models the center bolt (torsional damper bolt) is equipped with a LARGE flat washer which would prevent removal of the pulley. On these engines the pulley cannot be removed until the next step has been completed.
5. Remove the damper-to-crankshaft bolt. If removal is difficult, you have 2 options. The first is to hold the crankshaft from turning (on M/T vehicles this can be done by blocking the wheels, setting the parking brake and putting the van in gear. On A/T vehicles you must use a flywheel holding tool.). The second option is to cheat the bolt through impact (an air ratchet is best, though a sharp blow on the end of a wrench or breaker bar may also do the trick) or through using a penetrating oil. If the various special tools mentioned before are not available, apply penetrating oil to the bolt and allow it to sit overnight (this usually does the trick).
6. Using the a suitable torsional damper puller/installer tool (NOT AT JAWED TYPE) draw the damper from the end of the crankshaft.

   Ä When performing this operation, ALWAYS replace the front oil seal with a new one.

7. To replace the engine front oil seal in the timing cover, perform the following procedures (if the timing cover is being removed, this should be done after the cover is removed or during the beginning of the installation process):
   a. Using a medium prybar, carefully pry the oil seal from the timing cover. Take care not to score and damage the sealing surfaces and DO NOT distort the front cover.
   b. Coat the lips of the new seal with engine oil. The open end of the seal faces inside the engine.
   c. Using a suitable seal installer such as J-35468, or an equivalent sized driver, install the new oil seal into the timing cover.
8. Inspect the damper (oil seal surface) for rust or burrs; remove the roughness with fine emery cloth.

Figure 171.
On some models you will have to remove the damper hub-to-crankshaft bolt before the pulley

{ewc GSMVIMG,GSMVIMG, !88263p65.bmp}

88263p65

Figure 172.
The hub bolt on this 4.3L engine has a LARGE flat washer which spreads the clamp load on the pulley

{ewc GSMVIMG,GSMVIMG, !88263p66.bmp}

88263p66

Figure 173.
Loosen and remove the retaining bolts around the perimeter of the pulley face . . .

{ewc GSMVIMG,GSMVIMG, !88263p67.bmp}

88263p67

Figure 174.
. . . then remove the pulley from the damper

{ewc GSMVIMG,GSMVIMG, !88263p68.bmp}

88263p68

Figure 175.
Use a suitable (NON-JAWED) puller to loosen the damper on the crankshaft

{ewc GSMVIMG,GSMVIMG, !88263p69.bmp}

88263p69

Figure 176.
Once loosened, the damper is easily removed

{ewc GSMVIMG,GSMVIMG, !88263p70.bmp}

88263p70

Figure 177.
Use an appropriate torsional damper puller to remove the damper from the crankshaft

{ewc GSMVIMG,GSMVIMG, !88263g85.bmp}

88263g85

Figure 178.
The torsional damper installer is designed to gently draw the damper into position without damaging the hub

{ewc GSMVIMG,GSMVIMG, !88263g87.bmp}

88263g87

Figure 179.
Install replacement front oil seals using a suitable driver (such as J-35468)

{ewc GSMVIMG,GSMVIMG, !88263g86.bmp}

88263g86

Figure 180.
If necessary, drive a new oil seal into place before reinstalling the damper

{ewc GSMVIMG,GSMVIMG, !88263p71.bmp}

88263p71

To install:

Ä When installing the damper onto the crankshaft, be careful not to damage the front oil seal.

9. Lubricate the hub with engine oil, align it with the keyway and install it onto the crankshaft. Use the torsional damper puller/installer tool to slowly draw the damper into position..

   Ä If the tool is not available you MAY be able to align the damper and thread the retaining bolt a few turns, then use the hub retaining bolt to draw the damper into position. Be careful that sufficient threads are engaged first or you could strip the threads on the bolt or shaft. If the bolt cannot be started (because the distance is too great) obtain a second bolt of the same thread size, but of a longer length. You may also need some thick flat washers (in case the bolt is too long).

   Ä REMEMBER that the damper retaining bolt on some models MUST be installed AFTER the pulley (or stated another way, you may have to position the pulley before installing the damper bolt.

10. Tighten the damper hub-to-crankshaft bolt to 70 ft. lbs. (95 Nm) for 1985–95 vehicles or to 74 ft. lbs. (100 Nm) for 1996 vehicles.
11. If not done already, position the accessory drive belt pulley, then secure using the retaining bolts.
12. If removed, install the lower shroud, followed by the engine cooling fan and upper shroud.
13. Install the drive belt(s), then check and/or adjust the belt tension as applicable. For details, please refer to Section 1 of this manual.
14. Start the engine, then check for leaks or normal operation.

Timing Cover and Front Oil Seal {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Timing Cover and Front Oil Seal

REMOVAL & INSTALLATION

2.5L Engine

Ü See figures 181, 182, 183

Ä This procedure requires the use of the GM Seal Installer/Centering tool No. J–34995 or equivalent.

1. Disconnect the negative battery cable for safety.
2. Refer to the Crankshaft Pulley, Damper and Oil Seal, Removal and Installation procedures in this section and remove the damper from the crankshaft.
3. If not done already, remove the fan and the pulley.
4. Remove the alternator and the brackets from the front of the engine.
5. Remove the lower radiator hose clamp at the water pump.
6. Remove the timing cover bolts and cover. Check for bolts threaded from the front of the oil pan to the bottom of the cover. If present, these must be removed before attempting to loosen the cover.
7. If the front seal is to be replaced, it can be pried out of the cover with a small prytool.
8. Using a plastic scraper, clean the gasket mounting surfaces. Then clean the surface with solvent to remove all traces of oil and grease.

Ä The timing cover can become distorted very easily, so be careful when cleaning the gasket surface.

Figure 181.
Exploded view of the crankshaft pulley, damper/hub and timing gear cover assembly—2.5L engine

{ewc GSMVIMG,GSMVIMG, !88263g88.bmp}

88263g88

Figure 182.
Apply RTV sealer to the timing gear cover as shown

{ewc GSMVIMG,GSMVIMG, !88263g89.bmp}

88263g89

Figure 183.
GM seal installer and centering tool

{ewc GSMVIMG,GSMVIMG, !88263g90.bmp}

88263g90

To install:

9. Apply engine oil to the lips of the new oil seal. Using the GM Seal Installer/Centering tool No. J–34995 or equivalent, install the new oil seal into the timing cover; leave the tool installed in the timing cover.
10. Using RTV sealant or equivalent, apply a $^{1}/4$ in. (6mm) wide bead to the timing cover mounting surface and a $^{3}/8$ in. (9.5mm) wide bead to the oil pan at the timing cover sealing surface.
11. Using the GM Seal Installer/Centering Tool J-34995 or equivalent, align the front cover.

Install the cover while the RTV sealant is still wet and finger-tighten the retainers.

12. Tighten the timing cover-to-engine bolts to 90 inch lbs. (10 Nm) first, then, tighten the timing cover-to-oil pan bolts to 90 inch lbs. (10 Nm). Remove the seal installer/centering tool from the timing cover.
13. Install the lower radiator hose clamp to the water pump.
14. Install the alternator and the brackets at the front of the engine.
15. Install crankshaft damper and pulley. For details, please refer to the procedure found earlier in this section.
16. If not done already, install the fan and the pulley.
17. Connect the negative battery cable, start the engine and check for leaks.

4.3L Engine {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

4.3L Engine

1985–95 Models

Ü See figures 184, 185, 186, 187

Ä The following procedure requires the use of a torsional damper puller/installer tool such as GM tool no. J-23523-E (1985–92 models), J-39046 (1993–95 models) or an equivalent, and the GM Seal Installer tool No. J-35468 or equivalent.

1. Disconnect the negative battery cable for safety.
2. Remove the water pump assembly from the engine. For details, please refer to the procedure found earlier in this section.
3. Remove the crankshaft pulley and damper. For details, please refer to the procedure found earlier in this section.
4. Either loosen or remove the oil pan, as necessary. For 1985–91 models the manufacturer recommends that the oil pan be removed. For 1992–95 models the manufacturer recommends that the pan just be loosened. It is possible that this can be done on earlier models as well, but caution must be taken to prevent front cover and oil pan seal damage.
5. For 1995 vehicles, remove the crankshaft position sensor.
6. Remove the timing cover-to-engine bolts, then carefully remove the cover from the engine. If the oil pan was not removed, be careful not to damage the oil pan-to-front cover seal or sealing surfaces.
7. Using a plastic scraper, clean the gasket mounting surfaces. Using solvent and a rag, clean the oil and grease from the gasket mounting surfaces.
8. If the front cover seal is to be replaced, it may be pried front the front cover using a suitable prytool. Take care not to score and damage the seal bore, and take even greater care NOT TO distort the cover metal.
9. Inspect the timing cover for distortion and damage, if necessary, replace it.

Figure 184.
Loosen and remove the timing cover retaining bolts . . .

{ewc GSMVIMG,GSMVIMG, !88263p72.bmp}

88263p72

Figure 185.
. . . then carefully break the gasket seal and . . .

{ewc GSMVIMG,GSMVIMG, !88263p73.bmp}

88263p73

Figure 186.
. . . remove the cover from the engine

{ewc GSMVIMG,GSMVIMG, !88263p74.bmp}

88263p74

Figure 187.
If you install a replacement front seal with the cover OFF the engine, BE SURE TO SUPPORT IT to prevent damage

{ewc GSMVIMG,GSMVIMG, !88263g91.bmp}

88263g91

To install:

Ä Beginning in 1992, the manufacturer began suggesting you wait until the front cover is mounted to the engine before you install the replacement crankshaft oil seal. This may be to assure the cover is properly supported. On earlier vehicles, the manufacturer allowed for installation with the cover removed or installed, so waiting would be acceptable for all years of the 4.3L engine.

10. If desired on early-model engines, install a new seal to the cover using a suitable installation driver, such as J-35468 or equivalent. Be sure to support the back of the seal cover area during installation to prevent the cover from becoming distorted or damaged. Lightly coat the lips of the new seal with clean engine oil.

    Ä The oil seal is installed with the open end of the seal lips facing toward the inside of the engine.

11. Position a new front cover gasket to the engine or cover using a high-tack gasket cement to hold it in position. If the oil pan was not removed, lubricate the front of the oil pan seal with clean engine oil to aid in reassembly.
12. Install the front cover to the engine. If the oil pan is still in place, take care while engaging the front of the oil pan seal with the bottom of the cover.
13. Install front cover retaining bolts and tighten to 124 inch lbs. (14 Nm).

    Ä Tighten the timing cover bolts alternately and evenly, while gently pressing on the cover.

14. If removed and not installed earlier, use the seal installation driver to install the new crankshaft seal at this time.
15. For 1995 vehicles, install the crankshaft position sensor.
16. Either secure or install the oil pan, depending on your decision earlier.
17. Install the crankshaft damper and pulley.
18. Install the water pump assembly.
19. Connect the negative battery cable, the properly refill and bleed the engine cooling system.
20. Run the engine and check for leaks.

1996 Models {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Engine And Engine Overhaul

1996 Models

Ü See figures 184, 185, 186, 187

Ä The 1996 4.3L engine covered by this manual uses a composite engine front cover which must be discarded if it is removed from the engine. If a composite front cover is reused there is a good chance that it will leak.

1. Disconnect the negative battery cable for safety.
2. Remove the water pump assembly from the engine. For details, please refer to the procedure found earlier in this section.
3. Remove the crankshaft pulley and damper. For details, please refer to the procedure found earlier in this section.
4. Loosen the oil pan to help provide clearance for front cover removal without damaging the front cover-to-oil pan seal.
5. Remove the crankshaft position sensor.
6. Remove the timing cover-to-engine bolts, then carefully remove the cover from the engine. Be careful not to damage the oil pan-to-front cover seal or sealing surfaces.
7. Discard the old timing cover.
8. Using a plastic scraper, solvent and a rag, clean the oil, grease and varnish from the mounting surfaces on the engine.

To install:

9. Lubricate the front of the oil pan seal with clean engine oil to aid in reassembly.
10. Install the new front cover to the engine, then tighten the front cover retaining bolts to 124 inch lbs. (14 Nm).

    Ä Tighten the timing cover bolts alternately and evenly, while gently pressing on the cover.

11. Install the crankshaft position sensor.
12. Secure the oil pan.
13. Install the crankshaft damper and pulley.
14. Install the water pump assembly.
15. Connect the negative battery cable, the properly refill and bleed the engine cooling system.
16. Run the engine and check for leaks.

Timing Chain {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Timing Chain

REMOVAL & INSTALLATION

4.3L Engine

Ü See figures 188, 189, 190, 191, 192, 193, 194, 195

The 4.3L engine is the only engine covered by this manual which uses a timing chain and gear (sprocket) assembly to turn the camshaft. The 2.5L engine uses a direct gear drive (without a chain).

Ä The following procedure requires the use of the Crankshaft Sprocket Removal tool No. J-5825-A or equivalent, and the Crankshaft Sprocket Installation tool No. J-5590 or equivalent.

1. Remove the timing cover from the engine.
2. Rotate the crankshaft until the No. 4 cylinder is on the TDC of its compression stroke and the camshaft sprocket mark aligns with the mark on the crankshaft sprocket (facing each other at a point closest together in their travel) and in line with the shaft centers.
3. For 1996 models, remove the crankshaft position sensor reluctor ring from the end of the crankshaft.
4. Remove the camshaft sprocket-to-camshaft nut and/or bolts, then remove the camshaft sprocket (and balance shaft drive gear on VIN W engines) along with the timing chain. If the sprocket is difficult to remove, use a plastic mallet to bump the sprocket from the camshaft.

   Ä The camshaft sprocket (located by a dowel) is lightly pressed onto the camshaft and should come off easily. The chain comes off with the camshaft sprocket.

5. If necessary use J-5825-A or an equivalent crankshaft sprocket removal tool to free the timing sprocket from the crankshaft.

Figure 188.
Exploded view of a typical 4.3L engine timing chain and gear assembly—use of studs may vary

{ewc GSMVIMG,GSMVIMG, !88263g93.bmp}

88263g93

Figure 189.
Align the timing marks closest together (No. 4 TDC) before starting—NOTE that No. 1 TDC would be aligned, but with both timing marks at top of their travel

{ewc GSMVIMG,GSMVIMG, !88263g92.bmp}

88263g92

Figure 190.
Remove the timing cover, then turn the crankshaft as necessary to align the timing marks

{ewc GSMVIMG,GSMVIMG, !88263p75.bmp}

88263p75

Figure 191.
Loosen and remove the camshaft sprocket retaining bolts . . .

{ewc GSMVIMG,GSMVIMG, !88263p76.bmp}

88263p76

Figure 192.
. . . then remove the camshaft sprocket along with the timing chain

{ewc GSMVIMG,GSMVIMG, !88263p77.bmp}

88263p77

Figure 193.
If necessary, use a suitable puller to remove the crankshaft sprocket

{ewc GSMVIMG,GSMVIMG, !88263p78.bmp}

88263p78

Figure 194.
GM crankshaft sprocket removal tool

{ewc GSMVIMG,GSMVIMG, !88263g94.bmp}

88263g94

Figure 195.
Use the GM installation tool (or a suitable driver) to install the crankshaft sprocket

{ewc GSMVIMG,GSMVIMG, !88263g95.bmp}

88263g95

To install:

6. Inspect the timing chain and the timing sprockets for wear or damage, replace the damaged parts as necessary.
7. If removed, use J-5590, or an equivalent crankshaft sprocket installation tool and a hammer to drive the crankshaft sprocket onto the crankshaft, without disturbing the position of the engine.
8. On VIN W engines, align and install the balance shaft drive gear. For details, please refer to the balance shaft procedure found later in this section.

   Ä During installation, coat the thrust surfaces lightly with Molykote® or an equivalent pre-lube.

9. Position the timing chain over the camshaft sprocket. Arrange the camshaft sprocket in such a way that the timing marks will align between the shaft centers and the camshaft locating dowel will enter the dowel hole in the cam sprocket.
10. Position the chain under the crankshaft sprocket, then place the cam sprocket (on VIN W motors the balance shaft drive gear must still be in place), with the chain still mounted over it, in position on the front of the camshaft. Install and tighten the camshaft sprocket-to-camshaft retainers to 21 ft. lbs. (28 Nm).
11. With the timing chain installed, turn the crankshaft two complete revolutions, then check to make certain that the timing marks are in correct alignment between the shaft centers.
12. For 1996 models, install the crankshaft position reluctor ring to the end of the shaft.
13. Install the timing cover.

Timing Gears {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Timing Gears

Unlike the rest of the engines covered by this manual, the 2.5L engine does not use a timing chain assembly. Instead the camshaft timing gear is directly driven by the crankshaft timing gear. The timing gear (camshaft sprocket) is pressed onto the camshaft and requires the use of an arbor press to remove.

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REMOVAL & INSTALLATION

2.5L Engine

Ü See figures 196, 197

Ä The following procedure requires the use of an arbor press, a press plate, the GM gear removal tool No. J-971 or equivalent, and the GM gear installation tool No. J-21474-13, J-21795-1 or equivalent.

1. Remove the camshaft. For details, please refer to the procedure later in this section.
2. Using an arbor press, a press plate and the GM Gear Removal tool No. J-971 or equivalent, press the timing gear from the camshaft.

   Ä When pressing the timing gear from the camshaft, be certain that the position of the press plate does not contact the woodruff key.

3. To assemble, position the press plate to support the camshaft at the back of the front journal. Place the gear spacer ring and the thrust plate over the end of the camshaft, then install the woodruff key. Press the timing gear onto the camshaft, until it bottoms against the gear spacer ring.

   Ä The end clearance of the thrust plate should be 0.0015–0.005 in. (0.038–0.127mm). If less than 0.0015 in. (0.038mm), replace the spacer ring; if more than 0.005 in. (0.127mm), replace the thrust plate.

4. To complete the installation, align the marks on the timing gears and install the camshaft. For details, please refer to the procedure later in this section.

Figure 196.
The timing gear must be pressed from the camshaft using a suitable arbor press, driver and gear support

{ewc GSMVIMG,GSMVIMG, !88263g96.bmp}

88263g96

Figure 197.
Once the gear is pressed onto the camshaft, check the end clearance at the thrust plate using a feeler gauge

{ewc GSMVIMG,GSMVIMG, !88263g97.bmp}

88263g97

Camshaft {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Camshaft

REMOVAL & INSTALLATION

2.5L Engine

Ü See figures 198, 199

1. Disconnect the negative battery cable for safety. Refer to the Pushrod Cover, Removal and Installation and the Valve Lifters, Removal and Installation procedures in this section, then remove the cover, pushrods and the valve lifters from the engine.

   Ä When removing the pushrods and the valve lifters, be sure to keep them in order for reassembly purposes.

2. Place a catch pan under the radiator, open the drain cock and drain the cooling system.

   ****Caution**
   When draining the coolant, keep in mind that cats and dogs are attracted by ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.

3. Remove the power steering reservoir from the fan shroud, then remove the upper fan shroud and the radiator. Remove the grille, the headlight bezel and the bumper filler panel.
4. Remove the accessory drive belts, the cooling fan and the water pump pulley.
5. If equipped with air conditioning, disconnect the condenser baffles and the condenser attaching bolts, then raise the condenser and block it aside. Be careful not to stress or damage the A/C refrigerant lines.
6. Remove the crankshaft drive belt pulley and the damper hub. Remove the timing gear cover-to-engine bolts and the cover.
7. Label and disconnect the distributor electrical connectors, then remove the hold-down bolt and the distributor from the engine. Remove the oil pump driveshaft.
8. Label and disconnect the vacuum lines from the intake manifold and the thermostat housing, then remove the Exhaust Gas Recirculation (EGR) valve from the intake manifold.
9. Remove the camshaft thrust plate-to-engine bolts. While supporting the camshaft (to prevent damaging the bearing or lobe surfaces), remove it from the front of the engine.
10. Inspect the camshaft for scratches, pitting and/or wear on the bearing and lobe surfaces. Check the timing gear teeth for damage.

Figure 198.
Aligning the timing gear marks—2.5L engine

{ewc GSMVIMG,GSMVIMG, !88263g98.bmp}

88263g98

Figure 199.
Remove the camshaft-to-engine thrust plate bolts through the access hole in the gear—2.5L engine

{ewc GSMVIMG,GSMVIMG, !88263g99.bmp}

88263g99

To install:

11. Lubricate all of the parts with engine oil and install the camshaft carefully so not to damage the cam bearings. Torque the camshaft thrust plate-to-engine bolts to 90 inch lbs. (10 Nm).
12. Connect the vacuum lines to the intake manifold and the thermostat housing, then install the Exhaust Gas Recirculation (EGR) valve to the intake manifold.
13. Install the oil pump driveshaft.
14. Install the distributor, adjust the timing and connect the distributor electrical connectors.
15. Install the timing gear cover-to-engine bolts and the cover. Install the crankshaft drive belt pulley and the damper hub.
16. If equipped with air conditioning, connect the condenser baffles and the condenser.
17. Install the accessory drive belts, the cooling fan and the water pump pulley.
18. Install the power steering reservoir to the fan shroud, then the upper fan shroud, the radiator. Install the grille, the headlight bezel and the bumper filler panel.
19. Connect the negative battery cable. Refer to the Pushrod Cover, Removal and Installation and the Valve Lifters, Removal and Installation procedures in this section, then install the pushrods and the valve lifters to the engine.
20. Refill the engine with coolant, connect the negative battery cable, start the engine and check for leaks.

4.3L Engine {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Engine And Engine Overhaul

4.3L Engine

Ü See figures 200, 201

Ä The following procedure requires the use of a torsional damper puller/installer tool such as GM tool no. J-23523-E (1985–92 models), J-39046 (1993–96 models) or an equivalent.

1. From inside the vehicle, remove the engine cover. For details, please refer to Section 1 of this manual.
2. Properly relieve the fuel system pressure, then disconnect the negative battery cable.
3. Place a catch pan under the radiator, open the drain cock and drain the cooling system.

****Caution**
When draining the coolant, keep in mind that cats and dogs are attracted by ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.

4. Remove the engine cooling fan.
5. Remove the radiator assembly.
6. Remove the rocker arm covers.
7. Remove the intake manifold.
8. Remove the timing cover.
9. Remove the valve lifters.

Ä When removing the pushrods and the valve lifters, be sure to tag, arrange or otherwise keep them in order to assure installation in their original locations. Of course, if the camshaft is being replaced, this would not be necessary for the lifters, since they would have to be replaced as well.

10. Align the timing marks, then remove the timing chain and camshaft sprocket.
11. Thread two or three, $^{5}/16$–18 in. bolts, which are 4–5 in. (100–125mm) long into the camshaft sprocket retaining holes. Using these camshaft bolts as handles, support the camshaft and pull it from the front of the engine block. Pull the shaft STRAIGHT back and from the bearings, while rotating it slightly; be careful not to damage the camshaft bearing or lobe surfaces.
12. Inspect the camshaft for scratches, pitting and/or wear on the bearing and lobe surfaces. Check the timing sprockets teeth and timing chain for damage and/or wear, replace the damaged parts (if necessary).

Figure 200.
Using bolts as a handle, pull STRAIGHT back and carefully remove the camshaft from the engine

{ewc GSMVIMG,GSMVIMG, !88263ga1.bmp}

88263ga1

Figure 201.
Exploded view of the camshaft and other cylinder block component mounting—VIN W shown (VIN B, N or Z similar, but without balance shaft)

{ewc GSMVIMG,GSMVIMG, !88263ga2.bmp}

88263ga2

To install:

13. Before installing the camshaft, coat the lobes and bearings using either a high viscosity oil with zinc (such as GM 12345501) or with a suitable engine pre-lube.

    Ä GM recommends that whenever a new camshaft and/or a set of new lifters has been installed, that you change the engine oil and filter, and then add GM engine oil supplement 1052367 to the engine oil upon refill.

14. Using the bolts as handles, carefully slide the camshaft into the engine. Be certain to push the shaft straight inward to help prevent possible damage to the camshaft bearings.
15. Install the timing chain and camshaft sprocket, making sure to align the timing marks.

    Ä REMEMBER that if the lifters and/or pushrods are not replaced, they must be reinstalled in their original positions.

16. Install the valve lifters.
17. Install the timing cover.
18. Install the intake manifold.
19. Install the rocker arm covers.
20. Install the radiator assembly.
21. Install the engine cooling fan.
22. If the camshaft was replaced, change the engine oil and filter.
23. Connect the negative battery cable and properly refill the engine cooling system.
24. Run the engine and check for leaks.
25. Check and/or adjust the engine timing, as necessary.
26. Once the engine has cooled sufficiently, install the engine cover to the passenger compartment.

INSPECTION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

INSPECTION

Ü See figures 202, 203, 204

Using solvent, degrease the camshaft and clean out all of the oil holes. Visually inspect the cam lobes and bearing journals for excessive wear. If a lobe is questionable, check all of the lobes as indicated. If a journal or lobe is worn, the camshaft MUST BE reground or replaced.

Ä If a journal is worn, there is a good chance that the bushings are worn and need replacement.

If the lobes and journals appear intact, place the front and rear journals in V-blocks and rest a dial indicator on the center journal. Rotate the camshaft to check the straightness. If deviation exceeds 0.001 in. (0.0254mm), replace the camshaft.

Check the camshaft lobes with a micrometer, by measuring the lobes from the nose to the base and again at 90º (see illustration). The lobe lift is determined by subtracting the second measurement from the first. If all of the exhaust and intake lobes are not identical, the camshaft must be reground or replaced.

Figure 202.
Use a dial indicator to measure the camshaft for straightness (camshaft runout)

{ewc GSMVIMG,GSMVIMG, !88263ga3.bmp}

88263ga3

Figure 203.
Subtract measurement B from measurement A (width from height) in order to determine camshaft lobe lift

{ewc GSMVIMG,GSMVIMG, !88263ga4.bmp}

88263ga4

Figure 204.
A dial gauge can be used to measure lobe lift with the camshaft installed

{ewc GSMVIMG,GSMVIMG, !88263ga5.bmp}

88263ga5

Ä Camshaft lobe lift can also be measured with the shaft still installed.

To determine camshaft lobe wear, with the shaft still installed.

1. Remove the rocker arm covers.
2. Loosen and reposition the rocker arms so the pushrods can be accessed.
3. Mount a dial gauge so the plunger rests on the end of the pushrod (so it will read pushrod movement).
4. Turn the crankshaft slowly in the normal direction of rotation until the lifter is on the base of the camshaft lobe (the pushrod will not be at its lowest point of travel), then zero the gauge.
5. Rotate the crankshaft slowly until the pushrod moves to the fully raised position.
6. Compare the readings for each camshaft lobe (as shown by the dial indicator) with the specifications.

   Ä Keep in mind that hydraulic lifters can allow for some camshaft lobe height loss. If a camshaft is close, but out of specification, verify that plunger movement is not responsible for the difference before replacing the shaft.

7. Reposition and install the rocker arms. For details, please refer to the procedure found earlier in this section.

8. Install the rocker arm covers.

Camshaft Bearings {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Camshaft Bearings

REMOVAL & INSTALLATION

2.5L Engine

Ü See figure 205

Ä The following procedure requires the use of the GM Camshaft Bushing Removal/Installation Adapter tool No. J–21437–1 or equivalent, and GM Camshaft Bushing Removal/Installation Handle tool No. J–21054–1 or equivalent.

1. Refer to the Engine, Removal and Installation procedures in this section and remove the engine from the vehicle and secure it onto a work stand.
2. Refer to the Camshaft, Removal and Installation and the Oil Pan, Removal and Installation procedures in this section, then remove the camshaft and the oil pan from the engine.
3. Remove the flywheel-to-crankshaft bolts and the flywheel from the engine.
4. Using a blunt tool, drive the camshaft expansion plug from the rear of the engine.
5. Using the GM Camshaft Bushing Removal/Installation Adapter tool No. J–21437–1 or equivalent and a hammer, drive the front camshaft bearing toward the rear and the rear camshaft bearing toward the front of the engine.
6. Install the GM Camshaft Bushing Removal/Installation Handle tool No. J–21054–1 or equivalent, onto the GM Camshaft Bushing Removal/Installation Adapter tool No. J–21437–1 or equivalent, and drive the center camshaft bearing toward the rear of the engine.

Figure 205.
Camshaft bearing replacement requires special bearing removal and installation tools—2.5L engine

{ewc GSMVIMG,GSMVIMG, !88263ga6.bmp}

88263ga6

To install:

7. Position the bearing on the tool(s) and tighten the end bolt to draw the bearing into its seat. Make sure that the oil holes are lined up and free from obstructions.

Ä The front bearing MUST BE driven to approximately $^{1}/8$ in. (3mm) behind the front of the cylinder block; BE SURE that the oil hole-to-timing gear oil nozzle is uncovered.

8. Install the camshaft being careful not to damage the new bearings.
9. Install the oil pan.
10. Install the engine.
11. Adjust the valves as outlined in the "Valve Lash” procedures in Section 2.
12. Refill the cooling system and the crankcase. Start the engine, allow it to reach normal operating temperatures and check for leaks.

4.3L Engine {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

4.3L Engine

Ü See figures 206, 207

To perform this procedure, it is recommended to remove the engine from the vehicle.

Ä The following procedure requires the use of the GM Camshaft Bearing Remover/Installer tool No. J–6098 (1985–95 models), J–33049 (1996 models) or equivalent.

1. Refer to the Camshaft, Removal and Installation and the Crankshaft, Removal and Installation procedures in this section and remove the camshaft and the crankshaft from the engine; leave the cylinder heads attached and the pistons in place.

   Ä Before removing the crankshaft, tape the threads of the connecting rod bolts or cover them with lengths of rubber hose in order to prevent damage to the crankshaft. Fasten the connecting rods against the sides of the engine, so that they will not be in the way while replacing the camshaft bearings.

2. Drive the camshaft rear plug from the block.
3. Assemble the camshaft bearing remover/installer tool using its shoulder, on the bearing to be removed.
4. Gradually, tighten the puller nut until the bearing is removed. Remove the remaining bearings, leaving the front and the rear for last.
5. To remove the front and rear bearing, reverse the position of the tool, so as to press the bearings toward the center of the block.

Figure 206.
Special camshaft bearing removal and installation tools are necessary to replace the camshaft bearings

{ewc GSMVIMG,GSMVIMG, !88263ga7.bmp}

88263ga7

Figure 207.
It is CRITICAL that the camshaft bearing oil holes are properly aligned. This wire tool has a 90º bend to help check for proper oil hole alignment

{ewc GSMVIMG,GSMVIMG, !88263ga8.bmp}

88263ga8

To install:

6. Install the new bearings, leave the tool in this position, pilot the new front and rear bearings on the installer, then press them into position.
7. Return the tool to its original position and press the remaining bearings into position.

   Ä Ensure that the oil holes align when installing the bearings.

8. Coat a new camshaft rear plug using a suitable sealer, then drive it into position and stake it to aid in retention.
9. Install the camshaft using care not to damage the cam bearings.
10. Assemble the engine and install it into the vehicle as outlined in this section.
11. Refill all engine fluids, start the engine and check for proper operation.

Balance Shaft {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Balance Shaft

The higher performance VIN W engine was given a balance shaft (in addition to the usual crankshaft damper) in order to help smooth the engine. It is gear driven directly from a sprocket mounted between the camshaft timing sprocket and the camshaft itself.

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Engine And Engine Overhaul

REMOVAL & INSTALLATION

Ü See figures 208, 209, 210, 211, 212, 213, 214, 215

1. If equipped, properly discharge and recover the A/C refrigerant, using a suitable recovery station. If you do not have certification for and access to such equipment, take the vehicle to a reputable repair facility and have the system discharged.
2. From inside the vehicle, remove the engine cover. For details, please refer to Section 1 of this manual.
3. Properly relieve the fuel system pressure, then disconnect the negative battery cable.
4. Place a catch pan under the radiator, open the drain cock and drain the cooling system.

   ****Caution**
   When draining the coolant, keep in mind that cats and dogs are attracted by ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.

5. Remove the air cleaner box and air intake duct.
6. For 1996 vehicles, remove the A/C compressor, bracket and accessory drive bracket (as equipped). Immediately plug all openings in the A/C system to prevent system contamination.
7. Remove the engine cooling fan.
8. Remove the radiator assembly.
9. On 1992–94 vehicles, remove the headlight bezels.
10. Remove the grille.
11. Remove the air conditioner condenser. Immediately plug all openings in the A/C system to prevent system contamination.
12. Remove the water pump assembly.
13. Remove the crankshaft pulley and torsional damper.
14. Raise and support the front of the vehicle safely using jackstands.
15. Remove the oil pan.
16. Remove the front timing cover.
17. Remove the camshaft sprocket, timing chain and balance shaft drive gear.
18. Remove the balance shaft driven gear.

    Ä The balance shaft drive and driven gears are to be serviced ONLY as a matched set. This set INCLUDES the balance shaft driven gear bolt.

19. Remove the balance shaft retainer.
20. Remove the intake manifold assembly.
21. Remove the hydraulic valve lifter retainer.
22. Remove the balance shaft from the bearing using a soft faced mallet.
23. Remove the rear bearing using tool J-38834 and J-26941 or equivalent balance shaft

bearing service kit and needle bearing removal tool.

Ä The balance shaft and front bearing are to be serviced or replaced only as a complete assembly. DO NOT attempt to remove the front bearing from the shaft.

Figure 208.
Balance shaft drive (lower) and driven (upper) gears
{ewc GSMVIMG,GSMVIMG, !88263gb7.bmp}

88263gb7

Figure 209.
Exploded view of the balance shaft mounting—VIN W engine
{ewc GSMVIMG,GSMVIMG, !88263ga9.bmp}

88263ga9

Figure 210.
Remove the balance shaft using a soft-faced mallet
{ewc GSMVIMG,GSMVIMG, !88263gb1.bmp}

88263gb1

Figure 211.
GM shaft service kit, set-up to remove the shaft rear bearing
{ewc GSMVIMG,GSMVIMG, !88263gb2.bmp}

88263gb2

Figure 212.
Removing the shaft rear bearing using the service kit
{ewc GSMVIMG,GSMVIMG, !88263gb3.bmp}

88263gb3

Figure 213.
Installing the balance shaft rear bearing
{ewc GSMVIMG,GSMVIMG, !88263gb4.bmp}

88263gb4

Figure 214.
Using the shaft installer and driver handle to drive the shaft into position
{ewc GSMVIMG,GSMVIMG, !88263gb5.bmp}

88263gb5

Figure 215.
Balance shaft drive and driven gear timing mark alignment
{ewc GSMVIMG,GSMVIMG, !88263gb6.bmp}

88263gb6

To install:

24. Dip the bearings in clean engine oil before installation.
25. Using tool J-38834, install the balance shaft rear bearing with the flat edge and the manufacturer's markings facing the front of engine.
26. Dip the front balance shaft bearing into engine oil. Using tool J-36996 and J-8092 or equivalent shaft installer and driver handle, install the balance shaft into the block.
27. Install the balance shaft retainer and torque the bolts to 120 inch lbs. (14 Nm).
28. Install the balance shaft driven gear. Install the bolt and torque to 15 ft. lbs. (20 Nm) plus turn

the bolt an additional 35 degrees (using a torque angle meter).

29. Install the lifter retainer and turn the balance shaft to ensure proper clearance. If clearance does not exist, the lifter retainer may have to be replaced.
30. Turn the camshaft so that the timing mark on the balance shaft drive gear (temporarily installed) is facing straight upward (toward the driven gear).
31. Remove the drive gear, then turn the balance shaft so that the driven gear timing mark is facing straight down (toward the camshaft and drive gear (when it is reinstalled).
32. Install the drive gear to the camshaft, making sure that the timing marks on the drive and driven gears are still in alignment (dot-to-dot).
33. Install the balance shaft drive gear retaining stud and torque to 12 ft. lbs. (16 Nm).
34. Install the intake manifold assembly.
35. Align and install the timing chain and camshaft sprocket.
36. Install the front timing cover.
37. Install the oil pan.
38. Install the crankshaft pulley and torsional damper.
39. Install the water pump assembly.
40. If equipped, install the air conditioner condenser.
41. Install the grille.
42. On 1992–94 vehicles, install the headlight bezels.
43. Install the radiator assembly.
44. Install the engine cooling fan.
45. On 1996 vehicles, install the A/C compressor, bracket and accessory drive bracket (as applicable).
46. Install the air cleaner box and air intake duct.
47. If not done already, remove the jackstands and carefully lower the vehicle.
48. Refill the engine crankcase using fresh engine oil, then connect the negative battery cable.
49. Properly refill the engine cooling system, then check for leaks.
50. Once the engine has cooled sufficiently, install the engine cover to the passenger compartment.
51. If the A/C system was discharged, take the van to a reputable repair facility to have the system evacuated, recharged and leak tested. DO NOT WAIT LONG to do this or moisture which entered the system while it was discharged will cause corrosion and internal system damage. ALSO, DO NOT run the compressor until the system has been properly recharged. Depending on how your model is equipped this may mean you CANNOT use the defogger (this automatically turns the compressor on in some vehicles).

Pistons and Connecting Rods {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Pistons and Connecting Rods

REMOVAL

Ü See figures 216, 217, 218

> **Ä Although in some cases the pistons and connecting rods may be removed with the engine still in the vehicle, it is rarely worth the aggravation, especially when you are not working with a lift. On vehicles where this is possible (cylinder head and oil pan removal are both possible with the engine installed AND there is sufficient working clearance) take EXTREME care to assure no dirt or contamination is allowed into the cylinders during assembly and installation.**

Before removing the pistons, the top of the cylinder bore must be examined for a ridge. A ridge at the top of the bore is the result of normal cylinder wear, caused by the piston rings only traveling so far up the bore in the course of the piston stroke. The ridge can be felt by hand; it must be removed before the pistons are removed.

A ridge reamer is necessary for this operation. Place the piston at the bottom of its stroke, and cover it with a rag. Cut the ridge away with the ridge reamer, using extreme care to avoid cutting too deeply. Remove the rag, and remove the cuttings that remain on the piston with a magnet and a rag soaked in clean oil. Make sure the piston top and cylinder bore are absolutely clean before moving the piston. For more details, refer to the ridge removal and honing procedures later in this section.

> **Ä If you plan on consulting a machine shop for hot tanking, honing, boring or other block service, you should do so BEFORE disassembling your engine. They may have specific preferences on whether or not you remove a cylinder ridge or how to you are to label parts.**

1. Remove the engine assembly from the vehicle.
2. Remove the intake manifold and the cylinder head(s).
3. Remove the oil pan and the oil pump assembly.
4. Check the connecting rods and caps for identification marks. If none are present, stamp the cylinder number on the machined surfaces of the bolt bosses on the connecting rod and cap for identification when reinstalling. If the pistons are to be removed from the connecting rod, mark the cylinder number on the piston with a silver pencil or quick drying paint for proper cylinder identification and cap to rod location.

Figure 216.
Normal cylinder wear and ridge formation

{ewc GSMVIMG,GSMVIMG, !88263gb8.bmp}

88263gb8

Figure 217.
Place hose over the connecting rod studs to protect the crankshaft and cylinders from damage

{ewc GSMVIMG,GSMVIMG, !tccs3803.bmp}

tccs3803

Figure 218.
Carefully tap the piston out of the bore using a wooden dowel

{ewc GSMVIMG,GSMVIMG, !tccs3804.bmp}

tccs3804

> **Ä The 2.5L (4–cyl) engine is numbered 1–2–3–4 (front-to-rear); on the 4.3L (V6) engine, is numbered 1–3–5 (front-to-rear) on the left side and 2–4–6 (front-to-rear) on the right**

side.

5. Examine the cylinder bore above the ring travel. If a ridge exists, remove it with a ridge reamer before attempting to remove the piston and rod assembly.
6. Remove the rod bearing cap and bearing.
7. Install lengths of short rubber hose over the rod bolt threads; this will help prevent damage to the bearing journal and rod bolt threads.
8. Remove the rod and piston assembly through the top of the cylinder bore by gently tapping outward using a wooden dowel or wooden tool handle; remove the other rod and piston assemblies in the same manner.

   Ä BE SURE to note the direction in which the piston was facing. These engines usually use pistons which are notched to show proper orientation. Make sure you note where any notch (if present) is located, or mark the piston using paint for installation purposes. Also, if you had to mark the piston, be careful during cleaning either not to accidentally remove the mark (when you are not paying attention), or to place a new mark on the piston once it has been cleaned.

CLEANING AND INSPECTION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CLEANING AND INSPECTION

Using a piston ring expanding tool, remove the piston rings from the pistons; any other method (screwdriver blades, pliers, etc.) usually results in the rings being bent, scratched or distorted and/or the piston itself being damaged.

Pistons {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Pistons

Ü See figures 219, 220, 221, 222

Clean the varnish from the piston skirts and pins with a cleaning solvent. DO NOT WIRE BRUSH ANY PART OF THE PISTON. Clean the ring grooves with a groove cleaner and make sure that the oil ring holes and slots are clean.

****Caution**
Do NOT use any solvent that will damage aluminum parts. Some hot tank solutions will dissolve aluminum.

Inspect the piston for cracked ring lands, scuffed or damaged skirts, eroded areas at the top of the piston. Replace the pistons that are damaged or show signs of excessive wear.

Inspect the grooves for nicks of burrs that might cause the rings to hang up.

Measure the piston skirt (across the center line of the piston pin) and check the piston clearance (the difference between the measurement you get at the piston skirt and the measurement of the cylinder bore). Compare the clearance to the specifications found in the charts at the beginning of this section. If clearance is excessive, consult a machine shop about boring the cylinders for oversize pistons.

Figure 219.
Use a ring expander tool to remove the piston rings

{ewc GSMVIMG,GSMVIMG, !tccs3211.bmp}

tccs3211

Figure 220.
Clean the piston grooves using a ring groove cleaner

{ewc GSMVIMG,GSMVIMG, !tccs3208.bmp}

tccs3208

Figure 221.
You can use a piece of an old ring to clean the piston grooves, BUT be careful, the ring is sharp

{ewc GSMVIMG,GSMVIMG, !tccs3911.bmp}

tccs3911

Figure 222.
Measure the piston's outer diameter using a micrometer

{ewc GSMVIMG,GSMVIMG, !tccs3210.bmp}

tccs3210

Connecting Rods {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Connecting Rods

Wash the connecting rods in cleaning solvent and dry with compressed air. Check for twisted or bent rods and inspect for nicks or cracks. Replace any connecting rods that are damaged.

Cylinder Bores {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Cylinder Bores

Ü See figures 223, 224, 225

Using a telescoping gauge or an inside micrometer, measure the diameter of the cylinder bore, perpendicular (90º) to the piston pin, at $2^1/2$ in. (63.5mm) below the surface of the cylinder block. The difference between the cylinder bore measurement and the piston skirt measurement is the piston clearance.

If the clearance is within specifications or slightly below (after the cylinders have been bored or honed), finish honing is all that is necessary, If the clearance is excessive, try to obtain a slightly larger piston to bring the clearance within specifications. If this is not possible obtain the first oversize piston and hone the cylinder or (if necessary) bore the cylinder to size. Generally, if the cylinder bore is tapered more than 0.005 in. (0.127mm) or is out-of-round more than 0.003 in. (0.0762mm), it is advisable to rebore for the smallest possible oversize piston and rings. After measuring, mark the pistons with a felt-tip pen for reference and for assembly.

Ä Boring of the cylinder block should be performed by a reputable machine shop with the proper equipment. In some cases, clean-up honing can be done with the cylinder block in the vehicle, but most excessive honing and all cylinder boring MUST BE done with the block stripped and removed from the vehicle.

Figure 223.
Cylinder bore measuring points

{ewc GSMVIMG,GSMVIMG, !88263gb9.bmp}

88263gb9

Figure 224.
Measuring the cylinder bore using a dial indicator

{ewc GSMVIMG,GSMVIMG, !88263gc1.bmp}

88263gc1

Figure 225.
A telescoping gauge may also be used to measure the cylinder bore diameter

{ewc GSMVIMG,GSMVIMG, !tccs3209.bmp}

tccs3209

RIDGE REMOVAL & HONING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Engine And Engine Overhaul

RIDGE REMOVAL & HONING

Ü See figures 226, 227, 228, 229, 230

1. Before the piston is removed from the cylinder, check for a ridge at the top of the cylinder bore. This ridge occurs because the piston ring does not travel all the way to the top of the bore, thereby leaving an unworn portion of the bore.
2. Clean away any carbon buildup at the top of the cylinder with sand paper, in order to see the extent of the ridge more clearly. If the ridge is slight, it will be safe to remove the pistons without damaging the rings or piston ring lands. If the ridge is severe, and easily catches your fingernail, it will have to be removed using a ridge reamer.

   Ä A severe ridge is an indication of excessive bore wear. Before removing the piston, check the cylinder bore diameter with a bore gauge, as explained in the cleaning and inspection procedure. Compare your measurement with engine specification. If the bore is excessively worn, the cylinder will have to bored oversize and the piston and rings replaced.

3. Install the ridge removal tool in the top of the cylinder bore. Carefully follow the manufacturer's instructions for operation. Remove only the amount of material necessary to remove the ridge. Place the piston at the bottom of its stroke, and cover it with a rag. Cut the ridge away with the ridge reamer, using extreme care to avoid cutting too deeply. Remove the rag, and remove the cuttings that remain on the piston with a magnet and a rag soaked in clean oil. Make sure the piston top and cylinder bore are absolutely clean before moving the piston.

   ****Warning**

   Be very careful if you are unfamiliar with operating a ridge reamer. It is very easy to remove more cylinder bore material than you want, possibly requiring a cylinder overbore and piston replacement that may not have been necessary.

4. After the piston and connecting rod assembly have been removed, check the clearances as explained earlier in this section under the cleaning and inspection procedure, to determine whether boring and honing or just light honing are required. If boring is necessary, consult an automotive machine shop. If light honing is all that is necessary, proceed with the next step.
5. Honing is best done with the crankshaft removed, to prevent damage to the crankshaft and to make post-honing cleaning easier, as the honing process will scatter metal particles. However, if you do not want to remove the crankshaft, position the connecting rod journal for the cylinder being honed as far away from the bottom of the cylinder bore as possible, and wrap a shop cloth around the journal.
6. Honing can be done either with a flexible glaze breaker type hone or with a rigid hone that has honing stones and guide shoes. The flexible hone removes the least amount of metal, and is especially recommended if your piston-to-cylinder bore clearance is on the loose side. The flexible hone is useful to provide a finish on which the new piston rings will seat. A rigid hone will remove more material than the flexible hone and requires more operator skill.
7. Regardless of which type of hone you use, carefully follow the manufacturers instructions for operation.
8. The hone should be moved up and down the bore at sufficient speed to obtain a uniform finish. A rigid hone will provide a definite cross-hatch finish; operate the rigid hone at a speed to obtain a 45–65 degree included angle in the cross-hatch. The finish marks should be clean but not sharp, free from embedded particles and torn or folded metal.
9. Periodically during the honing procedure, thoroughly clean the cylinder bore and check the

piston-to-bore clearance with the piston for that cylinder.

10. After honing is completed and BEFORE the piston is checked for fit, thoroughly wash the cylinder bores and the rest of the engine with hot water and detergent. Scrub the bores well with a stiff bristle brush and rinse thoroughly with hot water. Thorough cleaning is essential, for if any abrasive material is left in the cylinder bore, it will rapidly wear the new rings and the cylinder bore. If any abrasive material is left in the rest of the engine, it will be picked up by the oil and carried throughout the engine, damaging bearings and other parts.
11. After the bores are cleaned, wipe them down with a clean cloth coated with light engine oil, to keep them from rusting.

Figure 226.
Correct cylinder bore honing pattern

{ewc GSMVIMG,GSMVIMG, !88263gc2.bmp}

88263gc2

Figure 227.
Removing cylinder glazing using a flexible hone

{ewc GSMVIMG,GSMVIMG, !tccs3213.bmp}

tccs3213

Figure 228.
A solid hone can also be used to cross-hatch the cylinder bore

{ewc GSMVIMG,GSMVIMG, !tccs3915.bmp}

tccs3915

Figure 229.
As with a ball hone, work the hone carefully up and down the bore to achieve the desired results

{ewc GSMVIMG,GSMVIMG, !tccs3916.bmp}

tccs3916

Figure 230.
A properly cross-hatched cylinder bore

{ewc GSMVIMG,GSMVIMG, !tccs3216.bmp}

tccs3216

PISTON PIN REPLACEMENT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

PISTON PIN REPLACEMENT

Ü See figures 231, 232

Ä The following procedure requires the use of the GM Fixture/Support Assembly tool No. J–24086–20 or equivalent, the GM Piston Pin Removal tool No. J–24086–8 or equivalent, and the GM Piston Pin Installation tool No. J–24086–9 or equivalent.

Use care at all times when handling and servicing the connecting rods and pistons. To prevent possible damage to these units, DO NOT clamp the rod or piston in a vise since they may become distorted. DO NOT allow the pistons to strike one another, against hard objects or bench surfaces, since distortion of the piston contour or nicks in the soft aluminum material may result.

1. Using an arbor press, the GM Fixture/Support Assembly tool No. J–24086–20 or equivalent, and the GM Piston Pin Removal tool No. J–24086–8 or equivalent, place the piston assembly in the fixture/support tool and press the pin from the piston assembly.

   Ä The piston and the piston pin are a matched set which are not serviced separately.

2. Using solvent, wash the varnish and oil from the parts, then inspect the parts for scuffing or wear.
3. Using a micrometer, measure the diameter of the piston pin. Using a inside micrometer or a dial bore gauge, measure the diameter of the piston bore.

   Ä If the piston pin-to-piston clearance is in excess of 0.001 in. (0.0254mm), replace the piston and piston pin assembly.

4. Before installation, lubricate the piston pin and the piston bore with engine oil.
5. To install the piston pin into the piston assembly, use an arbor press, the GM Fixture/Support Assembly tool No. J–24086–20 or equivalent, and the GM Piston Pin Installation tool No. J–24086–9 or equivalent, then press the piston pin into the piston/connecting rod assembly.

   Ä When installing the piston pin into the piston/connecting rod assembly and the installation tool bottoms onto the support assembly, DO NOT exceed 5000 psi (35,000 kPa) of pressure or structural damage may occur to the tool.

6. After installing the piston pin, make sure that the piston has freedom of movement with the piston pin. The piston/connecting rod assembly is ready for installation into the engine block.

Figure 231.
Remove the piston pin from the piston using an arbor press and suitable removal driver

{ewc GSMVIMG,GSMVIMG, !88263gc3.bmp}

88263gc3

Figure 232.
The piston pin is installed to the piston using the press and a suitable installer driver

{ewc GSMVIMG,GSMVIMG, !88263gc4.bmp}

88263gc4

PISTON RING REPLACEMENT AND SIDE CLEARANCE MEASUREMENT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

PISTON RING REPLACEMENT AND SIDE CLEARANCE MEASUREMENT

Ü See figures 233, 234, 235, 236

Check the pistons to see that the ring grooves and oil return holes have been properly cleaned. Slide a piston ring into its groove and check the side clearance with a feeler gauge. Make sure the feeler gauge is inserted between the ring and its lower land (lower edge of the groove), because any wear that occurs forms a step at the inner portion of the lower land. If the piston grooves have been worn to the extent that relatively high steps exist on the lower land, the piston should be replaced, because these will interfere with the operation of the new rings and ring clearances will be excessive. Piston rings are not furnished in oversize widths to compensate for ring groove wear.

Once the ring end-gap has been checked and shown to be within specification, install the rings on the piston, bottom ring first, using a piston ring expander. There is a high risk of breaking or distorting the rings and/or scratching the piston, if the rings are installed by hand or other means.

Position the rings on the piston as illustrated; spacing of the various piston ring gaps is crucial to the proper oil retention and cylinder wear. When installing the new rings, refer to the installation diagram furnished with the new parts.

Figure 233.
Exploded view of a piston and ring assembly

{ewc GSMVIMG,GSMVIMG, !88263gc5.bmp}

88263gc5

Figure 234.
Checking the ring-to-ring groove clearance (ring side clearance)

{ewc GSMVIMG,GSMVIMG, !tccs3923.bmp}

tccs3923

Figure 235.
Most rings are marked to show which side should face upward

{ewc GSMVIMG,GSMVIMG, !tccs3222.bmp}

tccs3222

Figure 236.
Upon assembly, make sure the piston gaps are properly arranged

{ewc GSMVIMG,GSMVIMG, !88263gc9.bmp}

88263gc9

CHECKING RING END-GAP {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CHECKING RING END-GAP

Ü See figure 237

The piston ring end-gap should be checked while the rings are removed from the pistons. Incorrect end-gap indicates that the wrong size rings are being used; **ring breakage could result**.

1. Compress the new piston ring into a cylinder (one at a time).
2. Squirt some clean oil into the cylinder so that the ring and the top 2 in. (51mm) of the cylinder wall are coated.
3. Using an inverted piston, push the ring approximately 1 in. (25.4mm) below the top of the cylinder.
4. Using a feeler gauge, measure the ring gap and compare it to the Ring Gap chart in this section. Carefully remove the ring from the cylinder.

Figure 237.
Ring end-gap is checked using a feeler gauge, after the ring is carefully inserted, square into the bore

{ewc GSMVIMG,GSMVIMG, !88263gc6.bmp}

88263gc6

ROD BEARING REPLACEMENT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ROD BEARING REPLACEMENT

Ü See figures 238, 239, 240, 241

Replacement bearings are available in standard size and undersize (for reground crankshafts). Connecting rod-to-crankshaft bearing clearance is checked using Plastigage® or an equivalent gauging material, at either the top or the bottom of each crank journal. The Plastigage® has a range of 0.001–0.003 in. (0.0254–0.0762mm).

1. Remove the rod cap with the bearing shell. Completely clean the bearing shell and the crank journal, blow any oil from the oil hole in the crankshaft; place the Plastigage® lengthwise along the bottom center of the lower bearing shell, then install the cap with the shell and torque the bolt or nuts to specification. DO NOT turn the crankshaft with the Plastigage® on the bearing.
2. Remove the bearing cap with the shell. The flattened Plastigage® will be found sticking to either the bearing shell or the crank journal. DO NOT remove it yet.
3. Use the scale printed on the Plastigage® package to measure the flattened material at its widest point. The number within the scale which most closely corresponds to the width of the Plastigage® indicates the bearing clearance in thousandths of an inch.
4. Check the specifications chart in this section for the desired clearance. It is advisable to install a new bearing if the clearance exceeds 0.003 in. (0.0762mm); however, if the bearing is in good condition and is not being checked because of bearing noise, bearing replacement is not necessary.
5. If you are installing new bearings, try a standard size, then each undersize in order until one is found that is within the specified limits when checked for clearance with Plastigage®; each undersize shell has its size stamped on it.
6. When the proper size shell is found, clean off the Plastigage®, oil the bearing thoroughly, reinstall the cap with its shell and tighten the rod bolt nuts to specification.

   Ä With the proper bearing selected and the nuts torqued, it should be possible to move the connecting rod back and forth freely on the crank journal as allowed by the specified connecting rod end clearance. If the rod cannot be moved, either the rod bearing is too far undersize or the rod is misaligned.

Figure 238.
To check bearing clearance, apply a strip of gauging material to the bearing shell, then install and tighten the bearing cap . . .

{ewc GSMVIMG,GSMVIMG, !88263gc7.bmp}

88263gc7

Figure 239.
. . . after tightening to specification, remove the bearing cap and compare the thickness of the material to the scale provided

{ewc GSMVIMG,GSMVIMG, !88263gc8.bmp}

88263gc8

Figure 240.
You can apply the gauging material to bearing journal (shown) or to the bearing shell

{ewc GSMVIMG,GSMVIMG, !tccs3243.bmp}

tccs3243

Figure 241.
Even if it was applied to the journal, it may wind up on the cap shell after it is

tightened

{ewc GSMVIMG,GSMVIMG, !tccs3912.bmp}

tccs3912

INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

INSTALLATION

Ü See figures 236, 242, 243, 244, 245

Position the rings on the piston as illustrated; **spacing of the various piston ring gaps is crucial to proper oil retention and even cylinder wear.** When installing new rings, refer to the installation diagram furnished with the new parts.

Install the connecting rod to the piston, making sure that the piston installation notches and marks (if any) on the connecting rod are in proper relation to one another.

1. Make sure that the connecting rod big-end bearings (including the end cap) are of the correct size and properly installed.
2. Fit rubber hoses over the connecting rod bolts to protect the crankshaft journals, as in the Piston Removal procedure. Lubricate the connecting rod bearings with clean engine oil.
3. Using a suitable ring compressor positioned over the piston, compress the rings around the piston head. Insert the piston assembly into the cylinder, so that the notch (on top of the piston) faces the front of the engine.
4. From beneath the engine, coat each crank journal with clean oil. Using a hammer handle, gently drive the connecting rod/piston assembly into the cylinder bore. Align the connecting rod (with bearing shell) onto the crankshaft journal.
5. Remove the rubber hoses from the studs. Install the bearing cap (with bearing shell) onto the connecting rod and the cap nuts. Tighten the connecting rod cap nuts to specification.
   - 2.5L engine (1985–88): 32 ft. lbs. (43 Nm)
   - 2.5L engine (1989–90): 30 ft. lbs. (40 Nm)
   - 4.3L engine (1985–90): 45 ft. lbs. (61 Nm)
   - 4.3L engine (1991–92): 20 ft. lbs. (27 Nm) + a 60 º turn
   - 4.3L engine (1993–96): 20 ft. lbs. (27 Nm) + a 70 º turn

   Ä When more than one connecting rod/piston assembly are being installed, the connecting rod cap nuts should only be tightened enough to keep each rod in position until all have been installed. This will ease the installation of the remaining piston assemblies.
6. Check the clearance between the sides of the connecting rods and the crankshaft using a feeler gauge. Spread the rods slightly with a small prybar to insert the feeler gauge. If the clearance is below the minimum tolerance, the rod may be machined to provide adequate clearance. If the clearance is excessive, substitute an unworn rod and recheck. If clearance is still outside specifications, the crankshaft must be welded and reground or replaced.
7. Install the oil pump assembly and the oil pan.
8. Install the cylinder head(s) and the intake manifold.
9. Install the engine assembly to the vehicle.

Figure 242.
Install the pistons facing the proper direction (as noted during removal)—If present, a notch usually faces to the front of the engine

{ewc GSMVIMG,GSMVIMG, !88263gd1.bmp}

88263gd1

Figure 243.
Most pistons are marked to indicate in engine positioning (usually a mark means

front)

{ewc GSMVIMG,GSMVIMG, !tccs3814.bmp}

tccs3814

Figure 244.
Installing the piston into the block using a ring compressor and the handle of a hammer

{ewc GSMVIMG,GSMVIMG, !tccs3914.bmp}

tccs3914

Figure 245.
After installation, check the connecting rod side clearance by CAREFULLY spreading the rods and inserting a feeler gauge

{ewc GSMVIMG,GSMVIMG, !88263gd2.bmp}

88263gd2

Engine Block Heater and Freeze Plugs {ewc MVIMAGE, MVIMAGE, ! nexttopicarrow.bmp}

Engine Block Heater and Freeze Plugs

REMOVAL & INSTALLATION

Ü See figures 246, 247, 248

**Caution
Removing the block heater or freeze plug may cause personal injury if the engine is not completely cooled. Even after the radiator has been drained, there will be engine coolant still in the block. Use care when removing the assembly from the block.

Ä To remove an engine freeze plug or block heater, accessories may have to be removed, such as the starter motor, motor mount, etc. Remove an obstruction before attempting to remove the freeze plug. In the worst case scenario, the engine may have to be removed from the vehicle if the suspension or frame prevent access to the plug.

1. Disconnect the negative battery cable for safety.
2. Raise and support the front of the vehicle safely using jackstands.
3. Drain the engine cooling system from the radiator. If possible, remove the engine block drain plug(s) to drain as much fluid as possible from the block itself.

**Caution
When draining the coolant, keep in mind that cats and dogs are attracted by ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.

4. Locate the plug or heater which must be removed and determine what steps will be necessary to access it.
5. **To remove the block heater,** disengage the electrical connector, loosen the retaining screw and remove the heater from the block.
6. **To remove the freeze plug,** drive a chisel through the plug and pry outward. Or drill an $^{1}/8$ in. hole into the plug and use a dent puller to remove the freeze plug.

Figure 246.
Engine block heater—located in the engine block freeze plug bore
{ewc GSMVIMG,GSMVIMG, !88263gd3.bmp}

88263gd3

Figure 247.
The freeze plug can be loosened using a punch (or chisel) and hammer
{ewc GSMVIMG,GSMVIMG, !tccs3905.bmp}

tccs3905

Figure 248.
Once the freeze plug has been loosened, it can be removed from the block
{ewc GSMVIMG,GSMVIMG, !tccs3906.bmp}

tccs3906

To install:

7. To install the freeze plug, coat the new plug with silicone sealer and clean the block mating surface free of rust and corrosion. Using a deep socket the size of the interior of the plug, drive the plug into the block until the plug lip is flush with the cylinder block. Run silicone sealer around the mating area.
8. To install the block heater, coat the O-ring with engine oil and clean the block mating surface free of rust and corrosion. Install the heater and tighten the retaining screw. Engage the wiring to the heater.
9. Connect the negative battery cable.
10. Properly refill and bleed the engine cooling system, then run the engine and check for leaks.
11. Shut the engine **OFF**, then remove the jackstands and carefully lower the vehicle.

Rear Main Oil Seal {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Rear Main Oil Seal

REMOVAL & INSTALLATION

2.5L Engine

Ü See figure 249

The rear main oil seal is a one piece unit. It can be removed or installed without removing the oil pan or the crankshaft.

Ä The following procedure requires the use of the GM Oil Seal Installation tool No. J-34924 or equivalent.

1. Disconnect the negative battery cable for safety.
2. Remove the transmission. For details, please refer to the Transmission, Removal and Installation procedures in Section 7.
3. If equipped with a manual transmission, remove the clutch assembly.
4. Match-mark and remove the flexplate or flywheel, as applicable.
5. Using a small prybar, carefully pry the oil seal from the rear of the crankshaft.

   Ä When removing the oil seal, be careful not to damage the crankshaft sealing surface.
6. To install the new oil seal into the rear retainer, perform the following procedures:
   a. Using fresh engine oil, lubricate the inner and outer diameter of the seal.
   b. Install the new seal onto the seal installation tool No. J-34924 or equivalent, then position the tool assembly against the crankshaft.
   c. Align the dowel with the alignment hole in the crankshaft and thread the attaching screws into the tapped holes in the crankshaft.
   d. Using a screwdriver, tighten the screws securely; this will ensure that the seal is installed squarely over the crankshaft.
   e. Turn the handle until it bottoms and remove the installation tool.
7. Align and install the flywheel or flexplate (as applicable).
8. If equipped with a manual transmission, install the clutch assembly.
9. Install the transmission.
10. Connect the negative battery cable.

Figure 249.
The rear main seal should be installed using J-34924, or an equivalent installation tool—2.5L engine

{ewc GSMVIMG,GSMVIMG, !88263gd4.bmp}

88263gd4

4.3L Engine {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Engine And Engine Overhaul

4.3L Engine

1985 Models

Ü See figures 250, 251, 252, 253

The 1985 4.3L engines covered by this manual were originally equipped with a 2-piece rear main seal.

1. Refer to the Oil Pan, Removal and Installation procedures in this section and remove the oil pan from the engine.
2. Remove the oil pump and the rear main bearing cap.
3. Pry the oil seal from the rear main bearing cap using a small suitable prytool.
4. Using a small hammer and a brass pin punch, CAREFULLY drive the top half of the oil seal from the rear main bearing. Drive it out far enough, so it may be removed with a pair of pliers.
5. Using a non-abrasive cleaner, clean the rear main bearing cap and the crankshaft.

Figure 250.
Remove the lower half of the rear main seal from the main bearing cap—1985 4.3L engines

{ewc GSMVIMG,GSMVIMG, !88263gd5.bmp}

88263gd5

Figure 251.
Carefully drive the upper half of the seal from the engine block

{ewc GSMVIMG,GSMVIMG, !88263gd6.bmp}

88263gd6

Figure 252.
You can make a rear main seal installation tool using these dimensions

{ewc GSMVIMG,GSMVIMG, !88263gd7.bmp}

88263gd7

Figure 253.
Apply RTV sealant to the rear main cap-to-case mounting surface

{ewc GSMVIMG,GSMVIMG, !88263gd8.bmp}

88263gd8

To install:

6. Fabricate an oil seal installation tool from 0.004 in. (0.01mm) shim stock, shape the end to $^{1}/2$ in. (12.7mm) long by $^{11}/64$ in. (4.4mm) wide.
7. Coat the new oil seal with engine oil; DO NOT coat the mating ends of the seal.
8. Position the fabricated tool between the crankshaft and seal seat in the cylinder case.
9. Position the new half seal between the crankshaft and the tip of the tool, so that the seal bead contacts the tip of the tool.

   Ä Make sure that the seal lip is positioned toward the front of the engine.

10. Using the fabricated tool as a shoe horn, to protect the seal's bead from the sharp edge of the seal seat surface in the cylinder case, roll the seal around the crankshaft. When the seal's ends are flush with the engine block, remove the installation tool.
11. Using the same manner of installation, install the lower seal half onto the lower half of the

rear main bearing cap.

12. Apply sealant to the cap-to-case mating surfaces and install the lower rear main bearing half to the engine; keep the sealant off of the seal's mating line.
13. Install the rear main bearing cap bolts and tighten to specification. Using a lead hammer, tap the crankshaft forward and rearward, to align the thrust bearing surfaces.
14. Install the oil pan.
15. Refill the crankcase with clean engine oil and connect the negative battery cable.
16. Start the engine, allow it to reach normal operating temperatures and check for leaks.

1986-96 Models {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Engine And Engine Overhaul

1986–96 Models

Ü See figures 254, 255, 256

Unlike the 1985 4.3L engines covered by this manual (which were equipped with a 2-piece rear main seal), the 1986–96 4.3L engines utilize a 1-piece seal which is installed to a rear seal retainer that bolts to the back of the block.

Ä The following procedure requires the use of the GM Oil Seal Installation tool No. J-35621 or equivalent.

1. Disconnect the negative battery cable for safety.
2. Remove the transmission. For details, please refer to the Transmission, Removal and Installation procedures in Section 7.
3. If equipped with a manual transmission, remove the clutch assembly.
4. Match-mark and remove the flexplate or flywheel, as applicable.
5. Insert a small prytool into the notches provided in the oil seal retainer and carefully pry the oil seal from the retainer.

Ä When removing the oil seal from the retainer, be careful not to nick the crankshaft sealing surface.

Figure 254.
Exploded view of the rear main oil seal retainer mounting—4.3L engine (NOTE the retainer does NOT have to be removed in order to replace the seal)

{ewc GSMVIMG,GSMVIMG, !88263gd9.bmp}

88263gd9

Figure 255.
Carefully pry the seal from the retainer using a small prytool at the notches provided in the retainer

{ewc GSMVIMG,GSMVIMG, !88263ge1.bmp}

88263ge1

Figure 256.
A threaded seal installation tool such as J-35621 is necessary to properly seat the new seal

{ewc GSMVIMG,GSMVIMG, !88263ge2.bmp}

88263ge2

To install:

6. Install the new oil seal into the rear retainer:
    a. Using engine oil, lubricate the inner and outer diameter of the seal.
    b. Install a new oil seal onto the GM Oil Seal Installation tool No. J-35621 (or equivalent), then position the tool and seal assembly against the crankshaft and thread the attaching screws into the tapped holes in the crankshaft.
    c. Using a screwdriver, tighten the screws securely; this will ensure that the seal is installed squarely over the crankshaft.
    d. Turn the handle until it bottoms and remove the installation tool.
7. Align and install the flywheel or flexplate (as applicable).
8. If equipped with a manual transmission, install the clutch assembly.

9. Install the transmission.
10. Connect the negative battery cable.

Crankshaft and Main Bearings {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Crankshaft and Main Bearings

REMOVAL & INSTALLATION

Ü See figures 257, 258, 259, 260, 261

1. Drain the crankcase oil and remove the engine from the van.
2. Remove the flywheel/flexplate and mount the engine on a work stand in a suitable working area. Invert the engine, so the oil pan is facing up.

   Ä If the cylinder heads are not being removed, the spark plugs should be removed in order to release engine compression and allow for easier rotation of the crankshaft when necessary.

3. Remove the engine front (timing) cover.
4. Align the timing marks, then remove the timing chain (on the 4.3L engine) and gears.

   Ä After removing the timing gear or sprocket from the crankshaft, be sure to remove the woodruff key from the crankshaft.

5. Remove the oil pan.

   ****Caution**
   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.

6. If necessary, remove the oil pump assembly.
7. Inspect the connecting rods and bearing caps for identification marks (numbers). If there are none, stamp the cylinder number on the machined surfaces of the bolt bosses of the connecting rods and caps for identification when reinstalling. If the pistons are to be removed eventually from the connecting rod, mark the cylinder number on the pistons with silver paint or felt-tip pen for proper cylinder identification and cap-to-rod location.
8. Remove the connecting rod nuts and caps, then store them in the order of removal. Place short pieces of rubber hose on the connecting rod studs to prevent damaging the crankshaft bearing surfaces.
9. Check the main bearing caps for identification marks (if not identified, mark them). Remove the main bearing caps and store them in order, for reassembly purposes; the caps must be reinstalled in their original position.
10. If equipped, remove the 1-piece rear main seal retainer from the engine.
11. Install rubber bands between a bolt on each connecting rod and oil pan bolts that have been reinstalled in the block (see illustration). This will keep the rods from banging on the block when the crank is removed.
12. Carefully lift the crankshaft out of the block. The rods will pivot to the center of the engine when the crank is removed.

    Ä When removing the bearing shells, it is recommended to replace them with new ones.

13. Using solvent, clean all of the parts for inspection purposes. If necessary, replace any part that may be questionable.

Figure 257.
Place hose over the connecting rod studs to protect the crankshaft and cylinders from damage

{ewc GSMVIMG,GSMVIMG, !tccs3803.bmp}

tccs3803

Figure 258.
Support the connecting rods with rubber bands and install rubber rod bolt caps to protect the crankshaft during removal and installation

{ewc GSMVIMG,GSMVIMG, !85383363.bmp}

85383363

Figure 259.
Plastigage® or an equivalent gauging material should be used to check main bearing clearances

{ewc GSMVIMG,GSMVIMG, !88263ge5.bmp}

88263ge5

Figure 260.
You can use a feeler gauge to check the crankshaft end-play during installation

{ewc GSMVIMG,GSMVIMG, !88263ge3.bmp}

88263ge3

Figure 261.
Align the thrust bearing (as illustrated), then tighten the main bearing caps to specification

{ewc GSMVIMG,GSMVIMG, !88263ge4.bmp}

88263ge4

To install:

14. Install new bearing shell inserts and check the bearing clearances. For details, please refer to the crankshaft cleaning and inspection information found later in this section.

    Ä If necessary, deliver the crankshaft to an automotive machine shop, have the crankshaft journals ground and new bearing shells matched.

15. Lubricate all of the parts and oil seals with clean engine oil.
16. Using a feeler gauge and a medium prybar, move the crankshaft forward-and-rearward. Check the crankshaft end-play by inserting a feeler gauge between the crankshaft and the thrust bearing shell. An alternate method is to use a dial indicator at the crankshaft snout. Install the indicator, move the crankshaft rearward, zero the indicator and then move the crankshaft forward. The dial indicator will read the end-play.
17. Tighten main bearing caps (in three steps) to specification:
    - 2.5L engine (1985–88): 70 ft. lbs. (95 Nm)
    - 2.5L engine (1989–90): 65 ft. lbs. (88 Nm)
    - 4.3L engine (1985): 70 ft. lbs. (95 Nm)
    - 4.3L engine (1986): 75 ft. lbs. (100 Nm)
    - 4.3L engine (1987–90): 80 ft. lbs. (108 Nm)
    - 4.3L engine (1991–95): 75 ft. lbs. (95 Nm)
    - 4.3L engine (1996): 77 ft. lbs. (105 Nm)
18. Remove the rubber hoses from the studs. Install the bearing cap (with bearing shell) onto the

connecting rod and the cap nuts. Tighten the connecting rod cap nuts to specification.

- 2.5L engine (1985–88): 32 ft. lbs. (43 Nm)
- 2.5L engine (1989–90): 30 ft. lbs. (40 Nm)
- 4.3L engine (1985–90): 45 ft. lbs. (61 Nm)
- 4.3L engine (1991–92): 20 ft. lbs. (27 Nm) + a 60º turn
- 4.3L engine (1993–96): 20 ft. lbs. (27 Nm) + a 70º turn

Ä When there is more than one connecting rod/piston assembly being installed, the connecting rod cap nuts should only be tightened enough to keep each rod in position until all have been installed. This will ease the installation of the remaining piston assemblies.

19. Check the clearance between the sides of the connecting rods and the crankshaft using a feeler gauge. Spread the rods slightly with a small prybar to insert the feeler gauge. If the clearance is below the minimum tolerance, the rod may be machined to provide adequate clearance. If the clearance is excessive, substitute an unworn rod and recheck. If clearance is still outside specifications, the crankshaft must be welded and reground or replaced.
20. If necessary, install the pump assembly.
21. Install the oil pan.
22. Make sure the woodruff key is installed in the end of the crankshaft, then install the timing chain (4.3L only) and gears.
23. Install the engine front (timing) cover.
24. Remove the engine from the work stand, then install the flywheel/flexplate.
25. Refill the crankcase and install the engine to the van.

CLEANING & INSPECTION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CLEANING & INSPECTION

Ü See figures 259, 262, 263, 264, 265, 266

1. Clean the crankshaft with solvent and a brush. Clean the oil passages with a suitable brush, then blow them out with compressed air.
2. Inspect the crankshaft for obvious damage or wear. Check the main and connecting rod journals for cracks, scratches, grooves or scores. Inspect the crankshaft oil seal surface for nicks, sharp edges or burrs that could damage the oil seal or cause premature seal wear.
3. If the crankshaft passes a visual inspection, check journal runout using a dial indicator. Support the crankshaft in V-blocks (or in the bearings on the engine block as shown if V-blocks are not available) and check the shaft runout. If crankshaft runout exceeds 0.001 in. (0.025mm) the shaft should be replaced. Consult a machine shop for advice.
4. Measure the main and connecting rod journals for wear, out-of-roundness or taper, using a micrometer. Measure in at least 4 places around each journal and compare your findings with the journal diameter specifications.
5. If the crankshaft fails any inspection for wear or damage, it must be reground or replaced.

   Ä The crankshaft used on the 2.5L engine is of the rolled fillet type and cannot be reground. If the measurements do not meet specification, replace the shaft.
6. Once the crankshaft has been cleared for a return to service, check the bearings using Plastigage® or an equivalent gauging material. The bearings must be checked regardless of whether they are new or used. To check the bearings:
   a. Temporarily install the upper and lower bearing halves to the block and main bearing cap (respectively).
   b. Wipe all oil from the crankshaft journal and outer/inner surfaces of the bearing shell.
   c. Temporarily position the crankshaft to the block and upper bearing journals.
   d. Place a piece of Plastigage® material in the center of the bearing.
   e. Install the bearing cap and bearing. Lubricate the main bearing bolts with engine oil, install the bolts and tighten them to specifications.
   f. Remove the bearing cap and determine the bearing clearance by comparing the width of the flattened Plastigage® material at its widest point with the graduations on the gauging material container. The number within the graduation on the envelope indicates the clearance in millimeters or thousandths of an inch. If the clearance is greater than allowed, REPLACE BOTH BEARING SHELLS AS A SET. Recheck the clearance after replacing the shells.

Figure 262.
A dial gauge may be used to check crankshaft end-play

{ewc GSMVIMG,GSMVIMG, !tccs3805.bmp}

tccs3805

Figure 263.
Carefully pry the shaft back and forth while reading the dial gauge for play

{ewc GSMVIMG,GSMVIMG, !tccs3806.bmp}

tccs3806

Figure 264.
A dial gauge may also be used to check crankshaft run-out

{ewc GSMVIMG,GSMVIMG, !tccs3807.bmp}

tccs3807

Figure 265.
Mounting a dial gauge to read crankshaft run-out

{ewc GSMVIMG,GSMVIMG, !tccs3815.bmp}

tccs3815

Figure 266.
Turn the crankshaft slowly by hand while checking the gauge

{ewc GSMVIMG,GSMVIMG, !tccs3808.bmp}

tccs3808

MAIN BEARING REPLACEMENT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

MAIN BEARING REPLACEMENT

Ü See figures 259, 267

Main bearing clearances must be corrected by the use of selective upper and lower shells. under NO circumstances should the use of shims behind the shells to compensate for wear be attempted. The bearings are easily replaced if the crankshaft is removed from the engine, but provided that no refinishing or replacement of the crankshaft is necessary, the bearings can also be replaced with the engine and crankshaft still installed in the van. To replace the main bearing shells, proceed as follows:

1. Refer to the Oil Pan, Removal and Installation procedures in this section and remove the oil pan.
2. If necessary, remove the oil pump assembly.
3. Loosen all of the main bearing cap bolts.
4. Remove the bearing cap bolts, the caps and the lower bearing shell.
5. Insert a flattened cotter pin or a roll out pin in the oil passage hole in the crankshaft, then rotate the crankshaft in the direction opposite to the cranking rotation. The pin will contact the outside edge of the upper shell and roll it out.
6. The main bearing journals should be checked for roughness and wear. Slight roughness may be removed with a fine grit polishing cloth, saturated with engine oil. Burrs may be removed with a fine oil stone. If the journals are scored or ridged, the crankshaft must be replaced.

Figure 267.
A roll-out pin can be fabricated from a cotter pin and used to replace bearings with the crankshaft installed

{ewc GSMVIMG,GSMVIMG, !88263ge6.bmp}

88263ge6

Ä The journals can be measured for out-of-round with the crankshaft installed by using a crankshaft caliper and inside micrometer or a main bearing micrometer. The upper bearing shell must be removed when measuring the crankshaft journals. Maximum out-of-round of the crankshaft journal must not exceed 0.0010 in. (0.025mm).

7. Clean the crankshaft journals and bearing caps thoroughly before installing the new main bearings.
8. Place the new upper shell on the crankshaft journal with the locating tang in the correct position and rotate the shaft to turn it into place using a cotter pin or a roll out pin as during removal.
9. Place a new bearing shell in the bearing cap.
10. Check the main bearing clearances using a gauging material. In order to do this you will have to support the crankshaft (at the flywheel and damper) to be certain that all clearance is taken-up between the upper bearing half and the shaft journal. Then apply a strip of gauging material to each of the bearings, install and tighten all of the main bearing caps, then remove the caps again and check the gauging material. For more details, please refer to the crankshaft cleaning and inspection information, found earlier in this section.
11. Lubricate the new bearings and the main bearing cap bolts with engine oil, then install the main bearing caps and tighten to specification.
12. Using a feeler gauge, pry the crankshaft forward and rearward, then check for the crankshaft (thrust bearing) end-play.

Ä In order to prevent the possibility of cylinder block and/or main bearing cap

damage, the main bearing caps are to be tapped into their cylinder block cavity, using a brass or leather mallet before the bolts are installed. Do not use the bolts to pull the main bearing caps into their seats. Failure to observe this procedure may damage the cylinder block or bearing cap.

13. Install the oil pump assembly.
14. Install the oil pan.

Flywheel/Flexplate {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Flywheel/Flexplate

The flywheel and the ring gear are machined from one piece of metal and cannot be separated.

Ä The flywheel on automatic transmission vehicles is usually referred to as a flexplate. Though the job they do is quite different, the two terms are often interchanged.

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REMOVAL & INSTALLATION

Ü See figure 268

1. Remove the transmission assembly from the vehicle.
2. If equipped with a manual transmission, remove the clutch and pressure plate assembly.
3. Remove the flywheel-to-crankshaft bolts, then remove the flywheel from the engine.

To install:

4. Inspect the flywheel for cracks, and inspect the ring gear for burrs or worn teeth. Replace the flywheel if any damage is apparent. Remove burrs with a mill file. On manual transmission vehicles, check the wheel for scoring, wear or other damage. If the scoring or wear is minimal, it may be possible to have the flywheel machined (turned) in order to keep it in service.
5. Install the flywheel. Most flywheels will attach to the crankshaft in only one position, as the bolt holes are unevenly spaced and/or the crankshaft is fitted with a dowel pin. Install the bolts and tighten to specification using a criss-cross pattern.
6. If equipped, install the clutch and pressure plate assembly.
7. Install the transmission assembly.

Figure 268.
Exploded view of a typical Astro and Safari flywheel mounting—flexplate mounting similar, but without a clutch and pressure plate assembly

{ewc GSMVIMG,GSMVIMG, !88263ge7.bmp}

88263ge7

EXHAUST SYSTEM {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

EXHAUST SYSTEM

Ü See figures 269, 270, 271, 272, 273, 274

Safety

For a number of different reasons, exhaust system work can be the most dangerous type of work you can do on your van. Always observe the following precautions:

- Support the van extra securely. Not only will you often be working directly under it, but you'll frequently be using a lot of force, such as heavy hammer blows to dislodge rusted parts. This can cause an improperly supported van to shift and possibly fall.
- Wear goggles. Exhaust system parts are always rusty. Metal chips can be dislodged, even when you're only turning rusted bolts. Attempting to pry pipes apart with a chisel makes chips fly even more frequently. Gloves are also recommended to protect against rusty chips and sharp, jagged edges.
- If you're using a cutting torch, keep it at a great distance from either the fuel tank or lines. Stop frequently and check the temperature of fuel and brake lines or the tank. Even slight heat can expand or vaporize the fuel, resulting in accumulated vapor or a liquid leak near your torch.
- Watch where your hammer blows fall. You could easily tap a brake or fuel line when you hit an exhaust system part with a glancing blow. Inspect all lines and hoses in the work area before driving the van.

****Caution**

Be very careful when working on or near the catalytic converter. External temperatures can reach 1500ºF (815ºC) and more, causing severe burns. Removal or installation should be performed only on a cold exhaust system.

A number of special exhaust system tools can be rented from auto supply houses or local stores that rent special equipment. A common one is a tail pipe expander, designed to enable you to join pipes of identical diameter.

Figure 269.
Exhaust system components—2.5L engine

{ewc GSMVIMG,GSMVIMG, !88263ge8.bmp}

88263ge8

Figure 270.
Exhaust system components—early-model 4.3L (VIN B, N and Z) engines

{ewc GSMVIMG,GSMVIMG, !88263ge9.bmp}

88263ge9

Figure 271.
Exhaust system components—late-model 4.3L (VIN Z) engines

{ewc GSMVIMG,GSMVIMG, !88263gf1.bmp}

88263gf1

Figure 272.
Exhaust system components—early-model 4.3L (VIN W) engines, except California emissions

{ewc GSMVIMG,GSMVIMG, !88263gf2.bmp}

88263gf2

Figure 273.
Exhaust system components—early-model 4.3L (VIN W) engines with California emissions

{ewc GSMVIMG,GSMVIMG, !88263gf4.bmp}

88263gf4

Figure 274.
Exhaust system components—1996 4.3L (VIN W) engines (1995 similar, except usually equipped with slip-joint at rear of converter)

{ewc GSMVIMG,GSMVIMG, !88263gf3.bmp}

88263gf3

It may also be quite helpful to use solvents designed to loosen rusted bolts or flanges. Soaking rusted hardware the night before you do the job can speed the work of freeing rusted parts considerably. Remember that some solvents are flammable. Apply them only after the parts are cool.

Two types of pipe connections are used on the exhaust system, they are: the ball joint (to allow angular movement for alignment purposes) and the slip joint. No gaskets are used in the entire system.

The system is supported by free hanging rubber mountings which permit some movement of the exhaust system but do not allow the transfer of noise and vibration into the passenger compartment. Any noise vibrations or rattles in the exhaust system are usually caused by misalignment of the parts.

****Caution**
Before performing any operation on the exhaust system, be sure to allow it to cool down.

Component Replacement {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Component Replacement

REMOVAL & INSTALLATION

Front Pipe

Ü See figures 269, 270, 271, 272, 273, 274, 275

Most of the early models covered by this manual and some of the late-model or Canada emission vehicles utilize a front exhaust pipe to convey gases from the manifolds to the converter or muffler (again, depending on the emission package). Certain California emission and late-model vehicles utilize a close-mount catalytic converter where the front pipe is part of the converter assembly.

1. Raise and support the front of the vehicle safely using jackstands.
2. Remove the front pipe(s)-to-manifold(s) nuts and separate (pry, if necessary) the front pipe (ball joint) from the exhaust manifold(s).
3. At the catalytic converter, loosen the front pipe-to-converter clamp nuts, slide the clamp away from converter and separate the front pipe from the converter.

   Ä Use a twisting motion to separate the front pipe-to-converter slip joint connection. If the front pipe cannot be removed from the catalytic converter, use a hammer (to loosen the connection) or wedge tool separate the connection.

4. Inspect the pipe for holes, damage or deterioration; if necessary, replace the front pipe.

To install:

5. Lubricate the front pipe-to-manifold(s) studs/nuts and the front pipe-to-converter clamp threads, then tighten the clamps to 20 ft. lbs. (27 Nm).
6. Start the engine and check for exhaust leaks.

Figure 275.
A deep socket is usually VERY helpful when trying to loosen exhaust pipe studs

{ewc GSMVIMG,GSMVIMG, !88263p79.bmp}

88263p79

Catalytic Converter {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Catalytic Converter

Ü See figures 269, 270, 271, 272, 273, 274, 275

The catalytic converter is an emission control device added to the exhaust system to reduce the emission of hydrocarbon and carbon monoxide pollutants.

Most of the early models covered by this manual and some of the late-model or Canada emission vehicles utilize a front exhaust pipe to convey gases from the manifolds to the converter or muffler (again, depending on the emission package). Certain California emission and late-model vehicles utilize a close-mount catalytic converter where the front pipe is part of the converter assembly.

Without Integral Front Pipe {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Without Integral Front Pipe

1. Raise and support the front of the vehicle on jackstands.
2. Remove the catalytic converter-to-muffler stud nuts and separate the muffler from the converter.

   Ä The connection between the converter and the muffler is a ball joint type, which can be easily separated.

3. Remove the catalytic converter-to-front pipe clamp nuts and move the clamp forward.
4. Remove the converter-to-mounting bracket bolts (if equipped), then twist the converter to separate it from the front pipe.
5. Inspect the condition of the catalytic converter for physical damage, replace it, if necessary.

   Ä When installing the catalytic converter, be sure that it is installed with adequate clearance from the floor pan, to prevent overheating of the vehicle floor.

6. **To install,** align the components and reverse the removal procedures; be careful not to damage the pipe sealing surfaces when tightening the retaining clamps. Tighten the clamps to 20 ft. lbs. (27 Nm).
7. Start the engine and check for exhaust leaks.

With Integral Front Pipe {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

With Integral Front Pipe

Ü See figures 276, 277

1. Raise and support the front of the vehicle safely using jackstands.
2. Support the catalytic converter assembly to keep it from falling and becoming damaged when it is detached.
3. Disengage the oxygen sensor electrical connection. For 1996 vehicles, you have 4 oxygen sensors, so make sure the wiring to all of them has been disengaged. Remove the wiring from any necessary clips and reposition it out of the way.
4. If equipped with a slip-joint at the rear of the converter, remove the clamp and separate the pipe from the converter.
5. If equipped with a bolted flange-joint at the rear of the converter, remove the converter-to-muffler retaining nuts.
6. Remove the nuts from the exhaust manifold studs. If equipped, remove the collars from the exhaust manifold studs.
7. Separate the converter pipe from the muffler and the exhaust manifolds, then carefully lower the front of the converter pipe down and remove the assembly from the hanger. Rotate the assembly over the rear of the transmission crossmember and remove it from the vehicle.

   ****Caution**
   Be very careful not to damage the converter or the oxygen sensor(s).

To install:

8. Align the components and reverse the removal procedures; be careful not to damage the pipe sealing surfaces when tightening the retainers. Tighten the exhaust manifold stud nuts to 15 ft. lbs. (20 Nm), except for on 1996 vehicles where the manifold stud nuts must be tightened to 18 ft. lbs. (24 Nm), using the proper sequence.
9. Either tighten the converter-to-muffler nuts to 30 ft. lbs. (40 Nm) or the converter rear slip-joint clamp to 27 ft. lbs. (37 Nm) for all except 1995 models which should be tightened to 44 ft. lbs. (60 Nm).
10. Start the engine and check for exhaust leaks.

Figure 276.
Exploded view of a converter pipe-to-manifold connection
{ewc GSMVIMG,GSMVIMG, !88263gf5.bmp}

88263gf5

Figure 277.
Catalytic converter pipe-to-exhaust manifold tightening sequence—1996 models
{ewc GSMVIMG,GSMVIMG, !88263gf6.bmp}

88263gf6

Muffler

Ü See figures 269, 270, 271, 272, 273, 274, 275

Ä The following procedure requires the use of GM Sealing Compound No. 1051249 or equivalent. When replacing the muffler, always replace the tail pipe.

1. Refer to the Tail Pipe, Removal and Installation procedures in this section and remove the tail pipe from the vehicle.
2. Loosen and move the catalytic converter-to-muffler clamp or remove the catalytic converter-to-muffler flange bolts and separate the items.
3. Remove the muffler-to-mounting bracket bolts and lower the muffler from the vehicle.
4. **To install,** coat the slip joints with GM Sealing Compound No. 1051249 or equivalent and loosely install the components onto the vehicle.
5. After aligning the components, tighten the connecting bolts and clamps to 20 ft. lbs. (27 Nm).

   Ä When torquing the exhaust system connectors, be careful not to tighten the pipe clamps too tightly, or deformation of the pipes may occur.

6. Start the engine and check for exhaust leaks.

Tail Pipe {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Tail Pipe

Ü See figures 269, 270, 271, 272, 273, 274, 275

Ä The following procedure requires the use of GM Sealing Compound No. 1051249 or equivalent. Normally, when the tail pipe requires replacement, the muffler should be replaced also.

1. Raise and support the rear of the vehicle on jackstands.
2. Remove the tail pipe-to-muffler clamp, then slide the clamp rearward.
3. Remove the tail pipe-to-mounting bracket clamp.
4. Using a twisting motion, remove the tail pipe from the muffler.

   Ä If removal of the tail pipe difficult, use a hammer to free the pipe from the muffler.

5. Inspect the tail pipe for holes of physical damage.

To install:

6. Use a new tail pipe (if necessary), a new muffler (if necessary), apply GM Sealing Compound No. 1051249 or equivalent to the slip joint(s), lubricate the pipe clamp threads with engine oil, loosely assemble the exhaust system, then tighten the components to 20 ft. lbs. (27 Nm).
7. Start the engine and check for exhaust leaks.

BASIC MECHANICAL TROUBLESHOOTING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

BASIC MECHANICAL TROUBLESHOOTING

Engine Speed Oscillates at Idle

When the engine idle speed will not remain constant, replace or repair the following items or systems, as necessary:

- A faulty fuel pump.
- A leaky Exhaust Gas Recirculation (EGR) valve.
- A blown head gasket.
- A worn camshaft.
- Worn timing gears, chain or sprockets.
- Leaking intake manifold-to-engine gasket.
- A blocked Positive Crankcase Ventilation (PCV) valve.
- Overheating of the cooling system.

Low Power Output of Engine {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Low Power Output of Engine

When the engine power output is below normal, replace or repair the following items or systems, as necessary:

- Overheating of the cooling system.
- Leaks in the vacuum system.
- Leaking of the fuel pump or hoses.
- Unadjusted valve timing.
- A blown head gasket.
- A slipping clutch disc or unadjusted pedal.
- Excessive piston-to-bore clearance.
- Worn piston rings.
- A worn camshaft.
- Sticking valve(s) or weak valve spring(s).
- A poorly operating diverter valve.
- A faulty pressure regulator valve (Auto. Trans.).
- Low fluid level (Auto. Trans.).

Poor High Speed Operation {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Poor High Speed Operation

When the engine cannot maintain high speed operations, replace or repair the following items or systems, as necessary:

- A faulty fuel pump producing low fuel volume.
- A restriction in the intake manifold.
- A worn distributor shaft.
- Unadjusted valve timing.
- Leaking valves or worn valve springs.

Poor Acceleration {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Poor Acceleration

When the engine experiences poor acceleration characteristics, replace or repair the following items or systems, as necessary:

- Incorrect ignition timing.
- Poorly seated valves.
- Improperly adjusted accelerator pump stroke (carburetor equipped).
- Worn accelerator pump diaphragm or piston (carburetor equipped).

Backfire (Intake Manifold) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Backfire (Intake Manifold)

When the engine backfires through the intake manifold, replace or repair the following items or systems, as necessary:

- Incorrect ignition timing.
- Incorrect operation of the choke (carburetor equipped).
- Choke setting (initial clearance) too large (carburetor equipped).
- Defective Exhaust Gas Recirculation (EGR) valve.
- A very lean air/fuel mixture (carburetor equipped).

Backfire (Exhaust Manifold) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Backfire (Exhaust Manifold)

When the engine backfires through the exhaust manifold, replace or repair the following items or systems, as necessary:

- Leaks in the vacuum hose system.
- Leaks in the exhaust system.
- Faulty choke adjustments or operation (carburetor equipped).
- Faulty vacuum diverter valve.

Engine Detonation (Dieseling) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Engine Detonation (Dieseling)

When the engine operates beyond the controlled limits, replace or repair the following items or systems, as necessary:

- Faulty ignition electrical system components.
- The ignition timing may be too far advanced.
- Inoperative Exhaust Gas Recirculation (EGR) valve.
- Inoperative Positive Crankcase Ventilation (PCV) valve.
- Faulty or loose spark plugs.
- Clogged fuel delivery system.
- Sticking, leaking or broken valves.
- Excessive deposits in the combustion chambers.
- Leaks in the vacuum system.

Excessive Oil Leakage {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Excessive Oil Leakage

When large amounts of oil are noticed under the engine after each operation, replace or repair the following items or systems, as necessary:

- Damaged or broken oil filter gasket.
- Leaking oil pressure sending switch.
- Worn rear main oil seal gasket.
- Worn front main oil seal gasket.
- Damaged or broken fuel pump gasket (mechanical pump).
- Damaged or loose valve cover gasket.
- Damaged oil pan gasket or bent oil pan.
- Improperly seated oil pan drain plug.
- Broken timing chain cover gasket.
- Blocked camshaft bearing drain hole.

Heavy Oil Consumption {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Heavy Oil Consumption

When the engine is burning large amounts of oil, replace or repair the following items or systems, as necessary:

- The engine oil level may be too high.
- The engine oil may be too thin.
- Wrong size of piston rings.
- Clogged piston ring grooves or oil return slots.
- Insufficient tension of the piston rings.
- Piston rings may be sticking in the grooves.
- Excessively worn piston ring grooves.
- Reversed (upside-down) compression rings.
- Non-staggered piston ring gaps.
- Improper Positive Crankcase Ventilation (PCV) valve operation.
- Damaged valve O-ring seals.
- Restricted oil drain back holes.
- Worn valve stem or guides.
- Damaged valve stem oil deflectors.
- Too long intake gasket dowels.
- Mismatched rail and expander of the oil ring.
- Excessive clearance of the main and connecting rods.
- Scored or worn cylinder walls.

Negative Oil Pressure {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Negative Oil Pressure

When the engine presents no oil pressure, replace or repair the following items or systems, as necessary:

- Low oil level in the crankcase.
- Broken oil pressure gauge or sender.
- Blocked oil pump passages.
- Blocked oil pickup screen or tube.
- Malfunctioning oil pump.
- Sticking oil pressure relief valve.
- Leakage of the internal oil passages.
- Worn (loose) camshaft bearings.

Low Oil Pressure {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Low Oil Pressure

When the engine presents low oil pressure, replace or repair the following items or systems, as necessary:

- Low oil level in the crankcase.
- Blocked oil pickup screen or tube.
- Malfunctioning or excessive clearance of the oil pump.
- Sticking oil pressure relief valve.
- Very thin engine oil.
- Worn (loose) main, rod or camshaft bearings.

High Oil Pressure {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

High Oil Pressure

When the engine presents high oil pressure, replace or repair the following items or systems, as necessary:

- Sticking (closed) oil pressure relief valve.
- Wrong grade of oil.
- Faulty oil pressure gauge or sender.

Knocking Main Bearings {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Knocking Main Bearings

When the main bearings are constantly making noise, replace or repair the following items or systems, as necessary:

- Oval shaped crankshaft journals.
- Loose torque converter or flywheel mounting bolts.
- Loose damper pulley hub.
- Excessive clearance of the main bearings.
- Excessive belt tension.
- Low oil supply to the main bearings.
- Extreme crankshaft end-play.

Knocking Connecting Rods {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Knocking Connecting Rods

When the connecting rod bearings are constantly making noise, replace or repair the following items or systems, as necessary:

- Misaligned connecting rod or cap.
- Missing bearing shell or excessive bearing clearance.
- Incorrectly torqued connecting rod bolts.
- Connecting rod journal of the crankshaft is out-of-round.

Knocking Pistons and Rings {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Knocking Pistons and Rings

When the pistons and/rings are constantly making noise, replace or repair the following items or systems, as necessary:

- Misaligned connecting rods.
- Out-of-round or tapered cylinder bore.
- Loose or tight ring side clearance.
- Build-up of carbon on the piston(s).
- Piston-to-cylinder bore clearance is excessive.
- Broken piston rings.
- Loose or seized piston pin(s).

Knocking Valve Train {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Knocking Valve Train

When the valve train is constantly making noise, replace or repair the following items or systems, as necessary:

- Retighten any loose rocker arms.
- Remove any dirt or chips in the valve lifters.
- Excessive valve stem-to-guide clearance.
- Remove restrictions from valve lifter oil holes.
- Incorrect valve lifter may be installed in the engine.
- Valve lock(s) may be missing.
- Valve lifter check ball may be faulty.
- Valve lifter leak down may be excessive.
- Rocker arm nut may be reversed (installed upside-down).
- Camshaft lobes may be excessively worn.
- Bent or worn pushrods.
- Excessively worn bridged pivots or rocker arms.
- Cocked or broken valve springs.
- Bent valve(s).
- Worn valve lifter face(s).
- Damaged lifter plunger or pushrod seat.

Knocking Valves {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Knocking Valves

When the valves are constantly noisy, replace or repair the following items or systems, as necessary:

- Unadjusted valve lash.
- Valve springs may be broken.
- Pushrods may be bent.
- Camshaft lobes may be excessively worn.
- Dirty or worn valve lifters.
- Valve guides may be worn.
- Valve seat or face runout may be excessive.
- Loose rocker arm studs.

{ewc GSMVIMG,GSMVIMG, !88263c09.bmp}

88263c09

{ewc GSMVIMG,GSMVIMG, !88263c10.bmp}

88263c10

{ewc GSMVIMG,GSMVIMG, !tccs3c06.bmp}

tccs3c06

{ewc GSMVIMG,GSMVIMG, !tccs3c07.bmp}

tccs3c07

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tccs3c09

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tccs3c10

{ewc GSMVIMG,GSMVIMG, !tccs3c11.bmp}

tccs3c11

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tccs3c12

DRIVEABILITY AND EMISSION CONTROLS

{ewc MVIMAGE,MVIMAGE, ! driveability.bmp}

AIR POLLUTION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

AIR POLLUTION

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 {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

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 {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

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 {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

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 {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

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 {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

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 4000ºF (2204ºC). 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 {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

AUTOMOTIVE EMISSIONS

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 {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

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 {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

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 {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CARBON MONOXIDE

Carbon monoxide is formed when not enough oxygen is present during the combustion process to convert carbon (C) to carbon dioxide (CO_2). 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 (NO_2). To accomplish this, carbon monoxide (CO) combines with oxygen (O_2) and nitric oxide (NO) to produce carbon dioxide (CO_2) and nitrogen dioxide (NO_2). ($CO + O_2 + NO = CO_2 + NO_2$).

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 {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

NITROGEN

Normally, nitrogen is an inert gas. When heated to approximately 2500ºF (1371ºC) 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 (NO_2). 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 {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Ozone

To further complicate matters, some of the nitrogen dioxide (NO_2) is broken apart by the sunlight to form nitric oxide and oxygen. (NO_2 + sunlight = NO + O). This single atom of oxygen then combines with diatomic (meaning 2 atoms) oxygen (O_2) to form ozone (O_3). 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 {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

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 pollutions and the introduction of catalytic converter to the automobile exhaust systems, a change was mandated. The automobile exhaust system, when equipped with a catalytic converter, changes the sulfur dioxide (SO_2) into the sulfur trioxide (SO_3).

When this combines with water vapors (H_2O), a sulfuric acid mist (H_2SO_4) 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 {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

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 manufacturers 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 {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

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 head 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 {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

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.

GASOLINE ENGINE EMISSION CONTROLS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

GASOLINE ENGINE EMISSION CONTROLS

Crankcase Ventilation System

OPERATION

Ü See figures 1, 2, 3

The Positive Crankcase Ventilation (PCV) system is used to evacuate the crankcase vapors. Outside vehicle air is routed through the air cleaner to the crankcase where it mixes with the blow-by gases and is passed through the PCV valve. It is then routed into the intake manifold. The PCV valve meters the air flow rate which varies under engine operation depending on manifold vacuum. In order to maintain idle quality, the PCV valve limits the air flow when intake manifold vacuum is high. If abnormal operating conditions occur, the system will allow excessive blow-by gases to back flow through the crankcase vent tube into the air cleaner. These blow-by gases will then be burned by normal combustion.

A plugged PCV valve or hose may cause rough idle, stalling or slow idle speed, oil leaks, oil in the air cleaner or sludge in the engine. A leaking PCV valve or hose could cause rough idle, stalling or high idle speed.

Other than checking and replacing the PCV valve and associated hoses, there is not service required. Engine operating conditions that would direct suspicion to the PCV system are rough idle, oil present in the air cleaner, oil leaks and excessive oil sludging or dilution. If any of the above conditions exist, remove the PCV valve and shake it. A clicking sound indicates that the valve is free. If no clicking sound is heard, replace the valve. Inspect the PCV breather in the air cleaner. Replace the breather if it is so dirty that it will not allow gases to pass through. Check all the PCV hoses for condition and tight connections. Replace any hoses that have deteriorated.

Figure 1.
PCV flow in the 2.5L engine

{ewc GSMVIMG,GSMVIMG, !88264g01.bmp}

88264g01

Figure 2.
PCV flow in the 4.3L engine

{ewc GSMVIMG,GSMVIMG, !88264g02.bmp}

88264g02

Figure 3.
Cross-section of the PCV valve

{ewc GSMVIMG,GSMVIMG, !88264g00.bmp}

88264g00

TESTING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TESTING

With the engine running, remove the PCV from the valve cover and place your thumb over the end of the valve. Check if vacuum is present at the valve. If vacuum is not present, check for plugged hoses, blockage of the manifold port at the throttle body/carburetor unit or a faulty PCV valve. Replace as necessary. With the engine not running, remove the PCV valve from the vehicle. Shake the valve and listen for the rattle of the check valve needle. If no rattle is heard the valve is defective and must be replaced.

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REMOVAL & INSTALLATION

Ü See figures 4, 5, 6, 7

1. To replace the valve, gently pull the hose from the top of the valve, then pull the valve out of the cover grommet.
2. Installation is the reverse of removal.

Figure 4.
PCV system—2.5L engine

{ewc GSMVIMG,GSMVIMG, !88264g03.bmp}

88264g03

Figure 5.
PCV system—4.3L CMFI/CSFI engine

{ewc GSMVIMG,GSMVIMG, !88264g06.bmp}

88264g06

Figure 6.
PCV system—4.3L carbureted engine

{ewc GSMVIMG,GSMVIMG, !88264g04.bmp}

88264g04

Figure 7.
PCV system—4.3L TBI engine

{ewc GSMVIMG,GSMVIMG, !88264g05.bmp}

88264g05

Evaporative Emission Control System {ewc MVIMAGE, MVIMAGE, ! nexttopicarrow.bmp}

Evaporative Emission Control System

OPERATION

Ü See figures 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20

The Evaporative Emission Control System (EECS) is designed to prevent fuel tank vapors from being emitted into the atmosphere. Gasoline vapors are absorbed and stored by a fuel vapor charcoal canister. The charcoal canister absorbs the gasoline vapors and stores them until certain engine conditions are met and the vapors can be purged and burned by the engine.

The charcoal canister purge cycle is controlled by a thermostatic vacuum switch, a timed vacuum source or by a solenoid valve the receives its instruction from the engine management system. The thermostatic switch is installed in the coolant passage and prevents canister purge when engine operating temperature is below 115ºF (46ºC). The timed vacuum source uses a manifold vacuum-controlled diaphragm to control canister purge. When the engine is running, full manifold vacuum is applied to the top tube of the purge valve which lifts the valve diaphragm and opens the valve. The solenoid valve is usually mounted on or near the intake manifold. In general, none of the systems, regardless of type, allow canister purge below 115ºF (46ºC).

Figure 8.
Sample of the emissions related hose routing sticker found on most vehicles

{ewc GSMVIMG,GSMVIMG, !88264p01.bmp}

88264p01

Figure 9.
The emissions label under the hood has all of the information pertinent to that vehicle on it

{ewc GSMVIMG,GSMVIMG, !88264p02.bmp}

88264p02

Figure 10.
Evaporative emission system—4.3L carbureted engine

{ewc GSMVIMG,GSMVIMG, !88264g07.bmp}

88264g07

Figure 11.
Canister purge vacuum switch—4.3L CSFI engine

{ewc GSMVIMG,GSMVIMG, !88264g20.bmp}

88264g20

Figure 12.
Typical canister mounting—it has two hoses attached with a third nipple blocked-off

{ewc GSMVIMG,GSMVIMG, !88264p03.bmp}

88264p03

Figure 13.
Fuel vapor canister—4.3L carbureted engine

{ewc GSMVIMG,GSMVIMG, !88264g08.bmp}

88264g08

Figure 14.
Evaporative emission system—2.5L engine

{ewc GSMVIMG,GSMVIMG, !88264g09.bmp}

88264g09

Figure 15.
Fuel vapor canister—2.5L engine

{ewc GSMVIMG,GSMVIMG, !88264g10.bmp}

88264g10

Figure 16.
Evaporative emission system—4.3L TBI engine

{ewc GSMVIMG,GSMVIMG, !88264g11.bmp}

88264g11

Figure 17.
Fuel vapor canister—4.3L TBI engine

{ewc GSMVIMG,GSMVIMG, !88264g12.bmp}

88264g12

Figure 18.
Some vapor canisters may have 3 projections yet only 2 are connected to the internals

{ewc GSMVIMG,GSMVIMG, !88264g13.bmp}

88264g13

Figure 19.
Evaporative emission system—4.3L CMFI engine

{ewc GSMVIMG,GSMVIMG, !88264g14.bmp}

88264g14

Figure 20.
Fuel vapor canister—4.3L CMFI engine

{ewc GSMVIMG,GSMVIMG, !88264g15.bmp}

88264g15

A vent located in the fuel tank, allows fuel vapors to flow to the charcoal canister. A tank pressure control valve, used on high altitude applications, prevents canister purge when the engine is not running. The fuel tank cap does not normally vent to the atmosphere but is designed to provide both vacuum and pressure relief.

Poor engine idle, stalling and poor driveability can be caused by a damaged canister or split, damaged or improperly connected hoses.

Evidence of fuel loss or fuel vapor odor can be caused by a liquid fuel leak:

- A cracked or damaged vapor canister
- A disconnected, misrouted, kinked or damaged vapor pipe or canister hoses
- A damaged air cleaner or improperly seated air cleaner gasket

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TESTING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TESTING

Vapor Canister

1. Apply a length of hose to the lower tube of the purge valve assembly and attempt to blow air through it. There should be little or no air should passing into the canister.

   Ä If the canister is equipped with a constant purge hole, a small amount of air will pass into the canister.

2. Using a hand-held vacuum pump, apply a vacuum of 15 in. Hg (51 kPa) to the control vacuum (upper) tube. If the vacuum does not hold for at least 20 seconds, the diaphragm is leaking. Replace the canister.

3. If the diaphragm holds vacuum, attempt to blow air through the hose connected to the PCV tube while vacuum is still being applied. An increase of air should be observed. If no increase is noted, the canister must be replaced.

Fuel Tank Pressure Control Valve {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Fuel Tank Pressure Control Valve

Ü See figure 21

1. Attach a length of hose to the tank side of the valve assembly and try to blow air through it. Little or no air should pass into the canister.
2. Using a hand-held vacuum pump, apply vacuum equivalent to 15 in. Hg (51 kPa) to the control vacuum tube. If the diaphragm does not hold vacuum, the diaphragm is leaking. Replace the valve.
3. If the diaphragm holds vacuum, attempt to blow air through the hose connected to the valve while vacuum is still being applied. Air should pass. If no air is noted, the valve must be replaced.

Figure 21.
Cutaway section of the fuel tank pressure control valve

{ewc GSMVIMG,GSMVIMG, !88264g24.bmp}

88264g24

Thermostatic Vacuum Switch {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Thermostatic Vacuum Switch

1. With engine temperature below 100ºF (38ºC), apply vacuum to the manifold side of the switch. The switch should hold vacuum.
2. Start and continue to run the engine until the engine temperature increases above 122ºF (50ºC). The vacuum should drop off.
3. Replace the switch if it fails either test.

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REMOVAL & INSTALLATION

Vapor Canister

Ü See figures 22, 23, 24

1. Tag and disconnect the hoses from the canister.
2. Remove the vapor canister retaining nut.
3. Remove the canister from the vehicle.

To install:

4. Install the canister. If necessary refer to the vehicle emission control label, located in the engine compartment for proper routing of the vacuum hoses.

Figure 22.
Typical vapor canister mounting—except 1996 models

{ewc GSMVIMG,GSMVIMG, !88264g17.bmp}

88264g17

Figure 23.
Typical vapor canister mounting—1996 models

{ewc GSMVIMG,GSMVIMG, !88264g21.bmp}

88264g21

Figure 24.
Vapor canister connections—1996 models

{ewc GSMVIMG,GSMVIMG, !88264g22.bmp}

88264g22

Thermostatic Vacuum Switch {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Driveability And Emission Controls

Thermostatic Vacuum Switch

1. Drain the cooling system to below the switch level.
2. Tag and disconnect the vacuum hoses from the switch.
3. Remove the thermostatic vacuum switch.

To install:

4. Install the thermostatic vacuum switch. Make sure to apply sealer to the switch threads.
5. Connect the vacuum hoses.
6. Refill the cooling system.

Canister Purge Solenoid {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Canister Purge Solenoid

Ü See figures 25, 26, 27

1. Disconnect the negative battery cable.
2. Disconnect the electrical connectors and hoses from the solenoid.
3. Pull the solenoid away from the bracket and remove the assembly.

To install:

4. Install the solenoid to the bracket by sliding it into place.
5. Connect the electrical connectors and the hoses.
6. Connect the negative battery cable.

Figure 25.
Removing the canister purge solenoid—4.3L TBI engine
{ewc GSMVIMG,GSMVIMG, !88264g16.bmp}

88264g16

Figure 26.
Removing the canister purge solenoid—4.3L CMFI engine
{ewc GSMVIMG,GSMVIMG, !88264g23.bmp}

88264g23

Figure 27.
Removing the canister purge solenoid—4.3L CSFI engine
{ewc GSMVIMG,GSMVIMG, !88264g19.bmp}

88264g19

Early Fuel Evaporation System {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Early Fuel Evaporation System

OPERATION

Ü See figures 28, 29, 30, 31

The Early Fuel Evaporation (EFE) system, used on carbureted models, consists of an EFE valve at the flange of the exhaust manifold, an actuator, and a thermal vacuum switch. The TVS is located in the coolant outlet housing and directly controls vacuum.

In both systems, manifold vacuum is applied to the actuator, which in turn, closes the EFE valve. This routes hot exhaust gases to the base of the carburetor. When coolant temperatures reach a set limit, vacuum is denied to the actuator allowing an internal spring to return the actuator to its normal position, opening the EFE valve.

Figure 28.
Valve, actuator and TVS—4.3L carbureted engine
{ewc GSMVIMG,GSMVIMG, !88264g25.bmp}

88264g25

Figure 29.
Thermal vacuum switch port identification
{ewc GSMVIMG,GSMVIMG, !88264g27.bmp}

88264g27

Figure 30.
Thermal vacuum switch location—49 state models
{ewc GSMVIMG,GSMVIMG, !88264g28.bmp}

88264g28

Figure 31.
Thermal vacuum switch location—California models
{ewc GSMVIMG,GSMVIMG, !88264g29.bmp}

88264g29

TESTING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TESTING

1. Locate the EFE valve on the exhaust manifold and note the position of the actuator arm. On some vehicles, the valve and arm are covered by a two-piece cover which must be removed for access. Make sure the engine is overnight cold.
2. Watch the actuator arm when the engine is started. The valve should close when the engine is started cold; the actuator link will be pulled into the diaphragm housing.
3. If the valve does not close, stop the engine. Remove the hose from the EFE valve and apply 10 in. Hg (33.8 kPa) of vacuum by hand pump. The valve should close and stay closed for at least 20 seconds (you will hear it close). If the valve opens in less than 20 seconds, replace it. The valve could also be seized if it does not close; lubricate it with spray type manifold heat valve lube. If the valve does not close when vacuum is applied and when it is lubricated, replace the valve.
4. If the valve closes, the problem is not with the valve. Check for loose, cracked, pinched or plugged hoses, and replace as necessary. Test the EFE solenoid (located on the valve cover bracket); if it is working, the solenoid plunger will emit a noise when the current is applied.
5. Warm up the engine to operating temperature.
6. Watch the EFE valve to see if it has opened. It should now be open. If the valve is still closed, replace the solenoid if faulty, and/or check the engine thermostat; the engine coolant may not be reaching normal operating temperature.

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REMOVAL & INSTALLATION

Ü See figure 32

Ä If the vehicle is equipped with an oxygen sensor, it is located near the EFE valve. Use care when removing the EFE valve as not to damage the oxygen sensor.

1. Disconnect the negative (-) battery cable and vacuum hose at the EFE valve.
2. Remove the exhaust pipe-to-manifold nuts, and the washers and tension springs if used.
3. Lower the exhaust cross-over pipe. On some models, complete removal of the pipe is not necessary.
4. Remove the EFE valve.

Figure 32.
EFE valve and actuator assembly mounting

{ewc GSMVIMG,GSMVIMG, !88264g26.bmp}

88264g26

To install:

5. Always install new seals and gaskets. Torque the exhaust nuts to 15 ft. lbs. (20 Nm). Connect the negative battery cable and vacuum hose to the valve.

Exhaust Gas Recirculation (EGR) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Exhaust Gas Recirculation (EGR)

OPERATION

Ü See figures 33, 34, 35, 36, 37, 38, 39, 40

The EGR system's purpose is to control oxides of nitrogen which are formed during the peak combustion temperatures. The end products of combustion are relatively inert gases derived from the exhaust gases which are directed into the EGR valve to help lower peak combustion temperatures.

The port EGR valve is controlled by a flexible diaphragm which is spring loaded to hold the valve closed. Vacuum applied to the top side of the diaphragm overcomes the spring pressure and opens the valve which allows exhaust gas to be pulled into the intake manifold and enter the engine cylinders.

The negative backpressure EGR valve has a bleed valve spring below the diaphragm, and the valve is normally closed. The valve varies the amount of exhaust flow into the manifold depending on manifold vacuum and variations in exhaust backpressure.

The diaphragm on this valve has an internal air bleed hole which is held closed by a small spring when there is no exhaust backpressure. Engine vacuum opens the EGR valve against the pressure of a large. When manifold vacuum combines with negative exhaust backpressure, the vacuum bleed hole opens and the EGR valve closes. This valve will open if vacuum is applied with the engine not running.

Figure 33.
EGR valve identification

{ewc GSMVIMG,GSMVIMG, !88264g30.bmp}

88264g30

Figure 34.
Linear EGR valve identification

{ewc GSMVIMG,GSMVIMG, !88264g34.bmp}

88264g34

Figure 35.
Flow diagram of the EGR valve

{ewc GSMVIMG,GSMVIMG, !88264g31.bmp}

88264g31

Figure 36.
Cutaway drawing of a negative pack pressure EGR valve

{ewc GSMVIMG,GSMVIMG, !88264g32.bmp}

88264g32

Figure 37.
Cutaway drawing of a linear EGR valve

{ewc GSMVIMG,GSMVIMG, !88264g33.bmp}

88264g33

Figure 38.
EGR system controlled by TVS

{ewc GSMVIMG,GSMVIMG, !88264g35.bmp}

88264g35

Figure 39.
EGR system controlled by solenoid valve and ECM

{ewc GSMVIMG,GSMVIMG, !88264g36.bmp}

88264g36

Figure 40.
EGR control solenoid

{ewc GSMVIMG,GSMVIMG, !88264g39.bmp}

88264g39

The linear EGR valve is operated exclusively by the control module command. The control module monitors various engine parameters:

- Throttle Position Sensor (TPS)
- Manifold Absolute Pressure (MAP)
- Engine Coolant Temperature (ECT) sensor
- Pintle position sensor

Output messages are then sent to the EGR system indicating the proper amount of exhaust gas recirculation necessary to lower combustion temperatures.

TESTING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Driveability And Emission Controls

TESTING

EGR Valve

NEGATIVE BACKPRESSURE EGR VALVE

1. Remove the vacuum hose from the EGR valve.
2. Using a vacuum source, connect it to the EGR valve hose fitting and apply 10 in. Hg (33.8 kPa); the valve should lift off of its seat. If not, replace the EGR valve.
3. Clean the carbon deposits from the valve and intake manifold. With the valve removed, run the engine for 3–5 seconds to blow the carbon out of the intake manifold.

LINEAR EGR VALVE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

LINEAR EGR VALVE

Ü See figures 41, 42

1. Remove the electrical connector from the EGR valve.
2. Measure the resistance between terminals A and E.
3. The resistance should be 9.5–10.5 ohms. Replace the valve if that is not correct
4. Remove the EGR valve from the engine.
5. Measure the resistance between terminals B and C while moving the pintle in and out. The resistance should change in a smooth fashion without skips or jumps. Replace if necessary.

Figure 41.
Linear EGR valve pinouts—with CMFI/CSFI

{ewc GSMVIMG,GSMVIMG, !88264g38.bmp}

88264g38

Figure 42.
Linear EGR valve pinouts—with TBI

{ewc GSMVIMG,GSMVIMG, !88264g41.bmp}

88264g41

EGR Control Solenoid {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

EGR Control Solenoid

1. Disconnect the electrical connector from the solenoid.
2. Using an ohmmeter, measure the solenoid's resistance, it should be more than 20 ohms. If less than 20 ohms, replace the solenoid and/or possibly the ECM.

Thermostatic Vacuum Switch {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Thermostatic Vacuum Switch

If the thermostatic vacuum switch is not working, a Code 32 will store in the ECM memory and a "Service Engine Soon" lamp will light on the instrument panel.

1. Remove the TVS from the engine.
2. Using a vacuum gauge, connect it to one of the hose connections and apply 10 in. Hg (33.8 kPa).

   Ä A vacuum drop of 2 in. Hg (6.7 kPa) in 2 minutes is allowable.
3. Place the tip of the switch in boiling water. When the switch reaches 195ºF (91ºC), the valve should open and the vacuum will drop; if not, replace the switch.

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Driveability And Emission Controls

REMOVAL & INSTALLATION

EGR Valve

Ü See figures 43, 44, 45, 46, 47, 48, 49, 50

1. Disconnect the negative battery cable.
2. Remove the air cleaner assembly or air inlet duct from the engine.
3. Remove the EGR valve vacuum tube from the valve, except for the linear EGR valves from which the electrical plug is disconnected.
4. Remove the EGR bolts and/or nuts and remove the EGR valve and gasket.

To install:

5. Install a new gasket to the EGR valve and install the EGR valve to the manifold.
6. Install the nuts and/or bolts. Tighten the bolts to 17–18 ft. lbs. (24–25 Nm) and/or the nuts to 15 ft. lbs. (20 Nm).
7. Connect the vacuum tube or electrical plug to the EGR valve.
8. Install the air cleaner or air duct and connect the negative battery cable.

Figure 43.
EGR mounting—2.5L engine

{ewc GSMVIMG,GSMVIMG, !88264g43.bmp}

88264g43

Figure 44.
EGR mounting—4.3L TBI engine

{ewc GSMVIMG,GSMVIMG, !88264g44.bmp}

88264g44

Figure 45.
EGR mounting—4.3L CMFI engine

{ewc GSMVIMG,GSMVIMG, !88264g40.bmp}

88264g40

Figure 46.
EGR mounting—4.3L CSFI engine

{ewc GSMVIMG,GSMVIMG, !88264g45.bmp}

88264g45

Figure 47.
Disconnect the vacuum hose and tag it for identification

{ewc GSMVIMG,GSMVIMG, !88264p04.bmp}

88264p04

Figure 48.
A distributor wrench makes accessing the mounting hardware much easier

{ewc GSMVIMG,GSMVIMG, !88264p05.bmp}

88264p05

Figure 49.
Pull the EGR valve away along with the old gasket

{ewc GSMVIMG,GSMVIMG, !88264p06.bmp}

88264p06

Figure 50.
Always use a new gasket when installing. Notice that this one is burned in the center

{ewc GSMVIMG,GSMVIMG, !88264p07.bmp}

88264p07

EGR Solenoid {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

EGR Solenoid

Ü See figures 51, 52, 53, 54

1. Disconnect the negative battery cable.
2. Remove the air cleaner, as required.
3. Unplug the electrical connector at the solenoid.
4. Disconnect the vacuum hoses.
5. Remove the retaining bolts and the solenoid.
6. Remove the filter, as required.

To install:

7. If removed, install the filter.
8. Install the solenoid and retaining bolts.
9. Connect the vacuum hoses.
10. Engage the electrical connector.
11. If removed, install the air cleaner.
12. Connect the negative battery cable.

Figure 51.
EGR and TVS connections—4.3L carbureted engine

{ewc GSMVIMG,GSMVIMG, !88264g37.bmp}

88264g37

Figure 52.
EGR valve and solenoid—4.3L carbureted engine

{ewc GSMVIMG,GSMVIMG, !88264g42.bmp}

88264g42

Figure 53.
EGR valve and solenoid—2.5L engine

{ewc GSMVIMG,GSMVIMG, !88264g46.bmp}

88264g46

Figure 54.
EGR valve and solenoid—4.3L TBI engine

{ewc GSMVIMG,GSMVIMG, !88264g47.bmp}

88264g47

Air Injector Reactor (AIR) System {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Air Injector Reactor (AIR) System

Ü See figures 55, 56, 57, 58, 59, 60

The AIR system injects compressed air into the exhaust system, near enough to the exhaust valves to continue the burning of the normally unburned segment of the exhaust gases. To do this, it employs an air injection pump and a system of hoses, valves, tubes, etc., necessary to carry the compressed air from the pump to the exhaust manifolds.

A diverter valve is used to prevent backfiring. The valve senses sudden increases in manifold vacuum and ceases the injection of air during rich periods. During coasting, this valve diverts the entire air flow through a muffler and during high engine speeds, expels it through a relief valve. Check valves in the system prevent exhaust gases from entering the pump.

Figure 55.
Diverter valve—4.3L 49 states carbureted engine

{ewc GSMVIMG,GSMVIMG, !88264g48.bmp}

88264g48

Figure 56.
Air control valve—4.3L California carbureted engine

{ewc GSMVIMG,GSMVIMG, !88264g49.bmp}

88264g49

Figure 57.
Deceleration control valve airflow

{ewc GSMVIMG,GSMVIMG, !88264g50.bmp}

88264g50

Figure 58.
AIR system—4.3L TBI engine

{ewc GSMVIMG,GSMVIMG, !88264g51.bmp}

88264g51

Figure 59.
Electric air control valve—4.3L TBI engine

{ewc GSMVIMG,GSMVIMG, !88264g52.bmp}

88264g52

Figure 60.
AIR system components

{ewc GSMVIMG,GSMVIMG, !88264g53.bmp}

88264g53

TESTING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TESTING

Ä The AIR system is not completely silent under normal conditions. Noises will rise in pitch as engine speed increases. If the noise is excessive, eliminate the air pump itself by disconnecting the drive belt. If the noise disappears, the air pump is at fault.

Check Valve

To test the check valve, disconnect the hose at the diverter valve. Place your hand over the check valve and check for exhaust pulses. If exhaust pulses are present, the check valve must be replaced.

Diverter Valve {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Diverter Valve

Pull off the vacuum line to the top of the valve with the engine running. There should be vacuum in the line, if not replace the line. No air should be escaping with the engine running at a steady idle. Open and quickly close the throttle. A blast of air should come out of the valve muffler for at least one second.

Air Pump {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Air Pump

Disconnect the hose from the diverter valve. Start the engine and accelerate it to about 1500 rpm. The air flow should increase as the engine is accelerated. If no air flow is noted or it remains constant, check the following:

1. Drive belt tension.
2. Listen for a leaking pressure relief valve. If it is defective, replace the whole relief/diverter valve.
3. Foreign matter in pump filter openings. If the pump is defective or excessively noisy, it must be replaced.

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REMOVAL & INSTALLATION

Ü See figures 61, 62

All hoses and fittings should be inspected for condition and tightness of connections. Check the drive belt for wear and tension periodically.

Figure 61.
AIR pump mounting

{ewc GSMVIMG,GSMVIMG, !88264g54.bmp}

88264g54

Figure 62.
Deceleration valve mounting

{ewc GSMVIMG,GSMVIMG, !88264g55.bmp}

88264g55

Air Pump {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Driveability And Emission Controls

Air Pump

1. Disconnect the output hose.
2. Hold the pump from turning by squeezing the drive belt.
3. Loosen, but do not remove, the pulley bolts.
4. Loosen the alternator so the belt can be removed.
5. Remove the pulley.
6. Remove the pump mounting bolts and the pump.

To install:

7. Install the pump with the mounting bolts loose.
8. Install the pulley and tighten the bolts finger-tight.
9. Install the drive belt.
10. Squeeze the drive belt to prevent the pump from turning.
11. Tighten the pump mounting bolts to 25 ft. lbs. (33 Nm). Tighten the pulley bolts to 90 inch lbs. (10 Nm).
12. Check and adjust the belt tension.
13. Connect the hose.
14. If any hose leaks are suspected, pour soapy water over the suspected area with the engine running. Bubbles will form wherever air is escaping.

Filter {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Filter

Ü See figure 63

1. Remove the pump and the diverter valve as an assembly.

   ****Warning**
   Do not clamp the pump in a vise or use a hammer or pry bar on the pump housing! Damage to the housing may result.

2. To change the filter, break the plastic fan from the hub. It is seldom possible to remove the fan without breaking it. Wear safety glasses.
3. Remove the remaining portion of the fan filter from the pump hub. Be careful that filter fragments do not enter the air intake hole.

To install:

4. Position the new centrifugal fan filter on the pump hub. Place the pump pulley against the fan filter and install the securing screws. Tighten the screws alternately to 95 inch lbs. (10 Nm). The fan filter will be pressed onto the pump hub.
5. Install the pump on the engine and adjust the drive belt.

Figure 63.
AIR pump filter replacement

{ewc GSMVIMG,GSMVIMG, !88264g56.bmp}

88264g56

Thermostatic Air Cleaner {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Thermostatic Air Cleaner

OPERATION

Ü See figure 64

This system is designed to warm the air entering the carburetor/TBI unit when underhood temperatures are low. This allows more precise calibration of the fuel system.

The thermostatically controlled air cleaner is composed of the air cleaner body, a filter, sensor unit, vacuum diaphragm, damper door and associated hoses and connections. Heat radiating from the exhaust manifold is trapped by a heat stove and is ducted to the air cleaner to supply heated air to the fuel system. A movable door in the air cleaner snorkel allows air to be drawn in from the heat stove (cold operation) or from the underhood air (warm operation). Periods of extended idling, climbing a grade or high speed operation are followed by a considerable increase in engine compartment temperature. Excessive fuel vapors enter the intake manifold causing an over-rich mixture, resulting in a rough idle. To overcome this, some engines may be equipped with a hot idle compensator.

Figure 64.
Thermal air cleaner operation modes

{ewc GSMVIMG,GSMVIMG, !88264g57.bmp}

88264g57

TESTING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TESTING

1. Remove the air cleaner assembly and cool to below 40ºF (4ºC). The damper door should be closed to outside air.
2. Check for the presence and condition of the air cleaner gasket.
3. Reinstall the air cleaner assembly and check to make sure the heat stove tube is connected at the air cleaner snorkel and exhaust manifold.
4. Start the engine and watch the damper in the air cleaner snorkel. As the air cleaner warms up, the damper door should open slowly to the outside air.
5. If the damper fails to operate, check for vacuum at the port on the carburetor/TBI unit. If vacuum is not present, the port must be unclogged.
6. If vacuum was OK at the port, check for vacuum at the damper. If vacuum is present and the damper fails to operate, the vacuum diaphragm must be replaced. If vacuum is not present, the sensor unit in the air cleaner is probably faulty.

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REMOVAL & INSTALLATION

Ü See figure 65

Vacuum Diaphragm

1. Remove the air cleaner.
2. If the truck uses a plastic heat tube elbow, use a $^{1}/8$ in. bit to drill out the two rivets that secure it to the heat tube and remove the elbow.
3. Using a $^{1}/8$ in. drill bit again, drill out the two rivets that secure the vacuum diaphragm assembly.
4. Remove the blow down spring and the carrier assembly.
5. Examine the spring clip on the hot air damper. Replace if necessary.

Figure 65.
Thermal air cleaner components

{ewc GSMVIMG,GSMVIMG, !88264g58.bmp}

88264g58

To install:

6. Install a new assembly with two pop rivets. Install a new blow down spring.
7. Install the heat elbow with two rivets, if equipped.
8. Install the air cleaner.

Sensor Unit {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Sensor Unit

1. Remove the air cleaner.
2. Label and disconnect the vacuum hoses leading to the sensor.
3. Remove the two clips securing the sensor to the air cleaner.

To install:

4. Position the sensor on the air cleaner.
5. Install the clips securing the sensor.
6. Connect the vacuum hoses and install the air cleaner.

Catalytic Converter {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Catalytic Converter

OPERATION

The catalytic converter is a muffler-like container built into the exhaust system to aid in the reduction of exhaust emissions. The catalyst element is coated with a noble metal such as platinum, palladium, rhodium or a combination of them. When the exhaust gases come into contact with the catalyst, a chemical reaction occurs which reduces the pollutants into harmless substances such as water and carbon dioxide.

There are two types of catalytic converters: an oxidizing type and a three-way type. The oxidizing catalyst requires the addition of oxygen to spur the catalyst into reducing the engine's HC and CO emissions into H2O and CO2.

PRECAUTIONS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Driveability And Emission Controls

PRECAUTIONS

1. Use only unleaded fuel.
2. Avoid prolonged idling; the engine should run no longer than 20 min. at curb idle and no longer than 10 min. at fast idle.
3. Don't disconnect any of the spark plug leads while the engine is running. If any engine testing procedure requires disconnecting or bypassing a control component, perform the procedure as quickly as possible. A misfiring engine can overheat the catalyst and damage the oxygen sensor.
4. Make engine compression checks as quickly as possible.
5. Whenever under the vehicle or around the catalytic converter, remember that it has a very high outside or skin temperature. During operation, the catalyst must reach very high temperatures to work efficiently. Be very wary of burns, even after the engine has been shut off for a while. Additionally, because of the heat, never park the vehicle on or over flammable materials, particularly dry grass or leaves. Inspect the heat shields frequently and correct any bends or damage.
6. In the unlikely event that the catalyst must be replaced, DO NOT dispose of the old one where anything containing grease, gas or oil can come in contact with it. The catalytic action with these substances will result in heat which may start a fire.

CARBURETED ELECTRONIC ENGINE CONTROLS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CARBURETED ELECTRONIC ENGINE CONTROLS

Electronic Control Module (ECM)

Ü See figures 66, 67

OPERATION

Ü See figure 68

Ä When the term Electronic Control Module (ECM) is used in this manual it will refer to the engine control computer regardless that it may be a Vehicle Control Module (VCM), Powertrain Control Module (PCM) or Engine Control Module (ECM).

The ECM is a reliable solid state computer, protected in a metal box. It is used to monitor and control all the functions of the Computer Command Control (CCC) system and is located in the passenger side footwell at the kick panel. The ECM can perform several on-car functions at the same time and has the ability to diagnose itself as well as other CCC system circuits.

Figure 66.
Component locations of carbureted engine emissions devices

{ewc GSMVIMG,GSMVIMG, !88264g59.bmp}

88264g59

Figure 67.
Engine harness connector and component locations

{ewc GSMVIMG,GSMVIMG, !88264g69.bmp}

88264g69

Figure 68.
ECM terminal voltages for carbureted engine

{ewc GSMVIMG,GSMVIMG, !88264g60.bmp}

88264g60

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REMOVAL & INSTALLATION

Ü See figure 69

1. Disconnect the negative battery cable.
2. Disengage the connectors from the ECM.
3. Remove the ECM mounting hardware.
4. Remove the ECM from the passenger compartment.
5. Installation is the reverse of removal.

Figure 69.
ECM mounting scheme

{ewc GSMVIMG,GSMVIMG, !88264g61.bmp}

88264g61

Oxygen Sensor {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Oxygen Sensor

OPERATION

Ü See figure 70

The oxygen sensor is a spark plug shaped device that is screwed into the exhaust pipe. It monitors the oxygen content of the exhaust gases and sends a voltage signal to the ECM. The ECM monitors this voltage and, depending on the value of the received signal, issues a command to the mixture control solenoid on the carburetor to adjust for rich or lean conditions.

The proper operation of the oxygen sensor depends upon four basic conditions:

1. Good electrical connections. Since the sensor generates low currents, good clean electrical connections at the sensor are a must.
2. Outside air supply. Air must circulate to the internal portion of the sensor. When servicing the sensor, do not restrict the air passages.
3. Proper operating temperatures. The ECM will not recognize the sensor's signals until the sensor reaches approximately 600ºF (316ºC).
4. Non-leaded fuel. The use of leaded gasoline will damage the sensor very quickly.

Figure 70.
The oxygen sensor is shaped like a spark plug and is located in the exhaust pipe
{ewc GSMVIMG,GSMVIMG, !88264g62.bmp}

88264g62

TESTING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TESTING

1. Start the engine and bring it to normal operating temperature, then run the engine above 1200 rpm for two minutes.
2. Backprobe with a high impedance averaging voltmeter (set to the DC voltage scale) between the oxygen sensor (O2S) and battery ground.
3. Verify that the O2S voltage fluctuates rapidly between 0.40–0.60 volts.
4. If the O2S voltage is stabilized at the middle of the specified range (approximately 0.45–0.55 volts) or if the O2S voltage fluctuates very slowly between the specified range (O2S signal crosses 0.5 volts less than 5 times in ten seconds), the O2S may be faulty.
5. If the O2S voltage stabilizes at either end of the specified range, the ECM is probably not able to compensate for a mechanical problem such as a vacuum leak or a high float level. These types of mechanical problems will cause the O2S to sense a constant lean or constant rich mixture. The mechanical problem will first have to be repaired and then the O2S test repeated.
6. Pull a vacuum hose located after the throttle plate. Voltage should drop to approximately 0.12 volts (while still fluctuating rapidly). This tests the ability of the O2S to detect a lean mixture condition. Reattach the vacuum hose.
7. Richen the mixture using a propane enrichment tool. Voltage should rise to approximately 0.90 volts (while still fluctuating rapidly). This tests the ability of the O2S to detect a rich mixture condition.
8. If the O2S voltage is above or below the specified range, the O2S and/or the O2S wiring may be faulty. Check the wiring for any breaks, repair as necessary and repeat the test.

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REMOVAL & INSTALLATION

Ü See figure 71

****Warning**
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 could affect the proper operation of the sensor. Keep the electrical connector and louvered end of the sensor clean and free of grease. NEVER use cleaning solvents of any type on the sensor!

Ä The oxygen sensor may be difficult to remove when the temperature of the engine is below 120ºF (49ºC). Excessive force may damage the threads in the exhaust manifold or exhaust pipe.

1. Unplug the electrical connector and any attaching hardware.
2. Remove the sensor using an appropriate sized wrench or special socket.

Figure 71.
Oxygen sensor mounting location
{ewc GSMVIMG,GSMVIMG, !88264g63.bmp}

88264g63

To install:

3. Coat the threads of the sensor with a GM anti-seize compound, part number 5613695, or its equivalent, before installation. New sensors are usually precoated with this compound.

   Ä The GM anti-seize compound is NOT a conventional anti-seize paste. The use of a regular paste may electrically insulate the sensor, rendering it useless. The threads MUST be coated with the proper electrically conductive anti-seize compound.

4. Install the sensor and tighten to 30 ft. lbs. (40 Nm). Use care in making sure the silicone boot is in the correct position to avoid melting it during operation.
5. Engage the electrical connector and attaching hardware if used.

Coolant Temperature Sensor (CTS) {ewc MVIMAGE, MVIMAGE, ! nexttopicarrow.bmp}

Coolant Temperature Sensor (CTS)

OPERATION

Ü See figure 72

The coolant temperature sensor is a thermistor (a resistor which changes value based on temperature). Low coolant temperatures produce high resistance (100,000 ohms at -40ºF/-40ºC) while low temperatures causes low resistance (70 ohms at 266ºF/130ºC). The sensor is mounted in the coolant stream and the ECM supplies a 5 volt signal to the sensor through a resistor in the ECM and measures the voltage. The voltage will be high when the engine is cold, and low when the engine is hot. By measuring the voltage, the ECM knows the engine coolant temperature effects most systems the ECM controls.

Figure 72.
Engine coolant temperature sensor

{ewc GSMVIMG,GSMVIMG, !88264g64.bmp}

88264g64

TESTING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TESTING

Ü See figure 73

1. Remove the sensor from the vehicle.
2. Immerse the tip of the sensor in container of water.
3. Connect a digital ohmmeter to the two terminals of the sensor.
4. Using a calibrated thermometer, compare the resistance of the sensor to the temperature of the water. Refer to the engine coolant sensor temperature vs. resistance chart.
5. Repeat the test at two other temperature points, heating or cooling the water as necessary.
6. If the sensor does not meet specification, it must be replaced.

Figure 73.
Coolant temperature sensor resistance chart

{ewc GSMVIMG,GSMVIMG, !88264g65.bmp}

88264g65

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REMOVAL & INSTALLATION

1. Disconnect the negative battery cable.
2. Drain the cooling system below the level of the sensor and disengage the sensor electrical connection.
3. Remove the coolant sensor.

To install:

4. Install the sensor and engage the electrical connector.
5. Refill the cooling system and connect the negative battery cable.

Differential Pressure (Vacuum) Sensor {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Differential Pressure (Vacuum) Sensor

OPERATION

The differential pressure sensor measures the changes in intake manifold pressure, which result from the engine load and speed changes, and converts this to a voltage output. The differential pressure sensor operates opposite of a MAP sensor

A closed throttle on engine coastdown will produce a high output, while a wide-open throttle will produce a low output. This low output is produced because the pressure inside the manifold is the same as outside the manifold, so 100 percent of the outside air pressure is measured.

The ECM sends a 5 volt reference signal to the sensor. As the manifold pressure changes, the electrical resistance of the sensor also changes. By monitoring the sensor output voltage, the ECM knows the manifold pressure. A higher pressure, low vacuum (high voltage) requires more fuel, while a lower pressure, higher vacuum (low voltage) requires less fuel.

The ECM uses the sensor to control fuel delivery and ignition timing.

TESTING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TESTING

Ü See figure 74

1. Backprobe with a high impedance voltmeter at sensor terminals A and C.
2. With the key **ON** and engine off, the voltmeter reading should be approximately 5.0 volts.
3. If the voltage is not as specified, either the wiring to the sensor or the ECM may be faulty. Correct any wiring or ECM faults before continuing test.
4. Backprobe with a high impedance voltmeter at MAP sensor terminals B and A.
5. Verify that the sensor voltage is less then 1.0 volts with the engine not running.
6. Start the vehicle.
7. Verify that the sensor voltage is greater than 3.0 volts at idle.
8. Verify that the sensor voltage drops at Wide Open Throttle (WOT).
9. If the sensor voltage is as specified, the sensor is functioning properly.
10. If the sensor voltage is not as specified, check the sensor and the sensor vacuum source for a leak or a restriction. If no leaks or restrictions are found, the sensor may be defective and should be replaced.

Figure 74.
Differential pressure sensor wiring schematic

{ewc GSMVIMG,GSMVIMG, !88264gA5.bmp}

88264gA5

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REMOVAL & INSTALLATION

Ü See figure 75

1. Disconnect the negative battery cable.
2. Tag and disconnect the vacuum harness assembly.
3. Disengage the electrical connector.
4. Release the locktabs, unfasten the bolts and remove the sensor.
5. Installation is the reverse of removal.

Figure 75.
Differential pressure sensor mounting

{ewc GSMVIMG,GSMVIMG, !88264g66.bmp}

88264g66

Throttle Position Sensor (TPS) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Throttle Position Sensor (TPS)

OPERATION

The Throttle Position Sensor (TPS) is located inside the carburetor. It is a potentiometer with one wire connected to 5 volts from the ECM and the other to ground. A third wire is connected to the ECM to measure the voltage from the TPS.

As the accelerator pedal is moved, the output of the TPS also changes. At a closed throttle position, the output of the TPS is low (approximately 0.5 volts). As the throttle valve opens, the output increases so that, at wide-open throttle, the output voltage should be approximately 4.5 volts.

By monitoring the output voltage from the TPS, the ECM can determine fuel delivery based on throttle valve angle (driver demand).

TESTING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TESTING

1. Backprobe with a high impedance voltmeter at TPS terminals A and B.
2. With the key **ON** and engine off, the voltmeter reading should be approximately 5.0 volts.
3. If the voltage is not as specified, either the wiring to the TPS or the ECM may be faulty. Correct any wiring or ECM faults before continuing test.
4. Backprobe with a high impedance voltmeter at terminals C and B.
5. With the key **ON** and engine off and the throttle closed, the TPS voltage should be approximately 0.5–1.2 volts.
6. Verify that the TPS voltage increases or decreases smoothly as the throttle is opened or closed. Make sure to open and close the throttle very slowly in order to detect any abnormalities in the TPS voltage reading.
7. If the sensor voltage is not as specified, replace the sensor.

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REMOVAL & INSTALLATION

The throttle position sensor is located in the carburetor. Please refer to Section 5 for the procedures to remove the TPS.

Vehicle Speed Sensor (VSS) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Vehicle Speed Sensor (VSS)

OPERATION

The vehicle speed sensor is sometimes located behind the speedometer or more commonly on the transmission. It sends a pulsing voltage signal to the ECM, which the ECM converts to vehicle speed. This sensor mainly controls the operation of the Torque Convertor Clutch (TCC) system, shift light and cruise control.

TESTING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TESTING

1. Backprobe the VSS terminals with a high impedance voltmeter (set at the AC voltage scale).
2. Safely raise and support the entire vehicle using jackstands. Make absolutely sure the vehicle is secure.
3. Start the vehicle and place it in gear.
4. Verify that the VSS voltage increases as the speed increases.
5. If the VSS voltage is not as specified the VSS may be faulty.

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REMOVAL & INSTALLATION

1. Raise and safely support the vehicle.
2. Unplug the electrical connector.
3. Remove the sensor from the transmission or transfer case.
4. Installation is the reverse of removal.

Knock Sensor {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Knock Sensor

OPERATION

Ü See figure 76

Located in the engine block, the Knock Sensor (KS) retards ignition timing during a spark knock condition to allow the ECM to maintain maximum timing advance under most conditions.

Figure 76.
The knock sensor informs the ECM when engine knock is occurring by producing a voltage via a piezoelectric crystal inside the housing

{ewc GSMVIMG,GSMVIMG, !88264g67.bmp}

88264g67

TESTING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TESTING

1. Connect a timing light to the vehicle and start the engine.
2. Check that the timing is correct before testing knock sensor operation.
3. If timing is correct, tap on the front of the engine block with a metal object while observing the timing to see if the timing retards.
4. If the timing does not retard, the knock sensor may be defective.

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REMOVAL & INSTALLATION

Ü See figure 77

1. Disconnect the negative battery cable.
2. Disengage the wiring harness connector from the knock sensor.
3. Remove the knock sensor from the engine block.

To install:

4. Apply a water base caulk to the knock sensor threads and install the sensor in the engine block.

****Warning**
Do not use silicon tape to coat the knock sensor threads as this will insulate the sensor from the engine block.

5. Engage the wiring harness connector.
6. Connect the negative battery cable.

Figure 77.
Engine knock sensor mounting location

{ewc GSMVIMG,GSMVIMG, !88264g68.bmp}

88264g68

FUEL INJECTED ELECTRONIC ENGINE CONTROLS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

FUEL INJECTED ELECTRONIC ENGINE CONTROLS

Electronic Control Module (ECM)

OPERATION

Ä When the term Electronic Control Module (ECM) is used in this manual it will refer to the engine control computer regardless that it may be a Vehicle Control Module (VCM), Powertrain Control Module (PCM) or Engine Control Module (ECM).

The Electronic Control Module (ECM) is required to maintain the exhaust emissions at acceptable levels. The module is a small, solid state computer which receives signals from many sources and sensors; it uses these data to make judgments about operating conditions and then control output signals to the fuel and emission systems to match the current requirements.

Engines coupled to electronically controlled transmissions employ a Powertrain Control Module (PCM) or Vehicle Control Module (VCM) to oversee both engine and transmission operation. The integrated functions of engine and transmission control allow accurate gear selection and improved fuel economy.

In the event of an ECM failure, the system will default to a pre-programmed set of values. These are compromise values which allow the engine to operate, although at a reduced efficiency. This is variously known as the default, limp-in or back-up mode. Driveability is almost always affected when the ECM enters this mode.

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REMOVAL & INSTALLATION

Ü See figures 78, 79

The ECM is located in the passenger side footwell in the kick panel up to 1996. In 1996, the ECM is located in the engine compartment next to the battery.

1. Disconnect the negative battery cable.
2. Disengage the connectors from the ECM.
3. Remove the spring retainer off and over the rail of the ECM on vehicles except 1996.
4. Slide the ECM out of the bracket at an angle.
5. Remove the ECM.

To install:

6. Install the ECM into the bracket.
7. Install the spring retainer (except 1996) and plug in the electrical connectors.
8. Connect the negative battery cable.

Figure 78.
ECM mounting scheme—except 1996 models

{ewc GSMVIMG,GSMVIMG, !88264g71.bmp}

88264g71

Figure 79.
ECM mounting scheme—1996 models

{ewc GSMVIMG,GSMVIMG, !88264g70.bmp}

88264g70

Oxygen Sensor {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Oxygen Sensor

OPERATION

Ü See figure 80

There are two types of oxygen sensors used in these vehicles. They are the single wire oxygen sensor ($O2S$) and the heated oxygen sensor ($HO2S$). The oxygen sensor is a spark plug shaped device that is screwed into the exhaust manifold. It monitors the oxygen content of the exhaust gases and sends a voltage signal to the Electronic Control Module (ECM). The ECM monitors this voltage and, depending on the value of the received signal, changes the injection parameters to maintain a proper air/fuel ratio. The 1996 models use 4 oxygen sensors. Two are used as inputs to adjust the mixture while the other two are used to monitor the condition of the catalytic converter.

The heated oxygen sensor has a heating element incorporated into the sensor to aid in the warm up to the proper operating temperature and to maintain that temperature.

Figure 80.
Heated oxygen sensor components

{ewc GSMVIMG,GSMVIMG, !88264g72.bmp}

88264g72

The proper operation of the oxygen sensor depends upon four basic conditions:

1. Good electrical connections. Since the sensor generates low currents, good clean electrical connections at the sensor are a must.
2. Outside air supply. Air must circulate to the internal portion of the sensor. When servicing the sensor, do not restrict the air passages.
3. Proper operating temperatures. The ECM will not recognize the sensor's signals until the sensor reaches approximately 600ºF (316ºC).
4. Non-leaded fuel. The use of leaded gasoline will damage the sensor very quickly.

TESTING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TESTING

Single Wire Sensor

1. Start the engine and bring it to normal operating temperature, then run the engine above 1200 rpm for two minutes.
2. Backprobe with a high impedance averaging voltmeter (set to the DC voltage scale) between the oxygen sensor (O2S) and battery ground.
3. Verify that the O2S voltage fluctuates rapidly between 0.40–0.60 volts.
4. If the O2S voltage is stabilized at the middle of the specified range (approximately 0.45–0.55 volts) or if the O2S voltage fluctuates very slowly between the specified range (O2S signal crosses 0.5 volts less than 5 times in ten seconds), the O2S may be faulty.
5. If the O2S voltage stabilizes at either end of the specified range, the ECM is probably not able to compensate for a mechanical problem such as a vacuum leak or a faulty pressure regulator. These types of mechanical problems will cause the O2S to sense a constant lean or constant rich mixture. The mechanical problem will first have to be repaired and then the O2S test repeated.
6. Pull a vacuum hose located after the throttle plate. Voltage should drop to approximately 0.12 volts (while still fluctuating rapidly). This tests the ability of the O2S to detect a lean mixture condition. Reattach the vacuum hose.
7. Richen the mixture using a propane enrichment tool. Voltage should rise to approximately 0.90 volts (while still fluctuating rapidly). This tests the ability of the O2S to detect a rich mixture condition.
8. If the O2S voltage is above or below the specified range, the O2S and/or the O2S wiring may be faulty. Check the wiring for any breaks, repair as necessary and repeat the test.

Heated Oxygen Sensor {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Heated Oxygen Sensor

1. Start the engine and bring it to normal operating temperature, then run the engine above 1200 rpm for two minutes.
2. Turn the ignition **OFF** disengage the HO2S harness connector.
3. Connect a test light between harness terminals A and B on three wire sensors or C and D on four wire sensors. With the ignition switch **ON** and the engine off, verify that the test light is lit. If the test light is not lit, either the supply voltage to the HO2S heater or the ground circuit of the HO2S heater is faulty. Check the HO2S wiring and the fuse.
4. Next, connect a high impedance ohmmeter between the HO2S terminals B and A on 3 wire sensors or C and D on four wire sensors. Verify that the resistance is 3.5–14.0 ohms.
5. If the HO2S heater resistance is not as specified, the HO2S may be faulty.
6. Start the engine and bring it to normal operating temperature, then run the engine above 1200 rpm for two minutes.
7. Backprobe with a high impedance averaging voltmeter (set to the DC voltage scale) between the oxygen sensor (O2S) and battery ground.
8. Verify that the O2S voltage fluctuates rapidly between 0.40–0.60 volts.
9. If the O2S voltage is stabilized at the middle of the specified range (approximately 0.45–0.55 volts) or if the O2S voltage fluctuates very slowly between the specified range (O2S signal crosses 0.5 volts less than 5 times in ten seconds), the O2S may be faulty.
10. If the O2S voltage stabilizes at either end of the specified range, the ECM is probably not able to compensate for a mechanical problem such as a vacuum leak or a faulty fuel pressure regulator. These types of mechanical problems will cause the O2S to sense a constant lean or constant rich mixture. The mechanical problem will first have to be repaired and then the O2S test repeated.
11. Pull a vacuum hose located after the throttle plate. Voltage should drop to approximately 0.12 volts (while still fluctuating rapidly). This tests the ability of the O2S to detect a lean mixture condition. Reattach the vacuum hose.
12. Richen the mixture using a propane enrichment tool. Voltage should rise to approximately 0.90 volts (while still fluctuating rapidly). This tests the ability of the O2S to detect a rich mixture condition.
13. If the O2S voltage is above or below the specified range, the O2S and/or the O2S wiring may be faulty. Check the wiring for any breaks, repair as necessary and repeat the test.

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REMOVAL & INSTALLATION

Ü See figures 81, 82, 83, 84, 85, 86

****Warning**
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 could affect the proper operation of the sensor. Keep the electrical connector and louvered end of the sensor clean and free of grease. NEVER use cleaning solvents of any type on the sensor!

Ä The oxygen sensor may be difficult to remove when the temperature of the engine is below 120ºF (49ºC). Excessive force may damage the threads in the exhaust manifold or exhaust pipe.

1. Disconnect the negative battery cable.
2. Unplug the electrical connector and any attaching hardware.
3. Remove the sensor.

To install:

4. Coat the threads of the sensor with a GM anti-seize compound, part number 5613695, or its equivalent, before installation. New sensors are precoated with this compound.

   Ä The GM anti-seize compound is NOT a conventional anti-seize paste. The use of a regular paste may electrically insulate the sensor, rendering it useless. The threads MUST be coated with the proper electrically conductive anti-seize compound.

5. Install the sensor and tighten to 30 ft. lbs. (40 Nm). Use care in making sure the silicone boot is in the correct position to avoid melting it during operation.
6. Engage the electrical connector.
7. Connect the negative battery cable.

Figure 81.
Oxygen sensor mounting—2.5L engine
{ewc GSMVIMG,GSMVIMG, !88264g73.bmp}

88264g73

Figure 82.
Oxygen sensor mounting (common location)—4.3L engine except 1996 models
{ewc GSMVIMG,GSMVIMG, !88264g74.bmp}

88264g74

Figure 83.
Oxygen sensor mounting (alternative location)—4.3L engine except 1996 models
{ewc GSMVIMG,GSMVIMG, !88264g75.bmp}

88264g75

Figure 84.
Oxygen sensor mounting locations—1996 4.3L engine
{ewc GSMVIMG,GSMVIMG, !88264g76.bmp}

88264g76

Figure 85.
This oxygen sensor wrench has a cut out to allow the wires to pass through

{ewc GSMVIMG,GSMVIMG, !88264p08.bmp}

88264p08

Figure 86.
Do not contaminate the tip of the oxygen sensor or the accuracy of the sensor will be affected

{ewc GSMVIMG,GSMVIMG, !88264p09.bmp}

88264p09

Crankshaft Position (CKP) Sensor {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Crankshaft Position (CKP) Sensor

OPERATION

The Crankshaft Position (CKP) Sensor provides a signal through the ignition module which the ECM uses as a reference to calculate rpm and crankshaft position.

TESTING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TESTING

1. Disconnect the CKP sensor harness. Connect an LED test light between battery ground and CKP harness terminal A.
2. With the ignition **ON** and the engine off, verify that the test light illuminates.
3. If not as specified, repair or replace the fuse and/or wiring.
4. Carefully connect the test light between CKP harness terminal A and B. Verify that the test light illuminates.
5. If not as specified, repair the CKP harness ground circuit (terminal B).
6. Turn the ignition **OFF** and disconnect the test light.
7. Next, connect suitable jumper wires between the CKP sensor and CKP sensor harness. Connect a duty cycle meter to the jumper wire corresponding to CKP terminal C and battery ground.
8. Crank the engine and verify that the duty cycle signal is between 40–60%.
9. If it is not as specified, the CKP sensor may be faulty.
10. Next, connect a AC volt meter to the jumper wire corresponding to CKP terminal C and battery ground.
11. Crank the engine and verify that the AC voltage signal is at least 10.0 volts.
12. If not as specified the CKP sensor may be faulty.

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REMOVAL & INSTALLATION

Ü See figure 87

1. Disconnect the negative battery cable.
2. Detach the sensor harness connector at the sensor.
3. Unfasten the retaining bolt, then remove the sensor from the front cover. Inspect the sensor O-ring for wear, cracks or leakage and replace if necessary.

To install:

4. Lubricate the O-ring with clean engine oil, then place on the sensor. Install the sensor into the front cover.
5. Tighten the retaining bolt.
6. Attach the sensor harness connector.
7. Connect the negative battery cable.

Figure 87.
Crankshaft position sensor

{ewc GSMVIMG,GSMVIMG, !88264g77.bmp}

88264g77

Mass Air Flow (MAF) Sensor {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Mass Air Flow (MAF) Sensor

OPERATION

Ü See figure 88

The Mass Air Flow (MAF) Sensor measures the amount of air entering the engine during a given time. The ECM uses the mass airflow information for fuel delivery calculations. A large quantity of air entering the engine indicates an acceleration or high load situation, while a small quantity of air indicates deceleration or idle.

Figure 88.
The mass air flow sensor directly measures the amount of air entering the engine

{ewc GSMVIMG,GSMVIMG, !88264g78.bmp}

88264g78

TESTING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TESTING

1. Backprobe with a high impedance voltmeter between MAF sensor terminals C and B.
2. With the ignition **ON** engine off, verify that battery voltage is present.
3. If the voltage is not as specified, either the wiring to the MAF sensor, fuse or the ECM may be faulty. Correct any wiring or ECM faults before continuing test.
4. Disconnect the voltmeter and backprobe with a frequency meter between MAF sensor terminals A and B.
5. Start the engine and wait until it reaches normal idle speed and verify that the MAF sensor output is approximately 2000 Hz.
6. Slowly raise engine speed up to maximum recommended rpm and verify that the MAF sensor output rises smoothly to approximately 8000 Hz.
7. If MAF sensor output is not as specified the sensor may be faulty.

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REMOVAL & INSTALLATION

Ü See figures 89, 90

1. Disconnect the negative battery cable.
2. Unplug the electrical connector.
3. Remove the air intake hoses from the sensor, then remove its attaching bolts, if equipped on some versions.
4. Installation is the reverse of removal.

Figure 89.
This style MAF sensor is mounted directly behind the air cleaner assembly

{ewc GSMVIMG,GSMVIMG, !88264p11.bmp}

88264p11

Figure 90.
Dirty contacts can cause the MAF to send bad signals to the ECM, so check it before installation

{ewc GSMVIMG,GSMVIMG, !88264p12.bmp}

88264p12

Engine Coolant Temperature (ECT) Sensor {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Engine Coolant Temperature (ECT) Sensor

OPERATION

Ü See figure 91

The Engine Coolant Temperature (ECT) sensor is mounted near the thermostat housing and sends engine temperature information to the ECM. The ECM supplies 5 volts to the coolant temperature sensor circuit. The sensor is a thermistor which changes internal resistance as temperature changes. When the sensor is cold (internal resistance high), the ECM monitors a high signal voltage which it interprets as a cold engine. As the sensor warms (internal resistance low), the ECM monitors a low signal voltage which it interprets as warm engine.

Figure 91.
Engine coolant temperature sensors are always mounted in a coolant passage, usually near the thermostat

{ewc GSMVIMG,GSMVIMG, !88264g79.bmp}

88264g79

TESTING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TESTING

Ü See figure 92

1. Remove the ECT sensor from the vehicle.
2. Immerse the tip of the sensor in container of water.
3. Connect a digital ohmmeter to the two terminals of the sensor.
4. Using a calibrated thermometer, compare the resistance of the sensor to the temperature of the water. Refer to the engine coolant sensor temperature vs. resistance illustration.
5. Repeat the test at two other temperature points, heating or cooling the water as necessary.
6. If the sensor does not met specification, it must be replaced.

Figure 92.
Engine coolant temperature sensor resistance chart

{ewc GSMVIMG,GSMVIMG, !88264g65.bmp}

88264g65

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REMOVAL & INSTALLATION

Ü See figures 93, 94

1. Disconnect the negative battery cable.
2. Drain the cooling system below the level of the sensor and disengage the sensor electrical connection.
3. Remove the coolant sensor.

To install:

4. Install the sensor and the electrical connector.
5. Refill the cooling system and connect the negative battery cable.

Figure 93.
The ECT is mounted in the intake manifold next to the thermostat housing on the V6 TBI engines

{ewc GSMVIMG,GSMVIMG, !88264g80.bmp}

88264g80

Figure 94.
The ECT is mounted in the lower intake manifold in the thermostat housing on the V6 engines

{ewc GSMVIMG,GSMVIMG, !88264g81.bmp}

88264g81

Intake Air Temperature (IAT) Sensor {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Intake Air Temperature (IAT) Sensor

OPERATION

Ü See figure 95

The Intake Air Temperature (IAT) Sensor is a thermistor which changes value based on the temperature of the air entering the engine. Low temperature produces a high resistance, while a high temperature causes a low resistance. The ECM supplies a 5 volt signal to the sensor through a resistor in the ECM and measures the voltage. The voltage will be high when the incoming air is cold, and low when the air is hot. By measuring the voltage, the ECM calculates the incoming air temperature.

The IAT sensor signal is used to adjust spark timing according to incoming air density.

Figure 95.
Typical intake air temperature sensor

{ewc GSMVIMG,GSMVIMG, !88264g82.bmp}

88264g82

TESTING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TESTING

Ü See figure 96

1. Remove the Intake Air Temperature (IAT) sensor.
2. Connect a digital ohmmeter to the two terminals of the sensor.
3. Using a calibrated thermometer, compare the resistance of the sensor to the temperature of the ambient air. Refer to the temperature vs. resistance illustration.
4. Repeat the test at two other temperature points, heating or cooling the air as necessary with a hair dryer or other suitable tool.
5. If the sensor does not meet specification, it must be replaced.

Figure 96.
Intake air temperature sensor resistance chart

{ewc GSMVIMG,GSMVIMG, !88264g65.bmp}

88264g65

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REMOVAL & INSTALLATION

Ü See figures 97, 98, 99

1. Disconnect the negative battery cable.
2. Disengage the sensor electrical connection.
3. Loosen and remove the IAT sensor.
4. Installation is the reverse of removal.

Figure 97.
The intake air temperature sensor pushes into the intake duct on the CMFI engines

{ewc GSMVIMG,GSMVIMG, !88264g83.bmp}

88264g83

Figure 98.
The intake air temperature sensor screws into the intake manifold on the 4–cylinder engine

{ewc GSMVIMG,GSMVIMG, !88264g84.bmp}

88264g84

Figure 99.
Intake air temperature sensor location on 1996 CSFI engine

{ewc GSMVIMG,GSMVIMG, !88264p10.bmp}

88264p10

Throttle Position Sensor (TPS) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Throttle Position Sensor (TPS)

OPERATION

Ü See figure 100

The Throttle Position Sensor (TPS) is connected to the throttle shaft on the throttle body. It is a potentiometer with one end connected to 5 volts from the ECM and the other to ground.

A third wire is connected to the ECM to measure the voltage from the TPS. As the throttle valve angle is changed (accelerator pedal moved), the output of the TPS also changes. At a closed throttle position, the output of the TPS is low (approximately .5 volts). As the throttle valve opens, the output increases so that, at wide-open throttle, the output voltage should be approximately 4.5 volts.

Figure 100.
Internal workings of a TPS

{ewc GSMVIMG,GSMVIMG, !88264gA3.bmp}

88264gA3

By monitoring the output voltage from the TPS, the ECM can determine fuel delivery based on throttle valve angle (driver demand).

TESTING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TESTING

Ü See figure 101

1. Backprobe with a high impedance voltmeter at TPS terminals A and B.
2. With the key **ON** and engine off, the voltmeter reading should be approximately 5.0 volts.
3. If the voltage is not as specified, either the wiring to the TPS or the ECM may be faulty. Correct any wiring or ECM faults before continuing test.
4. Backprobe with a high impedance voltmeter at terminals C and B.
5. With the key **ON** and engine off and the throttle closed, the TPS voltage should be approximately 0.5–1.2 volts.
6. Verify that the TPS voltage increases or decreases smoothly as the throttle is opened or closed. Make sure to open and close the throttle very slowly in order to detect any abnormalities in the TPS voltage reading.
7. If the sensor voltage is not as specified, replace the sensor.

Figure 101.
Most testing of the TPS can be done while it is still mounted on the throttle body

{ewc GSMVIMG,GSMVIMG, !88264p13.bmp}

88264p13

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REMOVAL & INSTALLATION

Ü See figures 102, 103, 104, 105, 106

1. Disconnect the negative battery cable and remove the air cleaner and gasket.
2. Disengage the electrical connector.
3. Unfasten the one or two TPS attaching screw assemblies.
4. Remove the TPS from the throttle body assembly.
5. Remove the TPS seal.

To install:

6. Install the TPS seal over the throttle shaft.
7. With the throttle valve closed, install the TPS on the throttle shaft. Rotate it counterclockwise, to align the mounting holes.
8. Install the 2 TPS attaching screw assemblies.
9. Engage the electrical connector.
10. Install the air cleaner and gasket.
11. Connect the negative battery cable.

Figure 102.
Throttle position sensor—TBI 700 and CMFI

{ewc GSMVIMG,GSMVIMG, !88264gA4.bmp}

88264gA4

Figure 103.
Throttle position sensor—TBI 220

{ewc GSMVIMG,GSMVIMG, !88264g85.bmp}

88264g85

Figure 104.
Throttle position sensor—CSFI

{ewc GSMVIMG,GSMVIMG, !88264g86.bmp}

88264g86

Figure 105.
Even though the TPS is not adjustable, marking its location before removal is a good idea

{ewc GSMVIMG,GSMVIMG, !88264p14.bmp}

88264p14

Figure 106.
Use the correct size bit in the mounting screws. This one just might strip out the screw

{ewc GSMVIMG,GSMVIMG, !88264p15.bmp}

88264p15

Manifold Absolute Pressure (MAP) Sensor {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Manifold Absolute Pressure (MAP) Sensor

OPERATION

Ü See figure 107

The Manifold Absolute Pressure (MAP) sensor measures the changes in intake manifold pressure, which result from the engine load and speed changes, and converts this to a voltage output.

A closed throttle on engine coast-down will produce a low MAP output, while a wide-open throttle will produce a high output. This high output is produced because the pressure inside the manifold is the same as outside the manifold, so 100 percent of the outside air pressure is measured.

The MAP sensor reading is the opposite of what you would measure on a vacuum gauge. When manifold pressure is high, vacuum is low. The MAP sensor is also used to measure barometric pressure under certain conditions, which allows the ECM to automatically adjust for different altitudes.

Figure 107.
Common GM style MAP sensor

{ewc GSMVIMG,GSMVIMG, !88264g87.bmp}

88264g87

The ECM sends a 5 volt reference signal to the MAP sensor. As the manifold pressure changes, the electrical resistance of the sensor also changes. By monitoring the sensor output voltage, the ECM knows the manifold pressure. A higher pressure, low vacuum (high voltage) requires more fuel, while a lower pressure, higher vacuum (low voltage) requires less fuel.

The ECM uses the MAP sensor to control fuel delivery and ignition timing.

TESTING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TESTING

1. Backprobe with a high impedance voltmeter at MAP sensor terminals A and C.
2. With the key **ON** and engine off, the voltmeter reading should be approximately 5.0 volts.
3. If the voltage is not as specified, either the wiring to the MAP sensor or the ECM may be faulty. Correct any wiring or ECM faults before continuing test.
4. Backprobe with the high impedance voltmeter at MAP sensor terminals B and A.
5. Verify that the sensor voltage is approximately 0.5 volts with the engine not running (at sea level).
6. Record MAP sensor voltage with the key **ON** and engine off.
7. Start the vehicle.
8. Verify that the sensor voltage is greater than 1.5 volts (above the recorded reading) at idle.
9. Verify that the sensor voltage increases to approximately 4.5. volts (above the recorded reading) at Wide Open Throttle (WOT).
10. If the sensor voltage is as specified, the sensor is functioning properly.
11. If the sensor voltage is not as specified, check the sensor and the sensor vacuum source for a leak or a restriction. If no leaks or restrictions are found, the sensor may be defective and should be replaced.

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REMOVAL & INSTALLATION

Ü See figures 108, 109, 110

1. Disconnect the negative battery cable.
2. Tag and disconnect the vacuum harness assembly, except 1996.
3. Disengage the electrical connector.
4. Release the locktabs, unfasten the bolts and remove the sensor.
5. Installation is the reverse of removal.

Figure 108.
MAP sensor mounting—2.5L engine
{ewc GSMVIMG,GSMVIMG, !88264g88.bmp}

88264g88

Figure 109.
MAP sensor mounting—4.3L engine, except 1996
{ewc GSMVIMG,GSMVIMG, !88264g89.bmp}

88264g89

Figure 110.
MAP sensor mounting—1996 4.3L engine
{ewc GSMVIMG,GSMVIMG, !88264g90.bmp}

88264g90

Vehicle Speed Sensor (VSS) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Vehicle Speed Sensor (VSS)

OPERATION

Ü See figure 111

The vehicle speed sensor is made up of a coil mounted on the transmission and a tooth rotor mounted to the output shaft of the transmission. As each tooth nears the coil, the coil produces an AC voltage pulse. As the vehicle speed increases the number of voltage pulses per second increases.

Figure 111.
Vehicle speed sensor mounting

{ewc GSMVIMG,GSMVIMG, !88264g91.bmp}

88264g91

TESTING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TESTING

1. To test the VSS, backprobe the VSS terminals with a high impedance voltmeter (set at the AC voltage scale).
2. Safely raise and support the entire vehicle using jackstands. Make absolutely sure the vehicle is stable.
3. Start the vehicle and place it in gear.
4. Verify that the VSS voltage increases as the driveshaft speed increases.
5. If the VSS voltage is not as specified the VSS may be faulty.

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Driveability And Emission Controls

REMOVAL & INSTALLATION

1. Disconnect the negative battery cable.
2. Disengage the electrical connection.
3. Unfasten the sensor retainers.
4. Remove the sensor and gasket or O-ring.

To install:

5. Install the sensor with a new gasket or O-ring.
6. Fasten the sensor retainers.
7. Engage the electrical connections.
8. Connect the negative battery cable.

Knock Sensor {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Knock Sensor

OPERATION

Located in the engine block, the knock sensor retards ignition timing during a spark knock condition to allow the ECM to maintain maximum timing advance under most conditions.

TESTING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TESTING

1. Connect a timing light to the vehicle and start the engine.
2. Check that the timing is correct before testing knock sensor operation.
3. If timing is correct, tap on the front of the engine block with a metal object while observing the timing to see if the timing retards.
4. If the timing does not retard, the knock sensor may be defective.

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REMOVAL & INSTALLATION

Ü See figures 112, 113

1. Disconnect the negative battery cable.
2. Disengage the wiring harness connector from the knock sensor.
3. Remove the knock sensor from the engine block.

To install:

4. Apply a water base caulk to the knock sensor threads and install the sensor in the engine block.

Warning
Do not use silicon tape to coat the knock sensor threads as this will insulate the sensor from the engine block.

5. Engage the wiring harness connector.
6. Connect the negative battery cable.

Figure 112.
Knock sensor locations—4.3L engine except 1996
{ewc GSMVIMG,GSMVIMG, !88264g92.bmp}

88264g92

Figure 113.
Knock sensor location—1996 4.3L engine
{ewc GSMVIMG,GSMVIMG, !88264g93.bmp}

88264g93

TROUBLE CODES {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TROUBLE CODES

General Information

Since the control module is programmed to recognize the presence and value of electrical inputs, it will also note the lack of a signal or a radical change in values. It will, for example, react to the loss of signal from the vehicle speed sensor or note that engine coolant temperature has risen beyond acceptable (programmed) limits. Once a fault is recognized, a numeric code is assigned and held in memory. The dashboard warning lamp: CHECK ENGINE or SERVICE ENGINE SOON (SES), will illuminate to advise the operator that the system has detected a fault. This lamp is also known as the Malfunction Indicator Lamp (MIL).

More than one code may be stored. Keep in mind not every engine uses every code. Additionally, the same code may carry different meanings relative to each engine or engine family.

In the event of an computer control module failure, the system will default to a pre-programmed set of values. These are compromise values which allow the engine to operate, although possibly at reduced efficiency. This is variously known as the default, limp-in or back-up mode. Driveability is almost always affected when the ECM enters this mode.

SCAN TOOLS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SCAN TOOLS

Ü See figures 114, 115, 116

On most models, the stored codes may be read with only the use of a small jumper wire, however the use of a hand-held scan tool such as GM's TECH-1® or equivalent is recommended. On 1996 models, an OBD-II compliant scan tool must be used. There are many manufacturers of these tools; a purchaser must be certain that the tool is proper for the intended use. If you own a scan type tool, it probably came with comprehensive instructions on proper use. Be sure to follow the instructions that came with your unit if they differ from what is given here; this is a general guide with useful information included.

The scan tool allows any stored codes to be read from the ECM or PCM memory. The tool also allows the operator to view the data being sent to the computer control module while the engine is running. This ability has obvious diagnostic advantages; the use of the scan tool is frequently required for component testing. The scan tool makes collecting information easier; the data must be correctly interpreted by an operator familiar with the system.

Figure 114.
Example of scan tool data and typical or baseline values

{ewc GSMVIMG,GSMVIMG, !84904059.bmp}

84904059

Figure 115.
Different types of computerized test equipment are available from aftermarket tool manufacturers

{ewc GSMVIMG,GSMVIMG, !tccs4P07.bmp}

tccs4P07

Figure 116.
Inexpensive scan tools, such as this Auto Xray®, can interface with your General Motors vehicle

{ewc GSMVIMG,GSMVIMG, !tccs4P12.bmp}

tccs4P12

An example of the usefulness of the scan tool may be seen in the case of a temperature sensor which has changed its electrical characteristics. The ECM is reacting to an apparently warmer engine (causing a driveability problem), but the sensor's voltage has not changed enough to set a fault code. Connecting the scan tool, the voltage signal being sent to the ECM may be viewed; comparison to normal values or a known good vehicle reveals the problem quickly.

ELECTRICAL TOOLS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ELECTRICAL TOOLS

The most commonly required electrical diagnostic tool is the digital multimeter, allowing voltage, ohmage (resistance) and amperage to be read by one instrument. The multimeter must be a high-impedance unit, with 10 megohms 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 batteries frequently in the unit.

Other necessary tools include an unpowered test light, a quality tachometer with an inductive (clip-on) pick up, and the proper tools for releasing GM's Metri-Pack, Weather Pack and Micro-Pack terminals as necessary. The Micro-Pack connectors are used at the ECM electrical connector. A vacuum pump/gauge may also be required for checking sensors, solenoids and valves.

Diagnosis and Testing {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Driveability And Emission Controls

Diagnosis and Testing

Diagnosis of a driveability and/or emissions problems requires attention to detail and following the diagnostic procedures in the correct order. Resist the temptation to perform any repairs before performing the preliminary diagnostic steps. In many cases this will shorten diagnostic time and often cure the problem without electronic testing.

The proper troubleshooting procedure for these vehicles is as follows:

VISUAL/PHYSICAL INSPECTION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

VISUAL/PHYSICAL INSPECTION

This is possibly the most critical step of diagnosis and should be performed immediately after retrieving any codes. A detailed examination of connectors, wiring and vacuum hoses can often lead to a repair without further diagnosis. Performance of this step relies on the skill of the technician performing it; a careful inspector will check the undersides of hoses as well as the integrity of hard-to-reach hoses blocked by the air cleaner or other component. Wiring should be checked carefully for any sign of strain, burning, crimping, or terminal pull-out from a connector. Checking connectors at components or in harnesses is required; usually, pushing them together will reveal a loose fit.

INTERMITTENTS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

INTERMITTENTS

If a fault occurs intermittently, such as a loose connector pin breaking contact as the vehicle hits a bump, the ECM will note the fault as it occurs and energize the dash warning lamp. If the problem self-corrects, as with the terminal pin again making contact, the dash lamp will extinguish after 10 seconds but a code will remain stored in the computer control module's memory.

When an unexpected code appears during diagnostics, it may have been set during an intermittent failure that self-corrected; the codes are still useful in diagnosis and should not be discounted.

CIRCUIT/COMPONENT REPAIR {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CIRCUIT/COMPONENT REPAIR

The fault codes and the scan tool data will lead to diagnosis and checking of a particular circuit. It is important to note that the fault code indicates a fault or loss of signal in an ECM-controlled system, not necessarily in the specific component.

Refer to the appropriate Diagnostic Code chart to determine the codes meaning. The component may then be tested following the appropriate component test procedures found in this section. If the component is OK, check the wiring for shorts or opens. Further diagnoses should be left to an experienced driveability technician.

If a code indicates the ECM to be faulty and the ECM is replaced, but does not correct the problem, one of the following may be the reason:

- There is a problem with the ECM terminal connections: The terminals may have to be removed from the connector in order to check them properly.
- The ECM or PROM is not correct for the application: The incorrect ECM or PROM may cause a malfunction and may or may not set a code.
- The problem is intermittent: This means that the problem is not present at the time the system is being checked. In this case, make a careful physical inspection of all portions of the system involved.
- Shorted solenoid, relay coil or harness: Solenoids and relays are turned on and off by the ECM using internal electronic switches called drivers. Each driver is part of a group of four called Quad-Drivers. A shorted solenoid, relay coil or harness may cause an ECM to fail, and a replacement ECM to fail when it is installed. Use a short tester, J34696, BT 8405, or equivalent, as a fast, accurate means of checking for a short circuit.
- The Programmable Read Only Memory (PROM) may be faulty: Although the PROM rarely fails, it operates as part of the ECM. Therefore, it could be the cause of the problem. Substitute a known good PROM.
- The replacement ECM may be faulty: After the ECM is replaced, the system should be rechecked for proper operation. If the diagnostic code again indicates the ECM is the problem, substitute a known good ECM. Although this is a very rare condition, it could happen.

Reading Codes {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Reading Codes

1988–95 MODELS

Ü See figures 117, 118, 119, 120, 121

Listings of the trouble for the various engine control system covered in this manual are located in this section. Remember that a code only points to the faulty circuit NOT necessarily to a faulty component. Loose, damaged or corroded connections may contribute to a fault code on a circuit when the sensor or component is operating properly. Be sure that the components are faulty before replacing them, especially the expensive ones.

The Assembly Line Diagnostic Link (ALDL) connector or Data Link Connector (DLC) may be located under the dash and sometimes covered with a plastic cover labeled DIAGNOSTIC CONNECTOR.

Figure 117.
The ALDL connector is also known as the DLC

{ewc GSMVIMG,GSMVIMG, !88264ga0.bmp}

88264ga0

1. The diagnostic trouble codes can be read by grounding test terminal B. The terminal is most easily grounded by connecting it to terminal A (internal ECM ground). This is the terminal to the right of terminal B on the top row of the ALDL connector.
2. Once the terminals have been connected, the ignition switch must be moved to the **ON** position with the engine not running.
3. The Service Engine Soon or Check Engine light should be flashing. If it isn't, turn the ignition **OFF** and remove the jumper wire. Turn the ignition **ON** and confirm that light is now on. If it is not, replace the bulb and try again. If the bulb still will not light, or if it does not flash with the test terminal grounded, the system should be diagnosed by an experienced driveability technician. If the light is OK, proceed as follows.
4. The code(s) stored in memory may be read through counting the flashes of the dashboard warning lamp. The dash warning lamp should begin to flash Code 12. The code will display as one flash, a pause and two flashes. Code 12 is not a fault code. It is used as a system acknowledgment or handshake code; its presence indicates that the ECM can communicate as requested. Code 12 is used to begin every diagnostic sequence. Some vehicles also use Code 12 after all diagnostic codes have been sent.
5. After Code 12 has been transmitted 3 times, the fault codes, if any, will each be transmitted 3 times. The codes are stored and transmitted in numeric order from lowest to highest.

   Ä The order of codes in the memory does not indicate the order of occurrence.
6. If there are no codes stored, but a driveability or emissions problem is evident, the system should be diagnosed by an experienced driveability technician.
7. If one or more codes are stored, record them. Refer to the applicable Diagnostic Code chart in this section.
8. Switch the ignition **OFF** when finished with code retrieval or scan tool readings.

   Ä After making repairs, clear the trouble codes and operate the vehicle to see if it will reset, indicating further problems.

Figure 118.
Carbureted engine trouble codes

{ewc GSMVIMG,GSMVIMG, !88264g94.bmp}

88264g94

Figure 119.
Fuel injected engine trouble codes through 1995, except with 4L60E and 4L80E transmissions

{ewc GSMVIMG,GSMVIMG, !88264g95.bmp}

88264g95

Figure 120.
Fuel injected engine trouble codes through 1995 with 4L60E transmissions

{ewc GSMVIMG,GSMVIMG, !88264g96.bmp}

88264g96

Figure 121.
Fuel injected engine trouble codes through 1995 with 4L60E transmissions (continued)

{ewc GSMVIMG,GSMVIMG, !88264g97.bmp}

88264g97

1996 MODELS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

1996 MODELS

Ü See figures 122, 123

On 1996 models, an OBD-II compliant scan tool must be used to retrieve the trouble codes. Follow the scan tool manufacturer's instructions on how to connect the scan tool to the vehicle and how to retrieve the codes.

Figure 122.
Trouble code list for 1996 gasoline engines

{ewc GSMVIMG,GSMVIMG, !88264g98.bmp}

88264g98

Figure 123.
Trouble code list for 1996 gasoline engines (continued)

{ewc GSMVIMG,GSMVIMG, !88264g99.bmp}

88264g99

Clearing Codes {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Clearing Codes

Stored fault codes may be erased from memory at any time by removing power from the ECM for at least 30 seconds. It may be necessary to clear stored codes during diagnosis to check for any recurrence during a test drive, but the stored codes must be written down when retrieved. The codes may still be required for subsequent troubleshooting. Whenever a repair is complete, the stored codes must be erased and the vehicle test driven to confirm correct operation and repair.

****Warning**
The ignition switch must be OFF any time power is disconnected or restored to the ECM. Severe damage may result if this precaution is not observed.

Depending on the electrical distribution of the particular vehicle, power to the ECM may be disconnected by removing the ECM fuse in the fusebox, disconnecting the in-line fuse holder near the positive battery terminal or disconnecting the ECM power lead at the battery terminal. Disconnecting the negative battery cable to clear codes is not recommended as this will also clear other memory data in the vehicle such as radio presets.

VACUUM DIAGRAMS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

VACUUM DIAGRAMS

Following is a listing of vacuum diagrams for many 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. Should the label be missing, or should the vehicle be equipped with a different engine from the original equipment, refer to the diagrams below for the same or similar configuration. New labels specific to your vehicle are available from the manufacturer.

Figure 124.
Vacuum hose routing—1985–87 with 2.5L TBI engine

{ewc GSMVIMG,GSMVIMG, !88264v01.bmp}

88264v01

Figure 125.
Vacuum hose routing—1988–90 with 2.5L TBI engine

{ewc GSMVIMG,GSMVIMG, !88264v02.bmp}

88264v02

Figure 126.
Vacuum hose routing—1985 4.3L carbureted engine (Federal)

{ewc GSMVIMG,GSMVIMG, !88264v03.bmp}

88264v03

Figure 127.
Vacuum hose routing—1985 with 4.3L carbureted engine (Federal and low altitude)

{ewc GSMVIMG,GSMVIMG, !88264v04.bmp}

88264v04

Figure 128.
Vacuum hose routing—1986–88 with 4.3L TBI engine

{ewc GSMVIMG,GSMVIMG, !88264v05.bmp}

88264v05

Figure 129.
Vacuum hose routing—1988–91 with 4.3L TBI engine (Federal without air pump)

{ewc GSMVIMG,GSMVIMG, !88264v06.bmp}

88264v06

Figure 130.
Vacuum hose routing—1988–91 with 4.3L TBI engine (Federal with air pump)

{ewc GSMVIMG,GSMVIMG, !88264v07.bmp}

88264v07

Figure 131.
Vacuum hose routing—1992–95 with 4.3L (VIN Z) engine

{ewc GSMVIMG,GSMVIMG, !88264v08.bmp}

88264v08

Figure 132.
Vacuum hose routing—1992–95 with 4.3L (VIN W) engine, Federal

{ewc GSMVIMG,GSMVIMG, !88264v10.bmp}

88264v10

Figure 133.
Vacuum hose routing—1992–95 with 4.3L (VIN W) engine, California
{ewc GSMVIMG,GSMVIMG, !88264v11.bmp}

88264v11

Figure 134.
Vacuum hose routing—1996 with 4.3L CSFI engine
{ewc GSMVIMG,GSMVIMG, !88264v09.bmp}

88264v09

FUEL SYSTEM

{ewc MVIMAGE,MVIMAGE, !
fuel.bmp}

BASIC FUEL SYSTEM DIAGNOSIS {ewc MVIMAGE, MVIMAGE, !
nexttopicarrow.bmp}

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 LINE FITTINGS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

FUEL LINE FITTINGS

Quick-Connect Fittings

REMOVAL & INSTALLATION

Ü See figure 1

Ä This procedure requires Tool Set J37088–A or an equivalent aftermarket fuel line quick-connect separator.

1. Grasp both sides of the fitting. Twist the female connector 1/4 turn in each direction to loosen any dirt within the fittings. Using compressed air, blow out the dirt from the quick-connect fittings at the end of the fittings.

****Caution**
Safety glasses MUST be worn when using compressed air to avoid eye injury due to flying dirt particles!

2. For plastic (hand releasable) fittings, squeeze the plastic retainer release tabs, then pull the connection apart.
3. For metal fittings, choose the correct tool from kit J37088–A or its equivalent for the size of the fitting to be disconnected. Insert the proper tool into the female connector, then push inward to release the locking tabs. Pull the connection apart.
4. If it is necessary to remove rust or burrs from the male tube end of a quick-connect fitting, use emery cloth in a radial motion with the tube end to prevent damage to the O-ring sealing surfaces. Using a clean shop towel, wipe off the male tube ends. Inspect all connectors for dirt and burrs. Clean and/or replace if required.

To install:

5. Apply a few drops of clean engine oil to the male tube end of the fitting.
6. Push the connectors together to cause the retaining tabs/fingers to snap into place.
7. Once installed, pull on both ends of each connection to make sure they are secure and check for leaks.

Figure 1.
Servicing quick connect fittings

{ewc GSMVIMG,GSMVIMG, !88265G30.bmp}

88265G30

CARBURETED FUEL SYSTEM {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Fuel System

CARBURETED FUEL SYSTEM

Only the 1985 4.3L engine uses a carburetor.

{ewc GSMVIMG,GSMVIMG, !88265c01.bmp}

88265c01

Mechanical Fuel Pump {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Mechanical Fuel Pump

The mechanical fuel pump is located on the right front of the engine.

REMOVAL & INSTALLATION

> ****Caution**
> **Before removing any component of the fuel system, be sure to reduce the fuel pressure in the system. Keep a fire extinguisher close by when servicing the fuel system. Place a rag under the fuel line and slowly remove the line from the fitting.**

1. Disconnect the negative battery cable, the fuel inlet hose from the fuel pump and the vapor return hose (if equipped).
2. Disconnect the fuel outlet hose from the fuel pump.
3. Remove the fuel pump-to-engine bolts, the fuel pump, the pushrod, the gasket and the mounting plate.
4. Using a putty knife, clean the gasket mounting surfaces.

To install:

5. Use a new gasket with silicone sealer.
6. Install the mounting plate, gasket, pushrod and fuel pump. Torque the mounting bolts to 27 ft. lbs. (37 Nm).
7. Connect the fuel outlet hose to the fuel pump.
8. Connect the fuel inlet hose to the fuel pump and the vapor return hose (if equipped).
9. Connect the negative battery cable, start the engine and check for fuel leaks.

TESTING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Fuel System

TESTING

Flow Test

1. Remove the fuel pump-to-carburetor line from the carburetor.
2. Place the fuel line into a clean container.
3. Crank the engine; approximately $^{1}/2$ pint of the fuel should be delivered in 15 seconds.
4. If the fuel flow is below minimum, inspect the fuel system for restrictions; if no restrictions are found, replace the fuel pump.

Pressure Test {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Fuel System

Pressure Test

Ä The following procedure requires the use of a GM Fuel Pressure Gauge tool No. J–29658–A or equivalent.

1. Remove the air cleaner, then disconnect and plug the THERMAC vacuum port on the carburetor.
2. Place a rag (to catch excess fuel) under the fuel line-to-carburetor connection. Disconnect the fuel line from the carburetor.

   Ä When disconnecting the fuel line, use a back-up wrench to hold the fuel nut on the carburetor.
3. Using a GM Fuel Pressure Gauge tool No. J–29658–A or equivalent, install it into the fuel line.
4. Start the engine and observe the fuel pressure. The pressure should be 4–6.5 psi (27.5–44.9 kPa).

   Ä If the fuel pressure does not meet specifications, inspect the fuel system for restrictions or replace the fuel pump.
5. Stop the engine, relieve the fuel pressure and remove the GM Fuel Pressure Gauge tool No. J–29658–A or equivalent.
6. Install a new fuel line-to-carburetor O-ring or washer. Unplug the THERMAC vacuum port. Start the engine and check for fuel leaks.

Carburetor {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ADJUSTMENTS

Idle Speed and Mixture Adjustments

Ä The following procedure requires the use of a dwell meter, GM tool No. J–29030–B, BT–7610–B or equivalent, a center punch, a hammer, a hacksaw, GM tool No. J–33815, BT–8253–B or equivalent.

The idle air bleed valve and the idle mixture needles are sealed with hardened plugs, to protect the factory settings. These settings are not to be tampered with, except for, cleaning, part replacement or if the carburetor is the cause of trouble.

1. If necessary to remove the idle air bleed cover, perform the following procedures:
   a. Remove the air cleaner and the gasket.
   b. Using masking tape or equivalent, cover the internal bowl vents and the air inlets to the idle air bleed valve.
   c. Carefully drill out the idle air bleed cover pop rivet heads.
   d. Using a drift and a small hammer, drive out the remaining portions of the rivet shanks.
   e. Remove/discard the idle air bleed cover and the masking tape used to cover the vents and the air passages.
2. To set the idle air bleed valve, perform the following procedures:
   a. Using the GM tool No. J–33815, BT–8253–B or equivalent, position it in the throttle side D-shaped hole in the air horn casting. The tool's upper end should be positioned over the open cavity next to the idle air bleed valve.
   b. Holding the gauging tool down slightly, so that the solenoid plunger is against the solenoid stop, adjust the idle air bleed valve so that the gauging tool will pivot over and just contact the top of the valve.
3. Using a new idle air bleed cover and pop rivets, install the cover to the air horn casting.
4. If necessary to adjust the idle mixture needle screws, perform the following procedures to remove the hardened steel plugs:
   a. Remove the carburetor from the engine.
   b. Invert the carburetor and drain the fuel from the float bowl.
   c. Position the carburetor, in the inverted position, in a holding fixture to gain access to the idle mixture needle plugs.

   Ä When positioning the carburetor, be careful not to damage the linkage, the tubes and other parts protruding from the air horn.

   d. Using a hacksaw, make two parallel cuts into the throttle body; cut on each side of the locator points beneath the idle mixture needle plugs.
   e. Using a punch and a hammer, drive the casting segment toward the hardened plug, be sure to drive out the plug.
   f. Repeat this process for the other plug.
5. Using the GM tool No. J–29030–B, BT–7610–B or equivalent, turn the idle mixture needle screws clockwise until they are lightly seated, then turn them counterclockwise 3 turns.
6. Using a new carburetor-to-intake manifold gasket, install the carburetor onto the engine, DO

NOT install the air cleaner or gasket.

7. Disconnect the vacuum hose-to-canister purge valve and plug it. At the carburetor, disconnect the electrical connector from the Mixture Control (M/C) solenoid.
8. Using a dwell meter, connect it to the M/C solenoid electrical connector and set it on the 6-cyl. scale.
9. Start the engine and allow it to reach normal operating temperatures.
10. Place the transmission in Drive (AT) or Neutral (MT), then adjust the idle mixture needle screws, in $^{1}/8$ turn increments, until the dwell reading varies within the 25–35º range (be as close to 30º as possible). If the reading is too low, turn the idle mixture needle screws counterclockwise. If the reading is too high, turn the idle mixture needle screws clockwise.

    Ä Be sure to allow the engine to stabilize between adjustments.
11. After the adjustment is complete, seal the idle mixture screw openings with silicone sealant, this will prevent any further adjustment of the idle mixture screws and prevent any fuel vapor loss.
12. Adjust the curb idle speed, if necessary.
13. Check and/or adjust the fast idle speed by referring information on the Vehicle Emission Control Information Label in the engine compartment.

Float and Fuel Level Adjustment {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Float and Fuel Level Adjustment

Ü See figure 2

Ä The following procedure requires the use of the GM Float Gauge tool No. J–34935, BT–8420–A or equivalent.

1. Remove the air cleaner from the carburetor.
2. With the engine idling and the choke plate in the Wide-Open position, insert the GM Float Gauge tool No. J–34935, BT–8420–A or equivalent, into the vent hole (slot) of the air horn; allow the gauge to float freely.

   Ä DO NOT press down on the gauge, for flooding or float damage may occur.

3. Observe the mark (on the gauge) that aligns with the top of the air horn; the float setting should be within 0.0625 in. (1.5mm) of the specifications.

   Ä Incorrect fuel pressure will adversely affect the fuel level.

4. If the float level is not correct, perform the following procedures:
   a. Turn the ignition switch **OFF**.
   b. Disconnect the fuel line, the throttle linkage and/or any electrical connectors from the top of the carburetor (air horn).
   c. Remove the air horn-to-fuel bowl screws. Lift the air horn from the fuel bowl and discard the gasket.
   d. Bend the float tang (at the needle valve) to the correct specifications.
   e. To install the air horn, use a new fuel bowl gasket, install the air horn and the air horn-to-fuel bowl screws.
   f. Install the throttle linkage and the fuel line.
5. To complete the installation, install the air cleaner. Start the engine and check for fuel leaks.

Figure 2.
Using the GM float gauge tool No. J–34935–1, BT–8420–A or equivalent, to check the float level

{ewc GSMVIMG,GSMVIMG, !88265g02.bmp}

88265g02

Air Valve Spring Adjustment {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Air Valve Spring Adjustment

Ü See figure 3

1. Using a $^{3}/32$ in. Allen wrench, loosen the air valve spring lock screw.
2. Turning the tension adjusting screw counterclockwise, open the air valve part way.
3. Turning the tension adjusting screw clockwise, close the air valve, then turn it an additional number of specified turns.
4. Tighten the lock screw, then apply Lithium grease to the spring-to-lever contact area.

Figure 3.
Adjusting the air valve spring—M4ME and E4ME carburetors

{ewc GSMVIMG,GSMVIMG, !88265g03.bmp}

88265g03

Choke Coil Lever Adjustment {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Choke Coil Lever Adjustment

Ü See figure 4

1. Drill out and remove the choke coil housing cover rivets. Retain the choke housing cover, then remove the thermostatic cover and coil assembly from the choke housing.
2. Place the fast idle cam follower on the high step of the fast idle cam.
3. Close the choke valve by pushing up on the thermostatic coil tang (counterclockwise).
4. Insert a drill or gauge, of the specified size, into the hole in the choke housing. The lower edge of the choke lever should be just touching the side of the gauge.
5. If the choke lever is not touching the side of the gauge, bend the choke rod until you see that it does.

Figure 4.
Adjusting the choke coil lever—E4ME carburetor

{ewc GSMVIMG,GSMVIMG, !88265g04.bmp}

88265g04

Fast Idle Cam (Choke Rod) Adjustment {ewc MVIMAGE, MVIMAGE, ! nexttopicarrow.bmp}

Fast Idle Cam (Choke Rod) Adjustment

Ü See figures 5, 6

Ä The following procedure requires the use of the GM Valve Angle Gauge tool No. J–26701, BT–7704 or equivalent.

1. Using a rubber band, attach it between the green tang of the intermediate choke shaft and the air horn housing.
2. Open the throttle and allow the choke valve to close.
3. Using the GM Valve Angle Gauge tool No. J–26701, BT–7704 or equivalent, attach it to the choke plate, then perform the following procedures:
   a. Rotate the degree scale until the zero is opposite the pointer.
   b. Center the leveling bubble.
   c. Rotate the scale to the specified angle degrees.
4. Position the cam follower on the 2nd step (against the rise of the high step) of the fast idle cam.

   Ä If the cam follower does not contact the cam, adjust the fast idle speed screw. Final fast idle speed adjustment MUST BE performed according to the underhood emission control information label.
5. Center the bubble of the Valve Angle Gauge, by bending the fast idle cam tang.

Figure 5.
Using the GM choke valve angle gauge tool No. J–26701, BT–7740 or equivalent, to check the choke valve

{ewc GSMVIMG,GSMVIMG, !88265g05.bmp}

88265g05

Figure 6.
Fast idle cam (choke rod) adjustment—E4ME carburetor

{ewc GSMVIMG,GSMVIMG, !88265g06.bmp}

88265g06

Front (Primary Side) Vacuum Break Adjustment {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Front (Primary Side) Vacuum Break Adjustment

Ü See figure 7

Ä The following procedure requires the use of the GM Valve Angle Gauge tool No. J–26701, BT–7704 or equivalent.

1. Using a rubber band, attach it between the green tang of the intermediate choke shaft and the air horn housing.
2. Open the throttle and allow the choke valve to close.
3. Using the GM Valve Angle Gauge tool No. J–26701, BT–7704 or equivalent, attach it to the choke plate, then perform the following procedures:
    a. Rotate the degree scale until the zero is opposite the pointer.
    b. Center the leveling bubble.
    c. Rotate the scale to the specified angle degrees.
4. Apply a vacuum source (18 in.Hg) to retract the vacuum break and plug the air bleed holes.
5. Center the bubble of the Valve Angle Gauge, by turning the adjusting screw.

Figure 7.
Front (primary side) vacuum break adjustment—E4ME carburetor

{ewc GSMVIMG,GSMVIMG, !88265g07.bmp}

88265g07

Rear (Secondary Side) Vacuum Break Adjustment {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Rear (Secondary Side) Vacuum Break Adjustment

Ü See figures 8, 9

?Ä The following procedure requires the use of the GM Valve Angle Gauge tool No. J–26701, BT–7704 or equivalent.

1. Using a rubber band, attach it between the green tang of the intermediate choke shaft and the air horn housing.
2. Open the throttle and allow the choke valve to close.
3. Using the GM Valve Angle Gauge tool No. J–26701, BT–7704 or equivalent, attach it to the choke plate, then perform the following procedures:
   a. Rotate the degree scale until the zero is opposite the pointer.
   b. Center the leveling bubble.
   c. Rotate the scale to the specified angle degrees.
4. Apply an 18 in. Hg (60 kPa) vacuum source to retract the vacuum break and plug the air bleed holes.
5. Center the bubble of the Valve Angle Gauge by performing one of the following procedures:
   a. Using a $^{1}/8$ in. Allen wrench, turn the vacuum break adjusting screw.
   b. Using a rod bending tool, support the S-rod and bend the vacuum break rod.

Figure 8.
Plugging the air bleed holes of the vacuum break—E4ME carburetor

{ewc GSMVIMG,GSMVIMG, !88265g08.bmp}

88265g08

Figure 9.
Rear (secondary side) vacuum break adjustment—E4ME carburetor

{ewc GSMVIMG,GSMVIMG, !88265g09.bmp}

88265g09

Air Valve Rod Adjustment {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Air Valve Rod Adjustment

Ü See figure 10

Ä The following procedure requires the use of an 18 in. Hg (60 kPa) vacuum source and a 0.025 in. plug gauge.

1. Apply an 18 in. Hg (60 kPa) vacuum source to retract the vacuum break and plug the air bleed holes.
2. Open the throttle and allow the choke valve to close.
3. Using a 0.025 in. plug gauge, position it between the control rod and the slot in the choke valve cam.
4. To adjust, bend (using a bending tool) the air valve rod.

Figure 10.
Air valve rod adjustment—E4ME carburetor

{ewc GSMVIMG,GSMVIMG, !88265g10.bmp}

88265g10

Secondary Lockout Adjustment {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Secondary Lockout Adjustment

Ü See figure 11

Ä The following procedure requires the use of a 0.015 in. plug gauge and a rod bending tool.

1. Pull the choke wide open by pushing out on the choke lever.
2. Open the throttle until the end of the secondary actuating lever is opposite the toe of the lockout lever.
3. Measure the clearance between the lockout lever and the secondary lever.
4. Bend the lockout pin until the clearance is 0.015 in.

Figure 11.
Secondary lockout adjustment—M4ME and E4ME carburetors
{ewc GSMVIMG,GSMVIMG, !88265g11.bmp}

88265g11

Unloader Adjustment {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Unloader Adjustment

Ü See figure 12

Ä The following procedure requires the use of the GM Valve Angle Gauge tool No. J–26701, BT–7704 or equivalent, a rubber band and a bending tool.

1. Using a rubber band, attach it between the green tang of the intermediate choke shaft and the air horn housing.
2. Open the throttle and allow the choke valve to close.
3. Using the GM Valve Angle Gauge tool No. J–26701, BT–7704 or equivalent, attach it to the choke plate, then perform the following procedures:
   a. Rotate the degree scale until the zero is opposite the pointer.
   b. Center the leveling bubble.
   c. Rotate the scale to the specified angle degrees.

   Ä On a Quadrajet, hold the secondary lockout lever away from the pin.
4. Adjust and hold the throttle lever in the wide-open position.
5. Center the bubble of the Valve Angle Gauge, by bending the fast idle lever tang.

Figure 12.
Adjusting the unloader—E4ME carburetor

{ewc GSMVIMG,GSMVIMG, !88265g12.bmp}

88265g12

Throttle Position Sensor (TPS) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Fuel System

Throttle Position Sensor (TPS)

Ü See figures 13, 14

The throttle position sensor is a position meter, mounted on the carburetor; one end is connected to the ECM and the other to a ground. As the throttle plate opens, the output voltage increases; at wide-open throttle the output voltage is approximately 5V.

Ä The following procedure requires the use of GM Adjustment tool No. J-28696 or equivalent, a digital voltmeter tool No. J–29125–A, a drill, a $^{5}/64$ in. drill bit.

1. Disconnect the negative battery cable from the battery.
2. Remove the air cleaner and stuff a clean rag into the intake bore to keep the carburetor clean.
3. To remove the throttle position plug cover, perform the following procedures:
   a. Using a $^{5}/64$ in. drill bit, drill a hole in the aluminum plug covering the throttle position solenoid adjusting screw.

   Ä When drilling the hole in the aluminum plug, be careful not to damage the adjusting screw head.

   b. Using a No. 8, $^{1}/2$ in. self-tapping screw, install it into the drilled hole.
   c. Using a wide blade screwdriver, pry against the screw head to remove the plug, then discard the plug.
4. Using the GM adjusting tool No. J–28696, BT–7967–A or equivalent, remove the throttle position solenoid adjusting screw.
5. Using the digital voltmeter tool No. J–29125–A or equivalent, connect one probe to the center terminal and the other to the bottom terminal of the throttle position solenoid connector.
6. Turn the ignition switch **ON** with the engine stopped. Install the throttle position solenoid adjustment screw.
7. Using the GM adjusting tool No. J–28696, BT–7967–A or equivalent, install the throttle position solenoid adjusting screw and turn it to obtain a voltage of 0.255V (air conditioning off and at curb idle).
8. After the adjustment is complete, install a new throttle position solenoid plug cover; drive the plug in until it flush with the raised pump lever boss on the casting.

   Ä If a throttle position solenoid plug is not available, apply Delco Threadlock Adhesive X-10® or equivalent, to the screw threads and repeat the adjustment.

9. After adjustment, clear the trouble code memory.

Figure 13.
Drilling a hole in the TPS screw cover plug

{ewc GSMVIMG,GSMVIMG, !88265g13.bmp}

88265g13

Figure 14.
Using the GM adjusting tool No. J–28696, BT–7967–A or equivalent, to adjust the TPS screw

{ewc GSMVIMG,GSMVIMG, !88265g14.bmp}

88265g14

Mixture Control Solenoid (Plunger Travel) {ewc MVIMAGE, MVIMAGE, !
nexttopicarrow.bmp}

Mixture Control Solenoid (Plunger Travel)

If the dwell is off at 3000 rpm, perform this check and/or adjustment procedure.

CHECKING

Ü See figure 15

Ä The following procedure requires the use of the GM Float Gauge tool No. J–34935, BT–8420–A or equivalent.

1. With the engine not running, remove the air cleaner from the carburetor.
2. Insert the GM Float Gauge tool No. J–34935–1, BT–8420–A or equivalent, into the vertical D-shaped vent hole of the air horn; allow the gauge to touch the solenoid plunger.

   Ä If difficulty is experienced in inserting the gauge into the hole, it may be necessary to grind some of the material from it.
3. With the gauge released (plunger in the Up position), observe and record the mark (on the gauge) that aligns with the top of the air horn.
4. Press down (lightly) on the gauge until it bottoms, then read and record the mark that aligns with the top of the air horn.
5. Subtract the Up position from the Down position; the difference is the total plunger travel:
   a. If the plunger travel is $^{1}/16$–$^{3}/16$ in. (1.5–4.8mm) and the dwell reading was OK at 3,000 rpm (10º–50º).
   b. If the plunger travel is less than $^{1}/16$ in. (1.5mm) or greater than $^{3}/16$ in. (4.8mm) or the dwell reading was off at 3,000 rpm, adjust the mixture control solenoid plunger travel.

Figure 15.
Checking the mixture control solenoid plunger travel—E4ME carburetor
{ewc GSMVIMG,GSMVIMG, !88265g15.bmp}

88265g15

ADJUSTMENT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ADJUSTMENT

Ü See figures 16, 17, 18

Ä The following procedure requires the use of the GM Mixture Solenoid Gauge tool No. J–33815–1, BT–8253–A or equivalent, and the GM Adjustment tool No. J–28696–10, BT–7928 or equivalent.

1. Disconnect the negative battery terminal from the battery, then the mixture control solenoid, the throttle position sensor and the idle speed solenoid connectors from the carburetor.
2. To remove the air horn, perform the following procedures:
    a. Remove the idle speed solenoid-to-air horn screws and the solenoid.
    b. Remove the choke lever-to-choke shaft screw, rotate the upper choke lever and remove the choke rod from the slot in the lever.
    c. To remove the choke rod from the lower lever (inside the float bowl casting), use a small screwdriver to hold the lower lever outward and twist the rod counterclockwise.
    d. Remove the fuel pump link from the pump lever; DO NOT remove the pump link from the air horn.
    e. From the front of the float bowl, remove the front vacuum break hose from the tube.
    f. Remove the air horn-to-fuel bowl screws and lift the air horn straight up from the float bowl; discard the gasket.

Ä When removing the air horn-to-float bowl screws, be sure to remove the 2 countersunk screws located next to the venturi.

3. Remove the solenoid adjustment screw, the rich limit stop, the mixture control solenoid plunger, the primary metering rods with the springs, the plastic filler block and the mixture control solenoid.
4. Inspect the carburetor for the cause of an incorrect mixture:
    a. Inspect for a worn mixture control solenoid bore or sticking plunger.
    b. Inspect the metering rods for an incorrect part number, sticking condition and improperly installed rods or springs.
    c. Inspect for dirt in the jets.
5. Using the GM Mixture Solenoid Gauging tool No. J–33815–1, BT–8253–A or equivalent, install it over the throttle side metering jet rod guide and temporarily reinstall the solenoid adjusting screw spring, the mixture control solenoid, the plunger, the rich limit stop and the solenoid adjusting screw.
6. To adjust the solenoid plunger, perform the following procedures:
    a. Using light finger pressure, as close to the plunger shaft as possible, hold the solenoid plunger in the Down position.
    b. Using the GM Adjustment tool No. J–28696–10, BT–7928 or equivalent, turn the solenoid adjusting screw clockwise until the plunger contacts the gauging tool.
    c. Turn the tool counterclockwise until the plunger breaks contact with the gauging tool.

Ä When the solenoid plunger contacts both the solenoid stop and the gauge tool, the adjustment is correct.

7. Noting the position of the tool's tee handle, turn the solenoid's adjusting screw clockwise (counting and recording the number of turns) until the solenoid bottoms against the float

bowl.

8. Remove the solenoid adjusting screw, the rich limit stop, the mixture control solenoid, the plunger, the solenoid adjusting screw spring and the gauging tool.
9. Install the solenoid adjusting screw spring, the mixture control solenoid, the plastic filler block, the primary metering rods/springs, the mixture control solenoid plunger, the rich limit stop and the solenoid adjusting screw.
10. Using the GM Adjustment tool No. J–28696–10, BT–7928 or equivalent, turn the adjusting screw clockwise (counting the exact number of turns from Step 7) until the solenoid bottoms against the float bowl.

Figure 16.
Exploded view of the mixture control solenoid assembly—E4ME carburetor
{ewc GSMVIMG,GSMVIMG, !88265g16.bmp}

88265g16

Figure 17.
Positioning the mixture control solenoid gauging tool
{ewc GSMVIMG,GSMVIMG, !88265g17.bmp}

88265g17

Figure 18.
Adjusting the mixture control solenoid screw
{ewc GSMVIMG,GSMVIMG, !88265g18.bmp}

88265g18

11. To install the air horn, use a new gasket and reverse the removal procedures. Start the engine and check the dwell at 3000 rpm.
12. To set the engine for dwell inspection, perform the following procedures:
    a. Disconnect and plug the vacuum line-to-canister purge valve.
    b. Ground the diagnostic test terminal.
    c. Attach a dwell meter to the engine.
    d. Operate the engine until normal operating temperature is established; the upper radiator hose is Hot.
13. To inspect the dwell, operate the engine at 3000 rpm and check for the following conditions:
    a. If the dwell is 10–50º the mixture control solenoid adjustment is complete.
    b. If the dwell is greater than 50º, check the carburetor for a rich condition.
    c. If the dwell is less than 10º, check for vacuum leaks or a lean operating carburetor.

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Fuel System

REMOVAL & INSTALLATION

Carburetor

1. Raise the hood. From inside the vehicle, remove the engine cover.
2. Disconnect the negative battery cable from the battery.
3. Remove the air cleaner and the accelerator linkage.
4. If equipped with an AT, remove the detent cable from the carburetor.
5. Disconnect the cruise control, if equipped.
6. Label and disconnect all of the necessary vacuum lines.
7. Place a shop cloth under the fuel line-to-carburetor connection and disconnect the fuel line from the carburetor; the cloth will catch the excess fuel.
8. Label and disconnect all of the necessary electrical connections.
9. Remove the carburetor-to-intake manifold bolts, the carburetor and the gasket (discard it).

To install:

10. Use a new carburetor-to-intake manifold gasket and install the carburetor onto the manifold. Torque the carburetor-to-intake manifold bolts to 84 inch lbs. (9.5 Nm) or 132 inch lbs. (14 Nm).
11. Connect all of the necessary electrical connections.
12. Place a shop cloth under the fuel line-to-carburetor connection and connect the fuel line to the carburetor; the cloth will catch the excess fuel.
13. Connect all of the necessary vacuum lines.
14. Connect the cruise control, if equipped.
15. If equipped with an AT, install the detent cable to the carburetor.
16. Install the accelerator linkage and air cleaner.
17. Connect the negative battery cable to the battery.
18. Install the engine cover and lower the hood.
19. Start the engine and check for leaks and proper operation.

Throttle Position Sensor (TPS) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Throttle Position Sensor (TPS)

Ü See figures 19, 20

1. Disconnect the negative battery cable from the battery, then the mixture control solenoid, the throttle position sensor and the idle speed solenoid connectors from the carburetor.
2. At the air horn, remove the following items by performing the following procedures:
   a. Remove the idle speed solenoid-to-air horn screws and the solenoid.
   b. Remove the choke lever-to-choke shaft screw, rotate the upper choke lever and remove the choke rod from the slot in the lever.
   c. To remove the choke rod from the lower lever (inside the float bowl casting), use a small screwdriver to hold the lower lever outward and twist the rod counterclockwise.
   d. Remove the fuel pump link from the pump lever; DO NOT remove the pump link from the air horn.
   e. From the front of the float bowl, remove the front vacuum break hose from the tube.
   f. Remove the air horn-to-fuel bowl screws and lift the air horn straight up from the float bowl; discard the gasket.

   Ä When removing the air horn-to-float bowl screws, be sure to remove the 2 countersunk screws located next to the venturi.
3. To remove the throttle position solenoid from the float bowl, perform the following procedures:
   a. Using a flat tool or a piece of metal, lay it across the float bowl to protect the gasket sealing surface.
   b. Using a small prybar, lightly depress the throttle position solenoid sensor and hold against the spring tension.
   c. Using a small chisel, pry upward (against the bowl staking) to remove the staking.

   Ä When removing the bowl staking, be sure to apply prying force against the metal piece and not the bowl casting.

   d. Pushing up on the bottom of the throttle position solenoid electrical connector, remove it and the connector assembly from the fuel bowl.

Figure 19.
Use a suitable tool to install the air horn onto the float bowl—E4ME carburetor
{ewc GSMVIMG,GSMVIMG, !88265g19.bmp}

88265g19

Figure 20.
Air horn torque sequence—E4ME carburetor
{ewc GSMVIMG,GSMVIMG, !88265g20.bmp}

88265g20

To install:

4. Install the throttle position solenoid/connector assembly, align the groove in the electrical connector with the slot in the float bowl casting. Push down on the assembly so that the connector and wires are located below the bowl casting surface; be sure the green throttle position solenoid actuator plunger is aligned in the air horn.
5. Install the air horn, hold the pump plunger assembly down against the return spring tension.

Align the pump plunger stem with the hole in the gasket and the gasket over the throttle position solenoid plunger, the solenoid plunger return spring, the metering rods, the solenoid mounting screws and the electrical connector. Use the two dowel locating pins (on the float bowl) to align the gasket.

6. While holding the solenoid metering rod plunger, the air horn gasket and the pump plunger assembly, align the slot in the end of the plunger with the solenoid mounting screw.
7. While lowering the air horn assembly (carefully) onto the float bowl, position the throttle position solenoid adjustment lever of the throttle position solenoid sensor and guide the pump plunger stem through the air horn casting seal.

   Ä To ease the installation of the air horn onto the float bowl, insert a thin screwdriver between the air horn gasket and the float bowl to raise the throttle position solenoid adjustment lever while positioning it over the throttle position solenoid sensor.

8. Install the air horn-to-float bowl screws and tighten all of the screws evenly, using the torquing sequence.
9. Reconnect all of the vacuum and electrical connectors. Clear the trouble code from the ECM memory. Check and/or adjust the throttle position solenoid voltage.
10. Connect the negative battery cable, start the engine, check for leaks and proper operation.

Mixture Control Solenoid {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Mixture Control Solenoid

Ä The following procedure requires the use of GM Solenoid Adjusting tool No. J–28696–1 or equivalent.

1. Disconnect the negative battery cable from the battery, then the mixture control solenoid and the Throttle Position Sensor (TPS) electrical connectors from the carburetor.
2. Remove the air horn, by performing the following procedures:
   a. Remove the choke lever-to-choke shaft screw, rotate the upper choke lever and remove the choke rod from the slot in the lever.
   b. To remove the choke rod from the lower lever (inside the float bowl casting), use a small screwdriver to hold the lower lever outward and twist the rod counterclockwise.
   c. Remove the fuel pump link from the pump lever; DO NOT remove the pump link from the air horn.
   d. From the front of the float bowl, remove the front vacuum break hose from the tube.
   e. Remove the air horn-to-fuel bowl screws and lift the air horn straight up from the float bowl; discard the gasket.

   Ä When removing the air horn-to-float bowl screws, be sure to remove the 2 countersunk screws located next to the venturi.

   f. Lift the air horn straight up from the float bowl.
3. Using the GM Solenoid Adjusting tool No. J–28696–1 or equivalent, remove the mixture control solenoid adjusting screw.
4. Lift the air horn-to-float bowl gasket from the dowel locating pins and discard it.
5. Remove the plastic filler block from over the float bowl.
6. Lift (carefully) each metering rod from the guided metering jet; be sure to remove the return spring with each rod.
7. Remove the mixture control solenoid-to-float bowl screw, then lift the solenoid and the connector assembly from the float bowl.

   Ä If a new mixture control solenoid package is being installed, the solenoid and the plunger MUST BE installed as a matched set.

8. When installing the mixture control solenoid, perform the following procedures:
   a. Align the solenoid's pin with the hole in the raised boss at the bottom of the float bowl.
   b. Align the wires of the solenoid's connector in the bowl slot or the plastic insert (if used).
   c. Install the solenoid-to-fuel bowl mounting screw and engage the first 6 screw threads (to assure proper thread engagement).
9. To complete the installation, use a new gasket and reverse the removal procedures. Calibrate the mixture control solenoid plunger.

{ewc GSMVIMG,GSMVIMG, !88265C26.bmp}

88265C26

{ewc GSMVIMG,GSMVIMG, !88265C27.bmp}

88265C27

Carburetor Overhaul {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Carburetor Overhaul

Ü See figures 21, 22, 23, 24

Efficient carburetion depends greatly on careful cleaning and inspection during overhaul, since dirt, gum, water or varnish in or on the carburetor parts are often responsible for poor performance.

Overhaul your carburetor in a clean, dust-free area. Carefully disassemble the carburetor, referring often to the exploded views and directions packaged with the rebuilding kit. Keep all similar and look-alike parts segregated during disassembly and cleaning to avoid accidental interchange during assembly. Make a note of all jet sizes.

When the carburetor is disassembled, wash all parts (except diaphragms, electric choke units, solenoids, pump plunger and any other plastic, leather, fiber or rubber parts) in clean carburetor solvent. DO NOT leave the parts in the solvent any longer than is necessary to sufficiently loosen the deposits. Excessive cleaning may remove the special finish from the float bowl and choke valve bodies, leaving these parts unfit for service. Rinse all parts in clean solvent and blow them dry with compressed air or allow them to air dry. Wipe clean all cork, plastic, leather and fiber parts with a clean, lint-free cloth.

Blow out all passages and jets with compressed air and be sure that there are no restrictions or blockages. Never use wire or similar tools to clean the jets, fuel passages or air bleeds. Clean all jets and valves separately to avoid accidental interchange.

Figure 21.
Exploded view of the carburetor assembly—E4ME carburetor
{ewc GSMVIMG,GSMVIMG, !88265g21.bmp}

88265g21

Figure 22.
Exploded view of the carburetor assembly—E4ME carburetor, continued
{ewc GSMVIMG,GSMVIMG, !88265g22.bmp}

88265g22

Figure 23.
Exploded view of the carburetor assembly—M4ME carburetor
{ewc GSMVIMG,GSMVIMG, !88265g23.bmp}

88265g23

Figure 24.
Exploded view of the carburetor assembly—M4ME carburetor, continued
{ewc GSMVIMG,GSMVIMG, !88265g24.bmp}

88265g24

Check all parts for wear or damage. If wear or damage is found, replace the defective parts. Especially check the following:

1. Check the float needle and seat for wear. If wear is found, replace the complete assembly.
2. Check the float hinge pin for wear and the float(s) for dents or distortion. Replace the float if fuel has leaked into it.
3. Check the throttle and choke shaft bores for wear or an out-of-round condition. Damage or wear to the throttle arm, shaft or shaft bore will often require replacement of the throttle body. These parts require a close fitting tolerance; wear may allow air leakage, which could affect starting and idling.

   Ä Throttle shafts and bushings are not included in overhaul kits. They can be

purchased separately.

4. Inspect the idle mixture adjusting needles for burrs or grooves. Any such condition requires replacement of the needle, since you will not be able to obtain a satisfactory idle.
5. Test the accelerator pump check valves. They should pass air one way but not the other. Test for proper seating by blowing and sucking on the valve. Replace the valve check ball and spring as necessary. If the valve is satisfactory, wash the valve parts again to remove breath moisture.
6. Check the bowl cover for warped surfaces with a straightedge.
7. Closely inspect the accelerator pump plunger for wear and damage, replacing as necessary.
8. After the carburetor is assembled, check the choke valve for freedom of operation.

Carburetor overhaul kits are recommended for each overhaul. These kits contain all gaskets and new parts to replace those which deteriorate most rapidly. Failure to replace all parts supplied with the kit (especially gaskets) can result in poor performance later.

Some carburetor manufacturers supply overhaul kits of three basic types: minor repair, major repair and gasket kits. Basically, they contain the following:

Minor Repair Kits:

- All gaskets
- Float needle valve
- All diagrams
- Spring for the pump diaphragm

Major Repair Kits:

- All jets and gaskets
- All diaphragms
- Float needle valve
- Pump ball valve
- Float
- Complete intermediate rod
- Intermediate pump lever
- Some cover holddown screws and washers

Gasket Kits:

- All gaskets

After cleaning and checking all components, reassembly the carburetor, using new parts and referring to the exploded view. When reassembling, make sure that all screws and jets are tight in their seats but DO NOT over tighten, for the tips will be distorted. Tighten all screws gradually, in rotation. DO NOT tighten the needle valves into their seats; uneven jetting will result. Always use new gaskets. Be sure to adjust the float level when reassembling.

DISASSEMBLY {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Fuel System

DISASSEMBLY

Idle Speed Solenoid Removal

Remove the attaching screws, then remove the Idle Speed Solenoid. The Idle Speed Solenoid should not be immersed in any carburetor cleaner, and should always be removed before complete carburetor overhaul, as carburetor cleaner will damage the internal components.

Idle Mixture Needle Plug Removal {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Idle Mixture Needle Plug Removal

1. Use hacksaw to make two parallel cuts in the throttle body, one on each side of the locator points near one idle mixture needle plug. The distance between the cuts will depend on the size of the punch to be used. Cuts should reach down to the steel plug, but should but extend more than $^1/8$ in. (3mm) beyond the locator points.
2. Place a flat punch at a point near the ends of the saw marks in the throttle body. Hold the punch at a 45º angle, and drive it into the throttle body until the casting breaks away, exposing the hardened steel plug. The plug will break, rather than remaining intact. Remove all the loose pieces.
3. Repeat the procedure for the other idle mixture needle plug.

Idle Air Bleed Valve Removal {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Idle Air Bleed Valve Removal

1. Cover internal bowl vents and air inlets to the bleed valve with masking tape.
2. Carefully align a $^{7}/64$ in. drill bit on rivet head. Drill only enough to remove head of each rivet holding the idle air bleed valve cover.
3. Use a suitably sized punch to drive out the remainder of the rivet from the castings. Repeat procedure with other rivet.

   ****Caution**
   For the next operation, safety glasses must be worn to protect eyes from possible metal shaving damage.

4. Lift off cover and remove any pieces of rivet still inside tower. Use shop air to blow out any remaining chips.
5. Remove idle air bleed valve from the air horn.
6. Remove and discard O-ring seals from valve. New O-ring seals are required for reassembly. The idle air bleed valve is serviced as a complete assembly only.

Air Horn Removal {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Air Horn Removal

1. Remove upper choke lever from the end of choke shaft by removing retaining screw. Rotate upper choke lever to remove choke rod from slot in lever.
2. Remove choke rod from lower lever inside the float bowl casting. Remove rod by holding lower lever outward with small screwdriver and twisting rod counterclockwise.
3. Remove secondary metering rods by removing the small screw in the top of the metering rod hanger. Lift upward on the metering rod hanger until the secondary metering rods are completely out of the air horn. Metering rods may be disassembled from the hanger by rotating the ends out of the holes in the end of the hanger.
4. Remove pump link retainer and remove link from pump lever.

   Ä Do not attempt to remove the lever, as damage to the air horn could result.
5. Remove front vacuum break hose from tube on float bowl.
6. Remove 11 air horn-to-bowl screws; then remove the 2 countersunk attaching screws located next to the venturi. If used, remove secondary air baffle deflector from beneath the 2 center air horn screws.
7. Remove air horn from float bowl by lifting it straight up. The air horn gasket should remain on the float bowl for removal later.

   Ä When removing air horn from float bowl, use care to prevent damaging the mixture control solenoid connector, Throttle Position Sensor (TPS) adjustment lever, and the small tubes protruding from the air horn. These tubes are permanently pressed into the air horn casting. DO NOT remove them.
8. Remove front vacuum break bracket attaching screws. The vacuum break assembly may now be removed from the air valve dashpot rod, and the dashpot rod from the air valve lever.

   Ä Do not place vacuum break assembly in carburetor cleaner, as damage to vacuum break will occur.
9. Remove Throttle Position Sensor (TPS) plunger by pushing plunger down through seal in air horn.
10. Remove the throttle position solenoid seal and pump plunger stem seal by inverting air horn and using a small screwdriver to remove staking holding seal retainers in place. Remove and discard retainers and seals.

    Ä Use care in removing the throttle position solenoid plunger seal retainer and pump plunger stem seal retainer to prevent damage to air horn casting. New seals and retainers are required for reassembly.
11. Invert air horn, and use Tool J–28696–4, BT–7967A, or equivalent, to remove rich mixture stop screw and spring.
12. Use a suitable punch to drive the lean mixture screw plug and rich mixture stop screw plug out of the air horn. Discard the plugs.
13. Further disassembly of the air horn is not required for cleaning purposes.

The choke valve and choke valve screws, the air valves and air valve shaft should not be removed. However, if it is necessary to replace the air valve closing springs or center plastic eccentric cam, a repair kit is available. Instructions for assembly are included in the repair kit.

Float Bowl Disassembly {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Float Bowl Disassembly

Ä The following special tools, or their equivalents, will be necessary for this procedure: J–28696–10, BT–7928, J–22769, BT–3006M, J–28696–4, and BT–7928.

1. Remove solenoid metering rod plunger by lifting straight up.
2. Remove air horn gasket by lifting it from the dowel locating pins on float bowl. Discard gasket.
3. Remove pump plunger from pump well.
4. Remove staking holding Throttle Position Sensor (TPS) in bowl as follows:
   a. Lay a flat tool or metal piece across bowl casting to protect gasket sealing surface.
   b. Use a small screwdriver to depress throttle position solenoid sensor lightly and hold against spring tension.
   c. Observing safety precautions, pry upward with a small chisel or equivalent to remove bowl staking, making sure prying force is exerted against the metal piece and not against the bowl casting. Use care not to damage the throttle position solenoid sensor.
   d. Push up from bottom on electrical connector and remove throttle position solenoid and connector assembly from bowl. Use care in removing sensor and connector assembly to prevent damage to this critical electrical part.
   e. Remove spring from bottom of throttle position solenoid well in float bowl.
5. Remove plastic bowl insert from float bowl.
6. Carefully lift each metering rod out of the guided metering jet, checking to be sure the return spring is removed with each metering rod.

   Ä Use extreme care when handling these critical parts to avoid damage to the metering rod and spring.
7. Remove the mixture control solenoid from the float bowl as follows:
   a. Remove screw attaching solenoid connector to float bowl. Do not remove solenoid connector from float bowl until called for in text.
   b. Use Tool J–28696–10, BT–7928, or equivalent, to remove lean mixture (solenoid) screw. Do not remove plunger return spring or connector and wires from the solenoid body. The mixture control solenoid, with plunger and connector, is only serviced as a complete assembly.
   c. Remove rubber gasket from top of solenoid connector and discard.
   d. Remove solenoid screw tension spring (next to float hanger pin).
8. Remove float assembly and float needle by pulling up on retaining pin. Remove needle and seat and gasket using set remover Tool J–22769, BT–3006M, or equivalent.
9. Remove large mixture control solenoid tension spring from boss on bottom of float bowl located between guided metering jets.
10. If necessary, remove the primary main metering jets using special Tool J–28696–4, BT–7928, or equivalent.

    Ä Use care installing tool on jet, to prevent damage to the metering rod guide (upper area), and locating tool over vertical float sections on lower area of jet. Also, no attempt should be made to remove the secondary metering jets (metering orifice plates). These jets are fixed and, if damaged, entire bowl replacement is required.

11. Remove pump discharge check ball retainer and turn bowl upside down, catching discharge ball as if falls.
12. Remove secondary air baffle, if replaced is required.
13. Remove pump well fill slot baffle only if necessary.

Choke Disassembly {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Choke Disassembly

Ä Special tools J–9789–118, BT–30–15, or their equivalents, will be necessary for this procedure.

The tamper-resistant choke cover is used to discourage unnecessary readjustment of the choke thermostatic cover and coil assembly. However, if it is necessary to remove the cover and coil assembly during normal carburetor disassembly for cleaning and normal carburetor disassembly for cleaning and overhaul, the procedures below should be followed.

1. Support float bowl and throttle body, as an assembly, on a suitable holding fixture such as Tool J–9789–118, BT–30–15, or equivalent.
2. Carefully align a $^{5}/32$ in. drill bit on the rivet head and drill only enough to remove the rivet head. Drill the 2 remaining rivet heads, then use a drift and small hammer to drive the remainder of the rivets out of the choke housing.

   Ä Use care in drilling to prevent damage to the choke cover or housing.
3. Remove the 2 conventional retainers, retainer with tab, and choke cover assembly from choke housing.
4. Remove choke housing assembly from float bowl by removing retaining screw and washer inside the choke housing. The complete choke assembly can be removed from the float bowl by sliding outward.
5. Remove secondary throttle valve lock-out lever from float bowl.
6. Remove lower choke lever from inside float bowl cavity by inverting bowl.
7. To disassemble intermediate choke shaft from choke housing, remove coil lever retaining screw at end of shaft inside the choke housing. Remove thermostatic coil lever from flats on intermediate choke shaft.
8. Remove intermediate choke shaft from the choke housing by sliding it outward. The fast idle cam can now be removed from the intermediate choke shaft. Remove the cup seal from the float bowl for cleaning purposes. DO NOT ATTEMPT TO REMOVE THE INSERT!
9. Remove fuel inlet nut, gasket, check valve, filter assembly and spring. Discard check valve filter assembly and gasket.
10. Remove 3 throttle body-to-bowl attaching screws and lockwashers and remove throttle body assembly.
11. Remove throttle body-to-bowl insulator gasket.

Throttle Body Disassembly {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Throttle Body Disassembly

Ä Special tools J–29030–B and BT–7610B, or their equivalents, will be necessary for this procedure.

Place throttle body assembly on carburetor holding fixture to avoid damage to throttle valves.

1. Remove pump rod from the throttle lever by rotating the rod until the tang on the rod aligns with the slot in the lever.
2. Use Tool J–29030–B, BT–7610B, or equivalent, to remove idle mixture needles for thorough throttle body cleaning.
3. Further disassembly of the throttle body is not required for cleaning purposes. The throttle valve screws are permanently staked in place and should not be removed. The throttle body is serviced as a complete assembly.

ASSEMBLY {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ASSEMBLY

Ä The following special tools, or their equivalents, will be necessary for this procedure: J–29030–B, BT–7610B, J–9789–118, BT–30–15, J–23417, BT–6911, J–28696–4, J–22769, BT–3006M, J–33815–1, BT–8253–A, J–28696–10, and BT–7928.

1. Install the lower end of the pump rod in the throttle lever by aligning the tang on the rod with the slot in the lever. The end of the rod should point outward toward the throttle lever.
2. Install idle mixture needles and springs using Tool J–29030–B, BT–7610B, or equivalent. Lightly seat each needle and then turn counterclockwise 3 turns, the final idle mixture adjustment is made on the vehicle.
3. If a new float bowl assembly is used, stamp or engrave the model number on the new float bowl. Install new throttle body-to-bowl insulator gasket over 2 locating dowels on bowl.
4. Install throttle body making certain throttle body is properly located over dowels on float bowl. Install 3 throttle body-to-bowl screws and lockwashers and tighten evenly and securely.
5. Place carburetor on proper holding fixture such as J–9789–118, BT–30–15 or equivalent.
6. Install fuel inlet filter spring, a new check valve filter assembly, new gasket and inlet nut. Tighten nut to 18 ft. lbs. (24 Nm).

   Ä When installing a service replacement filter, make sure the filter is the type that includes the check valve to meet government safety standard. New service replacement filters with check valve meet this requirement. When properly installed, the hole in the filter faces toward the inlet nut. Ribs on the closed end of the filter element prevent it from being installed incorrectly, unless forced. Tightening beyond the specified torque, 18 ft. lbs (24 Nm), can damage the nylon gasket.

7. Install a new cup seal into the insert on the side of the float bowl for the intermediate choke shaft. The lip on the cup seal faces outward.
8. Install the secondary throttle valve lock-out lever on the boss of the float bowl, with the recess hole in the lever facing inward.
9. Install the fast idle cam on the intermediate choke shaft (steps on cam face downward).
10. Carefully install fast idle cam and intermediate choke shaft assembly in the choke housing. Install the thermostatic coil lever on the flats on the intermediate choke shaft. Inside thermostatic choke coil lever is properly aligned when both inside and outside levers face toward the fuel inlet. Install inside lever retaining screw into the end of the intermediate choke shaft.
11. Install lower choke rod (inner) lever into cavity in float bowl.
12. Install choke housing to bowl, sliding intermediate choke shaft into lower (inner) lever. Tool J–23417, BT–6911 or equivalent, can be used to hold the lower choke lever in correct position while installing the choke housing. The intermediate choke shaft lever and fast idle cam are in correct position when the tang on lever is beneath the fast idle cam.
13. Install choke housing retaining screws and washers. Check linkage for freedom of movement. Do not install choke cover and coil assembly until inside coil lever is adjusted.
14. If removed, install air baffle in secondary side of float bowl with notches toward the top. Top edge of baffle must be flush with bowl casting.
15. If removed, install baffle inside of the pump well with slot toward the bottom.
16. Install pump discharge check ball and retainer screw in the passage next to the pump well.
17. If removed, carefully install primary main metering jets in bottom of float bowl using or Tool

J–28696–4, BT–7928, equivalent.

Ä Use care in installing jets to prevent damage to metering rod guide.

18. Install large mixture control solenoid tension spring over boss on bottom of float bowl.
19. Install needle seat assembly, with gasket, using seat installer J–22769, BT–3006M, or equivalent.
20. To make adjustment easier, carefully bend float arm before assembly.
21. Install float needle onto float arm by sliding float lever under needle pull clip. Proper installation of the needle pull clip is to hook the clip over the edge of the float on the float arm facing the float pontoon.
22. Install float hinge pin into float arm with end of loop of pin facing pump well. Install float assembly by aligning needle in the seat, and float hinge pin into locating channels in float bowl. DO NOT install float needle pull clip into holes in float arm.
23. Make a float level adjustment as necessary.
24. Install mixture control solenoid screw tension spring between raised bosses next to float hanger pin.
25. Install mixture control solenoid and connector assembly as follows:
    a. Install new rubber gasket on top of solenoid connector.
    b. Install solenoid carefully in the float chamber, aligning pin on end of solenoid with hole in raised boss at bottom of bowl. Align solenoid connector wires to fit in slot in bowl.
    c. Install lean mixture (solenoid) screw through hole in solenoid bracket and tension spring in bowl, engaging first 6 screw threads to assure proper thread engagement.
    d. Install mixture control solenoid gauging Tool J–33815–1, BT–8253–A, or equivalent over the throttle side metering jet rod guide, and temporarily install solenoid plunger.
    e. Holding the solenoid plunger against the solenoid stop, use Tool J–28696–10, BT–7928, or equivalent, to turn the lean mixture (solenoid) screw slowly clockwise, until the solenoid plunger just contacts the gauging tool. The adjustment is correct when the solenoid plunger is contacting BOTH the solenoid stop and the gauging tool.
    f. Remove solenoid plunger and gauging tool.
26. Install connector attaching screw, but DO NOT over tighten, as that could cause damage to the connector.
27. Install throttle position sensor return spring in bottom of well in float bowl.
28. Install throttle position sensor and connector assembly in float bowl by aligning groove in electrical connector with slot in float bowl casting. Push down on connector and sensor assembly so that connector and wires are located below bowl casting surface.
29. Install plastic bowl insert over float valve, pressing downward until properly seated (flush with bowl casting surface).
30. Slide metering rod return spring over metering rod tip until small end of spring stops against shoulder on rod. Carefully install metering rod and spring assembly through holding in plastic bowl insert and gently lower the metering rod into the guided metering jet, until large end of spring seats on the recess on end of jet guide.

****Caution**
Do not force metering rod down in jet. Use extreme care when handling these critical parts to avoid damage to rod and spring. If service replacement metering rods, springs and jets are installed, they must be installed in matched sets.

31. Install pump return spring in pump well.
32. Install pump plunger assembly in pump well.
33. Holding down on pump plunger assembly against return spring tension, install air horn gasket by aligning pump plunger stem with hole in gasket, and aligning holes in gasket over throttle position solenoid plunger, solenoid plunger return spring metering rods, solenoid attaching screw and electrical connector. Position gasket over the two dowel locating pins on the float bowl.
34. Holding down on air horn gasket and pump plunger assembly, install the solenoid-metering rod plunger in the solenoid, aligning slot in end of plunger with solenoid attaching screw. Be sure plunger arms engage top of each metering rod plunger.
35. If a service replacement mixture control solenoid package is installed, the solenoid and plunger MUST be installed as a matched set.

Air Horn Assembly {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Air Horn Assembly

Ä The following special tools, or their equivalents, will be necessary for this procedure: J–28696–10, J–2869–4, BT–7967A, J–34935–1, BT–8420A, BT–7928, J–33815–2, and BT–8353B.

1. If removed, install the throttle position solenoid adjustment screw in the air horn using Tool J–28696–10, BT–7967A, or equivalent. Final adjustment of the throttle position sensor is made on the vehicle.
2. Inspect the air valve shaft pin for lubrication. Apply a liberal quantity of lithium base grease to the air valve shaft pin, especially in the area contacted by the air valve spring.
3. Install new pump plunger and throttle position solenoid plunger seals and retainers in air horn casting. The lip on the seal faces outward, away from the air horn mounting surface. Lightly stake seal retainer in three places, choosing locations different from the original stakings.
4. Install rich mixture stop screw and rich authority adjusting spring from bottom side of the air horn. Use Tool J–2869–4, BT–7967A, or equivalent, to bottom the stop screw lightly, then back out 1/4 turn. Final adjustment procedure will be covered later in this section.
5. Install throttle position solenoid actuator plunger in the seal.
6. Carefully lower the air horn assembly onto the float bowl while positioning the throttle position solenoid adjustment lever over the throttle position solenoid sensor and guiding pump plunger stem through the seal in the air horn casting. To ease installation, insert a thin screwdriver between the air horn gasket and float bowl to raise the throttle position solenoid adjustment lever, positioning it over the throttle position solenoid sensor.
7. Make sure that the bleed tubes and accelerating well tubes are positioned properly through the holes in the air horn gasket. Do not force the air horn assembly onto the bowl, but lower it lightly into place over the 2 dowel locating pins.
8. Install 2 long air horn screws and lockwashers, 9 short screws and lockwashers and 2 countersunk screws located next to the carburetor venturi area. Install secondary air baffle beneath the No. 3 and 4 screws. Tighten all screws evenly and securely.
9. Install air valve rod into slot in the lever on the end of the air valve shaft. Install the other end of the rod in hole in front vacuum break plunger. Install front vacuum break and bracket assembly on the air horn, using 2 attaching screws. Tighten screws securely. Connect pump link to pump lever and install retainer.

Ä Use care installing the roll pin to prevent damage to the pump lever bearing surface and casting bosses.

10. Install 2 secondary metering rods into the secondary metering rod hanger (upper end of rods point toward each other). Install secondary metering rod holder, with rods, onto air valve cam follower. Install retaining screw and tighten securely. Work air valves up and down several times to make sure they remove freely in both directions.
11. Connect choke rod into lower choke lever inside bowl cavity. Install choke rod in slot in upper choke lever, and position lever on end of choke shaft, making sure flats on end of shaft align with flats in lever. Install attaching screw and tighten securely. When properly installed, the number on the lever will face outward.
12. Adjust the rich mixture stop screw:
    a. Insert external float gauging Tool J–34935–1, BT–8420A, or equivalent, in the vertical D-shaped vent hole in the air horn casting (next to the idle air bleed valve) and allow it to float freely.

b. Read (at eye level) the mark on the gauge, in inches, that lines up with the tip of the air horn casting.

c. Lightly press down on gauge, and again read and record the mark on the gauge that lines up with the top of the air horn casting.

d. Subtract gauge UP dimension, found in Step b, from gauge DOWN dimension, found in Step c, and record the difference in fractions of an inch. This difference in dimension is the total solenoid plunger travel.

e. Insert Tool J–28696–10, BT–7928, or equivalent, in the access hole in the air horn, and adjust the rich mixture stop screw to obtain $^{1}/8$ in. (3mm) total solenoid plunger travel.

13. With the solenoid plunger travel correctly set, install the plugs supplied in the service kit into the air horn to retain the setting and prevent fuel vapor loss:

    a. Install the plug, hollow end down, into the access hole to the lean mixture (solenoid) screw and use a suitably sized punch to drive the plug into the air horn until top of plug is even with the lower edge of the hole chamber.

    b. In a similar manner, install the plug over the rich mixture screw access hole and drive the plug into place so that the tip of the plug is $^{1}/16$ in. (1.5mm) below the surface of the air horn casting.

14. Install the Idle Air Bleed Valve as follows:

    a. Lightly coat 2 new O-ring seals with automatic transmission fluid, to aid in their installation on the idle air bleed valve body. The thick seal goes in the upper groove and the thin seal goes in the lower groove.

    b. Install the idle air bleed valve in the air horn, making sure that there is proper thread engagement.

    c. Insert idle air bleed valve gauging Tool J–33815–2, BT–8353B, or equivalent, in throttle side D-shaped vent hole of the air horn casting. The upper end of the tool should be positioned over the open cavity next to the idle air bleed valve.

    d. Hold the gauging tool down lightly so that the solenoid plunger is against the solenoid stop, then adjust the idle air bleed valve so that the gauging tool will pivot over and just contact the top of the valve.

    e. Remove the gauging tool.

    f. The final adjustment of the idle air bleed valve is made on the vehicle to obtain idle mixture control.

15. Perform the Air Valve Spring Adjustment and Choke coil Lever Adjustment as previously described.

16. Install the cover and coil assembly in the choke housing, as follows:

    a. Place the cam follower on the highest step of the fast idle cam.

    b. Install the thermostatic cover and coil assembly in the choke housing, making sure the coil tang engages the inside coil pickup lever. Ground contact for the electric choke is provided by a metal plate located at the rear of the choke cover assembly. DO NOT install a choke cover gasket between the electric choke assembly and the choke housing.

    c. A choke cover retainer kit is required to attach the choke cover to the choke housing. Follow the instructions found in the kit and install the proper retainer and rivets using a suitable blind rivet tool.

    d. It may be necessary to use an adapter (tube) if the installing tool interferes with the electrical connector tower on the choke cover.

17. Install the hose on the front vacuum brake and on the tube on the float bowl.
18. Position the idle speed solenoid and bracket assembly on the float bowl, retaining it with 2 large countersunk screws.
19. Perform the Choke Rod-Fast Idle Cam Adjustment, Primary (Front) Vacuum Break Adjustment, Air Valve Rod Adjustment - Front, Unloader Adjustment and the Secondary Lockout Adjustment as previously described.
20. Reinstall the carburetor on the vehicle with a new flange gasket.

THROTTLE BODY FUEL INJECTION (TBI) SYSTEM {ewc MVIMAGE, MVIMAGE, ! nexttopicarrow.bmp}

THROTTLE BODY FUEL INJECTION (TBI) SYSTEM

Relieving Fuel System Pressure

2.5L ENGINE

1. Loosen the fuel filler cap.
2. Unplug the fuel pump wiring at the fuel tank or from the fuse block, located in the passenger compartment, remove the fuse labeled, **Fuel Pump**.
3. Start the engine.

   Ä The engine will start and run, for a short period of time, until the remaining fuel is used up.
4. Engage the starter, a few more times, to relieve any remaining pressure.
5. Turn the ignition switch to **OFF** and install the fuel pump fuse into the fuse block or plug in the fuel pump wiring connector.
6. Tighten the fuel filler cap.

4.3L Engine

Loosen the fuel filler cap and allow the engine to sit for 5–10 minutes; this will allow the orifice (in the fuel system) to bleed off the pressure.

Electric Fuel Pump {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Electric Fuel Pump

Ü See figure 25

The electric fuel pump is attached to the fuel sending unit, located in the fuel tank.

REMOVAL & INSTALLATION

Because removal and installation of the fuel pump requires the removal of the fuel tank, refer to the procedures in the fuel tank portion of this section.

Figure 25.
The fuel pump and fuel gauge sender are incorporated in one unit mounted in the fuel tank

{ewc GSMVIMG,GSMVIMG, !88265g28.bmp}

88265g28

TESTING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Fuel System

TESTING

Flow Test

1. Relieve the fuel system pressure.
2. Remove the fuel pump feed line from the fuel inlet on the throttle body.
3. Place the fuel line in a clean container.
4. Turn the ignition switch **ON**; approximately $^{1}/2$ pint of the fuel should be delivered in 15 seconds.
5. If the fuel flow is below minimum, inspect the fuel system for restrictions; if no restrictions are found, replace the fuel pump.

Pressure Test {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Fuel System

Pressure Test

Ü See figure 26

Ä The following procedure requires the use of a GM Fuel Pressure Gauge tool No. J–29658–A or equivalent.

1. Properly relieve the fuel system pressure.
2. If necessary for access, remove the air cleaner assembly and plug the vacuum port(s).
3. Disconnect the flexible fuel supply line, located in the engine compartment between the fuel filter and throttle body.
4. Install a fuel pressure gauge, such as J-29658 or equivalent, in-line between the fuel filter and throttle body unit (between the steel line and flexible hose). If necessary use an adapter or Tee fitting in order to connect the gauge and complete the fuel circuit.

   Ä A Tee fitting may be fabricated for this purpose. Depending on the fuel pressure gauge, short lengths of steel tubing, appropriately sized flare nuts and a flare nut adapter may be used.
5. If the engine will run, start the engine and allow it to run at normal idle speed. The fuel pressure should be 9–13 psi (62–90 kPa).
6. If the engine does not run, turn the ignition **ON**, but do not attempt to start the engine. Listen for the fuel pump to run. Within 2 seconds of turning the ignition **ON**, pressure should be 9–13 psi (62–90 kPa). If necessary, cycle the ignition **OFF**, then **ON** again, in order to build up system pressure.
7. If the fuel pump did not run or system pressure did not reach specification, locate the fuel pump test connector. The test connector is usually found on the driver's side of the engine compartment (on or near the fender), with a single wire (usually red) leading from the relay to the connector. Using a jumper wire, apply battery voltage to the test connector in order to energize and run the fuel pump. The pump should run and produce fuel pressure of 9–13 psi (62–90 kPa). If the pump does not run, check the relay and fuel pump wiring.
8. If the pump pressure was lower than specification, first check for a restricted fuel line or filter and replace, as necessary. If no restrictions can be found, restrict the fuel supply line between the pressure gauge and the TBI unit (a flexible hose may be temporarily clamped to produce the restriction), then apply voltage to the test connector again. If pressure is now above 13 psi (90 kPa), replace the faulty pressure regulator. If pressure remains below 9 psi (62 kPa), then the problem is located in the fuel tank (the fuel pump, coupling hose or inlet filter).
9. If during Step 7, the pressure was higher than specification, disengage the injector connector, then disconnect the fuel return line flexible hose which connects the line from the throttle body to the tank line. Attach a $^5/16$ ID flex hose to the fuel line from the throttle body and place the other end into an approved gasoline container. Cycle the ignition in order to energize the fuel pump and watch system pressure. If pressure is still higher, check for restrictions in the throttle body return line. Repair or replace the line if restrictions are found or replace the faulty pressure regulator if no other causes of high pressure are identified. If fuel pressure is normal only with the flexible hose-to-fuel tank line out of the circuit, check that line for restrictions and repair or replace, as necessary.
10. Once the test is completed, depressurize the fuel system and remove the gauge.
11. Secure the fuel lines and check for leaks.
12. If removed, install the air cleaner assembly.

Figure 26.

Fuel system pressure testing

{ewc GSMVIMG,GSMVIMG, !88265g33.bmp}

88265g33

Fuel Pump Relay {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Fuel Pump Relay

Ü See figure 27

The fuel pump relay is mounted on the right-side of the engine compartment. Check for loose electrical connections; no other service is possible, except replacement.

Figure 27.
Fuel pump relay location

{ewc GSMVIMG,GSMVIMG, !88265g34.bmp}

88265g34

REMOVAL & INSTALLATION

1. Disconnect the negative battery cable from the battery.
2. Disconnect the relay/electrical connector assembly from the bracket.
3. Pull the fuel pump relay from the electrical connector.

Throttle Body {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Throttle Body

Ü See figures 28, 29, 30, 31, 32

The Model 300 throttle body, used on the 2.5L engine (1985–87), is a single barrel, single injector type. The 1988–90 2.5L engine is equipped with a model 700 single barrel, single injector type. The Model 220 throttle body, used on the 4.3L engine (1986–on), is a dual barrel, twin injector type. The operation of all three types are basically the same. This system is not to be confused with the direct port injection Central Multiport Fuel Injection (CMFI) or Central Sequential Multiport Fuel Injection (CSFI) systems.

Both throttle bodies are constantly monitored by the ECM to produce a 14.7:1 air/fuel ratio, which is vital to the catalytic converter operation.

Figure 28.
Operation of the TBI unit—Model 300
{ewc GSMVIMG,GSMVIMG, !88265g36.bmp}

88265g36

Figure 29.
Exploded view of the Model 300 throttle body—2.5L engine
{ewc GSMVIMG,GSMVIMG, !88265g37.bmp}

88265g37

Figure 30.
Exploded view of the Model 220 throttle body—4.3L engine
{ewc GSMVIMG,GSMVIMG, !88265g38.bmp}

88265g38

Figure 31.
Operation of the TBI unit—Model 700
{ewc GSMVIMG,GSMVIMG, !88265g39.bmp}

88265g39

Figure 32.
Exploded view of the Model 700 throttle body—2.5L engine
{ewc GSMVIMG,GSMVIMG, !88265g40.bmp}

88265g40

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Fuel System

REMOVAL & INSTALLATION

Ü See figures 33, 34, 35, 36, 37, 38, 39, 40, 41, 42

****Caution**

Before removing any component of the fuel system, be sure to reduce the fuel pressure in the system. The pressure regulator contains an orifice in the fuel system; when the engine is turned Off, the pressure in the system will bleed down within a few minutes.

1. Relieve the pressure in the fuel system.
2. Remove the air cleaner. Disconnect the negative battery cable from the battery.
3. Disconnect the electrical connectors from the idle air control valve, the throttle position sensor and the fuel injector(s).
4. Remove the throttle return spring(s), the cruise control (if equipped) and the throttle linkage.
5. Label and disconnect the vacuum hoses from the throttle body.
6. Place a rag (to catch the excess fuel) under the fuel line-to-throttle body connection, then disconnect the fuel line from the throttle body.
7. Remove the attaching hardware, the throttle body-to-intake manifold bolts, the throttle body and the gasket.

   Ä Be sure to place a cloth in the intake manifold to prevent dirt from entering the engine.

8. Using a gasket remover (if necessary), clean the gasket mounting surfaces.

Figure 33.
Replacing the throttle body—2.5L engine

{ewc GSMVIMG,GSMVIMG, !88265g41.bmp}

88265g41

Figure 34.
Replacing the throttle body—4.3L engine

{ewc GSMVIMG,GSMVIMG, !88265g42.bmp}

88265g42

Figure 35.
Both the throttle cable and the cruise control linkage need to removed

{ewc GSMVIMG,GSMVIMG, !88265p86.bmp}

88265p86

Figure 36.
Use a backup wrench and a flare wrench when disconnection the fuel lines

{ewc GSMVIMG,GSMVIMG, !88265p87.bmp}

88265p87

Figure 37.
Some fuel may spill out of the line connections, so place a rag under the fittings to catch it

{ewc GSMVIMG,GSMVIMG, !88265p88.bmp}

88265p88

Figure 38.

Always replace the fuel line O-rings

{ewc GSMVIMG,GSMVIMG, !88265p89.bmp}

88265p89

Figure 39.
Remove the 3 bolts holding the throttle body

{ewc GSMVIMG,GSMVIMG, !88265p90.bmp}

88265p90

Figure 40.
Lift the throttle body straight up and be careful not to drop anything into the manifold

{ewc GSMVIMG,GSMVIMG, !88265p91.bmp}

88265p91

Figure 41.
Slide the electrical connection from the groove

{ewc GSMVIMG,GSMVIMG, !88265p92.bmp}

88265p92

Figure 42.
Always replace the throttle body base gasket, otherwise a vacuum leak may occur

{ewc GSMVIMG,GSMVIMG, !88265p93.bmp}

88265p93

To install:

9. Use a new gasket. Install the gasket, throttle body and mounting bolts. Torque the throttle body-to-intake manifold nuts/bolts to 13 ft. lbs. (17 Nm).
10. Connect the fuel lines to the throttle body.
11. Connect the vacuum hoses to the throttle body.
12. Install the throttle return spring(s), the cruise control (if equipped) and the throttle linkage.
13. Depress the accelerator pedal to the floor and release it, to see if the pedal returns freely.
14. Connect the electrical connectors to the idle air control valve, the throttle position sensor and the fuel injector(s).
15. Install the air cleaner. Connect the negative battery cable to the battery.
16. Start the engine, check for leaks and proper operation.

ADJUSTMENTS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Fuel System

ADJUSTMENTS

Idle Speed and Mixture

1985–87 2.5L ENGINE

Ü See figure 43

> **Ä The following procedures require the use a tachometer, GM tool No. J–33047 or equivalent, GM Torx® Bit No. 20, silicone sealant, a 5/32 in. drill bit, a prick punch and a 1/16 in. pin punch.**

The throttle stop screw, used in regulating the minimum idle speed, is adjusted at the factory and is not necessary to perform. This adjustment should be performed ONLY when the throttle body has been replaced.

> **Ä The factory supplied replacement throttle body assembly will have the minimum idle adjusted at the factory.**

Figure 43.
Installing tool J–33047 to adjust the idle speed—Model 300

{ewc GSMVIMG,GSMVIMG, !88265g52.bmp}

88265g52

1. Remove the air cleaner and the gasket. Be sure to plug the THERMAC vacuum port (air cleaner vacuum line-to-throttle body) on the throttle body.
2. Remove the throttle valve cable from the throttle control bracket to provide access to the minimum air adjustment screw.
3. Using the manufacturer's instructions, connect a tachometer to the engine.
4. Remove the electrical connector from the Idle Air Control (IAC) valve, located on the throttle body.
5. To remove the throttle stop screw cover, perform the following procedures:
    a. Using a prick punch, mark the housing at the top over the center line of the throttle stop screw.
    b. Using a 5/32 in. drill bit, drill (on an angle) a hole through the casting to the hardened cover.
    c. Using a 1/16 in. pin punch, place it through the hole and drive out the cover to expose the throttle stop screw.
6. Place the transmission in Park (AT) or Neutral (MT), start the engine and allow the idle speed to stabilize.
7. Using the GM tool No. J–33047 or equivalent, install it into the idle air passage of the throttle body; be sure that the tool is fully seated in the opening and no air leaks exist.
8. Using the GM Torx® Bit No. 20, turn the throttle stop screw until the engine speed is 475–525 rpm (AT in Park or Neutral) or 750–800 rpm (MT in Neutral).
9. With the idle speed adjusted, stop the engine, remove the tool No. J–33047 from the throttle body.
10. Reconnect the Idle Air Control (IAC) electrical connector.
11. Using silicone sealant or equivalent, cover the throttle stop screw.
12. Reinstall the gasket and the air cleaner assembly.

1985-87 4.3L ENGINE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Fuel System

1985–87 4.3L ENGINE

Ä The following procedure requires the use of a tachometer, a prick punch, a 5/32 in. drill bit, a 1/16 in. pin punch, a grounding wire and silicone sealant.

1. Remove the air cleaner and the gasket.
2. Remove the throttle stop screw cover by performing the following procedures:
   a. Using a prick punch, mark the housing at the top over the center line of the throttle stop screw.
   b. Using a 5/32 in. drill bit, drill (on an angle) a hole through the casting to the hardened cover.
   c. Using a 1/16 in. pin punch, place it through the hole and drive out the cover to expose the throttle stop screw.

Ä The following adjustment should be performed ONLY when the throttle body assembly has been replaced; the engine should be at normal operating temperatures before making this adjustment.

3. With the Idle Air Control (IAC) connected, ground the diagnostic terminal of the Assembly Line Communications Link (ALCL) connector.

Ä The Assembly Line Communications Link (ALCL) connector is located in the engine compartment on the left side firewall.

4. Turn the ignition switch **ON** but DO NOT start the engine. Wait 30 seconds, this will allow the IAC valve pintle to extend and seat in the throttle body.
5. With the ignition switch turned On, disconnect the Idle Air Control (IAC) valve electrical connector.
6. Remove the ground from the Diagnostic Terminal ALCL connector and start the engine.
7. Adjust the idle stop screw to obtain 400–450 rpm (AT in Drive).
8. Turn the ignition **OFF** and reconnect the IAC valve electrical connector.
9. Using silicone sealant or equivalent, cover the throttle stop screw.
10. Reinstall the gasket and the air cleaner assembly.

1988-90 2.5L AND 1988-on 4.3L ENGINES {ewc MVIMAGE, MVIMAGE, ! nexttopicarrow.bmp}

1988–90 2.5L AND 1988–on 4.3L ENGINES

Ü See figure 44

Before performing this check, there should be no codes displayed, idle air control system has been checked and ignition timing is correct.

1. CONTROLLED IDLE SPEED CHECK: set the parking brake and block the wheels.
2. Connect a SCAN tool to the ALDL connector with the tool in the OPEN MODE.
3. Start the engine and bring it to normal operating temperature.
4. Check for correct state of Park/Neutral switch on the SCAN tool.
5. If the idle and IAC counts are not within specifications:
   - 2.5L MT in **NEUTRAL** 800 rpm, 5–20 IAC valve counts and in the closed loop.
   - 2.5L AT in **DRIVE** 750 rpm, 5–20 IAC valve counts and in the closed loop.
   - 4.3L MT in **NEUTRAL** 500–550 rpm, 2–12 IAC valve counts and in the closed loop.
   - 4.3L AT in **DRIVE** 500–550 rpm, 10–25 IAC valve counts and in the closed loop.
6. MINIMUM IDLE AIR RATE CHECK: check the controlled idle speed and perform the idle air control system check first.
7. With the IAC valve connected, ground the diagnostic **A** and **B** terminals of the ALDL connector.
8. Turn **ON** the ignition with engine NOT running, wait for ten seconds to allow the IAC valve to stabilize. Remove the ground from the ALDL and disconnect the IAC valve.
9. Connect the SCAN tool to the ALDL connector and place in the open mode. If a SCAN tool is not available, connect a tachometer to the engine.
10. Start the engine and allow to stabilize.
11. Check the rpm using the specifications.
12. If the minimum idle rate is not within specifications perform the following:
    a. Remove the idle stop screw plug by piercing it with an awl, then apply leverage to remove the plug.
    b. Adjust the screw to the specified rpm.
    c. Turn the engine OFF, disconnect the SCAN tool, reconnect the IAC valve and cover the idle stop screw with silicone sealer.
13. Install the air cleaner, adapter and gasket.

Figure 44.
Removing the idle stop screw plug—Model 700
{ewc GSMVIMG,GSMVIMG, !88265g53.bmp}

88265g53

Fuel Injectors {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Fuel System

Fuel Injectors

REMOVAL & INSTALLATION

Ü See figures 45, 46, 47, 48

> ****Caution**
> **When removing the injector(s), be careful not to damage the electrical connector pins (on top of the injector), the injector fuel filter and the nozzle. The fuel injector is serviced as a complete assembly ONLY. It is an electrical component and should not be immersed in any kind of cleaner.**

1. Remove the air cleaner. Disconnect the negative battery cable from the battery.
2. Refer to the Fuel Pressure Relief procedures in this section and relieve the fuel pressure.
3. At the injector connector, squeeze the 2 tabs together and pull it straight up.
4. Remove the fuel meter cover and leave the cover gasket in place.
5. Using a small pry bar or tool No. J–26868, carefully lift the injector until it is free from the fuel meter body.
6. Remove the small O-ring from the nozzle end of the injector. Carefully rotate the injector's fuel filter back-and-forth to remove it from the base of the injector.
7. Discard the fuel meter cover gasket.
8. Remove the large O-ring and back-up washer from the top of the counterbore of the fuel meter body injector cavity.

Figure 45.
Gently pry the injector out of the bore—Model 220 (Model 300 is similar)

{ewc GSMVIMG,GSMVIMG, !88265g43.bmp}

88265g43

Figure 46.
Replace the O-rings and washers whenever the injector is removed—Model 220 (Model 300 is similar)

{ewc GSMVIMG,GSMVIMG, !88265g44.bmp}

88265g44

Figure 47.
Gently pry the injector out of the bore—Model 700

{ewc GSMVIMG,GSMVIMG, !88265g45.bmp}

88265g45

Figure 48.
Replace the O-rings on the injector body when removed—Model 220, 4.3L engine shown

{ewc GSMVIMG,GSMVIMG, !88265p80.bmp}

88265p80

To install:

9. Lubricate the O-rings with automatic transmission fluid and push the fuel injector into the cavity.
10. Install a new fuel meter cover gasket and install the cover (Model 300 and 220). Install the

retainer and screw (Model 700).

11. Connect the injector electrical connector.
12. Install the air cleaner. Connect the negative battery cable to the battery.
13. Start the engine, check for leaks and proper operation.

Fuel Meter Cover {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Fuel Meter Cover

REMOVAL & INSTALLATION

Ü See figures 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60

Ä The fuel meter cover does not have to be removed to replace the single fuel injector for the Model 700 throttle body (1987–90 2.5L engine). For the Model 220 and 300, the fuel meter cover does have to be removed to replace the injector.

1. Remove the air cleaner. Disconnect the negative battery cable from the battery.
2. At the injector electrical connector, squeeze the 2 tabs together and pull it straight up.
3. Remove the fuel meter-to-fuel meter body screws and lockwashers.

   Ä When removing the fuel meter cover screws, note the location of the two short screws.

4. Remove the fuel meter cover and discard the gasket.

To install:

5. Use a new gasket and install the injector if removed.
6. Install the fuel meter cover and torque the screws to 30 inch lbs. (4.0 Nm).
7. Reconnect the injector electrical connector and negative battery cable.
8. Start the engine, check for leaks and proper operation.

Figure 49.
Removing the fuel meter cover from the throttle body—Model 300 (Model 220 is similar)

{ewc GSMVIMG,GSMVIMG, !88265g46.bmp}

88265g46

Figure 50.
The throttle body can be accessed once the engine cover and air cleaner have been removed

{ewc GSMVIMG,GSMVIMG, !88265p74.bmp}

88265p74

Figure 51.
Remove the adapter ring and disconnect from the breather hose

{ewc GSMVIMG,GSMVIMG, !88265p75.bmp}

88265p75

Figure 52.
Unplug the injector electrical connectors

{ewc GSMVIMG,GSMVIMG, !88265p76.bmp}

88265p76

Figure 53.
Use clean rags to block the throttle openings and prevent debris from dropping in the engine

{ewc GSMVIMG,GSMVIMG, !88265p77.bmp}

88265p77

Figure 54.

Remove the mounting screws from the meter body

{ewc GSMVIMG,GSMVIMG, !88265p78.bmp}

88265p78

Figure 55.
Lift the meter body up and off the injectors. The injectors can be removed at this point

{ewc GSMVIMG,GSMVIMG, !88265p79.bmp}

88265p79

Figure 56.
Check the condition of the gaskets. This one is torn and would leak fuel if reused

{ewc GSMVIMG,GSMVIMG, !88265p81.bmp}

88265p81

Figure 57.
The fuel pressure regulator can be removed from the meter cover

{ewc GSMVIMG,GSMVIMG, !88265p82.bmp}

88265p82

Figure 58.
The fuel pressure regulator diaphragm must be intact for proper operation

{ewc GSMVIMG,GSMVIMG, !88265p83.bmp}

88265p83

Figure 59.
Check the condition of the diaphragm and seating area before reassembly

{ewc GSMVIMG,GSMVIMG, !88265p84.bmp}

88265p84

Figure 60.
Exploded view of the fuel metering cover

{ewc GSMVIMG,GSMVIMG, !88265p85.bmp}

88265p85

Idle Air Control (IAC) Valve {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Idle Air Control (IAC) Valve

TESTING

Ü See figure 61

1. Disconnect the negative battery cable.
2. Test resistance between terminals A and B, then test between C and D.
3. If the resistance is nor 40–80 ohms, replace the IAC.
4. Connect the negative battery cable.

Figure 61.
View of the Idle Air Control (IAC) valve circuit
{ewc GSMVIMG,GSMVIMG, !88265gaa.bmp}

88265gaa

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Fuel System

REMOVAL & INSTALLATION

Ü See figures 62, 63

Ä The following procedure requires the use of the GM Removal tool No. J–33031 or equivalent.

1. From inside the vehicle, remove the engine cover.
2. Remove the air cleaner. Disconnect the negative battery terminal from the battery.
3. Disconnect the electrical connector from the idle air control valve.
4. Using a 1 $^{1}/4$ in. (approx. 32mm) wrench or the GM Removal tool No. J–33031, remove the idle air control valve (Model 220 and 300). Remove the two retaining screws and valve (Model 700).

****Caution**

Before installing a new idle air control valve, measure the distance that the valve extends (from the motor housing to the end of the cone); the distance should be no greater than 1 $^{1}/8$ in. (28mm). If it extends to far, damage will occur to the valve when it is installed. Push the valve pintle in slowly with finger pressure until the correct measurement is obtained.

To install:

5. Use a new gasket and the correct IAC replacement valve.
6. Install the valve and torque the thread mounted valve to 13 ft. lbs. (18 Nm) and the screw mounted valve to 28 inch lbs. (3.3 Nm). Use thread locking compound on the retaining screws before assembly.
7. Connect the valve and negative battery cable.
8. Start the engine and allow it to reach normal operating temperatures. Check for fuel leaks.
9. Turn the ignition **ON** for 5 seconds and **OFF** for 10 seconds to allow the IAC valve to reset.
10. The vehicle may have to driven a few miles before the IAC valve will return to normal.

Ä The ECM will reset the idle speed when the vehicle is driven at 30 mph (48 kph).

Figure 62.
Exploded view of the Idle Air Control (IAC) valves—Model 220 and 300

{ewc GSMVIMG,GSMVIMG, !88265g47.bmp}

88265g47

Figure 63.
Idle Air Control (IAC) valve—Model 700

{ewc GSMVIMG,GSMVIMG, !88265g48.bmp}

88265g48

CENTRAL MULTI-PORT FUEL INJECTION (CMFI) AND CENTRAL SEQUENTIAL FUEL INJECTION (CSFI) SYSTEMS {ewc MVIMAGE, MVIMAGE, ! nexttopicarrow.bmp}

CENTRAL MULTI-PORT FUEL INJECTION (CMFI) AND CENTRAL SEQUENTIAL FUEL INJECTION (CSFI) SYSTEMS

General Information

Ü See figures 64, 65, 66

The 4.3L (VIN W) engine is equipped with a Central Multi-port Fuel Injection (CMFI) and Central Sequential Fuel Injection (CSFI) systems. The system functions similarly to the TBI system in that an injection assembly (CMFI/CSFI unit) is centrally mounted on the engine intake manifold. The major differences come in the incorporation of a split (upper and lower) intake manifold assembly with a variable tuned plenum (using an intake manifold tuning valve) and the CMFI unit's single fuel injector which feeds 6 poppet valves (1 for each individual cylinder). On the Central Sequential Fuel Injection (CSFI) there are 6 injectors for 6 poppet valves. This allows sequential fuel injection to occur. Unless otherwise broken out, CMFI and CSFI will be dealt with as a single system.

The non-repairable CMFI/CSFI assembly or injection unit consists of a fuel meter body, gasket seal, fuel pressure regulator, fuel injector(s) and 6 poppet nozzles with fuel tubes. The assembly is housed in the lower intake manifold. Should a failure occur in the CMFI/CSFI assembly, the entire component must be replaced as a unit.

As with other fuel injection systems, all injection and ignition functions are controlled by the computer control module. The module accepts inputs from various sensors and switches, calculates the optimum air/fuel mixture and operates the various output devices to provide peak performance within specific emissions limits. The module will attempt to maintain the ideal air/fuel mixture of 14.7:1 in order to optimize catalytic converter operation. If a system failure occurs that is not serious enough to stop the engine, the module will illuminate the SERVICE ENGINE SOON light and will continue to operate the engine, although it may need to operate in a backup or fail-safe mode.

Figure 64.
CMFI air flow schematic

{ewc GSMVIMG,GSMVIMG, !88265g54.bmp}

88265g54

Figure 65.
Various CMFI engine components are mounted to the intake manifolds (the CMFI unit is located under the upper intake)

{ewc GSMVIMG,GSMVIMG, !88265g55.bmp}

88265g55

Figure 66.
CMFI assembly (CSFI is similar in concept)

{ewc GSMVIMG,GSMVIMG, !88265g57.bmp}

88265g57

Fuel is supplied to the injector through an electric fuel pump assembly which is mounted in the vehicle's fuel tank. The module provides a signal to operate the fuel pump though the fuel pump relay and oil pressure switch. The CMFI/CSFI unit internal pressure regulator maintains a system pressure of approximately 55–61 psi (380–420 kPa). When the injector is energized by the control module, an armature lifts allowing pressurized fuel to travel down the fuel tubes to the poppet valves. In the poppet valves, fuel pressure (working against the extension spring force) will cause the nozzle ball to open from its seat and fuel will flow from the nozzle. It takes approximately 51 psi (350 kPa) to force fuel from the poppet nozzle. Once the module de-energizes the injector, the armature will close, allowing fuel pressure in the tubes to drop and the spring force will close off fuel flow.

Other system components include a pressure regulator, an Idle Air Control (IAC) valve, a Throttle

Position (TP) sensor, Intake Air Temperature (IAT) sensor, Engine Coolant Temperature (ECT) sensor, a Manifold Absolute Pressure (MAP) sensor and an oxygen sensor.

The idle air control valve is a stepper motor that controls the amount of air allowed to bypass the throttle plate. With this valve the computer control module can closely control idle speed even when the engine is cold or when there is a high engine load at idle.

The computer module used on CMFI/CSFI vehicles has a learning capability which is used to provide corrections for a particular engine's condition. If the battery is disconnected to clear diagnostic codes, or for safety during a repair, the learning process must start all over again. A change may be noted in vehicle performance. In order to "teach" the vehicle, make sure the vehicle is at normal operating temperature, then drive at part throttle, under moderate acceleration and idle conditions, until normal performance returns.

OPERATING MODES {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

OPERATING MODES

Starting Mode

When the ignition switch is first turned **ON**, the fuel pump relay is energized by the module for 2 seconds in order to build system pressure. In the start mode, the computer module checks the ECT, IAT, TP sensor, MAP and crank signal in order to determine the best air/fuel ratio for starting. Ratios could range from 1.5:1 at approximately -33ºF (-36ºC), to 14.7:1 at 201ºF (94ºC).

Clear Flood Mode {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Clear Flood Mode

If the engine becomes flooded, it can be cleared by opening the accelerator to the full throttle position. When the throttle is open all the way and engine rpm is less than 600, the computer module will pulse the fuel injector at an air/fuel ratio of 16.5:1 while the engine is turning over in order to clear the engine of excess fuel. If throttle position is reduced below 65 percent, the module will return to the start mode.

Open Loop Mode {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Open Loop Mode

When the engine first starts and engine speed rises above 400 rpm, the computer module operates in the Open Loop mode until specific parameters are met. In Open Loop mode, the fuel requirements are calculated based on information from the MAP and ECT sensors. The oxygen sensor signal is ignored during initial engine operation because it needs time to warm up.

Closed Loop Mode {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Closed Loop Mode

When the correct parameters are met, the computer module will use O_2 sensor output and adjust the air/fuel mixture accordingly, in order to maintain a narrow band of exhaust gas oxygen concentration. When the module is correcting and adjusting fuel mixture based on the oxygen sensor signal along with the other sensors, this is known as feedback air/fuel ratio control. The computer module will shift into this Closed Loop mode when:

- Oxygen sensor output voltage is varied, indicating that the sensor has warmed up to operating temperature
- The ECT shows an engine coolant temperature above a specified level.
- The engine has been operating for a programmed amount of time.

Acceleration Mode {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Acceleration Mode

If the throttle position and manifold pressure is quickly increased, the module will provide extra fuel for smooth acceleration.

Deceleration Mode {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Fuel System

Deceleration Mode

As the throttle closes and the manifold pressure decreases, fuel flow is reduced by the module. If both conditions remain for a specific number of engine revolutions indicating a very fast deceleration, the module may decide fuel flow is not needed and stop the flow by temporarily shutting off the injectors.

Highway Fuel Mode (Semi-Closed Loop) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Fuel System

Highway Fuel Mode (Semi-Closed Loop)

The computer control module is programmed to enter a special highway mode to improve fuel economy. If the module senses the correct ECT, ignition control, canister purge activity and a constant engine speed, it will enter highway mode. During this operation, there will be very little adjustment of the long and short term fuel trims, also, the oxygen sensor values will usually read below 100 millivolts.

Decel Leanment Mode {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Decel Leanment Mode

The computer control module is programmed to further reduce emissions by leaning the fuel spray on deceleration. The module does this when a high MAP vacuum (low voltage or pressure) is sensed, BUT it should be noted that the module may do this when the vehicle is not moving. This mode of operation may be misdiagnosed as a lean condition. When diagnosing the control system using a scan tool with the transmission in Park, the oxygen sensor signal low (usually below 100 mV), and both fuel trim numbers around 128 counts, lower the engine speed to 1000 rpm. If the sensor and long term trim numbers respond normally, it is possible that the system was fooled into decel en-leanment operation. If the oxygen sensor and long term numbers do not respond at the lower rpm, there are other problems with the vehicle.

Battery Low Mode {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Fuel System

Battery Low Mode

If the computer module detects a low battery, it will increase injector pulse width to compensate for the low voltage and provide proper fuel delivery. It will also increase idle speed to increase alternator output and ignition dwell time to allow for proper engine operation.

Field Service Mode {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Field Service Mode

When the diagnostic terminal of the test connector is grounded with the engine running, the computer module will enter the Field Service Mode. If the engine is running in Open Loop Mode, the SERVICE ENGINE SOON Malfunction Indicator Lamp (MIL) will flash quickly, about $2^1/2$ times per second. When the engine is in Closed Loop Mode, the MIL will flash only about once per second. If the light stays **OFF** most of the time in Closed Loop, the engine is running lean. If the light is **ON** most of the time, the engine is running rich.

While the engine continues to operate in Field Service Mode certain conditions will apply:

- New trouble codes cannot be stored in computer memory.
- The closed loop timer is bypassed.

Fuel Pressure Relief {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Fuel Pressure Relief

Ü See figures 67, 68

Prior to servicing any component of the fuel injection system, the fuel pressure must relieved. If fuel pressure is not relieved, serious injury could result.

A Schrader valve is provided on this fuel system in order to conveniently test or release the fuel system pressure. A fuel pressure gauge and adapter will be necessary to connect the gauge to the fitting. The CMFI system covered here uses a valve located on the inlet pipe fitting, immediately before it enters the CMFI assembly (towards the rear of the engine).

1. Disconnect the negative battery cable to assure the prevention of fuel spillage if the ignition switch is accidentally turned **ON** while a fitting is still disconnected.
2. Loosen the fuel filter cap to release the fuel tank pressure.
3. Make sure the release valve on the fuel gauge is closed, then connect the fuel gauge to the pressure fitting located on the inlet fuel pipe fitting.

   Ä When connecting the gauge to the fitting, be sure to wrap a rag around the fitting to avoid spillage. After repairs, place the rag in an approved container.
4. Install the bleed hose portion of the fuel gauge assembly into an approved container, then open the gauge release valve and bleed the fuel pressure from the system.
5. When the gauge is removed, be sure to open the bleed valve and drain all fuel from the gauge assembly.

Figure 67.
Use a fuel pressure gauge with a bleed hose to relieve the fuel system pressure

{ewc GSMVIMG,GSMVIMG, !88265g29.bmp}

88265g29

Figure 68.
Fuel pressure connection

{ewc GSMVIMG,GSMVIMG, !88265g56.bmp}

88265g56

Electric Fuel Pump {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Electric Fuel Pump

The electric pump is attached to the fuel sending unit, located in the fuel tank.

TESTING

Ü See figure 67

1. Properly relieve the fuel system pressure.
2. Leave the gauge attached to the pressure fitting on the fuel inlet pipe.
3. If disconnected during the fuel pressure relief procedure, reconnect the negative battery cable.
4. If the engine will run, start the engine and allow it to run at normal idle speed. The fuel pressure should be 55–61 psi (380–420 kPa). Once the engine is at normal operating temperature, open the throttle quickly while noting fuel pressure; it should quickly approach 61 psi (420 kPa) if all components are operating properly (there is no need to proceed further). If the pressure was in specification before, but does not approach 61 psi (420 kPa) on acceleration, the pressure regulator in the CMFI/CSFI unit is faulty and the assembly should be replaced.
5. If the engine does not run, turn the ignition **ON**, but do not attempt to start the engine. Listen for the fuel pump to run. Within 2 seconds of turning the ignition **ON** pressure should be 55–61 psi (380–420 kPa) while the pump is running. Once the pump stops, pressure may vary by several pounds, then it should hold steady. If the pressure does not hold steady, wait 10 seconds and repeat this step, but pinch the fuel pressure line flexible hose and watch if the pressure holds. If it still does not hold, the CMFI/CSFI unit should be replaced. If the pressure holds with the pressure line pinched, check for a partially disconnected fuel dampener (pulsator) or faulty in-tank fuel pump.
6. If the fuel pump did not run or system pressure did not reach specification, locate the fuel pump test connector. The test connector is usually found on the driver's side of the engine compartment (on or near the fender), with a single wire (usually red) leading from the relay to the connector. Using a 10 amp fused jumper wire, apply battery voltage to the test connector in order to energize and run the fuel pump. The pump should run and produce fuel pressure of 55–61 psi (380–420 kPa). If the pump does not run, check the relay and fuel pump wiring.
7. If the pump pressure was lower than specification, first check for a restricted fuel line, filter or a disconnected fuel pulse dampener (pulsator) and repair/replace, as necessary. If no restrictions can be found, restrict the flexible fuel return line (by gradually pinching it) until the pressure rises above 61 psi (420 kPa), but DO NOT allow pressure to exceed 75 psi (517 kPa). If the fuel pressure rises above specification with the return line restricted, then the pressure regulator is faulty and the CMFI assembly should be replaced. If pressure still does not reach specification, check for a faulty fuel pump, partially disconnected fuel pulse dampener (pulsator), partially restricted pump strainer or an incorrect pump.
8. If during the previous steps, the fuel pressure was higher than specification, relieve the system pressure, then disconnect the engine compartment fuel return line. Attach a $^{5}/16$ ID flex hose to the fuel line from the throttle body and place the other end into an approved gasoline container. Cycle the ignition in order to energize the fuel pump and watch system pressure. If pressure is still higher, check for restrictions in the line between the pressure regulator and the point where it was disconnected. Repair or replace the line if restrictions are found or replace the CMFI/CSFI assembly with the faulty internal pressure regulator if no other causes of high pressure are identified. If fuel pressure is normal only with the rest of the return line out of the circuit, check that remaining line for restrictions and repair or replace, as necessary.

9. Once the test is completed, depressurize the fuel system and remove the gauge.

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Fuel System

REMOVAL & INSTALLATION

Removal and installation of the fuel pump and sending unit assembly requires the removal of the fuel tank. Please refer to the procedures later in this section.

Fuel Pump Relay {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Fuel Pump Relay

For CMFI/CSFI vehicles, the fuel pump relay is normally found in the convenience center, located under the center of the dashboard.

If a problem is suspected, first check for loose electrical connections; no other service is possible, except replacement.

REMOVAL & INSTALLATION

Ü See figure 69

1. Disconnect the negative battery cable.
2. Remove the retainer, if equipped.
3. Disengage the relay electrical connector.
4. Remove the relay by depressing the bracket clip at the rear of the relay, or removing the bolts from the retaining bracket, as applicable.
5. If necessary, use a new relay, then reverse the removal procedures.

Figure 69.
Common fuel pump relay mounting—CMFI/CSFI vehicles

{ewc GSMVIMG,GSMVIMG, !88265g58.bmp}

88265g58

CMFI Assembly {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CMFI Assembly

REMOVAL & INSTALLATION

Except 1996

Ü See figures 70, 71

The CMFI assembly is mounted to the lower intake manifold. The upper intake manifold assembly must be removed for access. The CMFI assembly includes a fuel meter body, gasket seal, fuel pressure regulator, fuel injector and 6 poppet nozzles with fuel tubes. Should a failure occur in any components of the CMFI unit, the entire assembly must be replaced.

1. Remove the plastic cover and properly relieve the fuel system pressure.
2. Disconnect the negative battery cable, then remove the air cleaner and air inlet duct.
3. Disengage the wiring harness from the necessary upper intake components including:
   - Throttle Position (TP) sensor
   - Idle Air Control (IAC) motor
   - Manifold Absolute Pressure (MAP) sensor
   - Intake Manifold Tuning Valve (IMTV)
4. Disengage the throttle linkage from the upper intake manifold, then remove the ignition coil.
5. Disconnect the PCV hose at the rear of the upper intake manifold, then tag and disengage the vacuum hoses from both the front and rear of the upper intake manifold.
6. Remove the upper intake manifold bolts and studs, making sure to note or mark the location of all studs to assure proper installation. Remove the upper intake manifold from the engine.
7. Disengage the injector wiring harness connector at the CMFI assembly.
8. Remove and discard the fuel fitting clip.
9. Disconnect the fuel inlet and return tube and fitting assembly. Discard the old O-rings.
10. Squeeze the poppet nozzle locktabs together while lifting each nozzle out of the casting socket. Once all 6 nozzles are released, carefully lift the CMFI assembly out of the casting.

Figure 70.
Exploded view of the upper and lower intake manifolds and the CMFI system components

{ewc GSMVIMG,GSMVIMG, !88265g59.bmp}

88265g59

Figure 71.
Upper intake manifold torque sequence

{ewc GSMVIMG,GSMVIMG, !88265g60.bmp}

88265g60

To install:

11. Align the CMFI assembly grommet with the casting grommet slots and push downward until it is seated in the bottom guide hole.

****Caution**
To reduce the risk of fire and personal injury, be ABSOLUTELY SURE that the poppet nozzles are firmly seated and locked into their casting

sockets. An unlocked poppet nozzle could work loose from its socket resulting in a dangerous fuel leak.

12. Carefully insert the poppet nozzles into the casting sockets. Make sure they are FIRMLY SEATED and locked into the casting sockets.
13. Position new O-ring seals (lightly coated with clean engine oil), then connect the fuel inlet and return tube and fitting assembly.
14. Install a new fuel fitting clip.
15. Temporarily connect the negative battery cable, then pressurize the fuel system by cycling the ignition switch **ON** for 2 seconds, then **OFF** for 10 seconds and repeating, as necessary. Once the fuel system is pressurized, check for leaks.
16. Disconnect the negative battery cable.
17. Position a new upper intake manifold gasket on the engine, making sure the green sealing lines are facing upward.
18. Install the upper intake manifold being careful not to pinch the fuel injector wires between the manifolds.
19. Install the manifold retainers, making sure the studs are properly positioned, then tighten them using the proper sequence to 124 inch lbs. (14 Nm).
20. Connect the PCV hose to the rear of the upper intake manifold and the vacuum hoses to both the front and rear of the manifold assembly.
21. Connect the throttle linkage to the upper intake, then install the ignition coil.
22. Engage the necessary wiring to the upper intake components including the TP sensor, IAC motor, MAP sensor and the IMTV.
23. Install the plastic cover, the air cleaner and air inlet duct.
24. Connect the negative battery cable.

1996 CSFI {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Fuel System

1996 CSFI

Ü See figures 72, 73, 74

The 1996 4.3L engine is equipped with a sequential version of CMFI. It is very similar to the standard non-sequential CMFI except that there is a separate injector for each cylinder. This allows each cylinder to receive a timed pulse of fuel exactly when needed.

1. Clean the upper manifold area and fuel meter body area before disassembly to help prevent dirt from entering the air intake tract when the manifold is removed.
2. Disconnect the negative battery cable. Relieve the fuel system pressure.
3. Disconnect the wiring from the fuel meter body.
4. Remove the fuel inlet and return pipes from the fuel meter body and upper manifold. Keep dirt from falling into the now open fuel ports on the meter body.
5. Remove the upper manifold from the lower section. The air inlet tract is now open to contamination, so stuff some rags into the openings to prevent dirt from falling in.
6. Mark the poppet valves relative to their cylinders. This will prevent mixing them up during installation.
7. Release the poppet valves from the lower manifold by squeezing the tabs together and pulling out.
8. Release the fuel meter body from the lower manifold by unlocking the tabs from the bracket and removing the bolts.
9. Pull up on the fuel meter body to remove it from the manifold.

To install:

10. Install the fuel meter body and tighten the bolts to 88 inch lbs. (10.0 Nm). Make sure the body has locked all the tabs in place.
11. Install the poppet valves into the bores in the same locations as they were removed. Be sure the tabs lock into place or fuel leakage will occur.
12. Install the upper intake manifold electrical connector.
13. Install new O-rings on the fuel lines. Install the fuel lines on the manifold and tighten the connections to 22 ft. lbs. (30.0 Nm).
14. Connect the negative battery cable. Turn the ignition switch **ON** for 2 seconds, **OFF** for 10 seconds, **ON** for 2 seconds and then **OFF** again. Check for leaks from the fuel connections. Fix as necessary.
15. Disconnect the negative battery cable and the fuel lines.
16. Install the upper intake manifold.
17. Connect the fuel lines and check the fuel meter body electrical connection.
18. Connect the negative battery cable.

Figure 72.
Exploded view of the CSFI system components

{ewc GSMVIMG,GSMVIMG, !88265g61.bmp}

88265g61

Figure 73.
The CSFI unit mounts to the lower manifold

{ewc GSMVIMG,GSMVIMG, !88265g62.bmp}

88265g62

Figure 74.
Exploded view of the CSFI components and manifolds

{ewc GSMVIMG,GSMVIMG, !88265g69.bmp}

88265g69

Throttle Body {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Throttle Body

This procedure is for the CSFI system. The CMFI system uses a throttle plate integral with the upper manifold.

REMOVAL & INSTALLATION

Ü See figures 75, 76

1. Disconnect the negative battery cable.
2. Remove the air inlet fastener and duct.
3. Disengage the Idle Air Control (IAC) valve and the Throttle Position Sensor (TPS) electrical connectors.
4. Disconnect the throttle and cruise control cables.
5. Disconnect the accelerator cable bracket bolts and nuts.
6. Disengage the wiring harness fastener nut.
7. Unfasten the throttle body retaining nuts and remove the throttle body.
8. Remove and discard the flange gasket.
9. Clean both gasket mating surfaces.

   Ä When cleaning the old gasket from the machined aluminum surfaces be careful as sharp tools may damage the sealing surfaces

To install:

10. Install the new flange gasket and the throttle body assembly.
11. Tighten the throttle body attaching nuts to 18 ft. lbs. (25 Nm).
12. Install the accelerator cable bracket bolts and nuts and tighten to 18 ft. lbs (25 Nm).
13. Connect the throttle and cruise control cables.
14. Engage the IAC valve and the TPS electrical connectors.
15. Install the air inlet fastener and duct. Connect the negative battery cable.

Figure 75.
These 3 long bolts or studs hold the throttle body to the upper manifold

{ewc GSMVIMG,GSMVIMG, !88265g70.bmp}

88265g70

Figure 76.
Make sure the gasket is in place while installing the throttle body otherwise air leaks can occur

{ewc GSMVIMG,GSMVIMG, !88265g71.bmp}

88265g71

CSFI Fuel Injectors {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Fuel System

CSFI Fuel Injectors

REMOVAL & INSTALLATION

1. Disconnect the negative battery cable.
2. Relieve the fuel system pressure.
3. Disengage the fuel meter body electrical connection and the fuel feed and return hoses from the engine fuel pipes.
4. Remove the upper manifold assembly.
5. Tag and remove the poppet nozzle out of the casting socket.
6. Remove the fuel meter body by releasing the locktabs.

   Ä Each injector is calibrated. When replacing the fuel injectors, be sure to replace it with the correct injector.

7. Disassemble the lower hold-down plate and nuts.
8. While pulling the poppet nozzle tube downward, push with a small screwdriver down between the injector terminals and remove the injectors.

To install:

9. Install the fuel meter body assembly into the intake manifold and tighten the fuel meter bracket retainer bolts to 88 inch. lbs. (10 Nm).

   ****Caution**
   To reduce the risk of fire or injury ensure that the poppet nozzles are properly seated and locked in their casting sockets

10. Install the fuel meter body into the bracket and lock all the tabs in place.
11. Install the poppet nozzles into the casting sockets.
12. Engage the electrical connections and install new O-ring seals on the fuel return and feed hoses.
13. Install the fuel feed and return hoses and tighten the fuel pipe nuts to 22 ft. lbs. (30 Nm).
14. Connect the negative battery cable.
15. Turn the ignition **ON** for 2 seconds and then turn it **OFF** for 10 seconds. Again turn the ignition **ON** and check for leaks.
16. Install the manifold plenum.

TESTING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Fuel System

TESTING

Ü See figure 77

Ä This test requires the use of Fuel Injector Tester J 39021 or its equivalent.

1. Disconnect the fuel injector harness and attach a noid light in order to test for injector pulse.
2. With the engine cool and the ignition turned **OFF**, install the fuel pressure gauge to the fuel pressure connection. Wrap a shop towel around the fitting while connecting the gauge to prevent spillage.
3. Turn **ON** the ignition and record the fuel gauge pressure with the pump running.
4. Turn **OFF** the ignition. Pressure should drop and hold steady at this point.
5. To perform this test, set the selector switch to the balance test 2.5 amp position.
6. Turn the injector **ON** by depressing the button on the injector tester. Note this pressure reading the instant the gauge needle stops.
7. Repeat the balance test on the remaining injectors and record the pressure drop on each.
8. Start the engine to clear fuel from the intake. Retest the injectors that appear faulty. Any injector that has a plus or minus 1.5 psi (10 kPa) difference from the other injectors is suspect.

Figure 77.
Fuel injector testers can be purchased or sometimes rented

{ewc GSMVIMG,GSMVIMG, !tccs5p03.bmp}

tccs5p03

Fuel Pressure Regulator {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Fuel Pressure Regulator

This procedure is for the CSFI system as the CMFI system uses an integral fuel pressure regulator. The CSFI uses a replaceable unit mounted on the CSFI assembly.

REMOVAL & INSTALLATION

Ü See figures 78, 79

1. Disconnect the negative battery cable.
2. Relieve the fuel system pressure. Refer to the fuel system relief procedure in this section.
3. Remove the upper manifold assembly.
4. Remove the fuel pressure regulator vacuum tube.
5. Disassemble the fuel pressure regulator snapring retainer.
6. Remove the fuel pressure regulator assembly and the O-rings. Discard the O-rings, filter and back-up O-rings.

To install:

7. Lubricate the O-rings with clean engine oil and install as an assembly.
8. Install the fuel pressure regulator, attach the vacuum tube.
9. Install the snapring retainer.
10. Install the upper manifold assembly.
11. Connect the negative battery cable.

Figure 78.
The fuel pressure regulator is retained by this clip
{ewc GSMVIMG,GSMVIMG, !88265g72.bmp}

88265g72

Figure 79.
Replace the O-rings whenever the fuel pressure regulator is removed
{ewc GSMVIMG,GSMVIMG, !88265g73.bmp}

88265g73

Idle Air Control Valve {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Idle Air Control Valve

REMOVAL & INSTALLATION

Ü See figure 80

1. Disconnect the negative battery cable.
2. Disengage the electrical connector from the idle air control valve.
3. Loosen and remove the IAC valve retaining bolts, then remove the valve from the engine.

To install:

****Warning**
Before installing a new idle air control valve, measure the distance that the valve extends (from the motor housing to the end of the cone); the distance should be no greater than 1 1/8 in. (28mm). If it is extended too far, damage may occur to the valve when it is installed.

4. Measure the valve pintle extension. To retract the pintle on a NEW valve, use firm thumb pressure and, if necessary, rock the pintle with a slight side-to-side motion. BUT, if reinstalling a used valve on which the pintle is extended further than specification, an IAC tester MUST be used to electrically retract the pintle.

   Ä Do not attempt to physically retract a pintle on an IAC valve that has been in service, the force may damage the pintle threads. The force required to retract the pintle is only safe on NEW IAC valves.

5. Lightly coat the IAC valve O-ring with clean engine oil.
6. Inspect the retaining screw threads for threadlocking material. If there is no longer sufficient material on the threads, clean the threads and apply Loctite®262 or equivalent. DO NOT use a stronger compound or future bolt removal may be difficult.
7. Install the IAC valve and tighten the retaining bolts to 27 inch lbs. (3.0 Nm).
8. Engage the valve electrical connector.
9. Connect the negative battery cable.
10. Reset the IAC valve pintle: turn the ignition **ON** (engine NOT running) for 5 seconds, then turn the ignition **OFF** for 10 seconds. Start the engine and check for proper idle operation.

Figure 80.
Measuring the IAC valve pintle

{ewc GSMVIMG,GSMVIMG, !88265g63.bmp}

88265g63

Intake Manifold Tuning Valve {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Intake Manifold Tuning Valve

Ü See figure 81

The upper intake manifold on the CMFI engine is of a variable tuned split plenum design. The manifold uses a centrally mounted tuning valve to equalize pressure in the side by side inlet plenums. The valve is electronically operated by the computer control module. The CSFI system does not utilize this component.

Figure 81.
Intake manifold tuning valve assembly

{ewc GSMVIMG,GSMVIMG, !88265g66.bmp}

88265g66

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Fuel System

REMOVAL & INSTALLATION

1. Disconnect the negative battery cable.
2. Remove the tuning valve attaching screws.
3. Remove the tuning valve from the top of the upper intake manifold assembly.
4. Remove and discard the old O-ring seal.

To install:

5. Lubricate the new O-ring seal with clean engine oil.
6. Make sure the threads of the retaining screws are coated with Loctite®262, or an equivalent threadlocking compound.
7. Position the tuning valve to the upper intake manifold, then carefully thread the retaining screws.

   Ä To avoid breaking the valve mounting ears, alternately tighten the attaching screws until they engage the mounting ear surface, then carefully tighten the screws to specification.

8. Tighten the retaining screws to 18 inch lbs. (2 Nm).
9. Engage the valve electrical connector, then connect the negative battery cable.

Oil Pressure Switch {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Oil Pressure Switch

The oil pressure switch is mounted to a fitting in the left rear of the engine block.

REMOVAL & INSTALLATION

1. Disconnect the negative battery cable.
2. Disengage the switch connector.
3. Using J-35748 or an equivalent wrench, carefully loosen and remove the oil pressure switch.
4. Installation is the reverse of removal.

FUEL TANK {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Fuel System

FUEL TANK

The fuel tank is located under the left side, center of the vehicle and is held in place by two metal straps.

Fuel Tank Assembly

REMOVAL & INSTALLATION

Ü See figures 82, 83

1. Disconnect the negative battery cable from the battery.

   Ä Be sure to keep a Class B (dry chemical) fire extinguisher nearby.

   ****Caution**
   Due to the possibility of fire or explosion, never drain or store gasoline in an open container.

2. Using a hand pump or a siphon hose, drain the gasoline into an approved container.
3. Raise and support the vehicle on jackstands.
4. Support the fuel tank and remove the fuel tank-to-vehicle straps.
5. Lower the tank slightly, then remove the sender unit wires, the hoses and the ground strap.
6. Remove the fuel tank from the vehicle.

To install:

Ä Be sure to connect the sender unit wires and the hoses before final installation of the fuel tank.

7. Align the insulator strips and position the tank into the vehicle. Torque the inner fuel tank bolts to 26 ft. lbs. (35 Nm) and the outer strap bolts to 30 ft. lbs. (40 Nm) in alternating sequence. Torque the nuts to 26 ft. lbs. (35 Nm). This must be done to prevent the bottom of the tank from bowing up and effecting the fuel level sender.
8. Make sure all hoses and electrical connectors are secure and properly routed to prevent damage.
9. Lower the vehicle, connect the negative battery cable, start the engine and check for leaks and proper operation.

Figure 82.
Fuel filler neck assembly

{ewc GSMVIMG,GSMVIMG, !88265g67.bmp}

88265g67

Figure 83.
The fuel tank bolts must be tightened alternately to prevent distortion of the fuel tank bottom

{ewc GSMVIMG,GSMVIMG, !88265g68.bmp}

88265g68

Electric Fuel Pump {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Electric Fuel Pump

REMOVAL & INSTALLATION

Ü See figures 84, 85, 86, 87

Ä The following procedure requires the use of the GM Fuel Gauge Sending Unit Retaining Cam tool No. J–24187 or equivalent.

**Caution

Before removing any component of the fuel system, be sure to reduce the fuel pressure in the system. The pressure regulator contains an orifice in the fuel system; when the engine is turned Off, the pressure in the system will bleed down within a few minutes.

1. If the fuel system has been in use, turn the ignition switch to **OFF** and allow the system time to reduce the fuel pressure.
2. Disconnect the negative battery terminal from the battery.

Ä Be sure to keep a Class B (dry chemical) fire extinguisher nearby.

**Caution

Due to the possibility of fire or explosion, never drain or store gasoline in an open container.

3. Using a hand pump or a siphon hose, drain the gasoline into an approved container.
4. Raise and support the vehicle on jackstands.
5. Support the fuel tank and remove the fuel tank-to-vehicle straps.
6. Lower the tank slightly, then remove the sender unit wires, the hoses and the ground strap.
7. Remove the fuel tank from the vehicle.
8. Using the GM Fuel Gauge Sending Unit Retaining Cam tool No. J–24187 (or equivalent) or a brass drift and a hammer, remove the cam locking ring (fuel sending unit) counterclockwise, then lift the sending unit from the fuel tank.
9. Remove the fuel pump from the fuel sending unit, by performing the following procedures:
   a. Pull the fuel pump up into the mounting tube, while pulling outward (away) from the bottom support.

   Ä When removing the fuel pump from the sending unit, be careful not to damage the rubber insulator and the strainer.

   b. When the pump assembly is clear of the bottom support, pull it out of the rubber connector.

To install:

10. Inspect the fuel pump hose and bottom sound insulator for signs of deterioration, then replace it, if necessary.
11. Push the fuel pump onto the sending tube.
12. Using a new sending unit-to-fuel tank O-ring, install the sending unit into the fuel tank.

Ä When installing the sending unit, be careful not to fold or twist the fuel strainer, for it will restrict the fuel flow.

13. Using the GM Fuel Gauge Sending Unit Retaining Cam tool No. J–24187 (or equivalent) or a

brass drift and a hammer, turn the sending unit-to-fuel tank locking ring clockwise.

14. Install the fuel tank, align the insulator strips and install the strap bolts. Torque the inner fuel tank strap-to-vehicle bolts to 26 ft. lbs. (35 Nm) and the outer fuel tank strap-to-vehicle nuts/bolts to 26 ft. lbs. (35 Nm).
15. Connect the fuel lines.
16. Connect the negative battery cable, start the engine and check for leaks.
17. Lower the vehicle.

Figure 84.
The fuel pump locking ring can be removed using this tool

{ewc GSMVIMG,GSMVIMG, !88265g31.bmp}

88265g31

Figure 85.
The fuel pump and fuel gauge sender assembly

{ewc GSMVIMG,GSMVIMG, !88265g32.bmp}

88265g32

Figure 86.
The fuel pump locking ring can also be removed using a brass drift

{ewc GSMVIMG,GSMVIMG, !tccs5p04.bmp}

tccs5p04

Figure 87.
With the locking ring removed, the fuel pump (and/or gauge sender) can be lifted from the tank

{ewc GSMVIMG,GSMVIMG, !tccs5p05.bmp}

tccs5p05

CHASSIS ELECTRICAL

{ewc MVIMAGE,MVIMAGE, !
chassis_ele.bmp}

UNDERSTANDING BASIC ELECTRICITY {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

UNDERSTANDING BASIC ELECTRICITY

At the rate which both import and domestic manufacturers are incorporating electronic control systems into their production lines, it won't be long before every new vehicle is equipped with one or more on-board computer. These electronic components (with no moving parts) should theoretically last the life of the vehicle, provided nothing external happens to damage the circuits or memory chips.

While it is true that electronic components should never wear out, in the real world malfunctions do occur. It is also true that any computer-based system is extremely sensitive to electrical voltages and cannot tolerate careless or haphazard testing or service procedures. An inexperienced individual can literally do major damage looking for a minor problem by using the wrong kind of test equipment or connecting test leads or connectors with the ignition switch ON. When selecting test equipment, make sure the manufacturers instructions state that the tester is compatible with whatever type of electronic control system is being serviced. Read all instructions carefully and double check all test points before installing probes or making any test connections.

The following section outlines basic diagnosis techniques for dealing with computerized automotive control systems. Along with a general explanation of the various types of test equipment available to aid in servicing modern electronic automotive systems, basic repair techniques for wiring harnesses and connectors is given. Read the basic information before attempting any repairs or testing on any computerized system, to provide the background of information necessary to avoid the most common and obvious mistakes that can cost both time and money. Although the replacement and testing procedures are simple in themselves, the systems are not, and unless one has a thorough understanding of all components and their function within a particular computerized control system, the logical test sequence these systems demand cannot be followed. Minor malfunctions can make a big difference, so it is important to know how each component affects the operation of the overall electronic system to find the ultimate cause of a problem without replacing good components unnecessarily. It is not enough to use the correct test equipment; the test equipment must be used correctly.

Safety Precautions {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Safety Precautions

****Caution**

Whenever working on or around any computer based microprocessor control system, always observe these general precautions to prevent the possibility of personal injury or damage to electronic components.

- Never install or remove battery cables with the key ON or the engine running. Jumper cables should be connected with the key OFF to avoid power surges that can damage electronic control units. Engines equipped with computer controlled systems should avoid both giving and getting jump starts due to the possibility of serious damage to components from arcing in the engine compartment when connections are made with the ignition ON.
- Always remove the battery cables before charging the battery. Never use a high output charger on an installed battery or attempt to use any type of "hot shot" (24 volt) starting aid.
- Exercise care when inserting test probes into connectors to insure good connections without damaging the connector or spreading the pins. Always probe connectors from the rear (wire) side, NOT the pin side, to avoid accidental shorting of terminals during test procedures.
- Never remove or attach wiring harness connectors with the ignition switch ON, especially to an electronic control unit.
- Do not drop any components during service procedures and never apply 12 volts directly to any component (like a solenoid or relay) unless instructed specifically to do so. Some component electrical windings are designed to safely handle only 4 or 5 volts and can be destroyed in seconds if 12 volts are applied directly to the connector.
- Remove the electronic control unit if the vehicle is to be placed in an environment where temperatures exceed approximately 176ºF (80ºC), such as a paint spray booth or when arc or gas welding near the control unit location in the car.

ORGANIZED TROUBLESHOOTING {ewc MVIMAGE, MVIMAGE, ! nexttopicarrow.bmp}

ORGANIZED TROUBLESHOOTING

When diagnosing a specific problem, organized troubleshooting is a must. The complexity of a modern automobile demands that you approach any problem in a logical, organized manner. There are certain troubleshooting techniques that are standard:

1. Establish when the problem occurs. Does the problem appear only under certain conditions? Were there any noises, odors, or other unusual symptoms?
2. 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, dirty connections or split or disconnected vacuum hoses. Always check the obvious before assuming something complicated is the cause.
3. 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? Is there vacuum at vacuum switches and/or actuators? Is there a mechanical problem such as bent linkage or loose mounting screws? Doing 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.
4. 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 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, for example, a shorted wire 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 or air leaks in the intake system; making careful inspection of components during testing essential to quick and accurate troubleshooting. Special, hand held computerized testers designed specifically for diagnosing the Computer Command Control system are available from a variety of aftermarket sources, as well as from the vehicle manufacturer, but care should be taken that any test equipment being used is designed to diagnose that particular computer controlled system accurately without damaging the control module (ECM) or components being tested.

> **Ä Pinpointing the exact cause of trouble in an electrical system can sometimes only be accomplished by the use of special test equipment. The following describes commonly used test equipment and explains how to put it to best use in diagnosis. In addition to the information covered below, the manufacturer's instructions booklet provided with the tester should be read and clearly understood before attempting any test procedures.**

TEST EQUIPMENT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TEST EQUIPMENT

Jumper Wires

Jumper wires are simple, yet extremely valuable, pieces of test equipment. Jumper wires are merely wires that are used to bypass sections of a circuit. The simplest type of jumper wire is merely a length of multistrand wire with an alligator clip at each end. Jumper wires 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 vehicle being tested. The well equipped tool box will have several different styles of jumper wires in several different lengths. Some jumper wires are made with three or more terminals coming from a common splice for special purpose testing. In cramped, hard-to-reach areas it is advisable to have insulated boots over the jumper wire terminals in order to prevent accidental grounding, sparks, and possible fire, especially when testing fuel system components.

Jumper wires are used primarily to locate open electrical circuits, on either the ground side of the circuit or on the hot (+) 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 is open. 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, are designed to operate on about 4 volts and running 12 volts directly to the injector terminals can burn out the wiring. By inserting an inline 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. When in doubt, use a voltmeter to check the voltage input to the component and measure how much voltage is being applied normally. By moving the jumper wire successively back from the lamp 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.

> ****Caution**
> **Never use jumpers made from wire that is of lighter gauge than used in the circuit under test. If the jumper wire is of too small gauge, it may overheat and possibly melt. Never use jumpers to bypass high resistance loads (such as motors) in a circuit. Bypassing resistances, in effect, creates a short circuit which may, in turn, cause damage and fire. Never use a jumper for anything other than temporary bypassing of components in a circuit.**

---

12 Volt Test Light {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Chassis Electrical

12 Volt Test Light

The 12 volt test light is used to check circuits and components while electrical current is flowing through them. It is used for voltage and ground tests. Twelve volt test lights come in different styles but all have three main parts; a ground clip, a probe, and a light. The most commonly used 12 volt test lights have pick-type probes. To use a 12 volt test light, connect the ground clip to a good ground and probe wherever necessary with the pick. The pick should be sharp so that it can penetrate wire insulation to make contact with the wire, without making a large hole in the insulation. The wrap-around light is handy in hard to reach areas or where it is difficult to support a wire to push a probe pick into it. To use the wrap around light, hook the wire to probed with the hook and pull the trigger. A small pick will be forced through the wire insulation into the wire core.

> ****Caution**
> **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 glows, you know that there is power up to that point; if the 12 volt test light does not glow when its probe is inserted into the wire or connector, you know that 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 does glow. When it does glow, the open is between the probe and point previously probed.

> **Ä The test light does not detect that 12 volts (or any particular amount of voltage) is present; it only detects that some voltage is present. It is advisable before using the test light to touch its terminals across the battery posts to make sure the light is operating properly.**

Self-Powered Test Light {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Self-Powered Test Light

The self-powered test light usually contains a 1.5 volt penlight battery. One type of self-powered test light is similar in design to the 12 volt test light. This type has both the battery and the light in the handle and pick-type probe tip. The second type has the light toward the open tip, so that the light illuminates the contact point. The self-powered test light is dual purpose piece of test equipment. It can be used to test for either open or short circuits when power is isolated from the circuit (continuity test). A powered test light should not be used on any computer controlled system or component unless specifically instructed to do so. Many engine sensors can be destroyed by even this small amount of voltage applied directly to the terminals.

Open Circuit Testing {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Open Circuit Testing

To use the self-powered test light to check for open circuits, first isolate the circuit from the vehicle's 12 volt power source by disconnecting the battery or wiring harness connector. Connect the test light ground clip to a good ground and probe sections of the circuit sequentially with the test light (start from either end of the circuit). If the light is out, the open is between the probe and the circuit ground. If the light is on, the open is between the probe and end of the circuit toward the power source.

Short Circuit Testing {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Short Circuit Testing

By isolating the circuit both from power and from ground, and using a self-powered test light, you can check for shorts to ground in the circuit. Isolate the circuit from power and ground. Connect the test light ground clip to a good ground and probe any easy-to-reach test point in the circuit. If the light comes on, there is a short somewhere in the circuit. To isolate the short, probe a test point at either end of the isolated circuit (the light should be on). Leave the test light probe connected and open connectors, switches, remove parts, etc., sequentially, until the light goes out. When the light goes out, the short is between the last circuit component opened and the previous circuit opened.

Ä The 1.5 volt battery in the 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 are high resistances 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. Never use a self-powered test light to perform checks for opens or shorts when power is applied to the electrical system under test. The 12 volt vehicle power will quickly burn out the 1.5 volt light bulb in the test light.

Voltmeter {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Voltmeter

A voltmeter is used to measure voltage at any point in a circuit, or to measure the voltage drop across any part of a circuit. It can also be used to check continuity in a wire or circuit by indicating current flow from one end to the other. Voltmeters usually have various scales on the meter dial and a selector switch to allow the selection of different voltages. 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 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). Depending on how the voltmeter is connected into the circuit, it has several uses.

A voltmeter can be connected either in parallel or in series with a circuit and it has a very high resistance to current flow. When connected in parallel, only a small amount of current will flow through the voltmeter current path; the rest will flow through the normal circuit current path and the circuit will work normally. When the voltmeter is connected in series with a circuit, only a small amount of current can flow through the circuit. The circuit will not work properly, but the voltmeter reading will show if the circuit is complete or not.

Available Voltage Measurement {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Available Voltage Measurement

Set the voltmeter selector switch to the 20V position and connect the meter negative lead to the negative post of the battery. Connect the positive meter lead to the positive post of the battery and turn the ignition switch ON to provide a load. Read the voltage on the meter or digital display. 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. This test determines voltage available from the battery and should be the first step in any electrical trouble diagnosis procedure. 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 a poor contact that will prevent proper charging and full battery current flow.

Normal battery voltage is 12 volts when fully charged. When the battery is supplying current to one or more circuits it is said to be "under load”. When everything is off the electrical system is under a "no-load” condition. A fully charged battery may show about 12.5 volts at no load; will drop to 12 volts under medium load; and will drop even lower under heavy load. If the battery is partially discharged the voltage decrease under heavy load may be excessive, even though the battery shows 12 volts or more at no load. When allowed to discharge further, the battery's available voltage under load will decrease more severely. For this reason, it is important that the battery be fully charged during all testing procedures to avoid errors in diagnosis and incorrect test results.

Voltage Drop {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Voltage Drop

When current flows through a resistance, the voltage beyond the resistance is reduced (the larger the current, the greater the reduction in voltage). When no current is flowing, there is no voltage drop because there is no current flow. All points in the circuit which are connected to the power source are at the same voltage as the power source. The total voltage drop always equals the total source voltage. In a long circuit with many connectors, a series of small, unwanted voltage drops due to corrosion at the connectors can add up to a total loss of voltage which impairs the operation of the normal loads in the circuit.

INDIRECT COMPUTATION OF VOLTAGE DROPS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

INDIRECT COMPUTATION OF VOLTAGE DROPS

1. Set the voltmeter selector switch to the 20 volt position.
2. Connect the meter negative lead to a good ground.
3. Probe all resistances in the circuit with the positive meter lead.
4. Operate the circuit in all modes and observe the voltage readings.

DIRECT MEASUREMENT OF VOLTAGE DROPS {ewc MVIMAGE, MVIMAGE, ! nexttopicarrow.bmp}

Chassis Electrical

DIRECT MEASUREMENT OF VOLTAGE DROPS

1. Set the voltmeter switch to the 20 volt position.
2. Connect the voltmeter negative lead to the ground side of the resistance load to be measured.
3. Connect the positive lead to the positive side of the resistance or load to be measured.
4. Read the voltage drop directly on the 20 volt scale.

Too high a voltage indicates too high a resistance. If, for example, a blower motor runs too slowly, you can determine if there is too high a resistance in the resistor pack. By taking voltage drop readings in all parts of the circuit, you can isolate the problem. Too low a voltage drop indicates too low a resistance. If, for example, a blower motor runs too fast in the MED and/or LOW position, the problem can be isolated in the resistor pack by taking voltage drop readings in all parts of the circuit to locate a possibly shorted resistor. The maximum allowable voltage drop under load is critical, especially if there is more than one high resistance problem in a circuit because all voltage drops are cumulative. A small drop is normal due to the resistance of the conductors.

HIGH RESISTANCE TESTING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

HIGH RESISTANCE TESTING

1. Set the voltmeter selector switch to the 4 volt position.
2. Connect the voltmeter positive lead to the positive post of the battery.
3. Turn on the headlights and heater blower to provide a load.
4. Probe various points in the circuit with the negative voltmeter lead.
5. Read the voltage drop on the 4 volt scale. Some average maximum allowable voltage drops are:
   - FUSE PANEL-0.7 volts
   - IGNITION SWITCH-0.5 volts
   - HEADLIGHT SWITCH-0.7 volts
   - IGNITION COIL (+)-0.5 volts
   - ANY OTHER LOAD-1.3 volts

   Ä Voltage drops are all measured while a load is operating; without current flow, there will be no voltage drop.

Ohmmeter {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Ohmmeter

The ohmmeter is designed to read resistance (ohms) in a circuit or component. Although there are several different styles of ohmmeters, all will usually 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). A calibration knob allows the meter to be set at zero for accurate measurement. Since all ohmmeters are powered by an internal battery (usually 9 volts), the ohmmeter can be used as 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 be used to perform continuity test for opens or shorts (either by observation of the meter needle or as a self-powered test light), and to read actual resistance in a circuit. It should be noted that the ohmmeter is used to check the resistance of a component or wire while there is no voltage applied to the circuit. Current flow from an outside voltage source (such as the vehicle battery) can damage the ohmmeter, so the circuit or component should be isolated from the vehicle electrical system before any testing is done. Since the ohmmeter uses its own voltage source, either lead can be connected to any test point.

> **Ä When checking diodes or other solid state components, the ohmmeter leads can only be connected one way in order to measure current flow in a single direction. Make sure the positive (+) and negative terminal connections are as described in the test procedures to verify the one-way diode operation.**

In using the meter for making continuity checks, do not be concerned with the actual resistance readings. Zero resistance, or any resistance readings, indicate continuity in the circuit. Infinite resistance indicates an open 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 to ground, while zero resistance indicates a dead short to ground.

RESISTANCE MEASUREMENT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

RESISTANCE MEASUREMENT

The batteries in an ohmmeter will weaken with age and temperature, so the ohmmeter must be calibrated or "zeroed" before taking measurements. To zero the meter, place the selector switch in its lowest range and touch the two ohmmeter leads together. Turn the calibration knob until the meter needle is exactly on zero.

> **Ä All analog (needle) type ohmmeters must be zeroed before use, but some digital ohmmeter models are automatically calibrated when the switch is turned on. Self-calibrating digital ohmmeters do not have an adjusting knob, but its a good idea to check for a zero readout before use by touching the leads together. All computer controlled systems require the use of a digital ohmmeter with at least 10 megohms impedance for testing. Before any test procedures are attempted, make sure the ohmmeter used is compatible with the electrical system or damage to the on-board computer could result.**

To measure resistance, first isolate the circuit from the vehicle power source by disconnecting the battery cables or the harness connector. Make sure the key is OFF when disconnecting any components or the battery. Where necessary, also isolate at least one side of the circuit to be checked to avoid reading parallel resistances. Parallel circuit resistances will always give a lower reading than the actual resistance of either of the branches. When measuring the resistance of parallel circuits, the total resistance will always be lower than the smallest resistance in the circuit. 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.

> ****Warning**
> **Never use an ohmmeter with power applied to the circuit. Like the self-powered test light, the ohmmeter is designed to operate on its own power supply. The normal 12 volt automotive electrical system current could damage the meter!**

Ammeters {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Ammeters

An ammeter measures the amount of current flowing through a circuit in units called amperes or amps. Amperes are units of electron flow which indicate how fast the electrons are flowing through the circuit. Since Ohms Law dictates that current flow in a circuit is equal to the circuit voltage divided by the total circuit resistance, increasing voltage also increases the current level (amps). Likewise, any decrease in resistance will increase the amount of amps in a circuit. 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, 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. More current flows through a heavily loaded circuit or when the charging system is operating.

An 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. The ammeter can help diagnose these conditions by locating the cause of the high or low reading.

Multimeters {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Multimeters

Different combinations of test meters can be built into a single unit designed for specific tests. Some of the more common combination test devices are known as Volt/Amp testers, Tach/Dwell meters, or Digital Multimeters. The Volt/Amp tester is used for charging system, starting system or battery tests and consists of a voltmeter, an ammeter and a variable resistance carbon pile. The voltmeter will usually have at least two ranges for use with 6, 12 and 24 volt systems. The ammeter also has more than one range for testing various levels of battery loads and starter current draw and the carbon pile can be adjusted to offer different amounts of resistance. The Volt/Amp tester has heavy leads to carry large amounts of current and many later models have an inductive ammeter pickup that clamps around the wire to simplify test connections. On some models, the ammeter also has a zero-center scale to allow testing of charging and starting systems without switching leads or polarity. A digital multimeter is a voltmeter, ammeter and ohmmeter combined in an instrument which gives a digital readout. These are often used when testing solid state circuits because of their high input impedance (usually 10 megohms or more).

The tach/dwell meter combines a tachometer and a dwell (cam angle) meter and is a specialized kind of voltmeter. The tachometer scale is marked to show engine speed in rpm and the dwell scale is marked to show degrees of distributor shaft rotation. In most electronic ignition systems, dwell is determined by the control unit, but the dwell meter can also be used to check the duty cycle (operation) of some electronic engine control systems. Some tach/dwell meters are powered by an internal battery, while others take their power from the car battery in use. The battery powered testers usually require calibration much like an ohmmeter before testing.

Special Test Equipment {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Special Test Equipment

A variety of diagnostic tools are available to help troubleshoot and repair computerized engine control systems. The most sophisticated of these devices are the console type engine analyzers that usually occupy a garage service bay, but there are several types of aftermarket electronic testers available that will allow quick circuit tests of the engine control system by plugging directly into a special connector located in the engine compartment or under the dashboard. Several tool and equipment manufacturers offer simple, hand held testers that measure various circuit voltage levels on command to check all system components for proper operation.

Although these testers usually cost about $300-500, consider that the average computer control module (or ECM) can cost just as much and the money saved by not replacing perfectly good sensors or components in an attempt to correct a problem could justify the purchase price of a special diagnostic tester the first time it's used.

These computerized testers can allow quick and easy test measurements while the engine is operating or while the car is being driven. In addition, the on-board computer memory can be read to access any stored trouble codes; in effect allowing the computer to tell you where it hurts and aid trouble diagnosis by pinpointing exactly which circuit or component is malfunctioning. In the same manner, repairs can be tested to make sure the problem has been corrected. The biggest advantage these special testers have is their relatively easy hookups that minimize or eliminate the chances of making the wrong connections and getting false voltage readings or damaging the computer accidentally.

> **Ä It should be remembered that these testers check voltage levels in circuits; they don't detect mechanical problems or failed components if the circuit voltage falls within the preprogrammed limits stored in the tester PROM unit. Also, most of the hand held testes are designed to work only on one or two systems made by a specific manufacturer.**

A variety of aftermarket testers are available to help diagnose different computerized control systems. Owatonna Tool Company (OTC), for example, markets a device called the OTC Monitor which plugs directly into the assembly line diagnostic link (ALDL). The OTC tester makes diagnosis a simple matter of pressing the correct buttons and, by changing the internal PROM or inserting a different diagnosis cartridge, it will work on any model from full size to subcompact, over a wide range of years. An adapter is supplied with the tester to allow connection to all types of ALDL links, regardless of the number of pin terminals used. By inserting an updated PROM into the OTC tester, it can be easily updated to diagnose any new modifications of computerized control systems.

Wiring Harnesses {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Wiring Harnesses

The average automobile contains about $^{1}/2$ mile 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 wire harnesses. Different wiring 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.

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. A ten percent voltage drop can result in slow or erratic motor operation, for example, even though the circuit is complete. Automotive wiring or circuit conductors can be in any one of three forms:

1. Single strand wire
2. Multistrand wire
3. Printed circuitry

Single strand wire has a solid metal core and is usually used inside such components as alternators, motors, relays and other devices. Multistrand 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 multistrand 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.

Wire Gauge {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Wire Gauge

Since computer controlled automotive electrical systems are very sensitive to changes in resistance, the selection of properly sized wires is critical when systems are repaired. The wire gauge number is an expression of the cross section area of the conductor. The most common system for expressing wire size is the American Wire Gauge (AWG) system.

Wire cross section area is measured in circular mils. A mil is $^1/1000$ in. (0.001 in.); a circular mil is the area of a circle one mil in diameter. For example, a conductor $^1/4$ in. in diameter is 0.250 in. or 250 mils. The circular mil cross section area of the wire is 250 squared (2502) or 62,500 circular mils. Imported car models usually use metric wire gauge designations, which is simply the cross section area of the conductor in square millimeters (mm2).

Gauge numbers are assigned to conductors of various cross section areas. As gauge number increases, area decreases and the conductor becomes smaller. A 5 gauge conductor is smaller than a 1 gauge conductor and a 10 gauge is smaller than a 5 gauge. As the cross section area of a conductor decreases, resistance increases and so does the gauge number. A conductor with a higher gauge number will carry less current than a conductor with a lower gauge number.

> **Ä Gauge wire size refers to the size of the conductor, not the size of the complete wire. It is possible to have two wires of the same gauge with different diameters because one may have thicker insulation than the other.**

12 volt automotive electrical systems generally use 10, 12, 14, 16 and 18 gauge wire. Main power distribution circuits and larger accessories usually use 10 and 12 gauge wire. Battery cables are usually 4 or 6 gauge, although 1 and 2 gauge wires are occasionally used. Wire length must also be considered when making repairs to a circuit. As conductor length increases, so does resistance. An 18 gauge wire, for example, can carry a 10 amp load for 10 feet without excessive voltage drop; however if a 15 foot wire is required for the same 10 amp load, it must be a 16 gauge wire.

An electrical schematic shows the electrical current paths when a circuit is operating properly. It is essential to understand how a circuit works before trying to figure out why it does not. Schematics break the entire electrical system down into individual circuits and show only one particular circuit. In a schematic, 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.

If you need to backprobe a connector while it is on the component, the order of the terminals must be mentally reversed. The wire color code can help in this situation, as well as a keyway, lock tab or other reference mark.

WIRING REPAIR {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Chassis Electrical

WIRING REPAIR

Soldering is a quick, efficient method of joining metals permanently. Everyone who has the occasion to make wiring repairs should know how to solder. Electrical connections that are soldered are far less likely to come apart and will conduct electricity much better than connections that are only "pig-tailed" together. The most popular (and preferred) method of soldering is with an electrical soldering gun. Soldering irons are available in many sizes and wattage ratings. Irons with higher wattage ratings deliver higher temperatures and recover lost heat faster. A small soldering iron rated for no more than 50 watts is recommended, especially on electrical systems where excess heat can damage the components being soldered.

There are three ingredients necessary for successful soldering; proper flux, good solder and sufficient heat. A soldering flux is necessary to clean the metal of tarnish, prepare it for soldering and to enable the solder to spread into tiny crevices. When soldering, always use a resin flux or resin core solder which is non-corrosive and will not attract moisture once the job is finished. Other types of flux (acid core) will leave a residue that will attract moisture and cause the wires to corrode. Tin is a unique metal with a low melting point. In a molten state, it dissolves and alloys easily with many metals. Solder is made by mixing tin with lead. The most common proportions are 40/60, 50/50 and 60/40, with the percentage of tin listed first. Low priced solders usually contain less tin, making them very difficult for a beginner to use because more heat is required to melt the solder. A common solder is 40/60 which is well suited for all-around general use, but 60/40 melts easier, has more tin for a better joint and is preferred for electrical work.

Soldering Techniques {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Soldering Techniques

Successful soldering requires that the metals to be joined be heated to a temperature that will melt the solder, usually 360ºF - 460ºF (182ºC - 238ºC). Contrary to popular belief, the purpose of the soldering iron is not to melt the solder itself, but to heat the parts being soldered to a temperature high enough to melt the solder when it is touched to the work. Melting flux-cored solder on the soldering iron will usually destroy the effectiveness of the flux.

> **Ä Soldering tips are made of copper for good heat conductivity, but must be "tinned" regularly for quick transference of heat to the project and to prevent the solder from sticking to the iron. To "tin" the iron, simply heat it and touch the flux-cored solder to the tip; the solder will flow over the hot tip. Wipe the excess off with a clean rag, but be careful as the iron will be hot.**

After some use, the tip may become pitted. If so, simply dress the tip smooth with a smooth file and "tin" the tip again. An old saying holds that "metals well cleaned are half soldered." Flux-cored solder will remove oxides but rust, bits of insulation and oil or grease must be removed with a wire brush or emery cloth. For maximum strength in soldered parts, the joint must start off clean and tight. Weak joints will result in gaps too wide for the solder to bridge.

If a separate soldering flux is used, it should be brushed or swabbed on only those areas that are to be soldered. Most solders contain a core of flux and separate fluxing is unnecessary. Hold the work to be soldered firmly. It is best to solder on a wooden board, because a metal vise will only rob the piece to be soldered of heat and make it difficult to melt the solder. Hold the soldering tip with the broadest face against the work to be soldered. Apply solder under the tip close to the work, using enough solder to give a heavy film between the iron and the piece being soldered, while moving slowly and making sure the solder melts properly. Keep the work level or the solder will run to the lowest part and favor the thicker parts, because these require more heat to melt the solder. If the soldering tip overheats (the solder coating on the face of the tip burns up), it should be retinned. Once the soldering is completed, let the soldered joint stand until cool. Tape and seal all soldered wire splices after the repair has cooled.

Wire Harness and Connectors {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Chassis Electrical

Wire Harness and Connectors

The on-board computer (ECM) wire harness electrically connects the control unit to the various solenoids, switches and sensors used by the control system. Most connectors in the engine compartment or otherwise exposed to the elements are protected against moisture and dirt which could create oxidation and deposits on the terminals. This protection is important because of the very low voltage and current levels used by the computer and sensors. All connectors have a lock which secures the male and female terminals together, with a secondary lock holding the seal and terminal into the connector. Both terminal locks must be released when disconnecting ECM connectors.

These special connectors are weather-proof and all repairs require the use of a special terminal and the tool required to service it. This tool is used to remove the pin and sleeve terminals. If removal is attempted with an ordinary pick, there is a good chance that the terminal will be bent or deformed. Unlike standard blade type terminals, these terminals cannot be straightened once they are bent. Make certain that the connectors are properly seated and all of the sealing rings in place when connecting leads. On some models, a hinge-type flap provides a backup or secondary locking feature for the terminals. Most secondary locks are used to improve the connector reliability by retaining the terminals if the small terminal lock tangs are not positioned properly.

Molded-on connectors require complete replacement of the connection. This means splicing a new connector assembly into the harness. All splices in on-board computer systems should be soldered to insure proper contact. Use care when probing the connections or replacing terminals in them as it is possible to short 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.

Open circuits are often difficult to locate by sight because corrosion or terminal misalignment are hidden by the connectors. Merely wiggling a connector on a sensor or in the wiring harness may correct the open circuit condition. This should always be considered when an open circuit or a failed sensor is indicated. Intermittent problems may also be caused by oxidized or loose connections. When using a circuit tester for diagnosis, always probe connections from the wire side. Be careful not to damage sealed connectors with test probes.

All wiring harnesses should be replaced with identical parts, using the same gauge wire and connectors. When signal wires are spliced into a harness, use wire with high temperature insulation only. With the low voltage and current levels found in the system, it is important that the best possible connection at all wire splices be made by soldering the splices together. It is seldom necessary to replace a complete harness. If replacement is necessary, pay close attention to insure proper harness routing. Secure the harness with suitable plastic wire clamps to prevent vibrations from causing the harness to wear in spots or contact any hot components.

> **Ä Weatherproof connectors cannot be replaced with standard connectors. Instructions are provided with replacement connector and terminal packages. Some wire harnesses have mounting indicators (usually pieces of colored tape) to mark where the harness is to be secured.**

In making wiring repairs, it's important that you always replace damaged wires with wires that are the same gauge as the wire being replaced. The heavier the wire, the smaller the gauge number. Wires are color-coded to aid in identification and whenever possible the same color coded wire should be used for replacement. A wire stripping and crimping tool is necessary to install solderless terminal connectors. Test all crimps by pulling on the wires; it should not be possible to pull the wires out of a good crimp.

Wires which are open, exposed or otherwise damaged are repaired by simple splicing. Where possible, if the wiring harness is accessible and the damaged place in the wire can be located, it is best to open the harness and check for all possible damage. In an inaccessible harness, the wire must be bypassed with a new insert, usually taped to the outside of the old harness.

When replacing fusible links, be sure to use fusible link wire, NOT ordinary automotive wire. Make sure the fusible segment is of the same gauge and construction as the one being replaced and double the stripped end when crimping the terminal connector for a good contact. The melted (open) fusible link segment of the wiring harness should be cut off as close to the harness as possible, then a new segment spliced in as described. In the case of a damaged fusible link that feeds two harness wires, the harness connections should be replaced with two fusible link wires so that each circuit will have its own separate protection.

Ä Most of the problems caused in the wiring harness are due to bad ground connections. Always check all vehicle ground connections for corrosion or looseness before performing any power feed checks to eliminate the chance of a bad ground affecting the circuit.

Repairing Hard Shell Connectors {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Repairing Hard Shell Connectors

Unlike molded connectors, the terminal contacts in hard shell connectors can be replaced. Weatherproof hard-shell connectors with the leads molded into the shell have non-replaceable terminal ends. Replacement usually involves the use of a special terminal removal tool that depress the locking tangs (barbs) on the connector terminal and allow 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.

> **Ä The insulation crimp must be tight to prevent the insulation from sliding back on the wire when the wire is pulled. The insulation must be visibly compressed under the crimp tabs, and the ends of the crimp should be turned in for a firm grip on the insulation.**

The wire crimp must be made with all wire strands inside the crimp. The terminal must be fully compressed on the wire strands with the ends of the crimp tabs turned in to make a firm grip on the wire. Check all connections with an ohmmeter to insure a good contact. There should be no measurable resistance between the wire and the terminal when connected.

Mechanical Test Equipment {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Mechanical Test Equipment

Vacuum Gauge

Most gauges are graduated in inches of mercury (in.Hg), although a device called a manometer reads vacuum in inches of water (in. H_2O). The normal vacuum reading usually varies between 18 and 22 in. Hg at sea level. To test engine vacuum, the vacuum gauge must be connected to a source of manifold vacuum. Many engines have a plug in the intake manifold which can be removed and replaced with an adapter fitting. Connect the vacuum gauge to the fitting with a suitable rubber hose or, if no manifold plug is available, connect the vacuum gauge to any device using manifold vacuum, such as EGR valves, etc. The vacuum gauge can be used to determine if enough vacuum is reaching a component to allow its actuation.

Hand Vacuum Pump {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Hand Vacuum Pump

Small, hand-held vacuum pumps come in a variety of designs. Most have a built-in vacuum gauge and allow the component to be tested without removing it from the vehicle. Operate the pump lever or plunger to apply the correct amount of vacuum required for the test specified in the diagnosis routines. The level of vacuum in inches of Mercury (in. Hg) is indicated on the pump gauge. For some testing, an additional vacuum gauge may be necessary.

Intake manifold vacuum is used to operate various systems and devices on late model vehicles. To correctly diagnose and solve problems in vacuum control systems, a vacuum source is necessary for testing. In some cases, vacuum can be taken from the intake manifold when the engine is running, but vacuum is normally provided by a hand vacuum pump. These hand vacuum pumps have a built-in vacuum gauge that allow testing while the device is still attached to the component. For some tests, an additional vacuum gauge may be necessary.

SUPPLEMENTAL INFLATABLE RESTRAINT (SIR) SYSTEM {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SUPPLEMENTAL INFLATABLE RESTRAINT (SIR) SYSTEM

General Information

Ü See figure 1

The Supplemental Inflatable Restraint (SIR) system offers protection in addition to that provided by the seat belt by deploying an air bag from the center of the steering wheel and dash panel (passenger side air bag, if equipped). The air bag deploys when the vehicle is involved in a frontal crash of sufficient force up to 30º off the centerline of the vehicle. To further absorb the crash energy, there is also a knee bolster located beneath the instrument panel in the driver's area and the steering column is collapsible.

The system has an energy reserve, which can store a large enough electrical charge to deploy the air bag(s) for up to ten minutes after the battery has been disconnected or damaged. The system **MUST** be disabled before any service is performed on or around SIR components or SIR wiring.

Figure 1.
This sticker warns of air bag components. Be careful when working around the SIR wiring harness

{ewc GSMVIMG,GSMVIMG, !88266p01.bmp}

88266p01

SYSTEM OPERATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SYSTEM OPERATION

The SIR system contains a deployment loop for each air bag and a Diagnostic Energy Reserve Module (DERM). The deployment loop supplies current through the inflator module which will cause air bag deployment in the event of a frontal collision of sufficient force. The DERM supplies the necessary power, even if the battery has been damaged.

The deployment loop is made up of the arming sensors, coil assembly, inflator module and the discriminating sensors. The inflator module is only supplied sufficient current when the arming sensor and at least one of the two discriminating sensors close simultaneously. The function of the DERM is to supply the deployment loop a 36 Volt Loop Reserve (36VLR) to assure sufficient voltage to deploy the air bag if ignition voltage is lost in a frontal crash.

The DERM, in conjunction with the sensor resistors, makes it possible to detect circuit and component malfunctions within the deployment loop. If the voltages monitored by the DERM fall outside expected limits, the DERM will indicate a malfunction by storing a diagnostic trouble code and illuminating the AIR BAG lamp.

SYSTEM COMPONENTS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SYSTEM COMPONENTS

Ü See figures 2, 3

Diagnostic Energy Reserve Module (DERM)/Sensing and Diagnostic Module (SDM)

This component is known as the DERM on 1993-95 vehicles and the SDM on 1996 vehicles. The term DERM will be used in this section. The DERM is designed to perform five main functions: energy reserve, malfunction detection, malfunction recording, driver notification and frontal crash recording.

The DERM maintains a reserve voltage supply to provide deployment energy for a few seconds when the vehicle voltage is low or lost in a frontal crash. The DERM performs diagnostic monitoring of the SIR system and records malfunctions in the form of diagnostic trouble codes, which can be obtained from a hand scan tool and/or on-board diagnostics. The DERM warns the driver of SIR system malfunctions by controlling the AIR BAG warning lamp and records SIR system status during a frontal crash.

Figure 2.
SIR components-1993-95 models

{ewc GSMVIMG,GSMVIMG, !88266g91.bmp}

88266g91

Figure 3.
SIR components-1996 models

{ewc GSMVIMG,GSMVIMG, !88266g92.bmp}

88266g92

Air Bag Warning Lamp {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Chassis Electrical

Air Bag Warning Lamp

The AIR BAG warning/indicator lamp is used to verify lamp and DERM operation by flashing 7 times when the ignition is first turned **ON**. It is also used to warn the driver of an SIR system malfunction.

Discriminating Sensors {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Discriminating Sensors

There are two discriminating sensors in the SIR system, the LH forward and RH forward discriminating sensors. These sensors are located on the right frame rail for the RH sensor and the left front frame rail for the LH sensor.

The discriminating sensor consists of a sensing element, diagnostic resistor and normally open switch contacts. The sensing element closes the switch contact when vehicle velocity changes are severe enough to warrant air bag deployment.

Arming Sensor {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Arming Sensor

The arming sensor is located on the left hand frame rail. The arming sensor is a switch located in the power side of the deployment loop. It is calibrated to close at low level velocity changes (lower than the discriminating sensors), assuring that the inflator module is connected directly to the 36VLR output of the DERM or Ignition 1 voltage when any discriminating sensor closes.

SIR Coil Assembly {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SIR Coil Assembly

The SIR coil assembly consists of two current carrying coils. They are attached to the steering column and allow rotation of the steering wheel while maintaining continuous deployment loop contact through the inflator module.

There is a shorting bar on the lower steering column connector that connects the SIR coil to the SIR wiring harness. The shorting bar shorts the circuit when the connector is disengaged. The circuit to the inflator module is shorted in this way to prevent unwanted air bag deployment when servicing the steering column or other SIR components.

Inflator Module {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Inflator Module

The inflator module is located on the steering wheel hub. The inflator module consists of an inflatable bag and an inflator (a canister of gas-generating material and an initiating device). When the vehicle is in a frontal crash of sufficient force to close the arming sensor and at least one discriminating sensor simultaneously, current flows through the deployment loop. Current passing through the initiator ignites the material in the inflator module, causing a reaction which produces a gas that rapidly inflates the air bag.

SERVICE PRECAUTIONS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Chassis Electrical

SERVICE PRECAUTIONS

- When performing service around the SIR system components or wiring, the SIR system **MUST** be disabled. Failure to do so could result in possible air bag deployment, personal injury or unneeded SIR system repairs.
- When carrying a live inflator module, make sure that the bag and trim cover are pointed away from you. Never carry the inflator module by the wires or connector on the underside of the module. In case of accidental deployment, the bag will then deploy with minimal chance of injury.
- When placing a live inflator module on a bench or other surface, always face the bag and trim cover up, away from the surface.

DISABLING THE SYSTEM {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

DISABLING THE SYSTEM

Ü See figures 4, 5, 6

Ä With the AIR BAG fuse removed and the ignition switch ON, the AIR BAG warning lamp will be on. This is normal and does not indicate any system malfunction.

1. Turn the steering wheel so that the vehicle's wheels are pointing straight ahead.
2. Turn the ignition switch to **LOCK**, remove the key, then disconnect the negative battery cable.
3. Remove the AIR BAG fuse from the fuse block.
4. Remove the steering column filler panel.
5. Disengage the Connector Position Assurance (CPA) and the yellow two way connector located at the base of the steering column.
6. Connect the negative battery cable.

Figure 4.
Driver's side 2-way SIR connector-1993-95 models

{ewc GSMVIMG,GSMVIMG, !88266g93.bmp}

88266g93

Figure 5.
Driver's side 2-way SIR connector-1996 models

{ewc GSMVIMG,GSMVIMG, !88266g94.bmp}

88266g94

Figure 6.
Passenger's side 2-way SIR connector-1996 models

{ewc GSMVIMG,GSMVIMG, !88266g95.bmp}

88266g95

ENABLING THE SYSTEM {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ENABLING THE SYSTEM

1. Disconnect the negative battery cable.
2. Turn the ignition switch to **LOCK**, then remove the key.
3. Engage the yellow SIR connector and CPA located at the base of the steering column.
4. Install the steering column filler panel.
5. Install the AIR BAG fuse to the fuse block.
6. Connect the negative battery cable.
7. Turn the ignition switch to **RUN** and make sure that the AIR BAG warning lamp flashes seven times and then shuts off. If the warning lamp does not shut off, make sure that the wiring is properly connected. If the light remains on, take the vehicle to a reputable repair facility for service.

HEATING AND AIR CONDITIONING {ewc MVIMAGE, MVIMAGE, ! nexttopicarrow.bmp}

HEATING AND AIR CONDITIONING

Ä Refer to Section 1 **for discharging, evacuating and recharging the air conditioning system. The system should be discharged by a qualified technician with proper recovery equipment. It is illegal to discharge refrigerant into the atmosphere and you may need a permit to purchase new refrigerant. If you do not possess the proper equipment, training and permits to perform refrigerant recovery, allow a repair shop to do that step for you.**

Heater Blower Motor

REMOVAL & INSTALLATION

Front (Main) Motor

Ü See figures 7, 8, 9, 10

The blower motor is located in the engine compartment on the right side of the firewall.

1. Disconnect the negative battery cable from the battery.
2. Disconnect the electrical connectors from the blower motor.
3. Remove the radiator coolant collecting bottle from the right side of the engine compartment.
4. Remove the windshield washer fluid bottle from the right side of the engine compartment.
5. If equipped with an acoustic cover over the motor, cut the cover between the clip lands and save the cover for reassembly.
6. Remove the blower motor-to-duct housing screws and the blower motor from the vehicle.
7. If necessary, replace the blower motor-to-duct housing gasket.

To install:

8. Install the motor and gasket. Torque the retaining screws to 18 inch lbs. (1.6 Nm). Install the acoustic cover, if removed.
9. Install the windshield washer fluid bottle on the right side of the engine compartment.
10. Install the radiator coolant collecting bottle on the right side of the engine compartment.
11. Connect the electrical connectors to the blower motor.
12. Connect the negative battery cable to the battery.
13. Check for proper operation.
14. Refill the windshield washer bottle and the radiator coolant collecting bottle.

Figure 7.
The heater blower motor is mounted on the heater case assembly. This is shown without AC, but it is similar with AC

{ewc GSMVIMG,GSMVIMG, !88266g01.bmp}

88266g01

Figure 8.
Both the ground connector and the power connector need to be removed from the push on tabs

{ewc GSMVIMG,GSMVIMG, !88266p02.bmp}

88266p02

Figure 9.

The blower motor is held on its circumference by screws

{ewc GSMVIMG,GSMVIMG, !88266p03.bmp}

88266p03

Figure 10.
Pulling the housing back will expose the fan blade connected to the motor shaft

{ewc GSMVIMG,GSMVIMG, !88266p04.bmp}

88266p04

Rear (Overhead) Motor {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Rear (Overhead) Motor

Ü See figure 11

A rear overhead heater provides heating to the rear of the vehicle. It is located on the left side of the vehicle, in front of the wheel fender and is concealed behind a cover.

1. Disconnect the negative battery cable from the battery.
2. Remove the cover-to-heater unit and the cover.
3. Disconnect the electrical connector from the blower motor.
4. Remove the blower motor-to-heater housing screws and the blower motor.
5. If necessary, replace the blower motor-to-heater housing gasket.

Figure 11.
Rear heater assembly

{ewc GSMVIMG,GSMVIMG, !88266g03.bmp}

88266g03

To install:

6. Use a new gasket (if necessary) and install the motor. Torque the retaining screws to 18 inch lbs. (1.6 Nm).
7. Connect the electrical connector to the blower motor.
8. Install the cover-to-heater unit and the cover.
9. Connect the negative battery terminal to the battery and check operation.

Blower Motor Resistor {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Blower Motor Resistor

Ü See figure 12

A blower motor resistor is mounted on top of each blower/heater or blower/evaporator case.

REMOVAL & INSTALLATION

1. Disconnect the negative battery cable from the battery.
2. Disconnect the electrical connector from the resistor.
3. Remove the resistor-to-case screws and lift the resistor from the case.
4. Install the resistor and retaining screws. Connect the electrical connector and negative battery cable.

Figure 12.
Blower motor resistor mounting location

{ewc GSMVIMG,GSMVIMG, !88266g02.bmp}

88266g02

Heater Core {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Heater Core

REMOVAL & INSTALLATION

Front Core

Ü See figures 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23

The front heater core is located on the right side of the passenger compartment, under the dash.

1. Disconnect the negative battery terminal from the battery.
2. Place a catch pan under the radiator, open the drain cock and drain the coolant to a level below the heater core.

   **Caution
   When draining the coolant, keep in mind that cats and dogs are attracted by the ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.

3. Remove the radiator overflow coolant bottle and the windshield washer fluid bottle.
4. In the engine compartment, remove the inlet/outlet hose clamps from the heater core. Remove and plug the heater hoses to prevent coolant spillage.
5. From inside the vehicle, remove the engine cover to provide extra room.
6. From under the dash, remove the lower right filler panel.
7. Remove the distributor duct, for extra room.
8. Remove the heater-to-cowl bolts and the heater assembly from the vehicle. In some instances this may not be necessary.
9. Separate the cover plate and the heater core from the heater assembly.

To install:

10. Assemble the cover plate and the heater core to the heater assembly.
11. Install the heater-to-cowl bolts and the heater assembly in the vehicle, if the entire assembly was removed.
12. Install the distributor duct.
13. From under the dash, install the lower right filler panel.
14. From inside the vehicle, install the engine cover.
15. In the engine compartment, install the inlet/outlet hoses on the heater core tubes.
16. Install the radiator overflow coolant bottle and the windshield washer fluid bottle.
17. Refill the coolant to the proper level and check for leaks.
18. Connect the negative battery cable to the battery.
19. Start the engine and recheck for leaks after it has reached operating temperature.

**Figure 13.
The heater core has its water connections in the engine compartment**

{ewc GSMVIMG,GSMVIMG, !88266p30.bmp}

88266p30

Figure 14.
With the engine cover off, the trim panel bolts are accessible

{ewc GSMVIMG,GSMVIMG, !88266p05.bmp}

88266p05

Figure 15.
Remove the trim panel to access the heater box

{ewc GSMVIMG,GSMVIMG, !88266p06.bmp}

88266p06

Figure 16.
The air distribution duct is mounted in front of the heater box

{ewc GSMVIMG,GSMVIMG, !88266p07.bmp}

88266p07

Figure 17.
Note the seal at the top of the duct. Make sure it is in place when assembling the duct

{ewc GSMVIMG,GSMVIMG, !88266p08.bmp}

88266p08

Figure 18.
The side cover is held by 2 bolts

{ewc GSMVIMG,GSMVIMG, !88266p09.bmp}

88266p09

Figure 19.
The side cover is also gasketed. Check its condition once removed

{ewc GSMVIMG,GSMVIMG, !88266p10.bmp}

88266p10

Figure 20.
The heater core is held by small bolts and molded-in brackets

{ewc GSMVIMG,GSMVIMG, !88266p11.bmp}

88266p11

Figure 21.
In most cases, the core can be separated from the heater box without removing the entire assembly

{ewc GSMVIMG,GSMVIMG, !88266p12.bmp}

88266p12

Figure 22.
Mounting scheme of the front heater module

{ewc GSMVIMG,GSMVIMG, !88266g04.bmp}

88266g04

Figure 23.
Exploded view of the front heater module

{ewc GSMVIMG,GSMVIMG, !88266g05.bmp}

88266g05

Rear Core {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Rear Core

Ü See figure 24

A rear heater core provides heating to the rear of the vehicle. It is located on the left side of the vehicle, in front of the wheel fender and is concealed behind a cover.

1. Disconnect the negative battery terminal from the battery.
2. Place a catch pan under the radiator, open the drain cock and drain the cooling system.

****Caution**
When draining the coolant, keep in mind that cats and dogs are attracted by the ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.

3. From under the vehicle (at the rear heating unit), remove the inlet/outlet hose clamps from the heater core. Remove and plug the heater hoses to prevent coolant excess spillage.
4. From inside the vehicle, remove the heating unit cover.
5. Remove the heater core from the blower assembly.
6. Inspect the heater hoses for deterioration, then replace (if necessary).

To install:

7. Install the heater core into the blower assembly. Make sure all the seals are positioned properly.
8. From inside the vehicle, install the heating unit cover.
9. From under the vehicle (at the rear heating unit), install the inlet/outlet hoses on the heater core tubes.
10. Refill the radiator to the proper level.
11. Connect the negative battery terminal to the battery.
12. Start the engine and check for leaks.

Figure 24.
Rear heater components

{ewc GSMVIMG,GSMVIMG, !88266g06.bmp}

88266g06

Control Assembly {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Control Assembly

Ü See figures 25, 26, 27, 28, 29, 30, 31

The control assembly is located on the instrument panel to the right side of the steering wheel.

REMOVAL & INSTALLATION

1. Disconnect the negative battery cable from the battery.
2. Remove the instrument panel bezel.
3. Remove the control assembly-to-instrument panel screws and pull the control assembly from the instrument panel.
4. Disconnect the electrical connectors, the control cables and the blower switch from the control assembly.

To install:

5. Install the control assembly after connecting the electrical connectors, the control cables and the blower switch.
6. Install the control assembly-to-instrument panel screws.
7. Install the instrument panel bezel.
8. Connect the negative battery terminal to the battery.
9. Check for proper operation.

Figure 25.
Control panel mounting-1985-95 models

{ewc GSMVIMG,GSMVIMG, !88266g07.bmp}

88266g07

Figure 26.
Control panel connections-1985-95 models

{ewc GSMVIMG,GSMVIMG, !88266g08.bmp}

88266g08

Figure 27.
Control panel mounting-1996 models

{ewc GSMVIMG,GSMVIMG, !88266g18.bmp}

88266g18

Figure 28.
Control panel connections-1996 models

{ewc GSMVIMG,GSMVIMG, !88266g19.bmp}

88266g19

Figure 29.
HVAC vacuum circuit

{ewc GSMVIMG,GSMVIMG, !88266g11.bmp}

88266g11

Figure 30.
Control panel testing chart-1985-95 models

{ewc GSMVIMG,GSMVIMG, !88266g09.bmp}

88266g09

Figure 31.
Control panel testing chart-1996 models

{ewc GSMVIMG,GSMVIMG, !88266g10.bmp}

88266g10

Air Conditioning Compressor {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Air Conditioning Compressor

REMOVAL & INSTALLATION

2.5L Engine

Ü See figure 32

Ä Refer to, Discharging The Air Conditioning System in Section 1 and discharge the air conditioning system. The system should be discharged by a qualified technician with proper recovery equipment. It is illegal to discharge refrigerant into the atmosphere and you may need a permit to purchase new refrigerant. If you do not possess the proper equipment, training and permits to perform refrigerant recovery, allow a repair shop to do that step for you.

1. Disconnect the negative battery cable.
2. Disengage the electrical connectors from the compressor.
3. At the rear of the compressor, remove the bracket from the exhaust manifold.
4. Remove the compressor-to-front bracket bolts, the drive belt and the compressor from the vehicle.

To install:

5. Install the compressor and torque the compressor-to-front bracket bolts to 22 ft. lbs. (30 Nm) and the compressor-to-rear bracket bolts to 18 ft. lbs. (25 Nm).
6. Refer to the, Drive Belt Adjusting procedures in Section 1 and adjust the air conditioning drive belt.
7. Refer to, Charging The Air Conditioning System in Section 1, evacuate and charge the air conditioning system.
8. Connect the negative battery cable and start the engine to check for proper operation.

Figure 32.
Air conditioning compressor mounting-2.5L engine

{ewc GSMVIMG,GSMVIMG, !88266g20.bmp}

88266g20

4.3L Engine {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

4.3L Engine

Ü See figures 33, 34, 35, 36

Ä Refer to Discharging The Air Conditioning System in Section 1 and discharge the air conditioning system. The system should be discharged by a qualified technician with proper recovery equipment. It is illegal to discharge refrigerant into the atmosphere and you may need a permit to purchase new refrigerant. If you do not possess the proper equipment, training and permits to perform refrigerant recovery, allow a repair shop to do that step for you.

1. Disconnect the negative battery cable.
2. Disengage the electrical connectors from the compressor.
3. From the rear of the compressor, remove the intake manifold-to-compressor support bracket.

Ä If the engine is equipped with a carburetor, disconnect the vacuum brake from the carburetor for access.

4. Remove the drive belt idler bracket-to-intake manifold bolts, the drive belt and the bracket from the vehicle.
5. Remove the compressor-to-mounting bracket bolts and the compressor from the vehicle.

To install:

6. Install the compressor and torque the compressor-to-front bracket bolts to 25 ft. lbs. (34 Nm), the idler belt-to-engine bracket bolts to 16 ft. lbs. (22 Nm) and the compressor support bracket bolts to 61 ft. lbs. (83 Nm).
7. Refer to the, Drive Belt Adjusting procedures in Section 1 and adjust the air conditioning drive belt.
8. Refer to, Charging The Air Conditioning System in Section 1, evacuate and recharge the air conditioning system.
9. Connect the negative battery cable and start the engine to check performance.

Figure 33.
Air conditioning compressor mounting-4.3L engine with radial compressor

{ewc GSMVIMG,GSMVIMG, !88266g21.bmp}

88266g21

Figure 34.
Air conditioning compressor mounting-4.3L (VIN Z) engine with axial compressor, except 1996 models

{ewc GSMVIMG,GSMVIMG, !88266g22.bmp}

88266g22

Figure 35.
Air conditioning compressor mounting-4.3L (VIN W) engine with axial compressor, except 1996 models

{ewc GSMVIMG,GSMVIMG, !88266g23.bmp}

88266g23

Figure 36.
Air conditioning compressor mounting-1996 4.3L engine

{ewc GSMVIMG,GSMVIMG, !88266g24.bmp}

88266g24

Air Conditioning Condenser {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Air Conditioning Condenser

REMOVAL & INSTALLATION

Ü See figure 37

1. Disconnect the negative battery cable.
2. Discharge the air conditioning system as outlined in Section 1. The system should be discharged by a qualified technician with proper recovery equipment. It is illegal to discharge refrigerant into the atmosphere and you may need a permit to purchase new refrigerant. If you do not possess the proper equipment, training and permits to perform refrigerant recovery, allow a repair shop to do that step for you.
3. Remove the grille and front end panel.
4. Remove the radiator support bar.
5. Disconnect the condenser inlet and outlet pipes. Plug all openings after disconnecting.
6. Remove the insulator retaining bolts and condenser.

To install:

7. Install the condenser and torque the retaining bolts to 20 ft. lbs. (27 Nm).
8. Unplug and connect the refrigerant pipes.
9. Install the radiator support bar, grille and front end panel.
10. Flush, evacuate and charge the air conditioning system as outlined in Section 1.

Figure 37.
Condenser assembly mounting

{ewc GSMVIMG,GSMVIMG, !88266g25.bmp}

88266g25

Evaporator Blower Motor {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Evaporator Blower Motor

REMOVAL & INSTALLATION

Front System

The blower motor is located in the engine compartment on the right side of the firewall. It is shared by the heater core.

1. Disconnect the negative battery cable from the battery.
2. Disconnect the electrical connector from the blower motor.
3. Remove the radiator coolant collecting bottle from the right side of the engine compartment.
4. Remove the windshield washer fluid bottle from the right side of the engine compartment.
5. Remove the relay bracket and move it aside.
6. Remove the blower motor-to-duct housing screws and the blower motor from the vehicle.

To install:

7. If necessary, replace the blower motor-to-duct housing gasket.
8. Install the blower motor-to-duct housing screws and the blower motor in the vehicle.
9. Install the relay bracket.
10. Install the windshield washer fluid bottle on the right side of the engine compartment.
11. Install the radiator coolant collecting bottle on the right side of the engine compartment.
12. Connect the electrical connector to the blower motor.
13. Connect the negative battery cable to the battery.
14. Check for proper operation.

Rear Overhead System {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Rear Overhead System

Ü See figure 38

The rear overhead blower motor is located at the rear door on the left side.

1. Disconnect the negative battery cable from the battery.
2. Remove the rear blower motor-to-vehicle cover.
3. Disconnect the electrical connectors from the rear blower motor.
4. Remove the blower motor-to-blower case screws and the blower motor from the vehicle.

To install:

5. Install the blower motor-to-blower case screws and the blower motor in the vehicle.
6. Connect the electrical connectors to the rear blower motor.
7. Install the rear blower motor-to-vehicle cover.
8. Connect the negative battery cable to the battery.
9. Check for normal operation.

Figure 38.
Rear air conditioning system components

{ewc GSMVIMG,GSMVIMG, !88266g14.bmp}

88266g14

Air Conditioning System Blower Motor Relay {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Air Conditioning System Blower Motor Relay

Ü See figures 39, 40

The blower motor relay is located on a bracket attached to the right side of the vehicle, near the blower motor.

REMOVAL & INSTALLATION

1. Disconnect the negative battery cable from the battery.
2. Disconnect the electrical connector from the blower motor relay.
3. Remove the blower motor relay bracket-to-vehicle screws, lift the bracket and remove the relay from the bracket.
4. To install, reverse the removal procedures.

Figure 39.
Early style blower motor relay mounting

{ewc GSMVIMG,GSMVIMG, !88266g13.bmp}

88266g13

Figure 40.
Late style blower motor relay mounting

{ewc GSMVIMG,GSMVIMG, !88266g26.bmp}

88266g26

Evaporator Core {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Evaporator Core

Two evaporator cores are used, one in the front (engine compartment) and one at the rear (overhead) door. The rear overhead air conditioning system works in conjunction with the front system.

REMOVAL & INSTALLATION

Ä Before removing the evaporator core, the air conditioning system must be discharged. Refer to the air conditioning Discharging procedures in Section 1 **and discharge the air conditioning system. The system should be discharged by a qualified technician with proper recovery equipment. It is illegal to discharge refrigerant into the atmosphere and you may need a permit to purchase new refrigerant. If you do not possess the proper equipment, training and permits to perform refrigerant recovery, allow a repair shop to do that step for you.**

Front System

Ü See figure 41

The front evaporator core is located in the engine compartment on the right side of the firewall inside the heater/evaporator/blower motor case.

1. Disconnect the negative battery cable from the battery.
2. Remove the radiator coolant collecting bottle and the windshield washer fluid bottle.
3. Disconnect any necessary electrical connectors.
4. Discharge the air conditioning system as outlined in Section 1. Disconnect the air conditioning refrigerant lines from the evaporator.
5. Remove the relay bracket and move it aside.
6. Remove the evaporator/blower case nuts and the case, then separate the evaporator from the case.

To install:

7. Install the evaporator into the case and tighten the retainers.
8. Install the relay bracket.
9. Connect the air conditioning refrigerant lines to the evaporator.
10. Connect any necessary electrical connectors.
11. Install the radiator coolant collecting bottle and the windshield washer fluid bottle.
12. Connect the negative battery cable to the battery.
13. Evacuate and recharge the air conditioning system as outlined in Section 1.
14. Start the engine, allow it establish normal operating temperatures and check the air conditioning cooling operation.

Figure 41.
Front evaporator case mounting

{ewc GSMVIMG,GSMVIMG, !88266g12.bmp}

88266g12

Rear Overhead System {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Rear Overhead System

Ü See figure 38

1. Disconnect the negative battery cable from the battery.
2. Remove the rear evaporator/blower motor-to-vehicle cover.
3. Disconnect the electrical connectors from the rear blower motor and the resistor.
4. Discharge the air conditioning system as outlined in Section 1. From under the left rear of the vehicle, remove the air conditioning line fitting-to-evaporator fitting nut.
5. Remove the evaporator/blower motor case-to-vehicle screws and the case from the vehicle.
6. Separate the air conditioning evaporator from the evaporator/blower motor case assembly.
7. Inspect the air conditioning line gaskets for damage and replace (if necessary).

To install:

8. Install the evaporator into the case. Install the case into the vehicle.
9. Torque the evaporator/blower motor case assembly-to-vehicle screws to 4 inch lbs. (0.5 Nm) and the air conditioning line fitting-to-evaporator fitting nut to 18 ft. lbs. (25 Nm).
10. Reconnect the electrical connectors.
11. Recharge the air conditioning system as outlined in Section 1.
12. Start the engine, allow it establish normal operating temperatures and check the air conditioning cooling operation.

Figure 38.
Rear air conditioning system components

{ewc GSMVIMG,GSMVIMG, !88266g14.bmp}

88266g14

Orifice (Expansion) Tube {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Orifice (Expansion) Tube

Ü See figures 42, 43

The orifice tube is a plastic assembly containing a fixed diameter tube with a mesh filter screen at either end. The tube is located between the condenser outlet and the evaporator inlet tube. The tube acts as a restriction to the high pressure liquid refrigerant in the liquid line, metering the flow of refrigerant to the evaporator.

Figure 42.
Orifice tube assembly

{ewc GSMVIMG,GSMVIMG, !88266g15.bmp}

88266g15

Figure 43.
Air conditioning system component schematic

{ewc GSMVIMG,GSMVIMG, !88266g16.bmp}

88266g16

Figure 44.
Accumulator assembly

{ewc GSMVIMG,GSMVIMG, !88266g17.bmp}

88266g17

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REMOVAL & INSTALLATION

1. Discharge the air conditioning system as outlined in Section 1. The system should be discharged by a qualified technician with proper recovery equipment. It is illegal to discharge refrigerant into the atmosphere and you may need a permit to purchase new refrigerant. If you do not possess the proper equipment, training and permits to perform refrigerant recovery, allow a repair shop to do that step for you.
2. Disconnect the liquid line at the evaporator inlet and remove the orifice tube from the inlet pipe.

   Ä If the tube will not dislodge from the inlet pipe, heat the pipe with a hair dryer to loosen the orifice tube. Use an orifice tube removing tool or a needle nose pliers if one is not available. Be careful not to break off the tube inside the inlet pipe.
3. Flush the entire system to remove any dirt or foreign materials.
4. Remove and replace the accumulator if the orifice tube is clogged with any foreign material.

   Ä The new tube will clog up if the system is not flushed and an accumulator is not replaced.

To install:

5. Install the orifice tube into the evaporator inlet pipe with the shorter screen end inserted first.
6. Reconnect the liquid line to the inlet pipe.
7. Evacuate and recharge the air conditioning system as outlined in Section 1.

Accumulator {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Accumulator

Ü See figure 44

REMOVAL & INSTALLATION

The accumulator is a large aluminum can connected to the evaporator. The unit is in charge of storing refrigerant, removing moisture and filter the system.

1. Discharge the air conditioning system as outlined in Section 1. The system should be discharged by a qualified technician with proper recovery equipment. It is illegal to discharge refrigerant into the atmosphere and you may need a permit to purchase new refrigerant. If you do not possess the proper equipment, training and permits to perform refrigerant recovery, allow a repair shop to do that step for you.
2. Disconnect the negative battery cable and pressure relief switch connector.
3. Disconnect and plug the accumulator inlet and outlet.
4. Cap the open lines immediately after removal.
5. Remove the accumulator retaining screws and accumulator.

To install:

6. Install 2 fluid oz. (60 ml) of 525 viscosity refrigerant oil into the new accumulator.
7. Install the accumulator with new O-rings.
8. Connect the two pipes to the unit.
9. Evacuate and recharge the system as outlined in Section 1 of this manual.

Water Control Valve-Air Conditioning Only {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Water Control Valve-Air Conditioning Only

REMOVAL & INSTALLATION

1. The water control valve is located at the heater core inlet and outlet pipes. The valve is used to shut off hot water flow to the heater core during air conditioning operation.
2. Allow the engine to cool down. Drain the engine coolant into a suitable container.

   ****Caution**
   When draining the coolant, keep in mind that cats and dogs are attracted by the ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.

3. Remove the hose clamps and hoses from the valve and remove the valve from the heater core pipes.

   ****Warning**
   Cut the hoses off of the heater core if they will not remove easily. Damage to the heater core may result if the hoses are forced away from the heater core.

4. Install the valve with new hoses and tighten the clamps.
5. Refill the engine with clean coolant.
6. Start the engine and check for proper operation.

RADIO {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Chassis Electrical

RADIO

Radio Assembly

REMOVAL & INSTALLATION

Ü See figures 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55

1. Disconnect the negative battery cable from the battery.
2. On some models you will need to remove the instrument panel-to-engine cover assembly.
3. Remove the radio-to-instrument panel bezel.
4. Remove the radio-to-instrument panel fasteners, except on 1996 models. On 1996 models, squeeze the clips to release the radio or remote cassette deck
5. Pull the radio (slightly) from the instrument, then disconnect the antenna and electrical connectors.
6. Remove the radio from the instrument panel.

To install:

7. Install the radio into the instrument panel after connecting the antenna and electrical connectors.
8. Install the radio-to-instrument panel fasteners.
9. Install the radio-to-instrument panel bezel.
10. Install the instrument panel-to-engine cover assembly, if removed.
11. Connect the negative battery cable to the battery and check operation.

Figure 45.
Radio mounting-1985-91 models

{ewc GSMVIMG,GSMVIMG, !88266g27.bmp}

88266g27

Figure 46.
Radio mounting-1991-95 models

{ewc GSMVIMG,GSMVIMG, !88266g30.bmp}

88266g30

Figure 47.
Remote cassette deck mounting-1996 models

{ewc GSMVIMG,GSMVIMG, !88266g32.bmp}

88266g32

Figure 48.
Typical dash speaker mounting

{ewc GSMVIMG,GSMVIMG, !88266g28.bmp}

88266g28

Figure 49.
Typical rear speaker mounting

{ewc GSMVIMG,GSMVIMG, !88266g29.bmp}

88266g29

Figure 50.

Radio mounting-1996 models

{ewc GSMVIMG,GSMVIMG, !88266g31.bmp}

88266g31

Figure 51.
The trim piece around the radio is held by 2 screws at the bottom

{ewc GSMVIMG,GSMVIMG, !88266p13.bmp}

88266p13

Figure 52.
Pull the trim piece off and disconnect the wiring to switches

{ewc GSMVIMG,GSMVIMG, !88266p14.bmp}

88266p14

Figure 53.
Unbolt the 4 fasteners at the mounting bracket to free the radio

{ewc GSMVIMG,GSMVIMG, !88266p15.bmp}

88266p15

Figure 54.
The radio slides straight in and out

{ewc GSMVIMG,GSMVIMG, !88266p16.bmp}

88266p16

Figure 55.
Don't forget to unplug the connections at the back of the radio!

{ewc GSMVIMG,GSMVIMG, !88266p17.bmp}

88266p17

WINDSHIELD WIPERS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

WINDSHIELD WIPERS

Ü See figures 56, 57, 58

The windshield wiper units are of the 2-speed, non-depressed park type, a washer pump mounted under the washer bottle and turn signal type wiper/washer switch. A single wiper motor operates both wiper blades. Rotating the switch to either **LO** or **HI** speed position completes the circuit and the wiper motor runs at that speed.

The pulse/demand wash functions are controlled by a plug-in printed circuit board enclosed in the wiper housing cover.

Figure 56.
The washer bottle has the washer pump built into the side of it. Removing the bottle allows access

{ewc GSMVIMG,GSMVIMG, !88266p31.bmp}

88266p31

Figure 57.
The electrical connector is the watertight and has a catch to keep it secure

{ewc GSMVIMG,GSMVIMG, !88266p32.bmp}

88266p32

Figure 58.
The check valve keeps fluid in the line at all time

{ewc GSMVIMG,GSMVIMG, !88266p33.bmp}

88266p33

Blade and Arm {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Blade and Arm

REMOVAL & INSTALLATION

Ü See figures 59, 60, 61, 62, 63

> **Ä The following procedure is easier if you use GM Windshield Wiper Blade/Arm Removal tool No. J8966 or equivalent.**

If the wiper assembly has a press type release tab at the center, simply depress the tab and remove the blade. If the blade has no release tab, use a screwdriver to depress the spring at the center; this will release the assembly. To install the assembly, position the blade over the pin (at the tip of the arm) and press until the spring retainer engages the groove in the pin.

To remove the element, either depress the release button or squeeze the spring type retainer clip (at the outer end) together and slide the blade element out. To install, slide the new element in until it latches.

1. Insert the tool under the wiper arm and lever the arm off the shaft. If you do not have the tool, use a pick to release the latch at the bottom of the arm.
2. Disconnect the washer hose from the arm (if equipped), then remove the arm.

To install:

3. Operate the wiper motor (momentarily) to position the pivot shafts into the park position. The proper park position for the arms is with the blades approximately 50mm on the driver's side, or 70mm on the passenger's side, above the lower windshield molding.
4. Connect the water hose and check operation.

Figure 59.
Removing the wiper arm using GM tool J-8966

{ewc GSMVIMG,GSMVIMG, !88266g33.bmp}

88266g33

Figure 60.
Wiper arm positioning

{ewc GSMVIMG,GSMVIMG, !88266g34.bmp}

88266g34

Figure 61.
If you don't have the special wiper arm tool, just pull back on the arm's side latch

{ewc GSMVIMG,GSMVIMG, !88266p18.bmp}

88266p18

Figure 62.
The arm is splined to meet the linkage. Note the latch at the bottom of the wiper arm

{ewc GSMVIMG,GSMVIMG, !88266p19.bmp}

88266p19

Figure 63.
On wiper arms with the washer nozzle built into it, you will need to disconnect the fluid hose

{ewc GSMVIMG,GSMVIMG, !88266p20.bmp}

88266p20

Windshield Wiper Motor {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Windshield Wiper Motor

The windshield wiper motor is located in the engine compartment on the left side of the cowl.

REMOVAL & INSTALLATION

Front Wipers

Ü See figures 64, 65, 66, 67, 68, 69, 70

1. Disconnect the negative battery cable and the electrical connector from the windshield wiper motor.
2. Remove the transmission link from the wiper motor crank arm by pulling or prying it toward the rear of the vehicle.
3. Remove the wiper motor-to-cowl bolts and the wiper motor from the vehicle.

To install:

4. Install the wiper motor-to-cowl bolts and the wiper motor in the vehicle.
5. Connect the transmission link to the wiper motor crank arm by pushing toward the front of the vehicle.
6. Connect the negative battery cable. Attach the electrical connector to the windshield wiper motor.

6. Check for proper operation.

Figure 64.
Wiper circuit-with pulse used on models through 1993

{ewc GSMVIMG,GSMVIMG, !88266g38.bmp}

88266g38

Figure 65.
Wiper switch testing-1994-96 models

{ewc GSMVIMG,GSMVIMG, !88266g40.bmp}

88266g40

Figure 66.
Wiper motor testing-1994-96 models

{ewc GSMVIMG,GSMVIMG, !88266g3b.bmp}

88266g3b

Figure 67.
Typical wiper motor mounting scheme

{ewc GSMVIMG,GSMVIMG, !88266g36.bmp}

88266g36

Figure 68.
The connector has a positive lock on it that will need to be pressed in to unplug it

{ewc GSMVIMG,GSMVIMG, !88266p21.bmp}

88266p21

Figure 69.
The bolts go through rubber isolators. Check the condition of the rubber when dismounting

{ewc GSMVIMG,GSMVIMG, !88266p22.bmp}

88266p22

Figure 70.
Once the linkage has been disconnected from the motor, the unit will pull right out

{ewc GSMVIMG,GSMVIMG, !88266p23.bmp}

88266p23

Rear Wipers {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Rear Wipers

Ü See figures 71, 72, 73

1. Disconnect the negative battery cable. Remove the electrical connector from the windshield wiper motor.
2. Remove the trim from over the motor assembly.
3. Disconnect the wiper motor electrical plug.
4. Remove the wiper arm from the wiper motor shaft.
5. Remove the nut, spacer, seal and the 2 bolts from the motor. Lift the motor out of the tailgate.

To install:

6. Install the motor, bolts, seal, spacer and nut. Torque the bolts to 62 inch lbs. (7 Nm).
7. Install the wiper arm and plug in the electrical connector.
7. Install the trim and connect the negative battery cable.

Figure 71.
Rear wiper circuit

{ewc GSMVIMG,GSMVIMG, !88266g41.bmp}

88266g41

Figure 72.
Rear wiper switch continuity chart

{ewc GSMVIMG,GSMVIMG, !88266g42.bmp}

88266g42

Figure 73.
Rear wiper assembly mounting

{ewc GSMVIMG,GSMVIMG, !88266g35.bmp}

88266g35

Wiper Linkage {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Wiper Linkage

REMOVAL & INSTALLATION

Ü See figures 74, 75, 76, 77, 78, 79, 80

Ä The following procedure is easier if you use GM Windshield Wiper Blade/Arm Removal tool No. J8966 or equivalent.

1. Using the GM Windshield Wiper Blade/Arm Removal tool No. J8966 or equivalent, remove the wiper blade/arm assemblies from the pivot shafts.
2. Remove the antenna, if necessary.
3. Remove the outside air cowl ventilator grille-to-cowl screws and the grille from the cowl.
4. At the center of the cowl, remove the link rod-to-motor drive nut, then disengage the link rod from the pins.
5. Remove the arm transmission pivot shaft assembly-to-cowl nuts.
6. Remove the pivot shaft assembly (with link rod) from the plenum chamber.

To install:

7. Operate the wiper motor (momentarily) to position the pivot shafts in the park position.
8. Install the pivot shaft assembly (with link rod) in the plenum chamber.
9. Install the arm transmission pivot shaft assembly-to-cowl nuts.
10. At the center of the cowl, install the link rod-to-motor drive nut.
11. Install the outside air cowl ventilator grille-to-cowl screws and grille to the cowl.
12. Install the antenna.
13. Install the wiper blade/arm assemblies on the pivot shafts. Check for proper operation.

Figure 74.
Remove the screws holding the cowl grille.
{ewc GSMVIMG,GSMVIMG, !88266p24.bmp}

88266p24

Figure 75.
The grille will only come off once the wiper arms are removed
{ewc GSMVIMG,GSMVIMG, !88266p25.bmp}

88266p25

Figure 76.
The screen comes out after the grille is removed
{ewc GSMVIMG,GSMVIMG, !88266p26.bmp}

88266p26

Figure 77.
The linkage pops off the motor arm to remove
{ewc GSMVIMG,GSMVIMG, !88266p27.bmp}

88266p27

Figure 78.
Check bushing condition when the linkage is removed
{ewc GSMVIMG,GSMVIMG, !88266p28.bmp}

88266p28

Figure 79.
The linkage stubs are held by the large nuts at the cowl

{ewc GSMVIMG,GSMVIMG, !88266p29.bmp}

88266p29

Figure 80.
Windshield wiper assembly and linkage

{ewc GSMVIMG,GSMVIMG, !88266g37.bmp}

88266g37

INSTRUMENTS AND SWITCHES {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

INSTRUMENTS AND SWITCHES

Instrument Cluster

REMOVAL & INSTALLATION

Except 1996 Models

Ü See figures 81, 82, 83, 84

1. Disconnect the negative battery cable from the battery.
2. Remove the lower steering column cover-to-instrument panel screws and the cover.
3. Remove the instrument cluster trim plate-to-instrument cluster screws and the panel, then allow the panel to hang to the left side by the wiring.
4. Remove the air conditioning control-to-instrument panel screws and move the control assembly aside.
5. For access, remove the seat alarm assembly from the bracket, on the left side of the instrument panel.
6. Remove the instrument panel cluster-to-instrument panel fasteners and the cluster assembly.
7. Disconnect the speedometer cable (of applicable), the speed sensor and any other necessary electrical connectors.

To install:

8. Connect the speedometer cable (if applicable), the speed sensor and any other necessary electrical connectors.
9. Install the instrument panel cluster-to-instrument panel fasteners and the cluster assembly.
10. Install the seat alarm assembly on the bracket, on the left side of the instrument panel.
11. Install the air conditioning control-to-instrument panel screws and the control assembly.
12. Install the instrument cluster trim plate-to-instrument cluster screws and the panel.
13. Install the lower steering column cover-to-instrument panel screws and the cover.
14. Connect the negative battery cable to the battery and check operation.

Figure 81.
Instrument cluster mounting-1985-92 models
{ewc GSMVIMG,GSMVIMG, !88266g3a.bmp}

88266g3a

Figure 82.
Instrument cluster mounting-1993-95 models
{ewc GSMVIMG,GSMVIMG, !88266g39.bmp}

88266g39

Figure 83.
Instrument cluster bulb and connector locations-Standard analog cluster
{ewc GSMVIMG,GSMVIMG, !88266g4a.bmp}

88266g4a

Figure 84.
Instrument cluster bulb and connector locations-Digital cluster
{ewc GSMVIMG,GSMVIMG, !88266g4e.bmp}

88266g4e

1996 Models {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

1996 Models

Ü See figures 85, 86

1. Disconnect the negative battery cable.
2. Apply the parking brake and turn the key to the **ON** position. Place the gear selector in 1st gear.
3. Pull the trim plate away from the dash until all the connectors are released. Unplug any electrical connections.
4. Remove the 4 screws holding the instrument cluster to the dash. Pull the cluster out from the electrical connectors.

To install:

5. Align the instrument cluster with the electrical connectors and push into place.
6. Install the 4 instrument cluster screws.
7. Place the trim plate in place and connect the electrical plugs. Press the trim plate into the connectors until they are all firmly attached.
8. Return the gear selector to **PARK** and turn the ignition switch to **OFF**. Connect the negative battery cable.

Figure 85.
Instrument cluster mounting screw locations-1996 models

{ewc GSMVIMG,GSMVIMG, !88266g4c.bmp}

88266g4c

Figure 86.
Instrument panel trim mounting points-1996 models

{ewc GSMVIMG,GSMVIMG, !88266g46.bmp}

88266g46

Speedometer {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Speedometer

REMOVAL & INSTALLATION

1. Disconnect the negative battery cable.
2. Remove the instrument cluster from the instrument panel.
3. Remove the speedometer head retaining screws and the speedometer.

To install:

4. Install the speedometer head and retaining screws.
5. Install the instrument cluster.
6. Connect the negative battery cable.

Gauges {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Chassis Electrical

Gauges

REMOVAL & INSTALLATION

1. Disconnect the negative battery cable.
2. Remove the instrument cluster from the instrument panel.
3. Remove the gauge retaining screws and gauge.

To install:

4. Install the gauge, retaining screws, instrument cluster and negative battery cable.
5. Check for proper operation.

Windshield Wiper Switch {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Windshield Wiper Switch

The windshield wiper switch is located within the steering column and is actuated by the external lever, except on 1996 vehicles. In 1996 a new steering column was introduced. The switch is now located up at the top of the column, just underneath the steering wheel.

REMOVAL & INSTALLATION

Ä Refer to the Combination Switch, Removal and Installation procedures in Section 8 **to replace the combination switch.**

Headlight Switch {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Headlight Switch

Ü See figures 87, 88

The headlight switch, a push button (rotary dial on 1996) switch to turn the lights on and off, is located on the left side of the instrument panel. A rheostat dial, located with the headlight/parking light switch, is used to control the illumination of the instrument panel.

A dimmer switch (part of the combination switch), to control the **Hi** and **Lo** beam operation, is located in the steering column; the lights are changed by pulling the lever toward the driver.

Figure 87.
Headlight switch electrical connections-1985-95 shown, 1996 similar

{ewc GSMVIMG,GSMVIMG, !88266g43.bmp}

88266g43

Figure 88.
This style headlight switch was used up to 1995. In 1996 a rotary switch was used

{ewc GSMVIMG,GSMVIMG, !88266g44.bmp}

88266g44

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Chassis Electrical

REMOVAL & INSTALLATION

1. Disconnect the negative battery cable from the battery.
2. Remove the lower steering column cover-to-instrument panel screws and the cover.
3. Remove the instrument cluster trim plate-to-instrument cluster screws and the panel, then allow the panel to hang to the left side by the wiring.
4. Disconnect the electrical connector from the rear of the headlight switch.
5. Disengage and remove the headlight switch from the instrument cluster trim plate.

To install:

6. Connect the electrical connector to the rear of the headlight switch.
7. Engage and install the headlight switch in the instrument cluster trim plate.
8. Install the instrument cluster trim plate-to-instrument cluster screws and the panel.
9. Install the lower steering column cover-to-instrument panel screws and the cover.
10. Connect the negative battery cable to the battery and check operation.

Back-Up Light Switch {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Back-Up Light Switch

REMOVAL & INSTALLATION

Automatic Transmission

Ü See figure 89

Vehicles up to and including 1995 model year have the back-up light switch mounted on the steering column. On the 1996 model year vehicles, the back-up light switch is part of the neutral safety switch mounted on the side of the transmission. Refer to the procedure for replacement of the neutral safety switch is Section 7.

1. Disconnect the negative battery cable from the battery.
2. From the steering column, disconnect the electrical harness connector from the back-up light switch.
3. Using a small pry bar, expand the back-up switch-to-steering column retainers and remove the switch from the steering column.

To install:

4. Place the gear selector in **NEUTRAL** and align the actuator on the switch with the hole in the shift tube. Align the mounting tangs with the mounting holes and press down to lock in place.
5. Connect the electrical harness connector to the back-up light switch.
6. Connect the negative battery cable to the battery.
7. Move the gear selector through all the positions including **PARK** and **LOW**. This should ratchet the switch and self adjust it.

9. Place the gear shift lever in the **REVERSE** position and check that the back-up lights turn on.

Figure 89.
The back up light switch also contains the neutral safety switch on automatic transmission equipped vehicles-1985-95 models

{ewc GSMVIMG,GSMVIMG, !88266g45.bmp}

88266g45

Manual Transmission {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Chassis Electrical

Manual Transmission

To replace the back-up light switch, refer to the Back-Up Light Switch, Removal and Installation procedures in Section 7.

Speedometer Cable {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Speedometer Cable

REMOVAL & INSTALLATION

Mechanical Speedometer

Ü See figure 90

1. Refer to the Instrument Cluster, Removal and Installation procedures in this section and remove the instrument cluster.
2. From the rear of the instrument cluster, remove the speedometer cable-to-head fitting.
3. If replacing ONLY the speedometer cable core, perform the following procedures:
    a. Disconnect the speedometer casing from the speedometer head.
    b. Pull the speedometer cable core from the speedometer casing.
    c. Using lubricant P/N 6478535 or equivalent, lubricate a new speedometer cable core and install the cable into the casing.
4. If replacing the speedometer cable core and the speedometer cable casing, perform the following procedures:
    a. Disconnect the speedometer cable casing from the speedometer head.
    b. Disconnect the speedometer cable casing from the transmission.
    c. Remove the various speedometer cable/casing retaining clips.
    d. Remove the speedometer cable/casing assembly from the vehicle.

Figure 90.
Mechanical speedometer cable routing

{ewc GSMVIMG,GSMVIMG, !88266g4b.bmp}

88266g4b

Electronic Speedometer {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Electronic Speedometer

Ü See figure 91

1. Disconnect the negative battery cable.
2. Raise and safely support the vehicle with jackstands.
3. Disconnect the harness connector at the transmission.
4. Remove the retaining bolt and sensor.
5. Drain the excess fluid into a drain pan.
6. Replace the O-ring seal if damaged.

To install:

7. Install the sensor with a new O-ring. Coat the seal with a film of transmission fluid.
8. Install the bolt and torque to 96 inch lbs. (11 Nm).
9. Connect the harness connector and negative battery cable.
10. Start the engine and allow it to reach normal operating temperature.
10. Refill the transmission with fluid to the proper level and check operation.

Figure 91.
Typical electronic speedometer speed sensor mounted in the transmission or the transfer case

{ewc GSMVIMG,GSMVIMG, !88266g47.bmp}

88266g47

{ewc GSMVIMG,GSMVIMG, !88266c02.bmp}

88266c02

{ewc GSMVIMG,GSMVIMG, !88266c03.bmp}

88266c03

{ewc GSMVIMG,GSMVIMG, !88266c04.bmp}

88266c04

{ewc GSMVIMG,GSMVIMG, !88266c05.bmp}

88266c05

{ewc GSMVIMG,GSMVIMG, !88266c06.bmp}

88266c06

{ewc GSMVIMG,GSMVIMG, !88266c07.bmp}

88266c07

Chassis Electrical

LIGHTING

Headlights

REMOVAL & INSTALLATION

Ä The following procedures may require the use of the GM Safety Aimer tool No. J687801 or equivalent.

Sealed Beam

Ü See figures 92, 93, 94, 95, 96

1. Disconnect the negative battery cable from the battery.
2. Remove the headlight bezel-to-fender screws and the bezel; allow the bezel to hang by the parking/side marker light wires.
3. Remove the headlight retaining-to-fender spring.
4. Remove the headlight retaining ring-to-fender screws and the retaining ring.
5. Disconnect the electrical connector from the headlight and remove the headlight from the vehicle.

To install:

6. Connect the electrical connector to the headlight and install the headlight into the vehicle.
7. Install the headlight retaining ring and the retaining ring-to-fender screws.
8. Install the headlight retaining ring-to-fender spring.
9. Install the headlight bezel and the bezel-to-fender screws.
10. Connect the negative battery cable to the battery.
11. Check the headlight operation. Although, adjustment procedures may not be necessary, DO check the aim of the headlight.

Ä If necessary to adjust the headlight aim, use the GM Safety Aimer tool No. J687801 or equivalent.

Figure 92.
Sealed beam headlight mounting

{ewc GSMVIMG,GSMVIMG, !88266g48.bmp}

88266g48

Figure 93.
The headlight bezel needs to be removed to access the mounting screws for the bulb itself

{ewc GSMVIMG,GSMVIMG, !88266p34.bmp}

88266p34

Figure 94.
Be careful with the headlight retaining ring screws. They can strip out easily

{ewc GSMVIMG,GSMVIMG, !88266p35.bmp}

88266p35

Figure 95.
If the ring becomes damaged, it can be replaced with parts from most auto supply stores

{ewc GSMVIMG,GSMVIMG, !88266p36.bmp}

88266p36

Figure 96.
Check the terminals for signs of burning. A bad connection here can cause all sorts of light problems

{ewc GSMVIMG,GSMVIMG, !88266p37.bmp}

88266p37

Composite Headlamp {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Composite Headlamp

Ü See figures 97, 98, 99, 100, 101, 102, 103, 104, 105, 106

1. Open the hood. Disconnect the negative battery cable from the battery.
2. Remove the composite headlamp side lens.
3. Remove the 3 bolts holding the composite headlight assembly to the body.
4. Unplug the bulb connector and remove the assembly from the vehicle.
5. Installation is the reverse of removal.

Figure 97.
Composite headlamp assembly

{ewc GSMVIMG,GSMVIMG, !88266g49.bmp}

88266g49

Figure 98.
Composite headlamp side lens

{ewc GSMVIMG,GSMVIMG, !88266g53.bmp}

88266g53

Figure 99.
Remove this screw to release the side lens

{ewc GSMVIMG,GSMVIMG, !88266p38.bmp}

88266p38

Figure 100.
Pull the side lens out to expose the main headlight mounting points

{ewc GSMVIMG,GSMVIMG, !88266p39.bmp}

88266p39

Figure 101.
Headlight side mounting bolt

{ewc GSMVIMG,GSMVIMG, !88266p40.bmp}

88266p40

Figure 102.
Headlight bracket mounting bolt

{ewc GSMVIMG,GSMVIMG, !88266p41.bmp}

88266p41

Figure 103.
Pull the entire headlight unit out from the body

{ewc GSMVIMG,GSMVIMG, !88266p42.bmp}

88266p42

Figure 104.
The composite headlights use separate bulbs that mount to the headlight assembly

{ewc GSMVIMG,GSMVIMG, !88266p43.bmp}

88266p43

Figure 105.
Do not touch the surface of the bulb or it will burn out prematurely

{ewc GSMVIMG,GSMVIMG, !88266p44.bmp}

88266p44

Figure 106.
With the headlight removed, you can get to the parking light bulbs

{ewc GSMVIMG,GSMVIMG, !88266p45.bmp}

88266p45

HEADLIGHT AIMING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

HEADLIGHT AIMING

Ü See figures 107, 108, 109

Horizontal and vertical aiming of each headlight is done by 2 adjusting screws which move the mounting ring against the tension of the coil spring.

Some state and local authorities have specific requirements for aiming headlights and these requirements should be followed.

Figure 107.
Headlight adjusting screws

{ewc GSMVIMG,GSMVIMG, !88266g50.bmp}

88266g50

Figure 108.
Headlight aiming preparation

{ewc GSMVIMG,GSMVIMG, !88266g51.bmp}

88266g51

Figure 109.
Headlight aiming limits

{ewc GSMVIMG,GSMVIMG, !88266g52.bmp}

88266g52

Fog Light {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Fog Light

REMOVAL & INSTALLATION

Ü See figures 110, 111, 112

Remove the fog light electrical connector, retaining bolt and light from the air dam and the bumper.

Figure 110.
The foglamp relay is located in the convenience center

{ewc GSMVIMG,GSMVIMG, !88266g5a.bmp}

88266g5a

Figure 111.
The bulb is mounted in the fog light by a bayonet mount

{ewc GSMVIMG,GSMVIMG, !88266p46.bmp}

88266p46

Figure 112.
The bulb is a halogen unit. Do not touch the glass surface

{ewc GSMVIMG,GSMVIMG, !88266p47.bmp}

88266p47

AIMING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

AIMING

1. Park the truck on level ground, facing, perpendicular to, and about 25 ft. (8 m) from a flat wall.
2. Remove any stone shields and switch on the fog lights.
3. Loosen the mounting hardware of the lights so you can aim them as follows:
    a. The horizontal distance between the light beams on the wall should be the same as between the lights themselves.
    b. The vertical height of the light beams above the ground should be 4 inches (100 mm) less than the distance between the ground and the center of the lamp lenses.
4. Tighten the mounting hardware.

Signal and Marker Lights {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Signal and Marker Lights

REMOVAL & INSTALLATION

Front Turn Signal and Parking Lights

Ü See figures 113, 114, 115, 116, 117, 118, 119

1. Disconnect the negative battery cable from the battery.
2. Remove the headlight bezel-to-fender screws and the bezel; allow the bezel to hang by the turn signal/parking/marker light wires.
3. From the rear headlight bezel, remove the turn signal/parking/marker lamp-to-bezel screws and the turn signal/parking/marker lamp.
4. Disconnect the turn signal bulb and the parking/marker bulb from the lamp housing and the housing from the vehicle.
5. To install, use new bulbs (if necessary) and reverse the removal procedures. Check the turn signal and the parking/marker light operations

Figure 113.
Front turn signal and parking lamp assembly-with sealed beam headlight
{ewc GSMVIMG,GSMVIMG, !88266g54.bmp}

88266g54

Figure 114.
Front turn signal and parking lamp assembly-with composite headlight
{ewc GSMVIMG,GSMVIMG, !88266g55.bmp}

88266g55

Figure 115.
The headlight bezel contains the turn signal and parking lamps
{ewc GSMVIMG,GSMVIMG, !88266p48.bmp}

88266p48

Figure 116.
Note the seal around the socket. Check its condition before installation
{ewc GSMVIMG,GSMVIMG, !88266p49.bmp}

88266p49

Figure 117.
This socket is a twist to lock design
{ewc GSMVIMG,GSMVIMG, !88266p50.bmp}

88266p50

Figure 118.
The replacement bulb just pushes into the socket
{ewc GSMVIMG,GSMVIMG, !88266p51.bmp}

88266p51

Figure 119.
The grease at the bottom of the bulb is to help prevent corrosion
{ewc GSMVIMG,GSMVIMG, !88266p52.bmp}

88266p52

Rear Turn Signal, Brake and Parking Lights {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Rear Turn Signal, Brake and Parking Lights

Ü See figures 120, 121, 122

1. Disconnect the negative battery cable from the battery.
2. Remove the rear turn signal/brake/parking lamp-to-vehicle screw and the lamp housing from the vehicle.
3. Replace the defective bulb(s).
4. To install, reverse the removal procedures.

Figure 120.
Rear lamp assembly

{ewc GSMVIMG,GSMVIMG, !88266g56.bmp}

88266g56

Figure 121.
The taillight housing is held by this screw

{ewc GSMVIMG,GSMVIMG, !88266p53.bmp}

88266p53

Figure 122.
The bulbs mount in sockets that twist into the taillight housing

{ewc GSMVIMG,GSMVIMG, !88266p54.bmp}

88266p54

License Plate Lamp {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

License Plate Lamp

REMOVAL & INSTALLATION

Ü See figures 123, 124, 125, 126

Remove the mounting screws, lamp assembly and light bulb.

Figure 123.
License plate light assembly

{ewc GSMVIMG,GSMVIMG, !88266g57.bmp}

88266g57

Figure 124.
The license plate light is held by 2 bolts

{ewc GSMVIMG,GSMVIMG, !88266p55.bmp}

88266p55

Figure 125.
The socket twists into the light housing

{ewc GSMVIMG,GSMVIMG, !88266p56.bmp}

88266p56

Figure 126.
The bulb pushes into the socket

{ewc GSMVIMG,GSMVIMG, !88266p57.bmp}

88266p57

Center High Mounted Stop Lamp {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Center High Mounted Stop Lamp

REMOVAL & INSTALLATION

Ü See figure 127, 128

Remove the mounting screws, unplug the wires and remove the lamp assembly.

Figure 127.
Center high mounted stop light assembly

{ewc GSMVIMG,GSMVIMG, !88266g58.bmp}

88266g58

Figure 128.
Light bulb applications

{ewc GSMVIMG,GSMVIMG, !88266g59.bmp}

88266g59

CRUISE CONTROL {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CRUISE CONTROL

The cruise control system is a speed control system which maintains a desired vehicle speed under normal driving conditions. However, steep grades up or down may cause variations in the selected speed.

The main components of the cruise control system are the mode control switches, controller (module), servo unit, speed sensor, vacuum supply, electrical and vacuum release switches.

To release the system, 2 release switches are provided. An electrical release switch is mounted on the brake pedal bracket and clutch pedal bracket on the vehicles equipped with manual transmissions. A vacuum release valve is mounted on the brake pedal bracket. The valve vents the trapped vacuum in the servo when the brake pedal is depressed, allowing the servo to return the throttle to idle position.

Ä The 1995-96 models use an all electric system. There are no vacuum systems used.

OPERATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

OPERATION

The controller interprets the position of the servo, position of the mode control switches and the output of the speed sensor. The servo consists of a vacuum tank and an open solenoid valve to vent the diaphragm chamber to atmosphere, except for the electric systems which use an electric stepper motor. The digital ratio adapter is a solid state device that is used to change the signal from the vehicle speed sensor to the a digital signal. The adapter is matched to the final drive of each vehicle and most be replaced with the proper adapter to match the final drive. This unit is located inside the vehicle speed sensor at the transmission.

DIAGNOSIS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Chassis Electrical

DIAGNOSIS

Ü See figures 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142

A problem can be mechanical, electrical and/or vacuum.

Initial Inspection

1. Check for bare, broken or disconnected wires and vacuum hoses.
2. Make sure the servo and throttle linkages operate freely and smoothly.
3. Check the "Ignition/Gauges" 20 amp fuse.
4. Verify that the check valve functions properly.
5. If no problems are found, refer to the "Cruise Control" diagnostic and wiring charts in this section.

Figure 129.
Cruise control diagnostic chart-1985-94 models

{ewc GSMVIMG,GSMVIMG, !88266g60.bmp}

88266g60

Figure 130.
Cruise control diagnostic chart-1985-94 models

{ewc GSMVIMG,GSMVIMG, !88266g61.bmp}

88266g61

Figure 131.
Cruise control diagnostic chart-1985-94 models

{ewc GSMVIMG,GSMVIMG, !88266g62.bmp}

88266g62

Figure 132.
Cruise control diagnostic chart-1985-94 models

{ewc GSMVIMG,GSMVIMG, !88266g63.bmp}

88266g63

Figure 133.
Cruise control diagnostic chart-1985-94 models

{ewc GSMVIMG,GSMVIMG, !88266g64.bmp}

88266g64

Figure 134.
Cruise control diagnostic chart-1985-94 models

{ewc GSMVIMG,GSMVIMG, !88266g65.bmp}

88266g65

Figure 135.
Cruise control diagnostic chart-1985-94 models

{ewc GSMVIMG,GSMVIMG, !88266g66.bmp}

88266g66

Figure 136.
Cruise control diagnostic chart-1995-96 models

{ewc GSMVIMG,GSMVIMG, !88266g67.bmp}

88266g67

Figure 137.
Cruise control diagnostic chart-1995-96 models

{ewc GSMVIMG,GSMVIMG, !88266g68.bmp}

88266g68

Figure 138.
Cruise control diagnostic chart-1995-96 models

{ewc GSMVIMG,GSMVIMG, !88266g69.bmp}

88266g69

Figure 139.
Cruise control wiring-1985-94 models

{ewc GSMVIMG,GSMVIMG, !88266g70.bmp}

88266g70

Figure 140.
Cruise control wiring-1985-94 models

{ewc GSMVIMG,GSMVIMG, !88266g71.bmp}

88266g71

Figure 141.
Cruise control wiring-1985-94 models

{ewc GSMVIMG,GSMVIMG, !88266g72.bmp}

88266g72

Figure 142.
Cruise control wiring-1995-96 models

{ewc GSMVIMG,GSMVIMG, !88266g73.bmp}

88266g73

Vacuum Release Switch {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Vacuum Release Switch

REMOVAL & INSTALLATION

Ü See figures 143, 144

1. Disconnect the negative battery cable.
2. Disconnect the instrument panel harness and vacuum lines.
3. Turn the retainer counter clockwise to unseal the valve and remove the valve.

To install:

4. Turn the retainer clockwise to seat.
5. Install the release valve until it seats on the retainer with the brake pedal in the depressed position.
6. Note that audible clicks can be heard as the threaded portion of the valve is pushed through the retainer toward the brake pedal.
   a. **Release Valve Adjustment:** fully depress the brake pedal with the engine NOT running.
   b. Push the vacuum hose side of the valve toward the bracket until the valve bottoms on the retainer.
   c. Pull the brake pedal firmly rearward against the pedal stop until no clicking sound can be heard.
   d. Release the brake and repeat step C.
7. Connect the vacuum and electrical connectors.
7. Connect the negative battery cable and check operation.

Figure 143.
The vacuum release switch is mounted to the same bracket as the brake light switch

{ewc GSMVIMG,GSMVIMG, !88266p58.bmp}

88266p58

Figure 144.
Vacuum release valve

{ewc GSMVIMG,GSMVIMG, !88266g74.bmp}

88266g74

Control Module {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Control Module

REMOVAL & INSTALLATION

Ü See figure 145

1. Disconnect the negative battery cable.
2. Remove the harness connector.
3. Remove the module by prying back the retaining clip on the bracket and sliding the module out.

To install:

4. Install the module and harness connector.
5. Connect the negative battery cable and check operation.

Figure 145.
Control module mounting

{ewc GSMVIMG,GSMVIMG, !88266g75.bmp}

88266g75

Servo Unit {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Servo Unit

REMOVAL & INSTALLATION

Ü See figures 146, 147, 148, 149

1. Disconnect the negative battery cable.
2. Remove the vacuum hoses (if equipped), retainer, rod-to-throttle shaft, bolts and the servo.

   Ä Do NOT allow any flexible components to route within 2 inches (50 mm) of moving parts and throttle linkages. Use plastic tie straps to hold components away from moving parts.

To install:

3. Install the servo, bolts, rod-to-throttle shaft, retainer and vacuum hoses.
4. Connect the negative battery cable and check operation.

Figure 146.
Servo unit-2.5L engine

{ewc GSMVIMG,GSMVIMG, !88266g76.bmp}

88266g76

Figure 147.
Servo unit-4.3L engine, with carburetor or TBI

{ewc GSMVIMG,GSMVIMG, !88266g77.bmp}

88266g77

Figure 148.
Servo unit-4.3L engine, with electronic cruise control

{ewc GSMVIMG,GSMVIMG, !88266g79.bmp}

88266g79

Figure 149.
Servo unit-4.3L (VIN W) engine

{ewc GSMVIMG,GSMVIMG, !88266g78.bmp}

88266g78

TRAILER WIRING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TRAILER WIRING

Wiring the van 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 states require extra marker lights for overly wide trailers. Also, most states 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 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 included 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 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 with separate turn signals, you can purchase an isolation unit so that the brake lights won't blink whenever the turn signals are operated, or, you can go to your local electronics supply house and buy four diodes to wire in series with the brake and turn signal bulbs. Diodes will isolate the brake and turn signals. The choice is yours. The isolation units are simple and quick to install, but far more expensive than the diodes. The diodes, however, require more work to install properly, since they require the cutting of each bulb's wire and soldering in place of the diode.

One, final point, the best kits are those with a spring loaded cover on the vehicle mounted socket. This cover prevent 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 {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CIRCUIT PROTECTION

Fuses

Ü See figures 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164

The fuses are of the miniaturized (compact) size and are located on a fuse block, they provide increased circuit protection and reliability. Access to the fuse block is gained either through a swing-down unit (located on the underside of the instrument panel, near the steering column) or through the glove box opening. On 1996 models, there is a fuse/relay panel mounted underhood. Each fuse receptacle is marked as to the circuit it protects and the correct amperage of the fuse.

Figure 150.
Remove the cover to expose the fuse panel

{ewc GSMVIMG,GSMVIMG, !88266p59.bmp}

88266p59

Figure 151.
Without a tester, it is impossible to check the fuses unless they are removed

{ewc GSMVIMG,GSMVIMG, !88266p60.bmp}

88266p60

Figure 152.
The underhood fuse panel has the fuse identification in the lid of the panel

{ewc GSMVIMG,GSMVIMG, !88266p61.bmp}

88266p61

Figure 153.
This puller will help remove the mini fuses

{ewc GSMVIMG,GSMVIMG, !88266p62.bmp}

88266p62

Figure 154.
These maxi fuses take the place of many of the fusible links

{ewc GSMVIMG,GSMVIMG, !88266p63.bmp}

88266p63

Figure 155.
The relays just plug into the panel

{ewc GSMVIMG,GSMVIMG, !88266p64.bmp}

88266p64

Figure 156.
Testing for a blown fuse

{ewc GSMVIMG,GSMVIMG, !88266g88.bmp}

88266g88

Figure 157.
Fuse block-1985-95 models

{ewc GSMVIMG,GSMVIMG, !88266g80.bmp}

88266g80

Figure 158.
Instrument panel fuse block-1996 models

{ewc GSMVIMG,GSMVIMG, !88266g81.bmp}

88266g81

Figure 159.
Instrument panel fuse block identification-1996 models

{ewc GSMVIMG,GSMVIMG, !88266g82.bmp}

88266g82

Figure 160.
Underhood fuse block-1996 models

{ewc GSMVIMG,GSMVIMG, !88266g83.bmp}

88266g83

Figure 161.
Underhood fuse block identification-1996 models

{ewc GSMVIMG,GSMVIMG, !88266g84.bmp}

88266g84

Figure 162.
Convenience center fuse block-1996 models

{ewc GSMVIMG,GSMVIMG, !88266g85.bmp}

88266g85

Figure 163.
Convenience center fuse block identification-1996 models

{ewc GSMVIMG,GSMVIMG, !88266g86.bmp}

88266g86

Figure 164.
Convenience center fuse block identification-1996 models

{ewc GSMVIMG,GSMVIMG, !88266g87.bmp}

88266g87

REPLACEMENT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REPLACEMENT

1. Pull the fuse from the fuse block.
2. Inspect the fuse element (through the clear plastic body) to the blade terminal for defects.

   Ä When replacing the fuse, DO NOT use one of a higher amperage.
3. To install, reverse the removal procedures.

Convenience Center {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Convenience Center

Ü See figures 165, 166

The Convenience Center is a swing-down unit located on the underside of the instrument panel, near the steering column. The swing-down feature provides central location and easy access to buzzers, relays and flasher units. All units are serviced by plug-in replacement.

Figure 165.
Convenience center and components-1985-95 models

{ewc GSMVIMG,GSMVIMG, !88266g89.bmp}

88266g89

Figure 166.
Convenience center and components-1996 models

{ewc GSMVIMG,GSMVIMG, !88266g9a.bmp}

88266g9a

Fusible Links {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Fusible Links

In addition to fuses, the wiring harness incorporates fusible links (in the battery feed circuits) to protect the wiring. Fusible links are 4 in. (102mm) sections of copper wire, 4 gauges smaller than the circuit(s) they are protecting, designed to melt under electrical overload. There are 4 different gauge sizes used. The fusible links are color coded so that they may be installed in their original positions.

REPLACEMENT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REPLACEMENT

Ü See figure 167

Here are some common fusible links and their locations. Refer to the wiring diagrams for specific fusible link information.

- Fusible link A - Rust/silver, to ECM, located at starter solenoid.
- Fusible link B - Gray/silver, to air conditioning blower, located at battery connection block.
- Fusible link C - Black/silver, to fuel pump circuit, located at battery connection block.
- Fusible link D - Black/silver, to ignition switch, located at battery connection block.
- Fusible link E - Rust/silver, to alternator, located at starter solenoid.
- Fusible link F - Rust/silver, to alternator (2.5L), located at starter solenoid.

Some replacement fusible links may be of a crimp on type style. This procedure is for splice and solder type links.

1. Disconnect the negative battery cable from the battery.
2. Locate the cause of the problem and repair before replacing the link.
3. Locate the burned out link.
4. Strip away the melted insulation and cut the burned link ends from the wire.
5. Strip the wire back $^{1}/2$ in. (12.7mm) to allow soldering of the new link.
6. Using a new fusible link 4 gauges smaller than the protected circuit and approximately 10 in. (254mm) long, solder it into the circuit.

   Ä Whenever splicing a new wire, always bond the splice with rosin core solder, then cover with electrical tape. Using acid core solder may cause corrosion.

Figure 167.
New fusible links are spliced and soldered to the wire

{ewc GSMVIMG,GSMVIMG, !88266g90.bmp}

88266g90

7. Tape and seal all splices with silicone to weatherproof repairs.
8. After taping the wire, tape the electrical harness leaving an exposed 5 in. (127mm) loop of wire.
9. Reconnect the battery.

Circuit Breakers {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Circuit Breakers

A circuit breaker is an electrical switch which breaks the circuit in case of an overload. The circuit breaker is located on the lower center of the fuse block. The circuit breaker will remain open until the short or overload condition in the circuit is corrected.

RESETTING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

RESETTING

Locate the circuit breaker on the fuse block, then push the circuit breaker in until it locks. If the circuit breaker kicks itself Off again, locate and correct the problem in the electrical circuit. The windshield wiper motor has a self setting circuit breaker built into the motor assembly. This breaker is non-serviceable and requires replacement of the wiper motor unit if defective.

Flashers {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Flashers

The turn signal flasher is mounted under the instrument panel to the right of the steering column.

The hazard flasher is mounted in the convenience center. The convenience center is located to the left of the steering column and at the lower edge of the instrument panel.

WIRING DIAGRAMS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

WIRING DIAGRAMS

Figure 168.
Sample diagram-how to read and interpret wiring
{ewc GSMVIMG,GSMVIMG, !tccs6w01.bmp}

tccs6w01

Figure 169.
Common wiring diagram symbols
{ewc GSMVIMG,GSMVIMG, !tccs6w02.bmp}

tccs6w02

Figure 170.
Engine controls-1985-86 2.5L engine
{ewc GSMVIMG,GSMVIMG, !88266w01.bmp}

88266w01

Figure 171.
Engine controls--1987-90 2.5L engine
{ewc GSMVIMG,GSMVIMG, !88266w02.bmp}

88266w02

Figure 172.
Engine controls-1985 4.3L engine
{ewc GSMVIMG,GSMVIMG, !88266w03.bmp}

88266w03

Figure 173.
Engine controls-1986 4.3L engine
{ewc GSMVIMG,GSMVIMG, !88266w04.bmp}

88266w04

Figure 174.
Engine controls-1987 4.3L engine
{ewc GSMVIMG,GSMVIMG, !88266w05.bmp}

88266w05

Figure 175.
Engine controls-1988-91 4.3L engine and 1992 4.3L (VIN Z) engine
{ewc GSMVIMG,GSMVIMG, !88266w06.bmp}

88266w06

Figure 176.
Engine controls-1992 4.3L (VIN W) engine
{ewc GSMVIMG,GSMVIMG, !88266w07.bmp}

88266w07

Figure 177.
Engine controls-1993-95 4.3L engine
{ewc GSMVIMG,GSMVIMG, !88266w08.bmp}

88266w08

Figure 178.
Engine controls-1996 4.3L engine

{ewc GSMVIMG,GSMVIMG, !88266w09.bmp}

88266w09

Figure 179.
Body wiring group 1-1985-86 models

{ewc GSMVIMG,GSMVIMG, !88266w10.bmp}

88266w10

Figure 180.
Body wiring group 1-1987 models

{ewc GSMVIMG,GSMVIMG, !88266w11.bmp}

88266w11

Figure 181.
Body wiring group 2-1985-87 models

{ewc GSMVIMG,GSMVIMG, !88266w12.bmp}

88266w12

Figure 182.
Body wiring group 1-1988 models

{ewc GSMVIMG,GSMVIMG, !88266w13.bmp}

88266w13

Figure 183.
Body wiring group 1-1989 models

{ewc GSMVIMG,GSMVIMG, !88266w14.bmp}

88266w14

Figure 184.
Body wiring group 2-1988-89 models

{ewc GSMVIMG,GSMVIMG, !88266w15.bmp}

88266w15

Figure 185.
Body wiring group 1-1990-95 models

{ewc GSMVIMG,GSMVIMG, !88266w16.bmp}

88266w16

Figure 186.
Body wiring group 2-1990-95 models

{ewc GSMVIMG,GSMVIMG, !88266w17.bmp}

88266w17

Figure 187.
Body wiring group 1-1996 models

{ewc GSMVIMG,GSMVIMG, !88266w18.bmp}

88266w18

Figure 188.
Body wiring group 2-1996 models

{ewc GSMVIMG,GSMVIMG, !88266w19.bmp}

88266w19

DRIVE TRAIN

{ewc MVIMAGE,MVIMAGE, !
drive.bmp}

MANUAL TRANSMISSION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

MANUAL TRANSMISSION

Understanding the Manual Transmission

Ü See figures 1, 2, 3

Because of the way an internal combustion engine breathes, it can produce torque (or twisting force) only within a narrow speed range. Most overhead valve pushrod engines must turn at about 2500 rpm to produce their peak torque. Often by 4500 rpm, they are producing so little torque that continued increases in engine speed produce no power increases.

The torque peak on overhead camshaft engines is, generally, much higher, but much narrower.

The manual transmission and clutch are employed to vary the relationship between engine RPM and the speed of the wheels so that adequate power can be produced under all circumstances. The clutch allows engine torque to be applied to the transmission input shaft gradually, due to mechanical slippage. The vehicle can, consequently, be started smoothly from a full stop.

The transmission changes the ratio between the rotating speeds of the engine and the wheels by the use of gears. 4-speed or 5-speed transmissions are most common. The lower gears allow full engine power to be applied to the rear wheels during acceleration at low speeds.

The clutch driveplate is a thin disc, the center of which is splined to the transmission input shaft. Both sides of the disc are covered with a layer of material which is similar to brake lining and which is capable of allowing slippage without roughness or excessive noise.

The clutch cover is bolted to the engine flywheel and incorporates a diaphragm spring which provides the pressure to engage the clutch. The cover also houses the pressure plate. When the clutch pedal is released, the driven disc is sandwiched between the pressure plate and the smooth surface of the flywheel, thus forcing the disc to turn at the same speed as the engine crankshaft.

Figure 1.
Exploded view of the MH3/ML3 5-speed transmission housing external components-MR2, 4-speed similar

{ewc GSMVIMG,GSMVIMG, !88267G01.bmp}

88267G01

Figure 2.
Exploded view of the MR2 4-speed transmission assembly

{ewc GSMVIMG,GSMVIMG, !88267G11.bmp}

88267G11

Figure 3.
Exploded view of the MH3/ML3 5-speed transmission assembly

{ewc GSMVIMG,GSMVIMG, !88267G12.bmp}

88267G12

The transmission contains a mainshaft which passes all the way through the transmission, from the clutch to the driveshaft. This shaft is separated at one point, so that front and rear portions can turn at different speeds.

Power is transmitted by a countershaft in the lower gears and reverse. The gears of the countershaft mesh with gears on the mainshaft, allowing power to be carried from one to the other. Countershaft gears are often integral with that shaft, while several of the mainshaft gears can either rotate independently of the shaft or be locked to it. Shifting from one gear to the next causes one of the gears to be freed from rotating with the shaft and locks another to it. Gears are locked and unlocked by internal dog clutches which slide between the center of the gear and the shaft. The forward gears usually employ synchronizers; friction members which smoothly bring gear and shaft to the same speed before the toothed dog clutches are engaged.

Identification {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Identification

Manual transmissions are identified by using the following descriptions:

- The number of forward gears.
- The measured distance between the centerlines of the mainshaft and the countergear.

The 4-speed (76mm) transmission is a fully synchronized unit with blocker ring synchronizers and a sliding mesh reverse gear. The transmission case houses the various gears, bearings and shafts, a shift control cover and an extension housing. The floor-mounted gearshift lever assembly is located on top of the extension housing; the shifting mechanism is connected to the shift control cover by adjustable shifting arms. The MR2 model is used in combination with both engines.

The 5-speed (77mm) transmission is a fully synchronized unit with blocker ring synchronizers and a sliding mesh reverse gear. It has an aluminum transmission case that houses the various gears, bearings and an extension housing. The floor-mounted gearshift lever assembly is located on top of the extension housing. The ML3 model, is used with the 2.5L engine; the MH3 model is used with the 4.3L engine.

In 1990, the Astro/Safari van could be ordered with All Wheel Drive as an option. At this redesign, the manual transmission was eliminated from the Astro and Safari line. From this point forward, all of these vans were produced with an automatic transmission.

Adjustment {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Adjustment

Ä The shifter mechanism, of the 5-speed transmission, does not require adjustment and can be serviced independently.

SHIFTER RODS

4-Speed (MR2)

Ü See figures 4, 5

Ä The following procedure requires the use of 1/4 in. pin gauge.

1. Raise and support the front of the vehicle safely using jackstands. This is necessary for access to the transmission housing and shifter rods.
2. At each shifting swivel (located on the shifter side cover), loosen the jam nuts on the shifter rods.
3. From inside the vehicle, place the floor mounted, gear shift lever in the Neutral position.
4. From under the vehicle, place the shifter rods in the Neutral position. Refer to the accompanying illustration for help locating Neutral on the transmission housing.
5. Using a 1/4 in. pin gauge, position it in the holes of the gear shift control levers.
6. While applying forward pressure (separately) on each shifter rod, tighten the shifter rod jam nuts, located on each side of the shifting swivel.
7. Remove the pin gauge and check the shifting operation. Lubricate the shifting levers.
8. Remove the jackstands and carefully lower the vehicle.

Figure 4.
Shift lever positions-MR2 4-speed transmission

{ewc GSMVIMG,GSMVIMG, !88267G02.bmp}

88267G02

Figure 5.
Adjusting the shifter rod linkage-MR2 4-speed transmission

{ewc GSMVIMG,GSMVIMG, !88267G03.bmp}

88267G03

CLUTCH SWITCH {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CLUTCH SWITCH

Ü See figure 6

A clutch switch is located under the instrument panel and attached to the top of the clutch pedal. The switch is provided for safety to keep the vehicle from starting unless the pedal is depressed (disengaging the clutch).

1. Disconnect the negative battery cable for safety.
2. Remove the lower steering column-to-instrument panel cover.
3. Disengage the electrical connector from the clutch switch.

   Ä Be sure to leave any carpets and floor mats (being used in the vehicle) in place, when making the adjustment.
4. At the clutch switch, move the slider (adjuster) to the rear of the clutch switch shaft.
5. Push the clutch pedal to the floor.
6. While holding the clutch pedal to the floor, move the slider down the clutch switch shaft until it stops.

   Ä When moving the slider down the clutch switch shaft, a clicking noise can be heard.
7. Release the clutch pedal; the adjustment is complete.
8. Engage the electrical connector and connect the negative battery cable.
9. Verify proper switch operation.
10. Install the lower steering column cover.

Figure 6.
Adjusting the clutch (starter safety) switch

{ewc GSMVIMG,GSMVIMG, !88267G04.bmp}

88267G04

Back-up Light Switch {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Back-up Light Switch

REMOVAL & INSTALLATION

Ü See figure 7

1. Disconnect the negative battery cable for safety.
2. Raise and support the rear of the vehicle safely using jackstands. Support the rear, not the front of the vehicle, so the back of the switch is facing upward. This should help minimize the amount of the transmission fluid which might weep from the bore once the switch is removed.
3. Position a small drain pan or rag under the switch, just in case the vehicle is not supported at an angle which would prevent transmission fluid leakage when the switch is removed.
4. From the left rear of the transmission, disengage the electrical connector from the back-up light switch.

   Ä If you are simply replacing the switch, prepare the replacement now (refer to the first installation step) and keep it handy. You can also minimize fluid loss by removing the old switch and immediately threading the new one.
5. Loosen the back-up light switch using a suitably sized box wrench or deep socket made for switch removal, then remove the switch from the transmission assembly.

Figure 7.
Exploded view of the back-up light switch mounting

{ewc GSMVIMG,GSMVIMG, !88267G05.bmp}

88267G05

To install:

6. Apply thread sealing compound and install the switch.
7. If a suitable deep socket and torque wrench are available, tighten the switch to 17 ft. lbs. (23 Nm).
8. Engage the electrical connector, the connect the negative battery cable.
9. Place the gear shift lever in the Reverse position and check the back-up lights are turned On.

   Ä On some vehicles the ignition must be in the ON position in order for the reverse lights to work.

Shift Linkage

REMOVAL & INSTALLATION

4-speed

Ü See figure 8

1. Disconnect the negative battery cable for safety.
2. Raise the vehicle and support with jackstands.
3. Disconnect the shift rods from the control lever.
4. Remove the control mounting bolts and shifter.
5. If necessary for access inside the van, remove the jackstands and carefully lower the vehicle.
6. Remove the shifter knob, boot retaining screws and boot.
7. Pull the shifter assembly from the floor.

To install:

8. Install the shifter assembly into the floor.
9. Install the shifter knob, boot retaining screws and boot.
10. If lowered for interior access, raise the vehicle and support again using jackstands.
11. Install the control mounting bolts and shifter.
12. Connect the shift rods to the control lever.
13. Remove the jackstands and carefully lower the vehicle.
14. Connect the negative battery cable.

Figure 8.
Exploded view of the 4-speed shifter assembly and mounting
{ewc GSMVIMG,GSMVIMG, !88267G06.bmp}

88267G06

5-speed {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

5-speed

Ü See figure 9

1. Disconnect the negative battery cable for safety.
2. Remove the transmission from the vehicle as detailed later in this section.
3. Remove the four dust cover clips, rubber boot and dust cover.
4. Remove the four control base-to-extension housing mounting bolts.
5. Remove the control assembly from the transmission.

Figure 9.
Exploded view of the 5-speed shifter assembly mounting
{ewc GSMVIMG,GSMVIMG, !88267G07.bmp}

88267G07

To install:

6. Position the control lever into the transmission and install the two bolts to the side of the extension housing.
7. Tighten the side bolts to 35 ft. lbs. (47 Nm) and the top bolts to 13 ft. lbs. (17 Nm).
8. Apply a bead of RTV sealer to the groove around the base of the dust cover, then install the cover and retaining clips.
9. Install the rubber boot and transmission assembly as outlined in this section.

Rear Extension Seal {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Rear Extension Seal

REMOVAL & INSTALLATION

Ü See figures 10, 11

1. Disconnect the negative battery cable for safety.
2. Raise and support the rear of the vehicle safely using jackstands. The rear of the vehicle should be raised high enough to prevent fluid loss from the rear of the transmission housing once the seal is removed.
3. Match-mark and remove the driveshaft as outlined in this section.
4. Using a suitable prybar or better yet, a seal removal tool (these are usually inexpensive and make the job much easier), pry the rear seal out of the extension housing.

****Warning**
The use of an improper tool to pry the seal from the housing could allow the bore to be damaged, preventing the seal's replacement from fully "sealing" the transmission. Fluid leaks could result.

To install:

5. Coat the outside of the seal with silicone sealer and the lip of the seal with chassis grease.
6. Install the new seal with a suitable driver or seal installer.
7. Align and install the driveshaft.
8. Remove the jackstands and carefully lower the vehicle.
9. Connect the negative battery cable.

Figure 10.
Use a seal puller to remove the extension housing seal (be careful not to damage the bore)

{ewc GSMVIMG,GSMVIMG, !88267P01.bmp}

88267P01

Figure 11.
Use a driver to install the replacement seal-Automatic shown, manual similar

{ewc GSMVIMG,GSMVIMG, !88267P02.bmp}

88267P02

Transmission {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REMOVAL & INSTALLATION

Ü See figures 8, 12

1. Disconnect the negative battery cable for safety.
2. Raise and support the vehicle safely using jackstands.
3. Match-mark and remove the driveshaft from the vehicle. For details, please refer to the driveshaft removal and installation procedure found later in this section.
4. Place a clean drain pan under the transmission, then remove the drain plug and drain the fluid from the transmission assembly. Install the drain plug to keep any remaining fluid from dripping throughout the procedure.
5. Loosen the shifter control knob-to-shifter control lever nut, then remove the shifter control knob. Remove the shifter control boot-to-chassis plate and the shifter control boot.
6. If removing an MH3/ML3, 5-speed transmission, unscrew the shift lever from the control lever.
7. If removing an MR2, 4-speed transmission, remove the shifter rods, then the shifter control assembly from the extension housing.
8. Disconnect the speedometer cable and the seal from the transmission.
9. Disengage the electrical connector from the transmission.
10. If necessary for clearance, disconnect and lower the exhaust pipe(s).
11. Place a transmission jack under the transmission housing, then secure it to the transmission. Raise the jack slightly so that it supports the weight of the transmission.
12. Remove the transmission-to-crossmember nuts/bolts and the transmission-to-chassis braces nuts/bolts, then remove the braces and the crossmember.

    Ä If any spacers are used, make a note of them so that they may be installed in their original positions.

13. While supporting the transmission, remove the transmission-to-bellhousing bolts; DO NOT allow it to hang on the input shaft.
14. Move the transmission and jack assembly rearward, then carefully lower and remove the transmission from the vehicle.

Figure 12.
Exploded view of the shift lever mounting-MH3/ML3 5-speed transmission
{ewc GSMVIMG,GSMVIMG, !88267G10.bmp}

88267G10

To install:

15. Place a thin coat of high temperature grease on the main drive gear splines.
16. Align the transmission's input shaft with the bellhousing and clutch assembly, then slide the transmission into the clutch.

    Ä When installing the transmission, shift the transmission into High gear, then turn the output shaft to align the input shaft splines with the clutch plate.

17. The balance of installation is the reverse of the removal procedure. Be sure to tighten all fasteners properly including:

- transmission-to-bellhousing bolts: 50 ft. lbs. (68 Nm).
- transmission-to-mount bolts: 40 ft. lbs. (54 Nm) for the MR2 or 33 ft. lbs. (45 Nm) for the for the MH3/ML3
- crossmember-to-mount bolts: 26 ft. lbs. (35 Nm) for the MR2 or 18 ft. lbs. for the MH3/ML3
- crossmember-to-chassis bolts: 37 ft. lbs. (50 Nm).
- transmission-to-brace bolts: 26 ft. lbs. (35 Nm).
- shifter control assembly-to-extension housing bolts: 23 ft. lbs. (31 Nm).
- shifter rod swivel nut: 18 ft. lbs. (24 Nm).
- shifter lever nut: 35 ft. lbs. (47 Nm).

18. Align and install the driveshaft, using the marks made during removal.
19. Remove the jackstands and carefully lower the vehicle.
20. Connect the negative battery cable.

CLUTCH {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CLUTCH

Understanding the Clutch

Ü See figure 13

MECHANICAL CLUTCH OPERATION

The purpose of the clutch is to disconnect and connect engine power at the transmission. A vehicle at rest requires a lot of engine torque to get all that weight moving. An internal combustion engine does not develop a high starting torque (unlike steam engines) so it must be allowed to operate without any load until it builds up enough torque to move the vehicle. To a point, torque increases with engine rpm. The clutch allows the engine to build up torque by physically disconnecting the engine from the transmission, relieving the engine of any load or resistance.

The transfer of engine power to the transmission (the load) must be smooth and gradual; if it weren't, drive line components would wear out or break quickly. This gradual power transfer is made possible by gradually releasing the clutch pedal. The clutch disc and pressure plate are the connecting link between the engine and transmission. When the clutch pedal is released, the disc and plate contact each other (the clutch is engaged) physically joining the engine and transmission. When the pedal is pushed in, the disc and plate separate (the clutch is disengaged) disconnecting the engine from the transmission.

Most clutch assemblies consists of the flywheel, the clutch disc, the clutch pressure plate, the throw out bearing and fork, the actuating linkage and the pedal. The flywheel and clutch pressure plate (driving members) are connected to the engine crankshaft and rotate with it. The clutch disc is located between the flywheel and pressure plate, and is splined to the transmission shaft. A driving member is one that is attached to the engine and transfers engine power to a driven member (clutch disc) on the transmission shaft. A driving member (pressure plate) rotates (drives) a driven member (clutch disc) on contact and, in so doing, turns the transmission shaft.

Figure 13.
Cross-sectional view of the clutch assembly

{ewc GSMVIMG,GSMVIMG, !88267G15.bmp}

88267G15

There is a circular diaphragm spring within the pressure plate cover (transmission side). In a relaxed state (when the clutch pedal is fully released) this spring is convex; that is, it is dished outward toward the transmission. Pushing in the clutch pedal actuates the attached linkage. Connected to the other end of this is the throw out fork, which hold the throw out bearing. When the clutch pedal is depressed, the clutch linkage pushes the fork and bearing forward to contact the diaphragm spring of the pressure plate. The outer edges of the spring are secured to the pressure plate and are pivoted on rings so that when the center of the spring is compressed by the throw out bearing, the outer edges bow outward and, by so doing, pull the pressure plate in the same direction - away from the clutch disc. This action separates the disc from the plate, disengaging the clutch and allowing the transmission to be shifted into another gear. A coil type clutch return spring attached to the clutch pedal arm permits full release of the pedal. Releasing the pedal pulls the throw out bearing away from the diaphragm spring resulting in a reversal of spring position. As bearing pressure is gradually released from the spring center, the outer edges of the spring bow outward, pushing the pressure plate into closer contact with the clutch disc. As the disc and plate move closer together, friction between the two increases and slippage is reduced until, when full spring pressure is applied (by fully releasing the pedal) the speed of the disc and plate are the same. This stops all slipping, creating a direct connection between the plate and disc which results in the transfer of power from the engine to the transmission. The clutch disc is now rotating with the pressure plate at engine speed and, because it is splined to the transmission shaft, the shaft now turns at the same engine speed.

The clutch is operating properly if:

1. It will stall the engine when released with the vehicle held stationary.
2. The shift lever can be moved freely between 1st and reverse gears when the vehicle is stationary and the clutch disengaged.

HYDRAULIC CLUTCH OPERATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

HYDRAULIC CLUTCH OPERATION

Astro and Safari vans use a hydraulically clutch activation system which consists of a master and a slave cylinder. When pressure is applied to the clutch pedal (the pedal is depressed), the pushrod contacts the plunger and pushes it up the bore of the master cylinder. During the first $^1/32$ in. (0.8mm) of movement, the center valve seal closes the port to the fluid reservoir tank and as the plunger continues to move up the bore of the cylinder, the fluid is forced through the outlet line to the slave cylinder mounted on the clutch housing. As fluid is pushed down the pipe from the master cylinder, this in turn forces the piston in the slave cylinder outward. A pushrod is connected to the slave cylinder and rides in the pocket of the clutch fork. As the slave cylinder piston moves rearward the pushrod forces the clutch fork and the release bearing to disengage the pressure plate from the clutch disc. On the return stroke (pedal released), the plunger moves back as a result of the return pressure of the clutch. Fluid returns to the master cylinder and the final movement of the plunger lifts the valve seal off the seat, allowing an unrestricted flow of fluid between the system and the reservoir.

A piston return spring in the slave cylinder preloads the clutch linkage and assures contact of the release bearing with the clutch release fingers at all times. As the driven disc wears, the diaphragm spring fingers move rearward forcing the release bearing, fork and pushrod to move. This movement forces the slave cylinder piston forward in its bore, displacing hydraulic fluid up into the master cylinder reservoir, thereby providing the self-adjusting feature of the hydraulic clutch linkage system.

Before attempting to repair the clutch, transmission, hydraulic system or related linkages for any reason other than an obvious failure, the problem and probable cause should be identified. A large percentage of clutch and manual transmission problems are manifested by shifting difficulties such as high shift effort, gear clash and grinding or transmission blockout. When any of these problems occur, a careful analysis of these difficulties should be made, then the basic checks and adjustments performed before removing the clutch or transmission for repairs. Run the engine at a normal idle with the transmission in Neutral (clutch engaged). Disengage the clutch, wait about 10 seconds and shift the transmission into Reverse (no grinding noise should be heard). A grinding noise indicates incorrect clutch travel, lost motion, clutch misalignment or internal problems such as failed dampers, facings, cushion springs, diaphragm spring fingers, pressure plate drive straps, pivot rings or etc.

Adjustments {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Adjustments

Since the hydraulic system provides automatic clutch adjustment, no adjustment of the clutch linkage or pedal height is required. For more details on how the hydraulic clutch actuation system operates, please refer to the general clutch information provided in this section.

Clutch Disc and Pressure Plate {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Clutch Disc and Pressure Plate

Ü See figures 14, 15

REMOVAL & INSTALLATION

Ü See figures 16, 17, 18, 19, 20, 21, 22

Caution
The clutch plate may contain asbestos, which has been determined to be a cancer causing agent. Never clean the clutch surfaces with compressed air! Avoid inhaling any dust from any clutch surface! When cleaning clutch surfaces, use a commercially available brake cleaning fluid.

1. Remove the transmission assembly from the vehicle. For details, please refer to the manual transmission procedure found earlier in this section.
2. Remove the slave cylinder attaching bolts, then position the cylinder aside.
3. Remove the clutch inspection cover.
4. Remove the retaining bolts, then remove the bellhousing.
5. Slide the clutch fork from the ball stud and remove the fork from the dust boot.

   Ä The ball stud is threaded into the clutch housing and can be easily replaced.

6. Install the Clutch Pilot tool No. J-33169 into the clutch plate to support it during removal.
7. The flywheel and clutch cover (pressure plate assembly) are marked with **X**'s for correct assembly or white painted letters, if these are not visible, scribe new match-marks.
8. Gradually loosen the clutch pressure plate-to-flywheel bolts (one turn at a time) until all of the spring pressure is released.
9. Remove the bolts and the clutch assembly.

   Ä The clutch pilot bearing is an oil impregnated type bearing pressed into the crankshaft. This bearing requires attention when the clutch is removed from the vehicle, at which time it should be cleaned and inspected for excessive wear or damage and should be replaced (if necessary).

10. Inspect the flywheel for wear, scoring or damage and machine or replace, if necessary.

Figure 14.
Typical clutch release bearing lubrication points

{ewc GSMVIMG,GSMVIMG, !88267G13.bmp}

88267G13

Figure 15.
Exploded view of the clutch assembly

{ewc GSMVIMG,GSMVIMG, !88267G14.bmp}

88267G14

Figure 16.
A clutch alignment arbor is used for removal or installation of the clutch and pressure plate assembly

{ewc GSMVIMG,GSMVIMG, !tccS7142.bmp}

TCCS7142

Figure 17.
Remove the transmission and bellhousing for access to the pressure plate

{ewc GSMVIMG,GSMVIMG, !tccS7115.bmp}

TCCS7115

Figure 18.
Loosen the pressure plate (clutch cover) bolts gradually and evenly in a cross-wise pattern

{ewc GSMVIMG,GSMVIMG, !tccS7116.bmp}

TCCS7116

Figure 19.
Removing the clutch and pressure plate

{ewc GSMVIMG,GSMVIMG, !tccS7118.bmp}

TCCS7118

Figure 20.
Be sure that the flywheel surface is clean of grease or contaminants, before installing the clutch

{ewc GSMVIMG,GSMVIMG, !tccS7124.bmp}

TCCS7124

Figure 21.
Use a clutch alignment arbor, to align the clutch assembly during installation

{ewc GSMVIMG,GSMVIMG, !tccS7127.bmp}

TCCS7127

Figure 22.
Clutch plate and pressure plate installed with the alignment arbor in place

{ewc GSMVIMG,GSMVIMG, !tccS7129.bmp}

TCCS7129

To install:

11. Crank the engine over by hand until the X-mark on the flywheel is on the bottom.
12. Position the clutch disc and pressure plate in the same relative location as removed and support with a clutch pilot tool.

    Ä The clutch disc is installed with the damper springs and slinger toward the transmission.

13. Rotate the clutch assembly until the X-marks on the flywheel and clutch cover align. Make sure the cover bolt holes are aligned with those in the flywheel.
14. Install the bolts, then tighten them evenly and gradually using a cross-wise pattern. Tighten the bolts evenly to 15-22 ft. lbs. (20-29 Nm). Do NOT over tighten.
15. Remove the clutch pilot tool.
16. Lubricate the ball socket on the clutch fork (using a high temperature grease) and reinstall on the ball stud.
17. Pack the recess on the inside of the throw out bearing collar and the throw out groove with graphite grease.
18. Install the bellhousing and the slave cylinder.
19. Install the throw out bearing on the fork. Lubricate the bearing groove (using a high temperature grease).

20. The balance of the installation procedure is the reverse of the removal steps. Be sure to properly tighten all fasteners including:
    - Pressure plate-to-flywheel bolts: 15-22 ft. lbs. (20-30 Nm) for the 4-speed or 25-35 ft. lbs. (34-47 Nm) for the 5-speed
    - Flywheel-to-crankshaft bolts: 60-75 ft. lbs. (81-102 Nm) for the 4-speed or 55-75 ft. lbs. (75-102 Nm) for the 5-speed
    - Slave cylinder-to-bellhousing bolts: 10-15 ft. lbs. (14-20 Nm).
21. Install the transmission assembly.

    Ä If installing an MR2, 4-speed transmission, lubricate and adjust the transmission shift linkages (using a high temperature grease).

Pilot Bearing {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Pilot Bearing

REMOVAL & INSTALLATION

Ü See figure 23

1. Disconnect the negative battery cable for safety.
2. Remove the transmission assembly. For details, please refer to the manual transmission procedure found earlier in this section.
3. Remove the clutch disc and pressure plate assembly. For details, please refer to the procedure found earlier in this section.

   ****Warning**
   The release bearing is permanently packed with lubricant and should NOT be soaked in a cleaning solvent as this would dissolve the lubricant.

4. Using a pilot bearing removing tool J-1448, remove the pilot bearing from the crankshaft.

   Ä If a bearing puller is not available, thoroughly pack the bearing cavity with fresh grease, then position a drift (whose outer diameter is close to, but not the same size as the bearing's inner diameter) in the center of the bearing. Drive the drift inward using a mallet, this should force the grease against the bearing cage, freeing it from the flywheel. Just be careful that enough grease is used to keep the drift from damaging the flywheel or other engine components.

Figure 23.
The easiest way to remove a pilot bearing is using a bearing puller tool
{ewc GSMVIMG,GSMVIMG, !88267G16.bmp}

88267G16

To install:

5. Apply a few drops of machine oil to the bearing.
6. Using a pilot bearing installing tool J-1522, or an equivalent driver, install the new pilot bearing.
7. Install the clutch and pressure plate assembly.
8. Install the transmission assembly to the vehicle.
9. Connect the negative battery cable and check operation.

Clutch Pedal {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Clutch Pedal

REMOVAL & INSTALLATION

Ü See figure 24

1. Disconnect the negative battery cable for safety.
2. Remove the hush panel and clutch start switch.
3. Remove the retainer (number 105 in the accompanying illustration), washer and pin.
4. Remove the pushrod, retainer and clutch pedal. Slide a long screw or rod through the bracket while removing the clutch pedal to hold the brake pedal in place.
5. Remove the bushings and spring.

Figure 24.
Exploded view of the clutch pedal assembly

{ewc GSMVIMG,GSMVIMG, !88267G17.bmp}

88267G17

To install:

6. Install a new spring and bushings.
7. Install the clutch pedal while removing the long screw or rod.
8. Install a new retainer, pushrod, pin, washer and retainer.
9. Lubricate the clutch pedal with chassis grease.
10. Install and adjust the clutch start switch.
11. Connect the negative battery cable and verify proper switch operation.
12. Install the hush panel.

Master Cylinder {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Master Cylinder

The clutch master cylinder is located in the engine compartment, on the left side of the firewall, above the steering column.

REMOVAL & INSTALLATION

Ü See figures 25, 26

1. Disconnect negative battery cable.
2. Remove hush panel from under the dash.
3. Disconnect pushrod from clutch pedal.
4. Disconnect hydraulic line from the clutch master cylinder using a flare nut wrench.
5. Remove the master cylinder-to-cowl brace nuts. Remove master cylinder and overhaul (if necessary).
6. Using a putty knife, clean the master cylinder and cowl mounting surfaces.

Figure 25.
Exploded view of the clutch master cylinder mounting
{ewc GSMVIMG,GSMVIMG, !88267G18.bmp}

88267G18

Figure 26.
Clutch hydraulic actuating system and component mounting
{ewc GSMVIMG,GSMVIMG, !88267G20.bmp}

88267G20

To install:

7. Install the master cylinder-to-cowl brace nuts and master cylinder.
8. Connect hydraulic line to the clutch master cylinder using a flare nut wrench.
9. Connect pushrod to clutch pedal.
10. Install hush panel to the dash.
11. Connect negative battery cable.
12. Tighten the master cylinder-to-cowl brace nuts to 10-15 ft. lbs. (14-20 Nm). Fill master cylinder with clean, fresh hydraulic fluid conforming to DOT 3 specifications.
13. Bleed the hydraulic clutch system and check for leaks.

OVERHAUL {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

OVERHAUL

Ü See figure 27

1. Remove the clutch master cylinder assembly from the vehicle.
2. Remove the filler cap and drain the fluid from the master cylinder.
3. Remove the reservoir and seal from the master cylinder. Pull back the dust cover and remove the snapring.
4. Remove the pushrod assembly. Using a block of wood, tap the master cylinder on it to eject the plunger assembly from the cylinder bore.
5. Remove the seal (carefully) from the front of the plunger assembly, ensuring no damage occurs to the plunger surfaces.
6. From the rear of the plunger assembly, remove the spring, the support, the seal and the shim.
7. Using clean brake fluid, clean all of the parts.
8. Inspect the cylinder bore and the plunger for ridges, pitting and/or scratches; the dust cover for wear and cracking; replace the parts if any of the conditions exist.

To assemble:

9. Use new seals, lubricate all of the parts in clean brake fluid, and fit the plunger seal to the plunger.
10. Insert the plunger assembly, valve end leading into the cylinder bore (easing the entrance of the plunger seal).
11. Position the pushrod assembly into the cylinder bore, then install a new snapring to retain the pushrod. Lubricate the inside of the dust cover with Girling® Rubber Grease or equivalent. Install dust cover onto the master cylinder.

    Ä Be careful not to use any lubricant that will deteriorate rubber dust covers or seals.

12. Install the master cylinder assembly to the vehicle.

Figure 27.
Exploded view of the clutch master cylinder assembly

{ewc GSMVIMG,GSMVIMG, !88267G19.bmp}

88267G19

Slave (Secondary) Cylinder {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Slave (Secondary) Cylinder

The slave cylinder is located on the left side of the bellhousing and controls the clutch release fork operation.

REMOVAL & INSTALLATION

Ü See figure 26

1. Disconnect the negative battery cable.
2. Raise and support the front of the vehicle on jackstands.
3. Disconnect the hydraulic line from clutch master cylinder. Remove the hydraulic line-to-chassis screw and the clip from the chassis.

   Ä Be sure to plug the line opening to keep dirt and moisture out of the system.

4. Remove the slave cylinder-to-bellhousing nuts.
5. Remove the pushrod and the slave cylinder from the vehicle, then overhaul it (if necessary).

To install:

6. Lubricate the leading end of the slave cylinder with Girling® Rubber Lube or equivalent.
7. Install the pushrod and the slave cylinder into the vehicle.
8. Install the slave cylinder-to-bellhousing nuts.
9. Connect the hydraulic line to the clutch master cylinder.
10. Fill the master cylinder with new brake fluid conforming to DOT 3 specifications. Bleed the hydraulic system. If the front of the vehicle is still raised, keep in mind that the clutch master cylinder cannot be properly filled. Check the fluid level often, then recheck and top off once the vehicle is lowered.
11. Tighten the slave cylinder-to-bellhousing nuts to 10-15 ft. lbs. (14-20 Nm).
12. Lower the front of the vehicle, then top off the clutch master cylinder reservoir.
13. Connect the negative battery cable.

OVERHAUL

Ü See figure 28

1. Remove the clutch slave cylinder from the vehicle.
2. Remove the shield, the pushrod and dust cover from the slave cylinder, then inspect the cover for damage or deterioration.
3. Remove the snapring from the end of the cylinder bore.
4. Using a block of wood, tap the slave cylinder on it to eject the plunger, then remove the seal and the spring.
5. Using clean brake fluid, clean all of the parts.
6. Inspect the cylinder bore and the plunger for ridges, pitting and/or scratches, the dust cover for wear and cracking; replace the parts if any of the conditions exist.

To assemble:

7. Use new seals and lubricate all of the parts in clean brake fluid. Install the spring, the plunger seal and the plunger into the cylinder bore, then install a new snapring.
8. Lubricate the inside of the dust cover with Girling® Rubber Grease or equivalent, then install it into the slave cylinder.

   Ä Be careful not to use any lubricant that will deteriorate the rubber dust covers or seals.

9. Install the clutch slave cylinder to the vehicle.

Figure 28.
Exploded view of the clutch slave cylinder assembly

{ewc GSMVIMG,GSMVIMG, !88267G21.bmp}

88267G21

BLEEDING THE HYDRAULIC CLUTCH {ewc MVIMAGE, MVIMAGE, ! nexttopicarrow.bmp}

BLEEDING THE HYDRAULIC CLUTCH

Bleeding air from the hydraulic clutch system is necessary whenever any part of the system has been disconnected or the fluid level (in the reservoir) has been allowed to fall so low, that air has been drawn into the master cylinder.

1. Fill master cylinder reservoir with clean, fresh brake fluid conforming to DOT 3 specifications.

   ****Warning**
   Never, under any circumstances, use fluid which has been bled from a system to fill the reservoir as it may be aerated, have too much moisture content and possibly be contaminated.

2. Raise and support the front of the vehicle on jackstands.
3. Remove the slave cylinder attaching bolts.
4. Hold the slave cylinder at approximately 45º with the bleeder at its highest point. Fully depress the clutch pedal and open the bleeder screw.
5. Close the bleeder screw and release the clutch pedal.
6. Repeat the procedure until all of the air is evacuated from the system. Check and refill the master cylinder reservoir as required to prevent air from being drawn through the master cylinder.

   Ä Never release a depressed clutch pedal with the bleeder screw open or air will be drawn into the system.

AUTOMATIC TRANSMISSION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

AUTOMATIC TRANSMISSION

Understanding Automatic Transmissions

The automatic transmission allows engine torque and power to be transmitted to the rear 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 transmission 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 transmission 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 transmission, a very sound understanding of the basic principles of operation will simplify troubleshooting.

TORQUE CONVERTER {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TORQUE CONVERTER

Ü See figure 29

The torque converter replaces the conventional clutch. It has three functions:

1. It allows the engine to idle with the vehicle at a standstill, even with the transmission in gear.
2. It allows the transmission to shift from range-to-range smoothly, without requiring that the driver close the throttle during the shift.
3. It multiplies engine torque to an increasing extent as vehicle speed drops and throttle opening is increased. This has the effect of making the transmission more responsive and reduces the amount of shifting required.

The torque converter is a metal case which is shaped like a sphere that has been flattened on opposite sides. It is bolted to the rear end of the engine's crankshaft. Generally, the entire metal case rotates at engine speed and serves as the engine's flywheel.

The case contains three sets of blades. One set is attached directly to the case. This set forms the torus or pump. Another set is directly connected to the output shaft, and forms the turbine. The third set is mounted on a hub which, in turn, is mounted on a stationary shaft through a one-way clutch. This third set is known as the stator.

A pump, which is driven by the converter hub at engine speed, keeps the torque converter full of transmission fluid at all times. Fluid flows continuously through the unit to provide cooling.

Under low speed acceleration, the torque converter functions as follows:

Figure 29.
The torque converter housing is rotated by the engine's crankshaft, and turns the impeller-The impeller then spins the turbine, which gives motion to the turbine shaft, driving the gears

{ewc GSMVIMG,GSMVIMG, !tccS7011.bmp}

TCCS7011

The torus is turning faster than the turbine. It picks up fluid at the center of the converter and, through centrifugal force, slings it outward. Since the outer edge of the converter moves faster than the portions at the center, the fluid picks up speed.

The fluid then enters the outer edge of the turbine blades. It then travels back toward the center of the converter case along the turbine blades. In impinging upon the turbine blades, the fluid loses the energy picked up in the torus.

If the fluid was now returned directly into the torus, both halves of the converter would have to turn at approximately the same speed at all times, and torque input and output would both be the same.

In flowing through the torus and turbine, the fluid picks up two types of flow, or flow in two separate directions. It flows through the turbine blades, and it spins with the engine. The stator, whose blades are stationary when the vehicle is being accelerated at low speeds, converts one type of flow into another. Instead of allowing the fluid to flow straight back into the torus, the stator's curved blades turn the fluid almost 90º toward the direction of rotation of the engine. Thus the fluid does not flow as fast toward the torus, but is already spinning when the torus picks it up. This has the effect of allowing the torus to turn much faster than the turbine. This difference in speed may be compared to the difference in speed between the smaller and larger gears in any gear train. The result is that engine power output is higher, and engine torque is multiplied.

As the speed of the turbine increases, the fluid spins faster and faster in the direction of engine rotation. As a result, the ability of the stator to redirect the fluid flow is reduced. Under cruising conditions, the stator is eventually forced to rotate on its one-way clutch in the direction of engine rotation. Under these conditions, the torque converter begins to behave almost like a solid shaft, with the torus and turbine speeds being almost equal.

PLANETARY GEARBOX {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

PLANETARY GEARBOX

Ü See figures 30, 31, 32

The ability of the torque converter to multiply engine torque is limited. Also, the unit tends to be more efficient when the turbine is rotating at relatively high speeds. Therefore, a planetary gearbox is used to carry the power output of the turbine to the driveshaft.

Figure 30.
Planetary gears work in a similar fashion to manual transmission gears, but are composed of three parts

{ewc GSMVIMG,GSMVIMG, !tccS7012.bmp}

TCCS7012

Planetary gears function very similarly to conventional transmission gears. However, their construction is different in that three elements make up one gear system, and, in that all three elements are different from one another. The three elements are: an outer gear that is shaped like a hoop, with teeth cut into the inner surface; a sun gear, mounted on a shaft and located at the very center of the outer gear; and a set of three planet gears, held by pins in a ring-like planet carrier, meshing with both the sun gear and the outer gear. Either the outer gear or the sun gear may be held stationary, providing more than one possible torque multiplication factor for each set of gears. Also, if all three gears are forced to rotate at the same speed, the gearset forms, in effect, a solid shaft.

Figure 31.
Planetary gears in the maximum reduction (low) range. The ring gear is held and a lower gear ratio is obtained

{ewc GSMVIMG,GSMVIMG, !tccS7013.bmp}

TCCS7013

Figure 32.
Planetary gears in the minimum reduction (drive) range. The ring gear is allowed to revolve, providing a higher gear ratio

{ewc GSMVIMG,GSMVIMG, !tccS7014.bmp}

TCCS7014

Most automatics use the planetary gears to provide various reductions ratios. Bands and clutches are used to hold various portions of the gearsets to the transmission case or to the shaft on which they are mounted. Shifting is accomplished, then, by changing the portion of each planetary gearset which is held to the transmission case or to the shaft.

SERVOS AND ACCUMULATORS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SERVOS AND ACCUMULATORS

Ü See figure 33

The servos are hydraulic pistons and cylinders. They resemble the hydraulic actuators used on many other machines, such as bulldozers. Hydraulic fluid enters the cylinder, under pressure, and forces the piston to move to engage the band or clutches.

Figure 33.
Servos, operated by pressure, are used to apply or release the bands, to either hold the ring gear or allow it to rotate

{ewc GSMVIMG,GSMVIMG, !tccS7015.bmp}

TCCS7015

The accumulators are used to cushion the engagement of the servos. The transmission fluid must pass through the accumulator on the way to the servo. The accumulator housing contains a thin piston which is sprung away from the discharge passage of the accumulator. When fluid passes through the accumulator on the way to the servo, it must move the piston against spring pressure, and this action smooths out the action of the servo.

HYDRAULIC CONTROL SYSTEM {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

HYDRAULIC CONTROL SYSTEM

The hydraulic pressure used to operate the servos comes from the main transmission oil pump. This fluid is channeled to the various servos through the shift valves. There is generally a manual shift valve which is operated by the transmission selector lever and an automatic shift valve for each automatic upshift the transmission provides.

> **Ä Many new transmissions are electronically controlled. On these models, electrical solenoids are used to better control the hydraulic fluid. Usually, the solenoids are regulated by an electronic control module.**

There are two pressures which affect the operation of these valves. One is the governor pressure which is effected by vehicle speed. The other is the modulator pressure which is effected by intake manifold vacuum or throttle position. Governor pressure rises with an increase in vehicle speed, and modulator pressure rises as the throttle is opened wider. By responding to these two pressures, the shift valves cause the upshift points to be delayed with increased throttle opening to make the best use of the engine's power output.

Most transmissions also make use of an auxiliary circuit for downshifting. This circuit may be actuated by the throttle linkage the vacuum line which actuates the modulator, by a cable or by a solenoid. It applies pressure to a special downshift surface on the shift valve or valves.

The transmission modulator also governs the line pressure, used to actuate the servos. In this way, the clutches and bands will be actuated with a force matching the torque output of the engine.

Identification {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Identification

Ü See figures 34, 35

The Turbo Hydra-Matic 700-R4 (also known as the 4L60 on models through 1992) and their electronically controlled cousin the 4L60-E (1993-96) 4-spd automatic transmission serial numbers are located on the rear right side of the transmission case, above the oil pan.

The THM 700-R4 (also known as the 4L60) was used in these models from 1985-92. It is a fully automatic transmission which provides 4 forward gears and a reverse gear. The oil pressure and shifting points are controlled by the throttle opening, via a Throttle Valve (TV) cable.

Figure 34.
Location and description of the THM-R4 (4L60) transmission serial number-early-model vehicles (1985-92)

{ewc GSMVIMG,GSMVIMG, !88261G06.bmp}

88261G06

Figure 35.
Location and description of the 4L60-E transmission serial number-late-model vehicles (1993-96)

{ewc GSMVIMG,GSMVIMG, !88261G07.bmp}

88261G07

Beginning in 1993, the 4L60-E (the new suffix stands for an electronically controlled version of the old transmission with the same name) replaced the its older cousin. Like the THM 700-R4, the 4L60-E is a fully automatic transmission providing 4 forward gears and a reverse gear. But unlike the older version, shift points are controlled by the engine or powertrain computer control module through 2 shift solenoids. The unit also utilizes and electronic Torque Converter Clutch (TCC) so the torque converter can operate as a direct link between the flexplate and the input shaft during high speed vehicle operation.

Fluid Pan and Filter {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Fluid Pan and Filter

REMOVAL & INSTALLATION

Ü See figures 36, 37, 38, 39, 40, 41, 42

The vehicle should be driven 15 miles to warm the transmission fluid before the pan is removed.

Ä The fluid should be drained while the transmission is warm. Fluid which is at normal operating temperature will flow better, removing more contaminants or impurities than cold fluid.

1. Raise and support the front of vehicle using jackstands.
2. Place a drain pan under the transmission pan.
3. If necessary, remove the crossmember from the rear of the transmission.
4. Remove the pan bolts from the front and the sides, then loosen the rear bolts 4 turns.
5. Using a small prybar, carefully separate the front of the pan from the transmission. This will allow the pan to partially drain. DO NOT use excessive force when attempting to break the gasket seal. DO NOT bend or otherwise damage the pan and the gasket mating surfaces. If necessary, loosen the bolts a few more turns to allow the pan more play without stressing the flange.
6. Remove the remaining pan bolts and lower the pan from the transmission. Again, be CAREFUL as the pan still contains a decent amount of HOT and MESSY transmission fluid. This is very slimy stuff and if you spill it on yourself (besides possibly being burned) you will feel slimy for days no matter how much you wash.

   Ä If the transmission fluid is dark or has a burnt smell, transmission damage is indicated. Have the transmission checked professionally.

7. Empty the pan, remove the gasket material and clean with a solvent. If you use a putty knife to clean the gasket surfaces, be very careful not to score or damage them. Most late-model vehicles utilize a rubber seal that comes off the pan, with relative ease.
8. As-long-as you've gone through the trouble to drop the pan, you might as well replace the filter. Changing the automatic transmission fluid and filter are the MOST important things you can do to help assure a long, trouble-free transmission life. Well, that and avoiding trying to pull tree stumps on a regular basis.
9. Remove the screen and the filter from the valve body.

   Ä When removing the filter from the valve body, be sure that the old O-ring is removed with the filter. Sometimes it remains stuck in the pump.

Figure 36.
Loosen all of the transmission pan retaining bolts . . .
{ewc GSMVIMG,GSMVIMG, !88261P53.bmp}

88261P53

Figure 37.
. . . then remove all but a few at the very rear of the pan
{ewc GSMVIMG,GSMVIMG, !88261P54.bmp}

88261P54

Figure 38.
Once most of the fluid has drained, carefully lower the pan from the transmission
{ewc GSMVIMG,GSMVIMG, !88261P55.bmp}

88261P55

Figure 39.
Remove the filter for inspection and replacement

{ewc GSMVIMG,GSMVIMG, !88261P56.bmp}

88261P56

Figure 40.
The gasket (or rubber seal, depending on the application) should be replaced to prevent leaks

{ewc GSMVIMG,GSMVIMG, !88261P57.bmp}

88261P57

Figure 41.
The magnet at the bottom of the pan should be thoroughly cleaned of all metal particles

{ewc GSMVIMG,GSMVIMG, !88261P58.bmp}

88261P58

Figure 42.
Exploded view of the automatic transmission fluid pan and filter

{ewc GSMVIMG,GSMVIMG, !88261G58.bmp}

88261G58

To install:

10. Install a new filter using a new gasket or O-ring.

    Ä If the transmission uses a filter having a fully exposed screen, it may be cleaned and reused.

11. To install the oil pan, use a new gasket and sealant, then reverse the removal procedures. GM recommends that you use Transgel® sealant on the new gasket. Tighten the pan bolts to 97 inch. lbs. (11 Nm) in a crisscross pattern.
12. Refill the transmission through the dipstick guide/filler tube. Please refer to the capacities chart later in this section to determine the proper amount of fluid to be added.

    ****Caution**
    Add fluid SLOWLY. DO NOT overfill the transmission, damage to the seals could occur. Overfilling the transmission could also cause small amounts of fluid to be forced back up and out of the tube. Automatic transmission fluid could then be expelled onto hot engine parts, possibly even causing a fire.

13. With the gearshift lever in **PARK**, start the engine and let it idle. DO NOT race the engine.
14. Apply the parking brake and move the gearshift lever through each position. Return the lever to **PARK** and check the fluid level with the engine idling. The level should be between the two dimples on the dipstick, about 6mm ($^1/4$ in.) below the ADD mark. On dipsticks that are so marked, the fluid should remain in the COLD zone until the transmission has fully warmed. Add fluid, if necessary.
15. Check the fluid level after the vehicle has been driven enough to thoroughly warm the transmission.

Adjustments {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Adjustments

SHIFT LINKAGE

Ü See figures 43, 44, 45

The 1985-95 vehicles covered by this manual that are equipped with automatic transmissions utilize a mechanical shift lever and linkage assembly. Starting in 1996, the shift linkage was replaced by a shift cable. For 1996 vehicles, please refer to the cable replacement and adjustment procedure found later in this section.

1. Firmly apply the parking brake and block the rear wheels.
2. Raise and support the front of the vehicle on jackstands.
3. At the left side of the transmission, loosen the shift rod swivel-to-equalizer lever nut on 1985-89 vehicles or the bracket-to-frame screw on 1990-95 vehicles.
4. At the steering column, place the gear selector lever into the Neutral position.

   Ä When positioning the gear selector lever, DO NOT use the steering column indicator to find the Neutral position, instead count gate positions from Park, through Reverse to the Neutral gate.

5. Rotate the transmission shift lever counterclockwise (toward the front of the transmission) to the first (Park) position, then turn it clockwise (rearward) to the 2nd detent (Neutral) position. Remember that the first position and the first detent are not the same. The first position, or fully counterclockwise is Park, when you turn the lever clockwise 1 detent, the transmission will be in Reverse, then turn it to the second detent and it will be in Neutral.
6. Holding the rod tightly in the swivel, tighten the retainer which was loosened to allow the adjustment. For 1985-89 vehicles, you should have loosened the equalizer lever nut and it should be tightened to 11 ft. lbs. (14 Nm). For 1990-95 vehicles, the bracket-to-frame screw should be tightened to 21 ft. lbs. (28 Nm).
7. Place the gear selector lever (on the steering column) in the **P** position and check the adjustment. Move the gear selector lever into the various positions; the engine must start ONLY in the **P** and the **N** positions.
8. If the engine will not start in the **N** and/or **P** positions, refer to the Back-Up Light Switch adjustment information in Section 6 and adjust the switch.

   ****Caution**
   With the gear selector lever in the PARK position, the parking pawl should engage the rear internal gear lugs or output ring gear lugs to prevent the vehicle from rolling and causing personal injury.

9. Align the gear selector lever indicator, if necessary.
10. Remove the jackstands and carefully lower the vehicle

Figure 43.
Shifting positions-THM 700-R4 (4L60) models with 3-gear (forward) shift levers

{ewc GSMVIMG,GSMVIMG, !88267G24.bmp}

88267G24

Figure 44.
Shifting positions-THM 700-R4 (4L60) and 4L60E models with 4-gear (forward) shift levers

{ewc GSMVIMG,GSMVIMG, !88267Ga4.bmp}

88267Ga4

Figure 45.
Exploded view of the automatic transmission shift linkage-1985-94 models (1995 similar)

{ewc GSMVIMG,GSMVIMG, !88267G25.bmp}

88267G25

THROTTLE VALVE (TV) CABLE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Drive Train

THROTTLE VALVE (TV) CABLE

Ü See figure 46

Only the THM 700-R4 (4L60) transmission (1985-92) utilizes a Throttle Valve (TV) and cable. Shift control on the 4L60-E is electronically controlled.

If the TV cable is broken, sticky, misadjusted or is the incorrect part for the model, the vehicle may exhibit various malfunctions, such as delayed or full throttle shifts.

Figure 46.
Adjusting the TV cable-V-6 on left, L-4 at middle and close-up of the adjuster assembly at right

{ewc GSMVIMG,GSMVIMG, !88267G26.bmp}

88267G26

Preliminary Checks {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Drive Train

Preliminary Checks

1. Inspect and, if necessary, correct the transmission fluid level.
2. Make sure that the brakes are not dragging and that the engine is operating correctly.
3. Make sure that the cable is connected at both ends.
4. Make sure that the correct cable is installed.

Adjustment {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Adjustment

1. Remove the engine cover in the passenger compartment for access to the throttle lever. For details on cover removal, please refer to Section 1 of this manual.
2. If necessary, remove the air cleaner.
3. If the cable has been removed and installed, check to see that the cable slider is in the zero or the fully adjusted position; if not, perform the following procedures:
   a. Depress and hold the readjust tab (located at the engine end of the TV cable).
   b. Move the slider back through the fitting (away from the throttle lever) until it stops against the fitting.
   c. Release the readjust tab.
4. Rotate the throttle lever to the Full Throttle Stop position. Be sure to manually operate the throttle lever, DO NOT use the accelerator pedal. The slider will ratchet toward the lever as it is rotated, so listen for at least 1 click.
5. Release the throttle lever.
6. Verify that the cable moves freely. The cable may appear to function properly with a stopped and cold engine. Recheck after normal operating temperature has been reached.
7. If removed for access, install the air cleaner assembly.
8. Road test the vehicle and confirm proper operation.
9. Install the engine cover to the passenger compartment.

Shift Cable {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Shift Cable

Ü See figures 47, 48, 49

REPLACEMENT & ADJUSTMENT

The 1985-95 vehicles covered by this manual that are equipped with automatic transmissions utilize a mechanical shift lever and linkage assembly. Starting in 1996, the shift linkage was replaced by a shift cable. For 1985-95 vehicles, please refer to the shift linkage adjustment procedure found earlier in this section.

Before attempting to remove the shift cable from the van, make sure that the transmission is in the mechanical Neutral position. You can verify this at the control lever on the transmission assembly by rotating it clockwise until it reaches the FULL STOP position, then rotating it back counterclockwise 2 detents.

Figure 47.
Shift cable routing and transmission attachment-1996 vehicles

{ewc GSMVIMG,GSMVIMG, !88267Ga7.bmp}

88267Ga7

Figure 48.
On All Wheel Drive (AWD) vehicles the shift cable is also secured to the transfer case

{ewc GSMVIMG,GSMVIMG, !88267Ga8.bmp}

88267Ga8

Figure 49.
Shift cable-to-steering column attachment

{ewc GSMVIMG,GSMVIMG, !88267Ga9.bmp}

88267Ga9

1. Raise and support the front of the vehicle safely using jackstands.
2. Climb under the vehicle and verify that the transmission is in mechanical Neutral.
3. Remove the clip from the bracket securing the shift cable to the transmission.
4. Disconnect the shift cable end from the transmission shift lever stud ball.
5. Remove the 3 shift cable clips from the body.
6. Remove the grommet from the hole in the floor panel.
7. On All Wheel Drive (AWD) vehicles, remove the bolt and washer securing the clip and shift cable to the transfer case assembly.
8. Move to the passenger compartment, then disconnect the clip securing the shift cable to the steering column bracket.
9. Disconnect the shift cable end from the steering column shift controller stud ball.

To install:

10. Make sure the transmission is still in mechanical Neutral (double-check if it might have accidentally been changed during cable removal).
11. Feed the steering column end of the shift cable through the grommet hole in the floor panel of the vehicle.
12. Install the shift cable end to the steering column shift controller stud ball, then fasten using the retaining clip.

13. Route the cable to the transmission bracket. DO NOT depress the locking tab that secures the shift cable to the transmission bracket. Make sure that the tab remains in the OUT position. Also, DO NOT install the shift cable end to the transmission shift lever stud ball.

To adjust:

14. Place the steering column shift lever into the Neutral position.
15. Make sure that the shift cable is properly routed and that it is not restricted. The shift cable must assume a natural routing. It must be free to move 0.80 in. (20mm) axially during the adjustment under adjustment spring loads.
16. Pull the cable completely forward and release it. When the cable is pulled COMPLETELY forward and released, the adjustment spring will position the cable at its most rearward position.
17. Connect the end of the shift cable to the transmission shift lever ball stud.

    Ä DO NOT pull the shift cable end forward of the ball stud prior to connecting the two. A poor adjustment could result.

18. Press the locking tab IN to secure the shift cable to the transmission bracket.
19. Complete the cable installation:
    a. On AWD vehicles, install the bolt and washer securing the clip and shift cable to the transfer case.
    b. Position the grommet in the floor panel hole.
    c. Install the 3 shift cable clips to the body.
20. Remove the jackstands and carefully lower the vehicle, then road test to confirm proper operation.

Neutral Safety Switch {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Neutral Safety Switch

On 1985-95 vehicles covered by this manual, the Neutral Safety Switch is a part of the Back-Up Light Switch and is mounted to the steering column. For replacement or adjustment, please refer to the Back-Up Light Switch, Removal and Installation procedures in Section 6 of this manual.

In 1996, the neutral safety switch was relocated to the side of the transmission assembly. This change corresponds to the change made that year from shift linkage to a shift cable.

REPLACEMENT & ADJUSTMENT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REPLACEMENT & ADJUSTMENT

Ü See figures 50, 51

> **Ä Any removal of the switch will require that the switch is adjusted before installation. Switch adjustment should only be accomplished using J-41364-A or an equivalent switch adjustment and alignment tool. If the tool is not available, you may be able to successfully adjust the switch using a hit and miss method, moving the switch slightly each time and rechecking to verify that the switch works properly (the vehicle starts ONLY when the transmission is in Park or Neutral). But, this could take some time and be quite frustrating, so an attempt to buy or borrow the adjustment tool first may be well worth it.**

1. Firmly apply the parking brake and block the rear wheels.
2. Disconnect the negative battery cable for safety.
3. Shift the transmission into Neutral.
4. Raise and support the front of the vehicle safely using jackstands.
5. Before attempting to remove or adjust the switch, make sure that the transmission is in the mechanical Neutral position. You can verify this at the control lever on the transmission assembly by rotating it clockwise until it reaches the FULL STOP position, then rotating it back counterclockwise 2 detents.
6. Disconnect the shift cable end from the transmission shift control lever by pulling the cable end from the lever ball stud.
7. Remove the nut securing the control lever to the manual shaft.
8. Disengage the wiring connectors from the neutral safety/back-up light switch.
9. Remove the 2 bolts which secure the switch to the transmission assembly.
10. Slide the switch from the manual shaft. If there is difficulty removing the switch, file the outer edge of the manual shaft lightly to remove any burrs from the shaft.

To adjust:

11. Position J-41364-A, or an equivalent adjustment tool, onto the neutral safety switch, making sure that the 2 slots on the switch (located where the manual shaft is inserted) are aligned with the 2 lower tabs on the tool. Then, rotate the tool until the tool's upper locator pin is aligned with the slot on the top of the switch.

> **Ä During installation, leave the adjustment tool mounted to the switch until the switch is secured and the position cannot change.**

Figure 50.
Exploded view of the transmission mounted neutral safety switch-1996 models only

{ewc GSMVIMG,GSMVIMG, !88267Gb7.bmp}

88267Gb7

Figure 51.
Use the adjustment tool to greatly ease your job during neutral safety switch adjustment or installation

{ewc GSMVIMG,GSMVIMG, !88267Gb8.bmp}

88267Gb8

To install:

12. Check the outer edge of the manual shaft to make sure there are no burrs which could prevent switch installation. If necessary, file the edge lightly to remove any remaining burrs.
13. Align the switch hub flats with the flats on the manual shaft.
14. Slide the switch onto the transmission manual shaft until the switch mounting bracket contacts the mounting bosses on the transmission.
15. Secure the switch to the transmission using the 2 retaining bolts. Tighten the bolts to 21 ft. lbs. (28 Nm).
16. Remove the switch adjustment tool from the switch assembly.
17. Engage the wiring harness connectors to the switch.
18. Install the transmission control lever to the manual shaft, then secure using the retaining nut. Tighten the nut to 21 ft. lbs. (28 Nm).
19. Connect the negative battery cable, then verify proper switch operation. The engine MUST start ONLY with the transmission in Park or Neutral. If further adjustment is required, loosen the switch retaining bolts and rotate the switch slightly, then tighten the bolts and check for proper operation.
20. Remove the jackstands and carefully lower the vehicle.

Back-up Light Switch {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Back-up Light Switch

On 1985-95 vehicles covered by this manual, the Back-Up Light Switch and is mounted to the steering column. For replacement or adjustment, please refer to the Back-Up Light Switch, Removal and Installation procedures in Section 6 of this manual.

In 1996, the back-up light and neutral safety switch assembly was relocated to the side of the transmission assembly. This change corresponds to the change made that year from shift linkage to a shift cable. For replacement and adjustment procedures, please refer to the neutral safety switch information found earlier in this section.

Extension Housing Seal {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Extension Housing Seal

REMOVAL & INSTALLATION

Ü See figures 52, 53, 54

1. Disconnect the negative battery cable for safety.
2. Block the front wheels.
3. Raise and support the rear of the vehicle safely using jackstands. Raise the rear of the vehicle sufficiently to keep all of the fluid in the transmission, away from the rear extension housing. If this cannot be done, the transmission pan will have to be removed in order to drain the fluid.
4. Match-mark and remove the driveshaft as outlined in this section.
5. Using a suitable prybar or better yet, a seal removal tool (these are usually inexpensive and make the job much easier), pry the rear seal out of the extension housing.

****Warning**
The use of an improper tool to pry the seal from the housing could allow the bore to be damaged, preventing the seal's replacement from fully "sealing" the transmission. Fluid leaks could result.

To install:

6. Coat the outside of the seal with a suitable non-hardening sealer.
7. Install the new seal with a suitable driver or seal installer.
8. Align and install the driveshaft.
9. Remove the jackstands and carefully lower the vehicle.
10. Connect the negative battery cable.

Figure 52.
Remove the driveshaft for access to the rear transmission (extension housing) seal

{ewc GSMVIMG,GSMVIMG, !88267P03.bmp}

88267P03

Figure 53.
Use a seal puller to remove the extension housing seal (BE CAREFUL not to damage the bore)

{ewc GSMVIMG,GSMVIMG, !88267P01.bmp}

88267P01

Figure 54.
Use a suitable driver to install the replacement seal into the housing

{ewc GSMVIMG,GSMVIMG, !88267P02.bmp}

88267P02

Transmission

REMOVAL & INSTALLATION

Ä The following procedures require the use of the Torque Converter Holding tool No. J-21366 or equivalent.

The manufacturer recommends that you drain the transmission fluid before attempting to remove the transmission assembly from the vehicle. The major reason for this is that depending on the condition of the transmission's seals and how the transmission is manipulated during removal, there is a good chance that the fluid will spill causing quite a mess. Keep in mind that in almost all instances, the transmission dipstick tube must be removed from the housing before the transmission can be removed from the vehicle. This provides a great escape route for fluid unless it can be thoroughly and safely plugged for the duration of the procedure. The bottom line is that you will have to make up your own mind.

Ä If you decide to drain the fluid from a transmission that you are also planning on returning to service, it may be a good idea to drive the vehicle and thoroughly warm the fluid before draining. This will assure you the best fluid change possible.

THM 700 R-4 (4L60) Transmission {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

THM 700 R-4 (4L60) Transmission

Ü See figures 55, 56, 57, 58, 59

1. Disconnect the negative battery cable for safety.
2. Remove the engine cover from the passenger compartment for access. For details, please refer to Section 1 of this manual.
3. Remove the air cleaner for access, then disconnect the Throttle Valve (TV) cable from the throttle lever.
4. Raise and support the front of the vehicle safely using jackstands.
5. Drain the transmission fluid by removing the pan.
6. Disconnect the shift linkage from the transmission assembly.
7. Match-mark and remove the driveshaft from the vehicle. On All Wheel Drive (AWD) vehicles, the front driveshaft should be removed as well.
8. Disconnect the support bracket at the catalytic converter along with any other components which must be removed for clearance.
9. Support the transmission or transmission and transfer case (as applicable) using a suitable floor jack.
10. Remove the transmission crossmember.

    ****Warning**
    DO NOT stretch or otherwise damage any cables, wires or other components when lowering the transmission in the next step.

11. Carefully lower the transmission in order to provide the necessary clearance to reach other components.
12. Remove the dipstick tube and seal from the transmission assembly, then cover or plug the opening to prevent dirt or contamination from entering the transmission and to minimize fluid leakage. Remember that even if you drained the transmission there is still a decent amount of the slimly fluid in the assembly and it will seep out of any opening you make during the procedure.
13. Disconnect the speedometer cable, on early-models or disengage speedometer harness (speed sensor) connector on late-models.
14. If used, disconnect the vacuum modulator line.
15. Disengage the electrical connectors and any electrical connector retaining clips from the transmission.
16. Disconnect the oil cooler lines. Immediately cap all openings in the transmission assembly and the lines to prevent excessive fluid loss or system contamination.
17. If equipped, remove the dampener and support.

Figure 55.
Exploded view of the speedometer cable assembly-early model THM 700-R4 (4L60) only

{ewc GSMVIMG,GSMVIMG, !88267G27.bmp}

88267G27

Figure 56.
Automatic transmission support brackets-2.5L engine

{ewc GSMVIMG,GSMVIMG, !88267G28.bmp}

88267G28

Figure 57.
Automatic transmission support brackets-4.3L engine

{ewc GSMVIMG,GSMVIMG, !88267G29.bmp}

88267G29

Figure 58.
Exploded view of the transmission mount assembly

{ewc GSMVIMG,GSMVIMG, !88267G30.bmp}

88267G30

Figure 59.
Exploded view of the automatic transmission mounting-1985-93 vehicles shown (1994-96 similar)

{ewc GSMVIMG,GSMVIMG, !88267Gd1.bmp}

88267Gd1

18. On AWD vehicles, check the transfer case for any wires, hoses, cables or other connections, then disengage them and position aside.

    Ä Before removal, note the position of the transmission support braces as they must be reinstalled in their original positions.

19. Remove the transmission support braces (at the torque converter cover).
20. Remove the torque converter cover, then match-mark the flexplate to the torque converter; re-aligning the marks during installation will maintain the original balance.
21. Remove the torque converter-to-flywheel bolts and slide the converter back into the transmission.
22. Place a block of wood and a jackstand under the rear of the engine and support it.
23. Remove the transmission-to-engine mounting bolts. Note the location of any clips or brackets for installation purposes, then position them aside.
24. With the transmission still supported by the first floor jack, carefully slide the transmission back off the locating pins. Once there is sufficient clearance, install a torque converter holding tool such as No. J-21366 or equivalent.
25. Carefully lower the transmission assembly from the vehicle.

To install:

26. Make sure the torque converter is properly seated in the transmission assembly and install the converter holding tool.
27. Support the transmission assembly (and transfer case on AWD vehicles) on a floor jack, then position it under the vehicle.
28. Carefully raise the transmission into position and remove the torque converter holding tool.
29. Slide the transmission straight onto the locating pins while aligning the flexplate and torque converter match-marks which were made during removal.

    Ä Once in position, the torque converter must be flush onto the flexplate and must be able to rotate freely by hand.

30. Install the transmission assembly-to-engine retaining bolts along with any brackets or clips which were positioned aside during removal. Tighten the transmission retaining bolts to 55 ft. lbs. (75 Nm) for 2.5L engines or to 35 ft. lbs. (47 Nm) for 1985-90 4.3L engines or to 23 ft.

lbs. (32 Nm) for 1991-92 4.3L engines.

31. Thread the torque converter-to-flexplate screws by hand until they are finger-tight to assure proper converter seating.
32. Tighten the torque converter bolts to 46 ft. lbs. (63 Nm) slowly and evenly.
33. Install the converter cover, carefully hooking the cover under the lip of the engine oil pan.
34. If equipped, install the support and dampener. Make sure the dampener is positioned 90º from the transmission's centerline.
35. Install the transmission support braces in the positions noted during removal.
36. Remove the caps or plugs, then connect the oil cooler lines to the transmission.
37. Connect the speedometer cable or engage the speedometer harness (speed sensor) connector, as applicable.
38. Engage the electrical wiring connectors to the transmission and secure any wiring clips which were removed.
39. Remove the cover or plug and install the dipstick tube using a new seal. Install the new seal first, then the tube.
40. Remove the support from the engine, then carefully raise the engine and transmission assembly fully into position.

    Ä When raising the transmission into place, be sure NOT to pinch or damage any cables, wires or other components.

41. Install the transmission crossmember and the transmission mount, along with any other components which were removed for clearance. Remove the floor jack.
42. Install the support bracket at the catalytic converter.
43. Align and install the driveshaft(s).
44. Connect the shift linkage.
45. Connect the TV cable to the throttle lever, then if removed for clearance, install the air cleaner.
46. Adjust the shift linkage and the TV cable, as necessary.
47. Remove the jackstands and carefully lower the vehicle.
48. If drained earlier, IMMEDIATELY refill the transmission using fresh fluid.
49. From inside the vehicle, install the engine cover.
50. Connect the negative battery cable.

4L60-E Transmission {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Drive Train

4L60-E Transmission

Ü See figures 59, 60, 61

1. Disconnect the negative battery cable for safety.
2. Raise and support the front of the vehicle safely using jackstands.
3. Drain the transmission fluid by removing the pan.
4. Disconnect the shift linkage (1993-95 vehicles) or the shift cable (1996 vehicles) from the transmission assembly, as applicable.
5. Match-mark and remove the driveshaft from the vehicle. On All Wheel Drive (AWD) vehicles, the front driveshaft should be removed as well.
6. On 1996 vehicles, remove the transfer case and adapter from the transmission assembly. For details, please refer to the transfer case removal procedure found later in this section.
7. On 1993-95 vehicles, disconnect the support bracket at the catalytic converter along with any other components which must be removed for clearance.
8. Support the transmission or transmission and transfer case (as applicable) using a suitable floor jack.
9. On 1996 vehicles, remove the 2 front torsion bars. For details, please refer to Section 8 of this manual.
10. On 1994-95 vehicles, unload the torsion bars. For details, please refer to Section 8 of this manual.
11. On 1994-96 vehicles, remove the rear transmission mount.
12. On 1993-95 vehicles, remove the transmission crossmember.

    ****Warning**
    DO NOT stretch or otherwise damage any cables, wires or other components when lowering the transmission in the next step.

13. Carefully lower the transmission in order to provide the necessary clearance to reach other components.
14. Remove the dipstick tube and seal from the transmission assembly, then cover or plug the opening to prevent dirt or contamination from entering the transmission and to minimize fluid leakage. Remember that even if you drained the transmission there is still a decent amount of the slimly fluid in the assembly and it will seep out of any opening you make during the procedure.
15. Disengage speedometer harness (speed sensor) connector.
16. Disengage the electrical connectors and any electrical connector retaining clips from the transmission.
17. Disconnect the oil cooler lines. Immediately cap all openings in the transmission assembly and the lines to prevent excessive fluid loss or system contamination.
18. On 1993 AWD vehicles, check the transfer case for any wires, hoses, cables or other connections, then disengage them and position aside.

    Ä On vehicles so equipped, before removal of the transmission support braces, note the brace positioning as they must be reinstalled in their original positions.

19. On 1993-95 vehicles, remove the transmission support braces (at the torque converter cover).

20. On 1996 vehicles, remove the starter motor assembly from the engine.
21. Remove the torque converter cover, then match-mark the flexplate to the torque converter; re-aligning the marks during installation will maintain the original balance.
22. Remove the torque converter-to-flywheel bolts and slide the converter back into the transmission.
23. Place a block of wood and a jackstand under the rear of the engine and support it.
24. Remove the transmission-to-engine mounting bolts. Note the location of any clips or brackets for installation purposes, then position them aside.
25. With the transmission still supported by the first floor jack, carefully slide the transmission back off the locating pins., Once there is sufficient clearance, install a torque converter holding tool such as No. J-21366 or equivalent.
26. Carefully lower the transmission assembly from the vehicle.

Figure 60.
Exploded view of the automatic transmission mount-1993-95 vehicles and 1996 AWD vehicles

{ewc GSMVIMG,GSMVIMG, !88267Gd2.bmp}

88267Gd2

Figure 61.
Exploded view of the automatic transmission mount-1996 2WD vehicles

{ewc GSMVIMG,GSMVIMG, !88267Gd3.bmp}

88267Gd3

To install:

27. Make sure the torque converter is properly seated in the transmission assembly and install the converter holding tool.
28. Support the transmission assembly (and the transfer case if it was removed with the transmission earlier AWD vehicles) on a floor jack, then position it under the vehicle.
29. Carefully raise the transmission into position and remove the torque converter holding tool.
30. Slide the transmission straight onto the locating pins while aligning the flexplate and torque converter match-marks which were made during removal.

    Ä Once in position, the torque converter must be flush onto the flexplate and must be able to rotate freely by hand.

31. Install the transmission assembly-to-engine retaining bolts along with any brackets or clips which were positioned aside during removal. Tighten the transmission retaining bolts to 23 ft. lbs. (32 Nm).
32. Thread the torque converter-to-flexplate screws by hand until they are finger-tight to assure proper converter seating.
33. Tighten the torque converter bolts to 46 ft. lbs. (63 Nm) slowly and evenly.
34. Remove the jackstand which was positioned to support the engine.
35. Install the converter cover. On most models the cover must be carefully hooked under the lip of the engine oil pan during installation.
36. On 1996 models, install the starter motor assembly.
37. On 1993-95 models, install the transmission support braces in the positions noted during removal.

38. On 1993 AWD vehicles, position and engage any wires, cables or other connections to the transfer case.
39. Remove the caps or plugs, then connect the oil cooler lines to the transmission.
40. Engage the speedometer harness (speed sensor) connector.
41. Engage the electrical wiring connectors to the transmission and secure any wiring clips which were removed.
42. Remove the cover or plug and install the dipstick tube using a new seal. Install the new seal first, then the tube.
43. Carefully raise the engine and transmission assembly fully into position.

    Ä When raising the transmission into place, be sure NOT to pinch or damage any cables, wires or other components.

44. On 1993-95 vehicles:
    a. Install the transmission crossmember and the transmission mount, along with any other components which were removed for clearance.
    b. Remove the floor jack.
    c. On 1994-95 vehicles, load the torsion bars.
    d. Install the support bracket at the catalytic converter.
45. On 1996 vehicles:
    a. Install the transmission mount, then remove the floor jack.
    b. On AWD vehicles, install the transfer case and adaptor.
46. Align and install the driveshaft(s). On AWD vehicles, install the rear driveshaft first.
47. On 1996 vehicles, install the front torsion bars.
48. Connect the shift linkage or cable, as applicable and adjust, as necessary.
49. Remove the jackstands and carefully lower the vehicle.
50. If drained earlier, IMMEDIATELY refill the transmission using fresh fluid.
51. Connect the negative battery cable.

TRANSFER CASE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TRANSFER CASE

Identification

Ü See figures 62, 63

The 1990-96 Astro and Safari vans could be ordered with All Wheel Drive (AWD) as an option. It is only available with an automatic overdrive transmission and the 4.3L engine. The BW-4472 transfer case is an aluminum two piece unit with a chain driven viscous clutch. The AWD is automatic and has no external controls. The torque is transmitted through the input shaft to the planet carrier assembly. The viscous clutch provides the connection between the gear ring and sun gear shaft. An aluminum tag is attached to the underside of the self-tapping case bolts.

Figure 62.
The BW-4472 transfer case assembly

{ewc GSMVIMG,GSMVIMG, !88267G32.bmp}

88267G32

Figure 63.
Transfer case fill and drain plugs (along with other external components)

{ewc GSMVIMG,GSMVIMG, !88267G33.bmp}

88267G33

Front or Rear Shaft (Output) Seal {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Front or Rear Shaft (Output) Seal

REMOVAL & INSTALLATION

Ü See figures 64, 65, 66

1. Raise and support the vehicle safely using jackstands. To help prevent the possibility of fluid leakage, the end of the vehicle at which the seal is being replaced should be lifted (raise the front if replacing the front seal, the rear for the rear seal).
2. Match-mark the driveshaft and flange for installation purposes, then remove the front or rear driveshaft, as applicable.
3. If replacing the front seal, remove the front output flange nut and washer, then remove the rubber sealing washer and the output flange.
4. Pry out the output oil seal with a suitable prybar or seal removal tool being careful not to damage the seal bore.

To install:

5. If replacing the rear seal, align the water drain hole in the output shaft oil seal with the drain groove in the extension housing.
6. Lubricate seal lips with fresh Dexron®III or Dexron®II fluid.
7. Install the seal to the transfer case assembly using a suitable driver or a seal installer such as J-367668-A.
8. If you are replacing the front seal, install the front output shaft flange, rubber sealing washer, steel washer and flange nut. Tighten the nut to 80 ft. lbs. (108 Nm).
9. Align and install the driveshaft.
10. Check the transfer case lubricant by removing the fill plug (but remember that if the vehicle MUST be level so you may have to raise and support the other end as well, unless there is sufficient clearance with the vehicle completely lowered. If fluid does not spill out of the hole, add automatic transmission fluid (Dexron®III or Dexron®II, please refer to Section 1 for more details) to the fill hole until lubricant reaches the top of the hole.
11. If not done earlier, remove the jackstands and carefully lower the vehicle.
12. Check operation and inspect for leaks.

Figure 64.
Exploded view of the front output shaft flange and seal

{ewc GSMVIMG,GSMVIMG, !88267GE1.bmp}

88267GE1

Figure 65.
Extension housing (rear output shaft) seal alignment

{ewc GSMVIMG,GSMVIMG, !88267G34.bmp}

88267G34

Figure 66.
Install the seal (front or rear) using a suitable driver or seal installation tool

{ewc GSMVIMG,GSMVIMG, !88267G35.bmp}

88267G35

Transfer Case Assembly {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Transfer Case Assembly

REMOVAL & INSTALLATION

Ü See figure 67

The manufacturer recommends that you drain the transmission fluid before attempting to remove the transfer case assembly from the vehicle. The major reason for this is that depending on the condition of the case's seals and how the case assembly is manipulated during removal, there is a chance that the fluid will spill causing quite a mess. Even if the seals are in good condition, with the driveshafts removed, fluid will be able leak past them readily. The vent hose is another possible escape route. The bottom line is that you will have to make up your own mind.

Ä If you decide to drain the fluid from a transfer case that you are also planning on returning to service, it may be a good idea to drive the vehicle and thoroughly warm the fluid before draining. This will assure you the best fluid change possible.

1. Disconnect the negative battery cable for safety.
2. Raise and support the vehicle safely using jackstands.
3. Drain the oil from the transfer case into a suitable container.
4. Match-mark and remove the driveshafts.
5. If necessary, disconnect the breather hose.
6. Disengage all electrical connectors.
7. Support the transfer case with a suitable jack.
8. Remove the transfer case support bracket and adapter-to-case bolts.
9. Remove the transfer case mount nuts and washers, then carefully lower the transfer case from the vehicle.
10. Remove and discard the old adapter gasket.

To install:

11. Make sure all gasket surfaces are clean and free of grease or oil.
12. Install a new transfer case-to-adapter gasket with sealer.
13. Carefully raise the transfer case assembly into position and Install the transfer case-to-adapter bolts. Tighten the bolts to 38 ft. lbs. (52 Nm).
14. Remove the jack from the case assembly.
15. Install the case mount to the crossmember using the washers and nuts. Tighten the retaining nuts to 26 ft. lbs. (35 Nm).
16. Install the support bracket to the engine and/or transfer case, depending on which bolts were removed. Tighten the bracket-to-engine bolts to 94 ft. lbs. (128 Nm) and/or the bracket-to-transfer case bolts to 66 ft. lbs. (90 Nm).
17. Engage the electrical connectors and, if removed, connect the breather hose.
18. Align and install the front and rear driveshafts.
19. Check the transfer case lubricant by removing the fill plug (but remember that if the vehicle MUST be level so you may have to raise and support the other end as well, unless there is sufficient clearance with the vehicle completely lowered. If fluid does not spill out of the hole, add automatic transmission fluid (Dexron®III or Dexron®II, please refer to Section 1 for more details) to the fill hole until lubricant reaches the top of the hole.

20. Remove the jackstands and carefully lower the vehicle.
21. Connect the negative battery cable and check operation.

Figure 67.
Exploded view of the transfer case assembly mounting
{ewc GSMVIMG,GSMVIMG, !88267GE2.bmp}

88267GE2

DRIVELINE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

DRIVELINE

Ü See figures 68, 69, 70

The Astro and Safari van's rear driveshaft is of the conventional, open type. Located at either end of the driveshaft is a universal joint (U-joint), which allows the driveshaft to move up and down to match the motion of the front and rear axle. The main problem with the simple U-joint is that as the angle of the shaft increases past three to four degrees, the driven yoke rotates slower or faster than the drive yoke. This problem can be reduced by adding an additional U-joint or incorporating a constant velocity joint.

For most of the All Wheel Drive (AWD) vehicles covered by this manual, the front driveshaft uses two Constant Velocity (CV) joints to transfer the power from the transfer case to the front drive axle. The constant velocity joint is used because it allows the driveline angle to be adjusted according to the up and down movement of the vehicle without disturbing the power flow. For 1995-96 AWD vehicles the rear CV-joint (driveshaft-to-transfer case connection) was replaced with a double cardan joint, which serves a similar purpose, through the use of 2 spider and yoke assemblies.

As for the rear driveshaft, both ends are attached using U-joints, but the design is slightly different between the front and rear of the shaft itself. The rear driveshaft's front U-joint (injected nylon or internal snaprings) connects the driveshaft to a slip-jointed yoke. This yoke is internally splined and allows the driveshaft to move in and out on the transmission splines. On the production U-joints, nylon is injected through a small hole in the yoke during manufacture and flows along a circular groove between the U-joint and the yoke, creating a non-metallic snapring.

The rear driveshaft's rear U-joint is clamped to the rear axle pinion. The rear U-joint is secured in the yoke, using external snaprings (inside the yoke ears). It is attached to the rear axle pinion by use of bolted straps.

Bad U-joints, requiring replacement, will produce a clunking sound when the vehicle is put into gear and when the transmission shifts from gear-to-gear. This is due to worn needle bearings or scored trunnion end possibly caused by improper lubrication during assembly. U-joints require no periodic maintenance and therefore have no lubrication fittings.

A vibration damper is employed as part of the slip joint. This damper cannot be serviced separately from the slip joint; if either component goes bad, the two must be replaced as a unit.

Figure 68.
Exploded view of the front driveshaft mounting-1990-94 AWD vehicles
{ewc GSMVIMG,GSMVIMG, !88267G36.bmp}

88267G36

Figure 69.
Exploded view of the front driveshaft mounting-1995-96 AWD vehicles
{ewc GSMVIMG,GSMVIMG, !88267GF1.bmp}

88267GF1

Figure 70.
Exploded view of the rear driveshaft mounting-1985-94 vehicles (1995-96 similar)
{ewc GSMVIMG,GSMVIMG, !88267G37.bmp}

88267G37

Driveshaft and U-Joints {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Driveshaft and U-Joints

****Warning**
If the vehicle is to be undercoated, the driveshaft and U-joints must be removed or completely covered to protect them from the undercoating. Failure to do this will most likely result in a loss of balance to the driveshaft leading to vibration and possible early U-joint failure.

REMOVAL & INSTALLATION

Ü See figures 68, 69, 70

Ä The driveshaft and its companion flanges are balanced at the factory. They must maintain this original alignment in order to maintain proper balance. Before removing any driveshaft ALWAYS match-mark the shaft to the flanges.

Drive Train

Front

1. Disconnect the negative battery cable for safety.
2. Raise and support the front of the vehicle safely using jackstands.
3. Match-mark the positions of the driveshaft components relative to the driveshaft and flanges. The components must be reassembled in the same position to maintain proper balance.
4. Remove the transfer case flange and front axle flange-to-driveshaft bolts.
5. Pull the driveshaft forward and down to remove.

To install:

6. Inspect the plastic shrouds (CV-joints) for cracking or deterioration, replace if necessary.
7. Install the shaft, while aligning the reference marks made during removal. The importance of this step cannot be over-emphasized.
8. Install the flange-to-driveshaft bolts at both ends of the shaft.
9. Tighten the transfer case flange bolts to 92 ft. lbs. (125 Nm) for 1990-95 vehicles or to 55 ft. lbs. (75 Nm) for 1996 vehicles.
10. Tighten the front axle flange bolts to 53 ft. lbs. (72 Nm) for 1990-95 vehicles or to 55 ft. lbs. (75 Nm) for 1996 vehicles.
11. Remove the jackstands and carefully lower the vehicle.
12. Connect the negative battery cable and check for proper operation.

Rear {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Drive Train

Rear

Ü See figures 71, 72, 73, 74

1. Disconnect the negative battery cable for safety.
2. Raise and support the rear of the vehicle safely using jackstands.
3. Using paint, match-mark the relationship of the driveshaft-to-pinion flange. The components must be reassembled in the same position to maintain proper balance.
4. Remove the universal joint-to-rear axle retainers.

   Ä If the bearing cups are loose, tape them together to prevent dropping or loosing the roller bearings.

5. Remove the driveshaft by sliding it forward, to disengage it from the axle flange, and then rearward, passing it under the axle housing.

   ****Warning**
   When removing the driveshaft, DO NOT drop it or allow the universal joints to bend at extreme angles, for this may fracture the plastic injected joints.

6. Inspect the driveshaft splines and surfaces for burrs, damage or wear.

To install:

7. Position the driveshaft into the transmission, then raise the rear and align it with the match-marks on the axle flange. The importance of properly aligning the match-marks made earlier cannot be over-emphasized.
8. Install the universal joint-to-pinion flange bolts and tighten to 27 ft. lbs. (37 Nm).
9. Remove the jackstands and carefully lower the vehicle.
10. Connect the negative battery cable and check for proper operation.

Figure 71.
ALWAYS match-mark the driveshaft yoke to the companion flange to assure proper installation

{ewc GSMVIMG,GSMVIMG, !88267Pa4.bmp}

88267Pa4

Figure 72.
Remove the U-joint-to-companion flange retainers, then . . .

{ewc GSMVIMG,GSMVIMG, !88267P05.bmp}

88267P05

Figure 73.
. . . push the driveshaft forward slightly and lower the rear from the flange

{ewc GSMVIMG,GSMVIMG, !88267P06.bmp}

88267P06

Figure 74.
Be sure to tape the U-joint caps to prevent bearing loss or damage should they come loose

{ewc GSMVIMG,GSMVIMG, !88267P07.bmp}

88267P07

U-JOINT OVERHAUL {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

U-JOINT OVERHAUL

Ü See figure 75

Two types of universal joints are used: The front of the rear driveshaft uses an internal snapring (production is plastic injected), while the rear driveshaft's rear joint and the double cardan joint used on the rear of the 1995-96 front driveshafts use an external snapring.

Ä KEEP IN MIND that if the U-joints have been replaced, it is possible that one type was substituted for another, since they are often available in the same sizes. To be sure with which type your driveshaft is equipped, visually inspect the trunnion bore on the outside of the flange. A snapring should be readily visible if you are using the external snapring type joint. If no snapring is visible, check for a retaining ring at the inner ear of the yoke to make sure there is no internal snapring.

Ä The following procedure requires the use of an Arbor Press, the GM Cross Press tool No. J-9522-3 or equivalent, the GM Spacer tool No. J-9522-5 or equivalent, and a $1^1/8$ in. socket.

Figure 75.
An external snapring type U-joint is easily identified by the visible snapring in the yoke bore

{ewc GSMVIMG,GSMVIMG, !88267p04.bmp}

88267p04

Internal Snapring (Nylon Injected) Type {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Internal Snapring (Nylon Injected) Type

Ü See figures 76, 77, 78, 79, 80, 81

1. While supporting the driveshaft, in the horizontal position, place it so that the lower ear of the front universal joint's shaft yoke is supported on a $1^1/8$ in. (30mm) socket.

   Ä DO NOT clamp the driveshaft tube in a vise, for the tube may become damaged.

2. Using the GM Cross Press tool No. J-9522-3 or equivalent, place it on the horizontal bearing cups and press the lower bearing cup out of the yoke ear; the pressing action will shear the plastic retaining ring from the lower bearing cup. If the bearing cup was not completely removed, insert the GM Spacer tool No. J-9522-5 or equivalent, onto the universal joint, then complete the pressing procedure to remove the joint.
3. Rotate the driveshaft and shear the plastic retainer from the opposite side of the yoke.
4. Disengage the slip yoke from the driveshaft.
5. To remove the universal joint from the slip yoke, perform the procedures used in Steps 1-4.

   Ä When the front universal joint has been disassembled, it must usually be discarded and replaced with a service kit joint, as the production joint is not usually equipped with bearing retainer grooves on the bearing cups.

6. Clean (remove any remaining plastic particles), then inspect the slip yoke and driveshaft for damage, wear or burrs.

   Ä The universal joint service kit includes: A pregreased cross assembly, four bearing cups with seals, needle rollers, washers, four bearing retainers and grease. Make sure that the bearing cup seals are installed to hold the needle bearings in place for handling.

To install:

7. Position one bearing cup assembly part way into the yoke ear (turn the ear to the bottom), insert the bearing cross (into the yoke) so that the trunnion seats freely into the bearing cup. Turn the yoke 180º and install the other bearing cup assembly.

   Ä When installing the bearing cup assemblies, make sure the trunnions are started straight and true into the bearing cups.

8. Using the arbor press, press the bearing cups onto the cross trunnion, until they seat.

   Ä While installing the bearing cups, twist the cross trunnion to work it into the bearings. If there seems to be a hangup, stop the pressing and recheck the needle roller alignment.

9. Once the bearing cup retainer grooves have cleared the inside of the yoke, stop the pressing and install the snaprings.
10. If the other bearing cup retainer groove has not cleared the inside of the yoke, use a hammer to aid in the seating procedure.
11. To install the yoke/universal assembly to the driveshaft, perform the Steps 7-10 of this procedure.

Figure 76.
Exploded view of an internal snapring U-joint assembly

{ewc GSMVIMG,GSMVIMG, !88267G38.bmp}

88267G38

Figure 77.

To remove the U-joint use a cross press and a 1 1/8 in. (30mm) socket

{ewc GSMVIMG,GSMVIMG, !88267G39.bmp}

88267G39

Figure 78.
If necessary, the use of a spacer will allow the bearing cup to be pushed further from the yoke

{ewc GSMVIMG,GSMVIMG, !88267G40.bmp}

88267G40

Figure 79.
A hammer may be used to relieve preload from a snapring (during removal) or to help seat the snapring (during installation)

{ewc GSMVIMG,GSMVIMG, !88267G41.bmp}

88267G41

Figure 80.
Installing the U-joint bearing cross (spider) to the yoke

{ewc GSMVIMG,GSMVIMG, !88267G42.bmp}

88267G42

Figure 81.
Installing an internal snapring on a replacement U-joint

{ewc GSMVIMG,GSMVIMG, !88267G43.bmp}

88267G43

External Snapring Type {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

External Snapring Type

Ü See figures 77, 78, 79, 80, 82, 83

1. Remove the snaprings from inside the yoke ears. This is done by carefully pinching the ends together using a pair of pliers (snapring or needlenose pliers work best).

   Ä If the ring does not readily snap from the yoke groove, tap the end of the bearing cup lightly to relieve the preload from the snapring.

2. While supporting the driveshaft, in the horizontal position, position it so that the lower ear of the front universal joint's shaft yoke is supported on a 1 $^1/8$ in. (30mm) socket.

   Ä DO NOT clamp the driveshaft tube in a vise, for the tube may become damaged.

3. Using the GM Cross Press tool No. J-9522-3 or equivalent, place it on the horizontal bearing cups and press the lower bearing cup out of the yoke ear. If the bearing cup was not completely removed, insert the GM Spacer tool No. J-9522-5 or equivalent, onto the universal joint, then complete the pressing procedure.
4. Rotate the driveshaft (or double cardan joint on late-model front shafts) and press the bearing cup from the opposite side of the yoke.
5. Disengage the slip yoke from the driveshaft (or the cardan joint from the front driveshaft, as applicable).
6. To remove the universal joint from the slip yoke (or to further disassemble the double cardan joint), perform Steps 1-4 which were used to remove the joint from the driveshaft.
7. Clean and inspect the yoke and the driveshaft for damage, wear or burrs.

To install:

8. Position one bearing cup assembly part way into the yoke ear (turn the ear to the bottom), insert the bearing cross (into the yoke) so that the trunnion seats freely into the bearing cup. Turn the yoke 180º and install the other bearing cup assembly.

   Ä When installing the bearing cup assemblies, make sure the trunnions are started straight and true into the bearing cups.

9. Using the arbor press, press the bearing cups onto the cross trunnion, until they seat.

   Ä While installing the bearing cups, twist the cross trunnion to work it into the bearings. If there seems to be a hangup, stop the pressing and recheck the needle roller alignment.

10. Once the bearing cup clears the retainer grooves (inside of the yoke ear), stop the pressing and install the snaprings.
11. If the other bearing cup has not cleared the retainer groove (inside the yoke ear), use a hammer and a brass drift punch to aid in the seating procedure.
12. To install the yoke (joint)/universal assembly to the driveshaft, perform the Steps 8-11 of this procedure.

Figure 82.
Exploded view of an external U-joint assembly

{ewc GSMVIMG,GSMVIMG, !88267G44.bmp}

88267G44

Figure 83.
Exploded view of the double cardan U-joint-1995-96 front driveshaft (AWD vehicles)

{ewc GSMVIMG,GSMVIMG, !88267GF2.bmp}

88267GF2

REAR DRIVE AXLE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REAR DRIVE AXLE

Understanding Drive Axles

The drive axle is a special type of transmission that reduces the speed of the drive from the engine and transmission while dividing the power to the wheels. Power enters the axle from the driveshaft via the companion flange. The flange is mounted on the drive pinion shaft. The pinion shaft and gear then carry the power into the differential and turn at transmission/driveshaft speed. The gear on the end of the pinion shaft drives a large ring gear the axis of rotation of which is 90 degrees away from that of the pinion. The pinion and gear reduce speed by the gear ratio of the axle, and change the direction of rotation to turn the axle shafts which drive both wheels. The axle gear ratio can be found by dividing the number of pinion gear teeth into the number of ring gear teeth.

The ring gear drives the differential case. The case provides the two mounting points for the ends of a pinion shaft on which are mounted two pinion gears. The pinion gears drive the two side gears, one of which is located on the inner end of each axle shaft.

By driving the axle shafts through this arrangement, the differential allows the outer drive wheel to turn faster than the inner drive wheel in a turn.

The main drive pinion and the side bearings, which bear the weight of the differential case, are shimmed to provide proper bearing preload, and to position the pinion and ring gears properly.

> ****Warning**
> **The proper adjustment of the relationship of the ring and pinion gears is critical. It should be attempted only by those with extensive equipment and/or experience.**

Limited-slip differentials include clutches which tend to link each axle shaft to the differential case. Clutches may be engaged either by spring action or by pressure produced by the torque on the axles during a turn. During turning on a dry pavement, the effects of the clutches are overcome, and each wheel turns at the required speed. When slippage occurs at either wheel, however, the clutches will transmit some of the power to the wheel which has the greater amount of traction. Because of the presence of clutches, early model limited-slip units require a special lubricant. Refer to Section 1 for more details on fluids and lubricants.

Identification {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Identification

Ü See figure 84

Two types of rear axles are used: The standard and the locking. The axle is of a semi-floating type, where the vehicle weight is carried on the axle housing. It is designed for use with an open driveline and fiberglass leaf springs. All of the power transmitting parts are enclosed in a Salisbury type axle (a carrier casting with pressed tubes, welded into the carrier). A removable cover at the rear of the housing, allows the axle to be serviced without removing the entire assembly from the vehicle.

The locking rear axle, equipped with a speed sensitive, multi-disc clutch pack mechanism, locks both wheels together if either wheel spins excessively during slow vehicle operation.

Figure 84.
View of a common rear axle identification number and location

{ewc GSMVIMG,GSMVIMG, !88267G45.bmp}

88267G45

The rear axle identification number is located on the front, right side of the axle tube. See the Rear Axle information in Section 1 for more information on determining the axle ratio, differential type, manufacturer and date built, from the letter codes.

Determining Axle Ratio {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Determining Axle Ratio

An axle ratio is obtained by dividing the number of teeth on the drive pinion gear into the number of teeth on the ring gear. For instance, on a 4.11:1 ratio, the driveshaft will turn 4.11 times for every turn of the rear wheels.

The most accurate way to determine the axle ratio is to drain the differential, remove the cover and count the number of teeth on the ring and the pinion.

An easier method is raise and support the rear of the vehicle on jackstands. Make a chalk mark on the rear wheel and the driveshaft. Block the front wheels and put the transmission in **NEUTRAL**. Turn the rear wheel one complete revolution and count the number of turns made by the driveshaft. The number of driveshaft rotations is the axle ratio. More accuracy can be obtained by going more than one tire revolution and dividing the result by the number of tire rotations.

The axle ratio is also identified by the axle serial number prefix on the axle; the axle ratios are listed in the dealer's parts books according to the prefix number.

Axle Shaft, Bearing and Seal {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Axle Shaft, Bearing and Seal

REMOVAL & INSTALLATION

Ü See figures 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99

A new pinion shaft lock bolt should be installed whenever either of the axle shafts are removed. You should probably purchase this and 2 new seals if you are planning on removing or replacing any components covered by this procedure.

Ä Axle shaft seal removal and installation uses the following special tools: the GM Axle Shaft Seal Installer tool No. J-33782 or equivalent and the Axle Shaft Bearing Installer tool No. J-34974 or equivalent.

The axle shaft and seal may be removed and replaced without disturbing the bearing or seal, BUT is highly recommended that you replace the seals as-long-as you've gone through the trouble to remove the axle shaft. Seal replacement is simple and it is cheap insurance against an oil leak which could ruin your brake shoes.

Ä If the bearing requires replacement, you will also need the following tools: GM Slide Hammer tool No. J-2619 or equivalent, the GM Adapter tool No. J-2619-4 or equivalent, the GM Axle Bearing Puller tool No. J-22813-01 or equivalent.

1. Raise and support the rear of the vehicle safely using jackstands.
2. Remove the rear wheel assemblies, then remove the brake drums.

****Caution**
Brake shoes may contain asbestos, which has been determined to be 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.

3. Using a wire brush, clean the dirt/rust from around the rear axle cover.
4. Place a catch pan under the differential, then remove the drain plug (if equipped) or rear axle cover and drain the fluid (discard the old fluid).
5. At the differential, remove the rear pinion shaft lock bolt and the pinion shaft.
6. Push the axle shaft inward and remove the C-lock from the button end of the axle shaft.
7. Remove the axle shaft from the axle housing. Be careful not to damage the oil seal.

****Warning**
On late-model vehicles equipped with an Anti-Lock Brake System (ABS) be careful not to damage the reluctor ring on the axle shaft or the speed sensor bolted to the backing plate, immediately adjacent to the shaft.

8. Using a putty knife, clean the gasket mounting surfaces.

Ä It is recommended, when the axle shaft is removed, to replace the oil seal.

9. To replace the oil seal use a medium prybar or, better yet, an inexpensive seal removal tool, to pry the oil seal from the end of the rear axle housing. DO NOT damage the housing oil seal surface. And again, on late-model ABS equipped vehicles, STAY CLEAR OF THE SPEED SENSOR.
10. If replacing the wheel bearing, perform the following procedures:
    a. Using the GM Slide Hammer tool No. J-2619 or equivalent, the GM Adapter tool No. J-2619-4 or equivalent and the GM Axle Bearing Puller tool No. J-22813-01 or equivalent,

install the tool assembly so that the tangs engage the outer race of the bearing.

b. Using the action of the slide hammer, pull the wheel bearing from the axle housing.

Figure 85.
Cross-sectional view of the rear axle, bearing and seal assembly

{ewc GSMVIMG,GSMVIMG, !88267G48.bmp}

88267G48

Figure 86.
Remove the tire and wheel assembly, along with the brake drum for access to the shaft

{ewc GSMVIMG,GSMVIMG, !88267P13.bmp}

88267P13

Figure 87.
Loosen the pinion shaft lock bolt using a ratchet or a box-end wrench (shown) . . .

{ewc GSMVIMG,GSMVIMG, !88267P08.bmp}

88267P08

Figure 88.
. . . then remove and discard the old lock bolt

{ewc GSMVIMG,GSMVIMG, !88267P09.bmp}

88267P09

Figure 89.
Pinion shaft lock bolt and rear axle C-lock locations (note a separate C-lock is used for each axle shaft)

{ewc GSMVIMG,GSMVIMG, !88267G46.bmp}

88267G46

Figure 90.
Grasp the end of the pinion shaft and pull

{ewc GSMVIMG,GSMVIMG, !88267P10.bmp}

88267P10

Figure 91.
Once the pinion shaft is fully removed . . .

{ewc GSMVIMG,GSMVIMG, !88267P11.bmp}

88267P11

Figure 92.
. . . the axle shaft can be pushed inward and the C-lock can be withdrawn

{ewc GSMVIMG,GSMVIMG, !88267P12.bmp}

88267P12

Figure 93.
Pull the shaft STRAIGHT back from the axle tube (be careful not to damage any components)

{ewc GSMVIMG,GSMVIMG, !88267P14.bmp}

88267P14

Figure 94.
On late-model vehicles with ABS carefully clean the ABS reluctor ring with a soft-bristled brush

{ewc GSMVIMG,GSMVIMG, !88267P15.bmp}

88267P15

Figure 95.
Keep the seal puller away from the ABS speed sensor, as pictured it could damage the sensor

{ewc GSMVIMG,GSMVIMG, !88267P16.bmp}

88267P16

Figure 96.
If removal is necessary use a slide hammer and bearing puller assembly to remove the rear axle wheel bearings

{ewc GSMVIMG,GSMVIMG, !88267G49.bmp}

88267G49

Figure 97.
The rear axle wheel bearings are installed using a driver

{ewc GSMVIMG,GSMVIMG, !88267G50.bmp}

88267G50

Figure 98.
The best way to install a replacement seal is with the proper seal driver

{ewc GSMVIMG,GSMVIMG, !88267G47.bmp}

88267G47

Figure 99.
During seal installation, KEEP THE DRIVER away from the speed sensor

{ewc GSMVIMG,GSMVIMG, !88267P17.bmp}

88267P17

To install:

11. If the wheel bearing was removed:
    a. Using solvent, thoroughly clean the wheel bearing, then blow dry with compressed air. Inspect the wheel bearing for excessive wear or damage, then replace it (if necessary).
    b. With a new or the reused bearing, thoroughly coat the bearing with gear lubricant.
    c. Using the Axle Shaft Bearing Installer tool No. J-34974 or equivalent, drive the bearing into the axle housing until it bottoms against the seat. Make sure the bearing installer does not contact and damage the speed sensor on ABS equipped vehicles.
12. If the axle shaft seal was removed:
    a. Clean and inspect the axle tube housing.
    b. Using the GM Axle Shaft Seal Installer tool No. J-33782 or an equivalent driver, seat the new seal into the housing until it is flush with the axle tube. Make sure the seal installer does not contact and damage the speed sensor on ABS equipped vehicles.
    c. Using gear oil, lubricate the new seal lips.
13. Slide the axle shaft into the rear axle housing and engage the splines of the axle shaft with the splines of the rear axle side gear, then install the C-lock retainer on the axle shaft button end.

****Warning**
BE CAREFUL not to damage the wheel bearing seal with the splines on the axle shaft. And, do we even have to mention the SPEED SENSOR again on ABS equipped vehicles!

14. After the C-lock is installed, pull the axle shaft outward to seat the C-lock retainer in the counterbore of the side gears.
15. Install the pinion shaft through the case and the pinions, then install a NEW pinion shaft lock bolt. Torque the new lock bolt to 25 ft. lbs. (34 Nm) for 1985-93 vehicles or to 27 ft. lbs. (36 Nm) for 1994-96 vehicles.
16. Use a new rear axle cover gasket and install the housing cover.
17. Install the brake drums, followed by the tire and wheel assemblies.
18. Properly refill the housing. For details, please refer to the information in Section 1 of this manual. REMEMBER that the vehicle must be completely level, meaning that if the rear is still raised and supported, the front should also be raised.
19. Remove the jackstands and carefully lower the vehicle.

Pinion Flange Seal {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Pinion Flange Seal

REMOVAL & INSTALLATION

Ü See figures 100, 101, 102

Because the pinion shaft flange is installed and tightened to achieve a set-preload, the current preload must be measured and matched during installation. The BEST way to achieve this is with a beam type inch lbs. torque wrench with a needle pointer.

Ä In order to perform this procedure you will need a companion flange holding tool and a seal installer.

1. Raise and support the rear of the vehicle safely using jackstands. If possible, lift and support the front of the vehicle as well to keep fluid from draining through the front of the axle housing (when the pinion flange and seal are removed). If this cannot be done, you should remove the rear axle cover in order to drain the fluid.
2. Remove the rear wheels and drums to remove all load from the pinion shaft, except the required pre-load
3. Match-mark and remove the driveshaft from the vehicle. If desired, the driveshaft can be left attached to the transmission (or transfer case, as applicable), but if so, it must be wired up to the body to prevent damage to the slip yoke U-joints. Also, it must be wired out of the way since you'll be working at the pinion flange.
4. Using an inch lbs. torque wrench, measure the force necessary to turn the pinion. This measurement equals the combined pinion bearing, seal, carrier bearing, axle bearing and seal pre-load. IT MUST BE MATCHED UPON INSTALLATION SO MEASURE CAREFULLY.
5. Make accurate match-marks among the pinion stem, pinion flange and pinion flange nut. Also, count the number of exposed threads on the pinion stem for reference. Again, this will be used to help assure that the proper pre-load is achieved upon installation.
6. Secure the pinion flange using a companion flange holding tool such as J 8614-01, then loosen the flange nut.
7. Remove the pinion flange nut and washer.

   Ä If the front of the vehicle is not supported significantly higher than the rear and you have not drained the rear axle, have a drain pan handy to catch any leaking fluid.

8. Remove the pinion flange. The holding tool can provide a useful hand-hold.
9. Remove the old seal using a seal removal tool, but BE CAREFUL not to score or damage the sealing surface in the rear axle housing bore.
10. Check the sealing surface of the pinion flange for tool marks, nicks or damage such as a groove worn by the seal. Replace the flange if necessary. Check the axle housing bore for burrs that might cause leaks around the outside of a new seal.

Figure 100.
Measure the pinion flange pre-load (force necessary to turn the flange) before loosening the retaining nut

{ewc GSMVIMG,GSMVIMG, !88267G56.bmp}

88267G56

Figure 101.
A companion flange holder tool is necessary to loosen or tighten the nut

{ewc GSMVIMG,GSMVIMG, !88267G57.bmp}

88267G57

Figure 102.
Use the proper sized seal installation tool or driver to install the replacement pinion seal

{ewc GSMVIMG,GSMVIMG, !88267G58.bmp}

88267G58

To install:

11. Install the new seal using J 23911, or an equivalent seal driver/installation tool.
12. Coat the outside of the pinion flange and the inside of the sealing lip (on the new seal) with GM seal lubricant No. 1050169, or equivalent.
13. CAREFULLY install the pinion flange to the shaft.

    ****Warning**
    DO NOT attempt to hammer the flange onto the shaft stem. Damage could occur and the pre-load measurements could be rendered useless.

14. Install the washer and retaining nut, then tighten the nut as-close-as possible to the reference mark (with the same number of exposed shaft threads as noted during removal) WITHOUT going past the mark. Turn the nut a little at a time, turning the pinion flange several times after each tightening to set the rollers.

    Ä If the companion flange holder is used while tightening the nut, make sure it is removed before each pre-load measurement.

15. Using an inch lbs. torque wrench, measure the pre-load (amount of effort necessary to turn the pinion) achieved by this setting. Continue to tighten the nut a little at a time, stopping to measure the pre-load again, until the pre-load measured during removal is matched.

    Ä If the original pre-load measurement was below 3 inch lbs. (0.34 Nm), then set the pre-load to 3-5 inch lbs. (0.34-0.56 Nm) during installation.

16. Align and install the driveshaft.
17. Install the brake drums, followed by the tire and wheel assemblies.
18. Remove the jackstands and carefully lower the vehicle.

Axle Housing {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Axle Housing

REMOVAL & INSTALLATION

Ü See figures 103, 104

1. Raise and support the rear of the vehicle safely using jackstands.

   Ä When supporting the rear of the vehicle, be sure to place the jackstands under the frame.

2. Position a floor jack under and support the rear axle housing.
3. Remove the rear tire and wheel assemblies, then remove the brake drums.
4. Remove the shock absorber-to-axle housing nuts and bolts, then swing the shock absorbers away from the axle housing.
5. Match-mark and remove the driveshaft from the rear axle. The driveshaft may either be removed completely from the vehicle or supported on a wire.
6. Disconnect the brake lines from the axle housing clips and the wheel cylinders.

   Ä When disconnecting the brake lines from the wheel cylinders, IMMEDIATELY plug all openings to minimize fluid loss and prevent system contamination. YOU MUST keep dirt from entering the lines.

7. Disconnect the parking brake cable.
8. Disconnect the axle housing-to-spring U-bolt nuts, the U-bolts and the anchor plates. Refer to the Leaf Spring procedures in Section 8 for details and safety.
9. Remove the vent hose from the top of the axle housing.
10. Using the floor jack, carefully lower the axle housing and remove it from the vehicle.

Figure 103.
Exploded view of the rear axle mounting-early-model vehicles
{ewc GSMVIMG,GSMVIMG, !88267G51.bmp}

88267G51

Figure 104.
Exploded view of the rear axle mounting-late-model vehicles
{ewc GSMVIMG,GSMVIMG, !88267G59.bmp}

88267G59

To install:

11. Using the floor jack, raise the axle housing into position under the vehicle.
12. Install the vent hose to the top of the axle housing.
13. Connect the axle housing-to-spring U-bolt nuts, the U-bolts and the anchor plates. Tighten the bolts to specification (for more details, please refer to the spring installation procedures in Section 8 of this manual).
14. Connect the brake lines to the axle housing clips and the wheel cylinders.
15. Connect the brake cables, then install the brake drums and bleed the hydraulic brake system. For details, refer to Section 9 of this manual.
16. Align the match-marks and install the driveshaft.
17. Install the shock absorber-to-axle housing nuts and bolts. Torque the shock absorber-to-axle

housing nuts/bolts to 75 ft. lbs. (102 Nm).

18. Install the rear tire and wheel assemblies.
19. Check and fill the axle housing, as necessary. For details, please refer to Section 1 of this manual. Remember that in order to check fluid level or properly refill the housing, the vehicle MUST be level (supported at 4 points).
20. Remove the jackstands and carefully lower the vehicle.

FRONT DRIVE AXLE (ALL WHEEL DRIVE) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

FRONT DRIVE AXLE (ALL WHEEL DRIVE)

Identification

Ü See figure 105

The front drive axle uses a conventional ring and pinion gear set to transmit the driving force of the engine to the front wheels. The halfshafts are completely flexible, consisting of an inner and outer constant velocity (CV) joint connected by an axle shaft. The inner CV joint is a TRI-POT design, which can move in and out. The outer CV joint is an RZEPPA design which is also flexible, but can not move in and out.

Figure 105.
Exploded view of the front drive axle component mounting

{ewc GSMVIMG,GSMVIMG, !88267G52.bmp}

88267G52

Halfshaft {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Halfshaft

REMOVAL & INSTALLATION

****Caution**
Do not allow the halfshaft to fully extend. The joint may become separated from the axle shaft, resulting in halfshaft failure and vehicle damage.

1990-93 Vehicles

Ü See figure 106

Ä In order to loosen the halfshaft retaining nut, you will have to be able to hold the shaft from turning. One acceptable method is to insert a drift into the opening at the top of the brake caliper and through the vanes of the rotor. If you do not have one available, an assistant can apply the brakes while you loosen the nut. BUT, the easiest way, would be to remove the cotter pin and nut locking retainer, then loosen the nut, just slightly, while the vehicle is still on the ground.

1. Disconnect the negative battery cable for safety.
2. Unlock the steering column so the linkage is free to move.
3. Raise the front of the vehicle and support safely using jackstands.
4. Remove the front tire and wheel assemblies.
5. If not done earlier, remove the cotter pin and nut locking retainer.
6. Remove the axle nut and washer.

Ä IMPORTANT: Support the lower control arm with a jackstands to release spring tension.

7. Remove the lower shock absorber nut and bolt.
8. Match-mark the halfshaft flange to the output shaft flange, then remove the halfshaft flange-to-output shaft bolts. Again, you will have to keep the assembly from turning, so insert a drift through the opening in the top of the brake caliper into the vanes of the brake rotor.
9. Use a Posilock® Puller model 110 or equivalent to push the halfshaft through the hub, then remove the halfshaft from the vehicle.

Figure 106.
Separating the halfshaft from the hub-1990-93 vehicles

{ewc GSMVIMG,GSMVIMG, !88267G53.bmp}

88267G53

To install:

10. Install the halfshaft to the hub, then install the axle washer and nut.
11. Insert a drift through the opening in the top of the brake caliper into the vanes of the brake rotor to keep the halfshaft from turning, then tighten the shaft nut to 160-200 ft. lbs. (220-270 Nm).
12. Install the nut locking retainer and a new cotter pin.
13. Align and install the halfshaft to the output shaft flange, then install the retaining bolts and tighten to 60 ft. lbs. (80 Nm).
14. Install the lower shock bolt and nuts, then tighten to 18 ft. lbs. (25 Nm).

15. Check and refill the front drive axle if any fluid was lost. Remember that the vehicle MUST be level. Refer to Section 1 of this manual for more details.
16. Install the tire and wheel assemblies, then remove the jackstands and carefully lower the vehicle.

****Warning**
Make sure the ignition switch is in the OFF position before connecting the negative battery cable otherwise the engine control computer could be INSTANTLY destroyed when voltage is applied.

17. Connect the negative battery cable and check for proper operation.

1994-96 Vehicles {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Drive Train

1994-96 Vehicles

Ü See figures 107, 108, 109, 110, 111, 112

> **Ä In order to loosen the halfshaft retaining nut, you will have to be able to hold the shaft from turning. One acceptable method is to insert a drift into the opening at the top of the brake caliper and through the vanes of the rotor. If you do not have one available, an assistant can apply the brakes while you loosen the nut. BUT, the easiest way, would be to remove the cotter pin and nut lock, then loosen the nut, just slightly, while the vehicle is still on the ground.**

1. Disconnect the negative battery cable for safety.
2. Unlock the steering column so the linkage is free to move.
3. Raise the front of the vehicle and support safely using jackstands.
4. If equipped, remove the front axle skid plate.
5. Remove the front tire and wheel assemblies.
6. If not done earlier, remove the cotter pin and nut locking retainer.
7. Remove the axle nut and washer. To keep the assembly from turning, insert a drift through the opening in the top of the brake caliper into the vanes of the brake rotor.
8. Match-mark the halfshaft flange to the output shaft flange, then loosen (BUT do not remove at this time) the halfshaft flange-to-output shaft bolts. Again, you will have to keep the assembly from turning.
9. Disconnect the brake hose support bracket from the upper control arm to allow for extra knuckle travel.
10. Disconnect the outer tie rod end from the knuckle. Push the linkage toward the opposite side of the vehicle, then support the outer tie rod up and out of the way to provide necessary clearance.

    ****Warning**
    DO NOT use a wedge type tool to separate the joint from the knuckle or damage may occur.

11. Position a floor jack or jackstand to support the lower control arm.

    ****Caution**
    The support MUST remain under the control arm for the duration of the procedure to hold the spring in position otherwise serious personal injury could result.

12. Remove the lower shock absorber nut and bolt. Compress the shock absorber and wire up, out of the way.
13. Remove the cotter pin and stud nut, then separate the upper ball joint from the steering knuckle.
14. Tip the knuckle outward and toward the rear of the vehicle, then wire the knuckle to the upper control arm to prevent stretching and damaging the brake hose.
15. Cover the shock mounting bracket and the ball stud on the lower control arm with a rag to prevent possible damage to the drive axle seal during removal or installation.
16. Drive the splined shaft from the knuckle using J-28733-B or an equivalent shaft removal tool.
17. Remove the halfshaft flange-to-output shaft bolts which were loosened earlier, then carefully

lower and remove the halfshaft from the vehicle.

Figure 107.
A drift can be inserted through the top of the caliper and the rotor vanes to keep the shaft from turning

{ewc GSMVIMG,GSMVIMG, !88267G60.bmp}

88267G60

Figure 108.
The brake line bracket should be removed from the upper control arm to provide additional knuckle travel

{ewc GSMVIMG,GSMVIMG, !88267G61.bmp}

88267G61

Figure 109.
Disconnect the lower shock fasteners and position the shock out of the way

{ewc GSMVIMG,GSMVIMG, !88267G62.bmp}

88267G62

Figure 110.
Disconnect the upper ball joint from the knuckle, so it be repositioned for clearance

{ewc GSMVIMG,GSMVIMG, !88267G63.bmp}

88267G63

Figure 111.
Wire the knuckle assembly to the upper control arm in order to provide clearance while preventing brake line damage

{ewc GSMVIMG,GSMVIMG, !88267G64.bmp}

88267G64

Figure 112.
Use a suitable separator tool to drive the axle shaft from the hub

{ewc GSMVIMG,GSMVIMG, !88267G65.bmp}

88267G65

To install:

18. Wipe the wheel bearing seal area on the knuckle clean, then check the seal for cuts or tears. If the seal is cut or torn, check the wheel bearings for damage and replace the seal.
19. Lubricate the wheel bearing seal lip.

    Ä Make sure the shock bracket and the control arm ball stud are both still covered with rags to help prevent possible damage to the CV-joint boot.

20. Carefully push the halfshaft into the hub, then install the axle washer and nut, but do not tighten yet.
21. Align the match-marks made earlier, then loosely install the halfshaft flange to the output shaft flange using the retaining bolts.
22. Install the upper ball joint to the steering knuckle, then tighten the retaining nut and install a new cotter pin. Now is a good time to lube the upper ball joint.
23. Install the shock absorber and secure using the nut and bolt.
24. Install the outer tie rod to the steering knuckle, tighten the retaining nut and install a new cotter pin.

25. Reposition and secure the brake hose bracket to the upper control arm.
26. If not done already, insert a drift through the opening in the top of the brake caliper into the vanes of the brake rotor to keep the halfshaft from turning, then tighten the shaft nut to 160-200 ft. lbs. (220-270 Nm) for 1994-95 vehicles or to 147 ft. lbs. (200 Nm) for 1996 vehicles.
27. Align and install the nut locking retainer, then install a new cotter pin. DO NOT back off the nut or tighten it more than specified in order to align the retainer and install the cotter pin. The retainer should allow sufficient adjustment in order to install a pin.

    Ä Be sure to bend the cotter pin so the retainer is held snugly in place to prevent rattling.
28. Tighten the halfshaft-to-output shaft flange bolts to 60 ft. lbs. (80 Nm).
29. Check and refill the front drive axle if any fluid was lost. Remember that the vehicle MUST be level. Refer to Section 1 of this manual for more details.
30. Install the tire and wheel assemblies, then remove the jackstands and carefully lower the vehicle.
31. If equipped, install the front axle skid plate.

    ****Warning**
    Make sure the ignition switch is in the OFF position before connecting the negative battery cable otherwise the engine control computer could be INSTANTLY destroyed when voltage is applied.
32. Connect the negative battery cable and check for proper operation.

OVERHAUL {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

OVERHAUL

Ü See figure 113

Outer CV-Joint

Ü See figures 114, 115, 116, 117

Ä Because of the difficulty and special tools involved, try to get an overhaul kit with replacement clamps as opposed to a swage ring. If you must install a swage ring to retain the boot, follow the kit instructions CLOSELY and borrow or rent the necessary tools. If this is not possible, take the halfshaft to a reputable service facility for overhaul or boot replacement.

1. Remove the drive axle (halfshaft) assembly from the vehicle.
2. Place the axle in a vise using a protective covering on the vise jaws to prevent axle damage.

****Caution**
Because the retaining clamps are under tension, use care when cutting and removing them. Wear gloves and safety goggles to protect you should the clamp spring loose upon releasing the tension.

3. Cut and remove the CV-boot retaining clamps. If the boot is not being replaced, use care not to cut or damage the boot.

Ä Some late-model vehicles are equipped with a swage ring. In order to remove the ring, use a hand grinder to cut through the ring. Take care not to damage the outer race while cutting the swage ring free.

4. Once the clamp (or swage ring) is removed, reposition the boot and wipe the grease away in order to locate the snapring.

Figure 113.
Exploded view of the halfshaft and CV-joint assemblies

{ewc GSMVIMG,GSMVIMG, !88267G66.bmp}

88267G66

Figure 114.
Aligning the cage windows with the outer race lands so the cage (and inner race) may be removed

{ewc GSMVIMG,GSMVIMG, !85387093.bmp}

85387093

Figure 115.
Rotating the inner race up and out of the cage

{ewc GSMVIMG,GSMVIMG, !85387094.bmp}

85387094

Figure 116.
Small retaining clamp installation and ear dimension

{ewc GSMVIMG,GSMVIMG, !85387095.bmp}

85387095

Figure 117.
Large retaining clamp installation and ear dimension-outer joint shown (inner joint uses same dimension)

{ewc GSMVIMG,GSMVIMG, !85387096.bmp}

5. Release the snapring using a suitable pair of snapring pliers, such as J-8059 or equivalent.
6. Remove the CV-joint assembly from the axle shaft.

   Ä If ONLY THE BOOT is being replaced, stop disassembly here. Only proceed further if component wear or damage is suspected and you wish to perform a complete overhaul of the joint.
7. Using a brass drift and hammer, tap the cage until it tilts sufficiently to remove the first ball, remove the remaining balls in the same manner.
8. Pivot the cage so the inner race is 90 degrees to the centerline of the outer race, then align the cage windows with the outer race lands and lift the cage (along with the inner race) from the outer race. Please refer to the illustration for clarification.
9. Rotate the inner race up and out of the cage.
10. Thoroughly clean all parts in an approved solvent, then check for wear or damage and replace, as necessary.

To install:

11. Apply a suitable high-temperature grease to the ball grooves of the inner and outer races.
12. Install the inner race to the cage by inserting and rotating.
13. Align the cage windows with the outer race lands, then install the cage (along with the inner race) to the outer race. Make sure the retaining ring side of the inner race faces outward.
14. Use the brass drift to tap the cage to a tilted position, then install the balls.
15. Pack the joint and boot using a suitable high-temperature grease.
16. Position the small boot clamp onto the outboard boot, then install the boot the axle shaft. Tighten the small clamp securely using a suitable clamp tool such as J-35910 or equivalent. If the tool has a torque wrench fitting, secure the clamp using 100 ft. lbs. (136 Nm) of torque.
17. Check the clamp ear gap dimension (distance that the inner bends of the crimp should be from each other), it should be a maximum of 0.085 in. (2.15mm). Please refer to the illustration for clarification.
18. Install the joint assembly to the shaft and secure using the snapring.

Pack the boot and outer joint assembly with the premeasured amount of the grease supplied with the service kit, then snap the boot onto the outer joint assembly and manipulate it to remove excess air.

19. Install the large retaining clamp using the clamp tool and torque wrench. Secure the clamp using 130 ft. lbs. (176 Nm) of torque. Again, check the clamp ear dimension, it should be a maximum of 0.102 in. (2.60mm)
20. Install the drive axle to the vehicle.

Inner CV-Joint {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Inner CV-Joint

Ü See figures 116, 117, 118, 119, 120, 121, 122, 123, 124

1. Remove the drive axle from the vehicle.
2. Place the axle in a vise using a protective covering on the vise jaws to prevent axle damage.
3. If equipped, remove the seal clamp protectors from the joint assembly.

****Caution**
Because the retaining clamps are under tension, use care when cutting and removing them. Wear gloves and safety goggles to protect you should the clamp spring loose upon releasing the tension.

4. Cut and remove the CV-boot retaining clamps. If the boot is not being replaced, use care not to cut or damage the boot.

Ä Some late-model vehicles are equipped with a swage ring. In order to remove the ring, use a hand grinder to cut through the ring. Take care not to damage the outer race while cutting the swage ring free.

5. Remove the axle shaft with spider assembly from the companion flange housing.

Ä Handle the spider assembly with care. The tripot balls and needle rollers may separate from the spider trunnions.

Figure 118.
Snapring and spider removal
{ewc GSMVIMG,GSMVIMG, !85387109.bmp}

85387109

Figure 119.
Proper inboard boot and housing positioning
{ewc GSMVIMG,GSMVIMG, !85387110.bmp}

85387110

Figure 120.
Remove the CV-joint housing and check for wear or damage
{ewc GSMVIMG,GSMVIMG, !85917037.bmp}

85917037

Figure 121.
With the spacer and spider pushed back, grasp the snapring using a pair of snapring pliers
{ewc GSMVIMG,GSMVIMG, !85917038.bmp}

85917038

Figure 122.
Remove the snapring from the shaft so the spider assembly may be removed
{ewc GSMVIMG,GSMVIMG, !85917040.bmp}

85917040

Figure 123.
With the snapring removed, the spider is free to be pulled from the shaft
{ewc GSMVIMG,GSMVIMG, !85917041.bmp}

85917041

Figure 124.
If necessary, remove the spacer ring from the shaft
{ewc GSMVIMG,GSMVIMG, !85917042.bmp}

85917042

6. Grasp the space ring using J-8059, or an equivalent pair of snapring pliers, then slide the ring back on the axle shaft in order to provide clearance to move the spider assembly.
7. Move the spider assembly back on the shaft in order to expose the retaining snapring.
8. Remove the snapring using a suitable pair of snapring pliers, such as J-8059 or equivalent.
9. Remove the spider assembly.
10. Thoroughly clean all grease from the housing. Check for rust at the boot mounting grooves. If found, remove with a wire brush.

To install:

11. Install the small boot clamp and inboard boot to the axle shaft.
12. If the spacer ring was removed, make sure it is positioned up on the shaft leaving room for spider and snapring installation.
13. Install the spider assembly to the axle shaft, making sure the snapring counterbore faces the housing end of the axle.
14. Install the snapring to the shaft, then properly position the spider and spacer ring.
15. Position the small boot clamp and tighten securely using a suitable clamp tool such as J-35910 or equivalent. If the tool has a torque wrench fitting, secure the clamp using 100 ft. lbs. (136 Nm) of torque.
16. Check the clamp ear gap dimension (distance that the inner bends of the crimp should be from each other), it should be a maximum of 0.085 in. (2.15mm). Please refer to the illustration for clarification.
17. Repack the housing using about half of the premeasured grease supplied with the service kit, then place the remainder of the grease in the boot. Coat the inside of the boot sealing lips with grease.
18. Make sure the joint/boot are assembled to the proper dimension of $6^1/4$ in. (160mm) between the clamps. Please refer to the illustration for clarification.
19. Install the large retaining clamp using the clamp tool and torque wrench. Secure the clamp using 130 ft. lbs. (176 Nm) of torque. Again, check the clamp ear dimension, it should be a maximum of 0.102 in. (2.60mm).
20. If used, install the clamp protectors over the large eared clamp.
21. Install the drive axle to the vehicle.

Shaft and Tube Assembly {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Drive Train

Shaft and Tube Assembly

REMOVAL & INSTALLATION

1990-92 Vehicles

1. Disconnect the negative battery cable for safety.
2. Unlock the steering column, then raise and support the vehicle safely using jackstands.
3. Remove the right front wheel.
4. Remove the halfshaft nut and washer.

   Ä IMPORTANT: Support the lower control arm with a jackstand to unload the spring pressure.

5. Remove the lower shock absorber bolt and nut.
6. Remove the output shaft bolts. Insert a drift through the opening in the top of the brake caliper into the vanes of the brake rotor.
7. Keep the shaft from turning and use a Posilock Puller Model 110 or equivalent to push the halfshaft through the hub.
8. Remove the right halfshaft.
9. Remove the tube support bracket nuts, carrier bolts, shaft and tube assembly.

To install:

10. Clean the sealing surfaces of the tube and carrier assembly with solvent.
11. Apply a bead of RTV sealer to the carrier sealing surface.
12. Install the shaft, tube and bolts. Torque the bolts to 36 ft. lbs. (48 Nm).
13. Install the support bracket nuts and torque to 55 ft. lbs. (75 Nm).
14. Install the halfshaft, output shaft-to-halfshaft bolts and torque to 60 ft. lbs. (80 Nm).
15. Install the lower shock bolt and nut.
16. Check the differential lubricant and add if necessary. Remember that the vehicle must be level or you will get an incorrect reading.
17. Install the front tire.
18. Remove the jackstands and carefully lower the vehicle.

    ****Warning**
    Make sure the ignition switch is in the OFF position before connecting the negative battery cable otherwise the engine control computer could be INSTANTLY destroyed when voltage is applied.

1993-96 Vehicles {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Drive Train

1993-96 Vehicles

1. Remove the right drive axle (halfshaft) from the vehicle. For details, please refer to the procedure located earlier in this section.
2. Remove the support bracket nuts and washers.
3. Remove the tube-to-carrier bolts.
4. Position a drain pan to catch any leaking fluid, then remove the tube and shaft assembly from the vehicle.

To install:

5. Thoroughly clean the sealing surfaces of the tube and carrier using a chlorinated solvent.
6. Apply a bead of sealant such as GM no. 12345739 or equivalent to the carrier sealing surface.
7. Install the shaft and tube assembly, then tighten the retaining bolts to 36 ft. lbs. (48 Nm).
8. Install the support bracket nuts and washers, then tighten to 54 ft. lbs. (73 Nm).
9. Install the right drive axle to the vehicle.
10. Check the differential lubricant and add if necessary. Remember that the vehicle must be level or you will get an incorrect reading.

Output Shaft Seal and Bearing {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Output Shaft Seal and Bearing

REMOVAL & INSTALLATION

Ü See figures 125, 126

Tools needed: slide hammer J-29307, countershaft roller bearing remover J-29369-2, axle tube bearing installer J-33844 and output shaft seal installer J-33893.

1. Remove the shaft and tube assembly as outlined in this section.
2. Remove the shaft with deflector and retaining ring by striking the inside of the shaft flange with a brass hammer to dislodge it from the tube. Pull the shaft out of the seal housing.
3. Remove the shaft seal and bearing by using the slide hammer and bearing puller.

Figure 125.
The output shaft seal and bearing assembly is removed using a slide hammer and bearing puller

{ewc GSMVIMG,GSMVIMG, !88267G67.bmp}

88267G67

Figure 126.
Use a suitable driver or seal installer to seal the replacement seal

{ewc GSMVIMG,GSMVIMG, !88267G68.bmp}

88267G68

To install:

4. Lubricate the seal lips, bearings and friction surfaces with axle lubricant before assembly.
5. Install the bearing. On some applications, the bearing installer will be necessary.
6. Install the seal using a suitable driver or seal installer tool.
7. Insert the shaft to the tube assembly, taking GREAT CARE not to damage the seal with the shaft splines.
8. Install the shaft and tube assembly as outlined in this section.

Pinion Oil Seal {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Pinion Oil Seal

REMOVAL & INSTALLATION

Ü See figures 127, 128, 129

1. Disconnect the negative battery cable for safety.
2. Raise and support the vehicle safely using jackstands.
3. Match-mark and remove the front driveshaft from the vehicle.
4. Mark the nut, washer and flange so during installation the same amount of torque can be provided for the correct amount of bearing pre-load.
5. Using an inch lbs. torque wrench (beam type with a needle gauge is usually easiest for this), measure the current pinion pre-load (the amount of force necessary to rotate the pinion).
6. Remove the pinion flange nut and washer using a companion flange holder J-8614-01 or equivalent to keep the assembly from spinning.
7. Place a container under the flange to catch any fluid which may leak, then remove the flange.
8. Remove the oil seal by driving it out of the carrier with a blunt chisel.

****Warning**
Be careful when removing the seal not to damage the sealing surface of the bore.

Figure 127.
Before removing the flange nut, measure pre-load (rotational force) using an inch lbs. torque wrench

{ewc GSMVIMG,GSMVIMG, !88267G69.bmp}

88267G69

Figure 128.
A flange holding tool will be necessary to loosen or tighten the pinion nut

{ewc GSMVIMG,GSMVIMG, !88267G54.bmp}

88267G54

Figure 129.
Use a suitable driver or seal installer to seat the replacement seal

{ewc GSMVIMG,GSMVIMG, !88267G70.bmp}

88267G70

To install:

9. Clean all seal surfaces and remove burrs.
10. Install the new seal using a suitable driver or an oil seal installer such as J-33782.
11. Lubricate the seal lip and outside of the pinion flange with differential fluid or, if available, GM seal lubricant no. 1050169.
12. Install the pinion flange, washer and nut, aligning all of the marks made earlier. The pinion flange must be installed with the SAME spline relationship marked during removal.
13. Tighten the nut to previously marked position, then check the pre-load.
14. If necessary, tighten the nut additionally to match the pre-load recorded earlier. Remember that the flange holding tool should be removed each time before re-checking the pre-load.

15. For 1990-95 vehicles, tighten the nut until an additional 3-5 inch lbs. (0.3-0.6 Nm) of pre-load is achieved. If no torque wrench is available, tighten the nut approximately $^{1}/16$ in. (1.5mm) past the alignment mark.
16. Align and install the front driveshaft.
17. Check and add fluid to the front differential, as necessary. Remember that the vehicle must be level or you will not obtain the proper reading.
18. Remove the jackstands and carefully lower the vehicle.
19. Connect the negative battery cable.

Differential Assembly {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Differential Assembly

REMOVAL & INSTALLATION

Ü See figure 130

1. Disconnect the negative battery cable for safety.
2. Unlock the steering.
3. Raise the vehicle and support it with jackstands.
4. Remove the front wheels.
5. Match-mark the positions of the driveshaft and halfshafts to their flanges.
6. Insert a drift through the opening in the top of the brake caliper into the vanes in the brake rotor to keep the axle from turning.
7. Disconnect the front driveshaft from the differential and secure out of the way.
8. Disconnect the vent hose.
9. Remove the halfshaft-to-output shaft bolts.
10. Remove the tube-to-carrier bolts.
11. Unbolt the halfshafts from the front axle (leaving them attached to the hub and knuckle assembly) and support out of the way with wire. Be careful not to damage the joint boots or CV-joints.
12. Remove the axle tube support bracket-to-frame nuts and washers.
13. Remove the upper and lower mounting nuts and bolts.
14. Remove the differential assembly from the vehicle by sliding the entire unit to the right, dropping the tube end and twisting the carrier to clear the mounting brackets, oil pan and steering linkage.

To install:

15. Install the differential and tube assembly.
16. Loosely install the upper, lower and bracket-to-frame mounting bolts and nuts.
17. Tighten the mounting bolts to 65 ft. lbs. (90 Nm), then tighten the frame nuts to 55 ft. lbs. (75 Nm) for 1990-95 vehicles or to 63 ft. lbs. (85 Nm) for 1996 vehicles.
18. Align the marks made earlier and install the halfshafts. Tighten the bolts to 60 ft. lbs. (80 Nm).
19. Connect the vent hose.
20. Align and install the front driveshaft.
21. Install the front wheels.
22. Check and refill the differential fluid, as necessary. Remember that the vehicle must be level or an incorrect level will occur.
23. Remove the jackstands and carefully lower the vehicle.

****Warning**
Make sure the ignition switch is in the OFF position before connecting the negative battery cable otherwise the engine control computer could be INSTANTLY destroyed when voltage is applied.

24. Connect the negative battery cable and check for proper operation.

Figure 130.
Front differential carrier assembly mounting

{ewc GSMVIMG,GSMVIMG, !88267G55.bmp}

88267G55

{ewc GSMVIMG,GSMVIMG, !88267c02.bmp}

88267c02

{ewc GSMVIMG,GSMVIMG, !88267c03.bmp}

88267c03

{ewc GSMVIMG,GSMVIMG, !88267c04.bmp}

88267c04

{ewc GSMVIMG,GSMVIMG, !88267c07.bmp}

88267c07

SUSPENSION AND STEERING

{ewc MVIMAGE,MVIMAGE, ! steer.bmp}

WHEELS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

WHEELS

Tire and Wheel Assembly

REMOVAL & INSTALLATION

Ü See figure 1

1. Apply the parking brake and block the opposite wheel.
2. If equipped with an automatic transmission, place the selector lever in **P**; with a manual transmission/transaxle, place the shifter in gear.
3. If equipped, remove the wheel cover or hub cap.
4. Break loose the lug nuts. 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, 1 or 2 heavy hammer blows directly on the end of the bolt head usually loosens the rust. Be careful as continued pounding will likely damage the brake drum or rotor.
5. Raise the vehicle until the tire is clear of the ground. Support the vehicle safely using jackstands.
6. Remove the lug nuts, then remove the tire and wheel assembly.

Figure 1.
Wheel lug nut tightening sequence-use a crisscross pattern
{ewc GSMVIMG,GSMVIMG, !88268Ga1.bmp}

88268Ga1

To install:

7. 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 surfaces and the brake rotors/drums. Failure to do so may cause the lug nuts to loosen in service.
8. Position the wheel on the hub or drum and hand-tighten the lug nuts. Make sure the coned ends face inward.
9. Tighten all the lug nuts, in a crisscross pattern, until they are snug.

   Ä Wheel lug nut torque is especially important on disc brake vehicles where the wheel studs are attached to the hub and bearing assembly. Improper tightening could lead to disc warpage on these vehicle.
10. Remove the jackstands and carefully lower the vehicle. Tighten the lug nuts, in a crisscross pattern. Always use a torque wrench to achieve the proper lug nut torque and to prevent stretching the wheel studs. For 1985-92 vehicles, tighten the lug nuts to 90 ft. lbs. (120 Nm). For 1993-96 vehicles, tighten the nuts to 100 ft. lbs. (140 Nm).
11. Repeat the torque pattern to assure proper wheel tightening.
12. If equipped, install the hub cab or wheel cover.

INSPECTION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

INSPECTION

Check the wheels for any damage. They must be replaced if they are bent, dented, heavily rusted, have elongated bolt holes, or have excessive lateral or radial runout. Wheels with excessive runout may cause a high-speed vehicle vibration.

Replacement wheels must be of the same load capacity, diameter, width, offset and mounting configuration as the original wheels. Using the wrong wheels may affect wheel bearing life, ground and tire clearance, or speedometer and odometer calibrations.

Wheel Lug Studs {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Wheel Lug Studs

REMOVAL & INSTALLATION

Front Wheels on 2wd Vehicles

Ü See figure 2

1. Raise and support the front of the vehicle safely using jackstands, 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 the rotor off the axle. 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.

   Ä If a press is not available, CAREFULLY drive the old stud out using a blunt drift. MAKE SURE the disc is properly and evenly supported or it may be damaged.

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.

Figure 2.
Use an arbor press to drive the old stud from the rotor-front wheel of 2wd vehicles

{ewc GSMVIMG,GSMVIMG, !85388005.bmp}

85388005

6. Finish installing the stud with the press.

   Ä 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 disc, 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 jackstands and carefully lower the vehicle.

Rear Wheels and Front Wheels on 4wd Vehicles {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Rear Wheels and Front Wheels on 4wd Vehicles

Ü See figure 3

1. Raise and support the vehicle safely using jackstands, then remove the wheel.
2. On front wheels, remove the brake caliper and rotor. Support the caliper from the suspension using wire or a coat hanger. For details, please refer to Section 9 of this manual.
3. On rear wheels, remove the brake drum.

   Ä When replacing the front hub bolts on vehicles with 4 wheel anti-lock brakes, remove and replace only 1 wheel lug stud at a time to avoid misaligning the speed sensor exciter ring.

4. DO NOT hammer the wheel stud to remove it. This will ruin the wheel bearing. Use the stud press tool such as J-6627A or equivalent to press the stud out of the hub. If sufficient clearance is not available with the hub or shaft installed, the components must be removed.

Figure 3.
On many vehicles a stud press tool may be used with the hub still installed on the vehicle

{ewc GSMVIMG,GSMVIMG, !85388006.bmp}

85388006

To install:

5. Clean the hole with a wire brush and start the new stud into the hole. Do not use any lubricant or thread sealer.
6. Stack 4 or 5 washers onto the stud and then put the nut on. Tighten the nut to draw the stud into place. It should be easy to feel when the stud is seated.
7. Install the rotor and caliper or drum, as applicable.
8. Install the wheel, then remove the jackstands and carefully lower the vehicle.

2-WHEEL DRIVE FRONT SUSPENSION {ewc MVIMAGE, MVIMAGE, ! nexttopicarrow.bmp}

2-WHEEL DRIVE FRONT SUSPENSION

Ü See figure 4

The front suspension is designed to allow each wheel to compensate for changes in the road surface without appreciably affecting the opposite wheel. Each wheel is independently connected to the frame by a steering knuckle, ball joint assemblies, and upper/lower control arms. The control arms are specifically designed and positioned to allow the steering knuckles to move in a prescribed 3 dimensional arc. The front wheels are held in proper relationship to each other by 2 tie rods which are connected to steering arms on the knuckles and to an intermediate rod.

Coil chassis springs are mounted between the spring housings on the frame and the lower control arms. Ride control is provided by double, direct acting, shock absorbers mounted inside the coil springs and attached to the lower control arms by nuts and bolts. The upper portion of each shock absorber extends through the upper control arm frame bracket and is secured with 2 grommets, 2 grommet retainers and a nut.

Figure 4.
Two wheel drive front suspension-Note that ABS equipped vehicles use a different splash shield (with a speed sensor)

{ewc GSMVIMG,GSMVIMG, !88268G01.bmp}

88268G01

Side role of the front suspension is controlled by a spring steel stabilizer shaft. It is mounted in rubber bushings which are held to the frame side rails by brackets. The ends of the stabilizer are connected to the lower control arms by link bolts isolated by rubber grommets.

The upper control arm is attached to the upper control arm shaft through isolating rubber bushings. The upper control arm shaft, in turn, is bolted to frame brackets.

A ball joint assembly is riveted to the outer end of the upper control arm. It is preloaded by a rubber spring to insure proper seating of the ball in the socket. The upper ball joint is attached to the steering knuckle by a torque prevailing nut.

The inner ends of the lower control arm have pressed-in bushings. Bolts, passing through the bushings, attach the arm to the frame. The lower ball joint assembly is a press fit in the arm and attaches to the steering knuckle with a torque prevailing nut.

Rubber grease seals are provided at the ball socket assemblies to keep dirt and moisture from entering the joint and damaging the bearing surfaces.

Coil Springs {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Suspension And Steering

Coil Springs

Ä In order to maintain proper suspension balance and vehicle handling, coil springs should only be replaced in axle sets.

REMOVAL & INSTALLATION

Ü See figures 5, 6, 7

Ä The following procedure requires the use of the GM Spring Remover tool No. J-23028 or equivalent.

1. Raise and support the front of the vehicle on jackstands so the lower control arms hang free.
2. Disconnect the shock absorber-to-lower control arm nuts, then push the shock absorber up into the coil spring.
3. Secure the GM Spring Remover tool No. J-23028 or equivalent, to a floor jack, then position the assembly under the lower control arm so it cradles the inner bushings.
4. Disconnect the stabilizer bar from the lower control arm.
5. Install a chain around the coil spring and through the lower control arm for safety, then remove the lower control arm nuts and bolts.

****Caution**
The coil springs are under a considerable amount of tension. Be extremely careful when removing or installing them; they can exert enough force to cause serious injury!

6. Raise the floor jack (with the spring remover tool) to take the tension off the lower control arm-to-chassis bolts/nuts.

Ä When removing the lower control arm-to-chassis fasteners, be sure to remove the rear set first, then the front set.

7. Slowly and carefully, lower the floor jack (USING THE SPRING REMOVER TOOL) until the tension is released from the coil spring.

Ä When removing the coil spring, DO NOT apply force to the lower control arm or the lower ball joint. Proper maneuvering of the spring will provide easy removal.

8. Remove the safety chain from the coil spring and control arm ONLY AFTER ALL SPRING TENSION has been released. Remove the coil spring from the control arm.

Figure 5.
The lower control arm MUST be supported using a spring remover tool and suitable jack

{ewc GSMVIMG,GSMVIMG, !88268G02.bmp}

88268G02

Figure 6.
Positioning the coil spring

{ewc GSMVIMG,GSMVIMG, !88268G03.bmp}

88268G03

Figure 7.
During installation, the lower control arm bolts MUST be facing the proper direction

{ewc GSMVIMG,GSMVIMG, !88268G04.bmp}

88268G04

To install:

9. Before installing the coil spring, position it in the following order:
   a. For 1985-92 vehicles, visually identify the top and bottom of the coil spring. The spring top has a coiled, flat shape with a gripper notch at the end of the coil; the bottom has a coiled, helical shape.
   b. On all models, the coil spring should be positioned so the tape (on the coil) is at the bottom.
   c. Position the lower end of the coil spring so it covers part or all of the inspection drain hole. The other drain hole MUST BE partially or completely uncovered.
   d. Place the insulator at the top of the coil spring, and on 1993-96 vehicles, make sure the lower insulator is positioned onto the control arm.
10. Secure the spring remover tool to the floor jack assembly, then raise the lower control arm/coil spring assembly using the floor jack and install the lower control arm-to-chassis nuts/bolts. The bolts must be installed facing the proper direction, please refer to the illustration for details. DO NOT fully tighten the nuts and bolts at this time.

    ****Caution**
    Failure to properly secure the spring remover tool to the floor jack could result in a sudden movement of the suspension or tool that would allow the spring to leap free. This could cause SERIOUS personal injury.

11. Secure the stabilizer shaft to the lower control arm.
12. Pull the shock absorber down, then install the shock absorber-to-lower control arm nuts/bolts. Torque the nuts and bolts to 18 ft. lbs. (25 Nm).
13. Remove the jackstands and carefully lower the front of the vehicle, so it is resting on its own weight.
14. With the suspension at normal height, tighten the lower control arm-to-chassis nuts/bolts (starting with the front nut, then the rear) to 96 ft. lbs. (128 Nm) for 1985-92 vehicles, to 92 ft. lbs. (125 Nm) for 1993-95 vehicles or to 66 ft. lbs. (90 Nm) for 1996 vehicles.
15. Check and/or adjust the front end alignment, as necessary.

Shock Absorbers {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Shock Absorbers

Ä In order to maintain proper suspension balance and vehicle handling, shock absorbers should only be replaced in axle sets.

REMOVAL & INSTALLATION

Ü See figures 8, 9, 10, 11

1. Raise and support the front of the vehicle on jackstands. Remove the wheels.
2. While holding the upper end of the shock absorber (to keep it from turning), remove the shock absorber nut, retainer and grommet. A hex is normally provided in the shock absorber stem to make this possible. If no hex is provided, look for an accessible flat.
3. Remove the shock absorber-to-lower control arm bolts (on most applications the nuts remain attached to the control arm), then slide the shock absorber from the bottom of the lower control arm.
4. Test the shock absorber and replace it, if necessary.

Figure 8.
Exploded view of the front shock absorber retainers

{ewc GSMVIMG,GSMVIMG, !88268G05.bmp}

88268G05

Figure 9.
DON'T loosen the retainer without holding the shaft (a box wrench is usually better than a socket)

{ewc GSMVIMG,GSMVIMG, !88268p01.bmp}

88268p01

Figure 10.
Once the upper shock retainer is removed, loosen the lower retaining bolts . . .

{ewc GSMVIMG,GSMVIMG, !88268p02.bmp}

88268p02

Figure 11.
. . . and carefully lower the shock from the control arm

{ewc GSMVIMG,GSMVIMG, !88268p03.bmp}

88268p03

To install:

5. Fully extend the shock absorber, insert it through the coil spring and the upper control arm, then loosely install the retainers.
6. While holding the stem from turning, tighten the shock absorber upper retaining nut to 15 ft. lbs. (20 Nm).
7. Tighten the shock absorber-to-lower control arm bolts to 18 ft. lbs. (25 Nm).

TESTING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Suspension And Steering

TESTING

Visually inspect the shock absorber. If there is evidence of leakage and the shock absorber is covered with oil, the shock is defective and should be replaced.

If there is no sign of excessive leakage (a small amount of weeping is normal) bounce the van at one corner by pressing down on the bumper and releasing it. When you have the van bouncing as much as you can, release the bumper. The van should stop bouncing after the first rebound. If the bouncing continues past the center point of the bounce more than once, the shock absorbers are worn and should be replaced.

Upper Ball Joint {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Upper Ball Joint

INSPECTION

Ü See figures 12, 13

Ä Before performing this inspection, make sure the wheel bearings are adjusted correctly and that the control arm bushings are in good condition.

1. Raise and support the front of the vehicle by placing jackstands under each lower control arm as close as possible to each lower ball joint.

   Ä Before performing the upper ball joint inspection, be sure the vehicle is stable and the lower control arm bumpers are not contacting the frame.

2. Wipe the ball joints clean and check the seals for cuts or tears. If a seal is damaged the ball joint MUST be replaced.
3. Position a dial indicator so it contacts the wheel rim.
4. To measure the horizontal deflection, perform the following procedures:
   a. Grasp the tire (top and bottom), then pull outward on the top and push inward on the bottom; record the reading on the dial indicator.
   b. Grasp the tire (top and bottom), then pull outward on the bottom and push inward on the top; record the reading on the dial indicator.
   c. If the difference in the dial indicator reading is more than 0.125 in. (3.18mm), or if the ball joint can be twisted in its socket (with finger pressure) once it is disconnected from the knuckle, it must be replaced.

Figure 12.
To check the ball joint, first wipe the grease and road crud off the it for a visual inspection

{ewc GSMVIMG,GSMVIMG, !88268p04.bmp}

88268p04

Figure 13.
Checking for ball joint looseness

{ewc GSMVIMG,GSMVIMG, !88268Ga2.bmp}

88268Ga2

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Suspension And Steering

REMOVAL & INSTALLATION

Ü See figures 14, 15, 16, 17

Ä The following procedure requires the use of the GM Ball Joint Remover tool No. J-23742 or equivalent.

1. Raise and support the front of the vehicle by placing jackstands under the lower control arms, between the spring seat and the lower ball joint. If jackstands are placed anywhere else, a floor jack MUST be used between the spring seat and the lower ball joint.

Ä Allow the jackstand or jack to remain under the lower control arm seat, to retain the spring and the lower control arm position.

2. Remove the tire and wheel assembly.
3. From the upper ball joint, remove the cotter pin, the nut and the grease fitting.
4. Using the GM Ball Joint Remover tool No. J-23742 or equivalent, separate the upper ball joint from the steering knuckle. Pull the steering knuckle free of the ball joint after removal and wire it to the body.

Ä After separating the steering knuckle from the upper ball joint, be sure to support steering knuckle/hub assembly to prevent damaging the brake hose.

5. Remove the upper ball joint from the upper control arm:
    a. Using a 1/8 in. (3mm) bit, drill a 1/4 in. (6mm) deep hole into each rivet.
    b. Using a 1/2 in. (13mm) bit, drill off the rivet heads.
    c. Using a pin punch and the hammer, drive the rivets from the upper ball joint-to-upper control arm assembly and remove the upper ball joint.

Figure 14.
Use a separator tool to free the upper ball joint from the steering knuckle

{ewc GSMVIMG,GSMVIMG, !88268G06.bmp}

88268G06

Figure 15.
Drill pilot holes in the upper ball joint rivets . . .

{ewc GSMVIMG,GSMVIMG, !88268G07.bmp}

88268G07

Figure 16.
. . . then drill off the rivet heads

{ewc GSMVIMG,GSMVIMG, !88268G08.bmp}

88268G08

Figure 17.
When installing a service replacement upper ball joint, be sure the bolts are positioned on the bottom (nuts on top)

{ewc GSMVIMG,GSMVIMG, !88268G09.bmp}

88268G09

To install:

6. Clean and inspect the steering knuckle hole. Replace the steering knuckle, if any out of roundness is noted.

7. Install a service replacement upper ball joint, positioning the ball joint-to-upper control arm bolts facing upward.
8. Tighten the upper ball joint-to-upper control arm bolts to the specification provided with the replacement joint. If no specification was provided, tighten the bolt to 96 inch lbs. (11 Nm) for 1985-89 vehicles or to 22 ft. lbs. (30 Nm) for 1990-96 vehicles.
9. Remove the steering knuckle support, then seat the upper ball joint into the steering knuckle and install the nut. Make sure the ball joint is FULLY SEATED into the steering knuckle, then tighten the upper ball joint-to-steering knuckle nut to 52 ft. lbs. (70 Nm) for 1985-87 vehicles, or to 65 ft. lbs. (85 Nm) on 1988-96 vehicles.
10. Install a new cotter pin to the lower ball joint stud.

    Ä When installing the cotter pin through the upper ball joint-to-steering knuckle nut, if the hole is not clear, always tighten the castle nut additionally to expose the cotter pin hole. NEVER loosen the nut for alignment.
11. Install the grease fitting, then lubricate the upper ball joint using a grease gun.
12. Install the tire and wheel assembly.
13. Inspect and/or adjust the wheel bearing and the front end alignment.
14. Remove the jackstands and carefully lower the vehicle.

Lower Ball Joint {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Lower Ball Joint

INSPECTION

Ü See figure 18

Ä Remember that mis-adjusted wheel bearings or worn control arm bushings can also produce symptoms similar to that of worn ball joints. If visual inspection shows the lower ball joints to be good, check these items next.

Wipe the joint clean of old grease and road crud, then check the seal to make sure it is not torn or cut. Visually check the wear indicator (the shoulder which the grease fitting is threaded into); if it is flush or inside the ball joint cover surface, replace the ball joint. If the indicator protrudes from the housing and the seal is intact, the joint is considered good. The joint must be replaced if the seal is damaged or if the indicator shows it to be worn past serviceability.

Figure 18.
The lower ball joint can be inspected for wear visually using the built-in indicator (the grease fitting)

{ewc GSMVIMG,GSMVIMG, !88268G11.bmp}

88268G11

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REMOVAL & INSTALLATION

Ü See figures 19, 20, 21, 22, 23, 24, 25, 26

Ä The following procedure requires the use of the GM Ball Joint Remover (separator) tool No. J-23742 or equivalent, and the GM Ball Joint Remover and Installer Set tool No. J-9519-E. The set includes a C-clamp like pressing tool and various fixture and driver adapters.

1. Raise and support the front of the vehicle on jackstands.
2. Remove the tire and wheel assembly.
3. Place a floor jack under the spring seat of the lower control arm, then raise the jack to support the arm.

Ä The floor jack MUST remain under the lower control arm, during the removal and installation procedures, to retain the arm and spring positions.

****Caution**
Improper placement or sudden release of the jack during this procedure could dislodge the coil spring causing serious personal injury.

4. Remove and discard the cotter pin from the lower ball joint stud, then remove the ball joint nut.
5. Using the GM Ball Joint Remover tool No. J-23742 or equivalent, disconnect the lower ball joint from the steering knuckle.
6. Pull the steering knuckle away from the lower control arm, place a block of wood between the frame and the upper control arm in order to hold the knuckle and hub assembly out of the way; make sure the brake hose is free of tension.
7. Remove the rubber grease seal and the grease fitting from the lower ball joint.
8. Remove the lower ball joint from the lower control arm using the ball joint remover set.

Figure 19.
The proper ball joint separator tool MUST be used if the joint is not being replaced, otherwise the joint may be damaged requiring replacement

{ewc GSMVIMG,GSMVIMG, !88268G10.bmp}

88268G10

Figure 20.
Support the lower control arm using a floor jack-this will keep the coil spring and arm in position

{ewc GSMVIMG,GSMVIMG, !88268p05.bmp}

88268p05

Figure 21.
Remove the cotter pin from the lower ball joint stud . . .

{ewc GSMVIMG,GSMVIMG, !88268p06.bmp}

88268p06

Figure 22.
. . . then loosen the stud nut-note that the tie rod end was removed earlier for illustration purposes

{ewc GSMVIMG,GSMVIMG, !88268p07.bmp}

88268p07

Figure 23.
Remove the ball joint nut then install a separator tool to free the joint . . .

{ewc GSMVIMG,GSMVIMG, !88268p08.bmp}

88268p08

Figure 24.
. . . use this tool ONLY if the joint is being replaced as the seal will likely be destroyed by the tool

{ewc GSMVIMG,GSMVIMG, !88268p09.bmp}

88268p09

Figure 25.
Use the ball joint removal tools in the Remover and Installer Set to press the old joint from the lower control arm

{ewc GSMVIMG,GSMVIMG, !88268G12.bmp}

88268G12

Figure 26.
The new ball joint should also be pressed into position using the tool set

{ewc GSMVIMG,GSMVIMG, !88268G13.bmp}

88268G13

To install:

9. Position the new lower ball joint into the lower control arm, then use the ball joint installer set to press the joint into the lower control arm.
10. Install the grease fitting and the grease seal onto the lower ball joint; the grease seal MUST BE fully seated on the ball joint and the grease purge hole MUST face inboard.
11. Remove the wooden block, then press the steering knuckle assembly onto the lower ball joint until is fully seated.
12. Install the ball joint-to-steering knuckle nut and tighten to 81 ft. lbs. (110 Nm) for 1985-92 vehicles, or to 90 ft. lbs. (125 Nm) on 1993-96 vehicles.
13. Install a new cotter pin to the lower ball joint stud.

    Ä When installing the cotter pin through the lower ball joint-to-steering knuckle nut, if the hole is not clear, always tighten the castle nut additionally to expose the cotter pin hole. NEVER loosen the nut for alignment.

14. Remove the floor jack.
15. Using a grease gun, lubricate the lower ball joint.
16. Check and adjust the wheel bearings and the front end alignment, as necessary.
17. Remove the jackstands and carefully lower the vehicle.

Stabilizer (Sway) Bar {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Stabilizer (Sway) Bar

REMOVAL & INSTALLATION

Ü See figures 27, 28, 29, 30

1. Raise and support the front of the vehicle on jackstands.
2. Remove the wheels to provide access (and light).
3. Disconnect the stabilizer bar link nuts, then slowly pull the bolts down, from underneath the lower control arms. As the bolts are removed, the retainers, insulators and link spacer will be freed from the bolt. BE SURE to note the locations for each of these components and keep them in order. It is probably best to install them in order over the bolt and put the nut on the end to keep any part from being lost.
4. Remove the stabilizer bar-to-frame clamps.
5. Remove the stabilizer bar from the vehicle. If necessary, remove the insulators from the shaft.

Figure 27.
Exploded view of the stabilizer shaft mounting

{ewc GSMVIMG,GSMVIMG, !88268Ga3.bmp}

88268Ga3

Figure 28.
Loosen the stabilizer bar link nut, while using a wrench to hold the bolt from turning . . .

{ewc GSMVIMG,GSMVIMG, !88268p10.bmp}

88268p10

Figure 29.
. . . then remove the bolt, gathering each of the link components and keeping them in order

{ewc GSMVIMG,GSMVIMG, !88268p11.bmp}

88268p11

Figure 30.
Make sure the offset on the bar is aligned properly during installation

{ewc GSMVIMG,GSMVIMG, !88268G14.bmp}

88268G14

To install:

6. If removed, install the insulators on the shaft. The slit on the insulator should be positioned toward the front of the vehicle.
7. Install the stabilizer shaft and brackets to the van, making sure the shaft is mounted with the identification on the right side of the vehicle. Install the shaft offset in the downward position and make sure the insulators are positioned squarely in the clamps.
8. Loosely install the stabilizer bar-to-frame clamps in order to hold the bar.
9. Install the stabilizer links through the control arms, positioning the necessary components (insulators, washers, retainers and the link spacer) as it is inserted. Connect the links to the ends of the bar, installing the washer and nut.
10. Tighten the stabilizer bar link-to-lower control arm bolts to 13 ft. lbs. (18 Nm) and the stabilizer retainer-to-frame bolts to 22 ft. lbs. (29 Nm) for 1985-87 vehicles or to 27 ft. lbs. (36

Nm) for 1988-96 vehicles.

Upper Control Arm {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Upper Control Arm

REMOVAL & INSTALLATION

Ü See figures 31, 32, 33

Ä The following procedure requires the use of the GM Ball Joint Remover tool No. J-23742 or equivalent.

Before starting the procedure, identify and note the location of the alignment shims. They must be installed in their original locations in order to preserve current vehicle wheel alignment.

1. Raise and support the front of the vehicle by placing jackstands under the lower control arms, between the spring seat and the lower ball joint. If the jackstands are placed in a different location, then a floor jack MUST be used under the lower control arm.

   Ä Allow the jackstand or floor jack to remain under the lower control arm seat, to retain the spring and the lower control arm position.

2. Remove the tire and wheel assembly.
3. Remove the cotter pin and nut from the upper ball joint.
4. Using the GM Ball Joint Remover tool No. J-23742 or equivalent, separate the upper ball joint from the steering knuckle/hub assembly. Pull the steering knuckle free of the ball joint after removal.

   Ä After separating the steering knuckle from the upper ball joint, be sure to support steering knuckle/hub assembly to prevent damaging the brake hose.

5. Remove the upper control arm-to-frame nuts and bolts, then lift and remove the upper control arm from the vehicle.

   Ä Tape the alignment shims together and identify them so they can be installed in the proper positions from which they were removed.

6. Clean and inspect the steering knuckle hole. Replace the steering knuckle, if any out of roundness is noted.
7. If replacement is necessary, mount the control arm in a vise, then remove the pivot shaft nuts and washers. Use a control arm bushing fixture (C-clamp like tool) along with a slotted washer and a piece of pipe (slightly larger than the bushing) to remove the old bushings.

Figure 31.
Exploded view of the upper control arm mounting
{ewc GSMVIMG,GSMVIMG, !88268G15.bmp}

88268G15

Figure 32.
Exploded view of the upper control arm, pivot shaft and bushings
{ewc GSMVIMG,GSMVIMG, !88268G16.bmp}

88268G16

Figure 33.
When replacing the bushings, make sure they are positioned as shown
{ewc GSMVIMG,GSMVIMG, !88268Ga5.bmp}

88268Ga5

To install

8. If removed, position the pivot shaft to the control arm and install the bushing using the fixture

tool, washer and a length of pipe with the same outer diameter as the bushing. Tighten the tool until the bushing is positioned on the shaft as shown in the illustration. Install the bushing retaining nuts and washers, then tighten them to 85 ft. lbs. (115 Nm).

9. Attach the upper control arm to the frame aligning the holes in the shaft with the holes in the frame. Insert the shims in their proper positions (as noted during removal). You may have to lift the upper control arm to gain access for shim installation.
10. Tighten the upper control arm-to-frame bolts to 66 ft. lbs. (90 Nm) for 1985-87 vehicles, to 75 ft. lbs. (100 Nm) for 1988-95 vehicles, or to 81 ft. lbs. (110 Nm) for 1996 vehicles.
11. Seat the upper ball joint into the steering knuckle and install the nut.
12. Tighten the upper ball joint-to-steering knuckle nut to 52 ft. lbs. (69 Nm) for 1985-87 vehicles, or to 65 ft. lbs. (85 Nm) for 1988-96 vehicles.
13. Install a new cotter pin to the upper ball joint stud.

    Ä When installing the cotter pin through the upper ball joint-to-steering knuckle nut, if the hole is not clear, always tighten the castle nut additionally to expose the cotter pin hole. NEVER loosen the nut for alignment.

14. Install the tire and wheel assembly.
15. Remove the jackstands and carefully lower the vehicle.
16. Check and adjust the wheel alignment, as necessary.

Lower Control Arm {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Lower Control Arm

REMOVAL & INSTALLATION

Ü See figure 34

Ä The following procedure requires the use of the GM Ball Joint Remover tool No. J-23742 or equivalent.

1. Refer to the Coil Spring, Removal and Installation procedures in this section and remove the coil spring.
2. Remove and discard the cotter pin, then remove the lower ball joint nut.
3. Using the GM Ball Joint Remover tool No. J-23742 or equivalent, disconnect the lower ball joint from the steering knuckle and the lower control arm from the vehicle.

   Ä Place a block of wood between the frame and the upper control arm; make sure the brake hose is free of tension.

4. If the bushings are being replaced, use a suitable bushing service set to remove the bushings from the control arm. The front bushing is normally flared and the flare must be driven down flush with the rubber using a blunt chisel before attempting removal.

Figure 34.
Exploded view of the lower control arm mounting

{ewc GSMVIMG,GSMVIMG, !88268Ga4.bmp}

88268Ga4

To install:

5. If the bushings were removed, use the bushing service set to install them to the control arms. If the front bushing is the flared type, use a flaring tool to produce an approximate flare of 45 degrees.
6. Position the lower ball joint stud into the steering knuckle.
7. Install the ball joint-to-steering knuckle nut and tighten to 81 ft. lbs. (110 Nm) for 1985-92 vehicles, or to 90 ft. lbs. (125 Nm) on 1993-96 vehicles.
8. Install a new cotter pin to the lower ball joint stud.

   Ä When installing the cotter pin through the lower ball joint-to-steering knuckle nut, if the hole is not clear, always tighten the castle nut additionally to expose the cotter pin hole. NEVER loosen the nut for alignment.

9. Install the coil spring as detailed earlier in this section.

Knuckle and Spindle {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Knuckle and Spindle

REMOVAL & INSTALLATION

Ü See figures 35, 36

Ä The following procedure requires the use of the GM Tie Rod End Puller tool J-6627 or equivalent, and the GM Ball Joint Remover tool No. J-23742 or equivalent.

1. Raise and support the front of the vehicle on jackstands.
2. Remove the wheels.

Ä When supporting the vehicle on jackstands, DO NOT place the jackstands directly under the lower control arms for the vehicle may slip off the jackstands during the steering knuckle removal.

3. Remove the brake caliper from the steering knuckle and support it on a wire.
4. Remove the grease cup, the cotter pin, the castle nut and the hub assembly.
5. Remove the splash shield-to-steering knuckle bolts and the shield.

Ä When removing the splash shield on late-model vehicles equipped with ABS, be sure to disconnect the speed sensor wiring and to treat the shield like an electrical component (Don't submerge it in solvent or anything which could damage the speed sensor assembly.

6. At the tie rod end-to-steering knuckle stud, remove the cotter pin and the nut. Using the GM Tie Rod End Puller tool J-6627 or equivalent, separate the tie rod end from the steering knuckle.
7. From the upper and lower ball joint studs, remove the cotter pins and the nuts.
8. Place a floor jack under the spring seat of the lower control arm and support the arm.
9. Using the GM Ball Joint Remover tool No. J-23742 or equivalent, separate the upper ball joint from the steering knuckle.
10. Carefully raise the upper control arm just sufficiently to separate it from the steering knuckle.
11. Using the GM Ball Joint Remover tool No. J-23742 or equivalent, separate the lower ball joint from the steering knuckle, then lift the steering knuckle from the lower control arm.
12. Clean and inspect the steering knuckle and spindle for signs of wear or damage; if necessary, replace the steering knuckle.

Figure 35.
Exploded view of the steering knuckle mounting

{ewc GSMVIMG,GSMVIMG, !88268G17.bmp}

88268G17

Figure 36.
Use a suitable steering linkage puller to disconnect the tie rod end from the knuckle

{ewc GSMVIMG,GSMVIMG, !88268G18.bmp}

88268G18

To install:

13. Position the steering knuckle onto the lower ball joint stud, then lift the upper control arm to insert the upper ball joint stud into the steering knuckle.

14. Tighten the upper ball joint-to-steering knuckle nut to 52 ft. lbs. (70 Nm) for 1985-87 vehicles, or to 65 ft. lbs. (85 Nm) on 1988-96 vehicles.
15. Tighten the lower ball joint-to-steering knuckle nut to 81 ft. lbs. (110 Nm) for 1985-92 vehicles, or to 90 ft. lbs. (125 Nm) on 1993-96 vehicles.
16. Install new cotter pins to the ball joint studs.

    Ä When installing the cotter pin through a ball joint stud and nut, if the hole is not clear, always tighten the castle nut additionally to expose the cotter pin hole. NEVER loosen the nut for alignment.

17. Remove the floor jack from under the lower control arm.
18. As necessary, lubricate the ball joints using a grease gun.
19. Install the tie rod end to the steering knuckle.
20. Install the splash shield, then tighten the shield-to-steering knuckle bolts to 10 ft. lbs. or 120 inch lbs. (14 Nm).
21. Install the hub and bearing assembly (along with the brake caliper), then adjust the wheel bearings. For details, please refer to Section 1 of this manual.
22. Remove the jackstands and lower the vehicle.
23. Before attempting to move the vehicle, pump the brake pedal slowly until a firm pedal is felt (this will seat the brake pads).
24. Check and adjust the front end alignment, as necessary.

Front Wheel Bearings {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Front Wheel Bearings

Because the front wheel bearings on 2-wheel drive vehicles must be periodically removed, inspected, repacked and installed, the necessary procedures have been included with the maintenance information found in Section 1 of this manual. Please refer to this information for front wheel bearing/race removal and installation.

4-WHEEL DRIVE FRONT SUSPENSION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

4-WHEEL DRIVE FRONT SUSPENSION

Ü See figure 37

The All Wheel Drive Astro van front suspension uses a rigidly mounted differential and constant velocity halfshafts. The differential remains stationary while the halfshafts move up and down to match irregularities in the road surface.

The upper and lower control arms are of the wishbone configuration as the 2 wheel drive. But, the major difference comes with the lower control arms which are sprung with torsion bars instead of coil springs. The torsion bars are mounted to the frame crossmember and are adjustable to maintain proper vehicle height.

Figure 37.
Exploded view of the 4wd front suspension assembly

{ewc GSMVIMG,GSMVIMG, !88268G23.bmp}

88268G23

Torsion Bars and Support {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Torsion Bars and Support

Certain procedures in this manual, including torsion bar removal and installation require that you first UNLOAD the torsion bar. This is accomplished using a special unloading tool such as J-36202 or equivalent. If you are performing service on another part of the vehicle, that first requires the torsion bars to be unloaded, refer to that portion of the torsion bar removal and installation procedure in this section and perform the necessary steps as outlined.

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REMOVAL & INSTALLATION

Ü See figures 38, 39, 40

1. Disconnect the negative battery cable for safety.
2. Raise and support the front of the vehicle safely using jackstands.
3. Mark and unload the torsion bars:
   a. Mark the adjustment bolt setting on the bolt adjusters.
   b. Increase tension on the adjustment arm using the unloader tool J-36202, or equivalent.
   c. Remove the adjusting bolt and retainer plate.
   d. Move the tool aside.
4. For 1990-92 vehicles:
   a. Slide the torsion bar forward and remove the adjustment arm.
   b. Remove the nuts and bolts from the torsion bar support-to-crossmember. Slide the crossmember rearward.
   c. Mark the location of the front and rear ends. Mark either left or right because the bars are different.
   d. Remove the support crossmember, retainer, spacer and insulator from the crossmember.
5. For 1993-96 vehicles:
   a. Remove the torsion bar anchor adaptor by sliding the adapter out toward the rear, then removing the adjustment arm.
   b. Note the location of the tape or painted stripe at the rear ends of the torsion bar (since there are different bars for the right and left sides), then remove the torsion bar from the vehicle.

Figure 38.
Torsion bar unloading tool

{ewc GSMVIMG,GSMVIMG, !88268G25.bmp}

88268G25

Figure 39.
Exploded view of the torsion bar mounting-1990-92

{ewc GSMVIMG,GSMVIMG, !88268Ga6.bmp}

88268Ga6

Figure 40.
Exploded view of the torsion bar mounting-1993-96

{ewc GSMVIMG,GSMVIMG, !88268G24.bmp}

88268G24

To install:

6. For 1993-96 vehicles:
   a. Note the location of the tape or painted stripe at the rear ends of the torsion bar and position the bar to the vehicle. Remember that there are different bars for different sides of the vehicle and the tape or paint should be located to the rear.

b. Install the bar anchor adaptor, by positioning the adjustment arm, then sliding the adapter tube over the torsion bar and adjustment arm.

c. Make sure the adapter tube is properly seated into the front face of the crossmember. Make sure the torsion bar is properly seated into the rear of the adapter tube against the stop tabs.

7. For 1990-92 vehicles:

   a. Install the insulator, spacer and retainer onto the support crossmember.

   b. Install the crossmember onto the frame, rearward of the mounting holes.

   c. Make sure the bars are on their respective sides. Slide the crossmember forward until the bars are supported.

   d. Install the adjustment arms, crossmember bolts and nuts. Torque the center nut to 18 ft. lbs. (24 Nm) and the edge nuts to 46 ft. lbs. (62 Nm).

8. Properly tension and adjust (as necessary) the torsion bar:

   a. Increase the tension on the torsion bar using the unloader tool.

   b. Install the adjustment retainer plates and bolt.

   c. Set the adjuster to the position marked during removal.

   d. Release the tension on the bar until the load is taken up by the adjustment bolt, then remove the unloader tool.

9. Remove the jackstands and carefully lower the vehicle.

10. Check and adjust the "Z” height as outlined in the alignment information later in this section.

Shock Absorbers {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Shock Absorbers

Ä In order to maintain proper suspension balance and vehicle handling, shock absorbers should only be replaced in axle sets.

REMOVAL & INSTALLATION

Ü See figures 41, 42

1. Raise the front of the vehicle and support safely using jackstands.
2. Remove the front tire and wheel assemblies.
3. For 1992 and later vehicles, remove the inner wheel well splash shields.
4. Remove the lower nut, washer and bolt.

   Ä Note the direction which the bolts are facing before removal. The bolts must be installed in the same direction as noted to assure there is not interference with suspension components during vehicle operation.

5. Remove the upper nut, washer and bolt, then collapse and remove the shock absorber.

Figure 41.
Exploded view of the early-model AWD shock mounting-1990-92 vehicles
{ewc GSMVIMG,GSMVIMG, !88268G26.bmp}

88268G26

Figure 42.
Exploded view of the late-model AWD shock mounting-1993-96 vehicles
{ewc GSMVIMG,GSMVIMG, !88268Ga7.bmp}

88268Ga7

To install:

6. Install the shock absorber to the brackets using the nuts and bolts. Be sure the bolts are facing the proper direction as noted during removal.
7. Tighten the nuts to 66 ft. lbs. (90 Nm) for 1990-95 vehicles or to 46 ft. lbs. (62 Nm) for 1996 vehicles.
8. If applicable, install the inner wheel well splash shields.
9. Install the front tire and wheel assemblies.
10. Remove the jackstands and carefully lower the vehicle.

Upper Ball Joint {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Upper Ball Joint

INSPECTION

Ü See figure 43

Ä Before performing this inspection, make sure the wheel bearings and control arm bushings are in good condition.

1. Raise and support the front of the vehicle by placing jackstands under each lower control arm as close as possible to each lower ball joint.

Ä Before performing the upper ball joint inspection, be sure the vehicle is stable and the lower control arm bumpers are not contacting the frame.

2. Wipe the ball joints clean and check the seals for cuts or tears. If a seal is damaged the ball joint MUST be replaced.
3. Position a dial indicator so it contacts the wheel rim.
4. To measure the horizontal deflection, perform the following procedures:
    a. Grasp the tire (top and bottom), then pull outward on the top and push inward on the bottom; record the reading on the dial indicator.
    b. Grasp the tire (top and bottom), then pull outward on the bottom and push inward on the top; record the reading on the dial indicator.
    c. If the difference in the dial indicator reading is more than 0.125 in. (3.18mm), or if the ball joint can be twisted in its socket (with finger pressure) once it is disconnected from the knuckle, it must be replaced.

Figure 43.
Checking for ball joint looseness

{ewc GSMVIMG,GSMVIMG, !88268Ga2.bmp}

88268Ga2

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REMOVAL & INSTALLATION

Ü See figures 44, 45

1. Raise the front of the vehicle and support safely using jackstands.
2. Remove the front tire and wheel assembly.
3. Remove the brake hose and bracket from the upper control arm.
4. Loosen the riveted ball joint from the control arm:
   a. Drill a $^1/8$ in. (3mm) hole, about $^1/4$ in. (6mm) deep into each rivet.
   b. Then use a $^1/2$ in. (13mm) drill bit, to drill off the rivet heads.
   c. Using a pin punch and the hammer, drive out the rivets in order to free the ball joint from the control arm assembly.
5. Remove the cotter pin and nut.
6. Remove the ball joint from the knuckle using a ball joint separator tool such as J-36607.

Figure 44.
Exploded view of the service replacement upper ball joint

{ewc GSMVIMG,GSMVIMG, !88268G27.bmp}

88268G27

Figure 45.
Upper ball joint separator tool

{ewc GSMVIMG,GSMVIMG, !88268Ga8.bmp}

88268Ga8

To install:

7. Position the new ball joint to the control arm.
8. Install the nuts and bolts supplied with the new ball joint. The bolt should be inserted from the top with the nut on the bottom. Tighten the nuts to 22 ft. lbs. (30 Nm).
9. Install the ball joint to the steering knuckle then secure using the nut. Tighten the nut to 95 ft. lbs. (128 Nm) for 1990-95 vehicles or to 66 ft. lbs. (90 Nm) for 1996 vehicles.

   Ä The upper ball joint retaining nut MUST be tightened with the vehicle suspension at normal ride height. This can either be accomplished by installing the wheels and lowering the vehicle, or by moving jackstands under the ends of the lower control arms and resting the vehicle on them. If the latter solution is tried, make sure the FULL WEIGHT of the vehicle front end is on the suspension.

10. Install a new cotter pin to the castellated nut. Tighten the nut (but no more than an additional $^1/6$ turn) in order to align the cotter pin. DO NOT loosen the nut from the specified torque.
11. Connect the brake hose and bracket to the control arm.
12. If not done already, install the tire and wheel assembly, then remove the jackstands and carefully lower the vehicle.
13. Check and adjust the front end alignment, as necessary.

Lower Ball Joint {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Lower Ball Joint

INSPECTION

Ü See figure 46

Ä Remember that worn wheel bearings or control arm bushings can also produce symptoms similar to that of worn ball joints. If visual inspection shows the lower ball joints to be good, check these items next.

Wipe the joint clean of old grease and road crud, then check the seal to make sure it is not torn or cut. Visually check the wear indicator (the shoulder which the grease fitting is threaded into); if it is flush or inside the ball joint cover surface, replace the ball joint. If the indicator protrudes from the housing and the seal is intact, the joint is considered good. The joint must be replaced if the seal is damaged or if the indicator shows it to be worn past serviceability.

Figure 46.
The lower ball joint can be inspected for wear visually using the built-in indicator (the grease fitting)

{ewc GSMVIMG,GSMVIMG, !88268G11.bmp}

88268G11

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REMOVAL & INSTALLATION

1990-92 Vehicles

Ü See figure 47

1. Raise the front of the vehicle and support safely using jackstands.
2. Remove the front wheels.
3. Remove 2 bolts from the front splash shield and pivot it in order to gain access to the tie rod.
4. Remove the inner tie rod end from the relay using a suitable steering linkage puller tool.
5. Remove the halfshaft nut and washer from the hub assembly. In order to accomplish this you will have to keep the halfshaft from turning. A drift can be inserted through the top of the caliper into the brake rotor vanes.
6. Remove the halfshaft assembly as outlined in Section 7 of this manual.
7. Loosen the riveted ball joint from the control arm:
   a. Center punch the bottom of the rivets.
   b. Drill a 1/8 in. (3mm) hole, about 1/4 in. (6mm) deep into each rivet.
   c. Then use a 1/2 in. (13mm) drill bit, to drill off the rivet heads.
   d. Using a pin punch and the hammer, drive out the rivets in order to free the ball joint from the control arm assembly.
8. Remove the ball joint cotter pin.
9. Support the lower control arm with a floor jack.
10. Remove the ball joint nut.
11. Mark the adjustment bolt, then unload the torsion bar using a suitable unloader tool. For details, please refer to the Torsion Bar removal and installation procedure found earlier in this section.
12. Free the ball joint from the knuckle using a ball joint separator tool, such as J-29193 or equivalent, then remove the ball joint.

Figure 47.
Exploded view of the service replacement lower ball joint

{ewc GSMVIMG,GSMVIMG, !88268G28.bmp}

88268G28

To install:

13. Install the ball joint to the control arm using the bolts, washers and nuts in the service kit. The bolts should be installed from the top, facing downward and the nuts should be placed from underneath the arm. Tighten the nuts to 22 ft. lbs. (30 Nm).
14. Raise or lower the control arm (as necessary) using the floor jack and position the ball joint stud in the knuckle.

    Ä The lower ball joint retaining nut MUST be tightened with the vehicle suspension at normal ride height. This can either be accomplished by starting the nut now, then installing the remaining components along with the wheels and lowering the vehicle, or by moving jackstands under the ends of the lower control arms and resting the vehicle on them. If the latter solution is tried, make sure the FULL WEIGHT of the vehicle front end is on the suspension.

15. Install the joint-to-control arm nut, then tighten the nut to 92 ft. lbs. (125 Nm) with the suspension at normal ride height and compression.
16. Install a new cotter pin to the castellated nut. Tighten the nut (but no more than an additional $^{1}/6$ turn) in order to align the cotter pin. DO NOT loosen the nut from the specified torque.
17. Load the torsion bar using the loading tool J-36202 and by setting the adjustment bolt to the mark made during removal. For details, please refer to the Torsion Bar procedures found earlier in this section.
18. Install the halfshaft assembly as outlined in Section 7.
19. Install the inner tie rod end, tighten the nut to 35 ft. lbs. (47 Nm) and install a new cotter pin, if so equipped.
20. Install the splash shield.
21. If not done already, install the tire and wheel assembly, then remove the jackstands and carefully lower the vehicle.
22. Check and adjust the front end alignment, as necessary.

1993-96 Vehicles {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Suspension And Steering

1993-96 Vehicles

Ü See figure 47

1. Raise the front of the vehicle and support safely using jackstands.
2. Remove the front wheels.
3. Remove 2 bolts from the front splash shield and pivot it in order to gain access to the tie rod.
4. Remove the inner tie rod end from the relay using a suitable steering linkage puller tool.
5. Remove the halfshaft nut and washer from the hub assembly. In order to accomplish this you will have to keep the halfshaft from turning. A drift can be inserted through the top of the caliper into the brake rotor vanes.
6. Remove the bolts retaining the hub and bearing assembly.
7. Remove the ball joint cotter pin.
8. Remove the ball joint nut.
9. Support the lower control arm with a floor jack.
10. Mark the adjustment bolt, then unload the torsion bar using a suitable unloader tool. For details, please refer to the Torsion Bar removal and installation procedure found earlier in this section.
11. Free the ball joint from the knuckle using a ball joint separator tool, such as J-35917 or equivalent, then remove the ball joint.
12. Loosen the riveted ball joint from the control arm:
    a. Center punch the bottom of the rivets.
    b. Drill a $^1/8$ in. (3mm) hole, about $^1/4$ in. (6mm) deep into each rivet.
    c. Then use a $^1/2$ in. (13mm) drill bit, to drill off the rivet heads.
    d. Using a pin punch and the hammer, drive out the rivets in order to free the ball joint from the control arm assembly.
13. Remove and discard the worn ball joint.

To install:

14. Install the ball joint to the control arm using the bolts, washers and nuts in the service kit. The bolts should be installed from the top, facing downward and the nuts should be placed from underneath the arm. Tighten the nuts to 22 ft. lbs. (30 Nm).
15. Raise or lower the control arm (as necessary) using the floor jack and position the ball joint stud in the knuckle.

    Ä The lower ball joint retaining nut MUST be tightened with the vehicle suspension at normal ride height. This can either be accomplished by starting the nut now, then installing the remaining components along with the wheels and lowering the vehicle, or by moving jackstands under the ends of the lower control arms and resting the vehicle on them. If the latter solution is tried, make sure the FULL WEIGHT of the vehicle front end is on the suspension.

16. Install the joint-to-control arm nut, then tighten the nut to 95 ft. lbs. (128 Nm) with the suspension at normal ride height and compression.
17. Install a new cotter pin to the castellated nut. Tighten the nut (but no more than an additional $^1/6$ turn) in order to align the cotter pin. DO NOT loosen the nut from the specified torque.

18. Load the torsion bar using the loading tool J-36202 and by setting the adjustment bolt to the mark made during removal. For details, please refer to the Torsion Bar procedures found earlier in this section.
19. Secure the hub and bearing assembly to the steering knuckle, then tighten the retaining bolts to 66 ft. lbs. (90 Nm).
20. Install the drive axle to the hub and bearing assembly, using the washer and nut. Tighten the nut to 160-200 ft. lbs. (220-270 Nm) for 1993-95 vehicles or to 147 ft. lbs. (200 Nm) for 1996 vehicles.
21. Install the inner tie rod end to the relay rod.
22. Reposition and secure the splash shield.
23. If not done already, install the tire and wheel assembly, then remove the jackstands and carefully lower the vehicle.
24. Check and adjust the front end alignment, as necessary.

Stabilizer (Sway) Bar {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Stabilizer (Sway) Bar

REMOVAL & INSTALLATION

Ü See figure 48

Ä Keep the right or left suspension components separated and do not interchange.

1. Raise and support the front of the vehicle on jackstands.
2. If necessary, remove the wheels to provide access (and light).
3. Disconnect the stabilizer bar link spacer nuts, then slowly pull the bolts up, from above the control arms and shaft. As the bolts are removed, the nut, insulators and link spacer will be freed from the bolt. BE SURE to note the locations for each of these components and keep them in order. It is probably best to install them in order over the bolt and put the nut on the end to keep any part from being lost.
4. Remove the stabilizer bar-to-frame clamps. On some models the clamps are retained by bolts only, while other models may use both nuts (studs) and bolts.
5. Remove the stabilizer bar from the vehicle. If necessary, remove the insulators from the shaft.

Figure 48.
Exploded view of the stabilizer bar mounting-1993-96 vehicles (early-models similar)

{ewc GSMVIMG,GSMVIMG, !88268G29.bmp}

88268G29

To install:

6. If removed, install the insulators on the bar. The slit on the insulator should be positioned toward the front of the vehicle.
7. Install the stabilizer bar and brackets to the van. Loosely install the clamps to the frame in order to hold the bar in position. In order to align the holes in the control arm and stabilizer bar, it may be necessary to unload the torsion bars. For details, please refer to the Torsion Bar removal and installation procedure found earlier in this section.
8. Tighten the clamp bolts to 12 ft. lbs. (17 Nm) for 1990-92 vehicles or tighten the clamp bolts and nuts (as applicable) to 41 ft. lbs. (55 Nm) for 1993-96 vehicles.
9. Install the spacers, link bolts and nuts. Tighten the nuts to 22 ft. lbs. (30 Nm) for 1990-92 vehicles or to 13 ft. lbs. (150 inch lbs. / 17 Nm) for 1993-96 vehicles.
10. Load the torsion bars, following the Torsion Bar installation procedure earlier in this section.
11. If removed, install the front wheels.
12. Remove the jackstands and carefully lower the vehicle.
13. Check and adjust the "Z” height as outlined in the alignment information later in this section.

Upper Control Arm {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Upper Control Arm

REMOVAL & INSTALLATION

Ü See figures 49, 50

Ä This procedure requires the use of a ball joint separator tool and NEW upper control arm retaining nuts.

1. Disconnect the negative battery cable for safety.
2. Raise the vehicle and support with jackstands.
3. Remove the front wheels.
4. If necessary, remove the air cleaner extension.
5. Remove the brake hose from the control arm and tie out of the way.
6. Remove the upper ball joint cotter pin and nut.
7. Disconnect the control arm from the knuckle using a ball joint separator.
8. For 1990-91 vehicles, remove the control arm nuts, bolts and washers.
9. For 1992-96 vehicles, remove the control arm cam hardware (nuts, cams and bolts).
10. Remove the control arm from the vehicle. If replacement is necessary, remove the bushings.

Figure 49.
Exploded view of the upper control arm and bushing mounting-1990-91 vehicles
{ewc GSMVIMG,GSMVIMG, !88268G30.bmp}

88268G30

Figure 50.
Exploded view of the upper control arm and bushing mounting-1992-96 vehicles
{ewc GSMVIMG,GSMVIMG, !88268G30.bmp}

88268G30

To install:

11. If removed, install the new bushings.
12. Install the upper control arm to the frame.
13. Install the upper control arm mounting hardware (bolts and cams or washers, as applicable, along with the NEW nuts). Make sure the bolt threads are opposed inside the bracket. On 1992-96 vehicles, make sure the cam lobes are pointing downward.

    Ä The control arm retainers MUST be tightened with the vehicle suspension at normal ride height. This can either be accomplished by starting the nuts now, then installing the remaining components along with the wheels and lowering the vehicle, or by moving jackstands under the ends of the lower control arms and resting the vehicle on them. If the latter solution is tried, make sure the FULL WEIGHT of the vehicle front end is on the suspension.

14. Tighten the control arm nuts to 88 ft. lbs. (120 Nm) for 1990-92 vehicles, to 105 ft. lbs. (145 Nm) for 1993-95 vehicles or to 91 ft. lbs. (123 Nm) for 1996 vehicles, all with the suspension at normal ride height and compression.

    Ä When tightening the control arm nuts, start with the FRONT NUT FIRST.

15. Install the upper ball joint to the steering knuckle then secure using the nut. Tighten the nut to 95 ft. lbs. (128 Nm) for 1990-95 vehicles or to 66 ft. lbs. (90 Nm) for 1996 vehicles.

Ä The upper ball joint retaining nut MUST be tightened with the vehicle suspension at normal ride height. This can either be accomplished by installing the wheels and lowering the vehicle, or by moving jackstands under the ends of the lower control arms and resting the vehicle on them. If the latter solution is tried, make sure the FULL WEIGHT of the vehicle front end is on the suspension.

16. Install a new cotter pin to the castellated nut. Tighten the nut (but no more than an additional $^1/6$ turn) in order to align the cotter pin. DO NOT loosen the nut from the specified torque.
17. Connect the brake hose and bracket to the control arm.
18. If removed, install the air cleaner extension.
19. If not done already, install the tire and wheel assembly, then remove the jackstands and carefully lower the vehicle.
20. Connect the negative battery cable.

Lower Control Arm {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Lower Control Arm

REMOVAL & INSTALLATION

Ü See figures 51, 52

Ä Tools Needed: universal tie rod separator J-24319-01, torsion bar unloader J-36202, lower control arm bushing service kit J-36618 (if the control arm bushing are being replaced) and ball joint C-clamp J-9519-23. Parts Needed: whether or not the control arm or bushing are being replaced, NEW control arm retaining nut should be used once the old ones have been loosened and removed.

1. Disconnect the negative battery cable for safety.
2. Raise and support the vehicle safely using jackstands.
3. Remove the front wheels.
4. Remove 2 bolts from the front splash shield and pivot it in order to gain access to the tie rod.
5. Disconnect the stabilizer bar from the control arm (keeping all of the link hardware sorted for proper installation). If necessary, completely remove the bar from the vehicle for access.
6. Remove the shock absorber as outlined in this section.
7. Disconnect the inner tie rod from the relay rod using a tie rod separator.
8. Remove the outer halfshaft nut and washer.
9. For 1990-92 vehicles, remove the halfshaft from the hub as outlined in Section 7.
10. For 1993-96 vehicles, remove the bolts from the hub and bearing kit.
11. Unload the torsion bar using the unloading tool J-36202. First, mark the adjuster for installation. For details, please refer to the Torsion Bar removal and installation procedures found earlier in this section.
12. Support the lower control arm with a jackstand, then remove the adjustment arm. Slide the bar forward and the adapter out of the rear to remove the adjusting arm.
13. Remove the lower ball joint cotter pin, nut and ball joint from the control arm using a ball joint separator.
14. Remove the nuts and bolts and lower control arm with the torsion bar assembly. Note the direction which the control arm retaining bolts are facing for installation purposes.
15. If replacing bushings: unbend the crimps (usually front bushing only) using a punch, then remove the bushings using a bushing service kit J-36618-2, J-9519-23, J-36618-4 and J-36618-1.

Figure 51.
Exploded view of the lower control arm assembly mounting-1990-91 vehicles
{ewc GSMVIMG,GSMVIMG, !88268G31.bmp}

88268G31

Figure 52.
Exploded view of the lower control arm assembly mounting-1992-96 vehicles
{ewc GSMVIMG,GSMVIMG, !88268Gb1.bmp}

88268Gb1

To install:

16. Install the front bushing using tools J-36618 and J-9519-23. Crimp the bushing in place after

installation.

17. Install the rear bushing using J-36618 and J-9519-23.
18. Install the torsion bar to the lower control arm and install the assembly into the vehicle. Position the front leg of the lower control arm into the crossmember before installing the rear leg into the frame bracket.
19. Install the control arm bolts (facing in the direction as noted during removal or shown in the accompanying illustration) with NEW nuts.

    Ä The control arm retainers MUST be tightened with the vehicle suspension at normal ride height. This can either be accomplished by starting the nuts now, then installing the remaining components along with the wheels and lowering the vehicle, or by moving jackstands under the ends of the lower control arms and resting the vehicle on them. If the latter solution is tried, make sure front suspension is at actual ride height compression. If you are unsure, it is best to start the nuts now and tighten them to specification once the vehicle is lowered.

20. Position the ball joint stud in the knuckle.
21. With the suspension at the correct height, tighten the control arm retaining nuts to 135 ft. lbs. (185 Nm) for 1990-92 vehicles, 125 ft. lbs. (170 Nm) for 1993-95 vehicles or to 98 ft. lbs. (133 Nm) for 1996 vehicles.

    Ä The lower ball joint retaining nut MUST be tightened with the vehicle suspension at normal ride height. This can either be accomplished by starting the nut now, then installing the remaining components along with the wheels and lowering the vehicle, or by moving jackstands under the ends of the lower control arms and resting the vehicle on them. If the latter solution is tried, make sure the FULL WEIGHT of the vehicle front end is on the suspension.

22. Install the joint-to-control arm nut, then tighten the nut to 92 ft. lbs. (125 Nm) with the suspension at normal ride height and compression.
23. Install a new cotter pin to the castellated nut. Tighten the nut (but no more than an additional $^{1}/6$ turn) in order to align the cotter pin. DO NOT loosen the nut from the specified torque.
24. Install the adjuster arm by sliding the adapter forward, over the torsion bar to install the sides of the nut. Load the torsion bar and install the adjuster bolt aligning the installation mark. For more details, please refer to the Torsion Bar procedure found earlier in this section.
25. For 1993-96 vehicles, insert the drive axle through the hub and bearing assembly, then install and tighten the hub and bearing assembly retaining bolts. Install and tighten the drive axle shaft nut and washer. For details, please refer to Section 7 of this manual.
26. For 1990-92 vehicles, install the halfshaft assembly, as outlined in Section 7 of this manual.
27. Install the inner tie rod end to the relay rod.
28. Install the shock absorber.
29. Install the stabilizer bar (if removed completely) and the stabilizer link(s) to the control arm(s).
30. Reposition and secure the splash shield.
31. Install the front wheels and lower the vehicle.
32. Recheck all fasteners for proper torque and installation before road testing.
33. Refill the differential if any fluid was lost.
34. Check and adjust the front end alignment, as necessary.

Knuckle, Hub and Bearings {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Suspension And Steering

Knuckle, Hub and Bearings

REMOVAL & INSTALLATION

Ä You will need an approved ball joint separator (NOT A PICKLE FORK), along with any tools which are required for halfshaft removal (as covered in Section 7 of this manual).

1. Remove $^{2}/3$ of the fluid from the brake reservoir.
2. Raise the vehicle and support with jackstands.
3. Remove the front wheels. Place a protective cover over the halfshaft boots.

****Caution**
Some brake pads contain asbestos, which has been determined to be 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.

4. Remove the brake caliper as outlined in Section 9. Support the caliper (with the brake line still attached) aside with a piece of wire.
5. Remove the brake disc, halfshaft nut and washer.
6. Remove the retaining nut, then disconnect the tie rod end from the knuckle using a tie rod separator.
7. Remove the hub and bearing assembly. Most AWD vehicles use a sealed hub and bearing assembly that is bolted to the knuckle. Loose and remove the mounting bolts, then if necessary, use a puller to separate the assembly from the halfshaft.
8. Remove the halfshaft as outlined in Section 7 of this manual.
9. If necessary, remove the splash shield from the knuckle.
10. Support the lower control arm with jackstands.
11. Remove the upper ball joint nut and disconnect the joint from the knuckle using a ball joint separator.
12. Remove the lower ball joint nut and disconnect the joint from the knuckle using a ball joint separator.
13. Remove the knuckle from the vehicle. Check and, if necessary, remove the old seal from the knuckle.

Ä The front wheel bearings are a sealed unit that requires no periodic maintenance or repacking. The hub and bearing has to be replaced as a unit if defective.

To install:

14. If removed, install a new seal into the knuckle using a seal installer J-36605.
15. Install the knuckle to the upper and lower ball joints. Install and tighten the nuts, but do not tighten fully at this time, they must be tightened with the suspension at normal compression and ride height.
16. If removed, install the splash shield.
17. Install the halfshaft assembly.

Ä Obviously, you cannot install the shaft washer and nut until after the hub and bearing assembly has been installed, but it will be easier to keep the shaft from

turning if you wait until the brake caliper is installed as well.

18. Install the hub and bearing assembly. Torque the bolts to 66 ft. lbs. (90 Nm).
19. Install the tie rod end to the steering knuckle. Tighten the nut and install a new cotter pin.
20. Install the brake disc and caliper
21. If not done earlier, install the halfshaft washer and nut, then tighten to specification. For details, please refer to Section 7 of this manual.
22. Install the front wheels.
23. Remove the jackstands and carefully lower the vehicle.
24. Properly refill the brake master cylinder. Pump the brake pedal a few times to seat the brake pads before moving the vehicle. DO NOT attempt to move the van until a firm pedal is obtained.
25. If not done earlier, tighten the upper and lower ball joint nuts to specification and install new cotter pins. For details, please refer to the ball joint procedures found earlier in this section.
26. Recheck all fasteners for proper torque and assembly.
27. Check and adjust the front end alignment, as necessary.

FRONT END ALIGNMENT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

FRONT END ALIGNMENT

Ü See figures 53, 54

Caster

Caster is a measure of the angle between the steering axis and vertical, as viewed from the side of the vehicle when the wheels are in the straight ahead position. Stated another way, it is the tilting of the front steering axis either forward or backward from the vertical. A backward tilt is said to be positive (+) and a forward tilt is said to be negative (-).

Figure 53.
Standard front wheel alignment measurements

{ewc GSMVIMG,GSMVIMG, !88268g32.bmp}

88268g32

Figure 54.
Camber and caster adjustment-2wd vehicles

{ewc GSMVIMG,GSMVIMG, !88268g33.bmp}

88268g33

Although is it measured using a special instrument, it can usually be seen by observing the location of the upper and lower control arm ball joints. A line drawn through the center of these 2 points represents the steering axis. When looking straight downward from the top of the upper control arm you can see if the ball joints are not aligned, indicating that the caster angle is more or less than 0 degrees. If vehicle has positive caster, the lower ball joint would be located ahead of the upper ball joint center line. If the vehicle has negative caster, the lower ball joint would be located behind the upper joint center line.

On 2wd trucks, the caster may be adjusted by changing placement of shims on the 2 upper control arm pivot shaft-to-frame bolts. On 4wd trucks, the caster is adjusted by turning the adjustment cams. To increase positive caster on a 4wd vehicle, move the front cam lobe inboard and the rear cam lobe outboard.

Camber {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Camber

Camber is the measure of wheel tilt from the vertical direction, when the wheel is viewed from the rear of the vehicle. Camber is negative when the top of the wheel is inboard and positive when the top is outboard. Always check for bent, damaged or worn suspension components before determining that adjustment is necessary. The amount of tilt is measured in degrees from the vertical and this measurement is called the camber angle.

On 2wd vehicles, camber is adjusted by removing or adding shims at both front and rear pivot shaft-to-frame contact points. To increase camber, subtract shims equally from both locations. On 4wd vehicles, adjustment is once again made using the adjustment cams.

Toe-In {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Toe-In

Ü See figures 55, 56, 57

Toe is a measurement of how far a wheel is turned in or out from the straight ahead direction. When the front of the wheel is turned in, the toe is positive. When the front of the wheel is turned out, toe is negative. An incorrect toe setting can affect steering feel and cause excessive tire wear.

Stated another way, toe-in is the amount that the front of the wheels are closer together than the backs of the same wheels.

The actual amount of toe-in is normally only a fraction of a degree.

Toe adjustment is normally performed as the last of the wheel alignment settings (after caster and camber). It is adjusted by turning the tie rod adjustment sleeves in order to obtain the proper specification. After setting, the number of threads inside the adjuster sleeve must be equal, within a tolerance of 3 threads, on either end of the sleeve.

Figure 55.
To adjust Toe-In, first loosen the tie rod adjuster clamp bolts . . .

{ewc GSMVIMG,GSMVIMG, !88268p31.bmp}

88268p31

Figure 56.
. . . then turn the adjuster tube as necessary to achieve the required toe-in specification

{ewc GSMVIMG,GSMVIMG, !88268p32.bmp}

88268p32

Figure 57.
When you are finished, the adjuster tube should be centered in the threads between the tie rod ends

{ewc GSMVIMG,GSMVIMG, !88268p33.bmp}

88268p33

Trim (Ride) Height {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Trim (Ride) Height

Ü See figures 58, 59, 60

The trim height "Z" measurement is used as an indicator if the front suspension is properly set-up. The height may be checked following suspension repairs or if damage to the suspension is suspected, such as after hitting a large pot hole. Refer to the illustrations for proper measurements.

On 2wd vehicles, if the measurement is out of specification, check for worn or damaged suspension components. On 4wd vehicles, some adjustment is possible through the torsion bar adjuster. Turning the adjustment bolt 1 full revolution will increase/decrease "Z" height by 0.2 in. (6.0mm). If a proper adjustment cannot be obtained, check for worn or damaged components.

Figure 58.
Measuring and adjusting the trim height "Z" dimension-2wd vehicles (late-model shown, early-model similar)

{ewc GSMVIMG,GSMVIMG, !88268gb2.bmp}

88268gb2

Figure 59.
Measuring and adjusting the trim height "Z" dimension-early-model AWD vehicles

{ewc GSMVIMG,GSMVIMG, !88268g34.bmp}

88268g34

Figure 60.
Measuring and adjusting the trim height "Z" dimension-late-model AWD vehicles

{ewc GSMVIMG,GSMVIMG, !88268gb3.bmp}

88268gb3

REAR SUSPENSION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REAR SUSPENSION

Ü See figures 61, 62

The rear suspension system consists of several major components: The double acting shock absorbers, variable rate single leaf fiberglass springs and various attachment parts. The single leaf fiberglass springs are connected to the frame by a hanger assembly with integral bushings in the front and a shackle assembly with integral bushings in the rear. The shackle assembly, in response to different road and payload conditions, allows the leaf spring to "change its length". The rear axle is connected to both the fiberglass leaf springs and the shock absorbers by various attaching parts.

Figure 61.
Exploded view of the rear suspension assembly-1985-94 models shown (late-model similar)

{ewc GSMVIMG,GSMVIMG, !88268G36.bmp}

88268G36

Figure 62.
These rear suspension parts are shared by all these vans (springs, shocks and floating rear axle)

{ewc GSMVIMG,GSMVIMG, !88268p12.bmp}

88268p12

An optional spring steel stabilizer bar helps to minimize body roll and is available as part of the sport suspension package. The stabilizer bar is attached to the rear axle and to the frame using rubber insulators, clamps and link assemblies.

Leaf Spring {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Leaf Spring

Ä In order to maintain proper suspension balance and vehicle handling, leaf springs should be replaced only in axle sets.

REMOVAL & INSTALLATION

1985-94 Vehicles

Ü See figures 63, 64

Ä The following procedure requires the use of 2 jackstands and 2 floor jacks.

1. Raise and support the rear of the vehicle safely using jackstands.

   Ä When supporting the rear of the vehicle, support the axle and the body separately to relieve the load on the rear spring. Because the axle may need to be raised or lowered, you probably want to support the van using the jackstands and secure the rear axle to the floor jacks.

2. Remove the rear wheel and tire assemblies.
3. Remove the shock absorber.
4. Remove the nuts from the U-bolt and lower plate (attaching the spring to the axle at the center of the spring). If the vehicle is equipped with a stabilizer bar it will be necessary to remove the lower nuts, washers and clamps. If necessary, swing the stabilizer bar down to obtain clearance when lowering the axle assembly.

   Ä The U-bolts, nuts and washers should be discarded when removed and replaced with new parts upon installation.

5. Remove the U-bolt, lower plate and anchor plate, then CAREFULLY lower the axle away from the spring.

   ****Warning**
   DO NOT let the axle hang by the brake hose at any point during the procedure or the hose may be severely damaged.

6. At the rear of the fiberglass spring, loosen (but DO NOT remove) the shackle-to-frame and the shackle-to-spring nuts and bolts.
7. At the front of the fiberglass spring, remove the retainer-to-hanger assembly nuts, washers and the retainer(s).
8. At the rear of the fiberglass spring, remove the spring-to-shackle nut, washer and bolt.
9. Remove the fiberglass spring from the vehicle.

Figure 63.
Exploded view of the leaf spring mounting-1985-94 vehicles
{ewc GSMVIMG,GSMVIMG, !88268G35.bmp}

88268G35

Figure 64.
Adjusting the rear suspension trim height
{ewc GSMVIMG,GSMVIMG, !88268G37.bmp}

88268G37

To install:

10. Attach the spring to the shackle (DO NOT tighten the nuts/bolts), rotate the shackle forward

to clear the rear bumper bracket, position the spring into the slot on the hanger and attach the retainer-to-hanger fasteners.

11. Using the axle supports, raise and position the axle housing under the fiberglass spring. Using NEW U-bolts, nuts and washers, along with the lower plates, connect the axle housing to the spring.

    Ä When installing the axle housing, be sure the full weight of the axle is resting on the supports; the fiberglass spring MUST NOT support any of the axle weight.

12. Torque the axle U-bolt-to-spring nuts to 48 ft. lbs. (65 Nm) and the axle lower plate-to-spring nuts to 41 ft. lbs. (55 Nm).

13. To adjust the rear suspension trim height, perform the following:

    a. Raise the axle/spring assembly until the clearance between the top of the axle and the bottom of the frame is 5.3-6.1 in. (135-155mm).

    Ä If the axle supports are not in complete contact with the axle housing and resting firmly on the floor, damage to the spring and axle could result.

    b. Tighten the shackle retainers to 81 ft. lbs. (110 Nm) for 1985-89 vehicles. For 1990-94 vehicles tighten the shackle-to-frame bolt to 81 ft. lbs. (110 Nm) and the shackle-to-spring bolt to 103 ft. lbs. (140 Nm).

    c. Tighten the retainer-to-hanger assembly nuts to 28 ft. lbs. (38 Nm).

14. Install the shock absorber to the axle housing.

    Ä When installing the shock absorber on the right side, be sure to position the parking brake bracket on the bolt before the nut is installed.

15. Install the wheel assemblies, then remove the jackstands and carefully lower the vehicle.

1995-96 Vehicles {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Suspension And Steering

1995-96 Vehicles

Ü See figures 65, 66

Ä The following procedure requires the use of 2 jackstands and 2 floor jacks.

1. Raise and support the rear of the vehicle safely using jackstands.

   Ä When supporting the rear of the vehicle, support the axle and the body separately to relieve the load on the rear spring. Because the axle may need to be raised or lowered, you probably want to support the van using the jackstands and secure the rear axle to the floor jacks.

2. Remove the rear wheel and tire assemblies.
3. For 1995 vehicles, remove the shock absorber.
4. On 1996 vehicles, if necessary for access to the lower spring plate front nut, remove the axle bumper and retainer.
5. Remove the nuts securing the U-bolt and lower plate (attaching the spring to the axle at the center of the spring). If the vehicle is equipped with a stabilizer bar it will be necessary to remove the lower nuts, washers and clamps, then swing the stabilizer bar down to obtain clearance when lowering the axle assembly.
6. Remove the U-bolt, lower plate and anchor plate, then CAREFULLY lower the axle away from the spring.

   ****Warning**
   DO NOT let the axle hang by the brake hose at any point during the procedure or the hose may be severely damaged.

7. At the rear of the fiberglass spring, remove the shackle nut and bolt, then disengage the spring from the shackle.
8. At the front of the fiberglass spring, remove the hanger nut and bolt, then remove the spring from the hanger and from the vehicle.

Figure 65.
Exploded view of the leaf spring mounting-1995-96 vehicles
{ewc GSMVIMG,GSMVIMG, !88268Gb4.bmp}

88268Gb4

Figure 66.
Measuring the rear suspension trim height
{ewc GSMVIMG,GSMVIMG, !88268Gb5.bmp}

88268Gb5

To install:

Ä To assure proper seating and attachment of the anchor plate over the spring end and the axle, the installation procedure must be followed closely.

9. Position the spring to the hanger, then loosely install the retaining nut and bolt.
10. Position the spring to the shackle, then loosely install the retaining nut and bolt.
11. CAREFULLY raise the axle until it contacts the spring.
12. Apply rubber lubricant to the isolator on the spring in order to aid installation of the anchor plate, then install the anchor plate to the top of the spring.

13. Install the lower plate and U-bolt around the axle and through the anchor plate. If your van is equipped with a stabilizer bar it will be necessary to install the clamps, washers and nuts.
14. Install the nuts to the lower plate and U-bolts. Starting with the inner (lower plate side) nuts, gradually tighten the 4 nuts so the anchor plate moves uniformly, side-to-side, over the spring. Tighten the nuts to 52 ft. lbs. (70 Nm) for 1995 vehicles or to 41 ft. lbs. (56 Nm) for 1996 vehicles.

    Ä After tightening the fasteners to specification, there should be no gap between the anchor plate, axle tube bracket and the lower plate. A metal-to-metal contact should exist.
15. Raise the axle so the vehicle's weight is supported by the spring. The rear suspension height should be approximately 5.3-5.7 in. (135-145mm). With the suspension at normal ride height, tighten the shackle and hanger retainers to 81 ft. lbs. (110 Nm) for 1995 vehicles or to 74 ft. lbs. (100 Nm) for 1996 vehicles.
16. If removed on 1996 vehicles, install the axle bumper and tighten the nut to 33 ft. lbs. (45 Nm).
17. For 1995 vehicles, install the shock absorber.
18. Install the tire and wheel assemblies.
19. Remove the jackstands and carefully lower the vehicle.

Shock Absorbers {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Shock Absorbers

TESTING

Visually inspect the shock absorber. If there is evidence of leakage and the shock absorber is covered with oil, the shock is defective and should be replaced.

If there is no sign of excessive leakage (a small amount of weeping is normal) bounce the van at one corner by pressing down on the bumper and releasing it. When you have the van bouncing as much as you can, release the bumper. The van should stop bouncing after the first rebound. If the bouncing continues past the center point of the bounce more than once, the shock absorbers are worn and should be replaced.

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Suspension And Steering

REMOVAL & INSTALLATION

Ü See figures 67, 68, 69, 70, 71, 72

Ä In order to maintain proper suspension balance and vehicle handling, shock absorbers should only be replaced in axle sets.

The following procedure requires the use of a lifting device and 2 jackstands.

1. Raise and support the rear of the vehicle using jackstands. Installation may be easier if you position the jackstands under the frame and support the axle housing independently using a floor jack. The jack can then be raised or lowered to help align the shock absorber with the mounts.
2. Remove the shock absorber-to-frame retainers at the top of the shock assembly.
3. Remove the shock absorber-to-axle housing retainers at the bottom of the assembly, then remove the shock absorber from the vehicle.

   Ä When removing the shock absorber-to-axle housing bolt on the right shock, the parking brake bracket must be removed after the nut.

4. Inspect and test the shock absorber, then replace as necessary.

To install:

5. Connect the shock absorber-to-frame nut/bolt (DO NOT tighten) and the shock absorber-to-axle nut/bolt.

   Ä If installing the shock absorber onto the right side, be sure to install the parking brake bracket.

6. Tighten the upper and lower shock absorber retainers to 75 ft. lbs. (102 Nm).
7. Remove the jackstands and carefully lower the vehicle.

Figure 67.
Exploded view of the rear shock mounting

{ewc GSMVIMG,GSMVIMG, !88268G39.bmp}

88268G39

Figure 68.
Loosen and remove the shock absorber upper retaining nut . . .

{ewc GSMVIMG,GSMVIMG, !88268p13.bmp}

88268p13

Figure 69.
. . . then remove the lower retainers

{ewc GSMVIMG,GSMVIMG, !88268p14.bmp}

88268p14

Figure 70.
On the right shock, the parking brake cable bracket must be removed and repositioned

{ewc GSMVIMG,GSMVIMG, !88268p15.bmp}

88268p15

Figure 71.
Lift the shock out of the lower mounting bracket, then . . .

{ewc GSMVIMG,GSMVIMG, !88268p16.bmp}

88268p16

Figure 72.
. . . remove it from the upper mounting stud and remove it from the vehicle

{ewc GSMVIMG,GSMVIMG, !88268p17.bmp}

88268p17

Stabilizer (Sway) Bar {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Stabilizer (Sway) Bar

REMOVAL & INSTALLATION

1985-93 Vehicles

Ü See figure 73

1. Raise the vehicle and support with jackstands.
2. Remove the bolts and washers from the link brackets.
3. Remove the nuts, washers and clamps from the anchor block studs.
4. Remove the insulator from the stabilizer bar.
5. Remove the upper link nuts, washers and bolts from the link assembly.
6. Remove the link bracket.
7. Remove the link nuts, washers and bolts. Pry open the lower link to obtain clearance from the link insulator.
8. Remove the link insulator from the stabilizer bar.

Figure 73.
Exploded view of the rear stabilizer bar mounting-1985-93 vehicles
{ewc GSMVIMG,GSMVIMG, !88268G38.bmp}

88268G38

To install:

9. Install the insulator to the bar.
10. Install the link assembly to the link insulator.
11. Install the link bolts, washers and nuts.
12. Install the link brackets to the link assembly.
13. Install the upper link nuts, washers and bolts.
14. Install the clamps over the insulator onto the anchor block studs.
15. Tighten the retainers to specification:
    - Link bracket bolts: 25 ft. lbs. (35 Nm)
    - Lower link bolts: 12 ft. lbs. (17 Nm)
    - Upper link bolts: 33 ft. lbs. (45 Nm)
    - Cap nuts: 38 ft. lbs. (52 Nm)
16. Remove the jackstands, then carefully lower and road test the vehicle.

1994-96 Vehicles {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

1994-96 Vehicles

Ü See figure 74

1. Raise and support the rear of the vehicle safely using jackstands.
2. Remove the top bolts from the stabilizer links.
3. Remove the stabilizer links from the frame brackets.
4. Remove the nuts from the stabilizer clamps, then remove the clamps. The stabilizer bar assembly will be free from the vehicle at this point.
5. If necessary for component replacement:
    a. Remove the insulator from the stabilizer bar.
    b. Remove the lower link nuts, washers and bolts from the link assembly.
    c. Pry open the lower link to obtain clearance from the link insulator, then remove the link from the insulator and stabilizer assembly.
    d. Remove the link insulator from the stabilizer bar.

Figure 74.
Exploded view of the rear stabilizer bar mounting-1994-96 vehicles
{ewc GSMVIMG,GSMVIMG, !88268Gb6.bmp}

88268Gb6

To install:

6. If removed, install the insulators to the stabilizer bar, then install the link assembly to the insulator. Install the link bolts, nuts and washers.
7. Install the clamp insulators, then install the stabilizer to the anchor block.
8. Position the clamp over the insulator and onto the anchor block studs. Secure the clamp using the washers and nuts.
9. Install the stabilizer links to the frame brackets.
10. Install the upper link bolts, washers and nuts to the frame bracket.
11. Tighten the retainers to specification:
    - Lower link bolts: 14 ft. lbs. (18 Nm)
    - Upper link bolts: 33 ft. lbs. (45 Nm)
    - Clamp nuts (1994-95): 52 ft. lbs. (70 Nm)
    - Clamp nuts (1996): 44 ft. lbs. (60 Nm)
12. Remove the jackstands, then carefully lower and road test the vehicle.

STEERING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

STEERING

Ü See figures 75, 76, 77, 78

The steering box (manual or power) consists of recirculating balls, which transmits force from the worm gear to the sector gear. A relay type steering linkage is used with a pitman arm connected to one end of the relay rod. The relay rod is supported by 2 idler arms; the idler arms pivot on a support which is attached to the frame. The relay rod is connected to the steering arms by 2 adjustable tie rods. Most models are equipped with a steering column which is designed to collapse on impact, thereby reducing possible chest injuries during accidents. When making any repairs to the steering column or steering wheel, excessive pressure or force capable of collapsing the column must be avoided. The ignition lock, ignition switch and an anti-theft system are built into each column.

Late-model vehicles are equipped with a driver's side Supplemental Inflatable Restraint (SIR) or Air Bag system. On these models it is EXTREMELY IMPORTANT that you follow correct servicing procedures in order to prevent serious personal injury that could result from an accidental deployment, or worse that could result if a repair prevents the system from operating properly. The air bag system should be properly disarmed BEFORE ANY PROCEDURE ON OR NEAR THE STEERING COLUMN. Also, after repairs are performed, the system should be properly armed and the system trouble indicator light should go out, indicating proper system operation. IF THE LIGHT REMAINS ON, HAVE THE VEHICLE TOWED TO A REPUTABLE REPAIR FACILITY.

Figure 75.
Exploded view of a common standard steering column-except 1996

{ewc GSMVIMG,GSMVIMG, !88268G53.bmp}

88268G53

Figure 76.
Exploded view of a common tilt steering column-except 1996

{ewc GSMVIMG,GSMVIMG, !88268G54.bmp}

88268G54

Figure 77.
Exploded view of a common early-model floor shift, tilt steering column

{ewc GSMVIMG,GSMVIMG, !88268G55.bmp}

88268G55

Figure 78.
Exploded view of the standard 1996 steering column (tilt uses same upper components)

{ewc GSMVIMG,GSMVIMG, !88268Gb7.bmp}

88268Gb7

The same basic style steering column is used on all 1985-95 Astro and Safari vans, with the possible option of standard or tilt wheel. This style of steering column has been used in GM vehicles for many years. It mounts a few of the switches (turn signal, wiper/washer and the ignition lock cylinder) inside the column, making a partial disassembly necessary for their replacement). The column mounts a few other items (ignition and dimmer switches) on top of the column, making it necessary to at least lower the column assembly from the dash for access. In 1996 an interior redesign allowed a change in column to a more simplified unit which mounts most switches in a more easily accessible position (under the upper and lower column shrouds).

Steering Wheel {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Steering Wheel

REMOVAL & INSTALLATION

Steering Column Without Air Bag

Ü See figure 79

Ä The following procedure requires the use of the GM Steering Wheel Puller tool No. J-1859-03 or equivalent.

1. Disconnect the negative battery cable.
2. Rotate the steering wheel so it is in the horizontal position.
3. If equipped with a horn cap, pry the cap from the center of the steering wheel. If equipped with a steering wheel shroud, remove the screw(s) from the rear of the steering wheel and remove the shroud.

   Ä If the horn cap or shroud is equipped with an electrical connector, disengage it.

4. Remove the steering wheel-to-steering shaft retainer (snapring) and nut.

   Ä Since the steering column is designed to collapse upon impact, it is recommended NEVER to hammer on it.

5. Match-mark the relationship of the steering wheel to the steering shaft in order to assure proper alignment upon installation.
6. Using the GM Steering Wheel Puller tool No. J-1859-03 or equivalent, press the steering wheel from the steering column.

   Ä Before installing the steering wheel, be sure the combination control switch is in the Neutral position. DO NOT misalign the steering wheel more than 1 in. (25mm) from the vertical centerline.

Figure 79.
Remove the steering wheel from the column using a suitable threaded puller

{ewc GSMVIMG,GSMVIMG, !88268G51.bmp}

88268G51

To install:

7. Install the steering wheel by aligning the match-marks and carefully pushing it onto the steering shaft splines.
8. Install the steering wheel-to-steering shaft nut and tighten to 30 ft. lbs. (41 Nm).
9. Connect the horn wire, then install the horn pad or shroud, as applicable.
10. Connect the negative battery cable and check operation.

Steering Column With Air Bag {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Suspension And Steering

Steering Column With Air Bag

EXCEPT 1996 MODELS

Ü See figure 80

1. Properly disable the SIR (air bag) system, then disconnect the negative battery cable. For details on disabling the air bag system, please refer to Section 6 of this manual.
2. Remove the SIR inflator module from the steering wheel:
    a. Remove the screws from the back of the steering wheel.
    b. Carefully lift the module away from the wheel, then push down and twist the horn contact lead to the right in order to remove it from the cam tower.
    c. Remove the Connector Position Assurance (CPA) retainer, then disengage the SIR wiring connector from the inflator module.
    d. Carefully remove the inflator module and position it aside in a safe place. MAKE SURE THE MODULE IS FACING UPWARD to leave space for air bag inflation should the unlikely event of an accidental deployment occur.

    Ä ALWAYS be very cautious when handling a live (undeployed) SIR module. Always leave room for air bag expansion should a deployment occur. This means it should always be placed face up, without ANYTHING on top of it. You should also carry it facing away from you for the same reason.
3. Loosen and remove the steering wheel retaining nut.
4. If applicable, disengage the horn lead assembly.
5. Match-mark the relationship of the wheel to the steering shaft. This is necessary to assure proper alignment upon installation.
6. Remove the wheel from the shaft using a suitable threaded steering wheel puller such as J-1859-03 or equivalent.

Figure 80.
Exploded view of the inflator module-to-steering wheel mounting-except 1996 models

{ewc GSMVIMG,GSMVIMG, !88268Gb9.bmp}

88268Gb9

To install:

7. Make sure the turn signal lever is in the neutral (no signal) position before attempting to install the steering wheel.
8. Slide the wheel onto the shaft splines while aligning the match-marks made earlier. DO NOT misalign the wheel more than 1 in. (25mm) from the horizontal centerline.
9. If applicable, engage the horn lead assembly.
10. Install the steering wheel retaining nut and tighten to 30 ft. lbs. (40 Nm).
11. Install the SIR inflator module
    a. Position the module at the steering wheel, then engage the SIR connector and install the CPA retainer.
    b. Position the SIR wires into the channel in the lower right portion of the steering wheel.
    c. Route the horn contact lead through the wheel and into the cam tower. Press the lead

into the tower and twist to the right (to the locked position).

d. Install the module to the steering wheel (starting with the top) while making sure NONE of the wires are pinched.

e. Install the retaining screws through the back of the module assembly and tighten to 70 inch lbs. (8 Nm).

12. Make sure the ignition is **OFF**, then connect the negative battery cable.

13. Properly enable the SIR system.

1996 MODELS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Suspension And Steering

1996 MODELS

Ü See figures 81, 82

1. Properly disable the SIR (air bag) system, then disconnect the negative battery cable. For details on disabling the air bag system, please refer to Section 6 of this manual.
2. Remove the SIR inflator module from the steering wheel:
    a. Turn the steering wheel 90 degrees to access the rear shroud hole for the inflator module.
    b. Carefully insert a screwdriver and push the leaf spring to release the pin.
    c. Turn the wheel 180 degrees to access the remaining rear shroud holes.
    d. Again, insert the screwdriver and push the leaf spring to release the pin.
    e. Tilt the module rearward from the top in order to access the wiring.
    f. Disconnect the lead wire from the clip on the inflator module and from the clip on the steering wheel.
    g. Remove the Connector Position Assurance (CPA) retainer from the module connector, then disengage the wiring.
    h. Carefully remove the inflator module and position it aside in a safe place. MAKE SURE THE MODULE IS FACING UPWARD to leave space for air bag inflation should the unlikely event of an accidental deployment occur.

    Ä ALWAYS be very cautious when handling a live (undeployed) SIR module. Always leave room for air bag expansion should a deployment occur. This means it should always be placed face up, without ANYTHING on top of it. You should also carry it facing away from you for the same reason.
3. Loosen and remove the steering wheel retaining nut.
4. If applicable, remove the horn plunger contact.
5. Match-mark the relationship of the wheel to the steering shaft. This is necessary to assure proper alignment upon installation.
6. Remove the wheel from the shaft using a suitable threaded steering wheel puller such as J-1859-A or equivalent.

Figure 81.
The inflator module is secured to the steering wheel using leaf springs and notched pins-1996 models

{ewc GSMVIMG,GSMVIMG, !88268Gc1.bmp}

88268Gc1

Figure 82.
Once the air bag is removed, steering wheel removal is much the same as it is for non-air bag models

{ewc GSMVIMG,GSMVIMG, !88268Gc2.bmp}

88268Gc2

To install:

7. Slide the wheel onto the shaft splines while aligning the match-marks made earlier. DO NOT misalign the wheel more than 1 in. (25mm) from the horizontal centerline.
8. If applicable, install the horn plunger contact.

9. Install the steering wheel retaining nut and tighten to 30 ft. lbs. (40 Nm).
10. Install the SIR inflator module
    a. Position the module at the steering wheel, then engage the SIR connector and install the CPA retainer.
    b. Secure the SIR lead wire to the clips on the steering wheel and the module.
    c. Install the module to the steering wheel by pressing it firmly into the wheel until all 4 notched pins are engaged in the leaf springs. DO NOT pinch the wires during this.
11. Make sure the ignition is **OFF**, then connect the negative battery cable.
12. Properly enable the SIR system.

Turn Signal Switch {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Turn Signal Switch

Ä When servicing any components on the steering column, should any fasteners require replacement, be sure to use only nuts and bolts of the same size and grade as the original fasteners. Using screws that are too long could prevent the column from collapsing during a collision.

REMOVAL & INSTALLATION

Steering Column Without Air Bag

Ü See figures 83, 84, 85

Ä The following procedure requires the use of the GM Lock Plate Compressor tool No. J-23653 or equivalent.

1. Disconnect the negative battery cable.
2. Refer to the Steering Wheel, Removal and Installation procedures in this section and remove the steering wheel.
3. If necessary, remove the steering column-to-lower instrument panel cover. Disengage the electrical harness connector from the steering column jacket (under the dash).
4. Using a small prytool, insert into the slots between the steering shaft lock plate cover and the steering column housing, then pry upward to remove the cover from the lock plate.
5. Using the GM Lock Plate Compressor tool No. J-23653-A or equivalent, screw the center shaft onto the steering shaft (as far as it will go), then screw the center post nut clockwise until the lock plate is compressed.
6. Using a small prybar, carefully pry the snapring from the steering shaft slot.

Ä If the steering column is being disassembled on a bench, the steering shaft will slide out of the mast jacket when the snapring is removed.

7. Remove the GM Lock Plate Compressor tool No. J-23653 or equivalent, and the lock plate.
8. Remove the multi-function lever-to-switch screw and the lever.
9. To remove the hazard warning switch, press the knob inward and unscrew it.
10. Remove the turn signal switch assembly-to-steering column screws.
11. Lift the turn signal switch assembly from the steering column, then slide the electrical connector through the column housing and the protector.

Ä If the steering column is the tilting type, position the steering housing into the Low position.

12. To remove the harness cover, pull it toward the lower end of the column; be careful not to damage the wires.
13. To remove the wire protector, grab the protector's tab with a pair of pliers, then pull the protector downward, out of the steering column.

Ä When assembling the steering column, use only fasteners of the correct length; overlength fasteners could prevent a portion of the assembly from compressing under impact.

Figure 83.
Compress the steering shaft locking plate using this special tool for access to the snapring

{ewc GSMVIMG,GSMVIMG, !88268G52.bmp}

88268G52

Figure 84.
Removing the turn signal wiring harness protective cover from the column

{ewc GSMVIMG,GSMVIMG, !88268G56.bmp}

88268G56

Figure 85.
Removing the turn signal switch from the column

{ewc GSMVIMG,GSMVIMG, !88268Gc3.bmp}

88268Gc3

To install:

14. Install the turn signal switch electrical connector:
    a. On the non-tilt columns, be sure the electrical connector is on the protector, then feed it and the cover down through the housing and under the mounting bracket.
    b. On the tilt columns, feed the electrical connector down through the housing and under the mounting bracket, then install the cover onto the housing.
15. Install the electrical connector to the clip on the jacket, the turn signal switch-to-steering column mounting screws, the lower instrument trim panel, the turn signal lever/screws and the hazard warning knob.

    Ä With the multi-function lever installed, place it into the Neutral position. With the hazard warning knob installed, pull it Outward.

16. Onto the upper end of the steering shaft, install the washer, the upper bearing preload spring, the canceling cam, the lock plate and a new retaining ring (snapring). Using the GM Lock Plate Compressor tool No. J-23653 or equivalent, compress the lock plate and slide the new retaining ring into the steering shaft groove.
17. Torque the multi-function switch-to-steering column screws to 35 inch lbs. (4 Nm) and the steering wheel nut to 30 ft. lbs. (41 Nm).
18. Connect the negative battery cable and check operation.

Steering Column With Air Bag {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Suspension And Steering

Steering Column With Air Bag

EXCEPT 1996 MODELS

Ü See figures 86, 87, 88, 89

1. Properly disable the SIR (air bag) system, then disconnect the negative battery cable. For details on disabling the air bag system, please refer to Section 6 of this manual.
2. Match-mark and remove the steering wheel.
3. Remove the SIR coil assembly retaining ring, then remove the coil assembly and allow it to hang freely from the wiring. Remove the wave washer.
4. Push downward on the shaft lock assembly until the snapring is exposed using the shaft lock compressor tool.
5. Remove the shaft lock retaining snapring, then carefully release the tool and remove the shaft lock from the column.
6. Remove the turn signal canceling cam assembly.
7. Remove the upper bearing spring, inner race seat and inner race.
8. Move the turn signal lever upward to the "Right Turn” position.
9. Remove the access cap and disengage the multi-function lever harness connector, then grasp the lever and pull it from the column.
10. Loosen and remove the hazard knob retaining screw, then remove the screw, button, spring and knob.
11. Remove the screw and the switch actuator arm.
12. Remove the turn signal switch retaining screws, then pull the switch forward and allow it to hang from the wires. If the switch is only being removed for access to other components, this may be sufficient.
13. If the switch is to be replaced, cut the wires near the top of the switch and discard the switch. Before cutting the wires, verify that the wire color codes are the same. Secure the connector of the new switch to the old wires, and pull the new harness down through the steering column while removing the old switch.
14. If the original switch is to be reused, attach a piece of wire or string around the connector and pull the harness up through the column, while pulling the string up through the column and leaving the string or wire in position to help with reinstallation later.
15. After freeing the switch wiring protector from its mounting, pull the turn signal switch straight up and remove the switch, switch harness, and the connector from the column.

    Ä On some vehicles access to the connector may be difficult. If necessary, remove the column support bracket assembly and properly support the column, and/or remove the wiring protectors.

Figure 86.
Exploded view of the SIR coil mounting in the upper steering column

{ewc GSMVIMG,GSMVIMG, !88268Gc4.bmp}

88268Gc4

Figure 87.
Use a shaft lock compressor tool to expose the shaft lock snapring (retaining ring)

{ewc GSMVIMG,GSMVIMG, !88268Gc5.bmp}

88268Gc5

Figure 88.
View of the turn signal switch and related component mounting in the upper steering column

{ewc GSMVIMG,GSMVIMG, !88268Gc6.bmp}

88268Gc6

Figure 89.
Centering the SIR coil assembly

{ewc GSMVIMG,GSMVIMG, !88268Gc7.bmp}

88268Gc7

To install:

16. Install the switch and wiring harness to the vehicle. If the switch was completely removed, use the length of mechanic's wire or string to pull the switch harness through the column, then engage the connector.

    Ä If the column support bracket or wiring protectors were removed, install them before proceeding.

17. Position the switch in the column and secure using the retaining screws.
18. Install the switch actuator arm and retaining screw.
19. Install the hazard knob assembly, then install the multi-function lever.
20. Install the inner race, upper bearing race seat and upper bearing spring.
21. Lubricate the turn signal canceling cam using a suitable synthetic grease (usually included in the service kit), then install the cam assembly.
22. Position the shaft lock and a new snapring, then use the lock compressor to hold the lock down while seating the new snapring. Make sure the ring is firmly seated in the groove, then carefully release the tool.

    Ä The coil assembly will become uncentered if the steering column is separated from the steering gear and allowed to rotate or if the centering spring is pushed down, letting the hub rotate while the coils assembly is removed from the steering column.

23. Make sure the coil is centered, then install the wave washer, followed by the coil and the retaining ring. The coil ring must be firmly seated in the shaft groove.
24. Align and install the steering wheel.
25. Make sure the ignition is **OFF**, then connect the negative battery cable.
26. Properly enable the SIR system.

1996 MODELS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Suspension And Steering

1996 MODELS

Instead of the long time used steering column found on most older GM vehicles the 1996 Astro and Safari vans are equipped with a new column that uses a multi-function combination switch mounted at the head of the column (below the steering wheel) and an upper/lower shroud assembly. The combination switch performs such functions as the wiper switch and the turn signal switch along with any other duties of the multi-function lever. For removal or installation of the multi-function switch assembly, please refer to the Combination Switch procedure found in this section.

Windshield Wiper Switch {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Windshield Wiper Switch

Ä When servicing any components on the steering column, should any fasteners require replacement, be sure to use only nuts and bolts of the same size and grade as the original fasteners. Using screws that are too long could prevent the column from collapsing during a collision.

REMOVAL & INSTALLATION

Steering Column Without Air Bag

1. Disconnect the negative battery cable.
2. Match-mark and remove the steering wheel.
3. If necessary for access, remove the steering column.

   Ä Although in some cases the components necessary to remove the wiper switch may be removed with the steering column installed in the vehicle, it is usually necessary to at least unbolt, lower and support the column.

4. Remove the turn signal switch.
5. Remove the lock cylinder assembly.
6. Remove the lock housing cover screws.
7. If applicable, remove the tilt lever.
8. Remove the lock housing cover assembly.
9. Except for vehicles with a floor shift, remove the column housing cover end cap (in some cases, this should be done along with the switch rod actuator), then remove the switch actuator pivot pin.
10. If necessary, unbolt the steering column support bracket from the column.
11. Disengage the wiper switch (pivot and pulse switch) connector from the wiring harness, then remove the wiring protector.
12. Attach a length of mechanic's wire to the switch connector, then carefully pull the harness through the column (from the top), leaving the wire in the column for assembly.
13. Remove the switch.

To install:

14. Install the switch to the lock housing cover assembly, then install the pivot pin.
15. Except for vehicles equipped with floor shift:
    a. Carefully pull the switch harness through the steering column using the mechanic's wire, then engage the connector to the harness.
    b. If applicable, install the column support bracket.
    c. Lubricate the dimmer switch rod actuator using lithium grease, then if removed, install the actuator to the column housing cover end cap.
    d. Install the end cap to the lock housing cover assembly. Make sure the bottom edge of the dimmer switch rod actuator is resting on the bend in the dimmer switch rod.
    e. Install the lock housing cover assembly, then secure using the retaining screws. Tighten the screw in the 12 o'clock position first, then the 8 o'clock position next and finally the screw in the 3 o'clock position.

16. On vehicles equipped with a floor shift:
    a. Install the gearshift bowl shroud to the floor shift lever bowl.
    b. Install the bowl with shroud to the steering column assembly, then secure using the 3 cross recess screws.
    c. Using the mechanic's wire, gently pull the wiper and turn signal switch wiring through the column.
    d. Install the upper bearing retainer, then install the lock housing cover assembly to the jacket. Finger-tighten the cover screws in a clockwise pattern, then tighten the screws to 47 inch lbs. (5.3 Nm).
    e. Install the wiring protectors and the support bracket.
17. Install the lock cylinder assembly.
18. Install the turn signal switch.
19. If removed or lowered, position and secure the steering column.
20. Align and install the steering wheel.
21. Connect the negative battery cable.

Steering Column With Air Bag {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Suspension And Steering

Steering Column With Air Bag

EXCEPT 1996 MODELS

1. Properly disable the SIR (air bag) system, then disconnect the negative battery cable. For details on disabling the air bag system, please refer to Section 6 of this manual.
2. Match-mark and remove the steering wheel.

   Ä Although in some cases the components necessary to remove the wiper switch may be removed with the steering column installed in the vehicle, it is usually necessary to at least unbolt, lower and support the column.
3. Remove the turn signal switch.
4. Remove the lock cylinder assembly.
5. Remove the lock housing cover screws.
6. If applicable, remove the tilt lever.
7. Remove the lock housing cover assembly.
8. Remove the column housing cover end cap (in some cases, this should be done along with the switch rod actuator), then remove the switch actuator pivot pin.
9. If necessary, unbolt the steering column support bracket from the column.
10. Disengage the wiper switch (pivot and pulse switch) connector from the wiring harness, then remove the wiring protector.
11. Attach a length of mechanic's wire to the switch connector, then carefully pull the harness through the column (from the top), leaving the wire in the column for assembly.
12. Remove the switch.

To install:

13. Install the switch to the lock housing cover assembly, then install the pivot pin.
14. Carefully pull the switch harness through the steering column using the mechanic's wire, then engage the connector to the harness.
15. If applicable, install the column support bracket.
16. Lubricate the dimmer switch rod actuator using lithium grease, then if removed, install the actuator to the column housing cover end cap.
17. Install the end cap to the lock housing cover assembly. Make sure the bottom edge of the dimmer switch rod actuator is resting on the bend in the dimmer switch rod.
18. Install the lock housing cover assembly, then secure using the retaining screws. Tighten the screw in the 12 o'clock position first, then the 8 o'clock position next and finally the screw in the 3 o'clock position.
19. Install the lock cylinder assembly.
20. Install the turn signal switch.
21. If removed or lowered, position and secure the steering column.
22. Align and install the steering wheel.
23. Make sure the ignition is **OFF**, then connect the negative battery cable.
24. Properly enable the SIR system.

1996 MODELS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Suspension And Steering

1996 MODELS

These vehicles use a combination switch assembly instead of a separate switch mounted in the column. For more details, please refer to the Combination Switch procedure found later in this section.

Combination Switch {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Combination Switch

Instead of the long time used steering column found on most older GM vehicles the 1996 Astro and Safari vans are equipped with a new column that uses a multi-function combination switch mounted at the head of the column (below the steering wheel) and an upper/lower shroud assembly. The combination switch performs such functions as the wiper switch and the turn signal switch along with any other duties of the multi-function lever.

Ä When servicing any components on the steering column, should any fasteners require replacement, be sure to use only nuts and bolts of the same size and grade as the original fasteners. Using screws that are too long could prevent the column from collapsing during a collision.

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REMOVAL & INSTALLATION

Ü See figures 90, 91

> **Ä Removal of the SIR coil is not necessary during this procedure. Avoid removing the coil and make sure the steering column, if disconnected from the gear, is not allowed to rotate excessively. This is to prevent uncentering and damaging the coil. Should the coil become uncentered, it must be removed, centered and repositioned on the steering column.**

1. Properly disable the SIR (air bag) system, then disconnect the negative battery cable. For details on disabling the air bag system, please refer to Section 6 of this manual.
2. Match-mark and remove the steering wheel from the column. For details, please refer to the procedure earlier in this section.
3. Either lower the steering column from the instrument panel for access or unbolt and remove the column. If the column is removed, prevent it from rotating so the SIR coil does not become uncentered.
4. If applicable, remove the tilt lever by pulling outward.
5. Remove the 2 Torx screws or pan head tapping screws (as applicable) from the lower column shroud, then tilt the shroud down and slide it back to disengage the locking tabs. Remove the lower shroud.
6. Remove the 2 Torx head screws from the upper shroud.
7. Lift the upper shroud for access to the lock cylinder hole. Hold the key in the **START** position and use a $^{1}/16$ in. Allen wrench to push on the lock cylinder retaining pin.
8. Release the key to the **RUN** position and pull the steering column lock cylinder set from the lock module assembly. Remove the upper shroud.
9. If necessary, remove the shift lever clevis, then remove the lever.
10. Remove the wiring harness straps (noting the positioning for installation purposes), then disengage the steering column bulkhead connector from the vehicle wiring harness.
11. Disengage the gray and black connectors for the multi-function combination switch from the column bulkhead connector.
12. Remove the 2 Torx switch retaining screws, then remove the switch from the steering column.

Figure 90.
Exploded view of the combination switch assembly mounting-1996 vehicles only

{ewc GSMVIMG,GSMVIMG, !88268Gc8.bmp}

88268Gc8

Figure 91.
The SIR coil MUST be centered if it is allowed to uncenter (unwind) during steering column service

{ewc GSMVIMG,GSMVIMG, !88268Gc9.bmp}

88268Gc9

To install:

13. Position the multi-function switch assembly, then use a suitable small bladed tool to compress the electrical contact while moving the switch into position. Make sure the electrical contact rests on the canceling cam assembly.

14. Install the switch retaining screws and tighten to 53 inch lbs. (6.0 Nm).
15. Engage the gray and black multi-function switch connectors to the column bulkhead connector.
16. Install the wiring harness straps as noted during removal.
17. If removed, install the shift lever and secure the clevis.
18. Position the shift lever and multi-function lever seals to ease installation of the upper and lower shrouds.
19. Install the upper shroud and lock cylinder. With the key installed to the lock cylinder and turned to the **RUN** position, make sure the sector in the lock module is also in this position.
20. Install the lock cylinder to the upper shroud, then align the locking tab and positioning tab with the slots in the lock module assembly. With the tabs aligned, carefully push the cylinder into position.
21. Install the upper shroud Torx head retaining screws and tighten to 12 inch lbs. (1.4 Nm).
22. Install the lower shroud, making sure the slots on the shroud engage with the upper shroud tabs. Tilt the lower shroud upward and snap the shrouds together.
23. Install the 2 lower shroud pan head or Torx head retaining screws and tighten to 53 inch lbs. (6.0 Nm).
24. Move the shift and multi-function lever seals into position.
25. If removed, install the tilt lever by aligning and pushing inward.
26. Position and secure the steering column.
27. Align and install the steering wheel.
28. Make sure the ignition is **OFF**, then connect the negative battery cable.
29. Properly enable the SIR system.

Ignition Switch {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Ignition Switch

For anti-theft reasons, on all models covered by this manual, the ignition switch is located where access is difficult. On all except 1996 vehicles, the switch is located inside the channel section of the brake pedal support and is completely inaccessible without first lowering the steering column. The switch is actuated by a rod and rack assembly. A gear on the end of the lock cylinder engages the toothed upper end of the actuator rod.

For 1996, the redesigned steering column relocated the ignition switch up the column, under the upper shroud and attached to the lock cylinder housing assembly. Although access is arguably easier here than in the channel of earlier columns, it still requires some effort.

Ä When servicing any components on the steering column, should any fasteners require replacement, be sure to use only nuts and bolts of the same size and grade as the original fasteners. Using screws that are too long could prevent the column from collapsing during a collision.

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REMOVAL & INSTALLATION

Steering Column Without Air Bag

Ü See figures 92, 93

1. Disconnect the negative battery cable. Remove the lower instrument panel-to-steering column cover. Remove the steering column-to-dash bolts and lower the steering column; be sure to properly support it.
2. Place the ignition switch in the **Locked** position.

   Ä If the lock cylinder was removed, the actuating rod should be pulled up until it stops, then moved down 1 detent; the switch is now in the Lock position.

3. Remove the 2 ignition switch-to-steering column screws and the switch assembly.

Figure 92.
Common early-model style ignition switch-NOTE proper switch position for installation

{ewc GSMVIMG,GSMVIMG, !88268G57.bmp}

88268G57

Figure 93.
Another common ignition switch found on GM steering columns-again finding the LOCK position is critical to assure proper adjustment during installation

{ewc GSMVIMG,GSMVIMG, !88268Gd1.bmp}

88268Gd1

To install:

4. Before installing the ignition switch, place it in the **Locked** position, then make sure the lock cylinder and actuating rod are in the **Locked** position (1st detent from the top).
5. Install the activating rod into the ignition switch and assemble the switch onto the steering column. Torque the ignition switch-to-steering column screws to 35 inch lbs. (4 Nm).

   Ä When installing the ignition switch, use only the specified screws since overlength screws could impair the collapsibility of the column.

6. Install the steering column and the lower instrument panel cover. Torque the steering column-to-instrument bolts to 22 ft. lbs. (30 Nm).
7. Connect the negative battery cable and check for proper operation.

Steering Column With Air Bag {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Steering Column With Air Bag

EXCEPT 1996 MODELS

Ü See figure 94

1. Properly disable the SIR (air bag) system, then disconnect the negative battery cable. For details on disabling the air bag system, please refer to Section 6 of this manual.
2. Remove the lower column trim panel, then remove the steering column-to-instrument panel fasteners and carefully lower the column for access to the switch.
3. On some vehicles, the dimmer switch must be removed in order to remove the ignition switch. If necessary, remove the dimmer switch.
4. Place the ignition switch in the **OFF-LOCK** position.

   Ä If the lock cylinder was removed, the switch slider should be moved to the extreme left position, then 1 detent to the right.
5. Remove the ignition switch-to-steering column retainers and disengage the switch wiring, then remove the assembly.

Figure 94.
Before installation, make sure the switch is in the OFF-LOCK position-a drill bit can be used to hold the switch in this position during installation

{ewc GSMVIMG,GSMVIMG, !88268Gd2.bmp}

88268Gd2

To install:

6. Before installing the ignition switch, place it in the **OFF-LOCK** position, then make sure the lock cylinder and actuating rod are in the **Locked** position (1st detent from the top or 1st detent to the right of far left detent travel).

   Ä Most replacement switches are pinned in the OFF-LOCK position for installation purposes. If so, the pins must be removed after installation or damage may occur. You can make your own pin by insert a $^{3}/32$ in. drill bit into the adjustment hole provided in the switch in order to limit switch travel. Just remember to remove the bit before attempting to place the switch in service.
7. Install the activating rod into the ignition switch and assemble the switch onto the steering column. Once the switch is properly positioned, tighten the ignition switch-to-steering column retainers to 35 inch lbs. (4.0 Nm).

   Ä When installing the ignition switch, use only the specified screws since over length screws could impair the collapsibility of the column.
8. If removed, install the dimmer switch.
9. Raise the column into position and secure, then install any necessary trim plates.
10. Make sure the ignition is **OFF**, then connect the negative battery cable.
11. Properly enable the SIR system.

1996 MODELS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

1996 MODELS

Ü See figures 95, 96

1. Properly disable the SIR (air bag) system, then disconnect the negative battery cable. For details on disabling the air bag system, please refer to Section 6 of this manual.
2. Either lower the steering column from the instrument panel for access or unbolt and remove the column. If the column is removed, prevent it from rotating so the SIR coil does not become uncentered.
3. Remove the combination switch from the steering column.
4. If equipped, remove the alarm switch from the lock module assembly by gently prying the retaining clip on the alarm switch using a small blade prytool. Then, rotate the alarm switch 1/4 turn and remove
5. Remove the 2 ignition switch self-tapping retaining screws.
6. Disengage the connector, then remove the wiring harness from the slot in the steering column. Remove the ignition and key alarm switch.

Figure 95.
Use a small bladed prytool or screwdriver to gently release the retaining clip on the key alarm

{ewc GSMVIMG,GSMVIMG, !88268Gd3.bmp}

88268Gd3

Figure 96.
Exploded view of the ignition switch and key alarm assembly

{ewc GSMVIMG,GSMVIMG, !88268Gd4.bmp}

88268Gd4

To install:

7. Position the switch to the column. Route the wire harness through the slot in the column housing assembly. Secure the harness using a wire strap through the hole located in the bottom of the housing assembly.
8. Install the switch retaining screws and tighten to 12 inch lbs. (1.4 Nm) in order to secure the switch.
9. If applicable, install the alarm switch to the lock module assembly by aligning the switch (with the retaining clip) parallel to the lock cylinder, then rotating the switch 1/4 turn until locked in place.
10. Install the combination switch to the steering column.
11. Position and secure the steering column.
12. Make sure the ignition is **OFF**, then connect the negative battery cable.
13. Properly enable the SIR system.

Dimmer Switch {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Dimmer Switch

Ä When servicing any components on the steering column, should any fasteners require replacement, be sure to use only nuts and bolts of the same size and grade as the original fasteners. Using screws that are too long could prevent the column from collapsing during a collision.

REMOVAL & INSTALLATION

Except 1996 Models

Ü See figure 97

1. If equipped, properly disable the SIR (air bag) system. For details on disabling the air bag system, please refer to Section 6 of this manual.
2. Disconnect the negative battery cable.
3. If equipped, remove the lower column trim panel.
4. Remove the steering column-to-instrument panel fasteners and lower the column for access to the switch. Extreme care is necessary to prevent damage to the collapsible column.
5. On some vehicles it may be necessary to remove the steering wheel in order to fully lower the column. If equipped with a tilt column, position the column in the upper most position for additional lowering clearance.

   Ä If the ignition switch shares fasteners with the dimmer switch it may be necessary to remove it first.

6. Remove the dimmer switch-to-steering column retainers, then remove the switch from the column. Disengage the switch wiring and remove it.

Figure 97.
A drill bit should be used to limit switch travel and aid in dimmer switch adjustment

{ewc GSMVIMG,GSMVIMG, !88268Gd5.bmp}

88268Gd5

To install:

7. Position the switch to the column and loosely install the retainers.
8. Insert a $^{3}/32$ in. drill bit into the adjustment hole provided in the switch in order to limit switch travel, then push the switch up against the actuator rod in order to remove lash.
9. Tighten the switch retainers, then remove the drill bit.
10. Engage the switch wiring.
11. If removed for access, install the ignition switch.
12. Raise the column into position and secure, then install any necessary trim plates.
13. If removed install the steering wheel.
14. Make sure the ignition is **OFF**, then connect the negative battery cable.
15. If equipped, properly enable the SIR system.

1996 Models

Instead of the long time used steering column found on most older GM vehicles the 1996 Astro and Safari vans are equipped with a new column that uses a multi-function combination switch mounted at the head of the column (below the steering wheel) and an upper/lower shroud assembly. The combination switch performs such functions as the wiper switch and the turn signal switch along with any other duties of the multi-function lever. For removal or installation of the multi-function switch assembly, please refer to the Combination Switch procedure found in this section.

Ignition Lock Cylinder {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Ignition Lock Cylinder

Ä When servicing any components on the steering column, should any fasteners require replacement, be sure to use only nuts and bolts of the same size and grade as the original fasteners. Using screws that are too long could prevent the column from collapsing during a collision.

REMOVAL & INSTALLATION

Steering Columns Without Air Bag

Ü See figure 98

1. Disconnect the negative battery cable.
2. Refer to the Turn Signal Switch, Removal and Installation procedures in this section and remove the turn signal switch.
3. Place the lock cylinder in the **RUN** position.
4. Remove the buzzer switch, the lock cylinder screw and the lock cylinder.

****Caution**
If the screw is dropped upon removal, it could fall into the steering column, requiring complete disassembly to retrieve the screw.

To install:

5. Rotate the lock cylinder clockwise to align the cylinder key with the keyway in the housing.
6. Push the lock cylinder all the way in.
7. Install the cylinder lock-to-housing screw. Tighten the screw to 14 inch lbs. (1.6 Nm).
8. Connect the negative battery cable and check operation.

Figure 98.
Exploded view of the lock cylinder mounting-early-model shown (late-model, except 1996, similar)

{ewc GSMVIMG,GSMVIMG, !88268G58.bmp}

88268G58

Steering Column With Air Bag {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Suspension And Steering

Steering Column With Air Bag

EXCEPT 1996 MODELS

Ü See figure 98

1. Properly disable the SIR (air bag) system, then disconnect the negative battery cable. For details on disabling the air bag system, please refer to Section 6 of this manual.
2. Match-mark and remove the steering wheel.
3. Remove the SIR coil assembly retaining ring, then remove the coil assembly and allow it to hang freely from the wiring. Remove the wave washer.

   Ä On some SIR equipped vehicles, it may be necessary to completely remove the coil and wiring from the steering column before removing the lock cylinder assembly. If so, attach a length of mechanic's wire to the coil connector at the base of the column, then carefully pull the harness and wire through the steering column towards the top. Leave the wire in position inside the column in order to pull the harness back down into position during installation.
4. Remove the turn signal switch from the column and allow it to hang from the wires (leaving them connected).
5. Remove the buzzer switch assembly. On some vehicles it may be necessary to temporarily remove the key from the lock cylinder in order to remove the buzzer. If so, the key should be reinserted before the next step.
6. Carefully remove the lock cylinder screw and the lock cylinder. If possible, use a magnetic tipped screwdriver on the screw in order to help prevent the possibility of dropping it.

   ****Caution**
   If the screw is dropped upon removal, it could fall into the steering column, requiring complete disassembly in order to retrieve the screw and prevent damage.

To install:

7. Align and install the lock cylinder set.
8. Push the lock cylinder all the way in, then carefully install the retaining screw. Tighten the screw to 22 inch lbs. (2.5 Nm) on tilt columns or to 40 inch lbs. (4.5 Nm) on standard non-tilt columns.
9. If necessary, install the buzzer switch assembly.
10. Reposition and secure the turn signal switch assembly

    Ä The coil assembly will become uncentered if the steering column is separated from the steering gear and allowed to rotate or if the centering spring is pushed down, letting the hub rotate while the coils assembly is removed from the steering column.
11. Make sure the coil is centered, then install the wave washer, followed by the coil and the retaining ring. The coil ring must be firmly seated in the shaft groove.
12. Align and install the steering wheel.
13. Make sure the ignition is **OFF**, then connect the negative battery cable.
14. Properly enable the SIR system.

1996 MODELS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Suspension And Steering

1996 MODELS

Ü See figures 99, 100

1. Properly disable the SIR (air bag) system, then disconnect the negative battery cable. For details on disabling the air bag system, please refer to Section 6 of this manual.
2. Either lower the steering column from the instrument panel for access or unbolt and remove the column. If the column is removed, prevent it from rotating so the SIR coil does not become uncentered.
3. If applicable, remove the tilt lever by pulling outward.
4. Remove the 2 pan head tapping screws from the lower column shroud, then tilt the shroud down and slide it back to disengage the locking tabs. Remove the lower shroud.
5. Remove the 2 Torx head screws from the upper shroud.
6. Lift the upper shroud for access to the lock cylinder hole. Hold the key in the **START** position and use a $^{1}/16$ in. Allen wrench to push on the lock cylinder retaining pin.
7. Release the key to the **RUN** position and pull the steering column lock cylinder set from the lock module assembly. Remove the upper shroud.

Figure 99.
Lock cylinder and upper shroud removal

{ewc GSMVIMG,GSMVIMG, !88268Gd6.bmp}

88268Gd6

Figure 100.
During installation, make sure the tab on the lock cylinder and the sector in the cylinder module assembly are aligned

{ewc GSMVIMG,GSMVIMG, !88268Gd7.bmp}

88268Gd7

To install:

8. Install the upper shroud and lock cylinder. With the key installed to the lock cylinder and turned to the **RUN** position, make sure the sector in the lock module is also in this position.
9. Install the lock cylinder to the upper shroud, then align the locking tab and positioning tab with the slots in the lock module assembly. With the tabs aligned, carefully push the cylinder into position.
10. Install the upper shroud Torx head retaining screws and tighten to 12 inch lbs. (1.4 Nm).
11. Install the lower shroud, making sure the slots on the shroud engage with the upper shroud tabs. Tilt the lower shroud upward and snap the shrouds together.
12. Install the 2 lower shroud pan head retaining screws and tighten to 53 inch lbs. (6.0 Nm).
13. Move the shift and multi-function lever seals into position.
14. If applicable, install the tilt lever by aligning and pushing inward.
15. Position and secure the steering column.
16. Make sure the ignition is **OFF**, then connect the negative battery cable.
17. Properly enable the SIR system.

Steering Column

REMOVAL & INSTALLATION

Ä Care should be used ANYTIME the steering column is serviced. Because of the column's collapsible design, it is quite susceptible to damage once it is removed from the vehicle. Leaning on, dropping or jarring the column could shear or loosen the plastic fasteners that maintain column rigidity.

****Warning**

On steering columns equipped with an air bag, extra caution must be used to keep the system from sustaining damage during column service. If the column is removed from the vehicle, but the SIR coil assembly is still installed, DO NOT ROTATE the steering shaft. Excessive rotation could destroy the SIR coil.

Except 1996 Models {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Except 1996 Models

Ü See figures 101, 102

1. If equipped with SIR (air bag) properly disable the system, then disconnect the negative battery cable.
2. Match-mark and remove the steering wheel from the steering column. For details, please refer to the procedures found earlier in this section.
3. If equipped with a column shift, disconnect the transmission control linkage from the column shift tube levers.
4. From inside the engine compartment, remove the intermediate shaft-to-steering column shaft pinch bolt.

   Ä Before separating the intermediate shaft from the steering column shaft, match-mark the relationship of the 2 shafts.
5. Remove the lower instrument panel-to-steering column cover, the steering column bracket-to-dash nuts/bolts (support the steering column) and the steering column-to-firewall cover (if necessary).
6. From under the dash, disengage the electrical harness connectors from the steering column.

   Ä Some models are equipped with a back-up light switch and a neutral/start switch. Be sure to disengage the wiring connectors from them.
7. Remove the steering column from the vehicle.

   Ä If equipped with a column shifter, rotate the steering column so the shift lever clears the dash opening.

Figure 101.
Exploded view of the steering column mounting-except 1996 models
{ewc GSMVIMG,GSMVIMG, !88268G59.bmp}

88268G59

Figure 102.
Intermediate shaft with Cardan joint
{ewc GSMVIMG,GSMVIMG, !88268G60.bmp}

88268G60

To install:

8. Carefully position the column in the vehicle.
9. Align the match-marks of the steering column shaft and the intermediate shaft, tighten the fasteners finger-tight.

   Ä Make sure the Cardan joint (intermediate shaft) operating angle is between 34-39º. For clarification, please refer to the accompanying illustration.
10. Tighten the intermediate shaft-to-steering column shaft pinch bolt to 30 ft. lbs. (41 Nm), the steering column bracket-to-dash nuts to 25 ft. lbs. (34 Nm) and the steering column-to-firewall screws to 7 ft. lbs. (10 Nm).
11. Engage the electrical harness-to-steering column connectors.
12. Align and install the steering wheel.
13. If equipped, connect the shift linkage.

14. Make sure the ignition is **OFF**, then connect the negative battery cable.
15. Properly enable the SIR system.

1996 Models {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Suspension And Steering

1996 Models

Ü See figures 103, 104

1. Set the front wheels to the straight-ahead position and lock the steering column using the ignition lock cylinder.
2. If equipped with SIR (air bag) properly disable the system, then disconnect the negative battery cable.
3. Remove the driver's knee bolster from the lower portion of the instrument panel, then remove the knee bolster deflector.
4. Disconnect the transmission control linkage from the column shift lever.
5. Disengage the column wiring. To do this you will have to unbolt the 48-way connector at the base of the column.
6. Match-mark and remove the steering wheel from the steering column. For details, please refer to the procedures found earlier in this section.
7. Match-mark the intermediate shaft to the steering column shaft to ensure proper installation, then remove the pinch bolt and separate the 2 shafts.
8. Remove the 2 lower column mounting nuts, then support the column and remove the upper mounting nuts.
9. Remove the column assembly from the vehicle, taking care to avoid any sudden shock which could damage the column.

Figure 103.
Exploded view of the steering column mounting-1996 vehicles
{ewc GSMVIMG,GSMVIMG, !88268Gd8.bmp}

88268Gd8

Figure 104.
Measuring the intermediate shaft angles
{ewc GSMVIMG,GSMVIMG, !88268Gd9.bmp}

88268Gd9

To install:

10. Carefully position the column assembly through the cowl opening and onto the 2 lower studs.
11. Raise the column into position, then loosely install the 2 upper column mounting nuts.
12. Install the lower column mounting nuts, then tighten the lower and upper mounting nuts to 22 ft. lbs. (30 Nm).
13. Align and install the intermediate shaft to the steering shaft, then install the pinch bolt and tighten to 30 ft. lbs. (41 Nm). Measure the intermediate shaft angle (it must be 38-40º).
14. Connect the transmission shift control linkage to the shift lever.
15. Align and install the steering wheel.
16. Engage the steering column wiring to the instrument panel wiring harness. Install the bolt securing the 48-way connector.
17. Make sure the ignition is **OFF**, then connect the negative battery cable.
18. Properly enable the SIR system.
19. Make sure the ignition is **OFF**, then install the knee bolster deflector and the knee bolster.

Steering Linkage {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Steering Linkage

Ü See figures 105, 106

The steering linkage consists of: a forward mounted linkage (parallelogram type), crimp (or torque prevailing) nuts at the inner pivots, castellated nuts at the steering knuckle arm, a second idler arm and steering gear pitman arm-to-relay rod connecting rod to maintain proper geometry, and a steering damper (some manual steering models). Each joint is equipped with a grease fitting, for durability.

Figure 105.
Exploded view of the 2 wheel drive steering linkage assembly

{ewc GSMVIMG,GSMVIMG, !88268G62.bmp}

88268G62

Figure 106.
All Wheel Drive (AWD) steering linkage assembly

{ewc GSMVIMG,GSMVIMG, !88268Ge1.bmp}

88268Ge1

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Suspension And Steering

REMOVAL & INSTALLATION

Ü See figures 107, 108, 109, 110, 111

Pitman Arm

Ü See figure 112

Ä The following procedure requires the use of a universal steering linkage puller such as J-24319-B, the GM Pitman Arm Remover tool No. J-29107 or equivalent, and the GM Steering Linkage Installer tool No. J-29193 (12mm) for most models or J-29194 (14mm) for some early models (or equivalent).

1. Raise and support the front of the vehicle safely using jackstands.
2. Disconnect the nut from the pitman arm ball joint stud.
3. Using a universal steering linkage puller (such as J-24319-B or equivalent), separate the connecting rod from the pitman arm. Pull down on the connecting rod and separate it from the stud.
4. Remove the pitman arm-to-pitman shaft nut and washer, then match-mark the relationship of the arm to the shaft (this will permit proper alignment during assembly).
5. Separate the pitman arm from the pitman shaft using J-29107, or an equivalent pitman arm removal tool.

Ä When separating the pitman arm from the shaft, DO NOT use a hammer or apply heat to the arm.

To install:

6. Align the pitman arm-to-pitman shaft match-mark, then install the washer along with a prevailing torque nut. Tighten the pitman arm-to-pitman shaft nut to 185 ft. lbs. (250 Nm).
7. Connect the pitman arm to the connecting rod ball stud (make sure the seal is on the stud). Position a steering linkage installer tool such as J-29193 (12mm) for most models or J-29194 (14mm) for some early models, onto the ball stud. Tighten the installer tool to 40 ft. lbs. (54 Nm) to seat the tapers; after seating, remove the tool.
8. Install the pitman arm-to-connecting rod ball joint nut, then tighten the ball joint nut to 35 ft. lbs. (47 Nm).
9. Remove the jackstands, then carefully lower the vehicle.

Figure 107.
These special tools are used to seat linkage shaft tapers during installation

{ewc GSMVIMG,GSMVIMG, !88268G61.bmp}

88268G61

Figure 108.
A universal steering linkage puller is necessary for almost all linkage replacement procedures

{ewc GSMVIMG,GSMVIMG, !88268Ge2.bmp}

88268Ge2

Figure 109.
Most steering linkage components are removed by first loosening and removing the nut . . .

{ewc GSMVIMG,GSMVIMG, !88268p18.bmp}

88268p18

Figure 110.
. . . then using a universal steering linkage puller to loosen the stud

{ewc GSMVIMG,GSMVIMG, !88268p19.bmp}

88268p19

Figure 111.
Once the stud is freed, separate the linkage

{ewc GSMVIMG,GSMVIMG, !88268p20.bmp}

88268p20

Figure 112.
Pitman arm removal requires the use of this special tool

{ewc GSMVIMG,GSMVIMG, !88268Ge4.bmp}

88268Ge4

Idler Arm {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Idler Arm

Ü See figures 113, 114, 115, 116

Ä The following procedure requires the use of a universal steering linkage puller such as J-24319-B, and the GM Steering Linkage Installer tool No. J-29193 (12mm) for most models or J-29194 (14mm) for some early models (or equivalent).

1. Raise and support the front of the vehicle safely using jackstands.

   Ä Jerking the right wheel assembly back and forth is not an acceptable testing procedure; there is no control on the amount of force being applied to the idler arm. Before suspecting idler arm shimmying complaints, check the wheels for imbalance, runout, force variation and/or road surface irregularities.

2. To inspect for a defective idler arm, perform the following procedures:
   a. Position the wheels in the straight-ahead position.
   b. Position a spring scale near the relay rod end of the idler arm and exert 25 lbs. (110 N) of force upward, then downward.
   c. Measure the distance between the upward and downward directions that the idler arm moves. The allowable deflection is 1/8 in. (3.2mm) for each direction; a total difference of 1/4 in. (6.4mm). If the idler arm deflection is beyond the allowable limits, replace it.
3. Remove the idler arm-to-frame bolts.
4. Remove the idler arm-to-relay rod ball joint nut.
5. Using a universal steering linkage puller tool (such as J-24319-B or equivalent), separate the relay rod from the ball joint stud.
6. Inspect and/or replace (if necessary) the idler arm.

Figure 113.
Idler arm inspection should be conducted using a spring scale
{ewc GSMVIMG,GSMVIMG, !88268G63.bmp}

88268G63

Figure 114.
Loosen and remove the idler arm-to-frame mounting bolts . . .
{ewc GSMVIMG,GSMVIMG, !88268p21.bmp}

88268p21

Figure 115.
. . . then separate the idler ball stud from the relay rod . . .
{ewc GSMVIMG,GSMVIMG, !88268p22.bmp}

88268p22

Figure 116.
. . . and remove the idler arm from the vehicle
{ewc GSMVIMG,GSMVIMG, !88268p23.bmp}

88268p23

To install:

7. Install the idler arm-to-frame bolts and tighten to 52 ft. lbs. (70 Nm) for all 1985-91 vehicles, 78 ft. lbs. (105 Nm) for 1992-95 vehicles (except 1992-93 AWD vehicles which should be tightened to 102 ft. lbs. using Loctite® on the threads) or to 102 ft. lbs. (138 Nm) for 1996

vehicles.

8. Connect the relay rod to the idler arm ball joint stud. Using the proper sized GM Steering Linkage Installer tool (either No. J-29193/12mm for most models or J-29194/14mm for some early models), seat the relay rod-to-idler arm ball joint stud. Tighten the tool to 40 ft. lbs. (54 Nm) in order to fully seat the taper, then remove the tool.
9. Install the idler arm-to-relay rod stud nut and torque it to 35 ft. lbs. (47 Nm).
10. Remove the jackstands and carefully lower the vehicle.
11. Check and adjust the front end toe-in, as necessary.

Relay Rod {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Relay Rod

Ä The following procedure requires the use of a universal steering linkage puller such as J-24319-B, and the GM Steering Linkage Installer tool No. J-29193 (12mm) for most models or J-29194 (14mm) for some early models (or equivalent).

1. Raise and support the front of the vehicle safely using jackstands.
2. Refer to the Tie Rod, Removal and Installation procedures in this section and disconnect the inner tie rod ends from the relay rod.
3. Remove the connecting rod stud-to-relay rod nut and the idler arm stud-to-relay rod nuts.
4. Using the universal steering linkage puller, disconnect the connecting rod from the relay rod.
5. Using the universal steering linkage puller, disconnect the relay rod from the idler arms, then remove the relay rod from the vehicle.

To install:

6. Clean and inspect the threads on the tie rod, the tie rod ends and the ball joints for damage, then replace them (if necessary). Inspect the ball joint seals for excessive wear, then replace them (if necessary).
7. Position the relay rod onto the idler arms (no mounting nuts). Thread the GM Steering Linkage Installer tool No. J-29193 (12mm) or J-29194 (14mm) or equivalent, onto the idler arm studs. Tighten the tool to 40 ft. lbs. (54 Nm) in order to seat the tapers. Remove the installer tool, then install the mounting nuts and torque the idler arm-to-relay arm stud nuts to 35 ft. lbs. (47 Nm).
8. Position the connecting rod onto the relay rod (no mounting nut). Thread the proper steering linkage Installer tool onto the connecting rod stud, then tighten to 40 ft. lbs. (54 Nm) to seat the taper. Remove the installer tool, then install the mounting nuts and torque the connecting rod-to-relay rod stud nuts to 35 ft. lbs. (47 Nm).
9. Position the inner tie rod ball joints onto the relay rod (no mounting nuts). Thread the proper steering linkage installer tool onto the tie rod studs and tighten to 40 ft. lbs. (54 Nm) to seat the tapers. Remove the installer tool, then install the mounting nuts and torque the tie rod-to-relay rod stud nuts to 35 ft. lbs. (47 Nm).
10. Remove the jackstands and carefully lower the vehicle. Check the steering linkage performance.
11. Check and adjust the front end toe-in, as necessary.

Connecting Rod {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Connecting Rod

Ä The following procedure requires the use of a universal steering linkage puller such as J-24319-B, and the GM Steering Linkage Installer tool No. J-29193 (12mm) for most models or J-29194 (14mm) for some early models (or equivalent).

1. Raise and support the front of the vehicle safely using jackstands.
2. Remove the connecting rod stud-to-relay rod nut and the connecting rod stud-to-pitman arm nut.
3. Using the universal steering linkage puller, separate the connecting rod from the relay rod and the pitman arm, then remove the connecting rod from the vehicle.
4. Clean and inspect the ball joint threads for damage, then replace the rod (if necessary). Inspect the ball joint seals for excessive wear, then replace them (if necessary).

To install:

5. Position the connecting rod onto the relay rod and the pitman arm (no mounting nuts). Thread the steering linkage installer tool onto the connecting rod studs, then tighten to 40 ft. lbs. (54 Nm) to seat the tapers. Remove the installer tools, then install the mounting nuts and torque them to 35 ft. lbs. (47 Nm).
6. Remove the jackstands and carefully lower the vehicle. Check the steering linkage performance.
7. Check and adjust the front end toe-in, as necessary.

Tie Rod {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Suspension And Steering

Tie Rod

Ü See figures 117, 118, 119, 120, 121, 122, 123, 124, 125

> **Ä The following procedure requires the use of a universal steering linkage puller such as J-24319-B, the GM Wheel Stud and Tie Rod Remover tool No. J-6627-A or equivalent, and the GM Steering Linkage Installer tool No. J-29193 (12mm) for most models or J-29194 (14mm) for some early models (or equivalent).**

1. Raise and support the front of the vehicle safely using jackstands.
2. Remove the cotter pin from the tie rod-to-steering knuckle stud.
3. Remove the tie rod-to-relay rod stud nut and the tie rod-to-steering knuckle stud nut.

   Ä DO NOT attempt to separate the tie rod-to-steering knuckle joint using a wedge type tool for seal damage could result.

4. Using the GM Wheel Stud Remover tool No. J-6627-A or equivalent, separate the outer tie rod stud from the steering knuckle and the inner tie rod stud from the relay rod. Remove the tie rod from the vehicle.
5. If removing ONLY the tie rod end, perform the following procedures:
   a. Disconnect the defective ball joint end of the tie rod.
   b. Loosen the adjuster tube clamp bolt.
   c. Unscrew the tie rod end from the adjuster tube; count the number of turns necessary to remove the tie rod end.
   d. Clean, inspect and lubricate the adjuster tube threads.
   e. To install a new tie rod end, screw it into the adjuster tube using the same number of turns necessary to remove it.
   f. Position the clamp bolts between the adjuster tube dimples (located at each end) and in the proper location (see illustration). Torque the adjuster tube clamp bolt 13 ft. lbs. (17 Nm).

To install:

6. Position the tie rod onto the steering knuckle and the relay rod. Thread the proper sized steering linkage installer tool onto the studs and tighten to 40 ft. lbs. (54 Nm) to seat the tapers. After seating the tapers, remove the tools, install the mounting nuts and torque mounting nuts to 35 ft. lbs. (47 Nm).
7. At the tie rod-to-steering knuckle stud, tighten the nut until a castle nut slot aligns with the hole in the stud, then install a new cotter pin.
8. Remove the jackstands and carefully lower the vehicle. Check the steering linkage performance.
9. Check and adjust the front end toe-in, as necessary.

Figure 117.
Inner tie rod and relay rod connections require the use of a press-type linkage/wheel stud remover

{ewc GSMVIMG,GSMVIMG, !88268Ge3.bmp}

88268Ge3

Figure 118.
Proper orientation of the tie rod clamps and adjuster tube

{ewc GSMVIMG,GSMVIMG, !88268G65.bmp}

88268G65

Figure 119.
To separate the tie rod end from the steering knuckle, first straighten the cotter pin . . .

{ewc GSMVIMG,GSMVIMG, !88268p24.bmp}

88268p24

Figure 120.
. . . then remove and discard the old cotter pin

{ewc GSMVIMG,GSMVIMG, !88268p25.bmp}

88268p25

Figure 121.
Using a wrench (shown) or a deep socket, loosen the tie rod stud retaining nut

{ewc GSMVIMG,GSMVIMG, !88268p26.bmp}

88268p26

Figure 122.
Unthread the nut from the stud . . .

{ewc GSMVIMG,GSMVIMG, !88268p27.bmp}

88268p27

Figure 123.
. . . then use a universal steering linkage puller to free the stud from the knuckle

{ewc GSMVIMG,GSMVIMG, !88268p28.bmp}

88268p28

Figure 124.
If only the rod end is being removed, match-mark the threads (to preserve toe adjustment) . . .

{ewc GSMVIMG,GSMVIMG, !88268p29.bmp}

88268p29

Figure 125.
. . . then loosen the adjuster clamp bolt and unthread the end from the adjuster tube

{ewc GSMVIMG,GSMVIMG, !88268p30.bmp}

88268p30

Damper Assembly {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Damper Assembly

The damper assembly is used to the remove steering wheel vibration and vehicle wander; not all vehicles are equipped with it.

1. Raise and support the front of the vehicle safely using jackstands.
2. Remove the damper assembly-to-connecting rod cotter pin and nut.
3. Remove the damper assembly-to-bracket nut/bolt and remove the damper assembly from the vehicle.

To install:

4. If necessary, install a new damper assembly. Torque the damper assembly-to-bracket nut/bolt to 22 ft. lbs. (29 Nm) and the damper assembly-to-connecting rod nut to 41 ft. lbs. (56 Nm).
5. Align the castle nut slot with the hole in the ball joint stud and install and secure a new cotter pin.
6. Remove the jackstands and carefully lower the vehicle. Check the steering linkage performance.
7. Check and adjust the front end toe-in, as necessary.

Manual Steering Gear {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Manual Steering Gear

The recirculating ball type manual steering gear is manufactured by Saginaw and is equipped with a mechanical ratio of 24:1.

ADJUSTMENTS

Ü See figures 126, 127

Steering gear adjustments are made only as corrections and NOT as periodic adjustments. Before adjusting the gear, check the remainder of the steering linkage and front suspension for wear or damage and repair/replace components, as necessary. Adjustment takes place in 2 major steps. First the worm bearing preload adjustment is made using the adjuster plug, then the overcenter preload is adjusted using the adjuster screw/bolt and jam nut.

Ä The following procedure requires the use the GM Pitman Arm Remover tool No. J-29107 or equivalent, and a 0-50 inch lbs. (0-5.5 Nm) torque wrench.

1. Disconnect the negative battery cable for safety.
2. Raise and support the front of the vehicle safely using jackstands.

   Ä Before adjustments are made to the steering gear, be sure to check the front end alignment, the shock absorbers, the wheel balance and the tire pressure.

3. Remove the pitman arm-to-pitman shaft nut and washer, then match-mark the relationship of the arm to the shaft (this will permit proper alignment during assembly).
4. Separate the pitman arm from the pitman shaft using J-29107, or an equivalent pitman arm removal tool.

   Ä When separating the pitman arm from the shaft, DO NOT use a hammer or apply heat to the arm.

5. Loosen the locknut for the steering gear adjuster plug, then back-off the adjuster plug $^{1}/4$ turn.
6. Remove the horn cap or cover from the steering wheel for access to the shaft nut.
7. Gently, turn the steering wheel (in 1 direction) to the stop; then, turn it back $^{1}/2$ turn.

   Ä When the steering linkage is disconnected from the steering gear, DO NOT turn the steering wheel hard against the stops or damage to the ball guides may result.

8. Position a 0-50 inch lbs. (0-5.5 Nm) torque wrench onto the steering wheel nut, then measure and record the bearing drag. To measure the bearing drag, use the torque wrench to rotate the steering wheel 90º.
9. Have an assistant tighten the adjuster plug slowly as the steering wheel is being turned using the torque wrench.

Figure 126.
Using an inch lbs. torque wrench, measure the bearing drag (force necessary to turn the steering wheel)

{ewc GSMVIMG,GSMVIMG, !88268G66.bmp}

88268G66

Figure 127.
Manual steering gear and adjuster components

{ewc GSMVIMG,GSMVIMG, !88268G67.bmp}

88268G67

The plug should be tightened to a point where the torque wrench shows a worm bearing preload of 5-8 inch lbs. (0.6-1.0 Nm). After the thrust bearing preload is obtained, torque the adjuster plug locknut to 25 ft. lbs. (34 Nm).

Ä If the steering gear feels lumpy (after adjustment), suspect damage to the bearings, probably due to the improper adjustment or severe impact.

10. After the worm bearing pre-load is properly set, adjust the overcenter preload as follows:
    a. Loosen the adjuster screw/bolt jam nut.
    b. Turn the steering wheel, from 1 stop all the way to the other stop, counting the number of turns. Turn the steering wheel back exactly 1/2 way to the center position.
    c. Turn the overcenter adjusting screw clockwise, until the lash is removed between the ball nut and the pitman shaft sector teeth, then tighten the locknut to 25 ft. lbs. (34 Nm).
    d. Use a 0-50 inch lbs. (0-5.5 Nm) torque wrench to check the highest force necessary to turn the steering wheel through the center position. Proper adjustment will yield a preload of 4-10 inch lbs. (0.5-1.2 Nm) over center.
    e. If necessary, loosen the locknut and readjust the overcenter adjusting screw to obtain the proper torque. Retorque the locknut to 25 ft. lbs. (34 Nm) and recheck the steering wheel torque through the center of travel.

    Ä If the maximum is too high, turn the overcenter adjuster screw counterclockwise, then tighten the adjuster locknut in the clockwise motion to achieve the proper torque.
11. Install the horn cap or cover.
12. Align the pitman arm-to-pitman shaft match-mark, then install the washer along with a prevailing torque nut. Tighten the pitman arm-to-pitman shaft nut to 185 ft. lbs. (250 Nm).
13. Remove the jackstands and carefully lower the vehicle, then connect the negative battery cable.

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REMOVAL & INSTALLATION

Ü See figure 128

Ä The following procedure requires the use the GM Pitman Arm Remover tool No. J-29107 or equivalent.

1. Disconnect the negative battery cable for safety.
2. Raise and support the front of the vehicle safely using jackstands. Place the front wheels in the straight-ahead position.
3. Remove the intermediate shaft-to-steering gear pinch bolt.
4. Remove the pitman arm-to-pitman shaft nut and washer, then match-mark the relationship of the arm to the shaft (this will permit proper alignment during assembly).
5. Separate the pitman arm from the pitman shaft using J-29107, or an equivalent pitman arm removal tool.

   Ä When separating the pitman arm from the shaft, DO NOT use a hammer or apply heat to the arm.
6. Remove the steering gear-to-frame bolts, then carefully lower the gear from the vehicle.

   Ä When installing the steering gear, be sure the intermediate shaft bottoms on the worm shaft, so the pinch bolt passes through the undercut on the worm shaft. Check and/or adjust the alignment of the pitman arm-to-pitman shaft.

Figure 128.
Exploded view of the manual steering gear mounting

{ewc GSMVIMG,GSMVIMG, !88268G68.bmp}

88268G68

To install:

7. Align and install the steering gear, then tighten the steering gear-to-frame bolts to 70 ft. lbs. (95 Nm).
8. Align the pitman arm-to-pitman shaft match-mark, then install the washer along with a prevailing torque nut. Tighten the pitman arm-to-pitman shaft nut to 185 ft. lbs. (250 Nm).
9. Install the intermediate shaft and torque the bolt to 30 ft. lbs. (41 Nm).
10. Remove the jackstands and carefully lower the vehicle.
11. Connect the negative battery cable.

Power Steering Gear {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Power Steering Gear

The recirculating ball type power steering gear used on these vehicles is basically the same as the manual steering gear, except that it uses a hydraulic assist on the rack piston.

The power steering gear control valve directs the power steering fluid to either side of the rack piston, which rides up and down the worm shaft. The steering rack converts the hydraulic pressure into mechanical force. Should the vehicle loose the hydraulic pressure, it can still be controlled mechanically.

ADJUSTMENTS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ADJUSTMENTS

Steering gear adjustments are made only as corrections and NOT as periodic adjustments. Before adjusting the gear, check the remainder of the steering linkage and front suspension for wear or damage and repair/replace components, as necessary. Adjustment takes place in 2 major steps. First the worm bearing preload adjustment is made using the adjuster plug, then the overcenter preload is adjusted using the adjuster screw/bolt and jam nut.

> **Ä To perform adjustments to the power steering gear, it is recommended to remove the power steering gear from the vehicle and place it in a vise. Before adjustments are performed to the system, be sure to check problems relating to hydraulic pressures and performance.**

Worm Bearing Preload {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Worm Bearing Preload

Ü See figures 129, 130, 131, 132

Ä The following procedure requires the use of the GM Adjustable Spanner Wrench tool No. J-7624 or equivalent.

1. Remove the steering gear from the vehicle and position it in a vise. For details, please refer to the procedure found earlier in this section.
2. Using a hammer and a brass punch, drive the adjuster plug locknut counterclockwise and remove it from the end of the steering gear.
3. Use an adjustable spanner wrench such as J-7624 or equivalent, to turn the adjuster plug inward, until it firmly bottoms in the housing with a torque of 20 ft. lbs. (27 Nm).
4. Use a scribing tool to place a match-mark (on the housing) next to the one of the spanner wrench holes in the adjuster plug.
5. Using a ruler, measure $^{1}/2$ in. (13mm) counterclockwise from the scribed mark (on the housing) and place another mark.
6. Use the spanner to turn the adjuster plug (counterclockwise) until the hole in the adjuster plug aligns with the 2nd scribed mark.
7. While holding the adjuster plug in alignment, install and tighten the adjuster plug locknut.
8. Perform the overcenter preload adjustment.

Figure 129.
Remove the adjuster locknut from the gear by driving it counterclockwise
{ewc GSMVIMG,GSMVIMG, !88268g69.bmp}

88268g69

Figure 130.
Match-mark the housing with the adjuster plug hole
{ewc GSMVIMG,GSMVIMG, !88268g70.bmp}

88268g70

Figure 131.
Measure back (counterclockwise) and scribe a second mark
{ewc GSMVIMG,GSMVIMG, !88268g71.bmp}

88268g71

Figure 132.
Use the spanner wrench to align the adjuster plug with the second mark
{ewc GSMVIMG,GSMVIMG, !88268g72.bmp}

88268g72

Overcenter Preload {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Overcenter Preload

Ü See figures 133, 134, 135

1. Adjust the worm bearing preload. For details, please refer to the procedure earlier in this section.
2. Rotate the stub shaft from stop-to-stop and count the number of turns necessary.
3. Starting from 1 stop, turn the stub shaft back $^{1}/2$ the number of turns (to the center of the gear).

   Ä With the stub gear centered, the flat on top of the shaft should face upward and be parallel with the side cover; the master spline on the pitman shaft should be in line with the adjuster screw.

4. Loosen the pitman shaft adjuster screw locknut, then turn the adjuster screw counterclockwise until it is fully extended. Turn the screw clockwise 1 full turn.
5. Place a 0-50 inch lbs. (0-6 Nm) torque wrench vertically on the stub shaft, then rotate it 45º (to each side) and record the highest drag measured near or on the center.
6. Turn the adjuster screw inward until the torque on the stub shaft is 6-10 inch lbs. (0.7-1.2 Nm) greater than the initial reading.
7. Tighten the adjuster screw jam nut while holding the adjuster screw from turning. Double check for the proper measurement to assure the screw was not turned while tightening the nut.
8. Install the power steering gear into the vehicle.

Figure 133.
Align the stub shaft with the side cover

{ewc GSMVIMG,GSMVIMG, !88268g73.bmp}

88268g73

Figure 134.
Align the pitman arm shaft master spline

{ewc GSMVIMG,GSMVIMG, !88268g74.bmp}

88268g74

Figure 135.
Use an inch lbs. torque wrench to measure overcenter rotation torque

{ewc GSMVIMG,GSMVIMG, !88268g75.bmp}

88268g75

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Suspension And Steering

REMOVAL & INSTALLATION

Ü See figure 136

1. Disconnect the negative battery cable for safety.
2. Raise and support the front of the vehicle safely using jackstands.
3. Position a fluid catch pan under the power steering gear.
4. At the power steering gear, disconnect and plug the pressure hoses; any excess fluid will be caught by the catch pan.

   Ä Be sure to cap or plug the hoses and the openings of the power steering pump to keep dirt out of the system.

5. Remove the intermediate shaft-to-steering gear bolt. Match-mark the intermediate shaft-to-power steering gear and separate the shaft from the gear.
6. Remove the pitman arm-to-pitman shaft nut and washer, then match-mark the relationship of the arm to the shaft (this will permit proper alignment during assembly).
7. Separate the pitman arm from the pitman shaft using J-29107, or an equivalent pitman arm removal tool.

   Ä When separating the pitman arm from the shaft, DO NOT use a hammer or apply heat to the arm.

8. Remove the power steering gear-to-frame bolts and washers, then carefully lower and remove the steering gear from the vehicle.

Figure 136.
Exploded view of the power steering gear mounting

{ewc GSMVIMG,GSMVIMG, !88268G76.bmp}

88268G76

To install:

9. Install the steering gear, then tighten the gear-to-frame bolts to 55 ft. lbs. (75 Nm) for 1985-93 vehicles and 1994-96 2 wheel drive vehicles, or tighten the bolts to 100 ft. lbs. (135 Nm) for 1994-96 AWD vehicles.
10. Remove the plugs, then connect the pressure hoses to the power steering gear.
11. Connect the intermediate shaft-to-power steering gear bolt and tighten to 30 ft. lbs. (41 Nm)
12. Align and install the pitman arm-to-pitman shaft, then install the nut and washer and tighten to 185 ft. lbs. (250 Nm).
13. Connect the negative battery cable.
14. Refill the power steering reservoir and bleed the power steering system.
15. Remove the jackstands and carefully lower the vehicle.
16. Road test the vehicle, then check and top-off the power steering fluid.

Power Steering Pump {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Suspension And Steering

Power Steering Pump

REMOVAL & INSTALLATION

Ü See figures 137, 138, 139, 140, 141, 142, 143

Ä The following procedure requires the use of the GM Puller tool No. J-29785-A (1985-92), Puller J-25034-B (1993-96) or equivalent, and the GM Pulley Installer tool No. J-25033-B or equivalent.

1. Disconnect the negative battery cable for safety.
2. For 1996 vehicles, remove the air cleaner assembly for access.
3. For 1993-96 vehicles, remove the hood latch and the upper fan shroud.
4. Release tension and remove the drive belt. For details, please refer to Section 1 of this manual.
5. Remove the power steering pump pulley using a suitable puller tool.
6. Remove the power steering pump retaining bolts, then reposition the pump as necessary for access to the hoses.
7. Position a fluid catch pan under the power steering pump.
8. Remove the hoses from the power steering pump and drain the excess fluid into the catch pan.

****Warning**
Be sure to cap all openings in the pump hydraulic system to prevent excessive fluid spillage and the possibility of system contamination.

9. Remove the power steering pump from the vehicle.

Figure 137.
Exploded view of the power steering pump assembly mounting-2.5L engine

{ewc GSMVIMG,GSMVIMG, !88268G77.bmp}

88268G77

Figure 138.
Exploded view of the power steering pump assembly mounting-early-model 4.3L engine

{ewc GSMVIMG,GSMVIMG, !88268G78.bmp}

88268G78

Figure 139.
Removing the power steering pump pulley-1985-92 vehicles

{ewc GSMVIMG,GSMVIMG, !88268G79.bmp}

88268G79

Figure 140.
Installing the power steering pump pulley

{ewc GSMVIMG,GSMVIMG, !88268G80.bmp}

88268G80

Figure 141.
Pump pulley removal and installation-1993-96 vehicles

{ewc GSMVIMG,GSMVIMG, !88268G81.bmp}

88268G81

Figure 142.
Exploded view of the power steering pump mounting-late-model 4.3L engines (1993-96 shown)

{ewc GSMVIMG,GSMVIMG, !88268G82.bmp}

88268G82

Figure 143.
Typical power steering pump hose routing-1996 shown

{ewc GSMVIMG,GSMVIMG, !88268G83.bmp}

88268G83

To install:

10. Position the pump to the vehicle, then uncap and connect the pump hoses.
11. Install the steering pump to the retaining bracket, then secure using the retaining bolts. Tighten the power steering pump-to-bracket bolts to 37 ft. lbs. (50 Nm). For 1996 vehicles, tighten the nut to 30 ft. lbs. (41 Nm).

    Ä On early-model vehicles where the drive belt is tensioned by pivoting the power steering pump assembly, do NOT fully tighten the mounting bolts at this time, since you will just have to loosen them again for belt installation and adjustment.

12. Install the pump pulley using the GM Pulley Installer tool No. J-25033-B or equivalent. Press the drive pulley onto the power steering pump.
13. Hand-tighten the pivot bolt, the adjusting bolt and the washer.
14. Install the drive belt. On early-model vehicles so equipped, properly adjust the belt tension. For details on belt installation and tension adjustment, please refer to Section 1 of this manual.
15. For 1993-96 vehicles install the upper fan shroud and the hood latch assembly.
16. For 1996 vehicles, install the air cleaner assembly.
17. Connect the negative battery cable.
18. Refill the power steering reservoir and bleed the power steering system.
19. Remove the jackstands and carefully lower the vehicle.
20. Road test the vehicle, then check and top-off the power steering fluid.

SYSTEM BLEEDING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SYSTEM BLEEDING

The power steering system should be bled after any component has been replaced, after any fluid line has been disconnected or air is suspected as the cause of a noise in the system. The system must be properly bled to help prevent possible pump damage, and to ensure proper, trouble and noise-free operation.

Ä Bleeding will take significantly longer on a system that has been completely emptied and/or on systems that contain long fluid lines and multiple components (such as a fluid cooler in addition to the pump, gear and reservoir).

1. Begin the bleeding procedure with the engine and fluid COLD.
2. FIRMLY set the parking brake and block the rear wheels.
3. Raise and support the front of the vehicle safely using jackstands.
4. Turn the steering wheel to the full left position, then check and top off the fluid reservoir to the FULL COLD mark.
5. Turn the steering wheel from lock-to-lock at least 20 times, while an assistant checks the fluid level and condition in the reservoir. Add fluid as necessary to keep the level at or near the FULL COLD mark.

   Ä Remember that if only the front wheels are raised, the fluid level on the dipstick will not be completely accurate. Keep the level a little below the mark, until the vehicle is lowered, then check and top it off as necessary.

6. Remove the jackstands and carefully lower the vehicle. If not done earlier, install the filler cap to the reservoir.
7. Start the engine and allow it to idle. Run the engine for approximately 2 minutes in order to allow the fluid to warm-up.
8. With the engine idling, turn the wheels in both directions (to the stops) several times.
9. Stop the engine, then check the fluid level and condition. Add power steering fluid to the level indicated on the reservoir.

   Ä Fluid with air in it will have a light tan or milky appearance. This air must be eliminated from the fluid before normal steering action can be obtained.

10. Road test the vehicle to make sure the steering functions normally and is free from noise.
11. Allow the vehicle to stand for 2-3 hours, then recheck the power steering fluid.

BRAKES

{ewc MVIMAGE,MVIMAGE, !brakes.bmp}

HYDRAULIC BRAKE SYSTEM {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

HYDRAULIC BRAKE SYSTEM

Ü See figures 1, 2

These vans are equipped with independent front and rear brake systems. The systems consist of a power booster, a master cylinder, a combination valve, front disc and rear drum assemblies.

The 1989 models are equipped with Rear Wheel Anti-Lock (RWAL) brakes. The system is designed to reduce the occurrence of rear wheel lockup during a severe brake application. A pressure regulator limits the amount of hydraulic line pressure to the rear brakes by the use of a control valve. The valve is controlled by a microcomputer which is tied in with the Electronic Control Unit (ECU). The ECU is mounted next to the master cylinder.

The 1990 and on models could be ordered with 4-Wheel Anti-Lock (4WAL) brakes as an option. The system is designed to reduce the occurrence of wheel lockup during a severe brake application. The system regulates hydraulic line pressure by the use of an Electro-Hydraulic Control Unit (EHCU) valve located under the master cylinder. An isolation valve maintains pressure to each wheel separately and the rear wheels combined.

Figure 1.
Rear wheel anti-lock brake system

{ewc GSMVIMG,GSMVIMG, !88269g02.bmp}

88269g02

Figure 2.
Four wheel anti-lock brake system

{ewc GSMVIMG,GSMVIMG, !88269g01.bmp}

88269g01

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.

> ****Warning**
> **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 and flush 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.**

DISC BRAKES {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

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:

1. A fixed caliper.
2. A floating caliper.
3. 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 {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

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.

VACUUM POWER BOOSTERS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

VACUUM 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 {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Brakes

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 {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

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.

HYDRO-BOOST {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

HYDRO-BOOST

The Hydro-Boost system replaces the vacuum booster in some vehicles. Basically, the Hydro-Boost system is a hydraulic motor that provides braking assist. Instead of using vacuum to supply the assist, it uses hydraulic pressure obtained from the power steering pump. The Hydro-Boost unit mounts in between the firewall and master cylinder, replacing the vacuum booster.

Adjustments {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Adjustments

REAR DRUM BRAKES

Ü See figures 3, 4, 5, 6

Normal adjustments of the rear drum brakes are automatic and are made during the reverse applications of the brakes. ONLY, if the lining has been renewed or if the self adjusters haven't worked properly, should the following procedure be performed.

Ä The following procedure requires the use of the GM Brake Adjustment tool No. J-4735 or equivalent.

1. Raise and support the rear of the vehicle on jackstands.
2. Using a punch and a hammer, at the rear of the backing plate, knock out the lanced metal area near the star wheel assembly.

   Ä When knocking out the lanced metal area from the backing plate, the wheels must be removed and all of the metal pieces discarded.
3. Using the GM Brake Adjustment tool No. J-4735 or equivalent, insert it into the slot and engage the lowest possible tooth on the star wheel. Move the end of the brake tool downward to move the star wheel upward and expand the adjusting screw. Repeat this operation until the brakes lock the wheel.
4. Insert a small screwdriver or piece of firm wire (coat hanger wire) into the adjusting slot and push the automatic adjuster lever out and free of the star wheel on the adjusting screw.
5. While holding the adjusting lever out of the way, engage the topmost tooth possible on the star wheel (with the brake tool). Move the end of the adjusting tool upward to move the adjusting screw star wheel downward and contact the adjusting screw. Back off the adjusting screw star wheel until the wheel spins freely with a minimum of drag. Keep track of the number of turns the star wheel is backed off.
6. Repeat this operation for the other side. When backing off the brakes on the other side, the adjusting lever must be backed off the same number of turns to prevent side-to-side brake pull.

   Ä Backing off the star wheel 12 notches (clicks) is usually enough to eliminate brake drag.
7. Repeat this operation on the other side of the rear brake system.
8. After the brakes are adjusted, install a rubber hole cover into the backing plate slot. To complete the brake adjustment operation, make several stops while backing the vehicle to equalize the wheels.
9. Road test the vehicle.

Figure 3.
The star wheel is used to adjust the rear brakes

{ewc GSMVIMG,GSMVIMG, !88269g03.bmp}

88269g03

Figure 4.
Use a punch to pop out the adjuster knockouts if it hasn't already been done

{ewc GSMVIMG,GSMVIMG, !88269p01.bmp}

88269p01

Figure 5.

Remove the metal tab from the backing plate. DO NOT allow it to fall into the drum

{ewc GSMVIMG,GSMVIMG, !88269p02.bmp}

88269p02

Figure 6.
Use a brake adjusting spoon to turn the starwheel. A screwdriver just won't work that well

{ewc GSMVIMG,GSMVIMG, !88269p03.bmp}

88269p03

BRAKE PEDAL TRAVEL {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

BRAKE PEDAL TRAVEL

Ü See figure 7

The brake pedal travel is the distance the pedal moves toward the floor from the fully released position. Inspection should be made with 90 lbs. pressure on the brake pedal, when the brake system is cold. The brake pedal travel should be $4^1/2$ in. (114mm) for manual, or $3^1/2$ in. (89mm) for power.

Ä If equipped with power brakes, be sure to pump the brake pedal at least 3 times with the engine OFF, before making the brake pedal check.

1. From under the dash, remove the pushrod-to-pedal clevis pin and separate the pushrod from the brake pedal.
2. Loosen the pushrod adjuster lock nut, then adjust the pushrod.
3. After the correct travel is established, reverse the removal procedure.

Figure 7.
The use of a pedal force gauge will make testing the pedal travel more accurate

{ewc GSMVIMG,GSMVIMG, !88269g44.bmp}

88269g44

Brake Light Switch {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Brake Light Switch

Ü See figures 8, 9

REMOVAL & INSTALLATION

Plunger Type

1. Disconnect the negative battery terminal from the battery.
2. Disconnect the electrical connector from the brake light switch.
3. Turn the brake light switch retainer (to align the key with the bracket slot), then remove the switch with the retainer.
4. To install, reverse the removal procedures. Adjust the brake light switch.

Figure 8.
Plunger type brake light switch

{ewc GSMVIMG,GSMVIMG, !88269g04.bmp}

88269g04

Figure 9.
Box type brake light switch

{ewc GSMVIMG,GSMVIMG, !88269g46.bmp}

88269g46

Box Type {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Brakes

Box Type

1. Disconnect the negative battery terminal from the battery.
2. Disconnect the electrical connector from the brake light switch.
3. Release the brake pushrod retainer, then remove the switch with the retainer.
4. To install, reverse the removal procedures.

ADJUSTMENT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Brakes

ADJUSTMENT

Only the plunger type of brake light switch needs to be adjusted. The box type is self adjusting.

1. Depress the brake pedal and press the brake light switch inward until it seats firmly against the clip.

   Ä As the switch is being pushed into the clip, audible clicks can be heard.

2. Release the brake pedal, then pull it back against the pedal stop until the audible click can no longer be heard.
3. The brake light switch will operate when the pedal is depressed 13mm (0.53 in.) from the fully released position.

Master Cylinder {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Master Cylinder

REMOVAL & INSTALLATION

Ü See figures 10, 11, 12, 13, 14, 15, 16

Ä The master cylinder removal and installation procedures are basically the same for all brake systems. Always use flare nut wrenches to remove the hydraulic brake line. Damage to the fitting nut may occur if this procedure is not followed.

1. Disconnect the negative battery cable. Apply the parking brakes or block the wheels.
2. Using a siphon, remove and discard some of the brake fluid from the master cylinder reservoirs.
3. Disconnect and plug the hydraulic lines from the master cylinder using flare nut wrenches only.
4. If equipped with a manual brake system, disconnect the pushrod from the brake pedal.
5. Remove the master cylinder-to-bracket (manual) or vacuum booster (power) nuts, then separate the combination valve/bracket from the master cylinder.
6. Remove the master cylinder, the gasket and the rubber boot from the vehicle.

To install:

7. Bench bleed the master cylinder and install the cylinder onto the vehicle. Torque the master cylinder mounting nuts to 28 ft. lbs. (38 Nm).
8. Connect the hydraulic lines and torque to 15 ft. lbs. (20 Nm).
9. Refill the master cylinder with clean brake fluid, bleed the brake system and check the brake pedal travel.

Ä If equipped with manual brakes, be sure to reconnect the pushrod to the brake pedal.

Figure 10.
All master cylinders are held with two nuts, regardless of the booster type

{ewc GSMVIMG,GSMVIMG, !88269g47.bmp}

88269g47

Figure 11.
Remove as much of the used fluid as possible from the reservoirs

{ewc GSMVIMG,GSMVIMG, !88269p04.bmp}

88269p04

Figure 12.
Use only flare wrenches on the line fittings or the fitting might get damaged

{ewc GSMVIMG,GSMVIMG, !88269p05.bmp}

88269p05

Figure 13.
Use a rag to catch any brake fluid that spills, otherwise the fluid could cause paint damage

{ewc GSMVIMG,GSMVIMG, !88269p06.bmp}

88269p06

Figure 14.
Be careful when removing the master cylinder nuts, they are close to the positive

battery terminal

{ewc GSMVIMG,GSMVIMG, !88269p07.bmp}

88269p07

Figure 15.
Remove the master cylinder and check for fluid in the booster

{ewc GSMVIMG,GSMVIMG, !88269p08.bmp}

88269p08

Figure 16.
Use fresh fluid when reinstalling the master cylinder

{ewc GSMVIMG,GSMVIMG, !88269p09.bmp}

88269p09

OVERHAUL {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

OVERHAUL

Ü See figures 17, 18, 19

1. Remove the master cylinder from the vehicle.
2. At the rear of the master cylinder, depress the primary piston and remove the lock ring.
3. Block the rear outlet hole on the master cylinder. Using compressed air, gently direct it into the front outlet hole to remove the primary and secondary pistons from the master cylinder. If compressed air is not available, use a hooked wire to pull out the secondary piston.

   ****Caution**
   If using compressed air to remove the pistons from the master cylinder, DO NOT stand in front of the pistons, for too much air will cause the pistons to be fired from the master cylinder, causing bodily harm.

4. From the secondary piston, remove the spring retainer and the seals.
5. Using the mounting flange (ear) on the master cylinder, clamp it into a vise.
6. Using a medium pry bar, pry the reservoirs from the master cylinder. Remove the reservoir grommets.

   Ä DO NOT attempt to remove the quick take-up valve from the master cylinder body; the valve is not serviceable separately.

7. Using denatured alcohol, clean and blow dry all of the master cylinder parts.
8. Inspect the master cylinder bore for corrosion or scratches; if damaged, replace the master cylinder with a new one.

To install:

9. Use new reservoir grommets (lubricated with brake lube) and press them into the master cylinder body. Install new seals onto the primary and secondary pistons.
10. Position the reservoirs on flat, hard surfaces (block of wood), then press the master cylinder onto the reservoirs, using a rocking motion.
11. Using heavy duty brake fluid, meeting DOT 3 specifications, lubricate the primary and secondary pistons, then install them into the master cylinder. While depressing the primary piston, install the lock ring.
12. Install new diaphragms onto the reservoir covers.
13. Install the master cylinder onto the vehicle and torque the mounting bolts to 28 ft. lbs. (38 Nm). Bleed the system.

Figure 17.
Remove the reservoir from the master cylinder by gently prying it off
{ewc GSMVIMG,GSMVIMG, !88269g05.bmp}

88269g05

Figure 18.
Exploded view of the master cylinder
{ewc GSMVIMG,GSMVIMG, !88269g06.bmp}

88269g06

Figure 19.
Press and rock the master cylinder to seat the reservoir in the grommets
{ewc GSMVIMG,GSMVIMG, !88269g07.bmp}

88269g07

Vacuum Power Brake Booster {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Vacuum Power Brake Booster

The power brake booster is a tandem vacuum suspended unit, equipped with a single or dual function vacuum switch that activates a brake warning light should low booster vacuum be present. Under normal operation, vacuum is present on both sides of the diaphragms. When the brakes are applied, atmospheric air is admitted to one side of the diaphragms to provide power assistance.

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REMOVAL & INSTALLATION

Ü See figures 20, 21

1. Disconnect the negative battery cable. Apply the parking brake or block the wheels.
2. Remove the master cylinder-to-power brake booster nuts and move the master cylinder out of the way; if necessary, support the master cylinder on a wire.

   Ä When removing the master cylinder from the power brake booster, it is not necessary to disconnect the hydraulic lines.

3. Disconnect the vacuum hose from the power brake booster.
4. From under the dash, disconnect the pushrod from the brake pedal.
5. From under the dash, remove the power brake booster-to-cowl nuts.
6. From the engine compartment, remove the power brake booster and the gasket from the vehicle.

   Ä If equipped with anti-lock brakes, support the control valves out of the way while removing the brake booster.

To install:

7. Use a new gaskets and install the brake booster onto the firewall. Torque the power brake booster-to-cowl nuts to 21 ft. lbs. (29 Nm) and the master cylinder-to-power brake booster nuts to 28 ft. lbs. (38 Nm).
8. Connect the pushrod and the vacuum hose.
9. Start the engine and check the brake system operation.

Figure 20.
The vacuum booster mounting nuts are inside the vehicle at the pedal assembly

{ewc GSMVIMG,GSMVIMG, !88269g08.bmp}

88269g08

Figure 21.
Exploded view of the vacuum booster assembly

{ewc GSMVIMG,GSMVIMG, !88269g09.bmp}

88269g09

Hydro-Boost {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Hydro-Boost

TESTING

1. A defective Hydro-Boost cannot cause any of the following conditions:
   a. Noisy brakes
   b. Fading pedal
   c. Pulling brakes

If any of these occur, check elsewhere in the brake system.

2. Check the fluid level in the master cylinder. It should be within $^1/4$ in. (6mm) of the top. If is isn't add only DOT-3 or DOT-4 brake fluid until the correct level is reached.
3. Check the fluid level in the power steering pump. The engine should be at normal running temperature and stopped. The level should register on the pump dipstick. Add power steering fluid to bring the reservoir level up to the correct level. Low fluid level will result in both poor steering and stopping ability.

   ****Caution**
   The brake hydraulic system uses brake fluid only, while the power steering and Hydro-Boost systems use power steering fluid only. Don't mix the two!

4. Check the power steering pump belt tension, and inspect all the power steering/Hydro-Boost hoses for kinks or leaks.
5. Check and adjust the engine idle speed, as necessary.
6. Check the power steering pump fluid for bubbles. If air bubbles are present in the fluid, bleed the system:
   a. Fill the power steering pump reservoir to specifications with the engine at normal operating temperature.
   b. With the engine running, rotate the steering wheel through its normal travel 3 or 4 times, without holding the wheel against the stops.
   c. Check the fluid level again.

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Brakes

REMOVAL & INSTALLATION

Ü See figures 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32

****Caution**
Power steering fluid and brake fluid cannot be mixed. If brake seals contact the steering fluid or steering seals contact the brake fluid, damage will result!

1. Turn the engine off and pump the brake pedal 4 or 5 times to deplete the accumulator inside the unit.
2. Remove the two nuts from the master cylinder, and remove the cylinder keeping the brake lines attached. Secure the master cylinder out of the way.
3. Remove the hydraulic lines from the booster.
4. Remove the booster unit from the firewall.
5. To install, reverse the removal procedure. Tighten the nuts to booster mounting nuts to 22 ft. lbs. (30 Nm); the master cylinder mounting nuts to 20 ft. lbs. (27 Nm). Bleed the Hydro-Boost system.

Figure 22.
Hydro-boost mounting order

{ewc GSMVIMG,GSMVIMG, !88269g58.bmp}

88269g58

Figure 23.
Hydro-boost hose routing

{ewc GSMVIMG,GSMVIMG, !88269g51.bmp}

88269g51

Figure 24.
Potential leakage points on the hydro-boost unit

{ewc GSMVIMG,GSMVIMG, !88269g52.bmp}

88269g52

Figure 25.
Exploded view of the hydro-boost unit

{ewc GSMVIMG,GSMVIMG, !88269g53.bmp}

88269g53

Figure 26.
Use a rag to catch the fluid when disconnecting the pressure hoses

{ewc GSMVIMG,GSMVIMG, !88269p10.bmp}

88269p10

Figure 27.
Always use a flare wrench on the fittings

{ewc GSMVIMG,GSMVIMG, !88269p11.bmp}

88269p11

Figure 28.
Note the O-ring on the end of the fitting. Use a new one when reconnecting

{ewc GSMVIMG,GSMVIMG, !88269p12.bmp}

88269p12

Figure 29.
Loosen and remove the booster mounting nuts from inside the vehicle

{ewc GSMVIMG,GSMVIMG, !88269p16.bmp}

88269p16

Figure 30.
Disconnect the pushrod from the pedal

{ewc GSMVIMG,GSMVIMG, !88269p15.bmp}

88269p15

Figure 31.
Withdraw the booster assembly by pulling straight out

{ewc GSMVIMG,GSMVIMG, !88269p13.bmp}

88269p13

Figure 32.
Once the booster is out far enough to clear the pushrod, it can be removed from the vehicle

{ewc GSMVIMG,GSMVIMG, !88269p14.bmp}

88269p14

HYDRO-BOOST SYSTEM BLEEDING {ewc MVIMAGE, MVIMAGE, ! nexttopicarrow.bmp}

HYDRO-BOOST SYSTEM BLEEDING

The system should be bled whenever the booster is removed and installed.

1. Fill the power steering pump until the fluid level is at the base of the pump reservoir neck. Disconnect the battery lead from the distributor.

   Ä Remove the electrical lead to the fuel solenoid terminal on the injection pump before cranking the engine.

2. Jack up the front of the car, turn the wheels all the way to the left, and crank the engine for a few seconds.
3. Check steering pump fluid level. If necessary, add fluid to the "ADD" mark on the dipstick.
4. Lower the car, connect the battery lead, and start the engine. Check fluid level and add fluid to the "ADD" mark, as necessary. With the engine running, turn the wheels from side to side to bleed air from the system. Make sure that the fluid level stays above the internal pump casting.
5. The Hydro-Boost system should now be fully bled. If the fluid is foaming after bleeding, stop the engine, let the system set for one hour, then repeat the second part of Step 4.

The preceding procedures should be effective in removing the excess air from the system, however sometimes air may still remain trapped. When this happens the booster may make a gulping noise when the brake is applied. Lightly pumping the brake pedal with the engine running should cause this noise to disappear. After the noise stops, check the pump fluid level and add as necessary.

Combination Valve {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Combination Valve

The standard combination valve is located in the engine compartment, directly under the master cylinder. It consists of 3 sections: the metering valve, the warning switch and the proportioning valve.

The metering section limits the pressure to the front disc brakes until a predetermined front input pressure is reached, enough to overcome the rear shoe retractor springs. Under 3 psi, there is no restriction of the inlet pressures; the pressures are allowed to equalize during the no brake period.

The proportioning section controls the outlet pressure to the rear brakes after a predetermined rear input pressure has been reached; this feature is provided for vehicles with light loads, to prevent rear wheel lock-up. The By-pass feature of this valve assures full system pressure to the rear brakes in the event of a front brake system malfunction. Also, full front pressure is retained if the rear system malfunctions.

The pressure differential warning switch is designed to constantly compare the front and the rear brake pressures; if one should malfunction, the warning light (on the dash) will turn On. The valve and switch are designed to lock On the warning position once the malfunction has occurred. The only way the light can be turned OFF is to repair the malfunction and apply a brake line force of 450 psi.

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REMOVAL & INSTALLATION

Ü See figures 33, 34

1. Disconnect and plug the hydraulic lines from the combination valve to prevent the loss of brake fluid or dirt from entering the system.
2. Disconnect the electrical connector from the combination valve.
3. Remove the combination valve-to-bracket nuts and the combination valve from the vehicle.

   Ä The combination valve is not repairable and must be replaced as a complete assembly.

To install:

4. Use a new combination valve (if defective) and install.
5. Torque the combination valve-to-bracket nuts to 37 ft. lbs. (49 Nm).
6. Reconnect the electrical connector to the combination valve. Bleed the brake system.

Figure 33.
Cut away view of a combination valve. The style of valve can vary

{ewc GSMVIMG,GSMVIMG, !88269g10.bmp}

88269g10

Figure 34.
On most applications, the combination valve is bolted to a bracket attached to the master cylinder mounting studs

{ewc GSMVIMG,GSMVIMG, !88269g11.bmp}

88269g11

SWITCH CENTERING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SWITCH CENTERING

Whenever work on the brake system is done, it is possible that the brake warning light will come on and refuse to go off when the work is finished. In this event, the switch must be centered.

1. Raise and support the truck.
2. Attach a bleeder hose to the rear brake bleed screw and immerse the other end of the hose in a jar of clean brake fluid.
3. Be sure that the master cylinder is full.
4. When bleeding the brakes, the pin in the end of the metering portion of the combination valve must be held in the open position (with the tool described in the brake bleeding section installed under the pin mounting bolt). Be sure to tighten the bolt after removing the tool.
5. Turn the ignition key **ON**. Open the bleed screw while an assistant applies heavy pressure on the brake pedal. The warning lamp should light. Close the bleed screw before the helper releases the pedal.
6. To reset the switch, apply heavy pressure to the pedal. This will apply hydraulic pressure to the switch which will re-center it.
7. Repeat Step 5 for the front bleed screw.
8. Turn the ignition **OFF** and lower the truck.

   Ä If the warning lamp does not light during Step 5, the switch is defective and must be replaced.

Brake Pipes and Hoses {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Brake Pipes and Hoses

REMOVAL & INSTALLATION

Flexible Hoses

Ü See figures 35, 36, 37, 38, 39

Flexible hoses are installed between the frame-to-front calipers and the frame-to-rear differential.

1. Using a wire brush, clean the dirt and/or grease from both ends of the hose fittings.
2. Disconnect the steel pipes from the flexible hose.
3. To remove the brake hose from the front brake caliper or the rear differential, perform the following procedures:
   a. Remove the brake hose-to-frame bracket retaining clip.
   b. Remove the brake hose-to-brake caliper or differential junction block bolt.
   c. Remove the brake hose and the gaskets from the vehicle.

   Ä After disconnecting the brake hose(s) from the fittings, be sure to plug the fittings to keep the fluid from discharging or dirt from entering the system.
4. Clean and inspect the brake hose(s) for cracking, chafing or road damage; replace the hose(s) if any signs are observed.

To install:

5. Using new flexible hose-to-caliper gaskets, install the flexible hose(s) and reverse the removal procedures. Torque the flexible hose(s)-to-front caliper bolt(s) to 32 ft. lbs. (44 Nm) and all other brake pipe fittings to 13 ft. lbs. (16 Nm).
6. Bleed the brake system.

   Ä Be sure that the hoses do not make contact with any of the suspension components.

Figure 35.
Front brake hose routing-Two wheel drive

{ewc GSMVIMG,GSMVIMG, !88269g12.bmp}

88269g12

Figure 36.
Front brake hose routing-All wheel drive

{ewc GSMVIMG,GSMVIMG, !88269g48.bmp}

88269g48

Figure 37.
Rear brake hose routing

{ewc GSMVIMG,GSMVIMG, !88269g13.bmp}

88269g13

Figure 38.
You don't need to use a flare wrench to remove a banjo fitting

{ewc GSMVIMG,GSMVIMG, !88269p28.bmp}

88269p28

Figure 39.
Always replace the crush gaskets every time the connection is disassembled

{ewc GSMVIMG,GSMVIMG, !88269p29.bmp}

88269p29

Steel Pipes {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Steel Pipes

Ü See figures 40, 41, 42

When replacing the steel brake pipes, always use steel piping which is designed to withstand high pressure, resist corrosion and is of the same size.

**Caution
Never use copper tubing, for it is subject to fatigue, cracking, and/or corrosion, which will result in brake line failure.

Ä The following procedure requires the use of the GM Tube Cutter tool No. J-23533 or equivalent, and the GM Flaring tool No. J-23530 or equivalent.

1. Disconnect the steel brake pipe(s) from the flexible hose connections or the rear wheel cylinders; be sure to remove any retaining clips.
2. Remove the steel brake pipe from the vehicle.
3. Using new steel pipe (same size) and a tube cutter, cut the pipe to length; be sure to add 3mm ($^1/8$ in.) for each flare.

Ä Be sure to install the correct pipe fittings onto the tube before forming any flares.

4. Using a double-flare tool, follow the instructions that come with the tool to form double flares on the ends of the pipes.
5. Using a small pipe bending tool, bend the pipe to match the contour of the pipe which was removed.

7. To install, reverse the removal procedures. Bleed the hydraulic system.

Figure 40.
Front brake pipe routing-Two wheel drive

{ewc GSMVIMG,GSMVIMG, !88269g49.bmp}

88269g49

Figure 41.
Front brake pipe routing-All wheel drive

{ewc GSMVIMG,GSMVIMG, !88269g50.bmp}

88269g50

Figure 42.
Flare identification

{ewc GSMVIMG,GSMVIMG, !88269g14.bmp}

88269g14

Bleeding {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Bleeding

The hydraulic brake system must be bled any time one of the lines is disconnected or any time air enters the system. If the brake pedal feels spongy upon application, and goes almost to the floor but regains height when pumped, air has entered the system. It must be bled out. Check for leaks that would have allowed the entry of air and repair them before bleeding the system. The correct bleeding sequence is; right rear, left rear, right front and left front.

MANUAL {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

MANUAL

Ü See figures 43, 44, 45

This method of bleeding requires 2 people, one to depress the brake pedal and the other to open the bleeder screws.

Ä The following procedure requires the use of a clear vinyl hose, a glass jar and clean brake fluid.

1. Clean the top of the master cylinder, remove the cover and fill the reservoirs with clean fluid. To prevent squirting fluid, replace the cover.

   Ä On vehicles equipped with front disc brakes, it will be necessary to hold in the metering valve pin during the bleeding procedure. The metering valve is located beneath the master cylinder and the pin is situated under the rubber boot on the end of the valve housing. This may be tapped in or held by an assistant.

2. Fill the master cylinder with brake fluid.
3. Install a box end wrench onto the bleeder screw on the right rear wheel.
4. Attach a length of small diameter, clear vinyl tubing to the bleeder screw. Submerge the other end of the tubing in a glass jar partially filled with clean brake fluid. Make sure the tube fits on the bleeder screw snugly or you may be squirted with brake fluid when the bleeder screw is opened.
5. Have your assistant slowly depress the brake pedal. As this is done, open the bleeder screw $^{1}/2$ turn and allow the fluid to run through the tube. Close the bleeder screw, then return the brake pedal to its fully released position.
6. Repeat this procedure until no bubbles appear in the jar. Refill the master cylinder.
7. Repeat this procedure on the left rear, right front and the left front wheels, in that order. Periodically, refill the master cylinder so that it does not run dry.
8. If the brake warning light is ON, depress the brake pedal firmly. If there is no air in the system, the light will go OFF.

Figure 43.
Keep the end of the hose immersed in clean brake fluid to prevent air from being drawn back into the system

{ewc GSMVIMG,GSMVIMG, !88269g15.bmp}

88269g15

Figure 44.
Make sure that the end of the bleeder hose is below the level of the bleeder screw

{ewc GSMVIMG,GSMVIMG, !88269p17.bmp}

88269p17

Figure 45.
The use of a long handled wrench makes bleeding the rear wheel cylinder easier

{ewc GSMVIMG,GSMVIMG, !88269p18.bmp}

88269p18

PRESSURE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

PRESSURE

Ü See figures 46, 47

Ä The following procedure requires the use of the GM Brake Bleeder Adapter tool No. J-29567 or equivalent, and the GM Combination Valve Depressor tool No. J-35856 or equivalent.

1. Using the GM Brake Bleeder Adapter tool No. J-29567 or equivalent, fill the pressure tank to at least $^{1}/3$ full of brake fluid. Using compressed air, charge the pressure tank to 20-25 psi. (138-172 kPa), then install it onto the master cylinder.
2. Using the GM Combination Valve Depressor tool No. J-35856 or equivalent, install it onto the combination valve to hold the valve open during the bleeding operation.
3. Bleed each wheel cylinder or caliper in the following sequence: right rear, left rear, right front and left front.
4. Connect a hose from the bleeder tank to the adapter at the master cylinder, then open the tank valve.
5. Attach a clear vinyl hose to the brake bleeder screw, then immerse the opposite end into a container partially filled with clean brake fluid.
6. Open the bleeder screw $^{3}/4$ turn and allow the fluid to flow until no air bubbles are seen in the fluid, then close the bleeder screw.
7. Repeat the bleeding process to each wheel.
8. Inspect the brake pedal for sponginess and if necessary, repeat the entire bleeding procedure.
9. Remove the depressor tool from the combination valve and the bleeder adapter from the master cylinder.

9. Refill the master cylinder to the proper level with brake fluid.

Figure 46.
This tool is used to depress the combination valve plunger to allow proper flow of brake fluid during bleeding

{ewc GSMVIMG,GSMVIMG, !88269g17.bmp}

88269g17

Figure 47.
The GM Pressure Bleeder adapter, J-29567 or equivalent, is needed when using this bleeding technique

{ewc GSMVIMG,GSMVIMG, !88269g18.bmp}

88269g18

Anti-Lock Brakes EHCU Valve {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Anti-Lock Brakes EHCU Valve

Ü See figure 48

Ä The rear wheel and 4-wheel anti-lock brakes are bled the same way as the standard brakes, pertaining to the master cylinder and each wheel cylinder. The difference is in the 4-wheel anti-lock system. The Electro-hydraulic Control Unit (EHCU) valve has to be bled after replacement only.

Use the 2 bleed screws on the EHCU valve for bleeding. There are also 2 bleeders on the front of the unit that look like normal brake bleeders. These are NOT the correct bleeders for bleeding the valve and they should not be turned.

1. Bleed the calipers and wheel cylinder first.
2. Install a valve depressor tool J-35856 onto the left high pressure accumulator bleed stem of the EHCU valve.
3. Slowly depress the brake pedal one time and hold. Loosen the left bleeder screw $^1/4$ turn to purge the air from the EHCU valve.
4. Tighten the bleeder screw to 60 inch lbs. (7 Nm) and slowly release the pedal.
5. Wait 15 seconds, then repeat the sequence, purging the EHCU valve.
6. Repeat steps 2-5 at the right side of the EHCU valve.
7. Remove the valve depressor tool.

Figure 48.
The EHCU should need to be bled ONLY after replacement

{ewc GSMVIMG,GSMVIMG, !88269g16.bmp}

88269g16

FRONT DISC BRAKES {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

FRONT DISC BRAKES

****Caution**
Brake shoes contain asbestos, which has been determined to be 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.

Brake Pads

INSPECTION

Ü See figures 49, 50, 51, 52

Brake pads should be inspected once a year or at 7500 miles (12,000 km), which ever occurs first. Check both ends of the outboard shoe, looking in at each end of the caliper; then check the lining thickness on the inboard shoe, looking down through the inspection hole. The lining should be more than $^{1}/32$ in. (0.8mm) thick above the rivet (so that the lining is thicker than the metal backing). Keep in mind that any applicable state inspection standards that are more stringent, take precedence. All 4 pads must be replaced if one shows excessive wear.

Ä All models have a wear indicator that makes a noise when the linings wear to a degree where replacement is necessary. The spring clip is an integral part of the inboard shoe and lining. When the brake pad reaches a certain degree of wear, the clip will contact the rotor and produce a warning noise.

Figure 49.
The brake pad wear warning sensor will squeal once the pad is thin enough that the tab touches the rotor

{ewc GSMVIMG,GSMVIMG, !88269g24.bmp}

88269g24

Figure 50.
Brake pad inspection points

{ewc GSMVIMG,GSMVIMG, !88269g25.bmp}

88269g25

Figure 51.
Get to know what a worn pad looks like versus a new pad

{ewc GSMVIMG,GSMVIMG, !88269g26.bmp}

88269g26

Figure 52.
Measure the thickness of the friction material, not the backing plate

{ewc GSMVIMG,GSMVIMG, !88269p19.bmp}

88269p19

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Brakes

REMOVAL & INSTALLATION

Ü See figures 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66

Ä The following procedure requires the use of a C-clamp and slip-joint lock pliers.

1. Siphon off about $^{2}/3$ of the brake fluid from the master cylinder reservoirs.

****Caution**

The insertion of thicker replacement pads will push the piston back into its bore and will cause a full master cylinder reservoir to overflow, possibly causing paint damage. In addition to siphoning off fluid, it would be wise to keep the reservoir cover on during pad replacement.

2. Raise and support the front of the vehicle on jackstands. Remove the wheels.

Ä When replacing the pads on just one wheel, uneven braking will result; always replace the pads on both wheels.

3. Install a C-clamp on the caliper so that the frame side of the clamp rests against the back of the caliper and so the screw end rests against the metal part (shoe) of the outboard pad.
4. Tighten the clamp until the caliper moves enough to bottom the piston in its bore. Remove the clamp.
5. Remove the 2 Allen head caliper mounting bolts enough to allow the caliper to be pulled off the disc.
6. Remove the inboard pad and loosen the outboard pad. Place the caliper where it will not strain the brake hose; it would be best to wire it out of the way.
7. Remove the pad support spring clip from the piston.
8. Remove the 2 bolt ear sleeves and the 4 rubber bushings from the ears.
9. Riveted style brake pads should be replaced when they are worn to within $^{1}/32$ in. (0.8mm) of the rivet heads; bonded style pads should be replaced when they are worn to no less than $^{1}/32$ in. (0.8mm) of the backing plate.
10. Check the inside of the caliper for leakage and the condition of the piston dust boot.

Figure 53.
The standard GM front disc brake

{ewc GSMVIMG,GSMVIMG, !88269p20.bmp}

88269p20

Figure 54.
Exploded view of the caliper and pad components-Two wheel drive

{ewc GSMVIMG,GSMVIMG, !88269g29.bmp}

88269g29

Figure 55.
Exploded view of the caliper and pad components-All wheel drive

{ewc GSMVIMG,GSMVIMG, !88269g65.bmp}

88269g65

Figure 56.
A prybar can be used to press the pads into the caliper enough to remove the caliper . . .

{ewc GSMVIMG,GSMVIMG, !88269g30.bmp}

88269g30

Figure 57.
. . . or a C-clamp applied to the outboard pad will press the piston in the bore without cocking

{ewc GSMVIMG,GSMVIMG, !88269p21.bmp}

88269p21

Figure 58.
Use the proper socket on the caliper bolts. There have been different types of bolt heads used

{ewc GSMVIMG,GSMVIMG, !88269g59.bmp}

88269g59

Figure 59.
The pins are the only thing that hold the caliper to the mount

{ewc GSMVIMG,GSMVIMG, !88269p22.bmp}

88269p22

Figure 60.
Check the pins for corrosion and damage

{ewc GSMVIMG,GSMVIMG, !88269p23.bmp}

88269p23

Figure 61.
Pull the caliper straight off the rotor to remove otherwise it could bind

{ewc GSMVIMG,GSMVIMG, !88269p24.bmp}

88269p24

Figure 62.
Support the caliper so the weight does not pull on the brake line

{ewc GSMVIMG,GSMVIMG, !88269p25.bmp}

88269p25

Figure 63.
Separate the outer pad from the caliper. You may need a small prybar to do this if the fit is tight

{ewc GSMVIMG,GSMVIMG, !88269p26.bmp}

88269p26

Figure 64.
The inner pad is held by this spring. Make sure it is in place before installing the new pad

{ewc GSMVIMG,GSMVIMG, !88269p27.bmp}

88269p27

Figure 65.
Upon installation, the pad will click into place if the retainer spring is installed properly

{ewc GSMVIMG,GSMVIMG, !88269g31.bmp}

88269g31

Figure 66.
An often forgotten step is compressing the brake pad ears. If it isn't done, the pads

can rattle

{ewc GSMVIMG,GSMVIMG, !88269g32.bmp}

88269g32

To install:

11. Lubricate the 2 new sleeves and 4 bushings with a silicone spray.
12. Install the bushings in each caliper ear. Install the 2 sleeves in the 2 inboard ears.
13. Install the pad support spring clip and the old pad into the center of the piston. You will then push this pad down to get the piston flat against the caliper. This part of the job is a hassle and requires an assistant. While the assistant holds the caliper and loosens the bleeder valve to relieve the pressure, obtain a medium pry bar and try to force the old pad inward, making the piston flush with the caliper surface. When it is flush, close the bleeder valve so that no air gets into the system.

    Ä Make sure that the wear sensor is facing toward the rear of the caliper.

14. Place the outboard pad in the caliper with its top ears over the caliper ears and the bottom tab engaged in the caliper cutout.
15. After both pads are installed, lift the caliper and place the bottom edge of the outboard pad on the outer edge of the disc to make sure that there is no clearance between the tab on the bottom of the shoes and the caliper abutment.
16. Place the caliper over the disc, lining up the hole in the caliper ears with the hole in the mounting bracket. Make sure that the brake hose is not kinked.
17. Start the caliper-to-mounting bracket bolts through the sleeves in the inboard caliper ears and through the mounting bracket, making sure that the ends of the bolts pass under the retaining ears of the inboard shoe.
18. Push the mounting bolts through to engage the holes in the outboard shoes and the outboard caliper ears and then threading them into the mounting bracket.
19. Torque the mounting bolts to 37 ft. lbs. (50 Nm). Pump the brake pedal to seat the linings against the rotors.
20. Using a pair of slip-joint locking pliers, place them on the notch on the caliper housing, bend the caliper upper ears until no clearance exists between the shoe and the caliper housing.
21. Install the wheels, lower the vehicle and refill the master cylinder reservoirs with brake fluid. Pump the brake pedal to make sure that it is firm. If it is not, bleed the brakes.

Brake Caliper {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Brake Caliper

REMOVAL & INSTALLATION

Ü See figures 67, 68, 69

1. Remove the brake caliper from the steering knuckle.
2. Disconnect the flexible brake hose-to-caliper bolt, discard the pressure fitting washers, then remove the brake caliper from the vehicle and place it on a work bench.
3. To inspect the caliper assembly, perform the following procedures:
    a. Check the inside of the caliper assembly for signs of leakage; if necessary, replace or rebuild the caliper.
    b. Check the mounting bolts and sleeves for signs of corrosion; if necessary, replace the bolts.

    Ä If the mounting bolts have signs of corrosion, DO NOT attempt to polish away the corrosion.

To install:

4. Use new caliper bushings and sleeves, use Delco® Silicone Lube or equivalent to lubricate the mounting bolts and new brake pads (if necessary).
5. After both pads are installed, lift the caliper and place the bottom edge of the outboard pad on the outer edge of the disc to make sure that there is no clearance between the tab on the bottom of the shoes and the caliper abutment.
6. Place the caliper over the disc, lining up the hole in the caliper ears with the hole in the mounting bracket.
7. Start the caliper-to-mounting bracket bolts through the sleeves in the inboard caliper ears and through the mounting bracket, making sure that the ends of the bolts pass under the retaining ears of the inboard shoe.
8. Push the mounting bolts through to engage the holes in the outboard shoes and the outboard caliper ears, then thread them into the mounting bracket.
9. To complete the installation, use new flexible brake hose-to-caliper washers. Torque the caliper-to-steering knuckle bolts to 30-45 ft. lbs. (41-61 Nm) and the flexible brake hose-to-caliper bolt to 18-30 ft. lbs. (25-41 Nm). Refill the master cylinder reservoirs and bleed the brake system. Pump the brake pedal to seat the linings against the rotors.
10. Using a pair of slip-joint locking pliers, place them on the caliper housing notch, bend the caliper upper ears until no clearance exists between the shoe and the caliper housing.
11. Install the wheels, lower the vehicle. Pump the brake pedal to make sure that it is firm. Road test the vehicle.

Figure 67.
The caliper bolts must pass under the pad retaining ears

{ewc GSMVIMG,GSMVIMG, !88269g28.bmp}

88269g28

Figure 68.
Check the clearance between the caliper and caliper mount. The numbers shown are total clearance, not individual sides-Two wheel drive

{ewc GSMVIMG,GSMVIMG, !88269g61.bmp}

88269g61

Figure 69.
Check the clearance between the caliper and caliper mount. The numbers shown are total clearance, not individual sides-All wheel drive

{ewc GSMVIMG,GSMVIMG, !88269g64.bmp}

88269g64

OVERHAUL {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Brakes

OVERHAUL

Ü See figures 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81

1. Remove the brake caliper from the vehicle.
2. Remove the inlet fitting from the brake caliper. Cap all openings to prevent system contamination or excessive fluid leakage.
3. Position the caliper on a work bench and place clean shop cloths in the caliper opening. Using compressed air, force the piston from its bore.

   ****Caution**
   DO NOT apply too much air pressure to the bore, for the piston may jump out, causing damage to the piston and/or the operator.

4. Remove and discard the piston boot and seal (with a plastic or wooden tool).
5. Clean all of the parts with non-mineral based solvent and blow dry with compressed air. Replace the rubber parts with those in the brake service kit.
6. Inspect the piston and the caliper bore for damage or corrosion. Replace the caliper and/or the piston (if necessary).
7. Remove the bleeder screw and its rubber cap.
8. Inspect the guide pins for corrosion, replace them (if necessary). When installing the guide pins, coat them with silicone grease.
9. To install, perform the following procedures:
   a. Maintain the proper tolerances.
   b. Lubricate the piston, caliper and seal with clean brake fluid and install those parts.

   Ä When positioning the piston dust boot on the piston, it goes in the groove nearest the piston's flat end with the lap facing the largest end. If placement is correct, the seal lips will be in the groove and not extend over the groove's step.

   c. Replace the mounting bolts and torque to 22-25 ft. lbs. (30-34 Nm).
10. Bleed the brake system after installation and pump the pedal before moving the vehicle.

Figure 70.
Exploded view of a brake caliper

{ewc GSMVIMG,GSMVIMG, !88269g62.bmp}

88269g62

Figure 71.
Use low pressure compressed air to remove the piston, but be sure to pad the opposite side of the caliper to prevent the piston from flying out . . .

{ewc GSMVIMG,GSMVIMG, !88269g33.bmp}

88269g33

Figure 72.
. . . a block of wood provides a suitable protective cushion for the piston

{ewc GSMVIMG,GSMVIMG, !88269p31.bmp}

88269p31

Figure 73.
Pull the piston out and away from the dust boot

{ewc GSMVIMG,GSMVIMG, !88269p32.bmp}

88269p32

Figure 74.
Check the surface of the piston for damage and corrosion

{ewc GSMVIMG,GSMVIMG, !88269p33.bmp}

88269p33

Figure 75.
Inspect the caliper for obvious defects before continuing the rebuild

{ewc GSMVIMG,GSMVIMG, !88269p34.bmp}

88269p34

Figure 76.
Use a small prytool to remove the dust boot

{ewc GSMVIMG,GSMVIMG, !88269g34.bmp}

88269g34

Figure 77.
The dust seal needs to be replaced every time it is removed

{ewc GSMVIMG,GSMVIMG, !88269p35.bmp}

88269p35

Figure 78.
Be careful when removing the piston seal not to nick or scratch the bore and seal seating area

{ewc GSMVIMG,GSMVIMG, !88269p36.bmp}

88269p36

Figure 79.
Use a proper tool, such as this, to install the dust boot . . .

{ewc GSMVIMG,GSMVIMG, !88269g63.bmp}

88269g63

Figure 80.
. . . using a dust boot tool will help make sure the boot is properly seated

{ewc GSMVIMG,GSMVIMG, !88269p37.bmp}

88269p37

Figure 81.
Before installation, check that the old crush gasket isn't stuck at the inlet port

{ewc GSMVIMG,GSMVIMG, !88269p30.bmp}

88269p30

Brake Disc (Rotor) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Brake Disc (Rotor)

The 2-wheel drive brake disc rotor and the wheel bearing hub assembly are designed as one piece; therefore, to remove the brake disc, remove the wheel bearing assembly.

The 4-wheel drive brake disc rotor is separate from the hub assembly and can be removed without removing the hub and bearings assembly. The hub and bearing assembly is non-serviceable and has to be replaced as a unit.

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Brakes

REMOVAL & INSTALLATION

2WD Model

Ü See figure 82

1. Raise and support the front of the vehicle safely using jackstands.
2. Remove the tire and wheel assembly.
3. Remove the brake caliper mounting bolts and carefully remove the caliper (along with the brake pads) from the rotor. Do not disconnect the brake line; instead wire the caliper out of the way with the line still connected.

   Ä Once the rotor is removed from the vehicle the wheel bearings may be cleaned and repacked or the bearings and races may be replaced. For more information, please refer to the wheel bearing procedures in Section 1 **of this manual.**

4. Carefully pry out the grease cap, then remove the cotter pin, spindle nut, and washer. Remove the hub, being careful not to drop the outer wheel bearings. As the hub is pulled forward, the outer wheel bearings will often fall forward and they may easily be removed at this time.

To install:

5. Carefully install the wheel hub over the spindle.
6. Using your hands, firmly press the outer bearing into the hub.
7. Loosely install the spindle washer and nut, but do not install the cotter pin or dust cap at this time.
8. Install the brake caliper.
9. Install the tire and wheel assembly.
10. Properly adjust the wheel bearings:
    a. Spin the wheel forward by hand and tighten the nut to 12 ft. lbs. (16 Nm) in order to fully seat the bearings and remove any burrs from the threads.
    b. Back off the nut until it is just loose, then finger-tighten the nut.
    c. Loosen the nut $^{1}/4$-$^{1}/2$ turn until either hole in the spindle lines up with a slot in the nut, then install a new cotter pin. This may appear to be too loose, but it is the correct adjustment.
    d. Proper adjustment creates 0.001-0.005 in. (0.025-0.127mm) end-play.
11. Install the dust cap.

11\. Install the wheel/hub cover, then remove the supports and carefully lower the vehicle.

Figure 82.
Exploded view of brake assembly-Two wheel drive

{ewc GSMVIMG,GSMVIMG, !88269g38.bmp}

88269g38

4WD Model {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

4WD Model

Ü See figure 83

1. Raise and support the front of the truck safely using jackstands under the frame.
2. Remove the tire and wheel assembly.
3. Remove the brake caliper mounting bolts and carefully remove the caliper (along with the brake pads) from the rotor. Do not disconnect the brake line; instead wire the caliper out of the way with the line still connected.
4. If equipped, remove the lockwashers from the hub studs in order to free the rotor.
5. Remove the brake disc (rotor) from the wheel hub.

To install:

6. Inspect the disc for nicks, scores and/or damage, then replace if necessary.
7. Install the disc over the wheel hub studs.
8. If used, install the lockwashers over the studs.
9. Install the brake caliper and pads. For details, please refer to the caliper procedure located earlier in this section.
10. Install the tire and wheel assembly.
12. Remove the jackstands and carefully lower the vehicle. DO NOT attempt to move the vehicle unless a firm brake pedal is felt.

Figure 83.
Rotor, hub and bearing assembly-All wheel drive

{ewc GSMVIMG,GSMVIMG, !88269g36.bmp}

88269g36

INSPECTION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

INSPECTION

Ü See figure 84

1. Raise and support the front of the vehicle on jackstands. Remove the wheels.
2. To check the disc runout, perform the following procedures:
    a. Using a dial indicator, secure and position it so that the button contacts the disc about 1 in. (25mm) from the outer edge.
    b. Rotate the disc. The lateral reading should not exceed 0.004 in. (0.1mm). If the reading is excessive, recondition or replace the disc.
3. To check the disc parallelism, perform the following procedures:
    a. Using a micrometer, check the disc thickness at 4 locations around the disc, at the same distance from the edge.
    b. The thickness should not vary more than 0.0005 in. (0.013mm). If the readings are excessive, recondition or replace the disc.
4. The surface finish must be relatively smooth to avoid pulling and erratic performance, also, to extend the lining life. Light rotor surface scoring of up to 0.015 in. (0.38mm) in depth, can be tolerated. If the scoring depths are excessive, refinish or replace the rotor.

Figure 84.
Use a dial indicator to determine brake disc runout

{ewc GSMVIMG,GSMVIMG, !88269g37.bmp}

88269g37

REAR DRUM BRAKES {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REAR DRUM BRAKES

Caution
Brake shoes contain asbestos, which has been determined to be 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.

Brake Drums

REMOVAL & INSTALLATION

1. Raise and support the rear of the vehicle on jackstands.
2. Remove the wheel and tire assemblies.
3. Pull the brake drum off. It may by necessary to gently tap the rear edges of the drum to start it off the studs.
4. If extreme resistance to removal is encountered, it will be necessary to retract the adjusting screw. Remove the access hole cover from the backing plate and turn the adjuster to retract the linings away from the drum.
5. Install a replacement hole cover before reinstalling the drum.
6. Install the drums in the same position on the hub as removed.

Ä The rear wheel bearings are not adjustable, they are serviced by replacement ONLY.

INSPECTION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

INSPECTION

1. Check the drums for any cracks, scores, grooves or an out-of-round condition; if it is cracked, replace it. Slight scores can be removed with fine emery cloth while extensive scoring requires turning the drum on a lathe.
2. Never have a drum turned more than 0.060 in. (1.5mm).

Brake Shoes {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Brake Shoes

INSPECTION

Remove the drum and inspect the lining thickness of both brake shoes. The rear brake shoes should be replaced if the lining is less than $^{1}/16$ in. (1.5mm) at the lowest point (bonded linings) or above the rivet heads (riveted linings) on the brake shoe. However, these lining thickness measurements may disagree with your state inspections laws.

Ä Brake shoes should always be replaced in sets.

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Brakes

REMOVAL & INSTALLATION

Ü See figures 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98

Ä The following procedure requires the use of the GM Brake Spring Pliers tool No. J-8057 or equivalent.

1. Raise and support the rear of the vehicle on jackstands.
2. Slacken the parking brake cable.
3. Remove the rear wheels and the brake drum.
4. Using the GM Brake Spring Pliers tool No. J-8057 or equivalent, disconnect the brake shoe return springs, the actuator pullback spring, the hold-down pins/springs and the actuator assembly.

   Ä Special brake spring tools are available from the auto supply stores, which will ease the replacement of the spring and anchor pin, but the job may still be performed with common hand tools.

5. Disconnect the adjusting mechanism and spring, then remove the primary shoe. The primary shoe has a shorter lining than the secondary and is mounted at the front of the wheel.
6. Disconnect the parking brake lever from the secondary shoe and remove the shoe.

To install:

7. Clean and inspect all of the brake parts.
8. Check the wheel cylinders for seal condition and leaking.
9. If necessary, repack the wheel bearings and replace the oil seals.
10. Inspect the replacement shoes for nicks or burrs, lubricate the backing plate contact points, the brake cable, the levers and adjusting screws, then reassemble them.
11. Make sure that the right and left hand adjusting screws are not mixed. You can prevent this by working on one side at a time. This will also provide you with a reference for reassembly. The star wheel should be nearest to the secondary shoe when correctly installed.
12. Using lithium grease or equivalent, lubricate the shoe pads (on the backing plate) and the adjusting screw threads.
13. Install the springs and adjusters. When completed, make an initial adjustment as previously described.

Figure 85.
Drum brake components

{ewc GSMVIMG,GSMVIMG, !88269g39.bmp}

88269g39

Figure 86.
The standard GM drum brake

{ewc GSMVIMG,GSMVIMG, !88269p38.bmp}

88269p38

Figure 87.
Use proper brake tools when removing parts like the return springs

{ewc GSMVIMG,GSMVIMG, !88269p39.bmp}

88269p39

Figure 88.
Note the direction in which each spring and component is installed for ease during installation

{ewc GSMVIMG,GSMVIMG, !88269p40.bmp}

88269p40

Figure 89.
Sometimes tools such as needle nosed pliers allow you additionally needed flexibility

{ewc GSMVIMG,GSMVIMG, !88269p41.bmp}

88269p41

Figure 90.
Use this tool by placing the socket over the pin and rotating until the tang lifts the spring or linkage off

{ewc GSMVIMG,GSMVIMG, !88269p42.bmp}

88269p42

Figure 91.
Do not lose this plate. Nothing holds it in place once the springs are removed

{ewc GSMVIMG,GSMVIMG, !88269p43.bmp}

88269p43

Figure 92.
A brake shoe retention pin removal tool makes the job much easier

{ewc GSMVIMG,GSMVIMG, !88269p44.bmp}

88269p44

Figure 93.
Press on the back side of the pin while using the tool to allow the pin to be released from the lock

{ewc GSMVIMG,GSMVIMG, !88269p45.bmp}

88269p45

Figure 94.
Try to remove most of the parts as entire assemblies. This will ease installation

{ewc GSMVIMG,GSMVIMG, !88269p46.bmp}

88269p46

Figure 95.
The shoes can come out together at this point and be disassembled on the bench

{ewc GSMVIMG,GSMVIMG, !88269p47.bmp}

88269p47

Figure 96.
Separate the parking brake lever from the shoes to free the shoes from the brake assembly

{ewc GSMVIMG,GSMVIMG, !88269p48.bmp}

88269p48

Figure 97.
After the shoes have been removed, this link will be one part left behind

{ewc GSMVIMG,GSMVIMG, !88269p49.bmp}

88269p49

Figure 98.
Drum brake components ready for inspection
{ewc GSMVIMG,GSMVIMG, !88269p50.bmp}

88269p50

Wheel Cylinders {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Wheel Cylinders

REMOVAL & INSTALLATION

Ü See figures 99, 100, 101

1. Remove the brake shoe assembly from the backing plate.
2. Clean away all of the dirt, crud and foreign material from around the wheel cylinder. It is important that dirt be kept away from the brake line when the cylinder is disconnected.
3. Disconnect and plug the inlet tube at the wheel cylinder.
4. Remove the wheel cylinder-to-backing plate bolts and the wheel cylinder from the backing plate.

   Ä If the wheel cylinder is sticking, use a hammer and a punch to drive the wheel cylinder from the backing plate.

To install:

5. Install the wheel cylinder and bolts. Torque the wheel cylinder-to-backing plate bolts to 13 ft. lbs. (18 Nm).
6. Install the rear brake shoes and hardware as outlined earlier in this Section.
7. Bleed the rear brake system. Adjust the rear brake assembly.

Figure 99.
Wheel cylinder mounting

{ewc GSMVIMG,GSMVIMG, !88269g41.bmp}

88269g41

Figure 100.
Only 2 bolts hold the wheel cylinder in place (Plug the line to prevent system contamination)

{ewc GSMVIMG,GSMVIMG, !88269p51.bmp}

88269p51

Figure 101.
Exploded view of the wheel cylinder

{ewc GSMVIMG,GSMVIMG, !88269g40.bmp}

88269g40

PARKING BRAKE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Brakes

PARKING BRAKE

Pedal Assembly

REMOVAL & INSTALLATION

Ü See figure 102

1. Disconnect the negative battery cable.
2. Release the parking brake before removal.
3. Remove the instrument panel and dash assembly as necessary for access.
4. Disconnect the release rod, and parking brake lamp switch.
5. Remove the bolts and disconnect the cable assembly.
6. Remove the pedal assembly from under the instrument panel.

To install:

7. Connect the cable assembly and install the pedal.
8. Install the bolts and torque to 18 ft. lbs. (24 Nm).
9. Connect the switch and release rod.
10. If removed, install the instrument panel and dash components.
11. Adjust the parking brake cable.
12. Connect the negative battery cable and check operation.

Figure 102.
Parking brake pedal assembly

{ewc GSMVIMG,GSMVIMG, !88269g42.bmp}

88269g42

Front Cable {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Front Cable

REMOVAL & INSTALLATION

Ü See figures 103, 104

1. Raise and support the front of the vehicle on jackstands.
2. Under the left center of the vehicle, loosen the cable equalizer assembly.
3. Separate the front cable connector from the equalizer cable.
4. Remove the front cable retaining bolts and clips, then bend the retaining fingers.
5. Disconnect the front cable from the parking pedal assembly and the cable from the vehicle.

To install:

6. To install the front cable, attach a piece of wire to the cable, fish it through the cowl and connect it to the equalizer cable. Adjust the parking brake.
7. Lower the vehicle and check the parking brake operation.

Figure 103.
Front parking brake cable routing

{ewc GSMVIMG,GSMVIMG, !88269g67.bmp}

88269g67

Figure 104.
Front parking brake cable bracket

{ewc GSMVIMG,GSMVIMG, !88269p52.bmp}

88269p52

Rear Cable {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Rear Cable

REMOVAL & INSTALLATION

Ü See figures 105, 106, 107, 108

1. Raise and support the rear of the vehicle on jackstands.
2. Under the left center of the vehicle, loosen the cable equalizer assembly.
3. Separate the front cable connector from the equalizer cable.
4. Remove the brake shoes.
5. At the backing plate, bend the cable retaining fingers.
6. Disconnect the rear cable(s) from the secondary brake shoe(s) and the cable(s) from the vehicle.

To install:

7. To install the rear cable(s), insert the cable through the backing plate and engage it with the secondary brake shoe.
8. Connect the cable to the equalizer cable.
9. Adjust the parking brake.

   Ä When installing the rear parking brake cables, make sure that the retaining fingers are completely through the backing plate.

10. Lower the vehicle and check the parking brake operation.

Figure 105.
Equalizer assembly

{ewc GSMVIMG,GSMVIMG, !88269g43.bmp}

88269g43

Figure 106.
Equalizer and rear cable assembly

{ewc GSMVIMG,GSMVIMG, !88269g66.bmp}

88269g66

Figure 107.
Pull out on the cable end to free the lever from the cable

{ewc GSMVIMG,GSMVIMG, !88269p53.bmp}

88269p53

Figure 108.
Use a box end wrench to press in the clips to free the cable from the backing plate

{ewc GSMVIMG,GSMVIMG, !88269p54.bmp}

88269p54

ADJUSTMENT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Brakes

ADJUSTMENT

Ü See figure 109

Ä Before adjusting the parking brakes, check the condition of the service brakes; replace any necessary parts.

1. Block the front wheels.
2. Raise and support the rear of the vehicle on jackstands.
3. Under the left center of the vehicle, loosen the equalizer.
4. Position the parking brake pedal on the second click (2 ratchet clicks).
5. Turn the cable equalizer until the rear wheel drags (when turned by hand).
6. Tighten the equalizer lock nut.
7. Release the parking brake pedal, then test it; the correct adjustment should be 9-16 clicks.

Figure 109.
Adjusting the parking brake at the equalizer

{ewc GSMVIMG,GSMVIMG, !88269p55.bmp}

88269p55

ANTI-LOCK BRAKE SYSTEMS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ANTI-LOCK BRAKE SYSTEMS

General Information

Ü See figures 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123

There are two basic types of anti-lock systems available for this vehicle; a Rear Wheel Anti-Lock (RWAL) brake system and 4 Wheel Anti-Lock (4WAL) brake system. The 4WAL system has two variations; a 3 sensor system and a 4 sensor system. The 2WD vehicles will be equipped with the 3 sensor system, but the AWD vehicles can be equipped with either. The systems are easily identified by looking at the rear wheels for a sensor harness. If there is a sensor harness and thus, rear wheel sensors, it is the 4 sensor system. If the vehicle is not equipped with a harness, it is the 3 sensor system. The 4 sensor system takes it speed references from each of the wheels. The 3 sensor system takes its speed references from each of the front wheels and the vehicle speed sensor located in the transmission (2WD) or the transfer case (AWD).

The RWAL system components consist of the Vehicle Speed Sensor (VSS), the Electronic Control Unit (ECU), the isolation/dump valve and the Vehicle Speed Sensor Buffer (also known as the Digital Ratio Adapter). The ECU also receives signals from various brake switches.

The 4WAL system components consist of the Electro-Hydraulic Control Unit (ECHU) valve (also known as the Brake Pressure Modulator Valve or BPMV), the wheel speed sensors, Vehicle Speed Sensor (VSS) on 3 sensor systems and the VSS Buffer.

Figure 110.
RWAL brake system diagram

{ewc GSMVIMG,GSMVIMG, !88269g80.bmp}

88269g80

Figure 111.
RWAL wiring diagram

{ewc GSMVIMG,GSMVIMG, !88269g81.bmp}

88269g81

Figure 112.
RWAL connector pinouts

{ewc GSMVIMG,GSMVIMG, !88269g82.bmp}

88269g82

Figure 113.
4WAL hydraulic system-1996 shown

{ewc GSMVIMG,GSMVIMG, !88269g83.bmp}

88269g83

Figure 114.
4WAL Component locations-except 1996 models

{ewc GSMVIMG,GSMVIMG, !88269g71.bmp}

88269g71

Figure 115.
4WAL Component locations-1996 models

{ewc GSMVIMG,GSMVIMG, !88269g72.bmp}

88269g72

Figure 116.
Three sensor 4WAL brake system diagram-Except 1996 models

{ewc GSMVIMG,GSMVIMG, !88269g84.bmp}

88269g84

Figure 117.
Four sensor 4WAL brake system diagram-Except 1996 models

{ewc GSMVIMG,GSMVIMG, !88269g85.bmp}

88269g85

Figure 118.
Three sensor 4WAL brake system wiring diagram-Except 1996 models

{ewc GSMVIMG,GSMVIMG, !88269g86.bmp}

88269g86

Figure 119.
Four sensor 4WAL brake system wiring diagram-Except 1996 models

{ewc GSMVIMG,GSMVIMG, !88269g87.bmp}

88269g87

Figure 120.
4WAL connector pinouts-Except 1996 models

{ewc GSMVIMG,GSMVIMG, !88269g88.bmp}

88269g88

Figure 121.
4WAL brake system diagram-1996 models

{ewc GSMVIMG,GSMVIMG, !88269g89.bmp}

88269g89

Figure 122.
4WAL brake system wiring diagram-1996 models

{ewc GSMVIMG,GSMVIMG, !88269g90.bmp}

88269g90

Figure 123.
4WAL brake system connector pinouts-1996 models

{ewc GSMVIMG,GSMVIMG, !88269g91.bmp}

88269g91

EHCU Valve/BPMV (4WAL) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

EHCU Valve/BPMV (4WAL)

REMOVAL & INSTALLATION

Except 1996 Models

Ü See figures 124, 125

The EHCU valve is not serviceable. Replace the valve only when defective.

1. Disconnect the negative battery cable.
2. Disconnect the intermediate steering shaft from the steering column.
3. Disconnect the brake lines from the bottom of the combination valve.
4. Disconnect the electrical connectors from the master cylinder and EHCU.
5. Remove the master cylinder and combination valve.
6. Disconnect the brake lines from the EHCU using a flare nut wrench.
7. Remove the bolts, nuts and EHCU from the vehicle.

To install:

8. Install the EHCU onto the bracket. Torque the mounting bolt to 33 ft. lbs. (45 Nm) and the nuts to 20 ft. lbs. (27 Nm).
9. Connect the electrical connectors and hydraulic lines. Torque the line fittings to 16 ft. lbs. (25 Nm).
10. Install the master cylinder, combination valve and hydraulic lines.
11. Reconnect the intermediate steering shaft.
12. Bleed the system and the EHCU.
13. Connect the negative battery cable, pump the brakes before road test and road test

Figure 124.
EHCU/BPMV mounting

{ewc GSMVIMG,GSMVIMG, !88269g19.bmp}

88269g19

Figure 125.
ECHU/BPMV brake line connections

{ewc GSMVIMG,GSMVIMG, !88269g68.bmp}

88269g68

1996 Models {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

1996 Models

Ü See figures 126, 127

1. Disconnect the negative battery cable.
2. Raise and safely support the vehicle.
3. Remove the two 13mm bolts that hold the unit to the bracket.
4. Unplug the electrical connectors from the unit.
5. Using a flare wrench, disconnect the hydraulic lines from the unit.
6. Remove the unit from the vehicle.

To install:

7. Install the unit in the vehicle and connect the hydraulic lines. Torque the fittings to 18 ft. lbs. (24 Nm).
8. Install the two 13mm mounting bolts and torque to 84 inch lbs. (9 Nm).
9. Plug in the electrical connectors.
10. Connect the negative battery cable.
11. Bleed the hydraulic system.

11. Lower the vehicle.

Figure 126.
EHCU/BPMV mounting-1996 models

{ewc GSMVIMG,GSMVIMG, !88269g69.bmp}

88269g69

Figure 127.
EHCU/BPMV exploded view-1996 models

{ewc GSMVIMG,GSMVIMG, !88269g70.bmp}

88269g70

Electronic Control Unit (RWAL) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Electronic Control Unit (RWAL)

REMOVAL & INSTALLATION

Ü See figure 128

The ECU is not serviceable. Replace the unit only when defective.

Ä Do not touch the electrical connections and pins or allow them to come in contact with brake fluid as this may damage the ECU.

1. Disconnect the negative battery cable and ECU connectors.
2. Remove the ECU by prying the tab at the rear of the ECU and pulling it toward the front of the vehicle.

To install:

3. Install the ECU by sliding the unit into the bracket until the tab locks into the hole.
4. Connect the electrical connectors and negative battery cable.

Figure 128.
Electronic control unit and isolation/dump valve mounting location-RWAL

{ewc GSMVIMG,GSMVIMG, !88269g20.bmp}

88269g20

Isolation/Dump Valve {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Isolation/Dump Valve

TESTING

1. Disconnect the negative battery cable.
2. Disconnect the isolation/dump valve harness from the ECU.
3. Check the dump valve coil resistance between terminals B and D. If the resistance is greater than 3.0 ohms, replace the assembly. The resistance should be between 1.0 and 3.0 ohms.
4. Check the isolation valve coil resistance between terminals A and D. The resistance should be between 3.0 and 6.0 ohms. Replace the assembly if the resistance is above 6.0 ohms.
5. Check the resistance of the anti-lock valve switch between terminals C and D and then check it between C and the assembly body. If the resistance is less than 50,000 ohms in either test, replace the assembly.

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Brakes

REMOVAL & INSTALLATION

Ü See figure 128

The isolation/dump valve is not serviceable. Replace the unit only when defective.

1. Disconnect the negative battery cable.
2. Disconnect the brake line fittings using a flare nut wrench.
3. Disconnect the bottom electrical connector from the ECU. Do not allow the isolation/dump valve to hang by the pigtail.
4. Remove the valve from the vehicle.

To install:

5. Install the valve and torque the bolts to 21 ft. lbs. (29 Nm).
6. Connect the electrical connectors and reconnect the brake lines using a flare nut wrench. Torque the fittings to 18 ft. lbs. (24 Nm).
7. Connect the negative battery cable and bleed the system.

Front Wheel Speed Sensor {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Brakes

Front Wheel Speed Sensor

TESTING

Ü See figures 129, 130

1. Disconnect the negative battery cable.
2. Raise the vehicle and support with jackstands. Remove the wheel and tire assembly.
3. Disconnect the front wheel speed sensor.
4. Measure the resistance of the sensor and compare to the chart.
5. Replace the sensor if the resistance does not meet specification.

Figure 129.
Front wheel speed sensor resistance chart-Non-integral sensors
{ewc GSMVIMG,GSMVIMG, !88269g76.bmp}

88269g76

Figure 130.
Front wheel speed sensor resistance chart-Integral sensors
{ewc GSMVIMG,GSMVIMG, !88269g77.bmp}

88269g77

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Brakes

REMOVAL & INSTALLATION

2-Wheel Drive

Ü See figures 131, 132, 133, 134, 135

1. Disconnect the negative battery cable.
2. Raise the vehicle and support with jackstands. Remove the wheel and tire assembly.

****Caution**
Some brake pads contain asbestos, which has been determined to be 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.

3. Remove the brake caliper, hub and rotor.
4. Disconnect the sensor electrical connector.
5. Remove the splash shield with the sensor from the steering knuckle.

To install:

6. Install the splash shield with the sensor onto the steering knuckle and torque the bolts to 11 ft. lbs. (15 Nm).
7. Connect the sensor wire.
8. Install the hub, rotor and caliper.
9. Install the front wheel and torque the lug nuts to 100 ft. lbs. (136 Nm).
10. Connect the negative battery cable and check operation.

Figure 131.
Front wheel speed sensor-2WD

{ewc GSMVIMG,GSMVIMG, !88269g21.bmp}

88269g21

Figure 132.
Sensor wire routing-2WD

{ewc GSMVIMG,GSMVIMG, !88269g73.bmp}

88269g73

Figure 133.
The front wheel speed sensor is accessible after removing the hub and rotor

{ewc GSMVIMG,GSMVIMG, !88269p56.bmp}

88269p56

Figure 134.
Simply remove the two mounting bolts to replace the sensor

{ewc GSMVIMG,GSMVIMG, !88269p57.bmp}

88269p57

Figure 135.
Pull the sensor off the backing plate and route the wires through the opening

{ewc GSMVIMG,GSMVIMG, !88269p58.bmp}

88269p58

4-Wheel Drive {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Brakes

4-Wheel Drive

There are two basic styles of front wheel sensor, integral and non-integral. The integral sensor is mounted in the hub bearing assembly, while the non-integral is mounted on the backing plate.

INTEGRAL SENSORS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Brakes

INTEGRAL SENSORS

Ü See figures 136, 137

1. Disconnect the negative battery cable.
2. Raise the vehicle and support with jackstands. Remove the wheel and tire assembly.

****Caution**
Some brake pads contain asbestos, which has been determined to be 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.

3. Remove the brake caliper and rotor.
4. Remove the sensor wire clips from the frame and the control arm.
5. Disconnect the sensor electrical connector.
6. Remove the sensor from the bearing assembly.

To install:

7. Install a new O-ring on the sensor. Do not contaminate the lubricant in the sealed bearing.
8. Install the sensor into the bearing assembly and torque the bolts to 13 ft. lbs. (18 Nm).
9. Connect the sensor wire.
10. Install the sensor wire in the clips..
11. Install the rotor and caliper.
12. Install the front wheel and torque the lug nuts.

12. Connect the negative battery cable and check operation.

Figure 136.
Integral front wheel speed sensor-AWD

{ewc GSMVIMG,GSMVIMG, !88269g75.bmp}

88269g75

Figure 137.
Front wheel speed sensor wire routing-AWD

{ewc GSMVIMG,GSMVIMG, !88269g74.bmp}

88269g74

NON-INTEGRAL SENSORS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Brakes

NON-INTEGRAL SENSORS

Ü See figures 137, 138

1. Disconnect the negative battery cable.
2. Raise the vehicle and support with jackstands. Remove the wheel and tire assembly.

****Caution**
Some brake pads contain asbestos, which has been determined to be 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.

3. Remove the brake caliper and rotor.
4. Remove the hub and bearing assembly.
5. Disconnect the sensor electrical connector.
6. Remove the splash shield with the sensor from the steering knuckle.

To install:

7. Install the splash shield with the sensor onto the steering knuckle and torque the bolts to 11 ft. lbs. (15 Nm).
8. Connect the sensor wire.
9. Install the hub and bearing assembly.
10. Install the rotor and caliper.
11. Install the front wheel and torque the lug nuts to 100 ft. lbs. (136 Nm).
13. Connect the negative battery cable and check operation.

Figure 138.
Non-integral front wheel speed sensor-AWD

{ewc GSMVIMG,GSMVIMG, !88269g22.bmp}

88269g22

Rear Wheel Speed Sensor {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Rear Wheel Speed Sensor

TESTING

Ü See figure 139

1. Disconnect the negative battery cable.
2. Raise the vehicle and support with jackstands. Remove the wheel and tire assembly.
3. Disconnect the rear wheel speed sensor.
4. Measure the resistance of the sensor and compare to the chart.
6. Replace the sensor if the resistance does not meet specification.

Figure 139.
Rear wheel speed sensor resistance chart

{ewc GSMVIMG,GSMVIMG, !88269g76.bmp}

88269g76

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Brakes

REMOVAL & INSTALLATION

Ü See figures 140, 141, 142, 143

1. Disconnect the negative battery cable.
2. Raise the vehicle and support with jackstands.
3. Remove the rear wheels.

****Caution**
Some brake pads contain asbestos, which has been determined to be 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.

4. Remove the brake drum and primary brake show.
5. Disconnect the sensor connector.
6. Remove the 2 bolts and sensor by pulling the wire through the hole in the backing plate.

To install:

7. Install the sensor, bolts and torque to 26 ft. lbs. (35 Nm).
8. Connect the electrical connector.
9. Install the primary shoe, brake drum and rear wheel. Torque the lug nuts to 100 ft. lbs. (136 Nm).
10. Connect the negative battery cable and check operation.

Figure 140.
Rear wheel speed sensor
{ewc GSMVIMG,GSMVIMG, !88269g23.bmp}

88269g23

Figure 141.
Rear wheel speed sensor wiring harness routing
{ewc GSMVIMG,GSMVIMG, !88269g78.bmp}

88269g78

Figure 142.
The tone ring splines need to be clean to work properly
{ewc GSMVIMG,GSMVIMG, !88269p59.bmp}

88269p59

Figure 143.
Rear wheel speed sensor mounting. Axle is removed for clarity
{ewc GSMVIMG,GSMVIMG, !88269p60.bmp}

88269p60

Vehicle Speed Sensor {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Vehicle Speed Sensor

The vehicle speed sensor is mounted in the transmission tail housing on 2WD vehicles and in the transfer case on 4WD vehicles.

TESTING

Ü See figure 144

1. Disconnect the negative battery cable.
2. Raise the vehicle and support with jackstands.
3. Disconnect the vehicle speed sensor wiring.
4. Measure the resistance of the sensor and compare to the chart.
5. Replace the sensor if the resistance does not meet specification.

Figure 144.
Vehicle speed sensor resistance chart

{ewc GSMVIMG,GSMVIMG, !88269g76.bmp}

88269g76

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REMOVAL & INSTALLATION

Ü See figures 145, 146, 147, 148, 149

1. Disconnect the negative battery cable.
2. Raise the vehicle and support with jackstands.
3. Disconnect the sensor connector.
4. Remove the bolt and sensor by pulling the sensor from the transmission or transaxle housing. Fluid will drip out of the opening, so be ready to catch the spillage.

To install:

5. Install a new O-ring on the vehicle speed sensor and coat with transmission fluid.
6. Install the sensor, bolts and torque to 97 inch lbs. (11 Nm).
7. Connect the electrical connector.

7. Connect the negative battery cable and check transaxle or transmission fluid level.

Figure 145.
Vehicle speed sensor mounting

{ewc GSMVIMG,GSMVIMG, !88269g79.bmp}

88269g79

Figure 146.
Unplug the weatherpak connector from the VSS

{ewc GSMVIMG,GSMVIMG, !88269p61.bmp}

88269p61

Figure 147.
The VSS is held by the one bolt and clamp

{ewc GSMVIMG,GSMVIMG, !88269p62.bmp}

88269p62

Figure 148.
Withdraw the VSS from the transmission or transaxle

{ewc GSMVIMG,GSMVIMG, !88269p63.bmp}

88269p63

Figure 149.
Fluid will come out of the VSS opening so be ready to catch the spillage

{ewc GSMVIMG,GSMVIMG, !88269p64.bmp}

88269p64

Self Diagnostics {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Self Diagnostics

READING TROUBLE CODES

Rear Wheel Anti-lock Brakes

Ü See figure 150

The trouble codes are read by jumping terminal **A** and terminal **H** of the ALDL (assembly line diagnostic link) with a jumper wire. Observe the flashing of the brake warning light. The terminals must be jumped for about 20 seconds before the code will begin to flash.

Count the number of short flashes starting from the long flash. Include the long flash as a count. Sometimes the first count sequence will be short, however, following counts will be accurate.

Figure 150.
Pinout of the ALDL connector

{ewc GSMVIMG,GSMVIMG, !88269g92.bmp}

88269g92

If there is more than one failure, only the first recognized code will be retained and flashed.

- Code 1-ECU malfunction
- Code 2-Open isolation valve or faulty ECU
- Code 3-Open dump valve or faulty ECU
- Code 4-Grounded anti-lock valve switch
- Code 5-Excessive dump valve activity during stop
- Code 6-Erratic speed system
- Code 7-Shorted isolation valve or faulty ECU
- Code 8-Shorted dump valve or faulty ECU
- Code 9-Open speed signal circuit
- Code 10-Brake lamp switch circuit
- Code 11-Faulty ECU
- Code 12-Faulty ECU
- Code 13-Faulty ECU
- Code 14-Faulty ECU
- Code 15-Faulty ECU

4-Wheel Anti-lock Brakes {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Brakes

4-Wheel Anti-lock Brakes

EXCEPT 1996 MODELS

Ü See figure 150

The trouble codes are read by jumping terminal **A** and terminal **H** of the ALDL (assembly line diagnostic link) with a jumper wire. Observe the flashing of the ANTI-LOCK warning light. The terminals must be jumped for about 20 seconds before the code will begin to flash.

Count the number of short flashes starting from the long flash. Include the long flash as a count. Sometimes the first count sequence will be short, however, following counts will be accurate.

If there is more than one failure, only the first recognized code will be retained and flashed.

- Code 21-RF speed sensor or circuit open
- Code 22-Missing RF speed signal
- Code 23-Erratic RF speed sensor
- Code 25-LF speed sensor or circuit open
- Code 26-Missing LF speed signal
- Code 27-Erratic LF speed sensor
- Code 29-Simultaneous drop out of front speed sensors
- Code 31-RR speed sensor or circuit open
- Code 32-Missing RR speed signal
- Code 33-Erratic RR speed signal
- Code 35-VSS or LR speed sensor or circuit open
- Code 36-Missing VSS or LR speed sensor or circuit open
- Code 37-Erratic VSS or LR speed sensor signal
- Code 38-Wheel speed error
- Code 41-54-Control valves
- Code 61-63-Reset switches
- Code 65-66-Open or shorted pump motor relay
- Code 67-Open motor circuit or shorted BPMV output
- Code 68-Locked motor or shorted motor circuit
- Code 71-74-Memory errors
- Code 81-Brake switch circuit shorted or open
- Code 86-Shorted anti-lock indicator lamp
- Code 88-Shorted brake warning lamp

1996 MODELS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Brakes

1996 MODELS

Trouble codes on the 1996 vehicles can only be read using a scan tool. It is not possible to read the trouble codes by the flashing light method. The trouble codes are the same as the earlier year vehicles.

CLEARING TROUBLE CODES {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Brakes

CLEARING TROUBLE CODES

On 1985-95 vehicles the trouble codes may be cleared using a Tech I scan tool or by performing the following procedures. On 1996 vehicles, the trouble codes can only be cleared by the Tech 1 scan tool.

1. Turn the ignition switch to the **RUN** position.
2. Use a jumper wire to ground the ALDL terminal **A** to **H** for 2 seconds.
3. Remove the jumper wire for 2 seconds.
4. Repeat the grounding and ungrounding 2 more times.
5. Check that the memory is cleared by making a diagnostic request.
6. Turn the ignition switch **OFF**.

{ewc GSMVIMG,GSMVIMG, !88269c01.bmp}

88269c01

{ewc GSMVIMG,GSMVIMG, !88269c02.bmp}

88269c02

{ewc GSMVIMG,GSMVIMG, !88269c03.bmp}

88269c03

{ewc GSMVIMG,GSMVIMG, !88269c04.bmp}

88269c04

{ewc GSMVIMG,GSMVIMG, !88269c05.bmp}

88269c05

{ewc GSMVIMG,GSMVIMG, !88269c54.bmp}

88269c54

{ewc GSMVIMG,GSMVIMG, !88269c55.bmp}

88269c55

{ewc GSMVIMG,GSMVIMG, !88269c56.bmp}

88269c56

{ewc GSMVIMG,GSMVIMG, !88269c57.bmp}

88269c57

BODY AND TRIM

{ewc MVIMAGE,MVIMAGE, !
body.bmp}

EXTERIOR {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

EXTERIOR

Front Doors

REMOVAL & INSTALLATION

Ü See figure 1

Ä The following procedure requires the use of the GM Door Hinge Spring Compressor tool No. J-28625-A or equivalent.

1. If equipped with power door components, perform the following procedures:
   a. Disconnect the negative battery cable from the battery.
   b. Refer to the Door Panel, Removal and Installation procedures in this section and remove the door panel.
   c. Disconnect the electrical harness connector from the power door lock motor and/or the power window regulator.
   d. Remove the electrical harness from the door.

**Caution
Before removing the hinge spring from the door, be sure to cover it (to keep it from flying); it could cause personal injury.

2. Using the GM Door Hinge Spring Compressor tool No. J-28625-A or equivalent, compress the door hinge spring and remove it.
3. To remove the door hinge pin clips, spread the clips and move them above the recess on the pin; when the pin is removed, the clip will ride on the pin and fall free of it.
4. Using a soft-head hammer and a pair of locking pliers, remove the lower pin from the door hinge; then, install a bolt (in the lower pin hole) to hold the door in place until the upper hinge pin is removed.
5. Remove the upper door hinge pin and support the door, then remove the bolt from the lower hinge pin hole and the door from the vehicle.

**Figure 1.
Replacing the door spring and hinge pin**

{ewc GSMVIMG,GSMVIMG, !88260g01.bmp}

88260g01

To install:

6. Position the door onto the hinges and insert a bolt through the lower hinge pin hole.
7. Using a new hinge pin clip, install the upper hinge pin.
8. Remove the bolt from the lower hinge pin hole. Using a new hinge pin, install it into the lower hinge pin holes.
9. Using the GM Door Hinge Spring Compressor tool No. J-28625-A or equivalent, compress the door hinge spring and install it into the door hinge.
10. If equipped with power door components, reconnect the electrical harness connector(s), install the door panel and the reconnect the negative battery cable.

ADJUSTMENTS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Body And Trim

ADJUSTMENTS

Factory installed hinges are welded in place, so no adjustment of the system is necessary or recommended.

Front Door Hinges {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Front Door Hinges

Ä The following procedure requires the use of an 1/8 in. (3mm) drill bit, 1/2 in. (13mm) drill bit, a center punch, a cold chisel, a portable body grinder, a putty knife, and a scribing tool.

REMOVAL & INSTALLATION

Ü See figures 2, 3

1. Refer to the Door, Removal and Installation procedures in this section and remove the door(s), then place the door on a padded workbench.
2. Using a putty knife, remove the sealant from the around the edge of the hinge.
3. Using a scribing tool, outline the position of the hinge(s) on the door and the body pillar.
4. Using a center punch, mark the center position of the hinge-to-door and the hinge-to-body pillar welds.
5. Using a 1/8 in. (3mm) bit, drill a pilot hole completely through each weld.

   Ä When drilling the holes through the hinge welds, DO NOT drill through the door or the body pillar.

6. Using a 1/2 in. (13mm) bit, drill a hole through the hinge base, following the 1/8 in. (3mm) pilot hole.
7. Using a cold chisel and a hammer, separate the hinge from the door and/or the body pillar. Using a portable grinder, clean off any welds remaining on the door or the body pillar.

Figure 2.
Installing replacement door hinges onto the vehicle

{ewc GSMVIMG,GSMVIMG, !88260g02.bmp}

88260g02

Figure 3.
Exploded view of the front door alignment points

{ewc GSMVIMG,GSMVIMG, !88260g03.bmp}

88260g03

To install:

8. To fasten the replacement hinge(s) to the door and/or body pillar, perform the following procedures:
   a. Align the replacement hinge, with the scribe lines, previously made.
   b. Using a center punch and the new hinge as a template, mark the location of each bolt hole.
   c. Using a 1/2 in. (13mm) bit, drill holes (using the center marks) through the door and body pillar.
   d. If the upper body side hinge is to be replaced, remove the instrument panel fasteners, pull the panel outwards and support it.
9. Use medium body sealant (apply it to the hinge-to-door or body pillar surface), the hinge-to-door/body pillar bolts and tapped anchor plate.
10. Tighten the hinge-to-door/body pillar bolts to 20 ft. lbs. (27 Nm).

11. Apply paint to the hinge and the surrounding area.

ADJUSTMENT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ADJUSTMENT

Ü See figures 3, 4, 5, 6

Ä The $^{1}/2$ in. (13mm) drill hinge holes provide for some adjustment.

1. Loosen, adjust, then tighten the hinge-to-door/body pillar bolts; close the door, then check the door gap, it should be 4-6mm between the door and the door frame.
2. With the door closed, it should be flush, plus or minus 1.0mm, with the body; if not, enlarge the striker hole.

Figure 4.
Exploded view of the front door striker mounting

{ewc GSMVIMG,GSMVIMG, !88260g04.bmp}

88260g04

Figure 5.
If the striker must be removed, first scribe an alignment mark . . .

{ewc GSMVIMG,GSMVIMG, !88260p01.bmp}

88260p01

Figure 6.
. . . then loosen the striker using a suitable driver (usually a Torx®)

{ewc GSMVIMG,GSMVIMG, !88260p02.bmp}

88260p02

Rear Doors {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Rear Doors

REMOVAL & INSTALLATION

Ü See figures 7, 8

1. Disconnect the negative battery cable.
2. Remove the door trim panel on the right door only.
3. Disconnect the wiring harness from the license plate lamp and power door lock, if so equipped. Remove the harness from the door.
4. Disconnect the check strap from the door frame.
5. Drive out the hinge pins while an assistant holds the door in place.
6. Remove the door from the vehicle.

To install:

7. With an assistant, install the door onto the vehicle.
8. Drive the hinge pins through both hinge halves.
9. Connect the wiring harness, install the trim panel and connect the negative battery cable.

Figure 7.
Rear door hinges

{ewc GSMVIMG,GSMVIMG, !88260g05.bmp}

88260g05

Figure 8.
Rear door check assembly

{ewc GSMVIMG,GSMVIMG, !88260g06.bmp}

88260g06

ADJUSTMENT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Body And Trim

ADJUSTMENT

Ü See figure 9

The original door hinges are welded in place, and adjustment is not recommended. However, with service bolt-on hinges, adjustment is possible.

1. Loosen the door striker.
2. Adjust the left door first and then the right.
3. Adjust the left door so that there is a 5.0mm gap between the door and the door frame at the top, bottom and side of the door.
4. Adjust the right door so that there is a 5.0mm gap between the door and the door frame at the top, bottom and side of the door.

Figure 9.
Rear door alignment

{ewc GSMVIMG,GSMVIMG, !88260g07.bmp}

88260g07

Rear Door Check {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Rear Door Check

REMOVAL & INSTALLATION

1. Open the door and disconnect the check assembly from the bracket.
2. Remove the mounting bracket screws, bracket and door trim panel.
3. Remove the boot-to-bracket bolts and boot.
4. Remove the bracket and check assembly from the inside of the door.

To install:

5. Install the bracket and check assembly.
6. Install the boot and bolts.
7. Install the trim panel, mounting bracket and screws.
8. Connect the check to the bracket and check operation.

Sliding Door {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Sliding Door

REMOVAL & INSTALLATION

Ü See figure 10

1. Remove the track cover.
2. Match-mark the alignment of the lower roller bracket-to-door position.
3. Remove the upper roller bracket-to-door screws, then the lower roller bracket-to-sliding door bolts.
4. Using an assistant, to support the sliding door, open the door and roll the center roller bracket off the end of the track.

To install:

5. Use an assistant to roll the center roller bracket onto the end of the track.
6. Align the lower roller bracket-to-door marks and install the mounting bolts. Tighten all of the door roller bracket bolts to 20 ft. lbs. (27 Nm).

Figure 10.
Exploded view of the upper/lower roller brackets and cable latch-sliding door assembly

{ewc GSMVIMG,GSMVIMG, !88260g08.bmp}

88260g08

ADJUSTMENT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ADJUSTMENT

Ü See figures 11, 12, 13, 14

Although the sliding door is designed without any adjustment provisions, it is possible to rework certain portions of the system.

- Using the rear striker, at the center rear of the door, adjust the height and flushness.
- Using the lower roller bracket, adjust the parallel gap at the base of the door.
- To obtain flushness and vertical support, at the front of the door, adjust the door locator pins and sockets.
- To obtain proper gap and a level swing-in, at the rear of the door, adjust the center roller track fore and aft.
- Using Lubriplate® or equivalent, lubricate the roller track contact surfaces.

1. To obtain the height (up/down) and the flushness (in/out) movements, between the door and the rear quarter panel, enlarge the rear striker hole.

   Ä When making the rear striker adjustments, DO NOT bend the striker to obtain the adjustment.

2. To obtain a parallel gap between the base of the door and the rocker panel, loosen the lower roller bracket bolts. Check and/or adjust the gap between the quarter panel and the door; the gap should be parallel from the window area down to the rocker panel. Tighten the lower bracket mounting bolts to 20 ft. lbs. (27 Nm).

   Ä To obtain the parallel adjustment, the upper bracket hole may have to be enlarged; enlarging the hole may mean that the feature alignment of the door may have to be compromised.

3. To obtain flushness between the door and the rocker panel, adjust the lower locating pin so that its surface is in contact with the outer edges of the locator guide. If you are having trouble obtaining the flushness, perform the following procedures:
   a. Using a rubber hammer, strike the locator pin (while in position) to bend the sheet metal slightly.
   b. Using a portable grinder, remove some of the material from the top or bottom of the locator guide; DO NOT remove too much material that a hole is ground through the guide.
   c. Readjust the door height at the lower roller bracket.
4. Adjust the upper locator pin until it is flush with the locator guide; the locator should rub the outer edge of the locator guide. If you are having trouble obtaining the adjustment, perform the following procedures:
   a. Using a rubber hammer, strike the locator pin (while in position) to bend the sheet metal slightly.
   b. Using a portable grinder, remove some of the material from the top or bottom of the locator guide; DO NOT remove too much material that a hole is ground through the guide.

Figure 11.
If the sliding door striker must be removed, first make alignment marks . . .

{ewc GSMVIMG,GSMVIMG, !88260p03.bmp}

88260p03

Figure 12.
. . . then loosen and remove the striker bolt using a suitable driver (usually a Torx®)

{ewc GSMVIMG,GSMVIMG, !88260p04.bmp}

88260p04

Figure 13.
Sliding door gap adjustments

{ewc GSMVIMG,GSMVIMG, !88260g09.bmp}

88260g09

Figure 14.
Exploded view of the door striker mounting-sliding door assembly

{ewc GSMVIMG,GSMVIMG, !88260g10.bmp}

88260g10

5. To obtain equal gaps between the door, the quarter panel and the door pillar, perform the following procedures:
   a. For access to the center roller track, remove the right rear tail light bezel, the interior trim from around the track and the track cover.
   b. Inspect the track rollers; the bottom rollers should ride on the track base and the side roller should ride on the outer flange of the track.
   c. Loosen the track fasteners and slide the track rearward until it comes in contact the center rollers, then center the door in the opening. Tighten the track fasteners by starting with the one closest to the rear door striker.
   d. Loosen the forward track fastener, then push the track up or down until the rear latch rolls onto the striker in a level position; if necessary, elongate the hole.
   e. Install the track cover, the interior trim and the rear tail light bezel.
6. Adjust the upper roller bracket so that the roller runs in the middle of the track; it must not touch the upper or lower edge of the track. If necessary physically adjust it, remove it from the bracket and bend it at its base.

Roller Brackets {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Roller Brackets

REMOVAL & INSTALLATION

Ü See figures 10, 15, 16

Upper

1. Remove the upper roller bracket trim.
2. Remove the front cap.
3. Remove the upper bracket-to-door screws and the bracket from the vehicle.

To install:

5. Position the bracket onto the vehicle. Tighten the upper roller bracket-to-door screws to 20 ft. lbs. (27 Nm). Adjust the door gap, if necessary.

Figure 15.
Exploded view of the center roller track cover (upper) and track (lower) assembly-sliding door

{ewc GSMVIMG,GSMVIMG, !88260g11.bmp}

88260g11

Figure 16.
Exploded view of the center roller bracket-sliding door

{ewc GSMVIMG,GSMVIMG, !88260g12.bmp}

88260g12

Center

The following procedure requires the use of an $^{1}/8$ in. (3mm) drill bit, $^{1}/2$ in. (13mm) drill bit, a center punch, a cold chisel, a portable body grinder, a putty knife, and a scribing tool.

1. Refer to the Sliding Door, Removal and Installation procedures in this section and remove the sliding door, then place the door on a padded workbench.
2. Using a putty knife, remove the sealant from around the edge of the bracket.
3. Using a scribing tool, outline the position of the bracket on the door.
4. Using a center punch, mark the center position of the bracket base welds.
5. Using a $^{1}/8$ in. (3mm) bit, drill a pilot hole completely through each weld.

   Ä When drilling the holes through the bracket welds, DO NOT drill through the door.

6. Using a $^{1}/2$ in. (13mm) bit, drill a hole through the bracket base, following the $^{1}/8$ in. (3mm) pilot hole.
7. Using a cold chisel and a hammer, separate the bracket from the door. Using a portable grinder, clean off any welds remaining on the door.
8. To fasten the replacement bracket to the door, perform the following procedures:
   a. Align the replacement bracket, with the scribe lines, previously made.
   b. Using a center punch and the new bracket as a template, mark the location of each bolt hole.
   c. Using a $^{1}/2$ in. (13mm) bit, drill holes (using the center marks) through the door.

To install:

9. Use medium body sealant and apply it to the bracket-to-door surface, the bracket-to-door bolts and tapped anchor plate. Tighten the bracket-to-door bolts to 20 ft. lbs. (27 Nm). Apply paint to the bracket and the surrounding area. Adjust the sliding door-to-body gap, if necessary.

Lower {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Lower

1. Remove the lower striker from the door.
2. Using a scribing tool, mark the lower roller bracket-to-door position.
3. Remove the lower roller bracket-to-door bolts and the catch cable from the bracket.
4. Slide the door to the fully back position.
5. Remove the lower roller bracket-to-body fasteners, pull the bracket from the body and slide the roller bracket out through the rear of the track.

To install:

6. Position the striker and roller bracket onto the door and install the bolts and cable. Tighten the lower roller bracket-to-door bolts to 20 ft. lbs. (27 Nm). Adjust the door-to-body gap, if necessary.

Bumpers {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Body And Trim

Bumpers

REMOVAL & INSTALLATION

Ü See figures 17, 18

Front

Ü See figures 19, 20, 21

1. For late-model vehicles so equipped, remove the front bumper fascia:
   a. Remove the grille for access.
   b. Remove the fascia-to-bumper lower brace bolts.
   c. Remove the fascia-to-fender bolts.
   d. Remove the fascia-to-impact bar retainers, then remove the fascia from the vehicle.
2. Remove the brace-to-frame bolts.
3. Remove the bracket-to-frame bolts.
4. Remove the bumper from the vehicle with the help of an assistant.
5. Remove the brace-to-plate bolt and nuts, braces from the bumper and bumper-to-plate bolts.
6. Remove the plate from the bumper, bracket-to-bumper bolts and bracket from the bumper.

Figure 17.
Once fascias or brackets are gone, bumper removal is a simple matter of unbolting retainers . . .

{ewc GSMVIMG,GSMVIMG, !88260p05.bmp}

88260p05

Figure 18.
. . . in most cases a backup wrench is necessary to keep the retainer from spinning

{ewc GSMVIMG,GSMVIMG, !88260p06.bmp}

88260p06

To install:

7. Install the bracket to the bumper, bracket-to-bumper nuts and bolts.
8. Install the bumper-to-plate bolts, braces to the bumper and brace-to-plate bolts and nuts.
9. Install the bumper onto the vehicle with the help of an assistant.
10. Install the bracket-to-frame bolts and tighten to 40 ft. lbs. (55 Nm).
11. If equipped, install the front fascia

Figure 19.
Exploded view of a typical early-model Astro and Safari front bumper mounting-two wheel drive vehicles

{ewc GSMVIMG,GSMVIMG, !88260g13.bmp}

88260g13

Figure 20.
Exploded view of a typical Astro and Safari front bumper mounting-all wheel drive vehicles

{ewc GSMVIMG,GSMVIMG, !88260g14.bmp}

88260g14

Figure 21.
Exploded view of a typical late-model Astro and Safari front bumper and fascia assembly

{ewc GSMVIMG,GSMVIMG, !88260g55.bmp}

88260g55

Rear {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Rear

Ü See figures 22, 23

1. On late-model vehicles so equipped, remove the rear bumper fascia from the bumper assembly.
2. Remove the brace-to-frame bolts, bracket-to-frame bolts and the bumper from the vehicle with the help of an assistant.
3. Remove the brace-to-bumper nuts, brace from the bumper and bracket-to-bumper bolts.
4. Remove the bracket from the bumper.

To install:

5. Install the bracket to the bumper, bracket-to-bumper bolts and the brace to the bumper.
6. Install the bumper onto the vehicle with the help of an assistant.
7. Install the bracket-to-frame bolts and nuts. Tighten the fasteners to 26 ft. lbs. (35 Nm).
8. If equipped, install the rear bumper fascia.

Figure 22.
Exploded view of a typical early-model Astro and Safari rear bumper mounting
{ewc GSMVIMG,GSMVIMG, !88260g15.bmp}

88260g15

Figure 23.
Exploded view of a typical Astro and Safari rear bumper fascia mounting
{ewc GSMVIMG,GSMVIMG, !88260g56.bmp}

88260g56

Grille {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Grille

REMOVAL & INSTALLATION

Ü See figures 24, 25

1. Remove the headlight bezel and front end panel-to-grille bolts.

   Ä On some late-model vehicles it will be necessary to remove the entire combination lamp assembly in order to remove the grille.

2. Remove the grille-to-radiator support screws and the grille.

To install:

3. Install the grille and radiator support screws.
4. Install the front end panel-to-grille bolts and the headlight bezel.

Figure 24.
Exploded view of a typical early-model Astro and Safari grille and front end panel mounting

{ewc GSMVIMG,GSMVIMG, !88260g16.bmp}

88260g16

Figure 25.
Exploded view of a typical late-model Astro and Safari grille mounting

{ewc GSMVIMG,GSMVIMG, !88260g57.bmp}

88260g57

Fender {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Fender

REMOVAL & INSTALLATION

Ü See figure 26

1. Disconnect the negative battery cable.
2. Remove the headlight bezel, bumper and cowl vent grille.
3. Raise and support the hood.
4. Remove the hood-to-fender nut and bolt.
5. Remove the front wheelhouse extension and fender-to-body bolts.
6. With an assistant, remove the fender from the vehicle. Be careful not to damage the painted surfaces.

Figure 26.
Front fender mounting points

{ewc GSMVIMG,GSMVIMG, !88260g18.bmp}

88260g18

To install:

7. Install the fender-to-body bolts and tighten to 18 ft. lbs. (25 Nm).
8. Install the front wheelhouse extension and hood-to-fender nuts and bolts.
9. Install the cowl vent grille, bumper and headlight bezel.
10. Connect the negative battery cable and align the fender.

Outside Mirrors {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Outside Mirrors

REMOVAL & INSTALLATION

Ü See figures 27, 28, 29

1. Disconnect the negative battery cable.
2. Remove the door trim panel as outlined in this section.
3. Disconnect the electrical connector, if so equipped.
4. Remove the retaining nuts and mirror assembly from the door.

To install:

5. Install the mirror and nuts to the door.
6. Connect the electrical connector, if so equipped.
7. Connect the negative battery cable and check operation.
8. Install the door trim panel as outlined in this section.

Figure 27.
Exploded view of the standard and power outside mirrors
{ewc GSMVIMG,GSMVIMG, !88260g17.bmp}

88260g17

Figure 28.
Power mirror diagnosis-part 1 of 2
{ewc GSMVIMG,GSMVIMG, !88260g19.bmp}

88260g19

Figure 29.
Power mirror diagnosis-part 2 of 2
{ewc GSMVIMG,GSMVIMG, !88260g20.bmp}

88260g20

Radio Antenna {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Radio Antenna

REMOVAL & INSTALLATION

Outer

Ü See figure 30

1. Disconnect the negative battery cable.
2. Remove the wiper arms and antenna mast from the base. The mast will unscrew using a pliers and rag to protect the mast finish.
3. Remove the cowl screws and cowl screen.
4. Remove the antenna base screws and lower dash extension.
5. Disconnect the outer antenna lead from the inner antenna lead and pull through the grommet.

To install:

6. Install the lead through the grommet and connect it to the inner lead.
7. Install the lower dash extension, antenna base screws, cowl screen and screen retaining screws.
8. Install the antenna mast, wiper arms and connect the negative battery cable.

Figure 30.
Exploded view of a typical Astro and Safari radio antenna mounting
{ewc GSMVIMG,GSMVIMG, !88260g21.bmp}

88260g21

Inner {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Inner

Ü See figure 31

1. Remove the dash panel speaker by prying up the grille and remove the retaining screws.
2. Remove the lower dash extension and inner antenna lead mounting screws.
3. Disconnect the antenna lead from the routing clips and radio receiver.

To install:

4. Install the antenna lead to the routing clips and radio receiver.
5. Install the inner lead mounting screws and lower dash extension.
6. Install the speaker and grille.

Figure 31.
Radio antenna wire routing

{ewc GSMVIMG,GSMVIMG, !88260g22.bmp}

88260g22

Door Locks {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Door Locks

REMOVAL & INSTALLATION

Front Door Manual Locks

OUTSIDE HANDLE AND LOCK CYLINDER

Ü See figure 32

1. Refer to the Door Panel, Removal and Installation procedures in this section and remove the door panel.
2. Remove the outside handle-to-door nuts.

   Ä Removing the soft plug at the edge of the door may provide additional room to access the bottom door handle nut.
3. Remove the outside handle-to-lock rod and the handle from the door.
4. Remove the lock rod from the lock cylinder, then the lock cylinder retainer, the gasket and the lock cylinder from the door.

To install:

5. Install the lock rod to the lock cylinder, then the lock cylinder retainer, the gasket and the lock cylinder to the door.
6. Install the outside handle-to-lock rod and the handle to the door.
7. Install the outside handle-to-door nuts.
8. Install the door panel.

Figure 32.
Exploded view of the outside handle and lock cylinder assembly-front door

{ewc GSMVIMG,GSMVIMG, !88260g23.bmp}

88260g23

LOCK ASSEMBLY {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

LOCK ASSEMBLY

Ü See figure 33

1. Refer to the Door Panel, Removal and Installation procedures in this section and remove the door panel.
2. Remove the outside handle-to-lock assembly rod.
3. Remove the lock cylinder-to-lock assembly rod.
4. Remove the inside handle-to-lock assembly rod.
5. Remove the inside lock-to-lock assembly rod.
6. Remove the lock assembly-to-door screws and the lock assembly from door.
7. Installation is the reverse of the removal.

Figure 33.
Lock cylinder assembly mounting and related components-front door
{ewc GSMVIMG,GSMVIMG, !88260g24.bmp}

88260g24

INSIDE HANDLE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Body And Trim

INSIDE HANDLE

Ü See figure 34

Ä The following procedure requires the use of a $^{3}/16$ in. (5mm) drill bit, $^{1}/4$ in. x $^{1}/2$ in. (6mm x 13mm) pop rivets and a pop rivet gun.

1. Refer to the Door Panel, Removal and Installation procedures in this section and remove the door panel.
2. Remove the inside handle-to-lock rod.
3. Using a $^{3}/16$ in. (5mm) bit, drill out the inside handle-to-door rivets, the remove the inside handle from the door.

To install:

4. Use $^{1}/4$ in. x $^{1}/2$ in. (6mm x 13mm) pop rivets and a pop rivet gun to install the inside handle to the door. Install the trim panel and check operation.

Figure 34.
Exploded view of the inside door handle mounting-front door

{ewc GSMVIMG,GSMVIMG, !88260g25.bmp}

88260g25

Front Door With Power Locks {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Body And Trim

Front Door With Power Locks

Ü See figure 35

REMOTE LOCK LEVER

Ä The following procedure requires the use of a $^{3}/16$ in. (5mm) drill bit, $^{1}/4$ in. x $^{1}/2$ in. (6mm x 13mm) pop rivets and a pop rivet gun.

1. Refer to the Door Panel, Removal and Installation procedures in this section and remove the door panel.
2. Remove the power door lock motor to remove the lever rod.
3. Remove the remote lever-to-lock assembly rod.
4. Remove the remote lever-to-inside lock lever rod.
5. Using a $^{3}/16$ in. (5mm) bit, drill out the inside handle-to-door rivets, the remove the handle from the door.

Figure 35.
Exploded view of typical Astro and Safari power door lock components

{ewc GSMVIMG,GSMVIMG, !88260g26.bmp}

88260g26

To install:

6. Use $^{1}/4$ in. x $^{1}/2$ in. (6mm x 13mm) pop rivets and a pop rivet gun to install the inside handle to the door.
7. Connect the remote lever-to-lock lever rod.

POWER DOOR LOCK MOTOR {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Body And Trim

POWER DOOR LOCK MOTOR

1. Refer to the Door Panel, Removal and Installation procedures in this section and remove the door panel.
2. Remove the power door lock motor to remove the lever rod.
3. Disconnect the electrical connector from the power door lock motor.
4. Remove the motor-to-door bolts and the motor from the door.

To install:

6. Position the motor to the door and install the mounting bolts. Reconnect the electrical connector and install the door trim panel.

Sliding Door {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Body And Trim

Sliding Door

LOCK ASSEMBLY

Ü See figure 36

1. Refer to the Sliding Door Panel, Removal and Installation procedures in this section and remove the door panel.
2. To remove the upper control-to-lock rods, perform the following procedures:
   a. Using a small prybar, pry the anchor clip out of the hole and push the clip away from the lever.
   b. Pull the rod and clip away from the lever.
3. To remove the remote control-to-locks rods from the remote control, perform the following procedures:
   a. Using a small prybar, pry the anchor clip out of the hole and push the clip away from the lever.
   b. Pull the rod and clip away from the lever.
4. Remove the lock screws and the lock from the door.

To install:

5. Position the lock and screws to the door. Connect the clips to the levers and check operation. Install the door trim panel.

Figure 36.
Lock assembly components-sliding door

{ewc GSMVIMG,GSMVIMG, !88260g27.bmp}

88260g27

POWER DOOR LOCK MOTOR {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Body And Trim

POWER DOOR LOCK MOTOR

Ü See figure 37

Ä The following procedure requires the use of $^{1}/4$ in. x $^{1}/2$ in. (6mm x 13mm) pop rivets and a pop rivet gun.

1. Refer to the Door Panel, Removal and Installation procedures in this section and remove the door panel.
2. Disconnect the negative battery cable from the battery.
3. Refer to the Sliding Door Panel, Removal and Installation procedures in this section and remove the door panel.
4. Disconnect the electrical wiring harness from the power door lock motor.
5. Using a $^{3}/16$ in. (5mm) bit, drill out the door lock motor-to-door rivets, then remove the motor from the door.

To install:

6. Use $^{1}/4$ in. x $^{1}/2$ in. (6mm x 13mm) pop rivets and a pop rivet gun to install the inside handle to the door.
7. Install new rivets or bolts to the power door lock motor-to-door.
8. Connect the electrical wiring harness.
9. Refer to the Sliding Door Panel, Removal and Installation procedures in this section and install the door panel.
10. Connect the negative battery cable to the battery and check operation.

Figure 37.
Exploded view of the power door lock motor assembly mounting-sliding door
{ewc GSMVIMG,GSMVIMG, !88260g28.bmp}

88260g28

Rear Door With Manual Locks {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Body And Trim

Rear Door With Manual Locks

OUTSIDE HANDLE AND LOCK CYLINDER

1. Refer to the Door Panel, Removal and Installation procedures in this section and remove the door panel.
2. Remove the control rod from the outside handle by prying the clip anchor out of the hole and pushing the clip away from the lever. Then pull the rod and the clip away from the lever.
3. Remove the outside handle-to-lock nuts and remove the rod and the handle from the door.
4. Remove the license plate housing bolts, and the license plate housing.
5. Remove the door lock shield.
6. Remove the lock control rod from the lock cylinder by prying the clip anchor out of the hole and pushing the clip away from the lever. Then pull the rod and the clip away from the lever.
7. Remove the lock cylinder retainer, and the lock cylinder from the door.

To install:

8. Install the lock cylinder retainer, and the lock cylinder to the door.
9. Install the lock control rod to the lock cylinder.
10. Install the door lock shield.
11. Install the license plate housing assembly and bolts.
12. Install the outside handle-to-lock nuts and handle.
13. Install the control rod to the outside handle.
14. Refer to the Door Panel, Removal and Installation procedures in this section and install the door panel.

LOCK ASSEMBLY {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Body And Trim

LOCK ASSEMBLY

Ü See figure 38

1. Refer to the Door Panel, Removal and Installation procedures in this section and remove the door panel.
2. Remove the outside handle-to-lock assembly rod.
3. Remove the lock cylinder-to-lock assembly rod.
4. Remove the inside handle-to-lock assembly rod.
5. Remove the inside lock-to-lock assembly rod.
6. Remove the lock assembly-to-door screws and the lock assembly from door.
7. Installation is the reverse of the removal.

Figure 38.
Rear door lock cylinder removal

{ewc GSMVIMG,GSMVIMG, !88260g29.bmp}

88260g29

UPPER AND LOWER LATCH REPLACEMENT {ewc MVIMAGE, MVIMAGE, ! nexttopicarrow.bmp}

Body And Trim

UPPER AND LOWER LATCH REPLACEMENT

Ü See figure 39

1. Refer to the Door Panel, Removal and Installation procedures in this section and remove the door panel.
2. Remove the control rods from the remote control by prying the clip anchor out of the hole and pushing the clip away from the lever. Then pull the rod and the clip away from the lever.
3. Remove the upper latch screws.
4. Remove the upper latch insulator cover.
5. Pry the plastic nails holding the weatherstrip away from the door and remove the weatherstrip from around the latch area.
6. Remove the door latch insulator.
7. Remove the upper latch and rod from the door.
8. Remove the lower latch screws.
9. Remove the lower latch reinforcement plate.
10. Remove the lower latch and rod from the door.

To install:

11. Install the lower latch and rod to the door.
12. Install the lower latch reinforcement plate.
13. Install the lower latch screws.
14. Install the upper latch and rod to the door.
15. Install the door latch insulator.
16. Install the weatherstrip to the latch area.
17. Install the upper latch insulator cover.
18. Install the upper latch screws.
19. Install the control rods to the remote control.
20. Refer to the Door Panel, Removal and Installation procedures in this section and install the door trim panel.

Figure 39.
Upper and lower door latches

{ewc GSMVIMG,GSMVIMG, !88260g30.bmp}

88260g30

Rear Door With Power Locks {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Body And Trim

Rear Door With Power Locks

REMOTE LOCK LEVER

1. Refer to the Door Panel, Removal and Installation procedures in this section and remove the door panel.
2. Disconnect the negative battery cable and remove the actuator to lever rod.
3. Using a $^{3}/16$ in. (5mm) bit, drill out the head of the actuator-to-door rivets.
4. Remove the actuator from the door.

To install:

5. Use $^{1}/4$ in. diameter bolt ($^{1}/2$ in. long) with a spring washer and nut to attach the actuator to the door. Connect the lever rod to the actuator. Check operation, then install the door trim panel.

POWER LOCK ACTUATOR {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Body And Trim

POWER LOCK ACTUATOR

Ü See figure 40

1. Refer to the Door Panel, Removal and Installation procedures in this section and remove the door panel.
2. Remove the power door lock actuator to remove the lever rod.
3. Disconnect the electrical connector from the power door lock actuator.
4. Remove the actuator-to-door bolts and the actuator from the door.

To install:

5. Position the actuator to the door and install the bolts. Connect the electrical connector and lever rod. Check operation, then install the door trim panel.

Figure 40.
Power lock actuator and related components

{ewc GSMVIMG,GSMVIMG, !88260g31.bmp}

88260g31

Hood {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Hood

REMOVAL & INSTALLATION

Ü See figures 41, 42

1. Disconnect the negative battery cable. Mark the area around the hinges to make installation easier. Tape or cover the painted areas around the hood for finish protection.
2. With an assistant, support the hood and remove the hinge to hood frame bolts.
3. Remove the hood from the van.

To install:

4. With an assistant, position the hood onto the van and install the retaining bolts. Adjust the hood to the original position and tighten the bolts to 20 ft. lbs. (27 Nm). Check alignment before slamming the hood. If adjustment is necessary, some adjustment is provided by the hinges, while other can usually be found at the striker on the hood or the latch on the radiator support.

   Ä Before loosening fasteners to make an adjustment, always scribe a match-mark as a point of reference.

Figure 41.
Before loosening ANY fasteners, ALWAYS scribe match-marks as points of reference

{ewc GSMVIMG,GSMVIMG, !88260p07.bmp}

88260p07

Figure 42.
Loosen the bolts and reposition the latch, as necessary for adjustment

{ewc GSMVIMG,GSMVIMG, !88260p08.bmp}

88260p08

Windshield {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Body And Trim

Windshield

Ä Bonded windshields require special tools and special removal procedures to be removed without being broken. For this reason we recommend that you refer all removal and installation to a qualified technician.

****Caution**
Always wear heavy gloves when handling glass to reduce the risk of injury!

When replacing a cracked windshield, it is important that the cause of the crack be determined and the condition corrected, before a new glass is installed.

The cause of the crack may be an obstruction or a high spot somewhere around the flange of the opening; cracking may not occur until pressure from the high spot or obstruction becomes particularly high due to winds, extremes of temperature, or rough terrain.

Suggestions of what to look for are described later in this section under inspection.

REMOVAL {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Body And Trim

REMOVAL

Ü See figures 43, 44, 45

When a windshield is broken, the glass may have already have fallen or been removed from the weatherstrip. Often, however, it is necessary to remove a cracked or otherwise imperfect windshield that is still intact. In this case, it is a good practice to crisscross the glass with strips of masking tape before removing the it; this will help hold the glass together and minimize the risk of injury.

If a crack extends to the edge of the glass, mark the point where the crack meets the weather strip. (Use a piece of chalk and mark the point on the cab, next to the weatherstrip.) Later, when examining the flange of the opening for a cause of the crack start at the point marked.

The higher the temperature of the work area, the more pliable the weather strip will be. The more pliable the weather strip, the more easily the windshield can be removed.

Before removing the glass, cover the instrument panel, and the surrounding sheet metal with protective covering and remove the wiper arms.

Figure 43.
Windshield reveal molding

{ewc GSMVIMG,GSMVIMG, !88260g32.bmp}

88260g32

Figure 44.
Cutting the window from the frame

{ewc GSMVIMG,GSMVIMG, !88260g33.bmp}

88260g33

Figure 45.
Windshield spacers

{ewc GSMVIMG,GSMVIMG, !88260g34.bmp}

88260g34

There are two methods of windshield removal, depending on the method of windshield replacement chosen. When using the short method of installation, it is important to cut the glass from the urethane adhesive as close to the glass as possible. This is due to the fact that the urethane adhesive will be used to provide a base for the replacement windshield.

When using the extended method of windshield replacement, all the urethane adhesive must be removed from the pinchweld flange so, the process of cutting the window from the adhesive is less critical.

Special tool J-24402-A, Glass Sealant Remover Knife, or its equivalent is required to perform this procedure. To remove the windshield:

1. Place the protective covering around the area where the glass will be removed.
2. Remove the windshield wiper arms, and the interior garnish moldings.
3. Remove the exterior reveal moldings and the support molding from the urethane adhesive by prying one end of the molding from the adhesive. Pull the free end of the molding away from the windshield or the pinchweld flange until the molding is completely free of the windshield.
4. Using J-24402-A cut the windshield from the urethane adhesive. If the short method of glass replacement is to be used, keep the knife as close to the glass as possible in order to leave a base for the replacement glass.
5. With the help of an assistant, remove the glass.

6. If the original glass is to be reinstalled, place it on a protected bench or a holding fixture. Remove any remaining adhesive with a razor blade or a sharp scraper. Any remaining traces of adhesive material can be removed with denatured alcohol or lacquer thinner.

   Ä When cleaning windshield glass, avoid contacting the edge of the plastic laminate material (on the edge of the glass) with volatile cleaner. Contact may cause discoloration and deterioration of the plastic laminate. Do not use a petroleum based solvent such as gasoline or kerosene. The presence of oil will prevent the adhesion of new material.

INSPECTION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

INSPECTION

An inspection of the windshield opening, the weather strip, and the glass may reveal the cause of a broken windshield. This can help prevent future breakage. If there is no apparent cause of breakage, the weatherstrip should be removed from the flange of the opening and the flange inspected. Look for high weld or solder spots, hardened spot welds sealer, or any other obstruction or irregularity in the flange. Check the weatherstrip for irregularities or obstructions in it.

Check the windshield to be installed to make sure that it does not have any chipped edges. Chipped edges can be ground off, restoring a smooth edge to the glass, and minimizing concentrations of pressure that cause breakage. Remove no more than necessary, in an effort to maintain the original shape of the glass and the proper clearance between it and the flange of the opening.

INSTALLATION METHODS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

INSTALLATION METHODS

There are two methods used for windshield replacement. The short method described previously in the removal procedure is used when the urethane adhesive can be used as a base for the new glass. This method would be used in the case of a cracked glass, if, no other service needs to be done to the windshield frame such as sheet metal or repainting work.

The extended method should be used when work must be done to the windshield frame such as straightening or repairing sheet metal or repainting the windshield frame. In this method all of the urethane adhesive must be removed from the pinchweld flange.

INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

INSTALLATION

Ü See figures 46, 47, 48

To replace a urethane adhered windshield, GM adhesive service kit No. 9636067 contains some of the materials needed, and must be used to insure the original integrity of the windshield design. Materials in this kit include:

1. One tube of adhesive material.
2. One dispensing nozzle.
3. Steel music wire.
4. Rubber cleaner.
5. Rubber primer.
6. Pinchweld primer.
7. Blackout primer.
8. Filler strip (for use on windshield installations for vehicles equipped with embedded windshield antenna).
9. Primer applicators.

Figure 46.
Pinchweld primer locations

{ewc GSMVIMG,GSMVIMG, !88260g35.bmp}

88260g35

Figure 47.
Windshield primer locations

{ewc GSMVIMG,GSMVIMG, !88260ga5.bmp}

88260ga5

Figure 48.
Urethane adhesive locations

{ewc GSMVIMG,GSMVIMG, !88260g36.bmp}

88260g36

Other materials are required for windshield installation which are not included in the service kit. These include:

10. GM rubber lubricant No. 1051717.
11. Alcohol for cleaning the edge of the glass.
12. Adhesive dispensing gun J-24811 or its equivalent.
13. A commercial type razor knife.
14. Two rubber support spacers.

Extended Method {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Extended Method

1. Clean all metal surrounding the windshield opening with a clean alcohol dampened cloth. Allow the alcohol to air dry.
2. Apply the pinchweld primer found in the service kit to the pinchweld area. Do not let any of the primer touch any of the exposed paint because damage to the finish may occur. Allow thirty minutes for the primer to dry.
3. Follow the steps listed under Short Method for the remainder of the procedure.

Short Method {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Short Method

1. Install the support molding onto the pinchweld flange from inside the vehicle. The joint of the molding should be located at the bottom center of the moulding.
2. Thoroughly clean the edge of the glass to which the adhesive material will be applied with a clean alcohol dampened cloth. Allow the alcohol to dry.
3. Apply the clear glass primer in the kit to the inner edge of the windshield from the edge of the glass inward 1.0mm. Apply the primer around the entire perimeter of the glass. Allow the primer to cure for thirty minutes.
4. Apply the blackout primer to the glass in the same area as the clear primer. Allow the blackout primer to dry to the touch.
5. Place two rubber blocks onto the base of the pinchweld flange. Place the blocks in line with the last screw on either side of the cowl grille cover.
6. With the aid of a helper, lift the glass into the opening. Center the glass in the opening, on top of the support molding.
7. Check the fit of the reveal molding. If necessary remove the glass and cut away additional urethane to give the proper windshield height. Place the glass in the window opening.
8. Cut the tip of the adhesive cartridge approximately 5mm from the end of the tip.
9. Apply the adhesive first in and around the spacer blocks. Apply a smooth continuous bead of adhesive into the gap between the glass edge and the sheet metal. Use a flat bladed tool to paddle the material into position if necessary. Be sure that the adhesive contacts the entire edge of the glass, and extends to fill the gap between the glass and the primer sheet metal (extended method) or solidified urethane base (short method).
10. Spray a mist of water onto the urethane. Water will assist in the curing process. Dry the area where the reveal molding will contact the body and glass.
11. Install new reveal moldings. Remove the protective tape covering the butyl adhesive on the underside of the molding. Push the molding caps onto each end of one of the reveal moldings. Press the lip of the molding into the urethane adhesive while holding it against the edge of the windshield. Take care to seat the molding in the corners. The lip must fully contact the adhesive and the gap must be entirely covered by the crown of the molding. Slide the molding caps onto the adjacent moldings. Use tape to hold the molding in position until the adhesive cures.
12. Install the wiper arms and the interior garnish moldings.

    Ä The vehicle should not be driven and should remain at room temperature for six hours to allow the adhesive to cure.

Rear Window Glass {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Rear Window Glass

REMOVAL & INSTALLATION

Swing Out Window

Ü See figures 49, 50, 51

Special Tool J-34946 Window Roll Pin Remover is required to perform this procedure.

1. Remove the latch to window screws.
2. While an assistant holds the glass in place, remove the hinge to glass screws, retainers, bushings and nuts.
3. Remove the glass from the door.
4. Remove the window roll pin using tool J-34964.
5. Remove the window latch.
6. Remove the latch retainer screws.
7. Remove the bearing, bushings and nut.

To install:

8. Install the bearing, bushings and nut.
9. Install the latch retainer screws.
10. Install the window latch.
11. Install the window roll pin using tool J-34964.
12. Install the glass to the door.
13. While an assistant holds the glass in place, install the hinge to glass screws, retainers, bushings and nuts.
14. Install the latch to window screws.

Figure 49.
Swing out window latch

{ewc GSMVIMG,GSMVIMG, !88260g37.bmp}

88260g37

Figure 50.
Window garnish molding

{ewc GSMVIMG,GSMVIMG, !88260g38.bmp}

88260g38

Figure 51.
Swing out window hinge

{ewc GSMVIMG,GSMVIMG, !88260g39.bmp}

88260g39

Stationary Window {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Stationary Window

Ü See figures 52, 53

Special tool J-28628, Adhesive Push/Pull Knife, or equivalent, is required to perform this procedure.

1. Remove the door garnish molding.
2. Remove the window molding.
3. Remove the window retainers.
4. Remove the window assembly from the vehicle using tool J-28628. Cut through the urethane adhesive from the inside of the vehicle.
5. Remove all the urethane from the pinchweld.

To install:

6. Clean the pinchweld flange and the new window assembly with solvent and allow it to air dry.
7. Apply urethane adhesive primer to the pinchweld flange and the window assembly molding in the area shown in the figure. Allow the primer to dry at least 30 minutes before applying the adhesive.
8. Apply a triangular bead of urethane adhesive 10mm high into the trough of the window assembly molding.
9. Install the window assembly in the pinchweld flange.
10. Install the window assembly retainers.
11. Apply a light mist of water to the window to check for leaks and to enhance the cure of the urethane.
12. Install the window molding.
13. Install the door garnish molding.
14. Allow the urethane adhesive 6 hours to cure before moving the vehicle.

Figure 52.
Primer locations for fixed windows

{ewc GSMVIMG,GSMVIMG, !88260g40.bmp}

88260g40

Figure 53.
Fixed window components

{ewc GSMVIMG,GSMVIMG, !88260g41.bmp}

88260g41

{ewc GSMVIMG,GSMVIMG, !88260g42.bmp}

88260g42

INTERIOR

Door Trim Panels

Special tool J-9886-01 or an equivalent door handle clip remover, is required to perform the following procedure.

REMOVAL & INSTALLATION

Ü See figures 54, 55, 56, 57, 58, 59, 60, 61, 62, 63

1. Remove the retaining screws and remove the armrest. Once the screws are removed on most models, the armrest can be removed by sliding towards the rear. On other models, the armrest should be CAREFULLY pried free.
2. Unless equipped with power windows, remove the window regulator handle using tool J-9886-01 or equivalent. If necessary, remove the window regulator handle bezel.
3. Remove the door handle trim cover by carefully prying it from the clips using J-9886-01 or equivalent. On models equipped with power locks and windows, pull the cover away from the door carefully, then disengage the wiring.
4. Remove any door trim panel retaining screws.

   Ä There is usually at least one door trim panel retaining screw, located behind the armrest pad.
5. CAREFULLY pry the door trim panel plastic fasteners free using a trim panel removal tool. The door handle clip remover can also usually be used for this.
6. Remove the trim panel from the door.

To install:

7. Position the door trim panel to the door. On most models you will have to place the window seal portion of the panel OVER the door frame.
8. Carefully snap the trim panel retainers into place.
9. Install the trim panel retaining screw(s).
10. Position and install the door handle trim cover. On models equipped with power locks and windows, engage the necessary wiring to the switches before snapping the cover in place.
11. Unless equipped with power windows, install the window regulator bezel and handle.
12. Install the armrest pad.

Figure 54.
Exploded view of a typical Astro and Safari door trim panel mounting

{ewc GSMVIMG,GSMVIMG, !88260g43.bmp}

88260g43

Figure 55.
Front door handle trim cover removal

{ewc GSMVIMG,GSMVIMG, !88260g44.bmp}

88260g44

Figure 56.
Remove the armrest screws and slide it back off the trim panel (on early-model vehicles) . . .

{ewc GSMVIMG,GSMVIMG, !88260p09.bmp}

88260p09

Figure 57.
. . . or carefully pry the armrest free (on late-model vehicles)

{ewc GSMVIMG,GSMVIMG, !88260p10.bmp}

88260p10

Figure 58.
Remove the armrest from the trim panel for access

{ewc GSMVIMG,GSMVIMG, !88260p11.bmp}

88260p11

Figure 59.
CAREFULLY pry the door handle trim cover free and pull outward . . .

{ewc GSMVIMG,GSMVIMG, !88260p12.bmp}

88260p12

Figure 60.
If equipped, remove the wiring retainer by twisting . . .

{ewc GSMVIMG,GSMVIMG, !88260p13.bmp}

88260p13

Figure 61.
. . . then disengage the wiring from the power lock and window switches

{ewc GSMVIMG,GSMVIMG, !88260p14.bmp}

88260p14

Figure 62.
Remove any trim panel retaining screws (like this one normally found under the armrest) . . .

{ewc GSMVIMG,GSMVIMG, !88260p15.bmp}

88260p15

Figure 63.
. . . then remove the trim panel by CAREFULLY prying the plastic snap-fasteners free from the door

{ewc GSMVIMG,GSMVIMG, !88260p16.bmp}

88260p16

Door Glass and Regulator {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Door Glass and Regulator

REMOVAL & INSTALLATION

Ü See figure 64

Caution

Always wear heavy gloves when handling glass to minimize the risk of injury!

Figure 64.
Window regulator components and mounting

{ewc GSMVIMG,GSMVIMG, !88260g45.bmp}

88260g45

Door Glass {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Body And Trim

Door Glass

1. Lower the glass to the bottom of the door and remove the door trim panel.
2. Remove the door channel run assembly.

   Ä Mask or cover any sharp edges that could scratch the glass.
3. Slide the glass forward until the front roller is in line with the notch in the sash channel.
4. Disengage the roller from the channel.
5. Push the window forward, then tilt it up until the rear roller is disengaged.
6. Place the window in a level position, and raise it straight up and out of the door.

To install:

7. Install the window into the door.
8. Push the window forward, then tilt it up until the rear roller is engaged.
9. Engage the roller to the channel.
10. Slide the glass forward until the front roller is in line with the notch in the sash channel.
11. Install the door channel run assembly.
12. Lower the glass to the bottom of the door and install the door trim panel.

Regulator {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Body And Trim

Regulator

1. Raise the window and tape the glass in the full up position using cloth body tape.
2. Remove the door trim panel and the door panel, then, using a $^{3}/16$ in. (5mm) bit, drill the head from the rivet.
3. Slide the regulator forward and then rearward to disengage the rear roller from the sash channel. Then disengage the lower roller from the regulator rail.
4. Disengage the forward roller from the sash channel at the notch in the sash channel.
5. Collapse the regulator and remove it through the access hole in the door.
6. Lubricate the regulator and the sash channel and regulator rails with Lubriplate® or its equivalent.

To install:

7. Collapse the regulator and install it through the access hole in the door.
8. Engage the forward roller to the sash channel at the notch in the sash channel.
9. Slide the regulator forward and then rearward to engage the rear roller to the sash channel. Then engage the lower roller to the regulator rail.
10. Install the door trim panel and the door panel.

Power Window Regulator {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Body And Trim

Power Window Regulator

1. Remove the negative battery cable.
2. Remove the door trim panel.
3. Remove the armrest bracket and water deflector.
4. Raise the window and tape the glass in the full up position using cloth body tape.
5. Remove the wiring harness from the regulator motor.
6. Remove the regulator to door rivets, using a $^{3}/16$ in. (5mm) bit to drill the heads from the rivets.
7. Slide the regulator forward and then rearward to disengage the rear roller from the sash channel. Then disengage the lower roller from the regulator rail.
8. Disengage the forward roller from the sash channel at the notch in the sash channel.
9. Collapse the regulator and remove it through the access hole in the door.

To install:

10. Lubricate the regulator and install through the access hole in the door.
11. Engage the forward roller to the sash channel at the notch in the sash channel.
12. Slide the regulator forward and then rearward to engage the rear roller to the sash channel. Then engage the lower roller to the regulator rail.
13. Install the regulator to door rivets, using $^{3}/16$ in. (5mm) rivets.
14. Install the wiring harness to the regulator motor.
15. Remove the tape from the glass.
16. Install the armrest bracket and water deflector.
17. Install the door trim panel.
18. Connect the negative battery cable and check operation.

Electric Window Motor {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Electric Window Motor

REMOVAL & INSTALLATION

Ü See figure 65

1. Remove the power window regulator as described above.

****Caution**
Step 2 MUST be performed if the regulator motor is to be removed from the regulator. The regulator lift arms are under pressure from the counterbalance spring and can cause serious injury if the motor is removed without locking the sector gear in position.

2. Install a pan head sheet metal tapping screw through the sector gear and the backing plate at the hole provided to lock the sector gear into position. Then drill out the motor to regulator attaching rivets.
3. Remove the motor from the regulator.

To install:

4. Lubricate the motor drive gear and the regulator sector teeth. Install the motor to the regulator and check the mesh of the motor to the regulator.
5. Install rivets to the motor and the regulator.
6. Remove the sheet metal tapping screw.
7. Install the power window regulator.

Figure 65.
To access the window motor, remove the door panel, then pull back the inner liner (water deflector)

{ewc GSMVIMG,GSMVIMG, !88260p17.bmp}

88260p17

Inside Rearview Mirror {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Inside Rearview Mirror

REMOVAL & INSTALLATION

Ü See figure 66

The rearview mirror is attached to a support which is secured to the windshield glass. A service replacement windshield glass has the support bonded to the glass assembly. To install a detached mirror support or install a new part, use the following procedures to complete the service.

1. Locate the support position at the center of the glass 86.75mm from the top of the glass to the top of the support.
2. Circle the location on the outside of the glass with a wax pencil or crayon. Draw a large circle around the support circle.
3. Clean the area within the circle with household cleaner and dry with a clean towel. Repeat the procedures using rubbing alcohol.
4. Sand the bonding surface of the support with fine grit (320-360) emery cloth or sandpaper. If the original support is being used, remove the old adhesive with rubbing alcohol and a clean towel.
5. Apply the adhesive as outlined in the kit instructions.
6. Position the support to the marked location with the rounded end UP.
7. Press the support to the glass for 30-60 seconds. Excessive adhesive can be removed after five minutes with rubbing alcohol.

Figure 66.
Rearview mirror support positioning

{ewc GSMVIMG,GSMVIMG, !88260g46.bmp}

88260g46

****Caution**
Do NOT apply excessive pressure to the windshield glass. The glass may break, causing personal injury!

Seats

REMOVAL & INSTALLATION

Front

Ü See figures 67, 68, 69

1. Disconnect the negative battery cable.
2. Remove the seat riser and floor nuts.
3. Disconnect the power seat wiring harness.
4. Remove the seat belt and guide from the floor studs.
5. Slide the seat forward and rearward to gain access to the seat bolts. Remove the seat from the vehicle with an assistant.
6. Remove the seat from the risers.

To install:

7. If removed, install the adjuster wire, seat riser nuts, bolts and riser.
8. Install the seat and connect the seat belt and guide to the floor studs.
9. Connect the power seat electrical connectors.
10. Tighten the floor-to-riser nuts to 26 ft. lbs. (35 Nm).
11. Connect the negative battery cable and check operation.

Figure 67.
Exploded view of a typical Astro and Safari front bucket seat mounting-with manual adjuster

{ewc GSMVIMG,GSMVIMG, !88260g47.bmp}

88260g47

Figure 68.
Exploded view of a typical Astro and Safari front bucket seat mounting-with power adjuster

{ewc GSMVIMG,GSMVIMG, !88260g48.bmp}

88260g48

Figure 69.
To remove the seats, begin by loosening and removing the riser and floor nuts

{ewc GSMVIMG,GSMVIMG, !88260p18.bmp}

88260p18

Intermediate Bench and Bucket Seat {ewc MVIMAGE, MVIMAGE, ! nexttopicarrow.bmp}

Intermediate Bench and Bucket Seat

Ü See figure 70

1. Lift up on the seat and release the latches located near the floor on the rear legs of the seat.
2. Lift up on the seat to disengage the latch assemblies and hooked retainers from the anchor pins.
3. If needed, removed the seat risers from the seat.

To install:

4. Install the seat riser to the seat, if removed.
5. Install the seat into the vehicle. Lift the seat into position and lower the front anchor plates. Lower the rear latch assemblies onto their anchor pin in the anchor plates. Make sure the seat is firmly latched and secured by pulling up and down on the seat.

Figure 70.
Exploded view of a typical Astro and Safari intermediate seat assembly-Bench shown (bucket and rear seats, similar)

{ewc GSMVIMG,GSMVIMG, !88260g51.bmp}

88260g51

Power Seat Motors {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Power Seat Motors

Ü See figures 71, 72

The six-way power seat adjusters are actuated by three 12V, reversible permanent magnet motors with built in circuit breakers. The motors drive the front and rear vertical gearnuts and a horizontal actuator. When the adjusters are at their limit of travel, an overload relay provides stall torque so the motors are not overloaded. Each motor can be serviced as a separate unit.

Figure 71.
Power seat diagnosis-part 1 of 2

{ewc GSMVIMG,GSMVIMG, !88260g49.bmp}

88260g49

Figure 72.
Power seat diagnosis-part 2 of 2

{ewc GSMVIMG,GSMVIMG, !88260g50.bmp}

88260g50

REMOVAL & INSTALLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Body And Trim

REMOVAL & INSTALLATION

1. Disconnect the negative battery cable.
2. Remove the seat assembly from the vehicle as outlined in this section.
3. Remove the adjuster assembly from the seat.
4. Remove the feed wires from the motor.
5. Remove the nuts securing the front of the motor support bracket-to-inboard adjuster. Partially withdraw the assembly from the adjuster and gearnut drives.
6. Remove the drive cables from the motor. Completely disassemble the support bracket with the motors attached.
7. Grind off the peened over ends of the grommet assembly securing the motor-to-support. Separate the motor from the support.

To install:

8. Drill out the top end of the grommet assembly using an $^{3}/16$ in. (5mm) bit.
9. Install the grommet assembly to the motor support bracket. Secure the motor with a $^{3}/16$ in. (5mm) rivet.
10. Install the drive cables.
11. Install the motor to the inboard adjuster.
12. Connect the motor feed wires and negative battery cable.
13. Install the adjuster assembly to the seat bottom.
14. With an assistant, install the seat and check for proper operation.

Headliner {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Body And Trim

Headliner

REMOVAL & INSTALLATION

Ü See figures 73, 74

1. Remove the upper window trim that supports the headliner.
2. Remove the sun visors and the door opening garnish moldings. Pull the headliner bow from the retainer (if equipped).
3. Remove the retainer bolts and the retainers.
4. Shift the headliner from side to side to disengage the headliner from the clips.
5. Remove the headliner from the vehicle.

To install:

6. Install the headliner to the vehicle.
7. Shift the headliner from side to side to engage the headliner to the clips.
8. Install the retainer bolts and the retainers.
9. Install the sun visors and the door opening garnish moldings.
10. Install the upper window trim that supports the headliner.

Figure 73.
Exploded view of a typical Astro and Safari headliner and attachment locations-NOTE-late-model vehicles may also be equipped with an overhead console above and between the front seats

{ewc GSMVIMG,GSMVIMG, !88260g52.bmp}

88260g52

Figure 74.
Exploded view of the overhead console mounting-available in late-model vehicles

{ewc GSMVIMG,GSMVIMG, !88260g58.bmp}

88260g58

{ewc GSMVIMG,GSMVIMG, !88260g53.bmp}

88260g53

{ewc GSMVIMG,GSMVIMG, !88260g54.bmp}

88260g54

TROUBLESHOOTING

{ewc MVIMAGE,MVIMAGE, ! troubleshooting.bmp}

7-B. Heater

1. Engine {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Troubleshooting

1. Engine

1-A. Engine Starting Problems

Gasoline Engines

1. Engine turns over, but will not start
    a. Check fuel level in fuel tank, add fuel if empty.
    b. Check battery condition and state of charge. If voltage and load test below specification, charge or replace battery.
    c. Check battery terminal and cable condition and tightness. Clean terminals and replace damaged, worn or corroded cables.
    d. Check fuel delivery system. If fuel is not reaching the fuel injectors, check for a loose electrical connector or defective fuse, relay or fuel pump and replace as necessary.
    e. Engine may have excessive wear or mechanical damage such as low cylinder cranking pressure, a broken camshaft drive system, insufficient valve clearance or bent valves.
    f. Check for fuel contamination such as water in the fuel. During winter months, the water may freeze and cause a fuel restriction. Adding a fuel additive may help, however the fuel system may require draining and purging with fresh fuel.
    g. Check for ignition system failure. Check for loose or shorted wires or damaged ignition system components. Check the spark plugs for excessive wear or incorrect electrode gap. If the problem is worse in wet weather, check for shorts between the spark plugs and the ignition coils.
    h. Check the engine management system for a failed sensor or control module.
2. Engine does not turn over when attempting to start
    a. Check the battery state of charge and condition. If the dash lights are not visible or very dim when turning the ignition key on, the battery has either failed internally or discharged, the battery cables are loose, excessively corroded or damaged, or the alternator has failed or internally shorted, discharging the battery. Charge or replace the battery, clean or replace the battery cables, and check the alternator output.
    b. Check the operation of the neutral safety switch. On automatic transmission vehicles, try starting the vehicle in both Park and Neutral. On manual transmission vehicles, depress the clutch pedal and attempt to start. On some vehicles, these switches can be adjusted. Make sure the switches or wire connectors are not loose or damaged. Replace or adjust the switches as necessary.
    c. Check the starter motor, starter solenoid or relay, and starter motor cables and wires. Check the ground from the engine to the chassis. Make sure the wires are not loose, damaged, or corroded. If battery voltage is present at the starter relay, try using a remote starter to start the vehicle for test purposes only. Replace any damaged or corroded cables, in addition to replacing any failed components.
    d. Check the engine for seizure. If the engine has not been started for a long period of time, internal parts such as the rings may have rusted to the cylinder walls. The engine may have suffered internal damage, or could be hydro-locked from ingesting water. Remove the spark plugs and carefully attempt to rotate the engine using a suitable breaker bar and socket on the crankshaft pulley. If the engine is resistant to moving, or moves slightly and then binds, do not force the engine any further before determining the problem.
3. Engine stalls immediately when started

a. Check the ignition switch condition and operation. The electrical contacts in the run position may be worn or damaged. Try restarting the engine with all electrical accessories in the off position. Sometimes turning the key on an off will help in emergency situations, however once the switch has shown signs of failure, it should be replaced as soon as possible.

b. Check for loose, corroded, damaged or shorted wires for the ignition system and repair or replace.

c. Check for manifold vacuum leaks or vacuum hose leakage and repair or replace parts as necessary.

d. Measure the fuel pump delivery volume and pressure. Low fuel pump pressure can also be noticed as a lack of power when accelerating. Make sure the fuel pump lines are not restricted. The fuel pump output is not adjustable and requires fuel pump replacement to repair.

e. Check the engine fuel and ignition management system. Inspect the sensor wiring and electrical connectors. A dirty, loose or damaged sensor or control module wire can simulate a failed component.

f. Check the exhaust system for internal restrictions.

4. Starter motor spins, but does not engage

    a. Check the starter motor for a seized or binding pinion gear.

    b. Remove the flywheel inspection plate and check for a damaged ring gear.

5. Engine is difficult to start when cold

    a. Check the battery condition, battery state of charge and starter motor current draw. Replace the battery if marginal and the starter motor if the current draw is beyond specification.

    b. Check the battery cable condition. Clean the battery terminals and replace corroded or damaged cables.

    c. Check the fuel system for proper operation. A fuel pump with insufficient fuel pressure or clogged injectors should be replaced.

    d. Check the engine's tune-up status. Note the tune-up specifications and check for items such as severely worn spark plugs; adjust or replace as needed. On vehicles with manually adjusted valve clearances, check for tight valves and adjust to specification.

    e. Check for a failed coolant temperature sensor, and replace if out of specification.

    f. Check the operation of the engine management systems for fuel and ignition; repair or replace failed components as necessary.

6. Engine is difficult to start when hot

    a. Check the air filter and air intake system. Replace the air filter if it is dirty or contaminated. Check the fresh air intake system for restrictions or blockage.

    b. Check for loose or deteriorated engine grounds and clean, tighten or replace as needed.

    c. Check for needed maintenance. Inspect tune-up and service related items such as spark plugs and engine oil condition, and check the operation of the engine fuel and ignition management system.

Diesel Engines {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Troubleshooting

Diesel Engines

1. Engine turns over but won't start
    a. Check engine starting procedure and restart engine.
    b. Check the glow plug operation and repair or replace as necessary.
    c. Check for air in the fuel system or fuel filter and bleed the air as necessary.
    d. Check the fuel delivery system and repair or replace as necessary.
    e. Check fuel level and add fuel as needed.
    f. Check fuel quality. If the fuel is contaminated, drain and flush the fuel tank.
    g. Check engine compression. If compression is below specification, the engine may need to be renewed or replaced.
    h. Check the injection pump timing and set to specification.
    i. Check the injection pump condition and replace as necessary.
    j. Check the fuel nozzle operation and condition or replace as necessary.
2. Engine does not turn over when attempting to start
    a. Check the battery state of charge and condition. If the dash lights are not visible or very dim when turning the ignition key on, the battery has either failed internally or discharged, the battery cables are loose, excessively corroded or damaged, or the alternator has failed or internally shorted, discharging the battery. Charge or replace the battery, clean or replace the battery cables, and check the alternator output.
    b. Check the operation of the neutral safety switch. On automatic transmission vehicles, try starting the vehicle in both Park and Neutral. On manual transmission vehicles, depress the clutch pedal and attempt to start. On some vehicles, these switches can be adjusted. Make sure the switches or wire connectors are not loose or damaged. Replace or adjust the switches as necessary.
    c. Check the starter motor, starter solenoid or relay, and starter motor cables and wires. Check the ground from the engine to the chassis. Make sure the wires are not loose, damaged, or corroded. If battery voltage is present at the starter relay, try using a remote starter to start the vehicle for test purposes only. Replace any damaged or corroded cables, in addition to replacing any failed components.
    d. Check the engine for seizure. If the engine has not been started for a long period of time, internal parts such as the rings may have rusted to the cylinder walls. The engine may have suffered internal damage, or could be hydro-locked from ingesting water. Remove the injectors and carefully attempt to rotate the engine using a suitable breaker bar and socket on the crankshaft pulley. If the engine is resistant to moving, or moves slightly and then binds, do not force the engine any further before determining the cause of the problem.
3. Engine stalls after starting
    a. Check for a restriction in the fuel return line or the return line check valve and repair as necessary.
    b. Check the glow plug operation for turning the glow plugs off too soon and repair as necessary.
    c. Check for incorrect injection pump timing and reset to specification.
    d. Test the engine fuel pump and replace if the output is below specification.

e. Check for contaminated or incorrect fuel. Completely flush the fuel system and replace with fresh fuel.

f. Test the engine's compression for low compression. If below specification, mechanical repairs are necessary to repair.

g. Check for air in the fuel. Check fuel tank fuel and fill as needed.

h. Check for a failed injection pump. Replace the pump, making sure to properly set the pump timing.

4. Starter motor spins, but does not engage

a. Check the starter motor for a seized or binding pinion gear.

b. Remove the flywheel inspection plate and check for a damaged ring gear.

1-B. Engine Running Conditions {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

1-B. Engine Running Conditions

Gasoline Engines

1. Engine runs poorly, hesitates
    a. Check the engine ignition system operation and adjust if possible, or replace defective parts.
    b. Check for restricted fuel injectors and replace as necessary.
    c. Check the fuel pump output and delivery. Inspect fuel lines for restrictions. If the fuel pump pressure is below specification, replace the fuel pump.
    d. Check the operation of the engine management system and repair as necessary.
2. Engine lacks power
    a. Check the engine's tune-up status. Note the tune-up specifications and check for items such as severely worn spark plugs; adjust or replace as needed. On vehicles with manually adjusted valve clearances, check for tight valves and adjust to specification.
    b. Check the air filter and air intake system. Replace the air filter if it is dirty or contaminated. Check the fresh air intake system for restrictions or blockage.
    c. Check the operation of the engine fuel and ignition management systems. Check the sensor operation and wiring. Check for low fuel pump pressure and repair or replace components as necessary.
    d. Check the throttle linkage adjustments. Check to make sure the linkage is fully opening the throttle. Replace any worn or defective bushings or linkages.
    e. Check for a restricted exhaust system. Check for bent or crimped exhaust pipes, or internally restricted mufflers or catalytic converters. Compare inlet and outlet temperatures for the converter or muffler. If the inlet is hot, but outlet cold, the component is restricted.
    f. Check for a loose or defective knock sensor. A loose, improperly torqued or defective knock sensor will decrease spark advance and reduce power. Replace defective knock sensors and install using the recommended torque specification.
    g. Check for engine mechanical conditions such as low compression, worn piston rings, worn valves, worn camshafts and related parts. An engine which has severe mechanical wear, or has suffered internal mechanical damage must be rebuilt or replaced to restore lost power.
    h. Check the engine oil level for being overfilled. Adjust the engine's oil level, or change the engine oil and filter, and top off to the correct level.
    i. Check for an intake manifold or vacuum hose leak. Replace leaking gaskets or worn vacuum hoses.
    j. Check for dragging brakes and replace or repair as necessary.
    k. Check tire air pressure and tire wear. Adjust the pressure to the recommended settings. Check the tire wear for possible alignment problems causing increased rolling resistance, decreased acceleration and increased fuel usage.
    l. Check the octane rating of the fuel used during refilling, and use a higher octane rated fuel.
3. Poor fuel economy
    a. Inspect the air filter and check for any air restrictions going into the air filter housing.

Replace the air filter if it is dirty or contaminated.

b. Check the engine for tune-up and related adjustments. Replace worn ignition parts, check the engine ignition timing and fuel mixture, and set to specifications if possible.

c. Check the tire size, tire wear, alignment and tire pressure. Large tires create more rolling resistance, smaller tires require more engine speed to maintain a vehicle's road speed. Excessive tire wear can be caused by incorrect tire pressure, incorrect wheel alignment or a suspension problem. All of these conditions create increased rolling resistance, causing the engine to work harder to accelerate and maintain a vehicle's speed.

d. Inspect the brakes for binding or excessive drag. A sticking brake caliper, overly adjusted brake shoe, broken brake shoe return spring, or binding parking brake cable or linkage can create a significant drag, brake wear and loss of fuel economy. Check the brake system operation and repair as necessary.

4. Engine runs on (diesels) when turned off

a. Check for idle speed set too high and readjust to specification.

b. Check the operation of the idle control valve, and replace if defective.

c. Check the ignition timing and adjust to recommended settings. Check for defective sensors or related components and replace if defective.

d. Check for a vacuum leak at the intake manifold or vacuum hose and replace defective gaskets or hoses.

e. Check the engine for excessive carbon build-up in the combustion chamber. Use a recommended decarbonizing fuel additive or disassemble the cylinder head to remove the carbon.

f. Check the operation of the engine fuel management system and replace defective sensors or control units.

g. Check the engine operating temperature for overheating and repair as necessary.

5. Engine knocks and pings during heavy acceleration, and on steep hills

a. Check the octane rating of the fuel used during refilling, and use a higher octane rated fuel.

b. Check the ignition timing and adjust to recommended settings. Check for defective sensors or related components and replace if defective.

c. Check the engine for excessive carbon build-up in the combustion chamber. Use a recommended decarbonizing fuel additive or disassemble the cylinder head to remove the carbon.

d. Check the spark plugs for the correct type, electrode gap and heat range. Replace worn or damaged spark plugs. For severe or continuous high speed use, install a spark plug that is one heat range colder.

e. Check the operation of the engine fuel management system and replace defective sensors or control units.

f. Check for a restricted exhaust system. Check for bent or crimped exhaust pipes, or internally restricted mufflers or catalytic converters. Compare inlet and outlet temperatures for the converter or muffler. If the inlet is hot, but outlet cold, the component is restricted.

6. Engine accelerates, but vehicle does not gain speed

a. On manual transmission vehicles, check for causes of a slipping clutch. Refer to the clutch troubleshooting section for additional information.

b. On automatic transmission vehicles, check for a slipping transmission. Check the transmission fluid level and condition. If the fluid level is too high, adjust to the correct level. If the fluid level is low, top off using the recommended fluid type. If the fluid exhibits a burning odor, the transmission has been slipping internally. Changing the fluid and filter may help temporarily, however in this situation a transmission may require overhauling to ensure long-term reliability.

Diesel Engines {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Troubleshooting

Diesel Engines

1. Engine runs poorly
   a. Check the injection pump timing and adjust to specification.
   b. Check for air in the fuel lines or leaks, and bleed the air from the fuel system.
   c. Check the fuel filter, fuel feed and return lines for a restriction and repair as necessary.
   d. Check the fuel for contamination, drain and flush the fuel tank and replenish with fresh fuel.
2. Engine lacks power
   a. Inspect the air intake system and air filter for restrictions and, if necessary, replace the air filter.
   b. Verify the injection pump timing and reset if out of specification.
   c. Check the exhaust for an internal restriction and replace failed parts.
   d. Check for a restricted fuel filter and, if restricted, replace the filter.
   e. Inspect the fuel filler cap vent . When removing the filler cap, listen for excessive hissing noises indicating a blockage in the fuel filler cap vents. If the filler cap vents are blocked, replace the cap.
   f. Check the fuel system for restrictions and repair as necessary.
   g. Check for low engine compression and inspect for external leakage at the glow plugs or nozzles. If no external leakage is noted, repair or replace the engine.

Engine Performance Troubleshooting Hints {ewc MVIMAGE, MVIMAGE, ! nexttopicarrow.bmp}

Engine Performance Troubleshooting Hints

When troubleshooting an engine running or performance condition, the mechanical condition of the engine should be determined *before* lengthy troubleshooting procedures are performed.

The engine fuel management systems in fuel injected vehicles rely on electronic sensors to provide information to the engine control unit for precise fuel metering. Unlike carburetors, which use the incoming air speed to draw fuel through the fuel metering jets in order to provide a proper fuel-to-air ratio, a fuel injection system provides a specific amount of fuel which is introduced by the fuel injectors into the intake manifold or intake port, based on the information provided by electronic sensors.

The sensors monitor the engine's operating temperature, ambient temperature and the amount of air entering the engine, engine speed and throttle position to provide information to the engine control unit, which, in turn, operates the fuel injectors by electrical pulses. The sensors provide information to the engine control unit using low voltage electrical signals. As a result, an unplugged sensor or a poor electrical contact could cause a poor running condition similar to a failed sensor.

When troubleshooting a fuel related engine condition on fuel injected vehicles, carefully inspect the wiring and electrical connectors to the related components. Make sure the electrical connectors are fully connected, clean and not physically damaged. If necessary, clean the electrical contacts using electrical contact cleaner. The use of cleaning agents not specifically designed for electrical contacts should not be used, as they could leave a surface film or damage the insulation of the wiring.

The engine electrical system provides the necessary electrical power to operate the vehicle's electrical accessories, electronic control units and sensors. Because engine management systems are sensitive to voltage changes, an alternator which over or undercharges could cause engine running problems or component failure. Most alternators utilize internal voltage regulators which cannot be adjusted and must be replaced individually or as a unit with the alternator.

Ignition systems may be controlled by, or linked to, the engine fuel management system. Similar to the fuel injection system, these ignition systems rely on electronic sensors for information to determine the optimum ignition timing for a given engine speed and load. Some ignition systems no longer allow the ignition timing to be adjusted. Feedback from low voltage electrical sensors provide information to the control unit to determine the amount of ignition advance. On these systems, if a failure occurs the failed component must be replaced. Before replacing suspected failed electrical components, carefully inspect the wiring and electrical connectors to the related components. Make sure the electrical connectors are fully connected, clean and not physically damaged. If necessary, clean the electrical contacts using electrical contact cleaner. The use of cleaning agents not specifically designed for electrical contacts should be avoided, as they could leave a surface film or damage the insulation of the wiring.

1-C. Engine Noises, Odors and Vibrations {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Troubleshooting

1-C. Engine Noises, Odors and Vibrations

1. Engine makes a knocking or pinging noise when accelerating
   a. Check the octane rating of the fuel being used. Depending on the type of driving or driving conditions, it may be necessary to use a higher octane fuel.
   b. Verify the ignition system settings and operation. Improperly adjusted ignition timing or a failed component, such as a knock sensor, may cause the ignition timing to advance excessively or prematurely.

      Check the ignition system operation and adjust, or replace components as needed.
   c. Check the spark plug gap, heat range and condition. If the vehicle is operated in severe operating conditions or at continuous high speeds, use a colder heat range spark plug. Adjust the spark plug gap to the manufacturer’s recommended specification and replace worn or damaged spark plugs.
2. Starter motor grinds when used
   a. Examine the starter pinion gear and the engine ring gear for damage, and replace damaged parts.
   b. Check the starter mounting bolts and housing. If the housing is cracked or damaged replace the starter motor and check the mounting bolts for tightness.
3. Engine makes a screeching noise
   a. Check the accessory drive belts for looseness and adjust as necessary.
   b. Check the accessory drive belt tensioners for seizing or excessive bearing noises and replace if loose, binding, or excessively noisy.
   c. Check for a seizing water pump. The pump may not be leaking; however, the bearing may be faulty or the impeller loose and jammed. Replace the water pump.
4. Engine makes a growling noise
   a. Check for a loose or failing water pump. Replace the pump and engine coolant.
   b. Check the accessory drive belt tensioners for excessive bearing noises and replace if loose or excessively noisy.
5. Engine makes a ticking or tapping noise
   a. On vehicles with hydraulic lash adjusters, check for low or dirty engine oil and top off or replace the engine oil and filter.
   b. On vehicles with hydraulic lash adjusters, check for collapsed lifters and replace failed components.
   c. On vehicles with hydraulic lash adjusters, check for low oil pressure caused by a restricted oil filter, worn engine oil pump, or oil pressure relief valve.
   d. On vehicles with manually adjusted valves, check for excessive valve clearance or worn valve train parts. Adjust the valves to specification or replace worn and defective parts.
   e. Check for a loose or improperly tensioned timing belt or timing chain and adjust or replace parts as necessary.
   f. Check for a bent or sticking exhaust or intake valve. Remove the engine cylinder head to access and replace.
6. Engine makes a heavy knocking noise
   a. Check for a loose crankshaft pulley or flywheel; replace and torque the mounting bolt(s)

to specification.

   b. Check for a bent connecting rod caused by a hydro-lock condition. Engine disassembly is necessary to inspect for damaged and needed replacement parts.

   c. Check for excessive engine rod bearing wear or damage. This condition is also associated with low engine oil pressure and will require engine disassembly to inspect for damaged and needed replacement parts.

7. Vehicle has a fuel odor when driven

   a. Check the fuel gauge level. If the fuel gauge registers full, it is possible that the odor is caused by being filled beyond capacity, or some spillage occurred during refueling. The odor should clear after driving an hour, or twenty miles, allowing the vapor canister to purge.

   b. Check the fuel filler cap for looseness or seepage. Check the cap tightness and, if loose, properly secure. If seepage is noted, replace the filler cap.

   c. Check for loose hose clamps, cracked or damaged fuel delivery and return lines, or leaking components or seals, and replace or repair as necessary.

   d. Check the vehicle's fuel economy. If fuel consumption has increased due to a failed component, or if the fuel is not properly ignited due to an ignition related failure, the catalytic converter may become contaminated. This condition may also trigger the check engine warning light. Check the spark plugs for a dark, rich condition or verify the condition by testing the vehicle's emissions. Replace fuel fouled spark plugs, and test and replace failed components as necessary.

8. Vehicle has a rotten egg odor when driven

   a. Check for a leaking intake gasket or vacuum leak causing a lean running condition. A lean mixture may result in increased exhaust temperatures, causing the catalytic converter to run hotter than normal. This condition may also trigger the check engine warning light. Check and repair the vacuum leaks as necessary.

   b. Check the vehicle's alternator and battery condition. If the alternator is overcharging, the battery electrolyte can be boiled from the battery, and the battery casing may begin to crack, swell or bulge, damaging or shorting the battery internally. If this has occurred, neutralize the battery mounting area with a suitable baking soda and water mixture or equivalent, and replace the alternator or voltage regulator. Inspect, service, and load test the battery, and replace if necessary.

9. Vehicle has a sweet odor when driven

   a. Check for an engine coolant leak caused by a seeping radiator cap, loose hose clamp, weeping cooling system seal, gasket or cooling system hose and replace or repair as needed.

   b. Check for a coolant leak from the radiator, coolant reservoir, heater control valve or under the dashboard from the heater core, and replace the failed part as necessary.

   c. Check the engine's exhaust for white smoke in addition to a sweet odor. The presence of white, steamy smoke with a sweet odor indicates coolant leaking into the combustion chamber. Possible causes include a failed head gasket, cracked engine block or cylinder head. Other symptoms of this condition include a white paste build-up on the inside of the oil filler cap, and softened, deformed or bulging radiator hoses.

10. Engine vibrates when idling

   a. Check for loose, collapsed, or damaged engine or transmission mounts and repair or replace as necessary.

   b. Check for loose or damaged engine covers or shields and secure or replace as necessary.

11. Engine vibrates during acceleration
    a. Check for missing, loose or damaged exhaust system hangers and mounts; replace or repair as necessary.
    b. Check the exhaust system routing and fit for adequate clearance or potential rubbing; repair or adjust as necessary.

1-D. Engine Electrical System {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

1-D. Engine Electrical System

1. Battery goes dead while driving
   a. Check the battery condition. Replace the battery if the battery will not hold a charge or fails a battery load test. If the battery loses fluid while driving, check for an overcharging condition. If the alternator is overcharging, replace the alternator or voltage regulator. (A voltage regulator is typically built into the alternator, necessitating alternator replacement or overhaul.)
   b. Check the battery cable condition. Clean or replace corroded cables and clean the battery terminals.
   c. Check the alternator and voltage regulator operation. If the charging system is over or undercharging, replace the alternator or voltage regulator, or both.
   d. Inspect the wiring and wire connectors at the alternator for looseness, a missing ground or defective terminal, and repair as necessary.
   e. Inspect the alternator drive belt tension, tensioners and condition. Properly tension the drive belt, replace weak or broken tensioners, and replace the drive belt if worn or cracked.
2. Battery goes dead overnight
   a. Check the battery condition. Replace the battery if the battery will not hold a charge or fails a battery load test.
   b. Check for a voltage draw, such as a trunk light, interior light or glove box light staying on. Check light switch position and operation, and replace if defective.
   c. Check the alternator for an internally failed diode, and replace the alternator if defective.

1-E. Engine Cooling System {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

1-E. Engine Cooling System

1. Engine overheats
   a. Check the coolant level. Set the heater temperature to full hot and check for internal air pockets, bleed the cooling system and inspect for leakage. Top off the cooling system with the correct coolant mixture.
   b. Pressure test the cooling system and radiator cap for leaks. Check for seepage caused by loose hose clamps, failed coolant hoses, and cooling system components such as the heater control valve, heater core, radiator, radiator cap, and water pump. Replace defective parts and fill the cooling system with the recommended coolant mixture.
   c. On vehicles with electrically controlled cooling fans, check the cooling fan operation. Check for blown fuses or defective fan motors, temperature sensors and relays, and replace failed components.
   d. Check for a coolant leak caused by a failed head gasket, or a porous water jacket casting in the cylinder head or engine block. Replace defective parts as necessary.
   e. Check for an internally restricted radiator. Flush the radiator or replace if the blockage is too severe for flushing.
   f. Check for a damaged water pump. If coolant circulation is poor, check for a loose water pump impeller. If the impeller is loose, replace the water pump.
2. Engine loses coolant
   a. Pressure test the cooling system and radiator cap for leaks. Check for seepage caused by loose hose clamps, failed coolant hoses, and cooling system components such as the heater control valve, heater core, radiator, radiator cap, and water pump. Replace defective parts and fill the cooling system with the recommended coolant mixture.
   b. Check for a coolant leak caused by a failed head gasket, or a porous water jacket casting in the cylinder head or engine block. Replace defective parts as necessary.
3. Engine temperature remains cold when driving
   a. Check the thermostat operation. Replace the thermostat if it sticks in the open position.
   b. On vehicles with electrically controlled cooling fans, check the cooling fan operation. Check for defective temperature sensors and stuck relays, and replace failed components.
   c. Check temperature gauge operation if equipped to verify proper operation of the gauge. Check the sensors and wiring for defects, and repair or replace defective components.
4. Engine runs hot
   a. Check for an internally restricted radiator. Flush the radiator or replace if the blockage is too severe for flushing.
   b. Check for a loose or slipping water pump drive belt. Inspect the drive belt condition. Replace the belt if brittle, cracked or damaged. Check the pulley condition and properly tension the belt.
   c. Check the cooling fan operation. Replace defective fan motors, sensors or relays as necessary.
   d. Check temperature gauge operation if equipped to verify proper operation of the gauge. Check the sensors and wiring for defects, and repair or replace defective components.
   e. Check the coolant level. Set the heater temperature to full hot, check for internal air pockets, bleed the cooling system and inspect for leakage. Top off the cooling system

with the correct coolant mixture. Once the engine is cool, recheck the fluid level and top off as needed.

Ä The engine cooling system can also be affected by an engine's mechanical condition. A failed head gasket or a porous casting in the engine block or cylinder head could cause a loss of coolant and result in engine overheating.

Some cooling systems rely on electrically driven cooling fans to cool the radiator and use electrical temperature sensors and relays to operate the cooling fan. When diagnosing these systems, check for blown fuses, damaged wires and verify that the electrical connections are fully connected, clean and not physically damaged. If necessary, clean the electrical contacts using electrical contact cleaner. The use of cleaning agents not specifically designed for electrical contacts could leave a film or damage the insulation of the wiring.

1-F. Engine Exhaust System {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

1-F. Engine Exhaust System

1. Exhaust rattles at idle speed
   a. Check the engine and transmission mounts and replace mounts showing signs of damage or wear.
   b. Check the exhaust hangers, brackets and mounts. Replace broken, missing or damaged mounts.
   c. Check for internal damage to mufflers and catalytic converters. The broken pieces from the defective component may travel in the direction of the exhaust flow and collect and/or create a blockage in a component other than the one which failed, causing engine running and stalling problems. Another symptom of a restricted exhaust is low engine manifold vacuum. Remove the exhaust system and carefully remove any loose or broken pieces, then replace any failed or damaged parts as necessary.
   d. Check the exhaust system clearance, routing and alignment. If the exhaust is making contact with the vehicle in any manner, loosen and reposition the exhaust system.
2. Exhaust system vibrates when driving
   a. Check the exhaust hangers, brackets and mounts. Replace broken, missing or damaged mounts.
   b. Check the exhaust system clearance, routing and alignment. If the exhaust is making contact with the vehicle in any manner, check for bent or damaged components and replace, then loosen and reposition the exhaust system.
   c. Check for internal damage to mufflers and catalytic converters. The broken pieces from the defective component may travel in the direction of the exhaust flow and collect and/or create a blockage in a component other than the one which failed, causing engine running and stalling problems. Another symptom of a restricted exhaust is low engine manifold vacuum. Remove the exhaust system and carefully remove any loose or broken pieces, then replace any failed or damaged parts as necessary.
3. Exhaust system hangs too low
   a. Check the exhaust hangers, brackets and mounts. Replace broken, missing or damaged mounts.
   b. Check the exhaust routing and alignment. Check and replace bent or damaged components. If the exhaust is not routed properly, loosen and reposition the exhaust system.
4. Exhaust sounds loud
   a. Check the system for looseness and leaks. Check the exhaust pipes, clamps, flange bolts and manifold fasteners for tightness. Check and replace any failed gaskets.
   b. Check and replace exhaust silencers that have a loss of efficiency due to internally broken baffles or worn packing material.
   c. Check for missing mufflers and silencers that have been replaced with straight pipes or with non-original equipment silencers.

   Ä Exhaust system rattles, vibration and proper alignment should not be overlooked. Excessive vibration caused by collapsed engine mounts, damaged or missing exhaust hangers and misalignment may cause surface cracks and broken welds, creating exhaust leaks or internal damage to exhaust components such as the catalytic converter, creating a restriction to exhaust flow and loss of power.

2. Drive Train {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

2. Drive Train

2-A. Automatic Transmission

1. Transmission shifts erratically
   a. Check and if not within the recommended range, add or remove transmission fluid to obtain the correct fluid level. Always use the recommended fluid type when adding transmission fluid.
   b. Check the fluid level condition. If the fluid has become contaminated, fatigued from excessive heat or exhibits a burning odor, change the transmission fluid and filter using the recommended type and amount of fluid. A fluid which exhibits a burning odor indicates that the transmission has been slipping internally and may require future repairs.
   c. Check for an improperly installed transmission filter, or missing filter gasket, and repair as necessary.
   d. Check for loose or leaking gaskets, pressure lines and fittings, and repair or replace as necessary.
   e. Check for loose or disconnected shift and throttle linkages or vacuum hoses, and repair as necessary.
2. Transmission will not engage
   a. Check the shift linkage for looseness, wear and proper adjustment, and repair as necessary.
   b. Check for a loss of transmission fluid and top off as needed with the recommended fluid.
   c. If the transmission does not engage with the shift linkage correctly installed and the proper fluid level, internal damage has likely occurred, requiring transmission removal and disassembly.
3. Transmission will not downshift during heavy acceleration
   a. On computer controlled transmissions, check for failed sensors or control units and repair or replace defective components.
   b. On vehicles with kickdown linkages or vacuum servos, check for proper linkage adjustment or leaking vacuum hoses or servo units.

   Ä Many automatic transmissions use an electronic control module, electrical sensors and solenoids to control transmission shifting. When troubleshooting a vehicle with this type of system, be sure the electrical connectors are fully connected, clean and not physically damaged. If necessary, clean the electrical contacts using electrical contact cleaner. The use of cleaning agents not specifically designed for electrical contacts could leave a film or damage the insulation of the wiring.

2-B. Manual Transmission {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

2-B. Manual Transmission

1. Transmission grinds going into forward gears while driving
   a. Check the clutch release system. On clutches with a mechanical or cable linkage, check the adjustment. Adjust the clutch pedal to have 1 inch (25mm) of free-play at the pedal.
   b. If the clutch release system is hydraulically operated, check the fluid level and, if low, top off using the recommended type and amount of fluid.
   c. Synchronizers worn. Remove transmission and replace synchronizers.
   d. Synchronizer sliding sleeve worn. Remove transmission and replace sliding sleeve.
   e. Gear engagement dogs worn or damaged. Remove transmission and replace gear.
2. Transmission jumps out of gear
   a. Shift shaft detent springs worn. Replace shift detent springs.
   b. Synchronizer sliding sleeve worn. Remove transmission and replace sliding sleeve.
   c. Gear engagement dogs worn or damaged. Remove transmission and replace gear.
   d. Crankshaft thrust bearings worn. Remove engine and crankshaft, and repair as necessary.
3. Transmission difficult to shift
   a. Verify the clutch adjustment and, if not properly adjusted, adjust to specification.
   b. Synchronizers worn. Remove transmission and replace synchronizers.
   c. Pilot bearing seized. Remove transmission and replace pilot bearing.
   d. Shift linkage or bushing seized. Disassemble the shift linkage, replace worn or damaged bushings, lubricate and reinstall.
4. Transmission leaks fluid
   a. Check the fluid level for an overfilled condition. Adjust the fluid level to specification.
   b. Check for a restricted transmission vent or breather tube. Clear the blockage as necessary and check the fluid level. If necessary, top off with the recommended lubricant.
   c. Check for a porous casting, leaking seal or gasket. Replace defective parts and top off the fluid level with the recommended lubricant.

2-C. Clutch {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

2-C. Clutch

1. Clutch slips on hills or during sudden acceleration
   a. Check for insufficient clutch pedal free-play. Adjust clutch linkage or cable to allow about 1 inch (25mm) of pedal free-play.
   b. Clutch disc worn or severely damaged. Remove engine or transmission and replace clutch disc.
   c. Clutch pressure plate is weak. Remove engine or transmission and replace the clutch pressure plate and clutch disc.
   d. Clutch pressure plate and/or flywheel incorrectly machined. If the clutch system has been recently replaced and rebuilt, or refurbished parts have been used, it is possible that the machined surfaces decreased the clutch clamping force. Replace defective parts with new replacement parts.
2. Clutch will not disengage, difficult to shift
   a. Check the clutch release mechanism. Check for stretched cables, worn linkages or failed clutch hydraulics and replace defective parts. On hydraulically operated clutch release mechanisms, check for air in the hydraulic system and bleed as necessary.
   b. Check for a broken, cracked or fatigued clutch release arm or release arm pivot. Replace defective parts and properly lubricate upon assembly.
   c. Check for a damaged clutch hub damper or damper spring. The broken parts tend to become lodged between the clutch disc and the pressure plate. Disassemble clutch system and replace failed parts.
   d. Check for a seized clutch pilot bearing. Disassemble the clutch assembly and replace the defective parts.
   e. Check for a defective clutch disc. Check for warpage or lining thicknesses larger than original equipment.
3. Clutch is noisy when the clutch pedal is pressed
   a. Check the clutch pedal stop and pedal free-play adjustment for excessive movement and adjust as necessary.
   b. Check for a worn or damaged release bearing. If the noise ceases when the pedal is released, the release bearing should be replaced.
   c. Check the engine crankshaft axial play. If the crankshaft thrust bearings are worn or damaged, the crankshaft will move when pressing the clutch pedal. The engine must be disassembled to replace the crankshaft thrust bearings.
4. Clutch pedal extremely difficult to press
   a. Check the clutch pedal pivots and linkages for binding. Clean and lubricate linkages.
   b. On cable actuated clutch systems, check the cable routing and condition. Replace kinked, frayed, damaged or corroded cables and check cable routing to avoid sharp bends. Check the engine ground strap for poor conductivity. If the ground strap is marginal, the engine could try to ground itself via the clutch cable, causing premature failure.
   c. On mechanical linkage clutches, check the linkage for binding or misalignment. Lubricate pivots or linkages and repair as necessary.
   d. Check the release bearing guide tube and release fork for a lack of lubrication. Install a smooth coating of high temperature grease to allow smooth movement of the release

bearing over the guide tube.

5. Clutch pedal remains down when pressed

   a. On mechanical linkage or cable actuated clutches, check for a loose or disconnected link.

   b. On hydraulically actuated clutches, check the fluid level and check for a hydraulic leak at the clutch slave or master cylinder, or hydraulic line. Replace failed parts and bleed clutch hydraulic system. If no leakage is noted, the clutch master cylinder may have failed internally. Replace the clutch master cylinder and bleed the clutch hydraulic system.

6. Clutch chatters when engaging

   a. Check the engine flywheel for warpage or surface variations and replace or repair as necessary.

   b. Check for a warped clutch disc or damaged clutch damper hub. Remove the clutch disc and replace.

   c. Check for a loose or damaged clutch pressure plate and replace defective components.

   Ä The clutch is actuated either by a mechanical linkage, cable or a clutch hydraulic system. The mechanical linkage and cable systems may require the clutch pedal free-play to be adjusted as the clutch disc wears. A hydraulic clutch system automatically adjusts as the clutch wears and, with the exception of the clutch pedal height, no adjustment is possible.

2-D. Differential and Final Drive {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

2-D. Differential and Final Drive

1. Differential makes a low pitched rumbling noise
   a. Check fluid level type and amount. Replace the fluid with the recommended type and amount of lubricant.
   b. Check the differential bearings for wear or damage. Remove the bearings, inspect the drive and driven gears for wear or damage, and replace components as necessary.
2. Differential makes a howling noise
   a. Check fluid level type and amount. Replace the fluid with the recommended type and amount of lubricant.
   b. Check the differential drive and driven gears for wear or damage, and replace components as necessary.

2-E. Transfer Assembly {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

2-E. Transfer Assembly

All Wheel and Four Wheel Drive Vehicles

1. Leaks fluid from seals or vent after being driven
   a. Fluid level overfilled. Check and adjust transfer case fluid level.
   b. Check for a restricted breather or breather tube, clear and check the fluid level and top off as needed.
   c. Check seal condition and replace worn, damaged, or defective seals. Check the fluid level and top off as necessary.
2. Makes excessive noise while driving
   a. Check the fluid for the correct type of lubricant. Drain and refill using the recommended type and amount of lubricant.
   b. Check the fluid level. Top off the fluid using the recommended type and amount of lubricant.
   c. If the fluid level and type of lubricant meet specifications, check for internal wear or damage. Remove assembly and disassemble to inspect for worn, damaged, or defective components.
3. Jumps out of gear
   a. Stop vehicle and make sure the unit is fully engaged.
   b. Check for worn, loose or an improperly adjusted linkage. Replace and/or adjust linkage as necessary.
   c. Check for internal wear or damage. Remove assembly and disassemble to inspect for worn, damaged, or defective components.

2-F. Driveshaft {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

2-F. Driveshaft

Rear Wheel, All Wheel and Four Wheel Drive Vehicles

1. Clunking noise from center of vehicle shifting from forward to reverse
    a. Worn universal joint. Remove driveshaft and replace universal joint.
2. Excessive vibration from center of vehicle when accelerating
    a. Worn universal joint. Remove driveshaft and replace universal joint.
    b. Driveshaft misaligned. Check for collapsed or damaged engine and transmission mounts, and replace as necessary.
    c. Driveshaft bent or out of balance. Replace damaged components and reinstall.
    d. Driveshaft out of balance. Remove the driveshaft and have it balanced by a competent professional, or replace the driveshaft assembly.

Ä Most driveshafts are linked together by universal joints; however, some manufacturers use Constant Velocity (CV) joints or rubber flex couplers.

2-G. Axles {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Troubleshooting

2-G. Axles

All Wheel and Four Wheel Drive Vehicles

1. Front or rear wheel makes a clicking noise
   a. Check for debris such as a pebble, nail or glass in the tire or tire tread. Carefully remove the debris. Small rocks and pebbles rarely cause a puncture; however, a sharp object should be removed carefully at a facility capable of performing tire repairs.
   b. Check for a loose, damaged or worn Constant Velocity (CV) joint and replace if defective.
2. Front or rear wheel vibrates with increased speed
   a. Check for a bent rim and replace, if damaged.
   b. Check the tires for balance or internal damage and replace if defective.
   c. Check for a loose, worn or damaged wheel bearing and replace if defective.
   d. Check for a loose, damaged or worn Constant Velocity (CV) joint and replace if defective.

Front Wheel Drive Vehicles {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Front Wheel Drive Vehicles

3. Front wheel makes a clicking noise
    a. Check for debris such as a pebble, nail or glass in the tire or tire tread. Carefully remove the debris. Small rocks and pebbles rarely cause a puncture; however, a sharp object should be removed carefully at a facility capable of performing tire repairs.
    b. Check for a loose, damaged or worn Constant Velocity (CV) joint and replace if defective.
4. Rear wheel makes a clicking noise
    a. Check for debris such as a pebble, nail or glass in the tire or tire tread. Carefully remove the debris. Small rocks and pebbles rarely cause a puncture; however, a sharp object should be removed carefully at a facility capable of performing tire repairs.

Rear Wheel Drive Vehicles {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Rear Wheel Drive Vehicles

5. Front or rear wheel makes a clicking noise
   a. Check for debris such as a pebble, nail or glass in the tire or tire tread. Carefully remove the debris. Small rocks and pebbles rarely cause a puncture; however, a sharp object should be removed carefully at a facility capable of performing tire repairs.
6. Rear wheel shudders or vibrates
   a. Check for a bent rear wheel or axle assembly and replace defective components.
   b. Check for a loose, damaged or worn rear wheel bearing and replace as necessary.

2-H. Other Drive Train Conditions {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

2-H. Other Drive Train Conditions

1. Burning odor from center of vehicle when accelerating
    a. Check for a seizing brake hydraulic component such as a brake caliper. Check the caliper piston for surface damage such as rust, and measure for out-of-round wear and caliper-to-piston clearance. For additional information on brake related odors, refer to section 3-A, condition number 9.
    b. On vehicles with a manual transmission, check for a slipping clutch. For possible causes and additional information, refer to section 2-C, condition number 1.
    c. On vehicles with an automatic transmission, check the fluid level and condition. Top off or change the fluid and filter using the recommended replacement parts, lubricant type and amount. If the odor persists, transmission removal and disassembly will be necessary.
2. Engine accelerates, but vehicle does not gain speed.
    a. On vehicles with a manual transmission, check for a slipping or damaged clutch. For possible causes and additional information refer to section 2-C, condition number 1.
    b. On vehicles with an automatic transmission, check the fluid level and condition. Top off or change the fluid and filter using the recommended replacement parts, lubricant type and amount. If the slipping continues, transmission removal and disassembly will be necessary.

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3. Brake System {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

3. Brake System

3-A. Brake System Troubleshooting

1. Brake pedal pulsates or shimmies when pressed
   a. Check wheel lug nut torque and tighten evenly to specification.
   b. Check the brake rotor for trueness and thickness variations. Replace the rotor if it is too thin, warped, or if the thickness varies beyond specification. Some rotors can be machined; consult the manufacturer’s specifications and recommendations before using a machined brake rotor.
   c. Check the brake caliper or caliper bracket mounting bolt torque and inspect for looseness. Torque the mounting bolts and inspect for wear or any looseness, including worn mounting brackets, bushings and sliding pins.
   d. Check the wheel bearing for looseness. If the bearing is loose, adjust if possible, otherwise replace the bearing.
2. Brakes make a squealing noise
   a. Check the brake rotor for the presence of a ridge on the outer edge; if present, remove the ridge or replace the brake rotor and brake pads.
   b. Check for debris in the brake lining material, clean and reinstall.
   c. Check the brake linings for wear and replace the brake linings if wear is approaching the lining wear limit.
   d. Check the brake linings for glazing. Inspect the brake drum or rotor surface and replace, along with the brake linings, if the surface is not smooth or even.
   e. Check the brake pad or shoe mounting areas for a lack of lubricant or the presence of surface rust. Clean and lubricate with a recommended high temperature brake grease.
3. Brakes make a grinding noise
   a. Check the brake linings and brake surface areas for severe wear or damage. Replace worn or damaged parts.
   b. Check for a seized or partially seized brake causing premature or uneven brake wear, excessive heat and brake rotor or drum damage. Replace defective parts and inspect the wheel bearing condition, which could have been damaged due to excessive heat.
4. Vehicle pulls to one side during braking
   a. Check for air in the brake hydraulic system. Inspect the brake hydraulic seals, fluid lines and related components for fluid leaks. Remove the air from the brake system by bleeding the brakes. Be sure to use fresh brake fluid that meets the manufacturer’s recommended standards.
   b. Check for an internally restricted flexible brake hydraulic hose. Replace the hose and flush the brake system.
   c. Check for a seizing brake hydraulic component such as a brake caliper. Check the caliper piston for surface damage such as rust, and measure for out-of-round wear and caliper-to-piston clearance. Overhaul or replace failed parts and flush the brake system.
   d. Check the vehicle’s alignment and inspect for suspension wear. Replace worn bushings, ball joints and set alignment to the manufacturer’s specifications.
   e. If the brake system uses drum brakes front or rear, check the brake adjustment. Inspect for seized adjusters and clean or replace, then properly adjust.

5. Brake pedal feels spongy or has excessive travel
    a. Check the brake fluid level and condition. If the fluid is contaminated or has not been flushed every two years, clean the master cylinder reservoir, and bleed and flush the brakes using fresh brake fluid that meets the manufacturer’s recommended standards.
    b. Check for a weak or damaged flexible brake hydraulic hose. Replace the hose and flush the brake system.
    c. If the brake system uses drum brakes front or rear, check the brake adjustment. Inspect for seized adjusters and clean or replace, then properly adjust.
6. Brake pedal feel is firm, but brakes lack sufficient stopping power or fade
    a. Check the operation of the brake booster and brake booster check valve. Replace worn or failed parts.
    b. Check brake linings and brake surface areas for glazing and replace worn or damaged parts.
    c. Check for seized hydraulic parts and linkages, and clean or replace as needed.
7. Vehicle has excessive front end dive or locks rear brakes too easily
    a. Check for worn, failed or seized brake proportioning valve and replace the valve.
    b. Check for a seized, disconnected or missing spring or linkage for the brake proportioning valve. Replace missing parts or repair as necessary.
8. Brake pedal goes to floor when pressed and will not pump up
    a. Check the brake hydraulic fluid level and inspect the fluid lines and seals for leakage. Repair or replace leaking components, then bleed and flush the brake system using fresh brake fluid that meets the manufacturer’s recommended standards.
    b. Check the brake fluid level. Inspect the brake fluid level and brake hydraulic seals. If the fluid level is ok, and the brake hydraulic system is free of hydraulic leaks, replace the brake master cylinder, then bleed and flush the brake system using fresh brake fluid that meets the manufacturer’s recommended standards.
9. Brakes produce a burning odor
    a. Check for a seizing brake hydraulic component such as a brake caliper. Check the caliper piston for surface damage such as rust, and measure for out-of-round wear and caliper-to-piston clearance. Overhaul or replace failed parts and flush the brake system.
    b. Check for an internally restricted flexible brake hydraulic hose. Replace the hose and flush the brake system.
    c. Check the parking brake release mechanism, seized linkage or cable, and repair as necessary.

Brake Performance Troubleshooting Hints {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Troubleshooting

Brake Performance Troubleshooting Hints

Brake vibrations or pulsation can often be diagnosed on a safe and careful test drive. A brake vibration which is felt through the brake pedal while braking, but not felt in the steering wheel, is most likely caused by brake surface variations in the rear brakes. If both the brake pedal and steering wheel vibrate during braking, a surface variation in the front brakes, or both front and rear brakes, is very likely.

A brake pedal that pumps up with repeated use can be caused by air in the brake hydraulic system or, if the vehicle is equipped with rear drum brakes, the brake adjusters may be seized or out of adjustment. A quick test for brake adjustment on vehicles with rear drum brakes is to pump the brake pedal several times with the vehicle's engine not running and the parking brake released. Pump the brake pedal several times and continue to apply pressure to the brake pedal. With pressure being applied to the brake pedal, engage the parking brake. Release the brake pedal and quickly press the brake pedal again. If the brake pedal pumped up, the rear brakes are in need of adjustment. Do not compensate for the rear brake adjustment by adjusting the parking brake, this will cause premature brake lining wear.

To test a vacuum brake booster, pump the brake pedal several times with the vehicle's engine off. Apply pressure to the brake pedal and then start the engine. The brake pedal should move downward about one inch (25mm).

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4. Wheels, Tires, Steering and Suspension {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

4. Wheels, Tires, Steering and Suspension

4-A. Wheels and Wheel Bearings

1. Front Wheel or Wheel Bearing Loose

All Wheel and Four Wheel Drive Vehicles

a. Torque lug nuts and axle nuts to specification and recheck for looseness.

b. Wheel bearing worn or damaged. Replace wheel bearing.

Front Wheel Drive Vehicles

a. Torque lug nuts and axle nuts to specification and recheck for looseness.

b. Wheel bearing worn or damaged. Replace wheel bearing.

Rear Wheel Drive Vehicles

a. Wheel bearing out of adjustment. Adjust wheel bearing to specification; if still loose, replace.

b. Torque lug nuts to specification and recheck for looseness.

c. Wheel bearing worn or damaged. Replace wheel bearing.

2. Rear Wheel or Wheel Bearing Loose

All Wheel and Four Wheel Drive Vehicles

a. Torque lug nuts and axle nuts to specification and recheck for looseness.

b. Wheel bearing worn or damaged. Replace wheel bearing.

Front Wheel Drive Vehicles

a. Wheel bearing out of adjustment. Adjust wheel bearing to specification; if still loose, replace.

b. Torque lug nuts to specification and recheck for looseness.

c. Wheel bearing worn or damaged. Replace wheel bearing.

Rear Wheel Drive Vehicles

a. Torque lug nuts and to specification and recheck for looseness.

b. Wheel bearing worn or damaged. Replace wheel bearing.

4-B. Tires {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

4-B. Tires

1. Tires worn on inside tread
   a. Check alignment for a toed-out condition. Check and set tire pressures and properly adjust the toe.
   b. Check for worn, damaged or defective suspension components. Replace defective parts and adjust the alignment.
2. Tires worn on outside tread
   a. Check alignment for a toed-in condition. Check and set tire pressures and properly adjust the toe.
   b. Check for worn, damaged or defective suspension components. Replace defective parts and adjust the alignment.
3. Tires worn unevenly
   a. Check the tire pressure and tire balance. Replace worn or defective tires and check the alignment; adjust if necessary.
   b. Check for worn shock absorbers. Replaced failed components, worn or defective tires and check the alignment; adjust if necessary.
   c. Check the alignment settings. Check and set tire pressures and properly adjust the alignment to specification.
   d. Check for worn, damaged or defective suspension components. Replace defective parts and adjust the alignment to specification.

4-C. Steering {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

4-C. Steering

1. Excessive play in steering wheel
   a. Check the steering gear free-play adjustment and properly adjust to remove excessive play.
   b. Check the steering linkage for worn, damaged or defective parts. Replace failed components and perform a front end alignment.
   c. Check for a worn, damaged, or defective steering box, replace the steering gear and check the front end alignment.
2. Steering wheel shakes at cruising speeds
   a. Check for a bent front wheel. Replace a damaged wheel and check the tire for possible internal damage.
   b. Check for an unevenly worn front tire. Replace the tire, adjust tire pressure and balance.
   c. Check the front tires for hidden internal damage. Tires which have encountered large pot holes or suffered other hard blows may have sustained internal damage and should be replaced immediately.
   d. Check the front tires for an out-of-balance condition. Remove, spin balance and reinstall. Torque all the wheel bolts or lug nuts to the recommended specification.
   e. Check for a loose wheel bearing. If possible, adjust the bearing, or replace the bearing if it is a non-adjustable bearing.
3. Steering wheel shakes when braking
   a. Refer to section 3-A, condition number 1.
4. Steering wheel becomes stiff when turned
   a. Check the steering wheel free-play adjustment and reset as needed.
   b. Check for a damaged steering gear assembly. Replace the steering gear and perform a front end alignment.
   c. Check for damaged or seized suspension components. Replace defective components and perform a front end alignment.

4-D. Suspension {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

4-D. Suspension

1. Vehicle pulls to one side
   a. Tire pressure uneven. Adjust tire pressure to recommended settings.
   b. Tires worn unevenly. Replace tires and check alignment settings.
   c. Alignment out of specification. Align front end and check thrust angle.
   d. Check for a dragging brake and repair or replace as necessary.
2. Vehicle is very bouncy over bumps
   a. Check for worn or leaking shock absorbers or strut assemblies and replace as necessary.
   b. Check for seized shock absorbers or strut assemblies and replace as necessary.

   Ä When one shock fails, it is recommended to replace front or rear units as pairs.
3. Vehicle leans excessively in turns
   a. Check for worn or leaking shock absorbers or strut assemblies and replace as necessary.
   b. Check for missing, damaged, or worn stabilizer links or bushings, and replace or install as necessary.
4. Vehicle ride quality seems excessively harsh
   a. Check for seized shock absorbers or strut assemblies and replace as necessary.
   b. Check for excessively high tire pressures and adjust pressures to vehicle recommendations.
5. Vehicle seems low or leans to one side
   a. Check for a damaged, broken or weak spring. Replace defective parts and check for a needed alignment.
   b. Check for seized shock absorbers or strut assemblies and replace as necessary.
   c. Check for worn or leaking shock absorbers or strut assemblies and replace as necessary.

4-E. Driving Noises and Vibrations {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

4-E. Driving Noises and Vibrations

Noises

1. Vehicle makes a clicking noises when driven
   a. Check the noise to see if it varies with road speed. Verify if the noise is present when coasting or with steering or throttle input. If the clicking noise frequency changes with road speed and is not affected by steering or throttle input, check the tire treads for a stone, piece of glass, nail or another hard object imbedded into the tire or tire tread. Stones rarely cause a tire puncture and are easily removed. Other objects may create an air leak when removed. Consider having these objects removed immediately at a facility equipped to repair tire punctures.
   b. If the clicking noise varies with throttle input and steering, check for a worn Constant Velocity (CV-joint) joint, universal (U- joint) or flex joint.
2. Vehicle makes a clunking or knocking noise over bumps
   a. A clunking noise over bumps is most often caused by excessive movement or clearance in a suspension component. Check the suspension for soft, cracked, damaged or worn bushings. Replace the bushings and check the vehicle's alignment.
   b. Check for loose suspension mounting bolts. Check the tightness on subframe bolts, pivot bolts and suspension mounting bolts, and torque to specification.
   c. Check the vehicle for a loose wheel bearing. Some wheel bearings can be adjusted for looseness, while others must be replaced if loose. Adjust or replace the bearings as recommended by the manufacturer.
   d. Check the door latch adjustment. If the door is slightly loose, or the latch adjustment is not centered, the door assembly may create noises over bumps and rough surfaces. Properly adjust the door latches to secure the door.
3. Vehicle makes a low pitched rumbling noise when driven
   a. A low pitched rumbling noise is usually caused by a drive train related bearing and is most often associated with a wheel bearing which has been damaged or worn. The damage can be caused by excessive brake temperatures or physical contact with a pot hole or curb. Sometimes the noise will vary when turning. Left hand turns increase the load on the vehicle's right side, and right turns load the left side. A failed front wheel bearing may also cause a slight steering wheel vibration when turning. A bearing which exhibits noise must be replaced.
   b. Check the tire condition and balance. An internally damaged tire may cause failure symptoms similar to failed suspension parts. For diagnostic purposes, try a known good set of tires and replace defective tires.
4. Vehicle makes a squeaking noise over bumps
   a. Check the vehicle's ball joints for wear, damaged or leaking boots. Replace a ball joint if it is loose, the boot is damaged and leaking, or the ball joint is binding. When replacing suspension parts, check the vehicle for alignment.
   b. Check for seized or deteriorated bushings. Replace bushings that are worn or damaged and check the vehicle for alignment.
   c. Check for the presence of sway bar or stabilizer bar bushings which wrap around the bar. Inspect the condition of the bushings and replace if worn or damaged. Remove the bushing bracket and apply a thin layer of suspension grease to the area where the bushings wrap around the bar and reinstall the bushing brackets.

5. Vehicle vibrates when driven

    a. Check the road surface. Roads which have rough or uneven surfaces may cause unusual vibrations.

    b. Check the tire condition and balance. An internally damaged tire may cause failure symptoms similar to failed suspension parts. For diagnostic purposes, try a known good set of tires and replace defective tires immediately.

    c. Check for a worn Constant Velocity (CV-joint) joint, universal (U- joint) or flex joint and replace if loose, damaged or binding.

    d. Check for a loose, bent, or out-of-balance axle or drive shaft. Replace damaged or failed components.

    Ä Diagnosing failures related to wheels, tires, steering and the suspension system can often times be accomplished with a careful and thorough test drive. Bearing noises are isolated by noting whether the noises or symptoms vary when turning left or right, or occur while driving a straight line. During a left hand turn, the vehicle's weight shifts to the right, placing more force on the right side bearings, such that if a right side wheel bearing is worn or damaged, the noise or vibration should increase during light-to-heavy acceleration. Conversely, on right hand turns, the vehicle tends to lean to the left, loading the left side bearings.

Knocking noises in the suspension when the vehicle is driven over rough roads, railroad tracks and speed bumps indicate worn suspension components such as bushings, ball joints or tie rod ends, or a worn steering system.

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5. Electrical Accessories {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

5. Electrical Accessories

5-A. Headlights

1. One headlight only works on high or low beam
   a. Check for battery voltage at headlight electrical connector. If battery voltage is present, replace the headlight assembly or bulb if available separately. If battery voltage is not present, refer to the headlight wiring diagram to troubleshoot.
2. Headlight does not work on high or low beam
   a. Check for battery voltage and ground at headlight electrical connector. If battery voltage is present, check the headlight connector ground terminal for a proper ground. If battery voltage and ground are present at the headlight connector, replace the headlight assembly or bulb if available separately. If battery voltage or ground is not present, refer to the headlight wiring diagram to troubleshoot.
   b. Check the headlight switch operation. Replace the switch if the switch is defective or operates intermittently.
3. Headlight(s) very dim
   a. Check for battery voltage and ground at headlight electrical connector. If battery voltage is present, trace the ground circuit for the headlamp electrical connector, then clean and repair as necessary. If the voltage at the headlight electrical connector is significantly less than the voltage at the battery, refer to the headlight wiring diagram to troubleshoot and locate the voltage drop.

5-B. Tail, Running and Side Marker Lights {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

5-B. Tail, Running and Side Marker Lights

1. Tail light, running light or side marker light inoperative
   a. Check for battery voltage and ground at light's electrical connector. If battery voltage is present, check the bulb socket and electrical connector ground terminal for a proper ground. If battery voltage and ground are present at the light connector, but not in the socket, clean the socket and the ground terminal connector. If battery voltage and ground are present in the bulb socket, replace the bulb. If battery voltage or ground is not present, refer to the wiring diagram to troubleshoot for an open circuit.
   b. Check the light switch operation and replace if necessary.
2. Tail light, running light or side marker light works intermittently
   a. Check the bulb for a damaged filament, and replace if damaged.
   b. Check the bulb and bulb socket for corrosion, and clean or replace the bulb and socket.
   c. Check for loose, damaged or corroded wires and electrical terminals, and repair as necessary.
   d. Check the light switch operation and replace if necessary.
3. Tail light, running light or side marker light very dim
   a. Check the bulb and bulb socket for corrosion and clean or replace the bulb and socket.
   b. Check for low voltage at the bulb socket positive terminal or a poor ground. If voltage is low, or the ground marginal, trace the wiring to, and check for loose, damaged or corroded wires and electrical terminals; repair as necessary.
   c. Check the light switch operation and replace if necessary.

5-C. Interior Lights {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

5-C. Interior Lights

1. Interior light inoperative
   a. Verify the interior light switch location and position(s), and set the switch in the correct position.
   b. Check for battery voltage and ground at the interior light bulb socket. If battery voltage and ground are present, replace the bulb. If voltage is not present, check the interior light fuse for battery voltage. If the fuse is missing, replace the fuse. If the fuse has blown, or if battery voltage is present, refer to the wiring diagram to troubleshoot the cause for an open or shorted circuit. If ground is not present, check the door switch contacts and clean or repair as necessary.
2. Interior light works intermittently
   a. Check the bulb for a damaged filament, and replace if damaged.
   b. Check the bulb and bulb socket for corrosion, and clean or replace the bulb and socket.
   c. Check for loose, damaged or corroded wires and electrical terminals; repair as necessary.
   d. Check the door and light switch operation, and replace if necessary.
3. Interior light very dim
   a. Check the bulb and bulb socket for corrosion, and clean or replace the bulb and socket.
   b. Check for low voltage at the bulb socket positive terminal or a poor ground. If voltage is low, or the ground marginal, trace the wiring to, and check for loose, damaged or corroded wires and electrical terminals; repair as necessary.
   c. Check the door and light switch operation, and replace if necessary.

5-D. Brake Lights {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

5-D. Brake Lights

1. One brake light inoperative
    a. Press the brake pedal and check for battery voltage and ground at the brake light bulb socket. If present, replace the bulb. If either battery voltage or ground is not present, refer to the wiring diagram to troubleshoot.
2. Both brake lights inoperative
    a. Press the brake pedal and check for battery voltage and ground at the brake light bulb socket. If present, replace both bulbs. If battery voltage is not present, check the brake light switch adjustment and adjust as necessary. If the brake light switch is properly adjusted, and battery voltage or the ground is not present at the bulb sockets, or at the bulb electrical connector with the brake pedal pressed, refer to the wiring diagram to troubleshoot the cause of an open circuit.
3. One or both brake lights very dim
    a. Press the brake pedal and measure the voltage at the brake light bulb socket. If the measured voltage is close to the battery voltage, check for a poor ground caused by a loose, damaged, or corroded wire, terminal, bulb or bulb socket. If the ground is bolted to a painted surface, it may be necessary to remove the electrical connector and clean the mounting surface, so the connector mounts on bare metal. If battery voltage is low, check for a poor connection caused by either a faulty brake light switch, a loose, damaged, or corroded wire, terminal or electrical connector. Refer to the wiring diagram to troubleshoot the cause of a voltage drop.

5-E. Warning Lights {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

5-E. Warning Lights

1. Warning light(s) stay on when the engine is started

Ignition, Battery or Alternator Warning Light

a. Check the alternator output and voltage regulator operation, and replace as necessary.

b. Check the warning light wiring for a shorted wire.

Check Engine Light

a. Check the engine for routine maintenance and tune-up status. Note the engine tune-up specifications and verify the spark plug, air filter and engine oil condition; replace and/or adjust items as necessary.

b. Check the fuel tank for low fuel level, causing an intermittent lean fuel mixture. Top off fuel tank and reset check engine light.

c. Check for a failed or disconnected engine fuel or ignition component, sensor or control unit and repair or replace as necessary.

d. Check the intake manifold and vacuum hoses for air leaks and repair as necessary.

e. Check the engine's mechanical condition for excessive oil consumption.

Anti-Lock Braking System (ABS) Light

a. Check the wheel sensors and sensor rings for debris, and clean as necessary.

b. Check the brake master cylinder for fluid leakage or seal failure and replace as necessary.

c. Check the ABS control unit, pump and proportioning valves for proper operation; replace as necessary.

d. Check the sensor wiring at the wheel sensors and the ABS control unit for a loose or shorted wire, and repair as necessary.

Brake Warning Light

a. Check the brake fluid level and check for possible leakage from the hydraulic lines and seals. Top off brake fluid and repair leakage as necessary.

b. Check the brake linings for wear and replace as necessary.

c. Check for a loose or shorted brake warning light sensor or wire, and replace or repair as necessary.

Oil Pressure Warning Light

a. Stop the engine immediately. Check the engine oil level and oil filter condition, and top off or change the oil as necessary.

b. Check the oil pressure sensor wire for being shorted to ground. Disconnect the wire from the oil pressure sensor and with the ignition in the **ON** position, but **not running**, the oil pressure light should not be working. If the light works with the wire disconnected, check the sensor wire for being shorted to ground. Check the wire routing to make sure the wire is not pinched and check for insulation damage. Repair or replace the wire as necessary and recheck before starting the engine.

c. Remove the oil pan and check for a clogged oil pick-up tube screen.

d. Check the oil pressure sensor operation by substituting a known good sensor.

e. Check the oil filter for internal restrictions or leaks, and replace as necessary.

**Warning

If the engine is operated with oil pressure below the manufacturer's specification, severe (and costly) engine damage could occur. Low oil pressure can be caused by excessive internal wear or damage to the engine bearings, oil pressure relief valve, oil pump or oil pump drive mechanism.

Before starting the engine, check for possible causes of rapid oil loss, such as leaking oil lines or a loose, damaged, restricted, or leaking oil filter or oil pressure sensor. If the engine oil level and condition are acceptable, measure the engine's oil pressure using a pressure gauge, or determine the cause for the oil pressure warning light to function when the engine is running, before operating the engine for an extended period of time. Another symptom of operating an engine with low oil pressure is the presence of severe knocking and tapping noises.

Parking Brake Warning Light

a. Check the brake release mechanism and verify the parking brake has been fully released.

b. Check the parking brake light switch for looseness or misalignment.

c. Check for a damaged switch or a loose or shorted brake light switch wire, and replace or repair as necessary.

2. Warning light(s) flickers on and off when driving

Ignition, Battery or Alternator Warning Light

a. Check the alternator output and voltage regulator operation. An intermittent condition may indicate worn brushes, an internal short, or a defective voltage regulator. Replace the alternator or failed component.

b. Check the warning light wiring for a shorted, pinched or damaged wire and repair as necessary.

Check Engine Light

a. Check the engine for required maintenance and tune-up status. Verify engine tune-up specifications, as well as spark plug, air filter and engine oil condition; replace and/or adjust items as necessary.

b. Check the fuel tank for low fuel level causing an intermittent lean fuel mixture. Top off fuel tank and reset check engine light.

c. Check for an intermittent failure or partially disconnected engine fuel and ignition component, sensor or control unit; repair or replace as necessary.

d. Check the intake manifold and vacuum hoses for air leaks, and repair as necessary.

e. Check the warning light wiring for a shorted, pinched or damaged wire and repair as necessary.

Anti-Lock Braking System (ABS) Light

a. Check the wheel sensors and sensor rings for debris, and clean as necessary.

b. Check the brake master cylinder for fluid leakage or seal failure and replace as necessary.

c. Check the ABS control unit, pump and proportioning valves for proper operation, and replace as necessary.

d. Check the sensor wiring at the wheel sensors and the ABS control unit for a loose or shorted wire and repair as necessary.

Brake Warning Light

a. Check the brake fluid level and check for possible leakage from the hydraulic lines and seals. Top off brake fluid and repair leakage as necessary.

b. Check the brake linings for wear and replace as necessary.

c. Check for a loose or shorted brake warning light sensor or wire, and replace or repair as necessary.

Oil Pressure Warning Light

a. Stop the engine immediately. Check the engine oil level and check for a sudden and rapid oil loss, such as a leaking oil line or oil pressure sensor, and repair or replace as necessary.

b. Check the oil pressure sensor operation by substituting a known good sensor.

c. Check the oil pressure sensor wire for being shorted to ground. Disconnect the wire from the oil pressure sensor and with the ignition in the **ON** position, but **not running**, the oil pressure light should not be working. If the light works with the wire disconnected, check the sensor wire for being shorted to ground. Check the wire routing to make sure the wire is not pinched and check for insulation damage. Repair or replace the wire as necessary and recheck before starting the engine.

d. Remove the oil pan and check for a clogged oil pick-up tube screen.

Parking Brake Warning Light

a. Check the brake release mechanism and verify the parking brake has been fully released.

b. Check the parking brake light switch for looseness or misalignment.

c. Check for a damaged switch or a loose or shorted brake light switch wire, and replace or repair as necessary.

3. Warning light(s) inoperative with ignition on, and engine not started

a. Check for a defective bulb by installing a known good bulb.

b. Check for a defective wire using the appropriate wiring diagram(s).

c. Check for a defective sending unit by removing and then grounding the wire at the sending unit. If the light comes on with the ignition on when grounding the wire, replace the sending unit.

5-F. Turn Signal and 4-Way Hazard Lights {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

5-F. Turn Signal and 4-Way Hazard Lights

1. Turn signals or hazard lights come on, but do not flash
   a. Check for a defective flasher unit and replace as necessary.
2. Turn signals or hazard lights do not function on either side
   a. Check the fuse and replace, if defective.
   b. Check the flasher unit by substituting a known good flasher unit.
   c. Check the turn signal electrical system for a defective component, open circuit, short circuit or poor ground.
3. Turn signals or hazard lights only work on one side
   a. Check for failed bulbs and replace as necessary.
   b. Check for poor grounds in both housings and repair as necessary.
4. One signal light does not work
   a. Check for a failed bulb and replace as necessary.
   b. Check for corrosion in the bulb socket, and clean and repair as necessary.
   c. Check for a poor ground at the bulb socket, and clean and repair as necessary.
5. Turn signals flash too slowly
   a. Check signal bulb(s) wattage and replace with lower wattage bulb(s).
6. Turn signals flash too fast
   a. Check signal bulb(s) wattage and replace with higher wattage bulb(s).
   b. Check for installation of the correct flasher unit and replace if incorrect.
7. Four-way hazard flasher indicator light inoperative
   a. Verify that the exterior lights are functioning and, if so, replace indicator bulb.
   b. Check the operation of the warning flasher switch and replace if defective.
8. Turn signal indicator light(s) do not work in either direction
   a. Verify that the exterior lights are functioning and, if so, replace indicator bulb(s).
   b. Check for a defective flasher unit by substituting a known good unit.
9. One turn signal indicator light does not work
   a. Check for a defective bulb and replace as necessary.
   b. Check for a defective flasher unit by substituting a known good unit.

5-G. Horn {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

5-G. Horn

1. Horn does not operate
    a. Check for a defective fuse and replace as necessary.
    b. Check for battery voltage and ground at horn electrical connections when pressing the horn switch. If voltage is present, replace the horn assembly. If voltage or ground is not present, refer to Chassis Electrical coverage for additional troubleshooting techniques and circuit information.
2. Horn has an unusual tone
    a. On single horn systems, replace the horn.
    b. On dual horn systems, check the operation of the second horn. Dual horn systems have a high and low pitched horn. Unplug one horn at a time and recheck operation. Replace the horn which does not function.
    c. Check for debris or condensation build-up in horn and verify the horn positioning. If the horn has a single opening, adjust the opening downward to allow for adequate drainage and to prevent debris build-up.

5-H. Windshield Wipers {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

5-H. Windshield Wipers

1. Windshield wipers do not operate
   a. Check fuse and replace as necessary.
   b. Check switch operation and repair or replace as necessary.
   c. Check for corroded, loose, disconnected or broken wires and clean or repair as necessary.
   d. Check the ground circuit for the wiper switch or motor and repair as necessary.
2. Windshield wiper motor makes a humming noise, gets hot or blows fuses
   a. Wiper motor damaged internally; replace the wiper motor.
   b. Wiper linkage bent, damaged or seized. Repair or replace wiper linkage as necessary.
3. Windshield wiper motor operates, but one or both wipers fail to move
   a. Windshield wiper motor linkage loose or disconnected. Repair or replace linkage as necessary.
   b. Windshield wiper arms loose on wiper pivots. Secure wiper arm to pivot or replace both the wiper arm and pivot assembly.
4. Windshield wipers will not park
   a. Check the wiper switch operation and verify that the switch properly interrupts the power supplied to the wiper motor.
   b. If the wiper switch is functioning properly, the wiper motor parking circuit has failed. Replace the wiper motor assembly. Operate the wiper motor at least one time before installing the arms and blades to ensure correct positioning, then recheck using the highest wiper speed on a wet windshield to make sure the arms and blades do not contact the windshield trim.

6. Instruments and Gauges {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

6. Instruments and Gauges

6-A. Speedometer, cable operated

1. Speedometer does not work
   a. Check and verify that the speedometer cable is properly seated into the speedometer assembly and the speedometer drive gear.
   b. Check the speedometer cable for breakage or rounded-off cable ends where the cable seats into the speedometer drive gear and into the speedometer assembly. If damaged, broken or the cable ends are rounded off, replace the cable.
   c. Check speedometer drive gear condition and replace as necessary.
   d. Install a known good speedometer to test for proper operation. If the substituted speedometer functions properly, replace the speedometer assembly.
2. Speedometer needle fluctuates when driving at steady speeds.
   a. Check speedometer cable routing or sheathing for sharp bends or kinks. Route cable to minimize sharp bends or kinks. If the sheathing has been damaged, replace the cable assembly.
   b. Check the speedometer cable for adequate lubrication. Remove the cable, inspect for damage, clean, lubricate and reinstall. If the cable has been damaged, replace the cable.
3. Speedometer works intermittently
   a. Check the cable and verify that the cable is fully installed and the fasteners are secure.
   b. Check the cable ends for wear and rounding, and replace as necessary.

6-B. Speedometer, electronically operated {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

6-B. Speedometer, electronically operated

1. Speedometer does not work
   a. Check the speed sensor pickup and replace as necessary.
   b. Check the wiring between the speed sensor and the speedometer for corroded terminals, loose connections or broken wires and clean or repair as necessary.
   c. Install a known good speedometer to test for proper operation. If the substituted speedometer functions properly, replace the speedometer assembly.
2. Speedometer works intermittently
   a. Check the wiring between the speed sensor and the speedometer for corroded terminals, loose connections or broken wires and clean or repair as necessary.
   b. Check the speed sensor pickup and replace as necessary.

6-C. Fuel, Temperature and Oil Pressure Gauges {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

6-C. Fuel, Temperature and Oil Pressure Gauges

1. Gauge does not register
   a. Check for a missing or blown fuse and replace as necessary.
   b. Check for an open circuit in the gauge wiring. Repair wiring as necessary.
   c. Gauge sending unit defective. Replace gauge sending unit.
   d. Gauge or sending unit improperly installed. Verify installation and wiring, and repair as necessary.
2. Gauge operates erratically
   a. Check for loose, shorted, damaged or corroded electrical connections or wiring and repair as necessary.
   b. Check gauge sending units and replace as necessary.
3. Gauge operates fully pegged
   a. Sending unit-to-gauge wire shorted to ground.
   b. Sending unit defective; replace sending unit.
   c. Gauge or sending unit not properly grounded.
   d. Gauge or sending unit improperly installed. Verify installation and wiring, and repair as necessary.

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7. Climate Control {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

7. Climate Control

7-A. Air Conditioner

1. No air coming from air conditioner vents
   a. Check the air conditioner fuse and replace as necessary.
   b. Air conditioner system discharged. Have the system evacuated, charged and leak tested by an MVAC certified technician, utilizing approved recovery/recycling equipment. Repair as necessary.
   c. Air conditioner low pressure switch defective. Replace switch.
   d. Air conditioner fan resistor pack defective. Replace resistor pack.
   e. Loose connection, broken wiring or defective air conditioner relay in air conditioning electrical circuit. Repair wiring or replace relay as necessary.
2. Air conditioner blows warm air
   a. Air conditioner system is discharged. Have the system evacuated, charged and leak tested by an MVAC certified technician, utilizing approved recovery/recycling equipment. Repair as necessary.
   b. Air conditioner compressor clutch not engaging. Check compressor clutch wiring, electrical connections and compressor clutch, and repair or replace as necessary.
3. Water collects on the interior floor when the air conditioner is used
   a. Air conditioner evaporator drain hose is blocked. Clear the drain hose where it exits the passenger compartment.
   b. Air conditioner evaporator drain hose is disconnected. Secure the drain hose to the evaporator drainage tray under the dashboard.
4. Air conditioner has a moldy odor when used
   a. The air conditioner evaporator drain hose is blocked or partially restricted, allowing condensation to build up around the evaporator and drainage tray. Clear the drain hose where it exits the passenger compartment.

7-B. Heater {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

7-B. Heater

1. Blower motor does not operate
   a. Check blower motor fuse and replace as necessary.
   b. Check blower motor wiring for loose, damaged or corroded contacts and repair as necessary.
   c. Check blower motor switch and resistor pack for open circuits, and repair or replace as necessary.
   d. Check blower motor for internal damage and repair or replace as necessary.
2. Heater blows cool air
   a. Check the engine coolant level. If the coolant level is low, top off and bleed the air from the cooling system as necessary and check for coolant leaks.
   b. Check engine coolant operating temperature. If coolant temperature is below specification, check for a damaged or stuck thermostat.
   c. Check the heater control valve operation. Check the heater control valve cable or vacuum hose for proper installation. Move the heater temperature control from hot to cold several times and verify the operation of the heater control valve. With the engine at normal operating temperature and the heater temperature control in the full hot position, carefully feel the heater hose going into and exiting the control valve. If one heater hose is hot and the other is much cooler, replace the control valve.
3. Heater steams the windshield when used
   a. Check for a loose cooling system hose clamp or leaking coolant hose near the engine firewall or under the dash area, and repair as necessary.
   b. Check for the existence of a sweet odor and fluid dripping from the heater floor vents, indicating a failed or damaged heater core. Pressure test the cooling system with the heater set to the fully warm position and check for fluid leakage from the floor vents. If leakage is verified, remove and replace the heater core assembly.

   Ä On some vehicles, the dashboard must be disassembled and removed to access the heater core.

Figure 1.
All but the most basic procedures will require an assortment of ratchets and sockets

{ewc GSMVIMG,GSMVIMG, !tccs1200.bmp}

tccs1200

Figure 2.
In addition to ratchets, a good set of wrenches and hex keys will be necessary
{ewc GSMVIMG,GSMVIMG, !tccs1201.bmp}

tccs1201

Figure 3.
A hydraulic floor jack and a set of jackstands are essential for lifting and supporting the vehicle

{ewc GSMVIMG,GSMVIMG, !tccs1202.bmp}

tccs1202

Figure 4.
An assortment of pliers, grippers and cutters will be handy for old rusted parts and stripped bolt heads

{ewc GSMVIMG,GSMVIMG, !tccs1203.bmp}

tccs1203

Figure 5.
Various drivers, chisels and prybars are great tools to have in your toolbox
{ewc GSMVIMG,GSMVIMG, !tccs1204.bmp}

tccs1204

Figure 6.
Many repairs will require the use of a torque wrench to assure the components are properly fastened

{ewc GSMVIMG,GSMVIMG, !tccs1205.bmp}

tccs1205

Figure 7.
Tools from specialty manufacturers such as Lisle® are designed to make your job easier . . .

{ewc GSMVIMG,GSMVIMG, !tccs101a.bmp}

tccs101a

Figure 8.
. . . these Torxdrivers and magnetic socket holders are just 2 examples of their handy products

{ewc GSMVIMG,GSMVIMG, !tccs101b.bmp}

tccs101b

Figure 9.
Although not always necessary, using specialized brake tools will save time
{ewc GSMVIMG,GSMVIMG, !tccs1209.bmp}

tccs1209

Figure 10.
A few inexpensive lubrication tools will make maintenance easier
{ewc GSMVIMG,GSMVIMG, !tccs1210.bmp}

tccs1210

Figure 11.
Various pullers, clamps and separator tools are needed for many larger, more complicated repairs

{ewc GSMVIMG,GSMVIMG, !tccs1211.bmp}

tccs1211

Figure 12.
A variety of tools and gauges should be used for spark plug gapping and installation

{ewc GSMVIMG,GSMVIMG, !tccs1212.bmp}

tccs1212

Figure 13.
Proper information is vital, so always have a Chilton Total Car Care manual handy
{ewc GSMVIMG,GSMVIMG, !tccs1213.bmp}

tccs1213

Figure 14.
Screwdrivers should be kept in good condition to prevent injury or damage which could result if the blade slips from the screw

{ewc GSMVIMG,GSMVIMG, !tccs1020.bmp}

tccs1020

Figure 15.
Power tools should always be properly grounded

{ewc GSMVIMG,GSMVIMG, !tccs1021.bmp}

tccs1021

Figure 16.
Using the correct size wrench will help prevent the possibility of rounding off a nut
{ewc GSMVIMG,GSMVIMG, !tccs1022.bmp}

tccs1022

Figure 17.
NEVER work under a vehicle unless it is supported using safety stands (jackstands)

{ewc GSMVIMG,GSMVIMG, !tccs1023.bmp}

tccs1023

Figure 18.
Here are a few of the most common screw/bolt driver styles

{ewc GSMVIMG,GSMVIMG, !tccs1037.bmp}

tccs1037

Figure 19.
There are many different types of threaded retainers found on vehicles
{ewc GSMVIMG,GSMVIMG, !tccs1036.bmp}

tccs1036

Figure 20.
Threaded retainer sizes are determined using these measurements
{ewc GSMVIMG,GSMVIMG, !tccs1038.bmp}

tccs1038

Figure 21.
Special fasteners such as these Torx® head bolts are used by manufacturers to discourage people from working on vehicles without the proper tools

{ewc GSMVIMG,GSMVIMG, !tccs1016.bmp}

tccs1016

Figure 22.
Various styles of torque wrenches are usually available at your local automotive supply store

{ewc GSMVIMG,GSMVIMG, !tccs1015.bmp}

tccs1015

Figure 23.
Determining bolt strength of metric fasteners—NOTE: this is a typical bolt marking system, but there is not a worldwide standard

{ewc GSMVIMG,GSMVIMG, !tccs1240.bmp}

tccs1240

Figure 24.
Standard bolt torque for metric fasteners—WARNING: use only as a guide
{ewc GSMVIMG,GSMVIMG, !tccs1241.bmp}

tccs1241

Figure 25.
Example of a beam type torque wrench

{ewc GSMVIMG,GSMVIMG, !tccs1039.bmp}

tccs1039

Figure 26.
A click type or breakaway torque wrench—note this one has a pivoting head
{ewc GSMVIMG,GSMVIMG, !tccs1040.bmp}

tccs1040

Figure 27.
Torque wrenches with pivoting heads must be grasped and used properly to prevent an incorrect reading

{ewc GSMVIMG,GSMVIMG, !tccs1041.bmp}

tccs1041

Figure 28.
The rigid case (direct reading) torque wrench uses a dial indicator to show torque
{ewc GSMVIMG,GSMVIMG, !tccs1042.bmp}

tccs1042

Figure 29.
Some specifications require the use of a torque angle meter (mechanical protractor)

{ewc GSMVIMG,GSMVIMG, !tccs1043.bmp}

tccs1043

Figure 30.
Standard and metric conversion factors chart

{ewc GSMVIMG,GSMVIMG, !tccs1044.bmp}

tccs1044

Figure 31.
The VIN is on a plate attached to the dash and visible through the driver's side of the windshield

{ewc GSMVIMG,GSMVIMG, !88261P01.bmp}

88261P01

Figure 32.
Description of the Vehicle Identification Number (VIN)

{ewc GSMVIMG,GSMVIMG, !88261G01.bmp}

88261G01

Figure 33.
Engine identification number location—early-model engines (2.5L top, 4.3L bottom)

{ewc GSMVIMG,GSMVIMG, !88261G02.bmp}

88261G02

Figure 34.
Engine identification number locations—1990–93 4.3L engines
{ewc GSMVIMG,GSMVIMG, !88261G03.bmp}

88261G03

Figure 35.
Engine identification number locations—1994–96 4.3L engines
{ewc GSMVIMG,GSMVIMG, !88261G04.bmp}

88261G04

Figure 36.
Manual transmission serial number location

{ewc GSMVIMG,GSMVIMG, !88261G05.bmp}

88261G05

Figure 37.
Location and description of the THM-R4 (4L60) transmission serial number—early-model vehicles (1985–92)

{ewc GSMVIMG,GSMVIMG, !88261G06.bmp}

88261G06

Figure 38.
Location and description of the 4L60-E transmission serial number—late-model vehicles (1993–96)

{ewc GSMVIMG,GSMVIMG, !88261G07.bmp}

88261G07

Figure 39.
Location and description of the drive axle serial number
{ewc GSMVIMG,GSMVIMG, !88261G08.bmp}

88261G08

Figure 40.
The Astro/Safari BW-4472 transfer case identification tag is held by a lower center case bolt

{ewc GSMVIMG,GSMVIMG, !88261G09.bmp}

88261G09

Figure 41.
On some vehicles, the air intake snorkel must be removed for access to the engine cover retaining screws

{ewc GSMVIMG,GSMVIMG, !88261G10.bmp}

88261G10

Figure 42.
A long-handled screwdriver will be necessary to access the 2 upper engine compartment-to-engine cover retaining screws

{ewc GSMVIMG,GSMVIMG, !88261G11.bmp}

88261G11

Figure 43.
The extension housing is freed by removing the upper bolts and lower nuts, then the cover latches can be released

{ewc GSMVIMG,GSMVIMG, !88261G12.bmp}

88261G12

Figure 44.
Upon installation make sure the cover and rubber seal are properly positioned to isolate the engine compartment

{ewc GSMVIMG,GSMVIMG, !88261G13.bmp}

88261G13

Figure 45.
The instrument panel extension housing is retained by 2 nuts and 2 bolts—1990–95 shown (1996 similar)

{ewc GSMVIMG,GSMVIMG, !88261G14.bmp}

88261G14

Figure 46.
Exploded view of the instrument panel extension housing—1990–95 vehicles
{ewc GSMVIMG,GSMVIMG, !88261G15.bmp}

88261G15

Figure 47.
Exploded view of the instrument panel extension housing—1996 vehicles
{ewc GSMVIMG,GSMVIMG, !88261G16.bmp}

88261G16

Figure 48.
Loosen and remove the instrument panel extension housing upper retaining bolts . . .

{ewc GSMVIMG,GSMVIMG, !88261P04.bmp}

88261P04

Figure 49.
. . . then remove the extension housing lower retaining nuts
{ewc GSMVIMG,GSMVIMG, !88261P05.bmp}

88261P05

Figure 50.
Carefully pull the extension housing forward, disengage the wiring and remove it from the vehicle

{ewc GSMVIMG,GSMVIMG, !88261P06.bmp}

88261P06

Figure 51.
Engine cover heater and air duct mounting—1990–95 vehicles
{ewc GSMVIMG,GSMVIMG, !88261G17.bmp}

88261G17

Figure 52.
Engine cover heater and air duct mounting—1996 vehicles

{ewc GSMVIMG,GSMVIMG, !88261G18.bmp}

88261G18

Figure 53.
On 1990–95 vehicles, the cover heater and air duct is removed by pulling it gently downward

{ewc GSMVIMG,GSMVIMG, !88261P07.bmp}

88261P07

Figure 54.
All 1990–96 engine covers are retained by upper brackets
{ewc GSMVIMG,GSMVIMG, !88261G19.bmp}

88261G19

Figure 55.
Remove the bolt and loosen the nut from each cover bracket, then rotate the brackets out of the way

{ewc GSMVIMG,GSMVIMG, !88261P08.bmp}

88261P08

Figure 56.
The upper cover-to-cowl screws and latches are the final retainers securing the engine cover

{ewc GSMVIMG,GSMVIMG, !88261G20.bmp}

88261G20

Figure 57.
Release the engine cover latches

{ewc GSMVIMG,GSMVIMG, !88261P09.bmp}

88261P09

Figure 58.
Loosen the captive engine cover-to-cowl retaining screws . . .

{ewc GSMVIMG,GSMVIMG, !88261P10.bmp}

88261P10

Figure 59.
Exploded view of the engine cover mounting

{ewc GSMVIMG,GSMVIMG, !88261G21.bmp}

88261G21

Figure 60.
. . . then carefully pull the cover back and remove it from the vehicle
{ewc GSMVIMG,GSMVIMG, !88261P11.bmp}

88261P11

Figure 61.
With the cover removed you have access to almost all of the upper engine components

{ewc GSMVIMG,GSMVIMG, !88261P12.bmp}

88261P12

Figure 62.
Exploded view of the air cleaner assembly—1985 2.5L engines
{ewc GSMVIMG,GSMVIMG, !88261G22.bmp}

88261G22

Figure 63.
Exploded view of the TBI air cleaner assembly—1986–87 engines
{ewc GSMVIMG,GSMVIMG, !88261G23.bmp}

88261G23

Figure 64.
Exploded view of the TBI air cleaner assembly—1988–94 engines
{ewc GSMVIMG,GSMVIMG, !88261G24.bmp}

88261G24

Figure 65.
Remove the nut(s) from the top of the air cleaner housing—1992 4.3L engine shown

{ewc GSMVIMG,GSMVIMG, !88261P13.bmp}

88261P13

Figure 66.
With the nut(s) removed, lift the cover from the air cleaner housing . . .

{ewc GSMVIMG,GSMVIMG, !88261P14.bmp}

88261P14

Figure 67.
. . . then remove the element

{ewc GSMVIMG,GSMVIMG, !88261P15.bmp}

88261P15

Figure 68.
Exploded view of the CMFI and CSFI air cleaner housing assembly
{ewc GSMVIMG,GSMVIMG, !88261G25.bmp}

88261G25

Figure 69.
On these vehicles, simply release the hold-down clamps and lift up on the cover . . .

{ewc GSMVIMG,GSMVIMG, !88261P16.bmp}

88261P16

Figure 70.
. . . then remove the air cleaner element from the housing
{ewc GSMVIMG,GSMVIMG, !88261P17.bmp}

88261P17

Figure 71.
Exploded view of the internal fuel filter—carbureted engines

{ewc GSMVIMG,GSMVIMG, !88261G26.bmp}

88261G26

Figure 72.
Exploded view of the late-model 2.5L engine fuel filter mounting
{ewc GSMVIMG,GSMVIMG, !88261G27.bmp}

88261G27

Figure 73.
Most vehicles covered by this manual use a fuel filter which is mounted vertically along the frame rail

{ewc GSMVIMG,GSMVIMG, !88261G28.bmp}

88261G28

Figure 74.
A backup wrench is used to keep the filter from twisting (damaging the other fuel line if still attached)

{ewc GSMVIMG,GSMVIMG, !88261P18.bmp}

88261P18

Figure 75.
Before loosening the fitting completely, position a rag to catch any remaining fuel which may spill

{ewc GSMVIMG,GSMVIMG, !88261P19.bmp}

88261P19

Figure 76.
The fuel filter on some late-model vehicles is mounted horizontally along the frame rail

{ewc GSMVIMG,GSMVIMG, !88261G29.bmp}

88261G29

Figure 77.
Once the filter and clamp assembly is removed (on late-model vehicles) the filter should be separated and discarded (but retain the clamp for the new filter)

{ewc GSMVIMG,GSMVIMG, !88261G30.bmp}

88261G30

Figure 78.
The intank fuel filter (strainer) is attached to the bottom of the pump or sending unit assembly—TBI model shown

{ewc GSMVIMG,GSMVIMG, !88261G31.bmp}

88261G31

Figure 79.
Typical air and vapor flow through PCV systems

{ewc GSMVIMG,GSMVIMG, !88261G33.bmp}

88261G33

Figure 80.
The PCV valve is normally fitted to a rubber grommet in the valve cover
{ewc GSMVIMG,GSMVIMG, !88261P20.bmp}

88261P20

Figure 81.
Once it is removed from the grommet, carefully pull it free of the vacuum hose
{ewc GSMVIMG,GSMVIMG, !88261P21.bmp}

88261P21

Figure 82.
Schematic for a typical evaporative emission control system—2.5L engine shown
{ewc GSMVIMG,GSMVIMG, !88261G34.bmp}

88261G34

Figure 83.
Schematic for a typical evaporative emission control system—4.3L TBI engine shown

{ewc GSMVIMG,GSMVIMG, !88261G35.bmp}

88261G35

Figure 84.
Periodically check the evaporative canister, lines and fittings for leaks
{ewc GSMVIMG,GSMVIMG, !88261P22.bmp}

88261P22

Figure 85.
On non-maintenance free batteries, the level can be checked through the case on translucent batteries; the cell caps must be removed on other models

{ewc GSMVIMG,GSMVIMG, !tccs1251.bmp}

tccs1251

Figure 86.
Check the specific gravity of the battery's electrolyte with a hydrometer
{ewc GSMVIMG,GSMVIMG, !tccs1252.bmp}

tccs1252

Figure 87.
A typical sealed (maintenance-free) battery with a built-in hydrometer—NOTE that the hydrometer eye may vary between battery manufacturers; always refer to the battery's label

{ewc GSMVIMG,GSMVIMG, !tccs1253.bmp}

tccs1253

Figure 88.
Maintenance is performed with household items and with special tools like this post cleaner

{ewc GSMVIMG,GSMVIMG, !tccs1206.bmp}

tccs1206

Figure 89.
The underside of this special battery tool has a wire brush to clean post terminals
{ewc GSMVIMG,GSMVIMG, !tccs1207.bmp}

tccs1207

Figure 90.
Place the tool over the terminals and twist to clean the post

{ewc GSMVIMG,GSMVIMG, !tccs1208.bmp}

tccs1208

Figure 91.
A special tool is available to pull the clamp from the post

{ewc GSMVIMG,GSMVIMG, !tccs1254.bmp}

tccs1254

Figure 92.
Clean the battery terminals until the metal is shiny

{ewc GSMVIMG,GSMVIMG, !tccs1255.bmp}

tccs1255

Figure 93.
The cable ends should be cleaned as well

{ewc GSMVIMG,GSMVIMG, !tccs1256.bmp}

tccs1256

Figure 94.
There are typically 3 types of accessory drive belts found on vehicles today
{ewc GSMVIMG,GSMVIMG, !tccs1218.bmp}

tccs1218

Figure 95.
An example of a healthy drive belt

{ewc GSMVIMG,GSMVIMG, !tccs1214.bmp}

tccs1214

Figure 96.
Deep cracks in this belt will cause flex, building up heat that will eventually lead to belt failure

{ewc GSMVIMG,GSMVIMG, !tccs1215.bmp}

tccs1215

Figure 97.
The cover of this belt is worn, exposing the critical reinforcing cords to excessive wear

{ewc GSMVIMG,GSMVIMG, !tccs1216.bmp}

tccs1216

Figure 98.
Installing too wide a belt can result in serious belt wear and/or breakage
{ewc GSMVIMG,GSMVIMG, !tccs1217.bmp}

tccs1217

Figure 99.
Serpentine drive belts require little attention other than periodic inspection or replacement

{ewc GSMVIMG,GSMVIMG, !88261P23.bmp}

88261P23

Figure 100.
When checking the serpentine belt, be sure it is properly seated in each of the pulleys

{ewc GSMVIMG,GSMVIMG, !88261G36.bmp}

88261G36

Figure 101.
A straightedge should be used to check pulley alignment

{ewc GSMVIMG,GSMVIMG, !88261G38.bmp}

88261G38

Figure 102.
The markings on the automatic tensioner are used to check serpentine belt wear
{ewc GSMVIMG,GSMVIMG, !88261G39.bmp}

88261G39

Figure 103.
A tension gauge is necessary to properly adjust tension on V-belt equipped engines

{ewc GSMVIMG,GSMVIMG, !88261G37.bmp}

88261G37

Figure 104.
Belt routing can be found on labels such as this one on the power steering reservoir . . .

{ewc GSMVIMG,GSMVIMG, !88261P24.bmp}

88261P24

Figure 105.
. . . or like this one on a 1996 Astro vehicle emission control information label
{ewc GSMVIMG,GSMVIMG, !88261P25.bmp}

88261P25

Figure 106.
Drive belt routing—1985–86 2.5L engines (V-belts)

{ewc GSMVIMG,GSMVIMG, !88261G40.bmp}

88261G40

Figure 107.
Drive belt routing—1985–86 4.3L engines (V-belts)

{ewc GSMVIMG,GSMVIMG, !88261G41.bmp}

88261G41

Figure 108.
Drive belt routing—1987–90 2.5L engines (Serpentine Belts)
{ewc GSMVIMG,GSMVIMG, !88261G42.bmp}

88261G42

Figure 109.
Drive belt routing—1987–91 4.3L engines (Serpentine Belts)

{ewc GSMVIMG,GSMVIMG, !88261G43.bmp}

88261G43

Figure 110.
Drive belt routing—1992–95 4.3L engines (Serpentine Belts)
{ewc GSMVIMG,GSMVIMG, !88261G44.bmp}

88261G44

Figure 111.
Drive belt routing—1996 4.3L engines (Serpentine Belts)
{ewc GSMVIMG,GSMVIMG, !88261G45.bmp}

88261G45

Figure 112.
To adjust or replace belts, first loosen the component mounting and adjusting bolts . . .

{ewc GSMVIMG,GSMVIMG, !88261G46.bmp}

88261G46

Figure 113.
. . . the pivot the component inward to remove the belt or outward to increase tension

{ewc GSMVIMG,GSMVIMG, !88261G47.bmp}

88261G47

Figure 114.
On this 4.3L engine, a large wrench (16mm) was used to pivot the belt tensioner and free the belt

{ewc GSMVIMG,GSMVIMG, !88261P26.bmp}

88261P26

Figure 115.
The cracks developing along this hose are a result of age-related hardening
{ewc GSMVIMG,GSMVIMG, !tccs1219.bmp}

tccs1219

Figure 116.
A hose clamp that is too tight can cause older hoses to separate and tear on either side of the clamp

{ewc GSMVIMG,GSMVIMG, !tccs1220.bmp}

tccs1220

Figure 117.
A soft spongy hose (identifiable by the swollen section) will eventually burst and should be replaced

{ewc GSMVIMG,GSMVIMG, !tccs1221.bmp}

tccs1221

Figure 118.
Hoses are likely to deteriorate from the inside if the cooling system is not periodically flushed

{ewc GSMVIMG,GSMVIMG, !tccs1222.bmp}

tccs1222

Figure 119.
CV-boots must be inspected periodically for damage

{ewc GSMVIMG,GSMVIMG, !tccs1011.bmp}

tccs1011

Figure 120.
A torn boot should be replaced immediately

{ewc GSMVIMG,GSMVIMG, !tccs1010.bmp}

tccs1010

Figure 121.
Cross-section of a spark plug

{ewc GSMVIMG,GSMVIMG, !tccs1045.bmp}

tccs1045

Figure 122.
Spark plug heat range

{ewc GSMVIMG,GSMVIMG, !tccs1046.bmp}

tccs1046

Figure 123.
Access to the spark plugs is through the wheel-well on most Astro and Safari vans
{ewc GSMVIMG,GSMVIMG, !88261P27.bmp}

88261P27

Figure 124.
Disconnect the spark plug wire by pulling on the BOOT, NOT THE WIRE
{ewc GSMVIMG,GSMVIMG, !88261P28.bmp}

88261P28

Figure 125.
A spark plug wire removal tool is recommended to prevent wire damage (and to make it easier)

{ewc GSMVIMG,GSMVIMG, !88261G48.bmp}

88261G48

Figure 126.
Loosen the spark plug using a ratchet and extension . . .
{ewc GSMVIMG,GSMVIMG, !88261P29.bmp}

88261P29

Figure 127.
. . . then carefully unthread and remove the plug from the cylinder head
{ewc GSMVIMG,GSMVIMG, !88261P30.bmp}

88261P30

Figure 128.
A normally worn spark plug should have light tan or gray deposits on the firing tip
{ewc GSMVIMG,GSMVIMG, !tccs2135.bmp}

tccs2135

Figure 129.
A carbon fouled plug, identified by soft, sooty, black deposits, may indicate an improperly tuned vehicle. Check the air cleaner, ignition components and engine control system

{ewc GSMVIMG,GSMVIMG, !tccs2136.bmp}

tccs2136

Figure 130.
A variety of tools and gauges are needed for spark plug service
{ewc GSMVIMG,GSMVIMG, !tccs1212.bmp}

tccs1212

Figure 131.
A physically damaged spark plug may be evidence of severe detonation in that cylinder. Watch that cylinder carefully between services, as a continued detonation will not only damage the plug, but could also damage the engine

{ewc GSMVIMG,GSMVIMG, !tccs2137.bmp}

tccs2137

Figure 132.
Checking the spark plug gap with a feeler gauge

{ewc GSMVIMG,GSMVIMG, !tccs2903.bmp}

tccs2903

Figure 133.
An oil fouled spark plug indicates an engine with worn piston rings and/or bad valve seals allowing excessive oil to enter the chamber

{ewc GSMVIMG,GSMVIMG, !tccs2138.bmp}

tccs2138

Figure 134.
Adjusting the spark plug gap

{ewc GSMVIMG,GSMVIMG, !tccs2904.bmp}

tccs2904

Figure 135.
This spark plug has been left in the engine too long, as evidenced by the extreme gap—Plugs with such an extreme gap can cause misfiring and stumbling accompanied by a noticeable lack of power

{ewc GSMVIMG,GSMVIMG, !tccs2139.bmp}

tccs2139

Figure 136.
A bridged or almost bridged spark plug, identified by a build-up between the electrodes caused by excessive carbon or oil build-up on the plug

{ewc GSMVIMG,GSMVIMG, !tccs2140.bmp}

tccs2140

Figure 137.
If the standard plug is in good condition, the electrode may be filed flat—WARNING: do not file platinum plugs

{ewc GSMVIMG,GSMVIMG, !tccs1141.bmp}

tccs1141

Figure 138.
Used spark plugs which show damage may indicate engine problems
{ewc GSMVIMG,GSMVIMG, !tccs2001.bmp}

tccs2001

Figure 139.
Inspect the spark plug to determine engine running conditions
{ewc GSMVIMG,GSMVIMG, !tccs2002.bmp}

tccs2002

Figure 140.
Checking plug wire resistance through the distributor cap with an ohmmeter
{ewc GSMVIMG,GSMVIMG, !tccs1008.bmp}

tccs1008

Figure 141.
Checking individual plug wire resistance with a digital ohmmeter
{ewc GSMVIMG,GSMVIMG, !tccs1009.bmp}

tccs1009

Figure 142.
Tag all spark plug wires and matching cap terminals before removal
{ewc GSMVIMG,GSMVIMG, !88261P31.bmp}

88261P31

Figure 143.
Release the distributor cap hold-down bolts

{ewc GSMVIMG,GSMVIMG, !88261P32.bmp}

88261P32

Figure 144.
Remove the cap for inspection, replacement or access to the rotor
{ewc GSMVIMG,GSMVIMG, !88261P33.bmp}

88261P33

Figure 145.
Carefully pull the rotor from the distributor shaft—note this type does NOT use retaining screws

{ewc GSMVIMG,GSMVIMG, !88261P34.bmp}

88261P34

Figure 146.
Some early-model distributors may have the ignition coil mounted to the distributor cap.

{ewc GSMVIMG,GSMVIMG, !88261G50.bmp}

88261G50

Figure 147.
Timing marks are found on the crankshaft damper (balancer) and engine front cover—late-model 4.3L engine shown

{ewc GSMVIMG,GSMVIMG, !88261G49.bmp}

88261G49

Figure 148.
View of a typical timing mark scale

{ewc GSMVIMG,GSMVIMG, !88261G51.bmp}

88261G51

Figure 149.
Aim the timing light at the crankshaft damper timing mark, but WATCH OUT for moving engine parts

{ewc GSMVIMG,GSMVIMG, !88261P35.bmp}

88261P35

Figure 150.
Valve arrangement—2.5L engines (E=Exhaust; I=Intake)
{ewc GSMVIMG,GSMVIMG, !88261G52.bmp}

88261G52

Figure 151.
Valve arrangement—4.3L engines (E=Exhaust; I=Intake)
{ewc GSMVIMG,GSMVIMG, !88261G53.bmp}

88261G53

Figure 152.
Adjust the rockers, by rotating the pushrods between your thumb and forefinger to feel for play

{ewc GSMVIMG,GSMVIMG, !88261G54.bmp}

88261G54

Figure 153.
This label warns technicians to use R-134a refrigerant (R-12 would damage this system)

{ewc GSMVIMG,GSMVIMG, !88261P36.bmp}

88261P36

Figure 154.
Schematic for a typical air condition system

{ewc GSMVIMG,GSMVIMG, !88261G55.bmp}

88261G55

Figure 155.
An antifreeze tester can be use to determine the freezing and boiling points of your coolant

{ewc GSMVIMG,GSMVIMG, !tccs1233.bmp}

tccs1233

Figure 156.
Bosch® wiper blade and fit kit

{ewc GSMVIMG,GSMVIMG, !tccs1223.bmp}

tccs1223

Figure 157.
Lexor® wiper blade and fit kit

{ewc GSMVIMG,GSMVIMG, !tccs1224.bmp}

tccs1224

Figure 158.
Pylon® wiper blade and adaptor

{ewc GSMVIMG,GSMVIMG, !tccs1225.bmp}

tccs1225

Figure 159.
Trico® wiper blade and fit kit

{ewc GSMVIMG,GSMVIMG, !tccs1226.bmp}

tccs1226

Figure 160.
Tripledge® wiper blade and fit kit

{ewc GSMVIMG,GSMVIMG, !tccs1227.bmp}

tccs1227

Figure 161.
To remove and install a Lexor® wiper blade refill, slip out the old insert and slide in a new one

{ewc GSMVIMG,GSMVIMG, !tccs1228.bmp}

tccs1228

Figure 162.
On Pylon® inserts, the clip at the end has to be removed prior to sliding the insert off

{ewc GSMVIMG,GSMVIMG, !tccs1229.bmp}

tccs1229

Figure 163.
On Trico® wiper blades, the tab at the end of the blade must be turned up . . .
{ewc GSMVIMG,GSMVIMG, !tccs1230.bmp}

tccs1230

Figure 164.
. . . then the insert can be removed. After installing the replacement insert, bend the tab back

{ewc GSMVIMG,GSMVIMG, !tccs1231.bmp}

tccs1231

Figure 165.
The Tripledge® wiper blade insert is removed and installed using a securing clip
{ewc GSMVIMG,GSMVIMG, !tccs1232.bmp}

tccs1232

Figure 166.
Trico® wiper blade insert (element) replacement

{ewc GSMVIMG,GSMVIMG, !tccs1236.bmp}

tccs1236

Figure 167.
Tridon® wiper blade insert (element) replacement

{ewc GSMVIMG,GSMVIMG, !tccs1237.bmp}

tccs1237

Figure 168.
This label (usually found on a door or jamb) gives the proper tire inflation pressures for your vehicle

{ewc GSMVIMG,GSMVIMG, !88261P37.bmp}

88261P37

Figure 169.
Common tire rotation patterns for 4 and 5-wheel rotations
{ewc GSMVIMG,GSMVIMG, !tccs1259.bmp}

tccs1259

Figure 170.
Compact spare tires must NEVER be used in the rotation pattern
{ewc GSMVIMG,GSMVIMG, !tccs1260.bmp}

tccs1260

Figure 171.
Unidirectional tires are identifiable by sidewall arrows and/or the word "rotation”
{ewc GSMVIMG,GSMVIMG, !tccs1234.bmp}

tccs1234

Figure 172.
P-Metric tire coding

{ewc GSMVIMG,GSMVIMG, !tccs1261.bmp}

tccs1261

Figure 173.
Tires should be checked frequently for any sign of puncture or damage
{ewc GSMVIMG,GSMVIMG, !tccs1097.bmp}

tccs1097

Figure 174.
Tires with deep cuts, or cuts which show bulging should be replaced immediately
{ewc GSMVIMG,GSMVIMG, !tccs1095.bmp}

tccs1095

Figure 175.
Examples of inflation-related tire wear patterns

{ewc GSMVIMG,GSMVIMG, !tccs1262.bmp}

tccs1262

Figure 176.
Radial tires have a characteristic sidewall bulge; don't try to measure pressure by looking at the tire. Use a quality air pressure gauge

{ewc GSMVIMG,GSMVIMG, !tccs1263.bmp}

tccs1263

Figure 177.
Common tire wear patterns and causes

{ewc GSMVIMG,GSMVIMG, !tccs1267.bmp}

tccs1267

Figure 178.
Tread wear indicators will appear when the tire is worn
{ewc GSMVIMG,GSMVIMG, !tccs1265.bmp}

tccs1265

Figure 179.
Accurate tread depth indicators are inexpensive and handy
{ewc GSMVIMG,GSMVIMG, !tccs1264.bmp}

tccs1264

Figure 180.
A penny works well for a quick check of tread depth

{ewc GSMVIMG,GSMVIMG, !tccs1266.bmp}

tccs1266

Figure 181.
Engine oil viscosity recommendations

{ewc GSMVIMG,GSMVIMG, !88261G56.bmp}

88261G56

Figure 182.
Look for the API oil identification label when choosing your engine oil
{ewc GSMVIMG,GSMVIMG, !tccs1235.bmp}

tccs1235

Figure 183.
To check engine oil, start by locating and withdrawing the oil dipstick
{ewc GSMVIMG,GSMVIMG, !88261P38.bmp}

88261P38

Figure 184.
On late-model vans with automatics, the engine dipstick is usually right below the A/T dipstick

{ewc GSMVIMG,GSMVIMG, !88261P39.bmp}

88261P39

Figure 185.
After the dipstick is cleaned, inserted and withdrawn, read the level using the stick's markings

{ewc GSMVIMG,GSMVIMG, !88261P40.bmp}

88261P40

Figure 186.
If additional oil is necessary, remove the cap from the filler tube . . .
{ewc GSMVIMG,GSMVIMG, !88261P41.bmp}

88261P41

Figure 187.
. . . the recommended viscosity oil may be found on many of the tube caps
{ewc GSMVIMG,GSMVIMG, !88261P42.bmp}

88261P42

Figure 188.
A funnel will help prevent a mess when you are pouring oil into the filler tube

{ewc GSMVIMG,GSMVIMG, !88261P43.bmp}

88261P43

Figure 189.
Loosen the drain plug using a rachet and socket (shown) or a box wrench
{ewc GSMVIMG,GSMVIMG, !88261P44.bmp}

88261P44

Figure 190.
Unthread the plug, then withdraw it (and your hand) quickly to keep from getting burned by hot oil

{ewc GSMVIMG,GSMVIMG, !88261P45.bmp}

88261P45

Figure 191.
A filter strap wrench is helpful, but it can be tricky in tight places . . .
{ewc GSMVIMG,GSMVIMG, !88261P46.bmp}

88261P46

Figure 192.
. . . be sure to maneuver the wrench so your hand stays clear of the HOT exhaust pipe

{ewc GSMVIMG,GSMVIMG, !88261P47.bmp}

88261P47

Figure 193.
Before installing a new oil filter, lightly coat the rubber gasket with clean oil
{ewc GSMVIMG,GSMVIMG, !tccs1901.bmp}

tccs1901

Figure 194.
The filler plug is normally found about mid-way up the side of the transmission, while drain plugs are found towards the bottom of the housing (for hopefully obvious reasons)

{ewc GSMVIMG,GSMVIMG, !88261G57.bmp}

88261G57

Figure 195.
Most transmission fluid dipsticks on later-model vehicles are labelled . . .

{ewc GSMVIMG,GSMVIMG, !88261P48.bmp}

88261P48

Figure 196.
. . . and a few are hinged (locking into place to seal the guide/filler tube)
{ewc GSMVIMG,GSMVIMG, !88261P49.bmp}

88261P49

Figure 197.
As with any dipstick, make sure the fluid level is within the given range(s)
{ewc GSMVIMG,GSMVIMG, !88261P52.bmp}

88261P52

Figure 198.
Fluid is added through the dipstick guide/filler tube . . .

{ewc GSMVIMG,GSMVIMG, !88261P50.bmp}

88261P50

Figure 199.
. . . making a funnel mandatory on most models

{ewc GSMVIMG,GSMVIMG, !88261P51.bmp}

88261P51

Figure 200.
Loosen all of the transmission pan retaining bolts . . .

{ewc GSMVIMG,GSMVIMG, !88261P53.bmp}

88261P53

Figure 201.
. . . then remove all but a few at the very rear of the pan
{ewc GSMVIMG,GSMVIMG, !88261P54.bmp}

88261P54

Figure 202.
Once most of the fluid has drained, carefully lower the pan from the transmission
{ewc GSMVIMG,GSMVIMG, !88261P55.bmp}

88261P55

Figure 203.
Remove the filter for inspection and replacement

{ewc GSMVIMG,GSMVIMG, !88261P56.bmp}

88261P56

Figure 204.
The gasket (or rubber seal, depending on the application) must be replaced no matter how good it looks

{ewc GSMVIMG,GSMVIMG, !88261P57.bmp}

88261P57

Figure 205.
The magnet at the bottom of the pan should be thoroughly cleaned of all metal particles

{ewc GSMVIMG,GSMVIMG, !88261P58.bmp}

88261P58

Figure 206.
Exploded view of the automatic transmission fluid pan and filter
{ewc GSMVIMG,GSMVIMG, !88261G58.bmp}

88261G58

Figure 207.
Use a ratchet and extension to remove the filler plug and check the axle fluid
{ewc GSMVIMG,GSMVIMG, !88261P59.bmp}

88261P59

Figure 208.
Gear oil can be added using a pump or a squeeze bottle

{ewc GSMVIMG,GSMVIMG, !88261P60.bmp}

88261P60

Figure 209.
Because there is usually no drain plug, the rear axle cover must be removed to change the fluid

{ewc GSMVIMG,GSMVIMG, !88261P61.bmp}

88261P61

Figure 210.
Begin by cleaning loose dirt from around the cover to prevent contamination when it is removed

{ewc GSMVIMG,GSMVIMG, !88261P62.bmp}

88261P62

Figure 211.
Loosen and remove the cover bolts, then . . .

{ewc GSMVIMG,GSMVIMG, !88261P63.bmp}

88261P63

Figure 212.
. . . carefully break the gasket seal at the housing (DO NOT damage the cover/housing)

{ewc GSMVIMG,GSMVIMG, !88261P64.bmp}

88261P64

Figure 213.
With the gasket seal broken, pull the cover back at the bottom allowing the fluid to drain

{ewc GSMVIMG,GSMVIMG, !88261P65.bmp}

88261P65

Figure 214.
Once most of the fluid has been emptied into the drain pan, remove the cover from the housing

{ewc GSMVIMG,GSMVIMG, !88261P66.bmp}

88261P66

Figure 215.
If equipped, the magnet should be cleaned of metal particles
{ewc GSMVIMG,GSMVIMG, !88261P67.bmp}

88261P67

Figure 216.
Transfer case fluid plugs

{ewc GSMVIMG,GSMVIMG, !88261G59.bmp}

88261G59

Figure 217.
Cutaway view of a typical cooling system flow

{ewc GSMVIMG,GSMVIMG, !tccs1082.bmp}

tccs1082

Figure 218.
On 1996 models, labels in the engine compartment warn you that special coolant is used

{ewc GSMVIMG,GSMVIMG, !88261P68.bmp}

88261P68

Figure 219.
On all models, the coolant level should be checked through the coolant recovery tank . . .

{ewc GSMVIMG,GSMVIMG, !88261P69.bmp}

88261P69

Figure 220.
. . . and if coolant is needed, it should be added to the tank
{ewc GSMVIMG,GSMVIMG, !88261P70.bmp}

88261P70

Figure 221.
Cooling systems should be pressure tested for leaks periodically
{ewc GSMVIMG,GSMVIMG, !tccs1083.bmp}

tccs1083

Figure 222.
The freezing/boiling points of your coolant can be checked using a simple, inexpensive antifreeze hydrometer

{ewc GSMVIMG,GSMVIMG, !88261G60.bmp}

88261G60

Figure 223.
Be sure the rubber gasket on the radiator cap has a tight seal
{ewc GSMVIMG,GSMVIMG, !tccs1079.bmp}

tccs1079

Figure 224.
Periodically remove all debris from the radiator fins

{ewc GSMVIMG,GSMVIMG, !tccs1081.bmp}

tccs1081

Figure 225.
To prevent a mess when draining the radiator, place a plastic tube over the radiator petcock

{ewc GSMVIMG,GSMVIMG, !88261P71.bmp}

88261P71

Figure 226.
When refilling the system, pour coolant directly into the radiator, then . . .
{ewc GSMVIMG,GSMVIMG, !88261P72.bmp}

88261P72

Figure 227.
. . . top off using the recovery tank (once the sealed radiator is at normal operating temperature)

{ewc GSMVIMG,GSMVIMG, !88261P73.bmp}

88261P73

Figure 228.
Many of the earlier models covered by this manual utilize 2 completely separate reservoirs . . .

{ewc GSMVIMG,GSMVIMG, !88261P74.bmp}

88261P74

Figure 229.
. . . remove the cover ONLY from the side that requires fluid
{ewc GSMVIMG,GSMVIMG, !88261P75.bmp}

88261P75

Figure 230.
If there are no markings on the reservoir, keep the fluid approximately $^{1}/4$ in. (6mm) from the top

{ewc GSMVIMG,GSMVIMG, !88261G61.bmp}

88261G61

Figure 231.
Late-model vehicle, such as this 1996 Astro, use a 1-piece reservoir assembly . . .
{ewc GSMVIMG,GSMVIMG, !88261P76.bmp}

88261P76

Figure 232.
. . . but fluid is added in the same manner, clean the cover, remove and pour

{ewc GSMVIMG,GSMVIMG, !88261P77.bmp}

88261P77

Figure 233.
The power steering fluid level is checked using the reservoir cap/dipstick . . .
{ewc GSMVIMG,GSMVIMG, !88261P78.bmp}

88261P78

Figure 234.
. . . hold the cap sideways, making sure the fluid level is within the operating range
{ewc GSMVIMG,GSMVIMG, !88261P79.bmp}

88261P79

Figure 235.
Although 2 operating ranges are provided, it is preferable to check the level HOT
{ewc GSMVIMG,GSMVIMG, !88261G62.bmp}

88261G62

Figure 236.
If necessary, fluid should be added (and as usual, a funnel is handy)
{ewc GSMVIMG,GSMVIMG, !88261P80.bmp}

88261P80

Figure 237.
Late model reservoirs are also mounted to the cowl, just on the other side of the engine

{ewc GSMVIMG,GSMVIMG, !88261P81.bmp}

88261P81

Figure 238.
Grease fittings, such as the one pictured, should be cleaned before the grease gun is attached

{ewc GSMVIMG,GSMVIMG, !88261P82.bmp}

88261P82

Figure 239.
Exploded view of the front wheel hub and bearing assembly—2-wheel drive without ABS shown (ABS similar but with a speed sensor assembly on the shield and a reluctor ring on the back of the hub)

{ewc GSMVIMG,GSMVIMG, !88261G63.bmp}

88261G63

Figure 240.
Remove the dust cap from the center of the hub and disc assembly
{ewc GSMVIMG,GSMVIMG, !88261P83.bmp}

88261P83

Figure 241.
If the cap is stuck use a thin chisel to drive it away from the disc . . .

{ewc GSMVIMG,GSMVIMG, !88261P84.bmp}

88261P84

Figure 242.
. . . then pry the cap free, but be careful not to deform and ruin the cap
{ewc GSMVIMG,GSMVIMG, !88261P85.bmp}

88261P85

Figure 243.
Once loosened, remove the cap for access to the bearing retainer (cotter pin, washer and nut)

{ewc GSMVIMG,GSMVIMG, !88261P86.bmp}

88261P86

Figure 244.
Bend the ends outward and pull or lever the cotter pin from the spindle . . .
{ewc GSMVIMG,GSMVIMG, !88261P87.bmp}

88261P87

Figure 245.
If difficulty is encountered, gently tap on the pliers with a hammer to help free the cotter pin

{ewc GSMVIMG,GSMVIMG, !tccS8026.bmp}

TCCS8026

Figure 246.
. . . then loosen and remove the castellated spindle nut

{ewc GSMVIMG,GSMVIMG, !88261P88.bmp}

88261P88

Figure 247.
Withdraw the thrust washer . . .

{ewc GSMVIMG,GSMVIMG, !88261P89.bmp}

88261P89

Figure 248.
. . . then remove the outer bearing, freeing the hub and disc assembly
{ewc GSMVIMG,GSMVIMG, !88261P90.bmp}

88261P90

Figure 249.
Pull the hub/disc assembly from the spindle and face downward on a clean working surface

{ewc GSMVIMG,GSMVIMG, !88261P91.bmp}

88261P91

Figure 250.
Remove the inner wheel bearing seal using a seal puller (this really makes the job easier) . . .

{ewc GSMVIMG,GSMVIMG, !88261P92.bmp}

88261P92

Figure 251.
On ABS equipped vehicles a puller removes the seal WITHOUT damaging the reluctor ring (the visible teeth)

{ewc GSMVIMG,GSMVIMG, !88261P93.bmp}

88261P93

Figure 252.
With the seal removed, the inner wheel bearing may be lifted from the back of the hub

{ewc GSMVIMG,GSMVIMG, !88261P94.bmp}

88261P94

Figure 253.
Removing the bearings races from the hub and disc assembly
{ewc GSMVIMG,GSMVIMG, !88261G64.bmp}

88261G64

Figure 254.
Installing the inner wheel bearing race to the hub and disc
{ewc GSMVIMG,GSMVIMG, !88261G65.bmp}

88261G65

Figure 255.
Installing the outer wheel bearing race to the hub and disc

{ewc GSMVIMG,GSMVIMG, !88261G66.bmp}

88261G66

Figure 256.
Thoroughly pack the bearing with fresh, high temperature wheel-bearing grease before installation

{ewc GSMVIMG,GSMVIMG, !tccS8033.bmp}

TCCS8033

Figure 257.
Apply a thin coat of fresh grease to the new inner bearing seal lip
{ewc GSMVIMG,GSMVIMG, !tccS8034.bmp}

TCCS8034

Figure 258.
Though a driver is preferred, any circular tool (pipe or socket) of similar size can install the seal

{ewc GSMVIMG,GSMVIMG, !88261P95.bmp}

88261P95

Figure 259.
Calculating proper tongue weight for your trailer

{ewc GSMVIMG,GSMVIMG, !tccs1005.bmp}

tccs1005

Figure 260.
Connect the jumper cables to the batteries and engine in the order shown
{ewc GSMVIMG,GSMVIMG, !tccs1080.bmp}

tccs1080

Figure 261.
Floor jacks can be used on frame rails (such as this front crossmember) to raise the vehicle . . .

{ewc GSMVIMG,GSMVIMG, !88261P96.bmp}

88261P96

Figure 262.
. . . but jackstands must be used to support it (note this stand is placed under a frame pad)

{ewc GSMVIMG,GSMVIMG, !88261P97.bmp}

88261P97

Figure 263.
The rear differential is another jacking point (you can get both rear wheels off the ground at once)

{ewc GSMVIMG,GSMVIMG, !88261P98.bmp}

88261P98

Figure 264.
You can use the crossmember to lift the front of the vehicle
{ewc GSMVIMG,GSMVIMG, !88261G67.bmp}

88261G67

Figure 265.
The front frame pads may be used to lift 1 side of the vehicle
{ewc GSMVIMG,GSMVIMG, !88261G68.bmp}

88261G68

Figure 266.
The rear axle can be used to lift (floor jack pictured) or support (jackstands) the vehicle

{ewc GSMVIMG,GSMVIMG, !88261G69.bmp}

88261G69

Figure 267.
The rear spring bracket can be used to lift 1 side of the vehicle
{ewc GSMVIMG,GSMVIMG, !88261G70.bmp}

88261G70

Figure 1.
Here is an example of a simple automotive circuit. When the switch is closed, power from the positive battery terminal flows through the fuse, then the switch and to the load (light bulb), the light illuminates and then, the circuit is completed through the return conductor and the vehicle ground. If the light did not work, the tests could be made with a voltmeter or test light at the battery, fuse, switch or bulb socket

{ewc GSMVIMG,GSMVIMG, !tccs2004.bmp}

tccs2004

Figure 2.
Damaged insulation can allow wires to break (causing an open circuit) or touch (causing a short)

{ewc GSMVIMG,GSMVIMG, !tccs2003.bmp}

tccs2003

Figure 3.
A 12 volt test light is useful when checking parts of a circuit for power

{ewc GSMVIMG,GSMVIMG, !tccs2006.bmp}

tccs2006

Figure 4.
Here, someone is checking a circuit by making sure there is power to the component's fuse

{ewc GSMVIMG,GSMVIMG, !tccs2007.bmp}

tccs2007

Figure 5.
Jumper wires with various connectors are handy for quick electrical testing
{ewc GSMVIMG,GSMVIMG, !tccs2005.bmp}

tccs2005

Figure 6.
ST distributor at home nestled at the back of the 4.3L engine
{ewc GSMVIMG,GSMVIMG, !88262p9a.bmp}

88262p9a

Figure 7.
El distributor with the coil mounted in the cap

{ewc GSMVIMG,GSMVIMG, !88262g01.bmp}

88262g01

Figure 8.
ST distributor with the coil mounted externally

{ewc GSMVIMG,GSMVIMG, !88262g14.bmp}

88262g14

Figure 9.
lectronic Spark Control components

{ewc GSMVIMG,GSMVIMG, !88262g13.bmp}

88262g13

Figure 10.
istributor testing—HEI with "coil in cap”

{ewc GSMVIMG,GSMVIMG, !88262g05.bmp}

88262g05

Figure 11.
istributor testing—HEI with "coil in cap," continued

{ewc GSMVIMG,GSMVIMG, !88262g06.bmp}

88262g06

Figure 12.
istributor testing—HEI with "coil in cap," continued

{ewc GSMVIMG,GSMVIMG, !88262g07.bmp}

88262g07

Figure 13.
istributor testing—HEI with remote coil

{ewc GSMVIMG,GSMVIMG, !88262g08.bmp}

88262g08

Figure 14.
istributor testing—HEI with remoted coil, continued
{ewc GSMVIMG,GSMVIMG, !88262g09.bmp}

88262g09

Figure 15.
gnition system check—2.5L engine

{ewc GSMVIMG,GSMVIMG, !88262c37.bmp}

88262c37

Figure 16.
gnition system check—2.5L engine, continued

{ewc GSMVIMG,GSMVIMG, !88262c38.bmp}

88262c38

Figure 17.
gnition system check—4.3L engine except with HVS

{ewc GSMVIMG,GSMVIMG, !88262c39.bmp}

88262c39

Figure 18.
gnition system check—4.3L engine except with HVS, continued
{ewc GSMVIMG,GSMVIMG, !88262c40.bmp}

88262c40

Figure 19.
gnition system check—4.3L engine except with HVS, continued
{ewc GSMVIMG,GSMVIMG, !88262c41.bmp}

88262c41

Figure 20.
gnition system check—4.3L engine except with HVS, continued
{ewc GSMVIMG,GSMVIMG, !88262c42.bmp}

88262c42

Figure 21.
VS distributors are easily identified by their flat appearance and side mounted ignition wire towers

{ewc GSMVIMG,GSMVIMG, !88262g18.bmp}

88262g18

Figure 22.
VS ignition systems have the ICM module mounted to the same bracket as the coil
{ewc GSMVIMG,GSMVIMG, !88262g19.bmp}

88262g19

Figure 23.
gnition component mounting points on early 4-cylinder engines
{ewc GSMVIMG,GSMVIMG, !88262g02.bmp}

88262g02

Figure 24.
gnition component mounting points on late 4-cylinder engines
{ewc GSMVIMG,GSMVIMG, !88262g15.bmp}

88262g15

Figure 25.
gnition component mounting points on HVS equipped 6-cylinder engines
{ewc GSMVIMG,GSMVIMG, !88262g20.bmp}

88262g20

Figure 26.
gnition coil testing points—HEI/EST coil

{ewc GSMVIMG,GSMVIMG, !88262g12.bmp}

88262g12

Figure 27.
gnition coil testing points—HVS coil

{ewc GSMVIMG,GSMVIMG, !88262g16.bmp}

88262g16

Figure 28.
erminal identification for coil and distributor

{ewc GSMVIMG,GSMVIMG, !88262g25.bmp}

88262g25

Figure 29.
lways pull on the boot to remove the ignition wires, never the wire itself
{ewc GSMVIMG,GSMVIMG, !88262p73.bmp}

88262p73

Figure 30.
epress the tabs to release the connector from the coil

{ewc GSMVIMG,GSMVIMG, !88262p74.bmp}

88262p74

Figure 31.
he coil will be mounted to the manifold directly or to a bracket which is bolted to the manifold

{ewc GSMVIMG,GSMVIMG, !88262p75.bmp}

88262p75

Figure 32.
heck the coil for cracks and other signs of damage before installation
{ewc GSMVIMG,GSMVIMG, !88262p76.bmp}

88262p76

Figure 33.
odule and pick-up coil for EST distributor

{ewc GSMVIMG,GSMVIMG, !88262g27.bmp}

88262g27

Figure 34.
he module easily unbolts without disassembling the distributor on EST equipped engines

{ewc GSMVIMG,GSMVIMG, !88262p78.bmp}

88262p78

Figure 35.
nplug the internal connections before trying to remove the module

{ewc GSMVIMG,GSMVIMG, !88262p78.bmp}

88262p78

Figure 36.
eat sink grease must be applied when installing the module or it may fail due to overheating

{ewc GSMVIMG,GSMVIMG, !88262p79.bmp}

88262p79

Figure 37.
ick-up coil testing points

{ewc GSMVIMG,GSMVIMG, !88262g17.bmp}

88262g17

Figure 38.
Exploded view of the distributor components—2.5L engine
{ewc GSMVIMG,GSMVIMG, !88262g21.bmp}

88262g21

Figure 39.
xploded view of the distributor components—4.3L engine, non-HVS distributor
{ewc GSMVIMG,GSMVIMG, !88262g22.bmp}

88262g22

Figure 40.
Support the distributor shaft while driving out the roll pin
{ewc GSMVIMG,GSMVIMG, !88262g23.bmp}

88262g23

Figure 41.
Use a socket to press the retainer clip over the shaft. Use a new retainer clip each time it is removed

{ewc GSMVIMG,GSMVIMG, !88262g24.bmp}

88262g24

Figure 42.
Connector identification for distributor—2.5L engine
{ewc GSMVIMG,GSMVIMG, !88262g26.bmp}

88262g26

Figure 43.
The HVS distributor mounts only one way. Do not try to rotate the distributor to change the timing

{ewc GSMVIMG,GSMVIMG, !88262g28.bmp}

88262g28

Figure 44.
Align the indent hole on the drive gear with the cast-in arrow before installation on the HVS distributor

{ewc GSMVIMG,GSMVIMG, !88262g29.bmp}

88262g29

Figure 45.
With the indent hole and cast-in arrow aligned, the rotor should point in this direction

{ewc GSMVIMG,GSMVIMG, !88262g31.bmp}

88262g31

Figure 46.
Connector locations on the HVS distributor

{ewc GSMVIMG,GSMVIMG, !88262g30.bmp}

88262g30

Figure 47.
ith the HVS distributor properly aligned and installed, the rotor should point to the mark

{ewc GSMVIMG,GSMVIMG, !88262g32.bmp}

88262g32

Figure 48.
Tag all the ignition wires before removing them from the cap or the spark plugs
{ewc GSMVIMG,GSMVIMG, !88262p80.bmp}

88262p80

Figure 49.
Disconnect the harnesses from the module

{ewc GSMVIMG,GSMVIMG, !88262p81.bmp}

88262p81

Figure 50.
Mark the alignment of the rotor before removing the distributor
{ewc GSMVIMG,GSMVIMG, !88262p82.bmp}

88262p82

Figure 51.
Mark the distributor base-to-block alignment before removing the distributor
{ewc GSMVIMG,GSMVIMG, !88262p86.bmp}

88262p86

Figure 52.
The distributor hold-down bolt must be removed to be able to draw out the distributor

{ewc GSMVIMG,GSMVIMG, !88262p87.bmp}

88262p87

Figure 53.
Depending on the hold-down's shape, there may be a correct orientation, so note how it is mounted

{ewc GSMVIMG,GSMVIMG, !88262p88.bmp}

88262p88

Figure 54.
Draw the distributor body straight up and out

{ewc GSMVIMG,GSMVIMG, !88262p89.bmp}

88262p89

Figure 55.
2.5L Engine
Firing Order: 1–3–4–2
Distributor Rotation: Clockwise

{ewc GSMVIMG,GSMVIMG, !88262G35.bmp}

88262G35

Figure 56.
4.3L Engine, non-HVS
Firing Order: 1–6–5–4–3–2
Distributor Rotation: Clockwise

{ewc GSMVIMG,GSMVIMG, !88262G36.bmp}

88262G36

Figure 57.
Ignition wire routing—early-model 2.5L engine

{ewc GSMVIMG,GSMVIMG, !88262g04.bmp}

88262g04

Figure 58.
Ignition wire routing—late-model 2.5L engine

{ewc GSMVIMG,GSMVIMG, !88262g11.bmp}

88262g11

Figure 59.
Ignition wire routing—4.3L engine with HEI (coil in cap)
{ewc GSMVIMG,GSMVIMG, !88262g03.bmp}

88262g03

Figure 60.
Ignition wire routing—4.3L engine with HEI (remote coil)
{ewc GSMVIMG,GSMVIMG, !88262g10.bmp}

88262g10

Figure 61.
Ignition wire routing—4.3L engine with HVS, right side

{ewc GSMVIMG,GSMVIMG, !88262g33.bmp}

88262g33

Figure 62.
Ignition wire routing—4.3L engine with HVS, left side

{ewc GSMVIMG,GSMVIMG, !88262g34.bmp}

88262g34

Figure 63.
The CS Series alternator is one of General Motors most commonly used units
{ewc GSMVIMG,GSMVIMG, !88262g51.bmp}

88262g51

Figure 64.
The SI Series alternator was used in 1985 and was the last to use a diode trio
{ewc GSMVIMG,GSMVIMG, !88262g52.bmp}

88262g52

Figure 65.
Alternator wiring—1985 2.5L engine

{ewc GSMVIMG,GSMVIMG, !88262g53.bmp}

88262g53

Figure 66.
Alternator wiring—1986 and on 2.5L engine

{ewc GSMVIMG,GSMVIMG, !88262g49.bmp}

88262g49

Figure 67.
Alternator wiring—4.3L engine

{ewc GSMVIMG,GSMVIMG, !88262g50.bmp}

88262g50

Figure 68.
Iternator ground tab location—1985

{ewc GSMVIMG,GSMVIMG, !88262g58.bmp}

88262g58

Figure 69.
Alternator testing—1985

{ewc GSMVIMG,GSMVIMG, !88262g57.bmp}

88262g57

Figure 70.
Alternator mounting—1985–86 2.5L engine

{ewc GSMVIMG,GSMVIMG, !88262g43.bmp}

88262g43

Figure 71.
Alternator mounting—1985–86 4.3L engine

{ewc GSMVIMG,GSMVIMG, !88262g44.bmp}

88262g44

Figure 72.
Alternator mounting—1987–90 2.5L engine

{ewc GSMVIMG,GSMVIMG, !88262g45.bmp}

88262g45

Figure 73.
Alternator mounting—1987–90 4.3L engine

{ewc GSMVIMG,GSMVIMG, !88262g46.bmp}

88262g46

Figure 74.
Alternator mounting—1991–95 4.3L engine

{ewc GSMVIMG,GSMVIMG, !88262g47.bmp}

88262g47

Figure 75.
Alternator mounting—1996 4.3L engine

{ewc GSMVIMG,GSMVIMG, !88262g48.bmp}

88262g48

Figure 76.
Before removing the positive lead from the alternator, DISCONNECT the battery ground cable

{ewc GSMVIMG,GSMVIMG, !88262p90.bmp}

88262p90

Figure 77.
Be careful when removing the the locknut as sometimes the terminal stud likes to rotate with the nut

{ewc GSMVIMG,GSMVIMG, !88262p91.bmp}

88262p91

Figure 78.
Remove the mounting bolts after removing the belt
{ewc GSMVIMG,GSMVIMG, !88262p92.bmp}

88262p92

Figure 79.
This mounting stud holds a bracket in addition to mounting the alternator
{ewc GSMVIMG,GSMVIMG, !88262p93.bmp}

88262p93

Figure 80.
Once the bracket is removed, the mounting stud can be removed
{ewc GSMVIMG,GSMVIMG, !88262p94.bmp}

88262p94

Figure 81.
Do not replace this stud with a regular bolt or the bracket will not have a mounting location

{ewc GSMVIMG,GSMVIMG, !88262p95.bmp}

88262p95

Figure 82.
ith the regulator hooked up as shown, the light should extinguish between 13.5 and 16.0 volts—1985 models

{ewc GSMVIMG,GSMVIMG, !88262g59.bmp}

88262g59

Figure 83.
Alternator service—1985 models

{ewc GSMVIMG,GSMVIMG, !88262g54.bmp}

88262g54

Figure 84.
Alternator service—1985 models, continued

{ewc GSMVIMG,GSMVIMG, !88262g55.bmp}

88262g55

Figure 85.
Alternator service—1985 models, continued

{ewc GSMVIMG,GSMVIMG, !88262g56.bmp}

88262g56

Figure 86.
The battery relies on this one mount to hold it in place
{ewc GSMVIMG,GSMVIMG, !88262g60.bmp}

88262g60

Figure 87.
Battery tray mounting points. Keep the tray clean to prevent corrosion due to acid attack

{ewc GSMVIMG,GSMVIMG, !88262g61.bmp}

88262g61

Figure 88.
This is representative battery cable routing on a 4-cylinder engine equipped truck
{ewc GSMVIMG,GSMVIMG, !88262g62.bmp}

88262g62

Figure 89.
This is representative battery cable routing on a 6-cylinder engine equipped truck
{ewc GSMVIMG,GSMVIMG, !88262g63.bmp}

88262g63

Figure 90.
This is the basic starter electrical circuit

{ewc GSMVIMG,GSMVIMG, !88262g66.bmp}

88262g66

Figure 91.
Cutaway view of the 5MT (SD–200) starter

{ewc GSMVIMG,GSMVIMG, !88262g64.bmp}

88262g64

Figure 92.
Cutaway view of the 10MT (SD–300) starter

{ewc GSMVIMG,GSMVIMG, !88262g65.bmp}

88262g65

Figure 93.
Insert a tool into the hole and push the pinion out until it engages the ring gear. This allows the pinion clearance to be measured

{ewc GSMVIMG,GSMVIMG, !88262g72.bmp}

88262g72

Figure 94.
Make sure that you measure at the tip of the gear to get an accurate pinion clearance measurement

{ewc GSMVIMG,GSMVIMG, !88262g69.bmp}

88262g69

Figure 95.
Starter mounting—2.5L engine

{ewc GSMVIMG,GSMVIMG, !88262g67.bmp}

88262g67

Figure 96.
Starter mounting—4.3L engine

{ewc GSMVIMG,GSMVIMG, !88262g68.bmp}

88262g68

Figure 97.
Disconnect the negative battery cable before removing the starter cables
{ewc GSMVIMG,GSMVIMG, !88262p96.bmp}

88262p96

Figure 98.
The torque converter cover may need to be removed on some versions to withdraw the starter

{ewc GSMVIMG,GSMVIMG, !88262p97.bmp}

88262p97

Figure 99.
Support the starter when removing the mounting bolts

{ewc GSMVIMG,GSMVIMG, !88262p98.bmp}

88262p98

Figure 100.
The starter can be heavy, so be ready for its heft once the final mounting bolt is removed

{ewc GSMVIMG,GSMVIMG, !88262p99.bmp}

88262p99

Figure 101.
Exploded view of the 5MT (SD–200) starter

{ewc GSMVIMG,GSMVIMG, !88262g70.bmp}

88262g70

Figure 102.
Cutaway view of the 10MT (SD–300) starter

{ewc GSMVIMG,GSMVIMG, !88262g71.bmp}

88262g71

Figure 103.
Coolant temperature and oil pressure senders—2.5L and 4.3L engines
{ewc GSMVIMG,GSMVIMG, !88262g73.bmp}

88262g73

Figure 104.
The oil pressure sender can be reached after removing the engine cover
{ewc GSMVIMG,GSMVIMG, !88262pa0.bmp}

88262pa0

Figure 105.
Do not put too much sideways force on the sender or you can damage the adapter
{ewc GSMVIMG,GSMVIMG, !88262pa1.bmp}

88262pa1

Figure 106.
You can use some pipe sealer to make sure oil doesn't leak past the sender threads

{ewc GSMVIMG,GSMVIMG, !88262pa2.bmp}

88262pa2

Figure 107.
Do not crossthread the sender into the adapter or you will definitely have a leak to contend with

{ewc GSMVIMG,GSMVIMG, !88262pa3.bmp}

88262pa3

Figure 1.
Damaged bolt hole threads can be replaced with thread repair inserts
{ewc GSMVIMG,GSMVIMG, !tccs3039.bmp}

tccs3039

Figure 2.
Standard thread repair insert (left), and spark plug thread insert
{ewc GSMVIMG,GSMVIMG, !tccs3040.bmp}

tccs3040

Figure 3.
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

{ewc GSMVIMG,GSMVIMG, !tccs3041.bmp}

tccs3041

Figure 4.
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

{ewc GSMVIMG,GSMVIMG, !tccs3042.bmp}

tccs3042

Figure 5.
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

{ewc GSMVIMG,GSMVIMG, !tccs3043.bmp}

tccs3043

Figure 6.
A screw-in type compression gauge is more accurate and easier to use without an assistant

{ewc GSMVIMG,GSMVIMG, !tccs3801.bmp}

tccs3801

Figure 7.
Typical 4.3L engine mounting on All Wheel Drive (AWD) and rear wheel drive Astro and Safari vans

{ewc GSMVIMG,GSMVIMG, !88263g01.bmp}

88263g01

Figure 8.
Scribing marks for cutting the tie bar—1995 models

{ewc GSMVIMG,GSMVIMG, !88263g02.bmp}

88263g02

Figure 9.
Drilling out holes for tie bar replacement brackets—1995 models
{ewc GSMVIMG,GSMVIMG, !88263g03.bmp}

88263g03

Figure 10.
Tie bar bracket positioning—1995 models

{ewc GSMVIMG,GSMVIMG, !88263g04.bmp}

88263g04

Figure 11.
A body protection hoist adapter set must be used to spread the weight evenly and prevent damage—1996 models

{ewc GSMVIMG,GSMVIMG, !88263g05.bmp}

88263g05

Figure 12.
A twin post hoist frame assembly support bar is necessary unless you are using a side lift hoist

{ewc GSMVIMG,GSMVIMG, !88263g06.bmp}

88263g06

Figure 13.
Universal lift brackets should be installed in place of the proper intake manifold bolts

{ewc GSMVIMG,GSMVIMG, !88263g07.bmp}

88263g07

Figure 14.
The proper frame bolt tightening sequence MUST BE OBSERVED to assure proper chassis-to-frame alignment

{ewc GSMVIMG,GSMVIMG, !88263g08.bmp}

88263g08

Figure 15.
Exploded view of the pushrod side cover mounting—2.5L engine
{ewc GSMVIMG,GSMVIMG, !88263g09.bmp}

88263g09

Figure 16.
A thin bead of RTV sealant is used on both the pushrod and rocker arm covers on the 2.5L engine

{ewc GSMVIMG,GSMVIMG, !88263g10.bmp}

88263g10

Figure 17.
Exploded view of the rocker arm cover mounting—2.5L engine
{ewc GSMVIMG,GSMVIMG, !88263g11.bmp}

88263g11

Figure 18.
Exploded view of a typical 4.3L rocker arm cover mounting

{ewc GSMVIMG,GSMVIMG, !88263g12.bmp}

88263g12

Figure 19.
Loosen the rocker arm retaining bolts using a wrench or ratchet and suitable driver . . .

{ewc GSMVIMG,GSMVIMG, !88263p01.bmp}

88263p01

Figure 20.
. . . then remove the bolts from the cylinder head and valve cover
{ewc GSMVIMG,GSMVIMG, !88263p02.bmp}

88263p02

Figure 21.
Lift and remove the valve cover from the cylinder head . . .

{ewc GSMVIMG,GSMVIMG, !88263p03.bmp}

88263p03

Figure 22.
. . . then remove and discard the old gasket

{ewc GSMVIMG,GSMVIMG, !88263p04.bmp}

88263p04

Figure 23.
Exploded view of the late-model 4.3L Vortec engine rocker arm cover mounting—1996 shown

{ewc GSMVIMG,GSMVIMG, !88263g13.bmp}

88263g13

Figure 24.
Exploded view of the rocker arm assembly—2.5L engine

{ewc GSMVIMG,GSMVIMG, !88263g14.bmp}

88263g14

Figure 25.
Exploded view of a 4.3L engine rocker arm assembly
{ewc GSMVIMG,GSMVIMG, !88263g15.bmp}

88263g15

Figure 26.
To remove the rocker arm, loosen and remove the nut and ball washer (pivot) . . .
{ewc GSMVIMG,GSMVIMG, !88263p05.bmp}

88263p05

Figure 27.
. . . then lift the rocker arm from the stud

{ewc GSMVIMG,GSMVIMG, !88263p06.bmp}

88263p06

Figure 28.
If necessary, remove the pushrod for replacement or inspection
{ewc GSMVIMG,GSMVIMG, !88263p07.bmp}

88263p07

Figure 29.
Keep ALL PARTS sorted or tagged for installation in their original locations
{ewc GSMVIMG,GSMVIMG, !88263p08.bmp}

88263p08

Figure 30.
Most 4.3L engines (except VIN W and some 1993–94 VIN Z models) will require valve lash adjustment during installation

{ewc GSMVIMG,GSMVIMG, !88263g16.bmp}

88263g16

Figure 31.
Exploded view of the thermostat and housing assembly—2.5L engine
{ewc GSMVIMG,GSMVIMG, !88263g17.bmp}

88263g17

Figure 32.
Exploded view of the thermostat and housing assembly—carbureted and TBI 4.3L engines

{ewc GSMVIMG,GSMVIMG, !88263g18.bmp}

88263g18

Figure 33.
If access is difficult with the hose attached . . .

{ewc GSMVIMG,GSMVIMG, !88263p09.bmp}

88263p09

Figure 34.
. . . remove the hose, then loosen and remove the housing retainers
{ewc GSMVIMG,GSMVIMG, !88263p10.bmp}

88263p10

Figure 35.
Once the housing is free, carefully lift it from the engine to expose the thermostat
{ewc GSMVIMG,GSMVIMG, !88263p11.bmp}

88263p11

Figure 36.
Sometimes, the thermostat will lift from the engine with the housing . . .
{ewc GSMVIMG,GSMVIMG, !88263p12.bmp}

88263p12

Figure 37.
. . . but if not, note the direction it is installed, then lift if from the engine for replacement

{ewc GSMVIMG,GSMVIMG, !88263p13.bmp}

88263p13

Figure 38.
Exploded view of the thermostat and housing assembly—4.3L (1992–95 VIN W) CMFI engine

{ewc GSMVIMG,GSMVIMG, !88263g19.bmp}

88263g19

Figure 39.
Exploded view of the thermostat and housing assembly—4.3L (1996 VIN W) CSFI engine

{ewc GSMVIMG,GSMVIMG, !88263g20.bmp}

88263g20

Figure 40.
Exploded view of the intake manifold mounting—early-model 2.5L engines (NOTE that torque values apply ONLY to models retained by bolts and STUDS)

{ewc GSMVIMG,GSMVIMG, !88263g21.bmp}

88263g21

Figure 41.
Disconnect all lines, hoses . . .

{ewc GSMVIMG,GSMVIMG, !88263p14.bmp}

88263p14

Figure 42.
. . . and wiring from the intake manifold or from manifold mounted support brackets

{ewc GSMVIMG,GSMVIMG, !88263p15.bmp}

88263p15

Figure 43.
Loosen and remove the intake manifold retaining bolts . . .

{ewc GSMVIMG,GSMVIMG, !88263p16.bmp}

88263p16

Figure 44.
. . . a ratchet with various extensions will be very helpful for this, then carefully . . .
{ewc GSMVIMG,GSMVIMG, !88263p17.bmp}

88263p17

Figure 45.
. . . remove the manifold—NOTE the TBI unit or carb need not be removed on VIN B, N or Z engines

{ewc GSMVIMG,GSMVIMG, !88263p18.bmp}

88263p18

Figure 46.
Once the manifold has been removed you have free access to the lifter valley
{ewc GSMVIMG,GSMVIMG, !88263p19.bmp}

88263p19

Figure 47.
To keep debris out of the engine, cover all openings before cleaning the gasket surfaces

{ewc GSMVIMG,GSMVIMG, !88263p20.bmp}

88263p20

Figure 48.
Exploded view of the 4.3L (VIN B, N and Z) engine intake manifold mounting and RTV sealant application—NOTE that bolt/stud locations will vary based on model year and emission packages

{ewc GSMVIMG,GSMVIMG, !88263g22.bmp}

88263g22

Figure 49.
Intake manifold bolt torque sequence—1985–90 4.3L (VIN B, N and Z) engines
{ewc GSMVIMG,GSMVIMG, !88263g23.bmp}

88263g23

Figure 50.
Intake manifold bolt torque sequence—1991–94 4.3L (VIN B or Z) engines
{ewc GSMVIMG,GSMVIMG, !88263g24.bmp}

88263g24

Figure 51.
Lower intake manifold bolt torque sequence—1992–95 4.3L (VIN W) engine
{ewc GSMVIMG,GSMVIMG, !88263g25.bmp}

88263g25

Figure 52.
Upper intake manifold bolt torque sequence—1992–95 4.3L (VIN W) engine
{ewc GSMVIMG,GSMVIMG, !88263g26.bmp}

88263g26

Figure 53.
Exploded view of the upper and lower intake manifold assembly—1992–95 4.3L (VIN W) engine

{ewc GSMVIMG,GSMVIMG, !88263g27.bmp}

88263g27

Figure 54.
Exploded view of the upper intake manifold and Central Sequential Fuel Injection (CSFI) components

{ewc GSMVIMG,GSMVIMG, !88263g28.bmp}

88263g28

Figure 55.
Exploded view of the lower intake manifold mounting—1996 4.3L (VIN W) CSFI engines

{ewc GSMVIMG,GSMVIMG, !88263g29.bmp}

88263g29

Figure 56.
Lower intake manifold-to-block RTV sealer area

{ewc GSMVIMG,GSMVIMG, !88263g30.bmp}

88263g30

Figure 57.
Lower intake manifold bolt torque sequence—1996 4.3L (VIN W) CSFI engines
{ewc GSMVIMG,GSMVIMG, !88263g31.bmp}

88263g31

Figure 58.
Exploded view of the exhaust manifold mounting and retainer torque sequence—2.5L engine

{ewc GSMVIMG,GSMVIMG, !88263g32.bmp}

88263g32

Figure 59.
Exploded view of typical 4.3L engine exhaust manifold mounting
{ewc GSMVIMG,GSMVIMG, !88263g33.bmp}

88263g33

Figure 60.
Loosen the retainers and disconnect the exhaust pipe from the manifold
{ewc GSMVIMG,GSMVIMG, !88263p21.bmp}

88263p21

Figure 61.
Except for 1996 models, disconnect the heat stove tube from the exhaust manifold
{ewc GSMVIMG,GSMVIMG, !88263p22.bmp}

88263p22

Figure 62.
Once the tab washers are flattened, loosen and remove the manifold retaining bolts . . .

{ewc GSMVIMG,GSMVIMG, !88263p23.bmp}

88263p23

Figure 63.
. . . then carefully remove the manifold from the vehicle
{ewc GSMVIMG,GSMVIMG, !88263p24.bmp}

88263p24

Figure 64.
Exploded view of late-model 4.3L engine heat shield mounting
{ewc GSMVIMG,GSMVIMG, !88263g34.bmp}

88263g34

Figure 65.
Late-model 4.3L engine exhaust manifold fastener locations—1996 VIN W shown
{ewc GSMVIMG,GSMVIMG, !88263g35.bmp}

88263g35

Figure 66.
Drain the cooling system using the radiator drain cock—a tube on the outlet may prevent a mess

{ewc GSMVIMG,GSMVIMG, !88263p25.bmp}

88263p25

Figure 67.
On some late-model vehicles you must remove the hood latch—start by match-marking it . . .

{ewc GSMVIMG,GSMVIMG, !88263p26.bmp}

88263p26

Figure 68.
. . . then loosen the retaining bolts . . .

{ewc GSMVIMG,GSMVIMG, !88263p27.bmp}

88263p27

Figure 69.
. . . and remove the assembly from the radiator support

{ewc GSMVIMG,GSMVIMG, !88263p28.bmp}

88263p28

Figure 70.
Loosen the upper fan shroud retainers . . .

{ewc GSMVIMG,GSMVIMG, !88263p29.bmp}

88263p29

Figure 71.
. . . be careful not to miss any (a long extension is handy for the upper-to-lower shroud bolts)

{ewc GSMVIMG,GSMVIMG, !88263p30.bmp}

88263p30

Figure 72.
With the retainers removed, carefully lift the upper fan shroud from the engine compartment

{ewc GSMVIMG,GSMVIMG, !88263p31.bmp}

88263p31

Figure 73.
Loosen and disconnect any threaded transmission or engine oil cooler lines . . .

{ewc GSMVIMG,GSMVIMG, !88263p34.bmp}

88263p34

Figure 74.
. . . note the shape of this open-end wrench, it is a special line wrench just for this purpose

{ewc GSMVIMG,GSMVIMG, !88263p35.bmp}

88263p35

Figure 75.
Disengage the overflow hose from the radiator . . .

{ewc GSMVIMG,GSMVIMG, !88263p32.bmp}

88263p32

Figure 76.
. . . and finally, loosen the clamps and disconnect and remaining radiator hoses . . .

{ewc GSMVIMG,GSMVIMG, !88263p33.bmp}

88263p33

Figure 77.
. . . then CAREFULLY lift the radiator from the engine compartment
{ewc GSMVIMG,GSMVIMG, !88263p36.bmp}

88263p36

Figure 78.
Transmission and engine cooler lines are either of the threaded type (left) or the Quick-Connect type (right)

{ewc GSMVIMG,GSMVIMG, !88263g36.bmp}

88263g36

Figure 79.
Exploded view of a typical early-model Astro and Safari radiator and cooling fan mounting

{ewc GSMVIMG,GSMVIMG, !88263g37.bmp}

88263g37

Figure 80.
Exploded view of a typical late-model Astro and Safari radiator mounting

{ewc GSMVIMG,GSMVIMG, !88263g38.bmp}

88263g38

Figure 81.
Use a small pick-type tool to release and remove the retaining clips from the cooler line fittings

{ewc GSMVIMG,GSMVIMG, !88263g39.bmp}

88263g39

Figure 82.
When installing the replacement clips to the cooler line fittings, PROPER ALIGNMENT IS CRITICAL

{ewc GSMVIMG,GSMVIMG, !88263g40.bmp}

88263g40

Figure 83.
Typical Astro and Safari engine oil cooler lines and components
{ewc GSMVIMG,GSMVIMG, !88263g42.bmp}

88263g42

Figure 84.
Late-model engine oil cooler line routing—1996 model shown
{ewc GSMVIMG,GSMVIMG, !88263g43.bmp}

88263g43

Figure 85.
Exploded view of the cooling fan assembly for the 2.5L engine without a clutch
{ewc GSMVIMG,GSMVIMG, !88263g44.bmp}

88263g44

Figure 86.
Fan removal usually boils down to a simple matter of removing the retainers (without cutting your hand) . . .

{ewc GSMVIMG,GSMVIMG, !88263p37.bmp}

88263p37

Figure 87.
. . . then pulling the fan blade assembly from the water pump and pulley
{ewc GSMVIMG,GSMVIMG, !88263p38.bmp}

88263p38

Figure 88.
Exploded view of the late-model 2.5L engine fan and clutch assembly
{ewc GSMVIMG,GSMVIMG, !88263g46.bmp}

88263g46

Figure 89.
Exploded view of an early-model 2.5L engine fan and clutch assembly
{ewc GSMVIMG,GSMVIMG, !88263g45.bmp}

88263g45

Figure 90.
Exploded view of a 4.3L engine fan and clutch assembly
{ewc GSMVIMG,GSMVIMG, !88263g47.bmp}

88263g47

Figure 91.
Exploded view of the fan and clutch assembly—1996 models
{ewc GSMVIMG,GSMVIMG, !88263g48.bmp}

88263g48

Figure 92.
Remove the accessory drive belt(s)—on most models that means the single serpentine belt

{ewc GSMVIMG,GSMVIMG, !88263p39.bmp}

88263p39

Figure 93.
Once the shroud, fan and clutch or spacer are out of the way, remove the water pump pulley

{ewc GSMVIMG,GSMVIMG, !88263p40.bmp}

88263p40

Figure 94.
Disconnect the hoses from the water pump . . .

{ewc GSMVIMG,GSMVIMG, !88263p43.bmp}

88263p43

Figure 95.
. . . in most cases this means loosening the clamp and pulling off the hose . . .
{ewc GSMVIMG,GSMVIMG, !88263p41.bmp}

88263p41

Figure 96.
. . . but a stuck hose can be carefully cut away if you determine it should be replaced anyway

{ewc GSMVIMG,GSMVIMG, !88263p42.bmp}

88263p42

Figure 97.
Loosen and remove the retaining bolts, then remove the water pump from the engine

{ewc GSMVIMG,GSMVIMG, !88263p44.bmp}

88263p44

Figure 98.
Exploded view of typical Astro and Safari water pump mountings—note that some early-models use studs at various locations to help mount engine accessories

{ewc GSMVIMG,GSMVIMG, !88263g49.bmp}

88263g49

Figure 99.
Exploded view of the cylinder head mounting—2.5L engine
{ewc GSMVIMG,GSMVIMG, !88263g50.bmp}

88263g50

Figure 100.
Cylinder head bolt torque sequence—2.5L engine

{ewc GSMVIMG,GSMVIMG, !88263g51.bmp}

88263g51

Figure 101.
Prepare the cylinder head by removing the rocker arm cover, intake manifold, and exhaust manifold

{ewc GSMVIMG,GSMVIMG, !88263p45.bmp}

88263p45

Figure 102.
Loosen the cylinder head bolts using the reverse of the torque sequence . . .
{ewc GSMVIMG,GSMVIMG, !88263p46.bmp}

88263p46

Figure 103.
. . . a breaker bar, socket and various length extensions are necessary to remove the bolts

{ewc GSMVIMG,GSMVIMG, !88263p47.bmp}

88263p47

Figure 104.
Once all the bolts are removed, break the gasket seal and lift the cylinder head from the block

{ewc GSMVIMG,GSMVIMG, !88263p48.bmp}

88263p48

Figure 105.
Protect the lifter valley and pistons bores using rags or a plastic cover . . .
{ewc GSMVIMG,GSMVIMG, !88263p49.bmp}

88263p49

Figure 106.
. . . then carefully clean the gasket mating surfaces of all old gasket and debris
{ewc GSMVIMG,GSMVIMG, !88263p50.bmp}

88263p50

Figure 107.
Upon installation, tighten the cylinder head bolts using the proper torque sequence

{ewc GSMVIMG,GSMVIMG, !88263p51.bmp}

88263p51

Figure 108.
Exploded view of a typical 4.3L engine cylinder head—1996 shown
{ewc GSMVIMG,GSMVIMG, !88263g52.bmp}

88263g52

Figure 109.
Cylinder head torque sequence—4.3L engines

{ewc GSMVIMG,GSMVIMG, !88263g53.bmp}

88263g53

Figure 110.
Use a gasket scraper to remove the bulk of the old head gasket material from the mating surface . . .

{ewc GSMVIMG,GSMVIMG, !tccs3132.bmp}

tccs3132

Figure 111.
. . . but an electric drill equipped with a wire wheel will expedite complete gasket removal

{ewc GSMVIMG,GSMVIMG, !tccs3133.bmp}

tccs3133

Figure 112.
Clean the combustion chambers using a wire brush—if the valves are removed use care around the valve seats

{ewc GSMVIMG,GSMVIMG, !tccs3802.bmp}

tccs3802

Figure 113.
If the cylinder head is disassembled, use an expandable wire type tool to clean the valve guides

{ewc GSMVIMG,GSMVIMG, !88263g58.bmp}

88263g58

Figure 114.
Check the cylinder head for warpage across each of these surface angles
{ewc GSMVIMG,GSMVIMG, !88263g54.bmp}

88263g54

Figure 115.
Check the cylinder head for flatness across the head surface
{ewc GSMVIMG,GSMVIMG, !tccs3918.bmp}

tccs3918

Figure 116.
Checks should be made both straight across the head and a both diagonals
{ewc GSMVIMG,GSMVIMG, !tccs3919.bmp}

tccs3919

Figure 117.
Compress the valve springs, then remove the valve keys in order to free the assembly . . .

{ewc GSMVIMG,GSMVIMG, !tccs3809.bmp}

tccs3809

Figure 118.
. . . then remove the spring from the valve stem in order to access the seal
{ewc GSMVIMG,GSMVIMG, !tccs3810.bmp}

tccs3810

Figure 119.
Remove the valve stem seal from the cylinder head

{ewc GSMVIMG,GSMVIMG, !tccs3811.bmp}

tccs3811

Figure 120.
Invert the cylinder head and withdraw the valve from the cylinder head bore
{ewc GSMVIMG,GSMVIMG, !tccs3141.bmp}

tccs3141

Figure 121.
A valve spring compressor is necessary to remove the valves—this C-clamp style model can only be used with the cylinder head removed from the engine. Jawed types, such as seen in the photos can also be used with the head installed

{ewc GSMVIMG,GSMVIMG, !88263g57.bmp}

88263g57

Figure 122.
Exploded and cross-sectional view of a common valve component assembly—2.5L engine shown

{ewc GSMVIMG,GSMVIMG, !88263g55.bmp}

88263g55

Figure 123.
Exploded view of early-model 4.3L engine valves and components—late-model similar

{ewc GSMVIMG,GSMVIMG, !88263g56.bmp}

88263g56

Figure 124.
Check the valve for damage or wear in these critical areas
{ewc GSMVIMG,GSMVIMG, !88263g59.bmp}

88263g59

Figure 125.
A valve worn out of specification should be replaced

{ewc GSMVIMG,GSMVIMG, !88263g60.bmp}

88263g60

Figure 126.
Valve stem wear patterns on engines equipped with rotator cups
{ewc GSMVIMG,GSMVIMG, !88263g61.bmp}

88263g61

Figure 127.
A dial gauge may be used to check valve stem-to-guide clearance
{ewc GSMVIMG,GSMVIMG, !tccs3142.bmp}

tccs3142

Figure 128.
Valve stems may be rolled on a flat surface to check for bends
{ewc GSMVIMG,GSMVIMG, !tccs3144.bmp}

tccs3144

Figure 129.
Use a micrometer to check the valve stem diameter

{ewc GSMVIMG,GSMVIMG, !tccs3910.bmp}

tccs3910

Figure 130.
Lapping the valves by hand

{ewc GSMVIMG,GSMVIMG, !88263g62.bmp}

88263g62

Figure 131.
Homemade lapping tool

{ewc GSMVIMG,GSMVIMG, !88263g63.bmp}

88263g63

Figure 132.
With the proper tools, valve springs and stem seals can be replaced with the cylinder head installed

{ewc GSMVIMG,GSMVIMG, !88263p52.bmp}

88263p52

Figure 133.
A lever type or jawed spring compressor can be used with the head installed
{ewc GSMVIMG,GSMVIMG, !88263g64.bmp}

88263g64

Figure 134.
The first step in spring inspection is to measure the installed height
{ewc GSMVIMG,GSMVIMG, !88263g65.bmp}

88263g65

Figure 135.
A special tool is needed to check valve spring pressure

{ewc GSMVIMG,GSMVIMG, !88263g66.bmp}

88263g66

Figure 136.
Use a caliper gauge to check the valve spring free-length

{ewc GSMVIMG,GSMVIMG, !tccs3907.bmp}

tccs3907

Figure 137.
Check the valve spring for squareness on a flat service; a carpenter's square can be used

{ewc GSMVIMG,GSMVIMG, !tccs3908.bmp}

tccs3908

Figure 138.
The valve spring should be straight up and down when placed like this
{ewc GSMVIMG,GSMVIMG, !tccs3909.bmp}

tccs3909

Figure 139.
Machine shops will check valve seat concentricity using a special dial gauge
{ewc GSMVIMG,GSMVIMG, !88263g67.bmp}

88263g67

Figure 140.
Reaming the valve guide for oversize valve stems

{ewc GSMVIMG,GSMVIMG, !88263g68.bmp}

88263g68

Figure 141.
Cross-sectional view of a knurled valve guide

{ewc GSMVIMG,GSMVIMG, !88263g69.bmp}

88263g69

Figure 142.
Exploded view of the hydraulic lifter-to-engine mounting—2.5L engine
{ewc GSMVIMG,GSMVIMG, !88263g70.bmp}

88263g70

Figure 143.
Exploded view of a roller-type hydraulic lifter assembly—2.5L engines and 1987–96 4.3L engines

{ewc GSMVIMG,GSMVIMG, !88263g71.bmp}

88263g71

Figure 144.
Using the GM pliers type lifter removal tool (J-3049) to remove a hydraulic lifter from its bore

{ewc GSMVIMG,GSMVIMG, !88263g72.bmp}

88263g72

Figure 145.
Cross-sectional view of a non-roller hydraulic lifter—roller type similar (except at base)

{ewc GSMVIMG,GSMVIMG, !88263g73.bmp}

88263g73

Figure 146.
Exploded view of the hydraulic roller lifter, retainer and restrictor mounting—1987–93 4.3L engines

{ewc GSMVIMG,GSMVIMG, !88263g74.bmp}

88263g74

Figure 147.
Exploded view of the hydraulic roller lifter and retainer mounting—1994–96 4.3L engines

{ewc GSMVIMG,GSMVIMG, !88263g75.bmp}

88263g75

Figure 148.
To remove the lifters, start by removing the intake manifold and the rocker arm cover

{ewc GSMVIMG,GSMVIMG, !88263p53.bmp}

88263p53

Figure 149.
Remove the bolts from the lifter retainer (this style was used from 1987–93) . . .
{ewc GSMVIMG,GSMVIMG, !88263p54.bmp}

88263p54

Figure 150.
. . . then remove the lifter retainer from the lifter valley
{ewc GSMVIMG,GSMVIMG, !88263p55.bmp}

88263p55

Figure 151.
Remove the restrictor for the lifter(s) you are removing . . .

{ewc GSMVIMG,GSMVIMG, !88263p56.bmp}

88263p56

Figure 152.
. . . then grasp and remove the lifter from the bore

{ewc GSMVIMG,GSMVIMG, !88263p57.bmp}

88263p57

Figure 153.
. . . a magnet is helpful to pull a well oiled lifter from the bore . . .
{ewc GSMVIMG,GSMVIMG, !tccs3812.bmp}

tccs3812

Figure 154.
. . . but a slide hammer type removal tool must be used if the lifter is stuck
{ewc GSMVIMG,GSMVIMG, !tccs3813.bmp}

tccs3813

Figure 155.
Exploded view of a typical oil pan assembly—early-model 4.3L engine shown
{ewc GSMVIMG,GSMVIMG, !88263g76.bmp}

88263g76

Figure 156.
RTV sealant application for the 2.5L engine oil pan

{ewc GSMVIMG,GSMVIMG, !88263g77.bmp}

88263g77

Figure 157.
On most vehicles covered by this manual you will have to unbolt the exhaust pipe for clearance

{ewc GSMVIMG,GSMVIMG, !88263p58.bmp}

88263p58

Figure 158.
Loosen and remove the oil pan retaining bolts (a variety of ratchet extensions will be helpful)

{ewc GSMVIMG,GSMVIMG, !88263p59.bmp}

88263p59

Figure 159.
If equipped, remove the oil pan reinforcements . . .

{ewc GSMVIMG,GSMVIMG, !88263p60.bmp}

88263p60

Figure 160.
. . . then lower the pan from the engine

{ewc GSMVIMG,GSMVIMG, !88263p61.bmp}

88263p61

Figure 161.
CAREFULLY remove the old gasket (on 4.3L engines it can be reused if it is not damaged)

{ewc GSMVIMG,GSMVIMG, !88263p62.bmp}

88263p62

Figure 162.
Exploded view of the oil pan mounting—1996 4.3L engines
{ewc GSMVIMG,GSMVIMG, !88263g78.bmp}

88263g78

Figure 163.
Sealant should be applied to this area during installation—1996 4.3L engines
{ewc GSMVIMG,GSMVIMG, !88263g79.bmp}

88263g79

Figure 164.
Oil pan retainer torque sequence—1996 4.3L engines

{ewc GSMVIMG,GSMVIMG, !88263g80.bmp}

88263g80

Figure 165.
Check the oil pan tolerance (pan-to-transmission clearance) as these 3 points
{ewc GSMVIMG,GSMVIMG, !88263g81.bmp}

88263g81

Figure 166.
Exploded view of the oil filter adapter mounting

{ewc GSMVIMG,GSMVIMG, !88263g84.bmp}

88263g84

Figure 167.
Exploded view of the oil pump mounting—2.5L engine
{ewc GSMVIMG,GSMVIMG, !88263g82.bmp}

88263g82

Figure 168.
Exploded view of the oil pump mounting—4.3L engine (late-model shown)
{ewc GSMVIMG,GSMVIMG, !88263g83.bmp}

88263g83

Figure 169.
Loosen and remove the oil pump retaining bolt(s) . . .

{ewc GSMVIMG,GSMVIMG, !88263p63.bmp}

88263p63

Figure 170.
. . . then remove the pump and extension shaft from the engine
{ewc GSMVIMG,GSMVIMG, !88263p64.bmp}

88263p64

Figure 171.
On some models you will have to remove the damper hub-to-crankshaft bolt before the pulley

{ewc GSMVIMG,GSMVIMG, !88263p65.bmp}

88263p65

Figure 172.
The hub bolt on this 4.3L engine has a LARGE flat washer which spreads the clamp load on the pulley

{ewc GSMVIMG,GSMVIMG, !88263p66.bmp}

88263p66

Figure 173.
Loosen and remove the retaining bolts around the perimeter of the pulley face . . .
{ewc GSMVIMG,GSMVIMG, !88263p67.bmp}

88263p67

Figure 174.
. . . then remove the pulley from the damper

{ewc GSMVIMG,GSMVIMG, !88263p68.bmp}

88263p68

Figure 175.
Use a suitable (NON-JAWED) puller to loosen the damper on the crankshaft
{ewc GSMVIMG,GSMVIMG, !88263p69.bmp}

88263p69

Figure 176.
Once loosened, the damper is easily removed

{ewc GSMVIMG,GSMVIMG, !88263p70.bmp}

88263p70

Figure 177.
Use an appropriate torsional damper puller to remove the damper from the crankshaft

{ewc GSMVIMG,GSMVIMG, !88263g85.bmp}

88263g85

Figure 178.
The torsional damper installer is designed to gently draw the damper into position without damaging the hub

{ewc GSMVIMG,GSMVIMG, !88263g87.bmp}

88263g87

Figure 179.
Install replacement front oil seals using a suitable driver (such as J-35468)
{ewc GSMVIMG,GSMVIMG, !88263g86.bmp}

88263g86

Figure 180.
If necessary, drive a new oil seal into place before reinstalling the damper
{ewc GSMVIMG,GSMVIMG, !88263p71.bmp}

88263p71

Figure 181.
Exploded view of the crankshaft pulley, damper/hub and timing gear cover assembly—2.5L engine

{ewc GSMVIMG,GSMVIMG, !88263g88.bmp}

88263g88

Figure 182.
Apply RTV sealer to the timing gear cover as shown

{ewc GSMVIMG,GSMVIMG, !88263g89.bmp}

88263g89

Figure 183.
GM seal installer and centering tool

{ewc GSMVIMG,GSMVIMG, !88263g90.bmp}

88263g90

Figure 184.
Loosen and remove the timing cover retaining bolts . . .

{ewc GSMVIMG,GSMVIMG, !88263p72.bmp}

88263p72

Figure 185.
. . . then carefully break the gasket seal and . . .

{ewc GSMVIMG,GSMVIMG, !88263p73.bmp}

88263p73

Figure 186.
. . . remove the cover from the engine

{ewc GSMVIMG,GSMVIMG, !88263p74.bmp}

88263p74

Figure 187.
If you install a replacement front seal with the cover OFF the engine, BE SURE TO SUPPORT IT to prevent damage

{ewc GSMVIMG,GSMVIMG, !88263g91.bmp}

88263g91

Figure 188.
Exploded view of a typical 4.3L engine timing chain and gear assembly—use of studs may vary

{ewc GSMVIMG,GSMVIMG, !88263g93.bmp}

88263g93

Figure 189.
Align the timing marks closest together (No. 4 TDC) before starting—NOTE that No. 1 TDC would be aligned, but with both timing marks at top of their travel

{ewc GSMVIMG,GSMVIMG, !88263g92.bmp}

88263g92

Figure 190.
Remove the timing cover, then turn the crankshaft as necessary to align the timing marks

{ewc GSMVIMG,GSMVIMG, !88263p75.bmp}

88263p75

Figure 191.
Loosen and remove the camshaft sprocket retaining bolts . . .
{ewc GSMVIMG,GSMVIMG, !88263p76.bmp}

88263p76

Figure 192.
. . . then remove the camshaft sprocket along with the timing chain
{ewc GSMVIMG,GSMVIMG, !88263p77.bmp}

88263p77

Figure 193.
If necessary, use a suitable puller to remove the crankshaft sprocket
{ewc GSMVIMG,GSMVIMG, !88263p78.bmp}

88263p78

Figure 194.
GM crankshaft sprocket removal tool

{ewc GSMVIMG,GSMVIMG, !88263g94.bmp}

88263g94

Figure 195.
Use the GM installation tool (or a suitable driver) to install the crankshaft sprocket
{ewc GSMVIMG,GSMVIMG, !88263g95.bmp}

88263g95

Figure 196.
The timing gear must be pressed from the camshaft using a suitable arbor press, driver and gear support

{ewc GSMVIMG,GSMVIMG, !88263g96.bmp}

88263g96

Figure 197.
Once the gear is pressed onto the camshaft, check the end clearance at the thrust plate using a feeler gauge

{ewc GSMVIMG,GSMVIMG, !88263g97.bmp}

88263g97

Figure 198.
Aligning the timing gear marks—2.5L engine

{ewc GSMVIMG,GSMVIMG, !88263g98.bmp}

88263g98

Figure 199.
Remove the camshaft-to-engine thrust plate bolts through the access hole in the gear—2.5L engine

{ewc GSMVIMG,GSMVIMG, !88263g99.bmp}

88263g99

Figure 200.
Using bolts as a handle, pull STRAIGHT back and carefully remove the camshaft from the engine

{ewc GSMVIMG,GSMVIMG, !88263ga1.bmp}

88263ga1

Figure 201.
Exploded view of the camshaft and other cylinder block component mounting—VIN W shown (VIN B, N or Z similar, but without balance shaft)

{ewc GSMVIMG,GSMVIMG, !88263ga2.bmp}

88263ga2

Figure 202.
Use a dial indicator to measure the camshaft for straightness (camshaft runout)
{ewc GSMVIMG,GSMVIMG, !88263ga3.bmp}

88263ga3

Figure 203.
Subtract measurement B from measurement A (width from height) in order to determine camshaft lobe lift

{ewc GSMVIMG,GSMVIMG, !88263ga4.bmp}

88263ga4

Figure 204.
A dial gauge can be used to measure lobe lift with the camshaft installed
{ewc GSMVIMG,GSMVIMG, !88263ga5.bmp}

88263ga5

Figure 205.
Camshaft bearing replacement requires special bearing removal and installation tools—2.5L engine

{ewc GSMVIMG,GSMVIMG, !88263ga6.bmp}

88263ga6

Figure 206.
Special camshaft bearing removal and installation tools are necessary to replace the camshaft bearings

{ewc GSMVIMG,GSMVIMG, !88263ga7.bmp}

88263ga7

Figure 207.
It is CRITICAL that the camshaft bearing oil holes are properly aligned. This wire tool has a 90º bend to help check for proper oil hole alignment

{ewc GSMVIMG,GSMVIMG, !88263ga8.bmp}

88263ga8

Figure 208.
Balance shaft drive (lower) and driven (upper) gears
{ewc GSMVIMG,GSMVIMG, !88263gb7.bmp}

88263gb7

Figure 209.
Exploded view of the balance shaft mounting—VIN W engine
{ewc GSMVIMG,GSMVIMG, !88263ga9.bmp}

88263ga9

Figure 210.
Remove the balance shaft using a soft-faced mallet

{ewc GSMVIMG,GSMVIMG, !88263gb1.bmp}

88263gb1

Figure 211.
GM shaft service kit, set-up to remove the shaft rear bearing

{ewc GSMVIMG,GSMVIMG, !88263gb2.bmp}

88263gb2

Figure 212.
Removing the shaft rear bearing using the service kit

{ewc GSMVIMG,GSMVIMG, !88263gb3.bmp}

88263gb3

Figure 213.
Installing the balance shaft rear bearing

{ewc GSMVIMG,GSMVIMG, !88263gb4.bmp}

88263gb4

Figure 214.
Using the shaft installer and driver handle to drive the shaft into position
{ewc GSMVIMG,GSMVIMG, !88263gb5.bmp}

88263gb5

Figure 215.
Balance shaft drive and driven gear timing mark alignment

{ewc GSMVIMG,GSMVIMG, !88263gb6.bmp}

88263gb6

Figure 216.
Normal cylinder wear and ridge formation

{ewc GSMVIMG,GSMVIMG, !88263gb8.bmp}

88263gb8

Figure 217.
Place hose over the connecting rod studs to protect the crankshaft and cylinders from damage

{ewc GSMVIMG,GSMVIMG, !tccs3803.bmp}

tccs3803

Figure 218.
Carefully tap the piston out of the bore using a wooden dowel
{ewc GSMVIMG,GSMVIMG, !tccs3804.bmp}

tccs3804

Figure 219.
Use a ring expander tool to remove the piston rings

{ewc GSMVIMG,GSMVIMG, !tccs3211.bmp}

tccs3211

Figure 220.
Clean the piston grooves using a ring groove cleaner

{ewc GSMVIMG,GSMVIMG, !tccs3208.bmp}

tccs3208

Figure 221.
You can use a piece of an old ring to clean the piston grooves, BUT be careful, the ring is sharp

{ewc GSMVIMG,GSMVIMG, !tccs3911.bmp}

tccs3911

Figure 222.
Measure the piston's outer diameter using a micrometer

{ewc GSMVIMG,GSMVIMG, !tccs3210.bmp}

tccs3210

Figure 223.
Cylinder bore measuring points

{ewc GSMVIMG,GSMVIMG, !88263gb9.bmp}

88263gb9

Figure 224.
Measuring the cylinder bore using a dial indicator

{ewc GSMVIMG,GSMVIMG, !88263gc1.bmp}

88263gc1

Figure 225.
A telescoping gauge may also be used to measure the cylinder bore diameter
{ewc GSMVIMG,GSMVIMG, !tccs3209.bmp}

tccs3209

Figure 226.
Correct cylinder bore honing pattern

{ewc GSMVIMG,GSMVIMG, !88263gc2.bmp}

88263gc2

Figure 227.
Removing cylinder glazing using a flexible hone

{ewc GSMVIMG,GSMVIMG, !tccs3213.bmp}

tccs3213

Figure 228.
A solid hone can also be used to cross-hatch the cylinder bore
{ewc GSMVIMG,GSMVIMG, !tccs3915.bmp}

tccs3915

Figure 229.
As with a ball hone, work the hone carefully up and down the bore to achieve the desired results

{ewc GSMVIMG,GSMVIMG, !tccs3916.bmp}

tccs3916

Figure 230.
A properly cross-hatched cylinder bore

{ewc GSMVIMG,GSMVIMG, !tccs3216.bmp}

tccs3216

Figure 231.
Remove the piston pin from the piston using an arbor press and suitable removal driver

{ewc GSMVIMG,GSMVIMG, !88263gc3.bmp}

88263gc3

Figure 232.
The piston pin is installed to the piston using the press and a suitable installer driver

{ewc GSMVIMG,GSMVIMG, !88263gc4.bmp}

88263gc4

Figure 233.
Exploded view of a piston and ring assembly

{ewc GSMVIMG,GSMVIMG, !88263gc5.bmp}

88263gc5

Figure 234.
Checking the ring-to-ring groove clearance (ring side clearance)
{ewc GSMVIMG,GSMVIMG, !tccs3923.bmp}

tccs3923

Figure 235.
Most rings are marked to show which side should face upward
{ewc GSMVIMG,GSMVIMG, !tccs3222.bmp}

tccs3222

Figure 236.
Upon assembly, make sure the piston gaps are properly arranged
{ewc GSMVIMG,GSMVIMG, !88263gc9.bmp}

88263gc9

Figure 237.
Ring end-gap is checked using a feeler gauge, after the ring is carefully inserted, square into the bore

{ewc GSMVIMG,GSMVIMG, !88263gc6.bmp}

88263gc6

Figure 238.
To check bearing clearance, apply a strip of gauging material to the bearing shell, then install and tighten the bearing cap . . .

{ewc GSMVIMG,GSMVIMG, !88263gc7.bmp}

88263gc7

Figure 239.
. . . after tightening to specification, remove the bearing cap and compare the thickness of the material to the scale provided

{ewc GSMVIMG,GSMVIMG, !88263gc8.bmp}

88263gc8

Figure 240.
You can apply the gauging material to bearing journal (shown) or to the bearing shell

{ewc GSMVIMG,GSMVIMG, !tccs3243.bmp}

tccs3243

Figure 241.
Even if it was applied to the journal, it may wind up on the cap shell after it is tightened

{ewc GSMVIMG,GSMVIMG, !tccs3912.bmp}

tccs3912

Figure 242.
Install the pistons facing the proper direction (as noted during removal)—If present, a notch usually faces to the front of the engine

{ewc GSMVIMG,GSMVIMG, !88263gd1.bmp}

88263gd1

Figure 243.
Most pistons are marked to indicate in engine positioning (usually a mark means front)

{ewc GSMVIMG,GSMVIMG, !tccs3814.bmp}

tccs3814

Figure 244.
Installing the piston into the block using a ring compressor and the handle of a hammer

{ewc GSMVIMG,GSMVIMG, !tccs3914.bmp}

tccs3914

Figure 245.
After installation, check the connecting rod side clearance by CAREFULLY spreading the rods and inserting a feeler gauge

{ewc GSMVIMG,GSMVIMG, !88263gd2.bmp}

88263gd2

Figure 246.
Engine block heater—located in the engine block freeze plug bore
{ewc GSMVIMG,GSMVIMG, !88263gd3.bmp}

88263gd3

Figure 247.
The freeze plug can be loosened using a punch (or chisel) and hammer
{ewc GSMVIMG,GSMVIMG, !tccs3905.bmp}

tccs3905

Figure 248.
Once the freeze plug has been loosened, it can be removed from the block
{ewc GSMVIMG,GSMVIMG, !tccs3906.bmp}

tccs3906

Figure 249.
The rear main seal should be installed using J-34924, or an equivalent installation tool—2.5L engine

{ewc GSMVIMG,GSMVIMG, !88263gd4.bmp}

88263gd4

Figure 250.
Remove the lower half of the rear main seal from the main bearing cap—1985 4.3L engines

{ewc GSMVIMG,GSMVIMG, !88263gd5.bmp}

88263gd5

Figure 251.
Carefully drive the upper half of the seal from the engine block
{ewc GSMVIMG,GSMVIMG, !88263gd6.bmp}

88263gd6

Figure 252.
You can make a rear main seal installation tool using these dimensions
{ewc GSMVIMG,GSMVIMG, !88263gd7.bmp}

88263gd7

Figure 253.
Apply RTV sealant to the rear main cap-to-case mounting surface
{ewc GSMVIMG,GSMVIMG, !88263gd8.bmp}

88263gd8

Figure 254.
Exploded view of the rear main oil seal retainer mounting—4.3L engine (NOTE the retainer does NOT have to be removed in order to replace the seal)

{ewc GSMVIMG,GSMVIMG, !88263gd9.bmp}

88263gd9

Figure 255.
Carefully pry the seal from the retainer using a small prytool at the notches provided in the retainer

{ewc GSMVIMG,GSMVIMG, !88263ge1.bmp}

88263ge1

Figure 256.
A threaded seal installation tool such as J-35621 is necessary to properly seat the new seal

{ewc GSMVIMG,GSMVIMG, !88263ge2.bmp}

88263ge2

Figure 257.
Place hose over the connecting rod studs to protect the crankshaft and cylinders from damage

{ewc GSMVIMG,GSMVIMG, !tccs3803.bmp}

tccs3803

Figure 258.
Support the connecting rods with rubber bands and install rubber rod bolt caps to protect the crankshaft during removal and installation

{ewc GSMVIMG,GSMVIMG, !85383363.bmp}

85383363

Figure 259.
Plastigage® or an equivalent gauging material should be used to check main bearing clearances

{ewc GSMVIMG,GSMVIMG, !88263ge5.bmp}

88263ge5

Figure 260.
You can use a feeler gauge to check the crankshaft end-play during installation
{ewc GSMVIMG,GSMVIMG, !88263ge3.bmp}

88263ge3

Figure 261.
Align the thrust bearing (as illustrated), then tighten the main bearing caps to specification

{ewc GSMVIMG,GSMVIMG, !88263ge4.bmp}

88263ge4

Figure 262.
A dial gauge may be used to check crankshaft end-play
{ewc GSMVIMG,GSMVIMG, !tccs3805.bmp}

tccs3805

Figure 263.
Carefully pry the shaft back and forth while reading the dial gauge for play
{ewc GSMVIMG,GSMVIMG, !tccs3806.bmp}

tccs3806

Figure 264.
A dial gauge may also be used to check crankshaft run-out

{ewc GSMVIMG,GSMVIMG, !tccs3807.bmp}

tccs3807

Figure 265.
Mounting a dial gauge to read crankshaft run-out
{ewc GSMVIMG,GSMVIMG, !tccs3815.bmp}

tccs3815

Figure 266.
Turn the crankshaft slowly by hand while checking the gauge
{ewc GSMVIMG,GSMVIMG, !tccs3808.bmp}

tccs3808

Figure 267.
A roll-out pin can be fabricated from a cotter pin and used to replace bearings with the crankshaft installed

{ewc GSMVIMG,GSMVIMG, !88263ge6.bmp}

88263ge6

Figure 268.
Exploded view of a typical Astro and Safari flywheel mounting—flexplate mounting similar, but without a clutch and pressure plate assembly

{ewc GSMVIMG,GSMVIMG, !88263ge7.bmp}

88263ge7

Figure 269.
Exhaust system components—2.5L engine

{ewc GSMVIMG,GSMVIMG, !88263ge8.bmp}

88263ge8

Figure 270.
Exhaust system components—early-model 4.3L (VIN B, N and Z) engines

{ewc GSMVIMG,GSMVIMG, !88263ge9.bmp}

88263ge9

Figure 271.
Exhaust system components—late-model 4.3L (VIN Z) engines
{ewc GSMVIMG,GSMVIMG, !88263gf1.bmp}

88263gf1

Figure 272.
Exhaust system components—early-model 4.3L (VIN W) engines, except California emissions

{ewc GSMVIMG,GSMVIMG, !88263gf2.bmp}

88263gf2

Figure 273.
Exhaust system components—early-model 4.3L (VIN W) engines with California emissions

{ewc GSMVIMG,GSMVIMG, !88263gf4.bmp}

88263gf4

Figure 274.
Exhaust system components—1996 4.3L (VIN W) engines (1995 similar, except usually equipped with slip-joint at rear of converter)

{ewc GSMVIMG,GSMVIMG, !88263gf3.bmp}

88263gf3

Figure 275.
A deep socket is usually VERY helpful when trying to loosen exhaust pipe studs
{ewc GSMVIMG,GSMVIMG, !88263p79.bmp}

88263p79

Figure 276.
Exploded view of a converter pipe-to-manifold connection
{ewc GSMVIMG,GSMVIMG, !88263gf5.bmp}

88263gf5

Figure 277.
Catalytic converter pipe-to-exhaust manifold tightening sequence—1996 models
{ewc GSMVIMG,GSMVIMG, !88263gf6.bmp}

88263gf6

Figure 1.
PCV flow in the 2.5L engine

{ewc GSMVIMG,GSMVIMG, !88264g01.bmp}

88264g01

Figure 2.
PCV flow in the 4.3L engine

{ewc GSMVIMG,GSMVIMG, !88264g02.bmp}

88264g02

Figure 3.
Cross-section of the PCV valve

{ewc GSMVIMG,GSMVIMG, !88264g00.bmp}

88264g00

Figure 4.
PCV system—2.5L engine

{ewc GSMVIMG,GSMVIMG, !88264g03.bmp}

88264g03

Figure 5.
PCV system—4.3L CMFI/CSFI engine

{ewc GSMVIMG,GSMVIMG, !88264g06.bmp}

88264g06

Figure 6.
PCV system—4.3L carbureted engine

{ewc GSMVIMG,GSMVIMG, !88264g04.bmp}

88264g04

Figure 7.
PCV system—4.3L TBI engine

{ewc GSMVIMG,GSMVIMG, !88264g05.bmp}

88264g05

Figure 8.
Sample of the emissions related hose routing sticker found on most vehicles
{ewc GSMVIMG,GSMVIMG, !88264p01.bmp}

88264p01

Figure 9.
The emissions label under the hood has all of the information pertinent to that vehicle on it

{ewc GSMVIMG,GSMVIMG, !88264p02.bmp}

88264p02

Figure 10.
Evaporative emission system—4.3L carbureted engine

{ewc GSMVIMG,GSMVIMG, !88264g07.bmp}

88264g07

Figure 11.
Canister purge vacuum switch—4.3L CSFI engine

{ewc GSMVIMG,GSMVIMG, !88264g20.bmp}

88264g20

Figure 12.
Typical canister mounting—it has two hoses attached with a third nipple blocked-off

{ewc GSMVIMG,GSMVIMG, !88264p03.bmp}

88264p03

Figure 13.
Fuel vapor canister—4.3L carbureted engine

{ewc GSMVIMG,GSMVIMG, !88264g08.bmp}

88264g08

Figure 14.
Evaporative emission system—2.5L engine

{ewc GSMVIMG,GSMVIMG, !88264g09.bmp}

88264g09

Figure 15.
Fuel vapor canister—2.5L engine

{ewc GSMVIMG,GSMVIMG, !88264g10.bmp}

88264g10

Figure 16.
Evaporative emission system—4.3L TBI engine

{ewc GSMVIMG,GSMVIMG, !88264g11.bmp}

88264g11

Figure 17.
Fuel vapor canister—4.3L TBI engine

{ewc GSMVIMG,GSMVIMG, !88264g12.bmp}

88264g12

Figure 18.
Some vapor canisters may have 3 projections yet only 2 are connected to the internals

{ewc GSMVIMG,GSMVIMG, !88264g13.bmp}

88264g13

Figure 19.
Evaporative emission system—4.3L CMFI engine

{ewc GSMVIMG,GSMVIMG, !88264g14.bmp}

88264g14

Figure 20.
Fuel vapor canister—4.3L CMFI engine

{ewc GSMVIMG,GSMVIMG, !88264g15.bmp}

88264g15

Figure 21.
Cutaway section of the fuel tank pressure control valve

{ewc GSMVIMG,GSMVIMG, !88264g24.bmp}

88264g24

Figure 22.
Typical vapor canister mounting—except 1996 models

{ewc GSMVIMG,GSMVIMG, !88264g17.bmp}

88264g17

Figure 23.
Typical vapor canister mounting—1996 models

{ewc GSMVIMG,GSMVIMG, !88264g21.bmp}

88264g21

Figure 24.
Vapor canister connections—1996 models

{ewc GSMVIMG,GSMVIMG, !88264g22.bmp}

88264g22

Figure 25.
Removing the canister purge solenoid—4.3L TBI engine

{ewc GSMVIMG,GSMVIMG, !88264g16.bmp}

88264g16

Figure 26.
Removing the canister purge solenoid—4.3L CMFI engine

{ewc GSMVIMG,GSMVIMG, !88264g23.bmp}

88264g23

Figure 27.
Removing the canister purge solenoid—4.3L CSFI engine
{ewc GSMVIMG,GSMVIMG, !88264g19.bmp}

88264g19

Figure 28.
Valve, actuator and TVS—4.3L carbureted engine

{ewc GSMVIMG,GSMVIMG, !88264g25.bmp}

88264g25

Figure 29.
Thermal vacuum switch port identification

{ewc GSMVIMG,GSMVIMG, !88264g27.bmp}

88264g27

Figure 30.
Thermal vacuum switch location—49 state models

{ewc GSMVIMG,GSMVIMG, !88264g28.bmp}

88264g28

Figure 31.
Thermal vacuum switch location—California models
{ewc GSMVIMG,GSMVIMG, !88264g29.bmp}

88264g29

Figure 32.
EFE valve and actuator assembly mounting

{ewc GSMVIMG,GSMVIMG, !88264g26.bmp}

88264g26

Figure 33.
EGR valve identification

{ewc GSMVIMG,GSMVIMG, !88264g30.bmp}

88264g30

Figure 34.
Linear EGR valve identification

{ewc GSMVIMG,GSMVIMG, !88264g34.bmp}

88264g34

Figure 35.
Flow diagram of the EGR valve

{ewc GSMVIMG,GSMVIMG, !88264g31.bmp}

88264g31

Figure 36.
Cutaway drawing of a negative pack pressure EGR valve

{ewc GSMVIMG,GSMVIMG, !88264g32.bmp}

88264g32

Figure 37.
Cutaway drawing of a linear EGR valve

{ewc GSMVIMG,GSMVIMG, !88264g33.bmp}

88264g33

Figure 38.
EGR system controlled by TVS

{ewc GSMVIMG,GSMVIMG, !88264g35.bmp}

88264g35

Figure 39.
EGR system controlled by solenoid valve and ECM

{ewc GSMVIMG,GSMVIMG, !88264g36.bmp}

88264g36

Figure 40.
EGR control solenoid

{ewc GSMVIMG,GSMVIMG, !88264g39.bmp}

88264g39

Figure 41.
Linear EGR valve pinouts—with CMFI/CSFI

{ewc GSMVIMG,GSMVIMG, !88264g38.bmp}

88264g38

Figure 42.
Linear EGR valve pinouts—with TBI

{ewc GSMVIMG,GSMVIMG, !88264g41.bmp}

88264g41

Figure 43.
EGR mounting—2.5L engine

{ewc GSMVIMG,GSMVIMG, !88264g43.bmp}

88264g43

Figure 44.
EGR mounting—4.3L TBI engine

{ewc GSMVIMG,GSMVIMG, !88264g44.bmp}

88264g44

Figure 45.
EGR mounting—4.3L CMFI engine

{ewc GSMVIMG,GSMVIMG, !88264g40.bmp}

88264g40

Figure 46.
EGR mounting—4.3L CSFI engine

{ewc GSMVIMG,GSMVIMG, !88264g45.bmp}

88264g45

Figure 47.
Disconnect the vacuum hose and tag it for identification
{ewc GSMVIMG,GSMVIMG, !88264p04.bmp}

88264p04

Figure 48.
A distributor wrench makes accessing the mounting hardware much easier
{ewc GSMVIMG,GSMVIMG, !88264p05.bmp}

88264p05

Figure 49.
Pull the EGR valve away along with the old gasket

{ewc GSMVIMG,GSMVIMG, !88264p06.bmp}

88264p06

Figure 50.
Always use a new gasket when installing. Notice that this one is burned in the center

{ewc GSMVIMG,GSMVIMG, !88264p07.bmp}

88264p07

Figure 51.
EGR and TVS connections—4.3L carbureted engine

{ewc GSMVIMG,GSMVIMG, !88264g37.bmp}

88264g37

Figure 52.
EGR valve and solenoid—4.3L carbureted engine

{ewc GSMVIMG,GSMVIMG, !88264g42.bmp}

88264g42

Figure 53.
EGR valve and solenoid—2.5L engine

{ewc GSMVIMG,GSMVIMG, !88264g46.bmp}

88264g46

Figure 54.
EGR valve and solenoid—4.3L TBI engine

{ewc GSMVIMG,GSMVIMG, !88264g47.bmp}

88264g47

Figure 55.
Diverter valve—4.3L 49 states carbureted engine

{ewc GSMVIMG,GSMVIMG, !88264g48.bmp}

88264g48

Figure 56.
Air control valve—4.3L California carbureted engine

{ewc GSMVIMG,GSMVIMG, !88264g49.bmp}

88264g49

Figure 57.
Deceleration control valve airflow

{ewc GSMVIMG,GSMVIMG, !88264g50.bmp}

88264g50

Figure 58.
AIR system—4.3L TBI engine

{ewc GSMVIMG,GSMVIMG, !88264g51.bmp}

88264g51

Figure 59.
Electric air control valve—4.3L TBI engine

{ewc GSMVIMG,GSMVIMG, !88264g52.bmp}

88264g52

Figure 60.
AIR system components

{ewc GSMVIMG,GSMVIMG, !88264g53.bmp}

88264g53

Figure 61.
AIR pump mounting

{ewc GSMVIMG,GSMVIMG, !88264g54.bmp}

88264g54

Figure 62.
Deceleration valve mounting

{ewc GSMVIMG,GSMVIMG, !88264g55.bmp}

88264g55

Figure 63.
AIR pump filter replacement

{ewc GSMVIMG,GSMVIMG, !88264g56.bmp}

88264g56

Figure 64.
Thermal air cleaner operation modes

{ewc GSMVIMG,GSMVIMG, !88264g57.bmp}

88264g57

Figure 65.
Thermal air cleaner components

{ewc GSMVIMG,GSMVIMG, !88264g58.bmp}

88264g58

Figure 66.
Component locations of carbureted engine emissions devices

{ewc GSMVIMG,GSMVIMG, !88264g59.bmp}

88264g59

Figure 67.
Engine harness connector and component locations

{ewc GSMVIMG,GSMVIMG, !88264g69.bmp}

88264g69

Figure 68.
ECM terminal voltages for carbureted engine

{ewc GSMVIMG,GSMVIMG, !88264g60.bmp}

88264g60

Figure 69.
ECM mounting scheme

{ewc GSMVIMG,GSMVIMG, !88264g61.bmp}

88264g61

Figure 70.
The oxygen sensor is shaped like a spark plug and is located in the exhaust pipe
{ewc GSMVIMG,GSMVIMG, !88264g62.bmp}

88264g62

Figure 71.
Oxygen sensor mounting location

{ewc GSMVIMG,GSMVIMG, !88264g63.bmp}

88264g63

Figure 72.
Engine coolant temperature sensor

{ewc GSMVIMG,GSMVIMG, !88264g64.bmp}

88264g64

Figure 73.
Coolant temperature sensor resistance chart

{ewc GSMVIMG,GSMVIMG, !88264g65.bmp}

88264g65

Figure 74.
Differential pressure sensor wiring schematic

{ewc GSMVIMG,GSMVIMG, !88264gA5.bmp}

88264gA5

Figure 75.
Differential pressure sensor mounting

{ewc GSMVIMG,GSMVIMG, !88264g66.bmp}

88264g66

Figure 76.
The knock sensor informs the ECM when engine knock is occurring by producing a voltage via a piezoelectric crystal inside the housing

{ewc GSMVIMG,GSMVIMG, !88264g67.bmp}

88264g67

Figure 77.
Engine knock sensor mounting location

{ewc GSMVIMG,GSMVIMG, !88264g68.bmp}

88264g68

Figure 78.
ECM mounting scheme—except 1996 models

{ewc GSMVIMG,GSMVIMG, !88264g71.bmp}

88264g71

Figure 79.
ECM mounting scheme—1996 models

{ewc GSMVIMG,GSMVIMG, !88264g70.bmp}

88264g70

Figure 80.
Heated oxygen sensor components

{ewc GSMVIMG,GSMVIMG, !88264g72.bmp}

88264g72

Figure 81.
Oxygen sensor mounting—2.5L engine

{ewc GSMVIMG,GSMVIMG, !88264g73.bmp}

88264g73

Figure 82.
Oxygen sensor mounting (common location)—4.3L engine except 1996 models
{ewc GSMVIMG,GSMVIMG, !88264g74.bmp}

88264g74

Figure 83.
Oxygen sensor mounting (alternative location)—4.3L engine except 1996 models
{ewc GSMVIMG,GSMVIMG, !88264g75.bmp}

88264g75

Figure 84.
Oxygen sensor mounting locations—1996 4.3L engine

{ewc GSMVIMG,GSMVIMG, !88264g76.bmp}

88264g76

Figure 85.
This oxygen sensor wrench has a cut out to allow the wires to pass through
{ewc GSMVIMG,GSMVIMG, !88264p08.bmp}

88264p08

Figure 86.
Do not contaminate the tip of the oxygen sensor or the accuracy of the sensor will be affected

{ewc GSMVIMG,GSMVIMG, !88264p09.bmp}

88264p09

Figure 87.
Crankshaft position sensor

{ewc GSMVIMG,GSMVIMG, !88264g77.bmp}

88264g77

Figure 88.
The mass air flow sensor directly measures the amount of air entering the engine
{ewc GSMVIMG,GSMVIMG, !88264g78.bmp}

88264g78

Figure 89.
This style MAF sensor is mounted directly behind the air cleaner assembly
{ewc GSMVIMG,GSMVIMG, !88264p11.bmp}

88264p11

Figure 90.
Dirty contacts can cause the MAF to send bad signals to the ECM, so check it before installation

{ewc GSMVIMG,GSMVIMG, !88264p12.bmp}

88264p12

Figure 91.
Engine coolant temperature sensors are always mounted in a coolant passage, usually near the thermostat

{ewc GSMVIMG,GSMVIMG, !88264g79.bmp}

88264g79

Figure 92.
Engine coolant temperature sensor resistance chart

{ewc GSMVIMG,GSMVIMG, !88264g65.bmp}

88264g65

Figure 93.
The ECT is mounted in the intake manifold next to the thermostat housing on the V6 TBI engines

{ewc GSMVIMG,GSMVIMG, !88264g80.bmp}

88264g80

Figure 94.
The ECT is mounted in the lower intake manifold in the thermostat housing on the V6 engines

{ewc GSMVIMG,GSMVIMG, !88264g81.bmp}

88264g81

Figure 95.
Typical intake air temperature sensor

{ewc GSMVIMG,GSMVIMG, !88264g82.bmp}

88264g82

Figure 96.
Intake air temperature sensor resistance chart

{ewc GSMVIMG,GSMVIMG, !88264g65.bmp}

88264g65

Figure 97.
The intake air temperature sensor pushes into the intake duct on the CMFI engines
{ewc GSMVIMG,GSMVIMG, !88264g83.bmp}

88264g83

Figure 98.
The intake air temperature sensor screws into the intake manifold on the 4–cylinder engine

{ewc GSMVIMG,GSMVIMG, !88264g84.bmp}

88264g84

Figure 99.
Intake air temperature sensor location on 1996 CSFI engine
{ewc GSMVIMG,GSMVIMG, !88264p10.bmp}

88264p10

Figure 100.
Internal workings of a TPS

{ewc GSMVIMG,GSMVIMG, !88264gA3.bmp}

88264gA3

Figure 101.
Most testing of the TPS can be done while it is still mounted on the throttle body
{ewc GSMVIMG,GSMVIMG, !88264p13.bmp}

88264p13

Figure 102.
Throttle position sensor—TBI 700 and CMFI

{ewc GSMVIMG,GSMVIMG, !88264gA4.bmp}

88264gA4

Figure 103.
Throttle position sensor—TBI 220

{ewc GSMVIMG,GSMVIMG, !88264g85.bmp}

88264g85

Figure 104.
Throttle position sensor—CSFI

{ewc GSMVIMG,GSMVIMG, !88264g86.bmp}

88264g86

Figure 105.
Even though the TPS is not adjustable, marking its location before removal is a good idea

{ewc GSMVIMG,GSMVIMG, !88264p14.bmp}

88264p14

Figure 106.
Use the correct size bit in the mounting screws. This one just might strip out the screw

{ewc GSMVIMG,GSMVIMG, !88264p15.bmp}

88264p15

Figure 107.
Common GM style MAP sensor

{ewc GSMVIMG,GSMVIMG, !88264g87.bmp}

88264g87

Figure 108.
MAP sensor mounting—2.5L engine

{ewc GSMVIMG,GSMVIMG, !88264g88.bmp}

88264g88

Figure 109.
MAP sensor mounting—4.3L engine, except 1996

{ewc GSMVIMG,GSMVIMG, !88264g89.bmp}

88264g89

Figure 110.
MAP sensor mounting—1996 4.3L engine

{ewc GSMVIMG,GSMVIMG, !88264g90.bmp}

88264g90

Figure 111.
Vehicle speed sensor mounting

{ewc GSMVIMG,GSMVIMG, !88264g91.bmp}

88264g91

Figure 112.
Knock sensor locations—4.3L engine except 1996

{ewc GSMVIMG,GSMVIMG, !88264g92.bmp}

88264g92

Figure 113.
Knock sensor location—1996 4.3L engine

{ewc GSMVIMG,GSMVIMG, !88264g93.bmp}

88264g93

Figure 114.
Example of scan tool data and typical or baseline values

{ewc GSMVIMG,GSMVIMG, !84904059.bmp}

84904059

Figure 115.
Different types of computerized test equipment are available from aftermarket tool manufacturers

{ewc GSMVIMG,GSMVIMG, !tccs4P07.bmp}

tccs4P07

Figure 116.
Inexpensive scan tools, such as this Auto Xray®, can interface with your General Motors vehicle

{ewc GSMVIMG,GSMVIMG, !tccs4P12.bmp}

tccs4P12

Figure 117.
The ALDL connector is also known as the DLC

{ewc GSMVIMG,GSMVIMG, !88264ga0.bmp}

88264ga0

Figure 118.
Carbureted engine trouble codes

{ewc GSMVIMG,GSMVIMG, !88264g94.bmp}

88264g94

Figure 119.
Fuel injected engine trouble codes through 1995, except with 4L60E and 4L80E transmissions

{ewc GSMVIMG,GSMVIMG, !88264g95.bmp}

88264g95

Figure 120.
Fuel injected engine trouble codes through 1995 with 4L60E transmissions
{ewc GSMVIMG,GSMVIMG, !88264g96.bmp}

88264g96

Figure 121.
Fuel injected engine trouble codes through 1995 with 4L60E transmissions (continued)

{ewc GSMVIMG,GSMVIMG, !88264g97.bmp}

88264g97

Figure 122.
Trouble code list for 1996 gasoline engines

{ewc GSMVIMG,GSMVIMG, !88264g98.bmp}

88264g98

Figure 123.
Trouble code list for 1996 gasoline engines (continued)

{ewc GSMVIMG,GSMVIMG, !88264g99.bmp}

88264g99

Figure 124.
Vacuum hose routing—1985–87 with 2.5L TBI engine

{ewc GSMVIMG,GSMVIMG, !88264v01.bmp}

88264v01

Figure 125.
Vacuum hose routing—1988–90 with 2.5L TBI engine

{ewc GSMVIMG,GSMVIMG, !88264v02.bmp}

88264v02

Figure 126.
Vacuum hose routing—1985 4.3L carbureted engine (Federal)
{ewc GSMVIMG,GSMVIMG, !88264v03.bmp}

88264v03

Figure 127.
Vacuum hose routing—1985 with 4.3L carbureted engine (Federal and low altitude)
{ewc GSMVIMG,GSMVIMG, !88264v04.bmp}

88264v04

Figure 128.
Vacuum hose routing—1986–88 with 4.3L TBI engine

{ewc GSMVIMG,GSMVIMG, !88264v05.bmp}

88264v05

Figure 129.
Vacuum hose routing—1988–91 with 4.3L TBI engine (Federal without air pump)
{ewc GSMVIMG,GSMVIMG, !88264v06.bmp}

88264v06

Figure 130.
Vacuum hose routing—1988–91 with 4.3L TBI engine (Federal with air pump)
{ewc GSMVIMG,GSMVIMG, !88264v07.bmp}

88264v07

Figure 131.
Vacuum hose routing—1992–95 with 4.3L (VIN Z) engine

{ewc GSMVIMG,GSMVIMG, !88264v08.bmp}

88264v08

Figure 132.
Vacuum hose routing—1992–95 with 4.3L (VIN W) engine, Federal
{ewc GSMVIMG,GSMVIMG, !88264v10.bmp}

88264v10

Figure 133.
Vacuum hose routing—1992–95 with 4.3L (VIN W) engine, California
{ewc GSMVIMG,GSMVIMG, !88264v11.bmp}

88264v11

Figure 134.
Vacuum hose routing—1996 with 4.3L CSFI engine

{ewc GSMVIMG,GSMVIMG, !88264v09.bmp}

88264v09

Figure 1.
Servicing quick connect fittings

{ewc GSMVIMG,GSMVIMG, !88265G30.bmp}

88265G30

Figure 2.
Using the GM float gauge tool No. J–34935–1, BT–8420–A or equivalent, to check the float level

{ewc GSMVIMG,GSMVIMG, !88265g02.bmp}

88265g02

Figure 3.
Adjusting the air valve spring—M4ME and E4ME carburetors
{ewc GSMVIMG,GSMVIMG, !88265g03.bmp}

88265g03

Figure 4.
Adjusting the choke coil lever—E4ME carburetor

{ewc GSMVIMG,GSMVIMG, !88265g04.bmp}

88265g04

Figure 5.
Using the GM choke valve angle gauge tool No. J–26701, BT–7740 or equivalent, to check the choke valve

{ewc GSMVIMG,GSMVIMG, !88265g05.bmp}

88265g05

Figure 6.
Fast idle cam (choke rod) adjustment—E4ME carburetor

{ewc GSMVIMG,GSMVIMG, !88265g06.bmp}

88265g06

Figure 7.
Front (primary side) vacuum break adjustment—E4ME carburetor
{ewc GSMVIMG,GSMVIMG, !88265g07.bmp}

88265g07

Figure 8.
Plugging the air bleed holes of the vacuum break—E4ME carburetor
{ewc GSMVIMG,GSMVIMG, !88265g08.bmp}

88265g08

Figure 9.
Rear (secondary side) vacuum break adjustment—E4ME carburetor
{ewc GSMVIMG,GSMVIMG, !88265g09.bmp}

88265g09

Figure 10.
Air valve rod adjustment—E4ME carburetor

{ewc GSMVIMG,GSMVIMG, !88265g10.bmp}

88265g10

Figure 11.
Secondary lockout adjustment—M4ME and E4ME carburetors
{ewc GSMVIMG,GSMVIMG, !88265g11.bmp}

88265g11

Figure 12.
Adjusting the unloader—E4ME carburetor

{ewc GSMVIMG,GSMVIMG, !88265g12.bmp}

88265g12

Figure 13.
Drilling a hole in the TPS screw cover plug

{ewc GSMVIMG,GSMVIMG, !88265g13.bmp}

88265g13

Figure 14.
Using the GM adjusting tool No. J–28696, BT–7967–A or equivalent, to adjust the TPS screw

{ewc GSMVIMG,GSMVIMG, !88265g14.bmp}

88265g14

Figure 15.
Checking the mixture control solenoid plunger travel—E4ME carburetor
{ewc GSMVIMG,GSMVIMG, !88265g15.bmp}

88265g15

Figure 16.
Exploded view of the mixture control solenoid assembly—E4ME carburetor
{ewc GSMVIMG,GSMVIMG, !88265g16.bmp}

88265g16

Figure 17.
Positioning the mixture control solenoid gauging tool

{ewc GSMVIMG,GSMVIMG, !88265g17.bmp}

88265g17

Figure 18.
Adjusting the mixture control solenoid screw

{ewc GSMVIMG,GSMVIMG, !88265g18.bmp}

88265g18

Figure 19.
Use a suitable tool to install the air horn onto the float bowl—E4ME carburetor
{ewc GSMVIMG,GSMVIMG, !88265g19.bmp}

88265g19

Figure 20.
Air horn torque sequence—E4ME carburetor

{ewc GSMVIMG,GSMVIMG, !88265g20.bmp}

88265g20

Figure 21.
Exploded view of the carburetor assembly—E4ME carburetor
{ewc GSMVIMG,GSMVIMG, !88265g21.bmp}

88265g21

Figure 22.
Exploded view of the carburetor assembly—E4ME carburetor, continued
{ewc GSMVIMG,GSMVIMG, !88265g22.bmp}

88265g22

Figure 23.
Exploded view of the carburetor assembly—M4ME carburetor
{ewc GSMVIMG,GSMVIMG, !88265g23.bmp}

88265g23

Figure 24.
Exploded view of the carburetor assembly—M4ME carburetor, continued
{ewc GSMVIMG,GSMVIMG, !88265g24.bmp}

88265g24

Figure 25.
The fuel pump and fuel gauge sender are incorporated in one unit mounted in the fuel tank

{ewc GSMVIMG,GSMVIMG, !88265g28.bmp}

88265g28

Figure 26.
Fuel system pressure testing

{ewc GSMVIMG,GSMVIMG, !88265g33.bmp}

88265g33

Figure 27.
Fuel pump relay location

{ewc GSMVIMG,GSMVIMG, !88265g34.bmp}

88265g34

Figure 28.
Operation of the TBI unit—Model 300

{ewc GSMVIMG,GSMVIMG, !88265g36.bmp}

88265g36

Figure 29.
Exploded view of the Model 300 throttle body—2.5L engine
{ewc GSMVIMG,GSMVIMG, !88265g37.bmp}

88265g37

Figure 30.
Exploded view of the Model 220 throttle body—4.3L engine

{ewc GSMVIMG,GSMVIMG, !88265g38.bmp}

88265g38

Figure 31.
Operation of the TBI unit—Model 700

{ewc GSMVIMG,GSMVIMG, !88265g39.bmp}

88265g39

Figure 32.
Exploded view of the Model 700 throttle body—2.5L engine

{ewc GSMVIMG,GSMVIMG, !88265g40.bmp}

88265g40

Figure 33.
Replacing the throttle body—2.5L engine

{ewc GSMVIMG,GSMVIMG, !88265g41.bmp}

88265g41

Figure 34.
Replacing the throttle body—4.3L engine

{ewc GSMVIMG,GSMVIMG, !88265g42.bmp}

88265g42

Figure 35.
Both the throttle cable and the cruise control linkage need to removed
{ewc GSMVIMG,GSMVIMG, !88265p86.bmp}

88265p86

Figure 36.
Use a backup wrench and a flare wrench when disconnection the fuel lines
{ewc GSMVIMG,GSMVIMG, !88265p87.bmp}

88265p87

Figure 37.
Some fuel may spill out of the line connections, so place a rag under the fittings to catch it

{ewc GSMVIMG,GSMVIMG, !88265p88.bmp}

88265p88

Figure 38.
Always replace the fuel line O-rings

{ewc GSMVIMG,GSMVIMG, !88265p89.bmp}

88265p89

Figure 39.
Remove the 3 bolts holding the throttle body

{ewc GSMVIMG,GSMVIMG, !88265p90.bmp}

88265p90

Figure 40.
Lift the throttle body straight up and be careful not to drop anything into the manifold

{ewc GSMVIMG,GSMVIMG, !88265p91.bmp}

88265p91

Figure 41.
Slide the electrical connection from the groove

{ewc GSMVIMG,GSMVIMG, !88265p92.bmp}

88265p92

Figure 42.
Always replace the throttle body base gasket, otherwise a vacuum leak may occur
{ewc GSMVIMG,GSMVIMG, !88265p93.bmp}

88265p93

Figure 43.
Installing tool J–33047 to adjust the idle speed—Model 300
{ewc GSMVIMG,GSMVIMG, !88265g52.bmp}

88265g52

Figure 44.
Removing the idle stop screw plug—Model 700

{ewc GSMVIMG,GSMVIMG, !88265g53.bmp}

88265g53

Figure 45.
Gently pry the injector out of the bore—Model 220 (Model 300 is similar)
{ewc GSMVIMG,GSMVIMG, !88265g43.bmp}

88265g43

Figure 46.
Replace the O-rings and washers whenever the injector is removed—Model 220 (Model 300 is similar)

{ewc GSMVIMG,GSMVIMG, !88265g44.bmp}

88265g44

Figure 47.
Gently pry the injector out of the bore—Model 700

{ewc GSMVIMG,GSMVIMG, !88265g45.bmp}

88265g45

Figure 48.
Replace the O-rings on the injector body when removed—Model 220, 4.3L engine shown

{ewc GSMVIMG,GSMVIMG, !88265p80.bmp}

88265p80

Figure 49.
Removing the fuel meter cover from the throttle body—Model 300 (Model 220 is similar)

{ewc GSMVIMG,GSMVIMG, !88265g46.bmp}

88265g46

Figure 50.
The throttle body can be accessed once the engine cover and air cleaner have been removed

{ewc GSMVIMG,GSMVIMG, !88265p74.bmp}

88265p74

Figure 51.
Remove the adapter ring and disconnect from the breather hose
{ewc GSMVIMG,GSMVIMG, !88265p75.bmp}

88265p75

Figure 52.
Unplug the injector electrical connectors

{ewc GSMVIMG,GSMVIMG, !88265p76.bmp}

88265p76

Figure 53.
Use clean rags to block the throttle openings and prevent debris from dropping in the engine

{ewc GSMVIMG,GSMVIMG, !88265p77.bmp}

88265p77

Figure 54.
Remove the mounting screws from the meter body

{ewc GSMVIMG,GSMVIMG, !88265p78.bmp}

88265p78

Figure 55.
Lift the meter body up and off the injectors. The injectors can be removed at this point

{ewc GSMVIMG,GSMVIMG, !88265p79.bmp}

88265p79

Figure 56.
Check the condition of the gaskets. This one is torn and would leak fuel if reused
{ewc GSMVIMG,GSMVIMG, !88265p81.bmp}

88265p81

Figure 57.
The fuel pressure regulator can be removed from the meter cover
{ewc GSMVIMG,GSMVIMG, !88265p82.bmp}

88265p82

Figure 58.
The fuel pressure regulator diaphragm must be intact for proper operation
{ewc GSMVIMG,GSMVIMG, !88265p83.bmp}

88265p83

Figure 59.
Check the condition of the diaphragm and seating area before reassembly
{ewc GSMVIMG,GSMVIMG, !88265p84.bmp}

88265p84

Figure 60.
Exploded view of the fuel metering cover

{ewc GSMVIMG,GSMVIMG, !88265p85.bmp}

88265p85

Figure 61.
View of the Idle Air Control (IAC) valve circuit

{ewc GSMVIMG,GSMVIMG, !88265gaa.bmp}

88265gaa

Figure 62.
Exploded view of the Idle Air Control (IAC) valves—Model 220 and 300
{ewc GSMVIMG,GSMVIMG, !88265g47.bmp}

88265g47

Figure 63.
Idle Air Control (IAC) valve—Model 700

{ewc GSMVIMG,GSMVIMG, !88265g48.bmp}

88265g48

Figure 64.
CMFI air flow schematic

{ewc GSMVIMG,GSMVIMG, !88265g54.bmp}

88265g54

Figure 65.
Various CMFI engine components are mounted to the intake manifolds (the CMFI unit is located under the upper intake)

{ewc GSMVIMG,GSMVIMG, !88265g55.bmp}

88265g55

Figure 66.
CMFI assembly (CSFI is similar in concept)

{ewc GSMVIMG,GSMVIMG, !88265g57.bmp}

88265g57

Figure 67.
Use a fuel pressure gauge with a bleed hose to relieve the fuel system pressure
{ewc GSMVIMG,GSMVIMG, !88265g29.bmp}

88265g29

Figure 68.
Fuel pressure connection

{ewc GSMVIMG,GSMVIMG, !88265g56.bmp}

88265g56

Figure 69.
Common fuel pump relay mounting—CMFI/CSFI vehicles

{ewc GSMVIMG,GSMVIMG, !88265g58.bmp}

88265g58

Figure 70.
Exploded view of the upper and lower intake manifolds and the CMFI system components

{ewc GSMVIMG,GSMVIMG, !88265g59.bmp}

88265g59

Figure 71.
Upper intake manifold torque sequence

{ewc GSMVIMG,GSMVIMG, !88265g60.bmp}

88265g60

Figure 72.
Exploded view of the CSFI system components

{ewc GSMVIMG,GSMVIMG, !88265g61.bmp}

88265g61

Figure 73.
The CSFI unit mounts to the lower manifold

{ewc GSMVIMG,GSMVIMG, !88265g62.bmp}

88265g62

Figure 74.
Exploded view of the CSFI components and manifolds

{ewc GSMVIMG,GSMVIMG, !88265g69.bmp}

88265g69

Figure 75.
These 3 long bolts or studs hold the throttle body to the upper manifold
{ewc GSMVIMG,GSMVIMG, !88265g70.bmp}

88265g70

Figure 76.
Make sure the gasket is in place while installing the throttle body otherwise air leaks can occur

{ewc GSMVIMG,GSMVIMG, !88265g71.bmp}

88265g71

Figure 77.
Fuel injector testers can be purchased or sometimes rented
{ewc GSMVIMG,GSMVIMG, !tccs5p03.bmp}

tccs5p03

Figure 78.
The fuel pressure regulator is retained by this clip

{ewc GSMVIMG,GSMVIMG, !88265g72.bmp}

88265g72

Figure 79.
Replace the O-rings whenever the fuel pressure regulator is removed
{ewc GSMVIMG,GSMVIMG, !88265g73.bmp}

88265g73

Figure 80.
Measuring the IAC valve pintle

{ewc GSMVIMG,GSMVIMG, !88265g63.bmp}

88265g63

Figure 81.
Intake manifold tuning valve assembly

{ewc GSMVIMG,GSMVIMG, !88265g66.bmp}

88265g66

Figure 82.
Fuel filler neck assembly

{ewc GSMVIMG,GSMVIMG, !88265g67.bmp}

88265g67

Figure 83.
The fuel tank bolts must be tightened alternately to prevent distortion of the fuel tank bottom

{ewc GSMVIMG,GSMVIMG, !88265g68.bmp}

88265g68

Figure 84.
The fuel pump locking ring can be removed using this tool
{ewc GSMVIMG,GSMVIMG, !88265g31.bmp}

88265g31

Figure 85.
The fuel pump and fuel gauge sender assembly

{ewc GSMVIMG,GSMVIMG, !88265g32.bmp}

88265g32

Figure 86.
The fuel pump locking ring can also be removed using a brass drift
{ewc GSMVIMG,GSMVIMG, !tccs5p04.bmp}

tccs5p04

Figure 87.
With the locking ring removed, the fuel pump (and/or gauge sender) can be lifted from the tank

{ewc GSMVIMG,GSMVIMG, !tccs5p05.bmp}

tccs5p05

Figure 1.
This sticker warns of air bag components. Be careful when working around the SIR wiring harness

{ewc GSMVIMG,GSMVIMG, !88266p01.bmp}

88266p01

Figure 2.
SIR components-1993-95 models

{ewc GSMVIMG,GSMVIMG, !88266g91.bmp}

88266g91

Figure 3.
SIR components-1996 models

{ewc GSMVIMG,GSMVIMG, !88266g92.bmp}

88266g92

Figure 4.
Driver's side 2-way SIR connector-1993-95 models

{ewc GSMVIMG,GSMVIMG, !88266g93.bmp}

88266g93

Figure 5.
Driver's side 2-way SIR connector-1996 models

{ewc GSMVIMG,GSMVIMG, !88266g94.bmp}

88266g94

Figure 6.
Passenger's side 2-way SIR connector-1996 models

{ewc GSMVIMG,GSMVIMG, !88266g95.bmp}

88266g95

Figure 7.
The heater blower motor is mounted on the heater case assembly. This is shown without AC, but it is similar with AC

{ewc GSMVIMG,GSMVIMG, !88266g01.bmp}

88266g01

Figure 8.
Both the ground connector and the power connector need to be removed from the push on tabs

{ewc GSMVIMG,GSMVIMG, !88266p02.bmp}

88266p02

Figure 9.
The blower motor is held on its circumference by screws

{ewc GSMVIMG,GSMVIMG, !88266p03.bmp}

88266p03

Figure 10.
Pulling the housing back will expose the fan blade connected to the motor shaft
{ewc GSMVIMG,GSMVIMG, !88266p04.bmp}

88266p04

Figure 11.
Rear heater assembly

{ewc GSMVIMG,GSMVIMG, !88266g03.bmp}

88266g03

Figure 12.
Blower motor resistor mounting location

{ewc GSMVIMG,GSMVIMG, !88266g02.bmp}

88266g02

Figure 13.
The heater core has its water connections in the engine compartment
{ewc GSMVIMG,GSMVIMG, !88266p30.bmp}

88266p30

Figure 14.
With the engine cover off, the trim panel bolts are accessible
{ewc GSMVIMG,GSMVIMG, !88266p05.bmp}

88266p05

Figure 15.
Remove the trim panel to access the heater box

{ewc GSMVIMG,GSMVIMG, !88266p06.bmp}

88266p06

Figure 16.
The air distribution duct is mounted in front of the heater box
{ewc GSMVIMG,GSMVIMG, !88266p07.bmp}

88266p07

Figure 17.
Note the seal at the top of the duct. Make sure it is in place when assembling the duct

{ewc GSMVIMG,GSMVIMG, !88266p08.bmp}

88266p08

Figure 18.
The side cover is held by 2 bolts

{ewc GSMVIMG,GSMVIMG, !88266p09.bmp}

88266p09

Figure 19.
The side cover is also gasketed. Check its condition once removed
{ewc GSMVIMG,GSMVIMG, !88266p10.bmp}

88266p10

Figure 20.
The heater core is held by small bolts and molded-in brackets
{ewc GSMVIMG,GSMVIMG, !88266p11.bmp}

88266p11

Figure 21.
In most cases, the core can be separated from the heater box without removing the entire assembly

{ewc GSMVIMG,GSMVIMG, !88266p12.bmp}

88266p12

Figure 22.
Mounting scheme of the front heater module

{ewc GSMVIMG,GSMVIMG, !88266g04.bmp}

88266g04

Figure 23.
Exploded view of the front heater module

{ewc GSMVIMG,GSMVIMG, !88266g05.bmp}

88266g05

Figure 24.
Rear heater components

{ewc GSMVIMG,GSMVIMG, !88266g06.bmp}

88266g06

Figure 25.
Control panel mounting-1985-95 models

{ewc GSMVIMG,GSMVIMG, !88266g07.bmp}

88266g07

Figure 26.
Control panel connections-1985-95 models

{ewc GSMVIMG,GSMVIMG, !88266g08.bmp}

88266g08

Figure 27.
Control panel mounting-1996 models

{ewc GSMVIMG,GSMVIMG, !88266g18.bmp}

88266g18

Figure 28.
Control panel connections-1996 models

{ewc GSMVIMG,GSMVIMG, !88266g19.bmp}

88266g19

Figure 29.
HVAC vacuum circuit

{ewc GSMVIMG,GSMVIMG, !88266g11.bmp}

88266g11

Figure 30.
Control panel testing chart-1985-95 models

{ewc GSMVIMG,GSMVIMG, !88266g09.bmp}

88266g09

Figure 31.
Control panel testing chart-1996 models

{ewc GSMVIMG,GSMVIMG, !88266g10.bmp}

88266g10

Figure 32.
Air conditioning compressor mounting-2.5L engine

{ewc GSMVIMG,GSMVIMG, !88266g20.bmp}

88266g20

Figure 33.
Air conditioning compressor mounting-4.3L engine with radial compressor
{ewc GSMVIMG,GSMVIMG, !88266g21.bmp}

88266g21

Figure 34.
Air conditioning compressor mounting-4.3L (VIN Z) engine with axial compressor, except 1996 models

{ewc GSMVIMG,GSMVIMG, !88266g22.bmp}

88266g22

Figure 35.
Air conditioning compressor mounting-4.3L (VIN W) engine with axial compressor, except 1996 models

{ewc GSMVIMG,GSMVIMG, !88266g23.bmp}

88266g23

Figure 36.
Air conditioning compressor mounting-1996 4.3L engine
{ewc GSMVIMG,GSMVIMG, !88266g24.bmp}

88266g24

Figure 37.
Condenser assembly mounting

{ewc GSMVIMG,GSMVIMG, !88266g25.bmp}

88266g25

Figure 38.
Rear air conditioning system components

{ewc GSMVIMG,GSMVIMG, !88266g14.bmp}

88266g14

Figure 39.
Early style blower motor relay mounting

{ewc GSMVIMG,GSMVIMG, !88266g13.bmp}

88266g13

Figure 40.
Late style blower motor relay mounting

{ewc GSMVIMG,GSMVIMG, !88266g26.bmp}

88266g26

Figure 41.
Front evaporator case mounting

{ewc GSMVIMG,GSMVIMG, !88266g12.bmp}

88266g12

Figure 42.
Orifice tube assembly

{ewc GSMVIMG,GSMVIMG, !88266g15.bmp}

88266g15

Figure 43.
Air conditioning system component schematic

{ewc GSMVIMG,GSMVIMG, !88266g16.bmp}

88266g16

Figure 44.
Accumulator assembly

{ewc GSMVIMG,GSMVIMG, !88266g17.bmp}

88266g17

Figure 45.
Radio mounting-1985-91 models

{ewc GSMVIMG,GSMVIMG, !88266g27.bmp}

88266g27

Figure 46.
Radio mounting-1991-95 models

{ewc GSMVIMG,GSMVIMG, !88266g30.bmp}

88266g30

Figure 47.
Remote cassette deck mounting-1996 models

{ewc GSMVIMG,GSMVIMG, !88266g32.bmp}

88266g32

Figure 48.
Typical dash speaker mounting

{ewc GSMVIMG,GSMVIMG, !88266g28.bmp}

88266g28

Figure 49.
Typical rear speaker mounting

{ewc GSMVIMG,GSMVIMG, !88266g29.bmp}

88266g29

Figure 50.
Radio mounting-1996 models

{ewc GSMVIMG,GSMVIMG, !88266g31.bmp}

88266g31

Figure 51.
The trim piece around the radio is held by 2 screws at the bottom
{ewc GSMVIMG,GSMVIMG, !88266p13.bmp}

88266p13

Figure 52.
Pull the trim piece off and disconnect the wiring to switches
{ewc GSMVIMG,GSMVIMG, !88266p14.bmp}

88266p14

Figure 53.
Unbolt the 4 fasteners at the mounting bracket to free the radio
{ewc GSMVIMG,GSMVIMG, !88266p15.bmp}

88266p15

Figure 54.
The radio slides straight in and out

{ewc GSMVIMG,GSMVIMG, !88266p16.bmp}

88266p16

Figure 55.
Don't forget to unplug the connections at the back of the radio!
{ewc GSMVIMG,GSMVIMG, !88266p17.bmp}

88266p17

Figure 56.
The washer bottle has the washer pump built into the side of it. Removing the bottle allows access

{ewc GSMVIMG,GSMVIMG, !88266p31.bmp}

88266p31

Figure 57.
The electrical connector is the watertight and has a catch to keep it secure
{ewc GSMVIMG,GSMVIMG, !88266p32.bmp}

88266p32

Figure 58.
The check valve keeps fluid in the line at all time

{ewc GSMVIMG,GSMVIMG, !88266p33.bmp}

88266p33

Figure 59.
Removing the wiper arm using GM tool J-8966

{ewc GSMVIMG,GSMVIMG, !88266g33.bmp}

88266g33

Figure 60.
Wiper arm positioning

{ewc GSMVIMG,GSMVIMG, !88266g34.bmp}

88266g34

Figure 61.
If you don't have the special wiper arm tool, just pull back on the arm's side latch
{ewc GSMVIMG,GSMVIMG, !88266p18.bmp}

88266p18

Figure 62.
The arm is splined to meet the linkage. Note the latch at the bottom of the wiper arm

{ewc GSMVIMG,GSMVIMG, !88266p19.bmp}

88266p19

Figure 63.
On wiper arms with the washer nozzle built into it, you will need to disconnect the fluid hose

{ewc GSMVIMG,GSMVIMG, !88266p20.bmp}

88266p20

Figure 64.
Wiper circuit-with pulse used on models through 1993

{ewc GSMVIMG,GSMVIMG, !88266g38.bmp}

88266g38

Figure 65.
Wiper switch testing-1994-96 models

{ewc GSMVIMG,GSMVIMG, !88266g40.bmp}

88266g40

Figure 66.
Wiper motor testing-1994-96 models

{ewc GSMVIMG,GSMVIMG, !88266g3b.bmp}

88266g3b

Figure 67.
Typical wiper motor mounting scheme

{ewc GSMVIMG,GSMVIMG, !88266g36.bmp}

88266g36

Figure 68.
The connector has a positive lock on it that will need to be pressed in to unplug it
{ewc GSMVIMG,GSMVIMG, !88266p21.bmp}

88266p21

Figure 69.
The bolts go through rubber isolators. Check the condition of the rubber when dismounting

{ewc GSMVIMG,GSMVIMG, !88266p22.bmp}

88266p22

Figure 70.
Once the linkage has been disconnected from the motor, the unit will pull right out
{ewc GSMVIMG,GSMVIMG, !88266p23.bmp}

88266p23

Figure 71.
Rear wiper circuit

{ewc GSMVIMG,GSMVIMG, !88266g41.bmp}

88266g41

Figure 72.
Rear wiper switch continuity chart

{ewc GSMVIMG,GSMVIMG, !88266g42.bmp}

88266g42

Figure 73.
Rear wiper assembly mounting

{ewc GSMVIMG,GSMVIMG, !88266g35.bmp}

88266g35

Figure 74.
Remove the screws holding the cowl grille.

{ewc GSMVIMG,GSMVIMG, !88266p24.bmp}

88266p24

Figure 75.
The grille will only come off once the wiper arms are removed
{ewc GSMVIMG,GSMVIMG, !88266p25.bmp}

88266p25

Figure 76.
The screen comes out after the grille is removed

{ewc GSMVIMG,GSMVIMG, !88266p26.bmp}

88266p26

Figure 77.
The linkage pops off the motor arm to remove

{ewc GSMVIMG,GSMVIMG, !88266p27.bmp}

88266p27

Figure 78.
Check bushing condition when the linkage is removed

{ewc GSMVIMG,GSMVIMG, !88266p28.bmp}

88266p28

Figure 79.
The linkage stubs are held by the large nuts at the cowl

{ewc GSMVIMG,GSMVIMG, !88266p29.bmp}

88266p29

Figure 80.
Windshield wiper assembly and linkage

{ewc GSMVIMG,GSMVIMG, !88266g37.bmp}

88266g37

Figure 81.
Instrument cluster mounting-1985-92 models

{ewc GSMVIMG,GSMVIMG, !88266g3a.bmp}

88266g3a

Figure 82.
Instrument cluster mounting-1993-95 models

{ewc GSMVIMG,GSMVIMG, !88266g39.bmp}

88266g39

Figure 83.
Instrument cluster bulb and connector locations-Standard analog cluster
{ewc GSMVIMG,GSMVIMG, !88266g4a.bmp}

88266g4a

Figure 84.
Instrument cluster bulb and connector locations-Digital cluster
{ewc GSMVIMG,GSMVIMG, !88266g4e.bmp}

88266g4e

Figure 85.
Instrument cluster mounting screw locations-1996 models

{ewc GSMVIMG,GSMVIMG, !88266g4c.bmp}

88266g4c

Figure 86.
Instrument panel trim mounting points-1996 models

{ewc GSMVIMG,GSMVIMG, !88266g46.bmp}

88266g46

Figure 87.
Headlight switch electrical connections-1985-95 shown, 1996 similar
{ewc GSMVIMG,GSMVIMG, !88266g43.bmp}

88266g43

Figure 88.
This style headlight switch was used up to 1995. In 1996 a rotary switch was used
{ewc GSMVIMG,GSMVIMG, !88266g44.bmp}

88266g44

Figure 89.
The back up light switch also contains the neutral safety switch on automatic transmission equipped vehicles-1985-95 models

{ewc GSMVIMG,GSMVIMG, !88266g45.bmp}

88266g45

Figure 90.
Mechanical speedometer cable routing

{ewc GSMVIMG,GSMVIMG, !88266g4b.bmp}

88266g4b

Figure 91.
Typical electronic speedometer speed sensor mounted in the transmission or the transfer case

{ewc GSMVIMG,GSMVIMG, !88266g47.bmp}

88266g47

Figure 92.
Sealed beam headlight mounting

{ewc GSMVIMG,GSMVIMG, !88266g48.bmp}

88266g48

Figure 93.
The headlight bezel needs to be removed to access the mounting screws for the bulb itself

{ewc GSMVIMG,GSMVIMG, !88266p34.bmp}

88266p34

Figure 94.
Be careful with the headlight retaining ring screws. They can strip out easily
{ewc GSMVIMG,GSMVIMG, !88266p35.bmp}

88266p35

Figure 95.
If the ring becomes damaged, it can be replaced with parts from most auto supply stores

{ewc GSMVIMG,GSMVIMG, !88266p36.bmp}

88266p36

Figure 96.
Check the terminals for signs of burning. A bad connection here can cause all sorts of light problems

{ewc GSMVIMG,GSMVIMG, !88266p37.bmp}

88266p37

Figure 97.
Composite headlamp assembly

{ewc GSMVIMG,GSMVIMG, !88266g49.bmp}

88266g49

Figure 98.
Composite headlamp side lens

{ewc GSMVIMG,GSMVIMG, !88266g53.bmp}

88266g53

Figure 99.
Remove this screw to release the side lens

{ewc GSMVIMG,GSMVIMG, !88266p38.bmp}

88266p38

Figure 100.
Pull the side lens out to expose the main headlight mounting points
{ewc GSMVIMG,GSMVIMG, !88266p39.bmp}

88266p39

Figure 101.
Headlight side mounting bolt

{ewc GSMVIMG,GSMVIMG, !88266p40.bmp}

88266p40

Figure 102.
Headlight bracket mounting bolt

{ewc GSMVIMG,GSMVIMG, !88266p41.bmp}

88266p41

Figure 103.
Pull the entire headlight unit out from the body

{ewc GSMVIMG,GSMVIMG, !88266p42.bmp}

88266p42

Figure 104.
The composite headlights use sperate bulbs that mount to the headlight assembly
{ewc GSMVIMG,GSMVIMG, !88266p43.bmp}

88266p43

Figure 105.
Do not touch the surface of the bulb or it will burn out prematurely

{ewc GSMVIMG,GSMVIMG, !88266p44.bmp}

88266p44

Figure 106.
With the headlight removed, you can get to the parking light bulbs
{ewc GSMVIMG,GSMVIMG, !88266p45.bmp}

88266p45

Figure 107.
Headlight adjusting screws

{ewc GSMVIMG,GSMVIMG, !88266g50.bmp}

88266g50

Figure 108.
Headlight aiming preparation

{ewc GSMVIMG,GSMVIMG, !88266g51.bmp}

88266g51

Figure 109.
Headlight aiming limits

{ewc GSMVIMG,GSMVIMG, !88266g52.bmp}

88266g52

Figure 110.
The foglamp relay is located in the convenience center

{ewc GSMVIMG,GSMVIMG, !88266g5a.bmp}

88266g5a

Figure 111.
The bulb is mounted in the fog light by a bayonet mount
{ewc GSMVIMG,GSMVIMG, !88266p46.bmp}

88266p46

Figure 112.
The bulb is a halogen unit. Do not touch the glass surface
{ewc GSMVIMG,GSMVIMG, !88266p47.bmp}

88266p47

Figure 113.
Front turn signal and parking lamp assembly-with sealed beam headlight
{ewc GSMVIMG,GSMVIMG, !88266g54.bmp}

88266g54

Figure 114.
Front turn signal and parking lamp assembly-with composite headlight
{ewc GSMVIMG,GSMVIMG, !88266g55.bmp}

88266g55

Figure 115.
The headlight bezel contains the turn signal and parking lamps
{ewc GSMVIMG,GSMVIMG, !88266p48.bmp}

88266p48

Figure 116.
Note the seal around the socket. Check its condition before installation
{ewc GSMVIMG,GSMVIMG, !88266p49.bmp}

88266p49

Figure 117.
This socket is a twist to lock design

{ewc GSMVIMG,GSMVIMG, !88266p50.bmp}

88266p50

Figure 118.
The replacement bulb just pushes into the socket

{ewc GSMVIMG,GSMVIMG, !88266p51.bmp}

88266p51

Figure 119.
The grease at the bottom of the bulb is to help prevent corrosion
{ewc GSMVIMG,GSMVIMG, !88266p52.bmp}

88266p52

Figure 120.
Rear lamp assembly

{ewc GSMVIMG,GSMVIMG, !88266g56.bmp}

88266g56

Figure 121.
The taillight housing is held by this screw
{ewc GSMVIMG,GSMVIMG, !88266p53.bmp}

88266p53

Figure 122.
The bulbs mount in sockets that twist into the taillight housing
{ewc GSMVIMG,GSMVIMG, !88266p54.bmp}

88266p54

Figure 123.
License plate light assembly

{ewc GSMVIMG,GSMVIMG, !88266g57.bmp}

88266g57

Figure 124.
The license plate light is held by 2 bolts

{ewc GSMVIMG,GSMVIMG, !88266p55.bmp}

88266p55

Figure 125.
The socket twists into the light housing

{ewc GSMVIMG,GSMVIMG, !88266p56.bmp}

88266p56

Figure 126.
The bulb pushes into the socket

{ewc GSMVIMG,GSMVIMG, !88266p57.bmp}

88266p57

Figure 127.
Center high mounted stop light assembly

{ewc GSMVIMG,GSMVIMG, !88266g58.bmp}

88266g58

Figure 128.
Light bulb applications

{ewc GSMVIMG,GSMVIMG, !88266g59.bmp}

88266g59

Figure 129.
Cruise control diagnostic chart-1985-94 models

{ewc GSMVIMG,GSMVIMG, !88266g60.bmp}

88266g60

Figure 130.
Cruise control diagnostic chart-1985-94 models

{ewc GSMVIMG,GSMVIMG, !88266g61.bmp}

88266g61

Figure 131.
Cruise control diagnostic chart-1985-94 models

{ewc GSMVIMG,GSMVIMG, !88266g62.bmp}

88266g62

Figure 132.
Cruise control diagnostic chart-1985-94 models

{ewc GSMVIMG,GSMVIMG, !88266g63.bmp}

88266g63

Figure 133.
Cruise control diagnostic chart-1985-94 models

{ewc GSMVIMG,GSMVIMG, !88266g64.bmp}

88266g64

Figure 134.
Cruise control diagnostic chart-1985-94 models

{ewc GSMVIMG,GSMVIMG, !88266g65.bmp}

88266g65

Figure 135.
Cruise control diagnostic chart-1985-94 models

{ewc GSMVIMG,GSMVIMG, !88266g66.bmp}

88266g66

Figure 136.
Cruise control diagnostic chart-1995-96 models

{ewc GSMVIMG,GSMVIMG, !88266g67.bmp}

88266g67

Figure 137.
Cruise control diagnostic chart-1995-96 models

{ewc GSMVIMG,GSMVIMG, !88266g68.bmp}

88266g68

Figure 138.
Cruise control diagnostic chart-1995-96 models

{ewc GSMVIMG,GSMVIMG, !88266g69.bmp}

88266g69

Figure 139.
Cruise control wiring-1985-94 models

{ewc GSMVIMG,GSMVIMG, !88266g70.bmp}

88266g70

Figure 140.
Cruise control wiring-1985-94 models

{ewc GSMVIMG,GSMVIMG, !88266g71.bmp}

88266g71

Figure 141.
Cruise control wiring-1985-94 models

{ewc GSMVIMG,GSMVIMG, !88266g72.bmp}

88266g72

Figure 142.
Cruise control wiring-1995-96 models

{ewc GSMVIMG,GSMVIMG, !88266g73.bmp}

88266g73

Figure 143.
The vacuum release switch is mounted to the same bracket as the brake light switch

{ewc GSMVIMG,GSMVIMG, !88266p58.bmp}

88266p58

Figure 144.
Vacuum release valve

{ewc GSMVIMG,GSMVIMG, !88266g74.bmp}

88266g74

Figure 145.
Control module mounting

{ewc GSMVIMG,GSMVIMG, !88266g75.bmp}

88266g75

Figure 146.
Servo unit-2.5L engine

{ewc GSMVIMG,GSMVIMG, !88266g76.bmp}

88266g76

Figure 147.
Servo unit-4.3L engine, with carburetor or TBI

{ewc GSMVIMG,GSMVIMG, !88266g77.bmp}

88266g77

Figure 148.
Servo unit-4.3L engine, with electronic cruise control

{ewc GSMVIMG,GSMVIMG, !88266g79.bmp}

88266g79

Figure 149.
Servo unit-4.3L (VIN W) engine

{ewc GSMVIMG,GSMVIMG, !88266g78.bmp}

88266g78

Figure 150.
Remove the cover to expose the fuse panel

{ewc GSMVIMG,GSMVIMG, !88266p59.bmp}

88266p59

Figure 151.
Without a tester, it is impossible to check the fuses unless they are removed
{ewc GSMVIMG,GSMVIMG, !88266p60.bmp}

88266p60

Figure 152.
The underhood fuse panel has the fuse identification in the lid of the panel
{ewc GSMVIMG,GSMVIMG, !88266p61.bmp}

88266p61

Figure 153.
This puller will help remove the mini fuses

{ewc GSMVIMG,GSMVIMG, !88266p62.bmp}

88266p62

Figure 154.
These maxi fuses take the place of many of the fusible links
{ewc GSMVIMG,GSMVIMG, !88266p63.bmp}

88266p63

Figure 155.
The relays just plug into the panel

{ewc GSMVIMG,GSMVIMG, !88266p64.bmp}

88266p64

Figure 156.
Testing for a blown fuse

{ewc GSMVIMG,GSMVIMG, !88266g88.bmp}

88266g88

Figure 157.
Fuse block-1985-95 models

{ewc GSMVIMG,GSMVIMG, !88266g80.bmp}

88266g80

Figure 158.
Instrument panel fuse block-1996 models

{ewc GSMVIMG,GSMVIMG, !88266g81.bmp}

88266g81

Figure 159.
Instrument panel fuse block identification-1996 models

{ewc GSMVIMG,GSMVIMG, !88266g82.bmp}

88266g82

Figure 160.
Underhood fuse block-1996 models

{ewc GSMVIMG,GSMVIMG, !88266g83.bmp}

88266g83

Figure 161.
Underhood fuse block identification-1996 models

{ewc GSMVIMG,GSMVIMG, !88266g84.bmp}

88266g84

Figure 162.
Convenience center fuse block-1996 models

{ewc GSMVIMG,GSMVIMG, !88266g85.bmp}

88266g85

Figure 163.
Convenience center fuse block identification-1996 models

{ewc GSMVIMG,GSMVIMG, !88266g86.bmp}

88266g86

Figure 164.
Convenience center fuse block identification-1996 models

{ewc GSMVIMG,GSMVIMG, !88266g87.bmp}

88266g87

Figure 165.
Convenience center and components-1985-95 models

{ewc GSMVIMG,GSMVIMG, !88266g89.bmp}

88266g89

Figure 166.
Convenience center and components-1996 models

{ewc GSMVIMG,GSMVIMG, !88266g9a.bmp}

88266g9a

Figure 167.
New fusible links are spliced and soldered to the wire

{ewc GSMVIMG,GSMVIMG, !88266g90.bmp}

88266g90

Figure 168.
Sample diagram-how to read and interpret wiring

{ewc GSMVIMG,GSMVIMG, !tccs6w01.bmp}

tccs6w01

Figure 169.
Common wiring diagram symbols

{ewc GSMVIMG,GSMVIMG, !tccs6w02.bmp}

tccs6w02

Figure 170.
Engine controls-1985-86 2.5L engine

{ewc GSMVIMG,GSMVIMG, !88266w01.bmp}

88266w01

Figure 171.
Engine controls--1987-90 2.5L engine

{ewc GSMVIMG,GSMVIMG, !88266w02.bmp}

88266w02

Figure 172.
Engine controls-1985 4.3L engine

{ewc GSMVIMG,GSMVIMG, !88266w03.bmp}

88266w03

Figure 173.
Engine controls-1986 4.3L engine

{ewc GSMVIMG,GSMVIMG, !88266w04.bmp}

88266w04

Figure 174.
Engine controls-1987 4.3L engine

{ewc GSMVIMG,GSMVIMG, !88266w05.bmp}

88266w05

Figure 175.
Engine controls-1988-91 4.3L engine and 1992 4.3L (VIN Z) engine
{ewc GSMVIMG,GSMVIMG, !88266w06.bmp}

88266w06

Figure 176.
Engine controls-1992 4.3L (VIN W) engine

{ewc GSMVIMG,GSMVIMG, !88266w07.bmp}

88266w07

Figure 177.
Engine controls-1993-95 4.3L engine

{ewc GSMVIMG,GSMVIMG, !88266w08.bmp}

88266w08

Figure 178.
Engine controls-1996 4.3L engine

{ewc GSMVIMG,GSMVIMG, !88266w09.bmp}

88266w09

Figure 179.
Body wiring group 1-1985-86 models

{ewc GSMVIMG,GSMVIMG, !88266w10.bmp}

88266w10

Figure 180.
Body wiring group 1-1987 models

{ewc GSMVIMG,GSMVIMG, !88266w11.bmp}

88266w11

Figure 181.
Body wiring group 2-1985-87 models

{ewc GSMVIMG,GSMVIMG, !88266w12.bmp}

88266w12

Figure 182.
Body wiring group 1-1988 models

{ewc GSMVIMG,GSMVIMG, !88266w13.bmp}

88266w13

Figure 183.
Body wiring group 1-1989 models

{ewc GSMVIMG,GSMVIMG, !88266w14.bmp}

88266w14

Figure 184.
Body wiring group 2-1988-89 models

{ewc GSMVIMG,GSMVIMG, !88266w15.bmp}

88266w15

Figure 185.
Body wiring group 1-1990-95 models

{ewc GSMVIMG,GSMVIMG, !88266w16.bmp}

88266w16

Figure 186.
Body wiring group 2-1990-95 models

{ewc GSMVIMG,GSMVIMG, !88266w17.bmp}

88266w17

Figure 187.
Body wiring group 1-1996 models

{ewc GSMVIMG,GSMVIMG, !88266w18.bmp}

88266w18

Figure 188.
Body wiring group 2-1996 models

{ewc GSMVIMG,GSMVIMG, !88266w19.bmp}

88266w19

Figure 1.
Exploded view of the MH3/ML3 5-speed transmission housing external components-MR2, 4-speed similar

{ewc GSMVIMG,GSMVIMG, !88267G01.bmp}

88267G01

Figure 2.
Exploded view of the MR2 4-speed transmission assembly

{ewc GSMVIMG,GSMVIMG, !88267G11.bmp}

88267G11

Figure 3.
Exploded view of the MH3/ML3 5-speed transmission assembly
{ewc GSMVIMG,GSMVIMG, !88267G12.bmp}

88267G12

Figure 4.
Shift lever positions-MR2 4-speed transmission

{ewc GSMVIMG,GSMVIMG, !88267G02.bmp}

88267G02

Figure 5.
Adjusting the shifter rod linkage-MR2 4-speed transmission
{ewc GSMVIMG,GSMVIMG, !88267G03.bmp}

88267G03

Figure 6.
Adjusting the clutch (starter safety) switch

{ewc GSMVIMG,GSMVIMG, !88267G04.bmp}

88267G04

Figure 7.
Exploded view of the back-up light switch mounting

{ewc GSMVIMG,GSMVIMG, !88267G05.bmp}

88267G05

Figure 8.
Exploded view of the 4-speed shifter assembly and mounting
{ewc GSMVIMG,GSMVIMG, !88267G06.bmp}

88267G06

Figure 9.
Exploded view of the 5-speed shifter assembly mounting

{ewc GSMVIMG,GSMVIMG, !88267G07.bmp}

88267G07

Figure 10.
Use a seal puller to remove the extension housing seal (be careful not to damage the bore)

{ewc GSMVIMG,GSMVIMG, !88267P01.bmp}

88267P01

Figure 11.
Use a driver to install the replacement seal-Automatic shown, manual similar
{ewc GSMVIMG,GSMVIMG, !88267P02.bmp}

88267P02

Figure 12.
Exploded view of the shift lever mounting-MH3/ML3 5-speed transmission
{ewc GSMVIMG,GSMVIMG, !88267G10.bmp}

88267G10

Figure 13.
Cross-sectional view of the clutch assembly

{ewc GSMVIMG,GSMVIMG, !88267G15.bmp}

88267G15

Figure 14.
Typical clutch release bearing lubrication points

{ewc GSMVIMG,GSMVIMG, !88267G13.bmp}

88267G13

Figure 15.
Exploded view of the clutch assembly

{ewc GSMVIMG,GSMVIMG, !88267G14.bmp}

88267G14

Figure 16.
A clutch alignment arbor is used for removal or installation of the clutch and pressure plate assembly

{ewc GSMVIMG,GSMVIMG, !tccS7142.bmp}

TCCS7142

Figure 17.
Remove the transmission and bellhousing for access to the pressure plate

{ewc GSMVIMG,GSMVIMG, !tccS7115.bmp}

TCCS7115

Figure 18.
Loosen the pressure plate (clutch cover) bolts gradually and evenly in a cross-wise pattern

{ewc GSMVIMG,GSMVIMG, !tccS7116.bmp}

TCCS7116

Figure 19.
Removing the clutch and pressure plate

{ewc GSMVIMG,GSMVIMG, !tccS7118.bmp}

TCCS7118

Figure 20.
Be sure that the flywheel surface is clean of grease or contaminants, before installing the clutch

{ewc GSMVIMG,GSMVIMG, !tccS7124.bmp}

TCCS7124

Figure 21.
Use a clutch alignment arbor, to align the clutch assembly during installation
{ewc GSMVIMG,GSMVIMG, !tccS7127.bmp}

TCCS7127

Figure 22.
Clutch plate and pressure plate installed with the alignment arbor in place
{ewc GSMVIMG,GSMVIMG, !tccS7129.bmp}

TCCS7129

Figure 23.
The easiest way to remove a pilot bearing is using a bearing puller tool
{ewc GSMVIMG,GSMVIMG, !88267G16.bmp}

88267G16

Figure 24.
Exploded view of the clutch pedal assembly

{ewc GSMVIMG,GSMVIMG, !88267G17.bmp}

88267G17

Figure 25.
Exploded view of the clutch master cylinder mounting

{ewc GSMVIMG,GSMVIMG, !88267G18.bmp}

88267G18

Figure 26.
Clutch hydraulic actuating system and component mounting

{ewc GSMVIMG,GSMVIMG, !88267G20.bmp}

88267G20

Figure 27.
Exploded view of the clutch master cylinder assembly

{ewc GSMVIMG,GSMVIMG, !88267G19.bmp}

88267G19

Figure 28.
Exploded view of the clutch slave cylinder assembly
{ewc GSMVIMG,GSMVIMG, !88267G21.bmp}

88267G21

Figure 29.
The torque converter housing is rotated by the engine's crankshaft, and turns the impeller-The impeller then spins the turbine, which gives motion to the turbine shaft, driving the gears

{ewc GSMVIMG,GSMVIMG, !tccS7011.bmp}

TCCS7011

Figure 30.
Planetary gears work in a similar fashion to manual transmission gears, but are composed of three parts

{ewc GSMVIMG,GSMVIMG, !tccS7012.bmp}

TCCS7012

Figure 31.
Planetary gears in the maximum reduction (low) range. The ring gear is held and a lower gear ratio is obtained

{ewc GSMVIMG,GSMVIMG, !tccS7013.bmp}

TCCS7013

Figure 32.
Planetary gears in the minimum reduction (drive) range. The ring gear is allowed to revolve, providing a higher gear ratio

{ewc GSMVIMG,GSMVIMG, !tccS7014.bmp}

TCCS7014

Figure 33.
Servos, operated by pressure, are used to apply or release the bands, to either hold the ring gear or allow it to rotate

{ewc GSMVIMG,GSMVIMG, !tccS7015.bmp}

TCCS7015

Figure 34.
Location and description of the THM-R4 (4L60) transmission serial number-early-model vehicles (1985-92)

{ewc GSMVIMG,GSMVIMG, !88261G06.bmp}

88261G06

Figure 35.
Location and description of the 4L60-E transmission serial number-late-model vehicles (1993-96)

{ewc GSMVIMG,GSMVIMG, !88261G07.bmp}

88261G07

Figure 36.
Loosen all of the transmission pan retaining bolts . . .

{ewc GSMVIMG,GSMVIMG, !88261P53.bmp}

88261P53

Figure 37.
. . . then remove all but a few at the very rear of the pan
{ewc GSMVIMG,GSMVIMG, !88261P54.bmp}

88261P54

Figure 38.
Once most of the fluid has drained, carefully lower the pan from the transmission
{ewc GSMVIMG,GSMVIMG, !88261P55.bmp}

88261P55

Figure 39.
Remove the filter for inspection and replacement

{ewc GSMVIMG,GSMVIMG, !88261P56.bmp}

88261P56

Figure 40.
The gasket (or rubber seal, depending on the application) should be replaced to prevent leaks

{ewc GSMVIMG,GSMVIMG, !88261P57.bmp}

88261P57

Figure 41.
The magnet at the bottom of the pan should be thoroughly cleaned of all metal particles

{ewc GSMVIMG,GSMVIMG, !88261P58.bmp}

88261P58

Figure 42.
Exploded view of the automatic transmission fluid pan and filter
{ewc GSMVIMG,GSMVIMG, !88261G58.bmp}

88261G58

Figure 43.
Shifting positions-THM 700-R4 (4L60) models with 3-gear (forward) shift levers
{ewc GSMVIMG,GSMVIMG, !88267G24.bmp}

88267G24

Figure 44.
Shifting positions-THM 700-R4 (4L60) and 4L60E models with 4-gear (forward) shift levers

{ewc GSMVIMG,GSMVIMG, !88267Ga4.bmp}

88267Ga4

Figure 45.
Exploded view of the automatic transmission shift linkage-1985-94 models (1995 similar)

{ewc GSMVIMG,GSMVIMG, !88267G25.bmp}

88267G25

Figure 46.
Adjusting the TV cable-V-6 on left, L-4 at middle and close-up of the adjuster assembly at right

{ewc GSMVIMG,GSMVIMG, !88267G26.bmp}

88267G26

Figure 47.
Shift cable routing and transmission attachment-1996 vehicles
{ewc GSMVIMG,GSMVIMG, !88267Ga7.bmp}

88267Ga7

Figure 48.
On All Wheel Drive (AWD) vehicles the shift cable is also secured to the transfer case

{ewc GSMVIMG,GSMVIMG, !88267Ga8.bmp}

88267Ga8

Figure 49.
Shift cable-to-steering column attachment

{ewc GSMVIMG,GSMVIMG, !88267Ga9.bmp}

88267Ga9

Figure 50.
Exploded view of the transmission mounted neutral safety switch-1996 models only

{ewc GSMVIMG,GSMVIMG, !88267Gb7.bmp}

88267Gb7

Figure 51.
Use the adjustment tool to greatly ease your job during neutral safety switch adjustment or installation

{ewc GSMVIMG,GSMVIMG, !88267Gb8.bmp}

88267Gb8

Figure 52.
Remove the driveshaft for access to the rear transmission (extension housing) seal

{ewc GSMVIMG,GSMVIMG, !88267P03.bmp}

88267P03

Figure 53.
Use a seal puller to remove the extension housing seal (BE CAREFUL not to damage the bore)

{ewc GSMVIMG,GSMVIMG, !88267P01.bmp}

88267P01

Figure 54.
Use a suitable driver to install the replacement seal into the housing
{ewc GSMVIMG,GSMVIMG, !88267P02.bmp}

88267P02

Figure 55.
Exploded view of the speedometer cable assembly-early model THM 700-R4 (4L60) only

{ewc GSMVIMG,GSMVIMG, !88267G27.bmp}

88267G27

Figure 56.
Automatic transmission support brackets-2.5L engine

{ewc GSMVIMG,GSMVIMG, !88267G28.bmp}

88267G28

Figure 57.
Automatic transmission support brackets-4.3L engine

{ewc GSMVIMG,GSMVIMG, !88267G29.bmp}

88267G29

Figure 58.
Exploded view of the transmission mount assembly

{ewc GSMVIMG,GSMVIMG, !88267G30.bmp}

88267G30

Figure 59.
Exploded view of the automatic transmission mounting-1985-93 vehicles shown (1994-96 similar)

{ewc GSMVIMG,GSMVIMG, !88267Gd1.bmp}

88267Gd1

Figure 60.
Exploded view of the automatic transmission mount-1993-95 vehicles and 1996 AWD vehicles

{ewc GSMVIMG,GSMVIMG, !88267Gd2.bmp}

88267Gd2

Figure 61.
Exploded view of the automatic transmission mount-1996 2WD vehicles

{ewc GSMVIMG,GSMVIMG, !88267Gd3.bmp}

88267Gd3

Figure 62.
The BW-4472 transfer case assembly

{ewc GSMVIMG,GSMVIMG, !88267G32.bmp}

88267G32

Figure 63.
Transfer case fill and drain plugs (along with other external components)
{ewc GSMVIMG,GSMVIMG, !88267G33.bmp}

88267G33

Figure 64.
Exploded view of the front output shaft flange and seal

{ewc GSMVIMG,GSMVIMG, !88267GE1.bmp}

88267GE1

Figure 65.
Extension housing (rear output shaft) seal alignment

{ewc GSMVIMG,GSMVIMG, !88267G34.bmp}

88267G34

Figure 66.
Install the seal (front or rear) using a suitable driver or seal installation tool
{ewc GSMVIMG,GSMVIMG, !88267G35.bmp}

88267G35

Figure 67.
Exploded view of the transfer case assembly mounting

{ewc GSMVIMG,GSMVIMG, !88267GE2.bmp}

88267GE2

Figure 68.
Exploded view of the front driveshaft mounting-1990-94 AWD vehicles
{ewc GSMVIMG,GSMVIMG, !88267G36.bmp}

88267G36

Figure 69.
Exploded view of the front driveshaft mounting-1995-96 AWD vehicles
{ewc GSMVIMG,GSMVIMG, !88267GF1.bmp}

88267GF1

Figure 70.
Exploded view of the rear driveshaft mounting-1985-94 vehicles (1995-96 similar)
{ewc GSMVIMG,GSMVIMG, !88267G37.bmp}

88267G37

Figure 71.
ALWAYS matchmark the driveshaft yoke to the companion flange to assure proper installation

{ewc GSMVIMG,GSMVIMG, !88267Pa4.bmp}

88267Pa4

Figure 72.
Remove the U-joint-to-companion flange retainers, then . . .

{ewc GSMVIMG,GSMVIMG, !88267P05.bmp}

88267P05

Figure 73.
. . . push the driveshaft forward slightly and lower the rear from the flange
{ewc GSMVIMG,GSMVIMG, !88267P06.bmp}

88267P06

Figure 74.
Be sure to tape the U-joint caps to prevent bearing loss or damage should they come loose

{ewc GSMVIMG,GSMVIMG, !88267P07.bmp}

88267P07

Figure 75.
An external snapring type U-joint is easily identified by the visible snapring in the yoke bore

{ewc GSMVIMG,GSMVIMG, !88267p04.bmp}

88267p04

Figure 76.
Exploded view of an internal snapring U-joint assembly

{ewc GSMVIMG,GSMVIMG, !88267G38.bmp}

88267G38

Figure 77.
To remove the U-joint use a cross press and a 1 1/8 in. (30mm) socket
{ewc GSMVIMG,GSMVIMG, !88267G39.bmp}

88267G39

Figure 78.
If necessary, the use of a spacer will allow the bearing cup to be pushed further from the yoke

{ewc GSMVIMG,GSMVIMG, !88267G40.bmp}

88267G40

Figure 79.
A hammer may be used to relieve preload from a snapring (during removal) or to help seat the snapring (during installation)

{ewc GSMVIMG,GSMVIMG, !88267G41.bmp}

88267G41

Figure 80.
Installing the U-joint bearing cross (spider) to the yoke

{ewc GSMVIMG,GSMVIMG, !88267G42.bmp}

88267G42

Figure 81.
Installing an internal snapring on a replacement U-joint

{ewc GSMVIMG,GSMVIMG, !88267G43.bmp}

88267G43

Figure 82.
Exploded view of an external U-joint assembly

{ewc GSMVIMG,GSMVIMG, !88267G44.bmp}

88267G44

Figure 83.
Exploded view of the double cardan U-joint-1995-96 front driveshaft (AWD vehicles)

{ewc GSMVIMG,GSMVIMG, !88267GF2.bmp}

88267GF2

Figure 84.
View of a common rear axle identification number and location
{ewc GSMVIMG,GSMVIMG, !88267G45.bmp}

88267G45

Figure 85.
Cross-sectional view of the rear axle, bearing and seal assembly
{ewc GSMVIMG,GSMVIMG, !88267G48.bmp}

88267G48

Figure 86.
Remove the tire and wheel assembly, along with the brake drum for access to the shaft

{ewc GSMVIMG,GSMVIMG, !88267P13.bmp}

88267P13

Figure 87.
Loosen the pinion shaft lock bolt using a ratchet or a box-end wrench (shown) . . .
{ewc GSMVIMG,GSMVIMG, !88267P08.bmp}

88267P08

Figure 88.
. . . then remove and discard the old lock bolt

{ewc GSMVIMG,GSMVIMG, !88267P09.bmp}

88267P09

Figure 89.
Pinion shaft lock bolt and rear axle C-lock locations (note a separate C-lock is used for each axle shaft)

{ewc GSMVIMG,GSMVIMG, !88267G46.bmp}

88267G46

Figure 90.
Grasp the end of the pinion shaft and pull

{ewc GSMVIMG,GSMVIMG, !88267P10.bmp}

88267P10

Figure 91.
Once the pinion shaft is fully removed . . .

{ewc GSMVIMG,GSMVIMG, !88267P11.bmp}

88267P11

Figure 92.
. . . the axle shaft can be pushed inward and the C-lock can be withdrawn
{ewc GSMVIMG,GSMVIMG, !88267P12.bmp}

88267P12

Figure 93.
Pull the shaft STRAIGHT back from the axle tube (be careful not to damage any components)

{ewc GSMVIMG,GSMVIMG, !88267P14.bmp}

88267P14

Figure 94.
On late-model vehicles with ABS carefully clean the ABS reluctor ring with a soft-bristled brush

{ewc GSMVIMG,GSMVIMG, !88267P15.bmp}

88267P15

Figure 95.
Keep the seal puller away from the ABS speed sensor, as pictured it could damage the sensor

{ewc GSMVIMG,GSMVIMG, !88267P16.bmp}

88267P16

Figure 96.
If removal is necessary use a slide hammer and bearing puller assembly to remove the rear axle wheel bearings

{ewc GSMVIMG,GSMVIMG, !88267G49.bmp}

88267G49

Figure 97.
The rear axle wheel bearings are installed using a driver

{ewc GSMVIMG,GSMVIMG, !88267G50.bmp}

88267G50

Figure 98.
The best way to install a replacement seal is with the proper seal driver
{ewc GSMVIMG,GSMVIMG, !88267G47.bmp}

88267G47

Figure 99.
During seal installation, KEEP THE DRIVER away from the speed sensor
{ewc GSMVIMG,GSMVIMG, !88267P17.bmp}

88267P17

Figure 100.
Measure the pinion flange pre-load (force necessary to turn the flange) before loosening the retaining nut

{ewc GSMVIMG,GSMVIMG, !88267G56.bmp}

88267G56

Figure 101.
A companion flange holder tool is necessary to loosen or tighten the nut

{ewc GSMVIMG,GSMVIMG, !88267G57.bmp}

88267G57

Figure 102.
Use the proper sized seal installation tool or driver to install the replacement pinion seal

{ewc GSMVIMG,GSMVIMG, !88267G58.bmp}

88267G58

Figure 103.
Exploded view of the rear axle mounting-early-model vehicles
{ewc GSMVIMG,GSMVIMG, !88267G51.bmp}

88267G51

Figure 104.
Exploded view of the rear axle mounting-late-model vehicles
{ewc GSMVIMG,GSMVIMG, !88267G59.bmp}

88267G59

Figure 105.
Exploded view of the front drive axle component mounting

{ewc GSMVIMG,GSMVIMG, !88267G52.bmp}

88267G52

Figure 106.
Separating the halfshaft from the hub-1990-93 vehicles

{ewc GSMVIMG,GSMVIMG, !88267G53.bmp}

88267G53

Figure 107.
A drift can be inserted through the top of the caliper and the rotor vanes to keep the shaft from turning

{ewc GSMVIMG,GSMVIMG, !88267G60.bmp}

88267G60

Figure 108.
The brake line bracket should be removed from the upper control arm to provide additional knuckle travel

{ewc GSMVIMG,GSMVIMG, !88267G61.bmp}

88267G61

Figure 109.
Disconnect the lower shock fasteners and position the shock out of the way
{ewc GSMVIMG,GSMVIMG, !88267G62.bmp}

88267G62

Figure 110.
Disconnect the upper ball joint from the knuckle, so it be repositioned for clearance

{ewc GSMVIMG,GSMVIMG, !88267G63.bmp}

88267G63

Figure 111.
Wire the knuckle assembly to the upper control arm in order to provide clearance while preventing brake line damage

{ewc GSMVIMG,GSMVIMG, !88267G64.bmp}

88267G64

Figure 112.
Use a suitable separator tool to drive the axle shaft from the hub
{ewc GSMVIMG,GSMVIMG, !88267G65.bmp}

88267G65

Figure 113.
Exploded view of the halfshaft and CV-joint assemblies

{ewc GSMVIMG,GSMVIMG, !88267G66.bmp}

88267G66

Figure 114.
Aligning the cage windows with the outer race lands so the cage (and inner race) may be removed

{ewc GSMVIMG,GSMVIMG, !85387093.bmp}

85387093

Figure 115.
Rotating the inner race up and out of the cage

{ewc GSMVIMG,GSMVIMG, !85387094.bmp}

85387094

Figure 116.
Small retaining clamp installation and ear dimension

{ewc GSMVIMG,GSMVIMG, !85387095.bmp}

85387095

Figure 117.
Large retaining clamp installation and ear dimension-outer joint shown (inner joint uses same dimension)

{ewc GSMVIMG,GSMVIMG, !85387096.bmp}

85387096

Figure 118.
Snapring and spider removal

{ewc GSMVIMG,GSMVIMG, !85387109.bmp}

85387109

Figure 119.
Proper inboard boot and housing positioning

{ewc GSMVIMG,GSMVIMG, !85387110.bmp}

85387110

Figure 120.
Remove the CV-joint housing and check for wear or damage
{ewc GSMVIMG,GSMVIMG, !85917037.bmp}

85917037

Figure 121.
With the spacer and spider pushed back, grasp the snapring using a pair of snapring pliers

{ewc GSMVIMG,GSMVIMG, !85917038.bmp}

85917038

Figure 122.
Remove the snapring from the shaft so the spider assembly may be removed
{ewc GSMVIMG,GSMVIMG, !85917040.bmp}

85917040

Figure 123.
With the snapring removed, the spider is free to be pulled from the shaft
{ewc GSMVIMG,GSMVIMG, !85917041.bmp}

85917041

Figure 124.
If necessary, remove the spacer ring from the shaft

{ewc GSMVIMG,GSMVIMG, !85917042.bmp}

85917042

Figure 125.
The output shaft seal and bearing assembly is removed using a slide hammer and bearing puller

{ewc GSMVIMG,GSMVIMG, !88267G67.bmp}

88267G67

Figure 126.
Use a suitable driver or seal installer to seal the replacement seal
{ewc GSMVIMG,GSMVIMG, !88267G68.bmp}

88267G68

Figure 127.
Before removing the flange nut, measure pre-load (rotational force) using an inch lbs. torque wrench

{ewc GSMVIMG,GSMVIMG, !88267G69.bmp}

88267G69

Figure 128.
A flange holding tool will be necessary to loosen or tighten the pinion nut
{ewc GSMVIMG,GSMVIMG, !88267G54.bmp}

88267G54

Figure 129.
Use a suitable driver or seal installer to seat the replacement seal
{ewc GSMVIMG,GSMVIMG, !88267G70.bmp}

88267G70

Figure 130.
Front differential carrier assembly mounting

{ewc GSMVIMG,GSMVIMG, !88267G55.bmp}

88267G55

Figure 1.
Wheel lug nut tightening sequence-use a crisscross pattern

{ewc GSMVIMG,GSMVIMG, !88268Ga1.bmp}

88268Ga1

Figure 2.
Use an arbor press to drive the old stud from the rotor-front wheel of 2wd vehicles
{ewc GSMVIMG,GSMVIMG, !85388005.bmp}

85388005

Figure 3.
On many vehicles a stud press tool may be used with the hub still installed on the vehicle

{ewc GSMVIMG,GSMVIMG, !85388006.bmp}

85388006

Figure 4.
Two wheel drive front suspension-Note that ABS equipped vehicles use a different splash shield (with a speed sensor)

{ewc GSMVIMG,GSMVIMG, !88268G01.bmp}

88268G01

Figure 5.
The lower control arm MUST be supported using a spring remover tool and suitable jack

{ewc GSMVIMG,GSMVIMG, !88268G02.bmp}

88268G02

Figure 6.
Positioning the coil spring

{ewc GSMVIMG,GSMVIMG, !88268G03.bmp}

88268G03

Figure 7.
During installation, the lower control arm bolts MUST be facing the proper direction

{ewc GSMVIMG,GSMVIMG, !88268G04.bmp}

88268G04

Figure 8.
Exploded view of the front shock absorber retainers

{ewc GSMVIMG,GSMVIMG, !88268G05.bmp}

88268G05

Figure 9.
DON'T loosen the retainer without holding the shaft (a box wrench is usually better than a socket)

{ewc GSMVIMG,GSMVIMG, !88268p01.bmp}

88268p01

Figure 10.
Once the upper shock retainer is removed, loosen the lower retaining bolts . . .
{ewc GSMVIMG,GSMVIMG, !88268p02.bmp}

88268p02

Figure 11.
. . . and carefully lower the shock from the control arm
{ewc GSMVIMG,GSMVIMG, !88268p03.bmp}

88268p03

Figure 12.
To check the ball joint, first wipe the grease and road crud off the it for a visual inspection

{ewc GSMVIMG,GSMVIMG, !88268p04.bmp}

88268p04

Figure 13.
Checking for ball joint looseness

{ewc GSMVIMG,GSMVIMG, !88268Ga2.bmp}

88268Ga2

Figure 14.
Use a separator tool to free the upper ball joint from the steering knuckle
{ewc GSMVIMG,GSMVIMG, !88268G06.bmp}

88268G06

Figure 15.
Drill pilot holes in the upper ball joint rivets . . .

{ewc GSMVIMG,GSMVIMG, !88268G07.bmp}

88268G07

Figure 16.
. . . then drill off the rivet heads

{ewc GSMVIMG,GSMVIMG, !88268G08.bmp}

88268G08

Figure 17.
When installing a service replacement upper ball joint, be sure the bolts are positioned on the bottom (nuts on top)

{ewc GSMVIMG,GSMVIMG, !88268G09.bmp}

88268G09

Figure 18.
The lower ball joint can be inspected for wear visually using the built-in indicator (the grease fitting)

{ewc GSMVIMG,GSMVIMG, !88268G11.bmp}

88268G11

Figure 19.
The proper ball joint separator tool MUST be used if the joint is not being replaced, otherwise the joint may be damaged requiring replacement

{ewc GSMVIMG,GSMVIMG, !88268G10.bmp}

88268G10

Figure 20.
Support the lower control arm using a floor jack-this will keep the coil spring and arm in position

{ewc GSMVIMG,GSMVIMG, !88268p05.bmp}

88268p05

Figure 21.
Remove the cotter pin from the lower ball joint stud . . .

{ewc GSMVIMG,GSMVIMG, !88268p06.bmp}

88268p06

Figure 22.
. . . then loosen the stud nut-note that the tie rod end was removed earlier for illustration purposes

{ewc GSMVIMG,GSMVIMG, !88268p07.bmp}

88268p07

Figure 23.
Remove the ball joint nut then install a separator tool to free the joint . . .
{ewc GSMVIMG,GSMVIMG, !88268p08.bmp}

88268p08

Figure 24.
. . . use this tool ONLY if the joint is being replaced as the seal will likely be destroyed by the tool

{ewc GSMVIMG,GSMVIMG, !88268p09.bmp}

88268p09

Figure 25.
Use the ball joint removal tools in the Remover and Installer Set to press the old joint from the lower control arm

{ewc GSMVIMG,GSMVIMG, !88268G12.bmp}

88268G12

Figure 26.
The new ball joint should also be pressed into position using the tool set
{ewc GSMVIMG,GSMVIMG, !88268G13.bmp}

88268G13

Figure 27.
Exploded view of the stabilizer shaft mounting

{ewc GSMVIMG,GSMVIMG, !88268Ga3.bmp}

88268Ga3

Figure 28.
Loosen the stabilizer bar link nut, while using a wrench to hold the bolt from turning . . .

{ewc GSMVIMG,GSMVIMG, !88268p10.bmp}

88268p10

Figure 29.
. . . then remove the bolt, gathering each of the link components and keeping them in order

{ewc GSMVIMG,GSMVIMG, !88268p11.bmp}

88268p11

Figure 30.
Make sure the offset on the bar is aligned properly during installation
{ewc GSMVIMG,GSMVIMG, !88268G14.bmp}

88268G14

Figure 31.
Exploded view of the upper control arm mounting

{ewc GSMVIMG,GSMVIMG, !88268G15.bmp}

88268G15

Figure 32.
Exploded view of the upper control arm, pivot shaft and bushings
{ewc GSMVIMG,GSMVIMG, !88268G16.bmp}

88268G16

Figure 33.
When replacing the bushings, make sure they are positioned as shown
{ewc GSMVIMG,GSMVIMG, !88268Ga5.bmp}

88268Ga5

Figure 34.
Exploded view of the lower control arm mounting

{ewc GSMVIMG,GSMVIMG, !88268Ga4.bmp}

88268Ga4

Figure 35.
Exploded view of the steering knuckle mounting

{ewc GSMVIMG,GSMVIMG, !88268G17.bmp}

88268G17

Figure 36.
Use a suitable steering linkage puller to disconnect the tie rod end from the knuckle

{ewc GSMVIMG,GSMVIMG, !88268G18.bmp}

88268G18

Figure 37.
Exploded view of the 4wd front suspension assembly

{ewc GSMVIMG,GSMVIMG, !88268G23.bmp}

88268G23

Figure 38.
Torsion bar unloading tool

{ewc GSMVIMG,GSMVIMG, !88268G25.bmp}

88268G25

Figure 39.
Exploded view of the torsion bar mounting-1990-92

{ewc GSMVIMG,GSMVIMG, !88268Ga6.bmp}

88268Ga6

Figure 40.
Exploded view of the torsion bar mounting-1993-96

{ewc GSMVIMG,GSMVIMG, !88268G24.bmp}

88268G24

Figure 41.
Exploded view of the early-model AWD shock mounting-1990-92 vehicles
{ewc GSMVIMG,GSMVIMG, !88268G26.bmp}

88268G26

Figure 42.
Exploded view of the late-model AWD shock mounting-1993-96 vehicles
{ewc GSMVIMG,GSMVIMG, !88268Ga7.bmp}

88268Ga7

Figure 43.
Checking for ball joint looseness

{ewc GSMVIMG,GSMVIMG, !88268Ga2.bmp}

88268Ga2

Figure 44.
Exploded view of the service replacement upper ball joint

{ewc GSMVIMG,GSMVIMG, !88268G27.bmp}

88268G27

Figure 45.
Upper ball joint separator tool

{ewc GSMVIMG,GSMVIMG, !88268Ga8.bmp}

88268Ga8

Figure 46.
The lower ball joint can be inspected for wear visually using the built-in indicator (the grease fitting)

{ewc GSMVIMG,GSMVIMG, !88268G11.bmp}

88268G11

Figure 47.
Exploded view of the service replacement lower ball joint
{ewc GSMVIMG,GSMVIMG, !88268G28.bmp}

88268G28

Figure 48.
Exploded view of the stabilizer bar mounting-1993-96 vehicles (early-models similar)

{ewc GSMVIMG,GSMVIMG, !88268G29.bmp}

88268G29

Figure 49.
Exploded view of the upper control arm and bushing mounting-1990-91 vehicles
{ewc GSMVIMG,GSMVIMG, !88268G30.bmp}

88268G30

Figure 50.
Exploded view of the upper control arm and bushing mounting-1992-96 vehicles
{ewc GSMVIMG,GSMVIMG, !88268G30.bmp}

88268G30

Figure 51.
Exploded view of the lower control arm assembly mounting-1990-91 vehicles
{ewc GSMVIMG,GSMVIMG, !88268G31.bmp}

88268G31

Figure 52.
Exploded view of the lower control arm assembly mounting-1992-96 vehicles
{ewc GSMVIMG,GSMVIMG, !88268Gb1.bmp}

88268Gb1

Figure 53.
Standard front wheel alignment measurements

{ewc GSMVIMG,GSMVIMG, !88268g32.bmp}

88268g32

Figure 54.
Camber and caster adjustment-2wd vehicles

{ewc GSMVIMG,GSMVIMG, !88268g33.bmp}

88268g33

Figure 55.
To adjust Toe-In, first loosen the tie rod adjuster clamp bolts . . .
{ewc GSMVIMG,GSMVIMG, !88268p31.bmp}

88268p31

Figure 56.
. . . then turn the adjuster tube as necessary to achieve the required toe-in specification

{ewc GSMVIMG,GSMVIMG, !88268p32.bmp}

88268p32

Figure 57.
When you are finished, the adjuster tube should be centered in the threads between the tie rod ends

{ewc GSMVIMG,GSMVIMG, !88268p33.bmp}

88268p33

Figure 58.
Measuring and adjusting the trim height "Z" dimension-2wd vehicles (late-model shown, early-model similar)

{ewc GSMVIMG,GSMVIMG, !88268gb2.bmp}

88268gb2

Figure 59.
Measuring and adjusting the trim height "Z" dimension-early-model AWD vehicles
{ewc GSMVIMG,GSMVIMG, !88268g34.bmp}

88268g34

Figure 60.
Measuring and adjusting the trim height "Z" dimension-late-model AWD vehicles
{ewc GSMVIMG,GSMVIMG, !88268gb3.bmp}

88268gb3

Figure 61.
Exploded view of the rear suspension assembly-1985-94 models shown (late-model similar)

{ewc GSMVIMG,GSMVIMG, !88268G36.bmp}

88268G36

Figure 62.
These rear suspension parts are shared by all these vans (springs, shocks and floating rear axle)

{ewc GSMVIMG,GSMVIMG, !88268p12.bmp}

88268p12

Figure 63.
Exploded view of the leaf spring mounting-1985-94 vehicles

{ewc GSMVIMG,GSMVIMG, !88268G35.bmp}

88268G35

Figure 64.
Adjusting the rear suspension trim height

{ewc GSMVIMG,GSMVIMG, !88268G37.bmp}

88268G37

Figure 65.
Exploded view of the leaf spring mounting-1995-96 vehicles
{ewc GSMVIMG,GSMVIMG, !88268Gb4.bmp}

88268Gb4

Figure 66.
Measuring the rear suspension trim height

{ewc GSMVIMG,GSMVIMG, !88268Gb5.bmp}

88268Gb5

Figure 67.
Exploded view of the rear shock mounting

{ewc GSMVIMG,GSMVIMG, !88268G39.bmp}

88268G39

Figure 68.
Loosen and remove the shock absorber upper retaining nut . . .
{ewc GSMVIMG,GSMVIMG, !88268p13.bmp}

88268p13

Figure 69.
. . . then remove the lower retainers

{ewc GSMVIMG,GSMVIMG, !88268p14.bmp}

88268p14

Figure 70.
On the right shock, the parking brake cable bracket must be removed and repositioned

{ewc GSMVIMG,GSMVIMG, !88268p15.bmp}

88268p15

Figure 71.
Lift the shock out of the lower mounting bracket, then . . .

{ewc GSMVIMG,GSMVIMG, !88268p16.bmp}

88268p16

Figure 72.
. . . remove it from the upper mounting stud and remove it from the vehicle
{ewc GSMVIMG,GSMVIMG, !88268p17.bmp}

88268p17

Figure 73.
Exploded view of the rear stabilizer bar mounting-1985-93 vehicles

{ewc GSMVIMG,GSMVIMG, !88268G38.bmp}

88268G38

Figure 74.
Exploded view of the rear stabilizer bar mounting-1994-96 vehicles
{ewc GSMVIMG,GSMVIMG, !88268Gb6.bmp}

88268Gb6

Figure 75.
Exploded view of a common standard steering column-except 1996
{ewc GSMVIMG,GSMVIMG, !88268G53.bmp}

88268G53

Figure 76.
Exploded view of a common tilt steering column-except 1996
{ewc GSMVIMG,GSMVIMG, !88268G54.bmp}

88268G54

Figure 77.
Exploded view of a common early-model floor shift, tilt steering column
{ewc GSMVIMG,GSMVIMG, !88268G55.bmp}

88268G55

Figure 78.
Exploded view of the standard 1996 steering column (tilt uses same upper components)

{ewc GSMVIMG,GSMVIMG, !88268Gb7.bmp}

88268Gb7

Figure 79.
Remove the steering wheel from the column using a suitable threaded puller
{ewc GSMVIMG,GSMVIMG, !88268G51.bmp}

88268G51

Figure 80.
Exploded view of the inflator module-to-steering wheel mounting-except 1996 models

{ewc GSMVIMG,GSMVIMG, !88268Gb9.bmp}

88268Gb9

Figure 81.
The inflator module is secured to the steering wheel using leaf springs and notched pins-1996 models

{ewc GSMVIMG,GSMVIMG, !88268Gc1.bmp}

88268Gc1

Figure 82.
Once the air bag is removed, steering wheel removal is much the same as it is for non-air bag models

{ewc GSMVIMG,GSMVIMG, !88268Gc2.bmp}

88268Gc2

Figure 83.
Compress the steering shaft locking plate using this special tool for access to the snapring

{ewc GSMVIMG,GSMVIMG, !88268G52.bmp}

88268G52

Figure 84.
Removing the turn signal wiring harness protective cover from the column
{ewc GSMVIMG,GSMVIMG, !88268G56.bmp}

88268G56

Figure 85.
Removing the turn signal switch from the column

{ewc GSMVIMG,GSMVIMG, !88268Gc3.bmp}

88268Gc3

Figure 86.
Exploded view of the SIR coil mounting in the upper steering column
{ewc GSMVIMG,GSMVIMG, !88268Gc4.bmp}

88268Gc4

Figure 87.
Use a shaft lock compressor tool to expose the shaft lock snapring (retaining ring)
{ewc GSMVIMG,GSMVIMG, !88268Gc5.bmp}

88268Gc5

Figure 88.
View of the turn signal switch and related component mounting in the upper steering column

{ewc GSMVIMG,GSMVIMG, !88268Gc6.bmp}

88268Gc6

Figure 89.
Centering the SIR coil assembly

{ewc GSMVIMG,GSMVIMG, !88268Gc7.bmp}

88268Gc7

Figure 90.
Exploded view of the combination switch assembly mounting-1996 vehicles only
{ewc GSMVIMG,GSMVIMG, !88268Gc8.bmp}

88268Gc8

Figure 91.
The SIR coil MUST be centered if it is allowed to uncenter (unwind) during steering column service

{ewc GSMVIMG,GSMVIMG, !88268Gc9.bmp}

88268Gc9

Figure 92.
Common early-model style ignition switch-NOTE proper switch position for installation

{ewc GSMVIMG,GSMVIMG, !88268G57.bmp}

88268G57

Figure 93.
Another common ignition switch found on GM steering columns-again finding the LOCK position is critical to assure proper adjustment during installation

{ewc GSMVIMG,GSMVIMG, !88268Gd1.bmp}

88268Gd1

Figure 94.
Before installation, make sure the switch is in the OFF-LOCK position-a drill bit can be used to hold the switch in this position during installation

{ewc GSMVIMG,GSMVIMG, !88268Gd2.bmp}

88268Gd2

Figure 95.
Use a small bladed prytool or screwdriver to gently release the retaining clip on the key alarm

{ewc GSMVIMG,GSMVIMG, !88268Gd3.bmp}

88268Gd3

Figure 96.
Exploded view of the ignition switch and key alarm assembly

{ewc GSMVIMG,GSMVIMG, !88268Gd4.bmp}

88268Gd4

Figure 97.
A drill bit should be used to limit switch travel and aid in dimmer switch adjustment

{ewc GSMVIMG,GSMVIMG, !88268Gd5.bmp}

88268Gd5

Figure 98.
Exploded view of the lock cylinder mounting-early-model shown (late-model, except 1996, similar)

{ewc GSMVIMG,GSMVIMG, !88268G58.bmp}

88268G58

Figure 99.
Lock cylinder and upper shroud removal

{ewc GSMVIMG,GSMVIMG, !88268Gd6.bmp}

88268Gd6

Figure 100.
During installation, make sure the tab on the lock cylinder and the sector in the cylinder module assembly are aligned

{ewc GSMVIMG,GSMVIMG, !88268Gd7.bmp}

88268Gd7

Figure 101.
Exploded view of the steering column mounting-except 1996 models
{ewc GSMVIMG,GSMVIMG, !88268G59.bmp}

88268G59

Figure 102.
Intermediate shaft with Cardan joint

{ewc GSMVIMG,GSMVIMG, !88268G60.bmp}

88268G60

Figure 103.
Exploded view of the steering column mounting-1996 vehicles
{ewc GSMVIMG,GSMVIMG, !88268Gd8.bmp}

88268Gd8

Figure 104.
Measuring the intermediate shaft angles

{ewc GSMVIMG,GSMVIMG, !88268Gd9.bmp}

88268Gd9

Figure 105.
Exploded view of the 2 wheel drive steering linkage assembly

{ewc GSMVIMG,GSMVIMG, !88268G62.bmp}

88268G62

Figure 106.
All Wheel Drive (AWD) steering linkage assembly

{ewc GSMVIMG,GSMVIMG, !88268Ge1.bmp}

88268Ge1

Figure 107.
These special tools are used to seat linkage shaft tapers during installation
{ewc GSMVIMG,GSMVIMG, !88268G61.bmp}

88268G61

Figure 108.
A universal steering linkage puller is necessary for almost all linkage replacement procedures

{ewc GSMVIMG,GSMVIMG, !88268Ge2.bmp}

88268Ge2

Figure 109.
Most steering linkage components are removed by first loosening and removing the nut . . .

{ewc GSMVIMG,GSMVIMG, !88268p18.bmp}

88268p18

Figure 110.
. . . then using a universal steering linkage puller to loosen the stud
{ewc GSMVIMG,GSMVIMG, !88268p19.bmp}

88268p19

Figure 111.
Once the stud is freed, separate the linkage

{ewc GSMVIMG,GSMVIMG, !88268p20.bmp}

88268p20

Figure 112.
Pitman arm removal requires the use of this special tool
{ewc GSMVIMG,GSMVIMG, !88268Ge4.bmp}

88268Ge4

Figure 113.
Idler arm inspection should be conducted using a spring scale
{ewc GSMVIMG,GSMVIMG, !88268G63.bmp}

88268G63

Figure 114.
Loosen and remove the idler arm-to-frame mounting bolts . . .
{ewc GSMVIMG,GSMVIMG, !88268p21.bmp}

88268p21

Figure 115.
. . . then separate the idler ball stud from the relay rod . . .
{ewc GSMVIMG,GSMVIMG, !88268p22.bmp}

88268p22

Figure 116.
. . . and remove the idler arm from the vehicle

{ewc GSMVIMG,GSMVIMG, !88268p23.bmp}

88268p23

Figure 117.
Inner tie rod and relay rod connections require the use of a press-type linkage/wheel stud remover

{ewc GSMVIMG,GSMVIMG, !88268Ge3.bmp}

88268Ge3

Figure 118.
Proper orientation of the tie rod clamps and adjuster tube
{ewc GSMVIMG,GSMVIMG, !88268G65.bmp}

88268G65

Figure 119.
To separate the tie rod end from the steering knuckle, first straighten the cotter pin . . .

{ewc GSMVIMG,GSMVIMG, !88268p24.bmp}

88268p24

Figure 120.
. . . then remove and discard the old cotter pin

{ewc GSMVIMG,GSMVIMG, !88268p25.bmp}

88268p25

Figure 121.
Using a wrench (shown) or a deep socket, loosen the tie rod stud retaining nut
{ewc GSMVIMG,GSMVIMG, !88268p26.bmp}

88268p26

Figure 122.
Unthread the nut from the stud . . .

{ewc GSMVIMG,GSMVIMG, !88268p27.bmp}

88268p27

Figure 123.
. . . then use a universal steering linkage puller to free the stud from the knuckle
{ewc GSMVIMG,GSMVIMG, !88268p28.bmp}

88268p28

Figure 124.
If only the rod end is being removed, matchmark the threads (to preserve toe adjustment) . . .

{ewc GSMVIMG,GSMVIMG, !88268p29.bmp}

88268p29

Figure 125.
. . . then loosen the adjuster clamp bolt and unthread the end from the adjuster tube

{ewc GSMVIMG,GSMVIMG, !88268p30.bmp}

88268p30

Figure 126.
Using an inch lbs. torque wrench, measure the bearing drag (force necessary to turn the steering wheel)

{ewc GSMVIMG,GSMVIMG, !88268G66.bmp}

88268G66

Figure 127.
Manual steering gear and adjuster components

{ewc GSMVIMG,GSMVIMG, !88268G67.bmp}

88268G67

Figure 128.
Exploded view of the manual steering gear mounting

{ewc GSMVIMG,GSMVIMG, !88268G68.bmp}

88268G68

Figure 129.
Remove the adjuster locknut from the gear by driving it counterclockwise
{ewc GSMVIMG,GSMVIMG, !88268g69.bmp}

88268g69

Figure 130.
Matchmark the housing with the adjuster plug hole

{ewc GSMVIMG,GSMVIMG, !88268g70.bmp}

88268g70

Figure 131.
Measure back (counterclockwise) and scribe a second mark

{ewc GSMVIMG,GSMVIMG, !88268g71.bmp}

88268g71

Figure 132.
Use the spanner wrench to align the adjuster plug with the second mark
{ewc GSMVIMG,GSMVIMG, !88268g72.bmp}

88268g72

Figure 133.
Align the stub shaft with the side cover

{ewc GSMVIMG,GSMVIMG, !88268g73.bmp}

88268g73

Figure 134.
Align the pitman arm shaft master spline

{ewc GSMVIMG,GSMVIMG, !88268g74.bmp}

88268g74

Figure 135.
Use an inch lbs. torque wrench to measure overcenter rotation torque

{ewc GSMVIMG,GSMVIMG, !88268g75.bmp}

88268g75

Figure 136.
Exploded view of the power steering gear mounting

{ewc GSMVIMG,GSMVIMG, !88268G76.bmp}

88268G76

Figure 137.
Exploded view of the power steering pump assembly mounting-2.5L engine
{ewc GSMVIMG,GSMVIMG, !88268G77.bmp}

88268G77

Figure 138.
Exploded view of the power steering pump assembly mounting-early-model 4.3L engine

{ewc GSMVIMG,GSMVIMG, !88268G78.bmp}

88268G78

Figure 139.
Removing the power steering pump pulley-1985-92 vehicles

{ewc GSMVIMG,GSMVIMG, !88268G79.bmp}

88268G79

Figure 140.
Installing the power steering pump pulley

{ewc GSMVIMG,GSMVIMG, !88268G80.bmp}

88268G80

Figure 141.
Pump pulley removal and installation-1993-96 vehicles

{ewc GSMVIMG,GSMVIMG, !88268G81.bmp}

88268G81

Figure 142.
Exploded view of the power steering pump mounting-late-model 4.3L engines (1993-96 shown)

{ewc GSMVIMG,GSMVIMG, !88268G82.bmp}

88268G82

Figure 143.
Typical power steering pump hose routing-1996 shown

{ewc GSMVIMG,GSMVIMG, !88268G83.bmp}

88268G83

Figure 1.
Rear wheel anti-lock brake system

{ewc GSMVIMG,GSMVIMG, !88269g02.bmp}

88269g02

Figure 2.
Four wheel anti-lock brake system

{ewc GSMVIMG,GSMVIMG, !88269g01.bmp}

88269g01

Figure 3.
The star wheel is used to adjust the rear brakes

{ewc GSMVIMG,GSMVIMG, !88269g03.bmp}

88269g03

Figure 4.
Use a punch to pop out the adjuster knockouts if it hasn't already been done

{ewc GSMVIMG,GSMVIMG, !88269p01.bmp}

88269p01

Figure 5.
Remove the metal tab from the backing plate. DO NOT allow it to fall into the drum
{ewc GSMVIMG,GSMVIMG, !88269p02.bmp}

88269p02

Figure 6.
Use a brake adjusting spoon to turn the starwheel. A screwdriver just won't work that well

{ewc GSMVIMG,GSMVIMG, !88269p03.bmp}

88269p03

Figure 7.
The use of a pedal force gauge will make testing the pedal travel more accurate
{ewc GSMVIMG,GSMVIMG, !88269g44.bmp}

88269g44

Figure 8.
Plunger type brake light switch

{ewc GSMVIMG,GSMVIMG, !88269g04.bmp}

88269g04

Figure 9.
Box type brake light switch

{ewc GSMVIMG,GSMVIMG, !88269g46.bmp}

88269g46

Figure 10.
All master cylinders are held with two nuts, regardless of the booster type
{ewc GSMVIMG,GSMVIMG, !88269g47.bmp}

88269g47

Figure 11.
Remove as much of the used fluid as possible from the reservoirs
{ewc GSMVIMG,GSMVIMG, !88269p04.bmp}

88269p04

Figure 12.
Use only flare wrenches on the line fittings or the fitting might get damaged
{ewc GSMVIMG,GSMVIMG, !88269p05.bmp}

88269p05

Figure 13.
Use a rag to catch any brake fluid that spills, otherwise the fluid could cause paint damage

{ewc GSMVIMG,GSMVIMG, !88269p06.bmp}

88269p06

Figure 14.
Be careful when removing the master cylinder nuts, they are close to the positive battery terminal

{ewc GSMVIMG,GSMVIMG, !88269p07.bmp}

88269p07

Figure 15.
Remove the master cylinder and check for fluid in the booster
{ewc GSMVIMG,GSMVIMG, !88269p08.bmp}

88269p08

Figure 16.
Use fresh fluid when reinstalling the master cylinder

{ewc GSMVIMG,GSMVIMG, !88269p09.bmp}

88269p09

Figure 17.
Remove the reservoir from the master cylinder by gently prying it off
{ewc GSMVIMG,GSMVIMG, !88269g05.bmp}

88269g05

Figure 18.
Exploded view of the master cylinder

{ewc GSMVIMG,GSMVIMG, !88269g06.bmp}

88269g06

Figure 19.
Press and rock the master cylinder to seat the reservoir in the grommets
{ewc GSMVIMG,GSMVIMG, !88269g07.bmp}

88269g07

Figure 20.
The vacuum booster mounting nuts are inside the vehicle at the pedal assembly
{ewc GSMVIMG,GSMVIMG, !88269g08.bmp}

88269g08

Figure 21.
Exploded view of the vacuum booster assembly

{ewc GSMVIMG,GSMVIMG, !88269g09.bmp}

88269g09

Figure 22.
Hydro-boost mounting order

{ewc GSMVIMG,GSMVIMG, !88269g58.bmp}

88269g58

Figure 23.
Hydro-boost hose routing

{ewc GSMVIMG,GSMVIMG, !88269g51.bmp}

88269g51

Figure 24.
Potential leakage points on the hydro-boost unit

{ewc GSMVIMG,GSMVIMG, !88269g52.bmp}

88269g52

Figure 25.
Exploded view of the hydro-boost unit

{ewc GSMVIMG,GSMVIMG, !88269g53.bmp}

88269g53

Figure 26.
Use a rag to catch the fluid when disconnecting the pressure hoses
{ewc GSMVIMG,GSMVIMG, !88269p10.bmp}

88269p10

Figure 27.
Always use a flare wrench on the fittings

{ewc GSMVIMG,GSMVIMG, !88269p11.bmp}

88269p11

Figure 28.
Note the O-ring on the end of the fitting. Use a new one when reconnecting
{ewc GSMVIMG,GSMVIMG, !88269p12.bmp}

88269p12

Figure 29.
Loosen and remove the booster mounting nuts from inside the vehicle
{ewc GSMVIMG,GSMVIMG, !88269p16.bmp}

88269p16

Figure 30.
Disconnect the pushrod from the pedal

{ewc GSMVIMG,GSMVIMG, !88269p15.bmp}

88269p15

Figure 31.
Withdraw the booster assembly by pulling straight out

{ewc GSMVIMG,GSMVIMG, !88269p13.bmp}

88269p13

Figure 32.
Once the booster is out far enough to clear the pushrod, it can be removed from the vehicle

{ewc GSMVIMG,GSMVIMG, !88269p14.bmp}

88269p14

Figure 33.
Cut away view of a combination valve. The style of valve can vary
{ewc GSMVIMG,GSMVIMG, !88269g10.bmp}

88269g10

Figure 34.
On most applications, the combination valve is bolted to a bracket attached to the master cylinder mounting studs

{ewc GSMVIMG,GSMVIMG, !88269g11.bmp}

88269g11

Figure 35.
Front brake hose routing-Two wheel drive

{ewc GSMVIMG,GSMVIMG, !88269g12.bmp}

88269g12

Figure 36.
Front brake hose routing-All wheel drive

{ewc GSMVIMG,GSMVIMG, !88269g48.bmp}

88269g48

Figure 37.
Rear brake hose routing

{ewc GSMVIMG,GSMVIMG, !88269g13.bmp}

88269g13

Figure 38.
You don't need to use a flare wrench to remove a banjo fitting
{ewc GSMVIMG,GSMVIMG, !88269p28.bmp}

88269p28

Figure 39.
Always replace the crush gaskets every time the connection is disassembled
{ewc GSMVIMG,GSMVIMG, !88269p29.bmp}

88269p29

Figure 40.
Front brake pipe routing-Two wheel drive

{ewc GSMVIMG,GSMVIMG, !88269g49.bmp}

88269g49

Figure 41.
Front brake pipe routing-All wheel drive

{ewc GSMVIMG,GSMVIMG, !88269g50.bmp}

88269g50

Figure 42.
Flare identification

{ewc GSMVIMG,GSMVIMG, !88269g14.bmp}

88269g14

Figure 43.
Keep the end of the hose immersed in clean brake fluid to prevent air from being drawn back into the system

{ewc GSMVIMG,GSMVIMG, !88269g15.bmp}

88269g15

Figure 44.
Make sure that the end of the bleeder hose is below the level of the bleeder screw
{ewc GSMVIMG,GSMVIMG, !88269p17.bmp}

88269p17

Figure 45.
The use of a long handled wrench makes bleeding the rear wheel cylinder easier
{ewc GSMVIMG,GSMVIMG, !88269p18.bmp}

88269p18

Figure 46.
This tool is used to depress the combination valve plunger to allow proper flow of brake fluid during bleeding

{ewc GSMVIMG,GSMVIMG, !88269g17.bmp}

88269g17

Figure 47.
The GM Pressure Bleeder adapter, J-29567 or equivalent, is needed when using this bleeding technique

{ewc GSMVIMG,GSMVIMG, !88269g18.bmp}

88269g18

Figure 48.
The EHCU should need to be bled ONLY after replacement
{ewc GSMVIMG,GSMVIMG, !88269g16.bmp}

88269g16

Figure 49.
The brake pad wear warning sensor will squeal once the pad is thin enough that the tab touches the rotor

{ewc GSMVIMG,GSMVIMG, !88269g24.bmp}

88269g24

Figure 50.
Brake pad inspection points

{ewc GSMVIMG,GSMVIMG, !88269g25.bmp}

88269g25

Figure 51.
Get to know what a worn pad looks like versus a new pad
{ewc GSMVIMG,GSMVIMG, !88269g26.bmp}

88269g26

Figure 52.
Measure the thickness of the friction material, not the backing plate
{ewc GSMVIMG,GSMVIMG, !88269p19.bmp}

88269p19

Figure 53.
The standard GM front disc brake

{ewc GSMVIMG,GSMVIMG, !88269p20.bmp}

88269p20

Figure 54.
Exploded view of the caliper and pad components-Two wheel drive
{ewc GSMVIMG,GSMVIMG, !88269g29.bmp}

88269g29

Figure 55.
Exploded view of the caliper and pad components-All wheel drive
{ewc GSMVIMG,GSMVIMG, !88269g65.bmp}

88269g65

Figure 56.
A prybar can be used to press the pads into the caliper enough to remove the caliper . . .

{ewc GSMVIMG,GSMVIMG, !88269g30.bmp}

88269g30

Figure 57.
. . . or a C-clamp applied to the outboard pad will press the piston in the bore without cocking

{ewc GSMVIMG,GSMVIMG, !88269p21.bmp}

88269p21

Figure 58.
Use the proper socket on the caliper bolts. There have been different types of bolt heads used

{ewc GSMVIMG,GSMVIMG, !88269g59.bmp}

88269g59

Figure 59.
The pins are the only thing that hold the caliper to the mount
{ewc GSMVIMG,GSMVIMG, !88269p22.bmp}

88269p22

Figure 60.
Check the pins for corrosion and damage

{ewc GSMVIMG,GSMVIMG, !88269p23.bmp}

88269p23

Figure 61.
Pull the caliper straight off the rotor to remove otherwise it could bind
{ewc GSMVIMG,GSMVIMG, !88269p24.bmp}

88269p24

Figure 62.
Support the caliper so the weight does not pull on the brake line
{ewc GSMVIMG,GSMVIMG, !88269p25.bmp}

88269p25

Figure 63.
Separate the outer pad from the caliper. You may need a small prybar to do this if the fit is tight

{ewc GSMVIMG,GSMVIMG, !88269p26.bmp}

88269p26

Figure 64.
The inner pad is held by this spring. Make sure it is in place before installing the new pad

{ewc GSMVIMG,GSMVIMG, !88269p27.bmp}

88269p27

Figure 65.
Upon installation, the pad will click into place if the retainer spring is installed properly

{ewc GSMVIMG,GSMVIMG, !88269g31.bmp}

88269g31

Figure 66.
An often forgotten step is compressing the brake pad ears. If it isn't done, the pads can rattle

{ewc GSMVIMG,GSMVIMG, !88269g32.bmp}

88269g32

Figure 67.
The caliper bolts must pass under the pad retaining ears
{ewc GSMVIMG,GSMVIMG, !88269g28.bmp}

88269g28

Figure 68.
Check the clearance between the caliper and caliper mount. The numbers shown are total clearance, not individual sides-Two wheel drive

{ewc GSMVIMG,GSMVIMG, !88269g61.bmp}

88269g61

Figure 69.
Check the clearance between the caliper and caliper mount. The numbers shown are total clearance, not individual sides-All wheel drive

{ewc GSMVIMG,GSMVIMG, !88269g64.bmp}

88269g64

Figure 70.
Exploded view of a brake caliper

{ewc GSMVIMG,GSMVIMG, !88269g62.bmp}

88269g62

Figure 71.
Use low pressure compressed air to remove the piston, but be sure to pad the opposite side of the caliper to prevent the piston from flying out . . .

{ewc GSMVIMG,GSMVIMG, !88269g33.bmp}

88269g33

Figure 72.
. . . a block of wood provides a suitable protective cushion for the piston
{ewc GSMVIMG,GSMVIMG, !88269p31.bmp}

88269p31

Figure 73.
Pull the piston out and away from the dust boot

{ewc GSMVIMG,GSMVIMG, !88269p32.bmp}

88269p32

Figure 74.
Check the surface of the piston for damage and corrosion
{ewc GSMVIMG,GSMVIMG, !88269p33.bmp}

88269p33

Figure 75.
Inspect the caliper for obvious defects before continuing the rebuild
{ewc GSMVIMG,GSMVIMG, !88269p34.bmp}

88269p34

Figure 76.
Use a small prytool to remove the dust boot

{ewc GSMVIMG,GSMVIMG, !88269g34.bmp}

88269g34

Figure 77.
The dust seal needs to be replaced every time it is removed
{ewc GSMVIMG,GSMVIMG, !88269p35.bmp}

88269p35

Figure 78.
Be careful when removing the piston seal not to nick or scratch the bore and seal seating area

{ewc GSMVIMG,GSMVIMG, !88269p36.bmp}

88269p36

Figure 79.
Use a proper tool, such as this, to install the dust boot . . .
{ewc GSMVIMG,GSMVIMG, !88269g63.bmp}

88269g63

Figure 80.
. . . using a dust boot tool will help make sure the boot is properly seated
{ewc GSMVIMG,GSMVIMG, !88269p37.bmp}

88269p37

Figure 81.
Before installation, check that the old crush gasket isn't stuck at the inlet port
{ewc GSMVIMG,GSMVIMG, !88269p30.bmp}

88269p30

Figure 82.
Exploded view of brake assembly-Two wheel drive

{ewc GSMVIMG,GSMVIMG, !88269g38.bmp}

88269g38

Figure 83.
Rotor, hub and bearing assembly-All wheel drive

{ewc GSMVIMG,GSMVIMG, !88269g36.bmp}

88269g36

Figure 84.
Use a dial indicator to determine brake disc runout

{ewc GSMVIMG,GSMVIMG, !88269g37.bmp}

88269g37

Figure 85.
Drum brake components

{ewc GSMVIMG,GSMVIMG, !88269g39.bmp}

88269g39

Figure 86.
The standard GM drum brake

{ewc GSMVIMG,GSMVIMG, !88269p38.bmp}

88269p38

Figure 87.
Use proper brake tools when removing parts like the return springs
{ewc GSMVIMG,GSMVIMG, !88269p39.bmp}

88269p39

Figure 88.
Note the direction in which each spring and component is installed for ease during installation

{ewc GSMVIMG,GSMVIMG, !88269p40.bmp}

88269p40

Figure 89.
Sometimes tools such as needle nosed pliers allow you additionally needed flexibility

{ewc GSMVIMG,GSMVIMG, !88269p41.bmp}

88269p41

Figure 90.
Use this tool by placing the socket over the pin and rotating until the tang lifts the spring or linkage off

{ewc GSMVIMG,GSMVIMG, !88269p42.bmp}

88269p42

Figure 91.
Do not lose this plate. Nothing holds it in place once the springs are removed
{ewc GSMVIMG,GSMVIMG, !88269p43.bmp}

88269p43

Figure 92.
A brake shoe retention pin removal tool makes the job much easier
{ewc GSMVIMG,GSMVIMG, !88269p44.bmp}

88269p44

Figure 93.
Press on the back side of the pin while using the tool to allow the pin to be released from the lock

{ewc GSMVIMG,GSMVIMG, !88269p45.bmp}

88269p45

Figure 94.
Try to remove most of the parts as entire assemblies. This will ease installation
{ewc GSMVIMG,GSMVIMG, !88269p46.bmp}

88269p46

Figure 95.
The shoes can come out together at this point and be disassembled on the bench
{ewc GSMVIMG,GSMVIMG, !88269p47.bmp}

88269p47

Figure 96.
Separate the parking brake lever from the shoes to free the shoes from the brake assembly

{ewc GSMVIMG,GSMVIMG, !88269p48.bmp}

88269p48

Figure 97.
After the shoes have been removed, this link will be one part left behind
{ewc GSMVIMG,GSMVIMG, !88269p49.bmp}

88269p49

Figure 98.
Drum brake components ready for inspection

{ewc GSMVIMG,GSMVIMG, !88269p50.bmp}

88269p50

Figure 99.
Wheel cylinder mounting

{ewc GSMVIMG,GSMVIMG, !88269g41.bmp}

88269g41

Figure 100.
Only 2 bolts hold the wheel cylinder in place (Plug the line to prevent system contamination)

{ewc GSMVIMG,GSMVIMG, !88269p51.bmp}

88269p51

Figure 101.
Exploded view of the wheel cylinder

{ewc GSMVIMG,GSMVIMG, !88269g40.bmp}

88269g40

Figure 102.
Parking brake pedal assembly

{ewc GSMVIMG,GSMVIMG, !88269g42.bmp}

88269g42

Figure 103.
Front parking brake cable routing

{ewc GSMVIMG,GSMVIMG, !88269g67.bmp}

88269g67

Figure 104.
Front parking brake cable bracket

{ewc GSMVIMG,GSMVIMG, !88269p52.bmp}

88269p52

Figure 105.
Equalizer assembly

{ewc GSMVIMG,GSMVIMG, !88269g43.bmp}

88269g43

Figure 106.
Equalizer and rear cable assembly

{ewc GSMVIMG,GSMVIMG, !88269g66.bmp}

88269g66

Figure 107.
Pull out on the cable end to free the lever from the cable
{ewc GSMVIMG,GSMVIMG, !88269p53.bmp}

88269p53

Figure 108.
Use a box end wrench to press in the clips to free the cable from the backing plate
{ewc GSMVIMG,GSMVIMG, !88269p54.bmp}

88269p54

Figure 109.
Adjusting the parking brake at the equalizer

{ewc GSMVIMG,GSMVIMG, !88269p55.bmp}

88269p55

Figure 110.
RWAL brake system diagram

{ewc GSMVIMG,GSMVIMG, !88269g80.bmp}

88269g80

Figure 111.
RWAL wiring diagram

{ewc GSMVIMG,GSMVIMG, !88269g81.bmp}

88269g81

Figure 112.
RWAL connector pinouts

{ewc GSMVIMG,GSMVIMG, !88269g82.bmp}

88269g82

Figure 113.
4WAL hydraulic system-1996 shown

{ewc GSMVIMG,GSMVIMG, !88269g83.bmp}

88269g83

Figure 114.
4WAL Component locations-except 1996 models

{ewc GSMVIMG,GSMVIMG, !88269g71.bmp}

88269g71

Figure 115.
4WAL Component locations-1996 models

{ewc GSMVIMG,GSMVIMG, !88269g72.bmp}

88269g72

Figure 116.
Three sensor 4WAL brake system diagram-Except 1996 models
{ewc GSMVIMG,GSMVIMG, !88269g84.bmp}

88269g84

Figure 117.
Four sensor 4WAL brake system diagram-Except 1996 models
{ewc GSMVIMG,GSMVIMG, !88269g85.bmp}

88269g85

Figure 118.
Three sensor 4WAL brake system wiring diagram-Except 1996 models
{ewc GSMVIMG,GSMVIMG, !88269g86.bmp}

88269g86

Figure 119.
Four sensor 4WAL brake system wiring diagram-Except 1996 models
{ewc GSMVIMG,GSMVIMG, !88269g87.bmp}

88269g87

Figure 120.
4WAL connector pinouts-Except 1996 models

{ewc GSMVIMG,GSMVIMG, !88269g88.bmp}

88269g88

Figure 121.
4WAL brake system diagram-1996 models

{ewc GSMVIMG,GSMVIMG, !88269g89.bmp}

88269g89

Figure 122.
4WAL brake system wiring diagram-1996 models

{ewc GSMVIMG,GSMVIMG, !88269g90.bmp}

88269g90

Figure 123.
4WAL brake system connector pinouts-1996 models

{ewc GSMVIMG,GSMVIMG, !88269g91.bmp}

88269g91

Figure 124.
EHCU/BPMV mounting

{ewc GSMVIMG,GSMVIMG, !88269g19.bmp}

88269g19

Figure 125.
ECHU/BPMV brake line connections

{ewc GSMVIMG,GSMVIMG, !88269g68.bmp}

88269g68

Figure 126.
EHCU/BPMV mounting-1996 models

{ewc GSMVIMG,GSMVIMG, !88269g69.bmp}

88269g69

Figure 127.
EHCU/BPMV exploded view-1996 models

{ewc GSMVIMG,GSMVIMG, !88269g70.bmp}

88269g70

Figure 128.
Electronic control unit and isolation/dump valve mounting location-RWAL
{ewc GSMVIMG,GSMVIMG, !88269g20.bmp}

88269g20

Figure 129.
Front wheel speed sensor resistance chart-Non-integral sensors
{ewc GSMVIMG,GSMVIMG, !88269g76.bmp}

88269g76

Figure 130.
Front wheel speed sensor resistance chart-Integral sensors
{ewc GSMVIMG,GSMVIMG, !88269g77.bmp}

88269g77

Figure 131.
Front wheel speed sensor-2WD

{ewc GSMVIMG,GSMVIMG, !88269g21.bmp}

88269g21

Figure 132.
Sensor wire routing-2WD

{ewc GSMVIMG,GSMVIMG, !88269g73.bmp}

88269g73

Figure 133.
The front wheel speed sensor is accessible after removing the hub and rotor
{ewc GSMVIMG,GSMVIMG, !88269p56.bmp}

88269p56

Figure 134.
Simply remove the two mounting bolts to replace the sensor
{ewc GSMVIMG,GSMVIMG, !88269p57.bmp}

88269p57

Figure 135.
Pull the sensor off the backing plate and route the wires through the opening
{ewc GSMVIMG,GSMVIMG, !88269p58.bmp}

88269p58

Figure 136.
Integral front wheel speed sensor-AWD

{ewc GSMVIMG,GSMVIMG, !88269g75.bmp}

88269g75

Figure 137.
Front wheel speed sensor wire routing-AWD

{ewc GSMVIMG,GSMVIMG, !88269g74.bmp}

88269g74

Figure 138.
Non-integral front wheel speed sensor-AWD

{ewc GSMVIMG,GSMVIMG, !88269g22.bmp}

88269g22

Figure 139.
Rear wheel speed sensor resistance chart

{ewc GSMVIMG,GSMVIMG, !88269g76.bmp}

88269g76

Figure 140.
Rear wheel speed sensor

{ewc GSMVIMG,GSMVIMG, !88269g23.bmp}

88269g23

Figure 141.
Rear wheel speed sensor wiring harness routing

{ewc GSMVIMG,GSMVIMG, !88269g78.bmp}

88269g78

Figure 142.
The tone ring splines need to be clean to work properly

{ewc GSMVIMG,GSMVIMG, !88269p59.bmp}

88269p59

Figure 143.
Rear wheel speed sensor mounting. Axle is removed for clarity
{ewc GSMVIMG,GSMVIMG, !88269p60.bmp}

88269p60

Figure 144.
Vehicle speed sensor resistance chart

{ewc GSMVIMG,GSMVIMG, !88269g76.bmp}

88269g76

Figure 145.
Vehicle speed sensor mounting

{ewc GSMVIMG,GSMVIMG, !88269g79.bmp}

88269g79

Figure 146.
Unplug the weatherpak connector from the VSS

{ewc GSMVIMG,GSMVIMG, !88269p61.bmp}

88269p61

Figure 147.
The VSS is held by the one bolt and clamp

{ewc GSMVIMG,GSMVIMG, !88269p62.bmp}

88269p62

Figure 148.
Withdraw the VSS from the transmission or transaxle

{ewc GSMVIMG,GSMVIMG, !88269p63.bmp}

88269p63

Figure 149.
Fluid will come out of the VSS opening so be ready to catch the spillage
{ewc GSMVIMG,GSMVIMG, !88269p64.bmp}

88269p64

Figure 150.
Pinout of the ALDL connector

{ewc GSMVIMG,GSMVIMG, !88269g92.bmp}

88269g92

Figure 1.
Replacing the door spring and hinge pin

{ewc GSMVIMG,GSMVIMG, !88260g01.bmp}

88260g01

Figure 2.
Installing replacement door hinges onto the vehicle

{ewc GSMVIMG,GSMVIMG, !88260g02.bmp}

88260g02

Figure 3.
Exploded view of the front door alignment points

{ewc GSMVIMG,GSMVIMG, !88260g03.bmp}

88260g03

Figure 4.
Exploded view of the front door striker mounting

{ewc GSMVIMG,GSMVIMG, !88260g04.bmp}

88260g04

Figure 5.
If the striker must be removed, first scribe an alignment mark . . .
{ewc GSMVIMG,GSMVIMG, !88260p01.bmp}

88260p01

Figure 6.
. . . then loosen the striker using a suitable driver (usually a Torx(r))
{ewc GSMVIMG,GSMVIMG, !88260p02.bmp}

88260p02

Figure 7.
Rear door hinges

{ewc GSMVIMG,GSMVIMG, !88260g05.bmp}

88260g05

Figure 8.
Rear door check assembly

{ewc GSMVIMG,GSMVIMG, !88260g06.bmp}

88260g06

Figure 9.
Rear door alignment

{ewc GSMVIMG,GSMVIMG, !88260g07.bmp}

88260g07

Figure 10.
Exploded view of the upper/lower roller brackets and cable latch-sliding door assembly

{ewc GSMVIMG,GSMVIMG, !88260g08.bmp}

88260g08

Figure 11.
If the sliding door striker must be removed, first make alignment marks . . .

{ewc GSMVIMG,GSMVIMG, !88260p03.bmp}

88260p03

Figure 12.
. . . then loosen and remove the striker bolt using a suitable driver (usually a Torx(r))

{ewc GSMVIMG,GSMVIMG, !88260p04.bmp}

88260p04

Figure 13.
Sliding door gap adjustments

{ewc GSMVIMG,GSMVIMG, !88260g09.bmp}

88260g09

Figure 14.
Exploded view of the door striker mounting-sliding door assembly
{ewc GSMVIMG,GSMVIMG, !88260g10.bmp}

88260g10

Figure 15.
Exploded view of the center roller track cover (upper) and track (lower) assembly-sliding door

{ewc GSMVIMG,GSMVIMG, !88260g11.bmp}

88260g11

Figure 16.
Exploded view of the center roller bracket-sliding door

{ewc GSMVIMG,GSMVIMG, !88260g12.bmp}

88260g12

Figure 17.
Once fascias or brackets are gone, bumper removal is a simple matter of unbolting retainers . . .

{ewc GSMVIMG,GSMVIMG, !88260p05.bmp}

88260p05

Figure 18.

. . . in most cases a backup wrench is necessary to keep the retainer from spinning

{ewc GSMVIMG,GSMVIMG, !88260p06.bmp}

88260p06

Figure 19.
Exploded view of a typical early-model Astro and Safari front bumper mounting-two wheel drive vehicles

{ewc GSMVIMG,GSMVIMG, !88260g13.bmp}

88260g13

Figure 20.
Exploded view of a typical Astro and Safari front bumper mounting-all wheel drive vehicles

{ewc GSMVIMG,GSMVIMG, !88260g14.bmp}

88260g14

Figure 21.
Exploded view of a typical late-model Astro and Safari front bumper and fascia assembly

{ewc GSMVIMG,GSMVIMG, !88260g55.bmp}

88260g55

Figure 22.
Exploded view of a typical early-model Astro and Safari rear bumper mounting
{ewc GSMVIMG,GSMVIMG, !88260g15.bmp}

88260g15

Figure 23.
Exploded view of a typical Astro and Safari rear bumper fascia mounting
{ewc GSMVIMG,GSMVIMG, !88260g56.bmp}

88260g56

Figure 24.
Exploded view of a typical early-model Astro and Safari grille and front end panel mounting

{ewc GSMVIMG,GSMVIMG, !88260g16.bmp}

88260g16

Figure 25.
Exploded view of a typical late-model Astro and Safari grille mounting
{ewc GSMVIMG,GSMVIMG, !88260g57.bmp}

88260g57

Figure 26.
Front fender mounting points

{ewc GSMVIMG,GSMVIMG, !88260g18.bmp}

88260g18

Figure 27.
Exploded view of the standard and power outside mirrors

{ewc GSMVIMG,GSMVIMG, !88260g17.bmp}

88260g17

Figure 28.
Power mirror diagnosis-part 1 of 2

{ewc GSMVIMG,GSMVIMG, !88260g19.bmp}

88260g19

Figure 29.
Power mirror diagnosis-part 2 of 2

{ewc GSMVIMG,GSMVIMG, !88260g20.bmp}

88260g20

Figure 30.
Exploded view of a typical Astro and Safari radio antenna mounting
{ewc GSMVIMG,GSMVIMG, !88260g21.bmp}

88260g21

Figure 31.
Radio antenna wire routing

{ewc GSMVIMG,GSMVIMG, !88260g22.bmp}

88260g22

Figure 32.
Exploded view of the outside handle and lock cylinder assembly-front door
{ewc GSMVIMG,GSMVIMG, !88260g23.bmp}

88260g23

Figure 33.
Lock cylinder assembly mounting and related components-front door
{ewc GSMVIMG,GSMVIMG, !88260g24.bmp}

88260g24

Figure 34.
Exploded view of the inside door handle mounting-front door

{ewc GSMVIMG,GSMVIMG, !88260g25.bmp}

88260g25

Figure 35.
Exploded view of typical Astro and Safari power door lock components
{ewc GSMVIMG,GSMVIMG, !88260g26.bmp}

88260g26

Figure 36.
Lock assembly components-sliding door

{ewc GSMVIMG,GSMVIMG, !88260g27.bmp}

88260g27

Figure 37.
Exploded view of the power door lock motor assembly mounting-sliding door
{ewc GSMVIMG,GSMVIMG, !88260g28.bmp}

88260g28

Figure 38.
Rear door lock cylinder removal

{ewc GSMVIMG,GSMVIMG, !88260g29.bmp}

88260g29

Figure 39.
Upper and lower door latches

{ewc GSMVIMG,GSMVIMG, !88260g30.bmp}

88260g30

Figure 40.
Power lock actuator and related components

{ewc GSMVIMG,GSMVIMG, !88260g31.bmp}

88260g31

Figure 41.
Before loosening ANY fasteners, ALWAYS scribe matchmarks as points of reference

{ewc GSMVIMG,GSMVIMG, !88260p07.bmp}

88260p07

Figure 42.
Loosen the bolts and reposition the latch, as necessary for adjustment
{ewc GSMVIMG,GSMVIMG, !88260p08.bmp}

88260p08

Figure 43.
Windshield reveal molding

{ewc GSMVIMG,GSMVIMG, !88260g32.bmp}

88260g32

Figure 44.
Cutting the window from the frame

{ewc GSMVIMG,GSMVIMG, !88260g33.bmp}

88260g33

Figure 45.
Windshield spacers

{ewc GSMVIMG,GSMVIMG, !88260g34.bmp}

88260g34

Figure 46.
Pinchweld primer locations

{ewc GSMVIMG,GSMVIMG, !88260g35.bmp}

88260g35

Figure 47.
Windshield primer locations

{ewc GSMVIMG,GSMVIMG, !88260ga5.bmp}

88260ga5

Figure 48.
Urethane adhesive locations

{ewc GSMVIMG,GSMVIMG, !88260g36.bmp}

88260g36

Figure 49.
Swing out window latch

{ewc GSMVIMG,GSMVIMG, !88260g37.bmp}

88260g37

Figure 50.
Window garnish molding

{ewc GSMVIMG,GSMVIMG, !88260g38.bmp}

88260g38

Figure 51.
Swing out window hinge

{ewc GSMVIMG,GSMVIMG, !88260g39.bmp}

88260g39

Figure 52.
Primer locations for fixed windows

{ewc GSMVIMG,GSMVIMG, !88260g40.bmp}

88260g40

Figure 53.
Fixed window components

{ewc GSMVIMG,GSMVIMG, !88260g41.bmp}

88260g41

Figure 54.
Exploded view of a typical Astro and Safari door trim panel mounting
{ewc GSMVIMG,GSMVIMG, !88260g43.bmp}

88260g43

Figure 55.
Front door handle trim cover removal

{ewc GSMVIMG,GSMVIMG, !88260g44.bmp}

88260g44

Figure 56.
Remove the armrest screws and slide it back off the trim panel (on early-model vehicles) . . .

{ewc GSMVIMG,GSMVIMG, !88260p09.bmp}

88260p09

Figure 57.
. . . or carefully pry the armrest free (on late-model vehicles)
{ewc GSMVIMG,GSMVIMG, !88260p10.bmp}

88260p10

Figure 58.
Remove the armrest from the trim panel for access
{ewc GSMVIMG,GSMVIMG, !88260p11.bmp}

88260p11

Figure 59.
CAREFULLY pry the door handle trim cover free and pull outward . . .
{ewc GSMVIMG,GSMVIMG, !88260p12.bmp}

88260p12

Figure 60.
If equipped, remove the wiring retainer by twisting . . .

{ewc GSMVIMG,GSMVIMG, !88260p13.bmp}

88260p13

Figure 61.
. . . then disengage the wiring from the power lock and window switches
{ewc GSMVIMG,GSMVIMG, !88260p14.bmp}

88260p14

Figure 62.
Remove any trim panel retaining screws (like this one normally found under the armrest) . . .

{ewc GSMVIMG,GSMVIMG, !88260p15.bmp}

88260p15

Figure 63.
. . . then remove the trim panel by CAREFULLY prying the plastic snap-fasteners free from the door

{ewc GSMVIMG,GSMVIMG, !88260p16.bmp}

88260p16

Figure 64.
Window regulator components and mounting

{ewc GSMVIMG,GSMVIMG, !88260g45.bmp}

88260g45

Figure 65.
To access the window motor, remove the door panel, then pull back the inner liner (water deflector)

{ewc GSMVIMG,GSMVIMG, !88260p17.bmp}

88260p17

Figure 66.
Rearview mirror support positioning

{ewc GSMVIMG,GSMVIMG, !88260g46.bmp}

88260g46

Figure 67.
Exploded view of a typical Astro and Safari front bucket seat mounting-with manual adjuster

{ewc GSMVIMG,GSMVIMG, !88260g47.bmp}

88260g47

Figure 68.
Exploded view of a typical Astro and Safari front bucket seat mounting-with power adjuster

{ewc GSMVIMG,GSMVIMG, !88260g48.bmp}

88260g48

Figure 69.
To remove the seats, begin by loosening and removing the riser and floor nuts
{ewc GSMVIMG,GSMVIMG, !88260p18.bmp}

88260p18

Figure 70.
Exploded view of a typical Astro and Safari intermediate seat assembly-Bench shown (bucket and rear seats, similar)

{ewc GSMVIMG,GSMVIMG, !88260g51.bmp}

88260g51

Figure 71.
Power seat diagnosis-part 1 of 2

{ewc GSMVIMG,GSMVIMG, !88260g49.bmp}

88260g49

Figure 72.
Power seat diagnosis-part 2 of 2

{ewc GSMVIMG,GSMVIMG, !88260g50.bmp}

88260g50

Figure 73.
Exploded view of a typical Astro and Safari headliner and attachment locations-NOTE-late-model vehicles may also be equipped with an overhead console above and between the front seats

{ewc GSMVIMG,GSMVIMG, !88260g52.bmp}

88260g52

Figure 74.
Exploded view of the overhead console mounting-available in late-model vehicles
{ewc GSMVIMG,GSMVIMG, !88260g58.bmp}

88260g58

{ewc GSMVIMG,GSMVIMG, !88261g37.bmp}

88261g37

{ewc GSMVIMG,GSMVIMG, !88261c04.bmp}

88261c04

{ewc GSMVIMG,GSMVIMG, !tccs1044.bmp}

tccs1044

{ewc GSMVIMG,GSMVIMG, !88261c02.bmp}

88261c02

{ewc GSMVIMG,GSMVIMG, !tccs1c01.bmp}

tccs1c01

{ewc GSMVIMG,GSMVIMG, !tccs1c02.bmp}

tccs1c02

{ewc GSMVIMG,GSMVIMG, !tccs1c03.bmp}

tccs1c03

{ewc GSMVIMG,GSMVIMG, !tccs1c04.bmp}

tccs1c04

{ewc GSMVIMG,GSMVIMG, !tccs1c05.bmp}

tccs1c05

{ewc GSMVIMG,GSMVIMG, !tccs1c06.bmp}

tccs1c06

{ewc GSMVIMG,GSMVIMG, !tccs1c07.bmp}

tccs1c07

{ewc GSMVIMG,GSMVIMG, !88261c03.bmp}

88261c03

{ewc GSMVIMG,GSMVIMG, !88261c05.bmp}

88261c05

{ewc GSMVIMG,GSMVIMG, !88261c06.bmp}

88261c06

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tccs1241

{ewc GSMVIMG,GSMVIMG, !88261c01.bmp}

88261c01

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tccs2c02

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tccs2c01

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88263c03

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88263c04

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88263c01

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88263c05

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88263c06

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88263c08

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88263c09

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88263c10

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tccs3c05

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tccs3c06

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tccs3c07

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tccs3c09

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tccs3c10

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tccs3c11

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tccs3c12

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88263c02

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88264g94

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88266g72

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88266c01

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88266c02

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88266c03

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88266c04

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88266g82

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88266g66

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88267c07

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88267c05

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88267c06

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88267c01

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88267c02

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88267c03

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88267c04

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88269g91

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88269c57

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88269c01

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88269c02

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88269c03

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88269c04

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88269c05

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88260g53

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88260g19

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88260g20

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88260g49

{ewc GSMVIMG,GSMVIMG, !88260g50.bmp}

88260g50

Figure 124.
Vacuum hose routing—1985–87 with 2.5L TBI engine
{ewc GSMVIMG,GSMVIMG, !88264v01.bmp}

88264v01

VACUUM HOSE ROUTING-1988-90 WITH 2.5L TBI ENGINE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Figure 125.
Vacuum hose routing—1988–90 with 2.5L TBI engine
{ewc GSMVIMG,GSMVIMG, !88264v02.bmp}

88264v02

VACUUM HOSE ROUTING-1985 4.3L CARBURETED ENGINE (FEDERAL) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Figure 126.
Vacuum hose routing—1985 4.3L carbureted engine (Federal)
{ewc GSMVIMG,GSMVIMG, !88264v03.bmp}

88264v03

VACUUM HOSE ROUTING-1985 WITH 4.3L CARBURETED ENGINE (FEDERAL AND LOW ALTITUDE) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Figure 127.
Vacuum hose routing—1985 with 4.3L carbureted engine (Federal and low altitude)
{ewc GSMVIMG,GSMVIMG, !88264v04.bmp}

88264v04

VACUUM HOSE ROUTING-1986-88 WITH 4.3L TBI ENGINE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Figure 128.
Vacuum hose routing—1986–88 with 4.3L TBI engine
{ewc GSMVIMG,GSMVIMG, !88264v05.bmp}

88264v05

VACUUM HOSE ROUTING-1988-91 WITH 4.3L TBI ENGINE (FEDERAL WITHOUT AIR PUMP) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Figure 129.
Vacuum hose routing—1988–91 with 4.3L TBI engine (Federal without air pump)
{ewc GSMVIMG,GSMVIMG, !88264v06.bmp}

88264v06

VACUUM HOSE ROUTING-1988-91 WITH 4.3L TBI ENGINE (FEDERAL WITH AIR PUMP) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Figure 130.
Vacuum hose routing—1988–91 with 4.3L TBI engine (Federal with air pump)
{ewc GSMVIMG,GSMVIMG, !88264v07.bmp}

88264v07

VACUUM HOSE ROUTING-1992-95 WITH 4.3L (VIN Z) ENGINE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Figure 131.
Vacuum hose routing—1992–95 with 4.3L (VIN Z) engine

{ewc GSMVIMG,GSMVIMG, !88264v08.bmp}

88264v08

VACUUM HOSE ROUTING-1992-95 WITH 4.3L (VIN W) ENGINE, FEDERAL {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Figure 132.
Vacuum hose routing—1992–95 with 4.3L (VIN W) engine, Federal
{ewc GSMVIMG,GSMVIMG, !88264v10.bmp}

88264v10

VACUUM HOSE ROUTING-1992-95 WITH 4.3L (VIN W) ENGINE, CALIFORNIA
{ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Figure 133.
Vacuum hose routing—1992–95 with 4.3L (VIN W) engine, California
{ewc GSMVIMG,GSMVIMG, !88264v11.bmp}

88264v11

VACUUM HOSE ROUTING-1996 WITH 4.3L CSFI ENGINE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Figure 134.
Vacuum hose routing—1996 with 4.3L CSFI engine

{ewc GSMVIMG,GSMVIMG, !88264v09.bmp}

88264v09

Figure 168.
Sample diagram-how to read and interpret wiring

{ewc GSMVIMG,GSMVIMG, !tccs6w01.bmp}

tccs6w01

COMMON WIRING DIAGRAM SYMBOLS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Figure 169.
Common wiring diagram symbols

{ewc GSMVIMG,GSMVIMG, !tccs6w02.bmp}

tccs6w02

ENGINE CONTROLS-1985-86 2.5L ENGINE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Figure 170.
Engine controls-1985-86 2.5L engine

{ewc GSMVIMG,GSMVIMG, !88266w01.bmp}

88266w01

ENGINE CONTROLS-1987-90 2.5L ENGINE {ewc MVIMAGE, MVIMAGE, ! nexttopicarrow.bmp}

Figure 171.
Engine controls--1987-90 2.5L engine
{ewc GSMVIMG,GSMVIMG, !88266w02.bmp}

88266w02

ENGINE CONTROLS-1985 4.3L ENGINE {ewc MVIMAGE, MVIMAGE, ! nexttopicarrow.bmp}

Figure 172.
Engine controls-1985 4.3L engine

{ewc GSMVIMG,GSMVIMG, !88266w03.bmp}

88266w03

ENGINE CONTROLS-1986 4.3L ENGINE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Figure 173.
Engine controls-1986 4.3L engine

{ewc GSMVIMG,GSMVIMG, !88266w04.bmp}

88266w04

ENGINE CONTROLS-1987 4.3L ENGINE {ewc MVIMAGE, MVIMAGE, !
nexttopicarrow.bmp}

Figure 174.
Engine controls-1987 4.3L engine

{ewc GSMVIMG,GSMVIMG, !88266w05.bmp}

88266w05

ENGINE CONTROLS-1988-91 4.3L ENGINE AND 1992 4.3L (VIN Z) ENGINE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Figure 175.
Engine controls-1988-91 4.3L engine and 1992 4.3L (VIN Z) engine
{ewc GSMVIMG,GSMVIMG, !88266w06.bmp}

88266w06

ENGINE CONTROLS-1992 4.3L (VIN W) ENGINE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Figure 176.
Engine controls-1992 4.3L (VIN W) engine

{ewc GSMVIMG,GSMVIMG, !88266w07.bmp}

88266w07

ENGINE CONTROLS-1993-95 4.3L ENGINE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Figure 177.
Engine controls-1993-95 4.3L engine

{ewc GSMVIMG,GSMVIMG, !88266w08.bmp}

88266w08

ENGINE CONTROLS-1996 4.3L ENGINE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Figure 178.
Engine controls-1996 4.3L engine

{ewc GSMVIMG,GSMVIMG, !88266w09.bmp}

88266w09

BODY WIRING GROUP 1-1985-86 MODELS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Figure 179.
Body wiring group 1-1985-86 models

{ewc GSMVIMG,GSMVIMG, !88266w10.bmp}

88266w10

BODY WIRING GROUP 1-1987 MODELS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Figure 180.
Body wiring group 1-1987 models

{ewc GSMVIMG,GSMVIMG, !88266w11.bmp}

88266w11

BODY WIRING GROUP 2-1985-87 MODELS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Figure 181.
Body wiring group 2-1985-87 models

{ewc GSMVIMG,GSMVIMG, !88266w12.bmp}

88266w12

BODY WIRING GROUP 1-1988 MODELS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Figure 182.
Body wiring group 1-1988 models

{ewc GSMVIMG,GSMVIMG, !88266w13.bmp}

88266w13

BODY WIRING GROUP 1-1989 MODELS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Figure 183.
Body wiring group 1-1989 models

{ewc GSMVIMG,GSMVIMG, !88266w14.bmp}

88266w14

BODY WIRING GROUP 2-1988-89 MODELS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Figure 184.
Body wiring group 2-1988-89 models

{ewc GSMVIMG,GSMVIMG, !88266w15.bmp}

88266w15

BODY WIRING GROUP 1-1990-95 MODELS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Figure 185.
Body wiring group 1-1990-95 models

{ewc GSMVIMG,GSMVIMG, !88266w16.bmp}

88266w16

BODY WIRING GROUP 2-1990-95 MODELS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Figure 186.
Body wiring group 2-1990-95 models

{ewc GSMVIMG,GSMVIMG, !88266w17.bmp}

88266w17

BODY WIRING GROUP 1-1996 MODELS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Figure 187.
Body wiring group 1-1996 models

{ewc GSMVIMG,GSMVIMG, !88266w18.bmp}

88266w18

BODY WIRING GROUP 2-1996 MODELS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Figure 188.
Body wiring group 2-1996 models

{ewc GSMVIMG,GSMVIMG, !88266w19.bmp}

88266w19

GLOSSARY

Understanding your mechanic is as important as understanding your car. Just about everyone drives a car, but many drivers have difficulty understanding automotive terminology. Talking the language of cars makes it easier to effectively communicate with professional mechanics. It isn't necessary (or recommended) that you diagnose the problem for him, but it will save him time, and you money, if you can accurately describe what is happening. It will also help you to know why your car does what it is doing, and what repairs were made.

ABS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ABS

ABS: Anti-lock braking system. An electro-mechanical braking system which is designed to minimize or prevent wheel lock-up during braking.

ABSOLUTE PRESSURE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ABSOLUTE PRESSURE

ABSOLUTE PRESSURE: Atmospheric (barometric) pressure plus the pressure gauge reading.

ACCELERATOR PUMP {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ACCELERATOR PUMP

ACCELERATOR PUMP: A small pump located in the carburetor that feeds fuel into the air/fuel mixture during acceleration.

ACCUMULATOR {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ACCUMULATOR

ACCUMULATOR: A device that controls shift quality by cushioning the shock of hydraulic oil pressure being applied to a clutch or band.

ACTUATING MECHANISM {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ACTUATING MECHANISM

ACTUATING MECHANISM: The mechanical output devices of a hydraulic system, for example, clutch pistons and band servos.

ACTUATOR {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ACTUATOR

ACTUATOR: The output component of a hydraulic or electronic system.

ADVANCE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ADVANCE

ADVANCE: Setting the ignition timing so that spark occurs earlier before the piston reaches top dead center (TDC).

ADAPTIVE MEMORY (ADAPTIVE STRATEGY) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ADAPTIVE MEMORY (ADAPTIVE STRATEGY)

ADAPTIVE MEMORY (ADAPTIVE STRATEGY): The learning ability of the TCM or PCM to redefine its decision-making process to provide optimum shift quality.

AFTER TOP DEAD CENTER (ATDC) {ewc MVIMAGE, MVIMAGE, ! nexttopicarrow.bmp}

AFTER TOP DEAD CENTER (ATDC)

AFTER TOP DEAD CENTER (ATDC): The point after the piston reaches the top of its travel on the compression stroke.

AIR BAG {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

AIR BAG

AIR BAG: Device on the inside of the car designed to inflate on impact of crash, protecting the occupants of the car.

AIR CHARGE TEMPERATURE (ACT) SENSOR {ewc MVIMAGE, MVIMAGE, ! nexttopicarrow.bmp}

AIR CHARGE TEMPERATURE (ACT) SENSOR

AIR CHARGE TEMPERATURE (ACT) SENSOR: The temperature of the airflow into the engine is measured by an ACT sensor, usually located in the lower intake manifold or air cleaner. ALDL (assembly line diagnostic link): Electrical connector for scanning ECM/PCM/TCM input and output devices.

AIR CLEANER {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

AIR CLEANER

AIR CLEANER: An assembly consisting of a housing, filter and any connecting ductwork. The filter element is made up of a porous paper, sometimes with a wire mesh screening, and is designed to prevent airborne particles from entering the engine through the carburetor or throttle body.

Typical type of air cleaner assembly on most of todays vehicles

{ewc GSMVIMG,GSMVIMG, !8852XG16.bmp}

8852XG16

AIR INJECTION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

AIR INJECTION

AIR INJECTION: One method of reducing harmful exhaust emissions by injecting air into each of the exhaust ports of an engine. The fresh air entering the hot exhaust manifold causes any remaining fuel to be burned before it can exit the tailpipe.

AIR PUMP {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

AIR PUMP

AIR PUMP: An emission control device that supplies fresh air to the exhaust manifold to aid in more completely burning exhaust gases.

AIR/FUEL RATIO {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

AIR/FUEL RATIO

AIR/FUEL RATIO: The ratio of air-to-gasoline by weight in the fuel mixture drawn into the engine.

ALIGNMENT RACK {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ALIGNMENT RACK

ALIGNMENT RACK: A special drive-on vehicle lift apparatus/measuring device used to adjust a vehicle's toe, caster and camber angles.

ALL WHEEL DRIVE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ALL WHEEL DRIVE

ALL WHEEL DRIVE: Term used to describe a full time four wheel drive system or any other vehicle drive system that continuously delivers power to all four wheels. This system is found primarily on station wagon vehicles and SUVs not utilized for significant off road use.

ALTERNATING CURRENT (AC) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ALTERNATING CURRENT (AC)

ALTERNATING CURRENT (AC): Electric current that flows first in one direction, then in the opposite direction, continually reversing flow.

ALTERNATOR {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ALTERNATOR

ALTERNATOR: A device which produces AC (alternating current) which is converted to DC (direct current) to charge the car battery.

Automotive alternator

{ewc GSMVIMG,GSMVIMG, !8852XG01.bmp}

8852XG01

AMMETER {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

AMMETER

AMMETER: An instrument, calibrated in amperes, used to measure the flow of an electrical current in a circuit. Ammeters are always connected in series with the circuit being tested.

AMPERAGE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

AMPERAGE

AMPERAGE: The total amount of current (amperes) flowing in a circuit.

AMPLIFIER {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

AMPLIFIER

AMPLIFIER: A device used in an electrical circuit to increase the voltage of an output signal.

AMP/HR. RATING (BATTERY) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

AMP/HR. RATING (BATTERY)

AMP/HR. RATING (BATTERY): Measurement of the ability of a battery to deliver a stated amount of current for a stated period of time. The higher the amp/hr. rating, the better the battery.

AMPERE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

AMPERE

AMPERE: The rate of flow of electrical current present when one volt of electrical pressure is applied against one ohm of electrical resistance.

ANALOG COMPUTER {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ANALOG COMPUTER

ANALOG COMPUTER: Any microprocessor that uses similar (analogous) electrical signals to make its calculations.

ANODIZED {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ANODIZED

ANODIZED: A special coating applied to the surface of aluminum valves for extended service life.

ANTIFREEZE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ANTIFREEZE

ANTIFREEZE: A substance (ethylene or propylene glycol) added to the coolant to prevent freezing in cold weather.

ANTI-FOAM AGENTS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ANTI-FOAM AGENTS

ANTI-FOAM AGENTS: Minimize fluid foaming from the whipping action encountered in the converter and planetary action.

ANTI-WEAR AGENTS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ANTI-WEAR AGENTS

ANTI-WEAR AGENTS: Zinc agents that control wear on the gears, bushings, and thrust washers.

ANTI-LOCK BRAKING SYSTEM {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ANTI-LOCK BRAKING SYSTEM

ANTI-LOCK BRAKING SYSTEM: A supplementary system to the base hydraulic system that prevents sustained lock-up of the wheels during braking as well as automatically controlling wheel slip.

ANTI-ROLL BAR {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ANTI-ROLL BAR

ANTI-ROLL BAR: See stabilizer bar.

Location of a typical anti-roll bar on a McPherson strut suspension

{ewc GSMVIMG,GSMVIMG, !8852XG17.bmp}

8852XG17

ARC {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ARC

ARC: A flow of electricity through the air between two electrodes or contact points that produces a spark.

ARMATURE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ARMATURE

ARMATURE: A laminated, soft iron core wrapped by a wire that converts electrical energy to mechanical energy as in a motor or relay. When rotated in a magnetic field, it changes mechanical energy into electrical energy as in a generator.

ATDC {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ATDC

ATDC: After Top Dead Center.

ATF {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ATF

ATF: Automatic transmission fluid.

ATMOSPHERIC PRESSURE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ATMOSPHERIC PRESSURE

ATMOSPHERIC PRESSURE: The pressure on the Earth's surface caused by the weight of the air in the atmosphere. At sea level, this pressure is 14.7 psi at 32ºF (101 kPa at 0ºC).

ATOMIZATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ATOMIZATION

ATOMIZATION: The breaking down of a liquid into a fine mist that can be suspended in air.

AUXILIARY ADD-ON COOLER {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

AUXILIARY ADD-ON COOLER

AUXILIARY ADD-ON COOLER: A supplemental transmission fluid cooling device that is installed in series with the heat exchanger (cooler), located inside the radiator, to provide additional support to cool the hot fluid leaving the torque converter.

AUXILIARY PRESSURE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

AUXILIARY PRESSURE

AUXILIARY PRESSURE: An added fluid pressure that is introduced into a regulator or balanced valve system to control valve movement. The auxiliary pressure itself can be either a fixed or a variable value. (See balanced valve; regulator valve.)

AWD {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

AWD

AWD: All wheel drive.

AXIAL FORCE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

AXIAL FORCE

AXIAL FORCE: A side or end thrust force acting in or along the same plane as the power flow.

AXIAL PLAY {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

AXIAL PLAY

AXIAL PLAY: Movement parallel to a shaft or bearing bore.

AXLE CAPACITY {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

AXLE CAPACITY

AXLE CAPACITY: The maximum load-carrying capacity of the axle itself, as specified by the manufacturer. This is usually a higher number than the GAWR.

AXLE RATIO {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

AXLE RATIO

AXLE RATIO: This is a number (3.07:1, 4.56:1, for example) expressing the ratio between driveshaft revolutions and wheel revolutions. A low numerical ratio allows the engine to work easier because it doesn't have to turn as fast. A high numerical ratio means that the engine has to turn more rpm's to move the wheels through the same number of turns.

BACKFIRE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

BACKFIRE

BACKFIRE: The sudden combustion of gases in the intake or exhaust system that results in a loud explosion.

BACKLASH {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

BACKLASH

BACKLASH: The clearance or play between two parts, such as meshed gears.

BACKPRESSURE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

BACKPRESSURE

BACKPRESSURE: Restrictions in the exhaust system that slow the exit of exhaust gases from the combustion chamber.

BAKELITE® {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

BAKELITE®

BAKELITE®: A heat resistant, plastic insulator material commonly used in printed circuit boards and transistorized components.

BALANCED VALVE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

BALANCED VALVE

BALANCED VALVE: A valve that is positioned by opposing auxiliary hydraulic pressures and/or spring force. Examples include mainline regulator, throttle, and governor valves. (See regulator valve.)

BAND {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

BAND

BAND: A flexible ring of steel with an inner lining of friction material. When tightened around the outside of a drum, a planetary member is held stationary to the transmission/transaxlecase.

BALL BEARING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

BALL BEARING

BALL BEARING: A bearing made up of hardened inner and outer races between which hardened steel balls roll.

BALL JOINT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

BALL JOINT

BALL JOINT: A ball and matching socket connecting suspension components (steering knuckle to lower control arms). It permits rotating movement in any direction between the components that are joined.

Front suspension ball joints

{ewc GSMVIMG,GSMVIMG, !8852XG02.bmp}

8852XG02

BARO (BAROMETRIC PRESSURE SENSOR) {ewc MVIMAGE, MVIMAGE, ! nexttopicarrow.bmp}

BARO (BAROMETRIC PRESSURE SENSOR)

BARO (BAROMETRIC PRESSURE SENSOR): Measures the change in the intake manifold pressure caused by changes in altitude.

BAROMETRIC MANIFOLD ABSOLUTE PRESSURE (BMAP) SENSOR {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

BAROMETRIC MANIFOLD ABSOLUTE PRESSURE (BMAP) SENSOR

BAROMETRIC MANIFOLD ABSOLUTE PRESSURE (BMAP) SENSOR: Operates similarly to a conventional MAP sensor; reads intake manifold pressure and is also responsible for determining altitude and barometric pressure prior to engine operation.

BAROMETRIC PRESSURE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

BAROMETRIC PRESSURE

BAROMETRIC PRESSURE: (See atmospheric pressure.)

BALLAST RESISTOR {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

BALLAST RESISTOR

BALLAST RESISTOR: A resistor in the primary ignition circuit that lowers voltage after the engine is started to reduce wear on ignition components.

BATTERY {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

BATTERY

BATTERY: A direct current electrical storage unit, consisting of the basic active materials of lead and sulphuric acid, which converts chemical energy into electrical energy. Used to provide current for the operation of the starter as well as other equipment, such as the radio, lighting, etc.

A sealed type battery

{ewc GSMVIMG,GSMVIMG, !tcca1g02.bmp}

Tcca1g02

BEAD {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

BEAD

BEAD: The portion of a tire that holds it on the rim.

BEARING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

BEARING

BEARING: A friction reducing, supportive device usually located between a stationary part and a moving part.

BEFORE TOP DEAD CENTER (BTDC) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

BEFORE TOP DEAD CENTER (BTDC)

BEFORE TOP DEAD CENTER (BTDC): The point just before the piston reaches the top of its travel on the compression stroke.

BELTED TIRE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

BELTED TIRE

BELTED TIRE: Tire construction similar to bias-ply tires, but using two or more layers of reinforced belts between body plies and the tread.

BEZEL {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

BEZEL

BEZEL: Piece of metal surrounding radio, headlights, gauges or similar components; sometimes used to hold the glass face of a gauge in the dash.

BIAS-PLY TIRE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

BIAS-PLY TIRE

BIAS-PLY TIRE: Tire construction, using body ply reinforcing cords which run at alternating angles to the center line of the tread.

BI-METAL TEMPERATURE SENSOR {ewc MVIMAGE, MVIMAGE, ! nexttopicarrow.bmp}

BI-METAL TEMPERATURE SENSOR

BI-METAL TEMPERATURE SENSOR: Any sensor or switch made of two dissimilar types of metal that bend when heated or cooled due to the different expansion rates of the alloys. These types of sensors usually function as an on/off switch.

BLOCK {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

BLOCK

BLOCK: See Engine Block.

BLOW-BY {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

BLOW-BY

BLOW-BY: Combustion gases, composed of water vapor and unburned fuel, that leak past the piston rings into the crankcase during normal engine operation. These gases are removed by the PCV system to prevent the buildup of harmful acids in the crankcase.

BOOK TIME {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

BOOK TIME

BOOK TIME: See Labor Time.

BOOK VALUE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

BOOK VALUE

BOOK VALUE: The average value of a car, widely used to determine trade-in and resale value.

BOOST VALVE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

BOOST VALVE

BOOST VALVE: Used at the base of the regulator valve to increase mainline pressure.

BORE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

BORE

BORE: Diameter of a cylinder.

BRAKE CALIPER {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

BRAKE CALIPER

BRAKE CALIPER: The housing that fits over the brake disc. The caliper holds the brake pads, which are pressed against the discs by the caliper pistons when the brake pedal is depressed.

BRAKE HORSEPOWER(BHP) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

BRAKE HORSEPOWER(BHP)

BRAKE HORSEPOWER(BHP): The actual horsepower available at the engine flywheel as measured by a dynamometer.

Disc brake

{ewc GSMVIMG,GSMVIMG, !8852XG03.bmp}

8852XG03

BRAKE FADE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

BRAKE FADE

BRAKE FADE: Loss of braking power, usually caused by excessive heat after repeated brake applications.

BRAKE HORSEPOWER {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

BRAKE HORSEPOWER

BRAKE HORSEPOWER: Usable horsepower of an engine measured at the crankshaft.

BRAKE PAD {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

BRAKE PAD

BRAKE PAD: A brake shoe and lining assembly used with disc brakes.

BRAKE PROPORTIONING VALVE {ewc MVIMAGE, MVIMAGE, !
nexttopicarrow.bmp}

BRAKE PROPORTIONING VALVE

BRAKE PROPORTIONING VALVE: A valve on the master cylinder which restricts hydraulic brake pressure to the wheels to a specified amount, preventing wheel lock-up.

BREAKAWAY {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

BREAKAWAY

BREAKAWAY: Often used by Chrysler to identify first-gear operation in D and 2 ranges. In these ranges, first-gear operation depends on a one-way roller clutch that holds on acceleration and releases (breaks away) on deceleration, resulting in a freewheeling coastdown condition.

BRAKE SHOE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

BRAKE SHOE

BRAKE SHOE: The backing for the brake lining. The term is, however, usually applied to the assembly of the brake backing and lining.

BREAKER POINTS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

BREAKER POINTS

BREAKER POINTS: A set of points inside the distributor, operated by a cam, which make and break the ignition circuit.

BRINNELLING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

BRINNELLING

BRINNELLING: A wear pattern identified by a series of indentations at regular intervals. This condition is caused by a lack of lube, overload situations, and/or vibrations.

BTDC {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

BTDC

BTDC: Before Top Dead Center.

BUMP {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

BUMP

BUMP: Sudden and forceful apply of a clutch or band.

BUSHING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

BUSHING

BUSHING: A liner, usually removable, for a bearing; an anti-friction liner used in place of a bearing.

CALIFORNIA ENGINE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CALIFORNIA ENGINE

CALIFORNIA ENGINE: An engine certified by the EPA for use in California only; conforms to more stringent emission regulations than Federal engine.

CALIPER {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CALIPER

CALIPER: A hydraulically activated device in a disc brake system, which is mounted straddling the brake rotor (disc). The caliper contains at least one piston and two brake pads. Hydraulic pressure on the piston(s) forces the pads against the rotor.

CAPACITY {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CAPACITY

CAPACITY: The quantity of electricity that can be delivered from a unit, as from a battery in ampere-hours, or output, as from a generator.

CAMBER {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CAMBER

CAMBER: One of the factors of wheel alignment. Viewed from the front of the car, it is the inward or outward tilt of the wheel. The top of the tire will lean outward (positive camber) or inward (negative camber).

Camber angle (front view)

{ewc GSMVIMG,GSMVIMG, !8852XG04.bmp}

8852XG04

CAMSHAFT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CAMSHAFT

CAMSHAFT: A shaft in the engine on which are the lobes (cams) which operate the valves. The camshaft is driven by the crankshaft, via a belt, chain or gears, at one half the crankshaft speed.

CANCER {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CANCER

CANCER: Rust on a car body.

CAPACITOR {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CAPACITOR

CAPACITOR: A device which stores an electrical charge.

CARBON MONOXIDE (CO) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CARBON MONOXIDE (CO)

CARBON MONOXIDE (CO): A colorless, odorless gas given off as a normal byproduct of combustion. It is poisonous and extremely dangerous in confined areas, building up slowly to toxic levels without warning if adequate ventilation is not available.

CARBURETOR {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CARBURETOR

CARBURETOR: A device, usually mounted on the intake manifold of an engine, which mixes the air and fuel in the proper proportion to allow even combustion.

CASTER {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CASTER

CASTER: The forward or rearward tilt of an imaginary line drawn through the upper ball joint and the center of the wheel. Viewed from the sides, positive caster (forward tilt) lends directional stability, while negative caster (rearward tilt) produces instability.

Caster angle (side view)

{ewc GSMVIMG,GSMVIMG, !8852XG05.bmp}

8852XG05

CATALYTIC CONVERTER {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CATALYTIC CONVERTER

CATALYTIC CONVERTER: A device installed in the exhaust system, like a muffler, that converts harmful byproducts of combustion into carbon dioxide and water vapor by means of a heat-producing chemical reaction.

CENTRIFUGAL ADVANCE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CENTRIFUGAL ADVANCE

CENTRIFUGAL ADVANCE: A mechanical method of advancing the spark timing by using flyweights in the distributor that react to centrifugal force generated by the distributor shaft rotation.

CENTRIFUGAL FORCE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CENTRIFUGAL FORCE

CENTRIFUGAL FORCE: The outward pull of a revolving object, away from the center of revolution. Centrifugal force increases with the speed of rotation.

CETANE RATING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CETANE RATING

CETANE RATING: A measure of the ignition value of diesel fuel. The higher the cetane rating, the better the fuel. Diesel fuel cetane rating is roughly comparable to gasoline octane rating.

CHECK VALVE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CHECK VALVE

CHECK VALVE: Any one-way valve installed to permit the flow of air, fuel or vacuum in one direction only.

CHOKE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CHOKE

CHOKE: The valve/plate that restricts the amount of air entering an engine on the induction stroke, thereby enriching the air:fuel ratio.

CHUGGLE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CHUGGLE

CHUGGLE: Bucking or jerking condition that may be engine related and may be most noticeable when converter clutch is engaged; similar to the feel of towing a trailer.

CIRCLIP {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CIRCLIP

CIRCLIP: A split steel snapring that fits into a groove to hold various parts in place.

CIRCUIT BREAKER {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CIRCUIT BREAKER

CIRCUIT BREAKER: A switch which protects an electrical circuit from overload by opening the circuit when the current flow exceeds a pre-determined level. Some circuit breakers must be reset manually, while most reset automatically.

CIRCUIT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CIRCUIT

CIRCUIT: Any unbroken path through which an electrical current can flow. Also used to describe fuel flow in some instances.

CIRCUIT, BYPASS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CIRCUIT, BYPASS

CIRCUIT, BYPASS: Another circuit in parallel with the major circuit through which power is diverted.

CIRCUIT, CLOSED {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CIRCUIT, CLOSED

CIRCUIT, CLOSED: An electrical circuit in which there is no interruption of current flow.

CIRCUIT, GROUND {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CIRCUIT, GROUND

CIRCUIT, GROUND: The non-insulated portion of a complete circuit used as a common potential point. In automotive circuits, the ground is composed of metal parts, such as the engine, body sheet metal, and frame and is usually a negative potential.

CIRCUIT, HOT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CIRCUIT, HOT

CIRCUIT, HOT: That portion of a circuit not at ground potential. The hot circuit is usually insulated and is connected to the positive side of the battery.

CIRCUIT, OPEN {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CIRCUIT, OPEN

CIRCUIT, OPEN: A break or lack of contact in an electrical circuit, either intentional (switch) or unintentional (bad connection or broken wire).

CIRCUIT, PARALLEL {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CIRCUIT, PARALLEL

CIRCUIT, PARALLEL: A circuit having two or more paths for current flow with common positive and negative tie points. The same voltage is applied to each load device or parallel branch.

CIRCUIT, SERIES {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CIRCUIT, SERIES

CIRCUIT, SERIES: An electrical system in which separate parts are connected end to end, using one wire, to form a single path for current to flow.

CIRCUIT, SHORT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CIRCUIT, SHORT

CIRCUIT, SHORT: A circuit that is accidentally completed in an electrical path for which it was not intended.

CLAMPING (ISOLATION) DIODES {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CLAMPING (ISOLATION) DIODES

CLAMPING (ISOLATION) DIODES: Diodes positioned in a circuit to prevent self-induction from damaging electronic components.

CLEARCOAT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CLEARCOAT

CLEARCOAT: A transparent layer which, when sprayed over a vehicle's paint job, adds gloss and depth as well as an additional protective coating to the finish.

CLUTCH {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CLUTCH

CLUTCH: Part of the power train used to connect/disconnect power to the rear wheels.

CLUTCH, FLUID {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CLUTCH, FLUID

CLUTCH, FLUID: The same as a fluid coupling. A fluid clutch or coupling performs the same function as a friction clutch by utilizing fluid friction and inertia as opposed to solid friction used by a friction clutch. (See fluid coupling.)

CLUTCH, FRICTION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CLUTCH, FRICTION

CLUTCH, FRICTION: A coupling device that provides a means of smooth and positive engagement and disengagement of engine torque to the vehicle powertrain. Transmission of power through the clutch is accomplished by bringing one or more rotating drive members into contact with complementing driven members.

Exploded view of typical clutch

{ewc GSMVIMG,GSMVIMG, !8852XG06.bmp}

8852XG06

COAST {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

COAST

COAST: Vehicle deceleration caused by engine braking conditions.

COEFFICIENT OF FRICTION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

COEFFICIENT OF FRICTION

COEFFICIENT OF FRICTION: The amount of surface tension between two contacting surfaces; identified by a scientifically calculated number.

COIL {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

COIL

COIL: Part of the ignition system that boosts the relatively low voltage supplied by the car's electrical system to the high voltage required to fire the spark plugs.

COMBINATION MANIFOLD {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

COMBINATION MANIFOLD

COMBINATION MANIFOLD: An assembly which includes both the intake and exhaust manifolds in one casting.

COMBINATION VALVE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

COMBINATION VALVE

COMBINATION VALVE: A device used in some fuel systems that routes fuel vapors to a charcoal storage canister instead of venting them into the atmosphere. The valve relieves fuel tank pressure and allows fresh air into the tank as the fuel level drops to prevent a vapor lock situation.

COMBUSTION CHAMBER {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

COMBUSTION CHAMBER

COMBUSTION CHAMBER: The part of the engine in the cylinder head where combustion takes place.

COMPOUND GEAR {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

COMPOUND GEAR

COMPOUND GEAR: A gear consisting of two or more simple gears with a common shaft.

COMPOUND PLANETARY {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

COMPOUND PLANETARY

COMPOUND PLANETARY: A gearset that has more than the three elements found in a simple gearset and is constructed by combining members of two planetary gearsets to create additional gear ratio possibilities.

COMPRESSION CHECK {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

COMPRESSION CHECK

COMPRESSION CHECK: A test involving removing each spark plug and inserting a gauge. When the engine is cranked, the gauge will record a pressure reading in the individual cylinder. General operating condition can be determined from a compression check.

Performing a compression check using a compression gauge

{ewc GSMVIMG,GSMVIMG, !tccS3801.bmp}

TCCS3801

COMPRESSION RATIO {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

COMPRESSION RATIO

COMPRESSION RATIO: The ratio of the volume between the piston and cylinder head when the piston is at the bottom of its stroke (bottom dead center) and when the piston is at the top of its stroke (top dead center).

COMPUTER {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

COMPUTER

COMPUTER: An electronic control module that correlates input data according to prearranged engineered instructions; used for the management of an actuator system or systems.

CONDENSER {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CONDENSER

CONDENSER: 1. An electrical device which acts to store an electrical charge, preventing voltage surges. 2. A radiator-like device in the air conditioning system in which refrigerant gas condenses into a liquid, giving off heat.

CONDUCTOR {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CONDUCTOR

CONDUCTOR: Any material through which an electrical current can be transmitted easily.

CONNECTING ROD {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CONNECTING ROD

CONNECTING ROD: The connecting link between the crankshaft and piston.

CONSTANT VELOCITY JOINT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CONSTANT VELOCITY JOINT

CONSTANT VELOCITY JOINT: Type of universal joint in a halfshaft assembly in which the output shaft turns at a constant angular velocity without variation, provided that the speed of the input shaft is constant.

CONTINUITY {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CONTINUITY

CONTINUITY: Continuous or complete circuit. Can be checked with an ohmmeter.

CONTROL ARM {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CONTROL ARM

CONTROL ARM: The upper or lower suspension components which are mounted on the frame and support the ball joints and steering knuckles.

CONVENTIONAL IGNITION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CONVENTIONAL IGNITION

CONVENTIONAL IGNITION: Ignition system which uses breaker points.

CONVERTER {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CONVERTER

CONVERTER: (See torque converter.)

CONVERTER LOCKUP {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CONVERTER LOCKUP

CONVERTER LOCKUP: The switching from hydrodynamic to direct mechanical drive, usually through the application of a friction element called the converter clutch.

COOLANT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

COOLANT

COOLANT: Mixture of water and anti-freeze circulated through the engine to carry off heat produced by the engine.

CORROSION INHIBITOR {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CORROSION INHIBITOR

CORROSION INHIBITOR: An inhibitor in ATF that prevents corrosion of bushings, thrust washers, and oil cooler brazed joints.

COUNTERSHAFT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

COUNTERSHAFT

COUNTERSHAFT: An intermediate shaft which is rotated by a mainshaft and transmits, in turn, that rotation to a working part.

COUPLING PHASE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

COUPLING PHASE

COUPLING PHASE: Occurs when the torque converter is operating at its greatest hydraulic efficiency. The speed differential between the impeller and the turbine is at its minimum. At this point, the stator freewheels, and there is no torque multiplication.

CRANKCASE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CRANKCASE

CRANKCASE: The lower part of an engine in which the crankshaft and related parts operate.

CRANKSHAFT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CRANKSHAFT

CRANKSHAFT: Engine component (connected to pistons by connecting rods) which converts the reciprocating (up and down) motion of pistons to rotary motion used to turn the driveshaft.

CURB WEIGHT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CURB WEIGHT

CURB WEIGHT: The weight of a vehicle without passengers or payload, but including all fluids (oil, gas, coolant, etc.) and other equipment specified as standard.

CURRENT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CURRENT

CURRENT: The flow (or rate) of electrons moving through a circuit. Current is measured in amperes (amp).

CURRENT FLOW CONVENTIONAL {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CURRENT FLOW CONVENTIONAL

CURRENT FLOW CONVENTIONAL: Current flows through a circuit from the positive terminal of the source to the negative terminal (plus to minus).

CURRENT FLOW, ELECTRON {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CURRENT FLOW, ELECTRON

CURRENT FLOW, ELECTRON: Current or electrons flow from the negative terminal of the source, through the circuit, to the positive terminal (minus to plus).

CV-JOINT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CV-JOINT

CV-JOINT: Constant velocity joint.

CYCLIC VIBRATIONS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CYCLIC VIBRATIONS

CYCLIC VIBRATIONS: The off-center movement of a rotating object that is affected by its initial balance, speed of rotation, and working angles.

CYLINDER BLOCK {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CYLINDER BLOCK

CYLINDER BLOCK: See engine block.

Basic cylinder block (engine block) casting

{ewc GSMVIMG,GSMVIMG, !8852XG20.bmp}

8852XG20

CYLINDER HEAD {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CYLINDER HEAD

CYLINDER HEAD: The detachable portion of the engine, usually fastened to the top of the cylinder block and containing all or most of the combustion chambers. On overhead valve engines, it contains the valves and their operating parts. On overhead cam engines, it contains the camshaft as well.

CYLINDER {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

CYLINDER

CYLINDER: In an engine, the round hole in the engine block in which the piston(s) ride.

DATA LINK CONNECTOR (DLC) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

DATA LINK CONNECTOR (DLC)

DATA LINK CONNECTOR (DLC): Current acronym/term applied to the federally mandated, diagnostic junction connector that is used to monitor ECM/PC/TCM inputs, processing strategies, and outputs including diagnostic trouble codes (DTCs).

DEAD CENTER {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

DEAD CENTER

DEAD CENTER: The extreme top or bottom of the piston stroke.

DECELERATION BUMP {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

DECELERATION BUMP

DECELERATION BUMP: When referring to a torque converter clutch in the applied position, a sudden release of the accelerator pedal causes a forceful reversal of power through the drivetrain (engine braking), just prior to the apply plate actually being released.

DELAYED (LATE OR EXTENDED) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

DELAYED (LATE OR EXTENDED)

DELAYED (LATE OR EXTENDED): Condition where shift is expected but does not occur for a period of time, for example, where clutch or band engagement does not occur as quickly as expected during part throttle or wide open throttle apply of accelerator or when manually downshifting to a lower range.

DETENT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

DETENT

DETENT: A spring-loaded plunger, pin, ball, or pawl used as a holding device on a ratchet wheel or shaft. In automatic transmissions, a detent mechanism is used for locking the manual valve in place.

DETENT DOWNSHIFT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

DETENT DOWNSHIFT

DETENT DOWNSHIFT: (See kickdown.)

DETERGENT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

DETERGENT

DETERGENT: An additive in engine oil to improve its operating characteristics.

DETONATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

DETONATION

DETONATION: An unwanted explosion of the air/fuel mixture in the combustion chamber caused by excess heat and compression, advanced timing, or an overly lean mixture. Also referred to as "ping".

DEXRON® {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

DEXRON®

DEXRON®: A brand of automatic transmission fluid.

DIAGNOSTIC TROUBLE CODES (DTCS) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

DIAGNOSTIC TROUBLE CODES (DTCS)

DIAGNOSTIC TROUBLE CODES (DTCS): A digital display from the control module memory that identifies the input, processor, or output device circuit that is related to the powertrain emission/driveability malfunction detected. Diagnostic trouble codes can be read by the MIL to flash any codes or by using a handheld scanner.

DIAPHRAGM {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

DIAPHRAGM

DIAPHRAGM: A thin, flexible wall separating two cavities, such as in a vacuum advance unit.

DIESELING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

DIESELING

DIESELING: The engine continues to run after the car is shut off; caused by fuel continuing to be burned in the combustion chamber.

DIFFERENTIAL {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

DIFFERENTIAL

DIFFERENTIAL: A geared assembly which allows the transmission of motion between drive axles, giving one axle the ability to rotate faster than the other, as in cornering.

DIFFERENTIAL AREAS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

DIFFERENTIAL AREAS

DIFFERENTIAL AREAS: When opposing faces of a spool valve are acted upon by the same pressure but their areas differ in size, the face with the larger area produces the differential force and valve movement. (See spool valve.)

DIFFERENTIAL FORCE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

DIFFERENTIAL FORCE

DIFFERENTIAL FORCE: (See differential areas.) digital readout: A display of numbers or a combination of numbers and letters.

Differential action during cornering

{ewc GSMVIMG,GSMVIMG, !8852XG07.bmp}

8852XG07

DIGITAL VOLT OHMMETER {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

DIGITAL VOLT OHMMETER

DIGITAL VOLT OHMMETER: An electronic diagnostic tool used to measure voltage, ohms and amps as well as several other functions, with the readings displayed on a digital screen in tenths, hundredths and thousandths.

DIODE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

DIODE

DIODE: An electrical device that will allow current to flow in one direction only.

DIRECT CURRENT (DC) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

DIRECT CURRENT (DC)

DIRECT CURRENT (DC): Electrical current that flows in one direction only.

DIRECT DRIVE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

DIRECT DRIVE

DIRECT DRIVE: The gear ratio is 1:1, with no change occurring in the torque and speed input/output relationship.

DISC BRAKE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

DISC BRAKE

DISC BRAKE: A hydraulic braking assembly consisting of a brake disc, or rotor, mounted on an axleshaft, and a caliper assembly containing, usually two brake pads which are activated by hydraulic pressure. The pads are forced against the sides of the disc, creating friction which slows the vehicle.

DISPERSANTS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

DISPERSANTS

DISPERSANTS: Suspend dirt and prevent sludge buildup. double bump (double feel): Two sudden and forceful applies of a clutch or band.

DISPLACEMENT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

DISPLACEMENT

DISPLACEMENT: The total volume of air that is displaced by all pistons as the engine turns through one complete revolution.

DISTRIBUTOR {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

DISTRIBUTOR

DISTRIBUTOR: A mechanically driven device on an engine which is responsible for electrically firing the spark plug at a pre-determined point of the piston stroke.

Typical distributor assembly

{ewc GSMVIMG,GSMVIMG, !8852XG21.bmp}

8852XG21

DOHC {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

DOHC

DOHC: Double overhead camshaft.

DOUBLE OVERHEAD CAMSHAFT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

DOUBLE OVERHEAD CAMSHAFT

DOUBLE OVERHEAD CAMSHAFT: The engine utilizes two camshafts mounted in one cylinder head. One camshaft operates the exhaust valves, while the other operates the intake valves.

DOWEL PIN {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

DOWEL PIN

DOWEL PIN: A pin, inserted in mating holes in two different parts allowing those parts to maintain a fixed relationship.

DRIVELINE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

DRIVELINE

DRIVELINE: The drive connection between the transmission and the drive wheels.

DRIVE TRAIN {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

DRIVE TRAIN

DRIVE TRAIN: The components that transmit the flow of power from the engine to the wheels. The components include the clutch, transmission, driveshafts (or axle shafts in front wheel drive), U-joints and differential.

DRUM BRAKE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

DRUM BRAKE

DRUM BRAKE: A braking system which consists of two brake shoes and one or two wheel cylinders, mounted on a fixed backing plate, and a brake drum, mounted on an axle, which revolves around the assembly.

DRY CHARGED BATTERY {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

DRY CHARGED BATTERY

DRY CHARGED BATTERY: Battery to which electrolyte is added when the battery is placed in service.

DVOM {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

DVOM

DVOM: Digital volt ohmmeter

Performing a resistance check using a DVOM

{ewc GSMVIMG,GSMVIMG, !tccS4P02.bmp}

TCCS4P02

DWELL {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

DWELL

DWELL: The rate, measured in degrees of shaft rotation, at which an electrical circuit cycles on and off.

DYNAMIC {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

DYNAMIC

DYNAMIC: A sealing application in which there is rotating or reciprocating motion between the parts.

EARLY {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

EARLY

EARLY: Condition where shift occurs before vehicle has reached proper speed, which tends to labor engine after upshift.

EBCM {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

EBCM

EBCM: See Electronic Control Unit (ECU).

ECM {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ECM

ECM: See Electronic Control Unit (ECU).

ECU {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ECU

ECU: Electronic control unit.

ELECTRODE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ELECTRODE

ELECTRODE: Conductor (positive or negative) of electric current.

ELECTROLYSIS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ELECTROLYSIS

ELECTROLYSIS: A surface etching or bonding of current conducting transmission/transaxlecomponents that may occur when grounding straps are missing or in poor condition.

ELECTROLYTE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ELECTROLYTE

ELECTROLYTE: A solution of water and sulfuric acid used to activate the battery. Electrolyte is extremely corrosive.

ELECTROMAGNET {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ELECTROMAGNET

ELECTROMAGNET: A coil that produces a magnetic field when current flows through its windings.

ELECTROMAGNETIC INDUCTION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ELECTROMAGNETIC INDUCTION

ELECTROMAGNETIC INDUCTION: A method to create (generate) current flow through the use of magnetism.

ELECTROMAGNETISM {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ELECTROMAGNETISM

ELECTROMAGNETISM: The effects surrounding the relationship between electricity and magnetism.

ELECTROMOTIVE FORCE (EMF) {ewc MVIMAGE, MVIMAGE, !
nexttopicarrow.bmp}

ELECTROMOTIVE FORCE (EMF)

ELECTROMOTIVE FORCE (EMF): The force or pressure (voltage) that causes current movement in an electrical circuit.

ELECTRONIC CONTROL UNIT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ELECTRONIC CONTROL UNIT

ELECTRONIC CONTROL UNIT: A digital computer that controls engine (and sometimes transmission, brake or other vehicle system) functions based on data received from various sensors. Examples used by some manufacturers include Electronic Brake Control Module (EBCM), Engine Control Module (ECM), Powertrain Control Module (PCM) or Vehicle Control Module (VCM).

ELECTRONIC IGNITION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ELECTRONIC IGNITION

ELECTRONIC IGNITION: A system in which the timing and firing of the spark plugs is controlled by an electronic control unit, usually called a module. These systems have no points or condenser.

ELECTRONIC PRESSURE CONTROL (EPC) SOLENOID {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ELECTRONIC PRESSURE CONTROL (EPC) SOLENOID

ELECTRONIC PRESSURE CONTROL (EPC) SOLENOID: A specially designed solenoid containing a spool valve and spring assembly to control fluid mainline pressure. A variable current flow, controlled by the ECM/PCM, varies the internal force of the solenoid on the spool valve and resulting mainline pressure. (See variable force solenoid.)

ELECTRONICS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ELECTRONICS

ELECTRONICS: Miniaturized electrical circuits utilizing semiconductors, solid-state devices, and printed circuits. Electronic circuits utilize small amounts of power.

ELECTRONIFICATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ELECTRONIFICATION

ELECTRONIFICATION: The application of electronic circuitry to a mechanical device. Regarding automatic transmissions, electrification is incorporated into converter clutch lockup, shift scheduling, and line pressure control systems.

ELECTROSTATIC DISCHARGE (ESD) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ELECTROSTATIC DISCHARGE (ESD)

ELECTROSTATIC DISCHARGE (ESD): An unwanted, high-voltage electrical current released by an individual who has taken on a static charge of electricity. Electronic components can be easily damaged by ESD.

ELEMENT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ELEMENT

ELEMENT: A device within a hydrodynamic drive unit designed with a set of blades to direct fluid flow.

ENAMEL {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ENAMEL

ENAMEL: Type of paint that dries to a smooth, glossy finish.

END BUMP (END FEEL OR SLIP BUMP) {ewc MVIMAGE, MVIMAGE, ! nexttopicarrow.bmp}

END BUMP (END FEEL OR SLIP BUMP)

END BUMP (END FEEL OR SLIP BUMP): Firmer feel at end of shift when compared with feel at start of shift.

END-PLAY {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

END-PLAY

END-PLAY: The clearance/gap between two components that allows for expansion of the parts as they warm up, to prevent binding and to allow space for lubrication.

ENERGY {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ENERGY

ENERGY: The ability or capacity to do work.

ENGINE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ENGINE

ENGINE: The primary motor or power apparatus of a vehicle, which converts liquid or gas fuel into mechanical energy.

ENGINE BLOCK {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ENGINE BLOCK

ENGINE BLOCK: The basic engine casting containing the cylinders, the crankshaft main bearings, as well as machined surfaces for the mounting of other components such as the cylinder head, oil pan, transmission, etc..

ENGINE BRAKING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ENGINE BRAKING

ENGINE BRAKING: Use of engine to slow vehicle by manually downshifting during zero-throttle coast down.

ENGINE CONTROL MODULE (ECM) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ENGINE CONTROL MODULE (ECM)

ENGINE CONTROL MODULE (ECM): Manages the engine and incorporates output control over the torque converter clutch solenoid. (Note: Current designation for the ECM in late model vehicles is PCM.)

ENGINE COOLANT TEMPERATURE (ECT) SENSOR {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ENGINE COOLANT TEMPERATURE (ECT) SENSOR

ENGINE COOLANT TEMPERATURE (ECT) SENSOR: Prevents converter clutch engagement with a cold engine; also used for shift timing and shift quality.

EP LUBRICANT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

EP LUBRICANT

EP LUBRICANT: EP (extreme pressure) lubricants are specially formulated for use with gears involving heavy loads (transmissions, differentials, etc.).

ETHYL {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ETHYL

ETHYL: A substance added to gasoline to improve its resistance to knock, by slowing down the rate of combustion.

ETHYLENE GLYCOL {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ETHYLENE GLYCOL

ETHYLENE GLYCOL: The base substance of antifreeze.

EXHAUST MANIFOLD {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

EXHAUST MANIFOLD

EXHAUST MANIFOLD: A set of cast passages or pipes which conduct exhaust gases from the engine.

Typical exhaust manifold

{ewc GSMVIMG,GSMVIMG, !8852XG23.bmp}

8852XG23

FAIL-SAFE (BACKUP) CONTROL {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

FAIL-SAFE (BACKUP) CONTROL

FAIL-SAFE (BACKUP) CONTROL: A substitute value used by the PCM/TCM to replace a faulty signal from an input sensor. The temporary value allows the vehicle to continue to be operated.

FAST IDLE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

FAST IDLE

FAST IDLE: The speed of the engine when the choke is on. Fast idle speeds engine warm-up.

FEDERAL ENGINE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

FEDERAL ENGINE

FEDERAL ENGINE: An engine certified by the EPA for use in any of the 49 states (except California).

FEEDBACK {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

FEEDBACK

FEEDBACK: A circuit malfunction whereby current can find another path to feed load devices.

FEELER GAUGE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

FEELER GAUGE

FEELER GAUGE: A blade, usually metal, of precisely predetermined thickness, used to measure the clearance between two parts.

FILAMENT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

FILAMENT

FILAMENT: The part of a bulb that glows; the filament creates high resistance to current flow and actually glows from the resulting heat.

FINAL DRIVE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

FINAL DRIVE

FINAL DRIVE: An essential part of the axle drive assembly where final gear reduction takes place in the powertrain. In RWD applications and north-south FWD applications, it must also change the power flow direction to the axle shaft by ninety degrees. (Also see axle ratio).

FIRING ORDER {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

FIRING ORDER

FIRING ORDER: The order in which combustion occurs in the cylinders of an engine. Also the order in which spark is distributed to the plugs by the distributor.

FIRM {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

FIRM

FIRM: A noticeable quick apply of a clutch or band that is considered normal with medium to heavy throttle shift; should not be confused with harsh or rough.

FLAME FRONT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

FLAME FRONT

FLAME FRONT: The term used to describe certain aspects of the fuel explosion in the cylinders. The flame front should move in a controlled pattern across the cylinder, rather than simply exploding immediately.

FLARE (SLIPPING) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

FLARE (SLIPPING)

FLARE (SLIPPING): A quick increase in engine rpm accompanied by momentary loss of torque; generally occurs during shift.

FLAT ENGINE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

FLAT ENGINE

FLAT ENGINE: Engine design in which the pistons are horizontally opposed. Porsche, Subaru and some old VWs are common examples of flat engines.

FLAT RATE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

FLAT RATE

FLAT RATE: A dealership term referring to the amount of money paid to a technician for a repair or diagnostic service based on that particular service versus dealership's labor time (NOT based on the actual time the technician spent on the job).

FLAT SPOT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

FLAT SPOT

FLAT SPOT: A point during acceleration when the engine seems to lose power for an instant.

FLOODING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

FLOODING

FLOODING: The presence of too much fuel in the intake manifold and combustion chamber which prevents the air/fuel mixture from firing, thereby causing a no-start situation.

FLUID {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

FLUID

FLUID: A fluid can be either liquid or gas. In hydraulics, a liquid is used for transmitting force or motion.

FLUID COUPLING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

FLUID COUPLING

FLUID COUPLING: The simplest form of hydrodynamic drive, the fluid coupling consists of two look-alike members with straight radial varies referred to as the impeller (pump) and the turbine. input torque is always equal to the output torque.

FLUID DRIVE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

FLUID DRIVE

FLUID DRIVE: Either a fluid coupling or a fluid torque converter. (See hydrodynamic drive units.)

FLUID TORQUE CONVERTER {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

FLUID TORQUE CONVERTER

FLUID TORQUE CONVERTER: A hydrodynamic drive that has the ability to act both as a torque multiplier and fluid coupling. (See hydrodynamic drive units; torque converter.)

FLUID VISCOSITY {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

FLUID VISCOSITY

FLUID VISCOSITY: The resistance of a liquid to flow. A cold fluid (oil) has greater viscosity and flows more slowly than a hot fluid (oil).

FLYWHEEL {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

FLYWHEEL

FLYWHEEL: A heavy disc of metal attached to the rear of the crankshaft. It smoothes the firing impulses of the engine and keeps the crankshaft turning during periods when no firing takes place. The starter also engages the flywheel to start the engine.

The flywheel is mounted to the rear of the crankshaft

{ewc GSMVIMG,GSMVIMG, !8852XG24.bmp}

8852XG24

FOOT POUND (ft. lbs. or sometimes, ft. lb.) {ewc MVIMAGE, MVIMAGE, ! nexttopicarrow.bmp}

FOOT POUND (ft. lbs. or sometimes, ft. lb.)

FOOT POUND (ft. lbs. or sometimes, ft. lb.): The amount of energy or work needed to raise an item weighing one pound, a distance of one foot.

FREEZE PLUG {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

FREEZE PLUG

FREEZE PLUG: A plug in the engine block which will be pushed out if the coolant freezes. Sometimes called expansion plugs, they protect the block from cracking should the coolant freeze.

FRICTION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

FRICTION

FRICTION: The resistance that occurs between contacting surfaces. This relationship is expressed by a ratio called the coefficient of friction (CL).

FRICTION, COEFFICIENT OF {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

FRICTION, COEFFICIENT OF

FRICTION, COEFFICIENT OF: The amount of surface tension between two contacting surfaces; expressed by a scientifically calculated number.

FRONT END ALIGNMENT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

FRONT END ALIGNMENT

FRONT END ALIGNMENT: A service to set caster, camber and toe-in to the correct specifications. This will ensure that the car steers and handles properly and that the tires wear properly.

FRICTION MODIFIER {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

FRICTION MODIFIER

FRICTION MODIFIER: Changes the coefficient of friction of the fluid between the mating steel and composition clutch/band surfaces during the engagement process and allows for a certain amount of intentional slipping for a good "shift-feel." full throttle detent downshift: A quick apply of accelerator pedal to its full travel, forcing a downshift.

FRONTAL AREA {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

FRONTAL AREA

FRONTAL AREA: The total frontal area of a vehicle exposed to air flow.

FUEL FILTER {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

FUEL FILTER

FUEL FILTER: A component of the fuel system containing a porous paper element used to prevent any impurities from entering the engine through the fuel system. It usually takes the form of a canister-like housing, mounted in-line with the fuel hose, located anywhere on a vehicle between the fuel tank and engine.

The fuel filter is mounted in-line with the fuel hose

{ewc GSMVIMG,GSMVIMG, !8852XG25.bmp}

8852XG25

FUEL INJECTION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

FUEL INJECTION

FUEL INJECTION: A system replacing the carburetor that sprays fuel into the cylinder through nozzles. The amount of fuel can be more precisely controlled with fuel injection.

FULL FLOATING AXLE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

FULL FLOATING AXLE

FULL FLOATING AXLE: An axle in which the axle housing extends through the wheel giving bearing support on the outside of the housing. The front axle of a four-wheel drive vehicle is usually a full floating axle, as are the rear axles of many larger (_ ton and over) pick-ups and vans.

FULL-TIME FOUR-WHEEL DRIVE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

FULL-TIME FOUR-WHEEL DRIVE

FULL-TIME FOUR-WHEEL DRIVE: A four-wheel drive system that continuously delivers power to all four wheels. A differential between the front and rear driveshafts permits variations in axle speeds to control gear wind-up without damage.

FUSE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

FUSE

FUSE: A protective device in a circuit which prevents circuit overload by breaking the circuit when a specific amperage is present. The device is constructed around a strip or wire of a lower amperage rating than the circuit it is designed to protect. When an amperage higher than that stamped on the fuse is present in the circuit, the strip or wire melts, opening the circuit.

FUSIBLE LINK {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

FUSIBLE LINK

FUSIBLE LINK: A piece of wire in a wiring harness that performs the same job as a fuse. If overloaded, the fusible link will melt and interrupt the circuit.

FWD {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

FWD

FWD: Front wheel drive.

GAWR {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

GAWR

GAWR: (Gross axle weight rating) the total maximum weight an axle is designed to carry.

GCW {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

GCW

GCW: (Gross combined weight) total combined weight of a tow vehicle and trailer.

GARAGE SHIFT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

GARAGE SHIFT

GARAGE SHIFT: initial engagement feel of transmission, neutral to reverse or neutral to a forward drive.

GARAGE SHIFT FEEL {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

GARAGE SHIFT FEEL

GARAGE SHIFT FEEL: A quick check of the engagement quality and responsiveness of reverse and forward gears. This test is done with the vehicle stationary.

GEAR {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

GEAR

GEAR: A toothed mechanical device that acts as a rotating lever to transmit power or turning effort from one shaft to another. (See gear ratio.)

GEAR RATIO {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

GEAR RATIO

GEAR RATIO: A ratio expressing the number of turns a smaller gear will make to turn a larger gear through one revolution. The ratio is found by dividing the number of teeth on the smaller gear into the number of teeth on the larger gear.

GEARBOX {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

GEARBOX

GEARBOX: Transmission

GEAR REDUCTION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

GEAR REDUCTION

GEAR REDUCTION: Torque is multiplied and speed decreased by the factor of the gear ratio. For example, a 3:1 gear ratio changes an input torque of 180 ft. lbs. and an input speed of 2700 rpm to 540 Ft. lbs. and 900 rpm, respectively. (No account is taken of frictional losses, which are always present.)

GEARTRAIN {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

GEARTRAIN

GEARTRAIN: A succession of intermeshing gears that form an assembly and provide for one or more torque changes as the power input is transmitted to the power output.

GEL COAT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

GEL COAT

GEL COAT: A thin coat of plastic resin covering fiberglass body panels.

GENERATOR {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

GENERATOR

GENERATOR: A device which produces direct current (DC) necessary to charge the battery.

GOVERNOR {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

GOVERNOR

GOVERNOR: A device that senses vehicle speed and generates a hydraulic oil pressure. As vehicle speed increases, governor oil pressure rises.

GROUND CIRCUIT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

GROUND CIRCUIT

GROUND CIRCUIT: (See circuit, ground.)

GROUND SIDE SWITCHING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

GROUND SIDE SWITCHING

GROUND SIDE SWITCHING: The electrical/electronic circuit control switch is located after the circuit load.

GVWR {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

GVWR

GVWR: (Gross vehicle weight rating) total maximum weight a vehicle is designed to carry including the weight of the vehicle, passengers, equipment, gas, oil, etc.

HALOGEN {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

HALOGEN

HALOGEN: A special type of lamp known for its quality of brilliant white light. Originally used for fog lights and driving lights.

HARD CODES {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

HARD CODES

HARD CODES: DTCs that are present at the time of testing; also called continuous or current codes.

HARSH(ROUGH) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

HARSH(ROUGH)

HARSH(ROUGH): An apply of a clutch or band that is more noticeable than a firm one; considered undesirable at any throttle position.

HEADER TANK {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

HEADER TANK

HEADER TANK: An expansion tank for the radiator coolant. It can be located remotely or built into the radiator.

HEAT RANGE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

HEAT RANGE

HEAT RANGE: A term used to describe the ability of a spark plug to carry away heat. Plugs with longer nosed insulators take longer to carry heat off effectively.

HEAT RISER {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

HEAT RISER

HEAT RISER: A flapper in the exhaust manifold that is closed when the engine is cold, causing hot exhaust gases to heat the intake manifold providing better cold engine operation. A thermostatic spring opens the flapper when the engine warms up.

HEAVY THROTTLE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

HEAVY THROTTLE

HEAVY THROTTLE: Approximately three-fourths of accelerator pedal travel.

HEMI {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

HEMI

HEMI: A name given an engine using hemispherical combustion chambers.

HERTZ (HZ) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

HERTZ (HZ)

HERTZ (HZ): The international unit of frequency equal to one cycle per second (10,000 Hertz equals 10,000 cycles per second).

HIGH-IMPEDANCE DVOM (DIGITAL VOLT-OHMMETER) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

HIGH-IMPEDANCE DVOM (DIGITAL VOLT-OHMMETER)

HIGH-IMPEDANCE DVOM (DIGITAL VOLT-OHMMETER): This styled device provides a built-in resistance value and is capable of limiting circuit current flow to safe milliamp levels.

HIGH RESISTANCE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

HIGH RESISTANCE

HIGH RESISTANCE: Often refers to a circuit where there is an excessive amount of opposition to normal current flow.

HORSEPOWER {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

HORSEPOWER

HORSEPOWER: A measurement of the amount of work; one horsepower is the amount of work necessary to lift 33,000 lbs. one foot in one minute. Brake horsepower (bhp) is the horsepower delivered by an engine on a dynamometer. Net horsepower is the power remaining (measured at the flywheel of the engine) that can be used to turn the wheels after power is consumed through friction and running the engine accessories (water pump, alternator, air pump, fan etc.)

HOT CIRCUIT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

HOT CIRCUIT

HOT CIRCUIT: (See circuit, hot; hot lead.) hot lead: A wire or conductor in the power side of the circuit. (See circuit, hot.)

HOT SIDE SWITCHING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

HOT SIDE SWITCHING

HOT SIDE SWITCHING: The electrical/electronic circuit control switch is located before the circuit load.

HUB {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

HUB

HUB: The center part of a wheel or gear.

HUNTING (BUSYNESS) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

HUNTING (BUSYNESS)

HUNTING (BUSYNESS): Repeating quick series of upshifts and downshifts that causes noticeable change in engine rpm, for example, as in a 4-3-4 shift pattern.

HYDRAULICS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

HYDRAULICS

HYDRAULICS: The use of liquid under pressure to transfer force of motion.

HYDROCARBON (HC) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

HYDROCARBON (HC)

HYDROCARBON (HC): Any chemical compound made up of hydrogen and carbon. A major pollutant formed by the engine as a by-product of combustion.

HYDRODYNAMIC DRIVE UNITS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

HYDRODYNAMIC DRIVE UNITS

HYDRODYNAMIC DRIVE UNITS: Devices that transmit power solely by the action of a kinetic fluid flow in a closed recirculating path. An impeller energizes the fluid and discharges the high-speed jet stream into the turbine for power output.

HYDROMETER {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

HYDROMETER

HYDROMETER: An instrument used to measure the specific gravity of a solution.

HYDROPLANING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

HYDROPLANING

HYDROPLANING: A phenomenon of driving when water builds up under the tire tread, causing it to lose contact with the road. Slowing down will usually restore normal tire contact with the road.

HYPOID GEARSET {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

HYPOID GEARSET

HYPOID GEARSET: The drive pinion gear may be placed below or above the centerline of the driven gear; often used as a final drive gearset.

IDLE MIXTURE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

IDLE MIXTURE

IDLE MIXTURE: The mixture of air and fuel (usually about 14:1) being fed to the cylinders. The idle mixture screw(s) are sometimes adjusted as part of a tune-up.

IDLER ARM {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

IDLER ARM

IDLER ARM: Component of the steering linkage which is a geometric duplicate of the steering gear arm. It supports the right side of the center steering link.

IMPELLER {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

IMPELLER

IMPELLER: Often called a pump, the impeller is the power input (drive) member of a hydrodynamic drive. As part of the torque converter cover, it acts as a centrifugal pump and puts the fluid in motion.

INCH POUND (inch lbs.; sometimes in. lb. or in. lbs.) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

INCH POUND (inch lbs.; sometimes in. lb. or in. lbs.)

INCH POUND (inch lbs.; sometimes in. lb. or in. lbs.): One twelfth of a foot pound.

INDUCTANCE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

INDUCTANCE

INDUCTANCE: The force that produces voltage when a conductor is passed through a magnetic field.

INDUCTION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

INDUCTION

INDUCTION: A means of transferring electrical energy in the form of a magnetic field. Principle used in the ignition coil to increase voltage.

INITIAL FEEL {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

INITIAL FEEL

INITIAL FEEL: A distinct firmer feel at start of shift when compared with feel at finish of shift.

INJECTOR {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

INJECTOR

INJECTOR: A device which receives metered fuel under relatively low pressure and is activated to inject the fuel into the engine under relatively high pressure at a predetermined time.

INPUT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

INPUT

INPUT: In an automatic transmission, the source of power from the engine is absorbed by the torque converter, which provides the power input into the transmission. The turbine drives the input(turbine)shaft.

INPUT SHAFT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

INPUT SHAFT

INPUT SHAFT: The shaft to which torque is applied, usually carrying the driving gear or gears.

INTAKE MANIFOLD {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

INTAKE MANIFOLD

INTAKE MANIFOLD: A casting of passages or pipes used to conduct air or a fuel/air mixture to the cylinders.

Typical intake manifold for a 4-cylinder engine

{ewc GSMVIMG,GSMVIMG, !8852XG26.bmp}

8852XG26

INTERNAL GEAR {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

INTERNAL GEAR

INTERNAL GEAR: The ring-like outer gear of a planetary gearset with the gear teeth cut on the inside of the ring to provide a mesh with the planet pinions.

ISOLATION (CLAMPING) DIODES {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ISOLATION (CLAMPING) DIODES

ISOLATION (CLAMPING) DIODES: Diodes positioned in a circuit to prevent self-induction from damaging electronic components.

IX ROTARY GEAR PUMP {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

IX ROTARY GEAR PUMP

IX ROTARY GEAR PUMP: Contains two rotating members, one shaped with internal gear teeth and the other with external gear teeth. As the gears separate, the fluid fills the gaps between gear teeth, is pulled across a crescent-shaped divider, and then is forced to flow through the outlet as the gears mesh.

IX ROTARY LOBE PUMP {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

IX ROTARY LOBE PUMP

IX ROTARY LOBE PUMP: Sometimes referred to as a gerotor type pump. Two rotating members, one shaped with internal lobes and the other with external lobes, separate and then mesh to cause fluid to flow.

JOURNAL {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

JOURNAL

JOURNAL: The bearing surface within which a shaft operates.

JUMPER CABLES {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

JUMPER CABLES

JUMPER CABLES: Two heavy duty wires with large alligator clips used to provide power from a charged battery to a discharged battery mounted in a vehicle.

JUMPSTART {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

JUMPSTART

JUMPSTART: Utilizing the sufficiently charged battery of one vehicle to start the engine of another vehicle with a discharged battery by the use of jumper cables.

KEY {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

KEY

KEY: A small block usually fitted in a notch between a shaft and a hub to prevent slippage of the two parts.

KICKDOWN {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

KICKDOWN

KICKDOWN: Detent downshift system; either linkage, cable, or electrically controlled.

KILO {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

KILO

KILO: A prefix used in the metric system to indicate one thousand.

KNOCK {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

KNOCK

KNOCK: Noise which results from the spontaneous ignition of a portion of the air-fuel mixture in the engine cylinder caused by overly advanced ignition timing or use of incorrectly low octane fuel for that engine.

KNOCK SENSOR {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

KNOCK SENSOR

KNOCK SENSOR: An input device that responds to spark knock, caused by over advanced ignition timing.

LABOR TIME {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

LABOR TIME

LABOR TIME: A specific amount of time required to perform a certain repair or diagnostic service as defined by a vehicle or after-market manufacturer .

LACQUER {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

LACQUER

LACQUER: A quick-drying automotive paint.

LATE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

LATE

LATE: Shift that occurs when engine is at higher than normal rpm for given amount of throttle.

LIGHT-EMITTING DIODE (LED) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

LIGHT-EMITTING DIODE (LED)

LIGHT-EMITTING DIODE (LED): A semiconductor diode that emits light as electrical current flows through it; used in some electronic display devices to emit a red or other color light.

LIGHT THROTTLE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

LIGHT THROTTLE

LIGHT THROTTLE: Approximately one-fourth of accelerator pedal travel.

LIMITED SLIP {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

LIMITED SLIP

LIMITED SLIP: A type of differential which transfers driving force to the wheel with the best traction.

LIMP-IN MODE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

LIMP-IN MODE

LIMP-IN MODE: Electrical shutdown of the transmission/ transaxle output solenoids, allowing only forward and reverse gears that are hydraulically energized by the manual valve. This permits the vehicle to be driven to a service facility for repair.

LIP SEAL {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

LIP SEAL

LIP SEAL: Molded synthetic rubber seal designed with an outer sealing edge (lip) that points into the fluid containing area to be sealed. This type of seal is used where rotational and axial forces are present.

LITHIUM-BASE GREASE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

LITHIUM-BASE GREASE

LITHIUM-BASE GREASE: Chassis and wheel bearing grease using lithium as a base. Not compatible with sodium-base grease.

LOAD DEVICE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

LOAD DEVICE

LOAD DEVICE: A circuit's resistance that converts the electrical energy into light, sound, heat, or mechanical movement.

LOAD RANGE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

LOAD RANGE

LOAD RANGE: Indicates the number of plies at which a tire is rated. Load range B equals four-ply rating; C equals six-ply rating; and, D equals an eight-ply rating.

LOAD TORQUE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

LOAD TORQUE

LOAD TORQUE: The amount of output torque needed from the transmission/transaxleto overcome the vehicle load.

LOCKING HUBS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

LOCKING HUBS

LOCKING HUBS: Accessories used on part-time four-wheel drive systems that allow the front wheels to be disengaged from the drive train when four-wheel drive is not being used. When four-wheel drive is desired, the hubs are engaged, locking the wheels to the drive train.

LOCKUP CONVERTER {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

LOCKUP CONVERTER

LOCKUP CONVERTER: A torque converter that operates hydraulically and mechanically. When an internal apply plate (lockup plate) clamps to the torque converter cover, hydraulic slippage is eliminated.

LOCK RING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

LOCK RING

LOCK RING: See Circlip or Snapring

MAGNET {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

MAGNET

MAGNET: Any body with the property of attracting iron or steel.

MAGNETIC FIELD {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

MAGNETIC FIELD

MAGNETIC FIELD: The area surrounding the poles of a magnet that is affected by its attraction or repulsion forces.

MAIN LINE PRESSURE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

MAIN LINE PRESSURE

MAIN LINE PRESSURE: Often called control pressure or line pressure, it refers to the pressure of the oil leaving the pump and is controlled by the pressure regulator valve.

MALFUNCTION INDICATOR LAMP (MIL) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

MALFUNCTION INDICATOR LAMP (MIL)

MALFUNCTION INDICATOR LAMP (MIL): Previously known as a check engine light, the dash-mounted MIL illuminates and signals the driver that an emission or driveability problem with the powertrain has been detected by the ECM/PCM. When this occurs, at least one diagnostic trouble code (DTC) has been stored into the control module memory.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR: Reads the amount of air pressure (vacuum) in the engine's intake manifold system; its signal is used to analyze engine load conditions.

MANIFOLD VACUUM {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

MANIFOLD VACUUM

MANIFOLD VACUUM: Low pressure in an engine intake manifold formed just below the throttle plates. Manifold vacuum is highest at idle and drops under acceleration.

MANIFOLD {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

MANIFOLD

MANIFOLD: A casting of passages or set of pipes which connect the cylinders to an inlet or outlet source.

MANUAL LEVER POSITION SWITCH (MLPS) {ewc MVIMAGE, MVIMAGE, ! nexttopicarrow.bmp}

MANUAL LEVER POSITION SWITCH (MLPS)

MANUAL LEVER POSITION SWITCH (MLPS): A mechanical switching unit that is typically mounted externally to the transmission/transaxleto inform the PCM/ECM which gear range the driver has selected.

MANUAL VALVE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

MANUAL VALVE

MANUAL VALVE: Located inside the transmission/transaxle, it is directly connected to the driver's shift lever. The position of the manual valve determines which hydraulic circuits will be charged with oil pressure and the operating mode of the transmission.

MANUAL VALVE LEVER POSITION SENSOR (MVLPS) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

MANUAL VALVE LEVER POSITION SENSOR (MVLPS)

MANUAL VALVE LEVER POSITION SENSOR (MVLPS): The input from this device tells the TCM what gear range was selected.

MASS AIR FLOW (MAF) SENSOR {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

MASS AIR FLOW (MAF) SENSOR

MASS AIR FLOW (MAF) SENSOR: Measures the airflow into the engine.

MASTER CYLINDER {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

MASTER CYLINDER

MASTER CYLINDER: The primary fluid pressurizing device in a hydraulic system. In automotive use, it is found in brake and hydraulic clutch systems and is pedal activated, either directly or, in a power brake system, through the power booster.

Master cylinder

{ewc GSMVIMG,GSMVIMG, !8852XG08.bmp}

8852XG08

McPHERSON STRUT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

McPHERSON STRUT

McPHERSON STRUT: A suspension component combining a shock absorber and spring in one unit.

McPherson struts combine shocks and springs in one assembly

{ewc GSMVIMG,GSMVIMG, !8852XG09.bmp}

8852XG09

MEDIUM THROTTLE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

MEDIUM THROTTLE

MEDIUM THROTTLE: Approximately one-half of accelerator pedal travel.

MEGA {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

MEGA

MEGA: A metric prefix indicating one million.

MEMBER {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

MEMBER

MEMBER: An independent component of a hydrodynamic unit such as an impeller, a stator, or a turbine. It may have one or more elements.

MERCON {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

MERCON

MERCON: A fluid developed by Ford Motor Company in 1988. It contains a friction modifier and closely resembles operating characteristics of Dexron®.

METAL SEALING RINGS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

METAL SEALING RINGS

METAL SEALING RINGS: Made from cast iron or aluminum, their primary application is with dynamic components involving pressure sealing circuits of rotating members. These rings are designed with either butt or hook lock end joints.

METER (ANALOG) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

METER (ANALOG)

METER (ANALOG): A linear-style meter representing data as lengths; a needle-style instrument interfacing with logical numerical increments. This style of electrical meter uses relatively low impedance internal resistance and cannot be used for testing electronic circuitry.

METER (DIGITAL) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

METER (DIGITAL)

METER (DIGITAL): Uses numbers as a direct readout to show values. Most meters of this style use high impedance internal resistance and must be used for testing low current electronic circuitry.

MICRO {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

MICRO

MICRO: A metric prefix indicating one-millionth (0.000001).

MILLI {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

MILLI

MILLI: A metric prefix indicating one-thousandth (0.001).

MINIMUM THROTTLE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

MINIMUM THROTTLE

MINIMUM THROTTLE: The least amount of throttle opening required for upshift; normally close to zero throttle.

MISFIRE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

MISFIRE

MISFIRE: Condition occurring when the fuel mixture in a cylinder fails to ignite, causing the engine to run roughly.

MODULE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

MODULE

MODULE: Electronic control unit, amplifier or igniter of solid state or integrated design which controls the current flow in the ignition primary circuit based on input from the pick-up coil. When the module opens the primary circuit, high secondary voltage is induced in the coil.

MODULATED {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

MODULATED

MODULATED: In an electronic-hydraulic converter clutch system (or shift valve system), the term modulated refers to the pulsing of a solenoid, at a variable rate. This action controls the buildup of oil pressure in the hydraulic circuit to allow a controlled amount of clutch slippage.

MODULATED CONVERTER CLUTCH CONTROL (MCCC) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

MODULATED CONVERTER CLUTCH CONTROL (MCCC)

MODULATED CONVERTER CLUTCH CONTROL (MCCC): A pulse width duty cycle valve that controls the converter lockup apply pressure and maximizes smoother transitions between lock and unlock conditions.

MODULATOR PRESSURE (THROTTLE PRESSURE) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

MODULATOR PRESSURE (THROTTLE PRESSURE)

MODULATOR PRESSURE (THROTTLE PRESSURE): A hydraulic signal oil pressure relating to the amount of engine load, based on either the amount of throttle plate opening or engine vacuum.

MODULATOR VALVE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

MODULATOR VALVE

MODULATOR VALVE: A regulator valve that is controlled by engine vacuum, providing a hydraulic pressure that varies in relation to engine torque. The hydraulic torque signal functions to delay the shift pattern and provide a line pressure boost. (See throttle valve.)

MOTOR {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

MOTOR

MOTOR: An electromagnetic device used to convert electrical energy into mechanical energy.

MULTIPLE-DISC CLUTCH {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

MULTIPLE-DISC CLUTCH

MULTIPLE-DISC CLUTCH: A grouping of steel and friction lined plates that, when compressed together by hydraulic pressure acting upon a piston, lock or unlock a planetary member.

MULTI-WEIGHT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

MULTI-WEIGHT

MULTI-WEIGHT: Type of oil that provides adequate lubrication at both high and low temperatures.

needed to move one amp through a resistance of one ohm.

MUSHY {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

MUSHY

MUSHY: Same as soft; slow and drawn out clutch apply with very little shift feel.

MUTUAL INDUCTION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

MUTUAL INDUCTION

MUTUAL INDUCTION: The generation of Ourrent from one wire circuit to another by movement of the magnetic field surrounding a current-carrying circuit as its ampere flow increases or decreases.

NEEDLE BEARING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

NEEDLE BEARING

NEEDLE BEARING: A bearing which consists of a number (usually a large number) of long, thin rollers.

NITROGEN OXIDE (NOx) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

NITROGEN OXIDE (NOx)

NITROGEN OXIDE (NOx): One of the three basic pollutants found in the exhaust emission of an internal combustion engine. The amount of NOx usually varies in an inverse proportion to the amount of HC and CO.

NONPOSITIVE SEALING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

NONPOSITIVE SEALING

NONPOSITIVE SEALING: A sealing method that allows some minor leakage, which normally assists in lubrication.

O2 SENSOR {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

O2 SENSOR

O2 SENSOR: Located in the engine's exhaust system, it is an input device to the ECM/PCM for managing the fuel delivery and ignition system. A scanner can be used to observe the fluctuating voltage readings produced by an 02 sensor as the oxygen content of the exhaust is analyzed.

O-RING SEAL {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

O-RING SEAL

O-RING SEAL: Molded synthetic rubber seal designed with a circular cross-section. This type of seal is used primarily in static applications.

OBD II (ON-BOARD DIAGNOSTICS, SECOND GENERATION) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

OBD II (ON-BOARD DIAGNOSTICS, SECOND GENERATION)

OBD II (ON-BOARD DIAGNOSTICS, SECOND GENERATION): Refers to the federal law mandating tighter control of 1996 and newer vehicle emissions, active monitoring of related devices, and standardization of terminology, data link connectors, and other technician concerns.

OCTANE RATING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

OCTANE RATING

OCTANE RATING: A number, indicating the quality of gasoline based on its ability to resist knock. The higher the number, the better the quality. Higher compression engines require higher octane gas.

OEM {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

OEM

OEM: Original Equipment Manufactured. OEM equipment is that furnished standard by the manufacturer.

OFFSET {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

OFFSET

OFFSET: The distance between the vertical center of the wheel and the mounting surface at the lugs. Offset is positive if the center is outside the lug circle; negative offset puts the center line inside the lug circle.

OHM'S LAW {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

OHM'S LAW

OHM'S LAW: A law of electricity that states the relationship between voltage, current, and resistance.
Volts = amperes x ohms

OHM {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

OHM

OHM: The unit used to measure the resistance of conductor-to-electrical flow. One ohm is the amount of resistance that limits current flow to one ampere in a circuit with one volt of pressure.

OHMMETER {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

OHMMETER

OHMMETER: An instrument used for measuring the resistance, in ohms, in an electrical circuit.

Checking resistance using an ohmmeter

{ewc GSMVIMG,GSMVIMG, !tccS1008.bmp}

TCCS1008

ONE-WAY CLUTCH {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ONE-WAY CLUTCH

ONE-WAY CLUTCH: A mechanical clutch of roller or sprag design that resists torque or transmits power in one direction only. It is used to either hold or drive a planetary member.

ONE-WAY ROLLER CLUTCH {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ONE-WAY ROLLER CLUTCH

ONE-WAY ROLLER CLUTCH: A mechanical device that transmits or holds torque in one direction only.

OPENCIRCUIT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

OPENCIRCUIT

OPENCIRCUIT: A break or lack of contact in an electrical circuit, either intentional (switch) or unintentional (bad connection or broken wire).

ORIFICE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ORIFICE

ORIFICE: Located in hydraulic oil circuits, it acts as a restriction. It slows down fluid flow to either create back pressure or delay pressure buildup downstream.

OSCILLOSCOPE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

OSCILLOSCOPE

OSCILLOSCOPE: A piece of test equipment that shows electric impulses as a pattern on a screen. Engine performance can be analyzed by interpreting these patterns.

OUTPUT SHAFT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

OUTPUT SHAFT

OUTPUT SHAFT: The shaft which transmits torque from a device, such as a transmission.

OUTPUT SPEED SENSOR (OSS) {ewc MVIMAGE, MVIMAGE, !
nexttopicarrow.bmp}

OUTPUT SPEED SENSOR (OSS)

OUTPUT SPEED SENSOR (OSS): Identifies transmission/transaxleoutput shaft speed for shift timing and may be used to calculate TCC slip; often functions as the VSS (vehicle speed sensor).

OVERDRIVE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

OVERDRIVE

OVERDRIVE: (1.) A device attached to or incorporated in a transmission/transaxlethat allows the engine to turn less than one full revolution for every complete revolution of the wheels. The net effect is to reduce engine rpm, thereby using less fuel. A typical overdrive gear ratio would be .87:1, instead of the normal 1:1 in high gear. (2.) A gear assembly which produces more shaft revolutions than that transmitted to it.

OVERDRIVE PLANETARY GEARSET {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

OVERDRIVE PLANETARY GEARSET

OVERDRIVE PLANETARY GEARSET: A single planetary gearset designed to provide a direct drive and overdrive ratio. When coupled to a three-speed transmission/transaxleconfiguration, a four-speed/overdrive unit is present.

OVERHEAD CAMSHAFT (OHC) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

OVERHEAD CAMSHAFT (OHC)

OVERHEAD CAMSHAFT (OHC): An engine configuration in which the camshaft is mounted on top of the cylinder head and operates the valve either directly or by means of rocker arms.

OVERHEAD VALVE (OHV) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

OVERHEAD VALVE (OHV)

OVERHEAD VALVE (OHV): An engine configuration in which all of the valves are located in the cylinder head and the camshaft is located in the cylinder block. The camshaft operates the valves via lifters and pushrods.

OVERRUNCLUTCH {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

OVERRUNCLUTCH

OVERRUNCLUTCH: Another name for a one-way mechanical clutch. Applies to both roller and sprag designs.

OVERSTEER {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

OVERSTEER

OVERSTEER: The tendency of some vehicles, when steering into a turn, to over-respond or steer more than required, which could result in excessive slip of the rear wheels. Opposite of understeer.

OXIDATION STABILIZERS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

OXIDATION STABILIZERS

OXIDATION STABILIZERS: Absorb and dissipate heat. Automatic transmission fluid has high resistance to varnish and sludge buildup that occurs from excessive heat that is generated primarily in the torque converter. Local temperatures as high as 6000F (3150C) can occur at the clutch plates during engagement, and this heat must be absorbed and dissipated. If the fluid cannot withstand the heat, it burns or oxidizes, resulting in an almost immediate destruction of friction materials, clogged filter screen and hydraulic passages, and sticky valves.

OXIDES OF NITROGEN {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

OXIDES OF NITROGEN

OXIDES OF NITROGEN: See nitrogen oxide (NOx).

OXYGEN SENSOR {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

OXYGEN SENSOR

OXYGEN SENSOR: Used with a feedback system to sense the presence of oxygen in the exhaust gas and signal the computer which can use the voltage signal to determine engine operating efficiency and adjust the air/fuel ratio.

PARALLEL CIRCUIT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

PARALLEL CIRCUIT

PARALLEL CIRCUIT: (See circuit, parallel.)

PARTS WASHER {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

PARTS WASHER

PARTS WASHER: A basin or tub, usually with a built-in pump mechanism and hose used for circulating chemical solvent for the purpose of cleaning greasy, oily and dirty components.

PART-TIME FOUR WHEEL DRIVE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

PART-TIME FOUR WHEEL DRIVE

PART-TIME FOUR WHEEL DRIVE: A system that is normally in the two wheel drive mode and only runs in four-wheel drive when the system is manually engaged because more traction is desired. Two or four wheel drive is normally selected by a lever to engage the front axle, but if locking hubs are used, these must also be manually engaged in the Lock position. Otherwise, the front axle will not drive the front wheels.

PASSIVE RESTRAINT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

PASSIVE RESTRAINT

PASSIVE RESTRAINT: Safety systems such as air bags or automatic seat belts which operate with no action required on the part of the driver or passenger. Mandated by Federal regulations on all vehicles sold in the U.S. after 1990.

PAYLOAD {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

PAYLOAD

PAYLOAD: The weight the vehicle is capable of carrying in addition to its own weight. Payload includes weight of the driver, passengers and cargo, but not coolant, fuel, lubricant, spare tire, etc.

PCM {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

PCM

PCM: Powertrain control module.

PCV VALVE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

PCV VALVE

PCV VALVE: A valve usually located in the rocker cover that vents crankcase vapors back into the engine to be reburned.

PERCOLATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

PERCOLATION

PERCOLATION: A condition in which the fuel actually "boils," due to excessive heat. Percolation prevents proper atomization of the fuel causing rough running.

PICK-UP COIL {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

PICK-UP COIL

PICK-UP COIL: The coil in which voltage is induced in an electronic ignition.

PINION GEAR {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

PINION GEAR

PINION GEAR: The smallest gear in a drive gear assembly. piston: A disc or cup that fits in a cylinder bore and is free to move. In hydraulics, it provides the means of converting hydraulic pressure into a usable force. Examples of piston applications are found in servo, clutch, and accumulator units.

PING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

PING

PING: A metallic rattling sound produced by the engine during acceleration. It is usually due to incorrect ignition timing or a poor grade of gasoline.

PINION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

PINION

PINION: The smaller of two gears. The rear axle pinion drives the ring gear which transmits motion to the axle shafts.

PISTON RING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

PISTON RING

PISTON RING: An open-ended ring which fits into a groove on the outer diameter of the piston. Its chief function is to form a seal between the piston and cylinder wall. Most automotive pistons have three rings: two for compression sealing; one for oil sealing.

PITMAN ARM {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

PITMAN ARM

PITMAN ARM: A lever which transmits steering force from the steering gear to the steering linkage.

Steering linkage

{ewc GSMVIMG,GSMVIMG, !8852XG10.bmp}

8852XG10

PLANET CARRIER {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

PLANET CARRIER

PLANET CARRIER: A basic member of a planetary gear assembly that carries the pinion gears.

PLANET PINIONS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

PLANET PINIONS

PLANET PINIONS: Gears housed in a planet carrier that are in constant mesh with the sun gear and internal gear. Because they have their own independent rotating centers, the pinions are capable of rotating around the sun gear or the inside of the internal gear.

PLANETARY GEAR RATIO {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

PLANETARY GEAR RATIO

PLANETARY GEAR RATIO: The reduction or overdrive ratio developed by a planetary gearset.

PLANETARY GEARSET {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

PLANETARY GEARSET

PLANETARY GEARSET: In its simplest form, it is made up of a basic assembly group containing a sun gear, internal gear, and planet carrier. The gears are always in constant mesh and offer a wide range of gear ratio possibilities.

PLANETARY GEARSET (COMPOUND) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

PLANETARY GEARSET (COMPOUND)

PLANETARY GEARSET (COMPOUND): Two planetary gearsets combined together.

PLANETARY GEARSET (SIMPLE) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

PLANETARY GEARSET (SIMPLE)

PLANETARY GEARSET (SIMPLE): An assembly of gears in constant mesh consisting of a sun gear, several pinion gears mounted in a carrier, and a ring gear. It provides gear ratio and direction changes, in addition to a direct drive and a neutral.

PLY RATING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

PLY RATING

PLY RATING: A. rating given a tire which indicates strength (but not necessarily actual plies). A two-ply/four-ply rating has only two plies, but the strength of a four-ply tire.

POLARITY {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

POLARITY

POLARITY: Indication (positive or negative) of the two poles of a battery.

PORT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

PORT

PORT: An opening for fluid intake or exhaust.

POSITIVE SEALING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

POSITIVE SEALING

POSITIVE SEALING: A sealing method that completely prevents leakage.

POTENTIAL {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

POTENTIAL

POTENTIAL: Electrical force measured in volts; sometimes used interchangeably with voltage.

POWER {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

POWER

POWER: The ability to do work per unit of time, as expressed in horsepower; one horsepower equals 33,000 ft.lbs. of work per minute, or 550 ft.lbs. of work per second.

POWER FLOW {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

POWER FLOW

POWER FLOW: The systematic flow or transmission of power through the gears, from the input shaft to the output shaft.

POWER-TO-WEIGHT RATIO {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

POWER-TO-WEIGHT RATIO

POWER-TO-WEIGHT RATIO: Ratio of horsepower to weight of car.

POWERTRAIN {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

POWERTRAIN

POWERTRAIN: See Drivetrain.

POWERTRAIN CONTROL MODULE(PCM) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

POWERTRAIN CONTROL MODULE(PCM)

POWERTRAIN CONTROL MODULE(PCM): Current designation for the engine control module (ECM). In many cases, late model vehicle control units manage the engine as well as the transmission. In other settings, the PCM controls the engine and is interfaced with a TCM to control transmission functions.

Ppm {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Ppm

Ppm: Parts per million; unit used to measure exhaust emissions.

PREIGNITION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

PREIGNITION

PREIGNITION: Early ignition of fuel in the cylinder, sometimes due to glowing carbon deposits in the combustion chamber. Preignition can be damaging since combustion takes place prematurely.

PRELOAD {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

PRELOAD

PRELOAD: A predetermined load placed on a bearing during assembly or by adjustment.

PRESS FIT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

PRESS FIT

PRESS FIT: The mating of two parts under pressure, due to the inner diameter of one being smaller than the outer diameter of the other, or vice versa; an interference fit.

PRESSURE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

PRESSURE

PRESSURE: The amount of force exerted upon a surface area.

PRESSURE CONTROL SOLENOID (PCS) {ewc MVIMAGE, MVIMAGE, !
nexttopicarrow.bmp}

PRESSURE CONTROL SOLENOID (PCS)

PRESSURE CONTROL SOLENOID (PCS): An output device that provides a boost oil pressure to the mainline regulator valve to control line pressure. Its operation is determined by the amount of current sent from the PCM.

PRESSURE GAUGE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

PRESSURE GAUGE

PRESSURE GAUGE: An instrument used for measuring the fluid pressure in a hydraulic circuit.

PRESSURE REGULATOR VALVE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

PRESSURE REGULATOR VALVE

PRESSURE REGULATOR VALVE: In automatic transmissions, its purpose is to regulate the pressure of the pump output and supply the basic fluid pressure necessary to operate the transmission. The regulated fluid pressure may be referred to as mainline pressure, line pressure, or control pressure.

PRESSURE SWITCH ASSEMBLY (PSA) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

PRESSURE SWITCH ASSEMBLY (PSA)

PRESSURE SWITCH ASSEMBLY (PSA): Mounted inside the transmission, it is a grouping of oil pressure switches that inputs to the PCM when certain hydraulic passages are charged with oil pressure.

PRESSURE PLATE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

PRESSURE PLATE

PRESSURE PLATE: A spring-loaded plate (part of the clutch) that transmits power to the driven (friction) plate when the clutch is engaged.

PRIMARY CIRCUIT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

PRIMARY CIRCUIT

PRIMARY CIRCUIT: The low voltage side of the ignition system which consists of the ignition switch, ballast resistor or resistance wire, bypass, coil, electronic control unit and pick-up coil as well as the connecting wires and harnesses.

PROFILE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

PROFILE

PROFILE: Term used for tire measurement (tire series), which is the ratio of tire height to tread width.

PROM (PROGRAMMABLE READ-ONLY MEMORY) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

PROM (PROGRAMMABLE READ-ONLY MEMORY)

PROM (PROGRAMMABLE READ-ONLY MEMORY): The heart of the computer that compares input data and makes the engineered program or strategy decisions about when to trigger the appropriate output based on stored computer instructions. **Pulse generator:** A two-wire pickup sensor used to produce a fluctuating electrical signal. This changing signal is read by the controller to determine the speed of the object and can be used to measure transmission/transaxleinput speed, output speed, and vehicle speed.

PSI {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

PSI

PSI: Pounds per square inch; a measurement of pressure.

PULSE WIDTH DUTY CYCLE SOLENOID (PULSE WIDTH MODULATED SOLENOID) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

PULSE WIDTH DUTY CYCLE SOLENOID (PULSE WIDTH MODULATED SOLENOID)

PULSE WIDTH DUTY CYCLE SOLENOID (PULSE WIDTH MODULATED SOLENOID): A computer-controlled solenoid that turns on and off at a variable rate producing a modulated oil pressure; often referred to as a pulse width modulated (PWM) solenoid. Employed in many electronic automatic transmissions and transaxles, these solenoids are used to manage shift control and converter clutch hydraulic circuits.

PUSHROD {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

PUSHROD

PUSHROD: A steel rod between the hydraulic valve lifter and the valve rocker arm in overhead valve (OHV) engines.

PUMP {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

PUMP

PUMP: A mechanical device designed to create fluid flow and pressure buildup in a hydraulic system.

QUARTER PANEL {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

QUARTER PANEL

QUARTER PANEL: General term used to refer to a rear fender. Quarter panel is the area from the rear door opening to the tail light area and from rear wheelwell to the base of the trunk and roof-line.

RACE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

RACE

RACE: The surface on the inner or outer ring of a bearing on which the balls, needles or rollers move.

RACK AND PINION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

RACK AND PINION

RACK AND PINION: A type of automotive steering system using a pinion gear attached to the end of the steering shaft. The pinion meshes with a long rack attached to the steering linkage.

Rack and pinion steering

{ewc GSMVIMG,GSMVIMG, !8852XG11.bmp}

8852XG11

RADIAL TIRE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

RADIAL TIRE

RADIAL TIRE: Tire design which uses body cords running at right angles to the center line of the tire. Two or more belts are used to give tread strength. Radials can be identified by their characteristic sidewall bulge.

RADIATOR {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

RADIATOR

RADIATOR: Part of the cooling system for a water-cooled engine, mounted in the front of the vehicle and connected to the engine with rubber hoses. Through the radiator, excess combustion heat is dissipated into the atmosphere through forced convection using a water and glycol based mixture that circulates through, and cools, the engine.

RANGE REFERENCE AND CLUTCH/BAND APPLY CHART {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

RANGE REFERENCE AND CLUTCH/BAND APPLY CHART

RANGE REFERENCE AND CLUTCH/BAND APPLY CHART: A guide that shows the application of clutches and bands for each gear, within the selector range positions. These charts are extremely useful for understanding how the unit operates and for diagnosing malfunctions.

RAVIGNEAUX GEARSET {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

RAVIGNEAUX GEARSET

RAVIGNEAUX GEARSET: A compound planetary gearset that features matched dual planetary pinions (sets of two) mounted in a single planet carrier. Two sun gears and one ring mesh with the carrier pinions.

REACTION MEMBER {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REACTION MEMBER

REACTION MEMBER: The stationary planetary member, in a planetary gearset, that is grounded to the transmission/transaxlecase through the use of friction and wedging devices known as bands, disc clutches, and one-way clutches.

REACTION PRESSURE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REACTION PRESSURE

REACTION PRESSURE: The fluid pressure that moves a spool valve against an opposing force or forces; the area on which the opposing force acts. The opposing force can be a spring or a combination of spring force and auxiliary hydraulic force.

REACTOR, TORQUE CONVERTER {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REACTOR, TORQUE CONVERTER

REACTOR, TORQUE CONVERTER: The reaction member of a fluid torque converter, more commonly called a stator. (See stator.)

REAR MAIN OIL SEAL {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REAR MAIN OIL SEAL

REAR MAIN OIL SEAL: A synthetic or rope-type seal that prevents oil from leaking out of the engine past the rear main crankshaft bearing.

RECIRCULATING BALL {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

RECIRCULATING BALL

RECIRCULATING BALL: Type of steering system in which recirculating steel balls occupy the area between the nut and worm wheel, causing a reduction in friction.

RECTIFIER {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

RECTIFIER

RECTIFIER: A device (used primarily in alternators) that permits electrical current to flow in one direction only.

REDUCTION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REDUCTION

REDUCTION: (See gear reduction.) regulator valve: A valve that changes the pressure of the oil in a hydraulic circuit as the oil passes through the valve by bleeding off (or exhausting) some of the volume of oil supplied to the valve.

REFRIGERANT 12 (R-12) or 134 (R-134) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REFRIGERANT 12 (R-12) or 134 (R-134)

REFRIGERANT 12 (R-12) or 134 (R-134): The generic name of the refrigerant used in automotive air conditioning systems.

REGULATOR {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

REGULATOR

REGULATOR: A device which maintains the amperage and/or voltage levels of a circuit at predetermined values.

RELAY {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

RELAY

RELAY: A switch which automatically opens and/or closes a circuit.

RELAY VALVE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

RELAY VALVE

RELAY VALVE: A valve that directs flow and pressure. Relay valves simply connect or disconnect interrelated passages without restricting the fluid flow or changing the pressure.

RELIEF VALVE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

RELIEF VALVE

RELIEF VALVE: A spring-loaded, pressure-operated valve that limits oil pressure buildup in a hydraulic circuit to a predetermined maximum value.

RELUCTOR {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

RELUCTOR

RELUCTOR: A wheel that rotates inside the distributor and triggers the release of voltage in an electronic ignition.

RESERVOIR {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

RESERVOIR

RESERVOIR: The storage area for fluid in a hydraulic system; often called a sump.

RESIN {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

RESIN

RESIN: A liquid plastic used in body work.

RESIDUAL MAGNETISM {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

RESIDUAL MAGNETISM

RESIDUAL MAGNETISM: The magnetic strength stored in a material after a magnetizing field has been removed.

RESISTANCE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

RESISTANCE

RESISTANCE: The opposition to the flow of current through a circuit or electrical device, and is measured in ohms. Resistance is equal to the voltage divided by the amperage.

RESISTOR SPARK PLUG {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

RESISTOR SPARK PLUG

RESISTOR SPARK PLUG: A spark plug using a resistor to shorten the spark duration. This suppresses radio interference and lengthens plug life.

RESISTOR {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

RESISTOR

RESISTOR: A device, usually made of wire, which offers a preset amount of resistance in an electrical circuit.

RESULTANT FORCE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

RESULTANT FORCE

RESULTANT FORCE: The single effective directional thrust of the fluid force on the turbine produced by the vortex and rotary forces acting in different planes.

RETARD {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

RETARD

RETARD: Set the ignition timing so that spark occurs later (fewer degrees before TDC).

RHEOSTAT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

RHEOSTAT

RHEOSTAT: A device for regulating a current by means of a variable resistance.

RING GEAR {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

RING GEAR

RING GEAR: The name given to a ring-shaped gear attached to a differential case, or affixed to a flywheel or as part of a planetary gear set.

ROADLOAD {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ROADLOAD

ROADLOAD: grade.

ROCKER ARM {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ROCKER ARM

ROCKER ARM: A lever which rotates around a shaft pushing down (opening) the valve with an end when the other end is pushed up by the pushrod. Spring pressure will later close the valve.

Typical rocker arm and shaft assembly

{ewc GSMVIMG,GSMVIMG, !8852XG29.bmp}

8852XG29

ROCKER PANEL {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ROCKER PANEL

ROCKER PANEL: The body panel below the doors between the wheel opening.

ROLLER BEARING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ROLLER BEARING

ROLLER BEARING: A bearing made up of hardened inner and outer races between which hardened steel rollers move.

ROLLER CLUTCH {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ROLLER CLUTCH

ROLLER CLUTCH: A type of one-way clutch design using rollers and springs mounted within an inner and outer cammed race assembly.

ROTARY FLOW {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ROTARY FLOW

ROTARY FLOW: The path of the fluid trapped between the blades of the members as they revolve with the rotation of the torque converter cover (rotational inertia).

ROTOR {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ROTOR

ROTOR: (1.) The disc-shaped part of a disc brake assembly, upon which the brake pads bear; also called, brake disc. (2.) The device mounted atop the distributor shaft, which passes current to the distributor cap tower contacts.

Rotor mounted on top of distributor shaft

{ewc GSMVIMG,GSMVIMG, !8852XG28.bmp}

8852XG28

ROTARY ENGINE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

ROTARY ENGINE

ROTARY ENGINE: See Wankel engine.

RPM {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

RPM

RPM: Revolutions per minute (usually indicates engine speed).

RTV {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

RTV

RTV: A gasket making compound that cures as it is exposed to the atmosphere. It is used between surfaces that are not perfectly machined to one another, leaving a slight gap that the RTV fills and in which it hardens. The letters RTV represent room temperature vulcanizing.

RUN-ON {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

RUN-ON

RUN-ON: Condition when the engine continues to run, even when the key is turned off. See dieseling.

SEALED BEAM {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SEALED BEAM

SEALED BEAM: A automotive headlight. The lens, reflector and filament from a single unit.

SEATBELT INTERLOCK {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SEATBELT INTERLOCK

SEATBELT INTERLOCK: A system whereby the car cannot be started unless the seatbelt is buckled.

SECONDARY CIRCUIT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SECONDARY CIRCUIT

SECONDARY CIRCUIT: The high voltage side of the ignition system, usually above 20,000 volts. The secondary includes the ignition coil, coil wire, distributor cap and rotor, spark plug wires and spark plugs.

SELF-INDUCTION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SELF-INDUCTION

SELF-INDUCTION: The generation of voltage in a current-carrying wire by changing the amount of current flowing within that wire.

SEMI-CONDUCTOR {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SEMI-CONDUCTOR

SEMI-CONDUCTOR: A material (silicon or germanium) that is neither a good conductor nor an insulator; used in diodes and transistors.

SEMI-FLOATING AXLE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SEMI-FLOATING AXLE

SEMI-FLOATING AXLE: In this design, a wheel is attached to the axle shaft, which takes both drive and cornering loads. Almost all solid axle passenger cars and light trucks use this design.

SENDING UNIT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SENDING UNIT

SENDING UNIT: A mechanical, electrical, hydraulic or electromagnetic device which transmits information to a gauge.

SENSOR {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SENSOR

SENSOR: Any device designed to measure engine operating conditions or ambient pressures and temperatures. Usually electronic in nature and designed to send a voltage signal to an on-board computer, some sensors may operate as a simple on/off switch or they may provide a variable voltage signal (like a potentiometer) as conditions or measured parameters change.

SERIES CIRCUIT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SERIES CIRCUIT

SERIES CIRCUIT: (See circuit, series.)

SERPENTINE BELT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SERPENTINE BELT

SERPENTINE BELT: An accessory drive belt, with small multiple v-ribs, routed around most or all of the engine-powered accessories such as the alternator and power steering pump. Usually both the front and the back side of the belt comes into contact with various pulleys.

SERVO {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SERVO

SERVO: In an automatic transmission, it is a piston in a cylinder assembly that converts hydraulic pressure into mechanical force and movement; used for the application of the bands and clutches.

SHIFT BUSYNESS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SHIFT BUSYNESS

SHIFT BUSYNESS: When referring to a torque converter clutch, it is the frequent apply and release of the clutch plate due to uncommon driving conditions.

SHIFT VALVE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SHIFT VALVE

SHIFT VALVE: Classified as a relay valve, it triggers the automatic shift in response to a governor and a throttle signal by directing fluid to the appropriate band and clutch apply combination to cause the shift to occur.

SHIM {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SHIM

SHIM: Spacers of precise, predetermined thickness used between parts to establish a proper working relationship.

SHIMMY {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SHIMMY

SHIMMY: Vibration (sometimes violent) in the front end caused by misaligned front end, out of balance tires or worn suspension components.

SHORT CIRCUIT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SHORT CIRCUIT

SHORT CIRCUIT: An electrical malfunction where current takes the path of least resistance to ground (usually through damaged insulation). Current flow is excessive from low resistance resulting in a blown fuse.

SHUDDER {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SHUDDER

SHUDDER: Repeated jerking or stick-slip sensation, similar to chuggle but more severe and rapid in nature, that may be most noticeable during certain ranges of vehicle speed; also used to define condition after converter clutch engagement.

SIMPSON GEARSET {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SIMPSON GEARSET

SIMPSON GEARSET: A compound planetary geartrain that integrates two simple planetary gearsets referred to as the front planetary and the rear planetary.

SINGLE OVERHEAD CAMSHAFT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SINGLE OVERHEAD CAMSHAFT

SINGLE OVERHEAD CAMSHAFT: See overhead camshaft.

SKIDPLATE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SKIDPLATE

SKIDPLATE: A metal plate attached to the underside of the body to protect the fuel tank, transfer case or other vulnerable parts from damage.

SLAVE CYLINDER {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SLAVE CYLINDER

SLAVE CYLINDER: In automotive use, a device in the hydraulic clutch system which is activated by hydraulic force, disengaging the clutch.

SLIPPING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SLIPPING

SLIPPING: Noticeable increase in engine rpm without vehicle speed increase; usually occurs during or after initial clutch or band engagement.

SLUDGE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SLUDGE

SLUDGE: Thick, black deposits in engine formed from dirt, oil, water, etc. It is usually formed in engines when oil changes are neglected.

SNAP RING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SNAP RING

SNAP RING: A circular retaining clip used inside or outside a shaft or part to secure a shaft, such as a floating wrist pin.

SOFT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SOFT

SOFT: Slow, almost unnoticeable clutch apply with very little shift feel.

SOFTCODES {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SOFTCODES

SOFTCODES: DTCs that have been set into the PCM memory but are not present at the time of testing; often referred to as history or intermittent codes.

SOHC {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SOHC

SOHC: Single overhead camshaft.

SOLENOID {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SOLENOID

SOLENOID: An electrically operated, magnetic switching device.

SPALLING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SPALLING

SPALLING: A wear pattern identified by metal chips flaking off the hardened surface. This condition is caused by foreign particles, overloading situations, and/or normal wear.

SPARK PLUG {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SPARK PLUG

SPARK PLUG: A device screwed into the combustion chamber of a spark ignition engine. The basic construction is a conductive core inside of a ceramic insulator, mounted in an outer conductive base. An electrical charge from the spark plug wire travels along the conductive core and jumps a preset air gap to a grounding point or points at the end of the conductive base. The resultant spark ignites the fuel/air mixture in the combustion chamber.

SPECIFIC GRAVITY (BATTERY) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SPECIFIC GRAVITY (BATTERY)

SPECIFIC GRAVITY (BATTERY): The relative weight of liquid (battery electrolyte) as compared to the weight of an equal volume of water.

SPLINES {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SPLINES

SPLINES: Ridges machined or cast onto the outer diameter of a shaft or inner diameter of a bore to enable parts to mate without rotation.

SPLIT TORQUE DRIVE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SPLIT TORQUE DRIVE

SPLIT TORQUE DRIVE: In a torque converter, it refers to parallel paths of torque transmission, one of which is mechanical and the other hydraulic.

SPONGY PEDAL {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SPONGY PEDAL

SPONGY PEDAL: A soft or spongy feeling when the brake pedal is depressed. It is usually due to air in the brake lines.

SPOOLVALVE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SPOOLVALVE

SPOOLVALVE: A precision-machined, cylindrically shaped valve made up of lands and grooves. Depending on its position in the valve bore, various interconnecting hydraulic circuit passages are either opened or closed.

SPRAG CLUTCH {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SPRAG CLUTCH

SPRAG CLUTCH: A type of one-way clutch design using cams or contoured-shaped sprags between inner and outer races. (See one-way clutch.)

SPRUNG WEIGHT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SPRUNG WEIGHT

SPRUNG WEIGHT: The weight of a car supported by the springs.

SQUARE-CUT SEAL {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SQUARE-CUT SEAL

SQUARE-CUT SEAL: Molded synthetic rubber seal designed with a square- or rectangular-shaped cross-section. This type of seal is used for both dynamic and static applications.

SRS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SRS

SRS: Supplemental restraint system

STABILIZER (SWAY) BAR {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

STABILIZER (SWAY) BAR

STABILIZER (SWAY) BAR: A bar linking both sides of the suspension. It resists sway on turns by taking some of added load from one wheel and putting it on the other.

STAGE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

STAGE

STAGE: The number of turbine sets separated by a stator. A turbine set may be made up of one or more turbine members. A three-element converter is classified as a single stage.

STALL {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

STALL

STALL: In fluid drive transmission/transaxleapplications, stall refers to engine rpm with the transmission/transaxleengaged and the vehicle stationary; throttle valve can be in any position between closed and wide open.

STALL SPEED {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

STALL SPEED

STALL SPEED: In fluid drive transmission/transaxleapplications, stall speed refers to the maximum engine rpm with the transmission/transaxleengaged and vehicle stationary, when the throttle valve is wide open. (See stall; stall test.)

STALL TEST {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

STALL TEST

STALL TEST: A procedure recommended by many manufacturers to help determine the integrity of an engine, the torque converter stator, and certain clutch and band combinations. With the shift lever in each of the forward and reverse positions and with the brakes firmly applied, the accelerator pedal is momentarily pressed to the wide open throttle (WOT) position. The engine rpm reading at full throttle can provide clues for diagnosing the condition of the items listed above.

STALL TORQUE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

STALL TORQUE

STALL TORQUE: The maximum design or engineered torque ratio of a fluid torque converter, produced under stall speed conditions. (See stall speed.)

STARTER {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

STARTER

STARTER: A high-torque electric motor used for the purpose of starting the engine, typically through a high ratio geared drive connected to the flywheel ring gear.

Starter motor assembly location

{ewc GSMVIMG,GSMVIMG, !8852XG30.bmp}

8852XG30

STATIC {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

STATIC

STATIC: A sealing application in which the parts being sealed do not move in relation to each other.

STATOR (REACTOR) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

STATOR (REACTOR)

STATOR (REACTOR): The reaction member of a fluid torque converter that changes the direction of the fluid as it leaves the turbine to enter the impeller vanes. During the torque multiplication phase, this action assists the impeller's rotary force and results in an increase in torque.

STEERING GEOMETRY {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

STEERING GEOMETRY

STEERING GEOMETRY: Combination of various angles of suspension components (caster, camber, toe-in); roughly equivalent to front end alignment.

STRAIGHT WEIGHT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

STRAIGHT WEIGHT

STRAIGHT WEIGHT: Term designating motor oil as suitable for use within a narrow range of temperatures. Outside the narrow temperature range its flow characteristics will not adequately lubricate.

STROKE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

STROKE

STROKE: The distance the piston travels from bottom dead center to top dead center.

SUBSTITUTION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SUBSTITUTION

SUBSTITUTION: Replacing one part suspected of a defect with a like part of known quality.

SUMP {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SUMP

SUMP: The storage vessel or reservoir that provides a ready source of fluid to the pump. In an automatic transmission, the sump is the oil pan. All fluid eventually returns to the sump for recycling into the hydraulic system.

SUN GEAR {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SUN GEAR

SUN GEAR: In a planetary gearset, it is the center gear that meshes with a cluster of planet pinions.

SUPERCHARGER {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SUPERCHARGER

SUPERCHARGER: An air pump driven mechanically by the engine through belts, chains, shafts or gears from the crankshaft. Two general types of supercharger are the positive displacement and centrifugal type, which pump air in direct relationship to the speed of the engine.

SUPPLEMENTAL RESTRAINT SYSTEM {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SUPPLEMENTAL RESTRAINT SYSTEM

SUPPLEMENTAL RESTRAINT SYSTEM: See air bag.

SURGE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SURGE

SURGE: Repeating engine-related feeling of acceleration and deceleration that is less intense than chuggle.

SWITCH {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SWITCH

SWITCH: A device used to open, close, or redirect the current in an electrical circuit.

SYNCHROMESH {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SYNCHROMESH

SYNCHROMESH: A manual transmission/transaxlethat is equipped with devices (synchronizers) that match the gear speeds so that the transmission/transaxlecan be downshifted without clashing gears.

SYNTHETIC OIL {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

SYNTHETIC OIL

SYNTHETIC OIL: Non-petroleum based oil.

TACHOMETER {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TACHOMETER

TACHOMETER: A device used to measure the rotary speed of an engine, shaft, gear, etc., usually in rotations per minute.

TDC {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TDC

TDC: Top dead center. The exact top of the piston's stroke.

TEFLON SEALING RINGS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TEFLON SEALING RINGS

TEFLON SEALING RINGS: Teflon is a soft, durable, plastic-like material that is resistant to heat and provides excellent sealing. These rings are designed with either scarf-cut joints or as one-piece rings. Teflon sealing rings have replaced many metal ring applications.

TERMINAL {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TERMINAL

TERMINAL: A device attached to the end of a wire or cable to make an electrical connection.

TEST LIGHT, CIRCUIT-POWERED {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TEST LIGHT, CIRCUIT-POWERED

TEST LIGHT, CIRCUIT-POWERED: Uses available circuit voltage to test circuit continuity.

TEST LIGHT, SELF-POWERED {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TEST LIGHT, SELF-POWERED

TEST LIGHT, SELF-POWERED: Uses its own battery source to test circuit continuity.

THERMISTOR {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

THERMISTOR

THERMISTOR: A special resistor used to measure fluid temperature; it decreases its resistance with increases in temperature.

THERMOSTAT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

THERMOSTAT

THERMOSTAT: A valve, located in the cooling system of an engine, which is closed when cold and opens gradually in response to engine heating, controlling the temperature of the coolant and rate of coolant flow.

THERMOSTATIC ELEMENT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

THERMOSTATIC ELEMENT

THERMOSTATIC ELEMENT: A heat-sensitive, spring-type device that controls a drain port from the upper sump area to the lower sump. When the transaxle fluid reaches operating temperature, the port is closed and the upper sump fills, thus reducing the fluid level in the lower sump.

THROTTLE POSITION (TP) SENSOR {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

THROTTLE POSITION (TP) SENSOR

THROTTLE POSITION (TP) SENSOR: Reads the degree of throttle opening; its signal is used to analyze engine load conditions. The ECM/PCM decides to apply the TCC, or to disengage it for coast or load conditions that need a converter torque boost.

THROTTLE PRESSURE/MODULATOR PRESSURE {ewc MVIMAGE, MVIMAGE, ! nexttopicarrow.bmp}

THROTTLE PRESSURE/MODULATOR PRESSURE

THROTTLE PRESSURE/MODULATOR PRESSURE: A hydraulic signal oil pressure relating to the amount of engine load, based on either the amount of throttle plate opening or engine vacuum.

THROTTLE VALVE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

THROTTLE VALVE

THROTTLE VALVE: A regulating or balanced valve that is controlled mechanically by throttle linkage or engine vacuum. It sends a hydraulic signal to the shift valve body to control shift timing and shift quality. (See balanced valve; modulator valve.)

THROW-OUT BEARING {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

THROW-OUT BEARING

THROW-OUT BEARING: As the clutch pedal is depressed, the throwout bearing moves against the spring fingers of the pressure plate, forcing the pressure plate to disengage from the driven disc.

TIE ROD {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TIE ROD

TIE ROD: A rod connecting the steering arms. Tie rods have threaded ends that are used to adjust toe-in.

TIE-UP {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TIE-UP

TIE-UP: Condition where two opposing clutches are attempting to apply at same time, causing engine to labor with noticeable loss of engine rpm.

TIMING BELT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TIMING BELT

TIMING BELT: A square-toothed, reinforced rubber belt that is driven by the crankshaft and operates the camshaft.

TIMING CHAIN {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TIMING CHAIN

TIMING CHAIN: A roller chain that is driven by the crankshaft and operates the camshaft.

TIRE ROTATION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TIRE ROTATION

TIRE ROTATION: Moving the tires from one position to another to make the tires wear evenly.

TOE-IN (OUT) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TOE-IN (OUT)

TOE-IN (OUT): A term comparing the extreme front and rear of the front tires. Closer together at the front is toe-in; farther apart at the front is toe-out.

Wheel toe-in (top view)

{ewc GSMVIMG,GSMVIMG, !8852XG12.bmp}

8852XG12

TOP DEAD CENTER (TDC) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TOP DEAD CENTER (TDC)

TOP DEAD CENTER (TDC): The point at which the piston reaches the top of its travel on the compression stroke.

TORQUE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TORQUE

TORQUE: Measurement of turning or twisting force, expressed as foot-pounds or inch-pounds.

TORQUE CONVERTER {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TORQUE CONVERTER

TORQUE CONVERTER: A turbine used to transmit power from a driving member to a driven member via hydraulic action, providing changes in drive ratio and torque. In automotive use, it links the driveplate at the rear of the engine to the automatic transmission.

TORQUE CONVERTER CLUTCH {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TORQUE CONVERTER CLUTCH

TORQUE CONVERTER CLUTCH: The apply plate (lockup plate) assembly used for mechanical power flow through the converter.

TORQUE PHASE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TORQUE PHASE

TORQUE PHASE: Sometimes referred to as slip phase or stall phase, torque multiplication occurs when the turbine is turning at a slower speed than the impeller, and the stator is reactionary (stationary). This sequence generates a boost in output torque.

TORQUE RATING (STALL TORQUE) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TORQUE RATING (STALL TORQUE)

TORQUE RATING (STALL TORQUE): The maximum torque multiplication that occurs during stall conditions, with the engine at wide open throttle (WOT) and zero turbine speed.

TORQUE RATIO {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TORQUE RATIO

TORQUE RATIO: An expression of the gear ratio factor on torque effect. A 3:1 gear ratio or 3:1 torque ratio increases the torque input by the ratio factor of 3. Input torque (100 ft. lbs.)x 3 = output torque (300 ft. lbs.)

TRACTION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TRACTION

TRACTION: The amount of usable tractive effort before the drive wheels slip on the road contact surface.

TORSION BAR SUSPENSION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TORSION BAR SUSPENSION

TORSION BAR SUSPENSION: Long rods of spring steel which take the place of springs. One end of the bar is anchored and the other arm (attached to the suspension) is free to twist. The bars' resistance to twisting causes springing action.

Torsion bar front suspension

{ewc GSMVIMG,GSMVIMG, !8852XG13.bmp}

8852XG13

TRACK {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TRACK

TRACK: Distance between the centers of the tires where they contact the ground.

TRACTION CONTROL {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TRACTION CONTROL

TRACTION CONTROL: A control system that prevents the spinning of a vehicle's drive wheels when excess power is applied.

TRACTIVE EFFORT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TRACTIVE EFFORT

TRACTIVE EFFORT: The amount of force available to the drive wheels, to move the vehicle.

TRANSAXLE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TRANSAXLE

TRANSAXLE: A single housing containing the transmission and differential. Transaxles are usually found on front engine/front wheel drive or rear engine/rear wheel drive cars.

TRANSDUCER {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TRANSDUCER

TRANSDUCER: A device that changes energy from one form to another. For example, a transducer in a microphone changes sound energy to electrical energy. In automotive air-conditioning controls used in automatic temperature systems, a transducer changes an electrical signal to a vacuum signal, which operates mechanical doors.

TRANSMISSION {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TRANSMISSION

TRANSMISSION: A powertrain component designed to modify torque and speed developed by the engine; also provides direct drive, reverse, and neutral.

TRANSMISSION CONTROL MODULE (TCM) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TRANSMISSION CONTROL MODULE (TCM)

TRANSMISSION CONTROL MODULE (TCM): Manages transmission functions. These vary according to the manufacturer's product design but may include converter clutch operation, electronic shift scheduling, and mainline pressure.

TRANSMISSION FLUID TEMPERATURE (TFT)SENSOR {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TRANSMISSION FLUID TEMPERATURE (TFT) SENSOR

TRANSMISSION FLUID TEMPERATURE (TFT)SENSOR: Originally called a transmission oil temperature (TOT) sensor, this input device to the ECM/PCM senses the fluid temperature and provides a resistance value. It operates on the thermistor principle.

TRANSMISSION INPUT SPEED (TIS) SENSOR {ewc MVIMAGE, MVIMAGE, ! nexttopicarrow.bmp}

TRANSMISSION INPUT SPEED (TIS) SENSOR

TRANSMISSION INPUT SPEED (TIS) SENSOR: Measures turbine shaft (input shaft) rpm's and compares to engine rpm's to determine torque converter slip. When compared to the transmission output speed sensor or VSS, gear ratio and clutch engagement timing can be determined.

TRANSMISSION OIL TEMPERATURE (TOT) SENSOR {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TRANSMISSION OIL TEMPERATURE (TOT) SENSOR

TRANSMISSION OIL TEMPERATURE (TOT) SENSOR: (See transmission fluid temperature (TFT) sensor.)

TRANSMISSION RANGE SELECTOR (TRS) SWITCH {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TRANSMISSION RANGE SELECTOR (TRS) SWITCH

TRANSMISSION RANGE SELECTOR (TRS) SWITCH: Tells the module which gear shift position the driver has chosen. turbine: The output (driven) member of a fluid coupling or fluid torque converter. It is splined to the input (turbine) shaft of the transmission.

TRANSFER CASE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TRANSFER CASE

TRANSFER CASE: A gearbox driven from the transmission that delivers power to both front and rear driveshafts in a four-wheel drive system. Transfer cases usually have a high and low range set of gears, used depending on how much pulling power is needed.

TRANSISTOR {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TRANSISTOR

TRANSISTOR: A semi-conductor component which can be actuated by a small voltage to perform an electrical switching function.

TREAD WEAR INDICATOR {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TREAD WEAR INDICATOR

TREAD WEAR INDICATOR: Bars molded into the tire at right angles to the tread that appear as horizontal bars when $^{1}/16$th in. of tread remains.

Location of tire tread wear indicators

{ewc GSMVIMG,GSMVIMG, !tccs1265.bmp}

tccs1265

TREAD WEAR PATTERN {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TREAD WEAR PATTERN

TREAD WEAR PATTERN: The pattern of wear on tires which can be "read" to diagnose problems in the front suspension.

TUNE-UP {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TUNE-UP

TUNE-UP: A regular maintenance function, usually associated with the replacement and adjustment of parts and components in the electrical and fuel systems of a vehicle for the purpose of attaining optimum performance.

TURBOCHARGER {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TURBOCHARGER

TURBOCHARGER: An exhaust driven pump which compresses intake air and forces it into the combustion chambers at higher than atmospheric pressures. The increased air pressure allows more fuel to be burned and results in increased horsepower being produced.

The turbocharged engine principle uses exhaust gas to spin the turbocharger, increasing maximum engine power output

{ewc GSMVIMG,GSMVIMG, !8852XG14.bmp}

8852XG14

TURBULENCE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TURBULENCE

TURBULENCE: The interference of molecules of a fluid (or vapor) with each other in a fluid flow.

TYPE F {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TYPE F

TYPE F: Transmission fluid developed and used by Ford Motor Company up to 1982. This fluid type provides a high coefficient of friction.

TYPE 7176 {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

TYPE 7176

TYPE 7176: The preferred choice of transmission fluid for Chrysler automatic transmissions and transaxles. Developed in 1986, it closely resembles Dexron® and Mercon. Type 7176 is the recommended service fill fluid for all Chrysler products utilizing a lockup torque converter dating back to 1978.

U-JOINT (UNIVERSAL JOINT) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

U-JOINT (UNIVERSAL JOINT)

U-JOINT (UNIVERSAL JOINT): A flexible coupling in the drive train that allows the driveshafts or axle shafts to operate at different angles and still transmit rotary power.

UNDERSTEER {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

UNDERSTEER

UNDERSTEER: The tendency of a car to continue straight ahead while negotiating a turn.

UNIT BODY {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

UNIT BODY

UNIT BODY: Design in which the car body acts as the frame.

UNLEADED FUEL {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

UNLEADED FUEL

UNLEADED FUEL: Fuel which contains no lead (a common gasoline additive). The presence of lead in fuel will destroy the functioning elements of a catalytic converter, making it useless.

UNSPRUNG WEIGHT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

UNSPRUNG WEIGHT

UNSPRUNG WEIGHT: The weight of car components not supported by the springs (wheels, tires, brakes, rear axle, control arms, etc.).

UPSHIFT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

UPSHIFT

UPSHIFT: A shift that results in a decrease in torque ratio and an increase in speed.

VACUUM {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

VACUUM

VACUUM: A negative pressure; any pressure less than atmospheric pressure.

VACUUM ADVANCE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

VACUUM ADVANCE

VACUUM ADVANCE: A device which advances the ignition timing in response to increased engine vacuum.

VACUUM GAUGE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

VACUUM GAUGE

VACUUM GAUGE: An instrument used for measuring the existing vacuum in a vacuum circuit or chamber. The unit of measure is inches (of mercury in a barometer).

VACUUM MODULATOR {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

VACUUM MODULATOR

VACUUM MODULATOR: Generates a hydraulic oil pressure in response to the amount of engine vacuum.

VALVES {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

VALVES

VALVES: Devices that can open or close fluid passages in a hydraulic system and are used for directing fluid flow and controlling pressure.

VALVE BODY ASSEMBLY {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

VALVE BODY ASSEMBLY

VALVE BODY ASSEMBLY: The main hydraulic control assembly of the transmission/transaxlethat contains numerous valves, check balls, and other components to control the distribution of pressurized oil throughout the transmission.

VALVE CLEARANCE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

VALVE CLEARANCE

VALVE CLEARANCE: The measured gap between the end of the valve stem and the rocker arm, cam lobe or follower that activates the valve.

VALVE GUIDES {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

VALVE GUIDES

VALVE GUIDES: The guide through which the stem of the valve passes. The guide is designed to keep the valve in proper alignment.

VALVE LASH (clearance) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

VALVE LASH (clearance)

VALVE LASH (clearance): The operating clearance in the valve train.

VALVE TRAIN {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

VALVE TRAIN

VALVE TRAIN: The system that operates intake and exhaust valves, consisting of camshaft, valves and springs, lifters, pushrods and rocker arms.

VAPOR LOCK {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

VAPOR LOCK

VAPOR LOCK: Boiling of the fuel in the fuel lines due to excess heat. This will interfere with the flow of fuel in the lines and can completely stop the flow. Vapor lock normally only occurs in hot weather.

VARIABLE DISPLACEMENT (VARIABLE CAPACITY) VANE PUMP {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

VARIABLE DISPLACEMENT (VARIABLE CAPACITY) VANE PUMP

VARIABLE DISPLACEMENT (VARIABLE CAPACITY) VANE PUMP: Slipper-type vanes, mounted in a revolving rotor and contained within the bore of a movable slide, capture and then force fluid to flow. Movement of the slide to various positions changes the size of the vane chambers and the amount of fluid flow. Note: GM refers to this pump design as variable displacement, and Ford terms it variable capacity.

VARIABLE FORCE SOLENOID (VFS) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

VARIABLE FORCE SOLENOID (VFS)

VARIABLE FORCE SOLENOID (VFS): Commonly referred to as the electronic pressure control (EPC) solenoid, it replaces the cable/linkage style of TV system control and is integrated with a spool valve and spring assembly to control pressure. A variable computer-controlled current flow varies the internal force of the solenoid on the spool valve and resulting control pressure.

VARIABLE ORIFICE THERMAL VALVE {ewc MVIMAGE, MVIMAGE, ! nexttopicarrow.bmp}

VARIABLE ORIFICE THERMAL VALVE

VARIABLE ORIFICE THERMAL VALVE: Temperature-sensitive hydraulic oil control device that adjusts the size of a circuit path opening. By altering the size of the opening, the oil flow rate is adapted for cold to hot oil viscosity changes.

VARNISH {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

VARNISH

VARNISH: Term applied to the residue formed when gasoline gets old and stale.

VCM {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

VCM

VCM: See Electronic Control Unit (ECU).

VEHICLE SPEED SENSOR (VSS) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

VEHICLE SPEED SENSOR (VSS)

VEHICLE SPEED SENSOR (VSS): Provides an electrical signal to the computer module, measuring vehicle speed, and affects the torque converter clutch engagement and release.

VESPEL SEALING RINGS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

VESPEL SEALING RINGS

VESPEL SEALING RINGS: Hard plastic material that produces excellent sealing in dynamic settings. These rings are found in late versions of the 4T60 and in all 4T60-E and 4T80-E transaxles.

VISCOSITY {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

VISCOSITY

VISCOSITY: The ability of a fluid to flow. The lower the viscosity rating, the easier the fluid will flow. 10 weight motor oil will flow much easier than 40 weight motor oil.

VISCOSITY INDEX IMPROVERS {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

VISCOSITY INDEX IMPROVERS

VISCOSITY INDEX IMPROVERS: Keeps the viscosity nearly constant with changes in temperature. This is especially important at low temperatures, when the oil needs to be thin to aid in shifting and for cold-weather starting. Yet it must not be so thin that at high temperatures it will cause excessive hydraulic leakage so that pumps are unable to maintain the proper pressures.

VISCOUS CLUTCH {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

VISCOUS CLUTCH

VISCOUS CLUTCH: A specially designed torque converter clutch apply plate that, through the use of a silicon fluid, clamps smoothly and absorbs torsional vibrations.

VOLT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

VOLT

VOLT: Unit used to measure the force or pressure of electricity. It is defined as the pressure

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VOLTAGE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

VOLTAGE

VOLTAGE: The electrical pressure that causes current to flow. Voltage is measured in volts (V).

VOLTAGE, APPLIED {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

VOLTAGE, APPLIED

VOLTAGE, APPLIED: The actual voltage read at a given point in a circuit. It equals the available voltage of the power supply minus the losses in the circuit up to that point.

VOLTAGE DROP {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

VOLTAGE DROP

VOLTAGE DROP: The voltage lost or used in a circuit by normal loads such as a motor or lamp or by abnormal loads such as a poor (high-resistance) lead or terminal connection.

VOLTAGE REGULATOR {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

VOLTAGE REGULATOR

VOLTAGE REGULATOR: A device that controls the current output of the alternator or generator.

VOLTMETER {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

VOLTMETER

VOLTMETER: An instrument used for measuring electrical force in units called volts. Voltmeters are always connected parallel with the circuit being tested.

VORTEX FLOW {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

VORTEX FLOW

VORTEX FLOW: The crosswise or circulatory flow of oil between the blades of the members caused by the centrifugal pumping action of the impeller.

WANKEL ENGINE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

WANKEL ENGINE

WANKEL ENGINE: An engine which uses no pistons. In place of pistons, triangular-shaped rotors revolve in specially shaped housings.

WATER PUMP {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

WATER PUMP

WATER PUMP: A belt driven component of the cooling system that mounts on the engine, circulating the coolant under pressure.

Water pump mounting onto front of the engine block

{ewc GSMVIMG,GSMVIMG, !8852XG32.bmp}

8852XG32

WATT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

WATT

WATT: The unit for measuring electrical power. One watt is the product of one ampere and one volt (watts equals amps times volts). Wattage is the horsepower of electricity (746 watts equal one horsepower).

WHEEL ALIGNMENT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

WHEEL ALIGNMENT

WHEEL ALIGNMENT: Inclusive term to describe the front end geometry (caster, camber, toe-in/out).

WHEEL CYLINDER {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

WHEEL CYLINDER

WHEEL CYLINDER: Found in the automotive drum brake assembly, it is a device, actuated by hydraulic pressure, which, through internal pistons, pushes the brake shoes outward against the drums.

Drum brake components

{ewc GSMVIMG,GSMVIMG, !8852XG15.bmp}

8852XG15

WHEEL WEIGHT {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

WHEEL WEIGHT

WHEEL WEIGHT: Small weights attached to the wheel to balance the wheel and tire assembly. Out-of-balance tires quickly wear out and also give erratic handling when installed on the front.

WHEELBASE {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

WHEELBASE

WHEELBASE: Distance between the center of front wheels and the center of rear wheels.

WIDE OPEN THROTTLE (WOT) {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

WIDE OPEN THROTTLE (WOT)

WIDE OPEN THROTTLE (WOT): Full travel of accelerator pedal.

WORK {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

WORK

WORK: The force exerted to move a mass or object. Work involves motion; if a force is exerted and no motion takes place, no work is done. Work per unit of time is called power. Work = force x distance = ft.lbs. 33,000 ft.lbs. in one minute = 1 horsepower

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ZERO-THROTTLE COAST DOWN {ewc MVIMAGE, MVIMAGE, ! nexttopicarrow.bmp}

ZERO-THROTTLE COAST DOWN

ZERO-THROTTLE COAST DOWN: A full release of accelerator pedal while vehicle is in motion and in drive range.

{ewc GSMVIMG,GSMVIMG, !88261p02.bmp}

88261p02

{ewc GSMVIMG,GSMVIMG, !88261p03.bmp}

88261p03

How to use the CD-ROM

How to use the CD-ROM

{ewc MVIMAGE,MVIMAGE, !
howtouse.bmp}

System Requirements {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

How to use the CD-ROM

System Requirements

Hardware Settings

- PC 486 or higher, with 16 MB RAM
  (Pentium 166, with 16 MB RAM recommended)
- Windows 95, 98, NT
  (Windows 98 recommended)
- 6 MB disk space
- 8x CD-ROM drive
- Color monitor with 256-color (8-bit) or greater video card
  - (16-bit color recommended)

System Settings

- Screen resolution set to 800 x 600
- 16-bit color display
- Printer's output resolution set to 600 dpi.
  - Laser Jet Printer recommended for schematics.

Technical Support {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Technical Support

Technical Support can be reached by any of the following methods.

by e-mail	techsupport@genisoft.com
by telephone	877.335.2533
by fax	905.831.2270

Navigating The CD-ROM {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Navigating the CD-ROM

{ewc GSMVIMG,GSMVIMG, !navigation.bmp}

Menu {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

How to use the CD-ROM

Menu

The Menu, across the top of the screen, contains tabs for dropdown menus under File, Edit, View, Go and Help.

Contents Window {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

How to use the CD-ROM

Contents Window

The Contents Window is located on the left side of the Main Window.   The Contents Window is a map of the CD-ROM's contents and functions.   Across the top of the Contents Window are four tabs labeled Contents, Glossary, Index, Search. The function of each of these tabs is discussed below.

{ewc GSMVIMG,GSMVIMG, !contentswindow.bmp}

Scroll bars may appear at the right and bottom of the Contents Window if the content of the window is too large for the frame.   The frame width may be altered by passing the cursor over the right margin of the Contents Window until the margin indicator (↔) appears, then hold the left mouse bottom while moving the cursor to the left or right.

Contents (Table of Contents)

Headings listed under the Contents tab identify the Main Topics contained within the CD-ROM.   White icons that look like a page indicate a Topic Window that can be displayed within the Viewing Window. Topics identified with a purple icon, representing a book cover, are Expandable Topics containing information for viewing following these steps:

1. Select an Expandable Topic, indicated by a purple icon, by single-clicking the left mouse button, or use the keyboard cursor arrow direction keys éê, then pressing ENTER.
2. A list will appear under the Expandable Topic heading that identifies all the topics available for viewing at the next level.
3. Open a Topic by single-clicking the left mouse button, or by moving the cursor to highlight the Topic, then pressing ENTER.

To collapse an Expanded Topic within the TOC list, double-click the mouse button on the Main Topic identified by a purple icon representing an open book.

To collapse all Expanded Topics, right click on a topic and choose CLOSE ALL.

Glossary

Single-click the left mouse button on the Glossary tab. A list of glossary words appears.   By typing a word into the text box located under the tabs, the list will automatically synchronize with your typing. You may also scroll down the list and single-click on the word.

To display the Glossary word description, select it from the list, then double-click the mouse button, or press ENTER.

Index

The Index functions very much like the Glossary. Single-click the left mouse button on the Index tab. A list of index items appears. By typing a word into the text box located under the tabs, the list will automatically synchronize with your typing. You may also scroll down the list and single-click on the word.

To display topics using the Index:

1. Select the Index word or phrase from the list then double-click the mouse button.
2. A list appears containing the Topic Windows that refer to the Indexed item.   This function is similar to the page numbers traditionally noted with a printed book Index.
3. Select a topic from the list, then double-click the mouse button. The Topic appears in the Viewing Window.

Search

GeniSoft supports dynamic word searching capability.

1. Type the desired word in the Word section text box, then press **List Topics** button or

press **Enter** on your keyboard.

2. A Search Results Window will appear listing all the topics where the word(s) appears throughout the manual.
3. Choose a topic and single-click Display with the left mouse button. The corresponding topic will appear in the Viewing Window. (on the right)

- Click here to see example searches

Searching for more than one word

If you are searching for more than one word at a time:

1. GeniSoft will find any appearance of each of the words entered in the Search dialog box Word section text box, if the words are separated by a space.

Concise Search

1. Type quotation marks ("") before and after the phrase you wish to search for. This will generate search results for the appearances of the exact phrase.
2. Between each word to be searched single-click u with the left mouse button. Choose either AND, OR, NEAR or NOT depending on which is appropriate.

   a) Choose AND to search multiple words.
   b) Choose OR to prefer one word over another in your search.
   c) Choose NEAR to search words within a close proximity.
   d) Choose NOT to exclude specific words in the search.

Searching Selected Groups

You can search through a range of groups (groups are Main Topics within the CD-ROM).

1. Single-click the left mouse button on the Advanced button.
2. In the Search dialog box, select the Selected Groups button within the Method section.
3. In the list box next to this button, select the group(s) in which you wish to search.
4. Textbook Edition will find your search word only in those selected groups.
5. Press OK to start your search.

The Navigation Toolbar {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

The Navigation Toolbar

Across the bottom of the Viewing Window is a Navigation Toolbar.

{ewc GSMVIMG,GSMVIMG, !navtoolbar.bmp}

Using the Browse Buttons

The Browse Buttons help you navigate through the book. Use the four buttons located on the left side of the Navigation Toolbar: Sync Contents, Previous, Next, Back Forward, Font Size.

Sync Contents Button

The Sync Contents button locates your currently open topic within the T.O.C.

Previous, Next Buttons

- The Previous button, represented by a blue up arrow indicates there is a previous Topic Window (page) linked with the current Topic Window. Pressing this button, or pressing F3, is like turning to the previous page in a book.
- The Next button, represented by a blue down arrow, indicates that more Topic Windows (pages) are linked with the current Topic Window. Pressing this button, or pressing F4, is like turning to the next page in a book.
- When the Previous or Next Button is dark gray in color, there are no previous or next Topic Windows available to view.

Back Button

- Press the Back Button, which is the light-blue arrow in the center-left side of the Navigation Toolbar, or press F4, to return the Viewing Window to the previously opened Topic Window.

Forward Button

- Press the Forward Button, which is the light-blue arrow in the center-right side of the Navigation Toolbar to return the Viewing Window to the previously opened Topic Window.

Font Size Button

- Press the Font Size Button, which is the blue and green button represented by two letter A's, to increase and decrease font size in the Viewing Window.

Viewing Window {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Viewing Window

A Viewing Window is to the right of the Contents Window (The window you are currently reading this page in). Selected topics are displayed in the Viewing Window.

Scroll bars may appear at the right and bottom of the Contents Window if the content of the window is too large for the frame. To alter the frame size or to hide the Contents Window, follow the procedures in the above topic, Contents Window.

GeniSoft Toolbar {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

GeniSoft Toolbar

The GeniSoft Toolbar, below the Menu, contains function icons for Contents, Bookmark, Print, Internet and Info.

{ewc GSMVIMG,GSMVIMG, !toolbar.bmp}

Alternative access

Contents:	Press the left-most tab in Contents Window
Bookmark:	From the Edit dropdown menu
Print:	From the File dropdown menu
Internet:	From the Help dropdown menu (Textbook Edition on the Web)
Info:	From the Go dropdown menu (Information) Click on the Publication Data Topic in Contents Windows

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Contents {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Contents

Makes the Table of Contents active in the Contents Window.

{ewc GSMVIMG,GSMVIMG, !activecontents.bmp}

Bookmark {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Bookmark

The Bookmark utility allows you to create a list of topics that you feel are important for future reference.

{ewc GSMVIMG,GSMVIMG, !bookmark.bmp}

Creating Bookmarks

1. While you have a topic selected in a Viewing Window, select the Bookmark icon.
2. The topic title will be displayed in a text box titled Current Topic.
3. If this information is correct, press ADD to save to the list.

Viewing Bookmarks

1. To re-open your marked section at a later time, select the Bookmark icon.
2. Select your desired topic from the Topic list. The list is kept in alphabetical order.
3. Select a topic title and then press display to display it.

Removing Bookmarks

1. To remove a bookmark, select the Bookmark icon.
2. Select your desired topic from the Topic list. The list is kept in alphabetical order.
3. Select a topic title and then press remove to delete it from the list.

Print

To print the currently open Topic Window:

1. Single-click the left mouse button on the Print icon, or press CTRL+P.
2. Choose number of copies, then press ENTER.

Internet {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

How to use the CD-ROM

Internet

To access extended information about this CD-ROM, or its contents: (Choose one)

1. Single-click the left mouse button on the Internet icon
2. Access from the Help dropdown menu (Textbook Edition on the Web)

Info {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Info

Display's all Publication Data as it relates to this CD-ROM and it's content.

Special Features on this CD-ROM {ewc MVIMAGE, MVIMAGE, !nexttopicarrow.bmp}

Special Features on this CD-ROM

Image Zoom Tool

Images can be magnified by single-clicking on the desired image. Images that have this feature available will change the arrow pointer into a magnifying glass.

A pop-up window will appear containing the desired image. Above the image is a slider. Click on the slider hold and drag to the right to magnify the image.

For example:

{ewc GSMVIMG,GSMVIMG, !zoom.bmp}

Image Zoom Tool

If the zoomed image window has scroll bars, you may increase the size of the frame by passing the cursor over the right margin, or the bottom margin of the frame until the margin indicator (↔) appears, then hold the left mouse bottom while moving the cursor until the scroll bar disappears.

Close an enlarged picture by single-clicking the x in the upper right corner of the frame.

Printing Pop-Up Images

In the pop-up image window, single-clicking the left mouse button on the print icon in the upper left corner of the window, then press OK in the Print dialog box.

Example Searches

Example Searches

	Searches Word	Result
Example #1	bolts	All topics containing bolts.
Example #2	*auto*	All topics with words containing "auto". Auto, Automatic, Automotive, Auto-ranging,
Example #3	"About Total Car Care"	All topics containing phrase "About Total Car Care".
Example #4	*V8 not V6 and engine	All topics containing words with "V8", and "engine" but not those that contain "V6"