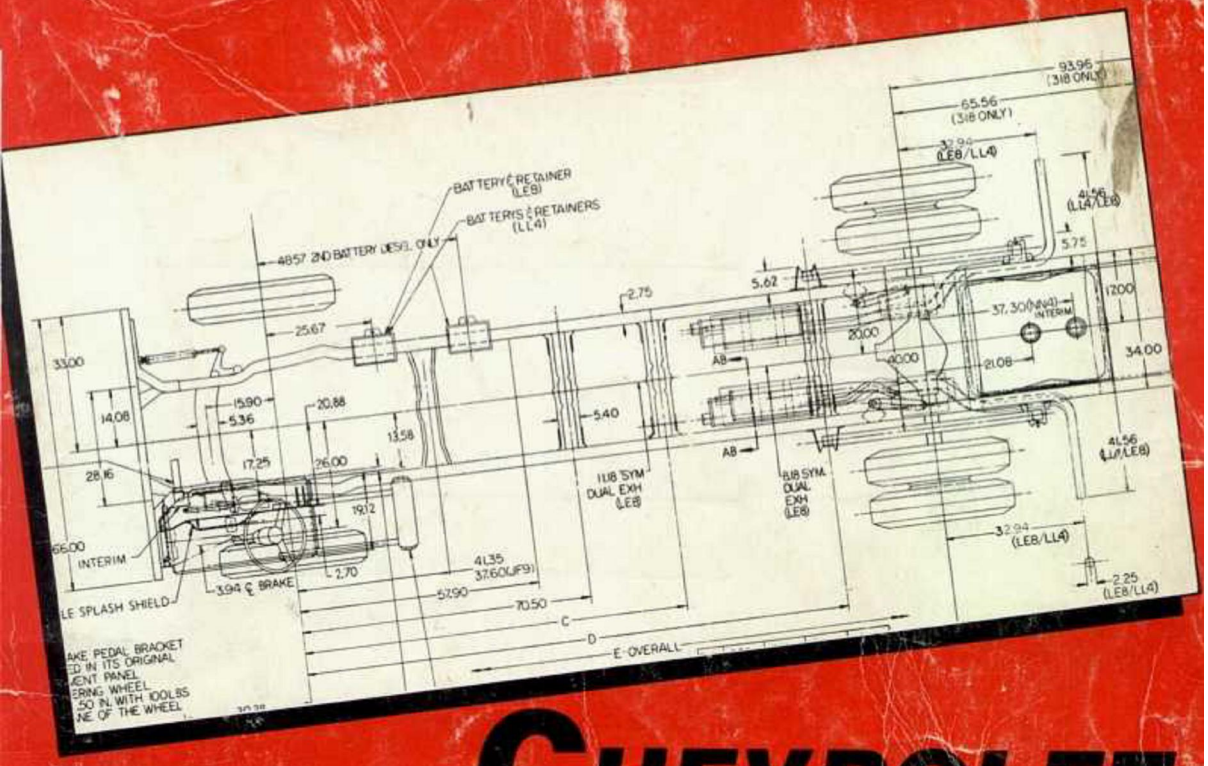


CHEVROLET MOTOR HOME CHASSIS SERVICE GUIDE

CHEVROLET RECREATIONAL VEHICLES

CHEVY TRUCKS

COMMERCIAL SPECIALTY VEHICLES

15.95

FOREWORD

This manual has been developed to provide the owner and operator with service information for the Chevrolet motor home chassis. Major components and systems are described and maintenance and inspection procedures are given. In addition to providing information for proper maintenance of the motor home chassis, some inspection and diagnosis procedures are included to help detect and identify common problem conditions which may occur.

In a section at the end of this manual are appendixes containing additional information helpful in maintaining the motor home. This includes information on drive belts, storage of the motor home, identification for nuts and bolts, and formulas for converting to metric measurements.

The organization of the Chevrolet Motor Home Chassis Service Guide is similar to that of the Chevrolet Light-Duty Truck 10-30 Series Shop Manual. While the information contained in this Service Guide is intended to establish proper maintenance and inspection procedures, there may be times when more detailed diagnostic and repair procedures contained in the Shop Manual may be required. The similarity in organization can make reference to the Shop Manual easier.

Specific references to Chevrolet Service Bulletins have been included within the text and appendixes of various sections of this manual. Chevrolet bulletins are intended for use by professional technicians, NOT a **"do-it-yourselfer."** They are written to inform these technicians of conditions that may occur on some vehicles, or to provide information that could assist in the proper service of a vehicle. Properly trained technicians have the equipment, tools, safety instructions, and know-how to do a job properly and safely. If a condition is described, DO NOT assume that the bulletin applies to your vehicle, or that your vehicle will have that condition. See your Chevrolet dealer for information on whether your vehicle may benefit from that information.

SUGGESTIONS FOR IMPROVED SERVICE

Motor homes can only service the needs of their owners when they are in dependable operating condition and able to perform properly. Costly breakdowns, service calls and downtime expense can be minimized through properly performed regular maintenance. Therefore, you should become familiar with Chevrolet's maintenance recommendations which have been developed in the interest of maximum vehicle performance and economical operation by those best qualified. These recommendations are outlined in the General Motors Maintenance Schedule for Light-Duty Trucks which was furnished with your Chevrolet chassis.

WHEN TRAVELING, CHEVROLET RECOMMENDS THE FOLLOWING TO OBTAIN SERVICE:

1. Wherever you are traveling, look in the yellow pages to see if there is a local Chevrolet dealership. Call the local dealership and ask to talk to the service manager. Tell him, as specifically as possible, the nature of your problem(s). Often, even a small dealership with limited facilities will be able to perform some of the simpler tasks of a lube or oil filter change, or other minor repairs. If the local dealer is not able to assist you, he may know of reputable towing companies, neighboring Chevrolet dealerships and independent repair facilities who may be able to help. Often the Chevrolet dealer may assist a warranty situation via a sublet through a local repair shop if the local Chevrolet dealer's shop cannot handle the necessary repairs.

2. If information is provided, motor home owners might call the RV manufacturer's service department. Based on prior positive experiences, the service department may be able to provide suggestions on where to take the vehicle, in that local area, for good repair work; i.e., the RV manufacturer's nearest local coach dealer, Chevrolet dealers, or even independent repair facilities with a history of proper and competent repair experience on the motor home.

3. Or the motor home owner may need to contact the Chevrolet Customer Assistance Center 1-800 FOR CHEV or (1-800-222-1020). When calling, be as specific as possible regarding the nature of the problem. Ask for the name and telephone number of the nearest dealer who has a demonstrated interest and the facilities for repairing motor coaches. Remember to ask for the name of that dealership's service manager so that you may call him directly to determine if he is able **and** available to handle your particular motor home service needs.

4. 24 hour road side assistance
   Call 1-800 CHEV USA
   Canada 1-800 268 6800 roadside
   1-800 263 3777 customer assistance

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GENERAL INFORMATION

Chevrolet chassis are available in two series for motor home use. These are the G-Series and the P-Series.

G-SERIES MOTOR HOME CHASSIS

The G-Series, or cutaway van, as it is commonly referred to before the addition of the motor home body, is a chassis which includes a full floor, frame, front cab (less back) and engine as shown in Figure 1-1. Many of the components including the front-end sheet metal, instrumentation, driving controls and seats are common with the Chevrolet Van.

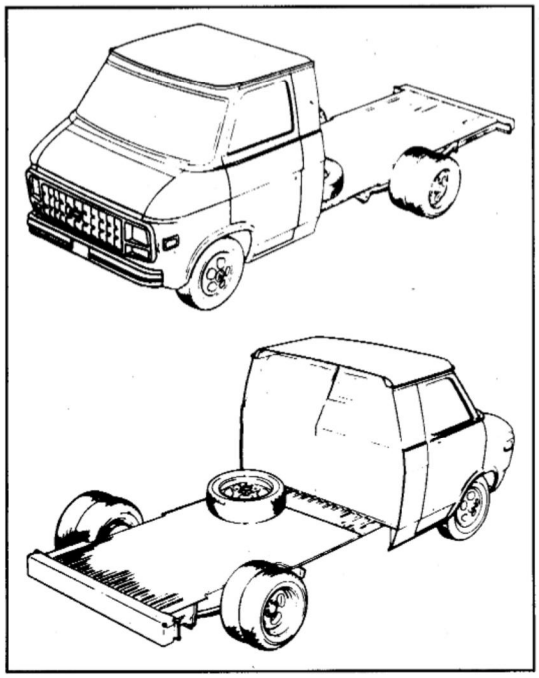


Figure 1-1 — G-Series Motor Home Chassis

P-SERIES MOTOR HOME CHASSIS

The P-Series motor home chassis is an engine and frame unit which includes the driving controls, as shown in Figure 1-2. The P-Series (P30 is the series and size class used for motor homes) is available in five wheelbase lengths. These are:

Model Number	Wheelbase Length (inches)
CP 3112	137
CP 31432 - 52	158.5
CP 31832 - 52	178
CP 31932 - 52	190**
CP 32032 - 52	208*

*Start-up production 1988 model year
**Start-up production 1991 model year

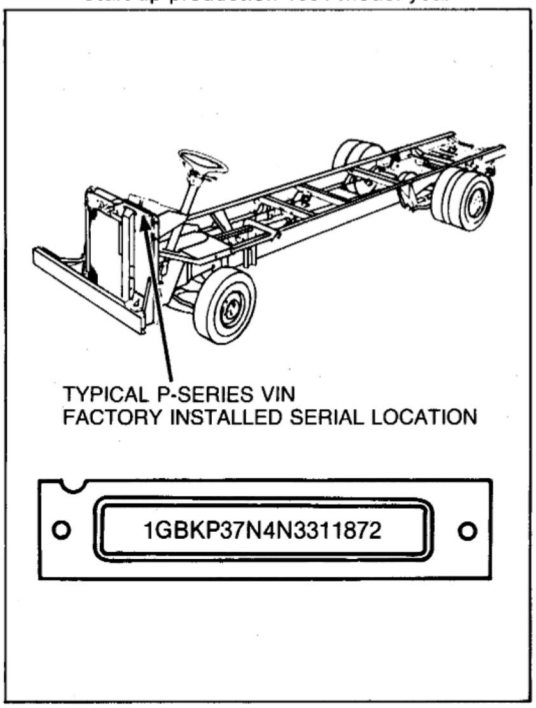
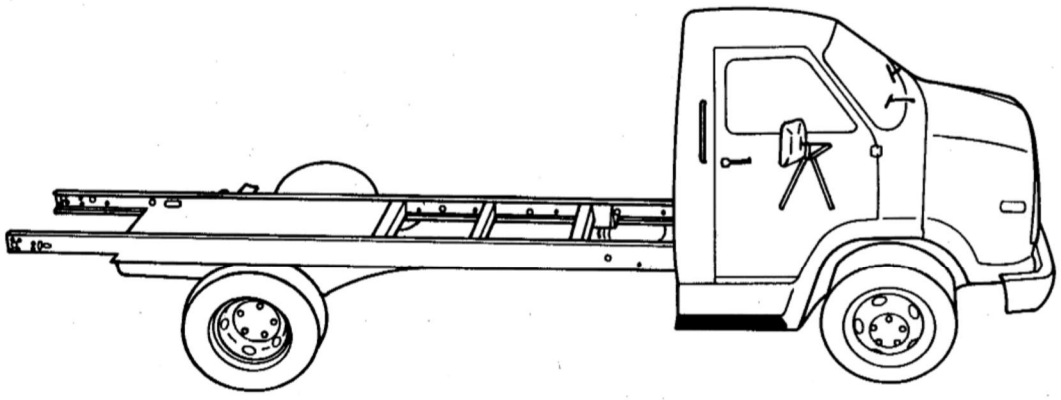


Figure 1-2 — P-Series Motor Home Chassis

IDENTIFICATION NUMBERS

There are several numbers that are important in identifying the vehicle and components used on the vehicle. They are the Vehicle Identification Number (VIN) and the Service Parts Identification Label - Figure 1-4

P30 HD CUTAWAY MOTOR HOME



P30 HD CUTAWAY AS A MOTOR HOME

- Outstanding strength and durability if Class A chassis: best-in-class GVWRs from 10,500 lbs. up to 14,500 lbs.
- Ease of upfitting on full frame with industry standard straight frame rails.
- Choice of four wheeelbases: 158.5-, 178-, 190-, and 208- inches.
- Can accommodate bodies of 22-, 24-, 26- and up to 27- feet in length.
- 7.4 liter (454 cubic inch) fuel-injected V8 gasoline engine with 230 horse-power and 380 lbs.-ft. of torque.
- Improvements to the 7.4-liter (454) V8 gasoline engine include revised inlet manifold, new hydrodynamic front crank seal and much more.
- Smooth-riding independent front suspension to step over bumps plus tapered leaf springs to enhance vehicle stability.
- One-piece fiberglass hood with grab handles that tilts forward for easy access to engine and other under-the-hood components.
- Fiberglass cab-entry steps for lifetime protection against corrosion.
- B-pillar grab handles for easy access to cab.
- Comfortable, roomy cab with standard adjustable high-back front bucket driver's seat.
- Ample use of glass for commanding view of the road.
- 4-speed automatic transmission (4L80-E) with over-drive electronically controlled for smooth shifting, powerful torque multiplication and economical highway operation.
- 4-wheel disc brakes for smooth, powerful braking (std. on 14,500 lbs. GVWR models).
- Solor-Ray™ light tinted glass reduces interior vehicle temperature in cab area for greater driver/passenger comfort.
- Dual rear wheels provide outstanding stability and enhanced ride smoothness.
- Up to 5,000-lb. capacity on front axle; up to 10,000-lb. capacity on full-floating rear axle.

STANDARD INTERIOR CONTENT

Air conditioning: front

Armrest: left hand padded

Cigarette lighter: included on instrument panel

Dome lamps: with front-door activated switches

Floor coverings: embossed black rubber mat on front floor area and wheelhousings

Gages: speedometer, odometer, trip odometer, fuel level, voltmeter, oil pressure, engine temperature and additional tell-tale lights

Headliner: hardboard

Heater: deluxe outside air heater and defogger

Insulation: in cab area

Parcel Tray: on top surface of instrument panel extension: includes beverage holder provisions

Radio: electronically-tuned AM radio with digital clock and fixed mast antenna

Seats: adjustable high-back front bucket driver's seat with all-vinyl trim

Steering Wheel: 2-spoke, with anti-theft feature on steering column

Stowage Box: with latched door on front face of instrument panel extension

Sunshades: padded, color-keyed RH and LH sunshades

Windshield Wipers: intermittent wiper system

STANDARD EXTERIOR CONTENT

Bumpers: chrome front

Headlamps: quad rectangular halogen

Horn: electric dual high-note and low-note

Tires: six LT215/85R16C steel belted radials (158.5 inch wheelbase)

six 7.50/16LT/D nylon ply blackwalls (178 inch wheelbase)

six 8.00R/19.5/D steel belted radial blackwalls (190 and 208 inch wheelbases)

Undercoating: on step panels and front wheelhousings

Wheels: six painted steel

Windows: light tinted Solor-Ray™ glass on all windows

VEHICLE IDENTIFICATION NUMBER (VIN)

The VIN is the legal identification of the vehicle. It appears on a plate which is attached to the top left of the instrument panel on the G-Series chassis and can be easily seen through the windshield from outside the vehicle (Figure 1-3). On the P-Series chassis the VIN is attached to the front of the dash and toe panel to the left of the steering column. (See Figure 1-2) for pre 1990. Currently the VIN plate is located center and on top of the radiator support. The VIN also appears on the Vehicle Certificates of Title and Registration. Refer to Figure 1-4 to determine the vehicle manufacturer, model and chassis type, engine type, GVW range, model year, plant code and production sequence number.

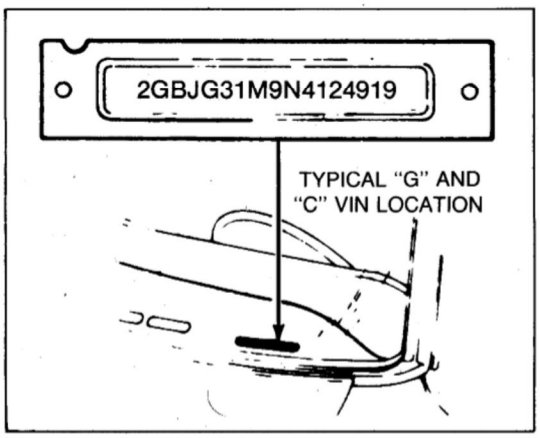


Figure 1-3 — Vehicle Identification Number (VIN)

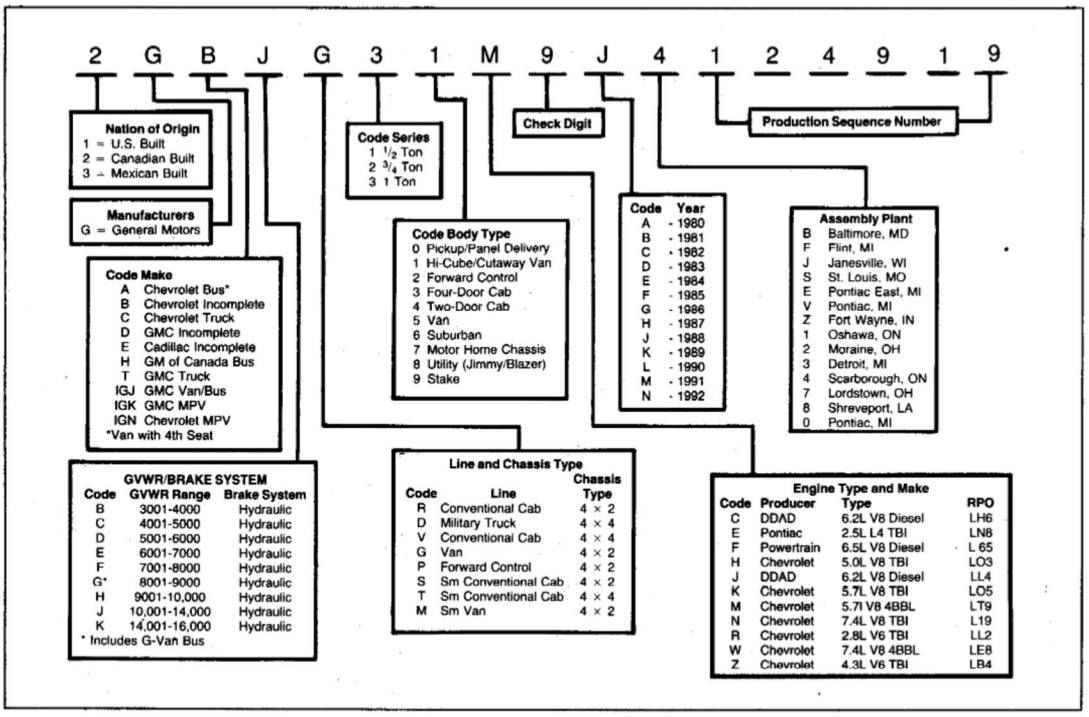


Figure 1-4 — Vehicle Identification Number Codes

SERVICE PARTS IDENTIFICATION LABEL

The Service Parts Identification Label (Figure 1-5) is provided on both G- and P-Series vehicles. On the G-Series vehicle, the label is located on an inner hood panel surface. On the P-Series vehicle, the label is located on an inner body panel by the body builder.

The label lists the vehicle identification number, wheelbase, and all production options or special equipment on the chassis when it was shipped from the factory including paint information. ALWAYS REFER TO THIS INFORMATION WHEN ORDERING PARTS.

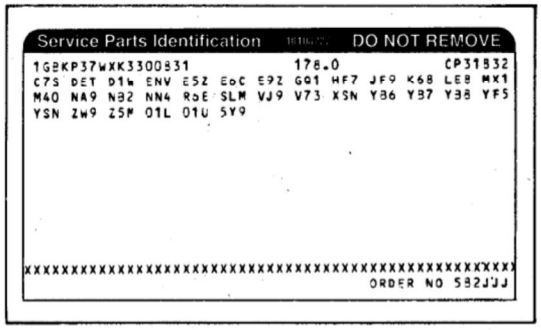


Figure 1-5 — Service Parts Identification Label

MOTOR HOME TOWING

The term "GCWR" is a new term to be learned when the motor home operator decides to enter the "world of towing." The term GCWR refers to the Gross Combination Weight Rating which includes the combined weight of the motor home (or truck) with all of its contents and the total weight of the trailer, car, boat or whatever is being towed.

Mini- and full-size motor homes do not have specific charts that cover trailer towing requirements. The chart shown in Figure 1-6 has been taken from the Chevrolet Trailer Guide and is presented as an aid to the motor home owner to assure reasonable performance without placing undue stress on the driveline components. The chart covers all engine and axle combinations used within General Motors, however all combinations are not available in the motor home product. Additional information may be available from the various motor home manufacturers as well as the current Chevrolet Trailer Guide. Examine the rating for your motor home provided by the RV manufacturer.

Refer to pages 5-3, 6-14, 7-1 and 8-7 for additional charts and information relating to work/stress and vehicle component life expectancy.

CAUTION: TO HELP AVOID PERSONAL INJURY DUE TO POOR BRAKING ACTION, ADEQUATE SIZE TRAILER BRAKES ARE REQUIRED ON TRAILERS OVER 1000 POUNDS OF LOADED WEIGHT.

GROSS COMBINATION WEIGHT RATING (GCWR) Includes Weight of Both Truck and Trailer By Engine & Axle Ratio For Recreational Applications

GCWR (lb.)	6000	6500	7000	7500	8000	8500	9000	9500	10,000	10,500	11,000	11,500	12,000	12,500	13,500	14,000	14,500	15,000	16,000	19,000
ENGINES	REAR AXLE RATIOS																			
2.5L (151) 4 GAS	3.73	4.10/4.11																		
2.8L (173) V6 GAS			3.42	3.73/4.11		3.73†														
4.3L (262) V6 GAS		2.41	2.56	2.73		3.08		3.42	3.73	4.11										
5.0L (305) V8 GAS			2.41	2.56		2.73		3.08		3.42		3.73								
5.7L (350) V8 GAS							2.73		3.08	3.23	3.42		3.73		4.10			4.56		
6.2L V8 DIESEL					2.73		3.08	3.23	3.42		3.73		4.10		4.56	5.13*				
7.4L (454) V8 GAS														3.21	3.42		3.73		4.10	4.56/4.88*

*Motor Home Chassis only. †Available only when RPO KC4 Engine Oil Cooler is specified.

THIS CHART SHOWS THE MAXIMUM ALLOWABLE GROSS COMBINATION WEIGHT RATING (GCWR) BASED ON ALL OF THE AVAILABLE TRUCK ENGINES AND REAR AXLE RATIOS WITH AUTOMATIC TRANSMISSIONS. THE GCWR INCLUDES THE TOTAL LOADED WEIGHT OF BOTH THE TRUCK AND TRAILER. ANY AVAILABLE ENGINE MAY BE USED FOR TRAILERING IF THE GCWR SHOWN IS NOT EXCEEDED. NOTE: THE TRAILER WEIGHT CAN BE INCREASED BY 25% IF THE VEHICLE SPEED WILL NOT EXCEED 25 MPH.

Figure 1-6 — Gross Combination Weight Rating Chart

NOTE: GCWR for unit with 4L80E transmission is 20,000# with 4:63 or 5:13 ratio.

ABOUT RV WEIGHTS

A discussion of recreational vehicle weight ratings, how they are determined, and how exceeding these figures can affect the operation of the vehicle.

By C. JAY HAYNOR, F15585
Technical Editor

Recently, Paul, a friend of mine who owns a large auto parts warehouse, was talking with me about one of his delivery trucks. The truck was a 1986 model with a gross vehicle weight rating (GVWR) of 11,000 pounds. This same chassis is used by motorhome manufacturers to build Class C coaches. The truck gave excellent service for eight months. Not too long after that, however, all of the driveshaft universal joints wore out, and multiple disc brake pad and rear brake shoe replacements were necessary. These and other repairs were causing Paul some concern. He noted that the front tires were cupped severely, and the rear tires had sidewall cracks. Paul's question to me was, "Why?"

When I talked with a few of the employees, they confirmed my suspicions. It seems that one of the salesmen was selling to a new account and used this truck to deliver some of the "parts." The "parts" included pallets of oil, transmission fluid, and batteries. The truck was overloaded and, equally important, subjected to poor weight distribution. The load on the rear was excessive, thereby cracking the sidewalls on the rear tires. The excessive rear load also lowered the rear of the truck, thereby raising the front. Because of that, the front tires made less contact with the road, and cupping resulted. This reminded me of pictures I once saw of a Federal Express airplane that was so heavily loaded in the rear that the front of the plane actually lifted well off the ground. The truck instance, though not as dramatic, was an example of the same type of overload condition. And many of the other mechanical difficulties that the truck began to experience could be attributed to overloading.

The major components of a chassis – including the engine, transmission, brakes, axles, tires, and frame – are designed to accommodate a particular weight, and if these components are overloaded, their life expectancy diminishes rapidly.

In the "good ole days" weight ratings were more guidelines than rigid "to the ounce" specifications. Then, along came the energy crunches of the 1970s. As a result, fuel economy and production costs became critical. Automobile manufacturers and RV manufacturers found that one of the fastest and easiest ways to increase fuel economy and to reduce production costs was to lighten the vehicles wherever they safely could. Today, more than ever before, it is of the utmost importance that we pay more attention to technical definitions and weights as they relate to our homes on wheels.

One of the organizations involved in establishing definitions that motorhome manufacturers and chassis builders use is the Recreation Vehicle Industry Association (RVIA). The weight issue is equally important to consumers. So, let's consider some of the definitions that we coach owners should understand before taking the next step, which is actually weighing our motorhomes.

Two definitions exist for the term **chassis** as it applies to motorhomes. In the case of a Class A motorhome, the chassis consists of the frame, running gear, steering, and suspension system. In the case of a Class C or micro-mini-motorhome, the chassis includes the same components as does a Class A motorhome chassis plus a cab.

From the definitions above, we can clearly see that the chassis is separate from the body or coach in a Class A motorhome and separate from the motorhome body in a Class C coach. It is the chassis manufacturer that determines the weight ratings and load specifications. The only exception would be if the chassis were modified and recertified by the company performing the modification. This would be indicated on a label positioned near the original label on the coach. The location of these labels varies from vehicle to vehicle.

Gross vehicle weight rating (GVWR) is the weight specified by the *chassis* manufacturer as the maximum loaded weight of the vehicle (including driver and passengers). Sometimes a tag axle – a non-powered rear axle – is added to a chassis. This usually is done to increase the GVWR of the chassis, and, as previously mentioned, it becomes the responsibility of that party to post and certify the new GVWR.

Gross axle weight rating (GAWR) is specified by the chassis manufacturer as the load carrying capacity of a single-axle system as measured at the tire-ground interface (in other words, at the place where the tire meets the ground). It is important to note that the GAWR is limited to the lowest individual rating of the tires, the wheels, the springs, or the axle – in other words, whichever component is the weakest link in the chain. Therefore, changing from load range D to load range E or F tires may or may not increase the GAWR, since this rating could be dependent upon other (weaker) components. The GAWR assumes that the weight is evenly distributed over the axle, with 50 percent on the right side and 50 percent on the left side – not 70/30, for instance. In other words, in the case of an axle with a GAWR of 6,000 pounds, the load distribution should be 3,000 pounds on one side and 3,000 pounds on the other.

Axle weight is both the amount of weight carried by a single axle and the amount of weight transmitted to the highway by one axle.

Shipping weight is the average weight of a specific vehicle as it leaves the assembly plant, including grease and oil plus regular production options but without any primary mover engine fuel (gasoline or diesel fuel).

Empty weight is defined as the shipping weight of a specific vehicle plus the maximum weight of primary mover engine fuel (gasoline or diesel fuel).

Curb weight is the weight of the vehicle empty (without payload and driver) but including engine fuel, coolant, engine oil, tools, spare tire, and all other standard equipment. It is determined without water in the tanks or water heater and with empty LP-gas containers. (Note: This definition, while accepted within the RV industry, may differ from definitions utilized by governmental regulatory agencies.)

Wet weight is the empty weight of a specific vehicle with the fresh water tanks, water heater, and LP-gas containers full but with waste water holding tanks empty. This weight is particularly significant to motorhome owners, because when you subtract this figure from the gross vehicle weight rating, you have a fairly accurate indication of the amount of weight that can be added to the vehicle, including driver and passengers, clothing, foodstuffs, etc.

Payload is a term commonly used in the trucking industry. In the RV industry, the term **carrying capacity** also is used. Carrying capacity is defined as the average weight that can be added to a specific vehicle without exceeding the GVWR. Carrying capacity can be computed by subtracting the empty weight of the vehicle from the GVWR figure. The addition of any other equipment or cargo and passengers adds to the vehicle weight and subtracts from the allowable carrying capacity. It is important to remember that the limiting factor in this rating could be the axles, springs, tires, transmission parking pawl, or any other equipment.

Center of gravity is the point where the weight of the chassis and/or body and payload is concentrated and, if suspended at that point, would balance front-to-rear and side-to-side. Cornering, acceleration, and other forces are considered as acting on a vehicle's center of gravity. Thus, it has a great influence on body lean and other handling characteristics. Even if all of the weights fall within the specifications, if they are not distributed properly, the coach could still suffer from excessive body lean or substandard handling characteristics. It should be noted that the center of gravity of a basement model coach will be higher than that of a traditionally designed motorhome.

Weight distribution is the arrangement of body and payload weight on a vehicle's chassis. It has a very definite bearing on the life of the tires, axles, springs, frame, and other parts. The fact that the total weight of the vehicle does not exceed the recommended maximum GVWR does not insure that the coach is not overloaded. Overloading can be due to improperly positioning heavy materials so that the load is centered over one rear tire or so far forward on the body that the front axle and tires are overloaded. An understanding of the proper methods of load placement will enable coach owners to prevent an overload condition. It should be noted also that the limiting factor is the weight rating, not the cubic foot capacity of the storage compartments. Some motorhome owners may be under the impression that if the manufacturer has provided the space, it must be acceptable for them to fill each nook and cranny to capacity. This isn't always the case, however. By providing varied and ample storage space, motor coach manufacturers are attempting to meet a multitude of needs.

Weighing your coach. Of course, the only way to be sure to avoid an overload condition is to weigh the coach. To do so accurately, the coach owner needs to find a scale that has a level area on the side, and to develop an excellent rapport with the person doing the weighing. The level side area is very important, because it will be necessary to have 50 percent of the left and right sides of the coach off the scale during some of the weighing. If the side area is not level, the side weights will be incorrect. Suitable scales might be found at truck stops, sand and gravel pit operations, and moving companies.

I would suggest that you make a photocopy of the coach weighing worksheet that accompanies this article and use it as a reference at the scale. Weigh the coach at an off time, since the entire process can take up to one-half hour. Before weighing the coach, load it as you normally would for travel, including food, clothing, fuel, water, propane, etc. This is *not* the time to be conservative!

The worksheet divides the coach into four sections. This is done by finding the halfway point between the front and rear tires (axles) and the halfway point between the front tires and then the halfway point between the rear tires. *Do not simply use the distance between the front and rear of the coach body; be sure to use the axles as a reference point.* Use tape to mark the side-to-side halfway points on the front bumper and on the rear bumper to make the reference points easily visible. Do the same for the front-to-rear halfway points by applying tape to the side of the coach. Dirve the coach onto the scale to the point that the front-to-rear tape pieces indicate that one-half of the wheelbase is on the scale and one-half is off. Referring to the worksheet, this will be weight number W1.

Weigh the tow car as you normally tow it, and if you find that it is overloaded, remove any weight necessary to bring it into specifications.

Next drive the entire motorhome onto the scale. This will be weight number W2. Then drive off the scale so that the side

tape stripe indicates that the rear half of the chassis remains on. This will be weight W3. I emphasize that it is important that one-half of the chassis, not the coach, rests on the scale during weighing.

Weight number W1 should not exceed the GAWR for the front axle. Weight number W2 should not exceed the total GVWR. Weight number W3 should not exceed the rear axle GAWR.

Now comes the time when rapport with the scale attendant and patience come in handy. To make these weights more meaningful, use the side-to-side and front-to-rear tape pieces to divide the chassis up into quarters and then weigh each section: front left, weight zone W4; rear left, weight zone W6; front right, weight zone W5; and finally rear right, weight zone W7. The weights for zone W4 and zone W5 should be about equal, as should the weights for zones W6 and W7. If this is not the case, try to move items inside the coach to bring the weights close.

When you compare the total weight of the two front quarters to the total axle weight, the figures probably will not be exactly equal, but they should be close. The same applies to the rear axle. It is also possible that the front and rear GAWR when totaled will be more than the GVWR. This is because the limiting factor may be something such as the transmission parking pawl, braking capacity, or another component.

Since tire manufacturers determine pressure recommendations for each individual tire based on the weight that a particular tire is carrying, these quartered weights are very important. Use the front and rear axle weights on the worksheet to determine the proper air pressure by consulting the tire manufacturer's tire manual, which should be available at any tire store.

One last word of caution: start with the weight you would normally carry when traveling. If the weight places the vehicle over the GVWR, remove some weight and weigh the coach again. The importance of weight and weight distribution in terms of safety and your motorhome's overall health cannot be overemphasized.

Another term with which motorhome owners should be familiar is **gross combination weight rating** (GCWR), which is the value specified by the *chassis* manufacturer as the maximum allowable total loaded weight of the tow vehicle and trailer combination. For our purposes the tow vehicle is the motorhome, and the trailer ordinarily is a towed car. To determine what size car can be towed safely behind a motorhome, subtract the actual motorhome weight, which must be less than the GVWR, from the GCWR. Normally this weight will be approximately 3,000 pounds, in which case the towed car combination (including trailer, dolly, or tow bar) should not exceed 3,000 pounds. Weigh the tow car as you normally tow it, and if you find that it is overloaded, remove any weight necessary to bring it into specifications.

I hope this short discussion of motorhome weights will motivate you to weigh your coach and make any necessary adjustments. And if you're looking for a new coach, it is hoped that this article will be another factor in your selection.

LUBRICATION

Various components of the motor home chassis must have the proper lubrication to operate as designed. This lubrication must be done in accordance with the intervals specified in the appropriate Maintenance Schedule for the vehicle.

Following are charts which list the recommended fluids and lubricants, component fluid capacities and lubrication points.

RECOMMENDED FLUIDS AND LUBRICANTS

USAGE	FLUID/LUBRICANT
Power steering system and pump reservoir	Power steering fluid, GM Part No. 1050017 or equivalent
Manual steering gear	Lubricant, GM Part No. 1052182 or equivalent
Differential — Standard or Locking Spiral Bevel Axel Gearing. Pinion enters ring gear at centerline	SAE-80W GL-5 or SAE-80W-90 GL-5 gear lubricant (SAE-80W — GL-5 in Canada) Do not use additive with Eaton locking differential
Differential — Rockwell model C-103-12¼", Commercial P model, Hypod gearing. Pinion enters ring gear below centerline.	SAE-85W-140 GL-5 above 10°F SAE-80W-90 GL-5 below 15°F Military spec 2105C
Brake system and master cylinder	Delco Supreme 11 fluid or DOT-3 1052535
Propeller shaft slip spline and U joints	Chassis Grease, GM Part No. 1052497 or equivalent
Hood Latch Assembly a. Pivots and spring anchor b. Release pawl	 a. Engine Oil b. Chassis Grease
Hood and Door Hinges	Engine Oil
Automatic Transmission Shift Linkage	Engine Oil
Chassis Lubrication	Chassis Grease, GM Part No. 1052497 or equivalent
Engine Oil (Gasoline)	"SG" or "SG/CC" or "SG/CD" Engine Oil
Engine Oil (Diesel)	"CE/SG" Engine Oil
Automatic Transmission	DEXRON IIE Auto. Trans. Fluid, GM Part No. 12345881
Parking Brake Cables	Chassis Grease, GM Part No. 1052497 or equivalent
Front Wheel Bearings	Wheel bearing lubricant, GM Part No. 1051344 (One Pound) or Exxon Ronex MP Grease or equivalent
Body door hinge pins, tailgate hinge and linkage, folding seat, fuel door hinge	Engine Oil
Windshield Washer Solvent	GM Optikleen washer solvent, GM Part No. 1051515 or equivalent
Engine Coolant GM 1825M Specifications	Mixture of water and high quality Ethylene Glycol base type antifreeze, GM Part No. 1052753 or equivalent
Key Lock Cylinder	Lockeze or GM Part No. 12345120

Figure 1-7 — Recommended Fluids and Lubricants

LUBRICANT CAPACITIES

USAGE		U.S. MEASURE
Differential		
10-1/2 In. Ring Gear (Chevrolet)		6-1/2 pts.
10-1/2 In. Ring Gear (Dana 70)		7.2 pts.
9-3/4 In. Ring Gear (Dana)		6.0 pts.
10.5 In. Ring Gear (Saginaw 70)		7.0 pts.
11.3 In. Ring Gear (Dana 80)		7.5 pts.
Engine Crankcase		
Code F-H L-M-P	5.7L V-8 — Drain & Refill	4 qts.
	— w/Filter Change	5 qts.
Code W	7.4L V-8 — Drain & Refill	6 qts.
	— w/Filter Change	7 qts.
Code C-F-J	6.2L–6.5 V-8 Diesel Including Filter	7 qts.
Transmission Automatic		
350C — Total		10 qts.
— Refill		3 qts.
475 — Total		11 qts.
— Refill		3.5 qts.
4L80E — Total		13.5 qts.
— Refill		7.7 qts.

Figure 1-8 — Lubricant Capacities

NOTE: With any side fill gear case, regardless of specification, fill the case until fluid runs back out the fill hole (Figure 1-9). DO NOT CONSIDER THE FILL ADEQUATE JUST BECAUSE YOU CAN REACH IT WITH YOUR FINGER.

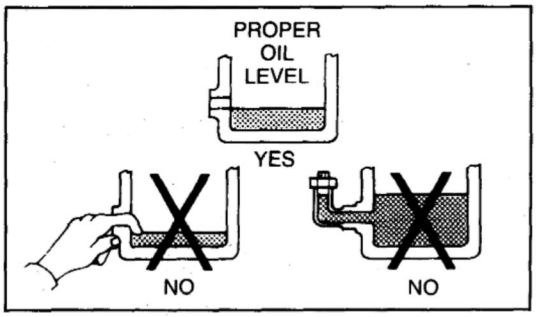
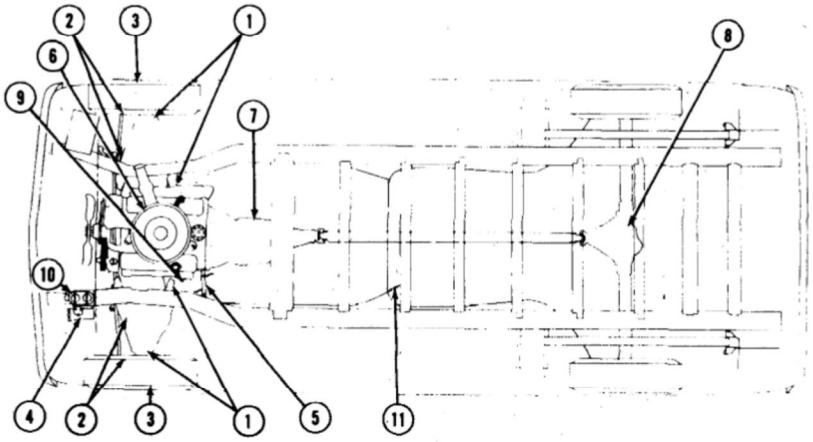


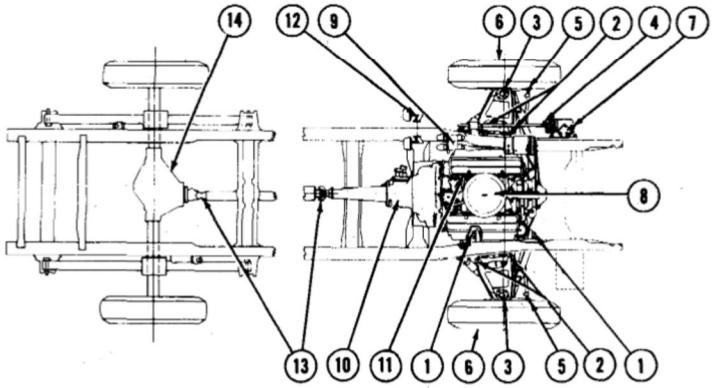
Figure 1-9 — Side Fill Gear Case Capacity

LUBRICATION POINTS



(1) Control Arm Bushings and Ball Joints
(2) Tie Rod Ends
(3) Wheel Bearings
(4) Steering Gear Clutch Cross-Shaft
(5) Trans. Control Shaft
(6) Air Cleaner — Element
(7) Transmission — Automatic
(8) Rear Axle
(9) Oil Filter
(10) Brake Master Cylinder
(11) Parking Brake Linkage

Figure 1-10 — Lubrication Points — G-Series



(1) Lower Control Arms
(2) Upper Control Arms
(3) Upper and Lower Control Arm Ball Joints
(4) Intermediate Steering Shaft (PA10)
(5) Tie Rod Ends
(6) Wheel Bearings
(7) Steering Gear
(8) Air Cleaner — Element
(9) Master Cylinder
(10) Transmission — Automatic
(11) Carburetor Linkage — V-8
(12) Brake Pedal Spring
(13) Universal Joints*
(14) Rear Axle

*On some models, universal joints are sealed with no provision for lubrication. On models which have lubrication provisions, use high-temperature lubricant (GM Part No. 1051344 or equivalent).

Figure 1-11 — Lubrication Points — P-Series

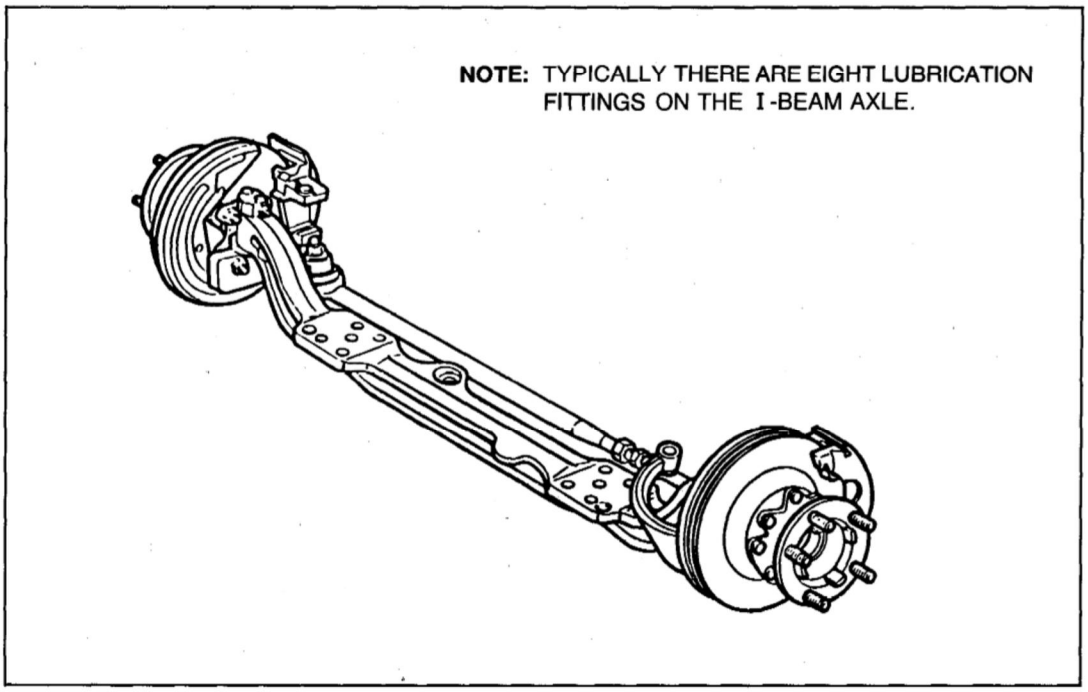


Figure 1-12 — Lubrication Points — P-Series with I-Beam Axle (Option No. FS3)

NOTE: See #13 Figure 1-11. Grease must exit from all 4 bearings when lubricating U joints. Also grease spline on 2 and 3 shaft units. Grease must exit from spline plug.

ADEQUATE TEMPERATURE MODULATION FROM DASH HEATER SYSTEMS

Over the past few months, I've received a number of letters on the subject of inadequate temperature modulation from dash heater systems. When one moves the temperature control lever to any position between the cold and warm extremes, one expects modulated air. In some instances, however, that's not what one receives. The air is either too hot or too cold, and no temperature modulation is taking place. With the winter months almost upon us, it would seem that a brief discussion and modification suggestion is in order.

Two different systems are used for modulating air temperature in engine-operated dash heating systems. One is excellent and the other is not so good. The excellent one is the blend air door control system. This system incorporates an air control door at the end of the temperature control lever. The door is controlled via the dash lever, which is connected to the door by a cable. To regulate the outlet temperature of the air, this cable moves the door to determine what percentage of incoming air will go through the heater core, which remains fully hot.

The other system controls the outlet air temperature by controlling the flow of hot water through the heater core. All air is directed through the heater core. The other end of the temperature control cable is attached to a manual control lever in a water valve located in the heater hose that leads to the heater core. Therein lies the problem — attempting to control the water temperature on the heater core. As one moves the temperature control lever on the dash, a cable moves a door inside the water valve, which modulates the water flow to the heater core. Unfortunately, the flow is decreased but not by very much, since the pressure is increased. As the pressure is increased, so is the flow, and this compensates for the door blockage. Another reason is that while the flow of water is controlled, the temperature is not. When the temperature becomes too hot, one moves the lever toward cool, and then it is necessary to move it slightly more, more, and more, until the lever is in the cool position. At this point, the coolant flow is totally blocked, and the hot air becomes cold within a few moments. So, one returns the lever to the warm position.

It is unlikely that you will have a temperature modulation concern if your coach's dash heater is equipped with a blend air door system. To determine which system the coach has, you will have to find out whether the other end of the temperature control lever is connected to the heater case or a valve in a heater hose. If the cable leads to a water valve, similar to the one in Figure 1, your coach has the latter type of system, and an effective and inexpensive solution exists — install a temperature control valve with an "H" in it, similar to the one in Figure 2. This revised valve is easy to install after one removes the original valve. The only addition is that it must also be installed in the heater return hose, which requires two more heater hose clamps. The "H" valve system allows the blocked coolant to flow very easily into the return line. The result is a greatly improved system.

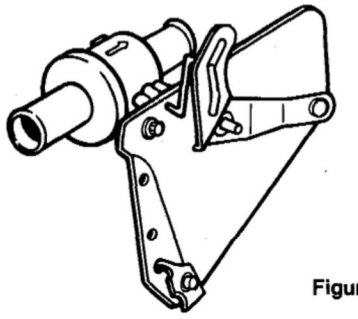


Figure 1

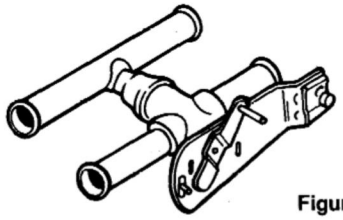


Figure 2

I have talked with the folks at Acme Radiator, and they have indicated that they will provide the "H" system heater control valve to FMCA members for $20 postage paid. To order the valve — part number 4100173 — write to Acme Radiator and Air Conditioning Inc., 17103 State Road 4 East, Goshen, IN 46526.

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HEATING SYSTEM

GENERAL DESCRIPTION

The heating system consists of a heater core housed in a case which, typically, includes an air inlet, blower motor assembly, air distribution ducts and doors to control the flow of air through the case. The configurations of G-Series and P-Series assemblies differ.

TROUBLESHOOTING THE SYSTEM

Problems of too little or no heat, poor air circulation, or inadequate defrosting action are sometimes encountered with a heating system.

The diagnosis chart (Figure 2-1) lists typical trouble symptoms, the probable causes, and what can be done to correct the condition.

TROUBLE	CAUSE AND CORRECTION
Temperature of heater air at outlets too low to heat up passenger compartment.	1. Refer to Chevrolet 10-30 Series Shop Manual.
Temperature of heater air at outlets adequate but the vehicle will not build up sufficient heat.	Check for body leaks such as: 1. Floor side kick pad ventilators partially open. 2. Leaking grommets in dash. 3. Leaking welded seams along rocker panel and windshield. 4. Leaks through access holes and screw holes. 5. Leaking rubber molding around door and windows. 6. Leaks between sealing edge of blower and air inlet assembly and dash, and between sealing edge of heater distributor assembly and dash.
Inadequate defrosting action.	1. Check that DEFROST lever completely opens defroster door in DEF position — Adjust if necessary. 2. Assure that temperature and air doors open fully - Adjust. 3. Look for obstructions in defroster ducts - Remove any obstructions. 4. Check for air leak in duct between defroster outlet on heater assembly and defroster duct under instrument panel — Seal area as necessary. 5. Check position of bottom of nozzle to heater locating tab — Adjust. 6. Check position of defroster nozzle openings relative to instrument panel openings. Mounting tabs provide positive position if properly installed.
Inadequate circulation of heated air through vehicle.	1. Check heater air outlet for correct installation — Reinstall. 2. Inspect floor carpet to ensure that carpet lies flat under front seat and does not obstruct air flow under seat, and also inspect around outlet ducts to ensure that carpet is well fastened to floor to prevent cupping of air flow — Correct as necessary.
Erratic heater operation.	1. Check coolant level — Fill to proper level. 2. Check for kinked heater hoses — Relieve kinks or replace hoses. 3. Check operation of all bowden cables and doors — Adjust as necessary. 4. Sediment in heater lines and radiator causing engine thermostat to stick open — Flush system and clean or replace thermostat as necessary. 5. Partially plugged heater core — Backflush core as necessary.
Hard-operating or broken controls.	1. Check for loose bowden cable tab screws or misadjusted bowden cables — Correct as required. 2. Check for sticking heater system door(s) — Lubricate as required, using a silicone spray.

Figure 2-1 — Heating System Diagnosis

AIR CONDITIONING

GENERAL DESCRIPTION

Two types of air conditioning systems are used in Chevrolet Motor Homes. For the G-Series, a blend-air system is used. This system combines both the heating and cooling functions in one unit. Cooling only is provided with the system used on the P-Series. The P-Series system is installed by the body manufacturer.

Both systems operate on the same basic principles of refrigeration. That is, a liquid refrigerant absorbs heat as it vaporizes, and loses heat as it condenses from a vapor back to a liquid. By varying the pressures within an air conditioning system, the refrigerant can be vaporized to absorb heat from inside the vehicle, and then condensed to release the heat to the outside atmosphere. System components include a compressor, condenser, expansion tube (G-Series) or a thermostatic expansion valve (P-Series), evaporator, and an accumulator or a receiver-dehydrator. In operation, the compressor produces the pressure which moves refrigerant through the system. Liquid refrigerant passing through the restriction of the expansion tube or valve changes into a vapor as it enters the low-pressure environment of the evaporator. (See Figure 2-2.)

As it changes to a vapor, it absorbs heat from the air being circulated around the evaporator. Suction created by the compressor draws the refrigerant vapor through the line from the evaporator. The vapor, which has been under low pressure, is pumped out of the compressor under high pressure. The high pressure in this part of the system is due to the expansion tube (or thermostatic expansion valve) which places a restriction in the line. As the high-pressure refrigerant vapor flows into the condenser, it changes to a liquid as it loses heat to the air flowing around the condenser. The liquid refrigerant flows through the line from the condenser to the expansion tube (or thermostatic expansion valve) to repeat the cycle.

System temperature is controlled by running the compressor intermittently, automatically turning it on and off as necessary to maintain proper temperatures. The compressor is started and stopped through the use of an electromagnetic clutch on the compressor pulley. The clutch is operated by a pressure-sensing switch (Pressure Cycling Switch — G-Series) or a temperature-sensing switch (Thermostatic Switch — P-Series).

In addition to the components described above, the air conditioning system is also equipped with either an accumulator (G-Series), or a receiver-dehydrator (P-Series).

RECEIVER-DEHYDRATOR P SERIES

The receiver-dehydrator, mounted near the condenser, serves as a reservoir for storage of high-pressure liquid produced in the condenser. It incorporates a screen sack filled with the dehydrating agent.

The receiver-dehydrator, used primarily as a liquid storage tank, also functions to trap minute quantities of moisture and foreign material which may have remained in the system after installation or service operations. A refrigerant sight glass is built into the receiver-dehydrator to be used as a quick check of the state and condition of charge of the entire system.

ACCUMULATOR G SERIES

The accumulator is located at the evaporator outlet. Its most important function is not to "accumulate" although this too is important. Its primary function is to separate any liquid retained in the vapor from the evaporator, retain the liquid and release the vapor to the compressor.

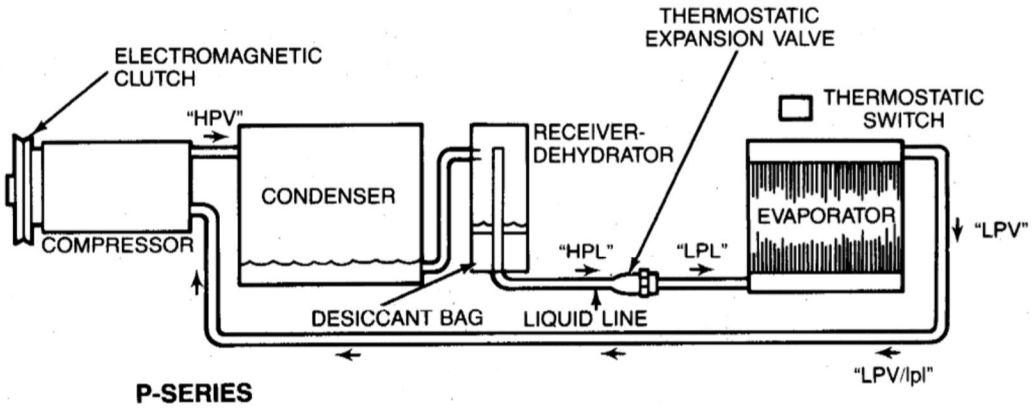
A bag of desiccant (dehydrating agent) is also located in the accumulator as a moisture-collecting device.

NOTE: If the refrigerant system has been opened — that is, exposed to the atmosphere — the desiccant may have absorbed a considerable amount of moisture. In such instances, the system must be evacuated before recharging. This process removes moisture from the system.

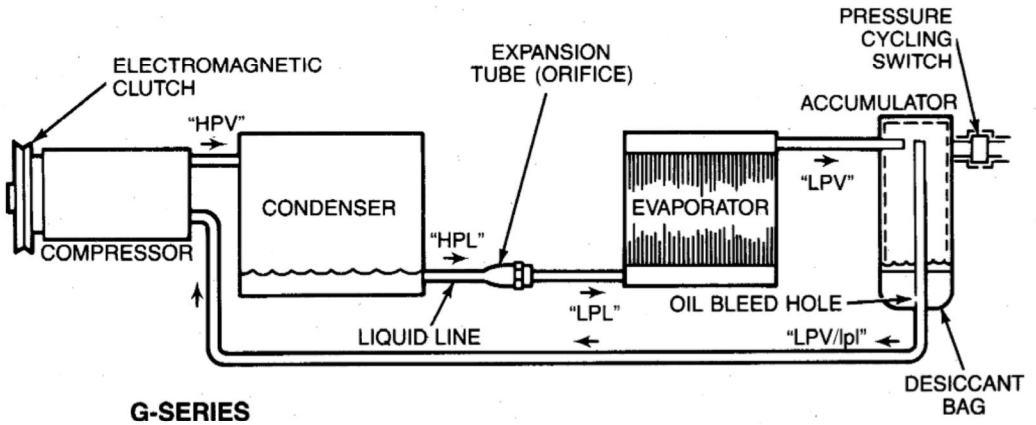
G-SERIES SYSTEM

Air, either outside air or recirculated air, enters the system and is forced through the system by the blower. As the air passes through the evaporator core, it receives maximum cooling if the air conditioning controls are calling for cooling. After leaving the evaporator, the air enters the heater and air conditioner selector duct assembly where, by means of diverter doors, it is caused to pass through or to bypass the heater core in the proportions necessary to provide the desired outlet temperature. Then conditioned air enters the vehicle through either the floor distributor duct or the dash outlets. During cooling operations, the air is cooled by the evaporator to below comfort level, it is then warmed by the heater to the desired temperature. During "heating only" operations, the evaporator will not be in operation and ambient air will be warmed to the desired level in the same manner.

The diverter doors which direct the air flow through this system are operated by the vacuum motors. The A/C control unit is positioned between the vacuum source and the motors to direct the application of vacuum as required.



P-SERIES



G-SERIES

HPV — HIGH-PRESSURE VAPOR
HPL — HIGH-PRESSURE LIQUID
LPV — LOW-PRESSURE VAPOR
LPL — LOW-PRESSURE LIQUID

Figure 2-2 — Basic Air Conditioning System — Refrigeration Schematic

P-SERIES SYSTEM

This system performs the cooling functions only. When heating (above ambient temperatures) is desired, the vehicle heater must be used.

This self-contained unit is bracket mounted to the dash by the motor home manufacturer. It operates on inside (recirculated) air only. Air is drawn into the unit, passed through the evaporator core (receiving maximum cooling) and then directed into the vehicle through adjustable outlets.

A thermostatic switch, located on the face plate is used to control compressor operation by sensing air temperature as it leaves the evaporator core.

MAINTENANCE AND INSPECTION

There are two sections to the air conditioning system. The first section includes the refrigeration components — compressor, condenser, evaporator, etc. The second section includes the air distribution components such as the blower, case assembly, diverter doors, vacuum lines and motors, etc.

Maintenance and inspection procedures are directed to each of these sections. Of course, for the P-Series, the air distribution section is quite simple and does not include the many components used in the G-Series.

REFRIGERATION SECTION

CAUTION: BECAUSE OF THE NATURE OF REFRIGERANT-12 AND THE HIGH PRESSURES WHICH ARE PRESENT IN THE REFRIGERANT SECTION OF THE SYSTEM, PERSONAL INJURY CAN RESULT IF ESTABLISHED DIAGNOSTIC AND SERVICE PROCEDURES ARE NOT FOLLOWED. THEREFORE, ALL SUCH WORK REQUIRED ON THE SYSTEM SHOULD BE REFERRED TO A QUALIFIED SHOP WITH THE NECESSARY TRAINED PERSONNEL AND EQUIPMENT.

THE FOLLOWING PROCEDURES ARE INTENDED TO IDENTIFY OR AVOID POTENTIAL PROBLEM CONDITIONS.

Inspection

Perform the following checks regularly:

1. Check outer surfaces of radiator and condenser cores to be sure they are not plugged with dirt, leaves or other foreign material. Be sure to check between the condenser and radiator as well as the outer surfaces.
2. Check the metal tubing lines to be sure they are free of dents or kinks which can cause a loss of system capacity due to a line restriction.
3. Check the flexible hose lines for brittleness or deterioration which could cause a system leak.
4. Check for proper drive-belt tension.

Operational Quick Checks

The following checks may indicate if the amount of refrigerant (charge) in the system is low. The ambient temperature must be above 70°F.

NOTE: Engagement of the compressor clutch in both of the tests below indicates that the clutch electrical circuit is O.K. If the clutch does not engage, then check for a blown fuse, loose connections or damaged or deteriorated wires. If these checks are O.K., then the problem may be in the compressor clutch or switch. Take the vehicle to a qualified shop for further testing.

G-SERIES

1. Prepare the motor homes as follows:
   - Engine must be warm (CHOKE OPEN and OFF FAST IDLE SPEED CAM) and at normal idle speed.
   - Hood and body doors open.
   - Selector (mode) lever set at NORM.
   - Temperature lever at COLD.
   - Blower on HI.
2. With the compressor engaged, place your hand first on the evaporator inlet pipe (between the expansion orifice and evaporator), and then on the accumulator can surface (Figure 2-3).
   - The temperature should feel the same for both and somewhat cooler than the ambient temperature.
   - If the inlet pipe feels cooler than the accumulator surface, the system's refrigerant charge is probably low.

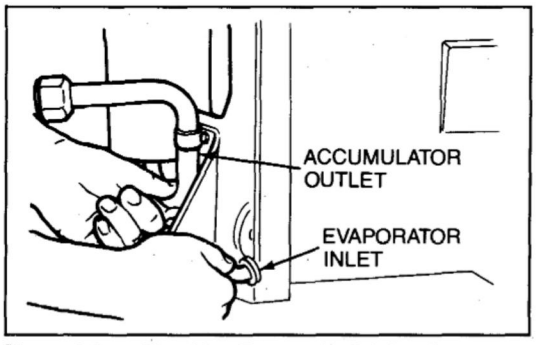


Figure 2-3 — Checking Evaporator Inlet and Accumulator Temperatures (G-Series)

P-SERIES (WITH SIGHT GLASS)

At temperatures higher than 70°F, the sight glass may indicate whether the refrigerant charge is sufficient. A shortage of liquid refrigerant is indicated after about five minutes of compressor operation by the appearance of slow-moving bubbles (vapor) or a broken column of refrigerant under the glass. Continuous bubbles may appear in a properly charged system on a cool day. This is a

normal situation. If the sight glass is generally clear and performance is satisfactory, occasional bubbles do not indicate a refrigerant shortage.

If the sight glass consistently shows foaming or a broken liquid column, it should be observed after partially blocking the air to the condenser. If under this condition the sight glass clears and the performance is otherwise satisfactory, the charge shall be considered adequate.

NOTE: The sight glass is located on or near the receiver-dehydrator.

AIR DISTRIBUTION SECTION

Electrical Circuit Diagnosis

The blower electrical circuit and motor are O.K. if the blower operates at all of the designated speeds. If the blower does not work at all, then check for a blown fuse, loose connections, and for damaged or deteriorated wires. If these checks are O.K. and/or the blower does not operate at all speeds, then the problem may be in the switch, relay or motor. Take the vehicle to a qualified shop for further testing.

Vacuum System Diagnosis (G-Series)

If the air is not flowing through the proper outlets (floor, dash, or defroster), then there may be a problem in the vacuum system, or with the diverter doors. Check the doors to see that they operate properly and do not bind.

Next, check all vacuum hoses and connections between the vacuum source, A/C control and vacuum motors for leaks. If any hoses are damaged or deteriorated, they should be replaced. If the hoses are O.K., the problem may be in the control assembly or vacuum motor(s). Take the vehicle to a qualified shop for further testing.

OPTIONAL AIR CONDITIONING SYSTEM

The factory installed air conditioning system has made several changes since first made available in the 1986 Class A chassis. The next several pages attempt to assist with part numbers and description of the items installed by Chevrolet or the coach builder.

Only parts of the A/C system are installed on the chassis as the coach body is installed by the coach builder whose responsibility is to complete the system including proper charging with freon and wiring system to insure proper operation. Those items not listed with part numbers are installed by the coach builder.

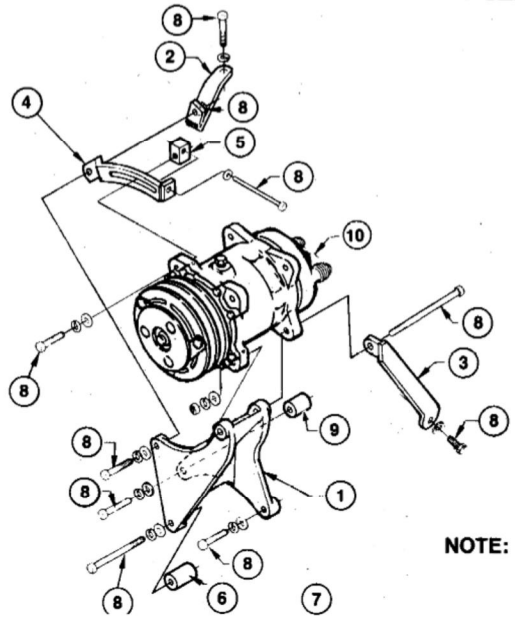
1986 thru mid year 1989, A/C systems and repair parts were provided by ARA Manufacturing Co. in Grand Prairie, TX. However, they are out of business and their surplus parts were sold to Acme Radiator and A/C Inc., 17103 State Road 4 East, Goshen, IN 46526, Phone (219) 534-1516.

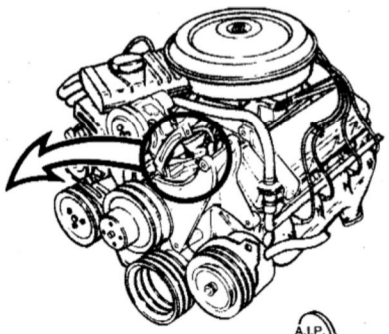
1989 to present the parts are provided by Wynns Inc. and most parts can be obtained through the General Motors dealers. Assistance for NPN Wynns parts can be obtained by calling 1-800-347-3883 1900 S.E. loop 820, Ft. Worth, TX 76140.

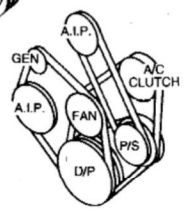
OPTIONAL AIR CONDITIONING SYSTEM

For 1986, at the request of several RV manufacturers, GM has made available the underhood portion of the air conditioning system as an available option — Option Number 7N4. GM can, as ordered, produce the engine mechanical air conditioning parts, as furnished by ARA Manufacturing Company..

The following illustrations and part number listings (both GM production numbers and corresponding ARA part numbers) are provided as an aid to the motor home owner concerning installation, repair and replacement of air conditioning system Option Number 7N4. This system became standard start-of-production 1988. (See NOTE on page 2-7.)







NOTE: SEE APPENDIX A — DRIVE BELTS AND TENSION SPECIFICATIONS FOR GM BELT NUMBERS

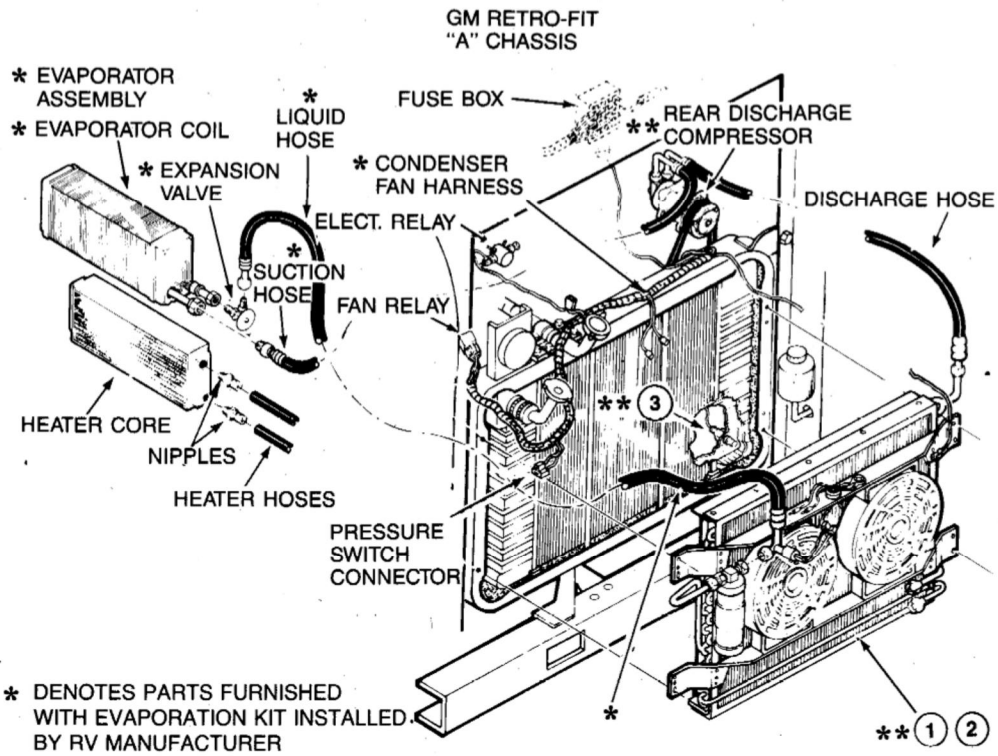
MOUNT AND DRIVE ASSEMBLY PARTS LIST

No.	ARA PART NO.	DESCRIPTION	QUANTITY	GM PROD. NO.
1	7045871	Compressor Mount	1	(14100871)
2	7045872	Compressor Mount Support	1	(14100872)
3	7045873	Compressor Brace	1	(14100873)
4	7045833	Compressor Adjusting Arm	1	(14100874)
5	7045824	Compressor Adjusting Block	1	(14100875)
6	5004112	Idler Spacer, 1-3/8" Long	1	(14100875)
7	1502902	Carton	1	
8	7004312	Bolt Kit. Consisting of: (1) 1/4" × 4" NC (Al Thread) Bolt (2) 3/8" × 7/8" NC Bolt (3) 3/8" × 1-1/2" NC Bolt (3) 3/8" × 1-3/4" NC Bolt (1) 3/8" × 4-1/4" NC Bolt (1) 3/8" × 5-1/4" NC Bolt (1) 1/4" Flatwasher (8) 3/8" Lockwasher (6) 3/8" (SAE) Flatwasher (1) 3/8" NC Hex Nut	1	(14100875)
9	5001018	Idler Spacer, 9/16" Long (Required on vehicles with single Air Injection Pump)		
10	0329174	Compressor No. 709 "Sanden" Clutch, 5-1/4" Diameter	1	(15578925)

NOTE: The following parts are all listed under the GM Part No. 14100875: Compressor Adjusting Block
Idler Spacer, 1-2/8" Long
Bolt Kit. Consisting of: (See Above Listing)

Figure A2-1-1 — Chevrolet Motor Home Chassis Compressor Assembly

OPTIONAL AIR CONDITIONING SYSTEM (Cont'd)



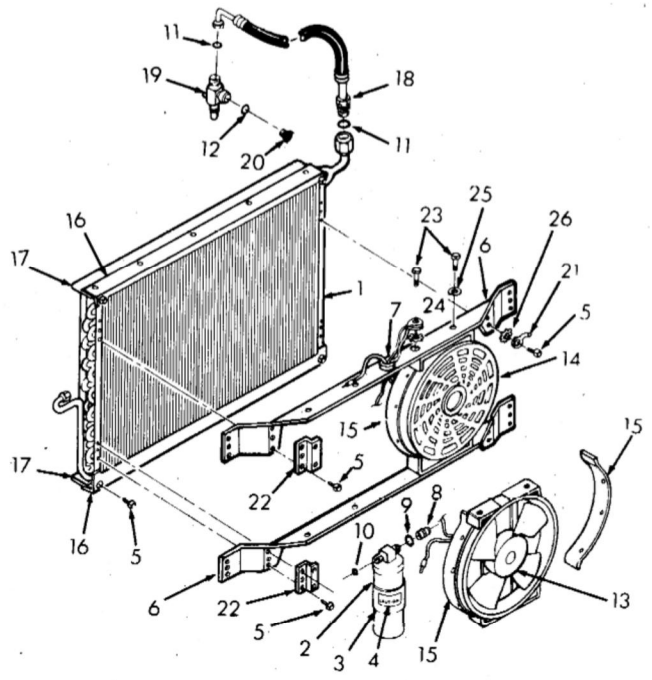
NOTE: AIR CONDITIONING SYSTEM DESCRIBED ABOVE BECAME STANDARD EQUIPMENT WITH START OF PRODUCTION 1988, EXCEPT WHEN UNIT WAS ORDERED AND BUILT WITH OPTION EN2 — AIR CONDITIONING DELETE, AS INDICATED ON THE SERVICE PARTS IDENTIFICATION LABEL (SEE PAGE 1-3). THIS SITUATION WOULD REQUIRE THE MANUFACTURER TO INSTALL THEIR OWN AIR CONDITIONING SYSTEM. BASIC CHANGE FOR INTERIM 1990 MODEL IS USE OF ONE 16 INCH FAN REPLACING TWO 10 INCH FANS STARTING 11-13-89.

CONDENSER ASSEMBLY PARTS LIST

No.	ARA PART NO.	DESCRIPTION	QUANTITY	GM PROD. NO.
1	0519336	1985-1/2 Condenser Assembly without engine oil cooler	1	(15547181)
1	0519406	1987 to Current Condenser Assembly with engine oil cooler in bottom (Shown above)	1	(15578281)
2	0570689	Mtg. Hardware, Consisting of Screw #14 × 3/4 HWH Z/P D/P	10	
3	0884940	Switch, Coolant Temperature	1	(15547201)

Figure A2-1-2 — Chevrolet Motor Home Chassis Condenser Assembly

OPTIONAL AIR CONDITIONING SYSTEM (Cont'd)

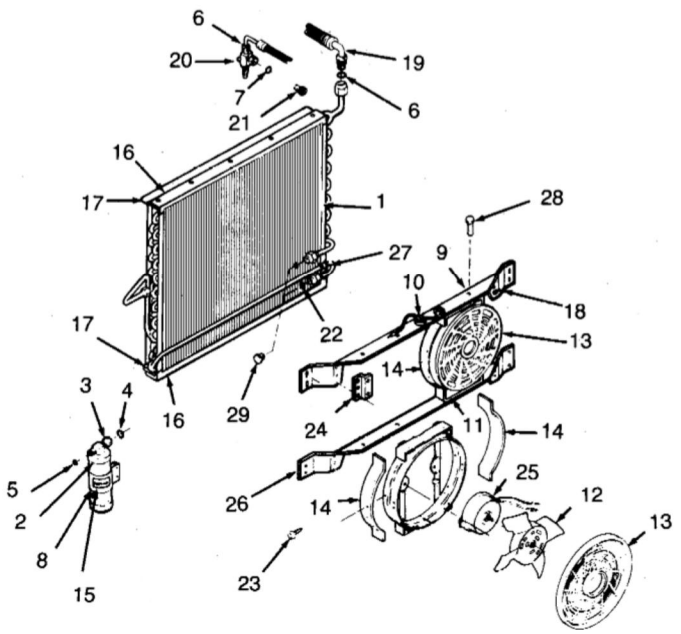


CONDENSER KIT PARTS LIST (without Oil Cooler)

No.	ARA PART NO.	DESCRIPTION	QUANTITY	GM PROD. NO.
1	0519369	Coil Condenser	1	(15547181)
2	1273235	Receiver-Drier	1	(15547182)
3	0319606	Bracket, Mounting Receiver-Drier	1	(15547188)
4	1900157	Sticker, Caution	1	(N.S.)
5	0039851	Screw, #8 x 1/2 HWH	20	
6	0319647	Bracket, Condenser Mounting	2	(15547189)
7	0996400	Grommet-Condenser Mt Brkt Ground Wire	1	(15547190)
8	0058337	Coupling-Receiver Drier	1	(15547183)
9	0543513	'O' Ring-Receiver Drier Outlet	1	(15547184)
10	0059605	'O' Ring #6-Receiver Drier Inlet	1	(15547185)
11	0059606	'O' Ring #8-Discharge Valve Hose	2	(15547186)
12	0059706	'O' Ring #10-Discharge Valve Cap	1	(15547187)
13	0964045	Condenser Fan Assy.	2	(15547191)
14	1701620	Guard, Fan	2	(15547193)
15	1016434	Seal, Condenser Fan	4	(15547194)
16	0319387	Bracket, Condenser Seal Mounting	2	(15547195)
17	1016433	Seal, Condenser to Radiator	2	(15547196)
18	0986195	Hose, Discharge #8	1	(15547198)
19	0548325	Service Valve, Discharge	1	(15547199)
20	0049849	Cap, Aluminum	1	(15547200)
21	0876802	Terminal, Adapter	1	(15547197)
22	0319563	Bracket, Adapter	2	(15547669)
23	0039852	Bolt, 1/4-20 x 5/8" HH Z/P	8	
24	0039853	Lockwasher, Star 1/4" Z/P	1	
25	0039855	Lockwasher, 1/4" Z/P	7	
26	0039854	Starwasher #10	1	

Figure A2-1-3 — Chevrolet Motor Home Chassis Condenser Kit —Without Engine Oil Cooler (1985 1/2 - 1987)

OPTIONAL AIR CONDITIONING SYSTEM (Cont'd)

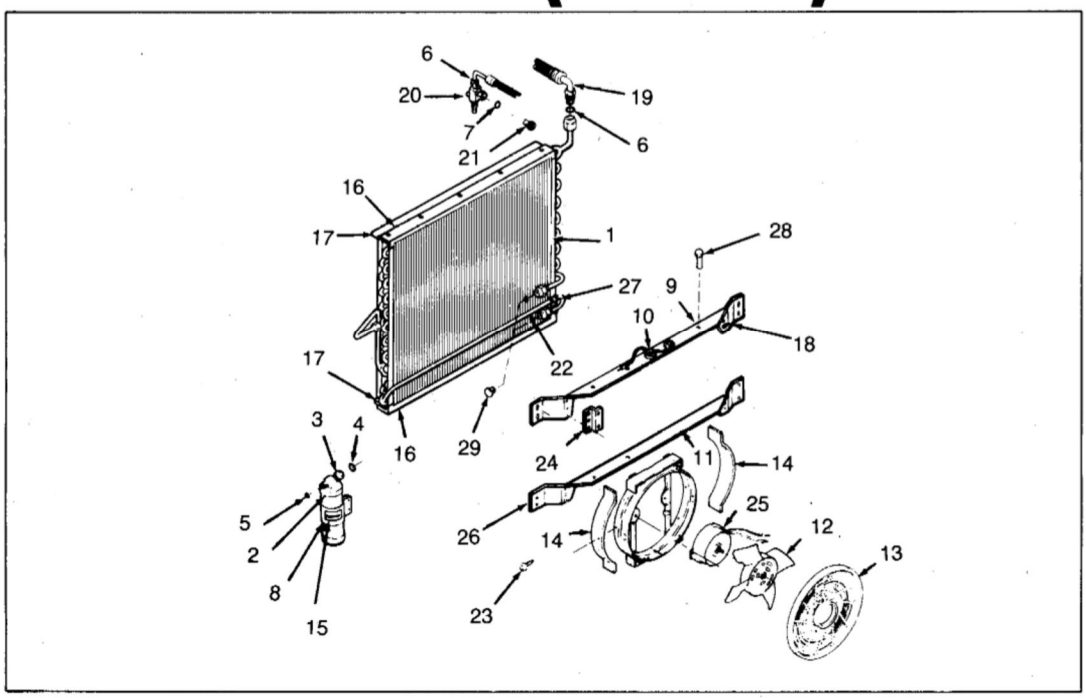


CONDENSER KIT PARTS LIST (with Oil Cooler)

NO.	ARA PART NO.	DESCRIPTION	QUANTITY	GM PART NO.
1	0519405	Coil Condenser	1	15578281
2	1273235	Receiver-Drier	1	15547182
3	0058337	Fitting, Self Sealing	1	15547183
4	0543513	O Ring Special	1	15547184
5	0059605	O Ring #6	1	15547185
6	0059606	O Ring #8	2	15547186
7	0559607	O Ring #10	1	15547187
8	0319606	Bracket, Receiver-Drier Mounting	1	15547188
9	0320184	Bracket Condenser Fan Mounting (Upper)	1	15578282
10	0996400	Grommet Lavelle #917	1	15547190
11	0964045	Condenser Fan and Seal Assembly	2	15547191
12	0964040	Blade Fan	2	15583108
13	1701620	Fan Guard	2	15547193
14	1016434	Seal, Fan/Condenser	4	15547194
15	1900157	Caution Label	1	NCSI
16	0319387	Bracket, Condenser Seal Mounting	2	15547195
17	1016433	Seal, Condenser to Radiator	2	15547196
18	0876802	Terminal Adapter	1	15547197
19	0986306	Hose, #8 Discharge	1	15584784
20	0548325	Service Valve Discharge	1	15547199
21	0049849	Cap, Aluminum	1	15547200
22	0543516	#8 O-Ring Hi-Temp	2	14055585
23	0039851	Screw, #8 × 1/2" HWH Z P	20	15547360
24	0319563	Bracket, Adapter	2	15581669
25	1120235	Motor, DC	2	15583107
26	0320185	Bracket, Condenser Fan Mounting (Lower)	1	15578283
27	0409443	Hose Clamp 1/2"	1	
28	0022151	Bolt, 1 4 20 × 5/8" HH	8	
29	0049887	Shipping Cap	2	

Figure A2-1-4 — Chevrolet Motor Home Chassis Condenser Kit —With Engine Oil Cooler (1988 - 1991)

AIR CONDITIONING SYSTEM (CONT'D)

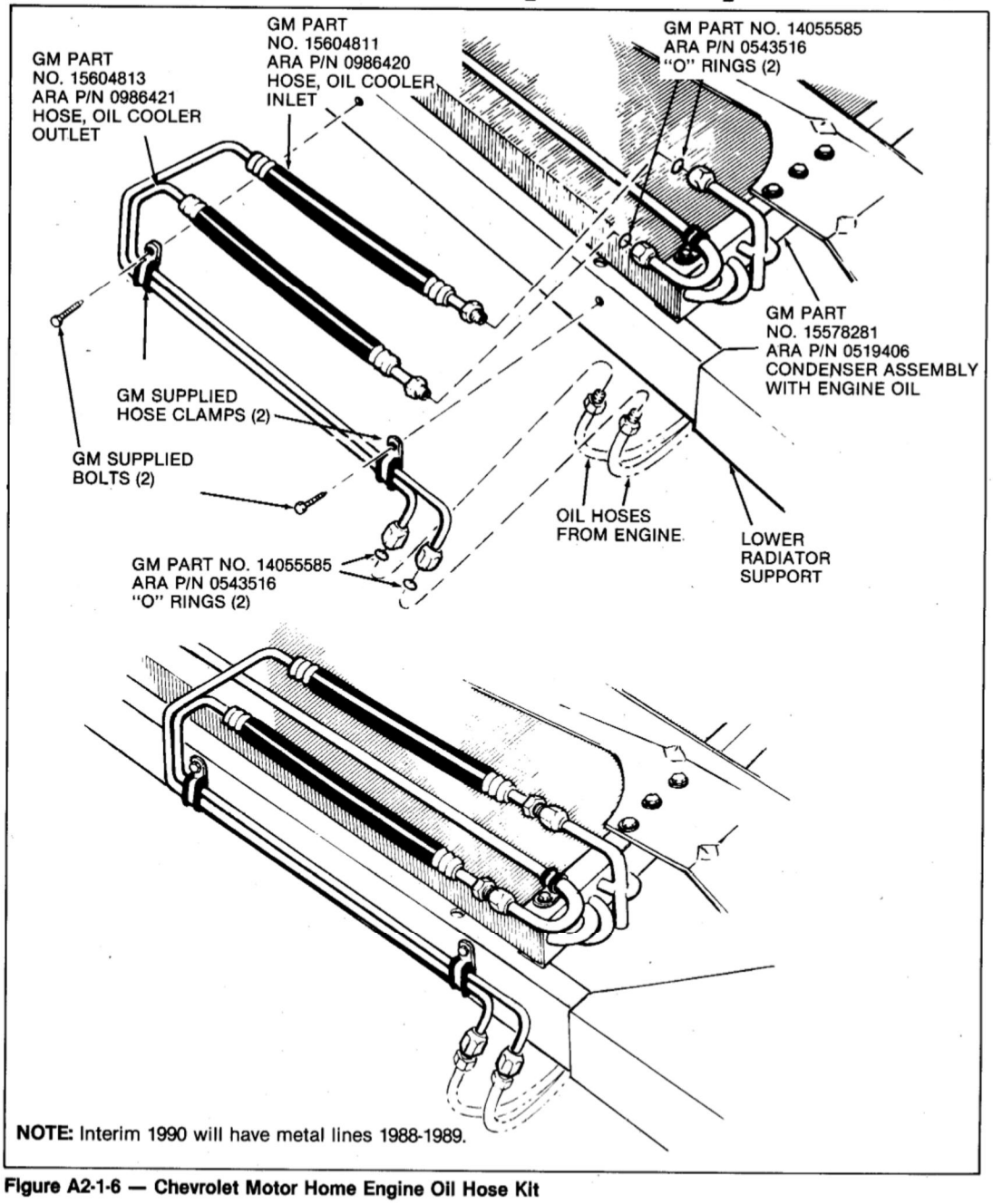


CONDENSER KIT PARTS LIST (with Oil Cooler)

NO.	ARA PART NO.	DESCRIPTION	QUANTITY
1	0519557	Coil Condenser	1
2	1273235	Receiver-Drier	1
3	0058337	Fitting, Self Sealing	1
4	0543513	O Ring Special	1
5	0059605	O Ring #6	1
6	0059606	O Ring #8	2
7	0559607	O Ring #10	1
8	0319606	Bracket, Receiver-Drier Mounting	1
9	0321934	Bracket Condenser Fan Mounting (Upper)	1
10	0996500	Grommet Lavelle #917	1
11	0964045	Condenser Fan and Seal Assembly	2
12	0964115	16" Fan Assembly	2
13	1701620	Fan Guard	2
14	1016434	Seal, Fan/Condenser	4
15	1900157	Caution Label	1
16	0319387	Bracket, Condenser Seal Mounting	2
17	1016433	Seal, Condenser to Radiator	2
18	0876802	Terminal Adapter	1
19	0986307	Hose, #8 Discharge	1
20	0548325	Service Valve Discharge	1
21	0049849	Cap, Aluminum	1
22	0039851	Screw, #8 x 1/2" HWH Z P	20
23	0319563	Bracket, Adapter	2
24	N55 see 12	Motor, DC	2
25	0321935	Bracket, Condenser Fan Mounting (Lower)	1
26	0986968	Inlet Tube	1
27	0986967	Outlet Tube	1
28		O Ring #8	4

Figure A2-1-5 — Chevrolet Motor Home Chassis Condenser Kit — With Engine Oil Cooler (1990 Interim)

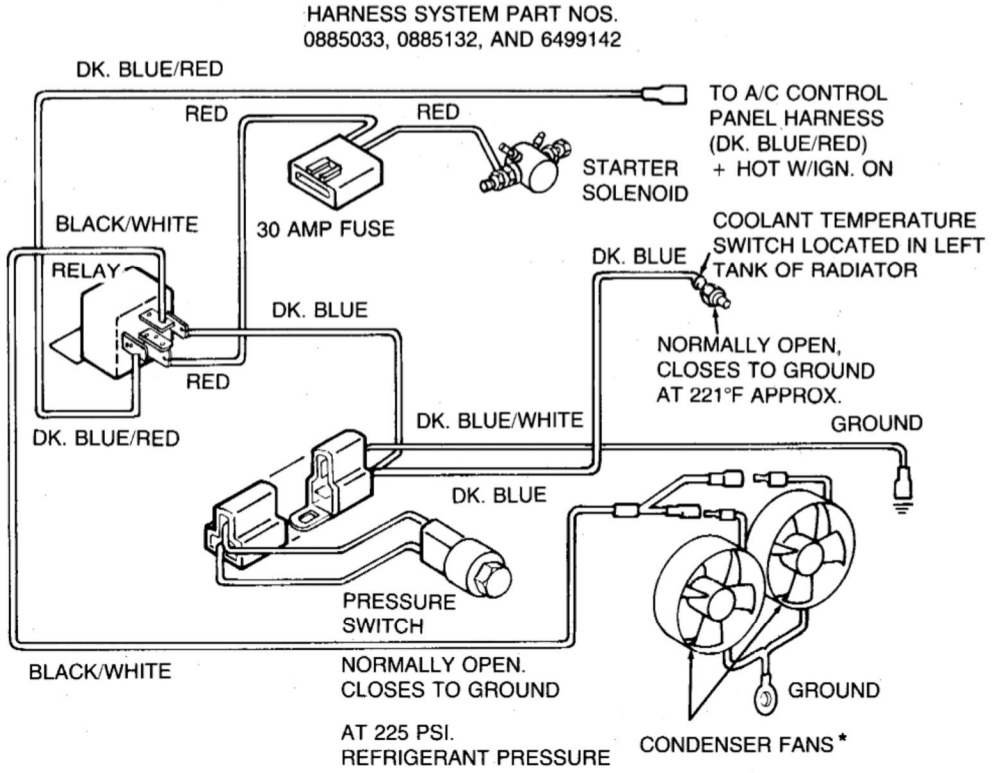
OPTIONAL AIR CONDITIONING SYSTEM (Cont'd)



NOTE: Interim 1990 will have metal lines 1988-1989.

Figure A2-1-6 — Chevrolet Motor Home Engine Oil Hose Kit

OPTIONAL AIR CONDITIONING SYSTEM (Cont'd)



NOTE: Wiring shown is not supplied or installed by GM through 1990. Shown as an aid to the technician as typical of RV manufacturers' installations of wiring purchased from ARA.

NOTE: Starting with the 1991 Class A motorhome, the A/C condenser fan is wired by Chevrolet through the main front end engine wiring harness. The coolant temperature switch is now located in the RH cylinder head with a green wire.

NOTE: Dual 10" fans are standard with Chevrolet installed A/C from 1986 through interim 1990. Interim 1990 changes to one 16" fan November 13, 1989. VIN L3315231

Figure A2-1-7 — Typical ARA Wiring Diagram — Class "A" RV Condenser with Fans

OPTIONAL AIR CONDITIONING SYSTEM (Cont'd)

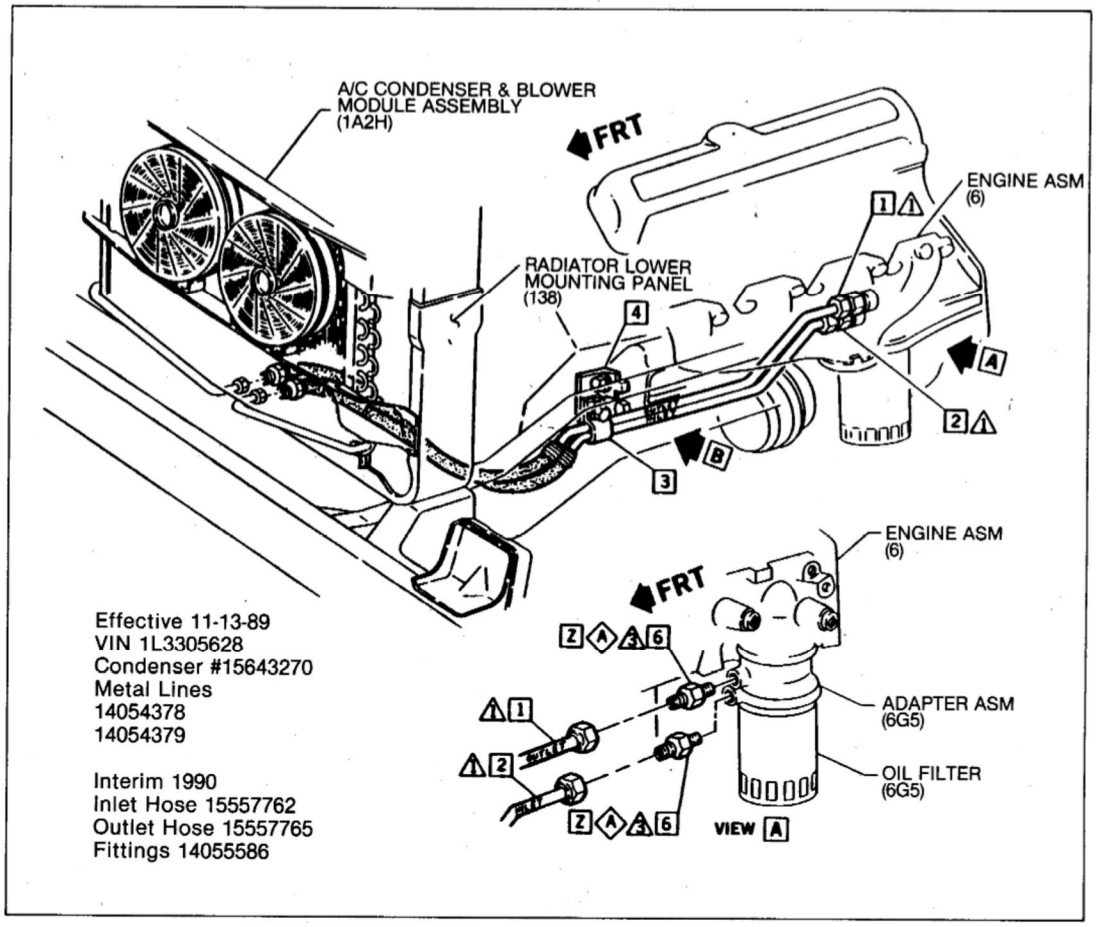
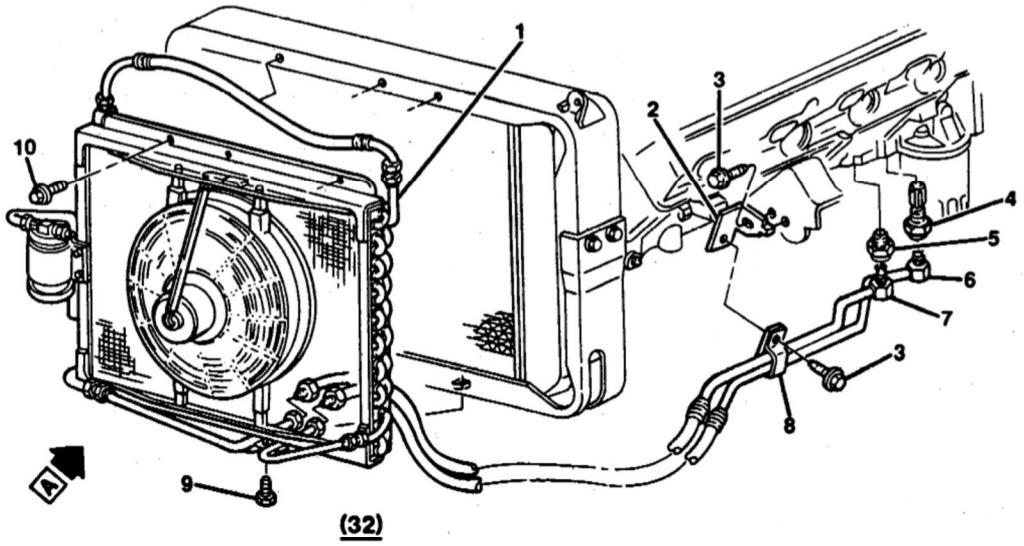


Figure A2-1-8 — Oil Cooler Lines P300 (32 52) & L19 & Env.

OPTIONAL AIR CONDITIONING SYSTEM (Cont'd)

1991 P3(32) ENGINE OIL COOLER (W/L19/7.4N & A/C)



NOTE: QUANTITY IS ONE PER VEHICLE UNLESS OTHERWISE SPECIFIED.

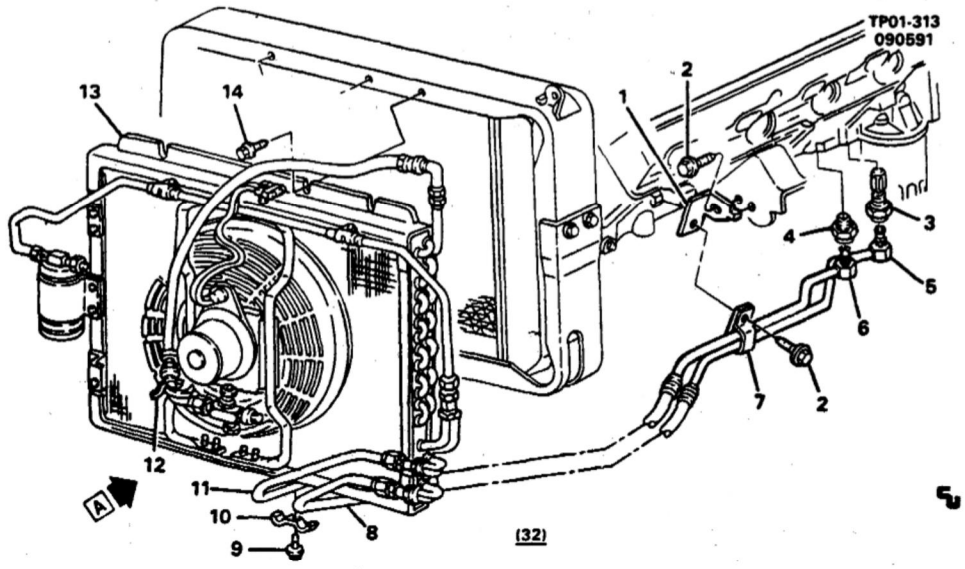
Figure A2-1-9 — 1991 P3(32) Engine Oil Cooler

1.	N.S.	**CONDENSER,** A/C (P3 32 W/7.4N)(*1) SINGLE FAN 1990-1992	15643270
	3.430	**BOLT,** W/CON WA, HEX (P3 32 W/7.4N)(AS REQD)	3997227
2.	1.540	**BRACKET,** ENGINE OIL COOLER HOSE (P3 32 W/7.4N)	14054335
3.	8.900	**BOLT,** HFH (M8X1.25X18)(AS REQD)	12337905
4.	1.540	**CONNECTOR,** ENGINE OIL COOLER HOSE (P3 32 W/7.4N)	15654938
5	1.540	**FITTING,** ENGINE OIL COOLER HOSE (P3 32 W/7.4N)	15538480
6.	1.540	**HOSE,** ENG OIL COOLER INLET (P3 32 W/7.4N & ENV, EXC EN2)	15638189
	1.540	**HOSE,** ENG OIL COOLER INLET (P3 32 W/7.4N & EN2, EXC ENV)	15638187
7.	1.540	**HOSE,** ENG OIL COOLER OUTLET (P3 32 W/7.4N & ENV. EXC EN2)	15638190
	1.540	**HOSE,** ENG OIL COOLER OUTLET (P3 32 W/7.4N & EN2, EXC ENV)	15638188
8.	1.540	**CLIP,** ENGINE OIL COOLER HOSE (P3 32 W/7.4N)(AS REQD)	15517986
9.	9.190	**BOLT,** W/LOCKWASHER A/C EVAP & BLO MDL (AS REQD)	14030698
10.	8.977	**SCREW,** W/FLAT WASHER, HEX TAP (M6.3X1.8X16)(AS REQD)	11509371

DEFINITIONS
- A/C ENGINE PROVISIONS
- EXC A/C

OPTIONAL AIR CONDITIONING SYSTEM (Cont'd)

1991-1992 P3(32) ENGINE OIL COOLER (L19/7.4N)(W/C60)



NOTE: QUANTITY IS ONE PER VEHICLE UNLESS OTHERWISE SPECIFIED. TP01-313

Figure A2-1-10 — 1991-1992 P3(32) Engine Oil Cooler

1.	1.540	**BRACKET,** ENGINE OIL COOLER HOSE (P3 32 W/7.4N)	14054335
2.	8.900	**BOLT,** HFH (M8X1.25X18)(AS REQD)	11513703
3.	1.540	**CONNECTOR,** ENGINE OIL COOLER HOSE (P3 32 W/7.4N)	15654938
4.	1.540	**FITTING,** ENGINE OIL COOLER HOSE (P3 32 W/7.4N)	15538480
5.	1.540	**HOSE,** ENGINE OIL COOLER INLET (P3 32 W/7.4N & ENV. EXC EN2)	15638189
	1.540	**HOSE,** ENGINE OIL COOLER INLET (P3 32 W/7.4N & EN2, EXC ENV)	15638187
6.	1.540	**HOSE,** ENGINE OIL COOLER OUTLET (P3 32 W/7.4N & ENV. EXC EN2)	15638190
	1.540	**HOSE,** ENGINE OIL COOLER OUTLET (P3 32 W/7.4N & EN2, EXC ENV)	15638188
7.	1.540	**CLIP,** ENGINE OIL COOLER HOSE (P3 32 W/7.4N)(AS REQD)	15517986
8.	1.540	**TUBE,** OIL COOLER INLET (P3 32 W/7.4N & C60)	15665135
9.	8.900	**BOLT,** HEX (5/16-18X3/4)(AS REQD)	9440967
10.	8.950	**CLAMP,** LOOP CUSHIONED (AS REQD)	2041644
11.	9.220	**TUBE,** AIR CONDITIONER OUTLET (P3 32 W/7.4N & C60)	15665136
12.	8.950	**STRAP,** METRIC PLASTIC ADJUSTABLE TIE (215MM LENGTH)(AS REQD)	11501906
13.	N.S.	**CONDENSER,** AIR CONDITIONER (P3 32 W/7.4N)(*1)	15687269
14.	8.977	**SCREW,** W/FL WASHER, HEX TAP (M6.3X1.8X16)(AS REQD)	11509371

NOTE 1: SEE ILLUSTRATION IN 9.000 FOR FURTHER DETAILS.

RPO DEFINITIONS
C60 - AIR CONDITIONER FRONT, MANUAL CONTROLS
ENV - AIR CONDITIONING ENGINE PROVISIONS
EN2 - AIR CONDITONING, DELETE

OPTIONAL AIR CONDITIONING SYSTEMS (Cont'd)

1994 AIR CONDITIONING

THE GOOD AND BAD OF CFCs

When R-12 (often referred to by its brand name Freon) was introduced in 1930, the industry hailed it as a miracle chemical. It was non-poisonous, easy and cheap to manufacture and quite stable. The first in the family of chlorofluorocarbons (CFCs) yet to come, R-12's apparent stability and low cost made air conditioning the creature comfort of the 20th century. Of all the R-12 manufactured, about two-thirds is used to service automotive air conditioners.

Unfortunately, recent scientific findings prove that we may have a big price to pay in the future for the comfort we've enjoyed in the past. The findings show that CFCs, like R-12 are depleting the Earth's protective ozone layer located in the stratosphere some 10 to 30 miles above the planet's surface. This precious layer of ozone filters out most of the sun's harmful ultraviolet rays.

THE CLEAN AIR ACT AMENDMENTS OF 1990

The most important part of the amendments to Section 609 of the Federal Clean Air Act have to do with servicing motor vehicle air conditioning and technician certification. The act states:

Servicing Motor Vehicle Air Conditioners – Effective January 1, 1992, no person repairing or servicing motor vehicles for consideration may perform any service on a motor vehicle air conditioner involving the refrigerant for such air conditioner without properly using approved refrigerant recycling equipment and no such person may perform such service unless such person has been properly trained and certified.

R134A REFRIGERANT

The change to R134A will be effective with the 1994 model chassis beginning in August 1993. The changes that are required to accept this new refrigerant on factory installed components on the P30 motor home chassis will affect those components added by your coach builder to complete the system.

SYSTEM DIFFERENCES

1. Condenser
   a. Width and Height the same
   b. Thickness changes from 1.4″ to 1.85″
   c. Inlet and outlet fittings – metric thread
   d. Service valve – located at condenser inlet instead of compressor
   e. Will be PRECHARGED
   f. Wynn's climate system.

2. A/C Compressor
   a. Lubricating oil is different than R-12 Systems. Oil used is Sanden SP-20 (GM part #15959132).
   b. Plumbing connections are clamp on, rather than threaded to prevent intermixing R-12 compressors and R-134A compressors.

3. A/C Plumbing
   a. The liquid line, from the receiver drier to the evaporator will be provided by the body builder. The receiver drier end of the line will have a metric quick connect fitting.
   b. The suction line from the evaporator to the compressor will be provided by the body builder. The compressor fitting end of the hose will have to match. This fitting is currently manufactured by S&H Fabricating, Walled Lake, Michigan. The line must be equipped with a quick connect gauge fitting.

4. A/C Evaporator
   a. The evaporator outlet must be equipped with a suction service valve similar in arrangemenht to the condenser discharge line.

GENERAL INFORMATION

1. Dedicated equipment is required to recycle, evacuate, and charge R-134A Systems. **Do Not** mix R-12 and R-134A. Contamination and damage to your coach will result.

2. It requires a different desiccant and higher system pressure and more airflow across the condenser.

3. GM approves only the following A/C hoses and tube suppliers for our vehicles. This is based on extensive lab tests which include pressure and temperature cycling, vibration tests, and moisture ingression testing, and field trials in car and truck fleets across the country. These suppliers are familiar with all the GM fitting designs, testing requirements, etc. Only two hoses are GM approved for use with R-134a. They are Parker P-90 Hose and Goodyear 4680 Hose. The coupling suppliers are:

S&H Fabricating
Walled Lake, Michigan
(313) 624-1661

Fayette Tubular Products
Fayette, Ohio
(419) 237-2531

Parker Automotive Products
Cleveland, Ohio
(216) 531-3000

4. The A/C Compressors are shipped from the factory with the proper oil charge for the system.

5. You should expect the identical performance from your R-134A System as your old R-12 System.

   A/C Compressor L19 Gas #15680077 Sanden
   L65 Diesel #1136400 Harrison

FRONT ALIGNMENT

GENERAL DESCRIPTION

The term "front alignment" refers to the angular relationships between the front wheels, the front suspension attaching parts and the ground.

The pointing in or "toe-in" of the front wheels, the tilt of the front wheels from vertical (when viewed from the front of the vehicle) and the tilt of the suspension members from vertical (when viewed from the side of the vehicle), are all involved in front alignment.

CASTER

Caster is the tilting of the front steering axis either forward or backward from the vertical (when viewed from the side of the vehicle). A backward tilt is said to be positive (+) and a forward tilt is said to be negative (−). (See Figure 3-1.)

CAMBER

Camber is the tilting of the front wheels from the vertical when viewed from the front of the vehicle. When the wheels tilt outward at the top, the camber is said to be positive (+). When the wheels tilt inward at the top, the camber is said to be negative (−). The amount of tilt is measured in degrees from the vertical and this measurement is called the camber angle. (See Figure 3-1.)

TOE-IN

Toe-in is the turning in of the front wheels. The actual amount of toe-in is normally only a fraction of an inch. The purpose of a toe specification is to ensure parallel rolling of the front wheels. (See Figure 3-1.)

Toe-in also serves to offset the small deflections of the wheel support system which occur when the vehicle is rolling forward. In other words, even when the wheels are set to toe-in slightly when the vehicle is standing still, they tend to roll parallel on the road when the vehicle is moving. It should be noted that excessive toe-in or toe-out will cause tire wear.

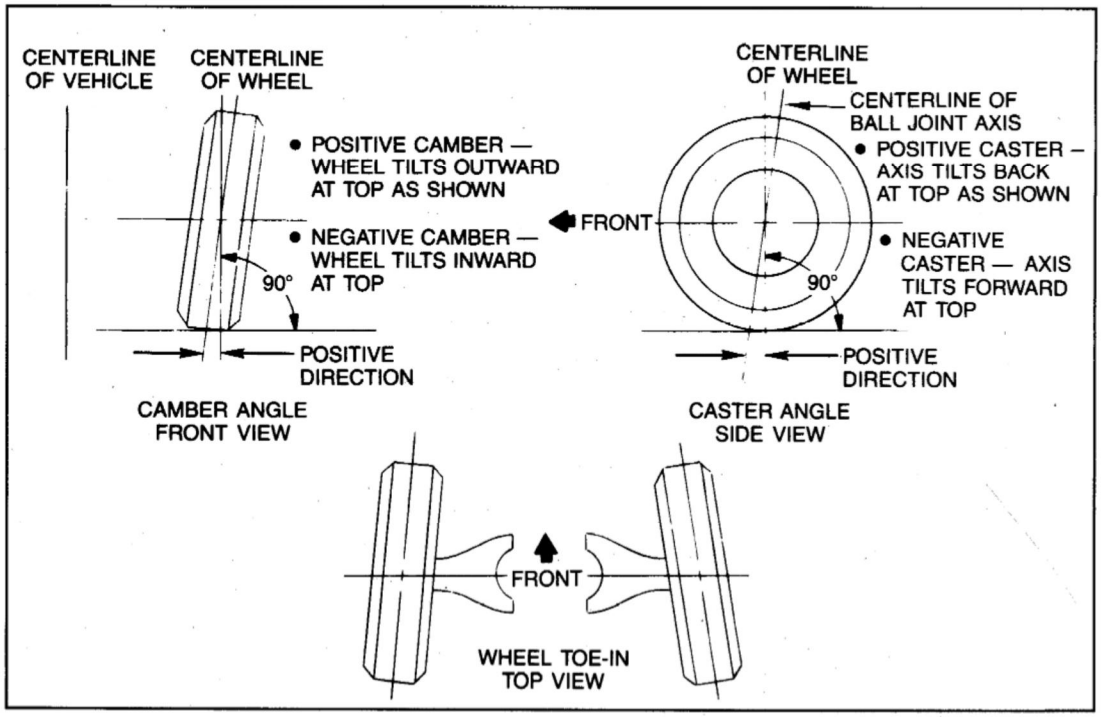


Figure 3-1 — Caster, Camber and Toe-in

MAINTENANCE AND INSPECTION

There are several factors which can affect front alignment. These factors include tire inflation pressures, the condition of wheel bearings, steering and suspension components. They are the basis for the following checks which can indicate problems that should be corrected.

1. Check all tires for proper inflation pressures and approximately the same tread wear.
2. Check front wheel bearings for looseness.
3. Check for looseness of ball joints, tie rod ends and steering relay rods and damper.
4. Check for excessive run-out of wheels and tires.
5. Check for a difference in the ride height between right and left sides of the vehicle. (See Figure 3-2.)

NOTE: Excessive or unevenly distributed loads also affect ride height and alignment. This should be taken into consideration when making the check. Also, if the motor home is equipped with air bag cylinders, it is important that the cylinders be inflated to the proper pressure for the load being carried, in order to maintain adequate ride height. (See Air Bag Cylinder Inspection information in the Suspension section of this manual.)

6. Check for steering gear looseness at frame.
7. Check for improperly operating shock absorbers. There may be evidence of a leaking shock(s).

CHECK RIDE HEIGHT MEASUREMENT (REFERRED TO AS EITHER DIMENSION "A" OR "BC") BETWEEN BRACKET AND CROSS MEMBER FLANGE. MEASUREMENT MUST BE PERPENDICULAR TO CROSS MEMBER FLANGE. MEASUREMENT IS "IRON TO IRON." RUBBER BUMPER IS NOT INCLUDED.

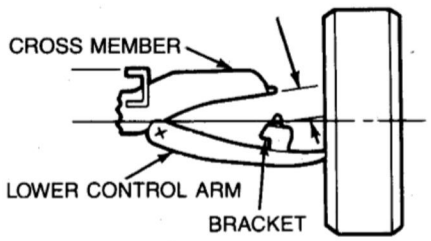


Figure 3-2 — Ride Height Measurement

8. Check for loose control arms.
9. Check for loose or missing stabilizer bar attachments.
10. Steering and vibration complaints are not always the result of improper alignment. An additional item to be checked is the possibility of tire lead due to worn or improperly manufactured tires. "Lead" is the deviation of the vehicle from a straight path on a level road without hand pressure on the steering wheel.

    Tire balance should also be checked.

NOTE: Alignment should be done with the unit fully loaded.

WHEEL ALIGNMENT SPECIFICATIONS — CASTER

DIMENSION "A"/"BC"

(IN.)	1-1/2	1-3/4	2	2-1/4	2-1/2	2-3/4	3	3-1/4	3-1/2	3-3/4	4	4-1/4	4-1/2	4-3/4	5
G-10, 20	3-1/2°	3-1/4°	3°	3°	2-3/4°		2-1/2°	2-1/4°	2°	2°	1-3/4°	1-1/2°			
G-30	2-3/4°	2-1/2°	2-1/4°	2°	1-1/2°		1°	3/4°	1/2°	1/4°	0°	– 1/4°			
P-20, 30			3°	2-1/2°	2-1/4°	2°	1-3/4°	1-1/2°	1-1/4°	1°	1/2°	1/2°	1/4°	0°	
MOTOR HOME (32)					5-1/2°	5-1/4°	5°	4-3/4°	4-1/2°	4°	3-3/4°	3-1/2°	3-1/4°	3°	3°

MODEL	CAMBER	TOE-IN (IN.)
G10, 20	.5°	3/16
G30	.2°	3/16
MOTORHOME (32)	0.1°	3/64 ± 1/64**

** Toe-in was reduced from 5/16 inch in 1985 as part of a GM trend reducing toe-in. If equipped with radial tires, some tire manufacturers would suggest toe-in specifications of 1/32 inch to 1/8 inch.

NOTE: 60 minutes equal 1 degree.

I-BEAM AXLE (OPTION FS3)	
TOE-IN (IN.)	3/16 ± 1/16
CASTER*	+2-1/2° ± 1/2°
CAMBER	+1-1/2° ± 1/2°
KING PIN INCLINATION (NOT ADJUSTABLE)	7° 10″

* Refer to Frame Angle Measurement Information in this section of the manual for correction to caster procedure.

Figure 3-3 — Alignment Specifications

ALIGNMENT CHECK

The caster, camber and toe-in specifications for both the G- and P-Series chassis are shown in Figure 3-3. The caster specifications will vary depending on the ride height measurement shown in Figure 3-2. This measurement is commonly referred to as either Dimension "A" or Dimension "BC" depending upon your reference source. This dimension is also affected by rear axle imbalance of weight (left to right). See Rear Suspension section of this manual for further information.

Another factor which will affect the caster measurement is the frame angle (Figure 3-4). Frame angle should be taken into account when determining the proper caster setting.

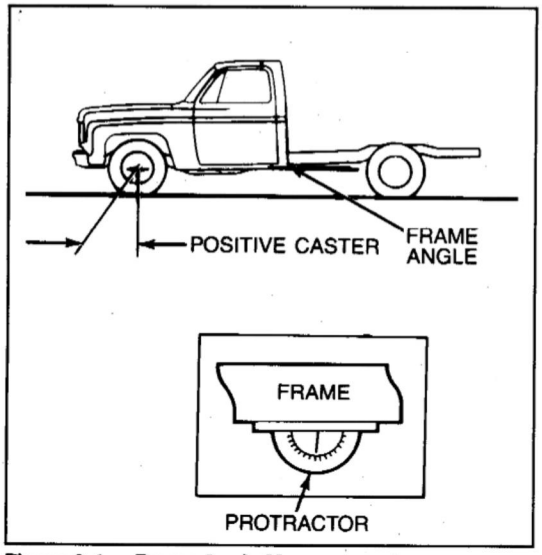


Figure 3-4 — Frame Angle Measurement

FRAME ANGLE MEASUREMENT

To determine the frame angle:

1. Park the motor home on a level surface.
2. Place a protractor with a level gage against the bottom of a straight section of the frame rail near the chassis midpoint.
3. Determine the angle the frame rail slopes from level.

NOTE: Determine if the vehicle has either an up-in-rear measurement or a down-in-rear measurement.

4. Determine the caster setting following the procedures in the appropriate shop manual.
5. Compute the actual caster setting from the frame angle and caster measurement taken as follows:
   (a) A **down-in-rear** frame angle must be subtracted from a **positive** caster specification.
   (b) An **up-in-rear** frame angle must be added to in the appropriate shop manual.
   (c) A **down-in-rear** frame angle must be added to a **negative** caster specification.
   (d) An **up-in-rear** frame angle must be subtracted from a **negative** caster specification.

LOWER BALL JOINT INSPECTION

Lower ball joints are a loose fit when not connected to the steering knuckle. Wear may be checked without disassembling the ball stud, as follows:

1. Support weight of control arms at wheel hub and drum.
2. Accurately measure distance between tip of ball stud and tip of grease fitting below ball joint.
3. Move support to control arm to allow wheel hub and drum to hang free. Measure distance as in Step 2. If the difference in measurements exceeds 2.38 mm (.094 or 3/32 inch) for all models, the ball joint is worn and should be replaced. (See Figure 3-5.)

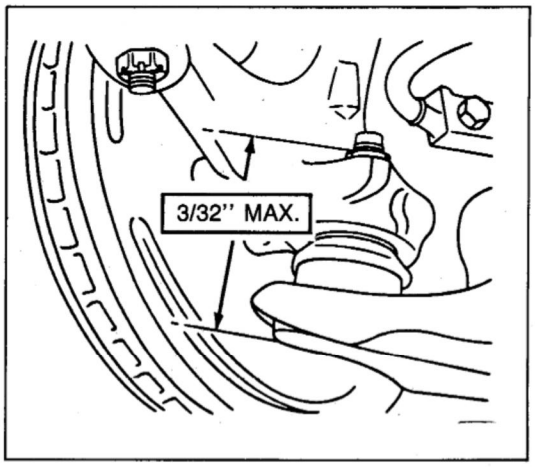


Figure 3-5 — Lower Ball Joint Check

STEERING SYSTEM

The steering system consists of the steering linkage, steering gear, steering pump, hoses, and the steering column and wheels. Vehicle direction is controlled from the steering wheel. Rotating the steering wheel rotates the input shaft (wormshaft) on the steering gear by means of a shaft in the steering column. Rotation of the wormshaft transfers this motion to the output shaft of the steering gear. The output shaft of the gear controls the directional position of the front wheels (right or left depending on input) through a series of arms or levers referred to as the steering linkage. A damper incorporated into the linkage helps to control the road shock transmitted to the linkage from the wheels.

STEERING LINKAGE

GENERAL DESCRIPTION

The steering linkage is located forward of the front cross member. The P-Series linkage is illustrated in Figure 3-6. Steering effort is transmitted to left- and right-hand adjustable tie rods through a relay rod. The relay rod is connected to an idler arm on the right and to the pitman arm on the left.

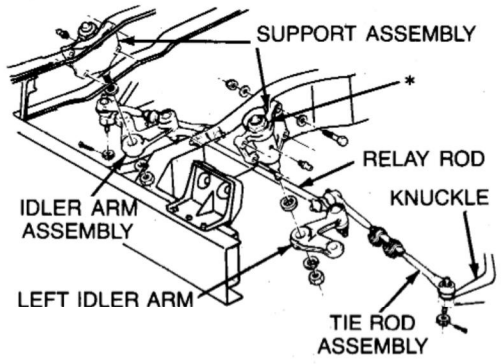


Figure 3-6 — Steering Linkage

MAINTENANCE AND INSPECTION

LUBRICATION OF STEERING LINKAGE

The steering linkage under normal conditions should be lubricated with any water-resistant EP-type chassis lubricant every 7,500 miles or six months, whichever occurs first. Lubricate every 3,000 miles or two months whichever occurs first when operating in dusty or muddy conditions, or if the vehicle is used "off-road."

STEERING LINKAGE, SUPPORT ASSEMBLIES (P-SERIES)

The fit of the shafts in the linkage support assemblies (Figure 3-6) should be tight with end play not exceeding .003 inch. Check the end play. If the end play exceeds .003 inch in either assembly, adjust it to within 0 to .003 inch. Loosen large lock nut torque cap to 25' lbs and then loosen 1/16 turn and tighten lock nut. If there is side play, replace the bushings (GM Part No. 266316) in the affected assembly.

STEERING DAMPER CHECK

The type of steering damper shown in Figure 3-7 is non-adjustable, nonrefillable and is not repairable. At each lubrication interval, perform Check No. 1 and No. 2 on the steering damper system.

Check 1

Check the damper attachments to be sure they are properly and securely installed. (Tighten, if loose.) The damper assembly should be replaced if the rubber bushings are badly worn.

Check 2

Inspect the damper for evidence of fluid leakage. A light film of fluid is permissible on the body of the damper near the shaft seal. A dripping damper should be replaced.

Check 3

Turn the steering wheel so as to extend the piston rod from the damper body. If the piston rod is rusted badly, replace the damper. If rust is light, clean the rod. Use care so that the rod surface is not damaged.

NOTE: On vehicles left in long-term storage, the piston rod may become quite rusted. The rod must be cleaned before the vehicle is moved. Failure to clean the rod will destroy the seals with the first inward movement of the rod — making replacement of the damper a certainty.

If the damper is not functioning properly, and/or is noisy, refer to a qualified service shop.

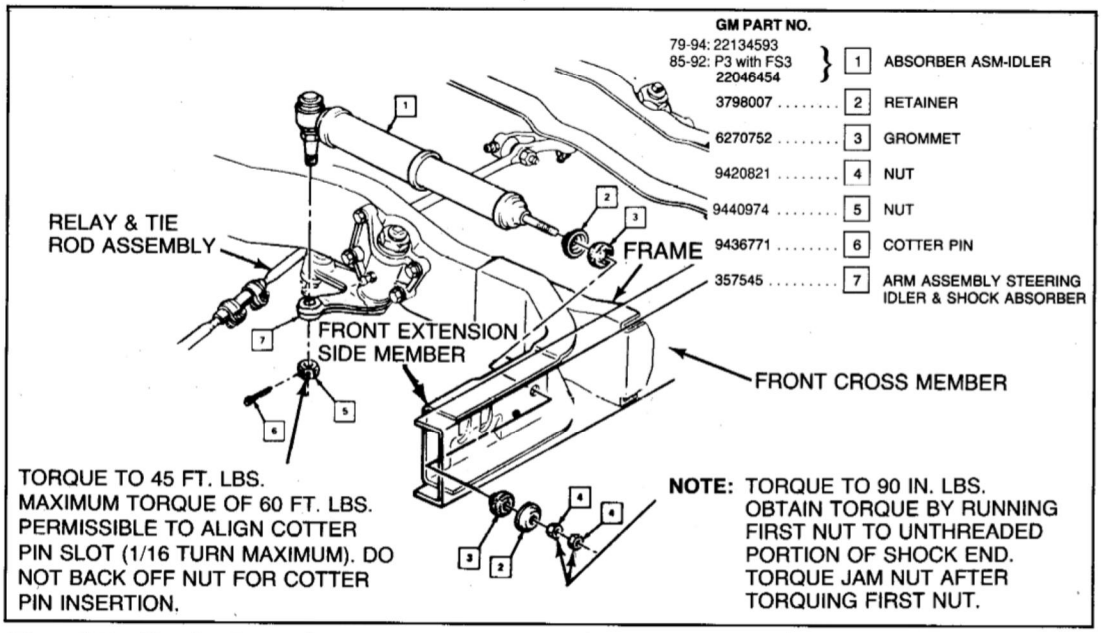


Figure 3-7 — Steering Damper

POWER STEERING SYSTEM

GENERAL DESCRIPTION

The optional power-assist steering utilizes the steering column and linkage previously described. However, the steering gear is different. It combines hydraulic pressure with the mechanical force of a manual steering system to reduce the steering effort required. In addition to a redesigned steering gear, the system requires a pump with pressure and return hoses connecting it to the steering gear. The pump, driven by a belt from the crankshaft, circulates the hydraulic fluid through the steering gear. Valves in the steering gear which are controlled by the steering wheel direct the flow of fluid as appropriate for right or left vehicle turns.

The steering gear is of the recirculating ball type. This gear provides for ease of handling by transmitting forces from the wormshaft to the pitman shaft through the use of ball bearings in the same way as the manual steering gear.

MAINTENANCE AND INSPECTION

Complaints of faulty steering are frequently the result of problems other than the steering gear or pump. Those areas of the steering system which can be easily checked and quickly corrected without disassembly and overhaul of any major components should be attempted first.

Conditions such as hard or loose steering, road shock or vibrations are not always due to the steering gear or pump, but are often related instead to such factors as low tire pressure and front-end alignment. These factors should be checked and corrected before any adjustment or disassembly of the power steering gear or pump is attempted.

Many factors affect power operation of the steering system of which the most common are:

1. Fluid level and condition.
2. Drive belt tension.
3. Loose component mountings.
4. Loose pump pulley.
5. Excess front axle weight.

These factors must be checked and corrected before making any further diagnosis of the steering system.

After the source of the problem has been found, determine the cause. For example, if the oil level in the reservoir is found to be low, refill and check the entire hydraulic system for oil leaks. Refilling the reservoir will not necessarily correct the problem.

HARD STEERING AT ENGINE IDLE

The P-Series motor home power steering assist system is designed for good response up to the 5,000-lb. suspension capacity. Complaints of little or no steering assist while at idle or with the driver's foot applying the brake are usually the result of the suspension being at or very near capacity. The reason this occurs is that the Hydro-Boost system has taken some power away from the steering assist system. At this point, the power steering assist system is at borderline capacity.

This situation can be corrected by removing the pressure on the brake. This will return the necessary pressure to the steering assist system allowing proper power steering assistance. Also, if additional weight were added to the front axle there would be a momentary system stall requiring slight movement of the vehicle in order to "feel" the power steering assist system operating. GM cannot endorse overloading. To avoid problems concerning overloading, move some load rearward to remove some of the weight from the front axle. Axle weight should never exceed tire or axle capacity. Refer to the proper shop manual for the power steering pump pressure checking procedures.

NOTE: Typical P-Series — Commercial power steering pump pressure is 1,200-1,300 PSI. Typical P-Series — Motor home power steering pump pressure is 1,350-1,450 PSI.

In order to improve static steer effort on the P30 (motor home chassis, the steering gear has been changed on all 14,500) — 14,800-16,000 GVW chassis effective on V.I.N. N3310596. The new 710 gear ratio is 17.5:1 and the older 708 gear was 14:1. The new 710 gear cannot be installed on the older units due to numerous changes and supports.

LEAKAGE CHECK

If you suspect leakage in the power steering system, follow the guidelines listed below. In some cases you will be able to locate the leak easily, but seepage leaks may be more difficult.

1. With the vehicle's engine off, wipe the complete power steering system dry (gear, pump, hoses, and connections).
2. Check oil level in pump's reservoir and adjust as required.
3. Start engine and turn steering wheel from stop to stop several times. Do not hold in corner for any length of time as this can damage the power steering pump. It is easier if someone else operates the steering wheel while you search for the seepage.
4. Find the exact area of leakage. Potential leak points are shown in Figure 3-8.

Some leaks can be corrected easily. (See Quick Fixes). Refer the problem of more extensive leaks to a qualified serviceman for repair.

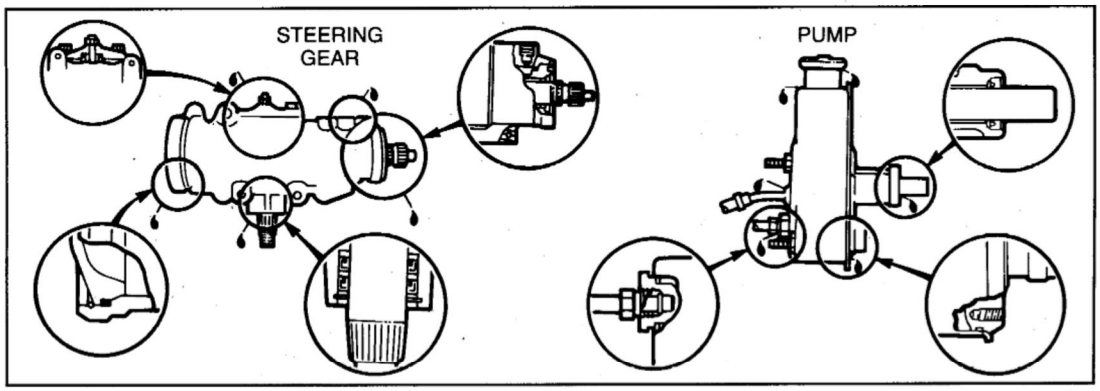


Figure 3-8 — Power Steering Pump Gear Box Leak Points

QUICK FIXES

The purpose of this section is to acquaint you with the types of leakage that can be repaired very easily. It contains information on reservoir oil level, the hoses and the hose connections.

An overfilled pump reservoir can be a cause for leakage complaint. The oil in the steering system expands as heated during normal usage. If overfilled, the excess is forced through the breather cap hole and may be sprayed over the engine by air blast. Operate the engine and steering system until normal operating temperature is obtained. Remove the reservoir cap and check the graduated level on the dipstick. Adjust the oil level as required.

Seepage at the hose connections can be a cause for leakage complaint and can be due to loose connection nuts. If leakage is observed at the hose connections, and the nut is not cross threaded, tighten the nuts at the gear to 30 ft. lbs. of torque.

The nut at the power steering pump should be tightened to 40 ft. lbs. of torque. If tightening to this torque does not stop the leak, refer to the appropriate shop manual. If either the return hose or pressure hose leaks, replace the hose.

After the source of a leak has been found and corrected, refill the system with GM Power Steering Fluid (GM Part No. 1050017 — quart size) or equivalent. Avoid the use of automatic transmission fluid in the power steering system since it does not contain the additives necessary for good seal life. In an emergency situation, automatic transmission fluid can be used to "get home." However, it should be replaced with power steering fluid as soon as is practical.

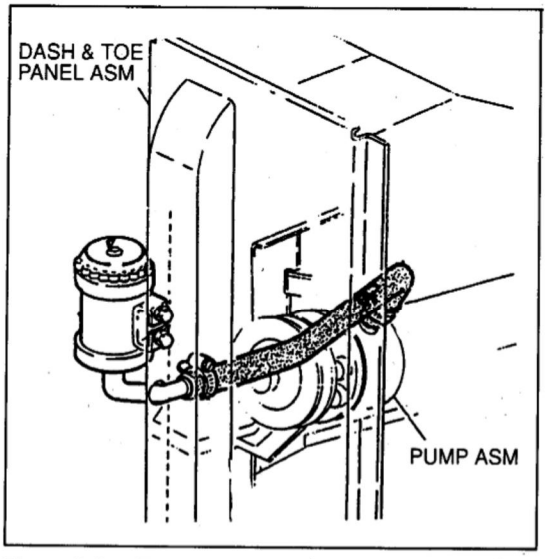


Figure 3-9 — Power Steering Reservoir

NOTE: Noise in the power steering system on the 14,500 and 14,800 lb GVW chassis may be the result of air in the system. Air in some cases may be trapped at the high point in the steering line from the reservoir to the steering pump. The air being trapped in this line is the result of line routing in relationship to the pump reservoir. Correct this condition by raising the reservoir 4 inches upward from the present location on the dash and toe panel — see Figure 3-9. This will route the hoses above the steering pump and eliminate the high point where air is being trapped. The above was a production change in November 1992 beginning with V.I.N. 306209.

NOTE: See page 6 Bulletin 90-391-5 Automatic Park System.

CAUTION: Automatic transmission fluid should **never** be used in the power steering system if the unit is equipped with option F44 -Automatic Park Brake System on the 16000#chassis.

NOTE: Contamination in the power steering system (metal flakes) can be removed by installing an A/C filter #25010169 AC-PF 883 in the power steering return line. The filter element should be checked to insure filter doesn't restrict the flow of returning fluid.

Component Replacement

Lip seals, which seal rotating shafts, require special treatment. This type of seal is used on the steering gear at the pitman shaft, at the stud shaft, and on the drive shaft of the pump. When leakage occurs in one of these areas, refer the problem to a qualified serviceman for repair.

PUMP BELT TENSION ADJUSTMENT

1. Loosen pivot bolt and pump brace adjusting nuts as required.

NOTE: Do not move pump by prying against reservoir or by pulling on filler neck, or damage to the pump could occur.

2. Move pump, with belt in place until belt is tensioned to the specifications. (See Appendix A — Drive Belts and Tension Specifications at the back of this manual.)

3. Tighten the pump brace adjusting nut. Then tighten the pivot bolt nuts.

4. Recheck the pump belt tension. Adjust as necessary.

SUSPENSION SYSTEM

The function of the suspension system is to support the vehicle body and chassis over the tires and wheels, and to absorb and cushion road shock. The springs in the suspension cushion the ride while the shock absorbers dampen or control the excess motion (up-and-down bounce) caused by variations in the road surface. The designs of the front and rear suspensions are different, but their function is the same.

FRONT SUSPENSION

GENERAL DESCRIPTION

The G- and P-Series vehicles incorporate an independent coil spring front suspension system, as shown in Figure 3-10. The control arms are of unequal length (S.L.A. Type).

This suspension system consists of upper and lower control arms pivoting on steel threaded or rubber bushings on upper and lower control arm shafts. The lower control arms are attached to the cross member. The upper control arms are attached to a frame bracket. These control arms are connected to the steering knuckle through pivoting ball joints.

A coil spring is located between the lower control arm and a formed seat in the suspension cross member, thus the lower control arm is the load-carrying member. Double-acting shock absorbers are also attached to the lower control arms and connect with the frame to the rear on the upper end. The front wheel bearings are tapered roller type and are used on all models.

Some P-Series motor homes may be equipped with air bag cylinders to increase the load-carrying capacity of the front suspension. These cylinders are positioned in the center of the coil springs.

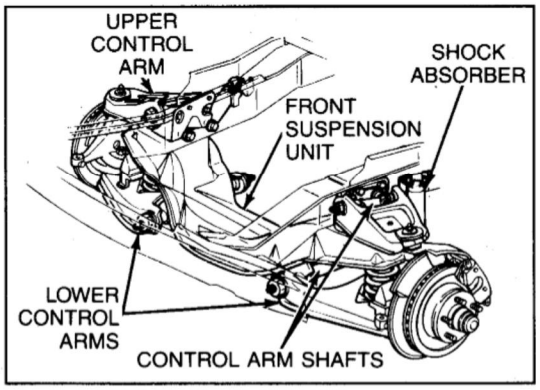


Figure 3-10 — Independent Front Suspension — Typical

MAINTENANCE AND INSPECTION

The front suspension must be lubricated periodically in accordance with the Maintenance Schedule. Grease fittings are indicated in the Lubrication section of this manual.

When the suspension is being lubricated, the components should also be checked for obvious signs of damage or wear. Leakage from the shock absorbers may indicate a need for replacement.

WHEEL BEARING LUBRICATION

As a part of normal service, the front wheel bearings should be removed, cleaned, inspected and lubricated each 12,000 miles. Repack the wheel bearings with high-temperature melting grease — approximately 500°F (GM Part No. 1051344 or equivalent). Refer to the appropriate Chevrolet Light-Duty Truck Shop Manual for the procedure.

WHEEL BEARING ADJUSTMENT CHECK

NOTE: Tapered roller bearings are used on all series vehicles and they have a slightly loose feel when properly adjusted. A design feature of front-wheel tapered roller bearings is that they must NEVER be preloaded. Damage can result by the steady thrust on roller ends which comes from preloading.

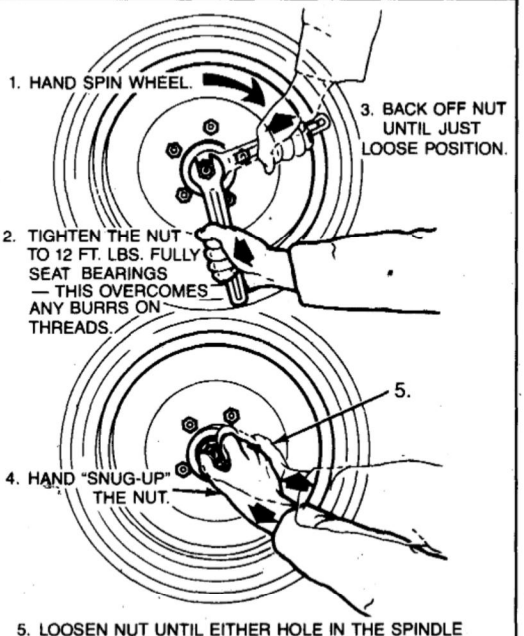
1. Raise the vehicle and support it at the front lower control arm.
2. Spin the wheel to check for any unusual noise or roughness.
3. If the bearings are noisy, tight, or excessively loose, they should be removed, cleaned, inspected and lubricated prior to adjustment. If it is necessary to inspect bearings, refer to the appropriate Chevrolet Light-Duty Truck Shop Manual.

To check for tight or loose bearings, grip the tire at the top and bottom and move the wheel assembly in and out on the spindle. Measure movement of hub assembly, if movement is less than .001 inch or greater than .005 inch, adjust bearings per the following adjustment procedure.

WHEEL BEARING ADJUSTMENT

1. Remove the hub cap or wheel disc from the wheel.
2. Remove the dust cap from the hub.
3. Remove the cotter pin from the spindle and spindle nut.

4. Tighten the spindle nut to 12 ft. lbs. while turning the wheel assembly forward by hand to fully seat the bearings. This will remove any grease which could cause excessive wheel bearing play later. Refer to Figure 3-11.
5. Back off the nut to the "just loose" position.
6. Hand tighten the spindle nut. Loosen the spindle nut until either hole in the spindle lines up with a slot in the nut (not more than 1/2 flat).
7. Install the new cotter pin. Bend the ends of the cotter pin against the nut. Cut off the extra length to ensure that the ends will not interfere with the dust cap.
8. Measure the looseness in the hub assembly. There will be from .001 to .005 inch end play when properly adjusted.
9. Install the dust cap on the hub.
10. Replace the wheel cover or hub cap.



5. LOOSEN NUT UNTIL EITHER HOLE IN THE SPINDLE LINES UP WITH A SLOT IN THE NUT — THEN INSERT COTTER PIN.

NOTE: BEND ENDS OF COTTER PIN AGAINST NUT. CUT OFF EXTRA LENGTH TO PREVENT INTERFERENCE WITH DUST CAP.

6. WHEN THE BEARING IS PROPERLY ADJUSTED THERE WILL BE FROM .001-.005 INCH END-PLAY (LOOSENESS).

Figure 3-11 — Wheel Bearing Adjustment

11. Lower the vehicle to the ground.
12. Perform the same operation for each front wheel.

AIR BAG CYLINDER INSPECTION

The air bag cylinders should be inspected periodically for signs of deterioration or damage. Air bag leaks can easily be checked on the vehicle. Inflate with a small amount of air conditioning freon No. 12 then locate the leak using an air conditioning leak detector. To check for possible leaks with the air bag removed from the vehicle, submerge the air bag in water and check for bubbles. (Replace with GM Part No. 367762.) Inflation pressures should be maintained at 10 PSI minimum to avoid chafing. Under load, 40-50 PSI is recommended for a 4,300-lb. suspension, 50 PSI for a 5,000-lb. suspension. 70 PSI is required on the 5,300-lb suspension. 80-90 PSI is recommended for the F44 5,500-lb. optional 16,000-lb. suspension. This unit uses an Airlift HD bag Part No. 15631881. Vendor #40-571

NOTE: Air bags are currently used on nearly all motor homes and are proposed for use on some G-Series (cut-away) models for 1988-89.

SERVICE TIP — (For units that appear somewhat low in front due to operating at near front suspension capacity.)

1. Jack up the motor home by the middle of the front cross member and allow the wheels to hang.
2. Remove the air from the air bag and reinflate the air bag to the proper pressure.
3. Lower the unit and bleed off air (as necessary) to maintain proper air bag pressure.

This may provide some ride height improvement as the air bag tends to stretch lengthwise slightly with this procedure.

VEHICLE RIDE HEIGHT — FRONT COIL SPRING/AIR BAG REPLACEMENT

The motor home owner should be cautioned in the use of some after-market front coil springs currently available. Some after-market front coil springs are merchandised as a method to increase ride height for the motor home. To obtain this additional ride height, manufacturers have increased the diameter of the wire slightly and added one extra coil. However, use of these after-market springs should be considered very risky for the motor home owner.

GM recommends the use of only factory-approved replacement parts for this "safety-sensitive" area of the vehicle. Some after-market coils are physically too large for the normally designed working area of the front coil spring as the wheel goes through its ride travel. On crush, these after-market springs can create a metal-to-metal "coil-bound" condition before the ride stops come into play. (The damage created by using a metal-to- metal solid coil can be compared to installing a piece of well casing in

place of a spring, then raising the vehicle in the air and dropping the vehicle to the ground.) The force of this metal-to-metal "coil-bound" condition is transferred directly into the potential destruction of the lower ball joints or broken lower control arms. The addition of a spring shim (donut-type spacer) has a similar effect of promoting a "coil-bound" condition.

Complaints of air bag failures are also the result of these after-market front coil springs. The springs have a tendency to "pinch" the air bag between the coils on crush.

Front coil springs should ONLY be replaced by a qualified service shop. Access to the front coil spring and the air bag is gained by lowering the lower control arm.

CAUTION: USE ONLY GM APPROVED REPLACEMENT PARTS FOR THIS SAFETY-SENSITIVE AREA OF THE VEHICLE.
1984 to Current..... GM Part No. 14054345
Prior to 1984..... GM Part No. 472222

NOTE: 1984 to current front springs (GM Part No. 14054345) can be used for 1983 and prior years that require front spring GM Part No. 472222. This will raise the front of the vehicle 3/8 inch to 1/2 inch measured at the "A/BC" measurement location shown in Figure A3-2-1. Study Figure A3-2-1 at the back of this section of the manual to determine if the useful life of the front coil springs is exhausted and replacement of the front coil springs is necessary.

SHOCK ABSORBER DIAGNOSIS

(Follow the Procedures Outlined Below in the Order Indicated.)

Inspection and Ride Test:

TIRE PRESSURE — Check the tire pressure and compare it to the recommended specification on the GVW label in the motor home. Adjust the pressure to specification as required. Poor vehicle control and ride complaint are caused in many cases by improper tire inflation.

SPECIAL SUSPENSION EQUIPMENT — Check the Service Parts Identification Sticker for any special suspension equipment, such as a heavy-duty suspension. Vehicles equipped with this type of option have a somewhat stiffer or harsh ride, and this should be kept in mind. Stiffness may occur while vehicle is still new (under 5,000 miles). The ride should improve somewhat after 7,000 to 8,000 miles.

VEHICLE LOAD CONDITIONS — Unusual load conditions can affect the ride and handling of the vehicle. If unusual loading is apparent, check the distribution of this weight. Note if it is all toward one side of the vehicle or at the extreme rear of the vehicle. Reposition load as required to obtain a more uniform weight distribution.

The importance of a near equal Rear Axle-to-Frame/Side-to-Side Measurement cannot be overstressed. This near equal measurement has a direct effect on desirable vehicle handling and on the front-end alignment "A or BC" dimension (with independent suspension). Generally, a near equal "D" dimension (see Figure 3-12) at the rear axle is needed in order to obtain an acceptable front-end alignment.

However, the motor home owner should be cautioned in the use of certain after-market suspension devices. These devices are merchandised as leveling devices to raise the "sagging" rear of the vehicle which may be caused by an overload situation or a weight distribution problem. Some of these after-market leveling devices severely limit the wheel travel that was designed into the GM chassis.

The following case study is presented as an aid to the motor home owner in identifying potentially dangerous after-market vehicle leveling devices.

GM CASE STUDY: A motor home was loaded to a maximum GVW, both front and rear. Sufficient air was applied to a typical after-market leveling device to establish a "dead-level" frame. In this case study, wheel travel was limited to 3/4 inch before the after-market device "went solid metal-to-metal" between the rear axle and the frame. This severe limitation on wheel travel promoted a "crash-through situation" on even the slightest bump. The force from this "crash-through situation" was transmitted into the vehicle frame, rear axle and the coach itself. GM has determined that these types of after-market leveling devices can be very damaging to the motor home and also can affect vehicle handling and are therefore potentially very dangerous.

If vehicle weights cannot be shifted due to vehicle build, consideration should be given to adding spring leaves or spacer blocks.

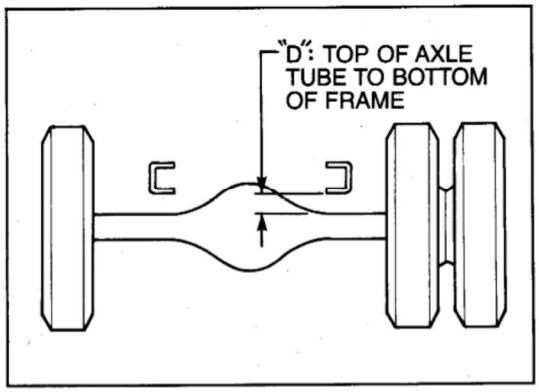


Figure 3-12 — Rear Axle-to-Frame/Side-to-Side Measurement

If the vehicle is within the rear spring rating but heavier on one side (tending to lean toward the generator or some other heavy appliance), you might consider adding a spacer block of sufficient thickness to equalize the left/right axle-to-frame measurement. Spacer blocks are not sold as GM parts but are fabricated at local machine shops. Installation of a spacer block and/or spring leaf is not covered by the GM warranty. The following information is provided as an aid to the motor home owner for loading situations.

NOTE: The addition of a spacer block can actually improve overall ride quality while the addition of a spring leaf tends to reduce the ride quality of the vehicle.

Spacer blocks can be added to either side or both sides of the vehicle and of different thickness to equalize or "open up" the "D" dimension shown in Figure 3-12.

Spacer blocks are generally 2 1/2 inches wide by 6 inches long and are installed between the spring pack and spring seat. (See Figure 3-13.) The thickness of the spacer block (to equalize left/right side dimensions) is determined by measuring the "D" dimension on each side and then subtracting one side's dimension from the other. The result is the thickness of the spacer block required for the low side of the vehicle.

Raising the back of the vehicle is generally trial and error. This is accomplished by driving the vehicle over stacked pieces of plywood 1/2 inch to 1 inch thick (in a level area) and checking that the side trim of the vehicle is level with each height increase. When the side trim is level and eye appealing to the owner, measure the height of the pieces of wood and add spacer blocks to equal that measurement. With most motor homes, you can add a spacer block of approximately 3/4 inch without replacement of the U-bolts. A minimum of 2 full threads on the U-bolt must extend thru the nut.

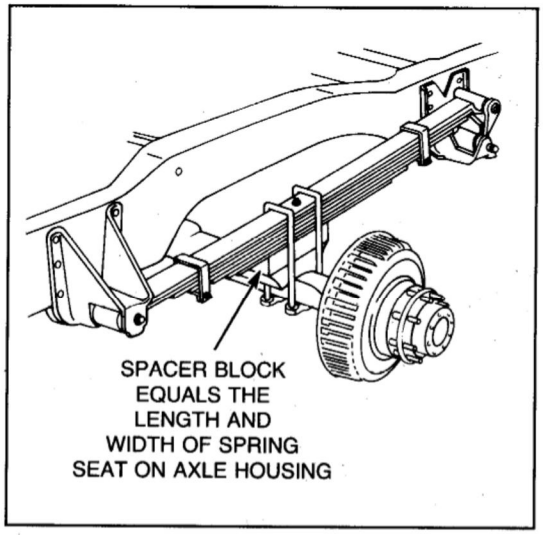


Figure 3-13 — Spacer Block

CAUTION: AS THE BACK OF THE VEHICLE IS RAISED, THE REAR HYDRAULIC FLEXIBLE BRAKE HOSE (RUNNING FROM FRAME MIDPOINT TO THE AXLE) IS EFFECTIVELY SHORTENED. DAMAGE CAN RESULT TO THE REAR HOSE WHEN THE AXLE DROPS AWAY FROM THE VEHICLE TO THE LOWER END OF THE WHEEL TRAVEL (WHEN THE VEHICLE ENCOUNTERS A CHUCK HOLE). CHECK TO MAKE SURE THAT THE REAR HOSE IS LONG ENOUGH TO AVOID DAMAGE IN SUCH A SITUATION. IF THERE IS ANY DOUBT, REPLACE THE REAR HOSE WITH A LONGER HOSE AND THEN BLEED THE BRAKES. DRIVE LINE ANGLE MAY ALSO BE AFFECTED.

The spacer block has a 3/4-inch hole drilled in the center. A slip-fit dowel, as long as the thickness of the spacer block, is inserted into the hole of the block. The center bolt head of the spring pushes the dowel down into the pocket in the spring seat and extends into the axle housing seat hole, as shown in Figure 3-14.

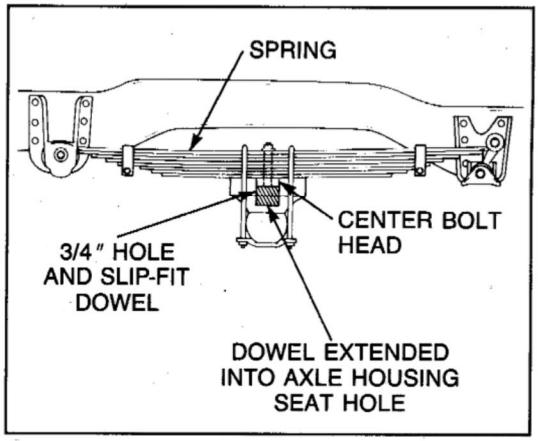


Figure 3-14 — Spacer Block Positioning

NOTE: There are several different spring center bolt head sizes available. The P-Series motor home chassis requires a 3/4-inch spring center bolt head size.

VEHICLE RIDE AND HANDLING CHECK — After completing the previous checks, drive the vehicle to determine if the problem has been corrected or to definitely establish the type of problem that still exists. If the problem still exists (poor handling, bottoming, noise, ride sway, etc.), the shock absorbers may be the cause. Refer to the appropriate Chevrolet Light-Duty Truck Shop Manual for more extensive test procedures.

REAR SUSPENSION

GENERAL DESCRIPTION

Both the G- and P-Series vehicles use a leaf spring/solid rear axle suspension system.

NOTE: 1993 SOP the 14,500-14,800-16,000# units are equipped with the new taper leaf spring.

The rear axle assembly is attached to multi-leaf springs by U-bolts. The spring front eyes are attached to the frame at the front hangers, through rubber bushings. The rear ends of the springs are attached to the frame by the use of shackles which allow the spring to "change its length" while the vehicle is in motion. Control arms are not required with leaf springs. (See Figure 3-15.)

Ride control is provided by two identical direct double-acting shock absorbers angle-mounted between the frame and brackets attached to the axle tubes.

On G-Series vehicles, the shock absorbers are mounted to the front of the axle on the right side, and to the rear of the axle on the left side. For P-Series vehicles, both right and left shock absorbers are mounted to the front of the axle.

MAINTENANCE AND INSPECTION

Since the rear springs and shock absorbers use rubber bushings in the mounts, no lubrication is required. However, inspect the suspension periodically for worn or damaged components such as weak or broken spring leaves, leaking shock absorbers, and loose or broken mounting bolts, etc. Check for uniformity of ride height between right and left sides. Replace any worn or damaged parts.

Rear shock absorbers should be inspected and their operation checked following the same procedures for shock absorbers listed in this section under Front Suspension.

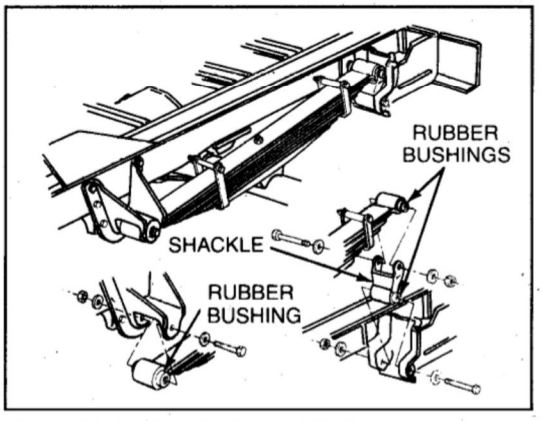


Figure 3-15 — Rear Spring Installation — G-Series — Typical

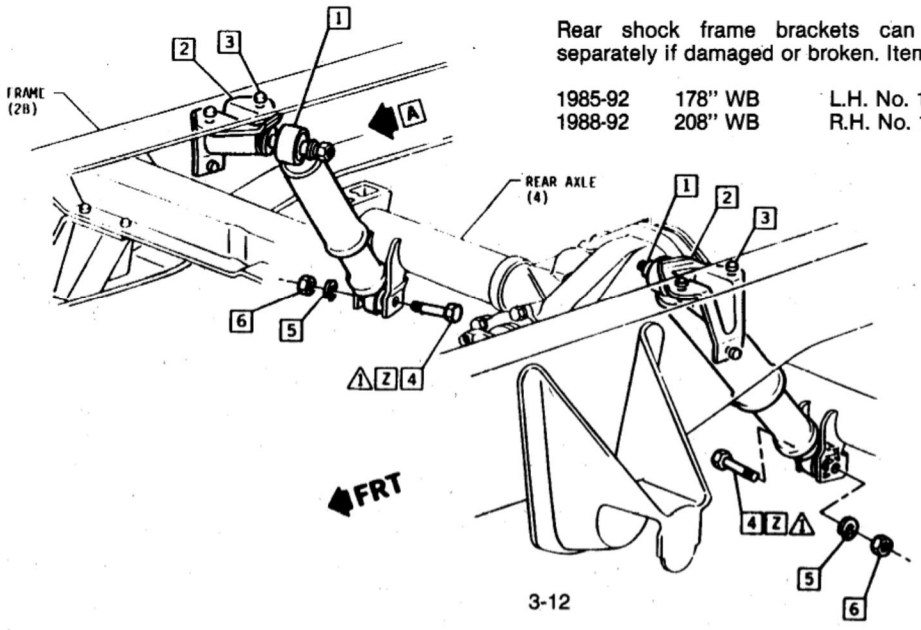
The U-bolts attaching the rear axle to the leaf springs should be checked and retightened to the specified torque after the first 500 miles of vehicle operation. Recheck the U-bolt torque each 10,000 miles thereafter. Torque specifications are listed in the chart which follows:

U-BOLT TORQUES — REAR

Model	Bolt Diameter	Torque
G-10,20	9/16 in.	115-130 ft. lbs.
G/P-20,30	5/8 in.	125-175 ft. lbs.
P-30	3/4 in.	200 ft. lbs.

Rear shock frame brackets can be purchased separately if damaged or broken. Item No. 2.

1985-92	178" WB	L.H. No. 15638125
1988-92	208" WB	R.H. No. 15638126



WHEELS AND TIRES

Use the proper size torque wrench when installing wheels. Hand tightening without a torque wrench or the use of a power impact tool can result in installation torques which are too high or too low. It will help prevent loosening of the wheel stud nuts and excessive stress placed on the stud bolts.

GENERAL DESCRIPTION

The factory-installed tires and wheels are designed to operate satisfactorily with loads up to and including the full rated load capacity when inflated to the recommended inflation pressures.

Correct tire pressures and driving techniques have an important influence on tire life. Heavy cornering, excessively rapid acceleration, and unnecessarily sharp braking increase tire wear.

MAINTENANCE AND INSPECTION

TIRE INSPECTION AND ROTATION

Front and rear tires perform different jobs and can wear differently depending on the type of roads driven, individual driving habits, etc. To obtain maximum tire life, tires should be inspected at intervals shown in the Maintenance Schedule. For the longest tire life, anytime irregular wear is noticed, the tires should be inspected and rotated and the cause of the uneven wear corrected. Be certain to check wheel nut tightness (using a torque wrench) and to adjust the tire pressures, front and rear, after rotation to agree with the recommended pressures. Recheck the torque (Figure 3-18) at 100 and 1,000 miles of operation after wheel installation, then, once every 6,000 miles thereafter.

The outer tire on a dual wheel will skid or drag on a turn because of the difference in the turning radii of the inner and outer tires. This results in faster wear of the outer tire. In general, the tire with the largest diameter or least wear should be positioned at the outside of each dual wheel. In addition, when vehicles are operated continuously on high-crown roads an increase in air pressure of from 5 to 10 PSI in the outside tire of each dual produces maximum tire life.

The "X Method" of rotation is recommended with radial tires. Due to their design, radial tires tend to wear faster in the shoulder area particularly in the front positions. This makes regular rotation especially necessary.

With dual wheel installations, it is recommended that the circumference of each tire to be installed on the rear axle be measured with a steel tape. If all tires do not measure the same, the two larger tires should be installed on one side and the two smaller tires on the opposite side.

INFLATION PRESSURE

The maximum cold inflation pressures for the factory-installed tires are listed on the Certification Label. (See Figure 3-16.) Tires must be inflated to these pressures when the Gross Vehicle Weight Rating (GVWR) or a Gross Axle Weight Rating (GAWR) is reached. For partial or uneven load distributions (front to rear), proper tire inflation pressure can be determined from the procedure under Determining Wheel/Tire Loads in this section. Improper tire inflation pressures for the load the vehicle is carrying can adversely affect tire life and vehicle performance.

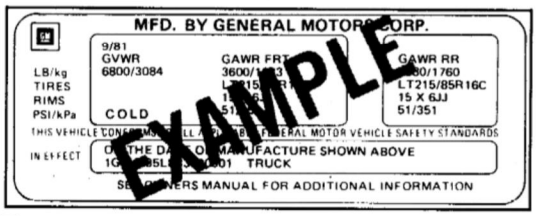


Figure 3-16 — Certification Label

For improved ride comfort in vehicles rated at 8,600 lbs. GVWR, it is permissible to use the lower tire pressure values shown on the label located on the rear edge of the driver's door provided there is a maximum of 200 lbs. cargo, no slide-in camper, and there are three or fewer occupants. The lower GVWR and GAWR (rear) reflect the maximum load-carrying capacity of the tires at lower pressure.

Too low an air pressure can result in tire overloading, abnormal tire wear, adverse vehicle handling, and reduced fuel economy. The tire flexes more and can build up excessive heat, weakening the tire and increasing susceptibility to damage or failure. Too high an air pressure can result in abnormal wear, harsh vehicle ride, and increased susceptibility to damage from road hazards. Lower inflation pressures should be used only with reduced vehicle loads and the rear tire pressure should be equal to or greater than the front pressure on single wheel application. After determining the load on each tire by weighing the vehicle on a scale, the correct cold inflation pressures for the actual tire loads can be obtained from the Tire/Wheel Load and Inflation Pressure Charts shown in Figure 3-17. Refer to the owner's and driver's manual for additional information on inflation pressure.

DETERMINING WHEEL/TIRE LOADS

To determine the load carried by each wheel and tire, weigh the motor home in two stages. First, position the vehicle with the front wheels on the scale, and take a

weight reading. Divide this reading by two to determine the load carried by each tire/wheel. Next, position the vehicle with the rear wheels on the scale, and take the second weight reading. Divide this reading by two (single rear wheels) or four (dual rear wheels) to determine the tire/wheel loads. Then, inflate tires to the proper pressure as determined by load. (See Figure 3-17.)

WHEEL AND TIRE BALANCING

It is desirable from the standpoints of tire wear, vehicle ride and handling ease to maintain proper balance of wheel and tire assemblies on all models. This may be accomplished by either of the two types of balancing systems in current use which balance wheels either on the vehicle or off. The "on the vehicle" type, however, is the more desirable in that all rolling components (brake drums, bearings, seals, etc.) are included in the balancing procedure and thereby have any existing unbalance corrected. Because of the specialized equipment required, wheel and tire balancing should be performed by a qualified service shop.

TIRE REPLACEMENT

When replacing tires, be sure to consult your owner's and driver's manual for information regarding the proper tire selection. Use of the incorrect size or type of tire may affect load-carrying capacity, ride, handling, speedometer/odometer calibration, vehicle ground clearance, and tire clearance to the body and chassis. If replacing only a single tire, it should be paired on the same axle with the least worn tire of the others.

CAUTION: DO NOT MIX DIFFERENT TYPES OF TIRES ON THE SAME VEHICLE SUCH AS RADIAL, BIAS, AND BIAS-BELTED TIRES EXCEPT IN EMERGENCIES, BECAUSE VEHICLE HANDLING MAY BE SERIOUSLY AFFECTED AND MAY RESULT IN LOSS OF CONTROL.

G-SERIES

(TIRE AND WHEEL LOAD LIMITS ARE SHOWN BELOW. VEHICLE LOADING MUST BE LIMITED SUCH THAT NEITHER THE WHEEL LOAD LIMITS NOR TIRE INFLATION ARE EXCEEDED.)

TIRE SIZE AND LOAD LIMITS — LBS.

TIRE SIZE	TIRE REV. PER MILE	LOAD RANGE	INFLATION PRESSURE — PSI										
			30	35	40	45	50	55	60	65	70	75	80
BIAS TIRES USED AS SINGLES													
8.00-16.5	734	C	1360	1490	1610	1730							
8.00-16.5	734	D	1360	1490	1610	1730	1840	1945	2045				
8.75-16.5	712	D	1570	1720	1850	1990	2110	2240	2350				
8.75-16.5	712	E	1570	1720	1850	1990	2110	2240	2350	2470	2570	2680	
BIAS TIRES USED AS DUALS													
8.00-16.5	734	C	1195	1310	1415	1520							
8.00-16.5	734	D	1195	1310	1415	1520	1620	1710	1800				
RADIAL TIRES USED AS DUALS													
8.75R16.5	712	E		1570	1720	1850	1990	2110	2240	2350	2470	2570	2680

****NOTE:** Wheel code is located on the wheel just to the right of the valve stem hole.

G-SERIES
WHEEL CODE AND LIMITS

CODE	WHEEL SIZE	MAX. LOAD LBS.	MAX. PRESSURE PSI
BR	15x7 JJ	1690	40
CD	15x6.5 JJ	1690	40
XH	15x6 JJ	1585	40
XW	15x6 JJ	1910	70

CODE	WHEEL SIZE	MAX. LOAD LBS.	MAX. PRESSURE PSI
YD	16.5x6	2680	85
YH	16.5x6	2680	85
YJ	16.5x6.75	2680	85
NO CODE	15x6.5 JJ	1690	40

Figure 3-17 — Tire/Wheel Load and Inflation Pressure Charts

P-SERIES

(TIRE AND WHEEL LOAD LIMITS ARE SHOWN BELOW, VEHICLE LOADING MUST BE LIMITED SUCH THAT NEITHER THE WHEEL LOAD LIMITS NOR TIRE INFLATION PRESSURE ARE EXCEEDED.)

RADIAL TIRE SIZE AND LOAD LIMITS — LBS.

TIRE SIZE	TIRE REV. PER MILE	LOAD RANGE	INFLATION PRESSURE — PSI						
			35	45	50	60	65	75	80
FRONT METRIC RADIAL TIRES USED AS SINGLES									
LT215/85R16	682	C	1495	1785	1940				
LT215/85R16	682	D	1495	1785	1940	2180	2335		
LT235/85R16	653	D	1700	2030	2205	2485	2623		
LT235/85R16	653	E	1700	2030	2205	2485	2623	2905	3042
REAR METRIC RADIAL TIRES USED AS DUALS									
LT215/85R16	682	C	1360	1625	1765				
LT215/85R16	682	D	1360	1625	1765	1985	2150		

TIRE SIZE	TIRE REV. PER MILE	LOAD RANGE	INFLATION PRESSURE — PSI			
			55	60	65	70
FRONT METRIC RADIAL TIRES USED AS SINGLES (MICHELIN)						
8R19.5	617	D	2355	2517	2682	2800
REAR METRIC RADIAL TIRES USED AS DUALS (MICHELIN)						
8R19.5	617	D	2287	2442	2597	2700

BIAS TIRE SIZE AND LOAD LIMITS — LBS.

TIRE SIZE	TIRE REV. PER MILE	LOAD RANGE	INFLATION PRESSURE — PSI									
			30	35	40	45	50	55	60	65	70	75	90
FRONT BIAS TIRES USED AS SINGLES													
7.50-16	652	C	1620	1770	1930	2060							
7.50-16	652	D	1620	1770	1930	2060	2190	2310	2440				
7.50-16	652	E	1620	1770	1930	2060	2190	2310	2440	2560	2670	2780	
8-19.5	613	D						2270	2410	2540	2680	2800	3170
8-19.5	613	E											3170
REAR BIAS TIRES USED AS DUALS													
7.50-16	652	C	1430	1565	1690	1815							
7.50-16	652	D	1430	1565	1690	1815	1930	2040	2140				
7.50-16	652	E								2245	2345	2440	
8-19.5	613	D						2230	2350	2460			
8-19.5	613	E						2230	2350	2460	2570	2680	

WHEEL CODE AND LIMITS

CODE	WHEEL SIZE	MAX. LOAD LBS.	MAX. PRESSURE PSI
AF or AR	16x6K	2440	80

CODE	WHEEL SIZE	MAX. LOAD LBS.	MAX. PRESSURE PSI
ZY	19.5x6	2540	80
ZT	19.5x6	2780	95

Figure 3-17 — Tire/Wheel Load and Inflation Pressure Charts (Continued) See Owners Manual

RADIAL TIRES USED AS SINGLES

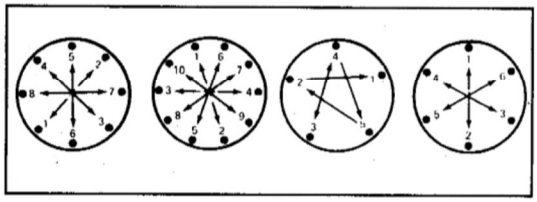
TIRE SIZE	TIRE REV. PER MILE	LOAD RANGE	INFLATION PRESSURE — PSI						
			35	40	45	50	55	60	65
7.50R16	654	D	1620	1770	1930	2060	2190	2310	2440
DUAL									
7.50R16	654	D	1430	1565	1690	1815	1930	2040	2140

SINGLES

TIRE SIZE	TIRE REV. PER MILE	LOAD RANGE	INFLATION PRESSURE — PSI						
			55	60	65	70	75	80	85
225/70R19.5	646	F	2475	2650	2835	3040	3220	3405	3640
DUAL									
225/70R19.5	646	F	2377	2557	2755	2862	2970	3185	3415

Two wheels are used on the assembly line that turns out the GM P-32 motorhome chassis. Chassis with gross vehicle weight ratings (GVWR) of 10,500 pounds to 12,300 pounds use a 19.5 x 6, 8-hole wheel with a 6.5-inch bolt circle — part number 15963341. Chassis with a GVWR of 14,500 pounds to 16,000 pounds use a 19.5 x 6, 10-hole wheel with a 7.25-inch bolt circle — part number 14005758.

CAUTION: USE A TORQUE WRENCH TO TIGHTEN LUG NUTS. TIGHTENING BY HAND OR WITH AN IMPACT WRENCH IS NOT RECOMMENDED. TORQUE SPECIFICATIONS LISTED ARE FOR DRY THREADS WITHOUT LUBRICATION. UNDER CONDITIONS OF ABNORMAL CORROSION, A MODEST AMOUNT OF LUBRICANT ON THE FIRST THREE THREADS OF THE WHEEL STUDS SHOULD ALLEVIATE ANY DIFFICULTIES. DO NOT USE PENETRATING OIL. DO NOT APPLY LUBRICANT TO THE BALL SEATS OF THE WHEELS OR TO THE BALL FACES OF CAP NUTS.



SERIES	DESCRIPTION	TORQUE (FT. LBS.)
G20	1/2 In. Bolts (5)	75-100
G-30, P-20, 30 Single Wheels	9/16 In. Bolts (8)	90-120
G-, P-30 Dual Wheels	9/16 In. Bolts (8)	140
	Heavy Duty 5/8 In. Bolts (10)	180

Figure 3-18 — Wheel Nut Tightening Sequence and Torque Specifications

WHEEL STUD BOLT REPLACEMENT

When one wheel stud bolt is broken on axles using five- to nine-bolt wheels, all stud bolts should be replaced. When one stud bolt is broken on an axle using ten-bolt wheels, the broken bolt, plus the adjacent bolt on each side should be replaced. The additional stress placed on bolts adjacent to the broken bolt weakens them and is the reason for replacement.

TYPICAL WHEEL AND STUD BOLT FAILURES

Worn/Broken Stud Bolts

Stripped threads on the stud bolts may be the result of excessive torquing of the studs (Figure 3-19) or may be the result of damage during wheel installation (when placing the wheel over the studs).

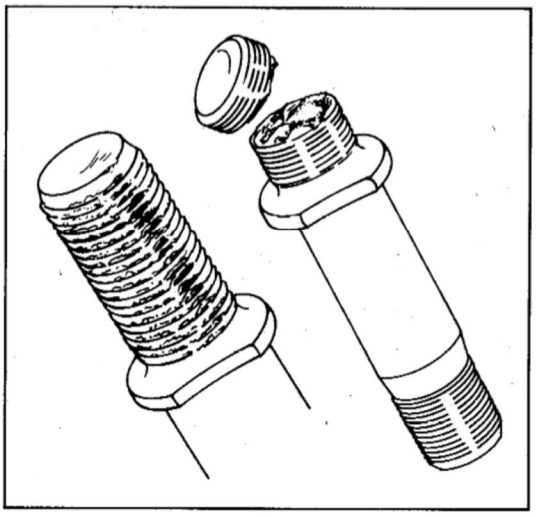


Figure 3-19 — Stripped/Broken Wheel Stud Bolts

Broken studs are a direct result of operating with loose cap nuts or improperly seated wheels.

Worn/Cracked Wheels

Worn wheel stud holes will usually be accompanied by evidence of a bright, worn surface on the wheel face. This condition indicates that loose wheels were working against each other. As shown in Figure 3-20, the stud holes are out of shape and a build-up of metal occurs around them. This condition requires that the wheels be replaced.

NOTE: Firestone Steel products are now Accuride Wheels Henderson Kentucky P.O. BOX 40 ZIP 42420-0040 PH 502 826-5000.

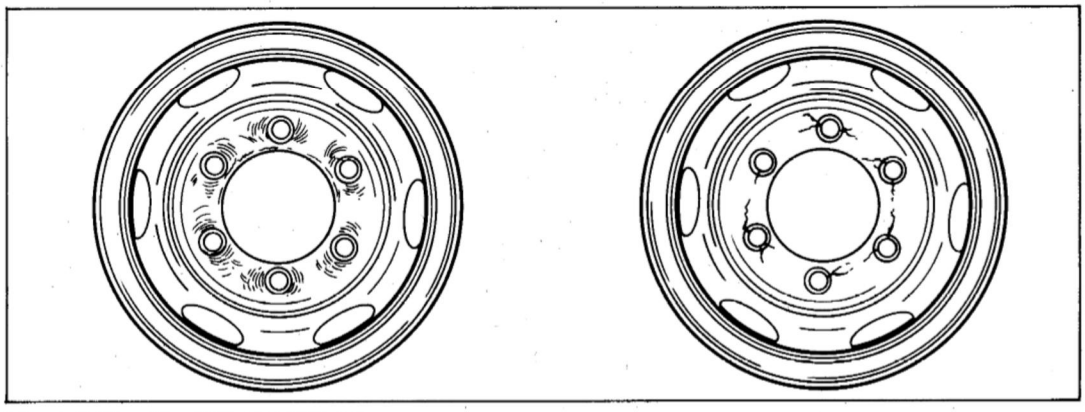


Figure 3-20 — Worn/Cracked Wheels

Cracks running from stud hole to stud hole (Figure 3-20) on the bolt circle indicate a loose-mounting condition. Cracks running from hand hole to stud hole, hand hole to hand hole, or hand hole to rim are a direct result of overloading. If this type of failure occurs, the position of the failed wheel on the vehicle should be noted and the actual working loads of that axle should be checked.

BENT RIM CHECK/TIRE TO RIM MATCHING

The following procedure can be used to check for a bent rim or to properly match a tire to a rim.

1. Mount the suspect wheel and tire assembly on a suitable fixture such as an off-car wheel balancer or front spindle of the vehicle.
2. Using a dial indicator, measure the center point of the tire thread. Mark the high point with chalk (to be used in Step 4).

NOTE: For this measurement, the tire should be "run" recently so that it is warm to avoid a false reading of cord "flattening" which is caused from sitting stationary.

3. Remove the tire from the rim and measure both the radial and the lateral runout at the bead area of the rim as shown in Figure 3-21. Using chalk, mark the high point on the radial runout of the rim.
4. Check the runout specifications listed in Figure 3-21. If the runout does not exceed the listed specifications, remount the tire on the rim. Position the high point of the tire (marked with chalk) OPPOSITE (180 degrees) from the chalk mark designating the high point of the rim. This procedure presents the least amount of radial vibration potential.
5. Balance and remount the wheel and tire assembly on the vehicle.

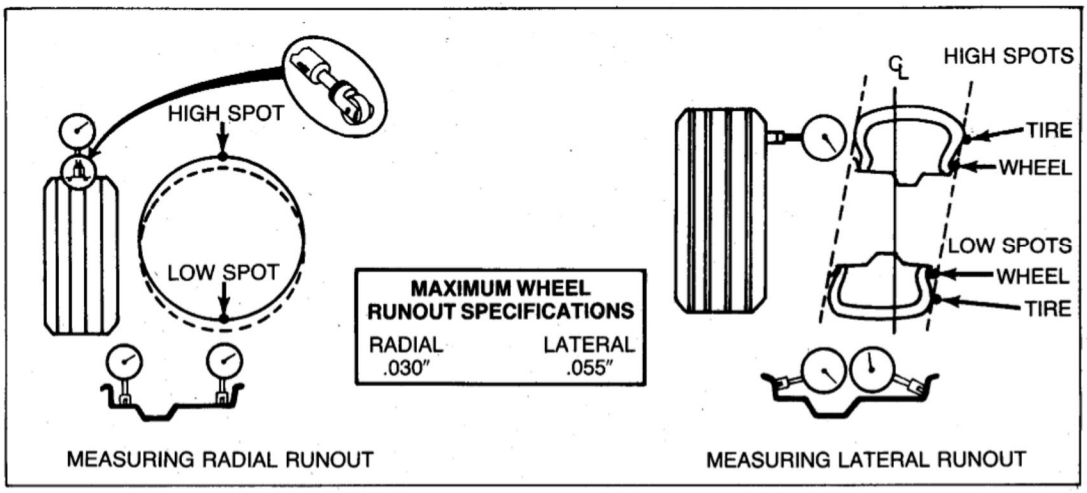


Figure 3-21 — Radial/Lateral Runout Measurement

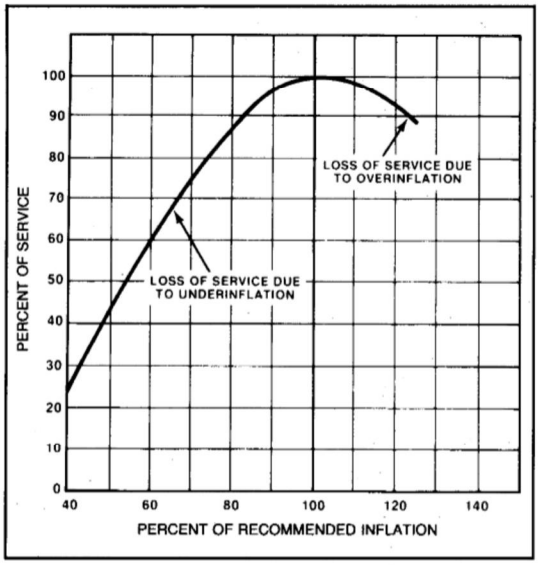


Figure 3-22 — Effect of Inflation on Tire Wear

TIRE WEAR

Proper inflation pressures for various tire loads are shown in Figure 3-17. For maximum tire life, these pressure recommendations should be followed. Both overinflation and underinflation can greatly reduce tire life. Likewise, the life of overloaded tires is shortened considerably. Greatest tire economy is achieved by selecting tires large enough to carry maximum loads without overloading, and by adjusting inflation pressures downward when less than maximum loads are carried.

EFFECT OF INFLATION ON TIRE WEAR

Overinflation — This is one of the greatest causes of tire damage. Overinflation does not add strength to a tire, nor does it compensate for overloading. Instead, it weakens the tire and causes more rapid wear (Figure 3-22). Specifically, overinflation causes (1) rapid wear in center of tread, (2) greater susceptibility to impact breaks, (3) weakening of bead, (4) stresses that lead to tread separation, (5) reduced cushioning, leading to increased truck maintenance costs, and (6) reduced traction and skid resistance.

Underinflation — This causes tires to flex excessively, causing heat build-up and increased tire wear (Figure 3-22). Underinflation leads to (1) excessive wear on shoulder of tread, (2) irregular tread wear, (3) ply separation, (4) greater susceptibility to bruising, and (5) tread separation.

EFFECT OF OVERLOADING ON TIRE WEAR

Tires that are loaded beyond their maximum-rated carrying capacity will have their useful life significantly shortened. As shown in Figure 3-23, tire life decreases rapidly as overloading increases. For example, it is seen that only a 10 percent overload reduces tire life by about 15 percent. An overload of 50 percent reduces tire life by 60 percent.

The dotted line is a projection of the solid curve, obtained with actual tire experience over a long period of time. The extreme left end of the solid curve shows that running tires at less than rated load results in a substantial increase in tread mileage.

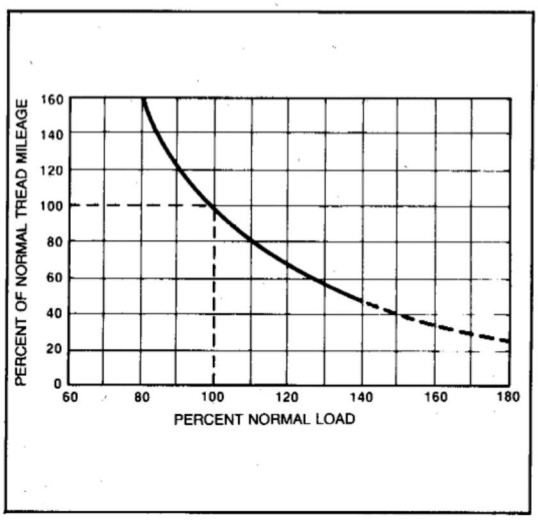


Figure 3-23 — Effect of Overloading on Tire Wear

EFFECT OF OVERHEATING ON TIRES

When a tire gets extremely hot by operating over a considerable distance in a severely underinflated or flat condition, or with dragging brakes (these are most common causes), the internal frictional heat created may build up to a point where the tire actually bursts into flame. This usually occurs in a dual assembly where one tire is flat and the other tire continues to operate in an overloaded and/or underinflated condition. In such cases, either the completely flat tire or the tire carrying the load could build up a sufficiently high temperature to ignite, as shown in Figure 3-24. Line A of this chart shows time and tire temperature with a tire operated at proper loading and inflation pressure. Line B shows a 20 percent overload and/or underinflation. Note that the tire temperature has moved into the HOT area of the chart. Line C of the chart reflects a 40 percent overload and/or underinflation which has moved into the DANGER area.

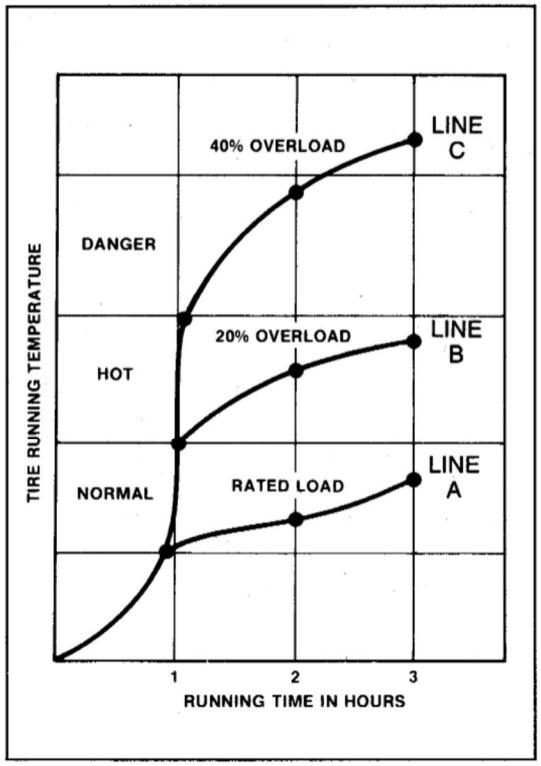


Figure 3-24 — Effects of Time, Temperature and Pressure on Tire Wear

NOTE: It is extremely difficult to extinguish a tire fire since the internal temperature causes repeated ignition. A fire extinguisher should be used to control the fire until the tire can be removed from the vehicle. The best protection against a tire fire is to avoid running on flats and to check operating pressures regularly.

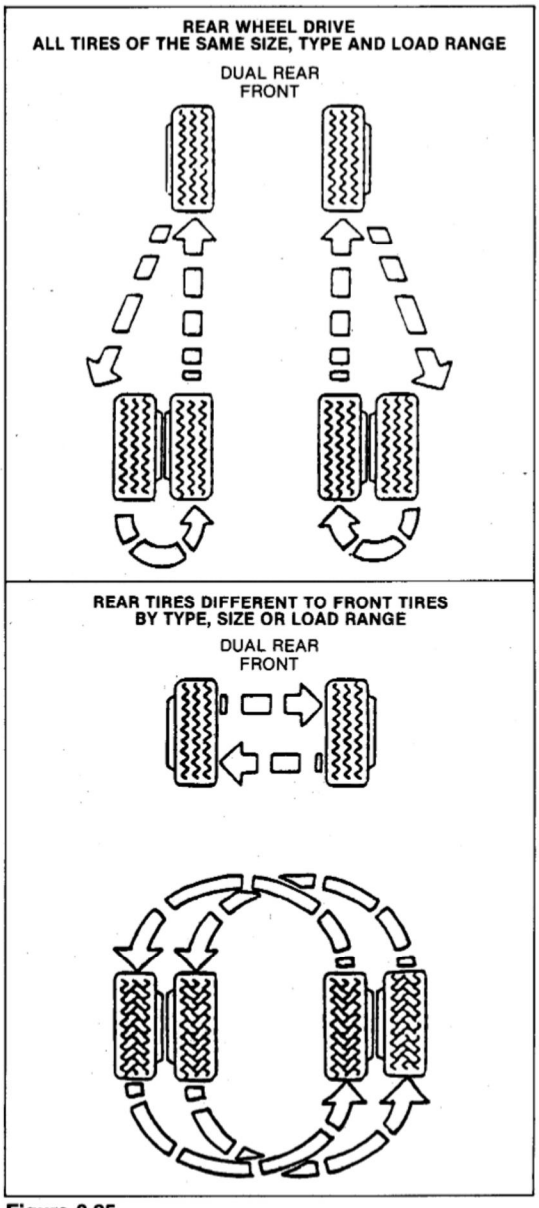
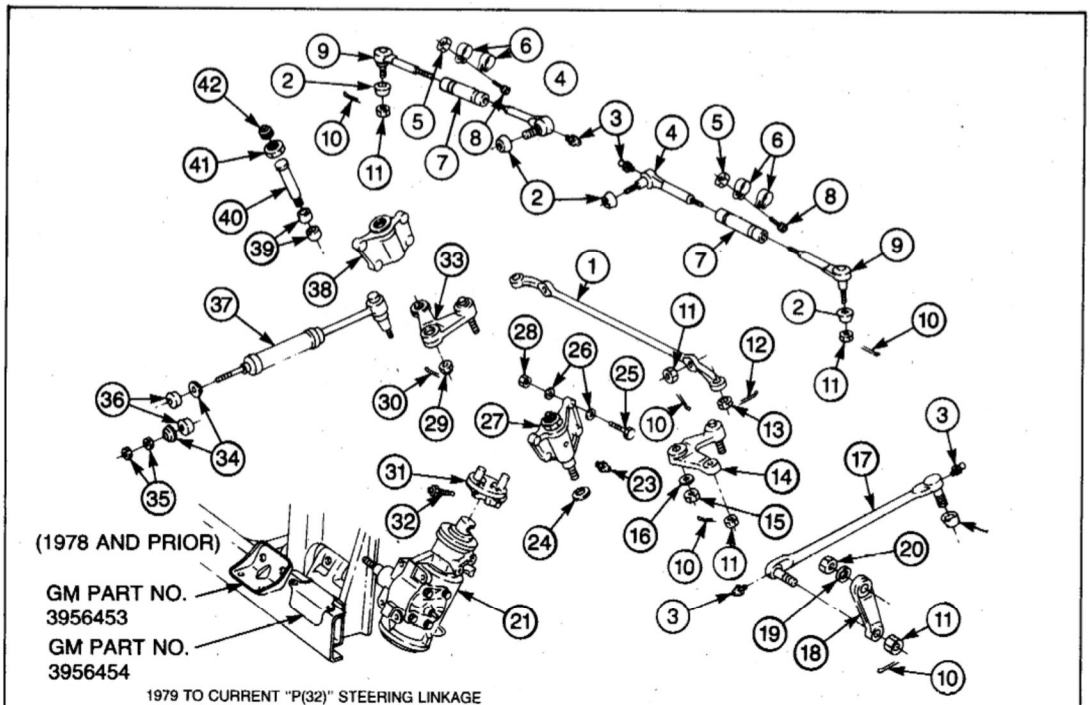


Figure 3-25

STEERING RELAY AND TIE ROD PARTS IDENTIFICATION

The following illustration has been extracted from the GM Parts Book. The typical Parts Book illustration shows group numbers of front-end parts. Major parts numbers have been added for reference.



1979 TO CURRENT "P(32)" STEERING LINKAGE

1.	6.870	ROD, Strg Relay	6270303
2.	6.242	SEAL, Tie Rod Soc Ball Stud	328144
3.	8.984	FITTING, Lug Straight (1/4"-28)	
4.	6.230	ROD, Inr Tie	14002550
5.	8.917	NUT (3/8"-16)	
6.	N.S.	CLAMP, Adj Tube (Part of #7)	
7.	6.232	TUBE UNIT, Tie Rod Adj (Includes Items 5,6,8)	12309226
8.	8.900	BOLT (3/8"-16 × 1 5/8")	
9.	6.233	ROD, Otr Tie	458201
10.	8.938	PIN, Cotter (1/8" × 1 1/4")	
11.	6.164	NUT, Strg Link	3983037
12.	8.938	PIN, Cotter (1/8" × 1 1/4")	
13.	8.917	NUT (5/8"-18)	
14.	6.895	ARM, Strg Relay and Conn Rod	14013037
15.	8.916	NUT (3/4"-16)	
16.	8.931	WASHER (3/4")	
17.	6.870	ROD, Strg Conn	6271489
18.	6.859	ARM, Pitman	6259993
19.	6.861	WASHER (1 1/2" OD 7/8 ID)	
20.	6.861	NUT (7/8"-14)	5667628
21.	6.508	GEAR, Strg(*1)	7834511
22.	6.898	SEAL, Strg Conn Rod Ball Stud	3865608
23.	8.984	FITTING, Lug Straight (1/8"-17)	
24.	6.898	SEAL, Strg Lnkg Piv Shf	3786454
25.	8.900	BOLT (7/16"-14 x 1 3/4")	
26.	8.929	WASHER (7/16")	
27.	N.S.	SUPPORT ASM, Strg Relay (See Items 38,39,40,41,42)	
28.	8.917	NUT (7/16"-14)	
29.	8.915	NUT (1/2"-20)	
30.	8.938	PIN, Cotter (3/32" × 1")	
31.	6.525	COUPLING, W/Flange Kit, Strg Gr	7828871
32.	6.525	BOLT, Strg Shft Cplg (3/8"-24 x 1 3/16")	7807271
33.	6.895	ARM, Strg Idler	14013036
34.	6.897	WASHER, Strg Idler Shk Abs Grommet	3798007
35.	8.915	NUT (3/8"-24)	
36.	7.244	GROMMET, Spl (1 7/32" OD 7/8" Thk)	6270752
37.	6.895	ABSORBER, Strg Relay and Tie Rod Shk	22011982
38.	6.896	SUPPORT, W/Bushings Strg Rly & Conn (Includes Item 39)	3941739
39.	6.896	BUSHING, Strg Rly & Conn Rod Supt Shf (Included in item 38)	266316
40.	6.896	SHAFT, Strg Rly & Conn Rod Arm Supt	3768940
41.	6.897	NUT, Strg Rly & Conn Rod Arm Supt Plug	3768947
42.	6.897	PLUG, Strg Rly & Conn Rod Arm Supt	3768945

NOTE 1: For information on serviceable components refer to applicable Assembly illustration.

APPENDIX 3-2

TYPICAL LOAD HEIGHT CURVES — MOTOR HOME

The following Load Height Curves have been extracted from the 1987 Chevrolet Commercial and Truck Chassis Body Builders Book showing Spring Number and Spring Charts for P-Series Motor Home units. As shown on the following charts, known weights compared to actual "A/BC"* or "D" dimensions can determine if the spring is performing according to its rating. Actual measurements will be ± 1/2-inch on the chart and normally considered within the spring makers production capability. At or near maximum ratings, most GM leaf springs are designed to be in a slight reverse arch. Check with your local Chevrolet Branch Office Truck Department for Spring Charts for other years and models.

* Depending upon reference sources, this dimension is referred to as either an "A" dimension or a "BC" dimension. For the purposes of this manual, both dimensions have been included to aid the motor home owner in the determination of spring ratings.

NOTE: This chart is for the typical P-Series Motor Home. Additional model information is available in the Body Builders Book.

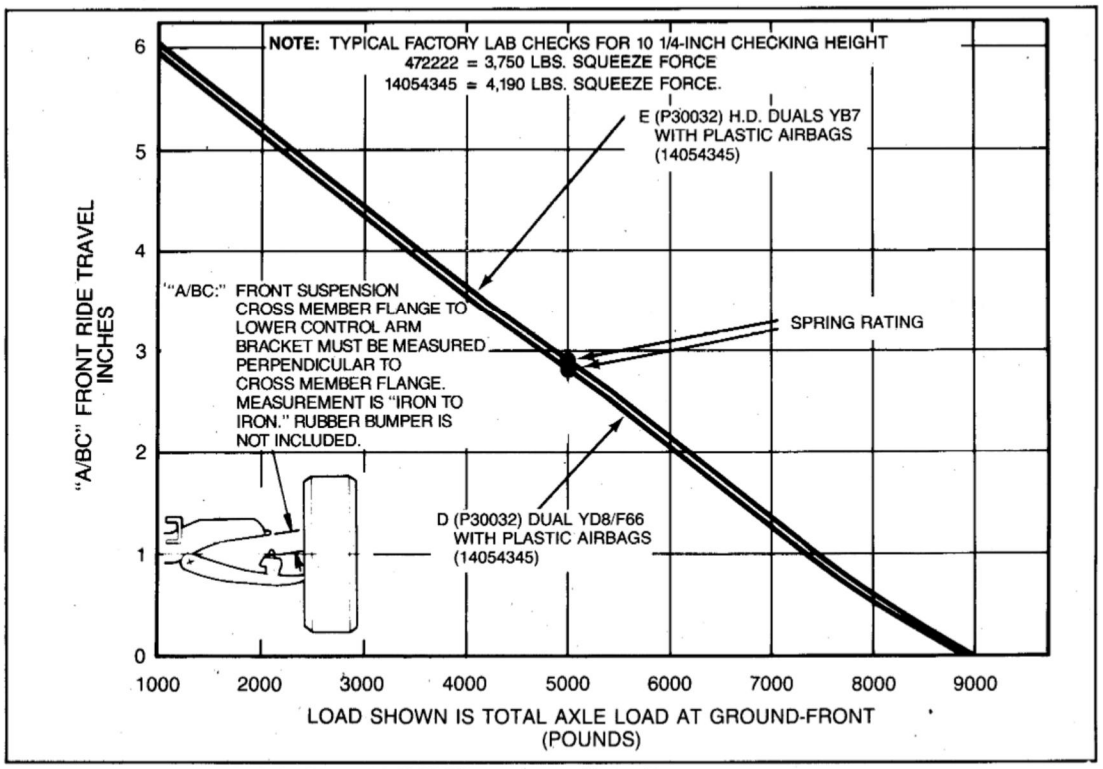


Figure A3-2-1 — Load Height Curve "A/BC" Dimension — Motor Home

NOTE: 1984 to Current — A front spring with GM Part No. 14054345 can be used for 1983 and prior years that require a front spring with GM Part No. 472222. This will raise the front of the vehicle 3/8 inch to 1/2 inch measured at the "A/BC" measurement location shown in the chart above.

TYPICAL LOAD HEIGHT CURVES — MOTOR HOME (Cont'd)

NOTE: This chart is for the typical P-Series Motor Home. Additional model information is available in the Body Builders Book.

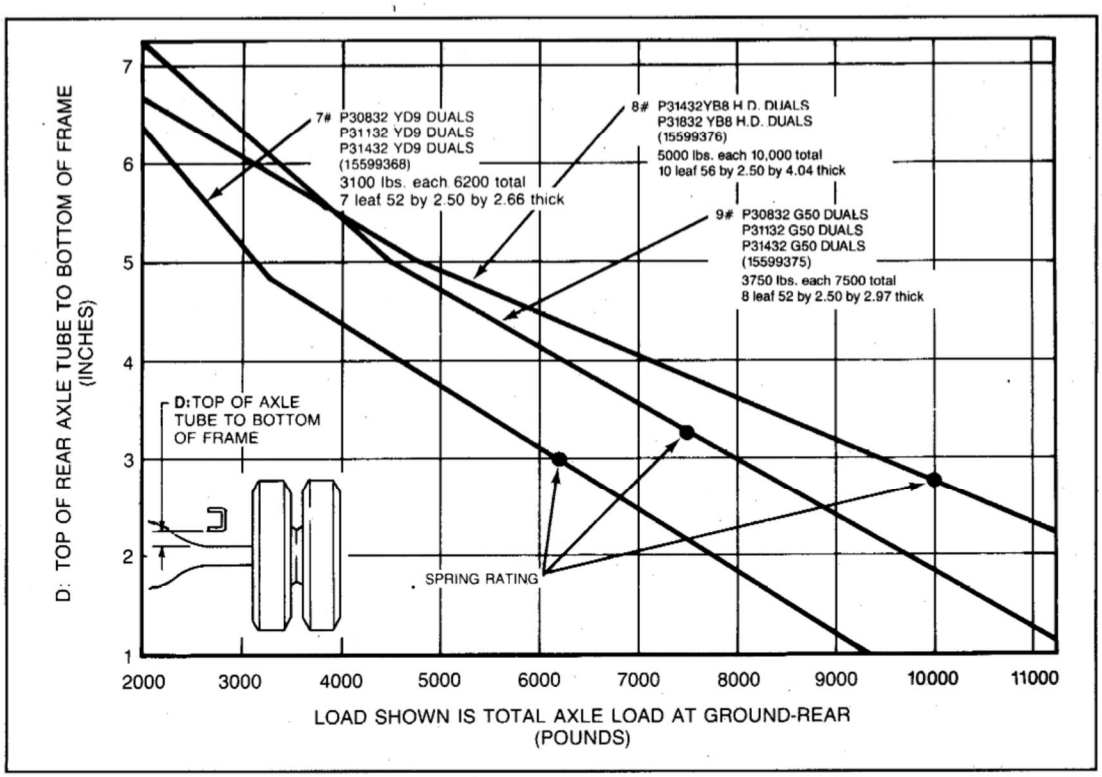


Figure A3-2-2 — Load Height Curve "D" Dimension — Motor Home

PROPELLER SHAFTS AND UNIVERSAL JOINTS

GENERAL DESCRIPTION

PROPELLER SHAFTS

The propeller shaft is a steel tube which is used to transmit power from the transmission output shaft to the differential. To accommodate various model, wheelbase and transmission combinations, drive shafts differ in length, diameter and the type of splined yoke. Each shaft is installed in the same manner. A universal joint and splined slip yoke are located at the transmission rear extension. The slip yoke permits fore and aft movement of the drive shaft as the differential assembly moves up and down. The spline is lubricated internally by transmission lubricant or grease. An oil seal at the transmission prevents leakage and protects the slip yoke from dust, dirt and other harmful materials. (See Figure 4-1.)

Since the drive shaft is a balanced unit, it should be kept completely free of undercoating and other foreign material which would upset shaft balance.

Both one-piece, two-piece and three-piece propeller shafts are used depending on the model.

On models that use a two-piece shaft, a three-piece or more shaft, the shaft is supported near its splined end in a rubber-cushioned ball bearing, commonly referred to as the center bearing, which is mounted in a bracket attached to a frame cross member. The center bearing is permanently lubricated and sealed.

UNIVERSAL JOINTS

The simple universal joint is basically two Y-shaped yokes connected by a cross member called a spider. The spider is shaped like an "X", and arms that extend from it are called trunnions. (See Figure 4-2.) The spider allows the two yoke shafts to operate at an angle to each other.

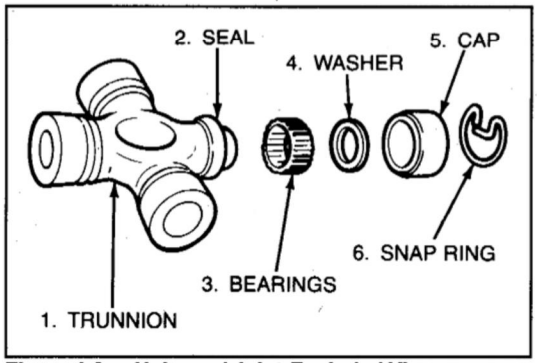


Figure 4-2 — Universal Joint-Exploded View

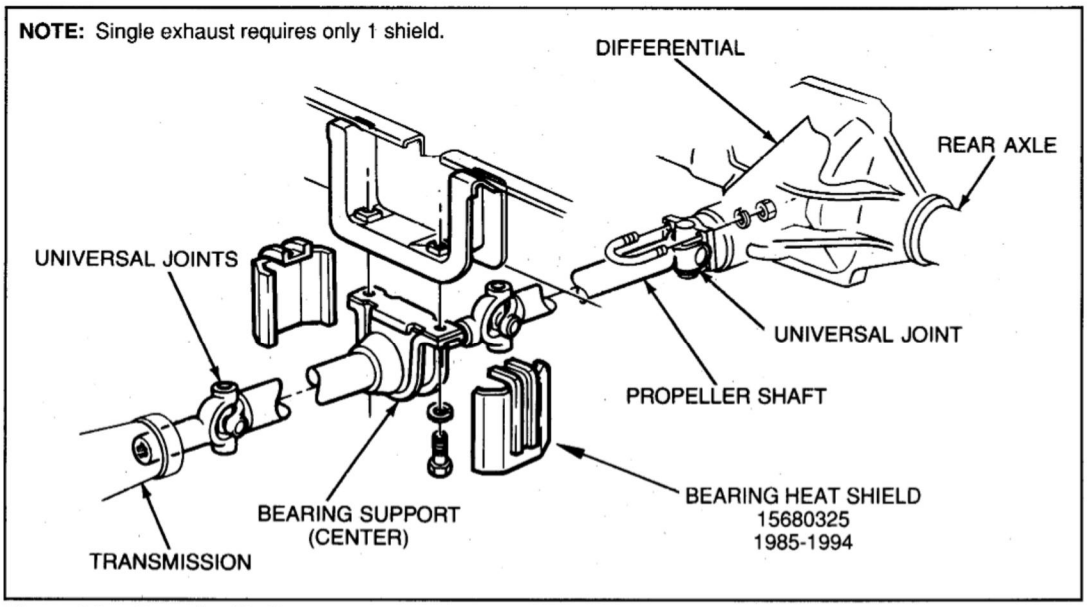


Figure 4-1 — Propeller Shaft

SECTION 4 — PROPELLER SHAFTS AND UNIVERSAL JOINTS

MAINTENANCE AND INSPECTION

Generally, the propeller shaft and universal joints require little maintenance. Periodic inspection is recommended, however, for proper propeller shaft balance and universal joint lubrication. If area around caps appears to be excessively dry, it may indicate a need for bearing relubrication or universal joint replacement. (See Figure 4-2.) A failing universal joint often squeaks on start-up or "klunks" with direction change.

If the center bearing is replaced, the bearing itself does not need to be packed with grease. However, chassis lubricant should be packed within the dust shields to form a dam to aid in preventing water and dirt from reaching the bearing. The dust shields are staked into position following the procedure detailed in the shop manual. (See Figure 4-3.) Typical U-joint and slip spline failures are shown in Figure 4-4.

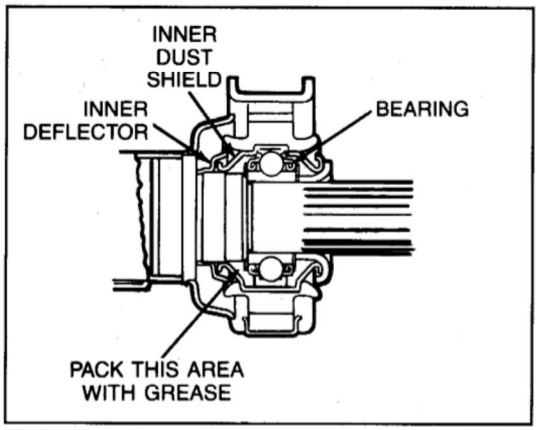


Figure 4-3 — Center Bearing

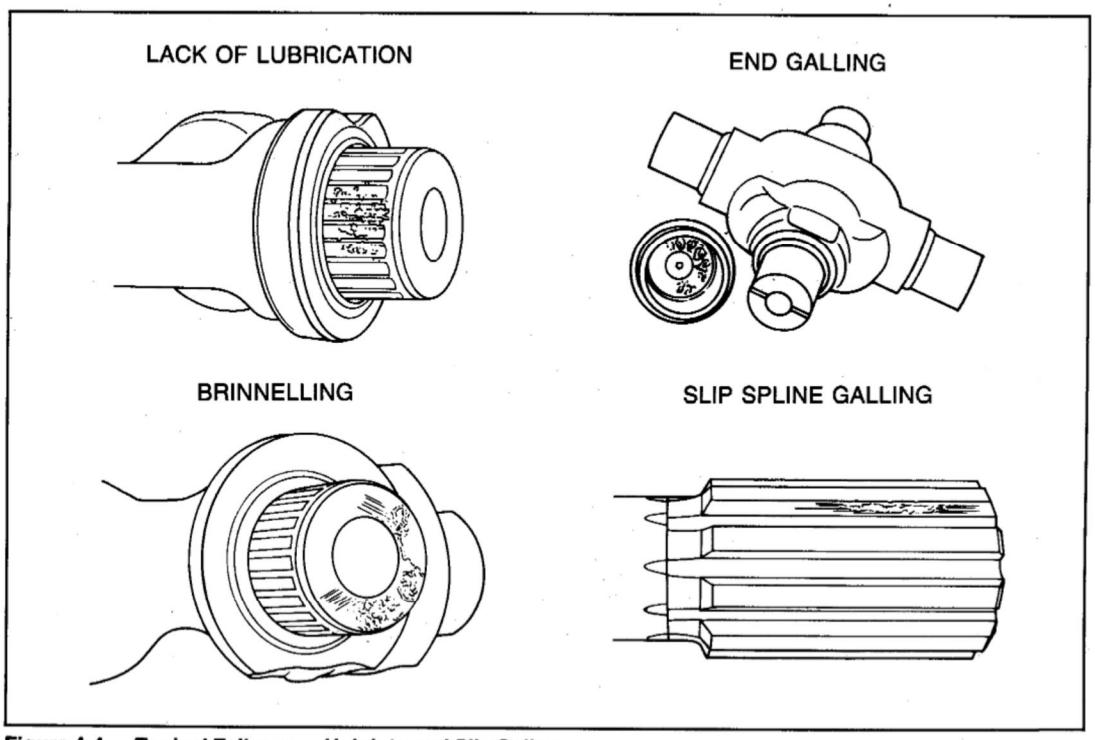


Figure 4-4 — Typical Failures — U-Joints and Slip Spline

DRIVELINE NOISE AND/OR VIBRATION CHECKS

The following information is presented as an aid to the motor home owner as diagnostic "thought-starters" and are listed as possible causes for driveline noise and/or vibrations. As applicable, references are made to those areas of this manual providing additional information.

CHECK IF:

- Drivelines are out of static and dynamic balance. See Driveline Balance Procedure section of this manual.
- Crosses in the universal joints are worn or damaged. See Figure 4-4 in this section of the manual.
- Center bearing is worn or loose. See Figure 4-3 in this section of the manual.
- Teeth on the ring and pinion gear of the driving axle are worn or pitted.
- Tires — wheels are out of balance.
- Spring U-bolts are loose.
- Parking brake drum is warped and/or out of balance. See Figure 6-5 of this manual.
- Difference in angular velocity of universal joints results from incorrect joint working angles. See Appendix 4-1 and Appendix 4-2 at the end of this section of the manual.
- Propeller shaft joints are out of phase on one or more splines. See Appendix 4-1/Figure A4-1-4 or Appendix 4-2/Figure A4-2-6 at the end of this section of the manual.
- Propeller shaft does not extend far enough into the slip joint. Propeller shaft should extend into the slip joint 2/3 to 3/4 of the spline length. This should not be less than 2-1/2 inches in length.
- Weld at the seam of the drive tube running the length of the drive tube is cracked or there is a cracked weld where the U-joint attaches to the propeller tube.
- U-joint has a missing needle bearing. This situation usually creates a "snapping" noise under load as the needles straighten under load. See Figure 4-2 in this section of the manual.
- Transmission rear support mount worn.
- Engine block motor mounts worn.

DRIVELINE BALANCE PROCEDURE

Each piece of a driveline propeller shaft is manufactured to be in "balance" by itself. However, there are times when assembly of two or more shafts together creates an undesirable running combination.

The following drive shaft balance procedure can be applied to a motor home and the procedure can be performed on the shop floor. **The wheels should be blocked and both axle shafts should be removed to prevent any possibility of spider gear spin-out during the balancing process.** The procedure requires the service technician to place four chalk marks (numbers 1 through 4) on the propeller shaft. (See Figure 4-5 and Figure 4-6.)

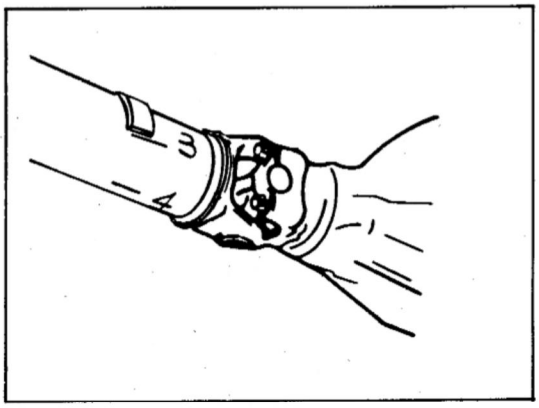


Figure 4-5 — Chalk Reference Marks on Propeller Shaft

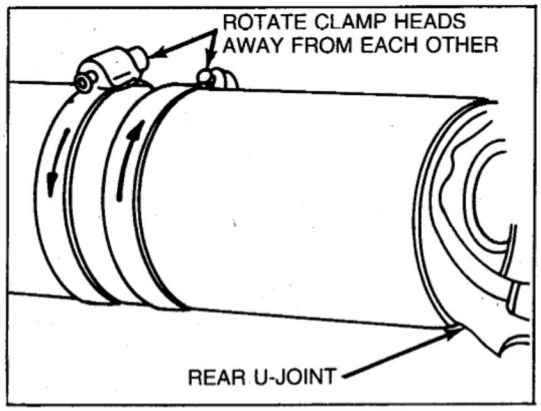


Figure 4-6 — Balance Hose Clamps in Position

Run the engine and drive shaft speed up to the point vibration is felt and note the speed showing on the speedometer. Also, note the "intensity" of the vibration. **STOP THE ENGINE AND DRIVE SHAFT.** Install a hose clamp and position the screw pointing toward one of the chalk reference marks. (See Figures 4-5 and 4-6.) Retest for vibration and note any gain or loss in vibration disturbance. A single hose clamp will *usually* increase or reduce the vehicle vibration by feel. The screw portion of the hose clamp is the weight being moved around the shaft.

A wheel balancer with a strobe light helps facilitate the balancing of the propeller shaft. The strobe light shows the amount of weight that is needed and the exact location where the weight is needed. However, human touch on a cross member, pinion nose, or transmission extension housing can be very helpful in combination with the strobe light.

1. Block the wheels and remove both axle shafts.

2. Mark and number the drive shaft at four points 90 degrees apart around each shaft just forward of the balance weights. (See Figure 4-5.)

3. Place the strobe light wheel balancer pick-up unit directly under the differential pinion nose as far as possible. (See Figure 4-7.) Repeat this step at each carrier bearing support (for two, three or more drive shaft units).

4. With the vehicle running in gear at the vehicle speed where the disturbance is at its peak, allow the driveline to stabilize by holding a constant speed. Point the strobe light at the spinning shaft and note the position of one of the numbers on the shaft.

CAUTION: NEVER RUN THE VEHICLE HIGHER THAN 60 MPH. ALL PERSONNEL MUST STAND CLEAR OF THE U-JOINT AND BALANCE WEIGHT AREA AS SERIOUS INJURY MAY RESULT.

5. Shut off the engine. Allow the shaft to stop, then manually turn the shaft until the chalk numbers are in the same position as shown by the strobe light.

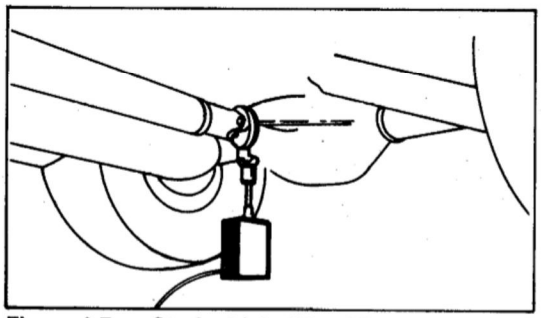


Figure 4-7 — Strobe Light Wheel Balancer Pick-up Unit

6. Install two hose clamps on the drive shaft as close to the rear of the drive shaft as possible, as shown in Figure 4-6. Position both screw clamp heads 180 degrees from the heavy point of the shaft as shown by the strobe light. (See Figure 4-8.) Tighten clamps.

NOTE: When the strobe light flashed, the heavy point of the shaft was down at the bottom 6 o'clock position. To balance the drive shaft, it is necessary to position both clamp heads 180 degrees from the heaviest point, or at the top of the shaft in the 12 o'clock position.

7. Run the vehicle through the speed range of the disturbance. If the problem is eliminated go to Step 9. If the disturbance is not gone and the strobe light shows the clamp heads at the bottom (6 o'clock position) of the shaft, go to Step 8.

   a. If the strobe light shows the two clamp heads at the top of the shaft, add one more hose clamp to the shaft and recheck. If the strobe light still shows the three clamp heads at the top (12 o'clock position) of the shaft, remove the shaft and reinstall it 180 degrees on the rear flange. Recheck the balance without any clamps. If the disturbance is gone, proceed to Step 9. If the disturbance is not gone, repeat the balance procedure beginning with Step 6.

   b. Generally if more than three hose clamps are needed, the shaft should be replaced unless the hose clamps are positioned opposite the welded-on factory weight. This position of the clamps would indicate that the factory weight position is counter productive in the original position. If the hose clamps are positioned opposite the factory weight, knock off the factory weight and rebalance the shaft beginning with Step 6.

   However, if the clamps are also 180 degrees from their original position after the shaft was rotated 180 degrees, the drive companion flange on the axle is out of balance and must be replaced.

8. Rotate two of the hose clamps equally away from each other toward the top (one each way from the original position as shown in Figure 4-8) in small amounts until you find the best possible balanced condition. In some cases, it may be necessary to use one clamp or possibly as many as three clamps to obtain a proper balance.

NOTE: It may be necessary to repeat these procedures at each cross member carrier bearing with the strobe pick-up contacting the nonmoving metal bearing retainer or against the cross member as close to the bearing as practical.

9. Install the axle shafts and road test the vehicle for final check of balance.

NOTE: Vibration felt in the vehicle in the repair stall may not be felt by the driver under road conditions.

10. After final check, drill a 1/8-inch hole through each clamp and drive shaft and install a pop rivet to prevent slip or tampering.

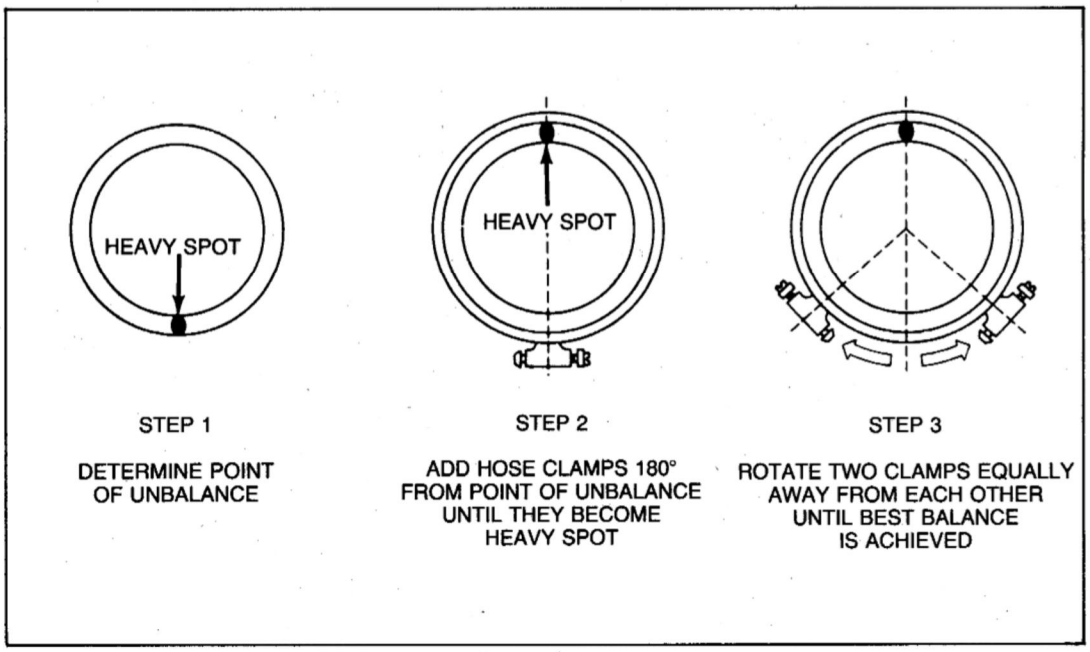


Figure 4-8 — Hose Clamp Positions to Balance Shaft

NOTE: Many years of engineering and testing are used to develop your motor home chassis for a smooth ride and handling.

Many units are modified by stretching or shortening of the wheelbase to match the style and/or length of the body by the coach builder.

This requires the frame and drive shafts to be cut and some length removed or added which is a long standing practice and does not create any problems **if** properly reengineered and assembled. However, many times, vibrations are created because the drive shafts and shaft hangers were not properly realigned or rebalanced before delivery. Other times, vibrations and/or damage are caused when different types of rear suspension and/or tag axles (non GM) are installed by either the coach company or later by the owner of the coach.

Alterations and/or such modifications noted above which create an owner concern or damage to the coach, are the responsibility of the company or the persons altering the chassis components after final assembly by General Motors.

DRIVELINE VIBRATIONS — ONE AND TWO DRIVE SHAFT SYSTEMS

The following information is directed to service personnel and is presented as an aid to the motor home owner in understanding driveline vibrations (as driveline vibration problems are often not recognized by the owner).

Driveline vibrations will generally be a high-speed vibration or a "buzz" at drive shaft speed compared to wheel and tire vibration that is a much slower speed. Standard factory units normally do not have problems unless the assembler in production has installed the incorrect length hanger bearing support or some part is off in design specification. The units most likely to have vibration problems are modified units where a wheelbase is changed, a drive shaft added or a change that has occurred when the suspension has been modified or changed (for example, a spring changed or after-market suspension installed replacing production springs).

On some units that have operated in a heavy-loaded condition, the last shaft and pinion nose will change enough to require a driveline and/or pinion nose change. The following information should be read by service personnel and understood as a guideline for alignment procedures.

NOTE: Motor homes produced with a wheelbase larger than 178 inches will have three drive shafts.

The following driveline rules are for one and two drive shaft systems.

Rule Number 1 — The working angles of each pair of U-joints must be within one-half degree of being equal on shafts that turn at 3,200 RPM or higher, or within one degree of being equal on shafts that turn at speeds below 3,200 RPM.

Rule Number 2 — (Involves a two drive shaft, three U-joint system.) With a three-joint system there is always an odd joint that cannot be paired with another joint. Since the U-joint between the transmission and the front shaft does not have a mate to cancel out its acceleration and deceleration, the front shaft should be within one-half degree of the transmission angle for high-speed shafts and within one degree for low-speed shafts. If the rear-end pinion angle is not equal to either the engine/transmission angle or front shaft angle, it should be at an angle between those two. There can be one-half degree difference between the center and rear U-joint working angles provided neither of the working angles exceeds 4 degrees on high-speed shafts, or 5 degrees on low-speed shafts.

The following is an actual driveline case study of an S-truck. The purpose of this example is to indicate that driveline problems are not restricted to large trucks.

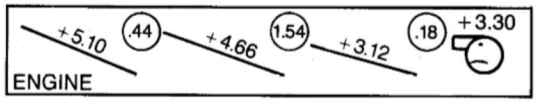


Figure A4-1-1 — Driveline Vibration — Case Study — Example No. 1

NOTE: The angles shown in Figure A4-1-1 were taken with a very accurate digital protractor and dramatically indicates an ability to work in extremely small figures.

In the example (Figure A4-1-1) note that the working angle between the engine and the first shaft of .44 degrees is well within the driveline rules. The first joint does not present any problems. With a .44-degree working angle and no mating joint, a vibration will never be felt. At the back two U- joints, the intent is to make a canceling pair within one-half degree working angle. As shown in the example, this is very poor; 1.54 degrees minus .18 degrees equals a 1.36-degree difference — clearly beyond the one-half degree rule.

However, examine what would happen if a one-degree caster wedge were installed to tip the pinion nose up to more closely follow the rule of setting the pinion to be "equal to the transmission angle or front-shaft angle or an angle between the two."

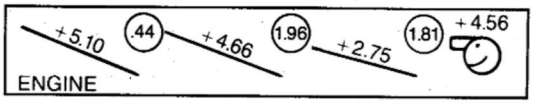


Figure A4-1-2 — Driveline Vibration — Case Study — Example No. 2

The example shows quite an improvement. Note that the two rear joints are canceling within the one-half degree rule. Another point learned in this case study concerns the use of the protractor. A one-degree shim was sent for, which was cast one degree but when installed turned out to be 1.26 degrees.

Another move that would seem to defy one of the driveline rules can sometimes be done on light-duty applications. This involves (through design considerations) keeping the pinion nose as low as possible to help reduce driveline tunnel size and the hump that is needed in the trunk floor for axle clearance.

DRIVELINE VIBRATIONS — ONE AND TWO DRIVE SHAFT SYSTEMS (Cont'd)

Note the result shown in the case study example (see Figure A4-1-3) of reversing the shim and tipping the pinion nose down by one plus degree.

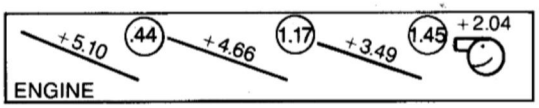


Figure A4-1-3 — Driveline Vibration — Case Study — Example No. 3

As a result, you end up with even smaller working angles but still within the one-half degree cancellation of Rule Number 1. This illustrates two very proper approaches to driveline correction (but still returning to the key point of joint working angles canceling in pairs and within one-half degree).

Before completing a discussion of two-shaft drivelines, consider the following: "Could the system be reversed and the one-half degree be placed at the pinion end?" The answer is a technical yes, but in reality, you are better off with the half degree at the engine end. With the solid-mount transmission and first shaft, you are generally better off to have your bigger working angles further from the passenger compartment at the pinion end. Noise and vibrations are further away and are somewhat absorbed in springs and suspension. Concerning this, consider what happens to the angles of the middle joint and at the pinion nose as the axle and the drive shaft move through loadings and ride travel. Chances are small of maintaining proper joint relationships. Stay with the one-half degree at the engine, and equal and canceling angles as a pair at the middle joint and pinion joint. Also, remember with a two-shaft system, that the drivelines must be in proper phase at the slip yoke. If off one spline, a vibration complaint will result. The illustrations of Figure A4-1-4 show proper phasing and maximum drive shaft runout.

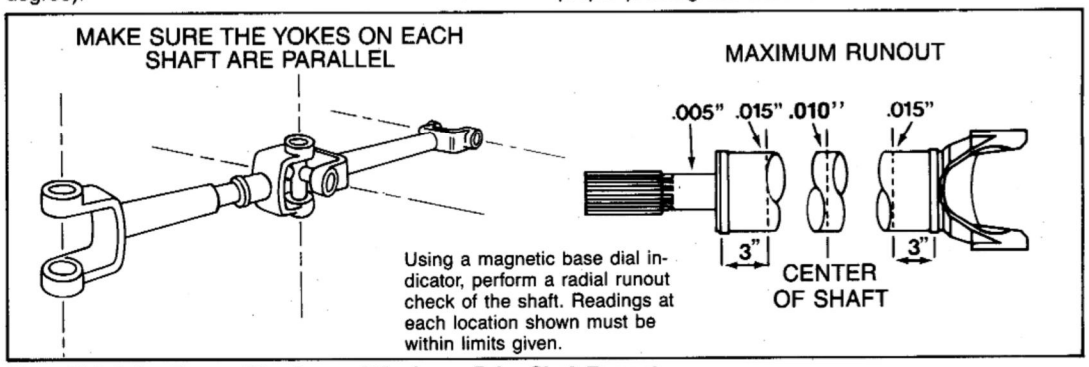


Figure A4-1-4 — Proper Phasing and Maximum Drive Shaft Runout

The following examples demonstrate acceptable driveline combinations and are presented as an aid in reemphasizing the simple single drive shaft two-joint system. Note the one common factor among the various combinations — the joint working angles are equal as a pair and qualify under Rule Number 1.

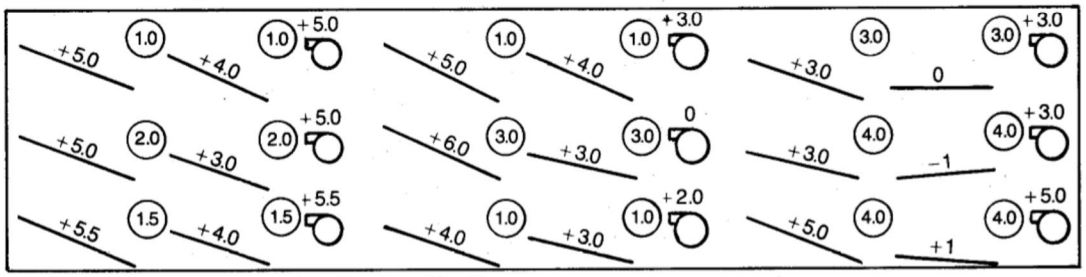


Figure A4-1-5 — Acceptable Driveline Combinations

DRIVELINE VIBRATIONS — THREE-SHAFT DRIVELINES

The following information is addressed to service personnel and is presented as an aid to the motor home owner in understanding the three-shaft drivelines typical of RV vehicles and farm trucks. Three-shaft drivelines are perhaps the simplest and most interesting of all drivelines because of the many and varied combinations possible.

The following are several basic rules:

Rule Number 1 — The working angle of each pair of U-joints must be within one-half degree of being equal on shafts that turn at 3,200 RPM or higher, or within one degree of being equal on shafts that turn at speeds below 3,200 RPM. No working angle shall exceed four degrees on high-speed shafts, or five degrees on low-speed shafts. (This is essentially the same rule as found in single and two drive shaft systems.)

Rule Number 2 — (The concept of the broken back angle.) The first shaft angle plus the third shaft angle is divided by two and equals the second shaft angle. For example: A first shaft of zero degrees plus the third shaft of 90 degrees equals 90 degrees divided by two equals 45 degrees as the proper setting for the second or middle shaft.

Rule Number 3 — When computing working angles, two components that are tilted in the same direction are subtracted from each other. When connecting components are not in the same direction, such as a positive and a negative angle, the angles are added to determine the working angle.

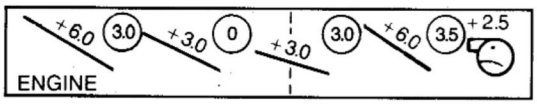


Figure A4-2-1 — Driveline Vibrations — Truck Case Study — Example No. 1

Examine the truck case study shown in Figure A4-2-1. To better understand the truck case study, draw a line vertically down through the middle drive shaft. You will find that you are really working with two trucks with single drive shafts. As you apply Rule Number 1, you will notice that there is not a problem with the rear pair of joints, but the front half of the truck, with three degrees of working angle and zero degrees for its mating joint, presents a problem.

With single-shaft drivelines, one method to employ would be to align the shafts so the shafts operate in parallel planes, but at different levels. (See Figure A4-2-2.) For example: Lower the second shaft to six degrees, and by installing a caster wedge, tip the pinion nose up slightly to six degrees.

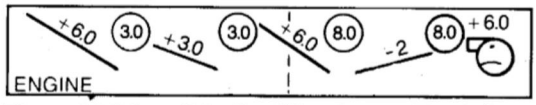


Figure A4-2-2 — Driveline Vibrations — Truck Case Study — Example No. 2

The above example shows equal canceling angles. However, the back pair exceed the four-degree maximum working angle of Rule Number 1. Note the last shaft is negative (uphill to the pinion). Negative shafts are added to positive shafts.

The following chart shows the relationship of shaft speed to maximum allowable working angle.

RPM	Max working angle	RPM	Max working angle
5000	3° 15″	3000	5° 5″
4500	3° 40″	2500	7° 0″
4000	4° 15″	2000	8° 40″
3500	5° 0″	1500	11° 30″

Figure A4-2-3 — Shaft Speed To Maximum Working Angle

In the above truck case study, the requirement was to raise the driveline system to eliminate the negative last shaft running uphill to the pinion. This situation created working angles that were too large. In this case study example, the broken back angle becomes an advantage and drastically reduces work in the process. (The original example shown in Figure A4-2-1 had the pinion nose at two and one-half degrees and the center shaft at three degrees.)

Using Rule Number 2, the following presents a case study example of a broken back angle out of the front of the truck. With the engine as the first shaft, and the middle drive shaft considered as the third shaft, determine the shaft setting for the second shaft. Use two and one-half degrees for the third shaft.

DRIVELINE VIBRATIONS — THREE-SHAFT DRIVELINES (Cont'd)

6	degrees as the first shaft
2 1/2	degrees as the third shaft
8 1/2	degrees divided by two equals 4 1/4 degrees second shaft

Figure A4-2-4 — Driveline Vibrations — Truck Case Study — Example No. 3

The following shows a broken back angle installed in the front half of the truck case study example.

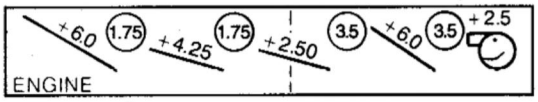


Figure A4-2-5 — Driveline Vibrations — Truck Case Study — Example No. 4

Note that by picking the middle shaft to be the same as the pinion, you have corrected the rear of the truck to near ideal cancellation, as well as correcting the front of the truck. Changing hanging bearing length is generally a cut-and-weld as an overlap to shorten a hanger, or fabricating a spacer block. (You must locally obtain longer bolts to make a longer hanger.) Almost everything that applies to single-shaft systems applies to three-shaft trucks. Even the broken back angle can occasionally be used in some specialized single-shaft trucks, such as airport luggage toters where the rear axle is moved forward almost under the driver's seat. With a very short drive shaft, parallel alignment would make working angles too large. In the toter, the pinion becomes the third shaft and the engine is the first shaft. The manufacturer may install a broken back to obtain equal working angles at the transmission and the pinion, and reduce working angles in the process.

It is also important, as in the two drive shaft truck, to have the last drive shaft properly phased on the slip spline. Make certain the fixed yoke and the splined yoke are in the same plane. If they are off even one spline, a vibration complaint may result. The illustrations below (see Figure A4-2-6) show proper phasing and maximum drive shaft runout.

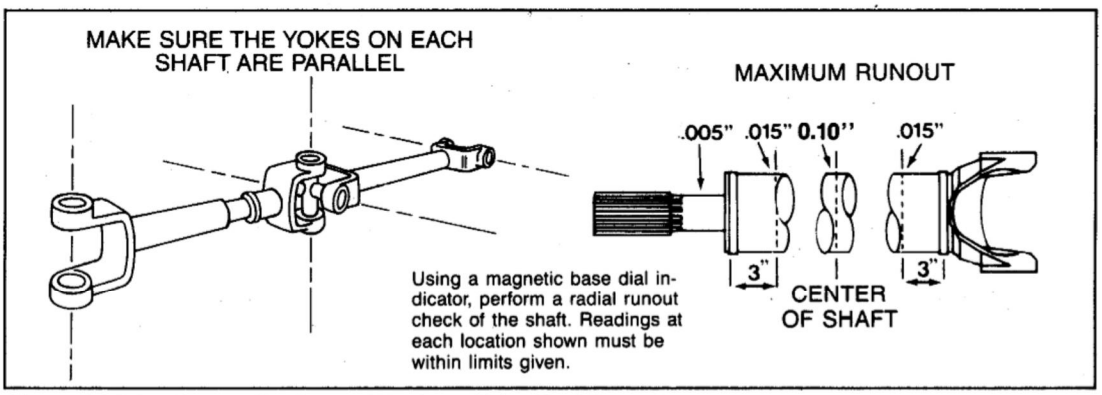


Figure A4-2-6 — Proper Phasing and Maximum Drive Shaft Runout

REAR AXLE

GENERAL DESCRIPTION

The rear axle assembly consists of the drive pinion, ring gear, differential and axle shafts in one housing. The drive pinion transfers power input from the propeller shaft to the ring gear which drives the axle shafts and rear wheels. The ring gear is a reduction gear which lowers the speed (RPM) of the propeller shaft to a speed which is usable for driving the rear wheels.

MAINTENANCE AND INSPECTION

DIFFERENTIAL FLUID

The differential requires little maintenance; however, periodic fluid level checks are recommended to ensure smooth operation. In addition, the fluid should be changed in accordance with the time and mileage intervals listed in the Maintenance Schedule for the vehicle.

To check differential fluid level, remove the plug, as shown in Figure 5-1. If the fluid level is sufficient, fluid will seep out of the opening. If it doesn't, add the necessary amount. Replace the plug, making sure it is properly seated.

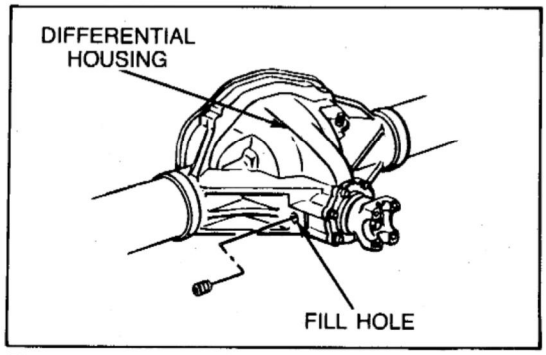


Figure 5-1 — Rear Axle Lubricant Fill Hole

Normal operating temperature of rear axles and manual gear-shifting transmissions is about 100 degrees above ambient temperature. Both units are cooled by lube oil. The lube oil carries heat from the friction points to the case where the heat is dissipated into the air flowing past the case. The following are typical examples of overheat possibilities. Overheating can be caused by the:

- Housing severely coated with dirt or dried mud which acts as an insulator holding heat in the housing.
- Differential operated with low lubricant levels due to leaks.
- Incorrect or mixed lubricant brands which foam and reduce heat transfer.
- Engine exhaust positioned too close to the transmission or a pipe leak directing heat on the differential.
- Break-in lubricant not drained quickly enough after being subjected to high break-in temperatures thereby destroying the lubrication additives.
- OVERLOADS — Overloads tend to reduce road speeds and cause the vehicle to be operated in lower gears for extended periods of time. This increases heat in the engine, transmission, drive-line universal joints and rear axles.

  HIGH SPEED OPERATIONS — Very high speeds tend to churn the lubricants to the point that aeration occurs. Lube oil filled with air bubbles cannot carry the heat away from its point of origin to the housings where it can be dissipated into the air stream.
- Extended period of time between lube oil changes. The additives contained in lube oils do wear out on a slow and gradual basis. As the additives wear out, the viscosity may change and the lubricating qualities are depleted. Additionally, the metals content (that occurs under normal wear) increases in the gear oil. As this process continues, temperatures and friction increase within the component until a failure occurs.

NOTE: Many large fleet operators have the lubricants that are drained from their vehicles analyzed to determine if the change frequency can be increased or must be decreased. For the individual owner the results of this lubricant analysis may not justify the expense. The individual owner may find that the best method to follow is to drain the fluid every fourth oil change and refill, to check the fluid level and add fluid as needed at every oil change, and in dusty areas or trailer towing applications, to drain the fluid at every oil change and refill. A large loss of fluid in this system may indicate a problem. Have the system inspected and repaired at once to avoid further damage.

WHEEL BEARING ADJUSTMENT (TAPERED BEARING)

Before checking bearing adjustment, make sure the brakes are fully released and do not drag.

NOTE: With any floating axle, wheel bearing lubrication is normally supplied by the gear oil in the axle. Anytime the wheel bearings are replaced or removed for inspection, it is a good practice to pack the bearings with high temperature wheel bearing grease (GM Part No. 1051344). The grease packing assures ample initial lubrication. As the rear axle gear oil works its way to the wheel bearings, the grease packing dissolves and is washed away with the gear oil.

MODEL	SOURCE	TYPE/CAPACITY	RING GEAR SIZE (In.)
P30	Chevrolet Dana Chevrolet-Saginaw	Dana 70 #10,000 Dana 80 #10,500 Saginaw #10,000	10-1/2 11.3 10-1/2
P30 (With H22/H23)	Rockwell	Banjo/11,000#	12
G30	Chevrolet	Salisbury/5700#	10-1/2
G30 (Dual Wheel)	Dana	Salisbury/6200#	9-3/4
G30 (Dual Wheel)	Dana	Salisbury/7500#	10-1/2

REAR WHEEL BEARING ADJUSTMENT SPECIFICATION

RING GEAR SIZE (In.)	BEARING ADJUSTING NUT TORQUE (Ft. Lbs.)*	ADJUSTING NUT BACK-OFF*	OUTER LOCKNUT TORQUE (Ft. Lbs.)	RESULTING BEARING ADJUSTMENT (In.)	TYPE OF BEARING
10-1/2 & 11	50	**	65	.001 TO .010 END PLAY	TAPERED ROLLER
9-3/4	50	**	65		
12	90	1/8*	250	SLIGHT PRELOADED	BARREL ROLLER

**Back off nut and retighten to 35 Ft. Lbs. then, back off 1/4 turn. *With wheel rotating.

Figure 5-2 — Wheel Bearing Adjustment Specifications

Check bearing play by grasping the tire at the top and pulling back and forth, or by using a pry bar under the tire. If bearings are properly adjusted, movement of the brake drum in relation to the brake flange plate will be barely noticeable and the wheel will turn freely. If movement is excessive, adjust the bearing as follows:

1. Remove the axle shaft and raise vehicle until the wheel is free to rotate.
2. Keyways and threads on the tube and nut must be clean and free from chips, burrs and shavings.
3. Disengage tang of the retainer and remove retainer from the axle housing tube.
4. Torque the adjusting nut to 50 ft. lbs., while at the same time rotating the hub assembly and making sure the bearing cones are seated and in contact with the spindle shoulder.

Proper wheel bearing adjustment can be made using a spanner wrench (GM Tool J-2222-L or equivalent).

5. Back off nut until loose. Refer to Figure 5-2 for specifications.
6. If adjusting nut slot is in alignment with keyway in the axle spindle, insert the square key into slot. If the adjusting nut slot is not aligned, back off nut a slight amount and insert the square key into the slot. Do not back off more than one slot to align the key.
7. Assemble the snap ring at the end of the spindle to retain the key in position.

WHEEL BEARING ADJUSTMENT (BARREL-TYPE BEARING)

Before checking bearing adjustment, make sure brakes are fully released and do not drag.

NOTE: With any floating axle, wheel bearing lubrication is normally supplied by the gear oil in the axle. Anytime the wheel bearings are replaced or removed for inspection, it is a good practice to pack the bearings with high temperature wheel bearing grease (GM Part No. 1051344). The grease packing assures ample initial lubrication. As the rear axle gear oil works its way to the wheel bearings, the grease packing dissolves and is washed away with the gear oil.

Check bearing play by grasping tire at top and pulling back and forth, or by using a pry bar under tire. If bearings are properly adjusted, (installed with slight preload), there will be **no** movement of the brake rotor and the wheel will turn freely. If there is movement, adjust bearings by using the following procedure:

1. Remove axle shaft and raise vehicle until wheel is free to rotate.

2. Disengage tang of retainer from locknut and remove both locknut and retainer from axle housing tube, with GM Tool J-25510 or equivalent.

3. Tighten inner adjusting nut (using GM Tool J-25510 or equivalent) to 90 ft. lbs. torque while rotating wheel hub at the same time to make sure all bearing surfaces are in contact. Then back off inner nut 1/8 turn while rotating wheel. The wheel should turn freely.

4. Install tanged retainer against the inner adjusting nut. Align inner adjusting nut so short tang of retainer will engage nearest slot on inner adjusting nut.

5. Install outer locknut and tighten to correct specified torque (250 ft. lbs.). Then bend long tang of retainer into slot of outer nut.

AXLE HOUSING

A gear set operated at its capacity rating will give 100 percent of rated life. Taking the same gear set and reducing the work load will give a very large gain in life. Overloading by even very small percentages causes a very serious loss in life. Overloading also tells a major story on increased tire wear, wheel bearing and axle housing failures.

The graph shown in Figure 5-3 (provided by Eaton Axle Division) indicates the approximate percentage of life expectancy of axle gear sets and other axle parts. The figures are based upon dynamometer tests (conducted by Eaton Axle Division) and are the direct result of accurately simulated load conditions.

NOTE: A gear set operated at its capacity rating will give 100 percent of rated life.

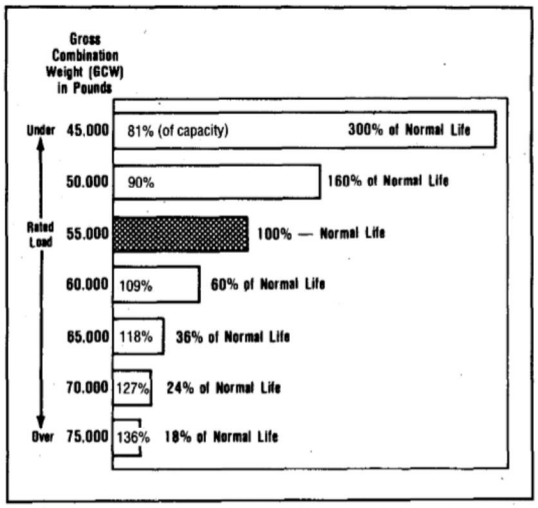
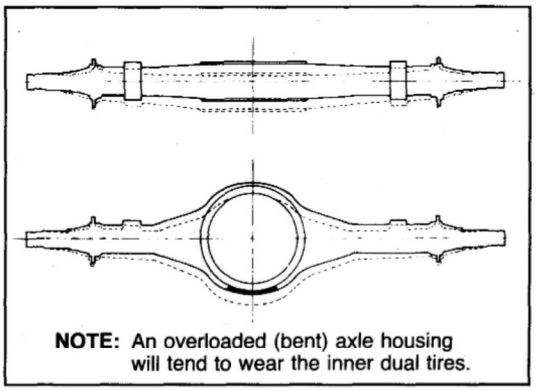


Figure 5-3 — Average Life of Overloaded and Underloaded Gears

BENT AXLE HOUSING

Overloads destroy axle housings and flexed housings tend to excessively load inner dual tire. Overloaded wheel bearings fail earlier than normal. Check for any grease lube leaks at the bottom of the axle housing. A split gasket (shown as the shaded area in Figure 5-4) almost always indicates an overload, or flex and housing distortion, which destroys the gasket between the carrier and the housing.



NOTE: An overloaded (bent) axle housing will tend to wear the inner dual tires.

Figure 5-4 — Bent Axle Housing

BRAKES

GENERAL DESCRIPTION

There are two brake systems on the motor home, the service brakes and the parking brakes.

The service brakes use hydraulic pressure from a foot-pedal-operated master cylinder to actuate cylinders which apply the brakes at each wheel. Fluid lines and hoses connect the master cylinder with each of the wheel cylinders. When the brake pedal is depressed, force is transferred through the pushrod to the master cylinder primary piston, which moves forward. Under normal conditions, the combination of hydraulic pressure and the force of the primary piston spring moves the secondary piston forward at the same time. When the pistons have moved forward, hydraulic pressure is built up and transmitted through the brake hydraulic lines to the front and rear brake assemblies. Hydraulic pressure behind the wheel cylinder cups forces the pistons outward, causing the brakes to be applied. Braking action occurs as a result of friction between the brake lining material and the metal surface of the rotor disc or the drum.

As brake pedal force is reduced, brake fluid pressure in the master cylinder is also reduced. This allows the drum brake retractor springs to retract the shoe and lining assemblies from contact with the drum which forces brake fluid out of the wheel cylinder assemblies and back into the master cylinder assembly. The reduction in fluid pressure also allows the disc brake caliper pistons to retract slightly by action of the piston seal. (See Figure 6-1.)

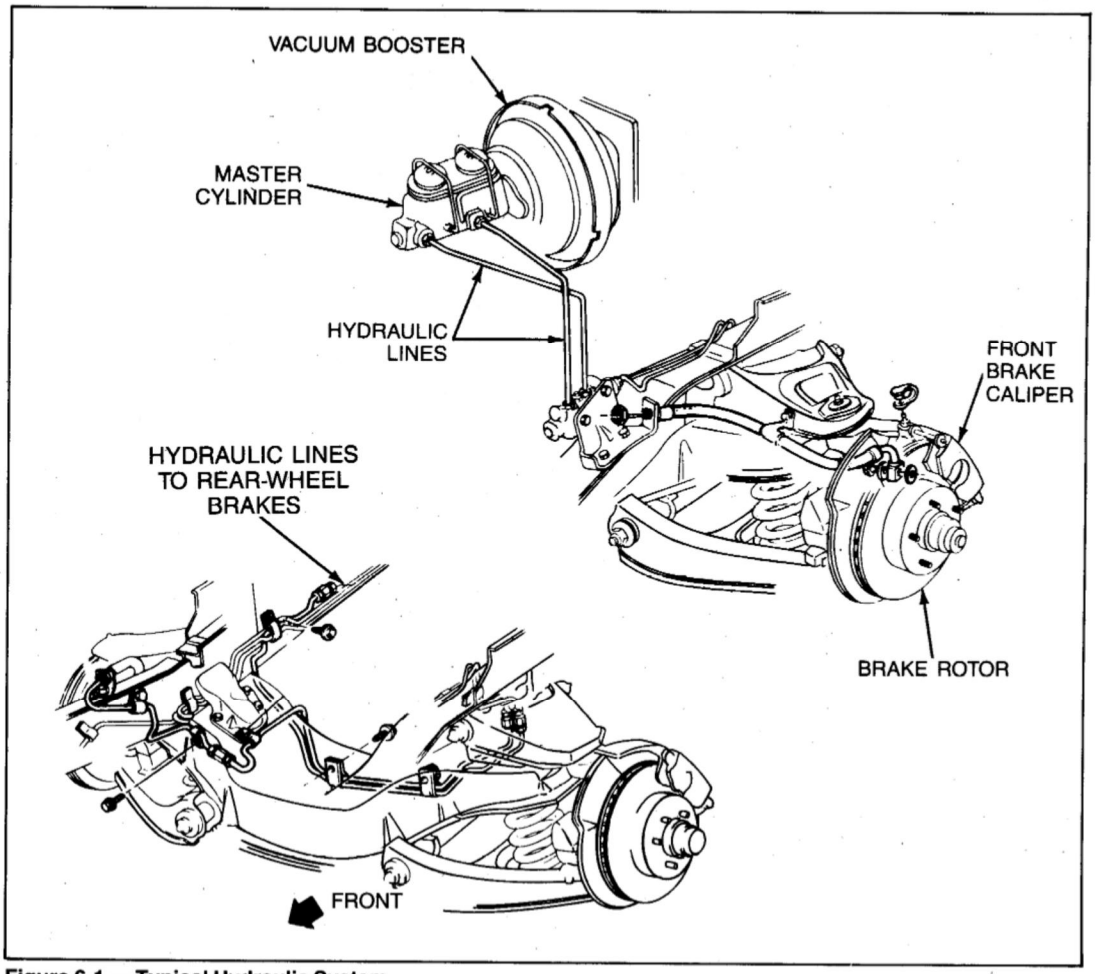


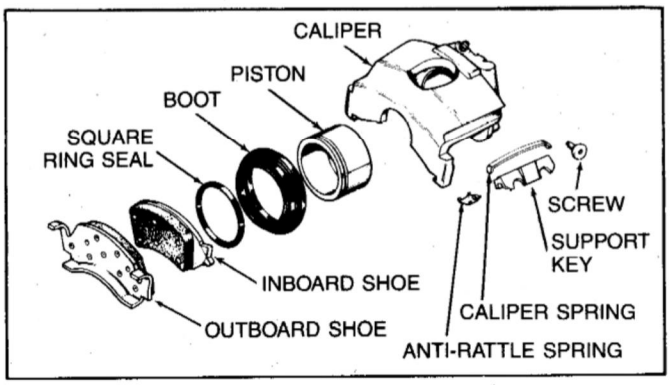
Figure 6-1 — Typical Hydraulic System

DISC BRAKES

Upon application of the brakes, fluid pressure applied to the piston(s) is transmitted to the inner shoe and lining, forcing the lining against the inner rotor surface. The pressure applied to the bottom of the piston bore(s) forces the caliper to slide or move on the mounting bolts toward the inner side, or toward the vehicle. Since the caliper is one piece, this movement toward the vehicle causes the outer section of the caliper to apply pressure against the back of the outer shoe and lining assembly, forcing the lining against the outer rotor surface. As line pressure builds up, the shoe and lining assemblies are pressed against the rotor surfaces with increased force, bringing the vehicle to a stop. (See Figure 6-2.)

Lining wear is automatically compensated for by the outward movement of the caliper and piston. Brake fluid fills this void as lining wears.

NOTE: OVERSIZE SUPPORT KEYS ARE AVAILABLE. REFER TO GM BULLETIN NO. 79-T-25 DATED JANUARY, 1980 (APPENDIX 6-1 AT THE BACK OF THIS SECTION)



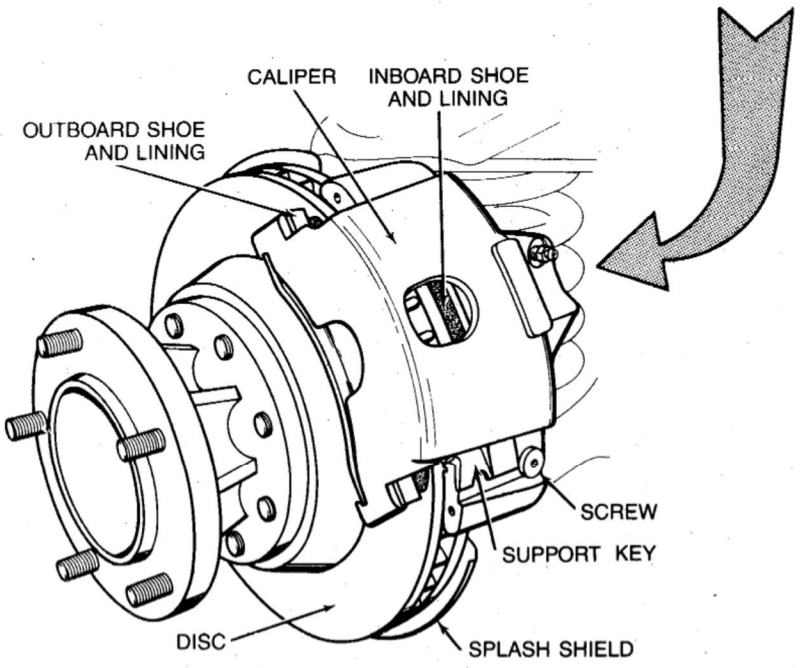


Figure 6-2 — Disc Brake

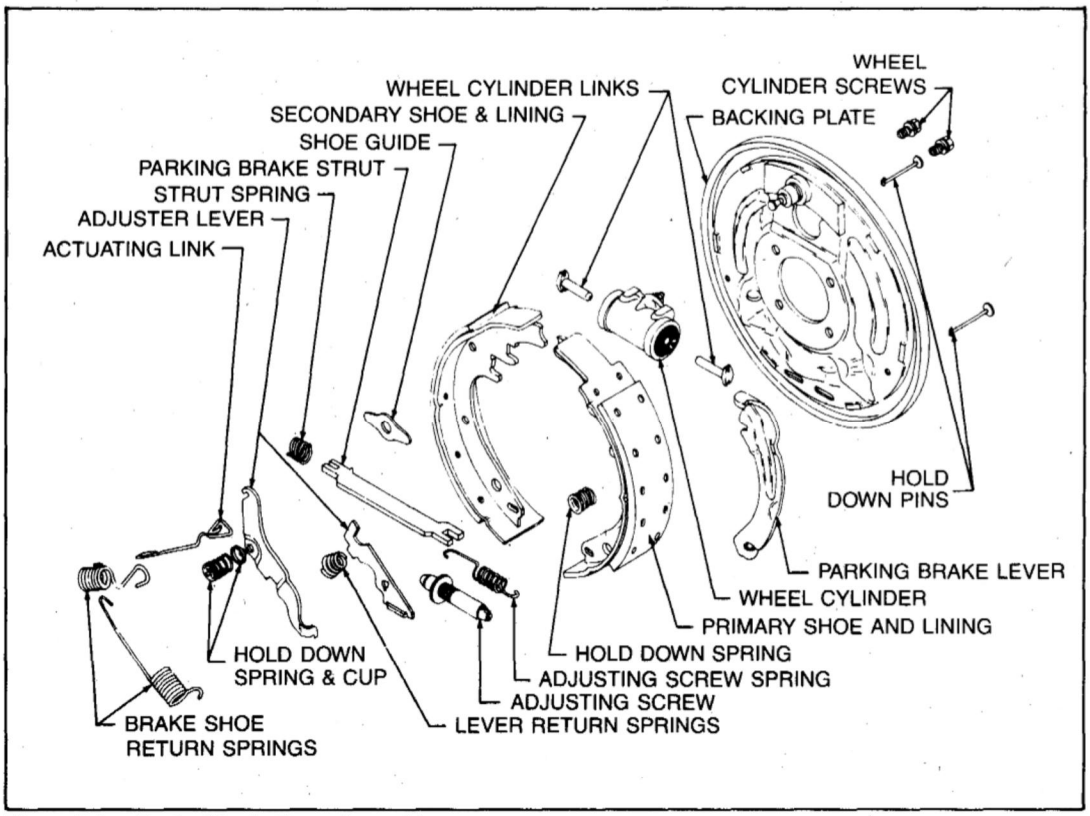


Figure 6-3 — Typical Brake Drum Assembly

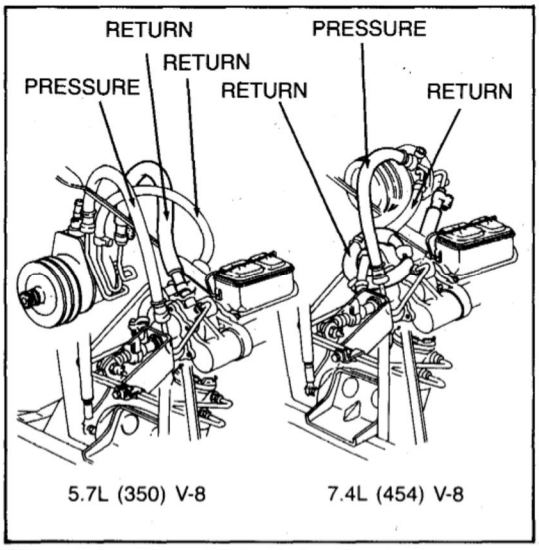


Figure 6-4 — Power Brake Hydro-Boost

DRUM BRAKES

When the brake pedal is depressed, fluid is forced through the brake lines into the piston. The wheel cylinder links are then forced out against the brake shoes which exert braking action on the drum. When the pedal is released, the return springs pull the shoes away from the drum. (See Figure 6-3.)

POWER UNITS

Additional braking power is supplied through either a vacuum booster or a Hydro-Boost. The master cylinder is mounted on the forward end of the vacuum booster or Hydro-Boost. (See Figure 6-4.)

The Hydro-Boost utilizes hydraulic pressure supplied from the power steering pump. A spring accumulator is also included in the booster to provide reserve braking power in case pressure from the power steering pump is unavailable. At normal curb idle with 150 lbs. of pedal pressure, the Hydro-Boost could be expected to produce 1,600-1,850 lbs. of line pressure measured at any wheel cylinder bleeder port. Similar pressures could be expected of most vacuum boosters with good engine vacuum.

Customers have expressed concern with their ability to push the brake pedal to the floor with the vehicle stationary and the engine running. If the Hydro-Boost brake pedal is forced to the floor, as can be done, and the motion stopping function and effectiveness of the brake system is still considered normal, then the pedal travel action of the Hydro-Boost brake system is also considered to be normal. (See Pedal Travel Check in this section of the manual.)

PARKING BRAKE(S)

Both the G-Series and P-Series are equipped with a parking brake system. This system is mechanically operated by a lever and strut or a pedal which will activate the rear brakes only or the propshaft drum brake unit (P-Series motor homes with a GVWR of 14,000 lbs. or more). Very little maintenance is required, but some periodic adjustment is necessary. (See Figure 6-5.)

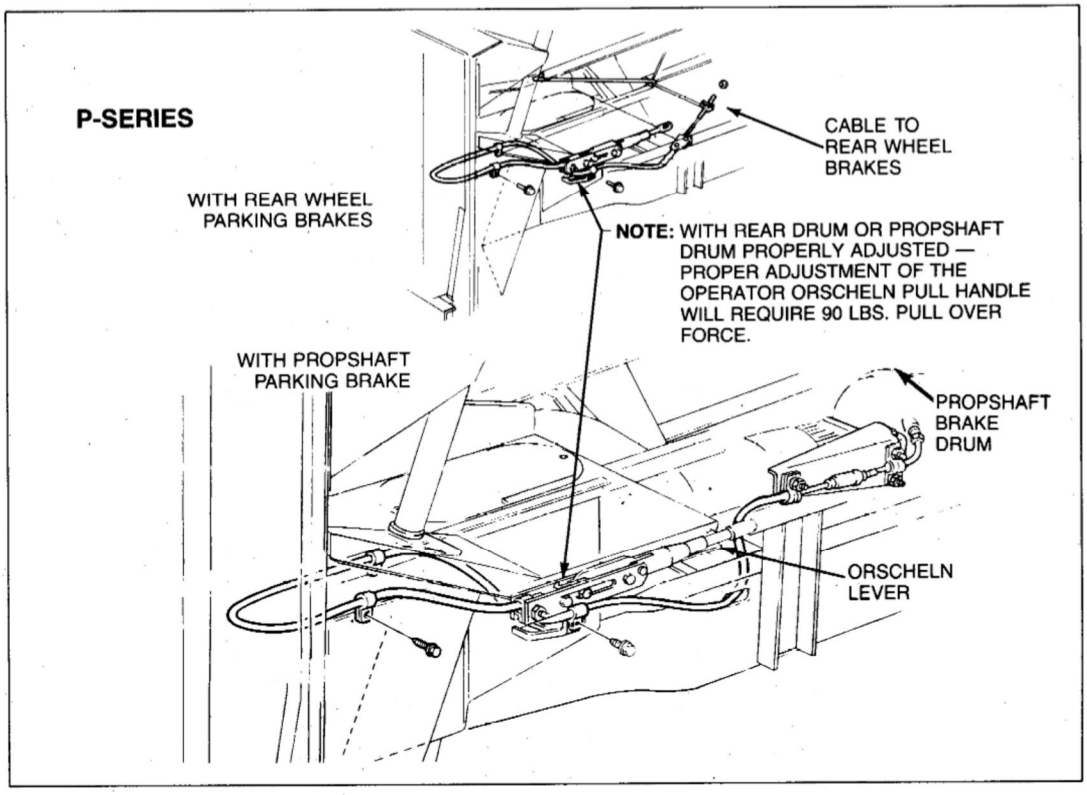


Figure 6-5 — Parking Brake System

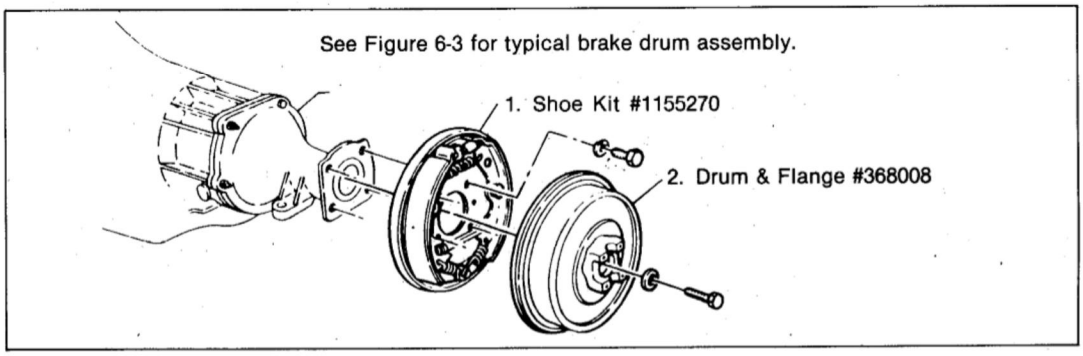


Figure 6-6

MAINTENANCE AND INSPECTION

FILLING THE MASTER CYLINDER

The master cylinder must be kept properly filled to ensure adequate reserve and to prevent air from entering the hydraulic system. However, because of expansion due to heat absorbed from the brakes and from the engine, the master cylinder must not be overfilled.

The master cylinder is located under the floor on the driver's side of the engine (P-Series), or on the cowl (G-Series). The position of the master cylinder on the P-Series may require the use of a flashlight and mirror to check the fluid level.

Thoroughly clean the reservoir cover before removal to avoid getting dirt into the reservoir. Remove the cover and diaphragm. Add fluid as required to bring the level to 1/4 inch (plus or minus 1/8 inch) from the lowest portion of the top of each reservoir. Use Delco Supreme No. II Hydraulic Brake Fluid (DOT No. 3) or equivalent.

Do not use shock absorber fluid or any other fluid which contains mineral oil. Do not use a container which has been used for mineral oil or a container which is wet from water. Mineral oil will cause swelling and distortion of rubber parts in the hydraulic brake system and water will mix with brake fluid, lowering the fluid boiling point. Keep all fluid containers capped to prevent water contamination.

CAUTION: CHECK FOR LEAKS IF A LARGE AMOUNT OF FLUID IS REQUIRED.

PEDAL TRAVEL CHECK

At periodic intervals, the motor home owner should inspect the vehicle brake system for "pedal travel." Brake pedal travel is the distance the brake pedal moves toward the floor from the fully released position (foot not applied to the brake). Brake pedal inspection should be made with the brakes "cold." With the engine turned off, depress the brake pedal a minimum of four (4) times to exhaust all vacuum and/or accumulator pressure. Applying approximately 90 pounds of pedal pressure, the distance the brake pedal should travel is as follows:

G-Series with power brakes..... 3.5 inches
P-Series with drum rear brakes..... 3.5 inches
P-Series with disc rear brakes (JF9) ..... 6.0 inches

BRAKE HOSE INSPECTION

The flexible hydraulic brake hose which transmits hydraulic pressure from the steel brake pipe on the frame to the rear axle and to the calipers should be inspected regularly in accordance with the vehicle Maintenance Schedule. The brake hose assembly should be checked for road hazard damage, for cracks and chafing of the outer cover, and for leaks and blisters. A light and mirror may be needed for an adequate inspection. If any of the above conditions are observed on the brake hose, it will be necessary to replace it.

LINING INSPECTION

Inspect the brake linings per the vehicle Maintenance Schedule and anytime the wheels are removed (tire rotation, etc.). Check both ends of the outer shoe by looking at each end of the caliper. Check the lining thickness on the inner shoe by looking down through the inspection hole in the top of the caliper housing. Whenever the lining is worn to the approximate thickness of the shoe, the shoe and lining should be removed. After removal, measure the lining thickness. The shoe and lining should be replaced anytime the lining is worn to within 1/32 inch of a rivet or of the shoe at any point, or when wear indicator contacts the rotor. Always replace linings in sets (both right and left front).

Some front disc brakes have a wear indicator that makes a noise when the linings wear to a degree where replacement is required. (See Figure 6-6.) The spring clip is an integral part of the inboard shoe and lining. When the lining is worn, the clip contacts the rotor and produces a warning noise.

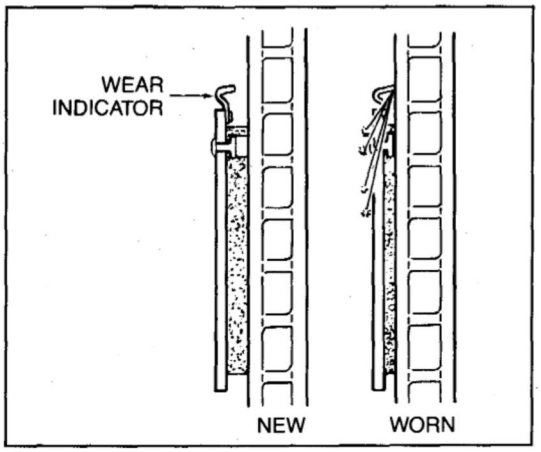


Figure 6-7 — Disc Brake Wear Indicators

Check the flatness of the brake pads. Place inboard and outboard pad surfaces together and check for a gap between the pad surfaces. If more than a .005-inch gap is measured at the middle of the pad (midway between attaching lugs), the pad must not be used. This applies to new or used brake pads. Whenever the front disc brakes are relined, the rear brakes should also be checked.

BRAKE DRUM INSPECTION

Whenever brake drums are removed, they should be thoroughly cleaned and inspected for cracks, scores, deep grooves and out-of-round condition.

A cracked drum is unsafe for further service and must be replaced. Do not attempt to weld a cracked drum.

Smooth up any slight scores. Heavy or extensive scoring will cause excessive brake lining wear, and it will probably be necessary to turn the drum on a lathe in order to true up the braking surface.

If the brake linings are slightly worn and the drum is grooved, the drum should be polished with fine emery cloth but should not be turned. At this stage, eliminating the groove in the drum would necessitate removal of too much metal, while if left alone, the grooves and lining ridges match and satisfactory service can be obtained.

If brake linings are to be replaced, a grooved drum should be turned for use with new linings. A grooved drum, if used with new lining, will not only wear the lining, but will make it difficult, if not impossible, to obtain efficient brake performance.

An out-of-round drum makes accurate brake shoe adjustment impossible and is likely to cause excessive wear of other parts of brake mechanism due to its eccentric action. An out-of-round drum can also cause severe and irregular tire tread wear as well as a pulsating brake pedal. When the braking surface of a brake drum exceeds the factory specification limits in taper and/or being out of round, the drum should be turned to true up the braking surface.

BRAKE ROTOR INSPECTION

To prevent brake roughness, the rubbing surfaces of the rotor must be flat, parallel and with lateral runout held to a minimum. The surface finish should be smooth to avoid pulling or erratic brake performance. Light scoring which results from normal use is not detrimental to brake operation if the scoring does not exceed .015 inch in depth.

Lateral runout, the side-to-side movement of the rotor as it rotates, if excessive (over .004 inch total indicator reading), can cause vibration when the brakes are applied. It is checked using a dial indicator gage which a qualified service shop should have.

DISC BRAKE SQUEAL OR SQUEAK

A persistent amount of "squeal or squeak" is often associated with heavy-duty disc brake usage. These noises are common for both foreign and domestic disc brake systems. Heat, humidity and severity of usage seem to be contributing factors to brake noise. Changing the brake pads, or rotor refinishing as a repair, is often considered a temporary repair, or even by some technicians as useless. The recommended approach is to have an inspection to assure there is free and proper operation of all caliper parts. At this point, the owner should realize that the brake noise exists, but is not detrimental to overall brake life.

NOTE: Refer to bulletin section on pads that will help reduce brake noise on pre 1992 units.

BRAKE CALIPER NOISE

Sometimes on vehicles with high mileage, a noise or rattle condition caused by wear at the brake caliper and knuckle slide surfaces may be encountered. This condition does not affect the operation of the brake system, but the noise or rattle condition can be corrected by installing an oversized key and spring available as a service replacement. GM Bulletin 79-T-25 (Jan. 1980) in Appendix 6-1 at the back of this section provides details for selecting the proper size replacement key and how to install the key.

BRAKE PEDAL/STOPLIGHT ADJUSTMENT

NOTE: The adjustments listed below do not change with time or miles. An incorrect adjustment would normally be noted in the first few miles of vehicle life or after service work of some kind performed under the dash resulting in system malfunction.

1. Check for a full upward and full release of the brake pedal. Determine if the stoplight switch, cruise control switch or any other item does not allow full upward pedal travel. (See Figure 6-7.) The stoplight switch/brake pedal mounting bracket provides automatic adjustment when the brake pedal is manually returned to its mechanical "up-stop" position.

2. Pull the brake pedal fully rearward against the pedal stop until audible "click" sounds can no longer be heard. This moves the stoplight switch assembly in a tubular clip, as shown in Figure 6-7, and provides a proper adjustment.

NOTE: Proper adjustment of the stoplight switch allows .06 inch to .36 inch free pedal travel and will turn on the stoplight switch after approximately .40 inch travel. (See Figure 6-8.)

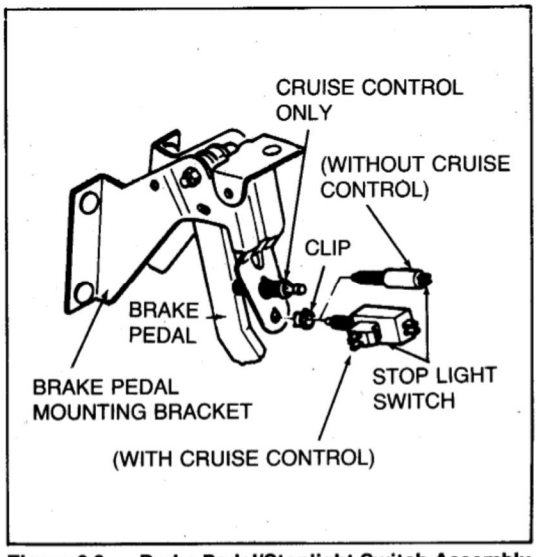


Figure 6-8 — Brake Pedal/Stoplight Switch Assembly

3. Check the 31-inch rod that runs down the front of the chassis and connects the brake pedal to the Hydro-Boost for proper adjustment. (See Figure 6-8.) The rod can be adjusted (longer or shorter) using the screw adjustment located at the bottom of the rod. Block the wheels and hold the inside pedal in the "full-up" position. Check that there is free entry of the special bolt through the relaxed pedal rod lever connecting the linkage into the Hydro-Boost. Turn the adjustment screw to lengthen or shorten the rod as necessary.

4. Tighten the adjusting lock nut to 22-30 ft. lbs. then tighten the nut on the special bolt and install a new cotter pin.

NOTE: Newer model rods can not be adjusted.

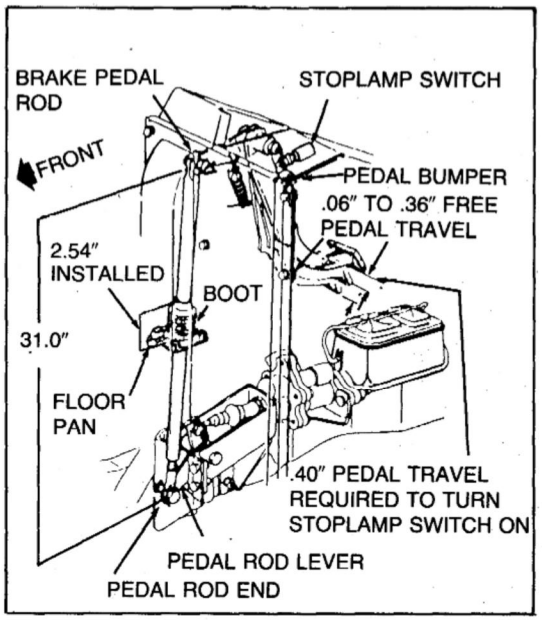


Figure 6-9 — Actuating Rod/Brake Pedal/Stoplight Adjustment

BLEEDING BRAKE HYDRAULIC SYSTEM

A bleeding operation is necessary to remove air whenever it is introduced into the hydraulic brake system.

It may be necessary to bleed the hydraulic system at all four wheel cylinders if air has been introduced through low fluid level or by disconnecting the brake pipes at the master cylinder. If a brake pipe is disconnected at any wheel cylinder, then that wheel cylinder only needs to be bled. If pipes are disconnected at any fitting located between the master cylinder and wheel cylinders, then all wheel cylinders served by the disconnected pipe must be bled.

NOTE: The following procedure is for manual bleeding of the brakes only. If possible, obtain approved commercial pressure-bleeding equipment or the GM Tools Vacuum Brake Bleeder. (See the GM Wheel Service System Brake Bleeder in Appendix 6-2 at the back of this section for further information regarding Brake Bleeder specifications, usage and ordering information.)

With power brakes, remove the vacuum reserve by applying the brakes several times with the engine off. Then, complete the following steps:

1. Fill the master cylinder reservoirs with brake fluid and keep at least one-half full of fluid during the bleeding operation. (See Figure 6-1.)

2. If the master cylinder is known or suspected to have air in the bore, then it must be bled (before bleeding any wheel cylinder or caliper) in the following manner:

   a. Disconnect the forward (blind end) brake pipe connection at the master cylinder.

   b. Allow brake fluid to fill the master cylinder bore until it begins to flow from the forward pipe connector port.

   c. Connect the forward brake pipe to the master cylinder and tighten.

   d. Depress the brake pedal slowly one time and hold. Loosen the forward brake pipe connection at the master cylinder to purge air from the bore. Tighten the connection and then release the brake pedal slowly. Wait 15 seconds. Repeat the sequence, including the 15-second wait, until all air is removed from the bore. Care must be taken to prevent brake fluid from contacting any painted surface.

   e. After all air has been removed at the forward connection, bleed the master cylinder at the rear (cowl) connection in the same manner as the front, as in Step "d" above.

   f. If it is known that the calipers and wheel cylinders do not contain any air, then it will not be necessary to bleed them.

3. Individual wheel cylinders or calipers are bled only after all air is removed from the master cylinder.

   a. Place a proper size box-end wrench over the bleeder valve. Attach transparent tube over valve and allow tube to be hand submerged in brake fluid in a transparent container. Depress the brake pedal slowly one time and hold. Loosen the bleeder valve to purge the air from the cylinder. Tighten bleeder screw and slowly release pedal. Wait 15 seconds. Repeat the sequence, including the 15-second wait until all air is removed. It may be necessary to repeat the sequence ten or more times to remove all the air.

4. If it is necessary to bleed all of the wheel cylinders and calipers, the following sequence should be followed: 1) Right-rear wheel cylinder; 2) Left-rear wheel cylinder; 3) Right-front caliper; 4) Left-front caliper.

5. Check the brake pedal for "sponginess" and the brake warning light for indication of unbalanced pressure. Repeat entire bleeding procedure to correct either of these two conditions.

BLEEDING HYDRO-BOOST BRAKE SYSTEM

Whenever the booster is removed and reinstalled, the steering system should be bled as outlined below.

NOTE: Power steering fluid and brake fluid cannot be mixed. If brake seals contact steering fluid or steering seals contact brake fluid, seal damage will result.

1. Fill fluid reservoir to the proper level and let the fluid remain undisturbed for at least two minutes.

2. Start the engine and let it run momentarily.

3. Add fluid if necessary.

4. Repeat above procedure until the fluid level remains constant after running engine.

5. Raise front end of the vehicle so that the wheels are off the ground.

6. Turn the wheels (off ground) right and left, lightly contacting the wheel stops.

7. Add fluid if necessary.

8. Lower the vehicle.

9. Start engine and depress the brake pedal several times while rotating the steering wheel from stop to stop.

10. Turn engine off and then pump the brake pedal 4-5 times to deplete accumulator pressure.

11. Check the fluid level and refill as required.

12. If fluid is extremely foamy, allow vehicle to stand for a few minutes with the engine off and repeat above procedure.

    a. Check belt tightness and check for a bent pully. (Pulley should not wobble with engine running.)

    b. Check to make sure hoses are not touching any other parts of the vehicle, particularly the sheet metal.

    c. Check the reservoir fluid level, filling it to the proper level if necessary, following operations 1 through 10. This step and step "d" are extremely important as low fluid level and/or air in the fluid are the most frequent causes of objectionable pump noises.

    d. Check for the presence of air in the fluid. Air will show up as a milky-looking fluid. If air is present, attempt to bleed the system as described in operations 1 through 10. If it becomes obvious that the pump will not bleed after a few trials, refer to the appropriate shop manual for more detailed test procedures.

13. The presence of trapped air in the system will cause the fluid level in the pump to rise when the engine is turned off. Continue to bleed the system until this condition no longer occurs.

POWER BRAKE UNITS

The hydraulic lines connecting the power steering pump, Hydro-Boost unit and steering gear, as well as the components themselves, should be checked regularly for signs of leaks, damage or deterioration on vehicles so equipped. For vehicles with vacuum boosters, inspect the vacuum hoses and booster chamber for damage or deterioration.

NOTE: Power steering fluid and brake fluid cannot be mixed. If brake seals contact steering fluid or steering seals contact brake fluid, seal damage will result.

Both the vacuum booster and Hydro-Boost should be serviced by a qualified repairman.

PARKING BRAKE

Adjustment of the parking brake cable is necessary whenever holding ability is not adequate or whenever the center brake cables have been disconnected. An improperly adjusted parking brake cable may also cause the brakes to drag. On 16,000# GVW units, the transmission must be in neutral.

The service brakes must be properly adjusted as a base for parking brake adjustment; conversely, the parking brake must be properly adjusted for the service brake to function as intended.

Inspection

If a complete release of the parking brake is not obtained, unless it is forcibly returned to its released position, or if application effort is high, check parking brake assembly for free operation. If operation is sticky or a bind is experienced, correct as follows:

1. Clean and lubricate brake cables and equalizer with Delco Brake Lube (or equivalent).

2. Inspect brake assembly for straightness and alignment (replace if necessary).

3. Clean and lubricate parking brake assembly with Delco Brake Lube (or equivalent).

4. Check routing of cables for kinks or binding.

Drum Balance

An imbalanced parking brake drum can cause vibrations. If a vibration occurs, perform the following to check for an imbalance problem with the parking brake drum:

1. Place the transmission into NEUTRAL and increase the engine speed to the approximate speed that the vibration is felt while driving the vehicle on the road.

2. If the vibration has disappeared, check the parking brake drum on the back of the transmission if so equipped.

3. Disconnect the propeller shaft at the back of the transmission and remove the drum.

4. Retest as in Step 1. If the vibration is gone, replace the drum. (See Figure 6-9.)

NOTE: If a strobe light wheel balancer is available, position the strobe pick-up against the transmission pan. Adapt the procedure listed in the Driveline Balance section of this manual to check for a balanced drum. Add weight under the retaining bolt of the parking brake drum as necessary.

Cable Adjustment

FOOT PEDAL TYPE (G-P series) — Before adjusting parking brake, check service brake condition and adjustment.

1. Loosen the equalizer adjusting nut.

2. Apply parking brake four notches from fully released position. Only 1 notch on P series.

3. Tighten the equalizer nut until a moderate drag is felt when the rear wheels are rotated forward. (See NOTE at the end of this procedure.)

4. Fully release parking brake and rotate the rear wheels. No drag should be present.

ORSCHELN LEVER TYPE (P-SERIES) —

1. Turn adjusting knob on parking brake lever counterclockwise to stop.

2. Apply parking

3. Loosen nut at intermediate cable equalizer and then adjust nut to give light drag at rear wheels. (See NOTE at the end of this procedure.)

4. Readjust parking brake lever knob to give a definite snap-over-center feel. Proper pull-over force is 90 pounds.

NOTE: This fastener is an important attaching part in that it could affect the performance of vital components and systems, and/or could result in major repair expense. It must be replaced with one having the same part number or with an equivalent part if replacement becomes necessary. Do not use a replacement part of lesser quality or substitute design.

Propeller Shaft Drum-Type Brake Adjustment (Adjustment — Drum On)

Refer to Figure 6-9.

1. Using a jack, raise vehicle so that at least one rear wheel is off ground. Block wheels and release the hand brake.

2. Remove cotter pin and clevis pin connecting the pull rod and relay lever. This will assure freedom for full shoe release.

NOTE: It may be necessary to knock out lanced area in brake drum (or backing plate) with punch and hammer to gain entry to adjusting screw through brake drum. Be sure to remove any metal that has fallen inside the parking brake drum.

3. Rotate brake drum to bring one of the access holes into line with adjusting screw at bottom of shoes (manual transmission), or top of shoes (automatic transmission).

4. Expand shoes by rotating adjusting screws with a screwdriver inserted through hole in the drum. Move outer end of screwdriver away from the drive shaft. Continue adjustment until shoes are tight against drum and drum cannot be rotated by hand. Back off adjustment and check drum for free rotation.

5. Place parking brake lever in the fully released position. Take up slack in the brake linkage by pulling back on cable just enough to overcome spring tension. Adjust clevis of the pull rod or front cable to line up with hole in the relay levers.

   a. Insert clevis pin and cotter pin, then tighten clevis locknut.

   b. Install a new metal hole cover in drum to prevent contamination of the brake.

   c. Lower rear wheels. Remove jack and wheel blocks. See Note under Cable Adjustment procedure in this section.

AUTOMATIC APPLY PARKING BRAKE
1990 P3 MOTOR HOME (16,000# GVW ONLY)

The parking brake system on the 1990 16,000 pound GVW P3 motorhome chassis incorporates a unique automatic apply feature with an internal expanding parking brake. The system is different than the 1989 and 1991 systems of the same model. The parking brake is spring applied and hydraulically released. Hydraulic pressure is supplied by the power steering pump. Full brake disengagement requires that 95-115 PSI pressure exist at the brake actuator.

The parking brake can be applied by using a hand button or automatically when the shift lever is in the park position. The system features an HR-1 relay valve serving as a flow control point. The HR-1 reduces and directs flow to and from a spring actuator operating the parking brake (See Figure 6-10).

Hydraulic System (Fig. 6-10)

Steering fluid under pressure is supplied from the power steering pump which is then routed through the brake hydro-boost unit on to the power steering gear to port #1 of the HR-1 relay valve thus pressurizing the system. All fluid is then directed back to the power steering pump by way of port #2 on the relay valve. Pressurized fluid is then directed to port #3 of the HR-1 relay valve where it is held at port "A" of the manual apply control valve. Fluid (assuming the shift selector lever is not in the "park" position) is directed out of port "B" of the manual valve to port "D" of the shift actuated control valve. Ports "C" on the manual valve and "F" on the shift valve are used to exhaust fluid and direct it back to the power steering pump reservoir and are always at zero pressure. Port "E" on the shift control valve is used as a "signal" pressure (fed to port #4 of the relay valve) to shuttle the relay valve to either channel pressurized fluid to or exhaust it out of the hydraulic brake actuator (port #5 of the relay valve) thereby releasing or applying the park brake assembly.

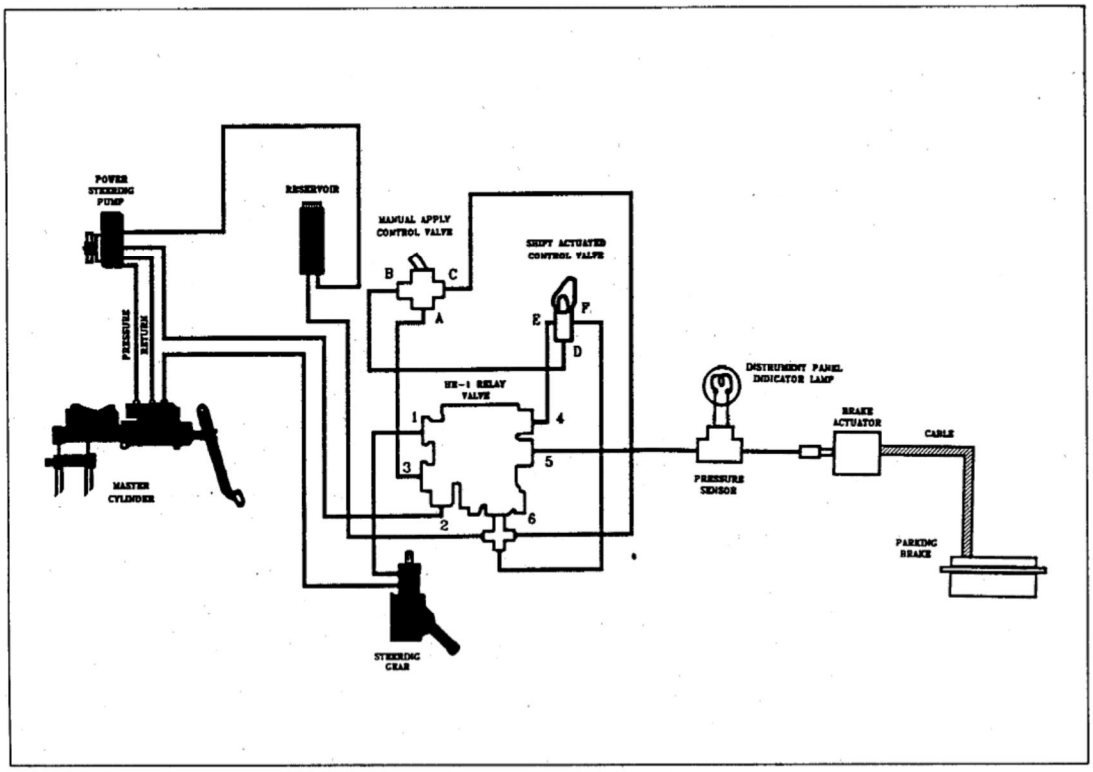


Figure 6-10

Various modes of operation are as follows:

Vehicle in park, engine running, manual apply control valve in the "released" position (Fig. 6-11)

Pressurized fluid is directed from port #3 of the relay valve to port "A" of the manual valve, on through the manual valve to its port "B" and then on to port "D" is blocked and prevented from entering the valve. Also, ports "E" and "F" are now hydraulically connected. With this connection, any fluid that was previously pressurized at port #4 of the relay valve, is allowed to pass through the shift valve and exhaust back to the power steering pump reservoir. With the lack of pressurized fluid at port #4 on the relay valve, pressurized fluid from port #1 of the relay valve is blocked inside of the valve preventing it from reaching port #5 and charging the brake actuator. Ports #5 and #6 of the relay valve are now internally connected. This allows the fluid in the brake actuator to exhaust through the relay valve and on to the power steering pump reservoir. With no hydraulic pressure at the actuator, spring pressure is free to apply the park brake.

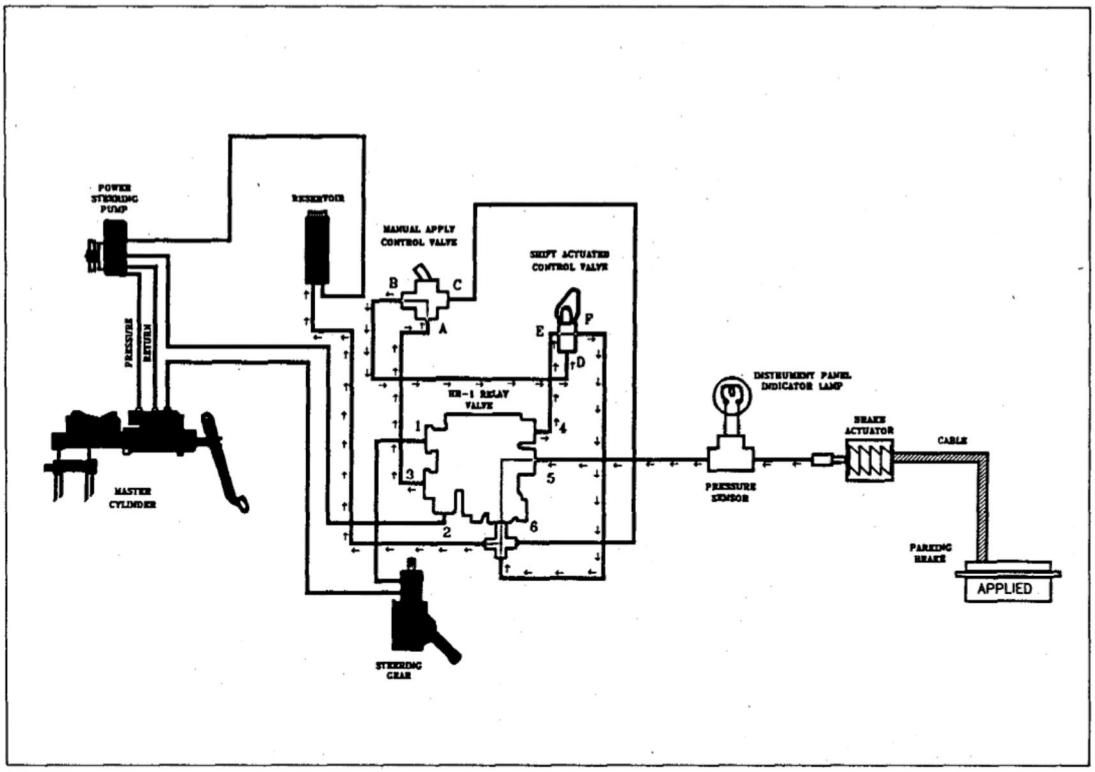


Figure 6-11

Vehicle in any gear position other than "park", engine running, manual apply control valve in the "released" position (Fig. 6-12)

Ports "E" and "F" of the shift valve are not hydraulically connected. Port "E" is connected with port "D" directing a signal feed to port #4 of the relay valve. This signal feed actuates the relay valve which blocks the connection of ports #5 and #6 in the relay valve and prohibits the exhausting of the brake actuator. Ports #1 and #5 of the relay valve are internally connected allowing pressurized fluid to be directed to the brake actuator which forces the actuator spring to be compressed and the park brake to release.

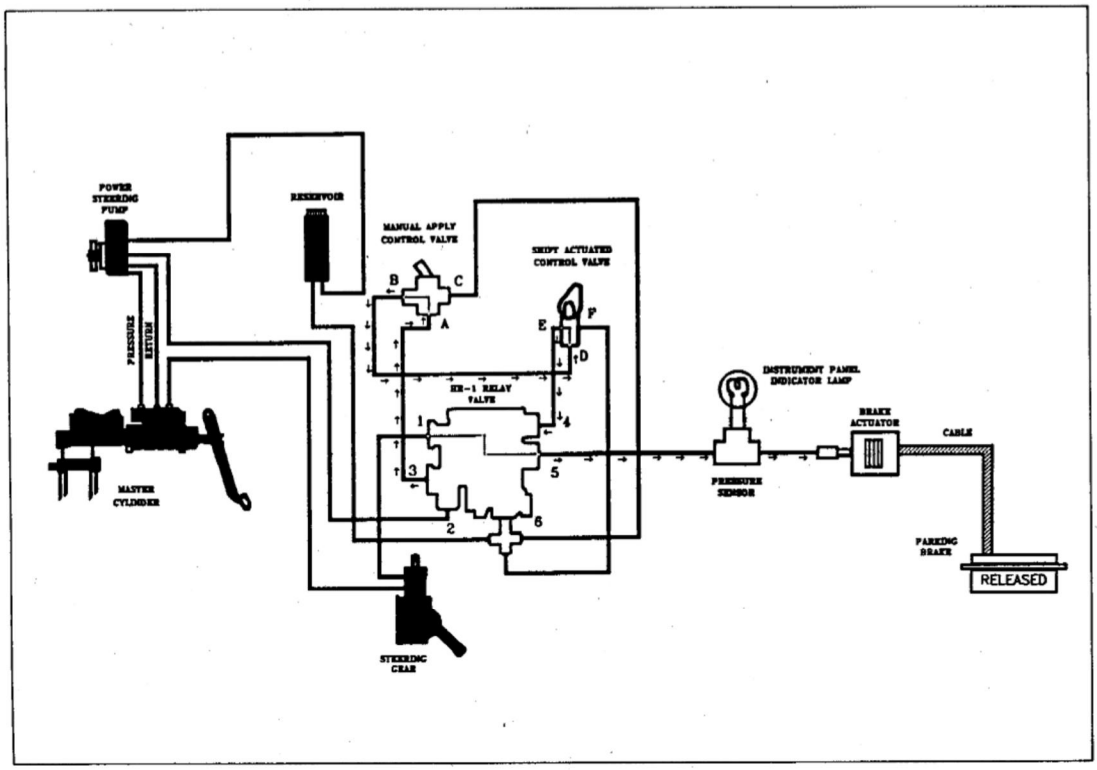


Figure 6-12

Vehicle in any gear position other than "park", engine running, manual apply control valve in the "applied" position (Fig. 6-13)

Ports "A" and "B" of the manual valve are not connected. Pressurized fluid at port "A" is blocked, preventing it from entering the valve. Ports "B" and "C" are hydraulically connected. This allows any fluid that was previously directed to port "D" of the shift valve to exhaust back to the power steering pump reservoir. With no pressurized fluid available at port "D" of the shift valve, no signal feed can be supplied to port #4 of the relay valve (via the internal connection between ports "D" and "E" of the shift valve based on the position of the shift valve). This lack of a signal feed allows the relay valve to actuate, blocking the flow of pressurized fluid from port #1 to port #5 in the valve and opening the passage between ports #5 and #6 allowing the fluid from the actuator to exhaust. With no pressurized fluid to release the actuator, spring pressure takes over and applies the park brake.

Operational Features

1. In the event the vehicle stalls, the wheels can be spun freely for at least ten minutes until pressure is drained from the brake actuator and the spring brake reapplies.

2. A parking brake light in the vehicle warns the operator when the brake is applied. This brake light will come on when the pressure at the actuator is less than 60 PSI.

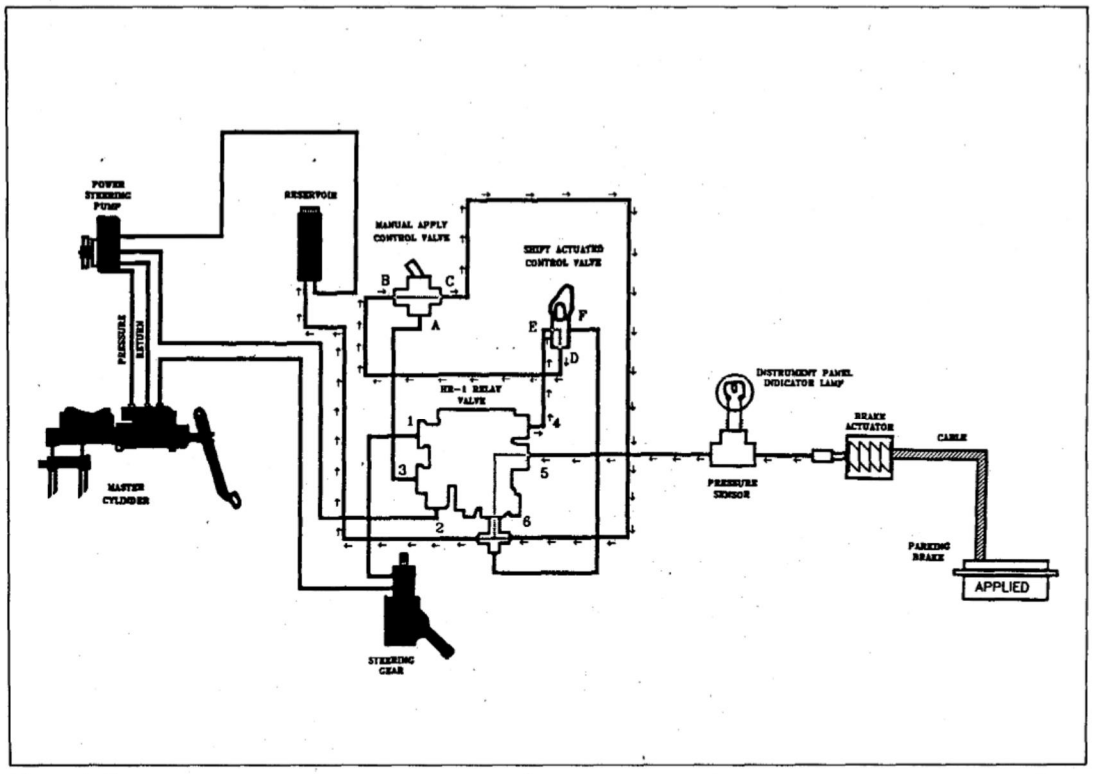


Figure 6-13

AUTOMATIC APPLY PARKING BRAKE
1991-1993 P3 MOTOR HOME (16,000# GVW ONLY)

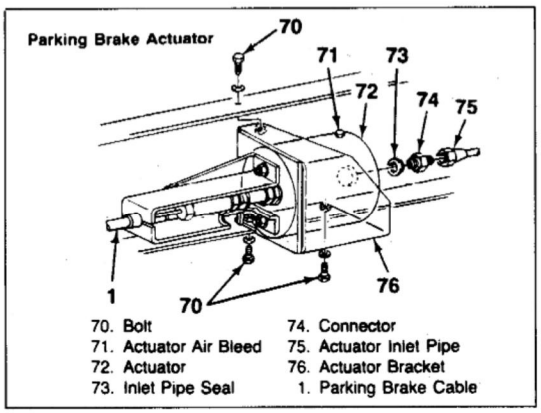
The parking brake system on the 1991 and 1993 16,000 pound GVW P3 motorhome chassis incorporates a revised system from the 1990. The Park position brake is spring applied and hydraulic released, the same as 1990. The 1991-93 system incorporates a manual Parking brake pedal which applies the system when the shift indicator is in any position other than Park.

With the shift selector in park; Engine running; and the manual foot lever in the released position, fluid will flow from the steering gear to port "SR" on the relay valve, through the relay valve and out port "TW" to the control valve supply port "SC". Once the system is charged, the pressure should range between 130 and 150 psi. Any excess fluid will be discharged through port "R" back to the pump. The supply port or charge port "SC" is blocked off due to the control valve position in the park mode.

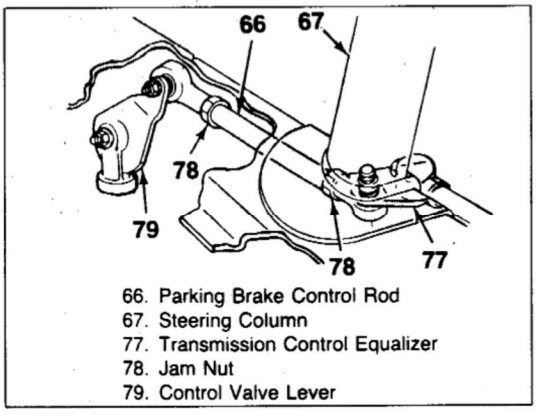
Any previously built pressure in the control valve flows through the control valve out port "EC" back through the relay valve, this triggers a release of pressure from port "D" of the relay valve through port "ER" to the reservoir. This allows the spring controlled actuator to apply the parking brake. The spring will apply the brake by traveling as far as the brake adjustment demand requires to balance brake apply and spring force.

When the valve is released from the park position, the fluid charge at the shift control valve port "SC" is diverted to port "DC". The shift control port "EC" is blocked off. The fluid charge at the relay valve port "SR" is diverted to port "D", this pressurizes the parking brake system and actuator. The fluid pressure working against the spring pressure in the actuator releases the parking brake.

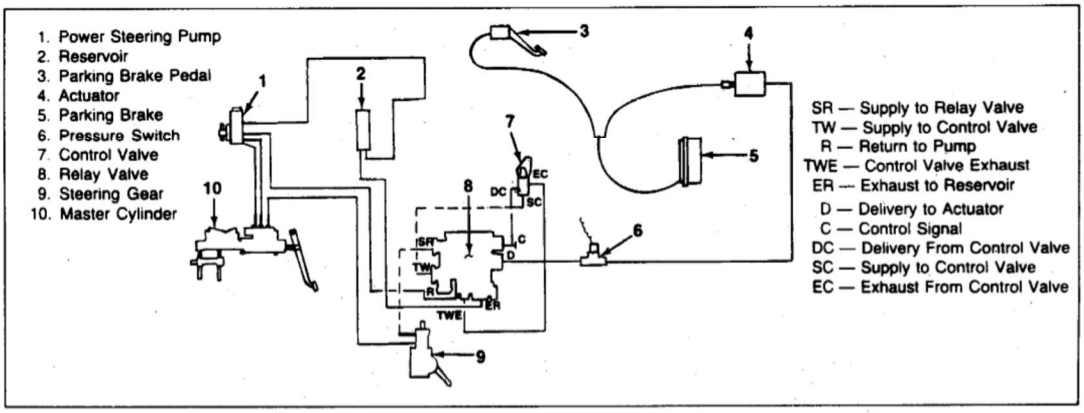
The manual foot lever should still be applied whenever the vehicle is shifted into park. This will alert the driver of the need for adjustment in the parking brake system.



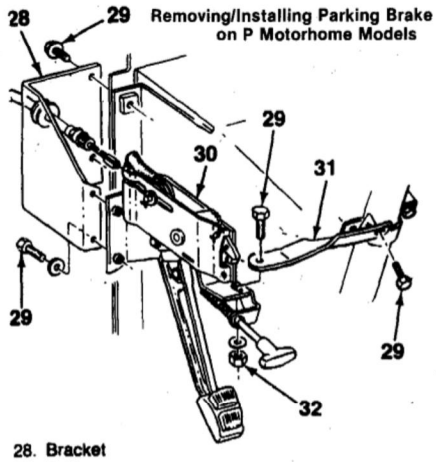
70. Bolt
71. Actuator Air Bleed
72. Actuator
73. Inlet Pipe Seal
74. Connector
75. Actuator Inlet Pipe
76. Actuator Bracket
1. Parking Brake Cable



66. Parking Brake Control Rod
67. Steering Column
77. Transmission Control Equalizer
78. Jam Nut
79. Control Valve Lever



Removing/Installing Parking Brake Pedal on P Motorhome Models

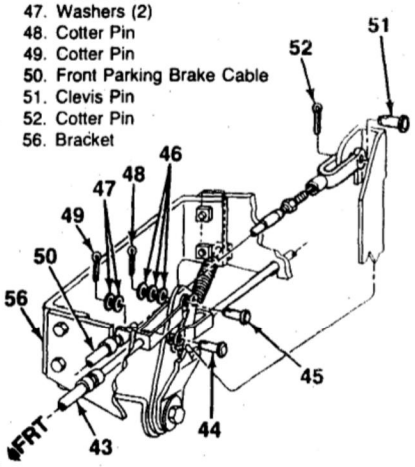


28. Bracket
29. Bolt
30. Parking Brake Pedal
31. Brace
32. Nut

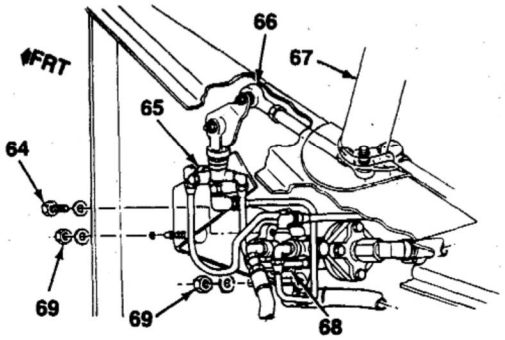
P-Motorhome Model

Relay Lever Assembly

43. Actuator Cable
44. Clevis Pin
45. Clevis Pin
46. Washers (3)
47. Washers (2)
48. Cotter Pin
49. Cotter Pin
50. Front Parking Brake Cable
51. Clevis Pin
52. Cotter Pin
56. Bracket



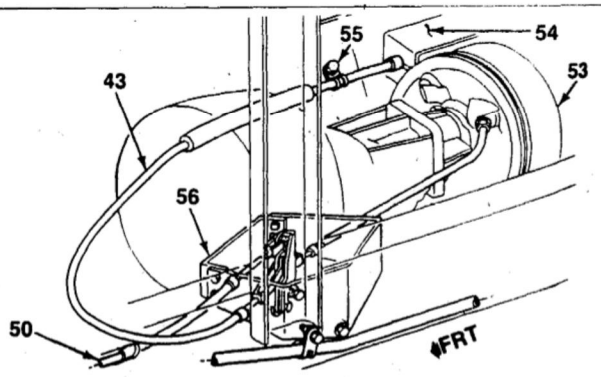
Relay and Control Valve



64. Bolt
65. Control Valve
66. Parking Brake Control Rod
67. Steering Column
68. Relay Valve
69. Nut

P-Motorhome Model Cable Components

50. Front Parking Brake Cable
43. Actuator Cable
53. Brake Drum
54. Actuator Bracket
55. Bolt and Clip
56. Bracket



BRAKE CALIPER NOISE

Reference: General Motors Dealer Service Technical Bulletin No. 79-T-25 (January, 1980)

1974-1979 G-, P-30 Series Models with JB-8 or JF-9 Brake Option

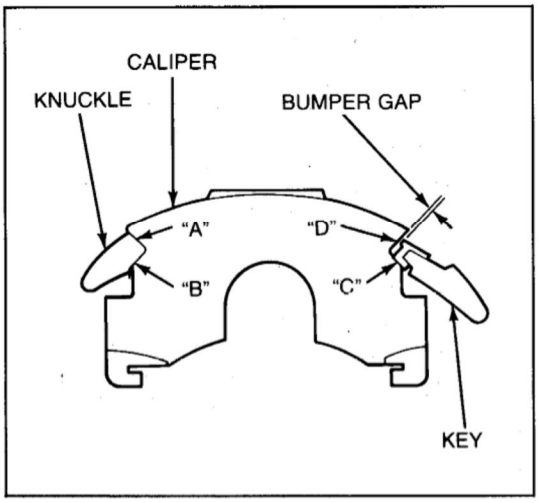
The following information has been extracted from the above mentioned bulletin.

A noise or rattle condition caused by wear at the brake caliper and knuckle slide surface may be reported on some high-mileage vehicles as a loose or rattling front end on all but smooth roads. This condition does not affect the operation of the brake system. The JB-8 and JF-9 brake systems have a caliper retention design which incorporates a key and a leaf spring retained in a "V" groove.

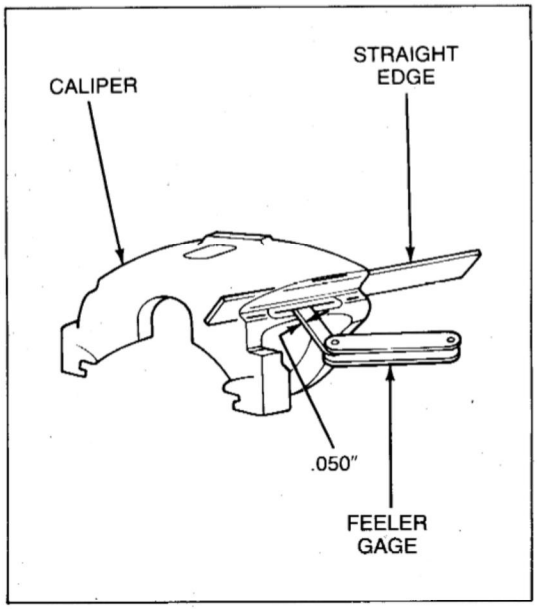
Vehicles which have the caliper rattle condition can be corrected by installing an oversized key and newly designed leaf spring available from General Motors Parts Division. The service keys will be available in five sizes (at .040-inch increments) to compensate for varying degrees of wear.

Follow the procedure given below for correction of complaint vehicles:

1. Remove caliper from knuckle by unscrewing key retention screw and tapping out key and spring.
2. Clean surfaces "A", "B", "C", and "D" (shown in the following illustration) with a wire brush, filing smooth any nicks and/or gouges.



3. Lay a straight edge across the forward caliper surfaces "C" and "D" (shown in the following illustration) and measure with a feeler gage the maximum depth of any wear on these surfaces. Calipers worn to a depth of .050 inch or more should be replaced.



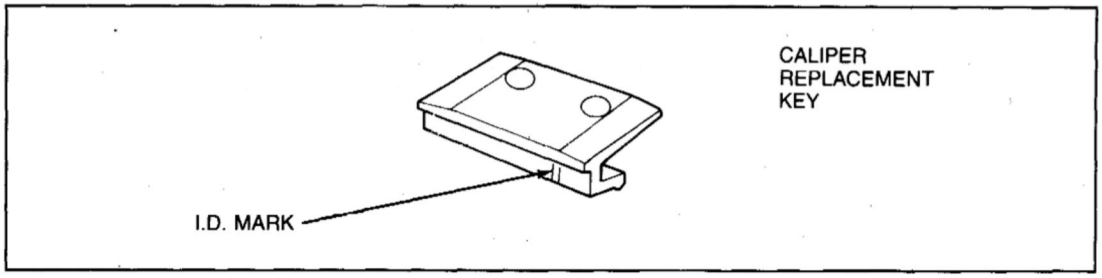
4. Reinstall the caliper back into the knuckle. Install a new standard size key and reinstall the key retention screw, but do not install the caliper support spring at this time.
5. Insert a screw driver into center of key/bumper gap and pry firmly to assure that caliper is seated against three slide surfaces —"A", "B", "C."
6. Measure bumper gap with largest feeler gage (or stack of gages) that will fit into the gap for its full length.
7. Select a replacement key according to the table on page 6-12.
8. Install selected replacement key and new design spring, GM Part No. 14023437, and reinstall retention screw.

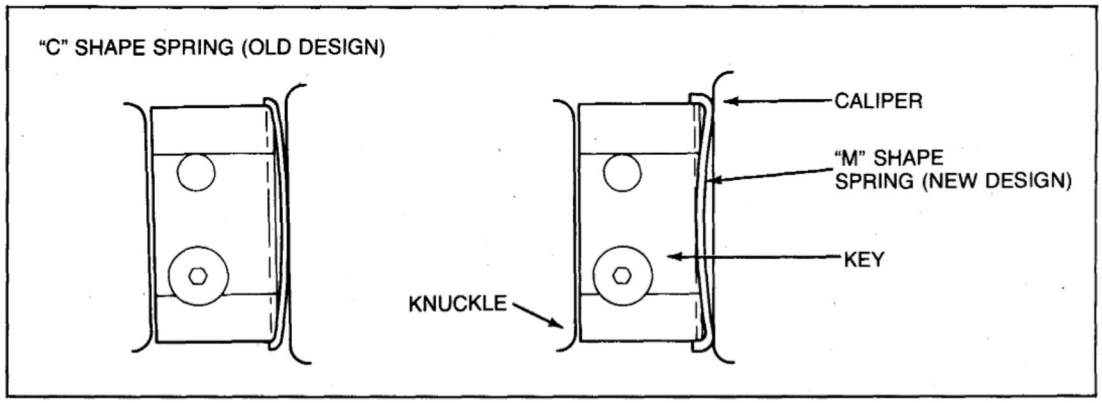
NOTE:

- If retention screw is damaged or shows signs of excessive wear, replace with new part (GM Part No. 331478).
- The spring has been redesigned from a "C" to an "M" shape. The "M" spring must be installed with the large radius in contact with the key.

BRAKE CALIPER NOISE (Cont'd)

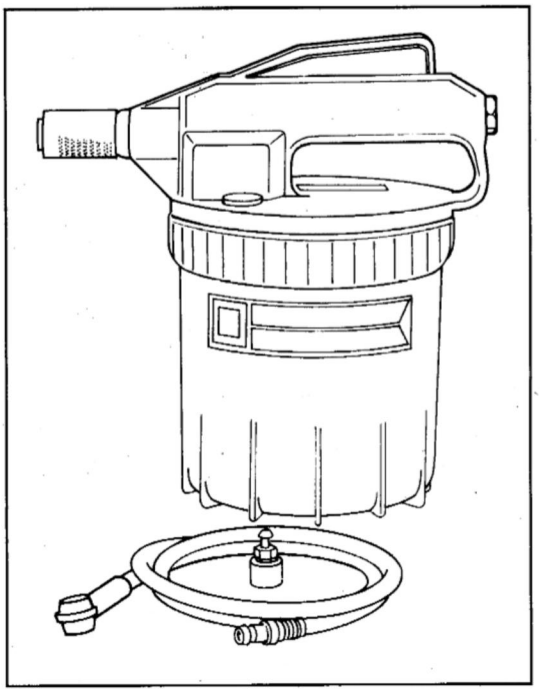
BUMPER GAP (IN.)		REPLACEMENT KEY I.D.	GM PART NO.
MORE THAN	BUT NOT EXCEEDING		
0	.060	Standard Size 1	14023439
.060	.100	.040 Oversized 11	14026793
.100	.140	.080 Oversized 111	14026794
.140	.180	.120 Oversized 1111	14026795
.180	.220	.160 Oversized 11111	14026796
.220	—	Replace Anchor Plate/Knuckle and Caliper and use new standard size key and new spring.	





VACUUM BRAKE BLEEDER

The following information has been extracted from the GM Dealer Equipment Catalog. Vacuum brake bleeder features, specifications and ordering information has been described.



FEATURES

- Vacuum operation
- Can be used for all types of cars, trucks, busses and motor bikes.
- Fluid is retained in the canister, eliminating costly paint damage from splashing.
- Brake set equipped with universal rubber connector on 40-inch quick-connect tubing and GM adapter.

SPECIFICATIONS

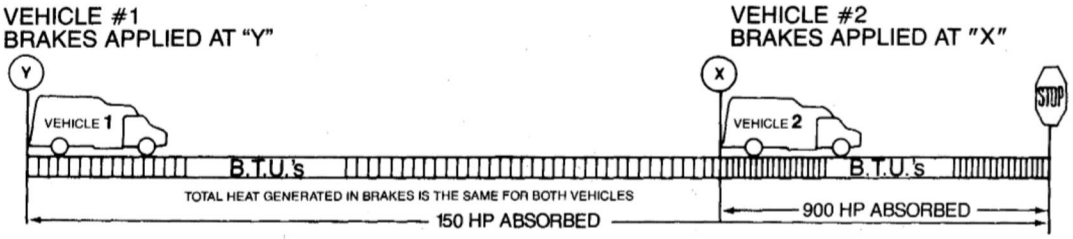
Air Consumption..... 7.4 CFM
Minimum vacuum capacity 60%
Connection thread..... 1/4-inch female thread
Canister volume..... .40 gal.

HOW IT WORKS

The brake bleeder is used as outlined below:

1. Connect the brake bleeder to an air supply (80 to 175 PSI) and the hose with the rubber connector end to the brake bleed screw.
2. Depress the lever on the bleeder top to create a vacuum in the canister.
3. Apply a suitable wrench to the bleed screw, and open. Air and brake fluid will now be drawn out of the system.

BRAKE LINING LIFE EXPECTANCY



VEHICLE #1 AND VEHICLE #2 TRAVELING AT SAME SPEED WHEN BRAKES ARE APPLIED

The following information is provided courtesy of Gray-Rock Company as an aid to the motor home owner in understanding brake lining life expectancy and premature drum failure. GM provides no statement as to the accuracy of this information, although it would appear to be correct.

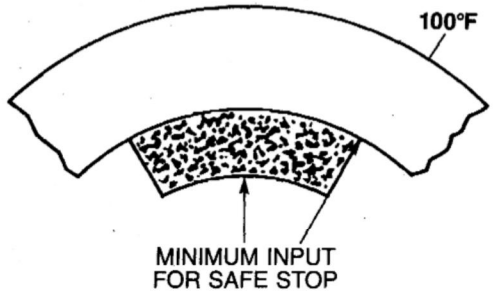
A brake is a heat machine. A soft touch on the brakes pays off in any model vehicle in the form of brake life and fuel economy. Each time brakes are applied, you are converting forward motion (that you bought and paid for as fuel costs) into heat energy of stopping.

Brakes change energy of motion to heat energy, and this energy is the same for *any* stop from a given speed. Many drivers take advantage of good brakes by stopping in shorter distances than necessary. The following example demonstrates improper braking techniques and the results. (See diagram above.)

Assume both drivers (Vehicle No. 1 and No. 2) are operating identical vehicles and making a stop from the same speed. Vehicle No. 1 anticipates the stop and applies the brakes at point "Y" as shown in the diagram above. Heat is generated at a rate that the brakes of Vehicle No. 1 can handle — about 500°F at drum surface. The driver of Vehicle No. 2, shown in the diagram, doesn't apply his brakes until he reaches point "X."

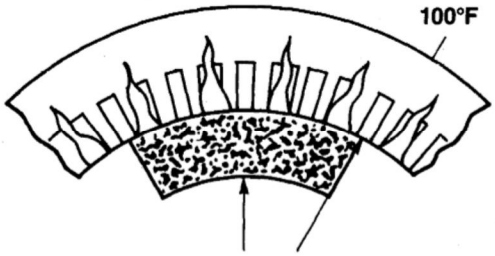
Although the work load on the brakes of both vehicles is the same, in the case of Vehicle No. 2, the work load is "poured" into the brakes in 1/6th the time. This means that the brakes must absorb 900 horsepower instead of just 150. Vehicle No. 2 develops up to 2,000°F temperature at drum surface and at a rate faster than it can be transferred and dissipated. The result is short lining life and premature drum failure.

BRAKE DRUMS ON VEHICLE #1 DURING BRAKE APPLICATION



500°F — NORMAL HEAT CONCENTRATION AT DRUM SURFACE

BRAKE DRUMS ON VEHICLE #2 DURING BRAKE APPLICATION



1800-2000°F — HIGH HEAT CONCENTRATION AT DRUM SURFACE

ENGINE

Your Chevrolet Motor Home Chassis is equipped with either the 5.7L or 7.4L (Mark IV) gasoline engine or the 6.2L diesel engine. Both the gasoline and diesel engines are four-cycle designs. That is, there are four distinct strokes (intake, compression, power and exhaust) in the power cycle of each engine cylinder. The power cycle of a cylinder takes place through two revolutions of the crankshaft.

NOTE: There is a "truck rule of thumb" that says, "For good engine life, the engine shall not cruise for long periods of time at speeds in excess of 80-90 percent of engine governed speed or as rated." Full-rated speed is acceptable for short durations such as when the transmission is going through its shift points. The chart shown in Figure 7-1 shows the general relationship of engine speed to engine life.

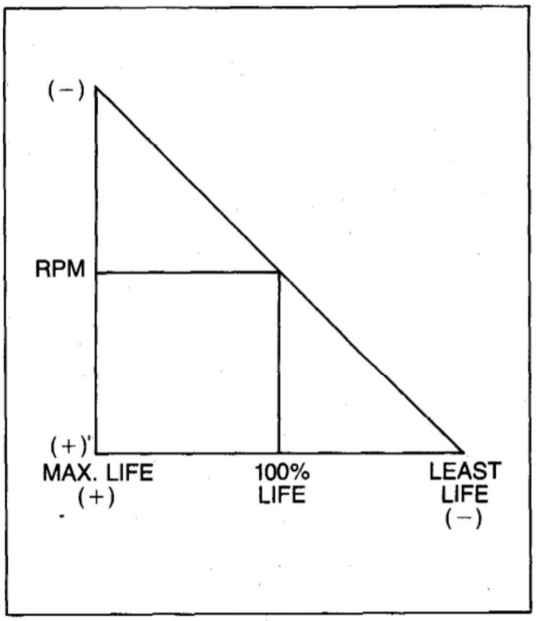


Figure 7-1 — Engine Speed to Engine Life

PRINCIPLES OF INCREASED ENGINE LIFE

Avoid Engine Idling For Long Periods Of Time

Long periods of engine idling will drop engine temperature and result in the incomplete burning of fuel. Raw unburned fuel can wash lubricating oil off cylinder walls and result in diluted crankcase oils and poor lubrication to all moving parts.

High Operating Temperatures Increase Oil Oxidation Rate

High engine temperatures that are caused by heavy loads, faulty cooling systems, incorrect timing, improper spark plugs, preignition and detonation, help to speed the oxidation of oils. Every 20 degree increase of temperature will double the oxidation rate. (See Figure 7-10.)

Extreme heat causes the oil to oxidize which forms tar and gum deposits in the oil. Varnish will also form and result in ring sticking, valve sticking and malfunction of other vital engine parts.

Clean oil coolers have proven successful in maintaining acceptable engine temperatures.

Allow Engine To "Cool Down" Slightly Before Shut-Down

If an engine has been heavily worked, it is a good policy to disengage the load from the engine and allow the engine to idle for a few minutes before turning off the ignition. This practice allows the engine to cool gradually and promotes a desirable dissipation of heat from any localized area of concentrated temperature. Such a practice avoids the rapid cooling that can cause warped valves, valve "tuliping," block distortion, cracked manifolds, etc. (See the Exhaust Manifold and Plug Wire Failure section for additional information, page 7-4.)

Water Temperature Is Important To Engine Operation And Engine Life

Water temperature of 195 degrees Fahrenheit or higher assures that cylinder walls are heated to a proper temperature needed to support good combustion and that other working parts of the engine have expanded evenly to favorable clearances for oil lubrication.

When water temperature is too low, the cylinder walls retard the heating of air during compression and delay ignition. This causes incomplete combustion, excessive exhaust smoke, poor emissions, and high fuel consumption.

Water Condensation In A Cold Engine Creates Unnecessary Engine Wear

It has been well established that low operating temperature increases engine wear. The products of combustion in a "cold-running" engine combined with moisture will form a corrosive film of oxide on the cylinder walls and engine components.

Engineers have estimated that as much as eight times the cylinder and engine wear occurs to an engine operating at temperatures to 100 degrees Fahrenheit compared to an engine operating at a temperature of 195 degrees Fahrenheit.

Avoid Initial "Scuffing" After Engine Rebuild

After an engine has been overhauled, a pressurized oil system helps prevent damage to newly installed engine parts caused from a lack of lubrication. The system sends a supply of oil through the oil lines to the lifters, bearings, etc., before the engine starts.

Design engineers have approximated that several hundred engine revolutions are required before the average lubrication system will supply the required amount of oil to the vital moving parts. This time lapse results because a normal oil pump must prime itself and then pump the oil throughout the system.

If a newly overhauled engine is "dry" when started, the newly installed parts will be more sensitive to break-in abuse due to the high frictional temperatures caused by the momentary lack of oil.

GASOLINE ENGINE

Both the 5.7L (350 Cubic Inch Displacement) and the 7.4L Mark IV (454 Cubic Inch Displacement) engines have eight cylinders and are designed to operate on no-lead gasoline.

Each is equipped with an electronic ignition system which has no breaker points or condenser. The system uses a spark plug in each cylinder to start combustion.

Typical 7.4L engine ratings and basic specifications are shown in Figure 7-2 and 7-3.

DIESEL ENGINE

The V-8, 6.2L diesel engine is similar to a V-8 gasoline engine in many ways but major differences exist in the cylinder heads, combustion chamber, fuel distribution system, air intake manifold and the method of ignition. The cylinder block, crankshaft, main bearings, rods, pistons and wrist pins are similar to those on a gasoline engine but are of a heavy-duty design because of the high compression ratio required in the diesel engine to ignite fuel. Ignition of the fuel in a diesel engine occurs because of heat developed in the combustion chamber during the compression stroke. Thus, no spark plugs or high-voltage ignition are necessary for a diesel engine.

Typical 6.2L engine ratings and basic specifications are shown in Figure 7-4.

1982 - 1989
Basic Specifications

Engine type	Valve-in-head
Piston displacement (Liter/Cu. In.)	7.4/454
Bore & stroke (nominal)	4.25" x 4.00"
Compression ratio	7.9:1
Carburetor type	4 Barrel
Exhaust — Single	All

Engine Ratings — Typical
All States
Heavy Duty Emissions
(8501 lbs. GVWR and above)

SAE net horsepower (77 °F)	240 @ 3800 rpm
SAE net torque ft-lb (77 °F)	375 @ 3200 rpm

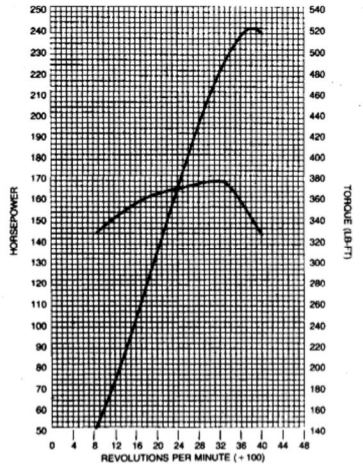


Figure 7-2 — Typical 7.4L Engine Ratings and Specifications

1990 - 1994
Basic Specifications

Engine type	Valve-in-head
Piston displacement (Liter/Cu. In.)	7.4/454
Bore & stroke (nominal)	4.25" x 4.00"
Compression ratio	7.9:1
Carburetor type	TBI
Exhaust — Single	All

Engine Ratings — Typical
All States
Heavy Duty Emissions
(8501 lbs. GVWR and above)

SAE net horsepower (77 °F)	230 @ 3600 rpm
SAE net torque ft-lb (77 °F)	385 @ 1600 rpm

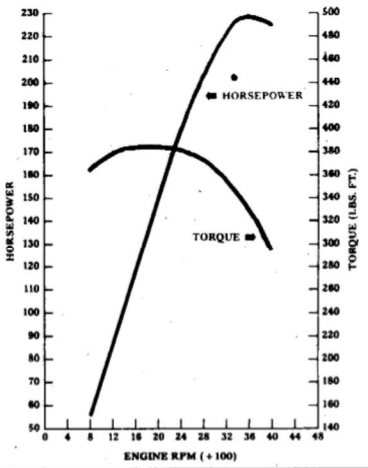


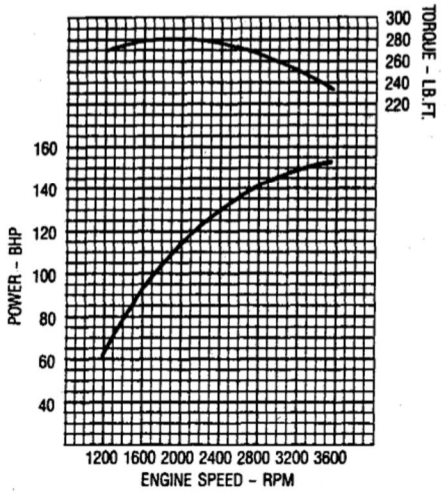
Figure 7-3 — Typical 7.4L Engine Ratings and Specifications

Engine Specifications

Engine type	Four cycle
No. of cylinders	8
Bore & stroke	4.06″ x 3.82″
Displacement	395 cu. in.
Injection pump	Stanadyne Mechanical Type
Brake HP	155 BHP @ 3500 RPM*
Peak Torque	285 lb. ft. @ 2000 RPM*
Comp. Ratio	21.3:1

*HP and Torque range from 140HP/255 lb. ft. to rating on chart.

Performance Curve



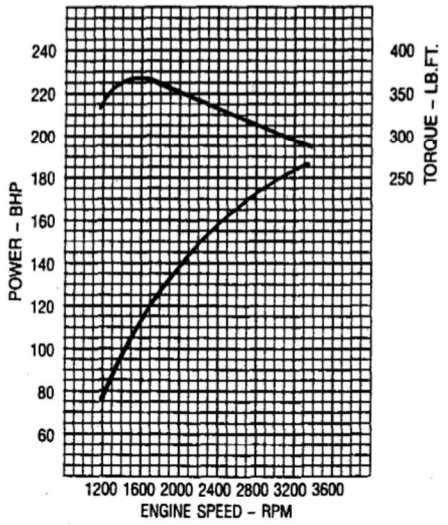
POWER OUTPUT AT SAE J1349 conditions

Figure 7-4 — Typical 6.2L Engine Ratings and Specifications

Engine Specifications

Engine type	Four cycle
No. of cylinders	8
Bore & stroke	3.98″ x 3.82″
Displacement	379 cu. in.
Injection pump	Stanadyne Mechanical Type
Brake HP	190 BHP @ 3400 RPM*
Peak Torque	380 lb. ft. @ 1700 RPM*
Comp. Ratio	21.5:1
Combustion chamber	Indirect injection
Turbo boost	10 psi @ peak torque
Turbo mfgr.	Borg Warner/IHI
RPO	L65 H.D. engine

Performance Curve



POWER OUTPUT AT SAE J1349 conditions

Figure 7-5 — Typical 6.5L Turbocharged Engine Ratings and Specifications

GM's 6.5L V8 TURBO DIESEL ENGINE

Turbocharged

The 6.5L features a completely integrated Borg Warner/IHI turbocharger. This turbocharger is waste-gated on the exhaust side of the turbo with an all-new wastegate that is patented by GM and is specifically designed for this system. This new wastegate provides very tangible benefits. By design, it reduces overall stress on the internal engine components. To accomplish this, the wastegate is designed to reduce turbo-boost pressure after maximum torque is obtained. This turbocharger delivers a top-boost of 10 psi at 1700 RPM and produces outstanding responsive acceleration on demand with no detectable turbo-lag.

Crankshaft Bearing and Seal

The crankshaft bearings used in the 6.5L are made of a more fatigue resistant bearing material. This material promotes a higher stress life of the bearings. The rear crankshaft seal is a one-piece seal that greatly reduces the chances of leakage.

Fuel Filtration System

The double filtration fuel filter on the 6.5L combines the fuel filter, water separator and fuel heater all in one canister. Its location and top-load vertical design allows easy filter cartridge replacement.

New Piston Design

The 6.5L bulkhead area was designed to handle the higher cylinder firing pressures of a turbocharged engine. In addition the coolant passages and the oil galleries were sized to provide the increased flow required by a turbo engine.

Serpentine Belt Drive

The 6.5L features a single serpentine drive belt with an automatic tension adjuster which improves belt life. The system maintains the desired belt tension needed to run the integral components while allowing for the easy replacement.

Water Separator Draincock

As the water separator is an integral part of the fuel filter on the 6.5L, the method of draining off the water has been designed for convenience. The water separator draincock has been located up front on the top of the engine, allowing for easy draining when required.

Optimized Combustion Chamber

To provide smokeless performance and to meet stringent emissions standards without sacrificing power, the 6.5L was designed with an optimized combustion chamber. This design provides an optimum balance of air in the pre-chamber in the head and of air in the cylinder. This balance of air enhances a more even and complete burning of the fuel.

Horsepower & Torque

The 6.5L Turbo Diesel has a horsepower rating of 190 @ 3400 RPM and a torque rating of 380 Lb.-ft. @ 1700 RPM, and provides a 30% torque rise over a usable 2800 RPM range.

EXHAUST MANIFOLDS

There are three types of materials used in the various years and models of the G- and P-Series motor home chassis. Each material described below has specific features and drawbacks to be considered before being selected by the design engineer.

- CAST IRON — Cast iron has been used for many years for the 454 CID engines including some current year engines. Cast iron is good for its ability to withstand heat and it is easy to produce and machine. However, a drawback to using cast iron as an exhaust manifold is that it can crack easily and has a slight tendency to warp.

- NODULAR IRON — Nodular iron has been used on many 350 CID and 454 CID engines. The nodular manifold is 5/16 in. thick versus 3/16 for the cast iron. Nodular iron has some of the same properties of cast iron but is not as prone to cracking. Also, nodular iron has less tendency to warp and become distorted than conventional cast iron.

- STAINLESS STEEL — Stainless steel had come into use with some past production 454 CID engines with the new emissions Systems. Starting in 1985 midyear through 1989 federal and 1989 California. It is very difficult to produce and the materials cost is high. The net result is that the total cost of using stainless steel manifold vs. the manifold cast family itself is extremely high.

With any manifold, the extremes of use are great. At one moment the manifold is 40 degrees Fahrenheit below zero and a few minutes later the manifold itself is white hot. Or, the manifold is white hot and the vehicle goes through a water puddle and quenches the manifold. Any and all parts can withstand a given amount of cycles or use before failure. GM warrants exhaust manifolds as part of the normal published warranties with the realization that it is very possible to produce a defective manifold. However, in instances where repetitive failures occur, the owner and service technician should examine the actual applications of use as to the cause of the failure (i.e., overload, road splash, poor air flow, incorrect bolt torque, incorrect parts or improper installation).

NOTE: Experience shows that installing exhaust manifold gaskets rather than resurfacing the manifold is only a short time repair. Leaking manifolds should be resurfaced or replaced and do not use a gasket but use anti-seize compound #1052771 to increase manifold life.

SERVICE TIPS

NODULAR IRON MANIFOLD SHRINKAGE

At times a service technician may experience a problem with replacement of a manifold after it has been removed for service. The technician is unable to reinstall the attaching bolts due to shrinkage of the manifold. This complaint is a result of heat present at the time the manifold was removed. The more heat present when the manifold is removed, the greater the "apparent" shrinkage of the manifold.

The manifold may be installed in the following manner:

1. Install the two (2) center attaching bolts and torque the bolts to 10 ft. lbs. Install additional bolts if alignment is possible.

2. Connect the exhaust pipes, crossover pipe, etc. to allow the engine to "run."

3. Start the engine and allow the engine to run (5 to 12 minutes) until the manifold expands allowing easy installation of the remaining bolts.

4. Torque the center bolts to a full 40 ft. lbs. torque and apply slightly less torque for each bolt as you proceed toward each end. (See Cast Iron Manifold Cracking section below for additional information.)

NOTE: This procedure is not considered detrimental to the exhaust manifold in any way and can be used to save the expense of a new manifold.

CAST IRON MANIFOLD CRACKING

Before installing a new manifold, the dowel pin holes and bolt holes should be increased 1/32 inch in diameter to enable the manifold to expand and contract without buckling. The reason for this is that in some of the larger engines, the manifold actually increases in length as much as 1/8 inch when going from atmospheric temperature to operating temperature.

Apply a liberal amount of anti-seize compound #1052771 to the manifold face and head face to increase manifold life. The compound appears to create a hard slate-like film with a very low coefficient of friction allowing the manifold to expand and contract and can be purchased through any Chevrolet dealership parts department.

When installing a manifold on 454 engines, torque the center bolts to a full 40 ft. lbs. torque and slightly less torque for each bolt as you proceed towards either end.

NOTE: If the bolts are not tightened enough, leaks will occur. If the bolts are overtightened, the manifold cannot expand and will buckle. Use a torque wrench whenever possible.

CAST IRON WARPING

Often times a warped cast iron manifold is caused by loose, poorly torqued attaching bolts or a broken attaching bolt. If the manifold is not held firmly against the block for proper heat absorption, exhaust heat can add to a warpage problem. The repair procedure may not require the manifold to be replaced providing a quality machine shop can resurface the face of the manifold flat. This can be an advantage as the cast iron has been "cured" with many heatings and coolings. Remachining the surface flat may actually be a better repair than manifold replacement.

EXHAUST MANIFOLD AND PLUG WIRE FAILURE

Chevrolet has determined that right side exhaust manifold and right side spark plug wire failure may be the result of inadequate air flow. This is due to the absence of a wheel-well panel on the right front wheel opening. This situation allows necessary engine cooling air flow to exit the engine compartment prior to passing the exhaust manifold and spark plug wires and therby cooling the manifold and spark plug wires as occurs on the left side of the engine compartment. See Figure 7-4.

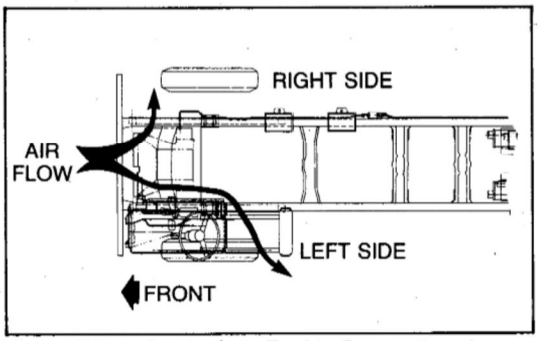


Figure 7-4 — Inadequate Engine Compartment Air Flow

This condition can be corrected by fabricating a metal panel similar to the one used on the left side of the vehicle. Adding the panel forces the air flow to pass along the right side of the engine compartment therby providing a cooling effect and greatly extends the manifold and spark plug wire life. See Figure 7-5.

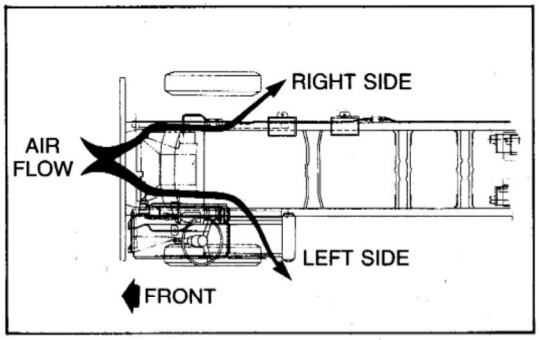


Figure 7-5 — Corrected Engine Compartment Air Flow

NOTE: Installation of the right hand engine heat splash shield GM Part #15680348 was implemented on 7-15-92 VIN #321432 see Figure 7-6-C.

Care must be taken in the design of the right side panel as to provide proper clearances around any hoses, wires and engine dress items and also to provide clearance for the tire throughout its movements. The panel should extend rearward to a point parallel to the number seven spark plug wire. The panel should be shaped and positioned similarly to the left side panel currently installed on the vehicle. Care must be taken to leave an opening at the rear of the engine compartment to allow cooling air to exit the engine compartment as on the left side panel. See Figure 7-5.

The motor home owner should be advised that when stopping the vehicle for fuel fill or rest stops after sustained highway driving, the engine should be allowed to idle for a period of three to five minutes before turning off the engine. This "idle time" allows the cooling fans enough time to reduce and stabilize the underhood temperature thereby increasing effective component life (spark plug wires, exhaust manifolds, belts, hoses, etc.).

EXHAUST MANIFOLD LEAKS

The following information is provided as an aid to the motor home owner of vehicles experiencing difficulty of both right and left exhaust manifold leaks. The information has been extracted from a Chevrolet Dealer Service Bulletin and intended to be used in conjunction with the right panel air flow correction described above.

Reference: Chevrolet Dealer Service Bulletin No. 86-255 (November, 1987)

Some 1981-86 vehicles with 7.4L engines and cast iron manifolds may experience a condition where an exhaust leak develops between the manifold and the cylinder head mating surface causing a "noise condition."

Starting in 1987, an improved cast iron exhaust manifold using nodular iron instead of grey iron was released on the 1987 RV vehicles with the 7.4L engine. The nodular iron manifold is less susceptible to heat warpage than the previously used grey iron exhaust manifold. This manifold can be used to repair leaking exhaust manifolds on earlier year trucks and motor homes. This manifold is **NOT** interchangeable with tubular manifolds used with the H5D (Federal Emissions NA5/NA6 equipped trucks built after July 1, 1985, with Heavy Duty Emissions and dual air pumps) emission system.

NOTE: To Install the Improved manifold, parts in Figure 7-6-A are required.

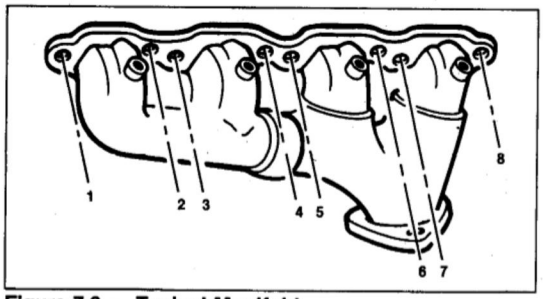


Figure 7-6 — Typical Manifold

NOTE: A recent study by our engineering department has revealed that a substantial increase in exhaust manifold life can be obtained by cutting the manifold attaching support in 3 places between bolts #2 & 3 and 4 & 5 and 6 & 7 with a metal saw which allows each runner to move independently. See Figure 7-6.

PARTS INFORMATION — IMPROVED CAST IRON MANIFOLD		
GM PART NO.	**USAGE**	**QUANTITY**
14103191	Manifold-Exhaust LH	1
10045732	Manifold Assembly-Exhaust RH	1
14053573	Stud-Exhaust Manifold LH	3
14053574	Stud-Exhaust Manifold RH	3
587575	Spring-Exhaust Manifold	6
9422297	Nut-Exhaust Manifold (3/8-16)	6
120395	Washer-Exhaust Manifold (3/8-Flat)	6
15592451	Seal Assembly-Exhaust Manifold	2
3909821	Bolt-Exhaust Manifold (3/8 x 1-3/16)	16
10017198	Plug-Oxygen Sensor (18mm) LH Side	1
5617102	Gasket-Oxygen Sensor Plug LH Side	1
10068600	Shield-Starter	1
9439915	Nut-Starter Shield (1/4-20)	2
1052771	Anti-seize Compound	1

NOTICE: THE RIGHT HAND MANIFOLD ASSEMBLY INCORPORATES A SHORTER HEAT STOVE. TO PROTECT STARTER WIRING, A HEAT SHIELD (GM PART NO. 10068600) MUST BE INSTALLED.

Figure 7-6-A

LEFT EXHAUST PIPE TO ENGINE OIL FILTER INTERFERENCE

The following information was extracted from a Chevrolet Dealer Service Bulletin relating to left exhaust manifold header pipe redesign.

Reference: Chevrolet Dealer Service Bulletin No. 86-250 (September, 1987)

Some 1985-86 P-3 models equipped with a 7.4L engine and H5D emissions may exhibit a situation where the left exhaust manifold pipe contacts the oil filter. This condition was corrected (effective S.O.P. 1987) with the release of a redesigned exhaust manifold pipe. See Figure 7-6-B. This new pipe provides increased clearances between the oil filter and the exhaust pipe.

This new exhaust manifold pipe may be obtained through GM-SPO (GM Part No. 15559924) and may be used on earlier production vehicles manufactured with a 7.4L engine and H5D emissions.

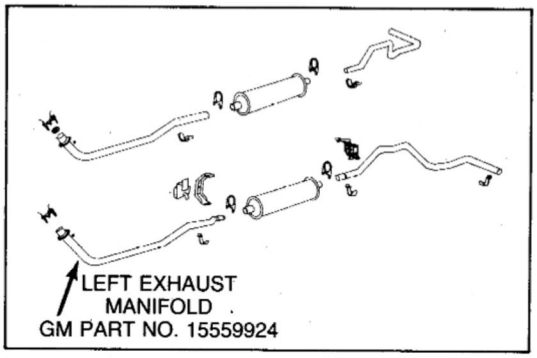


Figure 7-6-B — Redesigned Left Exhaust Manifold Pipe

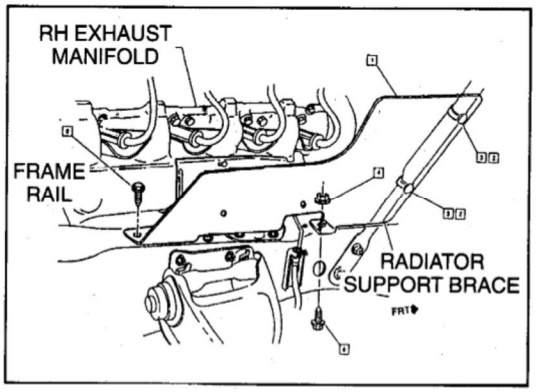


Figure 7-6-C

ENGINE LUBRICATION

GENERAL DESCRIPTION

The oil pan acts as a reservoir for holding the oil waiting to be circulated through the engine. The oil pan is attached to the bottom side or pan rail of the engine.

A pressure-feed type pump is mounted to the bottom side of the rear main bearing cap.

Extending down from the pump and into the oil, is a pick-up tube with a screen cover to filter out foreign material. Oil is picked up by this tube and pumped through the gear-type oil pump. In the gasoline engines, the distributor, driven by a helical gear on the camshaft, drives the oil pump. For the diesel engine, the pump is driven from the engine camshaft by means of an intermediate shaft. The oil is next pumped from the engine and through a cooler located in front of the radiator which cools the oil and thus helps to remove engine heat (Figure 7-7).

From the filter, the oil passes through a cooler. If this full-flow filter becomes clogged, the engine is equipped with a bypass valve which is spring loaded. This valve protects the engine from oil starvation by opening when increased pump pressure tries to pump oil through a clogged filter. When the pressure causes the bypass valve to open, the oil bypasses the filter and the engine continues to receive lubrication. Replacement of the filter at proper intervals will prevent damage to the engine due to a clogged filter.

From the filter, the oil is pumped through the drilled galleries in the case to the various moving metal parts in the engine. After being pumped to the critical engine parts, oil drains back to the crankcase. Also, as the crankshaft rotates it slings oil off the crankpins to cover cylinder wall pistons, piston pin and piston rings. Oil drains off these parts and back to the engine pan.

There is also a second bypass valve. This is the oil-cooler bypass valve. It works much the same as the oil filter bypass valve and opens to allow an alternate route for the oil if the cooler should become clogged.

There is an oil pressure switch which is assembled to the top rear of the cylinder block to sense oil pressure in the main gallery.

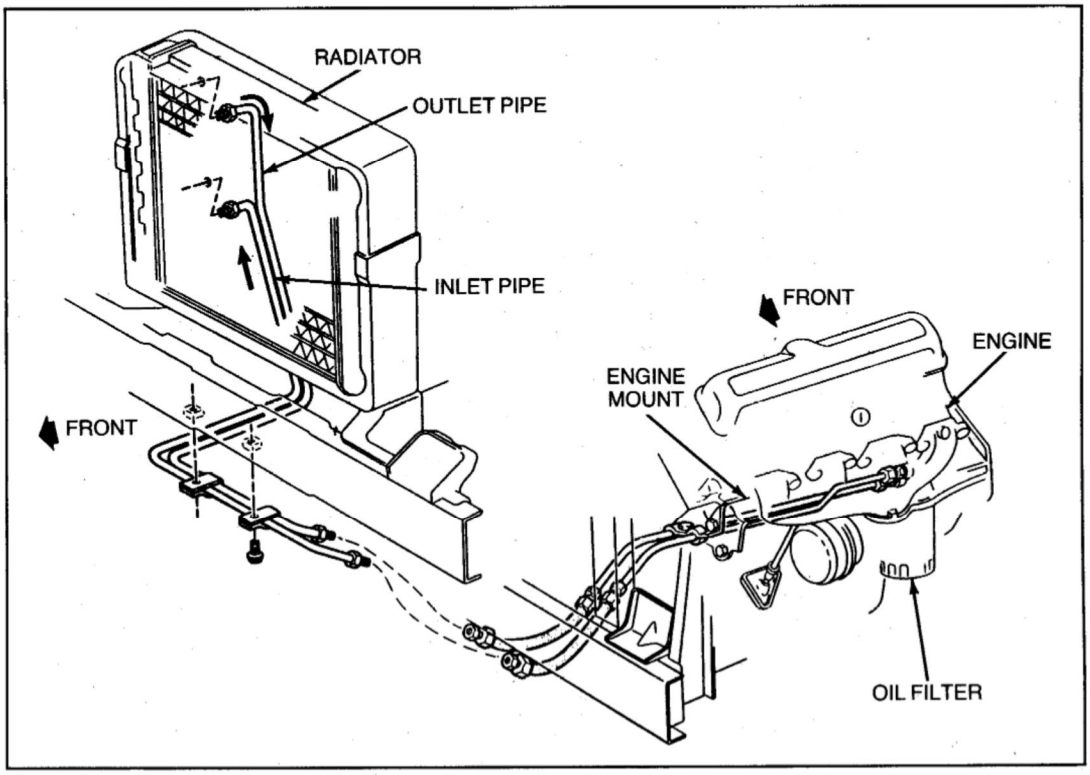


Figure 7-7 — Typical Engine Oil Cooler Installation — Mark IV — 1986 and Earlier

OILS

QUALITY

Engine oils are labeled on the containers with various API (American Petroleum Institute) designations of quality. For gasoline engines, Chevrolet recommends the use of an oil with the API designation "SG," either alone or shown with other designations such as "SG/CC." Oils which are **not** labeled "SG" should not be used. For diesel engines, Chevrolet recommends the use of oil designate of "SG/CE" or "SG/CD." Other designations including "SG" alone should not be used for diesel engines. Using oils of a quality other than those recommended for Chevrolet gasoline and diesel engines respectively could cause engine damge.

VISCOSITY

Engine oil viscosity (thickness) has an effect on fuel economy. Lower viscosity engine oils can provide better fuel economy; however higher temperature weather conditions require higher viscosity engine oils for satisfactory lubrication. **Using any viscosity oils other than those recommended could cause engine damage.**

When choosing an oil, consider the range of temperature your vehicle will be operated in before the next oil change. Then, select the recommended oil viscosity from the applicable chart shown in Figure 7-8 or Figure 7-9.

GASOLINE ENGINES — For temperatures above 0°F, SAE 10W-30, is preferred for a single-choice multi-viscosity oil. However, for heavy-duty expressway driving in summer temperatures, there can be an advantage to a single-viscosity straight SG/CD 30 oil.

NOTE: 10W-40 is missing from the chart shown in Figure 7-8. 10W-40 has been removed from all GM recommendations, because GM Research Laboratories have found generally a 1.2% fuel economy penalty compared to 10W-30. Of the oils surveyed, some contained inadequate additives or even no additives and some did not meet the 10W-40 viscosity requirements. GM testing showed 10W-40 oils tended to be more prone to high mileage ring sticking. These problems appeared more frequently in 10W-40 oils than in 10W-30 oils.

As a rule of thumb, in heavy-duty applications and sustained high-speed expressway driving, a single viscosity grade oil such as SAE 30 will be more satisfactory than multi-viscosity oils such as SAE 10W-30. Multi-viscosity oils have an advantage of cold weather starting ease and better initial lubrication with cold engine oils.

Notice that on the temperature chart shown in Figure 7-8, there is a trend away from the thinner viscosities as temperature goes up. The reason is that light oils do not have enough body for heavy-duty loads and high temperatures.

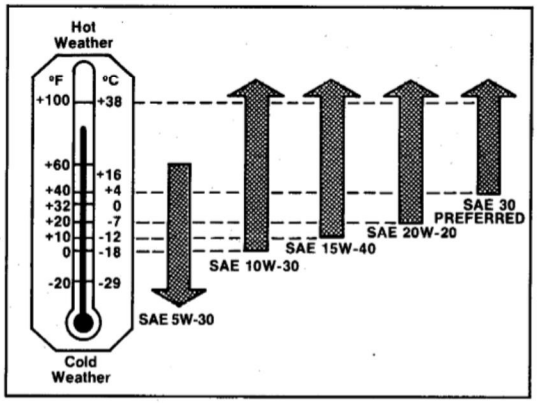


Figure 7-8 — Oil Viscosity Chart — Gasoline Engine

DIESEL ENGINES — For temperatures above 32°F, SAE 15W-40 is the preferred viscosity grade. SAE 30 oil can be used for continuous daily driving and all driving where the temperature will not be less than 32°F.

These oils combine excellent film strength with the best available additive package to prevent wear and protect against piston ring sticking at higher mileages. DO NOT USE SAE 10W-40 oils in diesel engines, because most of them can cause piston ring sticking and engine damage.

SAE 30 SG/CE and SF/CD oils are generally not suitable when temperatures fall below 32°F because of cold starting considerations. The use of SAE 15W-40 SG/CE or SF/CD at these lower temperatures (and in extremely cold areas SAE 10W-30 SG/CE or SF/CD) may be necessary.

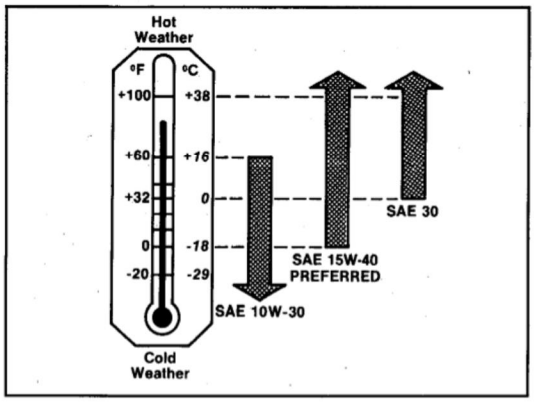


Figure 7-9 — Oil Viscosity Chart — Diesel Engine

Study the chart shown in Figure 7-9 carefully and follow its recommendations. As always, NEVER exceed the recommended oil change intervals since oil quality deteriorates rapidly with mileage, as carbon accumulates in the oil.

SG/CD oils have generally proven to be the most successful oils in diesel applications. The diesel combustion process tends to produce sticking piston rings and high-sulfur fuels create problems that SG/CD chemistry is best suited to correct. Purchase fuels with a sulfur content of less than 0.4%. When sulfur content raises to between 0.4% and 1.0%, it is a good practice to change oil at one-half the normal interval. When fuel sulfur content is above 1.0%, oil should be changed at one-fourth the normal interval.

SG/CE oils are generally best suited to gasoline engines. Gasoline engines do not have to cope with much of a sulfur problem and rarely develop ring sticking problems with proper oil change intervals. Gasoline engines, because of their temperatures and flat tappet cams, need oils of superior anti-wear properties and the SG/CE chemistry is much better for this application.

TEMPERATURE

Normal engine lube oil temperature in a heavy-duty truck engine is between the engine water temperature and 50 degrees above coolant temperature. When the temperature of the engine lube oil exceeds the temperature of the engine coolant by more than 50 degrees the engine lube oil cooler is not doing its job properly and requires immediate attention. Severe oxidation problems will occur to lube oils that are subjected to high heat and extended oil change intervals.

The oxidation rate of lube oils doubles with each 20 degrees of increase in lube oil temperature. Also, oxidation occurs in lube oil that is not being used or is in storage. Figure 7-10 indicates the expected oxidation rate of a lube oil containing a moderate amount of oxidation inhibitor under temperature increases of 20 degrees.

ENERGY CONSERVING OILS

It is recommended that you select an oil not only of the proper quality and viscosity, but also a fuel-saving product. These oils can be found in dealer service departments, service stations and other retail stores. They are identified by words such as: "Energy Conserving," "Energy Saving," "Conserves Gasoline," "Gas Saving," "Gasoline Saving," "Friction Reducing," "Improved Gasoline Mileage," "Improved Fuel Economy" or "Fuel Saving," etc. **Be sure the fuel-saving oil you choose is of the recommended viscosity and API designations.** Some fuel-saving oils **do not** meet the requirements necessary for your vehicle's engine.

SYNTHETIC ENGINE OILS

Synthetic engine oils and conventional, mineral-oil-based engine oils have some similarities. They are both blends

DEGREES F	LIFE EXPECTANCY
70	100 years
90	50 years
110	25 years
130	12 years 6 months
150	6 years 3 months
170	3 years 1.5 months
190	570.70 days
210	285.35 days
230	142.67 days
250	71.33 days
270	35.66 days
290	17.83 days

Figure 7-10 — Temperature vs. Oil Life Expectancy

of base oils and additives. In fact, most of the additives used in synthetic engine oils, are identical to those used in conventional engine oils; in at least one so-called synthetic oil, mineral oil is used as the base.

The mineral oil used in conventional engine oils is a mixture of hydrocarbons (hydrogen and carbon) obtained from crude oil pumped from the ground and refined by physical separation processes such as distillation and solvent extraction. The base oil used in most synthetic engine oils is obtained by chemical reaction processes involving materials produced from the same crude oil. For example, an acid and an alcohol can be obtained from crude oil and reacted to produce an ester — a commonly used synthetic base oil — which is a fluid composed of hydrogen, carbon and oxygen.

The performance quality of a finished engine oil, either conventional or synthetic, depends on a careful selection of the base oil and additives to produce the desired characteristics.

Chevrolet currently recommends the use of SG engine oil only. To determine whether an oil meets SG quality requirements, engine dynamometer tests (called Sequence Tests) are run which evaluate the ability of the oil to prevent wear, deposits, and rust and corrosion, as well as thickening of the oil itself.

The Sequence Tests have been carefully developed over many years to ensure that an SG engine oil will perform satisfactorily in car engines under a wide variety of service conditions. Oil change intervals are selected based on many miles of car test and field service experience. Oil quality, engine design, type of service, and change interval, must be carefully balanced to ensure satisfactory engine performance and durability. The current recom-

mended oil change intervals apply to any SG engine oil, conventional or synthetic.

Information currently available on synthetic oils does **not** justify any additional lengthening of the oil change intervals. Any engine part failures caused by using an oil beyond the recommended change intervals **will not** be covered under the New Vehicle Warranty.

MAINTENANCE AND INSPECTION

To provide proper lubrication for the engine and to help prevent engine damage, the oil level should be checked periodically to ensure that there is an adequate amount of oil. Also, the engine oil must be drained and replaced with fresh oil, and the oil filter replaced at the intervals recommended in the appropriate Maintenance Schedule.

CHECKING OIL LEVEL

- **Warm** — The best time to check the engine oil level is when the oil is warm, such as during a fuel stop. First, allow a minimum of 10 minutes for the oil to drain back to the oil pan. Then pull the dipstick out, wipe it clean and push it back down all the way.

NOTE: Failure to allow sufficient time for the oil to drain back into the oil pan can give an erroneous "low oil" reading and the appearance of excessive oil consumption. This applies to both gasoline and diesel engines. Approximately 10 minutes are required for full drain-back.

Pull the dipstick back out and look at the oil level on the dipstick. Some dipsticks are marked with "Add" and "Full" lines. Others are marked "Add 1 Qt." and "Operating Range." In all cases, keep the oil level above the "Add" line. Push the dipstick back down all the way after taking the reading. Add oil if needed.

- **COLD** — If you check the oil level when the oil is cold, do not run the engine first. The cold oil will not drain back to the pan fast enough to give a true oil level.

A good method of checking oil is as follows: At the end of a day's driving, pull the dipstick out slightly from the tube so that the tube is not sealed by the cap at the top of the dipstick. Leave the dipstick in this position overnight. Before starting the engine again the following day, seat the dipstick and check the oil level. This method will allow the oil to drain down easily and provide a more accurate reading.

CHANGING THE OIL

Oil can be drained from the engine through the drain hole in the bottom of the oil pan. Replacment oil is added through the fill tube at the top of the engine and near the radiator. Generally, the recommended oil change interval for heavy-duty service is 3,000 miles. More frequent intervals are recommended if any of the following severe operating conditions are encountered:

- Frequent long runs at high speeds and high ambient temperatures
- Operating in dusty areas
- Towing a trailer or car
- Idling for extended periods and/or low-speed operation
- Operating when outside temperatures remain below freezing and when most trips are less than 4 miles (6 kilometers).

NOTE: Refer to the owner's manual and vehicle Maintenance Schedule for the oil type, viscosity and alternate change intervals recommended for the operating conditions encountered.

CHANGING THE OIL FILTER

The oil filter is a spin-on type which can be removed with a band-type filter wrench. The replacement filter should be installed and hand tightened following the instructions with the filter.

454 ENGINE OIL FILL CAPACITY

The 454 engine used in the motor home has a crankcase capacity of six (6) quarts plus one (1) quart for the AC-PF35 oil filter for a total of seven (7) quarts. The seven (7) quart system has been in place for many years.

NOTE: After an oil and filter change, an incorrect dipstick reading could occur showing an overfill. Chevrolet has determined the problem to be in the dipstick and/or tube calibration. Through the process of converting to metric, several different parts sources, and some stack-up and assembly tolerance, it is difficult to fully understand the problem. Chevrolet has determined that there is not a durability problem with operating the seven (7) quart system down as much as two (2) quarts. Nevertheless, to comply with the original design criteria and for other technical reasons, it is recommended you verify the dipstick calibration.

An accurate procedure is as follows:

1. Drain the engine oil when hot and remove the oil filter. Allow 10 minutes for complete drain.
2. Install a new AC-PF35 oil filter and 6 quarts of oil.
3. Start engine and run 5 minutes and shut off and allow 10 minutes for oil to drain down from the heads.
4. Dipstick the engine 3 times, and with a small file, make a mark at the fluid edge in the dipstick that will indicate the new "add oil" mark.
5. Add 1 quart of oil, let set 5 minutes and again dipstick the engine 3 times and make a mark at the fluid edge which will indicate the full mark.

DIPSTICK REPLACEMENT

Some owners of the 1987 P-30 motor home chassis with 7.4L carbureted engines may realize problems with the oil level indicator (dipstick) assembly. Problems include (1.) the oil level indicator is difficult to reinstall or (2.) the gage shows an incorrect oil level.

If these conditions are encountered, they can be corrected by replacing the oil level indicator (GM Part No. 10085674). The new oil level indicator incorporates a "T" handle on the end and a twist on the shaft making it easier to install, and the new indicator has relocated oil fill level markings.

GUIDELINE FOR ENGINE OIL CONSUMPTION

The following information has been provided as a guide to the motor home owner concerning engine oil consumption. GM has produced the following guideline based upon information developed by Detroit Diesel.

Many attempts have been made by various manufacturers to establish how much oil consumption can be expected by the owner. Detroit Diesel established a series of charts that took individual engine families from the smallest to the largest. As an example, the smallest engine family (2-71) operating at 2,100 RPM could be expected in a 10-hour working period to use about one-half quart of oil. The largest engine normally used in stationary application (about seven feet high by nine feet long in an engine stand) is a 16-cylinder engine (called a 16V-71T) that normally uses 8 or 9 quarts of oil at 2,300 RPM in a 10-hour working period. In a stationary application, a very accurate prediction can be made, because the engine generally runs at a given RPM, is of a known size and is doing a given task, so the operator can easily use the charts.

Charts could be produced for gasoline engines just as well, but generally in the automotive industry most applications are not stationary uses. Rather, the normal highway usage includes everything from idle, to wide-open throttle, to pulling a trailer. You have learned from the Detroit Diesel information that the bigger the engine and corresponding horsepower the greater the thirst for oil and petroleum products. For the standard automotive application, General Motors has developed a graph illustrating the relationship between minimum acceptable engine oil consumption and fuel usage. (See Figure A7-1-1.) Engines with oil consumption below the level indicated by the "acceptable" line are potential candidates for repair. Note that engines working harder, i.e. using more fuel, will have higher oil consumption. Heavy-duty trucks, for example, will not achieve the same level of oil economy as passenger cars and, therefore, should not be considered for repair at the same levels.

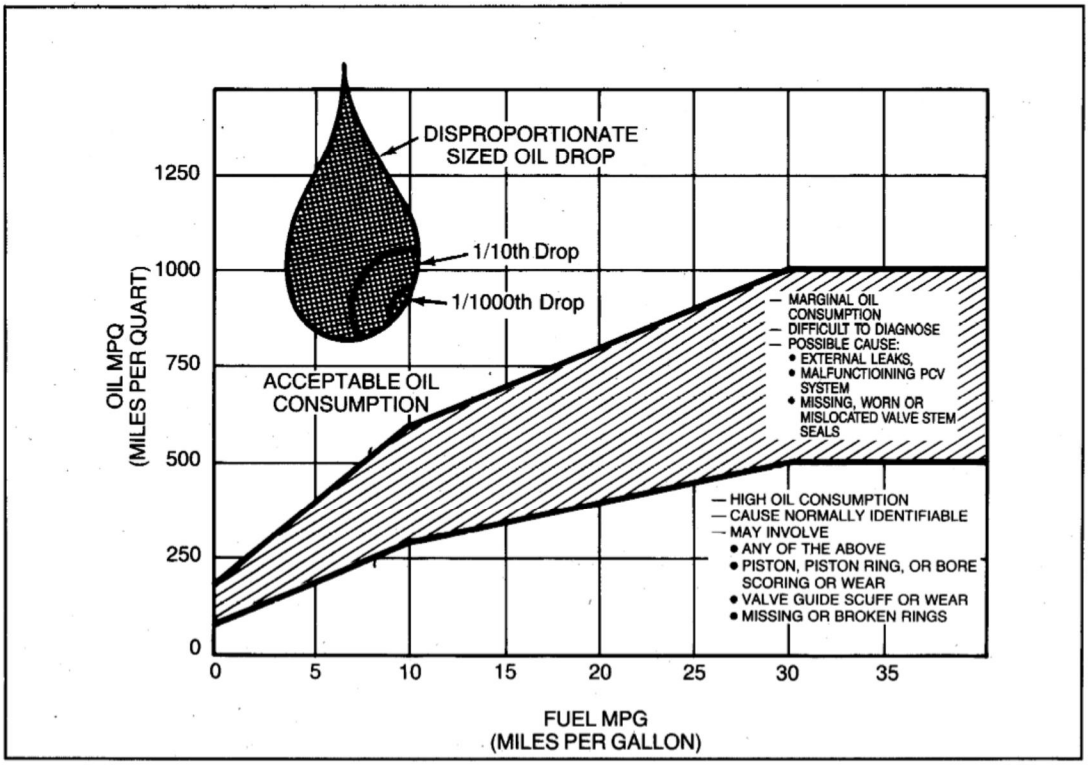


Figure A7-1-1 — Engine Oil Consumption vs. Fuel Usage

GUIDELINE FOR ENGINE OIL CONSUMPTION (Cont'd)

The graph shown in Figure A7-1-1 does not consider time as a factor, however, two time-related factors are involved: (1.) Judgements of excessive oil consumption should not be made until the engine is fully broken in (approximately 5,000 miles) and (2.) A sudden or significant change in oil consumption (when operating conditions remain the same) should be considered when deciding if repair is justified.

Engines with very high oil consumption normally have obvious, easily diagnosed causes. Scuffed bores, broken or overlapped rings, or worn valve guides or seals are typical examples.

Engines with marginally high oil consumption (indicated by the darkened section of the graph in Figure A7-1-1) are very difficult to diagnose even after disassembly. In these cases, initial efforts to correct the complaint should be directed at replacement of easily accessible items like gasketed areas with heavy leakage, PCV valve or oil separator, or valve stem seals, and verifying that the owner is using the best weight engine oil for the operating temperature before starting heavy repair in the piston ring and bore area.

Manufacturers of power piston rings state that piston rings in today's engines, control oil very effectively. If 1/10th of a drop of oil would be consumed per explosion when driving at 60 MPH, an eight-cylinder vehicle would use about 90 quarts of oil on a 600-mile trip. The actual average consumption of oil per explosion in today's engines is from 1/1,000th to 2/1,000th of a drop.

NOTE: If a service technician determines that your engine valve seals need replacement, the recommended seals for the 454 engine are the Orange VITON engine seals (GM Part No. 460527). VITON is an extremely good material for heavy-duty usage and is standard in the 454 & 427 truck engine.

ENGINE COOLING SYSTEM

GENERAL DESCRIPTION

To remove the excess heat from the engine and to maintain normal engine operating temperatures, both of the gasoline engines, and the 6.2L diesel engine use liquid cooling systems. Components of a typical system include a pump, thermostat, radiator, coolant recovery tank and hoses.

In operation, the pump circulates coolant through passages in the engine cylinder block and heads where it absorbs heat. The **hot** coolant flows out of the engine through a hose to the radiator. In the radiator, the coolant loses heat to the outside air circulating around the radiator core tubes. Cooled coolant then flows out of the radiator, through a hose back to the engine.

The engines have pressure-type cooling systems with thermostatic control on coolant circulation. The cooling system is sealed by a pressure-type radiator filler cap which causes the system to operate at higher-than-atmospheric pressure.

The higher pressure raises the boiling point of the coolant which increases the cooling efficiency of the radiator. The 15-pound pressure cap used raises the boiling point of coolant to approximately 262°F at sea level.

All models have a closed cooling system using a round pressure cap (Figure 7-11) and a coolant reservoir. Coolant can be added without removing the radiator cap.

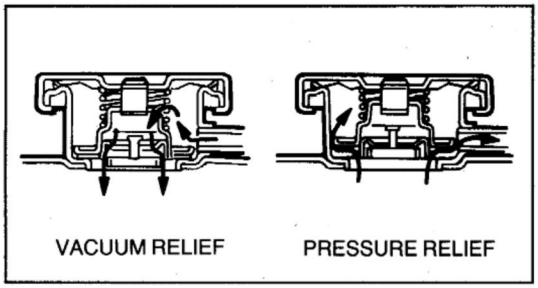


Figure 7-11 — Radiator Pressure Cap

A pressure-vacuum valve radiator cap (Figure 7-11) is used. As the engine warms up, pressure is developed due to the temperature expansion of the coolant. When pressure reaches the preset cap value (usually 15 PSI), the big spring compresses and the large gasket contacting the radiator neck unseats and allows the surplus coolant and air to flow into the coolant overflow tank. As the system cools upon shutdown, the coolant shrinks in volumetric size creating a partial vacuum in the radiator. This partial vacuum overcomes a small hidden spring and the very center relief valve of the cap unseats. Consequently, coolant from the overflow tank returns to the radiator to start the process over again.

Using the pressure relief cap in conjunction with the overflow tank, the design intent is to assure a 100 percent filled radiator at all times with any air or bubbles being pushed out of the radiator into the overflow tank. However, if the coolant level is too low initially, the cycle between the system and reservoir will not take place.

THERMOSTAT

The thermostat consists of a restriction valve actuated by a thermostatic element to help regulate the operating temperature of an engine. This is mounted in the forward part of the intake manifold, under the coolant outlet on the 5.7L and Mark IV gasoline engines and in the coolant crossover pipe located at the front of the engine on the 6.2L diesel (Figures 7-12 and 7-13). Thermostats are designed to open and close at predetermined temperatures.

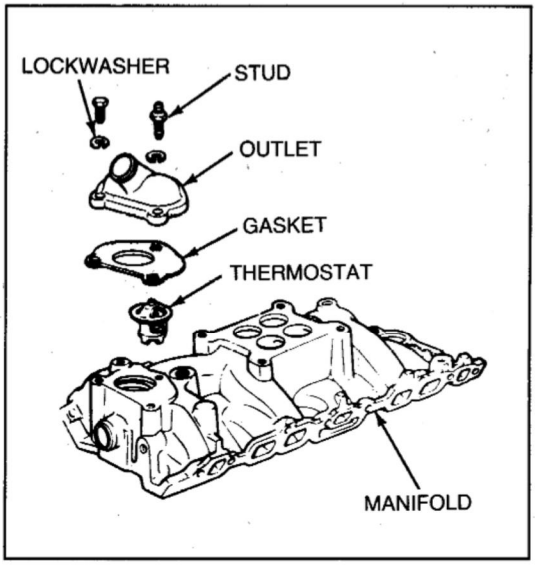


Figure 7-12 — Coolant Thermostat Location — 7.4L Mark IV Gasoline Engine

All Chevrolet engines have a pellet-type thermostat (Figure 7-14) which is used in the coolant outlet passage to control the flow of engine coolant. It provides fast engine warm-up and regulates coolant temperature levels. A wax pellet or power element in the thermostat expands when heated and contracts when cooled. The pellet is connected through a piston to a valve. When the pellet is heated, pressure is exerted against a rubber diaphragm which forces the valve to open. As the pellet is cooled the contraction allows a spring to close the valve. Thus, the valve remains closed while the coolant is cold, preventing circulation of coolant through the radiator, but allowing the coolant to circulate through the engine to warm it quickly and evenly.

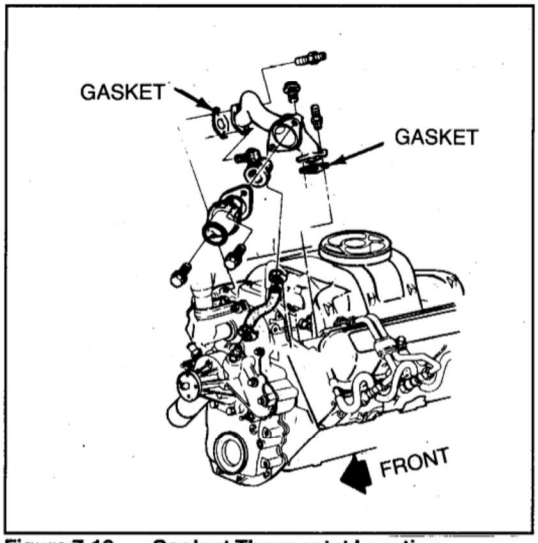


Figure 7-13 — Coolant Thermostat Location — 6.2L Diesel

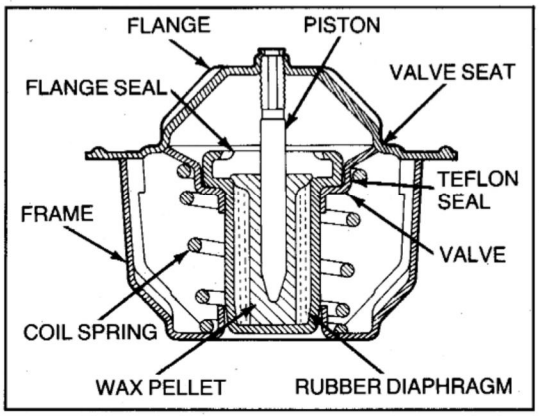


Figure 7-14 — Thermostat — Typical

As the engine becomes warm the thermostat pellet expands and the thermostat valve opens, permitting the coolant to flow through the radiator where heat is passed through the radiator walls. This opening and closing of the thermostat valve permits enough coolant to enter the radiator to keep the engine operating temperature above the lowest operating value stamped on the thermostat.

The engine thermostat is often the first item that is suspected and replaced when the engine overheat condition is encountered. The thermostat is only designed to keep the engine operating temperature above the thermostat minimum or rated temperature. It has no way to control temperature above this. If an engine is overheating, replacing a thermostat rated at 195°F with one rated at 165°F would not reduce the maximum operating temperature 30 degrees. If an engine is overheating, it is obviously operating above both 165 and 195 degrees Fahrenheit.

ENGINE COOLING FANS

Both the 5- and 7-blade engine cooling fans tend to be very noisy and draw a lot of horsepower. By varying the fan speed, both horsepower losses and noise are lowered except in maximum cooling demand situations. According to numerous industry tests, maximum cooling is required less than five percent of the total vehicle time. With the fan operating on low speed 95 percent of the time, there is a reduction in noise level and substantial savings in fuel.

The fan should be viewed as a two-speed fan — low and high speed. When in the hi-speed mode, the noise level will be more than double. Noise levels are somewhat logarithmic in nature. Viscous drive fans always provide some air flow across the radiator and air conditioning. This type of fan drive also helps maintain design temperature differential between inlet temperature and outlet temperature to a 10°F and 15°F differential at maximum engine speed and load. Good cooling system design avoids excessively cold coolant from going back into the bottom of the block. School bus engines will sometimes have heat shock problems because in addition to the radiator there are as many as four or five heater-and-defrosters and very long lines removing large amounts of heat from the coolant above and beyond the radiator capacity.

The variable drive fan is controlled by a temperature-sensitive clutch. (See Figure 7-15.) The clutch housing is constructed of lightweight metal which is filled with silicone oil and hermetically sealed.

Thermostat control of the fluid clutch permits the fan to operate only when additional air flow is required to reduce radiator coolant temperatures. During periods of operation, when radiator discharge air temperature is low, (below approximately 150°F), the fan clutch limits fan speed to 800-1,400 RPM. At this RPM, the clutch is disengaged since a small oil pump, driven by the separator plate, forces the silicone oil into the reservoir between the separator plate and the front cover assembly. Also the passage from this cavity to the clutch area is closed by a sliding valve. (See Figure 7-16, Line A.)

As operating conditions produce a high radiator discharge air temperature (above approximately 150°F), the temperature-sensitive bimetal coil tightens to move the sliding valve plate, allowing the flow of silicone oil into the clutch chamber to engage the clutch, providing maximum fan speed of approximately 2,200 RPM. (See Figure 7-16, Line B.)

The clutch coil is calibrated so that with a road load at an ambient temperature of approximately 90°F, the clutch is at a point of shifting between high and low fan speeds.

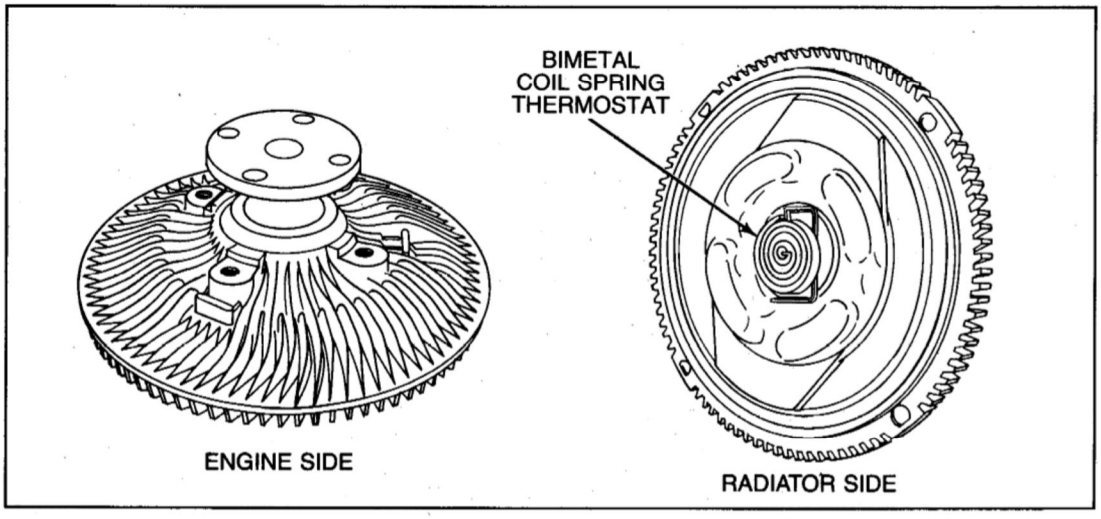


Figure 7-15 — Engine Cooling Fans

NOTE: The 2nd design was interim 1988 to 4-1-89. The 3rd design started 4-2-89. Part #15643265 stamped RL — the clutch is engaged at all speeds to help reduce the radiator temperature and fan noise. It engages only the amount required to keep the radiator within the operating temperature.

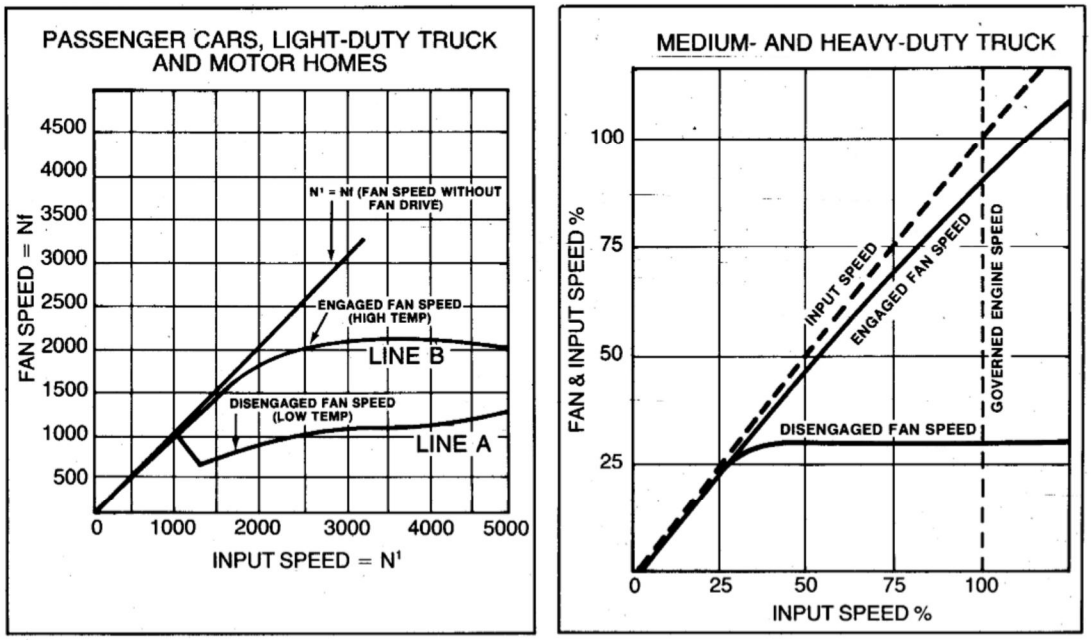


Figure 7-16 — Typical Speed and Temperature Modulations

No attempt should be made to adjust the calibration of the engine fan clutch assembly as each assembly is individually calibrated at the time of manufacture.

In extreme high temperature for rescue and multi-stop delivery vehicles or winter snowplow applications where the snow blade interferes with air flow, disconnecting the fan clutch thermostat control increases air flow through the radiator by allowing the fan speed to more closely follow engine speed until approximately 2,000 RPM.

To disconnect the bimetal coil spring thermostat on Eaton and Delco types, move the spring end tab out of the retaining slot and position counterclockwise (Figure 7-17).

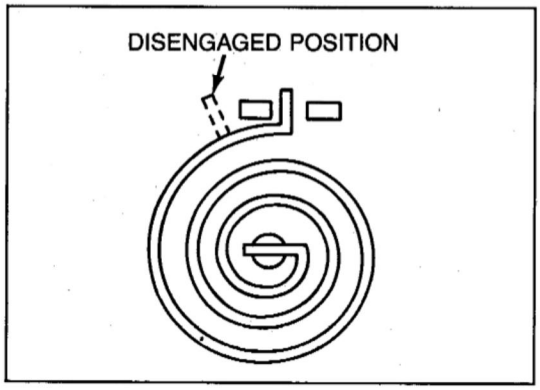


Figure 7-17 — Spring End Tab

CAUTION: DO NOT REMOVE THE SPRING COMPLETELY. COMPLETE REMOVAL OF THE SPRING CAN CAUSE THE FAN TO "FREE WHEEL" AND CAUSE OVERHEATING.

RADIATOR/HEATER AND ENGINE DEAERATION SYSTEM (After 1983 Model)

Heavy-duty cooling equipment is required when air conditioning or auxiliary belt-driven equipment is installed.

Continuous coolant flow is necessary from the heater connection on the engine to the heater connection on the radiator to control oil temperatures during closed thermostat (warm-up) operation. Shutting off this flow may result in premature engine or transmission failure.

If a heater unit is not installed in the vehicle or a heater shut-off valve is required, a line connecting the heater connection on the engine to the heater connection on the radiator must be installed. When a shut-off valve is required in the heating system, it must be "tee'd" into the system in such a manner as to maintain a continuous flow between the engine heater connection and the radiator heater connection at all times.

NOTE: The heater hose routing should not be altered from the standard system. If an auxiliary heater is added, it should be routed similarly to the RPO (C36) rear heater. Where the heater water return is routed to the radiator outlet tank, a shut-off valve should not be placed in the heater circuit.

A nipple has been provided in the radiator outlet tank for heater return water (Figure 7-18). The temporary rubber shipping cap should be removed, and the heater return (suction) hose should be attached to the radiator nipple using the clamp supplied with the shipping cap.

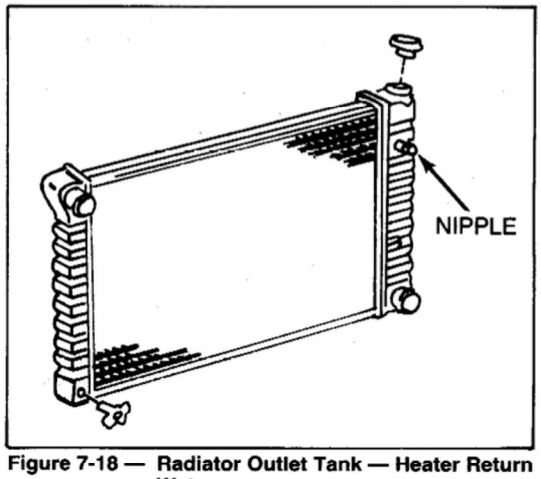


Figure 7-18 — Radiator Outlet Tank — Heater Return Water

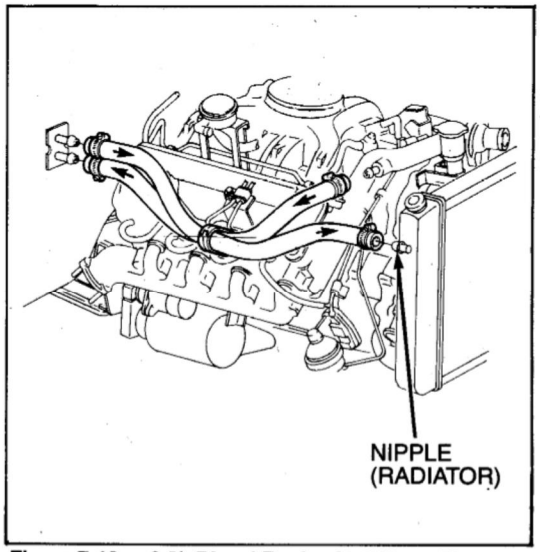


Figure 7-19 — 6.2L Diesel Engine Hot Water Flow

The 454 CID gasoline engine is essentially the same as the 6.2L diesel engine shown in Figure 7-19 except that hot water comes from the thermostat housing. Hot water enters the bottom of the heater core and exits out the top for better heat dissipation.

MAINTENANCE AND INSPECTION

The coolant level, appearance and strength should be checked periodically. It should be drained and replaced at the intervals recommended in the Maintenance Schedule, or sooner if it is dirty. Hoses should be checked regularly for signs of damage or deterioration and hose clamps tightened if necessary.

Check hoses for cuts or abrasion damage. If the hoses have become hard and brittle and show signs of cracking as a result of engine heat, they should be replaced. Hoses should also be replaced if they are soft and spongy, or swollen as a result of exposure to oil and grease. Any flaking or deterioration of the inner lining of the hose is also reason for replacement. Such particles can clog the cooling system, reducing its efficiency.

The radiator cap should be washed with clean water and pressure checked every 12 months.

COOLANT LEVEL

The need for additional coolant can be detected by observing the level of coolant in the "see through" reservoir while the engine is at normal operating temperature. The radiator cap need not normally be removed. (See Figure 7-20.)

The coolant level should be at the "Full Cold" mark when the system is cool or at ambient temperature. After the vehicle has been driven sufficiently to obtain normal operating temperatures, the level should be above the "Full Cold" mark.

Periodically, the radiator cap should be removed to observe coolant level in the radiator.

CAUTION: TO HELP AVOID THE DANGER OF BEING BURNED, DO NOT REMOVE THE RADIATOR CAP WHILE THE ENGINE AND RADIATOR ARE STILL HOT. SCALDING FLUID AND STEAM CAN BE BLOWN OUT UNDER PRESSURE IF THE CAP IS TAKEN OFF TOO SOON.

Coolant levels in any radiators with coolant recovery bottles should be maintained to the top of the filler neck.

The recovery bottle should be at its appropriate mark when checking.

Regardless of whether freezing temperatures are expected or not, cooling system protection should be maintained at least to −34°F, to provide adequate corrosion protection and loss of coolant from boiling. When adding solution due to a loss of coolant for any reason or in areas where temperatures lower than −34°F may occur, a sufficient amount of an ethylene glycol based antifreeze that meets GM specification 1825-M should be used (GM Part No. 1052753 — Gallon or equivalent).

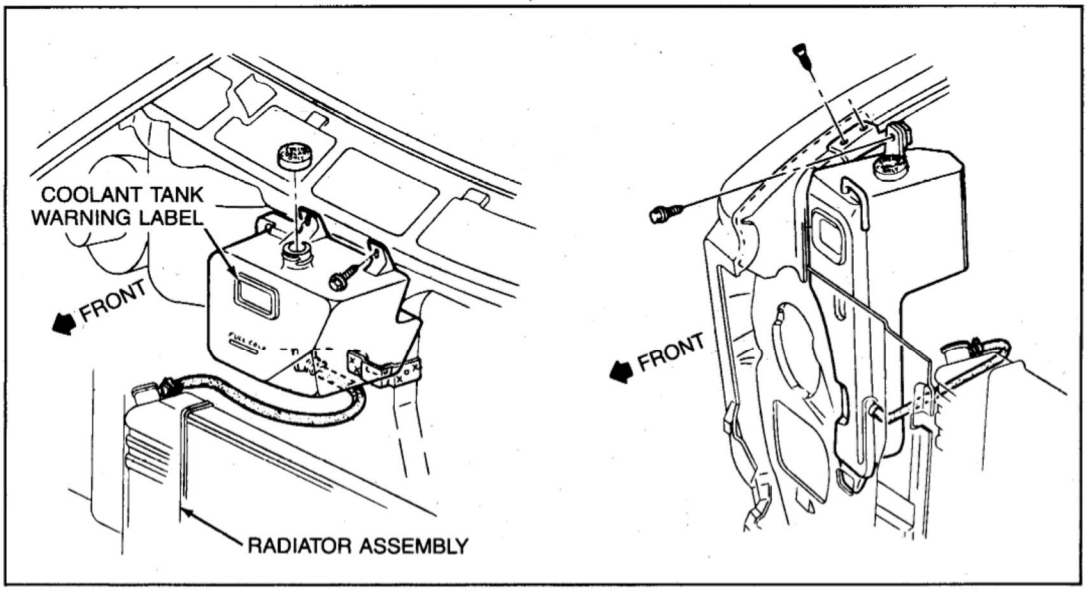


Figure 7-20 — Coolant Recovery Bottle

Antifreeze with a glycol content less than required for −34°F protection, also has a boiling point that is less than the temperature indicating light setting. The chart shown in Figure 7-21 shows the boiling point of water and of glycol in relation to pressure, and as CONCENTRATED ANTIFREEZE IS FLAMMABLE the chart shown in Figure 7-22 shows the relationship of the freeze point/flash point of antifreeze at various percentages by volume of solution. Understanding this potential fire source requires studying the chart of Figure 7-21 in relation to the information presented in Figure 7-22. It should be noted that an antifreeze related fire is the result of sustained driving while the vehicle is in an "overheat condition" indicated by a full scale reading of the temperature gage and/or steam from under the hood. These fires appear after catastrophic engine damage has occurred.

PRESSURE (LBS./SQ. IN.)	BOILING POINT (°F)	
	WATER	GLYCOL MIX (50/50)
0	212	223.5
1	215.3	227.2
2	218.5	230.0
3	221.6	233.0
4	224.6	236.0
5	227.4	238.8
6	229.8	241.6
7	232.8	244.0
8	234.8	246.2
9	237.1	249.2
10	239.4	251.7
11	241.6	254.5
12	243.7	256.3
13	245.7	258.3
14	247.8	260.3
15	249.7	262.5
16	251.7	264.4
17	253.6	266.2

Figure 7-21 — Boiling Point vs. Pressure Chart — Water/Glycol

NOTES:

- Factory-installed temperature gages have been calibrated so the owner sees a mid-range reading as the "normal" operating temperature. The reason for this is that many owners tend to perceive 212°F as the boiling point. However, this is not the case in an engine with a 15-lb. pressure system and a 50/50 solution of glycol and water, as shown in Figure 7-21. If the engine is equipped with a master gage or with one of the various digital electronic gages installed by RV manufacturers, the temperature reading of the engine will be higher than that of the factory-installed system. No matter which gage system is utilized, the motor home owner must realize that the purpose of any gage is to provide a warning of any rapid change in temperature from the "normal" reading of that particular gage.

FREEZING POINT & BOILING POINT	TEMPERATURE	
	FREEZE	BOIL*
33% by Volume Solution	0°F	220°F
40% by Volume Solution	−12°F	222°F
50% by Volume Solution	−34°F	227°F
60% by Volume Solution	−63°F	232°F
68% by Volume Solution (Maximum Freezing Protection)	−90°F	241°F
Concentrated	−8°F	320°F
Flash Point (Cleveland Open Cup)		
68% by Volume Solution		None
Concentrated		257°F
Fire Point (Cleveland Open Cup)		
68% by Volume Solution		None
Concentrated		266°F

* At sea level atmospheric pressure. The boiling point **decreases** about 2 degrees Fahrenheit per 1,000 feet of altitude and **increases** about 2.5 degrees Fahrenheit per pound of pressure developed in the system.

Figure 7-22 — Coolant Freeze Point/Flash Point

- Alcohol- or methanol-based antifreeze, or plain water, are not recommended for your engine at any time. They will not provide proper protection against corrosion.

- Additives in addition to a good quality ethylene glycol based antifreeze meeting the GM specifications are **not** required or recommended. Many of the claims for additives are associated with better heat transfer or cooling, but these claims are not supported by test data. In some instances, the ingredients may be incompatible with the recommended coolant. Also, when used alone with water as is sometimes suggested, the additive may not provide the corrosion protection given by the recommended coolant solution.

THERMOSTAT CHECK

If the thermostat is suspected of not operating properly, it can be removed and tested as follows:

1. Disconnect the battery negative cable at the battery.
2. Drain the cooling system until the radiator coolant level is below the thermostat.
3. Remove the coolant outlet attaching bolts and remove the outlet and thermostat.
4. Hang the thermostat on a hook in a minimum of 33% glycol solution at 25 degrees above the temperature stamped on the thermostat valve. Submerge the valve

completely and agitate the solution thoroughly. Under this condition, the valve should open.

5. Remove the thermostat and place it in a 33% glycol solution that is 10 degrees below the temperature indicated on the valve. With the valve completely submerged and the solution agitated thoroughly, the valve should close completely.

If the thermostat tests O.K., it can be reinstalled. If not, it should be replaced.

Prior to installing the thermostat, make sure the thermostat housing and coolant outlet sealing surfaces are clean.

1. Place a 1/8-inch bead of RTV sealer (GM Part No. 1052366 or equivalent) all around the coolant outlet sealing surface on the thermostat housing.
2. Place the thermostat in the housing.
3. Install the coolant outlet while the RTV sealant is still wet. Torque the retaining bolts to 20 ft. lbs.
4. Connect the battery negative cable.
5. Fill the cooling system with an ethylene glycol antifreeze and water mixture of 50/50.
6. Start and run the engine with radiator cap removed until the radiator upper hose becomes hot (thermostat open).
7. With the engine idling, add coolant to the radiator until the level reaches the bottom of the filler neck.
8. Install the cap, making sure arrows line up with the overflow tube.

FLUSHING COOLING SYSTEM

Various methods and equipment may be used to perform this service. If special equipment such as a back flusher is used, equipment manufacturer's instructions should be followed. However, it is advisable to remove the thermostat before flushing the system.

RADIATOR ADDITIVES

The following information has been extracted from GM Research Laboratories investigations concerning radiator additives for the prevention of overheating in the engine cooling system. The information is provided as an aid to the motor home owner in understanding the effects of using radiator additives.

The object of the investigation was to review the use of radiator additives that are being marketed with the claim that they improve heat transfer and reduce the coolant temperature in the engine cooling system.

Conclusions were:

1. These radiator additives are composed principally of either water, ethylene glycol, or a combination of the two, and inhibitors such as those commonly used in antifreezes. Some additives contain oil and/or a surface active agent.

2. Tests with these additives fail to show any added benefit in heat transfer or reduction in coolant temperatures.

3. When these additives are used with water alone, they will probably provide less corrosion protection than an antifreeze used at the recommended concentration; when used with conventional water-glycol solutions, the additive inhibitors may not be compatible with those from the glycol antifreeze.

4. Engine damage may result from loss of coolant due to overheating if the vehicle owner follows the recommendation to use these additives with water alone. (The boiling point of water is below the temperature at which the warning light is activated and the driver may not receive warning of a boiling condition.)

5. It is recommended that a strong position be taken against the use of these additives.

There has been a proliferation of additive products on the market that are purported to increase the cooling capability of the cooling system. These products are usually sold in one-quart containers at a price ranging between $2.00 and $3.50.

Although a number of claims are made for these products, such as added corrosion protection, the removal of scale, and pump lubrication, the principal claim is that associated with improved cooling.

The major portion of these additives is either water, ethylene glycol, or a mixture of the two. Inhibitors have been added that are typical of those commonly used in antifreeze or in summer inhibitor additives. Some of the inhibitors in the additives may be incompatible with inhibitors in antifreeze solutions; for example chromates are often incompatible with ethylene glycol antifreeze. If the additives are used with water alone, the inhibitors may not provide sufficient protection to all metals, and in some cases they may cause excessive corrosion; for example, amine inhibitors are aggressive to copper alloys and nitrite attacks solder unless other inhibitors are present to compensate for these effects.

The one variant in some cases is the use of a surface active agent that may increase heat transfer at a metal surface. One laboratory has shown increased heat transfer under controlled laboratory conditions but not in automotive service. However, surface active agents are often unstable at high temperatures, and they would not be expected to endure for long. The disadvantage of the surface active agent, as well as oil, is its tendency to cause increased foaming in the cooling system.

Most of the claims are associated with better heat transfer or cooling, but these claims are not supported by test data. Since the bulk of the material is water or ethylene glycol, it should not be expected that the addition of these additives would prevent overheating or make the engine run any cooler than when a quart of water or antifreeze had been added. It is possible that, in practice, the addition of a quart of this material may restore the coolant to the proper level, which provides better cooling, but so would the addition of water or ethylene glycol antifreeze.

The claim that these additives provide better heat transfer when added to water alone, is apparently based on the fact that they contain inhibitors that prevent the formation of corrosion products that would impair heat transfer. However, the suggestion that they can be used with water alone may offer a problem. First, the concentration of inhibitors may be less than that normally provided by a good antifreeze at the minimum recommended concentration of 33-1/3 percent and second, the inhibitors may not be as effective in preventing corrosion as those in a well-formulated antifreeze. Furthermore, the boiling point of water is 12 degrees lower than that of a 44 percent ethylene glycol solution (262°F vs. 250°F at 15 PSIG), and this may lead to loss of coolant and damage to the engine because the warning light is set to come on at higher temperature than that of the boiling point of water.

ENGINE COOLING INSTRUCTIONS TO RV MANUFACTURERS

The following information is provided as an aid to the motor home owner in understanding the essentials of the engine cooling requirements as provided to major RV manufacturers. All chassis manufacturers (Chevrolet/GMC, John Deere/Ford, Dodge) furnish the various RV manufacturers with Body Builders Books which provide basic instructions for the correct building procedures on an individual chassis.

Essential engine cooling requirements are:

1. All chassis manufacturers require a minimum grille opening stated in square inches to provide sufficient air to cool the manufacturer's engine. The instructions also indicate the grille to be a minimum of four inches from the radiator core. Listed below are the minimum frontal areas for the major manufacturers.

   Chevrolet/GMC .....360 square inches
   John Deere/Ford .....530 square inches
   1976 Dodge.....367 square inches
   1979 Dodge.....430 square inches

   Dodge and John Deere specify a maximum 45-degree air entry angle.

2. Large objects should not be placed in front of the radiator core or grille such as batteries, spare tires, washer bottles, coolant overflow tanks, bicycles, etc., as these types of items restrict air flow to the radiator core.

3. The grille opening should be "open" in configuration. Small holes for the grille opening tend to restrict air flow more than large holes although both may have the same frontal area.

4. Cooling can be improved by inserting filler panels between the outer vertical side edges of the radiator and grille. In addition, a filler panel should be fitted horizontally from the bottom of the radiator out to the bottom of the grille. This will prevent air from by-passing the radiator and exiting through the front wheel house area or under the radiator. These panels will force the air through the radiator.

5. A flexible air-tight seal must be provided between the upper radiator support and the body to aid idle cooling and prevent hot air recirculation. The seal assures that incoming "ram air" must go through the radiator core rather than by passing the radiator core (going up and over the core).

6. Bug screens should be avoided if at all possible. If conditions require a bug screen, motor home owners are advised to be alert to possible engine overheating problems as well as temperature changes. The screen's mesh should be — at most — half as dense as that of standard household screening. Household screening will create an overheating condition. The bug screen should be removed immediately upon leaving the bug infested area.

ENGINE FUELS

GASOLINE ENGINE

Fuel Types

Unleaded Gasoline — (*In GM Vehicles Designed for Leaded Fuels*) The need for leaded gasoline in the U.S. is decreasing as older vehicles designed for leaded gasoline are replaced with new ones requiring unleaded gasoline. Furthermore, the U.S. Environmental Protection Agency (EPA) began phasing down the concentration of lead in leaded gasoline during July, 1985. These two facts taken together could result in limited supplies of leaded gasoline being available for vehicles designed for such fuel.

The lead phasedown was based on health considerations and a desire to eliminate fuel-switching — the practice of using leaded gasoline in vehicles equipped with catalytic converters. Due to the fact that lead destroys the emission control properties of catalysts, leaded gasoline should not be used in engines equipped with these devices. GM supports this EPA effort to reduce lead emissions and to reduce fuel-switching.

All GM gasoline-fueled engines in (1.) passenger cars starting in 1971, (2.) 1971-78 trucks **less** than 6,000 lbs. GVW, and (3.) trucks **less** than 8,500 lbs. GVW starting in 1979, were designed to use unleaded gasoline and are unaffected by lead reduction efforts.

For all GM gasoline-fueled engines in (1.) pre-1971 passenger cars and trucks, (2.) 1971-78 trucks **over** 6,000 lbs. GVW, and (3.) trucks **over** 8,500 lbs. GVW starting in 1979, concerns exist about engine knock and exhaust valve seat durability when such engines are operated on gasoline without lead.

The octane quality of leaded regular gasoline is generally higher compared to unleaded regular gasoline. Thus, switching from leaded regular to unleaded regular in vehicles designed for leaded regular may cause some engines to knock. Occasional light knock is of little concern. However, persistent, heavy knock can cause engine damage and should be avoided. Two alternatives are available to avoid knock. The first is to use unleaded premium gasoline (or a mixture of unleaded regular and unleaded premium). The other is to retard the engine's basic spark timing.

The lead in gasoline creates a "cushion" between the valve and valve seat to minimize wear. Valve seat wear is aggravated by operating at high engine speeds and loads, particularly for long periods of time. Engines designed to use unleaded gasoline have hardened valve seats to compensate for the removal of lead.

Engines designed to use leaded gasoline can avoid excessive wear if operation is limited to reasonable speeds and loads. However, if excessive valve seat wear does occur, cylinder heads may be rebuilt with hardened valve seat inserts to avoid recurrence of the problem.

For those engines designed for leaded gasoline, GM recommends that they continue to be fueled with leaded gasoline as long as such gasoline is available.

Lead Substitute Additives — GM has **not** issued a service bulletin recommending the use of any lead substitute additive by the individual customer. GM has taken the position that many additives on the market today do not have sufficient data and testing to factually back up some of the claims being made. Some additives may in fact actually be counterproductive to the government's reasoning for lead removal and create undesirable emissions problems as well as being detrimental to overall engine life. There is a consensus among fuel and lube engineers that the use of lead substitute additives should **not** be a consumer decision and that if the **need** for an additive becomes established, the product should be blended into the gasoline as the fuel is produced by the the gasoline supplier to ensure better chemistry control.

Gasohol — Gasohol, a mixture of 10 percent ethanol (grain alcohol) and 90 percent gasoline may be used in Chevrolet gasoline engines without voiding the warranty. However, because of the composition of gasohol, engines will tend to operate leaner with gasohol than with gasoline. This can result in drivability conditions usually associated with leaner mixtures. Also the increased volatility of gasohol can contribute to hot weather drivability problems if adjustments are not made to the gasoline blend during the refining process.

The higher octane rating of gasohol compared to most unleaded gasolines, could help reduce the tendency for spark knock. But, gasohol contains less energy than gasoline, and fuel economy may or may not be quite as good. However, in some instances, depending on the entire design and calibrations, and certain operating conditions, it is possible to get improved fuel economy.

Exhaust emission levels may change up or down with the use of gasohol, again, depending on the calibration of the engine. At the present time, however, the EPA has not restricted the use of gasohol.

If gasohol is spilled on a painted surface, some dulling or softening of the paint may result.

NOTE: Refer to the information contained in Appendix 7-4 and Appendix 7-5 at the end of this section of the manual concerning the use of gasohol in vehicles equipped with gasoline engines, and potential problems of using methanol/gasoline blends.

DIESEL ENGINE

Fuel Types

NOTE: Do not use starting fluids. Such aids can cause immediate engine damage.

Diesel fuel is available in No. 1 or No. 2 grades. The difference between the grades is that No. 1 diesel fuel has had much of the paraffin (wax) removed. While the wax content increases the amount of energy in the fuel, it can clog the fuel filter(s) in cold weather, and stop the flow of fuel to the engine.

The Cetane Number used in rating diesel fuels is an indication of the energy content of the fuel — the higher the Cetane Number, the higher the energy content. The higher Cetane rating will improve the cold-starting performance of the engine, as long as the higher wax content does not impede the flow of fuel through the system. This introduces two other factors which affect diesel fuel — Cloud Point and Pour Point. The Cloud Point represents the temperature at which a predetermined percentage of the wax content in the fuel solidifies. The Pour Point represents a lower temperature at which the fuel cannot be made to flow.

The moisture content of the fuel can also affect cold weather starting and performance. Water can separate out of the fuel, settling in low points of the fuel line and freezing, or forming minute ice particles which flow into the filter(s) and tend to clog the filter(s).

Additives can be used to lower the Pour Point of the fuel, and to prevent moisture freezing in the fuel. However, additives will have little effect on the Cloud Point. Mixing different grades of diesel fuel can also be used to change the Pour Point and to change the Cloud Point as well.

USE OF GASOHOL IN GASOLINE ENGINES

The following information was extracted from a Chevrolet Dealer Service Information Bulletin relating to the use of gasohol in vehicles equipped with gasoline engines.

Reference: Chevrolet Dealer Service Information Bulletin No. 80-I-3 (July, 1979)

Gasohol, a fuel generally composed of 10 percent ethanol (grain alcohol) and 90 percent gasoline, is receiving considerable attention as a fuel for gasoline engines. It is possible that other kinds of alcohol, such as methanol (wood alcohol) may be added to gasoline in the future; however, this bulletin deals only with gasohol containing up to 10 percent ethanol. (Gasohol containing methanol is not being marketed at this time.) The purpose of this bulletin is to provide information which may be helpful in answering questions about gasohol which may arise regarding:

- Availability
- Drivability
- Fuel Economy
- Service Adjustments
- Warranty Coverage
- Emission Levels

Availability

Gasohol currently is available at many retail stations in the Midwest and some retail stations on the East Coast. Nationwide availability is expected to increase.

Drivability

Due to the composition of gasohol, vehicles equipped with gasoline engines will operate leaner with gasohol than with gasoline. This leaner operation with gasohol may tend to cause drivability conditions usually associated with leaner mixtures. However, drivability of vehicles with Computer Controlled Catalytic Converter (C-4) or Closed Loop Catalytic Converter (CLCC) Systems probably will be affected less, because these systems compensate for the leaning effect of gasohol.

NOTE: (Provided as a reference for the motor home owner.) If your vehicle is several years old, you should plan on changing all of the fuel filters at least once and the carburetor filter more than once. The reason given for this is that alcohol in itself is a solvent which dissolves the deposits left by gasoline in the fuel system.

The increased volatility of gasohol also can contribute to hot-weather drivability problems if, during the refining process, adjustments are not made to the gasoline blend. In general, gasohol has a higher octane rating than most unleaded gasolines, and it could help reduce the tendency for spark knock.

Fuel Economy

Gasohol (10 percent ethanol, 90 percent gasoline) contains less energy than gasoline by itself. Consequently, fuel economy of gasohol may not be quite as good as gasoline. However, there are differences in engine design and calibration which make it possible in some instances to achieve better fuel economy with gasohol.

Service Adjustments

Specified engine settings must not be changed for gasohol use. The service specifications for which the vehicle has been certified must be maintained.

Warranty Coverage

The use of gasohol containing up to 10 percent ethanol will not void the vehicle warranty. Dealers are requested to inform their Area Service Manager of any fuel system failures which are believed to be related to gasohol use. If gasohol contacts a painted surface, it may cause dulling or softening of the paint. Dulling or softening of paint due to contact with gasohol is not covered under the vehicle warranty.

Any drivability condition which is related solely to gasohol use is not covered under the vehicle warranty.

Emission Levels

Some changes in vehicle exhaust emission levels may occur when using gasohol. For example, carbon monoxide (CO) emissions will decrease in most vehicles, due to leaner mixture, but hydrocarbons (HC) and oxides of nitrogen (NO_X) emissions may either decrease or increase, depending on how the engine is calibrated. Exhaust emission levels of vehicles equipped with C-4 or CLCC systems should be affected less than vehicles without these systems. The generally higher volatility of gasohol compared to gasoline may result in increased evaporative emissions.

At the present time, the Environmental Protection Agency is not restricting the use of gasohol. However, local or state regulations, if applicable, must be observed.

METHANOL/GASOLINE BLENDS POSE POTENTIAL PROBLEMS

The following information has been extracted from a GMC Newsletter and is provided as an aid to the motor home owner concerning the potential problems posed by methanol/gasoline blends.

Reference: GMC Truck & Bus Group Newsletter (January, 1984)

USE OF GASOLINE/ALCOHOL BLENDS EXPLAINED IN OWNER'S MANUALS

Owners of 1984 model GM automobiles are given specific information in their owner's manuals on what types of fuel may be used in their vehicles. On the subject of gasoline/alcohol blends, the manuals state:

Gasoline/Ethanol Blends

Blends of unleaded gasoline and ethanol (grain alcohol), sometimes known as gasohol, are available in some areas. You may use these blends in your car, if they are not more than 10 percent ethanol, without jeopardizing the New Vehicle and Emission Warranties. Be sure the gasoline/ethanol blend has octane ratings no lower than those recommended for unleaded gasoline. Most drivers will not notice operating differences with blends of up to 10 percent ethanol, but some may. In that case, your dealer can make certain adjustments, provided they do not violate the Federal Emissions Standards. If you are still not satisfied with ethanol-gasoline blend performance, you may prefer to use unleaded gasoline.

Other Gasoline/Alcohol Blends

Some fuel suppliers sell gasoline containing alcohol without advertising the presence of alcohol or giving it a special name such as gasohol. If you are not sure whether there is alcohol in the gasoline you buy, check with the service station operator.

DO NOT USE gasolines containing methanol (methyl or wood alcohol) that do not also contain cosolvents and corrosion inhibitors for methanol. Also, DO NOT USE gasolines that contain more than five percent methanol even if they contain cosolvents and corrosion inhibitors. Fuel system damage or vehicle performance problems resulting from the use of such fuels are not the responsibility of General Motors and may not be covered under the new vehicle warranties.

Although gasolines containing five percent or less methanol and appropriate cosolvents and inhibitors for methanol may be suitable for use in your car, evidence of their suitability is as yet incomplete; therefore GM cannot, at this time, endorse their use.

METHANOL/GASOLINE BLENDS POSE POTENTIAL PROBLEMS

Gasoline quality is an important factor in providing satisfactory engine and vehicle performance and fuel system life. Gasoline has traditionally been composed entirely of a mixture of hydrocarbons and its quality generally has been sufficient to prevent problems with vehicle performance and fuel system materials.

In recent years, however, the quality of some gasolines has changed. Economic and other factors have led suppliers to use alcohols as gasoline components. The first of these was ethanol (grain alcohol), which was popularized in gasoline under the name "Gasohol." Vehicle performance and fuel system durability with gasolines containing up to 10 percent ethanol, by volume, have generally been satisfactory.

More recently, methanol (wood alcohol), an alcohol with distinctly different properties than ethanol, has become a gasoline blending agent. The addition of methanol to gasoline for use in motor vehicles is receiving increased attention due to favorable economics, excess methanol production capacity, and the desire to reduce petroleum imports.

General Motors recognizes the favorable aspects of pure methanol as a future alternative fuel and certainly will produce cars that can use methanol if it becomes generally available. However, current use of methanol in gasoline can pose problems if used in today's cars over an extended period — even at low methanol concentrations in gasoline.

GM is concerned about the rapid increase in the use of methanol/gasoline blends in today's cars for two reasons:

- There is no hard evidence on how much methanol can be blended with gasoline without adversely affecting vehicle operation and durability.
- There is no adequate service station pump labeling system that will tell motorists the methanol content of the fuel they are purchasing.

There is limited information that suggests small amounts (up to five percent) of methanol in gasoline may be suitable if a *cosolvent* — an ingredient that prevents the gasoline and methanol from separating when trace amounts of water are in the fuel — and a *corrosion inhibitor* to prevent damage to fuel system components are used. Evidence on the suitability of such blended fuels is incomplete and, therefore, their use cannot be endorsed by GM at this time.

METHANOL/GASOLINE BLENDS POSE POTENTIAL PROBLEMS (Cont'd)

It is likely some engines and fuel systems will be sensitive to methanol/gasoline blends that contain higher concentrations (greater than 10 percent) of methanol — even if the fuels contain cosolvents and corrosion inhibitors. This sensitivity is generally related to compatibility with materials commonly used in vehicle fuel systems, such as fuel tank plating and certain rubber parts in carburetion systems. Also, drivability — performance of the vehicle — is adversely affected.

GM is continuing to evaluate methanol/gasoline blends in both laboratory and vehicle tests to determine the effects of the blends on fuel system materials, engine deposits, drivability, emissions and fuel economy.

There are economic advantages that encourage blending methanol with gasoline. The average national tank price for unleaded gasoline sold to service station dealers (excluding taxes) in August, 1984 was approximately 94 cents a gallon, while methanol's cost was between 45 and 49 cents a gallon. On the other hand, ethanol's cost was between $1.62 and $1.80 per gallon. Ethanol/gasoline blends are competitive with gasoline only if a tax subsidy is allowed, but methanol/gasoline blends are not only competitive, they are enticing for the refiner, blender and retailer.

The U.S. Environmental Protection Agency (EPA) has granted waivers, legally allowing the blending of methanol in gasoline. Waivers cover methanol concentrations as high as 12 percent, as long as cosolvents are used. GM and other auto companies have not agreed with the EPA's decisions granting waivers for methanol/gasoline blends. The concern over use of methanol/gasoline blends has been heightened because illegally high levels of methanol have been found in some gasolines.

An EPA probe that began in the spring of 1983 in the Detroit area, revealed illegally high levels of methanol in gasoline. Out of 250 samples of unleaded gasoline from about 150 service stations, about eight percent — or 20 samples — had levels of methanol above those allowed by waivers, or did not contain cosolvents.

Because of concern over the compatibility of methanol/gasoline blends with current vehicle engines and fuel systems, and illegal blending of methanol in gasoline, a number of states are planning to require that the methanol content of the fuel be posted on dispensing pumps. Although this is a step in the right direction, GM believes that motorists would be better served by a uniform labeling system nationwide. This would eliminate confusion caused by states adopting different labels.

Historical Perspective

Alcohol/gasoline mixtures have been studied for more than 50 years. In the 1960s and early 1970s, the use of these blends was proposed (not always appropriately) as a way to reduce vehicle exhaust emissions and improve fuel economy. However, because the cost of alcohol was significantly higher than that of gasoline, the widespread use of alcohol/gasoline blends was not economically feasible.

Two significant actions of the past decade have renewed and expanded interest in alcohol/gasoline blends.

First, the severe interruptions of petroleum imports emphasized the need to increase production of domestic energy sources and reduce dependence on imported oil.

The production of alcohol fuels, particularly ethanol, became politically attractive in the late '70s at the height of the energy crisis. Its use was encouraged through tax subsidies. Commonly sold as Gasohol, it is now also marketed as unleaded, super unleaded, or premium unleaded gasoline (depending on its octane level), marked "with ethanol."

Also, during the recent recession, capacity for production of methanol from natural gas far exceeded demand. Methanol thus assumed a new attraction as a gasoline blending agent. The outlook for use of pure methanol as an automotive fuel is positive because the technical knowledge necessary to design and build methanol-fueled engines and vehicles is rapidly developing. (See Figure A7-5-1.) In blends with gasoline, as stated earlier, methanol may not be suitable for use in either existing vehicles or future model year vehicles unless the vehicles are modified.

NOTE: Several trade publications have predicted a sharp increase in the amount of methanol used as automotive fuel by the end of the decade. The "Lundberg Letter" projects methanol fuel use in 1990 will be 40 times greater than in 1980.

The second action which increased interest in alcohols as fuels was the reduction in the amount of lead antiknock additives used in gasoline. This reduction spurred by the EPA, occurred for two reasons:

- The need for unleaded gasoline in cars equipped with catalytic converters.
- The need to limit the emissions of lead into the atmosphere (by lowering permissible lead concentrations in leaded fuel).

METHANOL/GASOLINE BLENDS POSE POTENTIAL PROBLEMS (Cont'd)

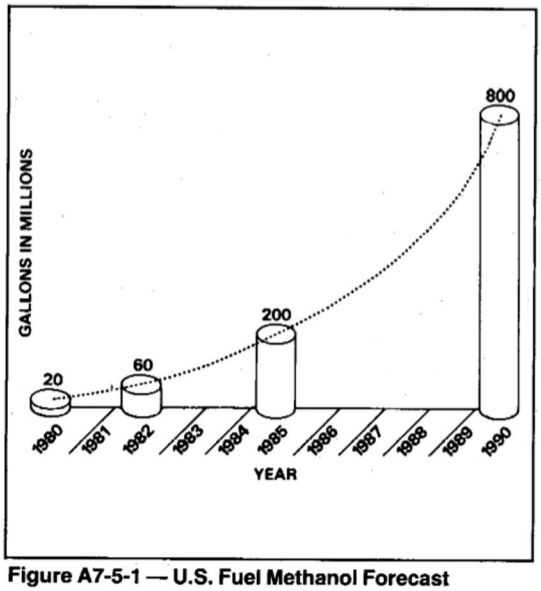


Figure A7-5-1 — U.S. Fuel Methanol Forecast

Alcohols offer a means of replacing some of the octane (antiknock) quality previously provided by lead compounds.

Major Disadvantages of Methanol/Gasoline Blends

There are a number of disadvantages associated with the use of methanol/gasoline blends in vehicles designed for gasoline. Of major significance are:

- DETERIORATION OF FUEL SYSTEM MATERIALS. Rubber, plastic, and metallic fuel system components in most vehicles were designed for use with gasoline, and may not provide satisfactory service with methanol/gasoline blends. Although few long-term durability tests have been run with blends, the results from a number of laboratory evaluations, as well as problems reported by motorists, make it clear that a variety of problems can occur. Most material problems are a function of time rather than distance traveled, so a 50,000-mile test completed in one year may not indicate what would happen during 50,000 miles of operation over four or five years. Components possibly affected include fuel tanks, in-tank fuel pumps, carburetion and fuel injection systems, and nitrile rubber commonly used in vehicle fuel systems.

- DRIVABILITY. Drivability is generally worse with methanol/gasoline blends than with gasoline alone. In hot weather, the generally high volatility of the blends, compared with gasoline, causes a greater tendency toward vapor lock problems. Cold weather problems — stalling and hesitation — have been reported.

- SEPARATION. The presence of even trace amounts of water in the fuel system may cause methanol/gasoline blends to become cloudy and separate into two layers, a gasoline layer on top and an alcohol/water layer on the bottom. A vehicle will not run satisfactorily on the alcohol/water mixture and corrosion of fuel system parts and deterioration of rubber parts can be greatly accelerated by contact with this mixture. Water tolerance of blends is increased by cosolvents, but even these do not completely eliminate the separation problem.

- FUEL ECONOMY. In late-model cars, fuel economy (miles per gallon) generally decreases with the addition of methanol to gasoline. This is due to the lower energy content (per gallon) of methanol compared with gasoline. For example, a blend of 10 percent methanol in gasoline contains about five percent less energy per gallon than gasoline.

- EVAPORATIVE EMISSIONS. Unless major changes are made in the distillation characteristics of gasoline, the addition of methanol to it significantly increases vapor pressure. This almost always results in a substantial increase in vehicle evaporative emissions.

Regulatory Considerations

The regulatory aspects of methanol/gasoline blends are complex. The Clean Air Act prohibits the addition of additives to unleaded fuel, including methanol, unless the fuel additive manufacturer obtains a waiver from the EPA. In order to obtain such a waiver, the fuel additive manufacturer must show that the fuel will not cause — or contribute to — the failure of the vehicle or engine to meet the applicable emission standards for five years, or 50,000 miles.

The EPA has published guidelines that stress the need for development of data on possible methanol blending problems. GM supports the principles embodied in the guidelines, but believes it is important that the EPA give careful consideration to potential problems when reviewing any fuel additive waiver application for alcohol/gasoline blends. During the last five years, a number of waivers have been granted.

METHANOL/GASOLINE BLENDS POSE POTENTIAL PROBLEMS (Cont'd)

GM and other automobile manufacturers are concerned that some of the blends approved by the EPA may be detrimental to vehicle emissions, performance and components. Although several fuel suppliers have been successful in marketing methanol/gasoline blends, the long-term effects of the blends on vehicle durability are not yet known. To assure customer satisfaction with its vehicles, GM is establishing a system to track reported vehicle problems to determine if methanol/gasoline blends are responsible. If further investigation determines methanol/gasoline blends can be used in the existing fleet of vehicles without materials, drivability, or emissions problems, GM believes their use should be permitted. But only with adequate labeling of fuel at the pump will consumers be able to recognize the contents in the fuel they are purchasing.

ENGINE FUEL SYSTEMS

There are distinct differences between the gasoline and diesel engine fuel systems. The 5.7L and 7.4L (Mark IV) gasoline engines use a carburetor to mix fuel with air. Strong engine vacuum, drawing intake air through the carburetor venturis, causes fuel to flow from the carburetor ports to be mixed in the air stream turbulence. This air/fuel mixture is distributed to each cylinder through the intake manifold. Engine speed is controlled by the position of throttle plates in the carburetor which open and close (by means of the accelerator linkage) to vary the amount of air/fuel mixture entering the manifold and cylinders. In the diesel engine, fuel is injected directly into a pre-chamber above each cylinder where it is mixed with air. Engine speed is controlled by varying the amount of fuel injected.

The components used in each system, gasoline and diesel, will be described in separate sections.

GASOLINE ENGINE SYSTEM DESCRIPTION

The gasoline engine fuel system includes the fuel tank, fuel pump, fuel filter, carburetor and all fuel and vacuum lines.

FUEL TANK

The fuel tank is located behind the rear axle and is strapped to the frame. It includes the fuel filler cap and neck, and a fuel gage sending unit. Its sole purpose is to provide a place for fuel storage.

FUEL PUMP

The fuel pump is located on the lower front half of the engine block on the passenger's side. Its purpose is to provide adequate pressure to move fuel to the carburetor.

The fuel pump is a diaphragm-type pump and is actuated by the rocker arm through a link and a push rod.

Some vehicles have a fuel pump with an outlet for a vapor return system. Any vapor which forms, is returned to the fuel tank along with hot fuel through a separate line. This greatly reduces any possibility of vapor lock by keeping cool fuel from the tank constantly circulating through the fuel pump. Some units are built with both mechanical and electric in tank pumps.

EVAPORATIVE CONTROL SYSTEM

Light-duty and some heavy-duty vehicles are equipped with an emissions system designed to prevent escape of fuel vapor to the atmosphere (Figure 7-23). Vapor generated by evaporation of fuel in the tank, previously exhausted to the atmosphere, is transferred by an emission line to the engine compartment. During periods of inoperation, an activated charcoal canister located in the emission line stores any vapor generated, for consumption during the next period of operation.

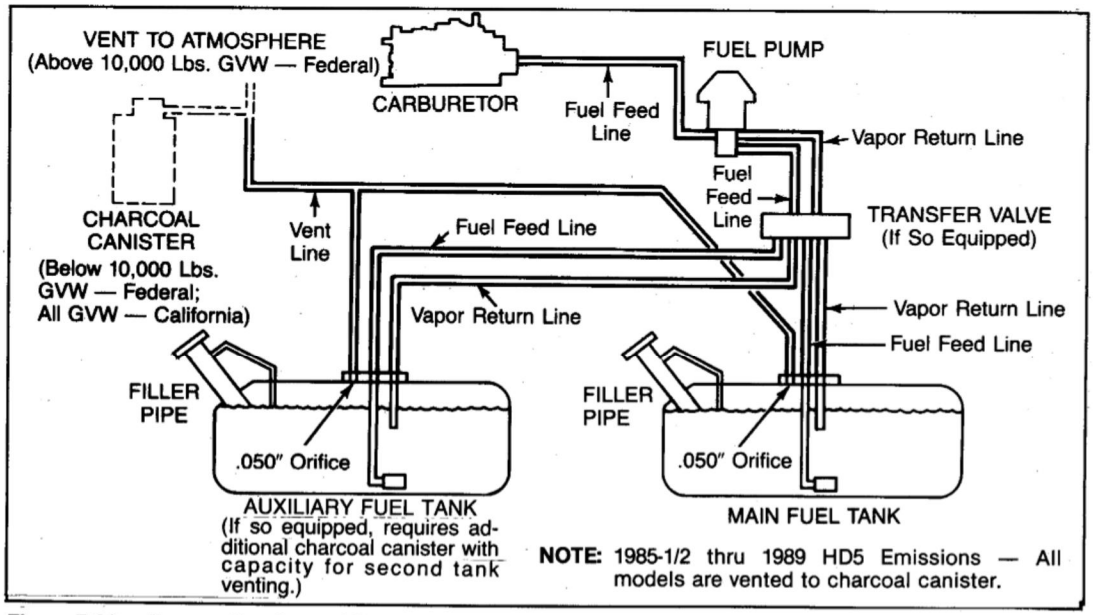


Figure 7-23 — Evaporative Control System

The amount of vapor drawn into the engine at any time is too small to have any effect on fuel economy or engine operation.

With this closed system, it is extremely important that only vapors be transferred to the engine. To avoid the possibility of liquid fuel being drawn into the system, the following features are included as part of the total system:

1. A fuel tank overfill protector is provided on all series to assure adequate room for expansion of liquid fuel volume with temperature changes. (Fill is limited to 80-90 percent total capacity.)

2. A one-point fuel tank venting system is provided on all series to assure that the tank will be vented under any conceivable vehicle attitude.

3. To protect the tank from mechanical damage in the event of excessive internal or external pressures resulting from the operation of this closed system, a pressure-vacuum relief valve, located in the gas cap, will control the tank's internal pressure.

System Hook-Up for Auxiliary Tank

If an auxiliary fuel tank is to be added, it must be vented as shown in Figure 7-23. See Figure 7-24 for additional fuel tank considerations.

FUEL FILTERS

An engine fuel filter is located in the carburetor fuel inlet. These fuel filter elements are of pleated paper. Elements are placed in the inlet hole with the gasket surface outward. A spring holds the element outward, sealing it by compressing a gasket surface against the inlet fitting.

The carburetor inlet fuel filter should be replaced at the intervals shown in the Maintenance Schedule. A plugged filter and/or check valve will restrict fuel flow.

After assembling any filter element in the carburetor, always start the engine and check for leaks in the fuel line and fittings before installing the air cleaner.

For the P-Series, an additional fuel filter is located in the fuel line along the inside or outside of the right frame rail depending on the year built. It is replaced by disconnecting the fuel line on both sides of the filter assembly, removing the old assembly, installing a new one, and then reconnecting the fuel line. Use caution to avoid fuel spillage.

NOTE: The position of the filter(s) may vary on the P-Series with the installation of aftermarket fuel tanks. The installation of additional filters at **each** tank is not recommended, because of the added work load these restrictions would place on the mechanical fuel pump.

A woven plastic filter is located on the lower end of the fuel pickup pipe in the fuel tank. This filter prevents dirt from entering the fuel line. Normally, no maintenance is required. Fuel stoppage at this point, indicates that the tank contains an abnormal amount of sediment; consequently, the tank should be removed and cleaned thoroughly.

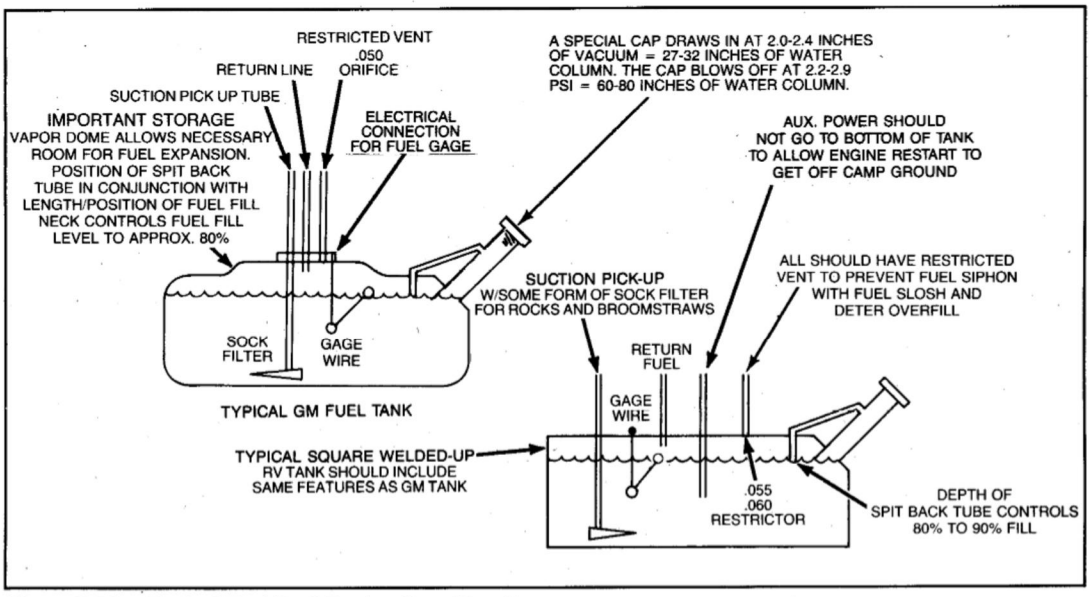


Figure 7-24 — Typical Fuel Tank Design Considerations

CARBURETOR

The carburetor is located on the top of the engine block, just under the air filter housing. Proper operation of the carburetor is extremely important as it performs several necessary functions. First, it controls the amount of air drawn in by the engine and controls the amount of fuel that is combined with air to form a combustible mixture. This must be done adequately to cover a wide range of operating speeds and conditions. Consequently the carburetor also controls engine output and speed by varying the amount of mixture reaching the eight cylinders.

Finally, the carburetor provides vacuum control for the spark advance and vacuum source for many of the federally mandated emission controls.

The M4MC model carburetor is used on most of the gasoline engines. It features tamper-resistant controls to discourage readjustment of factory settings, which could affect either or both emission control and drivability.

MAINTENANCE AND INSPECTION

The system should be inspected and maintained in accordance with the Maintenance Schedule. Fuel lines should be checked for signs of leakage, damage or deterioration. Clamps must be tightened if they are loose. Filters in the fuel line and the evaporative control system should be replaced at the recommended intervals. The carburetor choke linkage should be checked and the mounting bolts tightened as recommended.

CAUTION

1990 fuel injection requires ***only*** no lead fuel be used as regular fuel will ruin the catalytic converter.

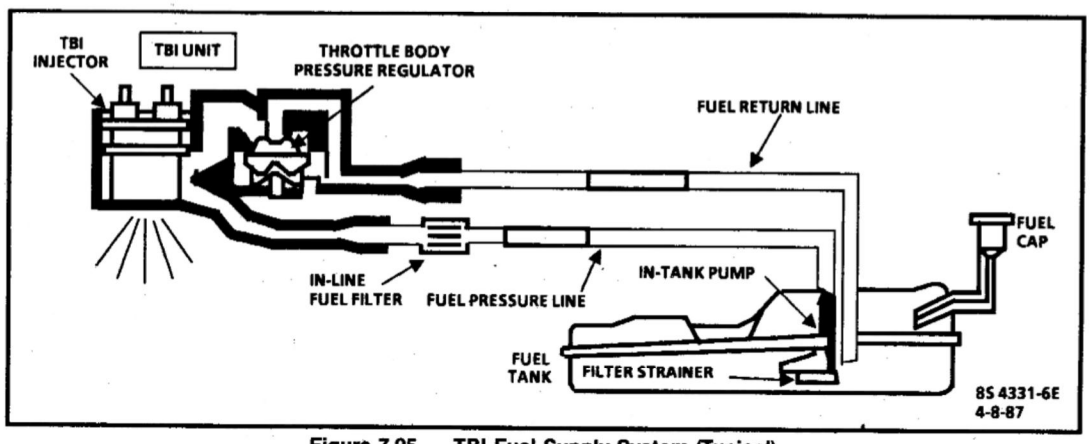


Figure 7-25 — TBI Fuel Supply System (Typical)

GENERAL DESCRIPTION

PURPOSE

The fuel control system is controlled by an electronic control module. The ECM is the control center of the computer command control system and is located under the steering column support bracket.

The basic function of the fuel control system is to control fuel delivery to the engine. Fuel is delivered to the engine by a throttle body injection (TBI) unit.

The main control sensor is the oxygen (O_2) sensor, which is located in the exhaust pipe. The O_2 sensor tells the ECM the amount of oxygen in the exhaust gas, and the ECM changes the air/fuel ratio to the engine by controlling the fuel injector. A 14.7:1 air/fuel ratio is required for efficient catalytic converter operation. Because the constant measuring and adjusting of the air/fuel ratio, the fuel injection system is called a "Closed Loop" system (Figure 7-26).

MODES OF OPERATION

The ECM monitors voltages from several sensors to determine how much fuel to give the engine. The fuel is delivered under one of several conditions called "modes." All the modes are controlled by the ECM.

Starting Mode

When the key is first turned "ON," the ECM turns on the fuel pump relay for two seconds and the fuel pump builds up pressure to the TBI unit. The ECM checks the coolant temperature sensor, throttle position sensor (TPS), manifold absolute pressure map sensor, and crank signal, then determines the proper air/fuel ratio for starting. This ranges from 1.5:1 at -36°C (-33°F) to 14.7:1, at 94°C (201°F) running temperature.

The ECM controls the amount of fuel delivered in the starting mode by changing how long the injector is turned "ON" and "OFF." This is done by "pulsing" the injector for very short times.

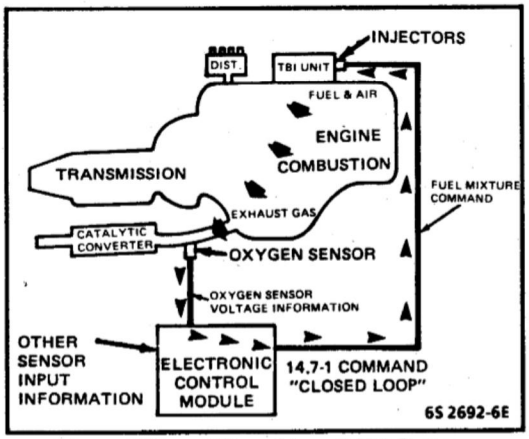


Figure 7-26 — "Closed Loop" TBI System

Clear Flood Mode

If the engine floods, clear it by pushing the accelerator pedal down all the way. The ECM then pulses the injector at a 20:1 air/fuel ratio, and holds this injector rate as long as the throttle stays wide open, and the engine is below 600 rpm. If the throttle position becomes less than 80%, the ECM returns to the starting mode.

Run Mode

The Run mode has two conditions called "Open Loop" and "Closed Loop."

Open Loop

When the engine is first started, and it is above 400 rpm, the system goes into "Open Loop" operation. In "Open Loop," the ECM ignores the signal from the O_2 sensor, and calculates the air/fuel ratio based on inputs from the coolant temperature and MAP sensors.

The system stays in "Open Loop" until the following conditions are met:

1. The O_2 sensor has varying voltage output, showing that it is hot enough to operate properly. (This depends on temperature.)
2. The coolant temperature sensor is above a specified temperature.
3. A specific amount of time has elapsed after starting the engine.

The 7.4L engine is designed to operate "Open Loop" at idle. The system will go to "Closed Loop" when the rpm is increased and all conditions above are met.

Closed Loop

The specific values for the above conditions vary with different engines, and are stored in the programmable read only memory (PROM). When these conditions are met, the systems go into "Closed Loop" operation. In "Closed Loop," the ECM calculates the air/fuel ratio (injector on-time) based on the signal from the O_2 sensor. This allows the air/fuel ratio to stay very close to 14.7:1.

Acceleration Mode

The ECM looks at rapid changes in throttle position and manifold pressure, and provides extra fuel.

Deceleration Mode

When deceleration occurs, the fuel remaining in the intake manifold can cause excessive emissions and backfiring. Again, the ECM looks at changes in throttle position and manifold pressure and reduces the amount of fuel. When deceleration is very fast, the ECM can cut off fuel completely for short periods.

Battery Voltage Correction Mode

When battery voltage is low, the ECM can compensate for a weak spark delivered by the distributor by:

- Increasing injector on time of fuel delivered
- Increasing the idle rpm
- Increasing ignition dwell time

Fuel Cutoff Mode

No fuel is delivered by the injectors when the ignition is "OFF." This prevents dieseling. Also, fuel is not delivered if no reference pulses are seen from the distributor, which means the engine is not running. Fuel cutoff also occurs at high engine rpm, to protect internal engine components from damage.

FUEL CONTROL OPERATION

The fuel control system (Figure 7-27) consists of the following components:

- Throttle body injection (TBI) unit
- Fuel pump
- Fuel pump relay
- Fuel tank
- Accelerator control
- Fuel lines
- Fuel filters
- Evaporative emission control system

The fuel control system has an electric fuel pump, located in the fuel tank on the gage sending unit. It pumps fuel to the throttle body through the fuel supply line, then through an in-line fuel filter. The pump is designed to provide pressurized fuel at about 125 kPa (18 psi).

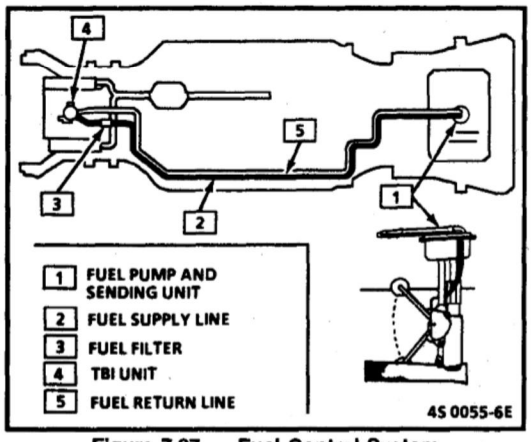


Figure 7-27 — Fuel Control System

A pressure regulator in the TBI keeps fuel available to the injectors at a constant pressure between 62 and 90 kPa (9 and 13 psi). Fuel in excess of injector needs is returned to the fuel tank by a separate line.

The ECM controls the injectors that are located in the fuel meter body assembly of the TBI. The injectors deliver fuel in one of several modes, described above.

In order to properly control the fuel supply, the fuel pump is operated by the ECM through the fuel pump relay and oil pressure switch (see "Fuel Pump Electrical Circuit").

MODEL 220 TBI UNIT

Model 220, (Figure 7-28), consists of three major casting assemblies:

- Fuel meter cover with:
  - Pressure regulator
- Fuel meter body with:
  - Fuel injectors
- Throttle body with:
  - Idle air control (IAC) valve
  - Throttle position sensor (TPS)

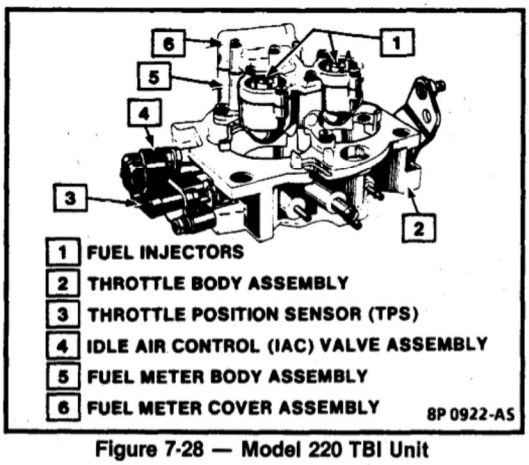


Figure 7-28 — Model 220 TBI Unit

Vacuum Ports

The throttle body portion of both TBI units may contain ports located above, or below the throttle valve. These ports generate the vacuum signals for the exhaust gas recirculation (EGR) valve, MAP sensor, and the canister purger purge system.

Fuel Injector(s)

The fuel injectors (Figure 7-29) are solenoid-operated device, controlled by the ECM. The ECM turns on the solenoid, which lifts a normally closed ball valve off a seat. Fuel, under pressure, is injected in a conical spray pattern at the walls of the throttle body bore above the throttle valve.

The fuel which is not used by the injectors passes through the pressure regulator before being returned to the fuel tank.

Pressure Regulator

The pressure regulator (see Figure 7-29) is a diaphragm-

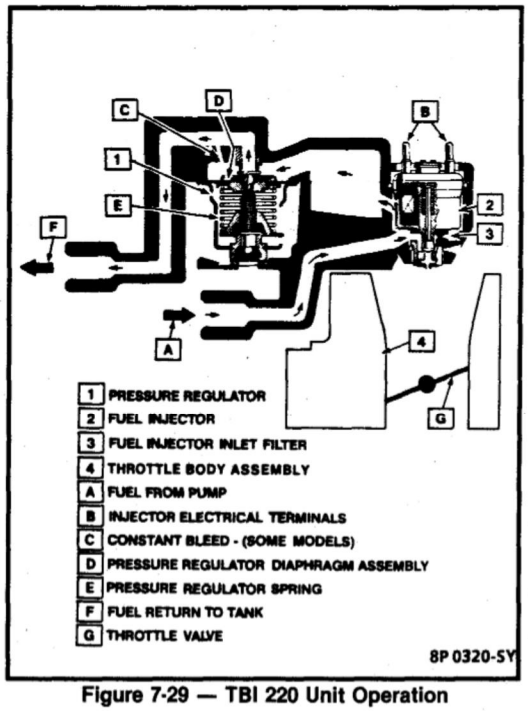


Figure 7-29 — TBI 220 Unit Operation

operated relief valve with injector pressure on one side and air cleaner pressure on the other. The function of the regulator is to maintain a constant pressure at the injectors at all times, by controlling the flow in the return line (by means of a calibrated bypass).

The pressure regulator on a TBI 220 unit is serviced as part of the fuel meter cover and should not be disassembled.

Idle Air Control System

All engine idle speeds are controlled by the ECM through the idle air control (IAC) valve mounted on the throttle body (Figure 7-30). The ECM sends voltage pulses to the IAC motor windings causing the IAC motor shaft and pintle to move "IN" or "OUT" a given distance (number of steps) for each pulse, (called counts).

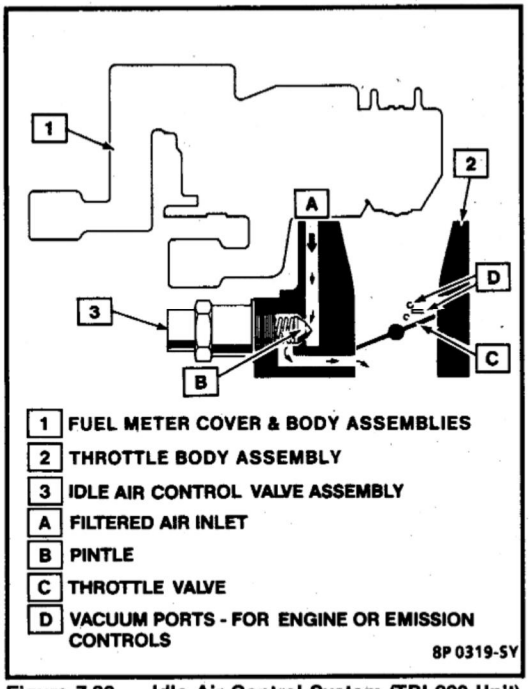


Figure 7-30 — Idle Air Control System (TBI 220 Unit)

This movement controls airflow around the throttle plate, which in turn, controls engine idle speed, either cold or hot. IAC valve pintle position counts can be seen using a "Scan" tool. O counts corresponds to fully closed passage, while 140 counts or more (depending on the application) corresponds to full flow.

- Actual or "controlled" idle speed is obtained by the ECM positioning the IAC valve pintle. Resulting idle speed is generated from the total idle air flow (IAC/ passage + PCV + throttle valve + vacuum leaks).
- Controlled idle speed is always specified for normal operating conditions. Normal operating condition is coolant temperature in operating range, the A/C is "OFF," automatic transmission in drive with proper Park/Neutral switch adjustment. A high or low coolant temperature, or A/C clutch engaged may signal the ECM to change the IAC counts.
- The minimum idle air rate is set at the factory with a stop screw. This setting allows enough air flow by the throttle valves to cause the IAC valve pintle to be positioned a calibrated number of steps (counts) from the seat during normal controlled idle operation. The IAC counts will be higher than normal on an engine with less than 500 miles, or an engine operating at high altitude or an engine with an accessory load such as the alternator, A/C, power steering or hydra-boost brakes activated.

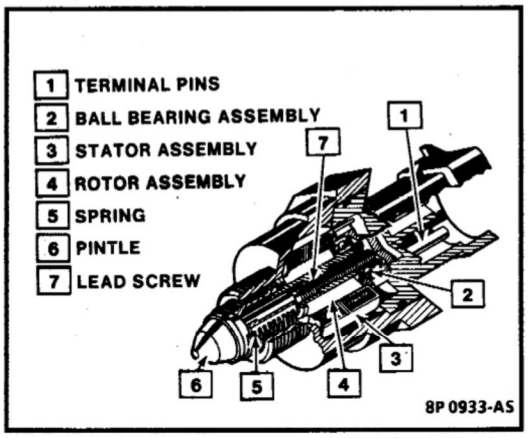


Figure 7-31 — Idle Air Control (IAC) Valve (TBI 220)

Throttle Position Sensor (TPS)

The throttle position sensor (TPS), is mounted on the side of the throttle body opposite the throttle lever assembly. Its function is to sense the current throttle valve position and relay that information to the ECM (see Figure 7-32). Throttle position information allows the ECM to generate the required injection control signals (base pulse).

If the TPS senses a wide open throttle, a voltage signal indicating this condition is sent to the ECM. The ECM then increases the injector base pulse width, permitting increased fuel flow.

As the throttle valve rotates in response to movement of the accelerator pedal, the throttle shaft transfers this rotation movement to the TPS. A potentiometer (variable resistor) within the TPS assembly changes its resistance (and voltage drop) in proportion to throttle movement.

By applying a reference voltage (5.0 volts) to the TPS input, a varying voltage (reflecting throttle position) is available at the TPS output. For example, approximately 2.5 volts results from a 50% throttle valve opening (depending on TPS calibration). The voltage output from the TPS assembly is routed to the ECM for use in determining throttle position.

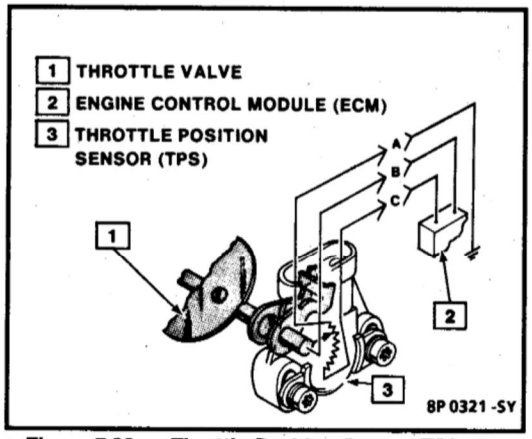


Figure 7-32 — Throttle Position Sensor (TBI 220)

FUEL PUMP CIRCUIT

The fuel pump is a turbine type, low pressure electric pump, mounted in the fuel tank. Fuel is pumped at a positive pressure (above 62 kPa or 9 psi) from the fuel pump through the in-line filter to the pressure regulator in the TBI unit (see Figure 7-25). Excess fuel is returned to the fuel tank through the fuel return line.

The fuel pump is attached to the fuel gage sender assembly. A fuel strainer is attached to the fuel pump inlet line and prevents dirt particles from entering the fuel line and tends to separate water from the fuel.

Vapor lock problems are reduced when using an electric pump because the fuel is pushed from the tank under pressure rather than being pulled under vacuum, a condition that produces vapor.

When the key is furst turned "ON" without the engine running, the ECM turns a fuel pump relay "ON" for two seconds. This builds up the fuel pressure quickly. If the engine is not started within two seconds, the ECM shuts the fuel pump "OFF" and waits until the engine starts. As soon as the engine is cranked, the ECM turns the relay "ON" and runs the fuel pump.

On the 5.7L engine in the G van and all other 5.7L or 7.4L engines in vehicles over 8500 GVW, a fuel module will override the ECM and the fuel pump will run for approximately twenty seconds. The fuel module corrects a hot restart (vapor lock) during a high ambient condition.

When the engine is cranking or running, the ECM receives distributor reference pulses which in turn energize the fuel injectors.

As a backup system to the fuel pump relay, the fuel pump can also be turned on by an oil pressure switch. When the engine oil pressure reaches about 28 kPa (4 psi), through cranking and the fuel pump relay does not complete the circuit, the oil pressure switch will close to complete the circuit to run the fuel pump.

An inoperative fuel pump relay can result in long cranking times, particularly if the engine is cold. The oil pressure switch will turn on the fuel pump as soon as oil pressure reaches about 28 kPa (4 psi).

FUEL FILTER PART #25055052 A-C GF 481 In-line Filter - located inside RF from rail

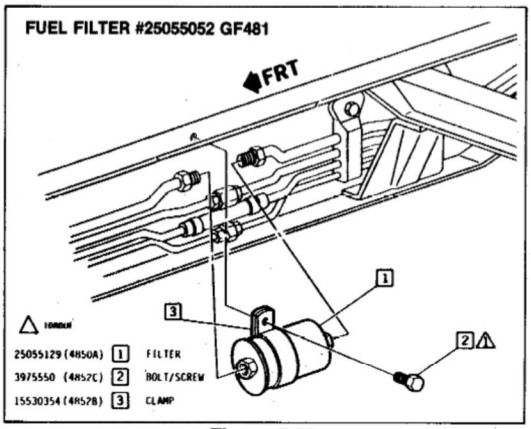


Figure 7-33

CAUTION: To reduce the risk of fire and personal injury, it is necessary to allow fuel pressure to bleed off before servicing fuel system components. (See "Fuel System Pressure Relief Procedure.")

The in-line filter is located in the fuel feed line. It prevents dirt from entering the TBI unit.

In-Tank Filter

A woven plastic filter is located on the lower end of the fuel pickup tube in the fuel tank. The filter prevents dirt from entering the fuel line and, also, stops water, unless the filter becomes completely submerged in water. This filter is self-cleaning and normally requires no maintenance. Fuel stoppage, at this point, indicates that the fuel tank contains an abnormal amount of sediment or water; the tank should, therefore, be thoroughly cleaned.

FUEL AND VAPOR PIPES

The fuel feed and return pipes and hoses extended

from the fuel pump and sender to the TBI unit. They are secured with clamps and are routed along the frame side member.

The vapor pipe and hoses extend from fuel pump and sender unit to the evaporative emission control vapor canister.

FUEL TANK

The fuel tank, at the rear of the underbody, is held in place by two metal straps. Anti-squeak pieces are used on top of the tank to reduce rattles.

Filler Neck

To help prevent refueling with leaded gasoline, the fuel filler neck on a gasoline engine vehicle has a built-in restrictor and deflector. The opening in the restrictor will only admit the smaller unleaded gas nozzle spout, which must be fully inserted to bypass the deflector. Attempted refueling with a leaded gas nozzle, or failure to fully insert the unleaded gas nozzle, will result in gasoline splashing back out of the filler neck.

Fuel Filler Cap

The fuel tank filler neck is equipped with a screw-type cap. The threaded part of the cap requires several turns counterclockwise to remove. The long threaded area was designed to allow any remaining fuel tank pressure to escape, while the cap was being removed. A built-in torque-limiting device prevents overtightening. To install, turn the cap clockwise until a clicking noise is heard. This signals that the correct torque has been reached and the cap is fully seated.

EVAPORATIVE EMISSION CONTROL

The system transfers fuel vapors from the fuel tank into a vapor canister and then vapors are purged into the intake manifold air flow and consumed in combustion.

DIESEL ENGINE

SYSTEM DESCRIPTION

The 6.2-liter diesel engine fuel system is composed of:

- Fuel tank with water sensor and screen filter
- Primary fuel filter
- Mechanical fuel pump
- Secondary fuel filter
- Fuel line heater
- Injection distributor pump
- High pressure lines
- Fuel injection nozzles.

Fuel is pulled from the fuel tank by the mechanical pump which is located on the right side of the engine. It is driven by an eccentric lobe on the camshaft through a pushrod. Fuel is pulled through the primary filter, by the mechanical pump. Fuel is then pumped through the fuel line heater and through the secondary filter mounted on the inlet manifold. Both filters remove foreign material which could damage the injection pump or clog the injector nozzle. From the filter, the fuel is pumped to the injection pump. (See Figure 7-25.)

The 6.2-liter injection pump is mounted on top of the engine under the intake manifold. It is gear driven by two gears — one attached to the front end of the camshaft which drives the second gear that is attached to the end of the injection pump shaft. These two gears are the same size and have the same number of teeth; thus, the injection pump shaft turns at the same rate as the camshaft and one-half the speed of the crankshaft. The pump will turn in the opposite direction to that of the camshaft and crankshaft.

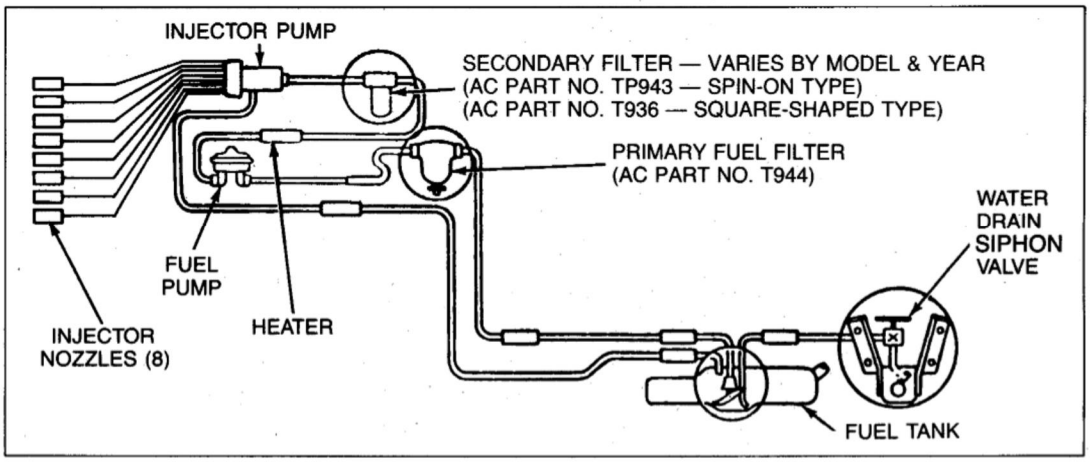


Figure 7-34 — Diesel Engine Fuel System

The injection pump is a high-pressure rotary-type pump that directs a metered, pressurized fuel through the high pressure tubes to the eight injector nozzles. The eight high pressure lines are all the same length although their shapes may be different. This prevents any difference in timing, cylinder to cylinder.

The fuel line heater operates when the ambient temperature is low enough to require heating of the fuel.

MAINTENANCE AND INSPECTION

WATER IN FUEL

The diesel engine has a "water-in-fuel" warning system allowing the user to guard against water in fuel, which is very critical in diesel engines.

The fuel tank is equipped with a filter which screens out the water and lets it lay in the bottom of the tank below the fuel pickup. When the water level reaches a point where it could be drawn into the system, a warning light flashes in the cab. A siphoning system starting at the tank and going to the rear spring hanger on some models and at the midway point of the right frame rail on other models permits the user to attach a hose at the shut-off and siphon out the water.

A primary filter (Figure 7-26) is located on the front of the dash and it also has water-draining provisions.

A secondary in-line fuel filter (Figure 7-27) is the final filter before fuel enters the injection-pump.

See Appendix 7-8 — Secondary Fuel Filters at the back of this section of the manual for additional equipment operation information.

When changing the fuel filter or when the vehicle has run out of fuel, disconnect the connector from the temperature switch and jumper connector terminals. This will aid in purging air from the pump. (This procedure is necessary only on a hot engine, as the circuit will always be closed when the engine is cold.)

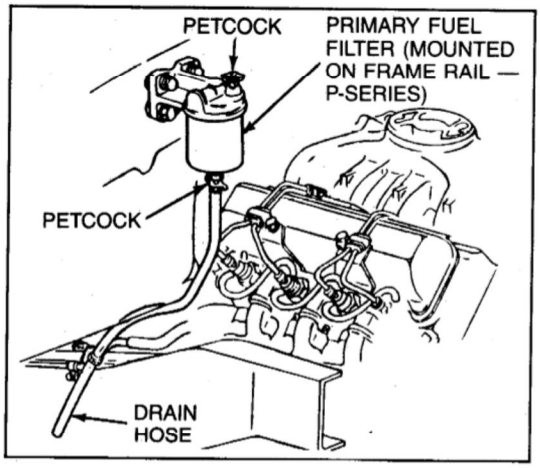


Figure 7-35 — Primary Fuel Filter (AC Type T944)

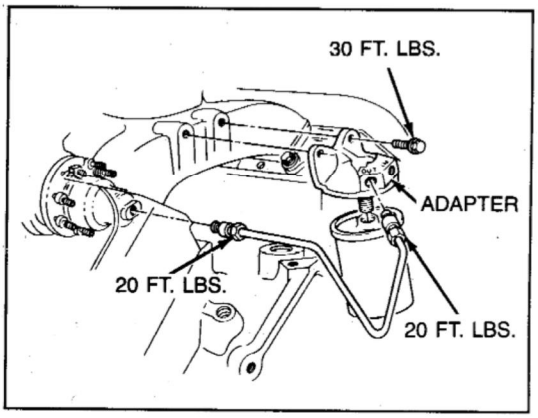


Figure 7-36 — Secondary Fuel Filter (AC Type TP943)

PRIMARY FUEL FILTER WATER DRAIN

If it should become necessary to drain water from the fuel tank, check the primary fuel filter (Figure 7-26) for water. This can be done as follows:

1. Open the petcock on the top of the primary filter housing.
2. Place a drain pan below the filter and open the petcock on the bottom of the drain assembly. (A length of hose is attached to the petcock to direct drained fluid below the frame.)
3. When all water is drained from the filter, close the petcock firmly.

NOTE: If the filter is completely drained, remove the filter and refill it with clean diesel fuel to prevent engine stalling.

4. Close the upper petcock tightly.
5. Start the engine and let it run briefly. The engine may run roughly for a short time until the air is purged from the system.
6. If the engine continues to run roughly, check that both petcocks at the primary filter are closed tightly.

SECONDARY FUEL FILTER (See Figure 7-27)

Removal

1. Remove the fuel filter lines from the adapter.
2. Remove the fuel filter adapter from the intake manifold.
3. Remove the filter.

Installation

Anytime either of the fuel filters is removed or replaced, refill it with clean diesel fuel to prevent engine stalling after start-up, and to avoid very long engine cranking time.

1. Install the filter to the adapter.
2. Install the adapter to the intake manifold.
3. Install the fuel filter lines.

DIESEL FUEL MANAGER/FILTER ELEMENT REPACEMENT

6.5L MODEL FM 100 (See Figure 7-28)

Removal

1. Remove the fuel filler cap to release any pressure or vacuum in the fuel tank.
2. Remove the element nut (7) turning it by hand in a counter-clockwise direction. If unable to turn by hand, a strap wrench (oil filter type) may be used to "break loose" the element nut.
3. Remove the element (8) by lifting it straight up and out of the heade assembly (9). It is not unnecessary to drain fuel from the header assembly (9) to change the filter element (8) since the fuel will remain in the header assembly's cavity.

Important

Make sure the mating surface between the element assembly and the header assembly is clean before installation.

Installation

1. Install the new element assembly by aligning the widest key slot located under the element assembly cap with the widest key in the header assembly.
   - Push the element in a downwards direction until the mating surfaces make contact.
2. Install the element nut (7).

Tighten

- Tighten the element nut (7) securely by hand.

1. Bleed air from the fuel manager/filter as follows:
   a. Open the air bleed valve on top of the fuel manager/ filter assembly.
   b. Connect a hose to the air bleed valve located on top of the element assembly and place the other end of the hose into a suitable container.

CAUTION: THE WATER/DIESEL FUEL MIXTURE IS FLAMMABLE, AND COULD BE HOT. TO HELP AVOID PERSONAL INJURY AND/OR PROPERTY DAMAGE, DO NOT TOUCH THE FUEL COMING FROM THE DRAIN HOSE, AND DO NOT EXPOSE THE FUEL TO OPEN FLAMES OR SPARKS.
BE SURE YOU DO NOT OVERFILL THE CONTAINER. HEAT (SUCH AS FROM THE ENGINE) CAN CAUSE THE FUEL TO EXPAND. IF THE CONTAINER IS TOO FULL, FUEL COULD BE FORCED OUT OF THE CONTAINER. THIS COULD LEAD TO A FIRE AND THE RISK OF PERSONAL INJURY AND/OR VEHICLE DAMAGE.

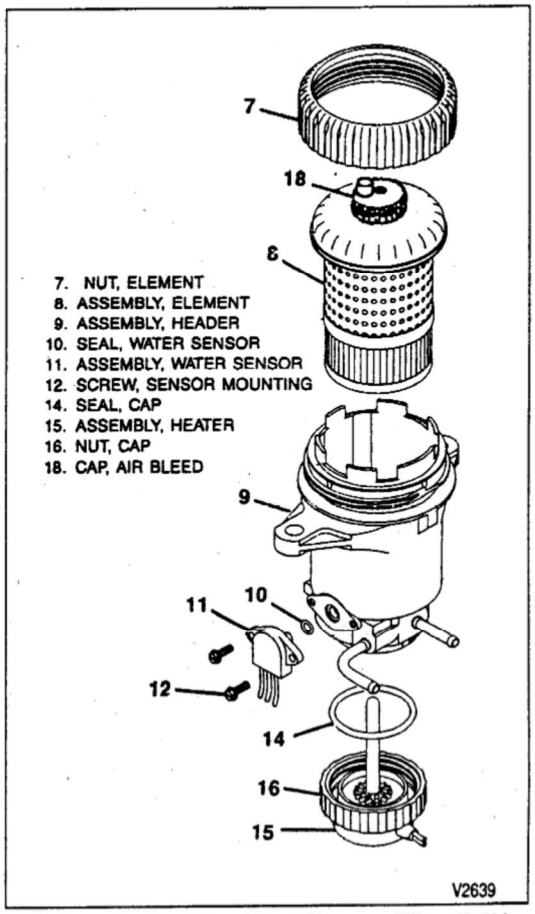


Figure 7-28 — Diesel Fuel Manager/Filter (6.5L)

c. Disconnect the fuel injection pump shut-down solenoid wire.
d. Crank the engine in 10 to 15 second intervals until clear fuel is observed at the air bleed hose (wait for one minute between cranking intervals).
e. Close the air bleed valve.
f. Connect the shut-down solenoid wire and reinstall fuel filler cap.
g. Start the engine and allow to run for five minutes at idle.
h. Check the fuel manager/filter for leaks.

FUEL PUMP REPLACEMENT (See Figure 7-29)

Removal

1. Remove the negative (–) battery cable(s).
2. Remove the electrical wiring from the pump.
3. Remove the harness from the pump support bracket.
4. Remove fuel lines from the pump.
   - Use two wrenches to remove the lines.
5. Remove the pump support bracket screws.
6. Remove the support bracket from the brake lines.
7. Remove the pump and bracket from the frame rail.

Installation

1. Install the pump and bracket to the frame rail.
2. Install the support bracket to the brake lines.
3. Install the pump support bracket screws.
4. Install the fuel lines to the pump.
   - Use two wrenches to install the lines.
5. Install the wiring harness to the support bracket.
6. Install the electrical wiring to the pump.
7. Install the negative (–) battery cable(s).

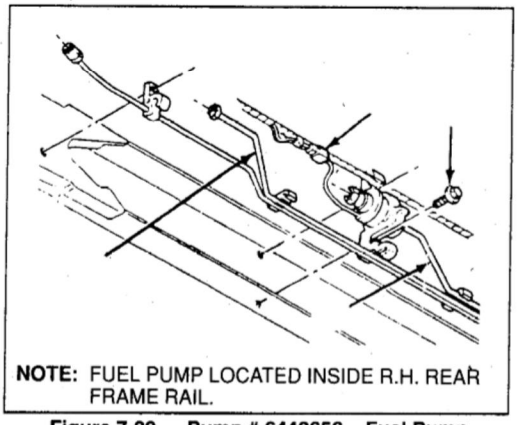
Inspect

- Inspect the fuel lines between fuel filter and tank for restrictions.
- Inspect the fuel tank sending unit for restrictions.

If "OK" replace the fuel pump.

FUEL PUMP TESTS

If the fuel system is suspected of not delivering enough fuel, it should be inspected as follows and both the "Fuel Pump Flow Test" and the "Fuel Pump Pressure Test" should be performed.



NOTE: FUEL PUMP LOCATED INSIDE R.H. REAR FRAME RAIL.

Figure 7-29 — Pump # 6442656 – Fuel Pump Location

- Make certain that there is sufficient fuel in the tank.
- Check for leaks at all fuel connections from the fuel tank to the injection pump.
- Tighten any loose connections.
- With the engine running, check all hoses and lines for flattening or kinks that would restrict the flow of fuel.
- Air leaks or restrictions on the suction side of the fuel pump will seriously affect pump output.

FUEL PUMP FLOW TEST

1. Remove the fuel line at the fuel filter inlet.
2. Disconnect the fuel injection pump electric shut-off solenoid wire (pink wire).
3. Place a suitable container at the end of the fuel filter inlet line.
4. Crank the engine for 15 seconds.
5. The fuel pump should supply 237 ml (1/2 pint) or more in 15 seconds.
6. Install the fuel injection pump electric shut-off solenoid wire (pink wire).
7. Install the fuel line at the fuel filter inlet.
   - If the system fails to pass the above test:

Inspect

- Inspect the fuel lines between fuel filter and tank for restrictions.
- Inspect the fuel tank sending unit for restrictions.

If "OK" replace the fuel pump.

FUEL PUMP PRESSURE TEST

1. Remove the fuel line at the fuel filter inlet.
2. Disconnect the fuel injection pump electric shut-off solenoid wire (pink wire).
3. Install a low pressure gage to the line.
4. Crank or run the engine for 10 to 15 seconds.
5. Fuel pressure should be 40 to 60 kPa (5.8 to 8.7 psi).
6. Connect the fuel injection pump electric shut-off solenoid wire (pink wire).
7. Install the fuel line at the fuel filter inlet.
   - If the system fails to pass the above test:

PLUGGED FUEL RETURN LINE AND ENGINE PERFORMANCE

The following information has been extracted from a Chevrolet Dealer Service Technical Bulletin and concerns poor engine performance due to a plugged fuel return line on the G-30 Cutaway and P-Series Class A Rail.

Reference: Chevrolet Dealer Service Technical Bulletin No. 78-I-53 (September, 1978)

Prior to Cutaway and Class A Rail body completion, a temporary fuel tank was utilized and required that the fuel return line remain disconnected and plugged.

The line was to be unplugged and connected by the body builder prior to final delivery of the completed vehicle. Failure to reconnect the fuel return line can cause a vapor lock condition at high altitudes or high ambient temperatures.

In the event of a lack of power or rough engine complaint on the subject vehicles, check for the proper connection of the fuel return line. (See Figure A7-6-1.)

NOTE: Some 1978 and 1979 "G" Vans with V-8 engines, when operated in high ambient temperatures and under high engine fuel demands, have experienced the deformation of the flexible hose which connects the fuel feed line to the fuel pump. (See Figure A7-6-1.)

This condition is difficult to diagnose due to the unusual conditions under which it takes place.

To prevent this hose from deforming, a new molded hose (GM Part No. 14010036) has been released for 1980 production and can also be used for service replacement. Effective with 1980 model production, an improved flexible hose was also introduced into production for the Class A Motor Home chassis. The new hose resists "sucking shut" in high heat and high fuel demand situations; however, it still will draw closed if tank or line filters become plugged. (GM Part No. 14026551 for 454 engines and GM Part No. 14026550 for 350 engines.)

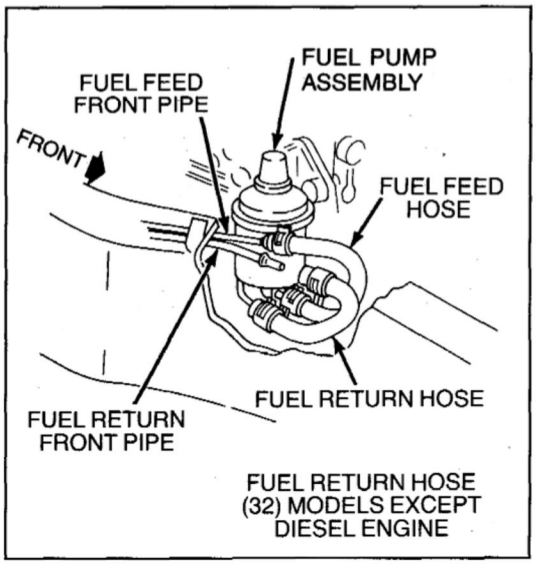


Figure A7-6-1 — Fuel Return Line Connections

VAPOR LOCK CAUSE AND CURE

The following information has been compiled from extensive research and testing performed by Chevrolet Engineering and RV manufacturers concerning fuel handling problems of the Class A Motor Home (during 1982 and 1983). Chevrolet and the RV manufacturers examined typical "problem units" furnished by various owners in order to better understand "real-world" vapor lock problems in the highly customized Class A Motor Home and develop corrective actions.

This information is presented as an aid to the motor home owner in understanding the problems associated with vapor lock and their suggested solutions.

Fuel System Plumbing

As determined from initial studies, Chevrolet engineers and RV manufacturing representatives determined that part of the problem concerning vapor lock involved the RV manufacturers' approach to the fuel system plumbing. Examination of problem units identified considerable plumbing errors, such as:

- Four feet of rubber hose added in the middle of the stretch chassis.
- A length of hose positioned over the top of the tank to the pickup.
- Total rubber plumbing which is tied to the rear hot water lines with zip straps so that there was a tendency for the fuel to boil and the lines to "suck shut" or kink at each zip strap.
- Vehicles equipped with a defective switch valve so that the ports did not line up properly and some of the valves would only switch occasionally. (Ports that did not line up caused restriction as did units that had two additional fuel filters and a stretch chassis. All of these factors add to the load on the mechanical fuel pump.)
- An electric fuel pump installed in the return line rather than the suction line.
- Incorrect tank cap venting.
- And so on.

Chevrolet and the RV manufacturers' representatives determined that 100 percent of the motor homes produced with plumbing errors such as those above could have vapor locking problems. Investigation showed that a properly plumbed fuel system down the inside of the frame rail was also not a 100 percent cure for the problem.

Fuel Properties

As part of the investigation, Chevrolet Fuel and Lubrication Engineers conducted a nationwide survey examining the possibility that fuels could cause vapor lock. Results of the survey show that oil companies have contributed to the cause of vapor lock by the addition of alcohol to the fuel without informing the public or advertising the fuel as gasohol. Also, it was determined that butane was added to "cover up" lower grade crudes and to increase octane ratings. The result of the fuel being adjusted and the octane modifiers was a general increase in the Reid vapor pressure (RVP) of the fuels (the higher the Reid vapor pressure the greater the possibility of vapor lock). The average Reid vapor pressure of regular unleaded gasoline was 9.3 in 1980, 9.8 in 1981 and 10.3 in 1982 (with individual locations showing a reading of 12 and 13). With fuel changes toward the higher Reid vapor pressure fuels, some motor home owners who have never experienced any problems could have vapor lock problems that did not exist a year or so ago. Also, it was determined that mountains, steep grades and overloaded vehicles tend to aggravate the vapor lock problem, as recorded in a park survey at Pikes Peak. Vapor lock at Pikes Peak is the single most recorded mechanical problem encountered.

Results of Vapor Lock Investigation

During the week of October 17, 1983, Chevrolet invited all Class A Motor Home manufacturers to the GM Proving Grounds in Phoenix, Arizona. The purpose of this meeting was to discuss the findings of the investigation into the cause of vapor lock and to make specific corrective recommendations for current and future production vehicles (including changes in truck emissions). The meeting was attended by 34 of 36 RV manufacturers. Chevrolet suggested that the RV manufacturers incorporate the following recommendations into current and future vehicle building, as well as develop some adaptation for problem units already existing in the field. The following recommendations were presented:

- A one-half inch steel fuel line mounted on the outside of the frame rail, protected against rub and chafe (see Figure A7-7-2).
- Also recommended is a pump bypass line along with a check valve. The 12-801 is a positive displacement pump and will not allow fuel flow if it stops running. The bypass, which closes under fuel pressure, will allow the engine mounted mechanical pump to pull fuel from the tank in the event of an electric pump failure. (See figure A7-7-1).
- The fuel requirements for the 454 engine at wide-open throttle are 25 gallons per hour at 2 PSI minimum and 3 PSI maximum. If fuel line lengths or routings create a situation where this cannot be met, an electric pump should be added at the fuel tank to supply fuel to the mechanical pump on the engine. Pressure in the supply line will further reduce the chance of bubbles forming versus a negative pressure situation with a mechanical pump only. (See Pressurized Fuel System Diagnosis Chart in Figure A7-7-8.)

VAPOR LOCK CAUSE AND CURE (Cont'd)

- A single in-line filter should be placed between the tank and the electric fuel pump. (One filter choice is AC Part No. GF62C.)
- A 3/8-inch rubber fuel line connection should be made at the mechanical fuel pump and at the fuel pump sending unit.
- Power for the electric fuel pump should be controlled through a relay or special oil pressure switch to assure shut-down in the event of vehicle upset (see Figure A7-7-3). Consideration could be given to a manual priming override in the event the system has totally run out of fuel. Normal starts would occur with the fuel remaining in the carburetor and upon starting as oil pressure came up the special switch or relay and would turn on the electric pump. (See installation instructions in Figure A7-7-4.)
- AC electric fuel pump (AC Part No. EP89) can also be used and does not require a fuel pressure regulator. The wiring remains the same.

Chevrolet invited all RV manufacturers to the Phoenix meeting to share the findings and test information, as it would be difficult for a singular RV manufacturer (or customer) to produce these tests on their own. Chevrolet informed the RV manufacturers that all necessary steps would be taken to correct any vapor lock problem on any chassis with a 137-, 158-, 178-inch wheelbase with a 100 percent factory system. As an additional commitment to the 1983 meeting, Chevrolet has informed all RV manufacturers that all necessary steps will be taken to correct any vapor lock problem for the 208-inch wheelbase Model CP32032 entering production for the 1988 model year with a 100 percent factory system. Additionally, Chevrolet requested that the RV manufacturers correct any field problems that are reported to them on any units that have been modified by the RV manufacturer — such as stretch chassis, dual tanks, dual fuel, oversize tanks, etc., as the individual manufacturers are more knowledgeable of their own systems and are in a better position to make their own modifications for the various models, years and options.

NOTE: Chevrolet has completed testing of a new 60-gallon tank. With the start of 1985 production, new fuel lines were installed on the outside of the frame rail. In the spring of 1985, a complete system was in production with in-tank electric pusher pump and external regulator adjustable by the RV manufacturer for an oversize wheelbase. (See Figure A7-7-5.)

Check Valve Installation

To install a fuel line anti-siphon check valve into the system, a 3/8" bypass line must be installed around the electric fuel pump and regulator (See Figure A7-7-1.) The valve is manufactured by Aluminum Fabricated Products (AFP 200) and must be fitted with 3/8" hose connector, available from Parker-Hannifin Corporation (Part No. 126HBL-6-6.) These parts are usually available from marine hardware suppliers.

Install as follows:

- Install one 3/8" T-fitting in the fuel line between the regulator and the mechanical fuel pump and one 3/8" T-fitting between the electric fuel pump and the fuel tank.
- Connect a 3/8" hose to the T's.
- If the bypass fuel line is already in place, remove 1-1/2 inches of 3/8 fuel line and insert check valve.
- Insert valve side in line toward mechanical fuel pump; insert fitting side into line from fuel tank.
- Secure bypass line and valve with 3/8" hose clamps.

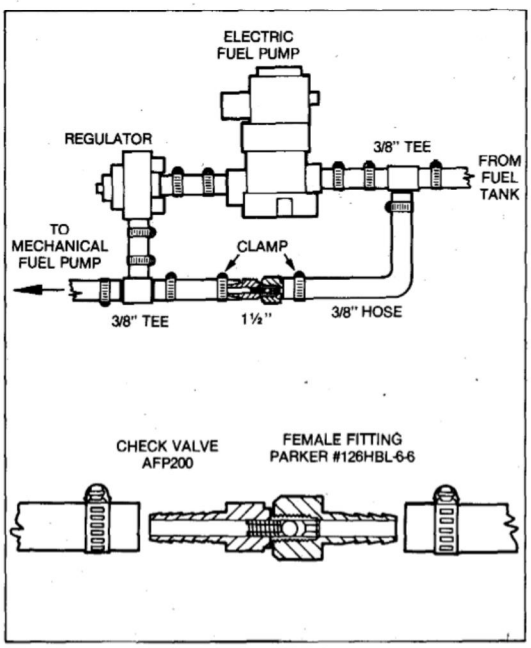


Figure A7-7-1

VAPOR LOCK CAUSE AND CURE (Cont'd)

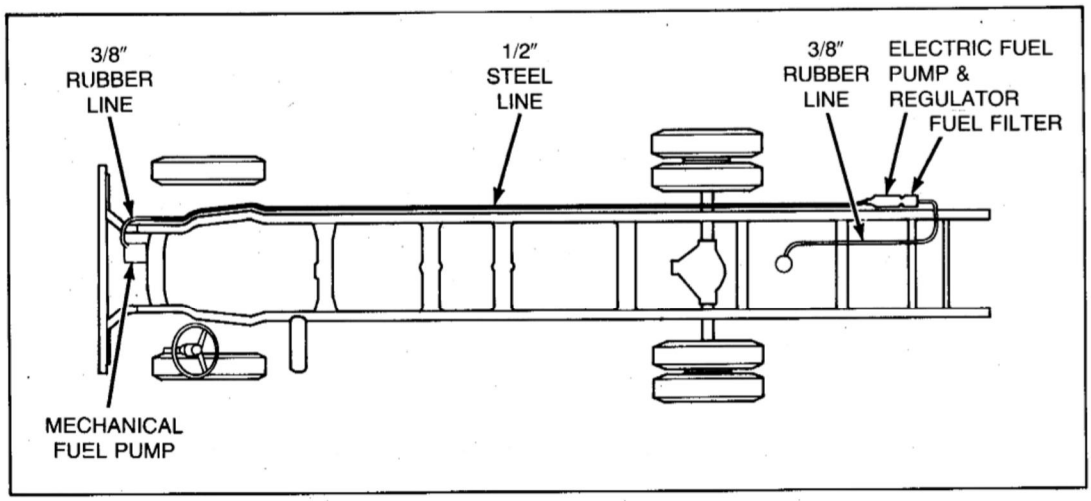
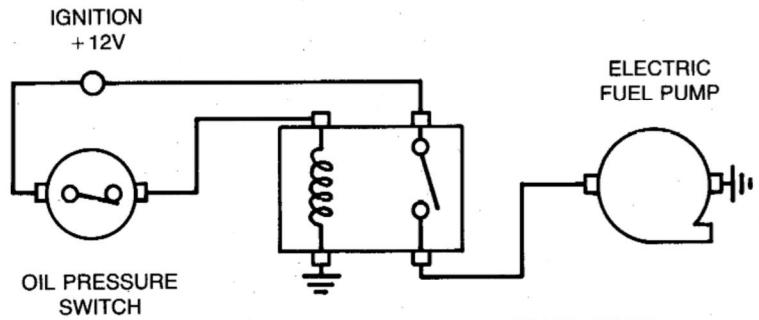


Figure A7-7-2 — 1984 Recommended Field Fix



NOTE: THE FOLLOWING OIL PRESSURE SWITCHES CAN BE USED WITH OR WITHOUT A RELAY SWITCH AND ARE CAPABLE OF HANDLING CURRENT DRAW REQUIREMENTS OF THE HOLLEY GPH 110 (PART NO. 12-801) MAX-PRESSURE PUMP.

GM PART NO.	CONNECTION
25036851	1/8 - 27 DRYSEAL (NPTF)
457874	1/8 - 27 DRYSEAL (NPTF)
14034354	1/4 - 18 DRYSEAL (NPTF)

CONNECTOR 12101921 WITH LOCK 12010259 CAN BE USED AS THE ELECTRICAL CONNECTION FOR EACH OF THESE SWITCHES.

HOLLEY ALSO PRODUCES A SWITCH (PART NO. 12-810) THAT DOES NOT REQUIRE A RELAY.

Figure A7-7-3 — Electric Fuel Pump/Oil Pressure Switch Relay

VAPOR LOCK CAUSE AND CURE (Cont'd)

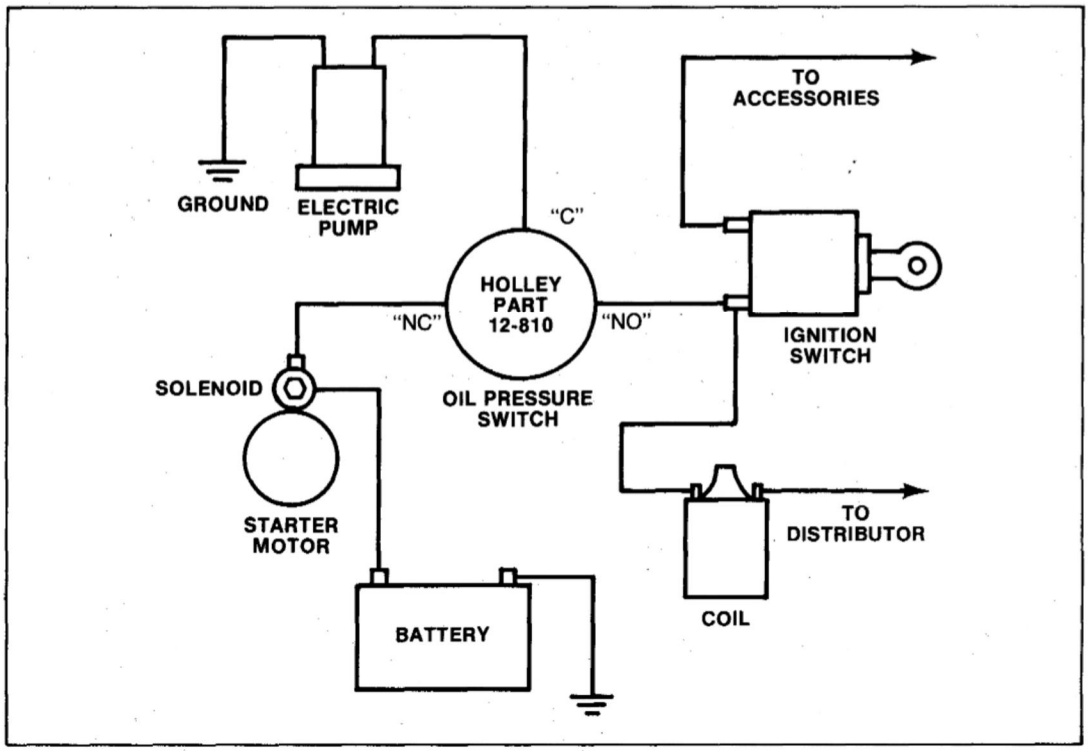


Figure A7-7-4 — Oil Pressure Switch — Typical Wiring Diagram

INSTALLATION INSTRUCTIONS

NOTE: Please read instructions completely before making installation.

1. Disconnect cable from battery.
2. Remove original equipment oil pressure switch and retain.
3. Screw a 1/8-inch pipe nipple into the hole from which the pressure switch was removed. Use any suitable thread sealant on all fittings, taking care to avoid an excess which might contaminate the engine.
4. Screw a 1/8-inch pipe tee onto the nipple and position it in a manner to facilitate the installation of the original oil pressure switch and the new fuel pump pressure switch in the remaining two holes.
5. Screw in the two switches and reconnect the lead to the original equipment oil pressure switch.

NOTE: The pump oil pressure switch will normally have three terminals marked: *C* (common), *NC* (normally closed), and *NO* (normally open).

6. Connect the fuel pump (black lead) to the terminal marked "C." In this line, add an in-line fuse holder and a 7.5-amp fuse.
7. Connect the terminal marked "NO" to the ON terminal of the ignition switch.
8. Connect the terminal marked "NC" to the starter motor circuit.
9. To complete the installation, connect the ground cable to the battery.

BE SURE TO CRIMP SECURELY ALL ELECTRICAL CONNECTORS AND CLEAN ANY AREA WHERE GROUND LEADS WILL BE FASTENED.

VAPOR LOCK CAUSE AND CURE (Cont'd)

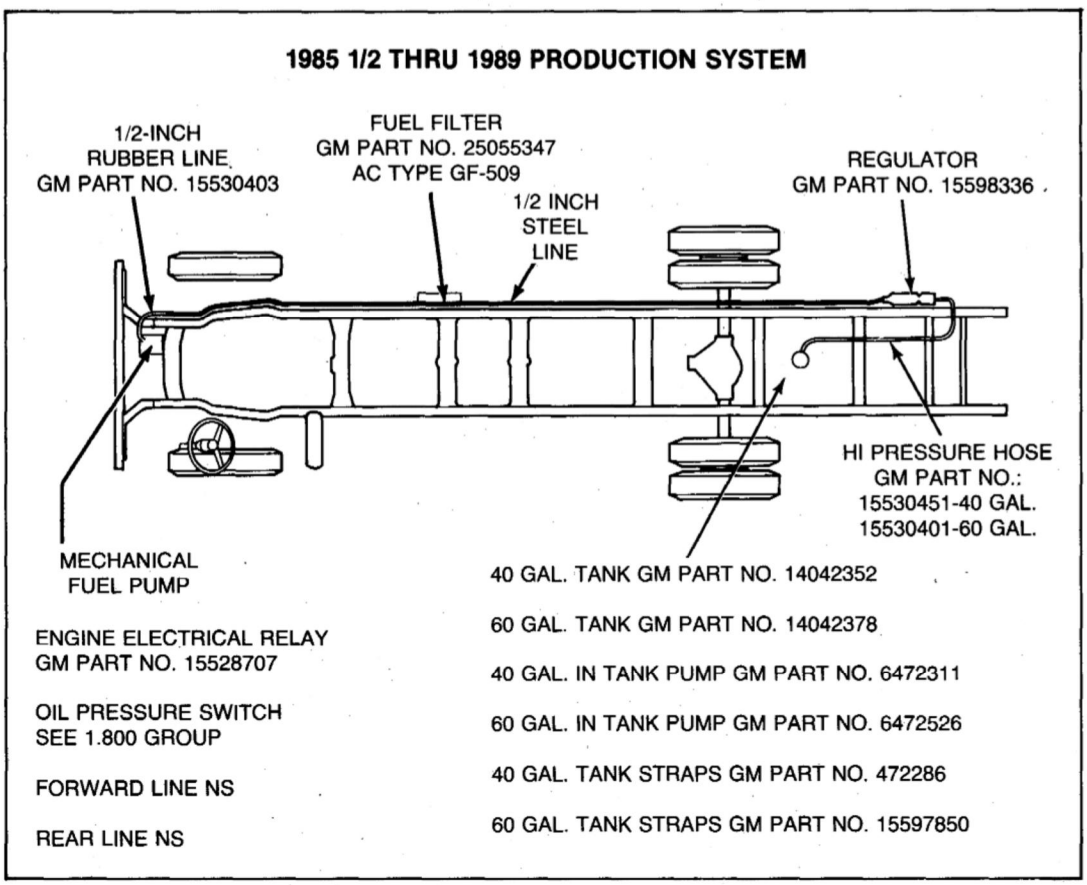


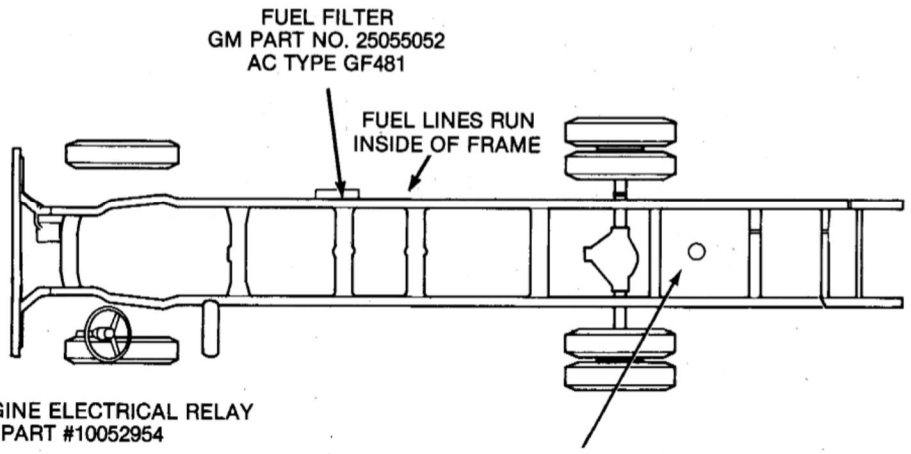
Figure A7-7-5 — 1985 1/2 to 1989 Pressurized Fuel System Components

NOTE: In July, 1985, GM began production of a new pressurized fuel system. From production, the RV manufacturer may choose a 40-gallon standard system, an optional 60-gallon system (Option No. NN4) or specify Option No. 9H2. Option No. 9H2 deletes Chevrolet's system and requires the manufacturer to install its own system. Check the Service Parts Identification Label for appropriate option number. See page 1-3.

NOTE: The factory electric in-tank fuel pump has an activating relay that is shipped loose in the parts box to the RV manufacturer. The wire harness is located at the left front corner of the engine compartment. There are two studs on the engine side of the tow pan for mounting the relay. See Figure A7-17-2 for mounting location.

VAPOR LOCK CAUSE AND CURE (Cont'd)

1990-1993 PRODUCTION SYSTEM FUEL INJECTION



ENGINE ELECTRICAL RELAY
GM PART #10052954

OIL PRESSURE SWITCH
SEE 1.800 GROUP

FUEL LINES NS

FUEL TANK OPTIONS
STD. 40 GALLON
NN4 60 GALLON
NJ9 80 GALLON RH OR LH FILL

40 GAL. FUEL SENDER GM PART NO. 25094633 PEW

60 GAL. FUEL SENDER GM PART NO. 25094631 PEX

80 GAL. FUEL SENDER GM PART NO. 25094783 PEY

FUEL SENDER TO TANK SEAL GM PART NO. 3893116

FUEL PUMP FITS ALL 3 GM PART NO. 6472763

FUEL IN TANK FILTER GM PART NO. 25055455

Figure A7-7-6

NOTE: Viton hose and clamp Kit #25028041 for short hose between electric fuel pump and fuel meter in tank.

Fuel Hoses 1990-92
Pressure line tank to rail line 15666408
Pressure line, rail to injector 15613689
Return line, injector to rail line 15613690
Return line, rail line to tank 15666409

Temporary fuel line usage was eliminated SOP 5-31-91.

1994
40 GAL. WITH PUMP GM PART NO. 25028266
60 GAL. WITH PUMP GM PART NO. 25028269
80 GAL. WITH PUMP GM PART NO. 25028272
PUMP ONLY GAS GM PART NO. 6443146
DIESEL METEOR ONLY
40 GAL. GM PART NO. 25027045
60 GAL. GM PART NO. 25004132
80 GAL. GM PART NO. 25029695
LIFT PUMP
1994 7.4 GAS
40 GAL. FUEL SENDER GM PART NO. 25028266
60 GAL. FUEL SENDER GM PART NO. 25028269
80 GAL. FUEL SENDER GM PART NO. 25028272
FUEL PUMP GM PART NO. 6443146
1994 6.2 DIESEL
40 GAL. FUEL SENDER GM PART NO. 25027045
60 GAL. FUEL SENDER GM PART NO. 25004132
80 GAL. FUEL SENDER GM PART NO. 25029695
LIFT PUMP GM PART NO. 6442656

VAPOR LOCK CAUSE AND CURE (Cont'd)

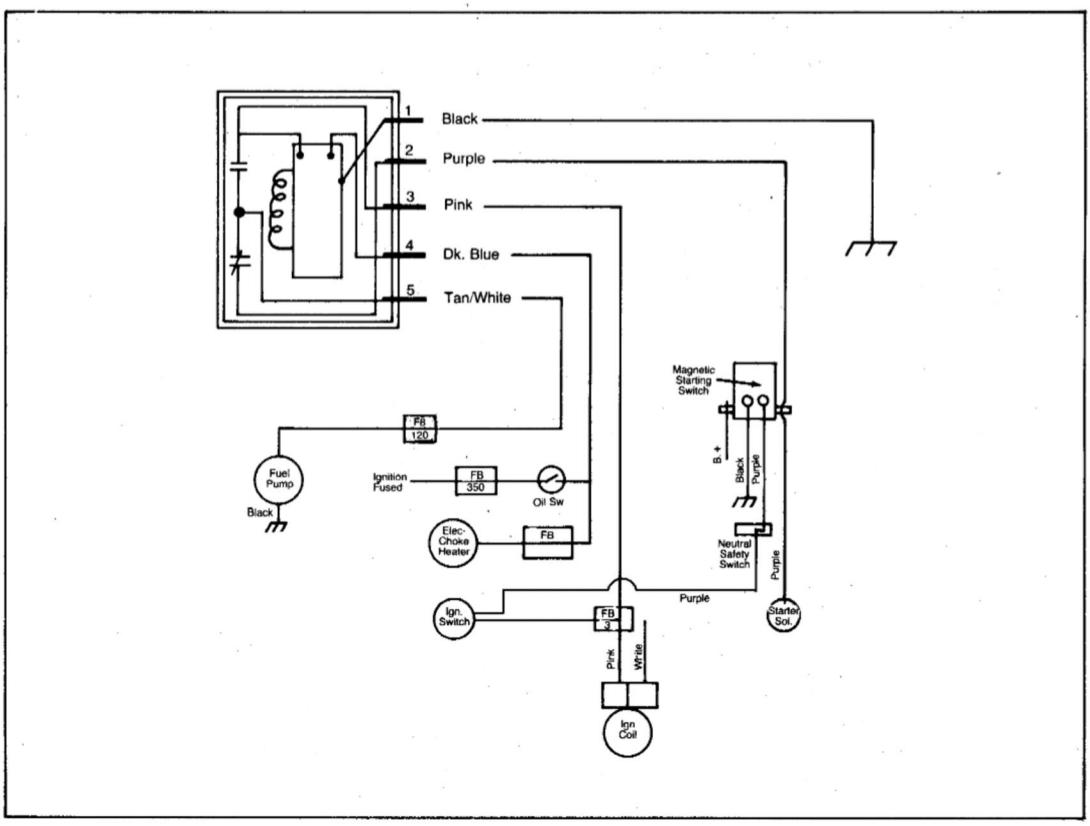


Figure A7-7-7 — Engine Electrical Fuel Pump Relay — Typical Wiring Diagram

NOTE: Without activation of the electric in-tank fuel pump, the chances for a vapor lock in the system increases because of the increased workload on the mechanical pump through the electric pump. To check the system, perform the following operational test. Turn the ignition key to the RUN position. Have an assistant check (listen/feel) the tank end for pump operation as a capacitor charges in the relay. The pump will run for approximately five seconds after the key has been turned. (Twelve volts is also supplied to the pump in the crank position and as the engine starts and oil pressure builds, 12 volts is supplied to the electric fuel pump whenever the engine is running.)

VAPOR LOCK CAUSE AND CURE (Cont'd)

1985 1/2 Through 1989 Model Year

Verify that the coach was built with a Chevrolet fuel tank or that it contains an electric intank fuel pump. This can be done by checking the invoices or Service Parts I.D. Label. A 40-gallon tank is standard. Option NN4 indicates a 60-gallon tank was installed. Option 9H2 indicates that the fuel system was installed by the coach builder and may not be of Chevrolet design.

Once the system has been identified, determine that the electric fuel pump is operating, as follows:

- With transmission in PARK position and emergency brake ON, turn ignition ON. **DO NOT START ENGINE.**
- Have someone hold their hand against the bottom of the fuel tank.
- A vibration should be felt on the hand for approximately 5 seconds after the ignition is turned on.

If the pump does not operate, and a vibration is not felt, check the fuel pump relay system wiring (see page 7-43 and 7-96 for location). Check electrical continuity from electric fuel pump relay (Fig. A7-7-3) to oil pressure switch and from oil pressure switch to electric fuel pump.

It is the responsibility of the coach manufacturer to insure that the electric fuel pump operates properly at time of coach assembly.

If the coach does not have an electric fuel pump, or was built before 1985 1/2, use the diagnostic chart on page 7-48.

Gas Fumes in Engine Compartment or Fuel in Charcoal Canister

1. Remove line from charcoal canister that runs to the fuel tank.
2. Remove gas cap from filler spout.
3. Blow air into disconnected canister line (Tank must be at least 1/4 full.)
4. Listen at spout for bubbles in the fuel tank.
5. If air bubbles in gasoline, the lines are crossed.

This condition usually occurs when the coach manufacturer has stretched the frame and the fuel lines have been extended. Look for a crossed line where the fuel lines have been spliced.

If blowing air into the disconnected line does not cause bubbles, check for damage to fuel lines, to the canister, and the valve on top of canister. (Fig. 7-96)

VAPOR LOCK CAUSE AND CURE (Cont'd)

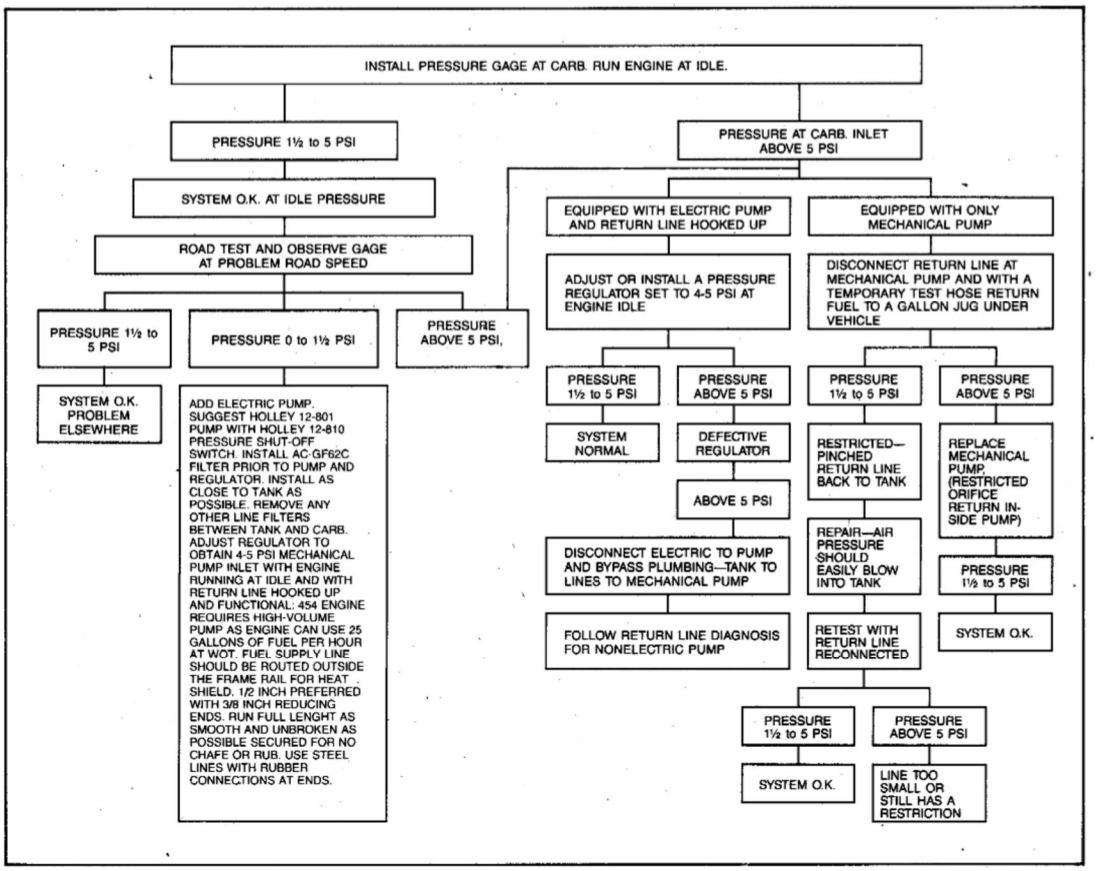


Figure A7-7-8 — Pressurized Fuel System Diagnosis Chart For Pre 1985 1/2 and Units

NOTE: Cool fresh air should be introduced through the fresh air induction via hose from the front of the radiator to the carburetor air cleaner snout. This has proven effective in reducing fuel percolation in the carburetor fuel bowl.

VAPOR LOCK CAUSE AND CURE (Cont'd)

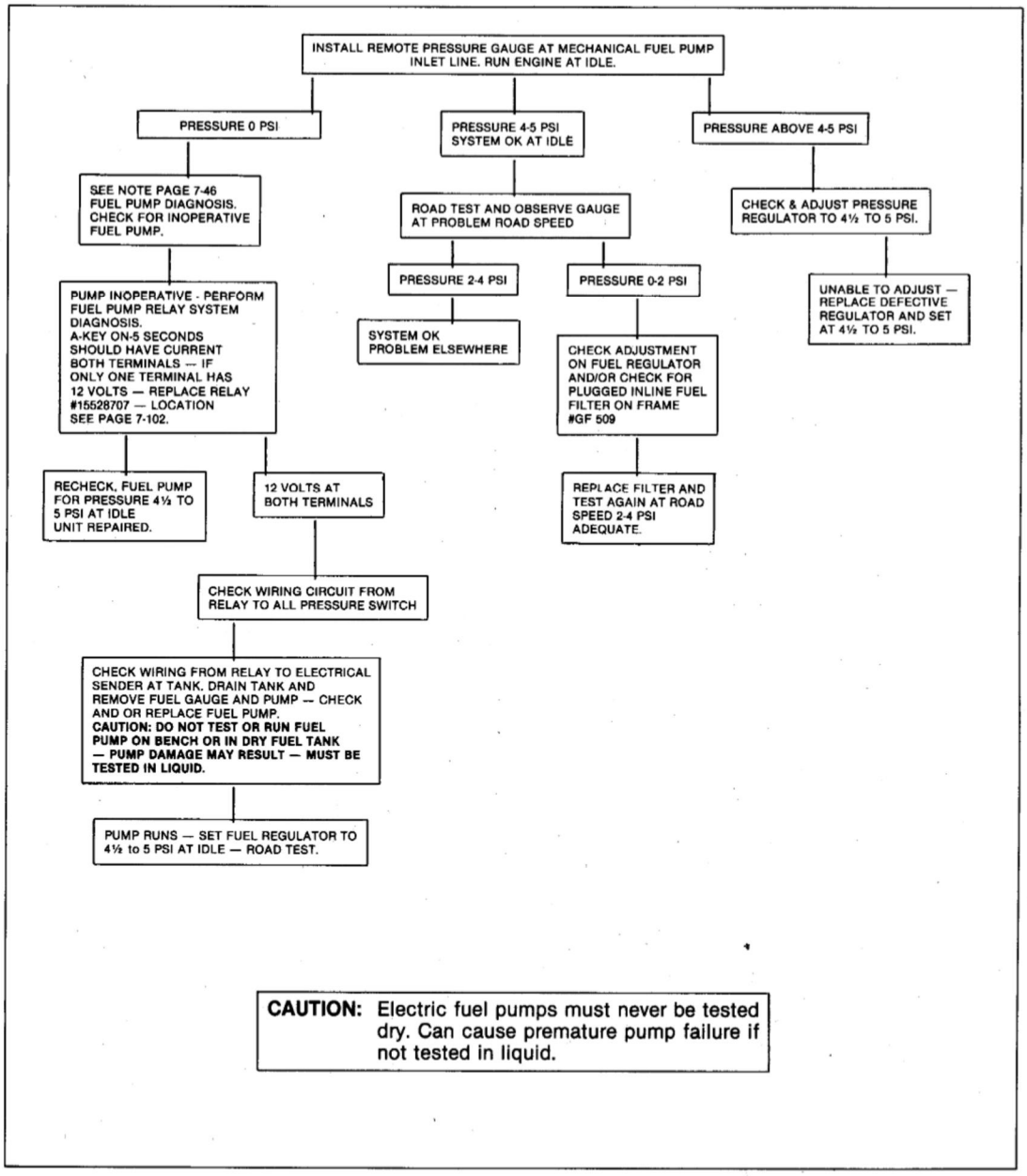


Figure A7-7-9 — Pressurized Fuel System Diagnostic Chart 1985 1/2 thru 1989

TROUBLESHOOTING AFTERMARKET FUEL SYSTEMS

The following information is presented as an aid to the motor home owner and RV manufacturers in understanding some of the problems and the suggested solutions for after-market fuel systems.

This information has been extracted from a GM field representative research and testing report concerning problems with after-market fuel systems. Chevrolet and RV manufacturers examined typical "problem units" furnished by various owners to better understand after-market fuel system problems that are unknowingly built into a fuel system.

GM has taken the position that any repairs to after-market fuel systems will be the responsibility of the RV manufacturer and/or the motor home owner. Problems associated with the vehicle fuel system will not be corrected under the GM warranty unless the system is a 100 percent GM fuel tank and system. (For additional information, see Appendix 7-7 — Vapor Lock Cause and Cure referring to the Chevrolet/RV Manufacturers meeting held in Phoenix, Arizona, October, 1983.)

RESEARCH FINDINGS — Many RV manufacturer's customer service representatives have experienced customer complaints in several areas concerning after-market fuel systems. The three overall complaints are:

1. Raw fuel is spilled out the vent to the ground or fills the charcoal canister.
2. The fuel tank fills slowly.
3. Raw fuel "shoots" from the tank when the fuel cap is removed.

COMPLAINT No. 1 — The situation of raw fuel spilling out the vent to the ground can only occur when the fuel tank reaches a 100 percent "brim-full" condition. As there is no air pocket in the top of the tank, the fuel expands as it is heated and creates one of two possible situations. Either the fuel tank itself will bulge due to the expansion of the fuel, or the fuel escapes through the vent to the ground or the charcoal canister at a rate that is controlled by pressure and the size of the vent.

COMPLAINT No. 2 — The "slow fill" complaint occurs on after-market fuel systems as the fuel entry point is positioned midway on the side of tank. This is a design "trade-off" versus a top-fill or corner-fill fuel entry location. When the level of the fuel covers the fill opening in the side of the tank, the fill rate slows because the incoming fuel must move or "displace" the existing fuel out of the way. Also, the size of the vent and the spit-back tube have a bearing on the rate of fuel fill. Even if the top of the fuel tank was completely removed (similar in appearance to a pail), the fill rate would still be very slow as the incoming fuel must still move and displace the existing fuel.

EXAMPLE: Filling a fuel tank would be much easier by pouring the fuel into the top to "splash" to the bottom versus filling the tank by forcing the fuel at the bottom of the pail which requires gravity to work against fluid weight and displacement.

COMPLAINT No. 3 — Fuel "shooting" from the fuel tank when the cap is removed is caused by the vent being too small, and/or an incorrect position of the main side-fill fuel entry tube and spit-back tube.

CASE STUDY EXAMPLE: An after-market fuel system was fitted with a spit-back tube extending approximately 1-3/8 inches into the fuel tank based on a planning design of 90 percent fill capacity of a tank 14 inches deep. (This is not enough of a margin of air space for all applications.) In this situation, when the fuel was above the half-way point of the tank, fuel was in the tank filler neck at the same level of the fuel in the tank. As the pressure increased in the tank from heat expansion and slightly restricted venting, the pressure was actually over the entire surface of the fuel. The moment the filler cap was removed, fuel rushed backward up the filler neck as the spit-back tube could not bleed off the pressure fast enough. (This situation is similar to shaking a carbonated soft drink to obtain maximum "fizz," then turning the bottle or can upside down and opening the container slowly.)

With a top-fill or corner-fill tank, (even with a restricted vent) the chance of fuel "spitting out" is greatly reduced as fuel is not present in the fill neck. The worst problem associated with a top-fill or corner-fill tank is air relief as the cap is removed.

The problem of fuel "spit back" can be corrected for a side fill tank **IF** the pressure is removed from the top of the tank.

TROUBLESHOOTING AFTERMARKET FUEL SYSTEMS (Cont'd)

TO HELP CORRECT THIS CASE STUDY COMPLAINT:

A design change is necessary in the restriction size of the vent line. As the size of the orifice is currently about a .030-inch opening, the above case study system would benefit by opening the vent hole to between .055 inch and .060 inch. This would allow additional pressure to bleed out of the top of the tank and to reduce downward pressure on the surface of the fuel.

A restricted vent is needed for two reasons:

- The restricted vent is required to make the automatic fuel shut-off work with the spit-back tube.
- The restricted vent also serves as an anti-siphon device when the fuel runs to one end of the tank.

A restricted vent that is too large defeats the purpose of the automatic shut-off and anti-siphon system. However, a restricted vent that is too small invites excessive pressure build-up in the tank.

Ideally, the spit-back tube should be positioned in the tank to allow approximately 20 percent free air level. A top-fill or corner-fill system should be considered with the fill pipe extending into the tank to the same depth as the spit-back tube and cut at an angle horizontal to the fluid level. This remedy should be used in conjunction with a .055-inch to .060-inch restricted vent and a GM-type fill cap.

ADDITIONAL TIPS — Troubleshooting after-market fuel systems does not end with tank hardware. Generally, pressure is a side effect of heated fuel causing expansion and fume pressures. A service technician should also examine the source(s) of the heat. Possible causes are:

- A hole in the exhaust blowing directly on the fuel tank.
- Serious overload or pulling of a trailer which puts abnormal "fire" in the exhaust.
- An engine that is running poorly having higher than normal unburned fuel in the exhaust system which is burned off with the A.I.R. pump increasing exhaust temperatures.
- An altered or modified exhaust system (by owner or RV manufacturer) with an improper tank-to-pipe clearance.

SECONDARY FUEL FILTERS

The following information has been extracted from the GM 6.2-Liter Diesel Engine manual. The information covers general operation, application and replacement part numbers of both the Model 75 and Model 80 Secondary Fuel Filter.

G-P SERIES — MODEL 75 SECONDARY FUEL FILTER

The G-P Series uses a Stanadyne Model 75 secondary fuel filter in 1983. (See Figure A7-9-1.) It is fastened using two ball clips. It is particularly important to place absorbent towels under the filter when changing it to improve cylinder and case valley drain and prevent fuel oil contamination of the clutch-driven disc.

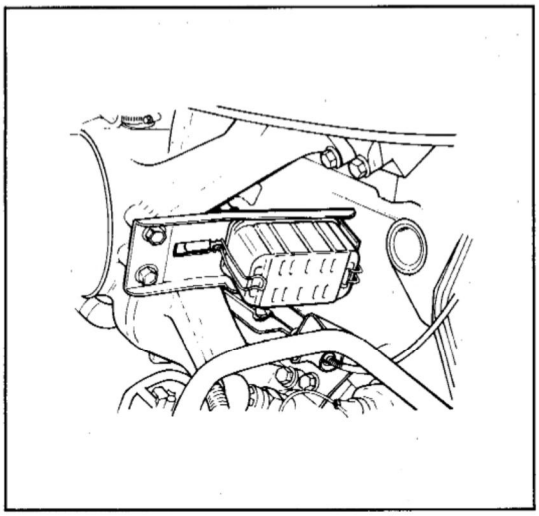


Figure A7-9-1 — Model 75 Secondary Fuel Filter

The Model 75 filter is a two-stage pleated paper type filter. The first stage consists of approximately 400 square inches of filtering area and will remove 94 percent of particles 10 microns or larger. The second stage is made of the same paper material and consists of approximately 200 square inches of filtering surface. The second stage is 98 percent effective in filtering the fuel already filtered by the first stage.

Particles which are larger than 10 microns may damage the pump's internal components. Figure A7-9-2 compares various micron sizes and will ultimately show the filter's effectiveness.

G-P SERIES — MODEL 80 SECONDARY FUEL FILTER

The Model 80 Stanadyne Fuel Filter provides the following features in one unit:

- Two-stage fuel filter
- Fuel/water separator
- Electronic "water-in-fuel" signal
- Electric fuel heater
- Integral hand primer
- "Filter change" signal — removed starting 1989.

Fuel Heater

The purpose of the heater (see Figure A7-9-3) is to heat fuel, so that the filter does not plug with paraffin wax crystals. This will allow use of fuels at temperatures substantially below the Cloud Point of the fuel. The heater is electrically powered from the ignition circuit 39 and is thermostatically controlled to work when waxing of the fuel is expected.

The device can be divided into two major functional components — the heater and the power control assemblies.

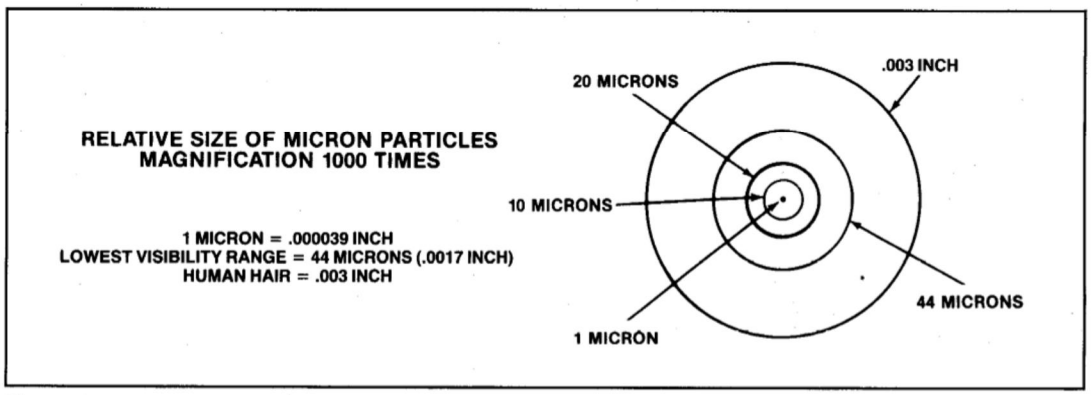


Figure A7-9-2 — Relative Size of Micron Particles

SECONDARY FUEL FILTERS (Cont'd)

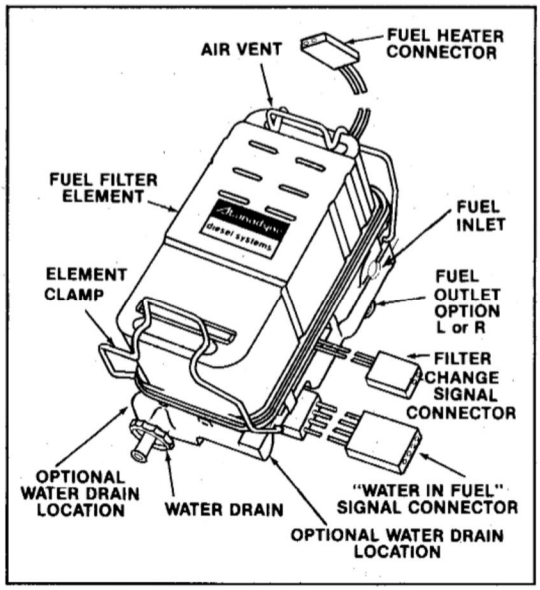


Figure A7-9-3 — Model 80 Fuel Filter and Base Assembly

Fuel Filter

The engine fuel filter is a two-stage pleated paper type filter (see Figure A7-9-4). The first stage consists of approximately 350 square inches of filtering area and will remove 96 percent of particles 5-6 microns or larger (see Figure A7-9-2). The second stage is made of the same paper material with glass particles and consists of approximately 100 square inches of filtering surface.

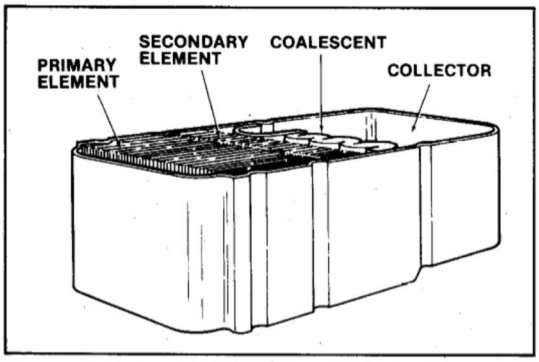


Figure A7-9-4 — Model 80 Filter Cross Section

The second stage is 98 percent effective in filtering the fuel already filtered by the first stage. Particles which are larger than 10 microns may damage the pump's internal components.

Water Sensor

The 6.2L uses a "water-in-fuel" warning system, which allows the user to guard against water in the fuel.

The water is detected by a capacitive probe located in the filter base. Electronics within the probe will connect a ground (circuit 150) to the ground side of the "water-in-fuel" lamp (circuit 508). This lamp is in the center of the instrument panel next to the glow plug lamp. In 1984 (4-wire water-sensor module) a bulb check was made anytime the ignition switch was in the start position. A "B+" signal on the purple wire at the "A" test switch (Figure A7-9-5) causes pin "D" to pull low, grounding the "water-in-fuel" bulb. In 1984-1/2 and 1985 (3-wire water-sensor module) when the ignition is turned on, the lamp will glow from 2 to 5 seconds, and fade away. This is done as a bulb check.

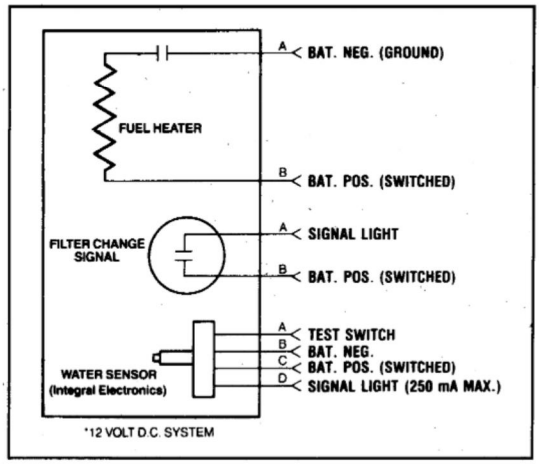


Figure A7-9-5 — Filter Base Wiring

Water Separator

The bottom of the filter is a hollow water collector (Figure A7-9-6). Because of the greater density of water, the water droplets will separate from the fuel oil. It will hold approximately 260 cubic centimeters of water (approximately 3-10 percent).

A nylon/fiberglass coalescent is used to blend the small water droplets into larger ones.

SECONDARY FUEL FILTERS (Cont'd)

Fuel Flow

See Figure A7-9-6. Fuel enters at the top right inlet and flows into the heating chamber. The heater is activated at 8°C (46°F) and below. The heated fuel enters the element at the top and flows down through the two-stage fuel filter media pack. While passing through the third stage, water coalesces and drops to a sump holding area. Clean fuel returns to the base and exits to the fuel injection pump. An electrical signal is obtained from the filter-change sensor located in the return path.

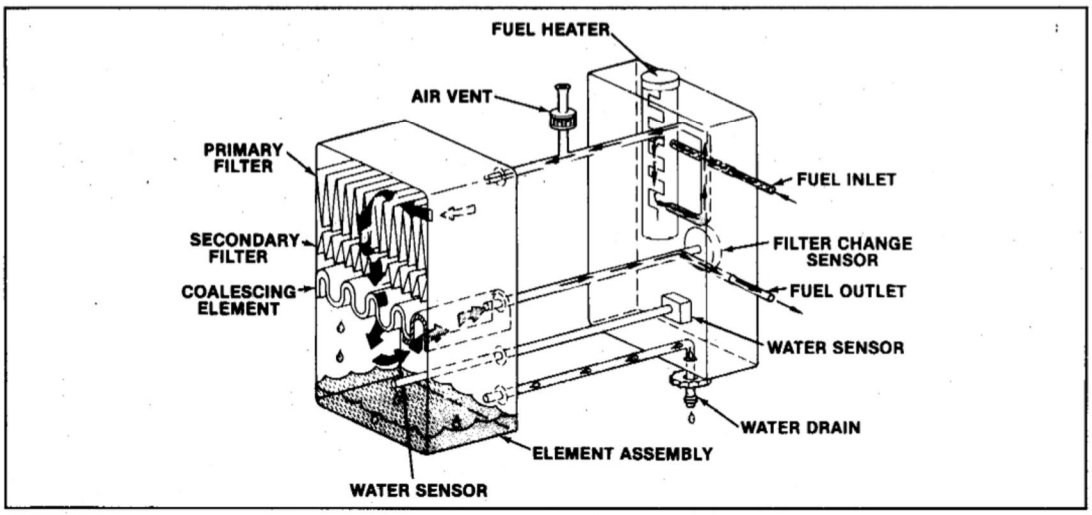


Figure A7-9-6 — Filter and Base Flow Schematic

ENGINE ELECTRICAL SYSTEM

The engine electrical system is separate from the motor home "living" system. It consists of a chassis battery, starting (cranking) system, charging system, ignition system and instrument panel wiring and chassis information gages.

BATTERY

GENERAL DESCRIPTION

The battery is a device designed to store electrical power for later use. It performs this function through chemical action.

The battery has three major functions in the electrical system. First, it is a source of electrical energy for starting the engine. Second, it acts as a voltage stabilizer for the electrical system. And third, it can, for a limited time, provide energy when the electrical load exceeds the output of the generator.

The sealed-top battery (Figure 7-28) is standard on all vehicle lines.

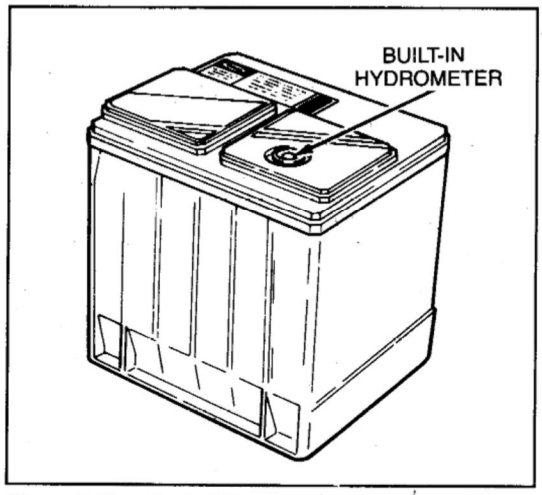


Figure 7-28 — Sealed-Top Battery

There are no vent plugs in the cover. The battery is completely sealed, except for two small vent holes in the side. These vent holes allow the small amount of gas produced in the battery to escape. The sealed-top battery has the following advantages over conventional batteries:

1. No water addition for the life of the battery. This improvement makes the sealed-top battery possible.

2. Overcharge protection. If too high a voltage level is applied to the sealed-top battery, it will not accept as much current as a conventional battery; the excess voltage will cause gassing, which leads to liquid loss.

3. Reduced self-discharge compared to a conventional battery. This is important when a battery is left standing for long periods of time.

4. Comparable power available in a lighter and smaller case.

RATINGS

A battery has two ratings: (1.) a reserve capacity rating at 80°F which is the time a fully charged battery will operate the vehicle with no generator operation, (2.) a cold crank rating at 0°F which indicates the cranking load capacity. The Ampere/Hour rating formerly found on batteries was based on the reserve capacity rating and is no longer used.

MAINTENANCE AND INSPECTION

A battery is not designed to last indefinitely; however, with proper care, it will provide many years of service. If the battery tests as "good" but fails to perform satisfactorily in service, the following are some of the more important factors that may point to the cause of the trouble.

1. Accessories left on overnight.

2. Slow average driving speeds for short periods.

3. The vehicle's electrical load is more than the generator output particularly with the addition of aftermarket equipment such as radio equipment, air conditioning, window defoggers or light systems.

4. Defects in the charging system such as electrical shorts, slipping fan belt, faulty generator or voltage regulator.

5. Battery abuse, including failure to keep the battery cable terminals clean and tight or a loose battery (one that is not securely held in place).

6. Batteries in vehicles stored for long periods of time become discharged with sulfation occuring. Sulfation of the plates reduces the battery's capacity for accepting a charge. Also, under conditions of high ambient temperature, the temperature of the electrolyte may become excessive — causing boiling and loss of electrolyte. See Appendix B — Preparing The Motor Home For Storage for additional information concerning battery storage damage.

NOTE: The inspection and test procedures which follow apply for the Delco Sealed-Top Freedom Battery. If your vehicle is equipped with a conventional-type and/or other brand battery, be sure to follow the test procedure and specifications recommended by the manufacturer.

VISUAL INSPECTION

The external condition of the battery should be checked periodically for damage such as cracked cover or case (Figure 7- 29). Also check terminal area for loose or broken parts.

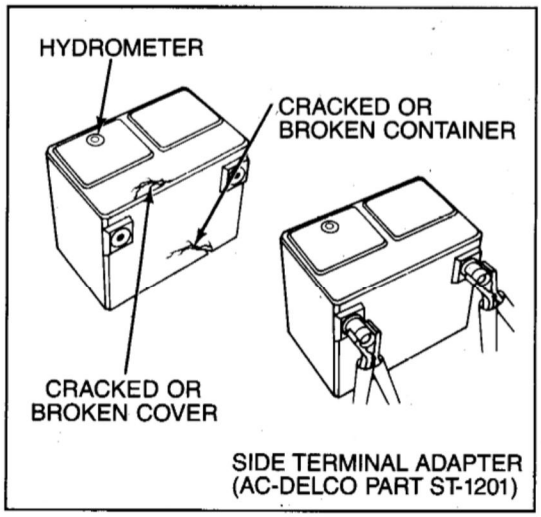


Figure 7-29 — Visual Battery Inspection

CAUTION: BATTERIES PRODUCE EXPLOSIVE GASES, CONTAIN CORROSIVE ACID, AND SUPPLY LEVELS OF ELECTRICAL CURRENT HIGH ENOUGH TO CAUSE BURNS. TO LESSEN THE CHANCE OF PERSONAL INJURY WHEN WORKING NEAR A BATTERY:

- Always wear eye protection or shield your eyes. Do not lean over a battery. Remove all metal jewelry.
- Never expose a battery to open flames or electric sparks. Also, do not smoke near a battery.
- Do not allow battery acid to contact eyes or skin. Flush any contacted area with water immediately and thoroughly. Get medical help.
- Do not allow metal tools to contact both the positive (red, "+") battery terminal (or any metal connected to this terminal) and any other metal on either vehicle at the same time. Make certain when attaching the jumper cable clamps to the positive terminals of the batteries that neither clamp contacts any other metal.
- Batteries should always be kept out of the reach of children.

BUILT-IN HYDROMETER (DELCO SEALED-TOP BATTERY)

The Delco sealed-top battery has a built-in temperature-compensated hydrometer in the top of the battery. This hydrometer is to be used with the following diagnostic procedure. When observing the hydrometer, make sure that the battery has a clean top. A light may be required in some poorly lit areas to see the right indication. Under normal operation, two indications can be observed (Figure 7-30).

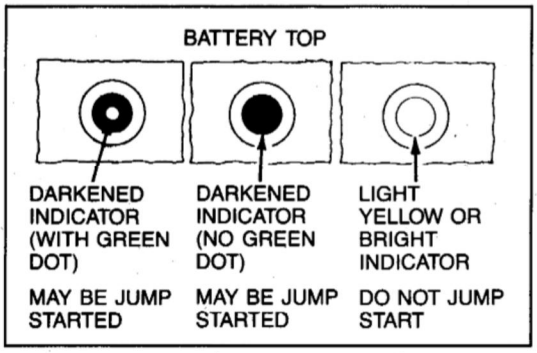


Figure 7-30 — Built-In Hydrometer

1. GREEN DOT VISIBLE. Any green appearance is interpreted as a green dot and the battery is ready for testing. Do **not** charge the battery.

2. DARK — GREEN DOT NOT VISIBLE. If there is a problem with cranking, the battery should be tested following the Electrical Load Test in this section. But, before testing, the battery must be recharged until the green dot is visible. After charging, you may have to shake or tilt the battery slightly for the green dot to show.

NOTE: A battery that has sat in a completely discharged condition or is extremely cold may not accept current for several hours after starting the charger. The charging and electrical systems should also be checked at this time.

Occasionally, a third condition may appear:

3. CLEAR OR LIGHT YELLOW. This means the fluid level is below the bottom of the hydrometer. This may have been caused by excessive or prolonged charging, a broken case, excessive tipping or normal battery wearout. When finding a battery in this condition, it may indicate high charging voltage caused by a faulty charging system and therefore, the charging and electrical system may need to be checked. If a poor cranking condition exists and is caused by the battery, it should be replaced.

CAUTION: DO NOT CHARGE OR TEST THE BATTERY OR JUMP START THE VEHICLE WHEN THE HYDROMETER IS CLEAR OR LIGHT YELLOW AS THIS COULD RESULT IN PERSONAL INJURY (PARTICULARLY TO EYES) OR PROPERTY DAMAGE FROM BATTERY EXPLOSION OR BATTERY ACID. SEE CAUTION UNDER "VISUAL INSPECTION" IN THIS SECTION OF THE MANUAL.

ELECTRICAL LOAD TEST (DELCO SEALED-TOP BATTERY)

Preliminary Steps

- If the battery has been on charge, remove the surface charge by connecting a 300-ampere load for 15 seconds.

CAUTION: SEE CAUTION UNDER "VISUAL INSPECTION" IN THIS SECTION OF THE MANUAL.

- If the battery is in the vehicle, attach the voltmeter leads to the battery terminals. If the battery is out of the vehicle, attach the voltmeter leads to the side terminal adapters (AC-Delco Part ST-1201 or GM Part No. 1846855) on the battery. For Delco heavy-duty batteries with threaded stud terminals, attach the voltmeter leads to the snug-fitted terminal adapter ST-1201; or if not available, attach the leads between the lead pad and the bottom of the terminal hex nut.

Test Procedure

1. Connect the voltmeter (preliminary steps) and apply the test load to the value printed on the battery label.
2. Read the voltage after 15 seconds with the load connected.
3. Disconnect the load and compare the voltage reading with the chart in Figure 7-31. If the voltage is less than the reading specified in the chart, replace the battery. If the reading is equal to or greater than that specified in the chart, the battery is good.

NOTE: Refer to battery top for additional load test amperes.

BATTERY	TEST LOAD (AMPS.)
692, 83-50	150
693, 83-60	180
695, 87A-60	230
696, 89A-60	270

Load Test Values

MINIMUM VOLTAGE	TEMPERATURE (°F)
9.6	70
9.5	60
9.4	50
9.3	40
9.1	30
8.9	20
8.7	10
8.5	0

Minimum Voltage Drop

Figure 7-31 — Battery Test Load Table and Voltage Drop Chart

JUMP STARTING — WITH AUXILIARY (BOOSTER) BATTERY

NOTE: Do not push or tow the vehicle to start it. There are no provisions in the GM automatic transmission for engagement of the transmission to turn over the engine. Efforts to push or tow the vehicle to start it will have no effect.

Both the booster and the discharged battery should be treated carefully when using jumper cables. Follow the conditions and procedure outlined below, being careful not to cause sparks.

CAUTION: FAILURE TO OBSERVE THESE CONDITIONS OR PROCEDURES COULD RESULT IN SERIOUS PERSONAL INJURY (PARTICULARLY TO EYES) OR PROPERTY DAMAGE FROM SUCH CAUSES AS BATTERY ACID, A BATTERY EXPLOSION, ELECTRICAL BURNS AND/OR DAMAGE TO ELECTRONIC COMPONENTS OF EITHER VEHICLE INVOLVED. SEE CAUTION UNDER "VISUAL INSPECTION" IN THIS SECTION OF THE MANUAL. IN ADDITION:

- Be sure the jumper cables and clamps to be used for jump starting do not have loose or missing insulation. Do not proceed if suitable cables are not available.
- If either battery has filler caps, check the fluid level. (Do not check using an open flame). If low, fill to the proper level with clear drinking water. Replace all caps before jump starting.
- Do not route the cable (or attach the clamp) on or near pulleys, fans, or other parts that will move when the engine is started.

Follow the procedure listed below for jump starting the vehicle with an auxiliary booster battery.

1. Set the parking brake firmly and place the automatic transmission in PARK (NEUTRAL for manual transmission). Turn off the ignition, turn off lights, and all other electrical loads.
2. Check the built-in hydrometer. If it is clear or light yellow, replace the battery, do not attempt to jump start.
3. Only 12-volt batteries can be used to start the engine.

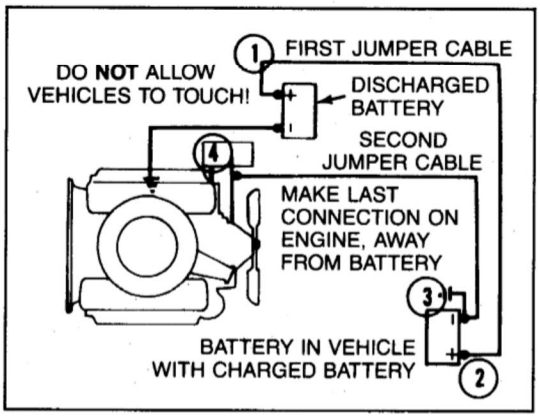


Figure 7-32 — Jump Start Cable Connections

NOTE: When jump starting a diesel engine vehicle with charging equipment, be sure equipment used is 12-volt and negative-ground. Do not use 24-volt charging equipment. Using such equipment can cause serious damage to the electrical system or electronic parts.

4. Attach the end of one jumper cable to the positive terminal of the booster battery and the other end of the same cable to the positive terminal of the discharged battery (Figure 7-32). Do not permit vehicles to touch each other as this could cause a ground connection and counteract the benefits of this procedure.

5. Attach one end of the remaining negative cable to the negative terminal of the booster battery, and the other end to a solid engine ground (such as A/C compressor bracket or generator mounting bracket) at least 18 inches from the battery of the vehicle being started.

DO NOT CONNECT DIRECTLY TO THE NEGATIVE TERMINAL OF THE DEAD BATTERY.

6. Start the engine of the vehicle that is providing the jump start and turn off electrical accessories. Then start the engine in the vehicle with the discharged battery.

7. Reverse these directions exactly when removing the jumper cables. The negative cable must be disconnected from the engine that was jump started first.

MULTI-BATTERY ELECTRONIC JUMP STARTING AID

Many RV manufacturers have built into their systems an "emergency start button" on the dashboard that electrically connects the coach batteries to the chassis battery. The purpose of this starting aid is to create an "automatic jump start." The motor home owner should be aware of the possible problems this system may create, such as:

- Many motor home owners, as a matter of habit, push the "emergency start button" with EACH start under the mistaken belief that three batteries are stronger than one. Without knowing the actual condition of the RV batteries, this action could unknowingly create "dead" or undercharged batteries. If the charge state of the RV battery is LOWER than the chassis battery, then within a few seconds after pushing the start button on the dash both the RV battery and the chassis battery become equal and the motor home owner is then dealing with two or three undercharged batteries.

- Rapid discharge, to equalize the state of charge between the batteries over a few seconds, is very hard on the batteries. Often, the only "hold back" to this is the connecting wire size. However, if the wires are small enough to slow the rate of discharge to avoid battery damage, then the wires can become overheated from carrying too much amperage. This situation presents a potential electrical failure and/or fire damage.

- Each time that the "emergency start button" is pushed, an electrical solenoid switch closes under the hood. Each time this solenoid switch closes, an electric spark arc occurs. Each time this spark arc occurs, a high resistance builds through the copper-to-copper contacts and reduces the overall effectiveness of the switch. In some cases (with severe battery electrical differential) the switch contacts have "stuck" after being used only once. This situation bypasses the isolator and effectively renders the battery isolator system useless.

Over the last few years, RV manufacturers have improved these "emergency start button" systems through the use of solid state technology. The application of this solid state technology has appeared to solve the problems associated with the earlier systems. The new system electronically monitors the condition of the RV battery vs. the chassis battery. If the chassis battery has a LOWER state of charge than the RV battery, a light on the dashboard will glow indicating that the "automatic jump start" system has kicked in automatically without the driver physically pushing the button. If the RV batteries are LOWER than the chassis battery, the system will not allow an electrical flow to occur between the batteries.

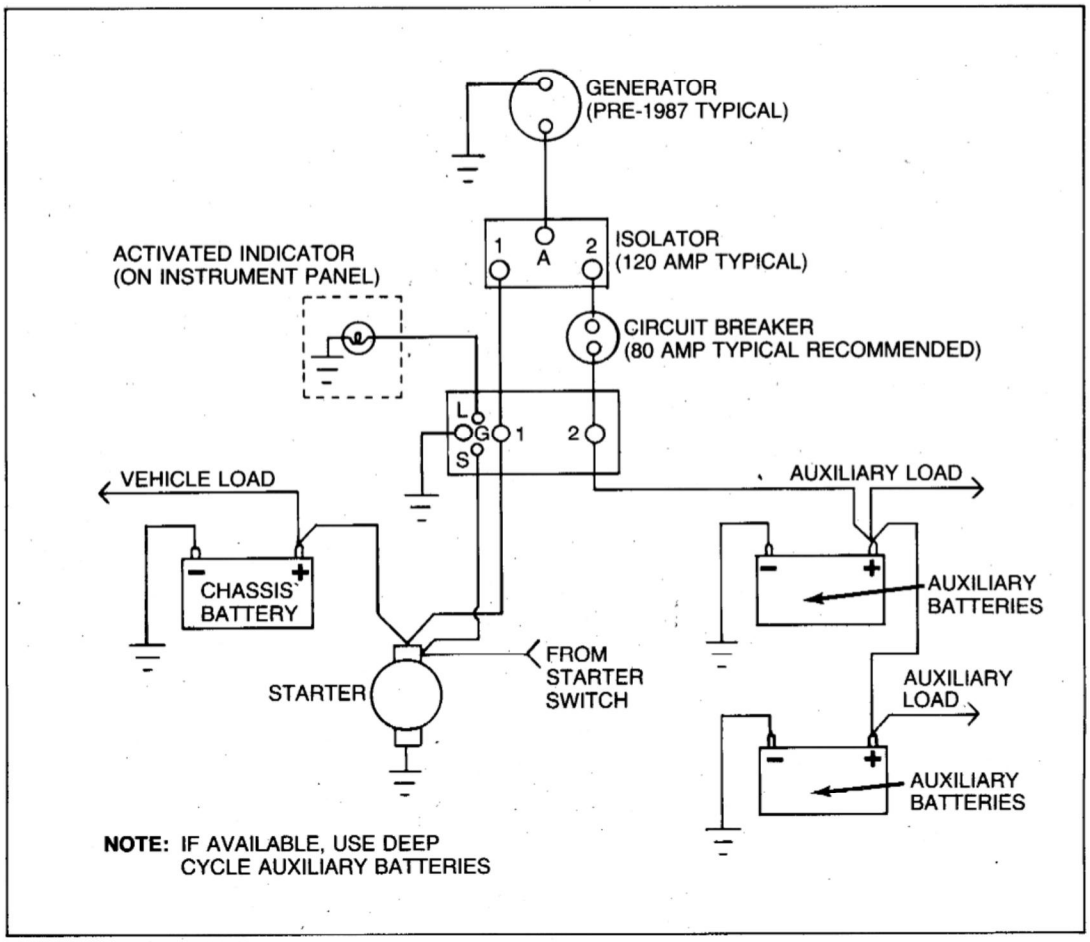


Figure 7-33 — Typical Multi-Battery Electronic Starting Aid Wiring Diagram

These fully automatic electronic starting aids allow a current to flow only to the starter motor thereby eliminating battery equalization. This helps to eliminate battery damage and a shortened battery life. A wiring diagram of a typical multi-battery electronic starting aid is shown in Figure 7-33.

BATTERY REMOVAL AND REPLACEMENT

When handling a battery, the following safety precautions should be observed:

1. Hydrogen gas is produced by the battery. A flame or spark near the battery may cause the gas to ignite.

2. Battery fluid is highly acidic. Avoid spilling on clothing or other fabric. Any spilled electrolyte should be flushed with large quantities of water and cleaned immediately.

To remove or replace a battery, always disconnect the negative cable first, then the positive cable. Torque the battery cables at battery to 9 ft. lbs.

NOTE: See Appendix 7-10 at the back of this section of the manual for additional information concerning battery replacement.

STARTING (CRANKING) SYSTEM

The starter on the motor home chassis requires no maintenance. It will provide years of service if proper cranking procedures are used. When starting an engine, never crank the starter longer than 30 seconds and allow at least 15 seconds between starting attempts. This will help keep the starter from overheating.

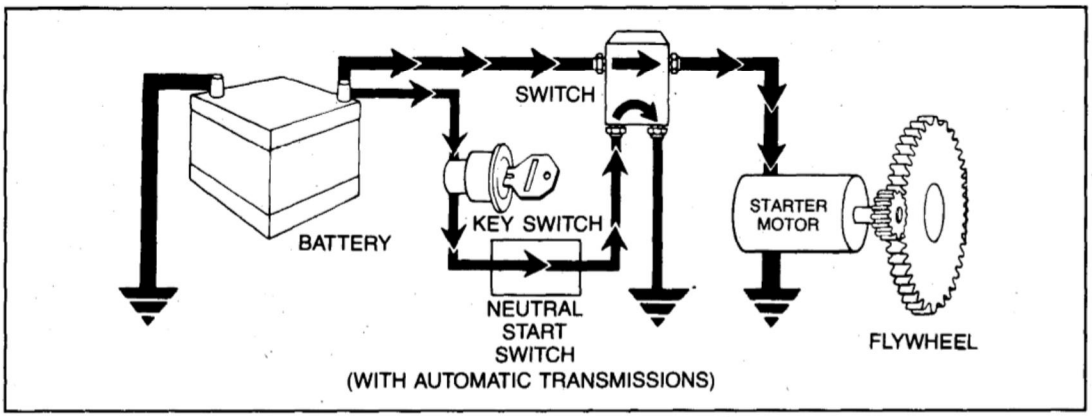


Figure 7-34 — Starting Circuit

GENERAL DESCRIPTION

The function of the starting system is to rotate the engine crankshaft at sufficient speed for ignition and the start of engine operation. This it does by means of the starting circuit which consists of the battery, starting motor, ignition switch, and the related electrical wiring. In addition, vehicles with automatic transmissions have a neutral start switch which prevents the engine from being started in any transmission selector lever position other than NEUTRAL, or PARK. These components are connected electrically as shown in Figure 7-34.

When the ignition switch is turned to START, electrical current flows from the battery through the key switch, neutral start switch and through the starter switch to ground. Inside the starter switch, current flow from this control circuit activates the solenoid which closes the circuit between the battery and the starting motor. The solenoid also moves the starter drive gear into contact with the crankshaft ring gear.

Three types of starter motors are used. The first, referred to as the 10MT series, is shown in Figure 7-35. The second type, referred to as the 27MT series, is used on diesel-equipped engines. The main difference is that the 27MT has a center bearing.

NOTE: The 1994 454 motor home starter will be a permanent magnet type planetary gear reduction starter designated as PG260. It provides better performance quality and reliability in a smaller starter motor.

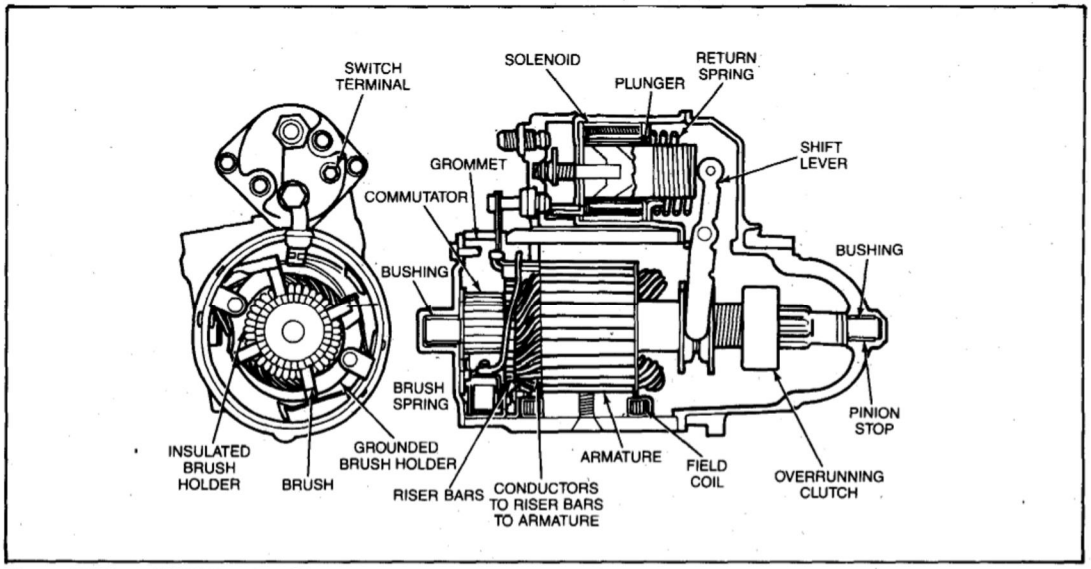


Figure 7-35 — 10MT Starting Motor

Certain starting motors have the shift lever mechanism and the solenoid plunger enclosed in the drive housing, protecting them from exposure to dirt, icing conditions and splashing.

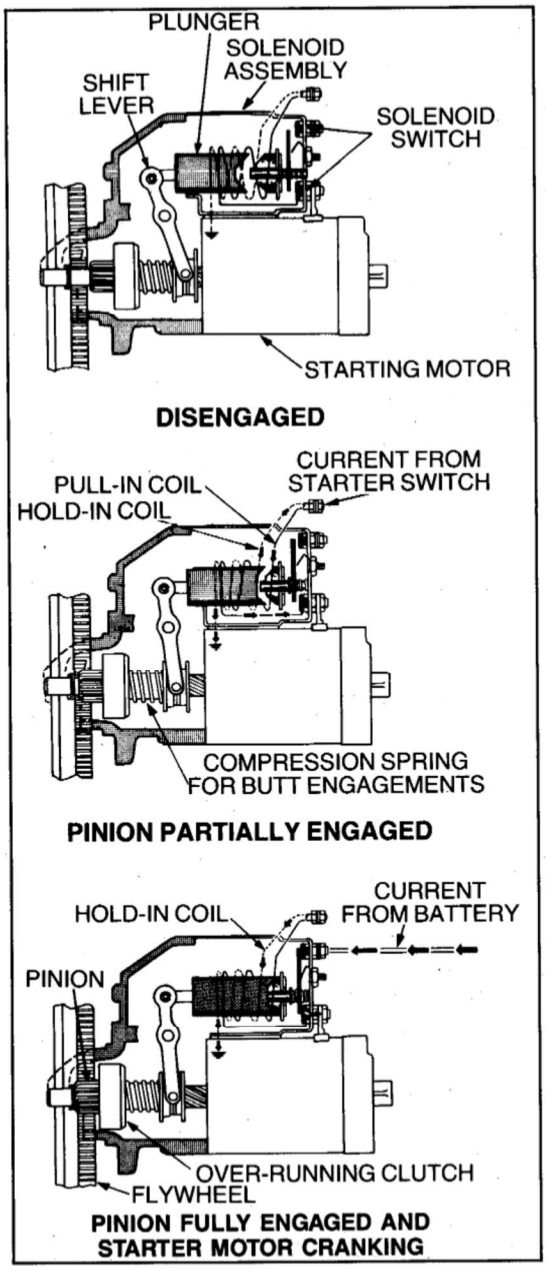


Figure 7-36 — Solenoid Electrical Operation

In the basic circuit shown in Figure 7-34, the solenoid windings are energized when the switch is closed. The resulting plunger and shift lever movement causes the pinion to engage the engine flywheel ring gear and the solenoid main contacts to close and cranking takes place. When the engine starts, pinion overrun protects the armature from excessive speed until the switch is opened, at which time the return spring causes the pinion to disengage. To prevent excessive overrun, the switch should be opened immediately when the engine starts.

The electrical operation of the solenoid is shown in Figure 7-36. The top illustration shows the starter disengaged. The center drawing depicts the pinion partially engaged with the pull-in coil and the hold-in coil activated. The bottom view shows the pinion fully engaged and the starter motor cranking with only the hold-in coil functioning.

MAINTENANCE AND INSPECTION

While the starter motor does not require maintenance, the system wiring should be inspected periodically for damage or corrosion. Inspect all connections to the starting motor, solenoid, ignition switch, neutral start switch and battery, including all ground connections. Clean and tighten all connections as required.

If there appears to be a problem with the starting system and the battery, wiring and switches are in satisfactory condition and the engine is known to be functioning properly, refer to the appropriate shop manual for more detailed diagnosis and test procedures.

STARTING PROBLEMS (HIGH AMBIENT TEMPERATURES)

Under some conditions of high ambient temperatures, when the engine has been turned off and the vehicle allowed to set for 10 to 15 minutes, it is possible to encounter a problem with the starter motor not activating when you attempt to restart the engine. This possibility occurs more frequently with the 7.4L engine when high engine compartment temperatures and the radiated heat from the exhaust pipe cause high resistance in the coil wires of the starter solenoid. This high resistance reduces current flow preventing activation of the solenoid and starter motor. After the engine has cooled down sufficiently, the starter motor should activitate properly upon restart.

STARTING PROBLEMS (POOR GROUND)

The P-Series motor home is equipped with a webbed ground strap that runs from the rear of the left cylinder head to the frame. To improve electrical contact, remove the strap from both connections. Scrape the (production) paint from both the cylinder head and the vehicle frame connections. Add a star washer between the cylinder head connection and the strap and between the vehicle frame connection and the strap. Replace the strap and tighten attaching bolts securely.

Refer to Appendix 7-12 — "Hot Start" Problem Conditions and Appendix 7-13 — Starter Motor Engagement After Initial Start-Up at the back of this section of the manual for additional corrective procedures.

CHARGING SYSTEM

GENERAL DESCRIPTION

The function of the charging system is to provide electrical power to the engine ignition system, to the vehicle accessories and to restore power lost from the battery.

The primary component of the system is the generator. The generator assembly includes the rotor, stator and recitifier subassemblies and an integral voltage regulator. When the engine is operating and turning the rotor, an alternating current flow is induced in the stator assembly by the electromagnetic field established in the rotor. The alternating current produced in the stator is changed to the direct current needed in the vehicle's electrical system by the rectifier assembly. This is accomplished through the use of diodes in the rectifier assembly which allow current flow in one direction only. The output of the generator is controlled by the voltage regulator. The voltage regulator does this by varying the strength of the electromagnetic field established in the rotor assembly.

The generator is connected to the vehicle electrically as shown in Figure 7-37. The integral regulator is mounted beneath the rear cover of the generator.

The brown field wire to the generator is used to initially activate the generator by providing the current needed to establish the electromagnetic field in the rotor. The 10-ohm resistance, provided by either the generator warning lamp or the resistance wire with optional gages, is needed to protect the diodes in the rectifier assembly.

GENERATOR SIZING AND SELECTION

The base generator, or Delcotron, in the GM motor home is rated 63 to 66 amps. Normally, this rating is large enough for most applications. However, in recent years, the typical RV owner has purchased and/or added on optional electrical equipment pushing base charging system capacity beyond current abilities.

A charging system that has demands beyond system ability can create problems, as there is not a way to charge the batteries when the system is always running with an electrical "short fall." The life expectancy of the charging system will be greatly reduced when the system is operating at 100 percent of capacity for extended time. Also engine compartment configurations and optional equipment can aggravate the situation due to restricted air flow and generator overheating.

NOTE: If GM factory systems are changed, the size of the main charging wire in the harness must be changed from a 3mm or 12 AWG wire size to an 8mm or 8 AWG wire size. The larger size charging wire is mandatory when installing an upgraded charging system.

BATTERY ISOLATOR

The battery isolator is a very important link in the total electrical system. Typical isolator hook-ups are shown in Figure 7-37 using broken lines. As shown, the red wire from the battery to the generator is moved to Terminal No. 1 of the battery isolator. A replacement wire connects the generator to Terminal "A" on the battery isolator as shown.

A typical RV battery isolator wiring schematic is shown in Figure 7-38. The isolator is equipped with one-way diodes allowing no reverse current flow back to "A" or between Terminal No. 1 or Terminal No. 2.

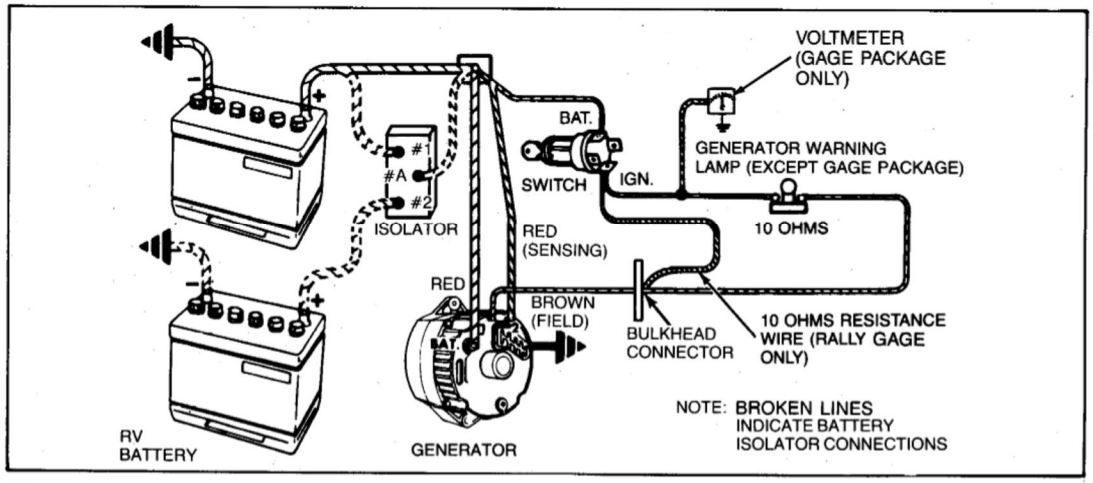


Figure 7-37 — Charging Circuit — SI System

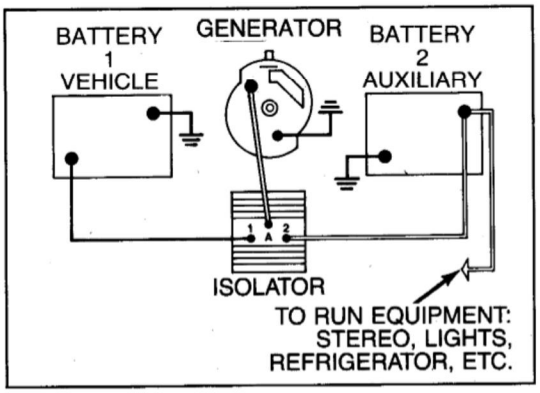
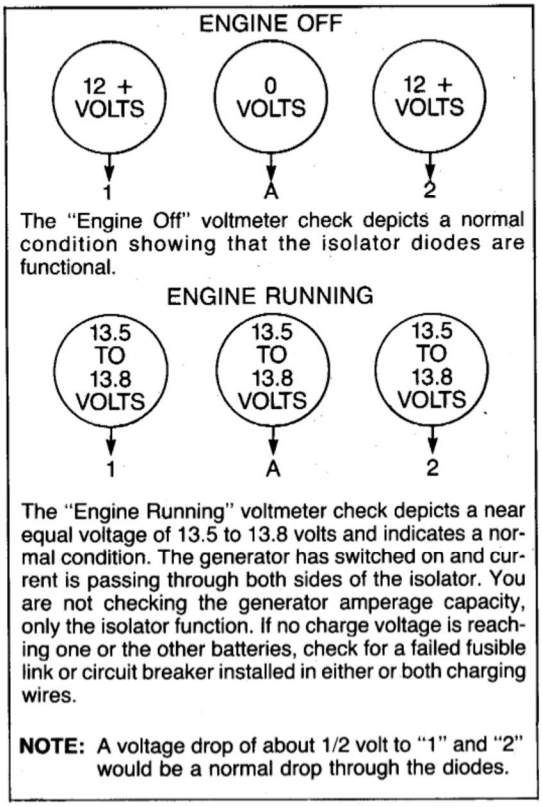


Figure 7-38 — Typical RV Battery Isolator Wiring

Shown in Figure 7-39 are two typical RV isolator voltmeter checks that will identify a functional isolator. Voltages are based on a reasonable state of charge in all batteries (12 volts).



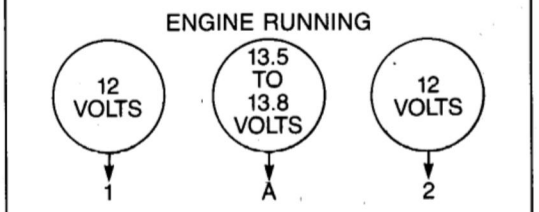
The "Engine Off" voltmeter check depicts a normal condition showing that the isolator diodes are functional.

The "Engine Running" voltmeter check depicts a near equal voltage of 13.5 to 13.8 volts and indicates a normal condition. The generator has switched on and current is passing through both sides of the isolator. You are not checking the generator amperage capacity, only the isolator function. If no charge voltage is reaching one or the other batteries, check for a failed fusible link or circuit breaker installed in either or both charging wires.

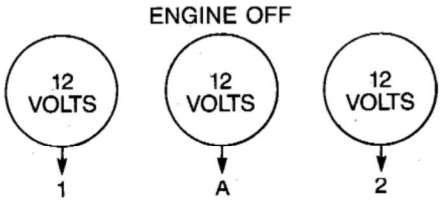
NOTE: A voltage drop of about 1/2 volt to "1" and "2" would be a normal drop through the diodes.

Figure 7-39 — Typical RV Isolator Voltmeter Checks

Shown in Figure 7-40 are typical RV battery isolator failure modes.



Under "Engine Running," the isolator is internally damaged. Diodes are open or burned out. There is no charging to either battery in this figure. This failure mode could also occur singularly to either outer leg of the isolator.



Shown under "Engine Off," the isolator is wired incorrectly externally or internally. Voltage should not be supplied to terminal "A" with the engine off. Check the source of the problem by removing the wire from the "A" terminal. The wire should not have any voltage and the isolator should not have any voltage either.

Figure 7-40 — Typical RV Battery Isolator Failure Modes

Three prime rules that must be followed for isolators are:

1. Each leg of the isolator must be sized to equal or exceed the total generator output. The reason is that one battery may require all of generator's output while the other(s) require none. Thus a single leg must be capable of carrying the maximum generator current output. Isolators should be purchased oversized if there is any chance of upgrading the generator at a later date.

GENERATOR RATED OUTPUT IN AMPS	MINIMUM CHARGING WIRE SIZE FOR WIRE LENGTH IN FEET				
	UP TO 10 FEET	11 FEET TO 14 FEET	15 FEET TO 20 FEET	21 FEET TO 25 FEET	26 FEET TO 30 FEET
Up to 70 amp	10	8	8	6	6
70 to 95 amp	6	6	4	4	4
95 to 120 amp	4	4	4	2	1
120 to 160 amp	4	4	2	2	0

Figure 7-41 — Charging Wire Size to Output

2. In the auxiliary battery side, a circuit breaker or fusible link should be included. A fusible link on the automotive side will be standard as produced by GM.

3. The size of the charging wire should be chosen using the chart shown in Figure 7-41.

CHARGING SYSTEM — 1987 TO CURRENT

With the start of 1987 production, the CS130 105 AMP Delcotron generator was provided as standard equipment on all P-30 motor home chassis. The CS series generator is unique in that it requires voltage to both the excitor terminal and the positive outpost in order to charge.

Solid state isolators are designed to prevent feedback of current from batteries to the generator. This requires that the isolator be redesigned to include a fourth terminal called an excitor terminal. This fourth terminal is connected to the ignition switch. The ignition switch provides current when in the "RUN" position to the excitor terminal on the isolator. Current is allowed to flow from the "E" terminal via a diode to the "A" terminal providing the necessary current allowing the generator to charge. Refer to Figure 7-42 for typical wiring of the solid state isolator and CS Series Delcotron generator.

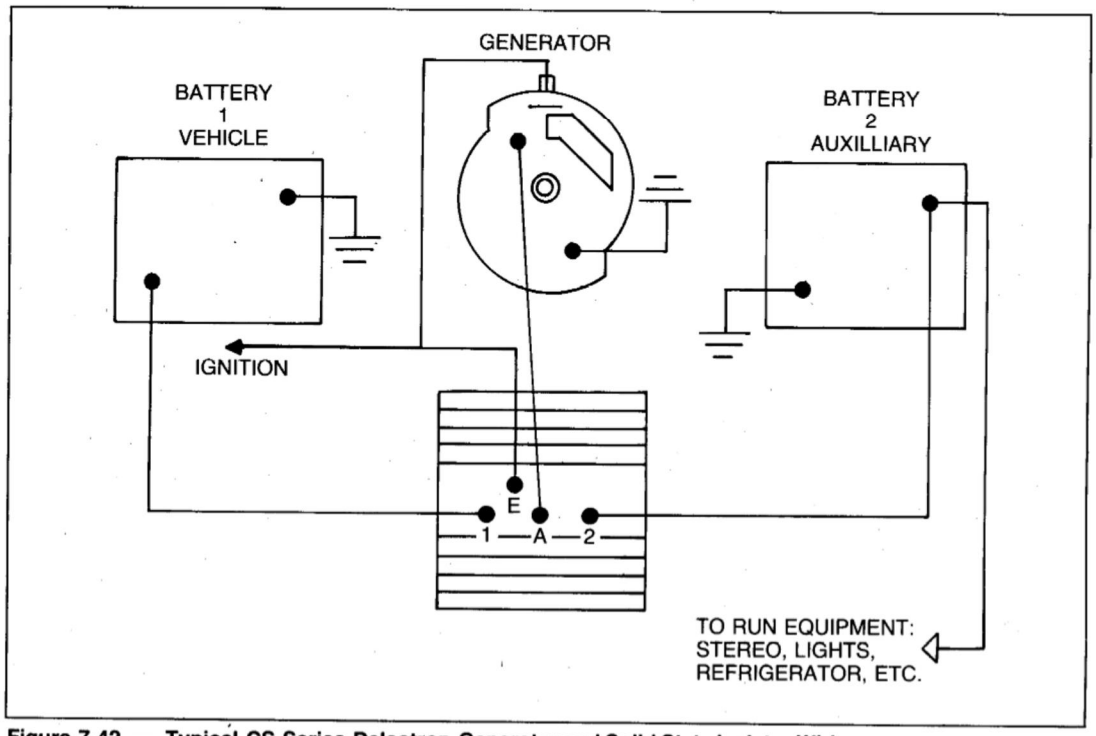


Figure 7-42 — Typical CS Series Delcotron Generator and Solid State Isolator Wiring

CS SERIES GENERATOR AND ISOLATOR DIAGNOSIS

A preliminary check of a "no charge" condition should be made to ensure that voltage is provided to both the excitor ("F" terminal) and the positive output post (B+) on the generator when the ignition is on. If voltage is not present on either terminal, the generator will not charge. See Figure 7-43.

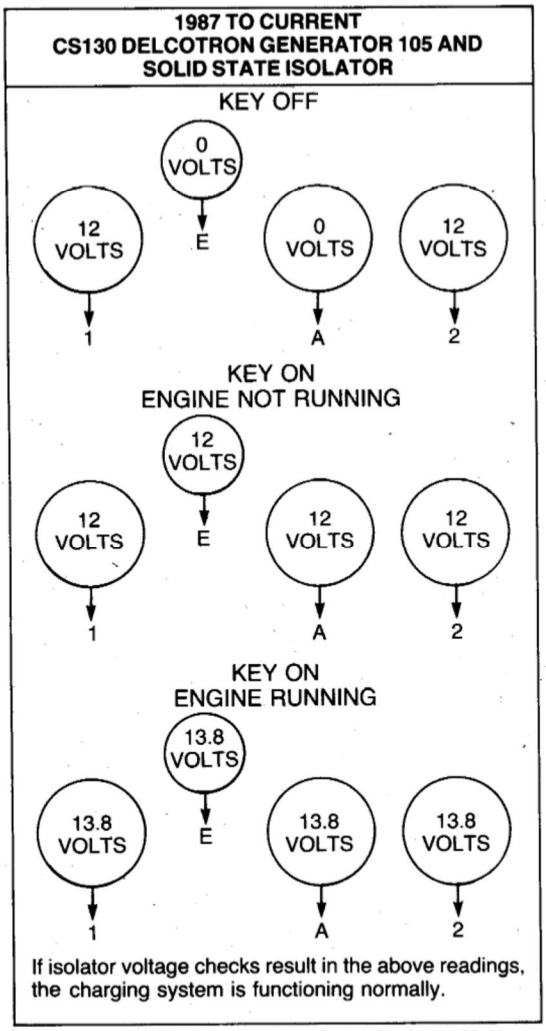


Figure 7-43 — Typical Solid State Isolator Voltage Checks

SOLID STATE ISOLATOR

If voltage is not present at the generator excitor terminal with the ignition key "ON" check the fuses and wiring. Repair as necessary. If battery voltage is not present at the generator output terminal, check the wiring and connections. Repair as necessary. If the vehicle is equipped with a solid state battery isolator, check for voltage at the isolator excitor terminal with the ignition key in the "RUN" position. If voltage is not present, check the fuse and wiring. Repair as necessary.

NOTE: When the vehicle is equipped with a solid state isolator and if the coach battery is discharged below 9 volts, excessive current will flow from the chassis battery through the excitor terminal to the low battery and can cause the excitor fuse to "blow" causing a "no charge" condition. This occurs when the key is turned to the "RUN" position prior to starting the engine.

If voltage is present at the "E" terminal but not on the "A" terminal, the isolator is defective and will require replacement.

ELECTROMECHANICAL ISOLATOR

The electromechanical circuit as shown in Figure 7-44 can be used for battery isolation on all 1987 to current motor chassis equipped with a CS Series generator.

MAINTENANCE AND INSPECTION

No periodic adjustments or maintenance of any kind are required on the entire generator assembly. However, belt tension should be checked periodically and adjusted as required. See Appendix 7-14 — Generator Belt Usage on 6.2L Diesel Engines at the back of this section, as well as the manual Appendix A — Drive Belts and Tension Specifications located at the back of the manual for additional information concerning belt tension specifications.

Noise from a generator may be caused by a loose drive pulley or loose mounting bolts. These parts should be tightened as required. Other causes of generator noise can be worn or dirty bearings, defective diode(s) or a defective stator. Such causes require an overhaul.

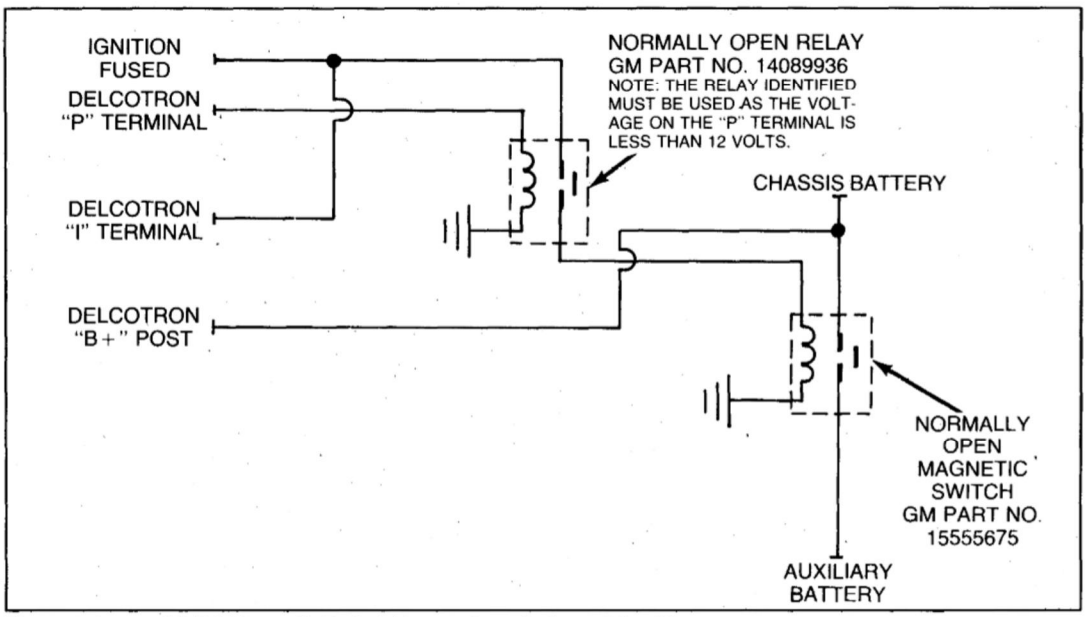


Figure 7-44 — CS130 Magnetic Switch/Battery Installation Wiring Diagram

IGNITION SYSTEM

GENERAL DESCRIPTION

The ignition circuit consists of the battery, the distributor, the ignition switch, the spark plugs and the primary and secondary wiring.

Electrical current to power the ignition system is provided by the battery during starting and by the charging system when the engine is operating. This low-voltage current flows through the ignition switch, the electronic module in the distributor and the coil in what is called the primary circuit. In the coil, the low-voltage current is changed to a high-voltage current each time the primary circuit is switched off and on by the electronic module. The module breaks the circuit in response to signals from the magnetic pickup assembly. These signals are timed with the power stroke of each cylinder.

The high-voltage current generated in the second part of the coil, flows to the center terminal of the distributor cap through the rotor, to each outer terminal of the distributor cap in rotation. From each distributor cap outer terminal, the current flows through the wire to the spark plug. At the spark plug, the current jumps the gap between the electrodes to ground, producing the spark for ignition. This high-voltage circuit is referred to as the secondary circuit.

H.E.I. DISTRIBUTOR

The High Energy Ignition (H.E.I.) distributor used on the 5.7L and the Mark IV engines, combines all ignition components in one unit (Figure 7-45). It is located on top of the engine block directly behind the carburetor. The external electrical connections (Figure 7-46) are the ignition switch feed wire, the tachometer pickup and eight spark plug leads. The ignition switch feed connector to the distributor has full battery voltage when the ignition switch is in the "RUN" and "START" positions. THERE IS NO RESISTOR WIRE FROM THE IGNITION SWITCH TO THE DISTRIBUTOR.

The ignition coil is in the distributor cap and connects through a resistance brush to the rotor. The High Energy Ignition system is basically identical in operation to conventional ignition systems except that the module and pickup coil replace the contact points.

The High Energy Ignition is a magnetic-pulse-triggered, transistor-controlled, inductive discharge ignition system. The magnetic pickup assembly located inside the distributor contains a permanent magnet, a pole piece with internal teeth, and a pickup coil. When the teeth of the timer core rotating inside the pole piece line up with the teeth of the pole piece, an induced voltage in the pickup coil signals the electronic module to trigger the coil primary circuit.

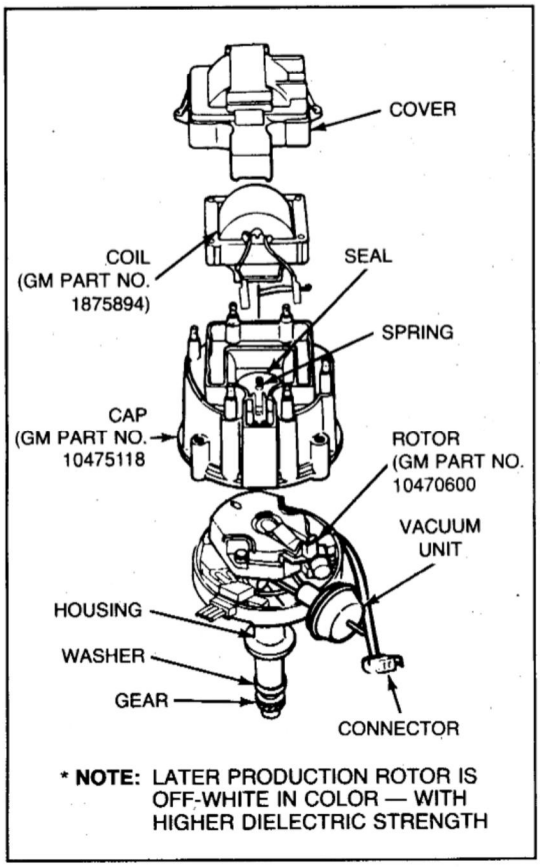


Figure 7-45 — H.E.I. Distributor — Exploded View

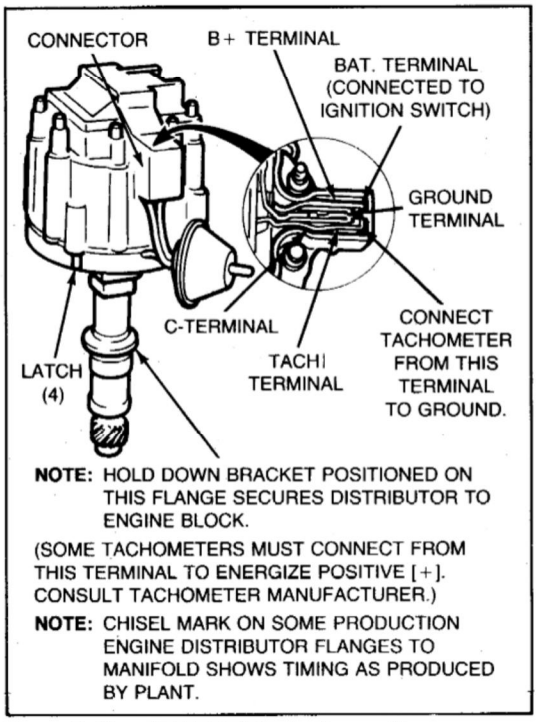


Figure 7-46 — H.E.I. Distributor Assembly Electrical Connections

The primary current decreases and a high voltage is induced in the ignition coil secondary winding which is directed through the rotor and secondary leads to fire the spark plugs. The capacitor in the distributor is for radio noise suppression.

The magnetic pickup assembly (Figure 7-47) is mounted over the main bearing on the distributor housing and is made to rotate by the vacuum control unit, thus providing vacuum advance. The timer core is made to rotate about the shaft by conventional advance weights, thus providing centrifugal advance.

The module automatically controls the dwell period, stretching it with increasing engine speed. The H.E.I. system also features a longer spark duration, made possible by the higher amount of energy stored in the coil primary winding. This is desirable for firing lean mixtures.

SECONDARY WIRING

The spark plug wire used with the H.E.I. system is a carbon-impregnated cord conductor encased in an 8mm diameter silicone rubber jacket. The silicone wiring will withstand very high temperatures and also provides an excellent insulator for the higher voltage of the H.E.I. system. The silicone spark plug boots form a tight seal on the plug.

SPARK PLUGS

Resistor-type, tapered-seat spark plugs with a 14mm thread diameter are used on the 5.7L and Mark IV gasoline engines. (See figure 7-48.) A gasket is not used on these tapered-seat plugs. The recommended torque specification for installing the plugs in these engines is 17-27 ft. lbs.

Normal or average service is assumed to be a mixture of idling, slow-speed and high-speed operation with some of each making up the daily total driving. Occasional or intermittent high-speed driving is essential to good spark plug performance as it provides increased and sustained combustion heat that burns away any excess deposits of carbon or oxide that may have accumulated from frequent idling or continual stop-and-go or slow-speed driving.

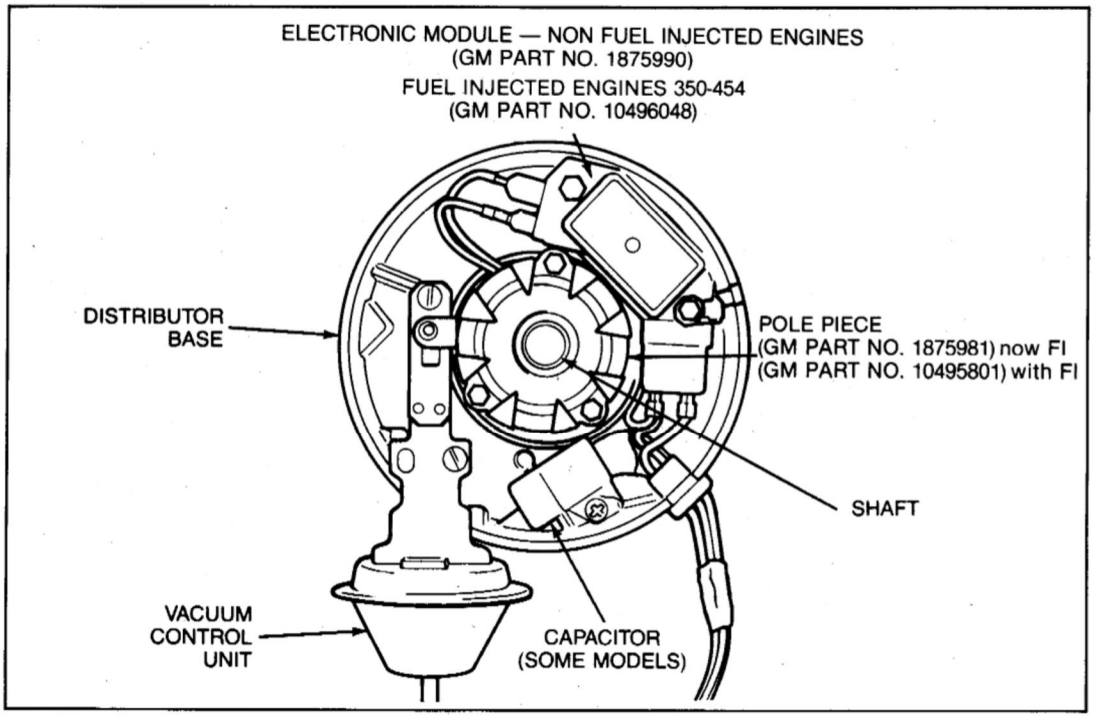


Figure 7-47 — H.E.I. Magnetic Pickup Assembly

ENGINE	AC PART NO. 1983-1984	1985-1989	1990-1994
350 CID	R45T	CR43TS	•R43TS
454 CID	R44T	R44T	

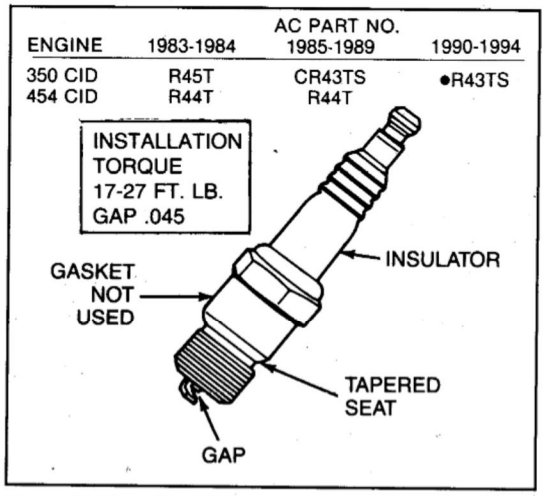


Figure 7-48 — Spark Plug

Spark plugs are protected by an insulating nipple made of special heat-resistant material which covers the spark plug terminal and extends downward over a portion of the plug insulator. These nipples prevent flash-over with resultant missing of engine, even though a film is allowed to accumulate on the exposed portion of plug porcelains.

Do not mistake corona discharge for flash-over or a shorted insulator. Corona is a steady blue light appearing around an insulator, just above the shell crimp. It is the visible evidence of high-tension field and has no effect on ignition performance. Usually it can be detected only in darkness.

This discharge may repel dust particles, leaving a clean ring on the insulator just above the shell. This ring is sometimes mistakenly regarded as evidence that combustion gases have blown out between the shell and insulator.

If it should become necessary to remove and replace the spark plugs, do not substitute a spark plug having a different heat range in order to compensate for a performance complaint. A spark plug of the proper heat range and one that is properly gapped will not cause a driveability problem. If spark plugs are installed that have a higher heat range than called for, the valves can become "tuliped" or the pistons can become pitted, eroded and burned through. On the other hand, if spark plugs with a lower than called for heat range are installed, plug fouling and bad emissions will usually result.

NOTE: Generally, spark plugs containing the suffix TS or CTS can be used interchangeably. (See Figure 7-48.) However, during the 1986 model year, AC Spark Plug changed the center electrodes in their spark plugs to copper. For these plugs, the letter C may be removed from the identification number on the jacket. EXAMPLE: A spark plug with a code identification of R•43TS or R43CTS would be changed to •R43TS.

IGNITION TIMING

To assure optimum engine performance, the ignition must be properly timed. This means that the spark plug must fire at precisely the instant when the fuel mixture is correct and cylinder compression is highest.

Set the ignition timing by following these instructions:

1. Refer to the Vehicle Emission Control Information Label located on the radiator support panel. Follow all instructions on the label.

2. With ignition off, connect the pickup lead of the timing light to the number 1 spark plug wire (engines with the timing pointer mounted over the upper side of the damper), or to the number 5 or 8 spark plug wire (engines with the timing pointer mounted at the lower left side of the damper). Use a jumper lead between the wire and plug or an inductive-type pickup. **DO NOT** pierce the wire or attempt to insert a wire between the boot and the wire. Connect the timing light power leads according to manufacturer's instructions.

3. Disconnect and plug the vacuum line at the distributor.

4. Start the engine and aim the timing light at the timing mark. (See Figure 7-49.) The line on the balancer or pulley will line up at the timing mark. If a change is necessary, loosen the distributor hold-down clamp bolt at the base of the distributor. While observing the mark with the timing light, slightly rotate the distributor until the line indicates the correct timing. Tighten the hold-down bolt and recheck the timing.

   On a motor home chassis with the engine having the timing pointer mounted at the lower left side of the damper, the timing light must be aimed up from beneath the vehicle. This procedure requires two people, one to observe the mark with the timing light while the second person makes any required adjustments at the distributor.

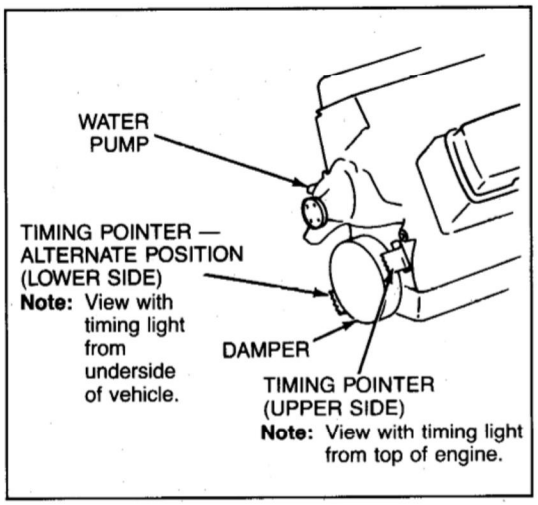


Figure 7-49 — Timing Mark — Typical

5. Turn off the engine and remove the timing light. Reconnect the number 1 spark plug wire, if removed.

MAINTENANCE AND INSPECTION

H.E.I. DISTRIBUTOR

No periodic lubrication is required. Engine oil lubricates the lower bushing and an oil-filled reservoir provides lubrication for the upper bushing.

H.E.I. TEST PROCEDURE

If there appears to be a problem with the ignition system, the following procedure can be used as a quick-check in determining the cause. More detailed procedures are given in the appropriate shop manual.

General Test

1. Remove a spark plug wire from each spark plug one at a time and check for spark using an H.E.I. Test Spark Plug ST125 (GM Part No. 5613602) or equivalent. If spark is present, the H.E.I. system is O.K.

NOTE: Using the Test Spark Plug to check for spark instead of allowing the spark to jump to ground from the disconnected wire can help to avoid possible damage to the module. A Test Spark Plug should be available at a local auto parts store.

2. Connect a test light between the distributor TACH terminal and ground.

3. Turn on the ignition switch.

   - If the light does not glow, check for power at the distributor BAT terminal. If there is no power at the BAT terminal, the problem is in the circuit wiring or the ignition switch. Repair as required. If there is power at the BAT terminal, and no power at the TACH terminal, the ignition coil primary winding is open. Replace the coil.

   - If the light glows, crank the engine. The light should glow intermittently, indicating that the module and pickup coil are working. Remove the distributor cap and check for spark at the center terminal of the cap using the H.E.I. Test Spark Plug and a jumper wire. If there is spark, the rotor is not functioning and should be replaced. If there is no spark, the coil is not functioning and should be replaced.

If the light glows steadily while the engine is being cranked, perform the module test.

Module Test

1. Remove the distributor cap and connect the H.E.I. Test Spark Plug to the center terminal with a jumper wire.

2. Remove the pickup coil connector from the module and turn the ignition switch on.

3. Touch one end of another jumper wire to the positive terminal of the battery and the other end to the small terminal of the module momentarily. As the jumper wire is removed from the module terminal, if there is:

   - a spark — the pickup coil is not functioning properly and may need to be replaced.

   - no spark — the module is not functioning properly and may need to be replaced.

CHECKING H.E.I. SYSTEM CONNECTIONS

If a component appears to be inoperative, the condition may actually be due to poor connections. This is especially true of low-voltage circuits, such as the pickup coil to module connections in the H.E.I. system.

Before any component or assembly is considered faulty and replaced, its terminal(s) should be cleaned, the connector-to-terminal fit tightened and the wire-to-terminal connection checked and resoldered if necessary.

The following procedure covers one example involving H.E.I. low-voltage circuits where good connections are essential. Refer to Figure 7-50.

1. Remove the module and clean the terminals with emery cloth or a wire brush to remove any oxide film.

2. Remove the connector body (if so equipped) from the pickup coil leads. Carefully inspect the terminal-to-wire connections (green and white leads) and recrimp if loose. Reflow the existing solder, and add solder if necessary to assure good connections. Avoid excess solder. Use a small iron or gun. Do not allow heat to damage the insulation or solder to run under the terminal. Squeeze the side rails of the terminals with needle-nose pliers to assure a tight fit on the module terminals.

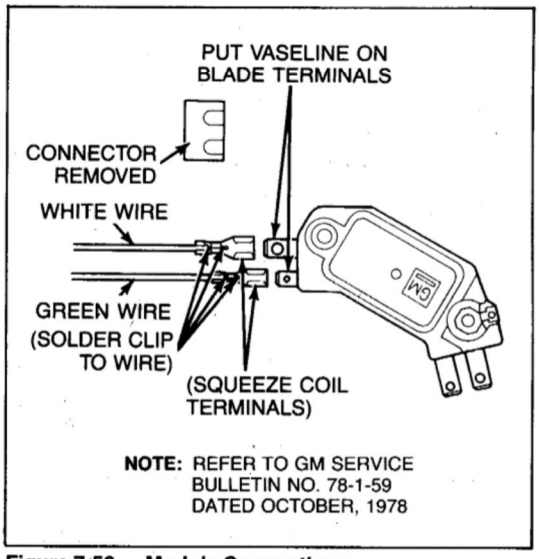


Figure 7-50 — Module Connections

3. Apply a thin coating of petroleum jelly (i.e., Vaseline) on all module terminals to reduce future oxidation. Make sure a small amount of silicone heat transfer grease (AC-Delco D-1920 or equivalent) is present on the module base. Apply the grease if necessary.

4. Reinstall the module on the H.E.I. base and reconnect the leads making sure all terminals are seated with good metal-to-metal contact.

SPARK PLUG WIRES

Use care when removing spark plug wire boots from spark plugs. Twist the boot 1/2 turn before removing, and pull on the boot only to remove the wire. Borroughs Tool No. BT-7901B or equivalent will make the removal of the spark plug wires easier. (See Figure 7-51.)

It is extremely important when replacing plug wires to route the wires correctly and through the proper retainers. Failure to route the wires properly can lead to radio ignition noise and crossfiring of the plugs, or shorting of the leads to ground.

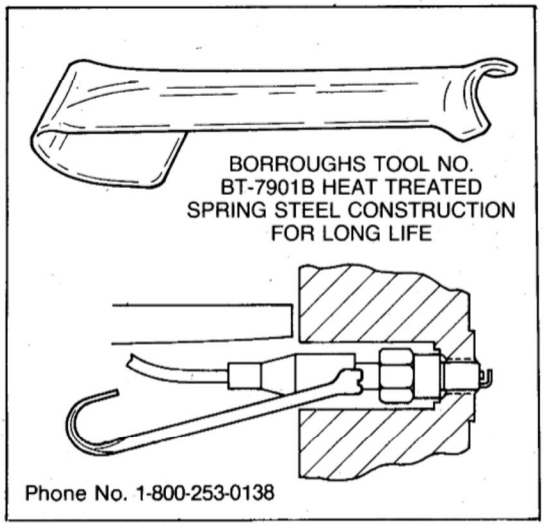


Figure 7-51 — Spark Plug Boot Puller

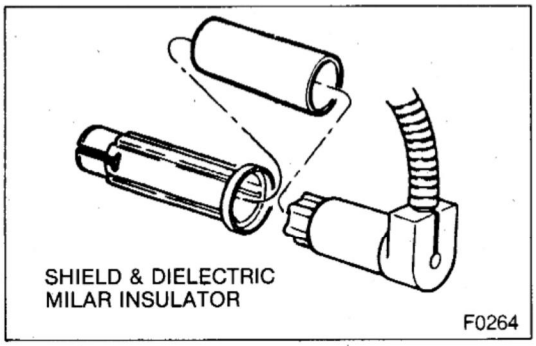


Figure 52—Spark Plug Shield for 7.4L

Cyl. 1 thru 6 & 8	10089660	2-5/8 inch
Cyl. 7	10089661	1-7/8 inch

Plug Wire Set

85-86	H4D 12043750
85-89	H5D 12072181
90-93	H5D 12074045

SPARK PLUGS

Worn or dirty plugs may give satisfactory operation at idling speed, but under operating conditions they frequently fail.

Faulty plugs are indicated in a number of ways: poor fuel economy, power loss, loss of speed, hard starting and general poor engine performance.

Spark plug failure, in addition to normal wear, may be due to carbon fouled plugs, excessive gap or broken insulator. (See Figure 7-48.)

Fouled plugs may be indicated by checking for black carbon deposits. The black deposits are usually the result of slow-speed driving and short runs where sufficient engine operating temperature is seldom reached. Worn pistons, rings, faulty ignition, over-rich carburetion and spark plugs which are too cold will also result in carbon deposits.

Excessive gap wear, on plugs of low mileage, usually indicates the engine is operating at high speeds or with loads that are consistently greater than normal or that a plug which is too hot is being used. In addition, electrode wear may be the result of plug overheating, caused by combustion gases leaking past the threads, due to insufficient torquing of the spark plug. Excessively lean carburetion will also result in excessive electrode wear.

Broken insulators are usually the result of improper installation or carelessness when regapping the plug. Broken upper insulators usually result from a poor-fitting wrench or an outside blow. The cracked insulator may not make itself evident immediately, but will as soon as oil or moisture penetrates the fracture. The fracture is usually just below the crimped part of the shell and may not be visible.

Broken lower insulators usually result from carelessness when regapping and generally are visible. In rare instances, this type of break may result from the plug operating too "hot," encountered in sustained periods of high-speed operation or under extremely heavy loads. When regapping a spark plug, to avoid lower insulator breakage, always make the gap adjustment by bending the ground (side) electrode. Spark plugs with broken insulators should always be replaced.

6.2L DIESEL GLOW PLUG ELECTRICAL SYSTEM

GENERAL DESCRIPTION

In the diesel engine, air alone is compressed in the cylinder; then after the air has been compressed, a charge of fuel is sprayed into the cylinder and ignition occurs due to the heat of compression. Eight glow plugs are used to preheat the chamber as an aid to starting.

The glow plugs are heaters that turn on when the ignition key is turned to the run position prior to starting the engine. They remain pulsing a short time after starting, then automatically turn off.

SYSTEM COMPONENTS

The 6.2-liter diesel glow plug control system consists of a thermal controller, glow plug relay, 6-volt glow plugs and a "glow plugs" lamp. (See Figure 7-53) Other components which have no function in controlling glow plug operation but are part of the electrical system, start-and-run operations are: fuel solenoid, fast idle and cold advance solenoids, cold advance temperature switch and the TCC, EGR (if equipped) and EPR solenoids. The electrical operation and diagnosis of the fuel solenoid, fast idle and cold advance solenoid and the cold advance temperature switch will be covered briefly here.

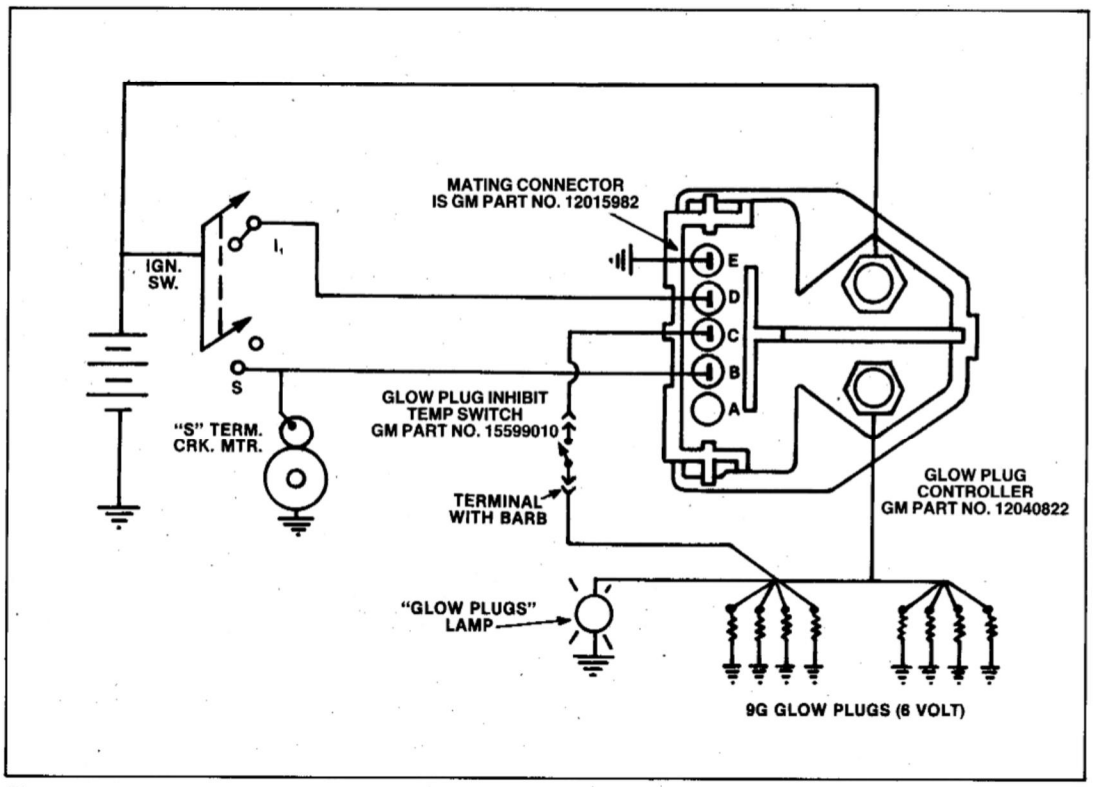


Figure 7-53 — Electronic Glow Plug Control System 1985 and Forward

Controller

The thermal controller is mounted in the water passage at the rear of the engine.

Thermostatic elements within the controller are designed to open or close the ground circuit to the glow plug relay as necessary to control the preheat and afterglow cycles of glow plug operation.

Glow Plug Relay

The glow plug relay provides current to the glow plugs. The relay is pulsed on and off by the thermal controller.

NOTE: Do not bypass the glow plug relay. This relay is automatically controlled. Any attempt to bypass the relay with a jumper wire or rewire for manual control, may result in glow plug failure.

Glow Plugs

The glow plugs used in this system are 6-volt plugs which are operated at electrical system voltage (12 volts). The plugs are a "fast start" design capable of reaching 1,800°F in 7.5 to 9 seconds when the engine temperature is 0°F. They are not designed to burn continuously and are pulsed on and off as needed, by the thermal controller.

"Glow Plugs" Lamp

The "glow plugs" lamp is mounted in the instrument cluster. The lamp is wired across the glow plugs and is illuminated whenever the glow plugs are heated.

Fuel Solenoid

The fuel solenoid is activated whenever the ignition switch is on. The solenoid is located in the fuel injection pump housing cover.

Cold Advance Solenoid

The cold advance solenoid, also located in the injection pump cover, is controlled by a cold advance temperature switch which activates this solenoid and the fast idle solenoid at a specified minimum temperature. The switch should be closed below 90°F and open above 122°F.

Instrumentation

Vehicles with the diesel engine have special instrumentation indicators to permit the operator to properly apply the starting procedure. A "glow plugs" light on the instrument panel provides this information on the engine starting conditions.

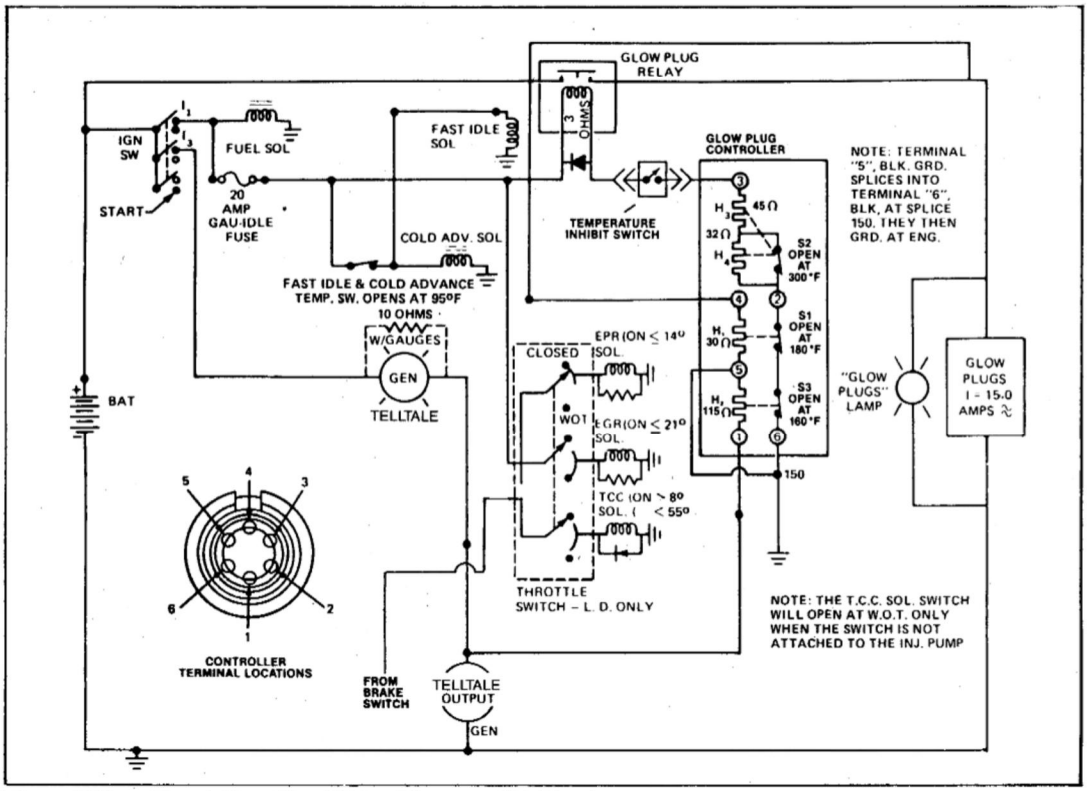


Figure 7-54 — Diesel Glow Plug Wiring Diagram 1982-85

Also these vehicles have a "water-in-fuel" lamp and "low engine coolant" lamp.

Modifications Required for Diesel Starting

BATTERY — The diesel engine uses dual batteries to provide the extra power required to operate the glow plugs and the larger starter used on this engine.

A standard generator supplies charging current to both batteries at the same time. There are no switches or relays in the charging circuit.

STARTER — The starter is larger and designed to crank the engine to at least the 100 RPM required for starting.

Circuit Operation — Cold Start (See Figure 7-54)

With the ignition switch in "RUN," the following events take place simultaneously:

1. The fuel solenoid is energized and opens the fuel metering valve. The fuel heater is powered, provided the temperature is low enough to require heating of the fuel.
2. Battery voltage is applied to the fast idle solenoid and cold advance solenoid through the fast idle/cold advance temperature switch (when closed).
3. Battery current flows through the thermal controller circuits and through the glow plug relay coil to ground.
4. The glow plug lamp, which is wired across the glow plugs, comes on whenever the glow plugs are powered.
5. The thermal controller starts the glow plug's heating cycle.

Initially, the glow plugs are activated continuously for a period of 7.5 to 9 seconds at 0°F (Figure 7-55). The glow plugs then begin to pulse on and off at a rate determined by the thermal characteristics of the controller. The initial current brings the glow plug preheat chamber up to the temperature required for cold starting. The pulse cycle (on and off) acts to maintain chamber temperature to provide stable engine warm-up. As the engine warms up, the ther-

mal controller turns off all current to the relay, deenergizing the glow plugs completely. The controller is capable of varying glow plug operation as required (up to one minute) when the engine is started warm, and little or no heating is necessary.

Controller failure, as in the case of prolonged preheat (more than 9 seconds), would cause a circuit breaker in the controller to open, cutting off glow plug operation completely.

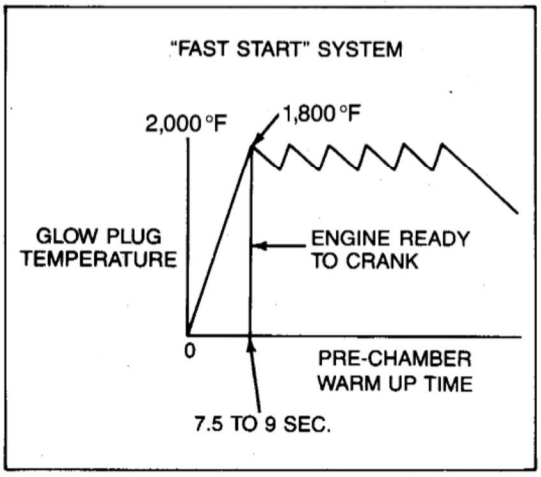


Figure 7-55 — Glow Plug Control

MAINTENANCE AND INSPECTION

No routine service is required for the diesel glow plug electrical system. However, should there be a problem with the system, it is wise to first inspect the system to ensure that all connectors are installed properly and that all connections are clean and tight. The glow plugs can be checked for continuity with the procedure in this section. If the inspection and checks do not reveal the problem, refer to the shop manual for the diagnosis procedure.

GLOW PLUG TEST

This test can be performed with the plugs either installed or removed from the engine. If the plugs are installed, the engine should be off and the feed wire disconnected from each plug.

Using an ohmmeter, adjusted to a low-range scale, check for continuity between the terminal and body of each plug as shown in Figure 7-56. The ohmmeter reading should be approximately 0.5 ohm. If the reading is infinity, the glow plug coil is burned out or faulty and the plug should be replaced.

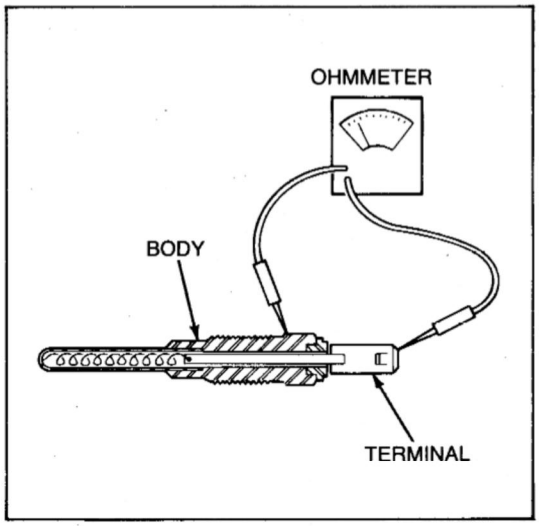


Figure 7-56 — Glow Plug Test

BATTERY SIZE AND CRANKING vs. TEMPERATURE

The following information is provided as an aid to the motor home owner in understanding battery size and cranking capacity in relation to temperature.

The chart shown in Figure A7-10-1 explains why a battery of sufficient electrical size is essential if satisfactory cranking of the engine is to be achieved at low temperatures. At temperatures below zero, the capacity of the battery at full charge is about 30 percent of rated capacity at 80°F. At the same time, the load imposed on the battery by the engine is about 3-1/2 times the normal cranking load at 80°F. In effect, at lower temperatures the battery would seem "smaller" while the engine would appear to be "larger," as depicted in the figure.

The charts below (Figure A7-10-2) provide an example of the "shrinking" battery in terms of Cold Cranking Amps (CCA) in relation to temperature.

Just as low winter temperatures can create cold-start cranking problems due to the electrical size and cranking capacity of a battery, the majority of winter engine failures are skuff and bearing seizures that occur upon initial start-up. The reason for these problems is oil starvation from drain-off and the fact that the oil is too thick to pump quickly to the bearing surfaces.

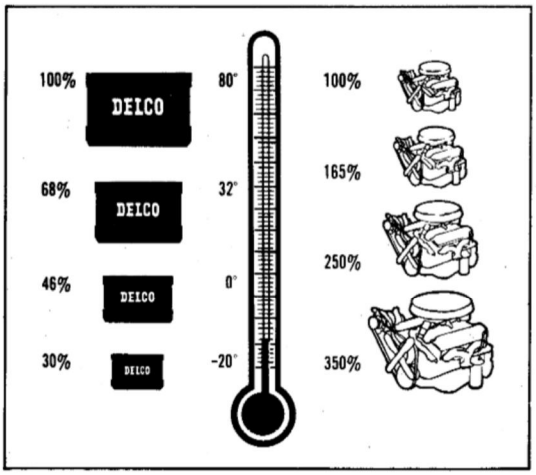


Figure A7-10-1 — Battery Cranking vs. Temperature

For best fuel economy and cold starting protection to engine surfaces, consider the range of temperature your vehicle will be operated in during the next oil change. Then, select the recommended oil viscosity from the applicable chart shown in Figure A7-10-3.

100% FULL-CHARGED BATTERY

	BASE BATTERY	HD BATTERY
	405 CCA	650 CCA
80 DEGREES = 100%	880 CCA	1413 CCA
32 DEGREES = 68%	598 CCA	960 CCA
0 DEGREES = 46%	405 CCA	650 CCA
-20 DEGREES = 30%	264 CCA	423 CCA

65% CHARGED BATTERY - GREEN EYE VISABLE

	BASE BATTERY	HD BATTERY
	405 CCA	650 CCA
80 DEGREES = 100%	572 CCA	918 CCA
32 DEGREES = 68%	389 CCA	624 CCA
0 DEGREES = 46%	263 CCA	422 CCA
-20 DEGREES = 30%	171 CCA	275 CCA

Figure A7-10-2 — Cold Cranking Amps vs. Temperature

BATTERY SIZE AND CRANKING vs. TEMPERATURE (Cont'd)

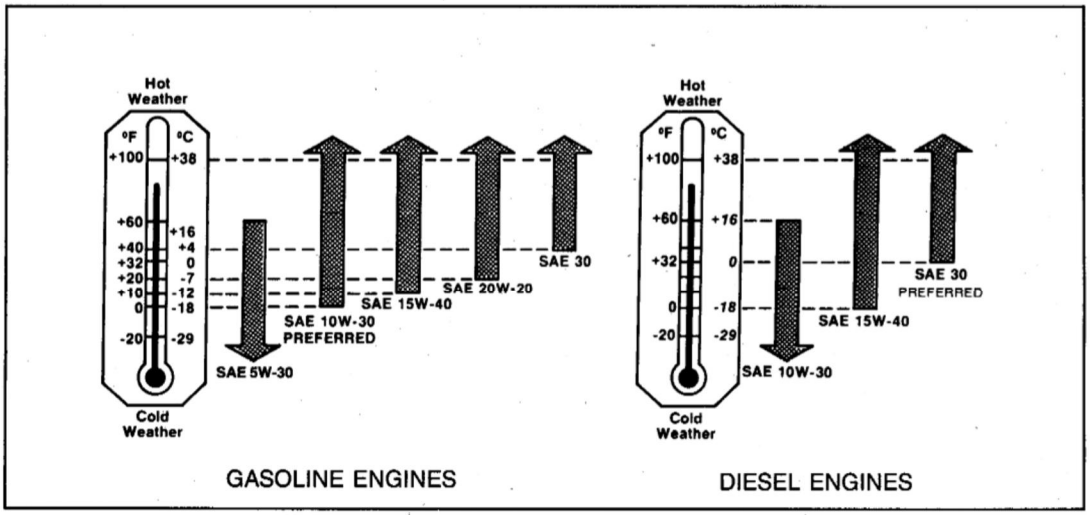


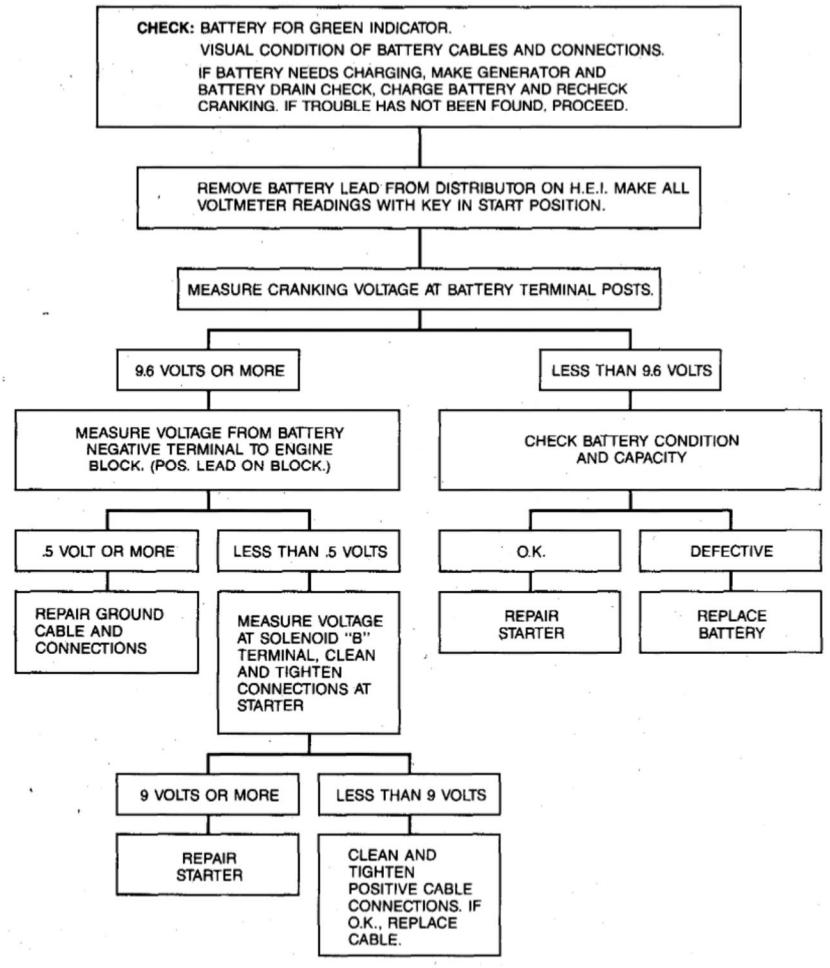
Figure A7-10-3 — Gasoline and Diesel Engine Oil Viscosity Charts

NOTE: THE GM MAINTENANCE SCHEDULE RECOMMENDS INSPECTION OF ALL ENGINE DRIVE BELTS AT EACH OIL CHANGE. DRIVE BELTS SHOULD BE INSPECTED FOR CRACKS, FRAYING AND WEAR. DRIVE BELTS SHOULD BE ADJUSTED OR REPLACED AS NEEDED. SEE APPENDIX A — DRIVE BELTS AND TENSION SPECIFICATIONS AT THE BACK OF THIS MANUAL FOR ADDITIONAL INFORMATION.

BATTERY SIZE AND CRANKING vs. TEMPERATURE (Cont'd)

NOTE: The following charts are provided to aid service personnel and the motor home owner for proper engine electrical diagnosis.

SLOW CRANKING, SOLENOID CLICKS OR CHATTERS



NOTE: THIS PROCEDURE IS DESIGNED FOR USE ON ENGINES AND BATTERIES AT ROOM OR NORMAL OPERATING TEMPERATURES. IT ALSO ASSUMES THERE ARE NO ENGINE DEFECTS WHICH WOULD CAUSE CRANKING PROBLEMS. TO USE IT UNDER OTHER CONDITIONS MIGHT RESULT IN MISDIAGNOSIS.

Figure A7-10-4 — Slow Cranking — Diagnosis Chart

BATTERY SIZE AND CRANKING vs. TEMPERATURE (Cont'd)

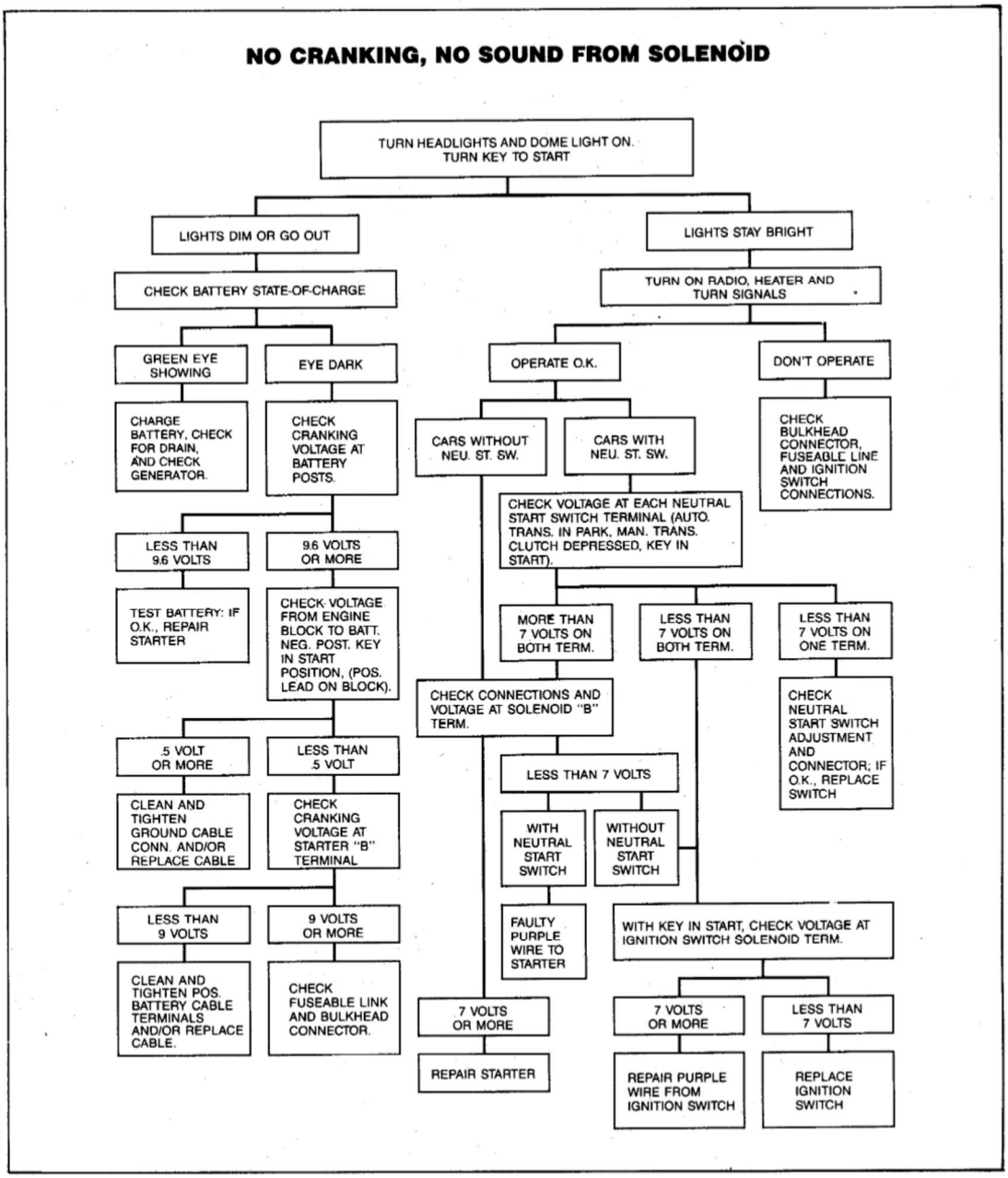


Figure A7-10-5 — No Cranking — Diagnosis Chart

ADD-ON (AUXILIARY) ELECTRICAL EQUIPMENT INSTALLATIONS

The following information has been extracted from a Chevrolet Dealer Service Technical Bulletin relating to add-on (auxiliary) electrical equipment installations for vehicles with side terminal batteries.

Reference: Chevrolet Dealer Service Technical Bulletin No. 85-17 (December, 1984)

The use of electronics on today's vehicles require that both power and ground connections for add-on (auxiliary) electrical equipment (mobile radios, light bars, etc.) be made at the battery.

The Side Terminal Adaptor Package (GM Part No. 1846855) when combined with the longer battery bolt (GM Part No. 12004188) and spacer (GM Part No. 12004189) will provide and maintain corrosion resistance and the electrical integrity designed into the Delco side terminal battery. (See Figure A7-11-1.) GM recommends that all service personnel and motor home owners involved in add-on (auxiliary) electrical equipment installations perform the following procedures.

The vehicle battery should be located and positioned to make use of the existing battery cables. If the battery requires relocation and longer cables are required, a proportionately larger gauge wire must be used.

If in relocating the battery, the negative ground cable is attached to the frame rail, a cable of similar gauge must be provided between the frame rail and the engine. This is required due to the heavy electrical loads imposed by the starting circuit.

To ensure proper operation of the battery cables, the following chart on length, gauge and materials must be adhered to:

CABLE GAUGE	COMBINED LENGTH OF POSITIVE AND NEGATIVE CABLE IN INCHES	
	COPPER	COPPER CLAD ALUMINUM
4	66	52
2	107	67
0	170	111

Figure A7-11-2 — Add-On Electrical Equipment — Wire Gauge and Materials Specifications

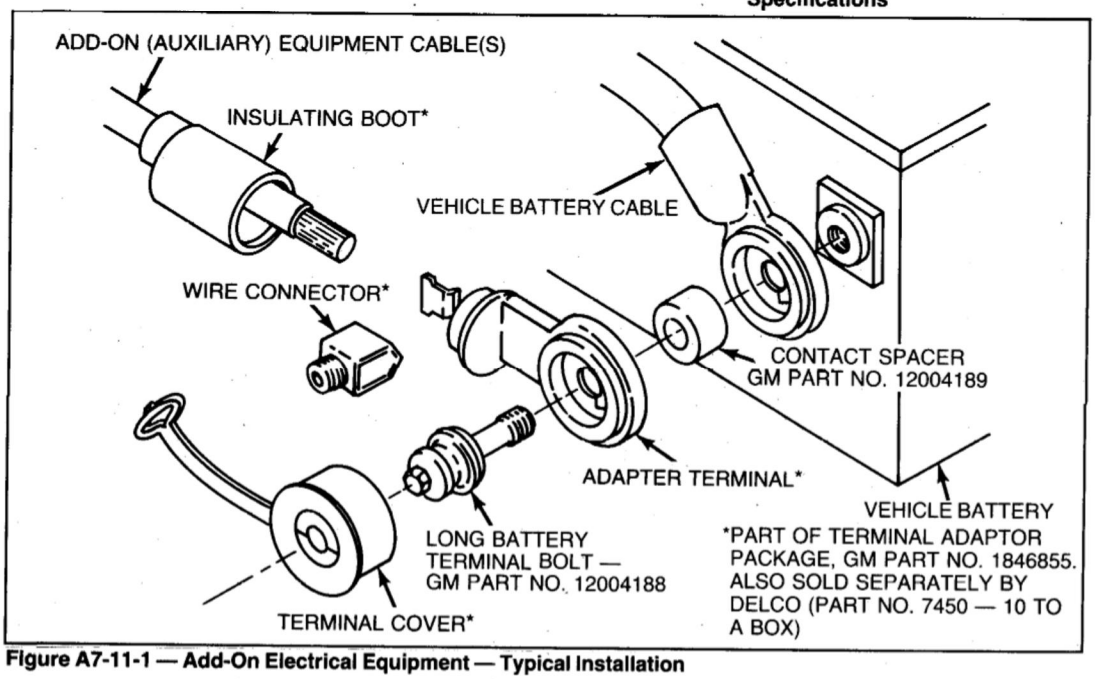


Figure A7-11-1 — Add-On Electrical Equipment — Typical Installation

"HOT START" PROBLEM CONDITIONS

First item to check when hot start (hot soak) is the ground cable — LH frame rail to LH cylinder head. Poor ground give high resistance when hot. Remove bolts and clean — be sure the star washer is used to insure good ground.

The following information has been extracted from three GM Service Bulletins relating to "hot start" problems. The information begins with a discussion of the simple basics of loose connections, proceeds to the addition of heat shields and finally to adding a magnetic switch. Problem conditions and corrective procedures are described.

Reference: Chevrolet Dealer Service Technical Bulletin No. 90-332-8A (August, 1990)

All Gasoline Engine Models

CONDITION: Starter solenoid does not engage in the ring gear during hot restart. Clicking sound is heard while trying to start the vehicle.

CAUSE: The starter solenoid engagement force is not strong enough to withstand the high temperature environment on some recreational vehicles.

CORRECTION: First, check the usual causes for a "clicking" solenoid. These causes include a discharged or defective battery, defective switches, excessive control circuit/connection resistance, or a defective solenoid.

If no troubles are found, a new starter solenoid package, P/N 10457024, is available to repair the vehicle. This package consists of a solenoid, lever and plunger assembly lever pin, and retaining ring. Make sure all Parts in the package are used.

The vehicle battery should be located and positioned to make use of the existing battery cables. If the battery requires relocation and longer cables are needed, larger gauge cables must be used to ensure proper voltage requirements.

To ensure proper operation of the battery cables, the following chart on length, gauge and materials must be strictly adhered to.

CABLE GAUGE	COMBINED LENGTH OF POSITIVE AND NEGATIVE CABLE IN INCHES	
	COPPER	COPPER CLAD ALUMINUM
4	66	52
2	107	67
0	170	111

Figure A7-12-2 — Battery Cable Gauge Specifications

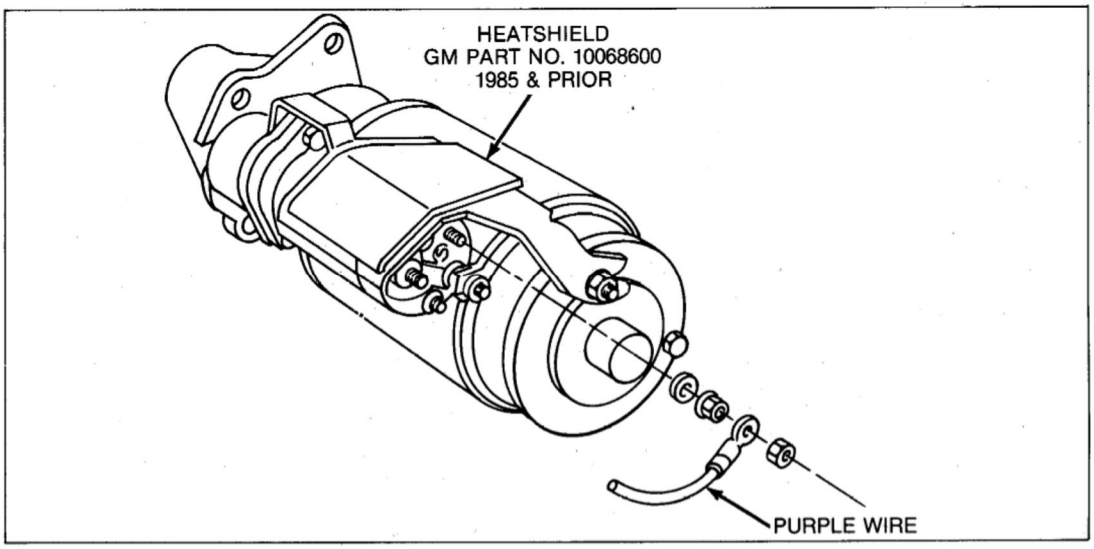


Figure A7-12-1 — "Hot Start" Problems — Starter Solenoid

"HOT START" PROBLEM CONDITIONS (Cont'd)

Reference:Chevrolet Dealer Service Technical Bulletin No. 78-T-28 (April, 1978)

P-Series Motor Homes with Mark IV Engines

The generic term "hot start" is applied loosely to an array of causes which can lead to an inability to crank. Typical "hot start" symptoms involve failure to crank after a 20-minute "hot soak" period with the engine off. Restarts are obtained by waiting for the engine compartment cool down, or in some cases, by energizing the starter solenoid directly with a screwdriver across the "S" and "B+" terminals.

High ambient and/or underhood temperatures can lead to component overheating. The two starting system components, most vulnerable to adverse thermal effects, are the battery and the starter motor solenoid as follows:

1. Batteries subjected to long-term storage or operating conditions which do not keep the battery adequately charged may be marginal because of sulfation. When operated in high ambients, electrolyte temperatures may be excessive. During engine-off hot soak periods, marginal batteries adjacent to radiators may approach the boiling point of the electrolyte, (about 230°F) depending on state of discharge.

2. The starter motor solenoid, in close proximity to the exhaust pipe, is subject to radiant heating which ultimately increases coil resistance. The resistance increase, decreases current flow to the point where the coil cannot be energized with the available applied voltage.

NOTE: Some motor home body builders install batteries in a tray near the radiator, while others use a sliding shelf away from engine temperatures. The trade-off, however, is longer battery cables and a higher voltage drop. Battery thermal guards or heat shields, reflective paints, and/or battery relocation are appropriate where evidence indicates battery thermal problems.

In some cases, the battery voltage available for solenoid operation is adequate when the coil is relatively cool, but insufficient when the coil is hot. Typically, the voltage drop across the ignition switch, neutral start switch circuit, to the solenoid, should not exceed 2 volts. This, normally, would allow approximately 8 volts for solenoid operation. Unfortunately, the ignition/start circuit voltage drop can exceed 4 volts due to switch contact resistance, wire lengths, etc. Since the solenoid requires a minimum of 7 volts for positive operation, a marginal or "no start" situation can occur.

On "hot start" complaint vehicles that exhibit symptoms related to inoperative solenoids, the use of magnetic switch, GM Part No. 001486 or No. 1115616 (or equivalent) is recommended. It is, in effect, a high-current relay whose contacts are connected across the solenoid "S" and "B+" terminals. (See Figure A7-12-3.) The coil of the magnetic switch is connected in series with the ignition/neutral start switch circuit. Maximum available voltage is, therefore, applied to the solenoid, since the voltage drop in the magnetic switch contact circuit is virtually zero.

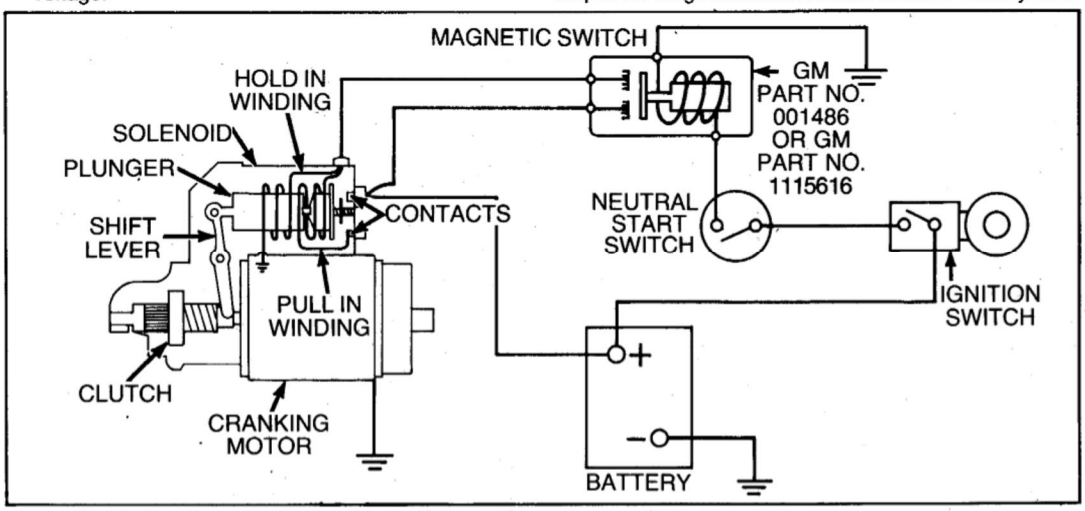


Figure A7-12-3 — Magnetic Switch/Starter Schematic

"HOT START" PROBLEM CONDITIONS (Cont'd)

Installation and connection of the magnetic switch can be accomplished as follows:

1. Drill two holes in the oil dipstick tube bracket. Use holes in the magnetic switch mount as a template for hole location. Removal of bracket will facilitate drilling. (See Figure A7-12-4.)
2. Mount the magnetic switch to the dipstick (tube) bracket using locking fasteners.
3. Unwrap harness tape, from engine harness wire bundle (approximately one foot) in area adjacent to magnetic switch.
4. Locate the No. 12 AWG wire with purple insulation. This wire connects the neutral start switch to the starter motor solenoid "S" terminal.
5. Cut the wire at a point which will allow connection of the severed ends to the magnetic switch.
6. Identify the cut end of the wire which connects to the "S" terminal of the starter motor solenoid. Terminate this wire with an appropriate lug for connection to one of the "large" studs on the magnetic switch.
7. Terminate the other end of the cut wire with an appropriate lug for connection to one of the "small" studs on the magnetic switch.
8. Disconnect all of the wires from the "B+" junction block and attach them to the remaining "large" stud on the magnetic switch.
9. Connect the remaining "small" stud on the magnetic switch to a secure chassis ground.
10. Run a functional/electric check to assure system operation.

In field situations where it is impractical to install a magnetic switch, use of reflective paint to reduce heat absorption is an alternative. Remove dirt from the starter motor and solenoid. With the starter motor installed on the engine, apply reflective paint — Krylon No. 1402 High Temperature (1,200°F) Aluminum Paint, or equivalent — to all accessible surface areas of the starter motor and solenoid. This is a temporary measure since any accumulation of dirt will reduce its effectiveness.

Reference:Chevrolet Dealer Service Technical Bulletin No. 80-T-27 (March, 1980)

G- and P-Series Models Produced Prior to March 15, 1980 — Approx.

On some 1979-80 vehicles, the starter motor may not engage after the engine has been turned off and allowed to "hot soak" for a short period of time (10-15 minutes). This condition can result from increased starter solenoid resistance when the solenoid temperature increases. Increased resistance causes reduced current flow to a point where the solenoid may not "pull-in." The symptoms are "no clicking noise" and no cranking when the ignition key is turned to the start position.

If normal diagnosis of battery or wiring does not disclose any out-of-line conditions, the problem may be caused by the solenoid return spring. This problem can be corrected by installing a new shorter return spring, GM Part No. 1978281 or equivalent. Or, install a new high-heat resistant solenoid, GM Part No. 1114458 (brown color) or equivalent, which incorporates the shorter return spring.

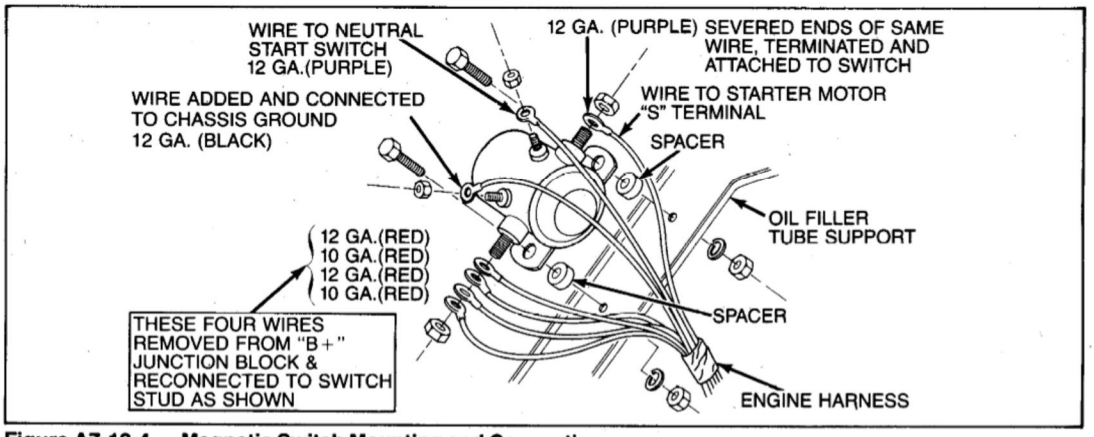


Figure A7-12-4 — Magnetic Switch Mounting and Connection

STARTER MOTOR ENGAGEMENT AFTER INITIAL START-UP

The following information has been extracted from a Chevrolet Dealer Service Technical Bulletin concerning the starter motor relay for 7.4L engines. Problem conditions and corrective procedures are described.

Reference: Chevrolet Dealer Service Technical Bulletin No. 84-41 (December, 1983)

1983-84 Motor Home Chassis

The starter motor on some motor home vehicles may re-engage after the engine has been started. This may result from the starter motor relay being energized after the initial start-up. Starter damage could result if this should happen.

To correct the situation, replace the starter relay with a magnetic switch. (See Figure A7-13-1.) Remove the relay connector on the existing engine harness and reterminate the wires with the appropriate size ring terminals.

This change was incorporated into production vehicles after 1984.

NOTE: A square box electrical relay (GM Part No. 356284) was used in production starting October 28, 1982 with the first serial number of 302886. This relay was used until March 3, 1984. Beginning with serial number 328810, production was switched back to a magnetic switch (GM Part No. 1115616). Both switch types are mounted in the same general location. If a problem arises with electrical relay GM Part No. 356284, it should be replaced with either magnetic switch GM Part No. 1115616 or No. 001486 (interchangeable GM Part Nos.). Other 4-post, non-GM switches may be electrically and functionally similar.

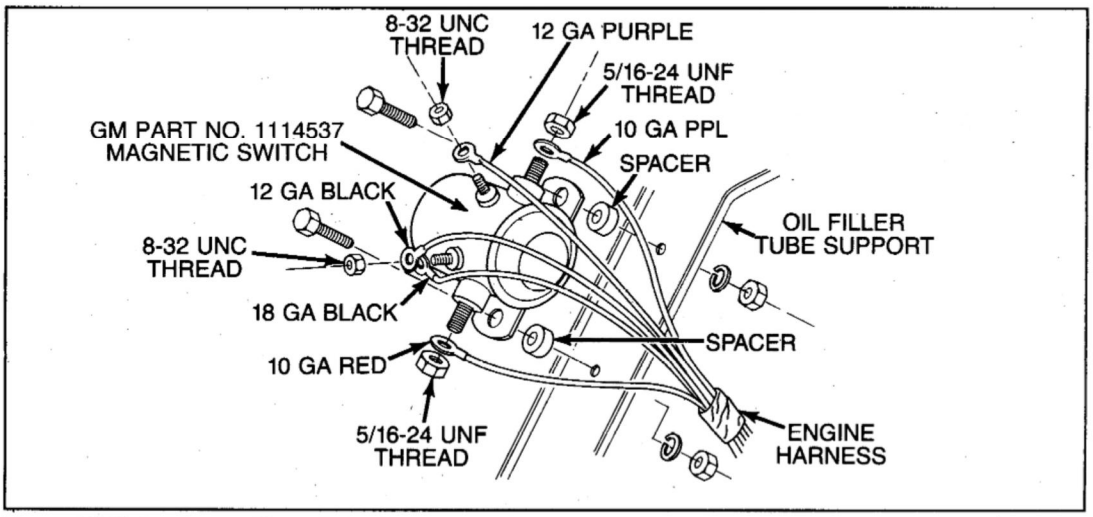


Figure A7-13-1 — Starter Motor Relay Connections

GENERATOR BELT USAGE ON 6.2L DIESEL ENGINES

The following information has been extracted from a Chevrolet Dealer Service Technical Bulletin concerning generator belt usage for 6.2L engines.

Reference: Chevrolet Dealer Service Technical Bulletin No. 83-103 (November, 1983)

Belts installed during production were developed to withstand the characteristics of the 6.2L diesel engine. Usage of substitute belts (with the same dimensions but not construction) will not give the same performance and may wear prematurely, even while operating at the prescribed belt tension.

To obtain optimum belt life, the following belts and tension settings are recommended to be used with the 6.2L diesel engine.

BELT USAGE	RECOMMENDED BELT	BELT TENSION	
		NEW	USED
Generator	GM Part No. 14050449 (.380 HiRide × 48)	175 lbs.	55-100 lbs.
A/C Belt*	GM Part No. 14033869 (.380 HiRide × 60)	175 lbs.	55-100 lbs.
P.S. Belt	GM Part No. 14050459 (.380 HiRide × 45 1/2)	175 lbs.	55-100 lbs.
1985-Current A/C Belt	GM Part No. 476406 (.380 HiRide × 61)	175 lbs.	55-100 lbs.
1985-Current Generator	GM Part No. 15592119 (.380 HiRide × 48)	175 lbs.	55-100 lbs.

** Motor Home does not have factory air conditioning*

NOTE: The generator/vacuum pump belt for 1984 G- and P-Series is #14071081. This is a cog type belt, 49″ × 3/8″.

Figure A7-14-1 — 6.2L Diesel Engine Belt Usage

APPENDIX 7-15

TORSIONAL ISOLATOR

The 6.2L torsional isolator is now available from GM Parts Division. The isolator is installed in place of the present crankshaft pulley. The isolator should be installed to correct complaints of short belt life. New bolts and washers are required to install the isolator.

GM PART NUMBER	MODEL	YEAR
15592125	P With Air Conditioning C, K, G With Air Conditioning G With Air Conditioning	1982-85 1982-84 1985
15592127	C, K, G, P Without Air Conditioning	1982-85
15592128	C, K With Air Conditioning	1985
Also Required: 4 - Bolts, GM Part No. 11500937 4 - Washers, GM Part No. 9438083		

Figure A7-15 -1 — Torsional Isolator Parts Identification

ELECTRONIC CRUISE CONTROL

The GM/AC electronic cruise control is currently available on G-Series vehicles and is proposed as an option for 1988 P-Series vehicles (under option number K34). The following information is provided as an aid to the motor home owner concerning problem conditions that may exist and corrective procedures are described.

The following provides corrective actions if the electronic cruise control will not engage:

1. Turn on the cruise control at the slide switch. Have an assistant listen near the servo positioned under the hood of the vehicle. When the ignition is turned ON, two clicks should be heard. (This means that there are 12 volts being sent through the cruise control slide switch, through the brake switch and out to the vacuum and vent solenoid valves in the servo.)

2. Remove the large hose at the servo. Applying suction by mouth, check for a complete seal. The vacuum valve should be sealed with the brake pedal released. When the brake pedal is depressed, you should lose vacuum. Replace the hose.

3. Start the engine and remove the small hose at the servo. Check to make sure there is a vacuum with the engine running. Replace the hose.

4. Turn the engine OFF and leave the ignition ON. Using a test light or a volt meter check the following positions and readings at the electronic controller box:
   TERMINAL A — 12 volts indicated when the slide switch is turned on.
   TERMINAL G — 12 volts indicated when the brake pedal is released with the slide switch on.
   TERMINAL M — 12 volts indicated when the resume/accelerate switch is pushed.
   TERMINAL L — 12 volts indicated when the set/coast button is pushed with the slide switch on. (This step checks all mode switches down to the controller.)

5. To check the vehicle speed sensor, turn the ignition on and verify voltage to the pink wire at the yellow speed sensor connector. There should be 12 volts passing through the wire. Check to show continuity at the black wire to ground. Using a volt meter, touch TERMINAL D at the electronic controller with the engine running. Roll the vehicle slowly five or six feet in the stall. The volt meter should jump from a zero reading to between 7-1/2 and 8-1/4 volts. This indicates a good vehicle speed sensor.

6. Check the servo electrically:
   TERMINAL A to C should read — 30 to 55 Ohms
   TERMINAL E to C should read — 30 to 55 Ohms
   TERMINAL B to D should read — 15 to 25 Ohms

7. If any of the above checks did not provide the cause of the problem and the cruise controller still does not operate, the electronic controller box can be presumed the cause of the problem and should be replaced.

CRUISE CONTROL RESPONSE

A properly adjusted cable will provide a more responsive "feel" as the diaphragm has less of a chance to bottom out allowing full engine throttle. A second benefit to a properly adjusted cable is the overall smoothness of response by removing play or slack from the cable system

The following is recommended to provide proper cruise control response:

1. Adjust the cable from the cruise control servo to the carburetor to obtain the least amount of slack while still maintaining a normal curb idle.

2. Lightly squeeze the rubber diaphragm on the servo control. Feel and observe cable movement as it first removes any slack and then starts throttle movement.

NOTE: A proper adjustment allows only slight perceptible movement before the throttle begins.

3. Adjustment varies by model but generally the adjustment is performed by removing the pin and moving up the adjusting holes in a stair-step series fashion.

NOTE: ARA Cruise Control service parts can be obtained at S.C.S. Frigette, 1200 W. Risinet, Fort Worth, TX 76140, phone 817-293-5313.

ELECTRONIC CRUISE CONTROL (Cont'd)

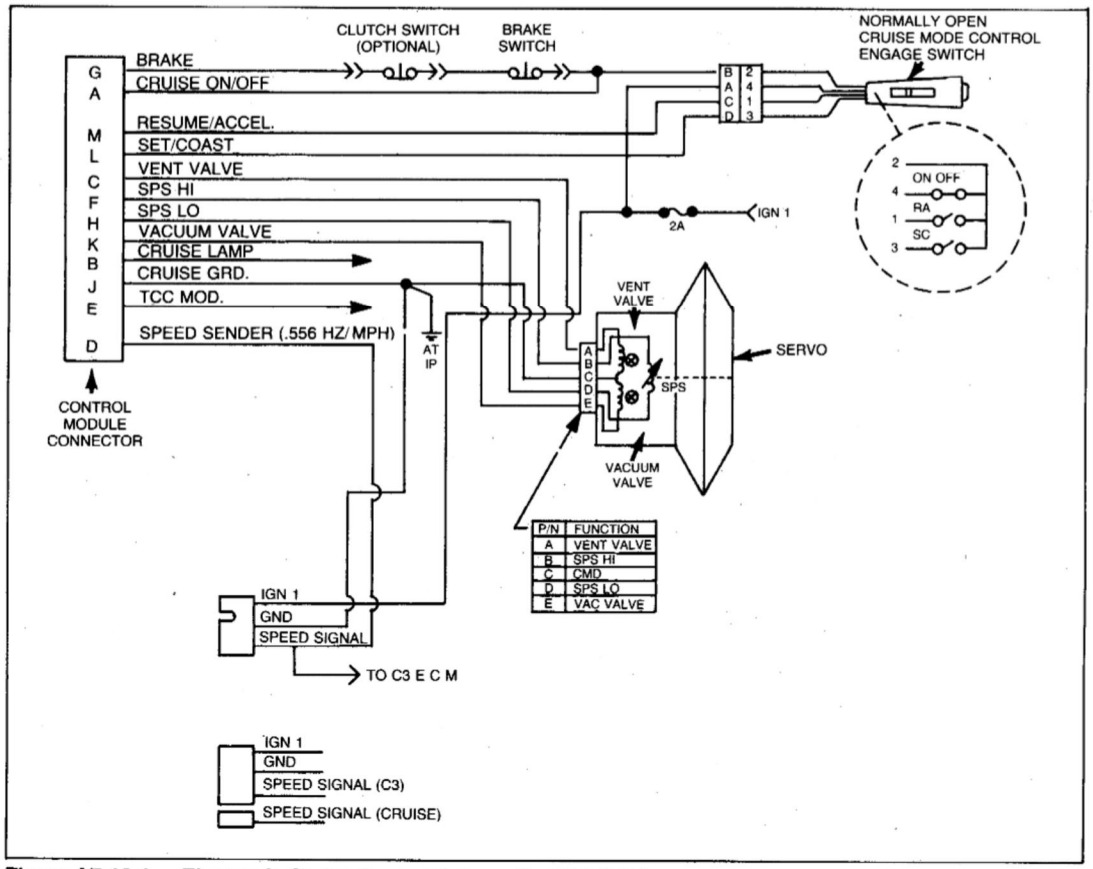


Figure A7-16-1 — Electronic Cruise Control Schematic 1988 & Prior

ELECTRONIC CRUISE CONTROL (Cont'd)

1989-94 ELECTRO-MOTOR CRUISE SYSTEM

DESCRIPTION

The Electro-Motor Cruise Control is a speed control system which maintains a desired vehicle speed under normal driving conditions. The Electro-Motor Cruise Control System has the capability to cruise, coast, resume speed, accelerate, tap-up, and tap-down.

The main parts of the cruise control system are the mode control switches, cruise control module, electrical release switches, and electrical harness.

The cruise control system uses a control module to obtain the desired vehicle cruise operation (figure 1). Two important components in the module help to do this. One is an electronic controller and the second is an electric motor. The controller monitors vehicle speed and operates the electric motor. The motor moves a connecting strap and throttle linkage in response to the controller motor to maintain the desired cruise speed. The cruise control module contains a low speed limit which will prevent system engagement below about 25 mph. The operation of the controller is controlled by mode control switches located on the turn signal lever.

MODEL CONTROL SWITCH

The mode control switch controls the various operating modes of the cruise control system. The switch is located on the multi-function lever.

VEHICLE SPEED SENSOR 1989

The P. Motorhome Cruise Control system uses only the input provided by the vehicle speed sensor located in the back of the speedometer head to maintain desired speeds. This system does not use vacuum or a servo.

NOTE: Effective SOP 1994 The previous K34 cruise control option will now be standard equipment from the factory.

ELECTRIC BRAKE RELEASE SWITCH

The brake pedal has two switches when a vehicle is equipped with cruise control. The combination stop light/cruise control switch is used in series with a separately mounted plunger type release switch. This is a redundant switch. When the brake pedal is depressed, each switch disengages the cruise control system. The cruise function remains disengaged after the brake pedal is released.

CRUISE CONTROL MODULE

The cruise control module is mounted on the top of the radiator support on the driver side. The cruise control module has an electronic controller and an electric motor to vary the throttle with each different cruise control mode. The cruise control module is not serviceable in the field. DO NOT ATTEMPT TO REPAIR THE MODULE.

NOTE: The factory installed cruise control servo cable can be ordered separate. #25075767

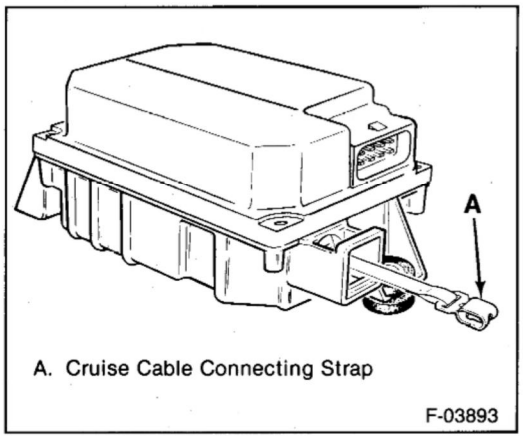


Figure A7-16-2 — Cruise Control Module

NOTE: Starting in 1991 with the overdrive transmission, the switch mounted near the top of the brake pedal bracket controls the Torque Convertor Clutch (TCC) in the 4L80EHD Transmission.

Additional information see bulletin #90-368-8C Page4 or Bulletin 91-137-9 Page 1

ELECTRONIC CRUISE CONTROL (Cont'd)

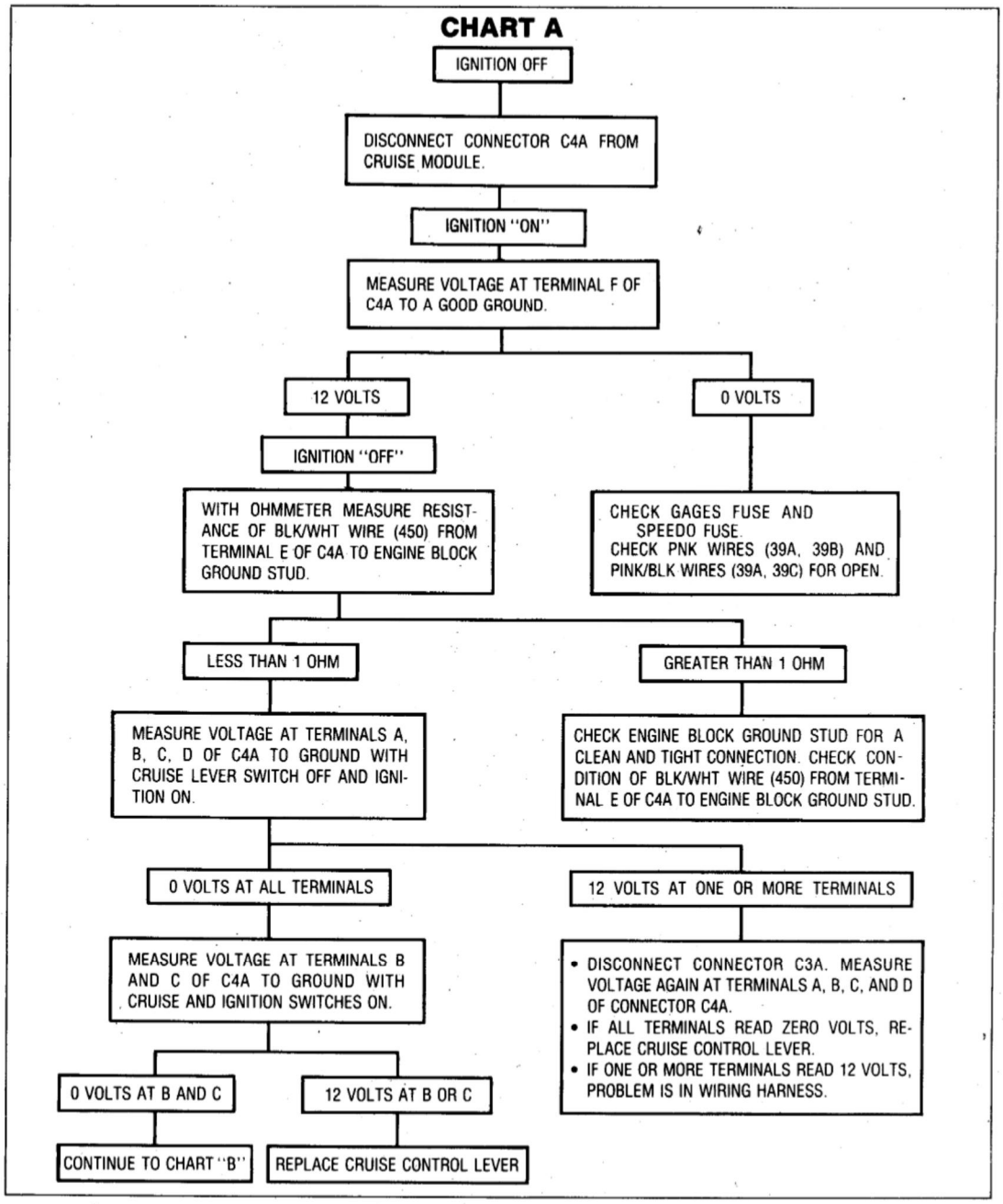


Figure A7-16-3 — Diagnosis of the Cruise Control System - Chart A

ELECTRONIC CRUISE CONTROL (Cont'd)

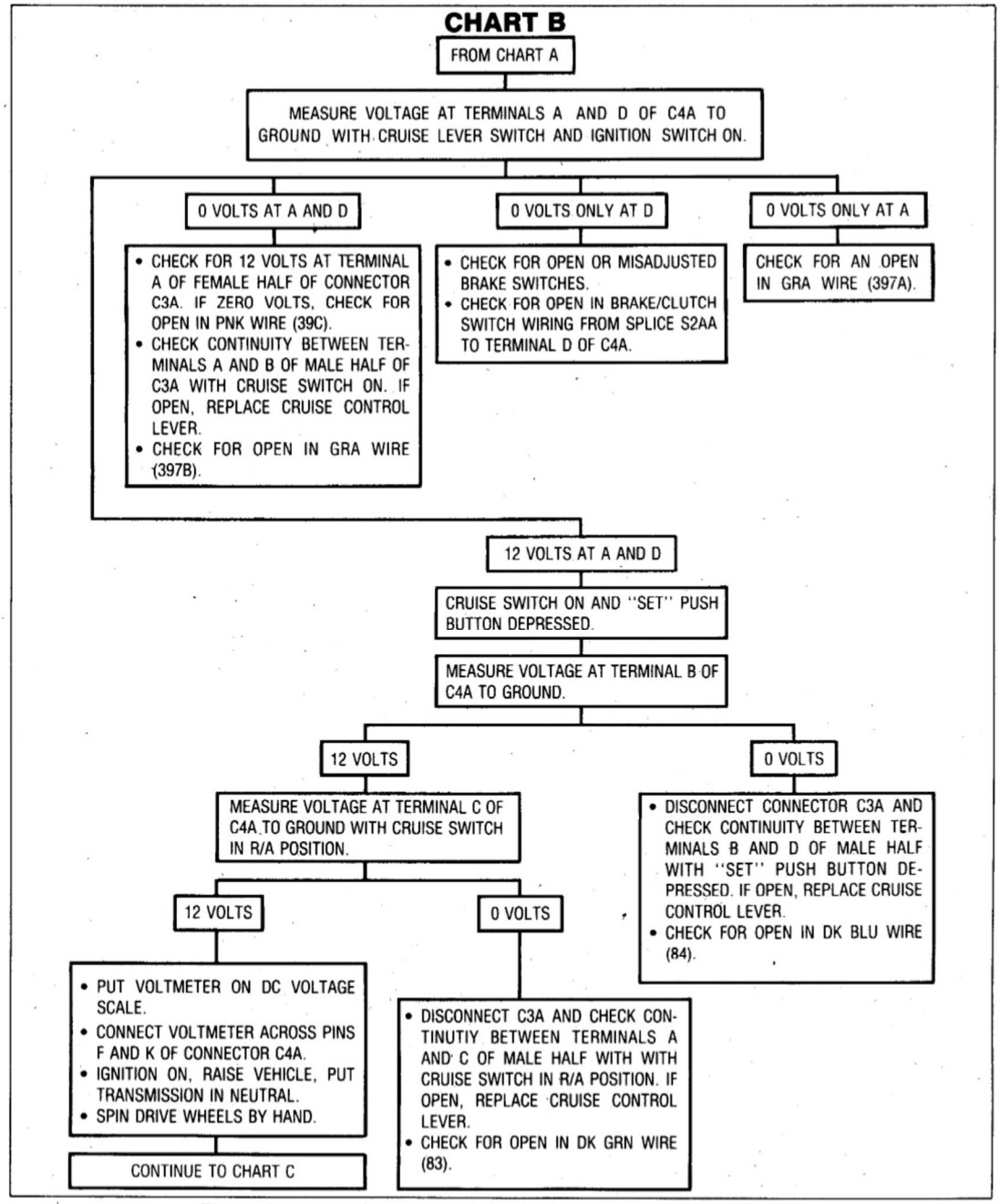


Figure A7-16-4 — Diagnosis of the Cruise Control System - Chart B

ELECTRONIC CRUISE CONTROL (Cont'd)

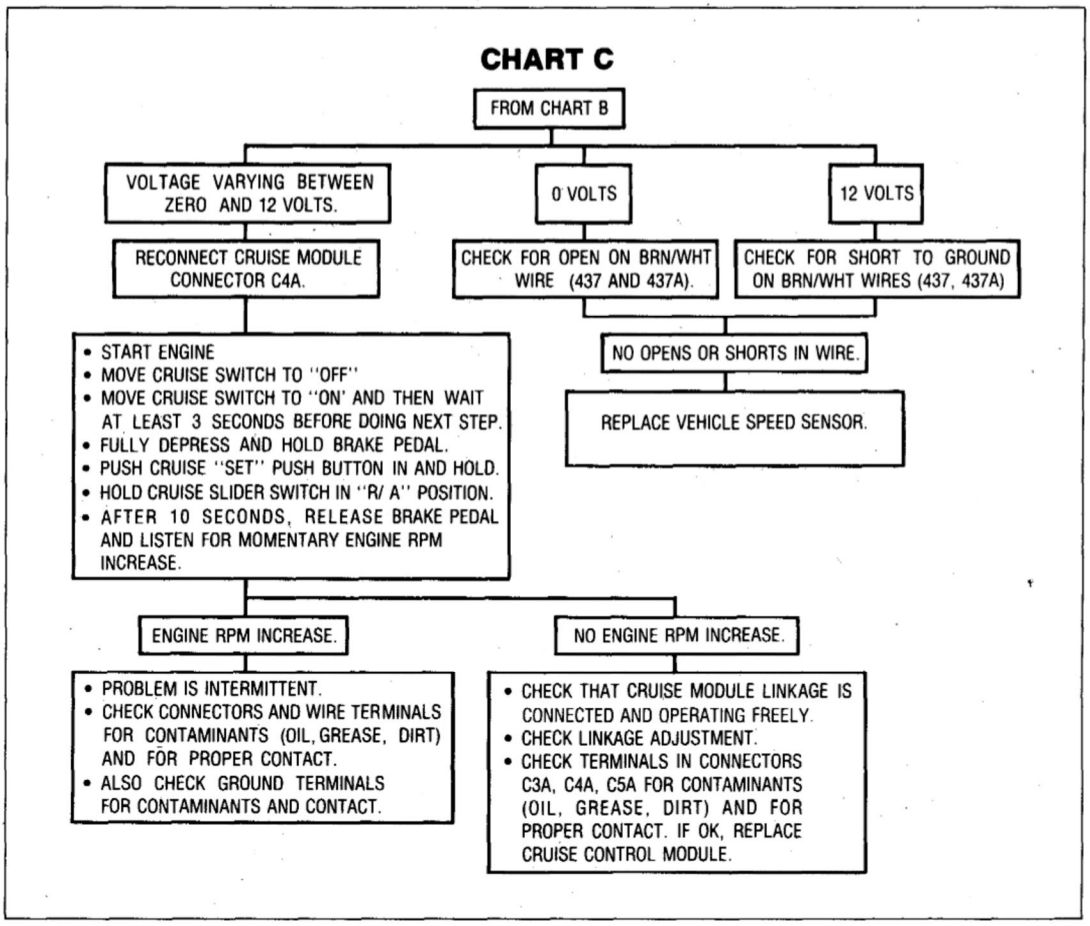


Figure A7-16-5 — Diagnosis of the Cruise Control System - Chart C

Additional information and diagnostics can be found in the C-K Pickup Shop Manual for the EMCS cruise control.

ENGINE EMISSION CONTROLS

VEHICLE EMISSION CONTROL INFORMATION LABEL

The Vehicle Emission Control Information Label (Figure 7-56) is located in the engine compartment (fan shroud, radiator support, hood underside, air cleaner, etc.) of every vehicle produced by General Motors Corporation. The label contains important emission specifications and setting procedures, as well as a vacuum hose schematic with emission components identified.

When servicing the engine or emission system, the Vehicle Emission Control Information Label should be checked for up-to-date information.

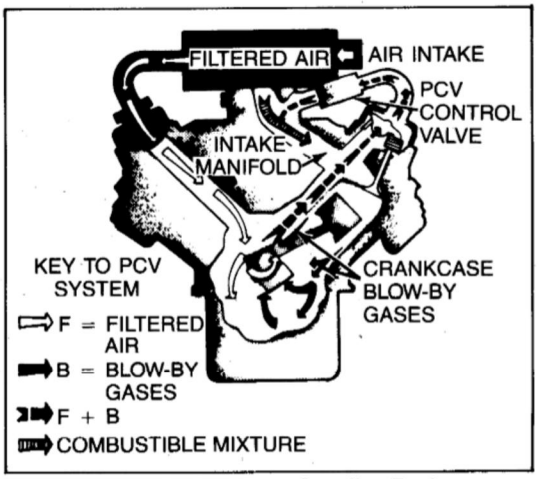


Figure 7-57 — PCV System — Gasoline Engine — Typical

EMISSION CONTROLS — SYSTEMS AND COMPONENTS

GENERAL DESCRIPTION

POSITIVE CRANKCASE VENTILATION (PCV) SYSTEM — GASOLINE ENGINE

Because small amounts of combustion gases seep past the piston rings, all engines have a closed Positive Crankcase Ventilation System to provide more complete scavenging of crankcase vapors (Figure 7-57).

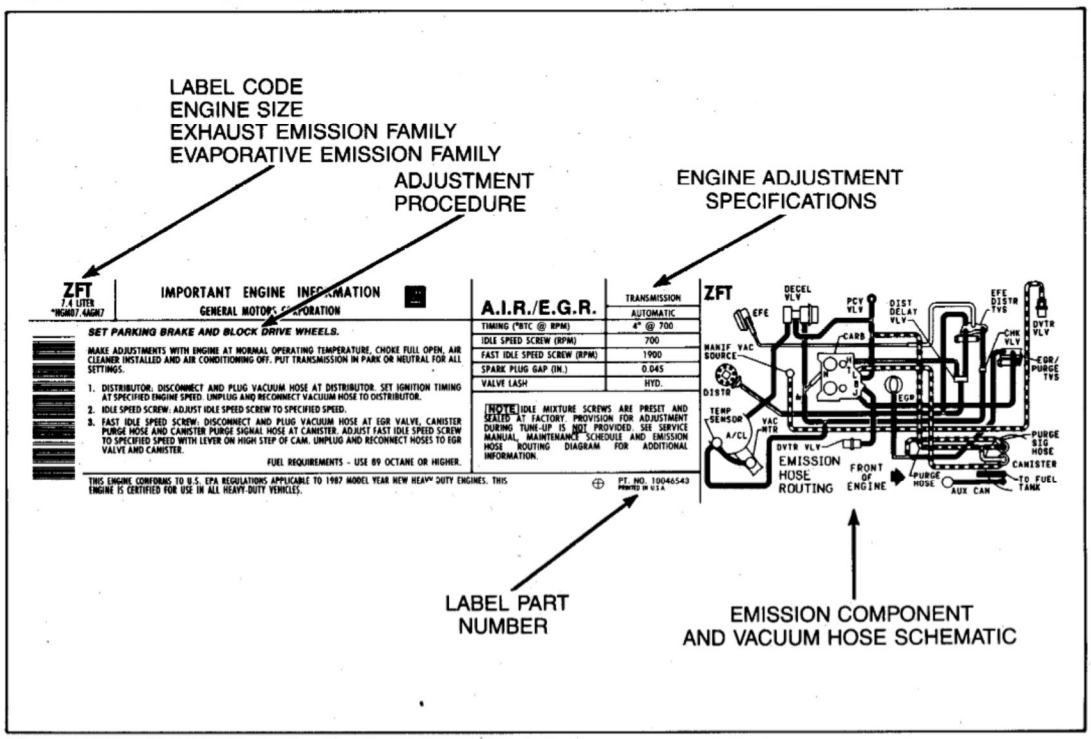


Figure 7-56 — Vehicle Emission Control Information Label

Ventilation air is drawn through a separate filter from the "dirty air" side of the air cleaner, through a hose down into the crankcase, up through the ventilator valve, through another hose and into the intake manifold. The intake manifold vacuum draws any fumes from the crankcase to be burned in the engine.

Periodically check for oil deposits in the air cleaner. The system has been designed as a closed system. If there are oil deposits on the air cleaner element or a puddle of oil found at the bottom of the air cleaner base, check the entire system for oil leaks. A leak in the system will allow reverse air flow from pulldown with the carburetor air flow drawing oil fumes out of the right-hand rocker cover into the air cleaner. Potential leak points include an incorrect oil fill cap, a leak at the dipstick or rocker cover. (See Figure 7-58.)

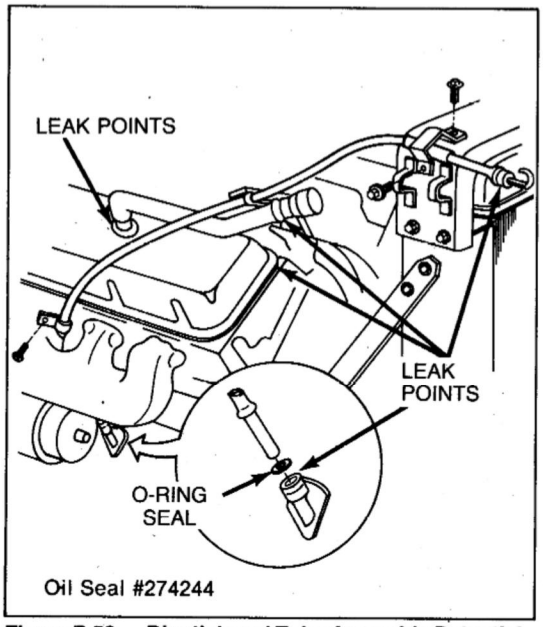


Figure 7-58 — Dipstick and Tube Assembly Potential Leak Points

CRANKCASE VENTILATION — DIESEL ENGINE

A Crankcase Depression Regulator Valve is used to regulate (meter) the flow of crankcase gases back into the engine. The Crankcase Depression Regulator Valve (CDRV) is designed to limit vacuum in the crankcase as the gases are drawn from the valve cover through the CDRV and into the intake manifold (air crossover).

Fresh air enters the engine through the combination filter, check valve and oil fill cap. The fresh air mixes with blow-by gases and enters the right cover. The gases pass through a filter on the valve cover and are drawn into the connecting tubing.

The intake manifold vacuum acts against a spring-loaded diaphragm to control the flow of crankcase gases.

Higher intake vacuum levels pull the diaphragm closer to the top of the outlet tube. This reduces the amount of gases being drawn from the crankcase and decreases the vacuum level in the crankcase. As the intake vacuum decreases, the spring pushes the diaphragm away from the top of the outlet tube, allowing more gases to flow to the intake manifold.

EARLY FUEL EVAPORATION (EFE) SYSTEM — GASOLINE ENGINE

The EFE system is used to provide a source of rapid heat to the engine induction system during cold driveaway. Rapid heating is desirable because it provides for quick fuel evaporation and more uniform fuel distribution to aid cold drivability. It also reduces the length of time carburetor choking is required, making reductions in exhaust emission levels possible.

EFE systems may use a valve which increases the exhaust gas flow under the intake manifold during cold engine operation. The valve is vacuum-operated and is controlled by a thermal vacuum switch (TVS) which applies vacuum when the coolant temperature is below the calibration valve.

THERMOSTATIC AIR CLEANER (THERMAC) — GASOLINE ENGINE

The Thermostatic Air Cleaner (THERMAC), shown in Figure 7-59, uses a damper door in the air cleaner inlet, controlled by a vacuum diaphragm motor to mix preheated and nonpreheated air entering the air cleaner to maintain a controlled air temperature into the carburetor. The vacuum motor is modulated by a temperature sensor in the air cleaner. The preheating of the air cleaner inlet air allows leaner carburetor and choke calibrations resulting in lower emission levels, while maintaining good drivability.

The preheated air is obtained by drawing inlet air through a stove attached to the exhaust manifold.

On vehicles which have been converted to burn LPG- or CNG-type fuel, by the motor home body manufacturer, the GM air cleaner and Thermac system may have been removed. This can result in a cold engine stumble especially at cold temperatures, when operating on gasoline as opposed to LPG- or CNG-type fuels.

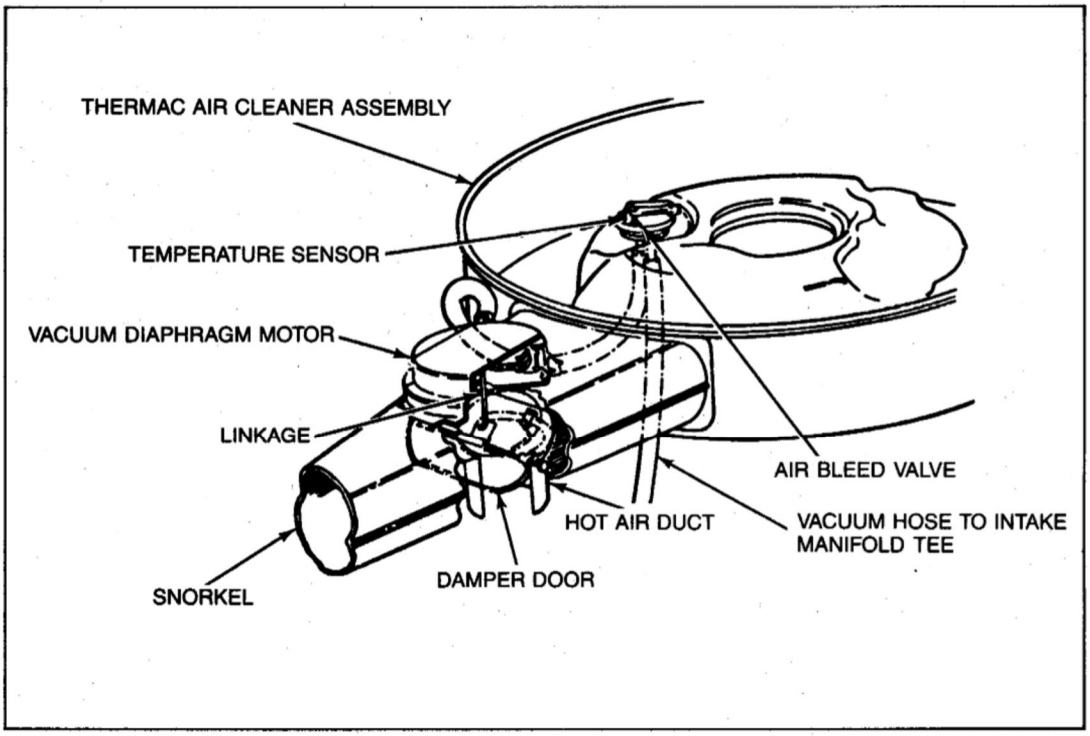
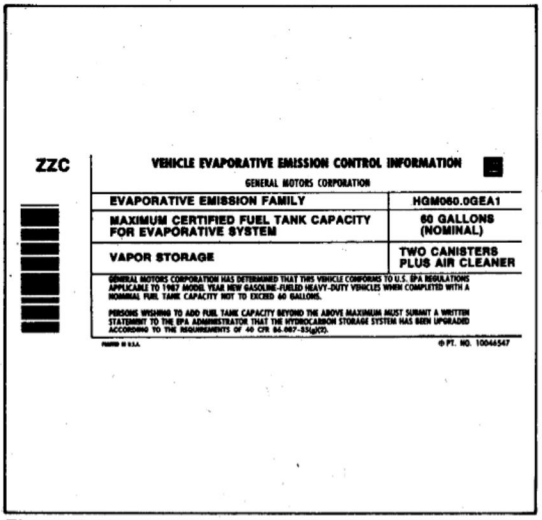


Figure 7-59 — Thermac Air Cleaner — Typical


ZZC

VEHICLE EVAPORATIVE EMISSION CONTROL INFORMATION

GENERAL MOTORS CORPORATION

EVAPORATIVE EMISSION FAMILY	HGM060.0GEA1
MAXIMUM CERTIFIED FUEL TANK CAPACITY FOR EVAPORATIVE SYSTEM	60 GALLONS (NOMINAL)
VAPOR STORAGE	TWO CANISTERS PLUS AIR CLEANER

GENERAL MOTORS CORPORATION HAS DETERMINED THAT THIS VEHICLE CONFORMS TO U.S. EPA REGULATIONS APPLICABLE TO 1987 MODEL YEAR NEW GASOLINE-FUELED HEAVY-DUTY VEHICLES WHEN COMPLETED WITH A NOMINAL FUEL TANK CAPACITY NOT TO EXCEED 60 GALLONS.

PERSONS BUILDING TO ADD FUEL TANK CAPACITY BEYOND THE ABOVE MAXIMUM MUST SUBMIT A WRITTEN STATEMENT TO THE EPA ADMINISTRATOR THAT THE HYDROCARBON STORAGE SYSTEM HAS BEEN UPWARDED ACCORDING TO THE REQUIREMENTS OF 40 CFR 86.087-53(g)(2).

PRINTED IN U.S.A. PT. NO. 10046547

Figure 7-60 — Vehicle Evaporative Emission Control Information Label

EVAPORATIVE EMISSION CONTROL SYSTEM (EECS)

GENERAL DESCRIPTION

The Vehicle Evaporative Emission Control Information label (Figure 7-60) contains the government regulations for the evaporative emission control system, vapor storage requirements and fuel tank capacity for the evaporative system.

The Evaporative Emission Control System (EECS) shown in Figure 7-61 limits the amount of fuel vapor into the atmosphere. The system traps fuel vapor from the fuel tank and carburetor float bowl into a fuel vapor canister. The fuel tank has a non-vented fuel cap and a single vent pipe to the canister. The canister absorbs and stores the fuel vapor in a carbon element until it can be removed and burned during the normal combustion process. When the engine is running, a thermostatic vacuum switch determines when the fuel vapor is purged into the intake air flow.

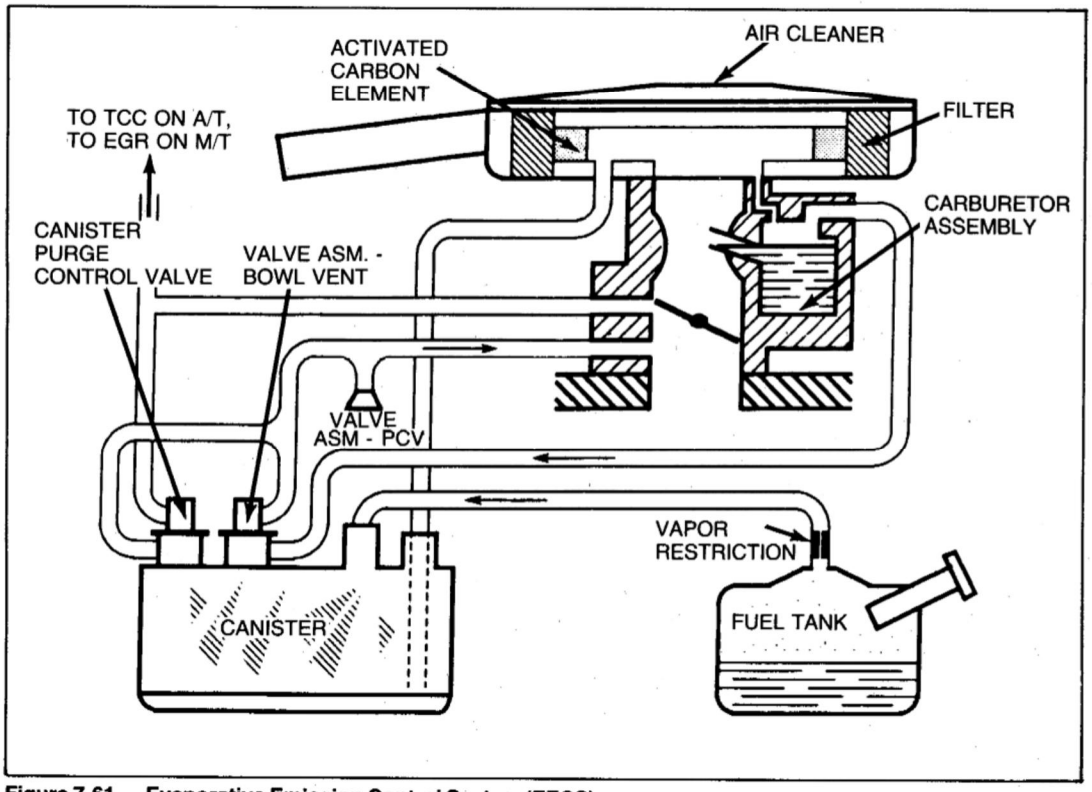


Figure 7-61 — Evaporative Emission Control System (EECS)

The Evaporative Emission Control System uses the following control valves:

- Purge control valve mounted on the canister.
- Vapor vent valve mounted on the canister.
- A thermal bowl vent valve (some applications).
- A thermostatic vacuum switch (TVS) installed in the intake manifold to sense engine coolant temperature.

When the engine is shut off, manifold vacuum is lost at the vapor vent valve. The spring-loaded valve in the vapor vent valve now connects the carburetor bowl vent to the canister. Carburetor float chamber vapors now pass into the canister for storage. When the engine is restarted, manifold vacuum draws the vapor vent controlling valve against spring pressure, closing off the bowl vent. Ported vacuum from the carburetor is connected to the TVS. When the TVS opens, ported vacuum opens the purge control valve. When the valve opens, manifold vacuum draws vapors from the canister into the intake manifold.

The thermal bowl vent valve (TBVV) is located in the section of hose that connects the carburetor bowl vent fitting to the canister control valve.

The TBVV will close and prevent vapor movement at 32°C (90°F) and below. The TBVV will open at 49°C (120°F) to permit vapor flow to the canister control valve.

FUEL VAPOR CANISTER — PRIMARY

The basic large-size, two-chamber, closed bottom primary fuel vapor canister is shown in Figure 7-62. This canister is used on all systems.

Gasoline vapors from the fuel tank flow into the tube labeled "FUEL TANK," and vapors from the carburetor float bowl flow into the tube labeled "CARB BOWL," and are absorbed by the carbon. The canister is purged when the engine is running above idle speed. The closed bottom design keeps water from entering the bottom of the canister, freezing, and restricting purge air flow. During purge, air is drawn from the clean side of the air cleaner, to the

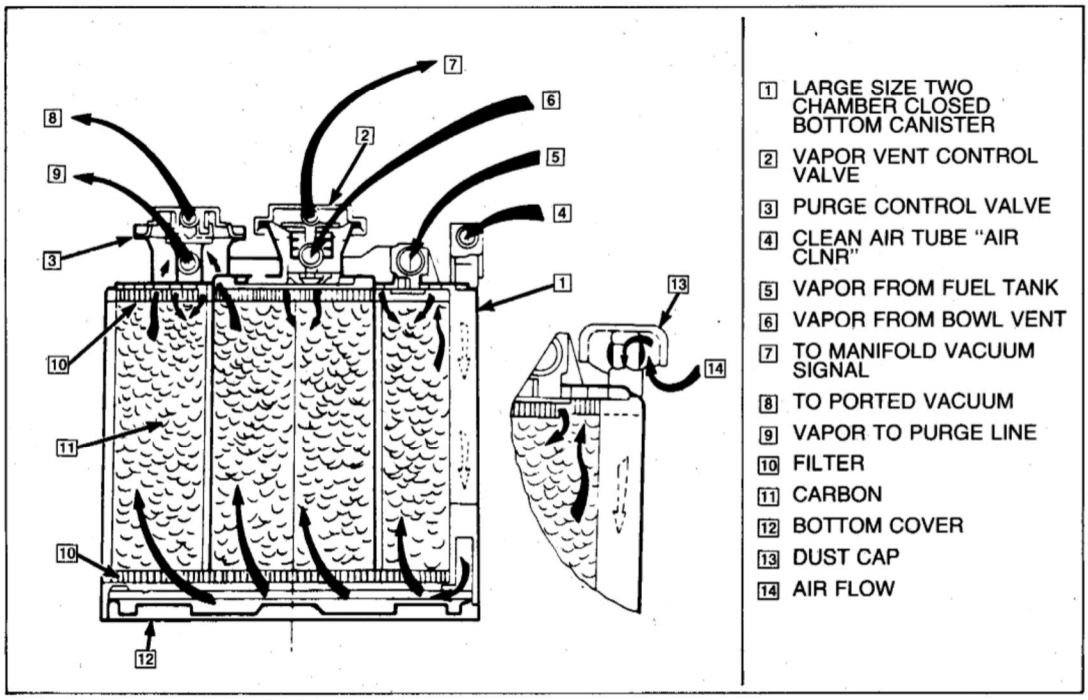


Figure 7-62 — Fuel Vapor Canister — Primary

tube on the canister labeled "AIR CLNR," through the carbon and into the intake manifold to be burned. Some closed bottom canisters draw purge air directly from the atmosphere.

Canister Purge Control Valve

The canister purge control valve shown in Figure 7-62 is a spring-biased diaphragm valve, normally closed, which allows or prevents purging of the canister. When the engine is off or idling, the spring holds the valve closed preventing canister purge. When the engine is off idle, however, timed manifold vacuum pulls the diaphragm upward and opens the valve allowing the canister to be purged.

Vapor Vent Control Valve

The vapor vent control valve shown in Figure 7-62 prevents venting of the carburetor float bowl during engine operation. A spring-biased diaphragm valve, normally open, allows (or prevents) fuel vapors from the float bowl to enter the canister. When the engine is off, spring tension holds the valve open, allowing normal venting.

When the engine is turned on, however, manifold vacuum pulls the diaphragm up to the valve.

FUEL VAPOR CANISTER — AUXILIARY

An Auxiliary Fuel Vapor Canister shown in Figure 7-63 is added to a primary closed bottom canister to increase capacity when a dual (auxiliary) fuel tank is used. On the bottom is a hose which connects to the primary canister's purge air inlet. On top is a purge air inlet. Vapor overflowing from the primary canister is stored in the auxiliary canister. During purge, vapor flows through the auxiliary canister, the primary canister and into the intake manifold for burning during combustion.

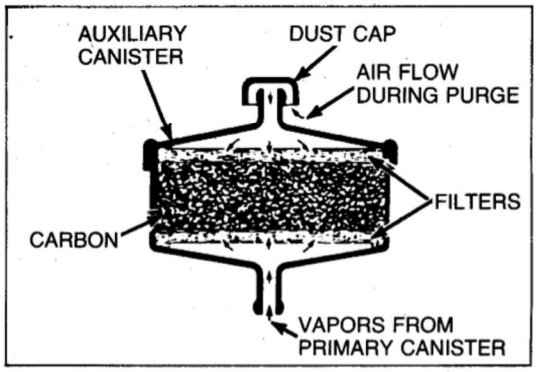


Figure 7-63 — Fuel Vapor Canister — Auxiliary

MAINTENANCE AND INSPECTION

POSITIVE CRANKCASE VENTILATION (PCV) — GASOLINE ENGINE

An engine which is operated without any crankcase ventilation can be damaged seriously. Therefore, it is important to replace the PCV valve (GM Part No. 6487779; AC CV774C or equivalent — 5.7L and Mark IV engines) at the recommended intervals.

If an engine is idling too slowly or roughly, this may be caused by a clogged ventilator valve or plugged hose; therefore, never adjust the carburetor idle without first checking the PCV valve and hose.

With this system any blow by in excess of the system capacity (from a badly worn engine, sustained heavy load, etc.) is exhausted into the air cleaner and is drawn into the engine.

Proper operation of the PCV System is dependent on a sealed engine. If oil sludging or dilution is noted, and the PCV System is functioning properly, check engine for possible cause and correct to ensure that the system will function as intended.

Checking the PCV System

1. Remove PCV valve from intake manifold or rocker arm shaft cover.
2. Run the engine at idle.
3. Place your thumb over end of valve to check for vacuum. If there is no vacuum at valve, check for plugged hoses or valve. Replace plugged and/or deteriorated hoses.
4. Shut off engine and remove PCV valve. Shake valve and listen for the rattle of check needle inside the valve. If valve does not rattle, replace valve (Figure 7-64). Remove PCV valve from rubber hose and look up the end of the hose using a flashlight. If the hose appears coated "oil wet," replace the PCV valve.
5. After installing a new PCV valve, readjust engine idle if necessary.

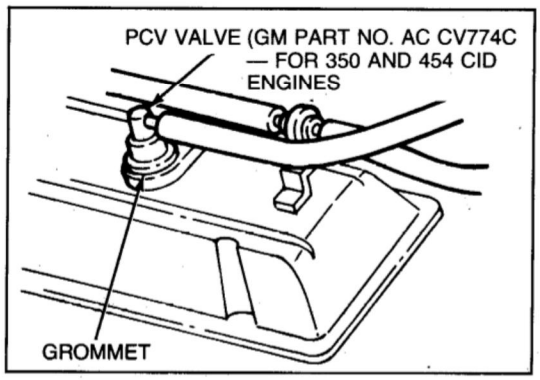


Figure 7-64 — PCV Valve

EARLY FUEL EVAPORATION (EFE)

Inspection

- Visually inspect the exhaust heat valve (Figure 7-65) for damage or binding linkage.
- Check that the linkage is connected and the vacuum hoses are properly routed and connected.
- Move exhaust heat valve by hand. If binding or stuck, free it with manifold heat valve lubricant, GM Part No. 10504022 or equivalent. If the valve cannot be freed, replace the valve.

Checking EFE System

1. With the engine cold, position the transmission in neutral or park and apply parking brake.
2. Start the engine and observe movement of the actuator rod and exhaust heat valve. Valve should move to its closed position.
3. If the valve does not close, disconnect the hose at the actuator and check for vacuum.
   - If there is vacuum, replace the actuator.
   - If there is no vacuum, disconnect the hose at the TVS to vacuum source.
   - If there is vacuum at the hose, replace the TVS.
   - If there is no vacuum, check for deteriorated hose and vacuum source to determine the lack of vacuum.
4. When the coolant reaches 180°F, the exhaust heat valve should move to its open position.
5. If the valve does not move, disconnect the hose at the actuator and check for vacuum.
   - If there is vacuum, replace the TVS.
   - If there is no vacuum, replace the actuator.

AIR INJECTION REACTOR (A.I.R.) SYSTEM — GASOLINE ENGINE

The Air Injection Reactor (A.I.R.) System (Figure 7-66) consists of: an air injection pump (with necessary brackets and drive attachments), an air diverter valve, a check valve, and an air pipe assembly for each exhaust manifold, and connection hoses.

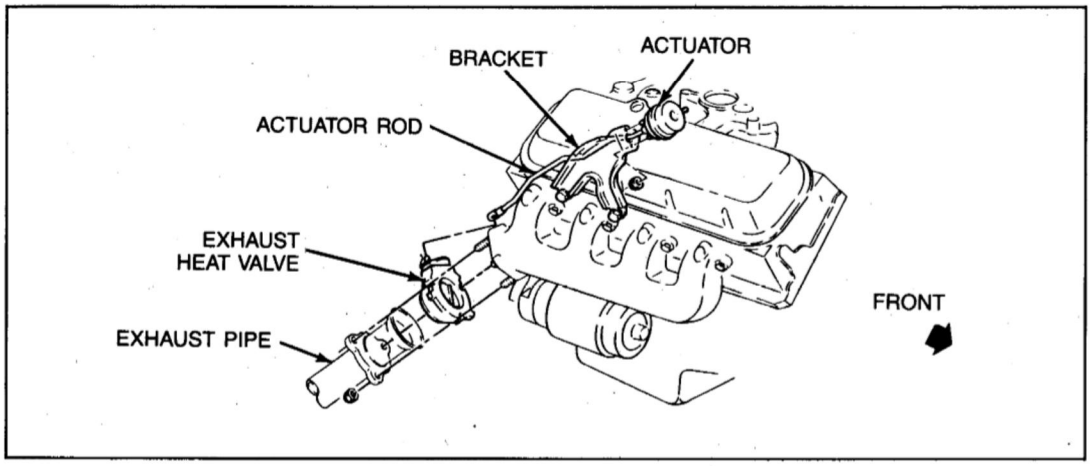


Figure 7-65 — Exhaust Heat Valve — EFE System

Inspection

Accelerate the engine to approximately 1,500 RPM and observe air flow from the hose(s). If the air flow increases as the engine is accelerated, the pump is operating satisfactorily. If the air flow does not increase or is not present, proceed as follows:

1. Check for proper drive belt tension. The A.I.R. system is not completely noiseless. Under normal conditions, noise rises in pitch as engine speed increases.

To determine if excessive noise is the fault of the system, operate the engine with the pump drive belt removed. If excessive noise does not exist with the belt removed, proceed as follows:

2. Check for a seized air injection pump. Do not oil the pump.

3. Check hoses, pipes and all connections for leaks and proper routing.

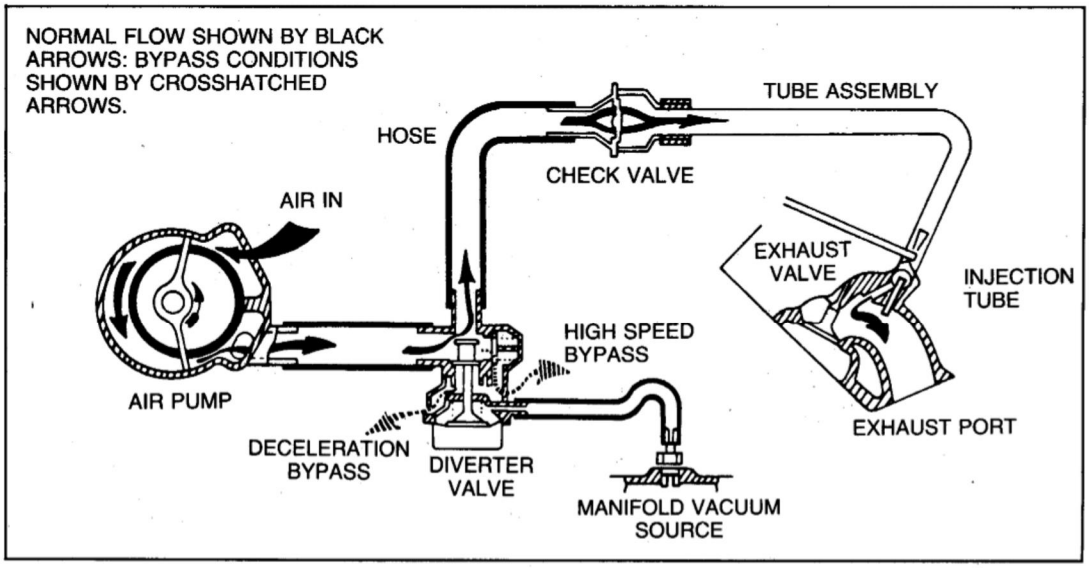


Figure 7-66 — Air System — Typical

4. Check diverter valve attaching screws for tightness.
5. Check injection pump for proper mounting and bolt torque.
6. Repair irregularities in these components as necessary.
7. If no irregularities exist and the air injection pump noise is still excessive, remove and replace the pump.

Air Pump Drive Belt Adjustment and Replacement

1. Inspect drive belt for wear, cracks and deterioration.
2. Loosen the alternator adjustment bolt.
3. Replace the belt if required.
4. Move the alternator or pump until the drive belt is at the proper tension, then retighten bolts. See Appendix A — Drive Belts and Tension Specifications at the back of this manual for specifications.
5. Check the belt tension using a belt tension gage.

CHECK VALVE INSPECTION

1. The check valve should be inspected whenever the hose is disconnected from the check valve or whenever check valve failure is suspected. (A pump that had become inoperative and had shown indications of containing exhaust gases in the pump would indicate check valve failure.)
2. Blow through the check valve (toward the cylinder head) then attempt to suck back through check valve. Flow should only be in one direction (toward the exhaust manifold). Replace valve which does not function in this manner.

THERMOSTATIC AIR CLEANER

Checking Thermac Air Cleaner

1. Inspect the system to be sure all hoses and tubes are connected. Check for kinked, plugged or deteriorated hoses.
2. If the engine is warm or above 80°F, remove the air cleaner. Allow it to cool to room temperature, below 80°F. Place a cool wet rag on the temperature sensor to aid in cooling.
3. Install the cooled air cleaner with cold air intake disconnected from snorkel (if equipped).
4. Observe the damper door before starting the engine. It should be in the open snorkel position (hot air duct covered.)
5. Start the engine. Watch the damper door in the air cleaner snorkel. When the engine is first started, the damper door should close. As the air cleaner warms up, the damper door should open slowly.
6. If the damper door does not close when the engine is started, remove the air cleaner.
7. Apply at least 7 in. of vacuum to the vacuum diaphragm motor through the hose disconnected at the temperature sensor. The damper door should completely block off the snorkel passage when vacuum is applied. If not, check to see if the linkage is hooked up correctly.
8. With the vacuum still applied, trap vacuum in the vacuum diaphragm motor by bending the hose. The damper door should remain closed; if not, replace the vacuum diaphragm motor assembly. (Failure of the vacuum diaphragm motor assembly is more likely to be caused by binding linkage or a corroded snorkel than by a failed diaphragm. This should be checked first, before replacing the diaphragm.)
9. Reinstall the air cleaner. As the engine warms up, the damper door should start to allow outside air and heated air to enter the carburetor.
10. If the air cleaner fails to operate as described above or if the correct operation of the air cleaner is still in doubt, perform a thermometer check of sensor.

Thermometer Check of Sensor

1. Start the test with the air cleaner temperature below 80°F. If the engine has been run recently, remove the air cleaner and place the thermometer as close as possible to the sensor. Let the air cleaner cool until the thermometer reads below 79°F, about 5 to 10 minutes. Reinstall the air cleaner on the engine and continue to Step 2 below.
2. Start and idle engine. The damper door should move to close the snorkel passage immediately if the engine is cool enough. When the damper door starts to open the snorkel passage (in a few minutes), remove the air cleaner cover and read the thermometer. It must read between 100°F and 130°F.
3. If the damper door does not start to open up the snorkel passage at the temperature indicated, the temperature sensor is malfunctioning and must be replaced.

Air Cleaner Element and PCV Filter Replacement

PAPER ELEMENT —

1. Remove the air cleaner cover.
2. Remove the air cleaner element and PCV filter.
3. Install a new element and PCV filter in the air cleaner.

4. Reinstall the air cleaner cover. Do not overtighten wing nut.

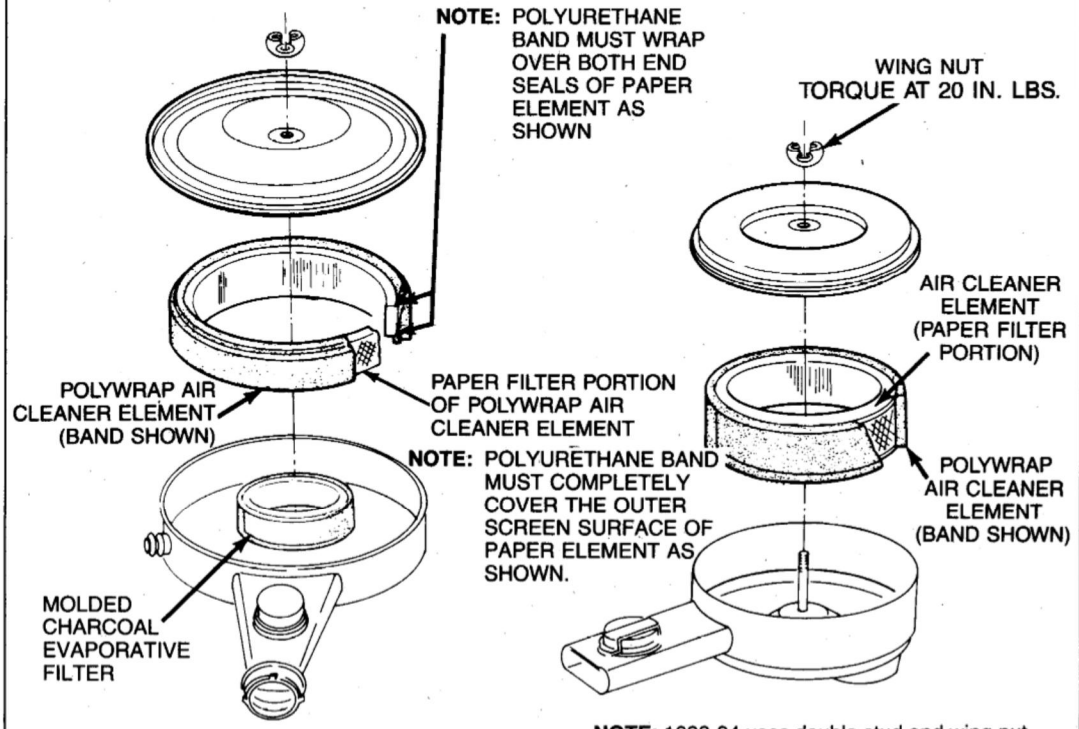
POLYWRAP ELEMENT (P-SERIES) —

1. Remove the air cleaner cover.
2. Remove the element.
3. Remove the polywrap band from the paper element and discard the element (Figure 7-67).
4. Clean the bottom section of the air cleaner and inspect the cover seal for tears or cracks. Replace the seal if damaged.
5. Inspect the band for tears and replace if damaged.
6. If the band is serviceable, wash it in kerosene or mineral spirits and squeeze out the excess solvent.

NOTE: Never use a hot degreaser or any solvent containing acetone or similar solvent; also, never shake, swing or wring the element to remove excess solvent as this may tear the polyurethane material. Instead, "squeeze" the excess solvent from the element. Squeezing will avoid damaging the element material.

7. Dip the band into light engine oil and squeeze out the excess oil.
8. Install the band around the outer surface of the new paper element.
9. Install the element in the bottom section of the air cleaner with either end up.
10. Install the air cleaner cover. Do not over-torque the wing nut(s).

NOTE: Some models and years do not use the Polywrap Air Cleaner System. Some models and years are equipped with a molded charcoal evaporative filter that is permanently attached to the air cleaner base. DO NOT ATTEMPT TO REMOVE OR SERVICE THIS FILTER. The function of this filter is to collect fuel vapors on engine shutdown. This filter "self-purges" as the engine is running. (See Figure 7-61).



NOTE: 1993-94 uses double stud and wing nut.

Figure 7-67 — Polywrap Air Cleaner

H5D EMISSION SYSTEM

On vehicles equipped with the H5D emission system (vehicles rated over 8,600 GVW and built after January 1, 1985), the "CHECK ENGINE" light may light up to inform the motor home owner of a possible problem while a problem does not actually exist. The following diagnostic procedure should be followed in correcting this condition.

NOTE: The "CHECK ENGINE" light will normally come on when the ignition is turned to the "ON" position and the engine is **NOT** running. This is provided as a bulb check.

The illumination of the "CHECK ENGINE" light indicates that there is a malfunction in the A.I.R. solenoid control module or wiring. (See Figure A7-17-1.) Perform the following corrective procedure:

1. Check the A.I.R. solenoid and A.I.R. moduled connectors for a proper connection.

2. With ignition on, disconnect each solenoid connector and with a test light, check for a light across the terminals. (See Figure A7-17-2.)

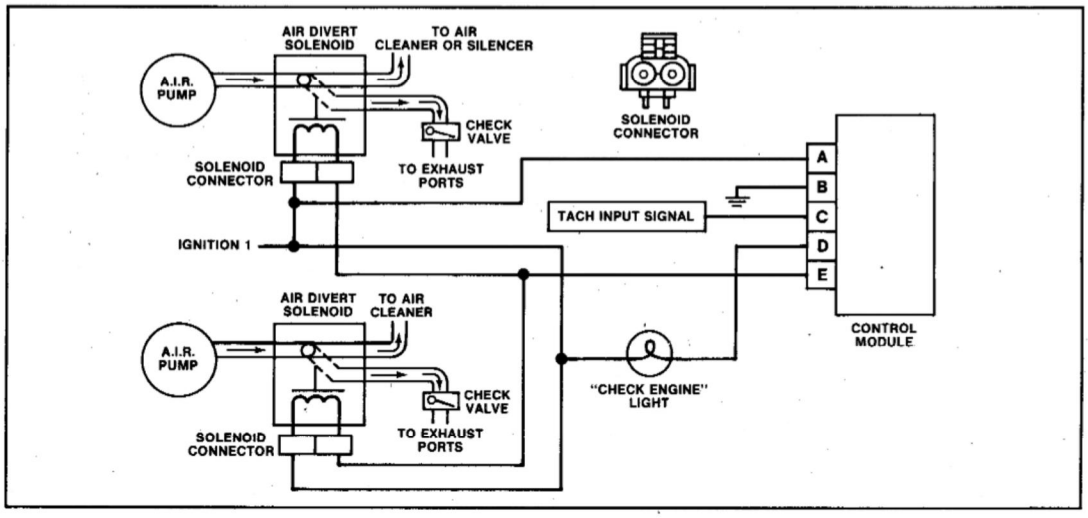


Figure A7-17-1 — A.I.R. Connector Diagram

H5D EMISSION SYSTEM (Cont'd)

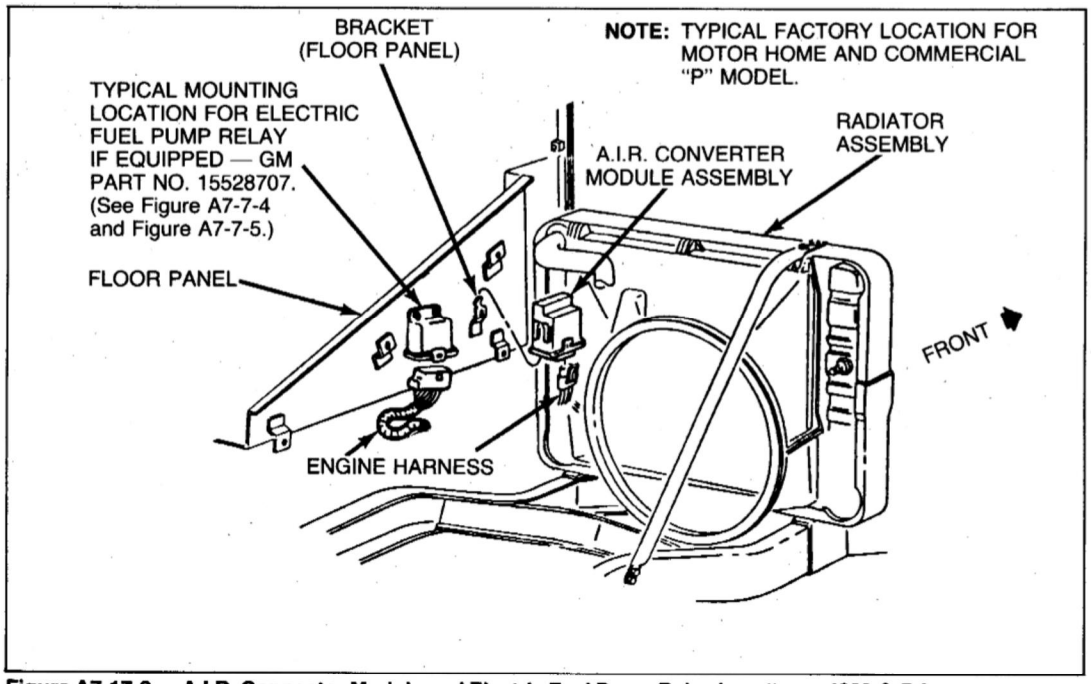


Figure A7-17-2 — A.I.R. Connector Module and Electric Fuel Pump Relay Locations 1989 & Prior

3. If O.K. (light on), check solenoid coil resistance and if less than 20 ohms, replace the solenoid and valve.
4. If not O.K. (light off), connect the solenoid connector(s) and disconnect connector at module. With a test light, check for a light between terminal "A" and "B."
5. If not O.K. (light off), check for an open circuit to the module.
6. If O.K. (light on), replace the module. (See parts listing in Figure A7-17-4.)

H5D EMISSION SYSTEM (Cont'd)

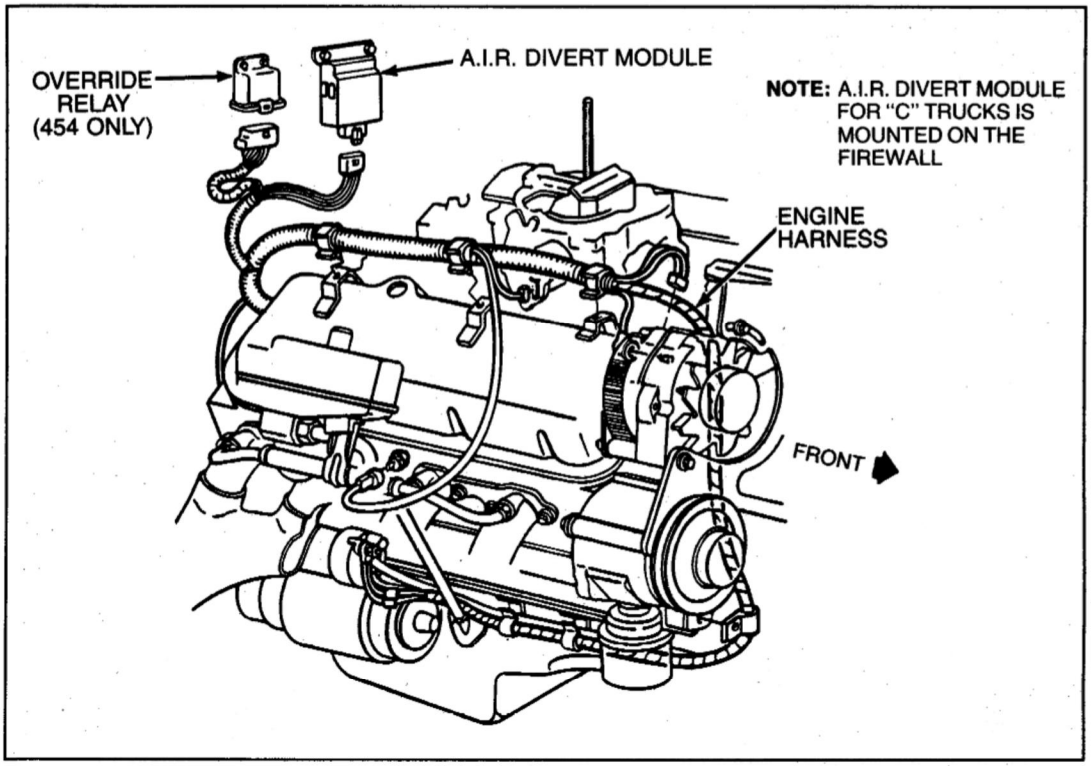


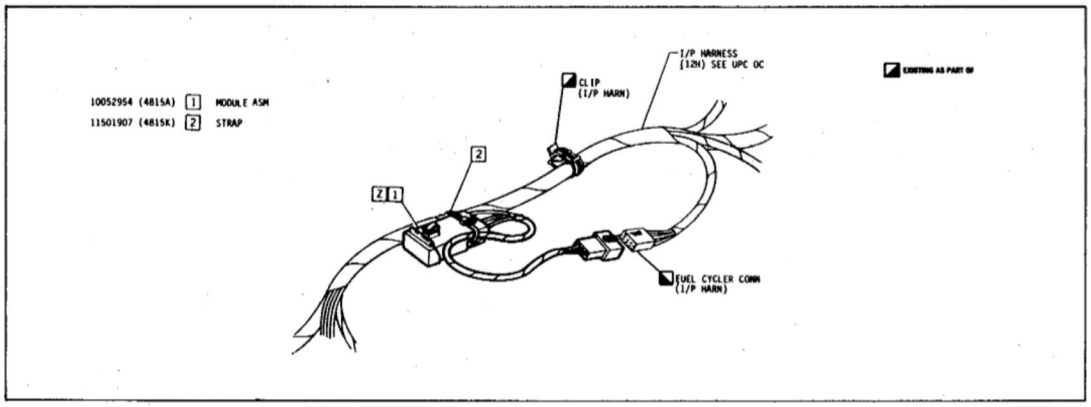
Figure A7-17-3 — H5D Override Relay

NOTE: 1985-1990 models equipped with the LE8 (454) and H5D have an override relay. (See Figure A7-17-3). This relay is necessary dur to the lower cranking speed of the LE8 (454) engine. If the relay fails, the CEL will come on. If it becomes necessary to replace the relay or the module, use the part numbers listed in Figure A7-17-4.

GM PART NO.	DESCRIPTION & APPLICATIONS				QUALITY
100669221	Module	1985-89	W/LE8	454	1
14087500	Module	1985	W/LT9	350	1
14102010	Module	1986	W/LT9	350	1
14100876	Module	1985-Current	W/L25	292	1
15528707	Relay	1985-89	W/LE8	454	1
14103304	Relay	1990-1993	N/L19	454	1
10052973	Module	1990-1993	N/L19	454	1
10052954	Module	1994	N/L19	454	1

Figure A7-17-4 — 454 and H5D Override Relay Parts List

H5D EMISSION SYSTEM (Cont'd)



The 1990 fuel module Part #10052973 is connected to the instrument panel wiring harness. The module and instrument panel wiring harness are shipped loose and must be installed by the body builder. This fuel cycler override module is necessary due to the lower cranking speed of the L19 (454) engine. The module overrides the ECM for 20 seconds to provide fuel pressure to the injector.

H5D EMISSION SYSTEM (Cont'd)

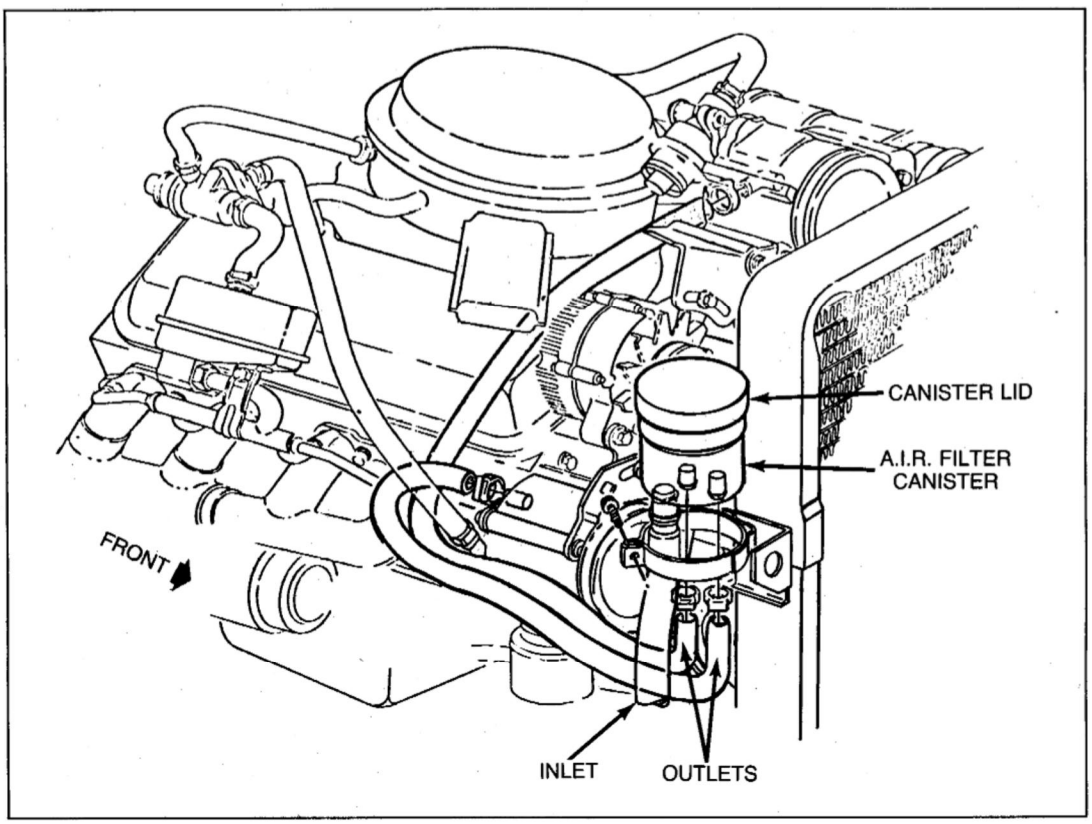


Figure A7-17-5 — A.I.R. Pump Failure — 1985 1/2 thru 1989 454 H5D Emissions

Due to the relocation of the A.I.R. Pump Filter Canister to the right front wheel well by the body builder, the canister must be sealed or shielded to prevent water, salt and dirt thrown by the tire to enter the A.I.R System through the hose connections at the bottom of the canister and/or through the lid at the top of the canister. See Figure A7-17-5. The air inlet hose must also be located away from direct water spray and sealed where it is attached to the core support.

Sealing the canister can be accomplished by applying a bead of Permatex No. 2 Sealer, or equivalent, to the canister hoses and lid.

1. Loosen inlet and outlet hose clamps and remove hoses from A.I.R. Filter Canister. Clean hose connections.
2. Remove and clean canister lid.
3. Apply a bead of Permatex No. 2 Sealer, or equivalent, to the canister inlet and outlet hose connections and inside circumfrence of the canister lid. Reinstall lid and hoses.
4. Tighten hose clamps securely.

NOTE: Production mounting of the A.I.R. Filter Canister is in the vertical position (canister lid facing up). An alternative method of eliminating water contamination would be to remount the canister horizontally (lid facing the right side of the vehicle), and rotate the canister in the clamp so that the two air outlets are positioned in the 11 o'clock and the 1 o'clock positions. (See Figure A7-17.5.) Positioning the canister in this manner eliminates the need to seal the canister or hoses as described above.

TRANSMISSION

GENERAL DESCRIPTION

The transmission (Figure 8-1) is mounted behind the engine. Its function is to convert the power output of the engine into usable power for the drive wheels of the motor home. By activating different gears within the transmission, the speed at which the output shaft of the transmission turns in relation to the speed of the engine crankshaft can be changed to meet the different driving load conditions.

NOTE: The 350C transmission has been replaced in production with the 400 Series transmission, effective 1986 on G-Series vehicles.

MODELS 350C AND 400-475 SERIES

Chevrolet motor homes are equipped with one of two different automatic transmissions, the 350C (G-Series) and the 400-475 (P-Series). Both are fully automatic units which use a three-element hydraulic torque converter.

The 350 automatic transmission, in addition to the torque converter, uses two planetary gear sets. Four multiple-disc clutches, two roller clutches, and an intermediate overrun provide the friction elements required to obtain the desired function of the two planetary gear sets.

The 400-475 automatic transmission uses a compound planetary gear set along with the torque converter. Three multiple-disc clutches, one gear unit, one roller clutch, and two bands provide the friction elements required to obtain the desired function of the compound planetary gear set.

The three-element torque converter consists of a pump or driving member, a turbine or driven member, and a stator assembly. It is filled with fluid and is attached to the engine crankshaft at the flywheel (or flexplate). The torque converter, which always rotates at engine speed, couples the engine to the planetary gears through the fluid and provides hydraulic torque multiplication when required.

Automatic transmissions replace the standard clutch and transmission. After starting the engine with the selector lever in "P" (Park) or "N" (Neutral) position, select the range desired and press the accelerator. All automatic transmissions are equipped with a starter safety switch designed to permit starting the engine only when the transmission selector is in the "P" or "N" position. For additional engine braking effect, as is sometimes needed in mountainous driving, place the transmission in a low range (LOW 1 or LOW 2).

LOW 2 — This range is used when extra performance is required for hill climbing or it can also be used to provide "engine braking" to slow the vehicle when going down medium grades. The shift lever may be moved from "D" to "2" (and vice versa) under most driving conditions.

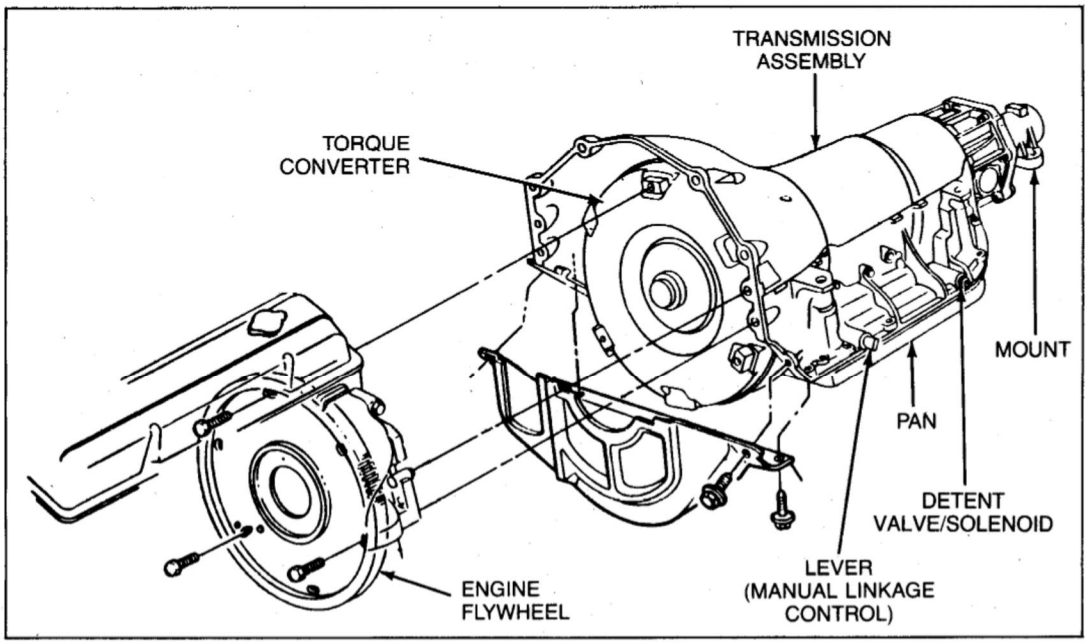


Figure 8-1 — Automatic Transmission — Typical

LOW 1 — This position is used to provide maximum engine braking when driving down very sharp grades or when maximum performance is required to climb a steep hill or run through deep snow or mud. You may shift into "1" at any speed but the transmission will not go into LOW until vehicle speed is under approximately 40 MPH.

CAUTION: TO REDUCE THE RISK OF PERSONAL INJURY, BEFORE GOING DOWN A STEEP OR LONG GRADE REDUCE SPEED AND SHIFT THE TRANSMISSION TO A LOWER GEAR. DO NOT HOLD THE BRAKE PEDAL DOWN TOO LONG OR TOO OFTEN WHILE GOING DOWNHILL. THIS COULD CAUSE THE BRAKES TO GET HOT AND NOT WORK AS WELL. AS A RESULT, THE VEHICLE WILL NOT SLOW DOWN AT THE USUAL RATE. FAILURE TO TAKE THESE STEPS COULD RESULT IN LOSS OF VEHICLE CONTROL.

TORQUE CONVERTER CLUTCH

A torque converter clutch assembly is also used on some models. The converter clutch is splined to the turbine assembly, and when operated, applies against the converter cover providing a mechanical direct drive coupling of the engine to the planetary gears. Converter clutch operation is determined by a series of controls and by drive range selection. The transmission must be in drive range, and the vehicle must have obtained a preset speed depending on the engine and transmission combination.

Aside from the torque converter, the hydraulic system within the transmission is pressurized by a gear-type pump and provides the working pressure required to operate the friction elements and automatic controls.

CONTROLS

For proper operation of the transmission, certain controls from outside of the transmission are required. These include:

1. Manual Linkage — To select the desired operating range.
2. Engine Vacuum — To operate the vacuum modulator.
3. Downshift Control —
   - Cable to operate the detent valve (350C).
   - Electrical circuit to operate the detent solenoid (400-475 Series).

MANUAL LINKAGE

The manual linkage is connected between the selector lever on the steering column, and the transmission. It is through this linkage that the vehicle driver can control the transmission operating range.

VACUUM MODULATOR SYSTEM

A vacuum modulator is used to automatically sense any change in torque input to the transmission. The vacuum modulator transmits this signal to the pressure regulator, which controls line pressure, so that all torque requirements of the transmission are met and smooth shifts are obtained at all throttle openings.

DOWNSHIFT (DETENT) CABLE SYSTEM — 350C TRANSMISSION — G-SERIES

The detent valve is activated by the downshift (detent) cable which is connected to the carburetor linkage. When the throttle is half open, the detent valve is actuated, causing a part throttle downshift at speeds below 50 MPH. When the throttle is fully opened, the detent valve is actuated causing the transmission to downshift. The 3-1 detent downshift may be obtained when vehicle speed is approximately 6 to 12 MPH below the maximum throttle 1-2 upshift point. The 3-2 detent downshift may be obtained when vehicle speed is approximately 4 to 8 MPH below the maximum throttle 2-3 upshift point.

DETENT DOWNSHIFT ELECTRICAL CIRCUIT — 400-475 SERIES TRANSMISSION

The detent solenoid is activated by an electric switch on the accelerator linkage. When the throttle is fully opened, the switch is closed, activating the detent solenoid and causing the transmission to downshift for passing speeds.

The switch has a two-wire connector and is mounted on a metal bracket under the dashboard to the left of the steering column above the driver's left foot. (Figure 8-2 shows a typical detent downshift switch except the switch has been rotated 90 degrees counterclockwise to allow a better view of the activating plunger.)

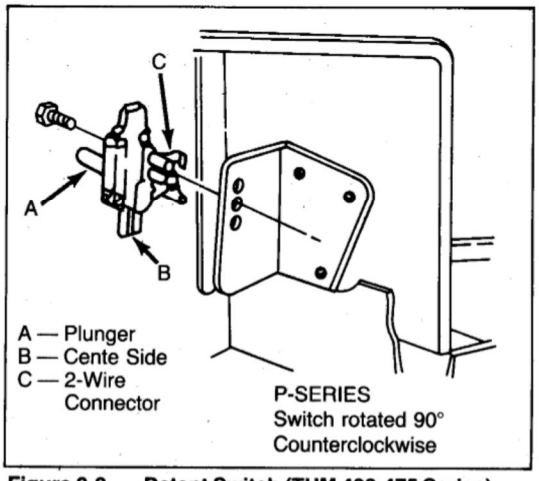


Figure 8-2 — Detent Switch (THM 400-475 Series)

To adjust the switch:

1. Preset the switch by pressing the plunger and/or movable plastic center slide downward as far as possible. In the preset position, the movable plastic center slide of the switch will snap down out of position and the center slide will be nearly flush with the top of the switch. Check the portion of the slide protruding from the bottom of the switch. The slide should extend approximately 1-1/4 inches in the reset position.

2. Press the accelerator pedal down to the "wide open" throttle position and the switch will "self-adjust" by snapping back into position. When adjusted, the center slide will be visually protruding out of the top of the switch (more than 1-1/4 inches as in Step 1).

The switch has been designed so that the switch contacts close (make contact) when the accelerator pedal is at or nearly at the floor. If the switch contacts do not close, too much carpet padding may have been installed by the RV manufacturer preventing the pedal from reaching the floor allowing the switch contacts to close.

Disconnect the two-wire connector and check if the contacts close at "wide-open throttle." Use an ohmmeter or continuity checker. With the continuity checker or ohm meter in position, depress the accelerator to the floor (with the engine off) to verify proper switch operation. If the contacts do not close, check to see if too much padding has been installed. Either remove the excess carpet padding or "build up" the diameter of the switch plunger. To "build up" the diameter of the switch plunger (allowing additional switch movement), install a piece of scrap 3/8-inch hose over the switch plunger. If the switch contacts still do not close, replace the switch (GM Part No. 1242101). Recheck and install the two-wire connector.

MAINTENANCE AND INSPECTION

The automatic transmission fluid level should be checked regularly (at each engine oil change) and changed at the intervals recommended in the Maintenance Schedule for your vehicle. Typically, the recommended interval for changing the fluid and service screen is every 24,000 miles (Heavy-Duty Emissions equipped vehicles) or every 12,000 miles if the vehicle was subjected to severe use.

In addition, the fluid cooler lines, electrical lines, vacuum lines, control linkage and transmission should be checked periodically for leaks, damage or deterioration.

NOTE: Transmission conditions can be the result of poor engine performance. If the engine requires a tune-up, this should be done before checking the transmission.

FLUID LEVEL AND APPEARANCE

When checking the fluid level, follow the appropriate procedure listed below. It is also important to know what appearance the fluid should have. Many times a transmission malfunction can be traced to an incorrect fluid level or improper reading of the dipstick. A fluid level which is too high **or** too low can cause overheating and clutch plate damage. In addition, overheating can be caused by excessive clutch plate slippage which can result from improperly installed plates, an out-of-adjustment selector linkage or the manner in which the vehicle is operated. The type of transmission fluid that is now being used may appear to be darker and have a stronger odor. This is normal, and not a positive sign of required maintenance or transmission failure.

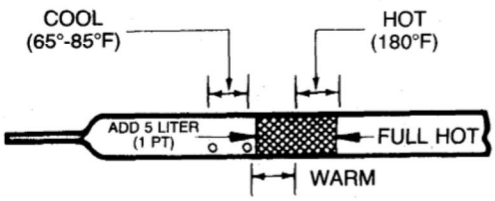
When the dipstick is removed, note whether the fluid is devoid of air bubbles or not. Fluid with air bubbles is an indication of an air leak in the suction lines, which can cause erratic operation and slippage. Water or ethylene glycol antifreeze in the fluid gives a milky, gray or pink cast to the fluid and can cause spewing of fluid from the transmission breather. Coolant in the fluid, whether water or antifreeze, can cause damage to the nylon parts or clutch plates in the transmission. If the fluid becomes contaminated with coolant, the most common cause is a leaking transmission cooler core. In addition to finding and fixing the leak, the transmission should be disassembled, cleaned and the clutch plates replaced with new ones.

Glycol test kits on the market can be used to detect antifreeze in the transmission fluid. While generally reliable, certain kits may produce positive test results because of additives used in some transmission fluids. The kit manufacturer's instructions should be followed closely.

Capacity

The fluid capacities of both transmissions are listed in the Lubrication section of this manual. To bring fluid level from "ADD" mark to "FULL" mark requires one pint of fluid. Fluid level should be checked at every engine oil change.

Fluid level should be at the "FULL" mark with transmission fluid at normal operating temperature of 180°F. With fluid at room temperature, 70°F, level will be between the two dimples on the dipstick. The normal operating temperature is obtained only after at least 15 miles of highway-type driving. (See Figure 8-3.)



NOTE: DO NOT OVERFILL. IT TAKES ONLY ONE PINT TO RAISE LEVEL FROM "ADD" TO "FILL" WITH A HOT TRANSMISSION.

Figure 8-3 — Transmission Dipstick — Fluid Levels at Varying Temperatures

Checking and Adding Fluid

TRANSMISSION AT OPERATING TEMPERATURE— The automatic transmission is designed to operate at the "FULL HOT" mark on the dipstick at normal operating temperatures of about 180°F and should be checked under these conditions. The normal operating temperature is obtained only after at least 15 miles of highway-type driving.

CAUTION: WITH NORMAL OPERATING TEMPERATURES, THE DIPSTICK WILL BE EXTREMELY HOT TO TOUCH. USE CARE TO AVOID BURNS.

To determine proper level, proceed as follows:

1. Apply the parking brake and block the vehicle wheels.
2. With the selector level in the PARK position, start the engine. DO NOT RACE ENGINE. Move the selector lever through each range.
3. Immediately check the fluid with the selector lever in PARK, engine running at SLOW IDLE and the car on a LEVEL surface. The fluid level on the dipstick should be at the "FULL HOT" mark.
4. If additional fluid is required, add sufficient fluid to bring the level to the "FULL HOT" mark on the dipstick.

TRANSMISSION AT ROOM TEMPERATURE (65° to 85°F) — Automatic transmissions are frequently overfilled because the fluid level is checked when the fluid is cold and the dipstick indicates fluid should be added. However, the low reading is normal since the level will rise as the fluid temperature increases (Figure 8-3). A level change of over 3/4 inch will occur as fluid temperature rises from 60° to 180°F.

Overfilling can cause foaming and loss of fluid through the vent. With too much fluid, the rotating members churn the fluid, producing aeration which reduces the fluid's cooling effectiveness. Slippage and transmission failure can result.

Fluid level that is too low can result in transmission charging pump cavitation, a loss of main and lubrication fluid pressure and clutch plate damage. It can cause slipping, particularly when the transmission is cold or the vehicle is on a hill.

Check the transmission fluid level with the engine running, the shift lever in PARK, and the vehicle level.

If the vehicle has recently been operated for an extended period at high speed or in city traffic in hot weather or the vehicle is being used to pull a trailer, an accurate fluid level cannot be determined until the fluid has cooled down, usually about 30 minutes after the vehicle has been parked.

Remove the dipstick and touch the transmission end of the dipstick cautiously to find out if the fluid is cool, warm or hot.

Wipe the dipstick clean and reinsert it until the cap seats. Remove the dipstick and note reading.

1. If the fluid feels cool, about room temperature (65°-85°F), the level should be between the two dimples below the "ADD" mark.
2. If it feels warm, the level should be close to the "ADD" mark (either above or below).
3. If it feels hot (cannot be held comfortably), the level should be between the "ADD" and "FULL" marks.

Changing Fluid

1. Raise the vehicle.
2. With a drain pan placed under the transmission pan, remove the pan attaching bolts from the front and side of the pan.
3. Loosen pan rear attaching bolts approximately four (4) turns.
4. Carefully pry the transmission pan loose, allowing the fluid to drain.
5. Remove the remaining bolts and remove the pan and gasket.
6. Drain the fluid from the pan. Clean the pan with solvent and dry thoroughly with clean compressed air.
7. Remove screen/filter and gasket.
8. Paper or felt-type filters should be replaced.
9. Install, as required, a new gasket or O-ring onto the screen/filter assembly. Lubricate O-rings with petrolatum.

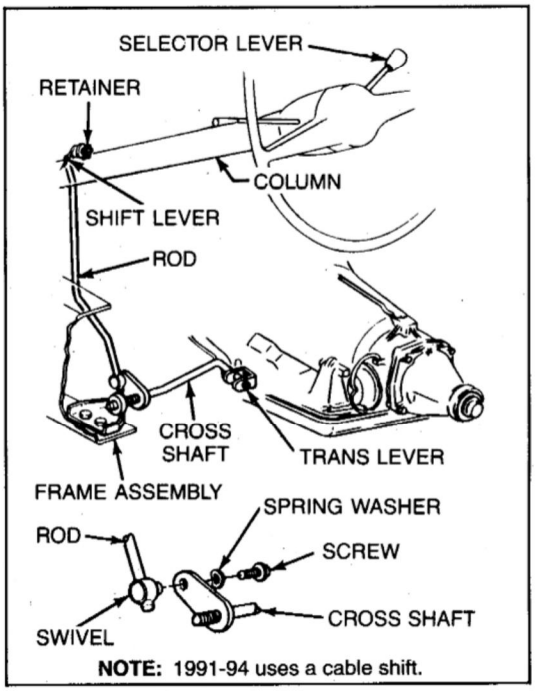
10. Install a new gasket on the pan and install the pan. Torque the attaching bolts to 13 ft. lbs. (350C transmission), 12 ft. lbs. (400-475 transmission).
11. Lower the vehicle and add the proper amount of DEXRON IIE® automatic transmission fluid through the filler tube.
12. With the selector lever in PARK position, apply the parking brake, start the engine and let idle (carburetor off fast idle step). DO NOT RACE ENGINE.
13. Move the selector lever through each range and, with the selector lever in PARK range, check fluid level.
14. Add additional fluid to bring the level between the dimples on the dipstick (cool level).

AUTOMATIC TRANSMISSION MANUAL LINKAGE

When the manual linkage (Figure 8-4) is properly adjusted, the engine will start in the PARK and NEUTRAL positions only.

The selector lever and manual linkage should move freely and not bind. Also, the pointer on the indicator quadrant should line up properly with the range indicators in all ranges.

Check the linkage to be sure that the connections are secure and that there is no binding. If there are indications that the linkage needs adjustment, take the vehicle to a qualified shop for service. If the linkage is not adjusted properly, an internal leak could occur at the manual valve which could cause a clutch and/or band failure.



NOTE: 1991-94 uses a cable shift.

Figure 8-4 — Transmission Manual Linkage—Typical

COOLER LINES

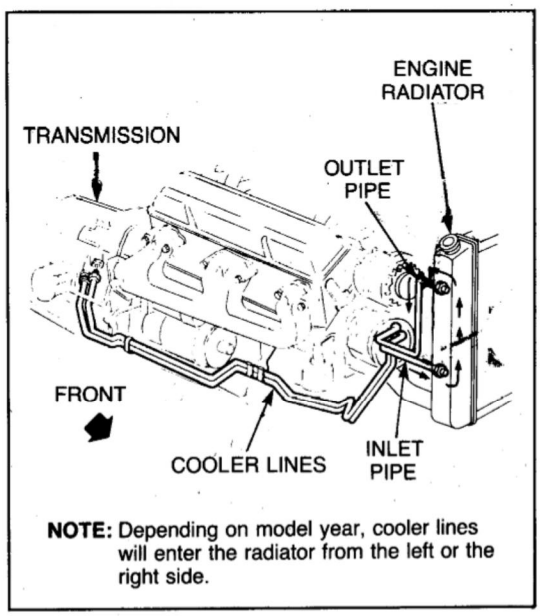
If replacement of transmission steel tubing cooler lines (Figure 8-5) is required, use only wrapped and brazed steel tubing meeting GM specifications 123M or equivalent. DO NOT USE COPPER OR ALUMINUM TUBING TO REPLACE STEEL TUBING. These materials do not have satisfactory fatigue durability to withstand normal vehicle vibrations. Steel tubing should be flared using the double flare method.

TRANSMISSION MOUNT

A loose transmission mount can cause a vibration in the driveline. To check for this condition, push up and pull down on transmission tailshaft while observing the transmission mount. If rubber separates from the metal plate of the mount or if the tailshaft moves up but not down (mount bottomed out), replace the mount. If there is relative movement between a metal plate of the mount and its attaching point, tighten the screws or nuts attaching the mount to the transmission or cross member (Figure 8-1).

TRANSMISSION SHIFTING

If problems are encountered with the transmission shifting (upshift or downshift), refer to the appropriate shop manual for the diagnosis and adjustment procedures, or take the vehicle to a qualified service shop.



NOTE: Depending on model year, cooler lines will enter the radiator from the left or the right side.

Figure 8-5 — Automatic Transmission Cooler Lines — Typical

ENGINE/TRANSMISSION TORQUE CONVERTER/CLUTCH BALANCING

The engine, torque converter, clutch cover or flywheel are balanced individually and are normally good for the life of the vehicle. Occasionally two or more components can be assembled with an imbalance problem and actually end up "working against each other" to create a less-than-desirable running condition. Or, a vehicle may be acceptable as produced, but after the clutch or transmission has been repaired a vibration may surface. This is especially true with some used or non-GM rebuilt parts.

An engine balance problem may exist if the vibration is present at a given engine RPM with the transmission in NEUTRAL and the wheels are not turning.

If diagnosis indicates that there is an engine and/or flywheel torque converter imbalance problem, the engine and torque converter can be balanced in the vehicle using the following procedure.

If the engine is equipped with an automatic transmission:

1. Remove the flywheel cover.

2. Reposition the converter in each attaching position on the flywheel and evaluate the vibration in each position. If there is no reduction in vibration, proceed to Step 3.

3. Remove a converter to flywheel bolt and add balance weight by installing a longer bolt with several flat washers under the head of the bolt. Determine if the vibration is more or less severe. The vibration should be appraised by moving the longer bolt and washers to each position possible.

4. Install the bolt and washers in the position which creates a properly balanced situation.

NOTE: It may be necessary to divide the weight between two adjacent bolts on the torque converter to obtain a proper balance.

If the vehicle is equipped with a manual transmission:

1. Place the transmission in NEUTRAL with the clutch engaged and increase the engine speed between 1,000 and 3,000 RPM. Note the degree of imbalance that occurs.

2. Place the transmission in gear with the clutch disengaged and increase the engine speed between 1,000 and 3,000 RPM. Note the degree of imbalance that occurs and compare it to the vibration which was determined in Step 1 above.

3. If a degree of imbalance is noted between Step 1 and Step 2, the clutch disc is probably causing the problem and should be replaced before proceeding. If no difference in imbalance is noted, install flat washers under the clutch pressure plate hold down-bolt following the procedure outlined in Step 3 above for the automatic transmission.

NOTE: If a strobe is available, follow the same general approach as outlined in the Driveline Balance Procedure section of this manual. Position the pickup against the engine oil pan.

ELECTRIC SPEEDOMETER 1991-94

The electromechanical speedometer replaces the cable driven speedometer on P - models. Components of the speedometer system includes the speedometer head, vehicle speed sensor (VSS), digital ratio adaptor controller, and the applicable wiring.

The speedometer head is an electromechanical device using integrated circuits that control the air core speedometer and stepper motor odometer.

The vehicle speed sensor is a permanent magnet signal generator located on the transmission output shaft. This analog signal, which is proportional to output shaft speed, is sent to the digital ratio adaptor controller.

The digital ratio adaptor controller (DRAC) is a solid state devoce which changes the analog signal supplied by the VSS to a digital signal. This digital signal is then fed to the speedometer.

The digital ratio adaptor controller is matched to the final drive of each vehicle. If the final drive ratio is changed (including tire size) for any reason, the DRAC must also be changed to match. This will ensure accurate speedometer readings. The parts book lists DRAC's (or Buffers) for a variety of tire sizes and rear axle ratios. Also, an incorrect DRAC will affect the Electronic Control Module (ECM), and the cruise control module.

1991-1994 4L80EHD

Effective with the 1991 model, the Class A motor home incorporates a 4-speed electronic shift overdrive transmission.

THE BENEFITS OF ELECTRONIC CONTROLS

A TRANSFORMATION IN TRANSMISSION TECHNOLOGY

In traditional, hydraulically controlled transmissions, the gear shifts are controlled by the opposing pressures of hydraulic fluid in a complex system of spring-loaded valves. In the new, electronically controlled Hydramatic 4L80-E transmission, gear shift points and shift feel are determined by electrical signals sent from the Powertrain Control Module.

The Powertrain Control Module processes data every 25 milliseconds from sensors based on throttle position, vehicle speed, gear range, altitude, temperature, engine load, and other inputs. Using this data, a signal is transmitted to the valve body Shift Solenoids, which activate the shift valves for precise shift execution. Shift points are thus precisely controlled and are identical from vehicle to vehicle.

Shift feel is also electronically controlled by the Powertrain Control Module. It sends signals to the Force Motor Solenoid, which controls fluid line pressure and determines how firm the shifts will feel.

The Powertrain Control Module makes the Hydra-matic 4L80-E an "intelligent" transmission which senses and adapts to changes in altitude, engine load, and other conditions. Electronic controls also eliminate the need for governor and modulator systems, which significantly reduces the mechanical complexity of the transmission.

GENERAL DESCRIPTION

The HYDRA-MATIC 4L80-E is an electronically controlled four-speed rear wheel drive automatic transmission. It consists primarily of a torque converter and three planetary gearsets. Five multiple disc clutches, one sprag, two roller clutches, and two bands provide the friction elements required to obtain the desired function of the planetary gearsets. A hydraulic pump and an electronically controlled valve body is used to operate the various systems contained within the transmission.

The torque converter contains a pump, a turbine, and a clutch pressure plate splined to the turbine. The torque converter acts as a fluid coupling to smoothly transmit torque from the engine to the transmission. It also hydraulically provides additional torque multiplication when required. The clutch pressure plate, when applied, provides a mechanical "direct drive" coupling of the engine to the transmission.

The three planetary gearsets provide the four forward ratios and reverse. Changing of the gear ratios is fully automatic, mainly in relation to throttle opening and vehicle speed.

The Powertrain Control Module (PCM) [or Transmission Control Module (TCM) on some applications], an on board computer, receives and processes input signals from various sensors on the vehicle and delivers output signals to the solenoids located in the control valve assembly. The solenoids control the transmission operating pressures, upshift and downshift patterns and torque converter clutch (TCC) operation.

Hydra-matic 4L80-E Transmission Specifications

Transmission Type
4L80-E = 4-Speed,
Longitudinal Mount,
High Torque Capacity,
Electronically Controlled

Automatic Overdrive with Torque Converter Clutch Assembly

Control Systems
Shift Pattern — Solenoid Control
Shift Quality — Force Motors Control
Torque Converter Clutch — Pulse Width Modulated Solenoid Control

Gear Ratios

1st	2.482
2nd:	1.482
3rd:	1,000
4th:	0.750
Rev:	2.077

Maximum Gross Vehicle Weight
7,484 kg (16,500 lb)

Maximum Gross Combined Vehicle Weight
9,072 kg (20,000 lb)

Transmission Fluid Type
Dexron IIE

Transmission Fluid Capacities
Bottom Pan
Removal: 7.3L (7.7 qt)
Dry: 12.8L (13.5 qt)

7 Position Quadrant
(P,R,N,OD,D,2.1)

EXPLANATION OF GEAR RANGES

The transmission can be operated in any one of the seven different positions shown on the shift quadrant.

P — Park position enables the transmission output shaft to be locked, preventing the vehicle from rolling either forward or backward. For safety reasons, the vehicle parking brake should be used in addition to the transmission "Park" position. Park position should not be selected until the vehicle has come to a complete stop. The engine may be started in the Park position.

R — Reverse enables the vehicle to be operated in a rearward direction.

N — Neutral position enables the engine to start and operate without driving the vehicle. If necessary, this position should be selected to restart the engine while the vehicle is moving.

D — Overdrive range should be used for all normal driving conditions for maximum efficiency and fuel economy. Overdrive range allows the transmission to operate in each of the four forward gear ratios. Downshifts to a lower gear, or higher gear ratio, are available for safe passing by depressing the accelerator or by manually selecting a lower gear with the shift selector.

It is not recommended to operate the transmission in overdrive range when pulling heavy loads or driving on extremely hilly terrain. Under such conditions that put an extra load on the engine, the transmission should be driven in a lower manual gear selection for maximum efficiency.

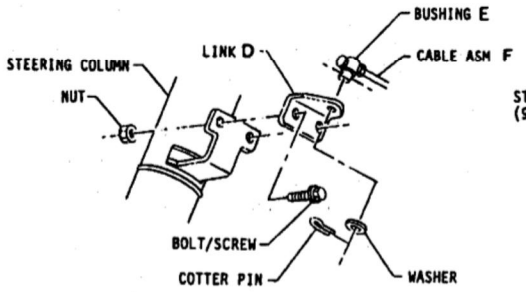
D — Manual Third can be used for conditions where it may be desirable to use only three gear ratios. These conditions include towing a trailer and driving on hilly terrain as described above. This range is also helpful for engine braking when descending slight grades. Upshifts and downshifts are the same as in Overdrive range for first, second and third gears except that the transmission will not shift into fourth gear.

2 — Manual Second adds more performance for congested traffic and hilly terrain. It has the same starting ratio (first gear) as Manual Third but prevents the transmission from shifting above second gear. Thus, Manual Second can be used to retain second gear for acceleration and engine braking as desired. Manual Second can be selected at any vehicle speed. If the transmission is in third or fourth gear when Manual Second is selected it will immediately shift to second gear.

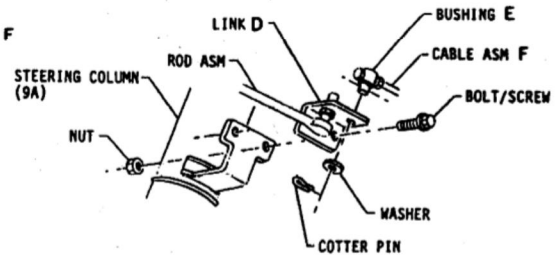
1 — Manual First can be selected at any vehicle speed. If the transmission is in third or fourth gear it will immediately shift into second gear. When the vehicle speed slows to below approximately 56 km/h (35mph) the transmission will then shift into first gear. This is particularly beneficial for maintaining maximum engine braking when descending steep grades.

1994 BRAKE/TRANSMISSION SHIFT INTERLOCK

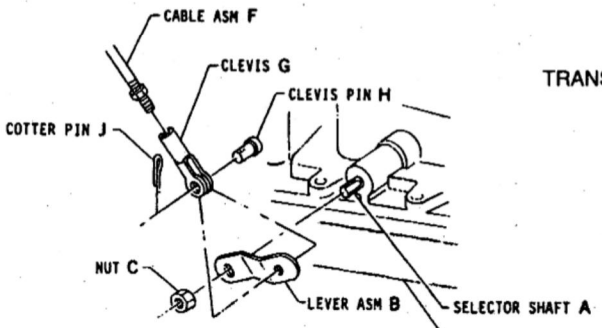
An improved safety feature inhibits the operator from moving the shift selector lever and the transmission out of "Park" unless the brake pedal is depressed. A solenoid-actuated plunger will interface with the steering column mounted transmission-shift lever which remains in a lock-out position until the vehicle brake is applied. The solenoid will be energized through the brake switch and allow the shift lever to move from the park position.



ADJUSTMENT AT STEERING COLUMN -C7P



ADJUSTMENT AT STEERING COLUMN & C7P



ADJUSTMENT AT TRANSMISSION

TRANSMISSION SHIFT CABLE
1991-1994
Part #156443445

AUTO TRANS SHIFT LEVER & CABLE INSTALLATION & ADJUSTMENT

1. With trans selector shaft (A) in Neutral, align slot on lever ASM (B) with flats on shaft (A).
2. Push lever ASM (B) on to shaft (A) far enough to engage retaining nut (C).

   CAUTION: Do not drive lever ASM (B) on to trans selector shaft (A) by hammering or bumping, as internal components of transmission will be damaged.
3. Hold lever ASM (B) & hand tighten retaining nut (C) to 20-27 N•m torque.

   CAUTION: Do not apply torque in excess of 27 N•m, as damage to selector shaft may occur.
4. Move lever ASM (B) (selector shaft) by hand through detent range positions to check for freedom from binding & positive detent engagement.
5. With steering column shift lever in neutral attach link (D), bushing (E) & cable ASM (F) as shown.
6. With trans lever ASM (B) in neutral position install and adjust clevis (G) for free pin (H).
7. Install clevis pin (H) & secure with cotter pin (J).
8. By moving steering column shift lever through full range check for positive detent engagement at trans for each position.
9. Readjust clevis (G) if necessary, for positive detent engagement.

NOTE: Do not use trans cable adjustment to adjust PRNDL alignment (see UPC 9A/07-04-03 for PRNDL asjustment procedure).

TRANSMISSION FLUIDS AND COOLER TIPS

OIL TEMPERATURE MEASURED AT CONVERTER OUTLET TO COOLER

350°F is the maximum temperature. This is the normal place to install a temperature gage or signal. The temperature in this location will vary significantly with each vehicle start-up or hill. If the temperature reaches 350°F, reduce throttle. To lower the transmission temperature with the transmission in NEUTRAL, run the engine at 1,200 RPM for 2-3 minutes to cool the oil. Do not allow the converter outlet temperature to exceed 350°F. Keep a close check to prevent the engine cooling system from overheating. 350°F or higher would be typical of rocking the vehicle in mud, snow, or sand, or a transmission in stall (full throttle, no vehicle movement). When the transmission is in stall, the transmission will develop heat at a rate of one degree per second of stall.

OIL TEMPERATURES MEASURED IN THE SUMP OR OIL PAN

150°F — Minimum operating temperature for continuous operation. It is possible in low ambient temperature to overcool the transmission with oil to air-type coolers; it is hard to overcool if used in conjunction with oil to water coolers installed in most standard automotive radiators.

190°-200°F — Proper oil level checking temperature.

200°F — Maximum oil level checking temperature. Beyond this, readings are not reliable because of expansion.

285°F — Maximum sump/oil pan temperatures for short duration, such as a long hill climb.

300°F — Metal parts inside the transmission begin to warp and distort in varying degrees, seals melt rapidly, and transmission fluid life is extremely short due to oxidation and distress.

AUTOMATIC TRANSMISSION FLUID OXIDATION

Automatic transmission fluid can provide up to 100,000 miles of service before oxidation occurs under normal operating temperatures of about 170°F. Above normal operating temperatures, the oxidation rate doubles (useful life of the fluid is cut in half) with each 20 degree increase in temperature.

The approximate life expectancy at various temperatures is as follows:

DEGREES F	MILES
175	100,000
195	50,000
212	25,000
235	12,000
255	6,000
275	3,000
295	1,500
315	750
335	325
355	160
375	80
390	40
415	Less than 30 Minutes

Figure A8-1-1 — Transmission Fluid — Life Expectancy/Temperature Relationship

This information shows why the various maintenance change intervals and/or oil coolers are recommended for severe usage.

NOTE: THE ABOVE CHART IS BASED ON THE ASSUMPTION THAT OIL TEMPERATURE REMAINS CONSTANT FOR THE MILES INDICATED. TEMPERATURES WHICH APPEAR FOR SHORT PERIODS, SUCH AS CLIMBING HILLS, ETC., WOULD NEED TO BE AVERAGED AGAINST NORMAL OPERATING TEMPERATURES TO DETERMINE ACTUAL LIFE EXPECTANCY.

AUTOMATIC TRANSMISSION FAILURE IMMEDIATELY AFTER SERVICING

If there was no known prior abuse, the new transmission fluid is not at fault. What has probably happened is that a certain amount of highly oxidized fluid remained in the transmission converter and cooler lines. The old fluid and new fluid will not mix. They settle out as sludge or varnish, causing valves to stick and/or plug oil passages and screens. When this happens, the transmission may malfunction or fail completely. The best way to prevent the problem is to follow the manufacturer's drain intervals for severe operating conditions such as trailer towing, mountain driving, and stop-and-go city driving.

TRANSMISSION FLUIDS AND COOLER TIPS (Cont'd)

AUTOMATIC TRANSMISSION FAILURE IMMEDIATELY AFTER OVERHAUL

Assuming proper workmanship and assembly, failure can often be caused by metal particles or debris trapped in the cooler circuit. Unless the converter, cooler, and cooler lines are thoroughly flushed during overhaul, the leftover contaminants will return through the cooler return lines to the transmission lube supply and may cause a second failure. To prevent this, be certain all the transmission components, cooler lines, and cooler are cleaned prior to reassembly. DO NOT TAKE SHORTCUTS.

DEXRON IIE® VERSUS TYPE F TRANSMISSION FLUID

Type F fluid must never be used where Dexron II® is specified. The difference in the fluids relates to their friction properties. GM transmissions are designed to shift smoothly which requires a low-static fluid such as Dexron IIE®. On the other hand, transmissions that require Type F transmission fluid are designed to shift more harshly, providing more shift feel. Type F fluid is a highly static fluid, and provides more friction than Dexron IIE®. If Type F fluid is used in a GM-designed transmission, shifting will become more harsh. In turn, harsh shifts apply higher shock loads to components that weren't designed for high-shock loads, and transmission failure is almost certain.

DEXRON IIE ® FLUID COLOR CHANGE AND STRONG ODOR

These two "tests" are **no longer** satisfactory criteria for recommending a fluid drain and refill. With the Dexron II® fluid, rapid loss of the red color and darkening of the new fluids are normal and **DO NOT** affect their performance. Contrary to past performance, the service technician **should not consider a dark appearance or burnt odor** as the signal to change fluid. The only accurate method for determining a fluid's serviceability or effectiveness is through a laboratory analysis. Short of a laboratory analysis the owner's manual drain recommendation should be followed.

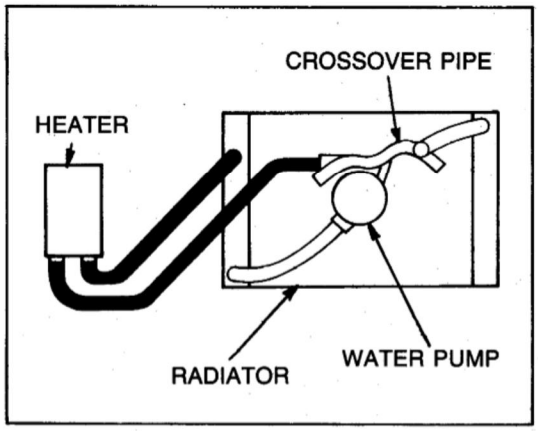


Figure A8-1-2 — Deaeration Cooling System

INSTALLATION OF A MANUAL WATER SHUT-OFF VALVE IN THE HEATER LINE

DO NOT install a manual water shut-off valve in the heater line. The heater water return is routed to the radiator outlet tank and continuous coolant flow is necessary to control oil temperatures during closed thermostat (warm-up) operation. (See Figure A8-1-2.) Shutting off this portion of the heater flow destroys the engine's deaeration system and may result in premature engine or transmission failure. A transmission warms up faster than the engine and it is not advisable to have the radiator transmission oil cooler exposed to air. A bubble cavitating in the engine water pump could cause engine hot spots. A water shut-off valve is permissible in the rear seat heater line.

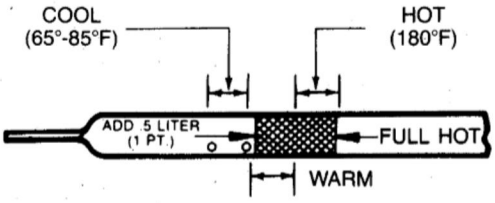
ADDING AN EXTERNAL FLUID COOLER

Before adding an external fluid cooler consideration should be given to many factors:

- Initial cost
- Need
- Potential extra leak points (For example: A tee added into the line is not one leak potential but three. A coupling provides two leak point possibilities — the cooler has two ends plus the cooler itself.)
- Lines have potential for fatigue and rubbing or chafing
- Quality of the installation.

The transmission dipstick itself might be considered a major factor for adding an external cooler. Current dipsticks have several dots at the low end of the operating range that would show a valid fluid level if checked cool at 65°-85°F. (See Figure A8-1-3.) This low reading is normal since the level will rise as the fluid temperature increases. A level change of over 3/4 inch will occur as fluid temperature rises from 60° to 180°F. If starting with the lower dot and, after driving, the level did not go over the maximum high of the hash marks, an extra cooler would be difficult to justify. For this condition, all that's needed is to consider fluid and filter change intervals per the owner's manual dealing with severity of service. If in doubt, change the fluid and filter. If after heavy driving or trailer pulling,the fluid level rises above the hash marks, an external cooler may remove enough extra heat to help stay within the operating hash marks. (See Figure A8-1-3.)

TRANSMISSION FLUIDS AND COOLER TIPS (Cont'd)



NOTE: DO NOT OVERFILL. IT TAKES ONLY ONE PINT TO RAISE LEVEL FROM "ADD" TO "FULL" WITH A HOT TRANSMISSION.

Figure A8-1-3 — Fluid Levels at Varying Temperatures

With fluid coolers, the hot oil enters the bottom of the cooler and the cooled fluid exits out of the top of the cooler for better heat dissipation. This is the reverse of the engine radiator. (See Figure A8-1-4.)

Overfilling can cause foaming and loss of fluid through the vent. With too much fluid, the gearing "churns" the fluid and produces aeration and foam, and reduces the fluid's cooling effectiveness. Slippage and clutch failure often result. A low fluid level can result in causing pump cavitation and loss of main and lubrication oil pressures. This can result in slipping and clutch damage, particularly when cold or when on a hill.

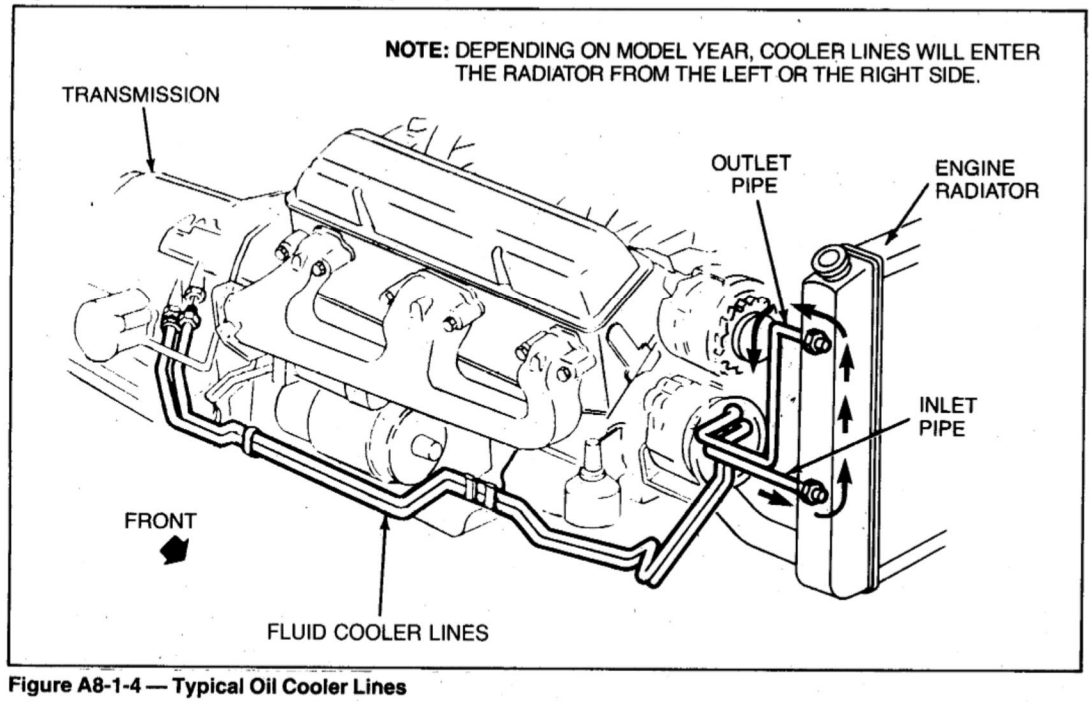


Figure A8-1-4 — Typical Oil Cooler Lines

NOTE: After-market transmission temperature gage should be installed in the lower (hot) oil line as viewed from entering the radiator.

After-market external oil to air cooler should be installed after the GM transmission cooler. The lower (hot) line should go first into the lower fitting of the GM radiator cooler then out from the top fitting to the after-market oil to air cooler. Extreme cold weather may require the after-market oil to air cooler be covered so not to cool the oil to much.

After-market external filter should be installed in the lower (hot) oil line to prevent any debris from reaching the radiator cooler if the filter is being installed in conjunction with a transmission failure or overhaul.

APPENDIX 8-2

TEMPERATURE MONITORS

The following information has been provided as an aid to the motor home owner. Features, specifications and ordering information have been provided.

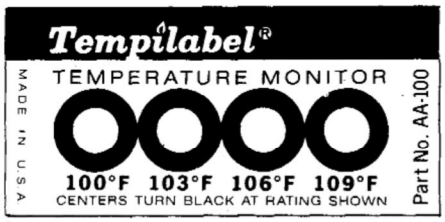
Tempilabels temperature monitors are extremely useful in monitoring the safe operating temperature of equipment such as gear boxes, transmission pans, radiators, the engine oil pan, heat exchangers, etc. Tempilabels are self-adhesive temperature monitors consisting of one or more heat-sensitive indicators sealed under transparent heat-resistant "windows." (See Figure A8-2-1.)

The centers of the indicator circles turn black at the temperature rating shown on the label. The color changes are irreversible and provide a temperature history of the surface being monitored. The Tempilabel can be removed and attached to a service record to provide a permanent service history.

The Tempilabel temperature monitor indicates a specific temperature or sequence of temperatures with a tolerance of one percent of the respective rating (plus or minus). The performance of the Tempilabel temperature monitor is not affected by transient contact with contaminants such as solvents, gasoline, fuel oil, lubricants, hot water or steam.

To use the Tempilabel, remove the film backing to expose the adhesive. Press the Tempilabel firmly to the desired work surface. No special treatment to the work surface is necessary although it should be clean to obtain maximum contact and adhesion.

Sample of product and listing of one of several series available is shown as Figure A8-2-1. Tempilabels are sold at nominal cost for a minimum order of 10.



Series AA/4A/4B/4C-Tempilabel®

NOTE: ACTUAL DIMENSIONS ARE 1-3/4-INCHES LONG AND 7/8-INCH HIGH. THE INDICATING WINDOW IS 7/32-INCH IN DIAMETER.

Part No.	Temperature Ratings			
4A-100	100	110	120	130°F
4A-110	110	120	130	140
4A-120	120	130	140	150
4A-130	130	140	150	160
4A-140	140	150	160	170
4A-150	150	160	170	180
4A-160	160	170	180	190
4A-170	170	180	190	200
4A-180	180	190	200	210
4A-190	190	200	210	220
4A-200	200	210	220	230
4A-210	210	220	230	240
4A-220	220	230	240	250
4A-230	230	240	250	260
4A-240	240	250	260	270
4A-250	250	260	270	280
4A-260	260	270	280	290
4A-270	270	280	290	300

Figure A8-2-1 — Typical Tempilabel Series

FOR FURTHER INFORMATION:

TEMPIL COMPANY
HAMILTON BOULEVARD
SOUTH PLAINFIELD, NEW JERSEY
07080
(201)757-8300

GEARED ROAD SPEED DETERMINATION

Geared road speed is the maximum theoretical speed of a vehicle based on engine RPM, transmission and axle gear ratios, and tire size. In actual use the vehicle may or may not have enough horsepower to attain this speed. To determine geared road speed the formula is as follows:

$$\text{GEARED ROAD SPEED} = \frac{\text{RPM} \times 60}{\text{R} \times \text{M}}$$

RPM = Engine speed at selected Net Horsepower. (To determine maximum geared road speed use engine RPM where maximum horsepower is developed.)

R = Ratio. Transmission gear x axle ratio = R

M = Tire revolutions per mile.

Example: A truck with 8-19.5 tires (613 revolutions per mile). 5.83 axle ratio, 4.8 liter (292) engine (3,400 RPM)

$$\frac{3{,}400 \times 60}{5.83 \times 613} = \frac{204{,}000}{3{,}574} = 57 \text{ MPH}$$

NOTE: See the Wheel and Tire section of this manual for typical motor home tire revolutions per mile. Nonlisted tire size revolutions per mile can be obtained from local tire dealer catalogs.

AUTOMATIC											
Model & RPO Number		350 MXI		400 MXI		475 MXI		700R4 MXI		4L80E	
Torque Converter		Lock-up	Break-away	Lock-up	Break-away	Lock-up	Break-away	Lock-up	Break-away	Lock-up	Break-away
Gear Ratios	First	2.52	5.29	2.48	5.70	2.48	5.46	3.06	6.73	5.21	2.48
	Second	1.52	3.19	1.48	3.40	1.48	3.26	1.63	3.58	3.11	1.48
	Third	1.00	2.10	1.00	2.30	1.00	2.20	1.00	2.20	2.10	1.00
	Fourth	—	—	—	—	—	—	.70	1.50	1.58	0.75
	Reverse	1.94	4.07	2.10	4.83	2.10	4.62	2.29	5.03	4.37	2.08

Figure A8-3-1

NOTE: Typical class A motor home will be equipped with a model 475 transmission. Typical Class C will be equipped with a 350 transmission thru 1990-1991 up both will have the 4L80E transmission.

As shown in the above chart, the breakaway ratio includes the transmission torque converter ratio. For example: In the 475 transmission, the mechanical first speed gearing is 2.48 to 1 times the torque multiplication of the torque converter ratio of 2.20 to 1, which equals the breakaway ratio of 5.46. Breakaway is shown in third gear primarily to show converter ratio. Third gear at normal road speeds can be considered a 1 to 1 ratio.

NOTE: For best engine life and economy, an engine should cruise at a continuous 80 to 90 percent of rated RPM. Shift points at rated RPM are acceptable. (See Figure A8-3-2.)

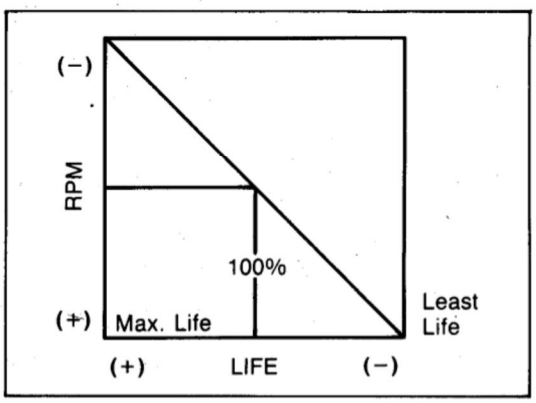


Figure A8-3-2 — Engine Speed vs. Rated Life Expectancy

APPENDIX 8-4

CHECKING GEAR RATIOS SINGLE DRIVE AXLES

The method outlined below may be used whenever it is desirable to check or verify the gear ratio of a rear axle. Two-speed axles may be checked by repeating the procedure in both high and low axle ratios.

1. Jack up a drive wheel on one side of the vehicle. Shift the transmission into NEUTRAL.

2. Mark the pinion flange or yoke of the drive unit at some convenient reference point. Mark the tire of the drive wheel that is off the ground. Turn this drive wheel two complete revolutions noting the number of revolutions of the marked pinion flange or yoke. The number of revolutions of the pinion flange or yoke indicates the gear ratio of this axle. For example:

Two revolutions of the drive wheel and 7-2/3 (7.66) revolutions of the flange or yoke mean the gear ratio of this axle is 7.66:1.

When only one drive wheel is free to turn, the action of the differential gear assembly requires that the drive wheel be given two complete revolutions to obtain the proper gear ratio by this method.

You could expect 4.10, 4.56 or 4.88 as typical Class A or C motor home axle ratios.

NOTE: See the Wheel and Tire section of this manual for typical motor home tire revolutions per mile. Non-listed tire size revolutions per mile can be obtained from local tire dealer catalogs.

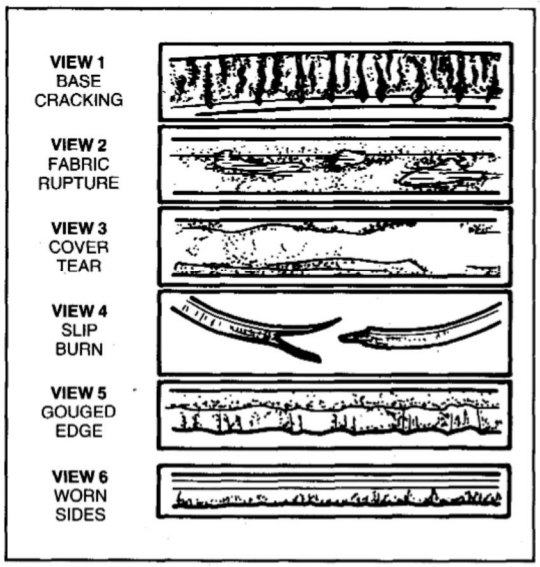
DRIVE BELTS AND TENSION SPECIFICATIONS

Proper care and maintenance of drive belts is an important part of good engine maintenance. Proper belt tension and the condition of the pulley grooves are of primary concern.

Since belts and pulleys wear with use, look at all frictional surface areas for signs of wear. Normal wear can be recognized as even wear, both on the belt and the grooves of the pulley. It is the unusual signs of wear that indicate some corrective action is necessary.

When checking, remember that failed or partially failed belts shown to be defective may have been damaged by a bad pulley, a misaligned drive or by some faulty mechanical component.

UNUSUAL WEAR CONDITIONS



BASE CRACKING

Excessive cross-checking (View 1) extending into the rubber on the base of a belt and showing little or no side wear indicates that it must be replaced. Small cracks only in the cover material do not indicate belt failure.

If the belt fails after three or four seasons of use, the belt should not be classified as being defective. However, if the base of the belt also shows cross-checking, the belt has been exposed to weather to the extent that the inner fabric is beginning to rot.

FABRIC RUPTURE

A fabric rupture (View 2) can be caused by operating a belt over a badly worn pulley, by too much tension which forces the belt down into the groove, or by foreign objects falling into the pulley groove while the drive is operating.

COVER TEAR

A tear in the cover of a belt (View 3) is normally a result of the belt accidentally coming into contact with some part of the application. It is no fault of the belt or its construction.

Cover tears are usually caused by belts running too loosely allowing them to "throw-out" centrifugally and rub other parts of the application. Proper belt tension will prevent this from happening.

NOTE: A slight raveling of the belt covering at the splice location does not indicate imminent belt failure. Simply cut off loose raveling.

SLIP BURN

This belt (View 4) was ruined by operating too loosely. The belt slipped under load. And when it finally grabbed, it snapped.

Proper belt tension would have avoided this failure.

GOUGED EDGE

A gouged edge in a belt (View 5) can be caused by a damaged pulley or interference with some part of the application.

Check the condition of the pulley. Make sure the belt does not rub on any part of the application while operating.

WORN SIDES

Badly worn belt sides (View 6) result from long operation without enough tension. The sides will be worn and slightly burned around the entire circumference.

Check for proper belt tension. Also check the pulleys for incorrect alignment.

DRIVE BELTS AND TENSION SPECIFICATIONS (Cont'd)

DEFECTIVE BELTS

EXCESSIVE STRETCH

A belt that stretches excessively is one that stretches beyond the adjustment provided to take up normal belt stretch.

LUMPY BELTS

Lumpy belts usually occur and are more noticeable on variable speed drives and other high-speed belt installations. The result is excessive vibration. If belts are not relieved of tension while the engine or vehicle is stored, they will often cause temporary vibration upon start-up. Give them time to straighten out.

INTERNAL CORD FAILURE

Failure of one or more of the internal tension cords will result in the belt rolling out of the pulley groove. Cords can be broken by prying the belt over the pulley.

IMPROPER LENGTH

It is possible that an improper length belt could accidently be installed on an engine. Always check to be certain that the belt length is correct before the belt is installed.

BELT INSTALLATION

Use the following procedure when installing new belts:

1. Move the belt tension adjustment to the position where it provides the most slack. In some cases it may be necessary to remove the accessory to install the belt.
2. Examine pulleys for chips, cracks, bent sidewalls, rust, corrosion or other damage.
3. Check pulley alignment.
4. Place belts in the pulley grooves by hand.

NOTE: Never pry or force a belt onto the pulley with a screwdriver, crowbar, wedge, etc., since both belt and drive can be damaged.

BELT REPLACEMENT

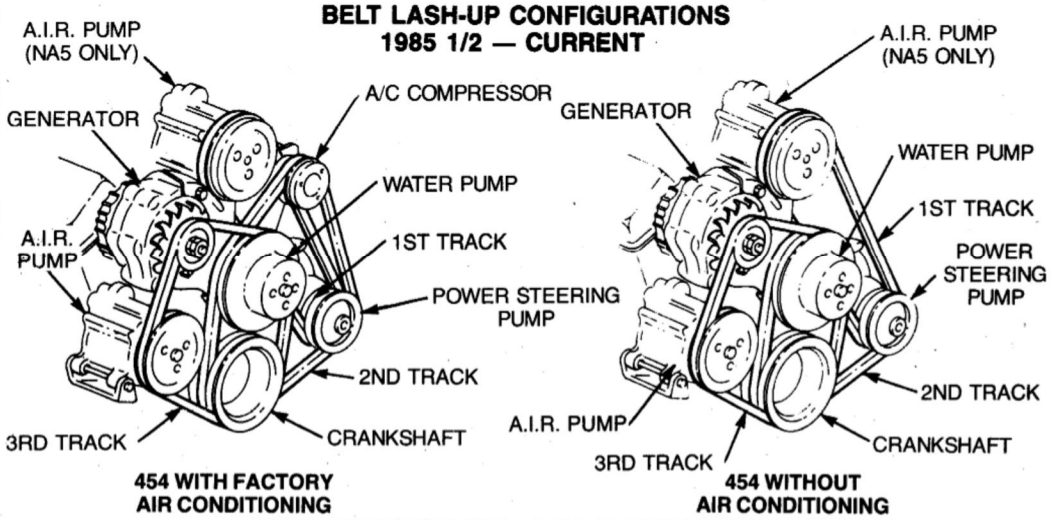
Here are a few service tips for replacing belts.

Replace Belts In Matched Sets

Never replace just one belt on a 2-groove, single pulley setup.

Never install only one belt from a different set of matched belts. Install a complete, matched belt set.

BELT LASH-UP CONFIGURATIONS
1985 1/2 — CURRENT



NOTE: 1990 THRU 1994 - A.I.R. PUMPS WERE ELIMINATED

DRIVE BELTS AND TENSION SPECIFICATIONS (Cont'd)

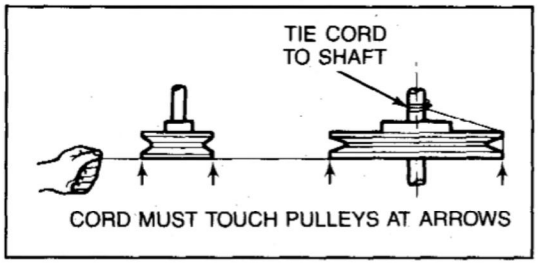
Check Condition Of Pulleys

Always check the condition of pulleys before replacing belts. Inspect the pulleys for chips, cracks, bent sidewalls, rust, corrosion, etc. Replace any pulleys found to be defective.

Check Pulley Alignment

Misaligned pulleys result in shortened belt life. Check the alignment between pulleys as follows:

1. Position a straightedge or cord line to touch both pulleys at all points. The shafts must be parallel.
2. Rotate each pulley a half revolution and note whether the contact of either pulley with the straightedge or cord line is disturbed. If so, this indicates a bent shaft or warped pulley.



BELT TENSION ADJUSTMENT

To carry their full load, belts must grip the entire area of contact with the pulley. When operated too loosely, belts can slip, heat, burn, or grab and snap. More belts fail from undertightening than from overtightening.

When operated too tightly, belts can damage the engine by causing side loading on the crankshaft, crankshaft bearings, and accessory bearings. Excess tension also stretches and weakens belts.

Proper Belt Tension (V-Belts): When installing V-belts, keep the following in mind:

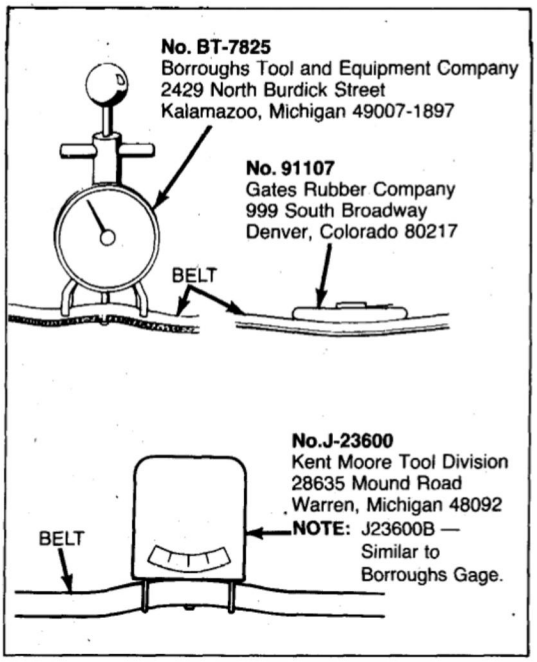
Adjust the belt tension so that a firm push with the thumb at a point midway between two pulleys will depress the belt no more than 1/4 inch (Chevrolet engine). If a V-belt tension gage is available, adjust the belt tension as outlined in the belt tension chart which follows.

NOTE: When installing or adjusting accessory drive belts, be sure the bolts in the accessory adjusting pivot point and in the adjusting slot are tightened properly.

ALL V8 ENGINES EXCEPT DIESEL		
Generator A.I.R. Pump P/S Pump	50 Lb. Min.	Adjust to 75 ± 5 Lbs. Used Adjust to 125 ± 5 Lbs. New
A/C Compressor	65 Lb. Min.	Adjust to 95 ± 5 Lbs. Used Adjust to 140 ± 5 Lbs. New
6.2L — V8 DIESEL		
Generator P/S Pump	70 Lb. Min.	Adjust to 75 ± 5 Lbs. Used Adjust to 110-140 Lbs. New
A/C Compressor	80 Lb. Min.	Adjust to 90 ± 5 Lbs. Used Adjust to 135-165 Lbs. New

BELT TENSION CHART

New drive belts will stretch after the first few hours of operation. Run the engine for 15 seconds to seat the belts, then check belt tension again. Retighten fan drive, pump drive and battery-charging generator drive belts after 1/2 hour or 15 miles and again after 8 hours or 240 miles of operation. Thereafter, check the tension of the drive belts every 200 hours or 6,000 miles and adjust them if necessary. Belt tension tools are available from several tool manufacturers, as listed below:



DRIVE BELTS AND TENSION SPECIFICATIONS (Cont'd)

APPLICATION CHART — BELTS & HOSES for P-30(32) Series Motor Home with 454 CID Engine

Year	Remarks	GM Part No.
Fan Belt, Generator Belt		
1979-85		9433752
1985 1/2 to 1989	Poly V, 6 Rib 55.98 inches (1422.0 mm)	14087540 (Production No. & Service No.)
1990	(1340 mm)	10085787
Power Steering Pump Belt		
1979-85	Without A/C	9433745
1985 1/2 to Current	Without A/C .47 inch × 45.5 inches	14087507 (Production No.) 10034695 (Service No.)
1985 1/2 to Current	With A/C, Hi Ride 3/8 inch × 41 inches GM Code: XL	14082454 (Production No.) 9433735 (Service No.)
A.I.R. Pump Belt		
1985 1/2 to 1989	With and Without A/C All Federal Jobs, Hi Ride .47 inch × 45.00 inches GM Code: CNA	14092344 (Production No.) 10034695 (Service No.)
Air Conditioning Belt (GM-ARA)		
1985 1/2 to Current	Hi Ride 3/8 inch × 60.5 inches GM Code: GA	15598439 (Production No.) 14033869 (Service No.)

DO NOT USE BELT DRESSING

Belt dressing is not recommended for belts at any time. Most dressings contain chemicals which tend to soften belts. While this softening process does increase the friction between the belt and pulley grooves, the result is only temporary.

BELT CLEANING INSTRUCTIONS

Remove all grease and oil as quickly as possible before they can penetrate the belt and cause deterioration.

Year	Remarks	GM Part No.
Radiator Hose		
73-81	Upper Hose Vertical Radiator 350 Engine 1 1/2 ID Ident 6259952	6259952
73-81	Upper Hose Vertical Radiator 454 Engine 1 1/2 ID Ident 6259953	6259953
1982 to Current	Upper Hose Horizontal Radiator 454 Engine Varies by Model & Option	14049401 15599363
1983	Upper Hose Horizontal Radiator	15595586
1984	6.2 Diesel Varies by Model & Option	14049497
1985	Upper Hose 454 Engine H4D	14049401
85-89	Upper Hose 454 Engine H5D	15599363
90-94	Upper Hose 454 Engine H5D	15638164
73-81	Lower Hose Vertical Radiator 350 and 454 Engine 1 3/4 ID Ident 343414	343414
1982	Lower Hose Horizontal Radiator 350 Engine Same as 73-81 Vertical Radiator	343414
1982 to 1984	Lower Hose Horizontal Radiator 454 Engine	14049500
1982 to Current	Lower Hose Horizontal Radiator 6.2 Diesel 4.54 Gas	15595587 14042372 14049500

PREPARING THE MOTOR HOME FOR STORAGE

Special consideration may be required when conditions of high humidity, extreme temperatures or outdoor storage are encountered. Local experience will dictate any additional protective measures for such conditions.

- Check battery/batteries and inspect test hydrometer on Delco Freedom or maintenance-free batteries and charge if green dot is not visible to avoid freezing and deterioration. Both battery cables should be disconnected at the battery/batteries to prevent gradual discharge, and the possibility of fire due to short circuits. On conventional batteries, check electrolyte specific gravity and charge if below 1.255. (See Battery Maintenance During Vehicle Storage section of this Appendix.)
- Prior to storage, fill tank/tanks, add fuel stabilizer, run engine and generator to insure stabilized fuel is circulated throughout the complete fuel system.
- Keep chassis windows closed. Make sure all covers are in place.
- Avoid trees in parking area to eliminate potential damage from tree sap or bird droppings. Remove high weed growth which affects paint by attracting insects or causing stains.
- Rinse, wash and wipe horizontal surfaces of motor home at least once per week when stored outside to remove accumulations which settle on flat surfaces.
- Leave parking brake in "OFF" position.
- Unit should be parked on level surface or with front of chassis higher than rear if level surfaces are not available. This is to prevent gasoline draining into engine over a long period causing possible damage to engine by "hydrostatic lock" when started.
- Check engine coolant and, if necessary, increase antifreeze.
- Check and secure all caps to prevent water, snow and dirt from entering engine.
- Check and keep tires inflated to recommended tire pressure.
- Remove windshield wiper arms and blades and store in vehicle.
- Start and run engine until completely warm. Drain engine oil and replace filter element, refill with fresh oil. If vehicle is equipped with air conditioning, the unit should be operated during this final engine warm-up to lubricate compressor seal.

Gasoline Engines Only — After the oil has been replaced, remove air cleaner and pour 1/2 to 1 pint of 10W or lighter oil into carburetor air intake with engine running. Pour slowly at first, then rapidly using last quarter to stall engine. Replace air cleaner.

REACTIVATING VEHICLE AFTER EXTENDED STORAGE

- Check oil and fluid levels and replenish as necessary in the following components: engine, radiator, crankcase, transmission and differential. Check gasoline supply. If the vehicle is equipped with air conditioning, refer to the procedure which follows below.
- Check under hood and under vehicle for nesting creatures and evidence of leakage of oils or fluids or physical damage.
- Inflate tires to recommended pressure.
- Clean battery end of cables and install fully charged battery.
- Lubricate chassis suspension and steering components.
- Check brake operation and fluid level. Bleed and adjust brakes if necessary.
- Remove spark plugs and clean and gap (gasoline engines).
- Check and clean carburetor air filter assembly.

IF VEHICLE IS EQUIPPED WITH AIR CONDITIONING

- Disconnect the compressor clutch wires before attempting to start vehicle.
- Check to see if compressor hub and clutch driver can be turned by hand. If not, the unit should be broken loose by manually turning the shaft with a wrench on the shaft lockout on the clutch driver plate. A few "rocking" turns should be sufficient so that the shaft can be turned by hand.
- Reconnect coil wires and check belt tension. Run engine with air conditioning on for a minute or two to reseal system.
- Check the refrigerant. This can be done by checking for air bubbles in the sight glass on the top of the receiver-dehydrator (on vehicles so equipped).

PREPARING THE MOTOR HOME FOR STORAGE (Cont'd)

BATTERY MAINTENANCE DURING VEHICLE STORAGE

Parasitic loads (drains) from the radio, clock, ECM, courtesy lights, and other accessories will discharge batteries in vehicles not used for an extended period of time, or especially during vehicle storage. Provisions to maintain a proper state of charge of batteries in these vehicles is necessary. The discharged batteries can freeze at temperatures as high as 32°F, resulting in permanent damage. Other permanent damage may also result to batteries allowed to stand discharged for extended periods.

To alleviate battery discharge, the negative battery cable should be disconnected on vehicles which are not going to be in service within a 20-day period. If this is not possible, batteries should be checked every 20-45 days, and recharged if necessary. If the "green dot" of the battery is not visible, then the battery must be recharged. (Check the battery maintenance and inspection procedures information in the Engine Electrical System section of this manual.)

Disconnected batteries will also self-discharge, especially in higher ambient temperatures; therefore, even disconnected batteries should be checked for a "green dot" every four months and recharged if necessary.

In addition, any electrical connections or fuses removed or disconnected to reduce parasitic loads should be reinstalled or connected prior to reactivating the vehicle after extended storage.

NOTE: The ignition switch must be OFF when connecting the battery cables or a battery charger. Failure to do so may overload or damage the ECM or other electronic components from voltage spikes which can occur during these operations.

APPENDIX C

NUT AND BOLT IDENTIFICATION

The following is presented as an aid to the motor home owner in understanding some of the problems of threaded fasteners, as well as to provide information to make better, safer and more permanent repairs.

- Every mechanic knows from experience that any nut or bolt can be overtightened to the point of failure. Few realize that nuts and bolts can also fail or break in service if not tightened enough.
- Loose nuts result from using the wrong grade bolt as often as from undertightening.
- In critical applications, standard threaded nuts used more than once can cause failure of the bolts they are installed on.
- There is a right way and a wrong way to install a flat washer on a bolt. An improperly installed flat washer can cause bolt failure. (See NOTE in Washer Applications section of this Appendix.)

FORCES ACTING ON NUTS AND BOLTS

To understand some of the problems of threaded fasteners, it is necessary to understand several factors concerning the forces that act upon nuts and bolts as well as the properties of the materials nuts and bolts are made from.

TENSION — One of the basic forces acting upon a nut and bolt is tension. Under tension, all grades of steel bolts will stretch. Up to a point (called the "yield point"), this stretching is not permanent and the bolt will return to its original dimensions once the tension has been removed. If the load is great enough to cause the bolt to stretch 2/10 of one percent of its original length, the stretching will become permanent.

TENSILE STRENGTH — Once the yield point of a bolt has been exceeded, the bolt will continue to support increasing loads but it will also stretch rapidly and permanently until the tension load equals the tensile strength. Tensile strength determines the point at which a bolt will break.

PROOF LOAD — Successful applications of nuts and bolts are achieved when the tension in the bolt comes as close as practical to the yield point without exceeding that point. This tension is called the "proof load" and is the maximum load the bolt can support.

TORQUE OR TORSION — It would be extremely convenient if the tension or clamping force of a bolt could be measured directly "in the field," however, this direct measurement cannot be accomplished successfully. The measurement must be made indirectly using another force that acts upon nuts and bolts. This force is referred to as torsion or torque. Torque is the twisting force that is applied to the nut and bolt during tightening.

When the bearing surfaces of a nut and bolt touch the workpieces that are being fastened together, friction is generated in two places; (1.) at the flanks of the threads on the bolt and nut and, (2.) at the point of contact of the nut or bolt head and the workpiece. About 40 percent of the torque (or twisting force) applied to a nut or bolt being tightened is expended overcoming thread friction while 50 percent of the torque input is lost to friction between the nut and the workpiece. This leaves 10 percent of the torque applied to new unlubricated nuts and bolts being available for bolt stretch or clamping force.

WASHER APPLICATIONS

Two of the most important parts of a well-engineered bolt are the washer face and the fillet where the shank of the bolt joins the head of the bolt.

WASHER FACE — The washer face is the raised portion of the head that contacts the workpiece. The washer surface keeps the hex points of the bolt head from digging into the workpiece and increasing the installation torque. This prevents a false torque wrench reading which would result in an undertightened bolt. The washer surface of the bolt has the same area as the bearing surface of the nut so that friction or torque will be equal whether the nut or bolt is actually being tightened.

FILLET — The fillet is the small radius or curve between the side of the shank and the washer face of the bolt. The purpose of the fillet is to reduce concentrations of stress where the bolt head and the shank of the bolt meet. A deep "scratch" in the fillet area could weaken the bolt to the point of causing the bolt head to break off under tension. One possible cause to this type of problem is the sharp edge of a drilled hole which digs into the fillet beneath the bolt head. As the sharp edge digs into the fillet, a small crack results which progresses to actual bolt failure when full tension is applied. The solution to this problem is to protect the fillet either by slightly countersinking the drilled hole to remove any sharp edge or by using a flat washer under the bolt head.

NOTE: There is a "right way" as well as a "wrong way" to install a flat washer. As part of the stamping process in making flat washers, every washer has both a "sharp" side and a slightly "rounded" side. Before using a flat washer, examine the washer closely to identify which side is sharp and which is slightly rounded. The rounded side must ALWAYS be placed next to the bolt head while the sharp side must be placed against the surface of the workpiece. Failure to position a washer in this manner defeats the purpose of the flat washer.

NUT AND BOLT IDENTIFICATION (Cont'd)

NUT AND BOLT FAILURE

Perhaps the most common cause of bolt failure is the use of too low a grade of bolt for the application. For example; a bolt that has a yield strength too low for the forces being applied will stretch permanently and when the equipment is shut-down and the load on the bolt relaxes, the result appears to be a loose nut. A service technician who spots the loose nut is going to tighten it; however, in this case tightening the nut and bolt will not solve the problem. When the equipment is started and the load is reapplied, the bolt will stretch again. The next time the load relaxes, the nut will again be loosened. Again the service technician will tighten the nut although this time the technician will probably apply additional force. If the bolt breaks, as it usually does, it is replaced with the same grade of bolt as the original and the process repeats itself.

There are several ways to avoid this cycle from occuring. They are:

1. Drill out the hole and replace the original bolt with one of the same grade having a larger diameter.

2. Use a higher grade bolt than the original.

3. In some cases, it may be possible to substitute a fine-thread nut and bolt for a coarse-thread nut and bolt of the same grade and diameter. Fine-thread bolts tend to be about 10 percent stronger than their coarse-thread counterparts.

Just as important as using the correct grade nut and bolt for a job is the necessity for the nut, bolt and washer to be matched to each other. If a low-grade nut is used with a high-grade bolt, it is very likely that the threads of the nut will either "strip out or freeze" to the bolt before the proper torque can be achieved. A soft flat washer used with a high-strength bolt and matching nut will have a tendency to compress or "brinnel" under specified torque settings. This situation reduces the bolt's tension and makes it subject to fatigue failure. A hardened washer is heat treated and "file hard."

HEAT-TREATED BOLT — Bolts of Grade 5 and higher are heat treated for greater strength. When these bolts are used in areas of vibration, extra care must be taken to be certain they are properly installed and tightened to avoid fatigue failure.

If a heat-treated bolt is installed without being tightened to its design torque (i.e., undertightened), the operational loads placed on the bolt (vibration, shock or impact) will exceed the clamping force applied using a wrench. Any shock or vibrational load above the yield point of the bolt will cause the bolt to stretch and relax like a spring. Providing that the stretch does not exceed 2/10 percent of the grip length of the bolt, the bolt will return to its previous length when the load is relaxed. However, the ability of heat-treated bolts to withstand repeated stretching and relaxing is limited. Continuous stretching of a heat-treated bolt causes tiny cracks to form at areas where stress is concentrated. These areas can be at the root of the threads, at the fillet under the head of the bolt, or anywhere there is a surface flaw such as a nick or scratch. In time, these cracks will widen and the bolt will fail.

FATIGUE FAILURES

Bolts must be tightened properly to eliminate repetitive stretching problems. Correct torque must be applied so that the clamping force that is generated is greater than any load the fastened workpieces would be subjected to. Correct torque ensures that a bolt is properly "pre-loaded." A pre-loaded bolt does not continually stretch and spring back, or is not subject to fatigue and/or failure.

Fatigue failures can also be caused by undertightening or reusing nuts and bolts in critical applications. The nut is perhaps the most dangerous fastener to use more than one time. The reason for this is that standard nuts have to be made softer than the bolts they match. Failure occurs because the threads of a new nut become slightly (but permanently) compressed when tightened the first time. This is referred to as the nut being "plastically" deformed. The second time the nut is used, the threads grip the bolt a little "tighter" using more of the applied torque to overcome thread friction and less of the torque to clamping force. Each time the nut is reused it loses more of its clamping power. The result is the same as an undertightened assembly even though a service technician were to follow a torque chart and use a torque wrench.

In some cases, nuts that have been reused as few as five times have been shown to be capable of only 57 percent of their original clamping force. Such a loss of pre-load would not only allow parts to shift out of alignment, it could also encourage fatigue failure.

In vibration areas, any condition that prevents a bolt from being properly pre-loaded or that causes the pre-load to deteriorate will activate fatigue failure. Quite often the initial tension is lost due to gasket compression, soft washers, "mushing out," etc.

TORQUE WRENCH APPLICATION

"DO NOT LUBRICATE" should become a common practice when using a torque wrench and standard torque tables. All torque chart values are valid only for clean, dry threads on new nuts and bolts unless otherwise called for in specific shop manual applications.

NUT AND BOLT IDENTIFICATION (Cont'd)

The reason for this is that any sort of lubrication cuts thread friction which allows more of the tightening torque to be converted to clamping force than has been accounted for in the torque chart. True DRY threads seldom exist as there are degrees of "oiliness" of different thread lubricants. If oiled threads or anti-sieze compounds are called for in a shop manual application, the manual will also call out a specific torque value for the area discussed. A manual might ask for a 10 percent reduction of torque when engine oil is a lubricant to as high as a 40 percent reduction of torque from the normal torque chart values when an anti-sieze compound is used.

A new torque method is being used in certain shop manual applications which is called a torque turn technique. Using this method, the bolt is torqued to a very low setting which is easy to obtain. Friction of the bolt head and/or dirt in the threads are of little consequence as this method is essentially a "snugging" process. After "snugged" to the light torque value called for, the shop manual will call for an additional 90 degree turn, or some specific number of degrees. Using elaborate measuring procedures, GM Engineering has determined that a service technician can arrive at a near ideal amount of bolt stretch for the given bolt size and application and an ideal clamp load of the workpieces.

STANDARDS FOR NUT AND BOLT GRADES

The basic standards for nut and bolt grades were established by the Society of Automotive Engineers (S.A.E.). General Motors has a corresponding rating system.

There are four basic grades of bolts used in assembly today. They are as follows:

1. **S.A.E. GRADE 1, 2, 3, & 4 (GM-260M)** — All have unmarked bolt heads and are not heat treated.

2. **S.A.E. GRADE 5 (GM-280M)** — All have three (3) lines on the bolt head dividing the head into three equal parts. These bolts are carbon steel with rolled heads, quenched and tempered in oil or water.

3. **S.A.E. GRADE 6 & 7 (GM-290M)** — All have four (4) or five (5) lines on the bolt head which divide this head into quarters or fifths. These bolts are medium carbon alloy steel with rolled heads, heat treated, quenched in oil and drawn.

4. **S.A.E. GRADE 8 (GM300M)** — All have six (6) marks on the bolt head equally spaced around the top. These bolts are made from carbon alloy steel, heat treated, oil quenched and temper drawn at 800 degrees Fahrenheit.

Nuts are available in three standard grades as follows:

1. **S.A.E. GRADE 2** — These are square nuts and are used in some basic farm machinery, construction and industrial machines. They are usually quite bulky and do not contain the quality of steel used in automotive nuts.

2. **S.A.E GRADE 5 (GM-286M)** — These nuts are made of medium carbon steel and are not marked. They may be plain steel or zinc coated and are used on bolts up through S.A.E. Grade 5 or GM-280M bolts.

3. **S.A.E. GRADE 8 (GM-301M)** — These nuts are made of medium carbon steel that is heat treated and quenched. They are marked with three (3) dots equally spaced around the top surface of the nut. GM-301M nuts are made of special steel and are identified by a copper flash or yellow chromate finish. Thick nuts such as those used on spring U-bolts are also special nuts that should not be substituted.

NOTE: S.A.E. GRADE 6 & 7 and GM-290M bolts are production-only parts and not carried by GM parts. If a replacement is needed, use Grade 8.

SERVICE TIPS

Some important points to observe are as follows:

- Always consult the appropriate shop manual for a given bolt torque as the first torque preference. The following torque charts are helpful for non-listed bolts.

- USE A TORQUE WRENCH. Hand tightening is simply a guessing game. An impact wrench (rattle gun) is more of a guessing game than hand tightening.

- Never replace a bolt with one of a lesser grade than the original.

- Do not exceed the nut or bolt torque listed on the charts for the grade and size bolt being used.

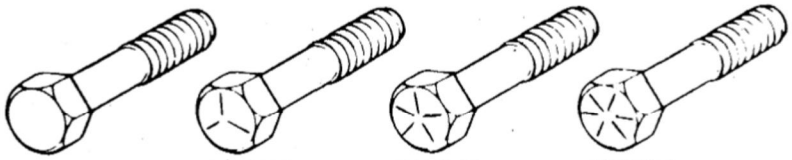
- Use lubricant on the bolt threads and/or head bearing surface **ONLY** when called for in the service manual.

- Avoid using an impact wrench (rattle gun) to apply torque values to any nut or bolt. (NOTE: Some factory assembly line rattle guns can be used as they are generally used in a specific application and torque accuracy is checked each shift.) If an impact wrench is used on torque prevailing nuts and bolts (nylon washer, strip or patch), it is recommended that the fasteners be replaced, due to the abuse of the impact gun.

NUT AND BOLT IDENTIFICATION (Cont'd)

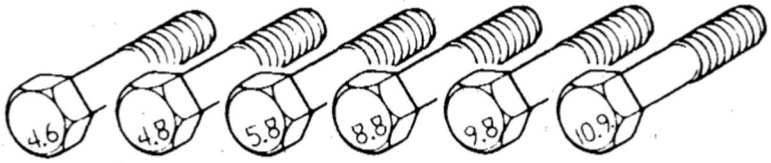
Common metric fastener strength property classes are 9.8 and 10.9 with the class identification embossed on the head of each bolt. Customary (inch) strength classes range from grade 2 to 8 with line identification embossed on each bolt head. Markings correspond to two lines less than the actual grade (i.e. grade 7 bolt will exhibit 5 embossed lines on the bolt head). Some metric nuts will be marked with single-digit strength identification numbers on the nut face. The following figure illustrates the different strength markings.

NUT AND BOLT IDENTIFICATION

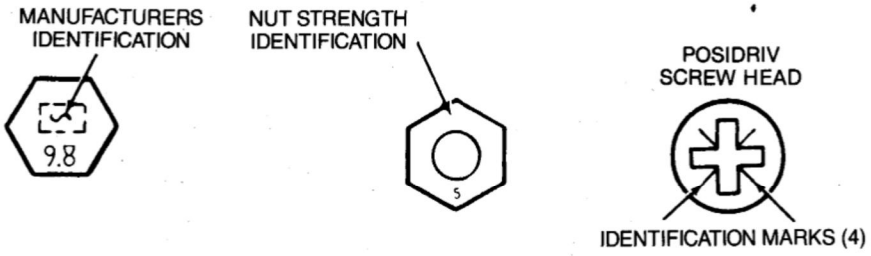


GRADE 2 (GM 260-M) | GRADE 5 (GM 280-M) | GRADE 7 (GM 290-M) | GRADE 8 (GM 300-M)

Customary (inch) bolts - Identification marks correspond to bolt strength - Increasing numbers represent increasing strength.

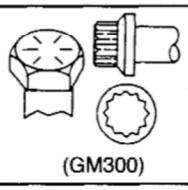


Metric Bolts - Identification class numbers correspond to bolt strength - Increasing numbers represent increasing strength.



NUT AND BOLT IDENTIFICATION (Cont'd)

STANDARD CAPSCREW MARKINGS AND TORQUE

Current Usage	Much Used	Much Used	Used at Times	Used at Times
Minimum Tensile Strength PSI MPa	To 1/2-69,000 [476] To 3/4-64,000 [421] To 1-55,000 [379]	To 3/4-120,000 [827] To 1-115,000 [793]	To 5/8-140,000 [965] To 3/4-133,000 [917]	150,000 [1,034]
Quality of Material	Indeterminate	Minimum Commercial	Medium Commercial	Best Commercial
SAE Grade Number	1 or 2	5	6 or 7	8
Capscrew Head Markings Manufacturer's marks may vary These are all SAE Grade 5 (3 lines)	(GM260)	(GM280)	 6 7 (GM290)	 (GM300)
Capscrew Body Size (Inches) – (Thread)	Torque Ft.-Lb. [N•m]	Torque Ft.-Lb. [N•m]	Torque Ft.-Lb. [N•m]	Torque Ft.-Lb. [N•m]
1/4 — 20	5 [7]	8 [11]	10 [14]	12 [16]
— 28	6 [8]	10 [14]		14 [19]
5/16 — 18	11 [15]	17 [23]	19 [26]	24 [33]
— 24	13 [18]	19 [26]		27 [37]
3/8 — 16	18 [24]	31 [42]	34 [46]	44 [60]
— 24	20 [27]	35 [47]		49 [66]
7/16 — 14	28 [38]	49 [66]	55 [75]	70 [95]
— 20	30 [41]	55 [75]		78 [106]
1/2 — 13	39 [53]	75 [102]	85 [115]	105 [142]
— 20	41 [56]	85 [115]		120 [163]
9/16 — 12	51 [69]	110 [149]	120 [163]	155 [210]
— 18	55 [75]	120 [163]		170 [231]
5/8 — 11	83 [113]	150 [203]	167 [226]	210 [285]
— 18	95 [129]	170 [231]		240 [325]
3/4 — 10	105 [142]	270 [366]	280 [380]	375 [508]
— 16	115 [156]	295 [400]		420 [569]
7/8 — 9	160 [217]	395 [536]	440 [597]	605 [820]
— 14	175 [237]	435 [590]		675 [915]
1 — 8	235 [319]	590 [800]	660 [895]	910 [1234]
— 14	250 [339]	660 [895]		990 [1342]

1. Always use the torque values listed above when definite specifications are not available.

Note: Do not use standard values in place of those specified for the above engine groups. Special attention should be observed in case of SAE Grade 6, 7 and 8 capscrews. Refer to applicable Shop Manual.

2. The above is based on use of clean and dry threads.

3. Reduce torque by 10% when engine oil is used as a lubricant.

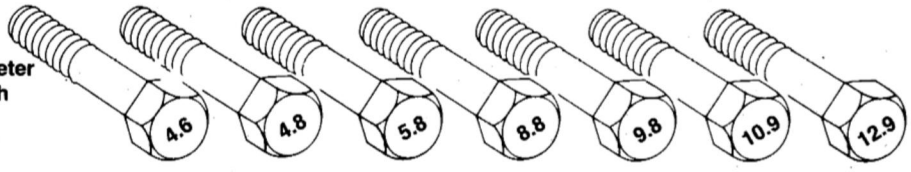
4. Reduce torque to 20% if new plated capscrews are used.

CAUTION: CAPSCREWS THREADED INTO ALUMINUM MAY REQUIRE REDUCTIONS IN TORQUE OF 30% OR MORE, UNLESS INSERTS ARE USED.

NUT AND BOLT IDENTIFICATION (Cont'd)

METRIC TORQUE CHART — NEWTON-METERS **

Metric Bolt Grade



		Torque Newton-meter						
M5	.197	3.2	4.4	5.5	7.2	8.8	12.1	13.2
M6	.236	5.5	7.7	8.8	12.1	15.4	19.8	23.1
M7	.276	8.8	12.1	15.4	21.9	26.4	30.3	38.5
M8	.315	13.2	17.6	22.0	29.7	37.4	48.4	55.0
M10	.394	25.3	35.2	40.4	60.5	77.0	93.5	110.0
M12	.472	44.0	61.6	77.0	104.5	132.0	165.0	198.0
M14	.551	71.5	99.0	121.0	132.0	209.0	264.0	308.0
M16	.630	110.0	154.0	187.0	297.0	319.0	418.0	484.0
M20	.787	220.0	291.5	363.0	572.0	693.0	814.0	946.0
M24	.945	374.0	506.0	638.0	1012.0	1199.0	1386.0	1628.0
M30	1.181	748.0	1166.0	1440.0	2002.0	2387.0	2772.0	3234.0

1. Always use the torque values listed above when definite specifications are not available.
2. The above is based on use of clean and dry threads.
3. Reduce torque by 10% when engine oil is used as a lubricant.
4. Reduce torque to 20% if new plated capscrews are used.

CAUTION: CAPSCREWS THREADED INTO ALUMINUM MAY REQUIRE REDUCTIONS IN TORQUE OF 30% OR MORE, UNLESS INSERTS ARE USED.

**** NOTE: Use only when manufacturer's specifications are not available. These values are for stiff metal-to-metal joints and are based on 90% of proof load. Do not use for gasketed joints or joints of soft materials.**

NUT AND BOLT IDENTIFICATION (Cont'd)

NON-LISTED TORQUE VALUES

Pipe Plugs and Fittings Torque

Pipe Thread Size	In Bosses or Aluminum Ft./Lb. [N•m]	In Case Iron or Steel Ft./Lb. [N•m]
1/16	3.3-3.7 [4.5-5.0]	5-10 [7-14]
1/8	5-10 [7-14]	10-15 [14-20]
1/4	10-15 [14-20]	15-20 [20-27]
3/8	15-20 [20-27]	20-25 [27-34]
1/2	20-25 [27-34]	35-40 [47-54]
3/4	30-35 [41-47]	50-55 [68-75]
1	40-45 [54-61]	65-70 [88-95]
1-1/4	50-55 [68-75]	80-85 [108-115]
1-1/2	60-65 [81-88]	95-100 [129-136]

Hose Swivel Nut Torque

Hose Size	Torque Ft./Lb. [N•m]
No. 4	4.5-5 [6-7]
No. 6	5-10 [7-14]
No. 8	15-20 [20-27]
No. 10	25-30 [34-41]
No. 12	35-40 [47-54]
No. 16	50-60 [68-81]
No. 20	65-75 [88-102]
No. 25	90-100 [122-136]
No. 32	130-140 [176-190]

Flared (Internal or External) Tube Nut Torque

Tube Size	Torque Ft./Lb. [N•m]
3/16	7-7.5 [9-10]
1/4	10-15 [14-20]
5/16	15-20 [20-27]
3/8	20-25 [27-34]
1/2	25-30 [34-41]
5/8	40-45 [54-61]
3/4	45-50 [61-68]
7/8	50-60 [68-81]
1	60-70 [81-95]

Note: Use these torque values when a specific torque is not listed.

Flexible Sleeve Tube Fitting Torque

Tube Size	Torque Ft./Lb. [N•m]
1/4 inch	5-10 [7-14]
1/2 inch	10-15 [14-20]
7/8 inch	15-20 [20-27]
1-1/4 inch	20-25 [27-34]

Hose Clamp Torque

Type	Torque In./Lb. [N•m]
T-Bolt	65-75 [7.3-8.5]
Worm Screw	35-45 [3.9-5.1]

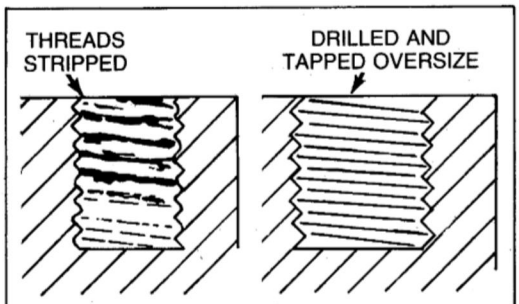
NUT AND BOLT IDENTIFICATION (Cont'd)

THREAD REPAIR INFORMATION

Occasionally, both internal and external threads may become only partially stripped. In such cases, they can often be repaired or cleaned up through the use of a thread die or tap.

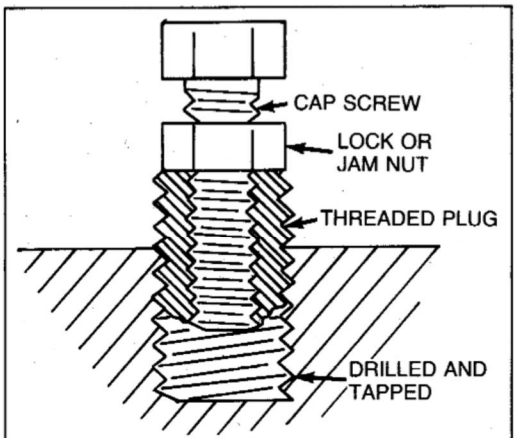
When threads in holes are damaged beyond repair, there are generally three choices of corrective actions. They are:

1. The hole may be drilled and tapped to the next suitable oversize and a larger diameter cap screw or stud installed. Use a chart to determine the proper tap size to use. A clearance or body drill (a drill that is the size of the bolt's major diameter) must be passed through the attaching part to allow an oversize cap screw to be used.



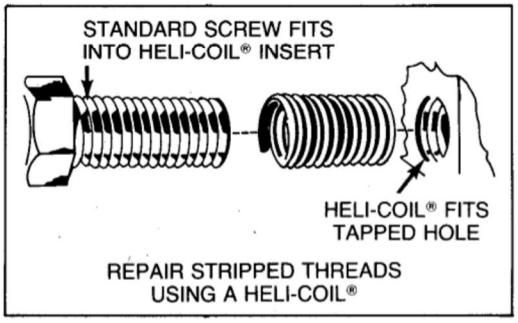
REPAIR STRIPPED THREADS BY DRILLING AND TAPPING TO NEXT OVERSIZE

2. The hole may be drilled and tapped to accept a threaded plug. The plug is drilled and tapped to the original screw size. A self-tapping plug that is already threaded to the original size may be used. For this repair, you must drill a hole to the specified size, run a threaded plug into the hole by using a cap screw and jam nut. When fully seated, the jam nut is loosened and the cap screw and jam nut are removed.



INSERT THREADED PLUG TO REPAIR STRIPPED THREADS

3. The hole may be drilled and tapped to accept a patented coil wire insert called a Heli-Coil®. A special tap is used that accomodates the odd size of the Heli-Coil®. The Heli-Coil® is then inserted using a special tool. This procedure brings the hole back to its original diameter and thread specifications. Heli-Coils® are available in standard threads as well as metric threads.



REPAIR STRIPPED THREADS USING A HELI-COIL®

WEIGHT DISTRIBUTION AND HELPFUL CONVERSIONS

Weight distribution of any special equipment item can be determined if the centerline (CL) or the center of gravity point is known in relation to the centerline of the axle. Once this dimension is known, divide this dimension by the wheelbase dimension.

The same rule applies if the centerline or center of gravity point is outside the wheelbase (such as a liftgate, snowplow or front-mounted winch).

Determine the distance from the closest axle and divide by the wheelbase. When the center of gravity point is outside the wheelbase, it results in negative weight distribution. In other words, the total amount of weight outside the axle is added to the closest axle plus the amount of weight that is taken off the opposite axle.

As an example, the body-payload weight distribution might be 9/91 percent for a 14-foot body with a 167-inch WB (wheelbase) — 102-inch CA (cab-to-axle).

Substituting the correct figures in the formula shown above would result in the following:

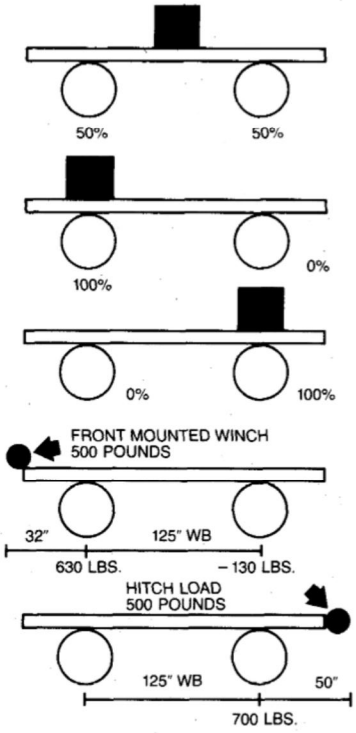
$$\frac{102 - 3 - 84}{167} = \frac{15}{167} = 8.98 \text{ or } 9\%$$

9% front, 91% rear

The 15″ listed above means that the centerline (CL) of the body is 15″ forward of the centerline (CL) of the rear axle.

Examples of weight distribution showing various factors appear on the chart below.

WEIGHT DISTRIBUTION FACTORS



WEIGHT DISTRIBUTION

LOAD CENTER DIRECTLY IN MIDDLE OF WHEELBASE.

50% FRONT AXLE
50% REAR AXLE

LOAD CENTER DIRECTLY OVER CENTERLINE OF FRONT AXLE.

100% FRONT AXLE
0% REAR AXLE

LOAD CENTER DIRECTLY OVER CENTERLINE OF REAR AXLE.

0% FRONT AXLE
100% REAR AXLE

LOAD CENTER OF WINCH 32″ BEYOND FRONT AXLE CENTERLINE. 32″ DIVIDED BY 125″WB = 26° 126% OF WINCH WEIGHT ON FRONT COMPONENTS. REAR COMPONENTS LIGHTENED BY 26%.

LOAD CENTER OF DEAD-WEIGHT HITCH LOAD 50″ BEHIND REAR AXLE CENTERLINE. 50″ DIVIDED BY 125″WB = 40%. 140% OF HITCH LOAD ON REAR COMPONENTS. FRONT COMPONENTS LIGHTENED BY 40%.

APPENDIX D

WEIGHT DISTRIBUTION AND HELPFUL CONVERSIONS (Cont'd)

HELPFUL CONVERSIONS AND CONSTANTS

MULTIPLY	BY	TO OBTAIN
Gallons	231.0	Cubic Inches
Gallons	3.785 4	Liters
Cubic Feet	1728.0	Cubic Inches
Cubic Feet	7.480	Gallons

1 Cubic Foot = 7.4805 Gallons
1 Cubic Foot = 1728 Cubic Inches
Pi = 3.14.16

To Determine
VOLUME OF A CYLINDER = Pi times radius squared times length or height.

Most RV hot water tanks are 6 gallons, figure 50 to 55 pounds to include water in the plumbing.

Propane tanks are never filled more than 80% by law to allow 20% expansion chamber for temperature changes.

To Determine
VOLUME OF A BOX = Length times height times depth.

To Determine
WEIGHT DISTRIBUTION INSIDE WHEELBASE = Number of inches behind front wheel divided by wheelbase. Example: 36″ divided by 178″ wheelbase equals 20% weight added to rear wheels, 80% to front axle.

WEIGHT DISTRIBUTION OUTSIDE WHEELBASE = Determine the distance from the closest axle and divide by the wheelbase. Example: a hitch 144″ behind the axle divided by wheelbase of 178″ equals 80% or 180% of hitch load on rear axle, the excess over 100% being removed from the front axle.

Typical Weights

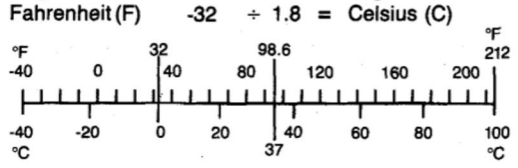
Water	8.328	pounds per gallon
Diesel fuel	7.0	pounds per gallon
Gasoline fuel	6.0	pounds per gallon
Propane C_3H_8	4.23	pounds per gallon

APPENDIX D

WEIGHT DISTRIBUTION AND HELPFUL CONVERSIONS (Cont'd)

METRIC — ENGLISH CONVERSION TABLE

MULTIPLY	BY	TO GET EQUIVALENT NUMBER OF:
	LENGTH	
Inch	25.4	millimeters (mm)
Foot	0.304 8	meters (m)
Yard	0.914 4	meters (m)
Mile	1.609	kilometers (km)
	AREA	
Inch^2	645.2	millimeters^2 (mm^2)
	6.45	centimeters^2 (cm^2)
Foot^2	0.092 9	meters^2 (m^2)
Yard^2	0.836 1	meters^2 (m^2)
	VOLUME	
Inch^3	16 387.	mm^3
	16.387	cm^3
	0.016 4	liters (l)
Quart	0.946 4	liters (l)
Gallon	3.785 4	liters (l)
Yard^3	0.764 6	meters^3 (m^3)
	MASS	
Pound	0.453 6	kilograms (kg)
Ton	907.18	kilograms (kg)
Ton	0.907	tonne (t)
	FORCE	
Kilogram	9.807	newtons (N)
Ounce	0.278 0	newtons (N)
Pound	4.448	newtons (N)
	TEMPERATURE	
Degree Fahrenheit (F)	-32 ÷ 1.8 =	degree Celsius (C)



MULTIPLY	BY	TO GET EQUIVALENT NUMBER OF:
	ACCELERATION	
Foot/sec^2	0.304 8	meter/sec^2 (m/s^2)
Inch/sec^2	0.025 4	meter/sec^2 (m/s^2)
	TORQUE	
Inch pound	0.112 98	newton-meters (N•m)
Foot pound	1.355 8	newton-meters
	POWER	
Horsepower	0.746	kilowatts (kw)
	PRESSURE OR STRESS	
Inches of water	0.249 1	kilopascals (kPa)
Pounds/sq. in.	6.895	kilopascals (kPa)
	ENERGY OR WORK	
BTU	1 055.	joules (J)
Foot pound	1.355 8	joules (J)
Kilowatt-hour	3 600 000. or 3.6 x 10^6	joules (J = one W's)
	LIGHT	
Foot candle	1.076 4	lumens/meter^2 (lm/m^2)
	FUEL PERFORMANCE	
Miles/gal	0.425 1	kilometers/liter (km/l)
Gal/mile	2.352 7	liters/kilometer (l/km)
	VELOCITY	
Miles/hour	1.609 3	kilometers/hr. (km/h)

WEIGHT DISTRIBUTION AND HELPFUL CONVERSIONS (Cont'd)

DECIMAL EQUIVALENTS

OF MILLIMETER, FRACTIONAL & NUMBER DRILL SIZES

1 mm = 0.03937 in.
1 cm = 0.3937 in.
1 dm = 3.937 in.
1 m = 39.37 in.
1 in = 25.4 mm
1 foot = 0.3048 m

1 yd. = 0.9144 m
1 sq. in. = 6.452 sq. cm
1 sq. ft. = 929 sq. cm
1 sq. yd. = 0.8361 sq. m
1 sq. cm = 0.155 sq. in.
1 sq. dm = 15.5 sq. in.

1 sq. m = 1.196 sq. yd.
1 oz. = 31.1035 grams
1 lb. = 373.24 grams
1 qt. = 0.9463 liters (liquid)
1 gal. = 3.7853 liters (liquid)
1 liter = 1.0567 liquid qt.

Milli-meter	Dec. Equiv.	Frac-tional	Num-ber	Milli-meter	Dec. Equiv.	Frac-tional	Num-ber	Milli-meter	Dec. Equiv.	Frac-tional	Num-ber	Milli-meter	Dec. Equiv.	Frac-tional	Num-ber	Milli-meter	Dec. Equiv.	Frac-tional
.1	.0039			1.75	.0689			—	.1570		22	6.8	.2677			10.72	.4219	27/64
.15	.0059			—	.0700		50	4.0	.1575			6.9	.2716			11.0	.4330	
.2	.0079			1.8	.0709			—	.1590		21	—	.2720		I	11.11	.4375	7/16
.25	.0098			1.85	.0728			—	.1610		20	7.0	.2756			11.5	.4528	
.3	.0118			—	.0730		49	4.1	.1614			—	.2770		J	11.51	.4531	29/64
—	.0135		80	1.9	.0748			4.2	.1654			7.1	.2795			11.91	.4687	15/32
.35	.0138			—	.0760		48	—	.1660		19	—	.2811		K	12.0	.4724	
—	.0145		79	1.95	.0767			4.25	.1673			7.14	.2812	9/32	—	12.30	.4843	31/64
.39	.0156	1/64	—	1.98	.0781	5/64	—	4.3	.1693			7.2	.2835			12.5	.4921	
.4	.0157			—	.0785		47	—	.1695		18	7.25	.2854			12.7	.5000	1/2
—	.0160		78	2.0	.0787			4.37	.1719	11/64	—	7.3	.2874			13.0	.5118	
.45	.0177			2.05	.0807			—	.1730		17	—	.2900		L	13.10	.5156	33/64
—	.0180		77	—	.0810		46	4.4	.1732			7.4	.2913			13.49	.5312	17/32
.5	.0197			—	.0820		45	—	.1770		16	—	.2950		M	13.5	.5315	
—	.0200		76	2.1	.0827			4.5	.1771			7.5	.2953			13.89	.5469	35/64
—	.0210		75	2.15	.0846			—	.1800		15	7.54	.2968	19/64	—	14.0	.5512	
.55	.0217			—	.0860		44	4.6	.1811			7.6	.2992			14.29	.5625	9/16
—	.0225		74	2.2	.0866			—	.1820		14	—	.3020		N	14.5	.5709	
.6	.0236			2.25	.0885			4.7	.1850		13	7.7	.3031			14.68	.5781	37/64
—	.0240		73	—	.0890		43	4.75	.1870			7.75	.3051			15.0	.5906	
—	.0250		72	2.3	.0905			4.76	.1875	3/16	—	7.8	.3071			15.08	.5937	19/32
.65	.0256			2.35	.0925			4.8	.1890		12	7.9	.3110			15.48	.6094	39/64
—	.0260		71	—	.0935		42	—	.1910		11	7.94	.3125	5/16	—	15.5	.6102	
—	.0280		70	2.38	.0937	3/32	—	4.9	.1929			8.0	.3150			15.88	.6250	5/8
.7	.0286			2.4	.0945			—	.1935		10	—	.3160		O	16.0	.6299	
—	.0292		69	—	.0960		41	—	.1960		9	8.1	.3189			16.27	.6406	41/64
.75	.0295			2.45	.0964			5.0	.1968			8.2	.3228			16.5	.6496	
—	.0310		68	—	.0980		40	—	.1990		8	—	.3230		P	16.67	.6562	21/32
.79	.0312	1/32	—	2.5	.0984			5.1	.2008			8.25	.3248			17.0	.6693	
.8	.0315			—	.0995		39	—	.2010		7	8.3	.3268			17.06	.6719	43/64
—	.0320		67	—	.1015		38	5.16	.2031	13/64	—	8.33	.3281	21/64	—	17.46	.6875	11/16
—	.0330		66	2.6	.1024			—	.2040		6	8.4	.3307			17.5	.6890	
.85	.0335			—	.1040		37	5.2	.2047			—	.3320		Q	17.86	.7031	45/64
—	.0350		65	2.7	.1063			—	.2055		5	8.5	.3346			18.0	.7087	
.9	.0354			—	.1065		36	5.25	.2067			8.6	.3386			18.26	.7187	23/32
—	.0360		64	2.75	.1082			5.3	.2086			—	.3390		R	18.5	.7283	
—	.0370		63	2.78	.1094	7/64	—	—	.2090		4	8.7	.3425			18.65	.7344	47/64
.95	.0374			—	.1100		35	5.4	.2126			8.73	.3437	11/32		19.0	.7480	
—	.0380		62	2.8	.1102			—	.2130		3	8.75	.3445			19.05	.7500	3/4
—	.0390		61	—	.1110		34	5.5	.2165			8.8	.3465			19.45	.7656	49/64
1.0	.0394			—	.1130		33	5.56	.2187	7/32	—	—	.3480		S	19.5	.7677	
—	.0400		60	2.9	.1141			5.6	.2205			8.9	.3504			19.84	.7812	25/32
—	.0410		59	—	.1160		32	—	.2210		2	9.0	.3543			20.0	.7874	
1.05	.0413			3.0	.1181			5.7	.2244			—	.3580		T	20.24	.7969	51/64
—	.0420		58	—	.1200		31	5.75	.2263			9.1	.3583			20.5	.8071	
—	.0430		57	3.1	.1220			—	.2280		1	9.13	.3594	23/64	—	20.64	.8125	13/16
1.1	.0433			3.18	.1250	1/8	—	5.8	.2283			9.2	.3622			21.0	.8268	
1.15	.0452			3.2	.1260			5.9	.2323			9.25	.3641			21.03	.8281	53/64
—	.0465		56	3.25	.1279			—	.2340		A	9.3	.3661			21.43	.8437	27/32
1.19	.0469	3/64	—	—	.1285		30	5.95	.2344	15/64	—	—	.3680		U	21.5	.8465	
1.2	.0472			3.3	.1299			6.0	.2362			9.4	.3701			21.83	.8594	55/64
1.25	.0492			3.4	.1338			—	.2380		B	9.5	.3740			22.0	.8661	
1.3	.0512			—	.1360		29	6.1	.2401			9.53	.3750	3/8	—	22.23	.8750	7/8
—	.0520		55	3.5	.1378			—	.2420		C	—	.3770		V	22.5	.8858	
1.35	.0531			—	.1405		28	6.2	.2441			9.6	.3780			22.62	.8906	57/64
—	.0550		54	3.57	.1406	9/64	—	6.25	.2460		D	9.7	.3819			23.0	.9055	
1.4	.0551			3.6	.1417			6.3	.2480			9.75	.3838			23.02	.9062	29/32
1.45	.0570			—	.1440		27	6.35	.2500	1/4	E	9.8	.3858			23.42	.9219	59/64
1.5	.0591			3.7	.1457			6.4	.2520			—	.3860		W	23.5	.9252	
—	.0595		53	—	.1470		26	6.5	.2559			9.9	.3898			23.81	.9375	15/16
1.55	.0610			3.75	.1476			—	.2570		F	9.92	.3906	25/64	—	24.0	.9449	
1.59	.0625	1/16	—	—	.1495		25	6.6	.2598			10.0	.3937			24.21	.9531	61/64
1.6	.0629			3.8	.1496			—	.2610		G	—	.3970		X	24.5	.9646	
—	.0635		52	—	.1520		24	6.7	.2638			—	.4040		Y	24.61	.9687	31/32
1.65	.0649			3.9	.1535			6.75	.2656	17/64	—	10.32	.4062	13/32	—	25.0	.9843	
1.7	.0669			—	.1540		23	6.75	.2657			—	.4130		Z	25.03	.9844	63/64
—	.0670		51	3.97	.1562	5/32	—	—	.2660		H	10.5	.4134			25.4	1.0000	1

WEIGHT DISTRIBUTION AND HELPFUL CONVERSIONS (Cont'd)

TORQUE CONVERSION TABLE

NEWTON-METERS [N•m]	FOOT POUNDS (FT.-LBS.)
1	0.7376
2	1.5
3	2.2
4	3.0
5	3.7
6	4.4
7	5.2
8	5.9
9	6.6
10	7.4
15	11.1
20	14.8
25	18.4
30	22.1
35	25.8
40	29.5
50	36.9
60	44.3
70	51.6
80	59.0
90	66.4
100	73.8
110	81.1
120	88.5
130	95.9
140	103.3
150	110.6
160	118.0
170	125.4
180	132.8
190	140.1
200	147.5
225	166.0
250	184.4

FOOT POUNDS (FT.-LBS.)	NEWTON-METERS [N•m]
1	1.356
2	2.7
3	4.0
4	5.4
5	6.8
6	8.1
7	9.5
8	10.8
9	12.2
10	13.6
15	20.3
20	27.1
25	33.9
30	40.7
35	47.5
40	54.2
45	61.0
50	67.8
55	74.6
60	81.4
65	88.1
70	94.9
75	101.7
80	108.5
90	122.0
100	135.6
110	149.1
120	162.7
130	176.3
140	189.8
150	203.4
160	216.9
170	230.5
180	244.0

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CHEVROLET
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WARRANTY COVERAGE RECAP
1985 THRU 1994

LIGHT DUTY TRUCKS

COVERAGE	1992 1994 MTHS/MILES	1989 1990 1991 MTHS/MILES	1988 1ST OWNER & 2ND OWNER W/TRANS. MTHS/MILES	1988 2ND OWNER WITHOUT TRANSFER MTHS/MILES	DEL.ON / AFTER 3/16/87 1987 1ST OWNER & 2ND OWNER W/TRANS. MTHS/MILES	DEL.ON / AFTER 3/16/87 1987 2ND OWNER WITHOUT TRANSFER MTHS/MILES	DEL.BEFORE 3/16/87 1987 1ST OWNER & 2ND OWNER W/TRANS. MTHS/MILES	DEL.BEFORE 3/16/87 1987 2ND OWNER WITHOUT TRANSFER MTHS/MILES	1985 1986 MTHS/MILES
BASE WARRANTY (EXCEPT TIRES) (5)	36/36	36/50 (13)	12/12	12/12	12/12	12/12	12/12	12/12	12/12
AIR CONDITIONING	36/36 (15)	36/50 (14)	12/UNLTD	12/UNLTD	12/UNLTD	12/UNLTD	12/UNLTD	12/UNLTD	12/UNLTD
POWERTRAIN COMP. W/$100 DEDUCT AFTER 12/12	36/36 (15)	36/50	72/60	24/24	72/60	24/24	72/60	24/24	24/24
EMISSION PERFORMANCE WARRANTY (7)	60/50	60/50	60/50	60/50	60/50	60/50	60/50	60/50	60/50
DIESEL ENGINES W/100 DEDUCTIBLE AFTER 12/12	60/100 (17)	36/50 (16)	72/60	36/50	72/60	36/50	72/60	36/50	36/50

(5) = See separate warranty folder.
(7) = Refer to policies & procedures manual to see if owner qualifies for 60/50 coverage.
(13) = With $100 deductible after 12/12.
(14) = First 12 months / unlimited mileage - no deductible.
(15) = No deductible on portion factory installed = Condenser – Compressor.
(16) = 1990-91 has 60/100 warranty.
(17) = 1992 $100 deductible after 36/36.

CHEVROLET Geo

CHEVROLET MOTOR DIVISION
General Motors Corporation
Technical Service Department

Dealer Service Bulletin

90-391-5
Number:
5
Section:
December 1990
Date:
065020
Corporate Bulletin No.:

Subject: **AUTOMATIC APPLY PARKING BRAKE**

Model and Year: **1990 P3 MOTOR HOME (16,000# GVW ONLY)**

TO: ALL CHEVROLET DEALERS

THIS BULLETIN CANCELS AND SUPERSEDES DEALER SERVICE BULLETIN NO. 90-367-5, DATED OCTOBER 1990. THE MODEL DESIGNATION HAS BEEN CORRECTED. ALL COPIES OF 90-367-5 SHOULD BE DISCARDED.

The parking brake system on the 1990 16,000 pound GVW P3 motorhome chassis incorporates a unique automatic apply feature with an internal expanding parking brake. The system is different than the 1989 and 1991 systems of the same model. The parking brake is spring applied and hydraulically released. Hydraulic pressure is supplied by the power steering pump. Full brake disengagement requires that 95-115 PSI pressure exists at the brake actuator.

The parking brake can be applied by using a hand button or automatically when the shift lever is in the park position. The system features an HR-1 relay valve serving as a flow control point. The HR-1 reduces and directs flow to and from a spring actuator operating the parking brake (see Figure 1).

Operational Features

1. In the event the vehicle stalls, the wheels can be spun freely for at least ten minutes until pressure is drained from the brake actuator and the spring brake reapplies.

2. A parking brake light in the vehicle warns the operator when the brake is applied. This brake light will come on when the pressure at the actuator is less than 60 PSI.

Parking Brake Adjustment

1. Adjusting the brake-to-drum clearance.

   - Adjust screw through the drum opening until the brake just locks up.

   - Back off the adjuster two to four notches.

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Drum should spin free with only light drag.

2. Adjusting the cable free play (see Figure 2).
   - Loosen the jam nut towards the brake actuator.
   - Turn the 3-inch-long hex nut along the stud until no free play exists.
   - Move the jam nut until it is against the 3-inch-long hex nut.
   - The actuator should stroke between .75 and 1.00 inch when properly adjusted.
3. Adjust the transmission linkage (see Figure 3).
   - Apply the parking brake.
   - Loosen the screw (226).
   - Put the column selector lever in the neutral position. Put the lever into the neutral gate, do not use the indicator to find the neutral position.
   - To put the transmission in neutral, move the shift lever (A) to the forward position, then back to the second detent.
   - Hold the rod (240) tightly in the swivel (244). Tighten the nut (226) to 23 N.m (17 lbs. ft.).
   - Put the column selector lever in the "P" (park) position.
   - Check the adjustment. The column selector lever must go into all positions. The engine must start in the "P" (park) or "N" (neutral) positions only.

Bleed Procedure 1

1. Fill the power steering pump fluid reservoir to the proper level and let the fluid settle for at least a few minutes.
2. Start the engine and let it run for a few seconds; then turn off the engine.
3. Add fluid, if necessary.
4. Repeat the above procedure until the fluid level remains constant after running the engine.
5. Block the rear wheels or raise them off the ground.
6. Raise the front of the vehicle so the wheels are off the ground.
7. Start the engine, put the transmission in neutral, and place the park apply button in the release position. Slowly turn the steering wheel right and left, lightly contacting the wheel stops.

8. Check the fluid level and add fluid, if necessary.

9. Lower the vehicle and turn the steering wheel slowly from lock to lock.

10. Stop the engine. Check the fluid level and refill as required.

11. If the fluid is extremely foamy, allow the vehicle to stand a few minutes and repeat the above procedure.

12. If air still remains in the system, proceed on to bleed procedure 2.

Bleed Procedure 2

1. Secure the vehicle.

2. With the engine running, move the shift lever from the park to the neutral position.

3. Back off the bleed nut on the actuator and allow the system to self-bleed.

4. Tighten the actuator bleed part and cycle the system.

5. If air still remains in the system, proceed on to bleed procedure 3.

Bleed Procedure 3

1. Secure the vehicle.

2. Crack open the exhaust fitting of the manual control valve.

3. Engage the parking brake using the manual control valve.

4. Allow a small amount of fluid to bleed out of the fitting, then quickly tighten the fitting.

5. Repeat bleed procedures 1-3, as required.

Replacing the HR-1 Relay Valve

1. Removal

   - Block the wheels and shut off the engine.
   - Disengage the parking brake by running the actuator arm nut down against the bracket retaining the stud in a released position.
   - Mark all lines and fittings.
   - Remove all lines from the HR-1.

2. Installation

   - Connect all lines to the HR-1. Be careful to use the marks made upon removal.
   - Check fluid in reservoir.

- Perform system tests outlined in this service bulletin.
- Move the jam nut until it is against the 3-inch-long hex nut.

3. Adjusting the transmission linkage.

   - Refer to the service manual. 1990 R/V,G,P models 7A1-55 shift linkage adjustment.

HR-1 Relay Valve Bleeding Procedure 1

- Secure the vehicle.
- With the engine running, move the shift lever from the park to the neutral position.
- Open the port on the actuator and allow the system to self-bleed.
- Tighten the actuator bleed port and cycle the system.
- If a whine noise can be heard, air still remains in the system; proceed on to Bleeding Procedure 2.

HR-1 Relay Valve Bleeding Procedure 2

- Secure the vehicle.
- Crack open the exhaust fitting of the manual control valve.
- Engage the parking brake using the manual control valve.
- Allow a small amount of fluid to bleed out of the fitting; then quickly tighten the fitting.
- If air still remains in the system, bleed the power steering system as described in the service manual.

DIAGNOSTIC INFORMATION:

The following Diagnostics Charts 1 and 2 can be used to to determine if the Automatic Apply Parking Brake System is functioning normally and to identify what repairs may be required.

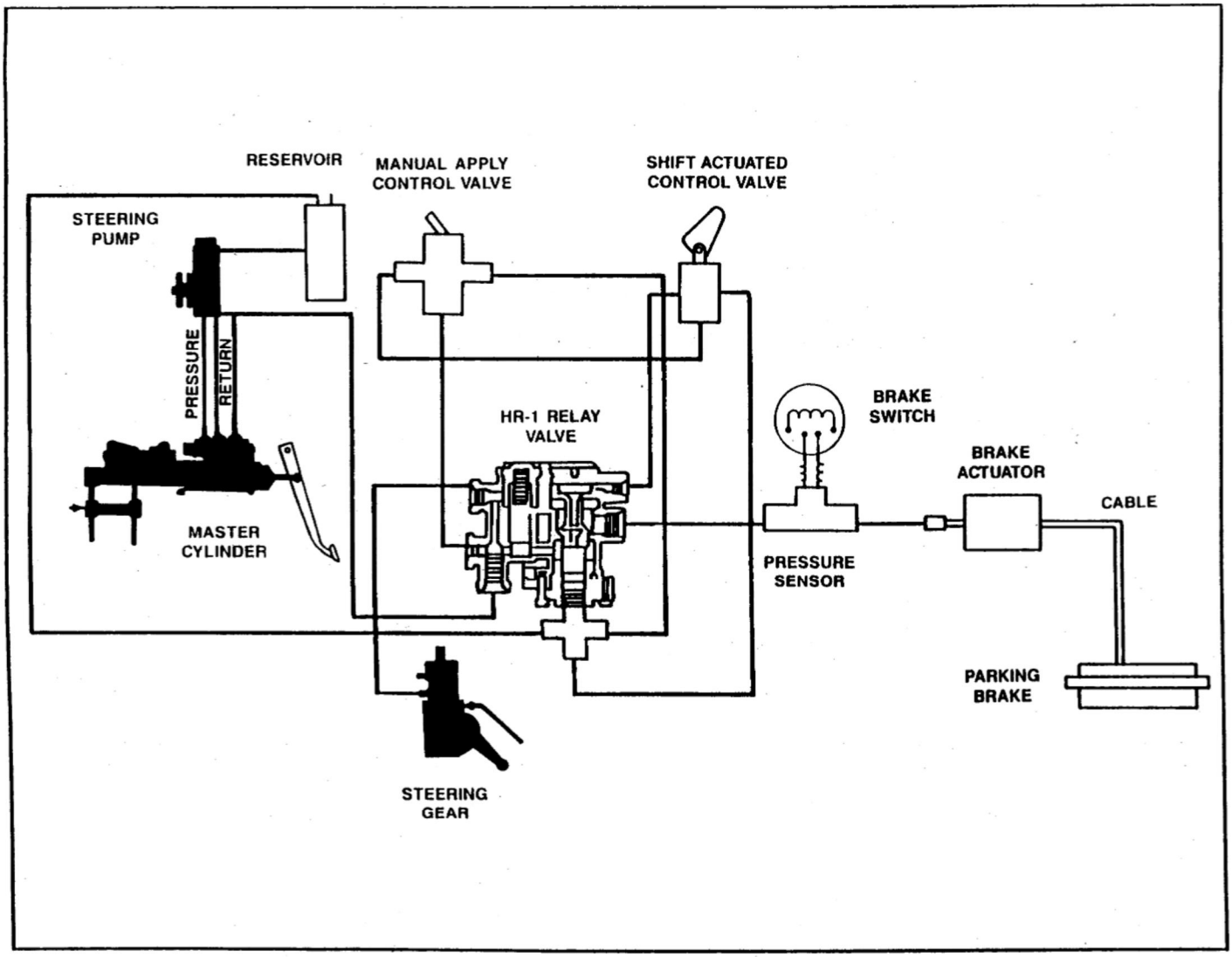
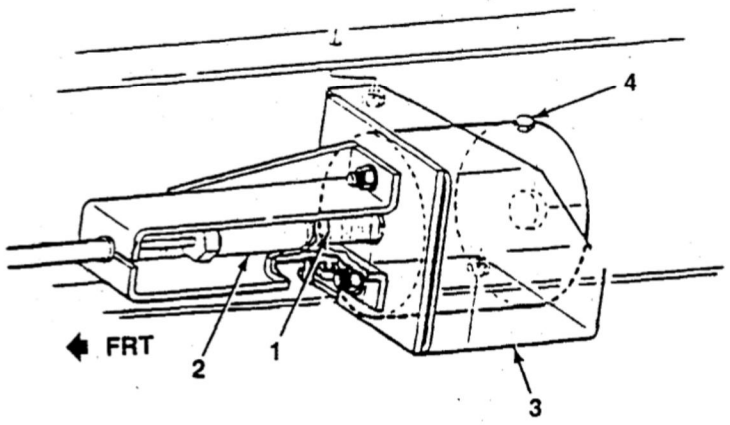


Figure 1—Parking brake system



1. JAM NUT
2. 3 INCH HEX NUT
3. ACTUATOR
4. BLEED PORT

Figure 2

NOTE: Improper adjustment of the park brake shoes or actuator can cause air noise in the power steering systems.

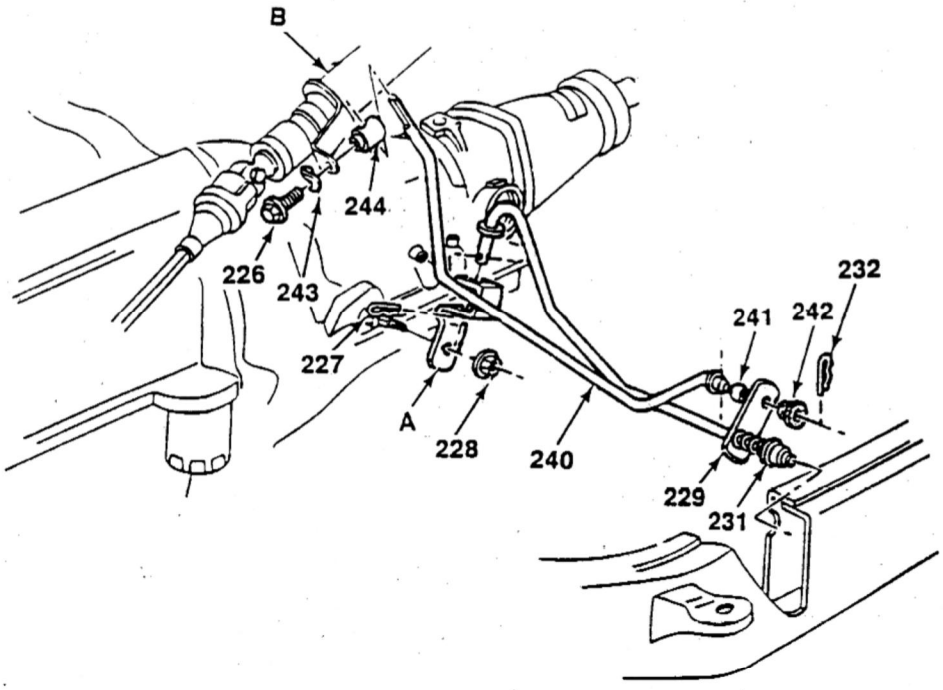
Step 1 - Reference page 6-9 propeller shaft drum-type brake adjustment.

Step 2 - Block wheels - Engine running - Park Position

A - Check actuator cable length inside support bracket to #2 hex nut.

B - Block wheels - Engine running - Neutral Position

CAUTION: Have someone in driver seat with service brake applied - recheck above cable length. Movement of cable should be 1.20 inches to 1.44 inches. Movement over 1.44 inches will allow power steering reservoir to empty and draw air causing power steering noise after each cycle of the actuator (See Figure 2).

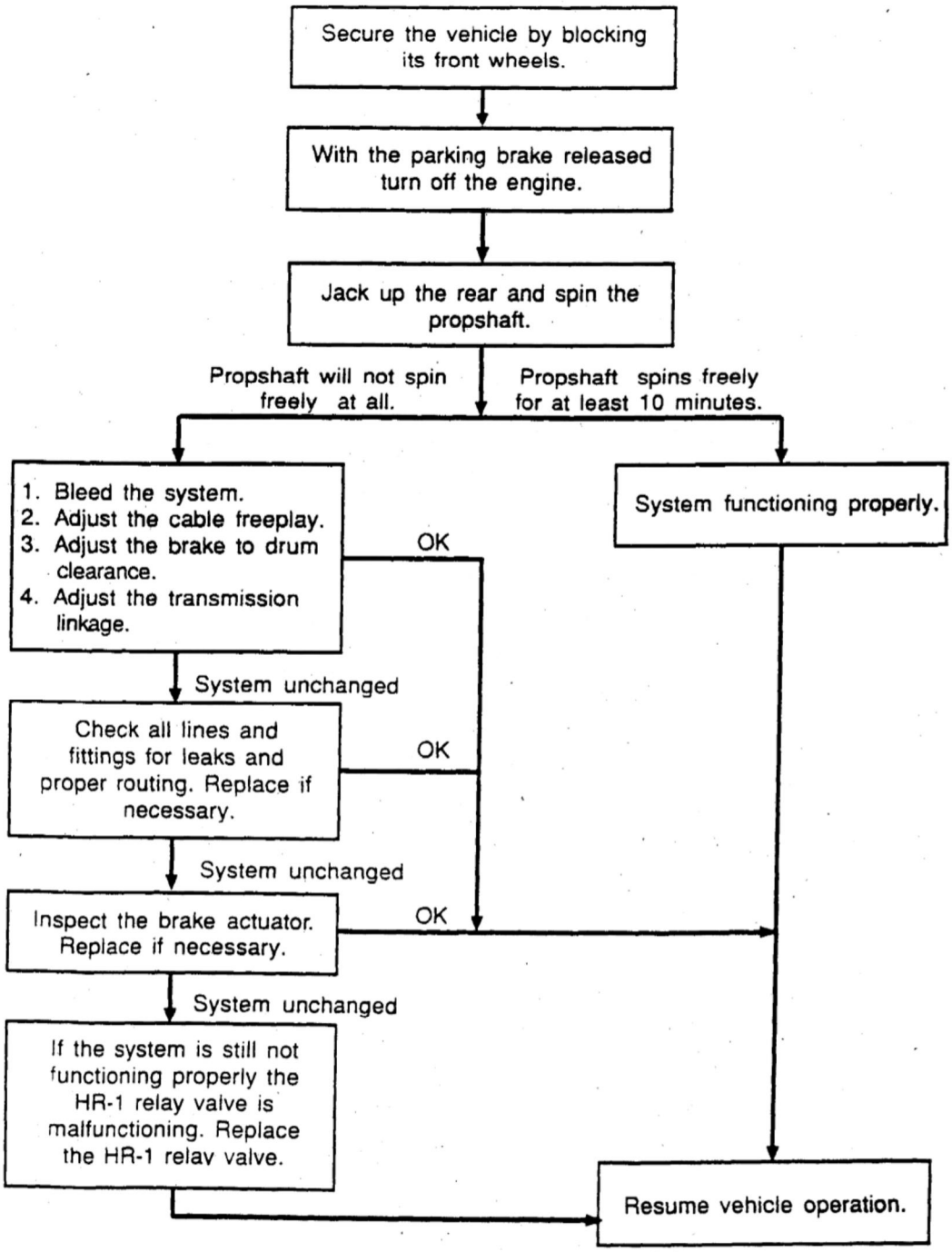


A. SHIFT LEVER
B. STEERING COLUMN
226. SCREW
227. RETAINING PIN
228. NUT
229. SPRING
231. INSULATOR
232. RETAINING PIN
238. EQUALIZER LEVER
240. ROD
241. BEARING
242. INSULATOR
243. WASHER
244. SWIVEL

Figure 3—Shift Linkage

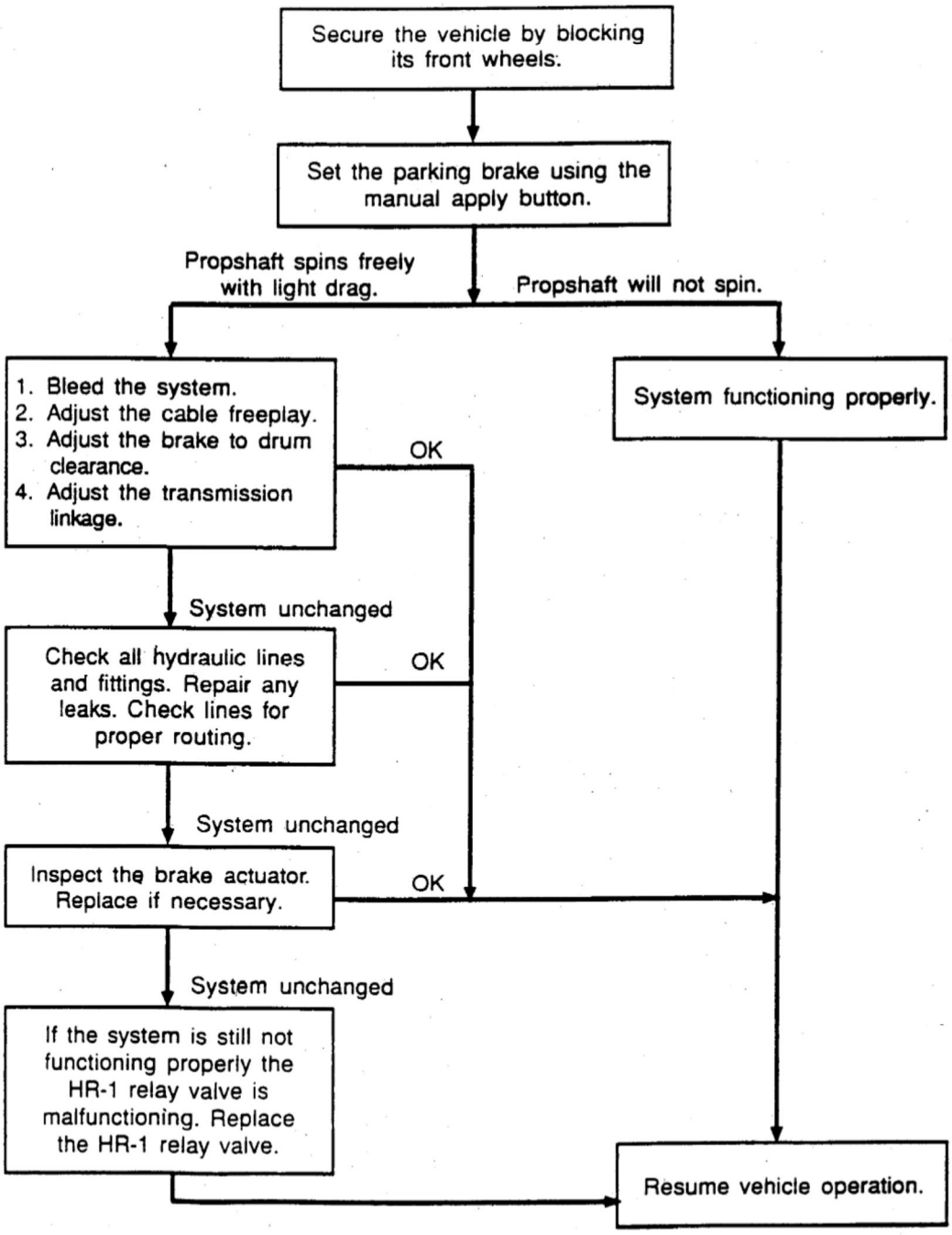
90-391-5

DIAGNOSTIC CHART 1



90-391-5

DIAGNOSTIC CHART 2



90-391-5

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CHEVROLET MOTOR DIVISION

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General Motors Corporation
Technical Service Department

Dealer Service Bulletin

Number:	90-435-5
Section:	5
Date:	OCT. 1991
Corporate Bulletin No.:	165007
ASE No.:	A5

Subject: **HYDRAULIC FLUID/LEAKING HYDRAULIC PARK BRAKE VALVE SEAL**

Model and Year: **1990 P3 16000 LB. MOTOR HOME (RPO C7P)**

Some owners of 1990 P3 16000# motor homes may experience a condition where the hydraulic park apply control valve leaks hydraulic fluid. This does not affect the parking brakes while they are applied. The cause may be an undersized O-ring which allows the fluid to pass out of the valve and/or a cap nut with insufficient thread which results in insufficient torque. For vehicles with the above condition, the O-ring and cap nut should be replaced and threaded surfaces torqued to the specifications listed below. Additional parts are provided in the repair kit and should be used if necessary.

Note: Excessive torquing of the cap nut (Figure 1, View A, #4) may result in the crushing of the bottom portion of the control valve.

SERVICE PROCEDURE: (Figure 1)

1. Place transmission in park position, set manual apply park brake by putting manual control knob in the on position. Leave the ignition in the off position. Put blocks on wheels.

2. Detach the left front wheel well panel. Retain all fasteners and panel for the reinstallation process. Locate the control valve (Figure 1). Prepare the removal area by having a towel or rag available to catch any oil leakage from the pipe/valve during removal.

3. Detach the supply pipe assembly at the elbow fitting (#5). Gently move pipe out of area to facilitate removal of the cap nut (#4) and elbow (Figure 1, View A, #5). The seal (#3) may not drop out due to oil viscosity; it may be necessary to use a thin pick to dislodge the seal (#3) from inside valve. Disconnect elbow from cap nut.

4. Prior to assembly, lubricate bores, O-ring, and threads with lubriplate (P/N 1050109) or equivalent. Install replacement O-ring (#3) over replacement cap nut (#4); place spring (#2) on inner pocket of cap nut (#4) and rest seal (#1) on top of the spring (#2). Balancing this assembly, gently raise into the valve body. Upon making contact with the valve, hand tighten assembly. Then torque cap nut (4) to 6-16 N.m. (5-12 lbs. ft.) in proper alignment with supply pipe.

5. Apply thread sealant to threads going into cap nut (#4) and threaded surface of elbow (#5). Thread elbow (#5) into cap nut (#4) and torque elbow to 12-14 N.m. (9-10 lbs. ft.). The final alignment of the elbow (#5) should be in the same direction as the plugged fitting located above the elbow (#5).

   CAUTION: Do not apply sealant over the elbow opening.

6. Reattach the supply pipe by gently bending it back into position; insert pipe into the elbow (#5) and torque the nut to 12-14 N.m. (9-10 lbs. ft.).

NOTE: To maintain proper fluid level throughout the bleed procedure, check and fill the power steering reservoir as necessary with power steering fluid (P/N 1050017).

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7. Leaving vehicle transmission in park position, bleed system by starting vehicle and allowing 30 seconds to elapse; then loosen the supply pipe nut just enough to allow air to escape the system. Prepare the area by having a towel or rag available to catch any oil leakage. When leakage occurs, retorque supply pipe nut to 12-14 N.m. (9-10 lbs. ft.). Put the manual control knob in "OFF" position, crack delivery ("DEL") fitting on manual control valve to bleed. Release and set the manual apply park brake six times to help the bleeding process. Retorque delivery fitting of manual control valve. Turn off engine; inspect valve and fitting for leakage; tighten as required.

8. Retrieve and reinstall retained fasteners and wheelhouse panel that were detached in Step 2.

SERVICE PARTS INFORMATION:

Part Number	Description	Quantity
15680238	Seal Repair Kit	1
1050109	Lubriplate	As Required
1050017	Power Steering Fluid	As Required
NPN	Teflon Tape	As Required

Parts are currently available from GMSPO.

WARRANTY INFORMATION:

For vehicles repaired under warranty use:

Labor Operation: T7296

Labor Time: 0.6 hr.

NOTE: Labor Operation is coded to base vehicle coverage in the warranty system.

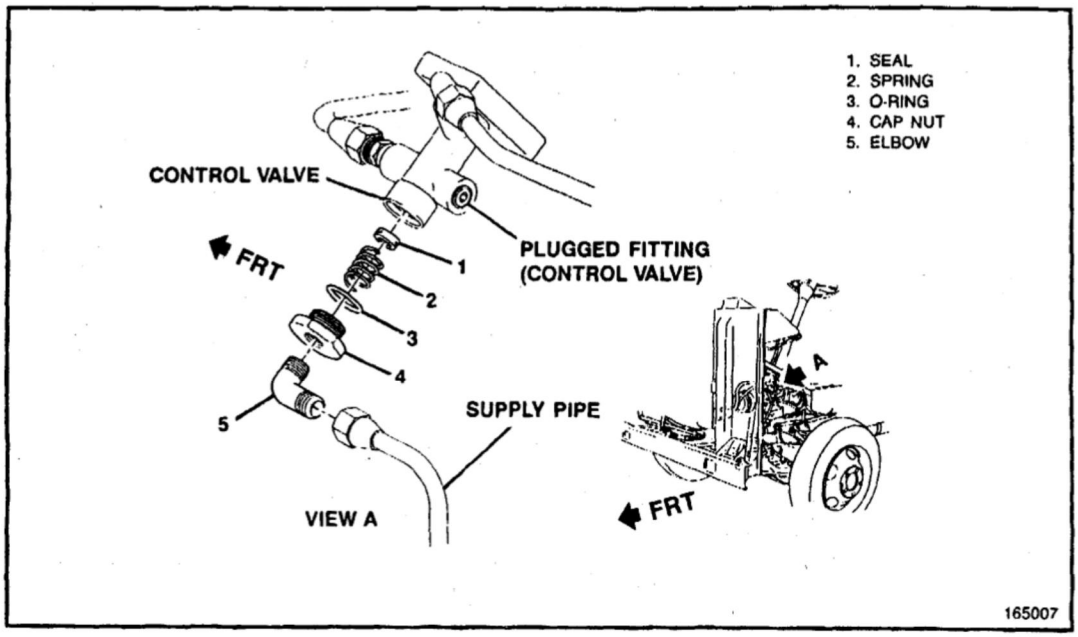


Figure 1

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CHEVROLET MOTOR DIVISION
General Motors Corporation
Technical Service Department

Dealer Service Bulletin

90-397-3B
Number:
3B
Section:
January 1991
Date:
063203
Corporate Bulletin No.:

Subject: **POWER STEERING PUMP NOISE/HIGHER FLUID PRESSURE**

Model and Year: **1990 P3 MOTORHOMES (16000# GVW ONLY)**

TO: ALL CHEVROLET DEALERS

Some of the above subject vehicles may experience higher noise due to vacuum buildup in the power steering reservoir.

To correct this condition, it is necessary to replace the power steering reservoir cap with a new vented cap and install a longer vent hose with a new fastening clamp.

SERVICE PARTS INFORMATION

Part Number	Description	Quantity Required
26018909	Cap	1
15654401*	Hose	1
1648216	Clamp	1

* Hose must be cut to 870mm length for proper protection of radiator from vented fluid.

Parts are currently available from GMSPO.

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CHEVROLET MOTOR DIVISION
General Motors Corporation
Technical Service Department

Dealer Service Bulletin

Number:	90-419-5
Section:	5
Date:	MAY 1991
Corporate Bulletin No.:	065024R

Subject: **AUTOMATIC/MANUAL APPLY PARKING BRAKE WILL NOT RELEASE/LEAKING POWER STEERING FLUID**

Model and Year: **1990 P3 MOTOR HOME CHASSIS**

Some 1990 P3 Motor Home Chassis 16000 Lbs GVW may experience fluid leaks near the hose clamps on the hydraulic manual apply park brake hose assembly. This will not allow the park brake to be released. This assembly was manufactured utilizing a hose and clamp assembly (Figure 1A).

To correct the above condition, a new crimped hose assembly (P/N 26025331) has been released (Figure 1B).

SERVICE PROCEDURE: (Figures 1A and 1B):

1. DO NOT put transmission selector in "Park" position. Use Neutral. DO NOT set manual park apply (leave "park brake" control knob in the OFF position, brake not applied). Ignition in the off position. Put blocks on wheels.

2. Remove the left front wheel well panel. Retain all fasteners and panel for the reinstallation process. Locate the return line hose from Figure 1A. Prepare the removal area by having a towel or rag available to catch any oil leakage from the hose during removal.

3. Obtain the replacement hose (P/N 26025331) prior to removing the old hose assembly.

4. Remove the clamped hose assembly, catch as much fluid as possible. Remove the O ring seal from the steering gear. Reinstall new O ring seal (P/N 26001594). Carefully seat O ring in steering gear seat. Install new hose (26025331) at steering gear and finger tighten. Then install hose at relay valve; again, finger tighten.

5. Torque the tube nut at the steering gear to 20-34 N.m (15-25 lbs. ft.) and the fitting at the valve assembly to 20-27 N.m. (15-20 lbs. ft.) (Figure 1B).

6. Bleed the power steering system. Using the procedures identified in the service manual for power steering, purge the system of air. After completion of the bleeding procedure reinspect the hose for any oil leaks. Retorque as required. Reinstall the wheel well panel.

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NOTE: Do not put transmission in "Park" position or apply manual control valve until after bleeding is completed.

SERVICE PARTS INFORMATION:

Part Number	Description	Quantity Required
26025331	Hose Assembly	1 (All P3 with 16,000 lb option C7P)
26001594	O Ring	1

Parts are currently available from GMSPO.

WARRANTY INFORMATION:

For vehicles repaired under warranty use:

Labor Operation: T7226

Labor Time: 0.7 hr.

Trouble Code: 92

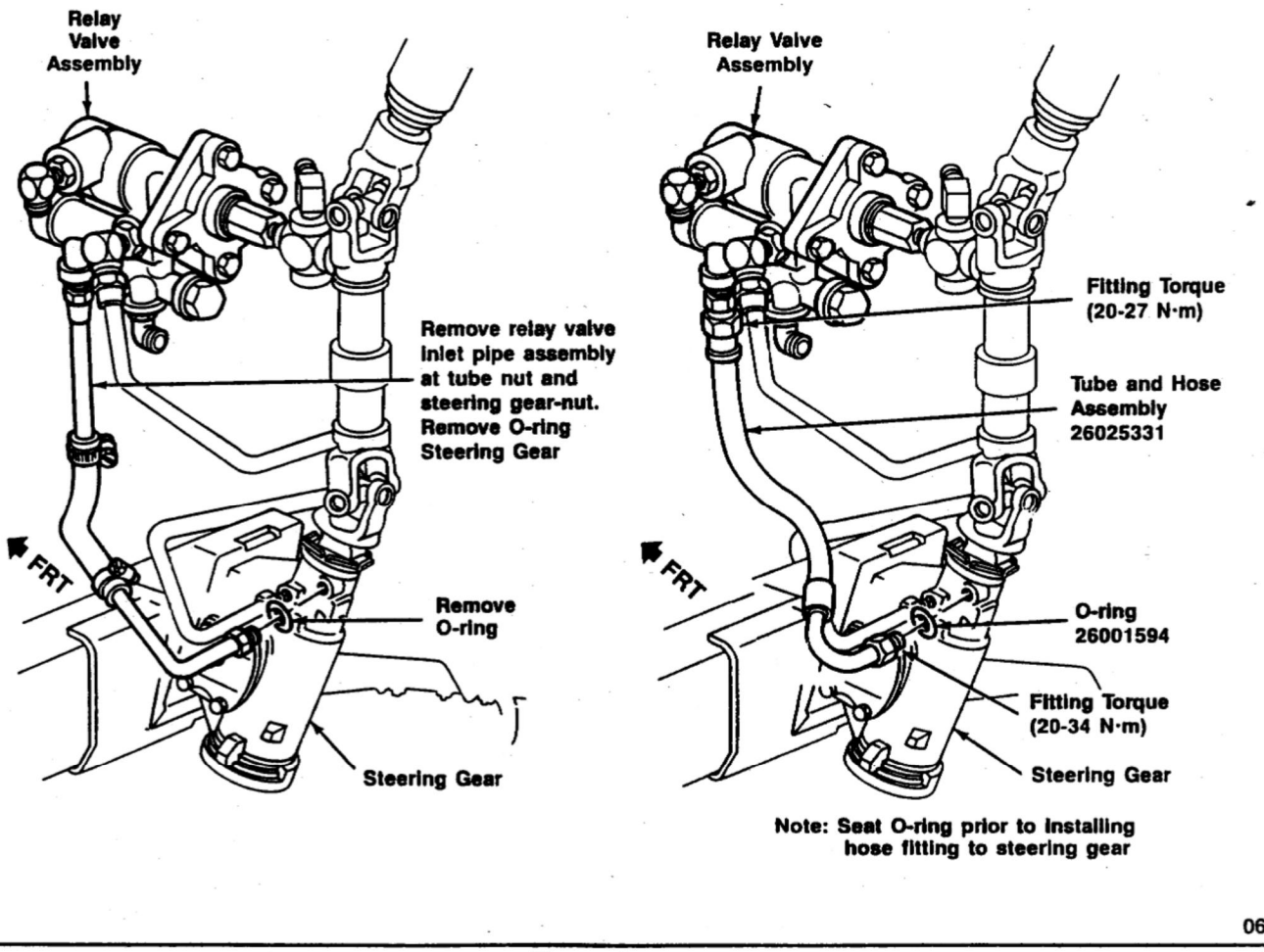

Removal Figure 1A
Relay Valve Assembly
Remove relay valve inlet pipe assembly at tube nut and steering gear-nut. Remove O-ring Steering Gear
FRT
Remove O-ring
Steering Gear
Installation Figure 1B
Relay Valve Assembly
Fitting Torque (20-27 N·m)
Tube and Hose Assembly 26025331
FRT
O-ring 26001594
Fitting Torque (20-34 N·m)
Steering Gear
Note: Seat O-ring prior to installing hose fitting to steering gear
065024

Figure 1

CHEVROLET Geo

CHEVROLET MOTOR DIVISION
General Motors Corporation
Technical Service Department

Dealer Service Bulletin

Number:	91-240-5
Section:	5
Date:	MARCH 1991
Corporate Bulletin No.:	065022

Subject: **AUTO APPLY PARKING BRAKE MAY NOT RELEASE**

Model and Year: **1990-91 P3 TRUCK**

Some 1990 - 1991 P3 Motorhomes with auto apply parking brake may not release. The cause may be loosening of the auto apply cable and/or the auto apply control valve. Follow the appropriate service procedure that addresses the condition.

AUTO APPLY CABLE ON 1990-91 P3 16,000# MOTORHOMES WITH C7P

The auto apply control cable may loosen or pull through the attaching clip. This loosening can be corrected by the replacement of the clip (2058447) and the installation of a new washer (2436161).

SERVICE PROCEDURE:(Figure 1):

1. Place shift lever in park, turn ignition key to the off position. Block the wheels to prevent vehicle movement during servicing.
2. Locate the park brake control cable under the instrument panel adjacent to the steering column (Figure 1).
3. Remove the bolt holding the cable in place. Retain the bolt and nut for the reinstallation procedure.
4. Remove the cable clip from the cable and discard. Utilizing a new clip (P/N 343464) attach the cable to the bracket using the existing bolt and nut and a new washer (P/N 2436161). Align the clip so that no kinking of the cable occurs during the tightening of the bolt and nut as shown in Figure 1.
5. Torque the nut to 6 - 9 N.m. (4.5 to 6.6 lbs. ft.).
6. Start the engine. Verify the vehicle's transmission is in the neutral position and the "park brake" control is applied. Release the "park brake" control and observe that light on dash goes out. Reapply the "park brake" control and observe that park brake actuates. Also verify that park brake cable operates smoothly.
7. Return vehicle to holding area; service inspection work is completed.

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SERVICE PARTS INFORMATION

Part Number	Description	Quantity
2436161	Washer	1 (all P30032 at 16,000 lb, Option C7P)
343464	Clip	1

WARRANTY INFORMATION

Labor Operation: T7216*

Labor Time: 0.2 hr.

TROUBLE CODE: 92

AUTO APPLY VALVE BRACE ON 1990 P3 16,000# MOTORHOMES WITH C7P

The auto apply control valve may loosen at the cam actuator arm. This condition can be corrected by the installation of a brace, (P/N 15666448).

SERVICE PROCEDURE (Figure 2):

1. Set parking brake, block wheels, ignition in the off position, and transmission in the park position.
2. Locate the park brake control valve on the left inside frame rail adjacent to the transmission shift control (Figure 2).
3. Remove the three bolts shown in figure 2. Discard the washers; retain the 5/16" bolt and nut. Obtain two new nuts and bolts for the lower mounting attachment.
4. Install the new brace (P/N 15666448) towards the transmission on the control valve so that the brace faces inboard. Install the two new lower bolts and nuts as shown. Reinstall the existing upper bolt and nut.

IMPORTANT: Nuts and bolts must be installed as shown in Figure 2 with the nuts clamping against the new brace.

5. Torque the two 1/4" nuts and the 5/16" nut to 6 - 9 N.m. (4.5 to 6.6 lbs. ft).
6. With the vehicle in the park position, remove the wheel blocks, start the engine, release the manual park brake, and cycle the auto park apply system by moving the shift lever from park to drive. Observe that the vehicle's park brake functions properly.
7. Turn off vehicle; put on parking brake; shift lever in park; inspect the control valve for any hydraulic leaks; torque fitting as required.

SERVICE PARTS INFORMATION

Part Number	Description	Quantity
15666448	Brace Park Brake	1 (all P30032 at 16,000, Control Valve option C7P)
9440148	Bolt 1/4"-20 X 2.00" (GM 280-M)	2
9422273	Nut 1/4"-20 (GM 286-M)	2

WARRANTY INFORMATION

Labor Operation: T7217*

Labor Time: 0.5 hr.

TROUBLE CODE: 92

AUTO APPLY VALVE BRACE ON 1991 P3 16,000# MOTORHOMES WITH C7P

The auto apply control valve may loosen at the cam actuator arm. This condition can be corrected by the installation of a brace, (P/N 15666448).

SERVICE PROCEDURE: (Figure 3)

1. Set parking brake, block wheels, ignition in the off position, and transmission in the park position.
2. Remove the left hand front splash shield, save all fasteners for reinstallation. Locate the park brake control valve on the left side above the steering gear (Figure 3).
3. Remove the three bolts shown in Figure 3. Discard the three washers, two 1/4" and one 5/16" washer. Replace the two 1/4" bolts and nuts with new hardware. Reuse the 3/16" bolt and nut.
4. Install the new brace (P/N 15666448) on the control valve so that the brace faces outboard. Install the two lower bolts and nuts. Reinstall the upper bolt and nut.

IMPORTANT: Nuts and bolts must be installed so that the nutsclamp against the new brace.

5. Torque the three nuts to 6 - 9 N.m. (4.5 to 6.6 lbs. ft.).
6. Reinstall the splash shield. Reuse the fasteners; torque to standard specifications (figure 3).
7. With the vehicle in the park position, remove the wheel blocks. Start the engine; release the manual park brake, and cycle the auto park apply system by moving the shift lever from park to drive. Observe that the vehicle's park brake functions properly.
8. Turn off vehicle; put on parking brake; shift lever in park. Inspect the control valve for any hydraulic leaks. Torque the fittings as required.

SERVICE PARTS INFORMATION

Part Number	Description	Quantity
15666448	Brace Park Brake	1 (all P30032 at 16,000, Control Valve option C7P)
9440148	Bolt 1/4"-20 X 2.00" (GM 280-M)	2
9422273	Nut 1/4"-20 (GM 280-M)	2

WARRANTY INFORMATION

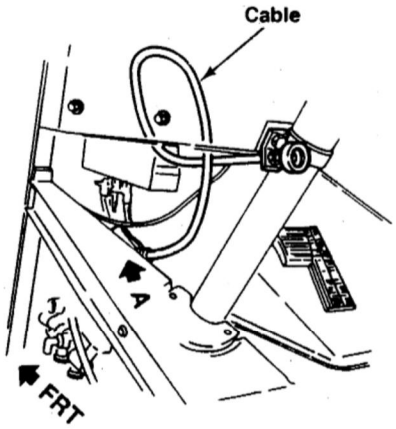
Labor Operation: T7218*

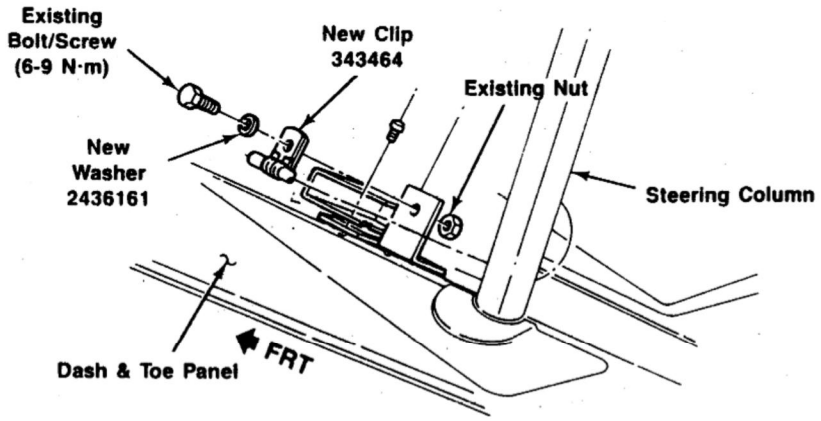
Labor Time: 0.7 hr

TROUBLE CODE: 92

* NOTE: All Labor Operation are coded to base vehicle coverage in the warranty system.

Parts are currently available from GMSPO.

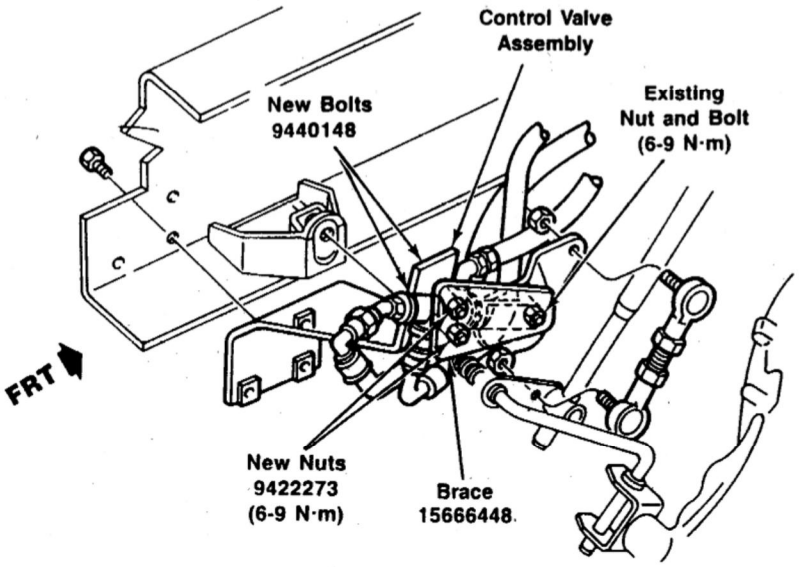




VIEW A

065022

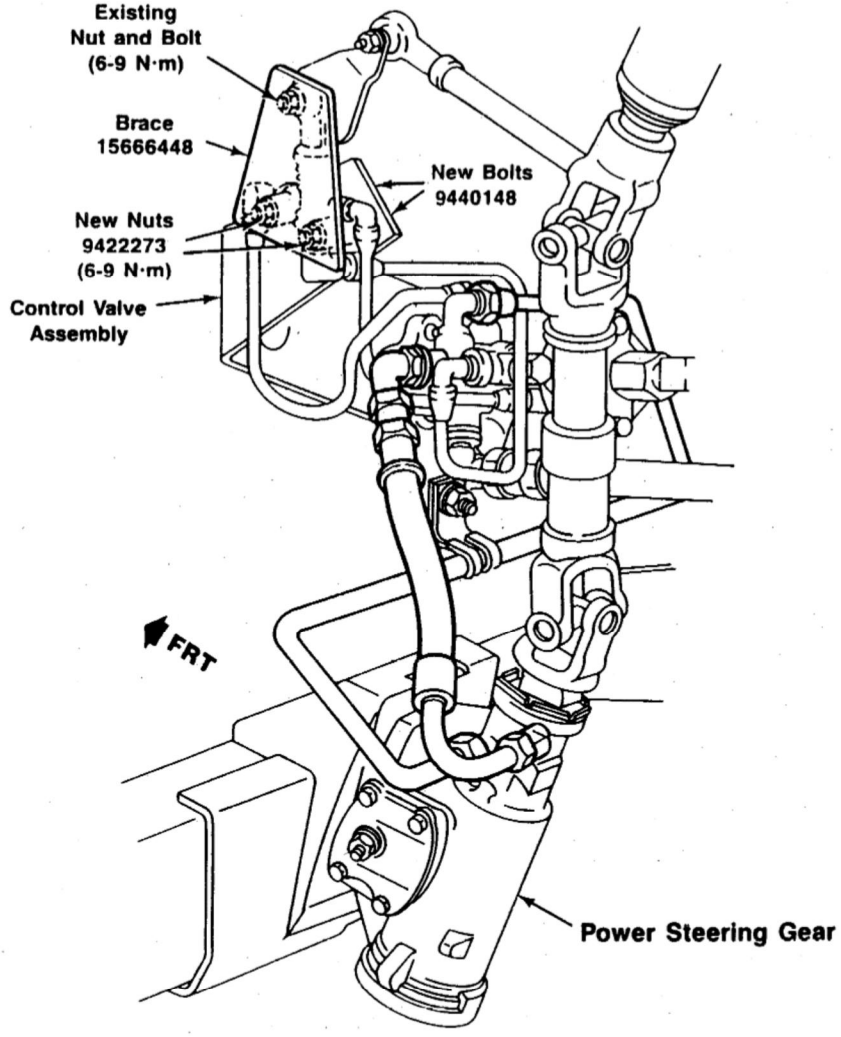
Figure 1—1990 Cable Clipping



Assembly Note: All three brace retaining nuts and bolts must be installed so that the nuts clamp against the new brace.

065022

Figure 2—1990 Auto Apply Brace For P30032 With C7P



Assembly Note: All three brace retaining nuts and bolts must be installed so that the nuts clamp against the new brace.

065022

Figure 3—1991 Auto Apply Valve Brace For P30032 With C7P

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CHEVROLET MOTOR DIVISION
General Motors Corporation
Technical Service Department

Dealer Service Bulletin

Number:	92-02-6E
Section:	6E
Date:	AUGUST 1991
Corporate Bulletin No.:	136514R

Subject: **SERVICE ENGINE SOON LIGHT (CODE 22)**

Model and Year: **1991-92 CAPRICE AND CAMARO WITH 5.0L AND 5.7L ENGINES**
1991-92 ALL TRUCKS WITH 3.1L, 4.3L, 5.0L, 5.7L AND 7.4L ENGINES

THIS BULLETIN CANCELS AND SUPERSEDES DEALER SERVICE BULLETIN 91-357-6E, DATED JUNE 1991. THE VIN BREAKPOINTS HAVE BEEN ADDED AND THE BULLETIN NUMBERS WHICH WERE CANCELLED SHOULD READ 91-60-6E AND 91-333-7A. ALSO THE 1992 MODEL YEAR HAS BEEN ADDED. ALL COPIES OF 91-357-6E SHOULD BE DISCARDED.

PLANT	VIN BREAKPOINT
SHREVEPORT	1GCCS14ZLM8177329
MORAINE	1GNCS13ZLM2211006
PONTIAC	1GCCT14Z5M0149156

This bulletin pertains to the 5.0L and 5.7L engine for passenger cars and 4.3L/3.1L, 5.0L/5.7L and 7.4L engines for light duty trucks.

Condition Some owners of the above vehicles may comment on a Service Engine Soon Light - Code 22 - Throttle Position Sensor low. Additional comments may include no upshift to 4th gear, no TCC, harsh transmission shifts, or poor idle quality. These conditions may be more prevalent after initial startup.

Cause: The above concerns may result from an intermittent electrical contact inside the Throttle Position Sensor (TPS).

Correction: If any of the subject conditions are found, complete the following procedure:

1. Perform the normal diagnostics per Section 6E of the Service Manual.
2. Check TPS/ECM connectors per Dealer Service Bulletin No. 91-106-6E.
3. If no problems are found using the normal 6E diagnostics or the bulletin, replace the TPS with a new TPS kit, P/N 17112679 per the procedure in Section 6E of the Service Manual. The new TPS will have a yellow dot at the connector area for easier identification.

Part is currently available from GMSPO.

Note: The lack of 4th gear, no TCC and harsh transmission shift concerns are only associated on truck applications with the HYDRA-MATIC 4L80-E (4 speed automatic) electronic transmission.

Use applicable labor operations and times.

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GSD 148D Rev. 12/89

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CHEVROLET MOTOR DIVISION
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Technical Service Department

Dealer Service Bulletin

REVISED
91-151A-5
Number:
5
Section:
AUGUST 1991
Date:
965016R
Corporate Bulletin No.:
A5
ASE No.:

Subject: **BRAKE SQUEAL/NOISE**

Model and Year: **1976-91 P3 MOTOR HOMES EQUIPPED WITH 4-WHEEL DISC BRAKES (RPO JF9)**

THIS BULLETIN REVISES DEALER SERVICE BULLETIN NO. 91-151-5, DATED JANUARY 1991. REPLACEMENT OF BOTH FRONT AND REAR LININGS HAS BEEN SPECIFIED. ALL COPIES OF 91-151-5 SHOULD BE DISCARDED.

A new brake lining service kit is available that contains brake pads constructed of a new compound developed to reduce brake noise and squeal. It is important to understand that the new pad material will not totally eliminate brake noise. It can, however, reduce the noises to a level which is more acceptable.

The new brake lining service kit, GM Part Number 15649295 contains all components necessary to replace either the front or rear brake linings. To better resolve brake squeal and maintain the vehicle's originally designed brake balance (front to rear), both front and rear linings should be replaced at the same time. The new brake pads can be identified by the CBD812 edge code printed on the side of the pad material.

SERVICE PARTS INFORMATION:

Part Number	Description
15649295	Brake Lining Service Kit

Note: Use one kit per axle.

Parts are currently available from GMSPO.

WARRANTY INFORMATION:

For vehicles repaired under warranty use:

Labor Operation	Location
H0042	Front
H0043	Rear

Use applicable labor time guide for labor hours.

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General Motors Corporation
Technical Service Department

Dealer Service Bulletin

91-133-5
Number:
5
Section:
December 1990
Date:
075003R
Corporate Bulletin No.:

Subject: **CHANGE IN BRAKE EFFECTIVENESS AFTER DISC BRAKE ROTOR REFINISHING/PAD REPLACEMENT**

Model and Year: **ALL PASSENGER CARS**
ALL LIGHT DUTY TRUCKS

TO: ALL CHEVROLET DEALERS

THIS BULLETIN CANCELS AND SUPERSEDES DEALER SERVICE BULLETIN NO. 90-316-5, DATED AUGUST 1990. INFORMATION HAS BEEN ADDED REGARDING HUB AND ROTOR CLEANING, PROPER TORQUING TECHNIQUE, REVISED MACHINING TABLE, CHANGE SPECIFICATION FOR MAXIMUM SCORINGING DEPTH. THE 1991 MODEL YEAR WAS ALSO ADDED. ALL COPIES OF 90-316-5 SHOULD BE DISCARDED.

Some comments have been received about a change in preceived braking effectiveness which occurs after rotors have been refinished and/or disc brake pads have been replaced. New lining materials have been formulated for increased lining life and to reduce brake squeal. Also, Federal regulations currently prohibit the use of asbestos in Original Equipment Manufactured (O.E.M.) front disc brake linings, and will totaly ban asbestos from all O.E.M. brake linings in the near future. Due to these changes, initial rotor surface finish is more critical than in the past, and is required for good brake performance.

Following are some recommended actions/procedures to assure proper performance of the brake systems on all vehicles after rotor and/or pad service has been performed:

1. When performing routine brake maintenance such as replacing worn disc brake pads or shoes, DO NOT refinish disc brake rotors or drums unless:

   A. There is a brake pulsation condition present, and this pulsation is found to be caused by the brake rotors or drums, or

   B. The rotors and/or drums are excessively scored. Surface scoring that does not exceed 1.2MM (0.050 in.) on rotors or drums should not affect brake operation.

      Before removing rotors from the hub assembly, mark the rotor and on wheel stud so that the rotor may be re-installed in the same position.

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If rotors are removed, it is very important that rust and scale be removed from the rotor and hub mating surfaces. Failure to do so may introduce excessive lateral runout when the rotor is mounted on the brake lathe, or when the rotor is re-installed to the hub.

2. When refinishing disc brake rotors, it is important that the brake lathe be in good operating condition and that all tools or bits are sharp. Recommended vibration dampeners and/or adaptors should be used and should be clean and free of nicks (remember, 1988-91 W models require the use of an adaptor, J37160, because of the two-piece design). The following table shows the recommended procedure for rotor machining:

	ROUGH CUT	FINISH CUT
Spindle Speed	150 RPM	150 RPM
Depth of Cut (per side)	0.127mm (0.005")	0.051mm (0.002")
Tool Cross Feed per Rev	0.152mm - 0.254mm (0.006" - 0.010")	0.051mm (0.002")Max
Vibration Damper	Yes	Yes
Sand Rotors-Final Finish	No	Yes

It is important that a rough and a finish cut be made. All brake lathes use a single-point cutting tool which is not capable of giving the necessary surface finish. A SECONDARY FINISHING OPERATION MUST BE PERFORMED TO OBTAIN THE NECESSARY SURFACE FINISH.

An acceptable finish can be obtained using the Ammco Model 8350 Safe Swirl Disc Rotor Grinder, or equivalent, using 120 grit sandpaper and sanding each rotor surface with moderate pressure for a minimum of 60 seconds with the rotor turning at 150 RPM. An alternate method is to use a sanding block with 150 grit sandpaper. With the rotor turning at approximately 150 RPM, sand each side for a minimum of 60 seconds using moderate pressure.

After the rotor has been sanded, the surfaces must be cleaned with a solvent such as brake cleaning, denatured alcohol, or equivalent.
THE FINISHED ROTOR SURFACE SHOULD BE AS CLOSE TO THAT OF A NEW ROTOR AS POSSIBLE. FAILURE TO OBTAIN THE BEST POSSIBLE ROTOR FINISH WILL AFFECT INITIAL BRAKING PERFORMANCE.

CAUTION: ROTORS OR DRUMS SHOULD ALWAYS BE REPLACED IF TURNING WILL RESULT IN A ROTOR OR DRUM THAT DOES NOT MEET MANUFACTURER SPECIFICATIONS FOR MINIMUM ROTOR THICKNESS OR MAXIMUM DRUM DIAMETER.

NOTICE: When re-installing tire and wheel assemblies, it is very important that proper procedures be followed when installing and torquing the wheel nuts:

A. Finger start all wheel nuts.

B. Tighten wheel nuts to specified torque (use the "star," or alternating nut pattern) using a torque wrench. DO NOT USE AN IMPACT WRENCH. UNEVEN AND/OR EXCESSIVE TORQUING OF THE WHEEL NUTS HAS BEEN FOUND TO DISTORT ROTORS, RESULTING IN PREMATURE CUSTOMER COMEBACKS FOR BRAKE PULSATION

3. After brake pads have been replaced and/or rotors have been refinished, it is recommended that the new braking surfaces be broken in, or burnished, to properly seat them. This can be accomplished by making 20 stops from 30 mph, using medium to firm pressure. Take care to avoid overheating the brakes.

4. It is strongly recommended that the correct, specified General Motors replacement part(s) be used when servicing G.M. vehicles. General Motors does not test non-G.M. parts for proper performance on G.M. vehicles. Therefore, the use of non-G.M. parts may result in unacceptable vehicle performance. It is also important that the correct G.M. part(s) be used in the correct G.M. application. For example, some 'A' model disc brake pads ('A' Heavy) will fit on 'C and H' models, but will not provide the same performance as the pads specified for use on C and H vehicles. It may seem preferable to stock fewer brake pad part numbers, but customer dissatisfaction may result if vehicle performance is affected.

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CHEVROLET MOTOR DIVISION
General Motors Corporation
Technical Service Department

Dealer Service Update Bulletin

Number:	91-210-7A
Section:	7A
Date:	FEBRUARY 1991
Corporate Bulletin No.:	177107R

Subject: **AUTOMATIC TRANSMISSION DIAGNOSIS CHARTS UPDATED**

Model and Year: **1991 C/K, R/V, P AND G TRUCKS WITH 4L80-E/4L80-EHD AUTOMATIC TRANSMISSION**

SERVICE UPDATE

BULLETIN COVERS:

HYDRA-MATIC 4L80-E/4L80-EHD Transmission updates occurring after Service Manual printing.

LIGHT DUTY TRUCK SERVICE MANUAL UPDATES:

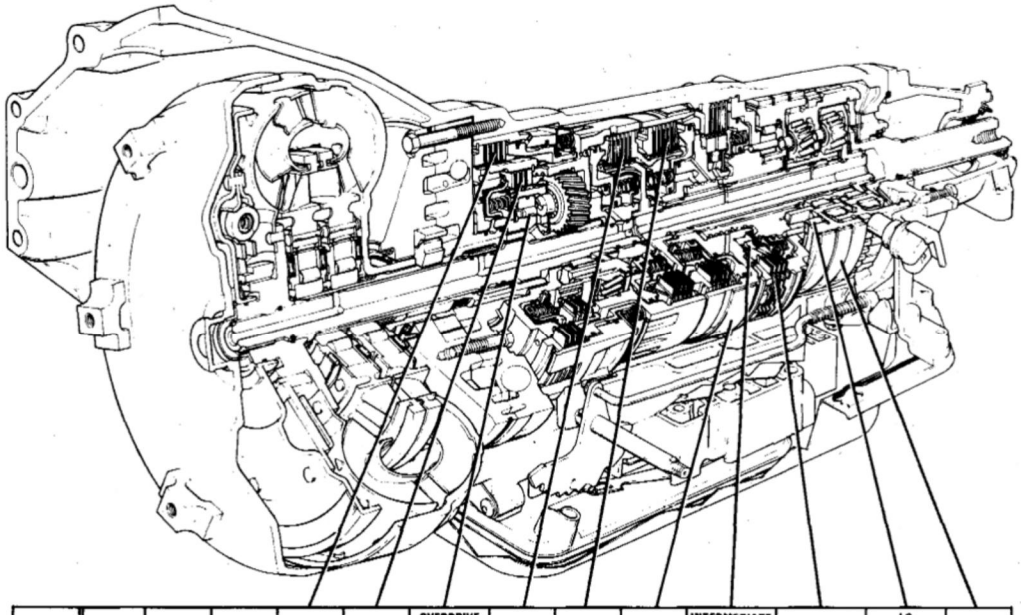
Automatic Transmission / Diagnosis Information:
Range Reference Chart has been revised. (Figure 1)
Wiring Diagram has been revised. (Figure 2)

Remove Notice under Torque Converter Clutch (TCC) Diagnosis:
Notice says: Do not bench test the TCC Solenoid using an automotive type battery. Accidentally crossed wires will damage the internal diode of the Solenoid. (This notice does not apply to the 4L80-E Transmission.)

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HYDRA-MATIC 4L80-E - GEAR RATIOS

FIRST	2.48	FOURTH	.75
SECOND	1.48	REVERSE	2.08
THIRD	1.00		



RANGE	GEAR	SOLENOID @A	SOLENOID @B	FOURTH CLUTCH	OVERRUN CLUTCH	OVERDRIVE ROLLER CLUTCH	FORWARD CLUTCH	DIRECT CLUTCH	FRONT BAND	INTERMEDIATE SPRAG CLUTCH	INTERMEDIATE CLUTCH	LO ROLLER CLUTCH	REAR BAND
P-N		ON	OFF			HOLDING							
R	REVERSE	ON	OFF			HOLDING		APPLIED					APPLIED
(D)	1st	ON	OFF			HOLDING	APPLIED			*		HOLDING	
	2nd	OFF	OFF			HOLDING	APPLIED			HOLDING	APPLIED	OVERRUNNING	
	3rd	OFF	ON			HOLDING	APPLIED	APPLIED		OVERRUNNING	APPLIED	OVERRUNNING	
	4th	ON	ON	APPLIED		OVERRUNNING	APPLIED	APPLIED		OVERRUNNING	APPLIED	OVERRUNNING	
D	1st	ON	OFF		APPLIED	HOLDING	APPLIED			*		HOLDING	
	2nd	OFF	OFF		APPLIED	HOLDING	APPLIED			HOLDING	APPLIED	OVERRUNNING	
	3rd	OFF	ON		APPLIED	HOLDING	APPLIED	APPLIED		OVERRUNNING	APPLIED	OVERRUNNING	
2	1st	ON	OFF		APPLIED	HOLDING	APPLIED			*		HOLDING	
	2nd	OFF	OFF		APPLIED	HOLDING	APPLIED		APPLIED	HOLDING	APPLIED	OVERRUNNING	
1	1st	ON	OFF		APPLIED	HOLDING	APPLIED			*		HOLDING	APPLIED
	2nd	OFF	OFF		APPLIED	HOLDING	APPLIED		APPLIED	HOLDING	APPLIED	OVERRUNNING	

*HOLDING BUT NOT EFFECTIVE

ON = SOLENOID ENERGIZED

OFF = SOLENOID DE-ENERGIZED

@ THE SOLENOID'S STATE FOLLOWS A SHIFT PATTERN WHICH DEPENDS UPON VEHICLE SPEED AND THROTTLE POSITION. IT DOES NOT DEPEND UPON THE SELECTED GEAR.

NOTE: DESCRIPTIONS ABOVE EXPLAIN COMPONENT FUNCTION DURING ACCELERATION.

Figure 1- Range Reference Chart

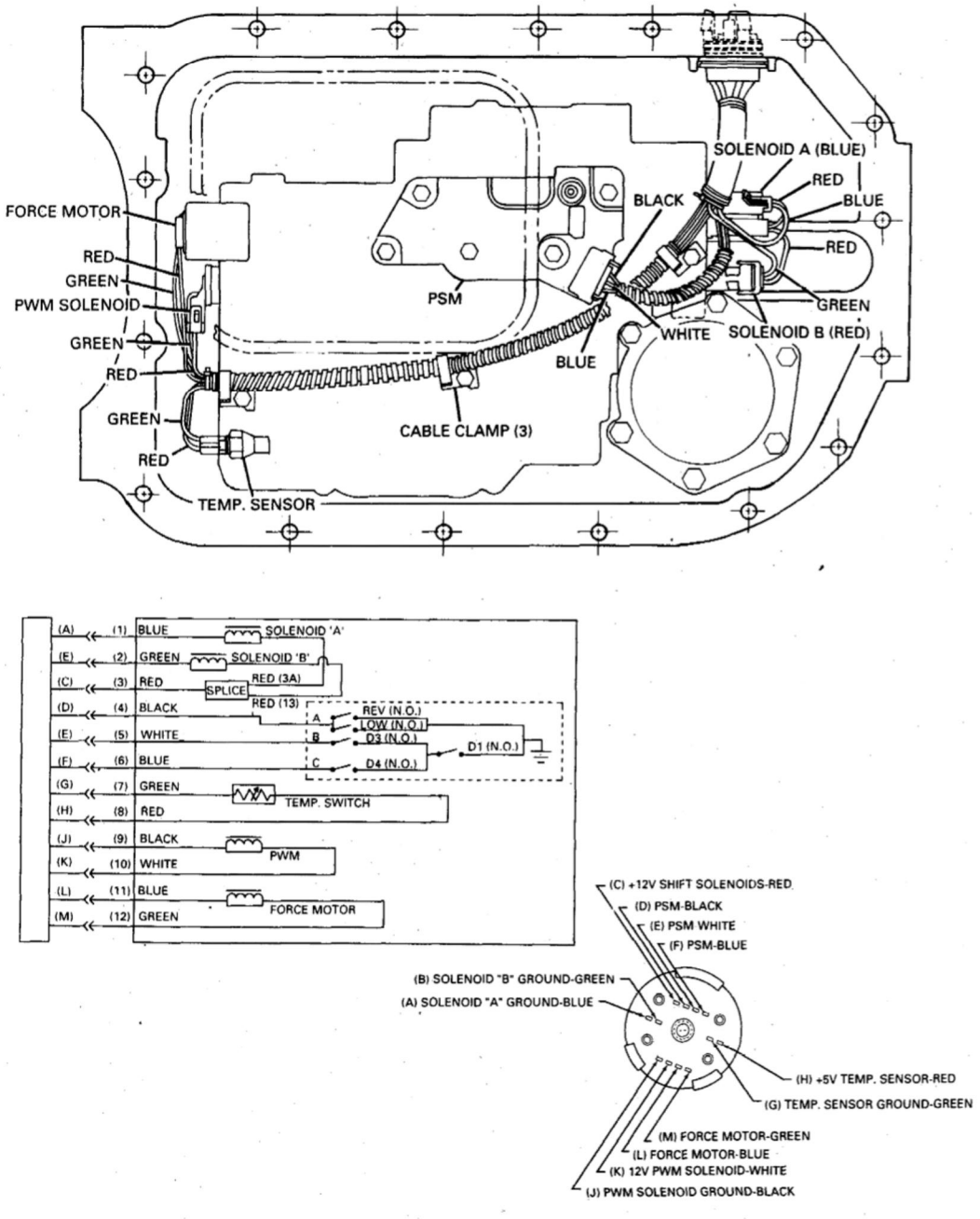


Figure 2 - Wiring Diagram

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General Motors Corporation
Technical Service Department

Dealer Service Bulletin

Number:	91-150-8C
Section:	8C
Date:	January 1991
Corporate Bulletin No.:	068302

Subject: **ELECTRONIC AND ELECTRO-MECHANICAL INSTRUMENT CLUSTERS**

Model and Year: **ALL LIGHT DUTY TRUCKS**

TO: ALL CHEVROLET DEALERS

Chevrolet and AC Delco have formed a joint program designed to help dealers locate exchange instrument clusters. A service called the "Instrument Cluster Locator Line" has been established.

For your regular service needs, you should contact the nearest AC Delco Service Center. If they do not have the required cluster, you should then use the Instrument Cluster Locator Line. To do so, call the Locator Line operator at (313) 974-0497 between 7:30 and 4:30 Eastern Standard Time. The following information is required:

- the name of the AC Delco Service Center previously contacted
- the part number of the unit needed
- your dealer name, address and telephone number
- the make and body style of the vehicle being repaired.

The operator will then locate another AC Delco Service Center which has the required cluster and call you back that same day to let you know where the part can be found.

You can then order the part directly from that Service Center. The part will be shipped within 24 hours and you will receive it within 48 hours. Please note that the Instrument Cluster Locator Line Program should only be used if the electronic or electro-mechanical cluster is not available from your local AC Delco Service Center.

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Dealer Service Bulletin

Number:	90-421-6E
Section:	6E
Date:	MAY 1991
Corporate Bulletin No.:	136511

Subject: **DETONATION AND/OR EXHAUST ODOR**

Model and Year: **1990 C/K, R/V, G AND P TRUCK WITH 7.4L ENGINE**

Condition: Some owners of 1990 trucks with the 7.4L engine may comment of either detonation at highway speeds or exhaust odor (sulfur smell) at idle.

Cause: The original spark advance and idle calibration may generate detonation or sulfur odor comments for a few isolated conditions.

Correction: On trucks where these conditions can not be repaired using normal service procedures, a revised calibration PROM should be installed (See below).

Part Number	Emission System	Trans.	PROM Broadcast	SCANNER I.D.
16165446	NA4 (above 8600 GVW)	M40 (Auto)	AYKK	5451
16165447	NA4 (above 8600 GVW)	M20 (Manual)	AYKL	5461

Parts are expected to be available on June 3, 1991. Until then normal part orders will not be accepted by GMSPO. Only verifiable emergency VIP orders will be accepted. SPO will make every effort to obtain parts. All parts will be placed on 400 control to waive VIP surcharges. However, the part will be shipped premium transportation at dealer`s expense. All other order types will be cancelled as incorrectly ordered while the 400 control is in place.

Note: These PROMs SHOULD NOT BE USED on the Chevy "S.S."

Labor Operation Number: T0500

Labor Time : .6 Hour

Trouble Code: 92

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CHEVROLET MOTOR DIVISION
General Motors Corporation
Technical Service Department

Dealer Service Bulletin

Number:	90-368-8C
Section:	8C
Date:	October 1990
Corporate Bulletin No.:	063305R

Subject: **INOPERATIVE SPEEDOMETER**

Model and Year: **1989-90 P3 (MOTOR HOME) CHASSIS**

TO: ALL CHEVROLET DEALERS

Some 1989-1990 P3 motor home chassis (32) and commercial van chassis (forward control chassis - model 42) may experience inoperative speedometers. This condition can be caused by either inadequate engagement of the upper speedometer cable or a broken lower speedometer cable tip.

To correct, it is necessary to install either a new upper or lower speedometer cable. The new upper speedometer cable has a longer shaft core tip to provide full engagement of the speedometer core tip between the Vehicle Speed Sensor (VSS) and speedometer head (part of the instrument cluster). The lower speedometer cable has a metal tip replacing a plastic tip to help prevent tip breakage.

Vehicle manufacturing breakpoint is listed below:

1GBJP37N7L3321236

Prior to performing the installation procedures, verify if the condition experienced is the result of inadequate engagement of the upper speedometer cable. If an inadequate engagement condition is present, replacement of the upper speedometer cable is required. Inspect the lower speedometer cable for a broken tip at the speed sender generator. If broken, replacement of the lower speedometer cable is required.

INSTALLATION INSTRUCTIONS:

UPPER SPEEDOMETER CABLE REMOVAL AND REPLACEMENT (see Figure 1):

1. Disconnect the negative battery connection.
2. Set park brake and put transmission lever in park.
3. Disconnect and remove the upper speedometer cable from the speedometer head in the instrument cluster.

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4. On Commercial vehicles, disconnect the opposite end of the cable from the road speed sender generator located underneath the vehicle (outboard of the left hand frame rail and in back of the front axle). On Motor Homes, disconnect the opposite end of the cable located in the left hand frame rail across from the transmission.

5. Install the new upper speedometer cable into the instrument cluster and connect to speedometer head.

6. On Commercial or Motor Home vehicles, reconnect the opposite end of the cable to the vehicle speed sensor (VSS). Route and attach cable to avoid kinking, chafing or high temperature areas. Clip at positioning cable.

7. Reconnect negative battery connection.

8. Check for proper operation of speedometer.

LOWER SPEEDOMETER CABLE REMOVAL AND REPLACEMENT (see Figure 1):

1. Disconnect the negative battery connection.

2. Inspect road speed sender generator for broken plastic speedometer cable tip. If broken, remove broken piece prior to installing new cable.

3. Disconnect the lower cable from the vehicle speed sensor (VSS).

4. Disconnect the opposite end of the cable at the transmission and remove cable.

5. Reconnect the lower speedometer case to the VSS.

6. Reconnect cable at transmission end. Route cable to avoid kinks or chafing.

7. Reconnect negative battery connection.

8. Check operation of speedometer.

SERVICE PARTS INFORMATION:

Part No.	Description	Qty.	P3 Model
16154975	Upr Speedo Cable Asm.	1	Commercial (42) with Gas Engines.
16154985	Upr Speedo Cable Asm.	1	Motor Home (32) with Gas Engines.
16155035	Lwr Speedo Cable Asm.	1	(*) Motorhome(32)/Commercial (42) with Gas Engines, Auto. Trans. & Power Disc Brakes.
16155045	Lwr Speedo Cable Asm.	1	(*) Commercial (42) with Gas Engines & Manual Trans.
16155055	Lwr Speedo Cable Asm.	1	(*) Motorhome (32)/Commercial (42) with Gas Engines & auto. Trans. & Hydraulic Brakes.

(*) P/N 16154975 Use with RPO's LB4/L05/L19.
P/N 16154985 Use with RPO L19.
P/N 16155035 Use with RPO's LB4/L05/L19 and M40 and JB7/JB8.
P/N 16155045 Use with RPO's LB4/L05 and M20.
P/N 16155055 Use with RPO's L05/L19 and M40 and JF9.

RPO CODES:

LB4 = 4.3L Gas Eng.	M40 = 3-Spd. Auto. Trans.
L05 = 5.7L Gas Eng.	JB7 = Power Disc, Drum 8400 Lbs.
L19 = 7.4L Gas Eng.	JB8 = Power Disc, Drum 10000 Lbs.
M20 = 4-Spd. Man. Trans.	JF9 = Hyd. Brake, 4 Wheel Disc

MODEL CODES:
32 = Motor Home Chassis
42 = Commercial - Forward Control Chassis

Parts are currently available from GMSPO.

WARRANTY INFORMATION

For vehicles repaired under warranty use:

Labor Operation	Description
N4382	R & R Upper Speedometer Cable
N4383	R & R Lower Speedometer Cable Labor Time

Use applicable Labor Time Guide for labor hours.

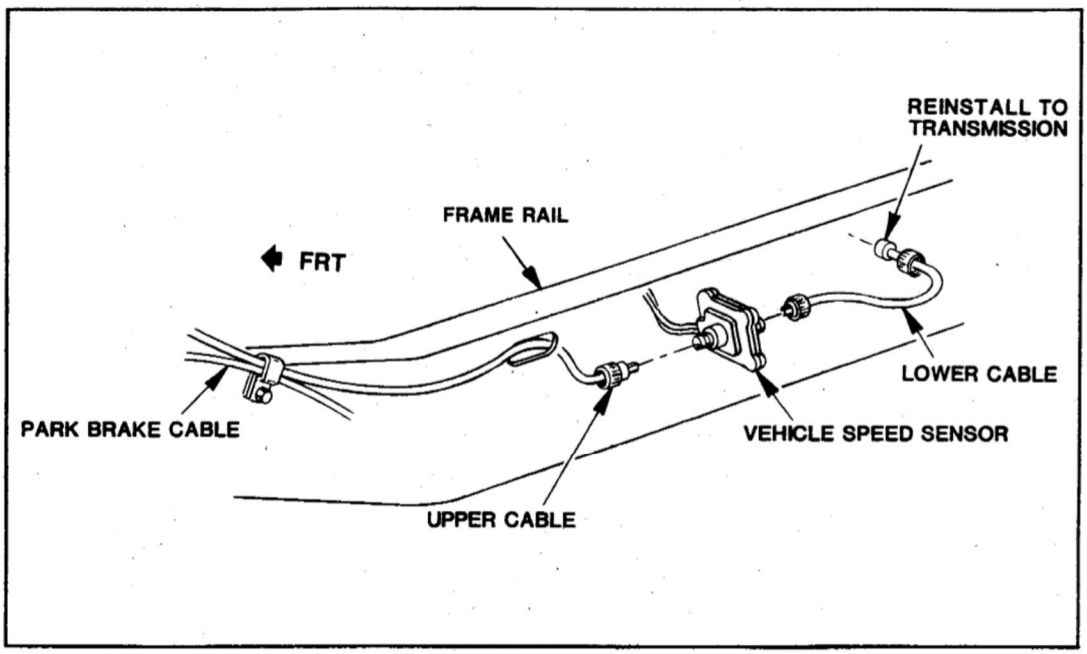


Figure 1

1990 — The vehicle speed sensor is located on the LH frame rail in the speedometer cable.

1991-1994 — The cruise control receives its signal from the drac module located on the LH side of the steering column.

(*) P/N 16154975 Use with RPO's LB4/L05/L19.
P/N 16154985 Use with RPO L19.
P/N 16155035 Use with RPO's LB4/L05/L19 and M40 and JB7/JB8.
P/N 16155045 Use with RPO's LB4/L05 and M20.
P/N 16155055 Use with RPO's L05/L19 and M40 and JF9.

RPO CODES:

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L05 = 5.7L Gas Eng.	JB7 = Power Disc, Drum 8400 Lbs.
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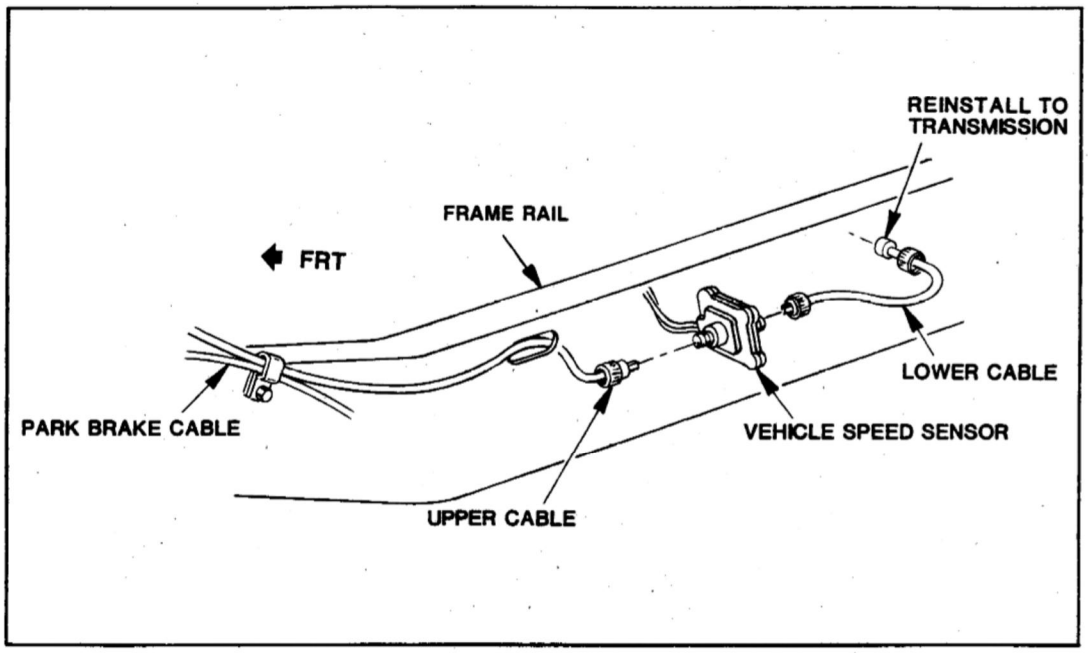


Figure 1

1990 — The vehicle speed sensor is located on the LH frame rail in the speedometer cable.

1991-1994 — The cruise control receives its signal from the drac module located on the LH side of the steering column.

CHEVROLET

CHEVROLET MOTOR DIVISION
General Motors Corporation
Technical Service Department

Dealer Service Bulletin

Number:	92-03-6B
Section:	6B
Date:	AUGUST 1991
Corporate Bulletin No.:	166201

Subject: **NEW STYLE HOSE CLAMP**

Model and Year: **1983-92 ALL C/K AND 1987-92 R/V TRUCKS WITH 4.3L, 5.0L, 5.7L, 6.2L, 7.4L ENGINES**

A new design hose clamp will be used in production starting with the 1992 model year on C/K trucks. Usage of this clamp will expand to include other models in the 1993 model year. The Mubea constant tension hose clamp was designed to reduce the amount of coolant leakage from radiator and heater hoses.

With the previous design, screw type clamps, it is difficult to maintain a constant load on the hose connection. Some of the load is lost under certain temperature changes. The Mubea clamp exerts a relatively even and constant pressure that is maintained under varying temperature conditions.

SERVICE PROCEDURE:

- The Mubea clamp must be installed on a hose which will be put on to a clean, dry, paint free surface. If lubrication is necessary for assembly, only GM lubricant P/N 998562 may be used.
- Production of trucks with the clamp began 02/91, starting with the water pump and radiator connections. The heater hoses will follow in some applications.
- If the vehicle was originally built with Mubea clamps, the clamp should be replaced with the same P/N Mubea clamp and not a screw type hose clamp.
- Also if the vehicle was originally built with screw/worm type clamps, the clamps should be replaced with screw/worm clamps.

Note: Standard pliers or hose clamp pliers will not work well on the new style clamp. Various tool companies have developed special pliers to install and remove these hose clamps. Some companies may have a plier available that is effective in removing the larger size clamps but may not open wide enough to accommodate the clamp once it is off the hose and relaxed. Do not compress the clamp (permanently) to make the tool fit it, since this will decrease the effectiveness of the clamp. GMC does not endorse any specific tool or company. Check with local sources to determine availability.

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GSD 148D Rev. 12/89

PARTS INFORMATION:

Mubea clamps will be used in the following applications:

Size	Part Number	Application
27mm	10108255	Heater Hoses
24mm	10146975	Heater Hoses
42mm	15671833	Radiator/Water Pump Hoses
50mm	10108249	Radiator/Water Pump Hoses
55mm	15671832	Radiator/Water Pump Hoses

Note: The clamp's size is stamped on the tab of the clamp.

Parts are currently available from GMSPO.

WARRANTY INFORMATION:

For vehicles repaired under warranty use:

Labor Operation: J3340

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Geo

CHEVROLET MOTOR DIVISION
General Motors Corporation
Technical Service Department

Dealer Service Bulletin

Number:	91-137-9
Section:	9
Date:	December 1990
Corporate Bulletin No.:	069001

Subject: **CRUISE CONTROL CABLE REPLACEMENT**

Model and Year: **1990-91 P3 MODELS**

TO: ALL CHEVROLET DEALERS

A replacement cruise control servo cable for 1990 and 1991 P3 models with factory installed cruise control has been released by GMSPO. It will no longer be necessary to purchase a module and cable assembly if just a cable is required (see Figure 1).

The part number for a cruise control servo cable without the module for the P3 models mentioned is 25075767.

Parts are currently available from GMSPO.

replacement cable 92 — 25075767
93 — 25140500
94 — 25140187

module assembly 90-92 — 25075766
93 — 25140082
94 — 25075219

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Cruise Control Module/Cable
P-3 Motorhome Chassis

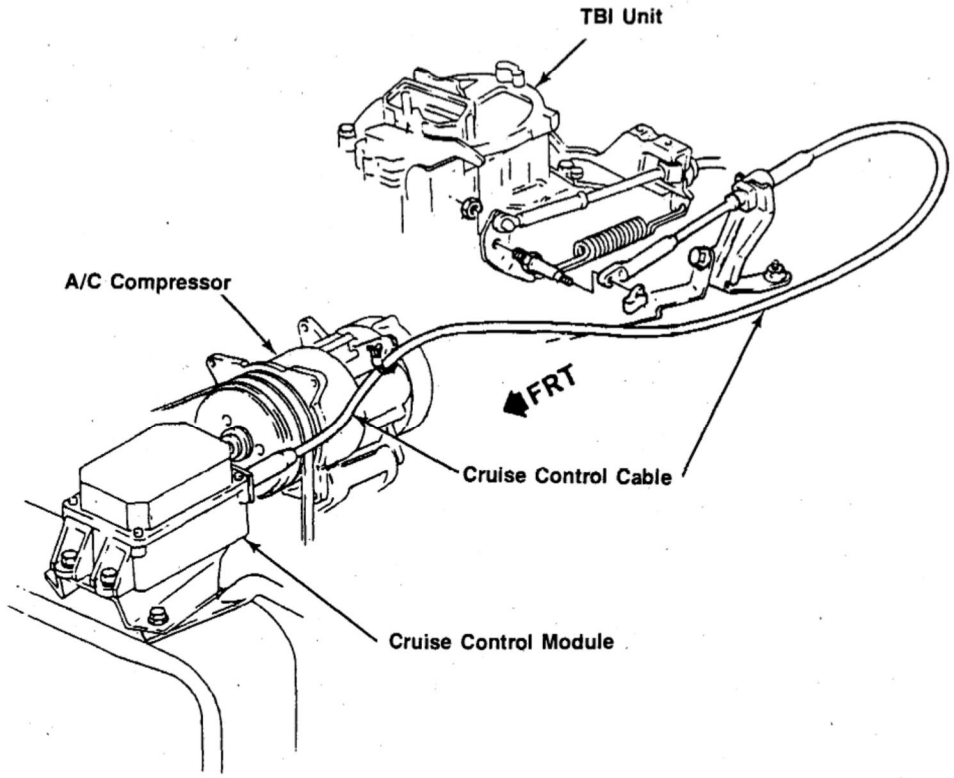


Figure 1

069001

CHEVROLET
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CHEVROLET MOTOR DIVISION
General Motors Corporation
Technical Service Department

Dealer Service Update Bulletin

Number:	92-12-7A
Section:	7A
Date:	SEPT. 1991
Corporate Bulletin No.:	177123
ASE No.:	A2

Subject: **REUSABLE BOTTOM PAN SEAL**

Model and Year: **1991-92 C/K, R/V, G AND P3 TRUCK WITH 4L80-E/4L80-EHD AUTOMATIC TRANSMISSION**

SERVICE UPDATE

TRANSMISSION APPLICATIONS:
1991-92 HYDRA-MATIC 4L80-E/4L80-EHD (MT-1)

SUBJECT:
Reusable Bottom Pan Seal
(Service Manual Information)

TRANSMISSION MODELS:
All Models

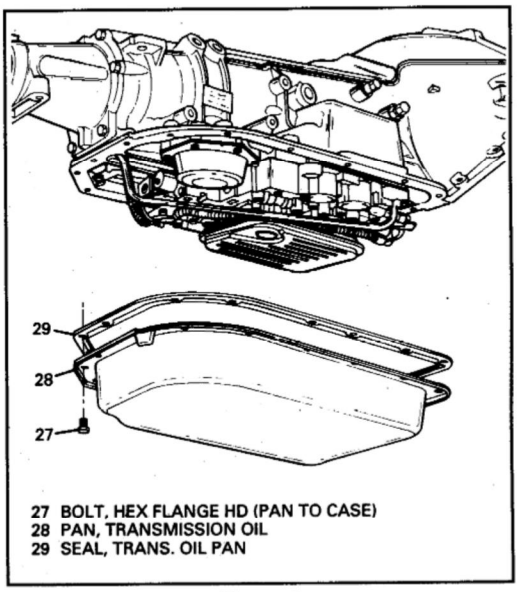
VEHICLE APPLICATIONS:
C/K, R/V, and P- Trucks, G-Van

Service Information: (Figure 1)

The HYDRA-MATIC 4L80-E transmission bottom pan seal (29) is REUSABLE. When removing the bottom pan (28), it is recommended to inspect the seal for any possible leak points that may cause future concerns:

- Tears in the rubber bead.
- Missing torque limiters or washers.
- Broken carrier seal.

If no signs have been found, then clean off seal with a clean soft cloth. Clean case and pan areas with part solvent before reinstalling seal.



27 BOLT, HEX FLANGE HD (PAN TO CASE)
28 PAN, TRANSMISSION OIL
29 SEAL, TRANS. OIL PAN

Figure 1

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CHEVROLET Geo

CHEVROLET MOTOR DIVISION
General Motors Corporation
Technical Service Department

Dealer Service Bulletin

Number:	93-57-6A
Section:	6A
Date:	NOV. 1992
Corporate Bulletin No.:	268304
ASE No.:	A1, A8

Subject: **INCORRECT OR ERRATIC OIL PRESSURE READINGS**

Model and Year: **1990-93 ALL LIGHT DUTY TRUCKS**

Owners of some 1990 through 1993 light duty trucks may comment that the oil pressure dash gage reads high, has erratic movement or is inoperative.

The internal resistance wire in the oil pressure sensor may not be properly supported, resulting in an intermittent open condition.

Service Procedure:

Check for normal causes of high oil pressure gage readings (high resistance or open circuit), such as a poor ground path caused by loose sensor mounting, oil cooler adapter loose, or poor electrical connections. If no cause can be found, replace the oil pressure sensor following the procedure below.

1. Disconnect the negative battery cable.
2. Remove the wiring harness connector from the oil pressure sensor.
3. Remove the oil pressure sensor.
4. Install the new oil pressure sensor.
5. Connect the wiring harness connector to the oil pressure sensor.
6. connect the negative battery cable.

Parts Information:

. New Oil Pressure Sensor Part Numbers for the 1990-1993 models are:

Model	Engine(s)	Engine VIN Codes	New P/N	Replaces
S/T	L38/LN8/L35	A,E,W	10201490 10201490	1647135 -90/91 10096178-92/93
	LL2/LB4	R,Z	10201491 10201491	1647136 -91/92 10096179-92/93
M/L	LN8/L35/LB4	E,W,Z	10201490 10201490	1647135 -90/91 10096178-92/93

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Model	Engine(s)	Engine VIN Codes	New P/N	Replaces
C/K	All Gas	10201489 Z,H,K,N	10068563-90/91 10201489	10137652-92/93
G	All Gas	Z,H,K,N	10201489 10201489	10068563-90/91 10137652-92/93
R/V	All Gas	K,N	10201489 10201489	10068563-90/91 10137652-92/93
P (60 psi)	All Gas	Z,K,N	10201489 10201489	10068563-90/91 10137652-92/93
P (80 psi)	All Gas	Z,K,N	10201490	10096178-92/93

Parts are currently available from GMSPO

Warranty Information:

For vehicles repaired under warranty use labor operation N2220.

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Geo

CHEVROLET MOTOR DIVISION
General Motors Corporation
Technical Service Department

Dealer Service Bulletin

REVISED
91-234A-0B
Number:
0B
Section:
JULY 1992
Date:
166001R
Corporate Bulletin No.:
A1, A8
ASE No.:

Subject: **NEW DESIGN SPARK PLUGS**

Model and Year: **1991 ALL PASSENGER CARS AND TRUCKS WITH CPC GAS ENGINES**

THIS BULLETIN CANCELS AND SUPERSEDES DEALER SERVICE BULLETIN 91-234-0B, DATED MARCH 1991. UPDATED TOOL INFORMATION IS BEING PROVIDED. ALL COPIES OF 91-234-0B SHOULD BE DISCARDED.

In 1991 GM introduced a new design spark plug for use in all trucks equipped with gas engines. These new design spark plugs have a ceramic insulator which is approximately 1/8 inch longer than the insulator used in previous model years.

The longer length spark plugs, which conform to S.A.E. and I.S.O. Engineering guidelines, magnify the problem of cracked insulators because currently, most spark plug sockets are not of sufficient length to properly engage the shell hex. If the spark plug shell hex is not fully engaged in the spark plug socket wrench, the socket may cock at an angle and cause insulator cracking and/or breakage during plug installation or removal.

When servicing these new design spark plugs, make sure that the spark plug socket being used is deep enough to accommodate the longer length insulator. The spark plug socket wrench should conform to the proposed S.A.E. and I.S.O. world standards for spark plug socket wrenches. Spark plug socket wrenches that conform to these standards are designed to accept the lengthened spark plugs and allow full engagement of the hex nut on the shell of the spark plug.

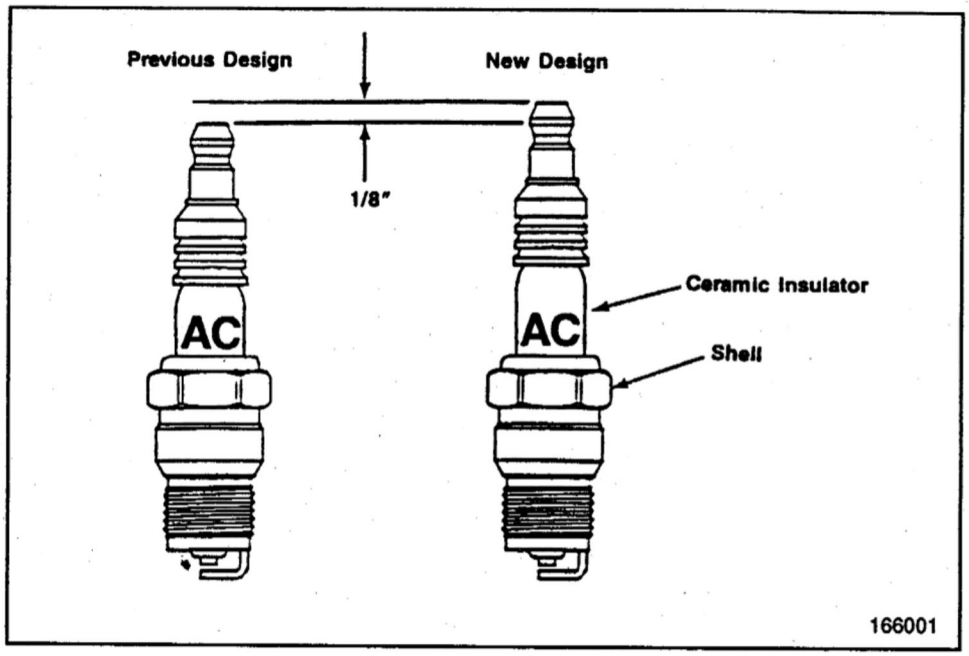
Use of a spark plug socket which is NOT deep enough may result in the ceramic insulator becoming cracked above the spark plug shell.

Note: SOME CRACKS IN THE INSULATOR MAY NOT BE VISIBLE. SUCH CRACKS MAY LATER CAUSE A SPARK PLUG TO MISFIRE. SPARK PLUG MISFIRES ARE OFTEN MISDIAGNOSED AS A SLIPPING TRANSMISSION, DEFECTIVE TORQUE CONVERTER CLUTCH, ENGINE IMBALANCE, OR MALFUNCTIONING FUEL SYSTEM.

To prevent insulator damage, it is recommended that the proper spark plug socket wrench be used when removing or replacing spark plugs. One such spark plug socket is the Kent-Moore J-39358 spark plug socket. The tool is available from Kent-Moore. For ordering information call 1-800-345-2233 or write:

Kent-Moore
SPX Corporation
39784 Little Mack
Roseville, MI 48066-2298
Fax: 313-774-9870

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Previous Design
New Design
1/8"
AC
AC
Ceramic Insulator
Shell
166001

CHEVROLET MOTOR DIVISION
General Motors Corporation
Service Department

CHEVROLET SERVICE

Chevrolet Dealer Service Bulletin

Number: 88-283-6E
Section: 6E
Date:

Subject: **ELECTROSTATIC DISCHARGE DAMAGE**

Model and Year: **1988 UP PASSENGER AND LIGHT DUTY TRUCKS WITH AN ELECTRONIC CONTROL MODULE (ECM)**

TO: ALL CHEVROLET DEALERS

Please add the following information to 6E Section "A" Diagnostic Charts/Trouble Codes, and to Section "C1" Electronic Control Module and Sensors.

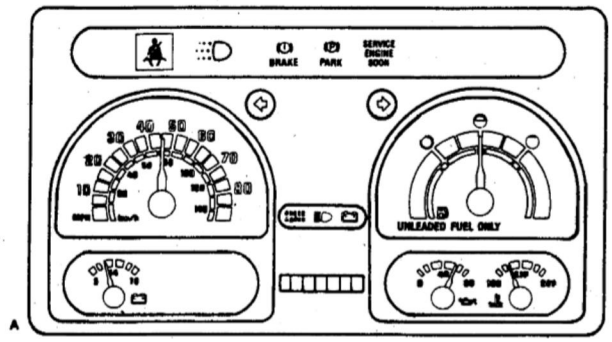
NOTICE: To prevent possible Electrostatic Discharge damage:
- Do Not touch the ECM connector pins or soldered components on the ECM circuit board.
- When handling a PROM, CAL-PAK or Mem-Cal, Do Not touch the component leads, and Do Not remove integrated circuit from carrier.

Electronic components used in control systems are often designed to carry very low voltage, and are very susceptible to damage caused by electrostatic discharge. It is possible for less that 100 volts of static electricity to cause damage to some electronic components. By comparison, it takes as much as 4,000 volts for a person to even feel the zap of a static discharge.

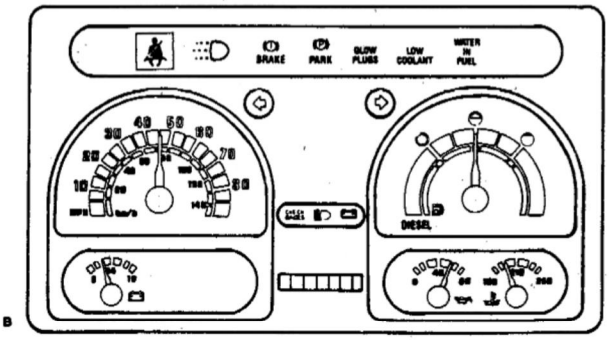
There are several ways for a person to become statically charged. The most common methods of charging are by friction and by induction. An example of charging by friction is a person sliding across a car seat, in which a charge of as much as 25,000 volts can build up. Charging by induction occurs when a person with well insulated shoes stands near a highly charged object and momentarily touches ground.

Charges of the same polarity are drained off, leaving the person highly charged with the opposite polarity. Static charges of either type can cause damage, therefore, it is important to use care with handling and testing electronic components.

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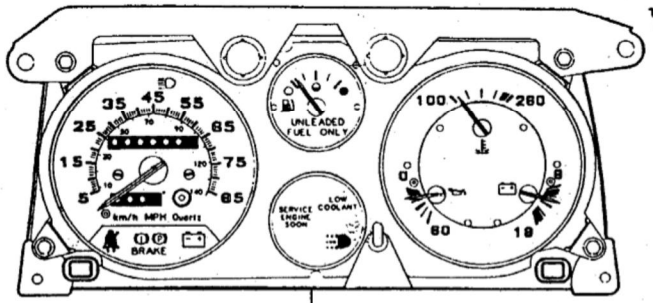


A



B

A. INSTRUMENT CLUSTER, GASOLINE ENGINE
B. INSTRUMENT CLUSTER, DIESEL ENGINE



1

CHEVROLET

CHEVROLET MOTOR DIVISION
General Motors Corporation
Technical Service Department

Geo

Dealer Service Bulletin

Number:	93-96-6C
Section:	6C
Date:	FEB. 1993
Corporate Bulletin No.:	306502
ASE No.:	A1, A8

Subject: **FACTORS THAT AFFECT FUEL ECONOMY**

Model and Year: **ALL YEARS ALL MODELS**

BACKGROUND INFORMATION:

EPA fuel economy estimates are posted on the fuel economy label of all new vehicles. The only intended use of these values is for comparison among the different vehicles. Fuel economy estimates are generated from data taken during a laboratory test using pre-production prototype vehicles under extremely controlled conditions using a professional driver, with the vehicle operating on an instrument similar to a treadmill. The comparisons of current vehicle fuel economy to the EPA fuel economy estimates is a misuse of the information and should be discouraged.

The EPA GAS MILEAGE GUIDE, available at each dealership, points out that the actual mileage when driving a vehicle may differ considerably from the estimated mileage. The guide also describes how vehicles are tested under identical conditions to insure the results can be compared with confidence.

The EPA GAS MILEAGE GUIDE also points out that city fuel economy estimate simulates a 7.5 mile, stop-and-go trip with an average speed of 20 mph. The trip takes 23 minutes and has 18 stops. About 18 percent of the time is spent idling, as in waiting at traffic lights or in rush hour traffic. Two kinds of engine starts are used - the cold start, which is similar to starting a car in the morning after it has been parked all night - and the hot start, similar to restarting a vehicle after it has been warmed up, driven and stopped for a short time.

The test to determine the highway fuel economy estimate represents a mixture of "non-city" driving. Segments corresponding to different kinds of rural roads and interstate highways are included. The test simulates a 10 mile trip and averages 48 mph. The test is run from a hot start and has little idling time and no stops.

The EPA GAS MILEAGE GUIDE explains that the actual test results are adjusted downward to arrive at the estimates used in the booklet and on the labels. City estimates are lowered by 10 percent and the highway estimate by 22 percent from the laboratory test results. The guide also points out that traveling at higher speeds lowers fuel economy and traveling at 65 mph instead of 55 mph lowers fuel economy over 15 percent.

FACTORS THAT AFFECT FUEL ECONOMY:

Axle Ratio

Numerically lower axle ratios generally produce better highway fuel economy. The exception to this is if the engine is "working" exceptionally hard, (heavy vehicle loads pulling a trailer, small engine in a large vehicle ...). In these cases a numerically higher axle may provide better fuel economy. Numerically higher axle ratios will also tend to provide more fuel economy in congested city traffic and stop and go conditions.

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Rev. 01/93

Brakes

Brake drag (even a minimal amount undetectable by coasting), can have a significant negative impact on fuel economy. Pull upward on the brake pedal to assure that the stoplight switch and cruise switch at the brake pedal are full and properly adjusted. A "click" sound when the pedal is pulled upward indicates that the switch was improperly adjusted. This causes the front brake pads to lightly rub the rotors, causing a fuel economy loss, without generating excessive heat or brake pad wear.

Driving Habits

Frequent short trips (less than 5 miles), especially in cooler ambient temperatures (less than 65 degrees), will necessitate fuel enrichment on start-ups, especially after "soaks" with the engine off for approximately a half hour or more.

Frequent accelerator pedal movement while driving will reduce fuel economy because of fuel enrichment during the periods of acceleration. Under such driving conditions the torque converter clutch (TCC) also disengages, contributing to fuel economy losses. Prolonged idle periods reduce fuel economy especially in cold ambients when vehicle is allowed to "warm up".

Fuels

Oxygenated fuels, with methanol and/or ethanol blended into the gasoline have lower energy and thus reduce fuel economy. Typically there is about a 1 MPG penalty for a vehicle which gets 25 to 30 MPG on 100 percent gasoline.

Using fuels of a lower octane than the vehicle was calibrated to will cause increased "KS" Knock Sensor system activity. This will result in a net decrease in spark advance and thus poorer fuel economy. Using fuel of a higher octane than the vehicle was calibrated for WILL NOT increase fuel economy.

Variations in how much fuel is added to the fuel tank during re-fueling can greatly affect calculated fuel economy. These effects decrease as the distance traveled and the number of tank fillups increase.

Green Engine

New vehicles have not yet had an opportunity for the engine to break in, (rings to seat...). A typical engine will take 3 to 5 thousand miles to break in and during this time period a gradual increase in fuel economy can be expected.

Parasitic Loads

Air conditioning and/or electrical loads, (headlights, heated backglass...) also result in lower fuel economy, (typically less than 1 MPG difference, each 10 AMPs takes approximately .4 MPG).

Road Conditions

Road surface condition impacts fuel economy. Gravel and/or pot holed roads decrease fuel economy. Hills (vs. level terrain) also negatively impact fuel economy. Even gradual unperceptible increases in elevation result in real measurable decreases in fuel economy. Similarly, driving in the rain or snow decreases fuel economy.

Suspension

Vehicle suspension misalignment can cause poor fuel economy. Check all four tires for abnormal and/or premature tire wear.

New tires, tire rotation, and/or front end alignment may be required to correct fuel economy.

Tires

Performance tires and/or tires with larger "contact areas," (like 60 series aspect ratio), can cause as much as 3 MPG

lower fuel economy when compared to hard "thin" tires. Find out if the tire size currently on the car is the same as original equipment. Replacement tires taller than original equipment tires cause the odometer to read LESS THAN actual distance traveled. This will result in lower calculated fuel economy than actual fuel economy.

Tire Pressure

Harder tires, (more air pressure, or different tire compositions) result in better fuel economy. Do not exceed maximum pressure as labeled on the tire, typically 30-35 psi. The disadvantage of this is that the greater the tire pressure, the harsher the vehicle ride.

Transmission

On 4-Speed automatics, it is possible to drive the vehicle in 3rd gear rather than "overdrive" and not perceive it. Typically this condition occurs when the shift indicator, or the shift linkage/detent is misadjusted. Misadjusted shift linkage can also result in improper signals to the ECM, which can result in less spark advance, and results in a drop in fuel economy.

Driving a vehicle in 3rd gear rather than overdrive at highway speeds typically results in a 3 to 5 MPG penalty.

Torque Converter Clutch operation is essential for good fuel economy. A non-locking torque converter typically results in a 1 to 2 MPG penalty at highway speeds.

Vehicle Weight

Each 125 lbs. of additional weight results in a .3 MPG loss of fuel economy. Thus, additional passengers, luggage ... will decrease fuel economy.

Vehicle Wind Resistance

More wind "DRAG" means less fuel economy. Thus, hang-on luggage carriers, cat toppers, open windows and/or open trunk... mean less fuel economy. (See "Driving Habits").

CHEVROLET
Geo

CHEVROLET MOTOR DIVISION
General Motors Corporation
Technical Service Department

Dealer Service Bulletin

Number:	92-46-6A
Section:	6A
Date:	NOV. 1991
Corporate Bulletin No.:	168302
ASE No.:	A1, A8

Subject: **OIL PRESSURE GAUGE READS HIGH**

Model and Year: **1991-92 P TRUCKS (MODEL 32 AND 42) WITH 4.3L (LB4), 5.7L (L05), 7.4L (L19)**

Some 1991-1992 P30 (32 and 42) with gasoline engines may show high oil pressure on the dash gauge. This condition is present only on the upper range of the oil pressure gauge (oil pressure will reflect correct readings in the lower and midrange on the scale of the gauge).

This high oil pressure reading may be caused by an incorrect oil pressure sending unit. Some vehicles were built with a 60 lb. sending unit instead of the correct 80 lb. sending unit.

To correct, it will be necessary to inspect the oil pressure sending unit to determine if it is the incorrect sending unit. This can be confirmed by the stamping on the sending unit. The incorrect sending unit (P/N 10068563) is stamped 563. The CORRECT sending unit (P/N 10096178) is stamped 178.

SERVICE PROCEDURE:

Tools Required: J35749 Oil Pressure Sensor Socket or equivalent.

Inspection

1. Inspect the side of the sending unit for the stamping number.

   Note: using a mirror to locate the stamping number may ease the inspection process.

2. If the sending unit is stamped 563, it should be replaced with the correct sending unit (P/N 10096178) using the procedure below.

Replacement of the Sending Unit

1. Disconnect the negative battery cable.

2. Remove the wiring harness connector from the oil pressure sending unit.
   * 5.7L and 4.3L engines-the oil pressure sending unit is located at the left front side of the distributor.
   * 7.4L engines-the oil sending unit is located at the front left side of the block.

3. Remove the oil pressure sending unit using tool J35749 or equivalent.

4. Install the oil pressure sending unit (P/N 10096178) using tool J35749 or equivalent.

5. Connect the wiring harness connector to the oil pressure sending unit.

6. Connect the negative battery cable.

Chevrolet bulletins are intended for use by professional technicians, NOT a "do-it-yourselfer." They are written to inform these technicians of conditions that may occur on some vehicles, or to provide information that could assist in the proper service of a vehicle. Properly trained technicians have the equipment, tools, safety instructions, and know-how to do a job properly and safely. If a condition is described, DO NOT assume that the bulletin applies to your vehicle, or that your vehicle will have that condition. See your Chevrolet dealer for information on whether your vehicle may benefit from that information.

SERVICE BULLETINS AND GENERAL INFORMATION

90-391-5 – Automatic Park
90-435-5 – Automatic Park
90-397-3 – Automatic Park
90-419-5 – Automatic Park
91-240-5 – Automatic Park
92-02-6E – Service Engine Light
91-151A-5 – Brake Squeak
91-133-5 – Brake Disc Rotor Refinish
91-210-7A – 4L80E Transmission
90-421-6E – Detonation - Exhaust Odor
90-368-8C – Inoperative Speedometer
92-03-6B – New Hose Clamps
91-137-9 – Cruise Control
92-12-7A – 4L80E Pan Gasket
93-57-6A – Incorrect Oil Pressure Readings
91-234A-0B – New Design Spark Plugs
88-283-6E – Electostatic Discharge Damage
93-96-6C – Factors Effecting Fuel Economy
92-46-6A – Oil Pressure Gauge Reads High

OPERATING TEMPERATURES

Engine Oil	–	Page 7-8 Normal engine oil temperature in between coolant temperature and 50 degrees above.
Coolant Temperature	–	Oil pressure 30 to 40 PSI while driving under operating temperature and moderate road speed.
Engine Coolant	–	Minimal operating temperature 200°. Redline is 240° with 195° thermostat.
Transmission Oil	–	Page 8-9.