1997-1998 SERVICE MANUAL

COMMERCIAL HUMMER® MODEL

AM GENERAL CORPORATION
408 South Byrkit Avenue
P.O. Box 728
Mishawaka, Indiana 46546-0728

AM General Number 05744615

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General Information, Lubrication and Maintenance

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SAFETY SUMMARY

Individuals who decide to perform their own repairs should have proper training and limit repairs to components which will not affect the safety of the vehicle or its occupants.

When replacement parts are required, it is strongly recommended that they are purchased through an authorized HUMMER dealer. It is essential that replacement parts meet or exceed manufacturer's specifications. Vehicle performance and personal safety may be impaired if other than original factory components are installed.

The installation of nonapproved accessories or conversions is not recommended as they could affect the vehicle's driving characteristics and personal safety. AM General Corporation will not be liable for personal injury or damage to property resulting from the installation of nonapproved accessories or conversions to the HUMMER.

Following the safety precautions as prescribed throughout this manual may greatly reduce the risks of personal injury and damage to the vehicle. However, it is unlikely that AM General Corporation will account for all possibilities.

Warnings, cautions, and notes are used throughout this service manual to assist service personnel in the performance of maintenance actions. These statements are designed as reminders for trained and experienced service personnel.

WARNINGS — Indicate potential safety hazards and must be followed to avoid personal injury. Warnings appear as follows:

WARNING: To avoid injury, do not remove surge tank filler cap before depressurizing cooling system when engine temperature is above 190° F (88° C).

CAUTIONS — Indicate potential equipment damage, and must be followed to avoid damage to components or systems. An example of a caution is shown below:

CAUTION: To avoid starter damage, do not operate starter continuously for more than 15 seconds. Wait 10 to 15 seconds between periods of operation.

NOTES — Indicate methods or actions that may simplify vehicle maintenance or help maintain vehicle performance. An example of a note is shown below:

NOTE: Clean all components, examine for wear or damage, and replace if necessary.

CARBON MONOXIDE

WARNING: Carbon monoxide (exhaust gases) can be fatal.

WARNING: Brain damage or death can result from heavy exposure to carbon monoxide. The following precautions must be followed to ensure personal safety.

1. Do not operate vehicle engine in enclosed areas. Do not idle the vehicle engine with vehicle windows closed. Be alert at all times for exhaust odors. Be alert for exhaust poisoning symptoms. They are:
   - Headache
   - Dizziness
   - Sleepiness
   - Loss of muscular control
2. If you see another person with exhaust poisoning symptoms:
   - Remove person from area
   - Expose to open air
   - Keep person warm
   - Do not permit physical exercise
   - Administer artificial respiration, if necessary
   - Notify medical personnel

The best defense against exhaust poisoning is adequate ventilation.

ABOUT THIS MANUAL

This service manual contains instructions for maintaining the 1997 commercial HUMMER. Spend some time looking through this manual. Features to improve the usefulness of this manual and increase your efficiency are:

Accessing Information - These include: tabulated sections for quick reference, extensive troubleshooting guides for specific systems, and step-by-step directions for service repairs.

Illustrations - A variety of methods are used to make locating and repairing components easy. Locator illustrations, exploded views, and cut-away diagrams make the information in this manual easy to understand.

The service manual is the best source available for providing information and data critical to vehicle operation and maintenance. In this manual you will find the following information:

- Safety Summary
- General Information
- General Service Procedures
- Detailed Service Procedures
- Torque Ranges
- Wiring Diagrams and Schematics

SERVICE MANUAL COMMENTS

HUMMER owners and dealership service personnel can submit service manual suggestions and comments in writing to:

AM General Corporation
Commercial Publications Department
408 S. Byrkit St.
P.O. Box 728
Mishawaka, IN 46546-0728

Forms are furnished at the end of this manual.

Service Manual Revisions

In order to receive future revisions to this service manual, please write to:

AM General Corporation
Service Parts Logistics Operations
Commercial Publications/Customer Service
408 South Byrkit Avenue
P.O. Box 728
Mishawaka, Indiana 46546-0728

(Be sure to specify publication number.)

HUMMER SERVICE HOTLINE

On occasion, an unusual service problem can arise that is not covered in the manual. For this reason, AM General Corporation has established a service hotline for dealership assistance. The hotline number is:

1-800-638-8303

Transfer Case Hotline

If you have questions that are not answered in Section 5 of this Service Manual, you can call the Transfer Case Hotline at 1-800-945-4327 (in the U.S.) for more information. International and Canadian customers and dealers should call 1-315-432-4110.

EMISSION CONTROL INFORMATION LABEL

The vehicle emission control label contains engine information such as curb idle rpm, engine displacement, catalytic converter type, fuel rate, and vacuum hose routing.

On NA diesel engines, the label is affixed to the driver side rocker arm cover.

On turbo diesel models, the label is affixed to the air cleaner housing (Figure 1-1).

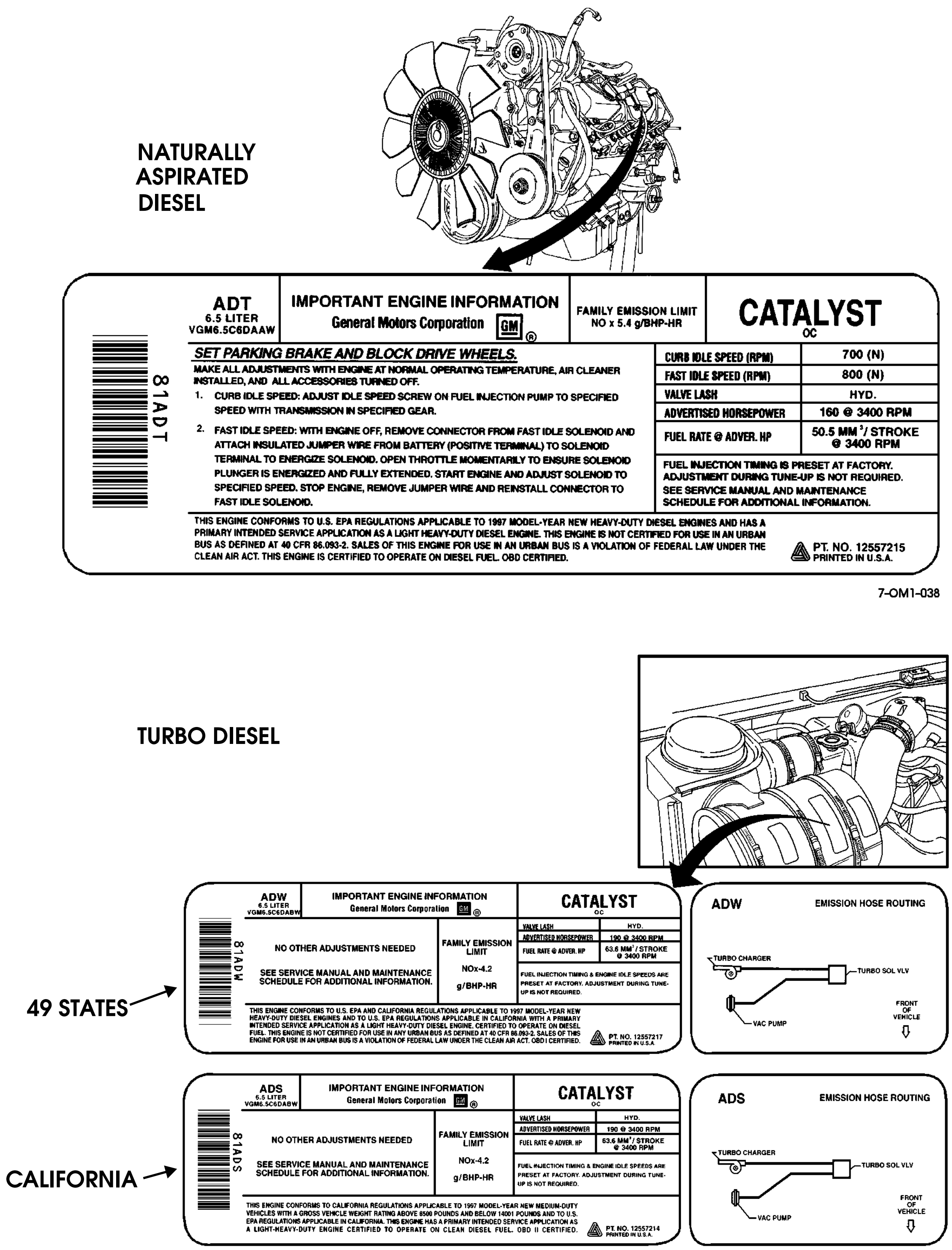


Figure 1-1: Emission Control Information Label Information

SAFETY CERTIFICATION LABEL

The safety certification label is located on the driver side B-pillar (door latch post) (Figure 1-2). The label is required by the National Highway Traffic Safety Administration and includes a tamper-proof feature. If the label is tampered with, a void pattern will appear across the label.

The label contains the name of the manufacturer, the month and year the vehicle was manufactured, the certification statement, the vehicle identification number (VIN), and the vehicle model type. It also contains the Gross Vehicle Weight Rating (GVWR), Gross Axle Weight Ratings (GAWR), and wheel and tire information. For more information on the GVWR and GAWR, refer to “VEHICLE LOADING INFORMATION” in the Hummer Owner’s Manual.

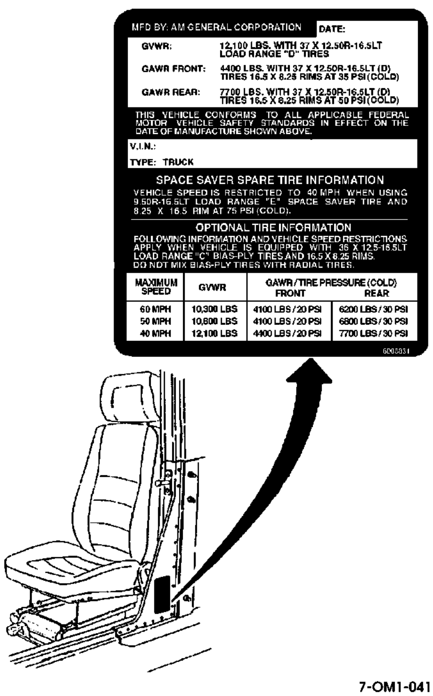


Figure 1-2: Safety Certification Label for Fleet Vehicles (12,100 lb. GVW vehicles)

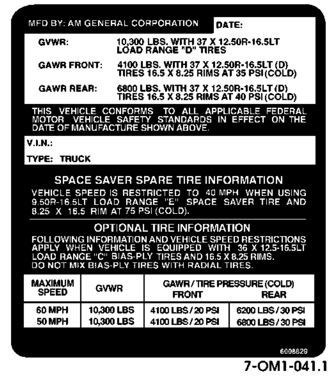


Figure 1-3: Safety Certification Label for 10,300 lb GVWR Vehicles

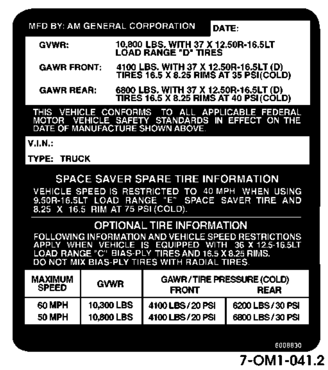


Figure 1-4: Safety Certification Label for 10,800 lb GVWR Vehicles

TRANSMISSION IDENTIFICATION

The 4L80-E automatic transmission serial number is located on a plate at the right side of the transmission (Figure 1-5).

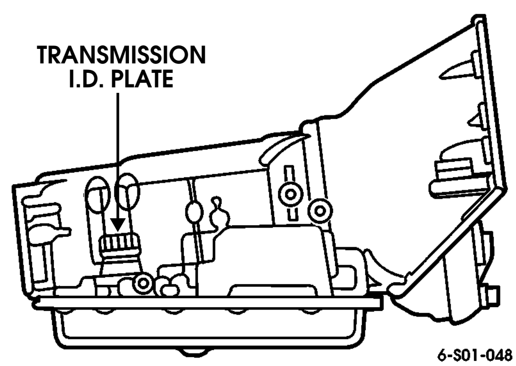


Figure 1-5: Transmission I.D. Plate Location

EPA NOISE EMISSION CONTROL INFORMATION LABEL

The EPA noise emission control information label is located on the passenger side B-pillar (door latch post). The label is required by the EPA and includes a tamper-proof feature. If the label is tampered with, a void pattern will appear across the label. Notify the dealer or the manufacturer if the label is missing or displays a void pattern (Figure 1-6).

The label contains the name of the manufacturer, the month and year the vehicle was manufactured, a statement regarding vehicle conformance to applicable U.S. EPA regulations, and a description of acts prohibited by the Noise Control Act of 1972.

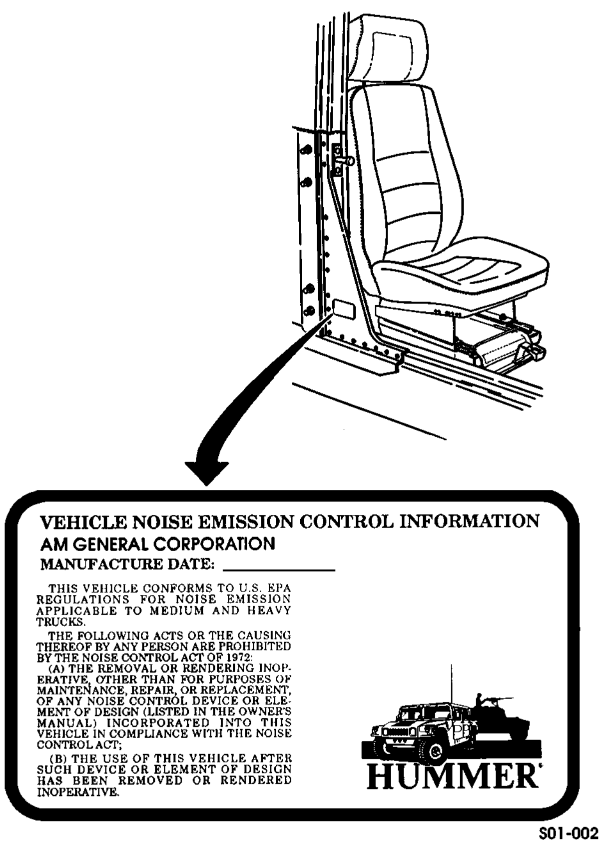


Figure 1-6: EPA Noise Emission Control Information Label Location

TRANSFER CASE IDENTIFICATION

The transfer case serial and assembly numbers are located on a tag attached to the rear case (Figure 1-7).

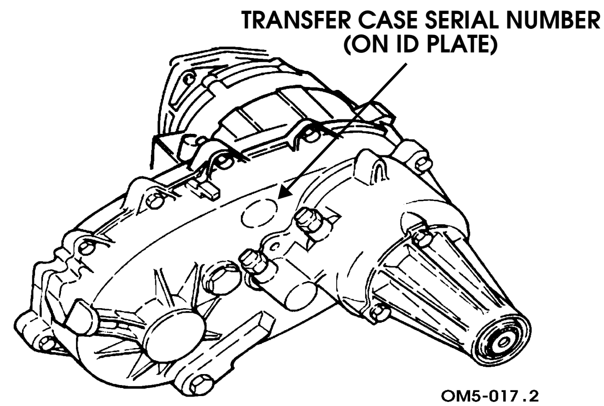


Figure 1-7: Transfer Case I.D. Plate Location

ENGINE IDENTIFICATION

The diesel engine serial number label is located at the rear of the left cylinder head (Figure 1-8).

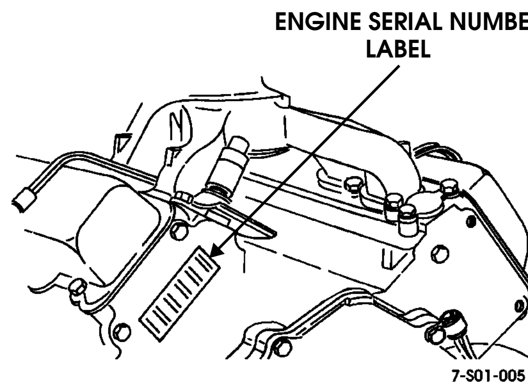


Figure 1-8: Engine I.D. Label Location

VEHICLE IDENTIFICATION NUMBER (VIN)

The VIN plate is located at the upper left front corner of the dashpad (Figure 1-9).

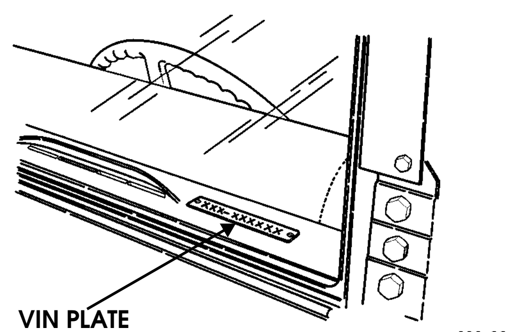
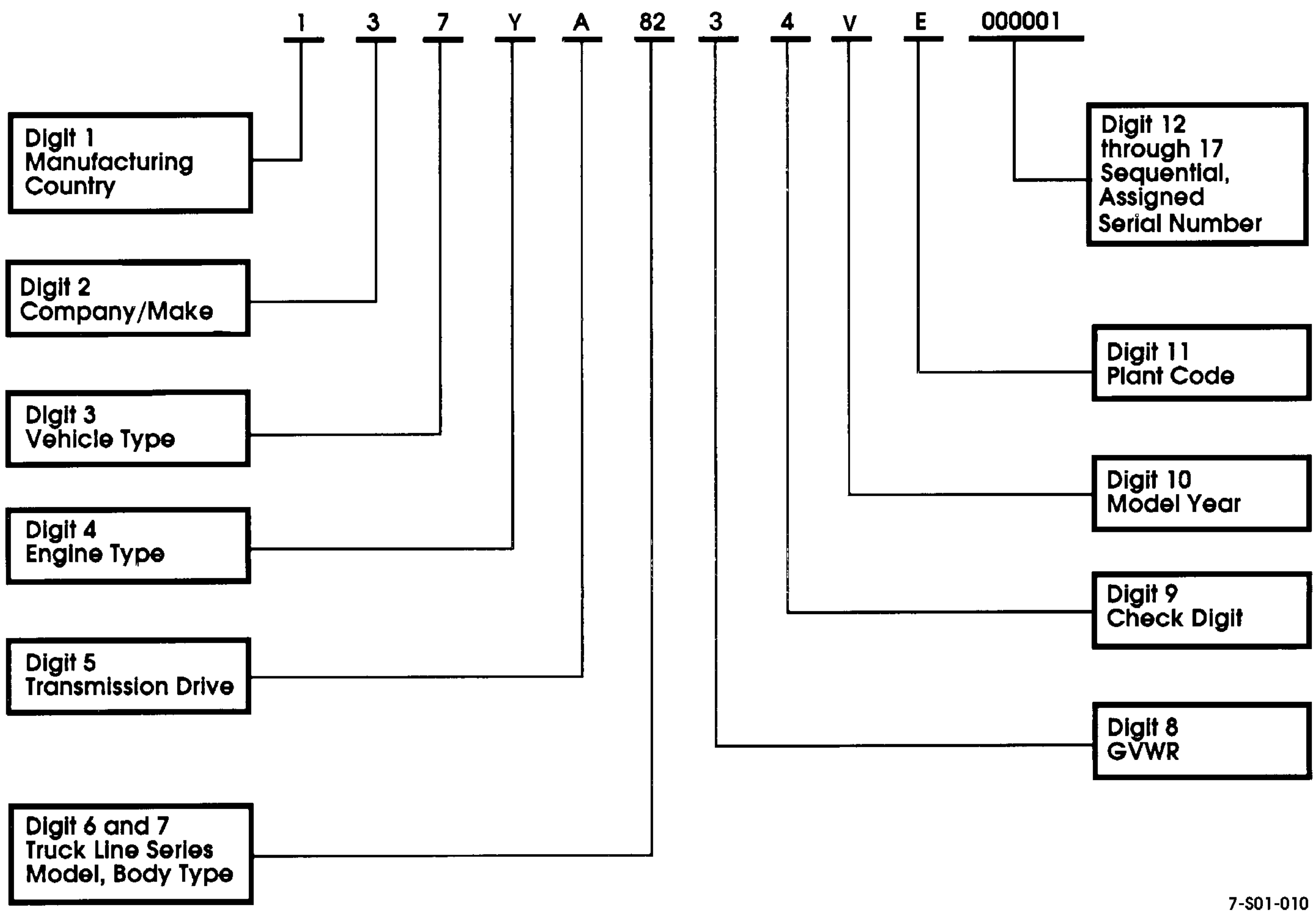


Figure 1-9: VIN Plate Location

The first twelve digits of the seventeen digit VIN are explained in the chart on the following page.



Vehicle Identification Number Decoding Chart

Digit	Code	Code Definition
1	1	United States
2	3	AM General Corporation
3	7	Commercial Vehicles
4	Y	6.5 L (395 in.^{3}), NA Diesel, GM, 8 cyl., 160 hp
	Z	6.5L Turbocharged Diesel, GM, 8 cyl., 195 hp
5	A	4-Speed, Automatic/LHD

Vehicle Identification Number Decoding Chart (Cont'd)

Digit	Code	Code Definition		
6 & 7	83	1-1/4 ton	4-door	Truck, utility
	84	1-1/4 ton	Station wagon	Truck, utility
	89	1-1/4 ton	2-door enlarged cab	Truck, utility
	90	1-1/4 ton	Open body w/full hard doors	Truck, utility
8	3	Class 3-10,001 lb - 14,000 lb (4,541 kg - 6,356 kg)		
9	—	Check Digit		
10	V	1997		
	W	1998		
	X	1999		
11	E	Mishawaka, Indiana		
12-17	—	Sequential Serial Number		

COMPONENT DATA

Engine:

Manufacturer .... GM Powertrain
Model .... 6.5 L (395 in.^{3})
Type .... Four Cycle, Diesel, Liquid-Cooled
Power Output:
NA Diesel .... 165 HP @ 3400 rpm/290 ft.lb. Torque @ 1800 rpm
Turbo Diesel .... 195 HP @ 3400 rpm/430 ft lb. Torque @ 1800 rpm

Engine Dimensions:

Length .... 35 in. (89 cm)
Width .... 28 in. (71 cm)
Height .... 28 in. (71 cm)
Net Weight, Dry .... 701 lb (318 kg)

Governed Speed:

Full Load .... 3,400 RPM
No Load .... 3,650 RPM
Idle Speed .... 700 RPM
Operating Speed .... 1,500-2,600 RPM

Cylinders:

Number 8
Arrangement .... 90° V
Firing Order .... 1-8-7-2-6-5-4-3 (Clockwise)
Bore .... 4.06 in. (103.12 mm)
Stroke .... 3.82 in. (97 mm)
Displacement .... 6.5 L (395 in.^{3})
Compression Ratio:
NA Diesel 20.9:1
Turbo Diesel 20.2:1

Lubricating System:

Type .... Pressure Feed
Operating Pressure (Normal) .... 80 psi (552 kPa) @ 2000 RPM
Operating Pressure (Idle) .... 10 psi (69 kPa)
System Capacity (Filter Included) .... 8 qt (7.6 L)
Operating Temperature (Normal) .... 180°-275° F (82°-135° C)
Oil Pump .... High Output
Filter .... Paper Element, Spin On

Fuel/Air System:

Fuel Supply Pump Type .... Electronic
Fuel Filter Type .... Two Stage Fuel Filter /Water Separator
Glow Plug Type .... (11G) Fast Start

Cooling System:

Type .... Liquid w/Fan and Radiator
Operating Temperature .... 190°-235° F (88°-113° C)
Filler Cap Pressure .... 15 psi (103 kPa)
Radiator Type .... 4 Row Core Downflow
Fan Type .... 10 Blade, suction w/viscous drive
Fan Diameter .... 19.5 in. (49.5 cm)
Thermostat
Starts to Open .... 190° F (88° C)
Fully Open .... 212° F (100° C)

Starter:

Manufacturer .... Prestolite
Model .... MMO
Capacity (Peak) .... 6.0 hp
Voltage .... 12 V

Generator:

Manufacturer .... Delco
Output .... 124 AMP @ 1842 Engine RPM
Rated Voltage .... 13.35 -15.9 V

Batteries:

Manufacturer .... East Penn
Type .... Maintenance-Free
Number 2
Voltage .... 12 V
Amperage
@ 0° F .... 825 Cold Cranking amps Each Battery
32° F .... 950 Cold Cranking amps Each Battery

Transmission:

Manufacturer .... GM Powertrain
Model 4L80-E
Type .... 4-Speed, Automatic
Converter Torque Ratio 2.2:1
Gear Ratios
First 2.48:1
Second 1.48:1
Third 1.00:1
Fourth 0.75:1
Reverse 2.08:1
Oil Type .... Dexron® III
Oil Pressure .... 35-324 psi (241-2,234 kPa)

Transfer Case:

Manufacturer .... New Venture Gear
Model 242
Type .... Full Time Four-Wheel Drive
Gear Ratios
High and High Lock 1:1
Low Range 2.72:1
Oil Type .... Dexron® III

Axle/Differential:

Manufacturer .... AM General Corporation design, made by Dana
Type
Axle .... Fixed Mounted Differential W/ Independent Half Shafts
Differential .... Hypoid Torque Biasing (Paired Worm Gears)
Gear Ratio 2.73:1

Geared Hub:

Manufacturer .... AM General Corporation design, made by Tremec
Type .... Spur Gears
Gear Ratio 1.92:1

Service Brake Caliper (Front):

Manufacturer .... Kelsey-Hayes
Piston Diameter .... 2.6 in. (6.6 cm)

Service/Parking Brake Caliper (Rear):

Manufacturer .... Kelsey-Hayes
Piston Diameter .... 2.6 in. (6.6 cm)

Service/Parking Brake Rotor:

Manufacturer .... Kelsey-Hayes
Diameter .... 10.5 in. (266.7 mm)
Thickness .... 0.87 in. (22 mm)
Minimum Thickness .... 0.81 in. (20.7 mm)

Service Brake Rotor (12,100 GVWR):

Manufacturer .... Kelsey-Hayes
Diameter .... 12.0 in. (304.8 mm)
Thickness .... 1.02 in. (26 mm)
Minimum Thickness .... 0.97 in. (24.7 mm)

Steering System:

Steering Gear
  Manufacturer .... Saginaw
  Type .... Recirculating Ball, Worm and Nut
  Ratio 13/16:1
Power Steering Pump
  Manufacturer .... Saginaw
  Model 185
  Output Pressure (Max) .... 1,465 - 1,515 psi (10,101 - 10,446 kPa)
    Flow Rate (Max) .... 2.6 gpm (9.8 Lpm)
    Capacity (@ 1500 RPM) .... 2.6 gpm (9.8 Lpm)
  Reservoir .... Built-In

Frame:

Manufacturer .... AM General Corporation design, made by Dana
Type .... Steel Box
No. of Crossmembers 5

Winch:

Manufacturer .... Warn
Model .... 12,000 lb., 12VDC HUMMER
Type .... Electric Drive, Thermal Cutoff Switch
Capacity .... 12,000 lb (5,448 kg)

Air Conditioner:

Manufacturer (Compressor) .... GM-Harrison
Model .... HT-6 HE
Field (Coil) .... 12 V
Oil Capacity .... 8 fl oz (237 ml)
Refrigerant R-134a
Capacity (system):
  W/ Auxiliary Air Conditioning (+ 2 oz. of oil) .... 2.3 lb. (1.04 kg)
  Front Unit Only .... 2.1 lb. (0.95 kg)

Wheels and Tires:

Manufacturer ....GoodyearTire Size37 in. X 12.5R-16.5
Wheel Type:
- standard .... One-Piece
- optional (fleet only).. Two-Piece, Take-Apart
- Size..16.5 x 8.25 in.

FLUID CAPACITIES

Cooling System ....26 qt (25 L)
Engine:
- Crankcase (oil pan) only ....7 qt (6.6 L)
- Crankcase and Filter..8 qt (7.6 L)
- Fuel Tank ....25 gal. (95 L)
- Auxiliary Fuel Tank ....17 gal. (64.3 L)
- Axle (front/rear) ....2 qt (1.9 L)

Transmission:
- Drain and Refill (with Pan Removed)..7.7 qt (7.3 L)
- W/ Dry Converter..13.5 qt (12.8 L)

Transfer Case..7 pt (3 L)
Geared Hub ....1 pt (0.47 L)
Steering System ....1 qt (0.95 L)
Brake Hydraulic System (DOT 5)
- 12,100 GVWR:
  - Master Cylinder..1.12 pt (0.53 L)
  - Total System..1.63 pt. (0.77L)
- 10,300 GVWR:
  - Master Cylinder..0.69 pt. (0.33L)
  - Total System..1.20 pt. (0.57L)

Windshield Washer Reservoir..1 gal. (3.78 L)

VEHICLE WEIGHTS

Non-Turbo Diesel Engine

NOTE: Fleet vehicles may have a GVWR of 10,800 lb (4,903 kg) instead of the usual 10,300 lb. (4,676 kg). The impact upon the curb weight and other weight ratings is minimal and therefore, new weight ratings for the 10,800 lb. (4,903 kg) GVWR vehicles have not been specified. Continue to follow the specifications provided for the 10,300 lb. (4,676 kg) GVWR vehicles.

Curb Weight (see Note):
- Two-Door Enlarged Cab (Hard Top) (XLC2) .... 6,290 lb (2,856 kg)
- Four Door Open Top (w/ full doors) (HMCO) .... 6,540 lb (2,969 kg)
- Four Door Hard Top (HMC4).. 6,690 lb (3,037 kg)
- Four-Door Enclosed Utility (HMCS) .... 6,840 lb (3,105 kg)

Payload (see Note):
- Two-Door Enlarged Cab (Hard Top) (XLC2) .... 4,010 lb (1,821 kg)
- Four-Door Open Top (w/ full doors) (HMCO).. 3,760 lb (1,707 kg)
- Four Door Hard Top (HMC4).. 3,610 lb (1,639 kg)
- Four-Door Enclosed Utility (HMCS) .... 3,460 lb (1,571 kg)

Gross Vehicle Weight (GVW) .... 10,300 lb (4,676 kg)
- Gross Axle Weight Rating (GAWR):
  - Front .... 4,100 lb (1,861 kg)
  - Rear .... 6,800 lb (3,087 kg)

Gross Combination Weight (GCW).. 14,800 lb (6,719 kg)

Maximum Towed Load

Two-Door Enlarged Cab (Hard Top) (XLC2)	8,510 lb (3,864 kg)
Four-Door Open Top (w/ full doors) (HMCO)	8,260 lb (3,750 kg)
Four-Door Hard Top (HMC4)	8,110 lb (3,682 kg)
Four-Door Station Wagon (HMCS)	7,960 lb (3,614 kg)

Non-Turbo Diesel Engines -- (12,100 lb. (5,489 kg) GVWR Vehicles -- Fleet Vehicles Only

Curb Weight (see Note):	
Two-Door Enlarged Cab (Hard Top) (XLC2)	6,550 lb (2,974 kg)
Four Door Hard Top (HMC4)	6,950 lb (3,155 kg)
Four-Door Enclosed Utility (HMCS)	7,100 lb (3,223 kg)
Payload (see Note):	
Two-Door Enlarged Cab (Hard Top) (XLC2)	5,550 lb (2,520 kg)
Four Door Hard Top (HMC4)	5,150 lb (2,338 kg)
Four-Door Enclosed Utility (HMCS)	5,000 lb (2,270 kg)
Gross Vehicle Weight (GVW)	12,100 lb (5,489 kg)
Gross Axle Weight Rating (GAWR):	
Front	4,400 lb (1,996 kg)
Rear	7,700 lb (3,493 kg)
Gross Combination Weight (GCW)	14,800 lb (6,719 kg)
Maximum Towed Load	
Two-Door Enlarged Cab (Hard Top) (XLC2)	8,250 lb (3,746 kg)
Four-Door Hard Top (HMC4)	7,850 lb (3,564 kg)
Four-Door Station Wagon (HMCS)	7,700 lb (3,496 kg)

Turbo Diesel Engine

NOTE: Fleet vehicles may have a GVWR of 10,800 lb (4,903 kg) instead of the usual 10,300 lb (4,676 kg). The impact upon the curb weight and other weight ratings is minimal and therefore, new weight ratings for the 10,800 lb. (4,903 kg) GVWR vehicles have not been specified. Continue to follow the specifications provided for the 10,300 lb. (4,676 kg) GVWR vehicles.

Curb Weight (see Note):	
Two-Door Enlarged Cab (Hard Top) (XLC2)	6,360 lb (2,887 kg)
Four Door Open Top (w/ full doors) (HMCO)	6,610 lb (3,001 kg)
Four Door Hard Top (HMC4)	6,760 lb (3,069 kg)
Four-Door Enclosed Utility (HMCS)	6,910 lb (3,137 kg)
Payload (see Note):	
Two-Door Enlarged Cab (Hard Top) (XLC2)	3,940 lb (1,788 kg)
Four-Door Open Top (w/ full doors) (HMCO)	3,690 lb (1,675 kg)
Four Door Hard Top (HMC4)	3,540 lb (1,607 kg)
Four-Door Enclosed Utility (HMCS)	3,390 lb (1,539 kg)
Gross Vehicle Weight (GVW)	10,300 lb (4,676 kg)
Gross Axle Weight Rating (GAWR):	
Front	4,100 lb (1,861 kg)
Rear	6,800 lb (3,087 kg)
Gross Combination Weight (GCW)	14,800 lb (6,719 kg)
Maximum Towed Load	
Two-Door Enlarged Cab (Hard Top) (XLC2)	8,440 lb (3,832 kg)
Four-Door Open Top (w/ full doors) (HMCO)	8,190 lb (3,718 kg)
Four-Door Hard Top (HMC4)	8,040 lb (3,650 kg)
Four-Door Station Wagon (HMCS)	7,890 lb (3,582 kg)

Turbo Diesel Engine -- (12,100 lb. (5,489 kg) GVWR Vehicles -- Fleet Vehicles Only

Curb Weight (see Note):
- Two-Door Enlarged Cab (Hard Top) (XLC2) .... 6,620 lb (3,005 kg)
- Four Door Hard Top (HMC4) .... 7,020 lb (3,187 kg)
- Four-Door Enclosed Utility (HMCS) .... 7,170 lb (3,255 kg)

Payload (see Note):
- Two-Door Enlarged Cab (Hard Top) .... 5,480 lb (2,488 kg)
- Four Door Hard Top (HMC4) .... 5,080 lb (2,306 kg)
- Four-Door Enclosed Utility (HMCS) .... 4,930 lb (2,238 kg)

Gross Vehicle Weight (GVW) .... 12,100 lb (5,489 kg)

Gross Axle Weight Rating (GAWR):
- Front .... 4,400 lb (1,996 kg)
- Rear .... 7,700 lb (3,493 kg)

Gross Combination Weight (GCW) .... 14,800 lb (6,719 kg)

Maximum Towed Load
- Two-Door Enlarged Cab (Hard Top) (XLC2) .... 8,180 lb (3,714 kg)
- Four-Door Hard Top (HMC4) .... 7,780 lb (3,532 kg)
- Four-Door Station Wagon (HMCS) .... 7,630 lb (3,464 kg)

VEHICLE DIMENSIONS

Length (see Note)184.5 in. (4,68.6 mm)
- Height .... 75 in. (190.5 mm)
- Width (without mirrors) .... 86.50 in. (219.7 mm)
- Ground Clearance .... 16 in. (41 cm) (at GVW)
- Wheelbase .... 130 in (330 cm)
- Track Width .... 72 in. (183 m)

NOTE: The vehicle weight and dimensions data applies to models without a winch.

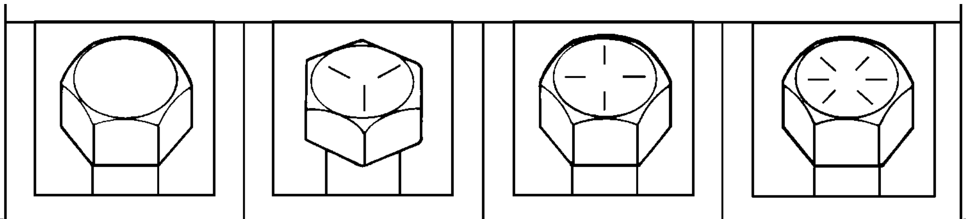
ABBREVIATIONS

A/C . . . . Air Conditioning
a.c. . . . . Alternating Current
AMP . . . . Ampere
CO . . . . Carbon Monoxide
C . . . . Celsius (centigrade)
cm . . . . Centimeter
CTIS . . . . Central Tire Inflation System
CDR . . . . Crankcase Depression Regulator
cm^3 . . . . Cubic Centimeter
$in.^3$ . . . . Cubic Inch
cyl . . . . Cylinder
° . . . . Degree (angle or temperature)
DTC . . . . Diagnostic Trouble Code
dia . . . . Diameter
d.c. . . . . Direct Current
EPA. . . . . Environmental Protection Agency
F . . . . Fahrenheit
ft . . . . Feet
ft/min . . . . Feet Per Minute
fl oz . . . . Fluid Ounce
gal. . . . . Gallon
g . . . . Gram
GAWR . . . . Gross Axle Weight Rating
GVW. . . . . Gross Vehicle Weight
GVWR . . . . Gross Vehicle Weight Rating
hp . . . . Horsepower
HVAC. . . . . Heat, Ventilation, and Air Conditioning
in. . . . . Inch
INC. . . . . Include
ID . . . . Identification
I.D. . . . . Internal Diameter
kg . . . . Kilograms
km . . . . Kilometer
km/h . . . . Kilometers Per Hour
kPa . . . . Kilopascals
lh . . . . Left Hand
L . . . . Liter
max. . . . . Maximum
m . . . . Meter
mpg . . . . Miles Per Gallon
mph . . . . Miles Per Hour
mm . . . . Millimeter
min . . . . Minimum
– . . . . Minus
– . . . . Negative
NA Diesel . . . . Naturally Aspirated Diesel
N•m . . . . Newton-meters
No. . . . . Number
Ohm . . . . Ohms
oz . . . . Ounce
O.D. . . . . Outside Diameter
P/N . . . . Part Number
% . . . . Percentage
pt . . . . Pint
+ . . . . Plus
+ . . . . Positive
lb . . . . Pound
lb-ft . . . . Pound-feet
lb-in. . . . . Pound-inch
psi . . . . Pounds Per Square Inch
qt . . . . Quart
: . . . . Ratio
ref. . . . . Reference
RPM . . . . Revolutions Per Minute
rh . . . . Right-Hand
cm^2 . . . . Square Centimeters
$in.^2$ . . . . Square Inches
VIN . . . . Vehicle Identification Number
V . . . . Volts
W . . . . Watts
UNC . . . . Unified Coarse
UNF . . . . Unified Fine

BOLT IDENTIFICATION AND TORQUE LIMITS (DRY*)

* A phosphate and oil bolt is considered dry

Bolt Head ID Marks and SAE GRADE

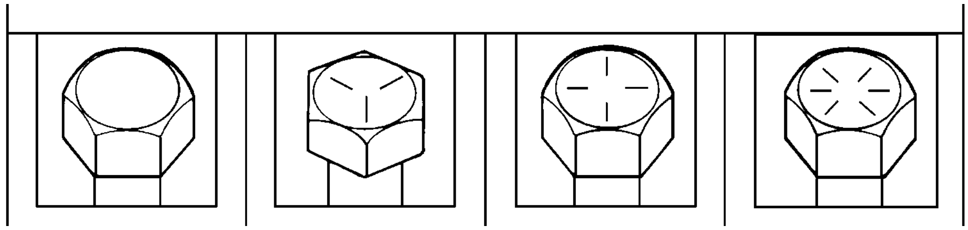


BOLT SIZE			SAE GRADE NO. 1 OR 2	SAE GRADE NO. 5	SAE GRADE NO. 6 OR 7	SAE GRADE NO. 8
DIA. INCHES	MILLI-METERS	THREADS PER INCH	POUND FEET (NEWTON-METERS)	POUND FEET (NEWTON-METERS)	POUND FEET (NEWTON-METERS)	POUND FEET (NEWTON-METERS)
1/4	6	20	5(7)	8(11)	10(14)	12(16)
1/4	6	28	6(8)	10(14)	——	14(19)
5/16	8	18	11(15)	17(23)	19(26)	24(33)
5/16	8	24	13(18)	19(26)	——	27(37)
3/8	10	16	18(24)	31(42)	34(46)	44(60)
3/8	10	24	20(27)	35(47)	——	49(66)
7/16	11	14	28(38)	49(66)	55(75)	70(95)
7/16	11	20	30(41)	55(75)	——	78(106)
1/2	13	13	39(53)	75(102)	85(115)	105(142)
1/2	13	20	41(56)	85(115)	——	120(163)
9/16	14	12	51(69)	110(149)	120(163)	155(210)
9/16	14	18	55(75)	120(163)	——	170(231)
5/8	16	11	63(85)	150(203)	167(226)	210(285)
5/8	16	18	95(129)	170(231)	——	240(325)
3/4	19	10	105(142)	270(366)	280(380)	375(509)
3/4	19	16	115(156)	295(400)	——	420(570)
7/8	22	9	160(217)	395(536)	440(597)	605(820)
7/8	22	14	175(237)	435(590)	——	675(915)
1	25	8	235(319)	590(800)	660(895)	910(1234)
1	25	14	250(339)	660(895)	——	990(1342)
1-1/8	29	—	——	800 - 880 (1085 - 1193)	——	1280 - 1440 (1736 - 1953)
1-1/4	32	—	——	—	——	1820 - 2000 (2468 - 2712)
1-3/8	35	—	——	1460 - 1680 (1980 - 2278)	——	2380 - 2720 (3227 - 3688)
1-1/2	38	—	——	1940 - 2200 (2631 - 2983)	——	3160 - 3560 (4285 - 4827)

BOLT IDENTIFICATION AND TORQUE LIMITS (WET*)

*A cadmium plated bolt is considered wet.

Bolt Head ID Marks and SAE Grade



BOLT SIZE			SAE GRADE NO. 1 OR 2	SAE GRADE NO. 5	SAE GRADE NO. 6 OR 7	SAE GRADE NO. 8
DIA. INCHES	MILLI-METERS	THREADS PER INCH	POUND FEET (NEWTON-METERS)	POUND FEET (NEWTON-METERS)	POUND FEET (NEWTON-METERS)	POUND FEET (NEWTON-METERS)
1/4	6	20	4(5)	7(10)	9(12)	11(15)
1/4	6	28	5(7)	9(12)	——	13(17)
5/16	8	18	10(14)	15(20)	17(23)	22(30)
5/16	8	24	12(16)	17(23)	——	24(33)
3/8	10	16	16(22)	28(38)	31(42)	40(54)
3/8	10	24	18(24)	32(43)	——	44(60)
7/16	11	14	25(34)	44(60)	50(68)	63(85)
7/16	11	20	27(37)	50(68)	——	70(95)
1/2	13	13	35(48)	68(92)	77(104)	95(129)
1/2	13	20	37(50)	77(104)	——	108(146)
9/16	14	12	46(62)	99(134)	108(146)	140(190)
9/16	14	18	50(67)	108(146)	——	153(207)
5/8	16	11	57(77)	135(183)	150(203)	189(256)
5/8	16	18	85(115)	153(207)	——	216(293)
3/4	19	10	95(129)	243(330)	252(342)	338(458)
3/4	19	16	104(141)	266(361)	——	378(513)
7/8	22	9	144(195)	356(483)	396(537)	545(739)
7/8	22	14	158(214)	392(532)	——	608(824)
1	25	8	212(287)	531(720)	594(805)	819(1111)
1	25	14	225(305)	594(805)	——	891(1208)
1-1/8	29	—	——	720 - 792 (976 - 1074)	——	1152 - 1296 (1562 - 1757)
1-1/4	32	—	——	——	——	1638 - 1800 (2221 - 2441)
1-3/8	35	—	——	1314 - 1512 (1782 - 2050)	——	——
1-1/2	39	—	——	1746 - 1980 (2368 - 2685)	——	2844 - 3204 (3857 - 4345)

U.S./METRIC CONVERSIONS AND EQUIVALENTS

Metric Conversions

MULTIPLY	BY	TO GET
INCHES	2.54	CENTIMETERS
FEET	0.305	METERS
MILES	1.609	KILOMETERS
SQUARE INCHES	6.451	SQUARE CENTIMETERS
CUBIC INCHES	16.39	CUBIC CENTIMETERS
FLUID OUNCES	29.573	MILLILITERS
PINTS	0.473	LITERS
QUARTS	0.946	LITERS
GALLON	3.785	LITERS
POUNDS	0.454	KILOGRAMS
SHORT TONS	0.907	METRIC TONS
POUND-INCHES	0.113	NEWTON-METERS
POUND-FEET	1.356	NEWTON-METERS
POUNDS PER SQUARE INCH	6.895	KILOPASCALS
MILES PER GALLON	0.425	KILOMETERS PER LITER
MILES PER HOUR	1.609	KILOMETERS PER HOUR

U.S. Standard Conversions

MULTIPLY	BY	TO GET
CENTIMETERS/MILLIMETERS	0.3937	INCHES
METERS	3.280	FEET
KILOMETERS	0.621	MILES
SQUARE CENTIMETERS	0.155	SQUARE INCHES
CUBIC CENTIMETERS	0.061	CUBIC INCHES
MILLILITERS	0.034	FLUID OUNCES
LITERS	2.113	PINTS
LITERS	1.057	QUARTS
LITERS	0.264	GALLONS
KILOGRAMS	2.205	POUNDS
METRIC TONS	1.102	SHORT TONS
NEWTON-METERS	0.738	POUND-FEET
NEWTON-METERS	8.851	POUND-INCHES
KILOPASCALS	0.145	POUNDS PER SQUARE INCH
	KILOMETERS PER LITER	2.354MILES PER GALLON
	KILOMETERS PER HOUR	0.621MILES PER HOUR

Temperature

32° FAHRENHEIT = 0° CELSIUS

212° FAHRENHEIT = 100° CELSIUS

CELSIUS = 0.556 X (F° -32)

FAHRENHEIT = (1.8 X C°) +32

PAINT AND TRIM COLORS

Interior trim colors are tan and gray. Seating materials are available in cloth and vinyl.

Soft top colors and codes are: Tan (T), Black (B), and White (W).

Exterior paint colors and codes are outlined in the following chart.

Top Coat Description	AM General Code
Red	R7
White	W8
Black	B9
Deep Green Metallic	G10
Fly Yellow	Y18
Burgundy Metallic	P17
Bright White	W14
Silver	S15

REPLACEMENT KEYS

Replacement keys can be cut using Briggs and Stratton or Curtis key cutting tools. Key codes are provided on an identificaion tag included with each key set (Figure 1-10).

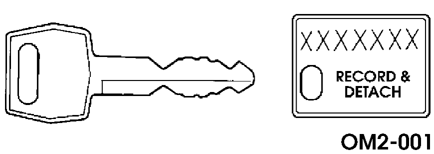


Figure 1-10: Key Code Location

REMOTE ENTRY RECEIVER/TRANSMITTER REPLACEMENT

The receiver can be programmed to work with up to four transmitters. To add, replace and/or delete transmitter:

1. Locate the unconnected gray wire with a pink or red connector taped to the remote entry harness connected to the receiver module beneath the console cover.
2. Assemble all the transmitters to be used.
3. Turn on the ignition switch.
4. Ground the pink-red connector four times in succession. The parking lamps will flash four times and the system will reset itself in the program mode.
5. Push the button on any transmitter and the lights will flash once.
6. Repeat this for the remaining transmitters for up to four transmitters. The above must be accomplished within 30 seconds from grounding the gray wire connector or the system will exit the programming mode and the procedure will have to be repeated.
7. Turn the ignition switch off following the above and check each transmitter for correct function.

REARVIEW MIRROR WITH COMPASS AND TEMPERATURE DISPLAY (OPTIONAL)

Some Hummer vehicles may be equipped with the optional rearview mirror with a digital electronic compass, outside temperature display and interior reading lamps. There should be an information card attached to the mirror. However the information is provided in the Owner's Manual as well.

The electronic compass shows forward direction in the digital display located above the rearview mirror. The compass will display the following directions: N, NW, W, SW, S, SE, E, and NE.

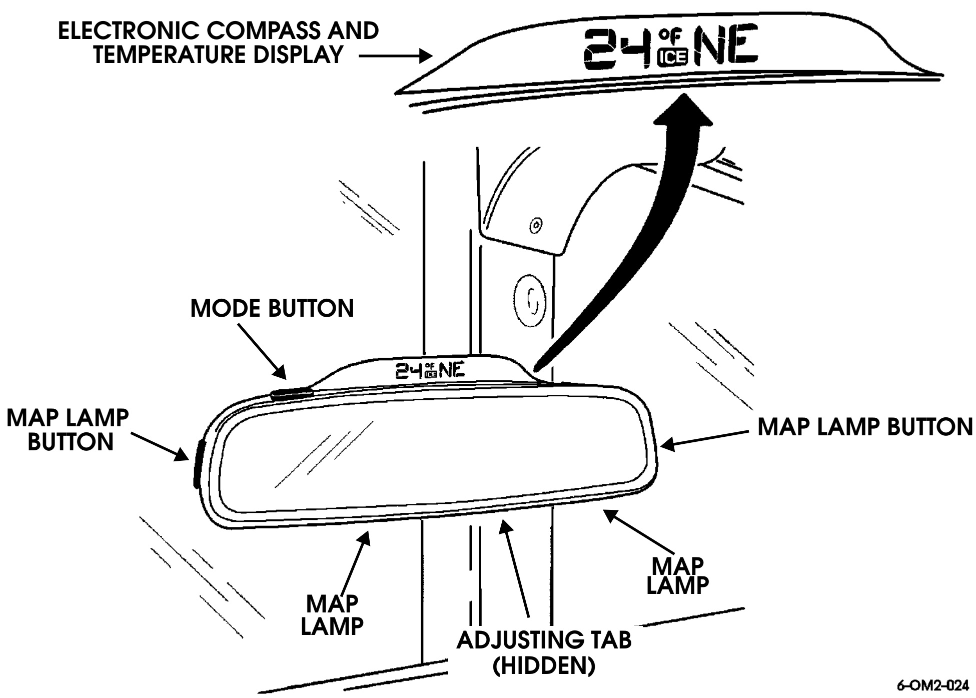


Figure 1-11: Rearview Mirror with Compass and Temperature Display

Temperature Display

The outside temperature display shows a digital temperature reading. When the temperature is less than 38 degrees, "ICE" will illuminate in the display for one minute to remind the driver to anticipate potential icy road conditions.

Compass Calibration

CAUTION: Do NOT mount Cellular or CB antennas within 2 feet of the mirror. Compass performance will be adversely affected.

The compass automatically calibrates itself as the vehicle is driven, therefore, no calibration should be required. However, if the vehicle's compass headings become inaccurate, manually calibrate the compass by following this procedure:

- Turn the ignition ON.
- Press and hold the Mode button for more than 15 seconds ("CAL" will illuminate in the display).
- Drive in at least 3 circles in an area away from long steel objects.

The display "CAL" will turn off when the compass is calibrated.

Calibration data is stored in memory so it should not have to be recalibrated if the vehicle loses battery power.

Zone Variation

The compass must be set to compensate for the difference between true north and magnetic north. To set the magnetic variation:

- Press and hold the Mode button for at least 5 seconds but not more than 10 seconds. When the ZONE symbol lights, release the button.
- Use the map to find your geographic location. Note the zone that you are in.
- Press the MODE button until your zone number appears on the display.
- The zone is set after 5 seconds of no activity of the mode button.

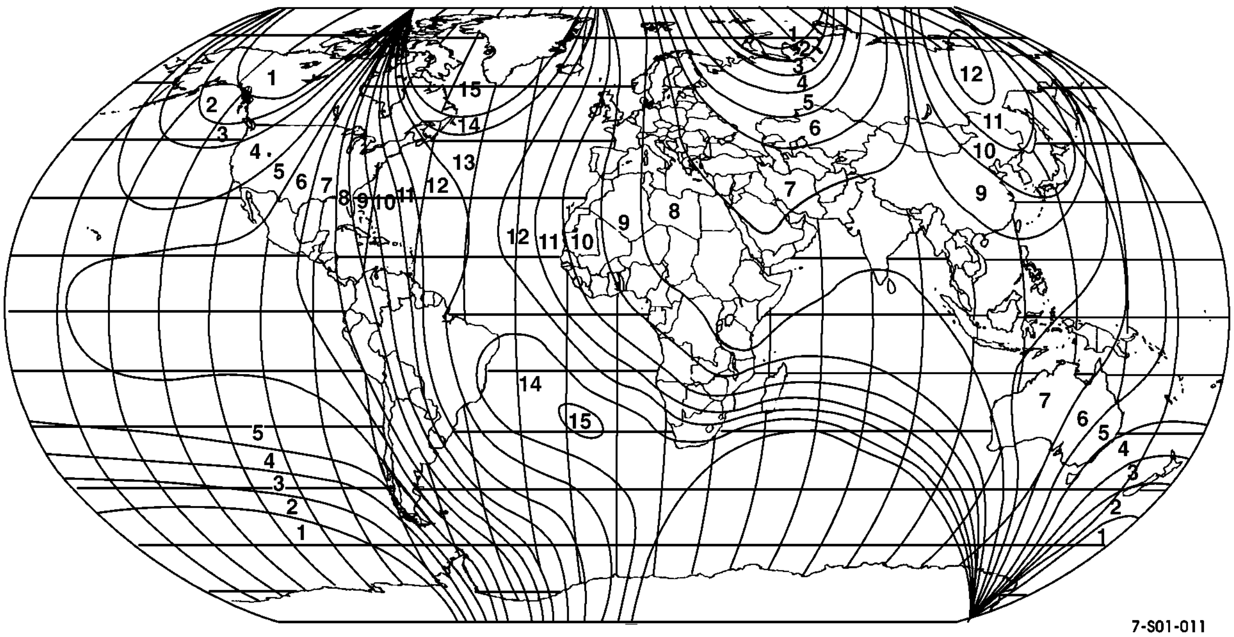


Figure 1-12: Magnetic Zone Variation

TOWING, LIFTING, JUMP STARTING

Vehicle Lifting/Jacking Points

Vehicle jacking points are shown in Figure 1-13. The vehicle can be raised with a floor jack at any of the indicated positions. Jacking can be performed at the front, rear, or at any one wheel.

In cases where the entire vehicle must be raised, use jack stands at equidistant points on the frame rails. Use a minimum of four stands to support the vehicle. Suggested capacity for individual jack stands is 3 ton, with a vertical reach of 19 in. (49 cm).

Typical jack stand placement for raising one side of the vehicle is shown in Figure 1-14. Always be sure the jack stand saddle is securely engaged and the stand is level.

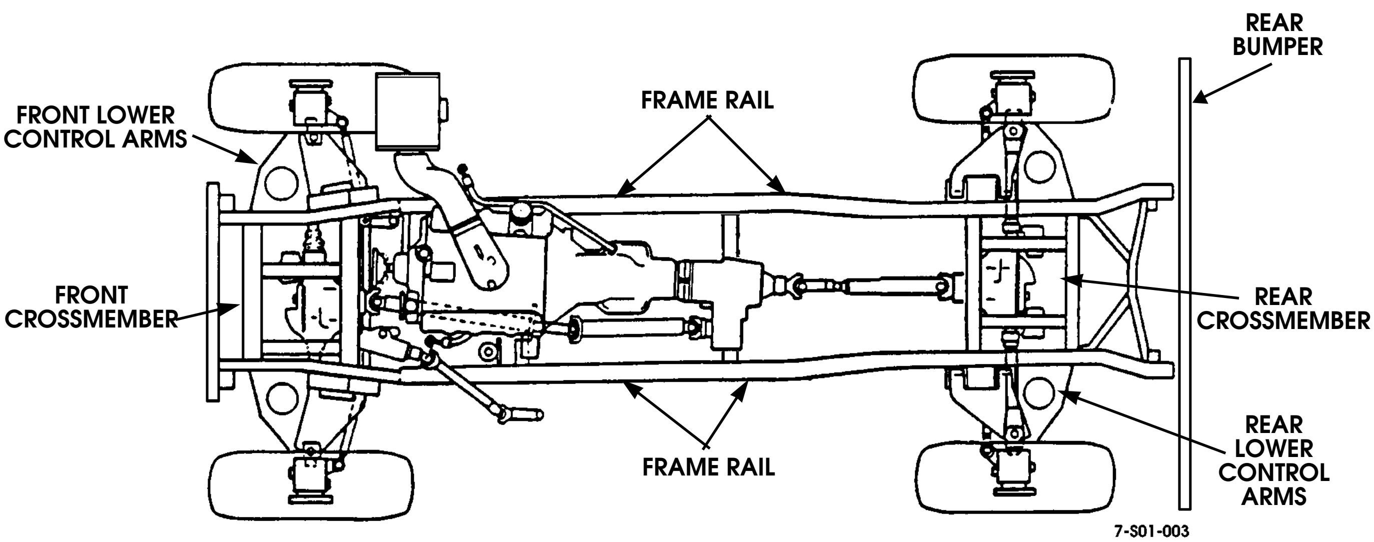


Figure 1-13: Vehicle Jacking Points

Vehicle Hoisting

Hummer vehicles can be raised on a hoist for service access. Drive-on and swivel arm hoists are both acceptable.

Hoist capacity and width are important. The greater width and weight of Hummer vehicles require a larger hoisting platform.

Do not use an under capacity hoist, or modify an existing hoist for use; this practice is neither safe nor recommended.

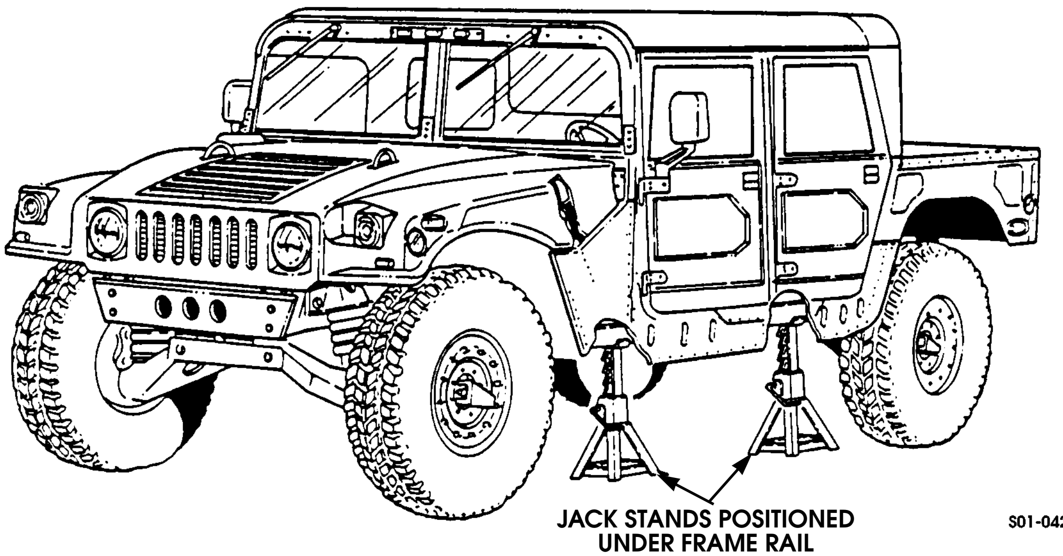


Figure 1-14: Typical Jack Stand Placement

Towing Recommendations

Hummer vehicles can be towed with wheel lift, sling-type, or flat bed tow equipment.

Flat bed and wheel lift equipment is recommended over sling type or A-frame equipment.

Towing Cautions:

- Remove or secure loads in the towed vehicle
- Never use the shackles on the front bumpers as tie down points
- Always use safety chains on sling towed vehicles
- Always follow the transmission/transfer case shift position recommendations (Transfer Case in N (Neutral); Transmission in P (Park).
- Use a low vehicle trailer for recreational towing (behind an RV or other vehicle) when possible.

Flat Bed/Wheel Lift Towing Procedures

Flat bed/wheel lift tow vehicles are highly recommended. They keep all of the towed vehicle wheels off the pavement. This is important with full time four wheel drive vehicles.

Loading only requires that the towed vehicle be raised or winched onto the towing platform. A further advantage of this type equipment is that tow speed and distance are not limited. Once the towed vehicle is loaded, set the parking brake, shift the transmission into Park and install the vehicle tie downs. Tie down attachment points are shown in Figure 1-15.

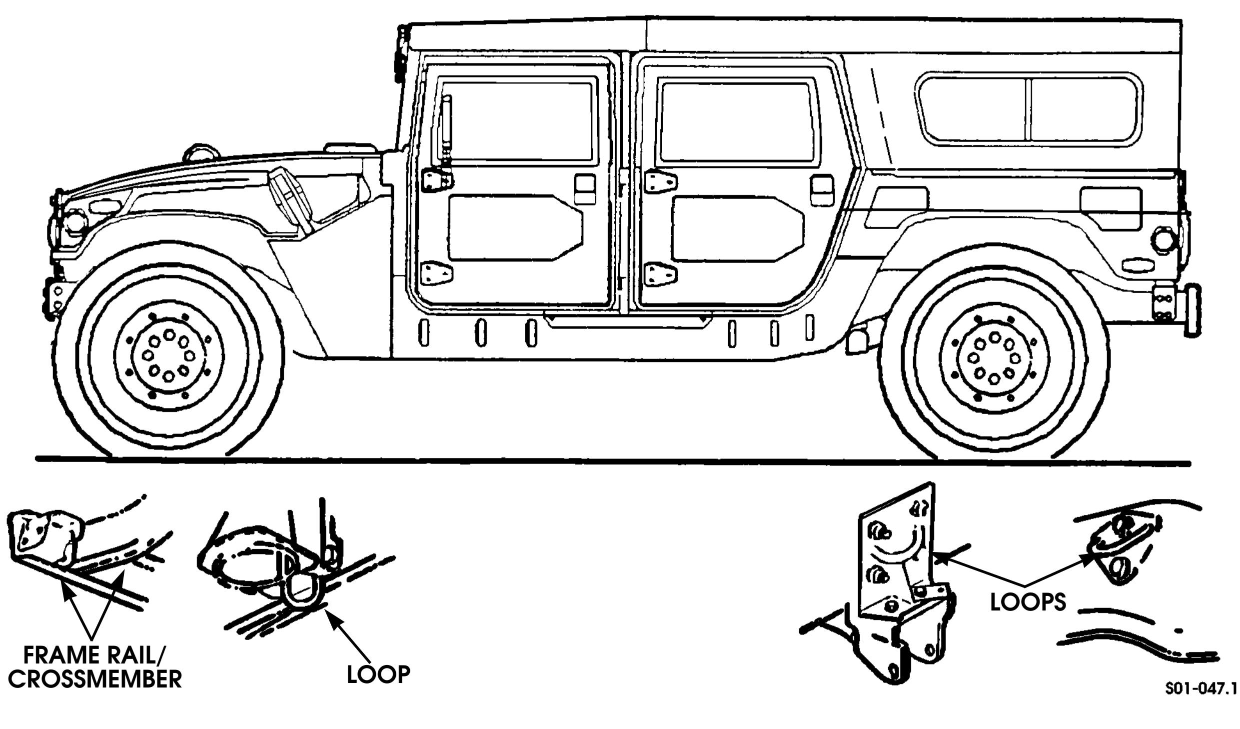


Figure 1-15: Vehicle Tie-Down Points

Conventional Towing Procedures

Front Towing

1. Loop chains around lower control arms and secure to tow sling (Figure 1-16).
2. Insert 4” x 4” x 48” length of wood between bumper and sling chains (Figure 1-16).
3. Raise front end and verify that sling is firmly positioned against front bumper.
4. Release parking brakes.
5. Shift transmission into Park and transfer case into Neutral.
6. Position tow dollies under rear wheels. Proceed with towing operations.

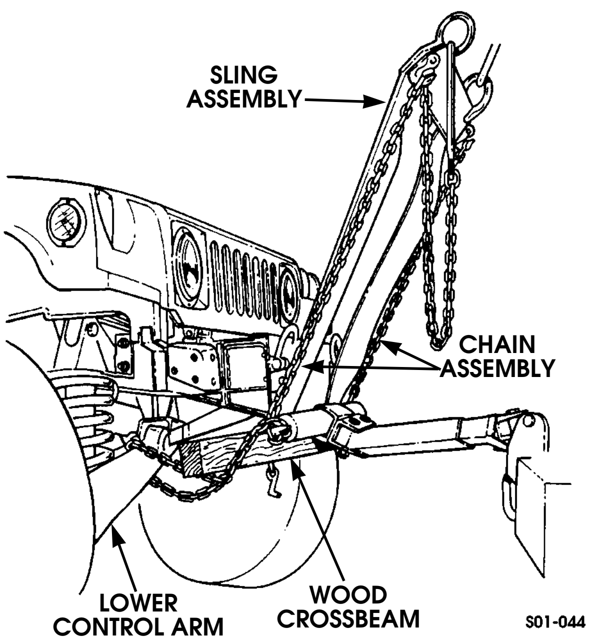


Figure 1-16: Front Towing With Conventional Equipment

Rear Towing

1. Loop sling chain around frame rails adjacent to rear cross-member and secure to tow sling (Figure 1-17).
2. Insert 4” x 4” x 48” length of wood between bumper and sling chains (Figure 1-17).
3. Raise rear end and verify that sling is firmly positioned against rear bumper.
4. Release parking brakes.
5. Shift transmission into Park and transfer case into Neutral.
6. Position tow dollies under front wheels. Proceed with towing operations.

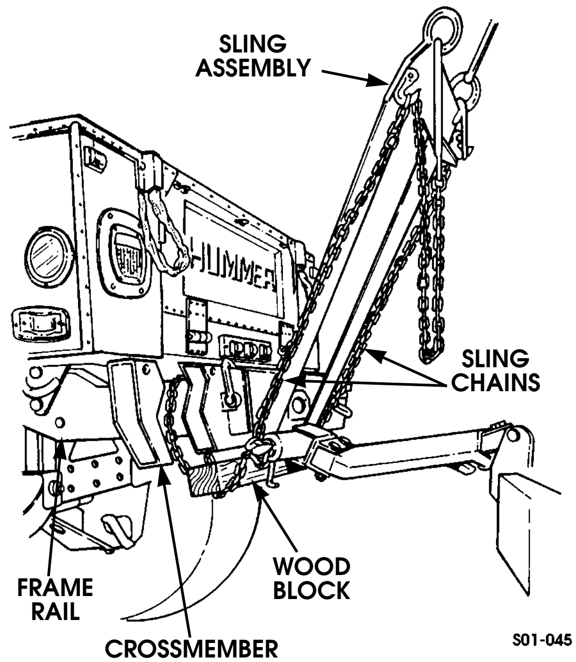


Figure 1-17: Rear Towing with Conventional Equipment

Conventional Towing When Keys are not Available

If the vehicle doors are locked and the keys are not available you cannot determine that the transmission is in Park and the transfer case is in “N” (Neutral). In these situations, you must use one of the following towing methods:

a. Use tow dollies at all wheels and flat tow,

or

b. Raise the vehicle front or rear and use tow dollies under the wheels not raised.

Recreational Towing

Hummer vehicles can be towed behind an RV if desired. A low-boy style vehicle trailer is best for this purpose. Flat towing is not recommended.

Jump Starting

Hummer vehicles can be jump started when necessary. Starting can be performed with a portable starting unit, separate booster batteries, or the battery in another vehicle.

Certain Cautions and Warnings must be observed when jump starting a vehicle. They are:

- If the battery in another vehicle is being used for jump starting, do not allow the two vehicles to touch. Contact can result in damage to the electrical system in both vehicles.
- Always connect negative to ground and positive to positive.
- Never jump start a vehicle with a frozen battery. This practice could lead to personal injury.
- Never jump start a battery when electrolyte level is below the top of the cell plates.
- Do not allow jumper cable clamps to touch after connecting them to the booster battery.
- Never allow open flame near batteries, especially during jump start operations or when batteries are charging. Personal injury could occur in either case.
- Never use 24 volt booster equipment, or equipment that is NOT negative ground. Either will seriously damage the vehicle electrical system.
- Remove all jewelry from hands and wrists to avoid arcing caused by accidental contact with battery current source.

Jump Start Procedure

1. Set parking brake and shift transmission into Park.
2. Do not jump start if low or dead battery is: frozen, cracked, has loose terminal socket, electrolyte level is below cell plates, or indicates less than 9 volts across terminals. Install temporary or replacement battery instead. However, if battery is only low on charge and is OK otherwise, proceed with jump starting.
3. Connect positive (+) jumper cable to battery positive terminal (Figure 1-18).

NOTE: An adapter may be required to connect the cables to some side mount terminals.

4. Connect negative (-) jumper cable to generator mounting bracket (Figure 1-18). Be sure cable clamp is securely attached.
5. If portable booster machine is being used, verify that machine is at 12 volt setting. Higher volt/amp settings can damage vehicle electrical system.
6. Start vehicle. Disconnect jumper cables immediately after engine startup.

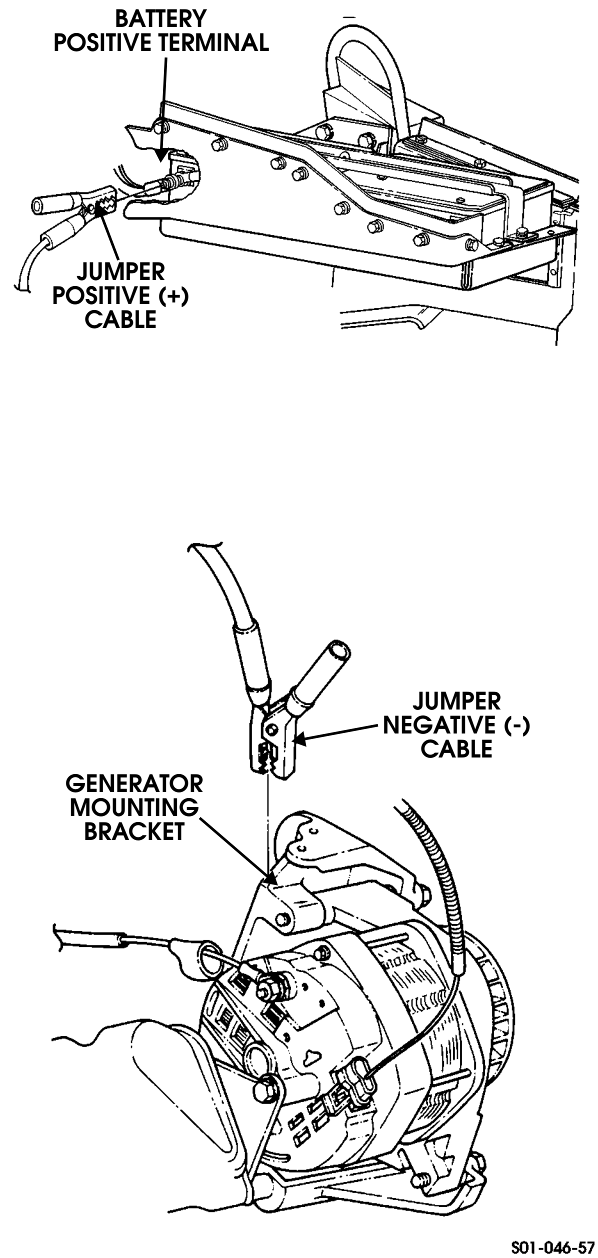


Figure 1-18: Jumper Cable Connections

MAINTENANCE SCHEDULE

Recommended Maintenance

Maintenance recommendations in this section were developed to maintain satisfactory vehicle operation. Items described in Maintenance Inspection Groups A, B, and C are important to proper operation, performance, and safety.

It is important that maintenance items outlined in the schedules be performed at suggested intervals. Regular maintenance will greatly improve vehicle reliability and longevity.

Normal Maintenance

The vehicle maintenance schedules reflect services required for normal operation. Normal operation includes city/highway driving on hard surface roads with only minimal operation on unpaved road surfaces.

Maintenance After Severe Operation

Severe operation includes extensive off-road driving, commercial use, sustained operation in high ambient temperatures, and trailer towing. This type of vehicle operation requires additional and more frequent service.

Commercial use involves regular operation as a delivery or service type vehicle. Severe off-road use involves extended operation on rough terrain, stream fording, or sustained operation in sand, mud, snow, or dirt surfaces. Severe operation also includes prolonged daily operation in heavy traffic when ambient temperatures are high.

The additional maintenance required immediately after severe off-road operation is as follows:

a. Wash the vehicle underbody, driveline and brake components, and all steering linkage and suspension parts with a low pressure water spray.

b. If vehicle was driven over rough terrain, examine the underbody and driveline components for impact damage. Also check for leaks and loose parts.

c. If vehicle was driven in salt water, thoroughly rinse the vehicle underbody, driveline and brake components, all linkage and suspension parts with a low pressure fresh water spray.

d. If the vehicle was driven through deep water, examine lubricant in the geared hubs and axles for water contamination. Drain and change the lubricant if necessary. Also clean the axle and hub vents if required.

e. Check the front/rear brake shoes for contamination by dirt, mud, sand, etc. Replace the shoes if foreign material has become embedded in the lining. However, if the shoes are only wet from water, allow them to air dry, or drive the vehicle about 1/4 mile with the brakes lightly applied to heat and dry the shoes.

f. Check transmission/transfer case fluid level and condition. Drain and replace the fluid in either assembly if water contamination is evident. If water contamination proves extensive, it will also be necessary to replace the transmission fluid filter, and flush the fluid coolers and lines.

g. Lubricate the steering linkage, ball joints, propeller shaft, and body lubrication points.

h. Check the brake and power steering fluid levels and top off as needed.

i. Examine the engine air filter. Replace the filter element if necessary and clean the air filter housing and dust unloader.

j. Change engine oil and replace engine oil filter if contamination is suspected.

Maintenance Inspection Groups A-B-C

The inspection groups outline additional components to be checked at stated mileage intervals. The intervals are described in the Vehicle Maintenance Schedule. Perform necessary service repair, replacement, or adjustments as each inspection item is checked.

Maintenance Inspection Group A consists of the following items:

- Check fluid levels and condition for power steering pump, cooling system (reservoir and surge tank), brakes, transmission, transfer case, geared hubs, and axles.
- Check CDR valve for oil saturation.
- Inspect condition of control arms, springs, and shock absorbers.
- Check tire wear and condition.
- Lubricate all grease fittings and body lubrication points.
- Inspect geared hubs for leaking seals or damage.
- Inspect service brakes and parking brake.
- Check axles for leaks or damage.
- Check wheel bolt and nut torque.
- Inspect condition of geared hub and axle vent lines.
- Inspect condition of transmission and transfer case vent lines.
- Inspect U-joints for wear or missing/damaged grease fittings.
- Inspect transmission/transfer case shift linkage for wear, binding, distortion.
- On non-turbo models, inspect accelerator linkage for wear, binding, loose, excessive play.
- Inspect condition of engine mounts and insulators.
- Check fuel filter and drain/clean if necessary.
- Check CTIS operation. Verify that system inflates/deflates tires and has no leaks.
- Check winch operation (if equipped) and cable condition. Pay-out and pay-in at least 30 feet of cable.
- Check ball joints for wear.
- Test drive vehicle and complete a functional check of all systems.
- Check air cleaner.

Maintenance Inspection Group B consists of the following items:

- Inspect fuel injection pump, lines, and fittings for leaks or damage.
- Check battery voltage and condition. Clean battery exterior with ammonia/water or baking soda/water mixture.
- Inspect serpentine belt condition.
- Inspect exhaust system and shields.
- Inspect and rotate tires.
- Inspect halfshaft boots and ball joint seals.
- Inspect condition of steering column, U-joints, tie rods, steering arm, center link, and idler arm.
- Check fuel tank vent line filter.
- Inspect condition of frame rails and crossmembers.
- Check A/C system operation.
- Check wheel alignment.

Maintenance Inspection Group C consists of the following items:

- Inspect surge tank, radiator and shroud, A/C condenser, power steering and transmission coolers, and all hoses and fittings for security of mounting, leaks, or damage.
- Inspect fuel tank, lines, and cap.
- Inspect all wiring harnesses for frays, splits, missing insulation, poor connections.
- Inspect power steering pump, power steering gear, hoses, lines, and fittings for leaks or damage.

Scheduled Maintenance Chart

3,000 Miles (4 800 km)

❒ Change engine oil and replace filter.

❒Check items in Maintenance Group A.

6,000 Miles (9 700 km)

❒Change engine oil and replace filter.

❒Clean or replace air filter.

❒Replace fuel filter element.

❒Check items in Maintenance Groups A and B.

9,000 Miles (14 500 km)

❒Change engine oil and replace filter.

❒Check items in Maintenance Group A.

12,000 Miles (19 300 km)

❒Change engine oil and replace filter.

❒Clean or replace air filter.

❒Replace fuel filter element.

❒Change engine coolant.

❒Change transmission and transfer case fluid.

❒Check items in Maintenance Groups A, B, and C.

15,000 Miles (24 100 km)

❒Change engine oil and replace filter.

❒Check items in Maintenance Group A.

18,000 Miles (29 000 km)

❒Change engine oil and replace filter.

❒Clean or replace air filter.

❒Replace fuel filter element.

❒Check items in Maintenance Groups A and B.

21,000 Miles (33 800 km)

❒Change engine oil and replace filter.

❒Check items in Maintenance Group A.

24,000 Miles (38 600 km)

❒Change engine oil and replace filter.

❒Clean or replace air filter.

❒Replace fuel filter element.

❒Change engine coolant.

❒Change transmission fluid and transfer case fluid.

❒Check items in Maintenance Groups A, B, and C.

27,000 Miles (43 400 km)

❒Change engine oil and replace filter.

❒Check items in Maintenance Group A.

30,000 Miles (48 300 km)

❒Change engine oil and replace filter.

❒Clean or replace air filter.

❒Replace fuel filter element.

❒ Check items in Maintenance Groups A and B.

33,000 Miles (53 100 km)

❒Change engine oil and replace filter.

❒Check items in Maintenance Group A.

36,000 Miles (58 000 km)

❒Change engine oil and replace filter.

❒Clean or replace air filter.

❒Replace fuel filter element.

❒Change engine coolant.

❒Change transmission and transfer case fluid.

❒Check items in Maintenance Groups A, B, and C.

39,000 Miles (62 800 km)

❐Change engine oil and replace filter.

❐Check items in Maintenance Groups A.

42,000 Miles (67 600 km)

❐Change engine oil and replace filter.

❐Clean or replace air filter.

❐Replace fuel filter element.

❐Check items in Maintenance Groups A and B.

45,000 Miles (72 400 km)

❐Change engine oil and replace filter.

❐Check items in Maintenance Group A.

48,000 Miles (77 200 km)

❐Change engine oil and replace filter.

❐Clean or replace air filter.

❐Replace fuel filter element.

❐Change engine coolant.

❐Change transmission and transfer case fluid.

❐Check items in Maintenance Groups A, B, and C.

51,000 Miles (81 000 km)

❐Change engine oil and replace filter.

❐Check items in Maintenance Group A.

54,000 Miles (86 900 km)

❐Change engine oil and replace filter.

❐Clean or replace air filter.

❐Replace fuel filter element.

❐Check items in maintenance Groups A and B.

57,000 Miles (91 700 km)

❐Change engine oil and replace filter.

❐Check items in Maintenance Group A.

60,000 Miles (96 500 km)

❐ Change engine oil and replace filter.

❐Clean or replace air filter.

❐ Replace fuel filter element.

❐ Change engine coolant.

❐ Inspect fuel tank, fuel cap and fuel lines.

❐ Check items in Maintenance Groups A, B, and C.

NOTES

Some maintenance may require the use of specialized knowledge or equipment and may be best handled by qualified service technicians at your nearest HUMMER service center.

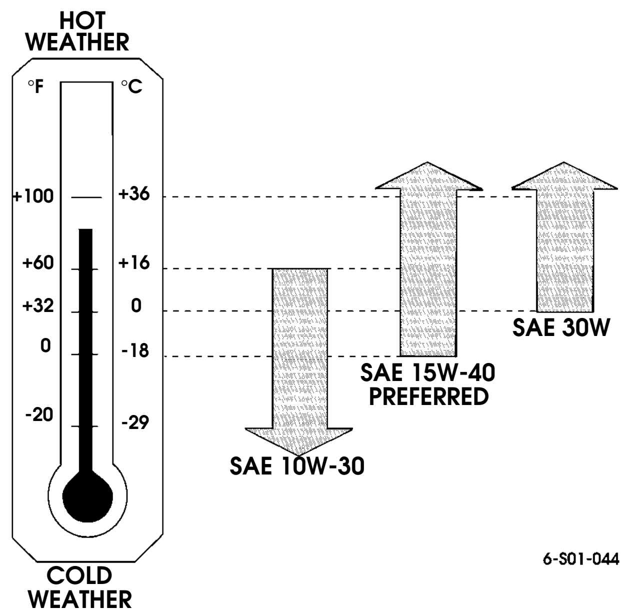
After your vehicle has been driven for 63,000 miles (101 370 km) repeat the schedule, starting at 3,000 miles (4 800 km).

RECOMMENDED FUEL/FLUIDS/LUBRICANTS/ CAPACITIES

Recommended Fuel

Recommended fuel for 6.5L NA diesel and turbo diesel engines is #2 diesel. Do not use any other type fuel.

Engine Oil



CG-4/SJ QUALITY PREFERRED
CF-4/SH QUALITY ACCEPTABLE
DO NOT USE SAE 10W-40 GRADE OIL, OR ANY OTHER GRADE NOT RECOMMENDED

Figure 1-19: Oil Viscosity Chart

Diesel engine oil capacities are:

- 7.0 qts (6.6L) without filter change
- 8.0 qts (7.6L) with filter change
- 2.0 qts (1.9L) for engine oil cooler

Refer to Section 2 for more information regarding engine oil.

Engine Coolant

Recommended engine coolant is a mixture of ethylene glycol antifreeze and water.

Use a mixture containing 50% antifreeze and 50% water.

Radiator capacity is 7 qts (6.6L). System capacity is approximately 26 qts (25L).

Transmission/Transfer Case/Steering Gear and Pump Fluid

Recommended lubricant for the transmission, transfer case, and steering system is Dexron III automatic transmission fluid.

Approximate fluid capacities are:

- 1 qt (0.95L) for the steering gear and pump
- 7 pints (3.3L) for the transfer case
- 13.5 qts (12.8L) for the transmission, converter, and cooler
- 7.7 qts (7.3L) for the transmission (during fluid drain/refill)

Brake Fluid

Recommended brake fluid for all Hummer vehicles is DOT 5 silicone brake fluid. Master cylinder approximate capacity is 0.7 pints (0.33L). Brake system approximate capacity is 1.2 pints (0.6L).

Front/Rear Axle and Geared Hub Lubricant

Recommended lubricant for axles and hubs is a heavy duty, multipurpose, API GL-5 gear lubricant, with viscosity ratings of 80W-90 or 75W-90.

The 80W-90 is an all purpose lubricant. The 75W-90 lubricant is suggested for use in areas where winter temperatures are consistently below freezing.

Steering Linkage and Suspension Lubricant

Recommended lubricant for steering and driveline components is an NLGI LB, or GC-LB grade multipurpose chassis grease. Use only those lubricants that display the NLGI certification symbol.

Body Lubrication

Door hinges, linkage parts, cables, and other body components can be lubricated with a number of different lubricants. Suggested lubricants and applications are:

- Window regulator mechanisms – spray white grease
- Window slides – silicone spray lube
- Door hinges – engine oil, ATF, or LPS brand spray lube
- Linkage/cables – LPS brand silicone spray lube
- Lock strikers – chassis grease, white grease, or LPS #3.
- Seat track – multipurpose chassis grease (NLGI-LB)
- Lock mechanisms –ATF, silicone spray lube, graphite lube

A/C Refrigerant and Compressor Oil

The only refrigerant that can be used is R-134a. No other refrigerant is recommended.

The only compressor oil recommended is PAG (polyalkylene glycol). It is the only oil compatible with refrigerant R-134a. No other oil is recommended. Any PAG oil used should be compatible with General Motors specifications.

A/C system capacities are:

- 8 fluid ounces (237 ml) of PAG oil (front unit only)
- 10 fluid ounces (295 ml) of PAG oil (with aux. A/C)
- 2.1 lb (0.95 kg) refrigerant (front unit only)
- 2.3 lb (1.04 kg) refrigerant (with aux. A/C)

LUBRICATION AND MAINTENANCE ITEMS

Engine Oil Level

The engine oil dipstick is at the driver side of the engine (Figure 1-20). Correct oil level is to the FULL mark. Acceptable level is in the crosshatch area below the FULL mark.

Check oil level only when the engine is shut down and the vehicle is on a level surface. Wait one minute after shut down to check.

Never overfill the engine. The excess oil will be churned into foam causing oil film breakdown and consequent engine damage.

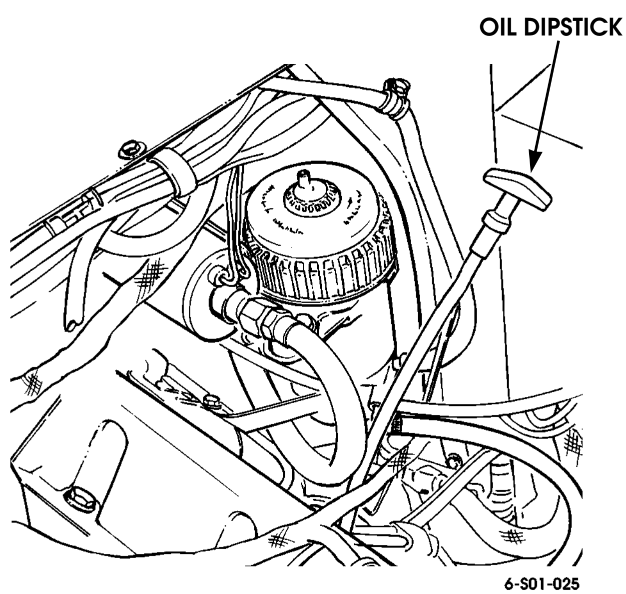


Figure 1-20: Oil Dipstick Location

Engine Oil and Filter Change

The oil filter is located on the driver side of the engine (Figure 1-21). A front mounted fill tube is used.

The spin-on oil filter is only removed with a standard band-type tool. Coat the seal on a new filter with oil and clean the adapter surface before installation. Tighten the filter by hand.

The oil pan drain plug has a gasket that should be replaced if cut, cracked, or distorted. Check the gasket seating surface on the oil pan. Burrs or nicks can be smoothed with a fine tooth file. Also replace the drain plug if the threads are worn or damaged. Be sure the plug is tightened to required torque of 20 lb-ft (27 N•m).

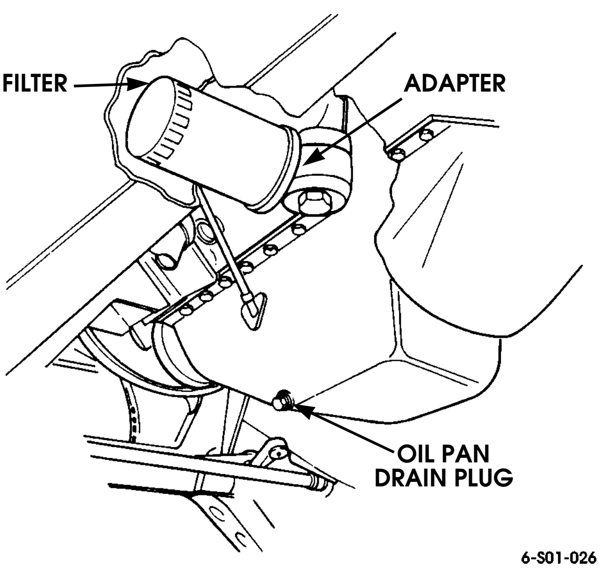


Figure 1-21: Oil Filter/Drain Plug Location

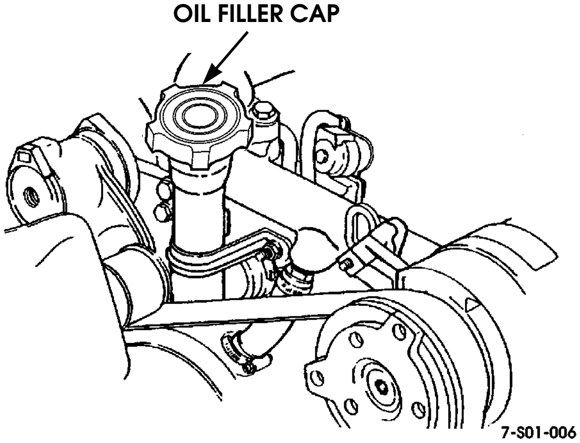


Figure 1-22: Engine Oil Fill Location

Fuel Filter Service

Replace the filter element every 6,000 mi (9 600 km), or annually, whichever occurs first (Figure 1-23).

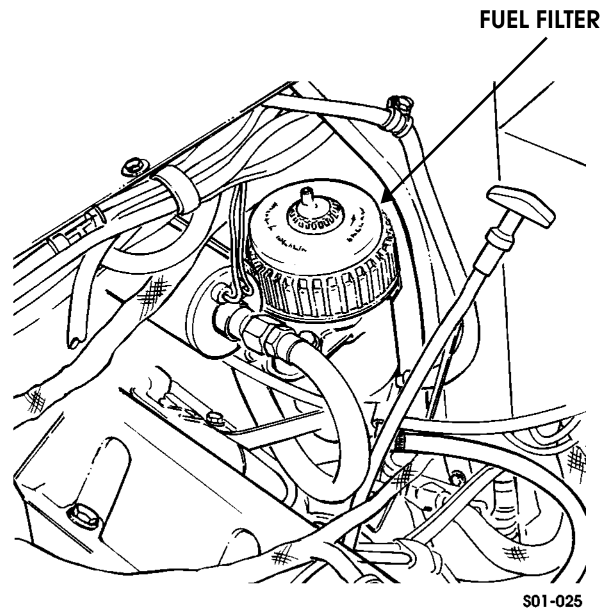


Figure 1-23: Fuel Filter Location

Transmission Fluid

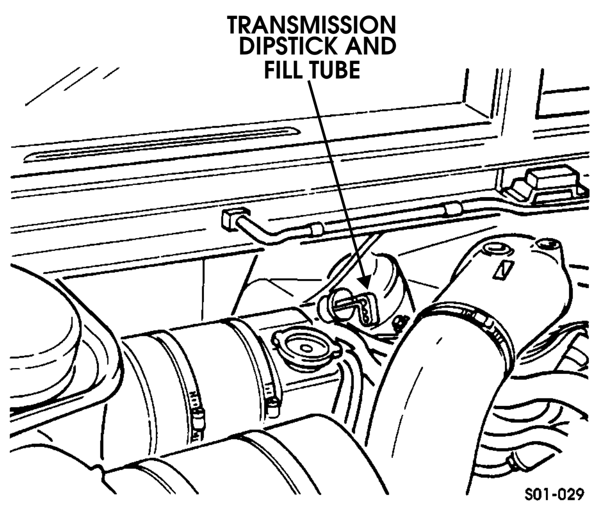


Figure 1-24: Transmission Dipstick Location

Replace the transmission fluid filter each time the fluid is changed. Refill the transmission with Dexron® III afterward.

Check transmission fluid level at least once each month. Procedure is as follows:

1. Drive vehicle until transmission fluid is at normal operating temperature. Fluid must be hot to obtain accurate reading.
2. Position vehicle on level surface.
3. Shift transmission into Park.
4. Operate engine at curb idle speed.
5. Remove transmission dipstick and check level (Figure 1-24). Correct level is within crosshatch marks on dipstick.
6. If fluid level is too high, remove excess through fill tube using suction gun and 3/16-in. teflon tubing. If level is low, check for leaks and, if OK, add fluid in 1-2 ounce increments until level is correct.

CAUTION: Do not overfill the transmission. The excess fluid will be churned into foam resulting in overflow from the fill and vent tubes, slip and flare during upshifts, fluid breakdown and eventual clutch failure.

7. Check fluid color and condition. Normal color ranges from dark red to light pink. Fluid that is dark brown, black, or orange and full of bubbles indicates a problem that may require overhaul.

Transfer Case Fluid

Check transfer case fluid level every 3,000 mi (4 900 km), or semiannually, whichever comes first. Remove fill plug and gasket. Level should be within 1/2 in. (12.7 mm) of fill plug opening when transfer case is level. Install fill plug and gasket, and tighten to 35 lb-ft (48 N•m). Change fluid every 12,000 mi (19 000 km) or annually, whichever occurs first (Figure 1-25).

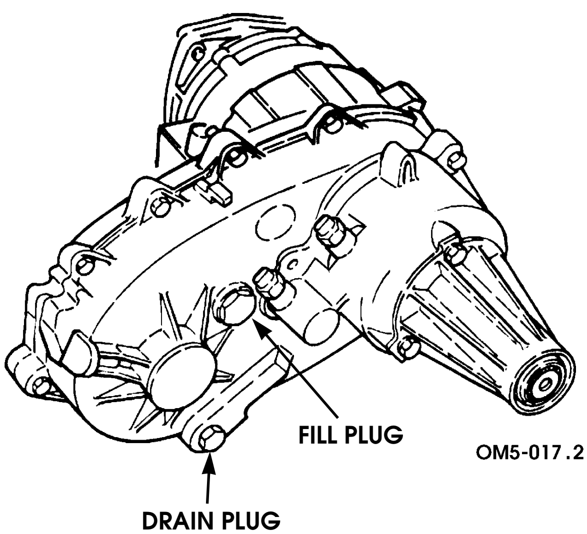


Figure 1-25: Transfer Case Fill/Drain Plug Location

Axle and Geared Hub

Check axle and hub lubricant condition and level every 3,000 mi (4 800 km) or semiannually, whichever occurs first.

Geared hub level should be within 1/2 in. (12.7 mm) of fill plug opening when lubricant is cold, or to plug level when hot.

Axle level should be within 1/4 in. (6.4 mm) of fill plug opening when lubricant is cold, or to plug level when hot (Figures 1-26 and 1-27).

Change axle and hub lubricant when contaminated by water or foreign material.

Use GL-5, SAE 80W-90 or 75W-90 gear lubricant only.

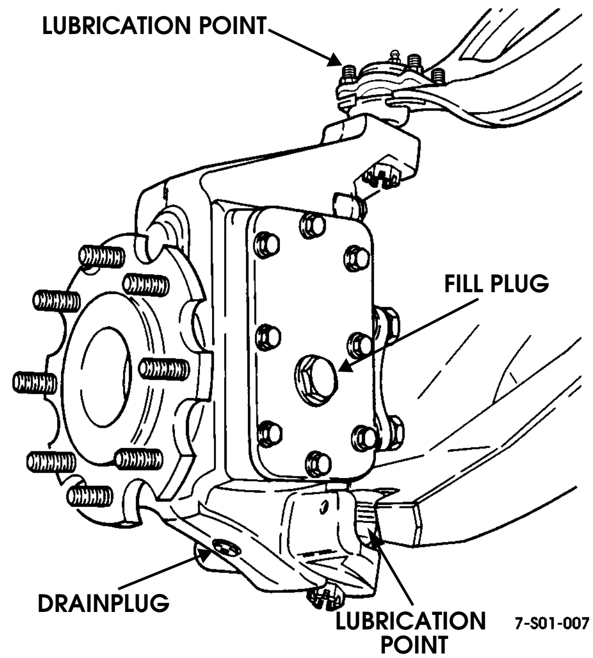


Figure 1-26: Geared Hub Fill/Drain Plug Locations

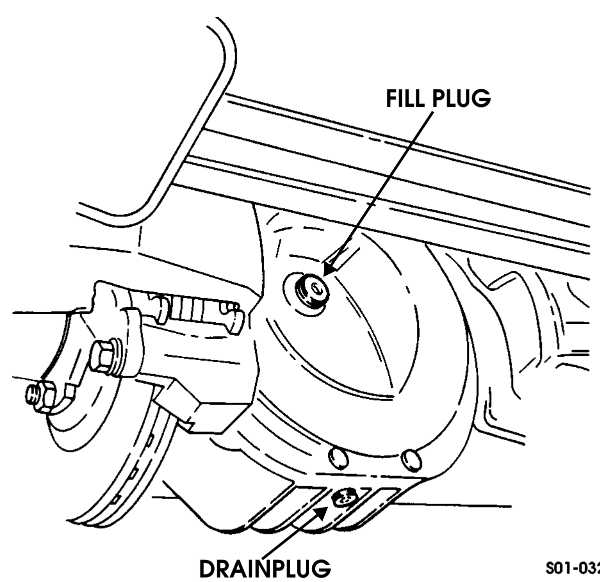


Figure 1-27: Axle Fill/Drain Plug Locations

Universal and Slip Joint Lubrication

Lubricate U-joints with a multipurpose, NLGI-LB grade chassis grease.

Lubricate propeller shaft universal and slip joints every 3,000 mi (4 800 km), or semiannually, whichever occurs first. Use a hand operated or low-pressure air powered lubrication gun. If operating conditions are severe service at 1,000 mi. (1 600 km) intervals.

The rear propeller shaft U-joints have two grease fitting locations (Figure 1-28). The front shaft has four fitting locations (Figure 1-29)

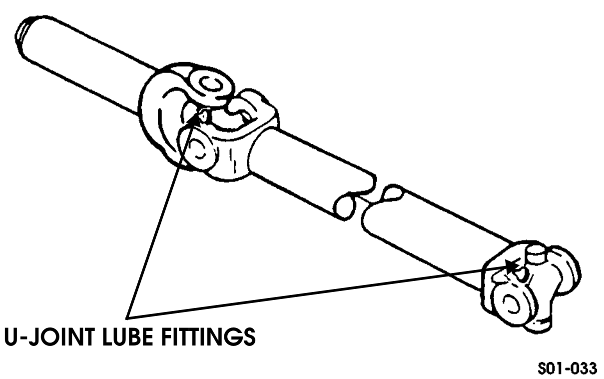


Figure 1-28: Propeller Shaft Lube Points

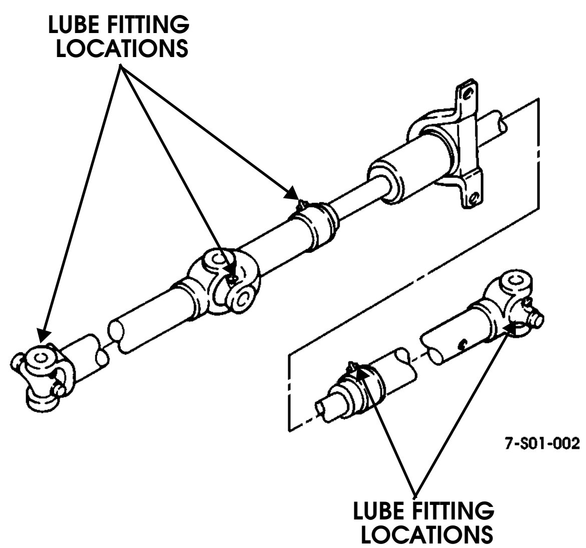


Figure 1-29: Front Propeller Shaft Lube Points

Steering and Suspension Lubrication Points

Lubricate steering and suspension components every 3,000 mi. (4 800 km), or semiannually, whichever occurs first. If operating conditions are severe, service at 1,000 mi. (1 600 km) intervals.

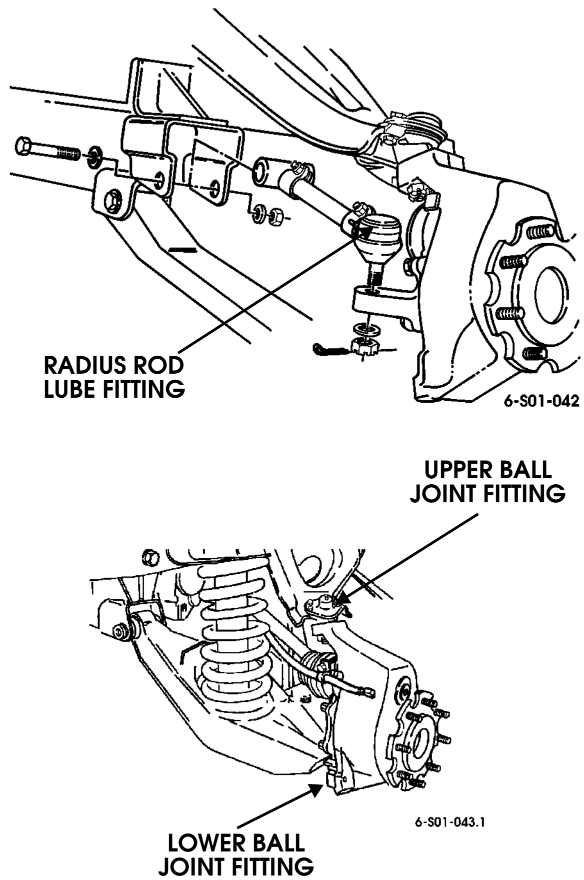


Figure 1-30: Ball Joint/Radius Rod Lube Points

Suspension lube points include the upper and lower ball joints and the rear suspension radius rods (Figure 1-30). Steering lube points include the tie rod ends, idler arm, steering arm, and intermediate steering shaft (Figure 1-31 through Figure 1-33).

Use a hand operated or low pressure air powered lube gun filled with a multipurpose chassis grease. NLGI-LB classification lubricating grease is recommended.

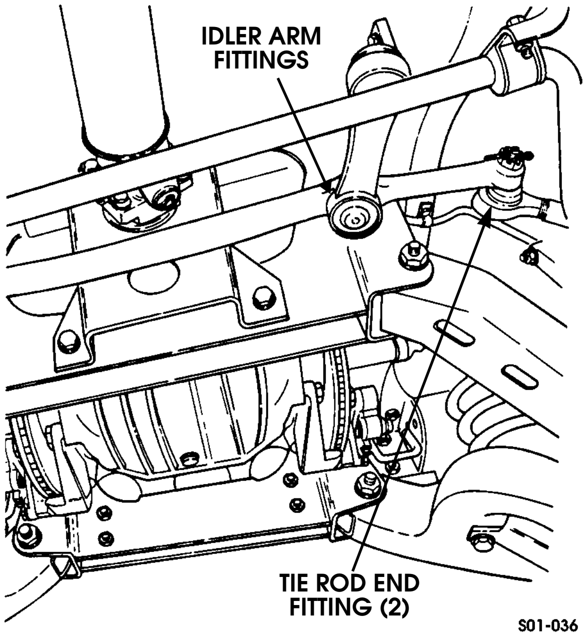


Figure 1-31: Idler Arm and Tie Rod Lube Points

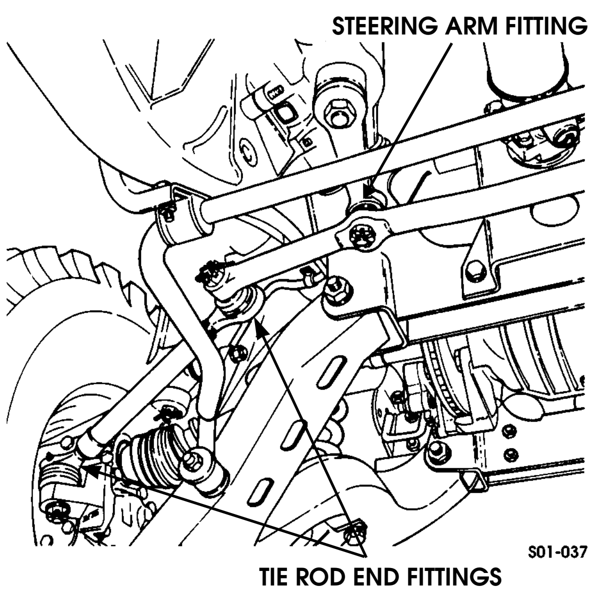


Figure 1-32: Tie Rod and Steering Arm Lube Points

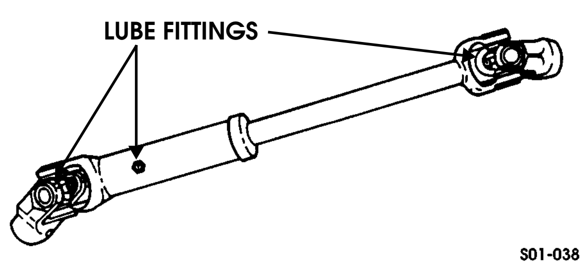


Figure 1-33: Intermediate Steering Shaft Lube Points

Power Steering Fluid

Check the fluid level in the power steering reservoir monthly and adjust level as necessary. If fluid is hot, level should be between “HOT” and “COLD” marks on the cap indicator. If fluid is cool, level should be between “ADD” and “COLD” marks. In either condition, level must be above “ADD” mark.

NOTE: Power steering fluid does not require periodic replacement.

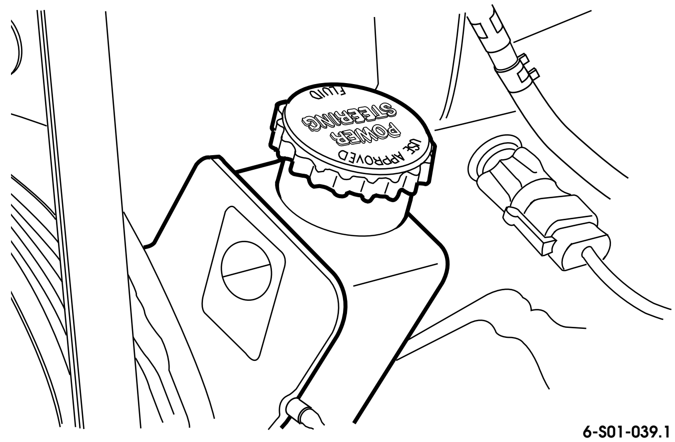


Figure 1-34: Power Steering Pump Reservoir

Cooling System Fluid Level Check

Check coolant level at the surge tank monthly and adjust level as necessary. Level should be at, or above, the cold fill line (Figure 1-35).

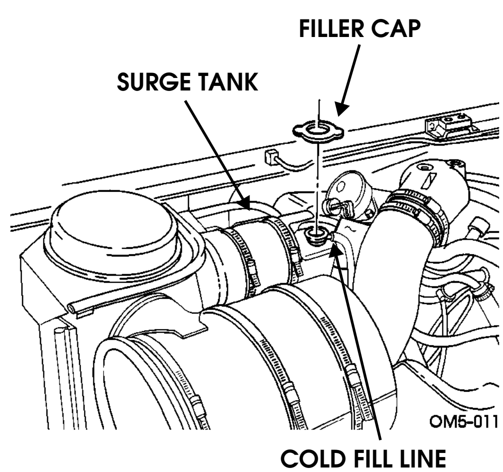


Figure 1-35: Surge Tank Coolant Level Indicator Location

Master Cylinder Fluid Level Check

CAUTION: Use DOT 5 silicone brake fluid only. Failure to use the proper fluid may affect brake performance or damage brake components.

NOTE: Brake fluid does not require periodic replacement.

Check master cylinder fluid level monthly. Correct fluid level is to within 1/8 in. (3.2 mm) from the top of each reservoir rim.

Clean the master cylinder cover and exterior before checking fluid level. Dirt on the cover must not be allowed to enter the reservoirs.

To check fluid level, rotate the bail wire inboard and off the cover (Figure 1-36). Then lift the cover and diaphragm off the cylinder. Fluid should be from 1/4 to 1/8 in. (6 to 3 mm) below reservoir rim. Add DOT 5 fluid if necessary and reinstall the cover and diaphragm.

NOTE: Replace the cover diaphragm if cut, torn or distorted. Also be sure it is correctly seated, otherwise leakage may occur.

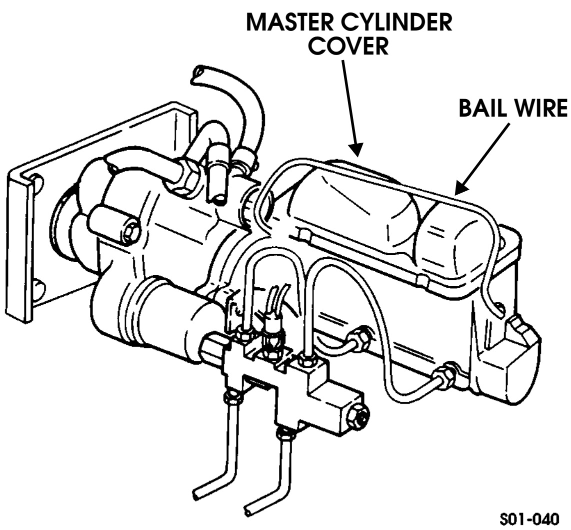


Figure 1-36: Master Cylinder Cover and Bail Wire Location

Wheels/Tires/CTIS

Inspect tire and wheel condition. Look for loose wheel nuts and rim stud nuts, or dented, deformed wheel rims. Note tire tread wear and sidewall condition. If the vehicle is used for extensive off road operation, check the sidewalls for bulges, bead damage, cuts, fabric breaks.

If the tire treads are worn, note type of wear. If wear is only on one shoulder, toe setting or camber may be incorrect. If tires are scalloped or worn at crown only, or both shoulders, inflation pressures are probably incorrect.

If the vehicle is equipped with CTIS, cycle the system and check operation. Verify tire inflation pressures with an accurate gauge.

Serpentine Belt

Replace the belt if frayed, cut, or torn. Minor, small surface cracks within the belt grooves are normal. Do not replace the belt unless cracks extend all the way through or across the belt face.

CDR Valve

Clean or replace the valve if oil soaked, or if it won’t sustain vacuum/atmospheric pressure testing. Also replace the valve hose if cracked, brittle and hard.

Body Lubrication Points

Every 6 months or 3,000 mi (4 800 km), whichever occurs first, lubricate the: accelerator linkage, hood hinges, hood stops, tailgate hinges, door hinges, door handles, parking brake lever, service brake pedal push rod stud, transfer case shift linkage, and transmission shift linkage (Figure 1-37). Suggested lubricants include engine oil or ATF for hinges; LPS silicone lube for linkages, handles, and brake push rod; white grease for seat tracks, window regulators and park brake lever. Door locks should use a graphite based lubricant such as Lock-Eze. Refer to the Recommended Fuel/Fluids/Lubricants/Capacities section for more detailed lube information.

Check condition of the spare tire and swing away carrier mechanism, if equipped. Be sure the spare is properly inflated and the carrier operates smoothly, without bind.

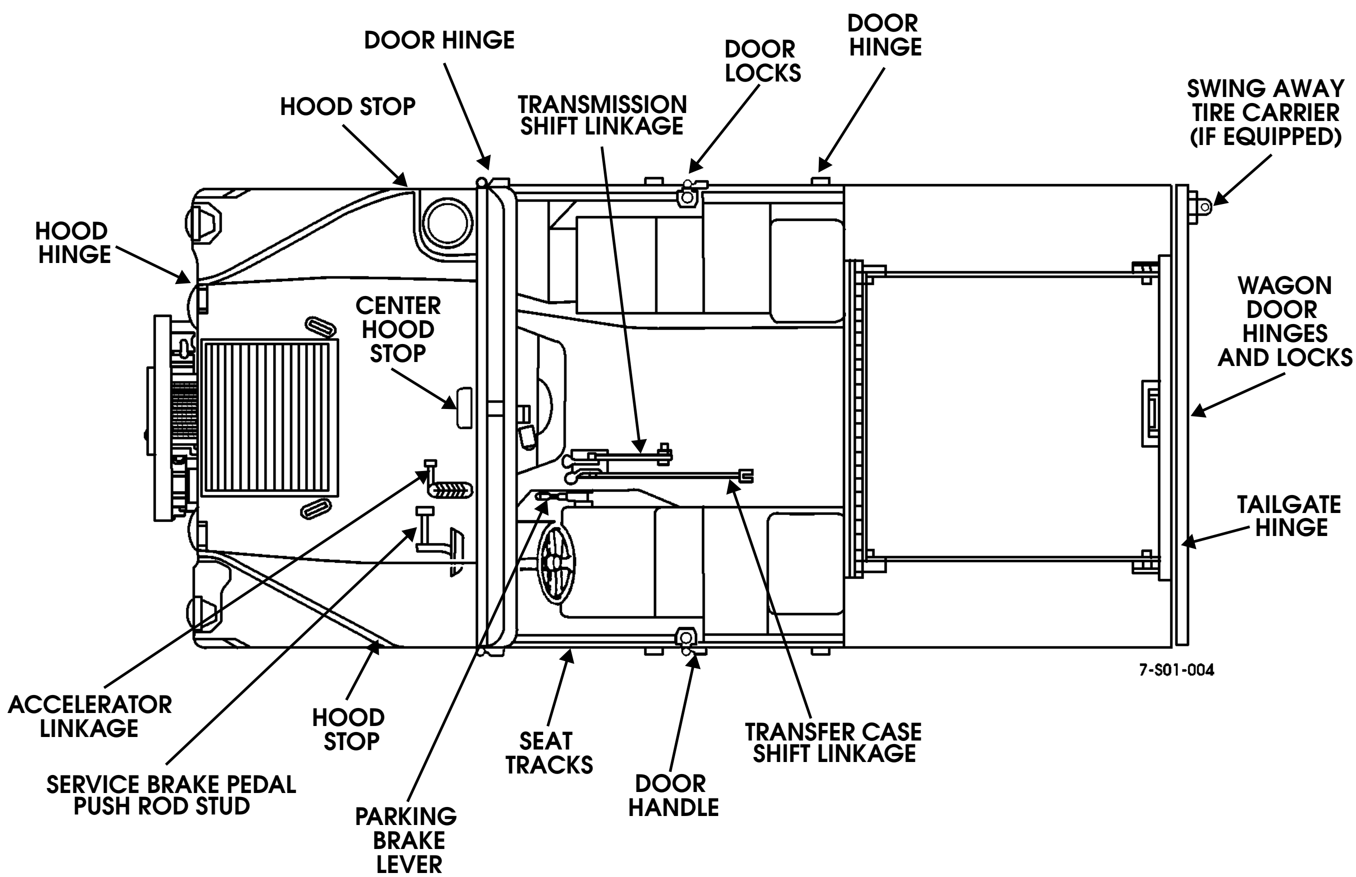


Figure 1-37: Body Lubrication Points

ESSENTIAL TOOLS

NOTE: See page 1-1 of the 1997 Service Parts Catalog for information on ordering Kent-Moore tools.

Engine

Tool No.	Description
J–23523-F	Harmonic Balancer Remover/Installer Set
J–26999-30	Compression Gauge Adapter
J–22102	Front Crankshaft Seal Installer
J–26999	Compression Gauge
J–39084	Rear Main Seal Installer
J–33139	Engine Lifting Sling and Bracket
J–23951	Water Manometer
J–34116	Cylinder Balance Tester
J–41712	Oil Pressure Switch Socket
J–35555	Vacuum (MITY-VAC) Pump
J–8001	Dial Indicator Set
J–23129	Universal Seal Remover, use with slide hammer J–6125-1B
J–41515-A	Glow Plug Socket
J–41613	Turbocharger Inlet Guard

Fuel, Emissions and Exhaust

Tool No.	Description
J–29075-AMG	Nozzle Tester
J–29872-A	Injection Pump Adjusting Tool (used with ratchet handle)
J–29873	Fuel Injector Socket (30mm)
J–41516-A	Injection Line (flare nut) Wrench
J–34151	Housing Pressure Adapter
J–38641-B	Diesel Fuel Hydrometer
J–28552-A	Fuel Pressure Gauge
J–29698-A	Injection Line (flare nut) Wrench
J–41089	Injection Pump Wrench
J–28552-A	Fuel Pressure/Return Adapter Set
J–29079-95	Nozzle Adapter, part of J–29075-AMG
J–33300-AMG	AMG Tach-N-Time Kit
J–33300-25A	Clamp-On Line Transducer, part of J–33300-AMG
J–33300-20A	Magnetic Crankshaft Probe, part of J–33300-AMG
J–41711	Injection Pump Timing Wrench, 6.5 Turbo
J–42520	Fuel Line Disconnect Tool Set

Transmission/Transfer Case

Tool No.	Description
J–35944-AMG	Transmission Oil Cooler Flush Kit
J–35944-500	Cooler Line Adapters
J–35944-22	Oil Cooler Flushing Fluid
J–8614-01	Yoke Holding Tool
J–8092	Universal Driver Handle
J–33043-2	Vacuum Gauge Block Assembly
J–25025-B	Dial Indicator and Guide Pin Set
J–39775	Transmission Test Jumper Harness
J–42497	Extension Housing Seal Installer
J–21867	Pressure Gauge and Hose Assembly
J–33831	Input Seal Installer
J–33835	Pump Housing Seal Installer
J–38869	Output Shaft Seal Installer
J–41623-A	Oil Cooler Release Tool
J–42543	Selector Shaft Seal Remover/Installer
J–42589	TP Sensor Jumper Harness

Wheels and Tires/Central Tire Inflation System

Tool No.	Description
J–39250	Runflat Compressor
J–39522	Socket Kit, 5-Point
J–42557	Cam Socket

Brake System

Tool No.	Description
J–42553	Disc Brake Tool Kit

Steering System

Tool No.	Description
J–24319-B	Steering Linkage and Tie-Rod Puller
J–25033-C	Pump Pulley Installer
J–33141	Adapter Fittings (used with J–25323)
J–25034-C	Pump Pulley Remover
J–25323	Power Steering System Analyzer
J–42548	Puller, Pitman Arm
J–8092	Universal Driver Handle

Axles, Suspension, and Frame

Tool No.	Description
J–8092	Universal Driver Handle
J–24319-B	Steering Linkage and Tie Rod Puller
J–8001	Dial Indicator
J–29162	Rear Retainer Seal Installer
J–33143	Input Seal Installer
J–8614-O1	Flange Holding Tool
J–42545	Clampnut Socket
J–35184	Seal Installer
J–35910	Axle Boot Crimping Tool
J–38869	Output Shaft Seal Installer
J–42546	1/4 in. Drive Torque Wrench (Preset)
J–42547	3/8 in. Drive Troque Wrench (Preset)
J–42591	Steering Cover Seal Installer

Heating/Air Conditioning (HVAC)

Tool No.	Description
J–41995	D-Tek Electronic Leak Detector
J–42549	HVAC Anemometer
J–42550	HVAC Flow Meter Adapter Kit

Electrical System

Tool No.	Description
TK-0-A	Tech 1 Diagnostic Scanner
TA–1151	Tech 1 Adapter, part of TK-0-A
TA–1152	Tech 1 Test Lead, part of TK-0-A
TA–1190-A	Operators Manual, Tech 1, part of TK-0-A
J–35616-A	Connector Test Adapter Set
J–42538-B	Fuel & Temperature Gauge Tester
J–42541	Crimper, 4pt., field grade
J–42645-A	HUMMER Mass Storage Cartridge
J–43160	Tech 1 DC Power Cable
7000041	Vehicle Interface Module (VIM)

Electrical System (Troubleshooting)

Tool No.	Description
J–35689-A J–39200 J–38125-A J–42541	Micro-Pack Extract Tool Fluke 87 DVOM Electrical Terminal Crimper, 4 pt., field grade

Miscellaneous Essential Tools

Tool No.	Description
J–26900-13 J–8092 J–8001 J–6125-1B J–23129 J–35910	Magnetic Base Driver Handle Dial Indicator Set Slide Hammer Seal Remover Axle Boot Crimping Tool

SPECIAL TOOLS

Engine

Tool No.	Description
J–29834	Valve Lifter Removal Tool
J–8080	Main Bearing Shell Remover/Installer (In-Vehicle)
J–6098-10	Camshaft Bearing Remover/Installer Set (use w/J–33049)
J–8062	Valve Spring Compressor
J–33042	Static Timing Mark Gauge
J–33049	Camshaft Bearing Replacement Set (Universal)
J–24270	Ridge Reamer
J–29134-8	Piston Pin Retaining Ring Compression Sleeve
J–8087	Cylinder Bore Gauge
J–39507	Piston Retaining Ring Installer Set
J–8089	Carbon Remover Brush, for cast iron and steel
J–8358	Carbon Remover Brush, for aluminum
J–25087-C	Oil Pressure Tester/Pump Primer
J–8037	Piston Ring Compressor
J–42545	Piston Ring Expander
J–6098-O1	Camshaft Bearing Remover/Installer (use with J–6098-10 and J–33049)

Fuel, Emissions and Exhaust

Tool No.	Description
J–26925	Mag-Tac Engine Tachometer

Transmission/Transfer Case

Tool No.	Description
J–2619-01	Slide Hammer and Adapter
J–29369	Bushing/Bearing Remover
J–33839	Rear Output Bushing Remover (use w/ J–8092)
J–33829	Pilot Bearing Installer (use w/J–8092)
J–33833	Output Shaft Main Bearing Installer (use w/J–8092)
J–33832	Front Output Shaft Rear Bearing Installer (use w/J–8092)
J–29170	Input Gear Bearing Remover (use w/J–8092)

Wheels and Tires/Central Tire Inflation System

Tool No.	Description
05710215	External tubeless tire repair kit
05710216	Internal tubeless tire repair kit
05744619	Video, one-piece wheel service

Steering System

Tool No.	Description
J–6219	Pitman Shaft Seal Installer
J–6221	Stub Shaft Bearing and Seal Remover/Installer
J–6278 (or J–21551)	Pitman Shaft Bearing Remover/Installer
J–7624	Spanner Wrench (Adjuster Plug)
J–7754-C	Inch-Pound Torque Wrench (Over-center Preload)
J–21552	Rack Piston Arbor

Axles, Suspension, and Frame

Tool No.	Description
J–33142	Axle Shaft and Seal Installer
J–27186	Pinion Rear Bearing Cup Remover
J–27187	Pinion Front Bearing Cup Remover
J–8611-01	Rear Pinion Bearing Race Installer
J–29162	Rear Retaining Seal Installer
J–8608	Rear Pinion Bearing Race Installer
J–39524	Pinion Depth Gauge Set
J–24385-01	Axle Housing Spreader
J–35237	Bearing Installer
J–3409-01	Stand, with Holding Fixtures
Part of J–3409-D	Axle Holding Fixture Adapter
J–22610	Keystone Clamp Pliers

Heating/Air Conditioning (HVAC)

Tool No.	Description
J–39500-A	A/C Recovery, Recycle, Evacuate and Discharge Service Cart (from Robinaire)
J–34021-A	Compressor Clutch Pulley, Core and Bearing Replacement Tool Set
J–39500-20A	High Side Coupler Adapter (Compact Profile)
J–39500-24A	Low Side Coupler Adapter (Compact Profile)
J–39183-C	Manifold Gauge Set
J–6742-03	Thermometer
J–36847	Condenser Fin Straightener Tool
J–24182-2A	Shrader Valve Core Tool

Section 2 ENGINE

INTRODUCTION

This section contains general information, diesel engine diagnosis, turbocharger service, and diesel engine repair and overhaul.

A table of contents is provided that lists the various repair items and the section page number where repair information is located. Use the contents tables to avoid random searches for needed information.

Specifications for diesel engines are located at the end of this section for quick reference. Service tool information can be found at the end of the Engine section.

TABLE OF CONTENTS

ENGINE DESCRIPTION

Two diesel engines are used in Hummer vehicles. Both are liquid cooled, four-stroke, 90° – V8 engines with a displacement of 6.5L (395 cu. in.). One engine is naturally aspirated and one is turbocharged (Figure 2-1). Both engines are manufactured by General Motors Corporation.

Engine Changes for 1997

The turbo diesel engine has been changed for the 1997 model year. The changes involve higher turbocharger output and the addition of a piston oil cooling system. The oil cooling is needed to handle the extra heat generated by increased engine torque and horsepower output.

The oil cooling system for turbo diesel pistons provides for oil spray onto the underside of the piston crown. This is accomplished by additional oil feed orifice tubes and galleries in the block. Oil spray occurs when the piston is approaching bottom dead center on the intake and power strokes. The connecting rods have added oil holes and the pistons have more material in the crown. The extra oil pressure and volume needed for piston cooling is provided by a high output oil pump. The pump is used exclusively on turbo diesel engines and has a working pressure of 80 psi (552 kPa). Oil feed for piston spray is through galleries and oil tubes located in the main bearing saddles and webs.

Turbo Diesel Parts Interchangeability

Engine parts from the 1996 and 1997 versions of the turbo diesel are **not** interchangeable. The block, heads, rods, bearings, and pistons are structurally and dimensionally different and cannot be intermixed.

The engine block and cylinder heads are cast iron. A one-piece aluminum intake manifold is used on NA diesel engines. Turbo engines are equipped with a three-piece aluminum manifold. Steel tube exhaust manifolds are used on NA diesel models while turbo models have cast iron exhaust manifolds.

The crankshaft is supported by five insert style main bearings. Thrust is taken by the number 3 main. The camshaft is also supported by five bearings; plain type bearings are used.

Turbo and NA engines are each equipped with three ring aluminum pistons. Connecting rods are forged steel. The pistons are attached to the rods with hardened steel piston pins. Each piston pin is retained by two snap rings; one at each end of the pin. The pin is a floating fit in the rod and piston.

A single chain driven camshaft operates the overhead valve train. Roller lifters and tubular push rods actuate the rocker arms. The arms are mounted on shafts bolted to each cylinder head.

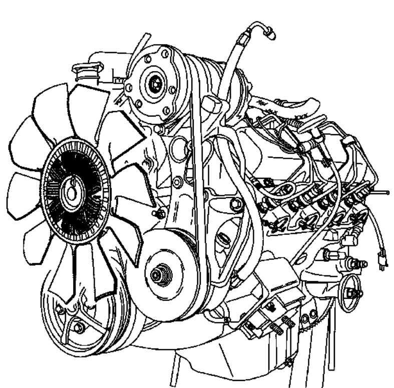
The cylinder heads on both engine versions are equipped with glow plugs for each cylinder and a prechamber for each combustion chamber. One plug and one prechamber are used in each combustion chamber. The glow plugs heat air entering the prechambers. This aids the combustion process and improves cold weather starting and operation. The glow plugs are activated only when ambient temperatures fall below a pre-set value. A controller/relay mounted on the intake manifold cycles the glow plugs when the ignition switch is in the Start and Run positions.

The turbocharged diesel engine is equipped with a Warner Gear turbocharger. A wastegate, in the turbine housing, controls boost. The wastegate is operated by an externally mounted vacuum actuator. The actuator opens the gate to decrease boost, or closes it to increase boost. Waste gate position is controlled by the PCM.

The turbocharger increases the amount of air entering the combustion chambers. This allows a proportionate increase in fuel injected into the cylinders. The result is a much denser cylinder charge and greater power output.

The turbocharger turbine and compressor impellers are the mechanisms that pump additional air into the combustion chambers. The impeller wheels are operated by the high speed gas flow through the engine exhaust system.

Engine lubrication is through a conventional mechanical pump located at the rear of the crankcase. The pump is shaft driven by the oil pump drive unit which in turn, is driven off the camshaft. A belt driven vacuum pump is used on both engines.Both versions of the 6.5L diesel are equipped with a high pressure fuel injection system. The system consists of an electric fuel supply pump, an injection pump, a separate injector nozzle for each cylinder, and the necessary injector feed lines.



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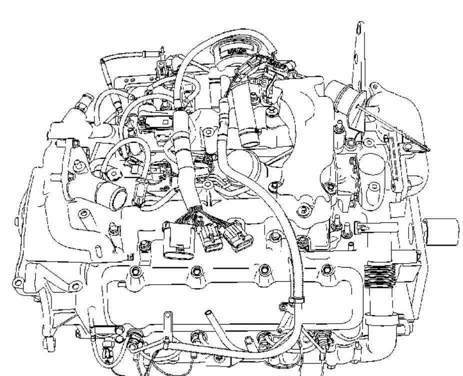
NA DIESEL



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TURBO-DIESEL

Figure 2-1: 6.5L Diesel Engines

The rotary type injection pump pressurizes, meters, and distributes fuel to the individual injectors. System working pressure is 1500 psi (105 bar) for NA diesel engines and 1750 psi (120 bar) for turbocharged engines. The pump is gear driven through matching gears on the pump and camshaft.

CAUTION: *The turbo and NA versions of the 6.5L diesel engine are different. The differences are both dimensional and physical. Do not interchange parts from one engine type to the other. This practice can result in unsatisfactory operation, premature wear, or engine failure.*

ENGINE IDENTIFICATION

The diesel engine I.D. decal is located on the forward face of the passenger side cylinder head (Figure 2-2).

The decal provides the engine assembly/serial number and a bar code. Similar decals are placed on the driver side cylinder head and passenger side of the oil pan.

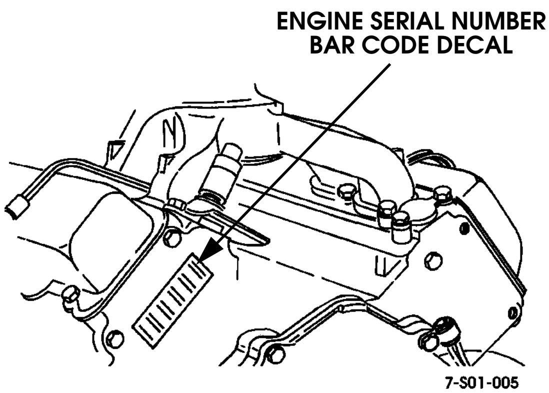

Figure 2-2: Diesel Engine I.D. Tag Location

Service Tools

The special service tools described in this section are available through the dealer tool program.

Specifications

Engine specifications for overhaul, adjustment, inspection and torque requirements are provided at the end of this section.

LUBRICANTS/SEALANTS/COOLANT

Engine Oil

Recommended engine oil for the GM built, diesel engines used in Hummer vehicles, is API classification CF-4 (Figure 2-3:). Base stock or synthetic oils are equally acceptable.

Oil viscosity recommendations are:

- Use 15W-40 at ambient temperatures from 0°F (-188°C) to above 100°F (401°C).
- Use 30W at ambient temperatures above 32°F (0°C).
- Use 10W-30 at ambient temperatures below 60°F (165°C).

Do not use 10W-40, or any other oil that is not specifically recommended. Use recommended oils only for lubrication purposes during repair and overhaul.

AM General suggests using Quaker State FCI-Universal HDX Engine Oil 15W-40 grade or equivalent.

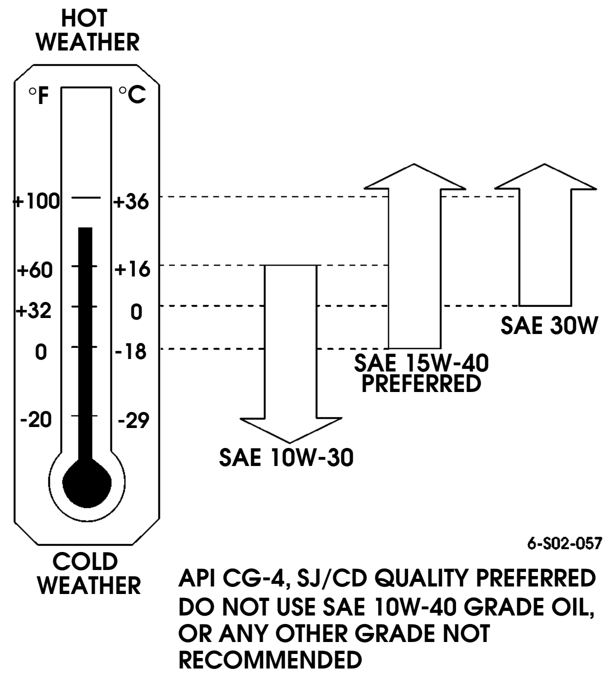

Figure 2-3: Oil Viscosity Chart

Sealants

Anerobic, RTV, and standard sealants are all used for various repairs.

RTV (room temperature vulcanizing) sealers are used when a non-rigid part is attached to a rigid part (e.g. oil pan to engine block).

Typical RTV sealers would be Permatex High Temp, Ultra Copper, Ultra Black, or Loctite 599.

Anerobic (gasket eliminator) sealants are used where two rigid parts are being assembled. This type of sealant cures in the absence of air. Typical anerobic sealers are Loctite 510 and 518.

Standard type sealers are used primarily as gasket dressing or thread sealants. Typical examples would be Permatex #2, or Perfect Seal spray sealer.

Thread locking sealants are frequently recommended for fasteners subject to heat and vibration. Recommended products are:

- Loctite 242 for all purpose use
- Loctite “Stud and Bearing Mount” for semi-permanent attachment

Coolant

Recommended engine coolant is an ethylene glycol base, all weather coolant with corrosion and anti-foaming inhibitors. All of the major brands are acceptable (i.e. Prestone, Peak, Zerex, etc.). Do not use coolants other than ethylene glycol based. Recycle coolant according to EPA regulations.

Do not use pure coolant in the cooling system, especially in cold-climate regions. Recommended mix is 50% antifreeze, 50% water.

CLEANING MATERIALS

Normal parts cleaning solvents can be used for most purposes.

Use brake or contact cleaner, to clean surfaces where anaerobic or RTV sealants will be applied. This type of solvent does not leave a residue that interferes with sealer cure or adhesion.

Carbon deposits can be emulsified by some spray type gasket removers. Permatex and 3M both have effective products.

Avoid using diesel fuel, gasoline, paint and lacquer thinners or kerosene for parts cleaning purposes. These products can leave an undesirable residue.

Cylinder and lifter bores should be cleaned with a liquid detergent and warm water mixture after honing or polishing. A bristle brush or cotton towel can be used to wash the bores until clean and free of oil, dirt, and abrasive grit.

COMPRESSION TEST

1. Disconnect fuel solenoid wire at injection pump.
2. Disconnect and remove all glow plugs.
3. Thread adapter J–26999-30 into glow plug hole of first cylinder to be tested. Then attach compression gauge J–26999 to adapter.
4. Have helper crank engine through six cycles (to generate six compression strokes). Note and record gauge pressure. Repeat procedure at remaining cylinders.
5. Minimum acceptable cylinder pressure is 380 psi (2626 kPa). In addition, lowest cylinder should be at least 80% of highest; this is maximum allowable cylinder variance.

CAUTION: *Never inject oil into the diesel engine cylinders for any reason. This could result in piston and rod damage because of the minimal clearances in a high compression diesel combustion chamber.*

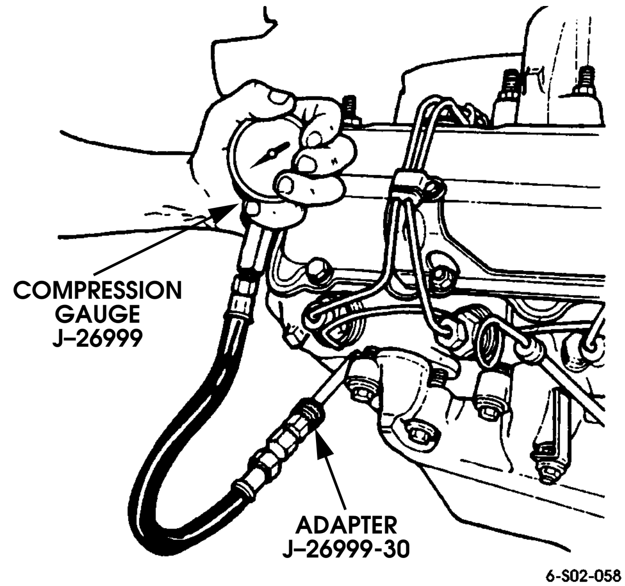

Figure 2-4: Compression Test Tools

FUEL FILTER WARNING LAMP

All Hummer diesel models are equipped with a fuel filter warning lamp. The lamp is in circuit with a sensor mounted in the filter. The purpose of the lamp is to alert the driver when water, ice, or wax buildup occurs in the filter.

Lamp illumination can be intermittent or continuous depending on the severity of water or wax buildup.

In most cases, continuous illumination of the lamp simply means it is time to drain the filter. However, a continuous lamp plus engine stall or restart problems may indicate a plugged filter or fuel lines.

Intermittent illumination of the lamp indicates that water is accumulating in the filter. In this instance, it is only necessary to drain off the water at the wheel house draincock.

ROAD TESTING

The purpose of road testing is basically to confirm or deny the existence of an engine fault. Procedure is as follows:

1. Note condition of wheels/tires before test. Worn, damaged tires or wheels can cause vibration or noise.
2. Check and adjust lube levels in engine and transmission and top off engine coolant if necessary.
3. Turn off A/C system.
4. Start and run engine at idle speed with transmission in neutral. Record any noise or vibration that may be present. “Rev” engine and note any noise/vibration plus any change in magnitude or frequency.
5. Drive vehicle at legal speed and note any evidence of noise, vibration, low power, miss, etc.

a. If vibration was noted, drive vehicle above vibration speed. Then shift into neutral and coast down through problem range. If vibration still occurs, problem is with chassis component. However, if vibration ceases, problem is with driveline component.
b. If noise is noted, shift into neutral at about 35 mph and note if noise changes in pitch, frequency, or stops altogether.

6. Operate A/C system and note effect. If noise or vibration begins, problem is related to A/C compressor, clutch, accessory mounting bracket, or belt. However, if noise/ vibration is absent, note this and proceed to next step.
7. On turbocharged models, connect compound gauge to manifold air intake tube fitting. Then press accelerator pedal to wide open position and record boost reading which should be 2 psi or greater.

ENGINE NOISE DIAGNOSIS

Engine noises are usually sensitive to changes in rpm and load. For example, a collapsed lifter will make an audible “ticking” noise that increases in frequency as rpm goes up.

Engine noises can also be determined according to speed of the related rotating component. For instance, valvetrain noises will be at a frequency that is one half crankshaft speed.

Accessories

Noise caused by engine accessories such as the vacuum pump alternator, power steering pump, A/C clutch, or drive pulleys is speed sensitive. An increase or decrease in engine rpm will generally change pitch and frequency, or even cause it to stop. A mechanics stethoscope will generally help pinpoint a noise source. Removing the accessory drivebelt will also help verify an accessory generated noise.

Bearings

Bearing noise can be differentiated by pitch. A damaged connecting rod bearing makes a higher pitched, metallic knocking sound. This as opposed to the lower pitch thump of a worn, or spun main bearing. A failed rod bearing can be confusing as it seems to make a greater frequency noise. This is because the bearing may knock at both ends of piston travel.

Piston and Connecting Rod

Piston slap is usually caused by severely worn cylinder bores and pistons, partially collapsed piston skirts, worn pin bores, severely worn rings, or an undersized piston. An incorrectly assembled, or installed connecting rod and piston assembly will also produce slap.

Slap always occurs at crankshaft speeds. In severe cases, slap may occur in both directions of piston travel. Although fairly common on high mileage engines, slap can be difficult to hear on low mileage engines. As the term implies, piston slap is appropriate for the sound generated. It occurs when a piston begins to rock within the cylinder as it travels up and down. This action causes the skirt to slap the cylinder wall as it straightens, then rocks away from the direction of thrust.

Valvetrain and Camshaft

Rocker arm and hydraulic lifter noise is probably the most easily identifiable. Both make tapping (or clicking) noises that only differ in pitch and volume. Although damaged valve springs or pushrods are more difficult to hear, they usually cause a power loss or rough engine condition and require inspection to locate.

A worn, missing, or incorrect thickness camshaft thrust washer will cause excessive cam end play. The most frequent result is an audible knocking sound localized at the rear of the block.

Timing gear and chain noise is not always audible, even when the chain and gears are severely worn. These components, when failed, are usually discovered during timing checks prompted by a low power or no-start condition.

NOTE: Valvetrain noise can also be the result (or first indicator) of low oil pressure.

Starter Noise

The starter bendix can hang and prevent quick disengagement after startup. The resulting noise can be misdiagnosed as engine related. A mechanics stethoscope is fairly effective at differentiating engine and starter noise.

Knocking Noise At Idle

Knocking noises can be from connecting rod bearings, a cracked flywheel, converter touching the housing or cover, A/C compressor, or loose exhaust component.

Look for exhaust components grounding against the body, frame, or driveline component. Remove the converter access cover and visually inspect the flywheel and converter. Check the cover and converter housing for signs of contact. A flywheel cracked at the hub will allow the converter to wobble slightly. Test the A/C system for incorrect charge levels which can produce compressor knock.

Diesel Fuel Knock or Rattle

The rattling sound unique to diesel engine is normal. It is a function of high compression ratio, injector nozzle spray pattern and pressure, and compression ignition. However, incorrect injection pump timing, low quality fuel, or injector nozzle faults can make the normal sound much more pronounced. If the normal rattling is accompanied by, or becomes a knocking sound, the fuel injectors, injection pump, pump timing, and fuel quality must all be tested.

DIAGNOSIS EQUIPMENT

Diagnosing engine mechanical problems can be performed with normal shop equipment.

Compression testing with a good quality gauge will reveal condition of the engine rings, pistons, cylinder bores, valves, and guides.

Vacuum diaphragm operation is quickly tested with a hand operated vacuum pump. These pumps are available from companies such as Kent-Moore, Snap-On, RobinAire and Lisle.

A digital or analog multimeter is used for many tasks such as checking wire continuity, shorted-open circuits and components, ground connections, battery condition, glow plug current levels, and so on.

A tachometer is required for checking/setting idle speeds. On diesel engines, an especially accurate tachometer is needed to check cranking speeds of 100-180 rpm.

An oil pressure gauge is necessary in order to accurately test engine oil pressure. The best gauges are mineral oil filled to avoid indicator needle bounce. The gauge should have a dial range up to 100 psi in 2 psi increments. Necessary adapters to connect the gauge are available from either the gauge manufacturer, or Kent-Moore Tool Corp.

An all purpose dial indicator set such as J8001, is also needed. Accurate measurement of clearances, component wear, chain deflection, and overhaul dimensional settings is only possible with a dial indicator. A good quality vernier caliper and micrometer set are also needed to check part tolerances.

SCAN TOOL USE

The Tech 2 scan tool is primarily designed to test/interrogate PCM/TCM circuits. The tool is extremely useful in locating sensor, switch, or computer faults that affect engine performance. However, the tool is not really designed to replace vacuum gauges, compression testers, multimeters, or 12 volt test lamps.

GLOW PLUG OPERATION AND TESTING

The engine glow plugs are used to heat air entering the combustion chamber. Heating the air results in improved cold temperature starting and engine warm-up.

A total of eight glow plugs are used; one for each cylinder. Each glow plug is threaded into a cylinder head port located just below the injector nozzle (Figure 2-5). The tip of each plug extends into a pre-chamber which concentrates the fuel/air mixture prior to combustion.

The glow plugs are operated by a controller/relay mounted on the rocker cover or intake manifold. The relay is in circuit with the ignition switch and is energized only when the switch is in the Start and Run positions.

Turning the ignition switch to Start position allows current to flow through the switch to the controller. Once energized the controller allows current to flow through the relay and to the individual glow plugs.

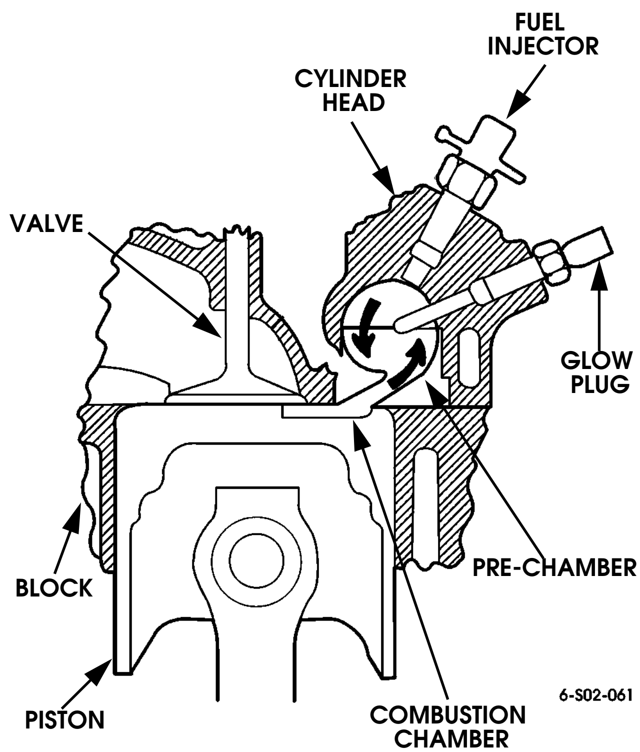

Figure 2-5: Glow Plug Location In Cylinder Head and Pre-Chamber

GLOW PLUG TEST

1. Check all glow plug connections which should be tight and corrosion free.
2. Verify that engine temperature is at or below 95°F (35°C).
3. Turn multimeter to amps or current flow setting.
4. Connect test leads between feed wire to each bank of glow plugs and to output terminal of glow plug controller/relay.
5. Turn ignition switch to Run position to cycle glow plugs. Current reading should be 50-55 amps at each bank when cycling.

NOTE: It may be necessary to cycle ignition switch to OFF position between checks to reset controller internal timer.

6. Check current at each glow plug. Disconnect glow plug wire. Then connect test leads in series between feed wire from relay and glow plug. Current should be 13-14 amps.
7. If current to each bank of glow plugs is less than 50-55 amps, or current at glow plug is less than 13-14 amps, further diagnosis is required. If current is zero at both locations, check fuses and circuit for shorts, grounds, opens. Fusible links at all 10 locations.

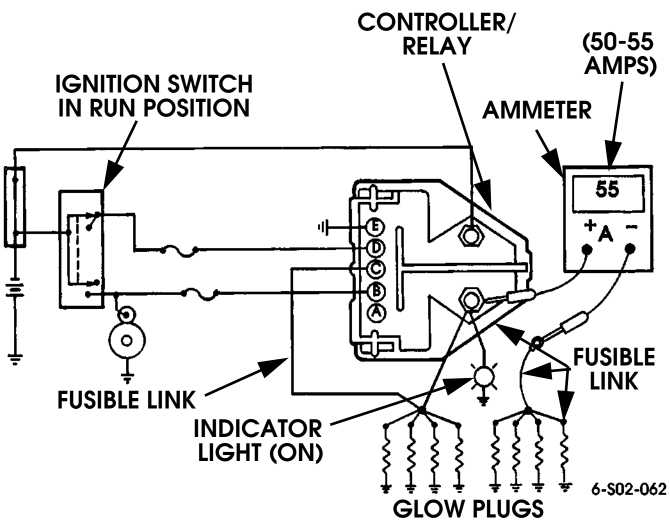

Figure 2-6: Checking Current Flow to Glow Plug Main Feed

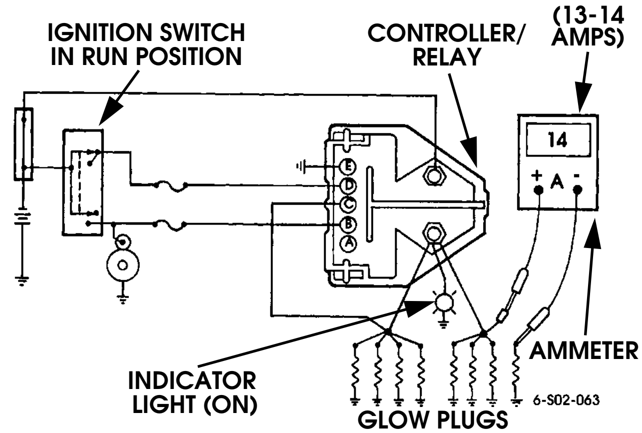

Figure 2-7: Checking Current at Each Glow Plug

OIL PUMP PRESSURE TEST

Connect the pressure test gauge to the transmitter fitting at the rear of the block. Pressure should be a minimum of 10 psi (69 kPa) at hot idle and increase to 40-45 psi (275-310 kPa) at 2000 rpm. Low pressures at both test ranges with correct oil level indicate:

- Pump pickup strainer or tube loose
- Pump pressure relief valve or spring problem
- Pump gears worn, chipped
- Pump shaft worn, slipping
- Oil galley plug loose, missing
- Main bearings severely worn
- Cam bearing turned (spun) or misaligned

ENGINE DIAGNOSIS

General Information

The diagnosis charts describe common faults that may occur. Potential causes are listed in order of probability. Although the charts list frequent causes for specific engine related problems, they do not cover every possible cause. The charts are intended to serve as guides only.

The diagnosis information in this section is aimed at solving engine mechanical problems with normal shop diagnostic equipment.

Diesel Engine Diagnosis

PROBLEM	POTENTIAL CAUSE	CORRECTION
Hard Starting	1. Insufficient cranking speed (below 100 rpm cold or 180 rpm hot). Caused by: • Low batteries • Bad cable connections • Serpentine belt or alternator problem	1. Check, repair cables or connections. Recharge batteries if low. Replace batteries if shorted, sulphated, damaged. Replace belt or tensioner if damaged. Test alternator output and repair or replace if low.
	2. Starter problem • Poor connections • Relay • Solenoid • Brushes • Armature • Starter drive damage	2. Check/repair cable and solenoid connections if needed. Check starter draw; overhaul if draw exceeds 450-475 amps. Remove and overhaul starter if brushes, starter drive, or armature are faulty.
	3. Insufficient fuel to injectors, or cold advance/ start switch has fault. Check run solenoid also.	3. Check fuel volume at supply pump and injectors while cranking engine. If volume is low, check for restrictions in lines or at filter. If volume is OK, check pressure at pumps and injectors and repair as needed. Replace cold advance switch or run solenoid if failed.
	4. Water in fuel (filter indicator light NOT on).	4. Drain off water at fuel filter draincock. Then crank engine with draincock open for 5-10 seconds to purge remaining water. If water continues to appear in fuel coming out draincock, purge fuel tank and lines, and refuel vehicle.
	5. Glow plugs inoperative (most noticeable at cold ambient temperatures).	5. Check fuse and wiring harness to plugs. Correct open or short as required. Refer to diagnosis in Section 12 if required.
	6. Air in fuel delivery lines.	6. Check for loose fuel line connections at pump and injectors. Correct if necessary then bleed any remaining air at injectors.
	7. Fuel return lines restricted or tank vent inoperative.	7. Check return lines (from engine to tank) and correct restrictions, kinks, plugged lines. Make sure tank vent is OK. Repair as necessary.
	8. Air cleaner plugged (after extended off-road operation).	8. Remove and clean air intake components. Replace filter element if plugged or restricted.
	9. Injection pump timing or camshaft timing may be off if pump, cam, or timing chain/ sprockets/gears were removed/replaced during service.	9. Check timing marks on pump and front cover. If aligned, check marks on pump gears and cam sprockets. Re-time if necessary.
	10. Vehicle misfueled.	10. Drain sample at filter draincock. Replace fuel load if fuel contains gasoline, kerosene, fuel oil, or low quality fuel.

Diesel Engine Diagnosis

PROBLEM	POTENTIAL CAUSE	CORRECTION
Hard Starting When Hot	1. Wrong fuel or poor quality fuel.	1. Drain and refill tank. Purge rest of fuel system and bleed injectors.
	2. Air leaks in fuel supply (suction) lines.	2. Check lines at fuel pump and injectors for leaks, or loose fittings. Tighten or replace lines as needed.
	3. Fuel return or vent line restricted.	3. Clear or replace either line if restricted, pinched, or damaged.
	4. Low fuel pressure to injector pump.	4. Replace fuel supply pump if pressure is less than 5 1/2 psi.
	5. Run solenoid problem.	5. Test and replace switch or solenoid if necessary.
	6. Low compression due to rings, pistons, valves.	6. Check compression and overhaul engine if necessary.
Hard Starting When Cold	1. Incorrect grade of diesel fuel.	1. Drain and refill fuel tank and filter. Bleed injectors and purge lines as needed.
	2. Water in fuel or wax buildup in filter.	2. Drain water. Remove and clean filter and lines if wax formation has occurred.
	3. Glow plugs inoperative.	3. Check current flow at relay. Minimum current is 55 amps. If OK, check current flow at each glow plug. Current should be 14 amp. Repair wiring or replace faulty glow plug(s).
	4. Fuel supply pump inoperative.	4. Check for pump operation, if inoperative check fuses and wiring. If pump operates, check flow.
	5. Cold advance/start switch problem.	5. Test and replace switch if necessary.
	6. Fast idle solenoid inoperative.	6. Test and replace if inoperative.
Engine Will Not Crank	1. Shift lever not entirely in Park (or Neutral position).	1. Check and correct linkage adjustment as needed.
	2. Insufficient battery voltage due to: • Low charge • Corroded connections • Damaged Cables or solenoid wires	2. Check batteries and cable connections. Charge low batteries and check generator and belt. Replace failed battery(s). Clean corrosion from cables connections. Replace or repair cables or terminals as needed.
	3. Blown fuse.	3. Check fuse condition at PDC. If blown fuse is found, check circuit for shorts, grounds.
	4. Park/Neutral position switch problem.	4. Test switch continuity with ohmmeter. Replace switch if open/shorted.

Diesel Engine Diagnosis

PROBLEM	POTENTIAL CAUSE	CORRECTION
Engine Will Not Crank - (Continued)	5. Starter or solenoid problem.	5. Check for bad or loose connections at starter and solenoid. If OK, note if starter surges when current is applied. Problem may be with Bendix or armature.
	6. Hydrostatic lock. Combustion chambers filled with fuel, or coolant due to faulty injectors, or blown head gasket. (Remove glow plugs, crank engine and note fluid coming out of plug holes).	6. Test and replace injectors that are stuck open. Replace blown head gasket or replace head if cracked.
	7. Flywheel ring gear teeth or starter Bendix damaged.	7. Remove transmission access cover and inspect ring gear and bendix. Replace flywheel or starter Bendix as necessary.
Engine Stalling	1. Idle rpm too low.	1. On non-turbo engine, adjust rpm to specified. Replace idle solenoid if idle rpm drops off. (Idle rpm on turbo diesel is not adjustable.)
	2. Air leaks in fuel lines.	2. Check lines from fuel pump to injectors. Replace lines that leak or have damaged fittings. Tighten loose injectors. Bleed injectors afterward.
	3. Fuel filter partially plugged by wax formation, dirt/sludge, or partially water filled.	3. Drain off filter contents at draincock. Clean out fuel tank and lines if filter contained sludge. Clean out filter if full of wax or dirt.
	4. Misfueled, wrong fuel, or low quality fuel.	4. Drain and refill tank. Drain fuel filter and bleed injectors.
	5. Restricted air intake due to plugged filter element, air cleaner, intake duct. Generally caused by extended off -road operation in dusty areas.	5. Replace filter if necessary. Remove and clean out air cleaner body, intake duct, cap, hoses, and dust unloader.
	6. Fuel supply pump problem or restriction in fuel lines, injector pump, or injectors.	6. Check fuel flow at pump and injectors. Supply pump minimum pressure is 5 1/2 psi. Replace worn, damaged, or failed parts.
	7. Fuel drain back or return lines restricted/ damaged.	7. Inspect and repair or replace lines, clamps as needed.

Diesel Engine Diagnosis

PROBLEM	POTENTIAL CAUSE	CORRECTION
Low Power, Poor Accelera-tion	1. Vehicle overloaded.	1. Lighten vehicle load.
	2. Low grade diesel fuel.	2. Drain tank and refuel.
	3. Sludge or wax buildup in fuel filter (low fuel supply).	3. Drain and clean filter.
	4. Air in fuel supply system.	4. Check lines from fuel supply pump and to injec-tors. Replace leaking, damaged lines as needed. Bleed air at injector fuel line fittings.
	5. Fuel supply pump failed.	5. Check and replace pump if output is less than 5 1/2 psi.
	6. Mistimed injection pump.	6. Check and correct as needed.
	7. Restriction in air intake system.	7. Check air intake cap, duct, air cleaner, hoses, and air horn. Clean/repair as needed. Replace filter if plugged.
	8a. Accelerator cable or injection pump throttle lever problem causing insufficient throttle opening (non-turbo).	8a. Check pedal, cable, lever operation. Be sure cable is properly secured and that lever is not loose or damaged. Replace worn, or damaged parts.
	8b. Pedal position sensor fault or vacuum pump failure.	8b. Replace sensor or pump if inoperative.
	9. Run solenoid has intermittent open or short.	9. Check wiring and solenoid. Repair wiring and con-nectors. Replace solenoid if failed.
	10. On turbo models, turbocharger, related wir-ing, or wastegate actuator fault may have occurred. May also be caused by exhaust gasket failure or manifold air leaks.	10. Check wiring, wastegate vacuum actuator, and PCM with Tech 2 scan tool. Run vacuum check on actuator and vacuum pump with vacuum tool. Check for intake/exhaust leaks. Replace turbo-charger, or related components as indicated by diagnosis.
	11. Injection pump, or injector failure.	11. Remove, inspect, and overhaul pump as needed. Replace damaged injectors.
	12. Engine problem: • Timing chain and gears worn. • Cam and injection pump gears mistimed. • Piston, ring, or valve wear. • Worn cam lobes. • Damaged piston(s).	12. Check compression and timing. Then disassemble engine and repair as needed. Remove engine com-pletely if diagnosis indicates crankshaft, rod, or piston problem.

Diesel Engine Diagnosis

PROBLEM	POTENTIAL CAUSE	CORRECTION
Exhaust Smoke: Blue Smoke	1. CDR valve fault. 2. Worn piston rings, valve stem seals, or valve guides.	1. Check valve operation with manometer or vacuum hand pump. Clean or replace valve and hose if necessary. 2. Remove glow plugs and check compression. Then repair valve train and cylinder heads, or perform piston ring replacement.
White Smoke	1. Low quality fuel. 2. Injection pump/engine timing is retarded. 3. Cold advance/start solenoid fault. 4. Engine coolant entering combustion chamber through blown gasket, cracked head, loose/damaged head bolts. May be accompanied by low coolant level and overheating. 5. Low ambient temperatures (below freezing).	1. Drain and refill tank with better quality fuel. 2. Check and correct timing to 5° BTDC. 3. Replace solenoid, if necessary, after checking circuit. 4. Verify problem and repair as necessary. Replace cracked head, block, or head gasket. 5. Normal condition caused primarily by water vapor. Not a concern unless it continues after warmup.
Black Smoke	1. Low grade diesel fuel. 2. Overrich fuel mixture: • Drain/return lines restricted. • Injector(s) stuck open. • Injection pump advance piston or regulator ball check worn or stuck. • Engine speed or throttle sensor fault. 3. Engine/injection pump timing advanced beyond specifications. 4. Black smoke at wide open throttle (turbocharged models only).	1. Drain and refill tank. 2. Test, diagnose and repair as required. 3. Reset timing to 5 1/2° BTDC on non-turbo engine. On turbo diesel it should be 0"-3" BTDC. If problem is caused by mistimed cam and injection pump gears, retime as described in this section. Refer to timing gear and chain service. 4. Restriction in air intake system, no vacuum to wastegate actuator, damaged wastegate, or air leak at intake or exhaust manifold.
Gray Smoke	1. Long idle periods. 2. Low grade fuel. 3. Fuel tank vent restricted. 4. Fuel return line restricted. 5. Engine problem (low compression excessive blowby, worn rings or valve stem seals).	1. Try to avoid prolonged idling. 2. Add proper quality fuel. (not necessary to drain and refill tank). 3. Clear vent and line. 4. Clear restriction. Replace line if kinked or pinched. 5. Diagnose and repair as indicated.

Diesel Engine Diagnosis

PROBLEM	POTENTIAL CAUSE	CORRECTION
Excessive Oil Consumption	1. Prolonged high speed, high load, or overload operation.	1. Reduce overload, or speed as needed.
	2. Incorrect oil grade used for high ambient temperature operation.	2. Switch to SG, SH-CD oil with SAE viscosity rating of 15W-40, 20W-50, or 30W.
	3. Oil leaks at: • Rocker covers •Oil pan • Rear main seal •Oil filter •Timing chain cover or seal • Cooler hoses/lines	3. Locate and correct leaks as needed.
	4. CDR valve or hose faulty.	4. Check valve and hose and replace if necessary.
	5. Engine problem: • Worn broken piston rings • Worn valve seats or guides	5. Run compression test to verify ring problem. Overhaul cylinder heads if guides, seals, valves are worn. If wear is premature, check injectors and injection pump. Excessive fuel will wash oil off walls/guides causing ring and valve wear.
Engine Vibration **NOTE**: See road test information in this section.	1. Loose engine accessories: • Alternator • A/C compressor • Power steering pump • Mounting brackets • Pulleys • Belt tensioner • Serpentine belt • Drive pulleys	1. Check and repair as needed. Replace damaged missing bolts and apply Loctite 242 to loose bolt threads. Replace serpentine belt if damaged. Replace bent, broken pulleys.
	2. Torsional damper damaged or loose.	2. Replace damper if damaged, worn, loose.
	3. Flywheel (driveplate) cracked or loose.	3. Replace flywheel and also check for ballooned or damaged converter.
	4. Torque converter imbalance caused by internal damage or missing balance weight.	4. Replace converter.
Overheating	1. Dirt, debris blocking air flow through coolers, condenser, and radiator.	1. Remove and clear fins with compressed air, soft bristle brush, or water stream.
	2. Low coolant level.	2. Add coolant and check for leaks (hoses, surge tank, hose connections, water pump, radiator).
	3. Serpentine belt loose, worn, or tensioner inoperative.	3. Replace belt and/or tensioner if either part has failed or is worn beyond limit.
	4. Prolonged idling/slow speed operation in heavy traffic when ambient temperatures are high.	4. If this type operation cannot be avoided, have driver turn on heater and "rev" engine when stopped in traffic. This will help dissipate some heat and get more air through radiator (from fan).

Diesel Engine Diagnosis

PROBLEM	POTENTIAL CAUSE	CORRECTION
Overheating (continued)	5. Failed thermostat or radiator cap.	5. Check thermostat and cap operation. Replace either part if inoperative.
	6. Fan clutch inoperative.	6. Replace clutch.
	7. Water pump inoperative.	7. Check coolant flow and replace pump if necessary.
	8. Blown head gasket.	8. Verify that coolant is leaking into combustion chamber and replace gasket.
	9. Crack in block, or leaking freeze plug.	9. Replace corroded freeze plugs. Replace block if cracked.
	10. Coolant temperature gauge or sensor faulty.	10. Test and replace gauges or sensors as needed.
High Fuel Consumption	1. Prolonged high speed - high load operation.	1. Normal with this type of operation. Have driver reduce speed or load if possible.
	2. Air cleaner/filter partially plugged.	2. Remove and clean air horn, intake hose, air cleaner. Replace filter.
	3. Fuel leaks in lines, hoses at connections.	3. Locate and repair as needed.
	4. Restriction in exhaust system (should also be accompanied by drop in power).	4. Inspect and replace bent, kinked, damaged components.
	5. Injection pump timing incorrect (advanced/ retarded).	5. Check and adjust timing.
	6. Decrease in boost on turbocharged models, caused by vacuum leak at actuator, manifold leak, or turbo damage.	6. Correct leaks. Replace actuator or turbocharger if inoperative.
	7. Brake drag	7. Repair stuck/seized calipers.
	8. Converter one way clutch failure.	8. Replace converter.
	9. Injection pump internal problem (valve, check, etc.).	9. Replace pump.
	10. Power loss due to worn rings, valve guides, cylinder bores, valves, etc.	10. Overhaul engine.

TURBOCHARGER SERVICE AND DIAGNOSIS

Description

The turbocharger used on 6.5L diesel engines is a Borg-Warner model 1H1 (Figure 2-8). Lubrication is by engine oil from the engine lubrication system.

Boost is monitored by the PCM and controlled by the wastegate and electronic accelerator pedal, which is unique to turbo engine models. The pedal assembly consists of a bracket, pedal and arm, and the pedal position sensor (potentiometer); a conventional throttle linkage is not used.

The turbocharger is mounted in the lifter valley at the rear of the engine block. It is positioned between the two halves of the intake manifold.

A turbocharger is fundamentally an air pump used to generate additional engine power. This is accomplished by increasing volume and pressure of air entering the engine combustion chambers. An increase in air volume allows a proportional increase in fuel injected into the cylinders. The net result is a denser fuel/air mixture. A denser mixture produces more power when compressed and burned in the combustion chamber.

A turbocharger feature concerns the method of operation. The turbocharger turbine and compressor impellers are rotated by the flow of engine exhaust gases. As a result, separate drive belts and pulleys are not needed.

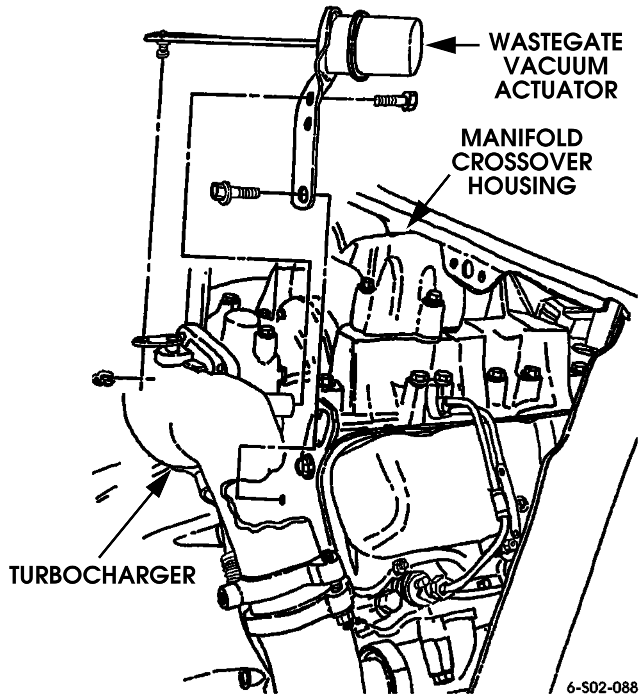

Figure 2-8: Turbocharger and Vacuum Actuator Mounting

The turbocharger used on 6.5L engines consists of a turbine impeller and housing, a compressor impeller and housing, a wastegate, a wastegate actuator and an impeller connecting-shaft (Figure 2-9). A separate, belt driven vacuum pump supplies vacuum for wastegate actuator operation

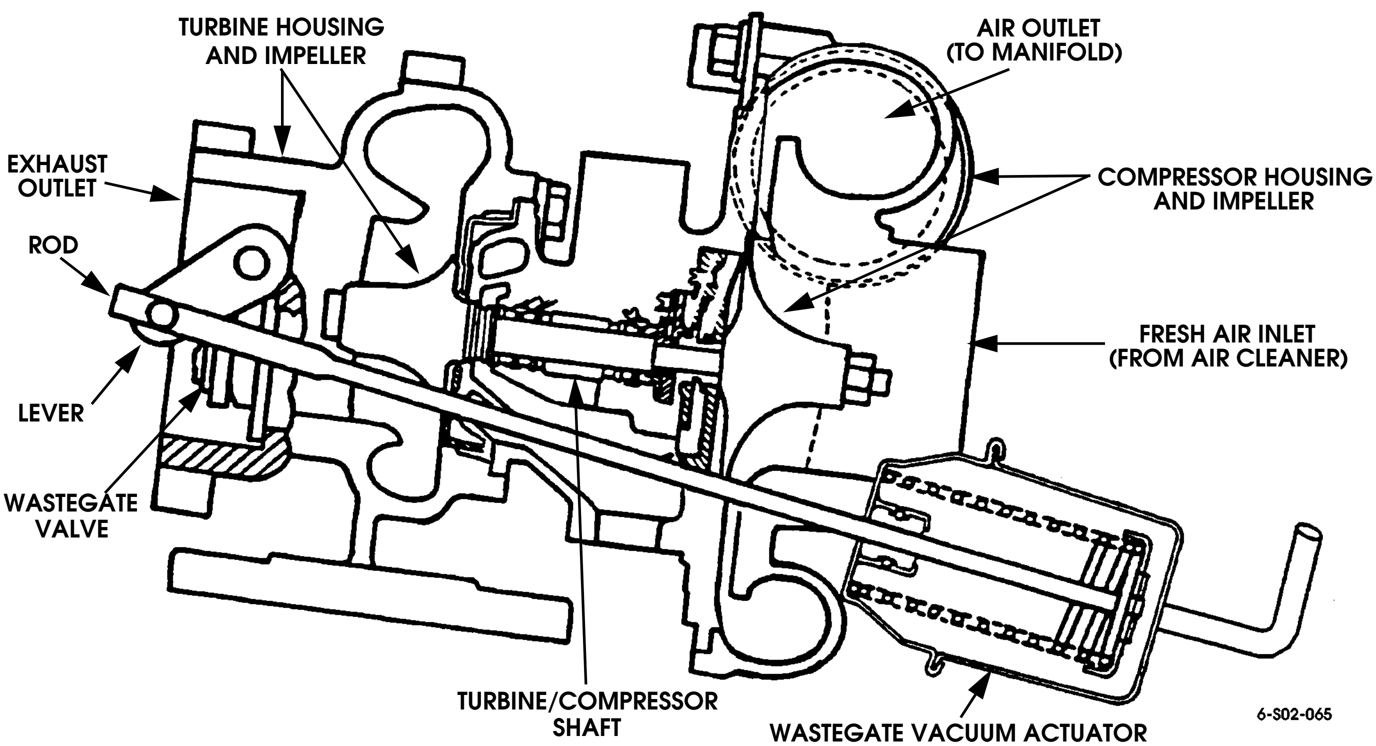

Figure 2-9: Turbocharger Components (Typical)

TURBOCHARGER OPERATION

The wastegate valve controls boost. It is operated by the vacuum actuator. Opening the valve stops boost and closing the valve generates boost. Boost levels are continuously monitored by the PCM.

In the operation, an increase in accelerator pedal sensor angle to boost detent, causes the pedal sensor to signal the PCM that engine load is increasing. At this point, the PCM closes the wastegate valve with the actuator and increases fuel flow to the injectors.

Closing the wastegate valve allows full exhaust gas flow into the turbine housing. As the gas enters the housing, it acts against the blades on the turbine impeller causing it to rotate. Since the turbine and compressor impellers are fixed to the same shaft, the turbine impeller causes the compressor impeller to rotate as well.

Once the compressor impeller begins rotating, it draws fresh air into the compressor housing. The air is then compressed and pumped into the intake manifold. Fresh air source for the compressor section is through the air cleaner and related ducting.

A decrease in pedal sensor angle signals the PCM that boost can be reduced or stopped entirely. The PCM then opens the wastegate valve by reducing vacuum to the actuator. Once open, the wastegate causes exhaust gas to bypass the turbine housing and impeller.

Electronic Accelerator Pedal

The electronic pedal is unique to models equipped with a turbocharged engine. It consists of a pedal, arm, and position sensor (potentiometer), attached to a mounting bracket (Figure 2-10).

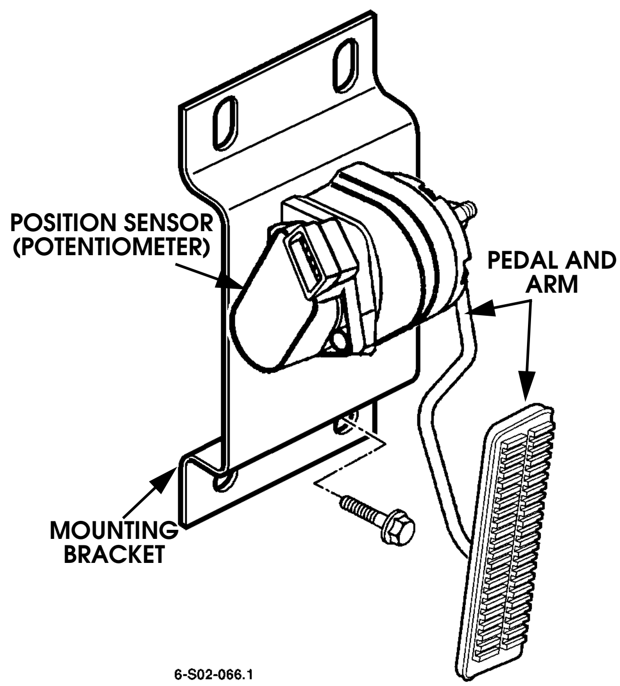

Figure 2-10: Electronic Accelerator Pedal

The position sensor is a potentiometer that operates like a TPS. It signals pedal position to the PCM. At boost detent position, the potentiometer signal causes the PCM to close the wastegate valve and generate boost.

Turbocharger Service

The turbocharger is not a repairable component. It must be replaced as an assembly when diagnosis indicates this is necessary.

Wastegate Actuator Test

The actuator is tested with a hand operated vacuum pump. Testing is performed with the engine off (not running) as follows:

1. Operate wastegate lever by hand. Lever should move back and forth freely without bind or drag.
2. Disconnect vacuum line at actuator and connect vacuum pump to actuator.
3. Apply 5 inches vacuum to actuator and note action. Actuator rod should close wastegate smoothly. If rod fails to move, release vacuum and proceed to next step.
4. Disconnect actuator rod at wastegate lever. Apply 5 inches vacuum to actuator, and note rod operation. If rod fails to move replace actuator. But if rod does move wastegate valve or lever is binding. Free up lever with heat valve lubricant. Replace turbocharger if wastegate valve is seized or binding.

Boost Pressure Test

Boost pressure is checked with a compound vacuum/pressure gauge. A road test under boost conditions is required. Procedure is as follows:

1. Attach compound gauge hose to fitting on air inlet tube, air horn, or turbocharger outlet.
2. Route hose to passenger side-window and into vehicle interior.
3. Road test vehicle. Have helper either drive or observe test gauge. Press accelerator pedal to wide open position and note gauge reading. A gauge reading of 2 psi (14 kPa) or more indicates normal operation.

NOTE: During deceleration, boost level may decrease, this is normal.

4. If gauge reading is zero, or well below 2 psi (14 kPa), check complete air intake and exhaust system for leaks and repair as needed. Also check vacuum actuator, and accelerator pedal potentiometer. Run electrical check with Tech 2 scan tool if electrical system problems are suspected.

Vacuum Pump Test

The pump can be checked with a standard vacuum gauge. Output should be minimum of 20-21 inches vacuum.

Turbocharger Removal

1. Remove front console, rear console, engine cover, and disconnect related wiring and A/C ducting.
2. Remove turbocharger heat shielding.
3. Loosen clamps attaching turbocharger inlet tubes to exhaust manifolds and turbocharger. Then work tubes loose and remove them.
4. Remove air duct and hoses connecting turbocharger to air cleaner.
5. Disconnect vacuum hose at wastegate vacuum actuator.
6. Loosen bolts that attach manifold crossover to left and right manifold halves.
7. Prop manifold crossover up with blocks.
8. Lift, turn and tilt turbocharger to remove it (Figure 2-11). Do not pry or force it off the engine.

Turbocharger Installation

1. Install new O-ring seal on turbocharger manifold outlet. Do not reuse old O-ring as leakage may occur.
2. Clean gasket surfaces of intake manifold and crossover housing.
3. Mount turbocharger on engine and install bolts that secure it to engine block.
4. Tighten crossover housing bolts.
5. Install air inlet duct and hose and connect vacuum pump to actuator.
6. Install turbocharger inlet tubes. Tighten flange clamps that secure tubes to manifolds and turbocharger to 71 lb. in. (8 N•m) torque.
7. Install turbocharger and exhaust pipe heat shielding.
8. Install engine cover, console, and ducting.

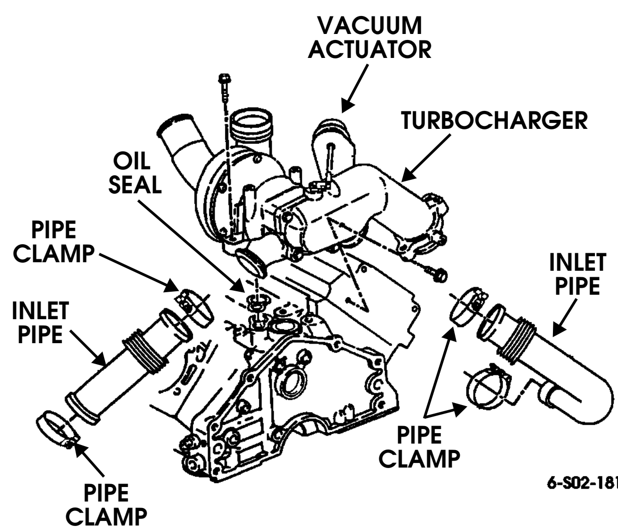

Figure 2-11: Turbocharger Mounting

Turbocharger Diagnosis

PROBLEM	POTENTIAL CAUSE	CORRECTION
Low Power Poor Acceleration (Black smoke not evident at 1/2 to wide open throttle)	1. Lean fuel mixture caused by insufficient fuel volume or pressure.	1. Problem is in fuel delivery system. Check fuel supply pump pressure, look for leaks in lines and at fittings, plugged fuel filter, accelerator cable problem, injection pump problem. Refer to low power information in guides for standard diagnosis.
Low Power, Poor Acceleration (Black smoke evident at 3/4 to wide open throttle)	1. Air filter plugged. 2. Restriction in air intake duct to turbocharger compressor wheel. 3. Air leak in turbocharger compressor inlet and outlet ducts. May be accompanied by high pitch whine indicating system air leak. 4. Loss of vacuum to wastegate actuator, or actuator is damaged. 5. Air leak at intake manifold. 6. Exhaust leak between cylinder head ports and turbine inlet of turbocharger. 7. Turbocharger damaged internally. 8. Fuel system problem (over-rich mixture).	1. Replace filter. 2. Remove and inspect duct components. Remove/ repair any restrictions. 3. Disassemble, inspect, repair worn, damaged, loose parts. 4. Check vacuum supply. Replace hose and fittings if necessary. If OK, use hand operated vacuum tester to check actuator operation. Replace actuator or vacuum pump, as required. 5. Tighten loose bolts. Or, remove manifold and replace gaskets if necessary. 6. Check exhaust manifolds pipes, and turbocharger connections for leaks. Replace damaged components, tighten loose fasteners. 7. Remove and inspect turbocharger. Replace if compressor/turbine wheels, or other internal components are damaged. 8. Refer to low power information in standard diagnosis.
Turbocharger Noise	1. Obstruction in air intake or outlet systems may cause high pitch whine. 2. Compressor/turbine impeller contacting housing, or other internal damage. May be accompanied by vibration.	1. Disassemble and clear blockage, or restriction. 2. Replace turbocharger.
Blue Exhaust Smoke with Warm Engine Only	1. Insufficient intake air volume. 2. Partially plugged oil drain tube. 3. Oil Leaking past worn compressor or turbine side seals. 4. Engine problem caused by worn rings, or valve seals.	1. Disassemble, inspect, and clear any restrictions. Replace damaged, worn ducting parts. 2. Remove and clear tube. Replace tube if fully plugged, pinched, or kinked. 3. Replace turbocharger. 4. Overhaul cylinder heads or engine as needed.

DIESEL ENGINE IN-VEHICLE SERVICE

General Information

The repair procedures described in this section cover engine service that can be performed in the vehicle. Engine removal is not required.

Left/Right Orientation

Left/right orientation throughout this section is from the driver seat. A left side location refers to the driver side of the vehicle and a right side location to the passenger side.

ENGINE MOUNTING BRACKET/INSULATOR

Removal

1. On non-turbo engines, disconnect air intake hose at air horn. Then remove air horn from intake manifold (Figure 2-12).
2. Remove fan and clutch as assembly.
3. Remove nuts/bolts attaching front propeller shaft center bearing to bracket.
4. Mark front propeller shaft U-joint and yoke position with paint or chalk. Then remove front propeller shaft and center bearing as assembly.
5. Remove bolts attaching starter cable bracket to engine. Move bracket aside for working clearance.
6. Remove bolts/nuts attaching transmission and mount to transmission crossmember (Figure 2-13).

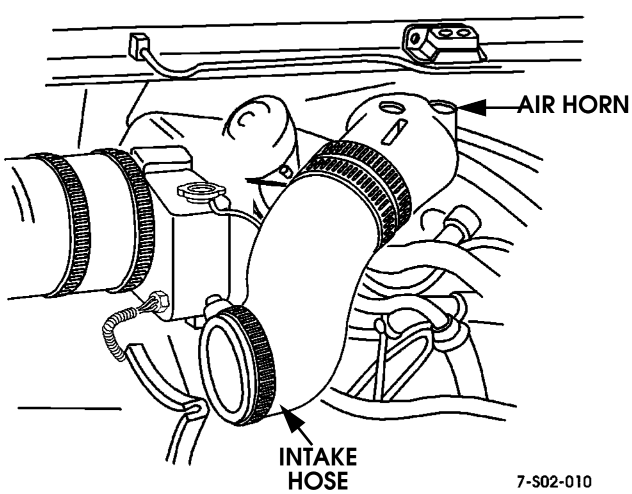

Figure 2-12: Air Horn and Intake Hose Location (Non-Turbo Engine)

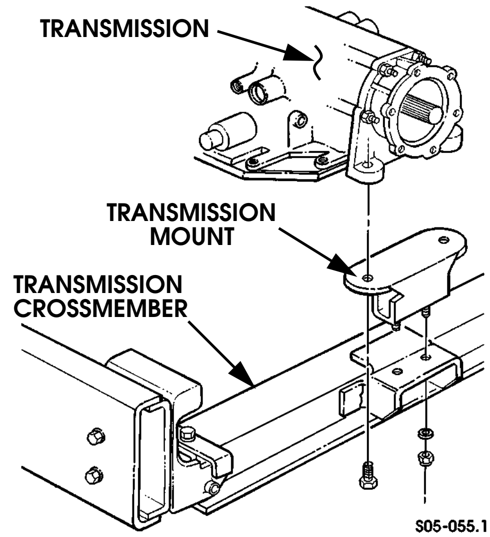

Figure 2-13: Transmission-To-Crossmember Mounting

7. Disconnect transmission and transfer case shift rods at shift lever arms.
8. Disconnect exhaust pipes, brackets, or hangers as needed.
9. Support engine with floor jack and wood block, or safety stand if vehicle is on hoist. Position block or stand under pan rail at rear main.
10. Remove nuts/bolts attaching insulators, or brackets to engine and frame.
11. Remove nut securing engine bracket to stud on starter motor (Figure 2-14).
12. Raise engine enough to remove insulator, or bracket (Figure 2-14).

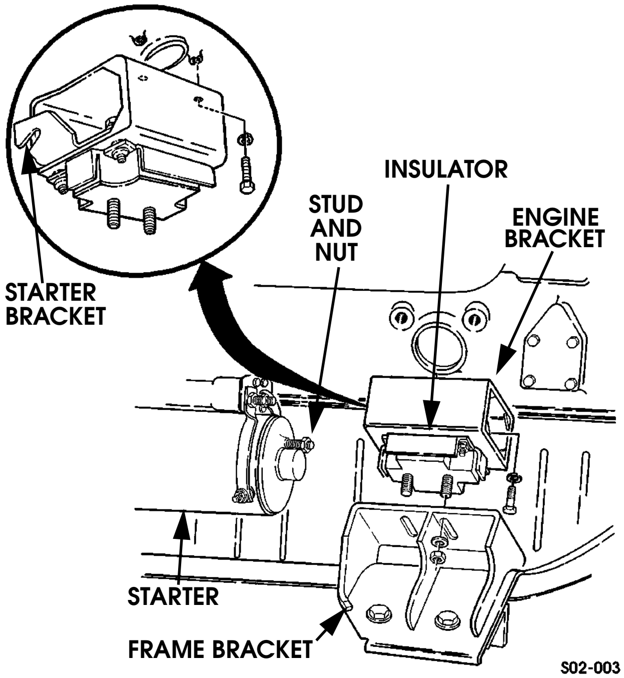

Figure 2-14: Engine Mounting Bracket and Insulator (Driver Side)

Installation

1. Position insulator on engine bracket (Figure 2-15).

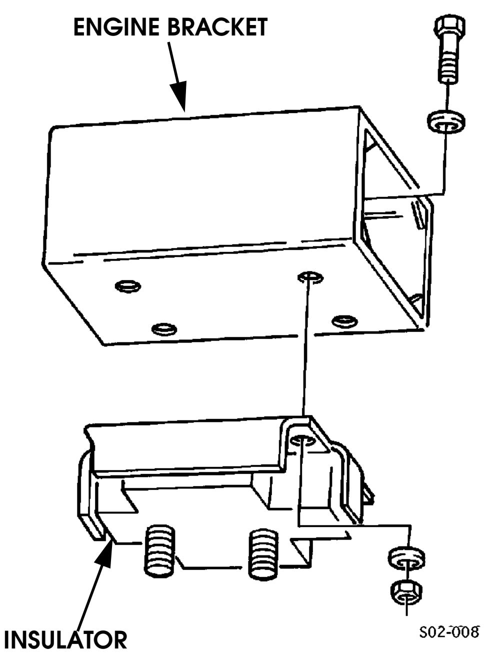

Figure 2-15: Engine Bracket and Insulator Assembly

2. Install engine bracket and insulator. Tighten engine bracket-to-block bolts to 30 lb-ft (41 N•m) torque. Tighten insulator stud nuts to 90 lb-ft (122 N•m) torque.
3. Install nut that secures engine bracket to stud on starter motor (Figure 2-14). Tighten nut to 24 lb-ft (33 N•m) torque.
4. Align and install bolts/nuts that attach transmission to transmission crossmember (Figure 2-13).
5. Connect transmission and transfer case shift rods to floor shift levers. Use new cotter pins to secure shift rod trunnions to shift lever arms.
6. Align and install front propeller shaft and center bearing. Tighten center bearing attaching bolts to 60 lb-ft (81 N•m) torque. Tighten U-joint clamp strap nuts to 13-18 lb-ft (18-24 N•m) torque.
7. Install starter cable bracket.
8. Connect exhaust pipes, brackets, or hangers if loosened/ removed for service access.
9. Install fan and clutch.
10. On non-turbo engines, install air horn on intake manifold and connect air cleaner hoses.

CRANKSHAFT PULLEY

Removal

1. Loosen (but do not remove) crankshaft pulley bolts (Figure 2-16).
2. Remove serpentine accessory drive belt as follows:
   a. Loosen drive belt by rotating belt tensioner in counterclockwise direction (Figure 2-17). Use 1/2 in. drive breaker bar to rotate pulley.
   b. Slide belt off tensioner and other pulleys. Then remove belt.
3. Remove crankshaft pulley bolt and remove pulley.

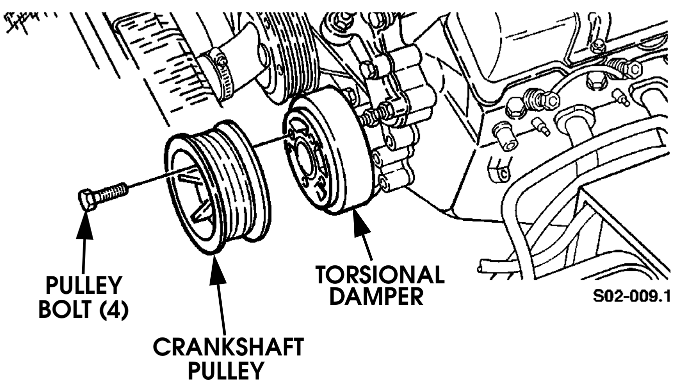

Figure 2-16: Crankshaft Pulley Mounting

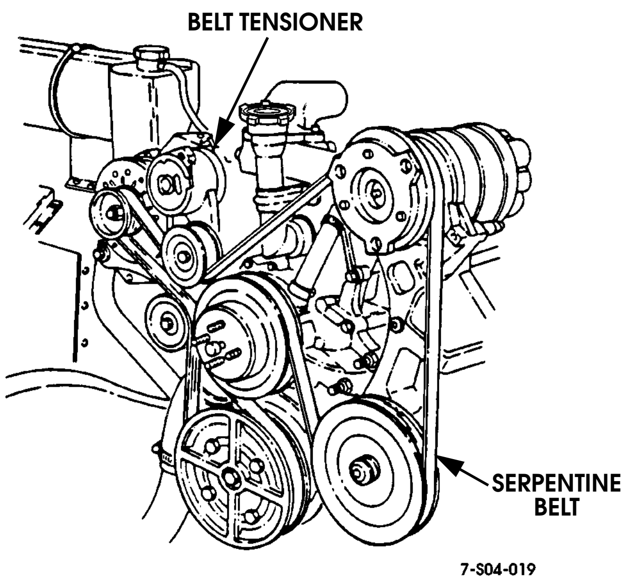

Figure 2-17: Serpentine Belt Tensioner Location

Installation

1. Clean face of torsional damper with brake cleaner. Smooth surface with file, or 280 grit paper, if necessary.
2. Install pulley on damper and install pulley bolts. Tighten bolts until snug.
3. Install serpentine belt on all pulleys except belt tensioner (Figure 2-18). Turn tensioner counterclockwise with breaker bar and slide belt onto tensioner. Then release breaker bar so tensioner can rotate clockwise to adjust belt.
4. Tighten crankshaft pulley bolts to 48 lb-ft (65 N•m) torque.

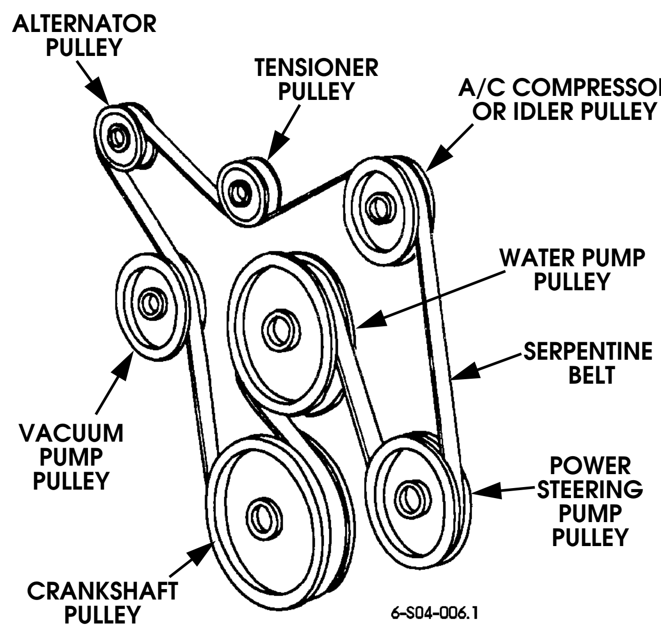

Figure 2-18: Serpentine Belt Installation

TORSIONAL DAMPER

Removal

1. Remove crankshaft pulley and serpentine belt. Refer to procedure in this section.
2. Remove damper bolt and washer (Figure 2-19).
3. Remove torsional damper with tool J23523-F (Figure 2-20).
4. Remove and inspect crankshaft keys. Replace keys if worn, chipped, or distorted.

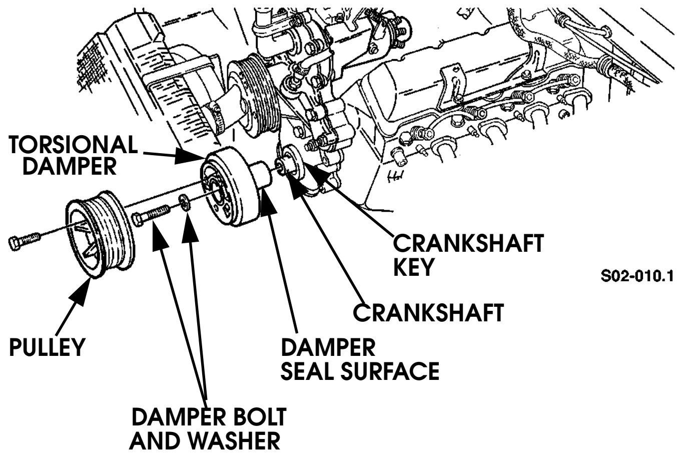

Figure 2-19: Torsional Damper and Crankshaft Pulley Mounting

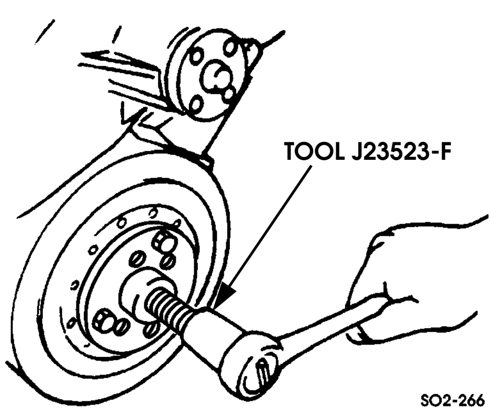

Figure 2-20: Torsional Damper Removal

Installation

1. Check seal contact surface of damper. Surface must be clean and smooth to avoid damaging timing cover seal. Smooth surface with 180 grit emery if necessary. Then polish surface with 220 grit emery coated with engine oil.
2. Inspect condition of front cover seal. Replace seal if worn, cut, cracked, or hardened. Use pry tool to remove oil seal and tool J22102 to install new seal.
3. Install damper drive key in crankshaft. Be sure keys are fully seated in crankshaft key slots.
4. Lubricate crankshaft nose, front cover seal, and seal surface of torsional damper with engine oil.
5. Install torsional damper on crankshaft. Be sure drive key is not displaced during damper installation.
6. Install damper washer and bolt. Tighten bolt to 160-200 lb-ft (217-270 N•m) torque.
7. Install crankshaft pulley. Tighten pulley bolts to 48 lb-ft (65 N•m) torque.
8. Install serpentine belt (Figure 2-18).

FRONT COVER OIL SEAL REPLACEMENT

1. Remove crankshaft pulley and torsional damper. Refer to procedures in this section.
2. Remove oil seal front cover with tool J22102 or pry tool (Figure 2-21).
3. Clean seal contact surface of torsional damper. Smooth surface, if necessary, with 180 grit emery. Then polish with 220 grit emery coated with engine oil. Seal surface must be smooth to avoid damaging new seal.
4. Install new seal in cover with tool J22102. Open end of seal goes toward interior of cover.
5. Lubricate new seal and seal surface of torsional damper, with engine oil, petroleum jelly, or light chassis grease.
6. Install keys in crankshaft. Then align and install torsional damper. Install damper belt and washer. Tighten bolt to 140-160 lb-ft (190-217 N•m).
7. Install crankshaft pulley and serpentine belt. Refer to procedure in this section.

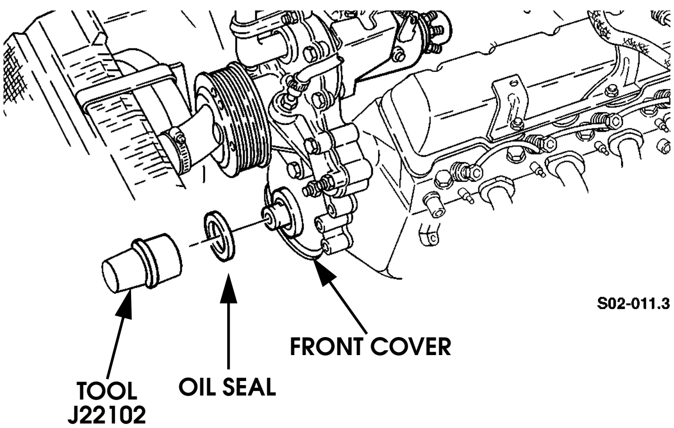

Figure 2-21: Front Cover Oil Seal Location

OIL PUMP DRIVE

Removal

1. Remove engine cover/console for access to rear of engine.
2. On turbo engine, remove turbocharger as described in this section.
3. Clean surface of drive, block and drive clamp with carb cleaner.
4. Remove bolt that secures oil pump drive clamp to block (Figure 2-22).
5. Disconnect sensor wire at drive.
6. Remove oil pump drive with turn and lift motion. Use channel lock or use grip pliers to remove drive.
7. Remove gasket from block or drive.
8. Cover pump drive opening in block to prevent dirt entry.

Installation

1. Install new gasket on oil pump drive.
2. Position and insert oil pump drive in block. Turn drive back and forth to seat it as needed.
3. Install drive clamp and bolt. Tighten bolt to 25-37 lb-ft (34-50 N•m) torque.
4. On turbo engine, install turbocharger as described in this section.
5. Reconnect sensor wire at drive.
6. Install engine console/cover.

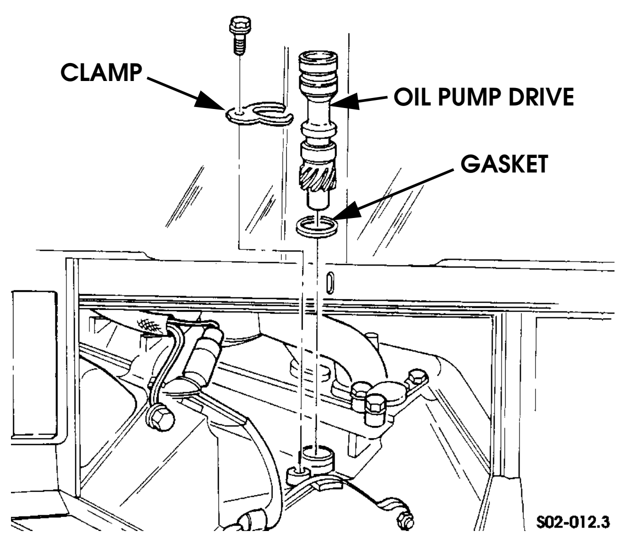

Figure 2-22: Oil Pump Drive Removal/Installation

FRONT COVER AND TIMING CHAIN

Cover Removal

1. Disconnect and remove batteries and tray.
2. Drain engine coolant.
3. Remove radiator upper and lower hoses.
4. Loosen crankshaft pulley belts.
5. Remove left and right splash shields.
6. Disconnect hood harness then remove hood with aid of helper. Place hinge pins in hinges after removal to avoid losing them.
7. Remove A/C condenser oil coolers, radiator, and fan shroud as assembly (Figure 2-23).
8. Loosen and remove serpentine drive belt. Use 1/2 in. drive breaker bar to rotate belt tensioner counterclockwise to loosen belt (Figure 2-17).
9. Disconnect heater, bypass and inlet hoses at water pump and coolant crossover (Figure 2-24).
10. Remove oil filler neck and coolant crossover (Figure 2-24).

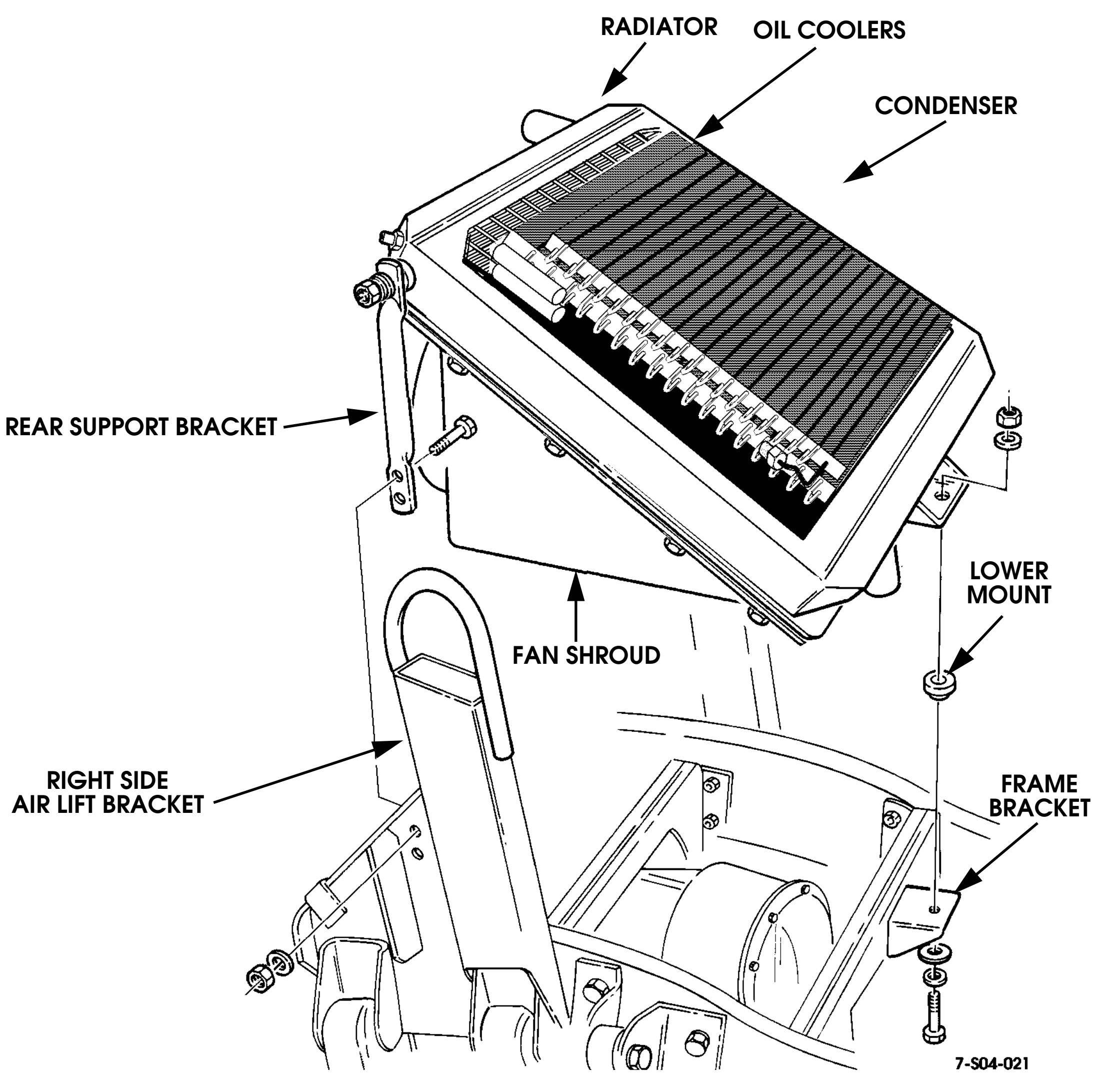

Figure 2-23: Condenser, Oil Coolers, Radiator and Fan Shroud Removal as an Assembly

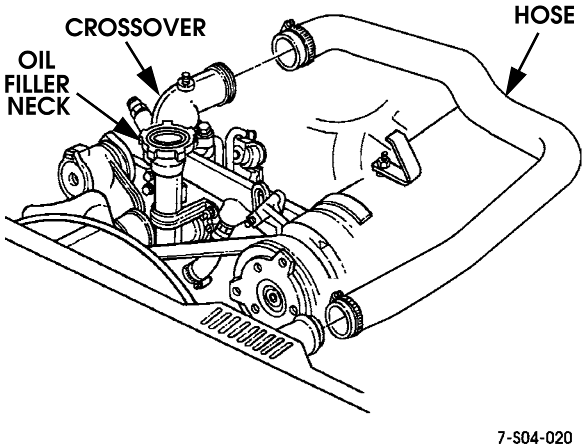

Figure 2-24: Upper Radiator Hose Connections (Non-Turbo Shown)

11. Remove fan and fan clutch.
12. Remove crankshaft pulley (Figure 2-16).
13. Remove torsional damper attaching bolt and washer (Figure 2-19).
14. Remove torsional damper with tool J23523-F (Figure 2-20).
15. Remove drive keys from crankshaft. Replace keys if worn, chipped, or distorted.
16. Remove water pump and adapter plate as assembly (Figure 2-25).
17. Remove bolts that attach front cover to oil pan (Figure 2-26).
18. Rotate crankshaft until timing marks on sprockets and gears are aligned and number one piston is at TDC.
19. Remove injection pump driven gear (Figure 2-26).
20. Remove baffle from front cover (Figure 2-26).
21. Remove nuts and washers attaching fuel injection pump to studs on front cover (Figure 2-26).

NOTE: There are timing marks on the front cover and injection pump. Note position of these marks for installation reference.

22. Remove bolts that attach front cover to engine block. Then break sealer bead with putty knife and remove cover.
23. Cover oil pan opening to prevent dirt entry.
24. Check timing chain deflection with dial indicator. Measure deflection mid-way between crankshaft and cam sprockets. Maximum allowable deflection is 0.810 in. (20.5 mm). Replace chain and sprockets if deflection is greater than specified.
25. Check camshaft end play with dial indicator. Maximum allowable end play is 0.012 in. (0.3 mm). Replace cam thrust plate and spacer if end play is greater than specified.

NOTE: Note position of timing marks on drive gear and crank and cam sprocket for installation reference.

26. Remove bolt and washer attaching injection pump drive gear to camshaft. Then remove gear (Figure 2-27).
27. Slide timing chain and sprockets off camshaft and crankshaft (Figure 2-27).
28. Remove drive keys from camshaft and crankshaft. Replace keys if chipped, cracked, or distorted. Minor burrs can be removed with a stone or fine tooth file.
29. Clean all old sealer off engine block, front cover, and water pump/adapter plate with scraper.

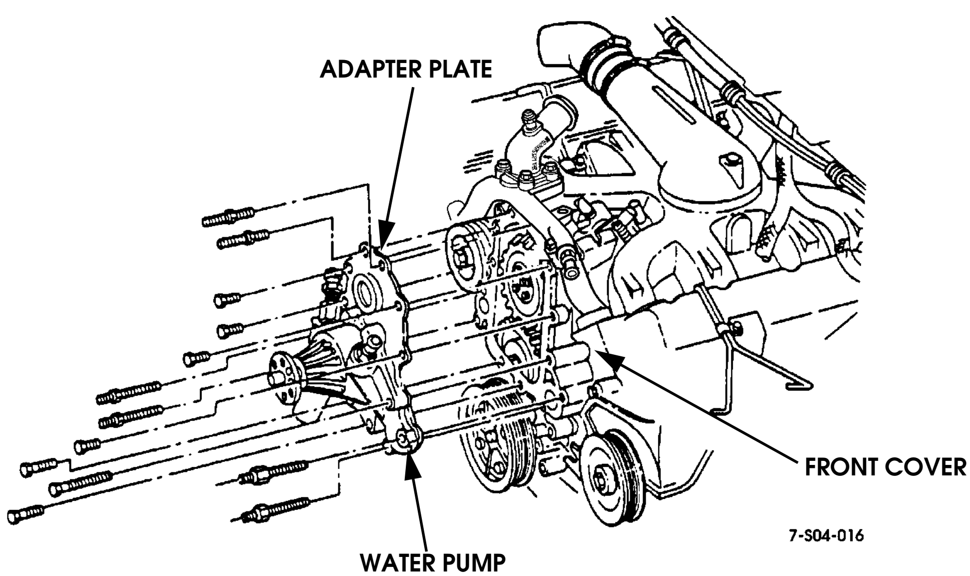

Figure 2-25: Water Pump and Adapter Plate Removal/Installation

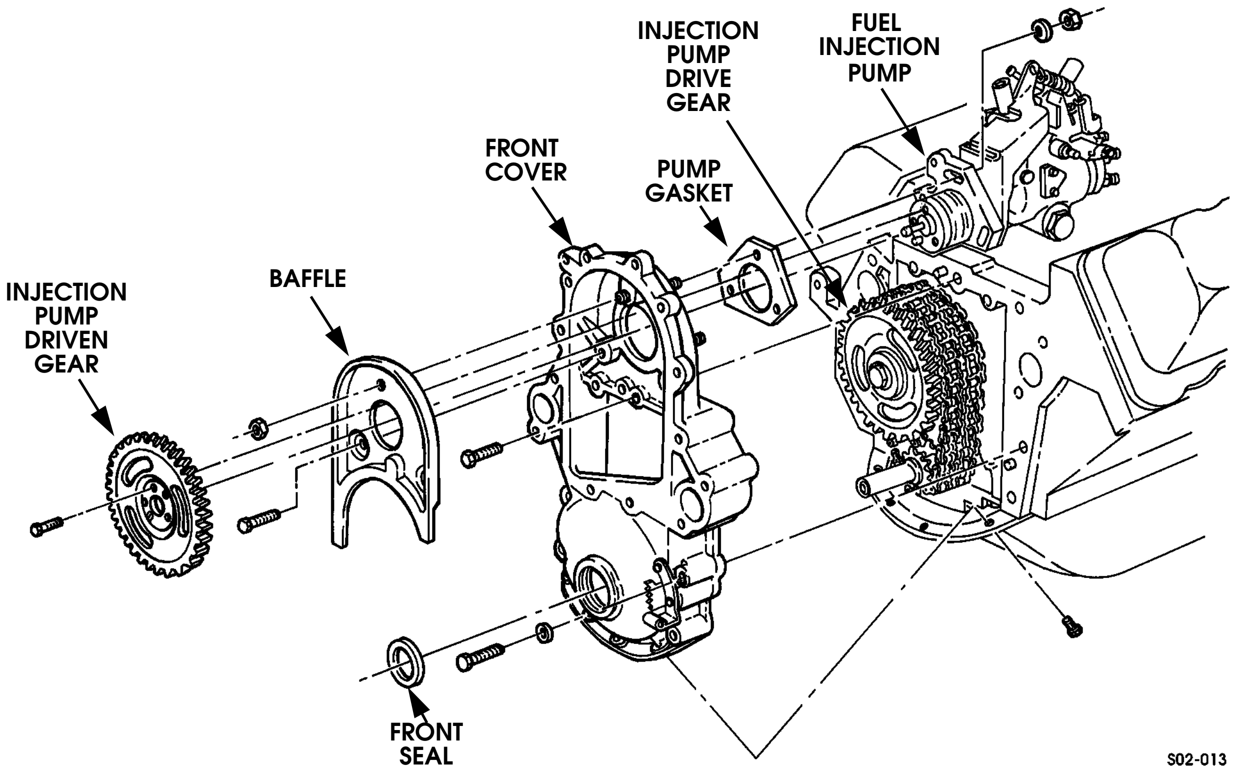

Figure 2-26: Drive Gear, Baffle, and Front Cover Removal

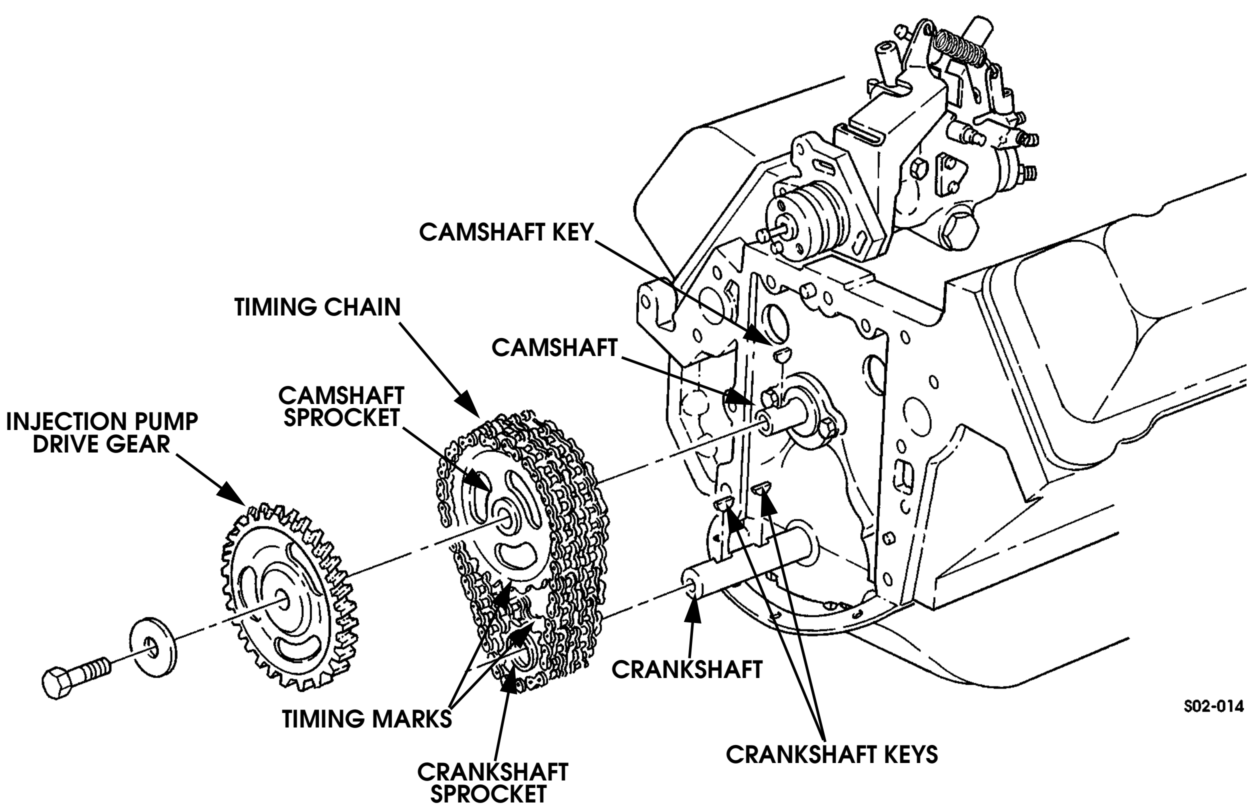

Figure 2-27: Drive Gear, Timing Chain, and Sprocket Removal

Front Cover Installation

NOTE: If a new cover is being installed, it will be necessary to locate and mark a TDC/timing mark on the cover. Refer to injection pump installation in the overhaul section for procedures.

1. Install new camshaft thrust plate and spacer if required.
2. Clean front cover and engine block sealing surfaces with carb cleaner and wipe dry.
3. Install drive keys in camshaft and crankshaft. Be sure keys are seated.
4. Assemble and install timing chain and sprockets (Figure 2-28). Check timing mark alignment before proceeding.
5. Install injection pump drive gear on camshaft (Figure 2-28). Timing mark on gear should be facing upward (12 o'clock position). Then install drive gear attaching washer and bolt. Tighten bolt to 55-60 lb-ft (75-81 N•m) torque.

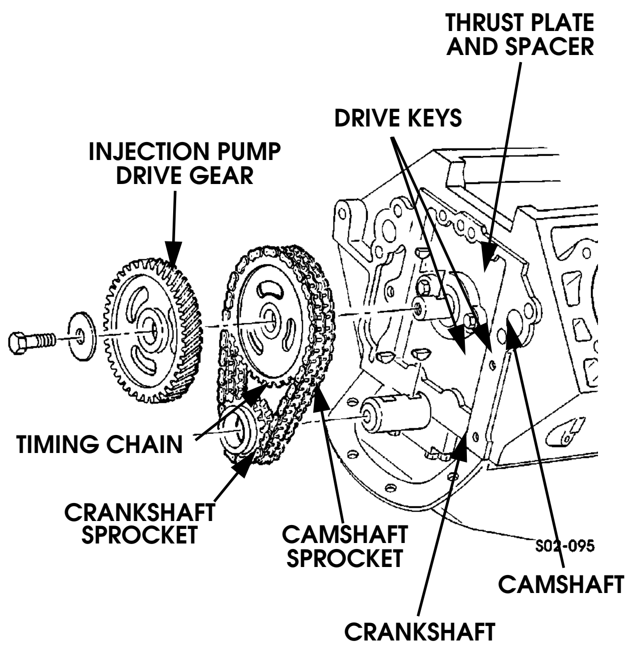

Figure 2-28: Timing Chain, Sprockets, and Drive Gear Installation

6. Install new seal in front cover with tool J22102.
7. Apply sealer to front cover as follows:
   - Use anerobic sealer, such as Loctite 510, on cover surfaces that contact engine block.
   - Use RTV-type sealer, such as Loctite 592, on oil pan and oil pan contact surface of front cover.
   - Refer to sealer application diagram (Figure 2-29).

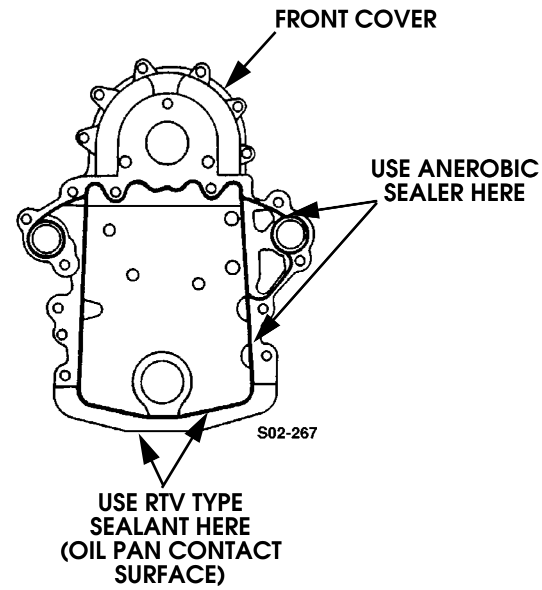

Figure 2-29: Front Cover Sealer Application Diagram

8. Install front cover on engine block (Figure 2-30). Be sure cover is fully seated on engine block dowels, engine block, and oil pan, before installing cover bolts.
9. Install front cover attaching bolts. Then tighten bolts as follows:
   - Tighten cover-to-engine block bolts to 33 lb-ft (45 N•m) torque.
   - Tighten oil pan-to-front cover bolts to 4-10 lb-ft (5-14 N•m) torque.
10. Install injection pump gasket on front cover studs (Figure 2-30:).

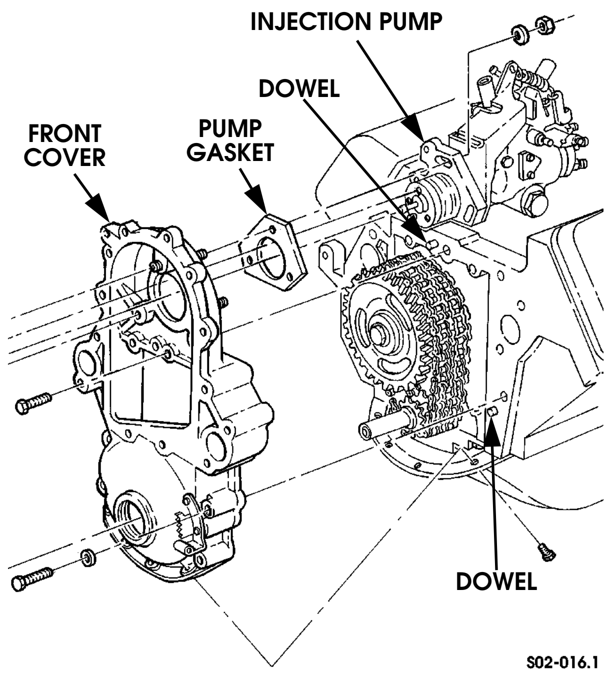

Figure 2-30: Front Cover Mounting

11. Install baffle in front cover (Figure 2-31). Maintain minimum clearance of 0.040 in. (1.02 mm) between baffle and injection pump drive gear. Tighten baffle attaching bolts/nuts to 33 lb-ft (45 N•m) torque.
12. Install fuel injection pump driven gear on pump shaft as follows:
    a. Align timing marks on drive and driven gears and install driven gear on pump shaft.
    b. Verify timing mark alignment. Drive gear mark should be at 12 o'clock position and driven gear mark at 6 o'clock position.

NOTE: If timing marks are not perfectly aligned, turn the pump shaft to correct alignment. Do not turn the gears.

    c. Install and tighten driven gear attaching bolts to 13-20 lb-ft (18-27 N•m) torque.
13. Check alignment of timing marks on front cover and injection pump flange. Rotate pump to align if necessary. Then install pump attaching nuts.
14. Secure fuel injection pump to front cover. Tighten pump attaching nuts to 13-20 lb-ft (18-27 N•m) torque.
15. Lubricate front cover seal lip with engine oil, or petroleum jelly. Then lubricate seal contact surface of torsional damper with engine oil. Be sure seal contact surface of damper is smooth and free of burrs, nicks, or corrosion.
16. Install damper drive key in crankshaft slot. Be sure key is fully seated.

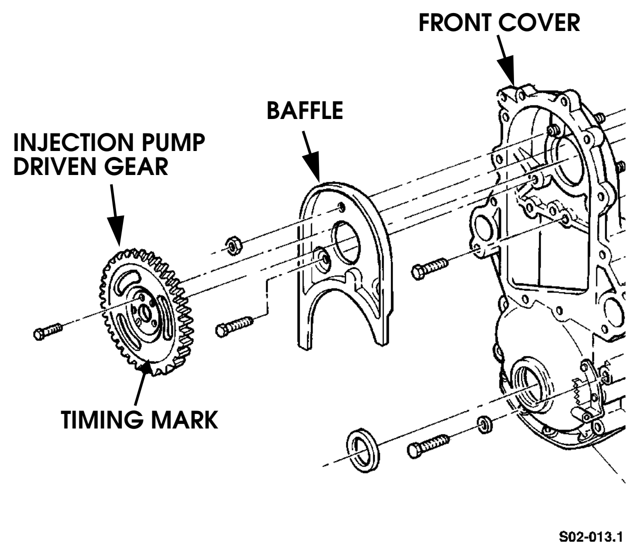

Figure 2-31: Baffle and Pump Driven Gear Installation

17. Install torsional damper. Then install damper attaching washer and bolt. Tighten bolt to 140-160 lb-ft (190-217 N•m) torque.
18. Install crankshaft pulley. Tighten pulley bolts to 48 lb-ft (65 N•m) torque.
19. Install coolant crossover and oil filler neck. Tighten crossover bolts to 31 lb-ft (42 N•m) torque and filler neck attaching nut to 13-20 lb-ft (18-27 N•m) torque.
20. Apply bead of anaerobic sealer, such as Loctite 510, to water pump and adapter plate. Refer to Figure 2-36 for sealer application.
21. Install water pump and adapter plate. Apply Permatex/Loctite pipe sealing compound, to fastener that goes in hole "A" (Figure 2-32). Tighten pump/adapter bolts to 13-20 lb-ft (18-27 N•m) torque.

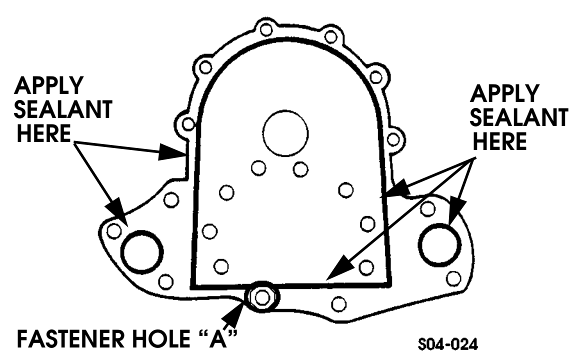

Figure 2-32: Water Pump Adapter Plate Sealer Application Diagram

22. Install fan pulley, fan, and fan clutch. Tighten attaching nuts to 15-20 lb-ft (20-27 N•m).

23. Install serpentine drive belt.
24. Connect heater and bypass hoses at water pump and crossover. Then attach radiator upper inlet hoses to inlet tube.
25. Install radiator and shroud (Figure 2-23). Then install air conditioning condenser and power steering fluid cooler.
26. Connect radiator upper and lower hoses.
27. Fill cooling system.
28. Connect battery negative cables.
29. Evacuate and recharge air conditioning system if necessary.
30. Start and run engine to verify proper operation. Purge air from cooling system (if necessary), and top off coolant level at surge tank.
31. On turbo diesel, reprogram TDC offset. Refer to procedure at end of this section.

OIL PUMP SERVICE

Removal

1. Drain engine oil and remove oil filter.
2. Remove oil pan bolts.
3. Tap oil pan with rubber mallet to break sealer bead. Use putty knife to help separate sealer bead if necessary. Then remove pan.
4. Loosen screw that secures bracket on oil pump pickup tube.
5. Remove nut that secures tube bracket to oil pump mounting stud (Figure 2-33). Then rotate bracket off stud.
6. Remove oil pump mounting stud (Figure 2-33).
7. Remove oil pump and pump shaft.

Inspection And Replacement

The oil pump can be disassembled for inspection but not repaired. The oil pump is only serviced as an assembly. Individual parts are not available.

Replace the pump if the oil pickup strainer and tube are loose, cracked, or distorted. Also replace the pump if the housing is damaged or the pump gears are worn, chipped, or cracked.

Check the pump shaft and pressure relief valve and spring. Replace the pump if the spring is collapsed or broken, the valve is damaged, the retaining pin is loose, or damaged, or the pump shaft is worn or damaged.

The oil pickup strainer can be cleaned with spray-type carb cleaner if necessary. However, replace the pump if heavy accumulations of oil sludge, grit, foreign material, or metal chips are present.

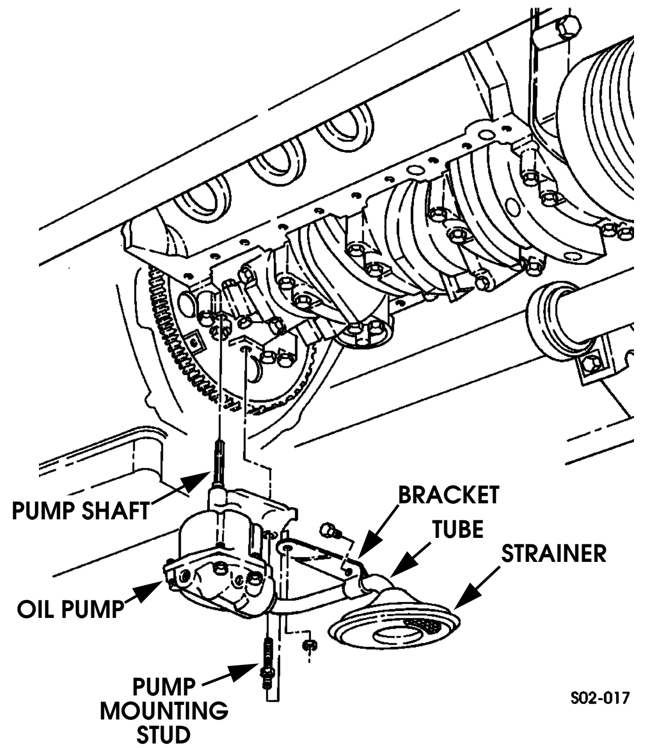

Figure 2-33: Oil Pump Mounting

Installation

1. Prime oil pump. Pour about four ounces of engine oil into pump through strainer and rotate shaft to coat gears.
2. Insert pump shaft into block. Then align and seat pump.
3. Install and tighten pump mounting stud to 59-74 lb-ft (80-100 N•m) torque.
4. Rotate pickup tube bracket onto pump mounting stud. Then install and tighten bracket retaining nut to 35 lb-ft (47 N•m).
5. Tighten clamp screw on pickup tube bracket to 12 lb-ft (16 N•m) torque.
6. Clean oil pan and engine block sealing surfaces with scraper and solvent. Final clean surfaces with brake or electrical contact cleaner to remove all residue. Otherwise, RTV sealer will not adhere properly.
7. Apply RTV-type sealer to front cover, oil pan, and engine pan rail surfaces. Sealers such as Permatex ultra copper, or black are equally acceptable.
8. Install rear seal in oil pan.
9. Position oil pan on engine and front cover. Then install and tighten oil pan bolts as follows:
   - Tighten rear two bolts to 89 lb-in (10 N•m) torque.
   - Tighten remaining bolts to 17 lb-ft (23 N•m) torque.
10. Install oil filter and refill with recommended grade engine oil.

REAR MAIN OIL SEAL REPLACEMENT

1. Remove transmission and transfer case assembly.
2. Remove flywheel.

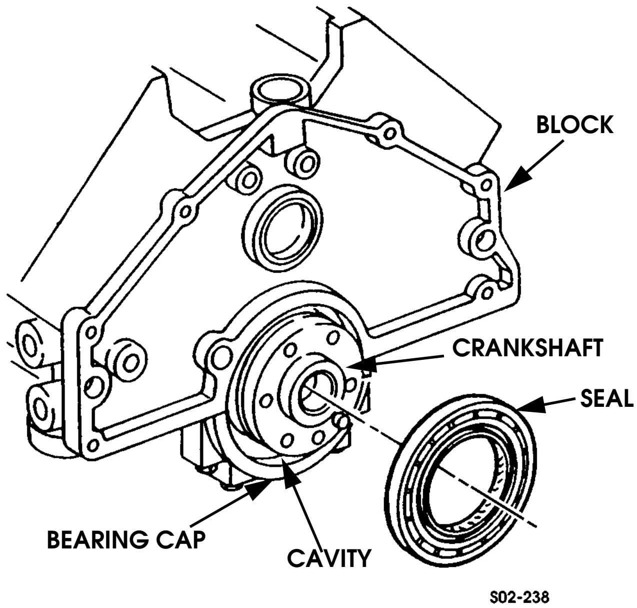

Figure 2-34: Rear Main Oil Seal Removal

CAUTION: *Do not damage crankshaft seal surface when removing old seal (Figure 2-34).*

3. Using small screwdriver or seal puller, remove old seal from cylinder block and main bearing cap cavity.
4. Clean old sealant or oil build-up from seal cavity. Check for excess wear in crank.
5. Lightly coat crankshaft and inner lip of seal with engine oil. Lube oil and I.D. of seal.
6. Position seal on crankshaft with seal lip toward block. Ensure seal lip does not flip on installation.
7. Position seal installer J39084 on crankshaft, press seal into cavity in block, then remove installer tool (Figure 2-35).
8. Install flywheel on crankshaft. Tighten bolts to 66 lb-ft (90 N•m).
9. Install transmission and transfer case assembly.
10. Run engine and check for leaks after assembly.

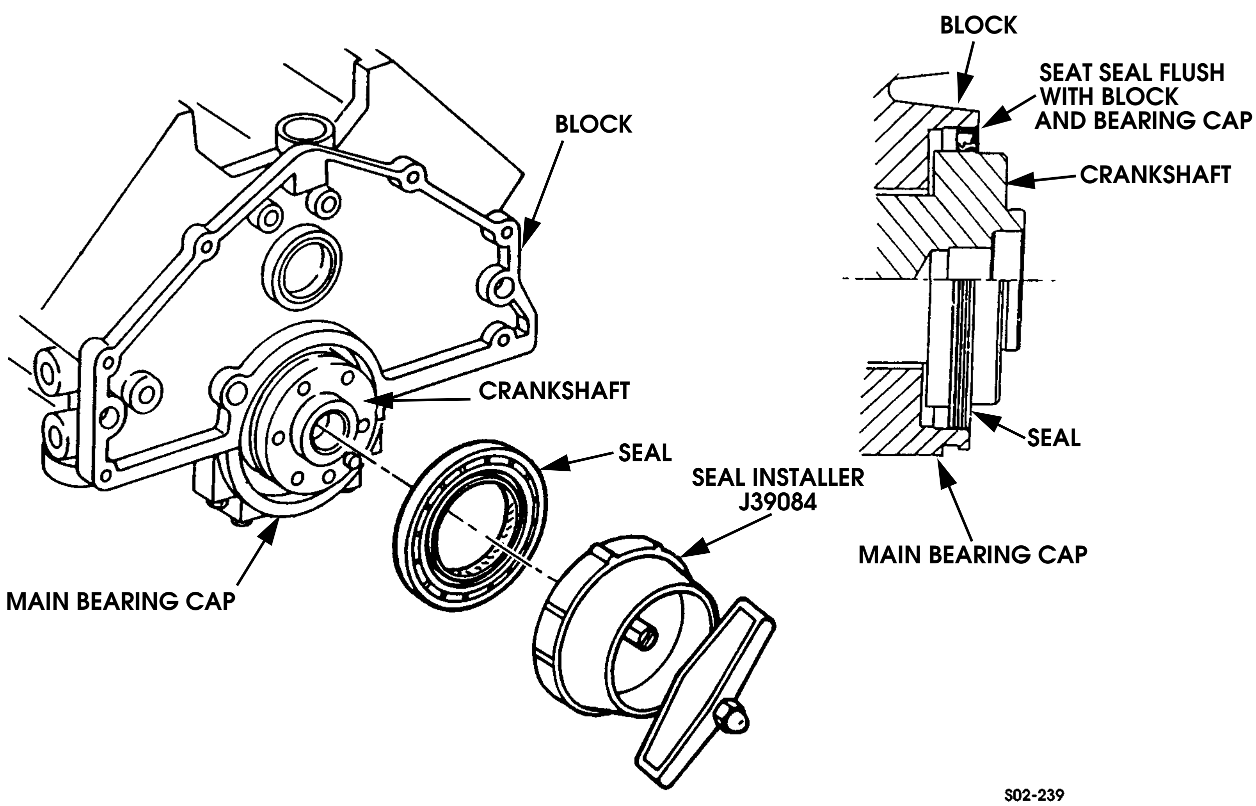

Figure 2-35: Rear Main Oil Seal Installation

INTAKE MANIFOLD SERVICE (NA DIESEL)

Removal

1. Disconnect battery negative cables.
2. Remove engine cover and front console.
3. Remove air horn and air intake hose. Then remove air horn rubber gasket from intake manifold.
4. Remove nuts and washers attaching harness brackets (Figure 2-36) and barometric pressure sensor bracket to intake manifold studs.
5. Remove CDR valve and hose.
6. Remove nut and washer attaching heater water valve to manifold. Then move bracket, valve, and hose aside.
7. Remove glow plug relay bracket nuts and washers, and move relay, wires, and cables aside.
8. Remove nuts attaching injector line brackets to manifold studs.

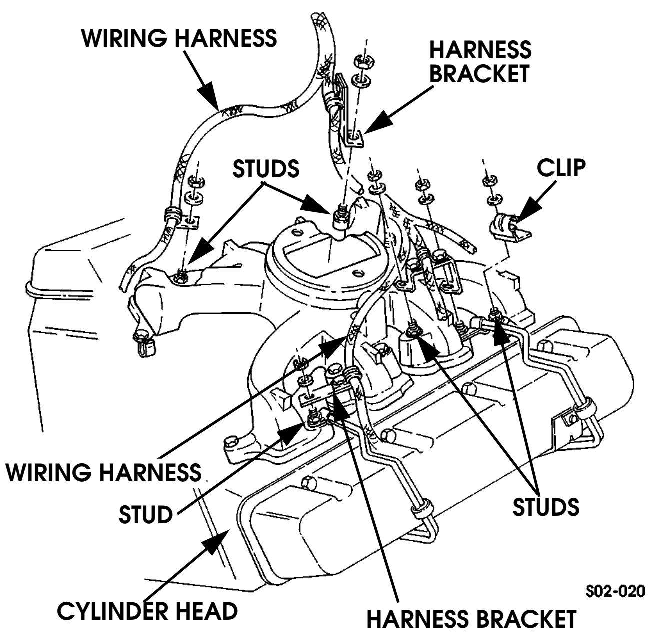

Figure 2-36: Wire Harness Attachment

9. Remove studs and bolts attaching intake manifold to cylinder heads (Figure 2-37).
10. Tap manifold with rubber mallet to loosen it. Then move manifold rearward and remove it through engine cover opening in passenger compartment.
11. Remove manifold gaskets. If gaskets are stuck on heads, cover intake openings in heads with shop towels. Then remove gaskets with scraper and solvent if necessary.
12. If intake manifold is only being removed for access to another component, clean old gasket material from manifold if necessary.

Cleaning/Inspection/Replacement

Clean the manifold with standard parts cleaning solvents and dry with compressed air. Stubborn carbon deposits can be removed with carb cleaner, or a gasket remover product.

Inspect the manifold for cracks, flange damage, or evidence of porosity. Replace the manifold if necessary.

If the manifold will be reused, smooth off any burrs or nicks on the gasket surfaces. Use an oil stone or fine tooth file for this purpose.

If a new manifold will be installed, be sure to either transfer the old, or install a new CDR valve hose nipple before hand.

Check the manifold fastener threads in each cylinder head. Clean the threads with a tap if necessary.

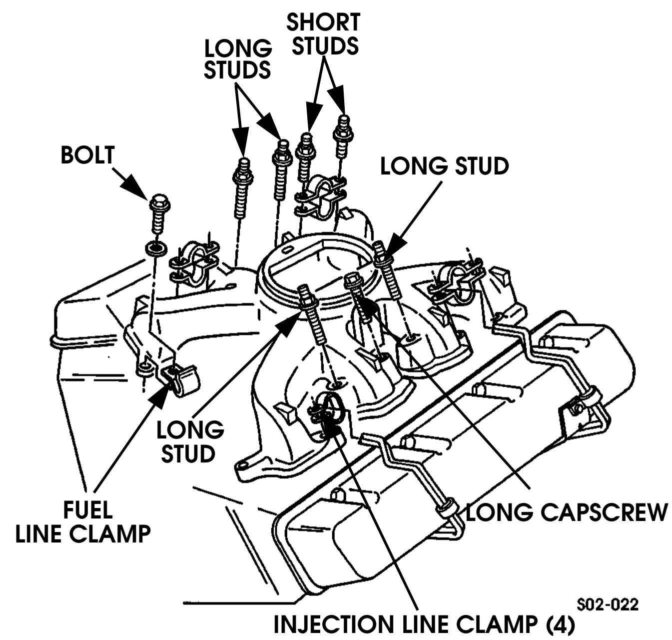

Figure 2-37: Intake Manifold Stud/Bolt Locations

Manifold Installation

1. Verify that cylinder head intake port gasket surfaces are clean and smooth. Smooth any nicks or burrs with an oil stone. Then re-clean area. Remove shop towels from intake ports afterward.
2. Position new intake manifold gasket on each cylinder head (Figure 2-38). A gasket dressing, such as Permatex High Tack, can be used to hold gaskets in place during manifold installation.
3. Align and position intake manifold on gaskets. Then install and finger tighten 2-3 studs to hold manifold in place.
4. Verify correct manifold and gasket seating and position. Adjust position if necessary.
5. Install remaining manifold attaching bolts and studs. Tighten bolts and studs in sequence (Figure 2-39). This is necessary to avoid leaks, or cracking the manifold. Correct stud and bolt is set to 31 lb-ft (42 N•m) torque.
6. Install wire harness and barometric pressure sensor brackets on manifold studs. Tighten bracket attaching nuts to 28-30 lb-ft (38-41 N•m) torque.
7. Install glow plug relay. Connect relay wires and cables (if disconnected).
8. Install fuel injector line clamps on manifold studs and secure with washers and nuts. Tighten clamp nuts to 28-30 lb-ft (38-41 N•m) torque.
9. Attach heater water valve bracket to manifold stud and secure with washer and nut. Tighten nut to 28-30 lb-ft (38-41 N•m) torque.
10. Install CDR valve and hose.

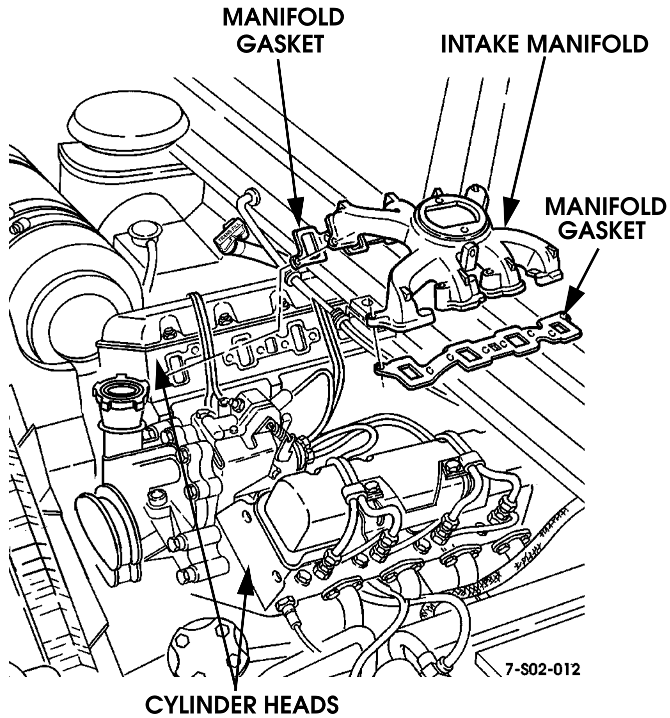

Figure 2-38: Intake Manifold and Gaskets

11. Install rubber gasket on intake manifold air inlet flange.
12. Position air horn on intake manifold and gasket. Install flat washer and rubber washer on each air horn bolt. Then apply sealer to bolt threads before installing them. Tighten bolts to 15-19 lb-ft (20-26 N•m) torque.
13. Connect air intake hose to air horn and air cleaner. Tighten clamp screws to 44-53 lb-in (5-6 N•m) torque.
14. Install engine cover and front console.
15. Connect battery negative cables.

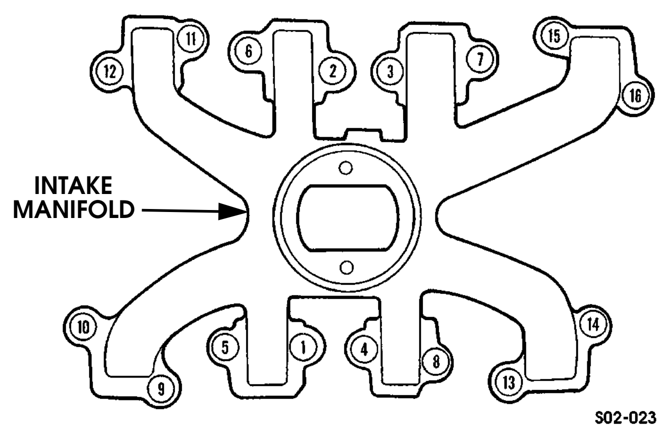

Figure 2-39: Manifold Bolt and Stud Tightening Sequence

ROCKER ARM COVER SERVICE

Right Side Cover Removal

1. Remove front console and engine cover.
2. Remove air horn and inlet hose. Then remove air cleaner assembly.
3. Drain radiator.
4. Remove surge tank.
5. Disconnect and remove water control valve, hoses, and bracket.
6. Remove CDR valve and hose.
7. Remove bolt that attaches transmission fill tube to cylinder head.
8. Remove brackets attaching electrical wire harnesses and sensors to intake manifold.
9. Remove nuts attaching fuel injector line clamps to intake manifold studs.
10. Remove intake manifold and gaskets. Cover cylinder head intake ports to prevent dirt entry.
11. Disconnect lines at fuel injectors. Cover injectors and cap lines immediately to prevent dirt entry.
12. Loosen lines at fuel injection pump.
13. Remove studs and bolts attaching rocker arm cover to cylinder head (Figure 2-40).
14. Tap rocker arm cover with rubber mallet to break sealer head and loosen cover. Do not pry cover loose.
15. Move fuel injector lines aside (rotate them out of way). Or, remove necessary injector lines if unable to move aside.

CAUTION: *Do not bend the fuel lines. The internal coating could fracture, peel off, and clog the injectors.*

16. Remove rocker arm cover.
17. Scrape old silicone sealer off cover. Then clean cover with parts cleaning solvent. Final-clean sealing surfaces with brake or electrical contact cleaner. This is necessary to remove residue left from cleaning solvent and ensure proper adhesion of new sealer.
18. Clean gasket surfaces of intake manifold and cylinder head. Be sure surfaces are clean and smooth. Remove minor nicks or scratches with 220 grit emery or paper.

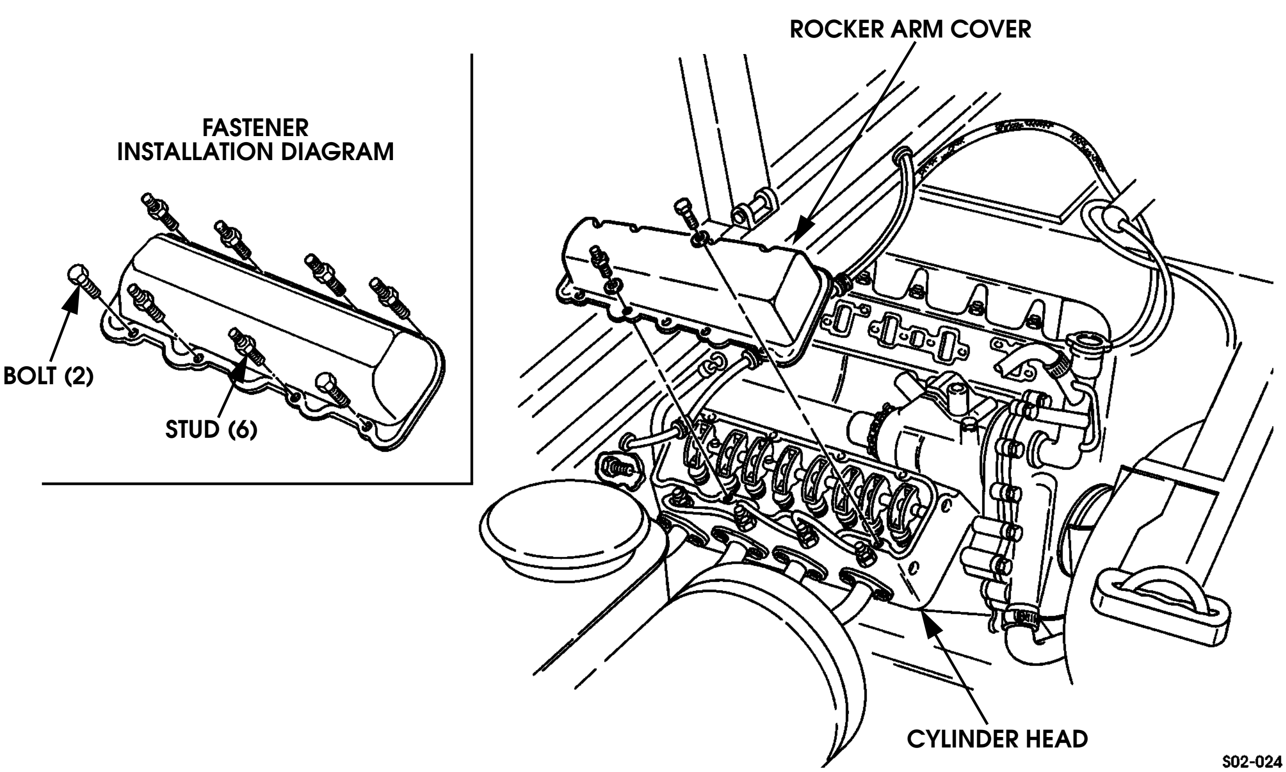

Figure 2-40: Rocker Arm Cover Removal/Installation (Right Side)

Right Side Cover Installation

1. Clean cover mounting surface of cylinder head with brake or contact cleaner and shop towels. This product will remove residue from the surface and ensure proper adhesion of new sealer.
2. If new rocker arm cover is being installed, clean seal surface with brake or contact cleaner.
3. Apply sealer to rocker arm cover sealing surface. Make sealer bead 3/16 in. wide by 1/16 in. thick. Use Loctite 599, Permatex Ultra Copper, or similar quality silicone sealer. Allow sealer to cure slightly (skin over) before installation.
4. Align and install rocker arm cover on cylinder head.
5. Install rocker arm cover attaching studs and bolts (Figure 2-40). Tighten cover fasteners evenly to 13-25 lb-ft (18-34 N•m) torque. Start at center and work toward ends when tightening.
6. Remove protective covering from injectors and lines. Then connect lines to injectors and to pump, if removed. Tighten line fittings to 20-22 lb-ft (27-30 N•m) torque.
7. Install intake manifold and new gaskets. A gasket dressing such as, perfect seal, or Permatex High Tack, can be used to hold gaskets in place. Tighten manifold bolts and studs to 31 lb-ft (42 N•m) torque in sequence (Figure 2-39:).
8. Install fuel injector line clamps and wire harness brackets on manifold studs. Tighten retaining nuts to 26 lb-ft (35 N•m) torque.
9. Install CDR valve and hose.
10. Install bolt that secures transmission fill tube to cylinder head.
11. Install water control valve and hoses.
12. Install surge tank.
13. Refill cooling system
14. Start engine and check cover for leaks. Then bleed each injector by loosening fuel line fitting (at injector), just enough to purge any trapped air. Stop engine when complete.
15. Install air cleaner, inlet hose, and air horn.
16. Install engine cover and front console.
17. Top off engine coolant and oil levels if required.

Left Side Cover Removal

1. Remove front console and engine cover.
2. Drain engine coolant.
3. Remove driver side splash shield.
4. Remove air inlet hose and air horn.
5. Disconnect radiator upper hoses at thermostat housing and radiator. Then remove hoses and inlet tube as assembly.
6. Disconnect fuel pump, remove it from clamp and move pump aside for working clearance.
7. Remove nuts attaching harness and sensor brackets to intake manifold studs.
8. Remove nuts attaching water valve and bracket. Then move valve and bracket aside for working clearance.
9. Remove nuts and washers attaching fuel injection line clamps to manifold studs. Remove and retain clamps and fasteners.
10. Remove studs and bolts attaching intake manifold to cylinder heads. Remove manifold and gaskets. Cover cylinder head intake ports with shop towels to prevent dirt entry (Figure 2-41).
11. Remove screws attaching oil dipstick and tube to cover. Then rotate tube away from engine for working clearance.
12. Disconnect fuel lines at driver side injectors. Then loosen (or remove) lines at pump. Rotate lines aside for working clearance. Cover lines and injectors to prevent dirt entry.

***CAUTION:** Do not bend the fuel injector lines. The internal coating could fracture, peel off, and clog the injectors.*

13. Remove rocker arm cover attaching bolts and studs. Then tap cover with rubber mallet to break sealer bead. Do not pry cover loose.
14. Remove rocker arm cover.
15. Clean cover in parts cleaning solvent and scrape all traces of old silicone sealer off cover seal surfaces. Final clean cover seal surfaces with brake or contact cleaner. This is necessary to remove residue from cleaning solvent, and ensure proper adhesion of new sealer.
16. Clean gasket surfaces of intake manifold and cylinder heads. Be sure surfaces are clean and smooth. Remove minor nicks or scratches with 220 grit emery or paper.

Left Side Cover Installation

1. Clean cover mounting rails on cylinder head with brake or contact cleaner and shop towels. This product will remove residue from surface and ensure proper adhesion of new sealer.
2. If new rocker arm cover is being installed, clean seal surface with brake or contact cleaner.
3. Apply sealer to rocker arm cover sealing surface. Make sealer bead 3/16 in. wide by 1/16 in. thick. Use Loctite 599, Permatex Ultra Copper, or similar quality silicone sealer. Allow sealer to cure slightly (skin over) before installation.
4. Align and install rocker arm cover on cylinder head.
5. Install rocker arm cover attaching bolts and studs (Figure 2-40). Tighten cover fasteners evenly to 13-25 lb-ft (18-34 N•m) torque (Figure 2-41).
6. Remove protective covering from injectors and lines. Then connect lines to pump and injectors. Tighten line fittings to 20-22 lb-ft (27-30 N•m) torque.
7. Install intake manifold and new gaskets. A gasket dressing such as Perfect Seal, or Permatex High Tack, can be used to hold gaskets in place. Tighten manifold bolts and studs to 31 lb-ft (42 N•m) torque in sequence shown (Figure 2-39).
8. Install fuel injector line clamps and harness and sensor brackets on manifold studs. Tighten retaining nuts to 26 lb-ft (35 N•m) torque.
9. Attach oil dipstick and tube to cover bracket.
10. Attach water control valve bracket to manifold.
11. Install and connect fuel pump.
12. Connect radiator upper hoses and inlet tube.
13. Refill engine cooling system.
14. Install air inlet hose and air horn.
15. Start engine and check cover for leaks. Then bleed each injector by loosening fuel line fitting (at injector), just enough to purge trapped air. Stop engine when complete.
16. Install engine cover and console.
17. Top engine coolant and oil levels if required.

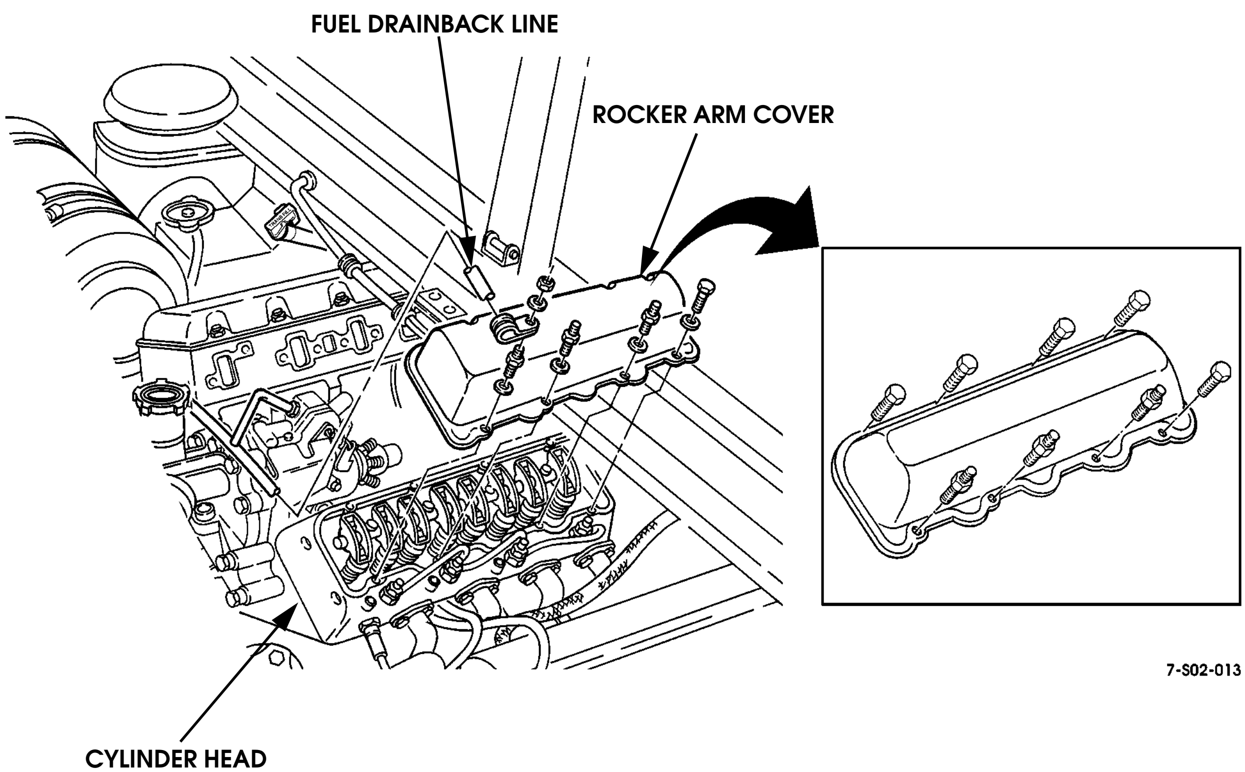

Figure 2-41: Left Side Rocker Arm Cover

ROCKER ARM, SHAFT, AND PUSHROD SERVICE

Removal

1. Remove one or both rocker arm covers as needed. Refer to procedures in this section.
2. Remove bolts and retainers that attach rocker arm shafts to cylinder head (Figure 2-42). Note position of bolts for installation reference. Bolts must be reinstalled in same threaded holes.
3. Lift and remove each rocker arm and shaft assembly (Figure 2-42). Do not intermix assemblies if they will be reused. Each assembly must be reinstalled in same position.
4. Remove pushrods in sequence. Keep them in order of removal. Also note which end of push rod goes in rocker arm. This end of rod is heat treated and usually identified with a paint mark

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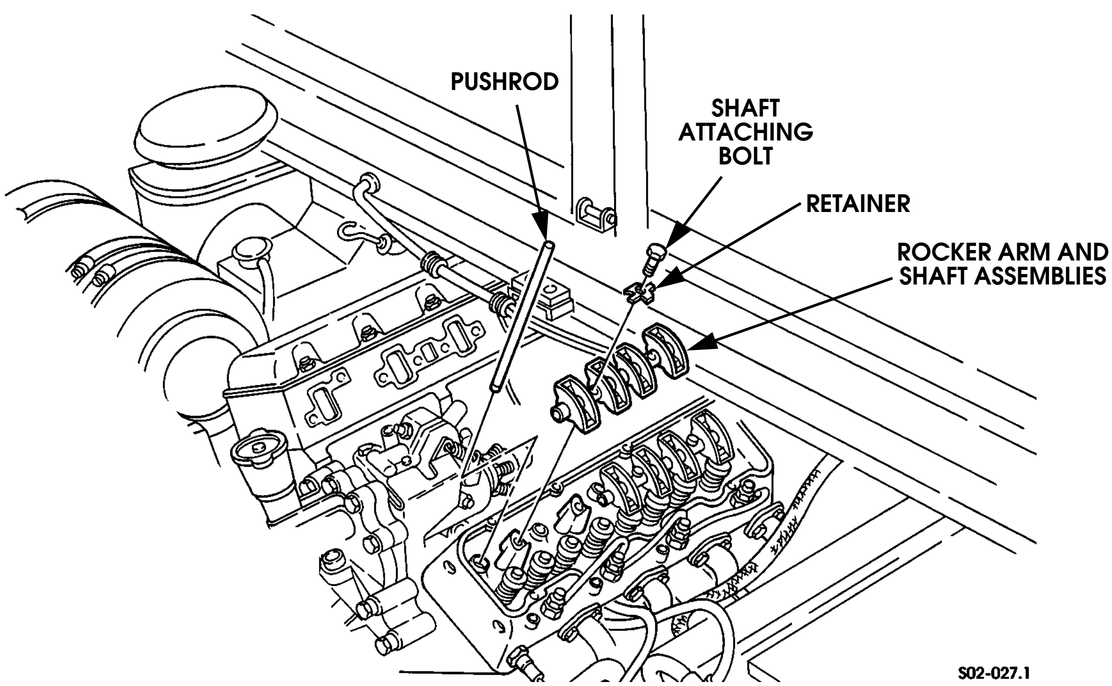

Figure 2-42: Rocker Arm Shafts and Pushrods

Cleaning and Inspection

Clean the valve train components in parts cleaning solvent. Carb cleaner or a spray type gasket remover can be used to remove stubborn deposits.

Mark position of the rocker arms on the shafts. Remove the rocker arm retainers with pliers. Then remove the arms and examine the shafts for wear, grooving, or surface cracks. Check the rocker arms for cracks at the shaft bores and for wear at the valve and push rod contact points. Replace worn, or damaged parts as needed.

Check the pushrods for wear, or distortion. Replace any push rod exhibiting wear (at either end), or if bent, or kinked.

NOTE: The rocker arm end of each pushrod is identified with a paint stripe. The ball at this end is also coated or heat treated giving it a distinctive copper color.

Installation

1. Lubricate all parts with engine oil, or with a quality assembly lube.
2. Install pushrods in same sequence as when removed. Verify that heat treated or coated end is facing up toward rocker arm.
3. Assemble rocker arms and shaft if necessary. Secure arms with new retainers but be sure reused arms are installed on same shafts and in same position. Do not intermix parts.
4. Index crankshaft and pistons for rocker arm shaft installation as follows:
   a. Position breaker bar and socket on crankshaft damper bolt. Do not use starter to rotate crankshaft. Turn shaft with hand tools only.
   b. Rotate crankshaft counterclockwise, and align mark on torsional damper with “O” mark on front cover timing tab.
   c. Rotate engine counterclockwise an additional 3 1/2 inches (89 mm), measured at mark on torsional damper. Damper mark should align with water pump first, lower attaching bolt at this point (Figure 2-51).
5. Align and install rocker arm and shaft assemblies (Figure 2-42). Be very sure pushrods are seated in lifters and in rocker arms.
6. Install rocker arm shaft retainers and bolts. Tighten bolts in small increments until snug, with socket and ratchet or nut runner.

CAUTION: *Do not use an air wrench to tighten the bolts. In addition, stop tightening if the bolts become hard to turn before they are seated. If this condition occurs, the crankshaft and pistons are not properly indexed, allowing the valves to contact the pistons.*

7. Verify that pushrods are properly seated in rocker arms and lifters. Then final-tighten rocker arm shaft bolts to 41 lb-ft (56 N•m) torque.
8. Install rocker covers and intake manifold as described in this section.

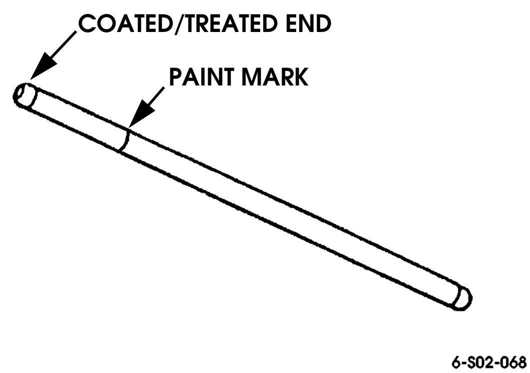

Figure 2-43: Pushrod I.D.

EXHAUST MANIFOLDS (NA DIESEL)

WARNING: To avoid injury, do not touch hot exhaust system components.

Removal (Passenger Side)

1. Remove front console and engine cover for access to manifold rear bolts and heat shields.
2. Remove bolt attaching transmission filler tube to cylinder head.
3. Working under vehicle, remove bolt attaching transmission filler tube to transmission case. Then remove filler tube. Cover tube opening in case to prevent dirt entry.
4. Remove heat shield guard.
5. Remove socket head bolts attaching heat shield to cylinder head and remove shield. Bolts are accessible from under vehicle.
6. Remove bolts/nuts attaching exhaust manifold to crossover pipe (Figure 2-44).
7. Remove socket head bolts attaching manifold to cylinder head and remove manifold and gasket. Also remove crossover pipe gasket if it remained in manifold.
8. Clean cylinder head exhaust port surfaces with wire brush and scraper. If manifold will be reused, clean manifold gasket surfaces as well.

Installation (Passenger Side)

1. Position new gasket on manifold. Insert one or two socket head bolts in manifold to hold new gasket in place.
2. Position manifold and gasket on cylinder head. Tighten previously installed screws finger tight to hold manifold in place.
3. Verify that gasket is properly positioned and install remaining manifold attaching bolts. Tighten bolts to 18-25 lb-ft (24-34 N•m) torque.
4. Install heat shield. Tighten heat shield bolts to 18-25 lb-ft (24-34 N•m) torque.
5. Install gasket in crossover pipe. Then connect crossover pipe to exhaust manifold. Tighten attaching bolts/nuts to 37 lb-ft (50 N•m) torque.
6. Install heat shield guard.
7. Install transmission filler tube.
8. Install engine cover and front console.

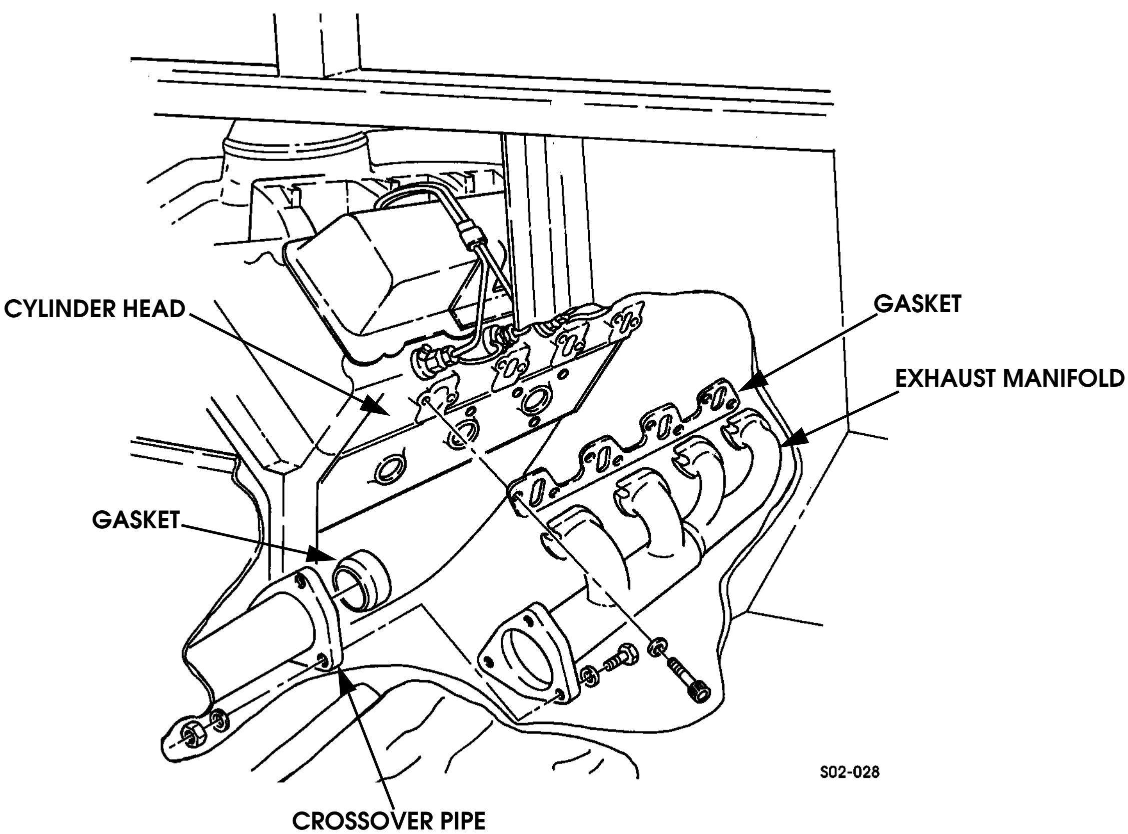

Figure 2-44: Exhaust Manifold Removal/Installation (Passenger Side)

Removal (Driver Side)

1. Remove front console and engine cover for access to manifold rear bolts.
2. Remove bracket attaching engine oil dipstick tube to rocker cover. Then rotate tube aside for working clearance.
3. Disconnect exhaust manifold from crossover pipe (Figure 2-45).
4. Remove socket head bolts that attach exhaust manifold to cylinder head and remove manifold and gaskets.
5. Clean cylinder head exhaust port surfaces with wire brush and scraper. If manifold will be reused, clean manifold gasket surfaces as well.

Installation (Driver Side)

1. Position new gasket on manifold. Insert one or two bolts in manifold to hold new gasket in place.
2. Position manifold and gasket on cylinder head. Tighten previously installed bolts finger tight to manifold in place.
3. Verify that gasket is properly positioned and install remaining manifold attaching bolts. Tighten bolts to 18-25 lb. ft. (24-34 N•m) torque.
4. Install new gasket in crossover pipe. Then connect pipe to exhaust manifold. Tighten attaching nuts/bolts to 37 lb-ft (50 N•m) torque.
5. Connect oil dipstick tube to bracket on rocker cover.
6. Install engine cover and front console.

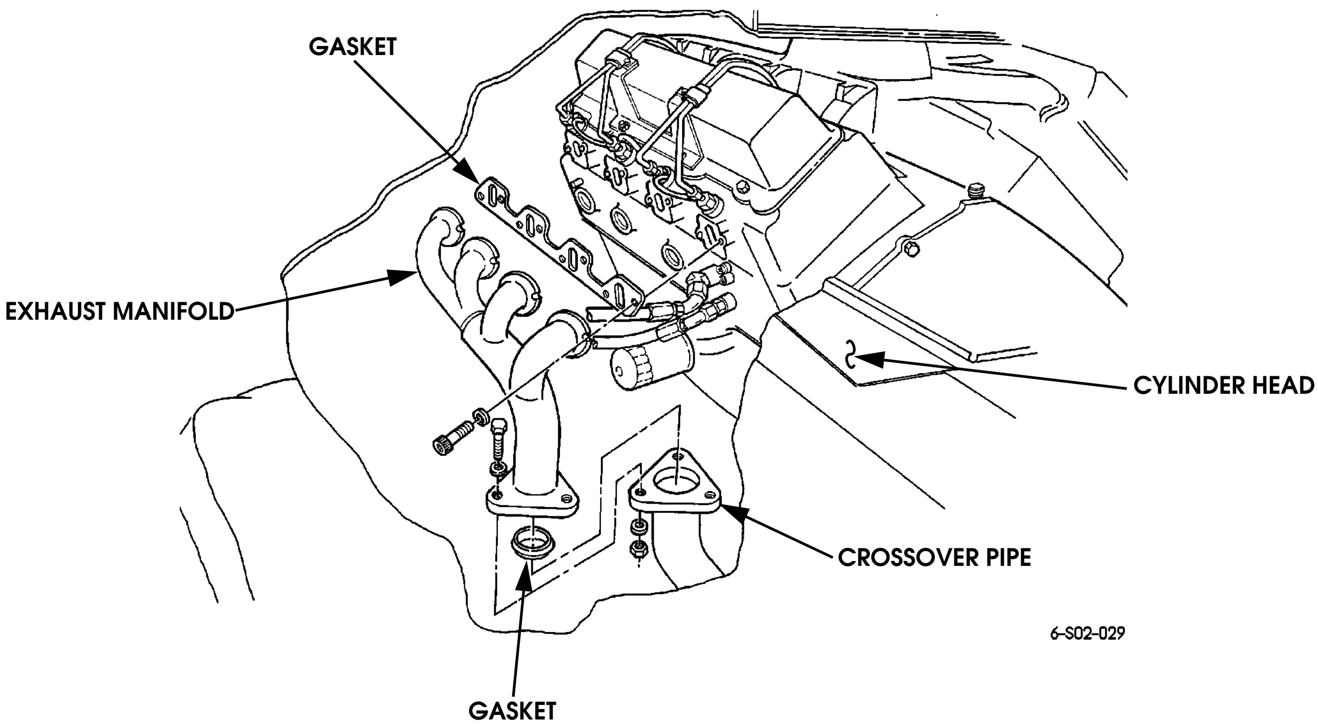

Figure 2-45: Manifold Removal/Installation (Driver Side)

EXHAUST MANIFOLD SERVICE

Right Exhaust Manifold Heat Shield Replacement

Removal

1. Remove console and engine access cover.
2. Remove right exhaust manifold rear heat shield.
3. Loosen screws securing heat shield and exhaust manifold to cylinder head (Figure 2-46).
4. Remove shield attaching locknut, capscrew, washer, and remove heat shield.
5. Position heat shield on crossover pipe and exhaust manifold.
6. Install heat shield and exhaust manifold on cylinder head and tighten capscrews to 25 lb-ft (34 N•m).
7. Install heat shield on exhaust manifold and crossover pipe. Tighten bolts to 37 lb-ft (50 N•m).
8. Install right exhaust manifold rear heat shield.
9. Install engine access cover and console.
10. Start engine and check for exhaust leaks.

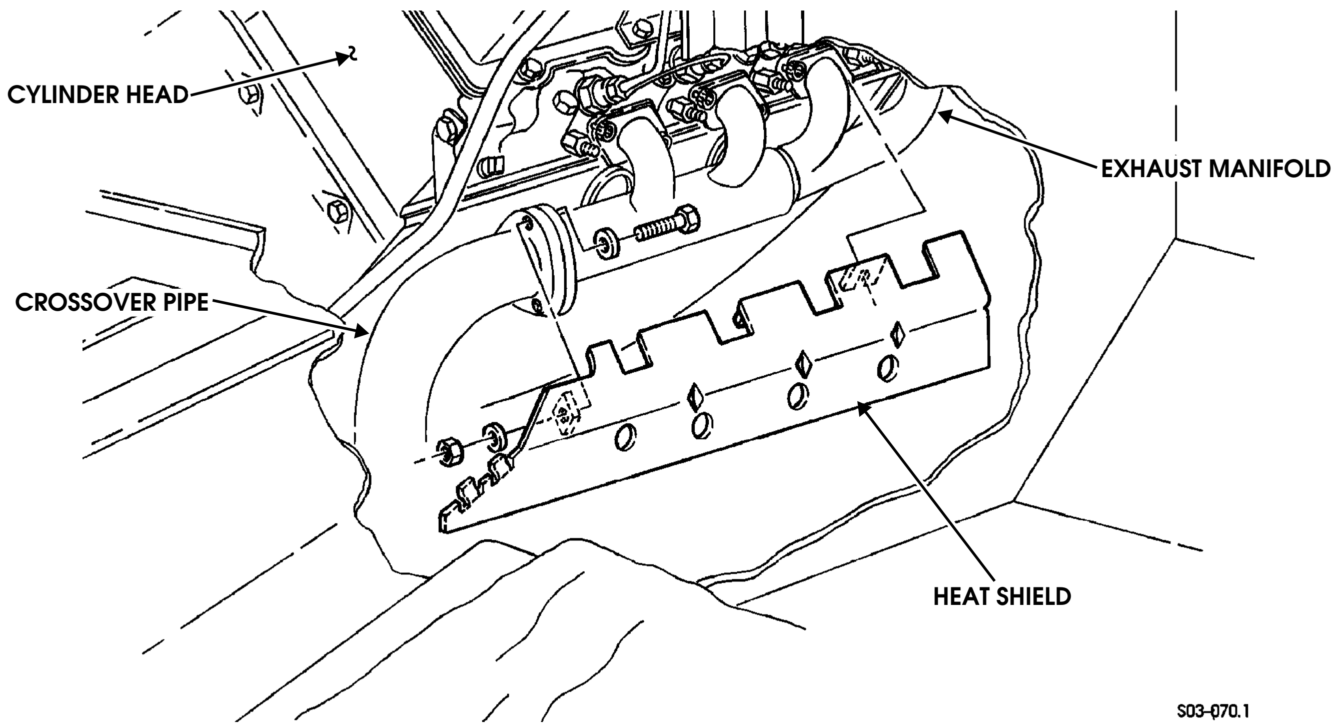

Figure 2-46: Right Exhaust Manifold Heat Shield (Non-Turbo Diesel Shown)

Right Exhaust Manifold Rear Heat Shield Replacement

1. Remove console and engine access cover.
2. Detach rear heat shield from transmission fill tube clamp (Figure 2-47).
3. Remove rear heat shield.
4. Install rear heat shield.
5. Attach rear heat shield to transmission fill tube clamp.
6. Install engine access cover and console.

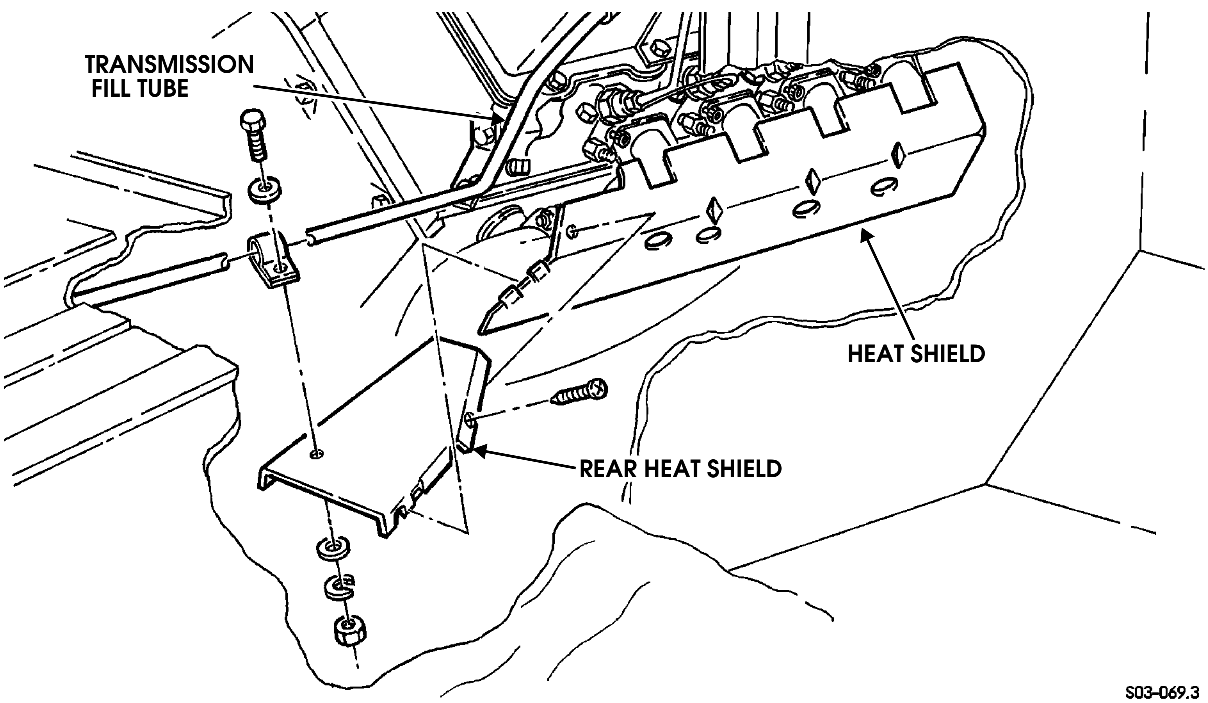

Figure 2-47: Right Rear Heat Shield (Non-Turbo Diesel Shown)

CYLINDER HEAD AND GASKET SERVICE

Cylinder Head (Left Side)

Removal

1. Remove hood with aid of helper as follows:
   - Disconnect hood harness
   - Remove harness dip at driver side frame rail bracket
   - Remove bolts that attach prop rod bracket to driver side frame bracket
   - Remove hood hinge pins
   - Lift and remove hood
2. Remove front console and engine cover.
3. Drain radiator and disconnect batteries.
4. Disconnect and cover fluid cooler lines at transmission and power steering coolers.
5. Remove driver side splash shield.
6. Remove serpentine belt and crankshaft pulley.
7. Remove air intake hose and air horn.
8. Remove A/C compressor, power steering pump, and mounting bracket as assembly. Position A/C compressor to side to allow access to rocker cover and cylinder head.
9. Remove oil dipstick tube, water crossover, thermostat housing, coolant hoses, and radiator upper hose inlet tube.
10. Disconnect or remove (Figure 2-48):
    - Barometric pressure sensor and bracket
    - Heater water valve bracket
    - Wire harness clips and brackets
    - Ground wires/cables at rear of cylinder head
    - Temperature sender wire
    - Fuel pump
    - Speed sensor at oil pump drive
    - Glow plugs
11. Remove fuel injector line clamps. Retain clamps and attaching washers and nuts.

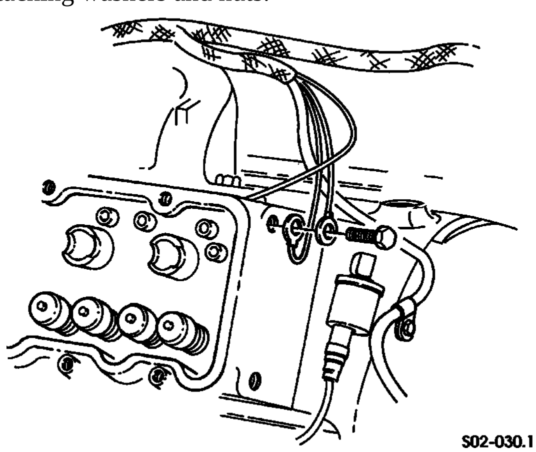

Figure 2-48: Ground Connections at Rear of Cylinder Head

12. Remove intake manifold and gaskets. Note attaching stud and bolt locations for reinstallation reference.
13. Disconnect driver side fuel injector lines at pump and injectors and remove lines. Cover injectors with duct tape to prevent dirt entry.
14. Remove bolts/nuts attaching crossover pipe to exhaust manifold.
15. Remove rocker arm cover. Tap cover with rubber mallet to loosen. Do not pry on cover to remove.
16. Remove rocker arm shaft bolts and retainers. Remove arm and shaft assemblies individually. Note original position for assembly reference.
17. Remove pushrods. Note position of rods for installation reference as they must be installed in original position.
18. Remove cylinder head bolts. Discard bolts as they are not reusable.
19. Remove cylinder head (Figure 2-49) with aid of helper. Or use chain hoist, portable hoist, or similar device to lift and remove cylinder head.

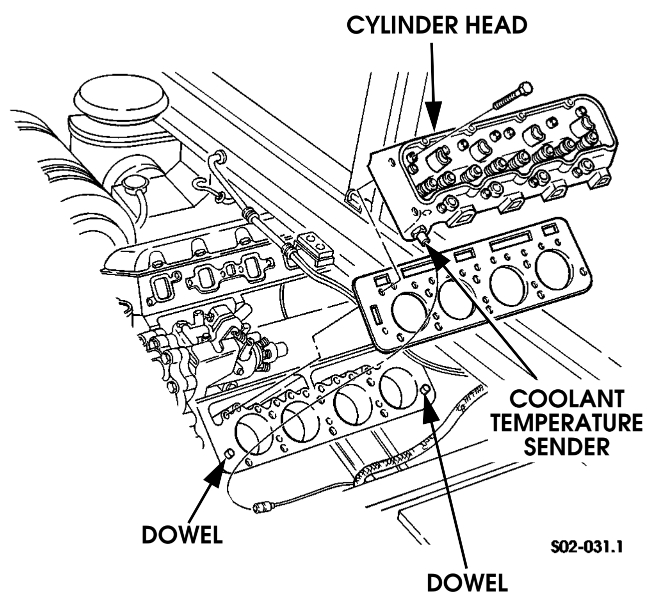

Figure 2-49: Cylinder Head and Gasket Removal/Installation

20. Remove cylinder head gasket. Discard gasket; it is not reusable.
21. Refer to overhaul section if head, valves, valve seats, springs, or seals require service. Check for warpage. If head was only removed to replace blown gasket, proceed to installation procedure.
22. Cover cylinder bores and lifter valleys with shop towels.

Cylinder Head (Left Side)

Installation

1. Clean gasket surface of cylinder block with scraper if necessary. Then remove protective covering from cylinder and lifter valleys.
2. Wipe cylinder block surface clean with solvent and cloth.
3. Position new head gasket on cylinder block. Be sure gasket is aligned on cylinder block dowels.

CAUTION: *Install the new gasket dry. Do not use any type of sealer on the gasket. Sealer can prevent proper seating and result in coolant leaks.*

4. Install cylinder head with aid of helper or with hoist. Be sure head is properly seated on cylinder block dowels.
5. Install and tighten new cylinder head bolts as follows:
   a. Apply light coat of Teflon Pipe Sealant (PST) to threads and under heads of new bolts.
   b. Install and tighten bolts to initial torque of 20 lb-ft (27 N•m). Follow tightening sequence (Figure 2-50).
   c. Tighten bolts to 50 lb-ft (68 N•m) torque evenly and in sequence shown (Figure 2-50).
   d. Final-tighten bolts an additional 90° (1/4-turn).
6. Install pushrods. Verify that they are in same sequence as when removed. Also be sure heat treated (copper color) end is toward rocker arm.

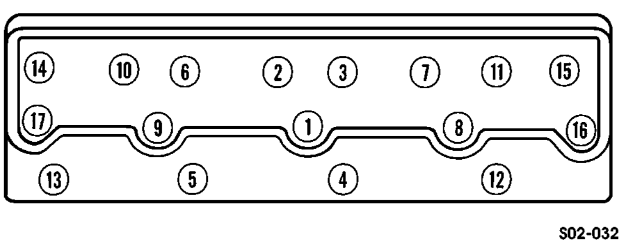

Figure 2-50: Cylinder Head Bolt Tightening Sequence

7. Index crankshaft and pistons for rocker arm and shaft installation as follows:
   a. Position breaker bar and socket on crankshaft damper bolt. Do not use starter motor to rotate crankshaft. Use socket and wrench on damper bolt only.
   b. Rotate crankshaft counterclockwise and align mark on torsional damper with "O" (TDC) mark on front cover timing tab.
   c. Index crankshaft by rotating it counterclockwise an additional 3-1/2 inches (89 mm). At this point, mark on damper will be roughly aligned with first lower water pump bolt (Figure 2-51).
8. Install rocker arm and shaft assemblies. Be sure pushrods are properly seated in lifter and rocker arms. Do this before tightening shaft retainer bolts. Install shaft retainers and bolts. Tighten bolts evenly to 41 lb-ft (56 N•m) torque.

CAUTION: *Stop tightening the shaft bolts if they become hard to turn before fully seated.*

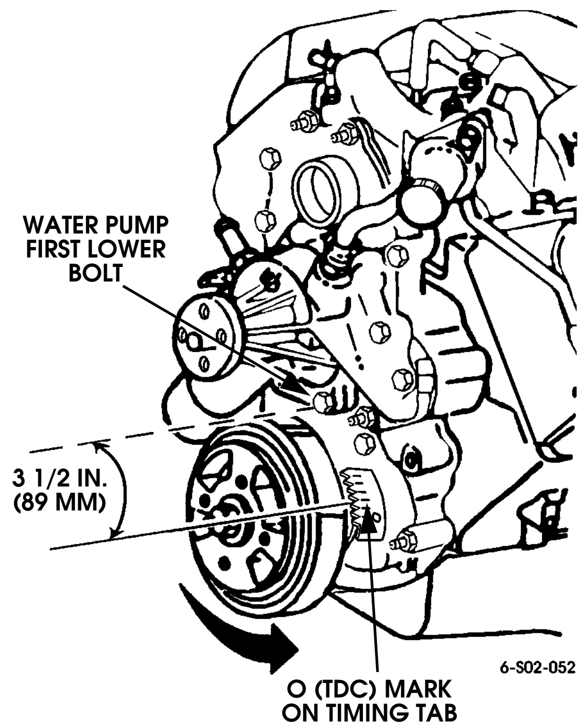

Figure 2-51: Crankshaft Indexing Position

9. Clean cylinder head and rocker cover sealing surfaces thoroughly. Then finish-clean with brake or contact cleaner and shop towels to remove cleaning residue. This is necessary to ensure proper adhesion of sealer.
10. Apply sealer to rocker arm cover (Figure 2-52). Make sealer bead 3/16 inch wide by 1/16 inch thick. Use RTV-type silicone, adhesive-sealer such as Loctite 592, or Permatex High Temp, Ultra Copper, or Ultra Blue. Allow sealer to cure slightly (skin over) before installing cover.

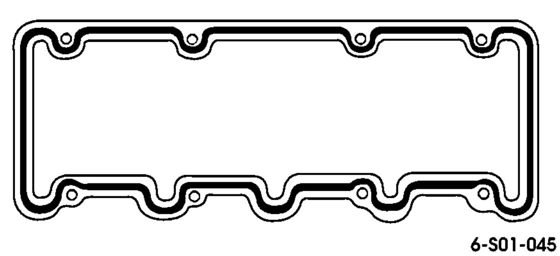

Figure 2-52: Applying Sealer to Rocker Arm Cover

11. Align and install rocker cover. Tighten cover bolts to 16 lb-ft (22 N•m) torque.
12. Install fuel injector lines. Tighten line fittings at pump and injector to 19 lb-ft (26 N•m) torque.
13. Install intake manifold and gaskets. Tighten manifold studs/bolts to 31 lb-ft (42 N•m) torque. Also install turbocharger, if equipped.
14. Install engine oil dipstick tube, if removed, and connect tube to rocker cover bracket.
15. Install water crossover and thermostat housing. Use new gaskets on crossover and tighten attaching bolts to 25-37 lb-ft (34-50 N•m) torque.
16. Install fuel injector line clamps, washers, and nuts. Tighten nuts to 26 lb-ft (35 N•m) torque.
17. Install or connect:
    - glow plugs
    - speed sensor (at oil pump drive)
    - fuel pump
    - temperature sender wire (at head)
    - ground wires/cables (at rear of head)
    - wire harness clips and brackets
    - water valve and bracket
    - barometric pressure sensor and bracket
18. Install A/C compressor, power steering pump, and pump mounting bracket.
19. Install serpentine belt.
20. Install air intake hose and air horn. Be sure gasket is seated on manifold before tightening air horn bolts.
21. Connect radiator hoses, inlet tube, A/C lines, and fluid cooler lines.
22. Refill engine cooling system.
23. Connect batteries.
24. Start and run engine. Bleed injectors by loosening line fittings just enough to purge air. Then tighten fittings and stop engine.
25. Check and top off engine coolant, engine oil, and transmission fluid as required.

Cylinder Head (Right Side)

Removal

1. Remove front console and engine cover (Figure 2-45).
2. Drain radiator and disconnect batteries.
3. Remove batteries and battery tray.
4. Remove passenger side splash shield.
5. Remove air cleaner, inlet hose, and air horn.
6. Remove surge tank and water valve and hoses.
7. Remove crossover and thermostat housing, inlet tube, and radiator upper hoses as assembly.
8. Remove serpentine belt.
9. Disconnect and remove alternator, brackets, idler pulley, and tensioner.
10. Disconnect or remove (Figure 2-53):
    - Barometric pressure sensor and bracket
    - Glow plug relay and bracket
    - Engine wire harness clips and ground wires
    - Cold advance/fast idle switch
    - Speed sensor (at oil pump drive)
    - Passenger side glow plugs and glow plug relay
11. Remove fuel injector line clamps, washers, nuts

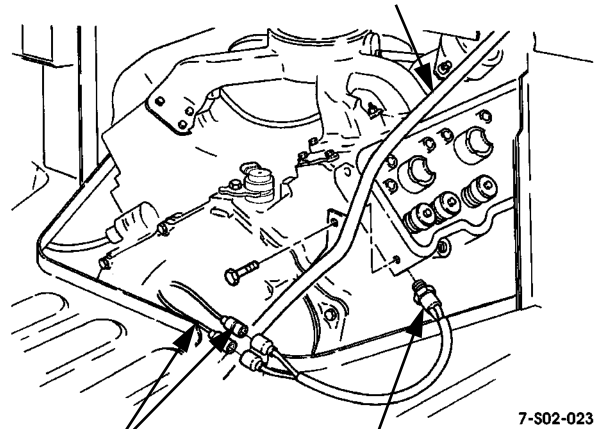

Figure 2-53: Cold Advance/Fast Idle Switch and Harness

12. Remove intake manifold and gaskets. Note attaching stud and bolt locations for installation reference.
13. Disconnect passenger side fuel injector lines at pump and injectors, and remove lines. Cover injectors with duct tape to prevent dirt entry.
14. Remove heat shield and guard. Then remove bolts/nuts attaching crossover pipe to exhaust manifold.
15. Remove rocker arm cover. Tap cover with rubber mallet to loosen. Do not pry on cover to remove.
16. Remove rocker arm shaft bolts and retainers. Remove arm and shaft assemblies individually. Note original position for assembly reference.
17. Remove pushrods. Note position or rods for installation reference as they must be installed in original position.
18. Remove cylinder head bolts. Discard bolts as they are not reusable.
19. Remove cylinder head with aid of helper. Or use chain hoist, portable hoist, or similar device to lift and remove cylinder head.

20. Remove cylinder head gasket. Discard gasket; it is not reusable.

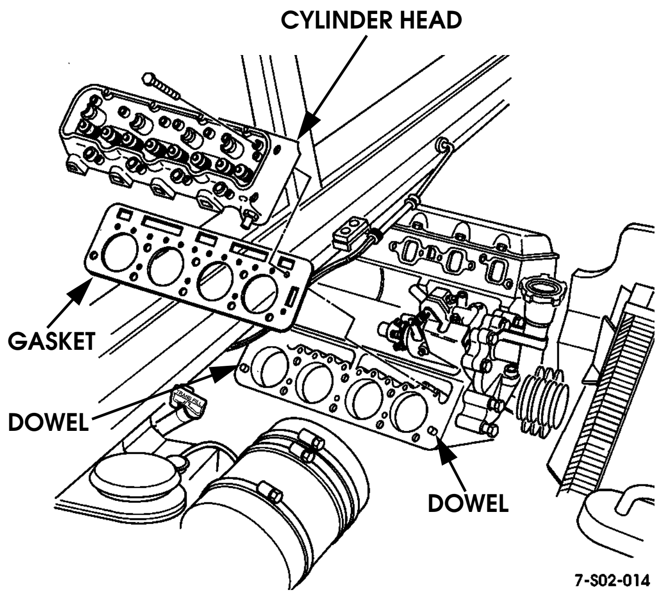

Figure 2-54: Right Side Cylinder Head Removal/ Installation

21. Refer to cylinder head cleaning and inspection information if head, valves, valve seats, springs, or seals require service. Check for warpage. If head was only removed to replace blown gasket, proceed to installation procedure.
22. Cover cylinder bores and lifter valleys with shop towels.

Cylinder Head (Right Side)

Installation

1. Clean gasket surface of cylinder block with scraper if necessary. Scuff sand surface with 180 grit emery or paper to provide better surface for gasket seating. Then remove protective covering from cylinders and lifter valleys.
2. Wipe cylinder block surface clean with solvent and cloth.
3. Position new head gasket on cylinder block. Be sure gasket is aligned on cylinder block dowels.

CAUTION: *Install the new gasket dry. Do not use any type of sealer on the gasket. Sealer can prevent proper seating and result in coolant leaks.*

4. Install cylinder head with aid of helper or with hoist.
5. Install and tighten new cylinder head bolts as follows:
   a. Apply light coat of sealer, such as Loctite Pipe Sealant w/Teflon, to thread and under heads of new bolts.
   b. Install and tighten bolts to initial torque 20 lb-ft (27 N•m). Follow tightening sequence shown (Figure 2-50).
   c. Tighten bolts to 50 lb-ft (68 N•m) torque evenly and in sequence shown (Figure 2-50).
   d. Final-tighten bolts an additional 90° (1/4-turn).
6. Install pushrods. Verify that they are in same sequence as when removed. Also be sure heat treated end is toward rocker arm.
7. Index crankshaft and pistons for rocker arm and shaft installation as follows:
   a. Position breaker bar and socket on crankshaft damper bolt. Do not use starter motor to rotate crankshaft. Use hand tools only.
   b. Rotate crankshaft counterclockwise and align mark on torsional damper with “O” (TDC) mark on front cover timing tab (Figure 2-51).
   c. Index crankshaft by rotating it counterclockwise an additional 3-1/2 inches (89 mm). At this point, mark on damper will be roughly aligned with first lower water pump bolt (Figure 2-51).
8. Install rocker arm and shaft assemblies. Be sure pushrods are properly seated in lifters and rocker arms. Do this before tightening shaft retainer bolts. Install shaft retainers and bolts. Tighten bolts evenly to 41 lb-ft (56 N•m) torque.

CAUTION: *Stop tightening the shaft bolts if they become hard to turn before they are fully seated. Check for misalignment or unseated push rods.*

9. Clean cylinder head and rocker cover sealing surfaces thoroughly. Then finish-clean with brake or contact cleaner and shop towels to remove residue. This is necessary to ensure proper seal adhesion.
10. Apply sealer to rocker arm cover. Make sealer bead 3/16 inch wide by 1/16 inch thick. Use RTV-type silicone, adhesive-sealer such as Loctite 592, or Permatex High Temp, Ultra Copper, or Ultra Blue. Allow sealer to cure slightly (skin over) before installing cover.
11. Align and install rocker cover. Tighten cover bolts to 16 lb-ft (22 N•m) torque.
12. Install fuel injector lines. Tighten line fittings at pump and injector to 19 lb-ft (26 N•m) torque.
13. Install intake manifold and gaskets. Tighten manifold studs/bolts to 31 lb-ft (42 N•m) torque.
14. Install water crossover and thermostat housing. Use new gaskets on crossover and tighten attaching bolts to 25-37 lb-ft (34-50 N•m) torque.

15. Install or connect:
    - Glow plugs and glow plug relay and bracket
    - Speed sensor (at oil pump drive)
    - Engine harness wires, clips, and brackets
    - Cold advance/fast idle switch
    - Barometric pressure sensor and bracket
    - Water valve bracket
16. Install and attach transmission fill tube.
17. Install heat shield and shield guard. Tighten heat shield bolts to 25 lb-ft (34 N•m) torque.
18. Install support bracket on rear of alternator and mounting bracket. Then install alternator, bracket, and tensioner as assembly. Connect alternator wires afterward.
19. Install vacuum pump.
20. Install serpentine belt.
21. Install surge tank.
22. Install air cleaner, air horn, inlet hose, and shield.
23. Assemble radiator upper hoses and tube and connect to thermostat housing.

NOTE: Check condition of the O-rings on the A/C and oil cooler fittings. Replace the O-rings if cut, worn, or distorted.

24. Connect radiator upper hose, heater hoses, and surge tank hoses.
25. Refill cooling system.
26. Install passenger side splash shield. Then install battery tray and horns (if removed).
27. Install and connect batteries.
28. Top off engine oil and transmission fluid as needed.
29. Start and run engine. Bleed injectors by loosening line fittings just enough to purge any air. Then tighten fittings and stop engine.
30. Top off engine coolant, oil, and transmission fluid as required.

VALVE LIFTER REPLACEMENT

The 6.5L diesel engines are equipped with roller-type hydraulic lifters. The lifters are not repairable. A failed lifter must be replaced as an assembly.

Service access to the lifters requires removal of one or both cylinder heads. Once the head is removed, the lifters can be removed with tool J29834.

Removal

1. Remove one or both cylinder heads as needed. Refer to procedures in this section.
2. Remove bolt attaching guide plate clamp to block and remove clamp (Figure 2-17).

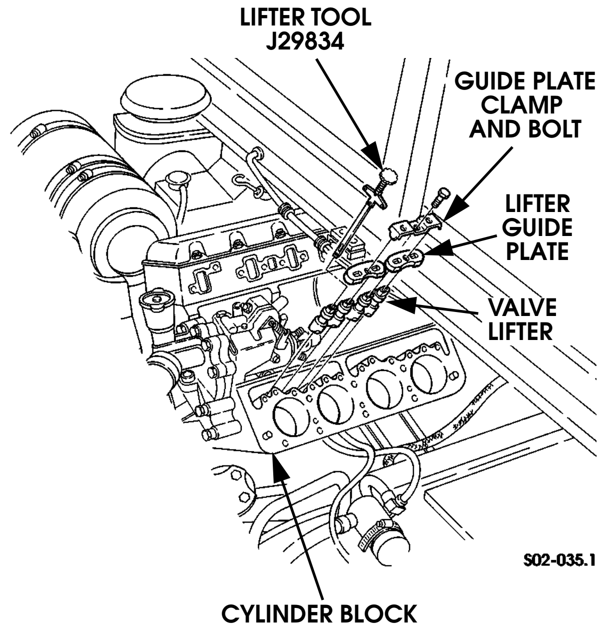

Figure 2-55: Valve Lifter Removal

3. Remove lifter guide plate. Use magnet and long hand held gripper tool to unseat and remove plate.

NOTE: If more than one lifter will be removed, keep the lifters in sequence of removal. It is important that original lifters be re-installed in the same bore. This ensures that the lifter and cam lobe wear-in patterns will match.

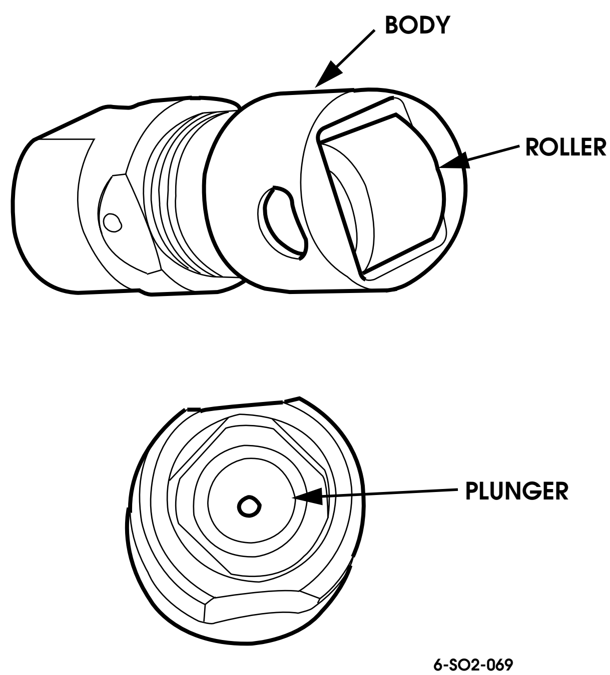

Figure 2-56: Lifter Inspection Points

4. Remove necessary lifters with tool J29834. Insert tool in lifter and push tool plunger downward to expand tool lugs and grip lifter. Then remove lifter with a pull and turn motion.

Cleaning and Inspection

Clean each lifter with a standard parts cleaning solvent. Dry the lifter with low pressure compressed air after cleaning.

Check the lifter body for scoring and wear. Then turn the lifter over and check condition of the roller (Figure 2-56). Replace the lifter if the body is worn or scored, or the roller is scuffed, chipped, loose, or the roller bearings are worn.

Press the lifter plunger down with a push rod and note if the plunger is collapsed. Replace collapsed lifters; they are not salvageable.

Installation

WARNING: The following procedural step requires the use of kerosene or diesel fuel for lifter priming. Since both liquids are flammable, do not prime the lifter near sparks, or an open flame. This is essential to ensure personal safety and injury avoidance.

1. Prime lifters as follows:
   a. Place lifter in container deep enough to submerge lifter. Pad container bottom to avoid damaging roller.
   b. Fill container with clean fresh kerosene or diesel fuel.
   c. Stroke lifter plunger with pushrod to pump fluid through lifter.
   d. Remove lifter from container and wipe it dry with lint free cloth or paper.
   e. Re-prime lifter with clean engine oil.
2. Apply cam lube to lifter roller and bearings.
3. Install lifters as follows:
   a. Insert lifter in bore with tool J29834.
   b. Align lifter and install guide plate on lifters. Be sure lifters and plates are aligned.
   c. Install guide plate clamp and bolt. Tighten bolt to 19 lb-ft (26 N•m) torque.
4. Install cylinder head(s) as described in this section.

CRANKSHAFT BEARING

Replacement In-Vehicle

The crankshaft main and rod bearings can be replaced without having to remove and completely disassemble the engine.

The rod bearings only require that the piston be at or near bottom dead center for access. The main bearings are rotated out of the bearing saddles with a 1/8 in. cotter pin or with equivalent. Procedure is as follows:

1. Disconnect battery cables at batteries.
2. Remove skid plate/underbody protector, if equipped.
3. Drain engine oil from oil pan.
4. Remove oil pan.
5. Remove oil pump.
6. Replace rod bearings as follows:
   a. Rotate crankshaft in counterclockwise direction until connecting rod cap attaching nuts are accessible.
   b. Remove rod cap nuts. Note position of rod cap for installation reference.
   c. Remove rod cap and lower half of bearing. Then push piston upward slightly and remove upper half of bearing.

NOTE: Connecting rod bearings are select fit parts. Record the color code markings on each bearing half for parts ordering and installation reference. Also note if cap was marked with “OS” code which indicates oversize bearings are required.

   d. Clean connecting rod and crankshaft bearing surfaces and dry with lint free shop towels.
   e. Install bearing halves in rod cap and in rod. Be sure bearing locating tangs are seated in cap and rod notches.
   f. Check bearing clearance with plastigauge. Clearance should be 0.0017-0.0039 in. (0.045-0.100 mm). Then remove rod cap, clean plastigauge off surfaces, lubricate crankshaft and bearing surfaces with engine oil and reinstall rod cap. Tighten new cap nuts to 44-52 lb-ft (60-71 N•m) torque.
7. Replace main bearings as follows:
   a. Loosen bearing cap bolts at adjacent bearings.
   b. Remove bearing cap bolts at first bearing to be replaced, and remove cap and bearing lower half (mark cap for reference before removal).
   c. Insert tool J8080 into oil hole in crankshaft bearing journal. Position “T”-end of tool against bearing upper half. Rotate crankshaft counterclockwise until tool pushes upper half of main bearing out of bearing saddle in block (Figure 2-57).
   d. Clean main cap, crankshaft journal, and bearing saddle in block with solvent. Refer to overhaul section for bearing specifications and select fitting.
   e. Start plain end of new upper bearing half into place by hand. Then push bearing into position with tool J8080. Be sure bearing tang is seated in notch in bearing saddle of block (Figure 2-57).

f. Check bearing clearance with plastigauge. Clearance should be 0.0017-0.003 in. (0.045-0.083 mm) for bearings one through four and 0.002-0.0036 in. (0.055-0.093 mm). Remove main cap, clean plastigauge off surfaces, lubricate bearing halves and crank journal with engine oil. Tighten new main bearing cap bolts as follows:
   - inner bolts to 111 lb-ft (150 N•m)
   - outer bolts to 100 lb-ft (136 N•m)

8. Install oil pump.
9. Apply RTV-type sealer to oil pan sealing surfaces and install pan. Tighten all but two rear pan bolts to 89 lb-in. (10 N•m) torque. Tighten two rear pan bolts to 17 lb-ft (23 N•m) torque.
10. Install new oil filter and refill with engine oil. Use SAE 10W-30 for temperatures under 40°F and 15W-40 for temperatures above that figure.
11. Connect battery cable and reinstall skidplate.
12. Test run. Test for leaks.

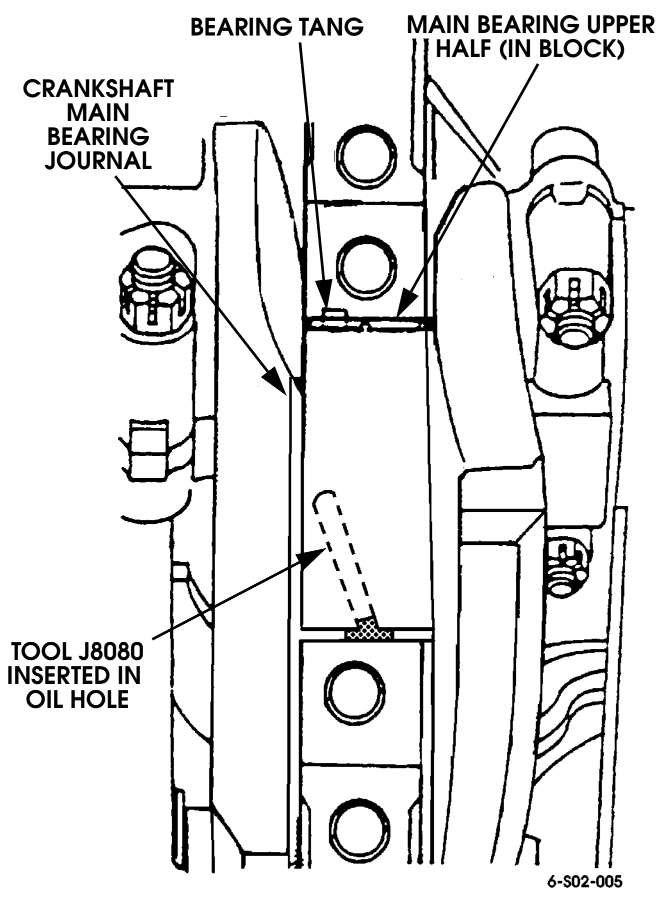

Figure 2-57: Removing/Installing Main Bearing Upper Half with Cotter Pin or Equivalent

INTAKE MANIFOLD (TURBO DIESEL)

Service

A three-piece intake manifold is used on turbocharged diesel engines (Figure 2-58). It consists of left and right manifold halves and a center manifold. The center manifold joins the other manifold halves to the turbocharger.

Gaskets and an O-ring seal are required at the manifold-to-cylinder head and manifold joints. A single O-ring is used to seal the center manifold-to-turbocharger flange joint.

Removal

1. Remove turbocharger. Refer to procedure in this section under Turbocharger Service and Diagnosis.
2. Remove center manifold bolts. Remove manifold from intake manifold halves and turbocharger. Discard manifold gaskets and O-ring seal.
3. Remove brackets/clamps securing wire harnesses to rocker covers and intake manifold halves.
4. Remove bolts/nuts/studs attaching intake manifold halves to cylinder heads. Tap manifolds with rawhide mallet to loosen and remove. Discard gaskets after removal.

Installation

1. Clean manifold and cylinder head gasket surfaces. Apply light coat of Permatex High Tack, or #2 sealer to gaskets and position gaskets on heads.
2. Install left and right manifold halves. Tighten attaching bolts and studs to 25-37 lb-ft (34-50 N•m) torque.
3. Install turbocharger and center manifold as described in this section.

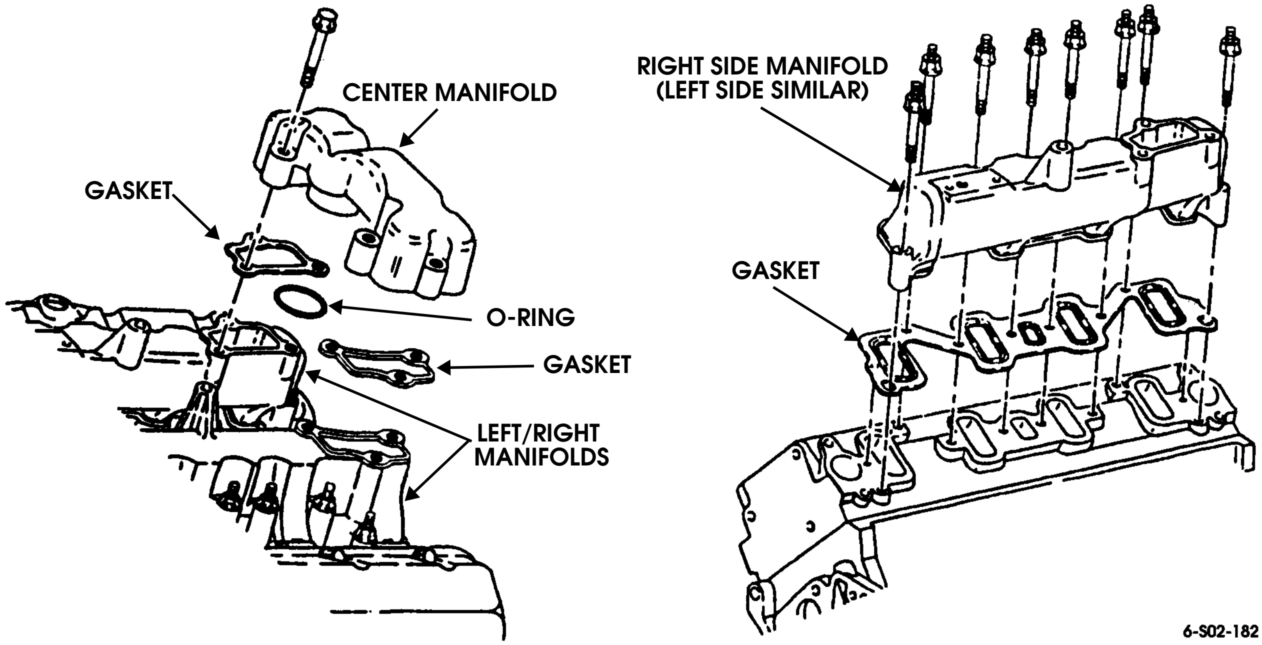

Figure 2-58: Intake Manifold Attachment

EXHAUST MANIFOLDS (TURBO DIESEL)

Removal

1. Remove consoles and engine cover for access to turbocharger inlet pipes. For information regarding inlet pipes, refer to Section 3.
2. Loosen flange clamps that secure left inlet pipe to exhaust manifold and turbocharger. On right side, loosen flange clamp and remove nuts that attach inlet pipe to exhaust manifold. Then disconnect pipe and move aside for working clearance.
3. Remove heat shield attaching nuts/bolts and remove shield, if equipped.
4. Disconnect glow plug wires.
5. Remove manifold attaching bolts and remove manifold (Figure 2-59).
6. Remove and discard manifold gasket.
7. Clean old gasket material off cylinder head and manifold with scraper and wire brush.

Installation

1. Place new gasket on manifold, position manifold on cylinder head, and install 1-2 bolts to hold manifold in place.
2. Install heat shield and remaining manifold bolts. Tighten bolts to 18-25 lb-ft (24-34 N•m) torque.
3. Connect glow plug wires.
4. Install flange clamps and turbocharger inlet pipes. If installing right side manifold, tighten inlet pipe-to-manifold attaching nuts to 37 lb-ft (50 N•m) torque. Tighten exhaust flange clamps to 71 lb-in (8 N•m) torque.
5. Install turbocharger heat shields.
6. Install engine cover and consoles.

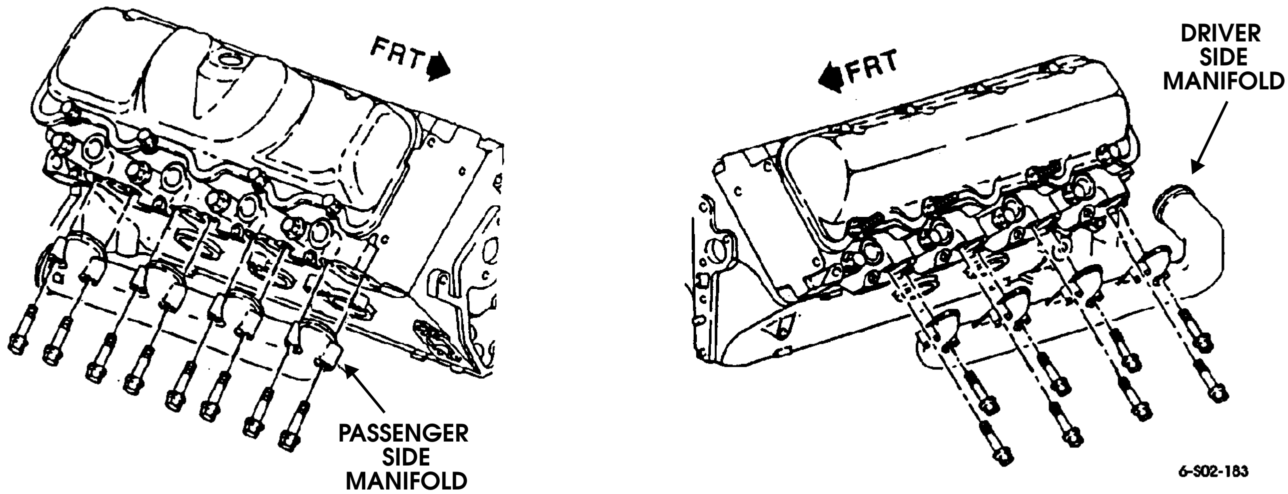

Figure 2-59: Exhaust Manifold Attachment (Turbo Diesel)

DIESEL VACUUM PUMP SERVICE

A vacuum pump is used on all diesel models.

The pump is located on the passenger side of the engine just below the alternator (Figure 2-60).

This supplies vacuum for wastegate actuator operation on turbo models and for A/C and heater operation on diesel models. The pump is belt driven and has a removable pulley.

The pump is tested with a standard vacuum gauge. Output should be a minimum of 20-21 inches vacuum.

Pump removal only requires loosening the serpentine belt, disconnecting the vacuum output hose, and removing the pump attaching bolts.

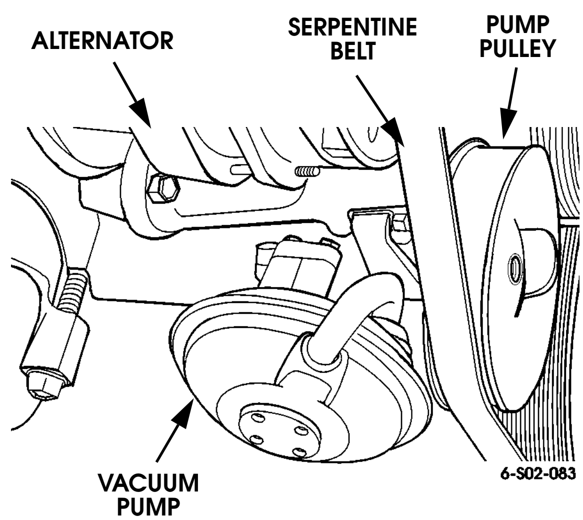

Figure 2-60: Vacuum Pump Location

OVERHAUL SERVICE INFORMATION

The disassembly, cleaning, inspection, overhaul, and assembly procedures apply to turbo and NA diesel engines equally. Where component differences exist, they will be noted within a procedure, or a separate procedure will be provided. For example, turbocharger service is covered separately within this section as is intake and exhaust manifold service for the two engine types.

CAUTION: *Although the turbo and NA engines are similar in appearance, they are quite different physically and dimensionally. Do not interchange parts between the two. This practice can result in unsatisfactory operation, premature wear, or failure.*

Anaerobic and RTV type sealers are both used during engine re-assembly. Anaerobic sealer such as Loctite gasket maker (515 or 510) is used on the timing chain cover. RTV sealers such as Permatex Ultra Copper, Ultra Blue, or Loctite 599, are used on the oil pan and rocker covers.

Thread locking chemicals such as Loctite 242 are specified wherever necessary. In addition, Permatex dielectric compound can be used on electrical connections to prevent corrosion.

Do not use substitute fasteners unless they are of the correct size and hardness grade. When replacement bolts/nuts are required, it is recommended that parts catalog items be used. This ensures that correct grade fasteners are used.

ENGINE REMOVAL (NA DIESEL)

1. Remove front console attaching screws. Move console rearward and disconnect radio, defroster switch, climate control, lighter, CD player (if equipped), and PCM. Then remove console.
2. Remove engine cover (and PCM if attached to cover).
3. Remove hood with aid of helper as follows:
   - Lower brushguard, then unlatch and raise hood.
   - Remove clip that attaches hood harness to driver side of frame.
   - Disconnect headlamp harness from front harness.
   - Remove bolts attaching prop rod bracket to driver side airlift bracket. Do not remove prop rod from hood. Leave rod attached. Tape rod to hood if desired.
   - Remove hood hinge pins
   - Remove hood with aid of helper.
4. Disconnect and remove batteries and cables.
5. Remove battery tray.
6. Remove driver and passenger side splash shields (Figure 2-61).

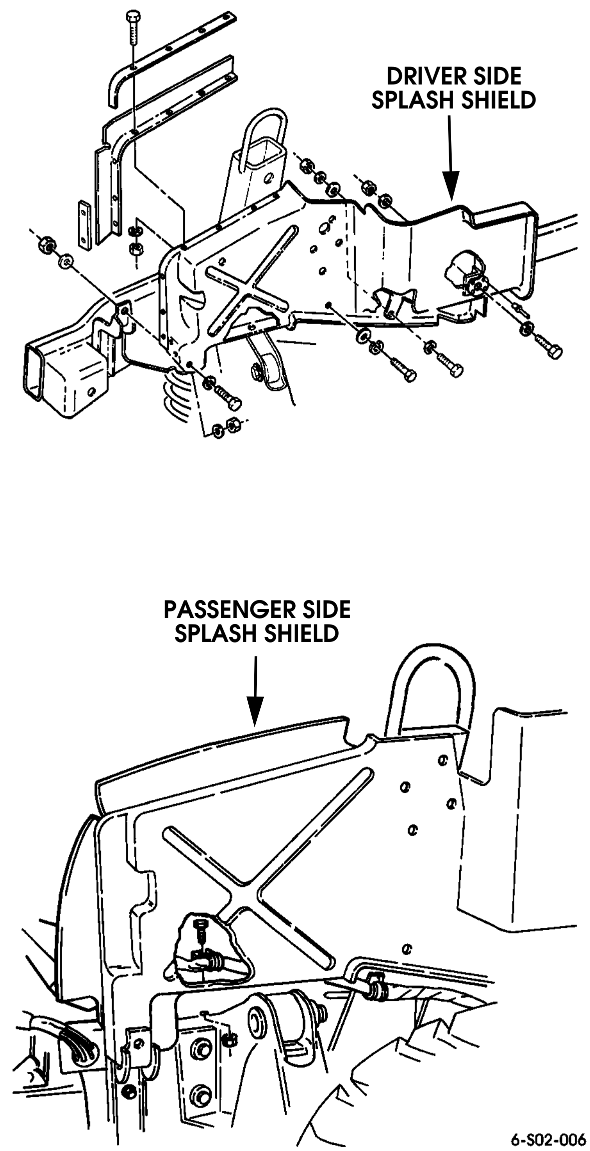

Figure 2-61: Splash Shield Attachment (NA Diesel Shown)

7. Drain engine coolant and engine oil.
8. Discharge A/C system with machine set in recovery mode.
9. Disconnect radiator upper and lower hoses.
10. Disconnect oil lines at transmission and power steering coolers. Cap lines to prevent dirt entry (Figure 2-62).

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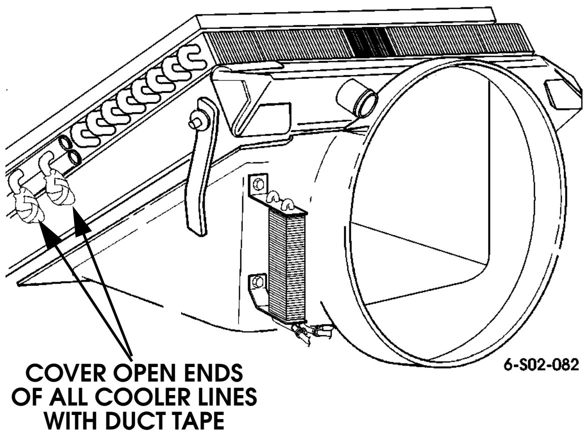

Figure 2-62: Covering Open Ends of Oil Cooler Lines

11. Disconnect A/C lines at condenser. Cap or tape lines and fittings to prevent dirt entry.
12. Remove rubber/sponge pads from air lift brackets.
13. Disconnect radiator hoses at thermostat housing and at radiator upper and lower outlets.
14. Drain power steering reservoir with suction gun. Then disconnect hose (from pump) at reservoir.
15. Remove bolts attaching radiator and shroud assembly to frame and brackets. Then (with aid of helper) remove radiator, shroud, condenser, and oil coolers as an assembly (Figure 2-64).

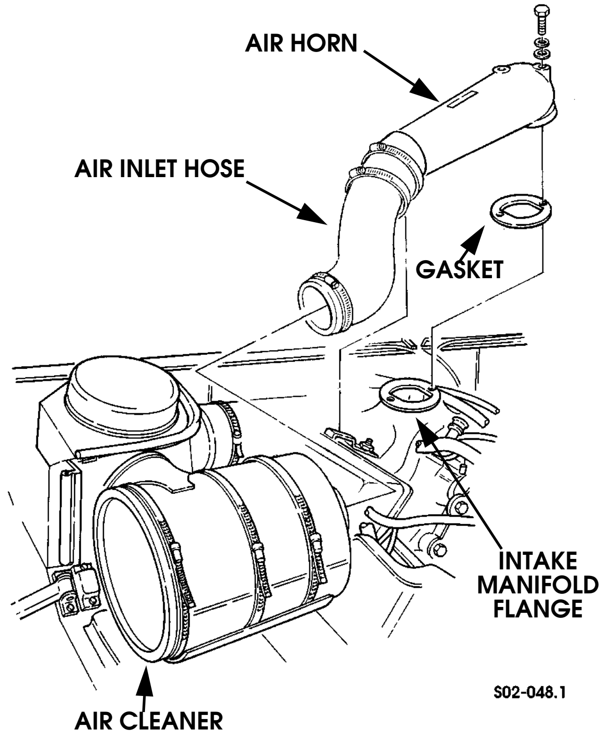

Figure 2-63: Air Horn and Hose Removal/Installation

16. Remove air horn bolts. Then remove air horn and inlet hose (Figure 2-63).

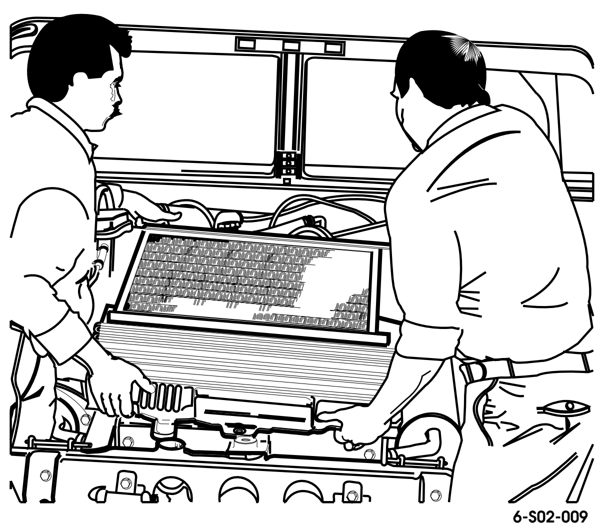

Figure 2-64: Radiator, Cooler, Fan Shroud Removal/Installation

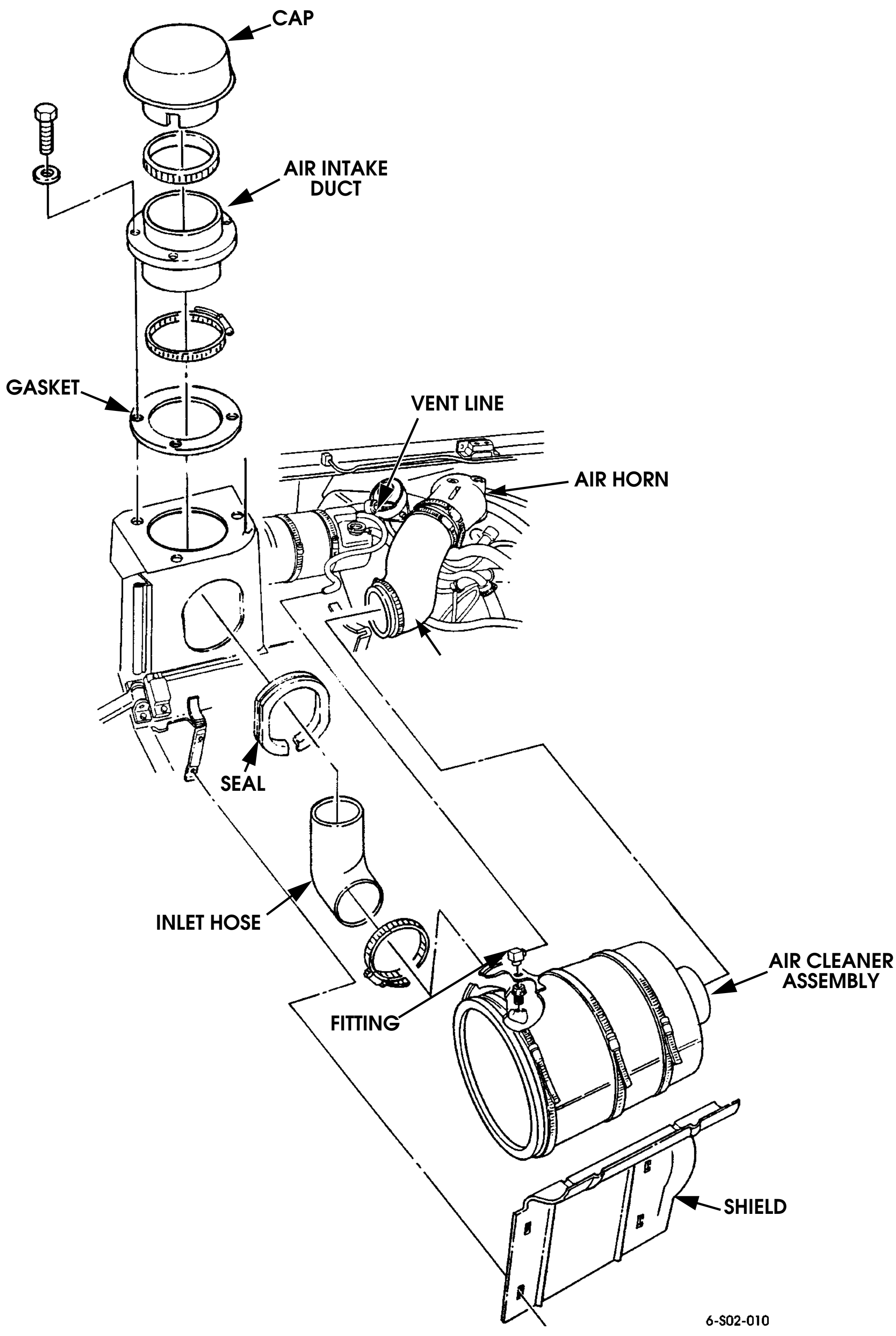

Figure 2-65: Air Cleaner Component Removal/Installation

17. Remove surge tank (Figure 2-66).
18. Remove air cleaner assembly and shield (Figure 2-65).

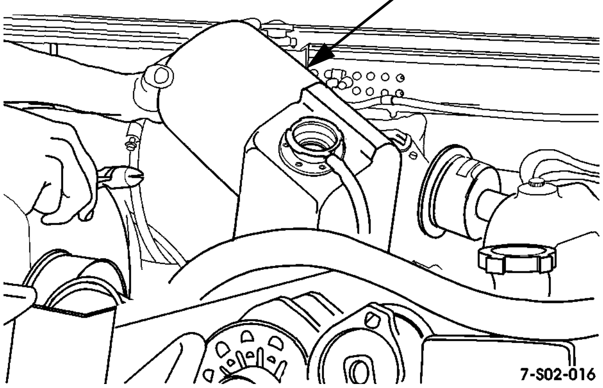

Figure 2-66: Surge Tank Removal/Installation

19. Loosen tensioner and remove serpentine belt (Figure 2-17)
20. Remove bolts attaching fan to water pump and pulley. Then remove fan and clutch as assembly.
21. Disconnect suction/discharge hose assembly at compressor and at T-connector at passenger side of engine compartment next to receiver/dryer. Move hoses aside for working clearance and cap open ends to prevent dirt entry (Figure 2-67).

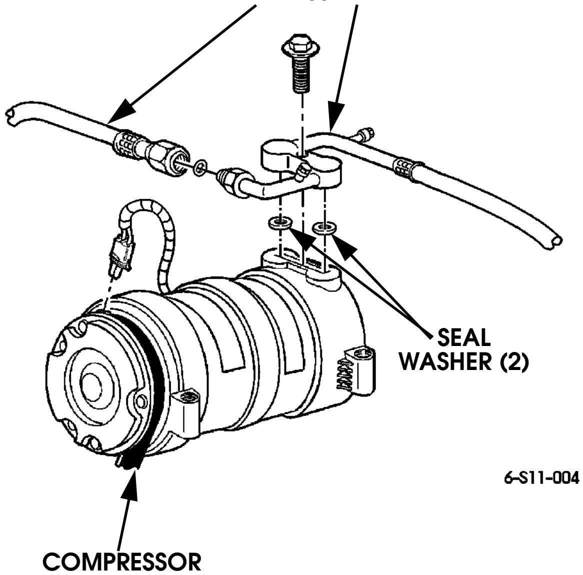

Figure 2-67: Suction/Discharge Hose Assembly Mounting

22. Disconnect accelerator cable as follows (Figure 2-68):
    - Remove clip securing cable to throttle lever.
    - Loosen cable attaching jam nuts.
    - Work small boot on cable downward.
    - Slide cable out of mounting bracket.

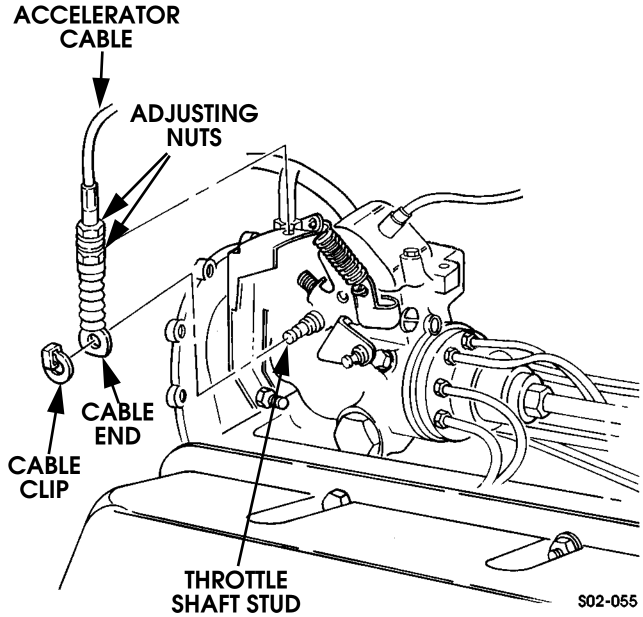

Figure 2-68: Accelerator Attachment

23. Disconnect bypass hose at water crossover.
24. Remove bolts attaching water control valve bracket. Then move valve, hose, and bracket aside for working clearance.
25. Disconnect CDR valve at rocker cover and intake manifold. Then remove valve and hose.
26. Disconnect and remove alternator, belt tensioner, idler pulley and brackets as assembly (Figure 2-69).
27. Remove brackets/retainers that secure wire harnesses to intake manifold and heads.

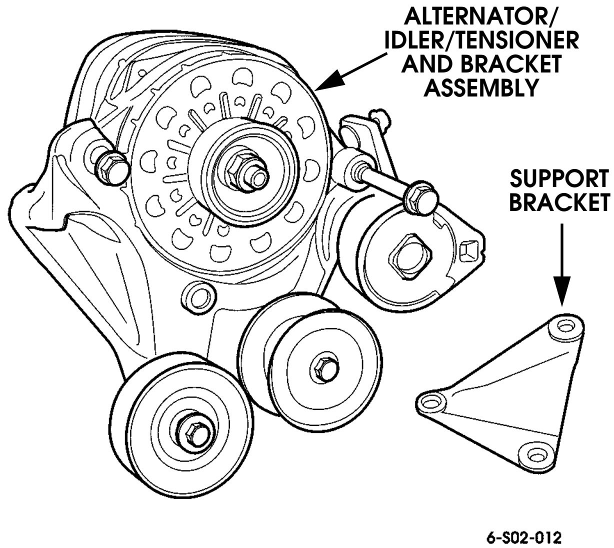

Figure 2-69: Alternator, Pulleys, and Bracket Removal/Installation

28. Disconnect wires at all glow plugs.
29. At rear of engine, disconnect following (Figure 2-70):
    - Ground wires/cables
    - Oil pressure sensing unit (in valley between heads)
    - Sensor wire at oil pump drive
    - Glow plug relay wires/cables

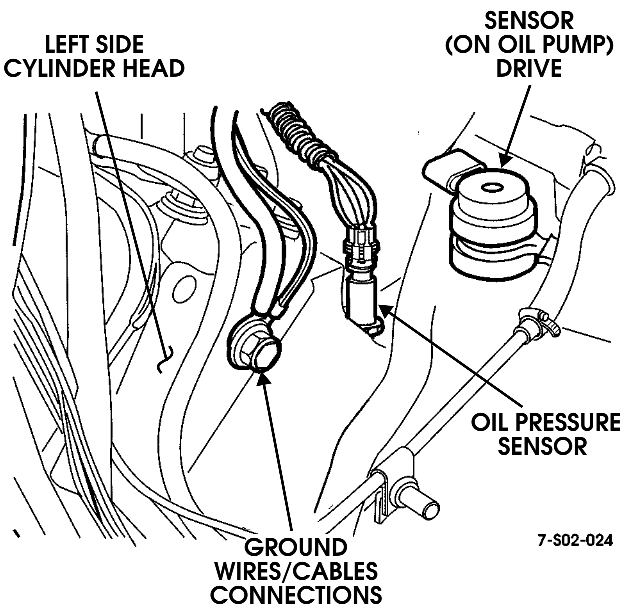

Figure 2-70: Connections at Rear of Engine

30. Disconnect fuel hose from injector pump line at underside of manifold.
31. Remove fuel pump from retaining clamp.
32. Disconnect and remove barometric pressure sensor and bracket.
33. Remove any remaining brackets and clips securing wire harnesses to engine.
34. Disconnect A/C compressor wires and coolant temperature sensor wire at driver side cylinder head.
35. Disconnect oil lines from power steering pump to hydro boost at hydro boost housing. Cap lines and hydro boost outlets to prevent dirt entry. Move lines aside for clearance.
36. Pull engine wire harnesses into passenger compartment to avoid damage during engine removal.
37. Remove heat shield just above exhaust manifold connection at passenger side of engine.
38. Working under vehicle, loosen, disconnect or remove the following:
    - Remove skid plate.
    - Remove starter and shield (with aid of helper).
    - Disconnect exhaust Y-pipe at manifolds and at catalytic converter pipe. Also loosen and move heat shield aside.
    - Remove oil filter and disconnect lines to oil cooler.
    - Remove transmission fill/dipstick tube (Figure 2-71).
    - Remove converter housing access cover and gasket.
    - Remove torque converter attaching bolts (Figure 2-72).
    - Remove bolts/nuts attaching engine mount insulators to frame brackets.

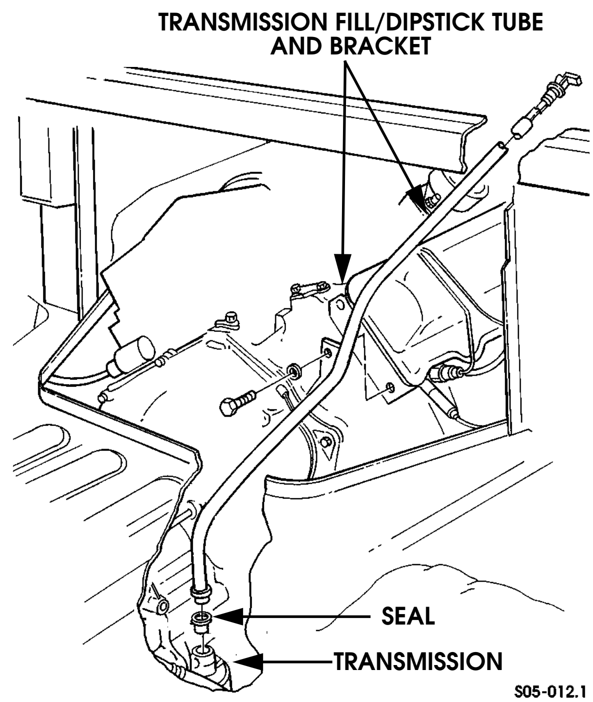

Figure 2-71: Transmission Dipstick Tube

39. Support transmission with floor jack. Position wood blocks between transmission and jack saddle.

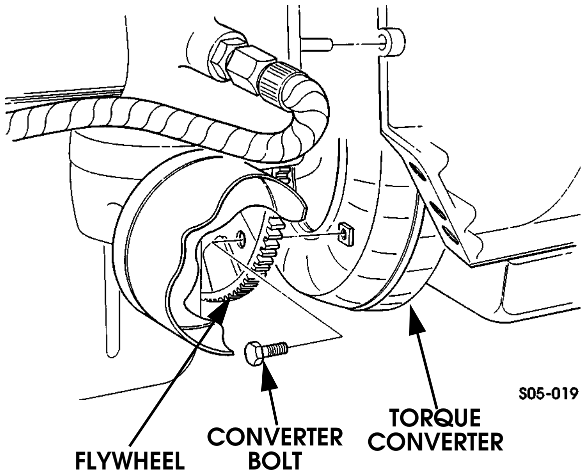

Figure 2-72: Converter Bolt Removal/Installation

40. Remove bolts/studs attaching transmission to engine block.
41. Attach engine lifting bracket and sling J33139 to engine. Bracket is attached to rear of passenger side cylinder head (Figure 2-73). Use flat washers as needed on bolts used to attach lifting sling. Be sure bracket is secured to sling with pin as shown.
42. Raise engine with hoist and remove it from engine bay.

CAUTION: *Make sure all electrical wires, harnesses, and fluid lines are disconnected and clear of engine assembly. Do this before removal to avoid damage.*

43. Drain oil from oil pan if engine will be disassembled for repair.
44. Mount engine on heavy duty engine stand or cradle (Figure 2-74). Engine stand should have minimum capacity of 1500 lb (680 kg). Then remove lifting sling.

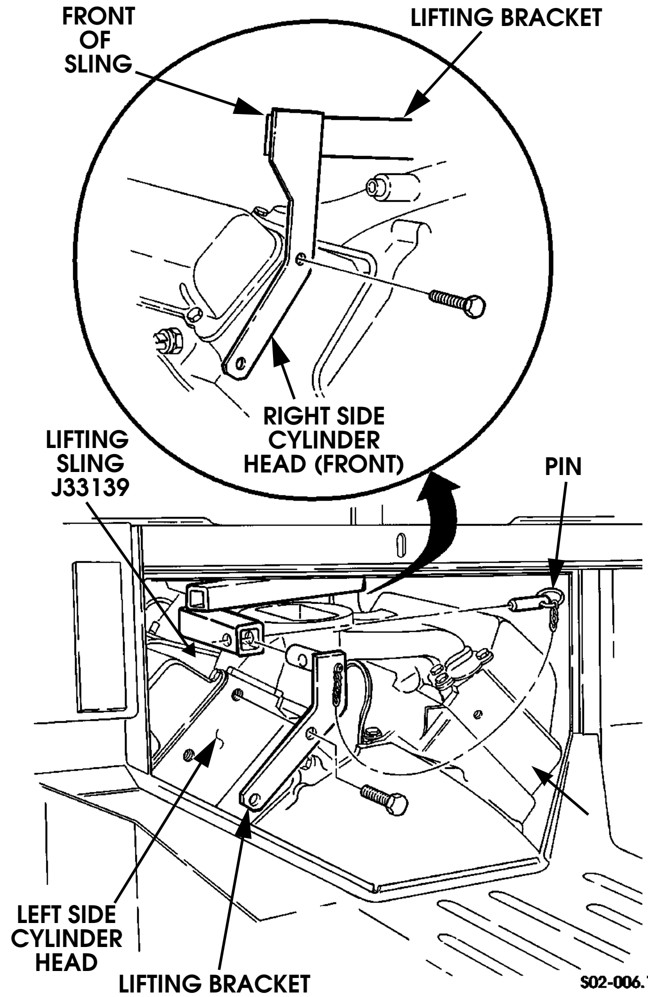

Figure 2-73: Lifting Bracket to Cylinder Head Attachment

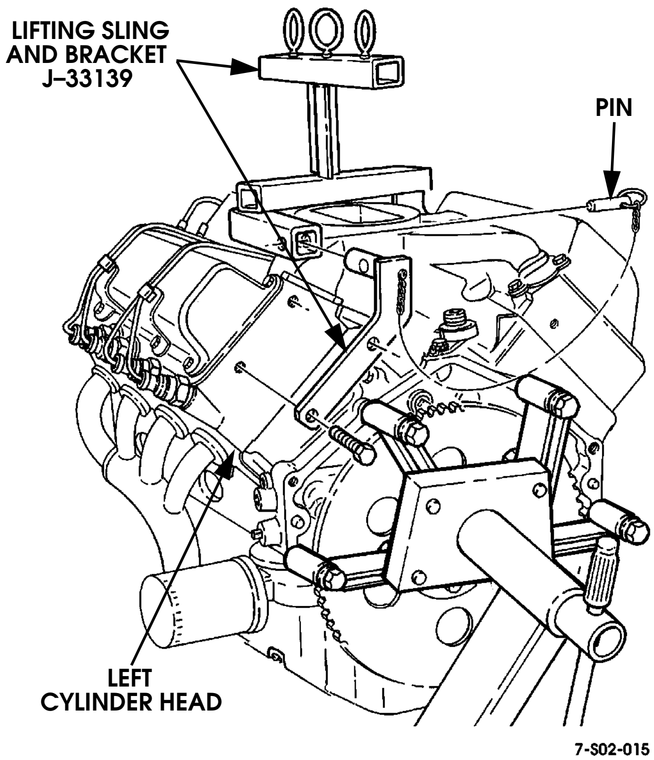

Figure 2-74: Engine Mounted on Repair Stand

ENGINE INSTALLATION (NA DIESEL)

1. If new engine is being installed, transfer mounting brackets and insulators, alternator, power steering pump, A/C compressor, drive plate (flywheel), and necessary mounting brackets, shields, damper, pulleys and fittings, from old to new engine.
2. Install lifting bracket J–33139 on engine. Bracket attaches to rear of driver side cylinder head. Opposite end of lifting bracket bolts to front of passenger side cylinder head.
3. Attach hoist to lifting bracket. Raise engine and guide it into engine bay with aid of helper.
4. Align and seat engine on transmission. Be sure converter pilot hub is seated in crankshaft and that transmission is seated on engine block dowels. Install 2-3 transmission attaching bolts (finger tight) to hold engine and transmission in place.
5. Align and seat engine mounting bracket insulators on frame brackets. Be sure insulator studs are fully seated in frame brackets before proceeding.
6. Apply Loctite 242 to transmission, converter, and engine mount nuts/bolts. Then install and tighten nuts, or bolts to following torque:
   - Converter bolts to 32 lb-ft (43 N•m)
   - Transmission bolts to 35 lb-ft (47 N•m)
   - Insulator stud nuts to 90 lb-ft (122 N•m)
7. Install converter housing access cover. Tighten cover attaching screws to 60 lb-in. (7 N•m) torque.
8. Connect engine oil cooler lines to fittings at rear of engine block (Figure 2-75).

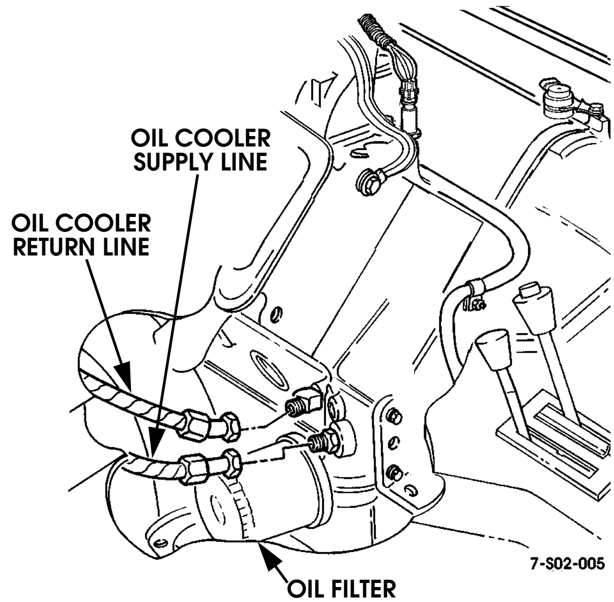

Figure 2-75: Oil Cooler Line Connection

9. Install starter motor and shield with aid of helper. Tighten starter mounting bolts to 30-40 lb-ft (41-54 N•m) torque. Do not connect cable and solenoid wire to starter at this time.
10. Install gaskets on exhaust crossover pipe flanges and attach pipe to exhaust manifolds. Then align and position heat shield and catalytic converter pipe. Tighten crossover pipe bolts finger tight only but tighten converter heat shield clamp bolt nuts to 10 lb-ft (14 N•m) torque.
11. Install new oil filter (Figure 2-75).
12. Pull engine harness wires back into engine bay. Apply Permatex dielectric compound to connectors, and terminals, pins to prevent oxidation and corrosion.
13. Install/connect following:
    - Harness brackets and clamps
    - Map sensor and bracket
    - Cold advance/fast idle switch
    - Transmission speed sensor (at oil pump drive)
    - Ground wires (Figure 2-70)
    - Injector cold advance solenoid, run solenoid, fast idle solenoid
    - Coolant temperature wire (driver side head)
    - Fuel/oil pressure sender or transmitter wires
    - Harness brackets and clamps
    - Water control valve and bracket

14. Install fuel pump in clamp at driver side of engine bay.
15. Install CDR valve and hose (Figure 2-76).

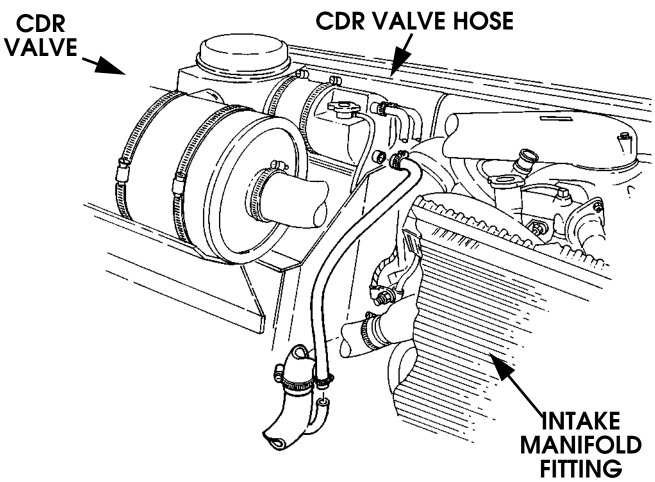

Figure 2-76: CDR Valve and Hose Installation

16. Route hydraulic lines from power steering pump to hydro-boost unit and connect lines. Be sure lines are clear of hot or rotating components and are not kinked at any spot.
17. Remove protective tape from A/C suction/discharge hose adapter and connect it to compressor. Install new seal washers if old ones are worn or cut (Figure 2-67).
18. Connect glow plug relay cable and wires (Figure 2-77).

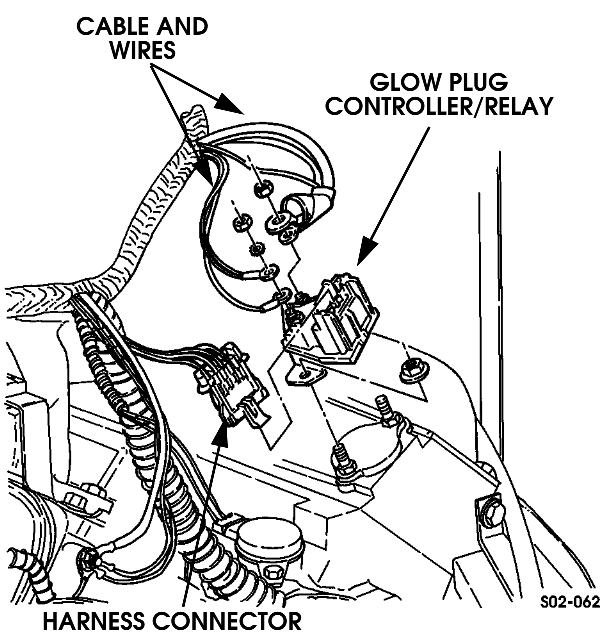

Figure 2-77: Glow Plug Relay Connections

19. Connect water control valve wires, install cover, and secure valve bracket to manifold stud.
20. Position support on back of alternator. Then install generator, mounting bracket, idler pulley, support, and tensioner assembly (Figure 2-69). Do not tighten mounting bolts at this time.
21. Route harness containing alternator, A/C pressure switch, and horn wires down through alternator bracket, and over to respective components. Then attach battery negative cable to stud at passenger side of engine, and position remaining cables for battery installation.
22. Connect heater hose to water pump. Route hose behind alternator bracket and down to pump hose fitting.
23. Mount idler pulley on alternator bracket.
24. Connect A/C hose to tee connector at receiver/dryer.
25. Install fan and clutch assembly. Tighten attaching bolts or nuts to 18 lb-ft (24 N•m) torque.
26. Install serpentine belt.
27. Install surge tank (Figure 2-66). Connect hoses to tank before hand.
28. Connect accelerator cable to injection pump. Also connect cruise control cable to pump, if equipped. Be sure cables are properly secured in brackets before proceeding.
29. Install air horn and inlet hose. Tighten air horn bolts snug. Do not overtighten. Bolt torque is 65 lb-in. (7 N•m).
30. Install and connect fuel supply and return lines. Secure supply line clip to bracket on manifold.
31. Attach radiator upper hoses and tube to thermostat housing. Secure middle clamp on tube to bracket bolted to intake manifold.
32. Connect battery positive cable and solenoid wire to starter motor. Cover cable and terminal with thick layer of clear silicone sealer.
33. Position radiator, shroud, condenser, and oil cooler assembly on frame and between air lift brackets, with aid of helper (Figure 2-64). Then secure assembly and supports to frame and airlift brackets. Tighten support bolts to 26 lb-ft (35 N•m) torque. Tighten frame mount bracket bolt to 30 lb-ft (41 N•m) torque.

NOTE: Verify that fan-to-shroud clearance is at least 1/8 inch (3.18 mm) at all points before proceeding. Loosen bolts and adjust position if necessary.

34. Connect radiator upper and lower hoses.
35. Remove protective wrapping or caps and connect hoses to A/C condenser and oil coolers. Use new O-rings on cooler or A/C hoses if old ones are damaged.
36. Connect hose from power steering pump to reservoir (on shroud).
37. Install passenger and driver side splash shields. Install underhood lamp to driver side shield, if removed.

38. Install horns and bracket, if removed
39. Connect wires to alternator, A/C switch on receiver/dryer, and horns.
40. Install air cleaner cap, intake duct, hose, air cleaner, and shield. Then connect inlet and vent hoses to air cleaner.
41. Install battery tray and batteries. Connect positive and negative cables to batteries afterward.
42. Install seals and cover plates on airlift brackets. Notched side of seals face engine.
43. Refill engine cooling system, refill engine crankcase with recommended oil, and top off transmission and power steering fluids.
44. Start and run engine. Bleed injectors at line fittings if necessary. Then stop engine, recheck coolant and lubricant levels, and add as necessary.

ENGINE REMOVAL (TURBO DIESEL)

1. Remove front console attaching screws. Move console rearward and disconnect radio, defroster switch, climate control, lighter, CD player, and PCM. Then remove console.
2. Remove engine cover (and PCM if attached to cover).
3. Remove hood with aid of helper as follows:
   - Unlatch and lower brushguard, if equipped.
   - Unlatch and raise hood.
   - Remove clip that attaches hood harness to driver side of frame.
   - Disconnect headlamp harness from front harness.
   - Remove bolts attaching prop and bracket to driver side air lift bracket. Do not remove prop rod from hood. Leave rod attached. Tape rod to hood if desired.
   - Remove hood hinge pins.
   - Remove hood with aid of helper.
4. Disconnect and remove batteries and cables.
5. Remove battery tray.
6. Remove driver and passenger side splash shields.
7. Drain engine coolant and engine oil.
8. Discharge A/C system with recovery machine set in recovery mode.
9. Disconnect radiator upper and lower hoses.
10. Disconnect oil lines at transmission and power steering coolers. Cap lines to prevent dirt entry.
11. Disconnect A/C lines at condenser. Cap or tape lines and fittings to prevent dirt entry.
12. Remove rubber/sponge pads from air lift brackets.

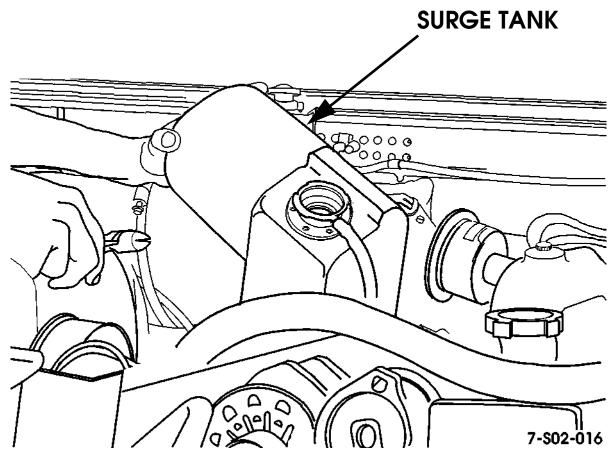

Figure 2-78: Surge Tank Removal/Installation

13. Disconnect radiator hoses at thermostat housing and at radiator upper and lower outlets.
14. Drain power steering reservoir with suction gun. Then disconnect hose (from pump) at reservoir.
15. Remove bolts attaching radiator and shroud assembly to frame and brackets. Then (with aid of helper), remove radiator, shroud, condenser, and oil coolers as an assembly.
16. Remove air inlet tube/hose at turbocharger.
17. Remove surge tank (Figure 2-78).
18. Remove air cleaner assembly and shield.
19. Loosen tensioner and remove serpentine belt.
20. Remove bolts attaching fan to water pump and pulley. Then remove fan and clutch as assembly.
21. Disconnect A/C hoses at compressor and at receiver/dryer. Move hoses aside for working clearance. Cap open ends to prevent dirt entry (Figure 2-79).
22. Disconnect bypass hose at water crossover.
23. Disconnect and remove generator, belt tensioner, idler pulley and bracket as assembly.
24. Remove brackets/retainers that secure wire harnesses to intake manifold and heads.
25. Disconnect wires at all glow plugs.
26. Remove fuel pump from retaining clamp.
27. Disconnect injection pump, pedal position sensor, and engine harness connectors. Move wire harnesses aside for removal clearance.
28. Disconnect glow plug relay wires and cables (Figure 2-77).
29. Disconnect exhaust pipe at right side manifold.
30. Remove any remaining brackets and clips securing wire harnesses to engine.
31. Disconnect A/C compressor clutch wires.

32. Disconnect oil lines from power steering pump to hydro boost at hydro boost housing. Cap lines and hydro boost outlets to prevent dirt entry. Move lines aside for clearance.
33. If possible, pull engine wire harnesses into passenger compartment to avoid damage during engine removal.
34. Remove turbocharger heat shield and disconnect vacuum actuator hose.
35. Working under vehicle, loosen, disconnect, or remove following:
    - Remove skid plate.
    - Remove starter and shield (with aid of helper).
    - Remove catalytic converter pipe. Also loosen and move heat shield aside.
    - Remove oil filter and disconnect lines to oil cooler.
    - Remove transmission fill tube.
    - Remove converter housing access cover and gasket.
    - Remove torque converter attaching bolts.
    - Remove nuts attaching engine mount insulators to frame brackets.
36. Support transmission with floor jack. Position wood blocks between transmission and jack saddle.
37. Remove bolts/studs attaching transmission to engine block.
38. Attach lifting sling, chain, or plate to engine.
39. Raise engine with hoist and remove it from engine bay.

***CAUTION:** Make sure all electrical wires, harnesses, and fluid lines are disconnected and clear of engine assembly. Do this before removal to avoid damage.*

40. Drain oil from oil pan if engine will be disassembled for repair.
41. Mount engine on heavy duty engine stand or cradle. Engine stand should have minimum capacity of 1500 lb (680 kg).

ENGINE INSTALLATION (TURBO DIESEL)

1. If new engine is being installed, transfer mounting brackets and insulators, generator, power steering pump, A/C compressor, drive plate (flywheel), turbocharger, and necessary mounting brackets, shields, damper pulleys and fittings, from old to new engine.
2. Attach lifting bracket, chain, or plate on engine.
3. Attach hoist to lifting bracket. Raise engine and guide it into engine bay with aid of helper.
4. Align and seat engine on transmission. Be sure converter pilot hub is seated in crankshaft and that transmission is seated on engine block dowels. Install 2-3 transmission attaching bolts (finger tight) to hold engine and transmission in place.
5. Align and seat engine mounting bracket insulators on frame brackets. Be sure insulator studs are fully seated in frame brackets before proceeding.
6. Apply Loctite 242 to transmission, converter, and engine mount nuts/bolts. Then install and tighten nuts and bolts to following torque:
    - Converter bolts to 32 lb-ft (43 N•m)
    - Transmission bolts to 35 lb-ft (47 N•m)
    - Insulator stud nuts to 90 lb-ft (122 N•m)
7. Install converter housing access cover. Tighten cover attaching screws to 60 lb-in. (7 N•m) torque.
8. Connect engine oil cooler lines to fittings at rear of engine block.
9. Install starter motor and shield with aid of helper. Tighten starter mounting bolts to 30-40 lb-ft (41-54 N•m) torque. Do not connect cable and solenoid wire to starter at this time.
10. Install catalytic converter pipe and heat shield, if removed and connect exhaust pipe to right side manifold. Tighten attaching nuts to 37 lb-ft (50 N•m) torque.
11. Install new oil filter.
12. Pull engine harness wires back into engine bay.
13. Install/connect following:
    - Wire harness brackets and clamps
    - MAP sensor and bracket
    - Coolant temp sensor and switch
    - Injection pump, engine harness, position sensor harness, sensor wires
    - Fuel/oil pressure sender or transmitter wires
    - Turbocharger actuator vacuum hose
14. Install fuel pump in clamp at driver side of engine bay.
15. Install CDR valve and hose if removed.
16. Route hydraulic lines from power steering pump to hydro-boost unit and connect lines. Be sure lines are clear of hot or rotating components and are not kinked at any spot.

17. Remove protective tape from A/C suction/discharge hose adapter and connect it to compressor. Install new seal washers if old ones are worn or cut.

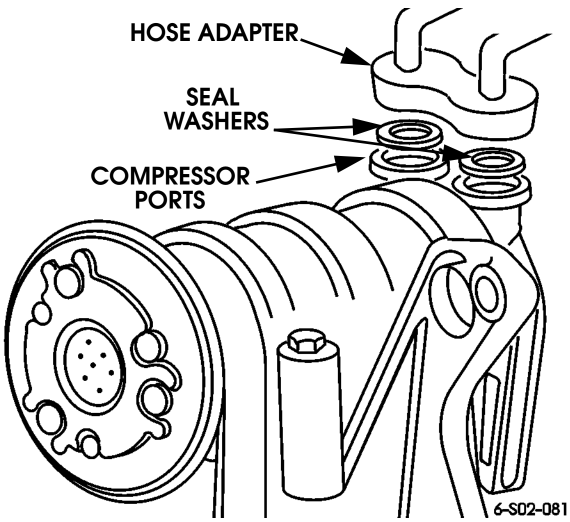

Figure 2-79: Suction/Discharge Hose Connection

18. Connect glow relay cable and wires.
19. Position support on back of alternator. Then install generator, mounting bracket, idler pulley, support, and tensioner assembly. Do not tighten mounting bolts at this time.
20. Route generator, A/C pressure switch, and horn wires down through generator bracket, and over to respective components. Then attach battery negative cable to stud at passenger side of engine, and position remaining cables for battery installation.
21. Connect heater hoses to water pump. Route hose behind alternator bracket and down to pump hose fitting.
22. Mount idler pulley on generator bracket.
23. Connect A/C hose to connector at receiver/dryer.
24. Install fan and clutch assembly. Tighten attaching bolts or nuts to 18 lb-ft (24 N•m) torque.
25. Install serpentine belt.
26. Install surge tank. Connect hoses to tank before hand.
27. Connect wires to injection pump.
28. Connect air inlet hose to turbocharger.
29. Install and connect fuel supply and return lines. Secure supply line clip to bracket on manifold.
30. Attach radiator upper hoses and tube to thermostat housing.
31. Connect battery positive cable and solenoid wire to starter motor. Cover cable and terminal with thick layer of clear silicone sealer.
32. Position radiator, shroud, condenser, and oil cooler assembly on frame and between air lift brackets, with aid of helper. Then secure assembly and supports to frame and air lift brackets. Tighten support bolts to 26 lb-ft (35 N•m) torque. Tighten frame mount bracket bolt to 30 lb-ft (41 N•m) torque.

NOTE: Verify that fan-to-shroud clearance is at least 1/8 inch (3.18 mm) at all points before proceeding. Loosen bolts and adjust position if necessary.

33. Connect radiator upper and lower hoses.
34. Remove protective wrapping or caps and connect hoses to A/C condenser and oil coolers. Use new O-rings on cooler and A/C hoses if old ones are damaged (Figure 2-79).
35. Connect hose from power steering pump to hydro-boost.
36. Install passenger and driver side splash shields. Install under hood lamp to driver side shield, if removed.
37. Install horns and bracket, if removed.
38. Connect wires to generator, A/C switch on receiver/dryer, and horns.
39. If removed, install air cleaner cap, intake duct, hose, air cleaner, and shield. Then connect inlet and vent hoses to air cleaner.
40. Install battery tray and batteries. Connect positive and negative cables to batteries.
41. Install seals and cover plates on air lift brackets. Notched side of seals face engine.
42. Refill engine cooling system, refill engine crankcase with recommended oil, and top off transmission and power steering fluids.
43. Start and run engine. Bleed injectors at line fittings if necessary. Then stop engine, recheck coolant and lubricant levels, and add as necessary.

ENGINE DISASSEMBLY

Serpentine Belt Removal

1. Rotate belt tensioner counterclockwise with 1/2 in. drive breaker bar.
2. Slide belt off tensioner pulley and remove belt.

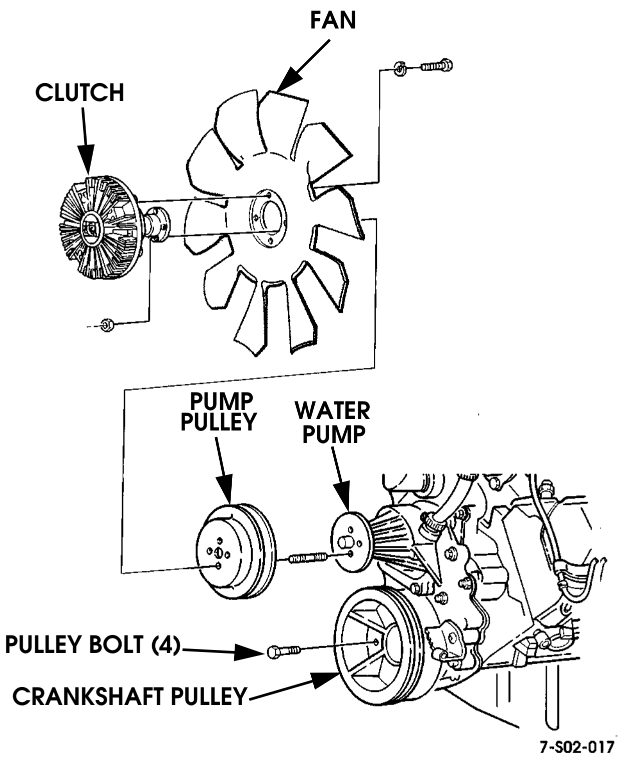

Figure 2-80: Fan and Pulley Removal

Fan-Pulley-Damper Removal

1. Remove nuts attaching fan and clutch to water pump.
2. Remove fan, clutch and water pump pulley (Figure 2-80).
3. Remove crankshaft pulley attaching bolts and remove pulley (Figure 2-80).
4. Remove torsional damper bolt with socket and impact wrench. Retain damper bolt and washer.
5. Loosen torsional damper with tool J23523-F (Figure 2-81).
6. Remove damper and woodruff keys from crankshaft.

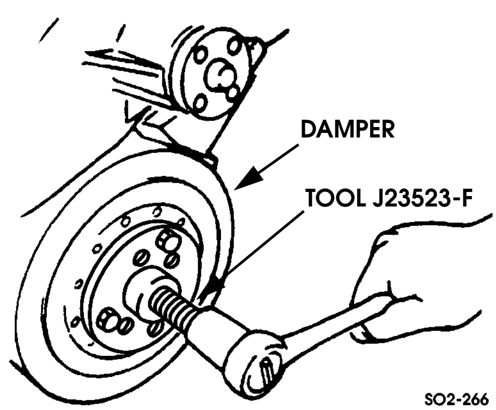

Figure 2-81: Torsional Damper Removal

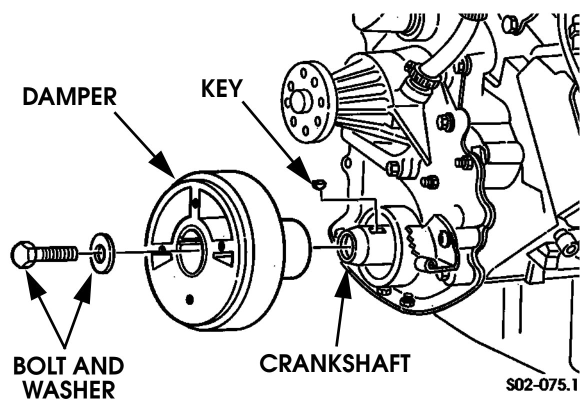

Figure 2-82: Torsional Damper Attachment

Alternator and Bracket Removal

1. Remove alternator mounting bolts and remove alternator.
2. Remove alternator mounting and support bracket bolts and remove both brackets (Figure 2-83).
3. Remove filler neck strap bolts and remove filler neck if desired (Figure 2-83).

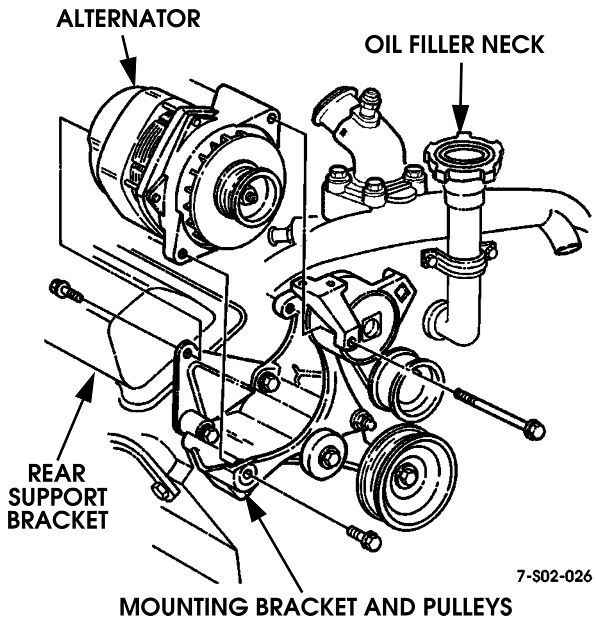

Figure 2-83: Alternator and Bracket Removal

A/C Compressor Removal

1. Remove A/C compressor braces.
2. Remove bolts/nuts attaching compressor to mounting bracket and remove compressor (Figure 2-84).

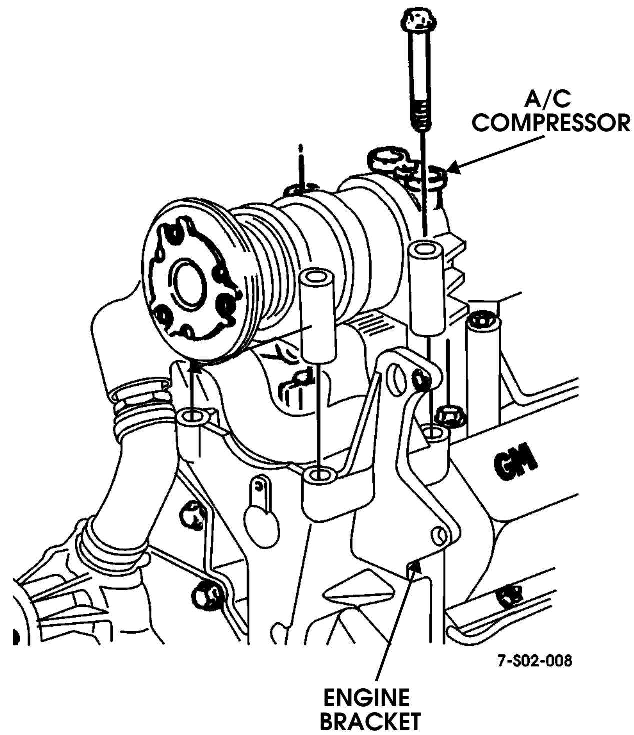

Figure 2-84: A/C Compressor Removal

Power Steering Pump and Bracket Removal

1. Remove bolts/nuts attaching pump mounting bracket to block and cylinder head and remove pump and bracket as assembly.
2. If pump requires service, remove pump attaching bolts and remove pump from bracket (Figure 2-85).

Exhaust Manifold Removal (Non-Turbo)

1. Remove stud and washer from left side (Figure 2-86).
2. Remove left manifold screws and manifold, and gasket. Discard gasket (Figure 2-86).

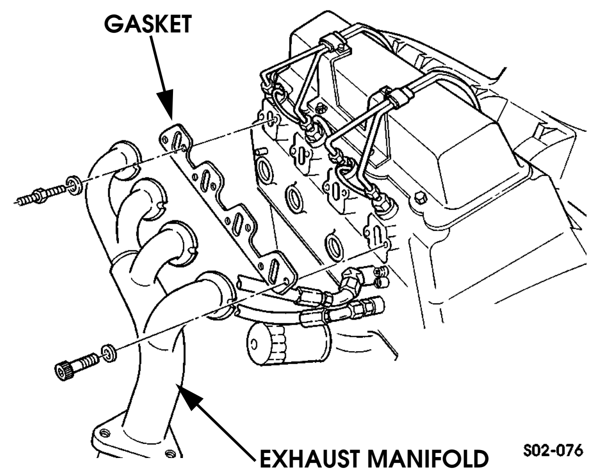

Figure 2-86: Left Side Exhaust Manifold and Gasket Removal

3. Remove right manifold screws and eight socket-head screws, manifold, and gasket. Discard gasket (Figure 2-87).

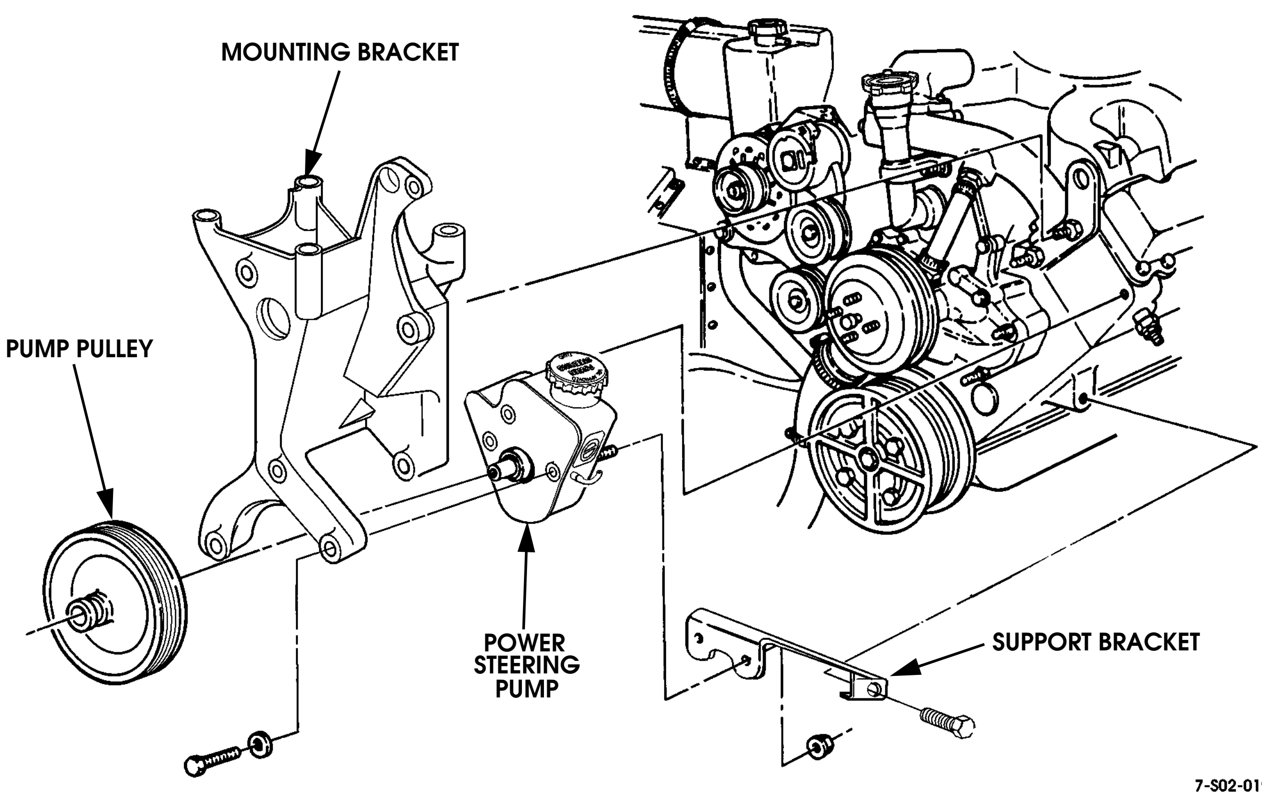

Figure 2-85: Power Steering Pump and Bracket Removal (Turbo Diesel)

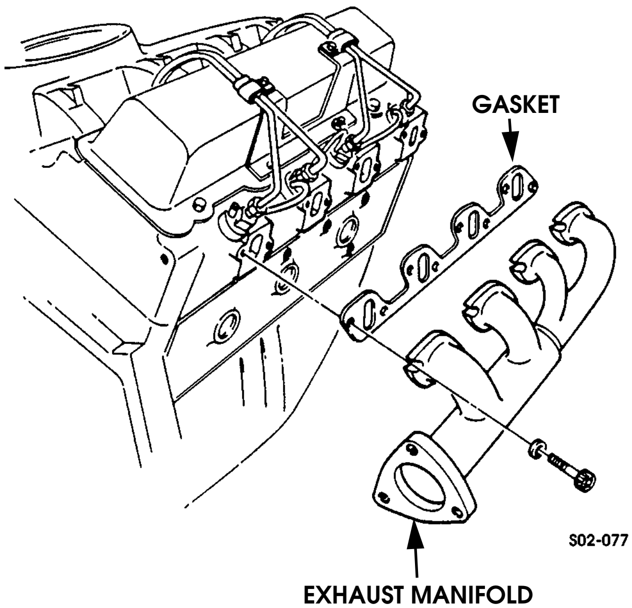

Figure 2-87: Right Side Exhaust Manifold Removal

Exhaust Manifold Removal (Turbo Diesel)

1. Loosen turbocharger left side inlet pipe flange clamps.
2. Remove left side inlet pipe.
3. Remove left side manifold attaching bolts and remove manifold and gasket. Discard gasket (Figure 2-88).
4. Loosen turbocharger right side inlet pipe flange clamps.
5. Remove right side manifold bolts and remove manifold and gasket. Discard gasket (Figure 2-89).
6. Remove inlet tube.

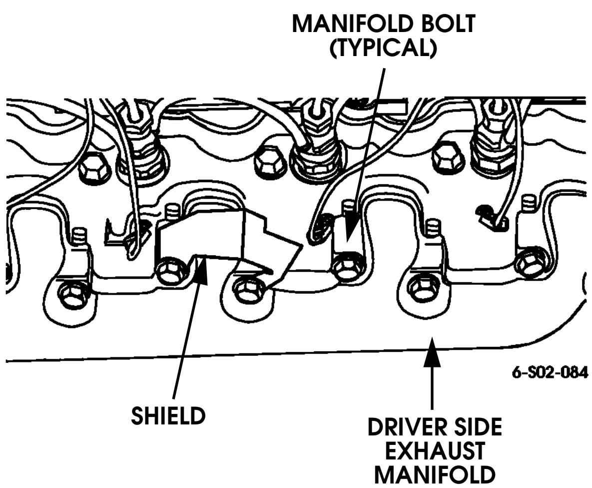

Figure 2-88: Left Side Exhaust Manifold Removal (Turbo Diesel)

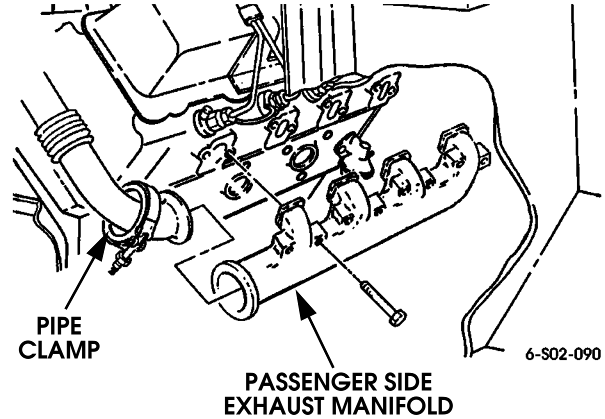

Figure 2-89: Right Side Exhaust Manifold Removal (Turbo Diesel)

Intake Manifold Removal (Non-Turbo)

1. Remove capscrews, studs, injector line clips, and washers that attach manifold to heads (Figure 2-90).

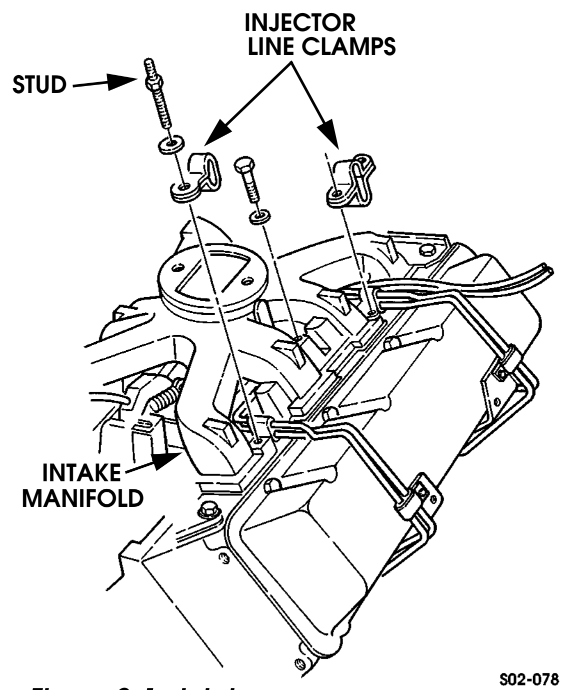

Figure 2-1 Intake Manifold Fastener Removal (Non-Turbo)

Figure 2-90: Intake Manifold Fastener Removal (Non-Turbo)

2. Tap manifold with rawhide mallet to loosen it.
3. Remove intake manifold and gaskets. Discard gaskets (Figure 2-91).

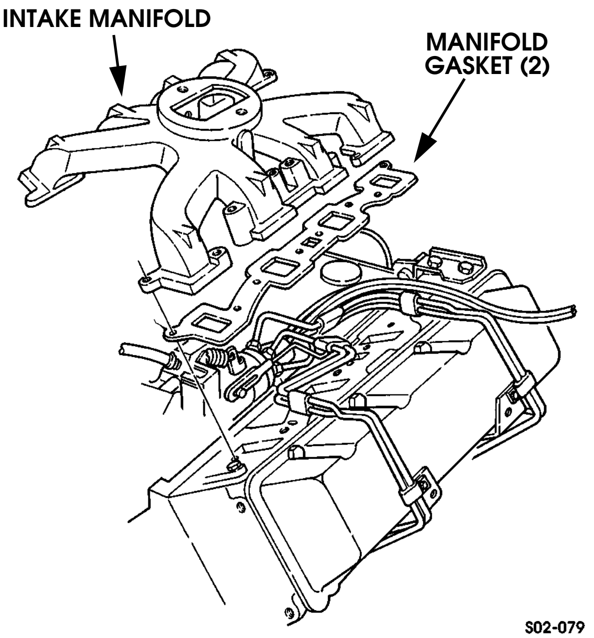

Figure 2-91: Intake Manifold Removal/Installation (Non-Turbo)

Turbocharger and Center Manifold Removal

1. Remove turbocharger inlet and outlet pipes.
2. Remove bolts attaching turbocharger to engine.
3. Remove bolts attaching vacuum actuator to turbocharger and engine block.
4. Remove turbocharger and actuator.
5. Remove center manifold and gaskets (Figure 2-92).

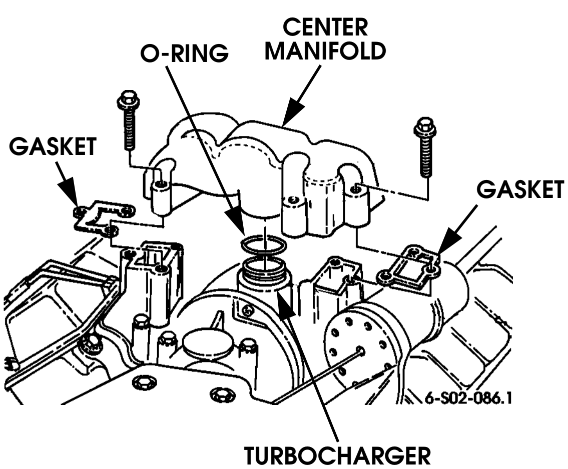

Figure 2-92: Center Manifold

Intake Manifold Removal (Turbo Diesel)

1. Remove bolts and studs attaching each manifold half to cylinder head.
2. Tap each manifold half with rawhide mallet to loosen it.
3. Lift and remove manifold halves and gaskets (Figures 2-93 and 2-94). Discard gaskets.

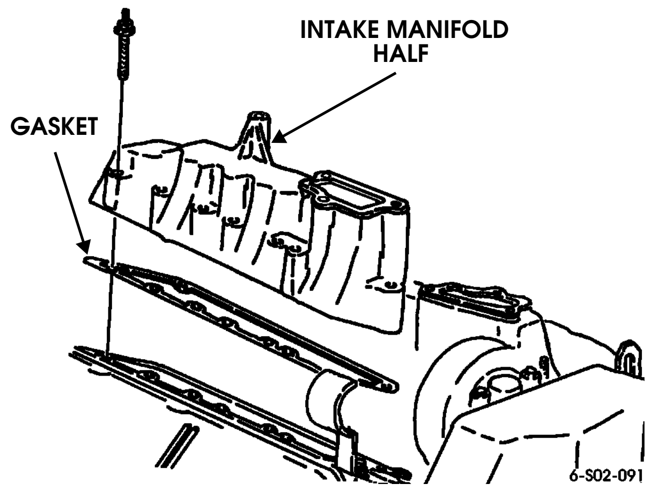

Figure 2-93: Driver Side Intake Manifolds Removal/Installation

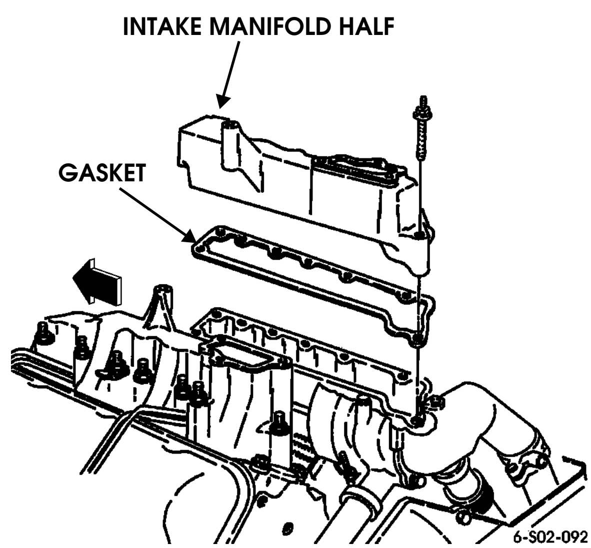

Figure 2-94: Passenger Side Intake Manifold Removal/Installation

Water Crossover Removal

1. Loosen clamp and disconnect bypass hose at water crossover (Figures 2-95 and 2-96).
2. Remove crossover attaching bolts/studs and remove crossover. Discard crossover gaskets (Figure 2-95).
3. Remove thermostat housing and thermostats if required. Note that turbo diesel has two thermostats (Figure 2-95).

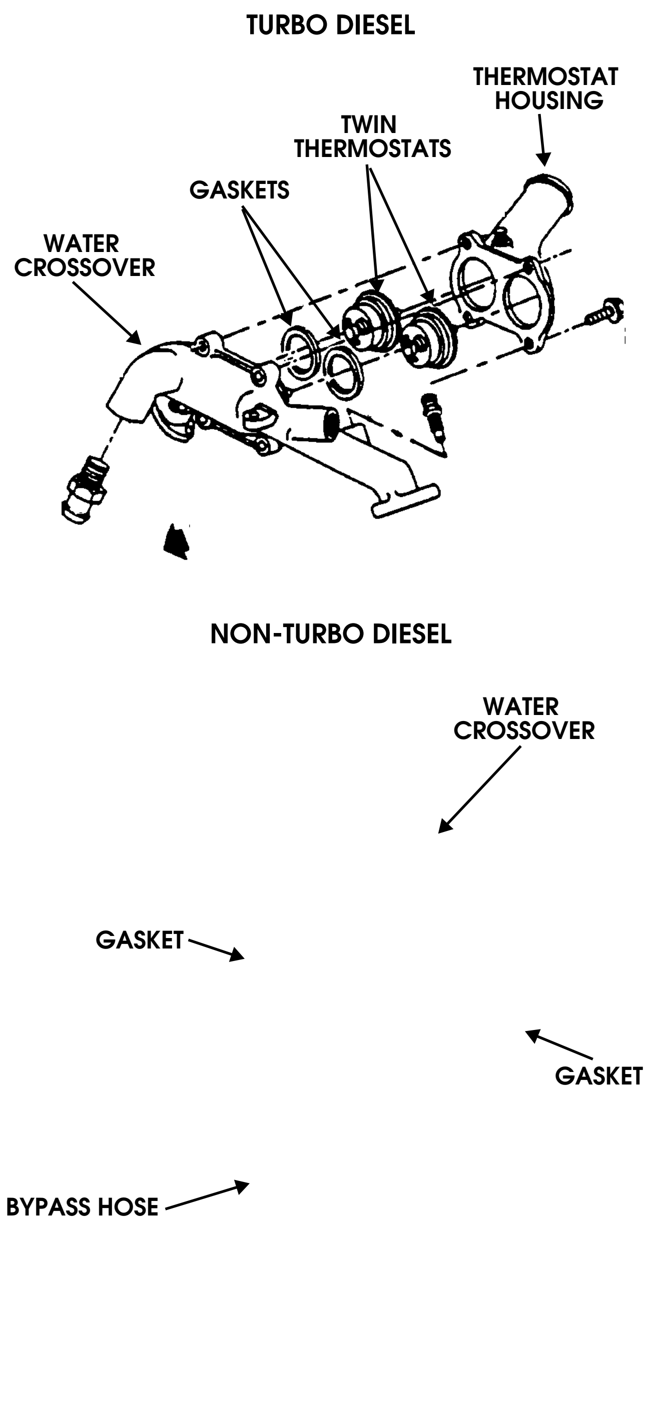

Figure 2-95: Water Crossover Mounting

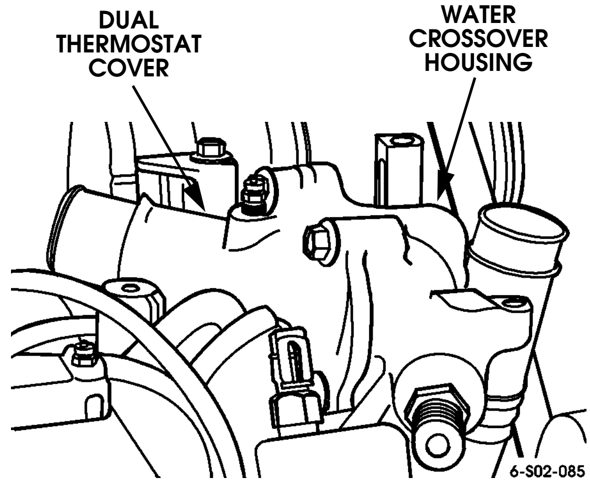

Figure 2-96: Water Crossover Location (Turbo Diesel)

Fuel Injection Line Removal

NOTE: Mark or tag fuel injection lines for installation reference.

1. Disconnect lines at injector nozzles (Figure 2-97).
2. Remove clamp and boot from lines at injection pump if equipped.
3. Disconnect and remove injection lines.

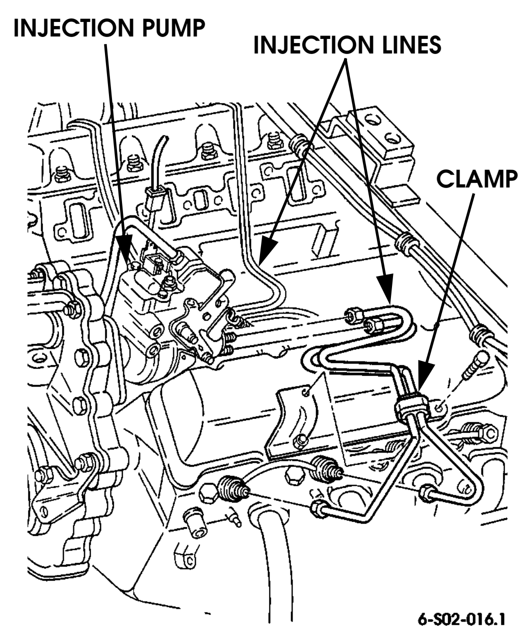

Figure 2-97: Fuel Injection Line Removal (Non-Turbo Shown)

Fuel Supply and Return Line Removal

1. Loosen clamp and remove fuel supply hose from fuel injection pump (Figure 2-98).
2. Loosen clamps and remove fuel return hose from injection pump and return line (Figure 2-98).
3. Remove fuel return line clamps at right and left valve covers.
4. Loosen clamps securing fuel return hoses to fuel injectors.
5. Remove fuel return jumper hoses and plugs at fuel injectors.

Rocker Arm Cover Removal

1. Remove injection line support bracket from studs (Figure 2-99).
2. Remove cover attaching bolts and studs.
3. Remove rocker arm cover. Tap cover with rubber mallet and twist it to remove. Do not pry on cover.
4. Repeat procedure for opposite cover.

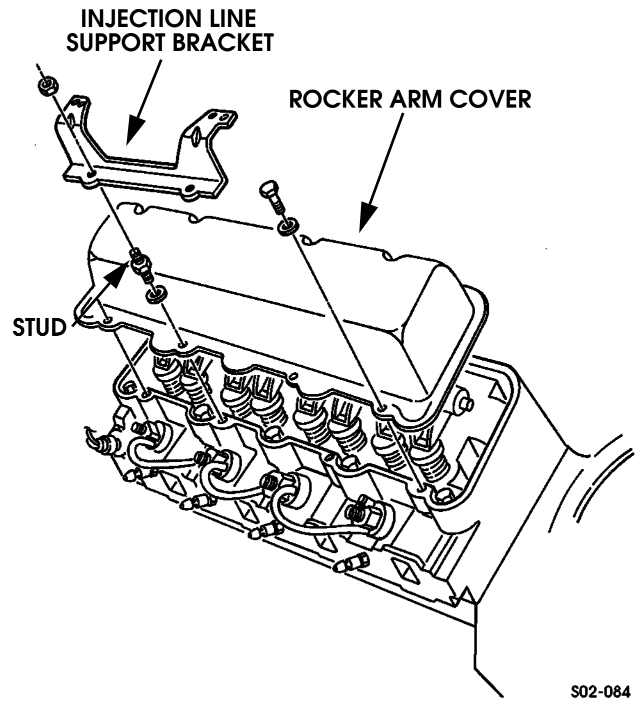

Figure 2-99: Rocker Arm Cover Removal

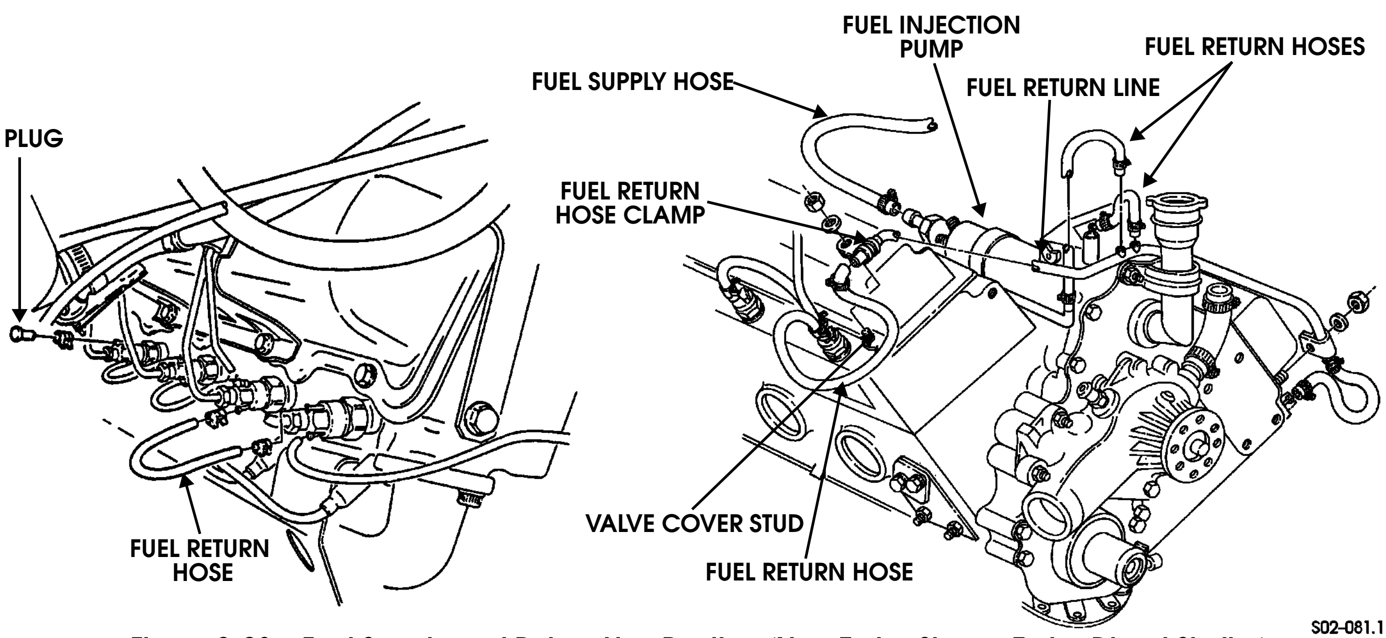

Figure 2-98: Fuel Supply and Return Line Routing (Non-Turbo Shown-Turbo Diesel Similar)

Rocker Arm Shaft and Pushrod Removal

1. Remove rocker arm retainers and bolts (Figure 2-100).
2. Mark or tag position of each rocker arm and shaft set before removal.
3. Remove rocker arm and shaft sets from cylinder head.
4. Remove pushrods. Keep pushrods in removal order. Do not intermix them.
5. Repeat procedure for opposite rocker sets.

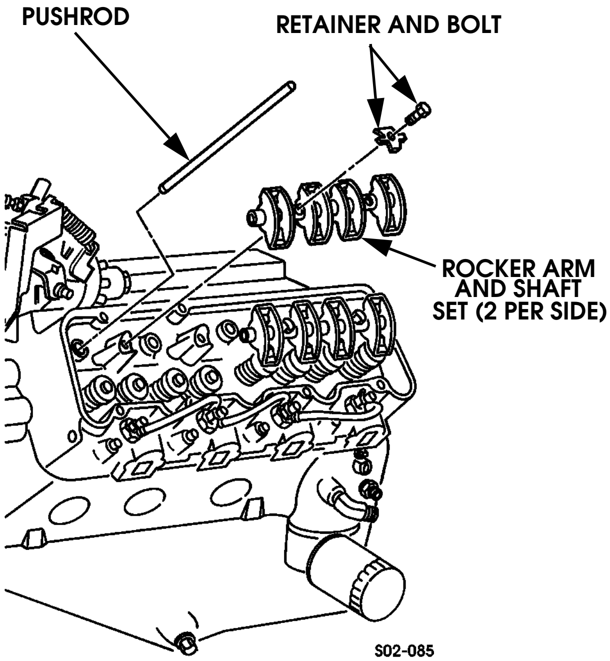

Figure 2-100: Rocker Arm and Shaft Removal

Fuel Injector Removal

1. Remove fuel return hoses and clamps from injectors (Figure 2-3).
2. Remove fuel injectors and gaskets (Figure 2-101).

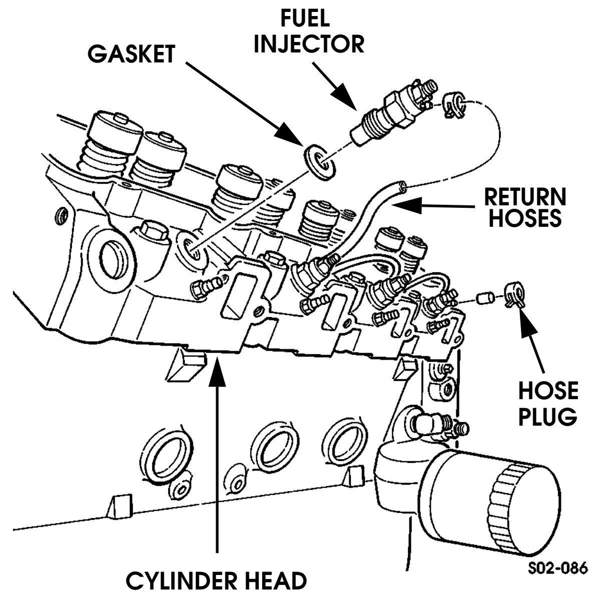

Figure 2-101: Fuel Injector Removal

Glow Plug Removal

Remove glow plugs from cylinder heads (Figure 2-4). Discard any damaged plugs.

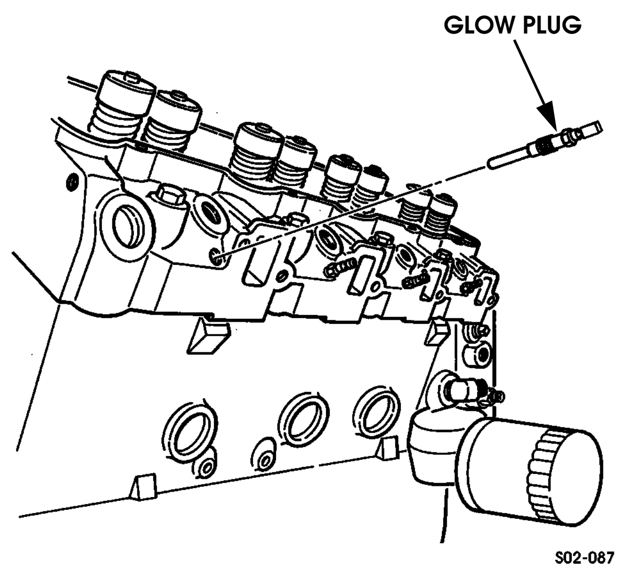

Figure 2-102: Glow Plug Removal

Cylinder Head Removal

1. Remove cylinder head bolts (Figure 2-103).
2. Remove cylinder head from block.
3. Remove cylinder head gasket. Discard gasket afterward.
4. Repeat procedure for opposite cylinder head.

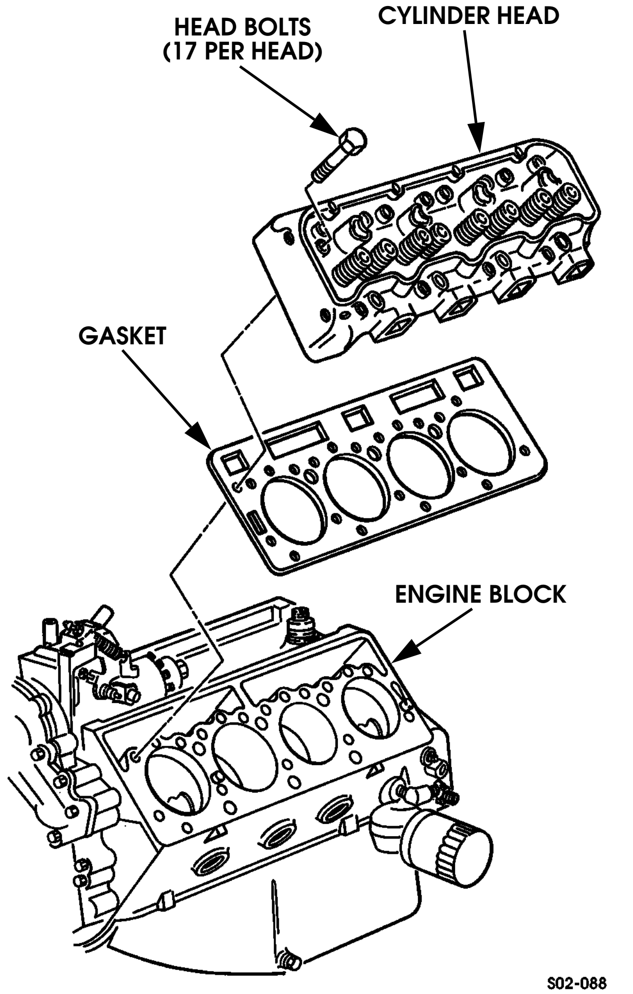

Figure 2-103: Cylinder Head and Gasket Removal

Valve Lifter Removal

1. Remove lifter clamp plates from cylinder block (Figure 2-104).
2. Remove lifter guide plates from block.

NOTE: NOTE: Mark or tag lifters for installation reference. Keep them in order of removal.

3. Remove lifters from block with tool J29834 (Figure 2-104).

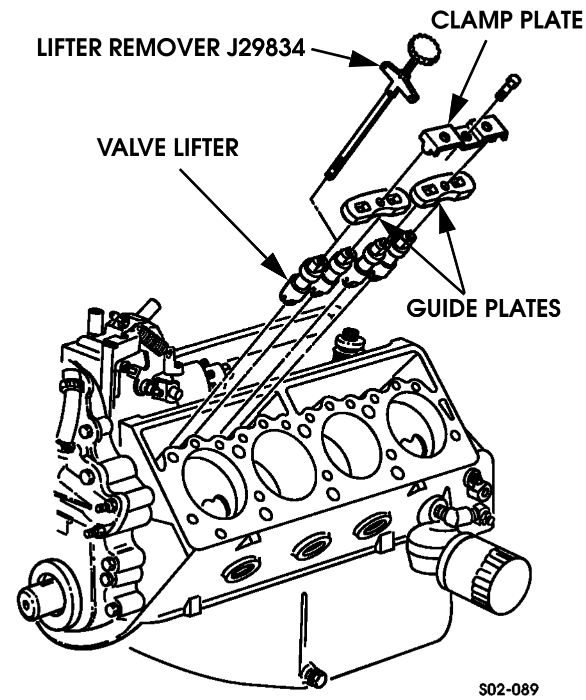

Figure 2-104: Valve Lifters

Water Pump/Adapter Plate/Oil Fill Tube Removal

1. Remove oil fill tube from adapter plate (Figure 2-105).

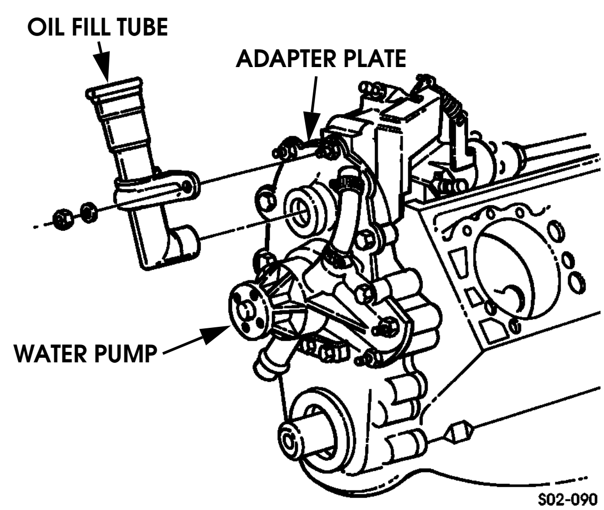

Figure 2-105: Oil Fill Tube Removal

2. Remove water pump and adapter plate from timing gear cover (Figure 2-106). Note location of attaching studs and bolts for installation reference.

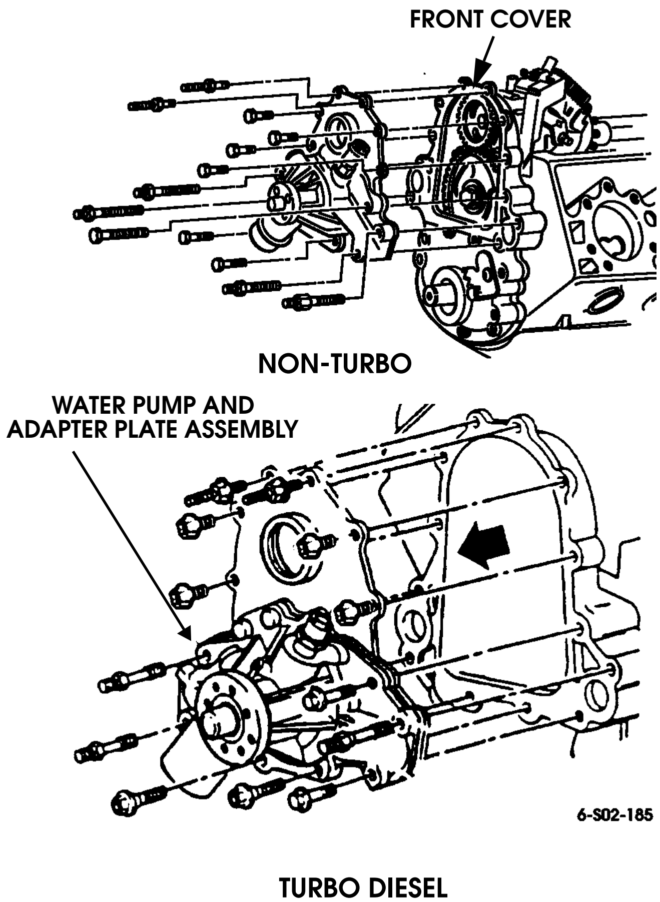

Figure 2-106: Water Pump and Adapter Plate Removal

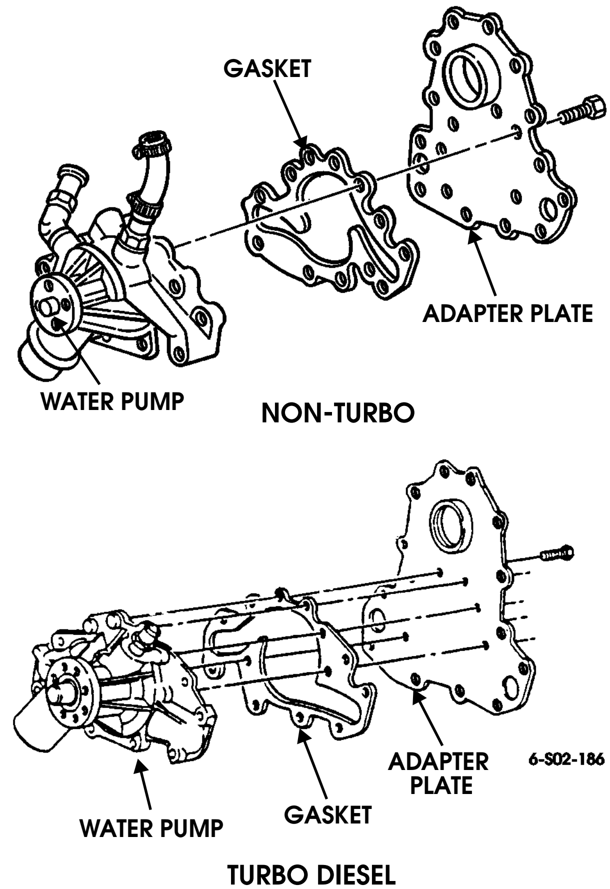

Figure 2-107: Water Pump, Adapter Plate, and Gasket Disassembly

3. Remove water pump, attaching bolts, and separate pump from adapter plate (Figure 2-107).
4. Remove and discard gasket.

Fuel Injection Pump Removal

1. Remove driven gear attaching bolts and remove gear from fuel injection pump (Figure 2-108).
2. Remove injection pump attaching nuts and washers from front cover studs.
3. Remove spring, cable bracket, and throttle lever.
4. Remove fuel injection pump and gasket from timing gear cover. Discard gasket.

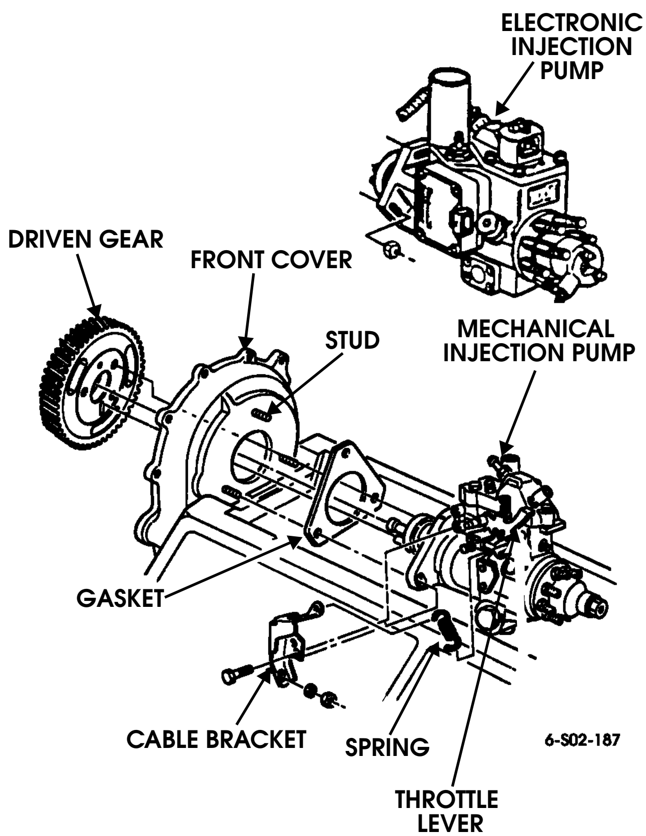

Figure 2-108: Fuel Injection Pump and Driven Gear Removal

Front Cover Removal

1. Remove baffle from front cover (Figure 2-109).
2. Remove bolts attaching front cover to oil pan.
3. Remove bolts attaching front cover to engine block.
4. Remove front cover. Use mallet to loosen cover. Do not pry cover loose.
5. Remove oil seal from cover

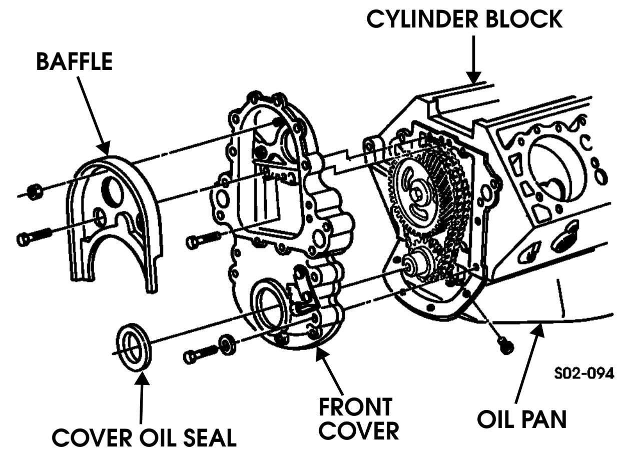

Figure 2-109: Front Cover and Baffle Removal

Timing Chain, Drive Sprockets, Drive Gear Removal

1. Measure timing chain deflection. Deflection must not exceed 0.810 in. (21 mm). Use dial indicator J8001 (Figure 2-111).
2. Measure camshaft end play. End play should not exceed 0.012 in. (0.3 mm). If end play exceeds 0.012 in. (0.3 mm), camshaft sprocket, thrust plate, or spacer is worn and will have to be replaced.
3. Remove injection pump drive gear bolt and remove drive gear from camshaft.
4. Remove crankshaft sprocket, camshaft sprocket, and timing chain as assembly (Figure 2-110).

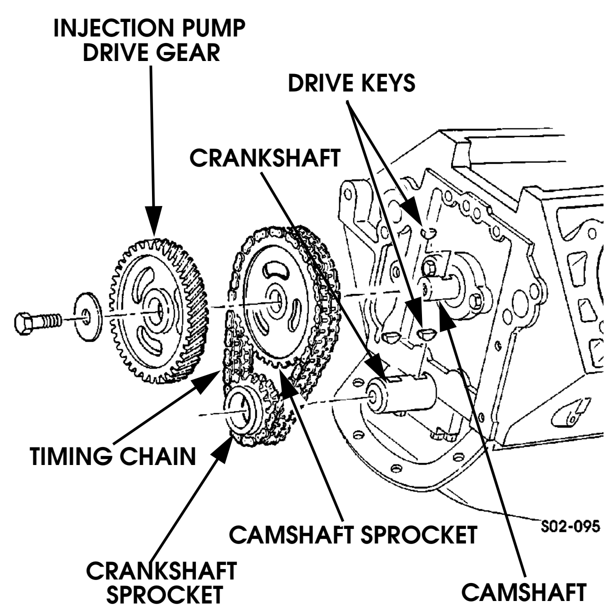

Figure 2-110: Timing Chain, Drive Sprocket, Drive Gear Removal

5. Remove drive keys from camshaft and crankshaft.

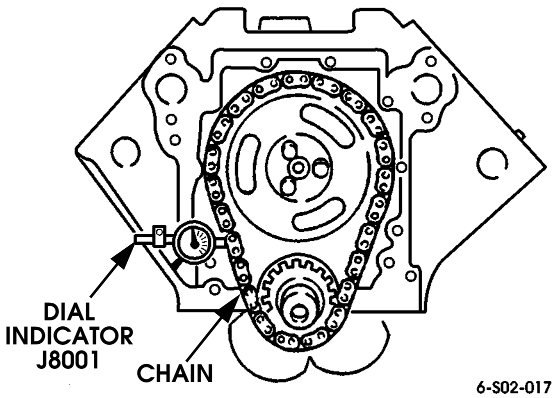

Figure 2-111: Measuring Timing Chain Deflection

Oil Filter, Adapter, and Oil Pressure Sending Unit Removal

1. Remove oil filter from adapter (Figure 2-111). Discard oil filter.

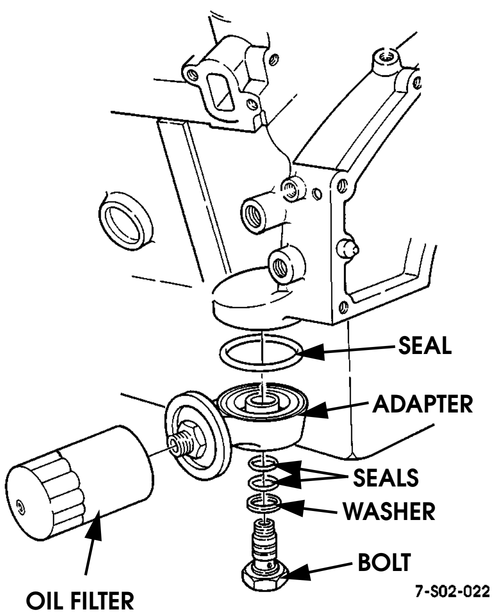

Figure 2-112: Oil Filter and Adapter Removal

2. Remove adapter bolt, washer, seals and adapter.
3. Unplug electrical connector and remove oil pressure sending unit from engine valley (Figure 2-113).

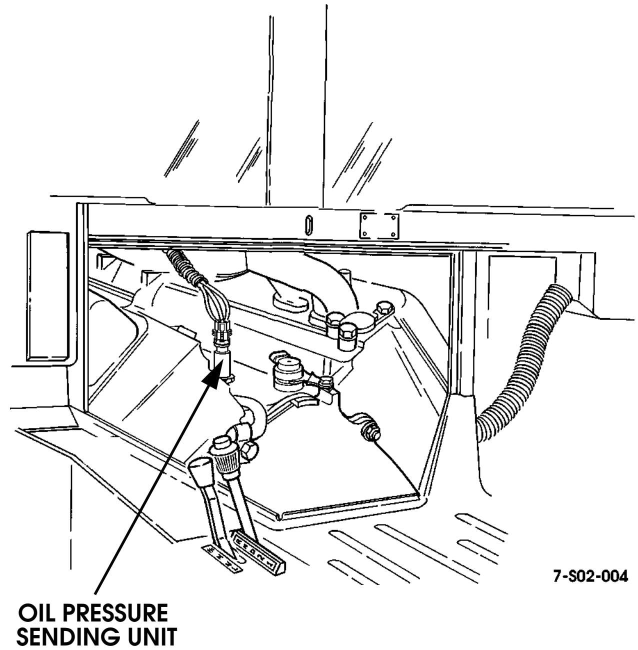

Figure 2-113: Oil Pressure Sending Unit Location

Oil Pan Removal

1. Drain oil from pan if not previously done.
2. Remove pan bolts.
3. Tap pan with rubber mallet to loosen. Then remove pan.
4. Remove pan rear seal (Figure 2-114). Discard seal.

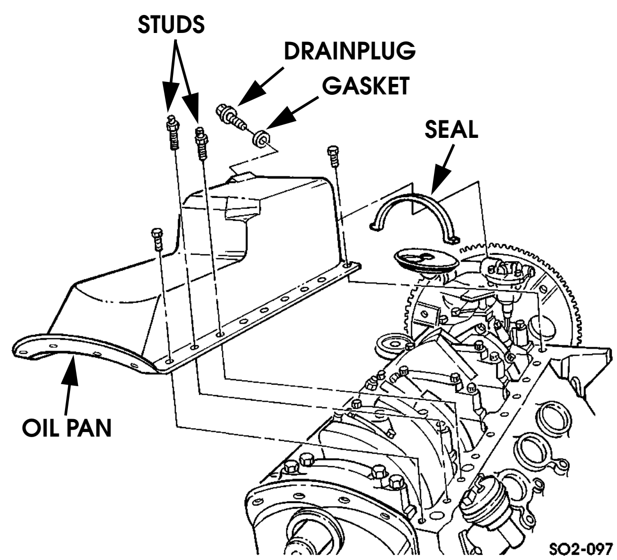

Figure 2-114: Oil Pan Removal

Oil Pump and Drive Removal

1. Remove nut from pump mounting stud (Figure 2-115).
2. Loosen bracket clamp screw and rotate bracket off mounting stud.
3. Remove pump mounting stud.
4. Lift and remove pump and pump shaft.
5. Remove oil pump drive clamp.
6. Lift and remove oil pump drive from block (Figure 2-116).
7. Remove and discard pump drive gasket.

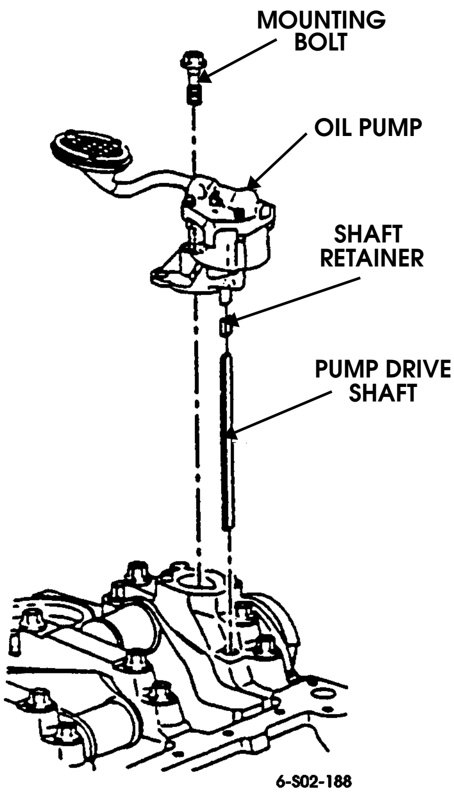

Figure 2-115: Oil Pump Removal/Installation

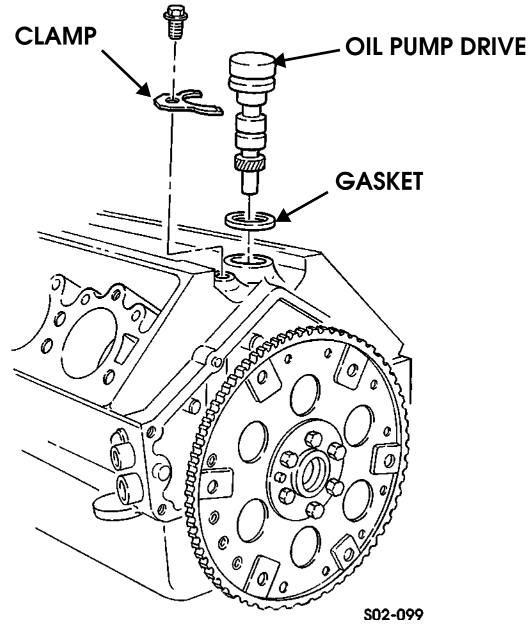

Figure 2-116: Oil Pump Drive Removal

Camshaft Removal

1. Remove thrust plate and spacer (Figure 2-117).

CAUTION: *Support camshaft during removal to avoid damaging bearings.*

2. Remove camshaft from cylinder block.

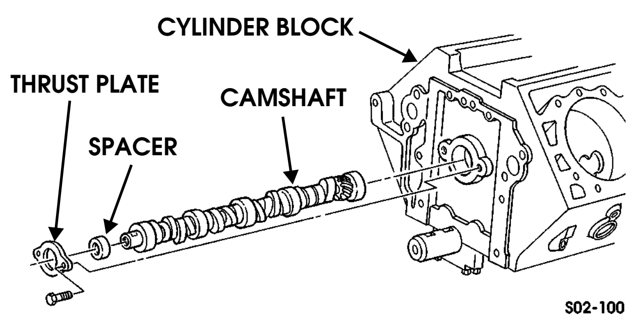

Figure 2-117: Camshaft Removal

Piston and Connecting Rod Removal

1. Remove ridge at top of each cylinder bore with ridge reamer J24270. Remove shavings - chips afterward.
2. Paint mark pistons for assembly reference.
3. Mark connecting rod caps with punch, if caps do not have factory marks.
4. Remove each piston - connecting rod assembly as follows (Figure 2-118):
   a. Remove number one piston connecting rod cap nuts.
   b. Remove rod cap and bearing half. Retain bearing for select fit reference.
   c. Slide lengths of appropriate size rubber hose over each rod bolt. This is necessary to avoid scratching crankshaft journal or cylinder bore.
   d. Remove and retain bearing half from connecting rod.
   e. Push rod and piston assembly out of bore by hand or with wood hammer handle.
   f. Reinstall rod bearings and end cap on rod to keep parts together.
   g. Remove connecting rod and piston assemblies two through eight in same manner.

Flywheel Removal

1. Remove six capscrews and flywheel from crankshaft (Figure 2-119).
2. Remove flywheel attaching bolts with impact wrench and suitable size socket.
3. Work flywheel off crankshaft flange with rocking motion.

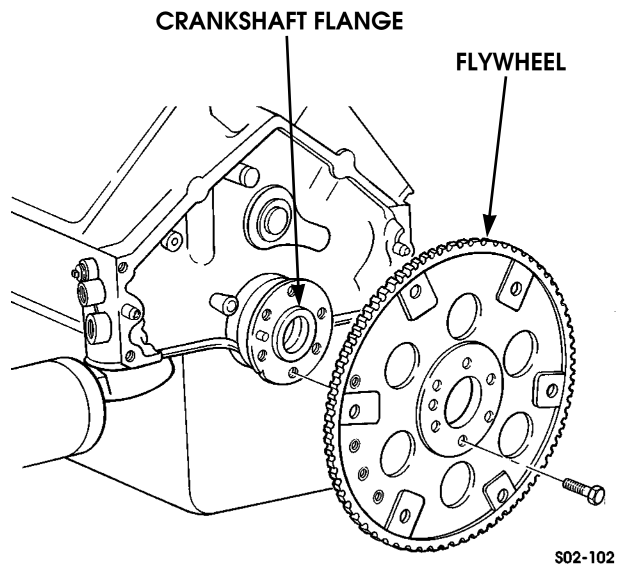

Figure 2-119: Flywheel Removal

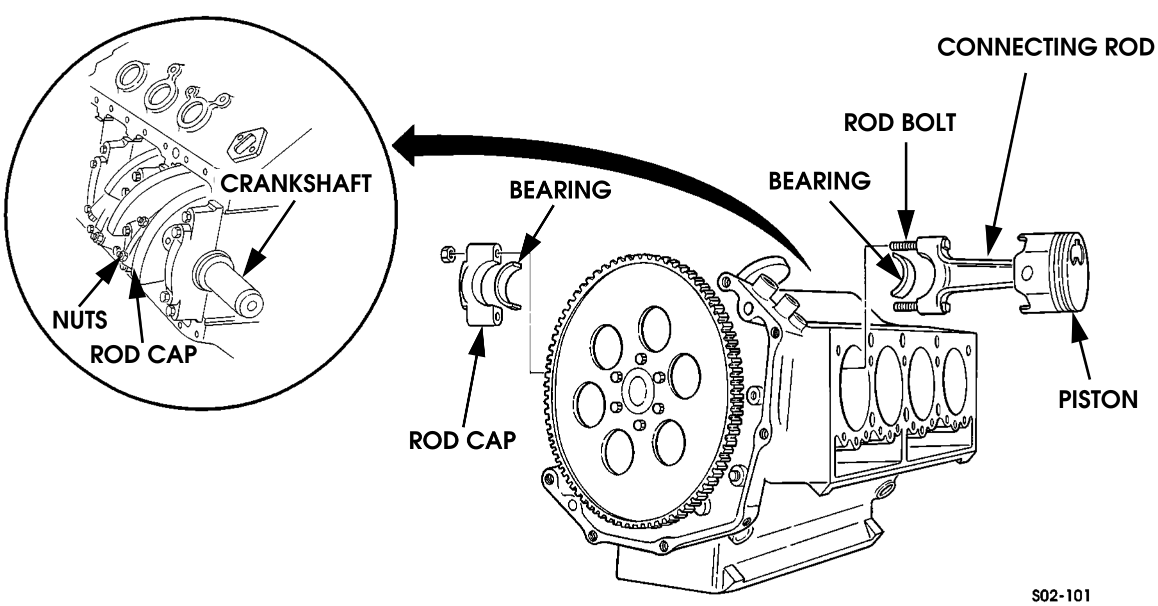

Figure 2-118: Piston and Connecting Rod Removal

Crankshaft and Main Bearings Removal

1. Inspect main bearing caps. Note if caps have factory I.D. markings on them. However, if caps do not have factory marks, it will be necessary to mark each cap with a center punch, or scriber. Main caps must be reinstalled in same location and direction, to maintain bore alignment for crankshaft journals (Figure 2-120).
2. Remove rear main oil seal.
3. Remove main bearing cap bolts. Discard bolts.
4. Tap main bearing caps with rawhide mallet to loosen. Then lift and remove caps. Keep them in order of removal (Figure 2-121).
5. Lift crankshaft out of bearing saddles in block. Place crankshaft on bench for cleaning and inspection.
6. Remove main bearing upper halves from block. Keep bearing halves for inspection and select fit reference.

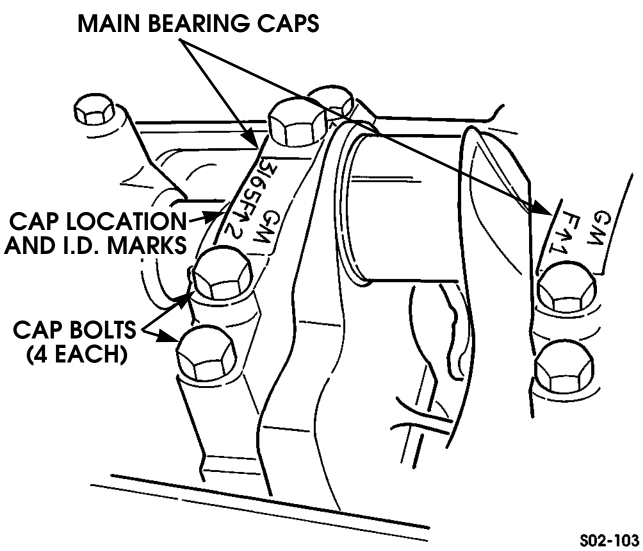

Figure 2-120: Main Bearing Cap I.D. Marks

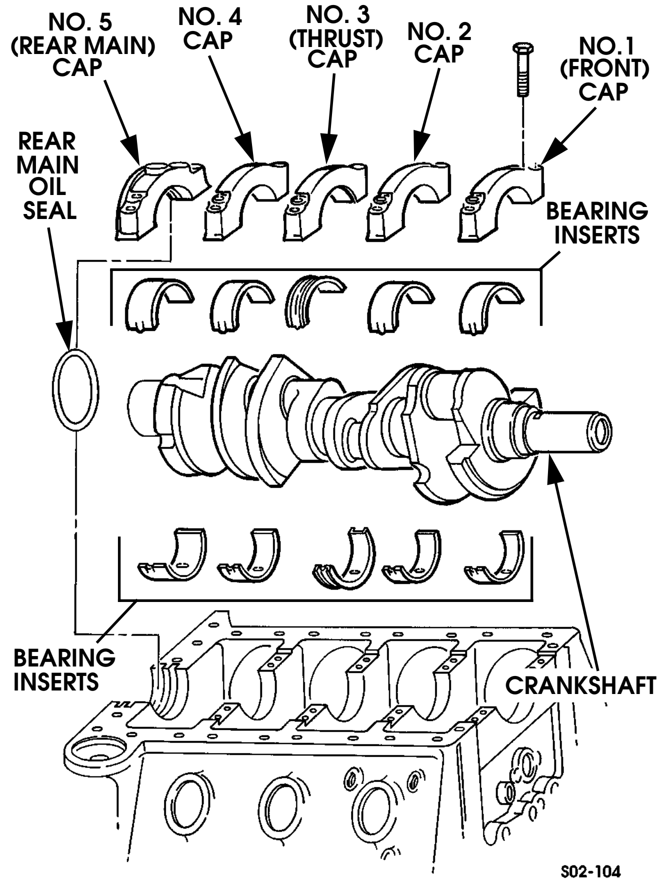

Figure 2-121: Crankshaft and Bearing Removal

CYLINDER BLOCK SERVICE

Cleaning

The block can be cleaned with standard parts cleaning equipment. However, if the crankcase and bores are heavily coated with varnish, gum, carbon, sludge, or rust deposits in the coolant passages, hot tanking will be necessary.

Clean out all oil galleys and water passages with wire brushes designed for this purpose.

CAUTION: *The cam bearings (Figure 2-122) must be replaced if the block is "hot tanked". The caustic solution used for this type of cleaning, will etch and weaken bearing surfaces. The expansion plugs and oil filter pressure regulating valve must also be removed before hot tank cleaning.*

Coat the block with a light solvent after cleaning to prevent rust formation. Useful solvents are available from LPS Corp., Solder Seal, WD-40 and similar firms.

NOTE: Be sure to inspect the piston cooling oil tubes in turbo diesel blocks. Verify that the tubes are clear (Figure 2-123).

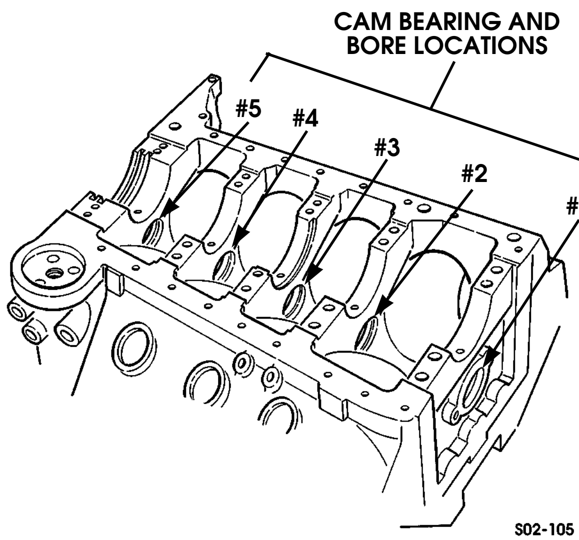

Figure 2-122: Camshaft Bearing Locations

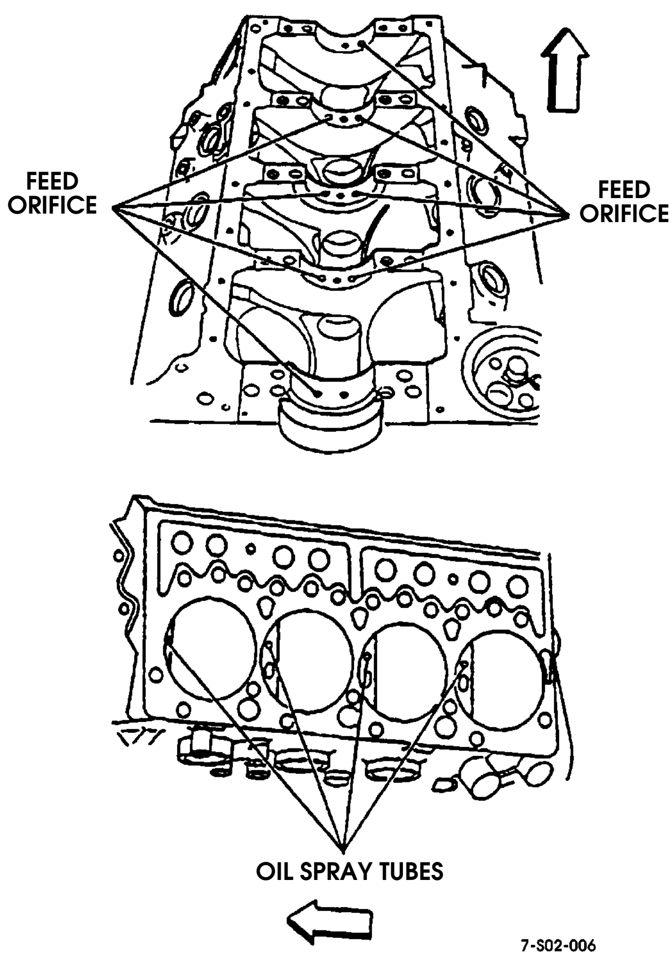

Figure 2-123: Piston Oil Cooling Feed and Spray Orifice Locations (Turbo Diesel Only)

Inspection

Check all of the block surfaces for nicks, scratches, cracks, damaged threads, or evidence of porosity at any point. Minor nicks and scratches can be smoothed with a fine tooth file or 180 grit emery. Damaged threads can be either chased, or repaired with Helicoil stainless steel thread inserts. Replace the block if cracked, or if porous spots are evident.

Light discoloration of gasket surfaces and cylinder bores is normal and not a cause for replacement. However, evidence of severe overheating and heat checking will require closer attention to dimensional checks.

Check condition of the expansion plugs (Figure 2-124), and camshaft plug. Replace the plugs if corroded, rusted, loose, or coolant leakage is evident. Refer to the procedure in this section if plug replacement is required.

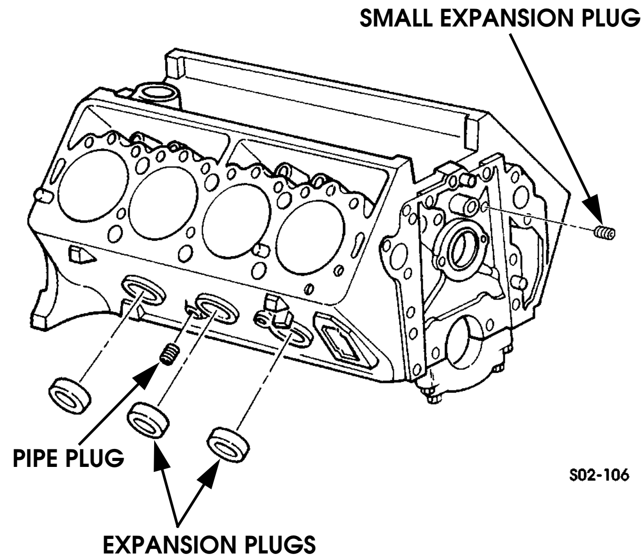

Figure 2-124: Cylinder Block Expansion Plug Locations

Check the cam bearings. Locations in the block are shown (Figure 2-122).

It is not necessary to replace the bearings if they only have a burnished, or polished appearance, and wear is very minimal. However, replace all of the bearings if one or more are scored, flaking, distorted, etched, pitted, loose, or misaligned. Also replace the bearings if the block was hot tank cleaned with the bearings in place. Refer to the bearing replacement procedure in this section.

On turbocharged engines, check the oil feed holes at the rear of the block near the oil pump drive. Make sure the feed holes are clear and not plugged. This is important as any restrictions will result in turbocharger failure.

Remove and inspect the oil pressure regulator and safety valves. Replace the regulator valve plug; do not reuse it. Replace the two valves if seized, binding, or plugged. Do not try to salvage the valves.

Check the pipe plugs at the sides and front of the block (Figure 2-125). Replace any plugs that are loose or leaking. Coat replacement plug threads with Permatex #2, or high temp silicone sealant before installation.

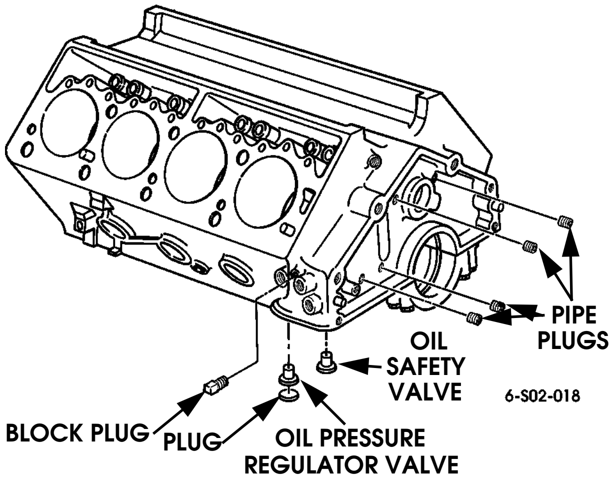

Figure 2-125: Cylinder Block Valve and Plug Locations

Cylinder Bore and Piston Measurement

Check surface flatness of the cylinder block deck with a straightedge and feeler gauge (Figure 2-126). Deck surface flatness must not vary by more than 0.002 in. (0.05 mm) in any six inch (15 cm) length, or 0.006 in. (0.15 mm) overall. Replace the cylinder block if deck flatness is not within stated limits. Do not attempt to salvage a block by machining the deck surface. This practice will result in valve-to-piston contact.

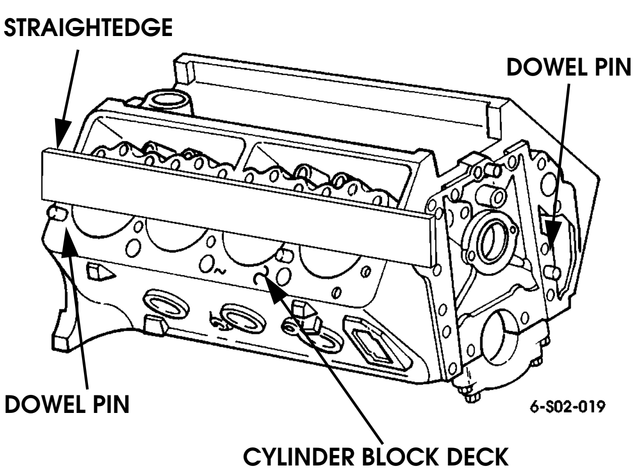

Figure 2-126: Checking Deck Flatness

Check condition of the cylinder head and front cover dowel pins (Figure 2-126). Remove and replace any pins that are loose.

Inspect the main bearing saddles, bearing caps, front cover surface, block webs, and pan rails (Figure 2-127). Replace the block if cracks, severe scoring, or distortion is evident at any point.

Measure degree of wear and taper in each cylinder bore with bore gauge J8087 (Figure 2-128).

a. Refer to the Service Piston and Cylinder Bore Specifications data at the end of this section for bore dimensions.
b. Center the bore gauge in the cylinder and zero the dial indicator (Figure 2-128).
c. Work the gauge slowly up and down the cylinder from top to bottom. Take measurements at cylinder axis points “A” and “B” (Figure 2-129). Note that most wear occurs in the top 2 1/2 in. (63.5 mm) of the cylinder.

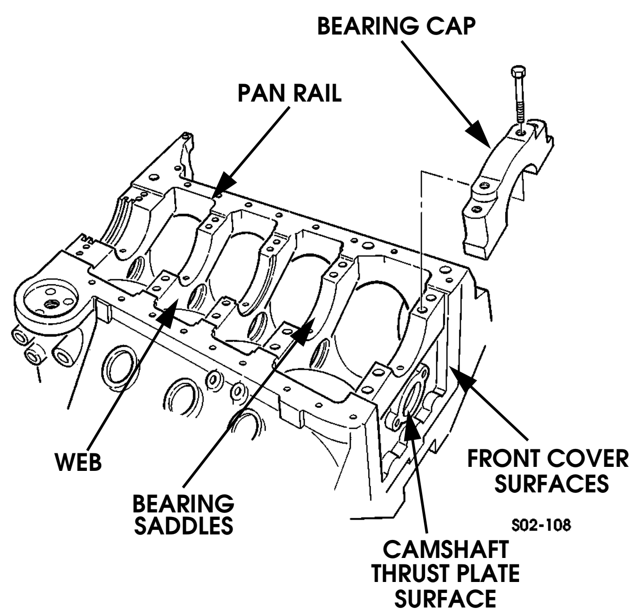

Figure 2-127: Rail, Web, Bearing Inspection Points

NOTE: Cylinder number 7 and 8 require an additional 0.0005 in. (0.013 mm) for piston clearance. Take this into account when checking bore wear.

d. Maximum allowable service wear and taper is 0.005 in. (0.013 mm).
e. Rebore the cylinder and replace the pistons if wear and taper exceed allowable service limits.

NOTE: Replace the cylinder block if bore diameter exceeds 4.075 in. (103.521 mm) on cylinder 1-6 and 4.076 in. (103.534 mm) on cylinders 7 and 8.

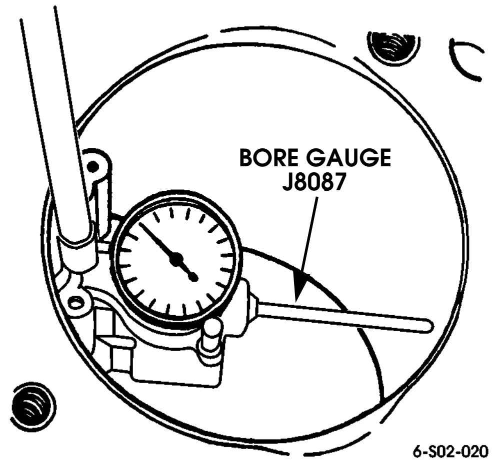

Figure 2-128: Measuring Cylinder Taper and Wear with Bore Gauge

Measure piston skirt diameter at the centerline of the piston pin but at a right angle (opposite) to the pin. Refer to the “Service Piston and Cylinder Bore Specifications” data at the end of this section for dimensions.

Remove the piston rings, insert the piston in the bore, and check piston-to-bore clearance with a feeler gauge. Clearance should not exceed 0.004 in. (0.120 mm) on cylinders 1 through 6, and 0.005 in. (0.133 mm) on cylinders 7 and 8.

- Replace the piston if the skirt is severely scored, collapsed, or worn below specified limits.
- Reuse the piston if in good condition and wear is minimal. However, if the cylinder bore is worn and requires reboring, the piston must be replaced, even if it’s in good condition.
- Replace the piston if the bore is OK but piston-to-bore clearance is greater than specified.

Remove all the expansion/freeze plugs with a punch and hammer. Coat the edges of replacement plugs with Permatex #2, or a high temp RTV sealer. Seat the new plugs in the block with a suitable size socket and hammer. Be very sure each plug is firmly seated. Replace any plug that becomes distorted during installation; do not salvage it.

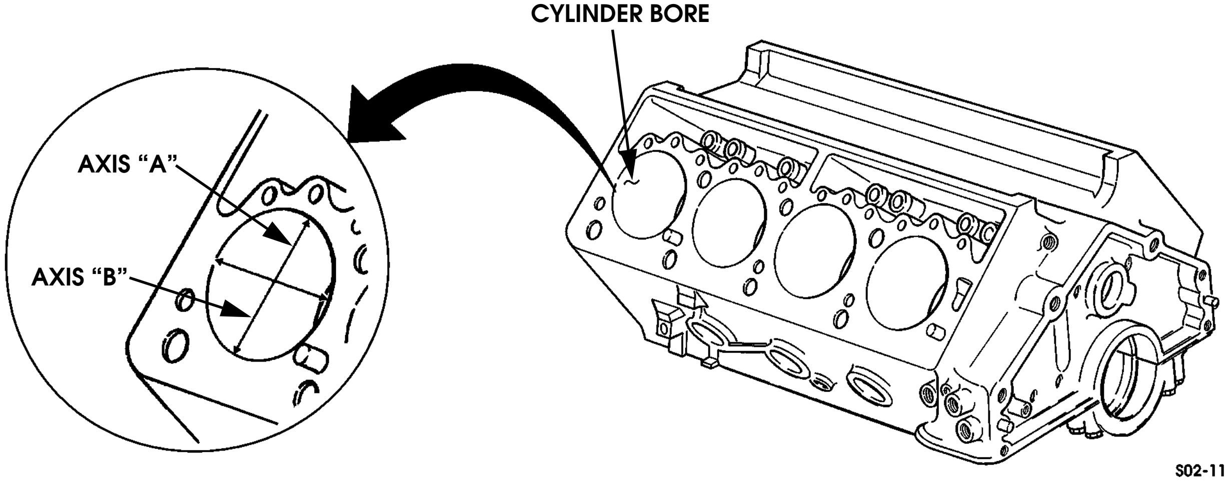

Figure 2-129: Cylinder Bore Measuring Points

Cylinder Boring and Honing Information

Check the ID letters stamped on the cylinder block pan rails. These letters identify the production standard piston grade size and cylinder bore. The letters used are J, K, G, and T. Grade and sizes are listed in the service piston and bore chart at the end of this section. Use this information as a check - before - ordering parts or performing any machining operations.

Production and oversize pistons from the factory are all the same weight, therefore engine balance is not affected. This means that a low mileage block does not have to have all the cylinders rebored if only one or two require this. However, on high mileage blocks, it is better to rebore all the cylinders to maintain equal cylinder pressures.

The main bearing caps should be installed and tightened to specified torque before commencing boring operations. The block decks should also be clean, smooth, and free of nicks and burrs. The boring bar must rest on a flat, even surface to avoid an off-center bore. Boring and honing plates are also recommended.

Keep boring bar cutting tool speed and feed rates within the tool manufacturers recommendations. Excessive feed or speed rates can produce unwanted tool marks. Extra honing operations will be required to correct this.

Boring should be a two step operation consisting of: a rough bore to remove about 90% of the required stock, and a finish bore to within 0.003-0.005 in. (0.0762-0.1270 mm) of the desired final size. The final bore size, including required piston-to-bore clearance, will be achieved during honing operations.

Cylinder honing is required to break the glaze, or to achieve final surface finish and piston clearance after boring operations. Glaze breaking hones are designed for hand operation in a drill motor. This type of honing only requires breaking through the varnish buildup on the walls. Machine operated cylinder hones, such as those built by the Sunnen Corp., are required for achieving final finish and size.

Honing operations on rebored cylinders should also be a two step procedure. A rough hone to within 0.0005 in. (0.13 mm) followed by a finish hone to size. The rough honing establishes size while finish honing generates the required 45° cross-hatch pattern. The crosshatch pattern provides a surface that will retain oil for proper wall lubrication. Perfectly smooth finishes are to be avoided.

NOTE: Service oversize pistons are available in one size only which is 0.020 in. (0.50 mm) over. This is the maximum allowable cylinder oversize. Note this before initiating boring operations.

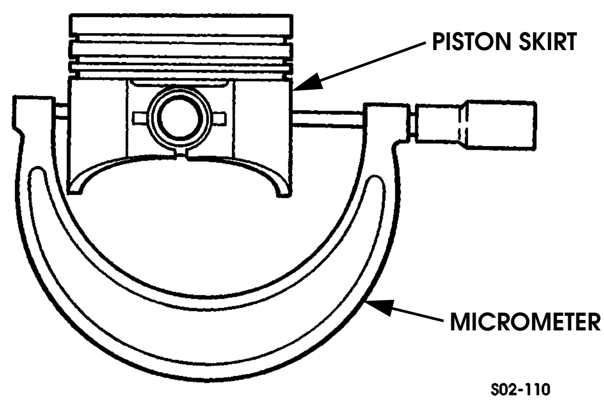

Figure 2-130 Measuring Piston Skirt Diameter

CAMSHAFT BEARING REPLACEMENT

Camshaft bearing tool set J33049 plus adapters J6098-11 and J6098-12 and tool set J6098-01 are required for bearing replacement.

During removal, bearings 1 and 5 are removed last because they must be in place to support the pilot tool. For this reason, these bearings must be installed first during replacement.

The front (no. 1) bearing has two oil feed holes. The remaining bearings have a single oil feed hole. All of the bearing feed holes must be aligned with the oil feed holes in the bearing bores.

Cam bearings 1, 2, 3, and 4 are the same size. However, bearing number 5 is a different diameter. Be sure the correct bearing is installed in each bore. Replacement bearings are numbered to help avoid incorrect placement.

The front (no. 1) bearing has a notch in it. This notch must face out toward the block front. Each of the bearings also has an oil groove. Install the bearings so the groove is at the top of the bore toward the upper part of the block.

Bearing Replacement Procedure

1. Remove camshaft plug at rear of block (Figure 2-131). Use long wood dowel or pipe tool and hammer to tap plug out rear of block. Discard plug afterward. It is not reusable.
2. Remove No. 2 bearing as follows:
   a. Insert pilot from tool set J33049 in No. 1 bearing (Figure 2-131).
   b. Slide puller screw from tool set J33049 through pilot and through No. 2 bearing.
   c. Install adapter J6098-11 on puller screw and seat adapter in No. 2 bearing.
   d. Tighten nut on puller screw to remove bearing.
3. Remove bearings 3 and 4 as described in step 2.
4. Remove bearing No. 5 with driver handle from tool set J6098-01 and adapter J6098-12 (Figure 2-132).
5. Remove bearing No. 1 with driver handle and J33049 (Figure 2-132).

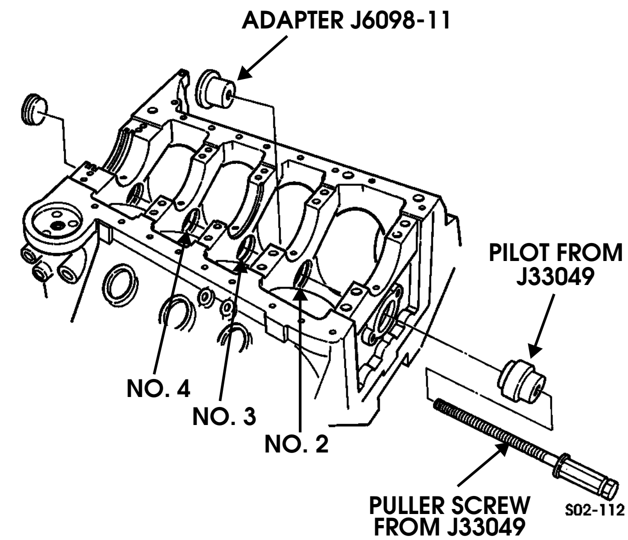

Figure 2-131: Removing Cam Bearings 2, 3, and 4

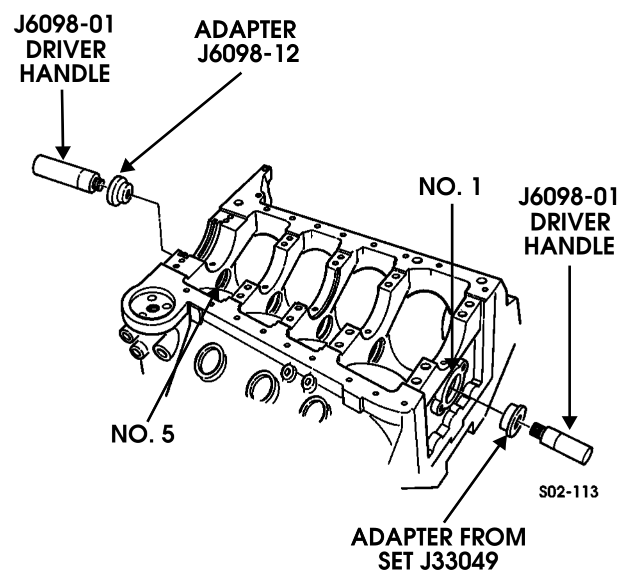

Figure 2-132: Removing Cam Bearings 1 and 5

CAUTION: *It is extremely important that the cam bearings be properly aligned during installation. Failure to align the oil feed holes in the bearings and oil feed slots in the bearing bores, will result in engine failure.*

6. Note ID numbers on new bearings. Place bearings in order to maintain correct installation sequence.
7. Mark center position of oil slot in each bearing bore with grease pencil or chalk. Place marks adjacent to each bearing bore so it is easily viewed. Make two marks for no. 1 bearing to ensure that both oil holes will be aligned.

8. Align oil hole in new No. 5 bearing with J6098-01 alignment mark on block. Seat bearing in block with driver handle and adapter J6098-12 (Figure 2-133).
9. Align both oil holes in new No. 1 bearing with oil holes in block (Figure 2-133). Bearing notch should be facing out and seam at 11 O'clock position. Seat bearing in block with driver handle and adapter J33049 (Figure 2-133).
10. Check installation of bearing number 1 and 5. Verify that bearing oil holes are centered on slots in bores and that bearings are flush with edges of bearing bores. The small groove in each bearing should be towards upper part of block. Remove and reposition either bearing if misaligned (Figure 2-133).
11. Install remaining bearings, starting with No. 2, as follows:
    a. Insert pilot in No. 1 bearing.
    b. Slide puller screw through pilot and No. 2 bearing bore (Figure 2-134).
    c. Position new bearing on adapter J33049 (Figure 2-134).
    d. Secure adapter to puller screw.
    e. Align bearing oil hole with paint mark on block.
    f. Tighten puller screw to draw bearing into place.
    g. Verify that bearing oil hole is properly aligned.
    h. Install bearings 3 and 4 in same manner.

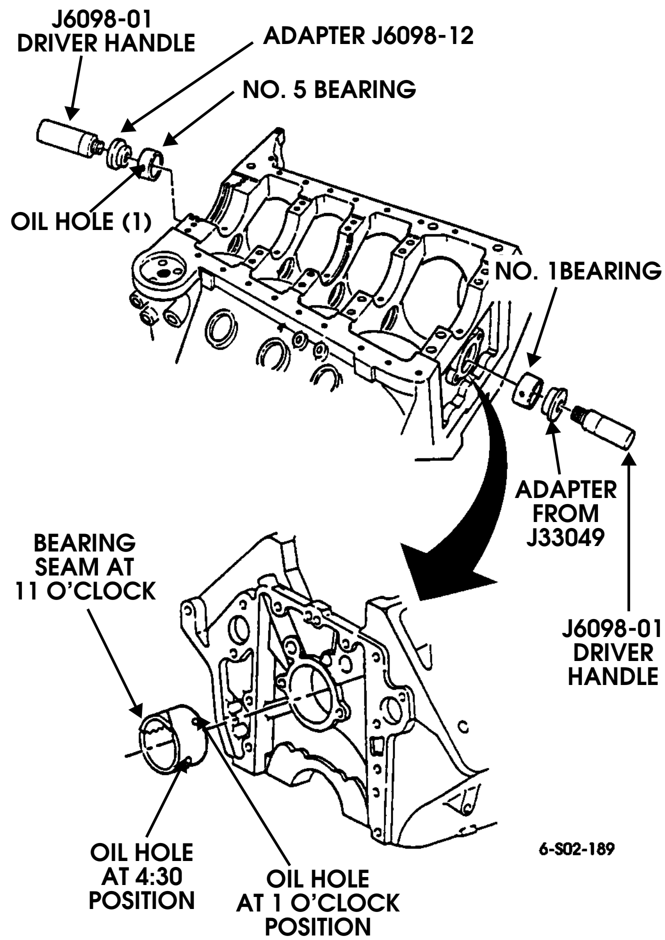

Figure 2-133: Installing Cam Bearings 1 and 5

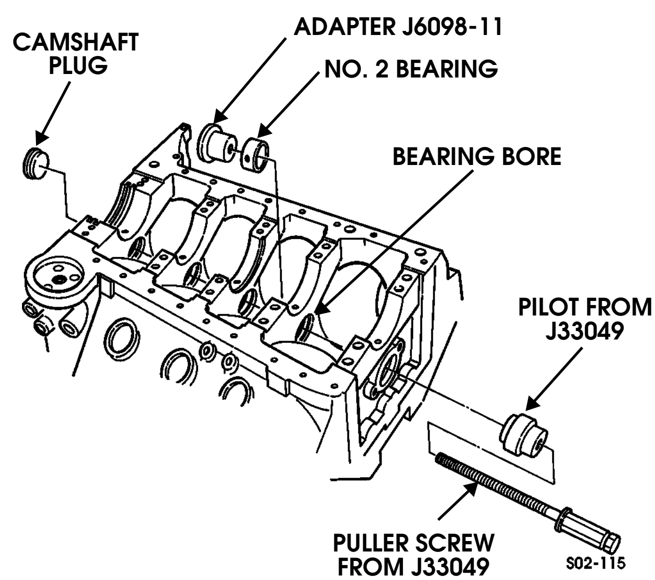

Figure 2-134: Installing Cam Bearings 2,3, and 4

CRANKSHAFT SERVICE

Clean the crankshaft with solvent and clear the journal oil holes with a wire brush if necessary. Dry the crankshaft with compressed air or lint free shop towels.

Inspect condition of rod and main journals (Figure 2-135). The journals must be smooth and free from scoring, grooves, taper, cracks, and checking/galling.

Minor nicks and burrs can be removed with an oil stone and 380 grit emery. Minor scratches, or scoring on journal surfaces can be smoothed with 320 grit emery followed by polishing with crocus cloth.

Check for cracks on all surfaces including the counterweights. Also check the threads in the crankshaft flange and nose. Rusty, rough threads can be cleaned up with a tap. However, replace the shaft if the threads are seriously damaged. Magnaflux or Zyglo the crankshaft if cracks are suspected.

Although the crankshaft journals can be machine polished to restore surface finish, replace the crankshaft if damaged, distorted, worn, or scored. Do not attempt to salvage it.

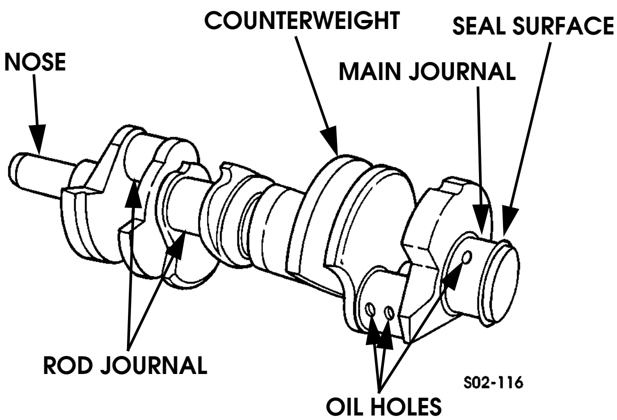

Figure 2-135: Crankshaft Inspection Points

Checking Crankshaft Journal Diameter and Runout

There are three main journal diameter ranges. These ranges are identified by a color code paint mark near one of the journals. The three size range color codes are blue, orange/red, and white. Note the code on the crankshaft and refer to the specification charts at the end of this section for size ranges.

Use a micrometer to check journal diameter. Measure both ends of each journal to check for taper along with wear (Figure 2-136).

Journal wear or taper must not exceed 0.0002-0.001 in. (0.05-0.025 mm).

Mount the crankshaft in a holding fixture and check runout at center (#3) main bearing journal (Figure 2-137).

Crankshaft runout should not exceed 0.0002 - 0.0008 in. (0.005 - 0.020 mm). Replace the crankshaft if runout is greater than specified. Do not attempt to straighten a cast iron crankshaft.

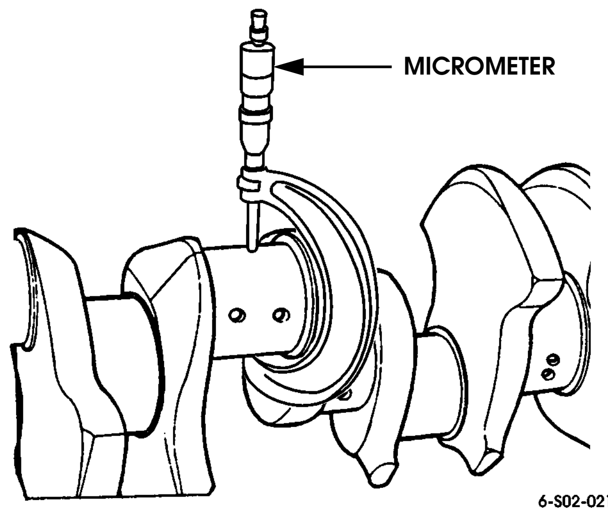

Figure 2-136: Measuring Journal Diameter

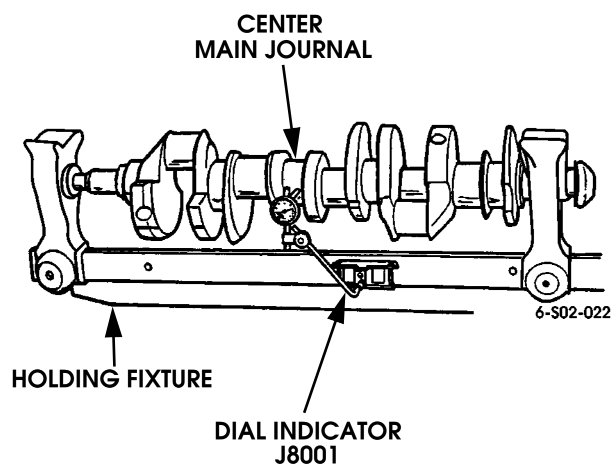

Figure 2-137: Measuring Crankshaft Runout

PISTON/CONNECTING ROD OVERHAUL

Remove and discard the old piston rings. Use a remover/installer tool similar to parallel jaw type tool shown (Figure 2-138). Discard rings after removal.

Use a ring groove tool to remove carbon and oil deposits from the ring grooves. Using a section from an old piston ring is not recommended for this purpose.

Disassembly the piston, and rod as follows:

a. Note piston-to-rod position for assembly reference.
b. Remove retaining rings that secure piston pin. Discard rings; they are not reusable.
c. Push piston pin out of piston and rod.
d. Separate piston, and rod, and pin (Figure 2-139).

Clean the piston, rod, and pin with solvent and carb cleaner if needed. Do not use a wire brush or any type of abrasive on the piston.

Inspect piston condition. Replace the piston if cracked, severely scuffed or scored, the ring lands are worn or damaged, or the skirt is collapsed (Figure 2-140).

Measure pin bore diameter in the piston (Figure 2-141). Then measure diameter of the piston pin (Figure 2-141). The difference between pin diameter and bore diameter, should be 0.0004 - 0.0006 in. (0.010-0.0153 mm). This figure represents the required pin-to-bore clearance. Replace the piston and pin as a set if clearance is greater than specified.

NOTE: Turbo diesel and non-turbo piston and rod assemblies are different. Do not interchange them.

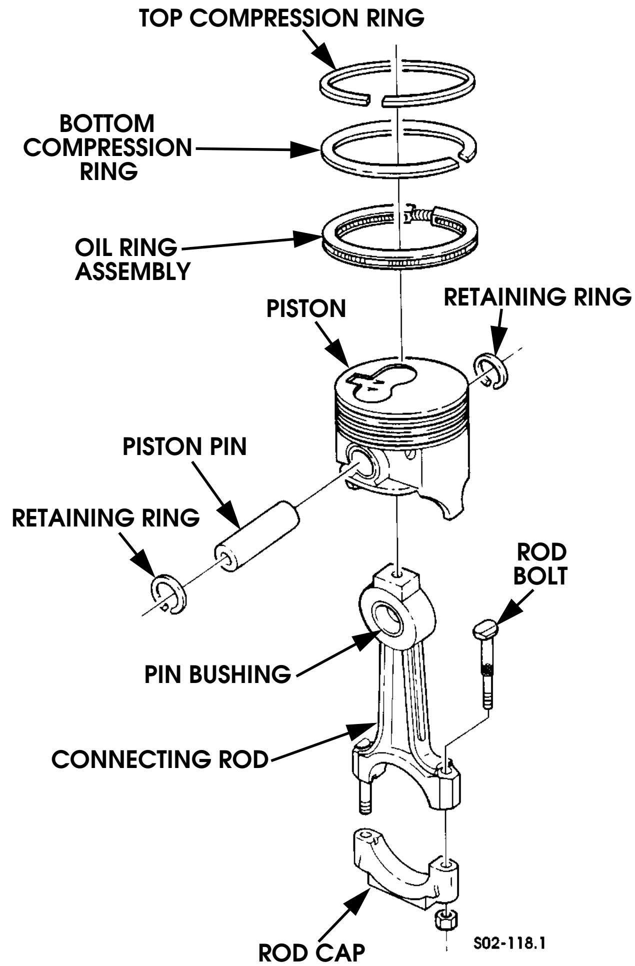

Figure 2-139: Connecting Rod and Piston Assembly

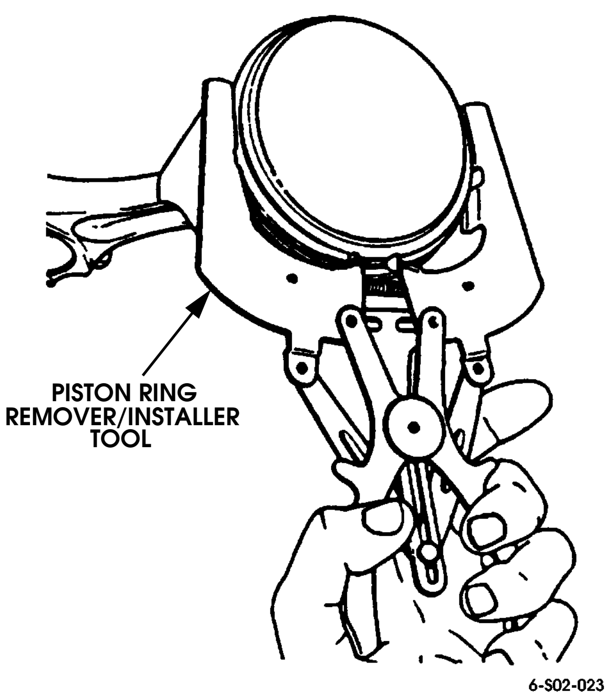

Figure 2-138: Piston Ring Removal/Installation Tool

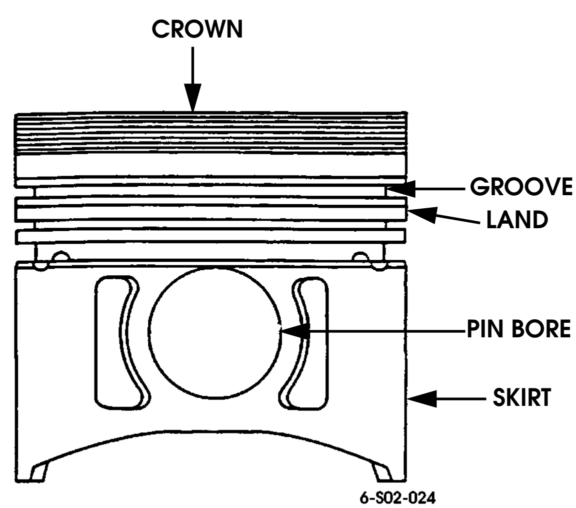

Figure 2-140: Piston Inspection Points

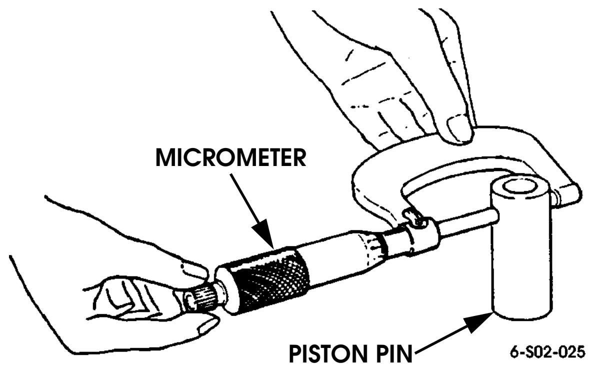

Figure 2-141: Measuring Piston Pin Diameter

Measure pin bushing diameter in connecting rod with small bore gauge or inside micrometer (Figure 2-142). Record bushing diameter and compare it to diameter of new or known good piston pin. The difference between the two measurements represents the piston pin-to-connecting rod pin bushing clearance. Required clearance is 0.0003-0.001 in. (0.0081-0.0309 mm). Replace the connecting rod if the bushing is worn oversize the bushing is not serviced separately.

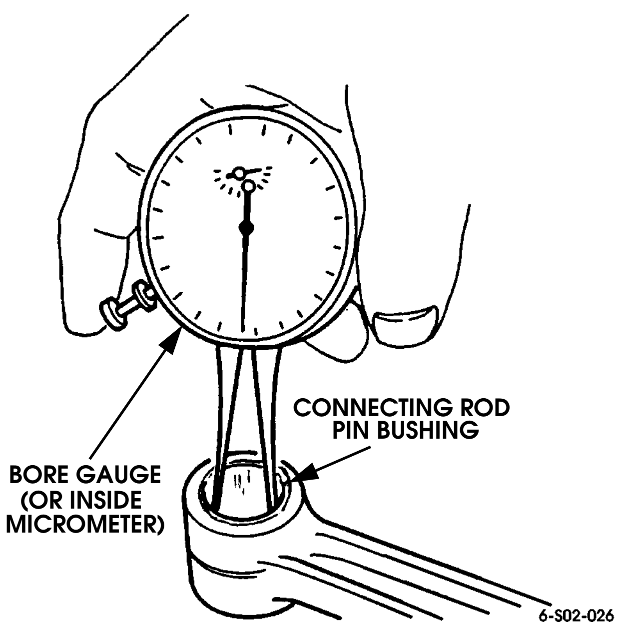

Figure 2-142: Checking Connecting Rod Pin Bushing Diameter

Check connecting rod straightness in a rod fixture, or on a surface plate or sheet of glass. The rod can be straightened if distortion is less than 0.002 in. (0.05 mm) end-to-end. Replace the rod if severely bent, twisted, or cracked.

Measure piston skirt diameter at, or just below the pin bore centerline. The correct gauge point is approximately 2.57 in. (65.3 mm) down from the piston crown (Figure 2-143). Be sure measurement is taken at a point opposite (at right angle to) the pin bore centerline as shown. Replace the pistons if wear is such that piston-to-bore clearance would be greater than:

- 0.004 in. (0.120 mm) for cylinder 1-6 and
- 0.005 in. (0.133 mm) for cylinder 7 and 8

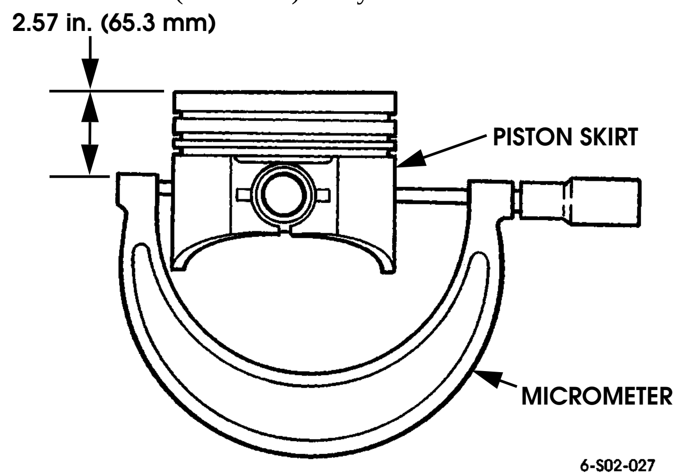

Figure 2-143: Measuring Piston Skirt Diameter at Gauge Point

Piston Selection and Fit

Production engines are equipped with different grade size pistons. The different grades allow factory select fitting of pistons. Correctly, three grades are used with the ID letters JT, KT, and GT or J, K, G, or T. The different grades are to accommodate minor variances in bore size. The ID letters are on the cylinder block pan rails adjacent to each cylinder bore, or the piston itself. The grade sizes are described in the piston and bore size chart at the end of this section.

Some general selection recommendations are:

- If an original piston is in good condition and meets all specifications, it can be reused.
- If the cylinder bore is OK but the piston was damaged, just use a new piston of the same grade size.
- If the piston grade size is not marked on the piston or pan rail, and the original piston is not reusable, select a piston that will provide the required piston-to-wall clearance. It is only necessary to know the actual bore size.
- The largest oversize piston available is 0.020 in. (0.50 mm).
- It is not necessary to rebore all the cylinders on a low mileage engine. Only the damaged cylinder needs to be repaired. This is permissible because factory service replacement and original pistons are all the same weight. Balance is not affected. However, it is recommended that all the pistons be replaced and the cyliners be rebored on high mileage engines.

- If a cylinder bore only requires honing to correct a problem, use the next grade size piston. Avoid going to the largest oversize piston unless absolutely necessary.
- Verify that a new piston is properly aligned on the connecting rod. The rod ID mark and the relief (combustion chamber) in the piston crown should be on the same side.

Piston and Connecting Rod Assembly

1. Lubricate piston pin, pin bore in piston, and bushing in rod with engine oil.
2. Install new bolts in rod and install rod cap.
3. Start pin and piston bore.
4. Position piston on rod. Relief in piston crown and rod bearing tangs/notches must be aligned (Figure 2-144).
5. Push piston pin through rod to secure it to piston.
6. Install piston pin retaining rings as follows:
    a. Place piston/rod assembly on clean section of workbench.
    b. Install tool J39507 on one end of piston pin (Figure 2-145).
    c. Start first retaining ring in piston pin bore (Figure 2-146). Position open end of ring downward toward bottom of piston.
    d. Use plastic or tape covered pry tool to work ring into pin bore.
    e. Insert tool J39507 into piston pin (Figure 2-144). Place tool tab on retaining ring. Seat ring by pressing downward and rotating tool in arc. Tool tab will press ring into place as it is rotated (Figure 2-147).
    f. Remove pin tools and install opposite retaining ring as described in steps c through e.

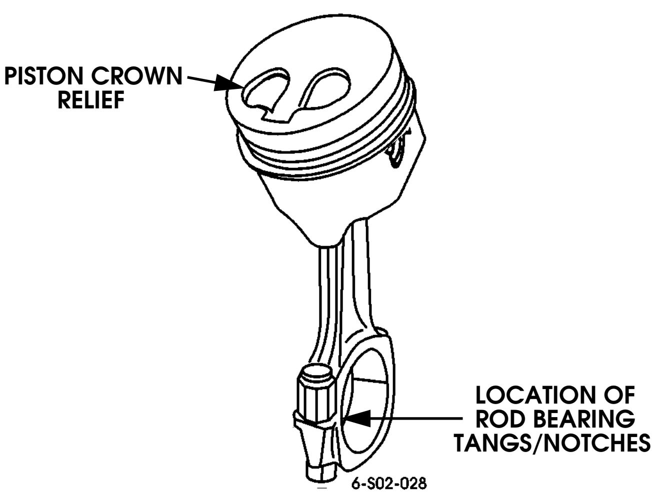

Figure 2-144: Piston and Connecting Rod Alignment

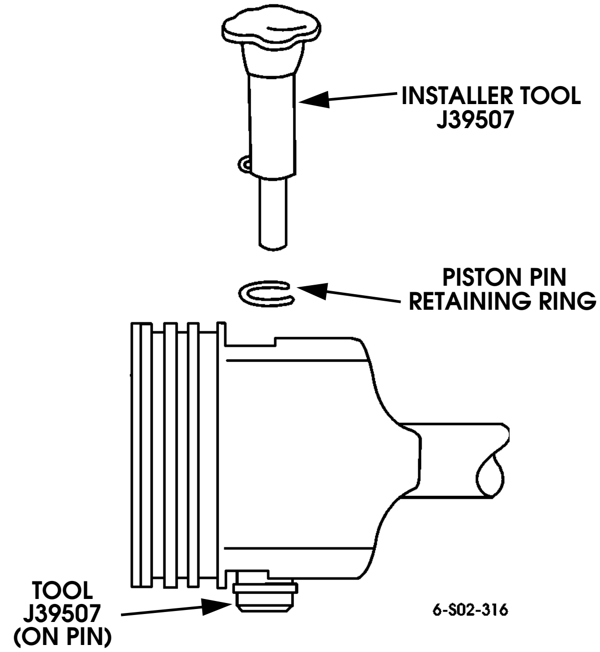

Figure 2-145: Positioning Pin for Installation of First Retaining Ring

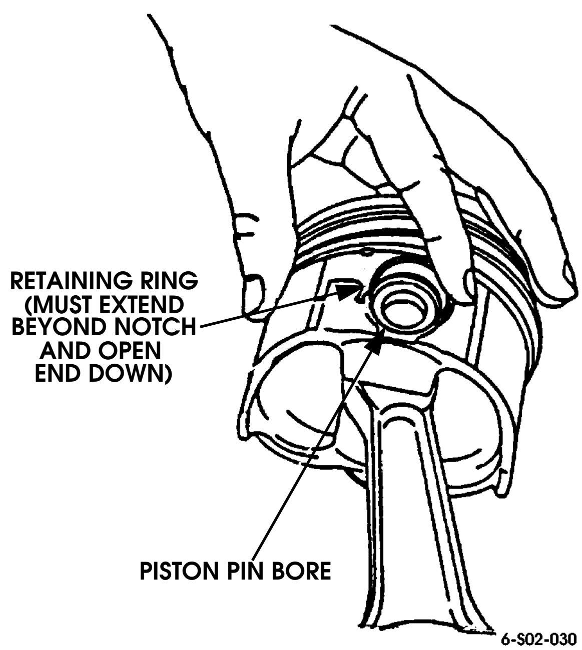

Figure 2-146: Starting Retaining Ring in Piston Pin Bore

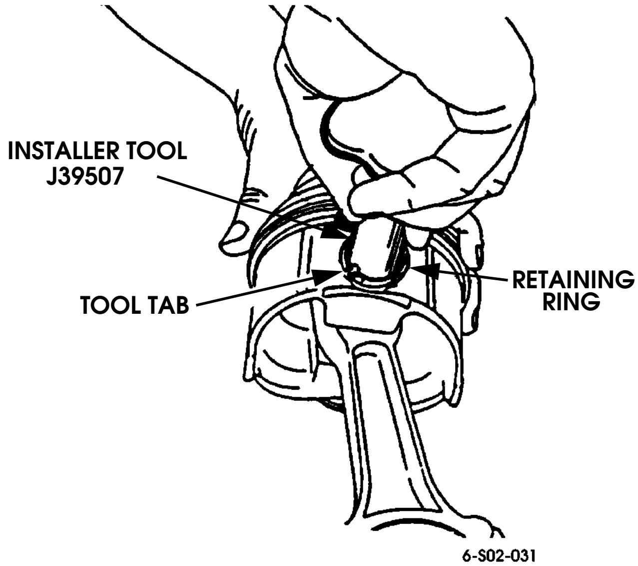

Figure 2-147: Seating Piston Pin Retainer Ring

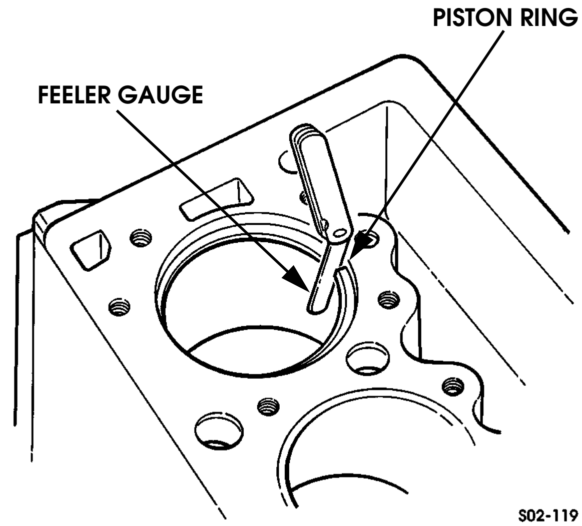

Figure 2-148: Checking Piston Ring End Gap

Piston Ring Installation

1. Check end gap of all rings. Insert ring in bore and push it down until its about 1-2 inches (2.5-5 cm) below top edge of bore. Verify that ring is level, then check end gap with feeler gauge (Figure 2-148). Correct end gaps are:
   - Oil ring is 0.009-0.020 in. (0.25-0.51 mm)
   - Bottom compression ring is 0.029-0.039 in. (0.75 -1.00 mm)
   - Top compression ring is 0.010-0.020 in. (0.26-0.51 mm)
2. If ring end gap is correct, proceed to step 3. But if gap is incorrect proceed as follows:
   a. If gap is only a few thousandths/mm too small, file or grind one ring end to obtain specified gap.
   b. If gap is almost non-existent, or ring ends overlap, rings are wrong size.
   c. If end gap is larger than specified by only a few thousands/mm, this indicates bore is slightly worn. Rings may be retained.
3. Install rings in sequence: oil ring first, bottom compression ring second, and top compression ring last. Use a quality expander tool to install the rings.
4. Position ring end gaps as shown (Figure 2-149). This avoids ring gap alignment which will cause loss of compression, blow by, and oil consumption.
5. Cover and store the piston and rod assemblies on a workbench prior to installation.

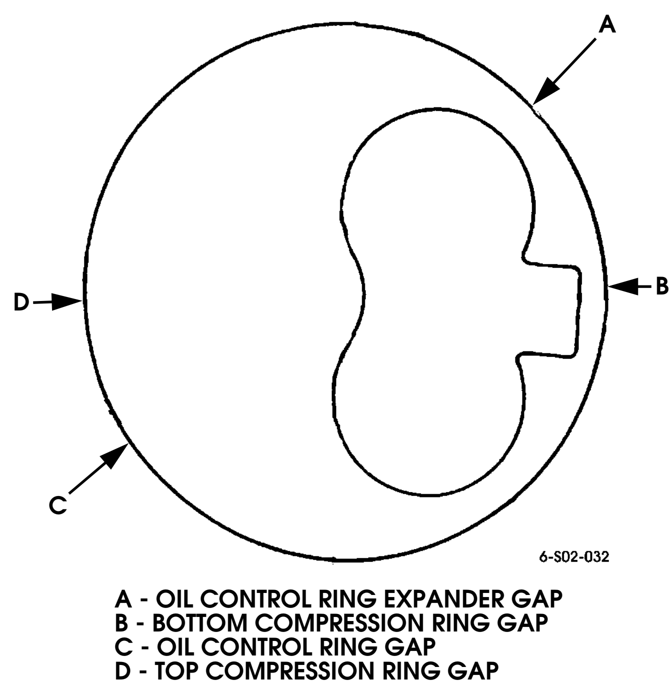

Figure 2-149: Recommended Positioning of Piston Ring Gaps

CAMSHAFT, TIMING CHAIN, SPROCKET, AND DRIVE GEAR SERVICE

Clean the camshaft and geartrain parts in solvent. Wipe the cam dry with shop towels only. Compressor can be used to dry the other parts.

Inspect the cam bearing journals for wear, scoring, scuffing, or discoloration from overheating. Replace camshaft if damaged or discolored (Figure 2-150).

Inspect oil pump drive gear on camshaft for damage. Replace camshaft if gear teeth are worn, chipped, or broken.

Measure bearing journal wear. Journals 1, 2, 3, and 4 should be 2.164-2.166 in. (54.975-55.025 mm). Journal 5 should be 2.007-2.009 in. (50.975-51.025 mm).

Mount the camshaft on “V” blocks and measure lift. Lift for both intake and exhaust valve lobes should be 0.281 ± 0.002 in. (7.133 ± 0.050 mm). Replace camshaft if any lobe is worn below specified range.

Inspect both sprockets for cracks, or chipped, broken teeth. Replace sprockets as a matched set if either one is damaged.

Inspect the timing chain for distortion, stretch, or binding. Replace the chain if damaged.

Inspect the fuel injection pump drive and driven gears for cracks, chipped or broken teeth, and wear. Replace both gears as a set if either one is damaged.

Inspect the thrust plate and spacer for wear. Replace either part if damaged or worn.

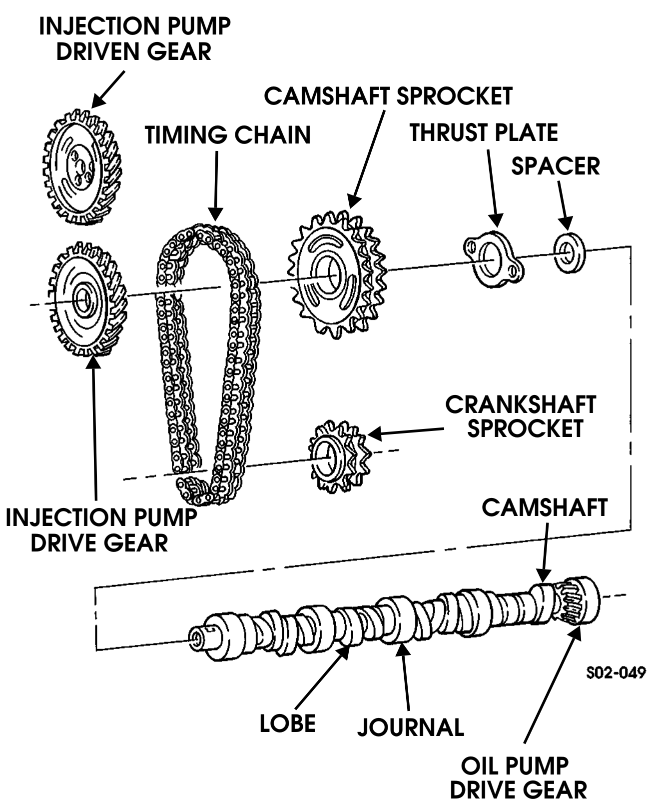

Figure 2-150: Camshaft and Geartrain

FRONT COVER AND OIL FILLER TUBE

Inspect the cover for cracks, scratches/nicks on the sealing surfaces, or damaged threads. Remove minor scratches/nicks with 180 grit emery. Repair thread damage with helicoil inserts. Replace part if damaged (Figure 2-151).

Inspect the adapter plate for cracks, scratches on mating and sealing surfaces, dents, pitting, and corrosion. Repair minor scratches with 180 grit emery. Replace the plate if cracked or bent.

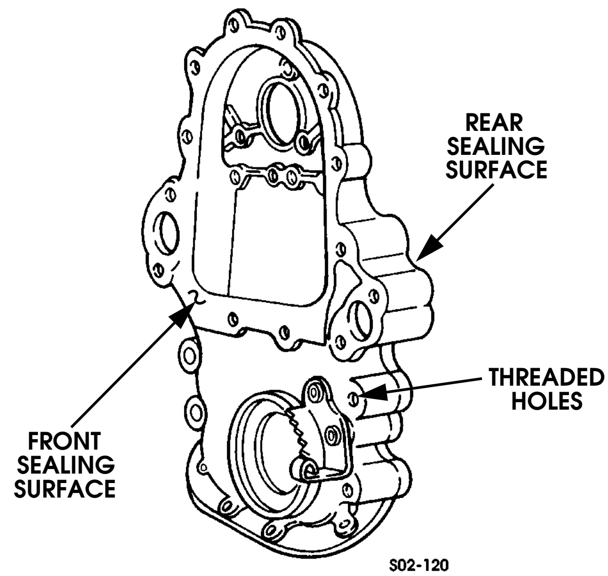

Figure 2-151: Front Cover Inspection Points

Inspect the oil filler tube grommet. Replace the grommet if cracked, brittle, or loose (Figure 2-152).

Inspect the oil filler tube. Replace the tube if cracked or distorted (Figure 2-153).

Inspect the filler cap sealing gasket. Replace the cap if the gasket is missing or damaged. Replace the cap if damaged.

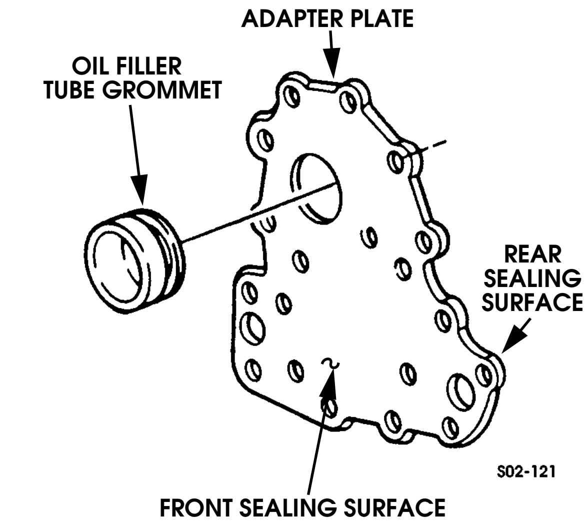

Figure 2-152: Adapter Plate Inspection Points

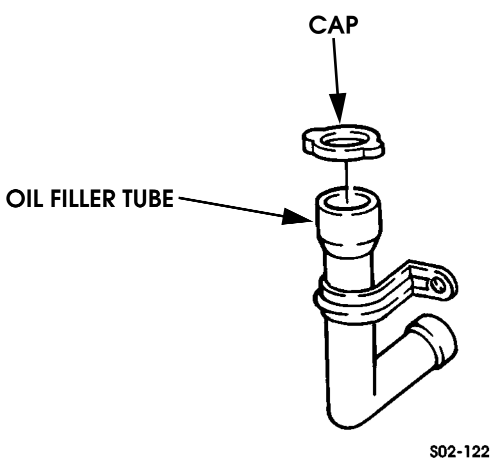

Figure 2-153: Oil Filler Tube and Cap

CYLINDER HEAD OVERHAUL

Disassembly

1. Remove glow plugs and injectors if not previously removed.
2. Remove temperature sender from left side head (Figure 2-154).
3. Remove cold start-advance switch (Figure 2-155).

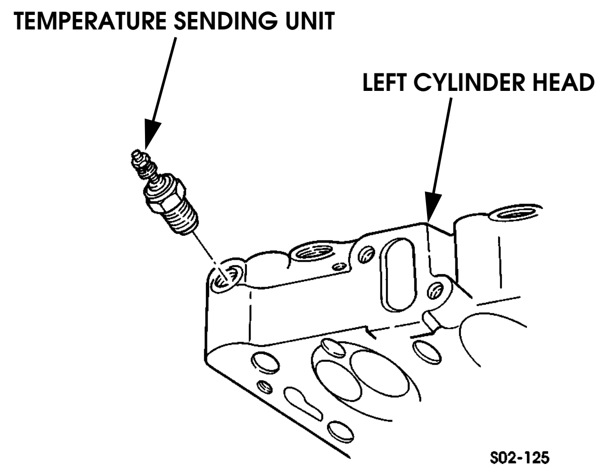

Figure 2-154: Temperature Sender Removal/ Installation

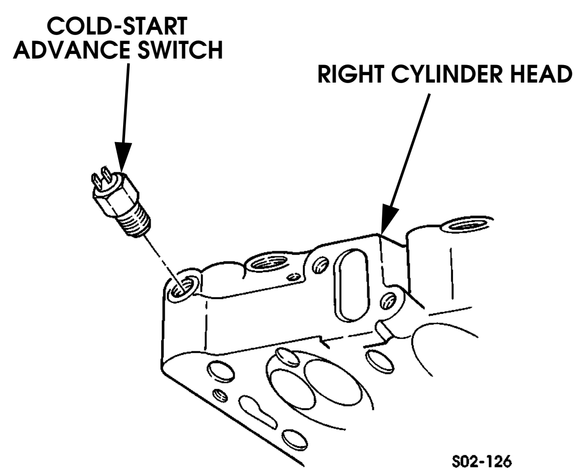

Figure 2-155: Cold-Start Advance Switch Removal/Installation

4. Clean valve faces with wire brush and measure amount valves are recessed in head with dial indicator. Intake valves should be recessed approximately 0.001 in. (0.034 mm) and exhaust valves approximately 0.002 in. (0.048

mm). Recessing means valve faces are positioned below cylinder head combustion chamber surface.

- If valves extend or protrude above chamber surface, engine is equipped with wrong valves, or heads have been mismachined.
- If valves are recessed to at least the stated values, continue with disassembly.

5. Remove valve assembly in sequence as follows:
   a. Compress valve spring with compressor tool J8062 (Figure 2-156).
   b. Remove valve locks (Figure 2-157).
   c. Release and remove compressor tool.
   d. Remove valve retainer, shield and spring.
   e. Remove stem seal from valve and slide valve out of guide and head.
   f. Remove shin.
   g. On exhaust valve, also remove nylon stem and guide seal (Figure 2-157).
   h. Remove remaining valve assemblies in same manner.
   i. Keep valve parts together on workbench or use yardstick with drilled holes to keep valve assemblies separate.

NOTE: Do not intermix the valve parts as intake and exhaust valve are different. In addition, the exhaust valves have two stem seals and a rotator style spring retainer.

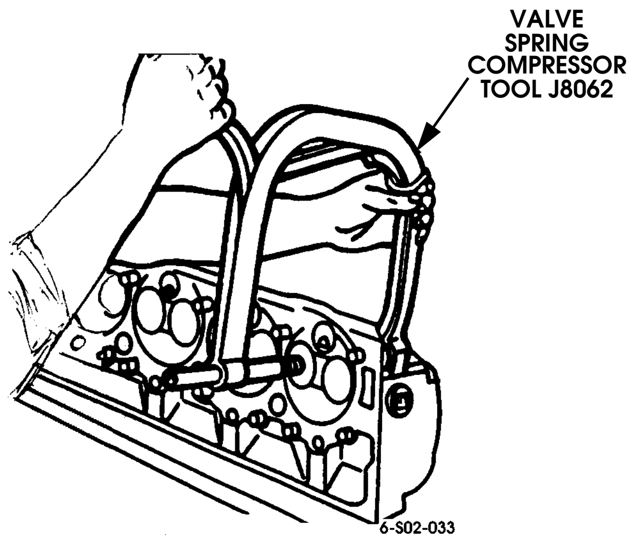

Figure 2-156: Compressing Valve Spring (to Remove Locks)

6. Mark position of pre-combustion chambers in each cylinder head (Figure 2-158). Ideally, chambers (if reused), should be installed in same location in head.
7. Remove prechambers from cylinder heads (Figure 2-158). Use a round pry tool to loosen and start each chamber out of seat in cylinder head.
8. Remove cover and gasket from right side head (Figure 2-159).

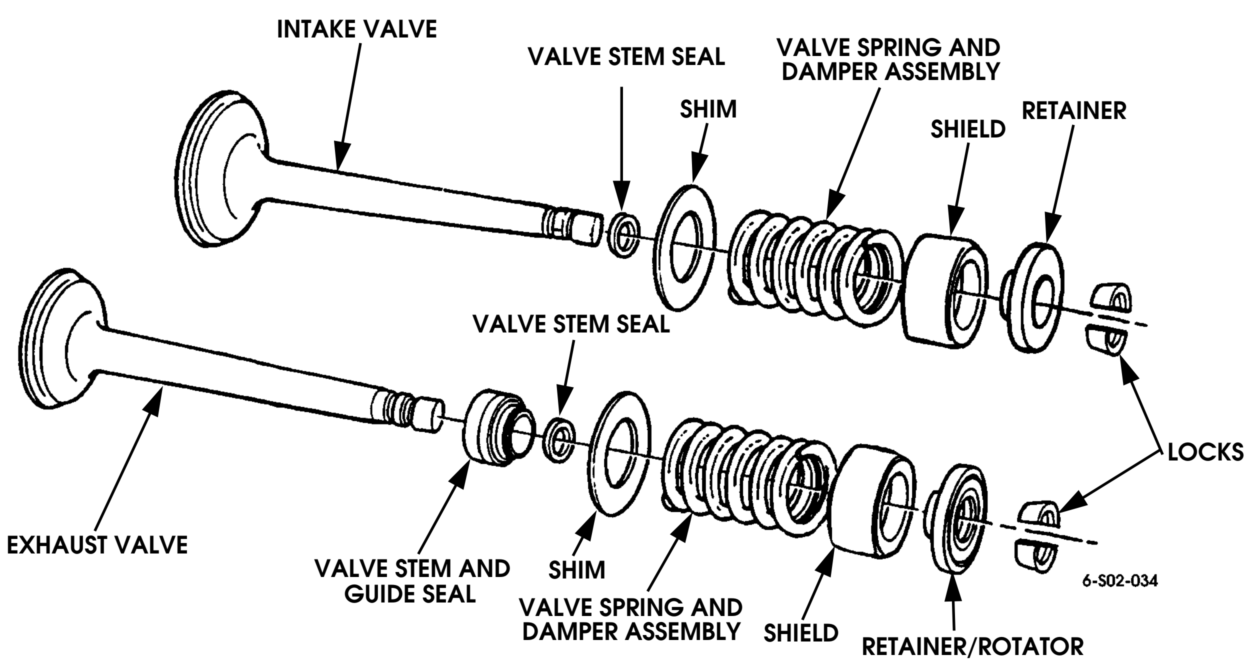

Figure 2-157: Intake and Exhaust Valve Components

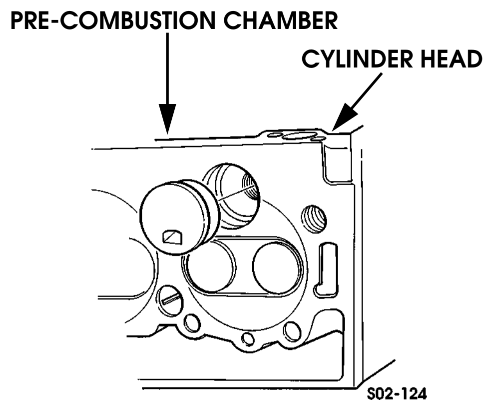

Figure 2-158: Pre-combustion Chamber Removal

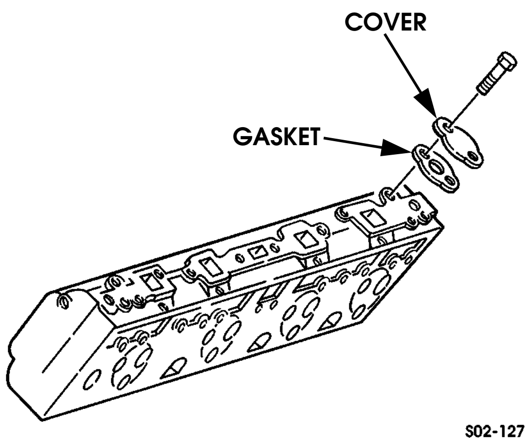

Figure 2-159: Cover Removal/Installation

Cleaning and Inspection

Clean the cylinder heads and valve components in parts cleaning solvent. Use carb cleaner and a wire brush to remove stubborn carbon deposits on the heads valves and prechambers.

Check flatness of intake/exhaust manifold seating surfaces with straightedge. Surfaces must be flat to within 0.006 in. (0.15 mm).

Check cylinder head flatness with straightedge and feeler gauge (Figure 2-160). Overall (end-to-end) flatness should not vary by more than 0.006 in. (0.152 mm). Replace the head if warped or distorted. Do not machine the head.

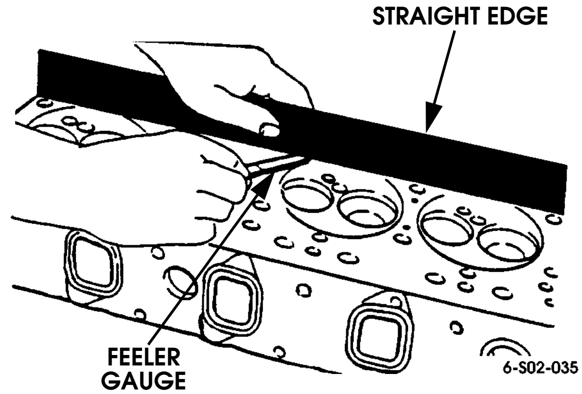

Figure 2-160: Checking Cylinder Head Flatness

Inspect the combustion prechambers (Figure 2-161). Minor cracks under 3/16 in. (0.48 mm) in length are not cause for replacement. Install new chambers only when cracks extend beyond the indicated length (Figure 2-161).

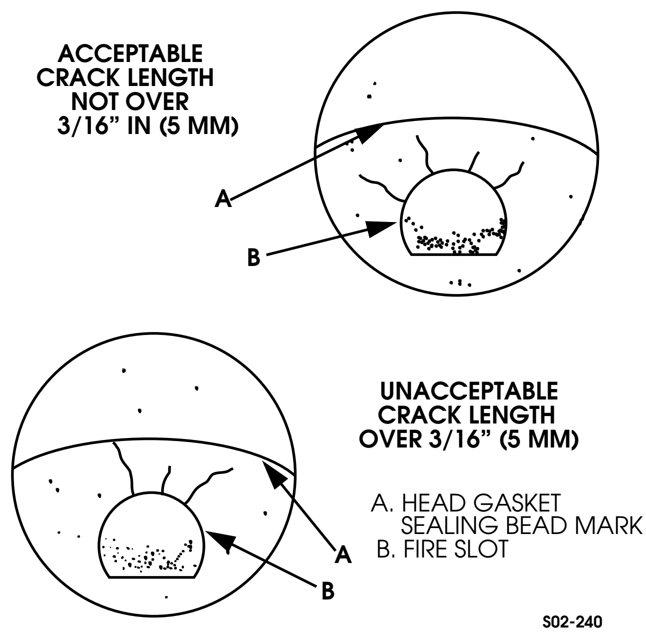

Figure 2-161: Prechamber Inspection Points

Check fit of each pre-chamber in the cylinder head. Replace loose (or cracked) chambers. Oversize chambers are available when needed. The oversize parts are marked with ID code "08." The code numerals appear on the chamber crown, side, or interior (Figure 2-162)

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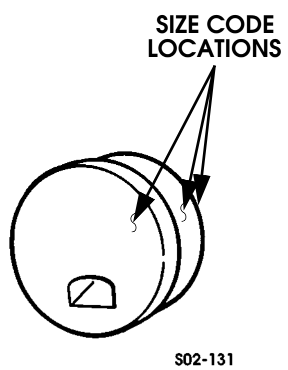


Figure 2-162: Oversize Prechamber I.D.

Measure valve stem clearance with a dial indicator. Required clearance is 0.001-0.003 in. (0.026-0.069 mm) for intake and exhaust valves. If clearance is beyond limits, ream the valve guide with reamer (Figure 2-163) and install new valve with 0.0035 in. (0.089 mm) larger stem.

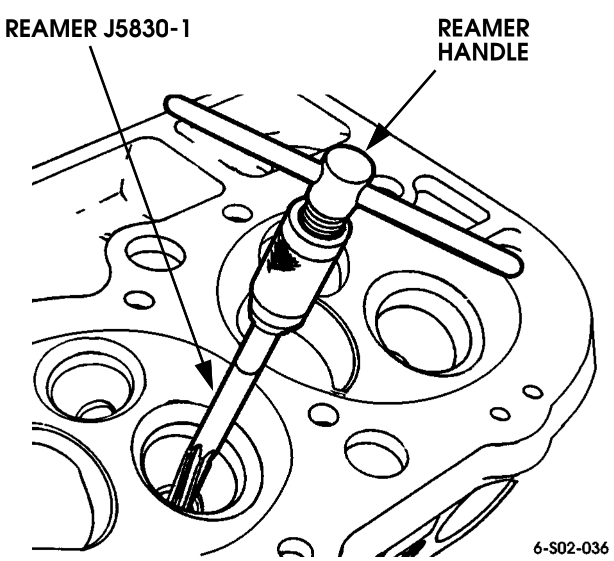
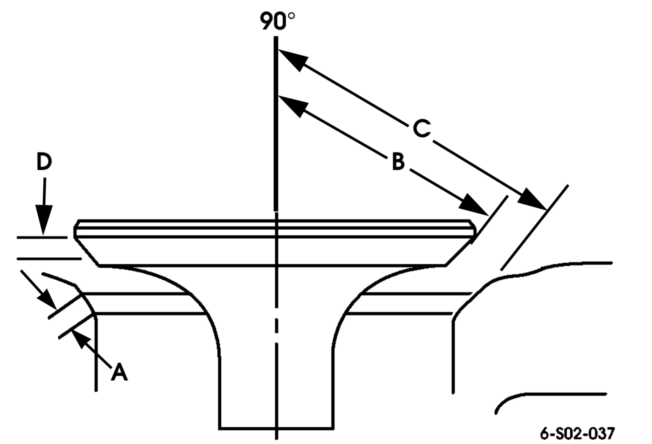


Figure 2-163: Typical Method of Reaming Valve Guides

Check the valve stems for wear, scoring, or distortion. Inspect the faces for pitting, cracks, or burnt segments. Also inspect the lock grooves at the stem top. Be sure the grooves are free of cracks, chipped spots, or worn broken lands. Replace any valve exhibiting the foregoing conditions.

Grind the valve faces only lightly to obtain the required 45° face angle (Figure 2-164). Take care to avoid cutting into the valve margin. Quik Way, Van Norman, Sioux or similar quality equipment is recommended.



A-SEAT WIDTH = INTAKE 0.035-0.060 in. (0.089-1.524 mm)
EXHAUST (0.060-0.093 in. (1.524-2.36 mm)
B-FACE ANGLE (INTAKE & EXHAUST) = 45°
C-SEAT ANGLE (INTAKE & EXHAUST) = 46°
D-VALVE FACE CONTACT AREA

Figure 2-164: Valve Refacing Angles and Widths

Grind the valve seats to the required 46° angle with the previously recommended equipment. Or, use a 4-6 blade carbide cutter to dress the seat.

Lightly lap the valves and seats with a fine grit compound. Clean the valves and seats and inspect the lap marks. The lap marks, which represent the actual contact areas on the valves and seats, should be concentric, and equal in width throughout. Ideal seat width is 0.063 in. (1.6 mm).

If the lap marks are thick-thin or eccentric, the valves or guides are worn beyond tolerance. Verify by rechecking valve stem clearance and valve seat runout with a dial indicator.

Cylinder Head Reassembly

1. Scuff sand all gasket surfaces with 180 grit paper.
2. Clean the valvetrain parts and cylinder head with solvent and dry with compressed air.
3. Install new freeze plugs in heads if necessary. Apply Permatex #2 or high temp adhesive/sealer to edges of plugs before installation. Be sure plugs are properly seated.
4. Install combustion prechambers in cylinder heads (Figure 2-165). Chambers should be flush to no more than 0.002 in. (0.05 mm) above head surface.
5. Install new nylon stem and guide seals on exhaust valve guides.
6. Lubricate valve stems and guides with 30w engine oil, or assembly lube.
7. Install valves as follows (Figure 2-165):
    a. Insert valve into guide and through nylon seal on exhaust valves.
    b. Install shim.
    c. Lubricate and install stem seal on valve.
    d. Position valve spring and damper on shim.
    e. Install shield followed by retainer on valve spring.
    f. Compress spring with spring compressor tool (Figure 2-156).
    g. Install valve locks. Be sure locks are fully seated before proceeding. Use petroleum jelly to hold locks in place during installation.
    h. Release and remove compressor tool.
8. Check valve spring installed height:
    a. Use dividers and micrometer or vernier caliper (Figure 2-166).
    b. Measure height from bottom of spring to top of shield as shown.
    c. Correct height is 46 mm (1.81 in.). Height can exceed specified figure by 0.127 mm (0.005 in.) but must never be lower than specified.
    d. Use thicker shim to decrease height, or thinner shim to increase height Replace any valve spring that cannot be set to specified height.
9. Apply Permatex #2, or high temp sealant to threads of coolant temperature sender and cold start-advance switches. Then install switches in heads (Figures 2-154 and 2-155). Temperature sender goes in left side head.
10. Install access cover and gasket, if removed. Use Permatex #2 or high temp sealant on gasket.
11. Cover assembled heads if they will not be installed immediately.

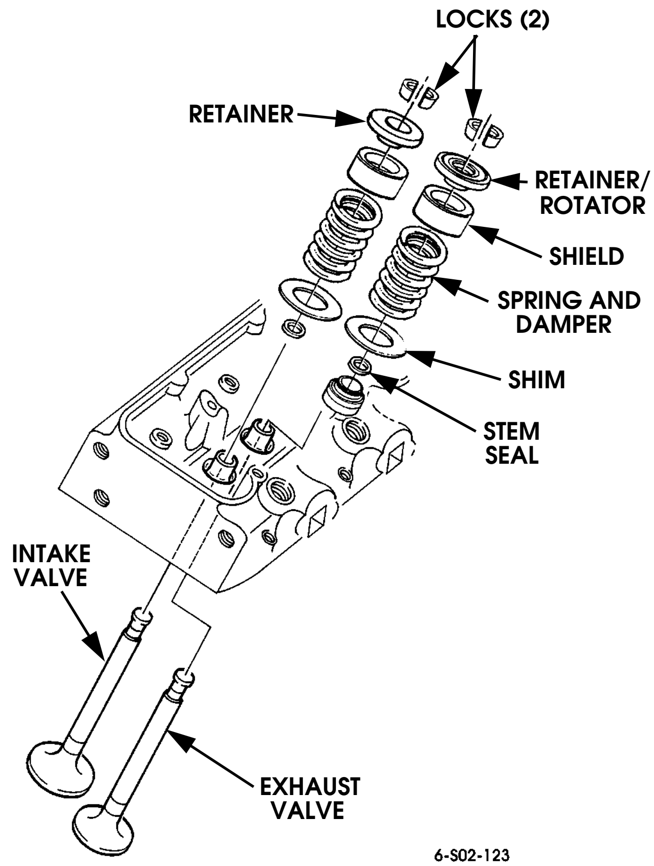


Figure 2-165: Valvetrain Installation Sequence

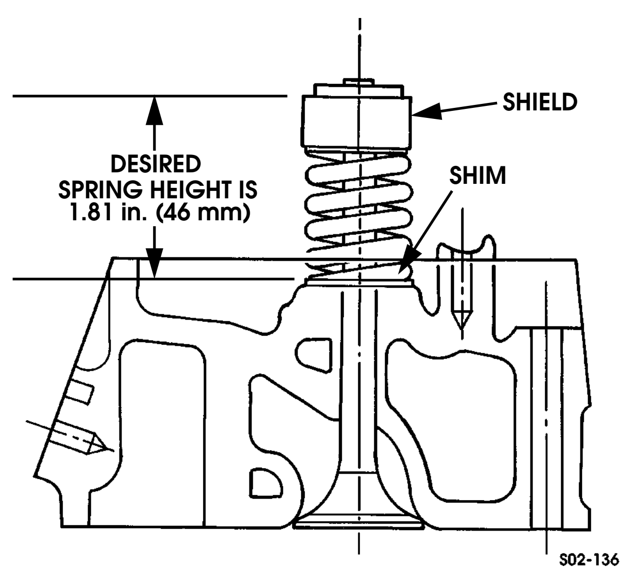


Figure 2-166: Installed Height of Valve Spring

LIFTER, PUSHROD, ROCKER ARM SERVICE

Clean the rocker arms, shafts, pushrods, guides, clamps, and lifters in parts cleaning solvent.

Immerse the lifters in solvent and use a pushrod to stroke the lifter plunger. Replace any lifter that is collapsed, or if fluid cannot be pumped out oil hole when plunger is stroked.

Inspect the lifter roller and bearings. Replace any lifter that exhibits wear on the body, roller, or bearings. Turn the roller and note action. Replace the lifter if the roller binds, or is seized.

Check each pushrod (Figure 2-167) for distortion and wear. Replace any pushrod that is bent. Check the pushrod ball ends. Replace the pushrod if either ball end is flattened, scored, or loose.

Inspect the lifter guide plates and clamps (Figure 2-167). Replace the plates and clamps if worn, or distorted. Also make sure the guide plates are a proper slip fit on the lifters.

Inspect the rocker arms and shafts for wear, cracks, scoring/grooving, or distortion. Check the pushrod contact area on each arm for wear, or scoring. Replace the rocker arms, or shaft as needed.

Discard the rocker arm retainers (Figure 2-168). Also discard the rocker shaft retainers if bent, distorted, or cracked.

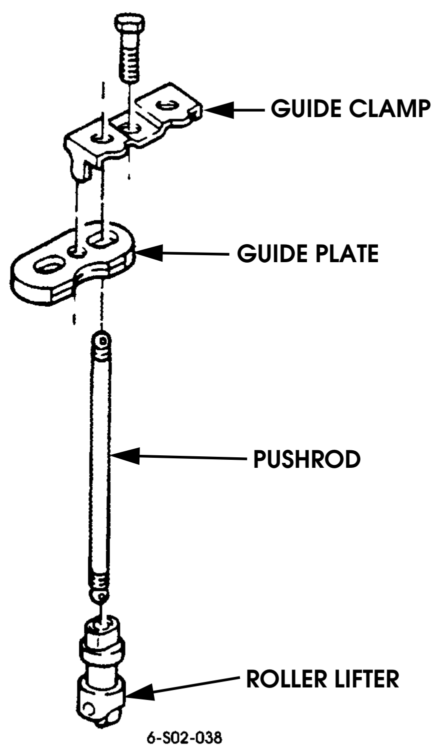


Figure 2-167: Lifter and Pushrod Components

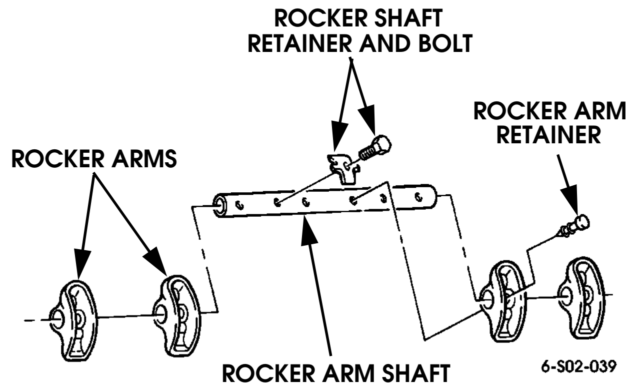


Figure 2-168: Rocker Arm and Shaft Components

DAMPER AND FLYWHEEL SERVICE

The flywheel can be immersed in cleaning solvent. However, the torsional damper should only be wiped clean with a cloth wetted with parts cleaner. The damper has a rubber composite insulator (Figure 2-169). This insulator can be damaged by immersion in some cleaning solutions.

Inspect the damper insulator ring (Figure 2-169). Replace the damper if the ring is cracked, distorted, protruding, or loose (hub can be turned independently of outer shell). Also check the hub bore, keyway, and seal surface. Minor nicks or scratches can be smoothed with 320 grit emery but replace the damper if these surfaces are severely scored, or cracked. Clean the bolt hole threads with a tap if necessary.

CAUTION: *6.5L diesel engines are externally balanced. The torsional damper is an integral part of the balancing mechanism. Never use a solid, or similar non-recommended damper as this practice can result in a broken crankshaft. Use factory replacement dampers only.*

Inspect the flywheel carefully (Figure 2-170). Look for worn, chipped, or broken ring gear teeth and check the hub for cracks at the mounting bolt holes. Place the flywheel on a flat surface and check the body for warping, distortion, or cracks at the converter attaching bolt holes. Replace the flywheel if it exhibits any of the foregoing conditions.

NOTE: The ring gear is not serviced separately. It is only available as part of a new flywheel.

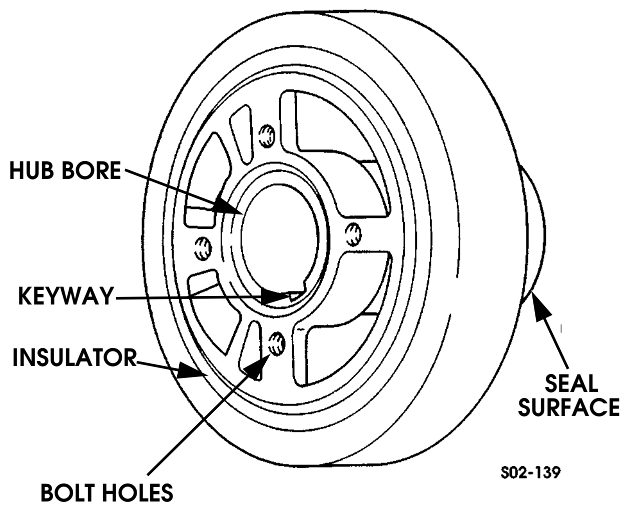


Figure 2-169: Torsional Damper Inspection Points

OIL PUMP AND PUMP DRIVE SERVICE

The oil pump can be disassembled for inspection if desired but not overhauled. The pump is serviced only as a complete assembly. Individual pump parts are not available.

The pump shaft, pickup tube clamp and bolt, and pump mounting stud are all available as service parts (Figure 2-171).

Replace the oil pump under the following conditions:

- Pressure test indicates low or no pump pressure
- High mileage overhaul
- Overhaul cause by oil pump failure
- Overhaul to correct problem that generated sludge, varnish
- Overhaul due to failure that produced chips, debris
- Repair caused by insufficient oil in engine

Inspect the oil pump drive gear and housing. Replace the drive as an assembly if damaged in any way; only the drive O-ring seal is replaceable.

The sensor on the oil pump drive is not serviceable. It is available only as part of the drive assembly.

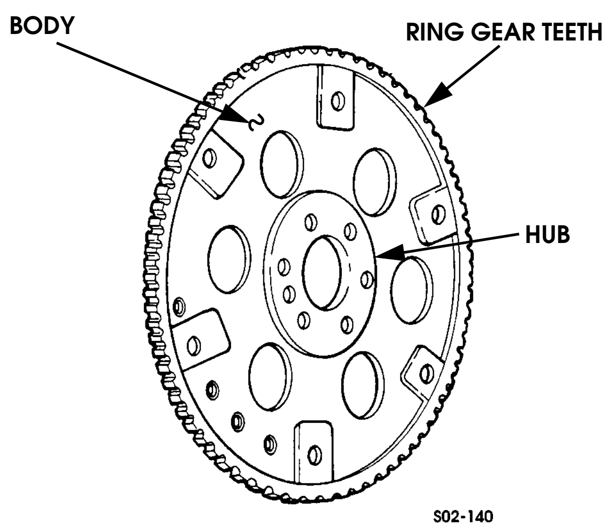


Figure 2-170: Flywheel Inspection Points

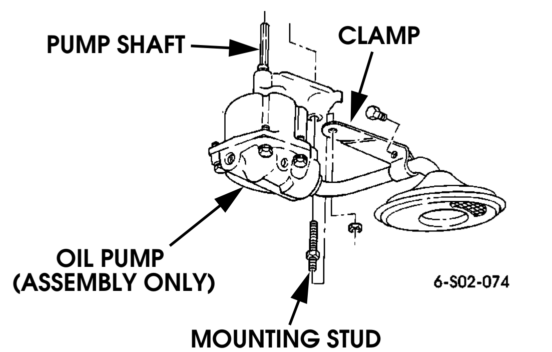


Figure 2-171: Oil Pump Serviceable Parts

OIL FILTER ADAPTER AND BYPASS VALVE SERVICE

Oil Filter Adapter

Inspect the adapter fitting and bolt for damaged threads (Figure 2-172). Replace either fitting if damaged.

Inspect the filter adapter for stripped or crossed threads, cracks, and chipped sealing surfaces. Replace the adapter if damaged.

Remove and discard the old O-rings and gasket from the bolts (Figure 2-172). Install new O-rings and seal on the bolt and lubricate them with engine oil.

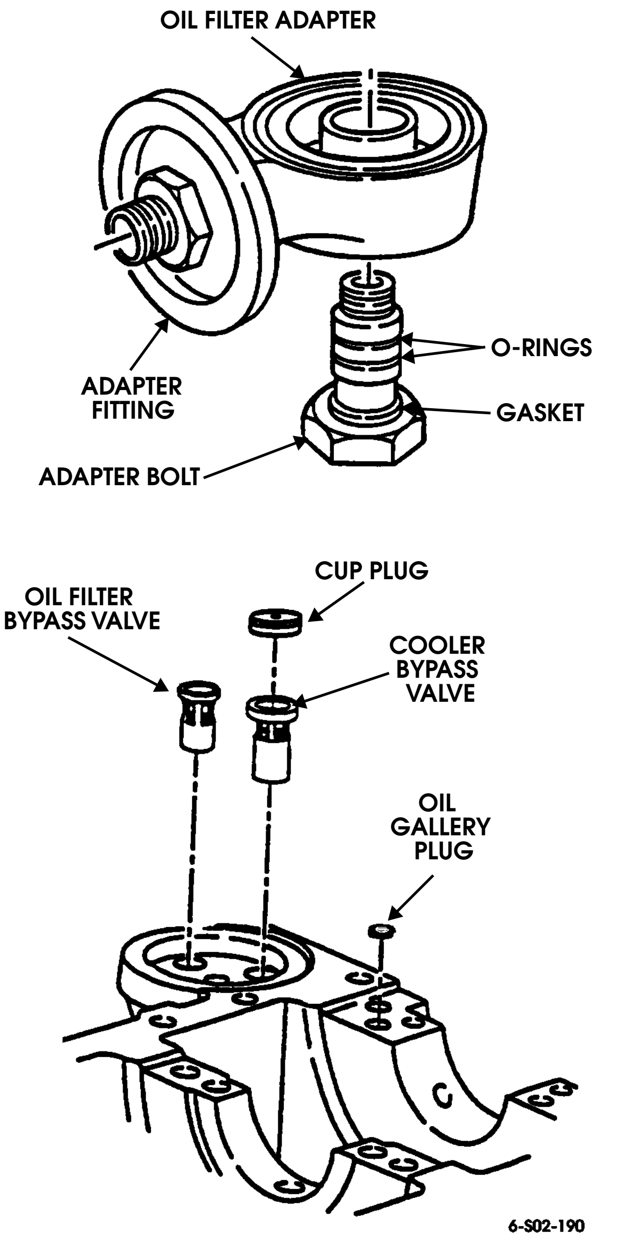


Figure 2-172: Filter Adapter and Bypass Valves

Bypass Valve

Remove the two bypass valves (Figure 2-172), and inspect them carefully. Replace either valve if damaged, or filled with shavings and/or debris.

NOTE: The filter bypass valve can be removed with a small hook tool. The cooler bypass valve however, requires use of tool J41710 for cup plug and valve removal.

FLUSHING ENGINE COOLER

Flush the engine oil cooler whenever a component failure contaminates the oil with metal or similar particles. The oil and filter should also be changed.

Cooler Flushing Procedure

1. Remove oil cooler lines at engine and allow oil to drain into suitable container.
2. With one line positioned in container, introduce air pressure (no more than 20 psi (140 kPa)) into the other line to force oil and contaminates out of cooler.
3. When cooler is clear of oil, use pump or vacuum unit to then either pump or draw solvent followed by fresh oil through cooler. Continue until oil coming from cooler is free of contaminants.
4. Reconnect cooler lines to engine adapter fittings.
5. Change engine oil and filter.

ROCKER COVER AND OIL PAN SERVICE

Clean the pan and covers in cleaning solvent. Use carb cleaner on stubborn deposits if necessary.

Inspect rocker covers and oil pan for cracks, sealing surface distortion, and dents. Repair minor dents. Replace either cover if damaged (Figure 2-173).

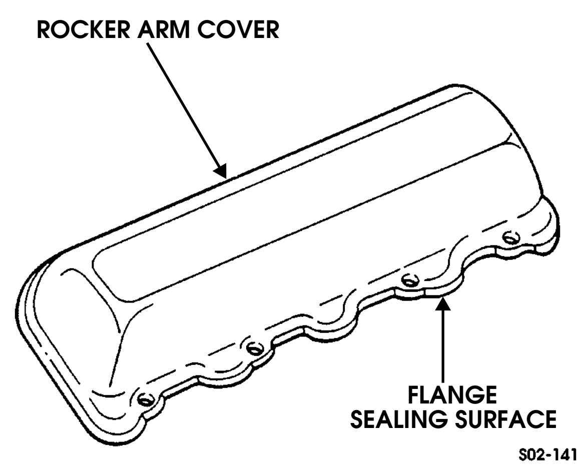


Figure 2-173: Rocker Arm Cover

Inspect the oil pan for cracks, sealing surface distortion, dents, and damaged threads (Figure 2-174).

Small dents, not involving stretched metal, are not a cause for replacement. Larger dents involving stretched or creased metal will result in leaks.

Inspect the drainplug and pan for crossed or stripped threads and burred flats. Discard the plug gasket. Replace the drain-plug if damaged.

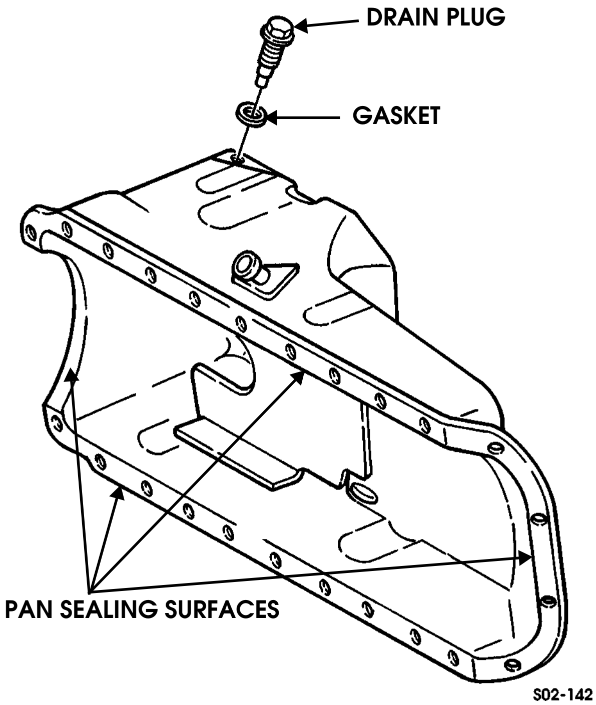


Figure 2-174: Oil Pan Inspection Points

INTAKE AND EXHAUST MANIFOLDS

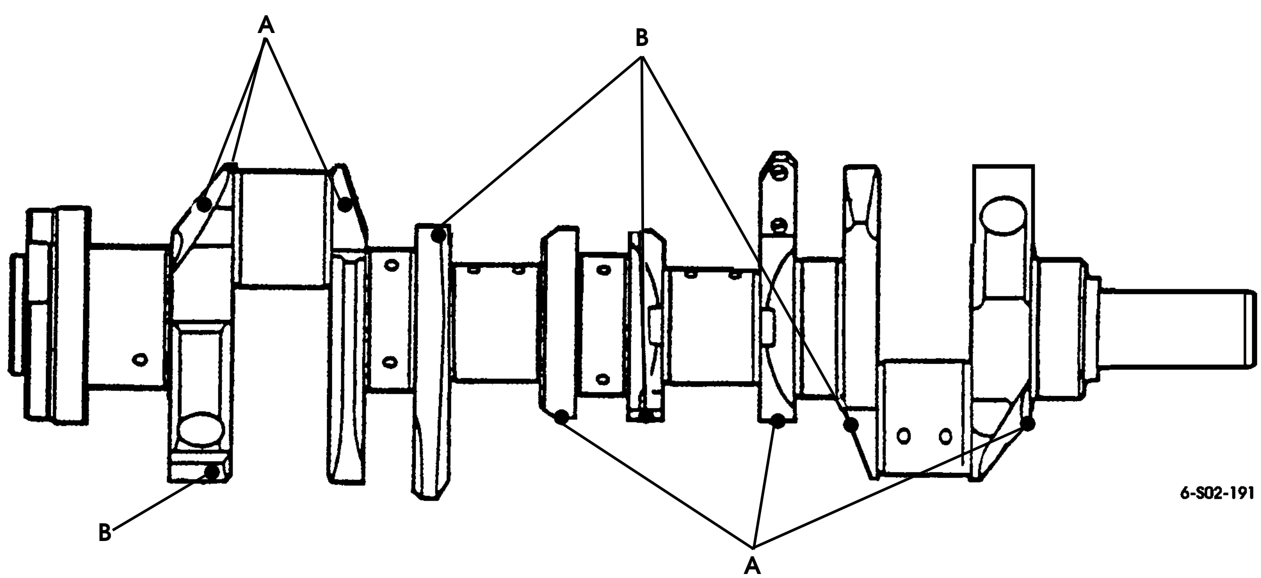
The manifolds can all be immersed in parts cleaning solvent. Carbon buildup in the exhaust manifolds can be removed with carb cleaner, wire brushing, or glass beading.

Check the manifold flange and gasket surfaces with a straight-edge. Replace any manifold with warped, distorted surfaces. Do not machine either type manifold in an attempt to salvage it.

Minor scratches and nicks on gasket surfaces can be smoothed with 80 grit emery cloth, an oil stone, or fine tooth file.

Inspect the manifolds for cracks on all surfaces. Check the exhaust manifolds and exhaust inlet pipes for splitting and flange or joint separation. Although seriously damaged parts should be replaced, minor damage on low mileage steel exhaust parts can be repaired by welding.

Inspect manifold fittings and threads. Replace loose damaged fittings and repair thread damage with a tap or helicoil insert.



A. MAIN BEARING JOURNAL MARKINGS (BLUE, ORANGE/RED, OR WHITE)
B. ROD BEARING JOURNAL MARKINGS (YELLOW OR GREEN)

Figure 2-175: Crankshaft Journal Size Identification

ENGINE ASSEMBLY AND ADJUSTMENT

Crankshaft Main Bearing Selection

Main bearings are available in standard and two undersizes for select fit purposes. Required bearing clearances are:

- 0.0017-0.003 in. (0.045-0.083 mm) at bearings 1 through 4
- 0.002-0.0036 in. (0.055-0.093 mm) at number 5 rear main

There are three main journal diameter ranges. The ranges are identified by a color code paint mark near one of the journals. The size range color codes are blue, orange/red, and white. Rod bearing journals are marked yellow or green. The color codes indicate journal diameter and correspond to the Main Bearing Selection Chart at the end of this section.

The main bearing bores in the block are also coded for size. There are three ranges identified by the numbers 1, 2, or 3. These numbers are stamped in the cylinder block pan rail. Refer to the Main Bearing Selection chart at the end of this section.

NOTE: Different bearings are used in turbo and non-turbo engines. Do not interchange the main or rod bearings.

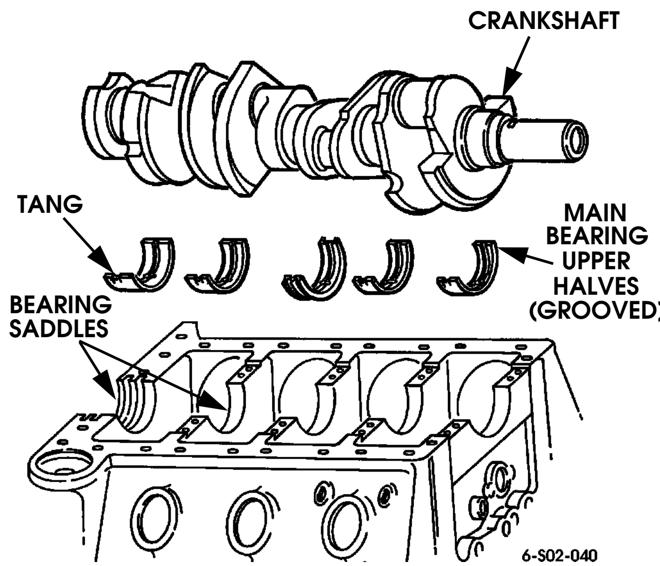


Figure 2-176: Installing Crankshaft and Main Bearing Upper Halves

Crankshaft and Main Bearing Installation

1. Measure main journal diameters, note color code on crankshaft, and size letter on engine pan rail. Select bearings as needed. 0.0005 in. (0.013 mm) bearings are standard while 0.001 in. (0.026 mm) bearings are undersize.
2. Identify and separate bearing halves before proceeding. Bearing upper halves have oil grooves while lower halves do not. Upper halves go in block while lower halves go in bearing cap. Extra wide bearing is thrust bearing and is installed in number 3 position.
3. Install main bearing upper halves in block (Figure 2-176). Install bearing halves dry. Do not lubricate bearing saddle in block or back of bearing. Be sure each bearing locating tab is properly seated in notch machined in block. Also be sure oil holes in bearing and block are aligned. Thrust bearing half goes in #3 main bearing saddle.
4. Install main bearing lower halves in bearing caps (Figure 2-177). Install bearings dry and be sure each bearing locating tang is seated in bearing cap notch. Thrust bearing half goes in #3 main cap.
5. Position crankshaft in block. Do not turn the shaft. Just carefully seat it in bearing upper halves.
6. Position length of plastigauge on each main bearing journal (Figure 2-178). Cut plastigauge so it extends across three quarters of journal. Position plastigauge so it is parallel to crankshaft center line as shown.

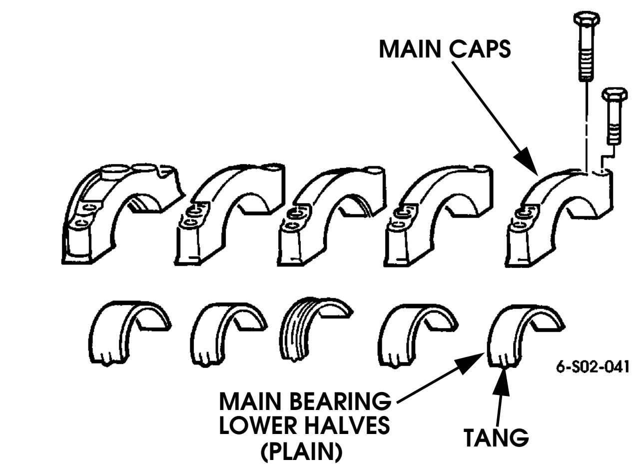


Figure 2-177: Assembling Main Caps and Bearing Lower Halves

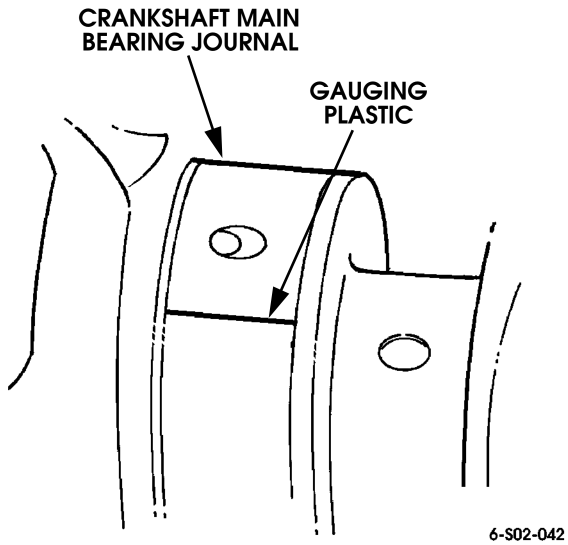


Figure 2-178: Gauging Plastic Position on Crankshaft Main journal

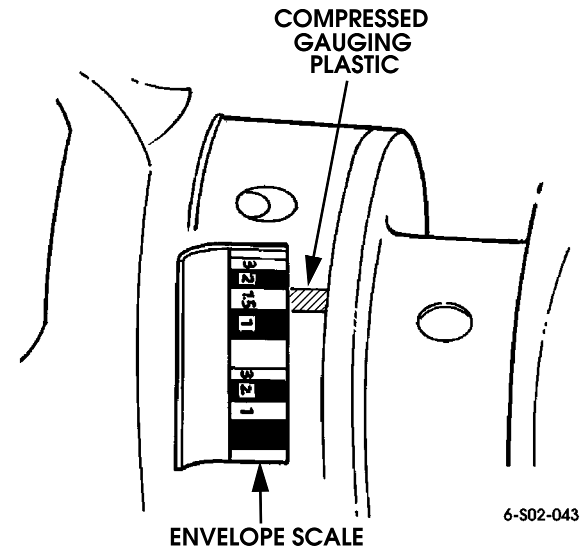


Figure 2-179: Measuring Gauging Plastic to Determine Bearing Clearance

NOTE: For engines built after March 13 1997, use torque values and sequence outlined later in this section. These engines have 10 mm bolts in the number 2, 3, and 4 outer main cap holes.

7. Install main bearing caps and old bolts retained from disassembly operations. Tighten inner cap bolts to 150 N•m (111 lb-ft) and outer bolts to 135 N•m (100 lb-ft) to compress gauging plastic.
8. Remove main bearing caps and measure plastigauge with graduated scale on gauge envelope (Figure 2-179). Measure widest point of compressed plastic.
   - If clearances are correct, proceed to next step.
   - If clearances are insufficient, try standard bearings. Or, if clearances are too large, try undersize bearings. In some cases, a combination of standard and undersize bearings to will be needed to obtain required clearance. Note that under size bearings refer to crankshaft diameter.
9. Carefully remove crankshaft and clean plastic off journals. Then lubricate main bearings and crankshaft with 40W engine oil or a quality assembly lube, and reinstall crankshaft.
10. Reinstall main bearing caps. Be sure caps are properly aligned. Bearing notches should be aligned and direction arrows toward front.
11. Apply Permatex High Temp silicone sealer to rear main bearing cap seat in block (Figure 2-180).
12. Install new inner and outer bearing cap bolts finger tight only. Bolts will not be tightened until after crankshaft end play check.

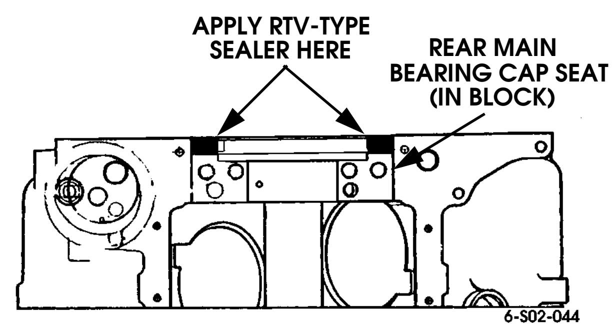


Figure 2-180: Sealer Application Points in Rear Main Bearing Cap Seat

CRANKSHAFT END PLAY CHECK

1. Tighten bolts in main caps 1 and 2 to approximately 16 N•m (12 lb-ft) torque.
2. Tap crankshaft rearward then forward to align thrust bearing. Use lead hammer or rawhide mallet to tap crankshaft.

NOTE: For engines built after March 13 1997, use torque values and sequence outlined later in this section. These engines have 10 mm bolts in the number 2, 3, and 4 outer main cap holes.

3. Tighten long inner main cap bolts to 150 N•m (111 lb-ft) and shorter outer bolts to135 N•m (100 lb-ft) torque.

4. Verify that crankshaft can be rotated freely without bind or drag.

NOTE: If crankshaft does not rotate freely or binds in spots, problem may be: misaligned main caps, bearing incorrectly installed, foreign material on bearing or journal, wrong bearing size.

5. Pry and hold crankshaft forward. Measure clearance between crankshaft and #3 main bearing with feeler gauge (Figure 2-181). Clearance should be 0.004-0.010 in. (0.10-0.25 mm). If clearance in incorrect, thrust bearing is incorrect size or not seated, or crankshaft thrust surface is worn. Correct as necessary. If clearance is OK, continue with assembly.

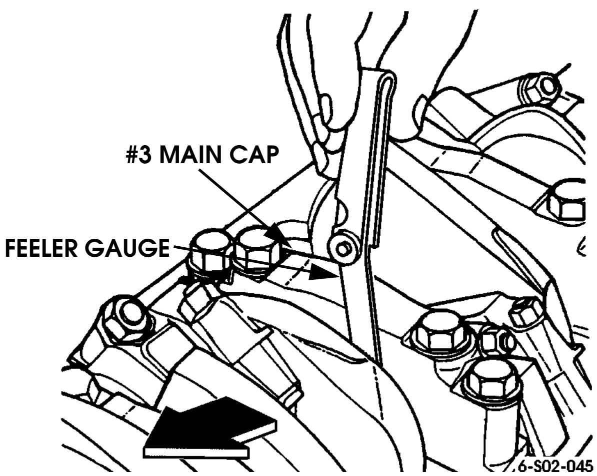


Figure 2-181: Measuring Crankshaft End Play

CRANKSHAFT MAIN CAP TORQUE SEQUENCE FOR ENGINES BUILT AFTER MARCH 13 1997

NOTE: These engines can be identified by the 10 mm bolts in the outer holes of the number 2, 3, and 4 main caps. Earlier engines have all 12 mm main cap bolts and should be tightened according to the information listed previously in this section.

1. Install the number 1, 2, 4 and 5 crankshaft bearing caps and bearings by tapping into place with a brass or leather mallet.
2. Apply engine oil to the crankshaft bearing cap bolt threads and install the inner 12 mm bolts.
3. Tighten the inner 12 mm bolts to 55 lb-ft (75 N.m).
4. Install the number 3 crankshaft bearing cap and bearing (thrust bearing) by tapping into place with a brass or leather mallet.
5. Install the 12 mm inner bolts and tighten to 10 lb-ft (14 N.m).
6. Tap the end of the crankshaft first rearward then forward with a lead hammer to line up the crankshaft bearing and crankshaft thrust surfaces then tighten the inner 12 mm bolts to 55 lb-ft (75 N.m).
7. With the crankshaft forced forward, use a feeler gauge to measure the crankshaft end play at the front end of the number three crankshaft bearing. The proper clearance is 0.004-0.010 in. (0.10-0.25 mm).
8. Lubricate and install the outer 12 mm and 10 mm crankshaft bearing cap bolts.
9. Tighten all crankshaft bearing bolts in the following sequence:
   - Retighten the inner 12 mm bolts to 55 lb-ft (75 N.m).
   - Tighten the inner 12 mm bolts an additional 90 degrees.
   - Tighten the outer 12 mm bolts (crankshaft bearing caps 1 and 5) to 48 lb-ft (65 N.m).
   - Retighten the outer 12 mm bolts (crankshaft bearing caps 1 and 5) to 48 lb-ft (65 N.m).
   - Tighten the outer 12 mm (crankshaft bearing caps 1 and 5) an additional 90 degrees.
   - Tighten the outer 10 mm bolts (bearing caps 2, 3, and 4) to 30 lb-ft (40 N.m).

CAUTION: *DO NOT tighten the outer 10 mm bolts an additional 90 degrees!*

10. Check the crankshaft for proper rotation.

NOTE: If crankshaft does not rotate freely or binds in spots, problem may be: misaligned main caps, bearing incorrectly installed, foreign material on bearing or journal, wrong bearing size.

REAR MAIN SEAL INSTALLATION

1. Lubricate new rear main seal lip with chassis grease or petroleum jelly.
2. Apply sealer such as Permatex #2 to outer circumference of new seal.
3. Install seal with tool J39084 (Figure 2-182). Be sure seal is flush with block and bearing cap as shown

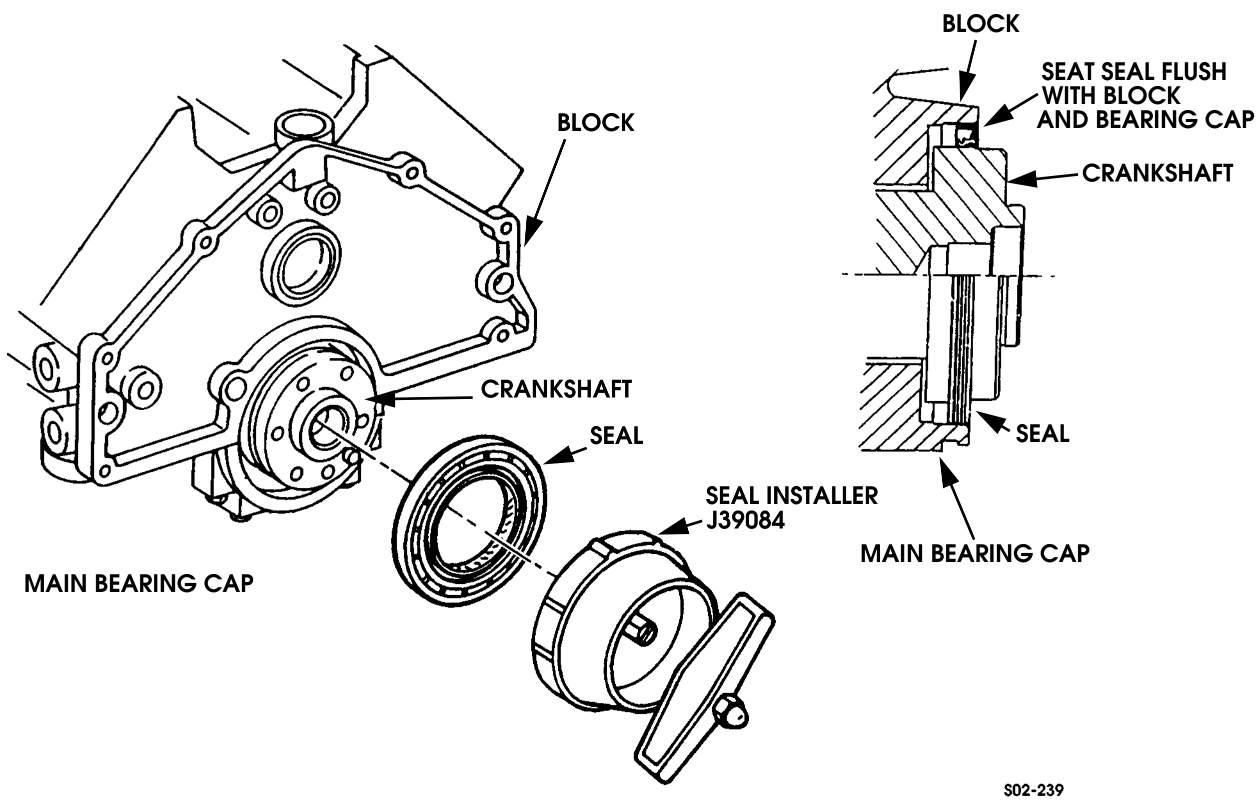


Figure 2-182: Rear Main Seal Installation

PISTON/CONNECTING ROD INSTALLATION AND BEARING FIT

Verify correct piston and rod assembly. Be sure piston crown relief and notches in rod for bearing inserts are aligned (Figure 2-183).

Install only one piston and connecting rod assembly at a time. This is necessary because rod bearing clearance must be checked with the bearing inserts dry. Check bearing clearance at each rod as it is installed.

Make sure the connecting rod caps are matched to their respective rods and are properly aligned. Failure to match and align the rod caps can result in premature bearing failure.

Standard and undersize bearing inserts can be combined in one rod to obtain desired clearance. Just be sure to install the undersize insert in the rod cap.

CAUTION: *Rod bearing clearance must be checked with the bearings dry (no lubrication). For this reason, the crankshaft must not be rotated during the measuring procedure. Otherwise, bearing damage will occur.*

1. Lubricate cylinder wall, piston rings, and all surfaces of piston (except crown), with engine oil.
2. Verify that piston ring ends are properly spaced. Refer to spacing diagram (Figure 2-149).
3. Insert rod bearing halves in rod end and bearing cap. Install bearing dry. They will not be lubricated until after clearance check with plastic gauging material.
4. Install lengths of rubber hose on each connecting rod bolt. Hose will prevent cylinder wall scratches and nicks during piston installation (Figure 2-183).
5. Compress piston rings on #1 piston with compressor tool (Figure 2-184).
6. Rotate crankshaft until rod journal for number one piston is accessible.
7. Start number one piston in cylinder. Position rod end so it is aligned with crankshaft journal. Also be sure relief in piston crown is toward outside of engine.
8. Press piston downward into cylinder with hammer handle (Figure 2-184). Guide rod end onto crankshaft journal at same time.
9. Check rod bearing clearance as follows:
   a. Place strip of plastic gauging material on crankshaft rod journal (Figure 2-185).
   b. Install rod cap and bearing and tighten rod bolt nuts to 65 N•m (48 lb-ft).
   c. Remove rod cap and measure gauging material with graduated scale on plastigauge envelope (Figure 2-185). Clearance should be 0.0017-0.0039 in. (0.045-0.100 mm).
   d. If clearance is OK, proceed to next step. If clearance is not OK, use new standard or undersize rod bearings to obtain correct clearance. If combination of standard and undersize bearing inserts are required, install undersize insert in rod cap. Note that standard bearings provide more clearance than under size bearings.
10. Remove rod cap. Clean gauging material off crankshaft journal. Lubricate rod bearing halves and crankshaft journal with engine oil or assembly lube. Then reinstall rod cap and tighten new rod cap nuts to 48 lb-ft (65 N•m) torque.
11. Install remaining piston and connecting rod assemblies as described in steps 1. through 10.

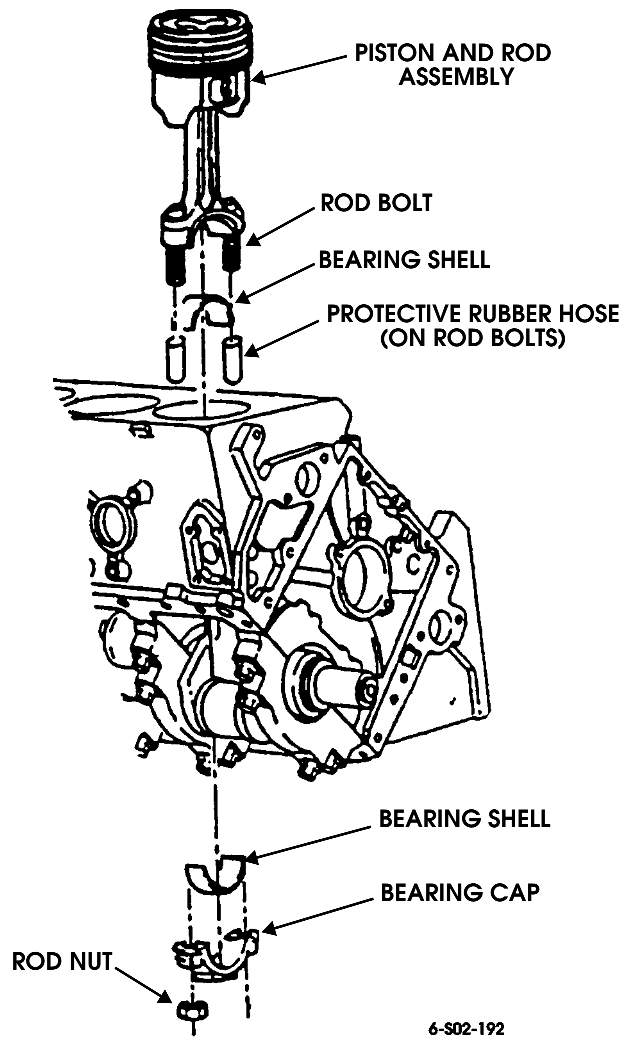


Figure 2-183: Piston and Rod Assembly

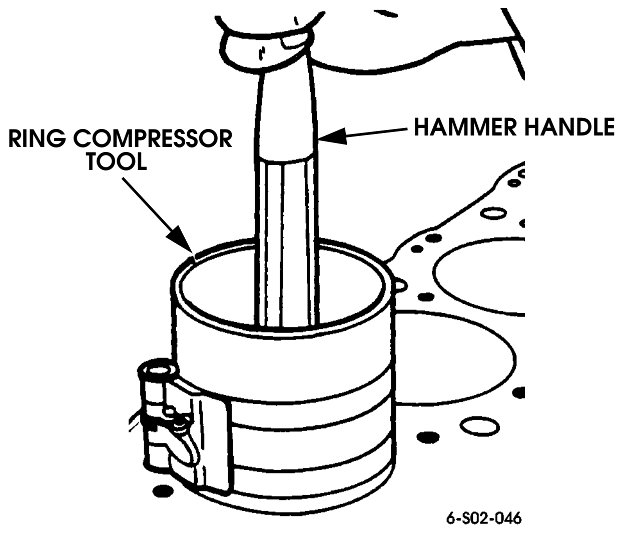


Figure 2-184: Piston Installation

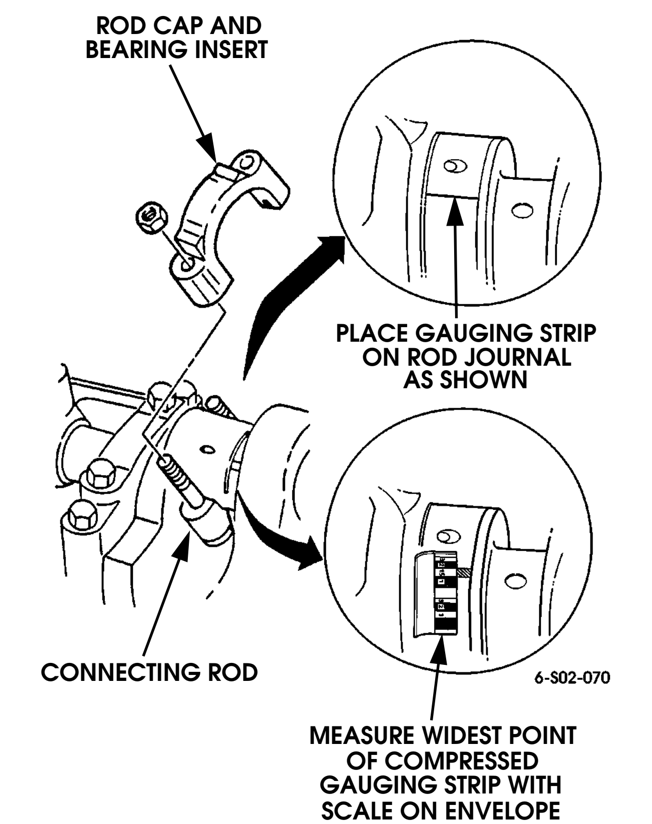


Figure 2-185: Measuring Connecting Rod Bearing Clearance with Plastic Gauging material

12. Check connecting rod side play with feeler gauge (Figure 2-186). Insert gauge between connecting rods on same journal. Clearance should be 0.007-0.025 in. (0.17-0.63 mm).

NOTE: If side clearance is incorrect, rod caps or rod and piston may be installed in wrong position.

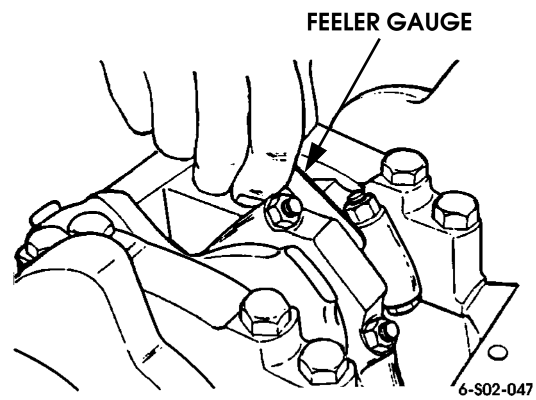


Figure 2-186: Checking Connecting Rod Side Clearance

OIL PUMP, OIL PAN, FLYWHEEL INSTALLATION

1. Pour 2-3 ounces engine oil into pump and rotate pump shaft to lubricate pump gears.
2. Install retainer and pump shaft in oil pump. Apply high temp bearing grease to upper end of shaft.
3. Install oil pump. Be sure pump is seated on rear main cap. Refer to *Oil Pump Drive Removal* in this section for more information.
4. Install pump mounting stud. Tighten stud to 59-74 lb-ft (80-100 N•m).
5. Seat pump pickup tube bracket on mounting stud. Tighten bracket nut to 35 lb-ft (47 N•m) torque. Tighten screw that secures bracket to pump pickup tube to 12 lb-ft (16 N•m) torque.
6. Apply silicone sealer, such as Permatex High Temp, Ultra Blue, or Ultra Black to surfaces of oil pan mounting flange surfaces (Figure 2-187).
7. Apply sealer to pan rear seal (Figure 2-187). Then press seal into place on oil pan. Coat seal ends with sealer as well.
8. Apply silicone sealer around two holes in right side panel rail on block (Figure 2-187).
9. Align and position oil pan on engine block pan rails. Tighten larger diameter bolts at rear of pan to 17 lb-ft (23 N•m) torque. Tighten remaining bolts/studs to 89 lb-in. (10 N•m) torque.

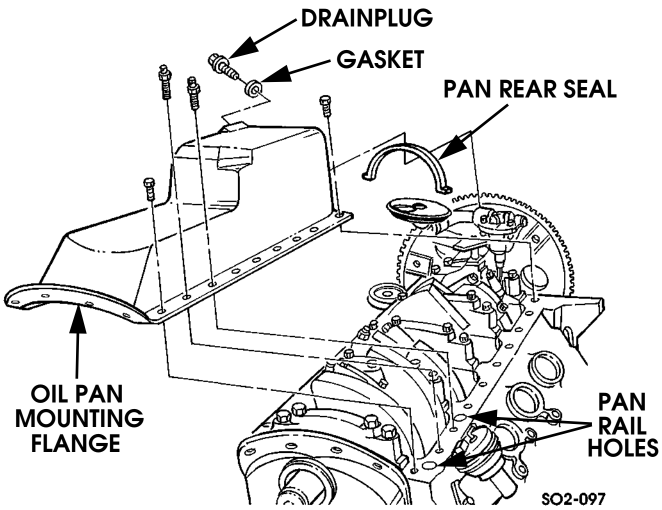


Figure 2-187: Oil Pan and Seal Installation

NOTE: Be sure pan rear seal was not displaced during pan installation.

10. Clean crankshaft flange and flywheel mounting surfaces.
11. Install flywheel on flange (Figure 2-188). Be sure converter bolt pads are facing out and away from engine.
12. Apply 1-2 drops Loctite 242 to new flywheel bolts (but only if new bolts do not have pre-applied thread locker). Then install and tighten bolts 65 lb-ft (88 N•m) torque.

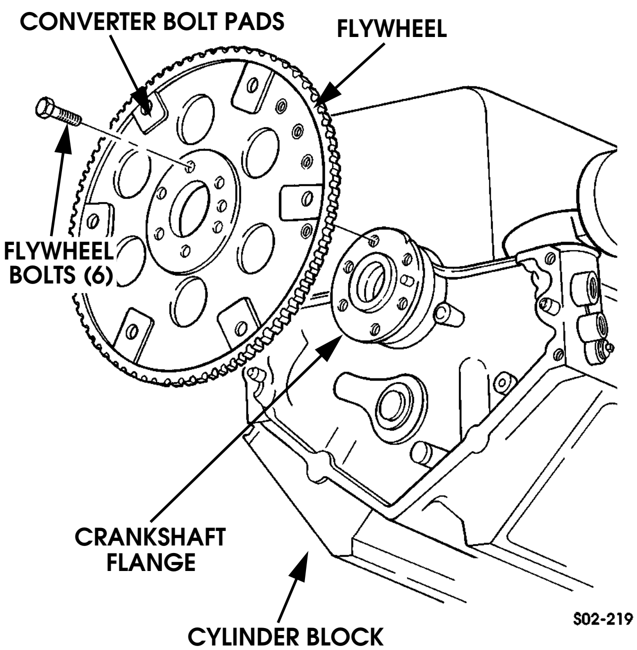


Figure 2-188: Flywheel Installation

CAMSHAFT INSTALLATION

1. Place engine in upright position so cam bearing bores are vertical.
2. Lubricate camshaft bearing journals with engine oil. Then lubricate cam bearings with long nozzle oil can.
3. Lubricate camshaft lobes with assembly lube.
4. Install 8-10 in. (20 -25 cm) long bolt or threaded rod on cam sprocket bolt hole. Bolt will serve as handle and make cam installation easier.
5. Install camshaft. Lower and guide cam carefully through and into bearings (Figure 2-189).
6. Lubricate and install camshaft spacer and thrust plate. Beveled edge of spacer faces toward cam.
7. Apply 1-2 drops Loctite 242 to thrust plate bolt threads. Then install and tighten bolts 17 lb-ft (23 N•m) torque.
8. Remove bolt or rod from camshaft.

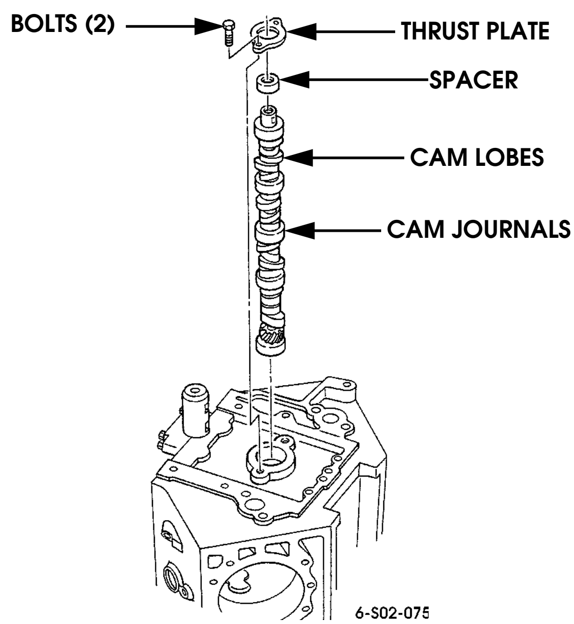


Figure 2-189: Camshaft Installation

TIMING CHAIN-SPROCKET-GEAR INSTALLATION

1. Rotate crankshaft so #1 piston is at TDC.
2. Install sprocket drive keys in camshaft and crankshaft (Figure 2-190).

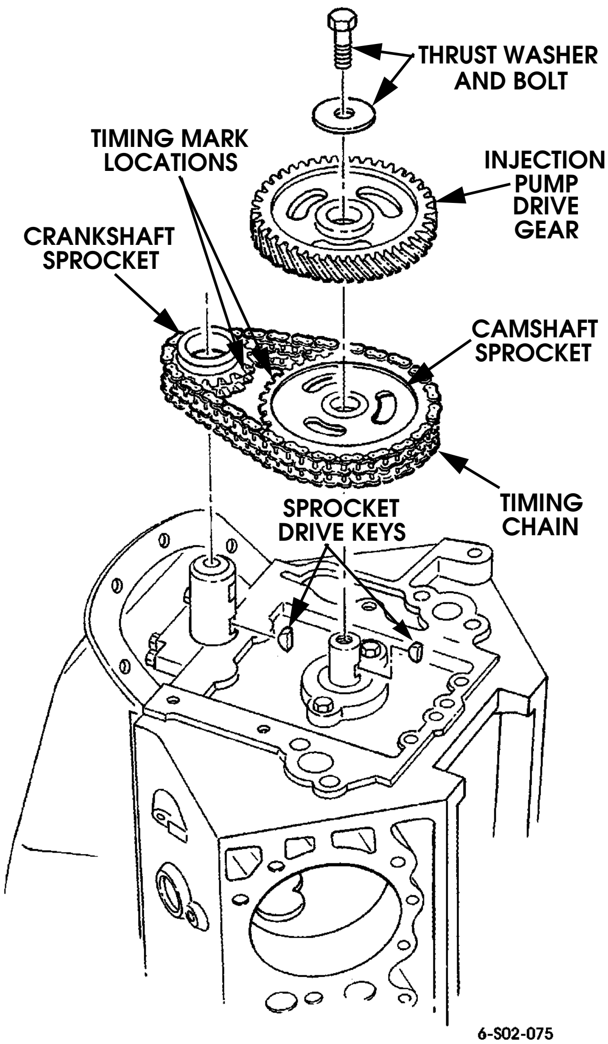


Figure 2-190: Timing Chain - Sprocket - Gear Installation

3. Place block in upright position so cam is facing up. Then rotate camshaft so drive key is toward top of block.
4. Assemble timing chain and sprockets. Make sure sprocket timing marks are aligned as shown (Figure 2-190).
5. Align sprockets with drive keys in crankshaft and camshaft. Then install chain and sprockets as assembly (Figure 2-190). Turn camshaft to align sprockets if necessary. Do not turn sprockets.
6. Check chain deflection with dial indicator. If deflection is greater than 0.51 in. (13 mm), chain is stretched and will have to be replaced.
7. Install injection pump drive gear, thrust washer, flat washer (if equipped), and bolt (Figure 2-190). Tighten bolt to 126 lb-ft (171 N•m) torque. Apply 1-2 drops Loctite 242 to bolt threads before installation. **Position gear so timing marks is at 12 o'clock position.**
8. Lubricate chain, sprockets, and gear with engine oil.

FRONT COVER AND BAFFLE INSTALLATION

1. Install new seal in front cover with installer tool J22102.
2. Apply sealer to front cover as follows:
   - Use anaerobic sealer such as Loctite 510 on cover surfaces that contact block (Figure 2-191).
   - Use RTV-type sealer such as Permatex High Temp, Ultra Blue, or Loctite 599 (gray) to oil pan contact surface of cover (Figure 2-191).
3. Install front cover on engine block (Figure 2-191). Be sure cover is seated on dowels, block face, and oil pan.
4. Install and tighten front cover bolts as follows:
   - Tighten cover-to-engine block bolts to 33 lb-ft (45 N•m)
   - Tighten cover-to-oil pan bolts to 4-10 lb-ft (5-14 N•m)
5. Install baffle on front cover. Maintain minimum clearance of 0.040 in. (1.02 mm) between baffle and injection pump gear. Tighten baffle attaching bolts/nuts to 33 lb-ft (45 N•m) torque.

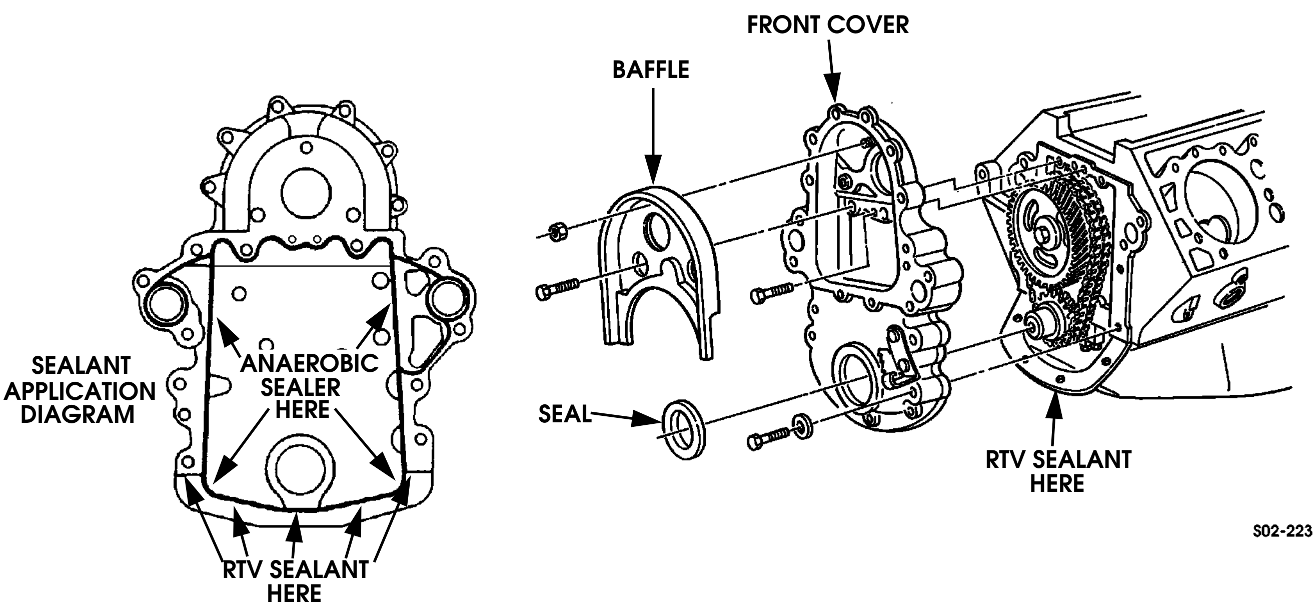


Figure 2-191: Front Cover Installation

FUEL INJECTION PUMP INSTALLATION

1. If a new front cover has been installed, it will be necessary to stamp a TDC timing mark on it as follows:
   a. Position #1 piston at top dead center (TDC).
   b. Align and set injection pump driven gear in place and in mesh with pump drive gear.
   c. Verify that timing marks on pump drive and driven gears are aligned. Also be sure slot in rear of driven gear is at approximate 6 o'clock position (Figure 2-192).
   d. Mount static timing fixture J33042 in the injection pump location in front cover (Figure 2-193). Do not use gasket.
   e. Attach fixture tool to pump driven gear. Then install one 10 mm nut to secure tool flange.
   f. Tighten large bolt on tool in clockwise direction (while facing front of engine), to 35 lb-ft (48 N•m) torque (Figure 2-193).
   g. Tighten 10 mm nut previously installed.
   h. Verify that crankshaft did not rotate and tool did not bind.
   i. Strike scriber on tool with brass hammer or mallet to create TDC mark on front cover. Remove tool afterward.

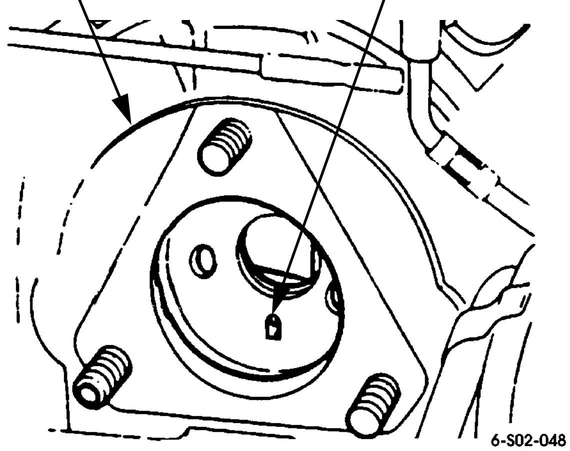


Figure 2-192: Checking Injection Pump Driven Gear Slot Position

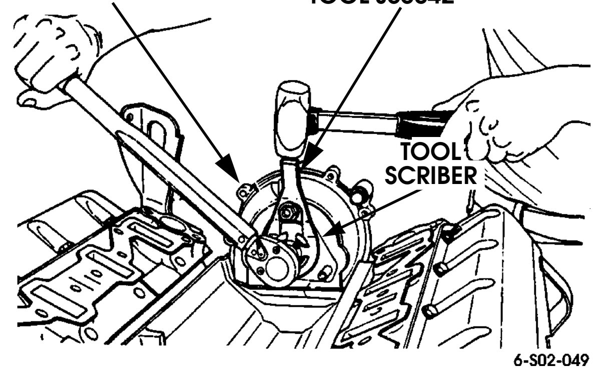


Figure 2-193: Stamping Timing (TDC) Mark on Front Cover

2. Install injection pump gasket on front cover studs.
3. Mount injection pump on front cover studs (Figure 2-194). Install retaining nuts finger tighten.
4. Rotate crankshaft if necessary, to place timing mark on injection pump drive gear at 12 o'clock position.
5. Align timing marks in injection pump and front cover. Then tighten pump retaining nuts to 31 lb-ft (42 N•m) torque.
6. On non-turbo pump, install throttle cable bracket and idle return spring, if not previously installed.
7. Align timing mark on injection pump driven gear with timing mark on drive gear (Figure 2-195).
8. Turn pump shaft (not gear), until shaft pin aligns with slot in driven gear. Then slide gear into place and secure it with gear attaching bolts. Apply 1-2 drops Loctite 242 to bolt threads beforehand and tighten bolts to 13-20 lb-ft (18-27 N•m) torque.
9. Verify that all timing marks are aligned.

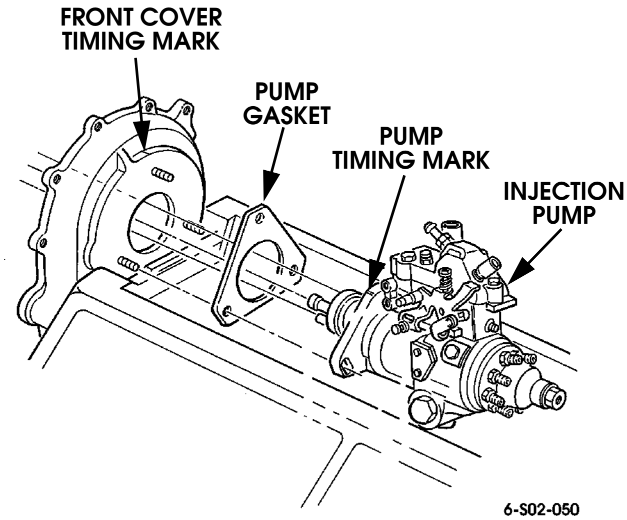


Figure 2-194: Injection Pump Installation (Non-Turbo Shown)

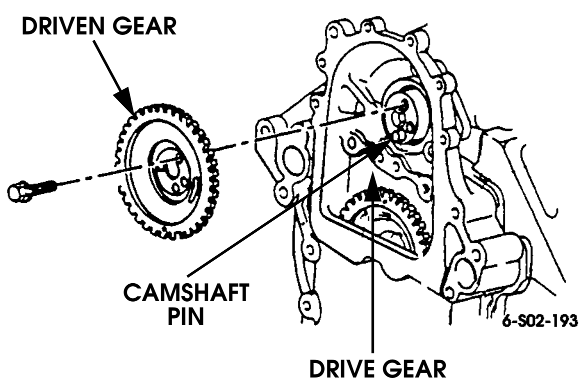


Figure 2-195: Pump Driven Gear Installation

WATER PUMP AND ADAPTER PLATE INSTALLATION

1. Apply Permatex #2 to both sides of gasket and install gasket and water pump on adapter plate (Figure 2-196). Tighten adapter plate bolts to 13-20 lb-ft (18-27 N•m).

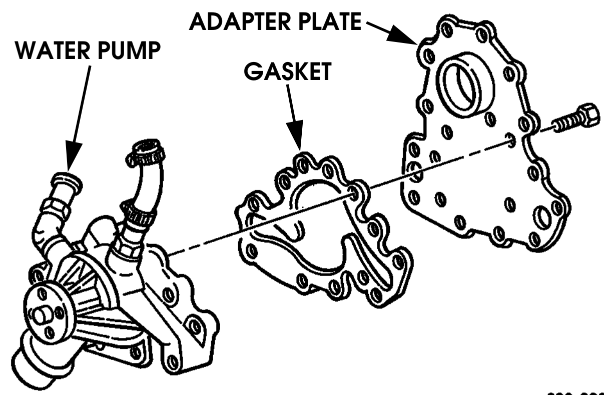


Figure 2-196: Assembling Water Pump and Adapter Plate

2. Apply Loctite gasket maker or 510 to contact area of adapter plate as shown (Figure 2-197).

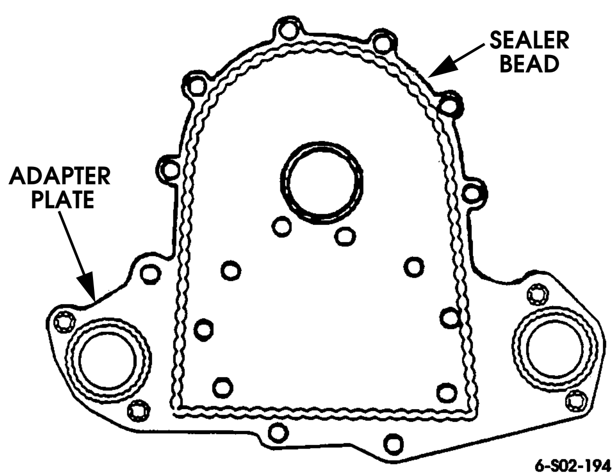


Figure 2-197: Adapter Plate Sealer Application

3. Install adapter plate and water pump on front cover. Tighten all studs and short bolts marked A to 13-20 lb-ft (18-27 N•m). Tighten large studs and large bolt marked B to 25-37 lb -ft (34-50 N•m) (Figure 2-198).

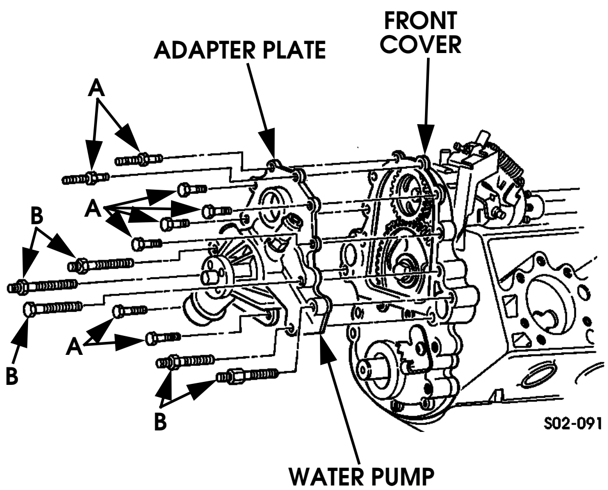


Figure 2-198: Adapter Plate and Water Pump Installation

4. Install oil fill tube on adapter plate with two washers and nuts. Tighten nuts to 13-20 lb-ft (18-27 N•m) (Figure 2-199).
5. Install pulley on water pump shaft flange.

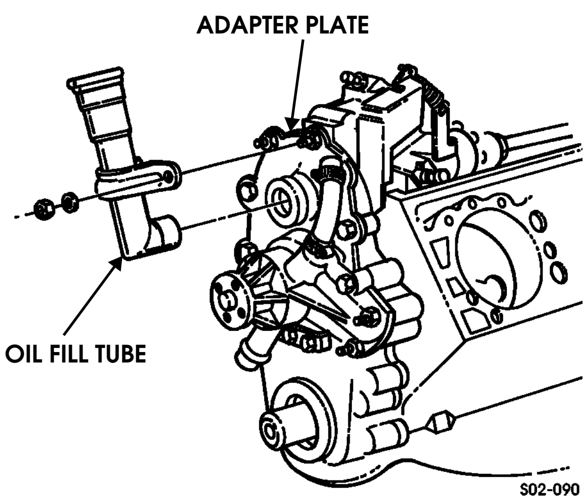


Figure 2-199: Oil Fill Tube Installation

VALVE LIFTER INSTALLATION

1. Prime valve lifters in kerosene then engine oil. Immerse lifter in kerosene first and oil last. Then pump plunger with pushrod to force solution through lifter.
2. Lubricate lifters with oil and install in cylinder block.
3. Position guide plates on lifters. Then install guide clamps and bolts. Tighten bolts to 15-20 lb-ft (20 -27 N•m) (Figure 2-200).
4. Rotate crankshaft several turns to ensure lifters move freely.

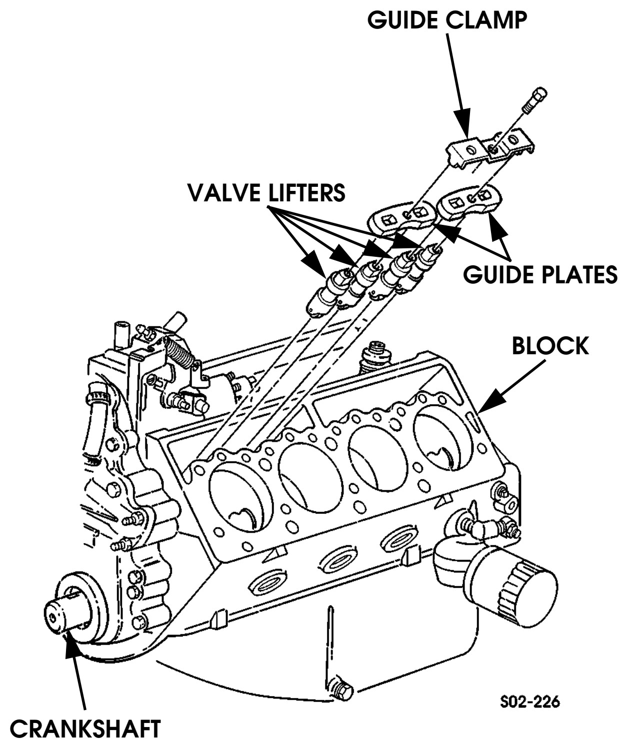


Figure 2-200: Valve Lifter Installation

CYLINDER HEAD INSTALLATION

Important:

- Make sure that the block and head gasket surfaces are clean.
- The head gasket material is soft. Handle the gasket with care and make sure the gasket surface is not creased or dented.

CAUTION: *Do not apply any type of sealant to the head gaskets. The head gasket is made with sealant on the gasket surface. Additional sealer may cause leakage and engine damage.*

1. Place each head gasket on block deck and dowels (Figure 2-201).
2. Carefully position each cylinder head on gasket and on dowels (Figure 2-201).

CAUTION: *Follow torque sequence for head bolts. This is necessary for correct compression of head gasket. Failure to do so will cause leaks.*

NOTE: Use the correct fastener in the correct location. Do not use paints, lubricants, or corrosion inhibitors on fasteners or fastener joint surfaces unless specified. These coatings affect torque and joint clamping force and may damage the fastener. Use the correct tightening sequence and specifications when installing fasteners in order to avoid damage to parts and systems.

3. Install cylinder head bolts as follows:
   a. Apply Loctite 592 pipe thread sealant to bolt threads and under bolt heads.
   b. Tighten bolts in sequence (Figure 2-202), to 20 lb-ft (25 N•m) torque.
   c. Repeat bolt tightening sequence to a torque of 55 lb-ft (75 N•m).
   d. Retighten bolts in sequence to 55 lb-ft (75 N•m).
   e. Tighten bolts an additional 90-100 degrees (1/4 plus turn).

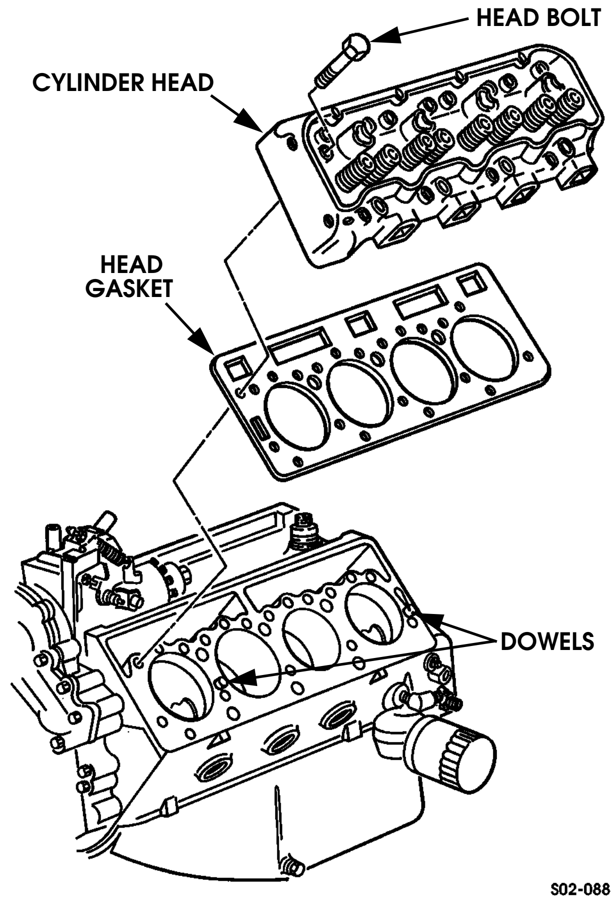


Figure 2-201: Cylinder Head and Gasket Installation

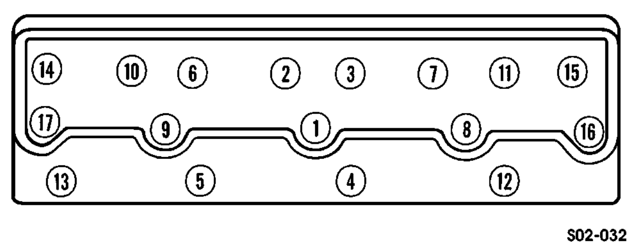


Figure 2-202: Cylinder Head Bolt Tightening Sequence

GLOW PLUGS AND INSPECTION NOZZLE INSTALLATION

1. Install glow plugs in each cylinder head (Figure 2-203). Tighten plugs to 8-12 lb-ft (11-16 N•m).

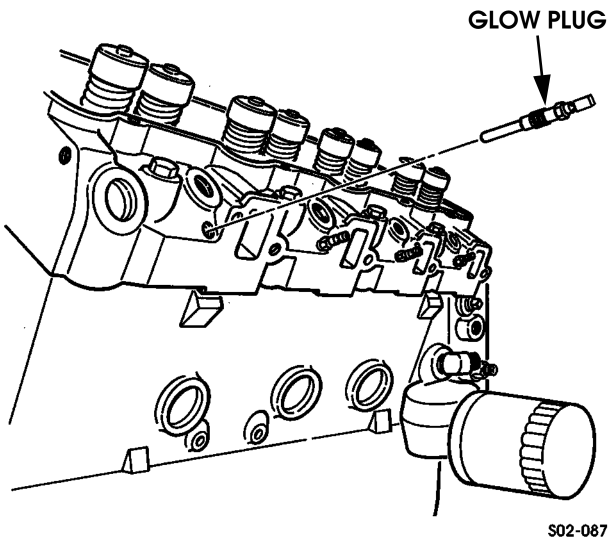


Figure 2-203: Glow Plug Installation

2. Install gasket on each injector nozzle (Figure 2-204).
3. Install injector nozzles in cylinder heads finger tight.
4. Tighten nozzles to 44-60 lb-ft (60-81 N•m) torque with installer tool J29873.
5. Connect return hoses between nozzles and install hose clamps.
6. Install plug on rear nozzle and install hose clamp.

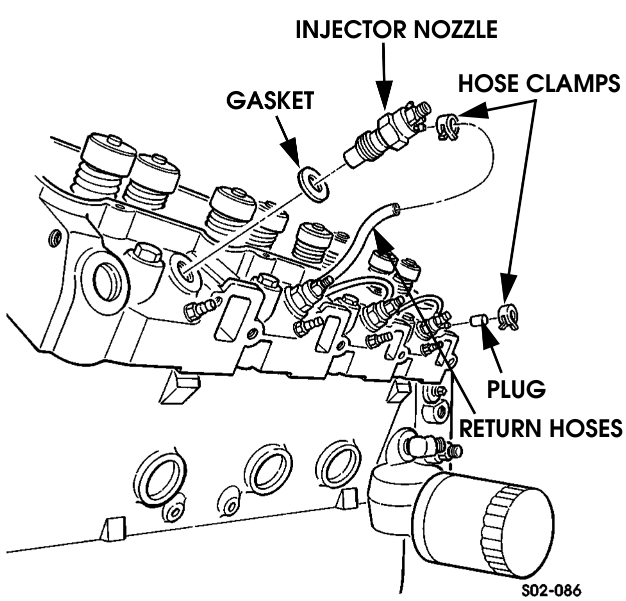


Figure 2-204: Fuel Injector Nozzle Installation

PUSHROD, ROCKER ARM AND SHAFT INSTALLATION

NOTE: The rocker arm end of each pushrod is identified with a paint stripe. In addition, the ball at this end of the pushrod is heat treated/coated giving it a distinctive color. Be sure the pushrods are installed with the correct end up and toward the rocker arm.

1. Insert pushrods in roller lifters. Verify that all pushrods are correctly installed.
2. Index crankshaft and pistons for rocker arm shaft installation as follows:
   a. Position breaker bar and socket on crankshaft damper bolt. Do not use starter to rotate crankshaft. Turn shaft with hand tools only.
   b. Rotate crankshaft counterclockwise, and align mark on torsional damper with “O” mark on front cover timing tab (Figure 2-205).
   c. Rotate engine counterclockwise an additional 3 1/2 inches (89 mm), measured at mark on torsional damper. Damper mark should align with water pump first, lower attaching bolt at this point (Figure 2-201).
3. Align and install rocker arm and shaft assemblies (Figure 2-206). Be very sure pushrods are seated in lifter and in rocker arms. Also be sure rocker arm retainers are in place and seated.
4. Install rocker arm shaft retainers and bolts. Tighten bolts in small increments until snug, with socket and ratchet or nut runner.

CAUTION: *Do not use an air wrench to tighten the bolts. In addition, stop tightening if the bolts become hard to turn before they are seated. If this condition occurs, the crankshaft and pistons are not properly indexed, allowing the valves to contact the pistons.*

5. Verify that pushrods are properly seated in rocker arms and lifters. Then final-tighten rocker arm shafts bolts to 41-lb-ft (56 N•m) torque.

ROCKER COVER INSTALLATION

1. Clean mounting flanges on both rocker covers and cylinder heads. Wipe flange sealing surfaces off with isopropyl alcohol to prepare surface for sealer application.
2. Apply RTV-type sealer to cover sealing surfaces.
3. Align and install covers on cylinder heads (Figure 2-207).
4. Install cover attaching bolts and studs and tighten to 13-25 lb-ft (18-34 N•m). Tighten fasteners starting at center and working toward each end.
5. Install all necessary fuel line and wire harness brackets on covers.

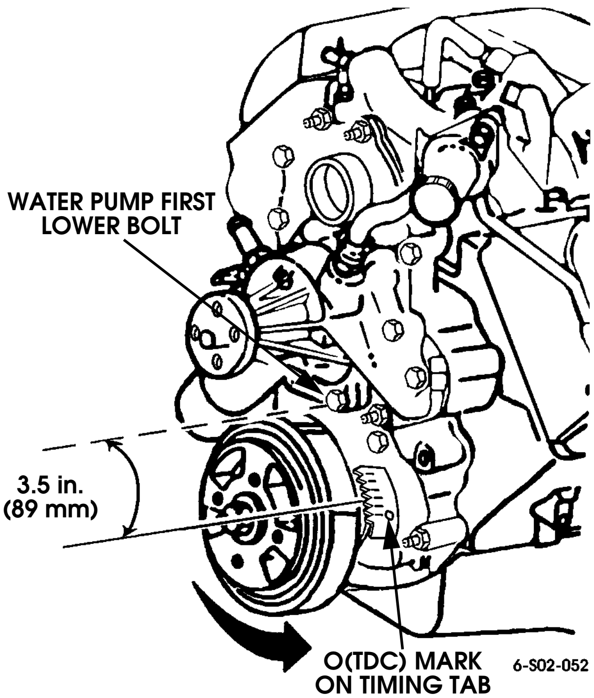


Figure 2-205: Crankshaft Index Position for Rocker Arm Installation

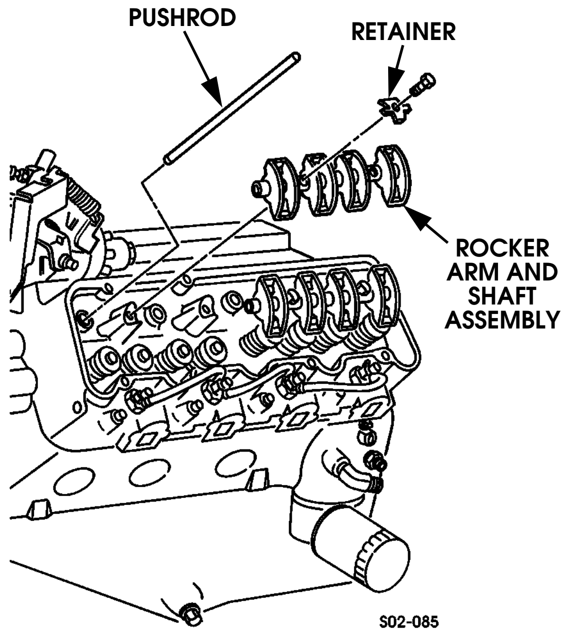


Figure 2-206: Rocker Arm and Shaft Installation

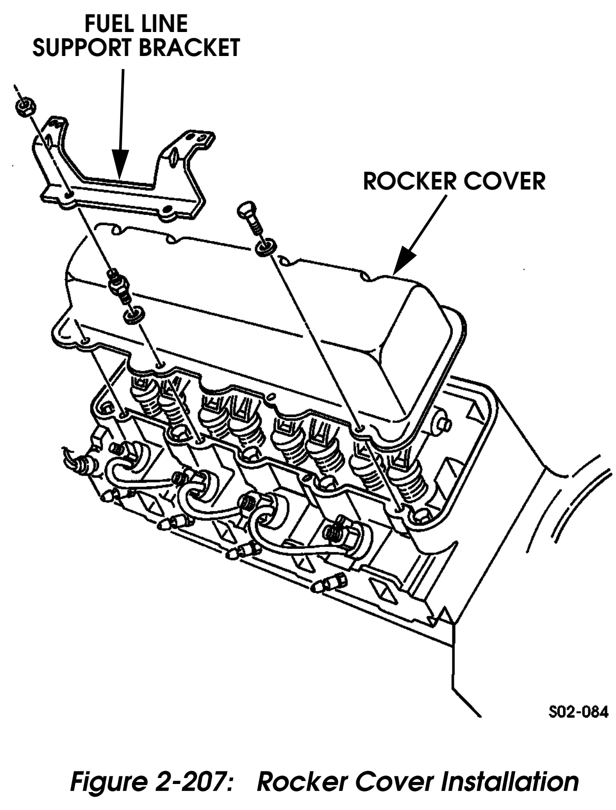


Figure 2-207: Rocker Cover Installation

FUEL INJECTOR LINE INSTALLATION

1. Flush injector lines with fresh diesel fuel and compressed air.
2. Attach fuel lines to injectors and pump. Verify line routing and connection (Figures 2-208 and 2-209).
3. Tighten fuel line fittings at injectors and at pump to 19 lb-ft (25 N•m) torque.
4. Install clips on injector lines (if removed).
5. Attach injector line clips to rocker covers.
6. Install boot over injection line fittings at pump.

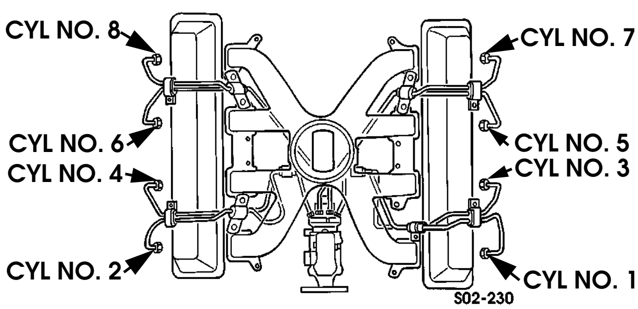


Figure 2-208: Fuel Injector Line Layout (NA Shown)

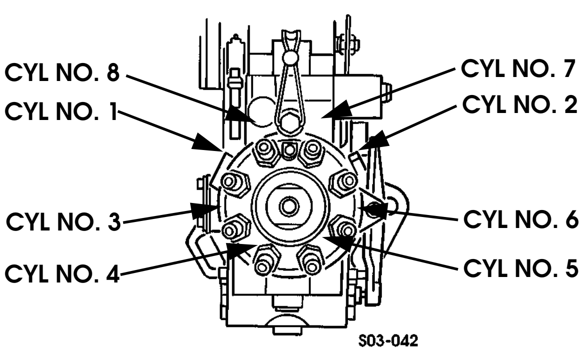


Figure 2-209: Fuel Connections at Pump

WATER CROSSOVER INSTALLATION

1. Apply Permatex #2 to crossover gaskets and position gaskets on cylinder heads (Figure 2-210).
2. If new crossover is being installed, transfer hose fittings to new crossover. Use Loctite PST on fitting threads.
3. Connect bypass hose to water pump (Figure 2-210).
4. Install crossover. Tighten cross-to-cylinder head bolts/studs to 25-37 lb-ft (34-50 N•m).
5. Connect bypass hose to crossover hose fittings on crossover (Figure 2-210).
6. Install thermostat, gasket and housing on water crossover. Apply Permatex #2 to gasket before installation and tighten housing bolts to 31 lb-ft (42 N•m) torque.

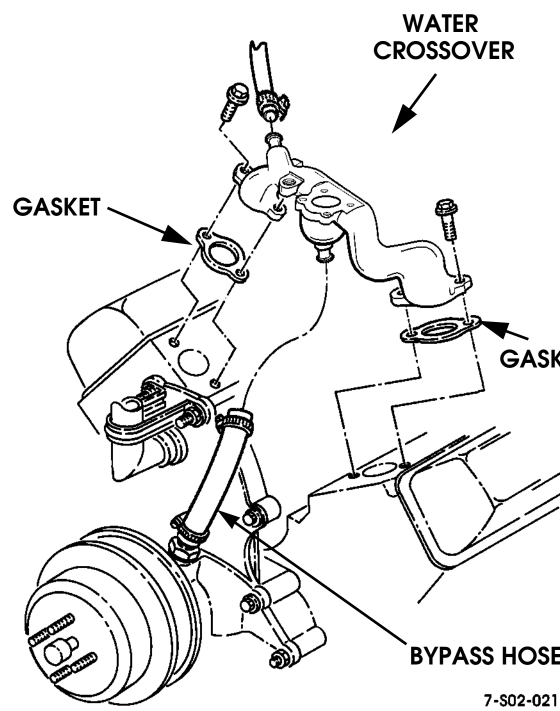


Figure 2-210: Water Crossover Installation (NA Shown)

EXHAUST MANIFOLD INSTALLATION

1. Position gasket on manifold. Then insert 1-2 bolts through manifold to hold gasket in place.
2. Install manifold attaching bolts finger tight.
3. Verify that gaskets are properly aligned tighten manifold bolts to 18-25 lb-ft (24-34 N•m) torque.

TORSIONAL DAMPER AND CRANKSHAFT PULLEY INSTALLATION

1. Install damper key in crankshaft (Figure 2-211).
2. Lubricate crankshaft hub, damper seal contact surface, and damper hub bore with engine oil or chassis grease.
3. Align and install damper on crankshaft.
4. Install washer and damper bolt. Tighten bolt 200 lb-ft (270 N•m) torque. Have helper prevent crankshaft from turning with holding tool installed on flywheel.

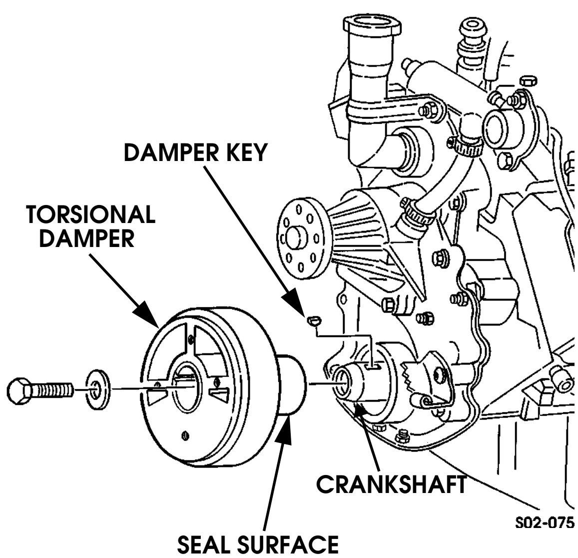


Figure 2-211: Torsional Damper Installation

INTAKE MANIFOLD INSTALLATION (NA DIESEL)

1. Apply Permatex High Tack to intake manifold gaskets and position gaskets on cylinder heads (Figure 2-212).
2. Install manifold on gaskets. Then install and tighten manifold studs and bolts to 31 lb-ft (42 N•m) torque. Tighten studs/bolts starting at center and working alternately toward each end.
3. Install new rubber seal on manifold air horn flange.
4. Install fuel injector line clamps on manifold studs. Tighten attaching nuts to 26-30 lb-ft (34-41 N•m) torque.

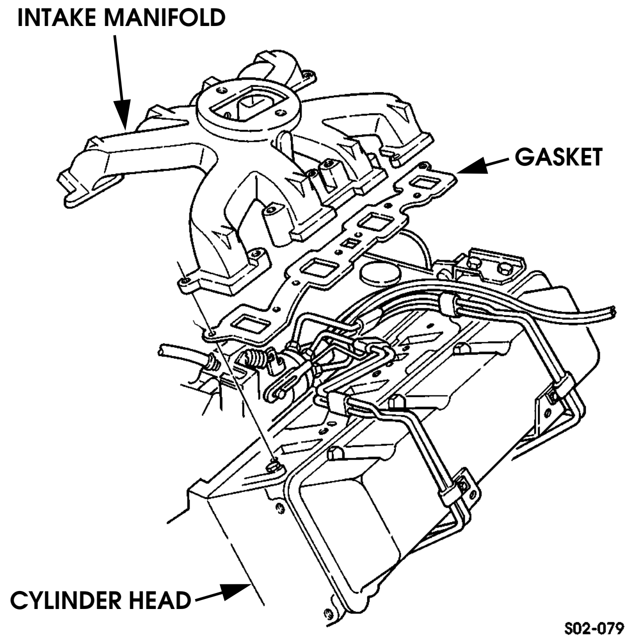


Figure 2-212: Intake Manifold Installation (NA Diesel)

TURBOCHARGER AND INTAKE MANIFOLD INSTALLATION (TURBO DIESEL)

1. Apply Permatex High Tack to manifold gaskets and position gaskets on cylinder heads.
2. Install left/right side manifold halves. Tighten attaching bolts/studs to 31 lb-ft (42 N•m) torque.
3. Mount turbocharger or cylinder block, and install attaching bolts, nuts, and brackets. Tighten attaching bolts/nuts to 43 lb-ft (58 N•m) torque.
4. Connect exhaust inlet tubes to exhaust manifolds and turbocharger (Figures 2-8 and 2-9). Tighten exhaust tube flange clamps to 7 lb-ft (10 N•m) torque.

NOTE: Do not install the intake manifold crossover housing at this time. The housing will not be installed until after the engine is installed in the vehicle.

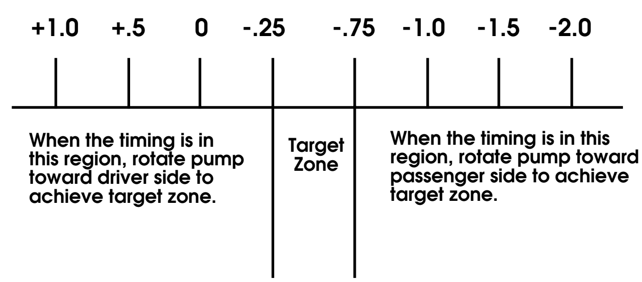
5. Install alternator mounting brackets, and idlers on right side cylinder head.
6. Install power steering pump and mounting brackets.
7. Install A/C compressor and braces.
8. Install crankshaft pulley. Tighten pulley attaching bolts to 48 lb-ft (65 N•m) torque.
9. Install water pump pulley, if not installed before this.
10. Install fan and clutch assembly. Tighten attaching bolts/nuts to 15-20 lb-ft (20-27 N•m) torque.
11. Install serpentine belt.
12. Install glow plugs, if not previously installed. Tighten plugs to 13 lb-ft (18 N•m) torque.
13. Install wire harness and hose brackets.

REPROGRAMMING TDC OFFSET (TURBO DIESEL)

TDC offset must be reprogrammed whenever the PCM, front cover, timing gears, timing chain, crankshaft position sensor, or other components affecting timing are replaced. The procedure for reprogramming TDC offset is as follows:

1. Verify that vehicle batteries are fully charged.
2. Start and run engine at curb idle speed.
3. Continue running engine at curb idle speed until coolant reaches normal operating temperature.
4. Connect Tech 1 scan tool to data link/diagnostic connector.
5. Select FO: OUTPUT TESTS from Miscellaneous Test menu.
6. Select FO: INJ PUMP.
7. Select TDC OFFSET LEARN.
8. Press Up Arrow key and PCM will learn engine top dead center offset value. This requires approximately 20 seconds.
9. Correct learned TDC Offset value should be between minus 0.25 and minus 0.75. If value is not within specified range, loosen injection pump and rotate it to correct value as follows:
   - If value is between plus 1.0 and minus 0.25, rotate pump toward driver side to achieve specified value.
   - If value is between minus 0.75 and minus 2.0, rotate pump toward passenger to achieve specified value.

NOTE: 1 mm pump movement in either direction results in approximately 2 degrees change.



TORQUE SPECIFICATIONS

Item	Lb-Ft.	Lb-In.	N•m
Block drainplugs	16	—	22
Camshaft gear bolt	126	—	171
Camshaft thrust plate bolts	17	—	23
Connecting rod nuts	48	—	65
Coolant crossover/thermostat housing bolts	31	—	42
Crankshaft pulley bolts	30	—	41
Cylinder head bolts	55*	—	75
Exhaust manifold bolts	25	—	34
Flywheel bolts	66	—	89
Front cover bolts/studs	33	—	45
Glow plugs	13	—	18
Hydraulic lifter guide plate and clamp bolts	19	—	26
Intake manifold bolts	31	—	42
Injection line fittings	19	—	26
Injector nozzles	59	—	80
Injection pump driven gear bolts	17	—	23
Injection pump mounting nuts	31	—	42
Oil filter adapter bolt	47	—	64
Main bearing cap bolts — Inner	111	—	150
Outer	100	—	136
Engines built after 3/13/97-inner	55*	—	75
Engines built after 3/13/97-12 mm outer	48*	—	65
Engines built after 3/13/97-10 mm outer	30	—	40
Oil pan bolts (all except rear two bolts)	—	89	10
(rear two bolts)	17	—	23
Oil pump mounting stud	66	—	89
Oil pan drain plug	20	—	27
Oil pump drive, clamp bolt	31	—	42
Rocker cover bolts	16	—	22
Rocker shaft bolts	41	—	56
Torsional damper bolt	200	—	270
Air horn bolts	—	45-65	5-7
Oil filler neck nuts	17	—	23
Water pump-to-adapter bolts	20	—	28
Water pump-to-front cover bolts	20	—	28
Turbocharger mounting bolts/nuts	43	—	58
Turbocharger inlet tube clamps	—	90	10
Starter bolts	35	—	47
Splash shield screws:			
5/16	—	90-130	10-15
1/4	—	45-65	5-7
Hose/wire harness brackets	12	—	16
Engine mount-to-block bolts	30-40	—	41-54
Exhaust U-bolt clamps	5	—	7
Insulator	90	—	122

*Tighten bolts in sequence an additional 1/4 turn.

ENGINE SPECIFICATIONS

General Data:

Displacement	6.5L/395 c.i.d.
Type	4 Cycle, Diesel, Liquid-Cooled
Bore	4.06 in. (103.12 mm)
Stroke	3.82 in. (97 mm)
Compression Ratio	
NA Diesel	20.9:1
Turbo	20.2:1
Firing Order	1-8-7-2-6-5-4-3
Oil Pressure	10 psi (69 kPa) at idle (hot); 80 psi (552 kPa) at 2000 RPM

Cylinder Bore

Diameter (Refer to Service Piston and Bore Specifications)

Out-of-Round (Maximum). . . . . 0.0008 in. (0.02 mm)
Taper (Thrust Side) (Maximum) . . . 0.0008 in. (0.02 mm)

Piston to Bore Clearance[1]:

Bores 1 through 6. . . 0.0037-0.0047 in. (0.094-0.120 mm)
Bores 7 and 8 . . . . 0.004-0.005 in. (0.107-0.133 mm)

Piston Ring:

Groove Clearance:

Top . . . . Keystone Ring
Second . . . . 0.0015-0.0031 in. (0.039-0.079mm)
Oil . . . . 0.0016-0.0035 in. (0.040-0.090 mm)

End Gap[2]:

Top . . . . 0.010-0.020 in. (0.26-0.51 mm)
Second . . . . 0.029-0.039 in. (0.75-1.00 mm)
Oil . . . . 0.010-0.020 in. (0.25-0.51 mm)

Piston Pin:

Diameter	1.220-1.221 in. (30.9961-31.0039 mm)
Fit in Piston	0.00039-0.0006 in. (0.010-0.0153 mm)
Fit in Rod	0.0003-0.001 in. (0.0081-0.0309 mm)

Crankshaft:

Journal Diameter
(Refer to Main and Rod Journal Specification Charts)
Journal Taper (Maximum) . . . . 0.0002 in. (0.005 mm)
Journal Out-of-Round (Maximum) 0.0002 in. (0.005 mm)

Main Bearing Clearance

No. 1, 2, 3, 4. . . . . 0.0018-0.003 in. (0.045-0.083 mm)
No. 5. . . . . 0.002-0.0037 in. (0.055-0.093 mm)

Crankshaft End Play	0.0039-0.0098 in. (0.10-0.25 mm)
Rod Bearing Clearance (Select Fit)	0.0017-0.0039 in. (0.045-0.100 mm)
Rod Side Clearance	0.007-0.025 in. (0.17-0.63 mm)

Camshaft:

Lobe Lift ± 0.05

Intake . . . . 0.281 in. (7.133 mm)
Exhaust. . . . . 0.281 in. (7.133 mm)
Camshaft End Play. . . . 0.002-0.012 in. (0.051-0.305 mm)

Journal Diameter (Refer to Camshaft Specifications Chart)

[1]NOTE: Add 0.0005 in. (0.013 mm) to cylinder bore diameters to determine proper bore size for cylinders no. 7 and no. 8.

[2]NOTE: Ring end gap specifications are for new bores; worn bores will generate larger ring end gaps.

Valve Train:

Lifter Type. . . . . .Hydraulic Roller
Rocker Arm Ratio 1.5:1
Valve Lash (Intake and Exhaust) . . . . Not Adjustable
Valve Recess Depth:

Intake . . . . 0.0013 in. (0.034 mm)
Exhaust. . . . . 0.0018 in. (0.048 mm)

Face Angle (Intake and Exhaust) . . . . 45°
Seat Angle (Intake and Exhaust). . . . . 46°
Seat Runout (Intake and Exhaust). . . . . . 0.0019 in. (0.05 mm)
Seat Width

Intake . . . . 0.035-0.060 in. (0.89-1.53 mm)
Exhaust. . . . . 0.062-0.093 in. (1.57-2.36 mm)

Stem Clearance

Intake . . . . 0.001-0.0027 in. (0.026-0.069 mm)
Exhaust. . . . . 0.001-0.0027 in. (0.026-0.069 mm)

Valve Spring Pressure

Closed . . . . 80 lb at 1.81 in. (356 N @ 46.0 mm)
Open. . . . . 230 lb at 1.39 in. (1025 N @ 35.3 mm)

Installed Height . . . . .1.8 in. (46 mm)
Timing Chain Free Play

New Chain . . . . 0.500 in. (12.7 mm)
Used Chain. . . . . 0.800 in. (20.3 mm)

SERVICE PISTON AND CYLINDER BORE SPECIFICATIONS (MM)

NOTE: Cylinders #7 and #8 require 0.013 mm (0.005 in.) additional clearance (piston to bore).

Engine Displacement	Piston Grade	Skirt Diameter	Bore Diameter 1 thru 6	Bore Diameter 7 & 8
6.5L	Production Std.—JT	102.865-102.880	102.972-102.987	102.985-103.003
	Production Rework —S or ST	103.008-103.026	103.117-103.130	103.130-103.143
	Service Std.,—JT	102.865-102.883	102.972-102.990	102.985-103.003
	Service Hi Limit—GT	102.904-102.922	103.013-103.026	103.026-103.039
	0.50 MM Oversize	103.339-103.417	103.508-103.512	103.521-103.525

CRANKSHAFT MAIN JOURNAL DIAMETER AND BEARING SELECTION (MM)

6.5L Engines				
Crankshaft Main Journal Diameter		Cylinder Main Bearing Bore Diameters		
#1 to #4	#5	79.850 79.842 Stamp 3	79.842 79.834 Stamp 2	79.834 79.826 Stamp 1
74.917 74.925 Blue	74.912 74.920 Blue	1-.026 U.S. in Case 1-.026 U.S. in Cap	1-.013 U.S. in Case 1-.026 U.S. in Cap	1-STD in Case 1-.026 U.S. in Cap
74.925 74.933 Orange or Red	74.920 74.928 Orange or Red	1-.026 U.S. in Case 1-.013 U.S. in Cap	1-.013 U.S. in Case 1-.013 U.S. in Cap	1-STD in Case 1-.013 in Cap
74.933 74.942 White	74.928 74.936 White	1-.026 U.S. in Case 1-STD in Cap	1-.013 in Case 1-STD in Cap	1-STD Case 1-STD in Cap

NOTE: U.S. indicates undersize bearing. Bearing sizes are in millimeters. To convert from metric to U.S. sizes, multiply metric (mm) figure by 0.03937.

CRANKSHAFT CONNECTING ROD JOURNAL DIAMETER AND BEARING SELECTION (MM)

Crankshaft Pin Journal Diameter	Connecting Rod Bearings	Rod & Cap Bearings Color Codes	Connecting Rod ID
60.913 mm 60.926 mm Green	Standard in rod .026 U.S. in cap	.026 U.S. (Green)	64.150 mm 64.124 mm
60.926 mm 60.939 mm Yellow	Standard in rod Standard in cap	Standard (Yellow)	

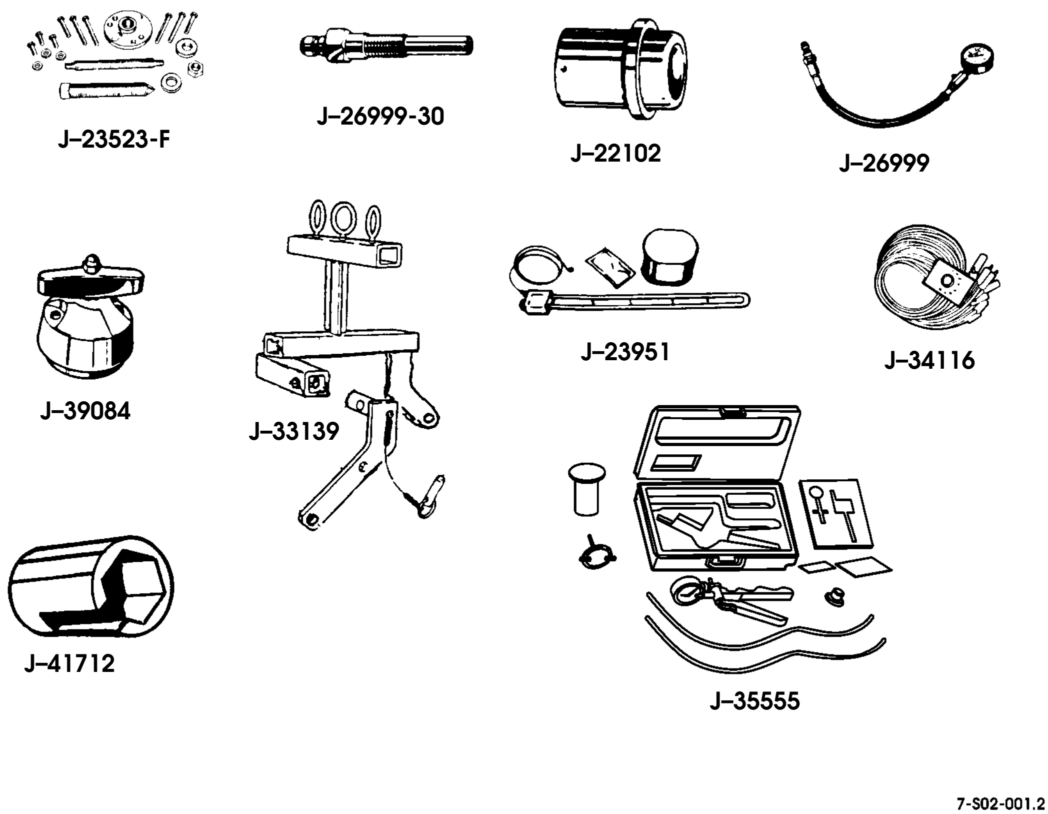
NOTE: To convert metric to U.S. sizes, multiply metric (mm) figure by 0.03937.

BLOCK, CAMSHAFT AND BEARING SIZES (MM)

6.5L Engines					
	#1	#2	#3	#4	#5
Camshaft Journal Diameter O.D (Diameter Tolerance 0.55 mm)	55.025 54.970	55.025 54.970	55.025 54.970	55.025 54.970	51.025 50.970
Finished Cam Bearing ID (Diameter tolerance 0.038 mm)	55.088 55.050	55.088 55.050	55.088 55.050	55.088 55.050	51.083 51.045
Camshaft Bearing Clearance	.118 .025	.118 .025	.118 .025	.118 .025	.113 .020
Cam Bore Diameter (Block)	59.17 59.12	58.92 58.87	58.67 58.62	58.42 58.37	50.42 50.37
Cam Bearing O.D.	59.30 59.25	59.05 59.00	58.80 58.75	58.55 58.50	50.55 50.50
Press Fit (Bearing to Block)	.18 .08	.18 .08	.18 .08	.18 .08	.18 .08

NOTE: To convert metric to U.S. sizes, multiply metric (mm) amount by 0.03937.

ESSENTIAL TOOLS



Tool No.	Description
J–23523-F	Harmonic Balancer Remover/Installer Set
J–26999-30	Compression Gauge Adapter
J–22102	Front Crankshaft Seal Installer
J–26999	Compression Gauge
J–39084	Rear Main Seal Installer
J–33139	Engine Lifting Sling and Bracket
J–23951	Water Manometer
J–34116	Cylinder Balance Tester
J–41712	Oil Pressure Switch Socket
J–35555	Vacuum (MITY-VAC) Pump
J–8001	Dial Indicator Set (not shown)
J–23129	Universal Seal Remover, use with slide hammer J–6125-1B (not shown)
J–41515-A	Glow Plug Socket, (not shown)
J–41613	Turbocharger Inlet Guard, (not shown)

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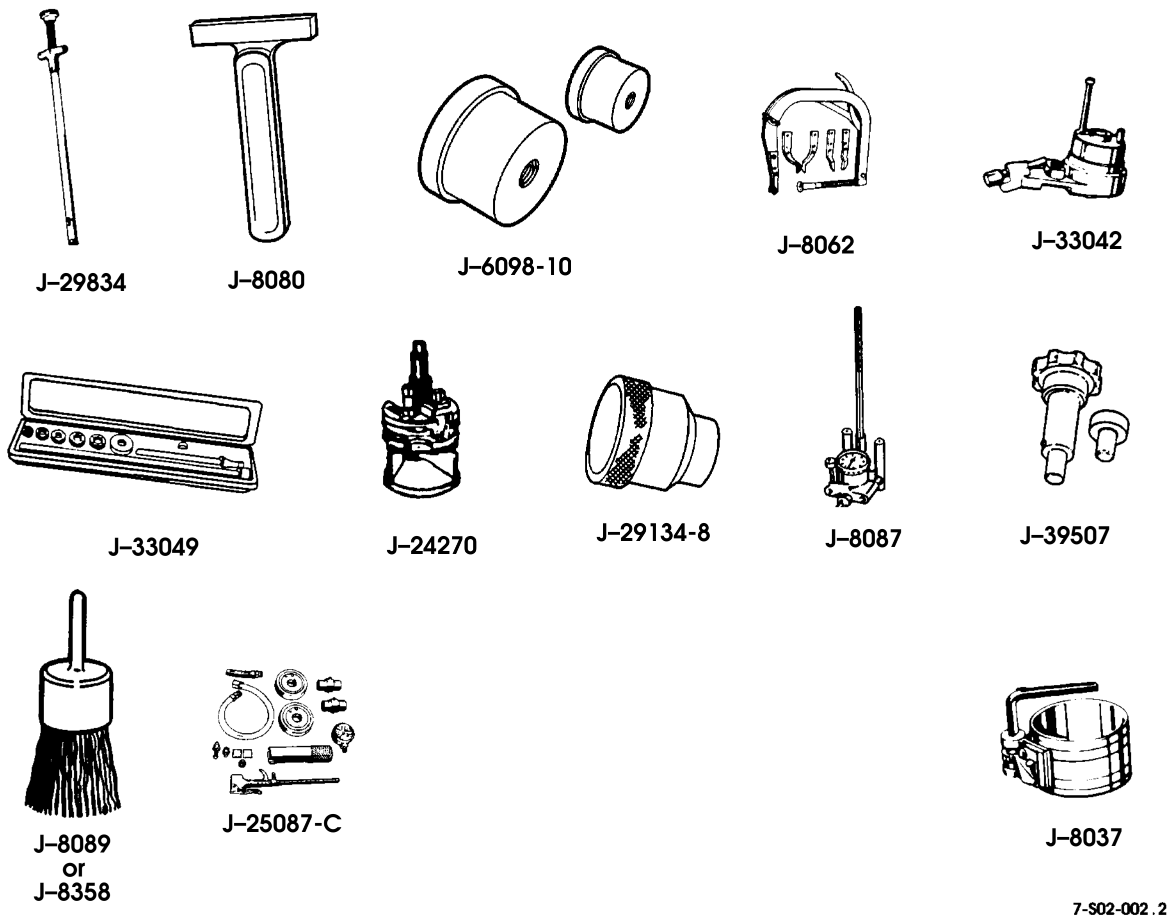
SPECIAL TOOLS



Tool No.	Description
J–29834	Valve Lifter Removal Tool
J–8080	Main Bearing Shell Remover/Installer (In-Vehicle)
J–6098-10	Camshaft Bearing Remover/Installer Set (use w/J–33049)
J–8062	Valve Spring Compressor
J–33042	Static Timing Mark Gauge
J–33049	Camshaft Bearing Replacement Set (Universal)
J–24270	Ridge Reamer
J–29134-8	Piston Pin Retaining Ring Compression Sleeve
J–8087	Cylinder Bore Gauge
J–39507	Piston Retaining Ring Installer Set
J–8089	Carbon Remover Brush, for cast iron and steel
J–8358	Carbon Remover Brush, for aluminum
J–25087-C	Oil Pressure Tester/Pump Primer
J–8037	Piston Ring Compressor
J–42545	Piston Ring Expander (not shown)
J–6098-O1	Camshaft Bearing Remover/Installer (use with J–6098-10 and J–33049) (not shown)

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General Information

The control module system has a computer, Powertrain Control Module (PCM) to control fuel delivery timing, and some emission control systems.

The control module system, monitors a number of engine and vehicle functions and controls the following operations:

- Fuel control
- Fuel injection timing
- Exhaust gas recirculation
- Transmission shift and shift quality functions. Specific transmission control diagnostics are covered in Section 5 of this service manual.

Powertrain Control Module (PCM)

The diesel Powertrain Control Module (PCM) is located in the passenger compartment and is the control center of the control module system.

The PCM constantly looks at the information from various sensors, and controls the systems that affect vehicle performance. The PCM performs the diagnostic function of the system. It can recognize operational problems, alert the driver through the MIL (Check Engine), and store one or more DTCs which identify the problem areas to aid the technician in making repairs.

The PCM is designed to process the various input information and then send the necessary electrical responses to control fuel delivery, timing and other emission control systems. The input information has an interrelation to more than one output, therefore, if the one input failed it could effect more than one system's operation.

PCM Function

The PCM supplies a buffered 5 or 12 volts to power various sensors or switches. This is done through resistances in the PCM which are so high in value that a test light will not light when connected to the circuit. In some cases, even an ordinary shop voltmeter will not give an accurate reading because its resistance is too low. Therefore, the use of a 10 megaohm impedance digital voltmeter is necessary to assure accurate voltage readings.

Reprogramming ("Flashing") The Control Module

Some vehicles allow reprogramming of the control module without removal from the vehicle. This provides a flexible and a cost-effective method of making changes in software and calibrations.

Verifying Vehicle Repair

Verification of vehicle repair will be more comprehensive for vehicles with OBD II system diagnostics. Following a repair, the technician should perform the following steps:

1. Review and record the fail records and/or Freeze Frame data for the DTC which has been diagnosed (Freeze Frame data will only be stored for an A or B type diagnostic and only if the MIL has been illuminated).
2. Clear DTC(s).
3. Operate the vehicle within conditions noted in the fail records and/or Freeze Frame data.
4. Monitor the DTC status information for the specific DTC which has been diagnosed until the diagnostic test associated with that DTC runs.

Following these steps is very important in verifying repairs on OBD II systems. Failure to follow these steps could result in unnecessary repairs.

Reading DTCs Using A Scan Tool

The recommended method for reading DTC(s) stored in memory is by using diagnostic Scan Tool plugged into the DLC. Follow instructions supplied by tool manufacturer.

"On-Board Diagnostic (OBD) System Check"

After the visual/physical under hood inspection, the "On-Board Diagnostic (OBD) "System Check" is the starting point for all diagnostic procedures and for locating the cause of an emissions test failure.

The correct procedure to diagnose a fault is to follow three basic steps.

1. Are the on-board diagnostics working? This is determined by performing the "On-Board Diagnostic (OBD) System Check." If the on-board diagnostics are not working, refer to diagnostic charts in this section. If the on-board diagnostics are working properly, the next step will be:
2. Is there a DTC stored? If a DTC is stored, go directly to the numbered DTC chart in this section. This will determine if the fault is still present. If no DTC is stored, the next step will be:
3. Scan Tool serial data transmitted by the control module. This involves displaying the information available on the serial data stream with a Scan Tool or one of the tools available for that purpose. Information on these tools and the meaning of the various displays can be found in this section. Normal readings under a particular operating condition can be found below the chart "On-Board Diagnostic (OBD) System Check."

Diagnostic Information

The diagnostic table and functional checks in this manual are designed to locate a faulty circuit or component through logic based on the process of elimination.

The charts are prepared with the requirements that the vehicle functioned correctly at the time of assembly and that there are no multiple failures.

The PCM performs a continual self-diagnosis on certain control functions. This diagnostic capability is complemented by the diagnostic procedures contained in this manual. The PCM's language for communicating the source of a malfunctions is a system of DTCs.

Malfunction Indicator Lamp (MIL) "Check Engine"

This light is on the instrument panel and has the following functions.

- It informs the driver that a problem has occurred and that the vehicle should be taken in for service as soon as reasonably possible.
- It displays DTCs stored by the PCM which help the technician diagnose system problems.

As a bulb and system check, the light will come "ON" with the key "ON" and the engine not running. When the engine is started, the light will turn "OFF." If the light remains "ON," the self-diagnostic system has detected a problem. If the problem goes away, the light will go out in most cases after 10 seconds, but a DTC will remain stored in the PCM.

When the light remains "ON" while the engine is running, or when a malfunction is suspected due to a driveability or emissions problem, an "On-Board Diagnostic (OBD) System Check" must be performed. This check will expose malfunctions which may not be detected if other diagnostics are performed prematurely.

"Check Throttle" Lamp

This light is on the instrument panel and has the following functions:

- It informs the driver that a problem has occurred in the Accelerator Pedal Position (APP) circuit and the vehicle should be taken in for service as soon as reasonably possible.
- If APP DTCs are stored by the PCM, the MIL will display these. The "Check Throttle" Lamp will not display DTCs.

As a bulb and system check, the light will come "ON" with the key "ON" for 2 seconds. When the engine is started, the light will turn "OFF." If the light remains "ON," the self-diagnostic system has detected a problem. If the problem goes away, the light will go out in most cases after 10 seconds, but a DTC will remain stored in the PCM.

When the light remains "ON" while the engine is running, or when a malfunction is suspected, an "On-Board Diagnostic (OBD) System Check" must be performed. This check will expose malfunctions which may not be detected if other diagnostics are performed prematurely.

Circuit Description

The "On-Board diagnostic (OBD) System Check" is an organized approach to identifying a problem created by a control module system malfunction. It must be the starting point for any driveability complaint diagnosis, this will direct the service technician to the next logical step in diagnosing the complaint. Understanding the chart and using it properly will reduce diagnostic time and prevent the unnecessary replacement of good parts.

Test Description

Number(s) below refer to the step number(s) on the Diagnostic Table.

1. When the ignition switch is cycled to "ON," the MIL should turn "ON" and remain "ON" steady. This sequence will determine that the vehicle diagnostics are operational.
2. Use Scan Tool to aid diagnosis, therefore, serial data must be available.
3. Although the PCM is powered up, a "Cranks But Will Not Run" symptom could exist because of a PCM or system problem.
4. Comparison of actual control system data with the Typical Scan Tool Data Values is a quick check to determine if any parameter is not within limits. A base engine problem (i.e., advanced cam timing) may substantially alter sensor values.
5. This step will isolate if the customer complaint is a MIL or driveability problem with no MIL. Refer to "DTC Identification" in this Section for a list of valid DTCs. An invalid DTC may be the result of a faulty Scan Tool, PROM or PCM.

Tech 1 Scan Tool

The diagnostic procedures in this manual assume the use of a Tech 1 scan tool. Since the Tech 1, produced by Expertec, is able to perform functions, such as, bidirectional communication that other scan tools are unable to perform, it has been made an essential tool. Although, the term scan tool will continue to be used for simplicity's sake, we recommend the Tech 1 be used whenever possible. Explicit instructions on connecting and using the various Tech 1 functions are contained in the Tech 1 owner's manual.

The PCM can communicate a variety of information through Data Link Connector (DLC) terminal "M." This data is transmitted at high frequency which requires a scan tool for interpretation.

PCM Identification

AM General identifies all HUMMER powerplants using the **fourth** digit of the VIN code. General Motors uses the **eighth** digit of the VIN code. When the Tech 1 Scan Tool asks for PCM identification, it will ask for the **eighth** digit. Look at the **fourth** digit of the VIN and translate to GM code:

ENGINE TYPE	
AMG	**GM**
Y	Y
Z	F

- Scroll through the choices until you read the correct character (Y or F).
- With the correct character highlighted, press the YES key to make the selection.
- The Tech 1 will prompt you to verify the engine type. Press YES if correct.

Powertrain Control Module (PCM)

Service of the PCM should normally consist of replacement of the PCM.

If the diagnostic procedures call for the PCM to be replaced, it will be necessary to program the EEPROM in the PCM using the procedure in this section

Important

- When replacing the production PCM with a service PCM, a DTC P1214 will be stored. It is important to program "TDC Offset" into the service PCM. Refer to "PCM Programming (TDC Offset)."

Important

- When a PCM has been replaced, a short glow plug duration will exist during the first ignition cycle (less than 2 seconds). After the first ignition cycle, the glow plug system will operate properly.

Important

- When replacing the production PCM with a service PCM (controller), it is important to transfer the broadcast code and production PCM number to the service PCM label. Please Do Not record on PCM cover. This will allow positive identification of PCM parts throughout the service life of the vehicle.

Important

- To prevent internal PCM damage, the ignition must be "OFF" when disconnecting or reconnecting power to PCM (for example, battery cable, PCM pigtail, PCM fuse, jumper cables, etc.). The ignition should be "OFF" for at least 30 seconds before disconnecting power to the PCM.

PCM Replacement

Remove or Disconnect

1. Negative battery cables.
2. PCM from passenger compartment.
3. Connectors from PCM.
4. PCM mounting hardware.

CAUTION: *To prevent possible electrostatic discharge to the PCM, do not touch the component leads, and do not remove integrated circuit from carrier.*

Install or Connect

1. PCM mounting hardware.
2. Connectors to PCM.
3. PCM in passenger compartment.
4. Negative battery cables.

NOTE: The MIL, antilock and brake lamps will continue to be enabled until the PCM is programmed. Once the programming is complete, the lamps will be turned "OFF" and normal operation will occur.

5. Proceed to "PCM Programming (EEPROM)"

PCM Programming (EEPROM)

1. Set up:
   - Battery is charged.
   - Ignition is "ON."
   - Battery/Cig. Lighter connection secure.
   - Data Link Connector attached.
2. Refer to up-to-date Techline terminal/equipment user's instructions.

3. If PCM fails to reprogram, do the following:
   - Check all PCM connections.
   - Check Techline terminal/equipment for latest software version.
   - Try again to reprogram PCM. If it fails again, replace the PCM. Refer to PCM replacement.
4. Allow vehicle to idle until coolant temperature is greater than 170°F (77°C) (refer to “PCM Programming TDC Offset”)

Functional Check

Vehicle must achieve a coolant temperature greater than 170°F (77°C) before an OBD system check can be performed.

- Check Data list for a TDC Offset.
- Perform OBD System Check.

PCM Programming (TDC Offset)

The PCM will automatically activate the TDC Offset program when the engine coolant is greater than 170°F (77°C). If the PCM is not programmed with a TDC Offset, a P1214 will set.

Step	Action	Value(s)	Yes	No
1	1. Connect the Scan Tool. 2. Key “ON” engine “OFF.” Is the MIL “ON”?	—	Go to Step 2	Go to Chart A-1
2	Ignition “ON,” engine “OFF.” Does the Scan Tool display PCM data?	—	Go to Step 3	Go to Chart A-2
3	Are any DTC(s) stored?	—	Go to Step 6	Go to Step 4
4	1. Key “OFF” for 20 seconds. 2. Ignition “ON,” and wait for glow plug cycle 3. Crank the engine for 10 seconds. Will the engine start?	—	Go to Step 5	Go to Chart A-3
5	Compare the Scan Tool engine data with typical values shown on following pages. Are values normal or within typical ranges?	—	Go to Step 7	Go to Step 8
6	Refer to applicable chart.	—	—	—
7	Refer to in Section 2 for engine diagnosis.	—	—	—
8	Refer to indicated “Component(s) System” checks.	—	—	—

Typical Engine Data Values

Idle/Upper Radiator Hose Hot/Closed Throttle/Park or Neutral/ACC. "OFF"

Tech 1 Parameter	Units Displayed	Typical Data Value
Engine Speed	RPM	±100 RPM from desired
Desired Idle	RPM	PCM idle command
ECT	C°/F°	85°C - 105°C (185°F - 221°F) *varies with coolant temp.
Start Up ECT	C°/F°	varies (depends on start up ECT)
IAT	C°/F°	60°C - 80°C (140°F - 177°F) *varies with incoming air
ECT Sensor	volts	1.7-2.2 volts (varies with coolant temp.)
Baro	kPa/Volts	3-5 volts (varies with altitude and baro pressure)
ESO Solenoid	on/off	on
Boost Solenoid	%	60 - 70%
Boost Pressure	kPa	60 - 103 kPa *varies with altitude
Actual EGR	kPa	75 - 85 kPa
Desired EGR	kPa	75 - 85 kPa
EGR Solenoid	%	35 - 45%
EGR Vent Sol.	on/off	on
Fuel Temp	C°/F°	60°C - 80°C (140°F - 176°F) *varies with fuel temp.
Fuel Rate	millimeters cubed	7 - 12 mm3
Glow Plug	volts	0 volts
Glow Plug System	disabled/enabled	disabled
Des. Inj Timing	Degrees	3.5 - 6.0°
Act. Inj. Timing	Degrees	3.5 - 6.0°
APP Angle	%	0%
APP 1	volts	.45 - .95 volts
APP 2	volts	4.0 - 4.5 volts
APP 3	volts	3.6 - 4.0 volts
Inj. Pump Sol. Closure Time	milliseconds	1.70 - 1.90 ms
TDC Offset	Degrees	+.75 - -1.95
Ignition Volts	volts	12 - 14 volts
MPH kp/h	MPH kp/h	0 0
Cruise Switch	on/off	off

Typical Engine Data Values

Idle/Upper Radiator Hose Hot/Closed Throttle/Park or Neutral/ACC. "OFF"

Tech 1 Parameter	Units Displayed	Typical Data Value
Cruise Active	on/off	off
Cruise Brake Sw.	open/closed	closed
Brake Switch	open/closed	open
Set Switch	on/off	off
Resume Switch	on/off	off
TR Switch	Park-Neutral, Reverse, Drive Ranges	Park
Crank Ref Missed	#	0 (missed)
Inj. Pump Cam Reference Missed	#	0 (missed)
Lift Pump	volts	12 - 15 volts
Lift Pump System	disabled/enabled	enabled
Engine Load	%	4 - 6%
Engine Torque	ft-lb	7 - 10 ft-lb
# of Current DTC's	#	0
DTC Set This Ign.	yes/no	no
Ignition volts	volts	12 - 15 volts
TFT Sensor	volts	2.5 - 3.5 volts
TFT	C°/F°	50°C - 70°C (122°F - 158°F) *varies
Calc. A/C Load	ft-lb	0 ft-lb
A/C Request	on/off	off
A/C Compressor	engaged/disengaged	disengaged
A/C Relay	yes/no	no
MIL Lamp	on/off	off
STS Lamp	on/off	off
4WDL Mode	enabled/disabled	disabled
Front Axle Switch	unlocked/locked	unlocked
A/B/C Range Sw.	on on on/off off off	off off
1-2 Sol. 2-3 Sol.	on off	on off
TCC Enabled	on/off	off
PC Solenoid	on/off	off
Device Control	yes/no	no
Engine Run Time	hours/minutes/seconds	varies

No Malfunction Indicator Lamp (MIL) "Check Engine"

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	—	Go to Step 2	Go to OBD System Check
2	Attempt to start the engine. Does the engine start?	—	Go to Step 3	Go to Step 6
3	Check the fuse number 4. Is the fuse OK?	—	Go to Step 4	Go to Step 14
4	Turn the ignition "ON," probe the ignition feed circuit at the cluster connector with a test light to ground. Is the test light "ON?"	—	Go to Step 5	Go to Step 11
5	1. Turn the ignition "OFF." 2. Disconnect the black PCM connector. 3. Turn the ignition "ON." 4. Connect a fused jumper to the MIL control circuit at the PCM connector. 5. Observe the MIL. Is the MIL "ON?"	—	Go to Step 9	Go to Step 10
6	Check the PCM ignition Feed and Battery Feed fuses. Are both of the fuses OK?	—	Go to Step 7	Go to Step 13
7	1. Turn the ignition "OFF." 2. Disconnect the PCM connectors. 3. Turn the ignition "ON." 4. Probe the PCM harness ignition and battery feed circuits with a test light to ground. Is the test light "ON" both circuit?	—	Go to Step 8	Go to Step 12
8	1. Check for a faulty PCM ground or a poor PCM ground connection. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to Step 20	Go to Step 9
9	1. Check for a poor connection at the PCM. 2. If a poor connection is found, repair as necessary. Was a problem found?	—	Go to Step 20	Go to Step 15
10	1. Check the MIL control circuit for an open. 2. If the MIL control circuit is open, repair as necessary. Was a problem found?	—	Go to Step 20	Go to Step 16
11	Repair open in the ignition feed circuit to the cluster connector. Is the action complete?	—	Go to Step 20	—
12	Locate and repair open in the PCM battery feed circuit or the PCM ignition feed circuit as necessary. Is the action complete?	—	Go to Step 20	—
13	Locate and repair short to ground in the PCM Ignition Feed circuit or the PCM Battery Feed circuit as necessary. Is the action complete?	—	Go to Step 20	—

No Malfunction Indicator Lamp (MIL) "Check Engine"

Step	Action	Value(s)	Yes	No
14	Locate and repair short to ground in the instrument cluster Ignition Feed circuit. Is the action complete?	—	Go to Step 20	—
15	Replace the PCM. NOTE: If the PCM is faulty, then PCM must be programmed. Go to PCM Replacement and Programming Procedures. Is the action complete?	—	Go to Step 20	—
16	1. Check the MIL control circuit for a poor connection at the instrument cluster connector. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to Step 20	Go to Step 17
17	1. Remove the instrument cluster. 2. Inspect the MIL bulb. Is the bulb OK?	—	Go to Step 19	Go to Step 18
18	Replace the MIL bulb. Is the action complete?	—	Go to Step 20	—
19	Replace the instrument cluster. Is the action complete?	—	Go to Step 20	—
20	1. Using the Scan Tool, select "DTC," "Clear Info." 2. Attempt to start the engine. Does the engine start and continue to run?	—	Go to Step 21	Go to Step 2
21	1. Allow engine to idle until normal operating temperature is reached. 2. Select "DTC," "Failed This Ign." Are any DTCs displayed?	—	Go to Applicable DTC Table	Go to Step 22
22	Using the Scan Tool, select "Capture Info," "Review Info." Are any DTCs displayed that have not been diagnosed?	—	Go to Applicable DTC Table	System OK

No Scan Data

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	—	Go to Step 2	Go to OBD System Check
2	1. Ignition "OFF" for 30 seconds. 2. Ignition "ON," Engine "OFF." Is the MIL "ON"?	—	Go to Step 3	Go to Chart A-1
3	Can the Scan Tool communicate with the PCM?	—	Go to Step 4	Go to Step 7
4	With the Scan Tool, command the MIL "ON" and "OFF."	—	Go to Step 17	Go to Step 5
5	1. Ignition "OFF." 2. Disconnect the PCM connectors. 3. Ignition "ON." Is the MIL "OFF"?	—	Go to Step 6	Go to Step 18
6	With the Scan Tool, check Engine Cal ID. Is the proper CAL ID present?	—	Go to Step 28	Go to Step 19
7	With a test light to ground, probe the DLC connector (pin 16). Is the test light "ON"?	—	Go to Step 8	Go to Step 20
8	With a test light to B+, probe the DLC connector (pins 4 and 5). Is the test light "ON" for both circuits?	—	Go to Step 9	Go to Step 21
9	Check for proper operation of the cigar lighter. Does the cigar lighter operate properly?	—	Go to Step 10	Go to Step 22
10	Verify proper operation of the Scan Tool with a known good vehicle with the same equipment/controller. Does the Scan Tool communicate with known good vehicle?	—	Go to Step 11	Go to Step 23
11	1. Disconnect the Scan Tool. 2. With the DVM connected to ground, check the PCM serial data line at the DLC connector (pin 2). Is voltage on the serial data line less than the specified value?	7v	Go to Step 12	Go to Step 15
12	With the DVM connected to ground, again check the PCM serial data line at the DLC connector (pin 2). Is voltage on the serial data line less than the specified value?	1v	Go to Step 13	Go to Step 16
13	1. Ignition "OFF." 2. With the DVM connected to ground, check resistance of the serial data line at the DLC connector (pin 2). Is resistance less than the specified value?	10 Ohms	Go to Step 14	Go to Step 27
14	1. Disconnect the PCM connectors. 2. With the DVM connected to ground check resistance of the serial data line at the DLC connector (pin 2). Is resistance less than the specified value?	10 Ohms	Go to Step 24	Go to Step 28

No Scan Data

Step	Action	Value(s)	Yes	No
15	1. Ignition "OFF." 2. Disconnect the PCM Connectors. 3. Ignition "ON." 4. Check voltage on the DLC connector (pin 2). Is voltage at the specified value?	0v	Go to Step 28	Go to Step 25
16	Reprogram the EEPROM and retest. Is serial data present?	—	Go to Step 26	Go to Step 28
17	System OK.	—	—	—
18	Repair short to ground on the MIL control circuit.	—	—	—
19	Reprogram the EEPROM and retest.	—	—	—
20	1. Check fuse number 7. 2. If fuse is blown, repair short to ground in the battery feed circuit to the DLC connector (pin 16). 3. If the fuse is OK, repair open in the battery feed circuit to the DLC connector (pin 16).	—	—	—
21	Repair open in circuit that did not light the test light. Refer to Section 12 for ground distribution.	—	—	—
22	Refer to Section 12 for cigar lighter repair.	—	—	—
23	Faulty Scan Tool and/or cable.	—	—	—
24	Repair short to ground in the serial data line.	—	—	—
25	Repair short to voltage in the serial data line.	—	—	—
26	System OK.	—	—	—
27	1. Check serial data line for an open. 2. If OK, check PCM and DLC connections. 3. If OK, replace the PCM. **NOTE:** If the PCM is faulty, the new PCM must be programmed. Go to PCM replacement and programming procedures. Is the action complete?	—	Go to OBD System Check	—
28	Replace the faulty PCM. **NOTE:** if the PCM is faulty, the new PCM must be programmed. Go the PCM replacement and programming procedures. Is the action complete?	—	Go to OBD System Check	—

Engine Cranks But Will Not Run

Step	Action	Value(s)	Yes	No
1	NOTE: Before clearing DTC(s) use the Scan Tool "Capture Info" to record Freeze Frame and Failure Record for reference, as data will be lost when "Clear Info" function is used. Was the "On-Board Diagnostic (OBD) System Check" performed?	—	Go to Step 2	Go to OBD System Check
2	Check for proper condition of batteries, refer to Section 6D. Is condition of batteries OK?	—	Go to Step 3	Go to Step 24
3	Check for adequate fuel in tank. Is fuel at an adequate level?	—	Go to Step 4	Go to Step 24
4	Check the quality of fuel, refer to Section 4. Is fuel quality OK?	—	Go to Step 5	Go to Step 24
5	Check glow plug system operation, refer to Section.	—	Go to Step 6	Go to Step 24
6	Check for proper cranking speed, refer to Section. Is cranking speed OK?	—	Go to Step 7	Go to Step 24
7	Check for a restriction in the fuel return system, refer to Section. Does the fuel return system operate properly?	—	Go to Step 8	Go to Step 24
8	Ignition "ON." Dies MIL come "ON"?	—	Go to Step 9	Go to Step 16
9	Install scan tool. Does scan tool display data?	—	Go to Step 10	Go to Step 17
10	1. Loosen injector line at injector. 2. Crank engine. Is there fuel coming out of injection line?	—	Go to Step 11	Go to Step 11
11	Disconnect Optical/Fuel temperature sensor. Does vehicle start?	7v	Go to Step 12	Go to Step 15
12	1. Recommend Optical/Fuel temperature sensor. 2. Disconnect fuel solenoid driver. 3. With J 39200 connected to ground, robe fuel inject control circuit at harness terminal. 4. Crank engine. Is voltage greater than or equal specified value?	1v	Go to Step 13	Go to Step 19
13	1. Fuel solenoid driver still disconnected. 2. Jumper closure ground circuit with a test light connected to B+. Is test light "ON"?	10 Ohms	Go to Step 14	Go to Step 20
14	1. Ignition "ON," engine "OFF." 2. Probe ignition feed circuit at the fuel solenoid harness connector with a test light connected to ground. Is test light "ON"?	10 Ohms	Go to Step 15	Go to Step 22

Engine Cranks But Will Not Run

Step	Action	Value(s)	Yes	No
15	Replace fuel injection pump.	0v	Go to Step 26	—
16	Refer to Table 3-1.	—	—	—
17	Refer to Table 3-2.	—	—	—
18	Injection system OK, refer to driveability section.	—	—	—
19	Check the fuel inject control circuit for an open or ground between the fuel solenoid driver and the PCM. Was a problem found?	—	Go to Step 23	Go to Step 25
20	Check the closure ground circuit for an open between the fuel solenoid driver and the PCM. Was a problem found?	—	Go to Step 23	Go to Step 21
21	Inspect the fuel solenoid driver connector and PCM connector for proper connection. Was a problem found?	—	Go to Step 23	Go to Step 25
22	Repair the open in the ignition feed circuit. Is action complete?	—	Go to Step 26	—
23	Repair the circuit as necessary. Is the action complete?	—	Go to Step 26	—
24	Make appropriate repairs. Is action complete?	—	Go to Step 26	—
25	Replace the faulty PCM. **NOTE:** If the PCM is faulty, the new PCM must be programmed. Go to PCM replacement and programming procedures. Is the action complete?	—	Go to Step 26	—
26	1. Using the Scan Tool, select “DTC,” “Clear Info.” 2. Attempt to start engine. Does the engine start and continue to run?	—	Go to Step 27	Go to Step 2
27	1. Allow engine to idle until normal operating temperature is reached. 2. Select “DCT,” “Fail this Ign.” Are any DTCs displayed?	—	Go to Step 28	—
28	Using the scan tool, select “Capture Info,” Review Info.” Are any DTCs displayed that have not been diagnosed?	—	Go to the applicable DTC table	System OK

DTC (DTC) IDENTIFICATION

The MIL (Service Engine Soon) lamp will be "ON" if an emission malfunction exists. If the malfunction clears, the lamp will go "OFF" and the DTC will be stored in the PCM. Any DTCs stored will be cleared if no problem recurs within l50 engine starts.

- All DTCs with the sign * are transmission related DTCs and have descriptions, diagnostic charts are in Section 5. Remember, always start with the lowest numerical engine DTC first. When diagnosing some engine DTCs, other transmission symptoms can occur.

Intermittents

A corresponding DTC will be stored in the memory of the PCM as a history DTC until DTCs have been cleared. When unexpected DTCs appear during the code reading process, one can assume that these DTCs were set by an intermittent malfunction and could be helpful in diagnosing the system. An intermittent DTC may or may not re-set. If it is an intermittent failure, a Diagnostic Trouble Code (DTC) chart is not used. Consult the "Diagnostic Aids" on the page facing the diagnostic chart corresponding to the intermittent DTC. Section "2" also covers the topic of "Intermittents". A physical inspection of the applicable sub-system most often will not resolve the problem.

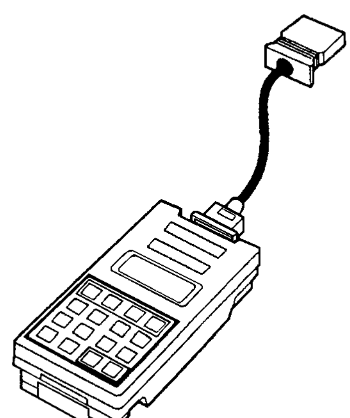
Scan Tool Use With Intermittents

In some scan tool allocations, the data update rate makes the tool less effective than a voltmeter, such as when trying to detect an intermittent problem which lasts for a very short time. However, the scan tool allows manipulation of wiring harnesses or components under the hood with the engine not running, while observing the scan tool readout.

The scan tool can be plugged in and observed while driving the vehicle under the condition when the MIL "Service Engine Soon" light turns "ON" momentarily or when the engine driveability is momentarily poor. If the problem seems to be related to certain parameters that can be checked on the scan tool, they should be checked while driving the vehicle. If there does not seem to be any correlation between the problem and any specific circuit, the scan tool can be checked on each position, watching for a period of time to see if there is any change in the reading that indicates intermittent operation.

The scan tool is also an easy way to compare the operating parameters of a poorly operating engine with those of a known good one. For example, a sensor may shift in value but not set a DTC. Comparing the sensor's readings with those of a known good vehicle may uncover the problem.

The scan tool has the ability to save time in diagnosis and prevent the replacement of good parts. The key to using the scan tool successfully for diagnosis lies in the technician's ability to understand the system he is trying to diagnose as well as understanding of the scan tool operation and limitations. The technician should read the tool manufacturer's operating manual to become familiar with the tool's operation.



S05-008

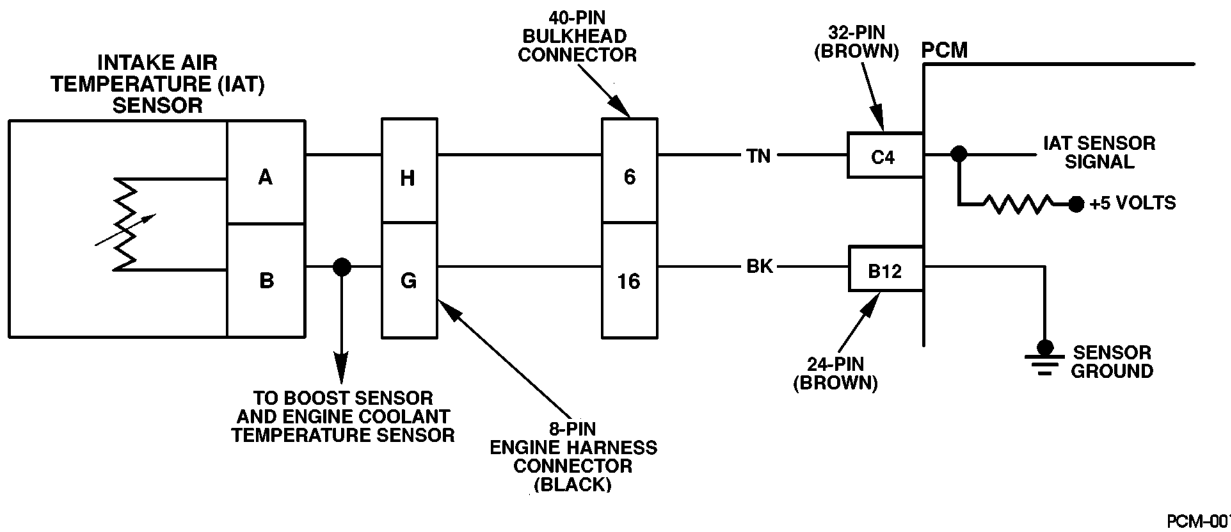
Diagnostic Trouble Code (DTC) Identification

DTC	Description	Type	Illuminate MIL
P0112	IAT Sensor Circuit Low Voltage	B	Yes
P0113	IAT Sensor Circuit High Voltage	B	Yes
P0117	ECT Sensor Circuit Low Voltage	B	Yes
P0118	ECT Sensor Circuit High Voltage	B	Yes
P0121	APP Sensor 1 Circuit Performance	C	No
P0122	APP Sensor 1 Circuit Low Voltage	C	No
P0123	APP Sensor 1 Circuit High Voltage	C	No
P0182	Fuel Temperature Sensor Circuit Low Voltage	B	Yes
P0183	Fuel Temperature Sensor Circuit High Voltage	B	Yes
P0215	Engine Shutoff Control Circuit	D	No
P0216	Injection Timing Control System	B	Yes
P0219	Engine Overspeed Condition	D	No
P0220	APP Sensor 2 Circuit	C	No
P0221	APP Sensor 2 Circuit Performance	C	No
P0222	APP Sensor 2 Circuit Low Voltage	C	No
P0223	APP Sensor 2 Circuit High Voltage	C	No
P0225	APP Sensor 3 Circuit	C	No
P0226	APP Sensor 3 Circuit Performance	C	No
P0227	APP Sensor 3 Circuit Low Voltage	C	No
P0228	APP Sensor 3 Circuit High Voltage	C	No
P0231	Lift Pump Secondary Circuit Low Voltage	B	Yes
P0236	TC Boost System	B	Yes
P0237	TC Boost Sensor Circuit Low Voltage	B	Yes
P0238	TC Boost Sensor Circuit High Voltage	B	Yes
P0251	Injection Pump Cam System	A	Yes
P0263	Cylinder Balance System Fault	D	No
P0266	Cylinder Balance System Fault	D	No
P0269	Cylinder Balance System Fault	D	No
P0272	Cylinder Balance System Fault	D	No
P0275	Cylinder Balance System Fault	D	No
P0278	Cylinder Balance System Fault	D	No
P0281	Cylinder Balance System Fault	D	No

Diagnostic Trouble Code (DTC) Identification

DTC	Description	Type	Illuminate MIL
P0284	Cylinder Balance System Fault	D	No
P0335	CKP Sensor Circuit Performance	A	Yes
P0370	Timing Reference High Resolution	A	Yes
P0380	Glow Plug Circuit Performance	B	Yes
P0501	Vehicle Speed Sensor Circuit	D	No
P0567	Cruise Resume Circuit	D	No
P0568	Cruise Set Circuit	D	No
P0571	Cruise Brake Switch Circuit	D	No
P0601	PCM Memory	D	No
P0602	PCM Not Programmed	D	No
P0606	PCM Internal Communication Interrupted	A	Yes
P1125	APP System	C	No
P1214	Injection Pump Timing Offset	B	Yes
P1216	Fuel Solenoid Response Time Too Short	D	No
P1217	Fuel Solenoid Response Time Too Long	D	No
P1218	Injection Pump Calibration Circuit	B	Yes
P1621	EEPROM Write	B	Yes
P1627	A/D Performance	B	Yes
P1635	5 Volt Reference Low	D	No
P1641	Malfunction Indicator Lamp (MIL) Control Circuit	D	No
P1643	Write to Start Lamp Control Circuit	B	No
P1654	Service Throttle Soon (STS) Lamp Control Circuit	D	No
P1656	Wastegate Solenoid Control Circuit	B	Yes

DTC P0112 INTAKE AIR TEMPERATURE (IAT) SENSOR CIRCUIT LOW VOLTAGE



Circuit Description

The Intake Air Temperature (IAT) sensor is a thermistor that controls signal voltage to the PCM. When the air is cold, the sensor resistance is high, therefore the PCM will see a high signal voltage. As air warms, sensor resistance becomes less and voltage drops.

Conditions for Setting the DTC

- Engine coolant temperature less than 42.5°C (109°F).
- Intake air temperature greater than or equal to 151°C (303°F).
- Conditions met for 2 seconds.

Action Taken When the DTC Sets

A possible poor performance problem may exist during cold weather operation.

Conditions for Clearing the MIL/DTC

- The PCM will turn the MIL off after three consecutive trips without a fault condition.
- A History DTC will clear when forty consecutive warm-up cycles that the diagnostic does not fail (coolant temperature has risen 5°C (40°F) from start up coolant temperature and engine coolant temperature exceeds 160°F (71°C) that same ignition cycle).
- Use of a Scan Tool

Diagnostic Aids

Check harness routing for a potential short to ground in the signal circuit. Scan Tool displays intake air temperature in degrees centigrade. Refer to “Intermittents” on page 13. A “skewed” sensor could result in poor driveability complaints.

Test Description

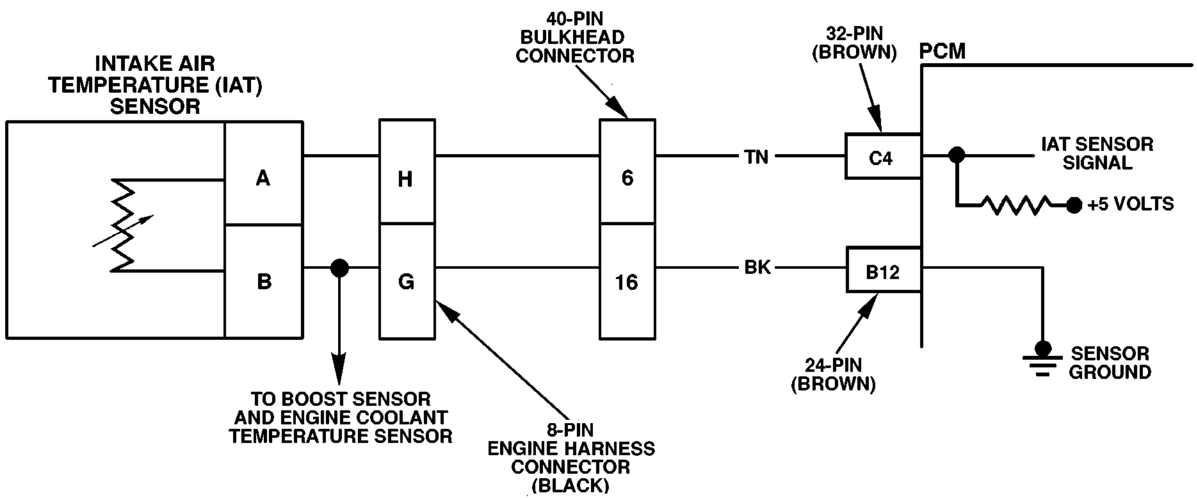
Number(s) below refer to the step number(s) on the Diagnostic Table.

2. This step determines if P0112 is a hard failure or an intermittent condition.
3. This test will determine if the PCM can recognize an open sensor.
4. This step will determine if the problem is s short to ground or a malfunctioning PCM.

DTC P0112 - Intake Air Temperature (IAT) Sensor Circuit Low Voltage

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the Scan tool "Capture Info" to record Freeze Frame and Failure Record for reference, as data will be lost when "Clear Info" function is used. Was the "On-Board Diagnostic (OBD) System Check" performed?	—	Go to Step 2	Go to OBD System Check
2	1. Scan tool connected. 2. Start the engine. 3. Monitor the IAT display on Scan Tool. Is the IAT display greater than or equal to the specified value?	151°C (303°F)	Go to Step 3	Go to Step 5
3	1. Turn the engine "OFF." 2. Turn the ignition "ON." 3. Disconnect the IAT sensor connector. Is the IAT display less than or equal to the specified value?	-30°C (-22°F)	Go to Step 7	Go to Step 4
4	1. Turn the ignition "OFF". 2. Using the J39200, measure the resistance across the IAT sensor harness connector. Is the resistance at the specified value?	Infinite	Go to Step 8	Go to Step 6
5	DCT is intermittent. If no additional DTCs are stored, refer to "Diagnostic Aids." If additional DTCs were stored, refer to those table(s). Are additional DTCs stored?	—	Go to the applicable DTC Table	Go to Diagnostic Aids
6	Repair the short to ground in the IAT signal circuit. Is the action complete?	—	Go to Step 9	—
7	Replace the IAT sensor. Is the action complete?	—	Go to Step 9	—
8	Replace the faulty PCM. NOTE: If the PCM is faulty, the new PCM must be programmed. Go to PCM replacement and programming procedures. Is the action complete?	—	Go to Step 9	—
9	1. Using the Scan Tool, select "DTC," "Clear Info." 2. Start engine and idle at normal operating temperature. 3. Select "DTC," "Specific," then enter the DTC number which was set. 4. Operate vehicle within the conditions for setting this DTC as specified in the supporting text. Does the Scan Tool indicate that this diagnostic Ran and Passed?	—	Go to Step 10	Go to Step 2
10	Using the Scan Tool, select "Capture Info," "Review Info." Are any DTC's displayed that have not been diagnosed?	—	Go to the applicable DTC table	System OK

DTC P0113 Intake Air Temperature (IAT) Sensor Circuit High Voltage



PCM-001

Circuit Description

The intake air temperature sensor is a thermistor that controls signal voltage to the PCM. When the air is cold, the sensor resistance is high, therefore the PCM will see a high signal voltage. As air warms, sensor resistance becomes less and voltage drops. This is a type B DTC.

Conditions for Setting the DTC

- Engine operating for 8 minutes.
- IAT less than or equal to -30°C (-22°F).
- Conditions met for 2 seconds.

Action Taken When the DTC Sets

Possible poor performance during cold weather operation.

Conditions for Clearing the MIL/DTC

- The PCM will turn the MIL off after three consecutive trips without a fault condition.
- A History DTC will clear when forty consecutive warm-up cycles that the diagnostic does not fail (Coolant temperature has risen 5°C(40°F) from start up coolant temperature and engine coolant temperature exceeds 160°F (71°C) that same ignition cycle).
- Use of a scan tool.

Diagnostic Aids

The scan tool displays intake air temperature in degrees centigrade. Refer to “Intermittent” on page 13. A “skewed” sensor could result in poor driveability complaints.

Test Description

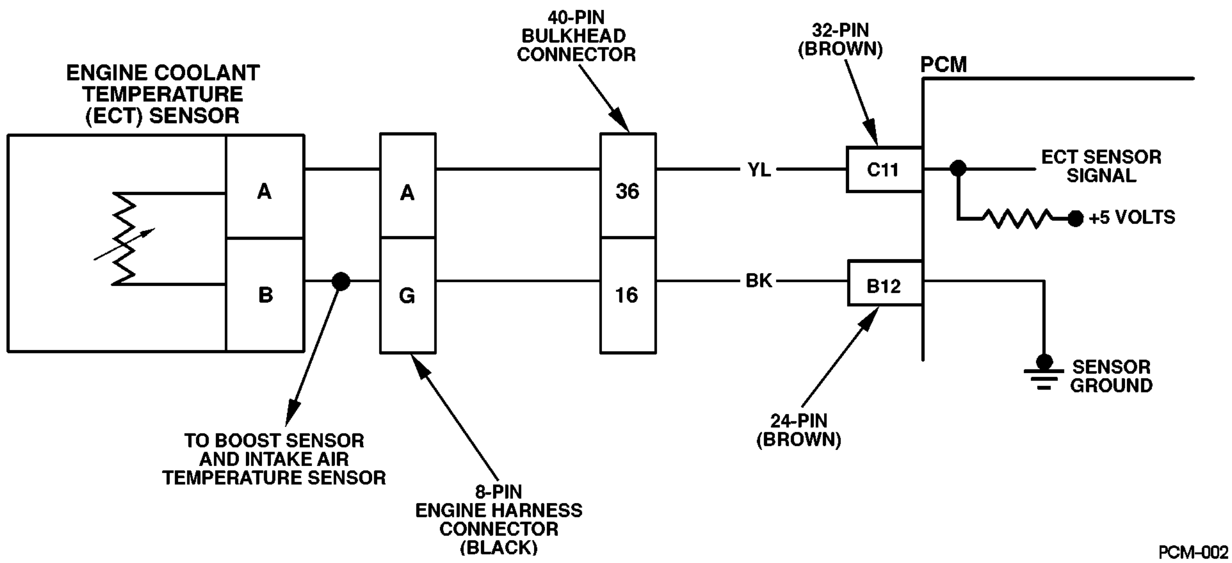
Number(s) below refer to the step number(s) on the diagnostic Table.

2. This step determines if P0113 is a hard failure or an intermittent condition.
3. This step will determine if there is a wiring problem or a faulty PCM.

DTC P0113 - Intake Air Temperature (IAT) Sensor Circuit High Voltage

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the Scan tool “Capture Info” to record Freeze Frame and Failure Record for reference, as data will be lost when “Clear Info” function is used. Was the “On-Board Diagnostic (OBD) System Check” performed?	—	Go to Step 2	Go to OBD System Check
2	1. Scan tool connected. 2. Start the engine. 3. Monitor the IAT display on Scan Tool. Is the IAT display colder than or equal to the specified value?	-30°C (-22°F)	Go to Step 3	Go to Step 5
3	1. Turn the engine “OFF.” 2. Turn the ignition “ON.” 3. Disconnect the IAT sensor connector. 4. Jumper the IAT harness terminals together. Does the scan tool display IAT greater than or equal to the specified value?	151°C (303°F)	Go to Step 6	Go to Step 4
4	Jumper the IAT sensor signal circuit to a known good ground. Does the scan tool display an IAT greater than or equal to the specified value?	151°C (303°F)	Go to Step 7	Go to Step 8
5	DTC is intermittent. If no additional DTCs are stored, refer to “Diagnostic Aids.” Are additional DTCs stored?	—	Go to the applicable DTC Table	Go to Diagnostic Aids
6	Inspect the sensor connector and PCM connector for a proper connection. Was a problem found?	—	Go to Step 9	Go to Step 10
7	Check the IAT sensor ground circuit for an open between the IAT sensor and the PCM. Was a problem found?	—	Go to Step 9	Go to Step 11
8	Check the IAT sensor signal circuit for an open between the IAT sensor and the PCM. Was a problem found?	—	Go to Step 9	Go to Step 11
9	Repair the circuit as necessary. Is the action complete?	—	Go to Step 12	—
10	Replace the faulty IAT sensor. Is the action complete?	—	Go to Step 12	—
11	Replace the faulty PCM. **NOTE:** If the PCM is faulty, the new PCM must be programmed. Go to PCM replacement and programming procedures. Is the action complete?	—	Go to Step 12	—
12	1. Using the Scan Tool, select “DTC,” “Clear Info.” 2. Start engine and idle at normal operating temperature. 3. Select “DTC,” “Specific,” then enter the DTC number which was set. 4. Operate vehicle within the conditions for setting this DTC as specified in the supporting text. Does the Scan Tool indicate that this diagnostic Ran and Passed?	—	Go to Step 13	—
13	Using the Scan Tool, select “Capture Info,” “Review Info.” Are any DTC’s displayed that have not been diagnosed?	—	Go to the applicable DTC table	System OK

DTC P0117 Engine Coolant Temperature (ECT) Sensor Circuit Low Voltage



Circuit Description

The engine coolant Temperature (ECT) sensor is a thermistor that controls signal voltage to the PCM. When the engine is cold, the sensor resistance is high, therefore the PCM will see high signal voltage. As the engine warms, sensor resistance becomes less and voltage drops. The voltage measured across the thermistor is interpreted as a temperature. This is a type B DTC.

Conditions for Setting the DTC

Engine coolant temperature greater than or equal to 151°C (303°F) for 2 seconds.

Action Taken When the DTC Sets

- High idle
- No TCC
- Shift schedules will be affected.

Conditions for Clearing the MIL/DTC

- The PCM will turn the MIL off after three consecutive trips without a fault condition.
- A History DTC will clear when forty consecutive warm-up cycles that the diagnostic does not fail (coolant temperature has risen 5°C (40°F) from start up coolant temperature and engine coolant temperature exceeds 71°C (160°F) that same ignition cycle).
- Use of a Scan Tool.

Diagnostic Aids

Check harness routing for a potential short to ground. After engine is started, the coolant temperature should rise steadily to about 85°C (185°F). refer to “Intermittents” on page 13. A “skewed” sensor could result in poor driveability complaints.

Test Description

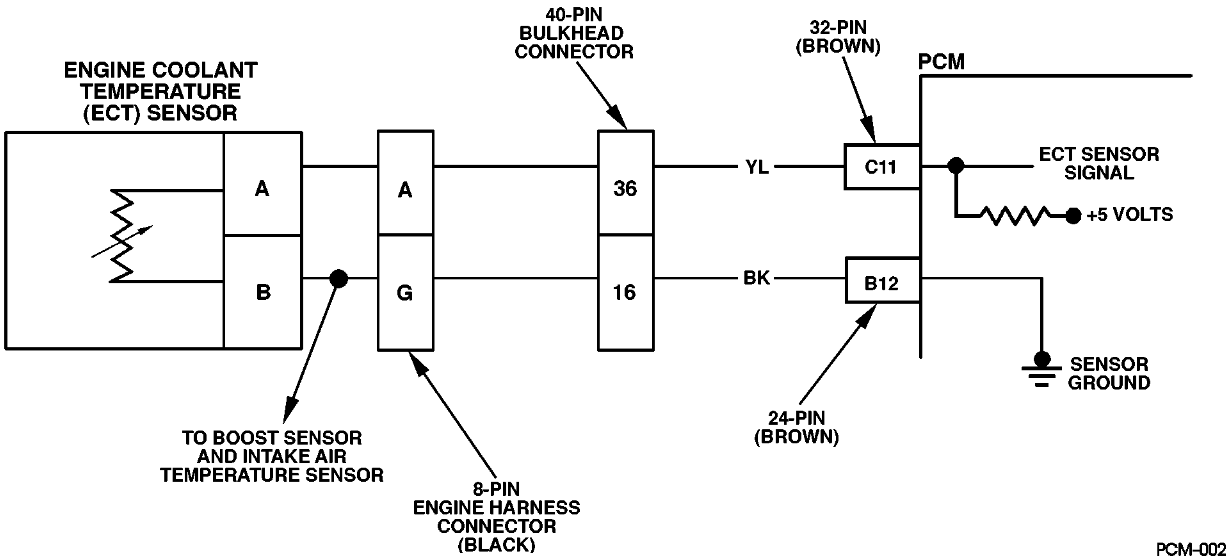
Number(s) below refer to the step number(s) on the Diagnostic Table.

2. This step determines if P0117 is a hard failure or an intermittent condition.
3. This test will check the PCM and the wiring.

DTC P0117 - Engine Coolant Temperature (ECT) Sensor Circuit Low Voltage

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the Scan tool "Capture Info" to record Freeze Frame and Failure Record for reference. This data will be lost when "Clear Info" function is used. Was the "On-Board Diagnostic (OBD) System Check" performed?	—	Go to Step 2	Go to OBD System Check
2	1. Scan tool connected. 2. Start the engine. 3. Monitor the ECT display on Scan Tool. Does the scan tool display ECT greater than or equal to the specified value?	151°C (303°F)	Go to Step 3	Go to Step 5
3	1. Turn the engine "OFF." 2. Turn the ignition "ON." 3. Disconnect the ECT sensor connector. Does the scan tool display ECT less than or equal to the specified value?	-30°C (-22°F)	Go to Step 7	Go to Step 4
4	1. Turn the ignition "OFF". 2. Using the J 39200, check the resistance across the ECT sensor harness connector. Is the resistance at the specified value?	Infinite	Go to Step 8	Go to Step 6
5	DCT is intermittent. If no additional DTCs are stored, refer to "Diagnostic Aids." If additional DTCs were stored, refer to those table(s) first. Are any additional DTCs stored?	—	Go to the applicable DTC Table	Go to Diagnostic Aids
6	Repair the short to ground in the ECT signal circuit. Is the action complete?	—	Go to Step 9	—
7	Replace the faulty ECT sensor. Is the action complete?	—	Go to Step 9	—
8	Replace the faulty PCM. **NOTE:** If the PCM is faulty, the new PCM must be programmed. Go to PCM replacement and programming procedures. Is the action complete?	—	Go to Step 9	—
9	1. Using the Scan Tool, select "DTC," "Clear Info." 2. Start engine and idle at normal operating temperature. 3. Select "DTC," "Specific," then enter the DTC number which was set. 4. Operate vehicle within the conditions for setting this DTC as specified in the supporting text. Does the Scan Tool indicate that this diagnostic Ran and Passed?	—	Go to Step 10	Go to Step 2
10	Using the Scan Tool, select "Capture Info," "Review Info." Are any DTC's displayed that have not been diagnosed?	—	Go to the applicable DTC table	System OK

DTC P0118 Engine Coolant Temperature (ECT) Sensor Circuit High Voltage



Circuit Description

The Engine Coolant Temperature (ECT) sensor is a thermistor that controls signal voltage to the PCM. When the engine is cold, the sensor resistance is high, therefore the PCM will see high signal voltage. As the engine warms, the sensor resistance becomes less and the voltage drops. The voltage measured across the thermister is interpreted as a temperature. This is a type B DTC.

Conditions for Setting the DTC

- Engine running for at least 8 minutes.
- ECT less than -30°C (-22°F).
- Conditions met for 2 seconds

Action Taken When the DTC Sets

Idle increase

Conditions for Clearing the MIL/DTC

- The PCM will turn the MIL off after three consecutive trips without a fault condition.
- A History DTC will clear when forty consecutive warm-up cycles that the diagnostic does not fail (coolant temperature has risen 5°C (40°F) from start up coolant temperature and engine coolant temperature exceeds 71°C (161°F) that same ignition cycle).
- Use of a scan tool.

Diagnostic Aids

- Check harness routing for a potential short to ground. After engine is started, the ECT temperature should rise steady to about 85°C (185°F). A mis-scaled sensor could result in poor driveability complaints.

Test Description

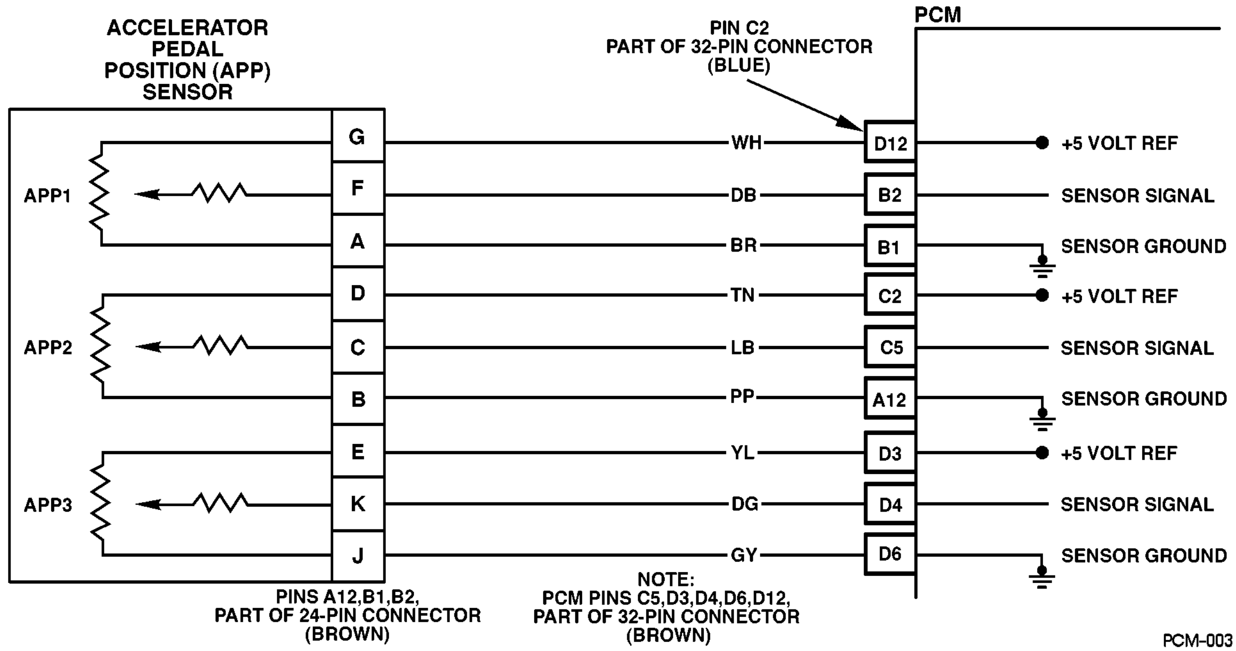
Number(s) below refer to number(s) on the diagnostic tables.

2. This test determines if PO 118 is an intermittent condition.
3. This test will determine if signal circuit is open, or a faulty PCM.

DTC P0118 - Engine Coolant Temperature (ECT) Sensor Circuit High Voltage

Step	Action	Value(s)	Yes	No
1	**Important:** Before clearing DTC(s) use the scan tool “Capture Info” to record Freeze Frame and Failure Record for reference, as data will be lost when “Clear Info” function is used. Was the “On-Board Diagnostic (OBD) System Check” performed?	—	Go to Step 2	Go to OBD System Check
2	1. Scan tool connected. 2. Start the engine. 3. Monitor the ECT display on Scan Tool. Is the ECT display less than or equal to the specified value?	-30°C (-22°F)	Go to Step 3	Go to Step 5
3	1. Turn the engine “OFF.” 2. Turn the ignition “ON.” 3. Disconnect the ECT sensor connector. 4. Jumper the ECT harness terminals together. Does the scan tool display ECT greater than or equal to the specified value?	151°C (303°F)	Go to Step 6	Go to Step 4
4	Jumper the ECT sensor signal circuit to a known good ground. Does the scan tool display a ECT greater than the specified value?	151°C (303°F)	Go to Step 7	Go to Step 8
5	DCT is intermittent. If no other DTC(s) are stored, go to “Diagnostic Aids”. Are there other DTCs stored?	—	Go to applicable DTC Table	Go to Diagnostic Aids
6	Inspect the sensor connector and PCM connector for a proper connection. Was a problem found?	—	Go to Step 9	Go to Step 10
7	Check the ECT sensor ground circuit for an open between the ECT sensor and the PCM. Was a problem found?	—	Go to Step 9	Go to Step 11
8	Check the ECT sensor signal circuit for an open between the ECT sensor and the PCM. Was a problem found?	—	Go to Step 9	Go to Step 11
9	Repair the circuit as necessary. Is the action complete?	—	Go to Step 12	—
10	Replace the faulty ECT sensor. Is the action complete?	—	Go to Step 12	—
11	Replace the faulty PCM. **NOTE:** If the PCM is faulty, the new PCM must be programmed. Go to PCM replacement and programming procedures. Is the action complete?	—	Go to Step 12	—
12	1. Using the Scan Tool, select “DTC”, “Clear Info”. 2. Start engine and idle at normal operating temperature. 3. Select “DTC”, “Specific”, then enter the DTC which was set. 4. Operate vehicle within the conditions for setting this DTC as specified in the supporting text. Does the Scan Tool indicate that this diagnostic Ran and Passed?	—	Go to Step 13	—
13	Using the Scan Tool, select “Capture Info”, “Review Info”. Are any DTC’s displayed that have not been diagnosed?	—	Go to applicable DTC table	System OK

DTC P0121 Accelerator Pedal Position (APP) Sensor 1 Circuit Performance



Circuit Description

The Accelerator Pedal Position (APP) module provides a voltage signal that changes relative to accelerator pedal position. There are three sensors located within the APP module that are scaled differently. This is a type C DTC.

Conditions for Setting the DTC

- Ignition voltage greater than 6.4 volts.
- Engine speed greater than 300 RPM.
- The difference between APP 1 and APP 2 is greater than .23 volts (PCM compares pre-scaled voltage (internal to PCM)).
- The difference between APP 1 and APP 3 is greater than .50 volts (PCM compares pre-scaled voltage (internal to PCM)).
- No in range faults for APP 2 or APP 3 (PCM checks for high and low voltage faults).
- Conditions met for 2 seconds.

Action Taken When the DTC Sets

- The input from APP 1 sensor is ignored.
- A current and history DTC will set but it will not turn on the “Service Throttle Soon” lamp.
- Throttle will operate normally as long as there is only one malfunction present. If there are two APP malfunctions present, the PCM will turn “ON” the “Service Throttle Soon” lamp and limit power. If a third APP malfunction is present, the “Service Throttle Soon” lamp will be “ON” and only allow the engine to operate at idle.

Conditions for Clearing the MIL/DTC

- A History DTC will clear when forty consecutive warm-up cycles that the diagnostic does not fail (coolant temperature has risen 5°C (40°F) from start up coolant temperature and engine coolant temperature exceeds 71°C (160°F) that same ignition cycle).
- Use of a Scan Tool

Diagnostic Aids

A scan tool reads APP 1 position in volts. It should read about .45 to .95 volt with throttle closed and ignition “ON” or at idle. Voltage should increase at a steady rate as throttle is moved toward Wide Open Throttle (WOT). Also, 90% pedal travel is acceptable for correct APP operation. Scan APP 1 sensor while depressing accelerator pedal with engine stopped and ignition “ON”. Display should vary from about .74 volt when throttle was closed to over about 3.7 volts when throttle is held at Wide Open Throttle (WOT) position. The following chart will check voltages on all APP circuits to see if they fall in normal ranges. The PCM compares pre-scaled voltages (these are voltages that the scan tool can’t read). The scan tool reads only output voltages.

Test Description

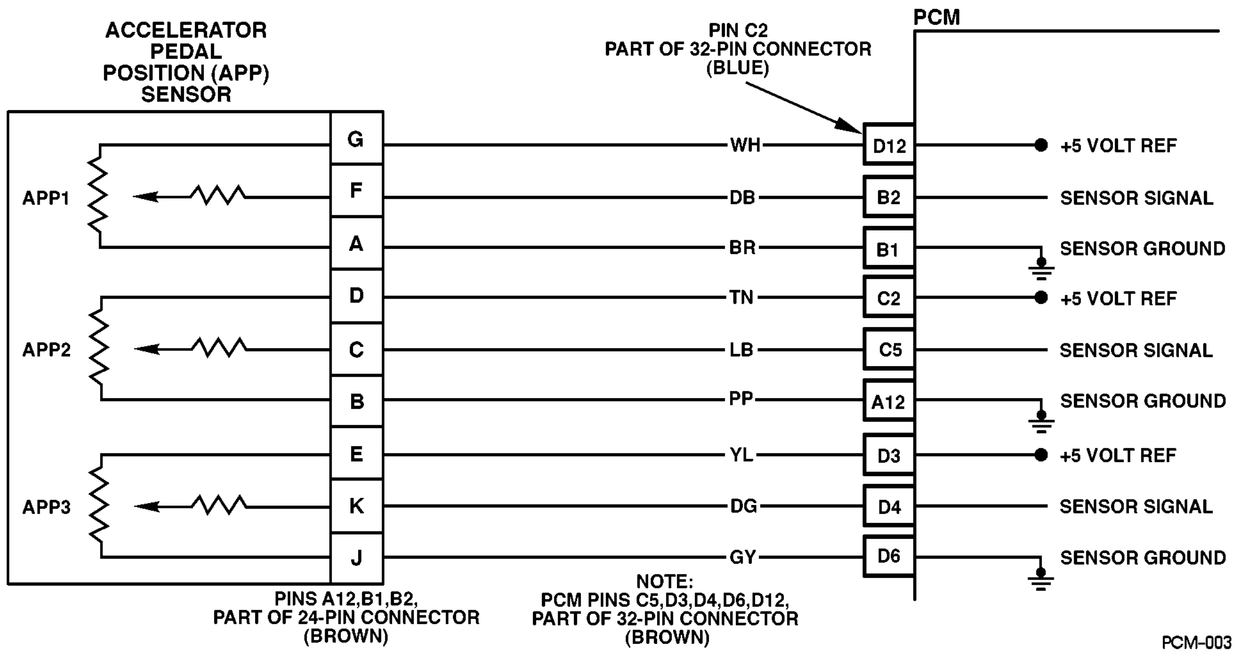
Number(s) below refer to the number(s) on the diagnostic table.

4. This step determines if there is a good 5 volt reference.
5. This step will check for an open in the ground circuit.

DTC P0121 - Accelerator Pedal Position (APP) Sensor 1 Circuit Performance

Step	Action	Value(s)	Yes	No
1	**Important:** Before clearing DTC(s) use the scan tool "Capture Info" to record Freeze Frame and Failure Record for reference, as data will be lost when "Clear Info" function is used. Was the *"On-Board Diagnostic (OBD) System Check"* performed?	—	Go to Step 2.	Go to *OBD System Check.*
2	1. Ignition "ON", engine "OFF". 2. With the throttle closed, observe APP voltages on the scan tool. Are APP voltages at specified values?	.45-.95v 4.0-4.5v 3.6-4.0v	Go to Step 3.	Go to Step 4.
3	DTC is intermittent. If no additional DTCs are stored, refer to "Diagnostic Aids". If additional DTCs were stored, refer to those chart(s).	—	Go to the applicable DTC table.	Go to *Diagnostic Aids.*
4	1. Disconnect the APP sensor electrical connector. 2. Ignition "ON", engine "OFF". 3. With J39200 connected to ground, probe APP sensor 5 volt reference circuits at APP harness terminals "G", "D" and "E". Is voltage at the specified value on all circuits?	4.75v	Go to Step 5.	Go to Step 6.
5	1. Ignition "ON", engine "OFF". 2. With a test light connected to B+, probe APP sensor ground circuits at the APP sensor harness terminals "A", "B" and "J". Is Test light ON (all circuits)?	—	Go to Step 9.	Go to Step 8.
6	1. Ignition "OFF". 2. Disconnect the PCM and check the 5 volt reference circuit for an open or short to ground. 3. If the 5 volt reference circuit is open or shorted to ground, repair as necessary. Was the 5 volt reference circuit open or shorted to ground?	—	Go to Step 11.	Go to Step 8.
7	Check the 5 volt reference circuit for a poor connection at the PCM and replace terminal if necessary. Did the terminal require replacement?	—	Go to Step 11.	Go to Step 10.
8	1. Ignition "OFF". 2. Disconnect the PCM, and check for an open sensor ground circuit to the PCM. 3. If problem is found, repair as necessary. Was APP sensor ground circuit open?	—	Go to Step 11.	Go to Step 10.
9	Replace the APP module. Is Action complete?	—	Go to Step 11.	—
10	Replace the faulty PCM. ***Notice:*** If the PCM is faulty, the new PCM must be programmed. Go to *PCM replacement and programming procedures.* Is the action complete?	—	Go to Step 11.	—
11	1. Using the Scan Tool, select "DTC", "Clear Info". 2. Start engine and idle at normal operating temperature. 3. Select "DTC", "Specific", then enter the DTC number which was set. 4. Operate vehicle within the conditions for setting this DTC as specified in the supporting text. Does the Scan Tool indicate that this diagnostic Ran and Passed?	—	Go to Step 12.	Go to Step 2.
12	Using the Scan Tool, select "Capture Info", "Review Info". Are any DTCs displayed that have not been diagnosed?	—	Go to the applicable DTC table	System OK

DTC P0122 Accelerator Pedal Position (APP) Sensor 1 Circuit Low Voltage



Circuit Description

The Accelerator Pedal Position (APP) module provides a voltage signal that changes relative to accelerator position. There are three sensors located within the APP module that are scaled differently. This is a type C DTC.

Conditions for Setting the DTC

- Voltage is less than .25 volts on APP 1.
- Conditions met for 2 seconds.

Action Taken When the DTC Sets

- The input from APP 1 sensor is ignored.
- A current and history DTC will set but it will not turn on the “Check Throttle” lamp.
- The throttle will operate normally as long as there is only one sensor malfunctioning. If two different APP sensors have a malfunction, the “Check Throttle” lamp will light and the PCM will limit power. If three APP sensors have a malfunction present, the “Service Throttle Soon” lamp will light and the PCM will only allow the engine to operate at idle.

Conditions for Clearing the MIL/DTC

- A History DTC will clear when forty consecutive warm-up cycles that the diagnostic does not fail (coolant temperature has risen 5°C (40°F) from start up coolant temperature and engine coolant temperature exceeds 71°C (160°F) that same ignition cycle).
- Use of a Scan Tool

Diagnostic Aids

A scan tool reads APP 1 position in volts. It should read about .45 to .95 volt with throttle closed and ignition “ON” or at idle. Voltage should increase at a steady rate as throttle is moved toward Wide Open Throttle (WOT). Also, 90% pedal travel is acceptable for correct APP operation. Scan APP sensor while depressing accelerator pedal with engine stopped and ignition “ON”. Display should vary from about .74 volt when throttle is closed to about 3.7 volts when throttle is held at Wide Open Throttle (WOT) position. A DTC P0122 will result if the signal or reference circuit are open.

Test Description

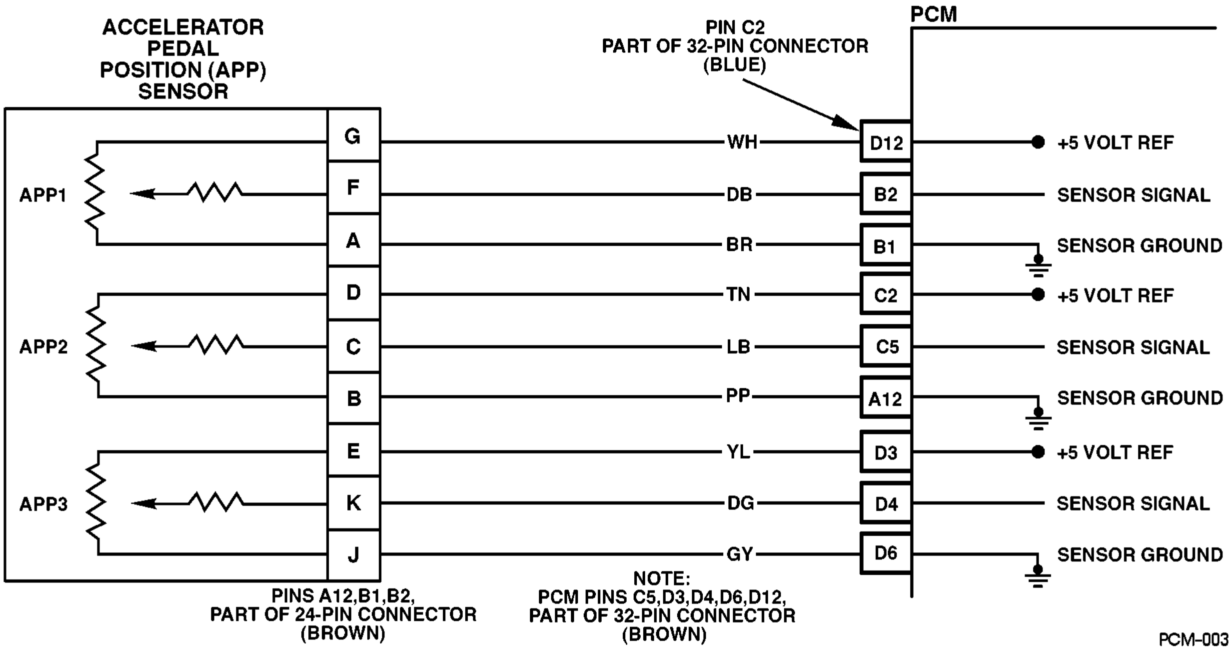
Number(s) below refer to the number(s) on the diagnostic table.

2. This step determines if P0122 is the result of a hard failure or an intermittent condition.
4. This step checks the PCM and wiring.

DTC P0122 - Accelerator Pedal Position (APP) Sensor 1 Circuit Low Voltage

Step	Action	Value(s)	Yes	No
1	**Important:** Before clearing DTC(s) use the scan tool "Capture Info" to record Freeze Frame and Failure Record for reference, as data will be lost when "Clear Info" function is used. Was the *"On-Board Diagnostic (OBD) System Check"* performed?	—	Go to Step 2.	Go to *OBD System Check.*
2	1. Ignition "ON", engine "OFF". 2. With the throttle closed, observe APP 1 voltages on the scan tool. Is APP 1 voltages less than or equal to specified value?	.25v	Go to Step 3.	Go to Step 4.
3	DTC is intermittent. If no additional DTCs are stored, refer to "Diagnostic Aids". If additional DTCs were stored, refer to those table(s) first. Are additional DTCs stored?	—	Go to the applicable DTC table.	Go to *Diagnostic Aids.*
4	1. Disconnect the APP sensor electrical connector. 2. Jumper APP 1 5 volt reference circuit and the APP 1 signal together at the APP sensor harness connector. 3. Observe the APP 1 voltage on the Scan Tool. Is APP 1 voltage greater than the specified value?	4.75v	Go to Step 10.	Go to Step 5.
5	1. Connect a test light between B+ and the APP 1 sensor signal circuit at the APP sensor harness connector. 2. Observe the APP 1 voltage on the Scan Tool. Is APP 1 voltage greater than the specified value?	4.75v	Go to Step 6.	Go to Step 8.
6	1. Ignition "OFF". 2. Disconnect the PCM and check the 5 volt reference circuit for an open or short to ground. 3. If the 5 volt reference circuit is open or shorted to ground, repair as necessary. Was the 5 volt reference circuit open or shorted to ground?	—	Go to Step 12.	Go to Step 7.
7	Check the 5 volt reference circuit for a poor connection at the PCM and replace terminal if necessary. Did the terminal require replacement?	—	Go to Step 13.	Go to Step 12.
8	1. Ignition "OFF". 2. Disconnect the PCM, and check the APP 1 signal circuit for an open, short to ground. 3. If the APP 1 sensor signal circuit is open or shorted to ground, repair as necessary. Was APP 1 signal circuit open or shorted to ground?	—	Go to Step 13.	Go to Step 9.
9	Check the APP 1 sensor signal circuit for a poor connection at the PCM and replace terminal if necessary. Did the terminal require replacement?	—	Go to Step 13.	Go to Step 12.
10	Check for a poor electrical connection at the APP module and repair if necessary. Was a problem found?	—	Go to Step 13	Go to Step 11
11	Replace the APP module. Is Action complete?	—	Go to Step 13.	—
12	Replace the faulty PCM. ***Notice:*** If the PCM is faulty, the new PCM must be programmed. Go to *PCM replacement and programming procedures.* Is the action complete?	—	Go to Step 13.	—
13	1. Using the Scan Tool, select "DTC", "Clear Info". 2. Start engine and idle at normal operating temperature. 3. Select "DTC", "Specific", then enter the DTC number which was set. 4. Operate vehicle within the conditions for setting this DTC as specified in the supporting text. Does the Scan Tool indicate that this diagnostic Ran and Passed?	—	Go to Step 14.	Go to Step 2.
14	Using the Scan Tool, select "Capture Info", "Review Info". Are any DTCs displayed that have not been diagnosed?	—	Go to the applicable DTC table	System OK

DTC P0123 Accelerator Pedal Position (APP) Sensor 1 Circuit High Voltage



Circuit Description

The Accelerator Pedal Position (APP) module provides a voltage signal that changes relative to accelerator position. There are three sensors located within the APP module that are scaled differently. This is a type C DTC.

Conditions for Setting the DTC

- Voltage is greater than 4.75 volts on APP 1 sensor.
- Conditions met for 2 seconds.

Action Taken When the DTC Sets

- The input from APP 1 sensor is ignored.
- A current and history DTC will set but it will not turn on the “Check Throttle” lamp. The throttle will operate normally as long as there is only one sensor malfunctioning. If two different APP sensors have a malfunction, the “Check Throttle” lamp will light and the PCM will limit power. If three APP sensors have a malfunction present, the “Service Throttle Soon” lamp will light and the PCM will only allow the engine to operate at idle.

Conditions for Clearing the MIL/DTC

- A History DTC will clear when forty consecutive warm-up cycles that the diagnostic does not fail (coolant temperature has risen 5°C (40°F) from start up coolant temperature and engine coolant temperature exceeds 71°C (160°F) that same ignition cycle).
- Use of a Scan Tool

Diagnostic Aids

A scan tool reads APP 1 position in volts. It should read about .45 to .95 volt with throttle closed and ignition “ON” or at idle. Voltage should increase at a steady rate as throttle is moved toward Wide Open Throttle (WOT). Also, 90% pedal travel is acceptable for correct APP operation. Scan APP 1 sensor while depressing accelerator pedal with engine stopped and ignition “ON”. Display should vary from about .74 volt when throttle is closed to about 3.7 volts when throttle is held at Wide Open Throttle (WOT) position. A P0123 will result if the ground circuit is open or the signal circuit is shorted to voltage. Refer to Intermittents in Section 2.

Test Description

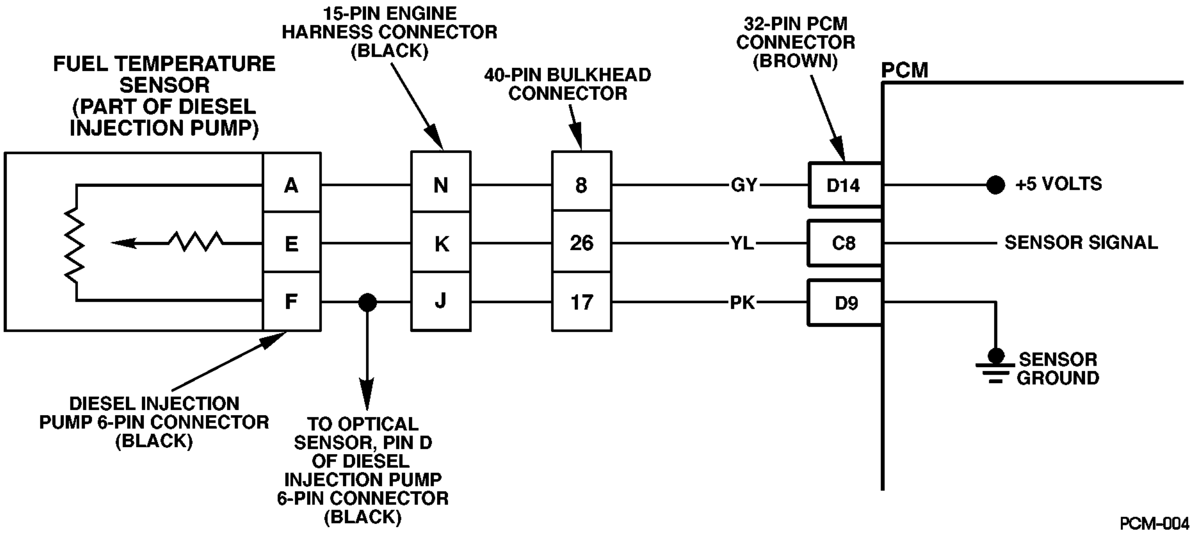
Number(s) below refer to the number(s) on the diagnostic table.

2. This step determines if DTC P0123 is the result of a hard failure or an intermittent condition.
3. This step checks the PCM and wiring.

DTC P0123 - Accelerator Pedal Position (APP) Sensor 1 Circuit High Voltage

Step	Action	Value(s)	Yes	No
1	**Important:** Before clearing DTC(s) use the scan tool "Capture Info" to record Freeze Frame and Failure Record for reference, as data will be lost when "Clear Info" function is used. Was the *"On-Board Diagnostic (OBD) System Check"* performed?	—	Go to Step 2.	Go to *OBD System Check.*
2	1. Ignition "ON", engine "OFF". 2. With the throttle closed, observe APP 1 display on the scan tool. Is APP 1 above the specified value?	4.75v	Go to Step 4.	Go to Step 3.
3	DTC is intermittent. If no additional DTCs are stored, refer to "Diagnostic Aids". If additional DTCs were stored, refer to those chart(s).	—	Go to the applicable DTC table.	Go to *Diagnostic Aids.*
4	1. Disconnect the APP sensor electrical connector. 2. Observe the APP 1 display on the Scan Tool. Is APP 1 less than the specified value?	.25v	Go to Step 5.	Go to Step 6.
5	Probe APP 1 sensor ground circuit at the APP sensor harness connector with a test light connected to B+. Is the test light "ON"?	—	Go to Step 7.	Go to Step 8.
6	1. Check for a short to voltage on the APP 1 sensor signal circuit. 2. If the APP 1 sensor signal circuit is shorted, repair it as necessary. Was the APP 1 sensor signal circuit shorted?	—	Go to Step 11.	Go to Step 10.
7	Check for poor electrical connections at the APP sensor and replace terminals if necessary. Did any terminals require replacement?	—	Go to Step 11.	Go to Step 9.
8	1. Check for an open sensor ground circuit. 2. If a problem is found, repair as necessary. Was APP 1 sensor ground circuit open?	—	Go to Step 11.	Go to Step 10.
9	Replace the APP module. Is Action complete?	—	Go to Step 11.	—
10	Replace the faulty PCM. ***Notice:*** If the PCM is faulty, the new PCM must be programmed. Go to *PCM replacement and programming procedures.* Is the action complete?	—	Go to Step 11.	—
11	1. Using the Scan Tool, select "DTC", "Clear Info". 2. Start engine and idle at normal operating temperature. 3. Select "DTC", "Specific", then enter the DTC number which was set. 4. Operate vehicle within the conditions for setting this DTC as specified in the supporting text. Does the Scan Tool indicate that this diagnostic Ran and Passed?	—	Go to Step 12.	Go to Step 2.
12	Using the Scan Tool, select "Capture Info", "Review Info". Are any DTCs displayed that have not been diagnosed?	—	Go to the applicable DTC table	System OK

DTC P0182 Fuel Temperature Sensor Circuit Low Voltage



Circuit Description

The fuel temperature sensor is a thermistor that controls signal voltage to the PCM. When the fuel is cold, the sensor resistance is high, therefore the PCM will see high signal voltage. As fuel warms, sensor resistance becomes less and voltage drops. The fuel temperature sensor is integrated with the optical sensor. This is a type B DTC.

Conditions for Setting the DTC

- Fuel temperature greater than 102°C (215°F).
- Conditions met for 2 seconds.

Action Taken When the DTC Sets

Poor idle quality during hot conditions.

Conditions for Clearing the MIL/DTC

- The PCM will turn the MIL off after three consecutive trips without a fault condition.
- A History DTC will clear when forty consecutive warm-up cycles that the diagnostic does not fail (coolant temperature has risen 5°C (40°F) from start up coolant temperature and engine coolant temperature exceeds 71°C (160°F) that same ignition cycle).
- Use of a Scan Tool.

Diagnostic Aids

A scan tool reads fuel temperature in degrees centigrade. After engine is started, the fuel temperature should rise steadily.

Test Description

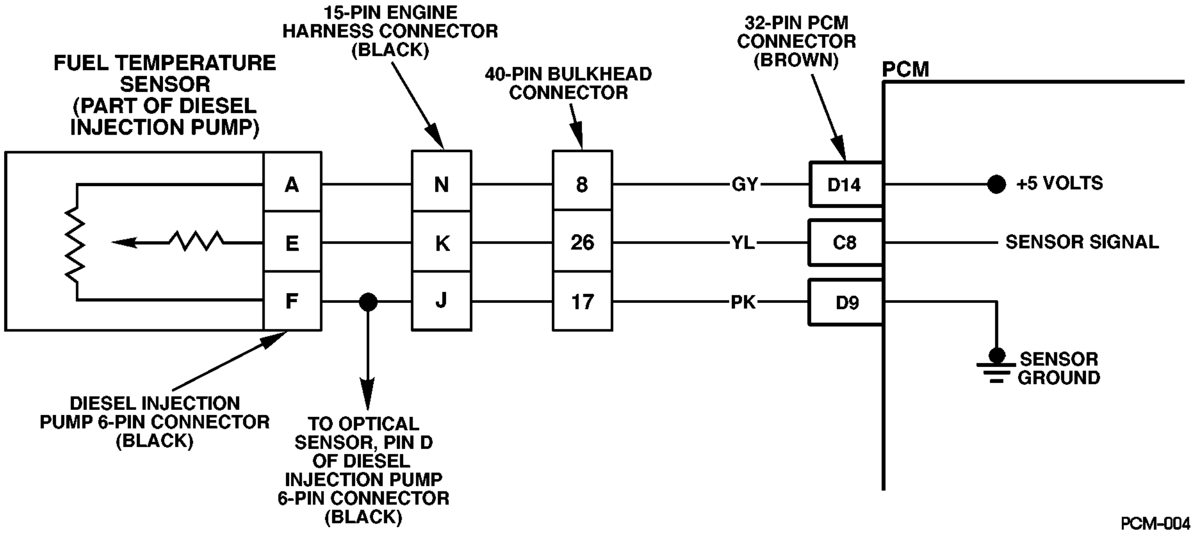
Number(s) below refer to the number(s) on the diagnostic table.

2. This step determines if DTC P0182 is a hard failure or an intermittent condition.
3. This step will determine if signal circuit is shorted to ground.

DTC P0182 - Fuel Temperature Sensor Circuit Low Voltage

Step	Action	Value(s)	Yes	No
1	**Important:** Before clearing DTC(s) use the scan tool “Capture Info” to record Freeze Frame and Failure Record for reference, as data will be lost when “Clear Info” function is used. Was the *“On-Board Diagnostic (OBD) System Check”* performed?	—	Go to Step 2.	Go to *OBD System Check.*
2	1. Scan tool connected. 2. Start the engine. 3. Monitor the Fuel Temp display on the scan tool. Is Fuel Temp greater than the specified value?	102°C (215°F)	Go to Step 3.	Go to Step 5.
3	1. Engine “OFF”. 2. Ignition “ON”. 3. Disconnect the Optical/Fuel Temperature sensor connector. Is Fuel Temp less than or equal to the specified value?	17°C (63°F)	Go to Step 7.	Go to Step 4.
4	1. Ignition “OFF”. 2. Using the J 39200, measure the resistance across the Fuel Temperature sensor harness connector. Is the resistance at the specified value?	Infinite	Go to Step 8.	Go to Step 6.
5	DTC is intermittent. If no additional DTCs are stored, refer to “Diagnostic Aids”. If additional DTCs were stored, refer those chart(s).	—	Go to the applicable DTC table	Go to *Diagnostic Aids.*
6	Repair the short to ground in the Fuel Temp signal circuit. Is the action complete?	—	Go to Step 9.	—
7	Replace the fuel injection pump. ***Notice:*** If fuel injection pump is faulty, the new injection pump must be timed. Go to *Checking or Adjusting injection timing.* Is the action complete?	—	Go to Step 9.	—
8	Replace the faulty PCM. ***Notice:*** If the PCM is faulty, the new PCM must be programmed. Go to *PCM replacement and programming procedures.* Is the action complete?	—	Go to Step 9.	—
9	1. Using the Scan Tool, select “DTC”, “Clear Info”. 2. Start engine and idle at normal operating temperature. 3. Select “DTC”, “Specific”, then enter the DTC number which was set. 4. Operate vehicle within the conditions for setting this DTC as specified in the supporting text. Does the Scan Tool indicate that this diagnostic Ran and Passed?	—	Go to Step 10.	Go to Step 2.
10	Using the Scan Tool, select “Capture Info”, “Review Info”. Are any DTCs displayed that have not been diagnosed?	—	Go to the applicable DTC table	System OK.

DTC P0183 Fuel Temperature Sensor Circuit High Voltage



Circuit Description

The fuel temperature sensor is a thermistor that controls signal voltage to the PCM. When the fuel is cold, the sensor resistance is high, therefore the PCM will see high signal voltage. As fuel warms, sensor resistance becomes less and voltage drops. The fuel temperature sensor is integrated with the optical sensor. This is a type B DTC.

Conditions for Setting the DTC

- Engine operating for 8 minutes.
- Fuel temperature less than or equal to 17°C (63°F).
- Conditions met for 2 seconds.

Action Taken When the DTC Sets

Poor idle quality during hot conditions.

Conditions for Clearing the MIL/DTC

- The PCM will turn the MIL off after three consecutive trips without a fault condition.
- A History DTC will clear when forty consecutive warm-up cycles that the diagnostic does not fail (coolant temperature has risen 5°C (40°F) from start up coolant temperature and engine coolant temperature exceeds 71°C (160°F) that same ignition cycle).
- Use of a Scan Tool.

Diagnostic Aids

A scan tool reads fuel temperature in degrees centigrade. After engine is started, the fuel temperature should rise steadily. A faulty connection, or an open in the signal circuit.

Test Description

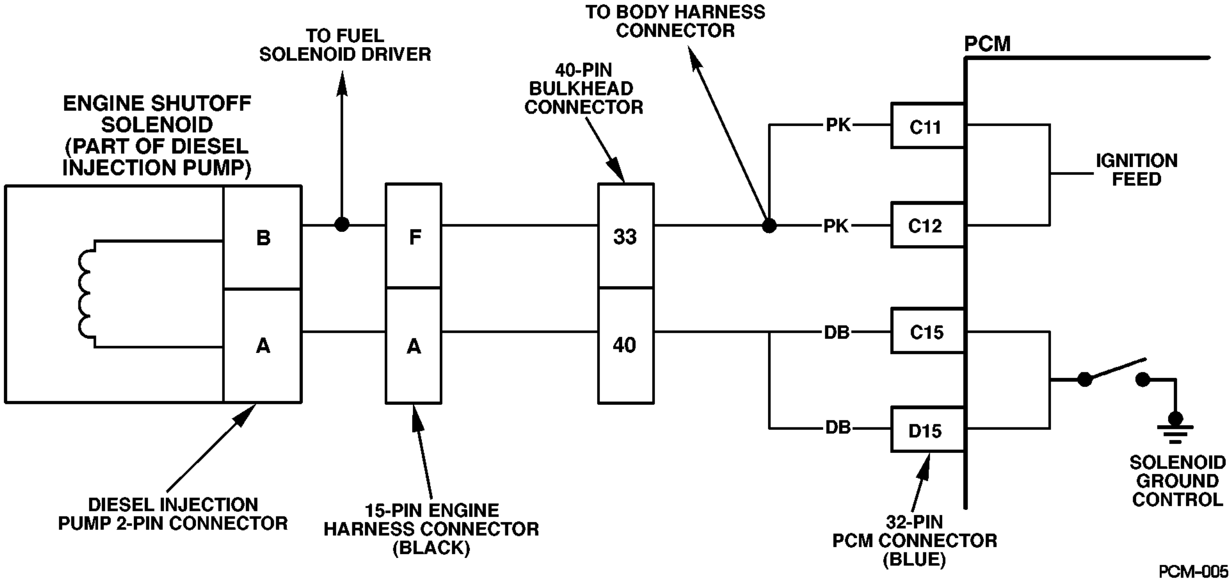
Number(s) below refer to the number(s) on the diagnostic table.

2. This step determines if DTC P0183 is a hard failure or an intermittent condition.
3. This step stimulates a DTC P0182. If the PCM recognizes the low signal voltage (high temp) the PCM and wiring are OK.
4. This test will determine if signal circuit is open. There should be 5 volts at sensor connector if measured with J 39200-DVM. This will determine if there is a wiring problem or a faulty PCM.

DTC P0183 - Fuel Temperature Sensor Circuit High Voltage

Step	Action	Value(s)	Yes	No
1	**Important:** Before clearing DTC(s) use the scan tool “Capture Info” to record Freeze Frame and Failure Record for reference, as data will be lost when “Clear Info” function is used. Was the *“On-Board Diagnostic (OBD) System Check”* performed?	—	Go to Step 2.	Go to *OBD System Check.*
2	1. Scan tool connected. 2. Start and idle engine. 3. Monitor the Fuel Temp display on the scan tool. Is Fuel Temp less than the specified value?	18°C (64°F)	Go to Step 3.	Go to Step 5.
3	1. Engine “OFF”. 2. Ignition “ON”. 3. Disconnect the Optical/Fuel Temperature sensor connector. 4. Jumper the Fuel Temperature harness terminals together. Does the Scan Tool display fuel temperature greater than the specified value?	105°C (221°F)	Go to Step 6.	Go to Step 4.
4	Jumper the Fuel Temperature sensor signal circuit to a known good ground. Does the Scan Tool display a Fuel Temp greater than the specified value?	105°C (221°F)	Go to Step 7.	Go to Step 8.
5	DTC is intermittent. If no additional DTCs are stored, refer to “Diagnostic Aids”. If additional DTCs are stored, refer to those chart(s). Are any other DTCs stored?	—	Go to the applicable DTC table	Go to *Diagnostic Aids.*
6	Inspect the sensor connector and PCM connector for proper connection. Was a problem found?	—	Go to Step 9.	Go to Step 10.
7	Check the Fuel Temperature sensor ground circuit for an open between the Fuel Temp sensor and the PCM. Was a problem found?	—	Go to Step 9.	Go to Step 11.
8	Check the Fuel Sensor signal circuit for an open between the Fuel Temp sensor and the PCM. Was a problem found?	—	Go to Step 9.	Go to Step 10.
9	Repair the circuit as necessary. Is the action complete?	—	Go to Step 13.	—
10	Inspect PCM connectors for proper connections and replace terminals, if necessary. Was a problem found?	—	Go to Step 13.	Go to Step 12.
11	Replace the injection pump. Is the action complete?	—	Go to Step 12.	—
12	Replace the faulty PCM. ***Notice:*** If the PCM is faulty, the new PCM must be programmed. Go to *PCM replacement and programming procedures.* Is the action complete?	—	Go to Step 12.	—
13	1. Using the Scan Tool, select “DTC”, “Clear Info”. 2. Start engine and idle at normal operating temperature. 3. Select “DTC”, “Specific”, then enter the DTC number which was set. 4. Operate vehicle within the conditions for setting this DTC as specified in the supporting text. Does the Scan Tool indicate that this diagnostic Ran and Passed?	—	Go to Step 13.	Go to Step 2.
14	Using the Scan Tool, select “Capture Info”, “Review Info”. Are any DTCs displayed that have not been diagnosed?	—	Go to the applicable DTC table	System OK.

DTC P0215 Engine Shutoff Solenoid Control Circuit



Circuit Description

The injection fuel supply line has a solenoid controlled shutoff located in the injection pump. When the solenoid is energized (key in the run position), the valve is open and fuel is supplied to the injection pump. By providing a ground path, the PCM energizes the solenoid. This is a type D DTC.

Conditions for Setting the DTC

- PCM requested ESO “ON”.
- Control circuit voltage at the PCM is greater than 8 volts.
- Conditions met for 2 seconds.

or

- PCM requested ESO “OFF”.
- Control circuit voltage at the PCM is less than 8 volts.
- Conditions met for 2 seconds.

Action Taken When the DTC Sets

P0215 will not turn “ON” the MIL.

Conditions for Clearing the MIL/DTC

- A History DTC will clear when forty consecutive warm-up cycles that the diagnostic does not fail (coolant temperature has risen 5°C (40°F) from start up coolant temperature and engine coolant temperature exceeds 71°C (160°F) that same ignition cycle).
- Use of a Scan Tool.

Diagnostic Aids

An open in the control circuit or the ignition feed circuit will cause a P0215. Also a no start condition will exist. The Scan Tool has the ability to turn the engine shutoff solenoid “ON” and “OFF”. This can be used as a quick operational check.

Test Description

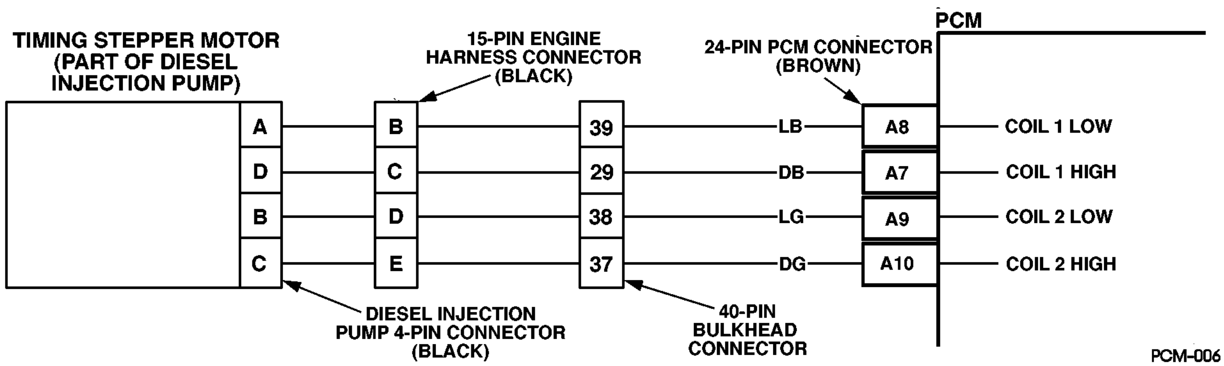
Number(s) below refer to the number(s) on the diagnostic table.

3. This step will check the ignition feed circuit for an open.

DTC P0215 - Engine Shutoff Solenoid Circuit Malfunction

Step	Action	Value(s)	Yes	No
1	**Important:** Before clearing DTC(s) use the scan tool "Capture Info" to record Freeze Frame and Failure Record for reference, as data will be lost when "Clear Info" function is used. Was the *"On-Board Diagnostic (OBD) System Check"* performed?	—	Go to Step 2.	Go to *OBD System Check.*
2	1. Ignition "ON", engine "OFF". 2. Using scan tool, command ESO "ON" and "OFF". Does ESO respond to scan tool commands?	—	Go to Step 4.	Go to Step 3.
3	1. Ignition "OFF". 2. Disconnect the PCM electrical connector. 3. Ignition "ON", engine "OFF". 4. With a test light connected to chassis ground, probe ESO control circuit at PCM harness connector. Is test light "ON".	—	Go to Step 5.	Go to Step 6.
4	DTC is intermittent. If no additional DTCs are stored, refer to "Diagnostic Aids". If additional DTCs are stored refer those table(s).	—	—	—
5	Check the ESO control circuit for a poor connection at the PCM and replace terminal if necessary. Did the terminal require replacement?	—	Go to Step 8.	Go to Step 7.
6	1. Check the ESO control circuit for: • an open • faulty bulb • faulty fuse 2. If the ESO control circuit was faulty, repair it as necessary. Was repair performed?	—	Go to Step 8.	—
7	Replace the faulty PCM. ***Notice:*** If the PCM is faulty, the new PCM must be programmed. Go to *PCM replacement and programming procedures.* Is the action complete?	—	Go to Step 8.	—
8	1. Using the Scan Tool, select "DTC", "Clear Info". 2. Start engine and idle at normal operating temperature. 3. Select "DTC", "Specific", then enter the DTC number which was set. 4. Operate vehicle within the conditions for setting this DTC as specified in the supporting text. Does the Scan Tool indicate that this diagnostic Ran and Passed?	—	Go to Step 10.	Go to Step 2.
9	Using the Scan Tool, select "Capture Info", "Review Info". Are any DTCs displayed that have not been diagnosed?	—	Go to the applicable DTC table	Go to Step 2.

DTC P0216 Injection Timing Control System



Circuit Description

Timing of the combustion event is accomplished by delivering a pulse of fuel into the combustion chamber at a desired degree of cylinder travel. This desired degree (defines the current position of the cylinder in relationship of Top Dead Center). This test compares desired timing to measured timing when certain conditions have been met. To retard injection timing the PCM extends the stepper motor. To advance injection timing the PCM retracts the stepper motor. This is a type B DTC.

Conditions for Setting the DTC

- Engine speed has not changed more than 56 rpm for 20.8 seconds.
- A 5 degree difference between Act. Inj. Time and Des. Inj. Time.

Action Taken When the DTC Sets

Possible combustion noise.

Conditions for Clearing the MIL/DTC

- The PCM will turn the MIL off after three consecutive trips without a fault condition.
- A History DTC will clear when forty consecutive warm-up cycles that the diagnostic does not fail (coolant temperature has risen 5°C (40°F) from start up coolant temperature and engine coolant temperature exceeds 71°C (160°F) that same ignition cycle).
- Use of a Scan Tool.

Diagnostic Aids

A hard start and possible poor performance condition might exist. Act. Inj. Time will freeze at the point of the fault. DTC P0216 will set if injection timing is not set correctly. Refer to Checking and Adjusting Injection Timing.

Test Description

Number(s) refer to the number(s) on the diagnostic table.

2. This step determines is a hard failure or an intermittent.
3. This step checks for an open or short in the injection timing coil circuit 1.
4. This step checks for an open or short in the injection timing coil circuit 2.
5. The important thing in this step is that the PCM is sending a varying voltage (voltage may vary between 1 and 12 (usually you will see voltage vary between 5 and 6 when engine is idling)), this will indicate that the PCM is OK and that there is a problem with the injection timing stepper motor. If there is a steady voltage present on any circuit, this will indicate a problem with the PCM or a circuit shorted to voltage.

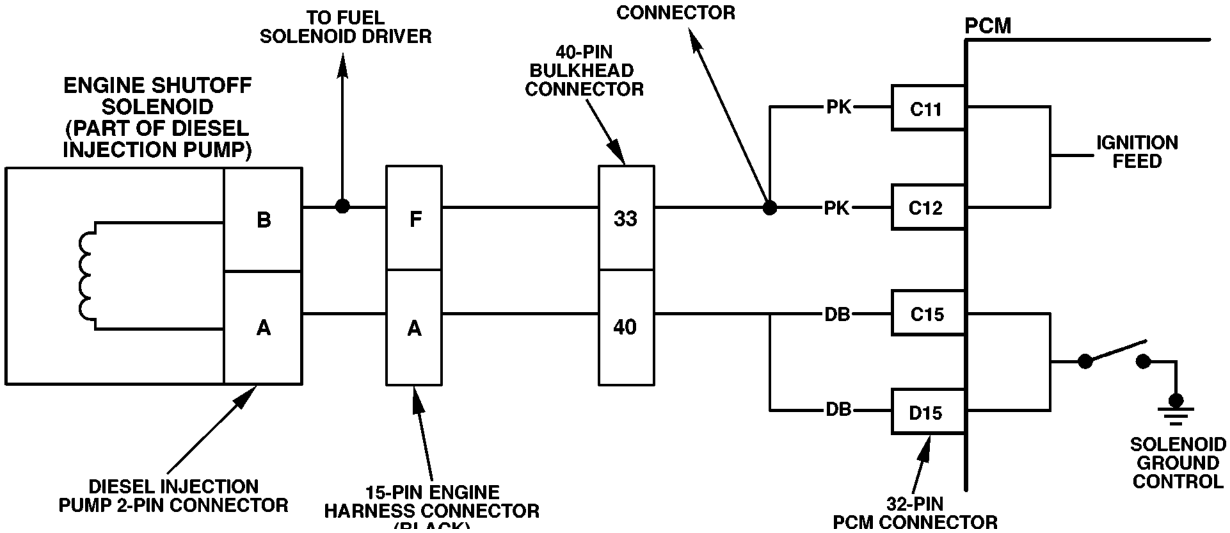
DTC P0216 - Injection Timing Control System

Step	Action	Value(s)	Yes	No
1	**Important:** Before clearing DTC(s) use the scan tool “Capture Info” Was the *“On-Board Diagnostic (OBD) System Check”* performed?	—	Go to Step 2.	Go to *OBD System Check.*
2	1. Engine at operating temperature. 2. Scan injection timing at idle and at 1500 rpm. Difference between Actual Inj. Time and Desired at idle or 1500 rpms?	5°	Go to Step 3.	Go to Step 4.
3	DTC is intermittent. An additional DTCs are stored.	—	Go to the DTC table	Go to Diagnostic Aids

DTC P0216 - Injection Timing Control System

Step	Action	Value(s)	Yes	No
4	1. Ignition "OFF". 2. Disconnect PCM. 3. Measure resistance between coil 1 low and coil 1 high at PCM harness. Is resistance between specified value?	10-60 Ohms	Go to Step 5.	Go to Step 9.
5	Measure resistance between coil 2 low and coil 2 high at PCM harness. Is resistance between specified value?	10-60 Ohms	Go to Step 6.	Go to Step 10.
6	1. Reconnect PCM. 2. Disconnect Injection Timing Stepper motor. 3. Start and idle engine. 4. Using scan tool, command Time Set "ON". 5. Check for varying voltage on all terminals at injection timing stepper motor electrical harness. Does voltage vary?	—	Go to Step 7.	Go to Step 12.
7	1. Disconnect crankshaft position sensor. 2. Measure resistance between crankshaft position sensor signal and 5 volt reference circuit at sensor pigtail. Is resistance between specified value?	950-1050 Ohms	Go to Step 8.	Go to Step 15.
8	Check for inj. timing set correctly and/or sheared camshaft driven key Was a repair performed?	—	Go to Step 18.	Go to Step 16.
9	1. Ignition "OFF". 2. Disconnect PCM, check for open in the coil 1 low and high circuit 3. If a problem is found, repair it as necessary. Was a repair required?	—	Go to Step 18.	Go to Step 16.
10	1. Ignition "OFF". 2. Disconnect PCM, check for open in coil 2 low and high circuit 3. If a problem is found, repair it as necessary. Was a repair required?	—	Go to Step 18.	Go to Step 16.
11	Check for poor electrical connection at the injection timing stepper motor. Was a repair performed?	—	Go to Step 12.	Go to Step 17.
12	Check the circuit for a short to ground or a poor connection at the PCM. Was a repair performed?	—	Go to Step 18.	Go to Step 17.
13	Check crankshaft sensor pigtail for a short to ground. Repair it as necessary. Was the circuit shorted to ground?	—	Go to Step 18.	Go to Step 14.
14	Check the circuit for a poor connection and replace terminal if necessary. Did Terminal require replacement?	—	Go to Step 18.	Go to Step 17.
15	Replace crankshaft position sensor. Is action complete?	—	Go to Step 18.	—
16	Replace injection pump. Is action complete?	—	Go to Step 18.	—
17	Replace the faulty PCM. Is the action complete?	—	Go to Step 18.	—
18	1. Using the Scan Tool, select "DTC", "Clear Info". 2. Start engine and idle at normal operating temperature. 3. Select "DTC", "Specific", then enter the DTC number which was set. Does the Scan Tool indicate that this diagnostic Ran and Passed?	—	Go to Step 19.	Go to Step 2.
19	Using the Scan Tool, select "Capture Info", "Review Info". Are any DTCs displayed that have not been diagnosed?	—	Go to the DTC table	System OK.

DTC P0219 Engine Overspeed Condition



Circuit Description

The PCM has the ability to put the vehicle in an ESO controlled idle if an engine overspeed condition has been detected. This is a type D DTC.

Conditions for Setting the DTC

5 ESO cycles with an rpm drop.

Action Taken When the DTC Sets

ESO controlled idle (the PCM will control rpm by turning the ESO “ON” and “OFF”. RPM will fluctuate from 800 to 1200 when DTC is set).

Conditions for Clearing the MIL/DTC

- A History DTC will clear when forty consecutive warm-up cycles that the diagnostic does not fail (coolant temperature has risen 5°C (40°F) from start up coolant temperature and engine coolant temperature exceeds 71°C (160°F) that same ignition cycle).
- Use of a Scan Tool.

Diagnostic Aids

This DTC will not set if an external fuel source is causing an overspeed condition. A DTC P1216 will set along with DTC P0219

Test Description

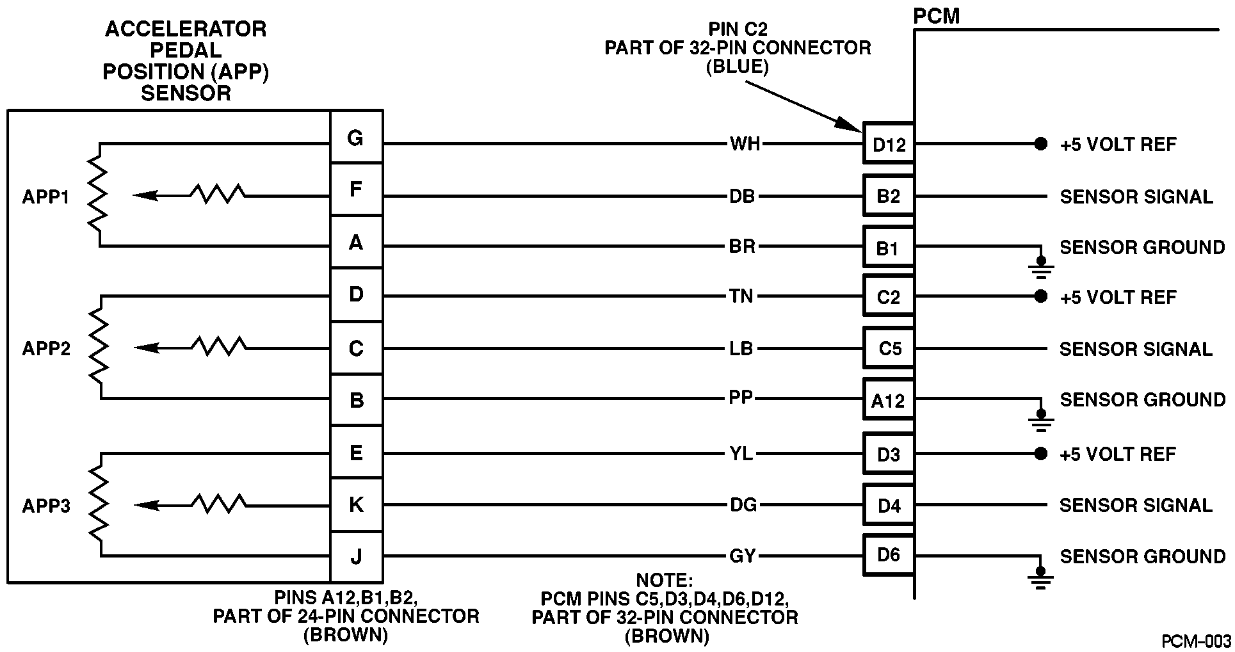
Number(s) below refer to the number(s) on the diagnostic table.

2. The injection pump is being replaced in this step.

DTC P0219 - Engine Overspeed Condition

Step	Action	Value(s)	Yes	No
1	Was the *"On-Board Diagnostic (OBD) System Check"* performed?	—	Go to Step 2.	Go to *OBD System Check.*
2	Replace injection pump. ***Notice:*** If injection pump is faulty, the new injection pump must be timed. Go to *Checking and Adjusting Injection Timing* in section 4. Is action complete?	—	Go to Step 4.	Go to Step 2.
3	1. Using the Scan Tool, select "DTC", "Clear Info". 2. Start engine and idle at normal operating temperature. 3. Select "DTC", "Specific", then enter the DTC number which was set. 4. Operate vehicle within the conditions for setting this DTC as specified in the supporting text. Does the Scan Tool indicate that this diagnostic Ran and Passed?	—	Go to Step 4.	Go to Step 2.
4	Using the Scan Tool, select "Capture Info", "Review Info". Are any DTCs displayed that have not been diagnosed?	—	Go to Applicable DTC table	Go to Step 2.

DTC P0220 Accelerator Pedal Position (APP) Sensor 2 Circuit



Circuit Description

The Accelerator Pedal Position (APP) module provides a voltage signal that changes relative to accelerator position. There are three sensors located within the APP module that are scaled differently. This is a type C DTC.

Conditions for Setting the DTC

- Reference voltage on APP 2 less than 4.8 volts.
- Condition met for 2 seconds.

Action Taken When the DTC Sets

If DTC P0220 is stored, the PCM will turn "ON" the "Service Throttle Soon" lamp and limit power.

Conditions for Clearing the MIL/DTC

- A History DTC will clear when forty consecutive warm-up cycles that the diagnostic does not fail (coolant temperature has risen 5°C (40°F) from start up coolant temperature and engine coolant temperature exceeds 71°C (160°F) that same ignition cycle).
- Use of a Scan Tool

Diagnostic Aids

The most likely cause of this DTC is loose connectors or terminals. All 5 volt reference circuits must be checked for proper reference voltage. Volt meter accuracy is important.

Test Description

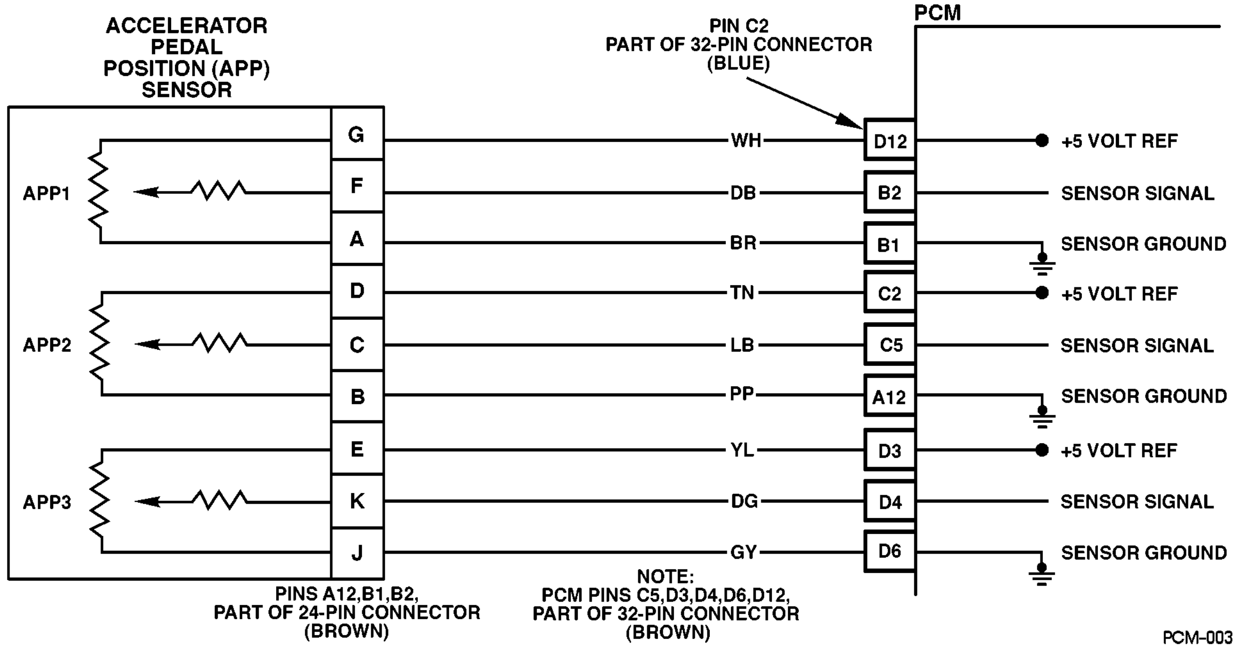
Number(s) below refer to the number(s) on the diagnostic table.

2. This step will determine if there is a good voltage reference.

DTC P0220 - Accelerator Pedal Position (APP) Sensor 2 Circuit

Step	Action	Value(s)	Yes	No
1	**Important:** Before clearing DTC(s) use the scan tool "Capture Info" to record Freeze Frame and Failure Record for reference, as data will be lost when "Clear Info" function is used. Was the *"On-Board Diagnostic (OBD) System Check"* performed?	—	Go to Step 2.	Go to *OBD System Check.*
2	1. Disconnect the APP sensor electrical connector. 2. Ignition "ON", engine "OFF". 3. With J 39200 connected to ground, check all APP 5 volt reference circuits at APP harness. Is voltage less than specified value?	4.8v	Go to Step 4.	Go to Step 3.
3	DTC is intermittent. If no additional DTCs are stored, refer to "Diagnostic Aids". If additional DTCs were stored, refer to those chart(s).	—	Go to the applicable DTC table.	Go to *Diagnostic Aids.*
4	1. Ignition "OFF". 2. Disconnect the PCM and check the 5 volt reference circuit for a short to ground. 3. If the 5 volt reference circuit is shorted to ground, repair as necessary Was the 5 volt reference circuit shorted to ground?	.25v	Go to Step 5.	Go to Step 6.
5	Replace the faulty PCM. ***Notice:*** If the PCM is faulty, the new PCM must be programmed. Go to *PCM replacement and programming procedures.* Is the action complete?	—	Go to Step 6.	—
6	1. Using the Scan Tool, select "DTC", "Clear Info". 2. Start engine and idle at normal operating temperature. 3. Select "DTC", "Specific", then enter the DTC number which was set. 4. Operate vehicle within the conditions for setting this DTC as specified in the supporting text. Does the Scan Tool indicate that this diagnostic Ran and Passed?	—	Go to Step 7.	Go to Step 2.
7	Using the Scan Tool, select "Capture Info", "Review Info". Are any DTCs displayed that have not been diagnosed?	—	Go to the applicable DTC table	System OK

DTC P0221 Accelerator Pedal Position (APP) Sensor 2 Circuit Performance



Circuit Description

The Accelerator Pedal Position (APP) module provides a voltage signal that changes relative to accelerator position. There are three sensors located within the APP module that are scaled differently. This is a type C DTC.

Conditions for Setting the DTC

- Ignition voltage is greater than 6.4 volts.
- Engine speed greater than 300 rpm.
- The difference between APP 2 and APP 1 is greater than .23 volts (PCM compares pre-scaled voltage (internal to PCM)).
- The difference between APP 2 and APP 3 is greater than .50 volts (PCM compares pre-scaled voltage (internal to PCM)).
- No in range faults for APP 1 or APP 3 (PCM checks for high and low voltage faults).
- Conditions met for 2 seconds.

Action Taken When the DTC Sets

- The input from APP 2 sensor is ignored.
- A current and history DTC will set but it will not turn on the “Service Throttle Soon” lamp.
- The throttle will operate normally as long as there is only one malfunction present. If there are two APP malfunctions present, the PCM will then turn “ON” the “Service Throttle Soon” lamp and limit power. If a third APP malfunction is present, the “Service Throttle Soon” lamp will be “ON” and will only allow the engine to operate at idle.

Conditions for Clearing the MIL/DTC

- A History DTC will clear when forty consecutive warm-up cycles that the diagnostic does not fail (coolant temperature has risen 5°C (40°F) from start up coolant temperature and engine coolant temperature exceeds 71°C (160°F) that same ignition cycle).
- Use of a Scan Tool

Diagnostic Aids

A scan tool reads APP 2 position in volts and should read about 4.5 volts with throttle closed and ignition “ON” or at idle. Voltage should decrease at a steady rate as throttle is moved toward Wide Open Throttle (WOT). Also, 90% pedal travel is acceptable for correct APP operation. Refer to Section 2 for “Intermittents”. Scan APP 2 sensor while depressing accelerator pedal with engine stopped and ignition “ON”. Display should vary from about 4.5 volts when throttle was closed to about 1.5 volts when throttle is held at Wide Open Throttle (WOT) position.

Test Description

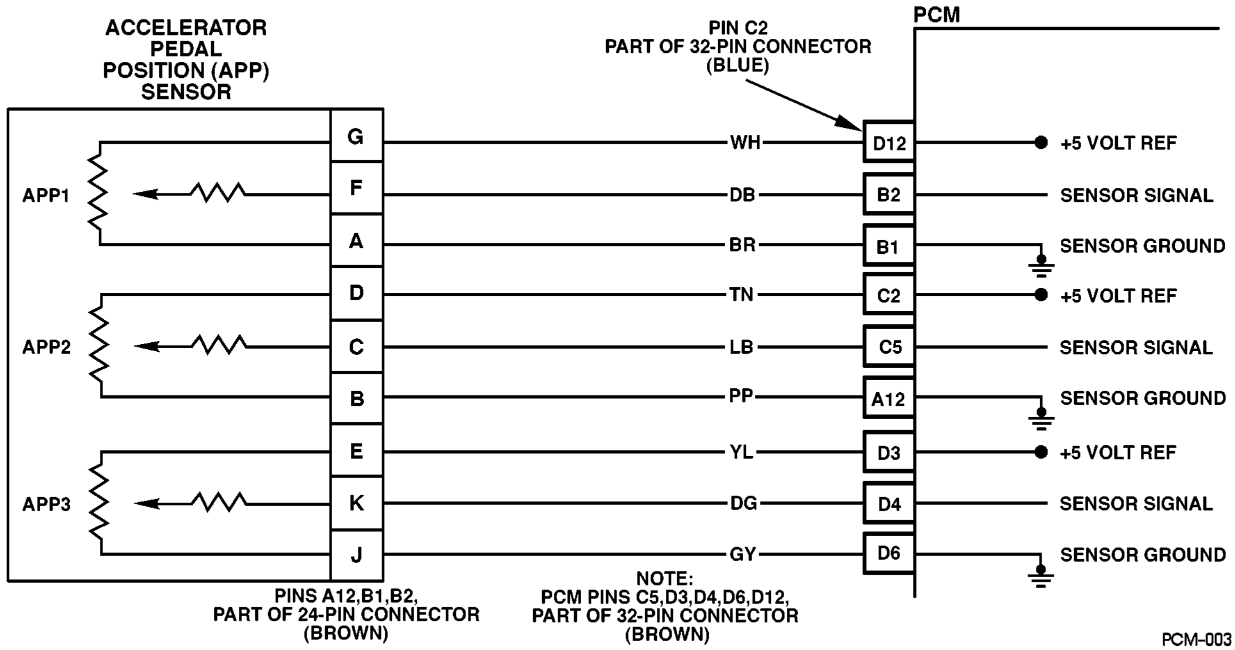
Number(s) below refer to the number(s) on the diagnostic table.

4. This step determines if there is a good 5 volt reference.
5. This step will check for an open in the ground circuit.

DTC P0221 - Accelerator Pedal Position (APP) Sensor 2 Circuit Performance

Step	Action	Value(s)	Yes	No
1	**Important:** Before clearing DTC(s) use the scan tool "Capture Info" to record Freeze Frame and Failure Record for reference, as data will be lost when "Clear Info" function is used. Was the *"On-Board Diagnostic (OBD) System Check"* performed?	—	Go to Step 2.	Go to *OBD System Check.*
2	1. Ignition "ON", engine "OFF". 2. With the throttle closed, observe APP voltages on the scan tool. Are APP at specified values?	.45-.95v 4.0-4.5v 3.6-4.0v	Go to Step 3.	Go to Step 4.
3	DTC is intermittent. If no additional DTCs are stored, refer to "Diagnostic Aids". If additional DTCs were stored, refer to those chart(s).	—	Go to the applicable DTC table.	Go to *Diagnostic Aids.*
4	1. Disconnect the APP sensor electrical connector. 2. Ignition "ON", engine "OFF". 3. With J 39200 connected to ground, probe APP sensor 5 volt reference circuits at APP harness terminals "G", "D" and "E". Is voltage at the specified value on all circuits?	4.75v	Go to Step 5.	Go to Step 6.
5	1. Ignition "ON", engine "OFF". 2. With a test light connected to B+, probe APP sensor ground circuits at the APP sensor harness terminals "A", "B" and "J". Is the test light "ON" (all circuits)?	—	Go to Step 9.	Go to Step 8.
6	1. Ignition "OFF" 2. Disconnect the PCM and check the 5 volt reference circuit for an open or short to ground. 3. If the 5 volt reference circuit is open or shorted to ground, repair it as necessary. Was the 5 volt reference circuit open or shorted to ground?	—	Go to Step 11.	Go to Step 7.
7	Check the 5 volt reference circuit for a poor connection at the PCM and replace terminal if necessary. Did the terminal require replacement?	—	Go to Step 11.	Go to Step 10.
8	1. Ignition "OFF" 2. Disconnect the PCM and check for an open sensor ground circuit to the PCM. 3. If problem is found, repair as necessary. Was APP sensor ground circuit open?	—	Go to Step 11.	Go to Step 10.
9	Replace the APP module. Is Action complete?	—	Go to Step 11.	—
10	Replace the faulty PCM. ***Notice:*** If the PCM is faulty, the new PCM must be programmed. Go to *PCM replacement and programming procedures.* Is the action complete?	—	Go to Step 10.	—
11	1. Using the Scan Tool, select "DTC", "Clear Info". 2. Start engine and idle at normal operating temperature. 3. Select "DTC", "Specific", then enter the DTC number which was set. 4. Operate vehicle within the conditions for setting this DTC as specified in the supporting text. Does the Scan Tool indicate that this diagnostic Ran and Passed?	—	Go to Step 12.	Go to Step 2.
12	Using the Scan Tool, select "Capture Info", "Review Info". Are any DTCs displayed that have not been diagnosed?	—	Go to the applicable DTC table	System OK

DTC P0222 Accelerator Pedal Position (APP) Sensor 2 Circuit Low Voltage



Circuit Description

The Accelerator Pedal Position (APP) module provides a voltage signal that changes relative to accelerator position. There are three sensors located within the APP module that are scaled differently. This is a type C DTC.

Conditions for Setting the DTC

- Voltage is less than .25 volts on APP 2 sensor.
- Conditions met for 2 seconds.

Action Taken When the DTC Sets

- The input from APP 2 sensor is ignored.
- A current and history DTC will set but it will not turn on the “Service Throttle Soon” lamp.
- The throttle will operate normally as long as there is only one sensor malfunction present. If two different APP sensors have a malfunction, the “Service Throttle Soon” lamp will light and the PCM will limit power. If three APP sensors have a malfunction present, the “Service Throttle Soon” lamp will light and the PCM will only allow the engine to operate at idle.

Conditions for Clearing the MIL/DTC

- A History DTC will clear when forty consecutive warm-up cycles that the diagnostic does not fail (coolant temperature has risen 5°C (40°F) from start up coolant temperature and engine coolant temperature exceeds 71°C (160°F) that same ignition cycle).
- Use of a Scan Tool

Diagnostic Aids

A scan tool reads APP 2 position in volts and should read about 4.5 volts with throttle closed and ignition “ON” or at idle. Voltage should decrease at a steady rate as throttle is moved toward Wide Open Throttle (WOT). An open or short to ground in CKT 996 or 993 will result in a P0222. Refer to Section 2 for “Intermittents”. Scan APP 2 sensor while depressing accelerator pedal with engine stopped and ignition “ON”, Display should vary from about 4.5 volts when throttle was closed to about 1.5 volts when throttle is held at Wide Open Throttle (WOT) position.

Test Description

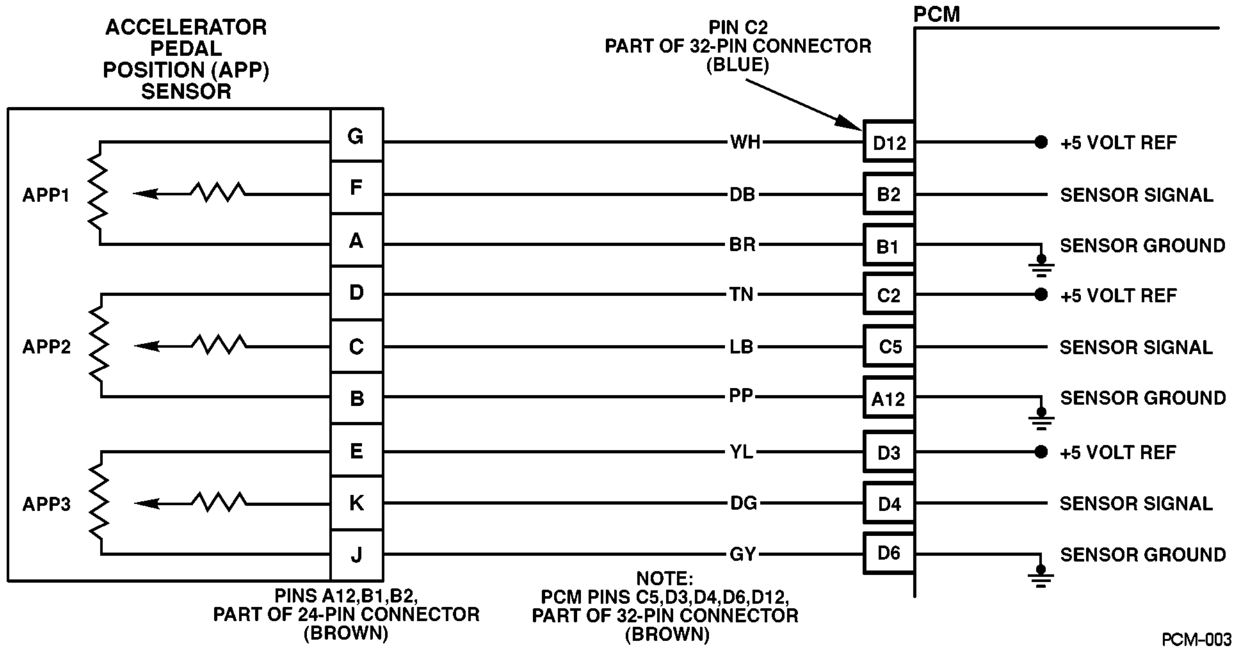
Number(s) below refer to the circled number(s) on the diagnostic table.

2. This step determines if P0222 is the result of a hard failure or an intermittent condition.
3. This step checks the PCM and wiring.

DTC P0222 - Accelerator Pedal Position (APP) Sensor 2 Circuit Low Voltage

Step	Action	Value(s)	Yes	No
1	**Important:** Before clearing DTC(s) use the scan tool "Capture Info". Was the *"On-Board Diagnostic (OBD) System Check"* performed?	—	Go to Step 2.	Go to *OBD System Check.*
2	1. Ignition "ON", engine "OFF". 2. With the throttle closed, observe APP 2 voltages on the scan tool. Is APP 2 voltage less than or equal to the specified value?	.25v	Go to Step 3.	Go to Step 4.
3	DTC is intermittent.. Are additional DTCs stored?	—	Go to the DTC table.	Go to *Diagnostic Aids.*
4	1. Disconnect the APP sensor electrical connector. 2. Jumper APP 2 5 volt reference circuit and the APP 2 signal together at the APP sensor harness connector. 3. Observe the APP 2 voltage on the Scan Tool. Is APP 2 voltage greater than the specified value?	4.75v	Go to Step 10.	Go to Step 5.
5	1. Connect a test light between B+ and the APP 1 sensor signal circuit at the APP sensor harness connector. 2. Observe the APP 2 voltage on the Scan Tool. Is APP 2 voltage greater than the specified value?	4.75v	Go to Step 6.	Go to Step 8.
6	1. Ignition "OFF". 2. Disconnect the PCM and check the 5 volt reference circuit for an open or short to ground. 3. If the 5 volt reference circuit is open or shorted to ground, repair as necessary. Was the 5 volt reference circuit open or shorted to ground?	—	Go to Step 12.	Go to Step 7.
7	Check the 5 volt reference circuit for a poor connection at the PCM and replace terminal if necessary. Did the terminal require replacement?	—	Go to Step 12.	Go to Step 11.
8	1. Ignition "OFF". 2. Disconnect PCM, and check APP 2 signal circuit for short to ground. 3. Repair as necessary. Was APP 2 signal circuit open or shorted to ground?	—	Go to Step 12.	Go to Step 9.
9	Check the APP 2 sensor signal circuit for a poor connection at the PCM and replace terminal if necessary. Did the terminal require replacement?	—	Go to Step 12.	Go to Step 11.
10	Replace the APP module. Is Action complete?	—	Go to Step 12.	—
11	Replace the faulty PCM. Is the action complete?	—	Go to Step 12.	—
12	1. Using the Scan Tool, select "DTC", "Clear Info". 2. Start engine and idle at normal operating temperature. 3. Select "DTC", "Specific", then enter the DTC number which was set. 4. Operate vehicle within the conditions for setting this DTC as specified in the supporting text. Does the Scan Tool indicate that this diagnostic Ran and Passed?	—	Go to Step 13.	Go to Step 2.
13	Using the Scan Tool, select "Capture Info", "Review Info". Are any DTCs displayed that have not been diagnosed?	—	Go to the DTC table	System OK

DTC P0223 Accelerator Pedal Position (APP) Sensor 2 Circuit High Voltage



Circuit Description

The Accelerator Pedal Position (APP) module provides a voltage signal that changes relative to accelerator position. There are three sensors located within the APP module that are scaled differently. This is a type C DTC.

Conditions for Setting the DTC

- Voltage is greater than 4.75 volts on APP 2.
- Conditions met for 2 seconds.

Action Taken When the DTC Sets

- The input from APP 2 sensor is ignored.
- A current and history DTC will set but it will not turn on the “Service Throttle Soon” lamp. The throttle will operate normally as long as there is only one malfunction present. If two different APP sensors have a malfunction, the “Service Throttle Soon” lamp will light and the PCM will limit power. If three APP sensors have a malfunction present, the “Service Throttle Soon” lamp will light and the PCM will only allow the engine to operate at idle.

Conditions for Clearing the MIL/DTC

- A History DTC will clear when forty consecutive warm-up cycles that the diagnostic does not fail (coolant temperature has risen 5°C (40°F) from start up coolant temperature and engine coolant temperature exceeds 71°C (160°F) that same ignition cycle).
- Ignition must be cycled if P1125 is also set.
- Use of a Scan Tool

Diagnostic Aids

A scan tool reads APP 2 position in volts and should read about 4.5 volts with throttle closed and ignition “ON” or at idle. Voltage should decrease at a steady rate as throttle is moved toward Wide Open Throttle (WOT). Also, 90% pedal travel is acceptable for correct APP operation. Refer to Section 2 for “Intermittents”. Scan APP 2 signal while depressing accelerator pedal with engine stopped and ignition “ON”. Display should vary from about 4.5 volts when throttle is closed to about 1.5 volts when throttle is held at Wide Open Throttle (WOT) position. Its possible P1125 will set along with P0223 if the signal circuit is open.

Test Description

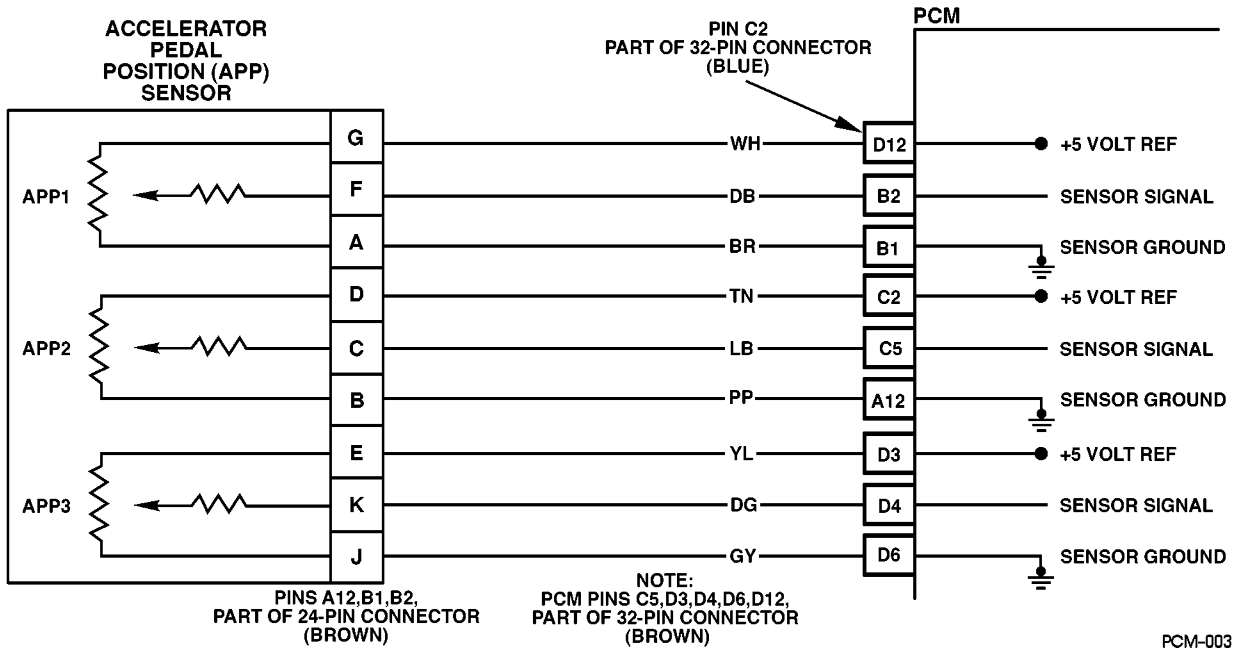
Number(s) below refer to the number(s) on the diagnostic table.

2. This step determines if P0223 is a hard failure or an intermittent condition.
3. This step will check for an open in the ground circuit.

DTC P0223 - Accelerator Pedal Position (APP) Sensor 2 Circuit High Voltage

Step	Action	Value(s)	Yes	No
1	**Important:** Before clearing DTC(s) use the scan tool "Capture Info" to record Freeze Frame and Failure Record for reference, as data will be lost when "Clear Info" function is used. Was the *"On-Board Diagnostic (OBD) System Check"* performed?	—	Go to Step 2.	Go to *OBD System Check.*
2	1. Ignition "ON", engine "OFF". 2. With the throttle closed, observe APP 2 display on the scan tool. Is APP 2 greater than or equal to the specified value?	4.75v	Go to Step 4.	Go to Step 3.
3	DTC is intermittent. If no additional DTCs are stored, refer to "Diagnostic Aids". If additional DTCs were stored, refer to those chart(s).	—	Go to the applicable DTC table.	Go to *Diagnostic Aids.*
4	1. Disconnect the APP sensor electrical connector. 2. Observe the APP 2 display on the Scan Tool. Is APP 2 less than or equal to the specified value?	.25v	Go to Step 5.	Go to Step 6.
5	Probe APP 2 sensor ground circuit at the APP sensor harness connector with a test light connected to B+. Is the test light "ON"?	—	Go to Step 7.	Go to Step 8.
6	1. Check for a short to voltage on the APP 2 sensor signal circuit. 2. If the APP 2 sensor signal circuit is shorted, repair it as necessary. Was the APP 2 sensor signal circuit shorted?	—	Go to Step 11.	Go to Step 10.
7	Check for poor electrical connections at the APP sensor and replace terminals if necessary. Did any terminals require replacement?	—	Go to Step 11.	Go to Step 10.
8	1. Check for an open sensor ground circuit. 2. If a problem is found, repair as necessary. Was APP 2 sensor ground circuit open?	—	Go to Step 11.	Go to Step 10.
9	Replace the APP module. Is Action complete?	—	Go to Step 11.	—
10	Replace the faulty PCM. ***Notice:*** If the PCM is faulty, the new PCM must be programmed. Go to *PCM replacement and programming procedures.* Is the action complete?	—	Go to Step 10.	—
11	1. Using the Scan Tool, select "DTC", "Clear Info". 2. Start engine and idle at normal operating temperature. 3. Select "DTC", "Specific", then enter the DTC number which was set. 4. Operate vehicle within the conditions for setting this DTC as specified in the supporting text. Does the Scan Tool indicate that this diagnostic Ran and Passed?	—	Go to Step 12.	Go to Step 2.
12	Using the Scan Tool, select "Capture Info", "Review Info". Are any DTCs displayed that have not been diagnosed?	—	Go to the applicable DTC table	System OK

DTC P0225 Accelerator Pedal Position (APP) Sensor 3 Circuit



Circuit Description

The Accelerator Pedal Position (APP) module provides a voltage signal that changes relative to accelerator position. There are three sensors located within the APP module that are scaled differently. This is a type C DTC.

Conditions for Setting the DTC

- Reference voltage on APP 3 less than 4.8 volts.
- Condition met for 2 seconds.

Action Taken When the DTC Sets

If DTC P0225 is present, the PCM will turn "ON" the "Service Throttle Soon" lamp and limit power.

Conditions for Clearing the MIL/DTC

- A History DTC will clear when forty consecutive warm-up cycles that the diagnostic does not fail (coolant temperature has risen 5°C (40°F) from start up coolant temperature and engine coolant temperature exceeds 71°C (160°F) that same ignition cycle).
- Use of a Scan Tool

Diagnostic Aids

All 5 volt reference circuits must be checked for proper reference voltage. Volt meter accuracy is important.

Test Description

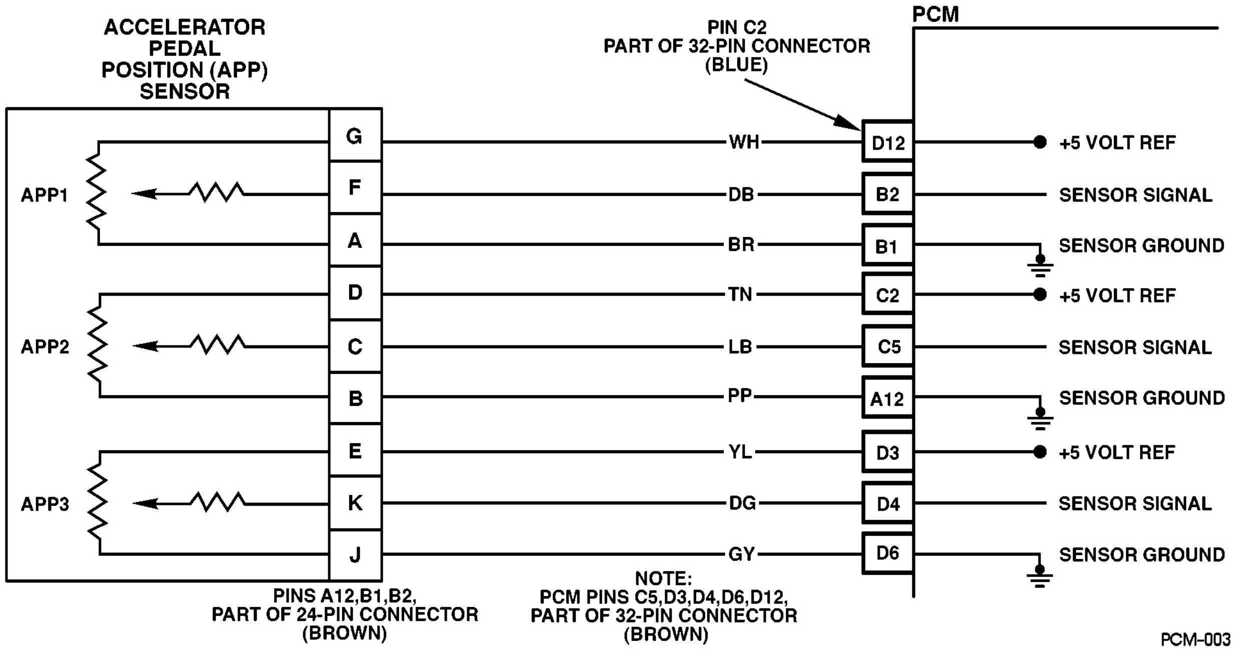
Number(s) below refer to the number(s) on the diagnostic table.

2. This step will check all 5 volt reference circuits.

DTC P0225 - Accelerator Pedal Position (APP) Sensor 3Circuit

Step	Action	Value(s)	Yes	No
1	**Important:** Before clearing DTC(s) use the scan tool “Capture Info” to record Freeze Frame and Failure Record for reference, as data will be lost when “Clear Info” function is used. Was the *“On-Board Diagnostic (OBD) System Check”* performed?	—	Go to Step 2.	Go to *OBD System Check.*
2	1. Disconnect the APP sensor electrical connector. 2. Ignition “ON”, engine “OFF”. 3. With J 39200 connected to ground, check all APP 5 volt reference circuits at APP harness. Is voltage less than specified value?	4.8v	Go to Step 4.	Go to Step 3.
3	DTC is intermittent. If no additional DTCs are stored, refer to “Diagnostic Aids”. If additional DTCs were stored, refer to those chart(s).	—	Go to the applicable DTC table.	Go to *Diagnostic Aids.*
4	1. Ignition “OFF”. 2. Disconnect the PCM and check the 5 volt reference circuit for a short to ground. 3. If the 5 volt reference circuit is shorted to ground, repair as necessary Was the 5 volt reference circuit shorted to ground?	.25v	Go to Step 6.	Go to Step 5.
5	Replace the faulty PCM. ***Notice:*** If the PCM is faulty, the new PCM must be programmed. Go to *PCM replacement and programming procedures.* Is the action complete?	—	Go to Step 6.	—
6	1. Using the Scan Tool, select “DTC”, “Clear Info”. 2. Start engine and idle at normal operating temperature. 3. Select “DTC”, “Specific”, then enter the DTC number which was set. 4. Operate vehicle within the conditions for setting this DTC as specified in the supporting text. Does the Scan Tool indicate that this diagnostic Ran and Passed?	—	Go to Step 7.	Go to Step 2.
7	Using the Scan Tool, select “Capture Info”, “Review Info”. Are any DTCs displayed that have not been diagnosed?	—	Go to the applicable DTC table	System OK

DTC P0226 Accelerator Pedal Position (APP) Sensor 3 Circuit Performance



Circuit Description

The Accelerator Pedal Position (APP) module provides a voltage signal that changes relative to accelerator position. There are three sensors located within the APP module that are scaled differently. This is a type C DTC.

Conditions for Setting the DTC

- Ignition voltage is greater than 6.4 volts.
- Engine speed greater than 300 rpm.
- The difference between APP 3 and APP 1 is greater than .23 volts (PCM compares pre-scaled voltage (internal to PCM)).
- The difference between APP 3 and APP 2 is greater than .50 volts (PCM compares pre-scaled voltage (internal to PCM)).
- No in range faults for APP 1 or APP 2 (PCM checks for high and low voltage faults).
- Conditions met for 2 seconds.

Action Taken When the DTC Sets

- The input from APP 3 sensor is ignored.
- A current and history DTC will set but it will not turn "ON" the "Service Throttle Soon" lamp.
- The throttle will operate normally as long as there is only one malfunction present. If there are two APP malfunctions present, the PCM will then turn "ON" the "Service Throttle Soon" lamp and limit power. If a third APP malfunction is present, the "Service Throttle Soon" lamp will be "ON" and will only allow the engine to operate at idle.

Conditions for Clearing the MIL/DTC

- A History DTC will clear when forty consecutive warm-up cycles that the diagnostic does not fail (coolant temperature has risen 5°C (40°F) from start up coolant temperature and engine coolant temperature exceeds 71°C (160°F) that same ignition cycle).
- Use of a Scan Tool

Diagnostic Aids

A scan tool reads APP 3 position in volts and should read about 4.0 volts with throttle closed and ignition "ON" or at idle. Voltage should decrease at a steady rate as throttle is moved toward Wide Open Throttle (WOT). Also, 90% pedal travel is acceptable for correct APP operation. Scan APP 3 sensor while depressing accelerator pedal with engine stopped and ignition "ON". Display should vary from about 4.0 volts when throttle was closed to about 2.0 volts when throttle is held at Wide Open Throttle (WOT) position.

Test Description

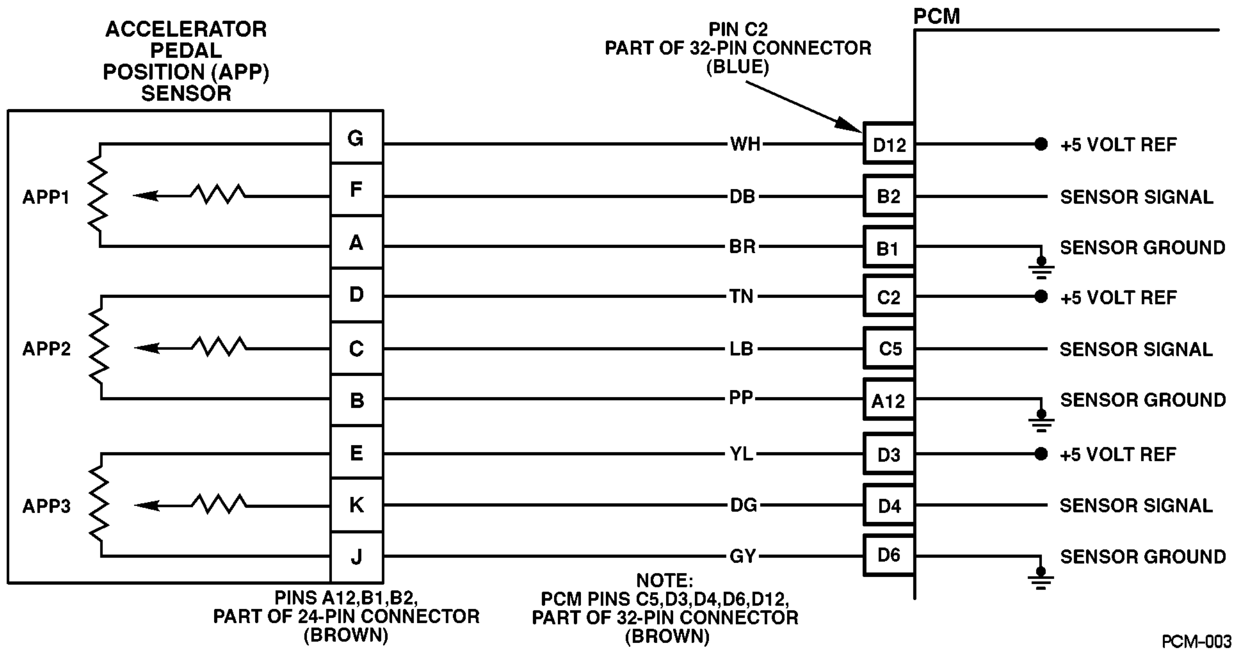
Number(s) below refer to the number(s) on the diagnostic table.

2. This step determines if there is a good reference voltage.

DTC P0226 - Accelerator Pedal Position (APP) Sensor 3 Circuit Performance

Step	Action	Value(s)	Yes	No
1	**Important:** Before clearing DTC(s) use the scan tool "Capture Info" to record Freeze Frame and Failure Record for reference, as data will be lost when "Clear Info" function is used. Was the *"On-Board Diagnostic (OBD) System Check"* performed?	—	Go to Step 2.	Go to *OBD System Check.*
2	1. Ignition "ON", engine "OFF". 2. With the throttle closed, observe APP voltages on the scan tool. Are APP voltages at specified values?	.45-.95v 4.0-4.5v 3.6-4.0v	Go to Step 3.	Go to Step 4.
3	DTC is intermittent. If no additional DTCs are stored, refer to "Diagnostic Aids". If additional DTCs were stored, refer to those chart(s).	—	Go to the applicable DTC table.	Go to *Diagnostic Aids.*
4	1. Disconnect the APP sensor electrical connector. 2. Ignition "ON", engine "OFF". 3. With J 39200 connected to ground, probe APP sensor 5 volt reference circuits at APP harness terminals "G", "D" and "E". Is voltage at the specified value on all circuits?	4.75v	Go to Step 5.	Go to Step 6.
5	1. Ignition "ON", engine "OFF". 2. With a test light connected to B+, probe APP sensor ground circuits at the APP sensor harness terminals "A", "B" and "J". Is the test light "ON" (all circuits)?	—	Go to Step 9.	Go to Step 8.
6	1. Ignition "OFF". 2. Disconnect the PCM and check the 5 volt reference circuit for an open or short to ground. 3. If the 5 volt reference circuit is open or shorted to ground, repair it as necessary. Was the 5 volt reference circuit open or shorted to ground?	—	Go to Step 11.	Go to Step 7.
7	Check the 5 volt reference circuit for a poor connection at the PCM and replace terminal if necessary. Did the terminal require replacement?	—	Go to Step 11.	Go to Step 10.
8	1. Ignition "OFF". 2. Disconnect the PCM and check for an open sensor ground circuit to the PCM. 3. If problem is found, repair as necessary. Was APP sensor ground circuit open?	—	Go to Step 11.	Go to Step 10.
9	Replace the APP module. Is Action complete?	—	Go to Step 11.	—
10	Replace the faulty PCM. ***Notice:*** If the PCM is faulty, the new PCM must be programmed. Go to *PCM replacement and programming procedures.* Is the action complete?	—	Go to Step 11.	—
11	1. Using the Scan Tool, select "DTC", "Clear Info". 2. Start engine and idle at normal operating temperature. 3. Select "DTC", "Specific", then enter the DTC number which was set. 4. Operate vehicle within the conditions for setting this DTC as specified in the supporting text. Does the Scan Tool indicate that this diagnostic Ran and Passed?	—	Go to Step 12.	Go to Step 2.
12	Using the Scan Tool, select "Capture Info", "Review Info". Are any DTCs displayed that have not been diagnosed?	—	Go to the applicable DTC table	System OK

DTC P0227 Accelerator Pedal Position (APP) Sensor 3 Circuit Low Voltage



Circuit Description

The Accelerator Pedal Position (APP) module provides a voltage signal that changes relative to accelerator position. There are three sensors located within the APP module that are scaled differently. This is a type C DTC.

Conditions for Setting the DTC

- Voltage is less than .25 volts on APP 3 sensor.
- Conditions met for 2 seconds.

Action Taken When the DTC Sets

- The input from APP 3 sensor is ignored.
- A current and history DTC will set but it will not turn on the “Service Throttle Soon” lamp.
- The throttle will operate normally as long as there is only one sensor malfunction present. If two different APP sensors have a malfunction, the “Service Throttle Soon” lamp will light and the PCM will limit power. If three APP sensors have a malfunction present, the “Service Throttle Soon” lamp will light and the PCM will only allow the engine to operate at idle.

Conditions for Clearing the MIL/DTC

- A History DTC will clear when forty consecutive warm-up cycles that the diagnostic does not fail (coolant temperature has risen 5°C (40°F) from start up coolant temperature and engine coolant temperature exceeds 71°C (160°F) that same ignition cycle).
- Use of a Scan Tool

Diagnostic Aids

A scan tool reads APP 3 position in volts and should read about 4.0 volts with throttle closed and ignition “ON” or at idle. Voltage should decrease at a steady rate as throttle is moved toward Wide Open Throttle (WOT). Also 90% pedal travel is acceptable for correct APP operation. Scan APP 3 sensor while depressing accelerator pedal with engine stopped and ignition “ON”, Display should vary from about 4.0 volts when throttle was closed to about 2.0 volts when throttle is held at Wide Open Throttle (WOT) position. Refer to “Intermittents”, in Section 2.

Test Description

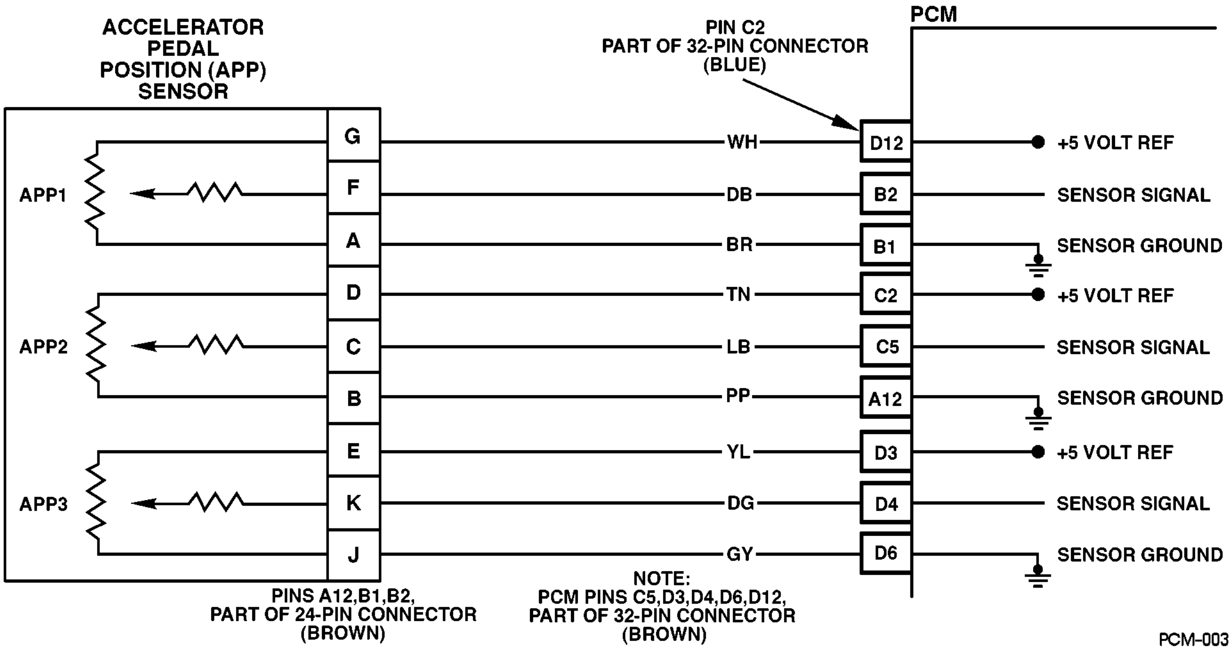
Number(s) below refer to the circled number(s) on the diagnostic table.

2. This step determines if P0227 is the result of a hard failure or an intermittent condition.
3. This step checks the PCM and wiring.

DTC P0227 - Accelerator Pedal Position (APP) Sensor 3 Circuit Low Voltage

Step	Action	Value(s)	Yes	No
1	**Important:** Before clearing DTC(s) use the scan tool "Capture Info" to record Freeze Frame and Failure Record for reference, as data will be lost when "Clear Info" function is used. Was the *"On-Board Diagnostic (OBD) System Check"* performed?	—	Go to Step 2.	Go to *OBD System Check.*
2	1. Ignition "ON", engine "OFF". 2. With the throttle closed, observe APP 3 voltages on the scan tool. Is APP 3 voltage less than or equal to the specified value?	.25v	Go to Step 4.	Go to Step 3.
3	DTC is intermittent. If no additional DTCs are stored, refer to "Diagnostic Aids". If additional DTCs were stored, refer to those table(s) first. Are additional DTCs stored?	—	Go to the applicable DTC table.	Go to *Diagnostic Aids.*
4	1. Disconnect the APP sensor electrical connector. 2. Jumper APP 3 5 volt reference circuit and the APP 3 signal together at the APP sensor harness connector. 3. Observe the APP 3 voltage on the Scan Tool. Is APP 3 voltage greater than the specified value?	5v	Go to Step 5.	Go to Step 6.
5	1. Connect a test light between B+ and the APP 3 sensor signal circuit at the APP sensor harness connector. 2. Observe the APP 3 voltage on the Scan Tool. Is APP 3 voltage greater than the specified value?	5v	Go to Step 10.	Go to Step 8.
6	1. Ignition "OFF". 2. Disconnect the PCM and check the 5 volt reference circuit for an open or short to ground. 3. If the 5 volt reference circuit is open or shorted to ground, repair as necessary. Was the 5 volt reference circuit open or shorted to ground?	—	Go to Step 13.	Go to Step 7.
7	Check the 5 volt reference circuit for a poor connection at the PCM and replace terminal if necessary. Did the terminal require replacement?	—	Go to Step 13.	Go to Step 12.
8	1. Ignition "OFF". 2. Disconnect the PCM, and check the APP 3 signal circuit for an open, short to ground. 3. If the APP 3 sensor signal circuit is open or shorted to ground, repair as necessary. Was APP 3 signal circuit open or shorted to ground?	—	Go to Step 13.	Go to Step 9.
9	Check the APP 3 sensor signal circuit for a poor connection at the PCM and replace terminal if necessary. Did the terminal require replacement?	—	Go to Step 13.	Go to Step 12.
10	Check for a poor electrical connection at the APP sensor. Was a repair performed?	—	Go to Step 13.	To to Step 12.
11	Replace the APP module. Is Action complete?	—	Go to Step 13.	—
12	Replace the faulty PCM. ***Notice:*** If the PCM is faulty, the new PCM must be programmed. Go to *PCM replacement and programming procedures.* Is the action complete?	—	Go to Step 13.	—
13	1. Using the Scan Tool, select "DTC", "Clear Info". 2. Start engine and idle at normal operating temperature. 3. Select "DTC", "Specific", then enter the DTC number which was set. 4. Operate vehicle within the conditions for setting this DTC as specified in the supporting text. Does the Scan Tool indicate that this diagnostic Ran and Passed?	—	Go to Step 14.	Go to Step 2.
14	Using the Scan Tool, select "Capture Info", "Review Info". Are any DTCs displayed that have not been diagnosed?	—	Go to the applicable DTC table	System OK

DTC P0228 Accelerator Pedal Position (APP) Sensor 3 Circuit High Voltage



Circuit Description

The Accelerator Pedal Position (APP) module provides a voltage signal that changes relative to accelerator position. There are three sensors located within the APP module that are scaled differently. This is a type C DTC.

Conditions for Setting the DTC

- Voltage is greater than 4.75 volts on APP 3 sensor.
- Conditions met for 2 seconds.

Action Taken When the DTC Sets

- The input from APP 3 sensor is ignored.
- A current and history DTC will set but it will not turn on the “Service Throttle Soon” lamp. The throttle will operate normally as long as there is only one malfunction present. If two different APP sensors have a malfunction, the “Service Throttle Soon” lamp will light and the PCM will limit power. If three APP sensors have a malfunction present, the “Service Throttle Soon” lamp will light and the PCM will only allow the engine to operate at idle.

Conditions for Clearing the MIL/DTC

- A History DTC will clear when forty consecutive warm-up cycles that the diagnostic does not fail (coolant temperature has risen 5°C (40°F) from start up coolant temperature and engine coolant temperature exceeds 71°C (160°F) that same ignition cycle).
- Use of a Scan Tool

Diagnostic Aids

A scan tool reads APP 3 position in volts and should read about 4.0 volts with throttle closed and ignition “ON” or at idle. Voltage should decrease at a steady rate as throttle is moved toward Wide Open Throttle (WOT). Also, 90% pedal travel is acceptable for correct APP operation. Refer to Section 2 for “Intermittents”. Scan APP 3 sensor while depressing accelerator pedal with engine stopped and ignition “ON”. Display should vary from about 4.0 volts when throttle is closed to about 2.0 volts when throttle is held at Wide Open Throttle (WOT) position.

Test Description

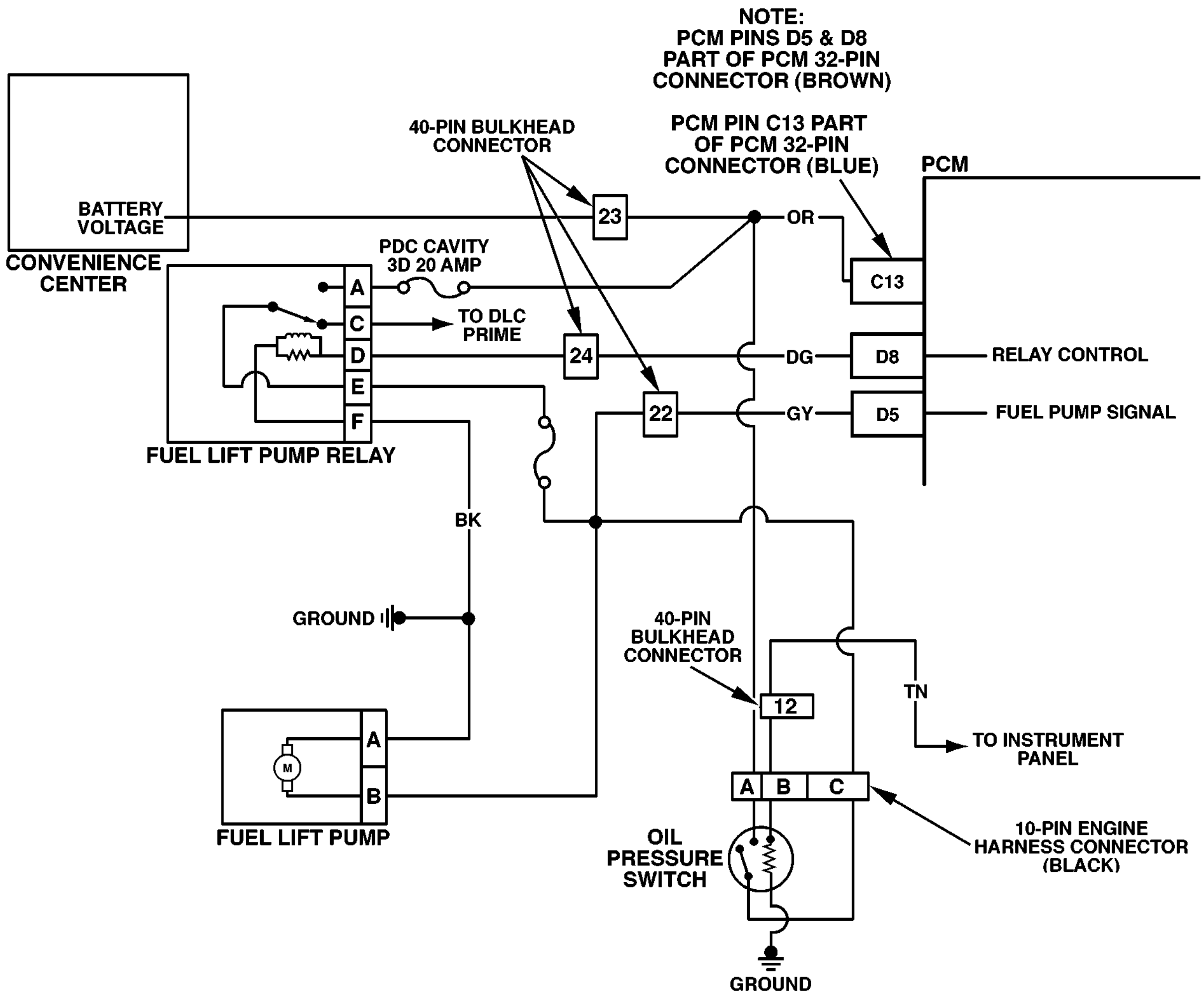
Number(s) below refer to the number(s) on the diagnostic table.

2. This step determines if P0228 is a hard failure or an intermittent condition.
3. This step checks the PCM and wiring.

DTC P0228 - Accelerator Pedal Position (APP) Sensor 3 Circuit High Voltage

Step	Action	Value(s)	Yes	No
1	**Important:** Before clearing DTC(s) use the scan tool "Capture Info" to record Freeze Frame and Failure Record for reference, as data will be lost when "Clear Info" function is used. Was the *"On-Board Diagnostic (OBD) System Check"* performed?	—	Go to Step 2.	Go to *OBD System Check.*
2	1. Ignition "ON", engine "OFF". 2. With the throttle closed, observe APP 3 display on the scan tool. Is APP 3 above the specified value?	4.75v	Go to Step 4.	Go to Step 3.
3	DTC is intermittent. If no additional DTCs are stored, refer to "Diagnostic Aids". If additional DTCs were stored, refer to those chart(s). Are additional DTCs stored?	—	Go to the applicable DTC table.	Go to *Diagnostic Aids.*
4	1. Disconnect the APP sensor electrical connector. 2. Observe the APP 3 display on the Scan Tool. Is APP 3 less than or equal to the specified value?	—	Go to Step 5.	Go to Step 7.
5	Probe APP 3 sensor ground circuit at the APP sensor harness connector with a test light connected to B+. Is the test light "ON"?	0.25v	Go to Step 8.	Go to Step 6.
6	1. Check for a short to voltage on the APP 3 sensor signal circuit. 2. If the APP 3 sensor signal circuit is shorted, repair it as necessary. Was the APP 3 sensor signal circuit shorted?	—	Go to Step 11.	Go to Step 10.
7	1. Check for an open sensor ground circuit. 2. If a problem is found, repair as necessary. Was APP 3 sensor ground circuit open?	—	Go to Step 11.	Go to Step 10.
8	Check for poor electrical connections at the APP sensor and replace terminals if necessary. Did any terminals require replacement?	—	Go to Step 11.	Go to Step 9.
9	Replace the APP module. Is Action complete?	—	Go to Step 11.	—
10	Replace the faulty PCM. ***Notice:*** If the PCM is faulty, the new PCM must be programmed. Go to *PCM replacement and programming procedures.* Is the action complete?	—	Go to Step 11.	—
11	1. Using the Scan Tool, select "DTC", "Clear Info". 2. Start engine and idle at normal operating temperature. 3. Select "DTC", "Specific", then enter the DTC number which was set. 4. Operate vehicle within the conditions for setting this DTC as specified in the supporting text. Does the Scan Tool indicate that this diagnostic Ran and Passed?	—	Go to Step 12.	Go to Step 2.
12	Using the Scan Tool, select "Capture Info", "Review Info". Are any DTCs displayed that have not been diagnosed?	—	Go to the applicable DTC table	System OK

DTC P0231 Fuel Lift Pump Secondary Circuit Low Voltage



PCM-007

Circuit Description

The status of the lift pump is monitored by the PCM. This signal is also used to store a DTC if the fuel pump relay is defective or fuel pump voltage is lost while the engine is running. There should be about 12 volts on circuit 120 during glow plug cycle. This is a Type B DTC.

Conditions for Setting the DTC

- Fuel lift pump commanded "ON".
- Ignition voltage minus 4 volts.
- Fuel lift pump voltage less than ignition voltage value.
- Conditions met for 2 seconds.

Action Taken When the DTC Sets

No action taken.

Conditions for Clearing the MIL/DTC

- The PCM will turn the MIL off after three consecutive trips without a fault condition.
- A History DTC will clear when forty consecutive warm-up cycles that the diagnostic does not fail (coolant temperature has risen 5°C (40°F) from start up coolant temperature and engine coolant temperature exceeds 71°C (160°F) that same ignition cycle).
- Use of a Scan Tool

Diagnostic Aids

This DTC will not check the fuel pump operation.

Test Description

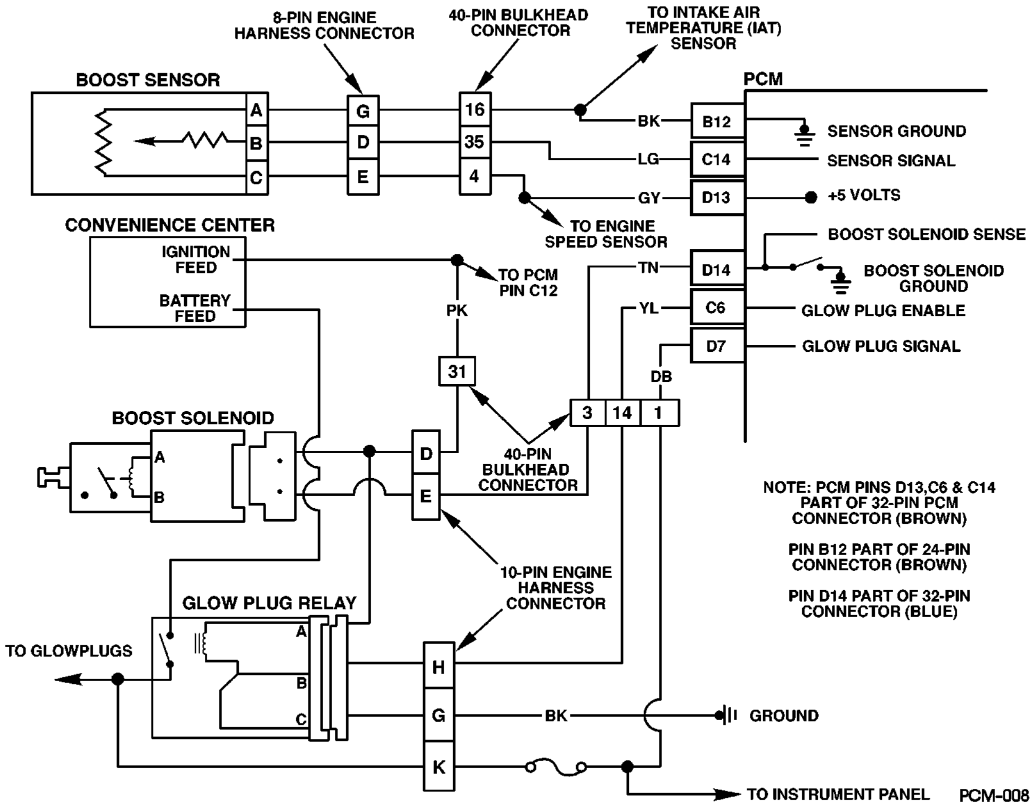
Number(s) below refer to the number(s) on the diagnostic table.

3. This step will check the fuel pump circuit.

DTC P0231 - Fuel Lift Pump Secondary Circuit Low Voltage

Step	Action	Value(s)	Yes	No
1	**Important:** Before clearing DTC(s) use the scan tool “Capture Info”. Was the *“On-Board Diagnostic (OBD) System Check”* performed?	—	Go to Step 2.	Go to *OBD System Check.*
2	1. Turn the ignition “OFF” for 20 seconds. 2. Turn the ignition “ON”. 3. Listen for the fuel lift pump. Does the lift pump operate during glow plug cycle and then turn “OFF”?	—	Go to *Diagnostic Aids.*	Go to Step 3.
3	1. Turn the ignition “OFF”. 2. Probe the fuel pump test terminal with a fused jumper to “B+”. Does the fuel pump operate?	—	Go to Step 8.	Go to Step 4.
4	1. Disconnect the fuel pump relay. 2. Probe the fuel pump test terminal with a fused jumper to “B+”. Does the fuel pump operate?	—	Go to Step 5.	Go to Step 6.
5	Replace the faulty fuel pump relay. Is the action complete?	—	Go to Step 6.	—
6	Check for a an open fuel pump signal circuit. Was a problem found?	—	Go to Step 7.	Go to Step 8.
7	Repair the open fuel pump signal circuit. Is the action complete?	—	Go to Step 8.	—
8	1. Turn the ignition “OFF”. 2. Remove the fuel pump relay. 3. Connect a test light to ground. 4. Probe the fuel pump relay harness connector terminal number “B1”. Is the test light “ON”?	—	Go to Step 10.	Go to Step 9.
9	Repair the open in the battery feed circuit to the fuel pump relay. Is the action complete?	—	Go to Step 10.	—
10	Connect a test light between terminal number “B1” and terminal number “A1” of the fuel pump relay harness connector. Is the test light “ON”?	—	Go to Step 12.	Go to Step 11.
11	Repair the open fuel pump relay ground circuit. Is the action complete?	—	Go to Step 12.	—
12	1. Turn the ignition “OFF”. 2. Connect a test light between terminal number “B3” and ground. 3. Monitor the test light. 4. Turn the ignition “ON”. Was a problem found?	—	Go to Step 16.	Go to Step 13.
13	Check for an open in circuit from fuel pump relay harness connector terminal number “B3” and PCM. Was a problem found?	—	Go to Step 14.	Go to Step 15.
14	Repair the open in the fuel pump relay control circuit. Is the action complete?	—	Go to Step 15.	—
15	Replace the faulty PCM. ***Notice:*** If the PCM is faulty, the new PCM must be programmed. Go to *PCM replacement and programming procedures.* Is the action complete?	—	Go to Step 16.	—
16	Check for a faulty connection at fuel pump relay harness connector terminal number “B3”. Was a problem found?	—	Go to Step 18.	Go to Step 17.
17	Replace the faulty fuel pump relay. Is the action complete?	—	Go to Step 18.	—

DTC P0236 Turbocharger (TC) Boost System



Circuit Description

The PCM operates a solenoid to control boost. This solenoid is normally open. By providing a ground path the PCM energizes the solenoid which then allows vacuum to pass to the wastegate valve. During normal operation, the PCM compares its wastegate duty cycle signal with the boost signal and makes corrections in the duty cycle accordingly. This is a type B DTC.

Conditions for Setting the DTC

- Engine speed greater than 2400 RPM.
- Fuel rate greater than 20 mm.
- Boost pressure less than or equal to 20 kPa from desired (internal to PCM).
- Conditions met for 10 seconds.

or

- Engine speed greater than 1800 but less than 2400 RPM.
- Fuel rate greater than 20 mm.
- Boost pressure less than or equal to (110 kPa) - ((100 kPa - Baro)/2) (internal to PCM).
- Conditions met for 2 seconds.

Action Taken When the DTC Sets

- Poor performance.
- Reduce maximum fuel.
- No TCC.

Conditions for Clearing the MIL/DTC

- The PCM will turn the MIL off after three consecutive trips without a fault condition.
- A History DTC will clear when forty consecutive warm-up cycles that the diagnostic does not fail (coolant temperature has risen 5°C (40°F) from start up coolant temperature and engine coolant temperature exceeds 71°C (160°F) that same ignition cycle).
- Use of a Scan Tool.

Diagnostic Aids

A vacuum leak or a pinched vacuum line may cause a DTC P0236. Check all vacuum lines and components connected to the hoses for leaks or sharp bends. Check vacuum source. A possible EGR DTC will store if there is a problem with the vacuum source. Also check for proper vacuum line routing. This diagnostic checks for a “skewed” sensor.

Test Description

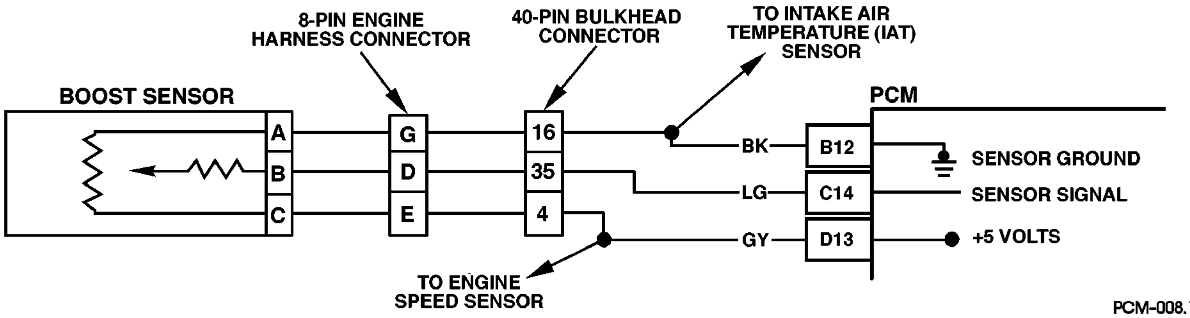
Number(s) below refer to the number(s) on the diagnostic table.

This will check the Boost sensor scaling. One step will check the scaling with vacuum applied and one without.

DTC P0236 - Turbocharger (TC) Boost System

Step	Action	Value(s)	Yes	No
1	**Important:** Before clearing DTC(s) use the scan tool "Capture Info". Was the *"On-Board Diagnostic (OBD) System Check"* performed?	—	Go to Step 2.	Go to *OBD System Check.*
2	Is DTC P1656 set?	—	Go to DTC table.	Go to Step 3
3	1. Disconnect the vacuum line at the turbocharger wastegate actuator. 2. Install a vacuum gauge in place of the turbocharger wastegate actuator. 3. Start the engine. 4. Observe the vacuum at idle. Is the vacuum greater than or equal to the specified value?	15 in. Hg	Go to Step 4.	Go to Step 6
4	1. Disconnect wastegate solenoid electrical connector with engine running. 2. With the vacuum gauge still in place, observe the vacuum at idle. Is the vacuum greater than the specified value?	1 in. Hg	Go to Step 7	Go to Step 12
5	1. Turn the engine OFF. 2. Connect a hand held vacuum pump to the turbocharger wastegate actuator. 3. Apply 5 in. Hg of vacuum. Does the turbocharger wastegate actuator hold vacuum?	—	Go to Step 7	Go to Step 12
6	1. Check all vacuum lines from vacuum pump to turbocharger wastegate actuator: • leaks • deformities • pinches 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to Step 13	Go to Step 9
7	1. Verify the engine if OFF. 2. Disconnect all vacuum lines to the wastegate actuator. 3. Grip the wastegate actuator rod with a pair of pliers. 4. Attempt to move the wastegate actuator rod back and forth. Does the turbocharger wastegate actuator rod move freely?	—	Go to Step 8	Go to Step 12
8	DTC is intermittent. If no additional DTCs are stored, refer to diagnostic Aids. Are any additional DTCs stored?	—	Go to the DTC table.	Go to Diag-nostic Aids
9	Check the vacuum pump for proper output (refer to Engine MEchanical). Is the action complete?	—	Go to STep 13.	
10	Check for a plugged wastegate solenoid filter. Repair as necessary. Is the wastegate solenoid filter plugged?	—	Go to Step 13	Go to Step 11
11	Replace the wastegate solenoid. Is the action complete?	—	Go to Step 13	—
12	Replace the turbocharger wastegate actuator. Is the action complete?	—	Go Step 13	—
13	1. Using the Scan Tool, select DTC, clear info. 2. Start engine and idle at normal operating temperature. 3. Select DTC, Specific, then enter the DTC number which was set. 4. Operate the vehicle until the Scan Tool indicates that the diagnostic RAN. Does the Scan Tool indicate that this diagnostic Passed?	—	Go to Step 14	Go to Step 2
14	Using the Scan Tool, select Capture Info, Review Info. Are any DTCs displayed that have not been diagnosed?	—	Go to the DTC TAble	System OK

DTC P0237 Turbocharger (TC) Boost Sensor Circuit Low Voltage



Circuit Description

The PCM sends a 5 volt reference signal to the boost sensor. As manifold pressure changes, the electrical resistance of the boost sensor also changes. By monitoring the sensor output voltage, the PCM detects how much pressure is being produced by the turbocharger in the intake manifold. The PCM uses the boost sensor to control turbo boost and fuel at different loads. This is a type B DTC.

Conditions for Setting the DTC

- Boost pressure less than 40 kPa.
- Conditions met for 2 seconds.

Action Taken When the DTC Sets

No turbo boost.

Conditions for Clearing the MIL/DTC

- The PCM will turn the MIL off after three consecutive trips without a fault condition.
- A History DTC will clear when forty consecutive warm-up cycles that the diagnostic does not fail (coolant temperature has risen 5°C (40°F) from start up coolant temperature and engine coolant temperature exceeds 71°C (160°F) that same ignition cycle).
- Use of a Scan Tool.

Diagnostic Aids

With the ignition "ON" and the engine stopped, boost pressure is equal to atmospheric pressure. Comparison of this reading with known good vehicle using the same sensor is a good way to check accuracy of a "suspect" sensor. Readings should be the same +.4 volt. Very little boost can be attained by revving the engine in neutral. If the Boost sensor signal circuit is open or shorted to ground, Boost solenoid will show a zero duty cycle. A J 39200 can be used to measure (actual) signal voltage at the PCM harness connector.

Test Description

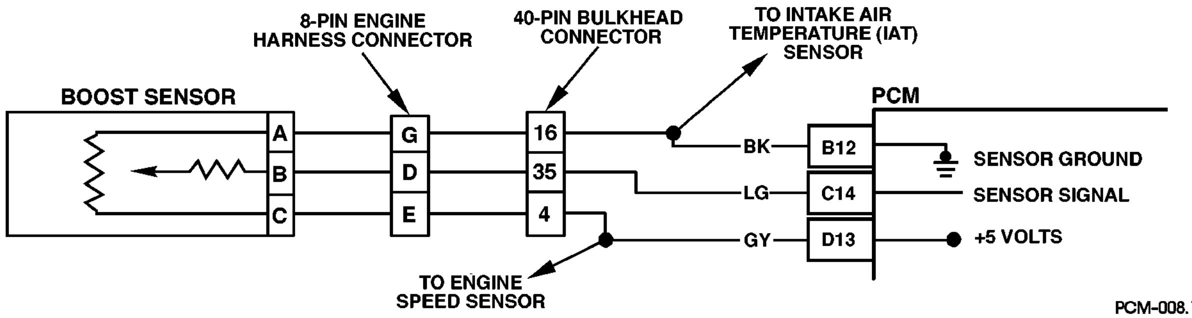
Number(s) below refer to the number(s) on the diagnostic table.

2. This step will determine if DTC P0237 is the result of a hard failure or an intermittent condition.
3. This step simulates conditions for a DTC P0237. If the PCM recognizes the change, the PCM and signal circuit are OK.

DTC P0237 - Turbocharger (TC) Boost Sensor Circuit Low Voltage

Step	Action	Value(s)	Yes	No
1	**Important:** Before clearing DTC(s) use the scan tool "Capture Info" to record freeze frame and failure records for reference, as data will be lost when "Clear Info" function is used. Was the *"On-Board Diagnostic (OBD) System Check"* performed?	—	Go to Step 2.	Go to *OBD System Check.*
2	1. Scan tool connected. 2. Engine idling. 3. With J 39200 connected to ground, probe PCM harness connector Boost signal circuit. Does the J 39200 display a voltage less than the specified value?	1.0v (40 kPa)	Go to Step 3.	Go to Step 5.
3	1. Turn the ignition "OFF". 2. Disconnect the Boost sensor electrical connector. 3. Jumper the Boost sensor 5 volt reference to the Boost sensor signal circuit at the harness. 4. Turn the ignition "ON". Does the scan tool display a Pressure greater than specified value?	202 kPa	Go to Step 6.	Go to Step 4.
4	1. Turn the ignition "OFF". 2. Boost sensor still disconnected. 3. Remove the jumper wire. 4. Jumper the Boost sensor signal circuit at the harness with a test light connected to B+. 5. Turn the ignition "ON". Does the scan tool display a Pressure greater than specified value?	202 kPa (4.0v)	Go to Step 8.	Go to Step 7.
5	DTC is intermittent. Are additional DTCs stored?	—	Go to DTC table.	See Diagnostic Aids
6	Check for a faulty connection at the Boost sensor. Was a problem found?	—	Go to Step 13.	Go to Step 10.
7	Check for an open or short to ground in Boost sensor signal circuit. Was a problem found?	—	Go to Step 13.	Go to Step 11.
8	Check for an open in the Boost sensor 5 volt reference circuit. Was a problem found?	—	Go to Step 13.	Go to Step 9.
9	Check for a short to ground in Boost sensor 5 volt reference circuit. Was a problem found?	—	Go to Step 13.	Go to Step 12.
10	Replace the faulty Boost sensor. Is the action complete?	—	Go to Step 13.	—
11	Check the terminal connectors at the PCM for a poor connections and repair if necessary. Was a problem found?	—	Go to Step 13.	Go to Step 12.
12	Replace the faulty PCM. ***Notice:*** If the PCM is faulty, the new PCM must be programmed. Go to *PCM replacement and programming procedures.* Is the action complete?	—	Go to Step 13.	—
13	1. Using the Scan Tool, select "DTC", "Clear Info". 2. Start engine and idle at normal operating temperature. 3. Select "DTC", "Specific", then enter the DTC number which was set. 4. Operate vehicle within the conditions for setting this DTC as specified in the supporting text. Does the Scan Tool indicate that this diagnostic Ran and Passed?	—	Go to Step 14.	Go to Step 2.
14	Using the Scan Tool, select "Capture Info", "Review Info". Are any DTCs displayed that have not been diagnosed?	—	Go to the DTC table	System OK.

DTC P0238 Turbocharger (TC) Boost Sensor Circuit High Voltage



Circuit Description

The PCM sends a 5 volt reference signal to the boost sensor. As manifold pressure changes, the electrical resistance of the boost sensor also changes. By monitoring the sensor output voltage, the PCM detects how much pressure is being produced by the turbocharger in the intake manifold. The PCM uses the boost sensor to control turbo boost and fuel at different loads. This is a type B DTC.

Conditions for Setting the DTC

- Boost Pressure greater than or equal to 4.8 volts (202 kPa).
- Engine Speed less than 3506 RPM.

Action Taken When the DTC Sets

No turbo boost.

Conditions for Clearing the MIL/DTC

- The PCM will turn the MIL off after three consecutive trips without a fault condition.
- A History DTC will clear when forty consecutive warm-up cycles that the diagnostic does not fail (coolant temperature has risen 5°C (40°F) from start up coolant temperature and engine coolant temperature exceeds 71°C (160°F) that same ignition cycle).
- Use of a Scan Tool.

Diagnostic Aids

With the ignition “ON” and the engine stopped, boost pressure is approximately equal to Baro. Comparison of this reading with known good vehicle using the same sensor is a good way to check accuracy of a “suspect” sensor. Readings should be the same +.4 volt. Very little boost can be attained by revving the engine in neutral. A J 39200 can be used to measure (actual) signal voltage at the PCM harness connector.

Test Description

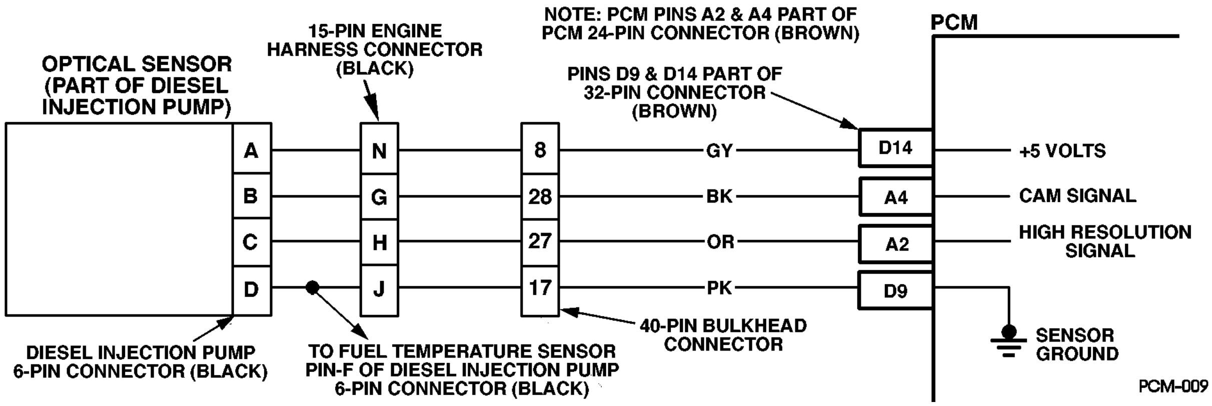
Number(s) below refer to the number(s) on the diagnostic table.

2. This step simulates conditions for a DTC P0237. If the PCM recognizes the change, the PCM and the signal circuit are OK.
3. This step will make sure the PCM is responding to a low signal voltage. This will indicate that the PCM is OK.

DTC P0238 - Turbocharger (TC) Boost Sensor Circuit High Voltage

Step	Action	Value(s)	Yes	No
1	**Important:** Before clearing DTC(s) use the scan tool "Capture Info" to record freeze frame and failure records for reference, as data will be lost when "Clear Info" function is used. Was the *"On-Board Diagnostic (OBD) System Check"* performed?	—	Go to Step 2.	Go to *OBD System Check.*
2	1. Scan tool connected. 2. Engine idling. Does the scan tool display a Boost Pressure greater than or equal to the specified value?	202 kPa (4.8v)	Go to Step 3.	Go to Step 4.
3	1. Turn the ignition "OFF". 2. Disconnect the Boost sensor electrical connector. 3. Turn the ignition "ON". Does the scan tool display a Boost Pressure less than or equal to the specified value?	9 kPa	Go to Step 5.	Go to Step 9.
4	DTC is intermittent. If no additional DTCs are stored, refer to "Diagnostic Aids". If additional DTCs are stored, refer to those chart(s). Are additional DTCs stored?	—	Go to the Applicable DTC table.	Go to Diagnostic Aids.
5	1. Ignition ON, engine OFF> 2. With a J39200 connected to ground, probe the 5 volt reference circuit at the boost sensor harness. Is voltage greater than the specified value?	5.2v	Go to Step 10.	Go to Step 6.
6	1. Boost sensor disconnected. 2. Jumper the Boost sensor ground circuit at the harness with a test light connected to B+. Is the test light "ON".	—	Go to Step 7.	Go to Step 11.
7	Check the Boost sensor for a restriction. Was a problem found.	—	Go to Step 13.	Go to Step 8.
8	Replace the faulty Boost sensor. Is the action complete?	—	Go to Step 13.	—
9	Check for a short to voltage in the Boost sensor signal circuit. Was a problem found?	—	Go to Step 13.	Go to Step 12.
10	Check for a short to ground in the Boost sensor circuit. Was a problem found?	—	Go to Step 13.	Go to Step 12.
11	Repair the Boost sensor circuit as necessary. Is the action complete?	—	Go to Step 13.	—
12	Replace the faulty PCM. ***Notice:*** If the PCM is faulty, the new PCM must be programmed. Go to *PCM replacement and programming procedures.* Is the action complete?	—	Go to Step 13.	—
13	1. Using the Scan Tool, select "DTC", "Clear Info". 2. Start engine and idle at normal operating temperature. 3. Select "DTC", "Specific", then enter the DTC number which was set. 4. Operate vehicle within the conditions for setting this DTC as specified in the supporting text. Does the Scan Tool indicate that this diagnostic Ran and Passed?	—	Go to Step 14.	Go to Step 2.
14	Using the Scan Tool, select "Capture Info", "Review Info". Are any DTCs displayed that have not been diagnosed?	—	Go to the applicable DTC table	System OK.

DTC P0251 Injection Pump Cam System



Circuit Description

The optical sensor provides a pump cam signal to the PCM by counting pulses on the sensor disk located in the injection pump. The pump cam is one of the most important inputs by the PCM for fuel control and timing. This test monitors the number of crankshaft position pulses that have occurred since the last cam pulse. The physical one to one correspondence between the pump cam and the crankshaft implies if more crank pulses are detected than cam pulses, cam pulses have been missed. This is a type A DTC.

Conditions for Setting the DTC

- RPM less than 300.
- 8 consecutive cam pulses missing for 8 #1 cylinder.

or

- RPM greater than or equal to 300.
- 8 consecutive cam pulses missing for 32 #1 cylinder.

Action Taken When the DTC Sets

Backup fuel.

Conditions for Clearing the MIL/DTC

- The PCM will turn the MIL off after three consecutive trips without a fault condition.
- A History DTC will clear when forty consecutive warm-up cycles that the diagnostic does not fail (coolant temperature has risen 5°C (40°F) from start up coolant temperature and engine coolant temperature exceeds 71°C (160°F) that same ignition cycle).
- Use of a Scan Tool (ignition must be cycled before DTC is cleared).

Diagnostic Aids

When PCM is in backup fuel, fast idle and poor performance problems will exist. If P0251 is also stored, there is a possible problem with signal circuit. P0251 and P0370 will set if vehicle has run out of fuel.

Test Description

Number(s) refer to the number(s) on the diagnostic table.

2. This step will determine if this is a hard or intermittent DTC.
4. This step will determine if there is a 5 volt reference.
6. This step will check to see if the sensor is sending a signal back to the PCM.

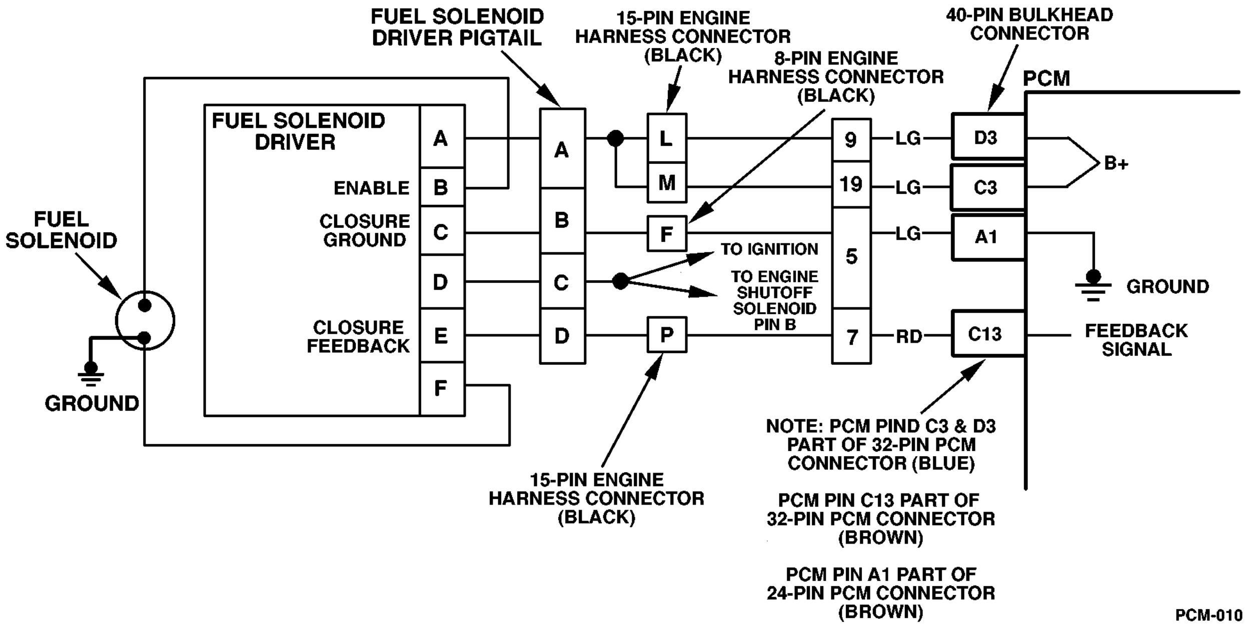
DTC P0251 - Injection Pump Cam System

Step	Action	Value(s)	Yes	No
1	**Important:** Before clearing DTC(s) use the scan tool “Capture Info”. Was the *“On-Board Diagnostic (OBD) System Check”* performed?	—	Go to Step 2.	Go to *OBD System Check.*
2	Start and idle engine. With the throttle closed, observe the Cam Ref Missed display on scan tool. Does scan tool display specified value?	8	Go to Step 4.	Go to Step 3.
3	DTC is intermittent. Are additional DTCs stored?	—	Go to DTC table.	Go to Diagnostic Aids.

DTC P0251 - Injection Pump Cam System

Step	Action	Value(s)	Yes	No
4	1. Ignition “OFF”. 2. Disconnect the Optical/Fuel temperature sensor electrical connector. 3. Ignition “ON” engine “OFF”. 4. Measure voltage between Optical/Sensor 5 volt circuit and chassis ground at harness connector. Is voltage at specified value?	5v	Go to Step 5.	Go to Step 7.
5	Probe the sensor ground circuit with a test light connected to B+ at the harness connector. Is test light “ON”?	—	Go to Step 6.	Go to Step 8.
6	1. Reconnect the Optical/Fuel temperature sensor. 2. Start and idle engine. 3. With scan tool, command 900 rpm. 4. On Hertz (Hz) scale, back probe Cam signal circuit at PCM. Is Hertz reading at specified value?	60 Hz (± 3 Hz)	Go to Step 12.	Go to Step 11.
7	1. Remove electrical harness filter from vehicle. 2. Check resistance on 5 volt reference circuit (terminal “A”). Is resistance greater than specified value?	2.0 Ohms	Go to Step 15.	Go to Step 8.
8	1. Ignition “OFF”. 2. Electrical harness filter removed from vehicle. 3. Disconnect the PCM and check the Optical/Sensor 5 volt circuit for an open, short to ground, or short to the sensor ground circuit. 4. If Optical/Sensor 5 volt circuit is open or shorted to ground, repair it as necessary. Was 5 volt circuit open or shorted to ground?	—	Go to Step 16.	Go to Step 10.
9	1. Check for open or poor sensor ground terminal connection at PCM. 2. If a problem is found, repair as necessary. Was a repair performed?	—	Go to Step 16.	Go to Step 14.
10	Check the Optical/Fuel Temperature 5 volt reference circuit for a poor connection at the PCM and replace terminal if necessary. Did the terminal require replacement?	—	Go to Step 16.	Go to Step 14.
11	1. Ignition “OFF”. 2. Check the Cam signal circuit for an open or short to ground. 3. If Cam signal circuit is open or shorted to ground, repair it. Was the Cam signal circuit open or shorted to ground?	—	Go to Step 16.	Go to Step 13.
12	Check for a poor connection at the PCM harness terminal and replace. Did the terminal require replacement?	—	Go to Step 16.	Go to Step 14.
13	Replace injection pump. Is action complete?	—	Go to Step 16.	—
14	Replace the faulty PCM. ***Notice:*** If the PCM is faulty, the new PCM must be programmed. Is the action complete?	—	Go to Step 16.	—
15	Replace electrical harness filter. Is action complete?	—	Go to Step 16.	—
16	1. Using the Scan Tool, select “DTC”, “Clear Info”. 2. Start engine and idle at normal operating temperature. 3. Select “DTC”, “Specific”, then enter the DTC number which was set. 4. Operate vehicle within the conditions for setting this DTC. Does the Scan Tool indicate that this diagnostic Ran and Passed?	—	Go to Step 17.	Go to Step 2.
17	Using the Scan Tool, select “Capture Info”, “Review Info”. Are any DTCs displayed that have not been diagnosed?	—	Go to DTC table	System OK.

DTC P0263, P0266, P0269, P0272, P0275, P0278, P0281 and P0284 Cylinder Balance System Faults



Circuit Description

The PCM has the ability to increase and decrease the amount of fuel to each cylinder to provide smooth idle operation. If the fuel correction exceeds define limits, DTC P0263 will set. This is a type D DTC.

Conditions for Setting the DTC

- Engine at idle.
- Engine coolant at normal temperatures.
- Cylinder fault must be constant.
- Fuel correction amount exceeds limits (internal to PCM).
- Conditions met for 2 seconds.

Action Taken When the DTC Sets

Possible rough idle.

Conditions for Clearing the MIL/DTC

- A History DTC will clear when forty consecutive warm-up cycles that the diagnostic does not fail (coolant temperature has risen 5°C (40°F) from start up coolant temperature and engine coolant temperature exceeds 71°C (160°F) that same ignition cycle).
- Use of a Scan Tool.

Diagnostic Aids

Injector balance test on scan tool should be used to confirm faulty cylinder. Scan tool will cutout specific cylinder requested. If original complaint was multiple cylinder balance DTCs and vehicle has a manual transmission, dual mass flywheel could be at fault. It's possible that if a cylinder balance fault has been detected and engine has been running for a long time, the PCM will try to increase or decrease fuel in other cylinders to compensate for a rough idle which will cause multiple cylinder balance DTCs to set. The scan tool snap shot mode can be used to properly identify the suspected cylinder. The most likely cause of cylinder balance DTCs are faulty nozzles or engine mechanical (low compression) problems.

Test Description

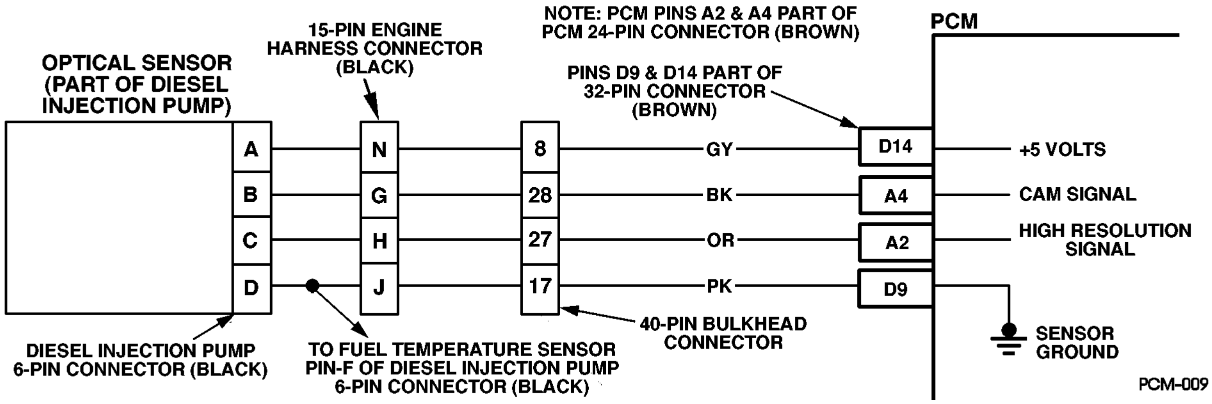
Number(s) below refer to the number(s) on the diagnostic table.

2. This step will properly identify a suspected cylinder by looking for a RPM drop (if RPM drops, cylinder is contributing, if not, cylinder is not contributing).

DTC P0263, P0266, P0269, P0272, P0275, P0278, P0281 and P0284 Cylinder Balance System Faults

Step	Action	Value(s)	Yes	No
1	**Important:** Before clearing DTC(s) use the scan tool "Capture Info" to record freeze frame and failure records for reference, as data will be lost when "Clear Info" function is used. Was the *"On-Board Diagnostic (OBD) System Check"* performed?	—	Go to Step 2.	Go to *OBD System Check.*
2	1. Scan tool connected. 2. Start and idle engine. 3. Engine at operating temperature. 4. Make sure all DTCs are cleared. 5. Using the scan tool, cutout ("Inj. Balance") the suspected cylinder. Is there an RPM drop in the suspected cylinder?	—	Go to Step 3.	Go to Step 4.
3	DTC is intermittent. If no additional DTCs are stored, refer to "Diagnostic Aids". If additional DTCs are stored, refer to those table(s). Are additional DTCs stored?	—	Go to the applicable DTC table.	Go to Diagnostic Aids.
4	Check for a basic engine mechanical or fuel delivery problem in that cylinder. Was a repair performed?	—	Go to Step 6.	Go to Step 5.
5	Replace the fuel injection pump. Refer to *Fuel Injection Pump*. Is the action complete?	—	Go to Step 6.	—
6	1. Using the Scan Tool, select "DTC", "Clear Info". 2. Start engine and idle at normal operating temperature. 3. Select "DTC", "Specific", then enter the DTC number which was set. 4. Operate vehicle within the conditions for setting this DTC as specified in the supporting text. Does the Scan Tool indicate that this diagnostic Ran and Passed?	—	Go to Step 7.	Go to Step 2.
7	Using the Scan Tool, select "Capture Info", "Review Info". Are any DTCs displayed that have not been diagnosed?	—	Go to the applicable DTC table	System OK.

DTC P0335 Crankshaft Position (CKP) Sensor Circuit Performance



Circuit Description

The crankshaft position sensor is a "Hall-effect" type sensor that monitors crankshaft position and speed. There are four teeth 90 degrees apart on the front of the crankshaft sprocket that induce a pulse in the sensor which is transmitted to the PCM. There is a physical one to one correspondence between the pump cam and crankshaft. This is a type A DTC.

Conditions for Setting the DTC

- RPM less than 300.
- 8 consecutive cam pulses missing for 8 #1 cylinder events.

or

- RPM greater than or equal to 300.
- 8 consecutive cam pulses missing for 32 #1 cylinder events.

Action Taken When the DTC Sets

Backup fuel.

Conditions for Clearing the MIL/DTC

- The PCM will turn the MIL off after three consecutive trips without a fault condition.
- A History DTC will clear when forty consecutive warm-up cycles that the diagnostic does not fail (coolant temperature has risen 5°C (40°F) from start up coolant temperature and engine coolant temperature exceeds 71°C (160°F) that same ignition cycle).
- Use of a Scan Tool.

Diagnostic Aids

When PCM is in backup fuel, long crank times, fast idle and poor performance conditions will exist. Check for good connection at crankshaft position sensor and at PCM. Many intermittent problems are caused by faulty electrical connections or wiring. When attempting to diagnose an intermittent problem, always begin by trying to reproduce the conditions under which the failure occurs. This usually involves raising the engine to a higher temperature or operating it near RPM that the problem occurs. Since heat and vibration are often the cause of intermittent, this may bring out the failure.

Test Description

Number(s) below refer to the number(s) on the diagnostic table.

2. This step will determine if DTC P0335 is the result of a hard failure or an intermittent condition.
4. This step checks the 5 volt reference circuit (the 5 volt reference may vary slightly).
5. This step checks the ground circuit.

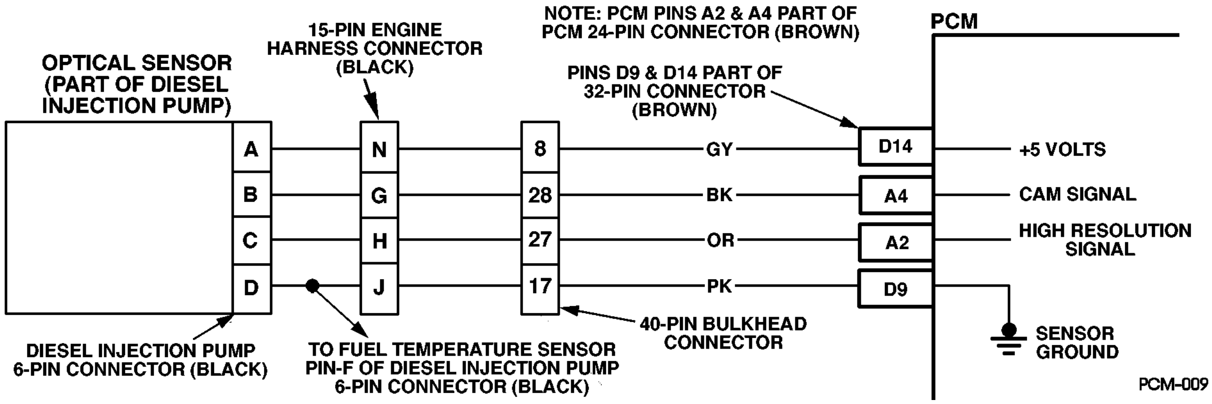
DTC P0335 - Crankshaft Position Sensor Circuit Performance

Step	Action	Value(s)	Yes	No
1	**Important:** Before clearing DTC(s) use the scan tool "Capture Info". Was the *"On-Board Diagnostic (OBD) System Check"* performed?	—	Go to Step 2.	Go to *OBD System Check.*
2	Start and idle engine. With throttle closed, observe "Crank Ref. Missed" display on scan tool. Does scan tool display specified value?	8	Go to Step 4.	Go to Step 3.

DTC P0335 - Crankshaft Position Sensor Circuit Performance

Step	Action	Value(s)	Yes	No
3	DTC is intermittent. If no additional DTCs are stored, refer to “Diagnostic Aids”. If additional DTCs are stored, refer those table(s). Are additional DTCs stored?	—	Go to the applicable DTC table.	Go to Diagnostic Aids.
4	Ignition “OFF”. Disconnect the Optical/Fuel temperature sensor electrical connector. Ignition “ON" engine “OFF”. Using a DVM (J 39200), measure voltage between the Optical/Fuel temperature 5 volt reference circuit and chassis ground. Is voltage at specified value?	4.8 - 5.2v	Go to Step 5.	Go to Step 7.
5	Probe sensor ground circuit with test light connected to B+. Is test light “ON”?	—	Go to Step 6.	Go to Step 8.
6	Reconnect the Optical/Fuel temperature sensor. Back probe the Optical/Fuel temperature sensor signal circuit at the PCM with a DVM (J 39200) connected to ground. Crank engine. Is voltage at the specified value?	4v	Go to Step 11.	Go to Step 10.
7	Ignition “OFF”. Disconnect PCM and check Optical/Fuel Temp. 5 volt reference circuit for open, short to ground, or short to sensor ground circuit. If the Optical/Fuel temperature 5 volt reference circuit is open or shorted to ground, repair as necessary. Was the circuit open or shorted to ground?	—	Go to Step 14.	Go to Step 9.
8	Check for open or poor sensor ground terminal conn. at PCM. If a problem is found, repair it. Was a repair performed?	—	Go to Step 14.	Go to Step 13.
9	Check the Optical/Fuel temperature 5 volt reference circuit for a poor connection at PCM and replace terminal if necessary. Did the terminal require replacement?	—	Go to Step 14.	Go to Step 13.
10	Ignition “OFF”. Disconnect PCM and check Optical/Fuel temperature signal circuit for open, short to ground, or short to sensor ground circuit. If the Optical/Fuel temperature signal circuit is open or shorted to ground, repair it. Was the Optical/Fuel temperature signal circuit open or shorted to ground?	—	Go to Step 14.	Go to Step 11.
11	Check the Optical/Fuel temperature signal circuit for a poor connection at the PCM and replace terminal if necessary. Did the terminal require replacement?	—	Go to Step 14.	Go to Step 12.
12	Replace the Crankshaft position sensor. After replacing the sensor, the PCM must be programmed with a new TDC OFFset. *Refer to the Service Manual for more information on the Crankshaft Position Sensor or reprogramming the PCM.* Is the action complete?	—	Go to Step 14.	—
13	Replace the faulty PCM. ***Notice:*** If the PCM is faulty, the new PCM must be programmed. Is the action complete?	—	Go to Step 14.	—
14	Using the Scan Tool, select “DTC”, “Clear Info”. Start engine and idle at normal operating temperature. Select “DTC”, “Specific”, then enter the DTC number which was set. Operate vehicle within the conditions for setting this DTC. Does the Scan Tool indicate that this diagnostic Ran and Passed?	—	Go to Step 15.	Go to Step 2.
15	Using the Scan Tool, select “Capture Info”, “Review Info”. Are any DTCs displayed that have not been diagnosed?	—	Go to the DTC table	System OK.

DTC P0370 Timing Reference High Resolution



Circuit Description

The optical sensor provides a high resolution signal to the PCM by counting pulses on the sensor disk located in the injection pump. The high resolution is one of the most important inputs by the PCM for fuel control and timing. This test monitors the number of high resolution pulses which have been missed (not detected). It’s based on a comparison between the number of pulses that were detected since the last pump cam pulse and the number of the pulses that should have occurred. This is a type A DTC.

Conditions for Setting the DTC

A number of High Resolution pulses (internal to PCM) per every 8 cam reference pulses.

Action Taken When the DTC Sets

Backup fuel.

Conditions for Clearing the MIL/DTC

- The PCM will turn the MIL off after three consecutive trips without a fault condition.
- A History DTC will clear when forty consecutive warm-up cycles that the diagnostic does not fail (coolant temperature has risen 5°C (40°F) from start up coolant temperature and engine coolant temperature exceeds 71°C (160°F) that same ignition cycle).
- Use of a Scan Tool.

Diagnostic Aids

When PCM is in backup fuel, fast idle and poor performance problems will exist. If P0251 is also stored, the snap shot mode on the scan tool should be used to properly identify fault. It is possible P0370 may set if there is air in fuel system (vehicle running out of fuel).

Test Description

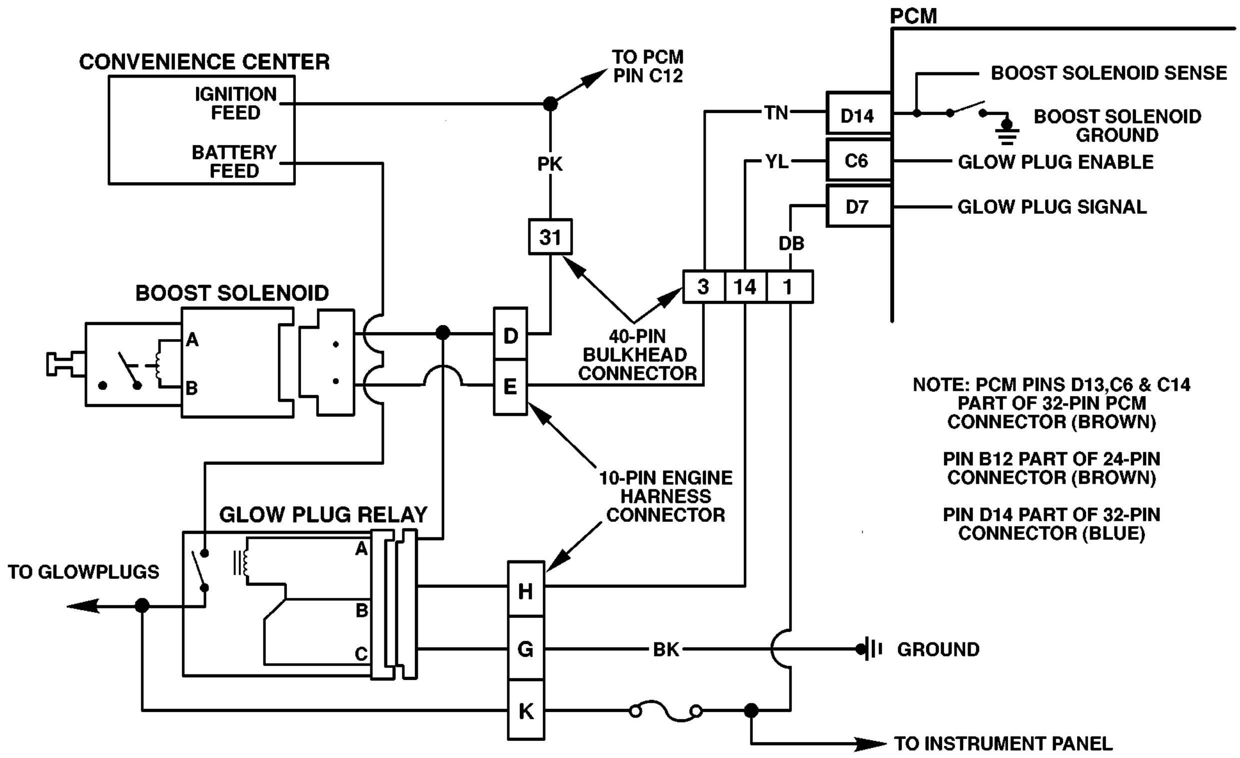
Number(s) below refer to the number(s) on the diagnostic table.

2. This step will determine if there is a 5 volt reference.
3. This step checks the ground circuit.
4. This step will check to see if the sensor is sending a signal back to the PCM.

DTC P0370 - Timing Reference High Resolution

Step	Action	Value(s)	Yes	No
1	**Important:** Before clearing DTC(s) use the scan tool “Capture Info”. Was the *“On-Board Diagnostic (OBD) System Check”* performed?	—	Go to Step 2.	Go to *OBD System Check.*
2	1. Ignition “OFF”. 2. Disconnect the Optical/Fuel temperature sensor electrical connector. 3. Ignition “ON” engine “OFF”. 4. Using a J 39200, measure voltage between the Optical/Fuel temperature 5 volt reference circuit and chassis ground at harness connector. Is voltage at the specified value?	.24 v	Go to Step 3.	Go to Step 5.
3	1. Ignition “OFF”. 2. Disconnect EGR Control Pressure/BARO sensor electrical connector. 3. Jumper the sensor 5 volt reference circuit to the sensor signal circuit at the harness connector. 4. Ignition “ON”. Does the scan tool display Actual EGR greater than the specified value?	4.0 v	Go to Step 6.	Go to Step 4.
4	1. Ignition “OFF”. 2. Remove the jumper wire. 3. Probe the sensor signal circuit with a test light connected to B+ at the harness connector. 4. Ignition “ON”. Does the scan tool display Actual EGR greater than the specified value?	4.0 v	Go to Step 9.	Go to Step 7.
5	DTC is intermittent. If no additional DTCs are stored, refer to “Diagnostic Aids”. If additional DTCs are stored, refer those charts(s) first.	—	—	—
6	Check for a faulty connection at the EGR sensor. Was a problem found?	—	Go to Step 12.	Go to Step 11.
7	Check for an open EGR sensor signal circuit. Was a problem found?	—	Go to Step 12.	Go to Step 8.
8	Check the EGR sensor signal circuit for a short to ground. Was a problem found?	—	Go to Step 12.	Go to Step 13.
9	Check for an open in the EGR sensor 5 volt reference circuit. Was a problem found?	—	Go to Step 12.	Go to Step 10.
10	Check for a short to ground in the EGR sensor 5 volt reference circuit. Was a problem found?	—	Go to Step 12.	Go to Step 13.
11	Replace the faulty EGR sensor. Is action complete?	—	Go to Step 14.	—
12	Repair the circuit as necessary. Is action complete?	—	Go to Step 14.	—
13	Replace the faulty PCM. Is the action complete?	—	Go to Step 14.	—
14	1. Using the Scan Tool, select “DTC”, “Clear Info”. 2. Start engine and idle at normal operating temperature. 3. Select “DTC”, “Specific”, then enter the DTC number which was set. 4. Operate vehicle within the conditions for setting this DTC. Does the Scan Tool indicate that this diagnostic Ran and Passed?	—	Go to Step 15.	Go to Step 2.
15	Using the Scan Tool, select “Capture Info”, “Review Info”. Are any DTCs displayed that have not been diagnosed?	—	Go to the DTC table	System OK.

DTC P0380 Glow Plug Circuit Performance



PCM-008.2

Circuit Description

The glow plug system is used to assist in providing the heat required to begin combustion during engine starting at cold ambient temperatures. The glow plugs are heated before and during cranking, as well as initial engine operation. The PCM controls the glow plug "ON" times by monitoring coolant temperatures and glow plug voltage. This is a type B code.

Conditions for Setting the DTC

- PCM has commanded glow plugs "ON" and voltage at the glow plugs is less than .8 volts.
- PCM has commanded glow plugs "OFF" and voltage at the glow plugs is less than .8 volts.
- PCM has commanded glow plugs "ON" and there is more than a 2 volt difference between glow plug voltage and ignition voltage.

Action Taken When the DTC Sets

Hard start or no start and possible white smoke.

Conditions for Clearing the MIL/DTC

- The PCM will turn the MIL off after three consecutive trips without a fault condition.
- A History DTC will clear when forty consecutive warm-up cycles that the diagnostic does not fail (coolant temperature has risen 5°C (40°F) from start up coolant temperature and engine coolant temperature exceeds 71°C (160°F) that same ignition cycle).
- Use of a Scan Tool.

Diagnostic Aids

If glow plug relay is stuck in the "ON" position, check for proper operation of glow plugs. When glow plugs are commanded "ON" by the Tech 1, an internal PCM timer protects the glow plugs from damage by cycling them "ON" for 3 seconds and the "OFF" for 12 seconds.

Test Description

Number(s) below refer to the number(s) on the diagnostic table.

2. This step will determine if P0380 is a hard failure.
3. This step will determine if PCM is requesting the glow plug system "ON".
7. This step will determine if the glow plug relay has been activated, and output voltage has been seen by the PCM.

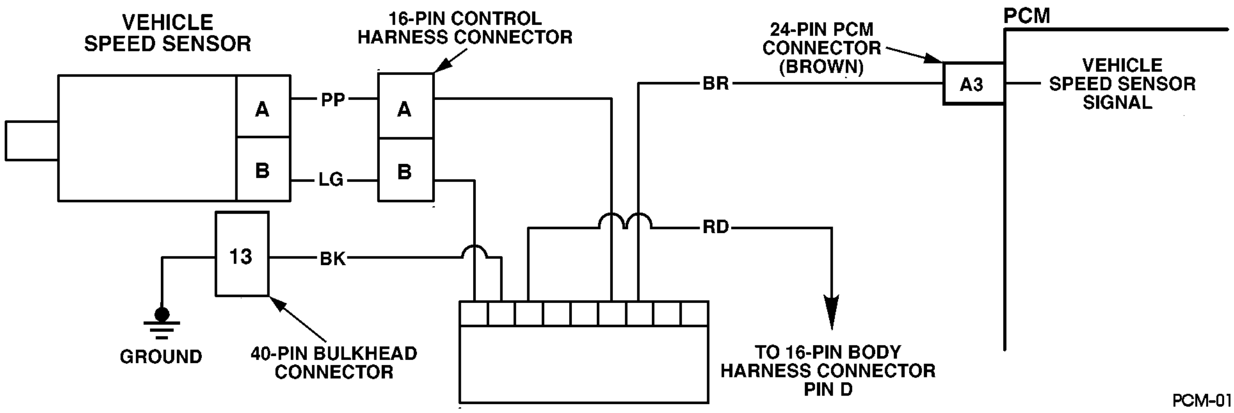
DTC P0380 - Glow Plug Circuit Performance

Step	Action	Value(s)	Yes	No
1	**Important:** Before clearing DTC(s) use the scan tool "Capture Info". Was the *"On-Board Diagnostic (OBD) System Check"* performed?	—	Go to Step 2.	Go to *OBD System Check.*

DTC P0380 - Glow Plug Circuit Performance

Step	Action	Value(s)	Yes	No
2	1. Scan tool installed. 2. Ignition “ON” engine “OFF”. 3. With scan tool command glow plugs “ON”. 4. Observe “Glow Plug System” on scan tool display. Does scan tool display “Glow Plug System” enabled?	—	Go to Step 3.	Go to Step 7.
3	1. Ignition “ON” engine “OFF”. 2. With scan tool command glow plugs “ON”. 3. Observe “Glow Plugs” display on scan tool display. Does scan tool display “Glow Plugs” at specified value?	B+ (+/- 2.0v)	Go to Step 4.	Go to Step 5.
4	DTC is intermittent. If no additional DTCs are stored, refer to “Diagnostic Aids”. If additional DTCs are stored, refer those table(s). Are additional DTCs stored?	—	Go to the applicable DTC table.	Go to Diagnostic Aids.
5	1. Disconnect glow plug relay connector. 2. Ignition “ON” engine “OFF”. 3. With test light connected to ground, probe glow plug relay harness ignition feed circuit. Is test light “ON”?	—	Go to Step 6.	Go to Step 10.
6	1. Ignition “ON” engine “OFF”. 2. Connect test light between glow plug harness ignition feed circuit and harness ground circuit. Is test light “ON”?	—	Go to Step 7.	Go to Step 11.
7	1. Ignition “ON” engine “OFF”. 2. Glow plug harness still disconnected. 3. With a J 39200 connected to ground, probe glow plug relay control circuit at the glow plug harness connector. 4. With scan tool, command glow plugs “ON”. Is voltage at specified value?	B+	Go to Step 8.	Go to Step 12.
8	1. Reconnect glow plug relay. 2. Ignition “ON” engine “OFF”. 3. With test light connected to ground, probe glow plug side of relay. 4. With scan tool, command glow plugs “ON”. Is test light “ON” when scan tool commands glow plugs “ON”?	—	Go to Step 14.	Go to Step 16.
9	Check glow plug relay control circuit for a poor connection at the PCM and replace terminal if necessary. Did any terminals require replacement?	—	Go to Step 18.	—
10	Repair open or short to ground in glow plug relay ignition feed circuit. Is the action complete?	—	Go to Step 18.	—
11	Repair open or poor connections in glow plug relay ground circuit. Is the action complete?	—	Go to Step 18.	—
12	1. Check glow plug relay control circuit for an open or short to ground. 2. If the glow plug relay control circuit is open or shorted to ground, repair as necessary. Was a problem found?	—	Go to Step 18.	Go to Step 13.
13	Check glow plug relay control circuit for a poor connection at the PCM and replace terminal if necessary. Was a problem found?	—	Go to Step 18.	Go to Step 17.
14	1. Check glow plug relay signal control circuit for an open or short to ground. 2. If the glow plug relay signal circuit is open or shorted to ground, repair as necessary. Was a problem found?	—	Go to Step 18.	Go to Step 15.
15	Check glow plug relay control circuit for a poor connection at the PCM and replace terminal if necessary. Was a problem found?	—	Go to Step 18.	—
16	Replace glow plug relay. Is the action complete?	—	Go to Step 18.	—
17	Replace the faulty PCM. ***Notice:*** If the PCM is faulty, the new PCM must be programmed. Go to *PCM replacement and programming procedures.* Is the action complete?	—	Go to Step 18.	—
18	1. Using the Scan Tool, select “DTC”, “Clear Info”. 2. Start engine and idle at normal operating temperature. 3. Select “DTC”, “Specific”, then enter the DTC number which was set. 4. Operate vehicle within the conditions for Setting this DTC. Does the Scan Tool indicate that this diagnostic Ran and Passed?	—	Go to Step 19.	Go to Step 2.
19	Using the Scan Tool, select “Capture Info”, “Review Info”. Are any DTCs displayed that have not been diagnosed?	—	Go to the applicable DTC table	System OK.

DTC P0501 Vehicle Speed Sensor Circuit



Circuit Description

The speed sensor circuit consists of a magnetic induction type sensor, a vehicle speed sensor buffer module and wiring. Gear teeth pressed on the output shaft induce an alternating current in the sensor. This signal is transmitted to the buffer. The buffer compensates for various axle ratios and converts the signal into a square wave for use by the speedometer, cruise control, antilock brake and the PCM. The buffer sends two different signals to the PCM. The CKT 437 circuit relays the transmission output speed which is used to control shift points, line pressure, TCC, DTC P0723 and DTC P0723. The CKT 834 circuit relays the vehicle speed which is used to control engine operating functions and DTC P0501. When DTC P0501 or P0723 is set, second gear only at a maximum line pressure will occur. This is a type D DTC.

Conditions for Setting the DTC

- Vehicle speed greater than 20 mph.
- Four wheel low not selected.
- VSS buffer calculated speed is less than half the transmission calculated speed.

or

- VSS buffer calculated speed is greater than transmission calculated speed by 20 mph.
- All conditions met for 2 seconds.

Action Taken When the DTC Sets

No cruise control.

Conditions for Clearing the MIL/DTC

- A History DTC will clear when forty consecutive warm-up cycles that the diagnostic does not fail (coolant temperature has risen 5°C (40°F) from start up coolant temperature and engine coolant temperature exceeds 71°C (160°F) that same ignition cycle).
- Use of a scan.

Diagnostic Aids

Check connections at VSS buffer and PCM. Refer to 4L80EDiagnostic Diagnostic Trouble Codes, Section 10 if DTC P0722 or DTC P0723 is also set.

Test Description

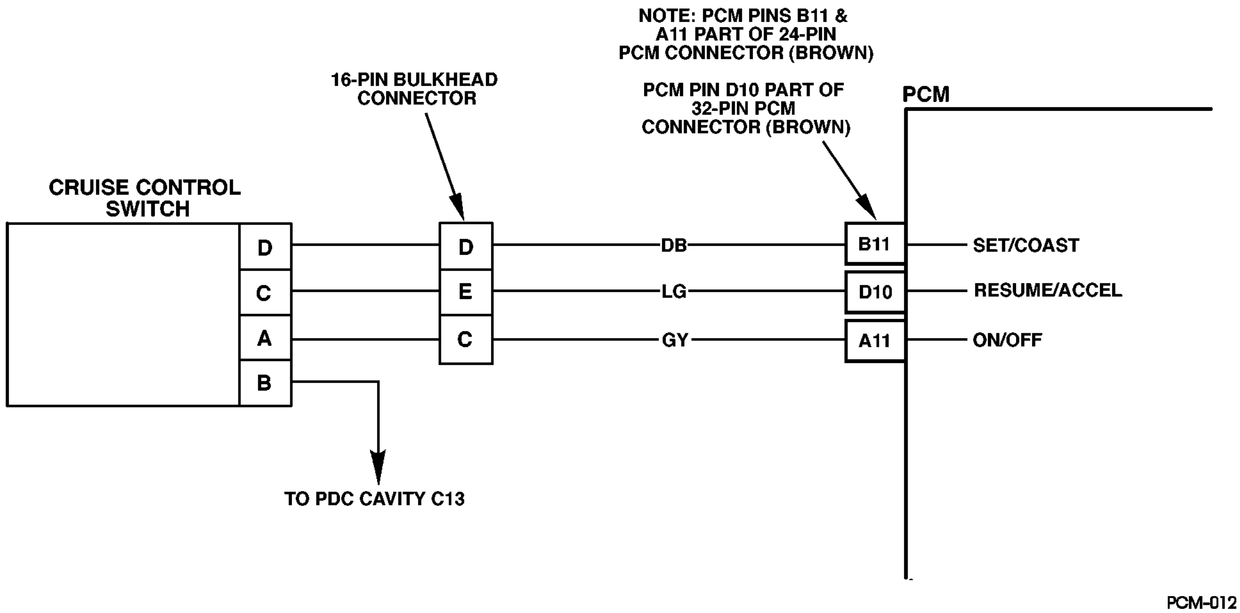
Number(s) below refer to the number(s) on the diagnostic table.

3. This tests for B+ at VSS buffer.
4. This tests for proper ground path for vehicle speed sensor signal buffer.

DTC P0501 - Vehicle Speed Sensor Circuit

Step	Action	Value(s)	Yes	No
1	**Important:** Before clearing DTC(s) use the scan tool "Capture Info" to record freeze frame and failure records for reference, as data will be lost when "Clear Info" function is used. Was the *"On-Board Diagnostic (OBD) System Check"* performed?	—	Go to Step 2.	Go to *OBD System Check.*
2	1. Install scan tool. 2. Raise drive wheels. 3. Engine operating. 4. Transmission in any drive range. With drive wheels rotating, does vehicle speed increase with drive wheel speed increase?	—	Go to Step 7.	Go to Step 3.
3	1. Transmission in park. 2. Back probe VSS buffer module ignition feed circuit with a test light connected to ground. Is the test light "ON"?	—	Go to Step 4.	Go to Step 8.
4	Back probe VSS buffer module ignition feed circuit to the ground circuit with a test light. Is the test light "ON"?	—	Go to Step 5.	Go to Step 9.
5	1. Back probe VSS buffer module at VSS input circuit (C7) to the other VSS input circuit (C12) with a J 39200 on the AC scale. 2. Transmission in any drive range with drive wheels rotating. Does voltage increase on J 39200 with drive wheel increase?	—	Go to Step 6.	Go to Step 10.
6	Does scan tool display a trans output speed (MPH) increase with drive wheel increase?	—	Go to Step 11.	Go to Step 13.
7	DTC is intermittent. If no additional DTCs are stored, refer to "Diagnostic Aids". If additional DTCs are stored, refer those charts(s) first. Are additional DTCs stored?	—	Go to applicable DTC table.	Go to *Diagnostic Aids*
8	Repair the open in the ignition feed circuit. Is action complete?	—	Go to Step 15.	—
9	Repair the open in the ground circuit. Is action complete?	—	Go to Step 15.	—
10	Check the complete VSS input circuit for an open or short to ground. Was a repair performed?	—	Go to Step 15.	—
11	Check VSS output circuit for an open or short to ground. Was a repair performed?	—	Go to Step 15.	Go to Step 12.
12	Check VSS output circuit for a poor connection at buffer module and PCM. Was a repair performed?	—	Go to Step 15.	Go to Step 14.
13	Replace VSS buffer module. Is action complete?	—	Go to Step 15.	—
14	Replace the faulty PCM. ***Notice:*** If the PCM is faulty, the new PCM must be programmed. Go to *PCM replacement and programming procedures.* Is the action complete?	—	Go to Step 15.	—
15	1. Using the Scan Tool, select "DTC", "Clear Info". 2. Start engine and idle at normal operating temperature. 3. Select "DTC", "Specific", then enter the DTC number which was set. 4. Operate vehicle within the conditions for setting this DTC as specified in the supporting text. Does the Scan Tool indicate that this diagnostic Ran and Passed?	—	Go to Step 16.	Go to Step 2.
16	Using the Scan Tool, select "Capture Info", "Review Info". Are any DTCs displayed that have not been diagnosed?	—	Go to the DTC table	System OK.

DTC P0567 Cruise Resume Circuit



Circuit Description

The cruise Resume/Accel switch is an input to the fuel control portion of the PCM. These inputs allow the PCM to control and hold a requested speed. Cruise Resume/Accel switch sends ignition voltage to the PCM when the switch is closed (“ON”). This is a type D DTC.

Conditions for Setting the DTC

- Cruise switch “OFF”.
- Ignition voltage on Resume switch signal circuit.

or

- Cruise switch “ON”.
- Resume switch “ON” for longer than 25.5 seconds

Action Taken When the DTC Sets

- Will not turn on the MIL.
- The PCM will disallow all cruise inputs.
- TCC shift schedules may be affected.

Conditions for Clearing the MIL/DTC

- A History DTC will clear when forty consecutive warm-up cycles that the diagnostic does not fail (coolant temperature has risen 5°C (40°F) from start up coolant temperature and engine coolant temperature exceeds 71°C (160°F) that same ignition cycle).
- Use of a Scan Tool.

Diagnostic Aids

Check for a resume/accel switch stuck in the engage position or the signal circuit is shorted to voltage.

Test Description

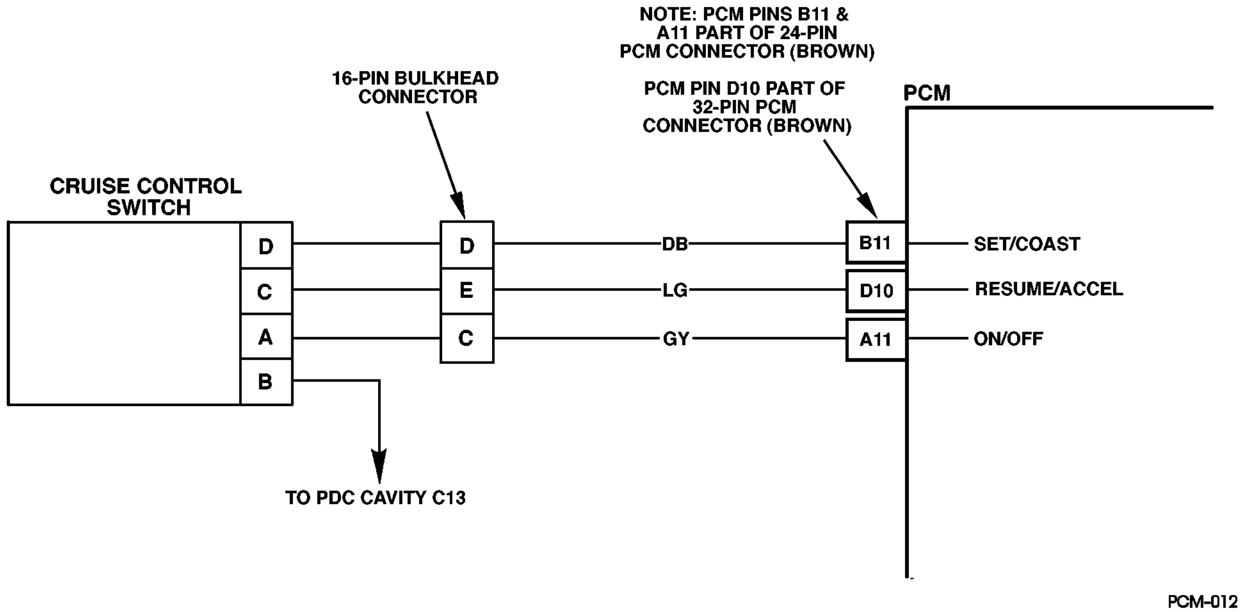
Number(s) below refer to the number(s) on the diagnostic table.

2. This step determines if the signal circuit is shorted to voltage.
3. This step determines if the PCM or switch is at fault.

DTC P0567 - Cruise Resume Circuit

Step	Action	Value(s)	Yes	No
1	**Important:** Before clearing DTC(s) use the scan tool “Capture Info” to record freeze frame and failure records for reference, as data will be lost when “Clear Info” function is used. Was the *“On-Board Diagnostic (OBD) System Check”* performed?	—	Go to Step 2.	Go to *OBD System Check.*
2	1. Scan tool connected. 2. Ignition “ON”, engine “OFF”. 3. Cruise switch “OFF”. Does scan tool display Resume Switch “ON”?	—	Go to Step 3.	Go to Step 4.
3	1. Ignition “ON”. 2. Disconnect the PCM brown 32 way connector. 3. Probe the Resume switch signal circuit at the PCM harness with a test light connected to chassis ground. Is the test light “ON”?	—	Go to Step 5.	Go to Step 7.
4	DTC is intermittent. If no additional DTCs are stored, refer to “Diagnostic Aids”. If additional DTCs are stored, refer to those charts(s) first. Are additional DTCs stored?	—	Go to the applicable DTC table	Go to Diagnostic Aids.
5	1. Resume switch signal circuit is shorted to voltage. 2. Repair as necessary. Is action complete?	—	Go to Step 8.	—
6	Replace the faulty PCM. ***Notice:*** If the PCM is faulty, the new PCM must be programmed. Go to *PCM replacement and programming procedures.* Is the action complete?	—	Go to Step 7.	—
7	1. Using the Scan Tool, select “DTC”, “Clear Info”. 2. Start engine and idle at normal operating temperature. 3. Select “DTC”, “Specific”, then enter the DTC number which was set. 4. Operate vehicle within the conditions for setting this DTC as specified in the supporting text. Does the Scan Tool indicate that this diagnostic Ran and Passed?	—	Go to Step 8.	Go to Step 2.
8	Using the Scan Tool, select “Capture Info”, “Review Info”. Are any DTCs displayed that have not been diagnosed?	—	Go to the applicable DTC table	System OK.

DTC P0568 Cruise Set Circuit



Circuit Description

The cruise Set/Coast switch is an input to the fuel control portion of the PCM. These inputs allow the PCM to control and hold a requested speed. Cruise Set/Coast switch sends an ignition voltage signal to the PCM when the Set/Coast switch is “ON”. This is a type D DTC.

Conditions for Setting the DTC

- Cruise switch “OFF”.
- Ignition voltage on Set switch signal circuit.

or

- Cruise switch “ON”.
- Set switch “ON” for longer than 25.5 seconds

Action Taken When the DTC Sets

- The PCM will disallow all cruise inputs.
- TCC shift schedules may be affected.

Conditions for Clearing the MIL/DTC

- A History DTC will clear when forty consecutive warm-up cycles that the diagnostic does not fail (coolant temperature has risen 5°C (40°F) from start up coolant temperature and engine coolant temperature exceeds 71°C (160°F) that same ignition cycle).
- Use of a Scan Tool.

Diagnostic Aids

If the Set/Coast switch stuck in the “ON” position or the driver is holding the Set/Coast switch “ON” for longer than 25.5 seconds, DTC P0569 will set. DTC P0568 only checks the signal circuit for a short to voltage.

Test Description

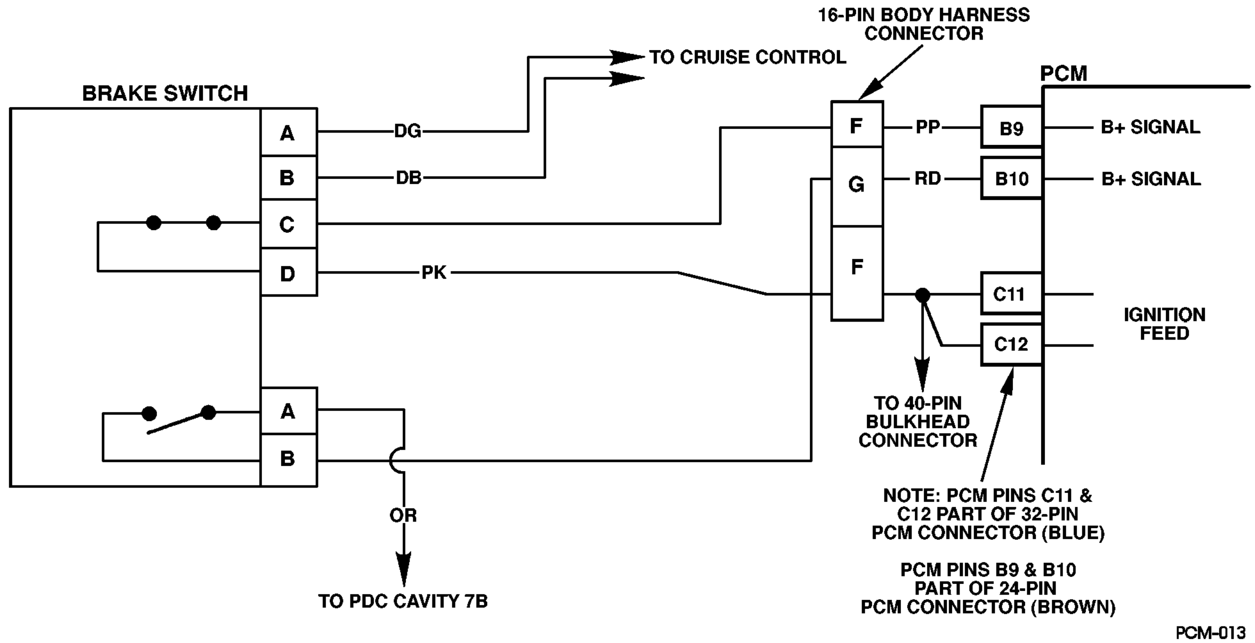
Number(s) below refer to the number(s) on the diagnostic table.

2. This step determines if the signal circuit is shorted to voltage.
3. This step determines if the PCM or switch is at fault.

DTC P0568 - Cruise Set Circuit

Step	Action	Value(s)	Yes	No
1	**Important:** Before clearing DTC(s) use the scan tool "Capture Info" to record freeze frame and failure records for reference, as data will be lost when "Clear Info" function is used. Was the *"On-Board Diagnostic (OBD) System Check"* performed?	—	Go to Step 2.	Go to *OBD System Check*.
2	1. Scan tool connected. 2. Ignition "ON", engine "OFF". 3. Cruise switch "OFF". Does scan tool display Set switch "ON"?	—	Go to Step 3.	Go to Step 4.
3	1. Ignition "ON". 2. Disconnect the PCM brown 24 way connector. 3. Probe the Set switch signal circuit at the PCM harness with a test light connected to chassis ground. Is the test light "ON"?	—	Go to Step 5.	Go to Step 7.
4	DTC is intermittent. If no additional DTCs are stored, refer to "Diagnostic Aids". If additional DTCs are stored, refer to those charts(s) first. Are additional DTCs stored?	—	Go to the applicable DTC table	Go to Diagnostic Aids
5	1. Resume switch signal circuit is shorted to voltage. 2. Repair as necessary. Is action complete?	—	Go to Step 8.	—
6	Replace the faulty PCM. ***Notice:*** If the PCM is faulty, the new PCM must be programmed. Go to *PCM replacement and programming procedures.* Is the action complete?	—	Go to Step 7.	—
7	1. Using the Scan Tool, select "DTC", "Clear Info". 2. Start engine and idle at normal operating temperature. 3. Select "DTC", "Specific", then enter the DTC number which was set. 4. Operate vehicle within the conditions for setting this DTC as specified in the supporting text. Does the Scan Tool indicate that this diagnostic Ran and Passed?	—	Go to Step 8.	Go to Step 2.
8	Using the Scan Tool, select "Capture Info", "Review Info". Are any DTCs displayed that have not been diagnosed?	—	Go to the applicable DTC table	System OK.

DTC P0571 Cruise Brake Switch Circuit



Circuit Description

The TCC normally closed brake switch supplies a B+ signal on CKT 810 to the PCM. The circuit is opened when the brakes are applied. The stop lamp/cruise control normally open brake switch supplies a B+ signal on CKT 22 to the PCM when the brake is applied. This is a type D DTC.

Conditions for Setting the DTC

- Switches disagree for 10 consecutive minutes.

or

- TCC and cruise control brake switches are not toggling “open” and “closed” during 6 brake applications on same ignition cycle.

Action Taken When the DTC Sets

Fourth gear operation in hot mode, and cruise control operation.

Conditions for Clearing the MIL/DTC

- A History DTC will clear when forty consecutive warm-up cycles that the diagnostic does not fail (coolant temperature has risen 5°C (40°F) from start up coolant temperature and engine coolant temperature exceeds 71°C (160°F) that same ignition cycle).
- Use of a scan.

Diagnostic Aids

Refer to PCM Intermittent Diagnostic Trouble Codes or Performance. Check customer driving habits and/or unusual traffic conditions (i.e. stop and go, expressway traffic).

Test Description

Number(s) below refer to the number(s) on the diagnostic table.

3. This test simulates brake switch closed or brakes “OFF”.
4. This test checks the feed circuit.

DTC P0571 - Cruise Brake Switch Circuit

Step	Action	Value(s)	Yes	No
1	**Important:** Before clearing DTC(s) use the scan tool “Capture Info” Was the *“On-Board Diagnostic (OBD) System Check”* performed?	—	Go to Step 2.	Go to *OBD System Check.*
2	1. Scan tool installed. 2. Ignition “ON”, engine “OFF”. 3. Apply brakes. Does scan tool display Cruise Brake switch “Closed” and then “Open” when brake is released?	—	Go to Step 3.	Go to Step 4.
3	Apply brakes again. Does scan tool display Brake switch “Closed” and then “Open” when brake is released?	—	Go to Step 8.	Go to Step 6.

DTC P0571 - Cruise Brake Switch Circuit

Step	Action	Value(s)	Yes	No
4	1. Ignition "ON", engine "OFF". 2. Stop lamp switch disconnected. 3. With test light connected to ground, probe normally open feed circuit (terminal "B"). Is the test light "ON"?	—	Go to Step 5.	Go to Step 9.
5	1. Disconnect stop lamp switch. 2. Jumper normally open (terminal "A") feed circuit and the normally open signal circuits (terminal "B") together. Does scan tool display Cruise Brake switch "Closed"?	—	Go to Step 6.	Go to Step 10.
6	1. Ignition "ON", engine "OFF". 2. Stop lamp switch disconnected. 3. With test light connected to ground, probe normally closed feed circuit (terminal "F"). Is the test light "ON"?	—	Go to Step 7.	Go to Step 12.
7	1. Stop lamp switch disconnected. 2. Jumper normally closed (terminal "F") feed circuit and the normally closed signal circuits (terminal "E") together. Does scan tool display Cruise Brake switch "Closed"?	—	Go to Step 6.	Go to Step 14.
8	DTC is intermittent. If no additional DTCs are stored, refer to "Diagnostic Aids". If additional DTCs are stored, refer to those charts(s) first. Are additional DTCs stored?	—	Go to applicable DTC table.	Go to *Diagnostic Aids*
9	Check normally open signal circuit (terminal "B") for an open or short to ground. Is action complete?	—	Go to Step 17.	—
10	Check normally open Cruise Brake switch signal circuit for an open or short to ground. Was a repair performed?	—	Go to Step 17.	Go to Step 11.
11	Check normally open Cruise Brake switch signal circuit for a poor connection at PCM. Was a repair performed?	—	Go to Step 17.	Go to Step 16.
12	Check normally closed feed circuit (terminal "F") for an open or short to ground. Is action complete?	—	Go to Step 17.	—
13	Check normally closed Cruise Brake switch signal circuit for an open or short to ground. Was a repair performed?	—	Go to Step 17.	Go to Step 14.
14	Check normally closed Cruise Brake switch signal circuit for a poor connection at PCM. Is action complete?	—	Go to Step 17.	—
15	Replace stop lamp switch. Is action complete?	—	Go to Step 17.	—
16	Replace the faulty PCM. ***Notice:*** If the PCM is faulty, the new PCM must be programmed. Go to *PCM replacement and programming procedures.* Is the action complete?	—	Go to Step 17.	—
17	1. Using the Scan Tool, select "DTC", "Clear Info". 2. Start engine and idle at normal operating temperature. 3. Select "DTC", "Specific", then enter the DTC number which was set. 4. Operate vehicle within the conditions for setting this DTC as specified in the supporting text. Does the Scan Tool indicate that this diagnostic Ran and Passed?	—	Go to Step 18.	Go to Step 2.
18	Using the Scan Tool, select "Capture Info", "Review Info". Are any DTCs displayed that have not been diagnosed?	—	Go to the applicable DTC table	System OK.

DTC P0601 - PCM Memory Check

Step	Action	Value(s)	Yes	No
1	**Important:** Before clearing DTC(s) use the scan tool “Capture Info” to record freeze frame and failure records for reference, as data will be lost when “Clear Info” function is used. Was the *“On-Board Diagnostic (OBD) System Check”* performed?	—	Go to Step 2.	Go to *OBD System Check.*
2	Replace the faulty PCM. ***Notice:*** If the PCM is faulty, the new PCM must be programmed. Go to *PCM replacement and programming procedures.* Is the action complete?	—	Go to Step 3.	—
3	1. Using the Scan Tool, select “DTC”, “Clear Info”. 2. Start engine and idle at normal operating temperature. 3. Select “DTC”, “Specific”, then enter the DTC number which was set. 4. Operate vehicle within the conditions for setting this DTC as specified in the supporting text. Does the Scan Tool indicate that this diagnostic Ran and Passed?	—	Go to Step 4.	Go to Step 2.
4	Using the Scan Tool, select “Capture Info”, “Review Info”. Are any DTCs displayed that have not been diagnosed?	—	Go to the applicable DTC table	System OK.

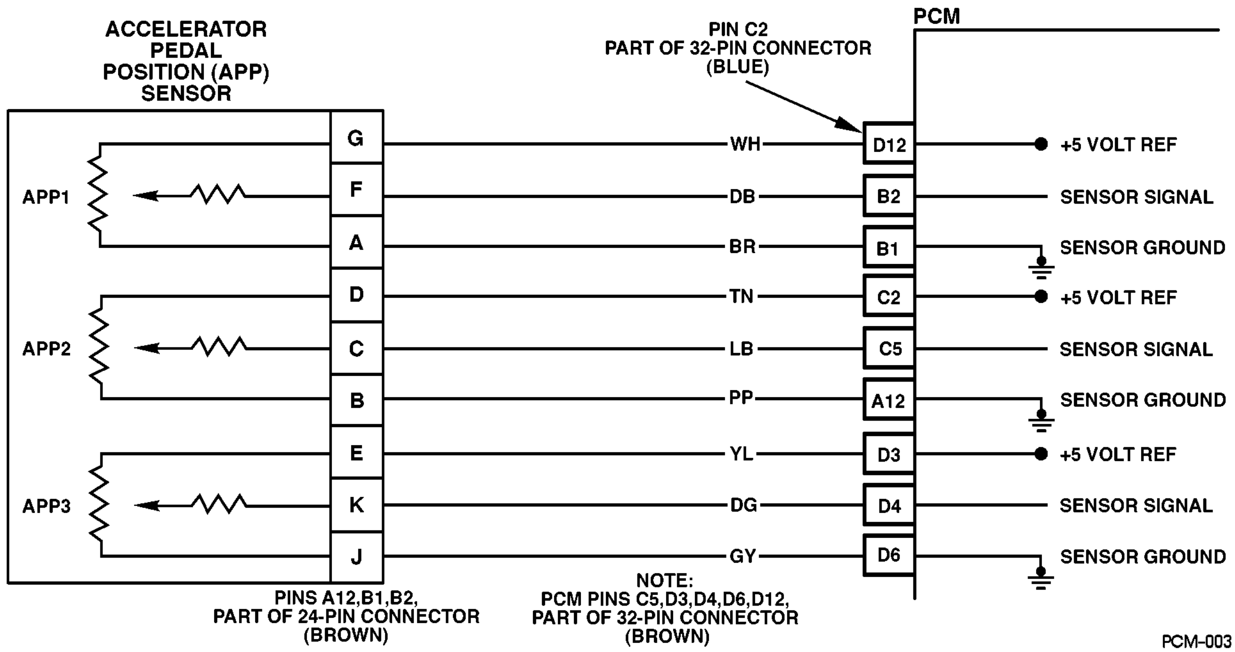
DTC P0602 - PCM Programming

Step	Action	Value(s)	Yes	No
1	**Important:** Before clearing DTC(s) use the scan tool “Capture Info” to record freeze frame and failure records for reference, as data will be lost when “Clear Info” function is used. Was the *“On-Board Diagnostic (OBD) System Check”* performed?	—	Go to Step 2.	Go to *OBD System Check.*
2	Replace the faulty PCM. ***Notice:*** If the PCM is faulty, the new PCM must be programmed. Go to *PCM replacement and programming procedures.* Is the action complete?	—	Go to Step 3.	—
3	1. Using the Scan Tool, select “DTC”, “Clear Info”. 2. Start engine and idle at normal operating temperature. 3. Select “DTC”, “Specific”, then enter the DTC number which was set. 4. Operate vehicle within the conditions for setting this DTC as specified in the supporting text. Does the Scan Tool indicate that this diagnostic Ran and Passed?	—	Go to Step 4.	Go to Step 2.
4	Using the Scan Tool, select “Capture Info”, “Review Info”. Are any DTCs displayed that have not been diagnosed?	—	Go to the applicable DTC table	System OK.

DTC P0606 - PCM Internal Communication Interrupted

Step	Action	Value(s)	Yes	No
1	**Important:** Before clearing DTC(s) use the scan tool "Capture Info" to record freeze frame and failure records for reference, as data will be lost when "Clear Info" function is used. Was the *"On-Board Diagnostic (OBD) System Check"* performed?	—	Go to Step 2.	Go to *OBD System Check.*
2	Is DTC P0370 set?	—	Refer to the applicable DTC table	Go to Step 3.
3	Replace the faulty PCM. ***Notice:*** If the PCM is faulty, the new PCM must be programmed. Go to *PCM replacement and programming procedures.* Is the action complete?	—	Go to Step 4.	—
4	1. Using the Scan Tool, select "DTC", "Clear Info". 2. Start engine and idle at normal operating temperature. 3. Select "DTC", "Specific", then enter the DTC number which was set. 4. Operate vehicle within the conditions for setting this DTC as specified in the supporting text. Does the Scan Tool indicate that this diagnostic Ran and Passed?	—	Go to Step 5.	Go to Step 2.
5	Using the Scan Tool, select "Capture Info", "Review Info". Are any DTCs displayed that have not been diagnosed?	—	Go to the applicable DTC table	System OK.

DTC P1125 Accelerator Pedal Position (APP) System



Circuit Description

The Accelerator Pedal Position (APP) module provides a voltage signal that changes relative to accelerator position. There are three sensors located within the APP module that are scaled differently. This is a type C DTC.

Conditions for Setting the DTC

PCM has recognized an intermittent APP fault and there are no current APP faults stored.

Action Taken When the DTC Sets

Vehicle will operate at limited power.

Conditions for Clearing the MIL/DTC

- A History DTC will clear when forty consecutive warm-up cycles that the diagnostic does not fail (coolant temperature has risen 5°C (40°F) from start up coolant temperature and engine coolant temperature exceeds 71°C (160°F) that same ignition cycle).
- Use of a Scan Tool.

Diagnostic Aids

A DTC P1125 will set along with multiple APP DTCs. All other DTCs should be diagnosed first.

Test Description

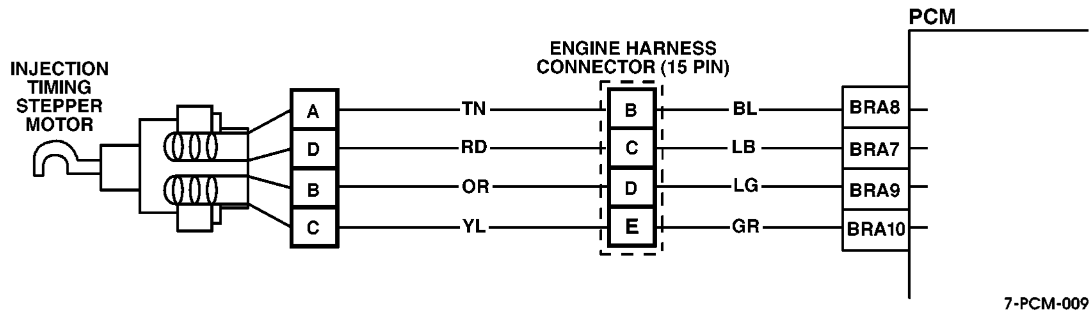
Number(s) below refer to the number(s) on the diagnostic table.

1. This step determines if DTC P1125 is a hard failure or an intermittent condition.

DTC P1125 - Accelerator Pedal Position (APP) System

Step	Action	Value(s)	Yes	No
1	**Important:** Before clearing DTC(s) use the scan tool "Capture Info" to record freeze frame and failure records for reference, as data will be lost when "Clear Info" function is used. Was the *"On-Board Diagnostic (OBD) System Check"* performed?	—	Go to Step 2.	Go to *OBD System Check.*
2	1. Disconnect the APP sensor electrical connector. 2. Ignition "ON", engine "OFF". 3. With J 39200 connected to ground, check all APP 5 volt reference circuits at APP harness. Is voltage less than specified value?	4.8v	Go to Step 4.	Go to Step 3.
3	DTC is intermittent. If no additional DTCs are stored, refer to "Diagnostic Aids". If additional DTCs are stored, refer to those charts(s) first. Are additional DTCs stored?	—	Go to the applicable DTC table	Go to Diagnostic Aids
4	1. Ignition "OFF". 2. Disconnect the PCM and check the 5 volt reference circuit for a short to ground. 3. If the 5 volt reference circuit is shorted to ground, repair it as necessary. Was the 5 volt reference circuit is shorted to ground?	—	Go to Step 6.	Go to Step 5.
5	Replace the faulty PCM. ***Notice:*** If the PCM is faulty, the new PCM must be programmed. Go to *PCM replacement and programming procedures.* Is the action complete?	—	Go to Step 6.	—
6	1. Using the Scan Tool, select "DTC", "Clear Info". 2. Start engine and idle at normal operating temperature. 3. Select "DTC", "Specific", then enter the DTC number which was set. 4. Operate vehicle within the conditions for setting this DTC as specified in the supporting text. Does the Scan Tool indicate that this diagnostic Ran and Passed?	—	Go to Step 7.	Go to Step 2.
7	Using the Scan Tool, select "Capture Info", "Review Info". Are any DTCs displayed that have not been diagnosed?	—	Go to the applicable DTC table	System OK.

DTC P1214 Injection Pump Timing Offset Error



Circuit Description

The PCM has the ability to determine the amount of offset needed to bring the engine to top dead center. This is used by the PCM to determine proper injection time.

Conditions for Setting the DTC

TDC offset greater than 2.5 degrees.

or

TDC Offset less than -2.5 degrees.

Action Taken When the DTC Sets

The MIL will illuminate on 2 test failures.

Conditions for Clearing the MIL/DTC

- •The PCM will turn the MIL off after three consecutive trips without a fault condition.
- •A History DTC will clear when forty consecutive warm-up cycles that the diagnostic does not fail (coolant temperature has risen 5° C (40° F) from start up coolant temperature and engine coolant temperature exceeds 71° C (160° F) that same ignition cycle.
- Use of a Scan Tool.

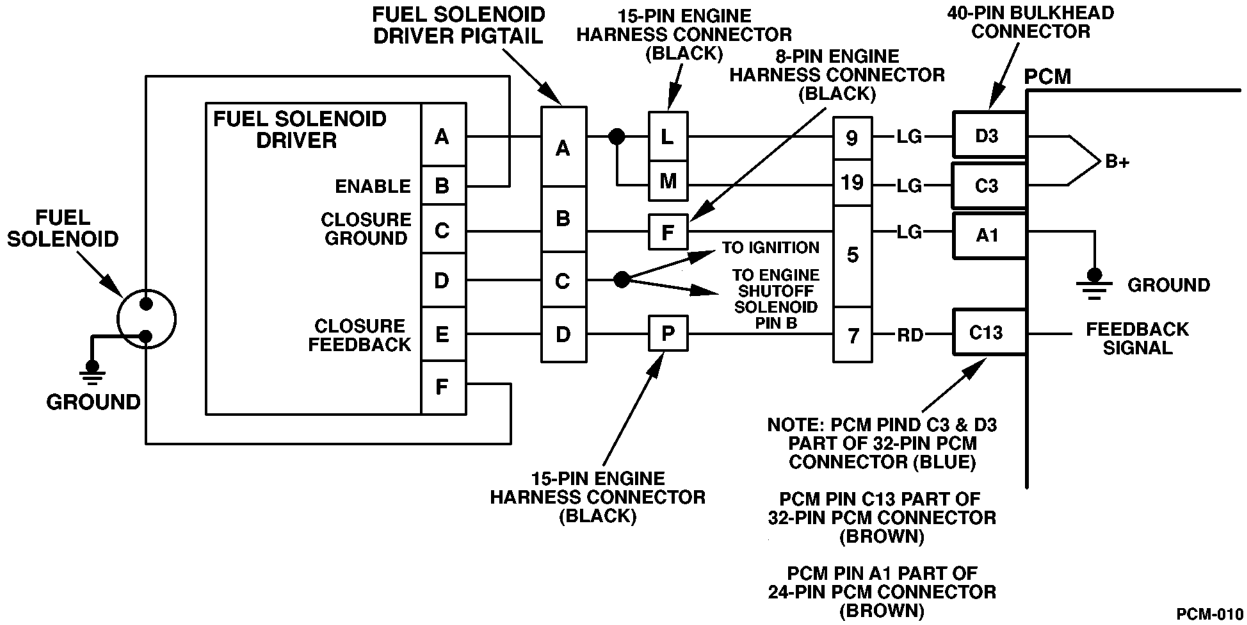
Diagnostic Aids

The PCM will only run the diagnostic test when a time set procedure has been activated. It is highly unlikely that the vehicle will be brought in with this DTC set. Refer to TDC Offset.

DTC P1214 - Injection Pump Timing Offset Error

Step	Action	Value(s)	Yes	No
1	**Important:** Before clearing DTC(s) use the scan tool "Capture Info" to record freeze frame and failure records for reference, as data will be lost when "Clear Info" function is used. Was the *"On-Board Diagnostic (OBD) System Check"* performed?	—	Go to Step 2.	Go to *OBD System Check.*
2	DTC is intermittent. If no additional DTCs are stored, refer to "Diagnostic Aids". If additional DTCs are stored, refer to those charts(s) first. Are additional DTCs stored?	—	Go to the applicable DTC table	Go to Diagnostic Aids
3	Are there any other DTCs set?	—	Go to the applicable DTC table	Go to Step 4.
4	Clear all codes and reset injection timing until "TDC Offset" is between specified values. Refer to *TDC Offset*. Is timing within specified value?	- 0.25 to - 0.75	Go to Step 7.	Go to Step 5.
5	Replace the faulty PCM. ***Notice:*** If the PCM is faulty, the new PCM must be programmed. Go to *PCM replacement and programming procedures.* Is the action complete?	—	Go to Step 6.	—
6	1. Using the Scan Tool, select "DTC", "Clear Info". 2. Start engine and idle at normal operating temperature. 3. Select "DTC", "Specific", then enter the DTC number which was set. 4. Operate vehicle within the conditions for setting this DTC as specified in the supporting text. Does the Scan Tool indicate that this diagnostic Ran and Passed?	—	Go to Step 7.	Go to Step 3.
7	Using the Scan Tool, select "Capture Info", "Review Info". Are any DTCs displayed that have not been diagnosed?	—	Go to the applicable DTC table	System OK.

DTC P1216 Fuel Solenoid Response Time Too Short



Circuit Description

The injection pump delivers fuel to individual cylinders by opening and closing a solenoid control fuel valve. The PCM monitors the amount of time it takes for the fuel solenoid valve to physically close after commanded to close. Closure time out of range is seen as a fault. This response time is measured in milliseconds. This is a type D DTC.

Conditions for Setting the DTC

- Battery voltage greater than 10 volts and less than 16 volts.
- Engine coolant temperature greater than -1°C (34°F).
- Engine speed greater than 506 RPM.
- Requested fuel rate is greater than 0.0 mm.
- Inj. Pump Closure Time less than .75 ms.

Action Taken When the DTC Sets

Possible poor performance or no start.

Conditions for Clearing the MIL/DTC

- A History DTC will clear when forty consecutive warm-up cycles that the diagnostic does not fail (coolant temperature has risen 5°C (40°F) from start up coolant temperature and engine coolant temperature exceeds 71°C (160°F) that same ignition cycle).
- Use of a scan.

Diagnostic Aids

If DTC P1216 is set with any other DTCs, diagnose them first. If the vehicle is running close to the DTC setting closure time, vehicle should be checked during cold start ups and during hot conditions.

Test Description

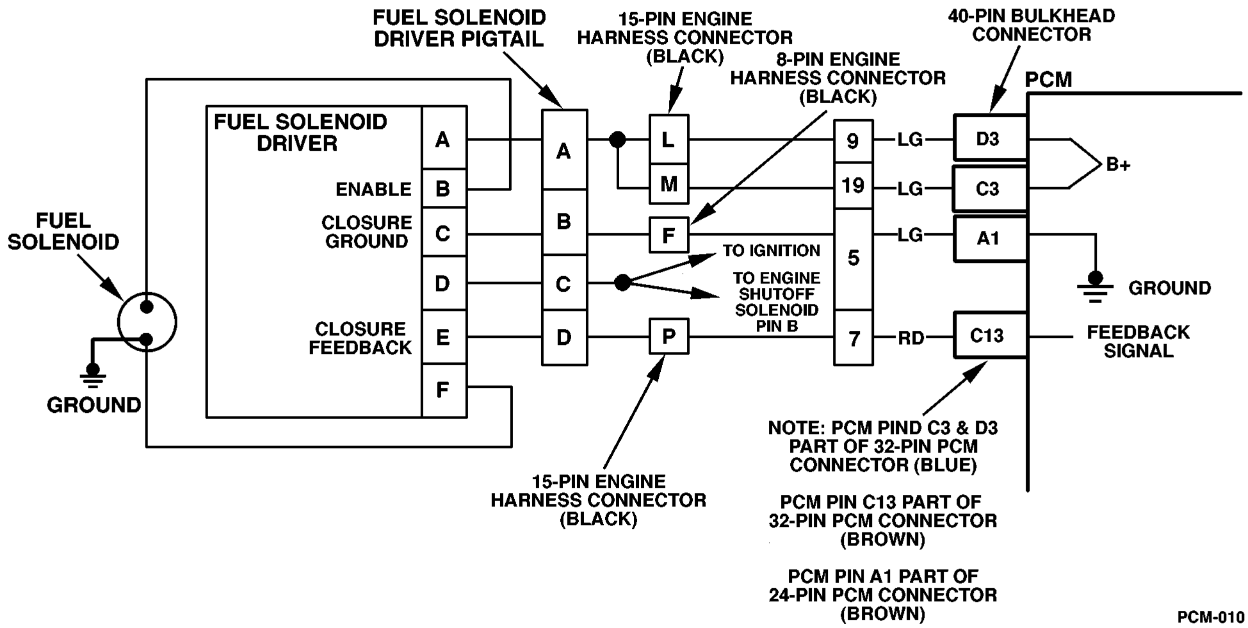
Number(s) below refer to the number(s) on the diagnostic table.

2. This step will determine if the ground circuit is open which causes the vehicle not to start.
3. This step will determine if the signal circuit is open or an injection pump (fuel solenoid) is a fault.

DTC P1216 - Fuel Solenoid Response Time Too Short

Step	Action	Value(s)	Yes	No
1	**Important:** Before clearing DTC(s) use the scan tool "Capture Info" to record freeze frame and failure records for reference, as data will be lost when "Clear Info" function is used. Was the *"On-Board Diagnostic (OBD) System Check"* performed?	—	Go to Step 2.	Go to *OBD System Check.*
2	**Is DTC P0219 set?**	—	Go to applicable table.	Go to Step 3.
3	**Will engine start?**	—	Go to Step 4.	Go to Step 7.
4	1. Engine at operating temperature. 2. Observe Inj. Pump Closure Time on scan tool. Is the scan tool display less than the specified value?	0.75 ms	Go to Step 5.	Go to Step 6.
5	1. Engine running. 2. Again, observe Inj. Pump Closure Time on scan tool. Does Inj. Pump Closure Time display the specified value?	0.1 ms	Go to Step 8.	Go to Step 10.
6	DTC is intermittent. If no additional DTCs are stored, refer to "Diagnostic Aids". If additional DTCs are stored, refer to those charts(s) first. Are additional DTCs stored?	—	Go to applicable DTC table.	Go to *Diagnostic Aids*
7	1. Check the Closure ground circuit for an open. 2. If the Closure circuit is open, repair as necessary. Was a repair performed?	—	Go to Step 12.	Go to Step 10.
8	1. Check the Closure signal circuit for an open or short to ground. 2. If the Closure signal circuit is open or shorted to ground, repair as necessary. Was a repair performed?	—	Go to Step 12.	Go to Step 9.
9	Check the Closure signal circuit for a poor connection at PCM and replace terminal if necessary. Is action complete?	—	Go to Step 12.	Go to Step 11.
10	Replace injection pump. ***Notice:*** If injection pump is faulty, the new injection pump must be timed. Refer to *Checking and Adjusting Injection Timing* in Section 4. Is the action complete?	—	Go to Step 12.	—
11	Replace the faulty PCM. ***Notice:*** If the PCM is faulty, the new PCM must be programmed. Go to *PCM replacement and programming procedures.* Is the action complete?	—	Go to Step 12.	—
12	1. Using the Scan Tool, select "DTC", "Clear Info". 2. Start engine and idle at normal operating temperature. 3. Select "DTC", "Specific", then enter the DTC number which was set. 4. Operate vehicle within the conditions for setting this DTC as specified in the supporting text. Does the Scan Tool indicate that this diagnostic Ran and Passed?	—	Go to Step 13.	Go to Step 2.
13	Using the Scan Tool, select "Capture Info", "Review Info". Are any DTCs displayed that have not been diagnosed?	—	Go to the applicable DTC table	System OK.

DTC P1217 Fuel Solenoid Response Time Too Long



Circuit Description

The injection pump delivers fuel to individual cylinders by opening and closing a solenoid control fuel valve. The PCM monitors the amount of time it takes for the fuel solenoid valve to physically close after commanded to close. Closure time out of range is seen as a fault. This response time is measured in milliseconds. This is a type D DTC.

Conditions for Setting the DTC

- Battery voltage greater than 10 volts and less than 16 volts.
- Engine coolant temperature greater than -1°C (34°F).
- Engine speed greater than 506 RPM.
- Requested fuel rate is greater than 0.0 mm.
- Inj. Pump Closure Time less than .75 ms.

Action Taken When the DTC Sets

Possible poor performance.

Conditions for Clearing the MIL/DTC

- A History DTC will clear when forty consecutive warm-up cycles that the diagnostic does not fail (coolant temperature has risen 5°C (40°F) from start up coolant temperature and engine coolant temperature exceeds 71°C (160°F) that same ignition cycle).
- Use of a scan.

Diagnostic Aids

A weak (mechanical failure) fuel solenoid will result in a DTC P1217. If DTC P1217 is set with any other DTCs, diagnose them first. If the vehicle is running close to the DTC setting closure time, vehicle should be checked during cold start ups and during hot conditions.

Test Description

Number(s) below refer to the number(s) on the diagnostic table.

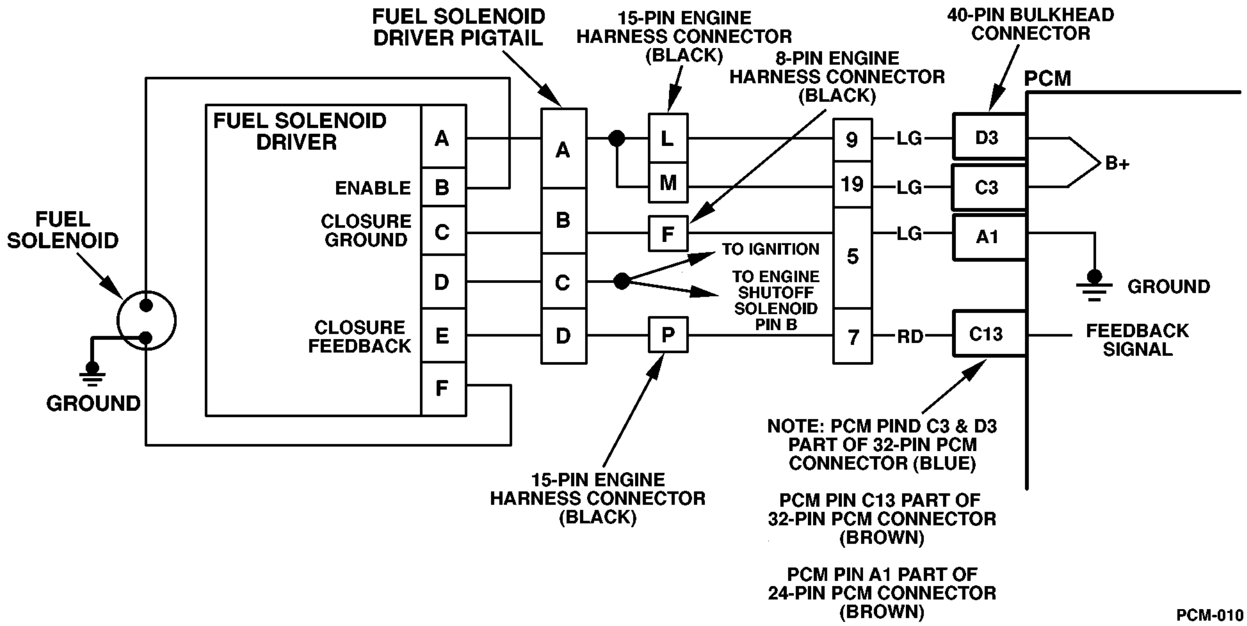
3. This step will determine if DTC P1217 is a hard failure or an intermittent.

This step will determine if the solenoid is at fault, or if there is a problem with the PCM or wiring.

DTC P1217 - Fuel Solenoid Response Time Too Long

Step	Action	Value(s)	Yes	No
1	**Important:** Before clearing DTC(s) use the scan tool "Capture Info" to record freeze frame and failure records for reference, as data will be lost when "Clear Info" function is used. Was the *"On-Board Diagnostic (OBD) System Check"* performed?	—	Go to Step 2.	Go to *OBD System Check.*
2	Is DTC P0370 set?	—	Refer to applicable table.	Go to Step 3.
3	1. Engine at operating temperature. 2. Observe Inj. Pump Closure Time on scan tool. Is the scan tool display greater than or equal to the specified value?	2.4 ms	Go to Step 5.	Go to Step 4.
4	1. All accessories on (includes aftermarket add-ons). 2. Engine idling. 3. All post glow plug cycles completed. 4. With a J39200 connected to ground, measure voltage at the FUEL SOL fuse (fuel solenoid driver ignition feed circuit) in the U/H relay center. Is voltage between specified value?	12 - 15v	Go to Step 7.	Go to Step 6.
5	DTC is intermittent. If no additional DTCs are stored, refer to "Diagnostic Aids". If additional DTCs are stored, refer to those charts(s) first. Are additional DTCs stored?	—	Go to applicable DTC table.	Go to *Diagnostic Aids*
6	Repair the fuel solenoid driver ignition feed circuit poor connections or aftermarket add-ons. Was a repair performed?	—	Go to Step 8.	—
7	Replace injection pump. ***Notice:*** If injection pump is faulty, the new injection pump must be timed. Refer to *Checking and Adjusting Injection Timing* in Section 4. Is the action complete?	—	Go to Step 8.	—
8	1. Using the Scan Tool, select "DTC", "Clear Info". 2. Start engine and idle at normal operating temperature. 3. Select "DTC", "Specific", then enter the DTC number which was set. 4. Operate vehicle within the conditions for setting this DTC as specified in the supporting text. Does the Scan Tool indicate that this diagnostic Ran and Passed?	—	Go to Step 9.	Go to Step 2.
9	Using the Scan Tool, select "Capture Info", "Review Info". Are any DTCs displayed that have not been diagnosed?	—	Go to the applicable DTC table	System OK.

DTC P1218 Injection Pump Calibration Circuit



Circuit Description

The PCM uses a calibrated resistor mounted internally in the injection pump to determine fuel rates. The resistor value is stored in the PCM memory. If the PCM memory has been disturbed or the PCM has been replaced, the PCM will relearn the resistor value on the next ignition cycle. This is a type B DTC.

Conditions for Setting the DTC

- PCM currently does not have a valid resistor valve.
- PCM is unable to read a resistor value.

Action Taken When the DTC Sets

The lowest fuel table. Possible poor performance problem.

Conditions for Clearing the MIL/DTC

- The PCM will turn the MIL off after three consecutive trips without a fault condition.
- A History DTC will clear when forty consecutive warm-up cycles that the diagnostic does not fail (coolant temperature has risen 5°C (40°F) from start up coolant temperature and engine coolant temperature exceeds 71°C (160°F) that same ignition cycle).
- Use of a scan.

Diagnostic Aids

Check connection at fuel injector driver. Clear DTC, and cycle ignition. If DTC clears, treat condition as intermittent.

Test Description

Number(s) below refer to the number(s) on the diagnostic table.

3. This step will determine if there is a problem with the connection at the fuel solenoid driver or faulty injection pump.

DTC P1218 Injection Pump Calibration Circuit

Step	Action	Value(s)	Yes	No
1	**Important**: Before clearing DTCs use the scan tool Capture Info to record freeze frame and failure records for reference, as data will be lost when Clear Info function is used. Was the Powertrain On-Board Diagnostic (OBD) System Check perfom-med?	—	Go to Step 2.	Go to *Power-train OBD System Check.*
2	Are than any other DTCs set?	—	Refer to Aplicable DTC Table	Go to Step 3.
3	1. Check connection at Fuel Solenoid Driver. 2. Clear DTC, and cycle ignition. 3. Start and idle engine. 4. Activate Time set procedure (the diagnostic will only run when a Time Set procedure is perfommed). 5. Exit out of Time set procedure and Select DTC, Specific, then enter the DTC number. Does the Scan Tool indicate that the diagnostic Passed?	—	Go to Step 5.	Go to Step 4.
4	Replace injection pump. Important: The new injection pump must be timed. Refer to *Fuel Injection Pump*. Is the action complete?	—	Go to Step 6.	—
5	DTC is intemmittent. If no additional DTCs are stored, refer to Diagnostic Aids. If additional DTCs were stored refer to those table(s). Are any additional DTC(s) stored?	—	Go to Apli-cable DTC Table.	Go to *Diag-nostic Aids.*
6	Using the Scan Tool, select Capture Info, Review Info. Are any DTCs displayed that have not been diagnosed?	—	Go to Apli-cable DTC Table.	System OK.

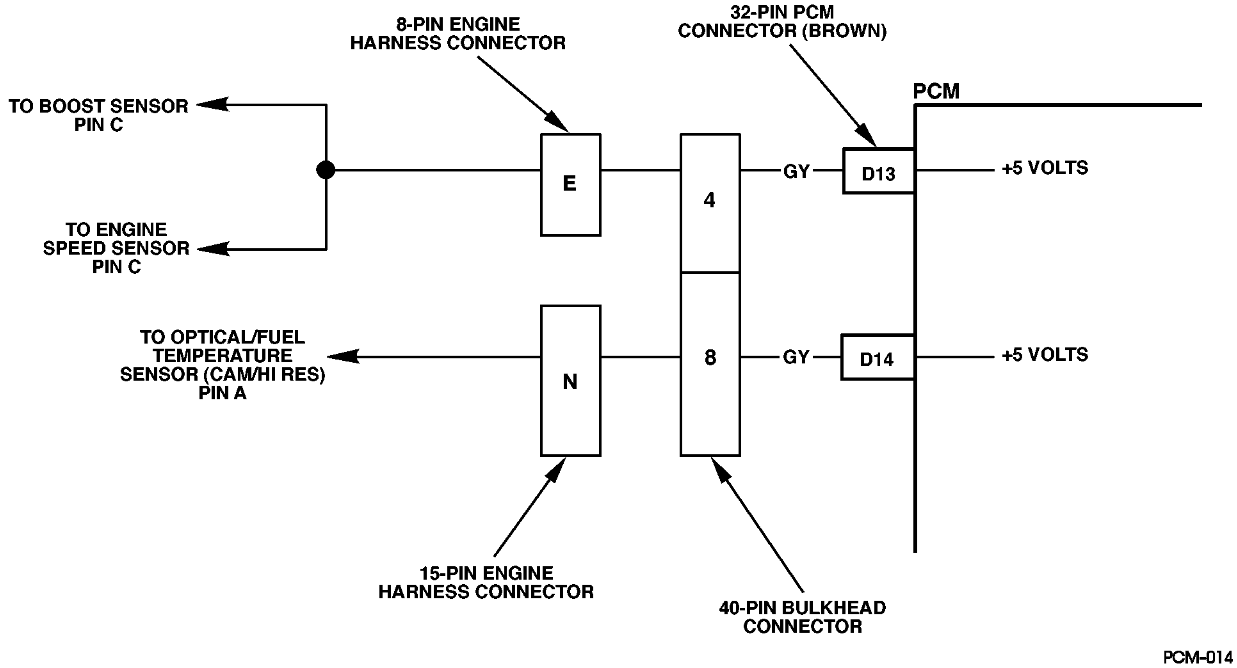
DTC P1621 EEPROM Write

Step	Action	Value(s)	Yes	No
1	**Important:** Before clearing DTC(s) use the scan tool “Capture Info” to record freeze frame and failure records for reference, as data will be lost when “Clear Info” function is used. Was the *“On-Board Diagnostic (OBD) System Check”* performed?	—	Go to Step 2.	Go to *OBD System Check.*
2	Replace the faulty PCM. ***Notice:*** If the PCM is faulty, the new PCM must be programmed. Go to *PCM replacement and programming procedures.* Is the action complete?	—	Go to Step 3.	—
3	1. Using the Scan Tool, select “DTC”, “Clear Info”. 2. Start engine and idle at normal operating temperature. 3. Select “DTC”, “Specific”, then enter the DTC number which was set. 4. Operate vehicle within the conditions for setting this DTC as specified in the supporting text. Does the Scan Tool indicate that this diagnostic Ran and Passed?	—	Go to Step 4.	Go to Step 2.
4	Using the Scan Tool, select “Capture Info”, “Review Info”. Are any DTCs displayed that have not been diagnosed?	—	Go to the applicable DTC table	System OK.

DTC P1627 - A/D Performance

Step	Action	Value(s)	Yes	No
1	**Important:** Before clearing DTC(s) use the scan tool “Capture Info” to record freeze frame and failure records for reference, as data will be lost when “Clear Info” function is used. Was the *“On-Board Diagnostic (OBD) System Check”* performed?	—	Go to Step 2.	Go to *OBD System Check.*
2	Replace the faulty PCM. ***Notice:*** If the PCM is faulty, the new PCM must be programmed. Go to *PCM replacement and programming procedures.* Is the action complete?	—	Go to Step 3.	—
3	1. Using the Scan Tool, select “DTC”, “Clear Info”. 2. Start engine and idle at normal operating temperature. 3. Select “DTC”, “Specific”, then enter the DTC number which was set. 4. Operate vehicle within the conditions for setting this DTC as specified in the supporting text. Does the Scan Tool indicate that this diagnostic Ran and Passed?	—	Go to Step 4.	Go to Step 2.
4	Using the Scan Tool, select “Capture Info”, “Review Info”. Are any DTCs displayed that have not been diagnosed?	—	Go to the applicable DTC table	System OK.

DTC P1635 PCM 5 Volt Reference Low



Circuit Description

The PCM provides a 5 volt supply for use in powering up sensors. This test monitors the voltage present at terminals BRD13 (shared by Boost and Crankshaft Position sensors) and BRD14 (Optical/Fuel temperature sensor (Cam/HI Res)). This is a type B DTC.

Conditions for Setting the DTC

5 volt reference is less than 1 volt.

Action Taken When the DTC Sets

- Backup fuel.
- No EGR.
- No turbo boost.

Conditions for Clearing the MIL/DTC

- A History DTC will clear when forty consecutive warm-up cycles that the diagnostic does not fail (coolant temperature has risen 5°C (40°F) from start up coolant temperature and engine coolant temperature exceeds 71°C (160°F) that same ignition cycle).
- Use of a scan.

Diagnostic Aids

During the time the failure is present, the setting of additional DTCs that share a 5 volt reference may also set.

Test Description

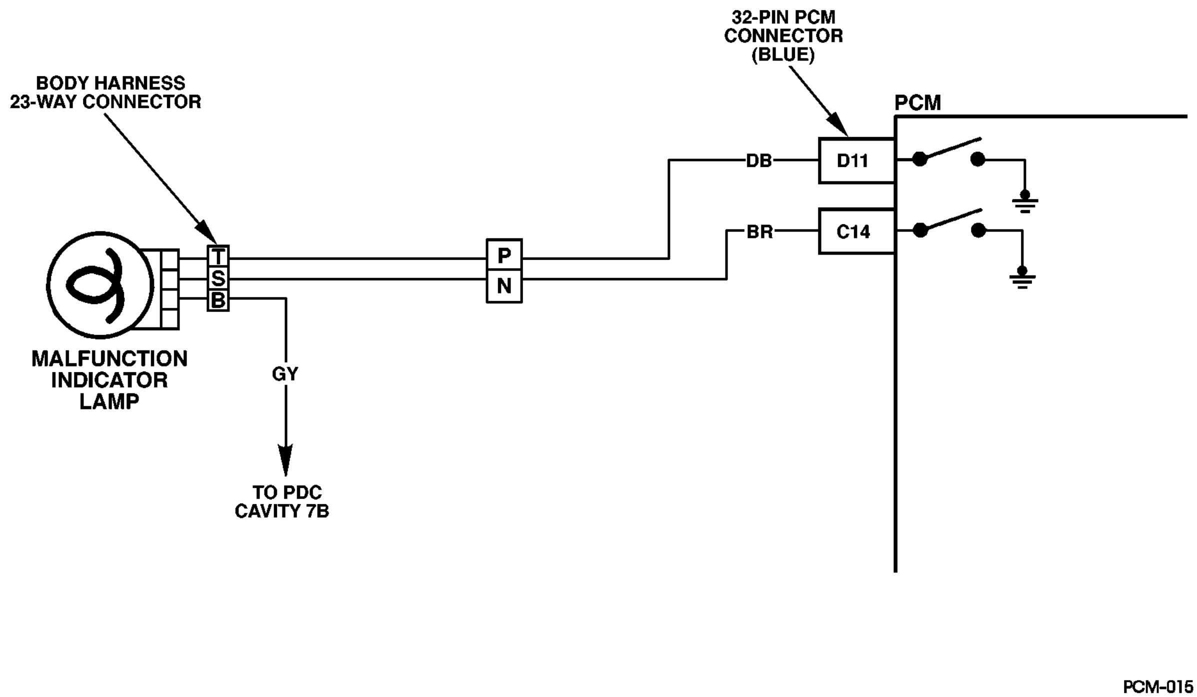
Number(s) below refer to the number(s) on the diagnostic table.

1. Checks to confirm that a DTC is still present.
2. Checks to determine if there is a 5 volt reference from the PCM.
3. Checks to determine if there is a short-to-ground in CKT 350 or CKT 375, or a short-to-ground in the PCM.

DTC P1635 - PCM 5 Volt Reference Low

Step	Action	Value(s)	Yes	No
1	**Important:** Before clearing DTC(s) use the scan tool “Capture Info” to record freeze frame and failure records for reference, as data will be lost when “Clear Info” function is used. Was the *“On-Board Diagnostic (OBD) System Check”* performed?	—	Go to Step 2.	Go to *OBD System Check.*
2	1. Scan tool installed. 2. Crank engine for 15 seconds or start up. Does DTC reset?	—	Go to Step 3.	Go to Step 5.
3	1. Ignition ON, engine OFF> 2. Disconnect EGR Control Pressure/BARO sensor. 3. With J39200 DVM, probe 5 volt reference circuit at harness connector. Is voltage less than the specified value?	4.0v	Go to Step 4.	Go to Step 6.
4	1. Disconnect PCM connector with EGR sensor 5 volt reference circuit. 2. With test light connected to B+, probe 5 volt reference circuit at PCM harness. Is test light ON?	—	Go to Step 7.	Go to Step 8.
5	DTC is intermittent. If no additional DTCs are stored, refer to “Diagnostic Aids”. If additional DTCs are stored, refer to those charts(s) first. Are additional DTCs stored?	—	Go to applicable DTC table.	Go to *Diagnostic Aids*
6	Replace EGR Control Pressure/BARO sensor.	—	Go to Step 8.	—
7	Repair short to ground in 5 volt reference circuit. Is the action complete?	—	Go to Step 8.	—
8	Replace the faulty PCM. ***Notice:*** If the PCM is faulty, the new PCM must be programmed. Go to *PCM replacement and programming procedures.* Is the action complete?	—	Go to Step 9.	Go to Step 8.
9	1. Using the Scan Tool, select “DTC”, “Clear Info”. 2. Start engine and idle at normal operating temperature. 3. Select “DTC”, “Specific”, then enter the DTC number which was set. 4. Operate vehicle within the conditions for setting this DTC as specified in the supporting text. Does the Scan Tool indicate that this diagnostic Ran and Passed?	—	Go to Step 6.	Go to Step 2.
10	Using the Scan Tool, select “Capture Info”, “Review Info”. Are any DTCs displayed that have not been diagnosed?	—	Go to the applicable DTC table	System OK.

DTC P1641 Malfunction Indicator Lamp (MIL) Control Circuit



Circuit Description

A dash light is illuminated by the PCM if diagnostics have detected certain errors related to the engine performance or engine sensor status. Illumination is accomplished by the PCM providing a ground path for the lamp circuit. This is a type D DTC.

Conditions for Setting the DTC

- MIL requested “ON”.
- Voltage at the MIL control circuit is greater than 0 volts.

or

- MIL requested “OFF”.
- Voltage at the MIL control circuit is greater than 0 volts.

Action Taken When the DTC Sets

Will not turn “ON” the MIL.

Conditions for Clearing the MIL/DTC

- A History DTC will clear when forty consecutive warm-up cycles that the diagnostic does not fail (coolant temperature has risen 5°C (40°F) from start up coolant temperature and engine coolant temperature exceeds 71°C (160°F) that same ignition cycle).
- Use of a scan.

Diagnostic Aids

A faulty bulb or the control circuit shorted to ground will cause a P1641 to set.

Test Description

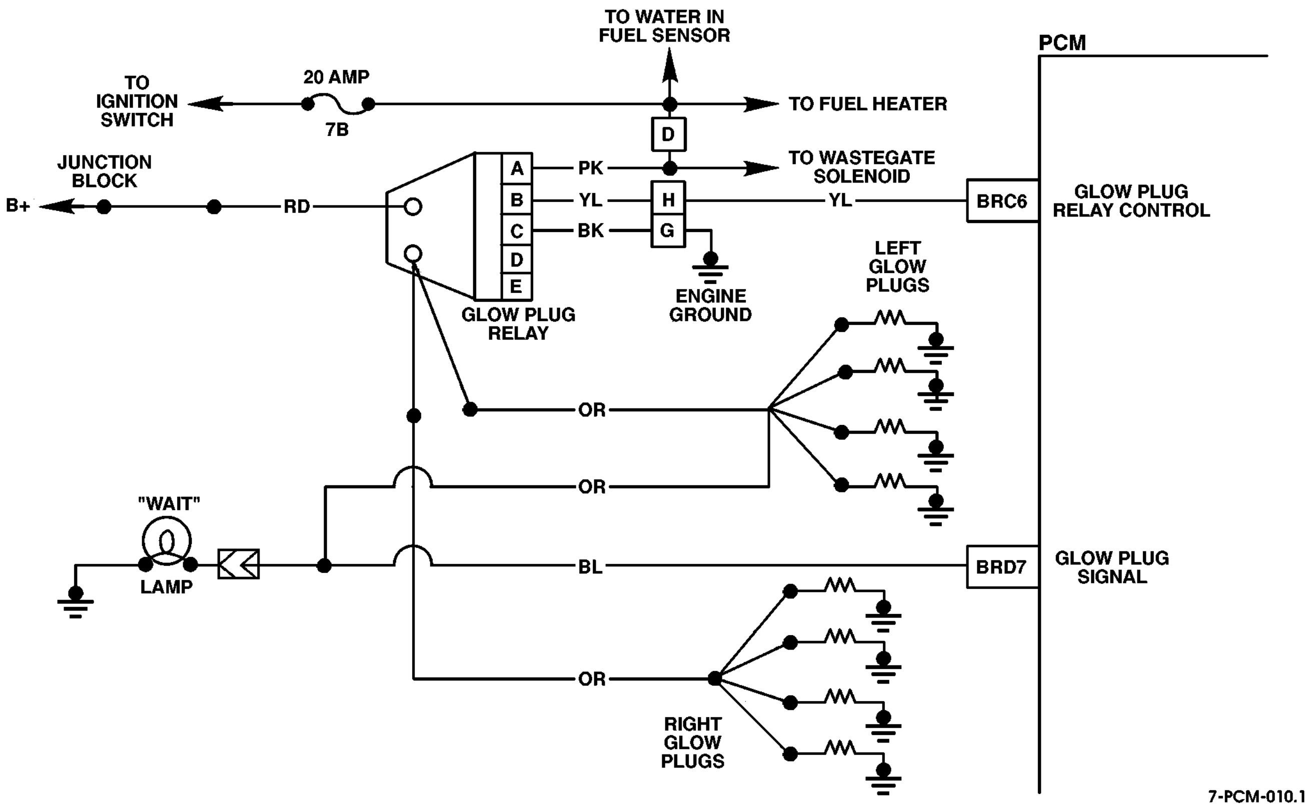
Number(s) below refer to the number(s) on the diagnostic table.

3. This test will check the control circuit for a short to ground.
5. This test will check the control circuit for an open.

DTC P1641 - Malfunction Indicator Lamp (MIL) Control Circuit

Step	Action	Value(s)	Yes	No
1	**Important:** Before clearing DTC(s) use the scan tool "Capture Info" to record freeze frame and failure records for reference, as data will be lost when "Clear Info" function is used. Was the *"On-Board Diagnostic (OBD) System Check"* performed?	—	Go to Step 2.	Go to *OBD System Check.*
2	1. Scan tool connected. 2. Ignition "ON" engine "OFF". Is the MIL "OFF"?	—	Go to Step 3.	Go to Step 5.
3	1. Ignition "OFF". 2. Disconnect the blue 32 way PCM electrical connector. 3. Ignition "ON" engine "OFF". Is the MIL "ON"?	—	Go to Step 4.	Go to Step 6.
4	MIL control circuit is shorted to ground. Is the action complete?	—	Go to Step 7.	—
5	1. Check the MIL control circuit for the following: • opens • poor connection at PCM • faulty bulb • faulty fuse. Was a problem found?	—	Go to Step 7.	Go to Step 6.
6	Replace the faulty PCM. ***Notice:*** If the PCM is faulty, the new PCM must be programmed. Go to *PCM replacement and programming procedures.* Is the action complete?	—	Go to Step 7.	—
7	1. Using the Scan Tool, select "DTC", "Clear Info". 2. Start engine and idle at normal operating temperature. 3. Select "DTC", "Specific", then enter the DTC number which was set. 4. Operate vehicle within the conditions for setting this DTC as specified in the supporting text. Does the Scan Tool indicate that this diagnostic Ran and Passed?	—	Go to Step 8.	Go to Step 2.
8	Using the Scan Tool, select "Capture Info", "Review Info". Are any DTCs displayed that have not been diagnosed?	—	Go to the applicable DTC table	System OK.

DTC P1643 Wait to Start Lamp Control Circuit



Refer to *PCM, Glow Plugs, Underhood Fuse-Relay Center*.

Circuit Description

A dash light (Wait To Start) is illuminated by the PCM when the glow plugs are commanded ON. When the PCM is commanding the Wait To Start lamp ON, the voltage potential of the circuit will be low (near 0 volts). When the PCM is commanding the Wait To Start lamp OFF, the voltage potential of the circuit will be high (near battery volts). The primary function of the PCM is to supply the ground for the Wait To Start lamp circuit. This is a type B DTC.

Conditions for Setting the DTC

- Wait To Start lamp requested ON.
- Voltage on Wait To Start tamp circuit high (near battery volts).

or

- Wait To Start lamp requested OFF.
- Voltage on Wait To Start lamp control circuit low (near 0 volts).Action Taken When the DTC Sets

Action Taken When the DTC Sets

No Wait To Start lamp.

Conditions for Clearing the MIL/DTC

- The PCM will turn the MIL off after three consecutive trips without a fault condition.
- A History DTC will clear when forty consecutive warm-up cycles that the diagnostic does not fail (coolant temperature has risen 5° C (40° F) from start up coolant temperature and engine coolant temperature exceeds 71° C (160° F) that same ignition cycle.
- Use of a Scan tool.

Diagnostic Aids

A faulty bulb or the control circuit shorted to ground will cause a P1643 to set.

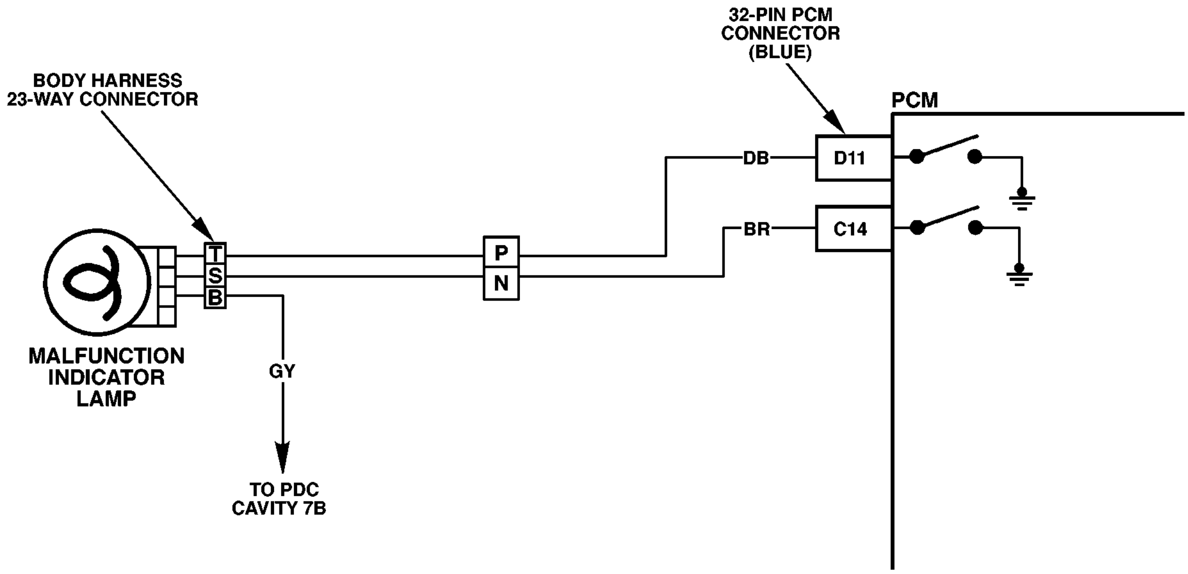
Test Description

5. 2.Repeat the command as many times as necessary (when glow plugs are commanded ON by the scan tool, an internal PCM timer protects the glow plugs from damage by cycling them ON for 3 seconds and OFF for 12 seconds. After the 12 seconds has elapsed, the glow plugs can be commanded ON again).
9. If no trouble is found in the control circuit or the connection at the PCM, the PCM maybe malfunctioning, however, this is an extremely unlikely failure.

DTC P1643 Wait to Start Lamp Control Circuit

Step	Action	Value(s)	Yes	No
1	**Important**: Before clearing DTC(s) use the scan tool to record freeze frame and failure records for reference, as data will be lost when Clear Info function is used. Was the Powertrain On-Board Diagnostic (OBD) System Check perfommed?	—	Go to Step 2.	Go to *Powertrain OBD System Check*.
2	1. Ignition ON, engine OFF. 2. Using a scan tool, command the Glow Plug system ON. Does the lamp turn ON?	—	Go to Step 3.	Go to Step 4.
3	DTC is intemnittent. If no additional DTCs are stored, refer to Diagnostic Aids. If additional DTCs were stored refer to those table(s). Are additional DTC(s) stored?	—	Go to the applicable DTC table	Go to *Diagnostic Aids*.
4	1. Ignition OFF. 2. Disconnect the PCM connector containing the Wait To Start lamp control circuit. 3. Ignition ON, engine OFF. Is the lamp OFF?	—	Go to Step 5.	Go to Step 7.
5	With a fusede jumper wire connected to ground, probe the Wait To Start lamp control circuit in the PCM harness connector. Is the lamp ON?	—	Go to Step 6.	Go to Step 8.
6	Check connections at PCM. Was a repair perfomned?	—	Go to Step 10.	Go to Step 9.
7	Wait To Start control circuit is shorted to ground, repair as necessary. Is the action complete?	—	Go to Step 10.	—
8	Check the Wait To Start circuit for the following. • Open ignition feed to the bulb • malfunctioning bulb • Control circuit open or shorted to B+. Was a repair performed?	—	Go to Step 10.	—
9	Replace the PCM. **Important**: The new PCM must be programmed. Refer to PCM Replacement/Programming. Is the action complete?	—	Go to Step 10.	—
10	1. Using the Scan Tool, select DTC, Clear Info. 2. Start engine and idle at normal operating temperature. 3. Select DTC, Specific, then enter the DTC number which was set. 4. Operate the vehicle until the Scan Tool indicates that the diagnostic Ran. Does the Scan Tool indicate that the diagnostic Passed?	—	Go to Step 11.	Go to Step 2.
11	Using the Scan Tool, select Capture Info, Review Info. Are any DTCs displayed that have not been diagnosed?	—	Go to the applicable DTC table	System OK.

DTC P1654 Check Throttle Circuit



PCM-015

Circuit Description

A dash light is illuminated by the PCM if diagnostics have detected certain errors related to the Accelerator Pedal Position (APP) sensor. Illumination is accomplished by the PCM providing a ground path for the light circuit. This is a type D DTC.

Conditions for Setting the DTC

- Check Throttle lamp requested “ON”.
- Voltage at the Check Throttle control circuit is greater than 0 volts.

or

- Check Throttle lamp requested “OFF”.
- Voltage at the Check Throttle control circuit is equal to 0 volts.

Action Taken When the DTC Sets

Will not turn “ON” the MIL.

Conditions for Clearing the MIL/DTC

- The PCM will turn the MIL off after three consecutive trips without a fault condition.
- A History DTC will clear when forty consecutive warm-up cycles that the diagnostic does not fail (coolant temperature has risen 5°C (40°F) from start up coolant temperature and engine coolant temperature exceeds 71°C (160°F) that same ignition cycle).
- Use of a scan.

Diagnostic Aids

A faulty bulb or the control circuit shorted to ground will cause a P1654 to set.

Test Description

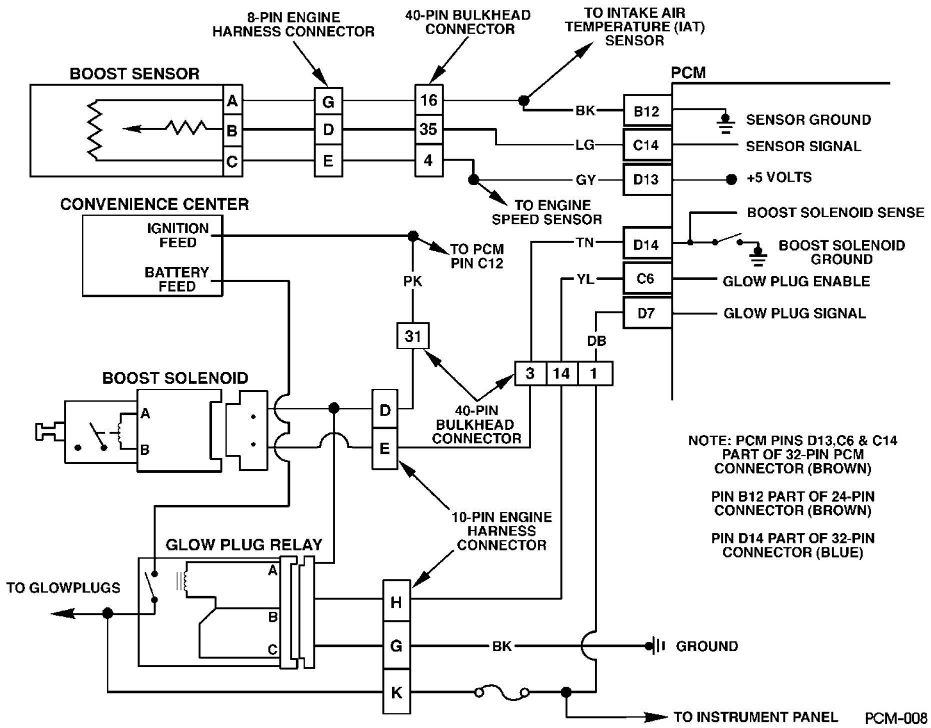
Number(s) below refer to the number(s) on the diagnostic table.

2. This test checks the ability of the PCM to command the Check Throttle lamp on during the bulb check (Check Throttle lamp should be “ON” for 2 seconds and then go out).
3. This test will check the control circuit for a short to ground.
6. This test will check the control circuit for an open.

DTC P1654 - Check Throttle Circuit

Step	Action	Value(s)	Yes	No
1	**Important:** Before clearing DTC(s) use the scan tool “Capture Info” to record freeze frame and failure records for reference, as data will be lost when “Clear Info” function is used. Was the *“On-Board Diagnostic (OBD) System Check”* performed?	—	Go to Step 2.	Go to *OBD System Check.*
2	1. Ignition “ON” engine “OFF”. 2. Using a scan tool, command the lamp ON and OFF. Does the Check Throttle lamp turn ON and OFF with each command?	—	Go to Step 3.	Go to Step 4.
3	DTC is intermittent. If no additional DTCs are stored, refer to “Diagnostic Aids”. If additional DTCs are stored, refer to those charts(s) first. Are additional DTCs stored?	—	Go to applicable DTC table.	Go to *Diagnostic Aids*
4	1. Ignition “OFF”. 2. Disconnect the blue 32 way PCM electrical connector. 3. Ignition “ON” engine “OFF”. Is the lamp “OFF”?	—	Go to Step 5.	Go to Step 7.
5	With a fused jumper wire connected to ground, probe the lamp control circuit in the PCM harness connector. Is the lamp ON?	—	Go to Step 6.	Go to Step 8.
6	1. Check for poor connections at PCM. 2. If a problem was found, repair as necessary. Was a repair performed?	—	Go to Step 10.	Go to Step 9.
7	Check Throttle control circuit is shorted to ground. Is the action complete?	—	Go to Step 10.	—
8	Check the Check Throttle control circuit for the following: • opens • poor connection at PCM • faulty bulb • faulty fuse. Was a problem found?	—	Go to Step 10.	—
9	Replace the faulty PCM. ***Notice:*** If the PCM is faulty, the new PCM must be programmed. Go to *PCM replacement and programming procedures.* Is the action complete?	—	Go to Step 10.	—
10	1. Using the Scan Tool, select “DTC”, “Clear Info”. 2. Start engine and idle at normal operating temperature. 3. Select “DTC”, “Specific”, then enter the DTC number which was set. 4. Operate vehicle within the conditions for setting this DTC as specified in the supporting text. Does the Scan Tool indicate that this diagnostic Ran and Passed?	—	Go to Step 11.	Go to Step 2.
11	Using the Scan Tool, select “Capture Info”, “Review Info”. Are any DTCs displayed that have not been diagnosed?	—	Go to the applicable DTC table	System OK.

DTC P1656 Wastegate Solenoid Control Circuit



Circuit Description

The turbocharger wastegate is a vacuum actuated valve used to control the exhaust gas heat sent to the turbo. The wastegate pulse width modulated solenoid meters the vacuum level at the wastegate valve actuator as commanded by the PCM. When the PCM is commanding the Wastegate solenoid ON, the voltage potential of the circuit will be low (near 0 volts). When the PCM is commanding the wastegate solenoid OFF, the voltage potential of the circuit will be high (near battery volts). The primary function of the PCM in this circuit is to supply the ground for the wastegate solenoid. This is a type B code.

Conditions for Setting the DTC

- Conditions for Setting the DTC
- PCM requested Wastegate solenoid ON.
- Voltage on Wastegate solenoid control circuit high (near battery volts).
- 2 consecutive faults detected.
- Conditions met for 2 seconds.
- or
- PCM requested Wastegate solenoid OFF.
- Voltage on Wastegate solenoid control circuit low (near 0 volts).
- 2 consecutive faults detected.
- Conditions met for 2 seconds.

Action Taken When the DTC Sets

Low Power.

Conditions for Clearing the MIL/DTC

- The PCM will turn the MIL off after three consecutive trips without a fault condition.
- A History DTC will clear when forty consecutive warm-up cycles that the diagnostic does not fail (coolant temperature has risen 5° C (40° F) from start up coolant temperature and engine coolant temperature exceeds 71° C (160° F) that same ignition cycle.
- Use of a Scan Tool.

Diagnostic Aids

This diagnostic will set when control circuit does not follow the PCM command (when the solenoid is requested ON voltage will drop, when the solenoid is OFF ignition voltage will be present). The scan tool has a 5 second ON time abort. The wastegate solenoid can be commanded ON for as many times as needed, in 5 second intervals. Its possible DTC P0236 may set along with DTC P1656. This diagnostic can be checked during key up. The engine will not respond to scan tool commands at idle (engine unable to achieve boost pressures greater than BARO at idle) or at any engine speed greater than idle (PCM control abort to prevent engine damage).

Test Description

Number(s) below refer to the step number(s) on the Diagnostic Table.

2. Be sure that both the ON and OFF states are commanded. Repeat the commands as many times as necessary.
3. This check can detect a partially shorted coil which would cause excessive current flow. Leaving the circuit energized for 2 minutes allows the coil to warm up. When warm, the coil may open (Amps drop to zero), or short (Amp draw greater than 0.75A).

14. If no trouble is found in the control circuit or the connection at the PCM, the PCM may be malfunctioning. However, this is an extremely unlikely failure.

.

DTC P1656 Wastegate Solenoid Control Circuit

Step	Action	Value(s)	Yes	No
1	**Important**: Before clearing DTCs use the scan tool Capture Info Was the Powertrain On-Board Diagnostic (OBD) System Check perfom-med?	—	Go to Step 2.	Go to *OBD System Check.*
2	1. Scan tool connected. 2. Ignition ON, engine OFF. 3. With scan tool, command Boost solenoid ON and OFF and listen for an audible click. Does the solenoid turn ON and OFF (audible click) with each command?	—	Go to Step 3.	Go to Step 5.
3	1. Ignition OFF. 2. Disconnect the PCM connector containing the Boost solenoid control circuit. 3. Ignition ON. 4. Using DVM J 39200 on 10 Amp scale, measure current from the sole-noid control circuit in the PCM harness connector to ground for 2 min-utes. Is current draw less then the specified value, but not zero?.	0.75A	Go to Step 8.	Go to Step 4.
4	1. Ignition OFF. 2. PCM connector still disconnected. 3. Disconnect Boost solenoid. 4. Using DVM J 39200, measure resistance from the solenoid control cir-cuit in the PCM harness connector to ground. Does DVM display infinite resistance?	—	Go to Step 13.	Go to Step 10.
5	1. Disconnect Boost solenoid. 2. Ignition ON, engine OFF. 3. Connect a test light between the terminals at the harness connector. 4. Using a scan tool. command the solenoid ON and OFF. Does test light turn ON and OFF with each command?	—	Go to Step 9.	Go to Step 6.
6	1. Ignition ON engine OFF. 2. With a test light connected to ground, probe the ignition feed circuit at the Boost solenoid harness connector. Is the test light ON?	—	Go to Step 7.	Go to Step 12.
7	1. Ignition OFF. 2. Reconnect solenoid. 3. Disconnect the PCM harness containing the solenoid control circuit. 4. Ignition ON. 5. With a fused jumper wire connected to ground, probe the solenoid con-trol circuit in the PCM hamess connector. Does the solenoid operate (audible click)?	—	Go to Step 11.	Go to Step 10
8	DTC is intermittent. If no additional DTCs are stored, refer to Diagnostic Aids. If additional DTCs were stored refer to the applicable DTC table(s) first. Are any additional DTCs stored?	—	Go to the applicable DTC table	Go to *Diag-nostic Aids*

DTC P1656 Wastegate Solenoid Control Circuit

Step	Action	Value(s)	Yes	No
9	Check for a poor connection at the Boost solenoid and replace temminals as necessary. Did the temminals require replacement?	—	Go to Step 15.	Go to Step 13
10	Repair Boost solenoid control circuit. Is the action complete?	—	Go to Step 15.	—
11	Check for a poor connection at the PCM, Boost solenoid control circuit. Was a problem found?	—	Go to Step 15.	Go to Step 14
12	Repair the open in the ignition feed circuit. Is the action complete?	—	Go to Step 15.	—
13	Replace the Boost solenoid. Refer to Wastegate Solenoid Is the action complete?	—	Go to Step 15.	—
14	Replace the PCM. **Important**: The new PCM must be programmed. Refer to PCM Replacement/Programming. Is the action complete?	—	Go to Step 15.	—
15	1. Using the scan tool, select DTC, Clear Info. 2. Start engine and idle at nommal operating temperature. 3. Select DTC, Specific, then enter the DTC number which was set. 4. Operate vehicle until the Scan Tool indicates that the diagnostic Ran. Does the scan tool indicate that this diagnostic Passed?	—	Go to Step 15.	Go to Step 2
16	Using the scan tool, select Capture Info, Review Info. Are any DTCs displayed that have not been diagnosed?	—	Go to the applicable DTC table	System OK

Section 3 Fuel, Emissions, and Exhaust

TABLE OF CONTENTS

FUEL SYSTEM

The fuel system components include:

- A 25 gallon (94.6 liter) fuel tank
- Fuel tank supply and return lines
- An electric fuel-lift pump
- A fuel filter-water separator assembly
- A gear driven fuel injection pump
- Individual fuel injector nozzles for each cylinder
- Fuel line check valves on the filtered side of the fuel system
- Fuel level transmitter (in fuel tank)
- Fuel drain back lines (at pump and injectors)
- A 17 gallon (64.3 liter) auxiliary fuel tank and selector switch
- Glow plugs (all cylinders)

The fuel supply and return lines are attached with quick connect fittings.

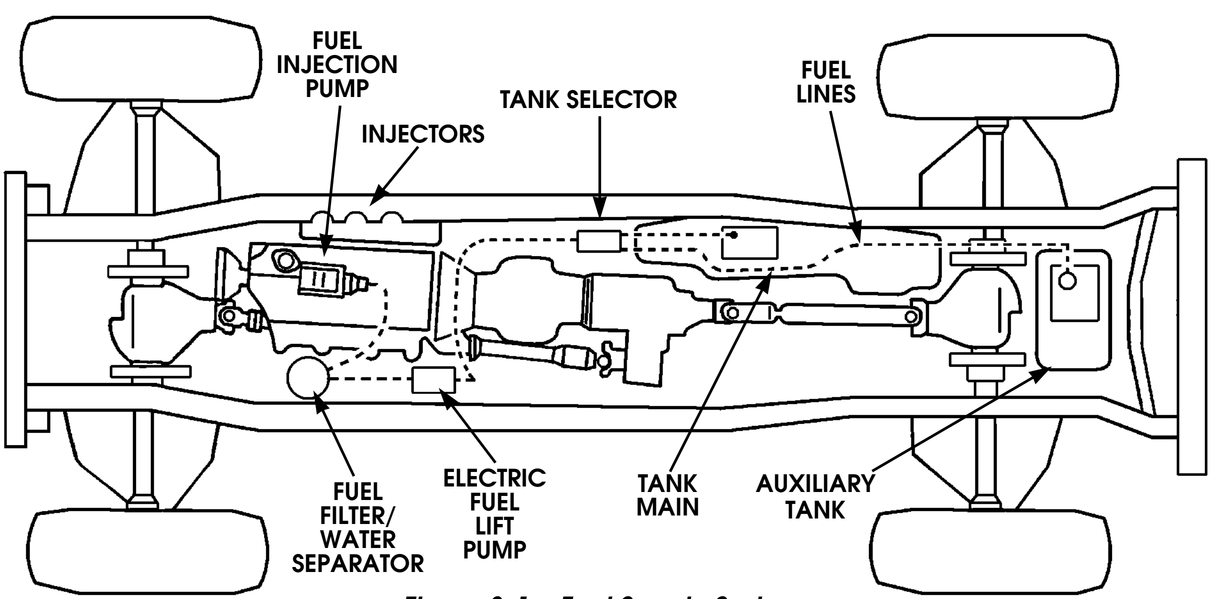


Figure 3-1: Fuel Supply System

Fuel Lift Pump

The fuel lift pump is located on the firewall near the drivers side of the engine. The electric fuel lift pump has a hollow plunger that slides in a bore located in the center passage between the inlet and outlet ports (Figure 3-2). An inlet valve is mounted on one end of the hollow plunger, and an outlet valve is positioned at the outlet end of the center passage. Both valves are closed by spring force.

The lift pump is designed to move fuel under a low (suction) pressure from the fuel tank and deliver it through the filter to the transfer pump, inside the fuel injection pump. To operate correctly, the injection pump must have fuel at the correct pressure and without air bubbles.

The lift pump is checked as part of the fuel supply system diagnosis. The lift pump should deliver fuel with a minimum volume of one half pint (0.24 liter) in 15 seconds and tee'd in at the injection pump fuel inlet connection running at idle, with a pressure of 5.8 to 8.7 psi (40 to 60 kPa). The lift pump suction line from the fuel tank must be air tight for correct operation of the injection pump. **Any air present in the fuel system will cause runability problems and possible diagnostic trouble codes (DTCs) to be set in PCM memory**

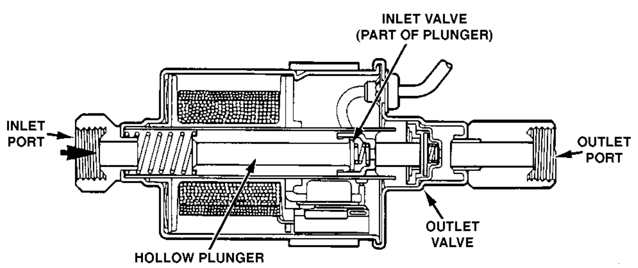


Figure 3-2: Fuel Lift Pump Construction

The fuel lift pump electrical circuit of the naturally aspirated engine includes the following main components (Figure 3-3):

- The oil pressure switch threaded into a lubrication system passage at the left rear of the cylinder block.
- A relay mounted near the junction block on the vehicle cowl, drivers side.
- The lift pump itself, mounted near the filter on the left side of the engine compartment.

When the driver moves the ignition switch to the CRANK” position, the lift pump relay is energized. The lift pump receives voltage directly from the relay through the fuse in the “CRANK” position. When the ignition switch is moved to the “RUN” position after cranking long enough to raise oil pressure above 5 psi (34 kPa), voltage is supplied to the fuel lift pump through the oil pressure switch independent of the relay.

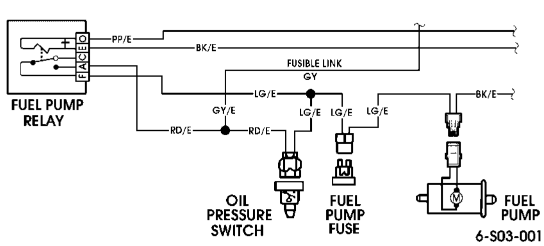


Figure 3-3: Fuel Lift Pump Electrical Circuit (NA)

The electrical circuit for the lift pump (Turbo) involves several main components (Figure 3-4):

- The oil pressure switch/sending unit, threaded into a lubrication system passage in the cylinder block valley.
- A relay mounted near the junction block on the vehicle cowl, drivers side.
- The lift pump itself, mounted near the filter on the left side of the engine compartment.

When the driver moves the ignition switch to the “RUN” position, the lift pump relay is energized by the PCM for 5 to 20 seconds, depending on residual pressure and PCM time out.

As soon as the PCM receives RPM signals from the EFI pump the relay is energized again. The lift pump remains running as long as the engine runs.

As a backup to the relay a redundant circuit through the oil pressure switch is provided.

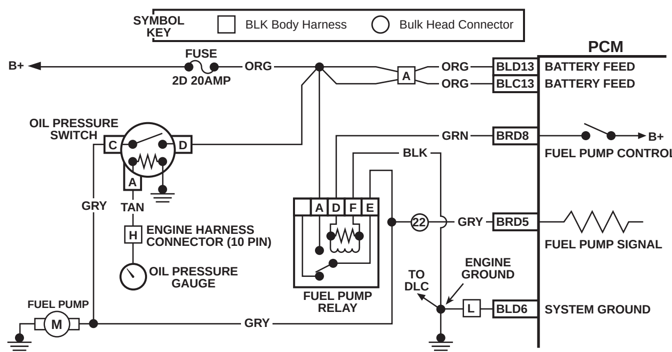


Figure 3-4: Fuel Lift Pump Electrical Circuit (Turbo)

Fuel Filter-Water Separator

The filter-water separator is located at the driver side of the engine compartment firewall (Figure 3-5). It performs five functions which are:

- Fuel filtering (2-stage)
- Water separation
- Water detection
- Water drain
- Fuel heater

Fuel filtering and water separation is through a 2-stage, replaceable filter element. The filter second stage causes water to separate from the fuel in the form of droplets. These droplets are collected in a reservoir at the bottom of the filter element housing. Water is then drained off through a drain valve and hose. The drain valve is located in the driver side wheel well.

Water detection and fuel heating are controlled by sensors in the filter housing. Water build-up causes the water sensor to activate the instrument panel “drain filter” warning light. Fuel heating occurs during cold ambient temperatures. It is controlled by a sensor in the fuel inlet port that monitors incoming fuel temperature. When temperature falls to a point where wax build-up could occur, the sensor activates the heat element within the filter housing. The heater will continue to operate until incoming fuel temperature is at or above 46° F (8° C).

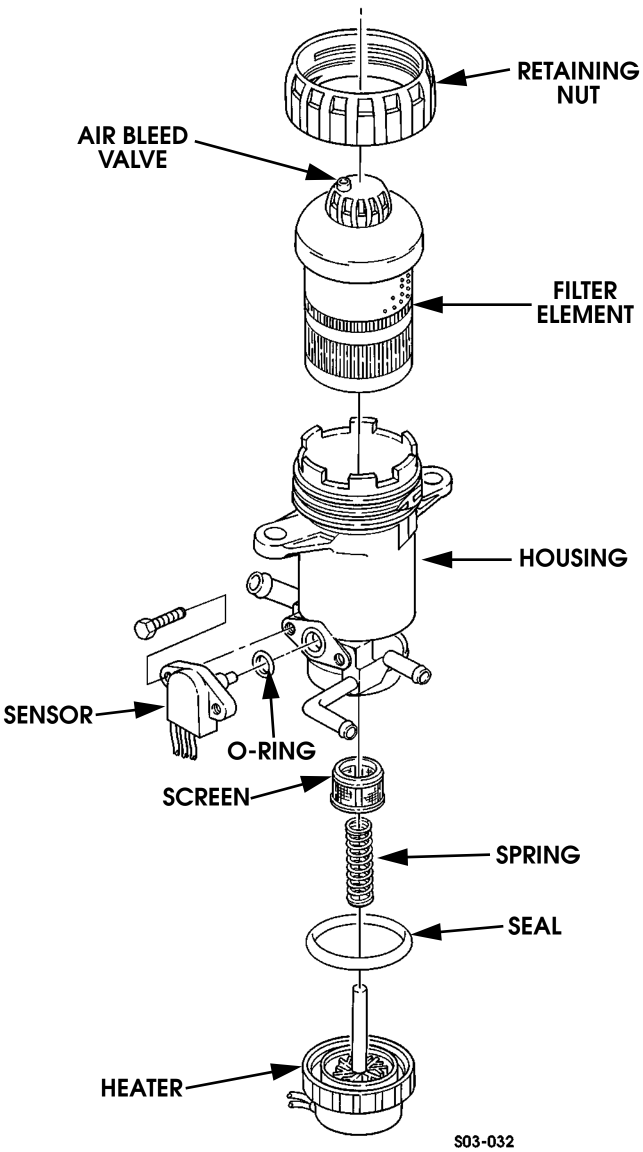


Figure 3-5: Fuel Filter Breakdown

Fuel Injection Pumps

The gear-driven injection pumps used for NA diesel and turbo diesel applications perform three basic functions, which are: fuel metering, fuel pressurization, and fuel distribution. A mechanical pump is used on NA diesel models. A PCM controlled, electronic pump is used on turbo diesel models.

Mechanical Pump (DB2)

On NA diesel models, fuel metering is performed by the metering valve. A rotary type pump mechanism pressurizes fuel to the injectors. Pressure at the injector nozzles is approximately 1800 psi (124 bar). Residual pressure in the injector lines is maintained at 500 psi (3447 kPa) during operation.

Fuel distribution to individual injectors occurs at the pump head and rotor assembly (Figure 3-6). High strength, plated steel lines are used to connect each injector to the pump.

The drive mechanism for the pump consists of a drive gear on the camshaft, and a driven gear on the pump. The pump is operated at camshaft speed in the opposite direction of rotation.

Throttle “opening” is controlled by a mechanical linkage assembly and limited by a mechanical governor.

The injection pump is equipped with a shut off solenoid controlled by the ignition switch. The purpose of the solenoid, is to close and stop fuel flow within the pump. This occurs when the ignition switch is moved to the “Off” position and the solenoid is de-energized causing spring pressure to close the solenoid valve.

DB2 pumps are equipped with a cold advance solenoid actuated by a cold advance switch in the rear of the right cylinder head. The purpose of the solenoid is to advance pump timing about 4° during cold weather operation. This improves cold starts, idle speed operation, and reduces white smoke.

Idle speed is adjusted at the throttle lever low idle screw and fast idle speed is adjusted at the fast idle solenoid.

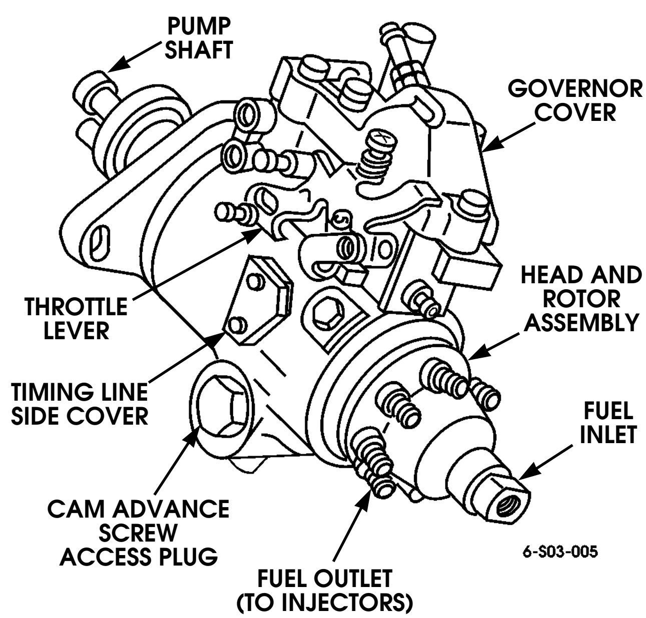


Figure 3-6: Mechanical Fuel Injection Pump (NA Diesel)

Electronic Pump

The turbo diesel injection pump (Figure 3-7) is controlled by the powertrain control module based on inputs from the electronic accelerator pedal and various engine sensors.

The drive mechanism for the pump consists of a drive gear on the camshaft, and a driven gear on the pump. The pump is operated at camshaft speed in the opposite direction of rotation.

A rotary type pump mechanism pressurizes fuel to the injectors. Pressure at the injector nozzles is approximately 2000 psi (138 bar). Residual pressure in the injector lines is maintained at 500 psi (3447 kPa) during operation.

Fuel distribution to individual injectors occurs at the pump head and rotor assembly and is activated by the fuel solenoid driver. High strength, plated steel lines are used to connect each injector to the pump.

The powertrain control module controls injection timing and fuel mixture according to input signals from various sensors.

A crankshaft position sensor and optical sensors are used to provide engine and injection pump position and speed signals. These signals are transmitted to the PCM and used as reference for fuel flow and timing.

The injection pump is equipped with a shut off solenoid controlled by the PCM. The purpose of the solenoid, is to close and stop fuel flow within the pump. This occurs when the ignition switch is moved to the “Off” position. At this point, loss of PCM hold-open voltage de-energizes the solenoid causing it to close.

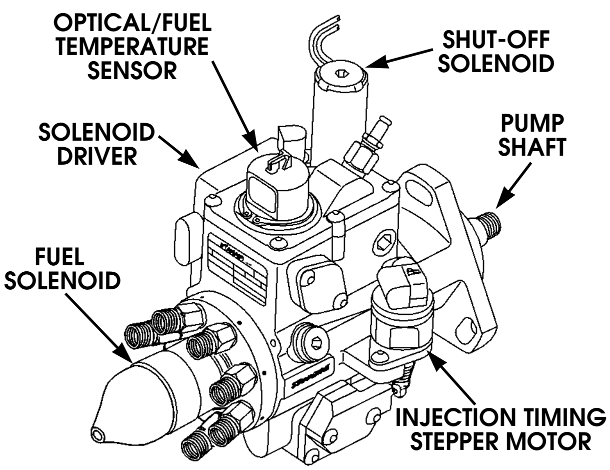


Figure 3-7: Electronic Fuel Injection Pump (Turbo Diesel)

Fuel Injectors

An identical fuel injector is used for each cylinder. The injector is threaded into the cylinder head and positioned so the injector nozzle extends into the combustion prechamber.

The injectors are a spring loaded, valve and pintle design (Figure 3-8). The pintle forms the injector nozzle and the valve seats in the nozzle tip opening.

Fuel is supplied to each injector and in the necessary sequence, by the fuel injection pump. The high pressure fuel pulse overcomes spring pressure lifting the valve off its seat. Pressurized fuel then enters the prechamber through the nozzle in the form of a highly atomized spray.

A small amount of fuel travels around the nozzle and valve for lubrication purposes. This fuel cycles back to the fuel return system through the fuel return ports at the upper end of each injector.

Different injectors are used for turbo and NA diesel applications. Do not interchange them. In addition, the fuel injectors are not repairable and are serviced only as an assembly. However, they may be cleaned to remove contamination.

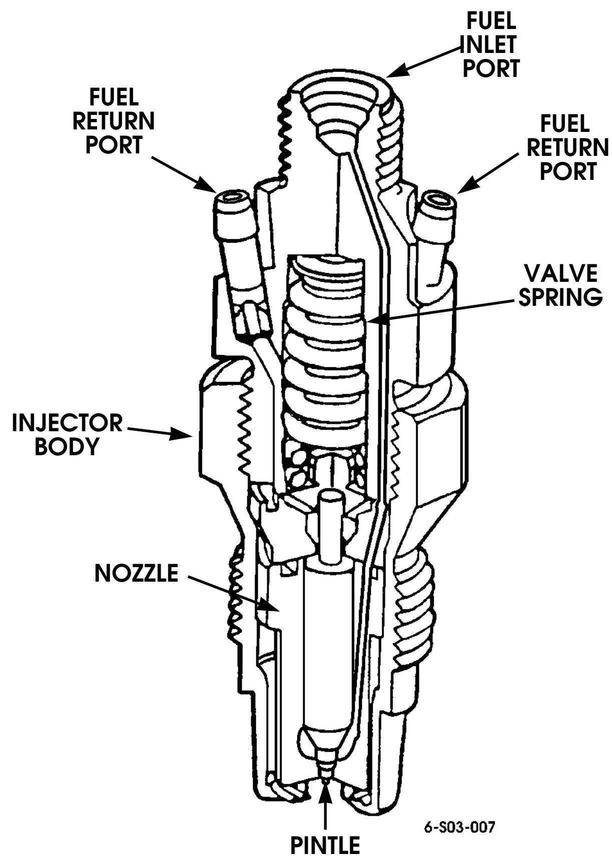


Figure 3-8: Fuel Injector Components (Diesel)

Fuel Tanks, Lines, and Valves

The main and auxiliary fuel tanks are made of high density polyethylene. Auxiliary fuel tank capacity is 17 gallons (64.3 liters). Main tank capacity is 25 gallons (94.6 liters).

Quick connect fittings are used at most of the fuel line connection points. Tool J–37088-A will be required for disconnection purposes, however, re-connecting the lines only requires a firm push to “snap” the line into place.

Fuel level transmitters for main and auxiliary tanks are mounted within the tanks. A selector valve, mounted on the passenger side of the frame, controls fuel flow and tank selection.

A check valve is used in the supply and return lines to prevent backflow. Vent lines are used at both tanks to avoid internal pressure buildup.

Fuel return lines are used to send unused fuel from the injectors and the injection pump back to the fuel tanks.

Glow Plugs

The diesel engine glow plugs are threaded into the cylinder head and extend into the combustion prechamber. The purpose of the plugs is to heat air entering the combustion chambers to begin the combustion process.

The glow plugs are used as an aid to starting; especially when ambient temperatures are low. The plugs are cycled on/off for short time periods during engine cranking and initial start-up. The plugs are not on continuously, as plug damage can occur after 6-7 seconds.

Naturally aspirated engines use a glow plug controller/relay which cycles the plugs on/off. The relay is located at the rear of the engine adjacent to the passenger side rocker cover. The relay is energized when the ignition switch is in Run and Start positions. The relay does not stop cycling the plugs after start-up. The relay continues glow plug operation until its internal temperature sensor shuts the relay off.

Turbo diesel engines use a glow plug relay that is controlled by the PCM based on inputs from engine temperature sensors. The glow plugs will cycle after the engine has started in cooler ambient temperatures.

ELECTRONIC ACCELERATOR PEDAL (TURBO DIESEL MODELS)

Turbo diesel models are equipped with an electronic accelerator pedal assembly (Figure 3-9). The assembly consists of a pedal and arm, mounting bracket, and potentiometer module.

The pedal potentiometer module contains three potentiometers that send varying voltage signals to the PCM. By comparing the different voltage signals against a standard, the PCM can determine fuel delivery rate based on accelerator pedal position.

A “check throttle” warning light is included in the electronic accelerator pedal circuit.

Some faults in the pedal potentiometer module or related wiring will trigger the check throttle warning light. The light is located in the instrument panel adjacent to the check engine light (MIL). Some faults will cause loss of cruise control only and multiple faults in the APP circuit can result in decreased performance or engine idle only.

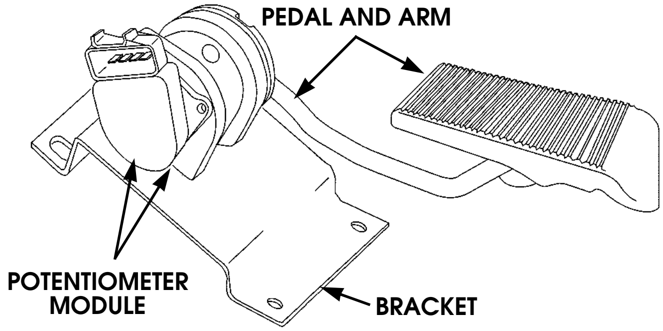


Figure 3-9: Electronic Accelerator Pedal Components

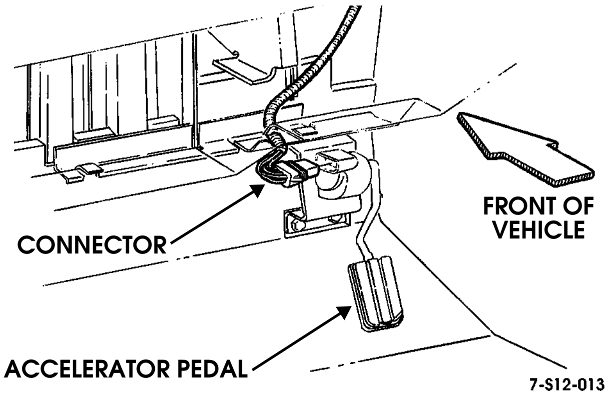


Figure 3-10: Electronic Accelerator Pedal (Location)

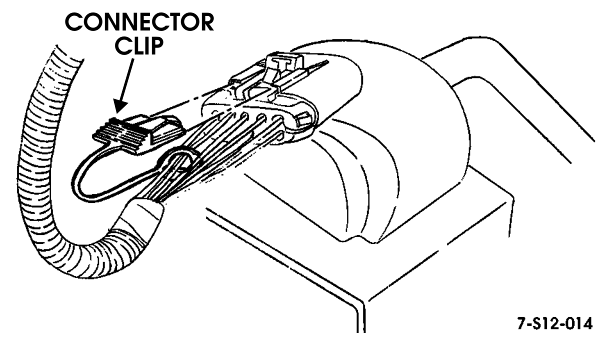


Figure 3-11: Accelerator Pedal Connector Clip

Electronic Fuel Injection Pump Operation

The electronic fuel injection pump is operated by the powertrain control module. The pump contains a fuel solenoid driver, an optical and fuel temperature sensor, a shut off solenoid, a stepper motor, and a fuel solenoid. Additional signal sources that affect pump operation are: the baro sensor, boost sensor, coolant temperature sensor, and electronic accelerator pedal.

At initial engine start, the fuel/lift pump continuously supplies fuel to the injection pump.

A change in accelerator pedal position to part throttle, causes an equivalent change in pedal potentiometer voltage output. The PCM then signals the solenoid driver to increase fuel flow. Flow rates are further refined based on various signals from engine sensors.

The boost sensor monitors changes in intake manifold pressure. Pressure changes are converted into a voltage signal transmitted to the PCM. High voltage readings indicate high manifold pressures and low voltage indicates low pressure.

The intake air temperature sensor monitors incoming air temperature. Cold air generates high sensor resistance readings while warm air generates lower readings. The resistance is sensed by the PCM which richens or leans the fuel mixture as needed.

Barometric pressure is monitored by the baro sensor. The sensor signal is used by the PCM to adjust injection pump timing and fuel mixture for different altitudes.

The stepper motor advances/retards injection timing on command by the PCM. Signals from the optical, air temperature, crankshaft position, coolant temperature, and fuel temperature sensors, are all utilized by the PCM to optimize settings.

Fuel injector cycles are monitored by the fuel solenoid (which controls injection). The solenoid returns a pulse width signal to the PCM everytime it seats. This signal indicates injection has occurred at one of the injectors.

The fuel solenoid driver is controlled by the PCM. Its function is to operate the fuel solenoid on command from the PCM. The fuel solenoid in turn, sends the high pressure fuel pulses (or pressure waves) to each injector. Fuel metering is performed by the driver and solenoid jointly. Flow rates however, are controlled by the PCM.

POWERTRAIN CONTROL MODULE (PCM)

The PCM, used on the turbo diesel only, is on a bracket attached to the engine cover. The diagnostic/data link connector is the access point for the scan tool. The connector is under the instrument panel at the left side of the steering column. It is a multi-pin connector with integral mounting bracket.

The PCM controls operation of the shutoff solenoid, glow plug controller/relay, fuel lift pump relay and injector timing sequence.

The PCM also controls the boost solenoid, fuel solenoid driver, fuel solenoid, and stepper motor.

Signal inputs used by the diesel PCM include:

- Coolant temperature
- Intake air temperature
- Boost pressure
- Optical/fuel temperature sensor
- Crankshaft position sensor
- Pedal position sensors (APP)
- Cruise control
- A/C switch
- Vehicle speed sensor

FUEL SYSTEM DIAGNOSIS

General Information

Fuel system diagnosis should begin with a preliminary inspection followed by a road test to confirm existence of a problem.

Preliminary inspection consists of visual checks designed to rule out faults caused by leaks, fuel line damage, or loose electrical connections.

Preliminary Inspection

1. Check fuel gauge readings for main and auxiliary tanks.
2. Visually inspect fuel lines at tanks, selector valve, fuel pump, and at engine. Look for loose, damaged, leaking lines.
3. Check vacuum actuator hose on turbo diesel models.
4. Check wiring for fuel lift pump.
5. Check glow plug and relay wiring. Also check electronic accelerator pedal wiring on turbo diesel. Look for loose connections at all points (including battery), or for damaged, pinched wires.
6. Check serpentine drive belt tension and condition. Also check NA diesel throttle cable and/or lever operation.
7. Note if any indicator lights are on. If engine runs, also check voltage, oil pressure, and coolant temperature readings.
8. Check exhaust system components for damage, loose joint connections, or grounding against body.
9. Inspect transmission linkage and wiring connections, especially if vehicle is used for off road operation.
10. If vehicle is drivable, and no obvious problems are found, road test vehicle. If vehicle is not drivable, refer to diagnosis charts and scan tool diagnosis.

Road Test

1. Note battery voltage. Low voltage can cause PCM power-up and initialization problems. Battery voltage should be no lower than 11.5 volts for satisfactory operation.
2. Connect scan tool to diagnostic connector. Set tool to record fault codes, or have helper use tool to interrogate system during test.
3. Start engine and check idle operation. Note any faults such as rough idle, stalling, excessive smoke.
4. Apply service brake and shift transmission into drive range. Note if engine stalls, runs rough, or another fault occurs.
5. Drive vehicle on road at posted limits. Note operation under light and heavy acceleration, and at normal cruise speeds. Note faults such as surge, miss, vibration, noise, low power, smoke (blue, black, white).
6. Shift into neutral at cruise speed and note engine operation. If vibration or noise was experienced but it now stops, problem may be with drive belt, engine mount, accessory, U-joint, or torque converter.
7. Return to shop and note fault codes recorded by PCM. If a fuel system fault was noted during road test, refer to diagnosis charts, perform fuel system tests, and check system electrical components with scan tool.

Fuel System Diagnosis—Diesel Engine

PROBLEM	POTENTIAL CAUSE	CORRECTION
Hard Starting	1. Driver/owner not following recommended start procedure.	1. Remind driver/owner of required procedure. Demonstrate procedure if necessary.
	2. Fuel contaminated, low qualty, or wrong fuel.	2. Drain off sample at fuel filter drain plug. Flush tank, lines, and filter if fuel is contaminated, wrong grade or type, suspect quality, or shows wax buildup.
	3. Air filter plugged.	3. Remove and clean filter, housing, air horn and inlet hose. Replace filter if plugged.
	4. Excessive water in fuel filter.	4. Drain off water at drain plug. Then remove, clean, and reinstall filter.
	5. Fuel pump intermittent or not engergized by relay or oil pressure switch. Caused by low oil level or oil pressure below 4 psi (28 kPa).	5. Check fuel pump circuit fuse, relay, wiring. Then check oil pressure switch and wiring. If engine oil pressure is low (on gauge), perform pressure test and replace pump if necessary.
	6. Fuel-lift pump fault.	6. Test pump pressure at pump outlet. Replace pump if pressure is below 5.8 psi (60 kPa).
	7. Fuel return, drain, or vent line restricted, plugged, or damaged.	7. Check lines for damage. Verify flow with compressed air. Repair or replace lines as necessary.
	8. Coolant temperature sensor fault.	8. Repair wiring or replace sensor if temperature readings are 5° greater or less than actual ambient air temperature. High resistance in sensor or circuit wiring will cause this.
	9. Glow plug fault.	9. Test voltage to and from relay/controller, and at plugs. Repair wiring, replace relay/controller, or replace glow plug(s) as needed. Refer to test procedures in this section and in sections 2 and 12.
	10. Shut-off solenoid fault.	10. Test and replace solenoid if necessary. Be sure solenoid fuse and wiring are OK beforehand. Look for bad connections if problem is intermittent.
	11. No cranking signal to PCM (turbo diesel models)	11. Test with scan tool. Look for bad ground, connections, or damaged/failed crankshaft position sensor.
	12. Exhaust system restriction.	12. Look for damaged pipes, muffler, converter, especially on vehicles used off road.
	13. Low engine cranking speed.	13. Check state of charge of batteries, load test and check connections. Refer to test procedures in Section 12. Check engine oil viscosity to ensure it is correct for the ambient temperature. Refer to specifications in Section 1. Check starter draw to determine if starter is dragging. Refer to test procedure in Section 12.

Fuel System Diagnosis—Diesel Engine

PROBLEM	POTENTIAL CAUSE	CORRECTION
No Start Condition (engine cranks but will not run)	1. Excessive amount of water or wax buildup in system.	1. Draw off sample at drain plug. Drain and flush system if necessary.
	2. Blown fuse.	2. Replace fuse. Check for shorts-grounds in affected circuit.
	3. No fuel to injection pump.	3. Test fuel-lift pump output. Replace pump if pressure is below 5.8 psi (60 kPa). Check lines and filter for restrictions if pump output is OK. Also test pump relay and oil pressure switch circuits. Be sure pump relay is being energized when ignition switch is in crank or start position.
	4. No fuel to injectors.	4. Check shut off solenoid (all models). On turbo diesel models, check fuel solenoid driver feed (terminal A) and ground (terminal C) circuits.
	5. Engine fault: • broken camshaft • damaged injection pump gears • timing chain or gear failure	5. Inspect and repair as needed.
	6. Fuel tank select valve problem.	6. Replace valve if it won't switch from main to auxiliary and back.
	7. No inject signal to PCM (turbo diesel only).	7. Run scan tool test and replace failed sensor, harness wire, or connector.
	8. Injection pump failure.	8. Replace pump but only if failure is indicated by scan tool and pressure test.
	9. PCM ground or feed circuit fault (on ground or ignition voltage reference signal).	9. Confirm with scan tool. Use multimeter and test lamp to locate faulty circuit.
	10. PCM fault.	10. Confirm with scan tool before replacement.
Engine Starts then Stalls	1. Air leak in fuel feed line.	1. Inspect lines and repair as needed. Bleed injectors afterward.
	2. Glow plug fault (cold ambient temperature).	2. Test and repair wiring, or replace failed glow plugs or relay/controller.
	3. Restriction in fuel tank vent or return lines.	3. Inspect and clear restriction. Replace cap vent, or lines as needed.
	4. Fuel-lift pump pressure below 2 psi (14 kPa) at injection pump, or 5.8 psi (40 kPa) at fuel pump outlet.	4. Replace pump but only if fuel lines to pump are not blocked, plugged, or restricted. Also be sure flow through 2-stage filter is not restricted as well.
	5. Idle rpm too low.	5. Adjust idle to required rpm.
	6. No injection signal to PCM (turbo diesel).	6. Test with scan tool and replace failed sensor or harness.

Fuel System Diagnosis—Diesel Engine

PROBLEM	POTENTIAL CAUSE	CORRECTION
Low Power, Sluggish Acceleration	1. Contaminated or low-quality fuel.	1. Drain, flush, and refill fuel system.
	2. High fuel temperature.	2. Normal condition in high ambient.
	3. Restriction in air intake system.	3. Remove and clean filter, housing, weathercap, hose, air horn.
	4. Throttle cable problem.	4. Adjust cable or replace it if damaged.
	5. Fuel tank vent or return line restriction.	5. Clear restrictions, replace lines.
	6. Exhaust system restriction.	6. Inspect entire system for damage and repair as needed. If vehicle is used for off-road operation, look for kinking, bent, or flattened pipes or muffler.
	7. Air leak at injector or line.	7. Tighten loose fittings or replace lines if necessary.
	8. Brake drag.	8. Inspect brake components. Look for seized or binding caliper piston, master cylinder problem, or failed hydro-boost.
	9. Torque converter problem. Overrunning clutch failure, or converter clutch binding, or slipping. Either fault will cause high fuel consumption and require more than normal throttle opening for acceleration.	9. Test operation with scan tool. Use snapshot mode to record maximum data. Replace converter if either clutch is damaged.
	10. Engine compression low.	10. Run compression test. Repair valves, cam, chain, rings as needed.
	11. Injection pump mistimed.	11. Check and correct pump timing. Replace either pump gear if damaged.
	12. Turbo diesel electronic accelerator fault such as short, ground, loose connection indicate potentiometer failure.	12. Check pedal potentiometer wires and connections. Test with scan tool if check throttle light is on. Repair wiring, or replace pedal assembly.
	13. One or more injectors failing.	13. Remove and test injectors. Replace faulty injectors as needed.
	14. Air leak at intake manifold.	14. Locate with soap and water solution (or oil). Tighten bolts, replace gaskets, or replace manifold if required.
	15. Turbocharger inoperative or no boost.	15. Check boost output. Replace wastegate actuator if leaking. Repair vacuum line if damaged. Replace turbocharger if compressor or turbine wheel vanes are broken, chipped, or if compressor shaft is seized/broken.
	16. Sensor failure (coolant or air temp, baro or boost sensors, etc.).	16. Locate with scan tool. Test with multimeter and replace as needed.
	17. PCM signal voltage too low.	17. Check battery voltage and generator output. Repair or replace parts as needed if voltage is below 10, or above 16.
	18. Injection pump fault.	18. Replace pump.

Fuel System Diagnosis—Diesel Engine

PROBLEM	POTENTIAL CAUSE	CORRECTION
Knock-Ping Under Acceleration.	1. Contaminated, incorrect, or low quality fuel.	1. Drain, flush, and refill fuel system.
	2. Air leak in fuel delivery system.	2. Inspect injector line fittings. Bleed injectors and tighten any loose fittings. Check all fuel supply lines for leaks.
	3. Engine overheat caused by low coolant level.	3. Add coolant. Repair leaks.
	4. Coolant and/or air temperature sensor fault.	4. Check with scan tool and replace as needed.
	5. Injection pump timing off.	5. Check and correct as needed.
	6. Worn valve seals or guides allowing oil into combustion chambers.	6. Repair engine as required.
	7. Carbon buildup on pistons and in chambers as result of substandard fuel, additives, or oil entering chamber past worn rings or through valve guides.	7. Use combustion chamber conditioner to break down carbon. Engine disassembly will be necessary if conditioner is not effective.
Black, White, or Blue Smoke at Idle and/or Under Load	1. Incorrect or substandard fuel.	1. Drain and refill tanks with correct fuel.
	2. Glow plug fault (white smoke at cold start-up).	2. Test and replace failed plugs, wires, or relay/controller.
	3. Worn piston rings, valve guides or stem seals (blue smoke) allowing oil into combustion chamber. High oil consumption may also be noted by owner.	3. Repair guides, replace seals, or replace rings as needed.
	4. Overrich mixture (black smoke) caused by stuck injector.	4. Test and replace any injectors that fail pressure leak test.
	5. Low fuel pump pressure (at pump).	5. Replace fuel-lift pump if pressure is below 2 psi (14 kPa) at pump.
	6. Timing advanced (white smoke at cold idle, black smoke under load when hot).	6. Check and adjust as necessary.
	7. Cold advance solenoid or switch fault (white smoke).	7. Test and replace solenoid/switch as required.
Rough Idle and/or Hesitation Under Acceleration	1. Substandard fuel.	1. Drain and replace fuel.
	2. Air leak in fuel line or injector.	2. Locate and correct leak. Bleed all injectors afterward.
	3. Fuel filter cap or tank vent restriction.	3. Replace cap or vent hose as required.
	4. Injector fault.	4. Locate and replace faulty injector.
	5. Intake manifold leak.	5. Replace manifold or gaskets as needed.

SCAN TOOL DIAGNOSIS

The scan tool is needed for operational testing of electronic components such as the PCM, electronic accelerator pedal potentiometer, and engine sensors.

The scan tool is connected to the vehicle electrical system through the diagnostic/data link connector. The connector is a black 16-way part. It is located under the instrument panel near the steering column.

Refer to Section 2 for detailed information on scan tool use.

Fuel Pump Pressure Test

Fuel pump pressure should be 5.8-8.7 psi (40-60 kPa) at idle.

1. Disconnect shut-off solenoid at injection pump on N/A engines and fuse 6B on turbo diesel engines.
2. Loosen fuel filler cap.
3. Disconnect fuel line at fuel filter inlet port.
4. Install a tee adapter in fuel line between pump and filter inlet port.
5. Connect test gauge to tee adapter. Gauge should have pressure capacity up to 20 psi (138 kPa).
6. Start and run engine and record fuel pump pressure.
7. If pump pressure is less than 5.8 psi (40 kPa), replace pump and retest pressure.
8. Remove pressure gauge and tee adapter. Reconnect fuel line to filter inlet.
9. Tighten fuel filler cap and reconnect shut-off solenoid.

Diesel Fuel Injector Test

WARNING: Pressure test tool J–29075-AMG duplicates normal injector operating pressures which can exceed 1700 psi (117 bar). Never place hands or arms near the injector nozzle during the test. The high pressure, finely atomized spray from the nozzle can penetrate flesh, destroy tissue, and result in blood poisoning. It is recommended that a clear protective receptacle be positioned around the injector to contain the spray. A receptacle can be fabricated from 3/16 to 1/4 in. clear plastic for test purposes.

Pressure test tool J–29075-AMG, injector adapter kit J–29079-125, a length of clear plastic 1/8 or 3/16 I.D. tubing, and a drip pan are required for the test.

1. Locate faulty injector by loosening fuel line fitting momentarily at each injector. Faulty injector will not have much affect on engine operation.
2. Remove suspect injector(s) from engine.
3. Install clear plastic tube on fuel drain/return ports on injector.
4. Attach injector to fitting and line on test tool (Figure 3-12).
5. Close shutoff valve on tool (Figure 3-12).

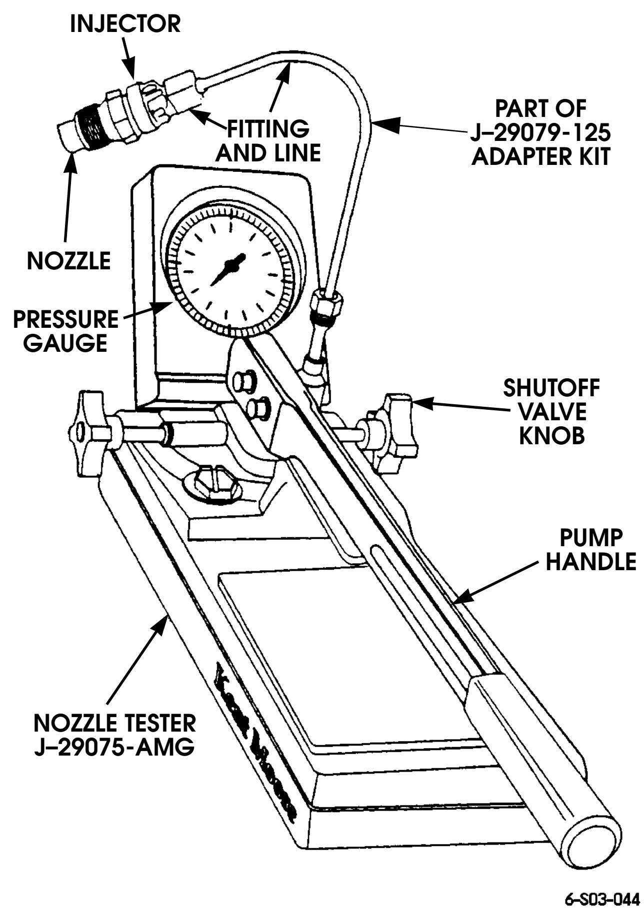


Figure 3-12: Pressure Testing Diesel Fuel Injector

6. Position drip pan under injector.
7. Place protective receptacle or box around injector.
8. Pump test tool handle to fill line, fitting, and injector with test fluid.
9. Test injector nozzle opening pressure as follows:
   a. Open test tool shutoff valve 1/4 turn.
   b. Press tool pump handle slowly downward and note pressure where test gauge needle stops.
   c. Maximum observed pressure represents injector opening pressure. Compare values to (Table Fuel Injection Nozzles on page 3–12) .
   d. Replace injector if opening pressure is less than specified.
10. Test injector nozzle leakage as follows:
    a. Open test tool shutoff valve an additional 1/2 to 1 1/2 turns.
    b. Press tool pump handle slowly downward until test tool gauge is at 1400 psi (95 bar) and observe injector nozzle tip.

c. A drop of fluid should form and remain on nozzle tip for at least 10 seconds.

d. Replace nozzle if fluid falls off tip in less than 10 seconds.

11. Test injector chatter as follows:

a. Close test tool shutoff valve.

b. Press tool pump handle slowly downward and listen for a chatter like noise.

c. If noise is not produced, pump handle faster and check for chatter noise again.

d. If injector produces a chatter, or hissing, squealing sound, injector is OK. Noise indicates nozzle needle valve is moving freely and that seat, guide, and pintle are also OK.

e. Replace nozzle if it does not produce noise. Lack of noise indicates failure of valve, spring, or seat.

Fuel Injection Nozzles

PART NO.	COLOR RING	APPLICATION	OPENING PRESSURE	
			NEW	USED
(05743223)	Orange	6.5L TD 96-97 L65 (VIN Z)	2030-2204 psi 140-152 bar	1700-2204 psi 117-152 bar
(05743795)	Purple	6.5L NA 94-97 L57 (VIN Y)	1783-1960 psi 123-135 bar	1500-1960 psi 103-135 bar

Engine Coolant Temperature Sensor Test (All)

The coolant temperature sensor is a thermistor that provides a temperature signal to the PCM (Figure 3-13). The signal is in the form of a voltage that changes according to sensor resistance. At low temperatures, resistance and voltage are both high. As temperature increases, resistance and voltage both decrease.

A sensor fault will cause the check engine light to illuminate and the torque converter clutch to apply early. If the sensor fails in a cold mode, it can produce overrich (open loop) operation and rough idle.

High Temperature—Low Resistance Test

1. Allow engine to cool down. Coolant should be at ambient temperature for test.
2. Connect scan tool, start engine, and note sensor temperature.
   - If indicated temperature is 266° F (130° C) or above, continue test.
   - If indicated temperature agrees with ambient, sensor is OK.
3. Disconnect sensor and note temperature indicated on scan tool:
   - If indicated temperature drops to -22° F (-30° C), sensor has failed and should be replaced.
   - If indicated temperature does not drop, problem is with sensor wiring or connections.

Low Temperature—High Resistance Test

1. Connect scan tool and start engine.
2. Note indicated temperature:
   - If temperature is normal, problem is with sensor wires and connections.
   - If temperature is at or above 266° F (130° C), continue with test. Disconnect sensor wires and note scan tool reading:
   - If temperature now reads -22° F (-30° C), sensor has failed.
   - If temperature is OK, problem is faulty sensor ground, reference wire shorted to ground, or PCM has fault.

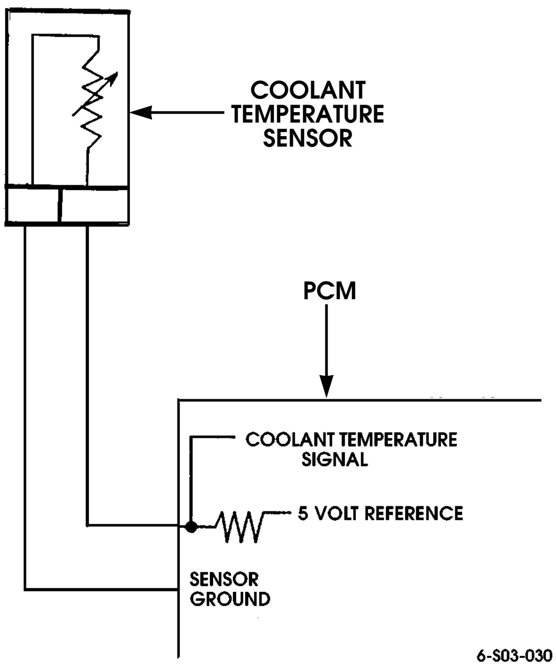


Figure 3-13: Coolant Temperature Sensor Circuit

Baro Sensor

The baro sensor on turbo diesel models is used to send a barometric pressure signal to the PCM. The signal is in the form of a voltage that is interpreted by the PCM. The sensor signal is to adjust fuel metering and timing at different altitudes. The scan tool is used for baro sensor testing.

Fuel Shut-Off Solenoid Test

A shut-off solenoid failure can result in run-on, or a no start condition. The failure may be with the solenoid, or with the related wiring (Figure 3-14). A 12 volt test light can be used to check solenoid circuitry as follows.

1. Turn ignition off.
2. Disconnect wires at solenoid.
3. Turn ignition back on.
4. Connect test lamp leads to solenoid terminal B and to ground.
   - If test light does **not** illuminate, problem is short/open in wire from solenoid to fuel solenoid fuse or bad connection.
   - If light illuminates, continue test.
5. Connect test lamp between battery positive post and terminal A at solenoid.
   - If lamp does not illuminate, problem is in wire connector, or solenoid has failed.
   - If lamp illuminates, problem is with wiring, connections, or PCM.

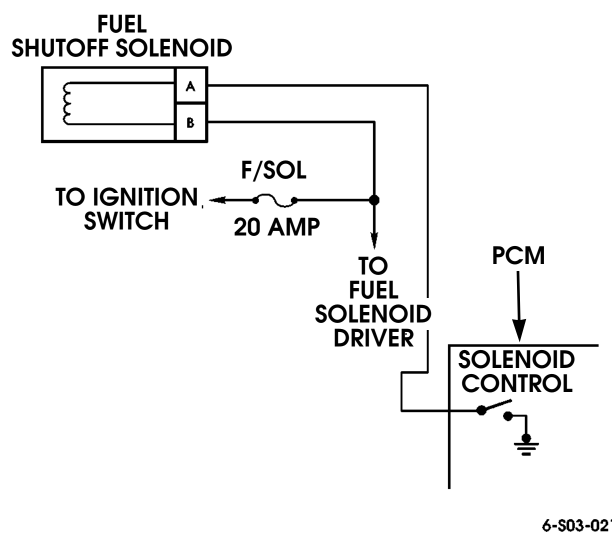


Figure 3-14: Fuel Shut-Off Solenoid Circuit

Optical/Fuel Temperature Sensor Tests (Turbo Diesel Only)

The optical/fuel temperature sensor supplies three signals to the PCM for fuel control and timing. A high resolution signal helps determine injection timing and fuel control. A pump cam signal provides reference pulses that monitor and help determine injection timing. The fuel temperature signal helps the PCM determine pump advance or retard requirements and fuel flow. The sensor is located at the top of the injection pump adjacent to the fuel shut-off solenoid.

A fault in the optical sensor or related wiring will produce fast idle and performance problems. A problem will cause a high resolution circuit fault, or a cam reference pulse error fault.

The sensor can be checked with a scan tool, 12 volt test lamp, and a voltmeter as follows:

High Resolution Fault Test

1. Turn ignition off.
2. Disconnect sensor harness connector.
3. Turn ignition on.
4. Connect voltmeter to sensor terminal A and to ground (Figure 3-15).
   - If meter indicates 5 volts, continue with test.
   - If meter indicates zero voltage, look for open/short in wire to PCM 5 volt reference terminal, connector, or PCM.
5. Connect volt/ohmmeter to a good engine ground and to sensor ground terminal D:
   - If resistance is .2 Ω or less, proceed to next test step.
   - If resistance is greater than .2 Ω, problem is with ground wire, connector, or sensor.

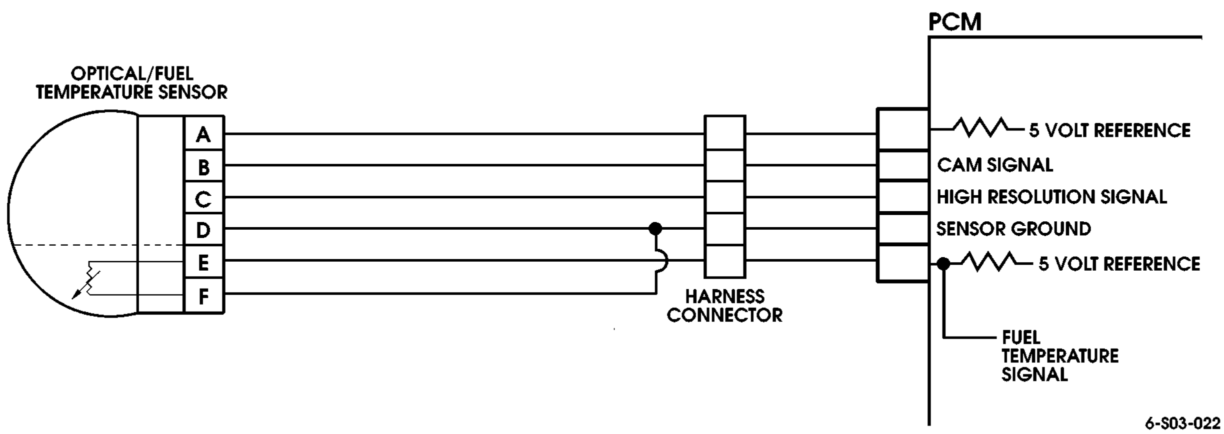


Figure 3-15: Optical/Fuel Temperature Sensor Circuit (Turbo Diesel)

Injection Timing Stepper Motor (Turbo Diesel)

The stepper motor is used to advance or retard timing of the electronic injection pump. The motor is controlled by the PCM and is actuated by input signals primarily from the coolant, air, and fuel temperature sensors.

A stepper motor fault will affect desired and measured injection timing degree readings on the scan tool. A difference of 5° or more between the readings indicates a motor fault.

Stepper Motor Test

1. Connect scan tool to diagnostic/data link connector.
2. Start and run engine until at normal operating temperature.
3. Note injection timing readings on scan tool.
   - If desired and measured injector timing readings differ by 5° or more, continue test.
   - If readings are no more than 3°-4° apart, but trouble code was set, problem is bad connection between PCM and motor.
4. Stop engine and turn ignition off.
5. Check resistance between PCM terminals for coil 1 low, and coil 1 high (Figure 3-16).
   - If resistance is between 10 and 50 ohms, continue test.
   - If resistance is not within specified range, problem is open wire, bad connection, or failed stepper motor.
6. Check resistance between PCM terminals coil 2 low, and coil 2 high (Figure 3-16).
   - If resistance is 10-50 ohms, problem is in PCM connection, or PCM.
   - If resistance is other than specified, problem is in wires to PCM coil 2 terminals, bad connection, or PCM has a fault.

Fuel Solenoid and Solenoid Driver (Turbo Diesel)

The solenoid and driver provide the fuel injection metering to the individual injectors. The driver receives the PCM command and transmits it to the solenoid which controls the actual injection process.

The solenoid driver also returns a pulse width signal back to the PCM. This signal informs the PCM that injection has taken place. The pulse width signal time is in milliseconds.

A fault in either component will cause an injection pulse width error code on the scan tool. This may result in surge, hesitation, or idle lope.

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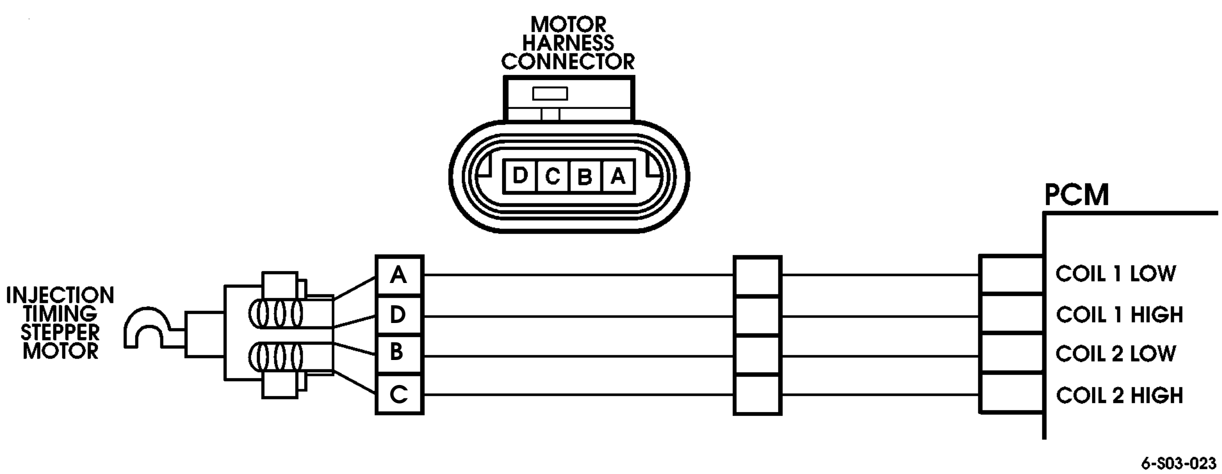


Figure 3-16: Injection Timing Stepper Motor Circuit (Turbo Diesel)

Crankshaft Position Sensor

The crankshaft position sensor is a Hall-effect device that monitors crankshaft position and rpm. Four reference teeth 90° apart, on the crankshaft timing sprocket cause the devise to turn "ON" or "OFF" producing a digital signal . This occurs as each tooth passes near the sensor magnetic field turning the sensor "ON". The sensor transmits information to the PCM in the form of a 5 volt digital signal.

A sensor fault will cause a "crank reference missed" reading to occur. The scan tool will display the number of reference pulses missed. Normal reading is zero.

If a sensor fault occurs, check the sensor wiring and connectors for shorts, opens, grounds, or loose connectors (Figure 3-17).

Sensor Test

1. Disconnect wires at fuel shut-off solenoid.
2. Connect voltmeter between PCM terminal BRA5 and ground and crank engine.
   - If meter indicates 5 volts, sensor is OK.
   - If meter indicates less than 5 volts or zero volts, check 5 volt reference at PCM terminal BRD13.
   - If 5 volt reference is OK,problem is bad connection or failed sensor.

Boost Sensor (Turbo Diesel)

The PCM supplies the boost sensor with a 5 volt reference signal (Figure 3-18). Changes in intake manifold pressure will cause a change in boost sensor resistance values and voltage. The PCM determines turbocharger boost by comparing changing sensor voltage to the original reference voltage.

A sensor failure will result in loss of turbocharger boost and consequent power decrease. Trouble code 61 or 62 will be set.

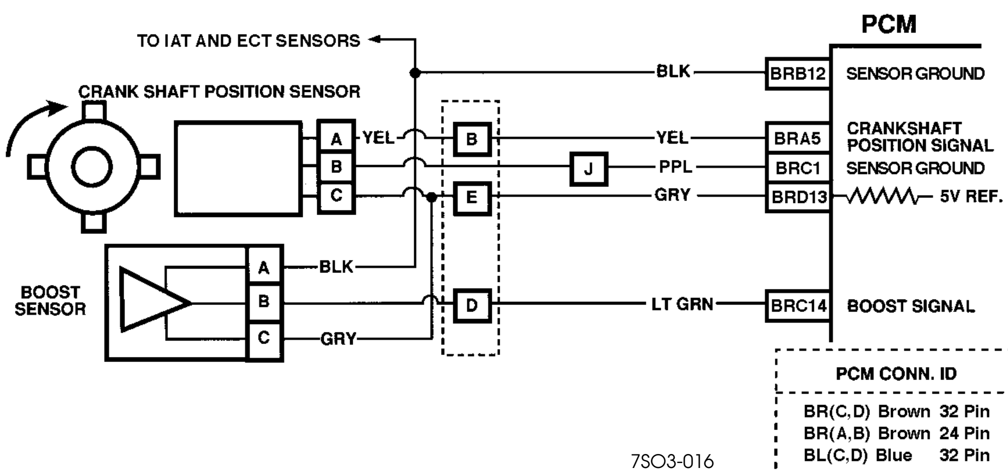


Figure 3-17: Crankshaft Position Sensor Circuit

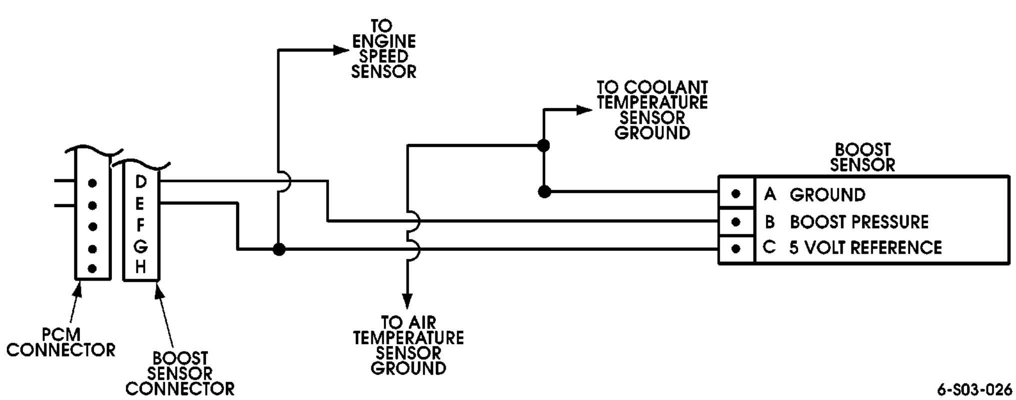


Figure 3-18: Boost Sensor Circuit (Turbo Diesel)

Boost Sensor Circuit Test

1. Connect scan tool to diagnostic/data link connector.
2. Start and run engine at idle speed.
3. Record boost sensor voltage.
   - If voltage is 4.0 volts or more, continue test.
   - If voltage is less than specified, compare sensor to known good one. Voltage should not vary by more than plus or minus 0.4 volt. If sensor voltage compares favorably with known good sensor, problem is in wiring or connections.
4. Turn ignition off and disconnect boost sensor wires.
5. Turn ignition switch back on (engine off), and note scan tool voltage reading.
   - If boost voltage is 1 volt or less, continue test.
   - If voltage is less than specified, problem is in wiring or connections between sensor and PCM.
6. Connect 12 volt test lamp between sensor terminal C and battery positive post.
   - If lamp illuminates, problem is with sensor, connectors, or fitting.
   - If lamp does not illuminate, problem is open wire.

Boost Sensor Performance Check

This check requires the scan tool to be connected, the engine running at curb idle rpm, and the transmission in Park.

At idle or at closed throttle decel, a properly functioning sensor will indicate a pressure reading about the same as barometric pressure. Sensor voltage (if any), should be low.

Sensor pressure readings should increase as throttle opening is increased. Voltage readings should also increase.

Boost pressure readings are opposite what you would read for vacuum. For example, as throttle opening increases, sensor pressure readings will also increase. Vacuum readings on the other hand, will decrease as throttle opening increases.

Electronic Accelerator Pedal Tests

The pedal module contains three potentiometer-type sensors that provide voltage signals to the PCM. Each potentiometer is scaled differently to provide varying voltage signals. The PCM compares the voltage variance between them to determine throttle position (Figure 3-19).

A fault in only one of the potentiometer sensors will not cause a trouble code to set. Two or more sensors must develop a fault before the check throttle light will illuminate.

A fault in two sensors will cause the warning light to illuminate and engine power will be limited by the PCM. A fault in all three sensors, will cause the PCM to illuminate the light and limit engine speed idle rpm only.

Trouble codes will set under the following circumstances:

- Two sensors generate voltage of 4.75 volts or more for a minimum of two seconds.
- Two sensors generate a voltage of 0.25 volts or less for a minimum of two seconds.
- Voltage difference between sensors 1 and 2 of 6% or more.
- Voltage difference of 10% or more, between sensors 1, 2, and 3.
- Fault in all three sensors (above or below normal signal voltage).

The Tech 1 scan tool is required for accurate sensor diagnosis. However, the sensor circuit wires can be tested for shorts, opens, grounds with 12 volt test lamp and/or multimeter.

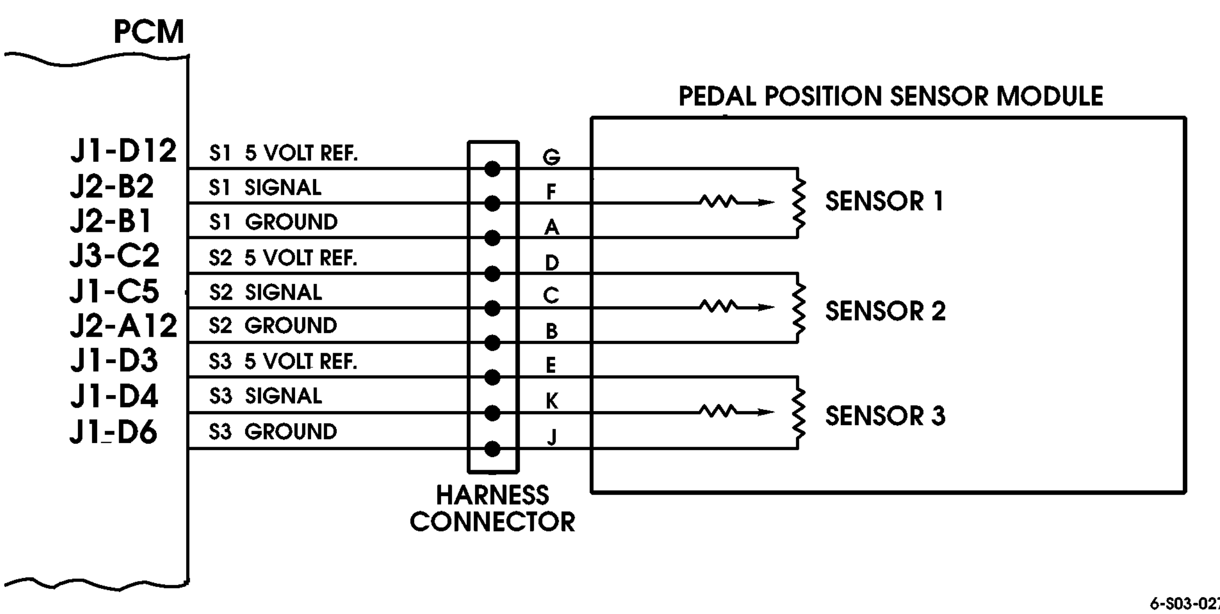


Figure 3-19: Electronic Accelerator Pedal Module Circuitry

AIR CLEANER SERVICE

Removal

NOTE: To remove dust unloader only, perform steps 1 and 2.

1. Remove air cleaner (Figure 3-20).
2. Loosen clamp and remove dust unloader from air cleaner assembly.
3. Loosen clamp and disconnect elbow from engine side of air cleaner assembly.
4. Disconnect vent line from fitting.
5. Loosen clamp and remove weathercap from air intake duct.
6. Remove three capscrews and washers from air intake duct.
7. Loosen three strap clamps around air cleaner assembly.
8. Raise air intake duct from air intake support. Loosen clamp and remove air intake duct and gasket from elbow and support. Discard gasket.
9. Remove air cleaner assembly.
10. Remove clamps from air cleaner assembly.
11. Remove fitting, adapter, and tube from air cleaner assembly.
12. Remove seal from air intake support.

Cleaning and Inspection

Replace air filter if plugged or saturated with dirt. Clean hose and dust unloader with shop towels. Clean other components with solvent and examine for wear or damage. Replace worn, damaged parts if necessary.

Installation

1. Install tube, adapter, and fitting on air cleaner assembly (Figure 3-20).
2. Install dust unloader on air cleaner. Tighten clamp to 44-53 lb-in. (5-6 N•m).
3. Install elbow and clamp on air cleaner. Do not tighten clamp at this time.
4. Position air cleaner assembly on air intake support and align elbow with top of support.
5. Align air cleaner and tighten clamp on elbow to 44-53 lb-in. (5-6 N•m).
6. Position air cleaner and strap clamps on support brackets. Then rotate until elbow clears air intake support.
7. Install air intake duct and clamp on elbow. Align bolt holes of air intake duct with holes of air intake support.
8. Install air intake duct on air intake support. Tighten clamp to 45-53 lb-in. (5-6 N•m).
9. Install air cleaner assembly on support brackets and tighten strap clamps.
10. Connect inlet hose to air horn and air cleaner.
11. Connect vent line to fitting on air cleaner.
12. Install weathercap on air intake duct and tighten clamp to 45-53 lb-in. (5-6 N•m).
13. Install air cleaner shield.
14. Install hood seal on air intake support (if removed).

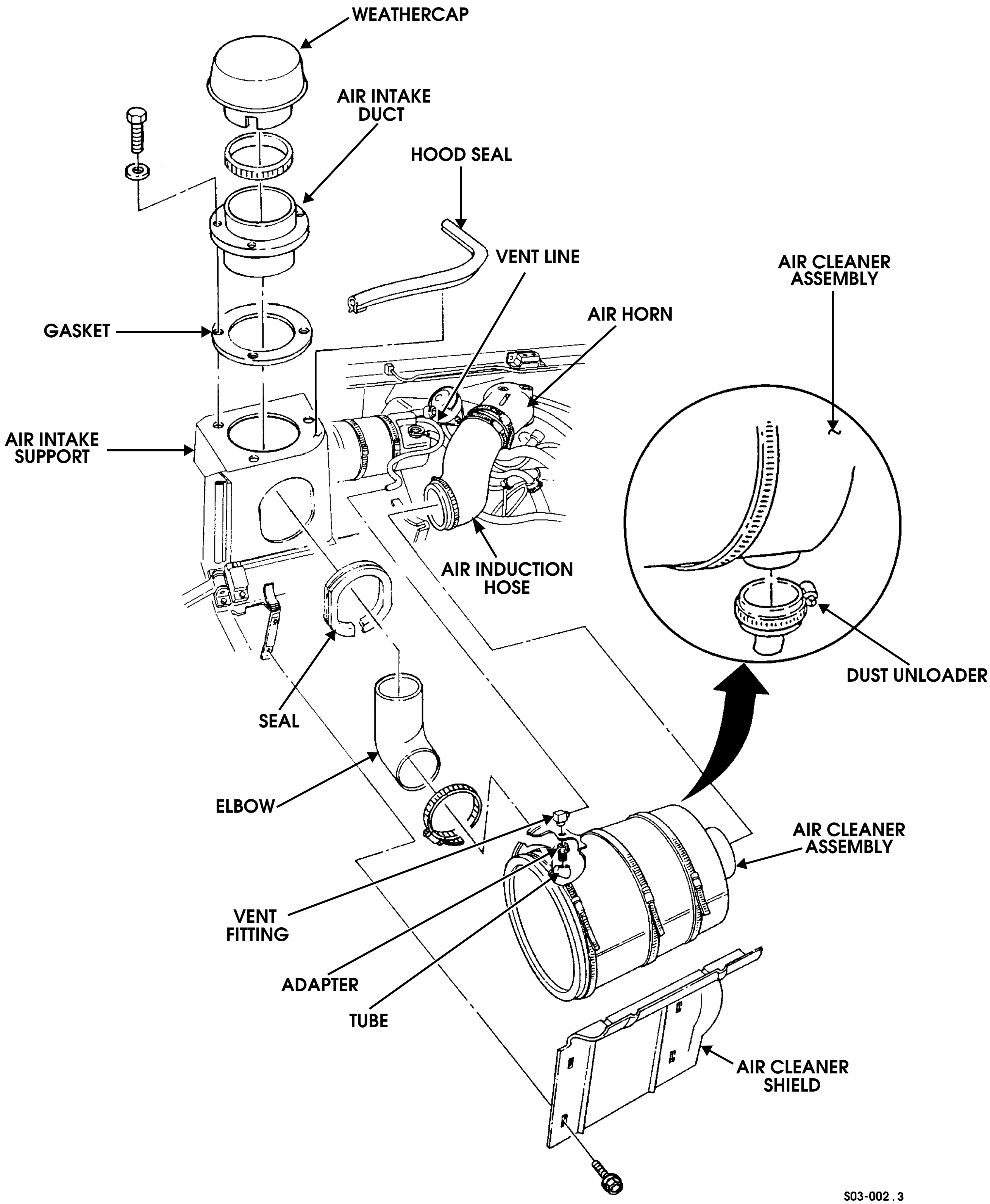


Figure 3-20: Air Cleaner Assembly and Dust Unloader

Air Cleaner Filter Element Service

Removal

1. Remove ring clamp, cover, and gasket from air cleaner (Figure 3-21).
2. Remove nut and washer assembly and filter element from air cleaner stud.

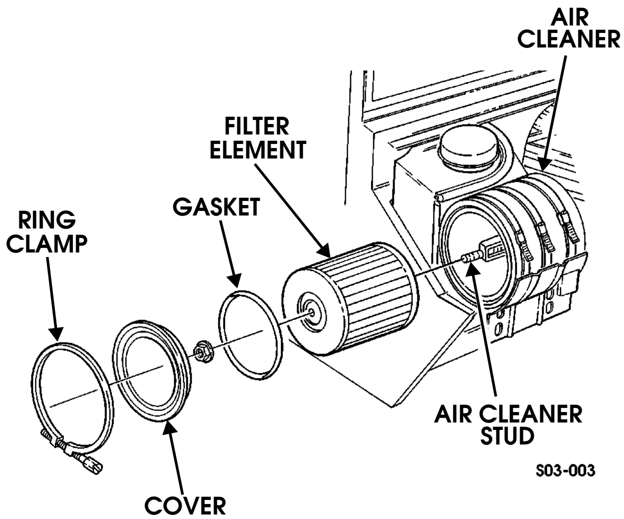


Figure 3-21: Air Cleaner Filter Element Removal/Installation

Inspection

1. Clean components with compressed air, examine for wear or damage, and replace if necessary.
2. Remove dust or sand by gently tapping around filter element.
3. Remove dirt and dust from filter element by directing flow of compressed air from inside to outside of filter element.

Installation

1. Slide filter element onto air cleaner stud and install nut and washer. Tighten nut and washer to 18-35 lb-in. (2-4 N•m) (Figure 3-21).

NOTE: To avoid damage to hood, ensure ring clamp bolt is between the three and six o'clock positions.

2. Install gasket, cover, and ring clamp on air cleaner assembly. Tighten ring clamp bolt to 27-35 lb-in. (3-4 N•m).

AIR HORN

Removal

1. Loosen clamp and remove air inlet hose from air horn (Figure 3-22).

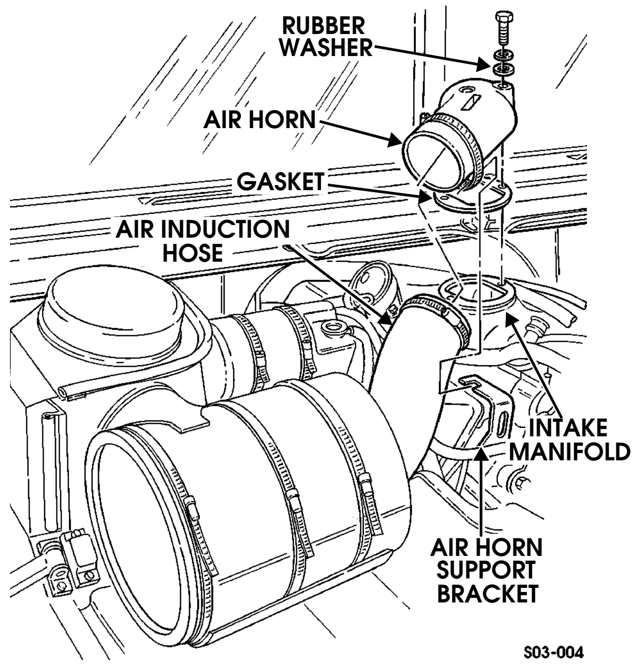


Figure 3-22: Air Horn Mounting (Diesel)

2. Remove screws, washers, and rubber washers that attach air horn to intake manifold. Discard rubber washers.
3. Loosen clamp that secures air horn to support bracket and remove air horn.
4. Remove gasket from intake manifold. Discard gasket.
5. Cover manifold opening to prevent dirt entry.

Installation

1. Install gasket on intake manifold (Figure 3-22).
2. Install clamp on air horn.
3. Apply sealing compound to air horn mounting screws, and install air horn on intake manifold. Then install rubber washers, flat washers, and air horn screws. Tighten screws to 44 lb-in. (5 N•m).
4. Connect air inlet hose to air horn. Tighten clamp to 44-53 lb-in. (5-6 N•m).
5. Install clamp on air horn and support bracket. Tighten clamp to 44 lb-in. (5 N•m).

Air Induction Hose Replacement

Removal

1. Loosen induction hose clamps.
2. Remove hose from air horn and air cleaner (Figure 3-23).

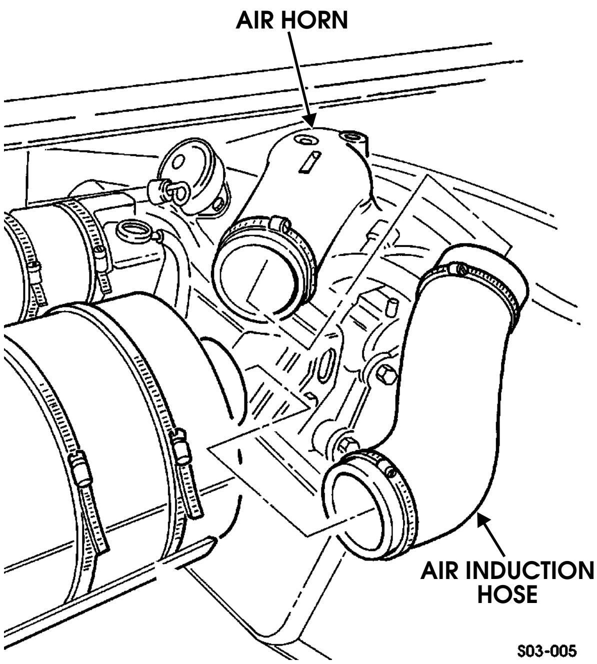


Figure 3-23: Air Induction Hose Attachment

Installation

1. Install induction hose on air horn and air cleaner.
2. Tighten hose clamps to 44 lb-in. (5 N•m) (Figure 3-23).

Air Horn Support Bracket Replacement

Removal

1. Remove air horn.
2. Remove nut, lockwasher, two clamps, and stud from air horn support bracket and cylinder head. Discard lockwasher (Figure 3-24).
3. Remove capscrew and air horn support bracket from cylinder head.

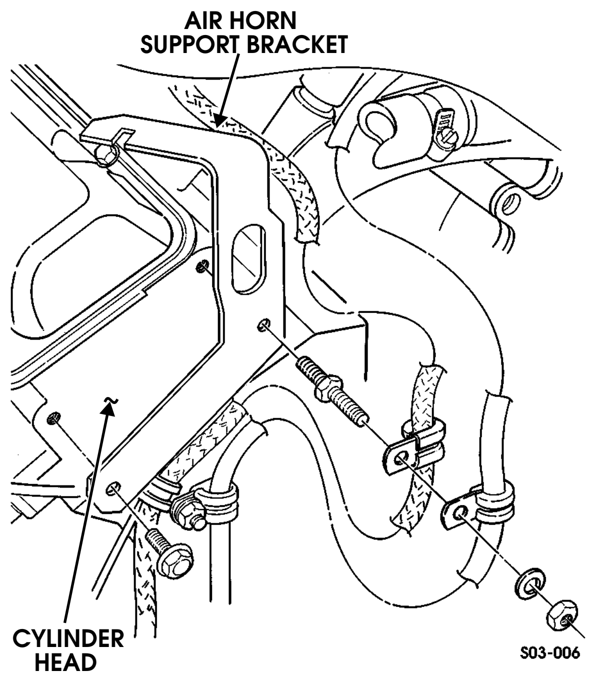


Figure 3-24: Air Horn Support Bracket Attachment

Installation

1. Position air horn support bracket on cylinder head and install stud. Tighten stud to 40 lb-ft (54 N•m) (Figure 3-24).
2. Install clamps, lockwasher, and nut that secure harness wires to stud.
3. Install air horn.

WEATHERCAP REPLACEMENT

Removal

Remove clamp and weathercap from air intake duct (Figure 3-25).

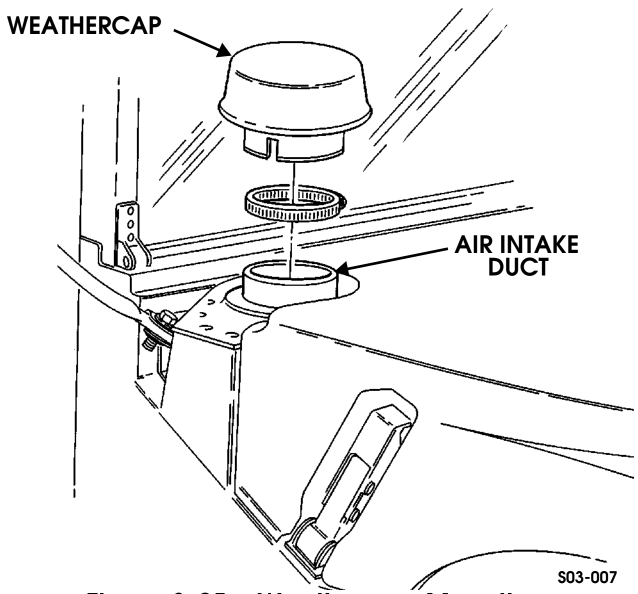


Figure 3-25: Weathercap Mounting

Installation

Install weathercap on air intake duct. Tighten clamp to 44-53 lb-in. (5-6 N•m).

FUEL TANK DRAINING

The fuel tank should only be drained with portable air powered drain equipment. This type of equipment is OSHA approved and will drain the tank through the filler neck.

The tank should be drained prior to removal. Follow the drain equipment manufacturer's instructions explicitly.

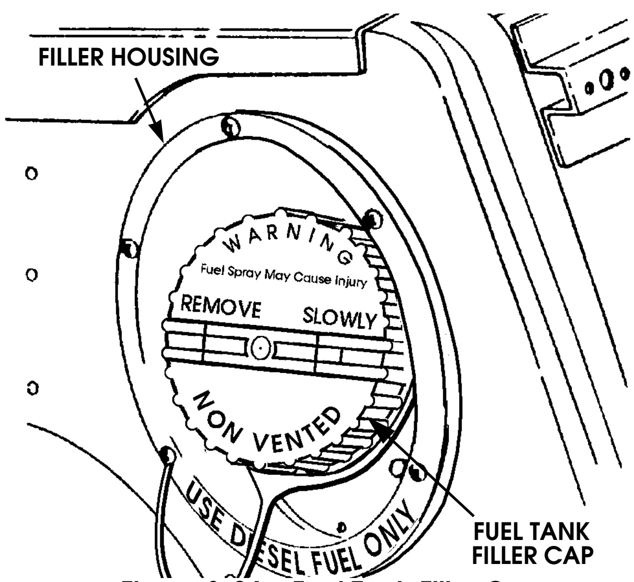


Figure 3-26: Fuel Tank Filler Cap

DRAINAGE BRACKET REPLACEMENT

Removal

1. Remove air cleaner assembly.
2. Remove three screws and drainage bracket from body (Figure 3-27).

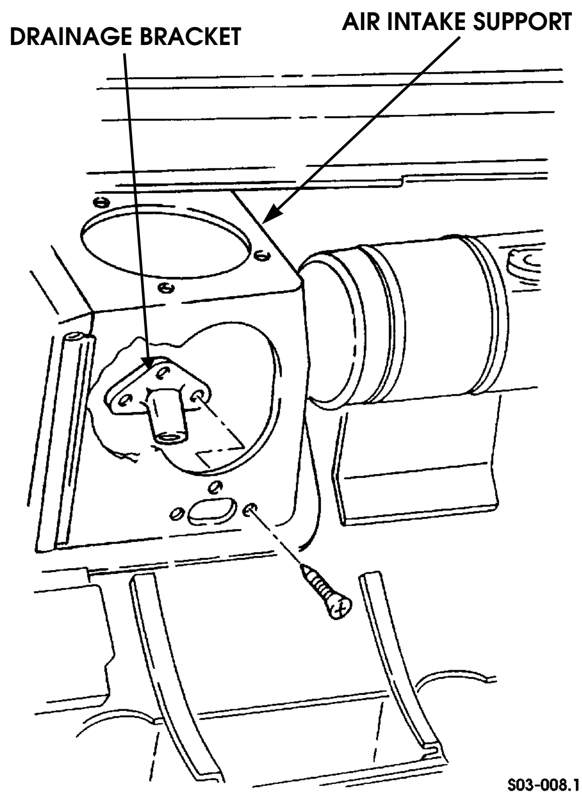


Figure 3-27: Drainage Bracket Location

Installation

1. Position drainage bracket on body and install bracket screws (Figure 3-27).
2. Install air cleaner assembly.

AIR INTAKE VENT LINE REPLACEMENT

Removal

Remove air intake vent line from tee fitting and air cleaner fitting (Figures 3-25 and 3-27).

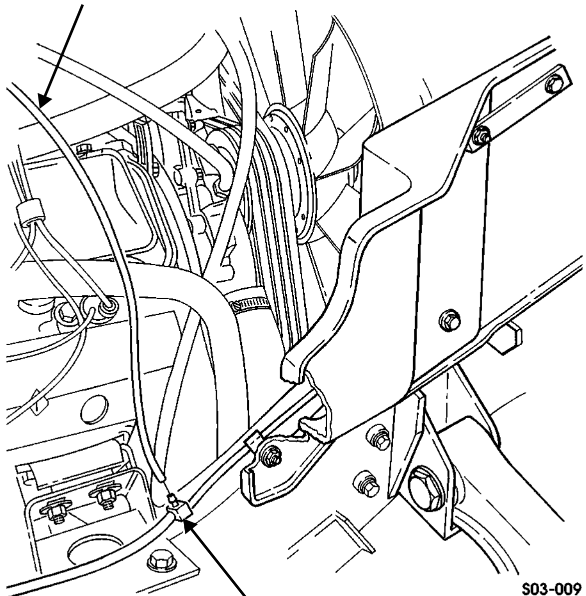


Figure 3-28: Air Intake Vent Line Routing

Installation

Install air intake vent line on tee fitting and air cleaner fitting (Figures 3-25 and 3-27).

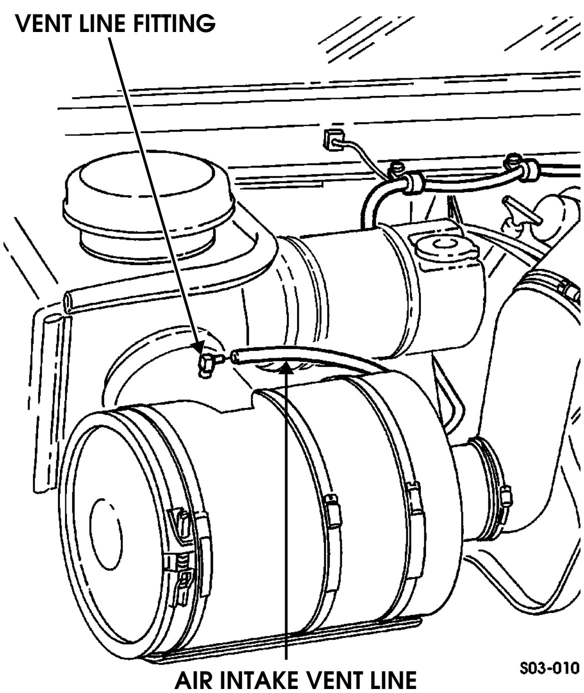


Figure 3-29: Air Cleaner Vent Line Fitting Location

MAIN FUEL TANK

Removal

1. Drain tank with recommended equipment.
2. Remove bolts attaching fuel filler housing to body.
3. Remove vapor canister shield and bracket. Then disconnect tank vent lines, and hoses at branch tee in fuel filler housing.
4. Remove clamps attaching filler tube to vent line or body.
5. Disconnect filler housing ground strap.
6. Loosen clamps securing connecting hose to filler tube and housing (Figure 3-30).

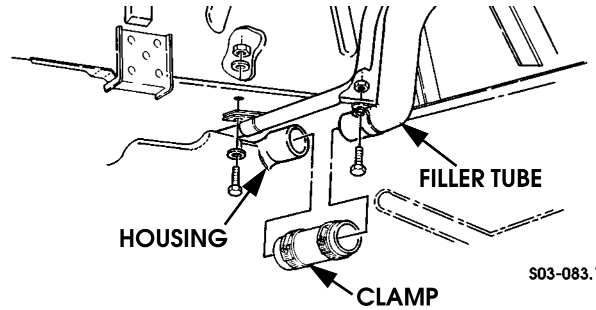


Figure 3-30: Filler Tube-to-Tank Attachment

7. Remove fuel filler housing and filler neck.
8. Raise vehicle.
9. Remove rear propeller shaft.
10. Rotate rear axle yoke to a vertical position. Tank may not clear yoke otherwise.
11. Support tank with transmission jack or other suitable support device.
12. Remove bolts and nuts attaching front and rear upper straps to lower straps (Figure 3-31).

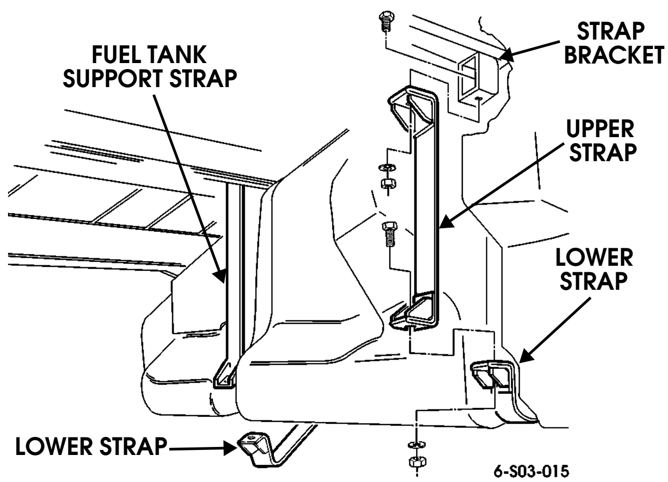


Figure 3-31: Fuel Tank Mounting Strap Attachment

13. Disconnect vent lines at fuel tank.
14. Lower tank enough for access to transmitter wires and fuel lines.
15. Disconnect transmitter wires.
16. Disconnect but do not remove rollover valve line.
17. Lower and remove fuel tank.

Fuel Level Transmitter/Pump/Vents/ Access Plate Replacement

The fuel level transmitter, vents, and access plate can all be serviced once the tank is out of the vehicle (Figure 3-32).

If the fuel tank requires replacement, be sure to replace all necessary gaskets, O-rings, seals, and strainer with new parts. Coat fitting threads with Loctite PST before installation.

Tank Cleaning

In cases where the tank was removed for correction of contamination, remove the transmitter, fuel pump, and access plate for maximum access. Use a soap and water solution and low pressure steam gun. Be sure to clean out the fuel supply and return lines as well. The tank can be dried with compressed air or allowed to air dry as desired.

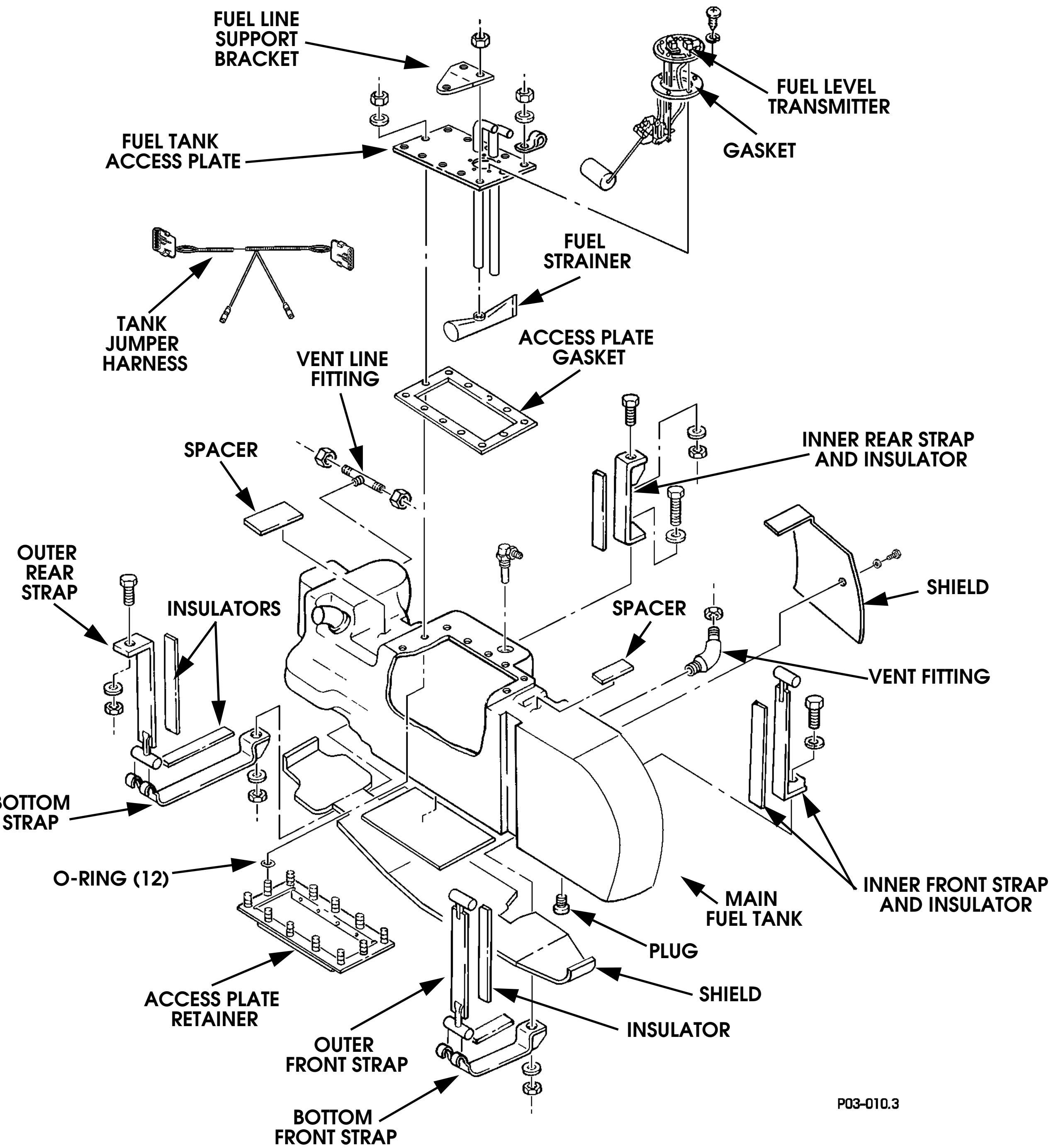


Figure 3-32: Fuel Tank and Components

Main Fuel Tank Installation

NOTE: If tank was replaced, or if transmitter, pump, fitting, or access plate was replaced, verify that components are properly seated and secured. Refer to Fuel Level Transmitter and Tank Access Plate Service procedure in this section.

1. Position tank on jack and raise tank just enough to permit installation of wires and lines.
2. Connect fuel lines as follows:
   a. Push lines onto tank supply and return tubes. Note that fuel supply tube is larger in diameter than the return tube.
   b. Push line onto tank tube until it snaps or clicks into place.
   c. Pull on lines to verify secure attachment.
3. Connect wiring and vent lines. Also connect rollover valve line.
4. Install filler neck-to-tank hose on fuel tank. Secure hose with new clamp if required.
5. Position tank and install bolts and nuts that attach tank upper to lower retaining straps. Tighten strap bolts to 23-27 lb-in. (3 N•m) torque.

NOTE: If the upper and lower straps touch after bolt tightening, replace the straps. They are stretched or distorted and will not adequately secure the tank.

6. Install propeller shaft.
7. Connect tank vent lines.
8. Lower vehicle
9. Install filler neck and connect ground strap.
10. Install filler neck housing and connect vent line.
11. Refill tank.
12. Start engine and verify proper operation. Repair any leaks if necessary.

AUXILIARY FUEL TANK

Removal

1. Drain auxiliary fuel tank. Drain tank with air powered portable drain equipment.
2. Remove tank filler neck housing from wheel house.
3. Remove bolts attaching auxiliary tank fuel filler neck and housing to body.
4. Disconnect filler neck at tank and vent line at housing.
5. Support auxiliary tank with floor jack positioned under tank skid plate.

NOTE: Do not loosen or remove the bolts attaching the tank to the skid plate. The tank and skid plate will be removed as an assembly.

6. Remove bolts and nuts attaching tank skid plate to left and right frame brackets and rear crossmember.
7. Lower tank enough to reach fuel lines. Then disconnect fuel lines, fuel level transmitter wires, and vent line. Mark lines and wires for assembly reference.

NOTE: The fuel supply and return lines are equipped with quick connect fittings. To disconnect, first lift and remove the fitting retainer from each fitting. Then pull the fittings free of the tank fuel tubes.

8. Lower the jack and remove the tank from under the vehicle.
9. Replace fuel level transmitter and access plate (Figure 3-32). Refer to next procedure in this section.

Installation

1. If new tank is being installed, transfer tank skid plate to new tank.
2. Place tank on floor jack and position it under vehicle.
3. Raise tank enough to reach feed lines.
4. Attach vent line and fuel level transmitter wires.
5. Connect fuel lines. Push each line onto tank tube. Secure lines with retainers. Be sure retainers are firmly seated in line fittings.
6. Raise and align tank skid plate with frame brackets and rear crossmember.
7. Install tank attaching bolts and nuts and tighten securely.
8. Install filler tube housing and fuel filler cap.
9. Install filler tube shield in wheelhouse.
10. Refill fuel tank.
11. Verify tank operation and fuel level reading.

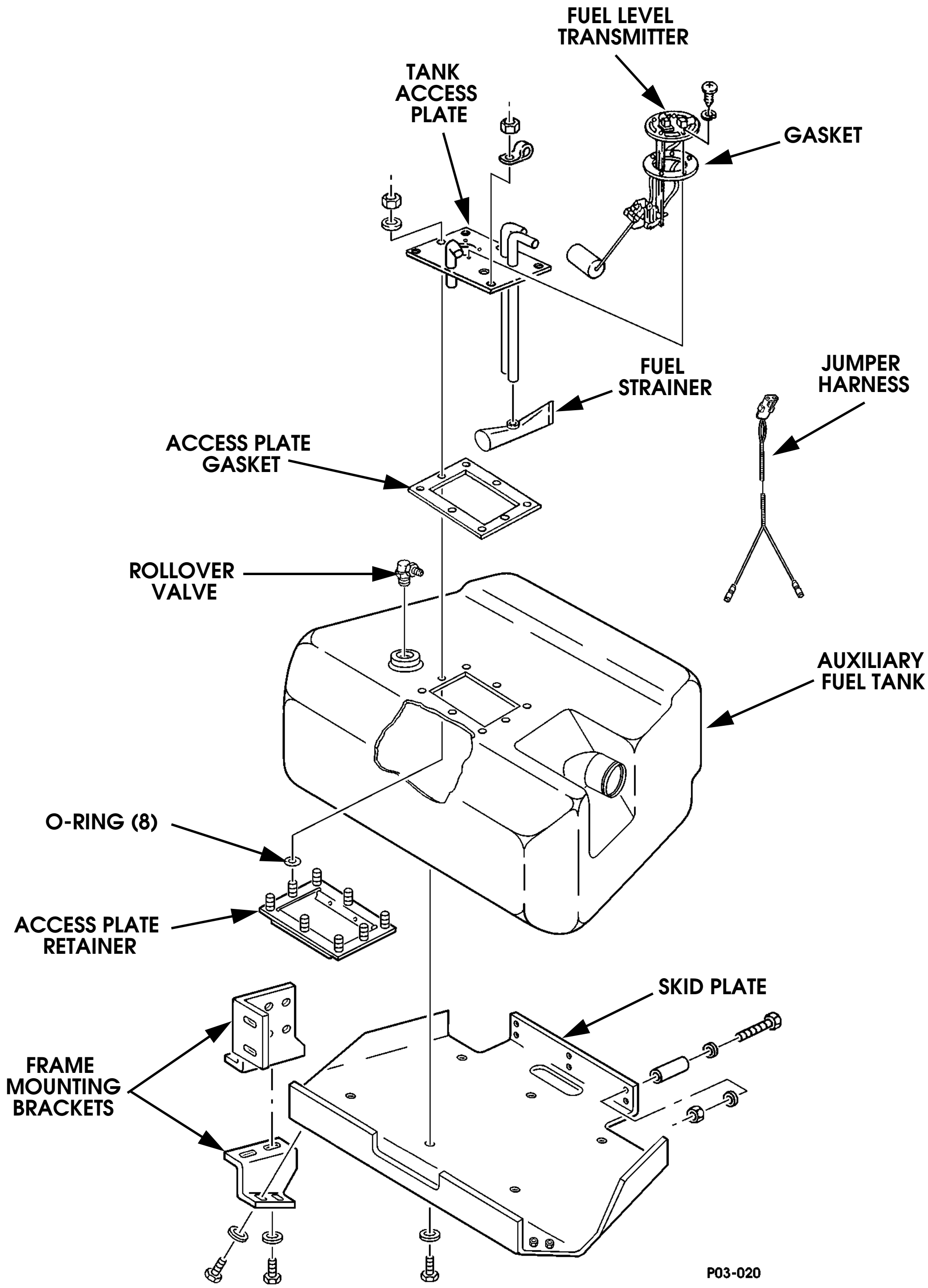


Figure 3-33: Auxiliary Fuel Tank Components

FUEL LEVEL TRANSMITTER AND TANK ACCESS PLATE SERVICE

Removal

1. Remove screws, lockwashers and fuel level transmitter from tank access plate (Figures 3-32 and 3-33).
2. Remove locknuts, washers, access plate and gasket from tank.
3. Remove access plate retainer and O-rings from tank. Discard O-rings.

Check fuel level transmitter operation as follows:

1. Hold transmitter so that float is in down/tank empty position (Figure 3-34).
2. Using an ohmmeter, check resistance value at terminals. Resistance should be 240±20Ω.
3. Hold transmitter so that float is in the up/tank full position (Figure 3-35).
4. Resistance should fall to 33.5±8Ω.

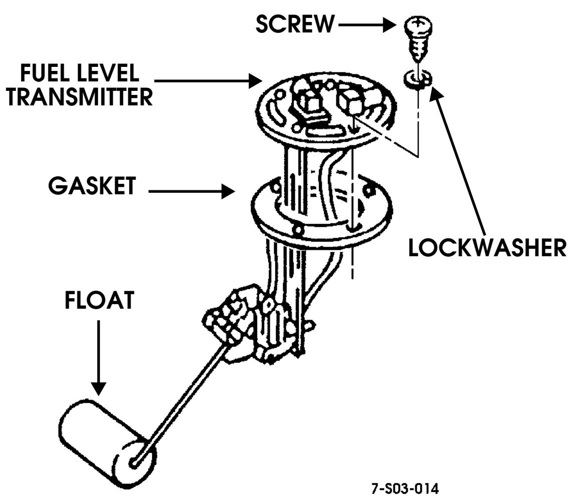


Figure 3-34: Fuel Level Transmitter in Down/Tank Empty Position

Installation

CAUTION: *Do not overtighten access plate or transmitter fasteners. Gasket damage and improper sealing could result.*

1. Thoroughly clean all gasket surfaces.
2. Place new O-rings on access plate retainer studs and position access plate retainer in tank (Figures 3-32 and 3-33).
3. Set gasket and access plate over studs and onto tank.
4. Apply liquid teflon thread sealant to studs and loosely install washers and locknuts until no clearance exists between access plate, gasket and tank.
5. Snug access plate locknuts in small increments and in a systematic circular pattern. Tighten locknuts until gasket bulges or until maximum torque of 72 lb-in. (8N.m) is obtained.
6. Apply liquid teflon thread sealant to transmitter mounting screws.
7. Secure gasket and transmitter to access plate using same method as indicated for access plate above.
8. Cap all tank fittings and perform leak check. Apply leak check solution or soapy water around access plate and transmitter gaskets and fasteners. Pump **3 p.s.i.** of compressed air into tank and verify absence of leaks.

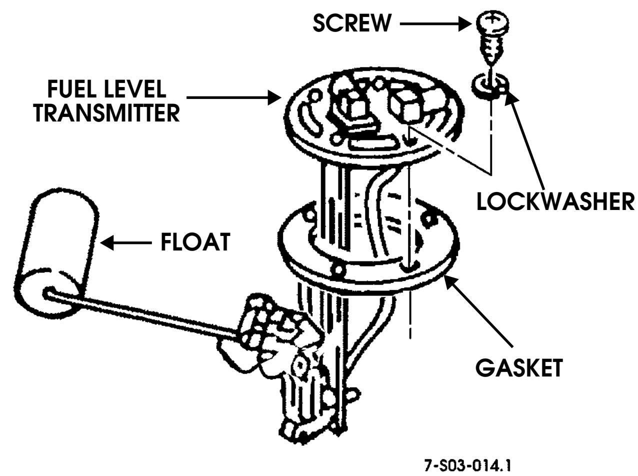


Figure 3-35: Fuel Level Transmitter in Up/Tank Full Position

Quick Connect Fittings

Quick connect fittings are used at the main tank fuel tubes, auxiliary tank fuel tubes, and at the fuel tank selector valve.

Two types of fittings are used. One type is an all plastic push on style with removable retainer. The second style is a metal, one-piece fitting with an internal tension clip to retain it. The plastic fitting retainer only requires a screwdriver and needlenose pliers to remove. The metal fitting requires a release tool, such as J–37088-A, in order to disconnect it.

The metal fittings are used at the main tank. The plastic, two-piece fittings are used at the auxiliary tank and fuel selector valve.

Metal Fittings

1. To disconnect, slide the release tool onto the line and into the fitting.
2. Press the tool inward to unseat the internal clip and pull the line off the fuel tube.
3. To reconnect, just push the fitting onto the line until it snaps or clicks into place.
4. Pull on the fitting afterward to verify proper seating.

Plastic Fittings

1. To disconnect, raise the retainer tab with a small flat blade screwdriver and remove the retainer with needlenose pliers.
2. To reconnect, push the fitting onto the tube, insert the retainer through the fitting sides, and seat it firmly.
3. Be sure the retainer seats behind the fuel tube flange.
4. Pull on the fitting afterward to verify proper seating.

FUEL TANK VENT FILTER REPLACEMENT

The fuel tank vent filter is located just above the surge tank at the passenger side of the engine compartment (Figure 3-36).

The filter is serviced as an assembly and should be replaced if restricted or damaged.

To replace the filter, remove the filter retaining clamp bolt, pull the filter out of the clamp, and disconnect it from the vent line. Be sure the replacement filter is properly secured in the clamp afterward. Also, use a new vent line clamp if the original is worn, or distorted.

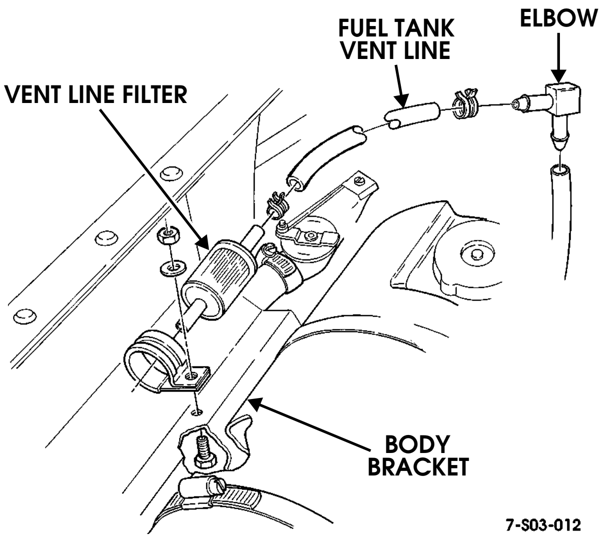


Figure 3-36: Fuel Tank Vent Line Locations (Typical)

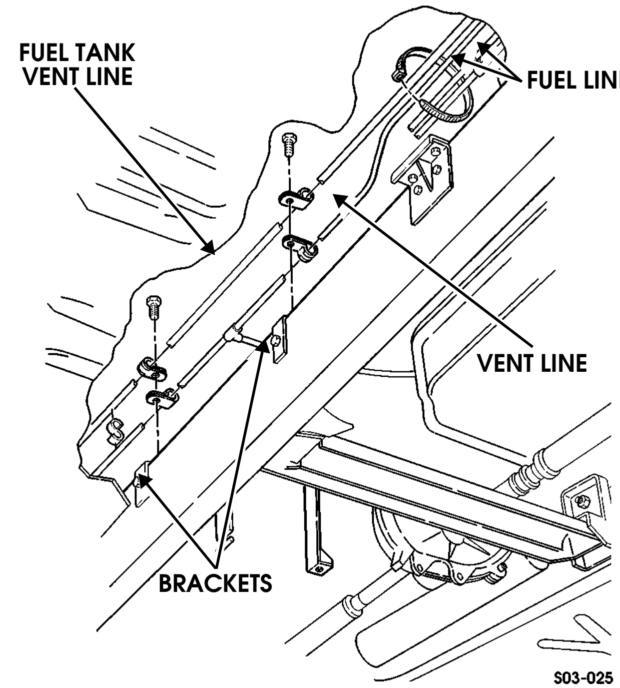


Figure 3-37: Fuel Tank Vent Filter Location

Fuel Tank Vent Line Service

Removal

1. Remove fuel tank. Refer to procedure in this section.
2. Remove clip and fuel tank vent line hose from vent line (Figure 3-37).
3. Remove vent line clamps and disenagage lines.
4. Remove tie strap securing vent line to fuel lines. Discard tie strap.
5. Disconnect fuel tank vent lines at tank fittings.

Installation

1. Connect vent lines to tank fitting.
2. Secure vent line to fuel lines with new tie strap (Figure 3-37).
3. Secure vent lines in brackets with clamps and bolts.
4. Install fuel tank.

MAIN OR AUXILIARY TANK FUEL LINE REPLACEMENT (ALL)

Removal

1. Drain tank with portable, air powered equipment.
2. Remove main or auxiliary fuel tank as described in this section.
3. Remove body mounting cushion bolts at four rear most mounting points. Body must be raised for access to fuel line and attaching clamps and clips.
4. Disconnect any electrical wires, linkage parts, cables, or lines as needed if insufficient slack exists.
5. Raise rear of body enough for access to rear lines, attaching clamps, and S-clips.
6. Disconnect fuel lines at main tank tubes.
7. Remove line clamps and tie straps.
8. Disconnect lines at fuel tank selector valve and remove lines.

9. Disconnect supply line at fuel pump.
10. On all models, if front lines are to be replaced, disconnect lines at fuel pump and return fittings.
11. Remove supply and/or return lines as needed (Figure 3-39).

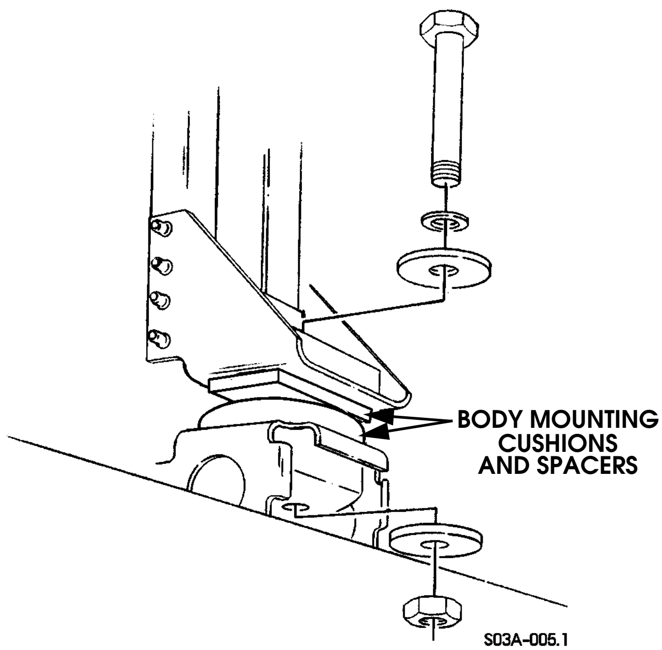


Figure 3-38: Body Mounting Cushions (Typical)

Installation

1. Route new lines as needed (Figure 3-39). Be sure lines are not kinked, pinched, or touching hot or rotating parts.
2. Connect front fuel lines to fuel pump and return fitting at injection pump. Then connect lines to fuel selector valve.
3. Secure lines to frame clamps, brackets, S-clips, and tie straps as needed.
4. Connect rear lines to auxiliary or main tank as required.
5. Install main or auxiliary fuel tank as described in this section.
6. Verify that fuel lines are securely connected and properly routed.
7. Lower body and install mounting cushion bolts. Tighten bolts to 90 lb-ft (122 N•m) torque.
8. Connect or attach electrical wires, linkage, cables, lines, brackets, or exhaust components loosened or removed to facilitate raising body.
9. Refill fuel tank.
10. Check tank operation. Verify proper transmitter operation and selector switch function.

FUEL SELECTOR VALVE

The selector valve is used on models equipped with an auxiliary fuel tank (Figure 3-39). The valve is electrically operated by a switch in the passenger compartment. The switch will be mounted on the instrument panel.

Valve function is to switch fuel supply from main to auxiliary tank (and back) when needed.

Quick connect fittings are used to attach each of the six fuel lines to the valve. The plastic, two-piece style fittings are used.

The valve is mounted on a bracket attached to the passenger side frame rail. Valve position is forward of the fuel tank and B-pillar area.

The valve is not a serviceable part and must be replaced when diagnosis indicates this is necessary.

Selector Valve Replacement

The valve is accessible from under the vehicle. Disconnect the battery and remove the valve-to-bracket bolts first. Then disconnect the fuel lines one at a time and tag them for reference. Last, disconnect the valve-to-switch harness and remove the valve. Reverse the process to install the valve.

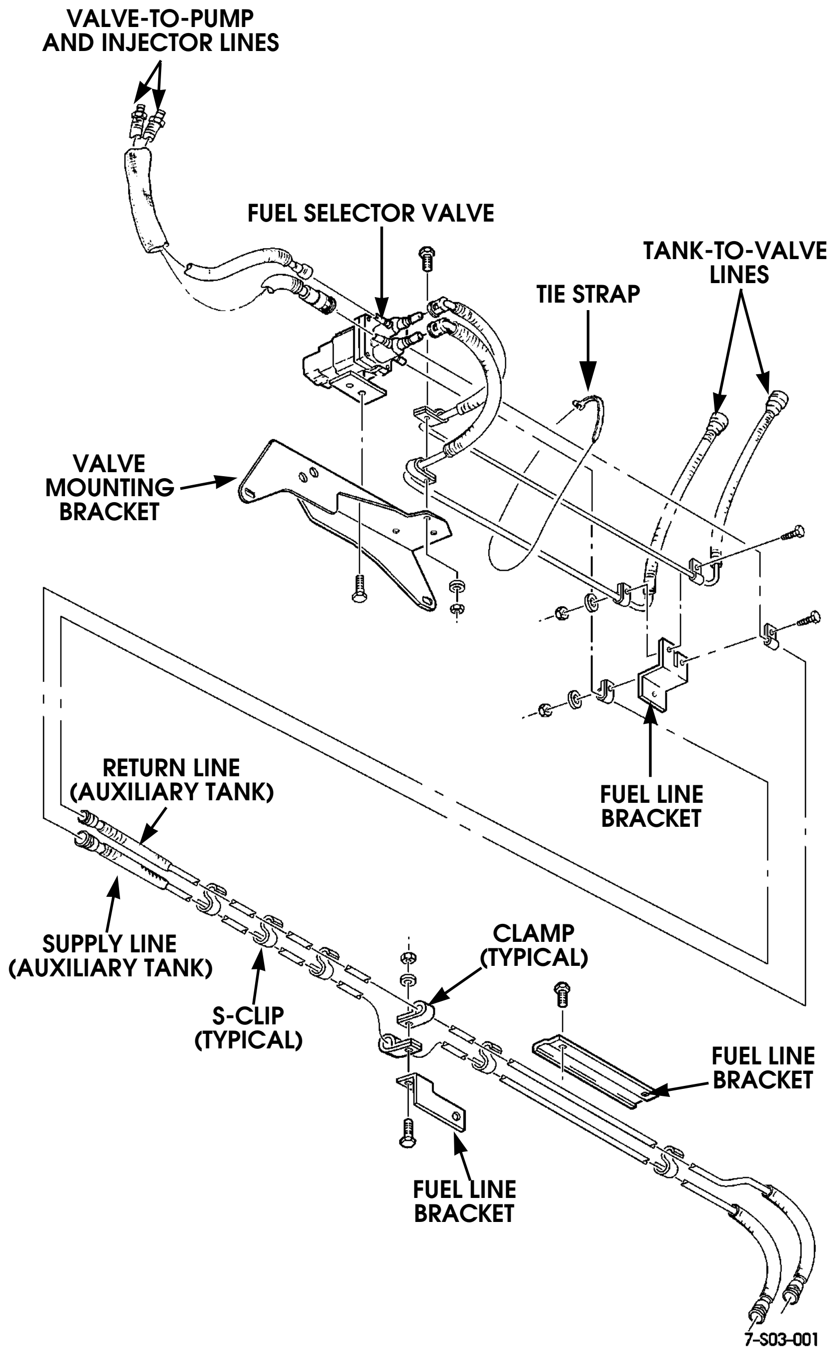


Figure 3-39: Fuel Lines, Connections, and Attachment

FUEL FILTER SERVICE

Fuel Filter Replacement

Removal

1. Disconnect fuel inlet and outlet hoses from filter (Figure 3-40).
2. Disconnect drain hose from fuel filter.
3. Disconnect filter harness connectors.
4. Remove filter attaching bolts and remove fuel filter from bracket.

Disassembly

1. Remove retaining nut and filter element from header.
2. Remove sensor and O-ring.
3. Loosen cap nut and remove fuel heater, seal, spring, and screen.

Assembly

1. Install screen, spring, cap seal, and fuel heater and tighten cap nut.
2. Install O-ring and sensor.
3. Install filter element and retaining nut.

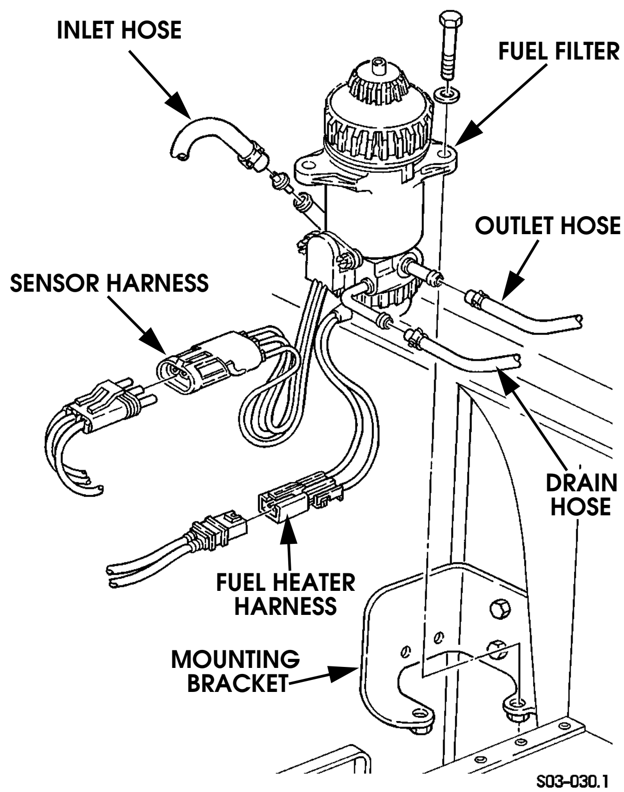


Figure 3-40: Fuel Filter Mounting

Installation

1. Install fuel filter on bracket and secure with washers and bolts (Figure 3-40).
2. Connect sensor and fuel heater harnesses to body harness connectors.
3. Connect drain hose to fuel filter.
4. Connect inlet and outlet hoses to fuel filter.

Purging Air From Filter

1. Loosen fuel filter air bleed valve one-half turn (Figure 3-41).
2. Run engine until fuel exits from air valve.
3. Tighten air valve.

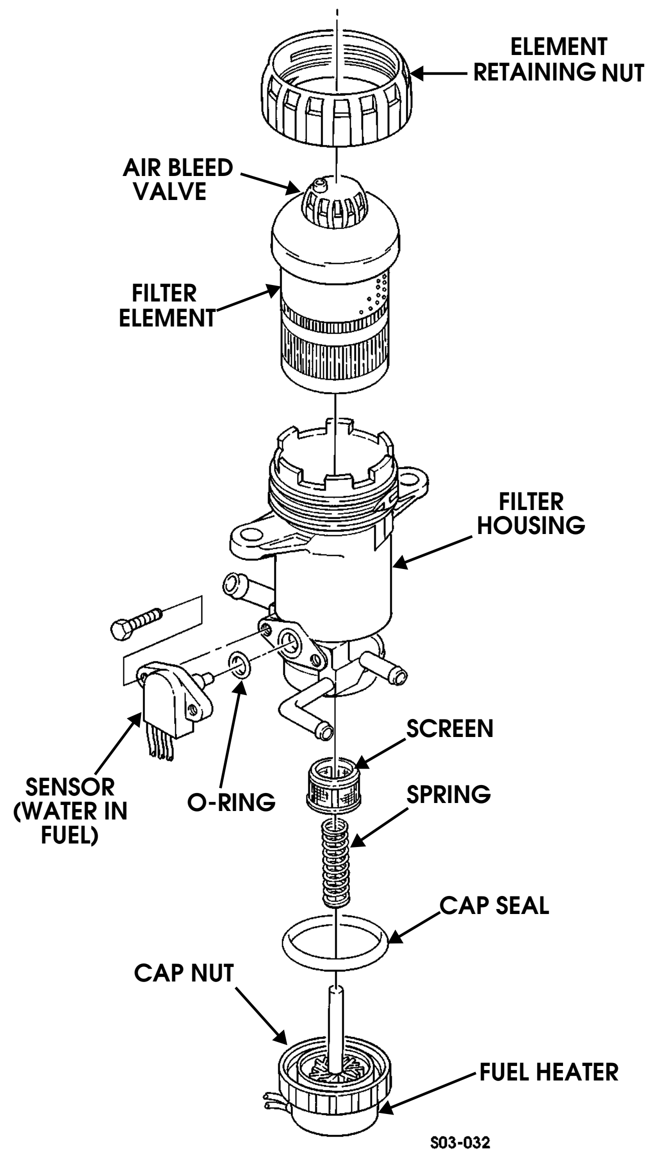


Figure 3-41: Fuel Filter Components

Fuel Filter Drain Hose and Valve Replacement

NOTE: To remove fuel filter drain valve only, perform steps 3 and 4.

Removal

1. Disconnect fuel filter drain hose from fuel filter (Figure 3-42).
2. Remove two tie straps and separate drain hose from transmission oil cooler lines.
3. Remove two tie straps and separate drain hose from transmission oil cooler lines.
4. Disconnect drain hose at drain valve.
5. Remove nut and drain valve from body

Installation

1. Install drain valve on body and tighten nut.
2. Connect drain hose to valve.
3. Connect drain hose to fuel filter.
4. Secure drain hose to transmission oil cooler lines with two tie straps.
5. Start engine and check for leaks.

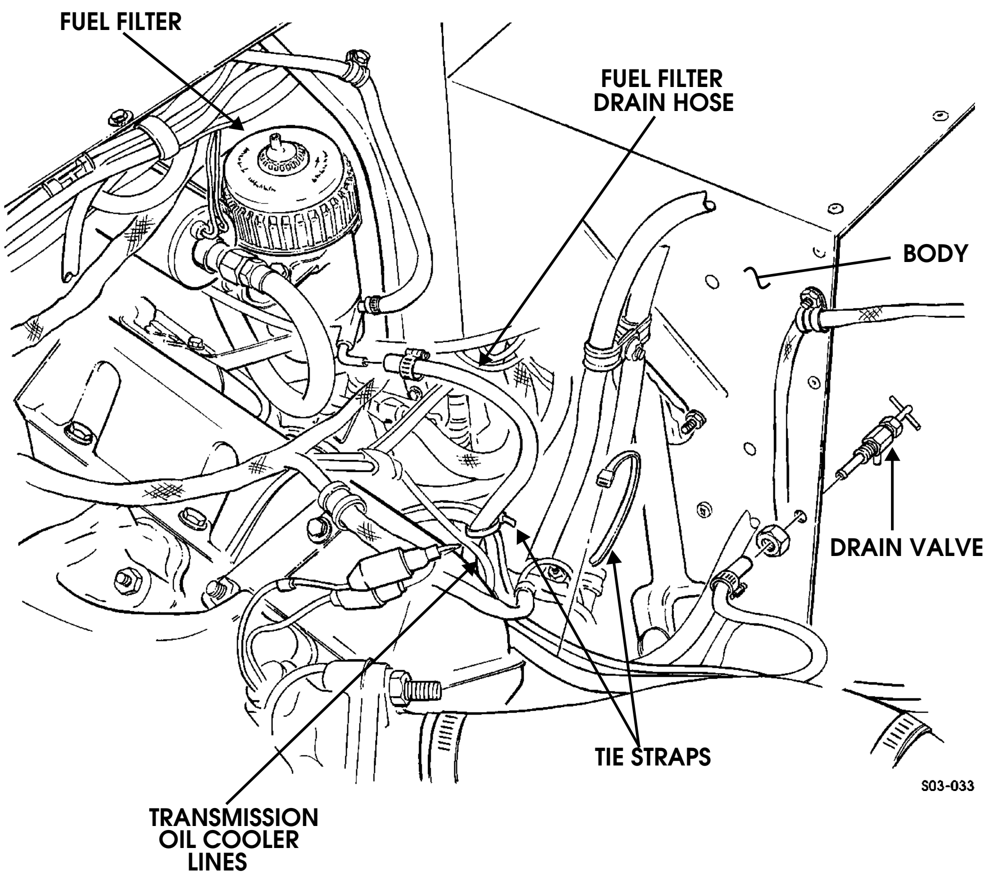


Figure 3-42: Fuel Filter Drain Hose and Valve Location

FUEL PUMP SERVICE

Fuel Pump Replacement

Removal

1. Disconnect fuel pump wiring harness (Figure 3-43).
2. Disconnect fuel pump hoses.
3. Loosen clamp and remove pump.
4. Remove adapters and O-rings from fuel pump. Discard O-rings.

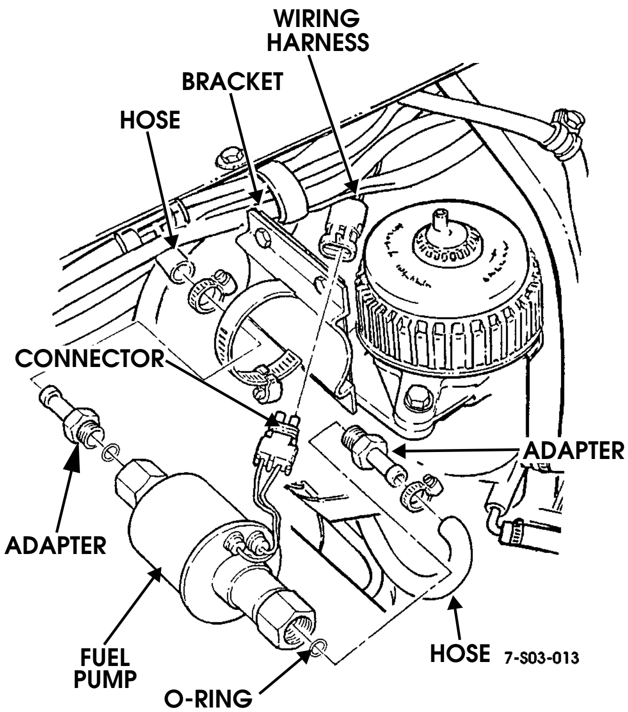


Figure 3-43: Fuel Pump Attachment

Installation

1. Install O-rings and adapters on fuel pump (Figure 3-43). Use new O-rings.
2. Install fuel pump in clamp and tighten clamp securely.
3. Connect hoses to fuel pump.
4. Connect wiring harness to pump.
5. Start engine and check fuel pump and hoses for leaks.

Fuel Injection Pump Boot Replacement (NA Diesel)

1. Remove clamp and boot from injection pump.
2. Slide new boot into place. Make sure it is seated on all fuel lines (Figure 3-44).
3. Install and tighten boot clamp.

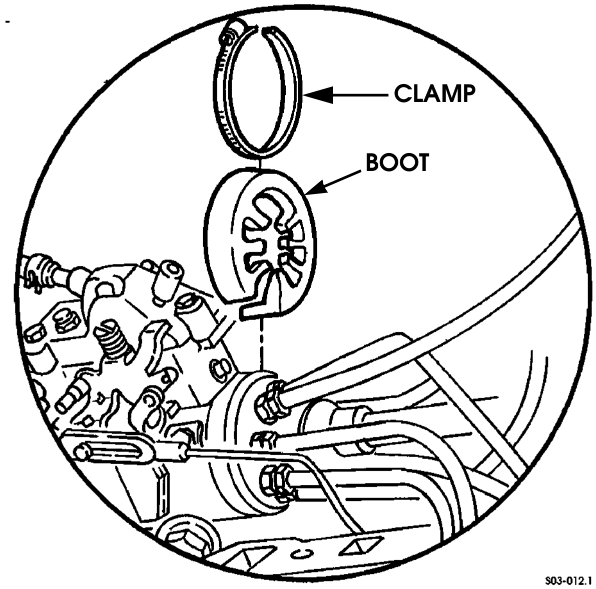


Figure 3-44: Injection Pump Boot Installation (NA Diesel Shown)

Fuel Tank-To-Filler Neck Hose Replacement

Removal

1. Drain fuel tank.
2. Remove filler tube housing bolts.
3. Disconnect filler tube vent hose.
4. Loosen clamps and remove hose from tank and filler (Figure 3-45).

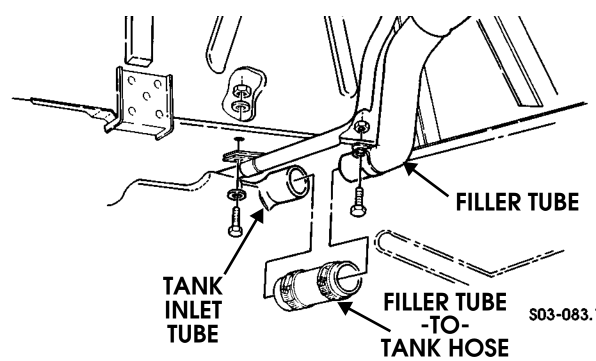


Figure 3-45: Filler Tube-To-Tank Attachment (All)

Installation

1. Install hose on tank and filler tube and tighten hose clamps.
2. Install filler tube and housing.
3. Fill fuel tank and check for leaks.

Diesel Injection Pump Fuel Hose or Tube Replacement

Removal

1. Remove return hose from injection pump and tube (Figure 3-46).
2. Remove tube-to-injector hose.
3. Remove injector connecting hoses (Figure 3-47).
4. Remove nozzle cap from rear nozzle nipple.

Installation

1. Install cap on rear injector nipple (Figure 3-47).
2. Install injector connecting hose.
3. Install tube-to-injector hose (Figure 3-46).
4. Install fuel return hoses on tube and injection pump.
5. Start engine and check for fuel leaks.

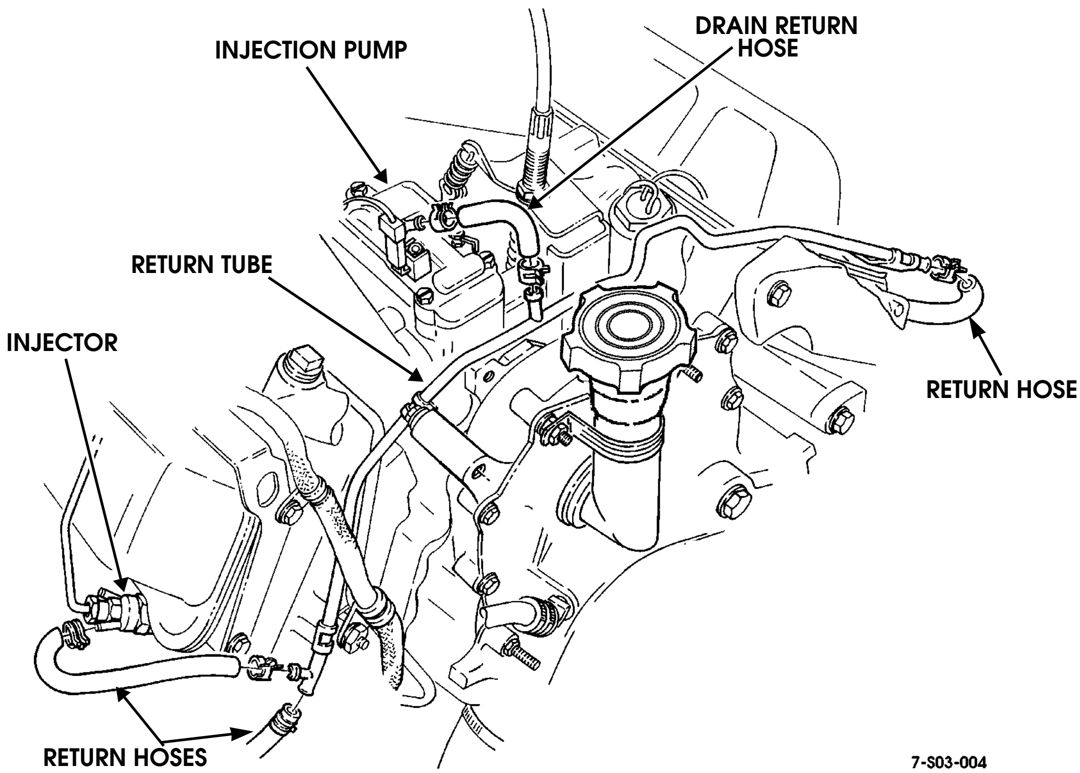


Figure 3-46: Diesel Fuel Injection Return Hose and Tube Routing (NA Diesel Shown)

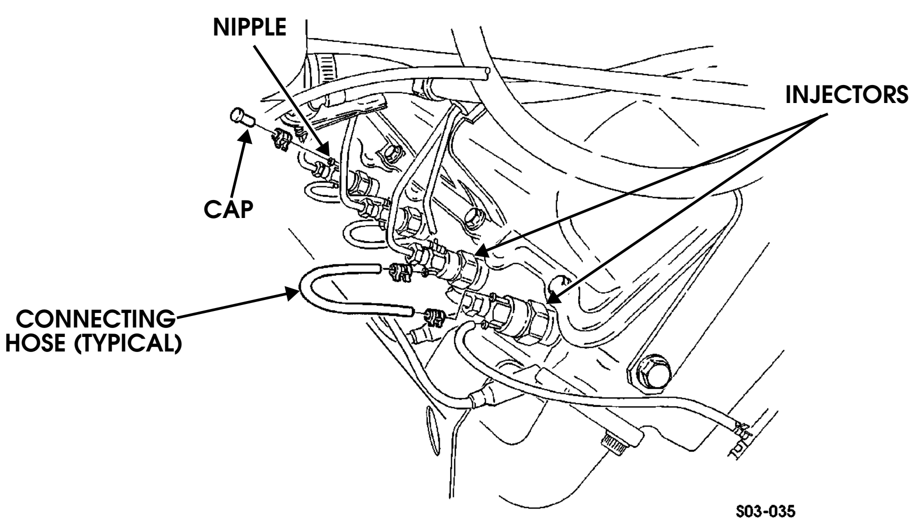


Figure 3-47: Injector-To- Injector Return Hose Connection

GLOW PLUG SERVICE

Glow Plug Tip Removal (Damaged or Broken)

1. Remove fuel injector from necessary cylinder.
2. Using torsional damper bolt (Figure 3-48),rotate crankshaft to bring affected piston to TDC position.
3. Using pliers, reach through injector nozzle port (Figure 3-49), break off expanded tip, and remove from prechamber.
4. Remove glow plug.

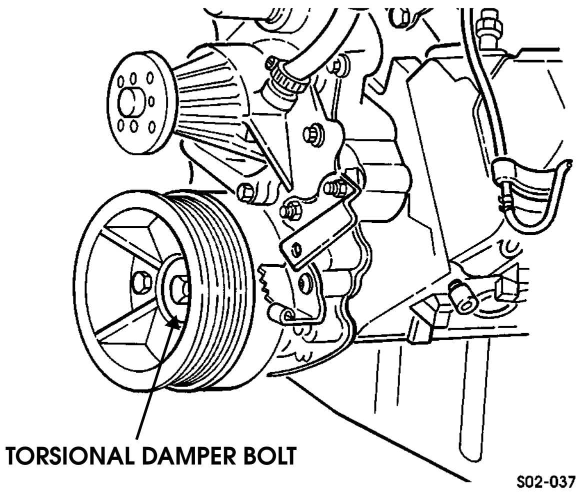


Figure 3-48: Torsional Damper Bolt Location

5. Direct stream of low-pressure compressed air into glow plug port. This will expel any remaining pieces of broken tip through injector port.

NOTE: If the preceding methods fail to remove glow plug tip remains from the prechamber, the cylinder head must be removed to clear the broken pieces.

6. Install new glow plug.
7. Install fuel injector.

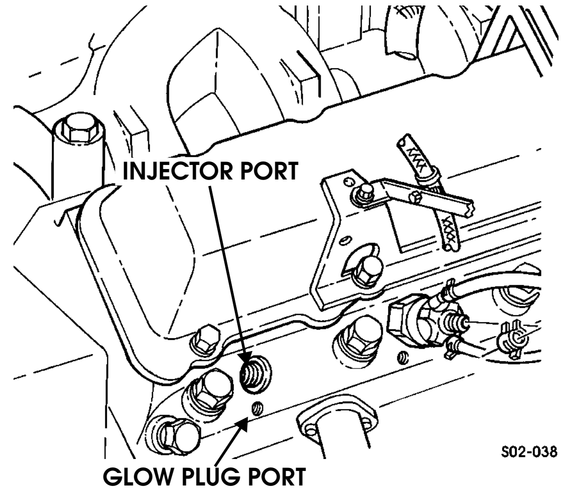


Figure 3-49: Glow Plug and Injector Port Locations

Glow Plug Replacement

Removal

1. Disconnect wire from glow plug with tool J–39083.
2. Remove glow plug from cylinder head (Figure 3-50).

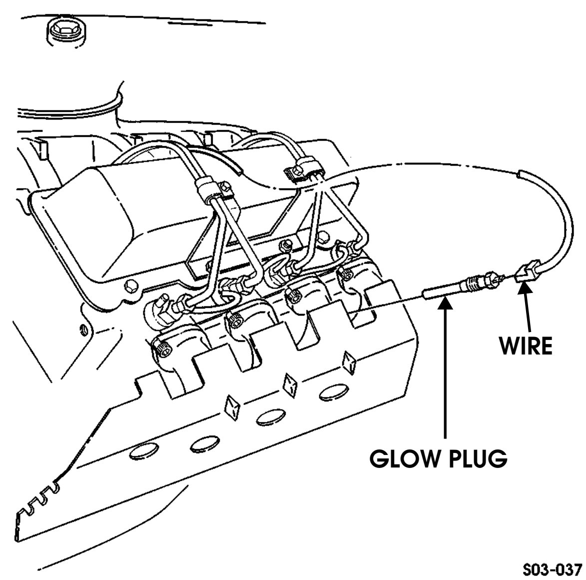


Figure 3-50: Glow Plug Removal/Installation (NA Diesel Shown)

Installation

1. Install glow plug in cylinder head. Tighten plug to 8-12 lb-ft (11-16 N•m) torque.
2. Connect wire to glow plug.

DIESEL FUEL INJECTION SYSTEM

Diesel Injection Line Bracket And Clamp

Removal

1. Remove console and engine covers.
2. Remove air horn.
3. Remove bracket (Figure 3-51).
4. Remove bracket from valve cover studs.
5. Remove line clamps if necessary.

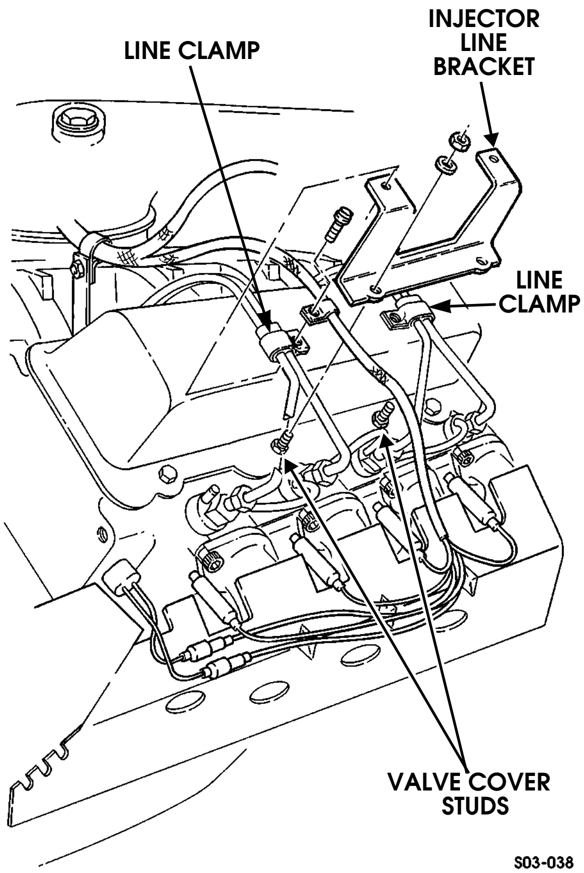


Figure 3-51: Injection Line Bracket Removal/ Installation (NA Diesel Shown)

Installation

1. Install clamps on lines if removed.
2. Install bracket on valve cover studs (Figure 3-52). Tighten bracket nuts to 13-20 lb-ft (18-27 N•m).
3. Install air horn.
4. Install console and engine cover.

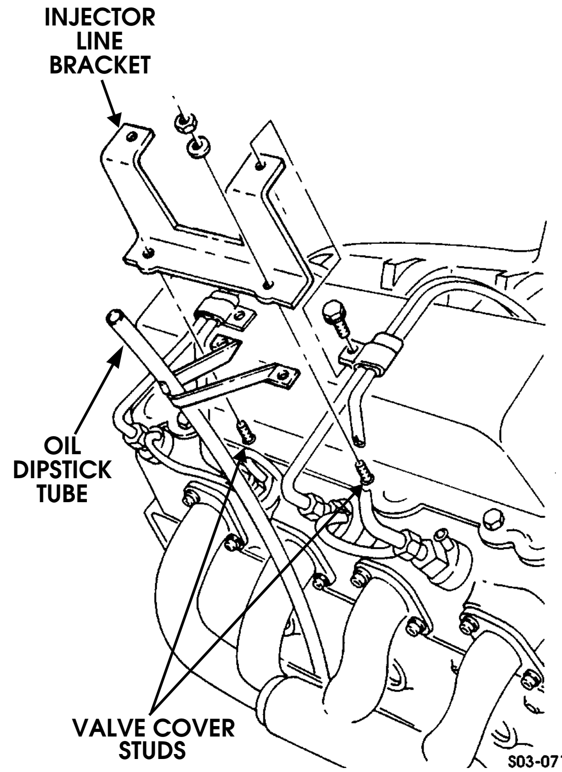


Figure 3-52: Injection Line Bracket Removal/ Installation (Driver-Side)

Fuel Injector Replacement

Removal

1. If removing rear injector, remove console and engine cover. Remove fuel return hose and cap from injector (Figure 3-53).
2. Disconnect fuel return hoses from necessary injector (Figure 3-54).
3. Remove clamp, and fuel injector line bracket and clamp.
4. Disconnect fuel line at injector (Figure 3-54).
5. Using socket J–29873, remove injector and gasket from cylinder head.

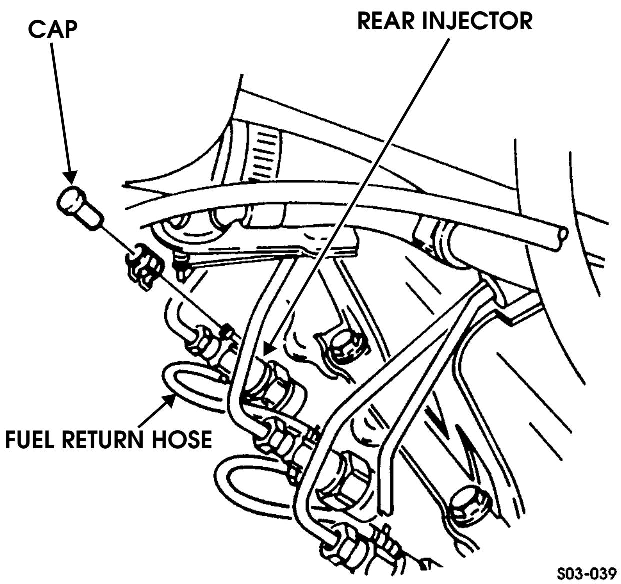


Figure 3-53: Rear Injector Fuel Cap Location

Installation

1. Apply antiseize compound to threads of new injector.
2. Install gasket and fuel injector in cylinder head. Tighten injector to 44-60 lb-ft (60-81 N•m).
3. Connect fuel line to injector. Tighten fuel line to 20 lb-ft (27 N•m).
4. Install injection line bracket and clamp.
5. Install fuel drain hose and cap.
6. Connect drain hoses to injectors.
7. Start engine and bleed injectors.
8. Install console and cover.

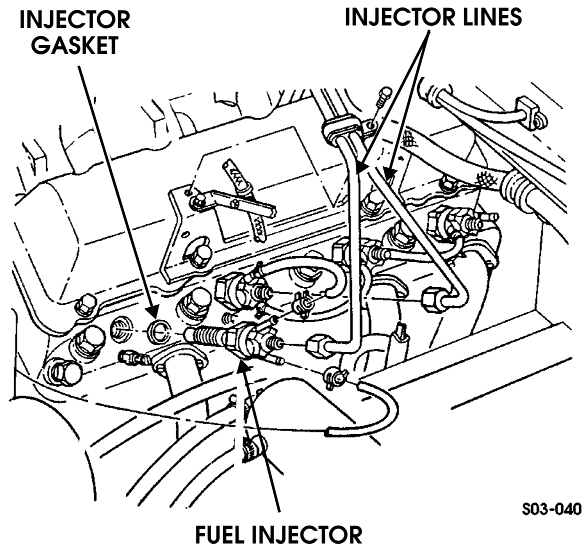


Figure 3-54: Fuel Injector and Gasket Removal/ Installation (NA Diesel Shown)

Injection Line Replacement

Removal

1. Remove injection pump boot.
2. Disconnect injection lines at injectors (Figure 3-55).

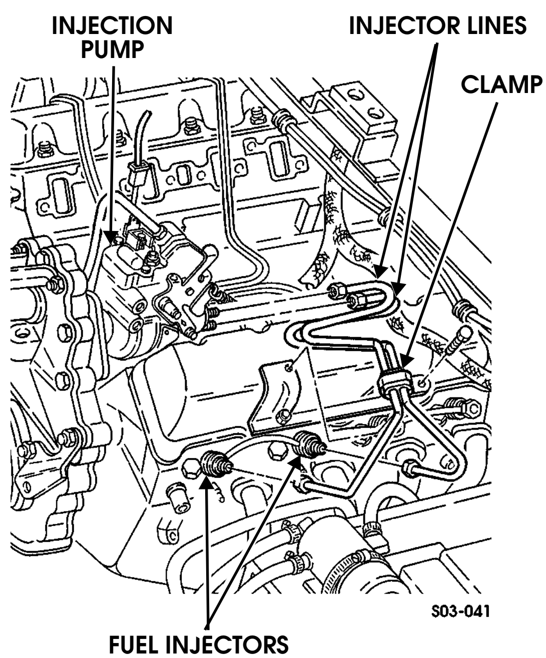


Figure 3-55: Fuel Injection Line Routing (Typical)

3. Remove injection line brackets.

NOTE: Tag fuel injection lines by cylinder number for installation reference.

4. Disconnect injection lines at pump.
5. Remove fuel line clamps.

Installation

1. Install clamps on injection lines (Figure 3-55).
2. Connect injection lines to pump (Figure 3-56).
3. Connect lines to injectors.

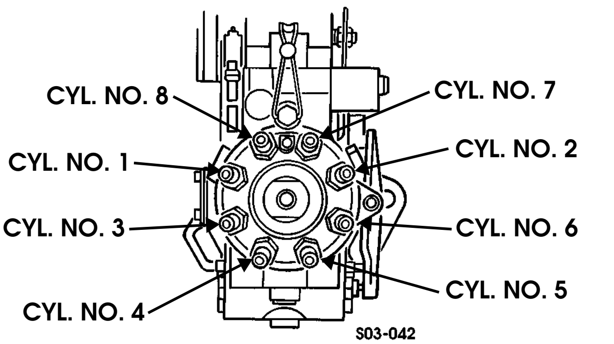


Figure 3-56: Fuel Injection Pump Line Connection (NA Diesel Shown)

4. Tighten injection line nuts to 20 lb-ft (27 N•m).
5. Install injection line brackets.
6. Install intake manifold.
7. Start and run engine.
8. Bleed all injectors.

Fuel Injection Pump

Removal

1. Remove engine oil filler neck and cap.
2. Disconnect intake hoses at intake manifold.
3. On NA diesel models, drain engine coolant and remove intake manifold and gaskets.
4. Disconnect fuel lines at injectors. Then remove fuel line clamps.
5. Remove clip attaching accelerator cable to pump lever.
6. Disconnect all solenoid and harness wires at injection pump.
7. Remove throttle position sensor.
8. Disconnect fuel hoses at injection pump.
9. Disconnect injector fuel lines at pump. Tag lines for assembly reference if desired.
10. Remove throttle return spring from throttle shaft lever.

NOTE: Rotate engine to gain access to driven gear-to-injection pump capscrews through oil filler tube opening

11. Remove bolts attaching pump driven gear.
12. Remove nuts and washers, attaching pump and gasket to timing gear cover.
13. Remove pump (Figure 3-57).

Service

Serviceable parts on the NA diesel injection pump are the solenoid, drive gears, pump cover, and gaskets. The pump should be replaced as an assembly whenever diagnosis indicates that pump failure has occurred.

The turbo diesel electronic injection pump is also not serviceable. Only the pump solenoids, sensors, gaskets, and drive gears are serviceable. The pump should be replaced as an assembly if an internal fault occurs.

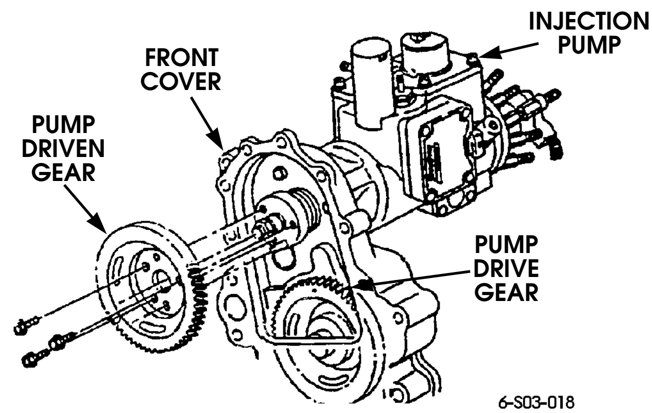


Figure 3-57: Fuel Injection Pump

Installation

1. Install gasket and fuel injection pump on timing gear cover (Figure 3-58)
2. Align pin on pump drive shaft with elongated hole in pump driven gear.
3. Align timing marks on injection pump and front cover.
4. Tighten injection pump attaching nuts.
5. Align and install pump driven gear. Tighten gear attaching bolts to 13-20 lb-ft (18-27 N•m).
6. Install hose adapter on injection pump if equipped.
7. Install accelerator cable and bracket.
8. Connect throttle return spring to throttle shaft lever and accelerator cable mounting bracket.
9. Connect fuel line to pump.
10. Install TPS.
11. Connect fuel lines to injectors.
12. Install injector line clamps and brackets.
13. Install engine oil filler tube.
14. Install fuel injector lines.
15. Install fast idle solenoid and mounting bracket, if equipped.
16. Adjust accelerator linkage on NA diesel models.
17. Connect fuel return hose.
18. Connect run and cold-advance solenoid leads to NA diesel injection pump.
19. On turbo diesel models, connect solenoid and sensor wires.
20. On turbo diesel, reprogram TDC offset.

Reprogramming TDC Offset

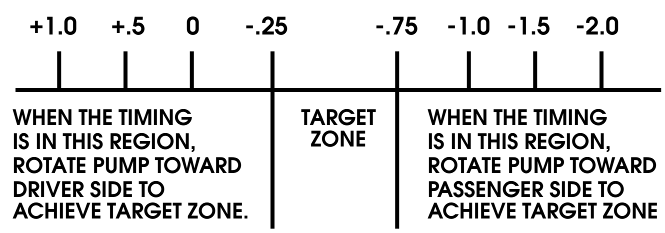
TDC offset must be reprogrammed whenever the PCM, front cover, timing gears, timing chain, crankshaft position sensor, or other components affecting timing are replaced. The procedure for reprogramming TDC offset is as follows:

1. Verify that vehicle batteries are fully charged.
2. Start and run engine at curb idle speed
3. Continue running engine at curb idle speed until coolant reaches normal operating temperature.
4. Connect Tech 1 scan tool to data link/diagnostic connector.
5. Select FO: OUTPUT TESTS from Miscellaneous Tests menu.
6. Select FO: INJ PUMP.
7. Select TDC OFFSET LEARN>.
8. Press Up Arrow key and PCM will learn engine top dead center offset value. This requires approximately 20 seconds.
9. Correct learned TDC offset value should be between minus 0.25 and minus 0.75. If value is not within specified range, loosen injection pump and rotate it to correct value as follows:

NOTE: The engines should be off before the injection pump is loosened and adjusted.

- If value is between plus 1.0 and minus 0.25, rotate pump toward driver side to achieve specified value.
- If value is between minus 0.75 and minus 2.0, rotate pump toward passenger to achieve specified value.

NOTE: 1 mm pump movement in either direction results in approximately 2 degrees change.



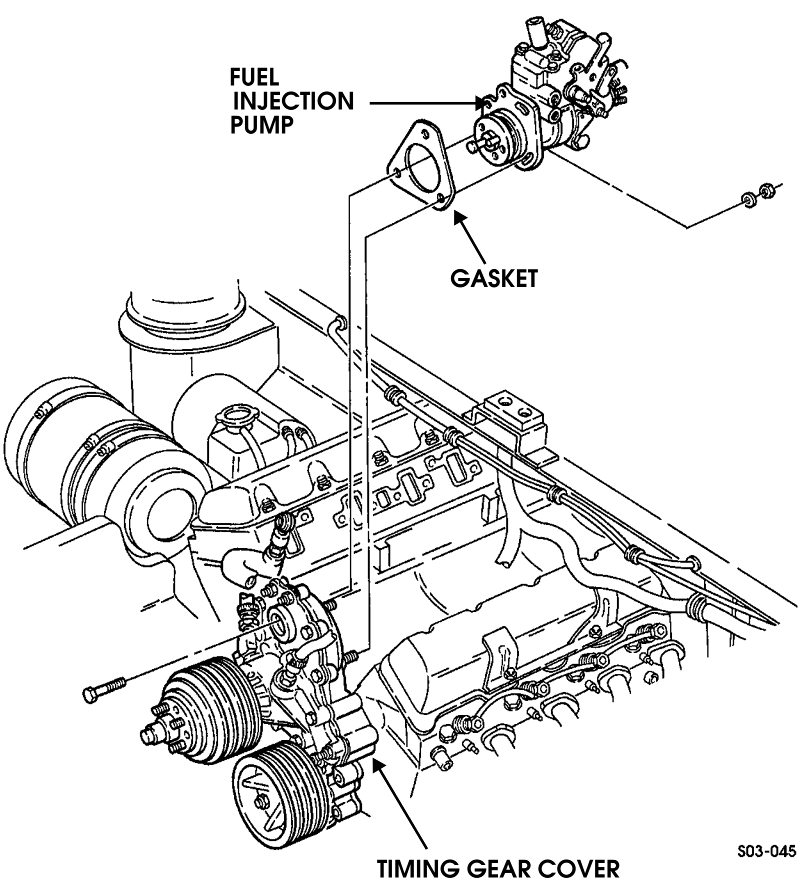


Figure 3-58: Injection Pump Removal/Installation

Fuel Injection Pump Solenoid Service (NA Diesel)

Removal

CAUTION: *Clean fuel injection pump body thoroughly before removing cover to prevent pump contamination. Keep work area clean, and free from blowing dirt or dust.*

1. Disconnect fuel return hose from pump (Figure 3-59).
2. Disconnect run and cold-advance solenoid leads from injection pump.

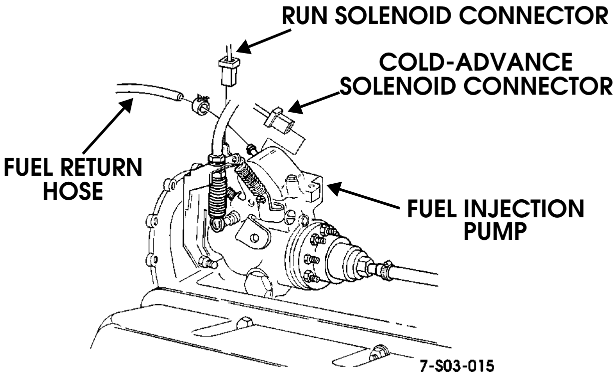


Figure 3-59: NA Diesel Injection Pump Hose and Solenoid Connections

3. Remove cover attaching screws, lockwashers, and washers. Then remove cover, and gasket from pump.
4. If cover will be replaced, remove check valve and O-ring (Figure 3-60).

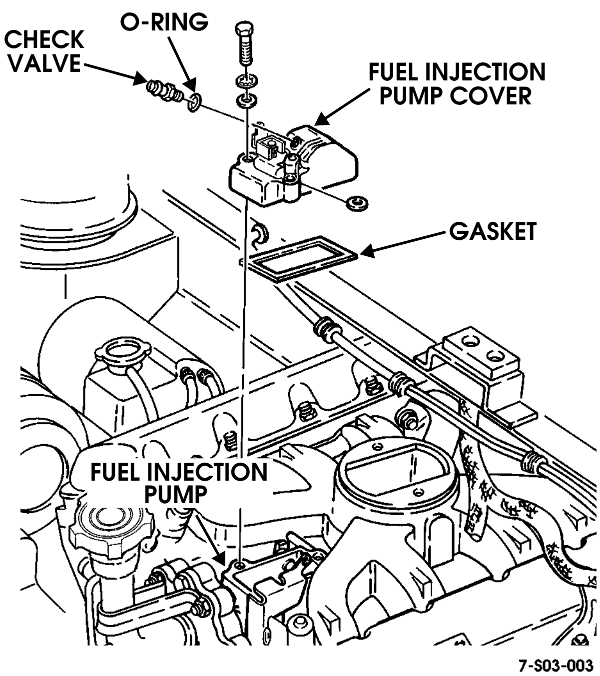


Figure 3-60: Pump Cover Removal/Installation (NA Diesel)

RUN SOLENOID REPLACEMENT

Remove the ground strap and terminal (Figure 3-61). Then remove the nuts, washers, and seals attaching the solenoid to the pump cover.

Clean the cover, ground strap, and terminal with electrical contact or brake cleaner before installing the new solenoid.

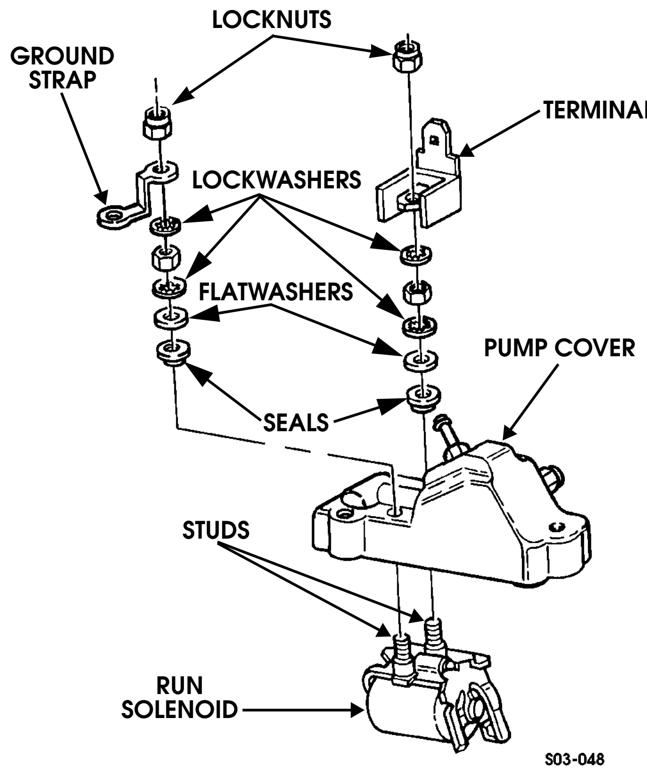


Figure 3-61: Run Solenoid Mounting

Secure run solenoid to injection pump cover with seals, washers and nuts. Then fasten lockwashers, ground strap and terminal with locknuts torqued to 35 lb-in. (4 N•m).

PUMP COVER INSTALLATION

1. Install O-ring and check valve in cover (Figure 3-62).
2. Install gasket and cover on injection pump and secure ground strap. Tighten cover screws to 35-44 lb-in. (4-5 N•m).
3. Connect return hose to injection pump.
4. Place ignition in RUN position and listen for clicking noise when connecting and disconnecting run solenoid wire. If clicking noise is not heard, remove and reinstall cover. If clicking noise is now present, connect run and cold-advance solenoid leads to injection pump.

CAUTION: *If clicking noise is not present, the throttle linkage may be jammed in the wide-open throttle position.*

5. Start engine and check for fuel leaks.

COLD-ADVANCE SOLENOID REPLACEMENT

Remove fuel injection pump run solenoid first. Next, remove the fuel return fitting and O-ring (Figure 3-62). Remove the locknut, terminal, lockwasher, nut, and washer, from the cold-advance solenoid stud. Remove the cold-advance solenoid from the cover.

Clean the cover, ground strap, and terminals with brake or electrical contact cleaner before solenoid installation.

Install the new cold-advance solenoid in the cover. Secure the solenoid with the seal, washer, lockwasher, nut, lockwasher, terminal, and locknut. Tighten the locknut to 35 lb-in. (4 N•m). Install the O-ring and fuel return fitting in the cover and install the run solenoid.

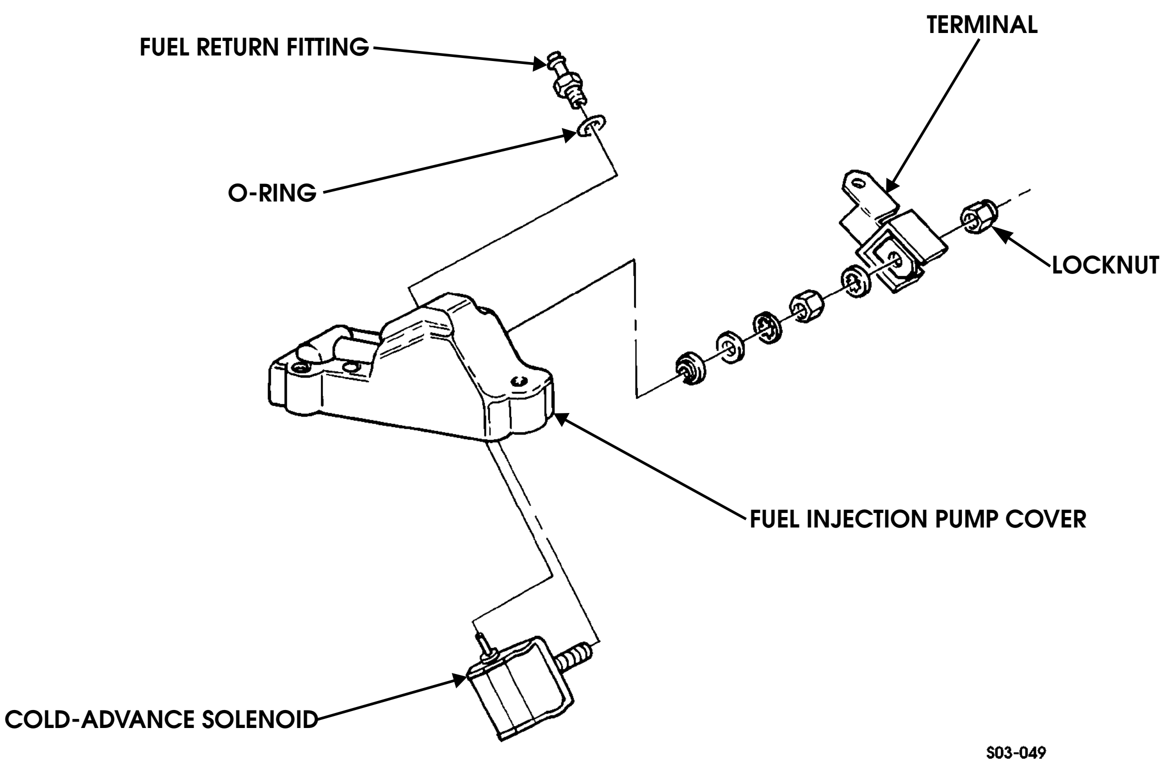


Figure 3-62: Cold-Advance Solenoid Mounting

COLD-ADVANCE/FAST-IDLE SWITCH REPLACEMENT

1. Disconnect connector from switch (Figure 3-63).
2. Remove switch from engine.
3. Apply teflon sealant to switch threads and install switch in engine.
4. Connect connector to switch.

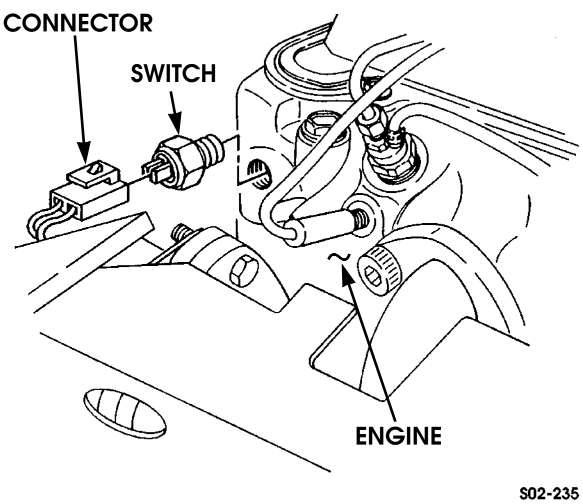


Figure 3-63: Cold-Advance/Fast-Idle Switch Removal/Installation

ENGINE TEMPERATURE SENDER REPLACEMENT

1. Remove nut, lockwasher, lead, and sender from engine (Figure 3-64).
2. Apply teflon sealant to sender threads, and install sender, lead, lockwasher, and nut on engine (Figure 3-64).

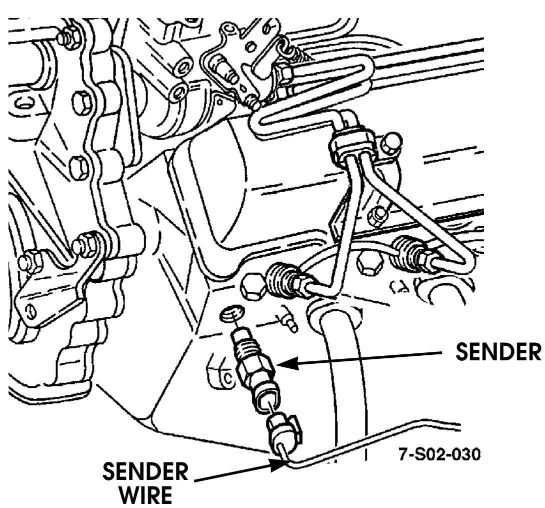


Figure 3-64: Engine Temperature Sender

GLOW PLUG RELAY/CONTROLLER REPLACEMENT

1. Disconnect battery ground cable.
2. Remove console and engine cover.
3. Disconnect harness wires at relay/controller (Figure 3-65)
.

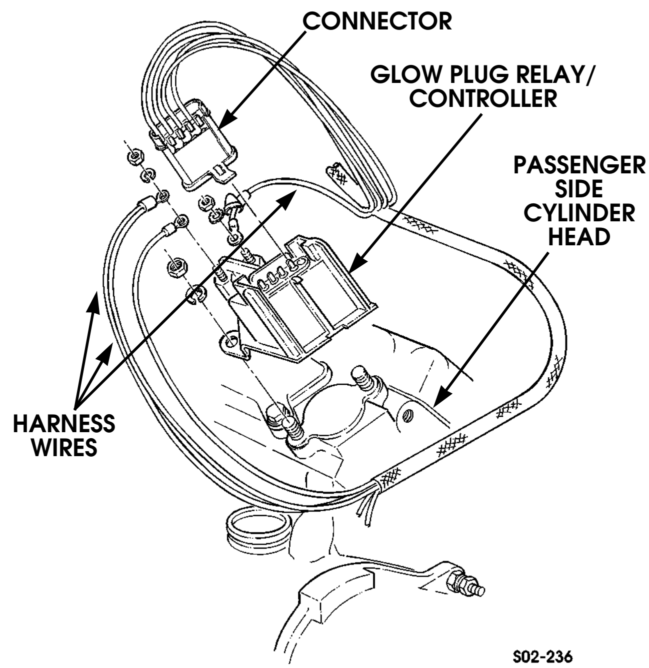


Figure 3-65: Glow Plug Relay/Controller Location

4. Disengage connector from glow plug controller.
5. Remove relay/controller fasteners and remove relay.
6. Position relay/controller on cylinder head and install attaching nuts and washers.
7. Engage connector in relay/controller.
8. Connect harness wires to relay/controller studs.
9. Install engine cover and console.
10. Connect battery ground cable.

SENSOR, OIL PRESSURE SWITCH, AND TRANSMITTER SERVICE (NA DIESEL)

The oil pressure switch, transmitter, baro sensor, and TPS are all serviceable parts (Figure 3-66).

The TPS is mounted on the injection pump and the baro sensor on the driver side of the intake manifold.

The oil pressure switch and transmitter are both accessible after removing the console and engine cover.

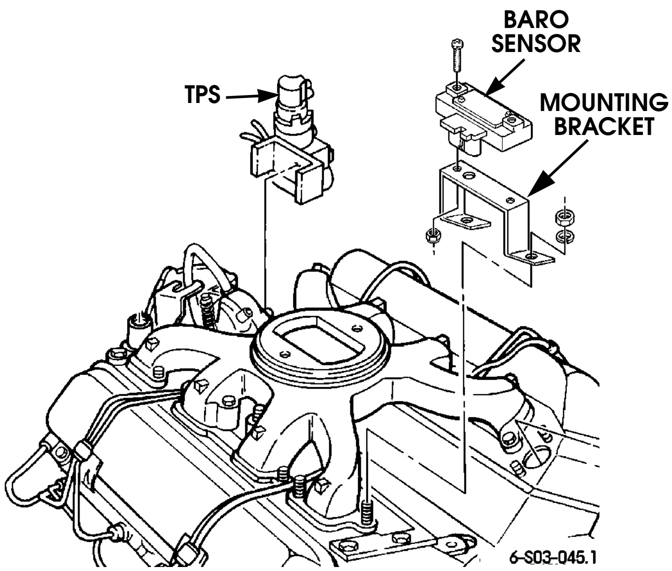


Figure 3-66: Sensor and Switch Location

SENSOR AND SWITCH SERVICE (TURBO DIESEL)

The sensors and switches on turbo diesel engines are serviceable parts.

The boost pressure switch is on the passenger side valve cover. The TPS is attached to the injection pump and the coolant temperature switch is in the water crossover.

The oil pressure switch is in the valley between the heads. The MAP and air temperature sensors are at the passenger side of the intake manifold.

FAST IDLE SOLENOID AND BRACKET REPLACEMENT (NA DIESEL ENGINE)

1. Disconnect wire from fast idle solenoid (Figure 3-67)
2. Remove solenoid attaching bolts and remove solenoid and bracket from accelerator cable bracket (Figure 3-67).
3. Attach solenoid and bracket to accelerator cable bracket.
4. Connect solenoid wire.

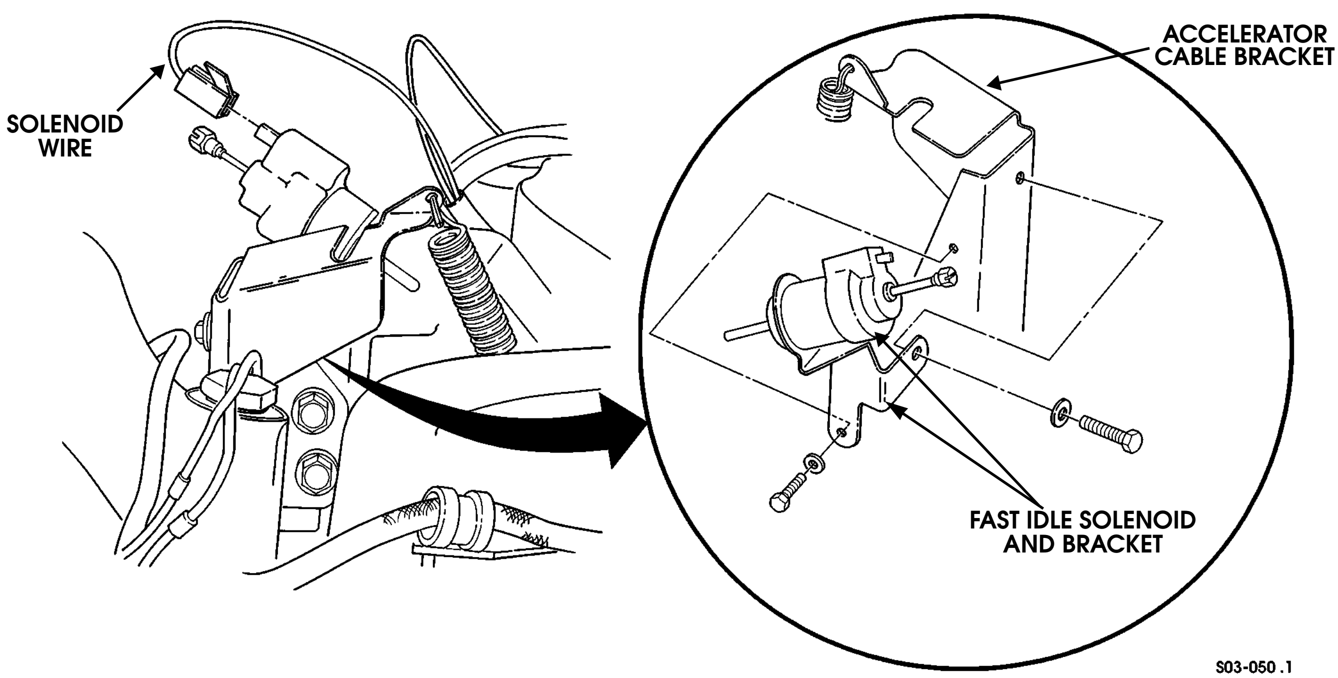


Figure 3-67: Fast Idle Solenoid and Bracket Mounting (NA Diesel Engine)

ACCELERATOR SERVICE

Accelerator Pedal Replacement (NA Diesel)

1. Remove pedal cotter pin, washer, pivot pin, accelerator pedal, and spring from accelerator rod. (Figure 3-68).

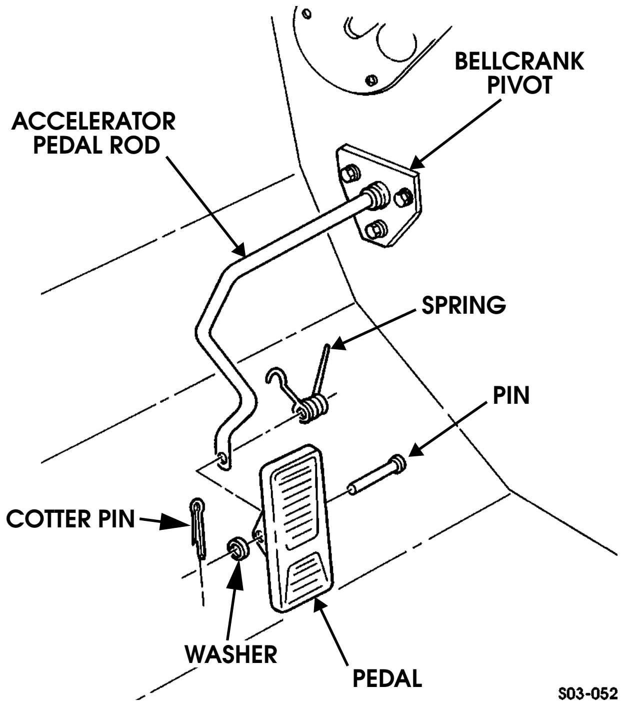


Figure 3-68: Accelerator Pedal Control Pad Removal/Installation

1. Install accelerator pedal and spring on accelerator rod with pin, washer, and cotter pin (Figure 3-69).
2. Start engine and check for proper accelerator operation.

Accelerator Linkage Service

Linkage Removal

1. Disconnect drive door check strap.
2. Remove driver seat attaching bolts and remove seat from vehicle.
3. Remove steering column closeout panel.
4. Working from under vehicle, disconnect accelerator cable at pedal connecting arm. Discard cotter pin used to secure cable.
5. Remove parking brake and shift control panel. Move parking brake lever and transmission/transfer case shift levers into an upright (vertical) position to allow panel removal.
6. Remove right hand, inner front kick panel and seat belt latch. Note that panel is notched so it will clear accelerator pedal rod. Also be sure seat belt latch wire has been disconnected before removal.
7. Remove bolts attaching bellcrank pivot to tunnel (Figure 3-69). On models where bolts are secure by nuts, have a helper assist in bolt and nut removal. Nuts are accessible from under the vehicle.

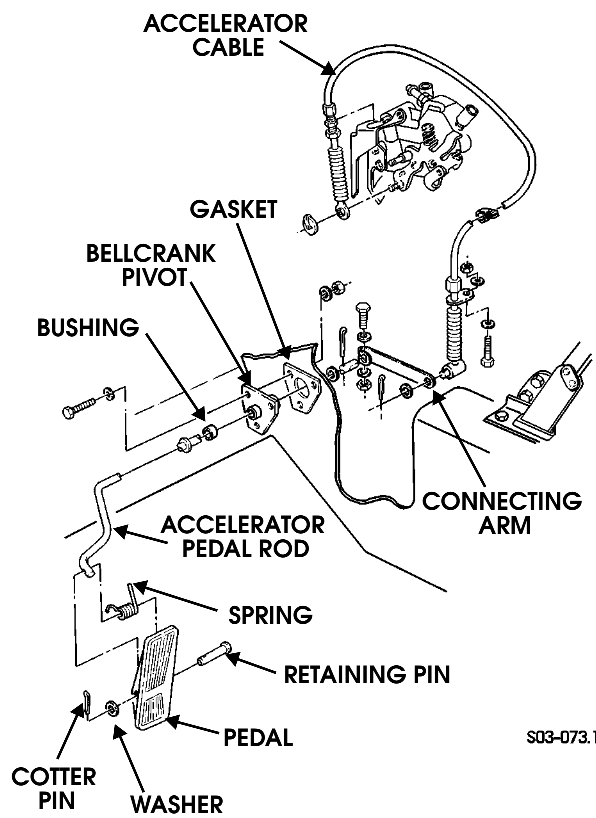


Figure 3-69: Accelerator Linkage Components

8. Work pedal rods and connecting arm through hole in dash and remove pedal assembly from the vehicle (Figure 3-70).

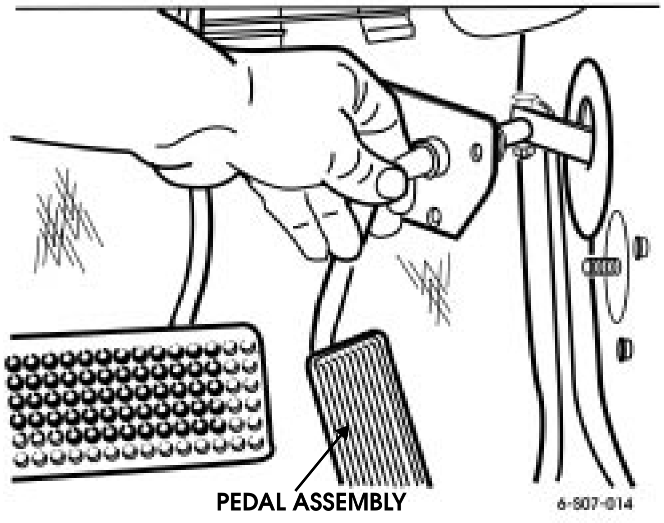


Figure 3-70: Accelerator Pedal Assembly

Installation

1. If pedal pad is to be replaced, remove pin and spring, install new pad and reinstall pin and spring. If new pedal rod will be installed, just transfer original pedal, spring and pin to new pedal rod assembly.
2. If new pedal rod is being installed, lubricate bellcrank bushings with Lubriplate before installation. The bellcrank has a grease fitting for this purpose.
3. Install accelerator pedal assembly and tighten bellcrank bolts to 10 lb-ft (14 N•m) torque.
4. Secure accelerator cable to pedal connecting arm with a new cotter pin.
5. Position inner kick panel and seat belt latch on tunnel, connect latch wire, and install panel attaching screws. Tighten seat belt latch bolt to 55 lb-ft (75 N•m) torque.

NOTE: Be sure the seat belt latch bolt is properly tightened before proceeding.

6. Install the CTIS control knob, if equipped.
7. Install parking brake and shift control panel.
8. Install steering column closeout panel.
9. Install driver seat. Tighten driver seat attaching bolts to 20 lb-ft (27 N•m) torque.
10. Connect driver door check strap.

Accelerator Cable Adjustment (NA Diesel)

1. Loosen accelerator cable adjusting nuts (Figure 3-71).
2. Depress accelerator pedal, and hold throttle shaft lever in full throttle position.
3. Set cable adjusting nuts so cable holds throttle shaft lever in full throttle position. Tighten adjusting nuts.
4. Release accelerator pedal. Ensure throttle shaft lever returns to idle position.
5. Start engine and verify proper accelerator operation.

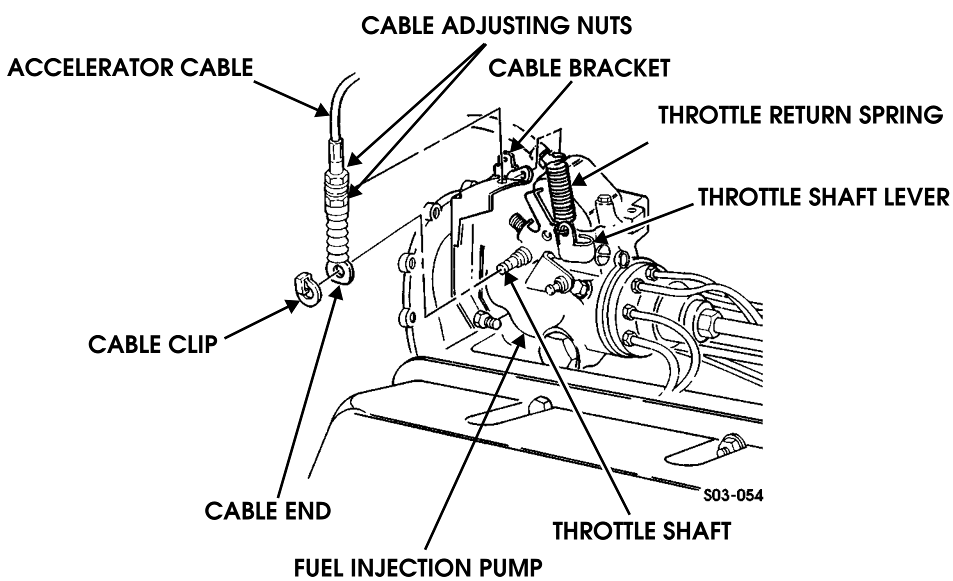


Figure 3-71: Throttle Shaft Lever Location (NA Diesel)

Accelerator Cable Mounting Bracket (NA Diesel Engine)

Removal

1. Loosen cable adjusting nuts and disconnect accelerator cable from bracket (Figure 3-72).

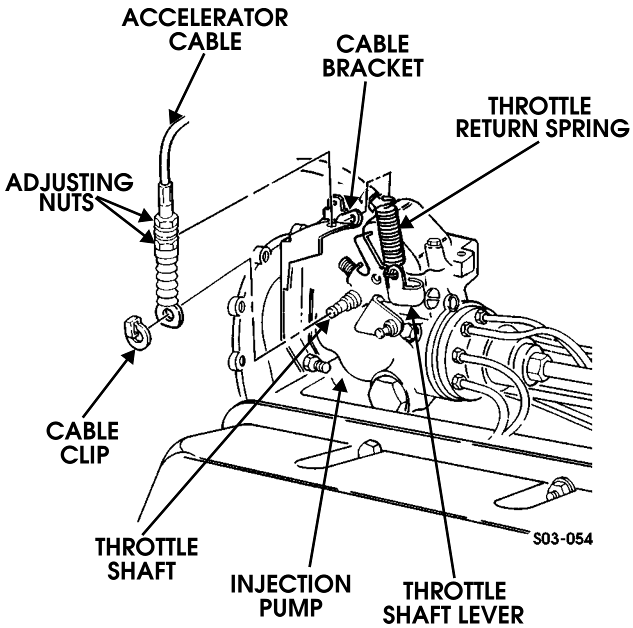


Figure 3-72: Accelerator Cable Mounting Attachment

2. Disconnect throttle return spring from cable bracket.
3. Remove cable clip and disconnect accelerator cable from throttle shaft.
4. Remove nut, washer, bolts, and bracket from injection pump and stud.

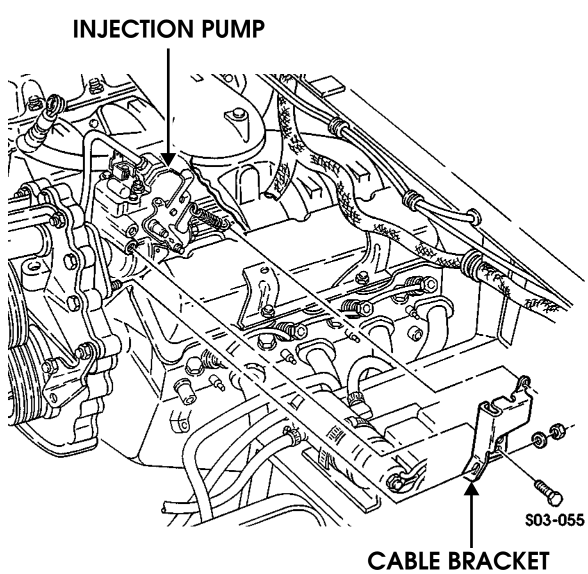


Figure 3-73: Cable Bracket Mounting

Installation

1. Install bracket on injection pump and stud. Tighten attaching bolts to 13 lb-ft (18 N•m) (Figure 3-73).
2. Move throttle shaft lever to full throttle position. Position accelerator cable on throttle shaft and install cable clip (Figure 3-72).
3. Connect throttle return spring to cable bracket.
4. Install accelerator cable on bracket and tighten cable adjusting nuts.
5. Check and adjust accelerator linkage if necessary.

IDLE SPEED ADJUSTMENT (NA DIESEL)

Engine curb idle speed should be set at 625-675 rpm. To adjust idle speed, turn idle speed adjusting screw on throttle shaft lever (Figure 3-74). Turn adjusting screw clockwise to increase rpm, or counterclockwise to decrease rpm.

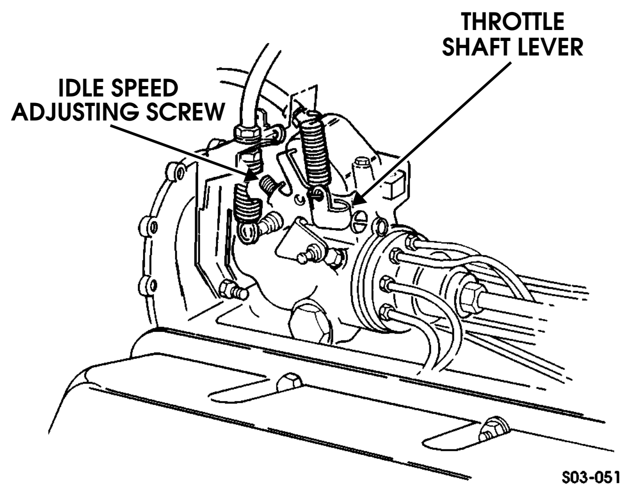


Figure 3-74: Idle Speed Adjusting Screw Location (NA Diesel)

Idle Speed Adjustment (Turbo Diesel)

Idle speed is not adjustable on turbo diesel engines. Idle speed is controlled entirely by the PCM and will vary depending on temperature of the engine coolant and ambient air.

STATIC TIMING CHECK

Static timing marks are stamped into the injection pump and front cover (Figure 3-75). Verify that these marks are aligned before performing a dynamic timing check.

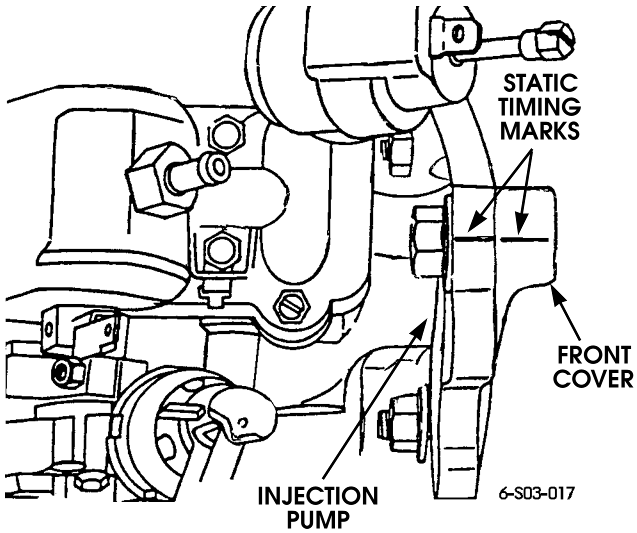


Figure 3-75: Diesel Engine Static Timing Mark Location

Injection Pump Timing Check (NA Diesel)

1. Connect timing tool J–33300 (Kent-Moore) following manufacturer's instructions (Figure 3-76).
2. Start engine and warm to operating temperature.
3. Set engine speed at 1300 rpm.
4. Correct reading is 5° BTDC for NA diesel and 3.5° BTDC for turbo diesel. If reading is incorrect, proceed to timing adjustment.

TPS Adjustment

TPS adjustment with or without the scan tool is covered in Section 5.

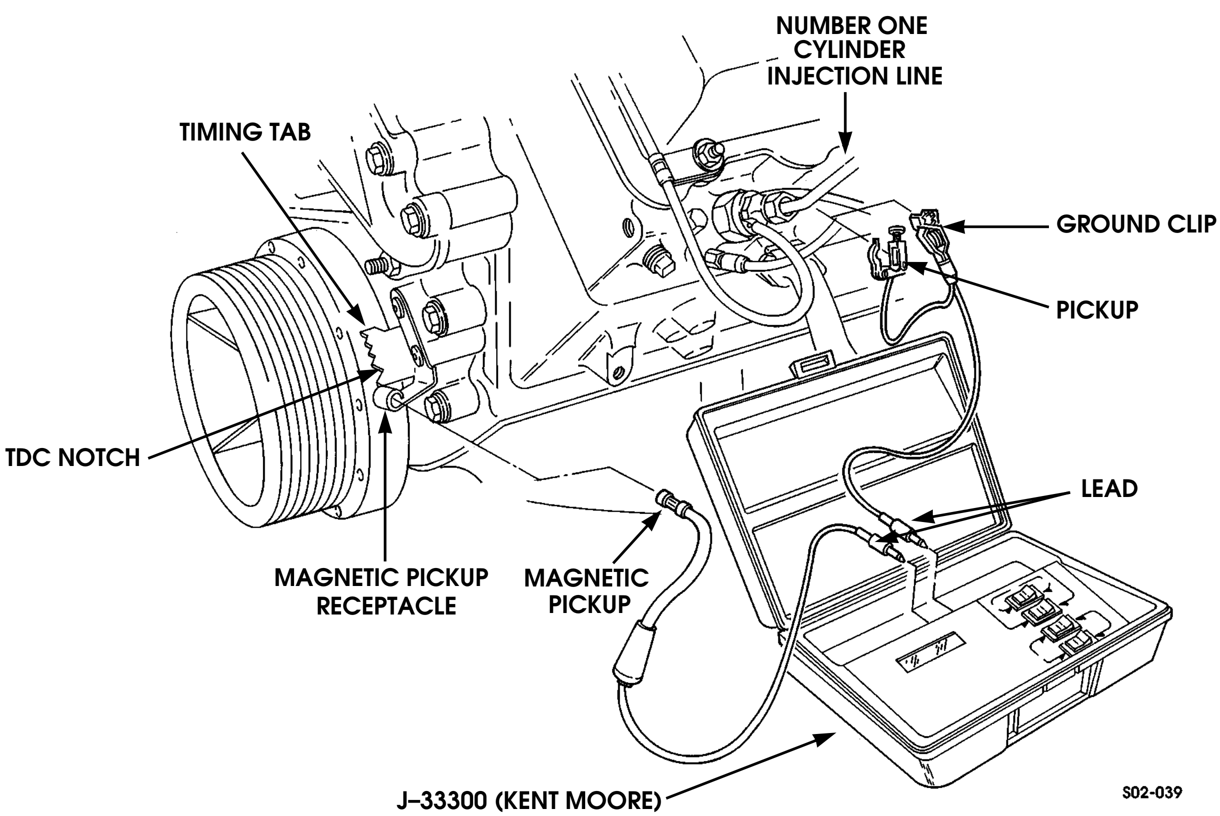


Figure 3-76: Dynamic Magnetic Pickup Timing Meter Connection (NA Diesel Only)

INJECTION PUMP TIMING ADJUSTMENT (NA DIESEL)

Only the NA Diesel injection timing is adjustable. Turbo diesel injection timing is controlled by the PCM and is not adjustable. The following adjustment procedure applies to NA diesels only.

WARNING: To avoid injury or engine damage, never adjust injection pump timing with the engine running.

1. Loosen three nuts attaching injection pump to front cover (Figure 3-77).
2. Install tool J–29872 on pump.

NOTE: Moving the injection pump timing mark, 0.03 in. (0.8 mm) will change timing approximately 1°.

3. Rotate injection pump clockwise to retard timing, and counterclockwise to advance timing to desired 5° BTDC.
4. Tighten injection pump-to-front cover nuts.
5. Recheck timing with timing tool J–33300 (Kent Moore) to verify proper setting.

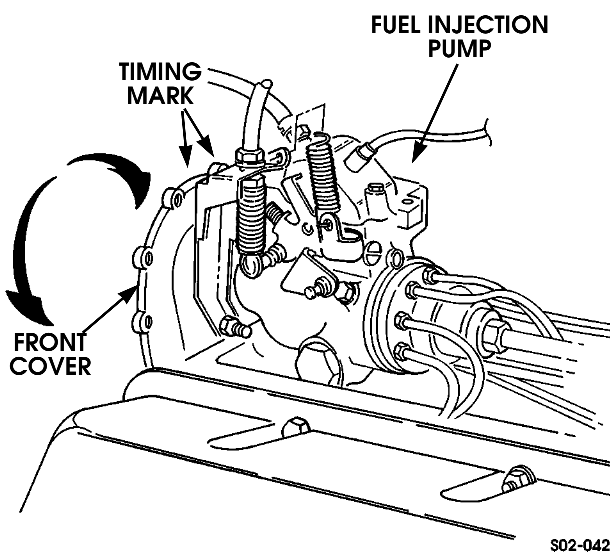


Figure 3-77: Timing Marks Location

FUEL SYSTEM CONTAMINATION

Organic Contamination

Diesel fuel systems are susceptible to fungi and other micro-organism infestation when water is present. These fungi can grow into long strings or large globules anywhere in the fuel system. Due to the amount of water, the most prevalent location for fungi is the fuel tank.

The growths appear slimy and may be black, green, or brown. They are introduced by refueling with an unfiltered or aged fuel source.

Fungi feed on the fuel and need only trace amounts of minerals and water. As they grow and multiply, they change fuel into water, sludge, acids, and products of metabolism.

The most common symptom is a loss of performance due to fuel filter clogging. Infestation can also show up as corrosion of metal parts such as injectors, fuel pumps, and steel lines.

WARNING: To avoid personal injury do not come into physical contact with biocide agents, cleaners, or additives used to remove fungi or micro-organisms.

If fungi have caused fuel system problems, sterilize the system with a diesel fuel system biocide or cleaning agent. Follow the manufacturer's instructions.

Use of biocides while operating under heavy loads such as towing a trailer is not recommended. Such use is permissible, but no additional biocide should be used when refueling during such operations.

Contamination that is severe or does not respond to biocides may require tank removal, disassembly, and steam-cleaning.

Water or Wax Contamination

1. Remove fuel cap from filler tube.
2. Drain fuel into portable tank with air powered pumping mechanism.
3. Drain filter, fuel pump, and fuel lines.
4. Refill tank with fresh fuel.
5. Start engine and bleed lines, filter, and injectors.

Checking Fuel Quality

A quick check on fuel quality can be performed with tool J–34352. The tool measures fuel specific gravity and indicates if quality is acceptable or not.

1. Drain the fuel filter housing as follows:
   - Stop engine.
   - Place container under drain valve hose at left front side of vehicle.
   - Open drain valve.
   - Start engine and run it at curb idle speed until clear fuel appears at drain valve exit hose.
   - Fill a 1-liter (0.946 quart) container with sample of clean fuel.
   - Close drain valve and stop engine.
   - Bring fuel sample to 60°F (16°C).
2. Fill hydrometer tool J–34352 with fuel sample as follows:
   - Squeeze hydrometer bulb
   - Immerse hydrometer tip in fuel sample
   - Release bulb and allow fuel to enter glass tube until indicator floats freely.
   - Gently spin hydrometer to relieve surface tension of fuel sample.

3. Read color coded scale on indicator.
4. Note fuel quality (Figure 3-78)
   a. if fuel is in yellow area on indicator, fuel contains gasoline or other contaminate.
   b. if fuel is in green area on indicator, fuel is of acceptable quality with cetane rating of 46 to 50.
   c. fuel is in red area on indicator, fuel quality is low with a cetane rating of 38 to 40.

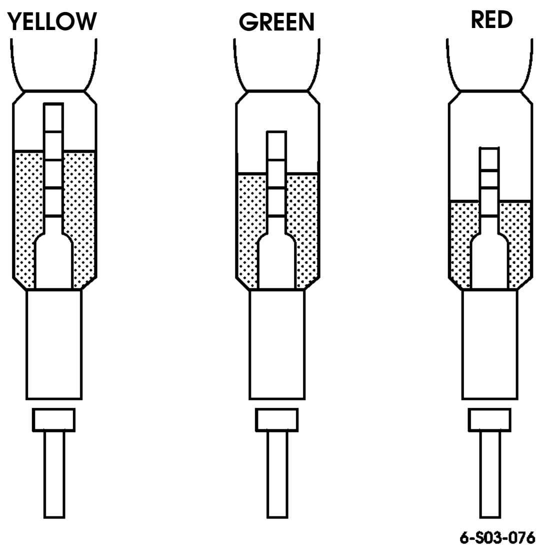


Figure 3-78: Checking Fuel Quality

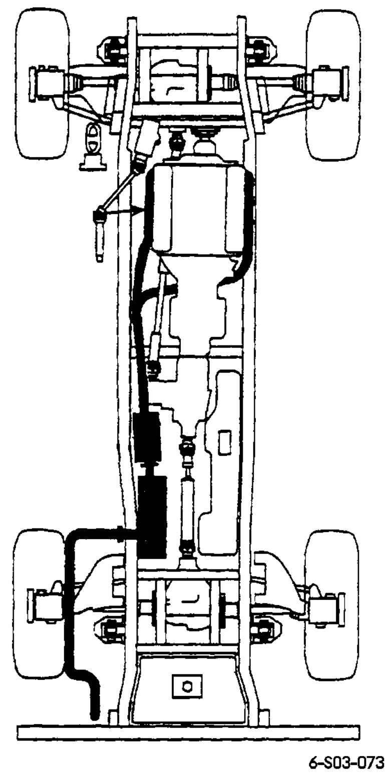


Figure 3-79: N/A Diesel

MUFFLER REPLACEMENT

1. Remove fasteners attaching muffler and gasket to catalytic converter (Figures 3-79 and 3-80).
2. Remove fasteners attaching muffler to tailpipe.
3. Remove fasteners attaching muffler to frame bracket and insulator.
4. Loosen tailpipe and transfer case exhaust pipe brackets.
5. Remove old muffler and install new muffler and gasket.
6. Align all pipes and tighten frame/body bracket fasteners.
7. Tighten muffler flange bolts to 26 lb-ft. (35 N•m).

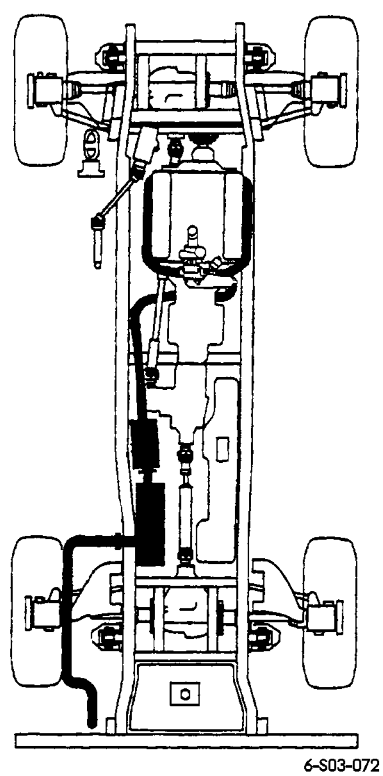


Figure 3-80: Turbo Diesel

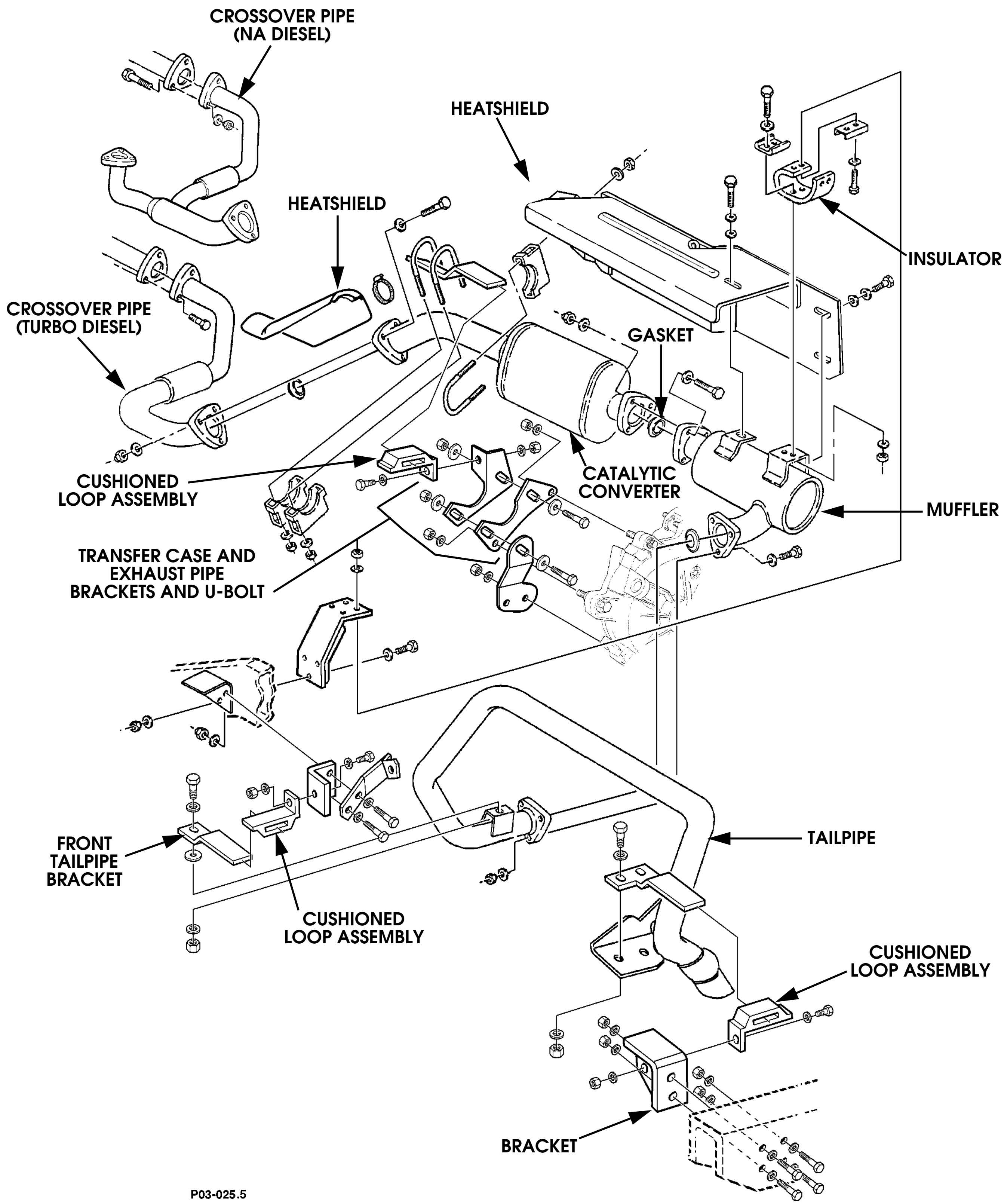


Figure 3-81: Exhaust System

CROSSOVER PIPE REPLACEMENT

1. Remove console and engine cover.
2. Remove passenger side exhaust manifold rear heat shield.
3. Loosen transfer case exhaust pipe bracket U-bolt (Figure 3-82).
4. Disconnect crossover pipe at manifolds and at catalytic converter.
5. Position new crossover pipe on manifolds. Tighten flange bolts to 26 lb-ft. (35 N•m).
6. Connect crossover pipe to catalytic converter and tighten flange bolts to 26 lb-ft. (35 N•m).
7. Tighten exhaust bracket U-bolt nuts at transfer case to 26 lb-ft. (35 N•m).
8. Install heat shield.
9. Install engine cover and console.
10. Start and run engine. Verify that exhaust components are clear of body, frame, and driveline parts.

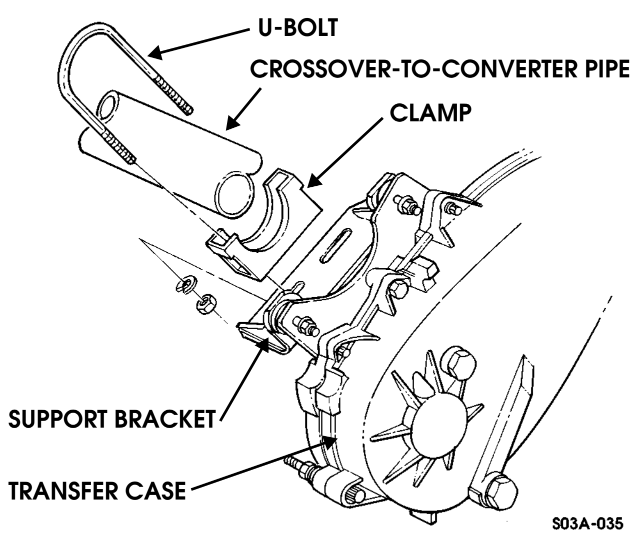
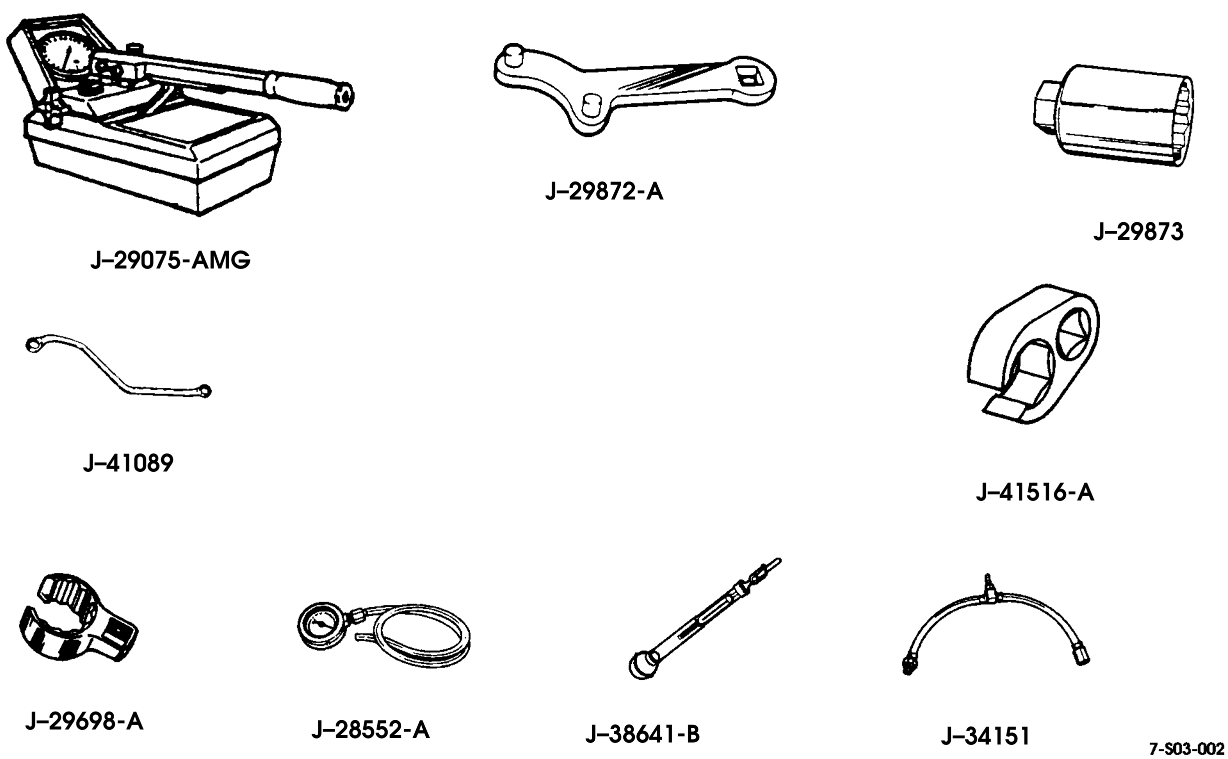


Figure 3-82: Transfer Case Exhaust Bracket Mounting

CATALYTIC CONVERTER REPLACEMENT

1. Loosen or remove necessary frame brackets and clamps that retain converter and pipe (Figures 3-81 and 3-82).
2. Remove bolts attaching converter to crossover or head pipe.
3. Remove flange bolts attaching converter to muffler and crossover or head pipe.
4. Remove U-bolt at transfer case bracket.
5. Remove converter.
6. Position new single or dual converter assembly in vehicle and loosely install flange bolts.
7. Connect necessary exhaust brackets and clamps to frame or body as required.
8. Tighten exhaust flange bolts to 26 lb-ft. (35 N•m).
9. Tighten frame bracket bolts.
10. Tighten transfer case exhaust bracket U-bolt nuts to 26 lb-ft. (35 N•m).

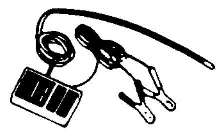
ESSENTIAL TOOLS



Tool No.	Description
J–29075-AMG	Nozzle Tester
J–29872-A	Injection Pump Adjusting Tool (used with ratchet handle)
J–29873	Fuel Injector Socket (30mm)
J–41516-A	Injection Line (flare nut) Wrench
J–34151	Housing Pressure Adapter
J–38641-B	Diesel Fuel Hydrometer
J–28552-A	Fuel Pressure Gauge
J–29698-A	Injection Line (flare nut) Wrench
J–41089	Injection Pump Wrench
J–28552-A	Fuel Pressure/Return Adapter Set (not shown)
J–29079-95	Nozzle Adapter, part of J–29075-AMG (not shown)
J–33300-AMG	AMG Tach-N-Time Kit (not shown)
J–33300-25A	Clamp-On Line Transducer, part of J-33300-AMG (not shown)
J–33300-20A	Magnetic Crankshaft Probe, part of J–33300 AMG (not shown)
J–41711	Injection Pump Timing Wrench, 6.5 Turbo (not shown)
J–42520	Fuel Line Disconnect Tool Set (not shown)

Procure from Kent-Moore.

SPECIAL TOOLS



J–26925

7-S03-002.1

Tool No.	Description
J–26925	Mag-Tac Engine Tachometer

Procure from Kent-Moore.

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Section 4 Cooling System

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ENGINE COOLING SYSTEM DESCRIPTION

The cooling system removes excess heat from the engine, engine oil, power steering fluid, transfer case fluid, and transmission fluid. Some engine heat is beneficial, but excess heat can cause engine oil to break down. If lubrication is significantly reduced, engine damage may result. To keep the oil at the proper temperature, the cooling system dissipates some of the heat produced by the engine.

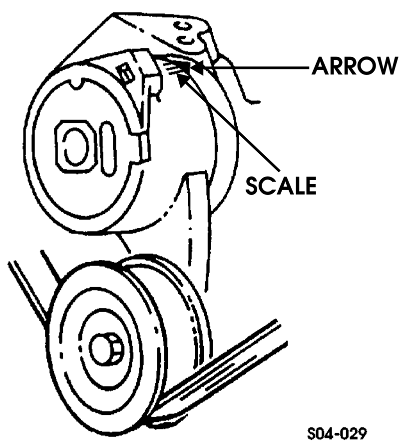

Figure 4-1: Automatic Belt Tensioner and Belt Length Scale

A serpentine belt drives the water pump which pumps coolant through the cooling system. Proper belt tension must be maintained at all times for the proper operation of the cooling system. This is accomplished by an automatic belt tensioner located at the front of the engine next to the generator (Figure 4-1). The amount of belt stretch may be determined with the scale located on the arm or the belt tensioner. If the arrow on the arm exceeds the parameters indicated, replacement is required.

NOTE: Inspection of a multiple ribbed serpentine belt may reveal cracks in the belt ribs. These cracks will not impair belt performance and are not a basis for belt replacement. If any belt ribs are missing, the belt should be replaced.

The cooling system is a closed continuous flow system with a pressure cap rated at 15 psi. Coolant travels through the engine block and circulates around the parts of the engine which generate heat: the cylinders, cylinder heads, combustion chambers, valve guides, valve seats, etc. As coolant is routed through the engine block, heat is transferred from the engine to the coolant.

The water crossover on diesel engines collects coolant from the cylinder heads and channels it to the thermostat housing. To prevent the engine from being over-cooled, the thermostat monitors the temperature of the coolant and prevents it from being routed to the radiator until it has reached a temperature high enough to require cooling (Figures 4-2 and 4-3). The thermostat begins to open at 190°F (88°C) and is fully open at 212 °F (100°C).

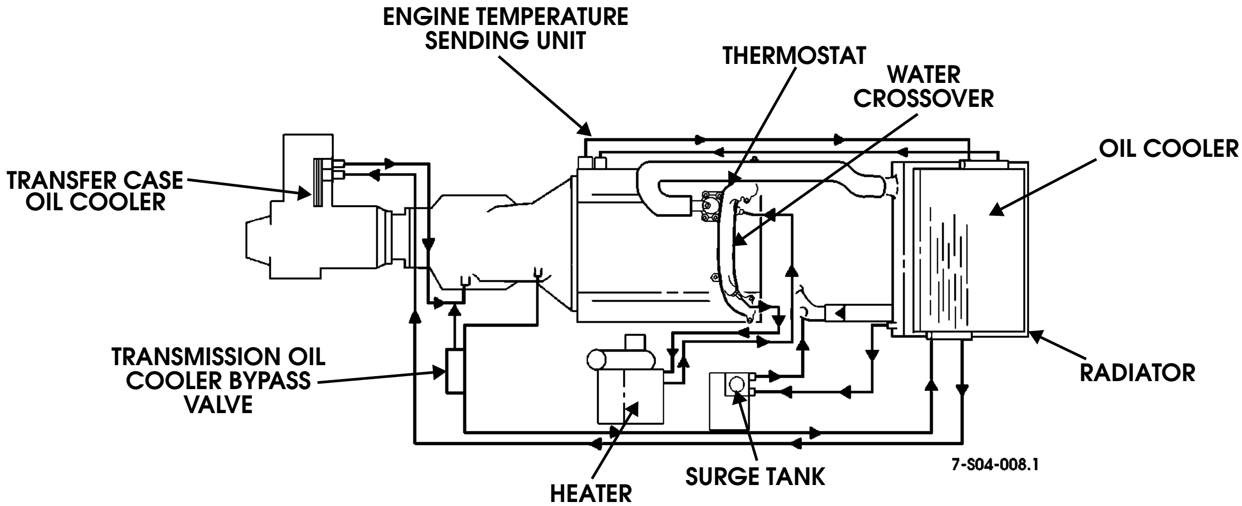

Figure 4-2: Cooling System Routing

When the thermostat detects the coolant is hot, the thermostat opens allowing coolant to be pumped to the radiator where it is routed through a series of fins and tubes. A fan draws in outside air to help dissipate the heat before the coolant is recirculated back through the engine (Figure 4-3).

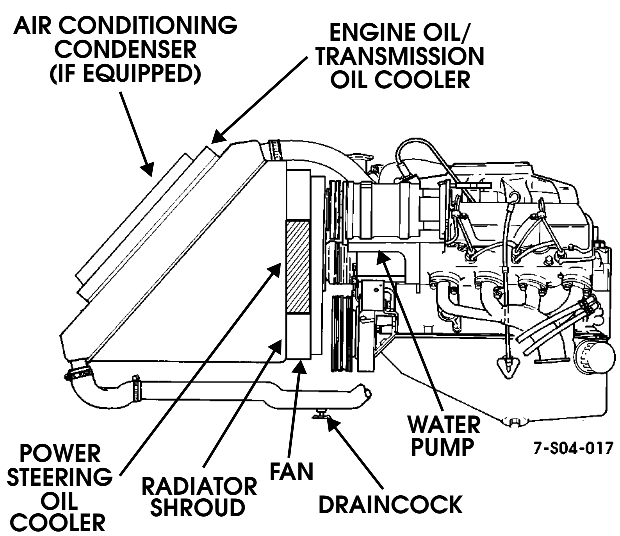

Figure 4-3: Cooling System

The heater provides heat to warm the interior of the vehicle for passenger comfort. Hot coolant leaves the engine and passes through a heater coil. A fan draws air through the heated coil which heats the air. The air is then channeled through a plenum chamber that directs the flow of the heated air into the passenger compartment.

If the engine is generating more heat than the cooling system can effectively dissipate, there may be a coolant or cooling system problem. The engine temperature sending unit transmits a signal indicating the coolant temperature to the temperature gauge on the instrument panel to let the driver know that the system should be serviced as soon as possible. Engine coolant is added to the system through the filler cap in the surge tank. After adding or refilling the diesel engine cooling system, open the valve on the water crossover and bleed the air from the system.

Like the radiator, the oil cooler also uses a series of fins and tubes to dissipate heat from fluid. The lower half of the oil cooler dissipates heat from the engine oil while the upper half cools transmission fluid.

Engine oil flows from the left rear of the engine block to the bottom half of the oil cooler, then returns to the engine block.

NOTE: To ensure an accurate engine oil level measurement check the engine oil within 1 to 2 minutes after shut down.

The transmission fluid is cooled by the top half of the split oil cooler. Transmission fluid flows from the transmission oil outlet to the top half of the oil cooler, then to the inside of the transfer case, where it returns to the transmission (Figures 4-2 and 4-3). The transmission fluid that passes through the transfer case does not mix with the transfer case fluid, but flows through a separate oil (secondary) cooler located within the transfer case.

A transmission cooler bypass valve is positioned between the transmission and transfer case cooler in the fluid line. The unit is rigidly mounted to the frame rail and is connected in parallel by hoses to the transmission cooler. The valve consists of a housing with inlet and outlet fittings, and an internal flow control valve, spring loaded in the closed position. The valve is designed to begin opening at approximately 20 psi and be fully open by 30 psi allowing fluid to bypass the transmission cooler and regulate fluid pressure in the cooler.

At low temperatures, fluid viscosity and pressure are typically high. By allowing fluid to bypass the cooler at low temperatures the transmission warms to normal operating temperature quicker. At high temperatures, fluid viscosity decreases and more fluid circulates through the cooler maintaining an even operating temperature and a constant pressure in the cooler (see Section 1 for service procedures).

A separate smaller oil cooler, mounted to the fan shroud, is used to cool the power steering fluid.

Two fluid returns are used: one from the hydro-boost and one from the power steering gear. Fluid flow through the hydro-boost is never completely restricted during braking. The hydro-boost incorporates a fluid return to release the hydraulic pressures used when applying the brakes (see Section 8 for service procedures).

ENGINE COOLING SYSTEM DIAGNOSIS AND TROUBLESHOOTING

WARNING: Do not release surge tank cap when engine is hot. Steam and/or coolant may cause serious injury.

Loss of Coolant

1. Pressurize system and check for leaks at all cooling system hoses.
    a. Tighten loose clamps, fasteners, or fittings.
    b. Replace leaking hoses.
2. Pressurize coolant system and check for leaks at water pump or around cylinder heads. If any leakage is present, replace cylinder head gaskets, cylinder heads, or water pump.
3. Check cylinder block for cracks. Replace if cylinder block is cracked.
4. Check expansion plugs and block heater for leaks.
5. Check radiator and surge tank.
6. Remove surge tank cap. With engine running, check for excessive bubbles in surge tank that may indicate leaking head gaskets or cracked cylinder heads. If bubbles are present, remove cylinder heads and check for defective head gaskets, cracked cylinder heads, or cracked cylinder block. Replace cylinder heads if damaged. Replace engine if cylinder block is cracked.

Engine Coolant Temperature Gauge Above 255°F (124°C), Engine Overheats

1. Inspect for low coolant. Verify low coolant sensor is operating properly. (Refer to Electrical Troubleshooting, Section 12).
2. Inspect the drivebelt and pulleys for damage.
    a. Replace any damaged parts.
    b. Check belt tension. Replace if necessary.

WARNING: Use caution when testing thermostat. Hot engine coolant will cause burns.

NOTE: Off-road driving in extremely dusty conditions may result in debris entrapment between the radiator and oil cooler. Trapped debris may increase coolant temperature.

3. Check for clogged or blocked radiator system. Clean and flush as required. Cleaning requires the separation of the oil cooler from the radiator and both units must be thoroughly flushed with water and compressed air.
4. Check thermostat for proper operation. Remove thermostat and place thermostat in container of water known to be 190°F (88°C). Observe valve. If valve does not open, replace thermostat.
5. Check radiator for bent fins. Straighten fins or replace radiator if damaged beyond repair.
6. Check operation of temperature gauge. Refer to Electrical Troubleshooting (Section 12).
7. Inspect fan blades for damage. Replace fan if damaged.
8. Check fan clutch operation.
    a. Check for excessive bearing play. Using fingers only, press tip of fan blade toward and away from engine. Tip of blade total movement should not exceed 0.20 in. (5.1 mm). If movement is more, replace fan drive.
    b. With engine off and ambient temperature of 50°F (10° C) or higher, fan should turn evenly with noticeable drag. If fan turns hard, very easily, or with uneven resistance, replace fan drive.
    c. Fan noise is sometimes evident under the following normal conditions:
        - When the drive is engaged for maximum cooling.
        - During the first 15 seconds to one minute after start-up, until the drive can redistribute the silicone fluid back to its normal disengage operating condition (after overnight settling).

        Fan noise or an excessive roar will generally occur continuously under all engine high speed conditions (2400 RPM and up) if the drive assembly is locked-up due to an internal failure. If the fan cannot be rotated by hand or there is a rough, grating feel as the fan is turned, replace the fan drive.
9. Check for leaking or defective water pump. Replace leaking or defective water pump.

WARNING: Do not release surge tank cap when engine is hot. Steam and/or coolant may cause serious injury.

Fan Runs Continuously (Noisy)

1. Check that all fan bolts are present and tightened to 45 lb-ft (61 N•m).
2. Perform steps 8a and 8b on preceding page.
3. Check for fan cut off (disengagement).
4. Observe fan drive disengagement after 1 to 1-1/2 minutes. If fan speed does not drop and coolant temperature remains below 190° F (88° C), replace fan drive.

RADIATOR AND FAN SHROUD ASSEMBLY SERVICE

Removal

1. Remove hood (Section 10).
2. Drain cooling system.
3. Remove oil cooler (Section 1).
4. Disconnect upper hose from radiator (Figure 4-4).
5. If equipped with air conditioner, discharge system and remove condenser (Section 11).
6. Remove power steering cooler mounting bolts and position cooler aside.
7. Disconnect ambient temperature switch, if equipped (Section 11).
8. Disconnect surge tank-to-radiator vent hose from adapter.
9. Disconnect lower radiator hose from radiator.
10. Remove strap securing fan shroud to radiator.
11. Remove lower mount from radiator and frame bracket (Figure 4-5).
12. Detach rear support brackets from airlift brackets (Figure 4-4).
13. Remove battery tray, and left splash shield. (Sections 10 and 12).
14. Remove the radiator from vehicle (Figure 4-5).
15. Remove retaining strips, and fan shroud from radiator.
16. Remove rear support brackets and insulators from radiator.

Cleaning and Inspection

NOTE: Clean all components, examine for wear or damage, and replace if necessary.

1. Remove debris embedded in radiator fins using water and compressed air (Figure 4-5).
2. Inspect radiator for breaks, punctures, cracks, or splits.
3. Inspect adapters and fan shroud (Figure 4-4).

Installation

CAUTION: *To avoid equipment damage, upper edge of fan shroud must align with radiator top tank seam to ensure proper engine cooling.*

NOTE: Ensure fan shroud edge aligns with tank seam on radiator.

1. Secure fan shroud to radiator with retaining strips, lockwashers, and bolts. Tighten bolts to 6 lb-ft (8 N•m) (Figure 4-5).
2. Secure rear support brackets and insulators to radiator with washers and locknuts. Tighten locknuts to 26 lb-ft (35 N•m).
3. Align radiator with frame bracket, and rear support brackets with airlift brackets (Figures 4-5 and 4-6).
4. Fasten rear support brackets to air lift brackets with bolts, washers, and locknuts. Do not tighten locknuts (Figure 4-4).

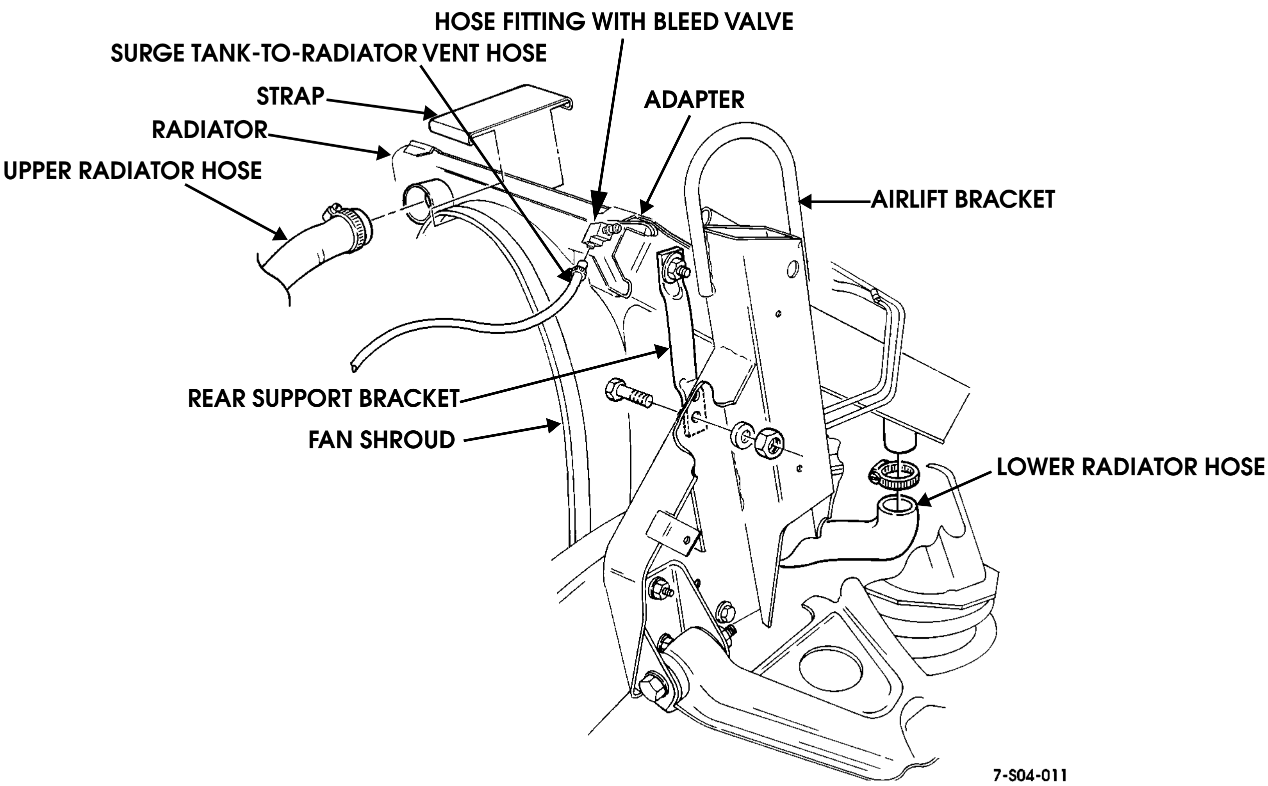

Figure 4-4: Radiator and Fan Shroud Assembly Mounting

5. Attach lower mount and radiator to frame bracket with washers, and locknut. Do not tighten (Figure 4-5).
6. Align fan shroud by sliding the radiator/shroud assembly to maintain 1 1/2 ± 1/8 in. (38.1 ± 3 mm) from edge of shroud ring and rear edge of fan. Measure at the 2, 4, 8, and 10 o'clock positions. The distance between the top of the fan blade and fan shroud must not be less than 1/4 in. (6 mm) at any position (Figure 4-6).
7. Tighten rear support bracket locknuts to 26 lb-ft (35 N•m). Tighten frame bracket bolt to 30 lb-ft (41 N•m) (Figures 4-4 and 4-5).
8. Install left splash shield and battery tray (Section 12).
9. Install strap on radiator and shroud (Figure 4-4).
10. Connect upper and lower radiator hoses to radiator.
11. Use bolts to attach power steering cooler to brackets.
12. Connect ambient temperature switch, if equipped (Section 11).
13. If equipped with air conditioner, install condenser and charge system (Section 11).
14. Connect surge tank-to-radiator vent hose to adapter.
15. Fill cooling system (Section 4).
16. Install oil cooler (Section 1).
17. Start engine and check cooling system for leaks.
18. Install hood (Section 10).

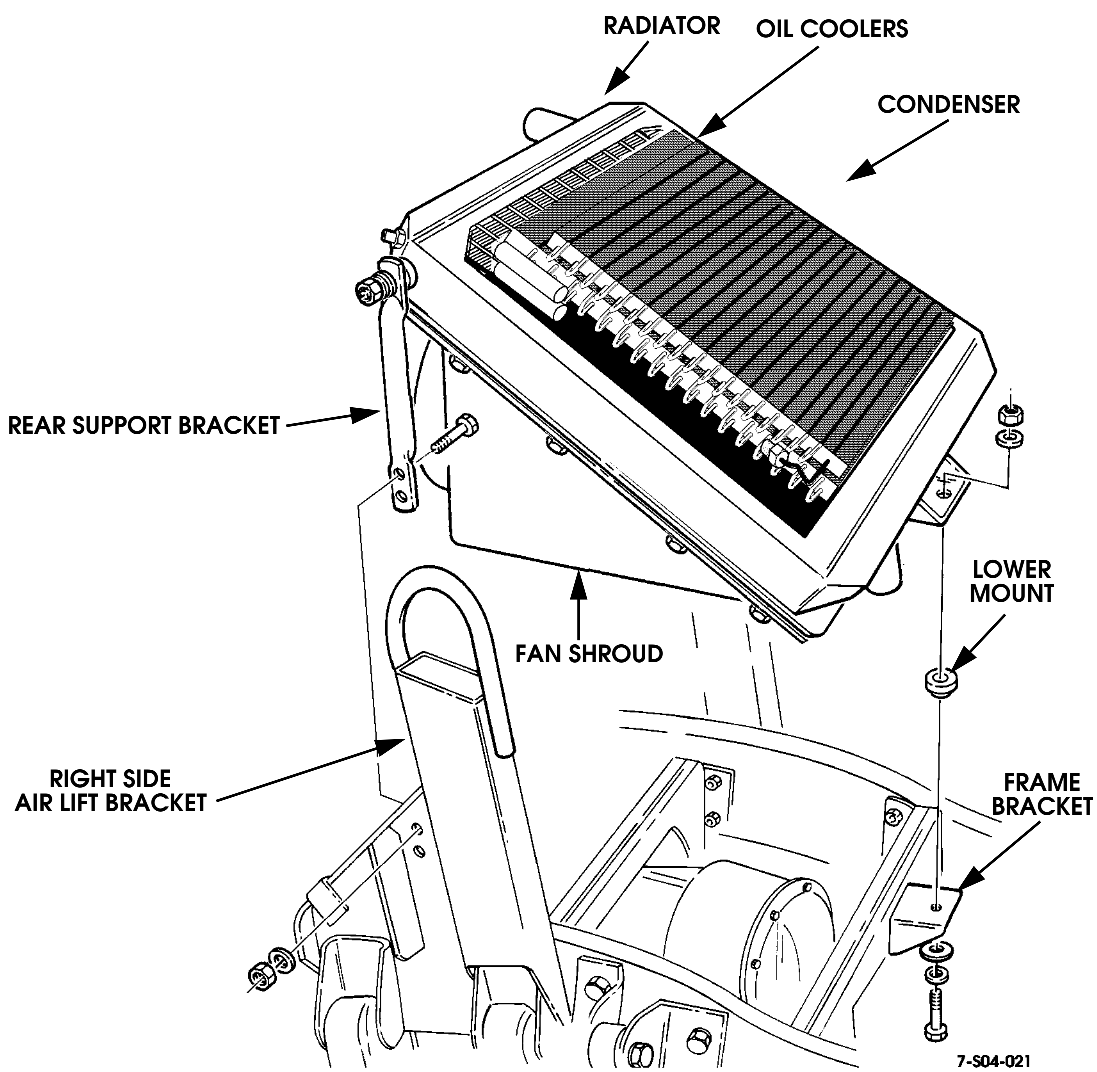

Figure 4-5: Radiator and Fan Shroud Assembly Breakdown

ENGINE COOLING SYSTEM SERVICE

Depressurizing/Draining

WARNING: To avoid injury, do not remove surge tank filler cap before depressurizing cooling system when engine temperature is above 190°F (88°C).

1. If engine is hot, place a thick cloth over surge tank filler cap. Turn counterclockwise to first stop to release internal pressure (Figure 4-8).
2. After pressure has vented, remove cap.
3. Open drain valve and drain system (Figure 4-7).
4. Close drain valve.

Replenishing

NOTE: Ensure surge tank coolant level is 3/4 full before securing filler cap.

1. Ensure drain valve is closed and heater control valve is open (Figure 4-7).
2. Fill system with proper antifreeze solution (Table 4-1).
3. Install filler cap on surge tank (Figure 4-8).
4. Start engine and run at fast idle (1500 rpm) until engine temperature reaches 190° F (88° C). Stop engine.
5. Depressurize system.
6. Fill with proper antifreeze solution until surge tank is 3/4 full (Table 4-1).
7. Install filler cap on surge tank (Figure 4-8).
8. Start engine and run at fast idle (1500 RPM) until engine temperature reaches 190° F (88° C). Stop engine.
9. Depressurize system. Use tester to ensure proper coolant protection is provided.
10. Install filler cap on surge tank.
11. Start engine and check cooling system for leaks.

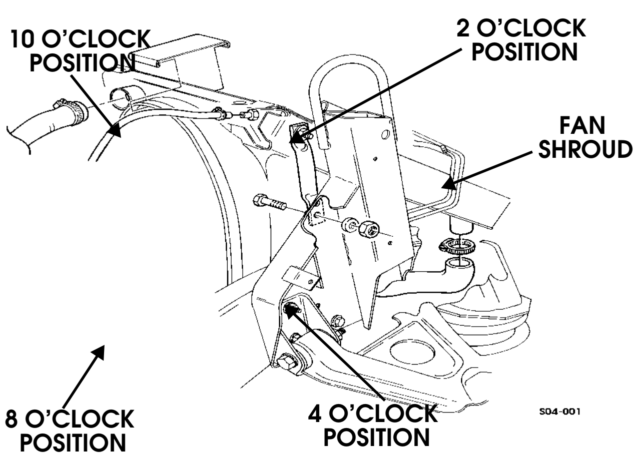

Figure 4-6: Fan Shroud Clearance Check Points

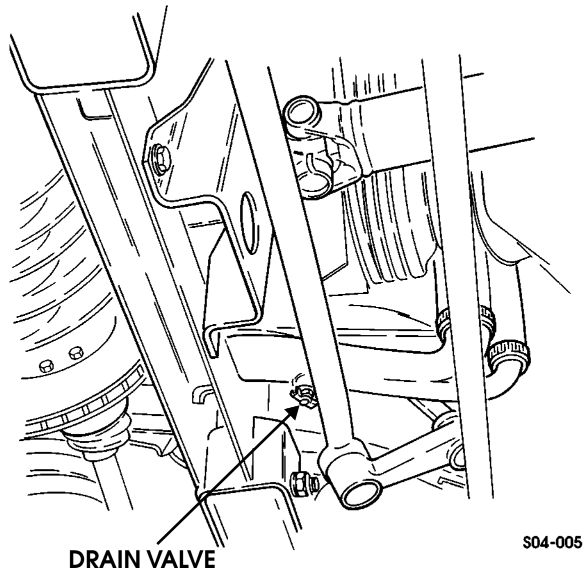

Figure 4-7: Drain Valve

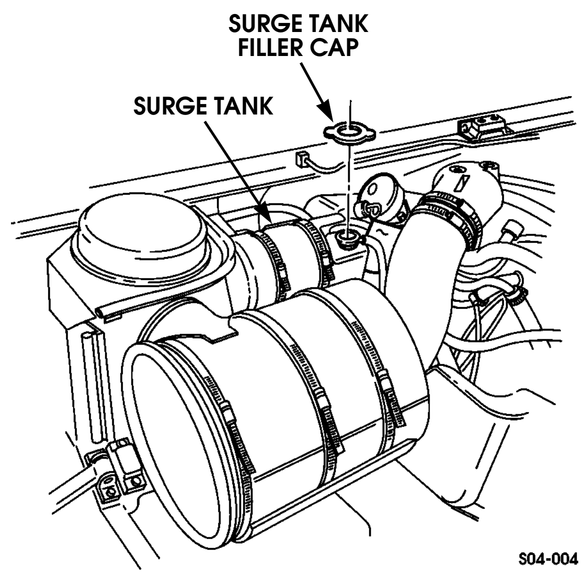

Figure 4-8: Surge Tank and Filler Cap Location

Expected Temperature	Antifreeze/ Water Mixture
120° to -32° F (49° to -36° C)	50% antifreeze/ 50% water

Table 4-1: Antifreeze Preparatio Guide

SHROUD SHIELD ASSEMBLY REPLACEMENT

Removal

1. Remove radiator and fan shroud.
2. Remove screws and shroud shield assembly from airlift bracket (Figure 4-9).

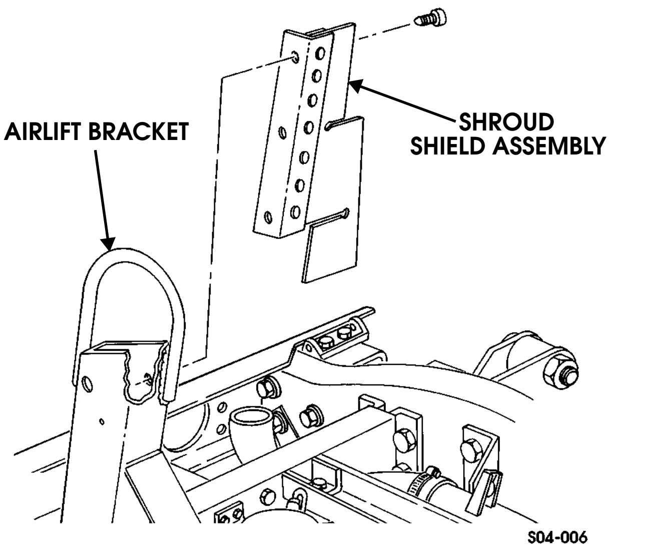

Figure 4-9: Shroud Shield Assembly Replacement

Installation

1. Secure shroud shield assembly to airlift bracket with screws (Figure 4-9).
2. Install radiator and fan shroud.

RADIATOR REAR SUPPORT BRACKET REPLACEMENT

Removal

1. Remove left splash shield (Section 10).
2. Remove battery tray and right splash shield (Section 12).
3. Remove radiator rear support bracket and insulator from radiator (Figure 4-10).
4. Remove support bracket from airlift bracket (Figure 4-11).

Installation

1. Fasten radiator rear support bracket to airlift bracket with bolts, washers, and locknuts. Do not tighten locknuts (Figure 4-11).
2. Secure insulator and support bracket to radiator with washers and locknut (Figure 4-10).
3. Tighten all locknuts to 26 lb-ft (35 N•m).
4. Install left splash shield (Section 10).
5. Install battery tray and right splash shield (Section 12).

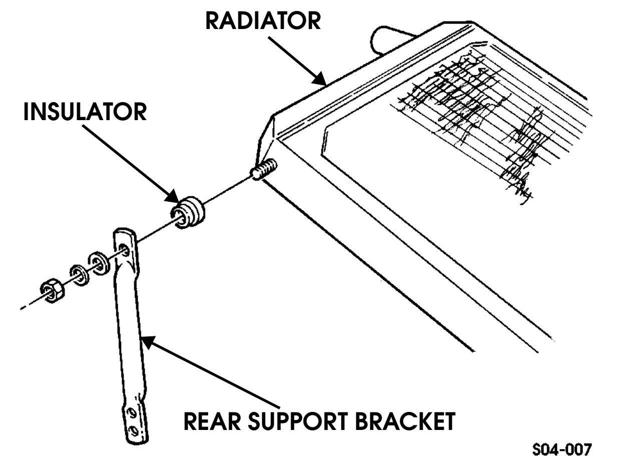

Figure 4-10: Insulator and Rear Support Bracket Location

SURGE TANK REPLACEMENT

Removal

1. Drain cooling system.
2. Disconnect radiator vent hose from surge tank (Figure 4-12).
3. Disconnect surge tank-to-lower radiator hose from surge tank.
4. Disconnect overflow hose from surge tank.
5. Disconnect low coolant sensor wiring harness.
6. Loosen clamps and remove surge tank from bracket.

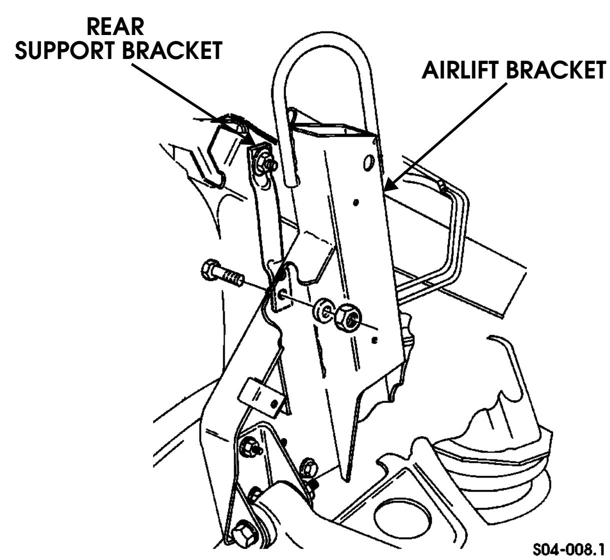

Figure 4-11: Rear Support Bracket Mounting

Installation

1. Secure surge tank to bracket with clamps (Figure 4-12).
2. Connect low coolant sensor wiring harness.

3. Connect surge tank-to-lower radiator hose to surge tank.
4. Connect radiator vent hose to surge tank.
5. Connect overflow hose to surge tank.
6. Fill and purge cooling system.

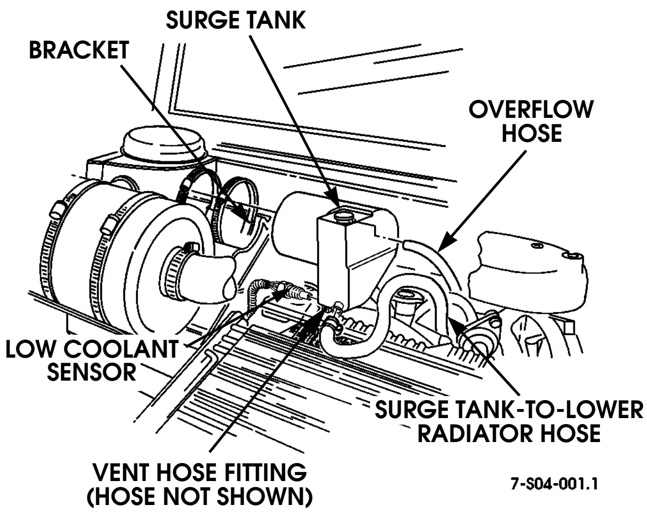

Figure 4-12: Surge Tank Replacement

SURGE TANK-TO-RADIATOR VENT HOSE REPLACEMENT

Removal

1. Depressurize cooling system.
2. Loosen two clamps and remove radiator vent hose from radiator and surge tank (Figure 4-13).
3. Reclaim coolant.

Installation

1. Secure radiator vent hose to surge tank and radiator with two clamps (Figure 4-13).
2. Tighten coolant filler cap.
3. Replace coolant.

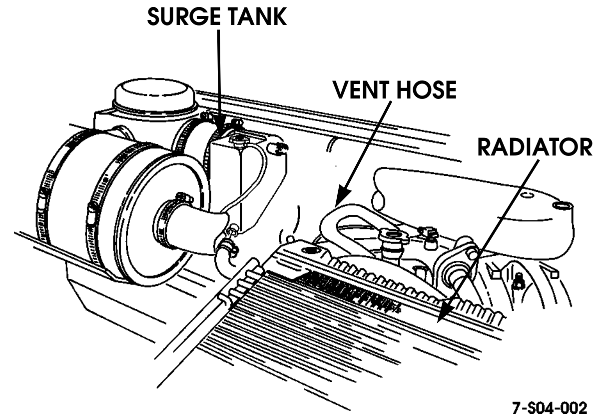

Figure 4-13: Surge Tank-to-Radiator Vent Hose Location

THERMOSTAT BYPASS HOSE REPLACEMENT

Removal

1. Drain cooling system.
2. Loosen two clamps and remove bypass hose from nipples on water pump and water crossover (Figure 4-14).

Installation

1. Secure bypass hose to nipples on water pump and water crossover with two clamps (Figure 4-14).
2. Fill cooling system.

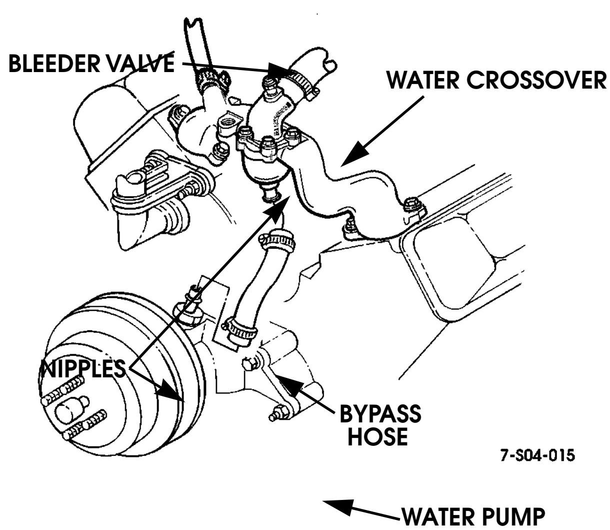

Figure 4-14: Thermostat Bypass Hose Replacement

UPPER RADIATOR HOSE REPLACEMENT

Removal

1. Drain cooling system as necessary.
2. Depressurize cooling system.
3. Loosen clamps and remove hose from thermostat housing and radiator (Figure 4-15).

Installation

1. Secure upper radiator hose to thermostat housing and radiator with clamps (Figure 4-15).
2. Fill cooling system.

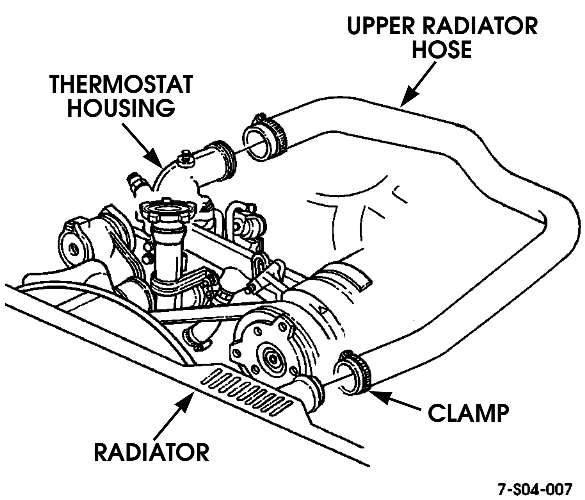

Figure 4-15: Upper Radiator Hose Location

LOWER RADIATOR HOSE REPLACEMENT

Removal

1. Drain cooling system.
2. Loosen clamps and remove lower radiator hose from radiator and lower tube assembly (Figure 4-16).

Installation

1. Secure lower radiator hose to lower tube assembly and radiator with clamps (Figure 4-16).
2. Fill cooling system.

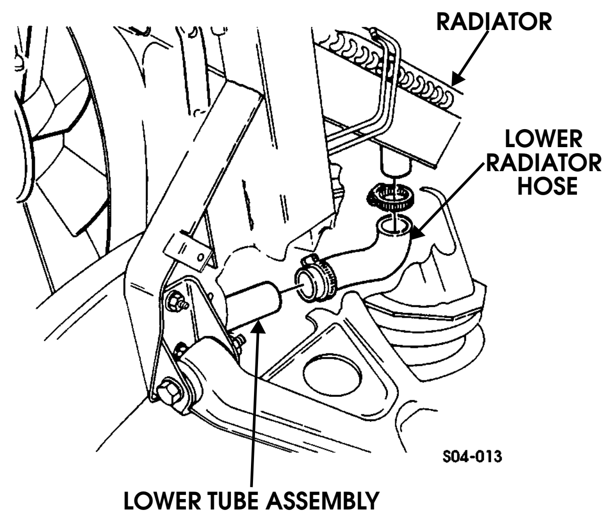

Figure 4-16: Lower Radiator Hose Location

RADIATOR LOWER TUBE ASSEMBLY REPLACEMENT

Removal

1. Drain cooling system.
2. Remove drain valve from lower tube assembly (Figure 4-17).
3. Disconnect radiator lower tube assembly from frame bracket.
4. Loosen clamp and disconnect water pump inlet hose from lower tube assembly.
5. Loosen clamp and disconnect surge tank-to-lower radiator hose from lower tube assembly.
6. Loosen clamp and disconnect lower radiator hose from lower tube assembly.
7. Remove lower tube assembly.

Installation

1. Secure lower tube assembly to frame bracket with bolts, washers, and locknuts. Tighten locknuts to 6 lb-ft (8 N•m) (Figure 4-17).
2. Connect lower radiator hose to lower tube assembly and tighten clamp.
3. Connect surge tank-to-lower radiator hose to lower tube assembly and tighten clamp.
4. Connect water pump inlet hose to lower tube assembly and tighten clamp.
5. Apply sealant tape to threads of drain valve and screw drain valve into lower tube assembly.
6. Fill cooling system.

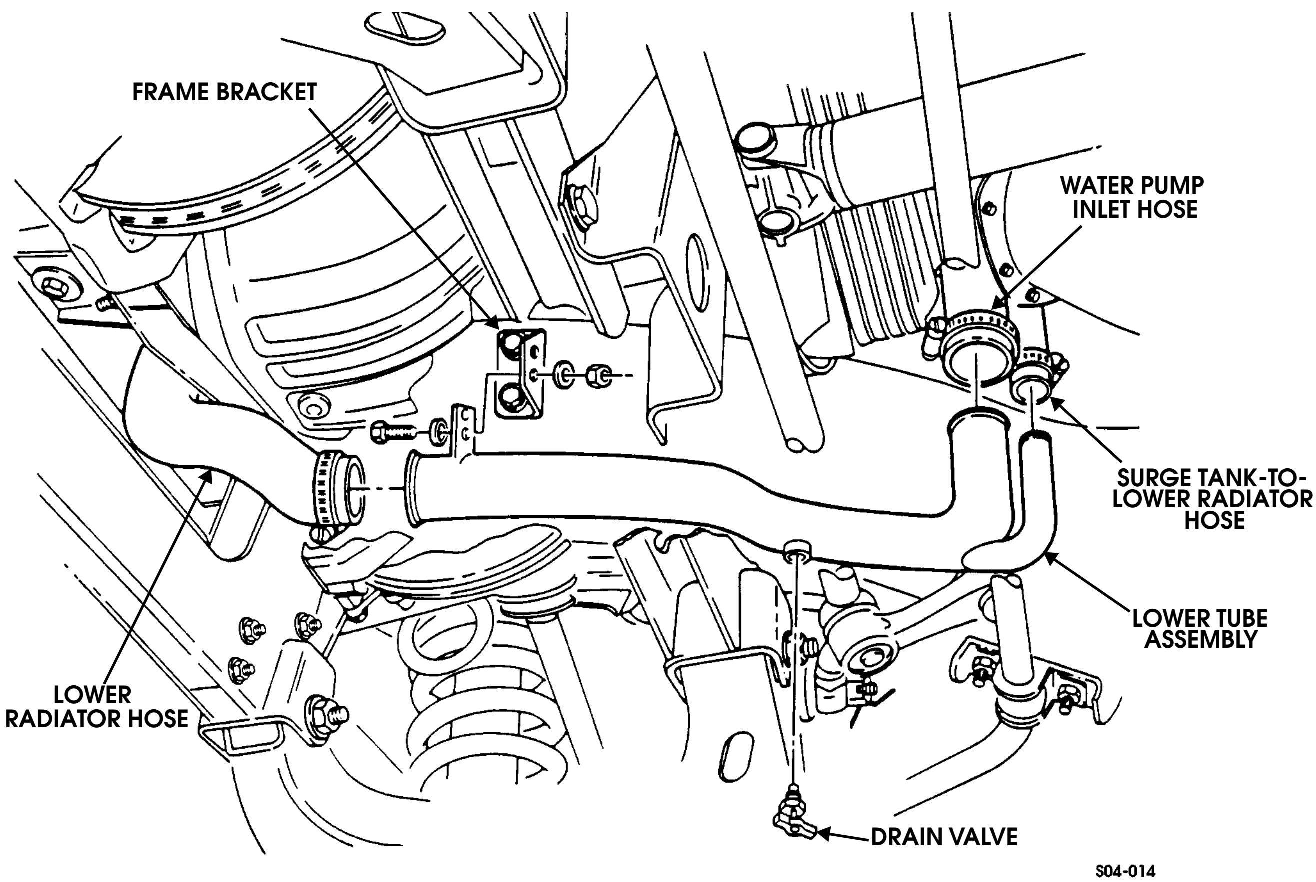

Figure 4-17: Radiator Lower Tube Assembly Location

WATER PUMP INLET HOSE REPLACEMENT

Removal

1. Drain cooling system.
2. Loosen clamps and remove water pump inlet hose from water pump and lower tube assembly (Figure 4-18).

Installation

1. Connect water pump inlet hose to lower tube assembly and water pump and tighten clamps (Figure 4-18).
2. Fill cooling system.

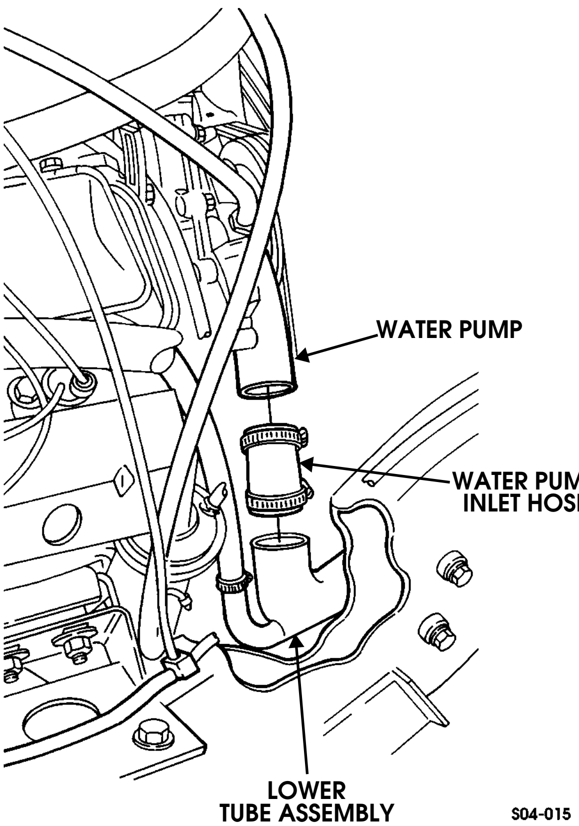

Figure 4-18: Water Pump Inlet Hose Location

SURGE TANK OVERFLOW HOSE REPLACEMENT

Removal

1. Remove overflow hose from surge tank filler neck (Figure 4-19).
2. Remove screw, clamp, and overflow hose from body.

Installation

1. Connect overflow hose to surge tank filler neck (Figure 4-19).
2. Secure overflow hose to body with clamp and screw.

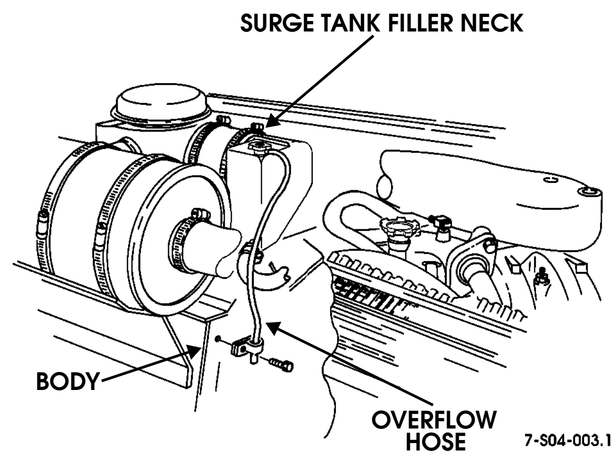

Figure 4-19: Surge Tank Overflow Hose Mounting

SURGE TANK-TO-LOWER RADIATOR TUBE HOSE REPLACEMENT

Removal

1. Drain cooling system.
2. Loosen clamps and remove hose from surge tank and lower tube assembly (Figures 4-20 and 4-22).

Installation

1. Install hose on lower tube assembly and surge tank and tighten clamps (Figures 4-20 and 4-22).
2. Fill cooling system.

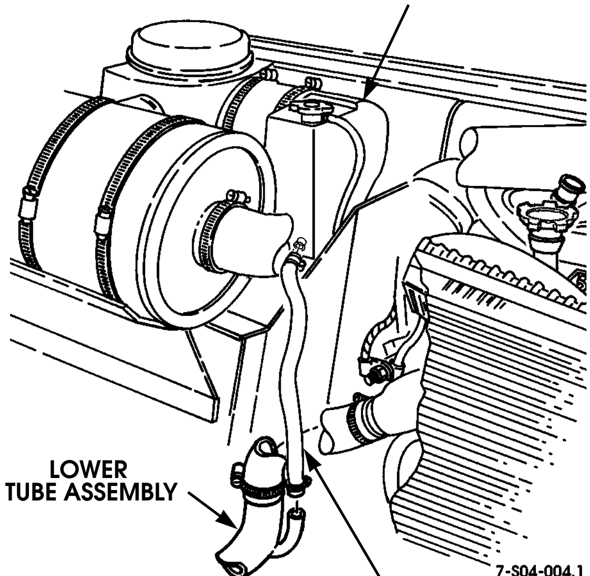

Figure 4-20: Surge Tank-to-Lower Tube Assembly Hose Location

LOW COOLANT SENSOR

The coolant level sensor is a solid-state semi-conductor device. The sensor's resistance varies as a function of its temperature. As voltage/current flows through the sensor, sensor temperature increases. In the presence of a liquid, in this case engine coolant, the temperature of the sensor is controlled by transferring heat to the coolant. Should the coolant level drop below the sensor, the heat and resistance of the sensor will rise. The "Low Coolant" warning light will then illuminate in response to the increased resistance at the sensor.

Removal

1. Drain and collect coolant from surge tank.
2. Disconnect the low coolant sensor electrical connector from the engine harness connector.
3. Remove the sensor and O-ring from the surge tank (Figure 4-21)

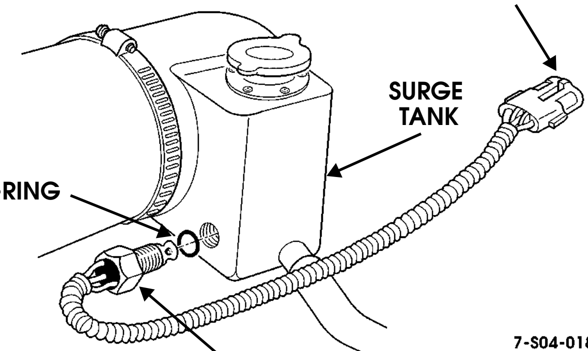

Figure 4-21: Low Coolant Sensor

Installation

1. Position O-ring on sensor and thread sensor into surge tank (Figure 4-21).
2. Plug the low coolant sensor electrical connector into the engine harness connector
3. Fill surge tank with coolant.

THERMOSTAT REPLACEMENT (NON-TURBO DIESEL)

Removal

1. Drain cooling system below level of thermostat.
2. Disconnect radiator upper hose from thermostat housing.
3. Remove thermostat housing from water crossover (Figure 4-22).
4. Remove thermostat and gasket from water crossover. Discard gasket.
5. Clean gasket surface of water crossover and thermostat housing (Figure 4-22).

Installation

1. Install thermostat in water crossover (Figure 4-22). Wax pellet end of thermostat goes toward engine.
2. Coat gasket with sealer and install it on water crossover.
3. Install thermostat housing. Tighten housing screws to 20 lb-ft (27 N•m).
4. Connect radiator upper hose to thermostat housing and tighten clamp.
5. Fill and bleed cooling system.

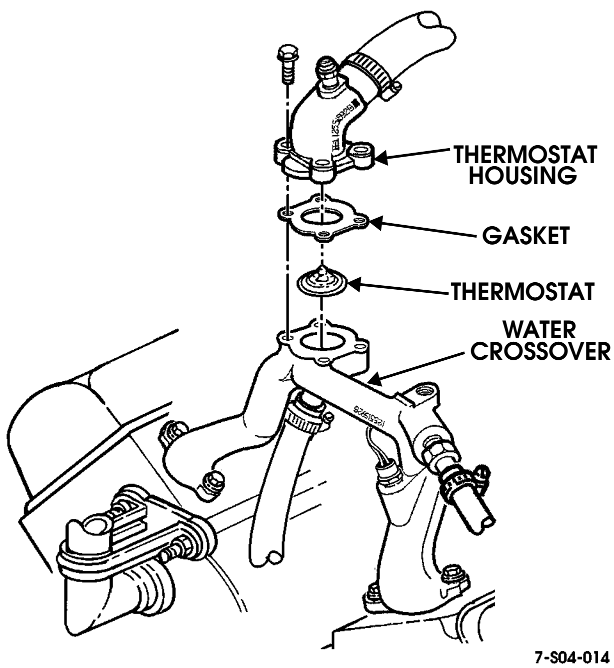

Figure 4-22: Thermostat (Non-Turbo Diesel)

THERMOSTAT REPLACEMENT (TURBO DIESEL)

1. Drain engine coolant below level of water crossover.
2. Remove bolts attaching thermostat cover to crossover housing.
3. Remove thermostat cover and gasket (Figure 4-23).
4. Remove both thermostats (Figure 4-24).
5. Position new thermostats in crossover housing (Figure 4-25). Be sure thermostat seals are seated in counterbores. Wax pellet end of each thermostat goes toward engine.
6. Apply Permatex no. 2 to both sides of thermostat housing gasket. If gasket is not used, apply 3/16 in. (5 mm) bead of Loctite 599, or Permatex Ultra Copper, or Ultra Black to cover or crossover mounting surface.
7. Install thermostat cover and tighten cover bolts securely.
8. Fill and bleed cooling system.

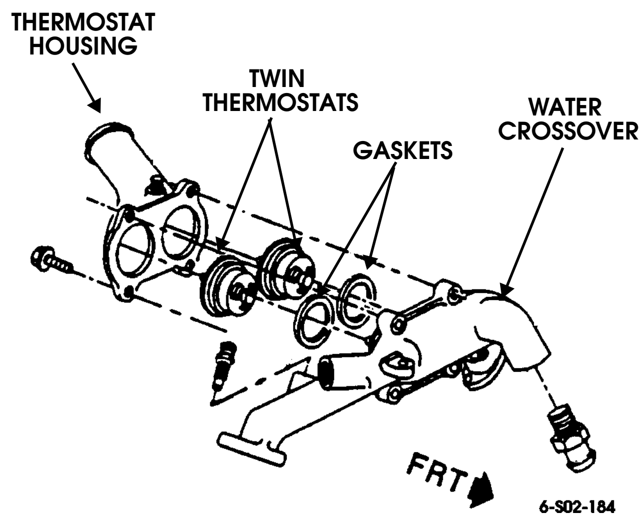

Figure 4-23: Thermostat and Cover Removal and Installation (Turbo Diesel)

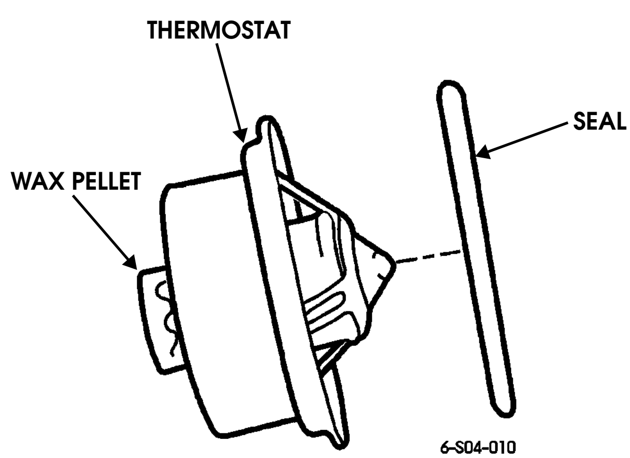

Figure 4-24: Turbo Diesel Thermostat

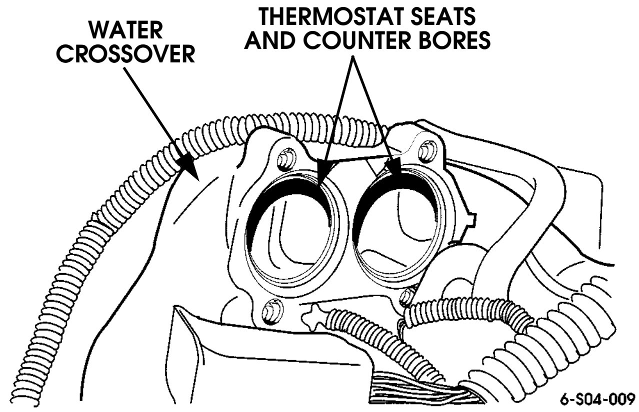

Figure 4-25: Thermostat Location in Crossover (Turbo Diesel)

WATER PUMP AND ADAPTER PLATE (TURBO DIESEL)

Removal

1. Remove hood with aid of helper.
2. Drain engine coolant.
3. Discharge A/C system refrigerant with equipment set on recovery mode.
4. Remove radiator, shroud, coolers, and A/C condenser as assembly.
5. Loosen and remove serpentine drive belt.
6. Remove fan and fan clutch (Figure 4-26). Then remove pump pulley.
7. Disconnect hoses at water pump.
8. Remove water pump and backing plate attaching bolts/studs and remove pump and plate as assembly (Figure 4-27).
9. Remove water pump and gasket from plate (Figure 4-28).
10. Clean all gasket material and sealer from plate.

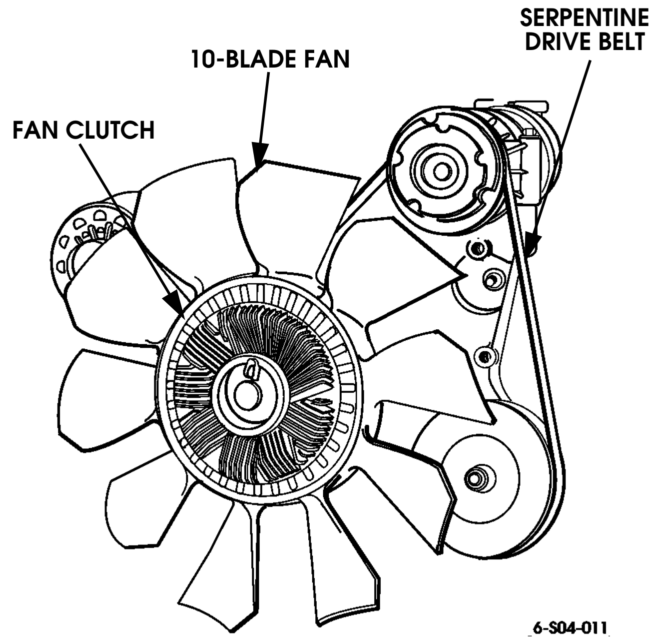

Figure 4-26: Fan and Clutch Mounting

Installation

1. If new pump is being installed, transfer hose adapter fittings to new pump. Apply Loctite PST to fitting threads beforehand.
2. Apply coat of Permatex no. 2, Ultra Black, or Ultra Copper to each side of water pump gasket. Then position gasket on pump.
3. Apply 1/8 - 3/16 in. (3.3-5 mm) wide bead of sealer to backing plate (Figure 4-29). Encircle bolt hole at bottom of plate with sealer as shown. Also apply sealer to threads of bolt or stud used in this hole to avoid leaks.
4. Position water pump on backing plate and install pump assembly. Tighten attaching bolts/studs 25-37 lb. ft. (34-50 N•m) torque.
5. Attach hoses to water pump.
6. Install fan and clutch.
7. Install and adjust serpentine drive belt.
8. Install radiator, shroud, coolers, and A/C condenser as assembly.
9. Evacuate and recharge A/C system.
10. Refill engine cooling system.
11. Install hood.
12. Start engine, bleed air from cooling system, and top off coolant level.

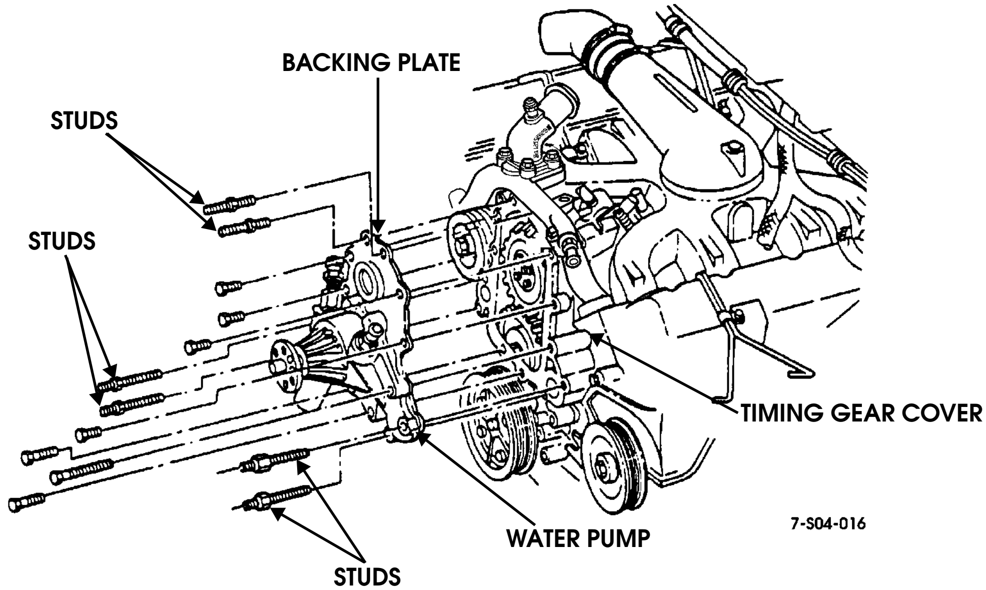

Figure 4-27: Water Pump and Adapter Plate Removal/Installation

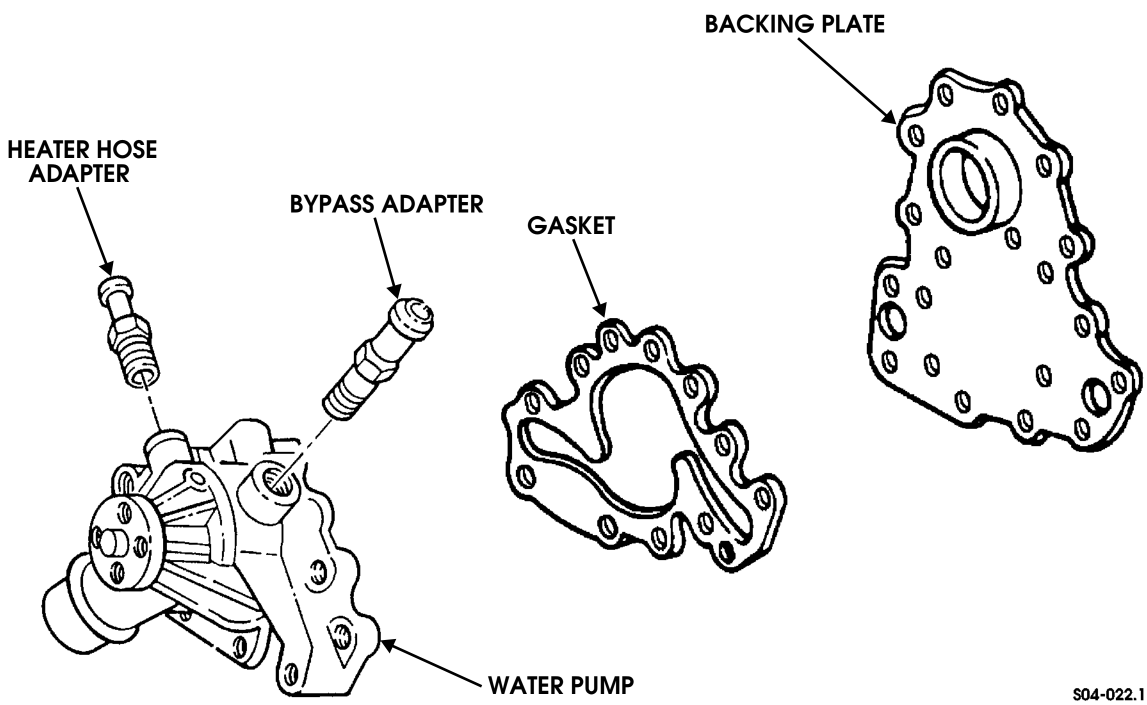

Figure 4-28: Water Pump (All Diesel Models)

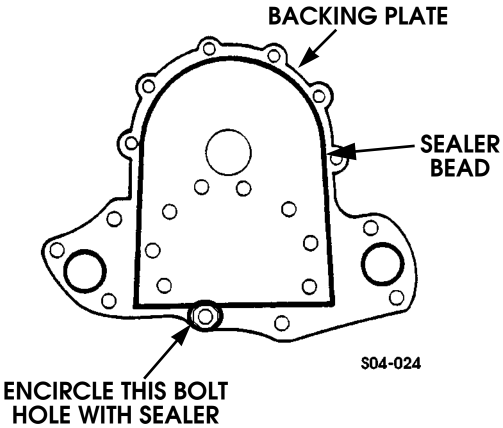

Figure 4-29: Backing Plate Sealer Application

WATER CROSSOVER SERVICE (NA DIESEL)

Removal

1. Drain engine coolant.
2. Disconnect hoses from water crossover (Figure 4-30).
3. Remove crossover and gaskets.
4. Remove old gasket material and sealer from crossover and heads.
5. If new crossover will be installed, transfer thermostat and housing to new crossover.

Installation

1. Apply sealer to both sides of crossover gaskets and position them on heads.
2. Install water crossover. Tighten bolts and/or studs to 25-37 lb-ft (34-50 N•m).
3. Install ground cables on studs and tighten nuts securely.
4. Connect hoses to water crossover.
5. Fill and bleed cooling system.

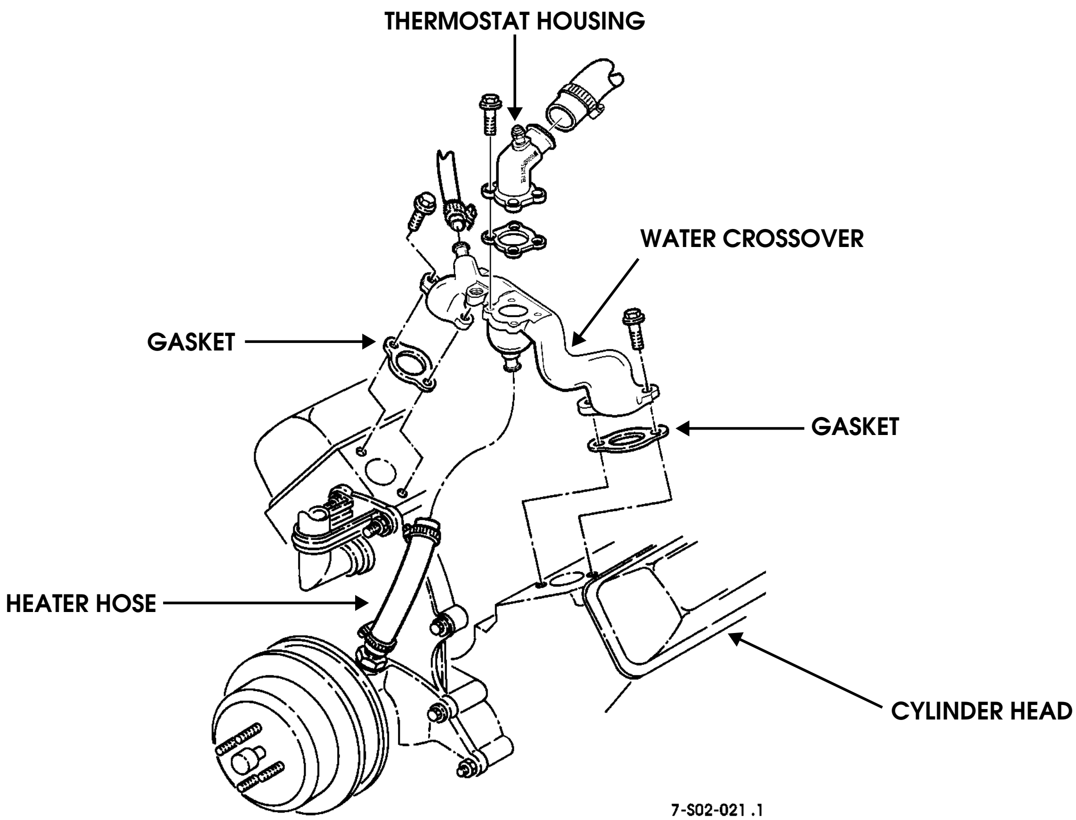

Figure 4-30: Water Crossover Removal/Installation (NA Diesel)

WATER CROSSOVER SERVICE (TURBO DIESEL)

Removal

1. Drain engine coolant to below level of crossover.
2. Disconnect heater, surge tank, and radiator hoses at crossover.
3. Disconnect coolant temperature sensor wires (Figure 4-31).

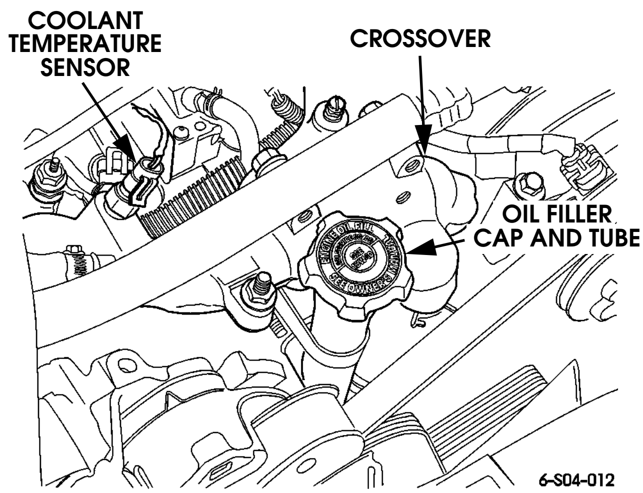

Figure 4-31: Filler Tube and Temperature Sensor Locations

4. Remove oil filler tube attaching nuts and remove filler tube (Figure 4-31).
5. Disconnect A/C compressor clutch wires (Figure 4-32).

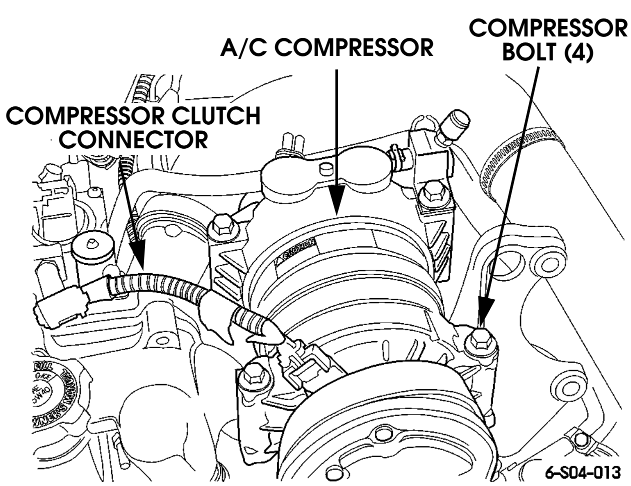

Figure 4-32: Compressor Clutch Bolt and Connector Location

6. Remove compressor clutch mounting bolts. Lift compressor out of bracket and move it aside for access to crossover bolts and nuts.
7. Remove water crossover attaching bolts/nuts (Figure 4-33).

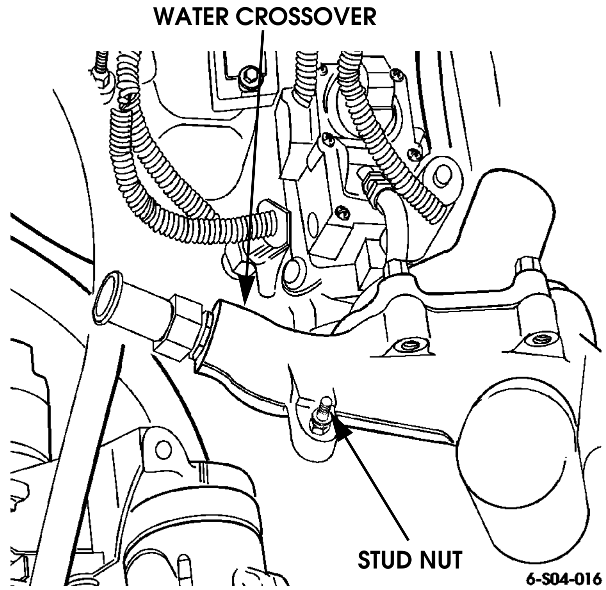

Figure 4-33: Water Crossover Attaching Hardware

8. Remove crossover and gaskets.
9. If crossover will be replaced, transfer air bleed valve and coolant temperature sensor to new crossover. Also transfer thermostats if necessary. Use Loctite PST on valve and sensor threads to ensure proper seal.

Installation

1. Apply Permatex Ultra Black or no. 2 sealer to both sides of crossover gaskets. Then position gaskets on cylinder heads.
2. Align and install crossover. Tighten crossover nuts/bolts to 25-37 lb. ft. (34-50 N•m) torque.
3. Install oil filler tube. Tighten attaching nuts to 13-20 lb. ft. (18-27 N•m) torque.
4. Connect hoses to water crossover.
5. Install A/C compressor in bracket and tighten bolts.
6. Connect wires to coolant temperature sensor.
7. Refill and bleed engine cooling system.

SERPENTINE BELT REPLACEMENT

1. Insert square lug of half-inch drive breaker bar in belt tensioner. Then move tensioner counterclockwise to loosen belt (Figure 4-34).
2. Remove belt from pulleys (Figure 4-35).
3. Position half-inch drive breaker bar in belt tensioner and move tensioner counterclockwise and position serpentine belt on pulleys as shown (Figure 4-35).
4. Release belt tensioner. Tensioner will automatically set belt tension when released.

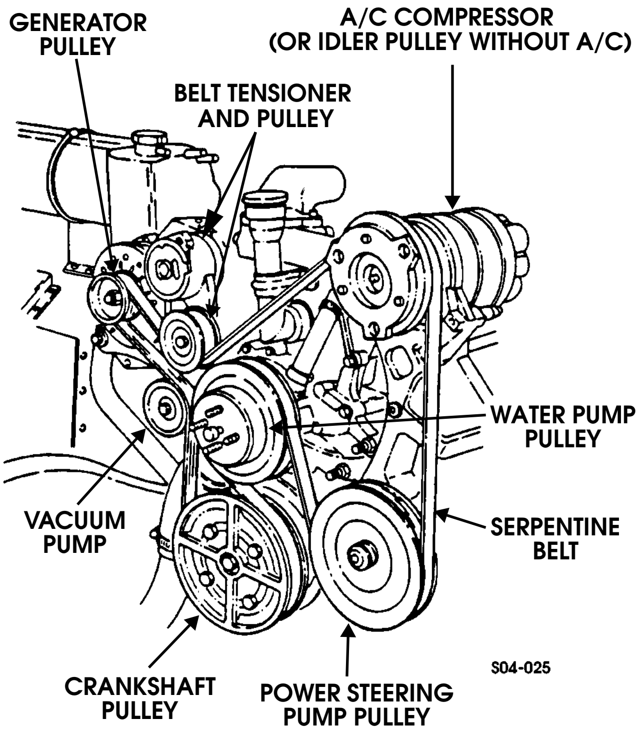

Figure 4-34: Serpentine Belt Tensioner Location

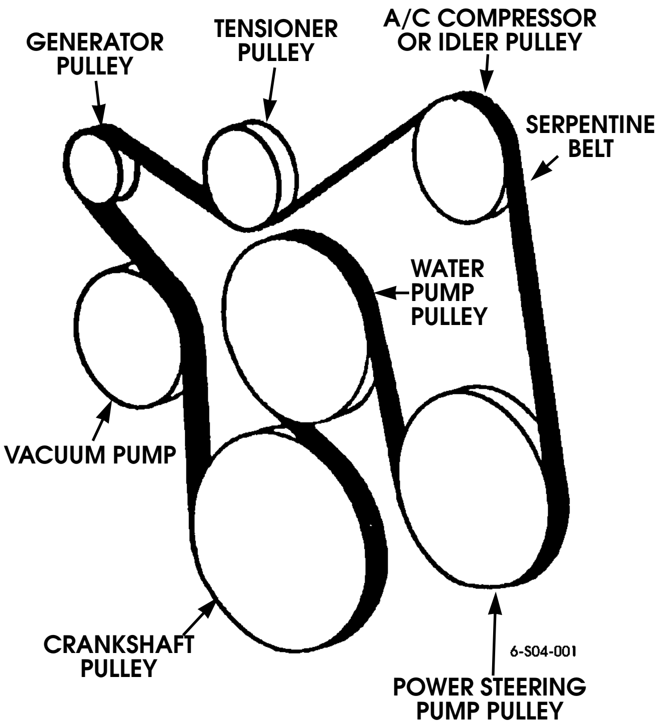

Figure 4-35: Serpentine Belt Routing

FAN AND WATER PUMP PULLEY SERVICE

Removal

1. Remove upper fan shroud extension.
2. Move A/C hose out of way.
3. Remove serpentine belt.
4. Remove fan and clutch assembly (Figure 4-36).
5. Remove water pump pulley.

Installation

1. Install pulley and fan assembly on water pump. Tighten attaching nuts to 15-20 lb-ft (20-27 N•m).
2. Install serpentine belt.
3. Check installed belt for alignment. Misalignment will cause belt to fray and/or roll off of the pulleys.
4. Install upper fan shroud extension.

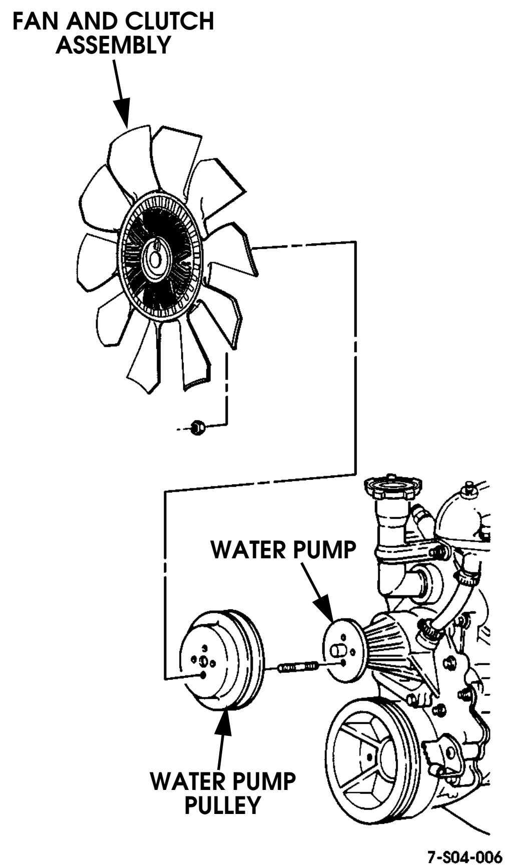

Figure 4-36: Fan Assembly and Water Pump Pulley Breakdown

Section 5 Transmission/Transfer Case

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TRANSMISSION DESCRIPTION

The Hydra-matic, model 4L80-E is used for all engine applications in Hummer vehicles. The 4L80-E is a four-speed, automatic transmission with fully electronic shift control. Fourth gear is an overdrive range.

Major transmission drive and apply components consist of: five multiple disc clutches, three roller/sprag clutches, three planetary gear sets, two bands, a control valve, band servos, accumulators, park lock mechanism, and torque converter with internal clutch (Figure 5-1).Transmission shift controls include the control module and sensors for fluid temperature, and output shaft speed. Solenoids are used to actuate the shift valves and apply the converter clutch. A pressure control solenoid, is used to boost operating pressure.

The control module energizes, or de-energizes the transmission shift solenoids and pressure control solenoid motor. The module controls shift points and sequence based on signals from engine/transmission sensors.

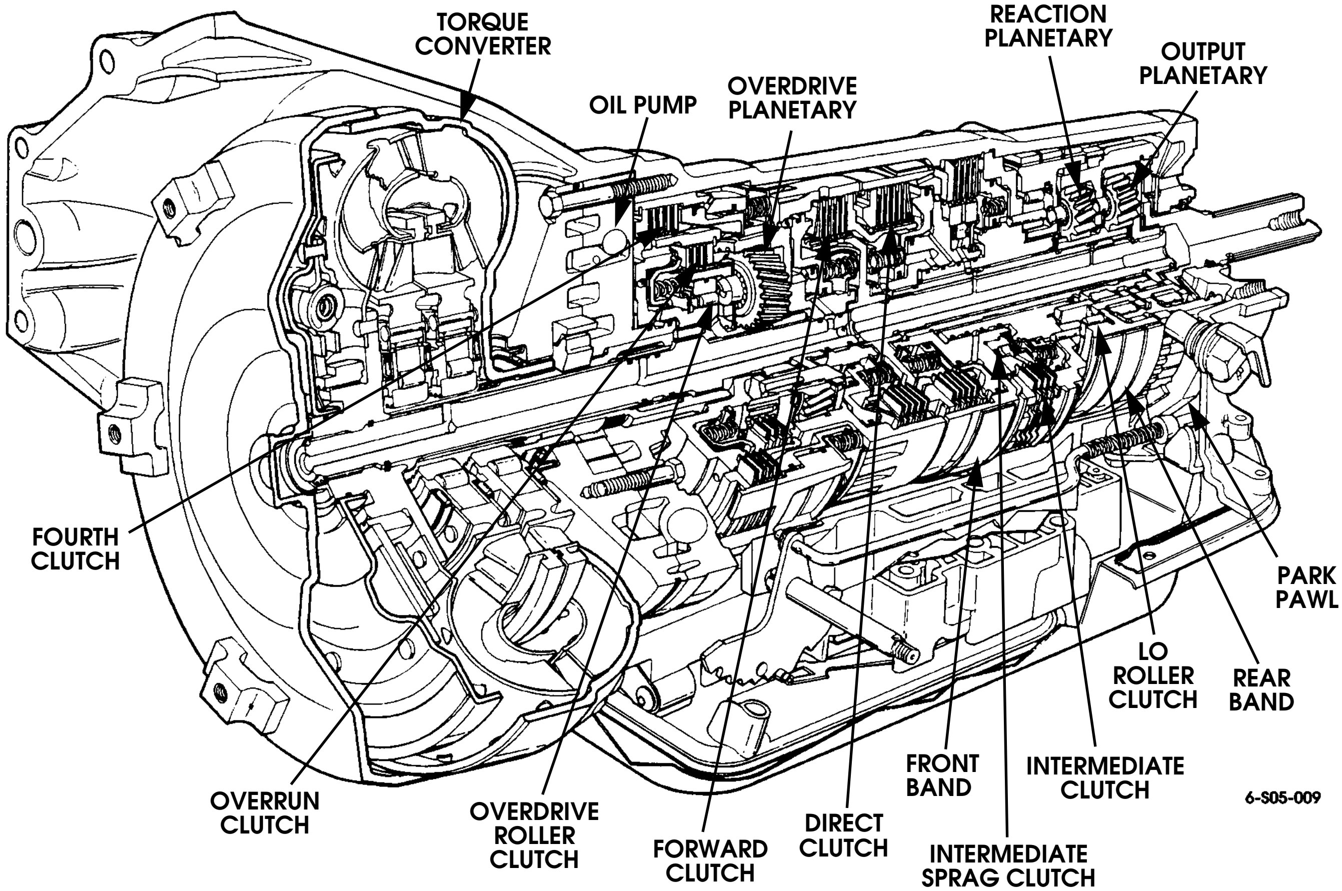


Figure 5-1: Transmission Drive and Apply Elements

TRANSMISSION GEAR RANGES

The 4L80-E gear ranges consist of: Park, Reverse, Neutral, overdrive D range, manual D range, manual 2 range and Manual 1 range.

In Park (P) range, none of the clutches and bands are applied. In addition, the transmission output shaft is locked by a pawl that engages gear teeth on the output carrier. The pawl is actuated by a rod and detent operated by the manual lever. Park range (along with Neutral), is used for engine starting.

In Reverse (R) range, the direct clutch and rear band are applied and the overdrive roller clutch is holding. The vehicle will backup (move rearward) only in this range.

In Neutral (N) range, none of the clutches or bands are applied. Vehicle movement is not provided for. Neutral is used primarily for engine starting, or when the vehicle must be moved while the engine is not running.

In Overdrive D range, the transmission will shift from first through fourth gear. This range is used for all normal driving conditions and also provides maximum fuel economy. Overdrive range is not, however, recommended for use on extremely steep terrain, or when pulling heavy loads. Manual D range should be used under these conditions.

In manual D range, the transmission will shift from first to third gear only. This range is recommended for high load, steep terrain driving. Manual D range also provides some engine braking when descending slight grades.

In manual second (2) range, the transmission will only shift from first to second. This range is useful on steep terrain or when pulling loads up an incline. Manual 2 range also provides overrun braking which is helpful on mild grades.

In manual low (1) range, the transmission remains in first gear. Upshifts will not occur. This range is useful for pulling heavy loads at low speed, or when ascending steep inclines. Overrun braking is also provided which is helpful when descending steep terrain.

TRANSMISSION GEAR RATIOS

Transmission gear ratios are:

First gear	2.48:1
Second gear	1.48:1
Third gear	1.00:1
Overdrive Fourth	.75:1
Reverse	2.08:1

TRANSMISSION IDENTIFICATION

An I.D. plate is attached to the passenger side of each Hydra-matic Transmission (Figure 5-2). The plate contains the model, Hydra-matic type, model year, calendar year, and Julian calendar date.

The I.D. plate information is required for correct service parts ordering.

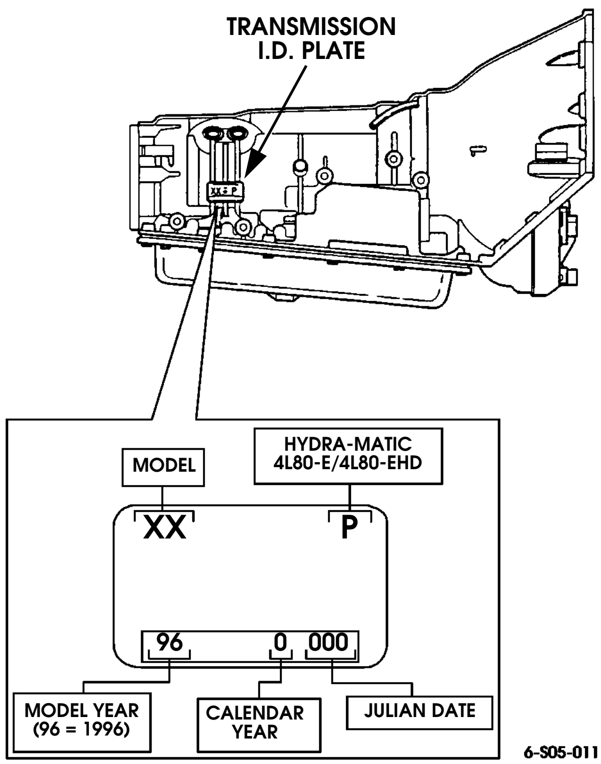


Figure 5-2: Transmission I.D. Plate Information

ELECTRONIC SHIFT CONTROL COMPONENTS

Upshifts and downshifts in overdrive and manual D ranges are electronically controlled. Transmission electronic components include (Figure 5-3):

- fluid temperature sensor
- input and output speed sensors
- 1-2 and 2-3 shift solenoids
- pressure switch manifold
- pressure control solenoid
- converter clutch solenoid
- TCM or PCM

Additional inputs to the transmission TCM/PCM are provided by: the engine coolant temperature sensor, A/C request switch, throttle position sensor/electronic accelerator pedal, engine speed/crankshaft position sensor, and brake switch.

Transmissions used with turbo diesel engines use a powertrain control module (PCM). A transmission control module (TCM) is used with non-turbo diesel engines.

Adapt Function

The 4L80-E transmission uses a line pressure control system, which has the ability to continuously adapt the system's line pressure. This compensates for normal wear and break in the following parts.

- The clutch fiber plates
- The seals
- The springs

The TCM/PCM maintains the following adapt parameters for the transmission:

- Upshift Adapt - The TCM/PCM monitors the Automatic Transmission Input (Shaft) Speed Sensor (A/T ISS) and the Output Speed Sensor (OSS) during commanded shifts in order to determine if a shift is occurring too fast or too slow. The TCM/PCM adjusts the signal to the transmission pressure control solenoid valve in order to maintain a set shift feel.
- Steady State Adapt - The TCM/PCM monitors the Automatic Transmission Input (Shaft) Speed Sensor (A/T ISS) and the Output Speed Sensor (OSS) after a shift in order to calculate the amount of slippage in that gear. The TCM/PCM then adjusts the signal to the Transmission Pressure Control Solenoid signal in order to maintain slippage below a set amount.

Reset the Transmission Adapt functions when the transmission is overhauled or replaced. To reset the Transmission Adapt functions, use the Tech 1 Scan Tool.

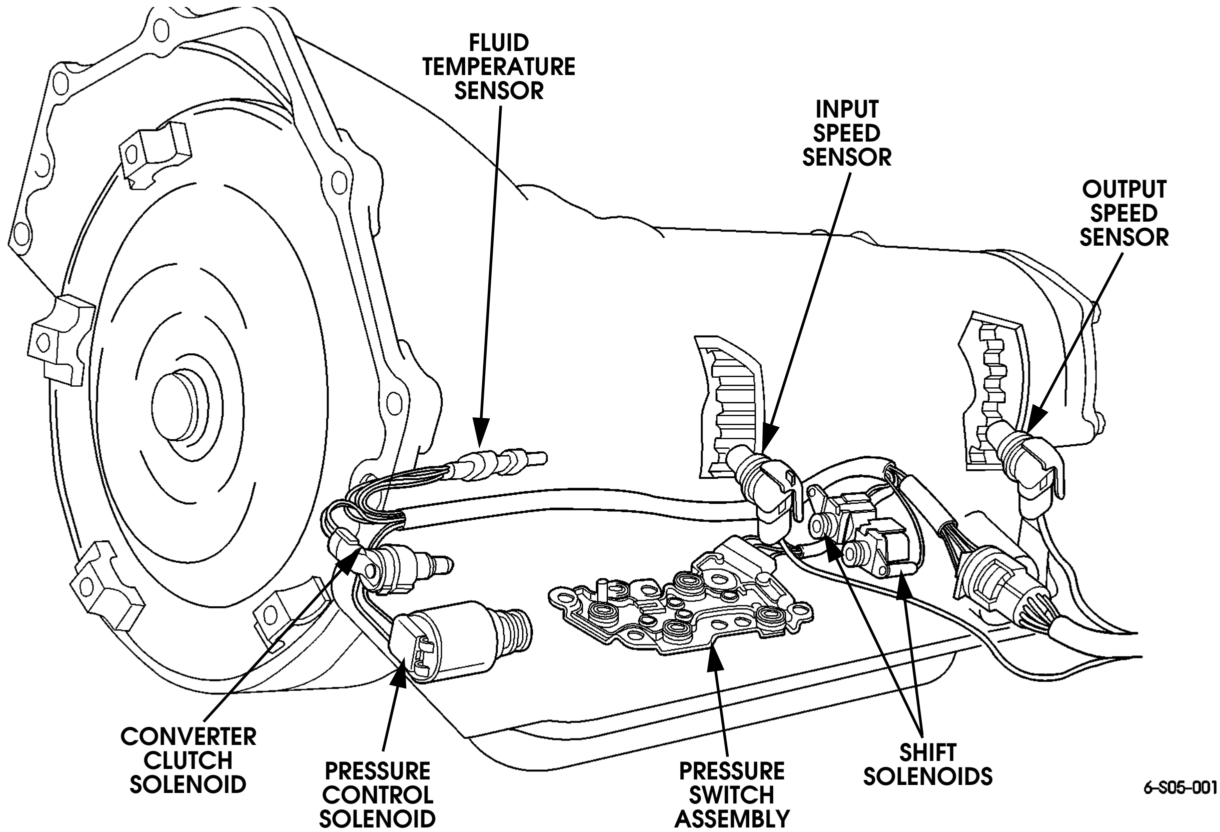


Figure 5-3: Transmission Shift Control Components

PRESSURE SWITCH ASSEMBLY

The pressure switch assembly is mounted on the valve body. It contains five pressure switches in circuit with the TCM/PCM (Figure 5-4). The switches are used to signal the TCM/PCM what gear range has been selected.

Each pressure switch is activated by fluid pressure (Figure 5-5). Fluid flow through the manifold is controlled by the valve body manual valve (Figure 5-6).

The five pressure switches are closed only when fluid pressure is applied. Fluid flow into the switch cavity presses the diaphragm downward against the contact element and switch contact (Figure 5-4). Once the switch closes, it completes the ground circuit to the TCM/PCM through one of the connector pins (Figure 5-4).

The hydraulic and electrical schematics in Figure 5-6 illustrate switch activation and fluid flow in third gear. The Drive and PRND 4/3 switches are pressurized closing the circuit to connector pin C (Figure 5-4). This changes the digital logic at Pin C to O and the logic at Pins A and B to 1 (Figure 5-6). The TCM/PCM reads this as third gear.

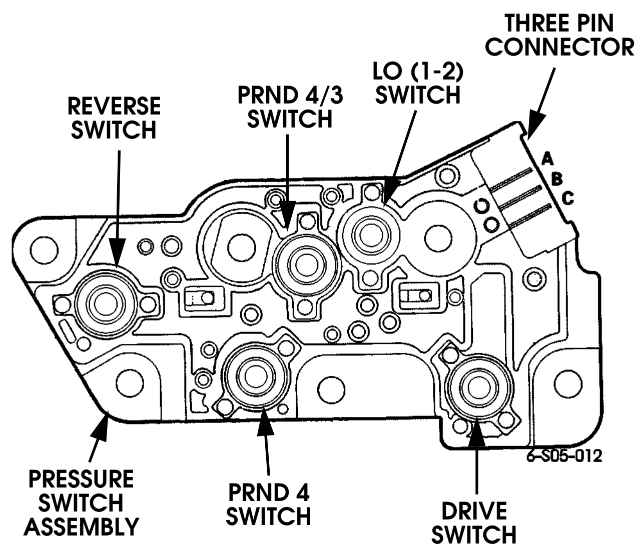


Figure 5-4: Pressure Switch and Connector Identification

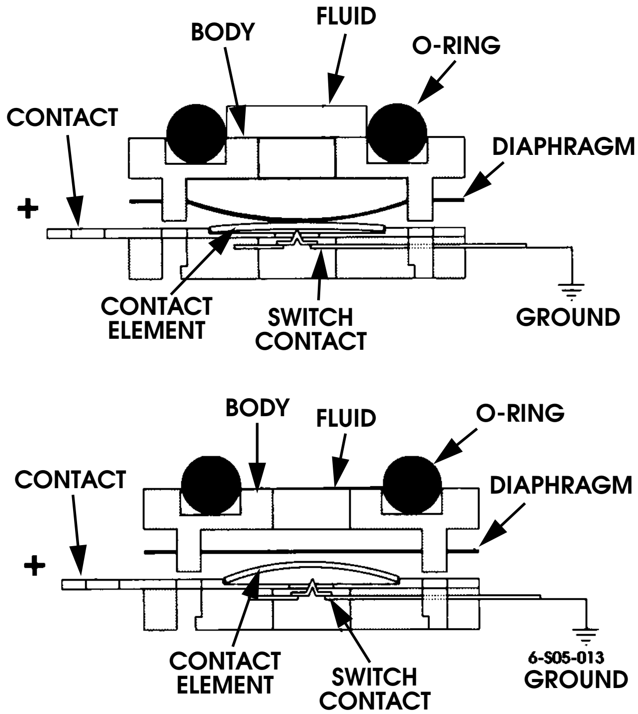
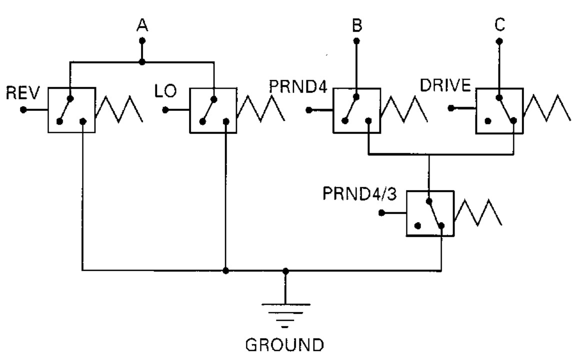


Figure 5-5: Pressure Switch Actuation

Range	Switch Pressure					Connector Pin Logic		
	Rev	Lo	PRND4	PRND43	Drive	A	B	C
Park						1	0	1
Reverse						0	0	1
Neutral						1	0	1
(D)						1	0	0
D						1	1	0
2						1	1	1
1						0	1	1

- Pressurized

0 - Grounded: 0V LOW
1 - Open: 12V HIGH



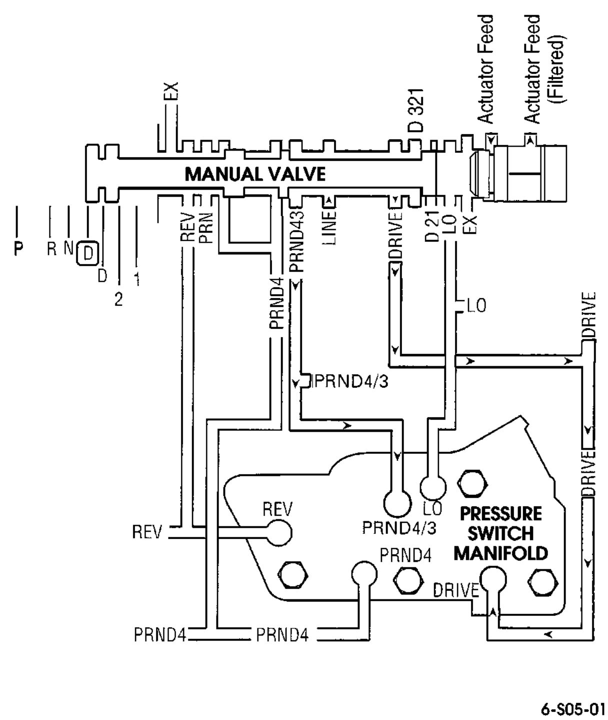


Figure 5-6: Hydraulic/Electrical Circuitry for Pressure Switch Assembly (Third Gear Shown)

INPUT AND OUTPUT SPEED SENSORS

The input and output speed sensors are variable reluctance, magnetic pickup units (Figure 5-7). They consist of a permanent magnet surrounded by a wire coil. Both sensors are mounted in the driver side of the transmission case.

The output speed sensor is positioned opposite a gear-type rotor pressed onto the output carrier. The input sensor is opposite the machined teeth on the forward clutch housing (Figure 5-7). The rotor and gear teeth interrupt the sensor magnetic field as they rotate. This induces an AC current in each sensor coil. The output sensor provides a voltage signal proportional to vehicle speed. The input sensor signal indicates transmission shaft/turbine speed. Both sensor signals are used by the TCM/PCM to determine shift speed, pattern, and converter clutch apply.

Sensor signals reaching the TCM/PCM are converted to a square wave form (Figure 5-7). The wave forms correspond to the teeth on the output carrier rotor and forward clutch. The increase in shaft speed will cause more teeth to interrupt the sensor magnetic field in a given time. This is reflected in an increase in the number of wave forms sent to the TCM/PCM. The wave forms are compared to a fixed signal voltage in the TCM/PCM to determine speeds.

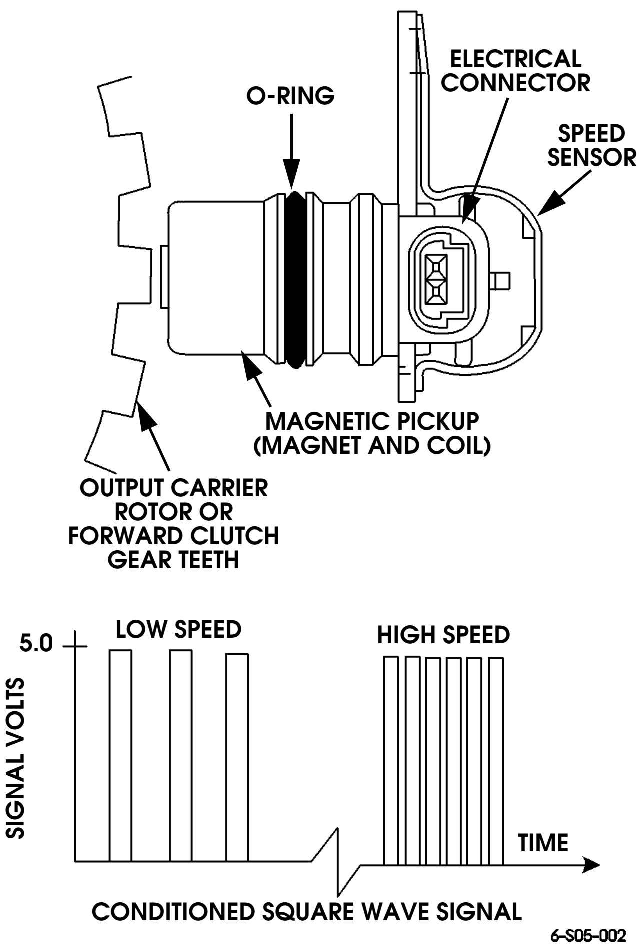


Figure 5-7: Transmission Speed Sensor Signal Form

TRANSMISSION FLUID TEMPERATURE SENSOR

The fluid temperature sensor is mounted on the valve body and is a nonremovable part of the transmission wiring harness. Failure of the sensor constitutes wiring harness replacement. It is a temperature sensitive resistor more commonly known as a thermister (Figure 5-8). Low fluid temperature produces high resistance. The TCM/PCM controls torque converter clutch apply based on sensor input signals.

The TCM/PCM will not allow converter clutch apply when fluid temperature is below 68°F (20°C). At higher fluid temperatures, the TCM/PCM will apply or release the converter clutch as follows:

- Apply the clutch in second, third, fourth when fluid temperature exceeds 250°F (122°C).
- Release the clutch and prevent apply in any gear range when fluid temperature reaches or exceeds 300°F (150°C).
- Prevent converter clutch apply and set a-fault code when fluid temperature reaches 310°F (154°C).

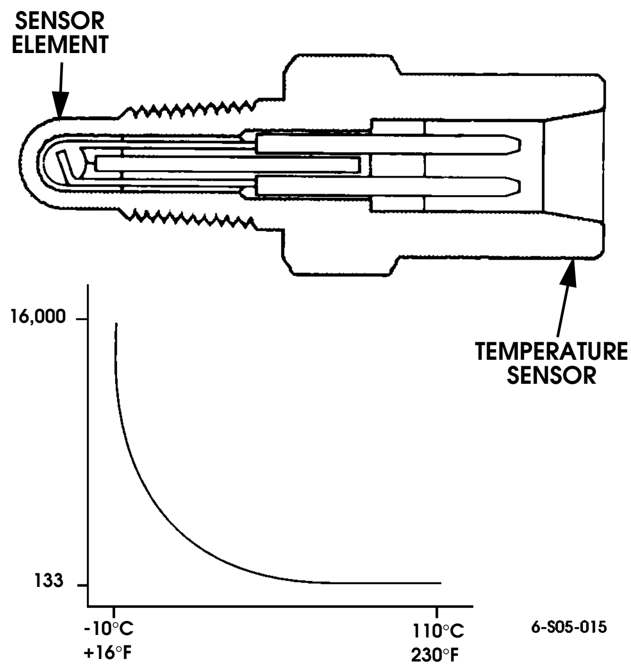


Figure 5-8: Temperature Sensor

SHIFT SOLENOIDS

Two solenoids are used to control upshifts and downshifts in the forward gear ranges. Solenoid A controls the 1-2 shift valve while Solenoid B controls the 2-3 shift valve. Both solenoids are mounted on the valve body and operated by the TCM/PCM.

The solenoids are energized or de-energized separately and in combination to control shifts. The following chart outlines solenoid activities in the various gear ranges.

Gear Range	1-2 Solenoid A	2-3 Solenoid B
Park, Reverse, Neutral	ON	OFF
First	ON	OFF
Second	OFF	OFF
Third	OFF	ON
Fourth	ON	ON

The solenoids are de-energized when the TCM/PCM completes the solenoid ground circuit. Incoming fluid passes around the check ball and exits through the exhaust port (Figure 5-9). Energizing the solenoid causes the coil to extend the plunger blocking off the exhausts port. Incoming fluid is then routed back to the 1-2 or 2-3 shift valve, overcomes spring pressure, and moves the valve to required shift position.

An example of solenoid actuation is provided in Figure 5-10 which illustrates third gear flow. Solenoid A is de-energized (off) causing signal A fluid to exhaust through the outlet port. The 1-2 shift valve remains in position through normal valve spring pressure. Energizing solenoid B, blocks the exhaust port causing signal B and actuator feed pressure to act against the 2-3 valve and spring. The two fluid pressures overcome spring pressure moving the 2-3 valve into Upshift position. However, in manual 1 and 2 ranges D21 fluid pressure prevents the 2-3 valve from moving to upshift position despite solenoid B energized state.

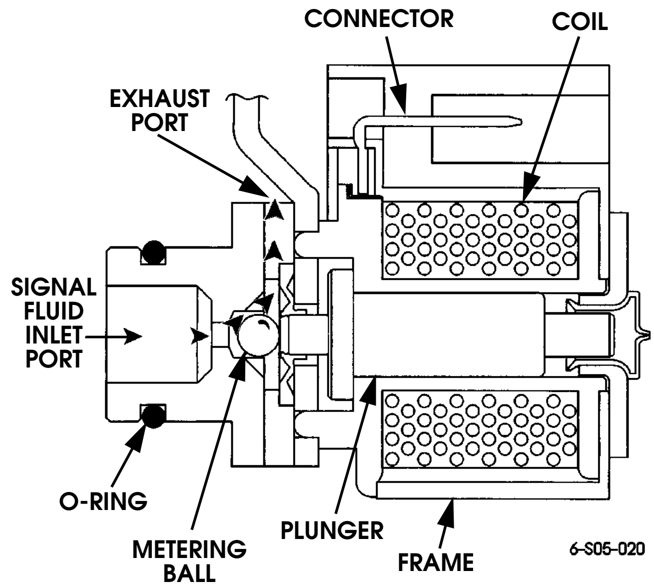


Figure 5-9: Shift Solenoid Cross Section

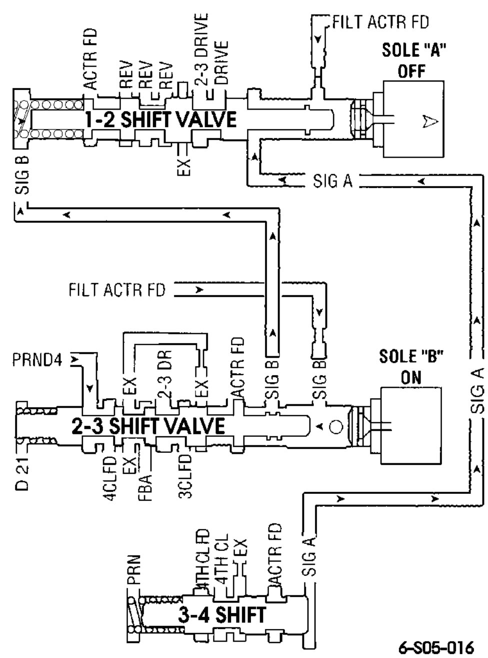


Figure 5-10: Shift Solenoid Actuation (Third Gear Shown)

TORQUE CONVERTER CLUTCH SOLENOID

The solenoid controls converter clutch apply and release signal pressure. It is located on the valve body adjacent to the pressure control solenoid. The solenoid is operated by the TCM/PCM.

In operation, energizing the solenoid allows converter clutch signal fluid and 2-3 drive fluid, to act on the ball and plunger (Figure 5-11). Fluid pressure moves the plunger to the apply position. This provides a path for apply fluid to act on the converter clutch limit, enable, and shift valves in the oil pump. Once these valves are moved to apply position, fluid pressure holding the clutch away from the converter cover is released.

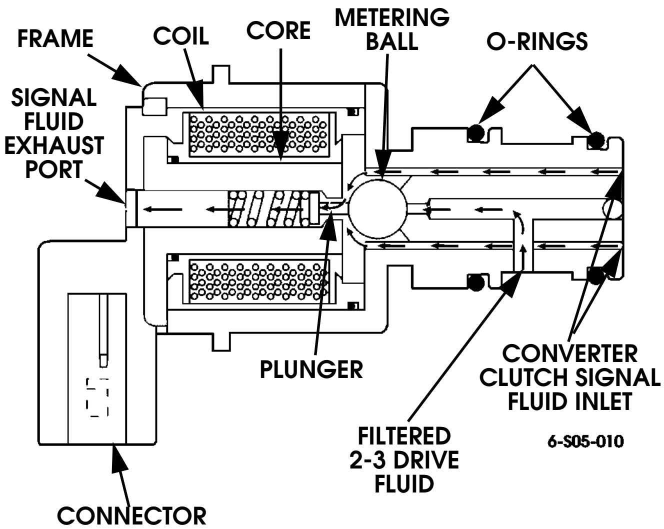


Figure 5-11: Converter Clutch Solenoid Cross Section

PRESSURE CONTROL SOLENOID

The solenoid (Figure 5-12) uses filtered actuator fluid to regulate torque signal fluid pressure. The solenoid is controlled by the TCM/PCM and is located on the valve body.

Torque signal fluid increases line pressure when required. Fluid is directed by the control solenoid against the reverse/boost valve (Figure 5-13). Pressure on the boost valve forces it against the pressure regulator valve adding to regulator valve spring pressure. This action moves the pressure regulator valve upward allowing greater flow into the line pressure feed passage.

The TCM/PCM energizes the control solenoid when throttle opening decreases. Torque signal fluid pressure then falls off and the regulator valve returns to normal position. Line pressures are boosted at high throttle openings and during reverse gear operation only. A failure in the transmission electrical circuit will also cause higher line pressures. This is a protective feature designed to prevent clutch slip.

Torque signal fluid from the solenoid, also affects the torque signal compensator valve in the accumulator, and the accumulator valve in the valve body.

At low throttle openings, the TCM/PCM applies a maximum of 1.1 amps current to the solenoid. This keeps the motor armature and coil energized holding the plunger away from the valve. The valve is moved inward by torque signal fluid pressure blocking the filtered actuator feed port and exposing the exhaust port. Torque signal fluid then exits through the exhaust port and returns to the system. Pressure on the reverse boost valve is minimal or at zero.

At higher throttle openings, TCM/PCM current flow to the solenoid decreases to zero. At this point, the solenoid armature and coil are de-energized (Figure 5-12). The plunger and valve are moved outward by spring force closing the exhaust port. Once the exhaust port is closed, torque signal fluid is directed to the boost valve. The combination of torque signal fluid and regulator valve spring pressure, then moves the pressure regulator valve to a higher pressure setting.

The solenoid replaces the vacuum modulator used on previous transmissions. Torque signal fluid acts much like throttle pressure fluid in prior transmissions.

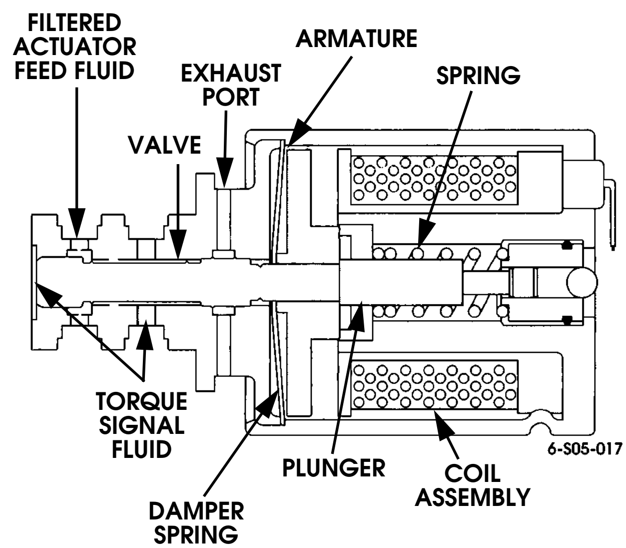


Figure 5-12: Pressure Control Solenoid In Energized (Closed) State

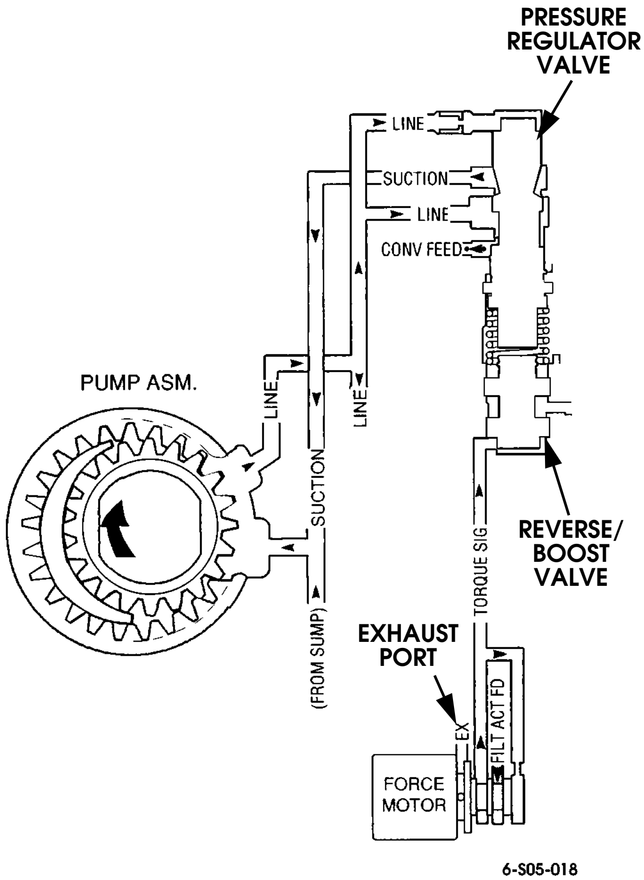


Figure 5-13: Pressure Control Solenoid Boost Schematics

ENGINE SENSOR INPUTS

The throttle position sensor (TP) or electronic accelerator pedal, coolant temperature sensor, A/C switch, brake switch, and crankshaft position sensor or speed sensor, all affect transmission operation.

The TP sensor or electronic accelerator pedal input signals inform the TCM/PCM of throttle position. This input affects pressure control solenoid operation and transmission line pressure. The solenoid increases line pressure at higher throttle openings.

The coolant temperature sensor input affects transmission shifting. The sensor signal can prevent shifts into overdrive fourth gear when coolant temperatures are low or extremely high.

Crankshaft position or engine speed sensor inputs are used by the TCM/PCM to adjust shift points and fluid pressures.

A signal from the A/C switch informs the TCM/PCM when the A/C switch and compressor are engaged. This signal affects transmission shift points to compensate for increased engine load and idle rpm.

The brake switch signal is used by the TCM/PCM to control downshift points. Brake application completes the switch circuit to the TCM/PCM which then downshifts the transmission as needed.

TORQUE CONVERTER

The torque converter consists of a cover, clutch pressure plate and damper, turbine, stator, and pump (Figure 5-14).

A roller clutch in the stator hub prevents stator freewheeling until coupling speed is reached. The clutch maintains torque multiplication until this point.

The converter clutch, located between the cover/impeller and the stator, eliminates normal internal slippage at cruise speeds. The clutch pressure plate has friction material bonded to it that engages the cover/impeller when applied. Clutch applied at normal cruise speeds improves fuel economy and reduces fluid temperature.

The converter is not a repairable part. It is serviced only by replacement.

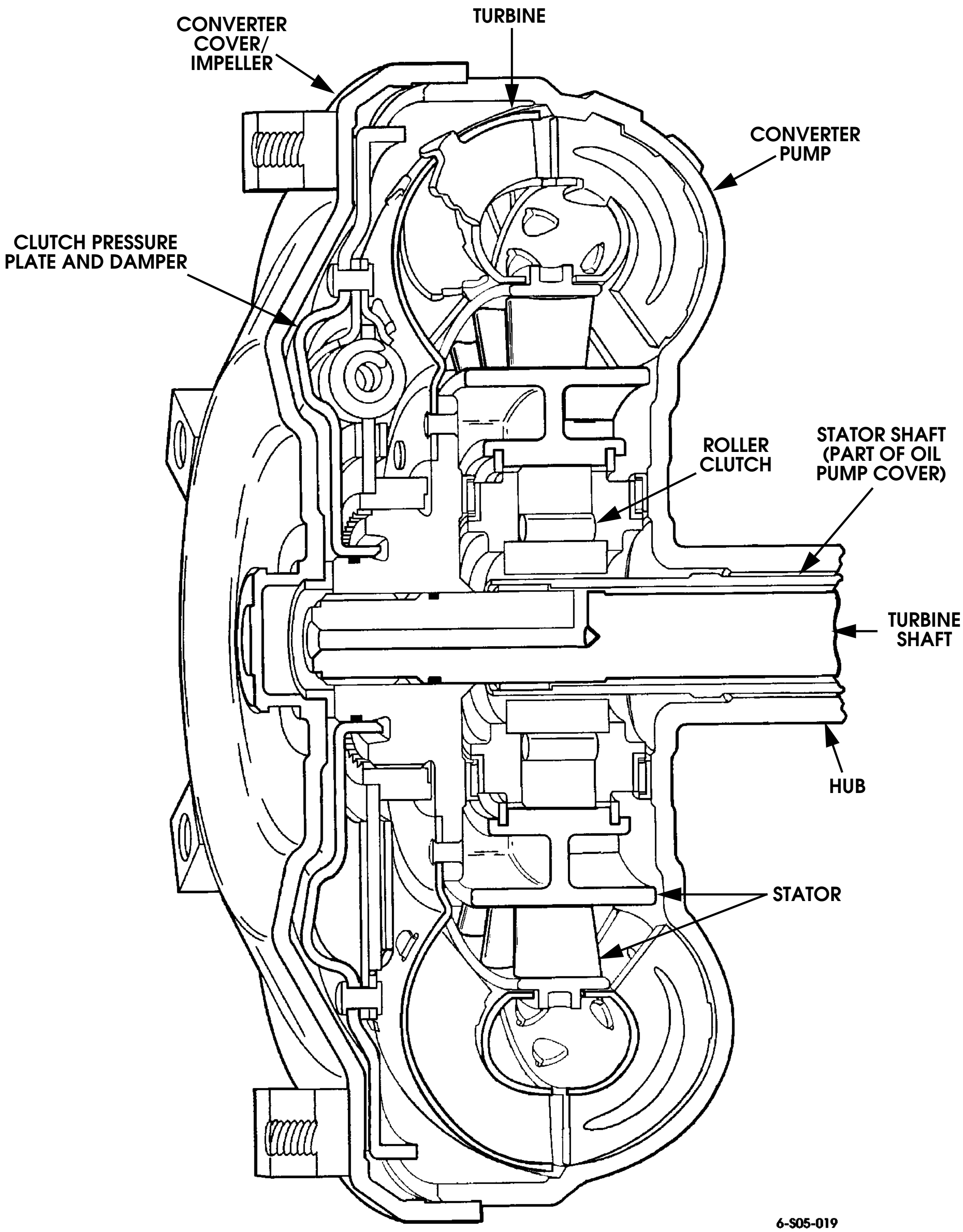


Figure 5-14: Torque Converter Components

TRANSMISSION SERVICEABILITY

The Hydra-matic transmission used in Hummer vehicles is serviced at two levels. Only external parts are serviced during and after the warranty period. A transmission internal component failure will require transmission replacement. Service replacement transmission are available through the GM reman program.

External repairs include replacement of the following:

- oil pan, gasket, and filter
- converter housing access covers
- shift solenoids
- rear servo
- speed sensors
- pressure control solenoid
- converter clutch solenoid
- accumulator
- park lock detent, actuator, pawl, pin, spring shift, plug, and bracket
- oil pump seals
- torque converter
- fill tube, O-ring, and dipstick
- adapter and gasket
- rear mount insulator and bracket
- transmission wiring harness
- vent lines and cooler lines
- TCM/PCM

TRANSMISSION DIAGNOSIS

Transmission diagnosis is a three step procedure. The first step involves two preliminary inspection procedures to check external parts. The second step involves road testing to confirm and identify a problem. The third step involves shop testing to locate the problem system or part. Shop testing includes pressure testing, scan tool diagnosis, and visual inspection.

Preliminary Inspection - Vehicle is Driveable

1. If problem involves vibration or noise, check following:
   - tires and wheels for wear or damage
   - drive belt and accessories for wear, or being loose
   - propeller shaft U-joints for wear or damage
   - exhaust pipes, muffler, converter touching body or frame
   - engine/transmission mount wear or damage
2. Check transmission fluid condition as follows:
   a. Remove dipstick from filler tube and note fluid color.
   b. If fluid is dark red to light pink, condition is OK. Proceed to next step.
   c. If fluid is dark orange, or brown, fluid has been overheated and should be changed. Cooler should also be flushed out. However, if fluid is black, smells burned and contains clutch material, transmission and converter should be replaced and the cooler flushed.
3. Check transmission fluid level as follows:
   a. Transmission fluid should be at normal operating temperature for accurate check. Drive vehicle if necessary.
   b. Start engine, apply brakes, shift through all gear ranges and back to Park. Run engine at curb idle speed.
   c. Remove dipstick and check fluid level. Fluid should be in crosshatch area of dipstick.
   d. If level is low, add fluid in 1/4 pint/liter increments if necessary. If fluid level is high, draw-off excess with suction gun and plastic tubing inserted in filler tube.

CAUTION: *Do not overfill the transmission. Excess fluid will be churned into foam aerating the fluid. The result will be fluid overheat, shift problems and clutch wear.*

4. If fluid level was low, check for leaks at the oil pump seal, cooler and lines, filler tube and oil pan.
5. Check shift linkage adjustment. If vehicle starts only in Park and Neutral, linkage is OK. Linkage needs adjustment when engine won’t start in one of the ranges, or if shift indicator in bezel is seriously misaligned.
6. Inspect transmission harness and case connector. Repair loose connections or damaged wiring as needed and proceed to next step.
7. If leaks, linkage, or fluid problems ar not encountered, proceed to road test.

Preliminary Inspection - Vehicle Is Disabled

1. Check fluid level and condition as described in procedure for driveable vehicles.
2. Check for fluid leaks or broken shift linkage.
3. Check driveline as follows: Raise vehicle so wheels are free to rotate. Then start engine, shift transmission and transfer case into gear, and note the following:
   a. If one or both propeller shafts turn but wheels do not, problem is with differential or axle shafts.
   b. If propeller shafts turn but transmission or transfer case is noisy, stop engine immediately. Then repair transmission or transfer case as needed.
   c. If propeller shafts do not rotate and transmission is not noisy, test transmission line pressure as described in this section.

Road Test

1. If engine and transmission have cooled down, drive vehicle 10-12 miles to return to normal operating temperature.

NOTE: The engine coolant and transmission fluid temperatures must be at normal operating levels for a proper road test. The engine and transmission temperature sensors will inhibit upshifts otherwise.

2. Check torque converter operation as follows:
   a. Operate vehicle at 50-55 mph (80-88 km/h).
   b. Lightly apply brakes and check for converter clutch release. Engine rpm will increase slightly when release occurs.
   c. Release brakes, accelerate again, and check for converter clutch apply. Engine rpm will fall off slightly when apply takes place.
   d. If shudder occurs during converter clutch apply, or clutch won't release, problem is with one of the converter control valves, solenoid, or fluid level is low. If shudder occurs after clutch apply, problem is with engine, mounts, or other driveline component.
   e. If more than normal throttle opening is required to accelerate and maintain cruise speed, stator roller clutch may have failed.
3. Check shifting in both D ranges. Verify 1-2 and 2-3 upshifts and 3-4 upshift in overdrive D range. Then manually shift into 2 position at 25 mph. Transmission should immediately shift into second gear but do not upshift to third. Stop vehicle and shift into 1 range. Accelerate to 25-30 mph and note operation. Transmission should remain in first gear, provide overrun braking effect at decel, and not upshift. Stop vehicle, shift into reverse and backup. Vehicle should move smoothly in reverse. Check kickdown operation in both D ranges. Transmission should downshift promptly when accelerator pedal is moved to wide open position.
4. Drive vehicle in all gear ranges. the following indicate transmission mechanical or electrical fault:
   - loss of one or more gear ranges
   - engine flare during shifts (indicates clutch slip)
   - rough-harsh shifts
   - noise in one or more gear ranges
   - delayed or harsh engagement in D or R
   - shudder or surge during shifts
   - engine starts in range other than P or N
   - engine stalls after shift to D
   - loss of drive or reverse

Road Test Analysis

Shift problems such as harsh, or late shifts, indicate a problem with the wiring, a sensor, low fluid level, or a TCM/PCM fault. Complete loss of a gear range when the fluid is cold or hot, indicates failure of a drive element.

An important diagnostic tool is the Transmission Elements In Use chart (Figure 5-15). The chart indicates what elements are applied, holding, or overrunning in each gear range. The chart also indicates shift solenoid status in each gear range as well. By comparing elements in use to a problem gear range, the number of parts to be checked can be narrowed considerably.

In cases where loss of drive, slow engagement, or engine flare are experienced, a line pressure test is needed. This test checks oil pump and force motor output and condition.

A torque converter fault will require scan tool testing to determine the problem part. A fault in one of the sensors or solenoids will also require scan tool testing. Incorrect shift points, no 3-4 upshift, converter shudder or slip, and harsh engagement are some of the problems caused by sensor, solenoid, wiring, or TCM/PCM fault.

Potential causes for common shift problems are described in the diagnosis guides. Corrective action is also provided. Problem causes are listed in order of probability (most-least).

Clutch Application Chart

	GEAR	1-2 SHIFT SOLE-NOID A	2-3 SHIFTS OLE-NOID B	FOURTH CLUTCH	OVER-RUN CLUTCH	OVER-DRIVE ROLLER CLUTCH	FOR-WARD CLUTCH	DIRECT BAND	FRONT BAND	INTER-MEDIATE SPRAG CLUTCH	INTER-MEDIATE CLUTCH	LO ROLLER CLUTCH	REAR BAND
P-N		ON	OFF			Holding							
R	Rev.	ON	OFF			Holding		Applied					Applied
OD	1st	ON	OFF			Holding	Applied			*		Holding	
	2nd	OFF	OFF			Holding	Applied			Holding	Applied	Over-running	
	3rd	OFF	ON			Holding	Applied	Applied		Over-running	Applied	Over-running	
	4th	ON	ON	Applied		Over-running	Applied	Applied		Over-running	Applied	Over-running	
D	1st	ON	OFF		Applied	Applied	Applied			*		Holding	
	2nd	OFF	OFF		Applied	Applied	Applied			Holding	Applied	Over-running	
	3rd	OFF	ON		Applied	Applied	Applied	Applied		Over-running	Applied	Over-running	
2	1st	ON	OFF		Applied	Applied	Applied			*		Holding	
	2nd	OFF	OFF		Applied	Applied	Applied		Applied	Holding	Applied	Over-running	
1	1st	ON	OFF		Applied	Applied	Applied			*		Holding	Applied

* Holding, but not effective • Solenoid operation follows a shift pattern dependent on vehicle speed and throttle position and not gear range.

ON = Solenoid energized

OFF = Solenoid de-energized

Figure 5-15: Transmission Elements In Use Chart

Line Pressure Test

1. Check and adjust fluid level if necessary.
2. Raise vehicle on hoist
3. Connect pressure gauge to transmission test port (Figure 5-16). Gauge must have 325-350 psi (2240-2413 kPa) capacity.
4. Start engine and check pressures in Park, Neutral and both Drive ranges. Pressure should be a minimum of 35 psi (241 kPa) at idle and increase to a maximum of 171 psi (1179 kPa) at greater throttle openings.
5. Shift transmission into reverse and note pressure. At idle, pressure should be a minimum of 67 psi (462 kPa) and increase to a maximum of 324 psi (2234 kPa) as throttle opening increases.
6. Stop engine, remove gauge, and lower vehicle.
7. If pressures were low in all ranges, pump may need repair or replacement. Problem may be worn, damaged gears, blown out cup plug, cross leakage, or worn bushing. If pressure is high, fault may be with pressure control solenoid, reverse/boost or pressure regulator valves, bad PCM ground or solenoid connection.

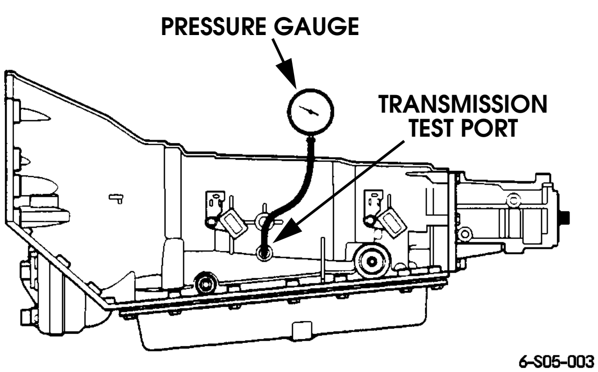


Figure 5-16: Pressure Gauge

Pressure Control Solenoid Test

1. Connect scan tool to diagnostic/data link connector.
2. Connect pressure test gauge to transmission.
3. Check fluid level and top off if necessary.
4. Shift into Park and apply parking brakes.
5. Start and operate engine at idle speed.
6. Access “override pressure control solenoid” test on scan tool.
7. Increase current to pressure control solenoid in amp increments shown in chart (Figure 5-17), and record pressure gauge readings. Allow gauge readings to stabilize for 3-5 seconds after each current change.
8. Stop engine and remove test tools.
9. Compare test pressure readings with charge readings. Pressures should decrease as current to solenoid is increased. Consistently high pressures indicate a fault in the TCM/PCM, related wiring, or solenoid. Low pressures indicate an oil pump fault, or hydraulic circuit fault.

Amp Feed To Pressure Control Solenoid (From TCM/PCM)	Line Pressure - PSI (kPa)
0.0-0.02	157-177 (1083-1220)
0.10	151-176 (1041-1214)
0.20	140-172 (965-1186)
0.30	137-162 (945-1117)
0.40	121-147 (834-1014)
0.50	102-131 (703-903)
0.60	88-113 (607-779)
0.70	63-93 (434-641)
0.80	43-73 (296-503)
0.90	37-61 (255-421)
0.98-1.1	35-55 (241-379)

Figure 5-17: Pressure Control Solenoid Test Specifications

RECOMMENDED FLUID

The recommended and preferred fluid for 4L80-E transmissions is Dexron III.

In cases where Dexron III is not readily available, Dexron IIE can be used to top off the fluid level. It is not, however, recommended for use as the primary fluid for a fluid change.

Fluid Capacity

Fluid capacity of the 4L80-E used in Hummer vehicles is:

- Transmission refill capacity (after filter change) is approximately 5 qts. (4.7 L).
- Dry fill capacity (after overhaul) is approximately 11.5 qts (10.9 L)
- Cooler and line capacity is approximately 1-2 pts (.47-.95 L)

Fluid Level and Condition

Transmission fluid level and condition are important to proper operation. An incorrect fluid level can lead to shift problems, fluid breakdown, and accelerated wear.

Check fluid level and condition during the preliminary inspection procedure. This is important, as a low fluid level, or overfill condition can lead to slip and flare, overheating, burned fluid, slow engagement, converter shudder, and no fourth gear upshift.

An overfill condition allows the gear train to churn the fluid into foam. this action aerates the fluid causing slip, overheating, oxidation, and overflow from the vent. A low level allows the pump to take in air along with the fluid. Air in the fluid will cause pressures to be low and develop slower than normal.

Checking Fluid Level

1. Fluid must be at normal operating temperature. Drive vehicle 10-15 miles (15-24 km) if necessary.
2. Position vehicle on level surface.
3. Operate engine at idle speed.
4. Shift transmission into Park.
5. Clean dipstick and top of fill tube with shop towel to avoid dirt entry.
6. Unlock and remove dipstick (Figure 5-18). Correct fluid level is to hot full mark at top of crosshatch (Figure 5-19). OK level is anywhere in crosshatch area.
7. Note color and condition of fluid. refer to fluid condition check.
8. Add fluid only if level is below bottom mark of crosshatch area. Add fluid in 1/4 to 1/2 pint/liter amounts to avoid overfill. However, if overfill condition exists, drain necessary amount of fluid with suction gun and length of small plastic tubing. Or drain excess off at cooler line with engine idling.
9. Install and lock dipstick and shut engine off.

Fluid Condition Check

Fluid condition should be checked at the same time as fluid level. Normal fluid color ranges from dark red to light pink.

Aerated fluid wil be foamy, full of air bubbles and range from red to light orange.

Overheated fluid ranges from dark orange to dark brown in color. Burned, oxidized fluid is black, thick, and smells burned. Overheated fluid should be changed and the cooler and lines flushed. Burned fluid can also be changed but only if shift problems were not experienced.

Check fluid on the dipstick for clutch friction material and metal particles. Transmission replacement or overhaul will be required if particles are present.

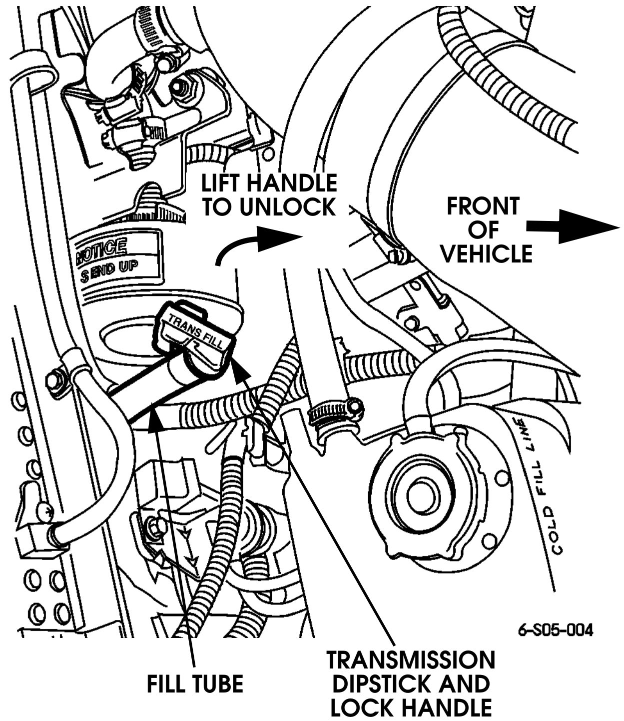


Figure 5-18: Releasing Transmission Dipstick Lock Handle

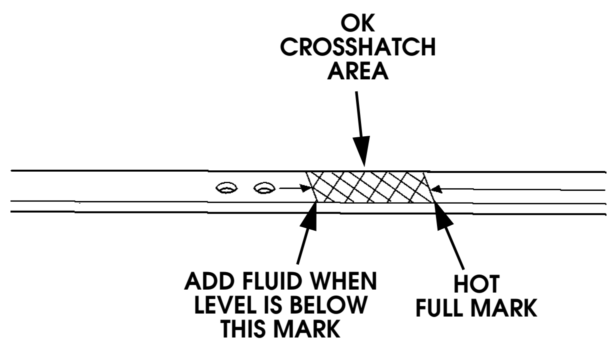


Figure 5-19: Transmission Fluid Level Marks

TRANSMISSION WARNING LAMPS

All Hummer vehicles are equipped with a transmission warning light. Turbo diesel models are also equipped with a check throttle light. The purpose of the lights is to alert the driver when a transmission, or electronic accelerator pedal circuit fault has occurred.

The warning lights are in circuit with the TCM/PCM, which controls light operation. The lights are illuminated for a few seconds at startup as part of a bulb check and circuit self test routine. The only other time illumination occurs, is when a system component or circuit fault occurs.

SCAN TOOL DIAGNOSIS

The Tech 1 Scan Tool (Figure 5-20) checks function of the solenoids, sensors, and TCM/PCM. The tool connector is attached to the vehicle data link connector (Figure 5-21). Power source for the scan tool is the vehicle cigarette lighter receptacle. A connecting cord and adapter are supplied with the scan tool kit.

The scan tool provides data on individual circuits, or on all the related electrical components in snap shot mode. A paper printout is provided in snap shot mode for analysis purposes.

The TCM/PCM memory and circuits are interrogated by the scan tool. The tool reads diagnostic trouble codes (DTC) and displays fault and performance parameters.

NOTE: Turbo engine requires use of a VIM (Vehicle Interface Module), part number 7000041. The Mass Storage Cartridge Kit, part number 7000000, is required for all vehicles.

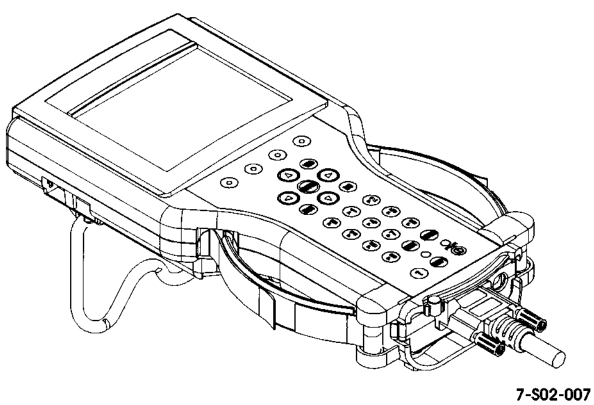


Figure 5-20: Tech 1 Scan Tool

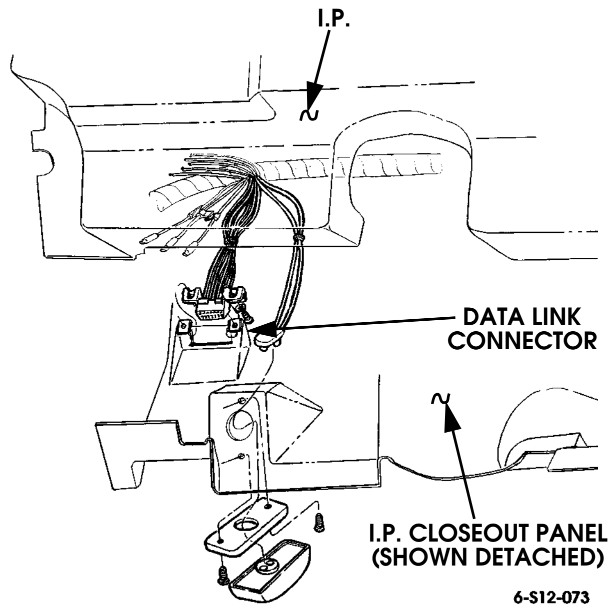


Figure 5-21: Data Link Connector

DIAGNOSTIC TROUBLE CODES (DTC)

A circuit fault causes the TCM/PCM to illuminate the warning light. At the same time, the applicable trouble code will be stored in memory. The scan tool is used to retrieve the code and check circuit or component operation.

Diagnostic trouble code identification and a brief description of fault action are as follows.

Code P0560

This code indicates low system voltage. The TCM/PCM turns the pressure control solenoid off, allows 4-3 and 3-2 downshifts then maintains second gear only.

Codes P0711/P0712/P0713

The listed codes all indicate incorrect transmission fluid temperature (high or low). The TCM/PCM sets max line pressure and applies the converter clutch in second, third, and fourth gear.

Codes P0716 or P0717

These codes indicate an input speed sensor fault. Either a no signal or range performance fault has occurred. The TCM/PCM sets max line pressure and inhibits shifts.

Codes P0719/P0724

These codes indicate a brake switch circuit high or low input voltage. Code 37/P0719 indicates the switch is stuck on. Code 38/P0724 indicates it is off. The TCM/PCM will prevent a 3-4 upshift and converter clutch engagement.

Code P0722

This code indicates either loss of vehicle speed input, or a fault in the transmission input speed sensor or circuit. The TCM/PCM sets max line pressure and may allow second gear only.

Code P0723

The above code indicates an input speed sensor or circuit fault. Code 74 results in non-apply of the converter clutch. Code P0723 indicates an intermittent problem in the sensor or circuit and results in max line pressure, loss of converter clutch apply, possible 1-2 shift only.

Codes P0741/P0742

These codes indicate a converter clutch circuit fault. Codes 39 and P0741 indicate the circuit is stuck off while 69 and P0742 indicate an ON condition. The TCM/PCM will set max line pressure, inhibit a 3-4 upshift and converter clutch engagement.

Code P0748

This code indicates a fault in the pressure control solenoid, related wiring, or control module. The TCM/PCM sets max line pressure and maintains the solenoid in the “OFF” position.

Code P0751/P0753

These codes indicate a 1-2 shift solenoid A or circuit fault. The TCM/PCM permits second and third, or first and fourth gear only and sets max line pressure.

Code P0756/P0758

All of the listed codes indicate a 2-3 shift solenoid B or circuit fault. The TCM/PCM will inhibit converter clutch engagement, hold the transmission in second gear, and set max line pressure.

Code P1810

This code indicates a pressure switch assembly fault. The TCM/PCM will allow overdrive D range operation and set max line pressure.

Code P1811

This code indicates maximum adapt long shift. The TCM/PCM sets maximum line pressure and freezes the shift adapts.

Code P1860

This code indicates a converter clutch fault caused by a solenoid problem. The TCM/PCM will prevent converter clutch engagement, or hold it engaged at max pressure if a fourth gear upshift has occurred.

Code P1870

This code indicates a transmission component is slipping. The TCM/PCM sets max line pressure and prevents converter clutch apply and 3-4 upshift.

Code P1871

This code indicates an undefined gear ratio. The TCM/PCM sets max line pressure and inhibits shifts.

Code P1875

This code indicates one of the 4-wheel drive indicator switches has failed. Or an internal fault has developed in the transfer case.

ELECTRICAL COMPONENT DIAGNOSIS INFORMATION

The following information describes the effect an electrical component fault can have on transmission operation and shifting. The information should be used to supplement shop testing and analysis.

TPS or Electronic Accelerator Pedal

A failure of either component wil cause erratic shifts, high or low line pressures, rough idle, or low power.

Crankshaft Position Sensor

A sensor fault will result in loss of converter clutch engagement, or the clutch will apply at the wrong time. The electronic fuel injection pump will also be affected causing rough idle, hesitation, or low power.

Input and Output Speed Sensors

A failure of either sensor will affect shifting and converter clutch apply. Shifts will be erratic and the converter clutch applies at the wrong time.

Pressure Control Solenoid

A solenoid failure will result in harsh shifts and high line pressures if it fails closed. A failure in an open position will result in soft shifts, possible slip, and decreased pressure at high throttle opening.

Converter Clutch Solenoid

A solenoid failure can result in harsh converter clutch apply, incorrect apply sequence, or no apply.

Pressure Switch Assembly

A switch failure can result in loss of fourth gear, no converter clutch apply, harsh shifts, and high line pressure.

Transmission Fluid and Engine Coolant Temperature Sensors

A failure of either sensor can result in loss of fourth gear and converter clutch apply.

Shift Solenoids

A failure of either solenoid will result in loss of one or more gears, wrong gear range, or a no-shift condition.

Brake Switch

A brake switch fault will affect converter clutch apply. The converter could remain engaged, or fail to engage.

Four-Wheel Low Range Switch

A switch failure can produce erratic shifts.

Transmission Harness and Case Connector

Loose, bent pins, loose connections, or damaged connector harness wires, can affect almost every phase of operation. Erratic shifts, no converter apply, overheating, and loss of one or more gear ranges can all occur. A check of the connector and harness (Figure 5-22) should be performed during initial inspection.

Transmission Diagnosis Guides

The diagnosis guides outline probable causes of various transmission malfunctions. The causes of the malfunctions are listed in order of potential (most to least probable). The guides do not cover every possible condition or possibility. They do however, provide a means of reducing the number of components requiring further diagnosis and inspection.

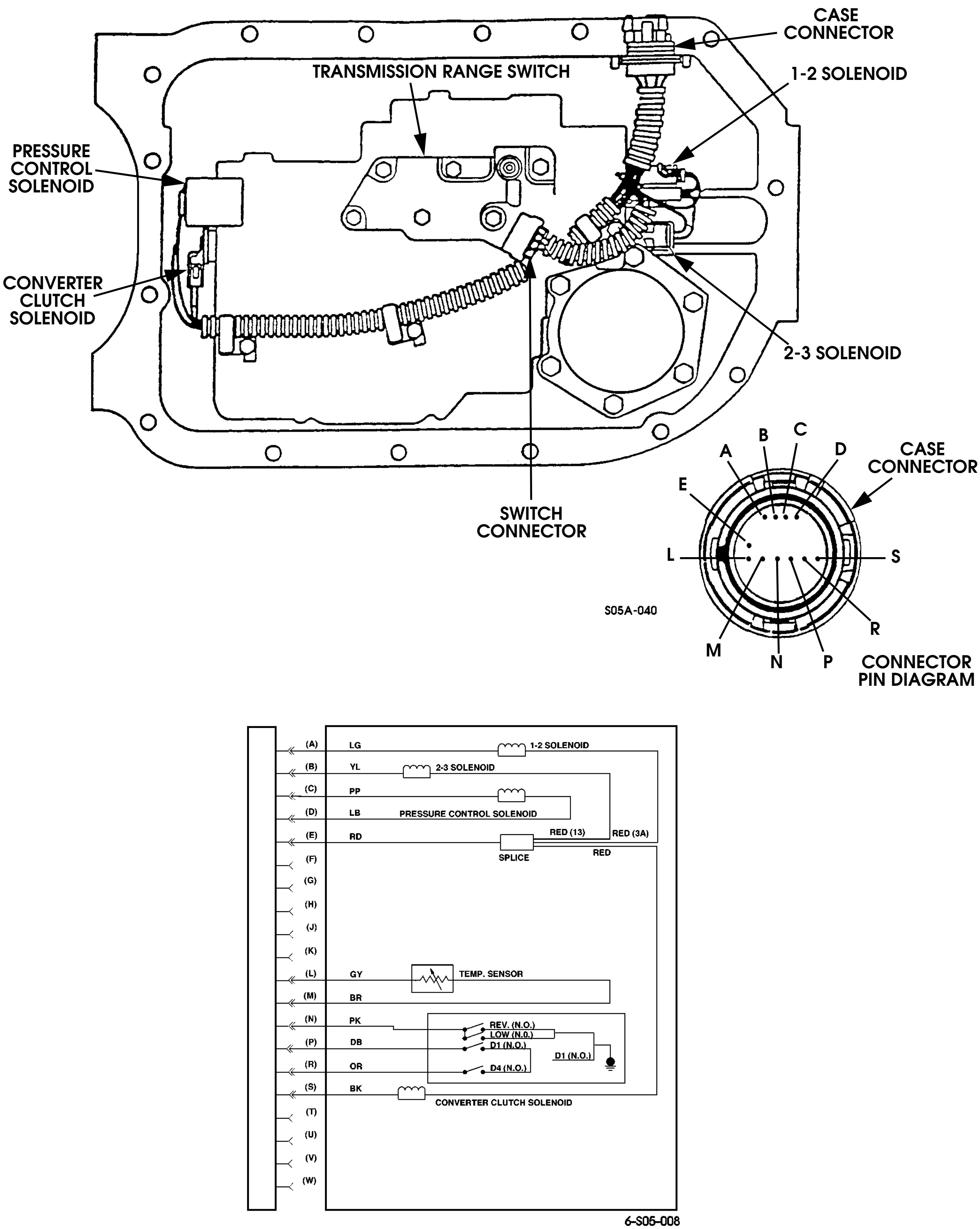


Figure 5-22: Transmission Internal Wiring Harness Assembly

TRANSMISSION DIAGNOSIS GUIDE

Problem	Potential Cause	Correction
Fluid Leaking Out of Vent and/or Foaming	1. Transmission overfilled. 2. Wrong or contaminated fluid. 3. Air entering fluid due to cross leakage at improperly seated pump cover or filter. 4. Transmission overheat. Caused by: • low fluid level • blocked fluid cooler • full load hot climate temperature operation. • converter clutch valve or spring failure • converter stator locked (seized) and will not free wheel at coupling speed	1. Drain Excess Fluid off through fill tube. Use suction gun and small diameter plastic or teflon tubing. 2. Drain and change fluid and filter. May also be necessary to remove and drain converter. 3. Reseat filter. Remove transmission and reseat pump if necessary. 4. Correct low fluid level and check for leaks. Reduce engine/transmission load. Replace transmission if clutch valve or spring condition exists. Replace plugged, damaged cooler.
Transmission Overheat	1. Low fluid level. 2. Fluid cooler problem: • Fins blocked with dirt, debris • cooler partially plugged • cooler (or lines) leaking 3. Converter clutch stuck in applied position. 4. Converter clutch valve, limit valve, or enable valve or spring failure. 5. Oil pump or body seal not seated causing cross leakage. May be accompanied by fluid foaming and leakage out vent. 6. Pressure regulator valve stuck in high demand position. 7. Converter stator clutch seized (locked). Engine overheat may also occur.	1. Add fluid and check for leaks. 2. Clean dirt/debris with water spray. Replace leaking or plugged cooler. Replace leaking cooler lines or fittings. 3. Replace converter. 4. Replace transmission. 5. Remove pump and replace seal. Be sure pump body is properly seated. 6. Remove oil pump and free up valve. 7. Replace converter.
Line Pressure Too High or Too Low	1. Oil pump problem: • loose PCM connection • seals failed • gears damaged • bushing worn, scored • pressure regulator valve or spring fault • reverse/boost valve fault • pressure relief spring collapsed, broken • loose pump bolts 2. Pressure control solenoid failed OFF or ON. 3. TCM/PCM fault.	1. Repair loose connection. Replace transmission if pump is damaged. 2. Replace solenoid 3. Replace TCM/PCM.

TRANSMISSION DIAGNOSIS GUIDE

Problem	Potential Cause	Correction
Vehicle Creeps In Neutral	1. Manual valve mispositioned or stuck. 2. Forward clutch fault.	1. Remove valve body and repair as needed. 2. Replace transmission.
Vehicle Moves In Park	1. Manual linkage loose, damaged, misadjusted, disconnected. 2. Park pawl, spring, or gear damaged.	1. Repair or adjust linkage as required. 2. Inspect and replace pawl, spring, or gear.
Vehicle Won't Move In Drive Range	1. Low fluid level. 2. Shift linkage misadjusted, disconnected, loose. 3. Pressure switch assembly fault. 4. Low fluid pressure caused by oil pump fault: • worn bushing • failed seal • broken gears • loose bolts 5. Transmission case seal, or gasket failure. 6. Input or turbine shaft damage (splines worn, shaft broken) 7. Roller clutch failure. 8. Torque converter hub damage. 9. Forward clutch problem: • piston seal failure • clutch plates burned, damaged, missing • burned reaction plate • worn teeth • failed check ball 10. Rear planetary gear set damage: • broken pinions • sun gear damage 11. Park pawl spring broken. 12. Turbine shaft ball not seating. 13. Mainshaft splines damaged.	1. Top off fluid level. If transmission now operates properly, locate and correct leaks. 2. Correct as required. 3. Replace switch assembly. 4. Remove pump and replace seal. Replace transmission if pump is damaged. 5. Locate and replace leaking gasket or seal. 6. Replace transmission if either shaft is damaged. 7. Replace transmission. 8. Replace converter. 9. Replace transmission. 10. Replace transmission. 11. Replace spring. 12. Replace transmission. 13. Replace transmission.

TRANSMISSION DIAGNOSIS GUIDE

Problem	Potential Cause	Correction
Vehicle Won't Back Up (No Reverse)	1. Low fluid level. 2. Shift linkage loose, misadjusted, damaged. 3. Reverse servo fault: • misassembled • piston or seal damage 4. Rear band fault: • wrong band apply pin • band worn 5. Direct clutch fault: • worn, damaged clutch plates • check ball leaking or missing 6. Overdrive roller clutch failure. 7. Valve body fault: • manual valve stuck, damaged • Pressure switch failure	1. Top off fluid. If vehicle now backs up, check and correct fluid leaks. 2. Repair linkage. 3. Overhaul servo. 4. Check and replace apply pin. 5. Replace transmission. 6. Replace transmission. 7. Remove and free-up binding valves. Replace switch assembly if failed. Replace transmission if valve body bores are damaged.
Engine Stalls When Transmission Is Shifted Into Gear	1. Idle speed incorrect (too low). 2. Torque converter clutch stuck in applied position, or clutch is dragging. 3. Forward clutch seized. 4. Fourth clutch seized or dragging.	1. Adjust idle speed on non-turbo diesel models. Check PCM operation with scan tool on turbo diesel. 2. Check converter clutch valve and solenoid operation. If OK, replace converter. 3. Replace transmission. 4. Replace transmission
Slips In Drive/ Reverse	1. Low fluid level. 2. Low fluid pressure. 3. Reverse servo seal failure (reverse range only).	1. Top off fluid level and check for leaks. 2. Check line pressure and overhaul pump if low. 3. Overhaul servo.
No First Gear In Either D Range	1. Low roller clutch failure (not attached or broken). 2. Center support race, splines, or snap ring failure. 3. Forward clutch problem. 4. Overdrive roller clutch problem. 5. Shift solenoid fault (either solenoid).	1. Replace transmission. 2. Replace transmission. 3. Replace transmission. 4. Replace transmission. 5. Check with scan tool and replace as needed.

TRANSMISSION DIAGNOSIS GUIDE

Problem	Potential Cause	Correction
No First Gear In 1 Range (Manual Low)	1. Low roller clutch failure. 2. Center support fault: • race broken • splines damaged • snap ring not seated • case damaged 3. Forward clutch fault. 4. Overdrive roller clutch failure. 5. Rear band fault: • band worn • servo failure • incorrect apply pin 6. Shift solenoid fault.	1. Replace transmission. 2. Replace transmission. 3. Replace transmission. 4. Replace transmission. 5. Replace transmission. 6. Check A and B solenoids with scan tool and repair as needed.
No Second Gear	1. Overdrive roller or intermediate sprag clutch damage. 2. Center support problem: • snap ring not seated • splines or race damaged • support bolt missing, damaged 3. Intermediate clutch air bleed cup plug leaking or missing. 4. Overrun clutch fault. 5. Forward clutch fault. 6. Intermediate clutch fault. 7. Shift solenoid fault.	1. Replace transmission. 2. Replace transmission. 3. Replace transmission. 4. Replace transmission. 5. Replace transmission. 6. Replace transmission. 7. Check with scan tool (both solenoids should be off).
No Third Gear	1. TCM/PCM ground wire fault. 2. No feed voltage to shift solenoid B (2-3). 3. Shift solenoid fault. 4. Direct clutch check ball stuck closed (partial apply and drag). 5. Intermediate sprag clutch fault. 6. Center support fault: • snap ring not seated • bolt missing or broken • support worn or damaged 7. Forward or direct clutch pack problem.	1. Repair bad connection. 2. Locate and repair open in wire harness. 3. Test with scan tool (B should be on and A should be off). Replace failed solenoid. 4. Replace transmission. 5. Replace transmission. 6. Replace transmission. 7. Replace transmission.

TRANSMISSION DIAGNOSIS GUIDE

Problem	Potential Cause	Correction
No Overdrive Fourth Gear	1. Shift solenoid A or B problem: • loss of supply voltage • shorted/open solenoid • bad ground • leaking O-ring 2. Pressure switch fault. 3. TCM/PCM ground fault. 4. Fourth clutch or overrun clutch failure. 5. Forward and clutch or direct clutch failure.	1. Check and repair solenoid feed wiring. Replace either solenoid if open or shorted. Use scan tool to check (both solenoids should be on). 2. Replace switch. 3. repair bad ground connection. 4. Replace transmission. 5. Replace transmission.
First and Fourth Gear Only - or - Manual Second and Third Only	1. Shift solenoid A stuck in off position. 2. voltage supply wire to solenoid a is loose, shorted, or open. 3. Fault in TCM/PCM ground. 4. Filter plugged. 5. 2-3 shift valve stuck.	1. Replace solenoid. 2. Locate and repair wire problem. 3. Locate and repair bad connection. 4. Change fluid and replace filter. Replace transmission if filter is full of clutch material. A dented oil pan can obstruct the filter and cause this problem 5. Replace valve, spring, or valve body if valve bore is damaged.
First and Second Gear Only	1. Shift solenoid B stuck in off position, or not connected to PCM. 2. Feed wire to shift solenoid B open/shorted.	1. Replace solenoid if seized. Repair wire connections to PCM if necessary. 2. Repair wire or replace harness as required.
No Torque (Drive) In Second	1. Worn or damaged intermediate sprag clutch.	1. Replace transmission.
No Overrun Braking In: First (1) -OR- Second (2)	1. Rear band or servo fault. 2. Main or output shaft damage. 3. Lo roller or sprag clutch fault. 1. Front band worn, wrong apply pin, or servo problem. 2. Direct clutch housing fault. 3. Overrun clutch fault. 4. Rear gear set problem.	1. Replace transmission. 2. Replace transmission. 3. Replace transmission. 1. Replace transmission. 2. Replace transmission. 3. Replace transmission. 4. Replace transmission.
Second and Third Gear Only In D Range	1. Shift solenoid A in off position: • open voltage feed wire • bad TCM/PCM ground • solenoid seized 2. 1-2 shift valve fault.	1. Repair solenoid feed or TCM/PCM ground wire as needed. Replace solenoid if stuck closed. 2. Replace valve body if 1-2 valve is scored or spring has collapsed.

TRANSMISSION DIAGNOSIS GUIDE

Problem	Potential Cause	Correction
Converter Clutch will Not Release or Will Not Apply	1. TCM/PCM, or pulse width solenoid wiring fault (short, open, ground). 2. Fluid contamination. 3. Converter clutch solenoid fault. 4. Fault with converter clutch, enable, or limit valves. 5. TCM/PCM fault. 6. Converter clutch failure. 7. Brake switch inoperative. 8. Turbine shaft seal leak.	1. Locate and repair wiring problem as needed. 2. Drain-change fluid and filter. flush cooler and lines. Replace converter. 3. Test with scan tool and replace if inoperative. 4. Remove oil pump and inspect valves (or pump body) if damaged. Smooth minor burrs, nicks with crocus cloth. 5. Test with scan tool and replace if fault is discovered. 6. Replace converter. 7. Replace switch if open or shorted. 8. Replace transmission.
Converter Clutch Slips or Soft Apply	1. Low fluid level. 2. Fluid contaminated or wrong fluid. 3. Turbine shaft seal leak. 4. Oil pump bushing worn. 5. Low fluid pressure. 6. Converter clutch (pulse width) solenoid fault.	1. Top off and check for leaks. 2. Drain and change fluid and filter. Flush cooler and lines. 3. Replace seals. 4. Replace bushing. 5. Test pressure and replace transmission if necessary. 6. Check solenoid wiring. If OK, replace solenoid
Converter Clutch Apply Timing Incorrect	1. Incorrect sensor input signal to TCM/PCM caused by inoperative sensor. 2. TCM/PCM problem.	1. Test operation of all sensors with scan tool. Replace failed sensors as needed. 2. Test with scan tool. Repair wires or module as required.
Harsh Shifts (All Drive Ranges)	1. Pressure control solenoid stuck in off (de-energized) position. 2. Accumulator fault: • piston spring broken • piston seal damage • piston spring missing • cover bolts loose • gasket damaged 3. Valve body check ball missing or mispositioned. 4. Incorrect TCM/PCM calibration.	1. Replace solenoid. 2. Overhaul accumulator. 3. Reposition check balls. Replace transmission if any check balls are missing. 4. Replace TCM/PCM.

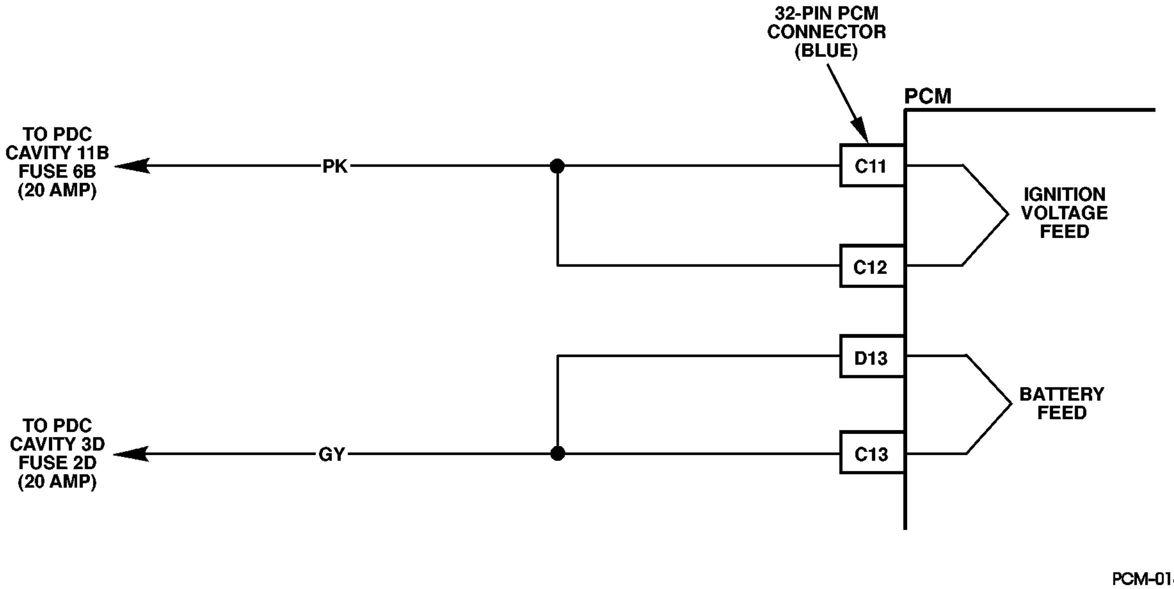
TRANSMISSION DIAGNOSIS GUIDE

Problem	Potential Cause	Correction
Harsh Engagement In Drive and Reverse	1. High idle speed. 2. Line pressure too high: • pressure control solenoid failed • reverse/boost, or pressure regulator valve stuck • accumulator spring or seal failure • shift sensor failure • missing valve body check ball	1. Adjust idle or check PCM with scan tool on turbo diesel. 2. Test pressure control solenoid and sensors with scan tool and replace as needed. Repair accumulator spring, or pressure regulator valves as needed.

DTC CHART

DTC	Description
P0560	System Voltage Malfunction
P0711	Transmission Fluid Temperature (TFT) Sensor Circuit - Range/Performance
P0712	Transmission Fluid Temperature (TFT) Sensor Circuit - Low Speed (High Temperature Indicated)
P0713	Transmission Fluid Temperature (TFT) Sensor Circuit - High Input (Low Temperature Indicated)
P0716	Input Speed Sensor Circuit - Range/Performance
P0717	Input Speed Sensor Circuit - No Signal
P0719	Brake Switch Circuit - Low Input
P0722	Output Speed Sensor - Low Input
P0723	Output Speed Sensor - Intermittent
P0724	Brake Switch Circuit - High Input
P0741	Torque Converter Clutch (TCC) Stuck “OFF”
P0742	Torque Converter Clutch (TCC) Stuck “ON”
P0748	Pressure Control Solenoid (PCS) Circuit - Electrical
P0751	1-2 Shift Solenoid Valve (1-2 SS Valve) - Performance
P0753	1-2 Shift Solenoid Valve (1-2 SS Valve) - Electrical
P0756	2-3 Shift Solenoid Valve (2-3 SS Valve) - Performance
P0758	2-3 Shift Solenoid - Electrical (2-3 SS Valve)
P1810	Pressure Switch Assembly (PSA) Circuit Malfunction
P1811	Maximum Adapt Long Shift
P1860	Torque Converter Clutch Pulse Width Modulation - Electrical
P1870	Transmission Component Slipping
P1871	Undefined Gear Ratio
P1875	Four-Wheel Drive Low Switch - Input Malfunction (Mechanical Shift)

DTC P0560 System Voltage Fault



Circuit Description

Circuit 291 is the voltage feed for the PCM. Circuit 537 is the battery feed for the PCM.

This DTC detects a low voltage, a high voltage for a long time, or a high voltage for a short time. This is a type “D” DTC.

Conditions For Setting DTC

System Voltage Low:

- Engine speed is greater than 1500 rpm.
- System voltage is less than 10.5 volts at a maximum transmission temperature of 152° C (305° F).
- System voltage is less than 6.7 volts at a minimum transmission temperature of -40° C (-40° F).
- All conditions met for 4 seconds.

System Voltage High:

- System voltage is greater than 19 volts for 4 seconds.

Action Taken When DTC Sets

- The PCM will cause an immediate shift to second gear.
- The PCM will turn off Pressure Control Solenoid.
- The PCM will inhibit converter clutch engagement.
- The PCM will freeze shift adapts.
- The PCM will NOT illuminate the Engine/Trans light.

Conditions For Clearing DTC

- The DTC can be cleared using the scan tool. The DTC will be cleared when the vehicle has achieved 40 warm-up cycles without a failure reported.
- The PCM will cancel the DTC default actions when the fault no longer exists and the ignition is cycled “off” long enough to power down the PCM.

Diagnostic Aids

- Charging the battery with a battery charger and jump-starting an engine may set DTC(s). If DTC(s) set when an accessory is operated, check for faulty connections or excessive current draw.
- Check for faulty connections at the starter solenoid or fusible link.
- Check for loose/damaged terminals at generator.
- Check belt wear/tension.
- If any engine DTCs or TP Sensor codes are present diagnose and clear these DTCs first. Then check to see if the transmission DTCs have set.

Test Description

The numbers below refer to the step numbers on the diagnostic chart.

3. This test checks charging system voltage.
4. This test checks battery voltage Input at the PCM.
6. This test checks ignition voltage input at the PCM.

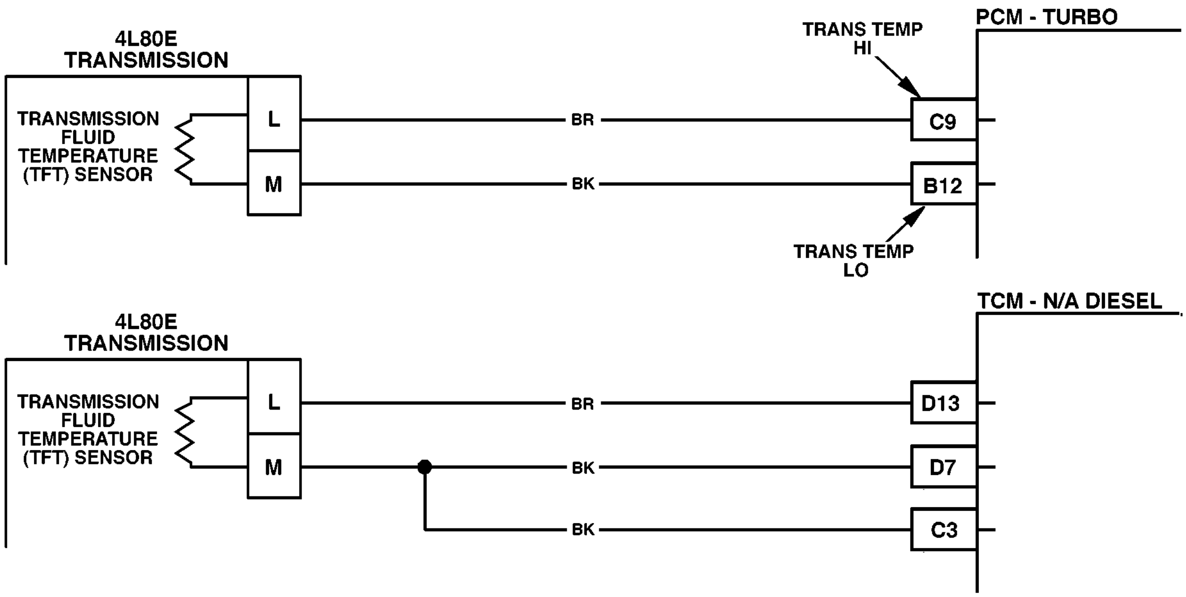
DTC P0560 System Voltage Fault (Turbo Diesel)

Step	Action	Value	Yes	No
1	1. Connect scan tool. 2. Turn the ignition switch to "on" position. **Important**: Before clearing DTC(s), use the scan tool to record "Failure Records" for reference, as data will be lost when the "Clear Info" function is used. 3. Record the DTC "Failure Records." **NOTE:** If any other DTCs are present, Refer to applicable diagnostic charts before continuing. 4. Using multimeter, measure the battery voltage across the battery terminals. Record the measurement for future reference. Is voltage higher than value shown?	10.5 volts	Go to Step 2	Check Battery
2	Start the engine and warm to normal operating temperature. Is generator charging (see voltmeter)?	12-14 volts	Check charging system	Go to Step 4
3	1. Increase engine speed to 1500 rpm. 2. Observe scan tool system voltage. Is system voltage within specified range?	13-15 volts	Go to Step 4	Check charging system
4	1. Turn the ignition switch "off." 2. Disconnect PCM connector (additional DTCs will set). 3. With engine "off," turn the ignition switch "on." 4. Using the multimeter and Connector Test Adapter Kit, measure the battery voltage input at PCM connector terminal "J3-C13." Is there a voltage variance between the voltage measured at the battery (taken in Step 2) and at terminal "J3-C13" that is greater than the value shown?	0.5 volts	Go to Step 5	Go to Step 5
5	Repair high resistance condition in. Was the circuit repaired?	—	Go to Step 10	—
6	1. Disconnect PCM connector. 2. Measure ignition voltage input at PCM connector terminals. Is there a voltage variance between voltage measured at the battery (taken in Step 2) and at terminal that is greater than value shown?	0.5 volts	Go to Step 7	Go to Step 8
7	Repair high resistance condition in circuit 439. Was the circuit repaired?	—	Go to Step 10	—
8	Check PCM connector terminals for bent, damaged, or backed out connector pins. Also check for weak terminal tension. Was a problem found?	—	Go to Step 10	Go to Step 9
9	Replace PCM. Is replacement complete?		Go to Step 11	—

DTC P0560 System Voltage Fault (Turbo Diesel)

Step	Action	Value	Yes	No
10	1. After the repair is complete, use the scan tool to select "DTC," then Unclear Info" function. 2. Select Specific DTC" and enter DTC "P0560." 3. Operate the vehicle under the following conditions: • Start the vehicle and warm to normal operating temperature. The PCM must see a system voltage between 8.3 and 18.9 volts.	—	—	—

DTC P0711 Transmission Fluid Temperature Sensor Circuit Range/Performance



Circuit Description

The Automatic Transmission Fluid Temperature (TFT) Sensor is a thermistor (temperature sensitive resistor). The TFT Sensor is part of the 4L80-E Automatic Transmission Wiring Harness Assembly (A/T Wiring Harness Assembly). The TFT Sensor receives a 5-volt reference signal from the Powertrain Control Module (PCM) on circuit 1227. When the fluid temperature is low, the TFT Sensor has a high resistance and the PCM detects a high voltage on circuit 1227. As fluid temperature rises, the TFT Sensor resistance gradually decreases and the PCM senses a lower voltage on circuit 1227.

If the PCM detects no change in the TFT sensor resistance or unrealistic changes in a short amount of time in the TFT sensor resistance (multiple changes within seconds), then DTC P0711 sets. DTC P0711 is a type D DTC. For California emissions vehicles, DTC P0711 is a type B DTC.

Conditions For Setting The DTC

- No DTCs P1117 or P1118.
- No OSS sensor DTC P0502.
- No A/T ISS sensor. DTC P0716 or P0717.
- No A/T Component Slipping DTC P1870.
- The system voltage is 10.0 - 16.0 volts.
- The engine is running greater than 475 rpm for at least 30 seconds.
- The engine coolant temperature (ECT) is greater than 176° F (80° C).
- The TFT is -40 to +70° F (-40 to + 21 ° C) at start up.
- The ECT has changed at least 122° F (50 ° C) since start up.
- The vehicle speed is greater than 3 mph for at least 900 seconds (15 minutes).
- The TCC slip speed is greater than 60 rpm for at least 850 seconds (14 minutes)>
- DTC P0711 sets if all of the above conditions have been met and one of the following conditions exist:
  - Non TFT change: The TFT has not changed more than 4° F (2.25° C), in more than 80 seconds.
  - An unrealistic temperature change: The TFT has changed more than 68°F (20 ° C) 14 times in 7 seconds.

Action Taken When The DTC Sets

- The PCM uses a TFT default value of 280° F (140° C).
- The PCM freezes shift adapts.
- The PCM illuminates the Malfunction Indicator Lamp (MIL).

Conditions For Clearing The MIL/DTC

- For California Emissions only, the PCM turns off the MIL after three consecutive ignition cycles without a failure report.
- The DTC can be cleared using the scan tool. The DTC will be cleared when the vehicle has achieved 40 warm-up cycles without a failure reported.
- The PCM will cancel the DTC default actions when the fault no longer exists and the ignition is OFF long enough to power down the PCM.

Diagnostic Aids

- When diagnosing for a possible intermittent short or open condition, wiggle the wiring harness while observing test equipment for a change.
- If any engine DTCs are present diagnose and clear these DTCs first. Then check to see if the transmission DTCs have reset.

Test Description

- The numbers below refer to the step numbers on the diagnostic chart.

2. This step tests for proper A/T fluid level and condition.
3. This step verifies that the vehicle sets DTC P0711.
5. The 12-volt test lamp is used as a fixed resistance.
6. Perform this step in order to ensure that the PCM monitors circuit 1227.
8. The TFT Sensor is part of the A/T Wiring Harness Assembly

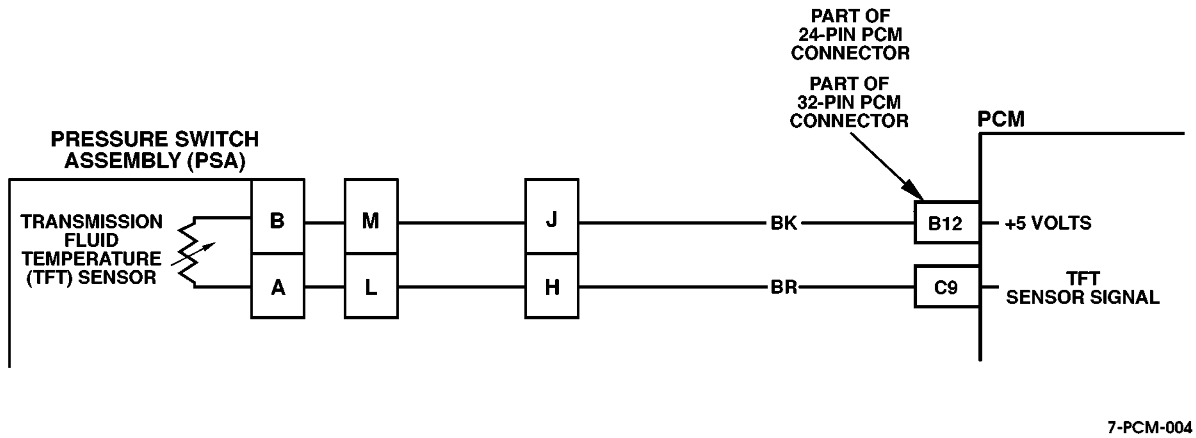
DTC P0711 Transmission Fluid Temperature Sensor Circuit Range/Performance

Step	Action	Value	Yes	No
1	Was the Powertrain ON-Board Diagnostic (OBD) System Check performed?	—	Go to Step 2	Go to Powertrain OBD System Check
2	Perform the A/T Fluid Checking Procedure. Did you perform the fluid checking procedure?	—	Go to Step 3	Go to Transmission Fluid Checking Procedure.
3	1. Install the scan tool (Tech 1). 2. With the engine OFF, turn the ignition switch to the RUN position. **Important**: Before clearing the DTC's, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the stored data. 3. Record the DTC Freeze Frame and Failure Records. 4. Select Trans. Fluid Temp on the scan tool. 5. Drive the vehicle and observe the scan tool for one of the following conditions: • No TFT change • An unrealistic change (The TFT change is greater than 36° F (20° C) 14 times in 7 seconds). Did either of the fail conditions occur?	—	Go to Step 4	Fault not present at this time. Refer to Diagnostic Aids.
4	Did the scan tool display an unrealistic change condition?	—	Go to Step 6	Go to Step 5

DTC P0711 Transmission Fluid Temperature Sensor Circuit Range/Performance

Step	Action	Value	Yes	No
5	1. Turn the ignition switch OFF. 6. Disconnect the transmission 20-way connector. 7. Install a 12 volt test lamp between terminal L and terminal M of the engine side of the transmission 20-way connector. Use the J35616-A Connector Test Adapter Kit (Covered in *Electrical* Section 12) 8. Turn the ignition switch to the RUN position. Does the scan tool Trans. Fluid Temp. display an unrealistic change?	—	Go to Step 7	Go to Step 8
6	1. Record the scan tool TFT display from step 4. 2. Turn the ignition OFF. 3. Disconnect the transmission 20-way connector. 4. Turn the ignition switch to the RUN position. Is the scan tool Trans. Fluid Temp. the same as in step 4?	—	Go to Step 7	Go to Step 8
7	Replace the PCM. Refer to Sßection 2. Is the replacement complete?	—	Go to Step 9	—
8	Replace the A/T Wiring Harness Assembly. Refer to 4L80-E Automatic Transmission ON-Vehicle Service. Is the replacement complete?	—	Go to Step 9	—
9	In order to verify your repair, perform the following procedure: 1. Select DTC. 2. Select Clear Info. 3. Operate the vehicle under the following conditions: • The TFT changes by more than 3° C (5° F) after the engine has been running for 35 seconds. • For a period of at least 11 seconds, the TFT does not change more than 36° F (20° C) within 0.2 seconds. 4. Select Specific DTC. 5. Enter DTC P0711. Has the test run and passed?	—	System OK	Begin the diagnosis again. Go to Step 1.

DTC P0712 Transmission Fluid Temperature (TFT) Sensor Circuit - Low Input (High Temperature Indicated) (Turbo Diesel)



Circuit Description

The transmission fluid temperature (TFT) sensor is a thermister that controls signal voltage to the PCM. The PCM supplies a 5-volt reference signal to the sensor. When the transmission fluid is cold, sensor resistance is high. The PCM detects high signal voltage. As the transmission fluid temperature increases to the normal operating temperature of 100° C (212° F), the sensor resistance becomes less and the voltage decreases to 1.5 to 2 volts.

This DTC detects a continuous short to ground in the temperature signal circuit or the sensor itself.

Conditions For Setting The DTC

- Ignition is “on.”
- TFT sensor indicating a voltage less than 0.3 volts.
- All conditions met for 10 seconds.

Action Taken When The DTC Sets

- Transmission default temperature will be 140° C (275° F).

NOTE: Note: Scan tool will not display default temperature.

- The PCM will illuminate the warning light.

Conditions For Clearing The DTC

- The PCM will turn off the warning light after three consecutive ignition cycles without a failure reported.
- The DTC can be cleared using the scan tool. The DTC will be when the vehicle has achieved 40 warm-up cycles without a failure reported.
- The PCM will cancel the DTC default actions when the fault no longer exists and the ignition is cycled “off” long enough to power down the PCM.

Diagnostic Aids

- With a transmission fluid overtemperature DTC P1812 also set, check the transmission cooling system.
- Check harness routing for a potential short to ground in circuit. Scan tool TFT display should rise steadily to about 100° C (212° F), then stabilize.
- Inspect the wiring for poor electrical connections at the PCM and at the transmission 20-way connector. Look for possible bent, backed out, deformed or damaged terminals. Check for weak terminal tension as well. Also check for a chafed wire that could short to bare metal or other wiring. Inspect for a broken wire inside the insulation.
- When diagnosing for a possible intermittent short or open condition, wriggle the wiring harness while observing test equipment for a change.
- The temperature to resistance value scale may be used to test the sensor at various temperature levels to evaluate the possibility of a “skewed” (mis-scaled) sensor. A “skewed” sensor could result in garage shifts or converter clutch complaints.
- Verify customer driving habits, trailer towing, etc...
- If any engine DTCs or TP Sensor codes are present diagnose and clear these DTCs first. Then check to see if the transmission DTCs have reset.

Test Description

The numbers below refer to the step numbers on the diagnostic chart.

2.This test checks for a short to ground or a “skewed” sen sor.

3.This test checks for an internal fault within the transmission by creating an open.

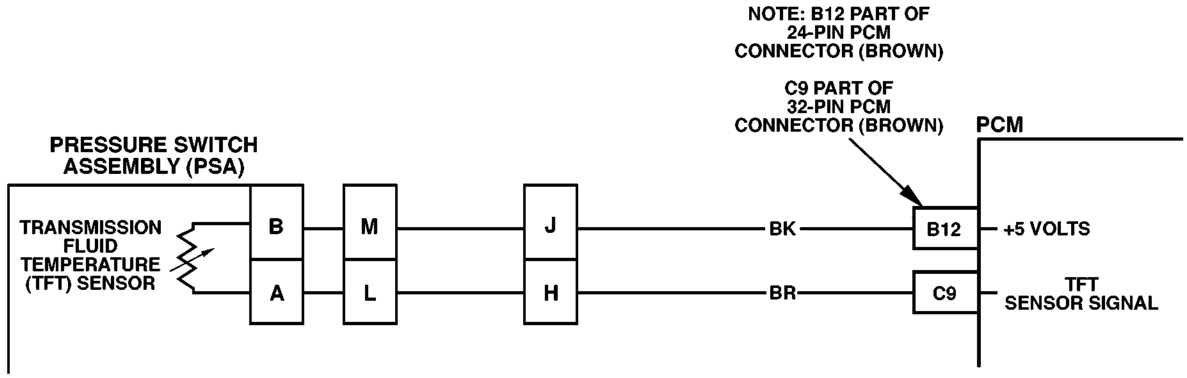
DTC P0712 Fluid Temperature Circuit Low/High (Turbo Diesel)

Step	Action	Value	Yes	No
1	Perform transmission fluid checking procedure. Was the fluid checking Procedure performed?	—	Go to Step 2	—
2	1. Install the scan tool. 2. Turn the ignition switch to "on" position. **Important:** Before clearing DTC(s), use the scan tool to record "Freeze Frame" and "Failure Records" for reference, as data will be lost when the "Clear Info" function is used. 3. Record the DTC "Freeze Frame" and "Failure Records." Does the scan tool display a "TFT Sensor" signal voltage less than shown in the value column?	0.2 volts	Go to Step 3	Refer to Diagnostic Aids
3	1. Turn the ignition "off." 2. Disconnect the transmission 20-way harness connector. 3. Turn the ignition "on." Does the scan tool display a "TFT Sensor" signal voltage greater than shown in the value column?	4.92 volts	Go to Step 4	Go to Step 8
4	1. Install 05743837 Jumper Harness on transmission side of the 20-way connector. 2. Using multimeter and Connector Test Adapter Kit, measure resistance between terminals "L" and "M." Is resistance high?	Check charging system	Refer to Diagnostic Aids	Go to Step 6
5	1. Remove transmission oil pan. 2. Check the internal wiring harness for a short to ground. Was a problem found?	—	Go to Step 7	Go to Step 6
6	1. Disconnect the internal wiring harness. 2. Measure the resistance of TFT sensor. Is the resistance high?	—	Refer to Diagnostic Aids	Go to Step 7
7	Replace the internal wiring harness. Is the replacement complete?	—	Go to Step 11	—
8	Check circuit 359 for short to ground. Was a problem found?	—	Go to Step 11	Go to Step 9
9	Check the TCM/PCM for faulty connections. Was a problem found?	—	Go to Step 11	Go to Step 10
10	Replace the TCM/PCM. Is the replacement complete?	—	Go to Step 11	—

DTC P0712 Fluid Temperature Circuit Low/High (Turbo Diesel)

Step	Action	Value	Yes	No
11	1. After the repair is complete, use the scan tool to select “DTC,” then “Clear Info” function. 2. Select “Specific DTC” and enter DTC “P0712.” 3. Ensure the following conditions are met: • TFT sensor indicates a voltage greater than 0.33 volts for 10 seconds. Has the last test failed?	—	Begin diagnosis again, Go to Step 1	Repair verified, exit DTC table.

DTC P0713 Transmission Fluid Temperature (TFT) Sensor Circuit - High Input (Low Temperature Indicated) (Turbo Diesel)



PCM-017.1

Circuit Description

The transmission fluid temperature (TFT) sensor is a thermister that controls signal voltage to the PCM which supplies a 5-volt reference signal to the sensor on circuit 359. When the transmission fluid is cold sensor resistance is high and the TCM/PCM will sense high signal voltage. As fluid temperature warms to normal operating temperature of 100° C (212° F), sensor resistance increases and the voltage drops to about 1.5 to 2 volts.

This DTC detects a continuous open or short to power in the signal circuit or the sensor.

Conditions For Setting DTC

- TFT sensor indicating a voltage greater than 4.92 volts.
- Ignition is “on.”
- All conditions met for 50.5 seconds.

Action Taken When DTC Sets

- Transmission default temperature will be 140° C (275° F).

NOTE: Scan tool will not display default temperature

- Freeze 1-2 shift adapts from being updated.
- The PCM will illuminate the warning light.

Conditions For Clearing DTC

- The PCM will turn off the warning light after three consecutive ignition cycles without a failure reported.
- The DTC can be cleared from the PCM with the scan tool. The DTC will be cleared when the vehicle has achieved 40 warm-up cycles without a failure reported.
- The PCM will cancel DTC default actions when the fault no longer exists and the ignition is cycled “off” lone enough to power down the PCM.

Diagnostic Aids

- Check harness for a faulty connection or an open in circuit.
- Inspect wiring for poor electrical connections at the PCM and at the transmission 20-way connector. Look for possible bent, backed out, deformed or damaged terminals. Check for weak terminal tension as well. Also check for a chafed wire that could short to bare metal or other wiring. Inspect for a broken wire inside the insulation.
- When diagnosing for a possible intermittent short or open condition, move or massage the wiring harness while observing test equipment for a change.
- Scan tool displays transmission fluid temperature in degrees. After transmission is operating, the temperature should rise steadily to about 100° C (212° E7), then stabilize.
- The temperature to resistance value scale may be used to check the TFT sensor at various temperature levels to evaluate the possibility of a “skewed” (mis-scaled) sensor. A “skewed” sensor can result in harsh shifts or converter clutch complaints.
- If any engine DTCs or TP Sensor codes are present diagnose and clear these DTCs first. Then check to see if the transmission DTCs have reset.

Test Description

The numbers below refer to the step numbers on the diagnostic chart.

2. This check verifies a problem in the TFT sensor circuit.
3. This test simulates a TFT sensor DTC P0712. If the TCM/PCM recognizes the low signal voltage (high temperature), and the scan tool displays 146° C (295° F) or greater, the TCM/PCM and wiring are functioning properly.
4. This test checks the TFT sensor and internal wiring harness.

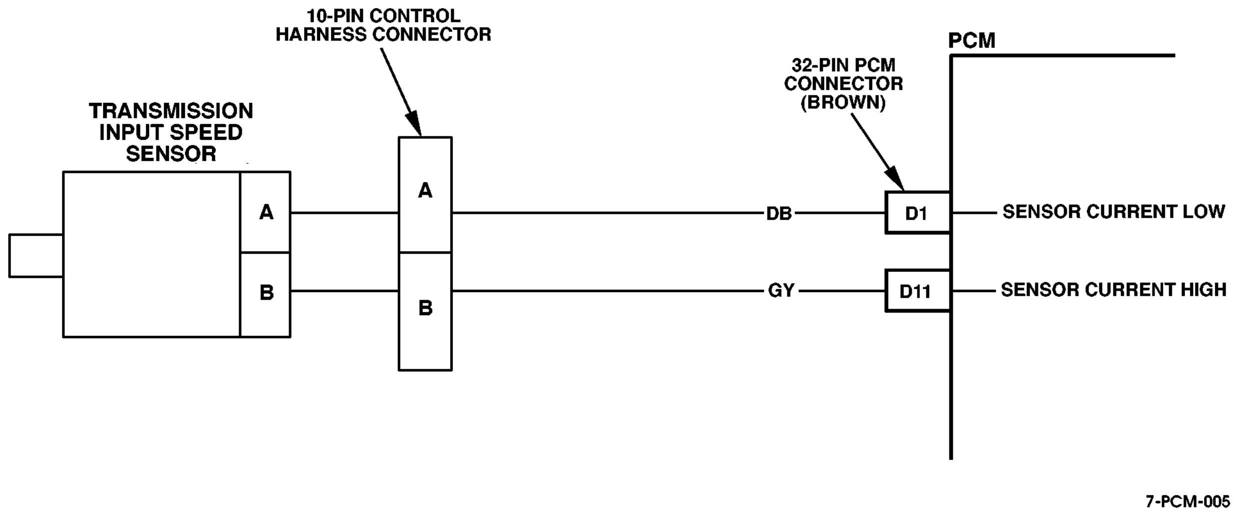
DTC P0713 Fluid Temperature Low (Turbo Diesel)

Step	Action	Value	Yes	No
1	Perform the transmission fluid checking procedure. Was the fluid checking Procedure performed?	—	Go to Step 2	—
2	1. Install the scan tool. 2. With the engine “off,” turn the ignition switch “on.” **Important:** Before clearing DTC(s), use the scan tool to record “Freeze Frame” and “Failure Records” for reference, as data will be lost when the “Clear Info” function is used. 3. Record the DTC “Freeze Frame” and “Failure Records.” Does the scan tool display a “TFT Sensor” signal voltage less than shown in the value column?	4.92 volts	Go to Step 3	Go to Diagnostic Aids
3	1. Turn ignition “off.” 2. Disconnect the transmission 20-way harness connector. 3. Install the J–39775 Jumper Harness on the engine side of the 20-way connector. 4. Install a fused jumper wire from terminal “L” to “M” on the engine harness. 5. Turn the ignition “on.” Does the “TFT Sensor” signal voltage drop to less than indicated in the value column?	0.2 volts	Go to Step 5	Go to Step 9
4	Turn ignition “off.” Install 05743837 Jumper Harness on the transmission side of the 20-way connector. Using the multimeter and Connector Test Adapter Kit, measure the resistance between terminals L and M. Is the resistance high?	—	Refer to Diagnostic Aids	Go to Step 5
5	1. Remove the transmission oil pan. 2. Check the internal wiring harness for an open. Was a problem found?	—	Go to Step 12	Go to Step 6

DTC P0713 Fluid Temperature Low (Turbo Diesel) Cont'd

Step	Action	Value	Yes	No
6	1. Disconnect the internal wiring harness. 2. Measure the resistance of the TFT sensor. Is the resistance high?	—	Refer to Diagnostic Aids	Go to Step 7
7	Replace the internal wiring harness. Is the replacement complete?	—	Go to Step 12	—
8	Check circuit 359 for an open or short to B+. Was a problem found?	—	Go to Step 12	Go to Step 9
9	Check circuit 923 for an open. Was a problem found?	—	Go to Step 12	Go to Step 10
10	Check the PCM for faulty or intermittent connections. Was a problem found?	—	Go to Step 12	Go to Step 11
11	Replace PCM. Is the replacement complete?	—	Go to Step 12	—
12	1. After the repair is complete, use the scan tool to select "DTC," then "Clear Info" function. 2. Select "Specific DTC" and enter DTC "P0713." 3. Ensure the following conditions are met: • TFT sensor indicates a voltage less than 4.92 volts for 50.5 seconds.	—	Go to Step 12	Repair verified, exit DTC table.

DTC P0716 Input Speed Sensor Circuit - Range/Performance (Turbo Diesel)



Circuit Description

The Transmission input speed sensor consists of a permanent magnet surrounded by a coil of wire. Current is induced in the sensor by the forward clutch housing lugs which pass through the sensor magnetic field. Signal voltage and frequency vary directly with forward clutch rotational speed.

This DTC detects uncharacteristic changes in input speed.

Conditions for Setting DTC

- No TP DTC P0122, P0123, P0222, P0223, P0227, or P0228.
- No DTC P0717.
- No DTC P0722 or P0723.
- No shift solenoid DTC P0751, P0753, P0756 or P0758.
- Throttle position is greater than 15%.
- Vehicle speed is greater than 20 MPH.
- Input speed varies by 1000 rpm within 2 seconds.

Action Taken When DTC Sets

- The PCM will command maximum line pressure.
- The PCM will freeze shift adapts.
- The PCM will turn on the warning lamp.

Conditions For Clearing DTC

- The PCM will turn the lamp off after three consecutive ignition cycles without a failure reported.
- The DTC can be cleared from PCM memory using the scan tool. The DTC can also be cleared from memory after 40 warm-up cycles without a failure reported.
- The PCM will cancel the DTC Action Taken items when the fault conditions no longer exist and the ignition is cycled “Off”' long enough to power down the PCM.

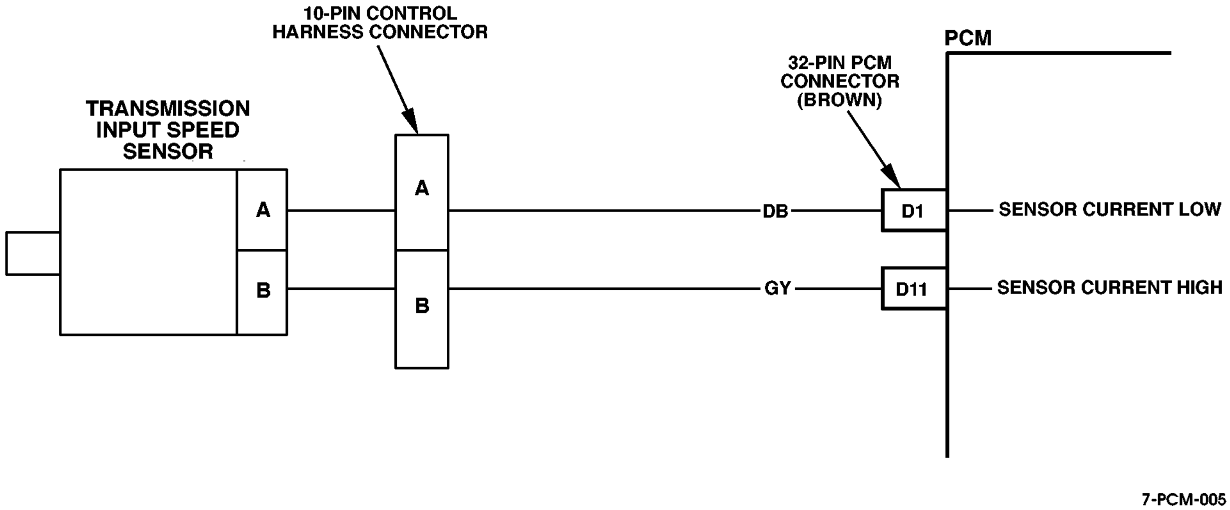
Diagnostic Aids

- Inspect the wiring for poor electrical connections at the PCM and the transaxle 20-way connector. Look for possible bent, backed out, deformed or damaged terminals. Check for weak terminal tension was well. Also, check for chafed wire that could short to bear metal or other wiring. Inspect for broken wire inside the insulation.
- When diagnosing for a possible intermittent short or open condition, move or massage the wiring harness while observing test equipment for a change.
- If any engine DTCs or TPS codes are present diagnose and clear these DTC(s) first. Then check to see if the transmission DTC(s) have reset.

DTC P0716 Input Speed Sensor Range/Performance (Turbo Diesel)

Step	Action	Value	Yes	No
1	1. Connect scan tool. **NOTE: Important:** Before clearing DTC(s) use the scan tool to record “Freeze Frame” and “Failure Records” for reference, as data will be lost when the “Clear Info” function is used. 2. Turn ignition “on”. 3. Record and clear the DTC Freeze-Frame/Failure Records and the DTCs.	—	Go to Step 2	—
2	1. Start engine, transmission in park. 2. Disconnect wiring harness at the Input Speed Sensor. 3. Connect multimeter set on AC Voltage across terminals of input speed sensor. Does the meter indicate voltage above value?	Above.5 volts	Go to Step 3	Go to Step 10
3	Check circuit 495 for an open. Was problem found?	—	Go to Step 7	Go to Step 4
4	Check sensor harness for open. Was problem found?	—	Go to Step 8	Go to Step 5
5	1. Probe across terminals J 1 -D 11 and J 1 -D 1 at PCM connector J1 with multimeter set on AC voltage. 2. Start engine, transmission in park. Does the meter indicate voltage above value?	Above.5 volts	Go to Step 6	Problem intermittent. Refer to Diagnostic aids.
6	Check PCM for faulty or intermittent connections. Was the problem found?	—	Go to Step 8	Go to Step 7
7	Repair open in circuit 495 as needed. Was the problem corrected?	—	Go to Step 13	—
8	Repair the faulty connections at the PCM. Was the problem corrected?	—	Go to Step 12	—
9	Replace the input speed sensor.	—	Go to Step 11	—
10	Replace PCM.	—	Go to Step 11	—
11	1. After repair is complete, select scan tool “Clear Info” function and operate the vehicle under the following conditions: • Vehicle “drive” range and engine running. • PCM must see an input speed change of less than 1000 rpm for 1 second. 2. Review the scan tool “Specific DTC” and enter “0716.”	—	—	Repair verified, exit DTC table.

DTC P0717 Input Speed Sensor Circuit - No Signal (Turbo Diesel)



Circuit Description

The transmission input speed sensor consists of a permanent magnet surrounded by a coil of wire. An AC voltage is induced in the sensor by lugs on the rotating forward clutch. Signal voltage and frequency vary directly with forward clutch rotational speed.

This DTC detects a low Input Speed when the vehicle has high vehicle and engine speeds.

Conditions For Setting DTC

- No DTC P0722 or P0723.
- No switch assembly DTC P1810.
- Vehicle speed is greater than 20 MPH.
- Engine running for greater than 7 seconds.
- Transmission not in Park or Neutral.
- Input speed is less than 200 RPM for at least 2 second.

Action Taken When DTC Sets

- The PCM will default the transmission to maximum line pressure.
- The PCM will freeze shift adapts.
- The PCM will turn on the warning lamp.

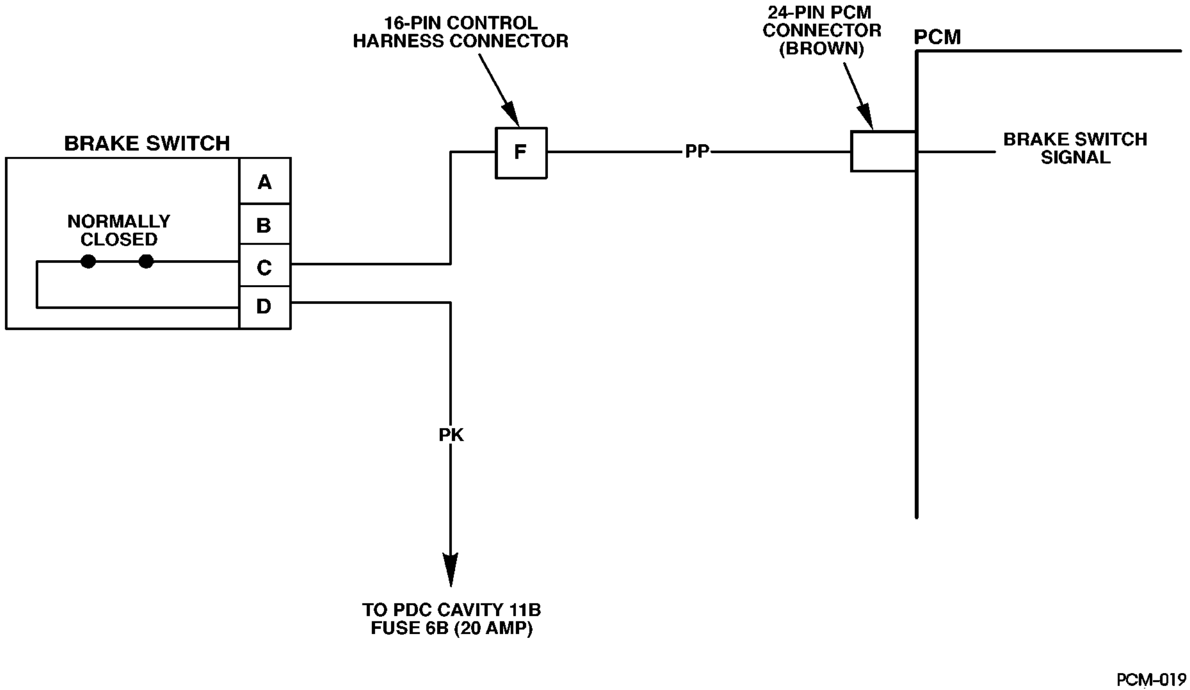
Conditions For Clearing DTC

- The PCM will turn the lamp off after three consecutive ignition cycles without a failure reported.
- The DTC can be cleared using the scan tool. The DTC will be cleared from history when the vehicle has achieved 40 warm-up cycles without reported failure.
- PCM will cancel DTC default actions when the fault no longer exists and ignition is cycled “Off” long enough to power down the PCM.

Diagnostic Aids

- Inspect wiring for poor electrical connections at the PCM and the 20-way connector Look for possible bent, backed out, deformed or damaged terminals. Also, check for chafed wire that could short to bare metal or other wiring. Inspect for broken wire inside the insulation.
- When diagnosing a possible intermittent short or open condition, move wiring while observing test equipment for a reading change.
- If any engine DTC(s) or TP Sensor codes are present diagnose and clear these DTC(s) first. Then check for transmission DTC(s) have reset.
- If any engine DTCs or TPS codes are present diagnose and clear these first. Then check to see if the transmission DTC(s) have reset.

DTC P0719 Brake Switch Circuit - Low Input, Stuck "ON" (Turbo Diesel)



Circuit Description

The brake switch indicates brake pedal position. The normally-closed brake switch supplies a B+ signal on circuit 810 to the PCM. The signal voltage circuit is opened when the brakes are applied. The PCM uses this signal to deenergize the converter clutch solenoid when the brakes are applied.

This DTC detects an open brake switch during acceleration.

Conditions For Setting The DTC

- No DTC P0502.
- The PCM detects an open brake switch/circuit (0 volts) for 15 minutes without going off for 2 seconds, and the following events occur seven consecutive times: vehicle speed is less than 8 km/h (5 mph); then vehicle speed is between 8 and 32 km/h (5 and 20 mph) for 4 seconds; then vehicle speed is greater than 32 km/h (20 mph) for 6 seconds.

Action Taken When The DTC Sets

- The PCM will NOT illuminate the warning lamp.
- PCM will disregard the brake switch state if TP is more than 12% and vehicle speed is greater than 40 mph.

Conditions For Clearing DTC

- The PCM will turn off the warning lamp after three consecutive ignition cycles without a failure reported.
- The DTC can be cleared from PCM memory by using a scan tool. It will be cleared when the vehicle has achieved 40 warm-up cycles without a failure reported.
- The PCM will cancel the DTC default actions when the fault no longer exists and the ignition is cycled off long enough to power down the PCM.

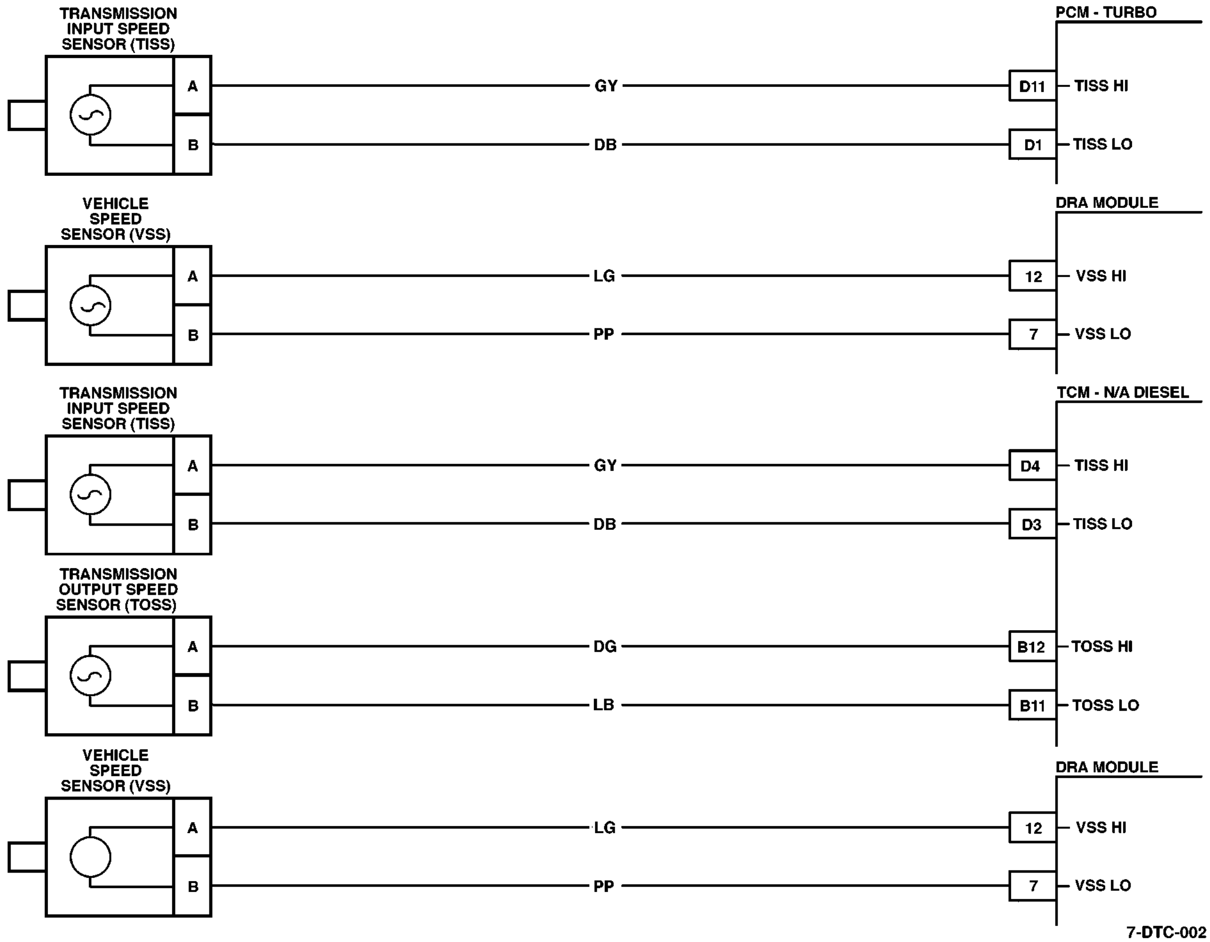
Diagnostic Aids

- Inspect the wiring for poor electrical connections at the PCM and brake switch. Look for damaged terminals,check for weak terminal tension, inspect for broken wire.
- When diagnosing for a possible intermittent short or open condition, move or massage the wiring harness while observing test equipment for a change.
- Check customer driving habits and/or unusual driving conditions (i.e. stop and go, expressway).
- Check brake switch for proper mounting and adjustment.
- Check for most current calibration I.D. and/or latest bulletins.
- If any engine DTCs or TPS codes are present diagnose and clear these first. Then check to see if the transmission DTCs have reset.

DTC P0719 Brake Switch Circuit - Low Input (Turbo Diesel)

Step	Action	Value	Yes	No
1	1. Connect scan tool. 2. Turn the ignition switch “on.” 3. Record “Freeze Frame” and “Failure Records.' 4. Select “Brake Switch” on scan tool. 5. Disconnect brake switch connector from brake switch. 6. Install a fused jumper from terminal “C” to terminal “D” of brake switch connector. Did brake switch status change from “Open” to ”Closed?'	—	Go to Step 5	Go to Step 3
2	Remove and inspect brake fuse for an open. Was the fuse open?	—	Go to Step 4	Go to Step 6
3	Inspect switch wires for a short to ground. Was a problem found and corrected?	—	Go to Step 8	—
4	Replace the brake switch.	—	Go to Step 8	—
5	Inspect switch-to-PCM circuit for open. Is the repair complete?	—	Go to Step 8	Go to Step 7
6	Replace PCM.	—	Go to Step 8	—
7	1. After repair is complete, use scan tool to select “DTC,” then “Clear Info” function. 2. Select “Specific DTC” and enter DTC “P0719.” 3. Ensure the following conditions are met: • Engine running. Select Brake Switch” on scan tool. Depress the brake to ensure the states change with the pedal at rest and depressed. Has the last test failed?	—	Begin diagnosis again, Go to Step 1	Repair verified, exit DTC table.

DTC P0722 Output Speed Sensor Low Input



Circuit Description

The speed sensor circuit consists of a magnetic induction type sensor, which is the Output Shaft Speed (OSS) Sensor, a Vehicle Speed Sensor (VSS) Buffer Module, and wiring. Gear teeth pressed onto the output shaft carrier assembly induce an alternating voltage into the sensor. This signal transmits to the VSS Buffer Module. The VSS Buffer Module compensates for various final drive ratios. The VSS Buffer Module also converts the AC OSS Sensor signal into a 40 pulse per revolution (PPR) DC 5 volt square wave form signal on circuit 437 to indicate transmission output speed.

When the Powertrain Control Module (PCM) detects a low output speed when the vehicle has a high engine speed in a drive gear range, then DTC P0722 sets. DTC P0722 is a type B DTC.

Conditions for Setting the DTC

- No TFP Val. Position Sw. DTC P1810.
- The APP Angle is greater than 12%.
- The engine torque must be 80-450 lb ft. (100-565 N•m).
- The engine speed must be 2000-3800 RPM.
- The A/T ISS Sensor speed is greater than 2000 RPM.
- The transmission is not in Park or Neutral.
- The engine vacuum is 0-105 kPa.
- The OSS Sensor speed is less than 200 RPM for at least 3 seconds.

Action Taken When the DTC Sets

- The PCM Defaults to maximum line pressure.
- The PCM freezes shift adapts.
- The PCM defaults to the calculated output speed value using the Input Shaft Speed sensor values.

Conditions for Clearing the DTC

1. The PCM turns OFF the MIL after three consecutive ignition cycles without a failure reported.
2. A scan tool can clear the DTC from the PCM history. The PCM clears the DTC from the PCM history if the vehicle completes 40 warm-up cycles without a failure reported.

3. The PCM cancels the DTC default actions when the fault no longer exists and the ignition is OFF long enough in order to power down the PCM.

Diagnostic Aids

- Inspect the wiring for poor electrical connections at the PCM. Inspect the wiring for poor electrical connections at the transmission 20-way connector. Look for the following problems:
  - A bent terminal
  - A backed out terminal
  - A damaged Terminal
  - Poor terminal tension
  - A chafed wire
  - A broken wire inside the insulation
- When diagnosing for an intermittent short or open, massage the wiring harness while watching the test equipment for a change. It may be necessary to drive the vehicle.
- Inspect the Speed Sensor wiring for contact with sharp metal edges.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

2. This step verifies the fault condition.
3. This step tests OSS Sensor integrity.
9. This step verifies power and ground to the VSS Buffer Module.
15. This step verifies the PCM input controlled by the Speed Buffer.

DTC P0722 Output Speed Sensor Low Input

Step	Action	Value	Yes	No
1	Was the Powertrain On-Board Diagnostic (OBD) System Check Performed	—	Go to Step 2	Go to *Powertrain OBD System Check*
2	1. Install the scan tool (Tech 1) 2. With the engine OFF, turn the ignition switch to the RUN position. **Important**: Before clearing the DTCs, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. 3. Record the DTC Freeze Frame and Failure Records and DTCs. 4. Raise the drive wheels and support the axle assembly. 5. Start the engine and place the transmission in Drive 3 range. 6. Gradually increase the wheel speed. Does the Transmission OSS increase with the drive wheel speed?	—	Cannot verify faulty. Exit DTC table and go to *Diagnostic Aids*	Go to Step 3
3	1. Turn the ignition OFF. 2. Disconnect the OSS Sensor connector from the OSS Sensor. 3. Connect a J39200 DVOM on AC Voltage scale between terminals A and B at the OSS Sensor. 4. Start the engine, and place the transmission in D3 range. 5. Slowly increase the wheel speed. Is the voltage greater than the specified value?	Greater than 0.5 volts at above 10 mph.	Go to Step 4	Go to Step 18

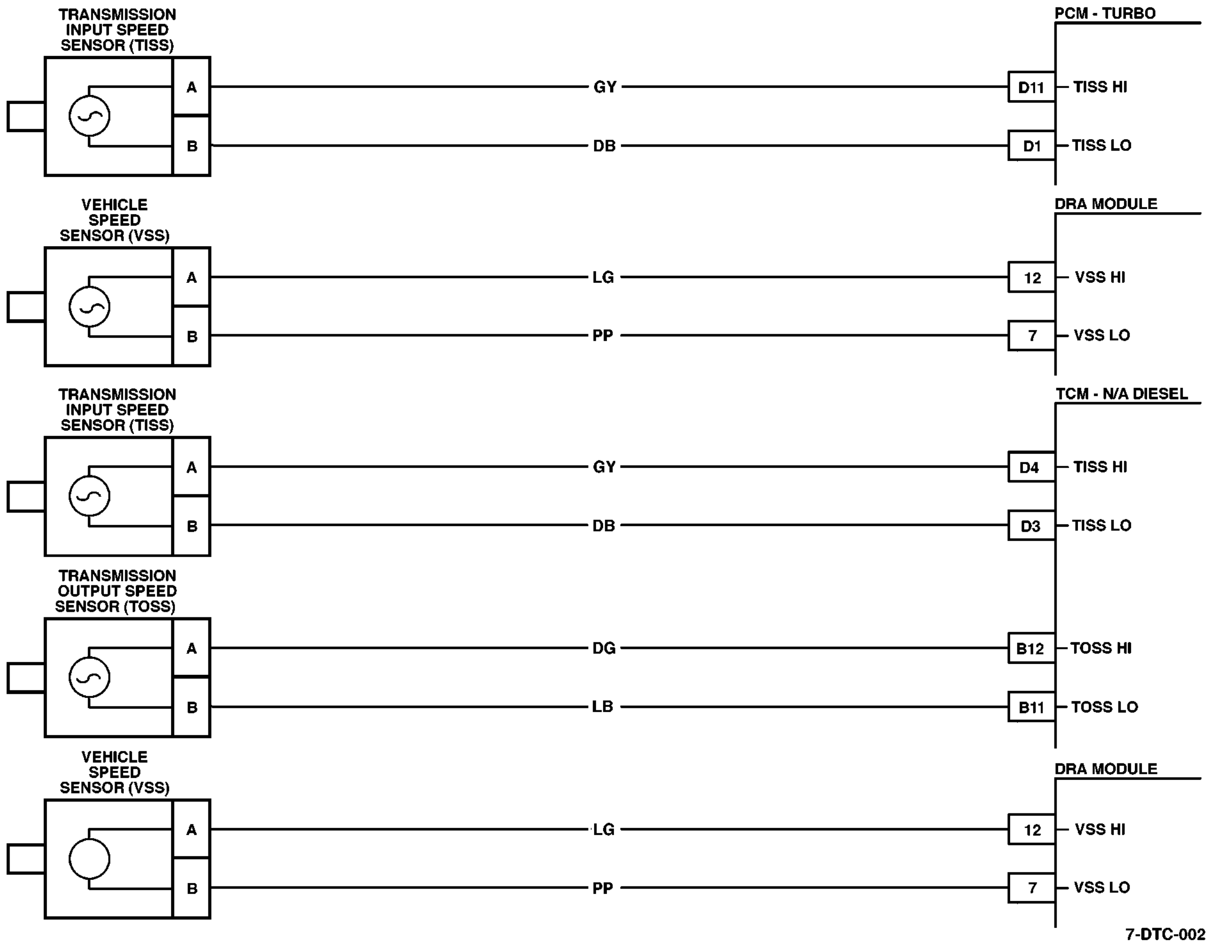
DTC P0560 System Voltage Fault (Turbo Diesel)

Step	Action	Value	Yes	No
4	1. Reconnect the OSS Sensor connector to the OSS Sensor. 2. Disconnect the VSS Buffer harness from the VSS Buffer. 3. Measure the voltage between terminals 7 and 12 of the Buffer Harness Connector. Use the J39200 DVOM. 4. Start the engine, and place the transmission in D3. 5. With the wheels turning, slowly accelerate to 2000 RPM. Is the voltage greater than the specified value?	0.5 volts AC	Go to Step 7	Go to Step 5
5	Inspect circuits 821 and 822 for an open. Refer to Electrical Diagnosis, Section 8. Did you find a problem?	—	Go to Step 16	Go to Step 6
6	Inspect circuits 821 and 822 for a short together or a short to ground. Refer to Electrical Diagnosis, Section 8. Did you find a problem?	—	Go to Step 16	—
7	1. Turn the ignition to the OFF position. 2. Measure the voltage between terminal 9 of the VSS Buffer connector, and a good ground with the J39200 DVOM on DC volts. 3. Turn the ignition ON. Is the voltage greater than the specified valve?	10.5 volts DC	Go to Step 9	Go to Step 8
8	Inspect the ignition feed circuit 39 for an open. Did you find a problem?	—	Go to Step 21	—
9	With the key to the ON position, measure the voltage between terminals 8 and 9 of the VSS Buffer connector. Is the voltage greater than the specified valve?	10.5 volts DC	Go to Step 11	Go to Step 10
10	Inspect the VSS Buffer Module ground circuit 451 for an open. Was the problem found and corrected?	—	Go to Step 21	—
11	With the connector off of the VSS Buffer Module and the key to the ON position, measure the voltage between terminal 13 of the VSS Buffer Harness Connector and a good ground. Is the voltage within the specified value?	4.8-5.2 volts DC	Go to Step 15	Go to Step 12
12	Is the voltage in Step 12 greater than the specified value?	5.2 volts DC	Go to Step 14	Go to Step 13
13	Inspect circuit 437 for an open or short to ground. Did you find a problem?	—	Go to Step 21	Go to Step 17
14	Inspect circuit 437 for a short to power. Did you find a problem?	—	Go to Step 21	Go to Step 17

DTC P0560 System Voltage Fault (Turbo Diesel)

Step	Action	Value	Yes	No
15	1. Reconnect the VSS Buffer Harness connector to the VSS Buffer Module. 2. With the DVOM set on DC volts and on a good ground, back probe terminal 13 of the VSS Buffer Module. 3. Start the engine, and place the transmission in D3. 4. With the wheels turning, slowly accelerate the engine to 2000 RPM. Is the voltage within the specified values?	1.5-3.5 volts DC	Go to Step 17	Go to Step 19
16	Repair circuits 821 and 822. Refer to Repair Procedures, Section 8. Did you correct the problem?	—	Go to Step 21	—
17	Inspect the PCM for faulty or intermittent connections. Did you find a problem?	—	Go to Step 21	Go to Step 20
18	Replace the OSS Sensor. Is the replacement complete?	—	Go to Step 21	—
19	Replace the VSS Buffer Module. Is the replacement complete?	—	Go to Step 21	—
20	Replace the PCM. Is the replacement complete?	—	Go to Step 21	—
21	In order to verify your repair, perform the following procedure: 1. Select DTC. 2. Select Clear Info. 3. Operate the vehicle under the following conditions: • Drive the vehicle under steady acceleration. • The PCM must see an output speed of greater than 500 RPM for 1 second. 4. Select Specific DTC. Enter DTC P0722. Has the test run and passed?	—	System OK	Begin the Diagnosis again. Go to Step 1

DTC P0723 Output Speed Sensor Intermittent



Circuit Description

The speed sensor circuit consists of a magnetic induction type sensor, which is the Output Shaft Speed (OSS) Sensor, a Vehicle Speed Sensor (VSS) Buffer Module, and wiring. Gear teeth pressed onto the output shaft carrier assembly induce an alternating voltage into the sensor. This signal transmits to the VSS Buffer Module. The VSS Buffer Module compensates for various final drive ratios. The VSS Buffer Module also converts the alternating current (AC) OSS signal into a 40 pulse per revolution (PPR) 5 volt DC square wave form signal on circuit 437 to indicate transmission output speed.

If the PCM detects an unrealistically large change in the Output Shaft Speed (OSS) Sensor reading, then DTC P0723 sets. DTC P0723 is a type A DTC.

Conditions for Setting the DTC

- No 4WD Low DTC P1875.
- No TFP Val. Position Sw. assembly change for greater than 7 seconds.
- The engine must be running more than 475 RPM for at least 7 second.
- The OSS RPM decrease is greater than 1000 RPM while in a Drive gear for at least 4 seconds.
- The PCM sets the Malfunction Indicator Lamp (MIL).

Action Taken When the DTC Sets

- The PCM defaults to maximum line pressure.
- The PCM freezes shift adapts.
- The PCM defaults to the calculated output speed value using the ISS Sensor values.

Conditions for Clearing the DTC

1. The PCM tuns OFF the MIL after three consecutive ignition cycles without a failure reported.
2. A scan tool can clear the DTC from the PCM history. The PCM clears the DTC from the PCM history if the vehicle completes 40 warm-up cycles without a failure reported.

3. The PCM cancels the DTC default actions when the fault no longer exists and the ignition is OFF long enough in order to power down the PCM.

Diagnostic Aids

- Inspect the wiring for poor electrical connections at the PCM. Inspect the wiring for poor electrical connections at the transmission 20-way connector. Look for the following problems:
  - A bent terminal
  - A backed out terminal
  - A damaged terminal
  - Poor terminal tension
  - A chafed wire
  - A broken wire inside the insulation
- It may be necessary to drive the vehicle.
- When diagnosing for an intermittent short or open, massage the wiring harness while watching the test equipment for a change.

Test Description

The numbers below refer to the numbers on the diagnostic table.

2. This step verifies the fault condition.
4. This step verifies the OSS Sensor and circuit output to the VSS Buffer Module.
7. This step tests the voltage supply to the VSS Buffer Module.
9. This step tests the integrity of the ground circuit.

DTC P0723 Output Speed Sensor Intermittent

Step	Action	Value	Yes	No
1	Was the Powertrain On-Board Diagnostic (OBD) System Check Performed?	—	Go to Step 2	Go to *Powertrain OBD System Check*
2	1. Install the scan tool (Tech 1). 2. With the engine OFF, turn the ignition switch to the RUN position. **Important**: Before clearing the DTCs, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. 3. Record the DTC Freeze Frame and Failure Records and DTCs. 4. Raise and support the drive wheels. 5. Start the engine and place the transmission in D3 range. 6. With the Drive wheels rotating, slowly accelerate to 2000 RPM and hold. Does the Transmission OSS drop or fluctuate more than the specified value?	1000 RPM	Go to Step 3	No fault verified at this time. Go to *Diagnostic Aids*
3	1. Turn the ignition OFF. 2. Disconnect the OSS Sensor connector from the OSS Sensor. 3. Connect a J39200 DVOM (covered in *Electrical* Section 12) on AC Voltage scale between terminals A and B at the OSS Sensor. 4. Turn the ignition to the RUN position, and start the engine. 5. Place the transmission in D3 range. 6. With the wheels rotating, slowly accelerate to 2000 engine RPM and hold. Does the voltage drop or fluctuate at 2000 RPM?	—	Go to Step 17	Go to Step 4

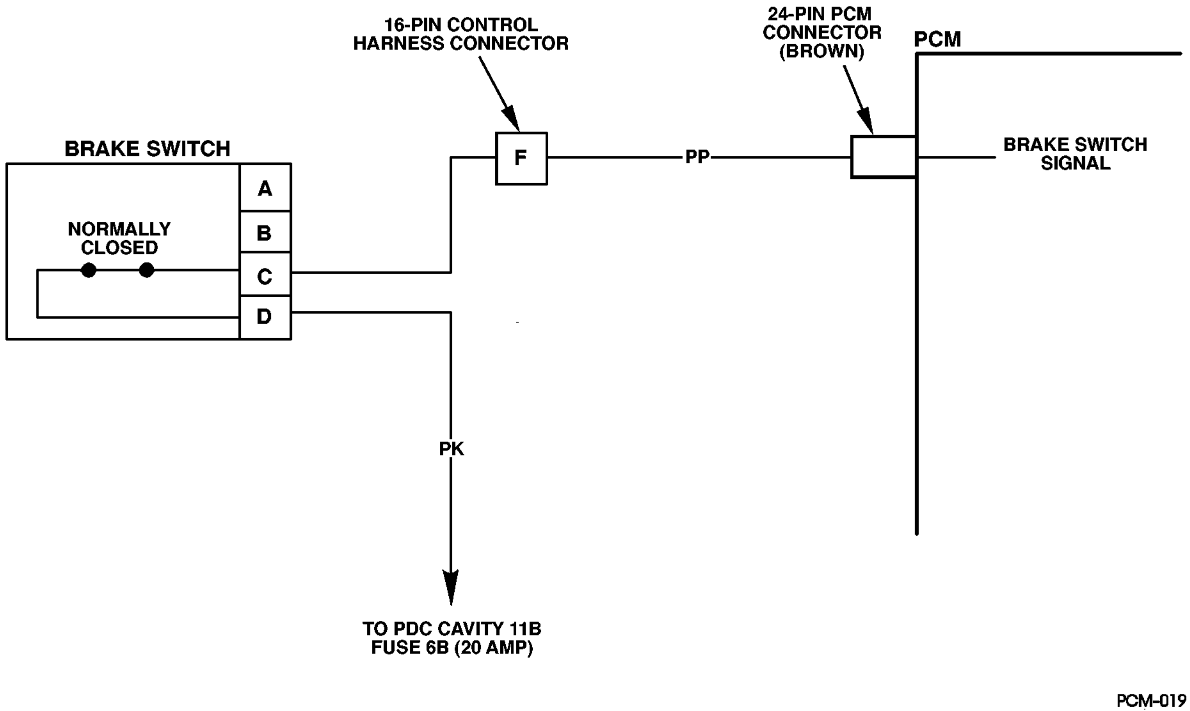
DTC P0723 Output Speed Sensor Intermittentl)

Step	Action	Value	Yes	No
4	1. Turn the ignition OFF. 2. Reconnect the OSS sensor harness to the sensor. 3. Disconnect the VSS Buffer Module harness connector from the component. 4. Turn the ignition ON and turn the engine OFF. 5. Set the J39200 DVOM on AC volts. 6. Connect the J39200 DVOM between terminals 7 and 12 of the VSS Buffer Module harness connector. 7. Start the engine. 8. Place the transmission in D3 range. 9. With the wheels rotating, slowly accelerate to 2000 engine RPM and hold steady. Does the voltage drop or fluctuate at 2000 RPM?	Above 0.5 volts AC	Go to Step 5	Go to Step 7
5	Inspect circuit 821 and circuit 822 for an intermittent Did you find a problem?	—	Go to Step 12	Go to Step 6
6	Inspect circuit 821 and circuit 822 for an intermittent short together or a short to ground. Did you find a problem?	—	Go to Step 12	—
7	With the engine OFF, turn the ignition switch ON. Select DC volts, and inspect for ignition voltage at terminal 9 of the VSS Buffer Module harness. Is the voltage greater than the specified value?	10.5 volts DC	Go to Step 9	Go to Step 8
8	Repair the intermittent open or high resistance in circuit 39. Is the repair complete?	—	Go to Step 21	—
9	1. Connect the J39200 DVOM between terminals 8 and 9 of the VSS Buffer Module harness connector. Set the DVOM on DC volts. 2. Turn the ignition to the Run position. Is the voltage greater than the specified value?	10.5 volts DC	Go to Step 11	Go to Step 10
10	Repair the open or high resistance in circuit 451. Is the repair complete?	—	Go to Step 21	—
11	1. With the engine OFF, turn the ignition to the RUN position. 2. Using the J39200 DVOM, measure the voltage at the VSS Buffer Harness connector terminal 13. Is the voltage steady and within the specified voltage?	4.8-5.2 volts DC	Go to Step 13	Go to Step 14
12	Repair the short in circuit 821 and circuit 822. Refer to Electrical Diagnosis, Section 8. Did you correct the problem?	—	Go to Step 21	—

DTC P0723 Output Speed Sensor Intermittent

Step	Action	Value	Yes	No
13	1. Turn the ignition to the OFF position. 2. Reconnect the VSS Buffer Module harness to the VSS Buffer Module. 3. Set the J39200 DVOM on the DC volts scale. 4. Back probe terminal 13 of the VSS Buffer Harness connector with the J39200 DVOM. 5. Start the engine. 6. Place the transmission in a D3 range. 7. With the wheels rotating, slowly accelerate the engine to 2000 RPM and hold. Is the voltage reading steady within the specified value?	1.5-3.5 volts DC	Go to Step 19	Go to Step 18
14	Is the voltage from step 11 greater than the specified value?	5.2 volts DC	Go to Step 15	Go to Step 16
15	Inspect for a short to power in circuit 437. Did you find a problem?	—	Go to Step 21	Go to Step 20
16	Inspect circuit 437 for continuity or short to ground. Refer to Electrical Diagnosis, Section 8. Did you find a problem?	—	Go to Step 21	Go to Step 19
17	Replace the OSS Sensor. Refer to 4L80-E On-Vehicle Service Speed Sensor Replacement. Is the replacement complete?	—	Go to Step 21	—
18	Replace the VSS Buffer Module. Is the replacement complete?	—	Go to Step 21	—
19	Inspect the PCM terminals and connector for proper tension or corrosion. Did you find a problem?	—	Go to Step 21	Go to Step 20
20	Replace the PCM. Refer to *PCM Replacement/Programming*, Section 6. Is the replacement complete?	—	Go to Step 19	—
21	In order to verify your repair, perform the following procedure: 1. Select DTC. 2. Select Clear Info. 3. Operate the vehicle under the following conditions: • Drive the vehicle in D3. • The PCM must see a Transmission OSS greater than 200 RPM and no change greater than 1000 RPM for 1 second. 4. Select Specific DTC. Enter DTC P0723. Has the test run and passed?	—	System OK	Begin the Diagnosis again. Go to Step 1

DTC P0724 Brake Switch Circuit High Input (Turbo Diesel)



Circuit Description

The brake switch indicates brake pedal position. The normally-closed brake switch supplies a B+ signal on circuit 810 to the PCM. The signal voltage circuit is opened when the brakes are applied. The PCM uses this signal to deenergize the converter clutch solenoid when the brakes are applied.

This DTC detects a closed brake switch during decelerations.

Conditions For Setting DTC

- No DTC P0722, P0723.
- The PCM detects a closed brake switch/circuit (12 volts) for 2 seconds during decelerations and the following events occur seven consecutive times: vehicle speed is greater than 32 km/h (20 mph) for 6 seconds; then vehicle speed is between 8 and 32 km/h (5 and 20 mph) for 4 seconds; then vehicle speed is less than 8 km/h (5 mph).
- All conditions exist with 7 occurrences.

Action Taken When The DTC Sets

- PCM disregards the brake switch state if TPS is greater than 12% and vehicle speed is greater than 45 mph.
- The PCM will NOT illuminate the warning lamp.

Conditions For Clearing The DTC

- The DTC can be cleared using a scan tool. The DTC will be cleared when the vehicle has achieved 40 warm-up cycles without a failure reported.
- The PCM will cancel the DTC default actions when the fault no longer exists and the ignition is cycled “off” long enough to power down the PCM.

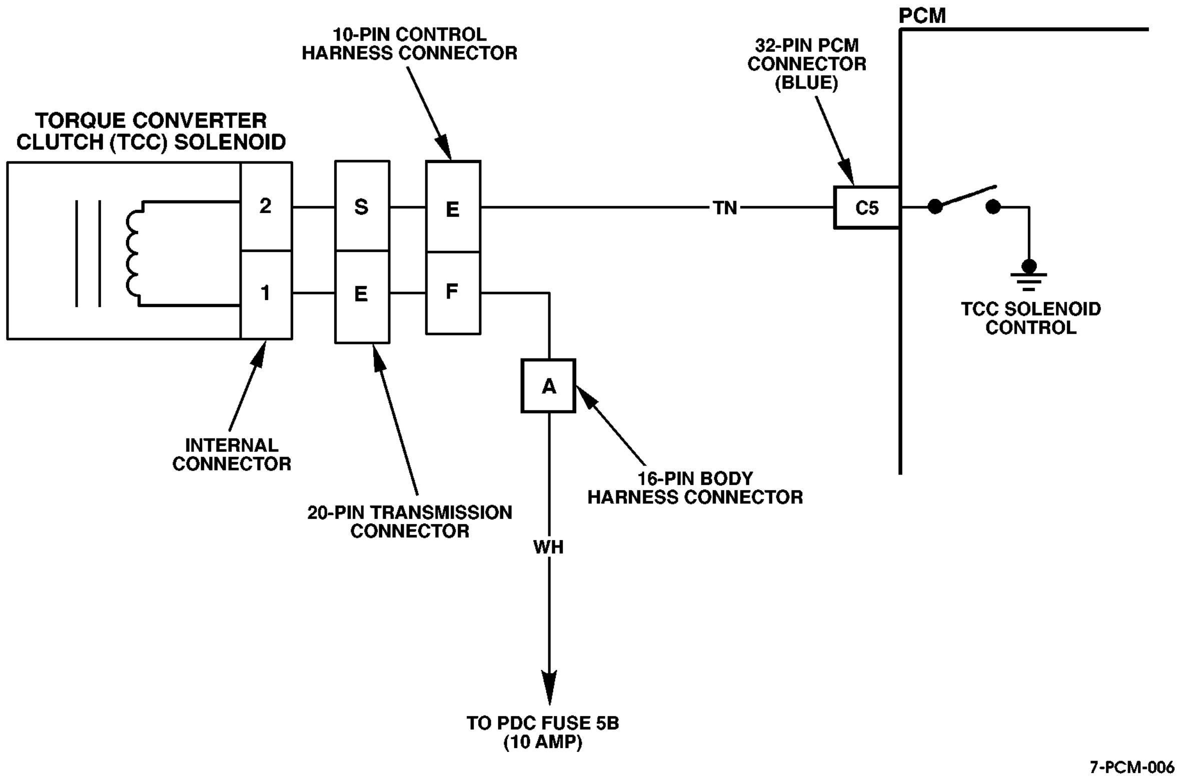
Diagnostic Aids

- Inspect the wiring for poor electrical connections at the PCM and brake switch. Look for bent, backed out, deformed or damaged terminals. Check for weak terminal tension as well. Also check for a chafed wire that could short to bare metal or other wiring. Inspect for a broken wire inside the insulation.
- When diagnosing for a possible intermittent short or open condition, move the wiring harness while observing test equipment for a change.
- Check customer driving habits and/or unusual traffic conditions (i.e. stop and go, expressway).
- Check brake switch for proper mounting and adjustment.
- If any engine DTCs or TPS codes are present diagnose and clear these DTCs first. Then check to see if the transmission DTCs have reset.

DTC P0724 Brake Switch Circuit High Input (Turbo Diesel)

Step	Action	Value	Yes	No
1	1. Install scan tool. 2. Turn ignition switch "on." **NOTE: Important:** Before clearing DTC(s), use the scan tool to record "Failure Records" for reference, as data will be lost when the "Clear Info" function is used. 3. Record the DTC "Failure Records." 4. Select "Brake Switch" on the scan tool. 5. Disconnect the brake switch connector from he brake switch. Did the brake switch status change from "Closed" to "Open?"	—	Go to Step 2	Go to Step 3
2	Replace brake switch.	—	Go to Step 5	—
3	Check switch wires circuit for short to B+. Was a problem found?	—	Go to Step 5	Go to Step 4
4	Replace the PCM. Is the replacement complete?	—	Go to Step 5	—
5	1. After the repair is complete, use the scan tool to select DTC," then "Clear Info" function. 2. Select "Specific DTC" and enter DTC "P0724." 3. Ensure the following conditions are met: • Select "Brake Switch" on scan tool, depress brake pedal. Switch state should change as pedal is depressed.	—	—	—

DTC P0741 Torque Converter Clutch Solenoid Stuck OFF (Turbo Diesel)



Circuit Description

The PCM energizes the converter clutch solenoid by creating a ground path on CKT 924. When grounded (energized) by the PCM, enable solenoid stops converter signal oil from exhausting. This causes converter signal oil pressure to increase and shift the valve. The solenoid will de-energize when the PCM no longer provides a ground path. When the solenoid is de-energized, it will exhaust fluid and release the TCC.This DTC detects high torque converter slip when the clutch is engaged.

Conditions For Setting DTC

- No DTCs P0121, P0122, P0220, P0221, P0222, P0223, P0225, P0226, P0227, or P0228.
- No DTC P0722, P0723.
- No DTCs P0716 or P0717.
- No DTCs P0742 or P1860.
- No DTC P1810.
- No DTC P1860.
- Converter clutch commanded on in 2nd or 3rd for more than 0.6 seconds.
- Engine running for at least 5 seconds.
- Converter clutch applied for more than 0.6 seconds.
- Transmission in 2nd or 3rd.
- Throttle Position greater than 20%.
- Pressure switch in D4, D3, or D2.
- Transmission fluid temperature between -10° C (14° F) and 150° C (302° F).
- Converter clutch slip speed is greater than 65 rpm for 4 seconds.
- All conditions must be met for a total of 2 occurrences.

Action Taken When DTC Sets

- PCM will inhibit converter clutch apply.
- PCM will inhibit 4th gear upshift.
- The PCM will illuminate the warning lamp.

Conditions For Clearing DTC

- The PCM will turn the warning light after three consecutive ignition cycles without a failure reported. The DTC can be cleared using the scan tool. The DTC will clear when the vehicle has achieved 40 warm-up cycles without a failure reported. The PCM will cancel the DTC default actions when the fault no longer exists and the ignition is cycled long enough to power down the PCM.

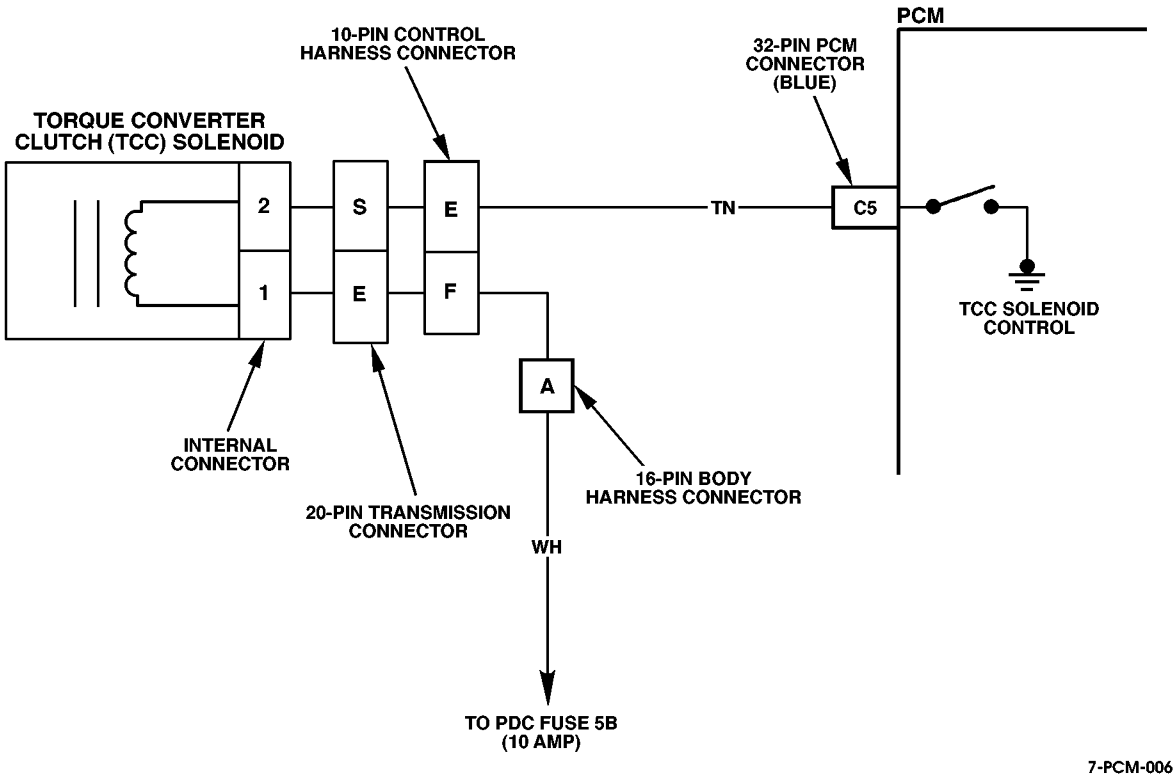
Diagnostic Aids

- Inspect the wiring for poor electrical at the PCM and the transmission 20-way connector. Look for possible bent, backed out, deformed or damaged terminals. Check for weak terminal tension as well. Also, check for chafed wire that could short to bare metal or other wiring Inspect for broken wire inside the insulation.
- If any engine DTCs or TP Sensor codes are present diagnose and clear these DTCs first. Then check to see if the transmission DTCs have reset.

DTC P0741 Torque Converter Clutch Solenoid Stuck Off (Turbo Diesel)

Step	Action	Value	Yes	No
1	1. Install the scan tool. **NOTE: Important:** Before clearing DTC(s) use the scan tool to record “Freeze Frame and “Failure Records” for reference, as data will be lost when the “Clear Info” function is used. 2. Drive vehicle in D3 third gear. 3. Record data using snapshot mode. Is snapshot data greater than value indicated when solenoid is commanded “on” (greater than 95%) for greater than 2 seconds?	65 rpm	Go to Step 2	Go to Step 2
2	The converter clutch is mechanically stuck off.	—	Go to Step 3	Go to Step 9
3	Check for the torque converter mechanically stuck “off”. Check following components: • Damaged exhaust orifice. • Torque converter damage. • Converter apply valve stuck in the Off release position. • Possible misaligned/damaged valve body gasket. • Restricted apply passage. Replace transmission if pump valves are damaged.	—	Replace converter. Begin the diagnosis again. Go to Step 1.	Repair verified, exist DTC table.
4	1. After the repair is complete select Tech-2 “Clear Info” functioned and operate the vehicle under the following conditions: • Drive the vehicle in D2, D3, and D4 with steady acceleration and TP over 10%. • PCM must see a TCC slip of less than 65 rpm for 4 seconds. 2. Review Tech-2 “Specific DTC” and enter “0741.”	—	—	Repair verified, exist DTC table.

DTC P0742 Torque Converter Clutch Stuck On (Turbo Diesel)



Circuit Description

The PCM energizes the converter clutch solenoid by creating a ground path on circuit 924. When grounded (energized) by the PCM, the solenoid stops converter signal oil from exhausting. This causes converter signal oil pressure to increase and move the clutch valve. The solenoid will de-energize when the PCM no longer provides a ground path. When the solenoid is de-energized, it will exhaust fluid and release the converter clutch.

This DTC detects low torque converter slip when the clutch is commanded OFF.

Conditions For Setting DTC

The following conditions occur once per TCC cycle two consecutive times:

- No DTCs P0121, P0122, P0220, P0221, P0222, P0223, P0225, P0226, P0227, or P0228.
- No engine speed DTC P0219.
- No DTCs, P0716 or P0717.
- No DTCs P0741 or P1860.
- No DTC P1810.
- No DTCs.
- Engine speed is less than 3650 RPM.
- Engine running for greater than 5 seconds. \
- Engine torque between 80 and 450 ft/lbs.
- Gear range is D4.
- Commanded gear must be 2nd, 3rd, or 4th.
- No engine torque malfunctions.
- Throttle Position must be greater than 10%.
- TCC slip speed must be between -15 RPM and +20 RPM for at least 5 seconds.
- All conditions met for 3 occurrences.

Action Taken When DTC Sets

- The PCM will command maximum line pressure.
- The PCM will freeze shift adapts.
- The PCM will turn on the warning lamp.

Conditions For Clearing DTC

- The PCM will turn off the warning lamp after three consecutive ignition cycles without a failure reported.
- The DTC can be cleared using the scan tool.
- The PCM will cancel DTC default actions when the fault no longer exists and the ignition is cycled off long enough to power down the PCM.

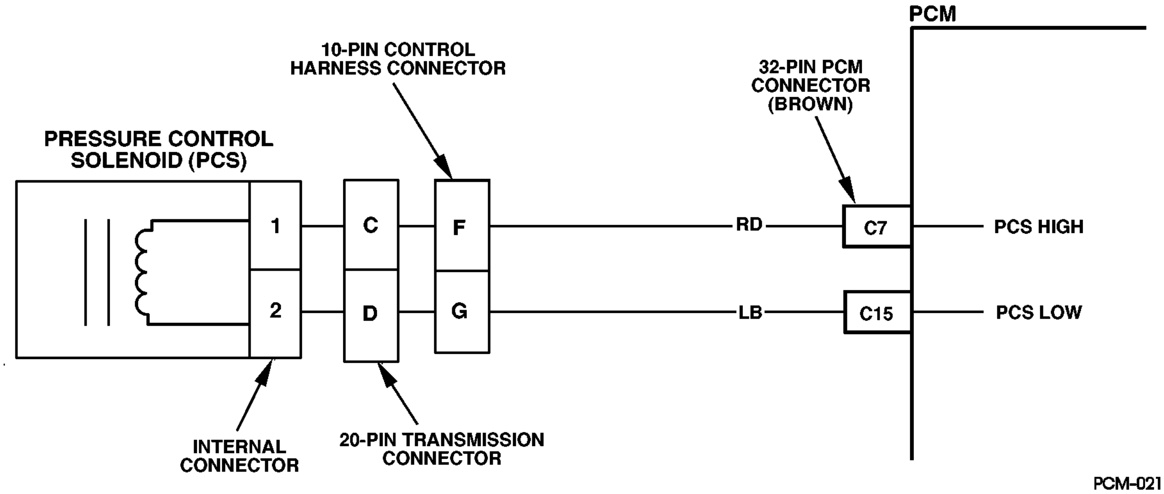
Diagnostic Aids

- If the converter clutch is seized with the parking brake applied and any gear range selected, the clutch fluid pressure will apply the clutch and cause an engine stall.
- If any engine DTCs codes are present diagnose and clear these DTCs first. Then check to see if the transmission DTCs have reset.

DTC P0742 Torque Converter Clutch Stuck On (Turbo Diesel)

Step	Action	Value	Yes	No
1	1. Connect scan tool. 2. Turn the ignition switch to on. 3. Record the DTC “Freeze Frame” and Failure Records.” 4. Using the scan tool, verify the “TP Sensor” operation. Are the TPS values within range shown in the value column?	0.6 - 5.0 volts	Go to Step 2	Go to Diagnostic Aids
2	Drive vehicle in D4 drive range under steady acceleration, with a throttle angle greater than 25%. Does scan tool display “TCC Slip Speed” between -15 and +20 rpm, TCC (converter clutch) solenoid off?	—	Go to Step 3	Go to Diagnostic Aids
3	TCC converter clutch is seized in on mode, check the following: • Clogged exhaust orifice in the TCC solenoid. • Converter clutch apply valve stuck in the apply position. • Misaligned or damaged valve body gasket. • Restricted release passage.	—	Go to Step 4	—
4	1. After the repair is complete, use the scan tool to select “DTC,” then “Clear Inform function. 2. Select “Specific DTC” and enter DTC “P0742.” 3. Operate the vehicle in D2, D3, or D4 with the TCC “Off” and the throttle above 10%. • TCC slip speed must be between 25 and 2500 rpm for 5 seconds.	—	—	Repair verified, exist DTC table.

DTC P0748 Pressure Control Solenoid (PCS) - Electrical (Turbo Diesel)



Circuit Description

The PCS is a PCM-controlled device used to regulate transmission line pressure. The PCM compares electronic accelerator pedal voltage, engine rpm, and other inputs to determine line pressure appropriate for a given load. The PCM will regulate pressure by applying a varying amperage to the PCS. The amperage can vary from 0.1 to 1.1 amp.

This DTC detects a continuous open or short to ground in the PCS circuit or the PCS.

Conditions For Setting DTC

- Engine must be running for at least 5 seconds.
- Difference in commanded and measured return amperage is greater than 0.16 amps.
- Conditions met for 200 milliseconds.

Action Taken When DTC Sets

- The PCM will disable the PCS.
- The PCM will freeze shift adapts.
- The PCM will NOT turn on the Malfunction Indicator Lamp (MIL).

Conditions For Clearing The DTC

- The DTC can be cleared from the PCM history by using the scan tool. The DTC will be cleared when the vehicle has achieved 40 warm-up cycles without a failure reported.
- The PCM will cancel the DTC default actions when the fault no longer exists and the ignition is cycled “off” long enough to power down the PCM.

Diagnostic Aids

- Inspect the wiring for poor electrical connections at the PCM and at the transmission 20-way connector. Look for possible bent, backed out, deformed or damaged terminals. Check for weak terminal tension as well. Also check for a chafed wire that could short to bare metal or other wiring. Inspect for a broken wire inside the insulation.
- When diagnosing for a possible intermittent short or open condition, wriggle the wiring harness while observing test equipment for a voltage change.
- If any engine DTCs or TP Sensor codes are present diagnose and clear these DTCs first. Then check to see if the transmission DTCs have reset.

Test Description

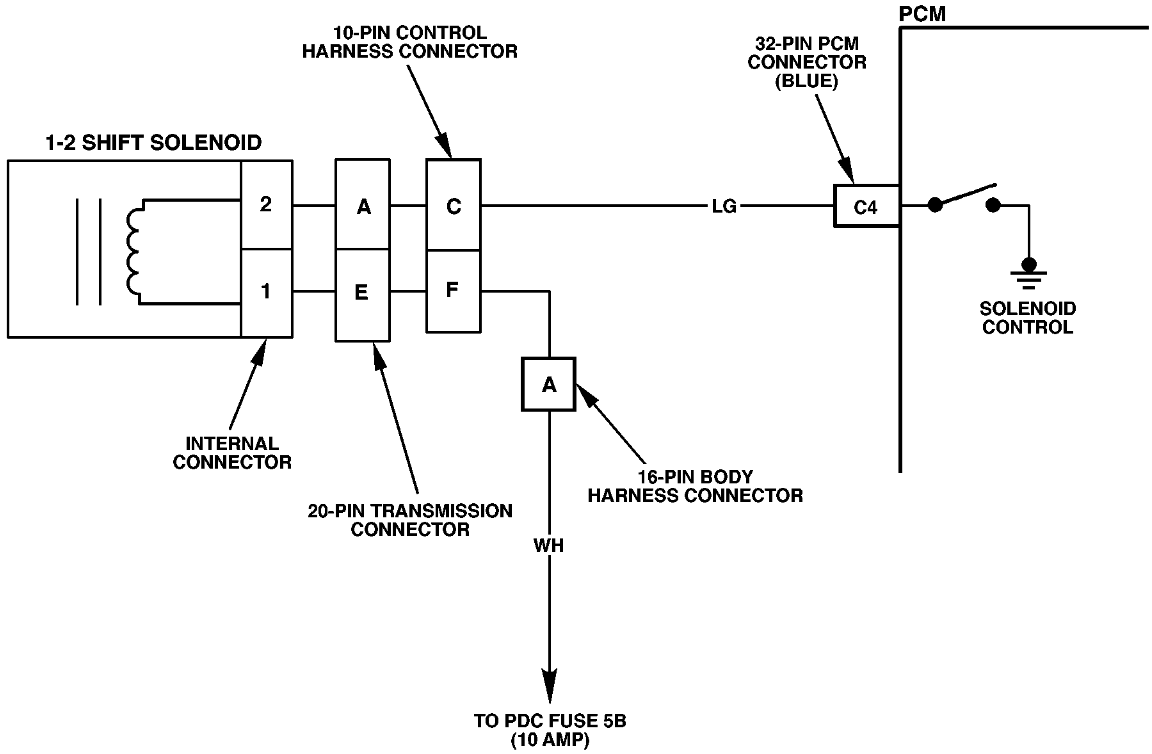
The numbers below refer to the step numbers on the diagnostic chart.

2. This test checks the ability of the PCM to command the PCS.
3. This test checks the PCS and internal wiring harness for incorrect resistance

DTC P0748 Pressure Control Solenoid - Electrical (Turbo Diesel)

Step	Action	Value	Yes	No
1	1. Connect scan tool. 2. Turn the ignition switch to on. **NOTE: Important:** Before clearing DTC(s), use the scan tool to record “Failure Records” for reference, as data will be lost when the “Clear Info” function is used. 3. Record the DTC “Failure Records.” 4. Start engine and shift into Park. 5. Using the transmission output control function on the scan tool, apply 0.1 amp through 1.0 amp while observing “PC Ref. Current” and “PC Act. Current.” Is the “PC Act. Current” reading always within the indicated value?	0.16 amp	Go to Diagnostic Aids	Go to Step 2
2	1. Turn ignition off. 2. Disconnect transmission 20-way connector. 3. Install the 05743837 Jumper Harness on the transmission side of the 20-way connector. 4. Using the multimeter and Connector Test Adapter Kit, measure the resistance between terminals “C” and “D.” Is the resistance within indicated values?	3-7 ohms	Go to Step 6	Go to Step 3
3	1. Remove transmission oil pan. 2. Disconnect wiring harness at PCS. 3. Measure resistance of PCS. Is resistance within indicated values?	3-7 ohms	Go to Step 5	Go to Step 4
4	Replace the PCS. Is the replacement complete?	—	Go to Step 8	—
5	Repair internal wiring harness for open. Is the repair complete?	—	Go to Step 8	—
6	Inspect/repair circuits 264 and 265 for short to ground or poor connections. Was a problem found?	—	Go to Step 8	Go to Step 7
7	Replace PCM. Is the replacement complete?	—	Go to Step 8	—
8	1. After the repair is complete, use the scan tool to select “DTC,” then “Clear Info” function. 2. Select “Specific DTC” and enter DTC “P0748.” 3. Ensure the following conditions are met: • The PCS duty cycle is not at its electrical high or low limit (short cleared).	—	—	Repair verified, exit DTC table.

DTC P0751 1-2 Shift Solenoid Valve Performance (Turbo Diesel)



7-PCM-007

Circuit Description

The 1-2 shift solenoid is used to control fluid acting on the 1-2 and 3-4 shift valves. The solenoid is a normally open valve used with the 2-3 solenoid to allow four different shifting combinations.

This DTC detects incorrect Gear Ratios when a Gear is commanded. This is a type “A” DTC.

Conditions For Setting The DTC

- No DTCs P0121, P0122, P0123, P0220, P0221, P0222, P0223, P0225, P0226, P0227 or P0228.
- No DTCs P0722 or P0723.
- No DTCs P0716 or P0717.
- No shift solenoid 1-2 DTC P0753.
- No shift solenoid 2-3 DTC P0758.
- No Pressure switch assembly DTC P1810.
- No Four Wheel Drive DTC P1875.
- Engine running.
- Vehicle speed is greater than 4.2 km/h (2.5 mph).
- Throttle angle is greater then 12%.
- Engine Torque between 60 ft/lbs and 450 ft/lbs.
- Transmission fluid temperature is greater than 20° C (69° F).
- Engine Speed is less than 3650 RPM.
- Not in Four Wheel Drive Low.

Stuck Off: (after two occurrences)

- Ist gear is commanded and the ratio is equal to 2nd gear for greater than 1.7 seconds.
- 4th gear is commanded (with converter clutch locked) and ratio is equal to 3rd gear for greater than 3 seconds.

Stuck On: (after five occurrences)

- 2nd gear is commanded and the ratio is equal to 1st gear for greater than 2.5 seconds.
- Condition is met with 5 occurrences.

Action Taken When The DTC Sets

- The PCM will command maximum line pressure.
- The PCM will freeze shift adapts.
- The PCM will turn on the warning lamp.

Conditions For Clearing The MIL/DTC

- The PCM will turn the warning lamp off after three consecutive ignition cycles without a failure reported.
- The DTC can be cleared using the scan tool.
- The PCM will cancel DTC default actions when the fault no longer exists and ignition is cycled “off” long enough to power down the PCM.

Diagnostic Aids

- Verify that the transmission meets the specifications in the 4L80-E shift speed chart.
- Other internal transmission failures may cause more than one shift to occur.
- If any engine DTCs or TPS codes are present diagnose and clear these DTCs first.

Test Description

The numbers below refer to the diagnostic chart.

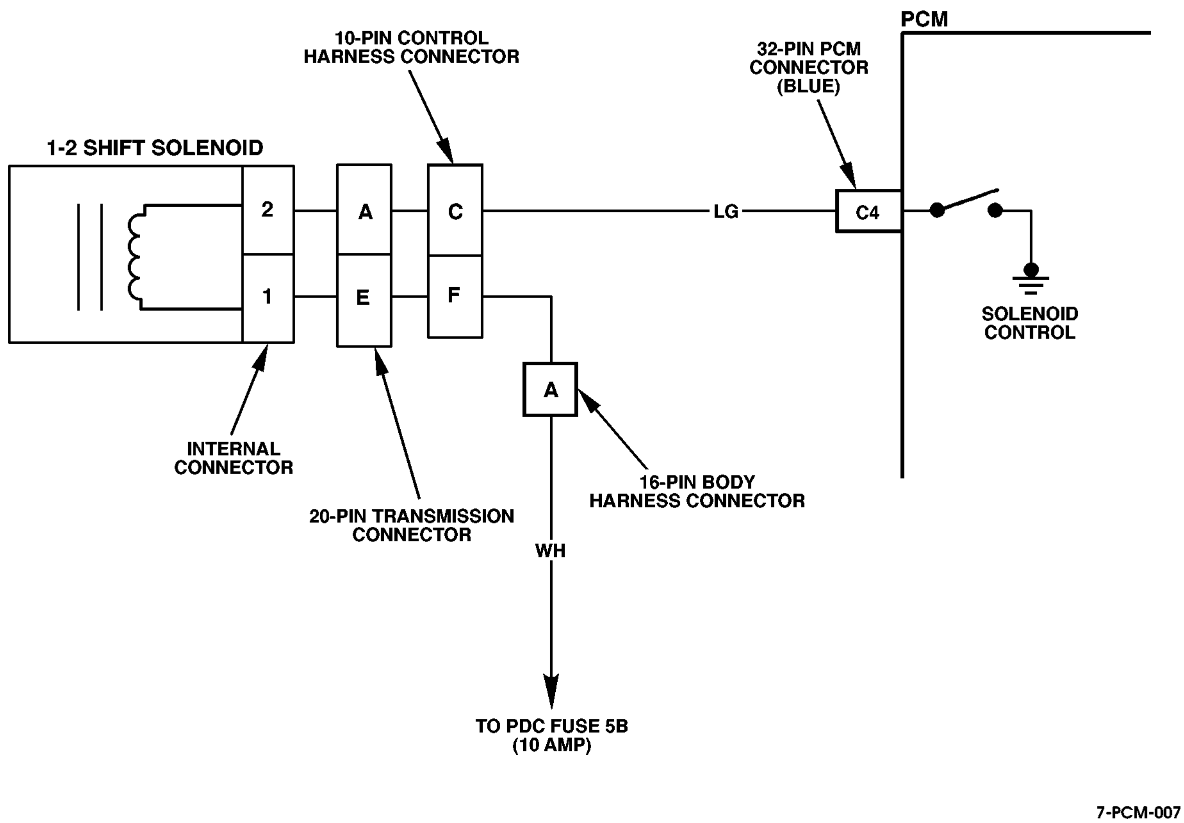
1. This test checks pressure switch function of the PSA.
2. This test checks that the scan tool commanded all shifts, all shift solenoids responded correctly, but all the shifts did not occur.

4L80-E CHART		
Gear	**1-2 Shift Solenoid**	**2-3 Shift Solenoid**
1	ON	OFF
2	OFF	OFF
3	OFF	ON
4	ON	ON

DTC P0751 1-2 Shift Solenoid Valve Performance (Turbo Diesel)

Step	Action	Value	Yes	No
1	1. Connect scan tool. 2. Turn ignition switch on. 3. Record DTC “Freeze Frame” and Failure Records.” 4. Start engine, apply brake pedal and shift to following ranges D1, D2, D3, D4, N, R, and P. Does each transmission range match the “TR Switch” on the scan tool?	—	Go to Step 2	Go to Pressure Switch Assembly (PSA) Resistance Check
2	1. Raise vehicle on hoist that allows wheels to rotate. 2. Start engine, shift into D4 range, use scan tool to command 1st, 2nd, 3rd, and 4th gears increasing speed. Did 2-3 or 1-4 only shift pattern occur? (Road testing may be necessary).	—	Go to Step 3	Go to Diagnostic Aids
3	Check the shift solenoid/hydraulic circuit for: • Shift solenoids for an internal malfunction. • Damaged seals on the shift solenoids. Was a problem found and corrected?	—	Go to Step 4	—
4	1. After the repair is complete, use scan tool to select “DTC” then “Clear Info” function. 2. Select “Specific DTC” and enter DTC “P0751.” 3. Operate the vehicle under the following conditions • Hold the throttle at 20% and accelerate to 55 mph (if the throttle moves more than 3%, stop the vehicle and start over). • PCM must see the proper ratio for each commanded gear for greater than one second in D1, D2, D3, and D4.	—	—	Repair verified, exist DTC table.

DTC P0753 1-2 Shift Solenoid Valve Electrical (Turbo Diesel)



Circuit Description

The 1-2 shift solenoid is used to control fluid acting on the 1-2 and 3-4 shift valves. The solenoid is a normally open valve used with the 2-3 solenoid to allow four different shifting combinations. The solenoid is attached to the control valve body. Ignition voltage is supplied directly to the 1-2 shift solenoid. The PCM controls the solenoid by providing a ground path through circuit 237.

This DTC detects a continuous open or short to ground in the 1-2 shift solenoid circuit or the 1-2 shift solenoid sensor.

Conditions For Setting DTC

- Ignition is on.
- Engine running for greater than 5 seconds.
- Invalid output state.
- Fails for 4.3 out of 5 seconds.

Action Taken When DTC Sets

- The PCM will command maximum line pressure.
- The PCM will freeze shift adapts.
- The PCM will turn on the warning lamp.

Conditions For Clearing DTC

- For California emissions, the PCM will turn the warning lamp off after three consecutive ignition cycles without a failure reported.
- The DTC can be cleared using the scan tool. The DTC will be cleared when the vehicle has achieved 40 warm-up cycles without a failure reported.
- The PCM will cancel DTC default actions when the fault no longer exists and the ignition is cycled “off” long enough to power down the PCM.

Diagnostic Aids

- Inspect the wiring for poor electrical connections at the PCM and at the transmission 20-way connector. Look for possible bent, backed out, deformed or damaged terminals. Check for weak terminal tension as well. Also check for a chafed wire that could short to bare metal or other wiring. Inspect for a broken wire inside the insulation.
- When diagnosing for a possible intermittent short or open condition, move or massage the wiring harness while observing test equipment for a change.
- An open ignition feed circuit can cause multiple DTCs to set.

- If any engine DTCs or TPS codes are present diagnose and clear these DTCs first. Then check to see if the transmission DTCs have reset.

4L80-E CHART		
Gear	**1-2 Shift Solenoid**	**2-3 Shift Solenoid**
1	ON	OFF
2	OFF	OFF
3	OFF	ON
4	ON	ON

Test Description

The numbers below refer to the step numbers on the diagnostic chart.

3. This test checks the function of the 1-2 shift solenoid and the internal wiring harness.
5. This test checks for power to the 1-2 shift solenoid from the ignition through the fuse.
13. This test measures the resistance of the component.

DTC P0753 1-2 Shift Solenoid Valve Electrical (Turbo Diesel)

Step	Action	Value	Yes	No
1	1. Connect scan tool. 2. Turn ignition switch to on. **NOTE: Important:** Before clearing DTC(s), use the scan tool to record “Freeze Frame” and “Failure Records” for reference, as data will be lost when the “Clear Info” function is used. 3. Record DTC “Freeze Frame” and “Failure Records.” Were DTCs P0753, P0758, P1860, P1864, and P1886 set?	—	Go to Step 2	Go to Step 3
2	1. Inspect applicable fuse. 2. If fuse was blown, Inspect/Repair circuit to sole-noid, and internal wiring harness for short to ground. Was problem found and corrected?	—	Go to Step 19	—
3	Command 1-2 shift solenoid “on” and “off” three times while listening to transmission pan with stethoscope. Does solenoid click when commanded?	—	Go to Step 4	Go to Step 5
4	1. Check every connection at the PCM. 2. Inspect the transmission 20-way connector for poor connections. Was a problem found?	—	Go to Step 19	Go to Diag-nostic Aids

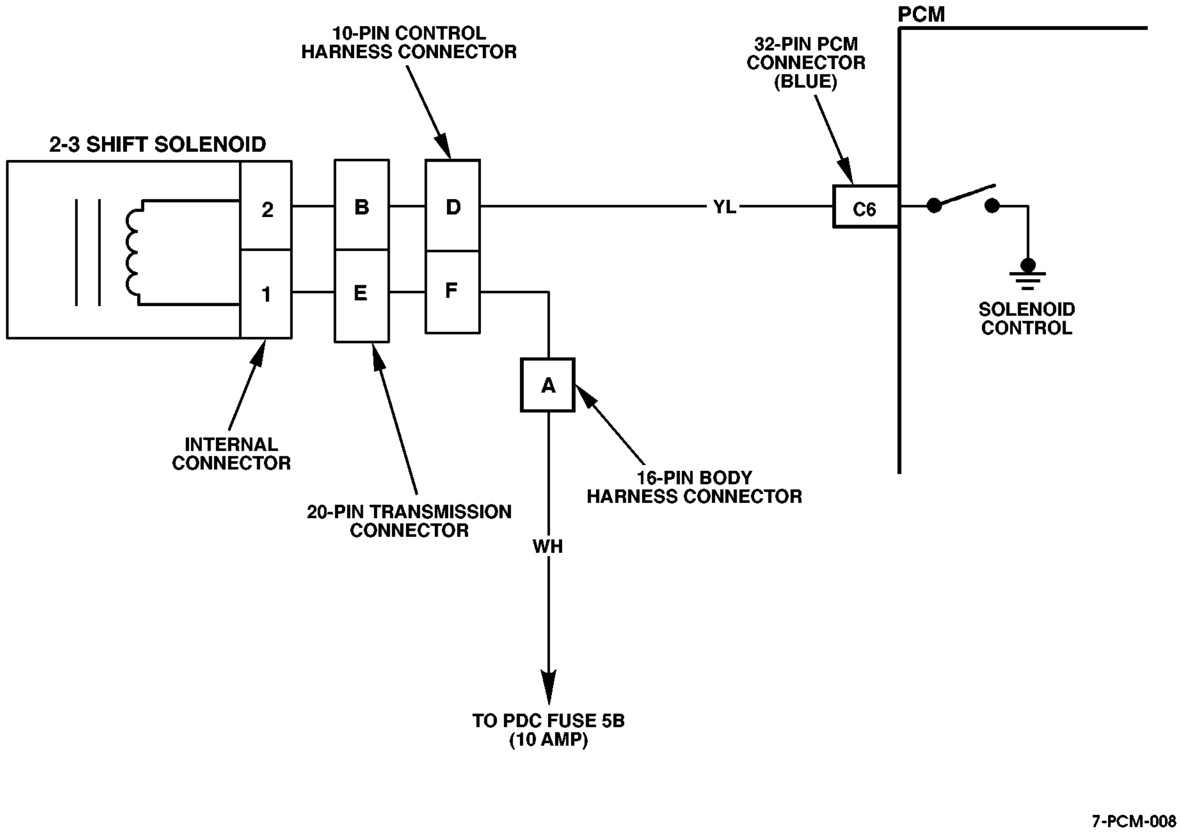
DTC P0753 1-2 Shift Solenoid Valve Electrical (Turbo Diesel)

Step	Action	Value	Yes	No
5	1. Turn ignition “off.” 2. Disconnect transmission 20-way connector (additional DTCs will set). 3. Install 05743837 Jumper Harness on engine harness connector. 4. Turn the ignition switch to “on.” 5. Connect test light from 05743837 Jumper Harness cavity “E” to ground. Is test light “on?”	—	Go to Step 6	Go to Step 7
6	1. Turn the ignition “off” long enough to power down PCM. 2. Install test light from cavity “E” to “A” of 05743837 Jumper Harness. 3. Start engine. 4. Command 1-2 shift solenoid “on” and “off” three times. Is test light “on” when 1-2 shift solenoid is commanded “on”, and “off”?	—	Go to Step 12	Go to Step 8
7	Repair the open or short to ground in the ignition feed circuit to the 1-2 shift solenoid. Was a problem found and corrected?	—	Go to Step 19	—
8	Monitor test light status. Was test light “off” at all times?	—	Go to Step 9	Go to Step 10
9	Inspect/repair circuit 237 for a short to ground condition. Was a problem found?	—	Go to Step 19	Go to Step 13
10	Was test light “on” at all times?	—	Go to Step 12	—
11	Replace the PCM. Is the replacement complete?	—	Go to Step 19	—
12	1. Turn ignition “off.” 2. Connect 05743837 Jumper Harness to transmission 20-way connector. 3. With multimeter and Connector Test Adapter Kit, measure the resistance between terminals “A” and “E.” Is resistance within the indicated values?	19-31 ohms	Go to Step 14	Go to Step 13
13	1. Remove oil pan and disconnect the internal wiring harness from the 1-2 shift solenoid. 2. Measure 1-2 shift solenoid resistance. Is resistance within the indicated values?	19-31 ohms	Go to Step 15	Go to Step 18

DTC P0753 1-2 Shift Solenoid Valve Electrical (Turbo Diesel)

Step	Action	Value	Yes	No
14	Using multimeter, measure resistance between terminals “A” and “E” and ground. Are both readings greater than indicated value?	250KΩ	Go to Diagnos-tic Aids	Go to Step 16
15	Inspect/repair the internal wiring harness for an open circuit. Was a problem found and corrected?	—	Go to Step 19	—
16	1. Disconnect the internal wiring harness from 1-2 shift solenoid. 2. Using multimeter measure the resistance from solenoid terminals to ground. Are readings greater than value indicated?	250KΩ	Go to Step 17	Go to Step 18
17	Inspect/repair the internal wiring harness for a short to ground. • Was a problem found and corrected?	—	Go to Step 19	—
18	Replace the 1-2 shift solenoid. • Refer to 1-2 Shift Solenoid Replacement. Is the replacement complete?	—	Go to Step 19	—
19	1. After the repair is complete, use the scan tool to select “DTC,” then “Clear Info” function. 2. Select “Specific DTC” and enter DTC “P0753.” 3. Operate the vehicle under the following conditions: • The 1-2 shift solenoid is commanded “on” and volts drop to zero. • The 1-2 shift solenoid is commanded “off' and volts increase to B+. • All conditions met for 4.3 out of 5 seconds.	—	—	Repair verified, exist DTC table.

DTC P0756 2-3 SHIFT SOLENOID VALVE PERFORMANCE (TURBO DIESEL)



Circuit Description

The 2-3 shift solenoid controls fluid acting on the 2-3 shift valves. The solenoid is normally open and is used with the 1-2 shift solenoid to provide four different shift combinations.

This DTC detects a non 1st gear when 1st gear is commanded, or 1st gear when 4th gear is commanded.

Conditions For Setting DTC

- No DTCs P0121, P0122, P0123, P0220, P0221, P0222, P0223, P0225, P0226, P0227, P0228.
- No DTC P0722 or P0723.
- No sensor DTCs P0712 or P0713.
- No 4WD Lo DTC P1875.
- No DTC P1810.
- No shift solenoid electrical DTCs P0753 or P0758.
- No engine speed DTCs P0219.
- No DTCs P0716 or P0717.
- Engine running.
- Not in 4WD Low.
- Vehicle speed is greater than 6 km/h (4 mph).
- Throttle position is greater than 12%.
- Transmission fluid temperature is between 20° and 130°
- C (68° and 266 F).
- Engine torque is between 80 and 450 ft/lbs.
- Engine speed is less than 3750 rpm.

Stuck On:

- Commanded Gear equals 1st and ratio equals 3rd for greater than 2 seconds (Actual gear equals 4th).
- Commanded Gear equals 2nd and ratio equals 3rd for greater than 2 seconds.
- Conditions occur for 4 occurrences.

Stuck Off:

- Commanded Gear equals 3rd and ratio equals 1st for greater than 3 seconds.
- Condition occurs for 8 occurrences (continual rolling counter).

Action Taken When DTC Sets

- The transmission will immediately land to 2nd gear.
- The PCM will command maximum line pressure.
- The PCM will freeze shift adapts.
- The PCM will illuminate the warning lamp.

Conditions For Clearing DTC

- For California emission vehicles the PCM will turn the lamp after three consecutive ignition cycles without a failure reported.
- The DTC can be cleared by using the scan tool.
- The PCM will cancel the DTC default actions when the fault no longer exists and the ignition is cycled “off' long enough to power down the PCM.

Diagnostic Aids

- Verify that the transmission meets the specifications in the 4L80-E shift speed chart.
- Other internal transmission failures may cause more than one shift to occur.
- Customer may complain of an engine over-rev condition or neutral in 4th gear.
- If any engine DTCs or TP Sensor codes are present diagnose and clear these DTCs first. Then check to see if the transmission DTCs have reset.

Test Description

The numbers below refer to the diagnostic chart.

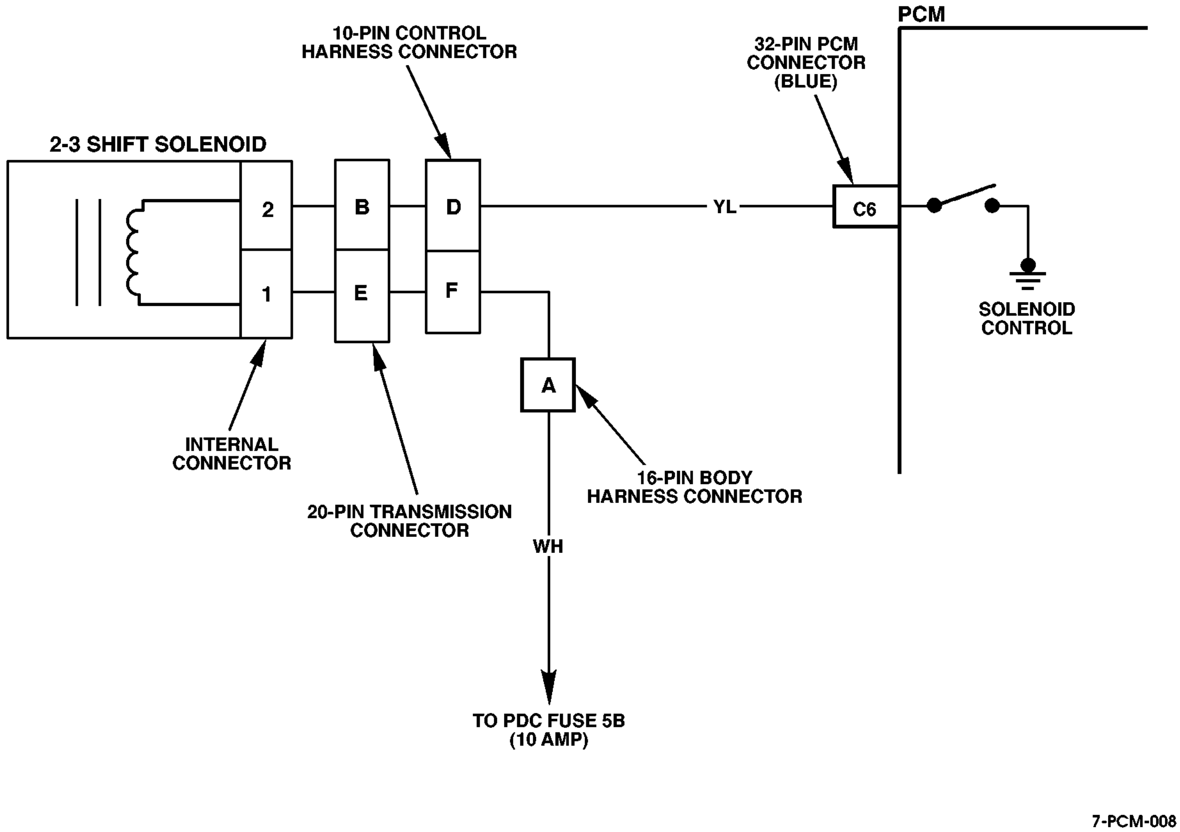
2. This test checks the function of the PSA.
3. This test checks for selected gear ratio vs. a ratio not obtainable under normal driving conditions.

4L80-E CHART		
Gear	**1-2 Shift Solenoid**	**2-3 Shift Solenoid**
1	ON	OFF
2	OFF	OFF
3	OFF	ON
4	ON	ON

DTC P0756 2-3 Shift Solenoid Valve Performance (Turbo Diesel)

Step	Action	Value	Yes	No
1	1. Connect scan tool. 2. Turn the ignition switch on. 3. Record “Freeze Frame” and “Failure Records.” 4. Start engine, apply brake pedal and shift into D1, D2, D3, D4, N, R, and P. Does each selected transmission range match “TR Switch” on the scan tool?	—	Go to Step 2	Go to Pressure Switch Assembly Resistance Check
2	1. Raise vehicle on twist that allows wheels to turn freely. 2. Start engine and shift into D4 range. Use scan tool to command 1st, 2nd, 3rd, and 4th gears while increasing engine speed. Was 1st gear commanded and not achieved, or 4th gear commanded and other than 4th gear occurred? (Road testing the vehicle may be necessary).	—	Go to Step 3	Go to Diagnostic Aids
3	Check the shift solenoid/hydraulic circuit for: • An internal malfunction. • Damaged seals on shift solenoids. Was a problem found and corrected?	—	Go to Step 4	—
4	1. After repair is complete, use scan tool to select “DTC,” then Clear Info” function. 2. Select “Specific DTC” and enter DTC “P0756.” 3. Operate the vehicle under the following conditions (only if traffic and road conditions permit): • PCM must see the proper gear ratio for each commanded gear for greater than one second in D1, D2, D3, and D4. Hold the throttle at 25% and accelerate to 55 mph.	—	—	Repair verified, exist DTC table.

DTC P0758, 2-3 Shift Solenoid Electrical (Turbo Diesel)



Circuit Description

The 2-3 shift solenoid controls fluid acting on the 2-3 shift valves. The solenoid is a normally open valve. It is used with the 1-2 shift solenoid to provide four different shift combinations. The solenoid is attached to the control valve body. Ignition voltage is supplied directly to the 2-3 shift solenoid. The PCM controls the solenoid by providing a ground path through circuit 315.

This DTC detects a continuous open or short to ground in the 2-3 shift solenoid circuit or 2-3 shift solenoid.

Conditions For Setting DTC

- Ignition on.
- No system voltage DTC P0560.
- The PCM commands the solenoid "on" and voltage remains high (B+).
- The PCM commands the solenoid off and voltage remains low (zero volts).
- All conditions met for 4.3 out of 7 seconds.

Action Taken When DTC Sets

- Immediate shift to second gear.
- The PCM commands maximum line pressure.
- Freeze 1-2 shift adapts from being updated.
- Inhibit converter clutch engagement.
- The PCM illuminates warning lamp.

Conditions For Clearing DTC

- For California vehicles the PCM turns the warning lamp off after three consecutive ignition cycles without a failure reported.
- The DTC can be cleared using the scan tool. The DTC will be cleared when the vehicle has achieved 40 warm-up cycles without a failure reported.
- The PCM will cancel the DTC default actions when the fault no longer exists and the ignition is cycled "off" long enough to power down the PCM.

Diagnostic Aids

- Inspect the wiring for poor electrical connections at the PCM and at the transmission 20-way connector. Look for possible bent, backed out, deformed or damaged terminals. Check for weak terminal tension as well. Also check for a chafed wire that could short to bare metal or other wiring. Inspect for a broken wire inside the insulation.

- When diagnosing for a possible intermittent short or open condition, move or massage the wiring harness while observing test equipment for a change.
- If any engine DTCs or TP Sensor codes are present diagnose and clear these DTCs first. Then check to see if the transmission DTCs have reset.

4L80-E CHART		
Gear	**1-2 Shift Solenoid**	**2-3 Shift Solenoid**
1	ON	OFF
2	OFF	OFF
3	OFF	ON
4	ON	ON

Test Description

The numbers below refer to the step numbers on the diagnostic chart.

3. This test checks the function of the 2-3 shift solenoid and the transmission internal wiring harness.
5. This test checks for power to the 2-3 shift solenoid from the ignition through the fuse.
14. This test measures the resistance of the component.

DTC P0758 2-3 Shift Solenoid B Electrical (Turbo Diesel)

Step	Action	Value	Yes	No
1	1. Connect scan tool. 2. Turn ignition switch to on. **NOTE: Important:** Before clearing DTC(s), use the scan tool to record “Freeze Frame” and “Failure Records” for reference, as data will be lost when the “Clear Info” function is used. 3. Record the DTC “Freeze Frame” and “Failure Records.” Were DTCs P0753, P0758, and P1860 set?	—	Go to Step 2	Go to Step 3
2	1. Inspect applicable fuse. 2. If fuse was blown, inspect/repair circuit wiring solenoid, and internal wiring harness for short to ground. Was a problem found and corrected?	—	Go to Step 20	—
3	Command 2-3 shift solenoid “on” and “off” three times while listening to transmission oil pan with stethoscope. Does solenoid click when commanded?	—	Go to Step 4	Go to Step 5
4	1. Check every connection at the PCM. 2. Inspect the transmission 20-way connector for poor connections. Was a problem found?	—	Go to Step 20	Go to Diagnostic Aids

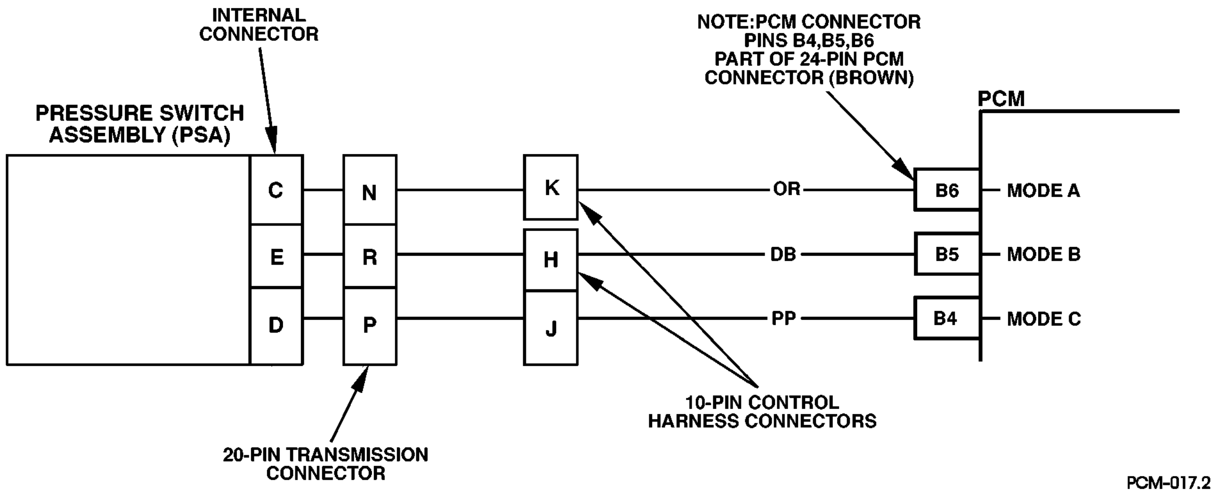
DTC P0758 2-3 Shift Solenoid B Electrical (Turbo Diesel)

Step	Action	Value	Yes	No
5	1. Turn ignition off. 2. Disconnect transmission 20-way connector (additional DTCs will set). 3. Connect 05743837 Jumper Harness to engine harness connector. 4. Stop engine, then turn the ignition on. 5. Connect test light from 05743837 Jumper Harness cavity “E” to ground. Is test light “on?”	—	Go to Step 6	Go to Step 7
6	1. Turn ignition “off” long enough to power down the PCM. 2. Connect test light from cavity “E” to “B” of 05743837 Jumper Harness. 3. Start engine. 4. Command the 2-3 shift solenoid “on” and “off” three times. Is test light “on” when 2-3 shift solenoid is commanded “on,” and “off”?	—	Go to Step 13	Go to Step 8
7	Repair open or short to ground in ignition feed circuit to 2-3 shift solenoid. Was a problem found and corrected?	—	Go to Step 20	—
8	Monitor test light status. Was test light “off” at all times?	—	Go to Step 9	Go to Step 10
9	Inspect/repair solenoid circuit for short to ground. Was a problem found and corrected?	—	Go to Step 20	Go to Step 12
10	Was test light “on” at all times?	—	Go to Step 11	—
11	Inspect/repair PCM harness for short to ground. Was a problem found and corrected?	—	Go to Step 20	Go to Step 12
12	Replace PCM. Is the replacement complete?	—	Go to Step 20	—
13	1. Turn ignition off. 2. Connect 05743837 Jumper Harness to transmission 20-way connector. 3. With multimeter and Connector Test Adapter Kit, measure resistance between terminals “B” and “E.” Is resistance within the indicated values?	19-31 ohms	Go to Step 15	Go to Step 14
14	1. Disconnect the internal wiring harness from the 2-3 shift solenoid. 2. Measure the resistance the 2-3 shift solenoid. Is resistance within indicated values?	19-31Ω	Go to Step 16	Go to Step 19

DTC P0758 2-3 Shift Solenoid B Electrical (Turbo Diesel)

Step	Action	Value	Yes	No
15	Using multimeter, measure resistance between terminals “B” and “E” and ground. Are both readings greater than indicated value?	250KΩ	Go to Diagnostic Aids	Go to Step 17
16	Inspect/repair internal wiring harness for an open circuit. Was problem found and corrected?	—	Go to Step 20	—
17	1. Disconnect internal wiring harness from 2-3 shift solenoid. 2. Using multimeter, measure the resistance from solenoid terminals to ground. Are both readings greater than indicated value?	250KΩ	Go to Step 18	Go to Step 19
18	Inspect/repair the internal wiring harness for a short to ground. Was problem found and corrected?	—	Go to Step 20	—
19	Replace the 2-3 shift solenoid. Is replacement complete?	—	Go to Step 20	—
20	1. After the repair is complete, use the scan tool to select “DTC,” then “Clear Info” function. 2. Select “Specific DTC” and enter DTC “P0758.” 3. Operate the vehicle under the following conditions: • The 2-3 shift solenoid is commanded “on” and the volts drop to zero. • The 2-3 shift solenoid is commanded “off” and the volts increase to B+. • All conditions met for 5 seconds.	—	—	Repair verified, exist DTC table.

DTC P1810 Pressure Switch Assembly (PSA) Fault (Turbo Diesel)



Circuit Description

The PSA consists of five normally open pressure switches. The PCM supplies battery voltage to each range signal. By grounding one or more of these circuits through various combinations of the switches, the PCM detects what manual valve position has been selected. It then compares actual voltage combinations to a PSA chart in PCM memory.

The PSA switch assembly cannot distinguish between Park and Neutral because the monitored valve body pressures are identical in both cases. With the ignition "on" and engine "off," Park/Neutral will be indicated. When the transmission 20-way connector is disconnected, ground potential for the three range signals is removed, and with ignition "on," D2 will be indicated.

This DTC detects an invalid state of the PSA sensor or the PSA circuit by deciphering the PSA inputs.

Conditions For Setting DTC

This DTC will set if any of the following conditions occurs:

Condition 1:

- No system voltage DTC P0560.
- Engine running.
- PCM detects an illegal PSA combination for greater than 25 seconds.

Condition 2:

- No system voltage DTC P0560.
- No DTCs P0722 or P0723.
- Engine speed is less than 50 rpm for.5 seconds, between 50 and 525 rpm for greater than 0.1 seconds, and than to greater than 525 rpm and vehicle speed is less than 3 km/h (2 mph).
- PCM detects gear range as D2 before and after start-up.
- Condition exists for greater than 7 seconds and is checked only at start-up.

Condition 3:

- No DTCs P0121, P0122, P0123, P0220, P0221, P0222, P0223, P0225, P0226, P0227 or P0228.
- No DTCs P0716 or P0717.
- No DTCs P0722 or P0723.
- No 1-2 shift solenoid DTCs P0751 or P0753.
- No 3-4 shift solenoid DTCs P0756 or P0758.
- Engine speed is less 3750 rpm.
- Vehicle speed is greater than 8 km/h (5 mph).
- Throttle angle is greater than 12%.
- Engine torque is between 80 ft/lbs and 450 ft.lb.
- Engine running for more than 5 seconds.
- PSA indicates P/N when ratio indicates less than1.58:1 for more than 10 seconds.
- PSA indicates reverse when ratio indicates D4, D3, D2, D1 for more than 15 seconds.
- PSA indicates D4, D3, D2, D1 when ratio indicates reverse for greater than 15 seconds.

Action Taken When The DTC Sets

- The PCM will command maximum line pressure.
- PCM assumes D4 for PRNDL shift pattern.
- The PCM will freeze shift adapts.
- The PCM will illuminate the warning lamp.

Conditions For Clearing DTC

- For California vehicles, the PCM will turn the lamp off after three consecutive ignition cycles without a failure reported.
- The DTC can be cleared using the scan tool. The DTC will be cleared when the vehicle has achieved 40 warm-up cycles without a failure reported.
- The PCM will cancel the DTC default actions when the fault no longer exists and the ignition is cycled “off” long enough to power down the PCM.

Diagnostic Aids

- Refer to the accompanying chart for the normal range signals and the illegal combinations.
- Inspect the wiring for poor electrical connections at the PCM and at the transmission 20-way connector. Look for possible bent, backed out, deformed or damaged terminals. Check for weak terminal tension as well. Also check for a chafed wire that could short to bare metal or other wiring. Inspect for a broken wire inside the insulation.
- When diagnosing for a possible intermittent short or open condition, move or massage the wiring harness while observing test equipment for a change.
- This DTC can be falsely set during a fluid fill procedure. After refilling, cycle key down, start and run vehicle for 20 seconds. Key down and allow the PCM to power down and then restart the vehicle.
- This DTC can be set falsely by low pump pressure or a stuck pressure regulator.
- This DTC can be set by a slipping forward clutch assembly. It may allow the PCM to see a 2.08:1 ratio (reverse) when the manual valve position is indicated as D4.
- If any engine DTCs or TP Sensor codes are present diagnose and clear these DTCs first. Then check to see if the transmission DTCs have reset.

Test Description

The numbers below refer to the step numbers on the diagnostic chart.

2. This test checks the indicated range signal to the manual valve actually selected.
3. This test checks for correct voltage from the PCM to the transmission 20-way connector.

Range Signal	A	B	C
Park	OFF	ON	OFF
Rev	ON	ON	OFF
Neutral	OFF	ON	OFF
D4	OFF	ON	ON
D3	OFF	OFF	ON
D2	OFF	OFF	OFF
D1	ON	OFF	OFF
Illegal	ON	OFF	ON
Illegal	ON	ON	ON

Expected Readings

“ON” = 0 volts/ “OFF = B+

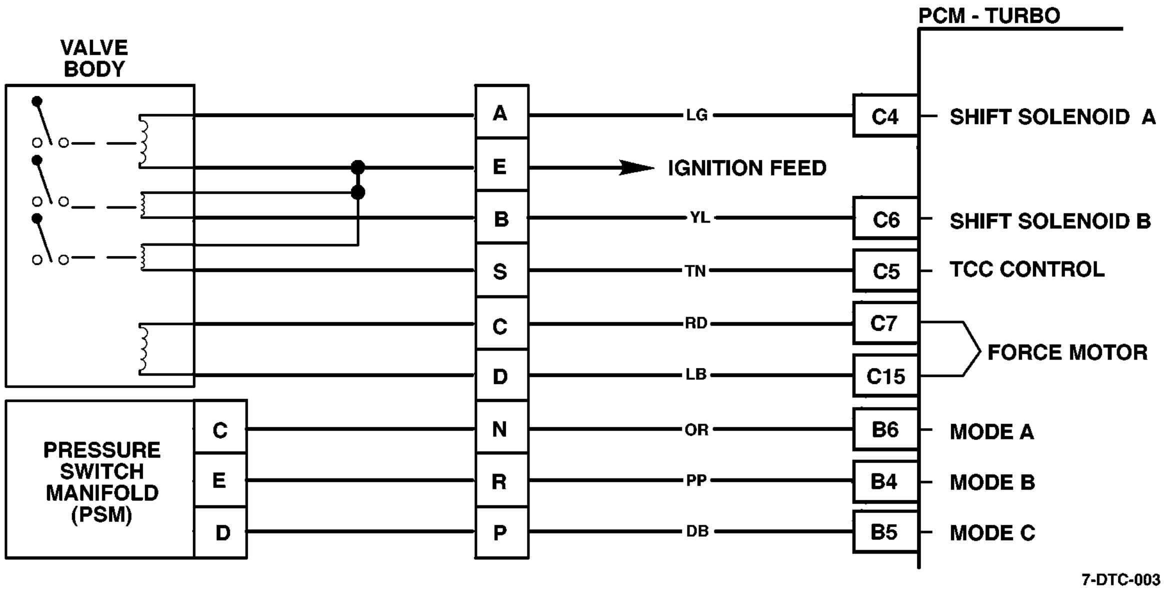
DTC P1810 Pressure Switch Circuit Fault (Turbo Diesel)

Step	Action	Value	Yes	No
2	Perform following check: • Transmission linkage (from select lever to the manual valve) is properly adjusted. • Fluid check. Were checks performed?	—	Go to Step 2	—
3	1. Connect scan tool. 2. Turn ignition switch to on. **NOTE: Important:** Before clearing DTC(s), use the scan tool to record “Freeze Frame” and “Failure Records” for reference, as data will be lost when the “Clear Info” function is used. 3. Record the DTC “Freeze Frame” and “Failure Records.” 4. Start and run engine at curb idle. 5. Apply service brake and shift into D1, D2, D3, D4, N, R, and P. Does each selected transmission range match the scan tool “TR Switch” display?	—	Go to Diagnostic Aids	Go to Step 3

DTC P1810 Pressure Switch Circuit Fault (Turbo Diesel)

Step	Action	Value	Yes	No
4	1. Turn ignition “off.” 2. Disconnect transmission 20-way connector (additional DTCs may set). 3. Connect 05743837 Jumper Harness to engine side of transmission 20-way connector. 4. Stop engine then turn ignition back to on. 5. Using multimeter and Connector Test Adapter Kit, check voltage at harness connector terminals “N,” “R,” and “P.” Is B+ displayed on all three circuits?	—	Go to Step 5	Go to Step 6
5	For circuits that did not indicate B+, check for an open or short to ground. Was a problem found?	—	Go to Step 9	Go to Step 6
6	To verify that circuits 762, 763, 764 are not shorted together, use a fused jumper to ground on each circuit while monitoring the scan tool “TR Switch” display. When a range signal circuit is grounded, are the other range signal circuits affected?	—	Go to Step 7	Go to Step 8
7	Check PCM connector terminals for poor connections. If no problem is found, replace PCM. Is the replacement complete?	—	Go to Step 9	—
8	Repair switch wiring as necessary. Is the repair complete?	—	Go to Step 9	—
9	Replace pressure switch. Was the PSA replaced?	—	Go to Step 9	—
10	1. After the repair is complete, use the scan tool to select “DTC,” then “Clear in fold function. 2. Select “Specific DTC” and enter DTC “P1810.” 3. Operate the vehicle under the following conditions: • Turn the ignition switch “on” for at least 2 seconds. Then start vehicle, idle for 5 seconds, then drive vehicle in D4 until converter clutch locks for 20 seconds.	—	—	Repair verified, exist DTC table.

DTC P1811 Maximum Adapt and Long Shift



Circuit Description

The Powertrain Control Module (PCM) compares the measured gear ratio to the known actual value. This allows the PCM to determine the actual

Conditions For Setting DTC

- The engine must be running for greater than 5 seconds.
- One of the following conditions exists, with the adapt cells at the maximum pressure allowed for 5 consecutive occurrences of one shift.
  - The 1-2 or the 2-3 upshifts are greater than 1.25 seconds.
  - The 3-4 upshifts are greater than 6.38 seconds.

Action Taken When DTC Sets

- The PCM will default the transmission to maximum line pressure.
- The PCM will freeze shift adapts.

Conditions For Clearing DTC

- The DTC can be cleared using the scan tool. The DTC will be cleared from history when the vehicle has achieved 40 warm-up cycles without reported failure.
- PCM will cancel DTC default actions when the fault no longer exists and ignition is cycled “Off” long enough to power down the PCM.

Diagnostic Aids

- Inspect wiring for poor electrical connections at the PCM and the 20-way connector Look for possible bent, backed out, deformed or damaged terminals. Also, check for chafed wire that could short to bare metal or other wiring. Inspect for broken wire inside the insulation.
- When diagnosing a possible intermittent short or open condition, move wiring while observing test equipment for a reading change.

Test Description

The numbers below refer to the step numbers on the diagnostic chart.

2. This step tests for low fluid level which can cause delayed shifts.

3. This step compares the indicated range signal from the Range Signal Chart to the Automatic Transmission Fluid Pressure Manual Valve Position Switch (TFP Val. Position Sw.) selected gear range.

5. This step tests for low line pressure, which can cause delayed and long shifts.

15. When DTC P1811 sets, the PCM commands maximum line pressure and does not inhibit TCC engagement. High engine speed and maximum line pressure can cause the Torque Converter to “balloon”.

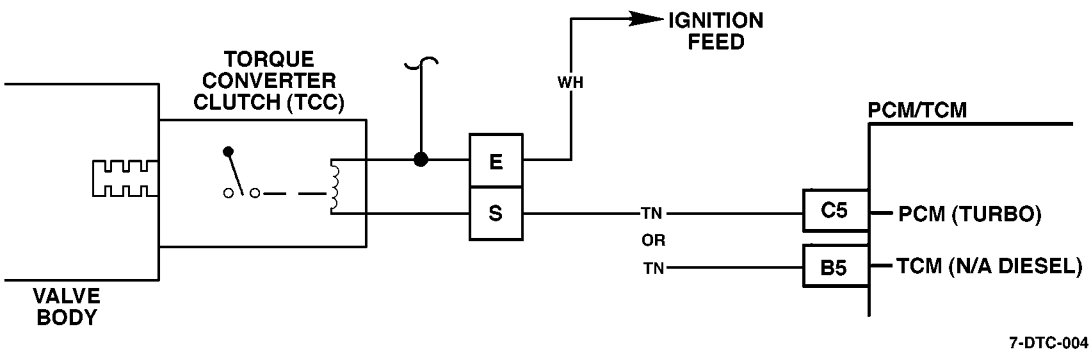
DTC P1811 Maximum Adapt and Long Shift

Step	Action	Value	Yes	No
1	Was the Powertrain ON-Board Diagnostic (OBD) System Check performed?	—	Go to Step 2	Go to OBD Powertrain System Check.
2	Have you performed the transmission fluid checking procedure?	—	Go to Step 3	Go to Transmission Fluid Checking Procedure.
3	1. Install the scan tool. 2. With the engine OFF, turn the ignition switch to the RUN position. **Important**: Before clearing the DTC's, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. 3. Turn the ignition switch to the RUN position. 4. Record the DTC Freeze Frame Failure Records and DTC's. Use the scan tool snapshot mode in order to record the shift times. **Important**: If any other engine or transmission DTC's are set, refer to their respective diagnostic tables first. 5. Select TFP sw. A/B/C on the scan tool. 6. Start the engine and apply the brake pedal. 7. Select each gear range: D1, D2, D3, D4, N, R, and P. Does each selected transmission range match the TFP Sw. A/B/C display on the scan tool? Refer to the Range Signal table.	—	Go to Step 7	
4	1. Drive the vehicle in D4 in order to obtain a 1-2, a 2-3, and a 3-4 shift time. 2. Using the scan tool, review the shift time information for 1-2, 2-3, and 3-4 shift times. Were all of the shift times above the specified value?	1-2, or 2-3 upshifts: 1.25 seconds 3-4 upshifts: 6.38 seconds	Go to Step 5	Go to Step 8
5	Perform the line pressure test. Refer to Line Pressure Test. Is the line pressure within specifications?	—	Go to Step 6	Go to Symptom Diagnosis Table, Low Line Pressure
6	1. Remove the transmission oil pan. Refer to Transmission Oil Pan Removal, in 4L80-E On-Vehicle Service. 2. Inspect the pan and the fluid for contamination. Is there excessive contamination in the transmission oil pan?	—	Go to Unit Repair	Go to Step 7
7	Inspect the transmission for fluid pressure loss in one of the following areas: • Valve Body Gasket • Forward Clutch Seals • Turbine Shaft Seals Refer to Unit Repair. Did you find and correct a problem?	—	Go to Step 17	—

DTC P1811 Maximum Adapt and Long Shift

Step	Action	Value	Yes	No
8	Inspect the 1-2, 2-3, and the 3-4 adapt cells on the scan tool. Were any of the upshift adapt cells at their maximum adapt limit?	—	Go to Step 9	Go to Diagnostic Aids
9	Did the 3-4 shift time exceed the specified value?	6.38 seconds	Go to Step 12	Go to Step 10
10	Did the 2-3 shift time exceed the specified value?	1.25 seconds	Go to Step 13	Go to Step 11
11	Did the 1-2 shift time exceed the specified value?	1.25 seconds	Go to Step 14	—
12	Inspect the following 3-4 shift circuit components: • 4th Gear Clutch Plates • 4th Gear Clutch Seals Refer to Unit Repair. Did you find and correct a problem?	—	Go to Step 15	—
13	Inspect the following 2-3 shift circuit components: • Turbine Shaft Seals • Forward Clutch Plates • Forward Clutch Seals • Direct Clutch Plates • Direct Clutch Seals Refer to Unit Repair. Did you find and correct a problem?	—	Go to Step 15	—
14	Inspect the following 1-2 shift circuit components: • Low Roller Clutch • Intermediate Clutch Plates • Intermediate Clutch Seals • Intermediate Sprag Clutch • Over drive Roller Clutch Refer to Unit Repair. Did you find and correct a problem?	—	Go to Step 15	—
15	Inspect the Torque Converter for “ballooning”. Did you find a problem?	—	Go to Step 16	Go to Step 17
16	Replace the Torque Converter. Is the replacement complete?	—	Go to Step 17	—
17	In order to verify your repair, perform the following procedure: 1. Select DTC. 2. Select Clear Info. 3. Turn the ignition key to the RUN position. 4. Review the scan tool DTC info. 5. Select Specific DTC. Enter DTC P1811. Has the test run and passed?	—	System OK.	Begin diagnostic again. Go to Step 1.

DTC P1860 Torque Converter Clutch Pulse Width Modulation Solenoid Electrical



Circuit Description

The Torque Converter Clutch Pulse Width Modulation Solenoid Valve (TCC PWM Sol. Valve) controls fluid acting on the converter clutch valve, which then controls TCC apply and release. The TCC PWM Sol. Valve attaches to the control valve body within the transmission. Ignition voltage goes directly to the TCC PWM Sol. Valve. The Powertrain Control Module (PCM) controls the TCC PWM Sol. Vase by providing a ground path on circuit 418. The current flows through the TCC PWM Sol. Valve coil according to the duty cycle (percentage of ON and OFF time). The TCC PWM Sol. Valve provides a smooth engagement of the torque converter clutch by operating on a duty cycle percent of ON time.

If the PCM detects a continuous open or short to ground in the TCC PWM Sol. Valve circuit or the TCC PWM Sol. Vase, then DTC P1860 sets. DTC P1860 is a type A DTC.

Conditions For Setting DTC

- System voltage is 10-16.5 volts.
- The engine is running more than 475 RPM for greater than 7 seconds.
- No shift solenoid DTCs P0751, P0753, P0756, and P0758.
- Commanded gear is D1.
- All of the above conditions are met, and one of the following conditions is met for 4.3 seconds out of 5 seconds.
  - The PCM commands the solenoid OFF, and the voltage remains bw (zero volts).
  - The PCM commands the solenoid to ON (100%) and the voltage remains high (B+).

Action Taken When DTC Sets

- •The PCM inhibits TCC engagement.
- •The PCM inhibits 4th gear if in hot mode.
- The PCM illuminates the Malfunction Indicator Lamp (MIL).

Conditions For Clearing DTC

1. The PCM turns OFF the MIL after three consecutive ignition cycles without a failure reported.
2. A scan tool can clear the DTC from the PCM history. The PCM clears the DTC from the PCM history if the vehicle completes 40 warm-up cycles without a failure reported.
3. The PCM cancels the DTC default actions when the fault no longer exists and the ignition is OFF long enough in order to power down the PCM

Diagnostic Aids

- Inspect the wiring for poor electrical connections at the PCM.
- Inspect the wiring for poor electrical connections at the transmission 20-way connector. Look for the following problems:
  - A bent terminal
  - A backed out terminal
  - A damaged terminal
  - Poor terminal tension
  - A chafed wire
  - A broken wire inside the insulation
- When diagnosing for an intermittent short or open, massage the wiring harness while watching the test equipment for a change.
- First diagnose and clear any engine DTCs that are present. Then inspect for any transmission DTCs that may have re-set.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

4. This step tests for voltage to the TCC PWM Sol. Valve.
6. This step tests the ability of the PCM and wiring to control the ground circuit.
8. This step tests the resistance of the TCC PWM Sol. Valve and the internal wiring harness
12. If the internal wiring harness is open, do not repair the internal wiring harness. You must replace the Automatic Transmission Wiring Harness Assembly

DTC P1860 Torque Converter Clutch Pulse Width Modulation Solenoid Electrical

Step	Action	Value	Yes	No
1	Was the Powertrain On-Board Diagnostic (OBD) System Check performed?	—	Go to Step 2	Go to Powertrain OBD System Check
2	1. Install the scan too/ (Tech 1). 2. With the engine OFF, turn the ignition switch to the RUN position. 3. Important: Before clearing the DTCs, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data 4. Record the DTC Freeze Frame and Failure Records. 5. If DTCs P0753, P0758, or P1860 are set, inspect the fuse. Is the fuse blown?	—	Go to Step 3	Go to Step 4
3	Inspect circuit 1020, the TCC PWM Sol. Valve and the internal wiring harness for a short to ground. Refer to Electrical Diagnosis, Section 8. Did you find and correct a problem?	—	Go to Step 17	—
4	1. Turn the ignition OFF. 2. Disconnect the transmission 20-way connector (additional DTCs may set). 3. Install the J39775 Jumper Harness on the engine harness connector. 4. With the engine off, turn the ignition to the RUN position. 5. Connect a test lamp from the J 39775 Jumper Harness cavity E to ground. Is the test lamp ON?	—	Go to Step 6	Go to Step 5

DTC P1860 Torque Converter Clutch Pulse Width Modulation Solenoid Electrical

Step	Action	Value	Yes	No
5	Repair the open or high resistance located in ignition voltage feed circuit 1020 to the TCC PWM Sol. Valve. Refer to Electrical Diagnosis, Section 8. Is the repair complete?	—	Go to Step 17	—
6	1. Install the test lamp from cavities E to S of the J39775 Jumper Harness. 2. Use the scan tool in order to command the TCC PWM Sol. Valve ON and OFF three times. Does the test lamp turn ON when you command the TCC PWM Sol. Valve ON, and does the lamp turn OFF when you command the TCC PWM Sol. Valve OFF?	—	Go to Step 8	—
7	Inspect and repair circuit 418 for an open or short to ground. Refer to Electrical Diagnosis, Section 8. Did you find a problem?	—	Go to Step 17	Go to Step 9
8	1. Install the J39775 Jumper Harness on the transmission 20-way connector. 2. Measure the resistance between terminals E and S. Use the J39200 DVOM and the J35616-A Connector Test Adapter Kit (Both covered in *Electrical* Section 12). Is the resistance within the specified values?	10-15	Go to Step 11	Go to Step 10
9	Replace the PCM. Refer to *PCM Replacement/Programming*, Section 6. Is the replacement complete?	—	Go to Step 17	—
10	1. Disconnect the internal wiring harness at the TCC PWM Sol. Valve. 2. Measure the resistance of the TCC PWM Sol. Valve. Is the resistance within the specified values?	10-15	Go to Step 12	Go to Step 15
11	Measure the resistance between terminal E and ground nd terminal S and ground. Are both readings greater than the specified value?	250	Go to Diagnostic Aids	Go to Step 13
12	Inspect the internal wiring harness for an open circuit. Refer to Electrical Diagnosis, Section 8. Did you find a problem?	—	Go to Step 16	—
13	1. Disconnect the internal wiring harness at the TCC PWM Sol. Valve. 2. Measure the resistance between each of the component terminals and ground. Are both readings greater than the specified value?	250	Go to Step 14	Go to Step 15
14	Inspect the internal wiring harness for a short to ground. Refer to Electrical Diagnosis, Section 8 Did you find a problem?	—	Go to Step 16	—

DTC P1860 Torque Converter Clutch Pulse Width Modulation Solenoid Electrical

Step	Action	Value	Yes	No
15	Replace the TCC PWM Sol. Valve. Refer to 4L80-E On-Vehicle Service. Is the replacement Complete?	—	Go to Step 17	—
16	Replace the Automatic Transmission Wiring Harness Assembly (A/T Wiring Harness Assy). Refer to 4L80-E On-Vehicle Service. Is the replacement complete?	—	Go to Step 17	—
17	In order to verify your repair, perform the following procedure: 1. Select DTC. 2. Select Clear Info. 3. Operate the vehicle under the following conditions: • The TCC PWM Sol. Valve is commanded ON and the volts drop to zero. • The TCC PWM Sol. Valve is commanded OFF and the volts increase to B+. • All conditions are met for 5 seconds. 4. Select Specific DTC. Enter DTC P1860. Has the test run and passed?	—	System OK	Begin the diagnosis again. Go to Step 1

DTC P1870 Transmission Component Slipping (Turbo Diesel)

Range	Gear	1-2 Sol	2-3 Sol	Fourth Clutch	Overrun Clutch	O/D Roller Clutch	FWD Clutch	Direct Clutch	Front Band	Interm. Sprag Clutch	Interm. Clutch	Lo Roller Clutch	Rear Band
Overdrive	1st	On	Off	–	–	H	A	–	–	*	–	H	–
	2nd	Off	Off	–	–	H	A	–	–	H	A	O	–
	3rd	Off	On	–	–	H	A	A	–	O	A	O	–
	4th	On	On	A	–	O	A	A	–	O	A	O	–

A = Applied
H = Holding
* = Holding but not effective
O = Overrunning

Circuit Description

The PCM monitors the difference in engine speed and transmission input speed. In D3 drive range with the converter clutch engaged, engine speed should closely match transmission output speed. In D4 drive range with the converter clutch engaged, clutch slip speed should be between -20 and +20 rpm.

This DTC detects excessive slip when the is engaged.

Conditions For Setting DTC

The following conditions are met for 10 seconds with 4th gear commanded.

- No engine speed DTC P0335.
- No DTCs P0121, P0122, P0123, P0220,P0221, P0222, P0223, P0225, P0226, P0227, P0228.
- No DTCs P0716 or P0717.
- No DTC P0722 or P0723.
- No DTCs P0741, P0742 or P0719.
- No shift solenoid I -2 DTCs P0751 or P0753.
- No shift solenoid 2-3 DTCs P0756 or P0758.
- No DTC P1810.
- Gear range is D4.
- Throttle angle between 12% and 70%. Engine torque between 60 and 280 ft/lbs.
- Fluid temperature is between -10°C and 130°C (14° F and 266° F).
- Engine speed is between 1200 and 3750 rpm. Input speed is between 40 and 205 rpm.
- Slip between +140 and +500 rpm is detected.
- Shift Solenoid performance counters are clear.

Action Taken When DTC Sets

- PCM will command maximum line pressure.
- PCM will inhibit converter clutch engagement.
- PCM inhibits 4th gear if in hot mode.
- PCM will freeze shift adapts. PCM illuminates the warning lamp.

Conditions For Clearing DTC

- For California vehicles, the PCM will turn the lamp off after three consecutive ignition cycles without a failure reported.
- The DTC can be cleared using the scan tool. The DTC will be cleared when the vehicle has achieved 40 warm-up cycles without a failure reported.
- The PCM will cancel the DTC default actions when the fault no longer exists and the ignition is cycled “off” long enough to power down the PCM.

Diagnostic Aids

- A pressure switch malfunction could set DTC P1870.
- A mechanical failure of the shift solenoids, or converter clutch solenoid could set a DTC P1870.
- Internal transmission failures may result in a DTC P1870.
- If any engine DTCs or TPS codes are present diagnose and clear these DTCs first. Then check to see if the transmission DTCs have reset.

Test Description

The numbers below refer to the step numbers on the diagnostic chart.

1. This test checks the indicated range signal to the actual selected range. A faulty switch could set a DTC P1870.
2. This test checks the torque converter for slippage while in a commanded lock-up state.

DTC P1870 Transmission Component Slip

Step	Action	Value	Yes	No
1	Was the Powertrain On-Board Diagnostic (OBD) System Check performed?	—	Go to Step 2	Go to Powertrain OBD System Check
2	Perform the Transmission Fluid Checking Procedure. Refer to Line Pressure Check Procedure. Did you perform the procedure?	—	Go to Step 3	Go to Transmission Fluid Checking Procedure
3	1. Install the scan tool (Tech 2). 2. With the engine OFF, turn the ignition switch to the RUN position. **Important:** Before clearing the DTCs, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. 3. Record the DTC Freeze Frame and Failure Records. 4. With the engine idling and at normal operating temperature, apply the brake pedal. 5. Select each transmission range: D1, D2, D3, D4, N, R and P. Does each selected transmission range match the scan tool TFP Switch A/B/C display? (Refer to the Range Signal table.)	—	Go to Step 4	Go to DTC P1810 Pressure Switch Assembly Malfunction
4	1. Connect the J21867 Pressure Gauge to the transmission line pressure tap. 2. Perform the Line Pressure Check. Refer to Line Pressure Check Procedure. Is the line pressure within specifications?	—	Go to Step 5	Go to the applicable System Diagnosis Table: Low Line Pressure High Line Pressure
5	Drive the vehicle under the following conditions: • The transmission is in D4. • The TCC is engaged. • The APP angle is 12-70%. At any time is the TCC Slip Speed within the specified range for 1 second?	140-500 RPM	Go to Step 6	Go to Diagnostic Aids

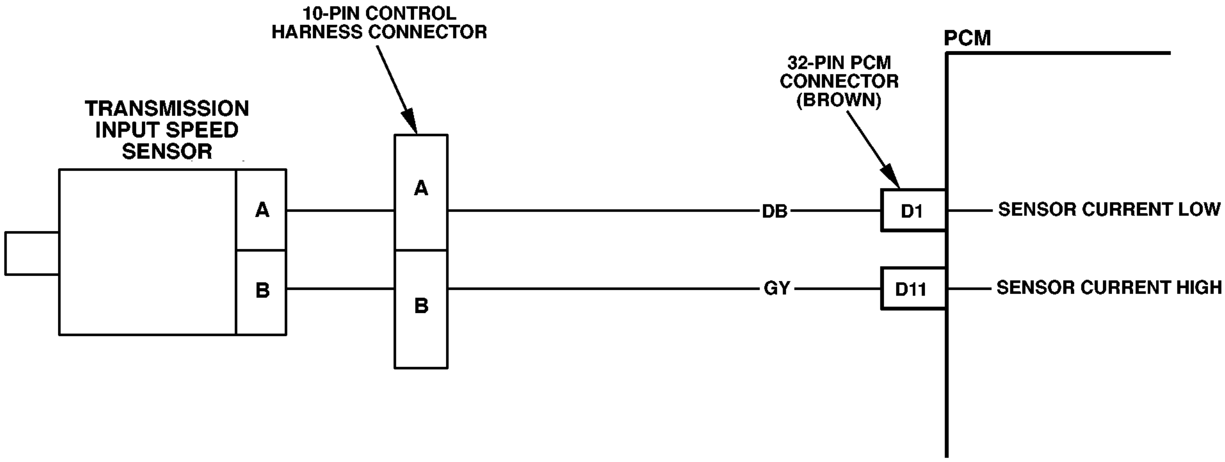
DTC P1870 Transmission Component Slip (Cont'd)

Step	Action	Value	Yes	No
6	Drive the vehicle under the following conditions: • The transmission is in D3. • Command the TCC ON with the scan tool. • The APP angle is 12-70%. At any time is the TCC Slip Speed within the specified range for 6 seconds?	140-500 RPM	Go to Step 8	Go to Step 7
7	Repeat the procedure in step 5. Drive the vehicle under the following conditions: • The transmission is in D4. • The TCC is engaged. • The APP angle is 12-70%. Are the results the same as in step 5?	140-500 RPM	Go to Step 9	Go to Step 11
8	Refer to 4L80-E System Diagnosis Table, Slipping TCC. Did you find and correct the problem?	—	Go to Step 12	—
9	1. Remove the transmission oil pan. Refer to Transmission Oil Pan Removal in 4L80-E On-Vehicle Service. 2. Inspect for contaminated fluid and excessive material in the pan. Is the fluid or the pan contaminated?	—	Go to 4L80-E Unit Repair	Go to Step 10
10	1. Inspect the 1-2 SS Valve for contamination or damaged seals. 2. Inspect the 2-3 SS Valve for contamination or damaged seals. Did you find a problem?	—	Go to Step 12	Go to Step 11
11	Inspect the following components for contamination or sticking: • The 1-2 shift valve. • The 2-3 shift valve. • The 3-4 shift valve. Did you find a problem?	—	Go to Step 12	Go to 4L80-E Unit Repair

DTC P1870 Transmission Component Slip (Cont'd)

Step	Action	Value	Yes	No
12	In order to verify your repair, perform the following procedure: 1. Select DTC. 2. Select Clear Info. 3. Operate the vehicle under the following conditions: • Drive the vehicle in 4th gear, with the TCC commanded ON. • The APP Angle is 12-70%. • The PCM must see a slip of -25 to +30 RPM for greater than 1 second. 4. Select Specific DTC. Enter DTC P1870. Has the test run and passed?	—	System OK	Begin the diagnosis again. Go to Step 1.

DTC P1871 Undefined Gear Ratio



7-PCM-005

Circuit Description

The PCM calculates ratio based on transmission input and output speed sensor readings. The PCM compares known transmission ratio to calculated ratio, for gear range selected.

This DTC detects an unknown ratio.

Conditions For Seating The DTC

The following conditions are met 10 seconds.

- No DTCs P0121, P0122, P0123, P0220, P0221, P0222, P0223, P0225, P0226, P0227, P0228.
- No DTCs P0716 or P0717.
- No DTCs P0722 or P0723.
- No DTCs P1810.
- No Four Wheel Drive Lo DTC P1875.
- Four Wheel Drive Lo fail counters are clear.
- Vehicle Speed is greater than 11 km/h (7 mph).
- Throttle angle is greater than 25%.
- Transmission fluid temperature is greater than 20°C (68°F).
- 4.5 seconds since last gear change.
- Engine Speed is greater than 3650 rpm.
- Engine Torque is between 80 and 450 ft/ lbs.
- Gear Ratio is greater than 2.63 or less than 0.70
- Above conditions occur for 10 seconds.

Action Taken When The DTC Sets

- The PCM will command maximum line pressure.
- The PCM will freeze shift adapts.

Conditions For Clearing The MTL/DTC

- The PCM will turn the warning lamp off after three consecutive ignition cycles without a failure reported.
- The DTC can be cleared using the scan tool.
- The PCM will cancel the DTC default actions when a fault no longer exists, and the ignition is cycled "Off" long enough to power down the PCM.

Diagnostic Aids

- Inspect the wiring for poor electrical connection at the PCM and the transmission 20-way connector.
- When diagnosing for a possible intermittent short or open condition, move or message the wiring harness while observing test equipment for a change.
- If any engine DTC(s) or TP Sensor codes are present in memory, diagnose and clear the engine DTC(s) first. Then check to see if the transmission DTC(s) have reset.

Test Description

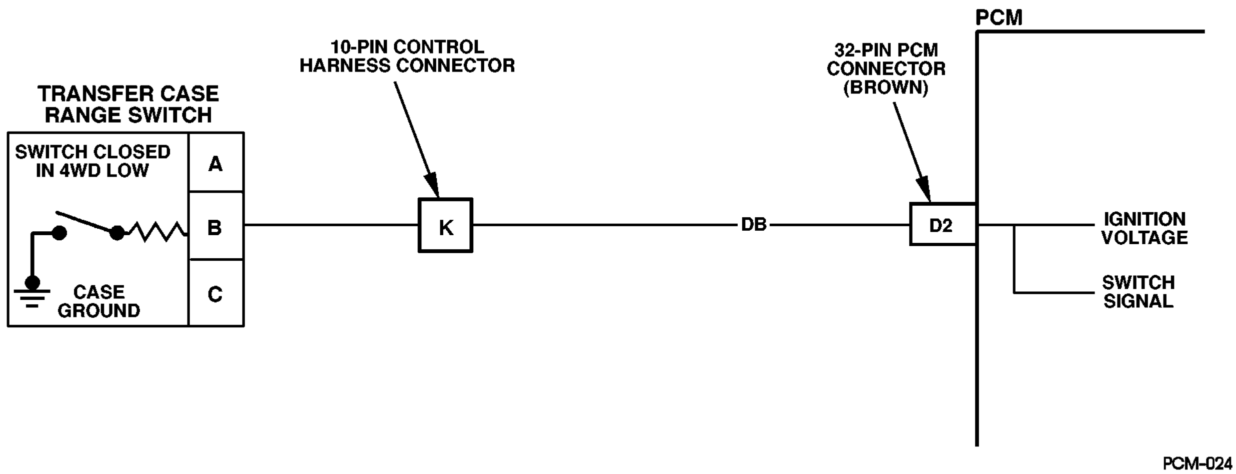
The numbers below refer to the diagnostic table.

1. This test checks indicated range signal to the actual selected range. A faulty switch could set pressure switch DTC P1870.
2. This test checks for proper ratios when in each commanded gear state.

DTC P1871 Undefined Gear Ratio

Step	Action	Value	Yes	No
2	1. Connect scan tool. 2. Turn ignition on. 3. Record and clear DTC Freeze-Frame/Failure Records and DTCs. 4. Start engine. 5. Apply brake and shift through D2, D3, D4, N, R, and P. Does scan tool transmission range match each of the selected gear range?	—	Go to Step 2	Refer to DTC 1810 diagnosis
3	1. Drive vehicle in 1st, 2nd, and 3rd gear with throttle angle greater than 25%. 2. Hold vehicle speed above 7 mph for at least 2 seconds in each gear range. 3. Use scan tool snapshot mode to record transmission gear ratio for commanded gear range (1st, 2nd, 3rd). Are gear ratios within parameters for each specified range?	—	Refer to diagnostic aids.	—
4	1. After repair is complete, select Scan Tool “Clear Info” function and operate the vehicle under the following conditions: • Key “on” and engine running. Drive the vehicle in 1st, 2nd and 3rd gear. PCM must see a valid gear range vs. the commanded gear. 2. Review the Scan Tool “Specific DTC”.	—	—	Repair verified, exit DTC table.

DTC P1875 Four-Wheel Drive Low Switch Fault (Turbo Diesel)



Circuit Description

The 4WD low circuit consists of a 4WD indicator, switch, and wiring. When the operator moves the shift lever to 4 Low, the 4WD indicator lamp will illuminate and circuit 784 voltage to the PCM will change from B+ to zero. The 4WD low switch signal is used to correct transmission output speed signal to PCM. This signal is used to compensate for transfer case gear reduction. The PCM uses the transmission output speed signal to adjust shift points, line pressure, and converter clutch scheduling.

This DTC detects a continuous open or short to ground in the 4WD circuit.

Conditions For Setting DTC

- No DTCs P0121, P0122 or P0123.
- No DTC P0502.
- No 1-2 shift solenoid DTC P0753.
- No 2-3 shift solenoid DTC P0758.
- No DTC P1810.
- No PWM solenoid DTC P1860.
- Engine speed is greater than 400 rpm for 8 seconds.
- Gear range is D4.
- Throttle angle is between 10% and 100%.
- Transmission fluid temperature is between 18-125°C (68°-248°F).
- Shift solenoid performance counters are zero.

All of the above conditions have been met and either one of the following fail conditions are true.

- Four wheel drive low is stuck “on” for 2 seconds. Gear ratio between 0.95 and 1.05:1.
- Four wheel drive low is stuck “off” for 3 seconds. Gear ratio between 2.66 and 2.76:1 in any two gears.

Action Taken When The DTC Sets

- Assume “Low” state when stuck “off' and “High” state when stuck ”on”.
- Freeze shift adapts from being updated.
- The PCM will illuminate the warning lamp.

Conditions For Clearing DTC

- The PCM will turn off the warning lamp after three consecutive ignition cycles without a failure reported.
- The DTC can be cleared using the scan tool. The DTC will be cleared when the vehicle has achieved 40 warm-up cycles without a failure reported.
- The PCM will cancel the DTC default actions when the fault no longer exists and the ignition is cycled “off” long enough to power down the PCM.

Diagnostic Aids

- Inspect the wiring for poor electrical connections at the PCM and at the transmission 20-way connector. Look for possible bent, backed out, deformed or damaged terminals. Check for weak terminal tension as well. Also check for a chafed wire that could short to bare metal or other wiring. Inspect for a broken wire inside the insulation.
- When diagnosing for a possible intermittent short or open condition, move or massage the wiring harness while observing test equipment for a change.
- If any engine DTCs or TP Sensor codes are present diagnose and clear these DTCs first. Then check to see if the transmission DTCs have reset.

Test Description

The numbers below refer to the step numbers on the diagnostic chart.

2. This test checks for voltage input to the 4WD indicator assembly.
3. This test checks for voltage input to the selector quadrant switch through the 4WD indicator assembly.

DTC P1875 4WD Low Switch Fault (Turbo Diesel)

Step	Action	Value	Yes	No
1	1. Connect scan tool. **Important:** Before clearing DTC(s) use the scan tool to record “Freeze Frame” and Failure Records for reference, as data will be lost when the “Clear Info” function is used. 2. Turn ignition “on”. 3. Record and clear DTC Freeze Frame/Failure Records and DTCs. 4. While observing scan tool shift transfer case into 4WD Hi and then 4WD Lo. Does scan tool 4WD Lo Switch read “NO” when in 4WD Hl and “YES” when in 4WD Lo?	—	Problem may be intermittent. Refer to Diagnostic Aids.	—
2	1. Turn ignition off. 2. Disconnect transfer case switch harness connector. 3. Turn the ignition on. 4. Check terminal “B” on engine side of wiring harness for voltage. Is B+ voltage available at terminal “B”?	—	Go to Step 3	Go to Step 6
3	1. Ground switch ground wire to a known good ground. 2. Observe scan tool 4WD Lo Sw data. Does scan tool 4WD Lo indicate “YES” when is grounded and “NO” when the is not grounded?	—	Go to Step 4	Go to Step 8
4	Check terminal at transfer case switch. Was problem found and corrected?	—	Go to Step 8	Go to Step 5
5	Replace transfer case 4WD Lo Switch. Was the 4WD Lo Switch replaced?	—	Go to Step 8	—
6	Check switch harness for open. Was problem found and corrected?	—	Go to Step 8	Go to Step 7
7	1. Replace the PCM. Was the PCM replaced?	—	Go to Step 8	—
8	1. After the repair is complete select scan tool “Clear Info” function and operate the vehicle under the following conditions: • Start the engine and drive the vehicle. 4th gear and TCC engagement must occur both in 2WD and 4WD Lo. The PCM must see a valid gear range in both transfer case stats. 2. Review the scan tool “DTC Info”.	—	—	Repair verified, exit DTC table.

TRANSMISSION FLUID AND FILTER REPLACEMENT

1. Support transmission/transfer case assembly with jack positioned under transfer case.
2. Remove bolts attaching rear mount to transmission (Figure 5-23).
3. Remove bolts attaching crossmember to frame brackets and remove crossmember.

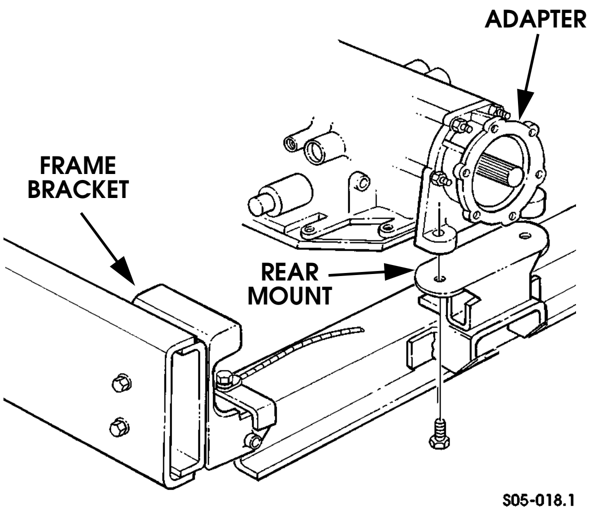


Figure 5-23: Transmission-to-Crossmember Mounting

4. Loosen transmission oil pan bolts and allow fluid to drain.
5. Move shift rod bracket aside and remove pan gasket, and oil pan (Figure 5-24). Pan gasket is reusable.
6. Remove oil filter from valve body (Figure 5-25).
7. Inspect filter seal (Figure 5-25). Undamaged seal is reusable.
8. Remove magnet from oil pan. Then clean pan and magnet.
9. Install seal in valve body.
10. Insert filter pipe in case with twisting motion. Align filter with valve body and work into place (Figure 5-25).
11. Position magnet in oil pan.
12. Install gasket on oil pan and install pan on transmission. Tighten pan bolts to 18 lb-ft (24 N•m) torque.
13. Install rear crossmember and transmission mount.
14. Remove support jack.
15. Refill transmission with Dexron III fluid.

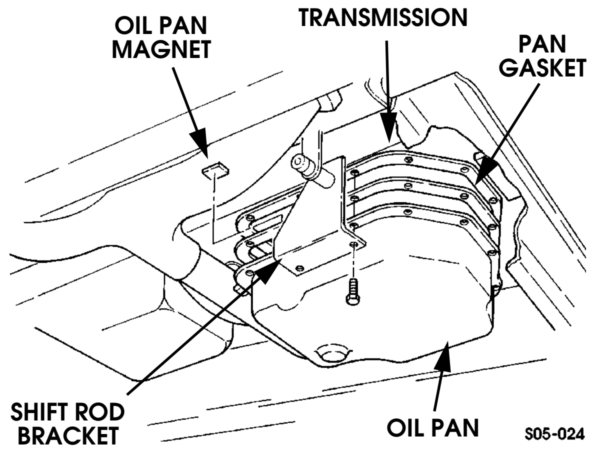


Figure 5-24: Oil Pan Removal/Installation

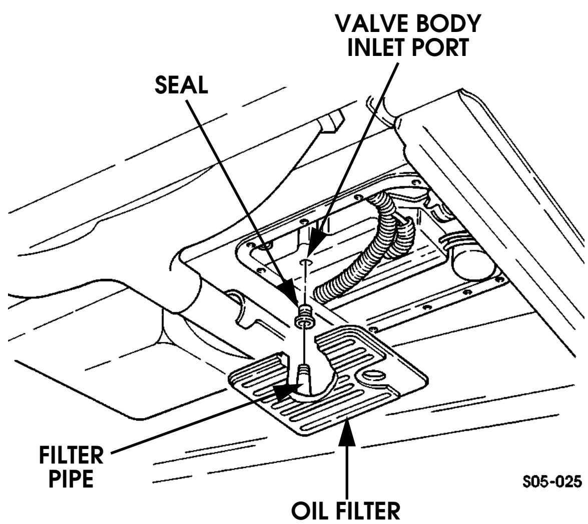


Figure 5-25: Oil Filter Removal/Installation

COOLER LINE AND BYPASS VALVE SERVICE

The transmission and transfer case oil cooler lines are replaceable parts.

The lines consist of metal tubing interconnected by sections of rubber hose (Figure 5-26). Each of the tube or hose sections can be replaced separately. It is not necessary to replace complete assemblies.

On 1997 Hummers, the cooler lines are fastened to the transmission with quick connect fittings. The flared end of the line fits tightly into the adapter and is secured to the adapter with a clip. The clip is then secured with a nylon retainer.

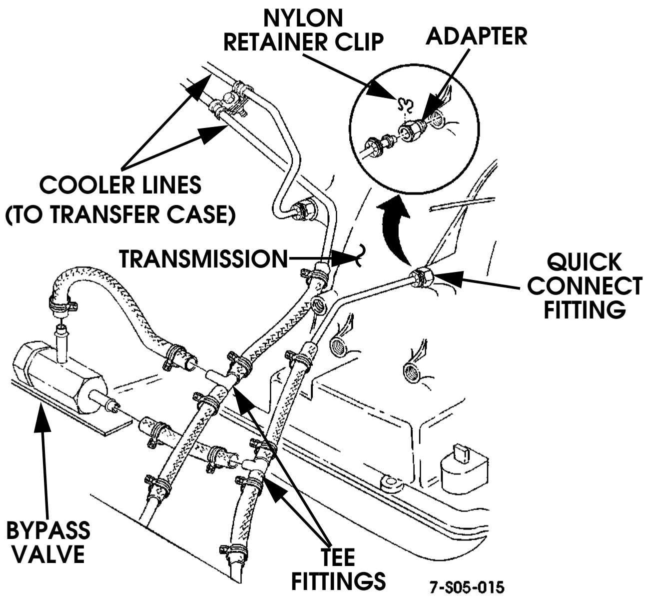


Figure 5-26: Bypass Valve Connections

A bypass valve is used in all Hummer vehicles (Figure 5-27). The valve limits pressure buildup in the oil cooler and lines.The bypass valve is attached to the passenger side cross-member-to-frame bracket bolt. The cooler lines are attached to body/chassis components with clamps (Figure 5-26).

OIL COOLER FLUSHING

NOTE: Oil cooler must be flushed whenever transmission is changed.

The cooler and lines should be flushed whenever a malfunction generates clutch or metal particles.

1. Loosen clamps and disconnect front cooler lines at cooler.
2. Use air nozzle and short bursts of compressed air to force fluid from cooler and lines.
3. Pump clean transmission fluid through cooler and lines to flush remaining contaminants. Use suction gun and fresh transmission fluid or flush kit J35944-A and fluid J35444-22.
4. Connect cooler lines and install clamps.
5. Flush transfer case cooler and lines using same procedure.

FILL TUBE REPLACEMENT

1. Remove dipstick from fill tube (Figure 5-28).
2. Remove console and engine cover.
3. Remove bolt attaching fill tube bracket to cylinder head on non-turbo, or heat shields on turbo models (Figure 5-28).
4. Work fill tube out of transmission.
5. Remove fill tube seal from transmission. Discard if damaged.

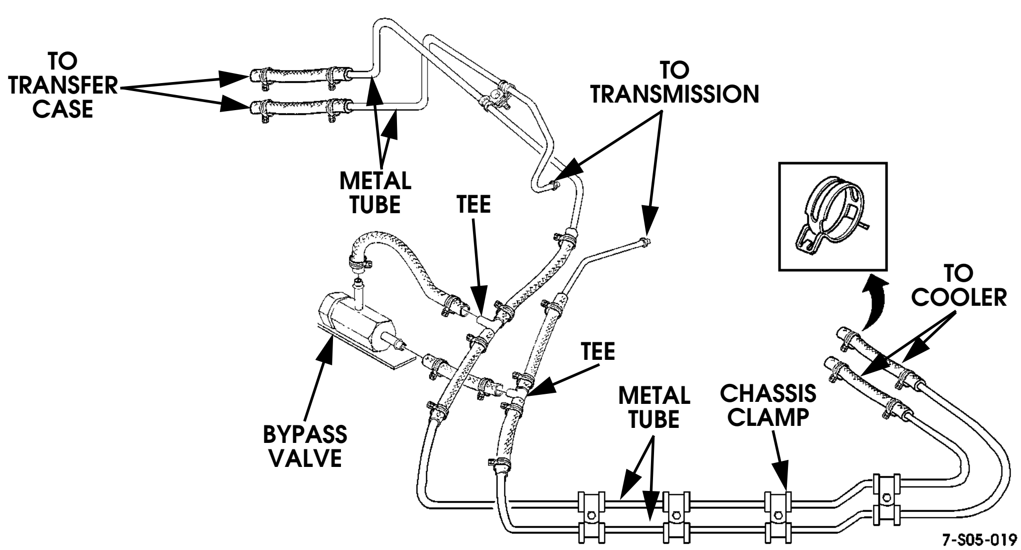


Figure 5-27: Transmission/Transfer Case Oil Cooler Line Connection

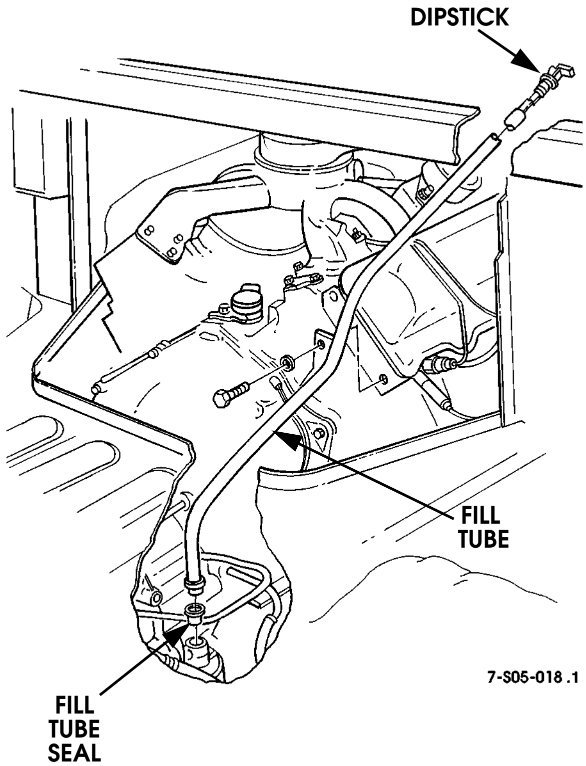


Figure 5-28: Fill Tube Attachment (NA Diesel Shown)

6. Install fill tube seal in transmission.
7. Push fill tube into transmission.
8. Secure fill tube to cylinder head or heat shield. Tighten bolt to 25-37 lb-ft (34-50 N•m).
9. Install dipstick in fill tube.
10. Install engine cover and console.
11. Start engine and top off transmission fluid level if required.

VENT LINE SERVICE

The transmission, transfer case, front and rear hubs, and winch are all connected to a common vent line system (Figure 5-29). The main vent lines are plastic while lines from the hubs to the tee connections consist of rubber hoses. Brass tee fittings are used at each vent line junction.

The transmission and transfer case vent lines and fittings are all serviceable parts.

Vent lines or fittings can be replaced individually. It is not necessary to replace all of the lines if only one section is damaged.

In cases where plastic vent line is supplied in bulk quantity, the required length can be cut to size with a fine tooth hacksaw blade. Diagonal pliers or similar cutting implements are not recommended.

If a plastic line proves difficult to install, a small amount of liquid soap can be used as a lubricant. Do not use any other product to ease line assembly and installation.

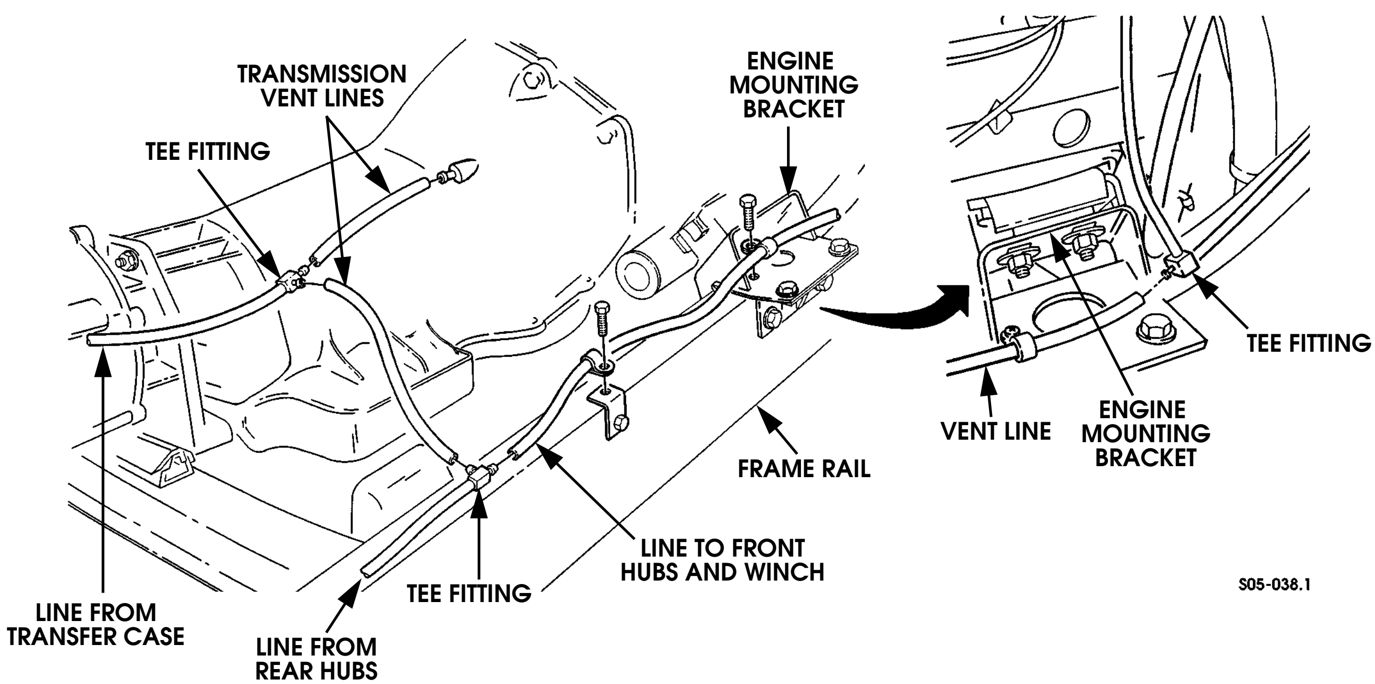


Figure 5-29: Transmission Vent Line

CONVERTER HOUSING UPPER COVER REPLACEMENT

1. Remove converter housing upper cover from transmission flange (Figure 5-30).
2. Remove gasket from cover.
3. Clean gasket or sealer remains from transmission flange.

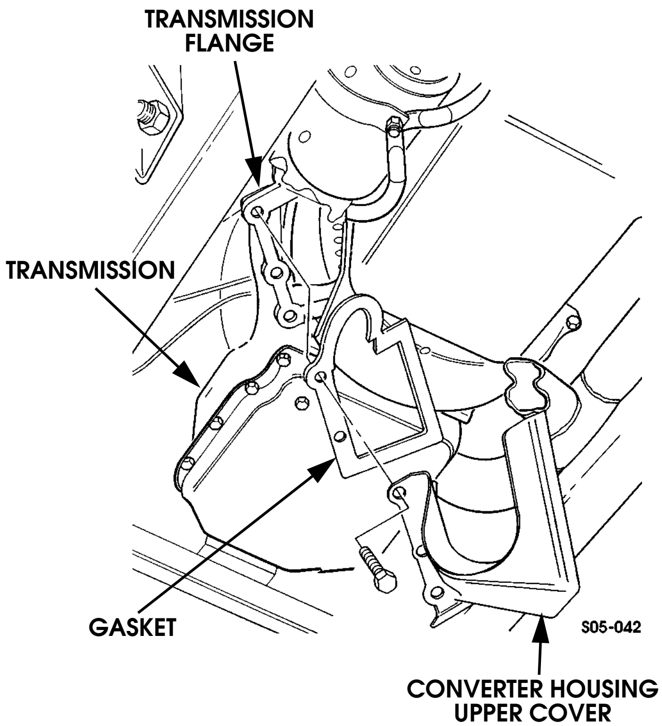


Figure 5-30: Converter Housing Upper Cover Mounting

4. Apply sealer to gasket and install gasket on cover.
5. Install cover on transmission flange.

CONVERTER HOUSING LOWER COVER REPLACEMENT

1. Remove crossover pipe.
2. Remove converter housing upper cover.
3. Remove lower bolts and remove cover from transmission (Figure 5-31).
4. Remove gasket from housing cover.
5. Clean sealer or gasket remains from transmission flange.

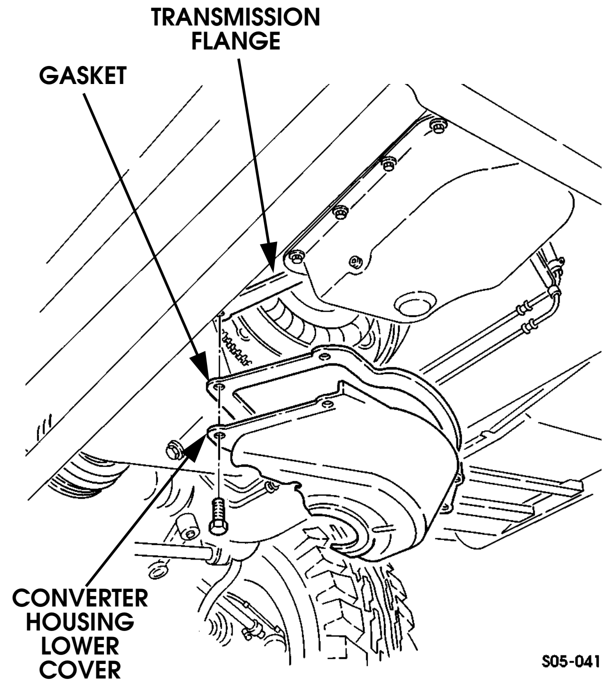


Figure 5-31: Converter Housing Lower Cover Mounting

6. Apply sealer to gasket and install on cover.
7. Apply sealer to housing cover.
8. Install housing cover on transmission flange.
9. Install converter housing upper cover.
10. Install crossover pipe.

VALVE BODY SWITCH AND SOLENOID SERVICE

The following electrical components can be replaced once the oil pan and/or valve body are removed from the transmission (Figure 5-32):

- 1-2 and 2-3 shift solenoids
- pressure switch
- pressure control solenoid
- converter clutch solenoid
- wiring harness

The park lock actuator components are also accessible after valve body removal. Refer to Park Lock Component Service.

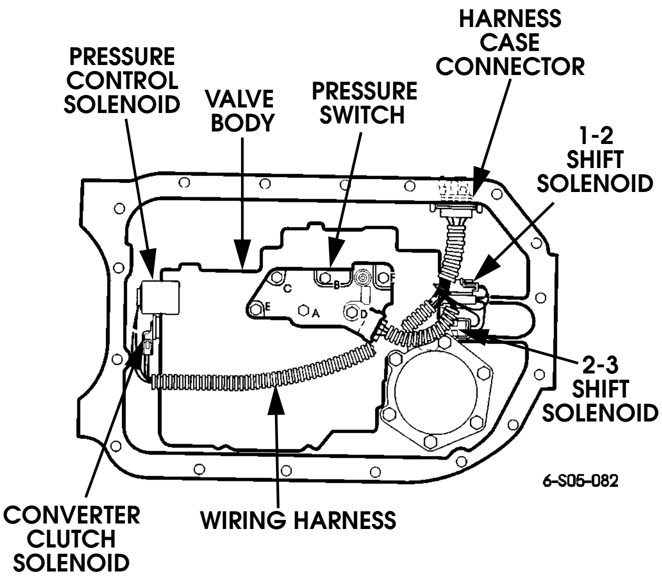


Figure 5-32: Valve Body Switch and Solenoid Locations

Valve Body Removal

1. Remove oil pan and filter. Refer to Fluid and Filter Replacement procedure in this section.
2. Remove bolts attaching lube pipe clamp and retainer. Then carefully remove lube pipe (Figure 5-33).
3. Disconnect wiring harness from switch and solenoids.
4. Remove special bolts attaching pressure switch to valve body and remove switch. Note special bolts separate and note position for installation reference (Figure 5-33).
5. Remove bolts attaching dipstick stop and park detent spring to valve body and remove stop and spring.
6. Remove remaining valve body bolts and carefully remove valve body, spacer plate, and gasket.

CAUTION: *The valve body check-balls are not secured and are loose. Keep the valve body level and the spacer plate in position during removal. This will avoid losing or mispositioning the check-balls. The check-balls are not available separately, they are available only as part of a complete valve body assembly.*

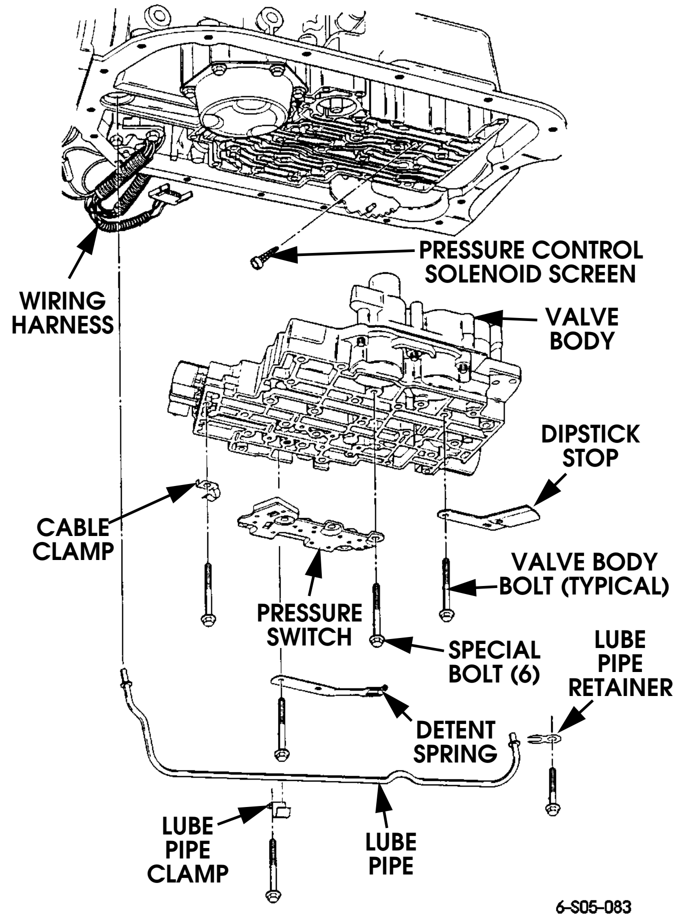


Figure 5-33: Valve Body Removal/Installation

7. Remove necessary solenoid from valve body. Refer to Figure 5-32 or Figure 5-34 for solenoid locations.
8. Remove wiring harness, if it is to be replaced.

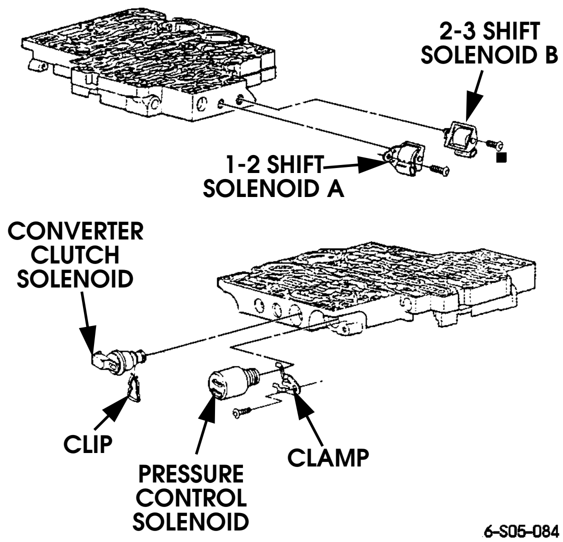


Figure 5-34: Solenoid Identification

Valve Body Installation

1. Install replacement solenoid or wiring harness as required.
2. Verify that valve body spacer plate and gasket are in position. Also be sure check-balls were not displaced. There should be eight check-balls.
3. Install valve body guide pins 05735207 in transmission case.
4. Carefully position valve body on guide pins and transmission case. Install 2-3 bolts to hold valve body in place and remove guide pins.
5. Install pressure switch, dipstick stop, harness clamp and detent spring but do not fully tighten bolts at this time.
6. Install lube pipe, retainer, and pipe clamp (Figure 5-33).
7. Tighten valve body bolts to 97 lb-in. (11 N•m) torque. Start at center and work outward in a spiral pattern (Figure 5-35).

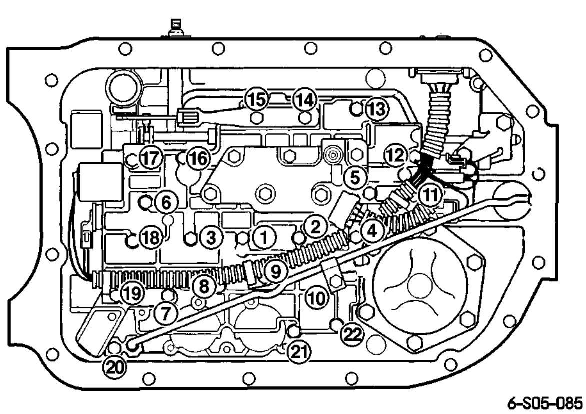


Figure 5-35: Valve Body Bolt Tightening Sequence (in Numerical Order)

***CAUTION:** The valve body bolts must be tightened to specified torque and in the indicated pattern. Overtightening or random tightening will distort the valve body resulting in valve bind, cross leakage, and shift problems.*

8. Connect wire harness to solenoids and switch.
9. Install oil filter and oil pan.
10. Refill transmission with Dexron III.

PARK LOCK COMPONENT SERVICE

The park lock components can be serviced without removing the transmission.

Access to the park lock components requires removal of the oil pan and valve body. Part replacement procedure is as follows.

Park Lock Component Replacement

1. Remove oil pan and valve body as described in this section.
2. Remove nut that retains detent on shaft (Figure 5-36). Then remove shaft pin.
3. Remove park pawl bracket bolt and bracket.
4. Remove detent and actuator rod (Figure 5-36).
5. Remove park pawl stud, retainer, spring, shaft, and plug (Figure 5-36).
6. Clean parts to be reused with solvent, dry with compressed air, and lubricate with Dexron III.
7. Install pawl shaft in case. Then install pawl on shaft. Install new shaft cup plug in case with 5/16 in. (7.9 mm) diameter rod.
8. Install pawl retainer and return spring (Figure 5-36).
9. Assemble detent and actuator rod. Then install rod over pawl.
10. Install detent shaft and seal. Be sure shaft is properly seated in detent.
11. Install detent nut on shaft. Tighten nut to 18 lb-ft (24 N•m) torque.
12. Install shaft pin.
13. Install actuator rod bracket and bolts. Tighten bolts to 18 lb-ft (24 N•m) torque.
14. Install return spring stud.
15. Install valve body, oil filter and oil pan.
16. Refill transmission with Dexron III. Correct fluid level is at top, or within cross hatch area on dipstick, with fluid hot, engine idling and transmission in park.

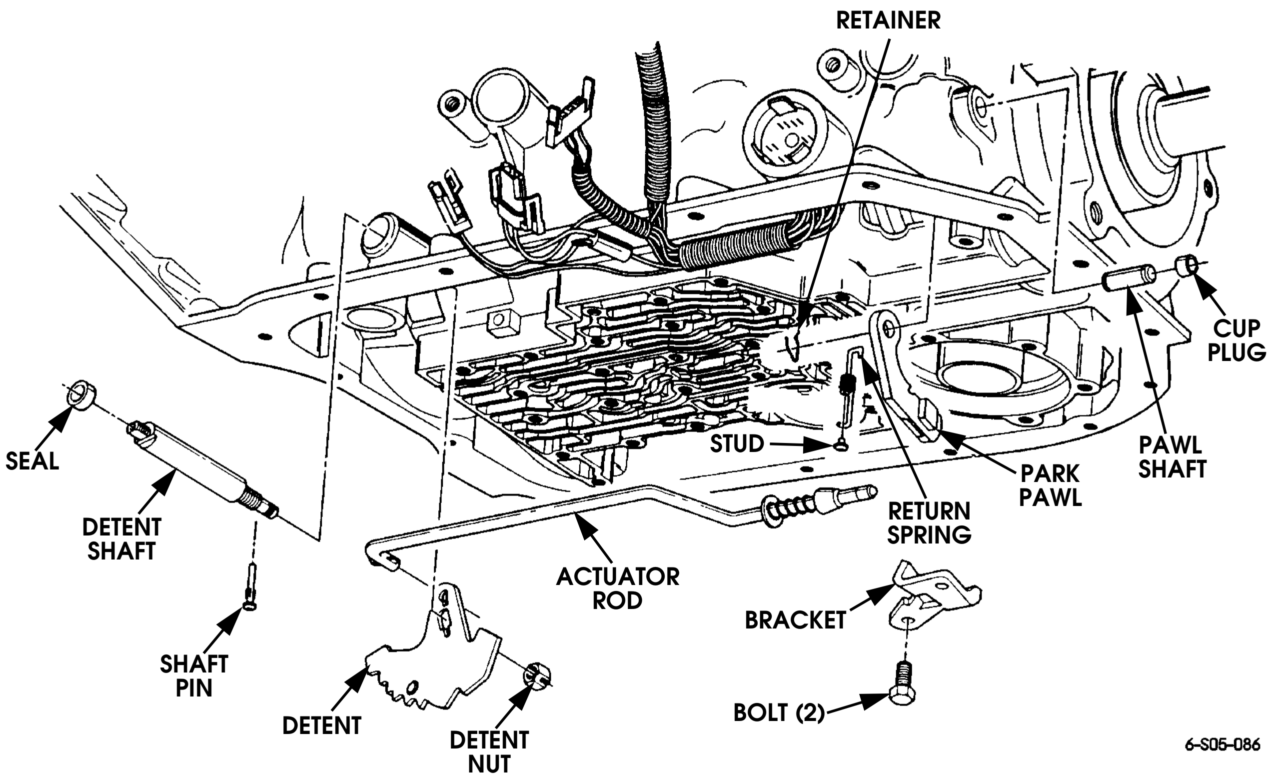


Figure 5-36: Park Lock Components

TORQUE CONVERTER/FLEXPLATE/OIL PUMP SEAL REPLACEMENT

1. Remove transmission as described in this section.
2. Remove torque converter from transmission (Figure 5-37).
3. Remove oil seal from pump. Use standard hook tool to pull seal.

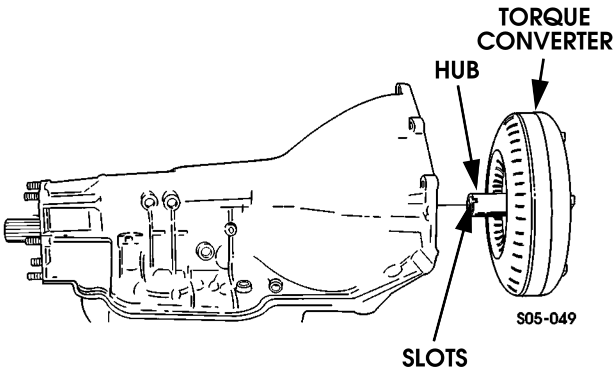


Figure 5-37: Torque Converter Removal/Installation

4. If flexplate is to be replaced, remove attaching bolts and remove driveplate.
5. Position new flexplate on crankshaft flange. Apply 1-2 drops of Loctite 242 to flexplate bolt threads. Then install and tighten bolts to 65 lb-ft (88 N•m) torque.

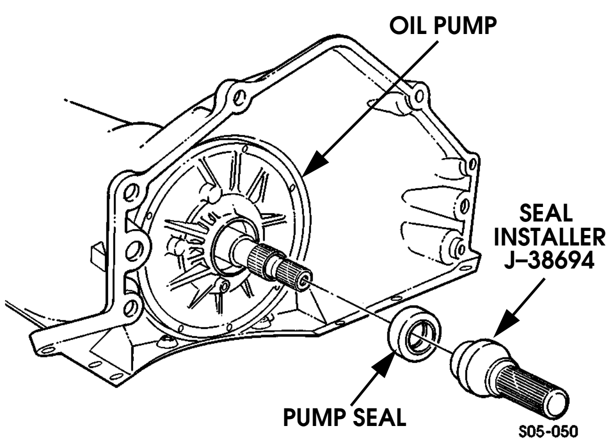


Figure 5-38: Oil Pump Seal Installation

6. Install seal with tool J–38694 (Figure 5-38).
7. Install torque converter. Be sure drive lugs on pump gear are engaged in drive slots of converter hub (Figure 5-37).
8. Install transmission as described in this section.

NOTE: Converter will be recessed in housing when installed completely and will turn freely when transmission is installed on engine.

TRANSMISSION REMOVAL

1. Remove console and engine cover.
2. Remove bolt attaching transmission fill tube to heat shield or cylinder head (Figures 5-39 and 5-40). Then remove fill tube from transmission case. Cover fill tube bore in case to prevent dirt entry.
3. Disconnect transfer case shift rod at operating lever (Figure 5-41).
4. Disconnect transmission shift rod trunnion from shift control arm (Figure 5-42).
5. Disconnect speed sensor and lock indicator switch wires at rear of transfer case (Figure 5-43). Then disconnect range switch at front of transfer case.
6. Remove clamps securing wire harness to transfer case and transmission.
7. Disconnect vent lines at transmission and transfer case.
8. Disconnect transmission harness at case connector by squeezing both lock tabs of harness connector, and pulling it straight out of case connector.

CAUTION: *Do not pull, twist, pry, or rotate the harness connector in an attempt to remove it. This action can damage the connector body, pin terminals and solder joints. Release only by squeezing the lock tabs (Figure 5-44).*

9. Disconnect harness wires at transmission input and output speed sensors (Figure 5-45).

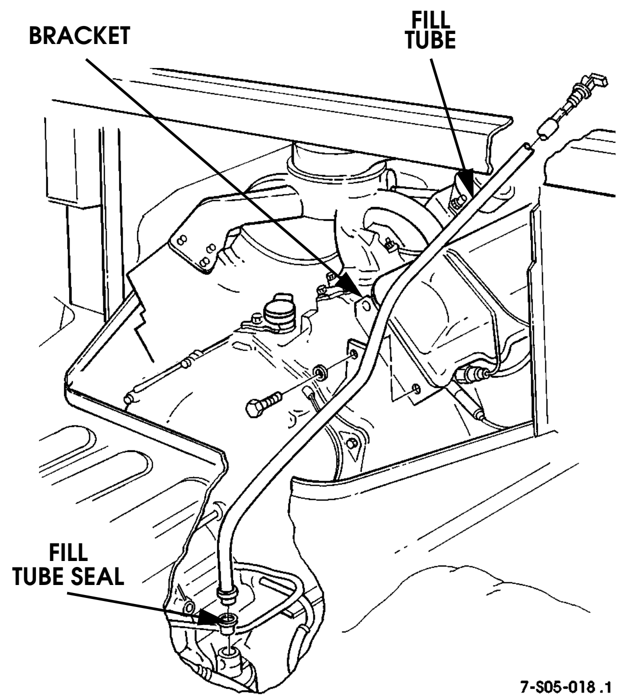


Figure 5-39: Fill Tube Attachment (NA Diesel)

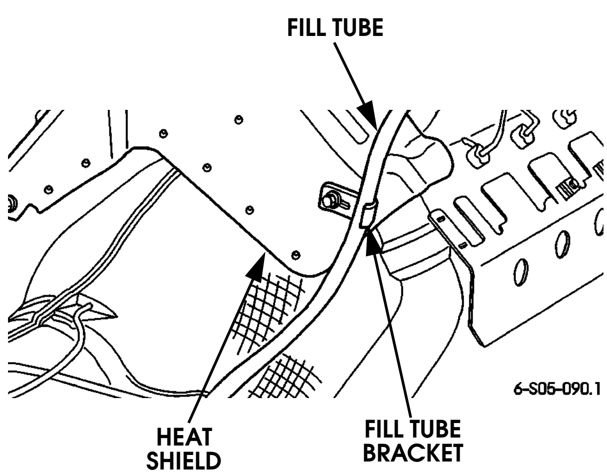


Figure 5-40: Fill Tube Bracket Location (Turbo Diesel)

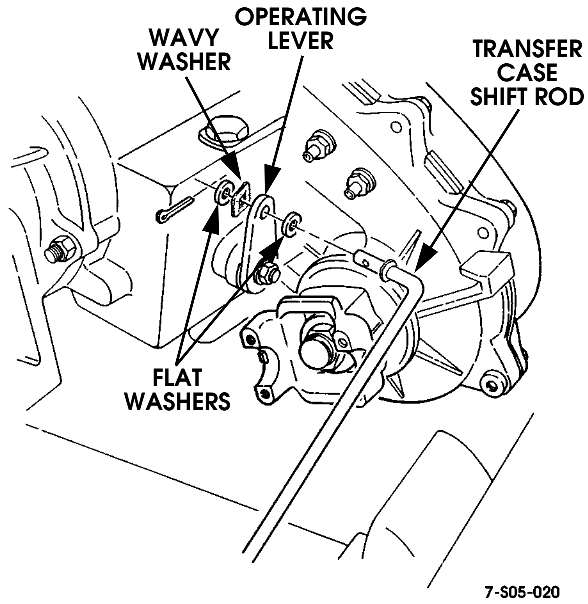


Figure 5-41: Shift Rod Attachment

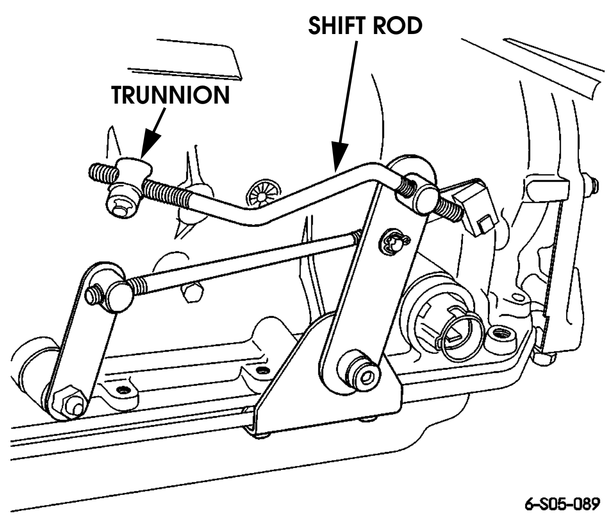


Figure 5-42: Transmission Shift Rod and Trunnion

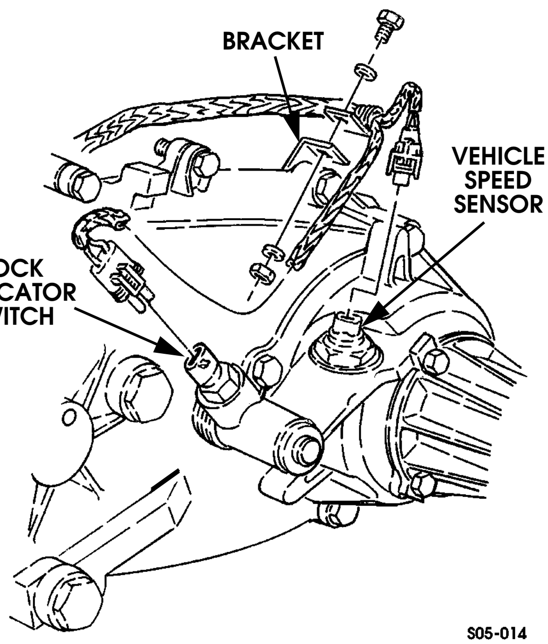


Figure 5-43: Vehicle Speed Sensor and Switch Harness Connection

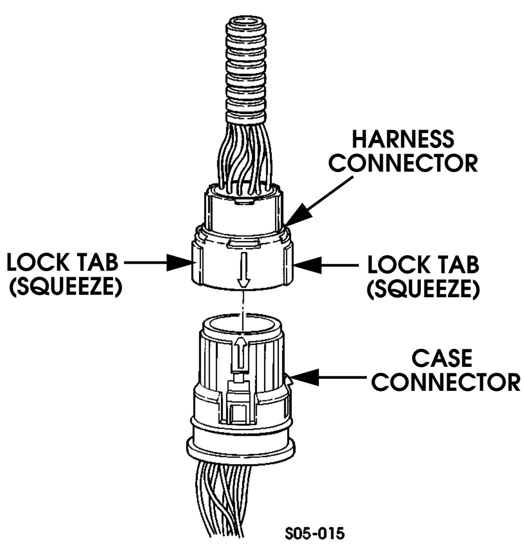


Figure 5-44: Releasing Transmission Case Harness Connectors

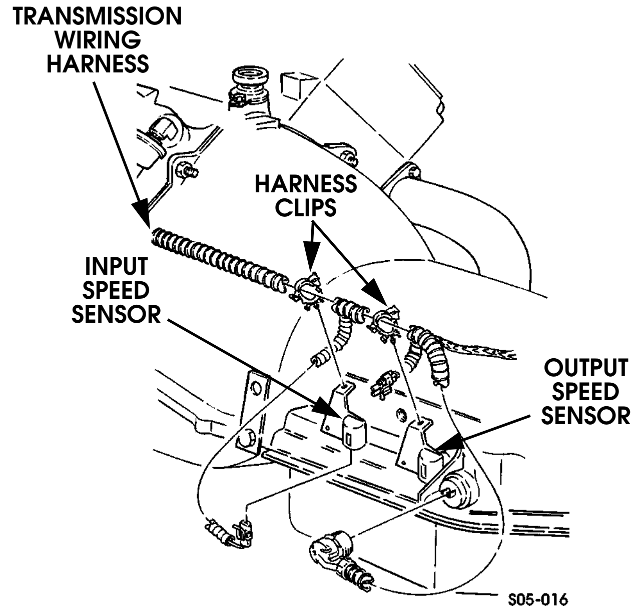


Figure 5-45: Speed Sensor Connections

10. Remove transmission harness from retaining clips.
11. Remove front and rear propeller shafts.
12. Remove exhaust crossover pipe, catalytic converter, muffler and tailpipe.
13. Remove converter housing covers.
14. Support engine with jack stand and wood block positioned under oil pan.
15. Support transmission with transmission jack.
16. Remove transfer case guide cable.
17. Disconnect cooler lines at transfer case and transmission.
18. Remove nuts attaching transfer case to transmission adapter and remove transfer case with aid of helper.
19. Remove bolts attaching transmission mount to transmission adapter (Figure 5-46). Then remove bolts attaching crossmember to frame brackets and remove crossmember.
20. Secure safety chain around transmission and jack (Figure 5-47).
21. Remove bolts attaching torque converter to driveplate flywheel (Figure 5-48).
22. Remove bolts and studs attaching transmission to engine (Figure 5-47).
23. Move transmission rearward until clear of engine. Then use C-clamp or strap attached to housing to hold converter in place.
24. Move transmission from under vehicle.

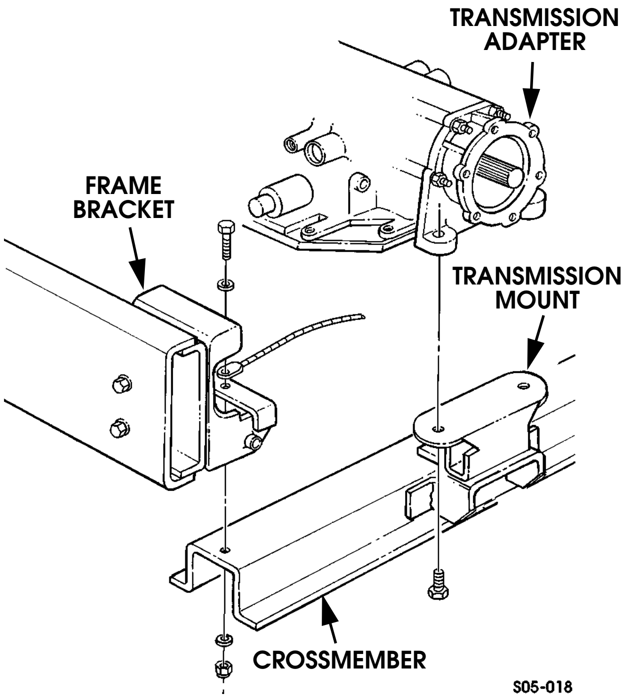


Figure 5-46: Transmission Rear Mounting

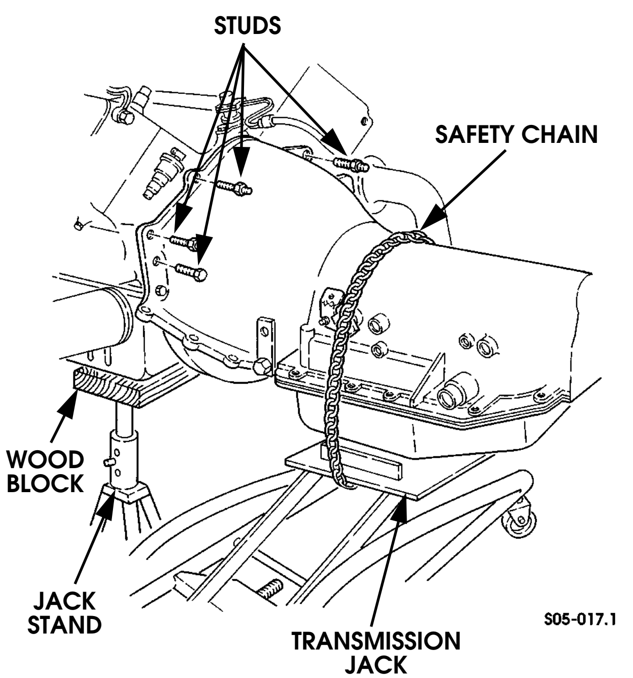


Figure 5-47: Transmission Removal/Installation

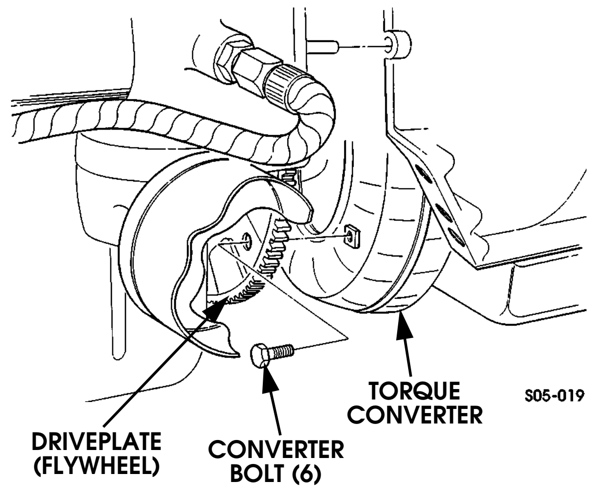


Figure 5-48: Torque Converter-To-Flexplate Bolt Locations

TRANSMISSION INSTALLATION

CAUTION: *If the transmission was replaced, or repaired to correct a problem that generated metal and clutch disc particles, the transmission cooler and lines must be thoroughly flushed and the torque converter replaced. This is necessary to avoid recontaminating and damaging the transmission.*

1. Mount transmission on transmission jack and secure transmission with safety chain (Figure 5-47).
2. Tilt transmission converter housing upward slightly to help retain converter during installation.
3. Smooth converter hub with 320-380 grit emery to remove burrs or sharp edges. Clean hub thoroughly afterward. Hub must be smooth to avoid damaging pump seal during installation.
4. Lubricate converter hub and pump seal with transmission fluid. Then install converter. Be sure converter is fully seated in pump before proceeding.
5. Move transmission into position and align transmission converter housing with engine block dowels. Slide transmission forward and into place. Be sure converter pilot is seated in crankshaft and that transmission is aligned on dowels. Install one or two studs or bolts to hold transmission in place.
6. Install and tighten transmission attaching stud and bolts to 35 lb-ft (47 N•m) torque.
7. Apply one or two drops of Loctite 242 to threads of attaching bolts. Then install and tighten bolts to 32 lb-ft (43 N•m) torque.
8. Install converter housing covers.
9. Install transfer case. Tighten attaching nuts to 30 lb-ft (41 N•m) torque.

10. Install rear crossmember and secure transmission mount to adapter. Tighten adapter-to-mount bolts to 65 lb-ft (88 N•m) torque. Tighten crossmember-to-frame bracket bolts to 90 lb-ft (122 N•m) torque.
11. Connect oil cooler lines to transmission and transfer case. Be sure lines are properly secured in clamps and brackets.
12. Connect vent lines to transmission and transfer case.
13. Connect transmission harness to transmission case connector. Be sure harness connector is fully seated and snaps into place.
14. Connect wires to transmission input and output sensors.
15. Connect wires to transfer case range and lock switches, and to speed sensor.
16. Attach transmission shift rod to arm of control assembly. Then connect transfer case shift rod to range lever on transfer case.
17. Install transfer case guide cable.
18. Check and top off transfer case fluid if necessary.
19. Install starter motor.
20. Install exhaust pipes, muffler, and catalytic converter.
21. Install front and rear propeller shafts.
22. Install transmission fill tube and dipstick. Replace fill tube seal if worn, cut, or distorted.
23. Install engine cover and console.
24. Add four quarts (3.7 liters) of Dexron III to transmission.
25. Drive vehicle long enough to bring transmission fluid to normal operating temperature.
26. Check transmission fluid level. Add fluid in small increments to avoid over filling. Correct hot level is in, or to top of crosshatch area on dipstick with engine idling and transmission in Park.

SHIFT CONTROL ASSEMBLY REMOVAL

NOTE: Wavy washers eliminate any potential transfer case shift linkage rattle (Figure 5-49). If a rattle is present on a vehicle not equipped with a wavy washer, install one as shown. Refer to parts manual for wavy washer part number.

NOTE: Open shifter boot cover (unfasten snaps and pull apart velcro strips) for access to shifter linkage.

1. Remove driver side inner kick panel.
2. Disconnect shift rod trunnions at housing shift arms (Figure 5-49).

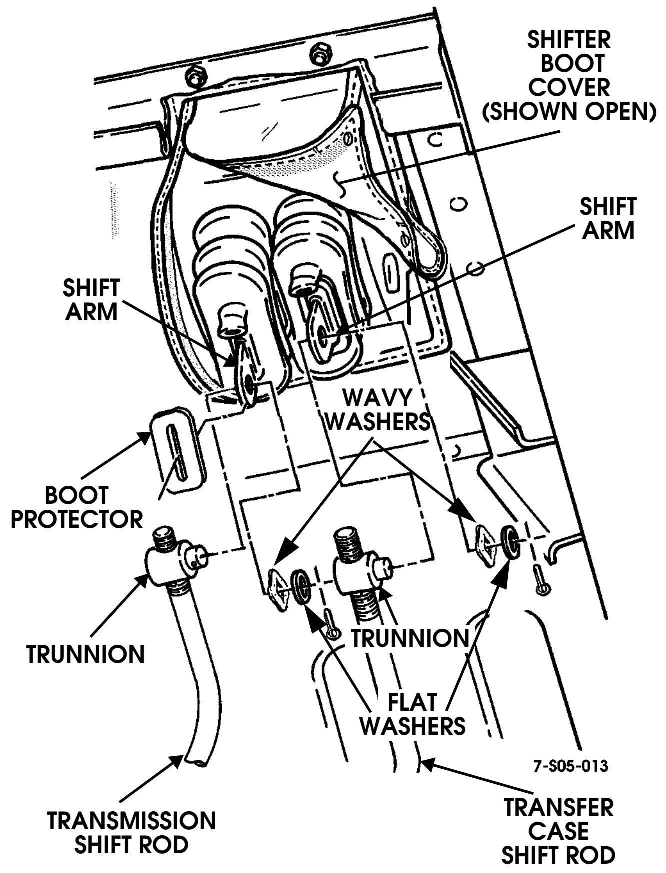


Figure 5-49: Shift Rod Connection (Illustration Shown with Shifter Boot Cover Opened)

3. Remove two shift control boot protectors.
4. Remove shift control housing bolts and remove assembly from body (Figure 5-50).
5. Move shift boot away from shift control housing for access to wires (Figure 5-50).
6. Remove wiring tie strap.

NOTE: Tag wires for installation reference.

7. Disconnect body harness wires from backup light switch.
8. Disconnect body harness wires from park/neutral position switch wires.
9. Disconnect body harness lead from shift indicator wire.
10. Disconnect interlock cable at shifter (Figure 5-51).
11. Remove boot from shift control housing.
12. Remove shift control assembly.

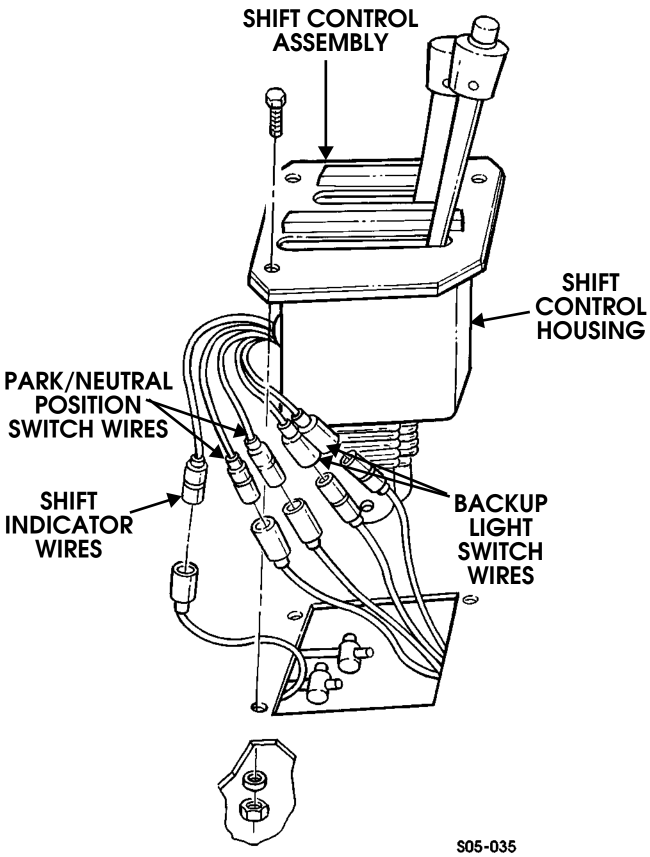


Figure 5-50: Harness Wire Identification

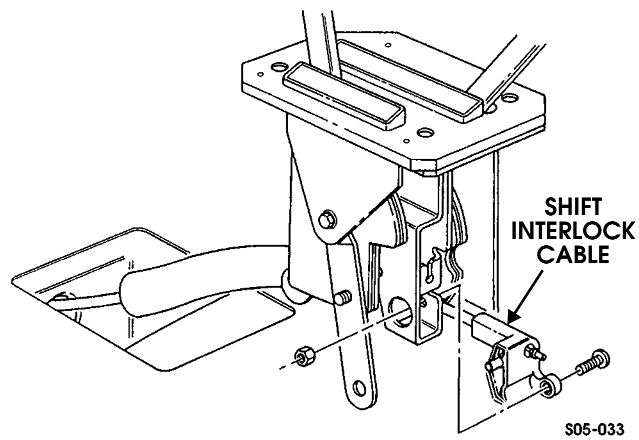


Figure 5-51: Interlock Cable Attachment

SHIFT CONTROL ASSEMBLY SERVICE

NOTE: Shifter Boot Cover (procedure in this section) must be removed for access to Shifter Control Boot.

The shift control housing and shift arms are not serviceable. The shift arm mechanisms can be lubricated to correct a bind condition when necessary. However, if any of the housing components are worn, or damaged, the housing must be replaced as an assembly.

The only control assembly parts that can be replaced separately, include the following (Figure 5-52):

- shift indicators
- shift knobs and spring pins
- housing cover plate and seal
- switches and retaining nuts
- wiring tie straps
- indicator bulb
- shifter boot and boot protector
- shifter boot cover (procedure in this section)

The park lock cable is also serviceable. Cable replacement and adjustment procedures are covered in Section 8, Steering System.

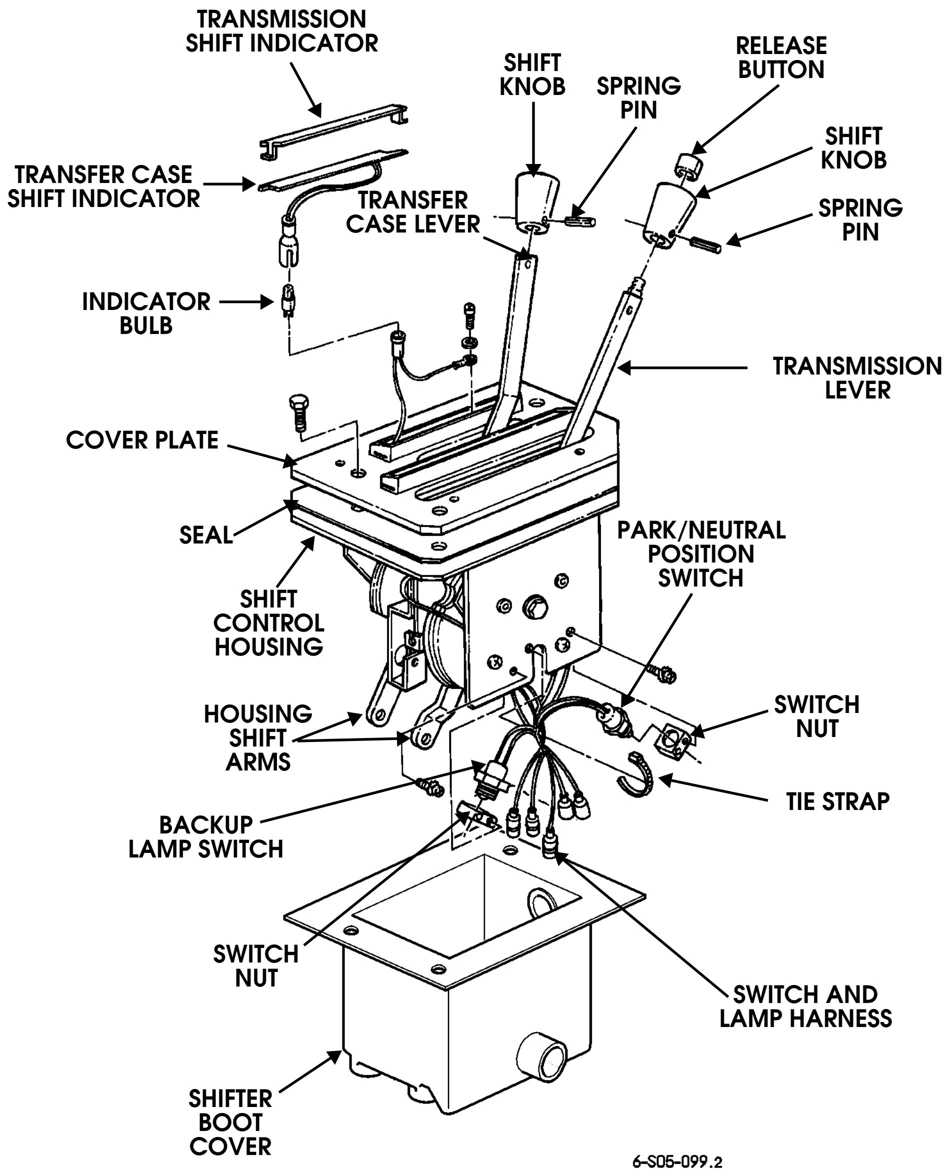


Figure 5-52: Shift Control Assembly Serviceable Components (Illustration Shown with Shifter Boot Cover Removed)

PARK/NEUTRAL POSITION OR BACKUP LAMP SWITCH REPLACEMENT

1. Remove driver side inner kick panel.
2. Open shifter boot cover for access to shift control arms.
3. Disconnect shift rods at shift control arms.
4. Remove bolts attaching shift control housing to tunnel floor.
5. Lift up for access and remove interlock cable.
6. Remove shift control assembly.
7. Remove shifter boot cover and shifter boot (Figure 5-53).
8. Remove position switch screws and remove switch from housing.
9. Remove tie strap and disconnect switch leads.
10. Disconnect backup or position switch wires at body harness.
11. Install switch on shift control housing and secure with lockwashers and screws.
12. Position wires in shifter boot and install shifter boot on housing assembly.
13. Install shift control assembly.
14. Install housing attaching screws.
15. Connect shift rods to control assembly shift arms.
16. Install inner kick panel.

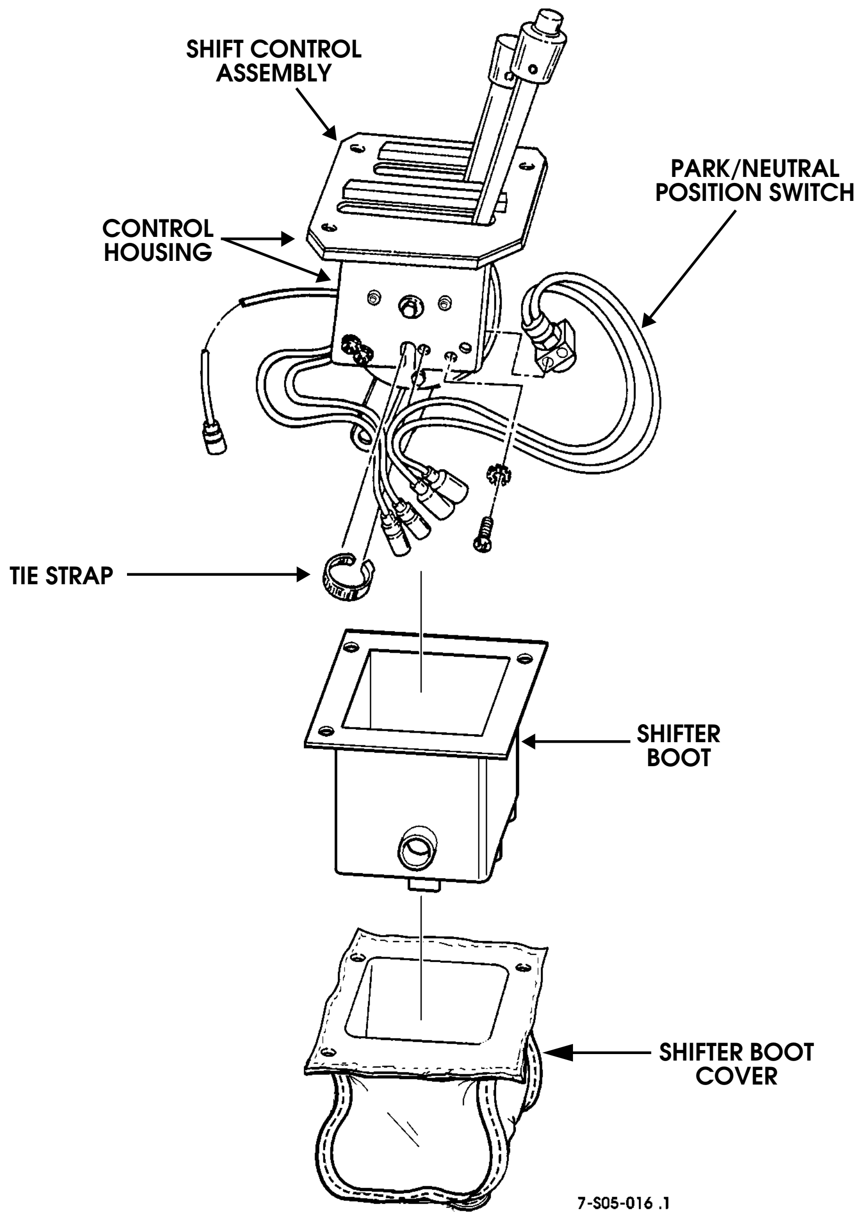


Figure 5-53: Shift Housing Switch Replacement

SHIFTER BOOT COVER REPLACEMENT

A "shifter boot cover" protects the shifter boot and linkage. The shifter boot cover is made of a silicone coated fiberglass, heat resistant material. This material provides the additional benefits of reduced noise and heat intrusion from under the vehicle into the passenger compartment.

Removal

WARNING: Exhaust system components can be extremely hot. To avoid injury, do not touch hot exhaust system components.

1. The exhaust system passes directly under the shift control assembly. Loosen, but do not remove, the two clamps holding the heat shield to the exhaust pipe so that it can be moved out of the way as necessary when performing the following procedure.
2. Unfasten shifter boot cover snaps and pull apart velcro strips to open cover (Figure 5-54).

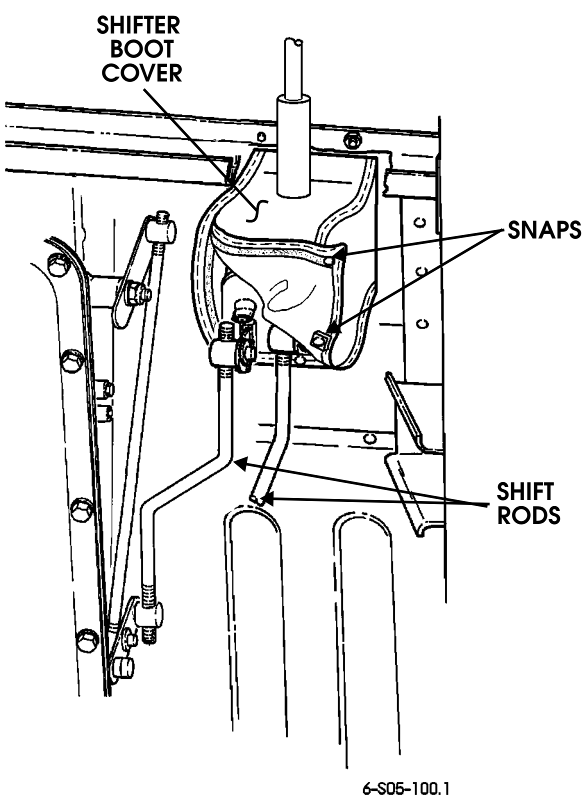


Figure 5-54: Shift Rod Removal

3. Remove shift rods from shift control assembly.
4. Remove bezel from shift control assembly (Figure 5-55).
5. Remove fasteners securing shift control assembly to tunnel and raise shift control assembly until interlock cable contacts tunnel, restricting further upward movement.
6. Cut shifter boot cover from the lip to the interlock cable hole as shown (Figure 5-55).
7. Work shifter boot cover lip out of tunnel opening and remove from under vehicle (Figure 5-56).

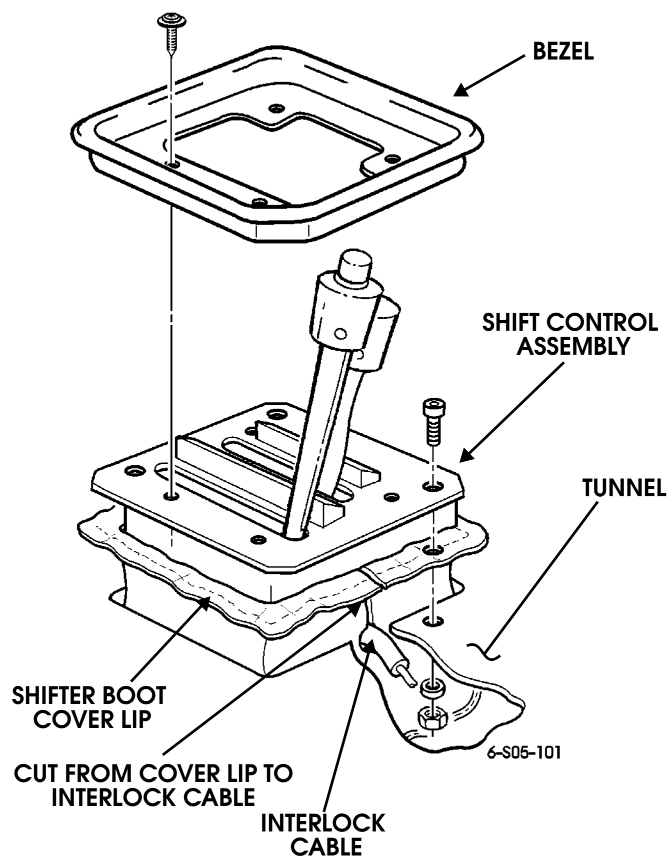


Figure 5-55: Cutting Shifter Boot Cover

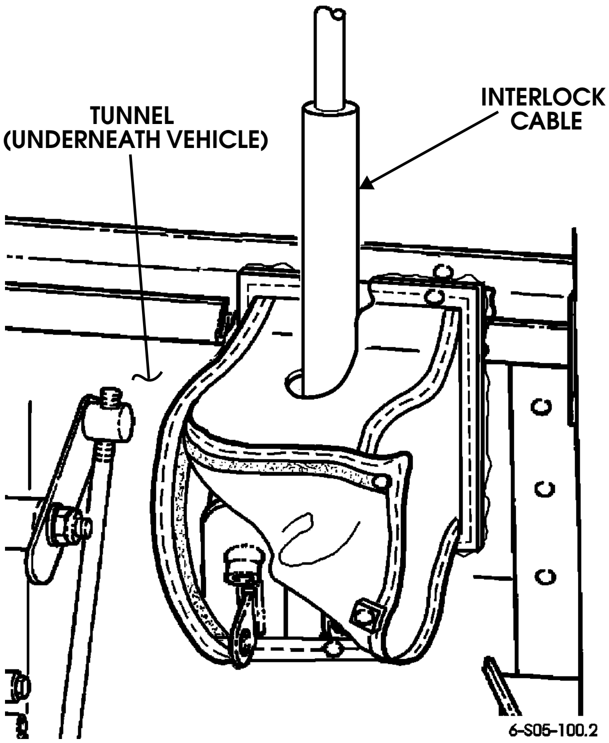


Figure 5-56: Shifter Boot Cover Removal

Installation

1. Work shifter boot cover lip into tunnel opening and align edges carefully to match opening.
2. Set shift control assembly into tunnel. Verify that fastener holes are positioned properly and shifter boot cover lip is not exposed.
3. Secure shift control assembly to tunnel.
4. Install bezel on shift control assembly.
5. Attach shift control rods to shift control assembly.
6. Fasten velcro and snaps to close shifter boot cover opening.
7. Properly position heat shield and tighten mounting clamps securely.

SHIFT CONTROL ASSEMBLY INSTALLATION

1. If cover plate and seal were removed, install new seal and plate. Then install wire harness and shift knobs.
2. Lubricate housing shift mechanism with spray lube.
3. Work interlock cable through boot and connect cable to shift housing (Figure 5-51).
4. Connect harness wires to switches and bulb.
5. Secure switch wires with new tie straps and slide boot up against housing. Be sure wire connectors to body harness are pulled through boot and secured with tie strap.
6. Install shift indicators and bulb if removed.
7. Seat shift control assembly in tunnel opening and secure with assembly attaching bolts. Tighten bolts to 6 lb-ft (8 N•m) torque.
8. Install two shift control housing boot protectors.
9. Connect transmission and transfer case shift rods to shift arms in control housing (Figure 5-49).
10. Install inner kick panel.

TRANSMISSION SHIFT ROD REPLACEMENT

1. Place shift lever in neutral.
2. Remove cotter pin, washer, and trunnion from housing shift arm.
3. Remove cotter pin and washer from shift rod rear trunnion. Disconnect trunnion and remove wave washer and shift rod from shift rod lever (Figure 5-57).

NOTE: Mark positions of trunnions on shift rods for installation reference.

4. Remove cotter pins securing trunnions to levers and remove rod.
5. Remove bolts attaching shift rod lever and bracket and remove lever and bracket.
6. Install new lever and bracket.
7. Install lever rod and shift rod. Adjust rods and linkage as described in Transmission Shift Linkage Adjustment Procedure.

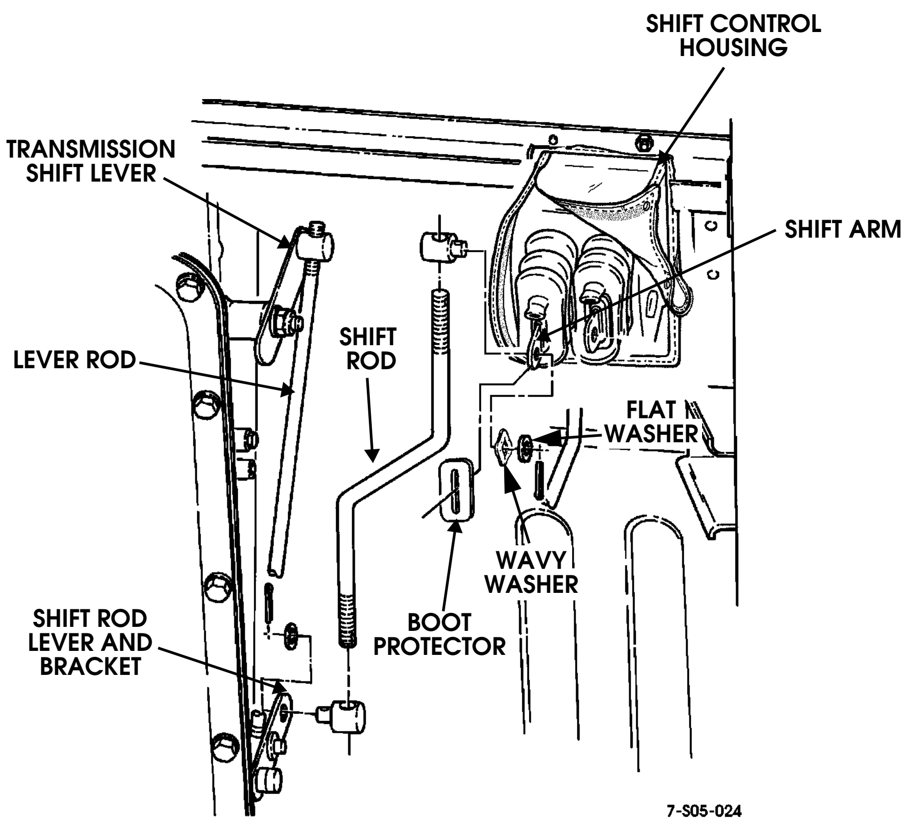


Figure 5-57: hift Linkage Disassembly/Assembly

SHIFT LINKAGE ADJUSTMENT

1. Move shift lever to manual low (1) range.
2. Disconnect transmission shift rod from arm in shift control housing.
3. Verify that transmission shift lever (Figure 5-58) is in manual low (1) range. If not, disconnect lever trunnion and adjust trunnion in, or out as needed. Then reconnect lever rod to shift lever.
4. Connect shift rod to shift control arm and check indicator alignment at shift lever. If indicator is not quite aligned, turn shift rod trunnion in or out to align.
5. Verify that shift rod and lever trunnions are correctly secured to arm and lever. Replace clevis pins if necessary.
6. Check shift operation. Verify that transmission shifts correctly and that indicator is properly aligned.

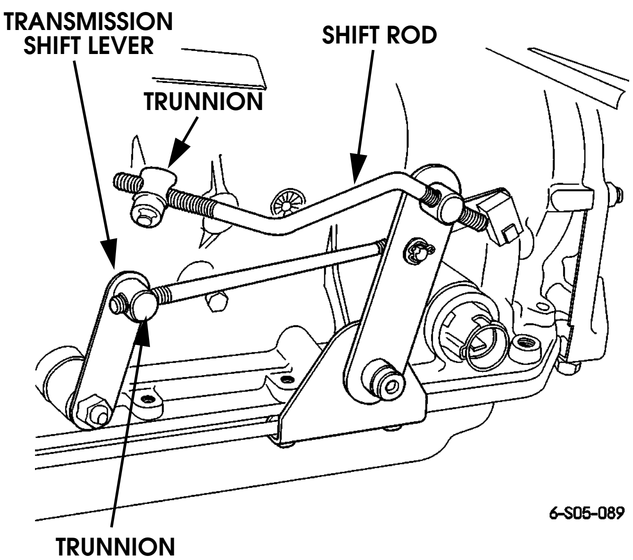


Figure 5-58: Transmission Shift Linkage

REAR MOUNT REPLACEMENT

1. Support transmission with floor jack and wood blocks.
2. Remove rear mount bolts/nuts and raise transmission slightly.
3. Remove rear mount from crossmember (Figure 5-59).

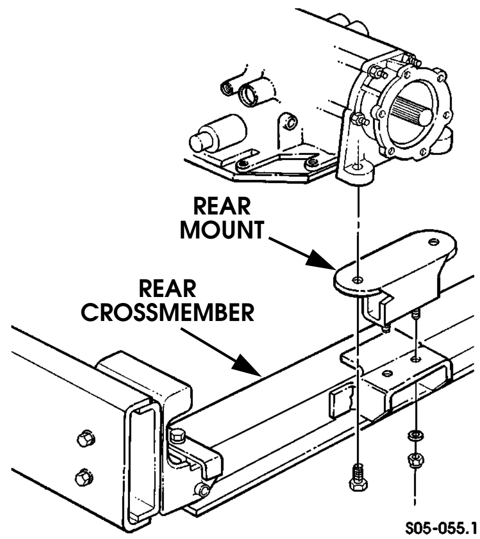


Figure 5-59: Rear Mount Replacement

4. Install mount on crossmember. Tighten attaching nuts to 65 lb-ft (88 N•m) torque.
5. Lower transmission and install mount-to-adapter bolts.
6. Tighten adapter bolts to 28 lb-ft (38 N•m) torque.

TRANSMISSION CONTROL MODULE (TCM) REPLACEMENT

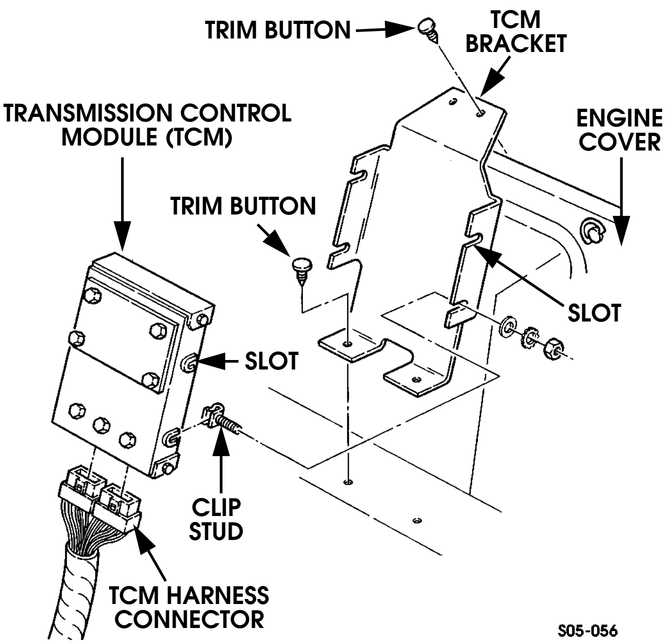


Figure 5-60: TCM and Bracket Attachment

***CAUTION:** Turn ignition switch OFF before disconnecting or reconnecting the transmission control module (TCM). Failure to do so may damage the TCM.*

1. Turn ignition switch OFF.
2. Remove front console and engine cover.
3. Disconnect harness wires from TCM (Figure 5-60).
4. Remove TCM clip stud and nuts and remove TCM.

NOTE: The new TCM does not contain a Programmable Read Only Memory (PROM). If the old PROM will be used, refer to PROM replacement. If a new PROM will be used, be sure the replacement unit part number is the same as old part number.

5. Install PROM in new TCM. Refer to PROM Replacement procedure.
6. Install clip studs and nuts on TCM (Figure 5-60).
7. Connect harness connectors to TCM.
8. Secure TCM to bracket.

PROM REPLACEMENT

1. Remove transmission control module (TCM).
2. Remove PROM access cover screws from TCM (Figure 5-61).

***CAUTION:** Do not remove any other screws from the TCM. Do not remove the cover from the PROM. Any other method of removal may cause damage to the PROM or PROM socket in the TCM.*

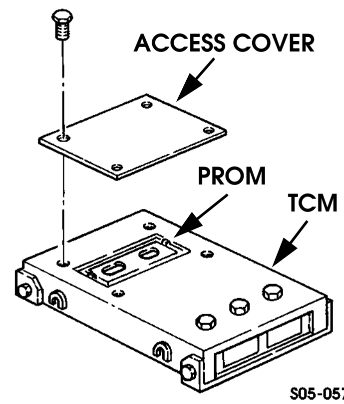


Figure 5-61: PROM Access Cover Attachment

3. Using two fingers, push both retaining clips away from PROM. While grasping PROM at both ends, lift it straight up out of socket (Figure 5-62).

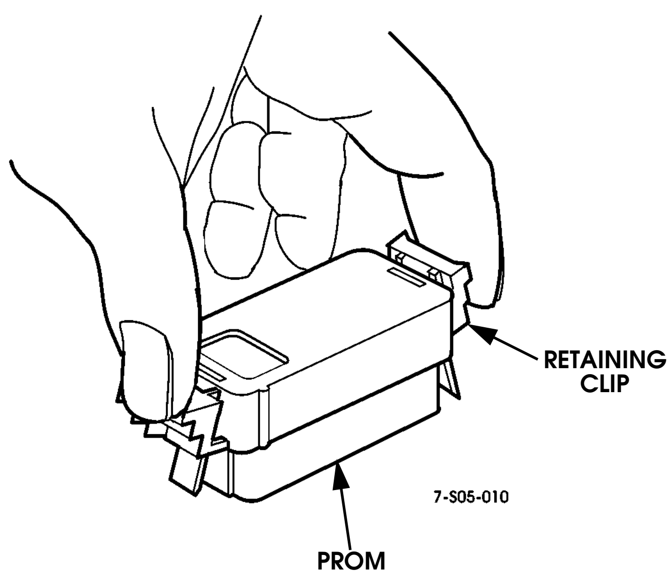


Figure 5-62: PROM Socket Retaining Clip Locations

***CAUTION:** To prevent possible electrostatic discharge damage to the TCM, do not touch the connector pins or soldered components on the circuit board. Also, do not remove the PROM cover.*

4. Inspect PROM alignment nodes and pins for damage or contaminants (Figure 5-63). Inspect TCM socket notches and pin connectors for damage and contaminants (Figure 5-64). Remove any contaminants with electrical contact cleaner. Replace PROM if pins or nodes are bent, burred, or dented.

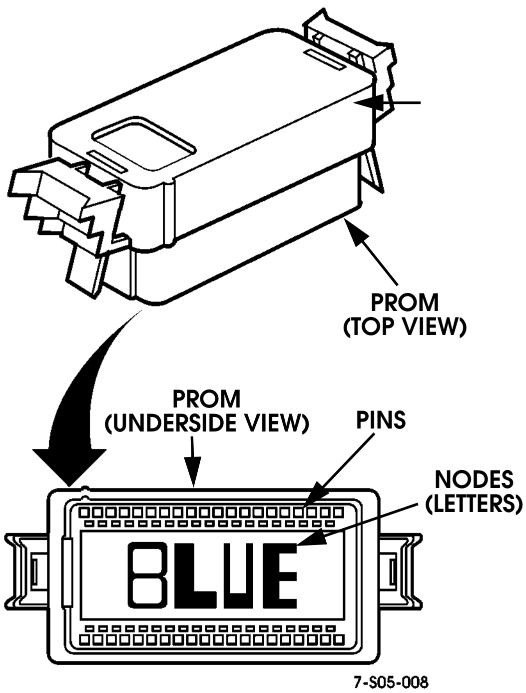


Figure 5-63: PROM Alignment Node and Pin Location

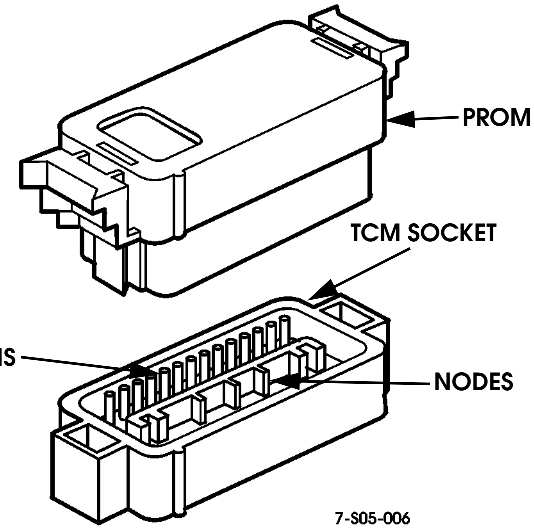


Figure 5-64: TCM Notch Locations

5. Verify that replacement TCM part number is same as old TCM.
6. Align nodes of PROM with mating notches on TCM socket (Figure 5-64).
7. Press straight down gently on ends of PROM until retaining clips are against side of PROM.
8. Press in on both retaining clips until they snap into place. A click should be heard as clips lock on PROM.
9. Install access cover on TCM.
10. Install TCM.

PROM Function Check

1. Turn ignition ON.
2. Ground data link connector pin 6. DTC 12 should flash four times on MIL if other codes are not present. This indicates PROM is installed properly, and functioning.
3. If DTC 51 occurs, or if the light is ON constantly with no DTC(s), the PROM is not fully seated, or is defective.
   a. Turn ignition off and disconnect TCM.
   b. If not fully seated, remove access cover and press firmly on ends of PROM.
   c. If necessary, remove and reinstall PROM.

THROTTLE POSITION SENSOR (TPS) ADJUSTMENT WITHOUT SCAN TOOL

1. Disconnect TPS connector from engine harness and install jumper wires between sensor and engine wiring harness (Figure 5-65).
2. Turn ignition switch to RUN position.
3. Using voltmeter, measure voltage between terminals A and C of sensor connector. Then multiply measurement by 0.33 to obtain desired TP sensor voltage.

   Example: 5.05 volts x 0.33 = 1.66 volts
4. Install a 0.646 in. (16.4 mm) gauge tool from tool J–33043-2, between throttle adjusting screw and boss on fuel injection pump housing (Figure 5-66).
5. Rotate injection pump throttle lever so that throttle adjusting screw holds gauge tool against housing boss. Secure lever in this position.

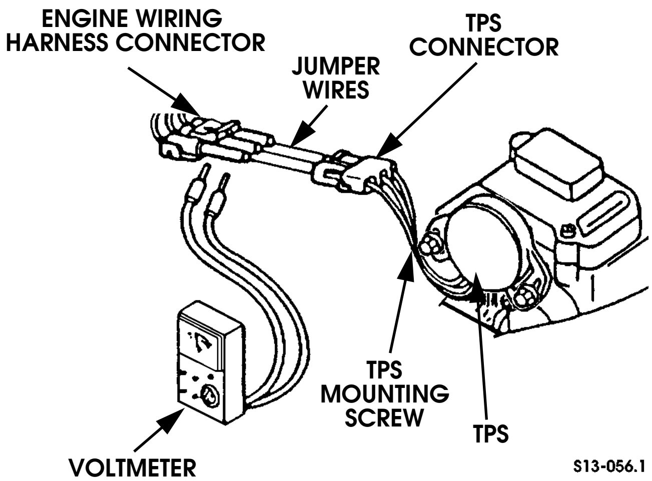


Figure 5-65: Measuring Sensor Voltage

6. Measure the voltage between sensor terminals B and C:
   - If voltage is within specification calculated in Step 3, proceed to step 10.
   - If voltage is not within calculated specification, proceed to next step.
7. Loosen sensor mounting screws and rotate sensor counterclockwise.
8. Connect voltmeter to sensor terminals B and C. Then rotate sensor slowly clockwise until voltmeter indicates desired voltage. Hold sensor in this position and tighten sensor mounting screws.
9. Confirm that adjustment did not change. Voltage should be approximately 90 percent (±5%) of voltage measured in step 3.

Example: 5.05 (measured voltage) x 0.33 (ratio) = 1.66 volts.

10. Reconnect sensor to engine wiring harness and remove gauge block.

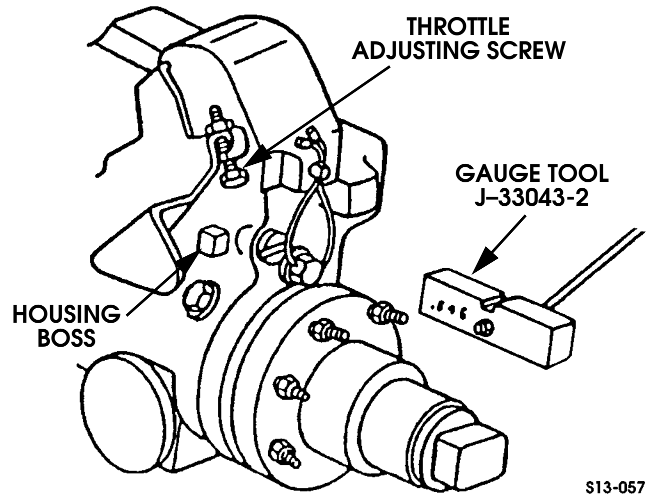


Figure 5-66: TPS Adjustment Gauge Installation

TRANSMISSION SPEED SENSOR REPLACEMENT

Both the input and output speed sensors are replaced the same way.

1. Turn ignition switch to OFF position.
2. Disconnect sensor wires.
3. Remove bolt attaching sensor to case.
4. Remove sensor with pull and twist motion.
5. Remove O-ring seal from sensor (Figure 5-67).

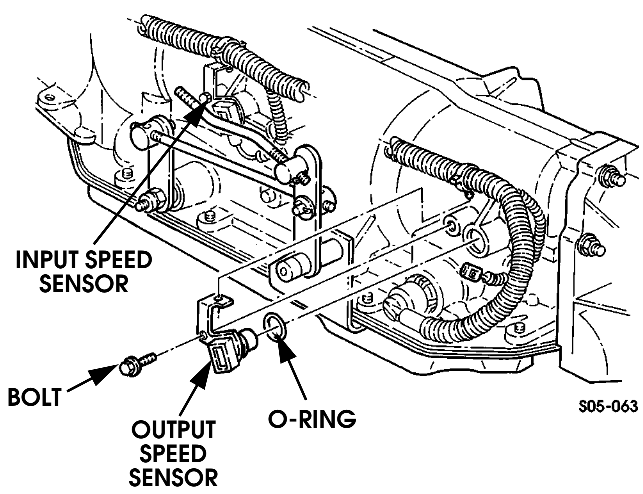


Figure 5-67: Speed Sensor Removal/Installation

6. Lubricate new O-ring seal with ATF and install it on sensor.
7. Install sensor with push and turn motion.
8. Install and tighten sensor bolt to 97 lb-in. (11 N•m) torque.
9. Connect wires to sensor.

TRANSFER CASE DESCRIPTION

Hummer vehicles are equipped with the New Process Gear, model 242 transfer case. If you have questions about the transfer case that are not answered by this section, you can call the Transfer Case Hotline at 1-800-945-4327 for more information

The 242 is a full-time, 4-wheel drive transfer case with three operating ranges plus a neutral position. Operating ranges are High (H), Low (L), and High Lock (HL). Low range (L) position provides a 2.72:1 reduction ratio for greater low speed, off-road torque capability.

The transfer case extension, bearing retainer, rear case, and front case are all aluminum castings. The front and rear output drive sprockets are interconnected by a drive chain (Figure 5-68). A differential in the transfer case, allows the front/rear output shafts to run at differing speeds. This permits full-time, 4-wheel drive operation in high range. The 242 is also equipped with an internal-mount oil cooler.

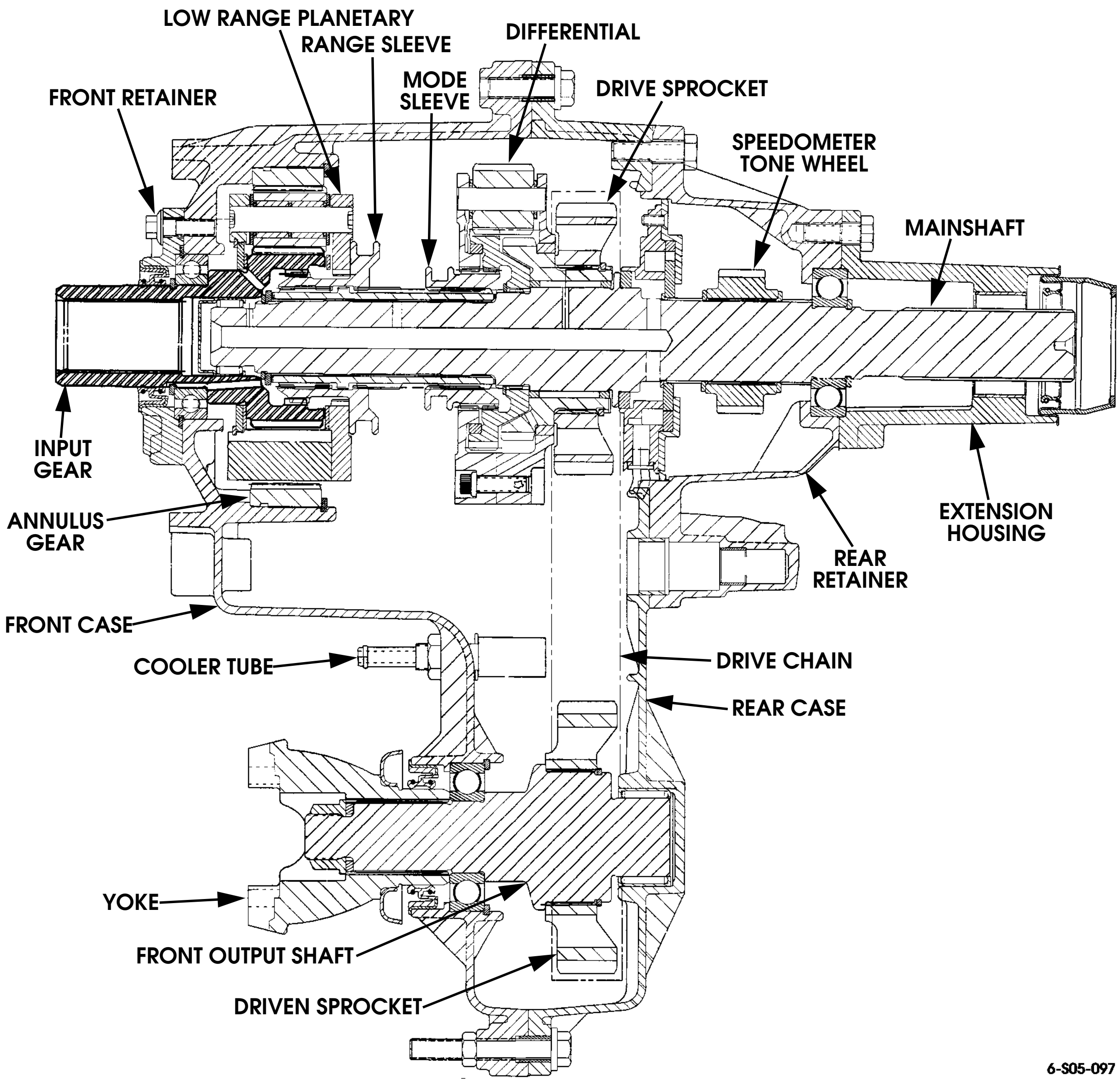


Figure 5-68: Model 242 Transfer Case

TRANSFER CASE OIL COOLER

The NP 242 used in Hummer vehicles is equipped with an internal oil cooler (Figure 5-69).

The cooler is mounted within the front case and secured by nuts and washers. O-rings are used to seal the cooler inlet/outlet tubes.

The cooler is interconnected to the transmission oil cooler circuit. However, transmission and transfer case oil are not intermixed. In operation, oil from the transmission cooler flows through the transfer case cooler. Heat from the transfer case oil is transmitted to the transmission oil which is then conveyed to the transmission cooler.

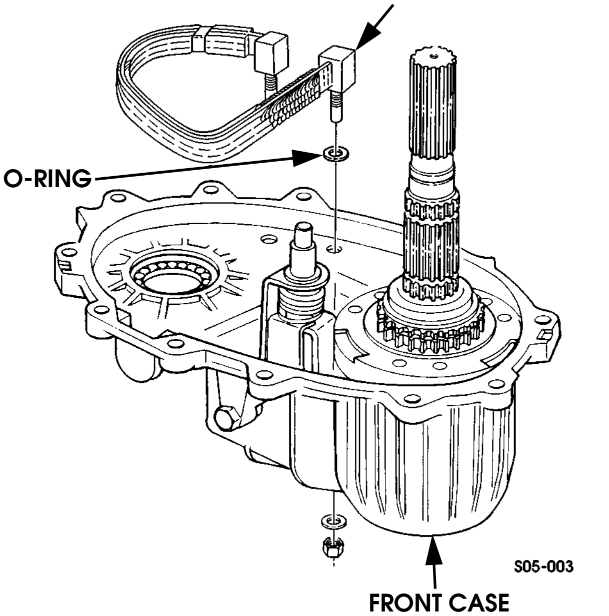


Figure 5-69: Oil Cooler Location

TRANSFER CASE IDENTIFICATION

An identification tag is attached to the rear case of each NP 242 transfer case (Figure 5-70). The tag provides the model number, assembly number, serial number, and low range ratio.

The serial number also represents the date of build. For example, a serial number of 10-10-95 would represent a build date of October 10, 1995.

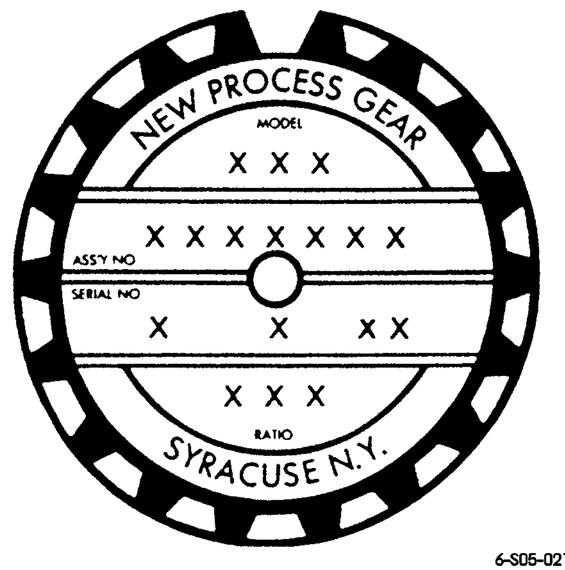


Figure 5-70: Transfer Case I.D. Tag Information

RECOMMENDED LUBRICANT

Dexron III is the recommended lubricant for the NP 242. Use it for topping off the fluid level and as replacement fluid for fluid changes, or after overhaul. Dexron IIE can also be used for topping off a low fluid level when Dexron III is not readily available.

Do not use friction modifiers or similar additives in the NP 242. Use recommended lubricants only.

Transfer Case Fluid Level

Correct transfer case fluid level is to the lower edge of the fill plug hole. Recommended fluid is Dexron III.

The vehicle must be on a level surface for an accurate fluid level check. If the vehicle is raised on a hoist to check fluid level, a drive-on style hoist is preferred. This type of hoist will keep the vehicle level.

The fill plug is just above the drain plug in the rear case. Tightening torque for the plug is 30 lb-ft (41 N•m).

OPERATING RANGES

The three operating ranges are for specific use on or off road. Usage recommendations are:

High Lock (HL)

High lock range is for use on low traction surfaces. It is an undifferentiated range and should only be employed on unpaved, or low traction surfaces; low traction defined as surfaces covered by snow, ice, sand, mud, or dirt. The differential is bypassed (locked out) in this range.

High (H)

High range is the only range recommended for use on hard, or paved road surfaces. This range can be used on, or off-road as desired.

Low (L)

Low range is for low speed, off road operation. The extra pulling power provided is useful when traversing steep grades, or driving in deep mud or sand. The low range gear provides a 2.72:1 reduction ratio when locked in the low range annulus gear.

Neutral

Neutral range is used for towing purposes.

TRANSFER CASE SHIFTING

The floor mounted shift lever is adjacent to the transmission shift lever. A straight-line shift pattern is employed (Figure 5-71).

The transfer case can be shifted from High (H) to High Lock (HL) and back, at any legal speed without putting the transmission in neutral.

The vehicle must be completely stopped and the transmission shifted to neutral before a shift to low range (L). This is necessary because the low range gear must be moved into engagement with the fixed annulus. Once the low range and annulus are engaged, the transfer case is locked into a 2.72:1 reduction ratio. All output to the propeller shafts is undifferentiated and equal. Maximum recommended vehicle speed in low range is 23-31 mph (37-50 kph), with the lower speed preferred.

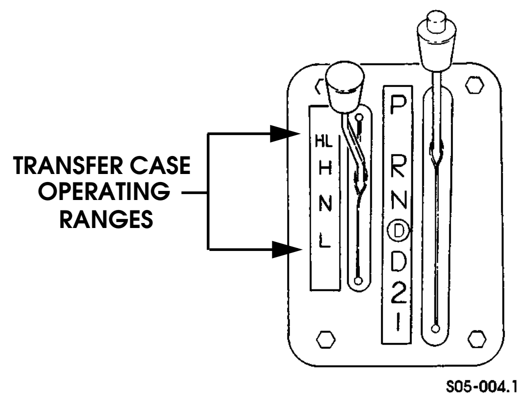


Figure 5-71: Transfer Case Shift Lever and Bezel

TRANSFER CASE DIAGNOSIS

The diagnosis guides outline probable causes of various transfer case malfunctions. The problem causes are listed in order of potential (most to least probable). The guides do not cover every possible condition or possibility. They do however, provide a means of reducing the number of components requiring further diagnosis and inspection.

TRANSFER CASE DIAGNOSIS

PROBLEM	POTENTIAL CAUSE	CORRECTION
Transfer Case Hard to Shift or Will Not Shift Into Desired Range	1. Vehicle speed too great to permit shifting. 2. Vehicle driven for extended period on paved road surface in high lock (HL) range. Internal torque load can prevent shifting. 3. Shift rod adjustment is incorrect. 4. Shift control housing fault. 5. Incorrect or low lubricant. 6. Transfer case internal fault. • sector damaged or loose • range or mode fork failure • damaged gear	1. Reduce speed to 15 mph if shifting from H to HL and back. Stop vehicle completely if shifting into low range. 2. Stop vehicle completely. Shift into neutral. Then into high (H) range. Do not operate vehicle on hard road surface in high lock. 3. Adjust rod. Refer to procedure in this section. 4. Remove and inspect housing shift arms. Replace housing if shift arm is damaged or binding. 5. Add fluid, or drain and refill transfer case. 6. Remove and overhaul transfer case.
Transfer Case Noisy In All Ranges	1. Low lubricant level. 2. Incorrect lubricant 3. Shift rod mispositioned. 4. Internal component wear or damage. 5. Extended operation on paved roads in high lock range. (Causes accelerated bearing, wear, gear wear, and chain stretch.)	1. Add lubricant and check for leaks. Correct leaks as needed. 2. Drain and refill transfer case. 3. Adjust shift rod as described in the section. 4. Remove and overhaul transfer case. 5. Inform driver that only high range should be used on paved surfaces. Repair transfer case if wear or damage has occurred.
Transfer Case Jumps Out Of Gear	1. Not fully engaged in desired gear range. 2. Shift linkage bind or misadjusted. 3. Range or mode fork problem: • fork cracked • inserts worn, missing • shift rail scored • shift sector or shaft worn 4. If transfer case jumps out of low range, problem is with low range gear, lockplate, or annulus.	1. Stop vehicle, shift into gear, and resume operation. 2. Adjust shift rod. Correct bind in control housing shift arm. 3. Remove, disassemble transfer case and repair as necessary. 4. Disassemble transfer case and repair as needed.
Lubricant Leaks From Vent Or Output Shaft Seals	1. Transfer case overfilled. 2. Vent or line restricted, kinked, pinched. 3. Output seal failure (front or rear) caused by wear, incorrect installation, cut seal lip.	1. Drain to correct level. Check transfer case cooler if transfer case is overfilled and transmission fluid level is low. 2. Replace vent or line as needed. Reroute line to eliminate kinks. 3. Replace seal(s). Correct cause of cut seal lip or abnormal wear of seal lip (rough surface on output shaft or yoke).
Rapid Tire Wear	1. Vehicle driven for extended periods in high lock on hard, paved road surfaces.	1. Inform driver that only high range should be used on hard, paved road surfaces.

TRANSFER CASE SHIFT ROD SERVICE

Removal

1. Unfasten snaps and pull velcro strips apart to open shifter boot cover.
2. Remove or cotter pins and washers securing shift rod to shift arm and range lever (Figure 5-72).
3. Remove shift rod and trunnion as assembly.
4. Remove trunnion from shift rod if necessary.

Installation

1. Install trunnion on shift rod.
2. Connect shift rod and trunnion to shift arm and range lever.
3. Secure shift rod with washers and or cotter pins.
4. Adjust shift rod. Refer to Shift Rod Adjustment procedure.
5. Push velcro strips together and fasten snaps to close shifter boot cover.

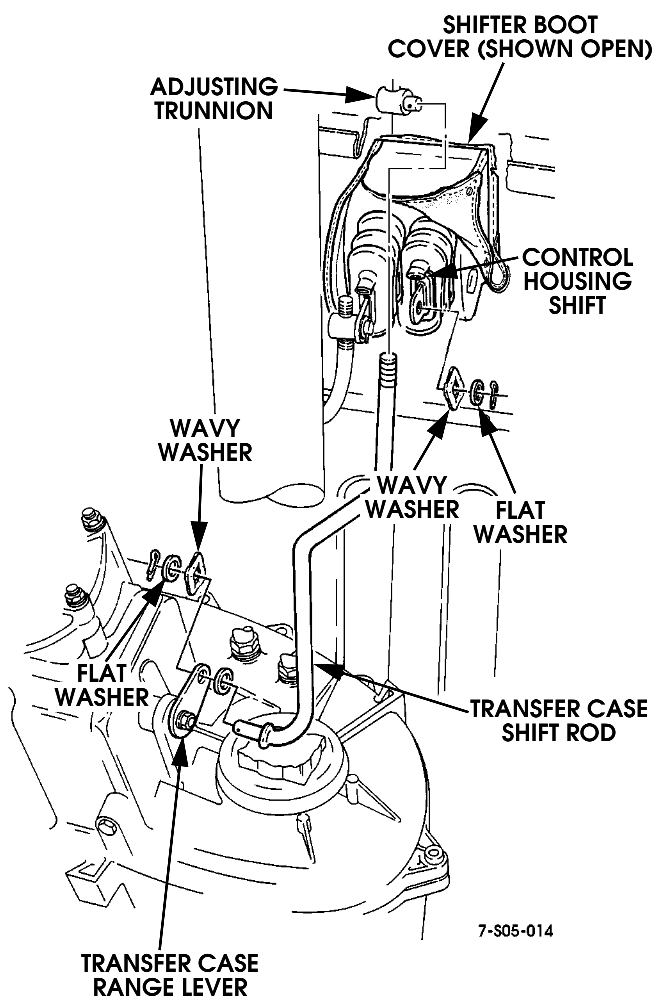


Figure 5-72: Transfer Case Shift Rod Attachment

Adjustment

1. Apply parking brakes and shift transmission into neutral.
2. Shift transfer case into high lock (HL) position.
3. Disconnect shift and trunnion at control housing shift arm (Figure 5-72).
4. Verify that transfer case range lever is in high lock position. This is last detent toward rear (Figure 5-73). Move lever fully into detent if necessary.
5. Adjust shift rod trunnion so it is slip fit in control housing shift arm. Install washer and cotter pin in trunnion.
6. Check shift rod adjustment. Be sure transfer case is firmly engaged in each detent (range) position. Also be sure shift lever aligns with range positions on floor shift lever bezel.

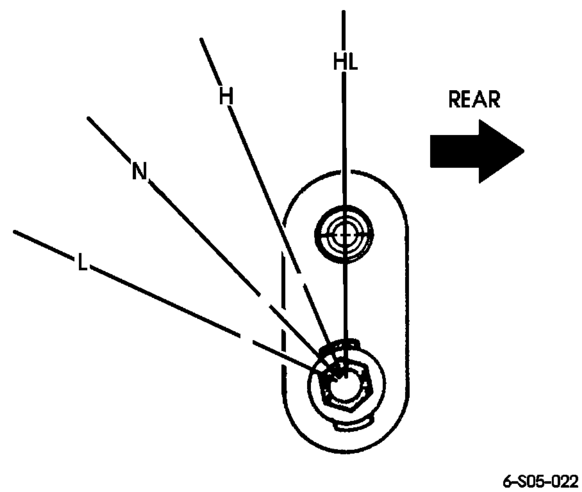


Figure 5-73: Range lever Positions

SPEED SENSOR AND/OR SWITCH REPLACEMENT

1. Disconnect harness connector from vehicle speed sensor, lock indicator switch, and/or range indicator switch (Figures 5-74 and 5-75).
2. Remove switch and/or sensor from transfer case (Figures 5-74 and 5-75).

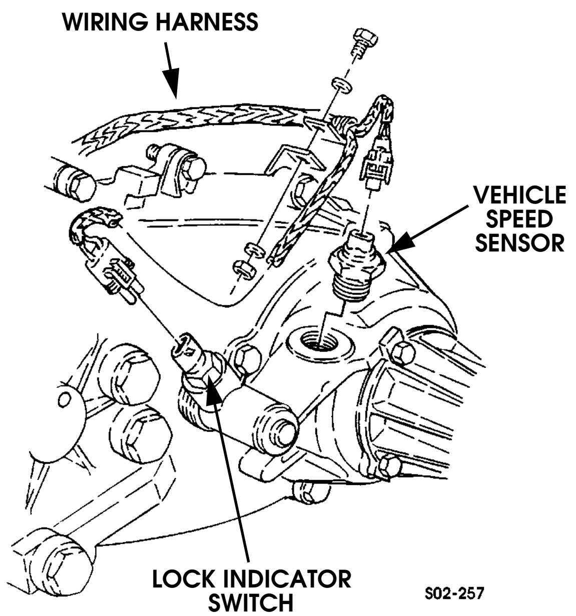


Figure 5-74: Speed Sensor and Lock Indicator Switch Location

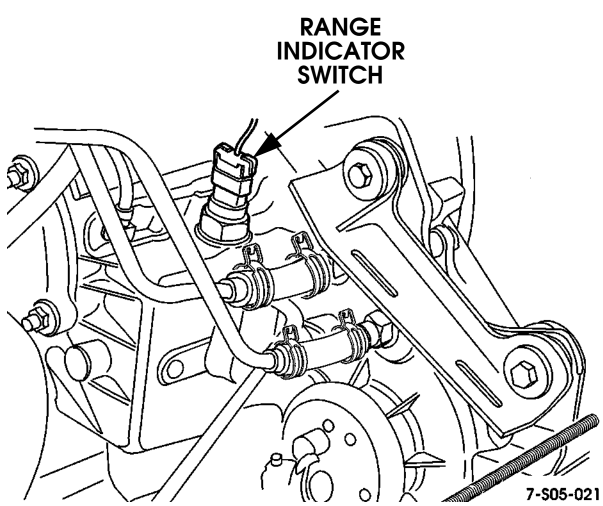


Figure 5-75: Range Indicator Switch Location

3. Install new switch and/or sensor in transfer case.
4. Attach harness connector to switch or sensor.

GUIDE CABLE REPLACEMENT

1. Remove bolts, nuts, and washers attaching cable bracket to muffler bracket (Figure 5-76).
2. Remove bolts, nuts, and washers securing guide cable.
3. Remove guide cable and bracket.
4. Attach guide cable bracket to muffler bracket.
5. Attach guide cable bracket to transfer case with washers and nuts.
6. Install guide cable and brake line support bracket. Tighten bracket bolt to 27-33 lb-ft (37-45 N•m).

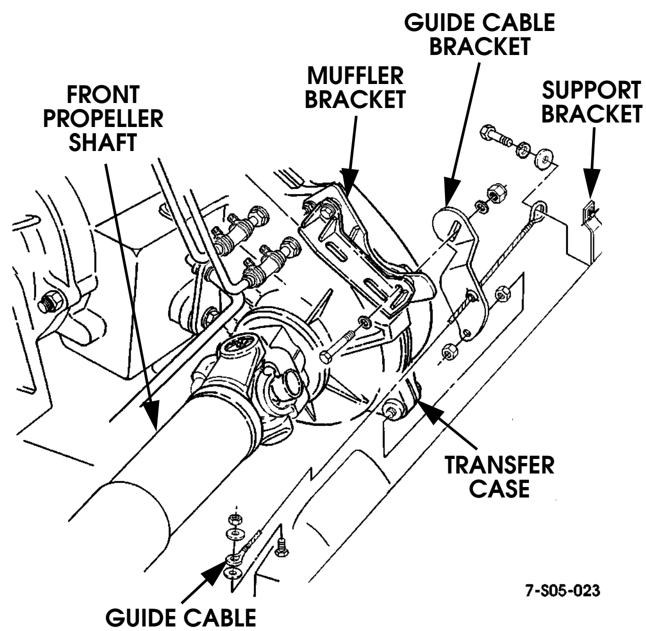


Figure 5-76: Guide Cable Attachment

VENT LINE REPLACEMENT

1. Loosen clamp and remove vent line from fitting on rear of transfer case (Figure 5-77).
2. Remove bolt, clamp, and vent line.
3. If installing a new vent line, transfer clamp to new vent line.
4. Connect vent line to tee fitting.
5. Connect vent line transfer case fitting and tighten clamp.
6. Attach clamp and vent line to transmission. Tighten clamp bolt to 16-20 lb-ft (22-27 N•m).

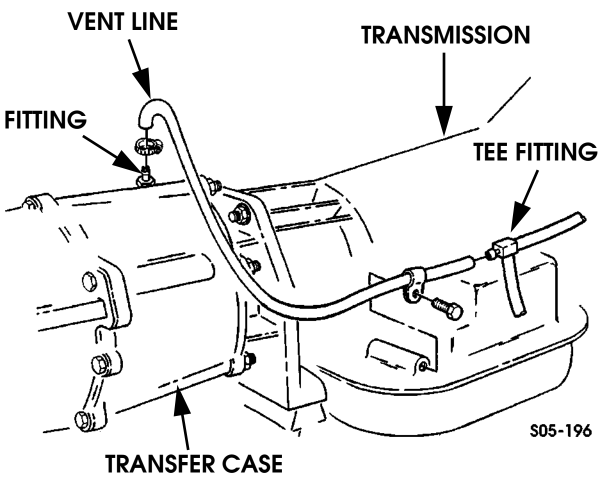


Figure 5-77: Transfer Case Vent Line Routing

FRONT OUTPUT SHAFT SEAL REPLACEMENT

1. Mark front propeller shaft and transfer case yoke for alignment reference.
2. Disconnect front propeller shaft at yoke. Retain U-bolts and nuts (Figure 5-78).
3. Remove yoke nut (Figure 5-79).
4. Remove yoke and seal washer. Use tool J–8614-01 to remove yoke if necessary.
5. Remove seal from front case bore with standard hook type seal puller.
6. Coat outer edge of new seal with thin coat of RTV type sealer.
7. Lubricate seal lip with transmission fluid and install seal with tool J–38869.

CAUTION: *The seal can be installed incorrectly. Be sure the seal lip is toward the case interior.*

8. Smooth seal contact surface of yoke with 320-400 grit emery coated with transmission fluid. Then clean and install yoke.
9. Install yoke seal washer.
10. Install and tighten yoke nut to 90-130 lb-ft (122-176 N•m) torque.
11. Connect propeller shaft to yoke. Tighten U-bolt nuts to 13-18 lb-ft (18-24 N•m) torque.
12. Check and top off transfer case fluid level if necessary.

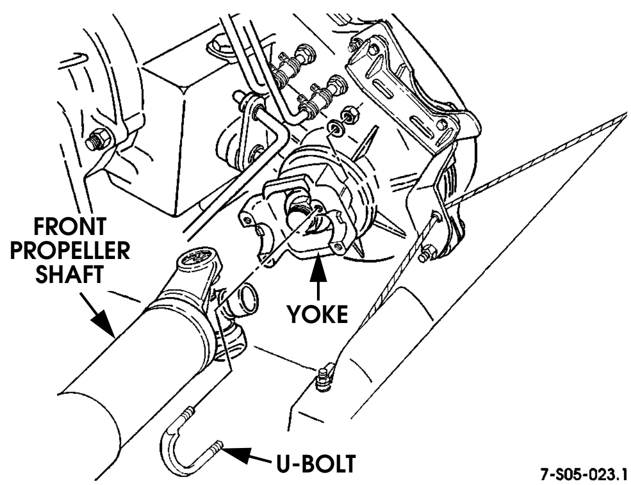


Figure 5-78: Disconnecting/Connecting Front Propeller Shaft

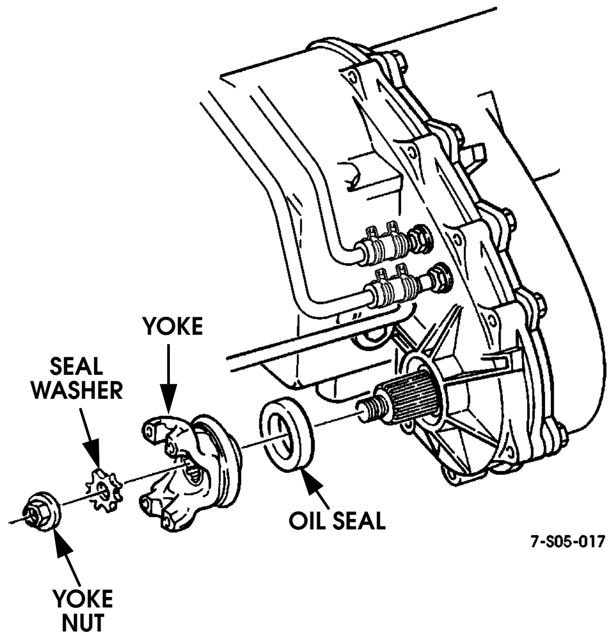


Figure 5-79: Front Output Shaft Yoke and Seal Removal/Installation

TRANSFER CASE FLUID CHANGE

The transfer case fill and drain plugs are both located in the rear case (Figure 5-80).

Correct fill level is to the lower edge of the fill plug hole. Recommended fluid is Dexron III.

1. Place vehicle on level surface. Or, if vehicle is raised on hoist for fluid change, a drive-on hoist is preferred. Vehicle must be level for accurate refill fluid level.
2. Remove drain and fill plugs and drain fluid into approved container.
3. Install and tighten drain plug to 35 lb-ft (47 N•m) torque.
4. Refill transfer case with Dexron III. Correct level is to lower edge of fill plug hole.
5. Install and tighten fill plug to 35 lb-ft (47 N•m) torque.
6. Lower vehicle, if on hoist.

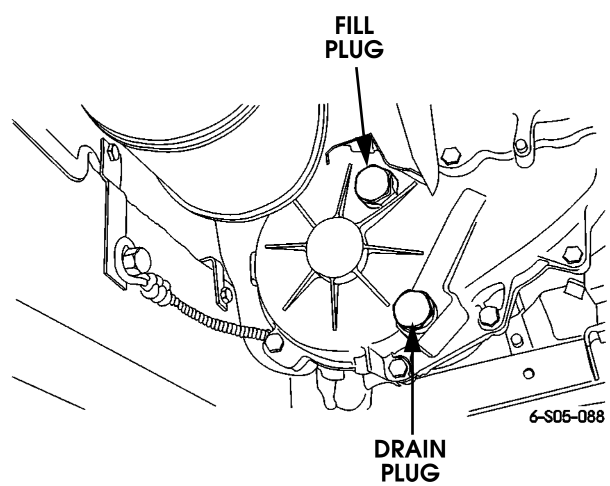


Figure 5-80: Transfer Case Drain and Fill Plug Locations

TRANSFER CASE REMOVAL

1. Remove drain plug and drain oil from transfer case. Reinstall drain plug afterward.
2. Disconnect propeller shafts from transfer case.
3. Disconnect wiring harness connectors from vehicle speed sensors range switch, and lock switch.
4. Remove wiring harness clamp and move harness away from transfer case.
5. Disconnect vent line from transfer case (Figure 5-77).
6. Disconnect cooler hoses at transfer case (Figure 5-81).
7. Disconnect shift rod at range lever (Figure 5-82).
8. Remove guide cable and bracket (Figure 5-82).

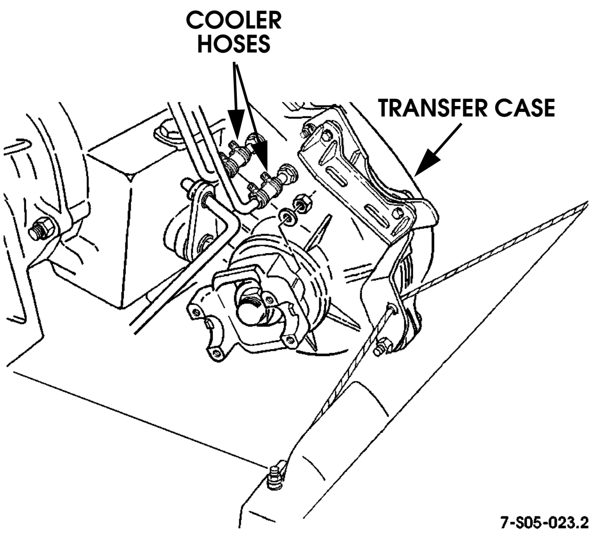


Figure 5-81: Cooler Hose Connections

9. Support transfer case with jack. Secure transfer case to jack with chain.
10. Remove nuts attaching transfer case to transmission adapter (Figure 5-83).

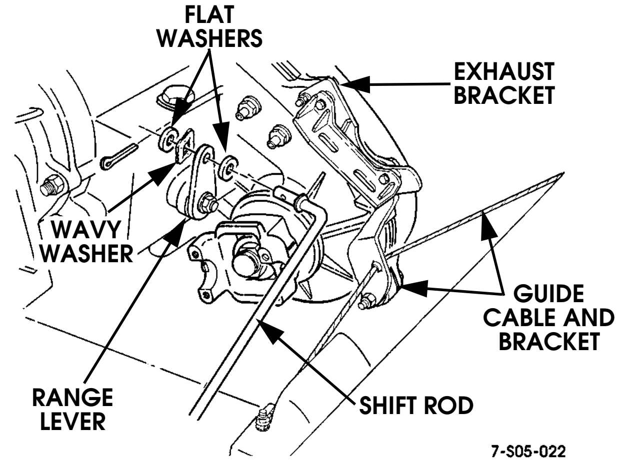


Figure 5-82: Shift Rod Attachment

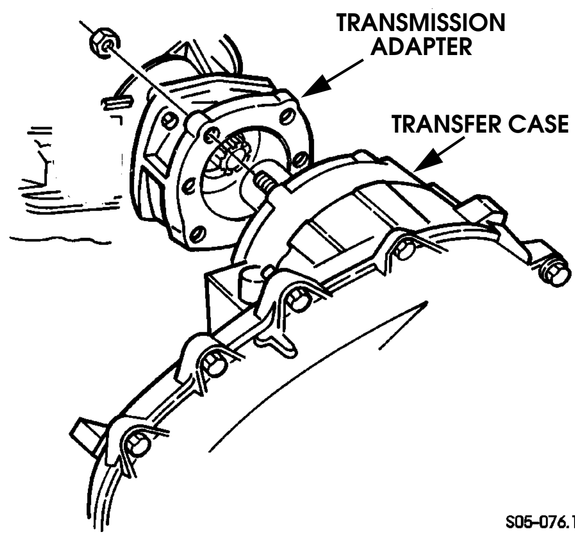


Figure 5-83: Separating Transfer Case From Transmission

11. Slide transfer case rearward and remove it from under vehicle (Figure 5-83).

TRANSFER CASE INSTALLATION

1. Mount transfer case on jack and secure with chain.
2. Apply bead of Loctite 518 to mounting surface of transmission adapter.
3. Align and install transfer case on transmission. Tighten transfer case attaching nuts to 37 lb-ft (50 N•m).
4. Remove jack.
5. Connect shift rod to range lever with washer and cotter pin (Figure 5-82).
6. Install guide cable and bracket.
7. Connect transfer case vent line.
8. Connect cooler hoses to transfer case cooler fittings.
9. Connect front and rear propeller shafts to transfer case. Tighten front shaft U-bolt nuts to 13-18 lb-ft (18-24 N•m) torque.
10. Install vehicle speed sensor.
11. Install range and lock indicator switches.
12. Attach harness clamp to transfer case.
13. Connect wiring harness connectors to speed sensor and switches.
14. Fill transfer case to bottom edge of fill plug hole with Dexron III.
15. Check and adjust shift rod if necessary.

TRANSFER CASE DISASSEMBLY AND OVERHAUL

1. Remove vehicle speed sensor and both indicator switches.
2. Remove front output shaft yoke (Figure 5-84). Remove yoke nut with suitable size socket and impact wrench. Then remove seal washer and yoke.

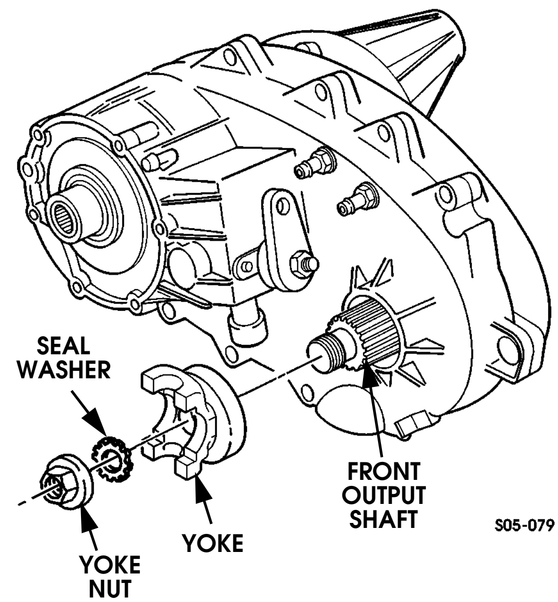


Figure 5-84: Front Yoke Removal/Installation

3. Remove extension housing bolts. Then tap housing in counterclockwise direction to break sealer bead (Figure 5-85). Use plastic mallet to tap housing.
4. Remove extension housing (Figure 5-86).

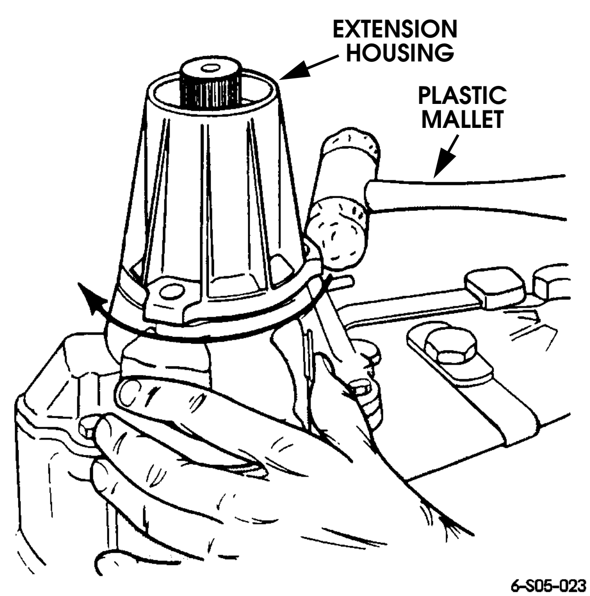


Figure 5-85: Loosening Extension Housing

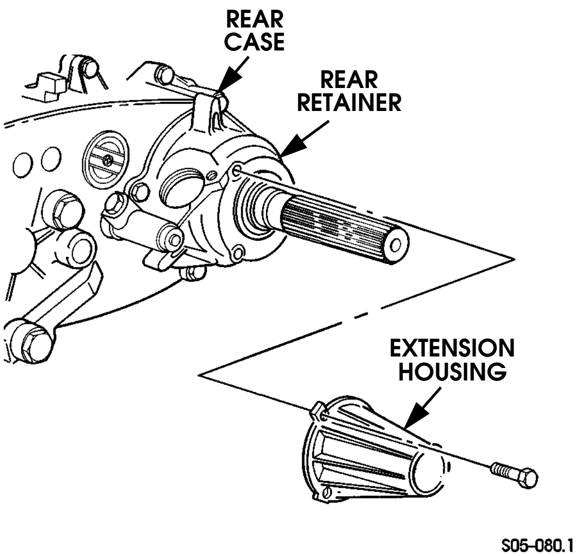


Figure 5-86: Extension Housing Removal

5. Remove rear retainer bolts. Then remove mainshaft bearing snap ring (Figure 5-87).
6. Pry rear retainer upward at each lug with screwdriver (Figure 5-88). Remove retainer after breaking sealer bead.

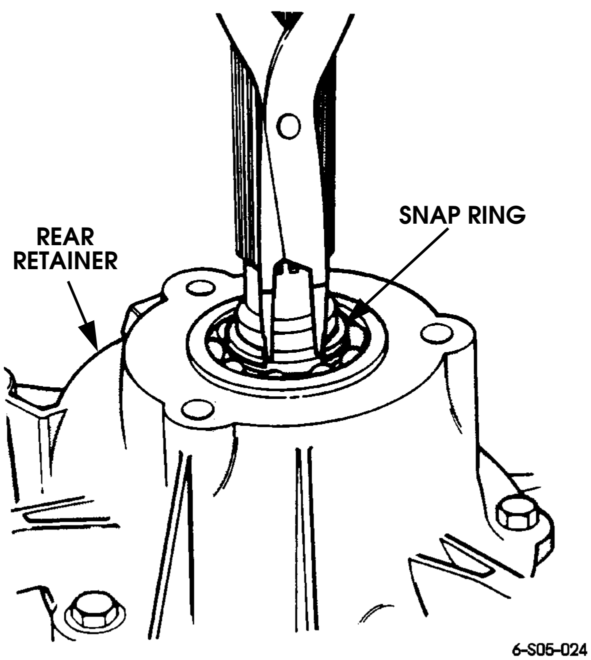


Figure 5-87: Mainshaft Snap Ring Bearing Removal

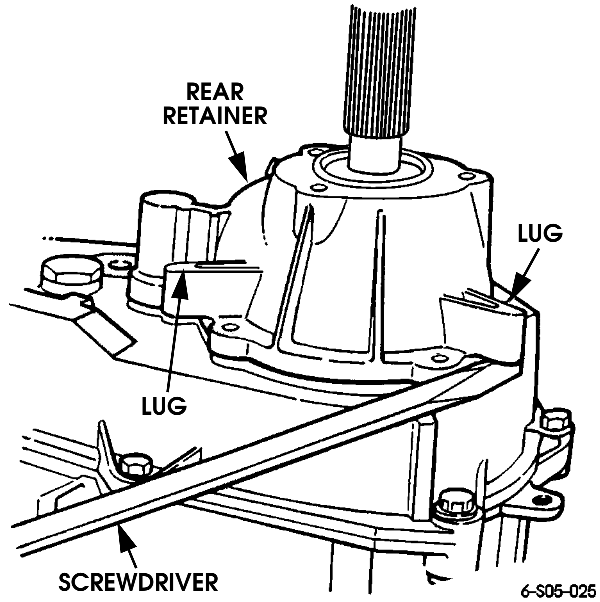


Figure 5-88: Rear Retainer Removal

7. Remove speedometer tone wheel and snap rings (Figure 5-89).
8. Remove rear case attaching bolts and remove rear case (Figure 5-90).

CAUTION: *Loosen the rear case with screwdrivers positioned in the slot at each end of the case. This will avoid damaging the case sealing surfaces.*

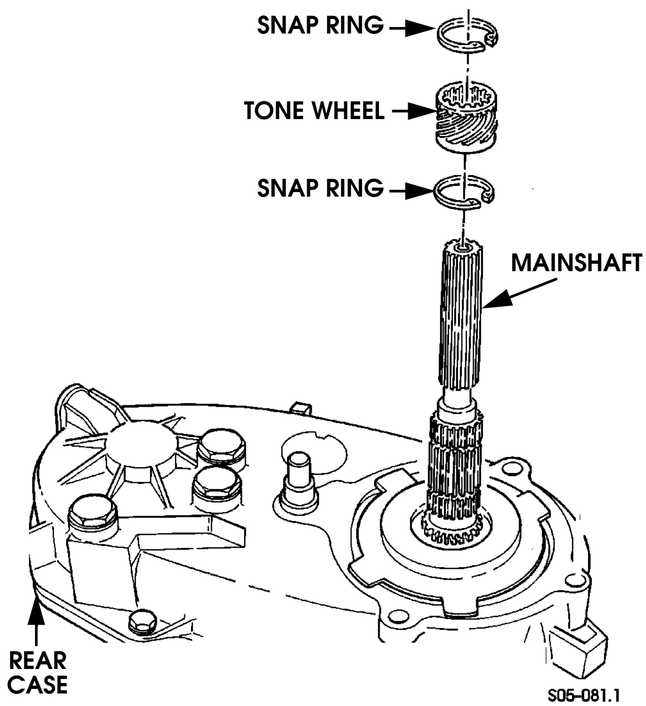


Figure 5-89: Speedometer Tone Wheel Removal/Installation

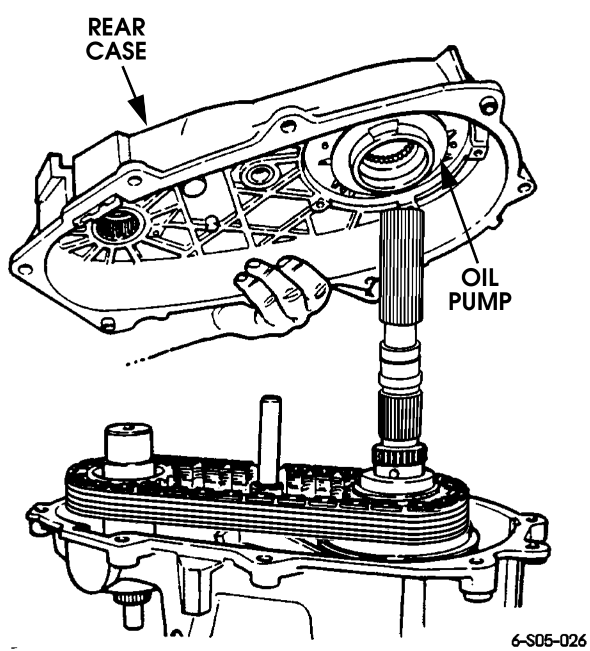


Figure 5-90: Rear Case Removal

9. Remove oil pump, pickup tube, hose, and screen (Figure 5-91).
10. Remove O-ring from oil pump inlet port (Figure 5-92).

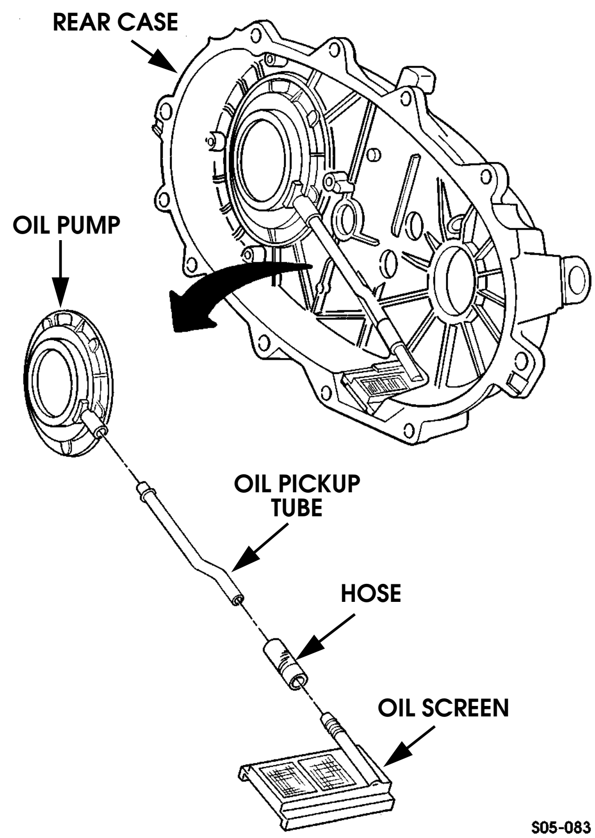


Figure 5-91: Oil Pump Assembly Removal

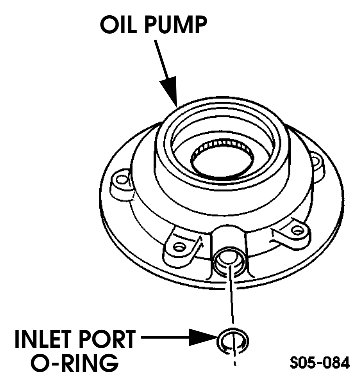


Figure 5-92: Oil Pump O-ring Location

11. Remove drive sprocket snap ring (Figure 5-93).
12. Remove drive sprocket (Figure 5-94).
13. Remove drive chain.
14. Remove front output shaft and driven sprocket as assembly (Figure 5-95).

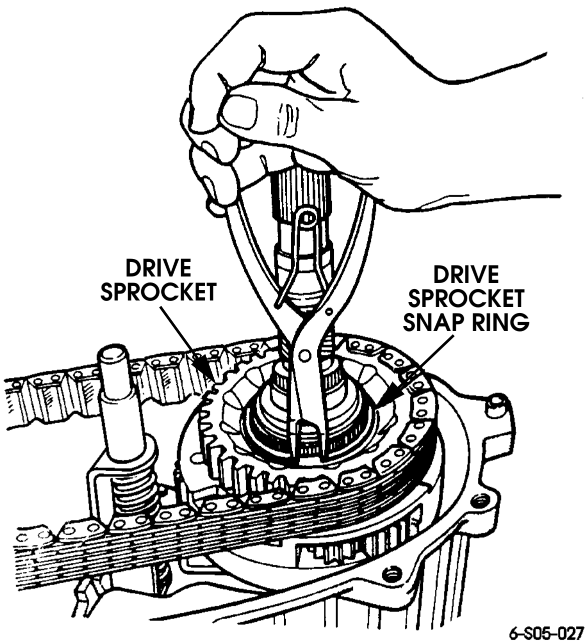


Figure 5-93: Drive Sprocket Snap Ring Removal/ Installation

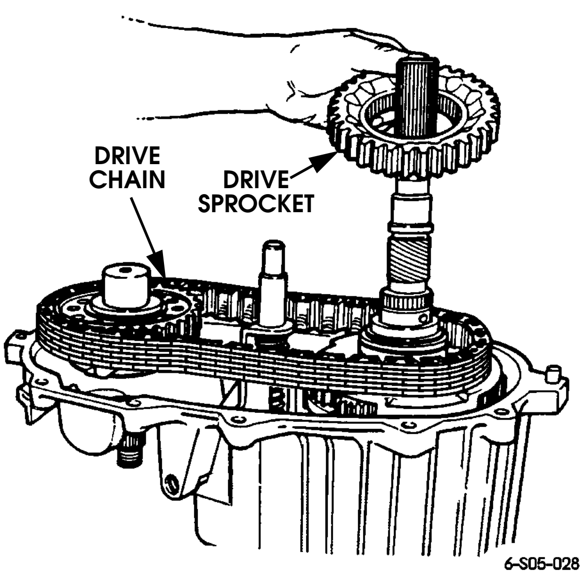


Figure 5-94: Drive Sprocket Removal

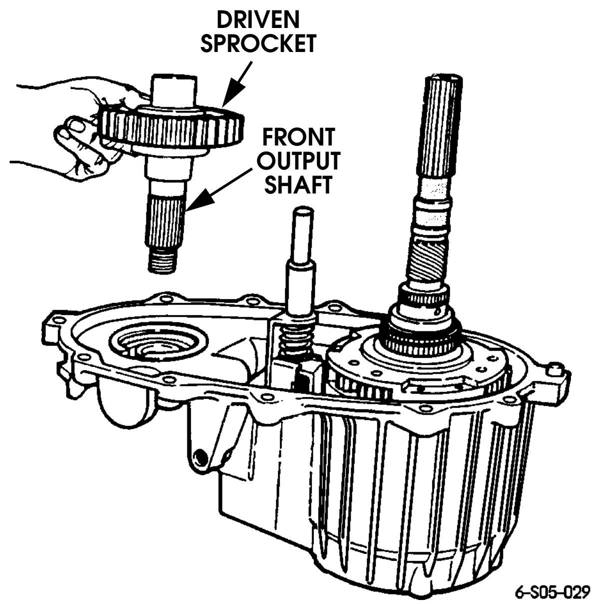


Figure 5-95: Front Shaft and Driven Sprocket Removal

15. Remove range lever nut, washer and lever from sector shaft (Figure 5-96).
16. Remove access plug for low range fork lock pin (Figure 5-96).
17. Remove low range fork lock pin with #1 or #2 easyout (Figure 5-97). Seat easyout in pin. Then withdraw pin with locking pliers using a twisting motion.

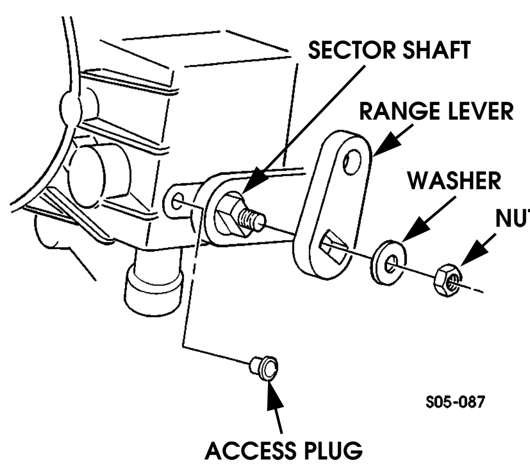


Figure 5-96: Range Lever Mounting

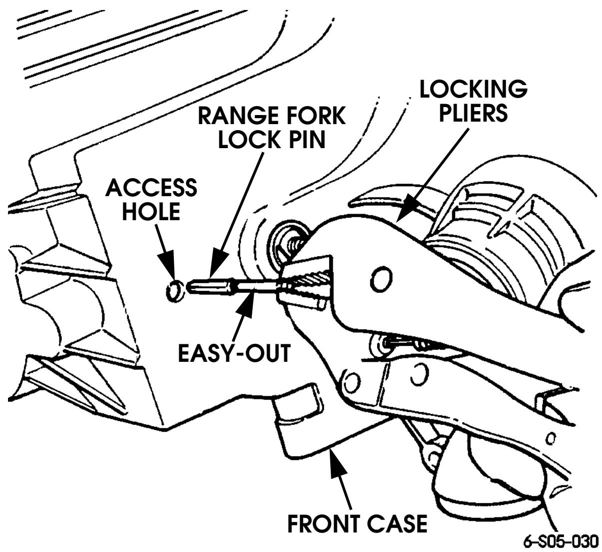


Figure 5-97: Removing Low Range Fork Lock Pin

18. Remove detent plug, spring, and plunger (Figure 5-98).
19. Remove oil cooler attaching nuts and washers. Then remove cooler and O-rings (Figure 5-98).
20. Remove shift rail (Figure 5-99).

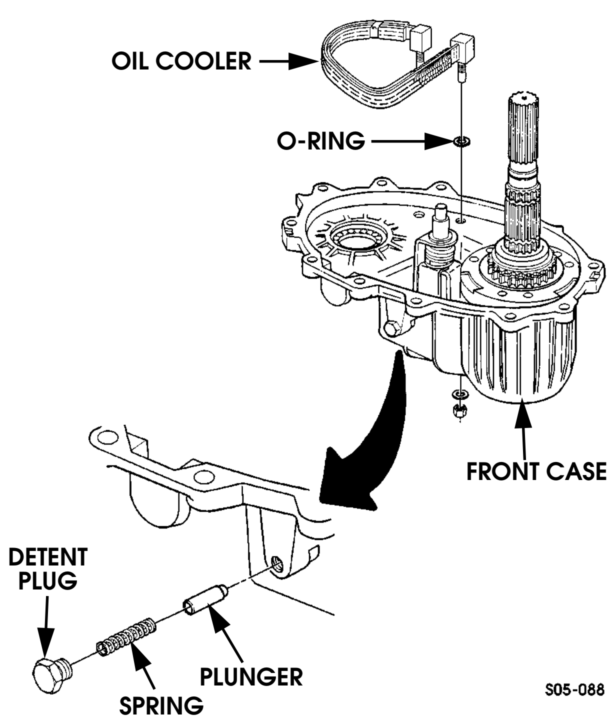


Figure 5-98: Oil Cooler and Detent Plug, Spring, Plunger Removal

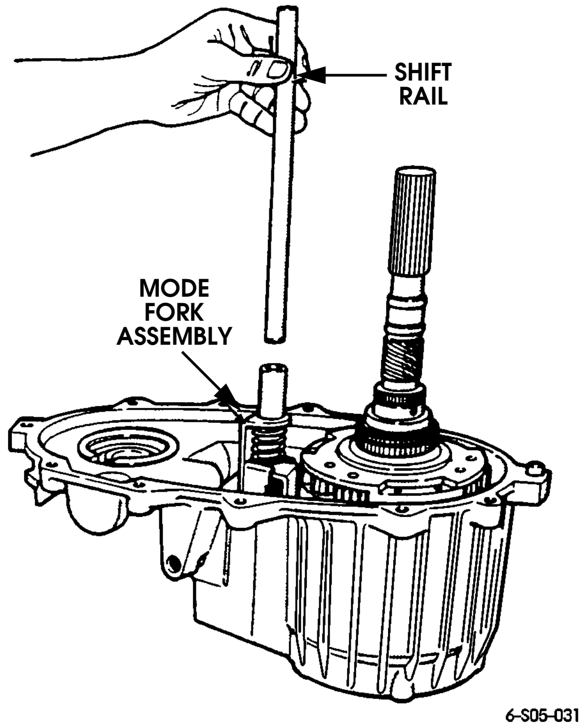


Figure 5-99: Shift Rail Removal/Installation

21. Remove mainshaft, differential, and mode fork as assembly (Figure 5-100).

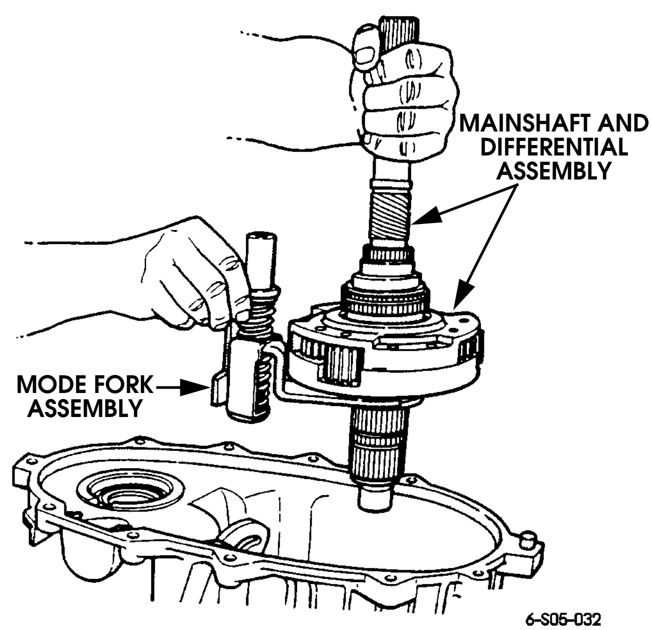


Figure 5-100: Mainshaft, Differential and Mode Fork Removal

22. Remove mode fork and sleeve from mainshaft (Figure 5-101). Note position of sleeve for installation reference. Do not disassemble fork assembly. Only the fork pads are serviceable.
23. Remove snap ring that secures intermediate clutch shaft on mainshaft (Figure 5-102).

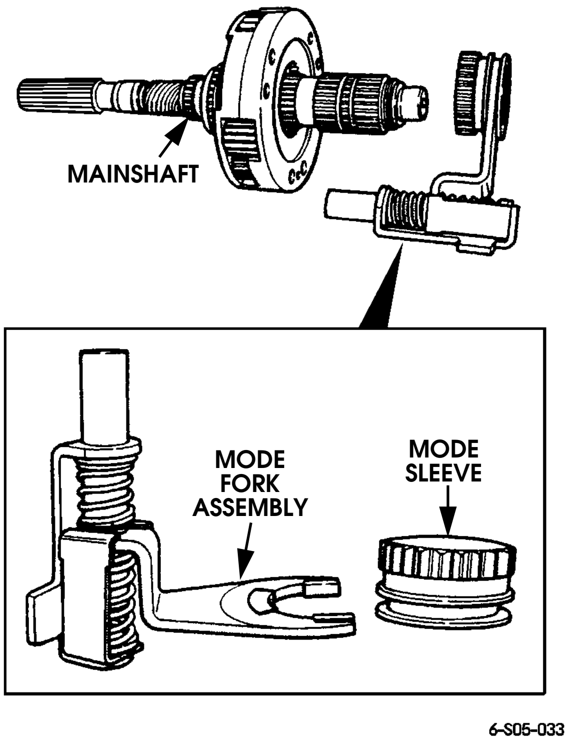


Figure 5-101: Mode Fork and Sleeve Removal

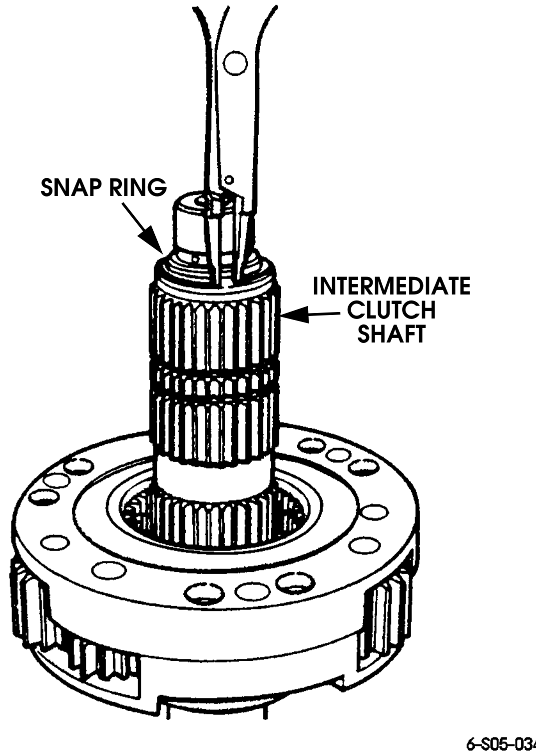


Figure 5-102: Intermediate Clutch Shaft Snap Ring Removal/Installation

24. Remove intermediate clutch shaft and tabbed thrust ring from mainshaft (Figure 5-103).

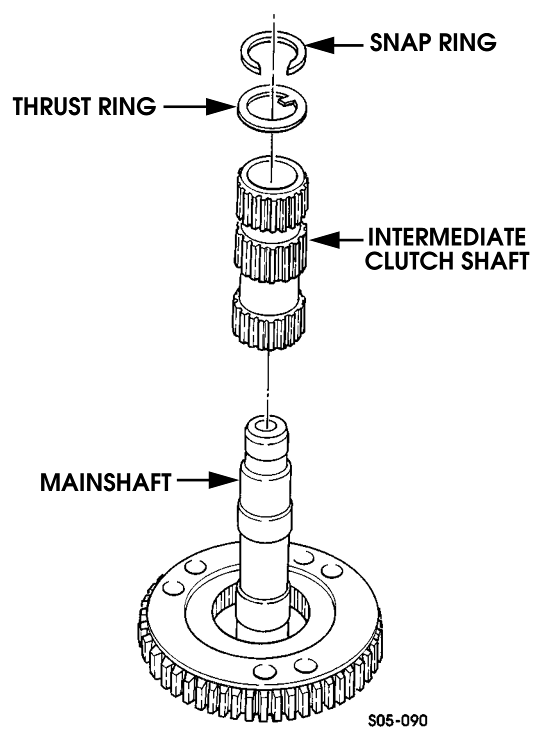


Figure 5-103: Clutch Shaft Removal

25. Remove differential snap ring (Figure 5-104).
26. Remove differential from mainshaft (Figure 5-105).
27. Remove mainshaft needle roller bearings and spacers (Figure 5-106).

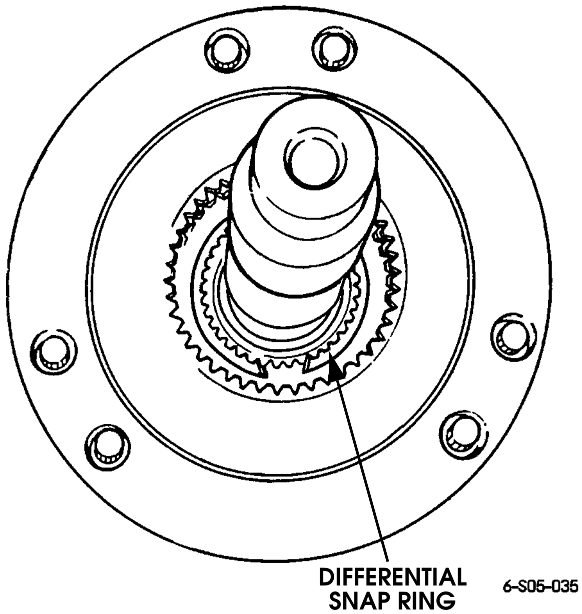


Figure 5-104: Differential Snap Ring Location

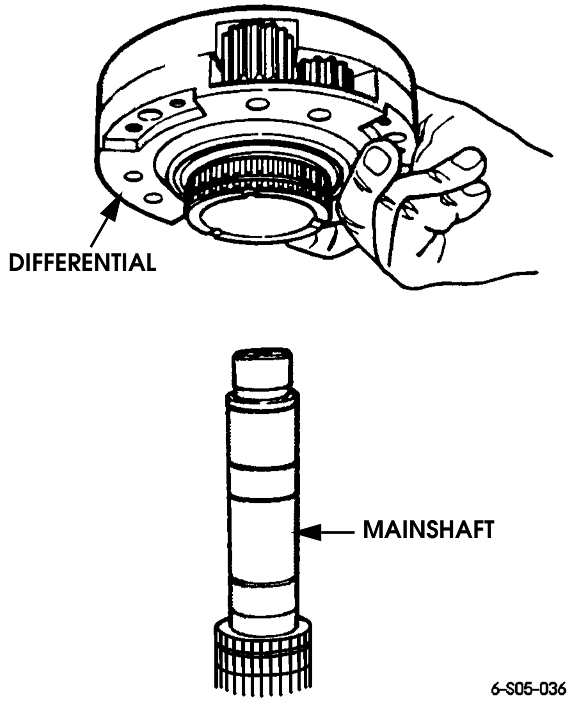


Figure 5-105: Differential Removal

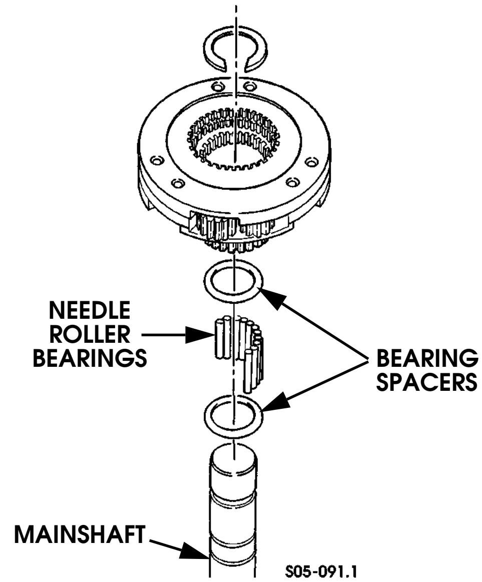


Figure 5-106: Mainshaft Bearing and Spacer Removal

28. Slide low range fork pin out of shift sector. Then remove low range fork and sleeve as assembly (Figure 5-107).
29. Remove shift sector.
30. Remove shift sector shaft bushing and O-ring (Figure 5-108).

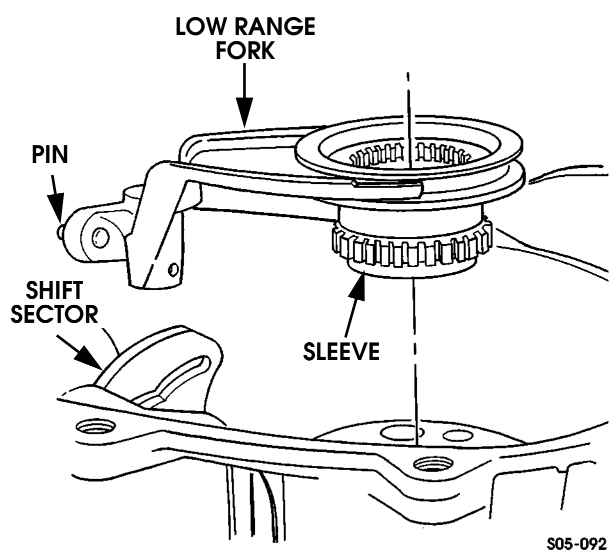


Figure 5-107: Range Fork and Sleeve Removal

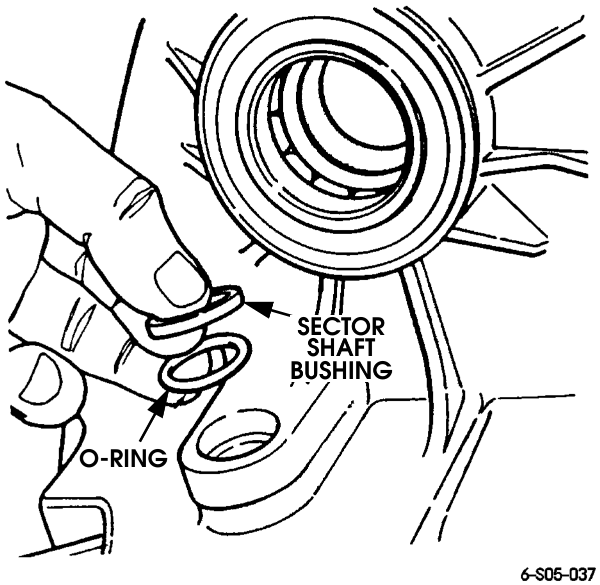


Figure 5-108: Sector Shaft Bushing and O-Ring Removal

31. Remove bolts attaching front retainer to front case. Then remove retainer by prying it loose with screwdriver positioned in retainer slot (Figure 5-109).

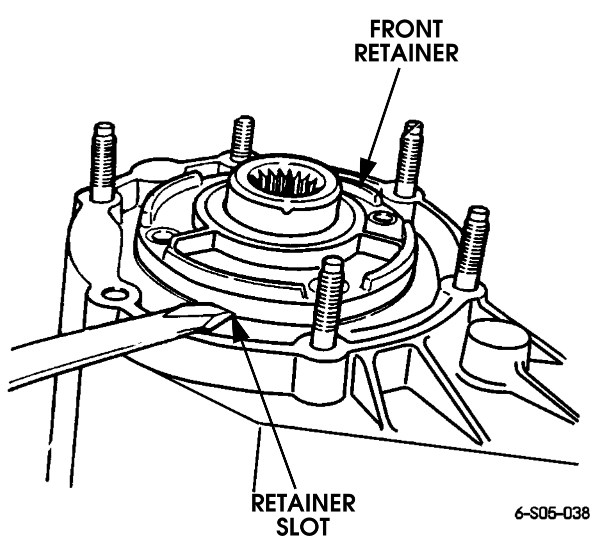


Figure 5-109: Front Retainer Removal

32. Remove snap ring that secures input gear in bearing (Figure 5-110).
33. Remove input gear and low range planetary as assembly. Tap input gear with rawhide or plastic mallet to free it from bearing.
34. Disassemble input gear and low range planetary as follows:

    a. Remove retaining ring that secures input gear in low range planetary (Figure 5-111).

    b. Remove lock ring and front thrust washer (Figure 5-112).

    c. Remove input gear and rear thrust washer from low range planetary (Figure 5-112).

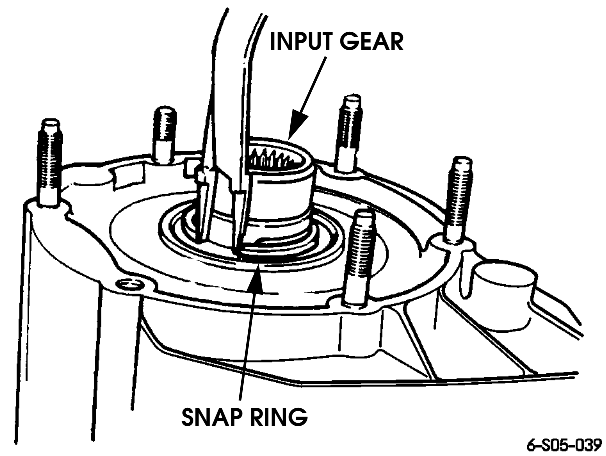


Figure 5-110: Input Gear Snap Ring Removal

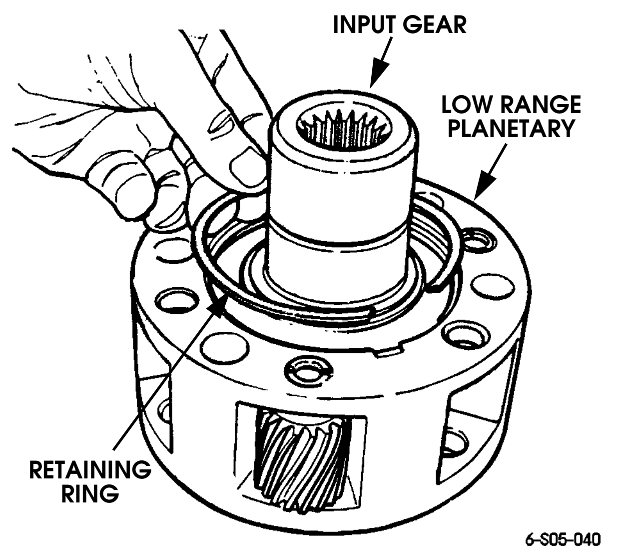


Figure 5-111: Input Gear Retaining Ring Removal

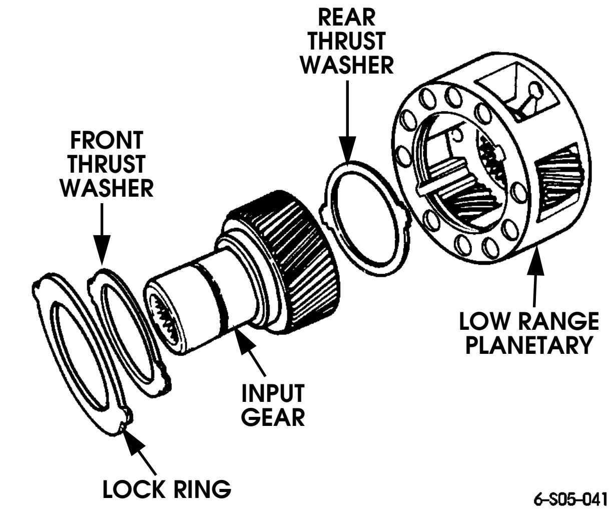


Figure 5-112: Input/Low Range Planetary Gear Disassembly Sequence

35. Remove and disassemble differential as follows:
    a. Scribe or paint mark front and rear cases for assembly reference (Figure 5-113).
    b. Remove case bolts (Figure 5-114).
    c. Pry front and rear cases apart with two screwdrivers (Figure 5-115).
    d. Remove planet gears and thrust washers (Figure 5-116).
    e. Remove sprocket and mainshaft gears as assembly (Figure 5-117).
36. Remove front output shaft front bearing seal with pry tool (Figure 5-118).

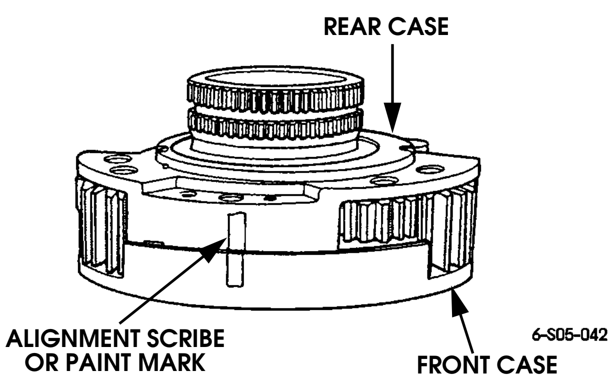


Figure 5-113: Marking Differential Cases for Assembly Reference

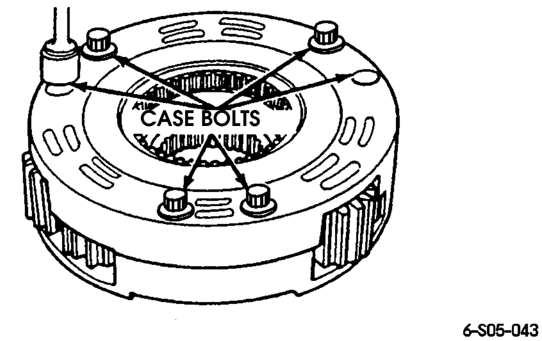


Figure 5-114: Differential Case Bolt Removal

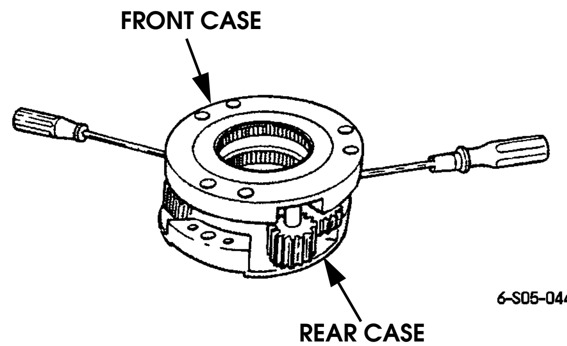


Figure 5-115: Separating Differential Cases

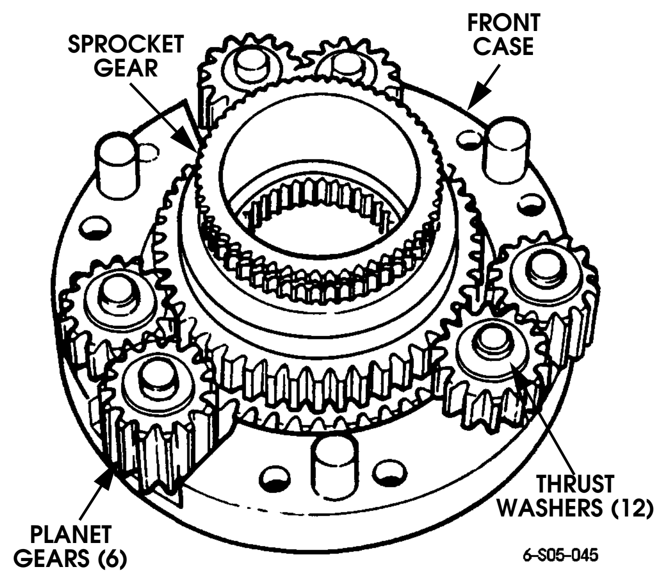


Figure 5-116: Planet Gear Locations In Bottom Case

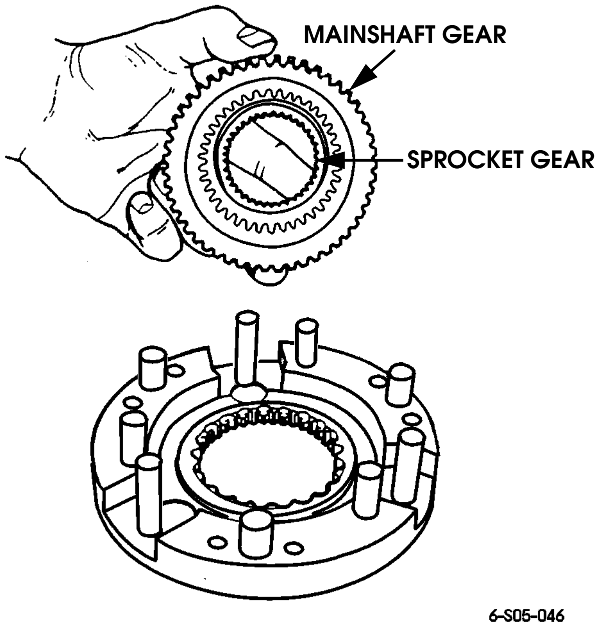


Figure 5-117: Mainshaft and Sprocket Gear Removal

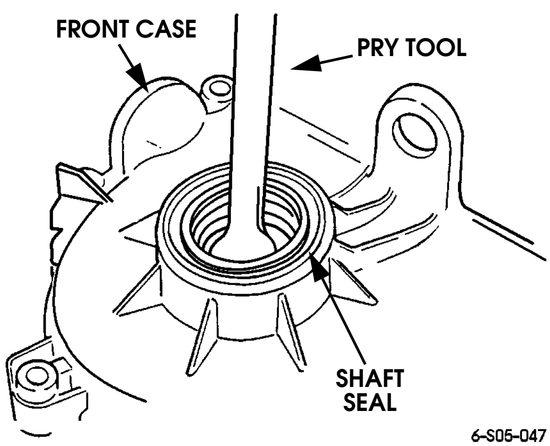


Figure 5-118: Removing Front Output Shaft Seal

TRANSFER CASE CLEANING AND INSPECTION

Clean the transfer case components thoroughly with standard parts cleaning solvent. Remove all traces of sealer from the case and retainer sealing surfaces.

Clean the oil pickup screen with solvent and dry it with compressed air. Also use compressed air to remove solvent residue from all oil feed passages and channels.

Geartrain

The differential pinion gears and thrust washers are serviceable components and can be replaced if worn or damaged. The differential cases are also serviceable but must be replaced as a set if either case is damaged.

Inspect the mainshaft splines, gear teeth and bearing surfaces carefully for evidence of wear, or damage. Replace the shaft if necessary. Do not attempt to salvage it if damaged.

The range and mode forks are serviced as assemblies. Replace either part if damaged. However, the nylon pads in the forks can be replaced if worn, or cracked.

Inspect the transfer case snap rings closely. Do not attempt to salvage a distorted snap ring by straightening or reshaping it. Replace any snap ring that is distorted, or worn.

Inspect the low range planetary, input gear and thrust washer, retainer, and snap ring. The low range planetary is serviced as an assembly only. Replace it if the case or pinions are damaged.

During inspection, also make sure the seal surface of the input gear is in good condition. Minor nicks on this surface can be reduced with crocus cloth. However, replace the gear if the seal surface is severely scored or worn.

Check condition of the low range annulus gear (Figure 5-119). Replace the front case and gear as an assembly if the gear is damaged. The annulus gear is not serviced separately.

The speedometer tone wheel should be replaced if worn, cracked, or spline teeth are worn.

Inspect the differential gears, thrust washers and case halves. Replace the mainshaft gear if the gear teeth or the brass ring on the underside of the gear are damaged. Replace the differential as an assembly if the gears, case halves, or the pins in the lower case half are damaged.

Inspect the case halves, extension housing, and both retainers for cracks, porosity, or damaged sealing surfaces. Inspect the shafts, gears, chain and shift components for wear or damage.

Inspect all of the transfer case bearings for wear, roughness, pitting, or galling. Replace worn or damaged bearings.

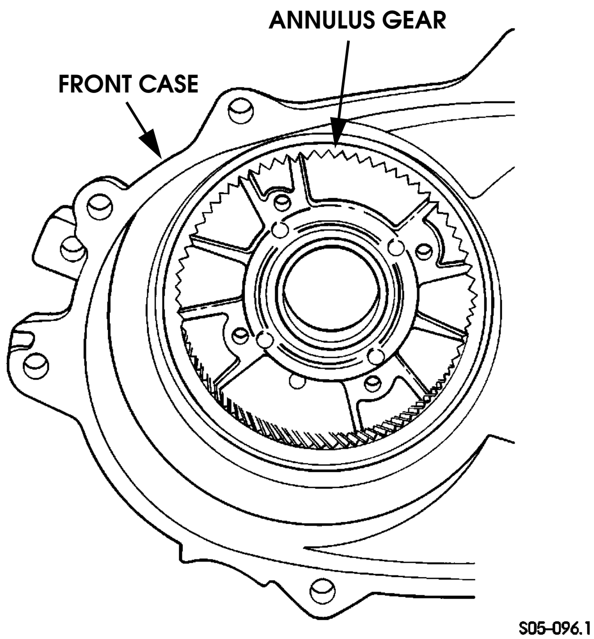


Figure 5-119: Annulus Gear Location In Front Case

Oil Pump

The oil pump is not a serviceable component. Replace the pump as an assembly if the gear teeth are worn, or if the pump has become damaged.

Bearings and Seals

The transfer case seals should be replaced during overhaul. Use new seals in the oil pump, input gear bearing retainer, front case, and extension housing. Also replace the yoke seal washer and detent plug O-ring.

FRONT OUTPUT SHAFT BEARING AND SEAL REPLACEMENT

1. Remove snap ring securing shaft front bearing in front case (Figure 5-120).
2. Tap old bearing out rear of front case with plastic or raw hide mallet.
3. Install new bearing with tool handle J–8092 and installer tool J33833 (Figure 5-121).
4. Lubricate new bearing with Dexron III.
5. Install new shaft seal with seal installer J–38869 (Figure 5-122). Then lubricate seal lip with Dexron III.
6. Remove front output shaft rear bearing from rear case as follows:
   a. Clamp rear case to bench with wood blocks and C-clamps.
   b. Pull bearing using slide hammer, adapter J–2619-01, and puller J–26369 (Figure 5-123).
   c. Install new bearing with tool handle J–8092 and installer J–33832 (Figure 5-124). The rear bearing bore is chamfered at the top. Install the bearing so it is flush with the chamfer lower edge.

CAUTION: *Do not bottom the bearing in the bore. This will block the oil feed hole in the rear case bearing bore.*

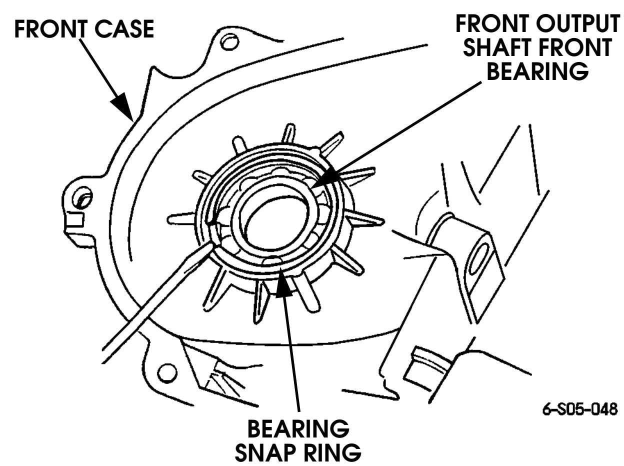


Figure 5-120: Front Output Shaft Front Bearing Snap Ring Removal/Installation

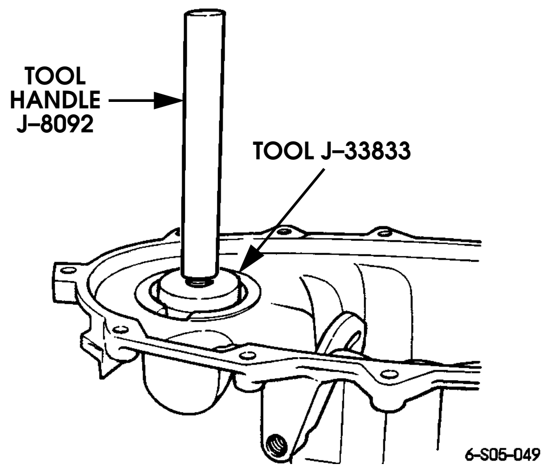


Figure 5-121: Front Output Shaft Front Bearing Installation

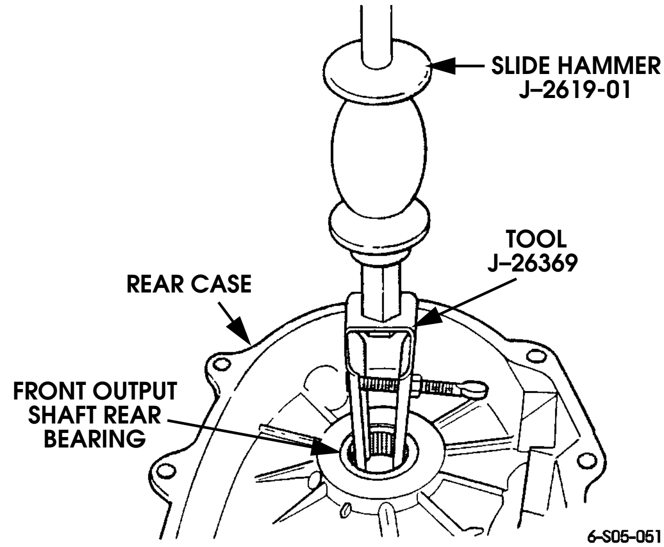


Figure 5-123: Front Output Shaft Rear Bearing Removal

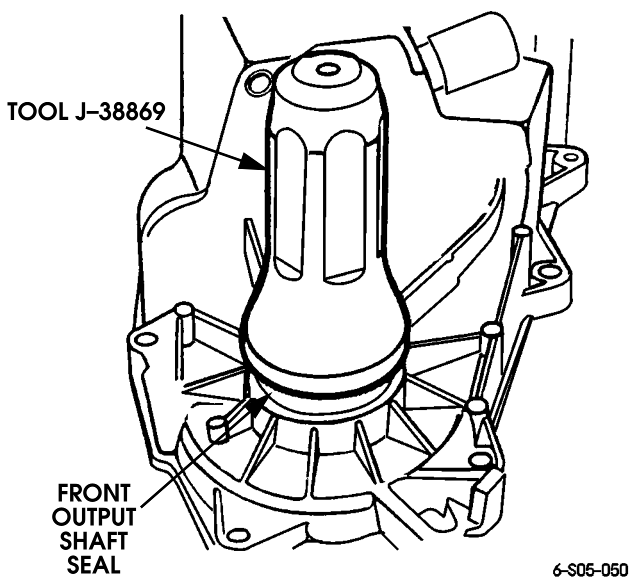


Figure 5-122: Front Output Shaft Seal Installation

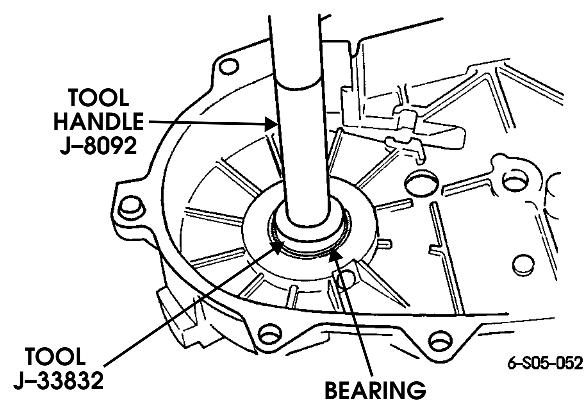


Figure 5-124: Front Output Shaft Rear Bearing Installation

INPUT GEAR BEARING REPLACEMENT

1. Remove old bearing from interior of front case as shown. Use tool handle J8092 and tool J29170 (Figure 5-125).
2. Install new bearing using tool handle J8092 and tool J29170 (Figure 5-126). Seat bearing so locating ring is firmly seated against case.

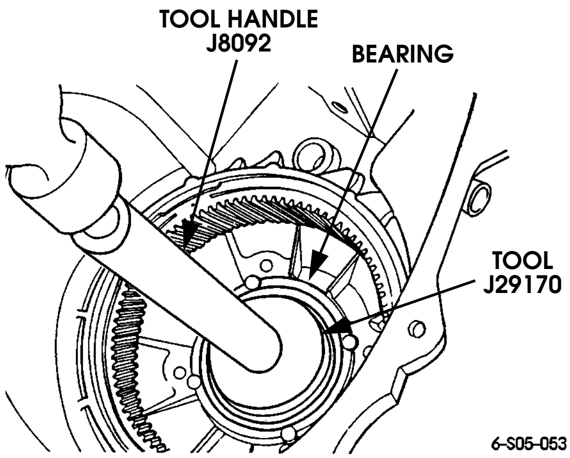


Figure 5-125: Input Gear Bearing Removal

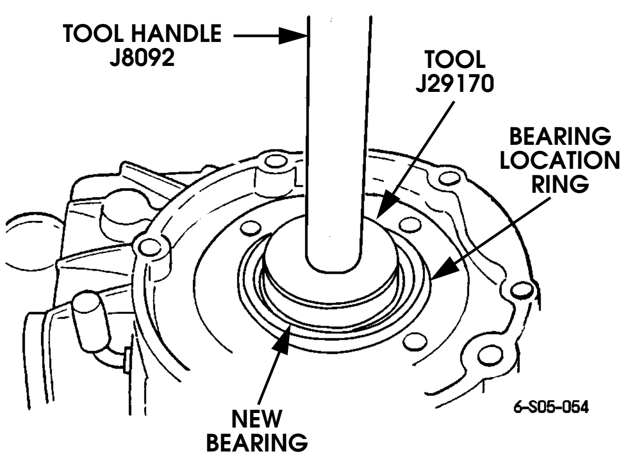


Figure 5-126: Input Gear Bearing Installation

MAINSHAFT PILOT BEARING REPLACEMENT

1. Remove pilot bearing from input gear with slide hammer J2619-01, and puller tool J29369-1 (Figure 5-127). Support input gear on vise or over precut notch or hole in workbench.
2. Install new pilot bearing in gear with tool handle J8092 and tool J33829 (Figure 5-128). Seat bearing flush with chamfer in bearing bore.

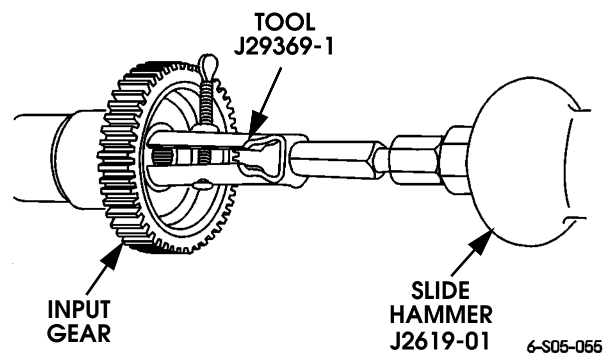


Figure 5-127: Removing Mainshaft Pilot Bearing From Input Gear

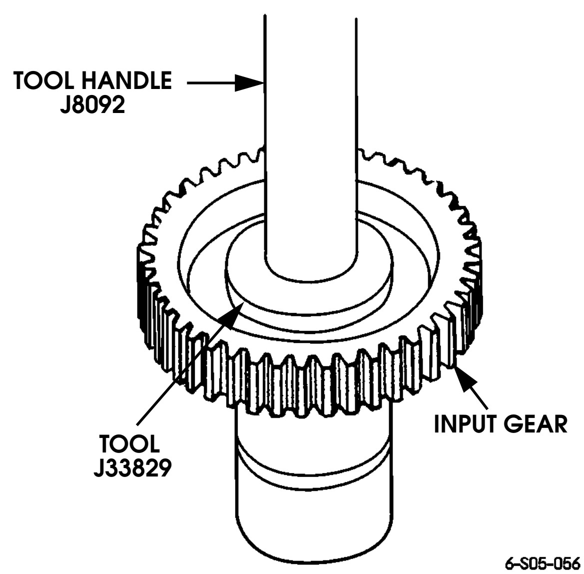


Figure 5-128: Installing Mainshaft Pilot Bearing In Input Gear

EXTENSION HOUSING BUSHING AND SEAL REPLACEMENT

1. Remove old seal with pry tool.
2. Drive out old bushing with tool handle J8092 and tool J33839 (Figure 5-129).
3. Position new bushing on tool J33839 and tap bushing into place until flush with bushing bore.
4. Install new seal in housing with J33843 or suitable size installer tool (Figure 5-130).
5. Lubricate seal lip with Dexron III or petroleum jelly.

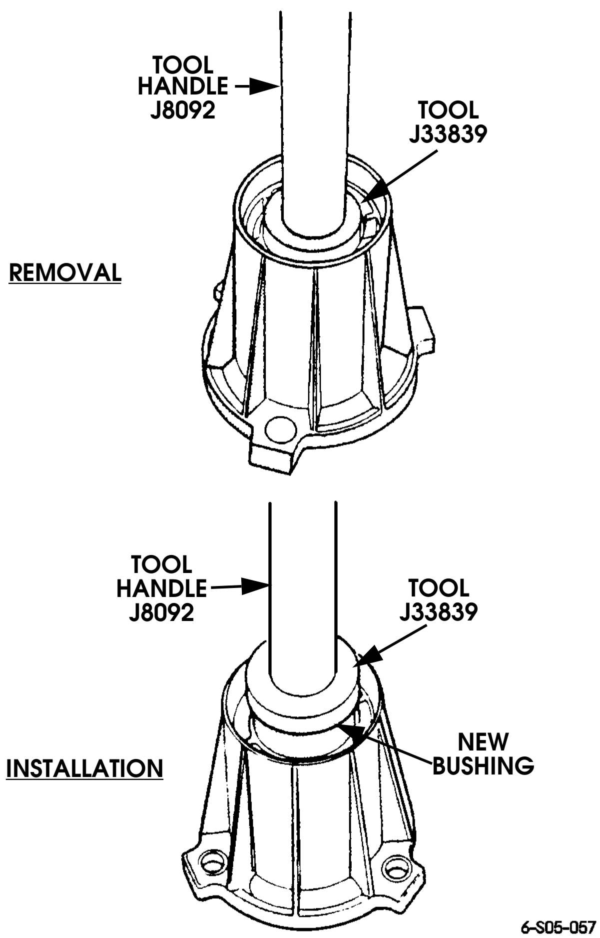


Figure 5-129: Extension Housing Bushing Replacement

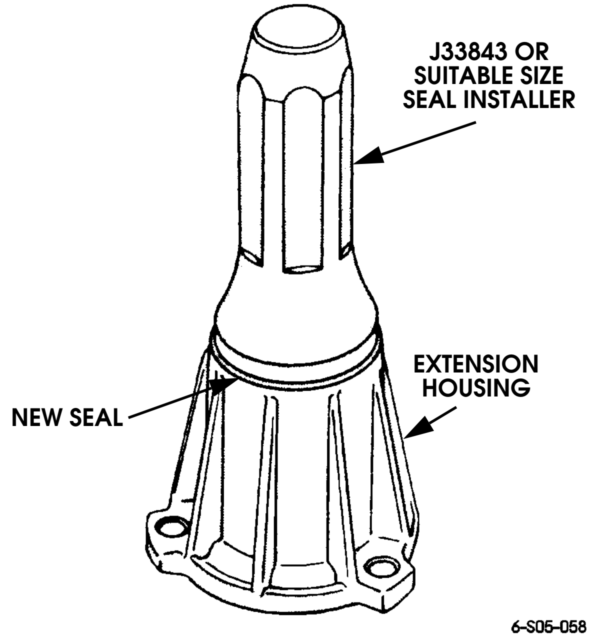


Figure 5-130: Extension Housing Seal Installation

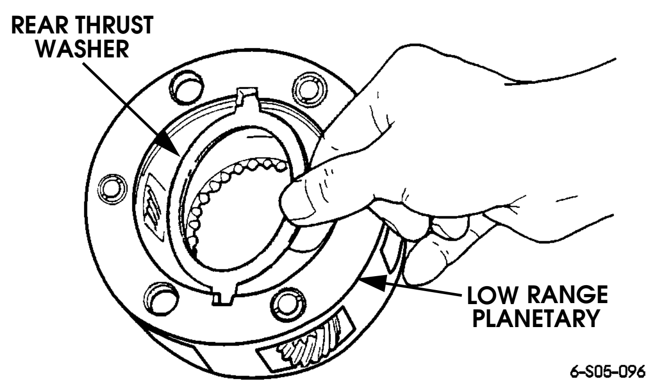


Figure 5-131: Rear Thrust Washer Installation

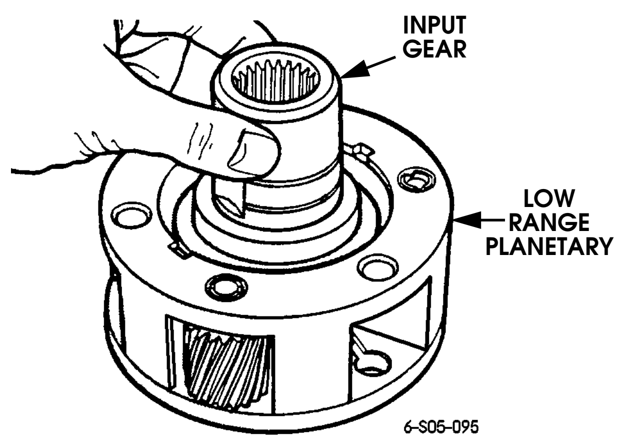


Figure 5-132: Input Gear Installation

TRANSFER CASE ASSEMBLY

1. Assemble input gear and low range planetary:
   a. Lubricate gear, planetary, and thrust washers with Dexron III.
   b. Install rear thrust washer in planetary. Be sure washer tabs are aligned in planetary notches as shown (Figure 5-132)

NOTE: The thrust washers are the same size and are interchangeable. Either washer can be used at the front or rear.

   c. Install input gear in planetary (Figure 5-133).
   d. Install front thrust washer. Be sure washer tabs are seated in planetary notches as shown (Figure 5-133).
   e. Install lock ring (Figure 5-134) and lock ring retainer (Figure 5-135).
2. Lubricate shift sector shaft and install sector in case (Figure 5-136).
3. Install input gear/planetary assembly in front case (Figure 5-137). Use wood hammer handle to tap input gear shaft through bearing.
4. Install input gear snap ring (Figure 5-138).
5. Install front retainer as follows:
   a. Install new seal in retainer with tool J33831 (Figure 5-139).
   b. Apply 3/16 in. (5 mm) bead of Loctite 518, Permatex Ultra Black, or Ultra Copper to sealing surface of retainer.
   c. Align oil feed slot in retainer with feed hole in front case and install retainer (Figure 5-140).
   d. Install and tighten retainer bolts to 12-18 lb-ft (16-24 N•m).

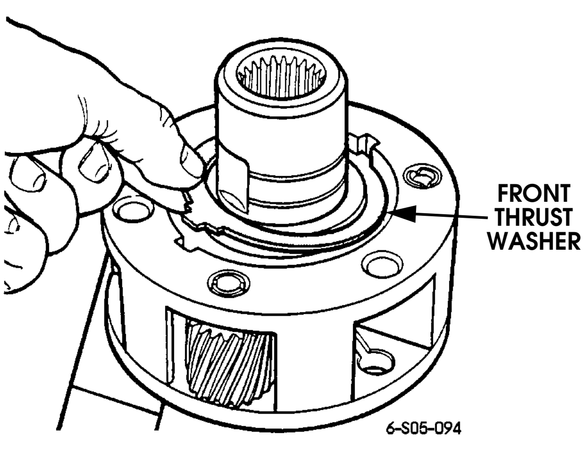


Figure 5-133: Front Thrust Washer Installation

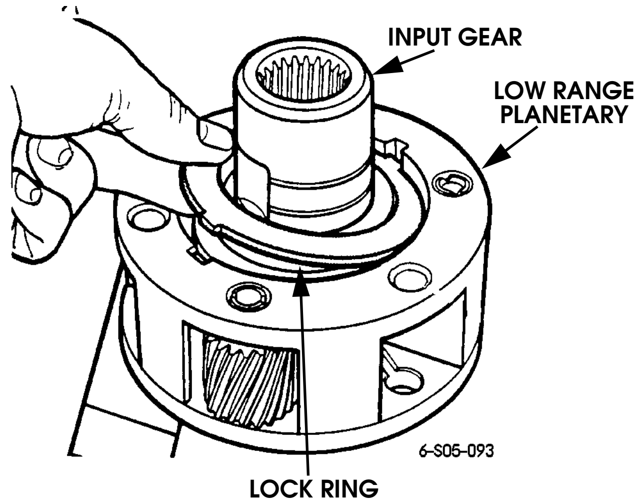


Figure 5-134: Lock Ring Installation

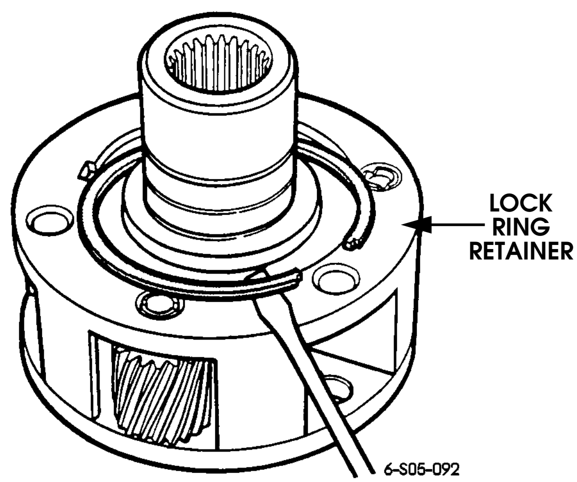


Figure 5-135: Input Gear Snap Ring Installation

6. Assemble low range fork and hub. Replace pads on fork if worn or damaged (Figure 5-141).
7. Install low range fork and hub. Be sure hub is seated in planetary and that fork pin is seated in shift sector lower slot (Figure 5-142).

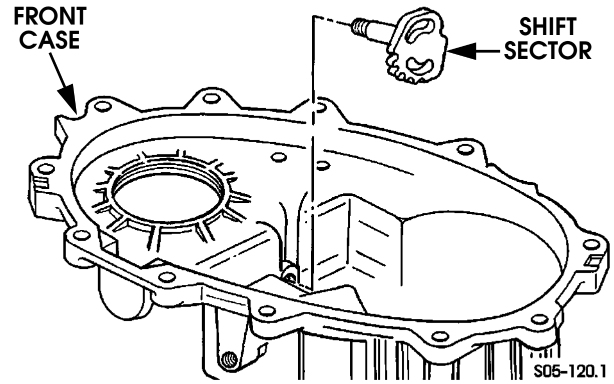


Figure 5-136: Shift Sector Installation

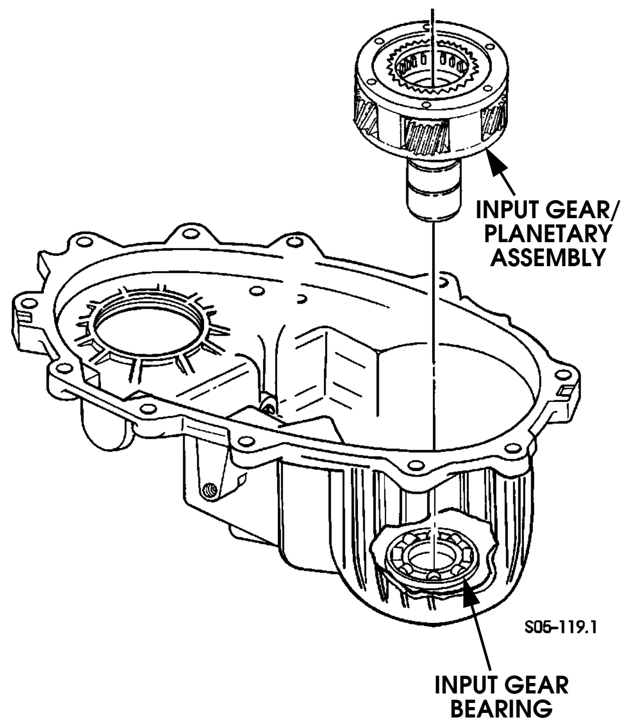


Figure 5-137: Input Gear/Low range Planetary Installation

8. Assemble differential as follows:
   a. Lubricate differential cases, gears, thrust washers with Dexron III.
   b. Install mainshaft gear in front case.
   c. Install sprocket gear.
   d. Install thrust washer on each front case pinion pin.
   e. Install long and short pinions in sets as shown.
   f. Install thrust washer at top of each pinion.
   g. Align and install rear case on front case. Be sure case alignment paint or scribe marks are matched as shown.
   h. Install and tighten differential case bolts evenly.

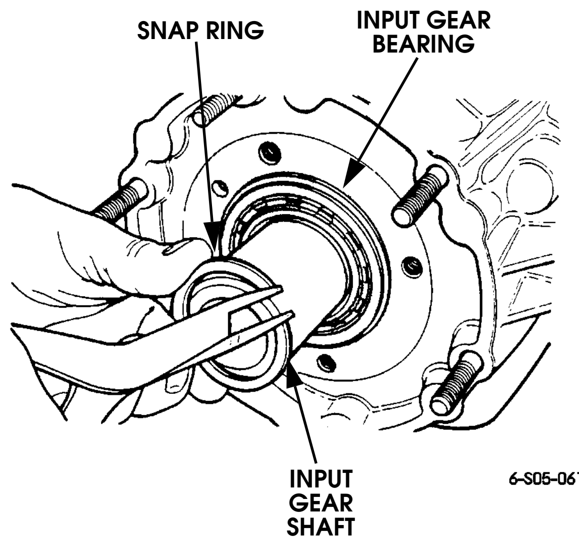


Figure 5-138: Input Gear Snap Ring Installation

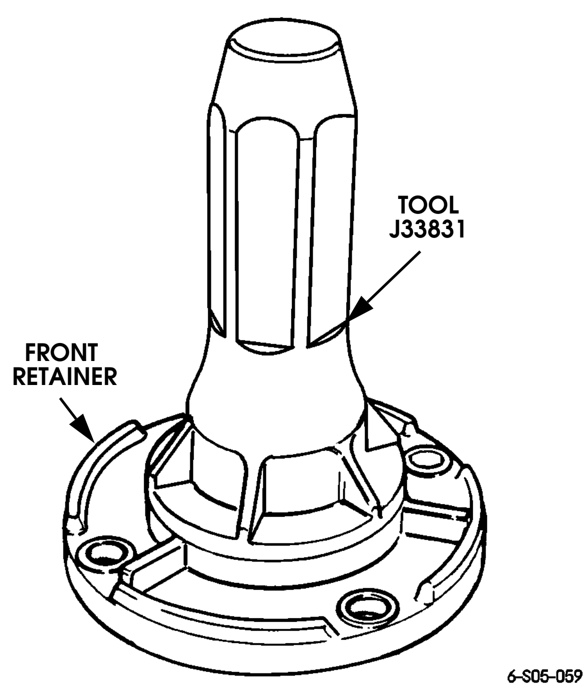


Figure 5-139: Front Retainer Seal Installation

9. Check condition of tone wheel on mainshaft. Replace wheel if teeth are chipped, cracked, or broken.
10. Coat needle bearing surface of mainshaft with petroleum jelly. Then install first spacer, 53 needle bearings, and remaining spacer. Use extra petroleum jelly to hold needle bearings in place (Figure 5-146).
11. Install differential on mainshaft. Verify that needle roller bearings were not displaced before proceeding (Figure 5-147).
12. Install differential snap ring (Figure 5-148).
13. Install intermediate clutch shaft. Be sure shaft is fully seated (Figure 5-149).
14. Install clutch shaft thrust ring and snap ring (Figure 5-150).

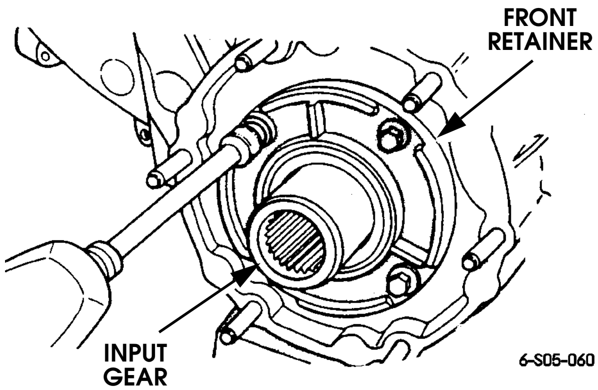


Figure 5-140: Front Retainer Installation

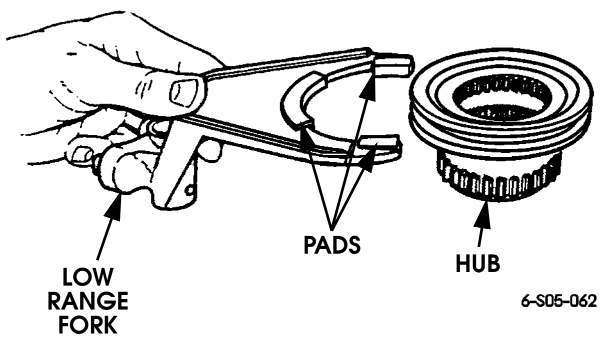


Figure 5-141: Assembling Low Range Fork and Hub

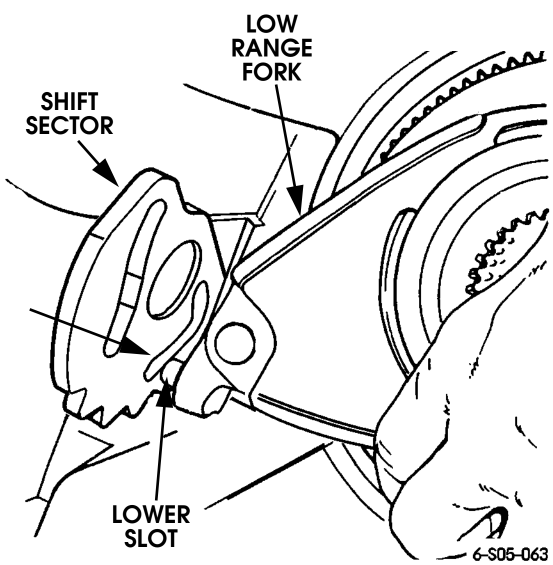


Figure 5-142: Engaging Low Range Fork Pin in Shift Sector

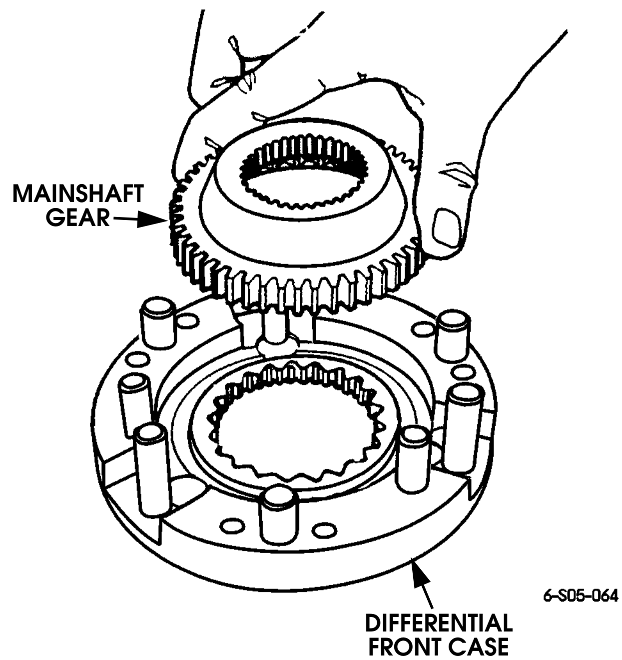


Figure 5-143: Installing Mainshaft Gear In Front Case

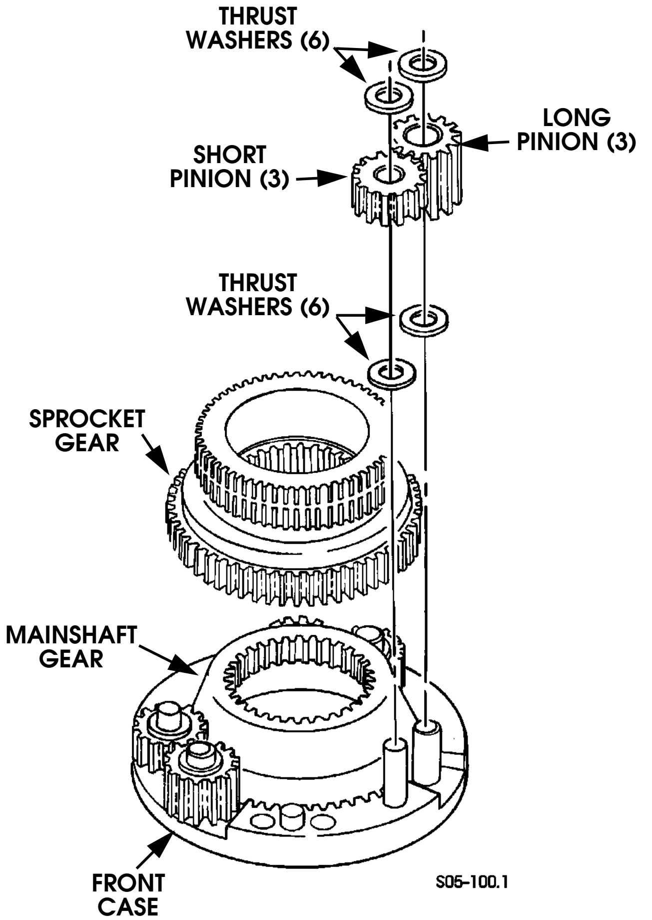


Figure 5-144: Differential Pinion and Sprocket Gear Installation

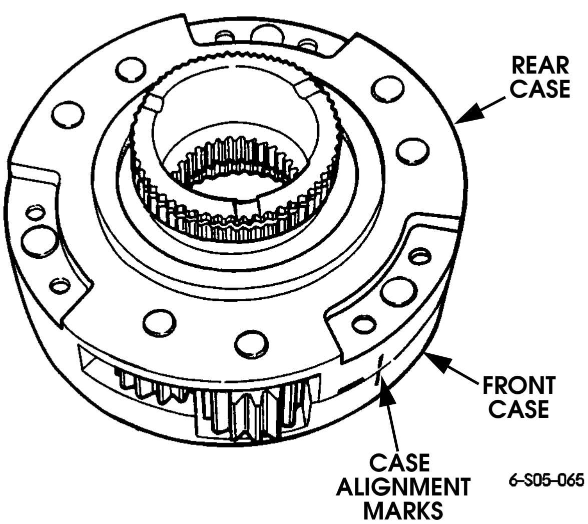


Figure 5-145: Assembling Differential Front/Rear Cases

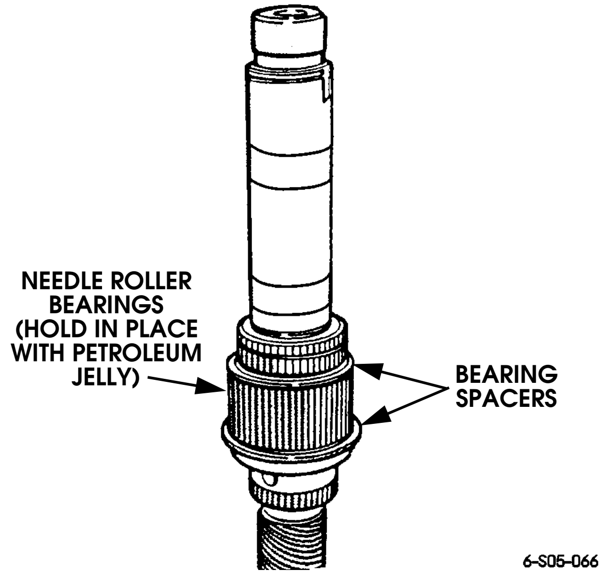


Figure 5-146: Mainshaft Bearing Roller Installation

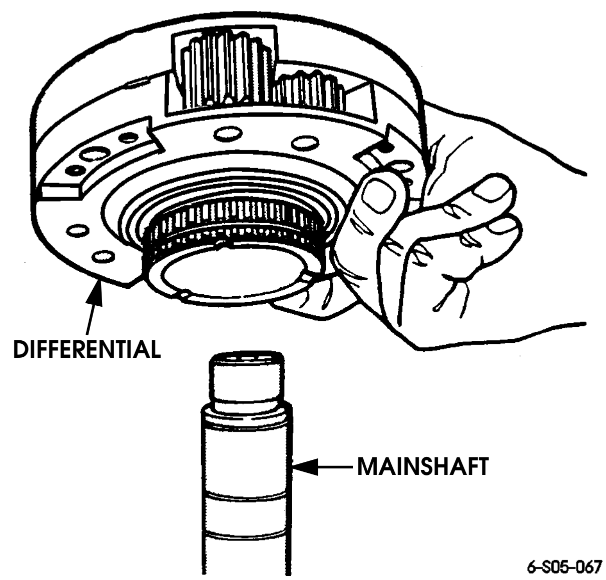


Figure 5-147: Installing Differential On Mainshaft

15. Install mode sleeve in mode fork. Replace fork pads if worn or cracked. Do not reuse worn pads (Figure 5-151).
16. Install assembled mode fork and sleeve on mainshaft. Then seat sleeve in differential (Figure 5-152).
17. Install assembled mainshaft, differential, mode fork, and sleeve. Be sure mainshaft is seated in input gear pilot bearing and that mode fork pin is seated in upper slot of shift sector as shown (Figure 5-153).

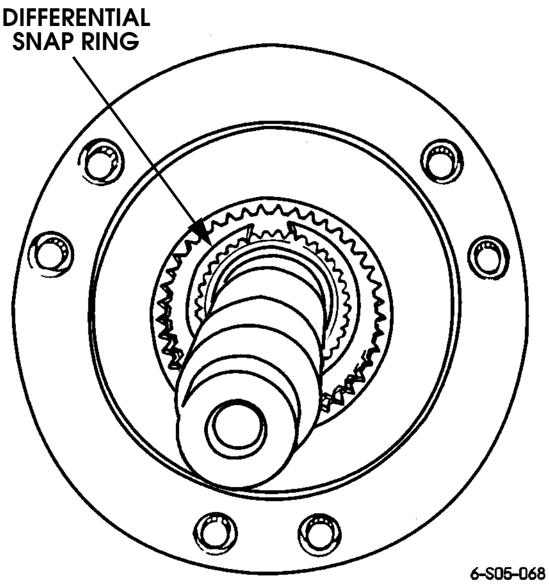


Figure 5-148: Differential Snap Ring Installation

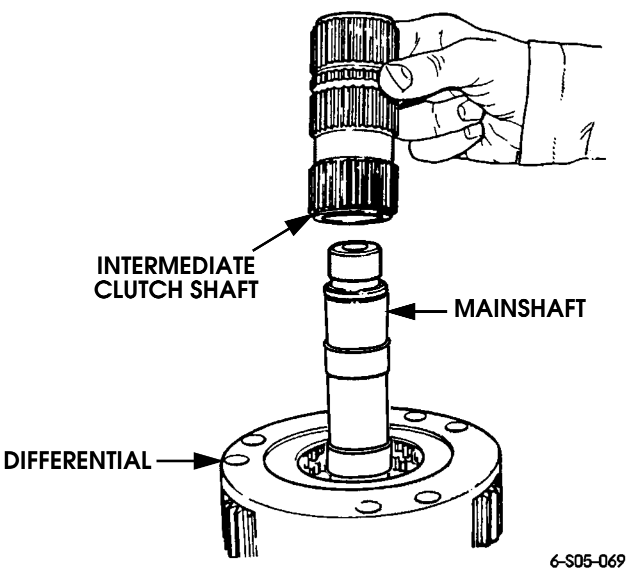


Figure 5-149: Intermediate Clutch Shaft Installation

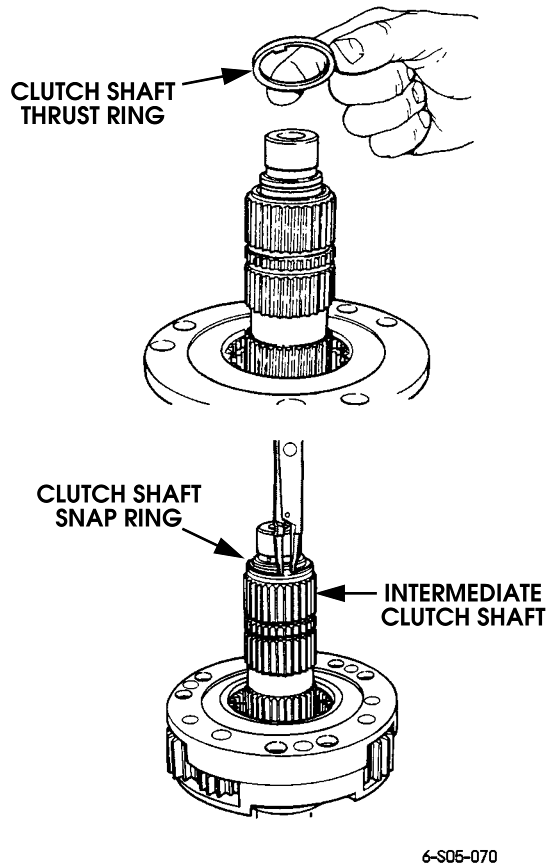


Figure 5-150: Intermediate Clutch Shaft Thrust Ring and Snap Ring Installation

18. Install shift rail. Install rail through mode fork, range fork, and into case bore. Then position lock pin hole in shift rail so it aligns with pin and access holes in case (Figure 5-154).
19. Install range fork lock pin. Start pin in bore with easy out as shown or with pencil magnet. Then seat pin with pin punch and hammer (Figure 5-155).

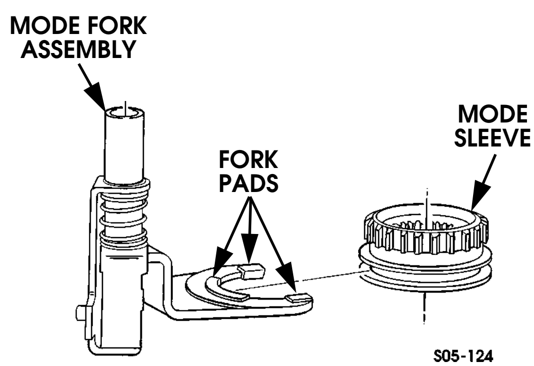


Figure 5-151: Installing Mode Sleeve in Mode Fork

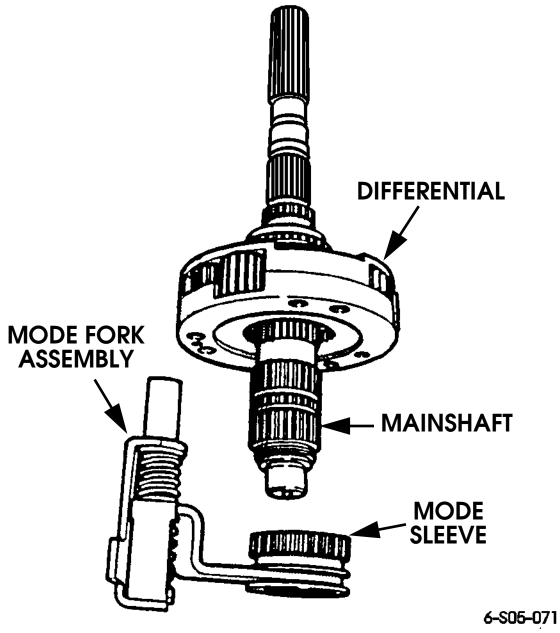


Figure 5-152: Mode Fork and Sleeve Installation

20. Install detent plunger, spring, and plug. Replace O-ring on plug before hand and tighten plug to 12-18 lb-ft (16-24 N•m) (Figure 5-156).
21. Install range lever on sector shaft, then secure lever with washer and nut (Figure 5-156). Tighten nut to 20-25 lb-ft (27-34 N•m).
22. Install shift sector shift O-ring and nylon bushing. Use thin wall socket to seat O-ring and bushing.
23. Install new O-ring on each oil cooler tube and install cooler in front case (Figure 5-157). Secure cooler with washers and nuts. Tighten nuts to 150-230 lb-in. (17-26 N•m).

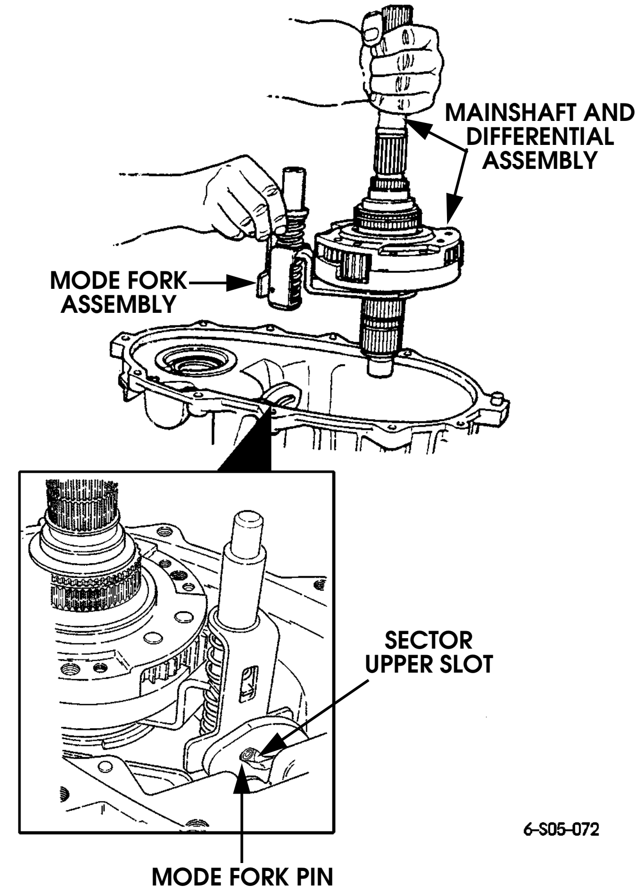


Figure 5-153: Mainshaft, Differential, and Mode Fork Installation

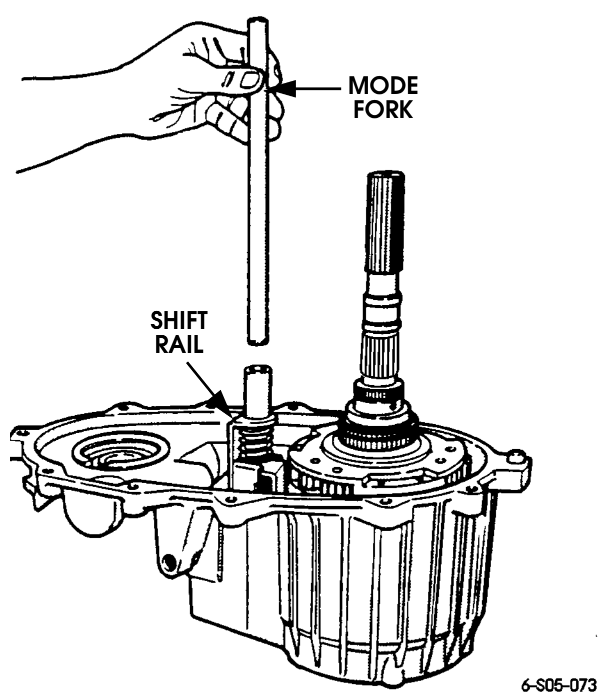


Figure 5-154: Shift Rail Installation

24. Assemble driven sprocket and front output shaft. Use new snap ring if old one is worn or distorted (Figure 5-158).

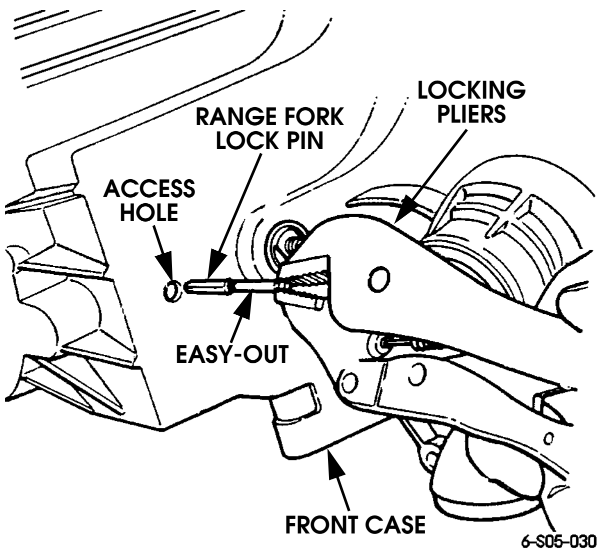


Figure 5-155: Installing Shift Rail Lock Pin

25. Install front output shaft and driven sprocket. Then install drive chain (Figure 5-159).
26. Install drive sprocket. Slide sprocket down onto mainshaft. Engage sprocket in chain and work it onto mainshaft splines (Figure 5-159).
27. Secure drive sprocket to mainshaft with new snap ring. Be sure snap ring is fully seated before proceeding (Figure 5-160).

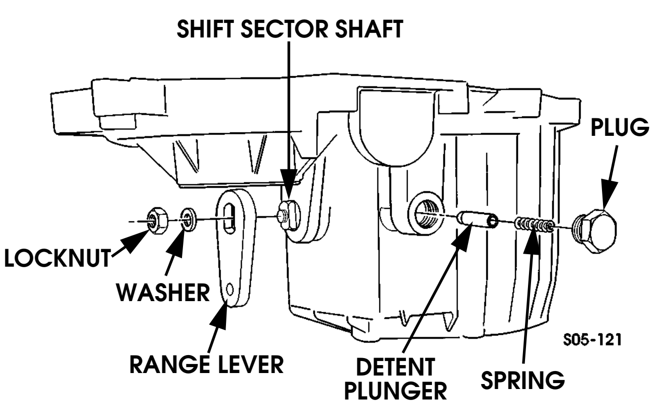


Figure 5-156: Range Cover and Shift Detent Installation

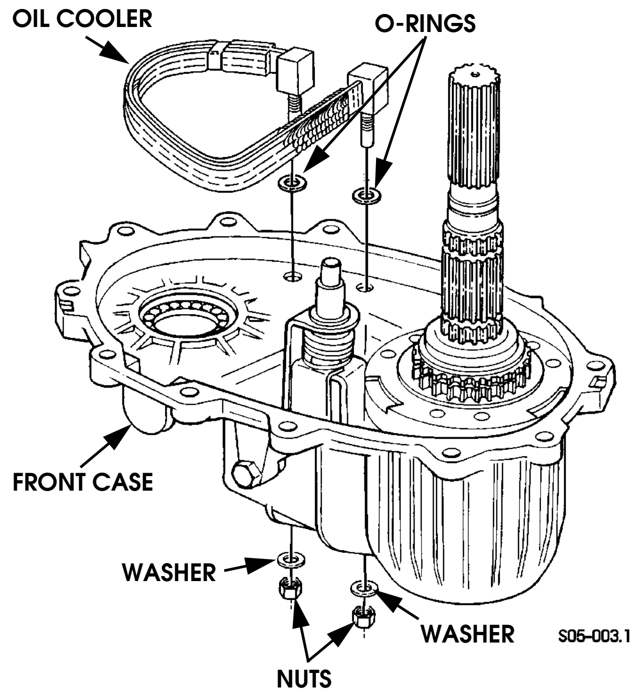


Figure 5-157: Oil Cooler Installation

28. Install new seal in oil pump with tool J33835 (Figure 5-161).
29. Install new O-ring in oil pump inlet port. Then assemble pump, pickup tube, connector hose and pickup screen (Figure 5-162).
30. Position pump assembly in rear case. Be sure pickup screen is seated in case notch as shown (Figure 5-163).

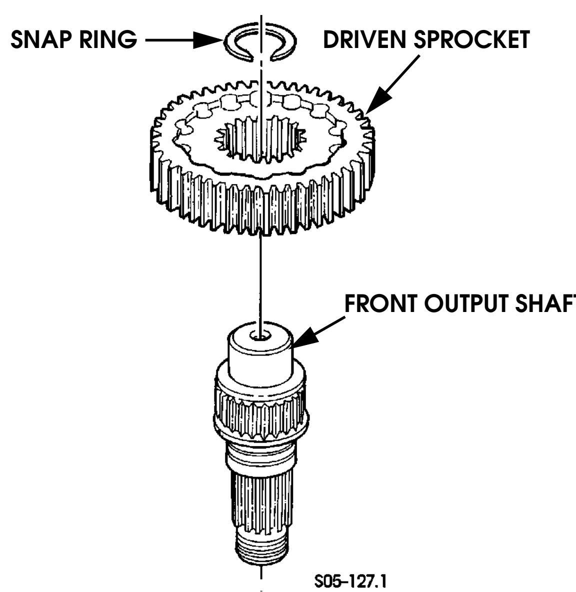


Figure 5-158: Front Output Shaft and Sprocket Assembly

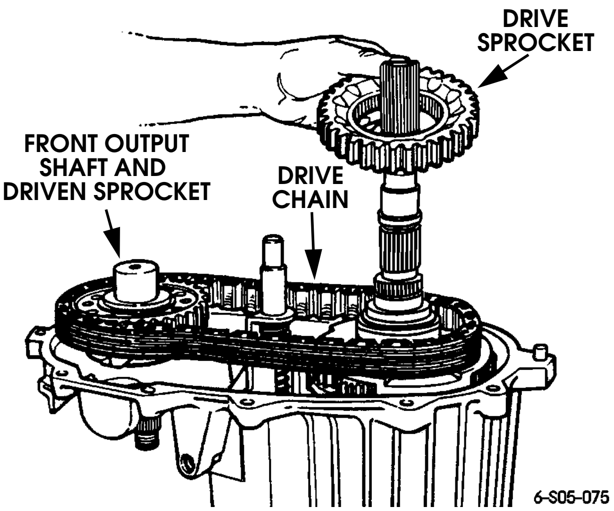


Figure 5-159: Drive Chain and Sprocket Installation

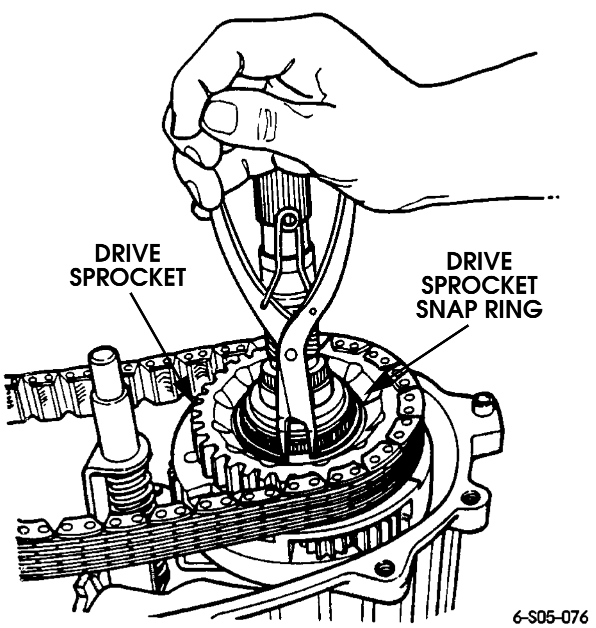


Figure 5-160: Securing Drive Sprocket to Mainshaft

31. Install magnet in front case pocket (Figure 5-164).
32. Apply 3/16 in. (5 mm) wide bead of Loctite 518, Permatex Ultra Black, or Ultra Copper to sealing flange of front case. Be sure sealer encircles each case bolt hole.
33. Align and install rear case on front case (Figure 5-165). Be sure alignment dowel is seated and that oil pump is properly engaged in mainshaft splines. Also be sure front output shaft is seated in rear bearing and shift rail is seated in rear case bore.
34. Install and tighten case bolts in diagonal pattern to 20-25 lb-ft (27-34 N•m).

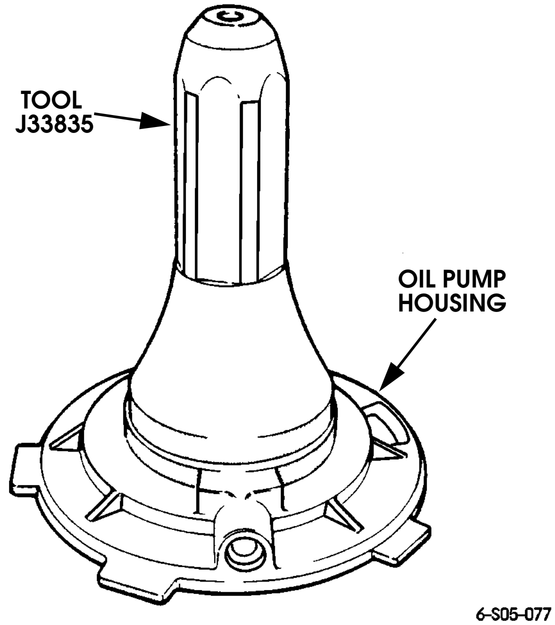


Figure 5-161: Oil Pump Seal Installation

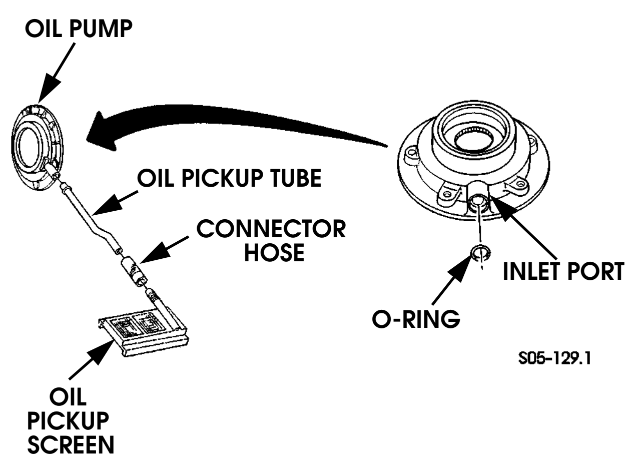


Figure 5-162: Oil Pump and Pickup Component Assembly

35. Install speedometer tone wheel and snap rings (Figure 5-166).
36. Install mainshaft bearing in rear retainer (Figure 5-167). Use tool handle J8092 and installer J33832.

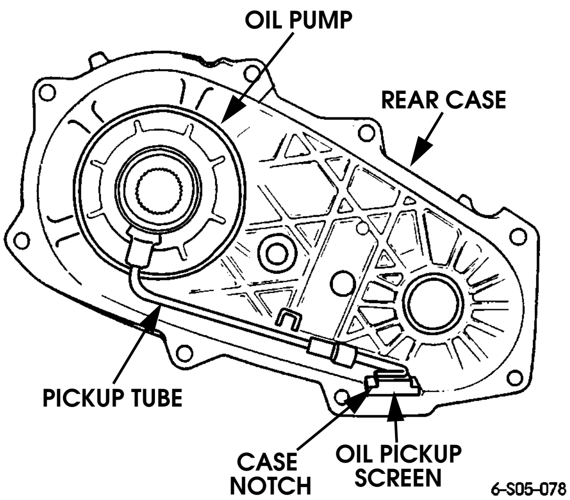


Figure 5-163: Oil Pump Assembly Installation

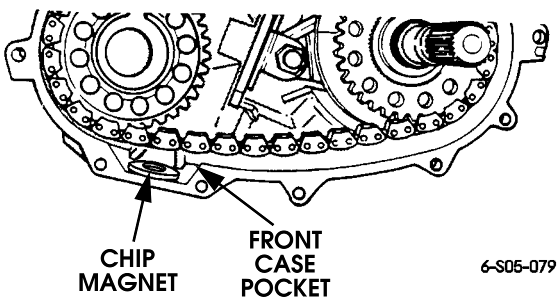


Figure 5-164: Chip Magnet Installation

37. Apply 3/16 in. (5 mm) wide bead of Loctite 518, Permatex Ultra Black, or Ultra Copper to flange surface of rear retainer.
38. Align and install rear retainer (Figure 5-168). Install and tighten retainer bolts to 22-25 lb-ft (30-34 N•m).
39. Install mainshaft bearing snap ring (Figure 5-168).
40. Apply 3/16 in. (5 mm) wide bead of Loctite 518, Permatex Ultra Black, or Ultra Copper to extension housing flange.
41. Align and install extension housing on rear retainer (Figure 5-169). Install and tighten housing bolts to 20-25 lb-ft (27-34 N•m).
42. Check seal contact surface of front yoke. Smooth surface with 320-400 grit emery if necessary. Then lubricate seal surface with Dexron III and Install yoke, new seal washer, and new yoke nut. Tighten yoke nut to 130-200 lb-ft (176-271 N•m). Use yoke tool J8614-01 to hold yoke while tightening nut (Figure 5-170).

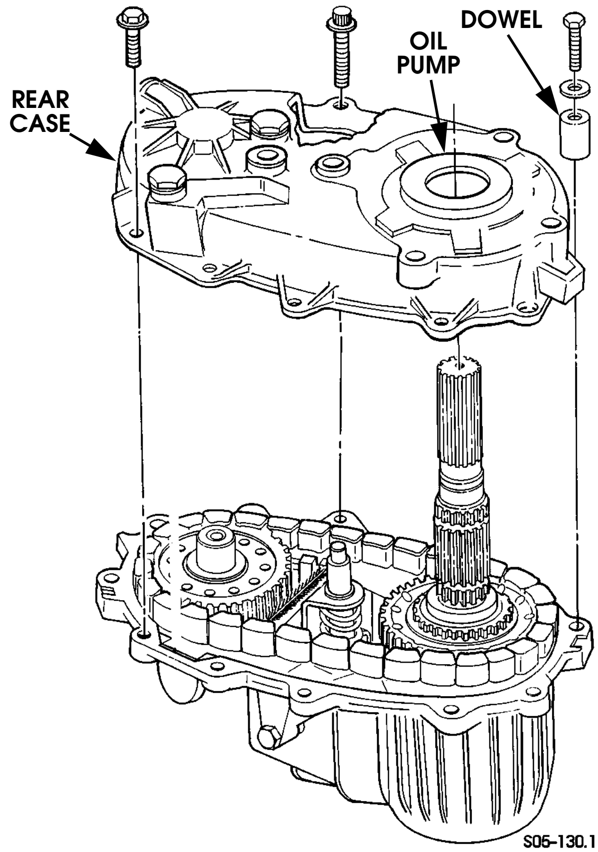


Figure 5-165: Rear Case Installation

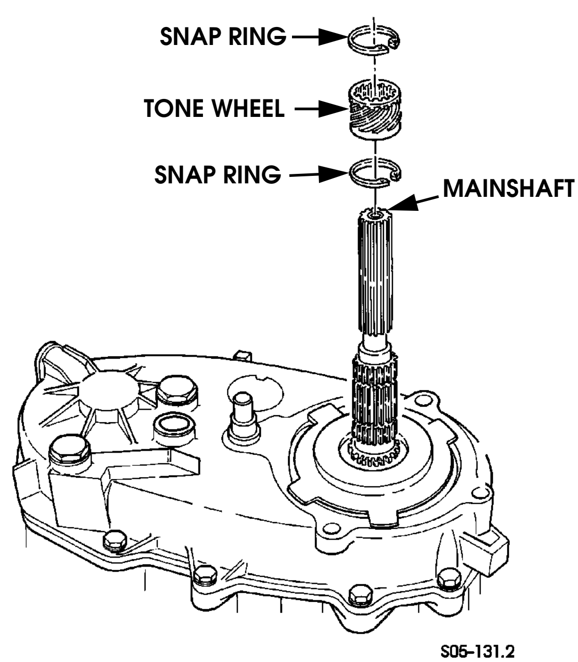


Figure 5-166: Tone Wheel Speedometer Installation

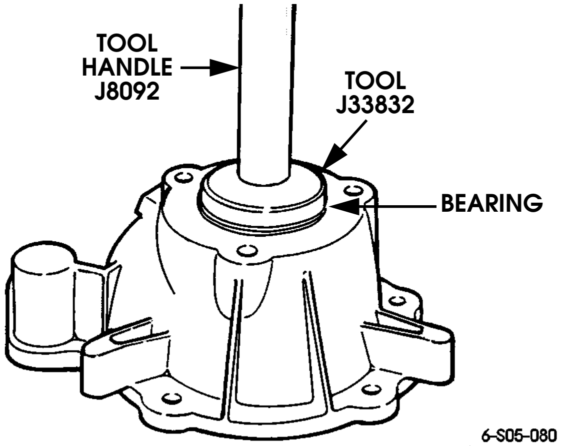


Figure 5-167: Installing Mainshaft Bearing In Rear Retainer

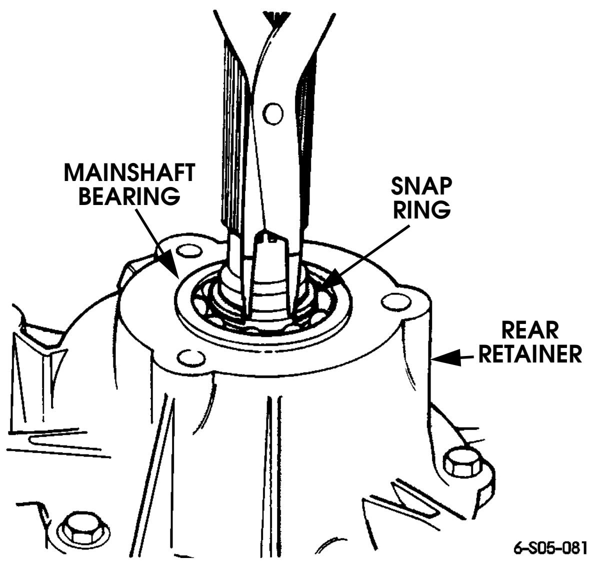


Figure 5-168: Rear Retainer and Mainshaft Bearing Snap Ring Installation

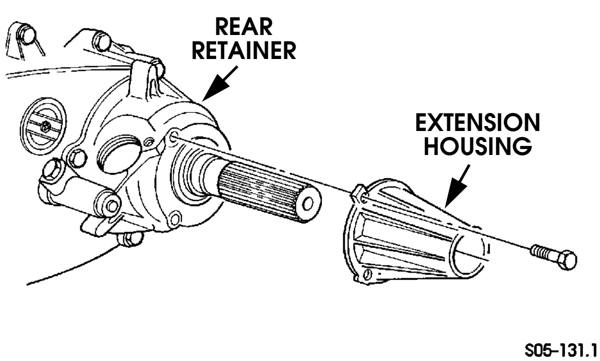


Figure 5-169: Extension Housing Installation

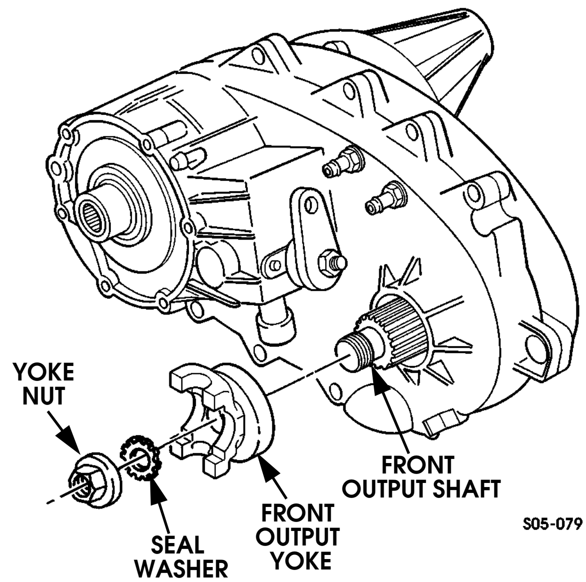


Figure 5-170: Front Yoke Installation

43. Install drain plug in rear case. Tighten plug to 30-40 lb-ft (41-54 N•m).
44. Apply Loctite PST to threads of indicator switches and speed sensor.
45. Install indicator switches. Tighten switches to 15-25 lb-ft (20-34 N•m).
46. Install speed sensor. Tighten sensor to 30-35 lb-ft (41-47 N•m).
47. Transfer case can be filled before or after installation in vehicle. Tighten fill plug to 30-40 lb-ft (41-54 N•m) after refill.

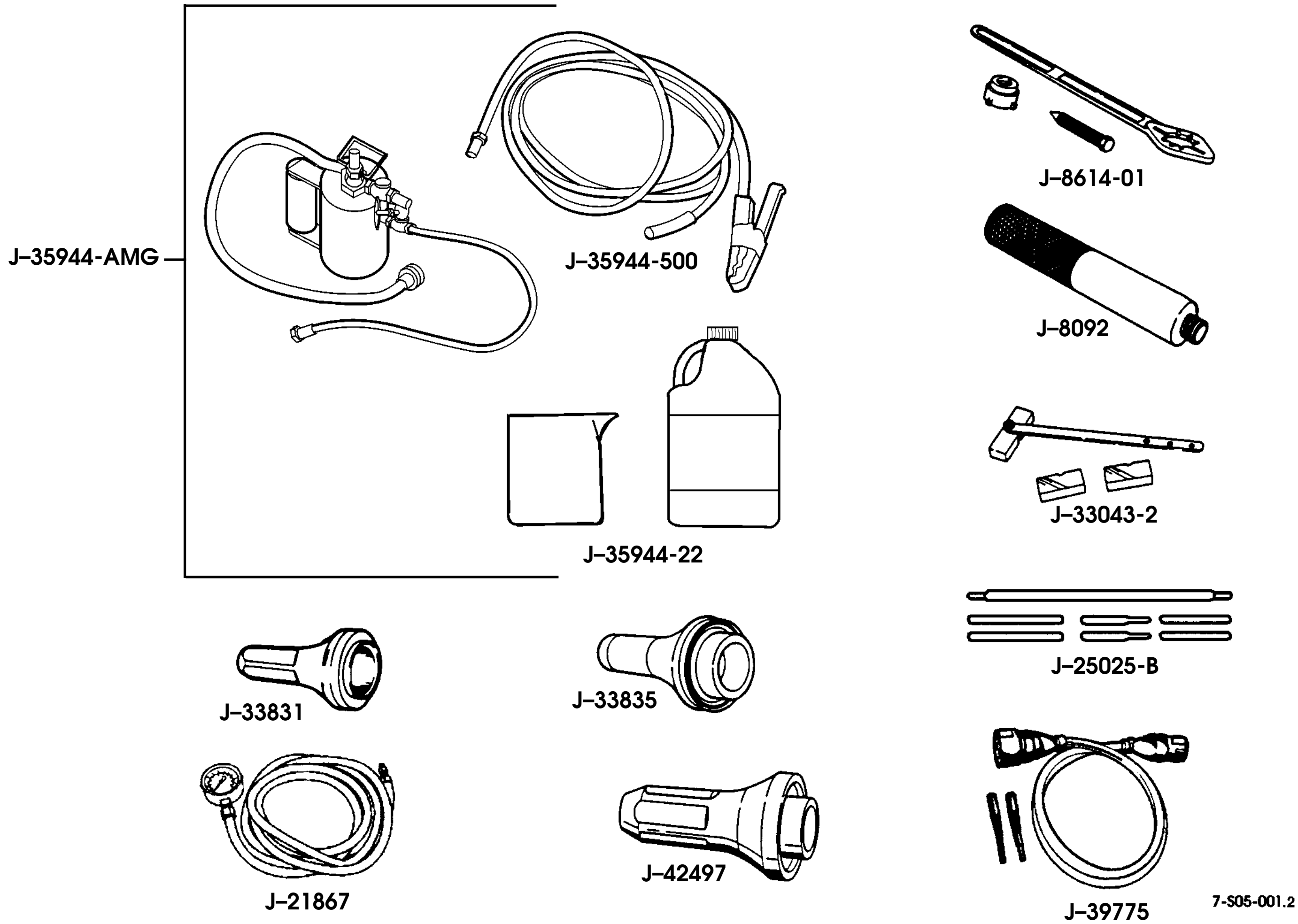
TRANSFER CASE TORQUE SPECIFICATIONS

Case bolts (all)	20-25 lb-ft (27-34 N•m)
Detent plug	12-18 lb-ft (16-24 N•m)
Drain/fill plugs	30-40 lb-ft (41-54 N•m)
Exhaust bracket nuts	18-22 lb-ft (24-30 N•m)
Extension housing bolts	20-25 lb-ft (27-34 N•m)
Front retainer bolts	12-18 lb-ft (16-24 N•m)
Front output shaft yoke nut	130-200 lb-ft (176-271 N•m)
Indicator switches (both)	15-25 lb-ft (20-34 N•m)
Oil cooler tube nuts	150-230 in.-lb (17-26 N•m)
Range lever nut	20-25 lb-ft (27-34 N•m)
Rear retainer bolts	22-25 lb-ft (30-34 N•m)
Speed sensor	30-35 lb-ft (41-47 N•m)
Transfer case mounting nuts	20-26 lb-ft (27-35 N•m)

TRANSMISSION TORQUE SPECIFICATIONS

Adapter-to-case nuts	25 lb-ft (34 N•m)
Converter bolts	32 lb-ft (44 N•m)
Converter housing cover bolts	62 lb-in. (7 N•m)
Manual shaft detent lever nut	18 lb-ft (24 N•m)
Oil pan bolts	32 lb-ft (44 N•m)
Oil pump bolt	97 lb-in. (11 N•m)
Park pawl bracket-to-case bolt	18 lb-ft (24 N•m)
Pressure test port plug	97 lb-in. (11 N•m)
Solenoid-to-valve body screw	71 lb-in. (8 N•m)
Transmission-to-engine bolts/studs	32 lb-ft (44 N•m)
Valve body screws	18 lb-ft (24 N•m)

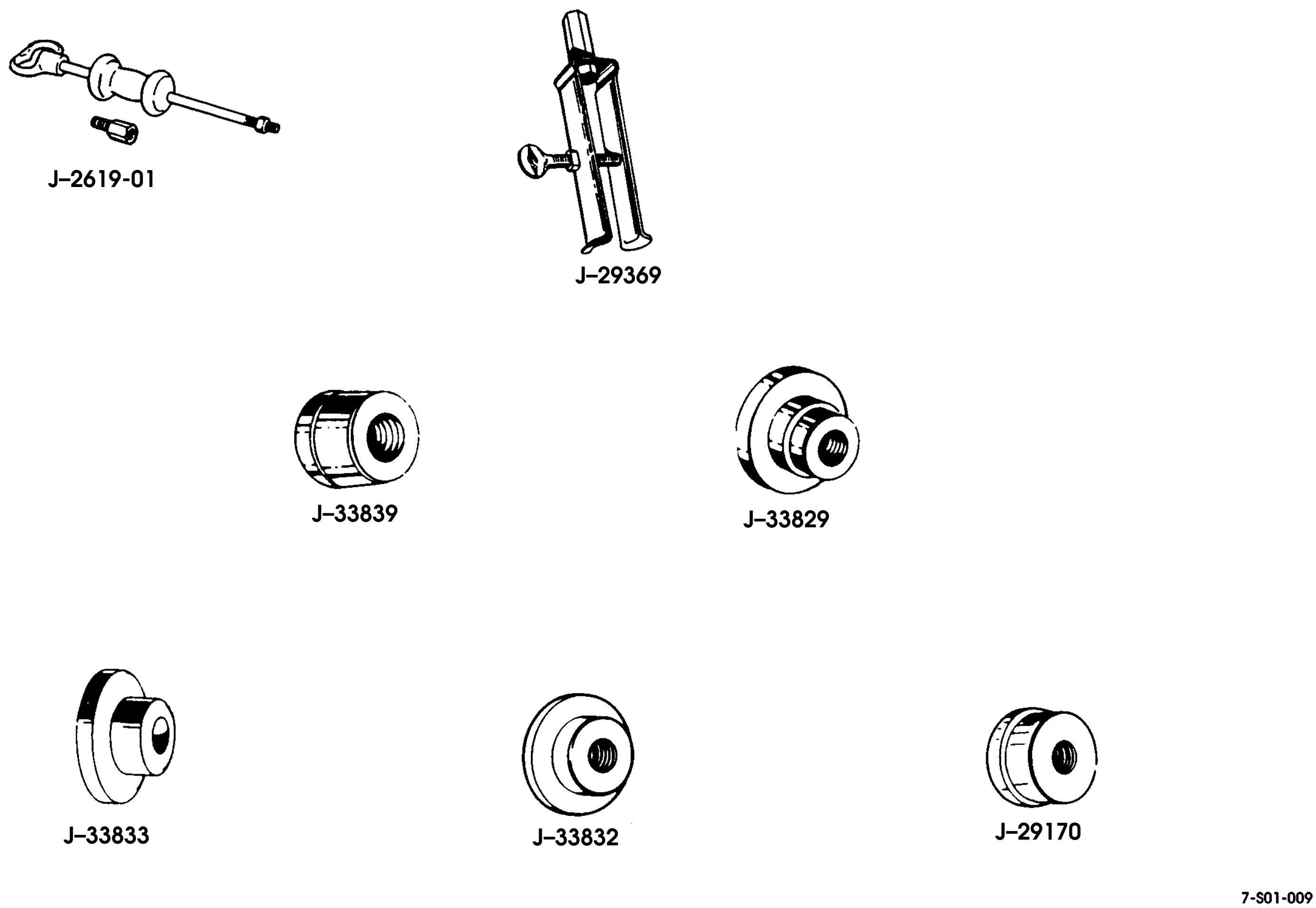
ESSENTIAL TOOLS



Tool No.	Description
J–39544-AMG	Transmission Oil Cooler Flush Kit
J–35944-500	Cooler Line Adapters
J–35944-22	Oil Cooler Flushing Fluid
J–8614-01	Yoke Holding Tool
J–8092	Universal Driver Handle
J–33043-2	Vacuum Gauge Block Assembly
J–25025-B	Dial Indicator and Guide Pin Set
J–39775	Transmission Test Jumper Harness
J–42497	Extension Housing Seal Installer
J–21867	Pressure Gauge and Hose Assembly
J–33831	Input Seal Installer
J–33835	Pump Housing Seal Installer
J–38869	Output Shaft Seal Installer (not shown)
J–41623-A	Oil Cooler Release Tool (not shown)
J–42543	Selector Shaft Seal Remover/Installer (not shown)
J–42589	TP Sensor Jumper Harness (not shown)

Procure from Kent-Moore.

SPECIAL TOOLS



Tool No.	Description
J–2619-01	Slide Hammer and Adapter
J–29369	Bushing/Bearing Remover Kit
J–33839	Rear Output Bushing Remover (use with J–8092)
J–33829	Pilot Bearing Installer (use with J–8092)
J–33833	Output Shaft Main Bearing Installer (use with J–8092)
J–33832	Front Output Shaft Rear Bearing Installer (use with J–8092)
J–29170	Input Gear Bearing Remover (use with J–8092)

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Section 6 Wheels and Tires/Central Tire Inflation System (CTIS)

TABLE OF CONTENTS

WHEEL AND TIRE ASSEMBLY REPLACEMENT

WARNING: Always take the wheel to an authorized service center for proper servicing. Use 16.5 inch diameter tires only. Mismatching tire and rim diameters is dangerous. A mismatched tire and rim assembly may explode and can result in serious injury or death.

WARNING: Put transmission into the PARK position, apply parking brake, and chock opposite wheel before removing wheel. Avoid removing any wheel when vehicle is on sloping terrain. Personal injury or damage to equipment may result. Remove only the inner group of lug nuts when removing a wheel from the vehicle. Removing the outer nuts which hold the rim together while the assembly is inflated could result in serious injury or death.

WARNING: Never mix tires of different size or tread design. Never mix bias and radial construction tires. Mixing tire types will adversely affect road handling and can lead to loss of vehicle control, and could result in serious injury or death.

NOTE: One piece wheel rim assemblies are standard equipment. The repair procedures for 2-piece wheel rims are provided to ensure safe, accurate methods are used when servicing the optional wheel choice.

NOTE: Two-piece take-apart and one piece tire and wheel assemblies are replaced basically the same. Always depress both CTIS quick-disconnect valve tabs on each axle set to prevent air loss from the other tire.

Removal

NOTE: On vehicles equipped with Central Tire Inflation System (CTIS), mark the wheel mounting studs for installation position, then perform steps 1 and 2.

1. Remove CTIS hose shield.
2. Remove tube and quick-disconnect valve from spindle.
3. Loosen, but do not remove, lug nuts (Figure 6-1).
4. Raise and support corner of vehicle.
5. Remove lug nuts and wheel from geared hub spindle.

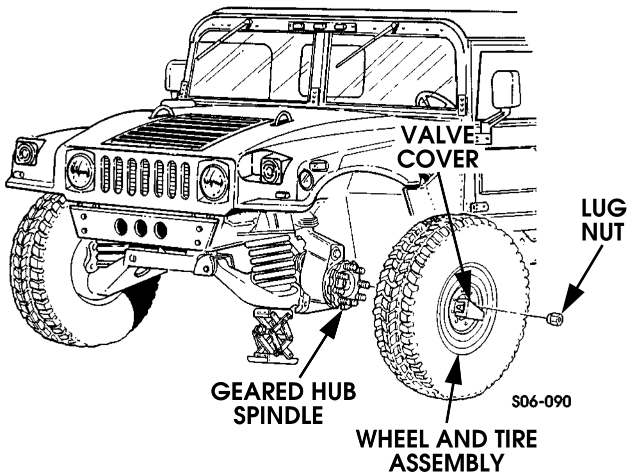


Figure 6-1: Wheel and Tire Assembly Replacement

Installation

NOTE: The Wrangler GS-A, 37 X 12.50R16.5 LT touring radial tire has an asymmetrical/directional tread design. The heavier, stiffer tread on the outside shoulder of tire must face outward when being installed. Before installing on a wheel, inspect sidewall of tire and ensure THIS SIDE OUTWARDS imprint is facing outward (Figure 6-2).

NOTE: Install lug nuts with fingers to full engagement. If nuts resist finger tightening examine studs and nuts for damage and replace if damaged.

1. Position wheel on geared hub spindle according to marks on mounting studs and attach with lug nuts (Figure 6-1).

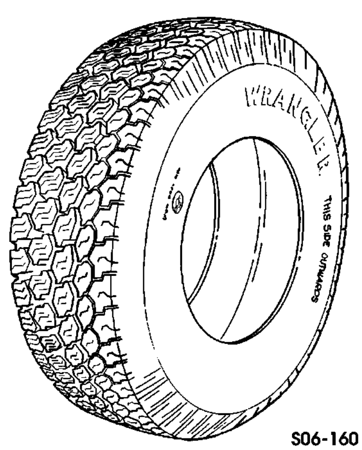


Figure 6-2: This Side Outwards Location

2. Remove support and lower corner of vehicle.
3. On one-piece wheels, tighten lug nuts to 126-154 lb-ft (171-209 N•m). Two-piece wheels should be torqued to 110 lb-ft (149 N•m). Use tightening sequence shown (Figure 6-3).

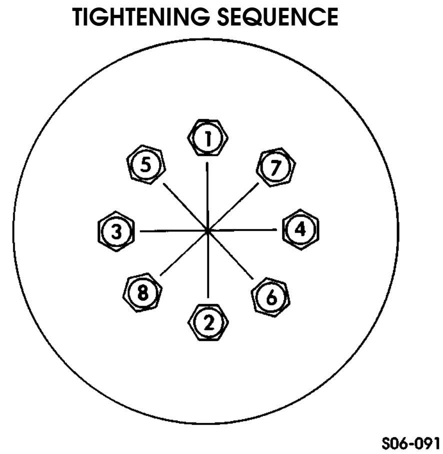


Figure 6-3: Lug Nut Tightening Sequence

CAUTION: *Do not allow pipe thread sealant into air system. Sealant will damage CTIS components and inhibit the CTIS operation.*

NOTE: Perform steps 4 and 5 for vehicles equipped with CTIS.

4. Install CTIS quick-connect valve and tube on spindle.
5. Install CTIS hose shield.

TIRE, TWO-PIECE WHEEL, AND RUNFLAT REPLACEMENT

WARNING: Do not use tire machine. Personal injury or damage to equipment may result.

CAUTION: *It is not recommended mixing one-piece wheel runflat assemblies and two-piece take-a-part runflat wheel assemblies on the same vehicle. Runflat profiles are different between the two types of wheel assemblies.*

Removal and Disassembly

1. If the vehicle is equipped with a Central Tire Inflation System (CTIS), perform steps a through d:
   a. Release the quick disconnect fitting located in the center of the geared hub spindle on all four wheels.
   b. Remove the hose shield and lay aside.
   c. Remove the brass fitting from the center of the geared hub spindle on the wheel(s) to be worked on.
   d. Use tire chalk to mark two of the geared hub spindle assembly studs nearest the air valve.

WARNING: In all disassembly operations, ensure tire is totally deflated before removing wheel locknuts. Failure to follow proper safety precautions could cause serious injury or death.

2. Remove wheel/tire assembly from vehicle.
3. Inspect vehicle geared hub spindle studs for bending, looseness, or stripped threads. Replace if damaged.
4. Inspect flanged lug nuts for fatigue, stripped threads, or other damage. Replace if damaged.
5. Use tire chalk to mark the valve location on the sidewall of the tire.
6. Remove valve cap and core from air valve and deflate tire.
7. Run a piece of wire through air valve to ensure it is not plugged (Figure 6-3).

NOTE: A special pentagon-shaped socket is required for removal and installation of two-piece wheel locknuts. Refer to essential tools at the end of this section.

WARNING: Do not use unauthorized tools. Damage to equipment or serious injury may result.

8. When tire is fully deflated, use a circular pattern and loosen twelve wheel locknuts securing rim halves together. If you hear air escaping, do not proceed. Wait until the sound stops and recheck core housing for obstructions. When you are certain the tire is fully deflated, continue to remove wheel locknuts. Discard locknuts. Remove and discard three pilot washers.

WARNING: Never inflate a two-piece wheel assembly with the wheel locknuts removed in an attempt to separate inner and outer rim halves. The assembly will separate under pressure resulting in serious injury or death.

9. Remove outer rim half from inner rim and tire.

NOTE: Perform steps 6 and 7 only if damage to core housing, insert, or O-ring is evident.

10. Inspect valve core housing and insert for damage. Replace both if damaged.
11. Remove valve core housing from insert. Remove insert and locknut from outer rim half.

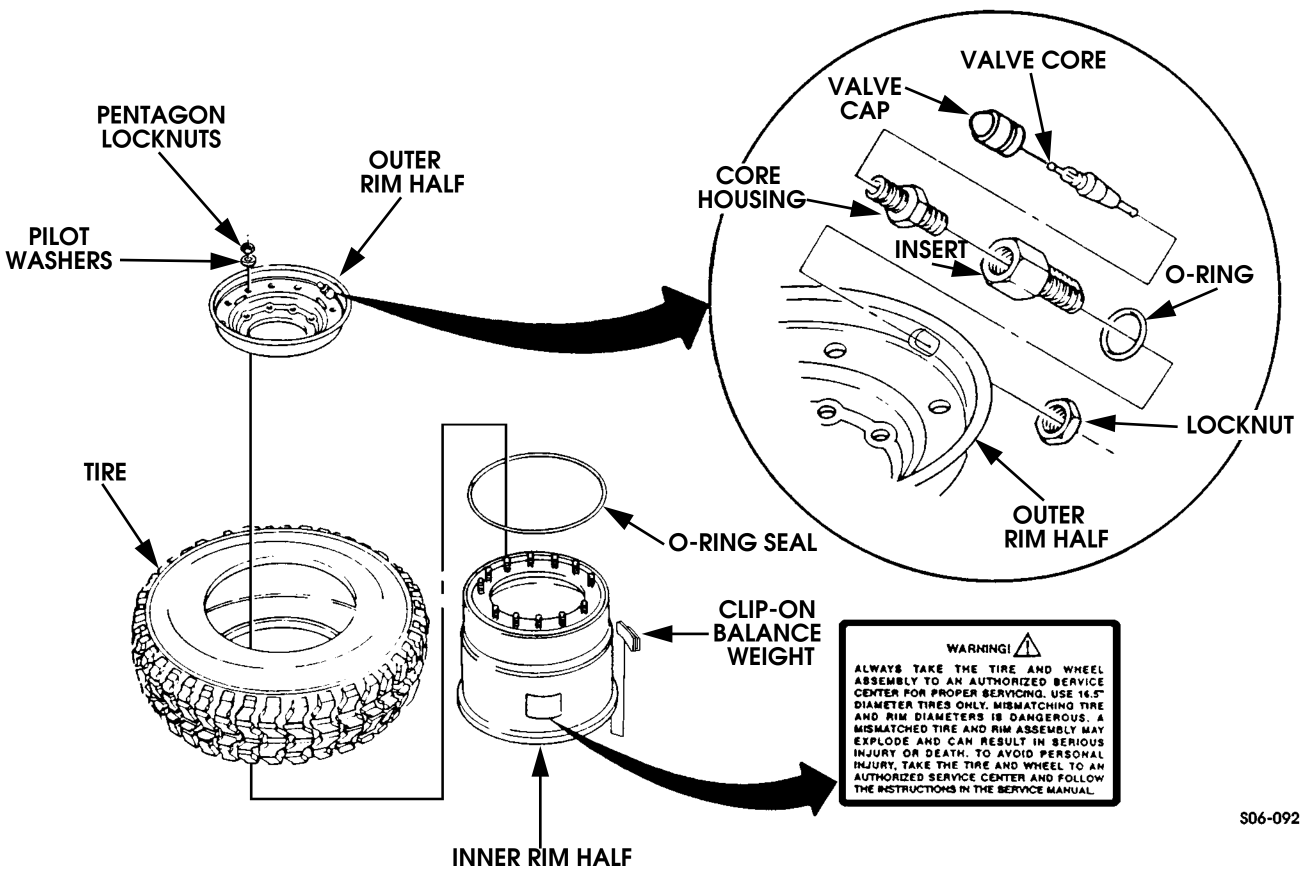


Figure 6-4: Two-Piece Wheel Breakdown

12. Remove O-ring from insert. Discard O-ring.
13. Remove O-ring seal from inner rim half. Discard O-ring seal.
14. Remove tire from inner rim half.

WARNING: Balance weights contain lead. Wash hands after handling.

15. Remove balance weights from rim halves. Discard balance weights.
16. Lay tire flat.

WARNING: To avoid injury, ensure runflat compressor strap is centered around runflat.

17. Using runflat compressor, compress runflat.
18. Position runflat compressor on an outer edge of runflat with handle assembly facing up and strap centered around runflat (Figure 6-5).

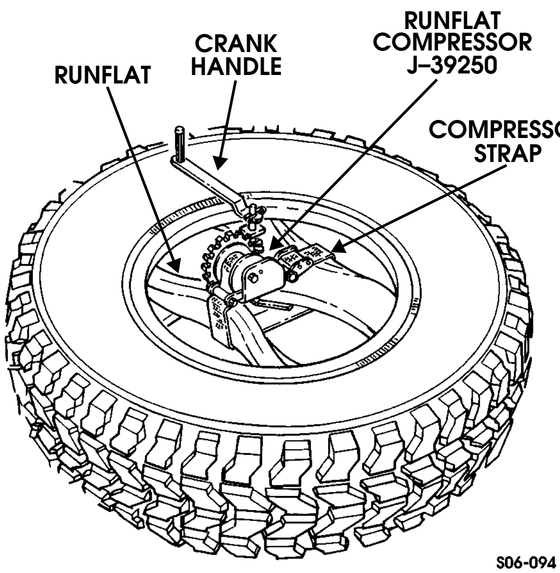


Figure 6-5: Crank Handle Runflat Compressor Operation

NOTE: Compress runflat by rotating the handle assembly in a clockwise direction. Rotate handle assembly counterclockwise to loosen.

19. Using runflat compressor, compress runflat.

NOTE: It may be necessary to use a tire spoon and tire lube to remove runflat from tire. When using runflat compressor, it may be necessary to remove handle before removing runflat.

20. Remove runflat from tire and remove runflat compressor from runflat (Figure 6-6).

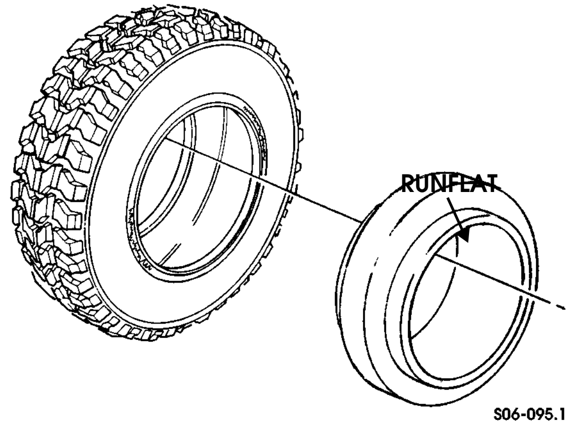


Figure 6-6: Runflat Appearance After Removal

Inspection and Cleaning

CAUTION: *Do not reuse a tire which has been run flat without thoroughly inspecting for damage. Failure to follow these instructions may result in damage to equipment.*

1. Remove any existing lubricant that has been previously applied to the inside of the tire using a mild detergent soap and water.
2. Dry all wheel and tire parts. Ensure inside of tire is free of any runflat lubricant, dirt, debris, rust, or moisture.

WARNING: Thorough tire inspection is critical. Continued use of worn or damaged tires could result in equipment damage, serious injury or death.

3. Inspect inside of tire for cord or belt separation and inner liner damage. Replace tire if damaged.
4. Inspect tire bead for abrasions. Replace tire if damaged.
5. Check for protruding objects inside tire which may not be visible from outside. If tire is punctured yet repairable, repair with internal (05710215) or external (05710216) tire repair kit.
6. Check tread depth on tire. Tread should not be worn below level of wear bars (Figure 6-7). Markings on the sides of the tires (e.g., the letters “TWI” or a triangle) show the location of wear bars. Replace tire if tread is worn below wear bars or 3/32 inch (2.38 mm).
7. Inspect runflat for splitting, cracking, wear, or excessive chafing. Damaged runflat performance will be nonexistent or greatly reduced. Replace runflat if damaged (Figure 6-6).

8. Inspect outside of tire for sidewall damage. Replace tire if damaged.
9. Inspect tread for puncture damage. If damage is too extensive for patch repair, replace tire.

WARNING: O-ring sealing surfaces and pressure relief grooves must be kept clean and free from rust and dirt. Failure to do so could cause the wheel assembly to separate under pressure causing serious injury or death.

10. Using wire brush, clean wheel attaching studs. Clean all dirt and foreign material from rim halves with soap and water and allow to air dry. Ensure O-ring sealing surfaces on rim halves are smooth and clean (Figure 6-8).
11. Inspect rim halves for cracks, bent sealing surfaces, or oversized mounting holes. Replace rim halves if cracked, bent, or if mounting holes are reamed.

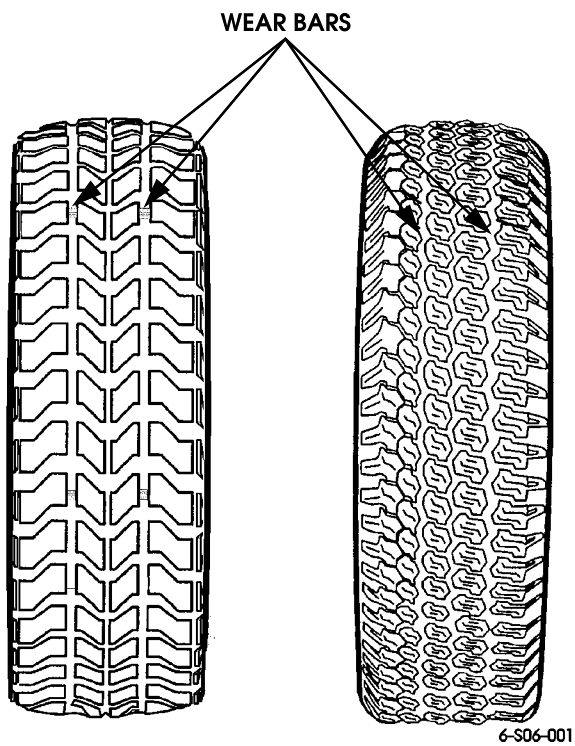


Figure 6-7: Wear Bar Identification

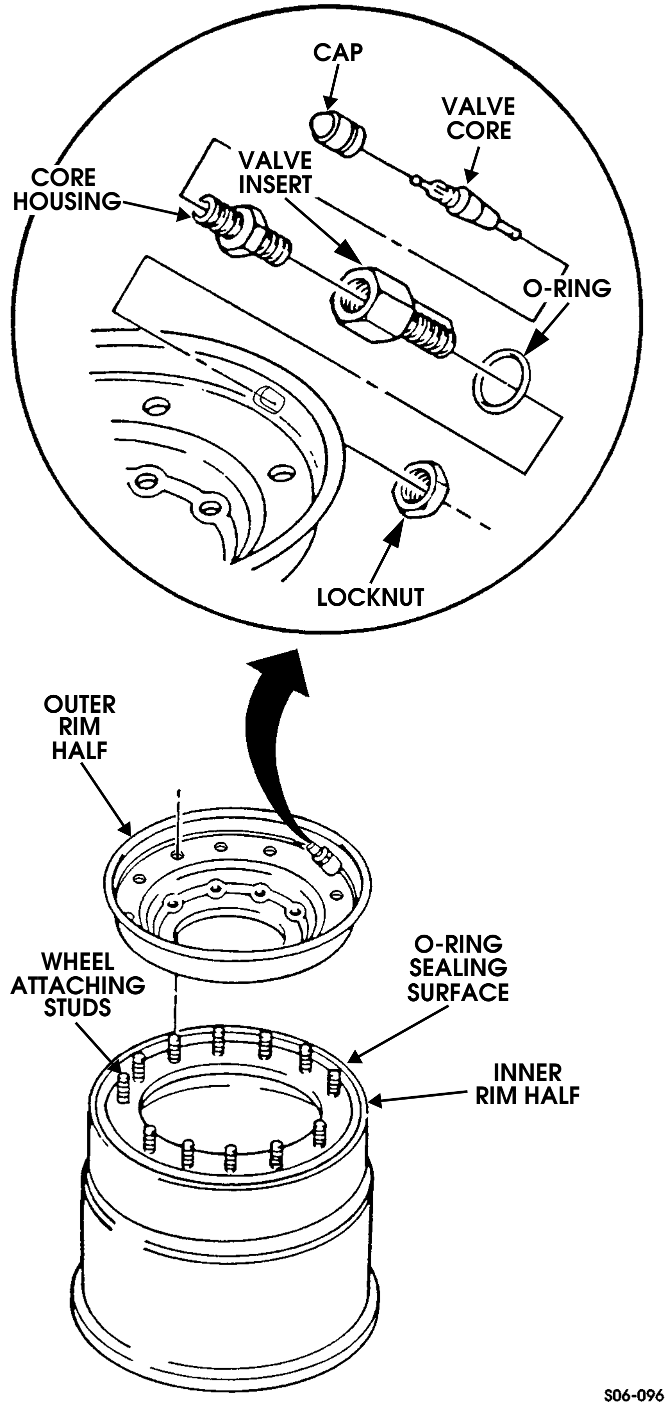


Figure 6-8: Two-Piece Rim Breakdown

WARNING: Never use wheel assemblies with wheel attaching studs that are damaged, loose, or have stripped threads. Damaged studs can cause improper assembly which could cause individual fasteners to fail. Any of these situations could cause serious injury or death.

NOTE: When replacing a damaged wheel attaching stud, also replace two adjacent studs.

12. Inspect inner rim half for cracked, broken, rusted, pitted, bent, loose, or stripped studs. **Replace damaged studs along with two adjacent studs**. Failure to do so may result in equipment damage, personal injury or death.
13. Inspect valve core for cracks or deterioration. Replace valve core if damaged (Figure 6-8).
14. Inspect core housing for cracks or deterioration. Replace if damaged.
15. Inspect insert and cap for damage. Replace if damaged.

Repair

1. If studs are damaged, drive studs out of inner rim half. Discard studs (Figure 6-9).
2. Align splines on studs with splines in inner rim half and drive studs into inner rim half until shoulders seat against inner rim half.

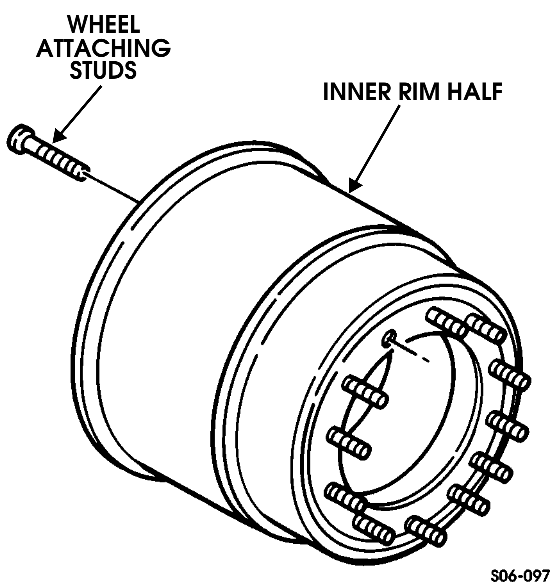


Figure 6-9: Inner Rim Half Stud Removal

Assembly

WARNING: Never use tubes in the two-piece take-apart wheel assemblies. Use of a tube defeats built-in safety features of the wheel, and could cause the wheel to come apart under pressure, resulting in serious injury or death. Use only replacement parts specified in parts manual. Wheels assembled with components which do not meet specifications could cause the assembly to separate under pressure, resulting in serious injury or death. To avoid injury ensure runflat compressor strap is centered on runflat.

1. Apply one 11-ounce tube of gel lubricant around inside of tire at crown area. Using clean brush, evenly spread gel lubricant 4 to 5 inches wide on tire crown area (Figure 6-10).

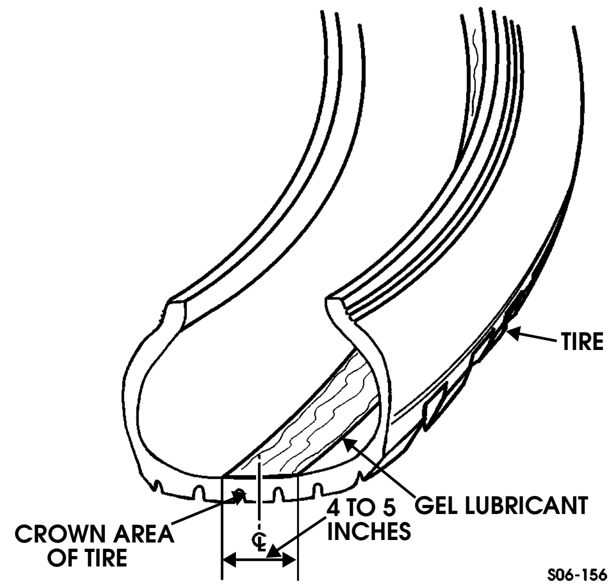


Figure 6-10: Runflat Gel Lubricant Application

2. Position runflat compressor on an outer edge of runflat with handle assembly facing up and strap centered around runflat (Figure 6-11).

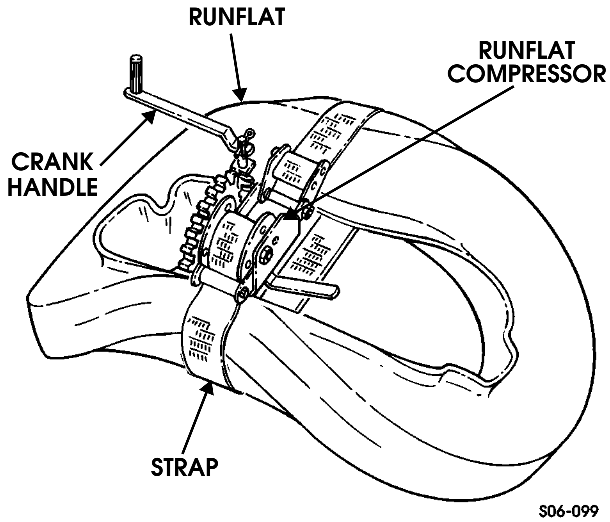


Figure 6-11: Runflat Compressor Positioning

NOTE: Compress runflat by rotating the handle in a clockwise direction. Rotate handle counterclockwise to loosen.

3. Using runflat compressor, compress runflat.
4. Stand tire up and lubricate tire bead and runflat with tire lube (Figure 6-12).

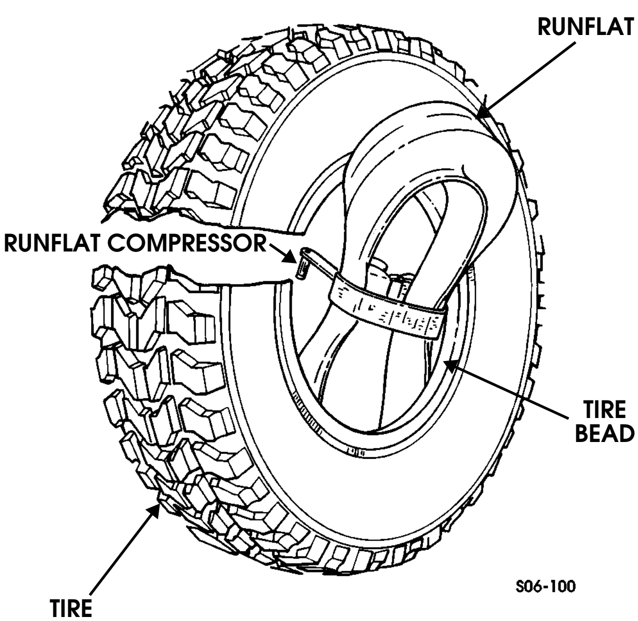


Figure 6-12: Runflat Insertion

NOTE: It may be necessary to remove the handle assembly on runflat compressor before inserting runflat into tire.

NOTE: Ensure shorter flange of runflat faces inner rim side of tire (Figure 6-13).

5. Insert runflat compressor side first as far as possible into tire.
6. Lay tire flat on side. Slowly loosen compressor. Runflat should position itself inside tire. If not, repeat steps 4 through 6 and/or use a tire spoon to assist in installation.

NOTE: If required, clean and lubricate bearing assembly on runflat compressor after removal.

7. Loosen runflat compressor and remove from tire.

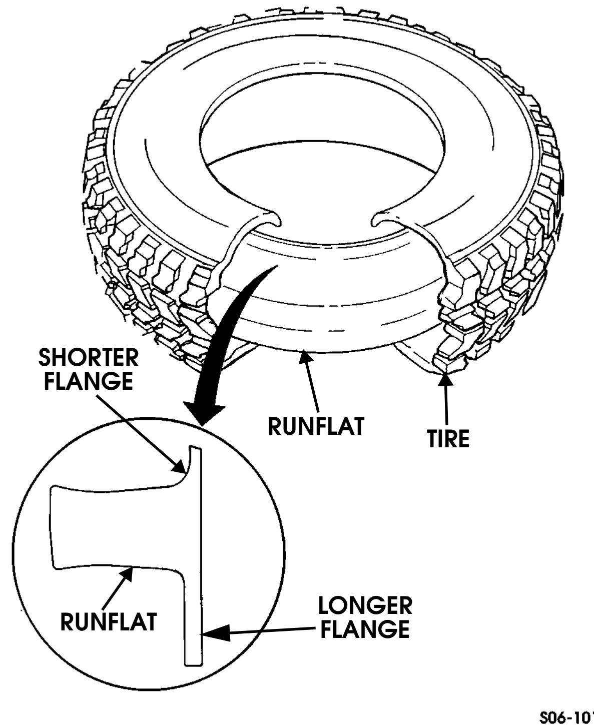


Figure 6-13: Runflat Positioning

8. Lubricate O-ring seal with tire lube and install O-ring seal on first ledge of inner rim half. Ensure O-ring seal is not twisted and is uniformly positioned in the groove outside of the studs. Do not overstretch O-ring seal (Figure 6-14).
9. Lubricate tire bead and rim bead seat areas with tire lube.

NOTE: Before installing tire on inner rim half, inspect tire sidewalls for a "paint dot." Paint dots are often used to indicate the tire's light spot for balancing purposes. If paint dot is present, position tire on rim halves so that paint dot is aligned with insert hole on outer rim half.

NOTE: The Wrangler GS-A, 37 X 12.50R16.5 LTD touring radial tire has a directional tire tread. The heavier, stiffer tread on the outside shoulder of tire must face outward when being installed. Before installing, inspect sidewall of tire and ensure THIS SIDE OUTWARDS imprint is facing outward (Figure 6-11).

10. Center runflat in tire. Carefully lower tire over inner rim half. Check to ensure O-ring seal has not been disturbed (Figure 6-14).

CAUTION: *Ensure the runflat is properly aligned with the valve stem in the wheel. Improper alignment can result in non-uniform bead pressure and improper runflat operation.*

11. Ensure runflat is not binding on flat portion of inner rim half. Runflat should clear inner rim half.
12. Install valve core in core housing.

NOTE: Perform step 15 only if core housing and insert were removed.

13. Install O-ring into pocket on insert. Install insert into valve hole of outer rim half with locknut. Tighten locknut to 40-60 lb-in (5-7 N•m). Apply thread-locking compound to core housing and thread valve bore into insert. Tighten core housing to 25-30 lb-ft (34-41 N•m).
14. Secure outer rim half to inner rim half.
15. Install three pilot washers spaced equally apart on studs located left of outer rim half notches (ensure washers are seated in outer rim half).

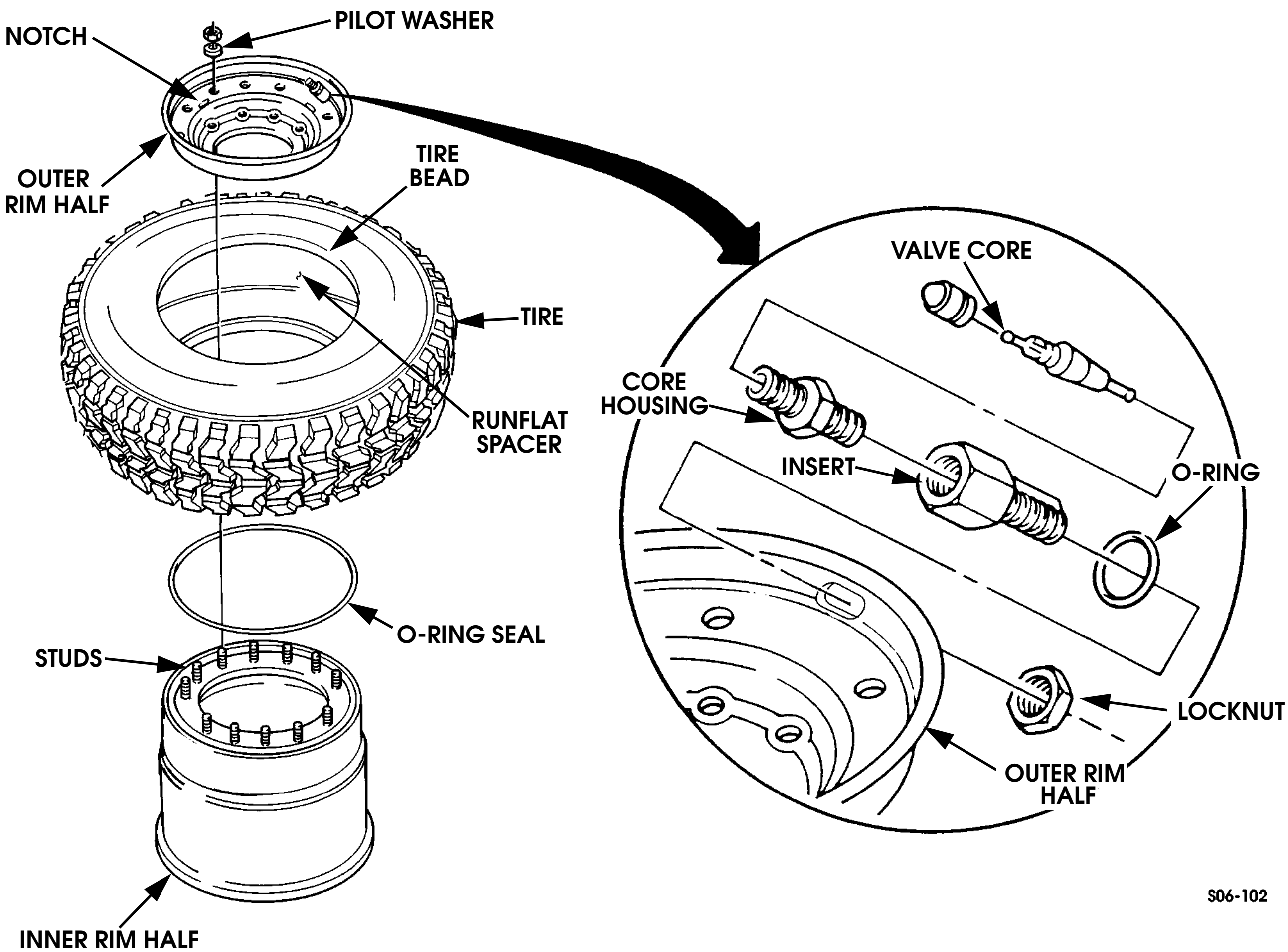


Figure 6-14: Two-Piece Wheel with One-Piece Runflat Breakdown

CAUTION: *Tighten locknuts gradually to avoid bending and/ or breaking studs, or damage to wheel components.*

NOTE: If vehicle is equipped with central tire inflation system, position shield mounting bracket on outer rim.

16. Secure outer rim half on inner rim half with twelve locknuts.

NOTE: If tire bead does not seat on the rim flange after inflation, deflate tire completely and remove from rim. Check to ensure that a 16.5 inch diameter tire is being used. Also check for bent or damaged components and replace if necessary. Lubricate tire bead and rim mating surfaces and reinstall tire on rim.

NOTE: Never tighten locknuts when tire is in an inflated condition. This will result in less accurate torque. Tighten locknuts to proper torque specifications every 3,000 miles (4800 km).

17. Tighten locknuts to 85 lb-ft (115 N•m) in tightening sequence shown (Figure 6-15).

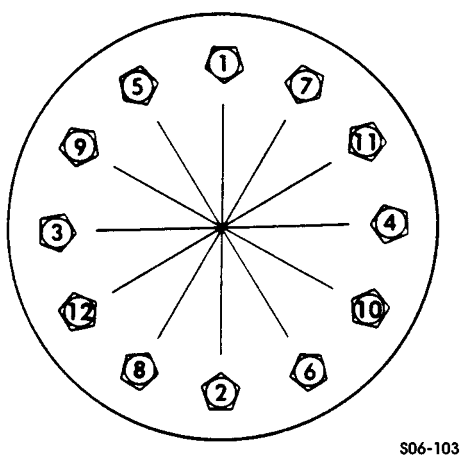


Figure 6-15: Locknut Tightening Sequence

18. Retighten locknuts to 125 lb-ft (170 N•m) in sequence shown.
19. Check wheel assembly for gaps at each stud. Use a 0.0015 inch (0.038 mm) thickness gauge to detect gaps. If gaps are detected, disassemble and reassemble wheel assembly and recheck for gaps. If gaps are still detected, replace inner rim half (Figure 6-16).

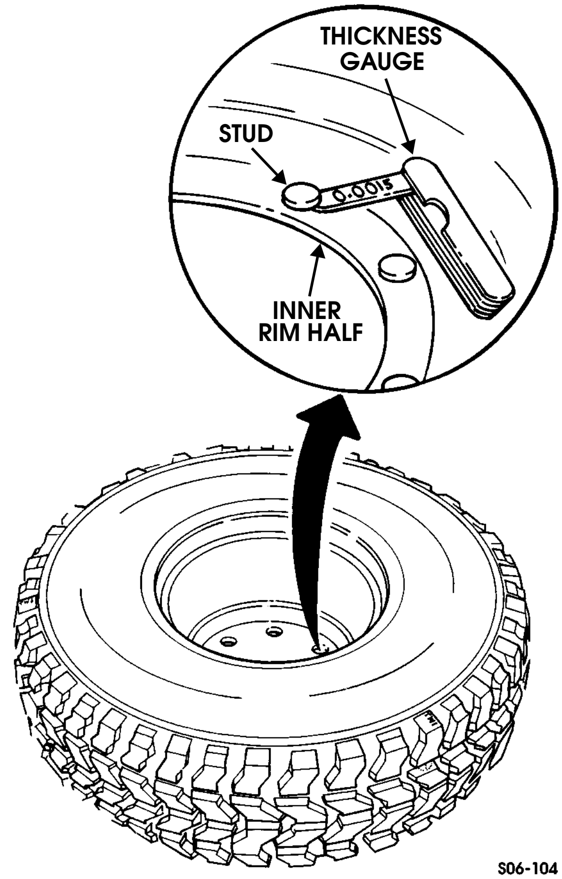


Figure 6-16: Checking Wheel Stud Gap

WARNING: Never inflate a tire without having checked wheel locknut torques to ensure the wheel locknuts are tightened to specifications. A wheel with improperly tightened locknuts could separate under pressure, resulting in serious injury or death. Always use a tire inflation cage for inflation purposes. Stand on one side of cage during inflation, never directly in front. Keep hands out of the cage during inflation. Inflate tire to recommended pressure using a clip-on air chuck. Do not exceed 50 psi (345 kPa) cold inflation pressure. Failure to follow these instructions may result in serious injury or death.

20. Place wheel in safety cage and inflate tire to recommended tire pressure.
21. Check for leaks around rim edges, insert, and core housing with soapy solution (Figure 6-17).
22. Paint locknuts and studs to prevent corrosion.

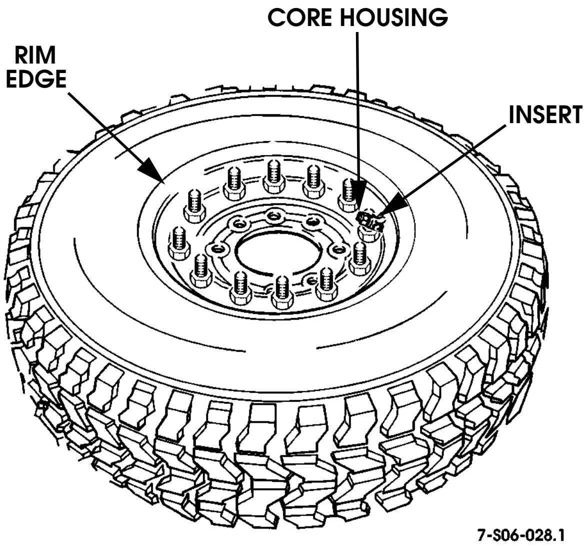


Figure 6-17: Leak Check Areas

INNER RIM STUD REPLACEMENT

Removal

1. Remove wheel from vehicle.
2. Place wheel in tire inflation cage.

WARNING: Ensure the tire is totally deflated before removing wheel locknuts. Failure to follow proper safety precautions may result in serious injury or death.

3. Remove valve core from valve bore and deflate tire. Run a wire through valve bore to ensure it is not plugged (Figure 6-18).

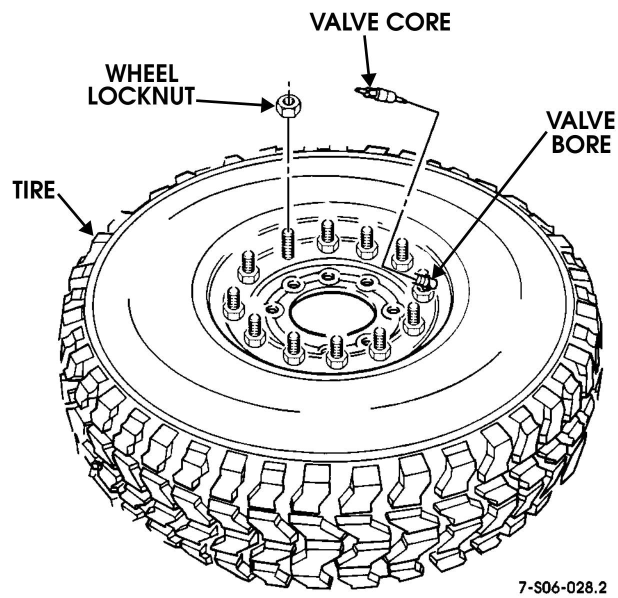


Figure 6-18: Valve Core and Valve Bore

NOTE: When replacing broken rim stud(s), replace studs on both sides of broken stud(s).

4. When tire is fully deflated, loosen wheel locknuts on each side of the broken stud(s). If you hear escaping air, do not proceed. Wait until the sound stops and recheck valve bore. When you are certain tire is fully deflated, proceed to remove wheel locknut. Discard locknut.
5. Drive studs out of inner rim. Discard studs (Figure 6-19).

Cleaning and Inspection

1. Using wire brush, clean remaining studs. Clean all dirt and foreign material from rim with soap and water and allow to air dry.

WARNING: Never use wheel assemblies with studs that are damaged, loose, or have damaged threads. Damaged studs can cause improper assembly, which could cause individual fasteners to fail. Any of these situations may result in serious injury or death.

2. Inspect inner rim for cracked, broken, rusted, pitted, bent, or loose studs, and studs with damaged, mutilated, or deformed threads. Replace defective parts (Figure 6-19).

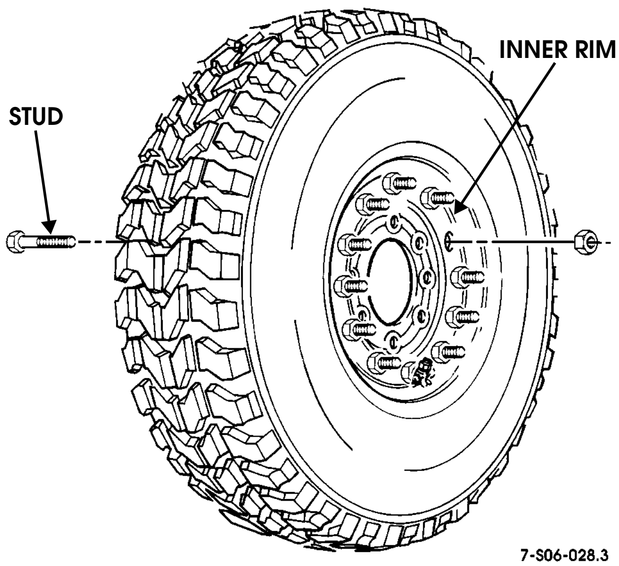


Figure 6-19: Inner Rim Stud

Installation

1. Align stud with splines in inner rim and drive stud into inner rim until stud shoulder seats against inner rim (Figure 6-19).
2. Repeat step 1 for all studs being replaced.

CAUTION: *Tighten locknuts gradually to avoid bent and broken studs, or damage to wheel components will result.*

3. Install locknuts on new studs.

NOTE: After replacing broken stud(s), all wheel locknuts must be re-torqued.

4. Tighten locknuts to 85 lb-ft (115 N•m) in sequence shown (Figure 6-20).
5. Tighten locknuts to 125 lb-ft (170 N•m) in sequence shown.

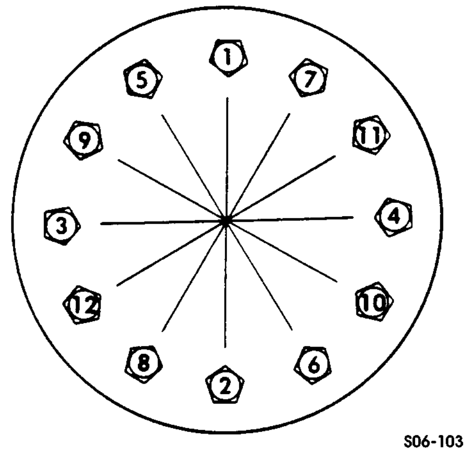


Figure 6-20: Lug Nut Tightening Sequence

6. Check wheel assembly for gaps at each stud. Use a 0.0015 in. (0.038 mm) thickness gauge to detect gaps. If gaps are detected, disassemble and reassemble wheel assembly and recheck for gaps. If gaps are still detected, replace outer rim half.

WARNING: Never inflate a wheel assembly without having checked wheel locknut torques to ensure the wheel locknuts are tightened to specifications. An assembly with improperly tightened locknuts could separate under pressure, resulting in serious injury or death.

WARNING: Always use a tire inflation cage for inflation purposes. Stand on one side of the cage during inflation, never directly in front. Keep hands out of cage during inflation. Inflate assembly to recommended pressure, using a clip-on air chuck. Do not exceed 50 psi (345 kPa) cold inflation pressure. Failure to follow these instructions may result in serious injury or death.

7. Place wheel in safety cage and inflate tire to the recommended tire pressure.
8. Check for leaks around rim edges and valve bore with soapy water (Figure 6-21).
9. Install wheel on vehicle.

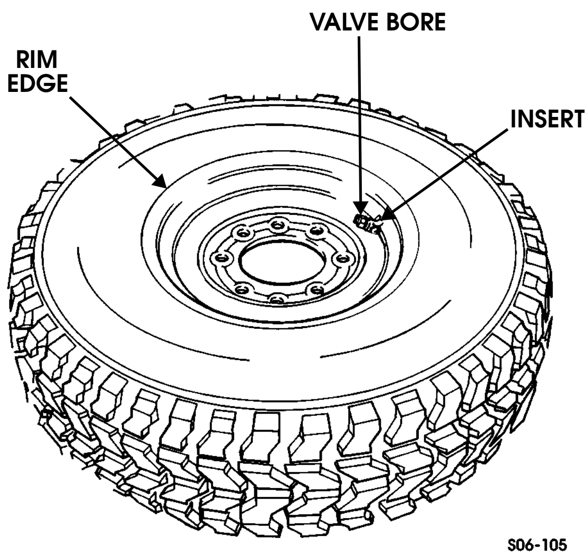


Figure 6-21: Leak Check Areas

TIRE, ONE-PIECE WHEEL, AND BEADLOCK SERVICE

NOTE: An assembly/disassembly video for one (1) piece wheels is available from AM General. Order P/N 05744619 through DCS.

CAUTION: *It is not recommended mixing one-piece wheel runflat assemblies and two-piece take-a-part runflat wheel assemblies on the same vehicle. Runflat profiles are different between the two types of wheel assemblies.*

Assembly and Disassembly

1. If the vehicle is equipped with a Central Tire Inflation System (CTIS), perform steps a through d:
   a. Release the quick disconnect fitting located in the center of the geared hub spindle on all four wheels.
   b. Remove the hose shield and lay aside.
   c. Remove the brass fitting from the center of the geared hub spindle on the wheel(s) to be worked on.
   d. Use tire chalk to mark two of the geared hub spindle assembly studs nearest the air valve.
2. Remove wheel/tire assembly from vehicle.
3. Inspect vehicle geared hub spindle studs for bending, looseness, or stripped threads. Replace if damaged.
4. Inspect flanged lug nuts for fatigue, stripped threads, or other damage. Replace if damaged.
5. Use tire chalk to mark the valve location on the sidewall of the tire.
6. Remove valve cap and core from air valve and deflate tire.
7. Run a piece of wire through air valve to ensure it is not plugged.

WARNING: Balance weights contain lead. Wash hands after handling.

8. Remove balance weights from wheel if present. Discard balance weights.
9. Install wheel/tire assembly on tire machine.

NOTE: You may be able to utilize the tire machine if it is capable of pushing the outside tire bead downward from the wheel flange enough to expose and remove the beadlock bolt, nut, and washers after unseating the bead.

10. Access beadlock bolt, nut, and washers. Position the upper bead breaker disc on the outside tire bead, opposite the air valve, and break the bead from the wheel (Figure 6-22).
    a. IF TIRE MACHINE IS CAPABLE, continue moving the disk downward until the beadlock bolt, nut and washers are exposed (Figure 6-22).
    b. IF TIRE MACHINE LACKS DOWNWARD THROW, use a pry bar to pull the tire bead away from the wheel (opposite the air valve) and expose beadlock, bolt, nut, and washers.

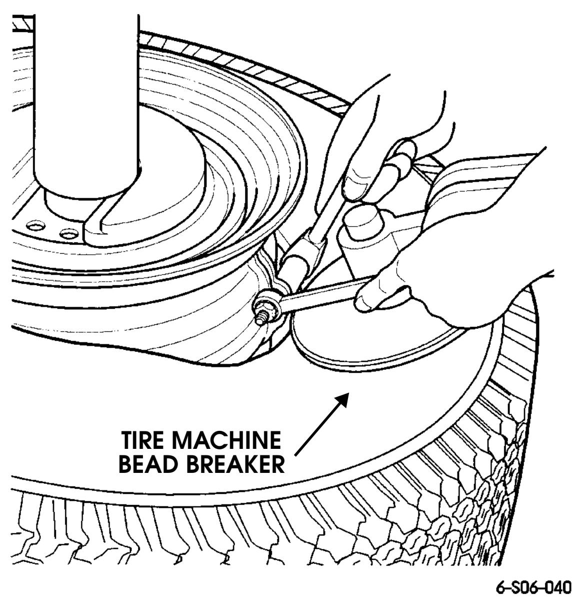


Figure 6-22: Beadlock Unbolting

11. Remove beadlock bolt, nut, and washers and discard.
12. Lubricate tire bead and remove outside bead from wheel flange.

NOTE: If the tire machine lower bead breaker disk is capable of pushing the inside tire bead up the wheel towards the outside wheel flange, it may be possible to raise the tire high enough to provide adequate clearance for beadlock removal.

13. Create adequate clearance between outside tire bead and outside wheel flange for beadlock removal. Break inside tire bead with tire machine lower bead breaker disk.
    a. IF TIRE MACHINE IS CAPABLE, continue moving the disk upward until the outside tire bead is raised high enough to allow for beadlock removal (Figure 6-23).
    b. IF TIRE MACHINE LACKS UPWARD THROW, place wheel/tire in an upright position and pull outside tire bead away from wheel.
14. Reach inside tire, spread beadlock apart, and roll beadlock out between wheel and tire with a corkscrew motion.
15. Lubricate tire bead and remove tire from wheel.

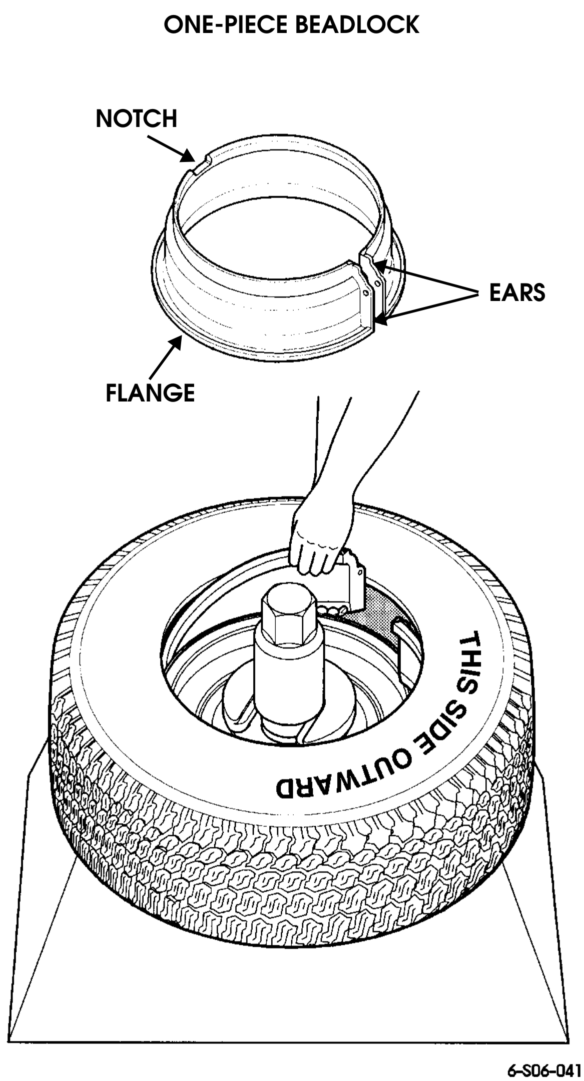


Figure 6-23: Beadlock Removal

Inspection and Cleaning

Cleaning

1. Make sure wheel is clean, dry, and corrosion free.
2. Check that inside of tire is clean and dry.

Tire Inspection

1. Inspect tire for the following conditions or defects. Replace tire if damaged.
    a. Inspect inside of tire for cord or belt separation and inner crown area damage.
    b. Inspect tire bead for damage.
    c. Check for protruding objects inside tire which may not be visible from outside. If tire is damaged, repair with external (05710215) or internal (05710216) tire repair kit.
    d. Check tread depth on tire. Tread should not be worn below level of wear bars. Markings on the side of the tires (e.g., the letters “TWI” or a triangle) show the location of wear bars. Replace tire if tread is worn below bars or 3/32 inch (2.38mm).

Beadlock Inspection

1. Inspect beadlock for the following conditions or defects. Replace if damaged.
    a. Wear or damage to the bolt hole ears.
    b. Splitting or cracking of beadlock assembly.
    c. Excessive chafing.

Wheel Inspection

1. Inspect wheel for the following conditions or defects:
    a. cracked or bent.
    b. mounting bolt holes for stress fatigue, oversized holes, or other damage.
    c. wheel flange for stress fatigue, deformation or other damage.
    d. valve and insert for cracks or deterioration.
2. Replace these items if damaged.

Assembly

CAUTION: *During assembly or disassembly, loose parts which are dropped inside the wheel/tire assembly must be removed. Failure to do so could result in damage to the wheel/tire assembly.*

1. Position wheel on tire machine with outside facing up. Lubricate tire bead and mount inside tire bead on wheel. Ensure “Side Facing Outwards” lettering faces up on GSA tires.
2. Position beadlock end between wheel and outer tire bead. Lubricate tire bead and beadlock and use a pry bar for ease of installation. Spread beadlock apart and insert beadlock, flanged side down, into and around inside of tire with a corkscrew motion (Figure 6-24).

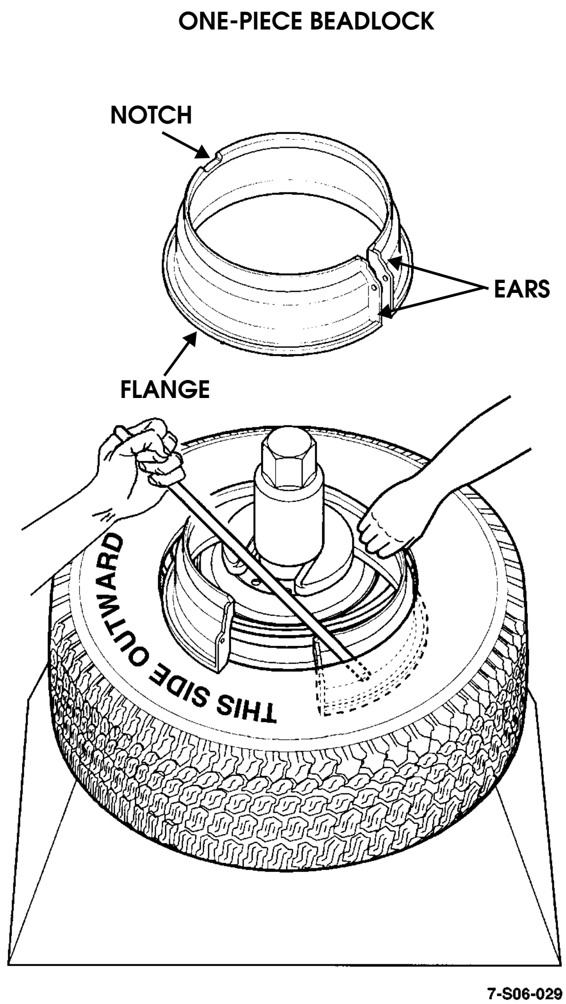


Figure 6-24: Beadlock Insertion

3. Position beadlock assembly so that the beadlock ears are opposite/180 degrees from air valve and beadlock notch is aligned with air valve nut.

NOTE: Before installing a new tire, inspect tire sidewalls for a “paint dot.” Paint dots are often painted on tires to indicate the tire’s light spot for balancing purposes and may be located on either side of the tire. If paint dot is present, position tire on wheel so that paint dot is aligned with air valve on wheel. If paint dot is not on air valve side of tire, reference paint dot from other side of tire for proper positioning with air valve.

4. Align light spot of tire with air valve.
5. Mount outer tire bead on wheel.
6. With valve core removed, inflate tire with just enough air pressure to seat tire beads on wheel.
7. Depressurize tire.

NOTE: You may be able to utilize the tire machine to install new bolt, nut, and washers if it is capable of pushing the outside tire bead down the wheel far enough to expose the beadlock bolt hole ears.

8. Access beadlock bolt hole ears. Position the upper bead breaker disk on the outside tire bead opposite the air valve and break the bead from the wheel flange.
   a. IF TIRE MACHINE IS CAPABLE, continue moving the disk downward until the beadlock bolt hole ears are exposed.
   b. IF TIRE MACHINE LACKS DOWNWARD THROW, use a pry bar to pull the tire bead away from the wheel (opposite the air valve) and expose beadlock bolt hole ears.
9. Install new bolt, washers and nut securing beadlock ends together. Do not tighten at this time.
10. Inspect beadlock positioning to ensure that air valve nut is properly positioned in beadlock notch.
11. Using two wrenches tighten bolt and nut to 60 in/lb.(6.8 N•m).
12. Inspect gap between beadlock ends. Gap should be 0.3125 - 0.390 inch (8 - 10 mm).
13. Lubricate tire bead.
14. With valve core removed, inflate tire and seat tire beads on wheel.

WARNING: Always use a tire inflation cage for inflation purposes. Stand one side of cage during inflation, never directly in front. Keep hands out of the cage during inflation. Inflate assembly to recommended pressure using a clip-on air chuck. Do not exceed 50 psi (345 kPa) cold inflation pressure. Failure to follow these instructions may result in serious injury or death.

15. Install valve core, inflate tire to recommended tire pressure, and install valve cap.

16. Check for leaks around wheel edges, insert, and air valve with soapy solution.
17. Balance wheel/tire assembly. Refer to tire balance procedure in the service manual.
18. Install wheel on vehicle.
    a. Roll wheel/tire assembly to the vehicle
    b. Place the wheel/tire assembly on the geared hub spindle studs.
    c. Start the flanged lug nuts by hand.
    d. Snug the flanged lug nuts.
    e. Lower the vehicle.
    f. Torque the flanged lug nuts evenly and sequentially to 140 ft/lb (Figure 6-25).

If the vehicle is equipped with CTIS perform the additional steps:

a. Line up the air valve with the marked spindle assembly studs.
b. Lubricate the threads on the CTIS fitting with teflon pipe sealant.
c. Install the fitting in the geared hub spindle.

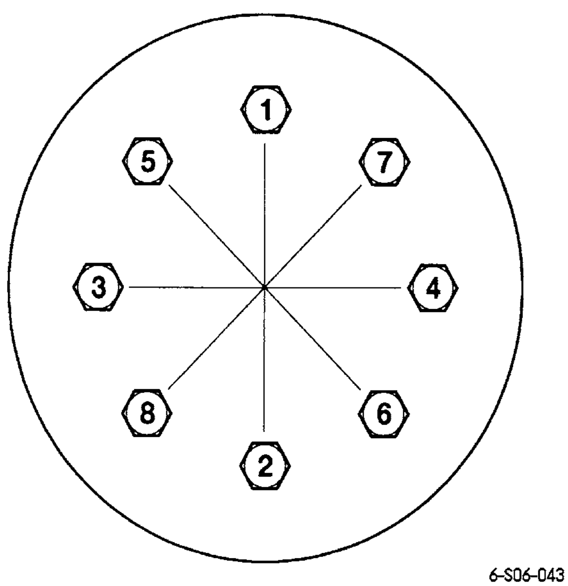


Figure 6-25: Tightening Sequence

d. Engage the quick disconnect fittings on all four wheels.
e. Install the CTIS hose shield.

TIRE, ONE-PIECE WHEEL, AND TWO-PIECE RUNFLAT SERVICE

CAUTION: *It is not recommended mixing one-piece wheel and runflat assemblies and two-piece take-a-part wheel and runflat assemblies on the same vehicle. Runflat profiles differ between the two types of wheel assemblies.*

Disassembly

1. If the vehicle is equipped with a Central Tire Inflation System (CTIS), perform steps a through d.
    a. Release the quick disconnect fitting located at the center of the geared hub spindle on all four wheels.
    b. Remove the hose shield and lay aside.
    c. Remove the 3/4 inch brass fitting from the center of the geared hub spindle on the wheel(s) to be worked on.
    d. Use tire chalk to mark two of the geared hub spindle studs nearest the air valve.
2. Remove wheel/tire assembly from vehicle.
3. Inspect geared hub spindle studs for bending, looseness, or stripped threads. Replace if damaged.
4. Inspect flanged lug nuts for fatigue, stripped threads, or other damage. Replace if damaged.
5. Use tire chalk to mark the air valve location on the sidewall of the tire.
6. Remove valve cap and core from air valve and deflate tire. Run a piece of wire through air valve to ensure it is not plugged.

WARNING: Balance weights contain lead. Wash hands after handling.

7. Remove balance weights from wheel if present. Discard balance weights.
8. Install wheel/tire assembly on tire machine.
9. Using tire machine break loose both tire beads.
10. Lubricate outside tire bead and use tire machine to remove bead from wheel flange.
11. Pull tire bead up away from wheel to expose runflat assembly. Tire bead may be held in position by inserting two tapered pry bars or similar tool into the runflat holes and pulling tire bead away from wheel (Figure 6-26).

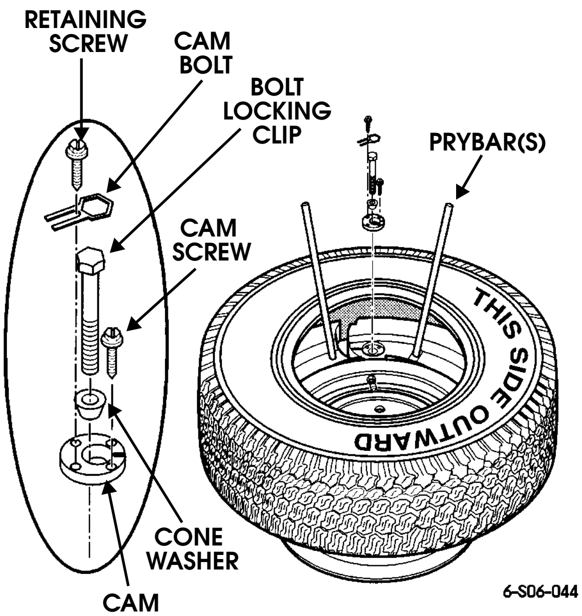


Figure 6-26: Runflat Removal

12. Remove the retaining screw and the bolt locking clip.
13. Loosen and remove bolt and cone washer securing runflat halves together.
14. Repeat steps 11 through 13 for opposing fastener assembly.

NOTE: If the tire machine lower bead breaker disk is capable of pushing the inside tire bead up the wheel towards the outside wheel flange, it may be possible to raise the tire high enough to provide adequate clearance for runflat removal.

15. Create adequate clearance between outside tire bead and outside wheel flange for runflat removal. Break inside tire bead with tire machine lower bead breaker disk.
    a. IF TIRE MACHINE IS CAPABLE, continue moving the disk upward until the outside tire bead is raised high enough to allow for runflat removal (Figure 6-2).
    b. IF TIRE MACHINE LACKS UPWARD THROW, position wheel/tire in an upright position and pull outside tire bead away from wheel.
16. Reach inside tire and remove runflat halves from tire.
17. Lubricate tire bead and remove tire from wheel.

Inspection and Cleaning

Cleaning

1. Remove any existing lubricant that has been applied to the inside of the tire, using tire buffing solution.
2. Clean all wheel, runflat and tire parts using tire buffing solution.
3. Dry all wheel, runflat and tire parts. Ensure inside of tire and all wheel, runflat and tire parts are free of any runflat lubricant, dirt, rust or moisture.

Tire Inspection

1. Inspect tire for the following conditions or defects. Replace tire if damaged.
    a. Inspect inside of tire for cord or belt separation and inner crown area damage.
    b. Inspect tire bead for damage.
    c. Check for protruding objects inside tire which may not be visible from outside. If tire is damaged, repair with external (05710215) or internal (05710216) tire repair kit.
    d. Check tread depth on tire. Tread should not be worn below level of wear bars. Markings on the side of the tires (e.g., the letters "TWI" or a triangle) show the location of wear bars. Replace tire if tread is worn below bars or 3/32 inch (2.38mm).

Runflat Inspection

1. Inspect runflat for the following conditions or defects. Replace runflat(s) if damaged.
    a. Splitting or separation of rubber from composite material.
    b. Wear or damage of outside rim or centering flange.
    c. Excessive chafing or particles of the tire's steel belt embedded into runflat assemblies.
    d. Cam bolt threaded washers for stress fatigue, cracks or thread damage.
    e. Cam bolt threaded washer retaining screws.
    f. Cam for stress fatigue, cracks or other damage.
    g. Cam retaining screw.
    h. Bolt locking clip and retaining screw for damage.
    i. Cam bolt for stress fatigue, cracks or thread damage.
    j. Cam bolt cone for stress fatigue, cracks or other damage.

Wheel Inspection

1. Inspect wheel for the following conditions or defects. Replace wheel if damaged.
   a. Cracked or bent.
   b. Mounting bolt holes for stress fatigue, oversized holes, or other damage.
   c. Wheel flange for stress fatigue, deformation or other damage.
   d. Valve and insert for cracks or deterioration. Replace these items if damaged.

Assembly

NOTE: If tires are to be replaced allow new tires to reach room temperature (above 60°) before mounting. This will make the tire more pliable and easier to work with.

CAUTION: *During assembly or disassembly, loose parts which are dropped inside the wheel/tire assembly must be removed. Failure to do so could result in damage to wheel/tire assembly.*

1. Apply one tube (approximately 11 ounces) of runflat gel lubricant to inside crown area of tire. Using clean brush, evenly spread gel lubricant 4 to 5 inches wide on inner crown area.
2. Inspect runflat threaded washers ensuring all four retaining screws are installed and tight.
3. Inspect runflat cam scribe line position ensuring cam scribe line is towards raised reference line on each runflat half. (Figure 6-27). If cam scribe lines are not in proper position, remove screws securing cams and reposition cam scribe lines properly.

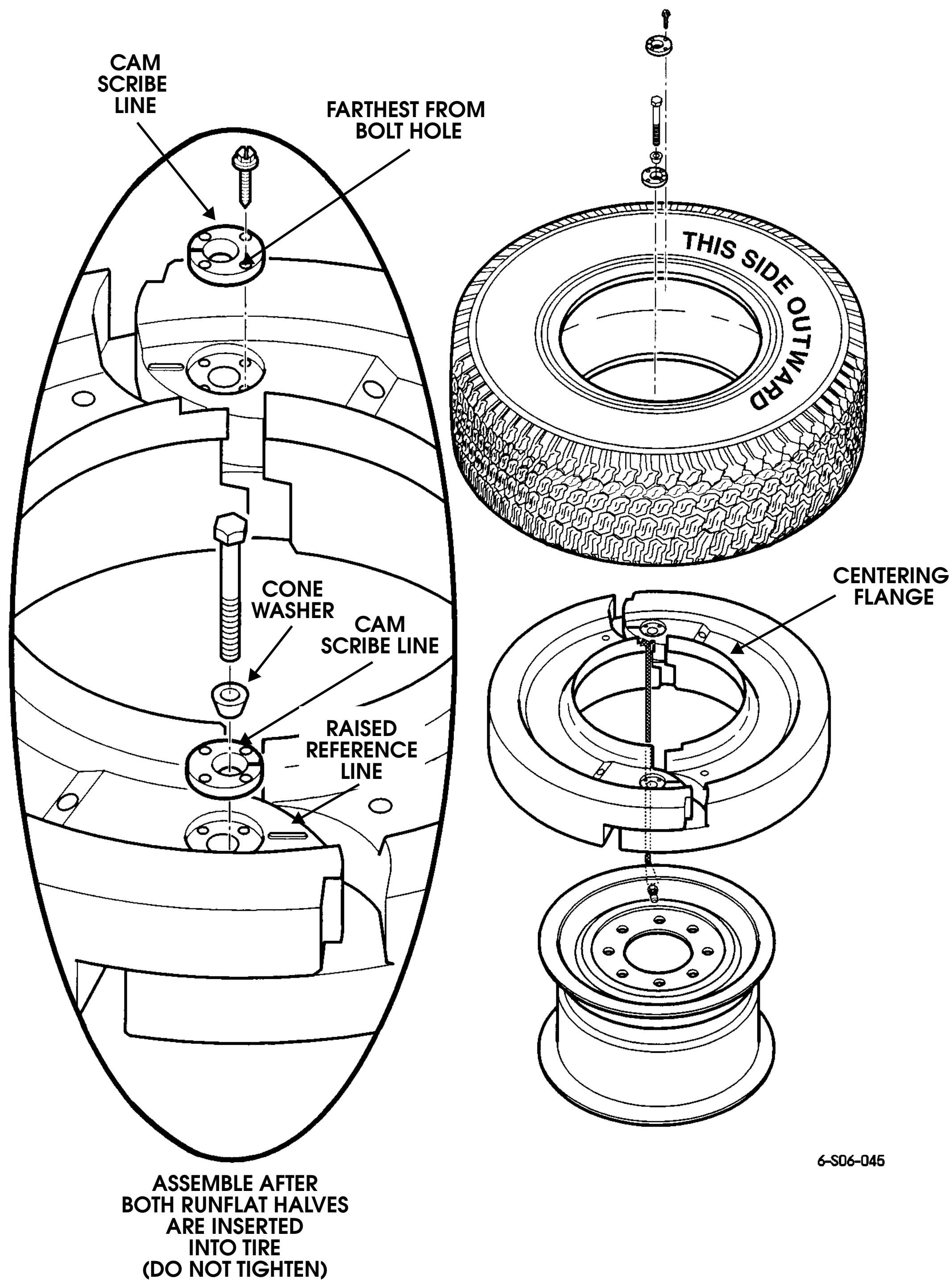


Figure 6-27: Runflat Installation

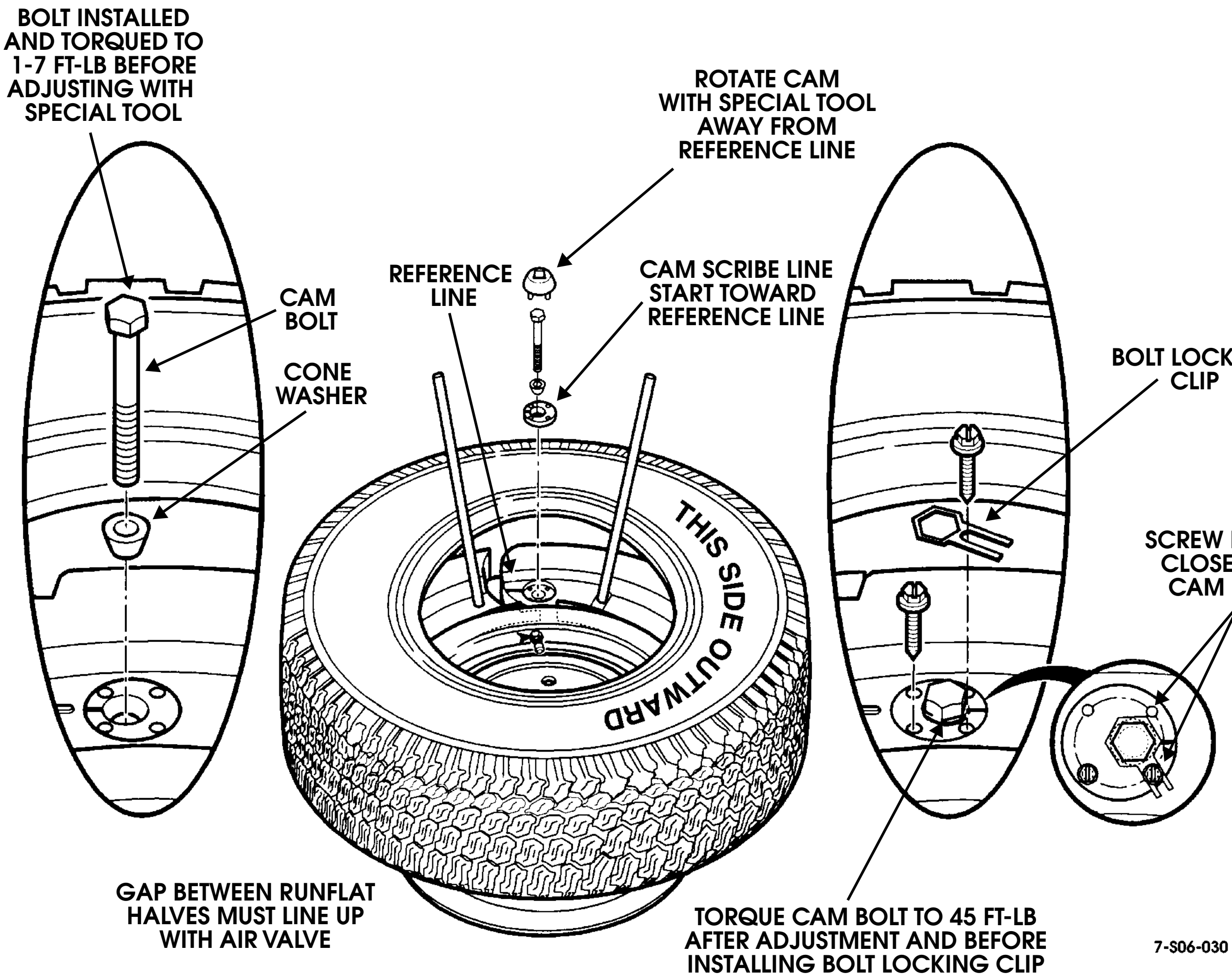


Figure 6-28: Runflat Assembly

4. Install one screw securing cam to runflat using screw hole farthest from bolt hole on each runflat half (Figure 6-28).
5. Position runflat halves into tire with centering flange facing to outside of tire. Lubricate runflat as necessary.
6. Assemble one end of the runflat assembly by inserting one bolt and cone washer. Engage finger tight at this time.
7. Position wheel on tire machine with outside facing up. Lubricate tire beads and mount inside tire bead on wheel. Ensure “SIDE FACING OUTWARDS” lettering faces up on GSA tires.
8. Position runflat ends without bolt and cone to align with air valve on wheel. Ensure runflat notch aligns with air valve lock nut (Figure 6-28).
9. Using two tapered prybars or similar tools inserted into runflat holes near runflat ends pry tire away from wheel. This will expose the runflat cam assembly and position the runflat centering flange properly on the wheel for bolt insertion. (Figure 6-28).
10. Install remaining bolt and cone washer.
11. Initially tighten bolt 1-7 ft/lb.(1.3 - 9.5 N•m).
12. Remove existing screw securing cam washer to runflat assembly.

***CAUTION:** Runflat cam washer scribe line must be towards the raised reference mark (loose) position or positioned 180 degrees from raised reference mark (tight) as determined by step 13 when cam bolt is torqued in step 15.*

13. Using Cam socket tool (J42557) and torque wrench rotate cam washer 180 degrees from raised reference mark. If less than 20 ft/lb (27 N•m) is required to position cam washer 180 degrees then the cam may be left rotated 180 degrees. If more than 20 ft/lb (27 N•m) of torque is reached before cam washer can be turned 180 degrees then return cam washer to original position (Figure 6-28).
14. Position cam washer to align screw holes and install one screw in screw hole farthest from cam bolt (Figure 6-27).
15. Tighten cam bolt to 45 ft/lb. (68 N•m).

16. Position cam bolt locking clip on cam bolt. Align cam bolt clip tangs to closest screw hole from bolt. It may be necessary to slightly tighten cam bolt to align screw hole.
17. Install cam bolt locking clip screw.
18. Inspect air valve lock nut inside wheel to ensure air valve is positioned correctly in runflat notch.
19. Remove prybars and repeat steps 11 through 17 for opposing runflat cam assembly.
20. Align chalk mark on tire with air valve on wheel.
21. Lubricate tire bead and mount tire bead on wheel.

NOTE: Before installing a new tire inspect tire sidewalls for a "paint dot." Paint dots are often painted on tires to indicate the tire's light spot for balancing purposes and may be located on either side of the tire. If paint dot is present, position tire on wheel so that paint dot is aligned with air valve on wheel. If paint dot is not on air valve side of tire, reference paint dot from other side of tire for proper positioning with air valve.

WARNING: Always use a tire inflation cage for inflation purposes. Stand one side of cage during inflation, never directly in front. Keep hands out of the cage during inflation. Inflate assembly to recommended pressure using a clip-on air chuck. Do not exceed 50 psi (345 kPa) cold inflation pressure. Failure to follow these instructions may result in serious injury or death.

22. Before installing valve core inflate tire to seat beads, use of tire bead seater may be required.
23. Install valve core, inflate tire to recommended tire pressure and install valve cap.
24. Check for leaks around wheel edges, insert, and air valve with soapy solution.
25. Balance wheel/tire assembly with 15 oz. maximum weight. Refer to tire balance procedure in service manual if necessary.
26. Install wheel/tire assembly on vehicle.
    a. Roll wheel/tire assembly to the vehicle.
    b. Place the wheel/tire assembly on the geared hub spindle studs.
    c. Start the flanged lug nuts by hand.
    d. Snug the lug nuts.
    e. Lower the vehicle.
    f. Torque the lug nuts evenly and sequentially to 140 ft/lb ±10% (Figure 6-29).

If the vehicle is equipped with CTIS perform these additional steps:

a. Line up air valve between the marked studs on geared hub spindle.
b. Lubricate the threads on the CTIS fitting with teflon pipe sealant.
c. Install the fitting in the geared hub spindle.
d. Engage the quick disconnect fittings on all four wheels.
e. Install the CTIS hose shield.

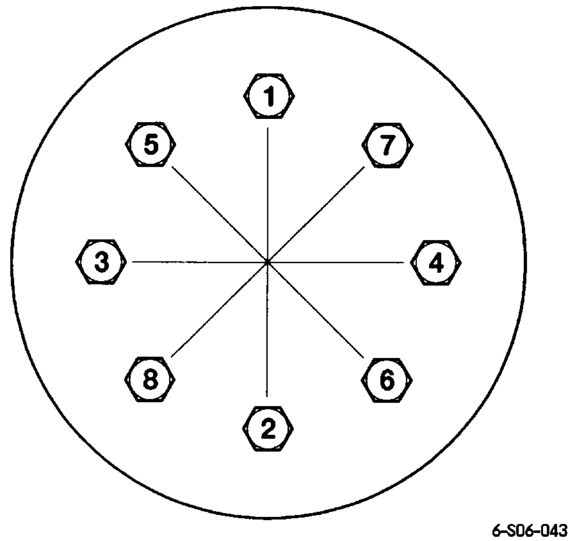


Figure 6-29: Lug Nut Tightening Sequence

RUNFLAT COMPRESSOR BELT REPLACEMENT

Installation

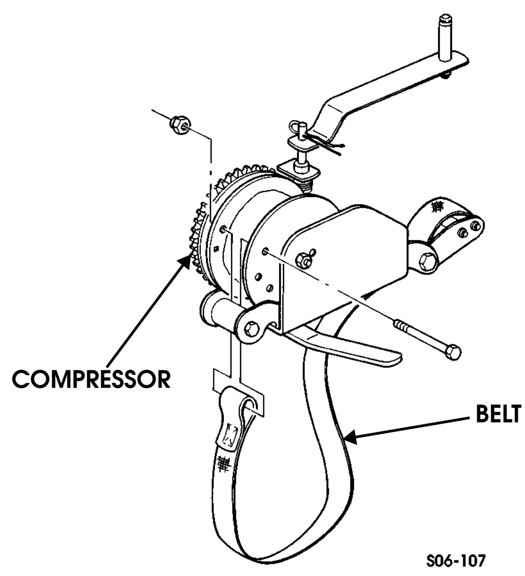


Figure 6-30: Runflat Compressor Belt Replacement

NOTE: Belt overlap is to be positioned so that you have equal amount of belt on each side of the worm gear shaft assembly. Perform steps 1 and 2 for crank handle runflat compressor.

1. Install belt on compressor with bolt and locknut (Figure 6-30).
2. Loop free end of belt around retaining bracket (Figure 6-31).

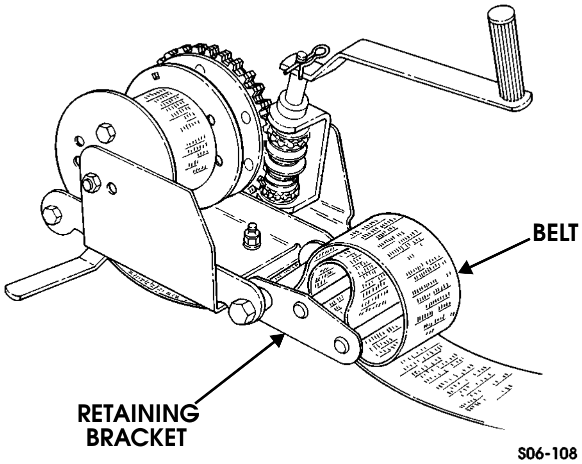


Figure 6-31: Runflat Compressor Belt Installation

Inspecting Tire Tread Wear

Tire tread wear is a good indicator of tire balance and suspension condition. Unbalanced tires often cause cupped or scalloped tread wear patterns (Figure 6-32). Tire wear inspection should be performed for all vibration complaints. Resolve tire wear problems before continuing with diagnosis.

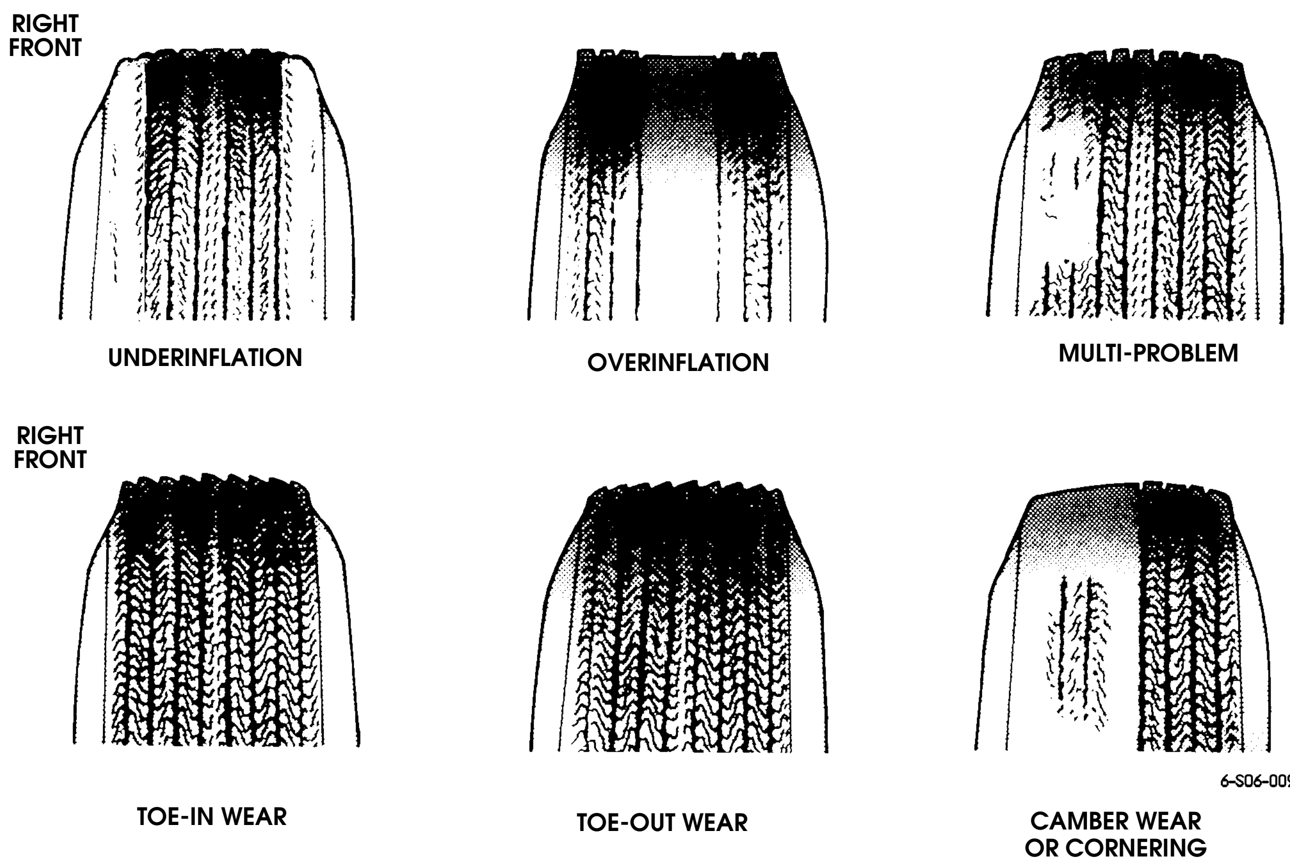


Figure 6-32: Tire Wear Patterns

WHEEL AND TIRE BALANCING

General

There are two types of tire and wheel balancing: static and dynamic. Static balance is the equal distribution of weight around the wheel circumference. Wheels that are statically unbalanced cause a bouncing action called vehicle shake and possible steering nibble or oscillation. This condition will eventually cause uneven tire wear (Figure 6-33).

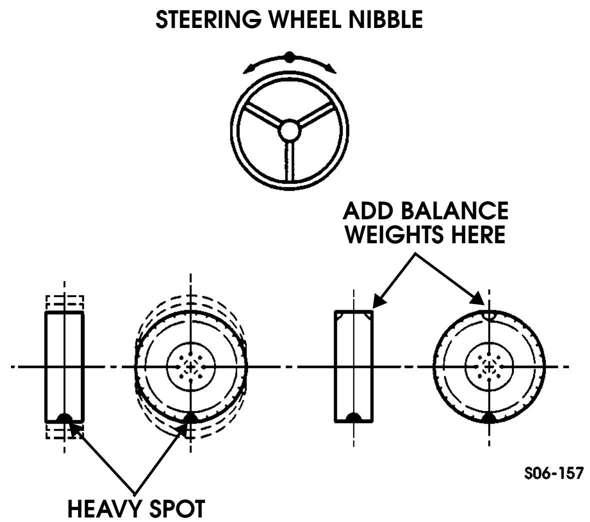


Figure 6-33: Static Imbalance Correction

Dynamic balance is the equal distribution of weight on each side of the centerline, so that when the wheel spins there is no tendency for it to move from side to side. Wheels that are dynamically unbalanced may cause wheel shimmy, vehicle shake or a steering wheel vibration called nibble or oscillation (Figure 6-34).

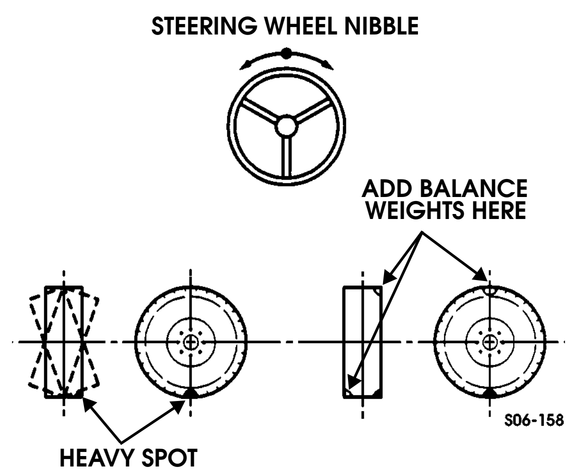


Figure 6-34: Static Imbalance Correction

NOTE: Most electronic off-vehicle balancers are more accurate than on-vehicle spin balancers. They are easy to use and give a dynamic (two-plane) balance. On-vehicle balancing is not recommended. When balancing off-vehicle, the wheel should be mounted to the balancer with a cone through the back side of the center pilot hole or by the wheel (spindle) stud holes. The spindle stud method is recommended for CTIS wheels.

Balancing

1. Remove wheel and tire assembly from the vehicle.

WARNING: Remove all stones and foreign material from the tire tread before spin balancing. Failure to follow this warning may result in injury.

NOTE: Deposits of foreign material must be cleaned from the inside of the wheel and the tire tread to obtain a good balance. The tire should be inspected for obvious damage, then balanced according to the equipment manufacturers recommendations.

2. Mount wheel and tire assembly, curb side out, on dynamic balancer and start balance cycle (Figure 6-35).

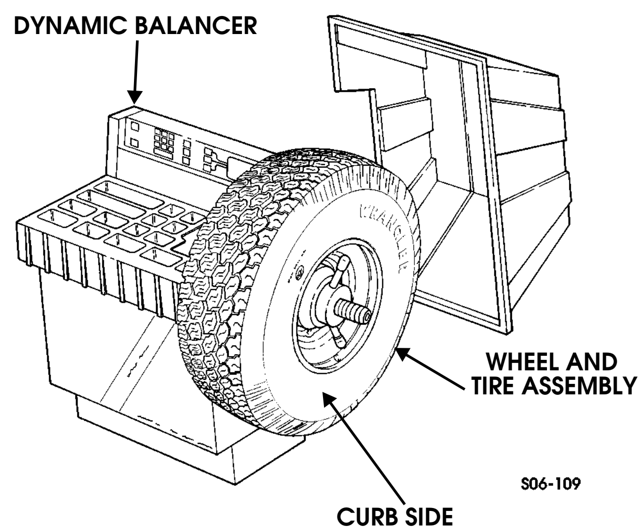


Figure 6-35: Dynamic Balancer Mounting

3. Locate and mark wheel and tire assembly light spot on the tire (Figure 6-36).
4. Record weight and position readings.

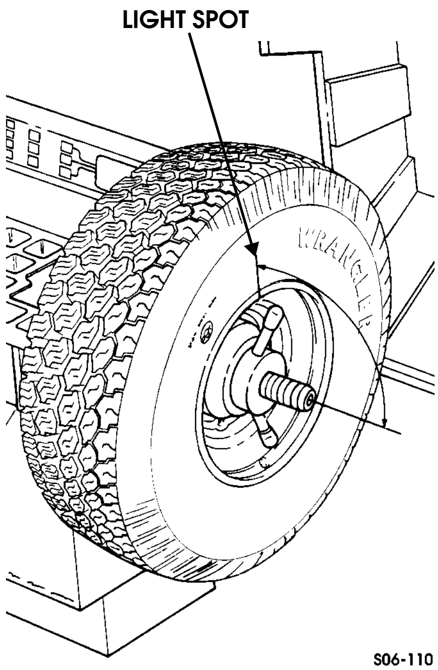


Figure 6-36: Marking Wheel and Tire Assembly Light Spot

NOTE: If more than 15 oz. of weight is required to balance the tire, wheel and runflat (if installed) assembly, rotate tire 180° on wheel. Tires can be balanced using either adhesive backed tape-on or clip-on type balance weights. Do not use wheel balancing liquids to balance wheel and tire assembly. Balancing liquids may be incompatible with and cause damage to wheel, tire, runflat, and CTIS components.

5. Attach balance weights to inner and/or outer edges of wheel (indicated by dynamic balancer), ensuring weight is centered on light spot, or weights are placed evenly to sides of light spot if more than one weight is used. When installing weight clips, use a small hammer or clip-clawhammer tool. Tap weights to conform to wheel flange edge contour (Figure 6-37).
6. Start balance cycle and repeat steps 3 through 5 until tire is properly balanced.
7. Remove wheel and tire assembly from dynamic balancer and install on vehicle.

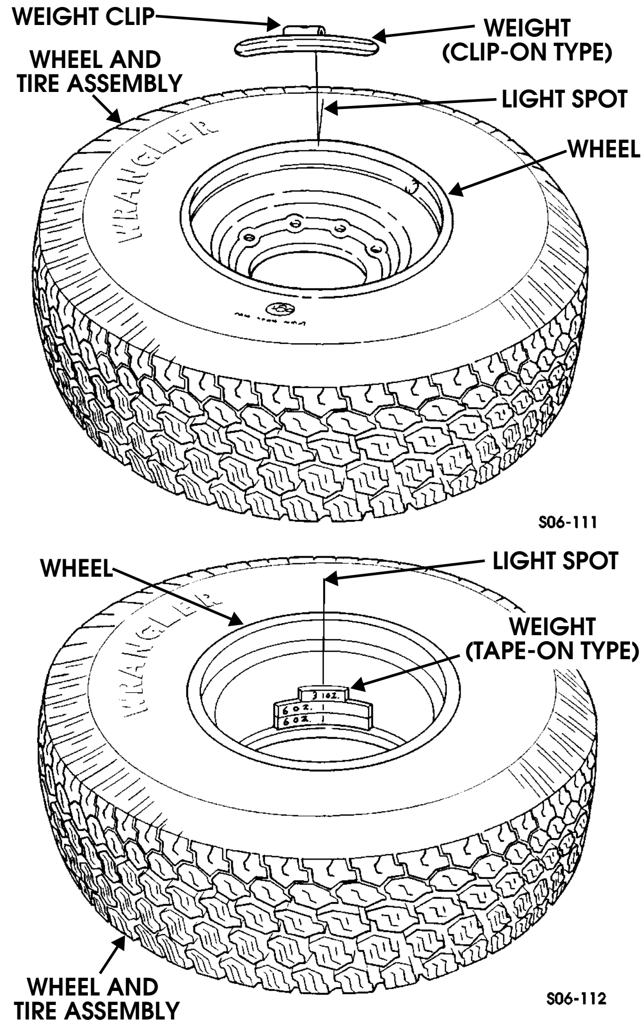


Figure 6-37: Balance Weight Placement

Suspected Runflat Movement Procedure

1. Disassemble wheel and remove runflat from tire.
2. Clean inside of tire, wheel, and O-ring seal with soap and water. Allow cleaned parts to dry prior to assembly.
3. Apply runflat gel lubricant at crown area on inside tire area (Figure 6-10).
4. Install runflat into tire and assemble wheel.
5. Balance wheel and tire assembly.

TROUBLESHOOTING A NON-BALANCING WHEEL AND TIRE ASSEMBLY

NOTE: If a wheel and tire assembly cannot be balanced, or balance cannot be maintained, any of the following conditions may be causing the problem:

- Runflat movement on the wheel rim.
- Excessive radial or lateral runout condition of the wheel.
- Improper seating of tire bead on the wheel flange.

NOTE: Perform the following if the runflat is moving on the wheel. If an excessive runout condition is suspected, proceed to Wheel Runout and Wheel and Tire Assembly Runout Inspection.

WHEEL RUNOUT INSPECTION

NOTE: It is suggested that the lateral runout check be done first, as excessive lateral runout can affect radial runout.

1. Clean dirt, debris, or rust from wheel.
2. Inspect wheel and two-piece take-apart wheel centering washers. Take measurements from inboard and outboard rim flanges for radial and lateral runout.

CAUTION: *Never start the wheel balancer with the dial indicator in place. The checks should be done by slowly rotating the wheel BY HAND ONLY.*

3. With wheel or wheel and tire assembly on wheel balancer, place magnetic base roller tip dial indicator in position.
4. Slowly rotate the wheel one revolution and zero the dial indicator.
5. Rotate the assembly one more complete turn and record the indicator reading (Figure 6-38).
6. If measurement for **lateral** runout exceeds 0.060 inch (1.52 mm), replace inner or outer wheel half (as applicable) on two-piece wheels and entire wheel if equipped with one-piece wheels.
7. If measurement for **radial** runout exceeds 0.060 inch (1.52 mm), replace inner or outer wheel half on two-piece wheels and entire wheel if equipped on one-piece wheels.

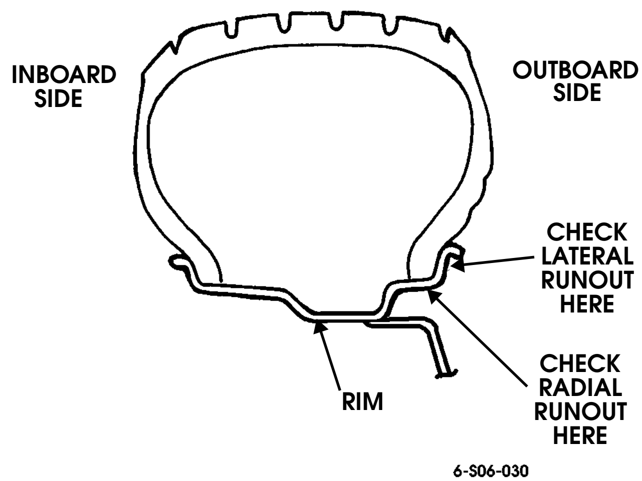


Figure 6-38: Wheel Runout Inspection Points

8. Assemble and balance wheel and tire assembly (Figure 6-37). Every time a wheel and tire is assembled, it should be balanced.

NOTE: An improperly seated tire will cause runout. Inspect GG rings to be sure bead is properly seated.

9. Be sure that the tire is properly mounted and seated on the wheel. Check the distance between the GG rings on the tire and the wheel flange. The distance between the GG rings and the wheel flange should be the same (concentric) all the way around the tire (Figure 6-39).
10. Verify that GG rings are not recessed below the wheel flange at any point around the wheel.
11. If the GG rings are non-concentric with, or are recessed below the wheel flange, remove the tire from the wheel and reinstall.
12. Balance wheel and tire assembly.

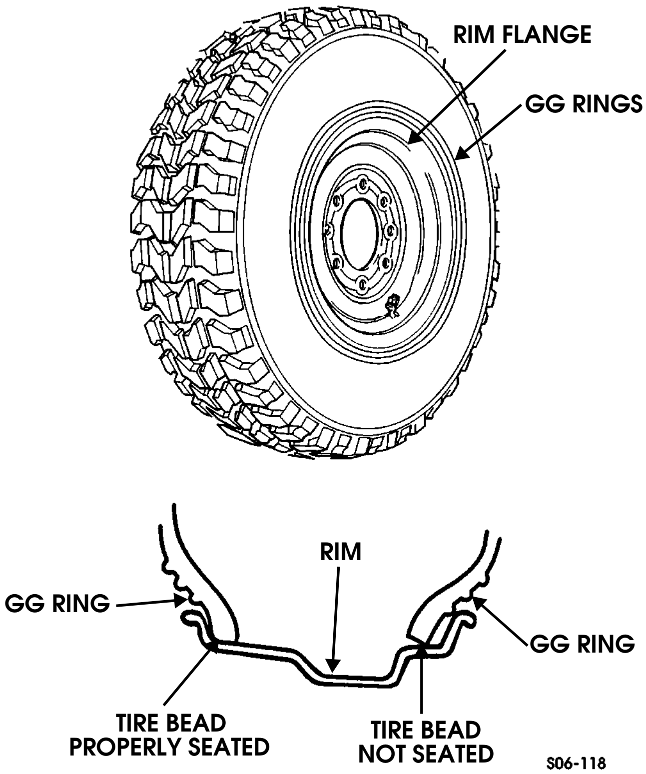


Figure 6-39: Checking Tire Bead Seating

Wheel And Tire Assembly Runout Inspection

NOTE: Before measuring the runout of a tire and wheel assembly, drive the vehicle long enough to warm up the tires. Then do the following:

1. Install tire and wheel assembly on wheel balancer.
2. Check GG rings to be sure tire bead is properly seated.
3. Position a dial indicator with a magnetic base and a roller tip on the balancer so the different runout checks can be done (Figure 6-40).
4. NEVER start the wheel balancer with the dial indicator in place. The checks should be done by slowly rotating the tire BY HAND ONLY on the tire balancer.
5. Slowly rotate the assembly one complete turn and zero the dial indicator on the low spot.
6. Rotate the assembly one more complete turn and note the amount of total runout.

NOTE: In order to measure radial runout, it will be necessary to tape the center tread of the tire (Figure 6-40). Otherwise, the dial indicator stylus will catch in the tread lugs.

7. Measure at points 1 and 2 (Figure 6-40). The maximum allowable lateral and radial runout is 0.120 inch and 0.210 inch, respectively.

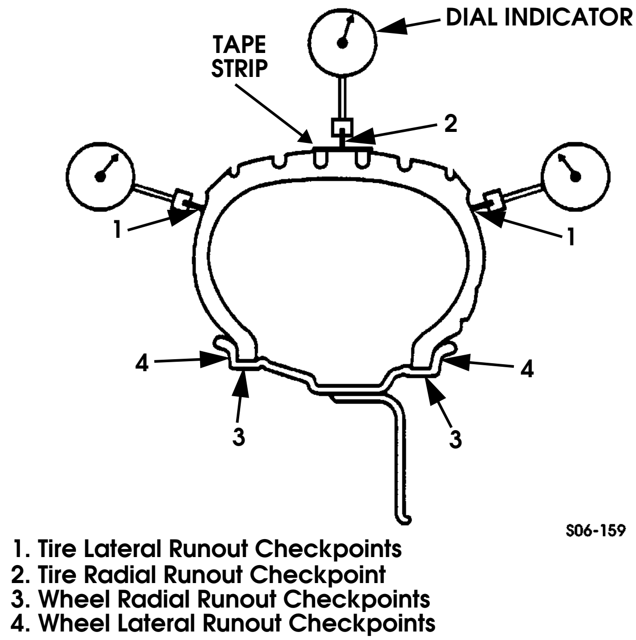


Figure 6-40: Wheel and Tire Runout Checkpoints

Geared Hub Spindle and Stud Runout

When wheel and tire runout occurs on the vehicle but not in off-vehicle inspecting, the geared hub spindle and spindle studs should be checked for radial and lateral runout (Figure 6-41).

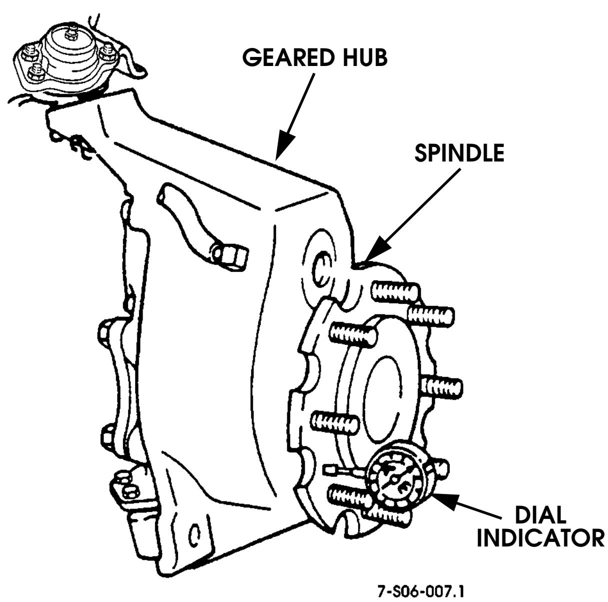


Figure 6-41: Geared Hub Spindle Runout Inspection

Geared Hub Spindle Runout Inspection

Using a dial indicator, position the roller tip on the machined surface outside the bolts on the spindle face.

Measure the runout using the following method:

1. Turn the spindle by hand to locate the low spot.
2. Zero the dial indicator.
3. Turn the spindle by hand to check the total lateral runout.
4. 0.005 inch is the acceptable lateral runout.

Measuring Geared Hub Spindle Stud Runout

Position the dial indicator roller to contact the wheel mounting studs. Ensure that the studs are fully pressed in, if not seat or replace the studs as necessary (Figure 6-42).

Measure the runout using the following method:

1. Turn the spindle by hand to register on each of the studs.
2. Zero the dial indicator on the lowest stud.
3. Check the total runout on the remaining studs.
4. 0.030 inch is the acceptable radial runout.

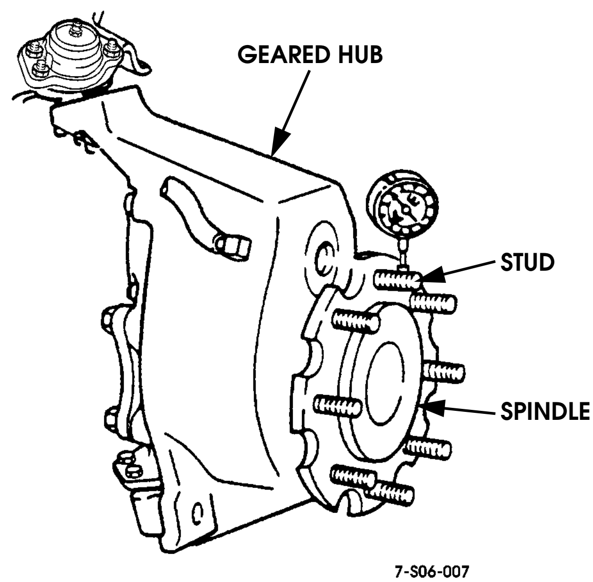


Figure 6-42: Geared Hub Spindle Stud Runout Inspection

WHEEL ALIGNMENT

Check alignment on a rack with the front tires in the straight-ahead position and inflated to manufacturer's recommended pressure.

Preliminary Inspection

1. Check tire condition, tread wear (Figure 6-32), run-out, and inflation.
2. Raise and support vehicle so wheels are free to rotate. Then secure the steering wheel in straight-ahead position.
3. Check tie rods and upper control arms for distortion, play, or looseness (Figure 6-43). Replace worn, damaged parts before proceeding.

NOTE: If the vehicle was previously lifted off the ground for other service, center the steering wheel, roll the vehicle forward and back to settle the suspension and relieve the tension on the ball joints before beginning checking procedure.

4. Check upper ball joints: With the vehicle on the ground (being careful not to damage the boot), place the tip of a prybar between the steering knuckle and the ball joint boot (Figure 6-44). With the shank of the prybar contacting the upper control arm as shown, pry upward and note the movement of the ball joint against a ruler. Be careful to measure only the ball joint movement and not the flex of the conrol arm resulting from prying against it. Any upper ball joint with more than 1/16” (1.6 mm) movement should be replaced.
5. Check geared hubs for spindle end play or side-to-side movement by grasping the edge of the tire and attempting to move the tire up and down.

NOTE: If any spindle movement is apparent, adjust the spindle bearings.

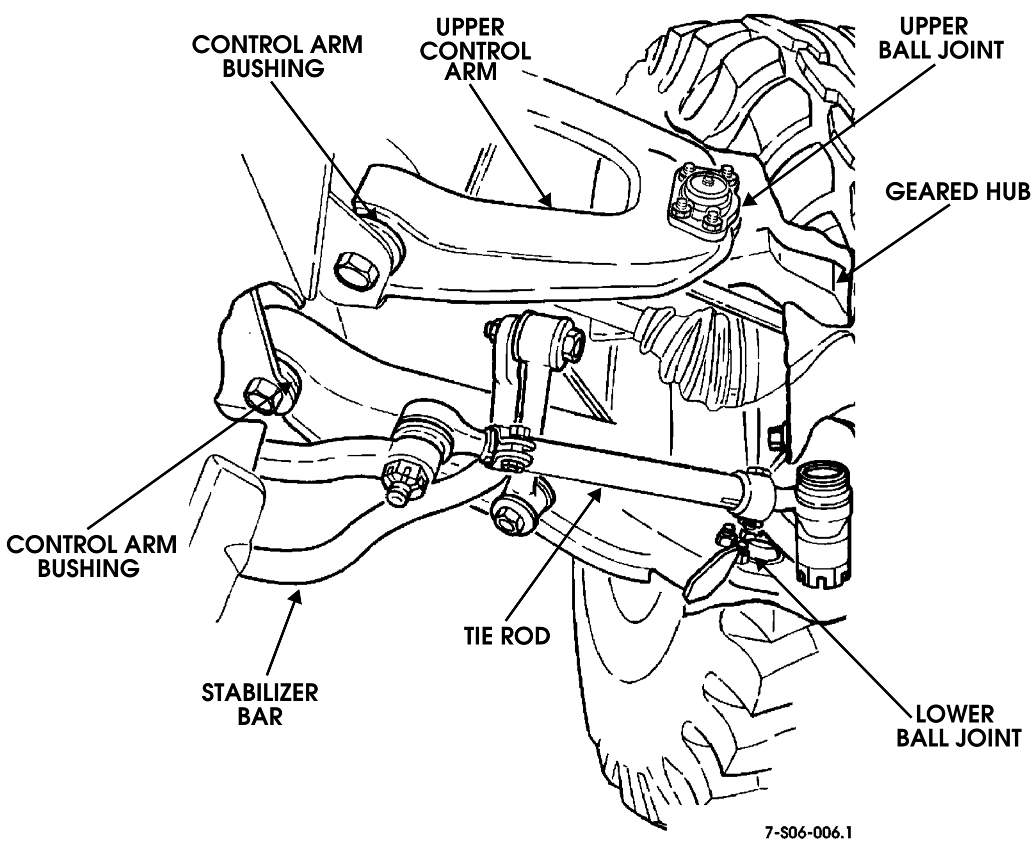


Figure 6-43: Suspension Inspection Components

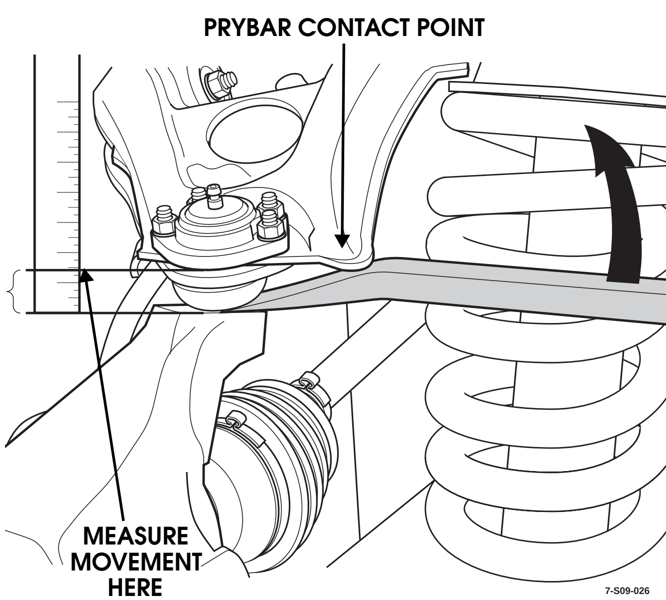


Figure 6-44: Ball Joint Wear Check

6. Inspect control arm bushings for wear or damage. Replace bushings if necessary.
7. Check lower ball joints: Support lower control arm with a jack or stand to unload lower ball joint. Place bar between lower arm at ball joint and geared hub and measure vertical play obtained by moving pry bar down (Figure 6-44.1). Maximum play should not exceed 1/8” (3.5 mm). Replace ball joint if end play exceeds the limit.
8. Check steering center link, idler arm and tie rod ends for wear or damage (Figure 6-45). Replace parts as needed before proceeding.
9. Check idler and steering arms by pulling the center link vertically up and down with a 50 lb. spring scale. Maximum allowable movement is 1/4 inch (7 mm), 1/8 inch (3.5 mm) up or down, when pulled within 2 inch (51 mm) of ball stud.

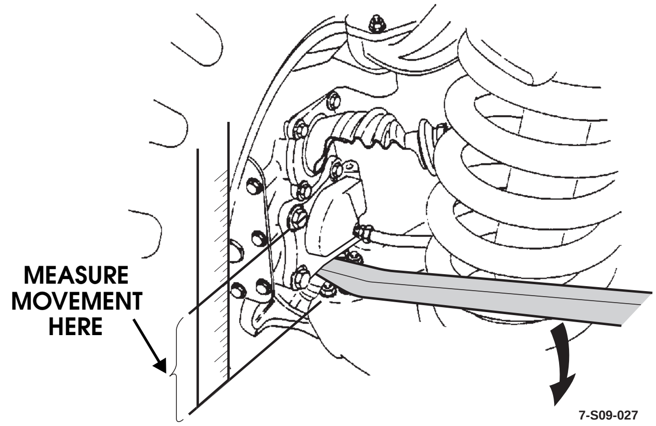


Figure 6-44.1 Lower Ball Joint Check Wear

10. Lower the vehicle.
11. Check tie rod end wear by trying to move the tie rod vertically and horizontally. Replace the tie rod end(s) if any movement is apparent.
12. Inspect the center link for distortion. Center link deformation will cause front wheel toe-out. If center link deformation is suspected, remove the suspect center link from the vehicle and place it on a level surface next to a new center link. Carefully compare the two parts, checking for distortion and tapered hole wear. Replace the suspect center link if tapered holes are worn or if the center link is distorted.
13. Check the center link and stabilizer bar for cracks or distortion. Replace if necessary.
14. Inspect the stabilizer bar bushings for excessive wear and/ or distortion. Replace if necessary.
15. Check the steering gear for looseness-to-frame, proper operation, and excessive leakage. Repair if necessary.

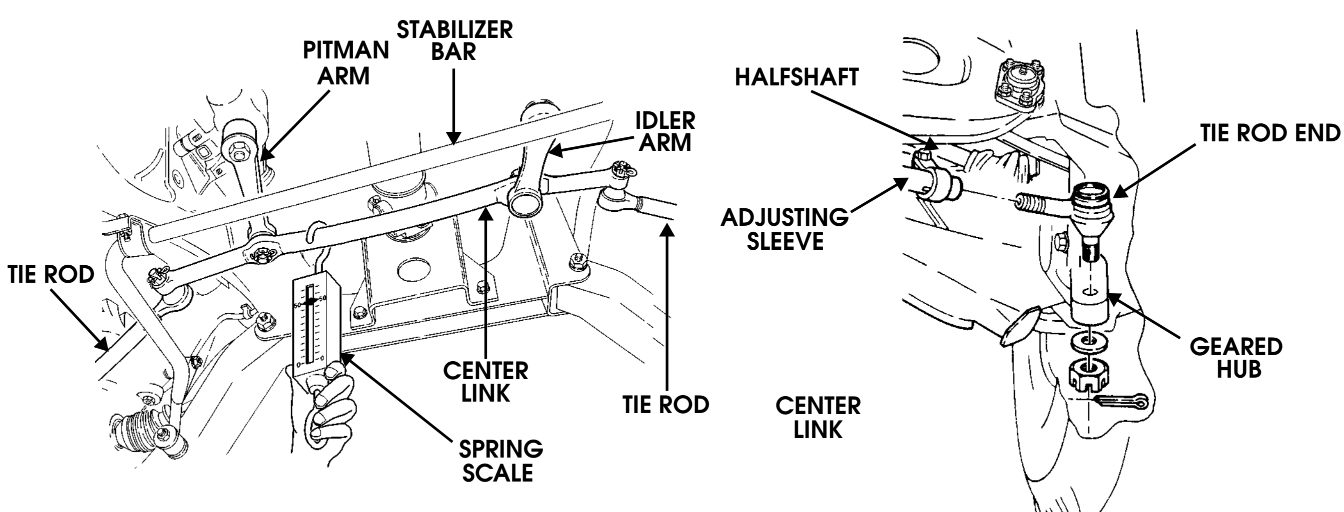


Figure 6-45: Suspension Component Identification

CHECKING WHEEL ALIGNMENT

1. Move vehicle onto alignment rack and position front tires on alignment rack turntables.
2. Place front wheels in straight ahead position on turntables.
3. Install alignment measuring equipment on vehicle wheels. Follow manufacturers instructions to avoid incorrect measurements.
4. Measure and record caster, camber, toe-in, and toe-out. Refer to alignment specifications (Figure 6-46).
5. If alignment angles are within specified limits, move vehicle from rack. However, if angles are incorrect, leave vehicle on alignment rack and proceed to Wheel Alignment Correction.

SERVICE WHEEL ALIGNMENT							
		SERVICE CHECKING			SERVICE SETTING		
SUSPENSION POSITION	**TIRE PRESSURE (PSI)**	**CASTER (DEGREES)**	**CAMBER (DEGREES)**	**TOE-TOTAL (DEGREES)**	**CASTER (DEGREES)**	**CAMBER (DEGREES)**	**TOE-TOTAL (DEGREES)**
FRONT	26	+1.5 to +4.0 (B)	0 to +1.75 (B)	0 to +0.25 (C)	+2.5 to +3.5 (A)	+0 to +.50 (A)	0 to +0.19 (C&E)
REAR	28	na	-0.1 to +1.0 (B)	-0.25 to 0 (D)	na	+.25 to +0.75 (A)	-0.19 to 0 (D&E)

To measure in inches, 0.1 degree = 1/16", 0.19 degrees = 1/8", 0.25 degrees = 5/32

(A) Left and right side to be equal within 0.5 degrees.

(B) Left and right side to be equal within 1.0 degrees.

(C) Toe-in (Positive sense) left and right sides to be set separately and evenly per wheel. Steering wheel must be held in a center position within + or - 5 degrees

(D) Toe-out (negative sense) left and right side to be set separately and evenly per wheel

(E) Left and right sidetoe settings to be equal within 0.10 degree

NOTE:

Alignment settings should be checked and adjusted on a rack that allows all four wheels/tires to support vehicle weight.

Set wheel alignment while the vehicle is in its normally loaded condition.

Vehicles which are consistently operated with heavy on-board loads should have alignment adjusted with the vehicle under heavy on-board load.

Ride height should be checked and corrected if necessary and the hood should be closed while taking measurements.

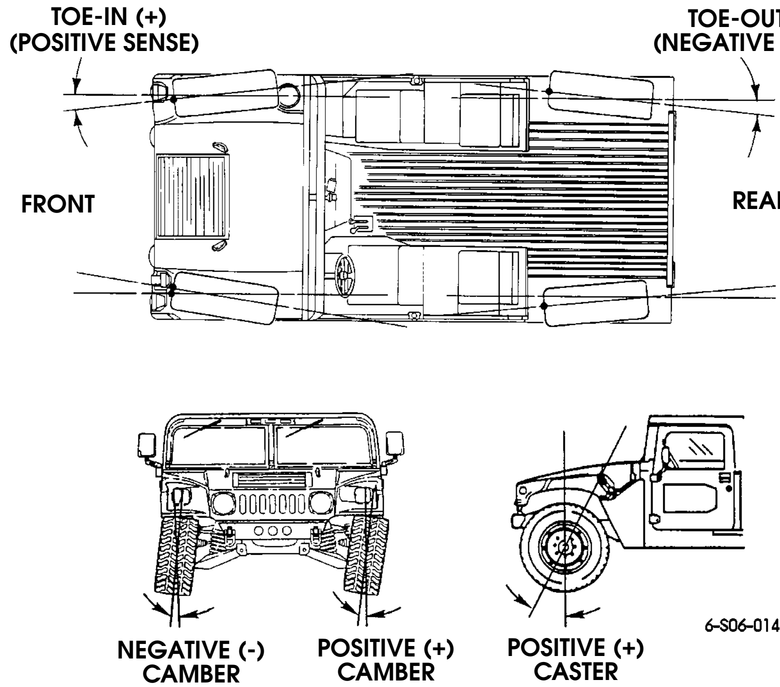


Figure 6-46: Wheel Alignment Information

WHEEL ALIGNMENT CORRECTION

Alignment adjustments should be performed one at a time and in sequence to avoid errors. Recommended adjustment sequence is:

a. caster
b. camber
c. front toe setting
d. rear toe setting
e. steering stops

Leave the vehicle on the alignment rack for each of the adjustment procedures. This way, angle correction can be monitored continuously during actual adjustment.

Caster Adjustment

Caster adjustment applies to the front wheels only. It is controlled by a shim installed between the airlift bracket and upper control arm front bracket (Figure 6-47). A positive caster angle is required on all Hummer vehicles.

Preferred caster angle is +2.5 to +3.5 degrees. Maximum allowable side-to-side variation is 0.5 degree.

1. Support lower control arms and geared hubs with jack built into alignment rack. Or, use floor jack and jack stands if rack is not equipped with built-in jack.
2. Remove upper control arm pivot bolts (Figure 6-48). Retain bolts and washers but discard nuts if they are lock-type.
3. Loosen bolts that attach upper control arm brackets to airlift bracket and frame (Figure 6-48). Do not remove the bolts; just loosen them.
4. Adjust caster angle by changing shim thickness between control arm front bracket and airlift bracket (Figure 6-47):
   - Preferred caster is +2.5 to +3.5 degrees and left-right variation must not exceed 0.5 degree.
   - A thicker shim increases positive caster while a thinner shim decreases it.
   - Shims are available in 0.060 inch and 0.120 inch (1.5 and 3.0 mm) thicknesses for adjustment purposes. An 0.060 inch shim will change caster approximately 0.3 degrees and a 0.120 inch shim will change caster approximately 0.6 degrees.
5. Add or remove shims as needed. Then tighten control arm and airlift bracket attaching bolts to 90 ft-lb (122 N•m) torque.
6. Install but do not fully tighten upper control arm pivot bolts.
7. Install front wheels.
8. Remove supports and position front wheels on turntables.
9. Tighten control arm pivot bolts to 260 ft-lb (352 N•m) torque.
10. Verify correct caster angle at both front wheels. Be sure side-to-side caster variation does not exceed 0.5 degree.
11. Leave vehicle on rack for camber and toe adjustments.

Camber Adjustment

Camber adjustment applies to the front and rear wheels equally. It is controlled by shims installed between each upper control arm bracket and the airlift bracket (Figure 6-48).

Preferred camber for all Hummer vehicles is zero to +0.5 degrees at the front and +0.25 to +0.75 degrees at the rear. Maximum allowable side-to-side variation is 0.5 degree front and rear.

1. Support lower control arms and geared hubs with jack built into alignment rack. Or, use floor jack and jack stands if rack is not equipped with built-in jack.
2. Remove front and/or rear wheels as needed.
3. Remove upper control arm pivot bolts (Figure 6-48). Retain bolts and washers but discard nuts if they are lock-type.
4. Loosen bolts that attach upper control arm brackets to airlift bracket and frame (Figures 6-47 and 6-48). Do not remove the bolts; just loosen them.
5. Adjust camber angle by changing shim between each control arm bracket and airlift bracket (Figure 6-48):
   - Use the same thickness shims between each control arm bracket and the airlift bracket
   - Do not disturb the previously installed front wheel caster shims. Simply insert the camber shims behind, or in front of the caster shims.
   - A thicker shim increases positive camber by 0.6°. A thinner shim increases positive camber by 0.3°. Shims are available in 0.060 inch and 0.120 inch (1.5 and 3.0 mm) thicknesses for adjustment purposes.
6. Add or remove shims as needed. Then tighten control arm and airlift bracket attaching bolts to 90 ft-lb (122 N•m) torque.
7. Install but do not fully tighten upper control arm pivot bolts.
8. Install front and/or rear wheels as needed.
9. Remove supports and position front wheels on turntables.
10. Tighten control arm pivot bolts to 260 ft-lb (352 N•m) torque.
11. Verify correct camber angle at both front wheels. Be sure side-to-side variation does not exceed 0.5 degree.
12. Leave vehicle on rack for toe settings and steering stop adjustment.

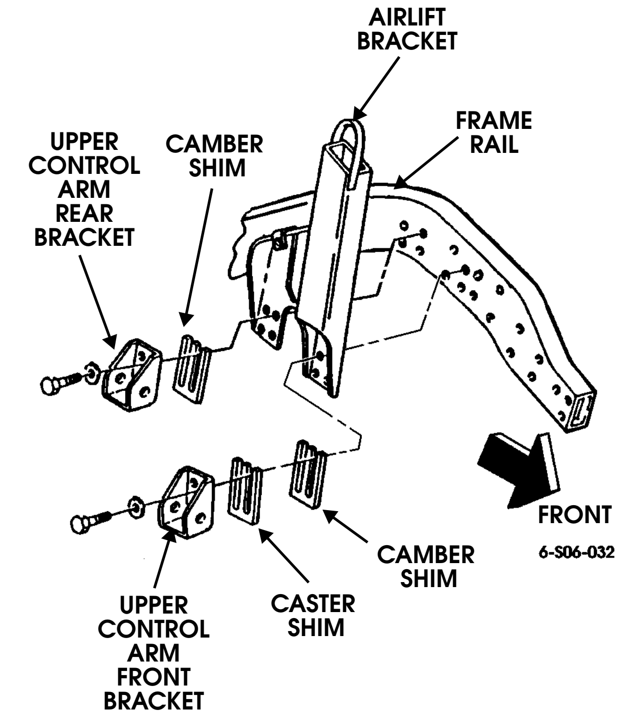


Figure 6-47: Caster Shim Location (Passenger Side Front Shown)

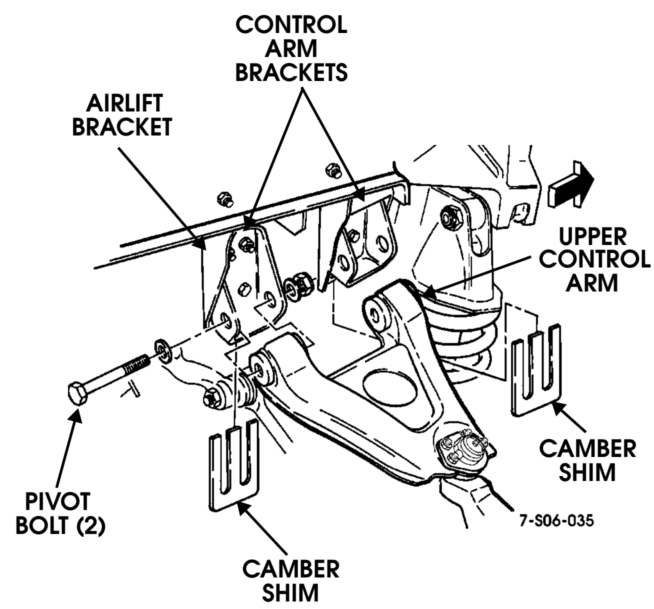


Figure 6-48: Camber Shim Location (Passenger Side Front Shown)

Front Wheel Toe Adjustment

1. Position both front wheels on alignment rack turntables. Set the front wheels in the straight-ahead position and center the steering gear.
2. Loosen adjusting sleeve clamps on both tie rods (Figure 6-49).
3. Turn sleeves until toe measurement is within specifications.
4. Tighten the adjusting sleeve clamp nuts and verify correct toe adjustment.

CAUTION: *Be sure that the bolt and nut on the adjusting sleeve clamp nut nearest to the geared hub is facing the halfshaft. The bolt and nut on the adjusting sleeve clamp nearest to the frame must be facing away (180 degrees) from the stabilizer bar. After adjustment, the lengths of both tie rod end assemblies should be the same, plus or minus 1/16 inch (1.6 mm).*

CAUTION: *The sleeve clamps must be positioned between 3/16" and 5/16" from the end of the sleeve and the bolt and nut torqued to 30 lb. ft. (Figure 6-51).*

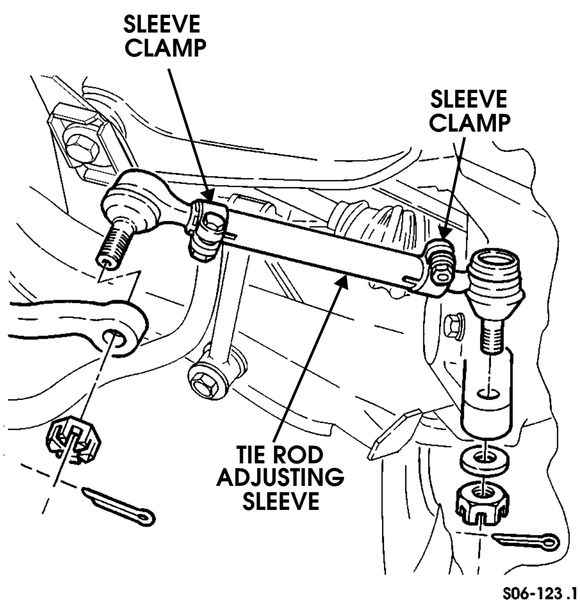


Figure 6-49: Front Wheel Toe Adjustment Points

5. Verify that steering wheel is centered. Move steering wheel to the straight-ahead position if necessary.

Rear Wheel Toe Adjustment

1. Position both rear wheels on alignment rack turntables.
2. Loosen clamps on both radius rods (Figure 6-50).
3. Turn the adjusting sleeves until toe measurement is within specifications.
4. Tighten clamp nuts and verify toe adjustment.

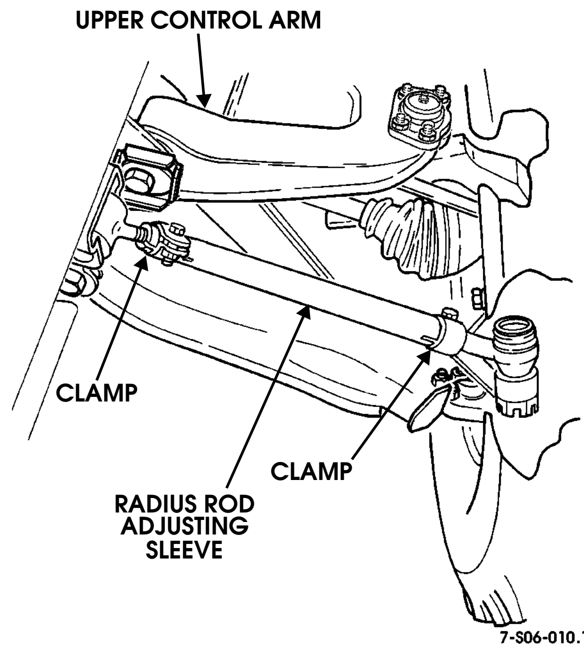


Figure 6-50: Rear Wheel Toe Adjustment Points

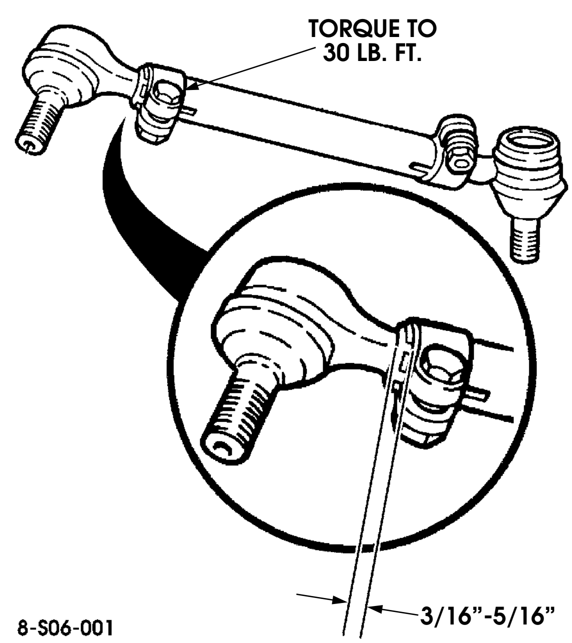


Figure 6-51: Sleeve Clamp Position

CENTRAL TIRE INFLATION SYSTEM

The optional Central Tire Inflation System (CTIS) is unique to the HUMMER. The CTIS allows the driver to increase or decrease tire pressure based on terrain and climate conditions. The system can also be used to direct air to a tire that has a leak.

The CTIS controls are located on the instrument panel. An inflate/deflate switch determines if air is added to the tires or released from the tires. When the tires are being inflated, an indicator light on the instrument panel illuminates. If the pressure in any of the tires drops to 8 psi (55 kPa) or below, the low pressure indicator light will illuminate and an alarm will sound. If the tire pressure ever exceeds 55 psi (379 kPa), a relief valve automatically relieves any excess pressure. The tire selector valve position determines whether the pressure in the front, rear or all four tires will be adjusted. The air pressure gauge indicates the current pressure in the tires. Refer to the short, white needle for front tire pressure and the longer, orange needle for the pressure in the rear tires. Temperature rise and fall affects air pressure in a tire. As the vehicle is operated it is typical for the air pressure to rise 3-5 psi (21-34 kPa). As the wheels and tires cool down, the air pressure will drop. This is normal and such a drop in tire pressure does not indicate any leaks in the system.

The CTIS consists of an electric air compressor that pumps air through a series of valves, tubes, and hoses to the front and/or rear tires. Compressed air travels through the manifold where three electric valves connected in parallel direct the compressed air to the front, rear or both tires. When deflation is selected, air is routed from the tires through the three electric valves and is exhausted through the deflate valves (Figure 6-52).

Each wheel assembly has a manual quick-disconnect valve which can be used to prevent air flow to and from the tire, such as during long-term storage or while changing a tire. If the vehicle will remain dormant for two weeks or more, it is a good practice to disconnect the system at the wheels. These quick-disconnect valves are also used to restrict air flow to the operational tires when the driver wants to direct air flow to a damaged tire. For example, if a tire has a small puncture and has a leak, the quick-disconnect valves on the operational tires can be disconnected, enabling compressed air to be directed exclusively to the leaking tire. This may maintain enough tire pressure in the leaking tire to allow the driver to get the vehicle to an appropriate location for safe tire repair or replacement (Figure 6-53).

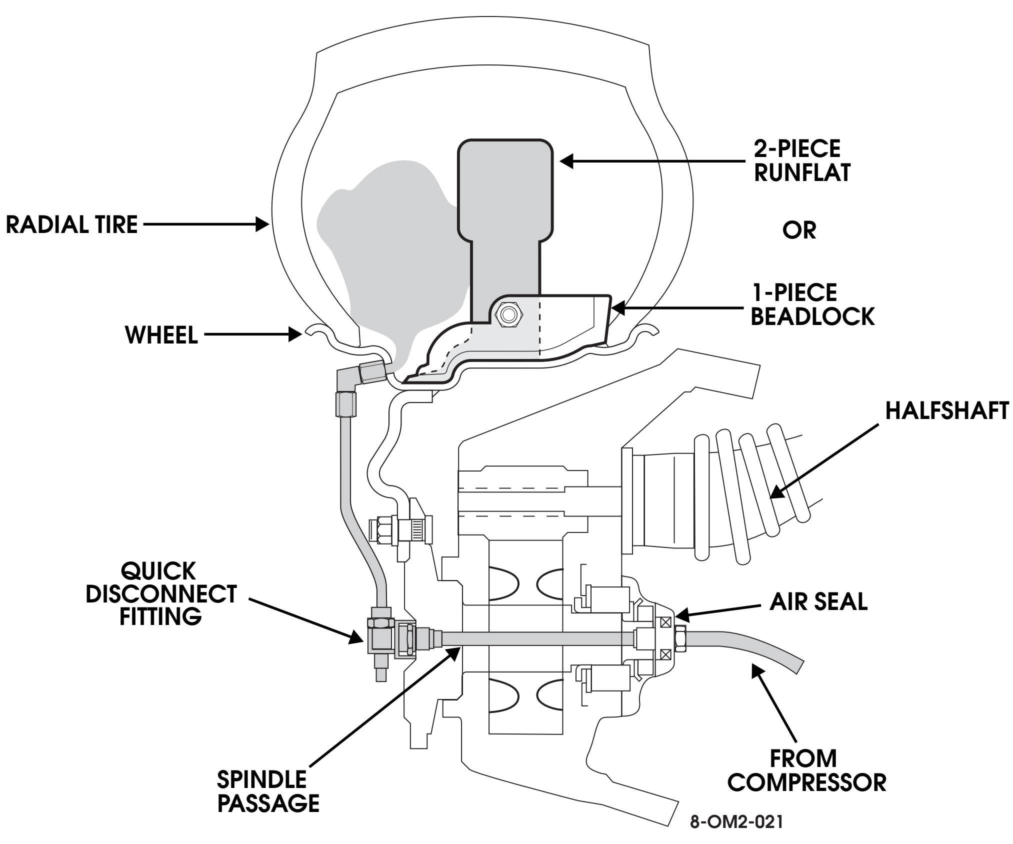


Figure 6-52: Central Tire Inflation System (CTIS)

To disconnect the CTIS from the wheel assemblies, first turn inflate/deflate switch to the OFF position. Release the four quick-disconnect valve assemblies from all four spindles by depressing the quick-disconnect valve tabs attached to the valve spindle nuts (Figure 6-54). When the tabs are depressed, the valve assemblies will spring away from the spindles about 1/2 inch (12.7 mm). To reconnect the quick-disconnect valve assemblies, push the valve assemblies toward the spindles until they click into place.

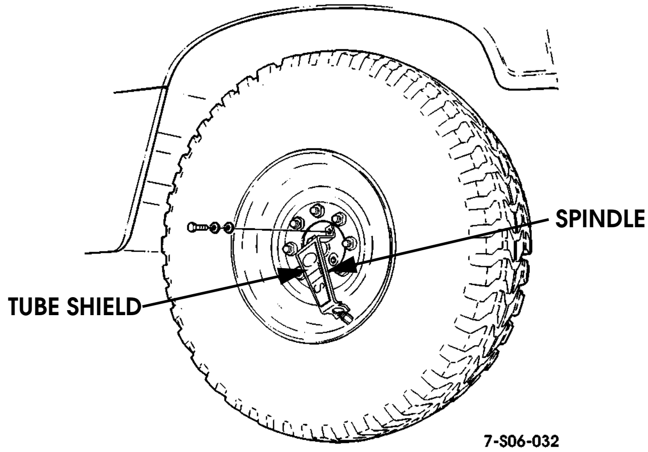


Figure 6-53: Quick-Disconnect Valve

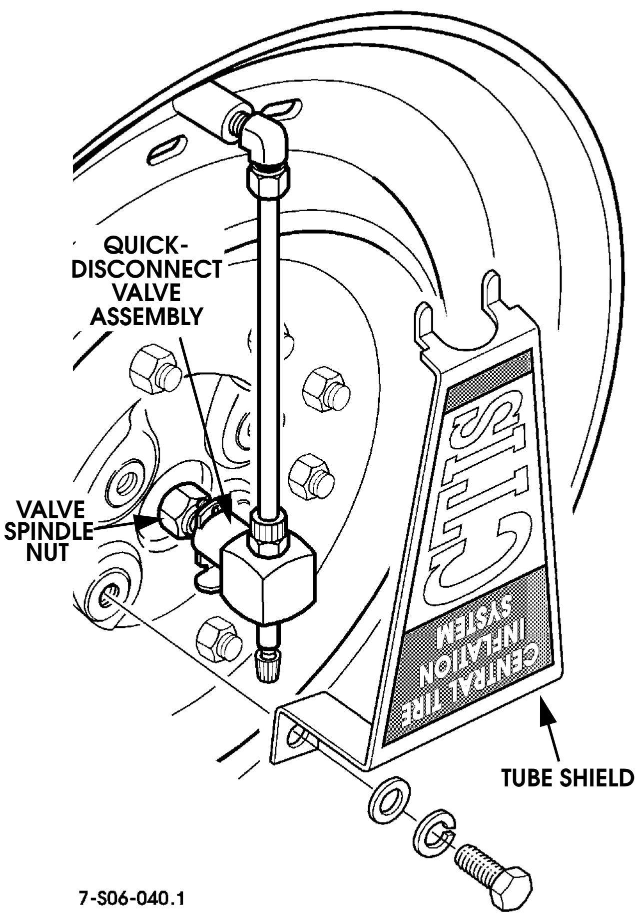


Figure 6-54: Quick-Disconnect Tab

CTIS TROUBLESHOOTING

The following pages contain troubleshooting information for locating and correcting mechanical, pneumatic, and electrical problems that may develop with the CTIS.

Electrical Troubleshooting

Symptoms are listed for system malfunctions, and procedures and corrections are diagramed to assist service technicians.

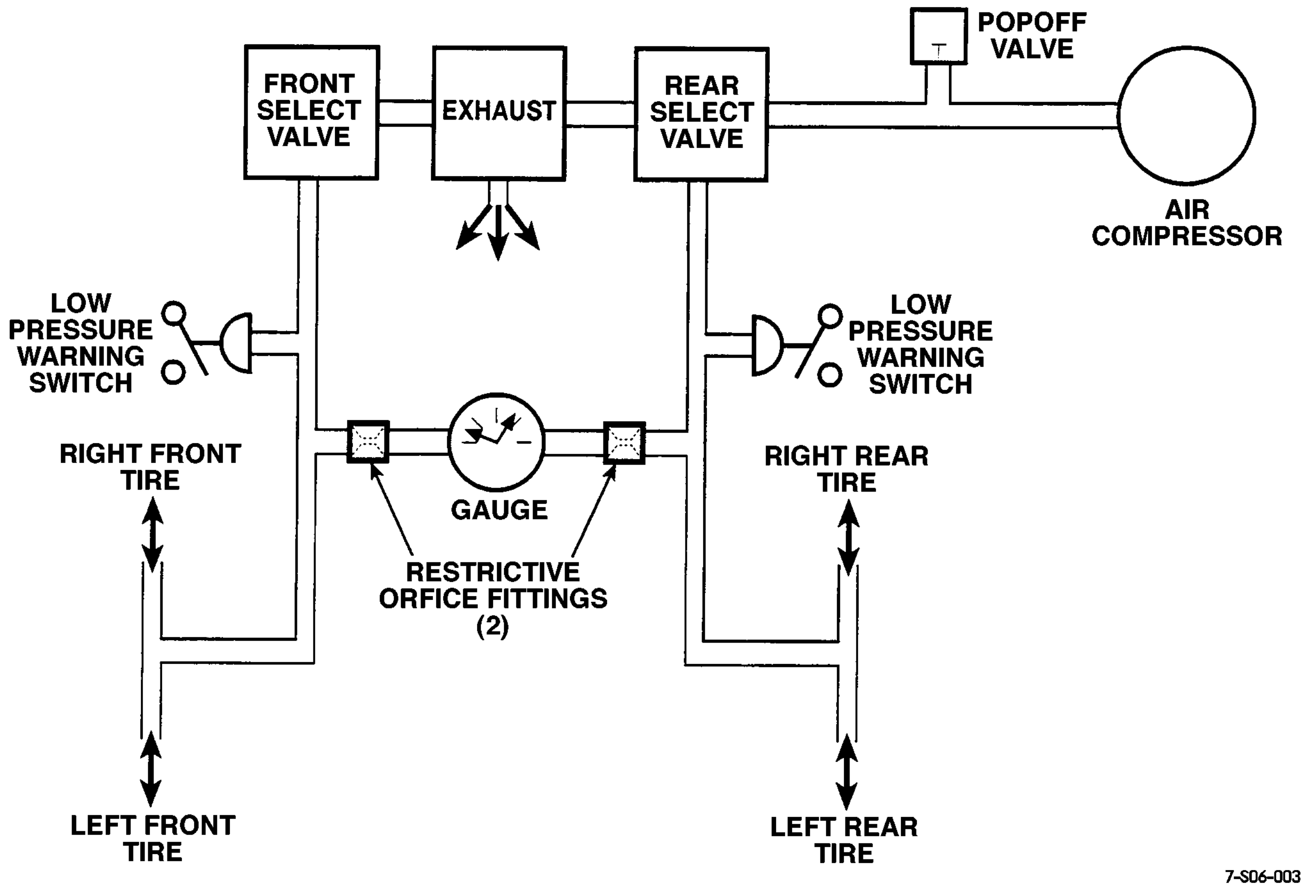
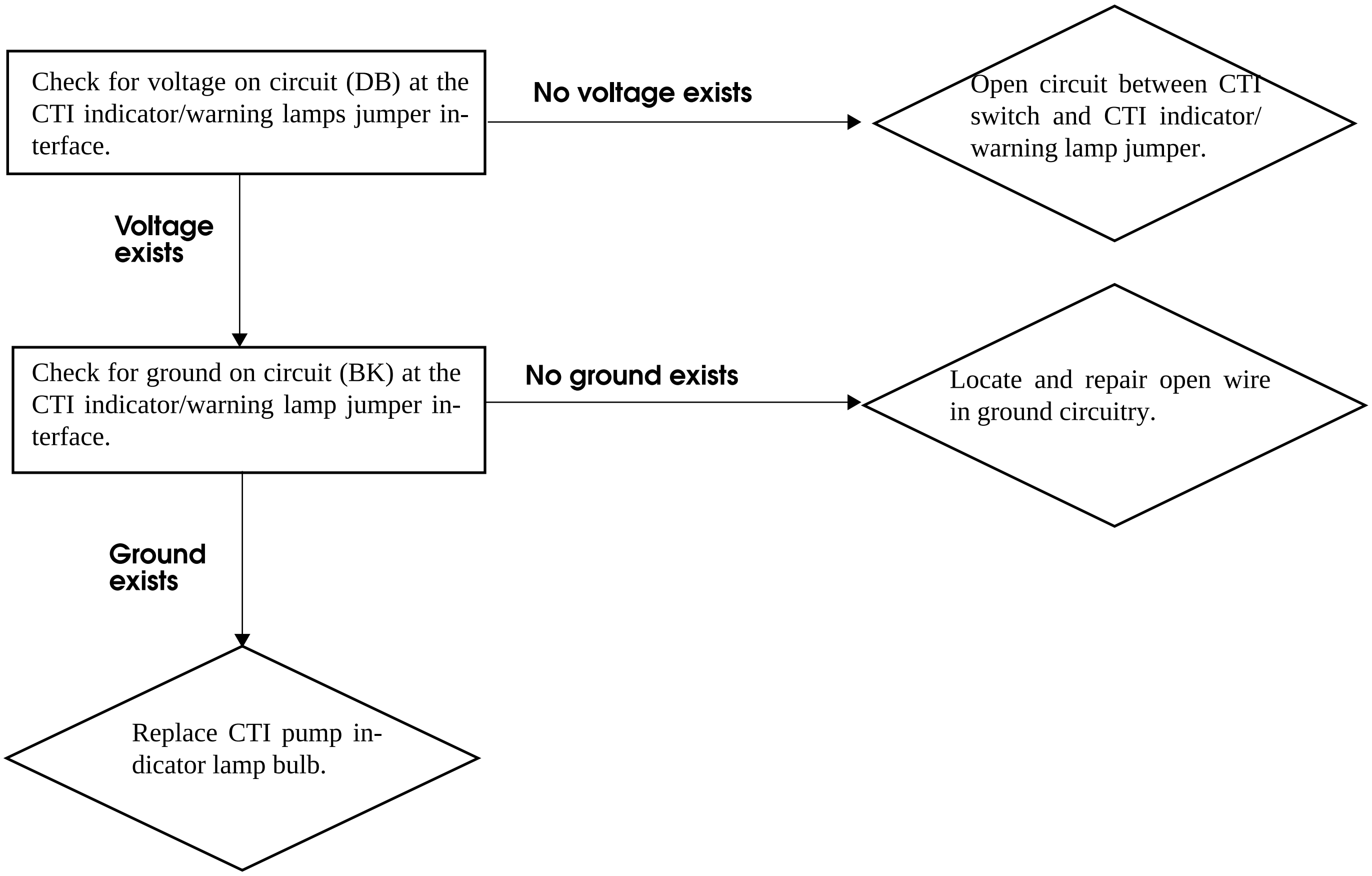
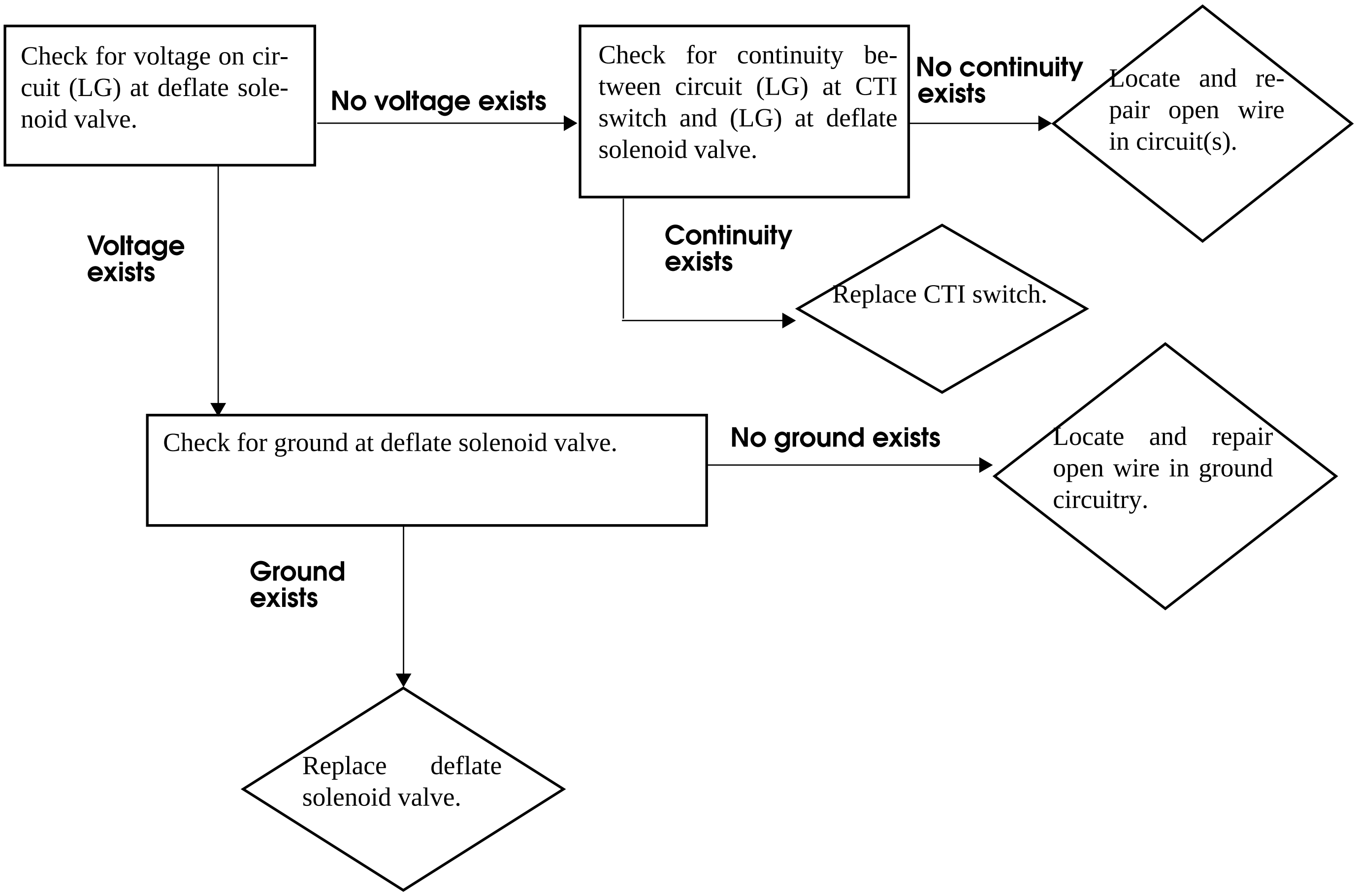


Figure 6-55: Pneumatic Diagram for Central Tire Inflation System

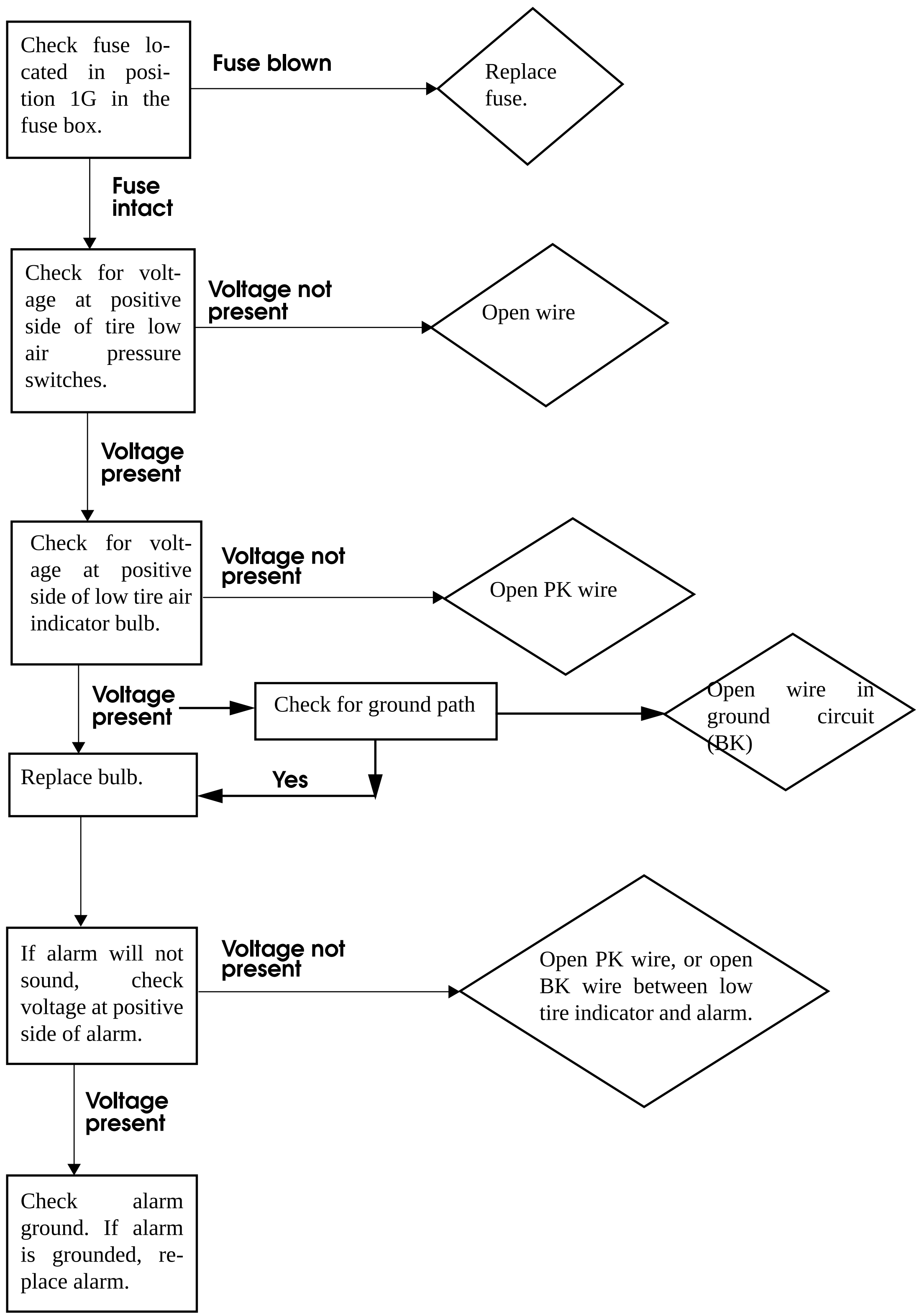
CTI Air Pump Operates, But CTI Indicator Lamp Will Not Light.



CTI System Will Not Deflate, But Will Inflate

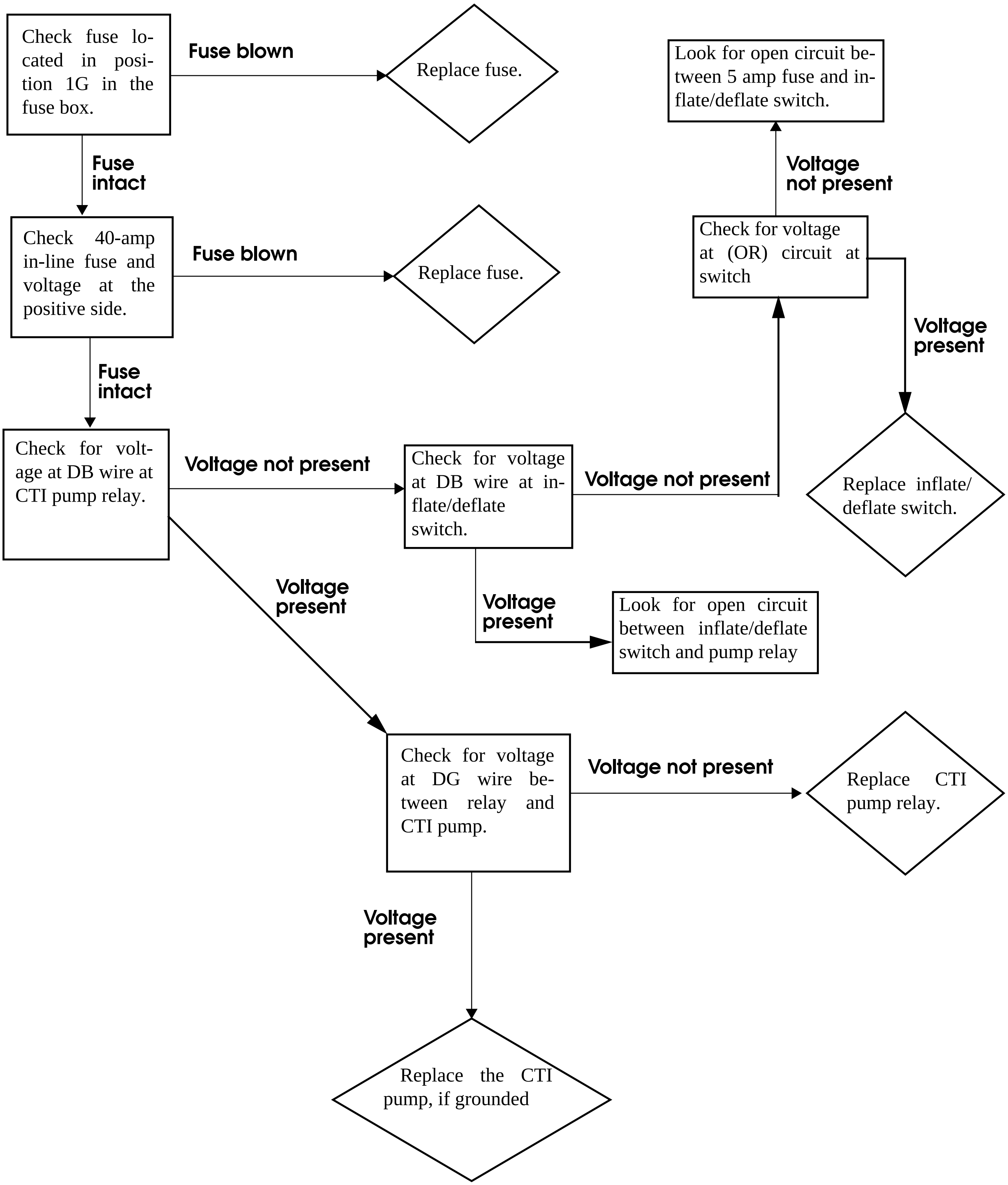


CTI Low Pressure Alarm and Indicator Will Not Operate When Tire PSI is Below 8 PSI



CTI Pump Inoperative

(CTI air pump does not operate when CTI switch is in INFLATE position.)



CTIS AIR LEAK TROUBLESHOOTING

This section contains troubleshooting information for locating and correcting air leaks within the Central Tire Inflation System.

WARNING: CTIS air system components are subject to high pressure. Always relieve air pressure before loosening or removing air system component(s) by disconnecting the quick-disconnect valve assemblies at each wheel end. Failure to follow this warning may result in serious personal injury.

CTIS Troubleshooting Checklist

1. Fill all tires to at least 40 psi (270 kPa) using the on-board compressor or shop air source.
2. Note the needle positions on the air gauge. If the needles are not even, line them up by inflating the lower pressure tires. Then return the inflate/deflate switch to OFF.

NOTE: The tires are isolated from the rest of the system so that the areas between the compressor selector valve and geared hubs and selector valve can be isolated and checked.

3. Isolate each tire and wheel assembly by disconnecting each quick-disconnect valve.
4. After tires have been isolated, measure and record each tire's air pressure.
5. After a minimum of 10 minutes, check to see if the air gauge needles have moved.

NOTE: Leaks can be detected by using soapy water, but commercially available leak detection liquids such as "Gaz-Tec" work best. Most leaks can be corrected by tightening fittings. Replace the fittings or air lines only when necessary.

6. Determine if the front, rear, or both air systems have leaked. If a leak is detected, concentrate on that area and follow the appropriate troubleshooting chart.
   - Geared Hubs, Seals, and Fittings - Chart 1
   - Deflate Valve Area - Chart 2
   - Under Vehicle Air Leak - Chart 3
7. After checking and repairing leak points, place the selector switch in the BOTH position.
8. Note the gauge needle positions. Reposition or re-inflate to align the needles.
9. Wait at least two minutes and check to see if the needles have moved. If movement is detected, concentrate on detecting the leak point. Follow Refer to Troubleshooting Chart 4 – Air Compressor Leak Test in this Section..

NOTE: If tires were hot, air loss may be a result of the tires cooling down. If this is the case, all tires should lose about the same amount of air.

10. Check the air pressure in each tire and compare it to the information taken earlier. Note any air pressure loss and concentrate on that tire position. Refer to Refer to Troubleshooting Chart 5– Tire and Quick-Disconnect Valve in this Section..

If no air loss is detected, there may be a small leak which will require an overnight evaluation.

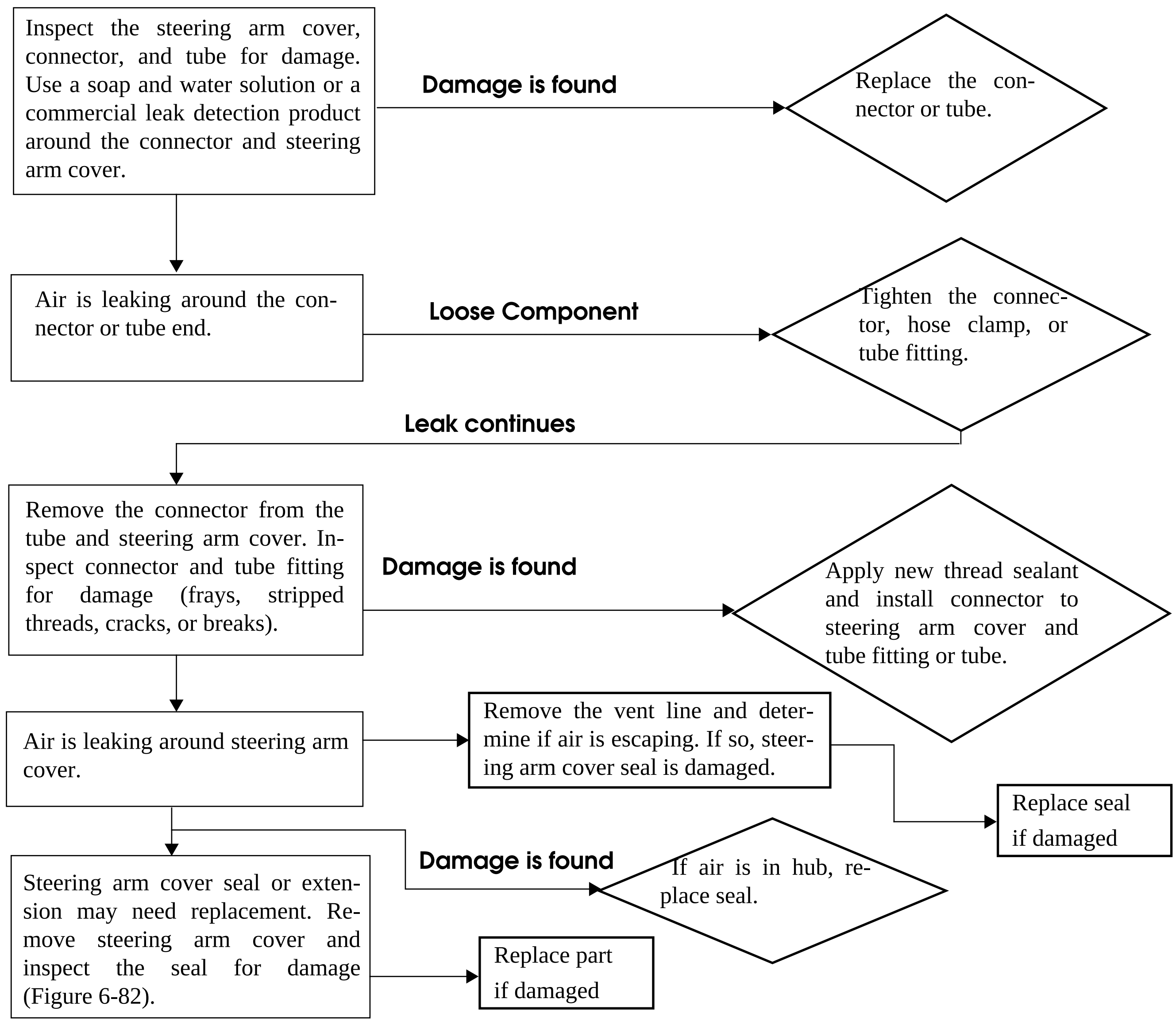
NOTE: Always complete the entire troubleshooting procedure to ensure that all potential leak points have been corrected.

Verification

After completing the troubleshooting procedure, verify the system by repeating the CTIS Troubleshooting checklist steps.

WARNING: CTIS air system components are subject to high pressure. Always relieve air pressure before loosening or removing air system components(s) by disconnecting quick-disconnect valve assemblies at each wheel end. Failure to follow this procedure may result in serious injury to personnel.

Troubleshooting Chart 1 – Geared Hubs, Seals and Fittings



Troubleshooting Chart 2 – Deflate Valve Area

Inspect the deflate valve and connections for damage (Figure 6-69). Use a soap and water solution to check for leaks.

Air is escaping from the dust excluder or the seams on the Deflate Valve (Figure 6-70).

Replace the deflate valve.

Air is escaping from the sides of the check valve.

Replace the check valve.

Leaks

Tighten all suspect connections. If this fails to seal the air leak, take the connections apart, clean, apply new sealant, and tighten.

Troubleshooting Chart 3 – Under Vehicle Air Leak

Follow the CTI lines under the vehicle. Inspect for damage. Use a soap and water or commercial leak detection solution to detect air leaks.

Tighten all suspect connectors. If this fails to stop the air leak, remove the suspect part (elbow, fitting or connector) and inspect the threads for stripping. Clean, apply new pipe sealant, and install into the CTI system.

Troubleshooting Chart 4 – Air Compressor Leak Test

Inspect all fittings, tees, valves and hoses connected to the compressor (Figure 6-56). Use soap and water or commercial leak detection product to

Check the relief valve to ensure air is not leaking from the relief valve stem area.

Air is leaking

Replace the relief valve.

Air is leaking

If air is leaking from a fitting, tee, elbow or tube connection, tighten the part. If leak persists, remove the CTI part, clean, apply new sealant to the threads and install the CTI part.

Troubleshooting Chart 5– Tire and Quick-Disconnect Valve

Inspect the quick-disconnect valve, quick-disconnect valve nut, tube, nut and sleeve assembly, insert, and elbow for damage (Figure 6-80).

Quick-disconnect component is frayed, stripped, cracked, or broken.

Replace the component.

Tighten all connections. If air is still leaking, remove the CTI part, clean, apply new sealant to the threads, and install the CTI part.

Inspect the tire for punctures and rim leaks. Use a soap and water solution to check for air leaks around the rim of the tire. Repair or replace the tire as neces-

CTIS Leak Detection Test

1. Start engine and inflate front and rear tires to 40 psi (276 kPa).
2. Turn the tire selector switch to OFF.
3. Turn engine OFF.
4. Remove air vent line located at the air intake horn and listen for air escaping through the vent line.
5. Remove the transmission dipstick from the dipstick tube and listen for air or transmission fluid escaping through the dipstick tube.
6. If air or fluid is detected in steps 4 or 5, inspect the steering arm cover seals using the CTIS leak isolation test.

CTIS Leak Isolation Test

1. Start the engine and inflate front and rear tires to 40 psi (276 kPa).
2. Turn the tire selector switch to OFF.
3. Turn engine OFF.
4. Close (release) all four wheel quick-disconnect valves.
5. Remove the vent line from one geared hub.
6. Open (engage) the quick-disconnect valve at this wheel to allow air pressure from the tire to enter bored passage inside the geared hub.
7. Listen for escaping air around the steering arm seal through the geared hub vent opening.
8. If air is escaping through the vent line fitting, replace the steering arm seal (Section 16).
9. Inspect the other three geared hubs using steps 5, 6, 7, and 8 above.
10. Replace defective seals as required, then retest system.

CTIS Leakdown Testing

NOTE: Suspected air loss in the CTIS after the vehicle has been parked for several days may be attributed to one of the following: improperly seated O-rings, loose air line connection(s), quick-disconnect valve(s) not connected, tire leak(s), faulty valve(s), or a faulty steering arm cover seal. Suspected air leak(s) may be detected using a soap/water solution or equivalent. O-rings that appear to be cut, distorted, or suspected of leaking should be replaced. When traversing off road in extremely muddy terrain, the dust excluder should be inspected for trapped mud.

1. Verify quick-disconnect valves are connected to wheels.
2. Apply parking brake. Start engine and allow to idle.
3. Place tire selector switch to BOTH position and inflate/deflate switch to INFLATE position.
4. Observe air pressure gauges until air pressure reaches 40 psi (276 kPa).
5. Place inflate/deflate switch to OFF position. Stop engine.
6. Record tire pressure on instrument panel gauges and right-rear tire pressure. Compare recorded pressures to readings taken 30 minutes later, If more than one (1) pound has leaked, check system as described above to detect where the leak is located.

COMPRESSOR SERVICE

WARNING: CTIS components are subject to high air pressure. Always relieve air pressure before loosening or removing air system components by disconnecting quick-disconnect valve assemblies. Failure to follow this warning may result in serious injury.

Removal

1. Raise and secure hood.
2. Disconnect leads from compressor (Figure 6-56).
3. Loosen clamp securing air intake hose to fitting and disconnect hose from fitting.
4. Disconnect push connector and tube from street tee at compressor.
5. Loosen two clamps securing compressor to bracket and remove compressor.
6. Remove street tee from compressor.
7. Remove four locknuts, upper brackets, clamps, and four isolators from lower brackets. Discard locknuts.

Cleaning and Inspection

Clean and inspect compressor, leads, fittings, and mounting hardware. Check for cracks, frayed wire, stripped threads, and improper operation. Replace defective parts.

Installation

1. Install four isolators, two upper brackets, and clamps to lower bracket with four locknuts (Figure 6-56).
2. Install hose to quick release fitting to compressor. Use silicone lubricant.

CAUTION: *Do not allow sealant into air system. Sealant will damage CTIS components.*

NOTE: Apply sealant to all threads before installation.

3. Install compressor on bracket with two clamps.
4. Connect compressor-to-air manifold tube to quick release fitting.
5. Connect air intake hose to fitting and secure with hose clamp.
6. Connect leads to compressor.
7. Lower and secure hood.
8. Check for correct operation.
9. Check for leaks.

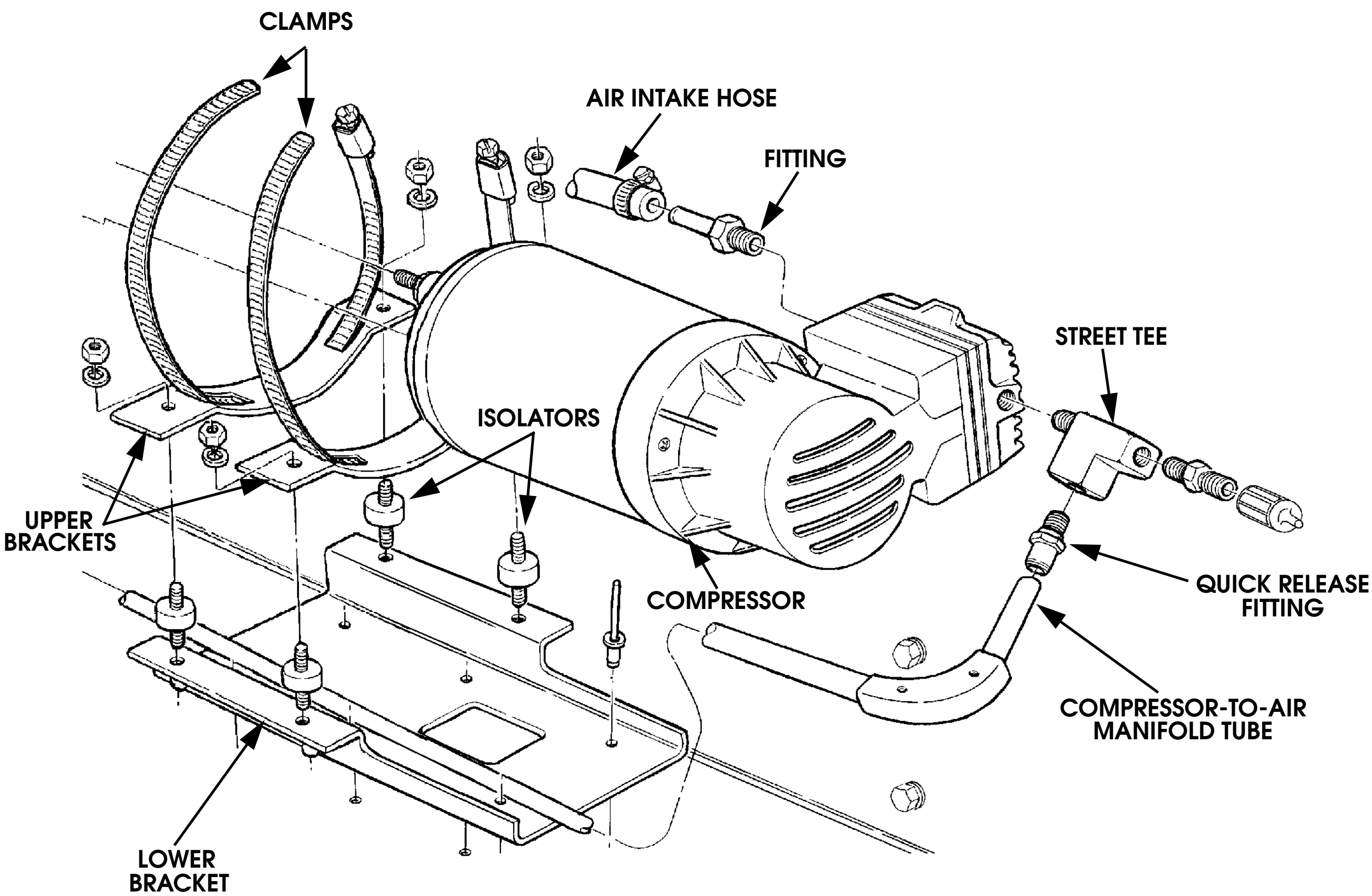


Figure 6-56: CTIS Compressor

CTIS INSTRUMENT CLUSTER

WARNING: CTIS components are subject to high air pressure. Always relieve air pressure before loosening or removing air system components by disconnecting quick-disconnect valve assemblies. Failure to follow this warning may result in serious injury.

NOTE: Prior to removal, tag all leads for installation.

Removal

1. Remove screws and CTIS instrument cluster from instrument panel. Discard CTIS instrument cluster if damaged. (Figure 6-57).

Disassembly

1. Remove inflate/deflate switch and tire selector switch.
2. Remove compressor/pressure indicator light.
3. Remove air pressure gauge.

Assembly

1. Install air pressure gauge.
2. Install compressor/pressure indicator light.
3. Install inflate/deflate switch.

Installation

1. Secure CTIS instrument cluster to instrument panel with screws (Figure 6-57).

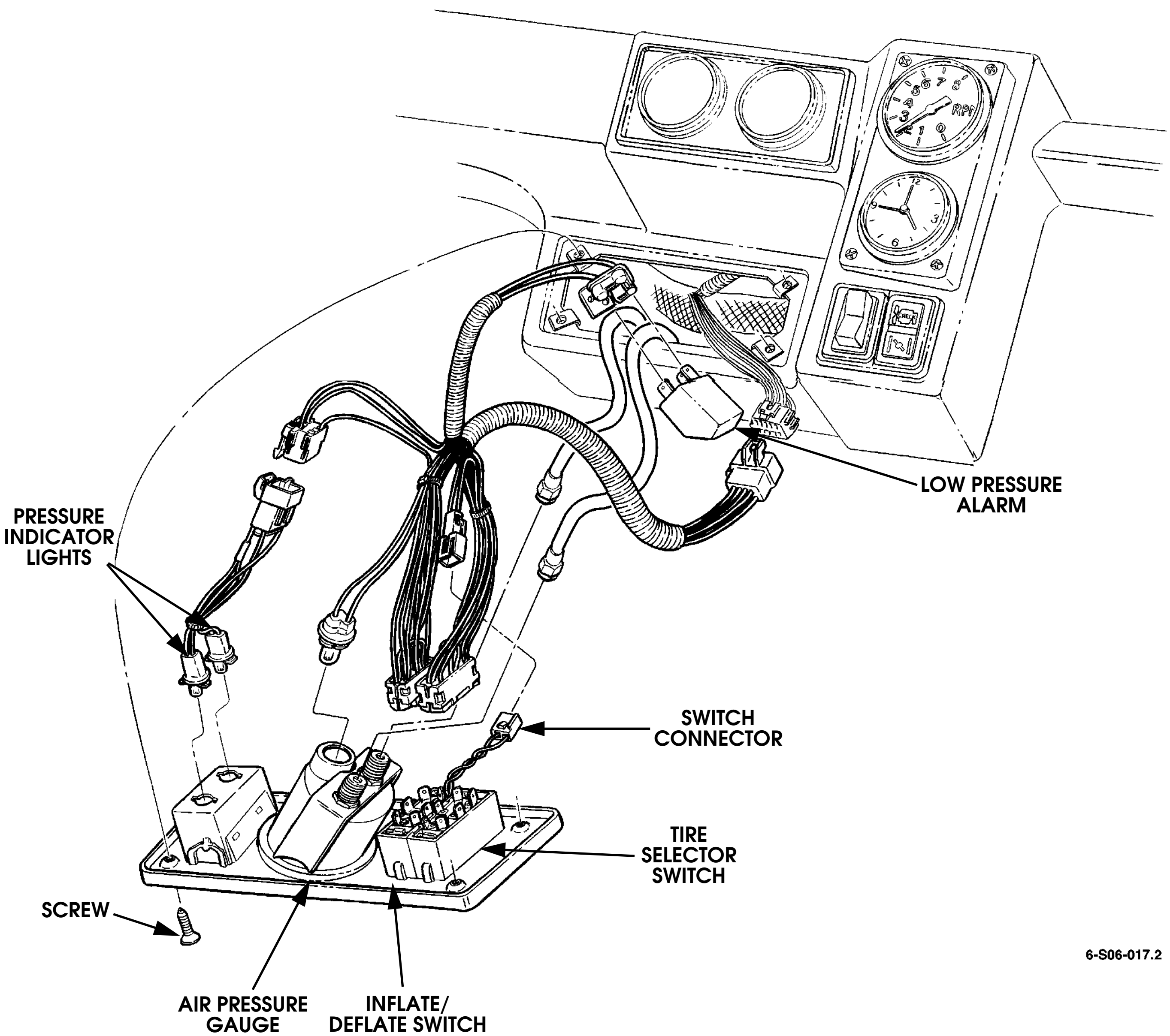


Figure 6-57: CTIS Instrument Cluster Appearance (Viewed from Behind)

INFLATE/DEFLATE AND TIRE SELECTOR SWITCHES

Removal

1. Remove CTIS instrument cluster.
2. Disconnect connector from inflate/deflate switch and tire selector switch (Figures 6-57 and 6-58).
3. Remove two lamp assemblies from compressor/pressure indicator light.
4. Remove inflate/deflate and tire selector switches from CTIS instrument cluster and housing.

Cleaning and Inspection

Clean and inspect inflate/deflate switch and lamp assemblies for damage. Replace defective parts.

Installation

1. Install inflate/deflate and tire selector switches in housing on CTIS instrument cluster (Figure 6-58).
2. Install two lamp assemblies in compressor/pressure indicator light.
3. Connect connector to switches.
4. Install CTIS instrument cluster.
5. Start engine and ensure lamp and switches operate properly.

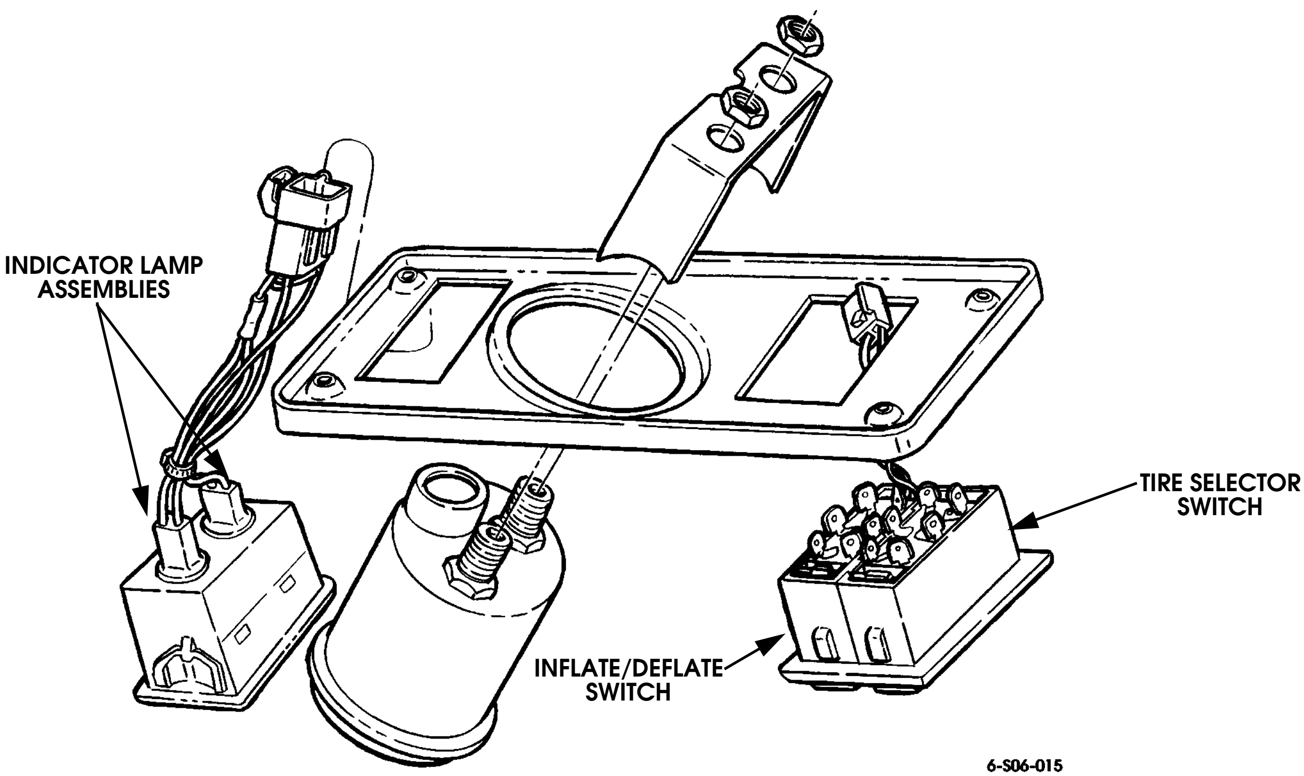


Figure 6-58: Inflate/Deflate Switch, Tire Selector Switch and Indicator Lights

COMPRESSOR/LOW PRESSURE INDICATOR LIGHTS

Removal

1. Remove CTIS instrument cluster.
2. Remove lamp assemblies from compressor/pressure indicator light (Figure 6-59).
3. Turn lamp one quarter turn, and remove lamps from sockets.

Cleaning and Inspection

Clean and inspect indicator lamps for damage. Replace defective parts.

Installation

1. Install lamps in sockets and turn one quarter turn (Figure 6-59).
2. Install lamp assemblies in compressor/pressure indicator light.
3. Install CTIS instrument cluster.
4. Start engine, and ensure lamp and switch operate properly.

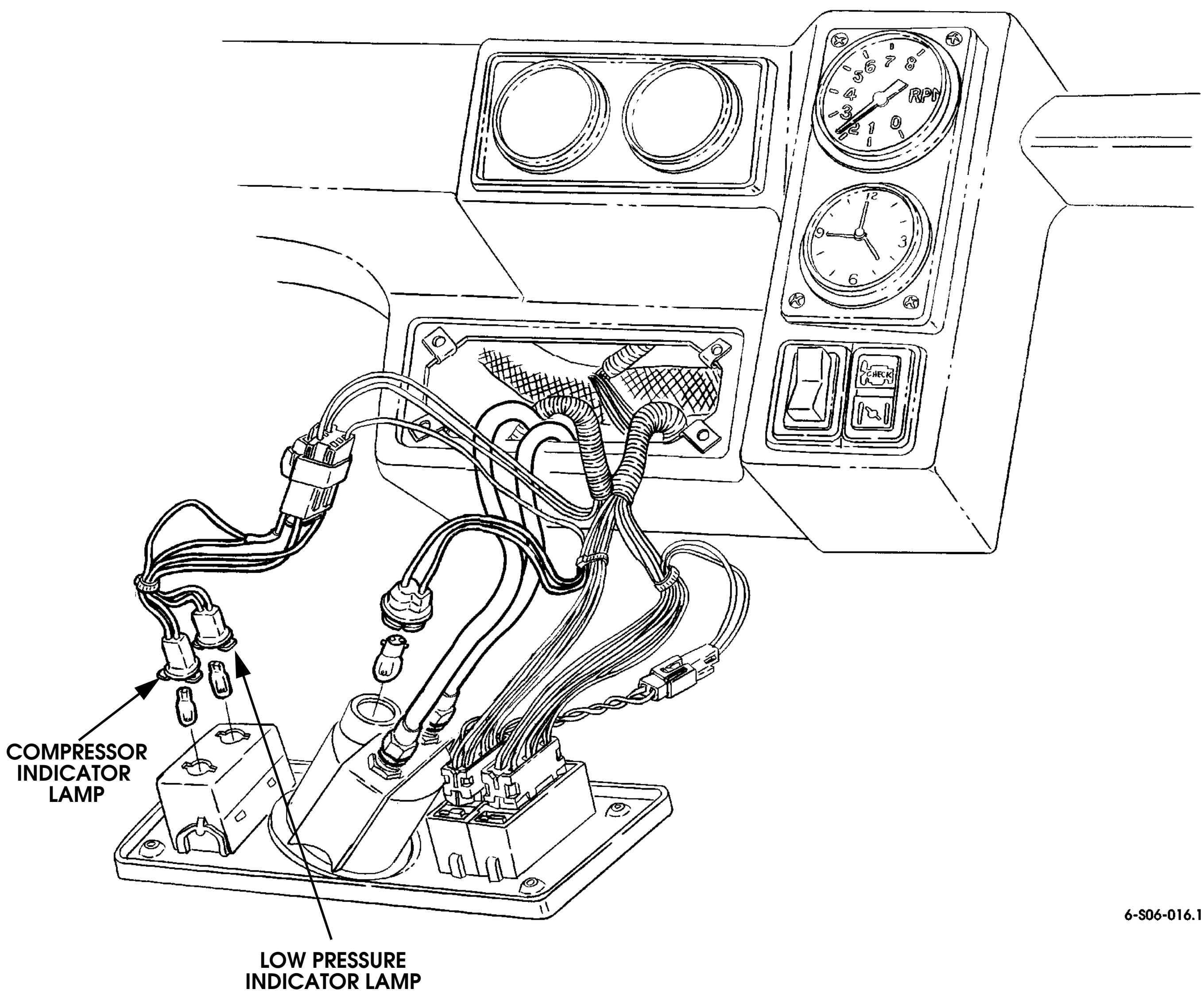


Figure 6-59: Compressor/Low Pressure Indicator Lights

AIR PRESSURE GAUGE

WARNING: CTIS components are subject to high air pressure. Always relieve air pressure before loosening or removing air system components by disconnecting quick-disconnect valve assemblies. Failure to follow this warning may result in serious injury.

Removal

1. Remove CTIS instrument cluster.
2. Remove lamp from air pressure gauge (Figure 6-60).
3. Disconnect two air pressure indicator lines from air pressure gauge.
4. Remove two nuts, lockwashers, air pressure gauge, and bracket from CTIS instrument cluster (Figure 6-60). Discard lockwashers.

Cleaning and Inspection

Clean and inspect air pressure gauge and lamp. Check for cracks and stripped threads. Replace defective parts.

CAUTION: *Do not allow sealant into air system. Sealant will damage CTIS components.*

NOTE: Apply sealant to threads prior to installation.

Installation

1. Install air pressure gauge and bracket on CTIS instrument cluster with two nuts and lockwashers. Tighten nuts to 8 lb-in. (0.9 N•m) (Figure 6-60).
2. Connect two air pressure indicator lines to air pressure gauge.
3. Install lamp in air pressure gauge.
4. Install CTIS instrument cluster.
5. Start engine and ensure air pressure gauge operates properly.

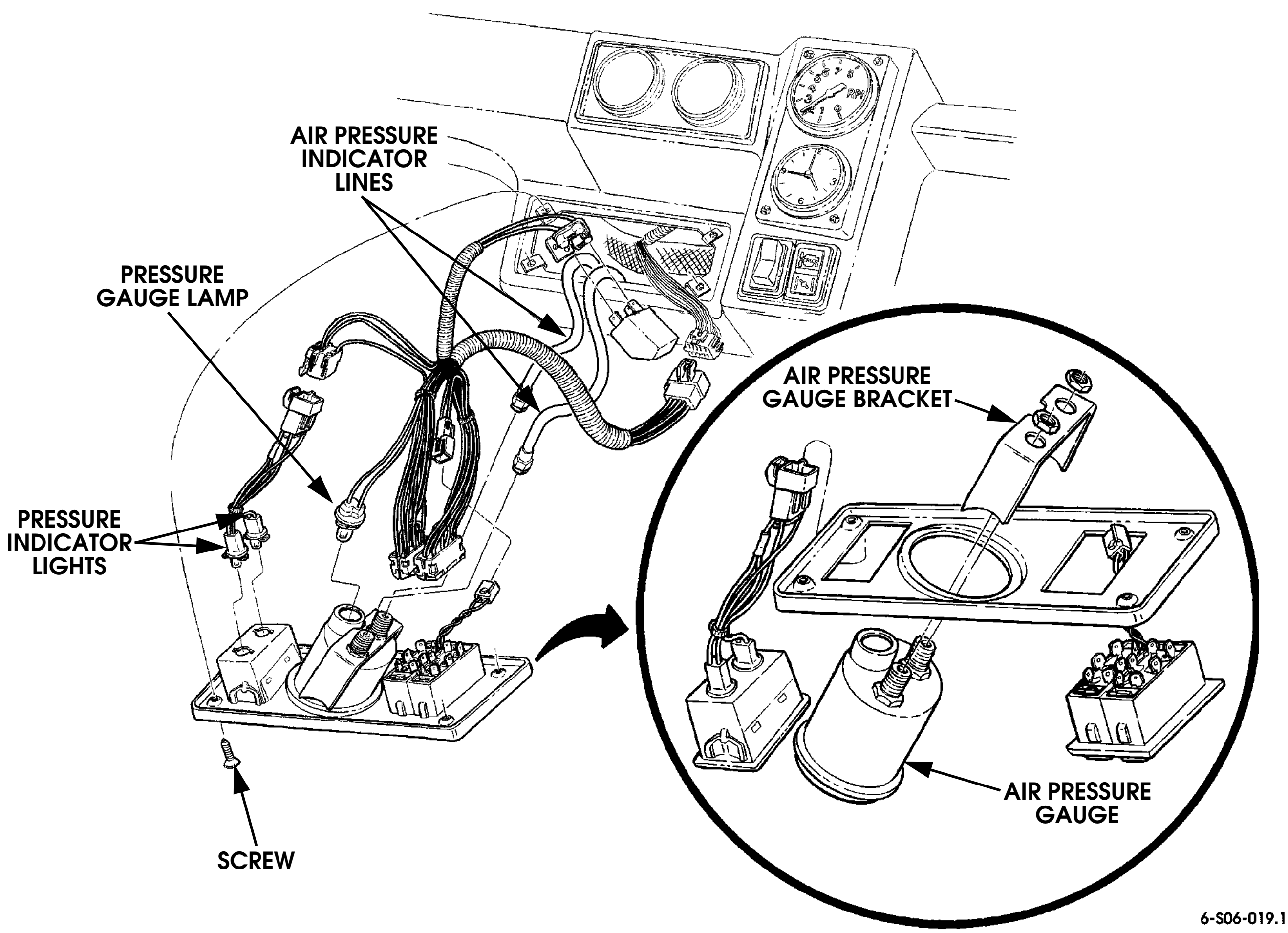


Figure 6-60: Air Pressure Gauge

AIR PRESSURE GAUGE LAMP REPLACEMENT

Removal

1. Remove CTIS instrument cluster.
2. Remove lamp from air pressure gauge (Figure 6-61).
3. Remove lamp from socket. Discard lamp if defective.

Installation

1. Install lamp in socket (Figure 6-60).
2. Install lamp in air pressure gauge.
3. Install CTIS instrument cluster.
4. Start engine and ensure air pressure gauge lamp operates properly.

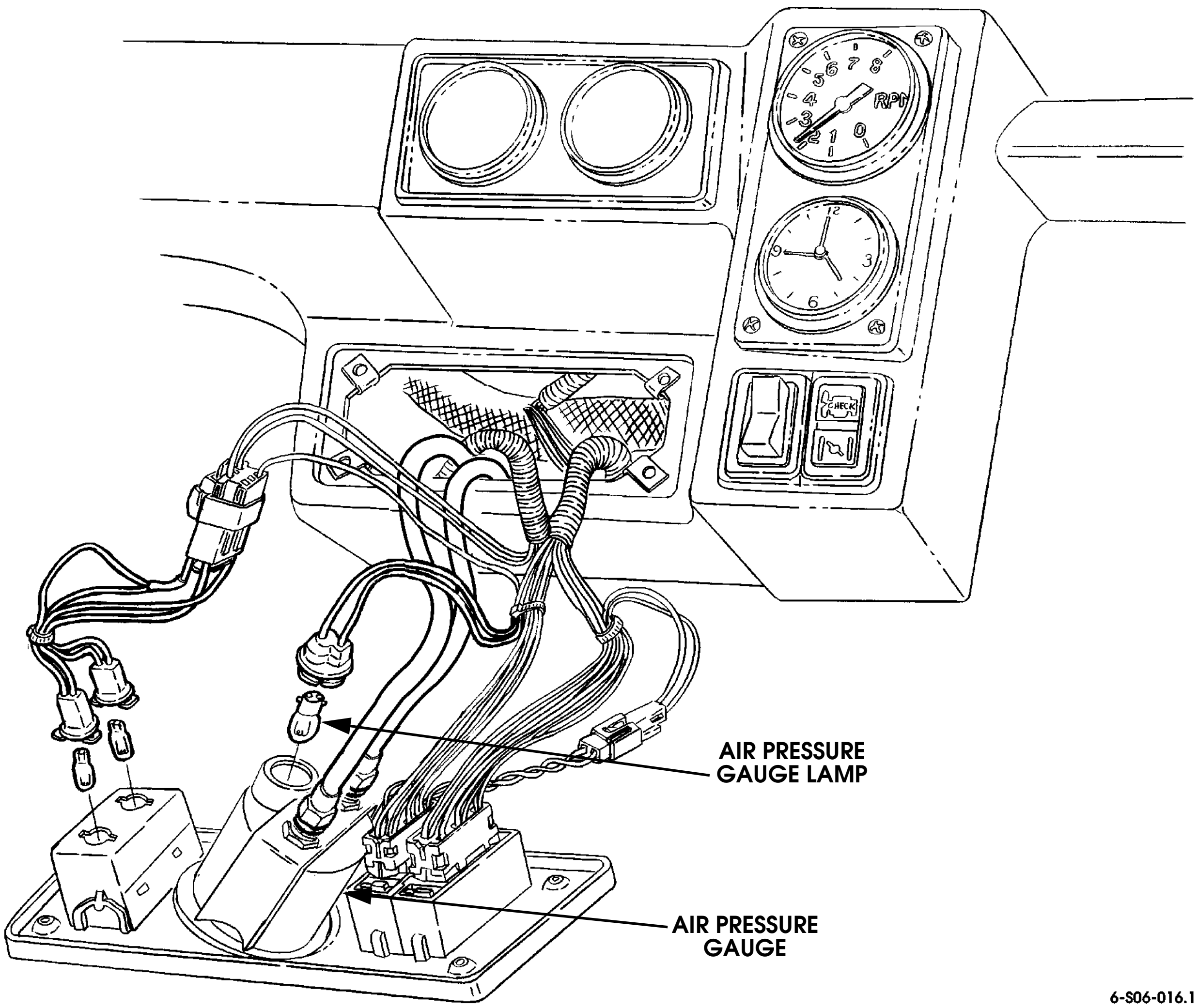


Figure 6-61: Air Pressure Gauge Lamp

CTIS LOW PRESSURE ALARM REPLACEMENT

Removal

1. Remove CTIS instrument cluster.
2. Remove low pressure alarm from connector (Figure 6-62).

Installation

1. Install low pressure alarm on connector
2. Install CTIS instrument cluster (Figure 6-62).

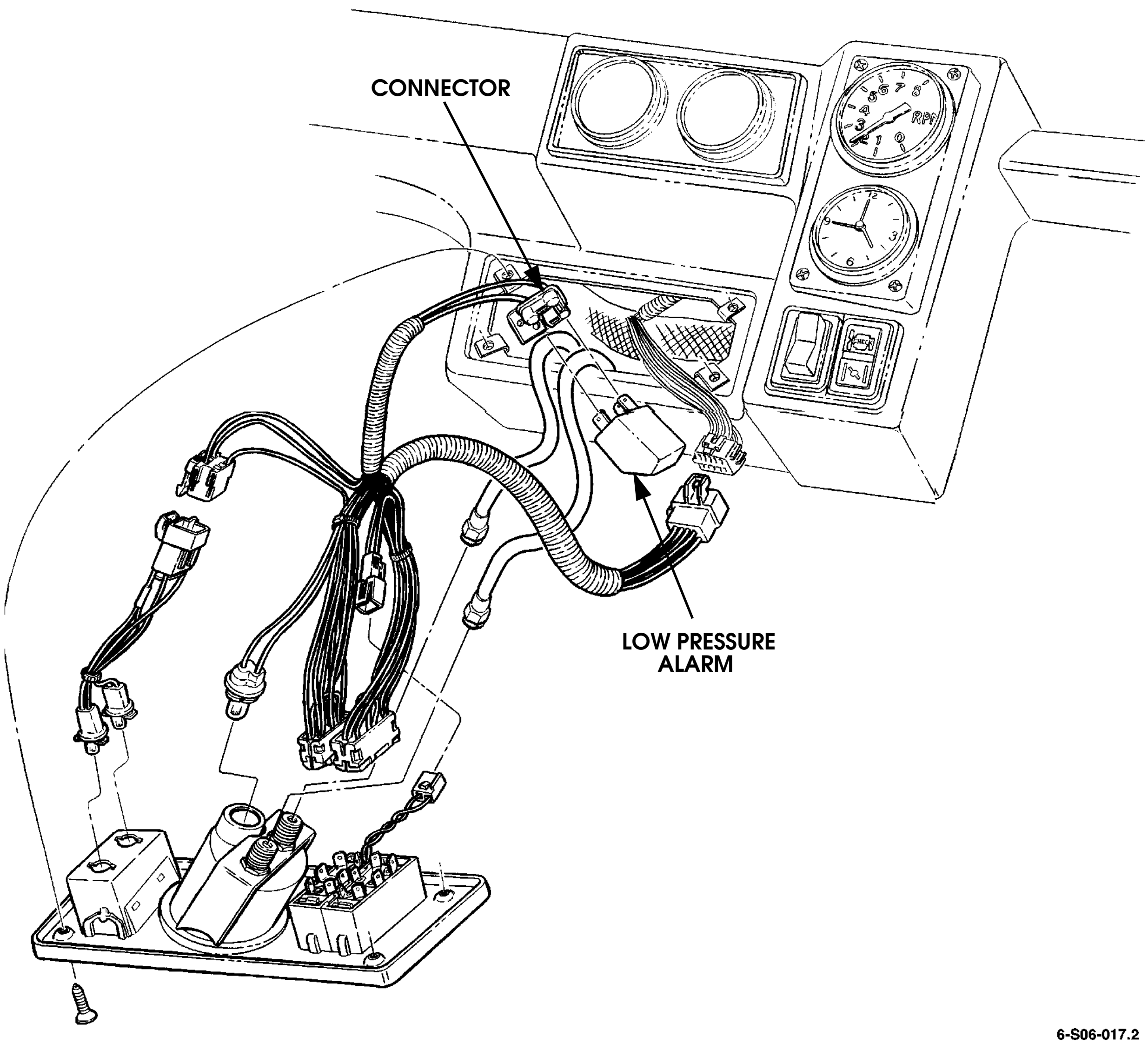


Figure 6-62: Low Pressure Alarm Location

CTIS INTERIOR HARNESS

NOTE: Prior to removal, tag all leads for installation.

Removal

1. Remove CTIS instrument cluster.
2. Disconnect connector from inflate/deflate and tire selector switches (Figure 6-63).
3. Remove two lamp assemblies from compressor/pressure indicator light.
4. Remove lamp from air pressure gauge.
5. Remove low pressure alarm.
6. Disconnect harness connector from body harness connector and remove interior harness.

Cleaning and Inspection

Clean and inspect CTIS harness and connectors. Check for defects such as frayed wires and cracks. Repair or replace defective parts.

Installation

1. Position interior harness in approximate mounting location and connect harness connector to body harness connector (Figure 6-63).
2. Install low pressure alarm on flasher connector.
3. Install lamp in air pressure gauge.
4. Install two lamp assemblies to compressor/pressure indicator light.
5. Connect connector to inflate/deflate and tire selector switches.
6. Install CTIS instrument cluster.

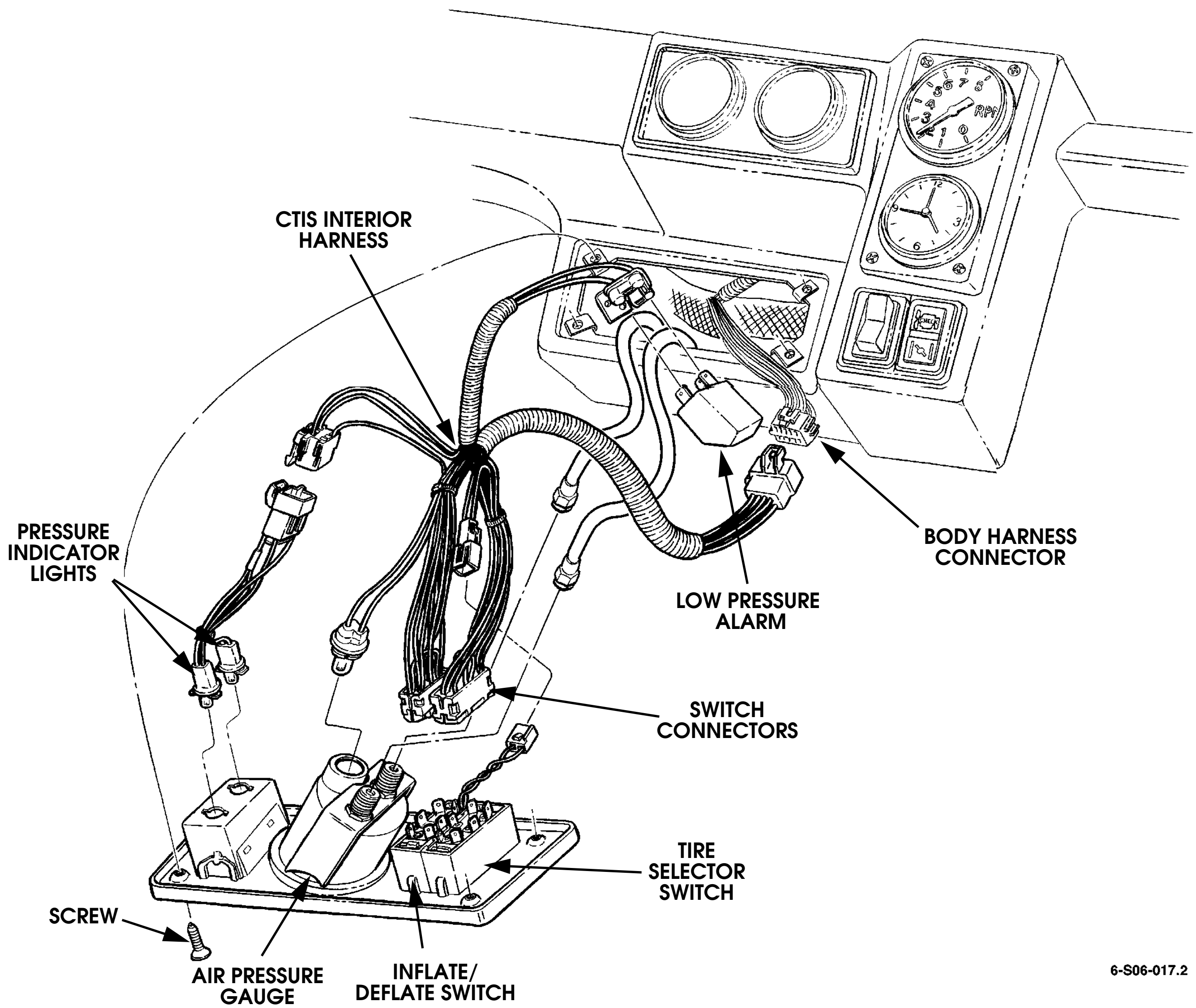


Figure 6-63: CTIS Interior Harness Appearance

AIR PRESSURE SWITCH REPLACEMENT

WARNING: CTIS components are subject to high air pressure. Always relieve air pressure before loosening or removing air system components by disconnecting quick-disconnect valve assemblies. Failure to follow this warning may result in serious injury.

NOTE: Front and rear air pressure switches are replaced similarly.

Removal

1. Disconnect harness leads from air pressure switch.
2. Remove air pressure switch from manifold.

CAUTION: *Do not allow sealant into air system. Sealant will damage CTIS components.*

Installation

1. Apply sealant to threads and screw air pressure switch into manifold.
2. Connect harness leads to air pressure switch.

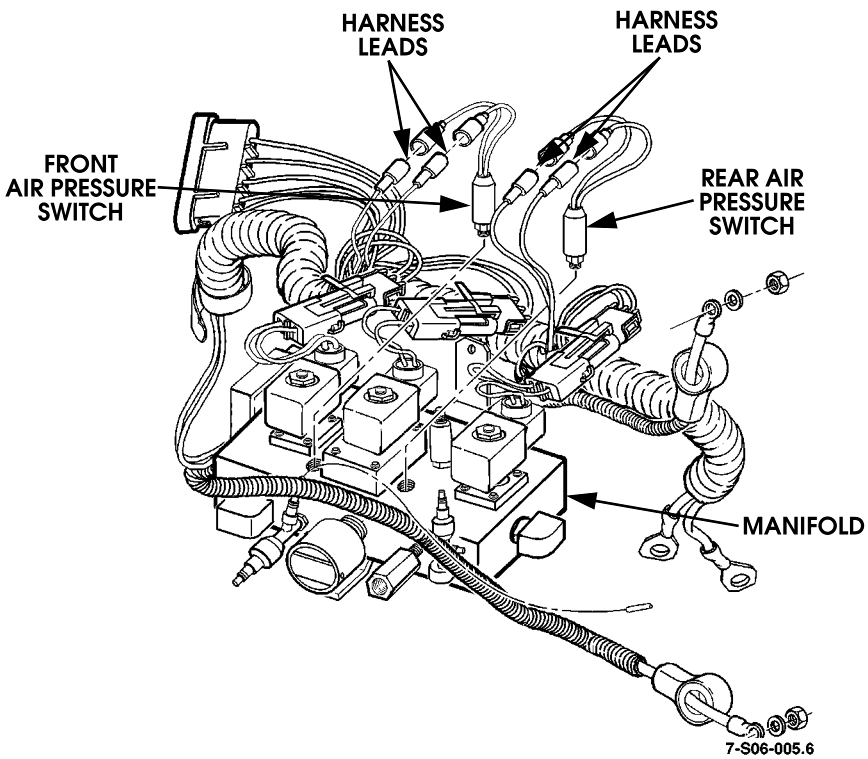


Figure 6-64: Air Pressure Switch Locations

AIR PRESSURE INDICATOR LINES REPLACEMENT

WARNING: CTIS components are subject to high air pressure. Always relieve air pressure before loosening or removing air system components by disconnecting quick-disconnect valve assemblies. Failure to follow this warning may result in serious injury.

Removal

NOTE: Replacement procedures for the front and rear air pressure indicator lines are basically the same. This procedure covers the front air pressure indicator line.

1. Remove CTIS instrument cluster.
2. Disconnect air pressure indicator lines from air pressure gauge (Figure 6-65).

CAUTION: *Do not allow sealant into air system. Sealant will damage CTIS components.*

NOTE: Apply sealant to threads prior to installation.

Installation

1. Connect air pressure indicator lines to air pressure gauge (Figure 6-65).
2. Install CTIS instrument cluster.

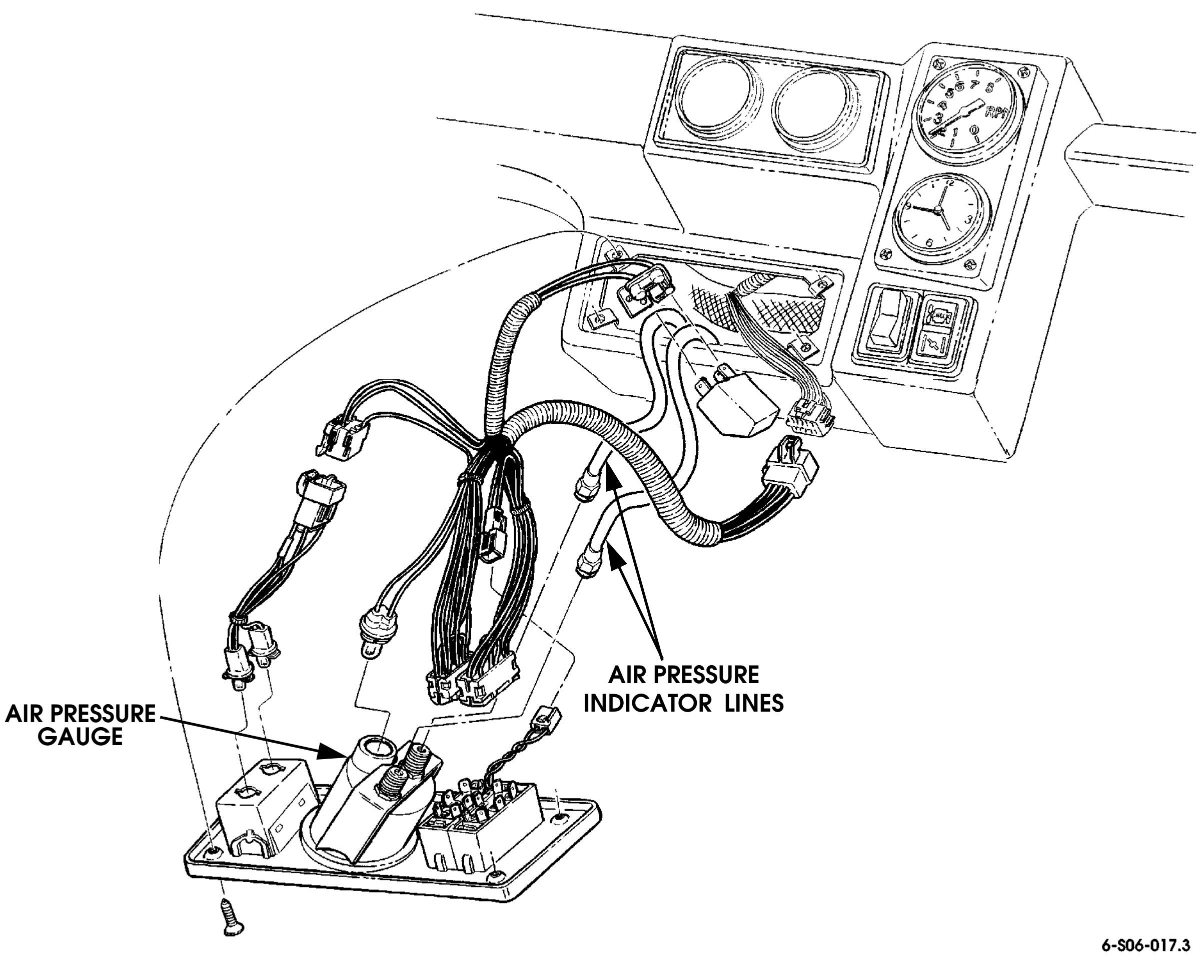


Figure 6-65: Front Air Pressure Indicator Line

CTIS HARNESS SERVICE

NOTE: Prior to removal, tag all leads for installation.

Removal

1. Raise and secure hood.
2. Disconnect battery ground cable (Section 12).
3. Remove two nuts, red lead, and black lead from power/ground stud (Figure 6-66).
4. Remove plastic cover from fuse housing.
5. Remove two screws, yellow lead, and red lead from fuse housing.
6. Disconnect CTIS-to-main body harness connector.
7. Disconnect connector from relay.
8. Disconnect four leads from pressure switches.
9. Disconnect deflate valve electrical connector.
10. Disconnect front inflate valve electrical connector.
11. Disconnect rear inflate valve electrical connector.
12. Slide two boots off compressor terminals.
13. Remove two nuts and leads from compressor and remove harness from vehicle.

Inspection

Inspect CTIS leads, connectors, and wiring. Check for cracks, shorts, and frayed wires. Replace defective parts.

Installation

1. Position harness in approximate mounting location on vehicle.
2. Install two leads on compressor with nuts and slide two boots over terminals (Figure 6-66).
3. Connect rear inflate valve electrical connector.
4. Connect front inflate valve electrical connector.
5. Connect deflate valve electrical connector.
6. Connect four leads to pressure switches.
7. Connect connector to relay.
8. Connect CTIS-to-main body harness connector.
9. Secure yellow lead and red lead to fuse with two screws.
10. Install plastic cover on fuse housing.
11. Connect black and red leads to power/ground stud.
12. Connect battery ground cable (Section 12).
13. Lower and secure hood.

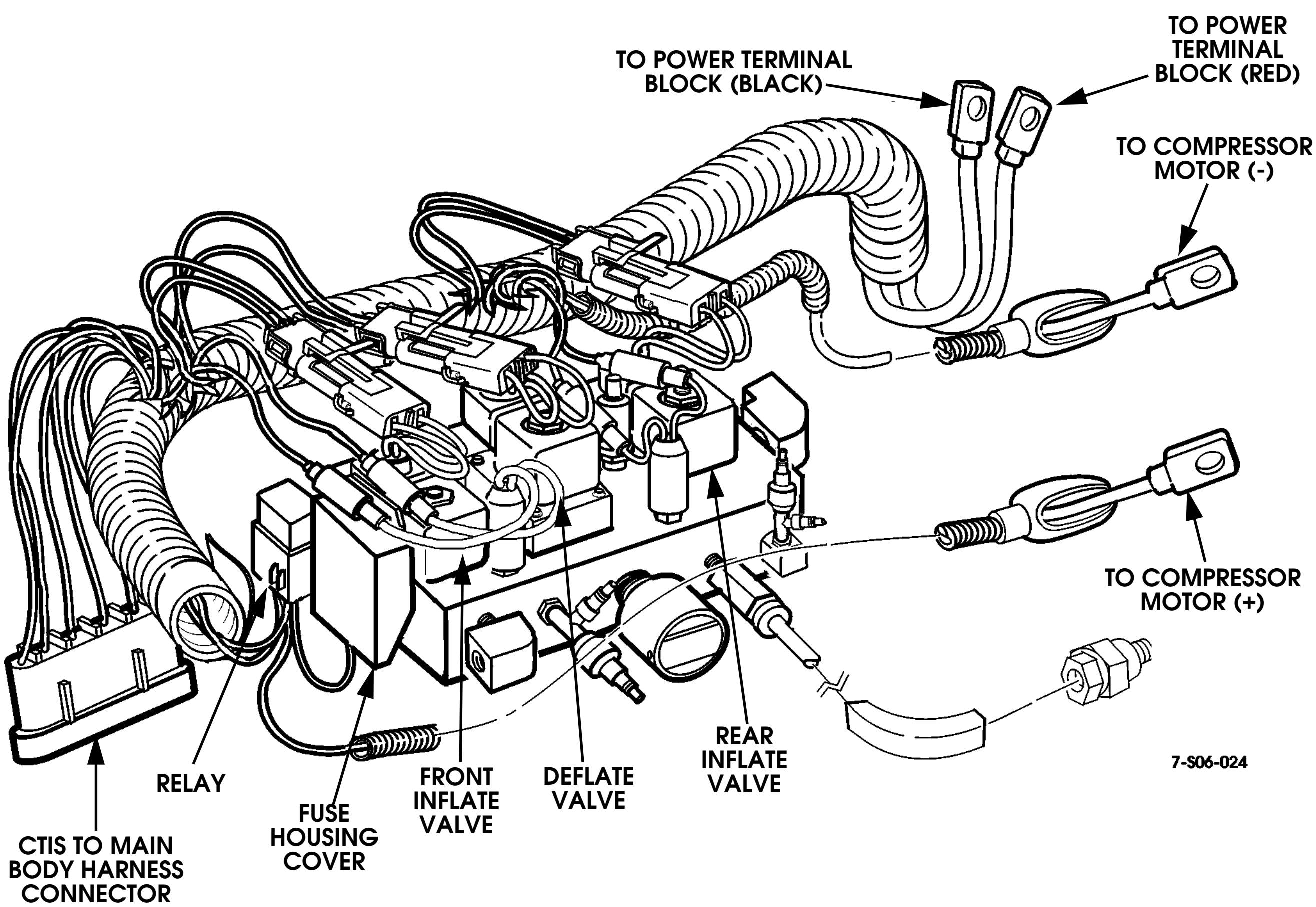


Figure 6-66: CTIS Exterior Harness Assembly

CTIS COMPRESSOR FUSE REPLACEMENT

NOTE: Prior to removal, tag all leads for installation.

Removal

1. Raise and secure hood.
2. Disconnect battery ground cable (Section 12).
3. Remove plastic cover from fuse housing (Figure 6-67).
4. Remove two screws and leads from fuse housing.
5. Remove fuse from housing.

Inspection

Inspect CTIS leads, connectors, and wiring. Check for cracks, shorts, and frayed wires. Replace defective parts.

Installation

1. Install fuse in housing (Figure 6-67).
2. Install two leads on fuse housing with screws.
3. Install plastic cover on fuse housing.
4. Connect battery ground cable (Section 12).
5. Lower and secure hood.

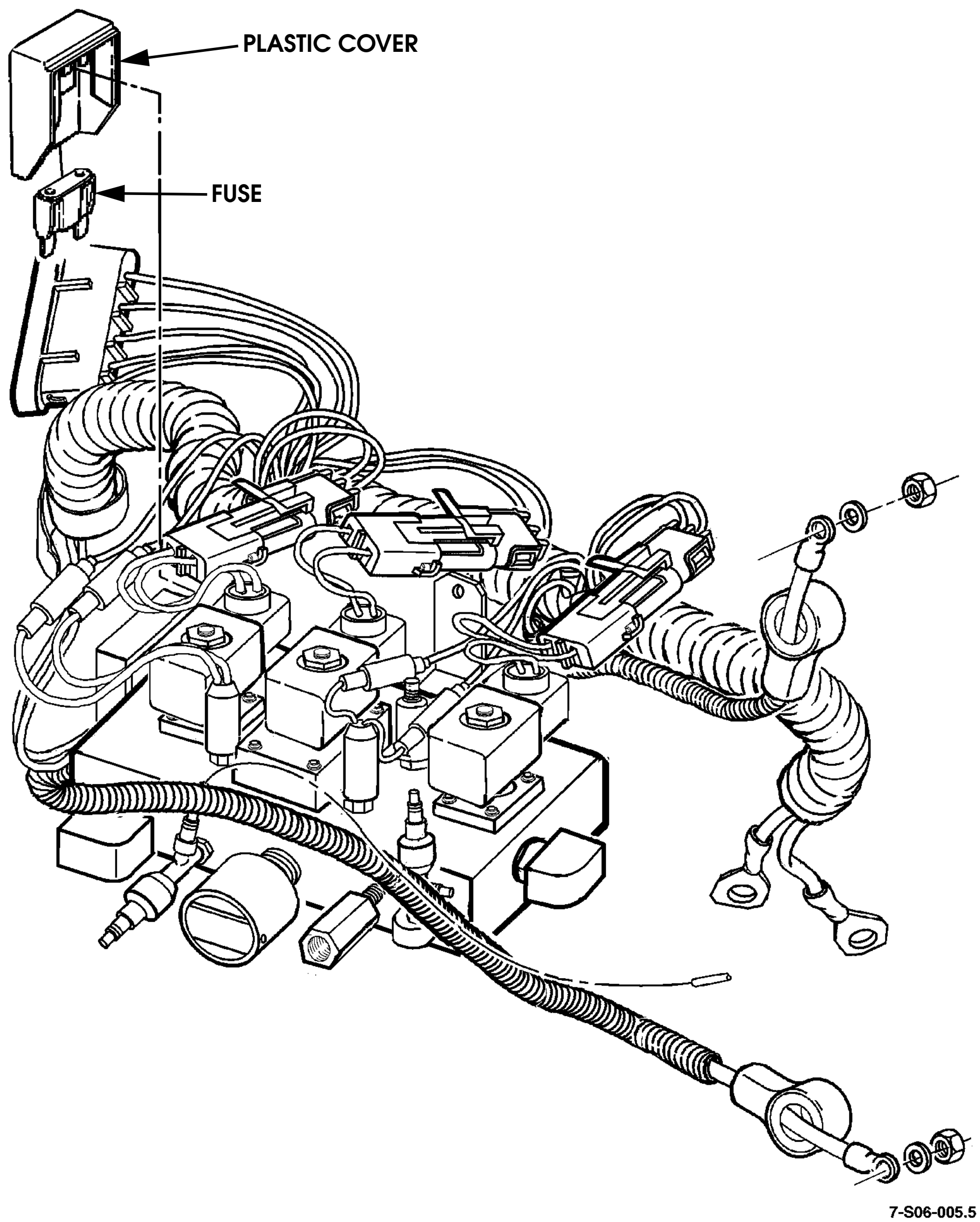


Figure 6-67: CTIS Compressor Fuse Location

CTIS COMPRESSOR RELAY REPLACEMENT

NOTE: Prior to removal, tag all leads for installation.

Removal

1. Raise and secure hood.
2. Disconnect electrical connector from relay (Figure 6-68).
3. Remove locknut, screw, and relay from bracket. Discard locknut.

Inspection

Inspect CTIS leads, connectors, and wiring. Check for cracks, shorts, and frayed wires. Replace defective parts.

Installation

1. Install relay on bracket with screw and new locknut (Figure 6-68).
2. Connect electrical connector to relay.
3. Lower and secure hood.

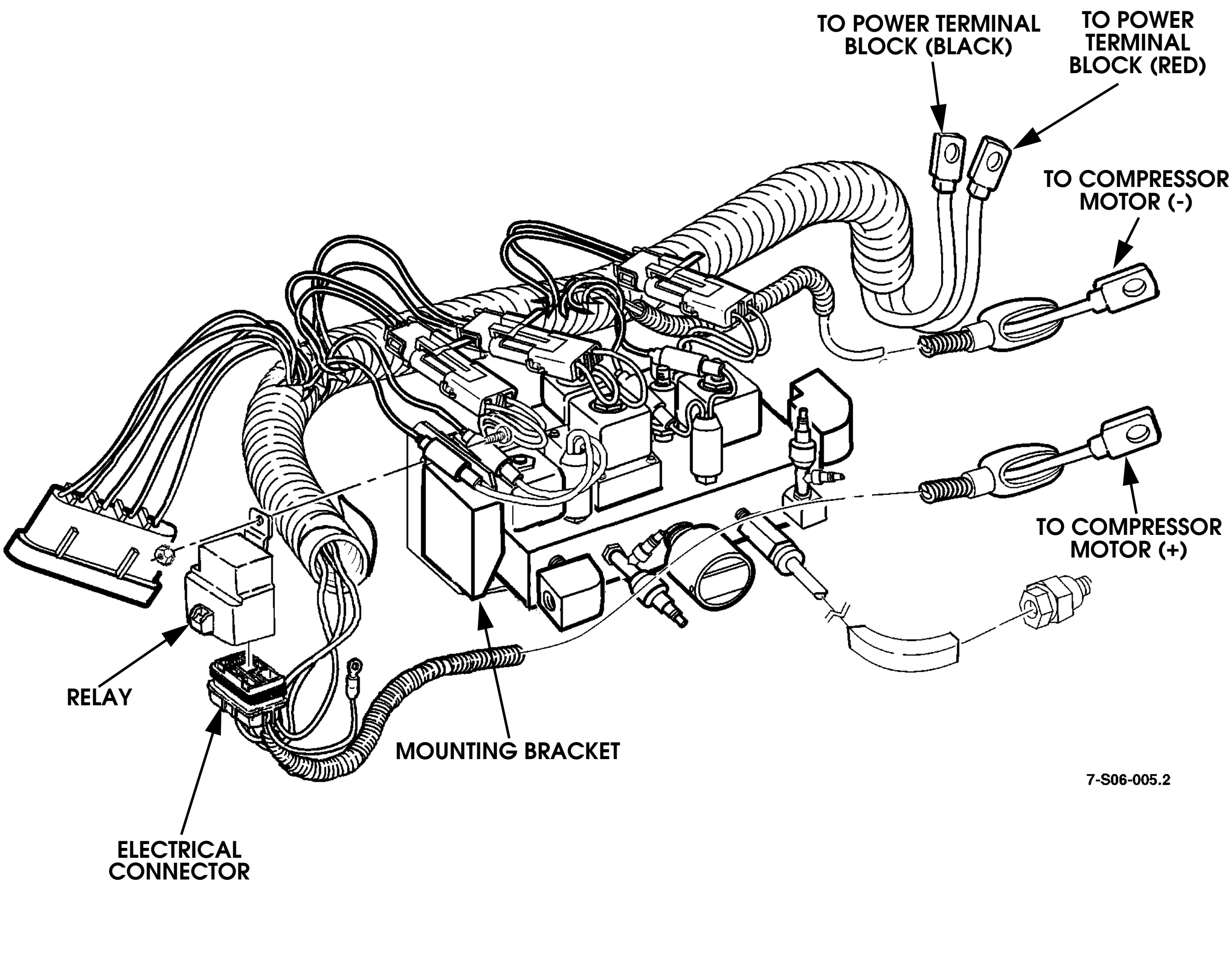


Figure 6-68: CTIS Compressor Relay Mounting

DEFLATE VALVE ASSEMBLY REPLACEMENT

WARNING: CTIS components are subject to high air pressure. Always relieve air pressure before loosening or removing air system components by disconnecting quick-disconnect valve assemblies. Failure to follow this warning may result in serious injury.

Removal

1. Raise and secure hood.
2. Disconnect deflate valve electrical connector (Figure 6-69).
3. Remove screws and deflate valve from manifold.

Cleaning and Inspection

Clean and inspect deflate valve and bracket. Check for cracks and stripped threads. Replace if defective.

Installation

CAUTION: *Do not allow sealant into air system. Sealant will damage CTIS components.*

NOTE: Apply sealant to threads prior to installation.

1. Secure deflate valve to manifold with screws (Figure 6-69).
2. Connect deflate valve electrical connector.
3. Lower and secure hood.

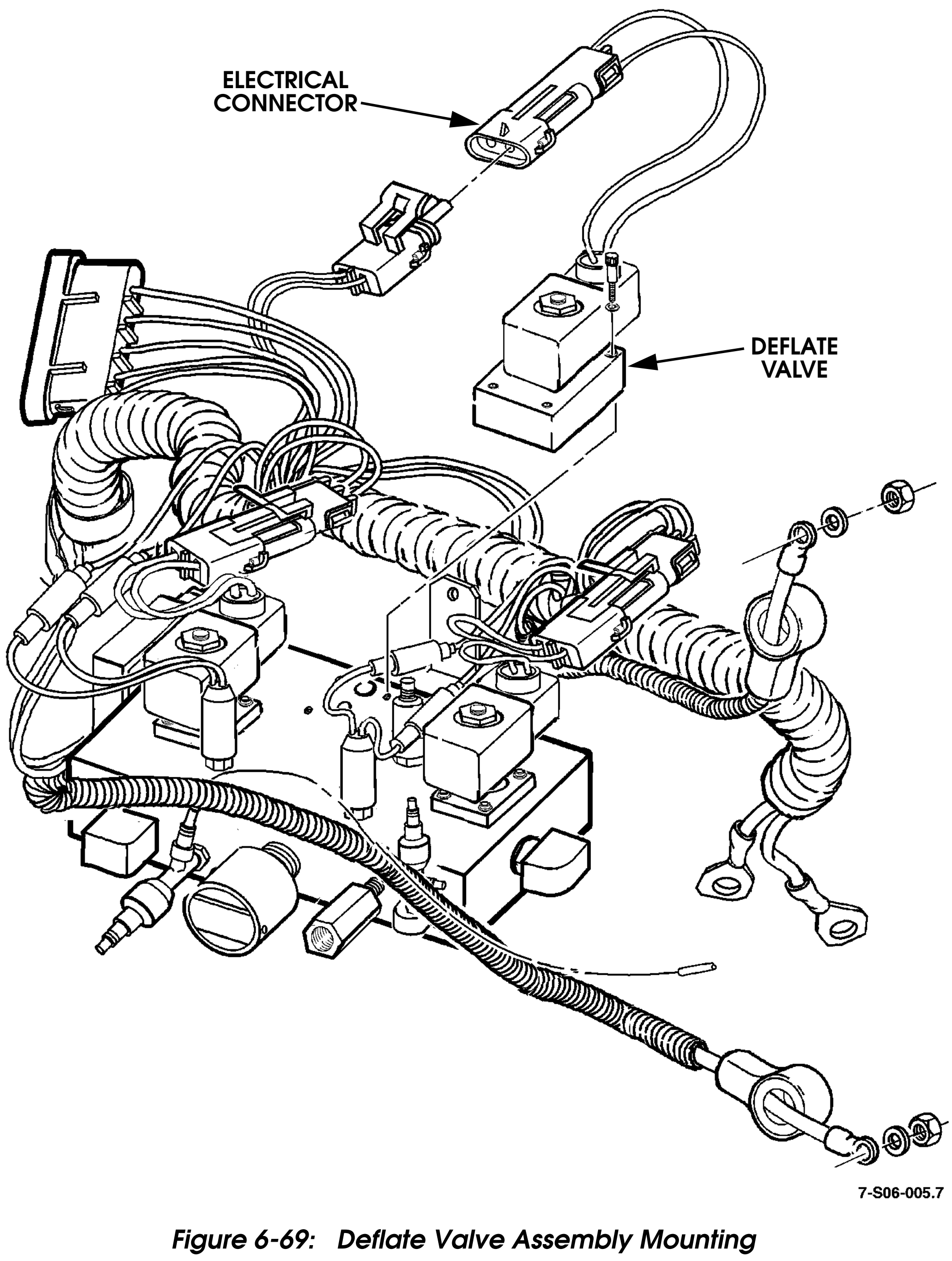


Figure 6-69: Deflate Valve Assembly Mounting

DUST EXCLUDER REPLACEMENT

WARNING: CTIS components are subject to high air pressure. Always relieve air pressure before loosening or removing air system components by disconnecting quick-disconnect valve assemblies. Failure to follow this warning may result in serious injury.

Removal

1. Raise and secure hood.
2. Remove dust excluder from deflate valve (Figure 6-70).

Cleaning and Inspection

Clean and inspect dust excluder. Check for cracks and stripped threads. Replace if defective.

Installation

CAUTION: *Do not allow sealant into air system. Sealant will damage CTIS components.*

NOTE: Apply sealant to threads prior to installation.

1. Install dust excluder on deflate valve (Figure 6-70).
2. Lower and secure hood.

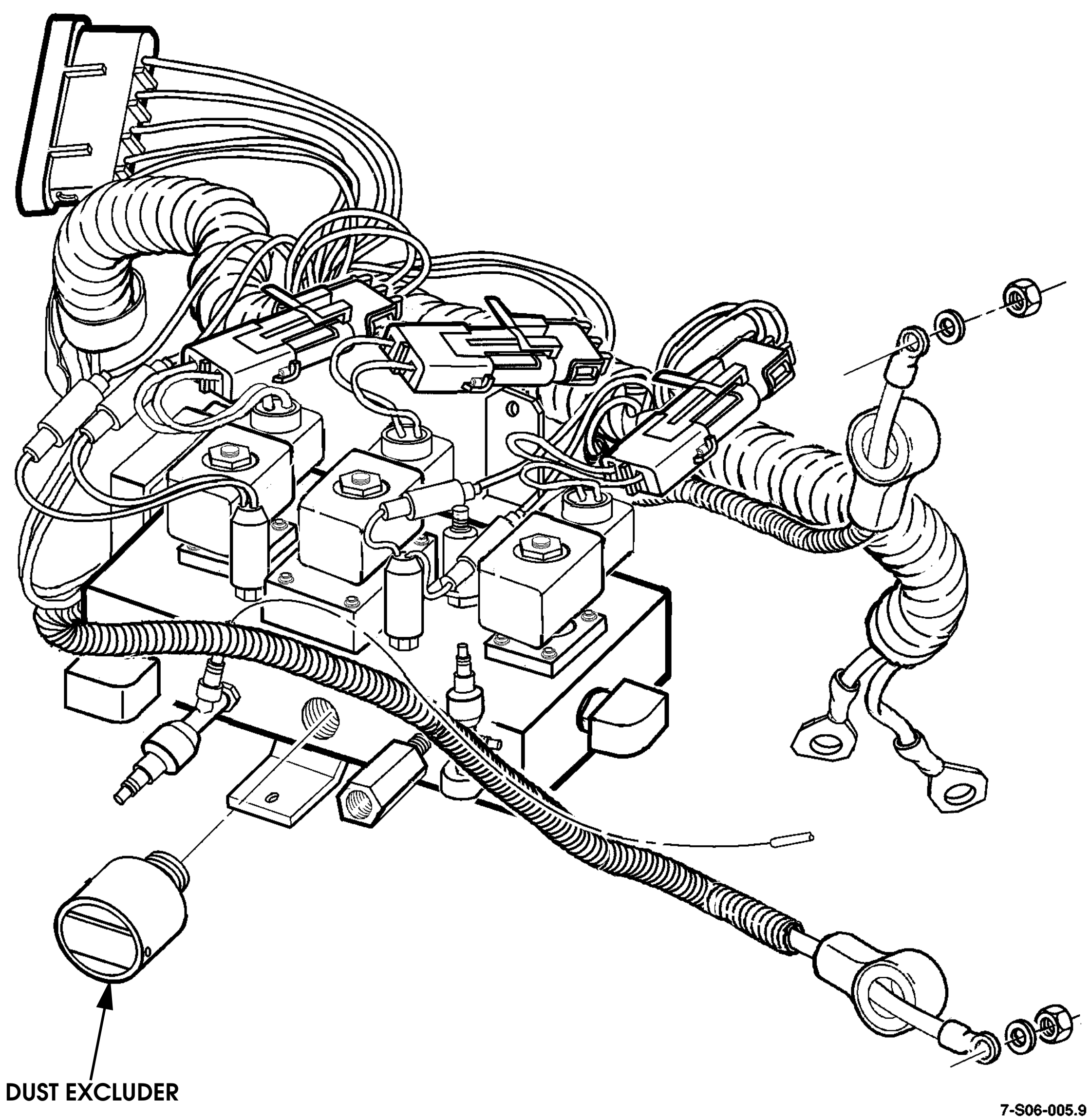


Figure 6-70: Dust Excluder Location

FRONT SUPPLY TUBE AND HOSE REPLACEMENT

WARNING: CTIS components are subject to moderately high air pressure. Always relieve air pressure before loosening or removing air system components by disconnecting quick-disconnect valve assemblies. Failure to follow this warning may result in serious injury.

The HUMMER CTIS uses rubber hoses, nylon tubing, and reinforced (braided) lines. Damaged portions of any air line type should be removed, discarded, and replaced with a new section. Leaks in air lines usually develop where there is constant rubbing or friction against another component, existing air lines, fasteners, frame rail, or air line clamp. Such leaks are usually small and difficult to detect unless adequate air pressure of approximately 20-30 psi (138-207 kPa) is in the line. If a leak is suspected, apply soap suds to the affected area for easier detection and replace damaged section.

CTIS SUPPLY LINE REPLACEMENT

1. Disconnect supply line at pump/valve assembly (Figure 6-71).
2. Disconnect supply hose at T-fitting secured to front frame crossmember (Figure 6-72).
3. Remove tie straps securing hose.
4. Work line out from under vehicle rather than through engine compartment.
5. Tape ends of new hose to prevent dirt entry.
6. Work line up to pump/valve assembly from underneath.
7. Remove tape from hose ends and connect hose to T-fitting and pump/valve assembly.
8. Make sure line is clear of suspension and engine components.

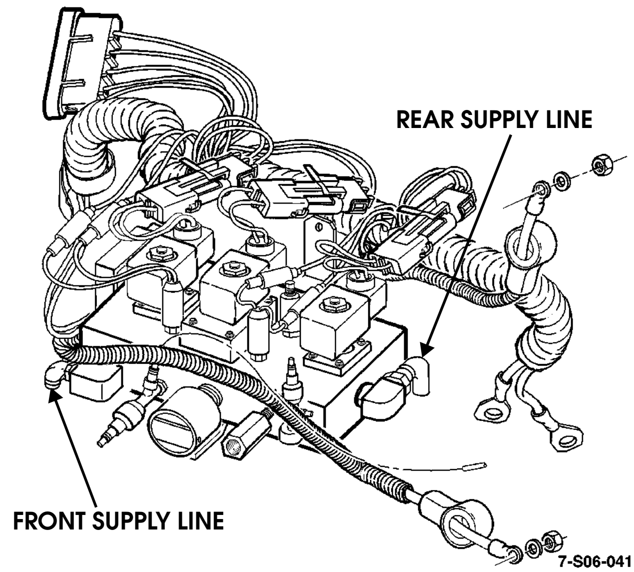


Figure 6-71: Front and Rear Supply Line Connections

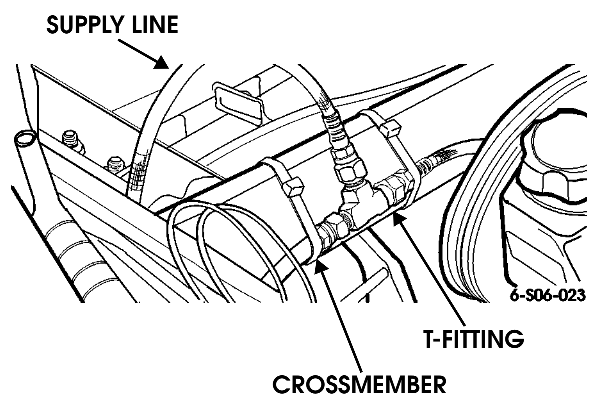


Figure 6-72: Supply Hose Connection

FRONT CTI LINE REPLACEMENT

1. Disconnect line at front hub (Figure 6-73).
2. Loosen clamp on bracket attached to lower control arm, then move air line out of bracket (Figure 6-74).
3. Disconnect front air line at T-fitting secured to front crossmember.
4. Cut tie straps and remove front air line.
5. Tape ends of new line to prevent dirt entry. Then route line to front wheel and T-fittings.
6. Secure hose to fittings and in clamp on lower control arm bracket.
7. Install tie straps as needed.

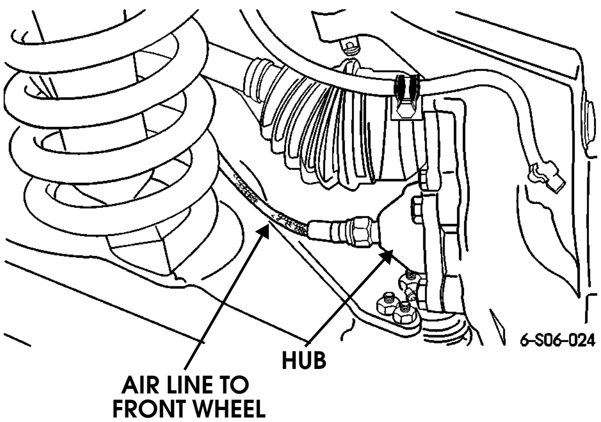


Figure 6-73: Line Connection to Hub

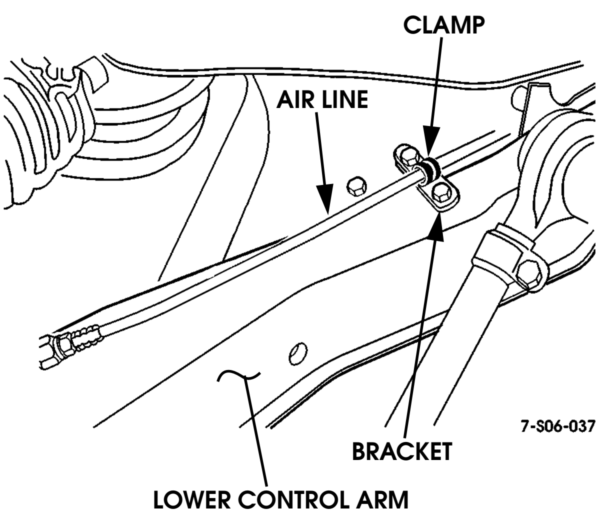


Figure 6-74: Line Bracket and Clamp Location

REAR CTI LINE REPLACEMENT

1. Disconnect line at rear wheel and at T-fitting (Figure 6-75).
2. Remove line from clamp on lower control arm and from rear hub.
3. If working on right rear line, remove clamp over crossmember to remove line (Figure 6-76).
4. Tape ends of new line to prevent dirt entry.
5. Connect line to T-fitting and rear hub.
6. Secure line in control arm clamp.
7. If working on right rear line, secure line to crossmember with clamp (Figure 6-76).

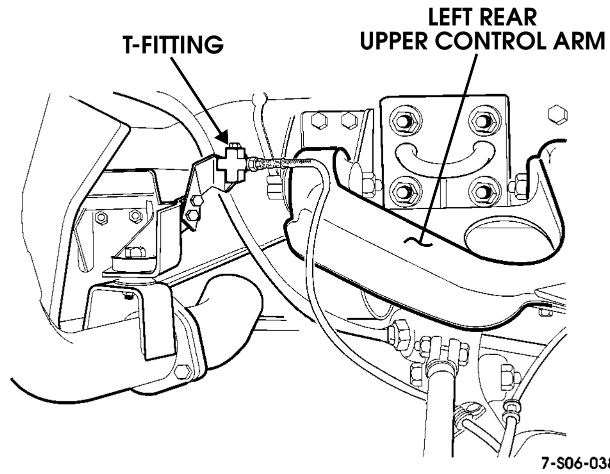


Figure 6-75: T-Fitting Location

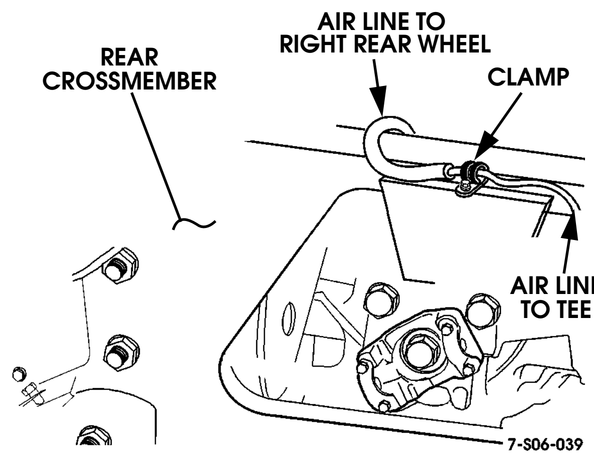


Figure 6-76: Right Rear Line Routing Over Rear Crossmember

AIR INTAKE LINE REPLACEMENT

Removal

1. Raise and secure hood.
2. Loosen hose clamp and disconnect air intake hose from connector (Figure 6-77).

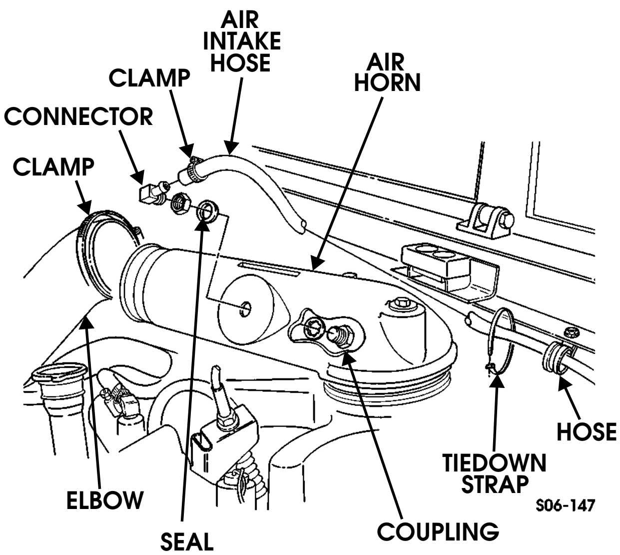


Figure 6-77: Air Intake Hose

3. Loosen clamp and disconnect air cleaner elbow from air horn.
4. Remove nut, washer, coupling, connector, and seal from air horn.
5. Loosen hose clamp securing air intake hose to hose end (Figure 6-78).

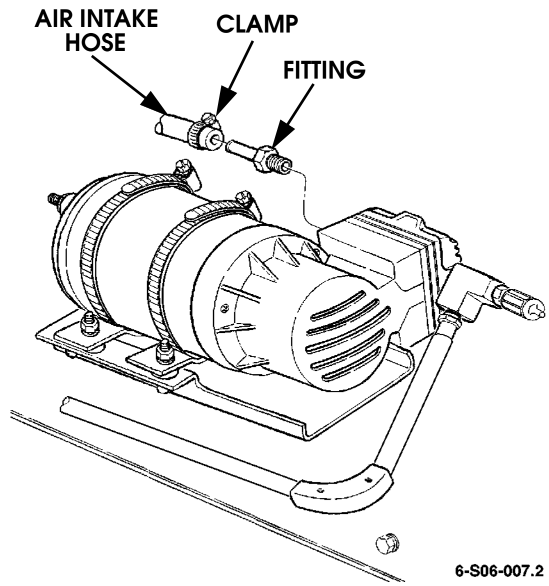


Figure 6-78: Air Intake Hose to Fitting

6. Remove tiedown straps and air intake hose from hoses.

Cleaning and Inspection

Clean and inspect air intake hose, elbow, coupling assembly and seal. Check for leaks, cracks, and stripped threads.

CAUTION: *Do not allow sealant into air system. Sealant will damage CTIS components.*

NOTE: Apply sealant to threads prior to installation.

Installation

1. Connect air intake hose to hose end and secure with hose clamp (Figure 6-78).
2. Install seal, coupling, washer, nut, and connector to air horn (Figure 6-77).
3. Connect air cleaner elbow to air horn and secure with clamp.
4. Connect air intake hose to air horn connector and secure with hose clamp.
5. Secure air intake hose to hoses with tiedown straps (Figure 6-78).
6. Lower and secure hood.

TUBE SHIELD REPLACEMENT

1. Remove bolts, washers and tube shield from wheel.
2. Install new CTIS decal on tube shield, if necessary.
3. Install tube shield tabs into slots on wheel.
4. Secure tube shield to spindle with bolts and washers.

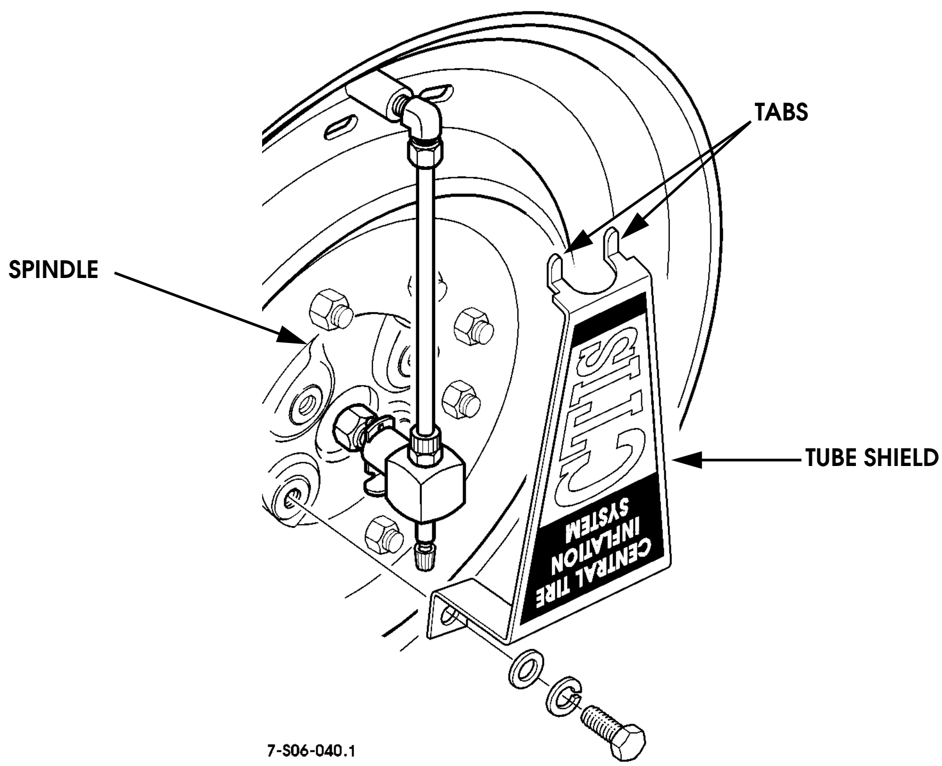


Figure 6-79: Tube Shield Assembly

QUICK-DISCONNECT VALVE AND TUBE REPLACEMENT

WARNING: CTIS components are subject to high air pressure. Always relieve air pressure before loosening or removing air system components by disconnecting quick-disconnect valve assemblies. Failure to follow this warning may result in serious injury.

NOTE: The replacement of all four quick-disconnect valves and tube assemblies is identical.

Removal

1. Raise and support vehicle.
2. Remove tube shield.
3. Remove tube and nut from quick-disconnect valve (Figure 6-80).

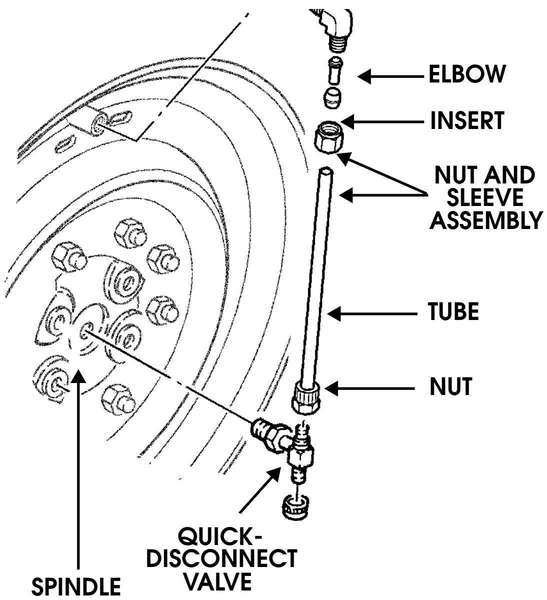


Figure 6-80: Quick-Disconnect Valve Assembly

CAUTION: *Do not force apart quick-disconnect valve. The quick-disconnect valve is a one-piece component. Damage to quick-disconnect valve will result if forced apart.*

4. Remove quick-disconnect valve from spindle.
5. Disconnect tube from elbow, then remove nut and sleeve assembly and insert from tube.
6. Remove elbow.

Cleaning and Inspection

Clean and inspect tube and quick-disconnect valve. Check for leaks, stripped threads, and cracks. Replace defective parts.

Installation

CAUTION: *Do not allow sealant into air system. Sealant will damage CTIS components.*

NOTE: Apply sealant to threads prior to installation.

1. Install quick-disconnect valve into spindle (Figure 6-80).
2. Install elbow.
3. Install nut on tube and connect tube to quick-disconnect valve.
4. Install nut and sleeve assembly and insert on tube and connect tube to elbow.
5. Install tube shield.
6. Lower vehicle.

REAR TUBE CONNECTION SHIELD REPLACEMENT

NOTE: The replacement of the left and right rear tube connection shields is basically the same. This procedure covers the left rear tube connection shield.

Removal

Remove two bolts, washers, shield, and two washers from steering arm cover (Figure 6-81).

Cleaning and Inspection

Clean and inspect shield and mounting hardware. Check for cracks and stripped threads. Replace defective parts.

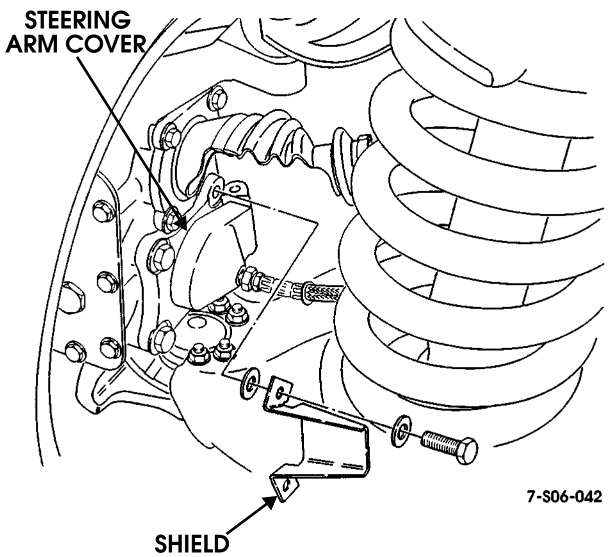


Figure 6-81: Rear Tube Connection Shield

Installation

Install shield on steering arm cover with two washers, bolts, and two washers. Tighten bolt to 75 lb-ft (102 N•m) (Figure 6-81).

GEARED HUB REPLACEMENT (CTIS)

WARNING: CTIS components are subject to high air pressure. Always relieve air pressure before loosening or removing air system components by disconnecting quick-disconnect valve assemblies. Failure to follow this warning may result in serious injury.

NOTE: The geared hub spindle has been bored to allow a direct air passage through the spindle to the quick-disconnect valve assembly. The front of the spindle is bored and tapped to allow installation of a quick-disconnect coupling. The rear of the spindle is bored for the insertion of a spindle extension, which creates an air-tight passageway into the steering arm cover. A bored hole in the steering arm cover allows the installation of a rotary seal and an air line, which routes compressed air to the tires.

Removal

1. Remove tube shield.
2. Remove rear tube connection shield.

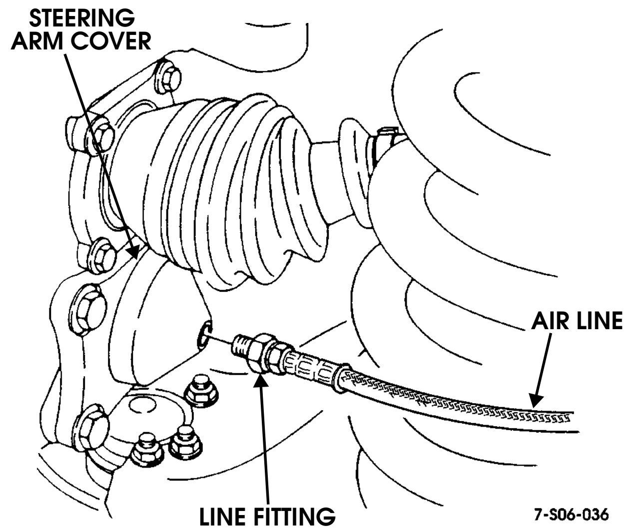


Figure 6-82: Line Connection at Steering Arm Cover

3. Remove line fitting from steering arm cover (Figure 6-82).
4. Remove geared hub.

Installation

1. Install geared hub.
2. Apply sealant to line fitting and install in steering arm cover (Figure 6-82).
3. Install rear tube connection shield.
4. Install tube shield.

SPINDLE EXTENSION AND SEAL REPLACEMENT

Removal

1. Remove rear tube connection shield.
2. Remove four bolts, washers, and steering arm cover from geared hub (Figure 6-83).
3. Remove retaining ring and seal from steering arm cover.
4. Remove spindle extension from spindle.

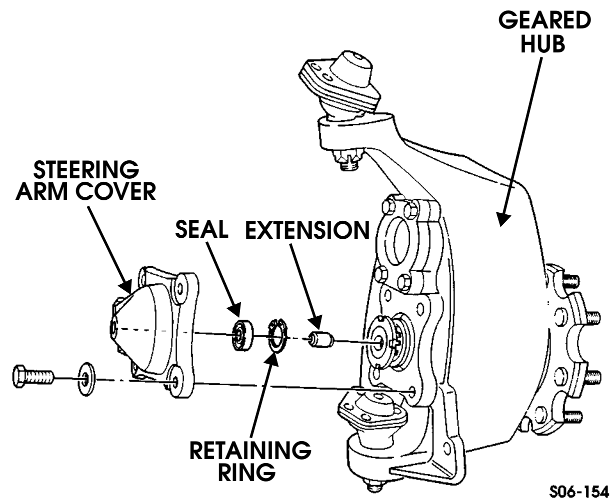


Figure 6-83: Spindle Extension and Seal

Cleaning and Inspection

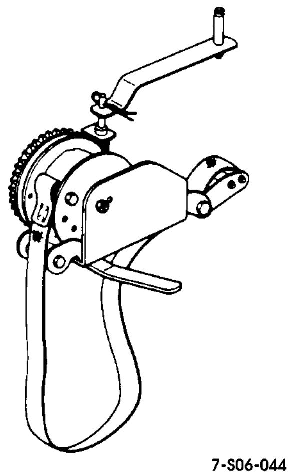
Clean and inspect spindle extension and seal. Check for leaks and cracks. Replace defective parts.

Installation

CAUTION: *Do not allow sealant or adhesive into air system. Sealant will damage CTIS components.*

1. Apply sealant to seal and install seal in steering arm cover (Figure 6-83).
2. Secure seal to steering arm cover with retaining ring.
3. Apply a small amount of adhesive to end of spindle extension and install into spindle.
4. Install steering arm cover on geared hub with four washers and bolts. Tighten bolts to 75 lb-ft (102 N•m).
5. Install rear tube connection shield.

ESSENTIAL TOOLS

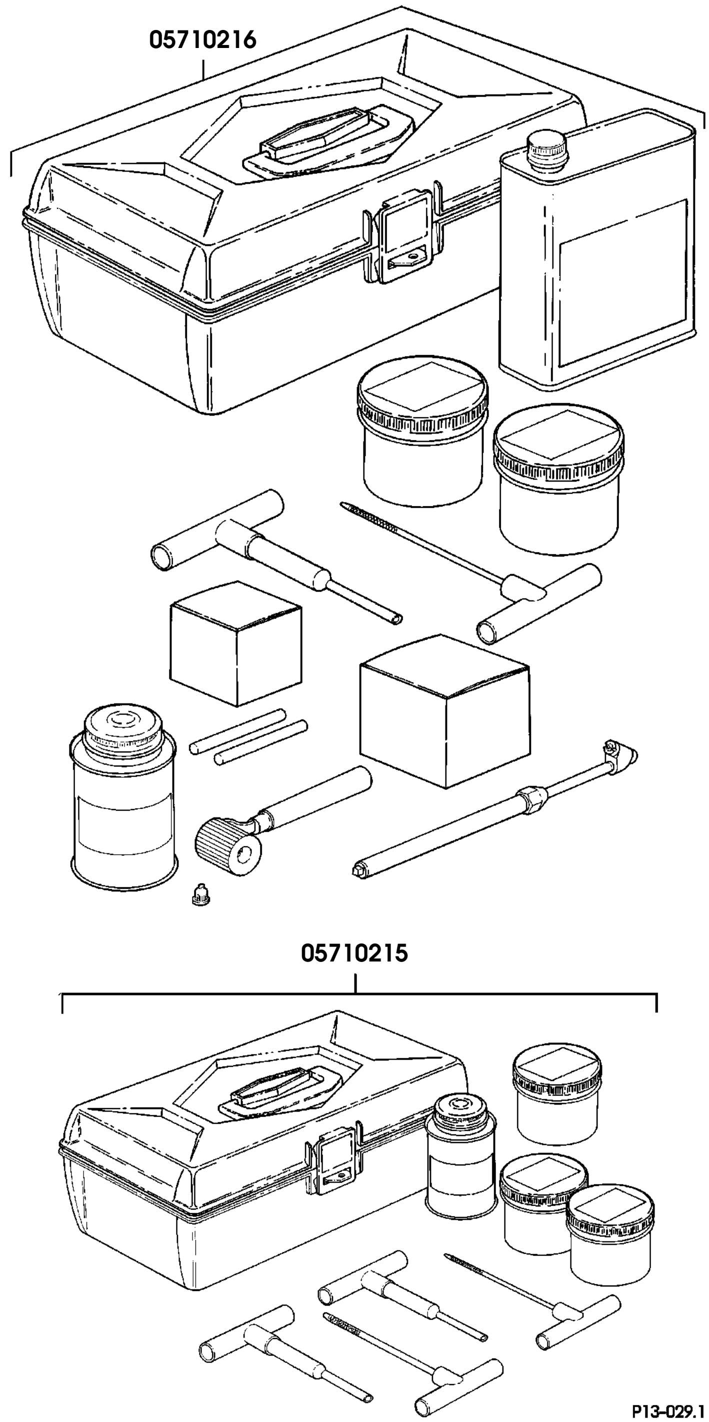


J–39250

Tool No.	Description
J–39250 J–39522 J–42557	Runflat Compressor Socket Kit, 5-Point (not shown) Cam Socket (not shown)

Procure from Kent-Moore.

SPECIAL TOOLS



Tool No.	Description
05710215	External Tubeless Tire Repair Kit
05710216	Internal Tubeless Tire Repair Kit
05744619	Video, One-Piece Wheel Service (not shown)

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Section 7 Brake System

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POWER BRAKE SYSTEM DESCRIPTION

The hydraulic power disc brake system is a four-wheel, in-board-mounted design. The dual reservoir master cylinder stores brake fluid and converts mechanical brake pedal force to hydraulic pressure. The proportioning valve provides balanced front-to-rear braking and activates the brake warning lamp in case of a brake hydraulic system malfunction. The dual reservoir master cylinder provides fluid for separate front and rear brake systems (Figure 7-1). The hydro-boost provides power brake assist and is operated by fluid pressure from the power steering pump. The hydro- boost is equipped with an accumulator. The accumulator stores nitrogen gas under pressure in the event that both the normal assist and accumulator assist are not available. The power steering pump provides hydraulic oil pressure to operate the brake system's hydro-boost feature. If the power steering pump fails to supply hydraulic pressure to the hydro-boost, the pressure stored in the accumulator will provide enough hydraulic pressure for approximately four power-assisted stops. Applying the parking brake prevents the rear brake rotors from rotating and can also be used to help stop the vehicle in low speed emergency situations.

The disc brakes are mounted on the output flanges of the front and rear axle assemblies.

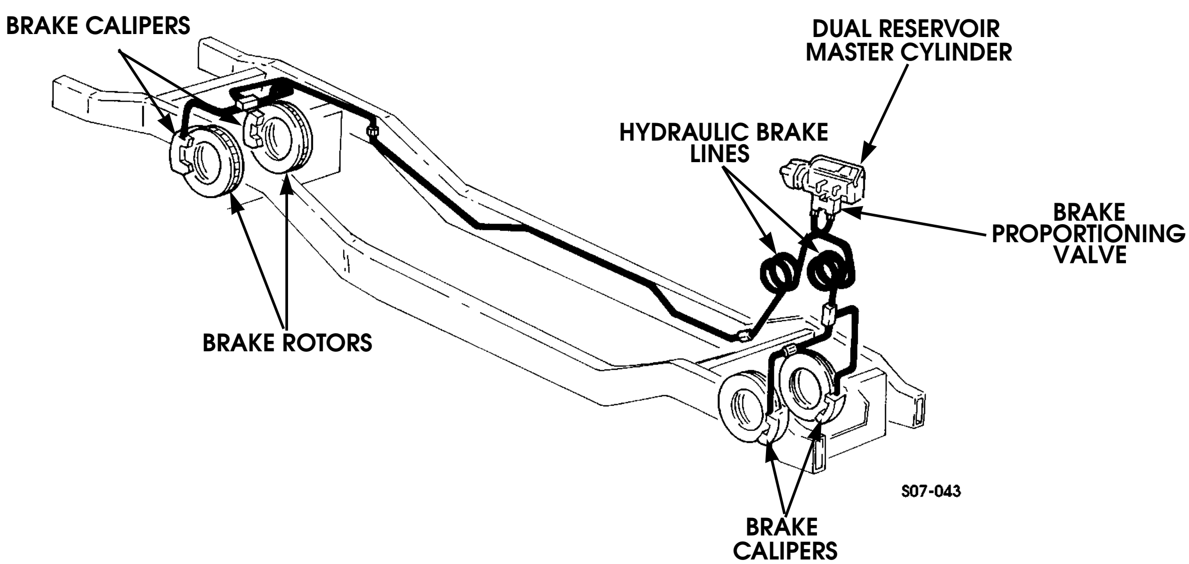

Figure 7-1: Brake System

BRAKE SYSTEM DIAGNOSIS

Road Testing

1. If red warning light is illuminated, note pedal action and brake response.
2. Check brake pedal response with transmission in Neutral and engine running. Pedal should remain firm under steady foot pressure. If pedal falls away, problem is either in hydro-boost, master cylinder, or brakeline.
3. During road test, make normal and firm brake stops in 25-40 mph range. Note faulty brake operation such as pull, grab, drag, noise, fade, pedal pulsation, etc.
4. Inspect suspect brake components and refer to problem diagnosis information for causes of various brake conditions.

Component Inspection

Fluid leak points and dragging brake units can usually be located without removing any components. The area around a leak point will be wet with fluid. The components at a dragging brake unit (wheel, tire, rotor) will be quite warm or hot to the touch.

Other brake problem conditions will require component removal for proper inspection. Raise the vehicle and remove the necessary wheels for better visual access.

During component inspection, pay particular attention to heavily rusted/corroded brake components (e.g. rotors, caliper pistons, lines, etc.).

Heavy accumulations of rust may be an indicator of rust and corrosion damage to a brake component. It is wise to remove surface rust in order to accurately determine the depth of rust penetration and damage. Light surface rust is fairly normal and not a major concern (as long as it is removed). However, heavy rust buildup, especially on high mileage vehicles, may actually cover structural damage to such important components as brakelines and rotors.

Diagnosing Service Brake Problems

Brake Warning Light Operation

The red brake warning light will illuminate when the parking brakes are applied, and when there is a leak in the front or rear wheel brake hydraulic circuit. A low fluid level can also trigger the warning light. If the light comes on, first verify that the parking brakes are fully released. Then check pedal action and fluid level. If a problem is confirmed, inspect the wheel brake hydraulic system.

Pedal Falls Away

A brake pedal that falls away under steady foot pressure is generally the result of a system leak. The leak point could be at a brakeline, fitting, hose, or caliper. Internal leakage in the master cylinder caused by worn or damaged piston cups, may also be the problem cause.

If leakage is severe, fluid will be evident at or around the leaking component. However internal leakage in the master cylinder will not be physically evident. Refer to the cylinder test procedure in this section.

Low Pedal

If a low pedal is experienced and the warning light is **not** on, worn lining and worn rotors are the most likely cause.

If the red warning light is on, a system leak is the most likely cause. A leak at a caliper, brakeline, or brake hose will activate the differential pressure switch in the proportioning valve. The switch will shuttle forward or rearward depending on where the leak is. Switch movement in either direction will complete the electrical circuit to the red warning light causing the light to illuminate.

Spongy Pedal

A spongy pedal is most often caused by air in the system. However, substandard brake lines and hoses will also cause a condition similar to a spongy pedal. The proper course of action is to bleed the system, or replace suspect quality brake lines and hoses.

Hard Pedal or High Pedal Effort

A hard pedal or high pedal effort may be due to lining that is water soaked, contaminated, glazed, or badly worn.

Brake Drag

Brake drag occurs when the lining is in constant contact with the rotor. Drag can occur at one wheel, all wheels, fronts only, or rears only. It is a product of incomplete brakeshoe release. Drag can be minor or severe enough to overheat the linings, and rotors.

Brake drag also has a direct effect on fuel economy. If undetected, minor brake drag can be misdiagnosed as an engine or transmission/torque converter problem.

Minor drag will usually cause slight surface glazing of the lining. It can also generate hard spots in rotors from the overheat-cool down process. In most cases, the rotors, wheels and tires are quite warm to the touch after the vehicle is stopped.

Severe drag can char the brake lining all the way through. It can also distort and score rotors to the point of replacement. The wheels, tires and brake components will be extremely hot. In severe cases, the lining may generate smoke as it chars from overheating.

Some common causes of brake drag are:

- seized or sticking caliper piston
- caliper binding on bushings or pin slides
- incorrect length caliper mounting bolts (too long)
- loose caliper mounting bracket
- misassembled components
- misadjusted brakelight switch
- binding brake pedal
- master cylinder/hydroboost internal fault

If brake drag occurs at all wheels, the problem may be related to a blocked master cylinder compensator port or faulty hydroboost.

An improperly mounted or adjusted brakelight switch can prevent full brake pedal return. The result will be the same as if the cylinder compensator ports are blocked. In this case, the brakes would be partially applied all the time causing drag.

Brake Fade

Brake fade is a product of overheating caused by brake drag. However, brake overheating and subsequent fade can also be caused by riding the brake pedal, making repeating high deceleration stops in a short time span, or constant braking on steep roads. Refer to the Brake Drag information in this section for causes.

Pedal Pulsation

Pedal pulsation is caused by components that are loose, or beyond tolerance limits.

Disc brake rotors with excessive lateral runout or thickness variation are the primary causes of pulsation. Other causes are loose calipers, and worn, damaged tires.

Brake Pull

A front pull condition could be the result of contaminated lining in one caliper, seized caliper piston, binding caliper, loose caliper, loose or corroded slide pins, improper brakeshoes, or a damaged rotor.

A worn, damaged wheel bearing or suspension component are further causes of pull. A damaged front tire (bruised, ply separation) can also cause pull.

A common and frequently misdiagnosed pull condition is where direction of pull changes after a few stops. The cause is a combination of brake drag followed by fade at the dragging brake unit.

As the dragging brake overheats, efficiency is so reduced that fade occurs. If the opposite brake unit is still functioning normally, its braking effect is magnified. This causes pull to switch direction in favor of the brake unit that is functioning normally. Check the tires to be sure that they are inflated to the appropriate tire pressure. It could be another cause of your vehicle "pulling" to one side.

When diagnosing a change in pull condition, remember that pull will return to the original direction if the dragging brake unit is allowed to cool down (and is not seriously damaged).

Rear Brake Grab

Rear grab (or pull) is usually caused by contaminated lining, bent or binding pads or improperly assembled components. This is particularly true when only one rear wheel is involved. However, when both rear wheels are affected, the master cylinder or proportioning valve could be at fault.

Brakes Do Not Hold After Driving Through Deep Water Puddles

This condition is generally caused by water soaked lining. If the lining is only wet, it can be dried by driving with the brakes lightly applied for a mile or two. However, if the lining is both wet and dirty, disassembly and cleaning will be necessary.

Brake Fluid Contamination

There are two basic causes of brake fluid contamination. The first involves allowing dirt, debris, water, or other liquid materials to enter the cylinder reservoirs when the cover is off. The second involves topping off, or filling the cylinder reservoirs with a non-recommended fluid.

Brake fluid contaminated with only dirt, or debris usually retains a normal appearance. Generally, the foreign material will remain suspended in the fluid and be visible. The fluid and foreign material can be removed from the reservoir with a suction gun but only if the brakes have not been applied. If the brakes are applied after contamination, system flushing will be required. The master cylinder will also have to be flushed or replaced if the contaminants cannot be removed. Foreign material lodged in the reservoir compensator/return ports can cause brake drag by restricting fluid return after brake application.

Brake fluid contaminated by a non-recommended fluid, generally appears highly discolored, milky, oily looking, or foamy. In some cases, it may even appear as if the fluid contains sludge. **However, be advised that brake fluid will darken over time and occasionally be cloudy in appearance. These are normal conditions and should not be mistaken for contamination.**

If some type of oil has been added to the system, the fluid will separate into distinct layers. To verify this, drain off a sample with a clean suction gun. Then pour the sample into a glass container and observe fluid action. If the fluid separates into distinct layers, it is definitely contaminated.

The only real correction for contamination by non-recommended fluid is to flush the entire hydraulic system and replace all the seals.

Brake Noise

Squeak/Squeal

The factory installed brakelining in Hummer vehicles is made from asbestos free materials. These materials have different operating characteristics than previous lining materials. Under certain conditions, asbestos free lining may generate some squeak, groan or chirp noise. This noise is considered normal and does not indicate a problem. The only time inspection is necessary, is when noise becomes constant or when grinding, scraping noises occur.

Constant brake squeak or squeal may be due to linings that are wet or contaminated with brake fluid, grease, or oil. Glazed linings and rotors with hard spots can also contribute to squeak. Dirt and foreign material embedded in the brake lining can also cause squeak/squeal.

Loud brake squeak, squeal, scraping, or grinding sounds are a sign of severely worn brake lining. If the lining has worn completely through in spots, metal-to-metal contact occurs. If the condition is allowed to continue, rotors can become so scored that replacement is necessary.

Thump/Clunk

Thumping or clunk noises during braking are frequently **not** caused by brake components. In many cases, such noises are caused by loose or damaged steering, suspension, or engine components. However, calipers that bind on the slide surfaces can generate a thump or clunk noise. Loose adapter bolts or halfshaft-to-rotor bolts will cause noise.

Chatter/Shudder

Brake chatter is usually caused by loose or worn components, or glazed/burnt lining. Rotors with hard spots can also contribute to chatter. Additional causes of chatter are out-of-tolerance rotors, brake lining not securely attached to the shoes, loose wheel bearings and contaminated brake lining.

Brakelining Contamination

Brakelining contamination is a product of leaking calipers, driving through deep water puddles, or lining that has become covered with grease or oil due to leaking axle seals.

Wheel and Tire Problems

Some conditions attributed to brake components may actually be caused by a wheel or tire problem.

A damaged wheel can cause shudder, vibration and pull. A worn or damaged tire can also cause pull.

Severely worn tires with little or no tread left can produce a grab-like condition as the tire loses and recovers traction.

Flat-spotted tires can cause vibration and wheel tramp and generate shudder during brake operation.

A tire with internal damage such as a severe bruise or ply separation can cause pull and vibration.

Diagnosing Parking Brake Problems

Parking Brake Problem Causes

In most cases, the actual cause of an improperly functioning parking brake (too loose/too tight/won’t hold), can be traced to a rear brake component.

The leading cause of improper parking brake operation, is excessive clearance between the brake pads and the rotor surface. Excessive clearance is a result of lining and/or rotor wear or inoperative adjuster components.

Inspect and adjust parking brake lever as necessary.

BRAKE SYSTEM TROUBLESHOOTING

Parking Brake Does Not Hold Vehicle

1. Check parking brake adjustment and ensure linkage and cables operate freely. Adjust parking brake lever and/or cables or replace damaged and worn parts.
2. Inspect rear brake caliper brake pads for serviceability. Minimum brake lining thickness is 1/8 in. (3.2 mm). Replace all rear brake pads if any pad does not meet thickness specifications.
3. Check caliper for binding or dragging. Check for binding caliper guide pins.

Low or Spongy Brake Pedal on First Application or Pedal Goes to Floor

NOTE: The HUMMER is equipped with DOT 5 silicone brake fluid. **Do not mix with other brake fluids**.

NOTE: When low or spongy brakes exist, the brake light on the instrument panel may illuminate when the brake pedal is applied.

WARNING: Always wear eye protection when bleeding brakes. Failure to do this may cause personal injury if brake fluid comes in contact with eyes.

1. Remove master cylinder cover and visually check reservoirs for low fluid level or contamination.
   a. If fluid is contaminated, flush system with clean brake fluid.
   b. If fluid is low, check for worn brake pads, observe for leakage, broken, cracked or kinked lines, worn master cylinder, etc. Replace any worn parts. Add DOT 5 as needed.
2. Check hydro-boost. Depress brake pedal several times, with engine off, to exhaust accumulator pressure. Depress brake pedal and start engine.
   a. Brake pedal should fall, then push back against operator's foot.
   b. Perform pressure test (Section 8).
   c. Replace hydro-boost if not operating properly.
3. Bleed master cylinder then bleed brakes.

Decreased Brake Pedal Travel or Slow Return

1. Check for worn brake pedal return spring. Replace if worn.
2. Check brake pedal bushings for signs of wear or binding. Replace if worn and lubricate as needed.
3. Check for kinked or damaged brake lines which may restrict brake fluid. Replace any damaged lines.
4. Check hydro-boost. Depress brake pedal several times, with engine off, to exhaust accumulator pressure. Depress brake pedal and start engine.
   a. Brake pedal should fall, then push back against operator's foot.
   b. Perform pressure test (Section 8).
   c. Replace hydro-boost if not operating properly.
5. Check brake calipers for binding as a result of corrosion or dirt. Check brake rotors for free movement. If rotors do not move freely, remove calipers and clean caliper guide pins.
6. Check parking brake cable for proper operation. Repair as required.

Excessive Pedal Pressure Required to Stop Vehicle

1. Remove master cylinder cover and visually check reservoirs for low fluid level or contamination.
   a. If fluid is contaminated, flush system with clean brake fluid.
   b. If fluid is low, check for worn brake pads, observe for leakage, broken, cracked or kinked lines, worn master cylinder, etc. Replace any worn parts.
2. Check fluid in power steering pump reservoir. Fill fluid to proper level (Section 1).
3. Check serpentine belt tension. Replace belt (Section 8) if necessary.
4. Check brake pads for proper installation, contamination, or distortion. Check brake pads for excessive wear. Minimum brake lining thickness is 1/8 in. (3.2 mm). Replace brake pads as axle sets (front or rear) if any pad does not meet specifications

NOTE: To preserve even braking, both calipers must be in equal condition.

5. Check brake calipers for binding as a result of corrosion or dirt. Check brake rotors for free movement. If rotors do not move freely, remove calipers and clean caliper guide pins.
6. Check for frozen piston in brake caliper. If inner pad is not worn to limit, but piston cannot be retracted, rebuild or replace both calipers.
7. Check for pinched or kinked supply and return lines to hydro-boost. Reposition or replace any damaged lines.
8. Check for damaged brake lines. Replace any damaged brake lines.
9. Check for malfunctioning hydro-boost. Depress brake pedal several times, with engine off, to exhaust accumulator pressure. Depress brake pedal and start engine.
   a. Brake pedal should fall, then push back against operator's foot.
   b. Perform pressure test (Section 8).
   c. Replace hydro-boost if not operating properly.
10. Check power steering system. Refer to step 6 in the Diagnostic portion of *Hard Steering* in Section 8.

Noisy Brakes

1. Check brake pads for proper installation, contamination, or distortion. Check brake pads for excessive wear. Minimum brake lining thickness is 1/8 in. (3.2 mm). Replace brake pads as sets (front or rear) if any pad does not meet specifications. Make sure pads are flat and smooth.
2. Check rotor for glazing or scoring. Turn the rotor if glazed or scored. Do not exceed the minimum thickness shown on the inside of the rotor hat section. It is not recommended that rotors be turned when spotted or heat checked.
3. Check halfshaft mounting.
   a. Apply a thread-locking compound to the halfshaft-to-rotor capscrews and torque to 57 lb-ft (77 N•m).
   b. Apply a thread-locking compound to the halfshaft retaining capscrew (in geared hub) and torque to 37 lb-ft (50 N•m). Tighten any loose fasteners.

Brake Chatter Noise

On some new vehicles, roughness or a chatter sound from the brakes may be noticed during low speed brake application. The noise is a result of the lining edges of an unburnished brake pad rubbing against the rotor. Burnishing is a part of the vehicle break-in process which fully seats and conditions new brake pads. Although annoying, the brake noise is not detrimental to vehicle safety or performance, and will eventually be eliminated through normal brake use.

If roughness or chatter persists on a new vehicle, then chamfering of the brake pad lining edges can be performed. Chamfering of the brake pad is done by slightly grinding or filing the edge of the pad lining on a grinding wheel.

To complete the chamfering procedure:

1. Remove the eight service brake pads from the vehicle. Mark each pad for vehicle and caliper location.
2. Chamfer (grind or file) the brake pad lining edges. Ensure both brake pad lining edges are chamfered on each of the eight brake pads (Figure 7-2). Make sure pads are flat and even.
3. Install eight service brake pads at the original vehicle and caliper location.
4. Operate vehicle and check brakes for proper operation.

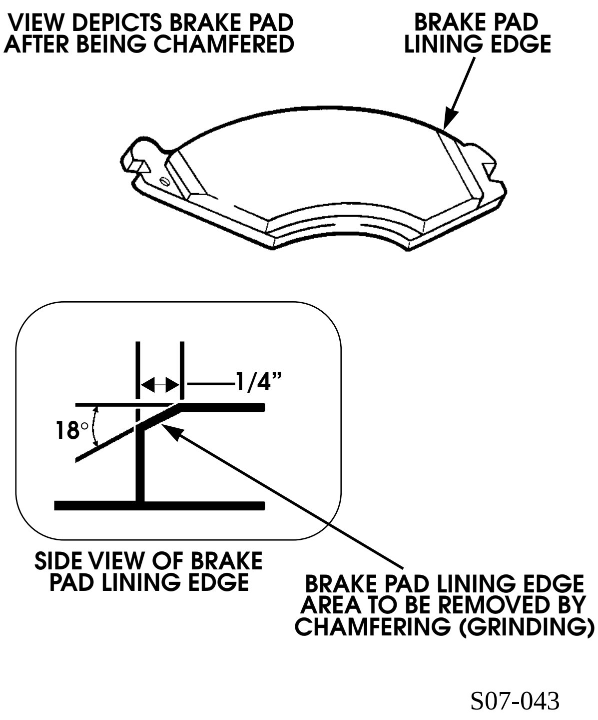

Figure 7-2: Chamfering Brake Pad

Booster or Pedal Pulsation

1. Check hydro-boost. Depress brake pedal several times, with engine off, to exhaust accumulator pressure. Depress brake pedal and start engine.
   a. Brake pedal should fall, then push back against operator's foot.
   b. Perform pressure test (Section 8).
   c. Replace hydro-boost if not operating properly.
2. Check halfshaft-to-rotor mounting for missing or loose capscrews. Torque capscrews to 48 lb-ft (65 N•m) and apply a thread locking compound.
3. Check brake rotor lateral run-out. Refinish any rotor not meeting specifications. Refer to *Checking Lateral Runout* in this section for more information.

Erratic Braking Action

1. Check for correct tire pressure.
2. Check brake pads for binding as a result of corrosion or dirt. Check brake pads for excessive wear. Minimum brake lining thickness is 1/8 in. (3.2 mm). Replace brake pads as sets (front or rear) if any pad does not meet specifications.
3. Check brake calipers for binding as a result of corrosion or dirt. Check for seized or binding brake caliper pistons. Repair any binding or seized caliper pistons. Check brake rotors for free movement. If rotors do not move freely, remove calipers and clean caliper guide pins (Figure 7-3).

NOTE: Calipers pins must be replaced in pairs. Caliper pins and bushing should be lubricated with silicone grease.

4. Check for leaking caliper piston seals. Replace or rebuild any calipers with leaking seals.
5. Check rotor for glazing or scoring. Turn the rotor if glazed or scored. Do not exceed the minimum thickness shown on the inside of the rotor hat section. It is not recommended that rotors be turned when spotted or heat checked.
6. Check for damaged brake lines. Replace any damaged brake lines.
7. Check for faulty proportioning valve. With the vehicle at curb weight, decelerate from 20 mph (32 kph) on dry concrete road and apply sufficient pressure to lock up the brakes. If the front brakes lock up before rear brakes, replace the proportioning valve.
8. Check toe adjustment. Adjust toe, if necessary. Refer to Section 5.

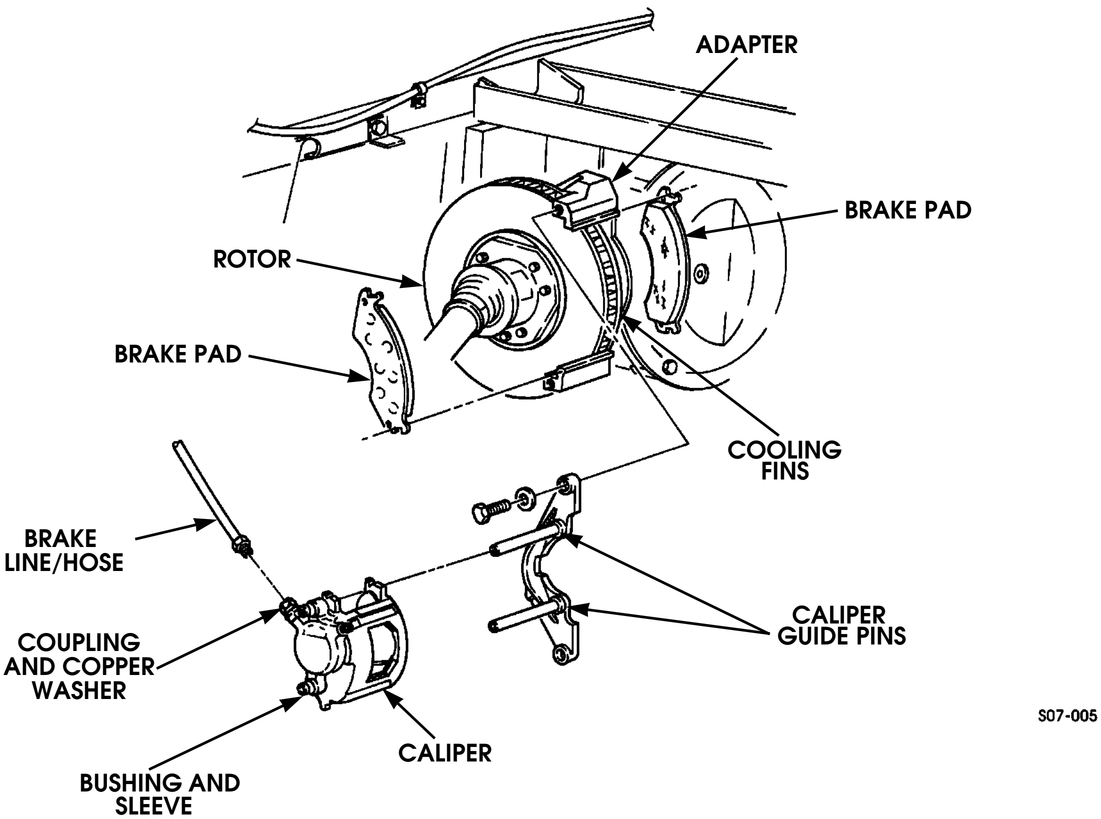

Figure 7-3: Brake Caliper and Brake Pads

HYDRO-BOOST SYSTEM DIAGNOSIS

PROBLEM	POSSIBLE CAUSE	CORRECTION
Slow Brake Pedal Return or Brakes Apply When Turning Steering Wheel	1. Damaged/broken return spring. 2. Excessive seal friction in booster. 3. Faulty spool action. 4. Restriction in return line from booster to pump reservoir. 5. Damaged input rod end.	1. Replace spring. 2. Replace the hydro-boost. 3. Flush the steering system while pumping the brake pedal. 4. Replace the line. 5. Replace the hydro-booster.
Grabs Suddenly or Booster Chatters - Pedal Vibrates	1. Faulty spool action caused by contamination. 2. Power steering pump belt slips. 3. Low fluid level in power steering pump.	1. Flush steering system while pumping brake pedal. 2. Tighten belt. 3. Fill reservoir and check for external leaks.
Accumulator Leak-Down Reserve System Does Not Hold Charge	1. Contamination in steering hydro-boost system. 2. Internal leakage in accumulator system	1. Flush steering system while pumping brake pedal. 2. Replace hydro-boost.
Excessive Brake Pedal Efforts	1. Loose, glazed, or broken pump belt. 2. No fluid in pump reservoir. 3. Leaks in system hoses. 4. Leaks at tube fittings and connections. 5. Leakage at pneumatic accumulator seal. 6. Leakage at piston seal. 7. Leakage at input seal. 8. Leakage at cover-to-housing seal. 9. Leakage at spool plug seal. 10. Leakage at ball plug	1. Tighten or replace belt. 2. Fill reservoir and check for external leaks. 3. Replace faulty parts. 4. Tighten fittings or replace tube seats or O-rings. 5. Replace O-ring. 6. Overhaul with new seal kit. 7. Overhaul with new seal kit. 8. Overhaul with new seal kit. 9. Overhaul with spool plug seal kit. 10. Replace hydro-boost.
NOTE: The power steering fluid and brake fluid cannot be mixed. If the brake seals contact steering fluid or the steering seals contact brake fluid, seal damage will result.		

Noise Diagnosis

The following noises are associated with the hydro-boost and may or may not be cause for concern. Some noises are normal and for the most part temporary in nature. Other noises may be a sign of excessive wear or the presence of air in either the booster or the steering system.

1. A moan or low frequency hum usually accompanied by a vibration in the pedal or steering column may be observed during parking maneuvers or other low-speed maneuvers. This may be caused by a low fluid level in the power steering pump or by air in the fluid. Holding the pump at relief pressure (steering wheel held all the way in one direction) for more than five seconds will cause air to enter the system. Check the fluid level and fill if needed. The system must then sit for one hour to remove the air.
2. A high-speed fluid noise may be heard when the brake pedal is fully depressed. This condition is normal.
3. Whenever the accumulator pressure is used, a slight hiss may be noticed. It is the sound of the hydraulic fluid escaping through the accumulator valve, and is completely normal.
4. After the accumulator has been emptied and the engine is started again, another hissing sound may be heard during the first brake application or the first steering maneuver. This is caused by the fluid rushing through the accumulator charging orifice. It is normal and will only be heard once after the accumulator is emptied. If this sound continues however, even though no apparent accumulator pressure assist was made, it could be an indication that the accumulator is not holding pressure and should be checked using the procedure *Accumulator Leakdown Test* in this section.

Booster Functional Test

With the engine off, apply the brake pedal several times until the accumulator is completely depleted. Depress the brake pedal using 40 lb-ft (54 N•m) of force and start the engine. The pedal will fall and then push back against your foot.

Accumulator Leakdown Test

1. Start the engine and charge the accumulator by applying the brake pedal or by turning the steering wheel from stop to stop. Turn off the engine and let the vehicle sit for one hour. After one hour there should be at least two power-assisted applications with the engine off.
2. If the reserve system will not retain a charge for one hour, but functions normally immediately following charging, the accumulator valves are at fault. Replace the hydro-booster.
3. If the accumulator can be heard charging and discharging but does not hold a charge, replace the hydro-booster.
4. Deplete the accumulator by pressing the brake pedal several times. If the accumulator can has lost its charge, it is possible to rotate or wobble the accumulator can with respect to the housing. Replace the hydro-booster.

Handling - The booster should not be carried by the accumulator nor should the booster ever be dropped on the accumulator. The snap ring which holds the accumulator into the housing should be checked for proper positioning before the booster is used. The accumulator contains high pressure gas and with any high pressure gas a certain degree of danger is present if mishandled.

Disposal - The accumulator should not be exposed to excessive heat, fire or incineration. Before discarding accumulator following replacement, drill a 1/16 inch diameter hole in the end of accumulator can to relieve the pressure. BE SAFE! Protect your eyes. Wear approved safety glasses.

SERVICE BRAKE SYSTEM BLEEDING

NOTE: If only the front or rear half of the system has been serviced, it is usually necessary to bleed only that half of the system. However, if a firm brake pedal cannot be obtained after bleeding, it will be necessary to bleed the entire system. The brake hydraulic system can be bled manually or by using a pressure tank and adapters. Each method is outlined in the following procedures.

WARNING: Always wear eye protection when bleeding brakes. Failure to do this may cause injury if brake fluid comes in contact with eyes.

Pressure Bleeding

CAUTION: *When using a pressure bleeding tank, follow the manufacturer's instructions for its use. Use only DOT 5 silicone brake fluids when bleeding. Do not exceed the recommended working pressure when pressurizing the tank. A tank pressure of 15-20 psi (103-138 kPa) is sufficient to bleed the brake hydraulic system. Release all air pressure from the tank after using it.*

NOTE: This procedure covers bleeding at one wheel. Repeat bleeding task for remaining wheels.

1. Remove cover from master cylinder. Fill master cylinder if necessary.
2. Install pressure tank bleeder adapter to master cylinder (Figure 7-4).
3. Connect line from pressure tank to adapter.

NOTE: Bleed calipers in the following order: right rear, left rear, right front, left front.

4. Remove protective cap from bleeder screw on caliper assembly (Figure 7-5).
5. Connect short piece of hose to bleeder screw, and place other end of hose in container 3/4 full of brake fluid.
6. Open valve on line from pressure tank to master cylinder allowing pressurized brake fluid to enter system (Figure 7-4).
7. Open bleeder screw 3/4 turn and observe brake fluid in container. Close bleeder screw when brake fluid flows free of air bubbles (Figure 7-5).
8. Disconnect hose from bleeder screw and install protective cap on bleeder screw.
9. Close valve on line from pressure tank to master cylinder (Figure 7-4).
10. Disconnect line from adapter.
11. Remove adapter from master cylinder and fill master cylinder if necessary.
12. Install master cylinder cover.

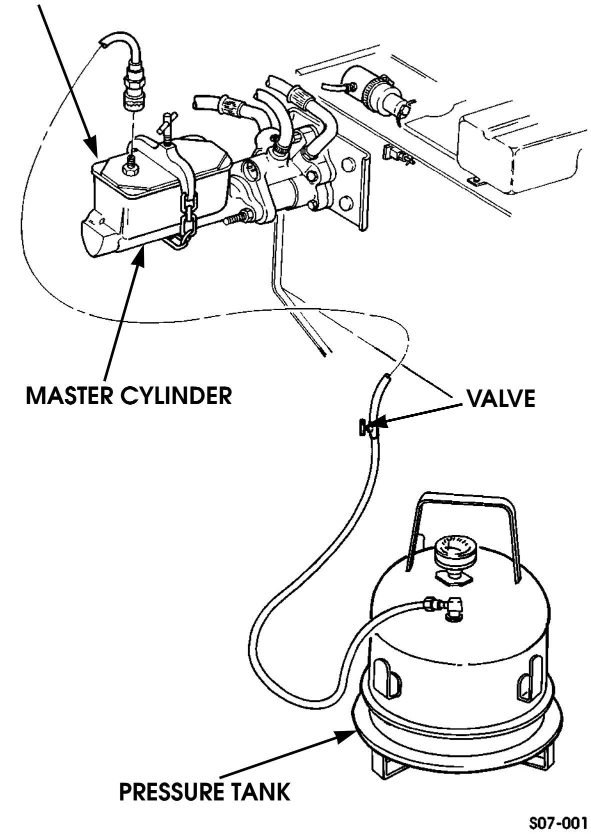

Figure 7-4: Pressure Bleeding Brake System

Manual Bleeding

NOTE: This procedure covers bleeding at one wheel. Repeat bleeding task for remaining wheels. Assistance is required to depress the brake pedal when manually bleeding brakes while mechanic opens and closes bleeder screw.

NOTE: Bleed calipers in the following order: right rear, left rear, right front, left front.

1. Remove protective cap from bleeder screw on caliper assembly (Figure 7-5).
2. Connect short piece of hose to bleeder screw, and place other end of hose in container 3/4 full of brake fluid.

***CAUTION:** Check the master cylinder fluid level frequently during the bleeding operation and refill the reservoirs as necessary. Do not allow the master cylinder to run out of fluid at any time, or additional air will be drawn into the system.*

3. Have an assistant depress the brake pedal. Open bleeder screw 3/4 turn.

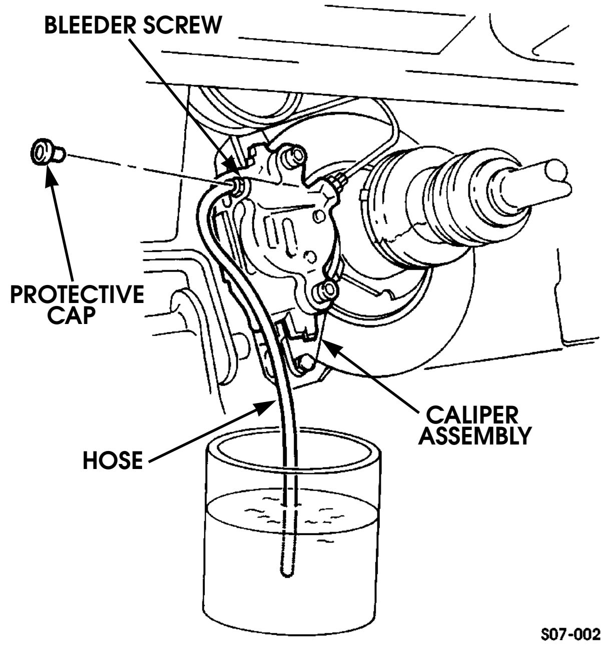

Figure 7-5: Manually Bleeding Brake System

4. When pedal reaches floor, tighten bleeder screw and have assistant slowly release brake pedal.
5. Repeat steps 3 and 4 until fluid flows clear and free of air bubbles.
6. Disconnect hose from bleeder screw and install protective cap on bleeder screw.
7. Operate vehicle and check brakes for proper operation.

SERVICE BRAKE PAD REPLACEMENT

NOTE: Larger brake pads and rotors are used on 12,100 lb GVWR Hummers. Check the parts manual carefully to be sure the replacement pads are correct for the application.

NOTE: The following procedure applies to the front brake system only.

Removal

1. Using crowfoot, remove two capscrews and washers securing yoke and caliper to adapter.

NOTE: Note positioning of brake pad surfaces for installation.

2. Remove yoke, caliper, and two brake pads.

Cleaning and Inspection

NOTE: Clean all components, examine for wear or damage, and replace if necessary.

1. Inspect dust boot for tears or deterioration (Figure 7-6).
2. Inspect rotor for heat cracks, spotting, discoloration, pitting, or scoring. Resurface rotors if discolored, pitted, or scored. It is not recommended that rotors be turned when spotted or heat cracks.

NOTE: If operation in wet and muddy conditions is expected, replace brake pads if brake lining thickness is 1/8 in. (3.2 mm) or less.

3. Inspect brake pads for glazing, oil saturation, or wear. If glazed, oil saturated, or if brake lining thickness is less than 1/8 in. (3.2 mm), replace brake pads. Brake pads should be replaced as an axle set (front or rear).

Installation

WARNING: Ensure brake pads are installed with linings facing rotor. Failure to do this will cause poor performance, damage to equipment, and may result in injury.

1. Position brake pads on adapter.

NOTE: When installing yoke and caliper, use a suitable tool to compress the piston.

2. Apply a non-hardening thread-locking compound to tapped holes of adapter. Using crowsfoot, secure yoke and caliper to adapter with two washers and capscrews. Tighten capscrews to 30-40 lb-ft (41-54 N•m).

LINING AND ROTOR BURNISHING

After you replace brake pads and/or refinish rotors, it is recommended that the new braking surface be broken in, or "burnished." To do this, make 20 stops, one every one to two miles at 30 mph, using medium pedal effort. The amount of time it takes to stop should be approximately five seconds. During this procedure, use care to avoid overheating the brakes.

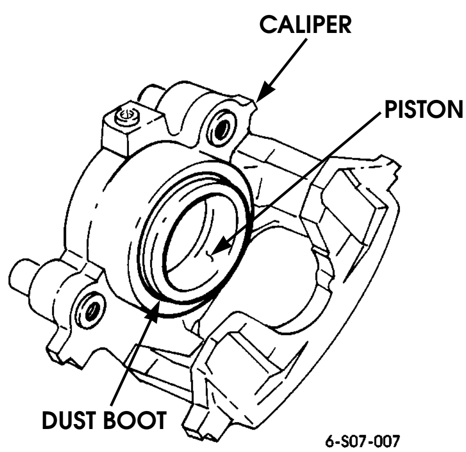

Figure 7-6: Caliper Assembly

FRONT SERVICE BRAKE CALIPER REPLACEMENT

NOTE: The following procedure applies to the front brake system only. If removing left front caliper, halfshaft must be removed.

NOTE: The brake caliper assemblies found on the 12,100 GVWR Hummer have dimensionally different adapters for mounting the calipers to the vehicle chassis. Check the parts manual carefully to be sure the replacement assembly is correct for the application. Service procedures are the same for either caliper assembly.

Removal

1. Disconnect brake line from coupling (Figure 7-7).
2. Using crowfoot, remove two capscrews and washers securing yoke and caliper to adapter.

NOTE: Note positioning of brake pad surfaces for installation.

3. Remove yoke, caliper, and two brake pads from adapter.
4. Slide yoke and caliper guide pins out from caliper. Remove coupling and washer from caliper.

Cleaning and Inspection

NOTE: Clean all components, examine for wear or damage, and replace if necessary.

1. Clean mating surfaces of caliper and adapter (Figure 7-7).
2. Inspect caliper and caliper piston for pitting, or damage (Figure 7-6).
3. Inspect caliper guide pins and sleeves for wear.
4. Inspect dust boot and bushings for tears or deterioration.
5. Inspect yoke and caliper guide pins for corrosion. Perform step 6 if corroded. If not, perform step 8 (Figure 7-7).
6. Remove caliper guide pins from yoke. Discard caliper guide pins.
7. Inspect rotor for heat checks, discoloration, pitting, or scoring. Check rotor thickness variation.

NOTE: Replace brake pads in sets only. Replace brake pads if brake lining thickness is less than 1/8 in. (3.2 mm) and operation in wet and muddy conditions is expected.

8. Inspect brake pads for glazing, oil saturation, or wear. If glazed, oil saturated, or if brake lining thickness is less than 1/8 in. (3.2 mm), replace both pads and pads from opposite caliper.

Installation

1. Install a washer and coupling to caliper (Figure 7-6).

NOTE: Vehicles with a 12,100 GVWR are not equipped with a coupling.

WARNING: Ensure brake pads are installed with linings facing rotor. Failure to do this will cause poor performance and damage to equipment and may result in injury.

2. Position brake pads on adapter (Figure 7-7).

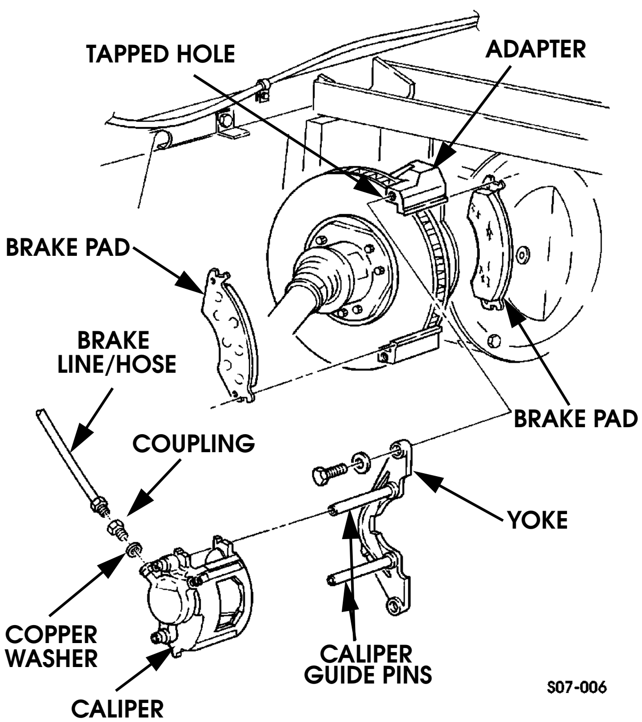

Figure 7-7: Service Brake Components

3. Apply a non-hardening thread-locking compound to threads of caliper guide pins and install pins into yoke (if removed during cleaning and inspection). Tighten caliper guide pins to 30 lb-ft (41 N•m). Guide pins and bushing should be lubricated with silicone grease.
4. Position caliper onto yoke.

NOTE: When installing calipers, use a suitable tool to bottom out piston in caliper if needed.

5. Apply thread-locking compound to tapped holes of adapter. Using crowfoot, secure yoke and caliper to adapter with two washers and capscrews. Tighten two capscrews to 40 lb-ft (54 N•m).
6. Connect brake line to coupling.
7. Bleed brake system.

MASTER CYLINDER REPLACEMENT

Removal

CAUTION: *Cover or plug all open connections immediately after disconnecting to prevent contamination*

NOTE: Although 12,100 lb GVWR vehicles have a different style master cylinder than do the other Hummer models (Figure 7-10), service procedures remain the same.

NOTE: Have drainage container ready to catch brake fluid.

1. Disconnect front and rear brake lines from master cylinder (Figure 7-8).
2. Remove locknut, washer, and proportioning valve from right master cylinder mounting stud and master cylinder. Discard locknut.

CAUTION: *Do not apply excessive pressure or force on master cylinder.*

3. Remove two locknuts and master cylinder from hydro-boost. Discard locknuts (Figure 7-8).

Installation

1. Bench-bleed master cylinder.

CAUTION: *Ensure O-ring is properly seated on master cylinder prior to installation. Damage to master cylinder may result if O-ring is not properly seated.*

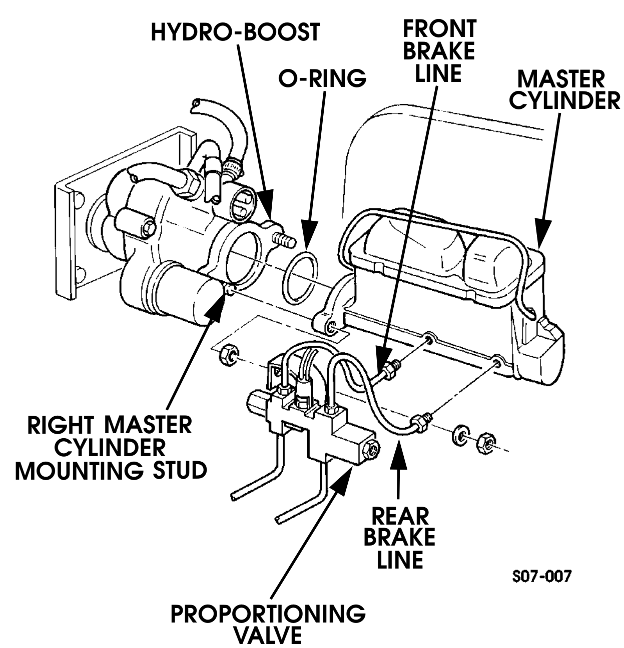

Figure 7-8: Master Cylinder

2. Install master cylinder to hydro-boost with two locknuts. Tighten locknuts to 22 lb-ft (30 N•m) (Figure 7-8).
3. Install proportioning valve to right master cylinder mounting stud with washer and locknut. Tighten locknut to 22 lb-ft (30 N•m) (Figure 7-8).
4. Install front and rear brake lines to master cylinder.

Master Cylinder Bleeding

NOTE: Master cylinder must be filled and kept at least half full during bleeding operation (Figure 7-9).

1. Depress brake pedal slowly and hold. Loosen front brake line to purge air from the front reservoir (closest to the hydro-boost).
2. Tighten front brake line and release brake pedal.
3. Repeat steps 1 and 2 until front reservoir is purged of air.
4. Repeat steps 1 through 3 for rear reservoir with rear brake line.
5. Bleed brake system.

MASTER CYLINDER BENCH BLEEDING

Bleeding

NOTE: Master cylinder must be filled and kept at least half full during bleeding operation. Perform this procedure prior to installing master cylinder on vehicle.

1. Secure master cylinder flange in vise.
2. Remove cover and fill reservoirs with silicone brake fluid.
3. Screw threaded end of bleeder hose into brake line port on master cylinder and insert opposite end into reservoir. Repeat step for other bleeder hose (Figure 7-9).
4. Slowly push piston into master cylinder. Do not release piston. Air will be forced into hoses. Repeat as needed until no bubbles noted from lines. Lines must stay in fluid until installed.
5. Refill reservoirs with silicone brake fluid and repeat step 4 until no air bubbles remain in brake fluid.
6. Remove bleeder hoses from brake line ports on master cylinder.
7. Install cover on master cylinder and remove from vise.
8. Install master cylinder.
9. Bleed brake system.

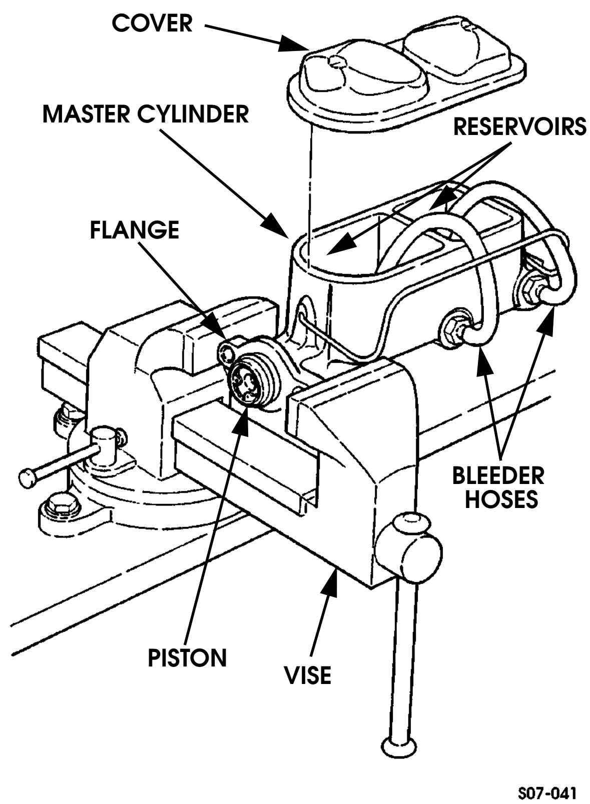

Figure 7-9: Bench Bleeding Master Cylinder

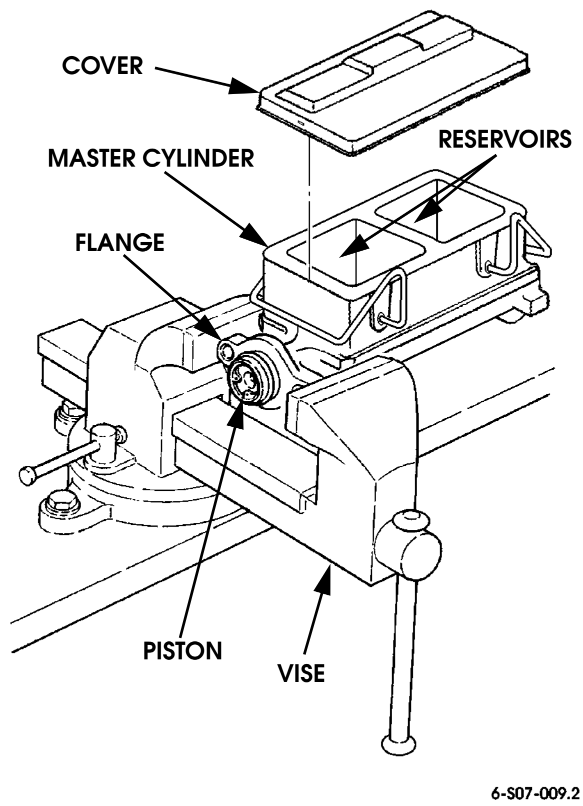

Figure 7-10: Bench Bleeding Master Cylinder (12,100 GVWR)

HYDRO-BOOST REPLACEMENT

Removal

1. Remove two nuts securing proportioning valve and splash shield mount bracket to hydro-boost/master cylinder assembly.
2. Remove nut securing mount bracket to splash shield and remove mount bracket.
3. Remove two nuts securing the master cylinder to the hydro-boost and pull the master cylinder out and to one side taking care not to kink the brake lines.
4. Disconnect two high pressure lines and one return line from hydro-boost (Figure 7-11).
5. Remove cotter pin, washer, and pushrod from brake pedal bellcrank. Remove spring washer from brake pedal bellcrank and discard cotter pin and spring washer.
6. Remove four nuts, lockwashers, washers, gasket, and hydro-boost from cowl. Discard lockwashers.

Installation

1. Install gasket and hydro-boost on cowl with four washers, lockwashers, and nuts. Do not tighten nuts. (Figure 7-11).
2. Install spring washer on brake pedal bellcrank. Connect hydro-boost pushrod to brake pedal bellcrank. Install washer and cotter pin.
3. Tighten nuts to 21 lb-ft (28 N•m).
4. Connect two high pressure lines and one return line to hydro-boost.
5. Install master cylinder, splash shield mount bracket and proportioning valve.
6. Bleed hydro-boost system.

BLEEDING THE HYDRO-BOOST SYSTEM

Whenever the booster is removed and installed, the steering system should be bled.

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

1. Fill the power steering pump reservoir to the proper level and let the fluid remain undisturbed for at least two minutes.
2. Start the engine and run momentarily. Add fluid if necessary.
3. Repeat steps 1 and 2 until the fluid level remains constant after running the engine.
4. Turn off the engine.
5. Raise the front of the vehicle so the wheels are off the ground. Support the vehicle with suitable safety stands.
6. Turn the wheels from stop to stop. Add fluid if necessary.
7. Lower the vehicle from the safety stands.
8. Start the engine and depress the brake pedal several times while rotating the steering wheel from stop to stop.
9. Turn the engine off and pump the brake pedal 4 to 5 times.
10. Check the brake fluid level. Add fluid if necessary.
11. If the fluid is extremely foamy, allow the vehicle to stand a few minutes with the engine on. Then repeat steps 7, 8, and 9.
12. Check for the presence of air in the oil. Air in the oil will give the fluid a milky appearance. Air in the system will also cause the fluid level in the pump to rise when the engine is turned off.

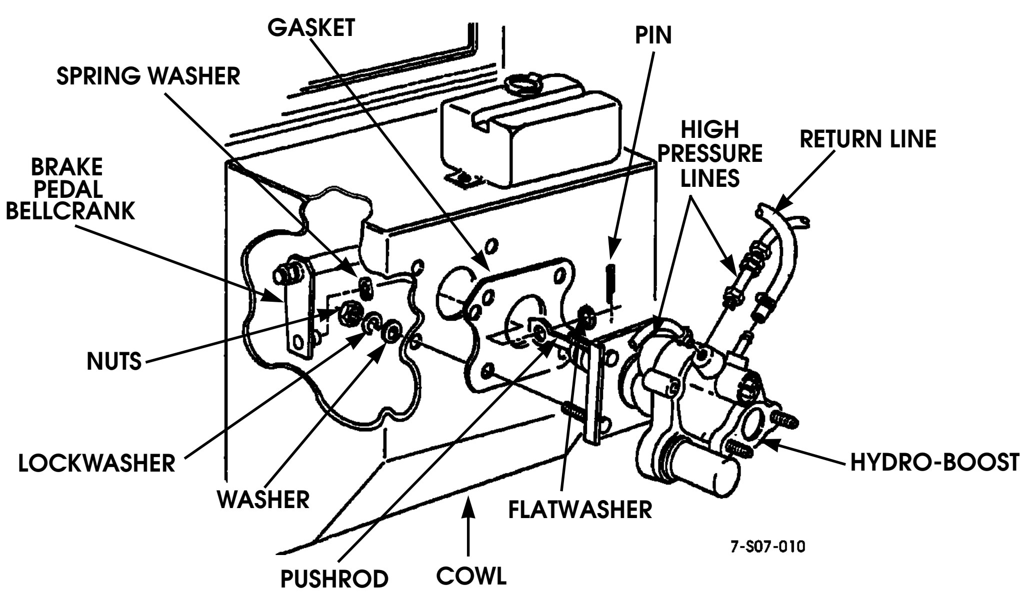

Figure 7-11: Hydro-boost Replacement Procedure

BRAKE LINE REPLACEMENT

NOTE: Brake line replacement procedures for the service brake system and the rear dual service/parking brake system are basically the same. Service brake system is shown.

NOTE: After servicing the brake system, bleed the brakes and refill as necessary.

Caliper-to-Tee Brake Line Removal

NOTE: Removal and installation procedures are basically the same for all caliper-to-tee brake lines. This procedure covers the left rear caliper-to-tee line.

1. Disconnect brake line from caliper.
2. Disconnect brake line from rear tee at forward rear crossmember.
3. Remove capscrew and clamp securing brake line and vent line to forward-rear crossmember, and remove brake line.

Caliper-to-Tee Brake Line Installation

1. Connect brake line to rear tee at forward-rear crossmember.
2. Connect brake line to caliper.
3. Install clamp on brake line and vent line.
4. Install brake line, vent line, and clamp on forward-rear crossmember with capscrew.

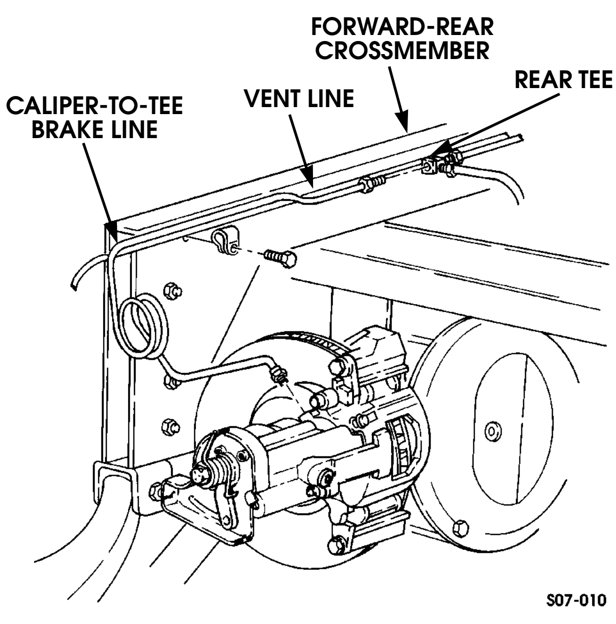

Figure 7-12: Caliper-to-Tee Brake line

Rear Brake Line Removal

1. Disconnect rear brake line from rear tee (Figure 7-13).
2. Remove capscrew and clamp securing rear brake line to forward-rear crossmember (Figure 7-14).
3. Disconnect rear brake line from intermediate brake line and remove rear brake line.

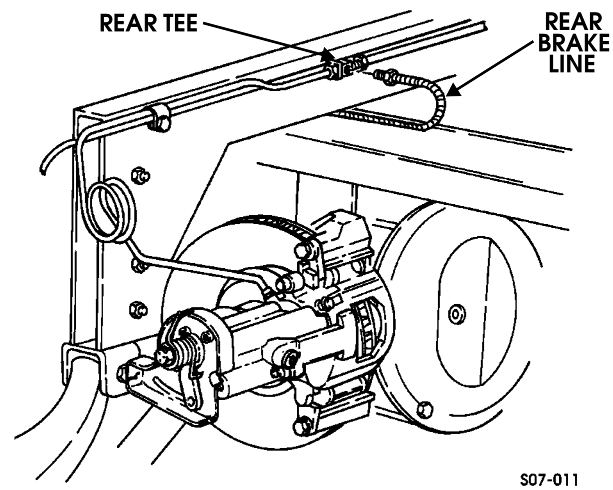

Figure 7-13: Rear Brake Line

Rear Brake Line Installation

1. Connect rear brake line to intermediate brake line (Figure 7-14).
2. Install rear brake line and clamp on forward-rear crossmember with capscrew.
3. Connect rear brake line to rear tee (Figure 7-13).

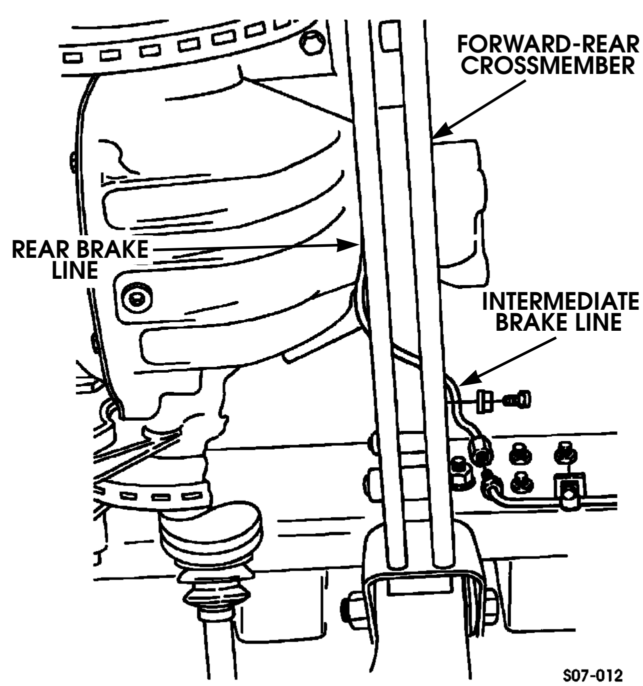

Figure 7-14: Rear Brake Line

Intermediate Brake Line Removal

1. Disconnect intermediate brake line from rear brake line (Figure 7-14).
2. Remove five capscrews, clamps, and intermediate brake line from frame (Figures 7-13 and 7-16).
3. Disconnect intermediate brake line from union brake line and remove brake line (Figure 7-17).

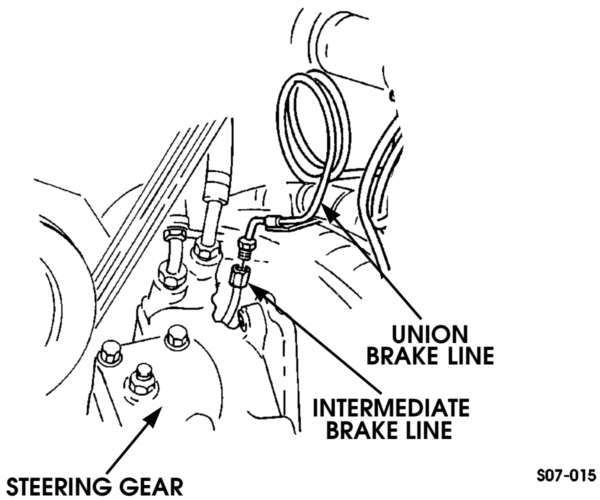

Figure 7-15: Intermediate Brake Line

Intermediate Brake Line Installation

1. Connect intermediate brake line to union brake line (Figure 7-15).
2. Connect intermediate brake line to rear brake line (Figure 7-16).
3. Install intermediate brake line on frame with five clamps and capscrews (Figure 7-17).

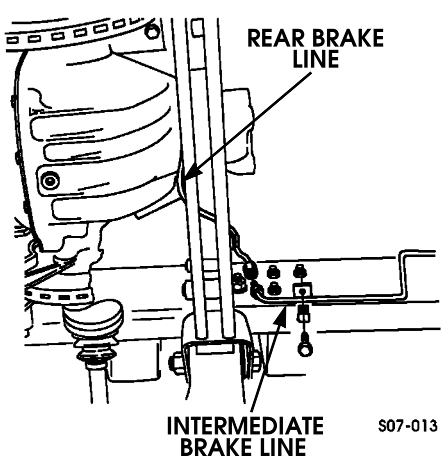

Figure 7-16: Intermediate Brake Line

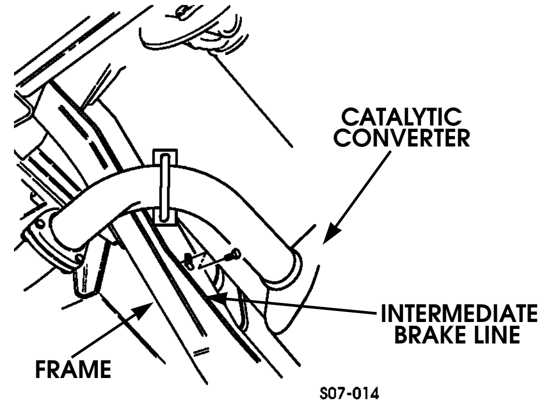

Figure 7-17: Intermediate Brake Line

Proportioning Valve to Union Brake Line Removal

1. Disconnect union brake line from proportioning valve (Figure 7-18).
2. Remove nut, washer, capscrew, and clamp securing union brake line to bracket.
3. Disconnect and remove union brake line from intermediate brake line.

Proportioning Valve to Union Brake Line Installation

1. Connect union brake line to intermediate brake line (Figure 7-18).
2. Install union brake line and clamp on bracket with capscrew, washer, and nut.
3. Connect union brake line to proportioning valve.

Proportioning Valve to Front Tee Brake Line Removal

1. Disconnect rear brake line from proportioning valve (Figure 7-18).
2. Disconnect and remove rear brake line from front tee.

Proportioning Valve to Front Tee Brake Line Installation

1. Connect rear brake line to front tee (Figure 7-18).
2. Connect rear brake line to proportioning valve.
3. Bleed brake system.

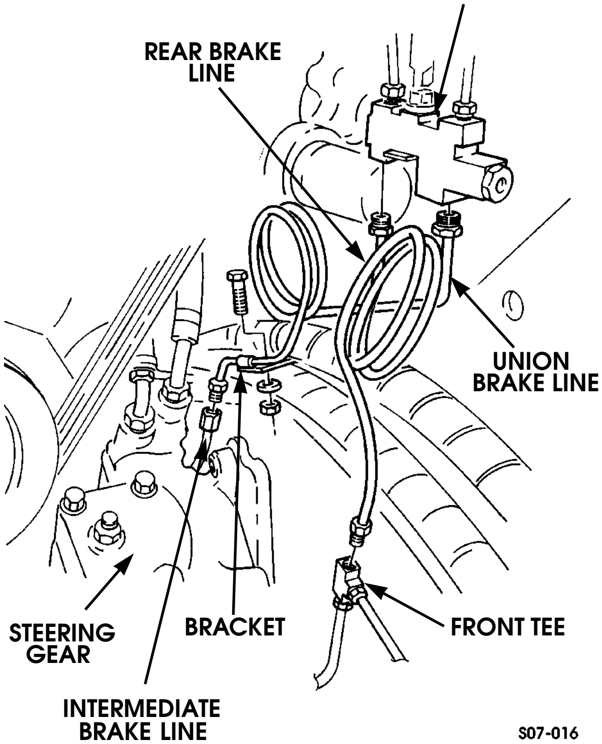

Figure 7-18: Proportioning Valve

BRAKE LINE REPLACEMENT 10,300 LB. GVWR

Both metal brake lines and hoses should be inspected for leaks or deterioration every time the vehicle is being serviced. Rubber brake hoses are not repairable. They should be replaced if cracked, swollen, dry-rotted, or otherwise damaged.

The brake hoses are clipped to frame mounted brackets and attached to the metal lines with threaded fittings. Brake hoses have inverted flares in order to seal with the flared ends on the metal lines. Lubricate fittings with brake fluid prior to assembly.

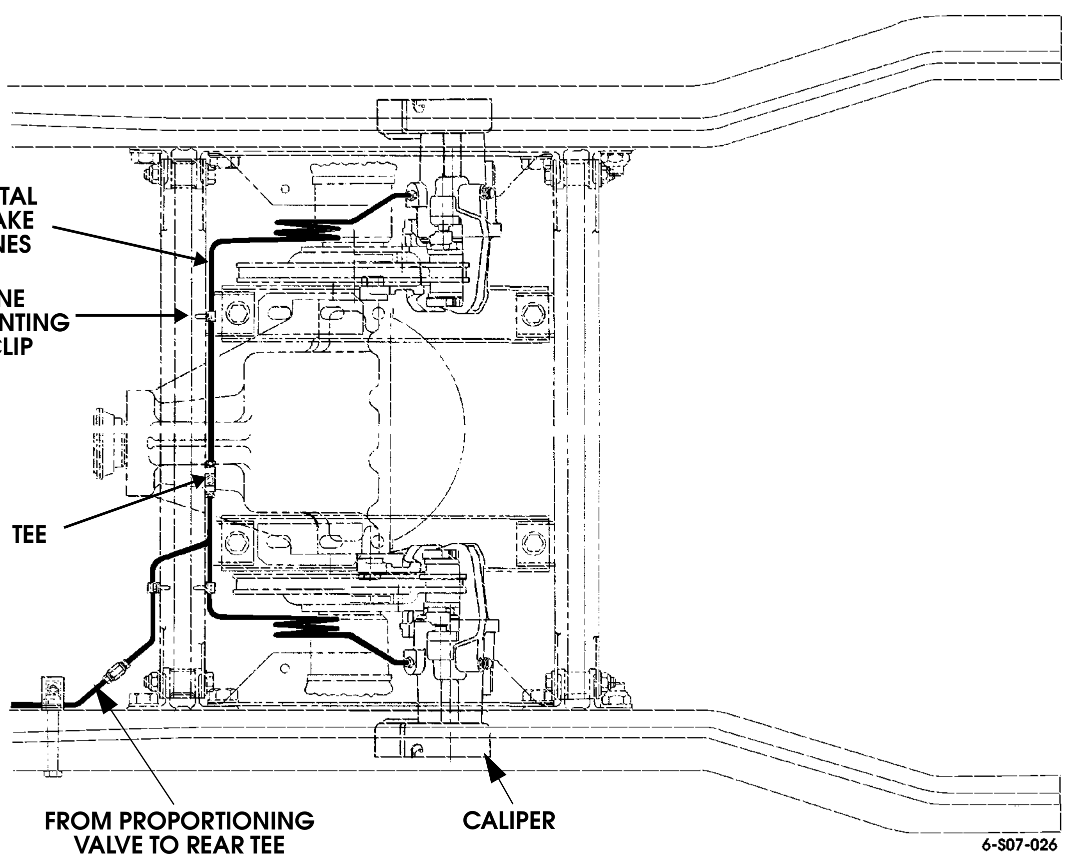

Figure 7-19: Rear Brake Component Location - Vehicles with 10,300 GVWR

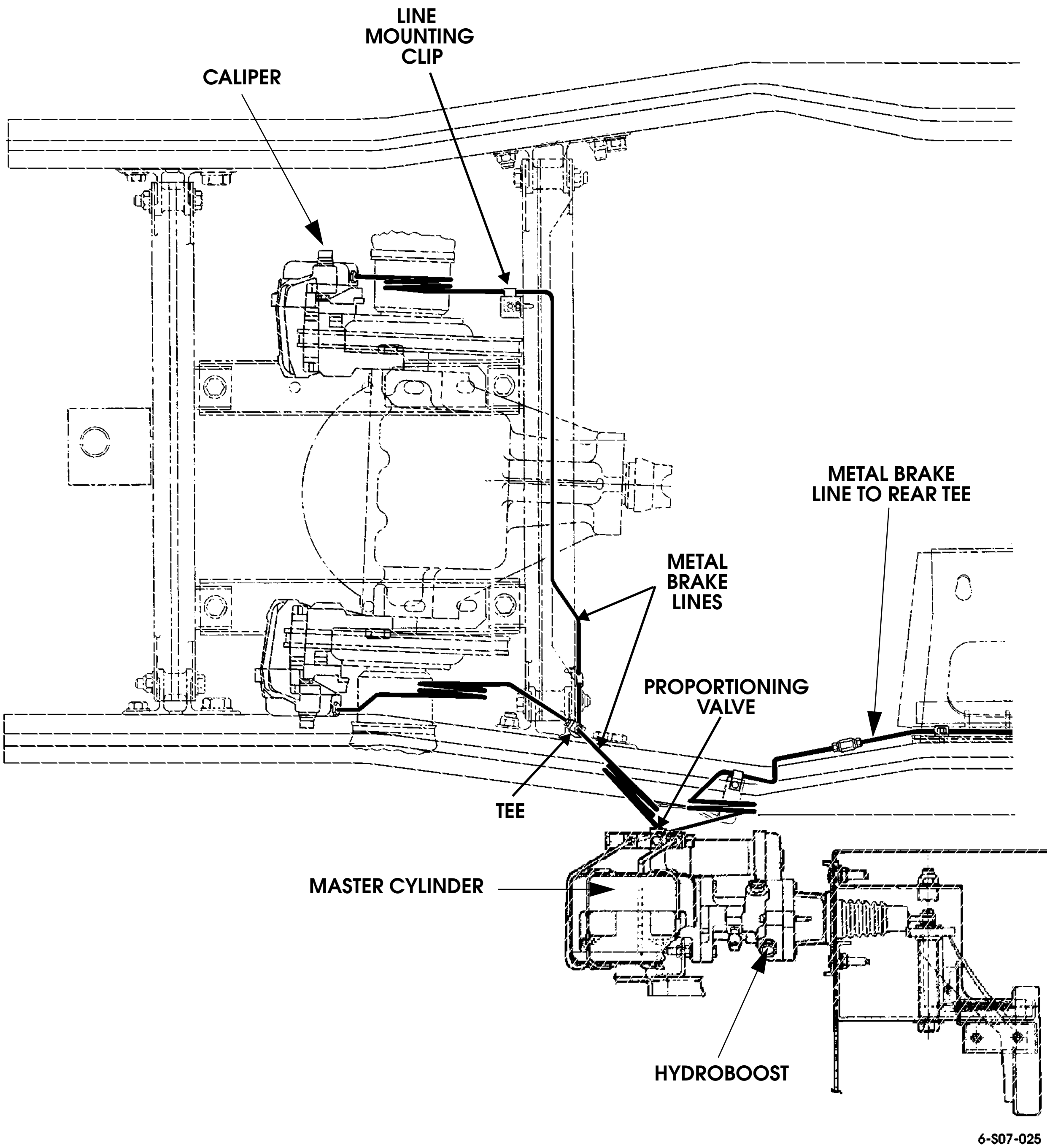

Figure 7-20: Front Brake Component Location - Vehicles with 10,300 GVWR

BRAKE LINE REPLACEMENT 12,100 LB. GVWR

The optional 12,100 lb. GVWR Hummer has a different hydraulic brake line configuration than other Hummer models. Vehicles built with this option have flexible brake hoses between the front and rear brake tees and calipers (Figure 7-21).

Both metal brake lines and hoses should be inspected for leaks or deterioration every time the vehicle is being serviced. Rubber brake hoses are not repairable. They should be replaced if cracked, swollen, dry-rotted, or otherwise damaged.

The brake hoses are clipped to frame mounted brackets attached to the metal lines with threaded fittings. Brake hoses have inverted flares in order to seal with the flared ends on the metal lines. Lubricate fittings with brake fluid prior to assembly.

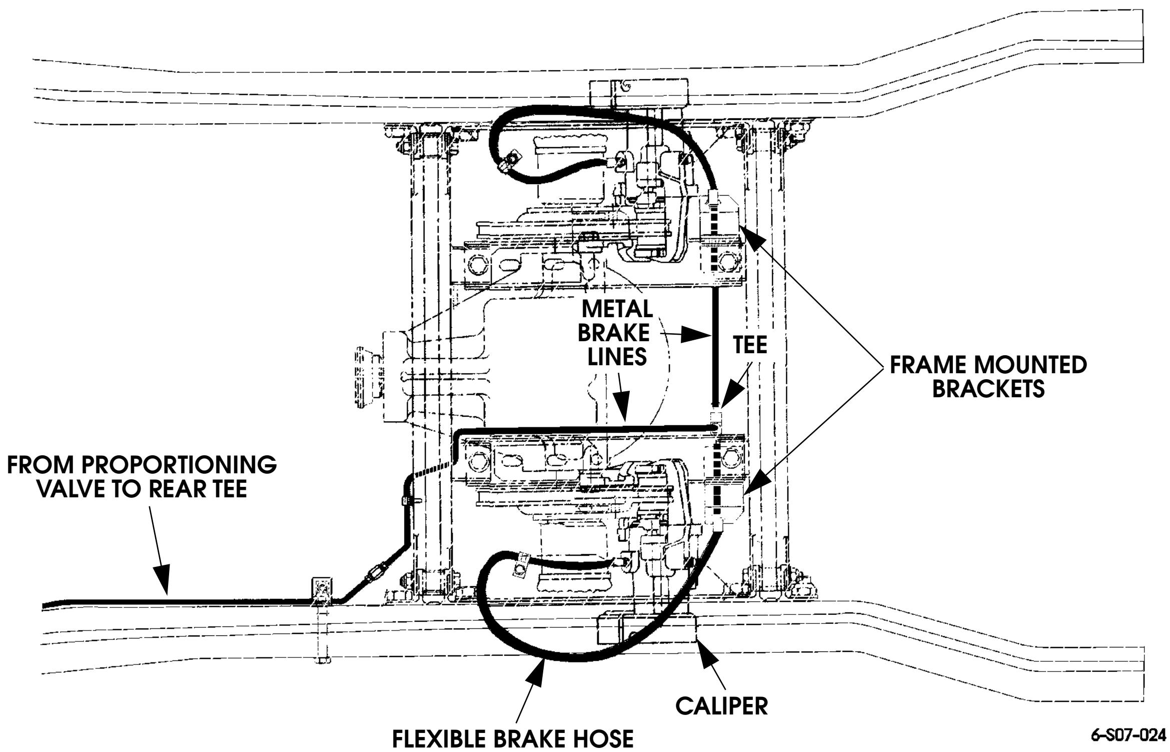

Figure 7-21: Rear Brake Component Location - Vehicles with 12,100 GVWR

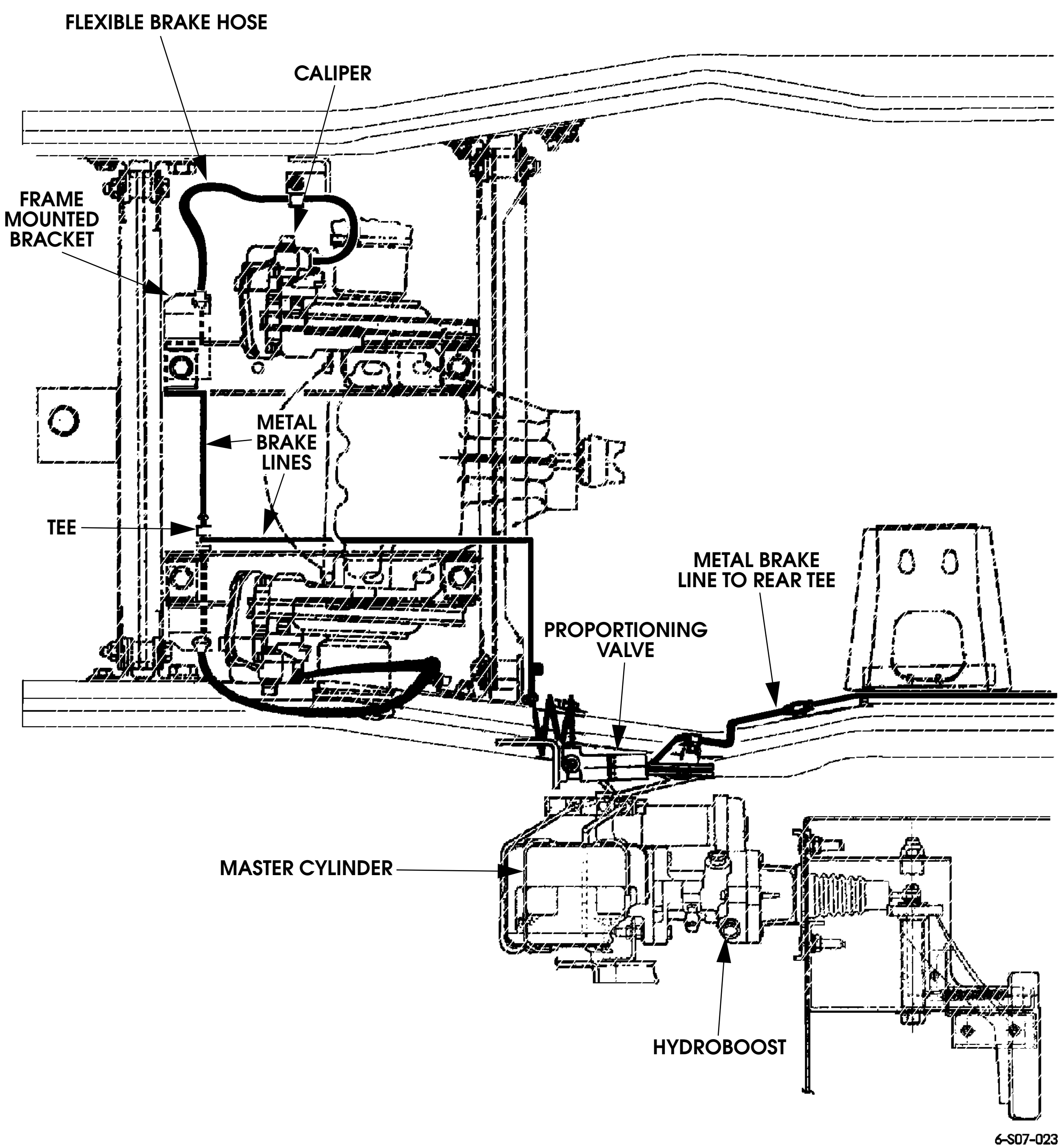

Figure 7-22: Front Brake Component Location - Vehicles with 12,100 GVWR

SERVICE BRAKE PEDAL REPLACEMENT

Removal

1. Disconnect the stoplight switch (Figure 7-23).
2. Remove pushnut and disconnect stoplight switch rod (if so equipped) from brake pedal assembly. Discard pushnut. (Figure 7-23).
3. Disconnect return spring from brake pedal assembly.
4. Remove cotter pin and washer securing hydro-boost pushrod to brake pedal bellcrank, and disconnect hydro-boost pushrod from brake pedal bellcrank. Remove spring washer. Discard cotter pin and spring washer.
5. Remove nut, two washers, pivot pin, and brake pedal assembly from bracket.
6. Remove two bushings from brake pedal assembly. Discard two bushings.

Installation

1. Apply silicone grease to inside of two bushings. Install two bushings in brake pedal assembly.
2. Install brake pedal assembly on bracket with pivot pin, two washers, and nut. Using adapter and crowfoot, tighten nut to 60 lb-ft (81 N•m).
3. Install spring washer on brake pedal bellcrank. Connect hydro-boost pushrod to brake pedal bellcrank with washer and cotter pin.
4. Connect return spring to brake pedal assembly.
5. Use the pushnut to install the stoplight switch rod (if so equipped) to brake pedal assembly.
6. Connect the stoplight switch.
7. Operate vehicle and check brakes for proper operation.
8. Check brake lights for proper operation.

PROPORTIONING VALVE REPLACEMENT

Removal

CAUTION: *Do not attempt to disassemble proportioning valve. Damage to equipment will result.*

1. Disconnect electrical connector from proportioning valve (Figure 7-24).
2. Disconnect four brake lines from proportioning valve.
3. Remove locknut, washer, and proportioning valve from hydro-boost. Discard locknut.

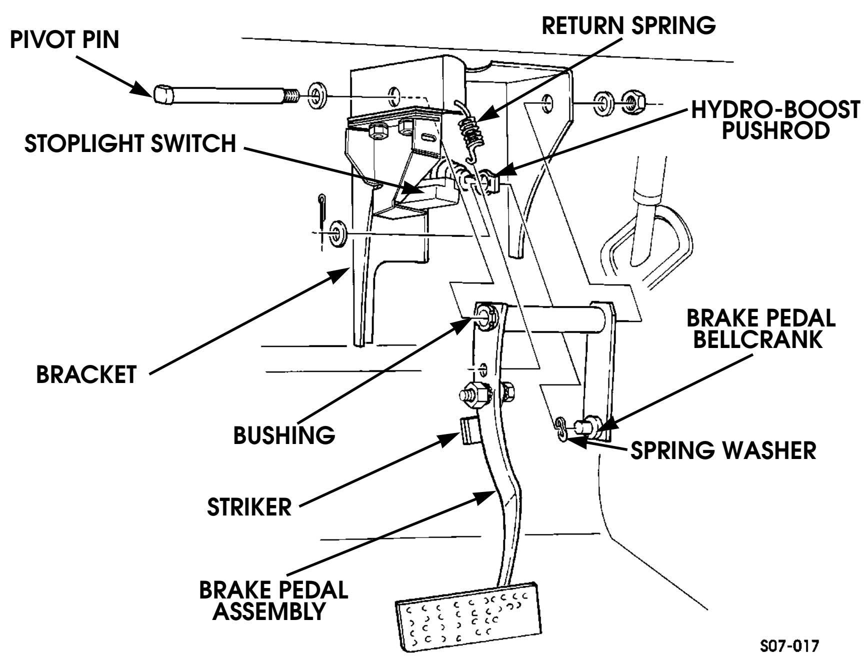

Figure 7-23: Service Brake Pedal Components

Installation

1. Install proportioning valve on hydro-boost with washer and locknut. Tighten locknut to 22 lb-ft (30 N•m) (Figure 7-24).
2. Connect four brake lines to proportioning valve.
3. Apply lubricating oil to pin on proportioning valve.
4. Connect electrical connector to proportioning valve.
5. Bleed brake system.
6. Operate vehicle and check brakes for proper operation.
7. Check brake lines at proportioning valve for leaks.

SERVICE BRAKE ROTOR REPLACEMENT

NOTE: Larger diameter brake rotors (12”) are used on the 12,100 lb. GVWR Hummer brake system. All other Hummer models use a 10.5” diameter rotors. Service procedures are the same regardless of rotor diameter.

Removal

1. Remove service brake caliper.
2. Remove six capscrews, lockwashers, halfshaft, and rotor from output flange. Discard lockwashers (Figure 7-25).

Installation

1. Apply thread-locking compound to threads of capscrews.
2. Install rotor on output flange.
3. Secure halfshaft and rotor to output flange with six lockwashers and capscrews. Tighten capscrews to 48 lb-ft (65 N•m).
4. Install service brake caliper.

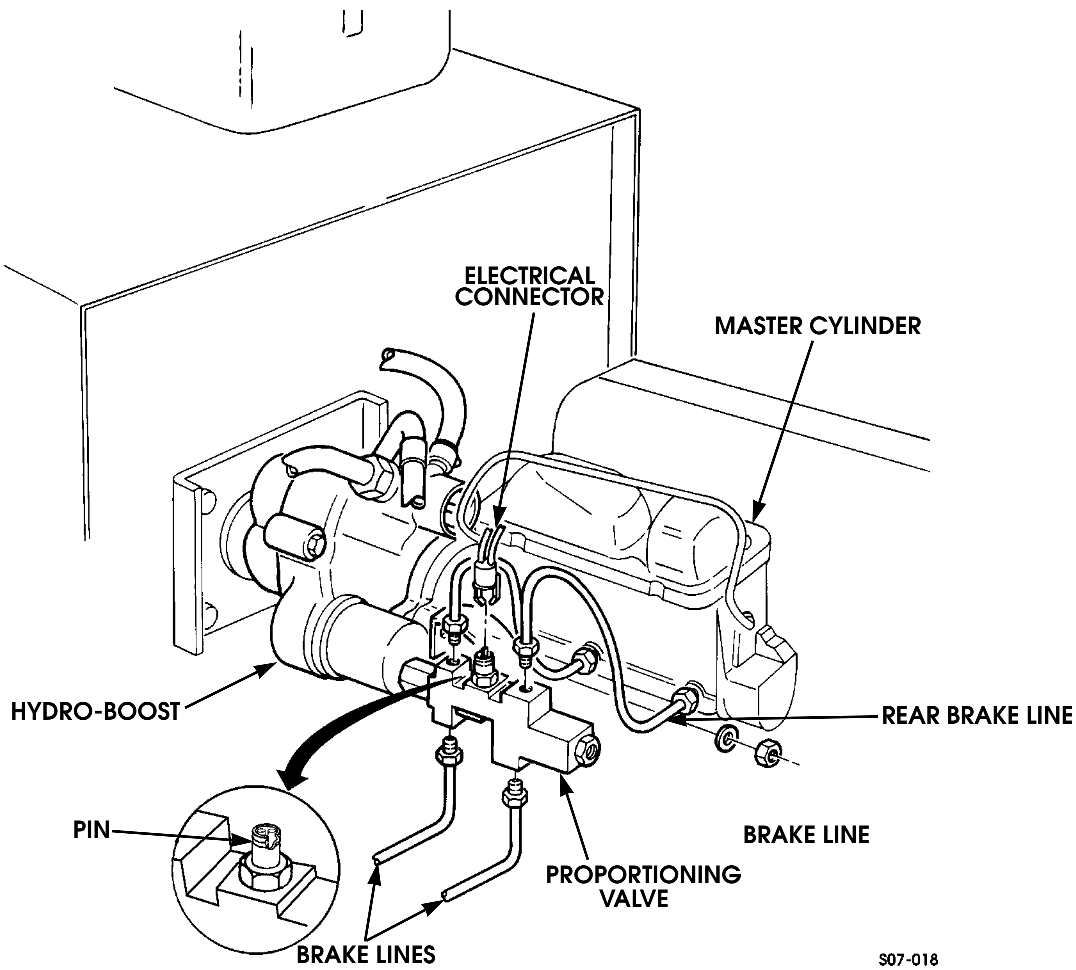

Figure 7-24: Hydro-Boost, Master Cylinder, and Proportioning Valve Mounting

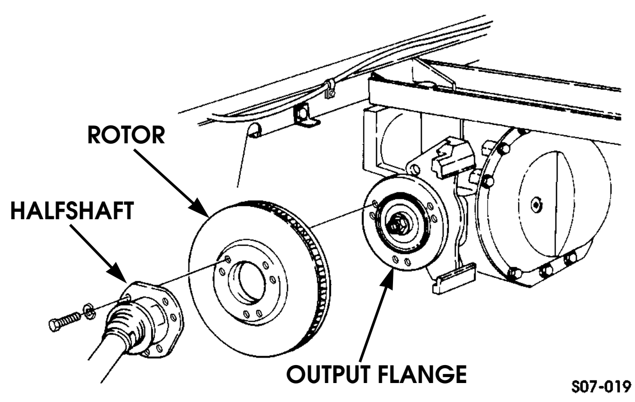

Figure 7-25: Service Brake Rotor

REAR DUAL SERVICE/PARKING BRAKE PAD REPLACEMENT

NOTE: Larger brake pads and rotors are used on 12,100 lb. GVWR Hummers. Check the parts manual carefully to be sure the replacement pads are correct for the application.

Removal

1. Put transmission in PARK, chock wheels, and release parking brake.
2. Remove cotter pin, washer, and clevis pin securing parking brake cable to lever. Discard cotter pin (Figure 7-26).
3. Remove clip securing parking brake cable to caliper cable bracket and disconnect cable from caliper cable bracket. Discard clip.

CAUTION: *Caliper must be supported during removal to prevent damage to brake line.*

4. Remove two capscrews and washers securing yoke and caliper to adapter, and pull yoke and caliper away from rotor (Figure 7-27).

NOTE: Note positioning of brake pad surfaces for installation.

5. Remove two brake pads from adapter and rotor.

Cleaning and Inspection

NOTE: Clean all components, examine for wear or damage, and replace if necessary.

1. Clean mating surfaces of caliper and adapter and lightly lubricate adapter slides with grease (Figure 7-27).

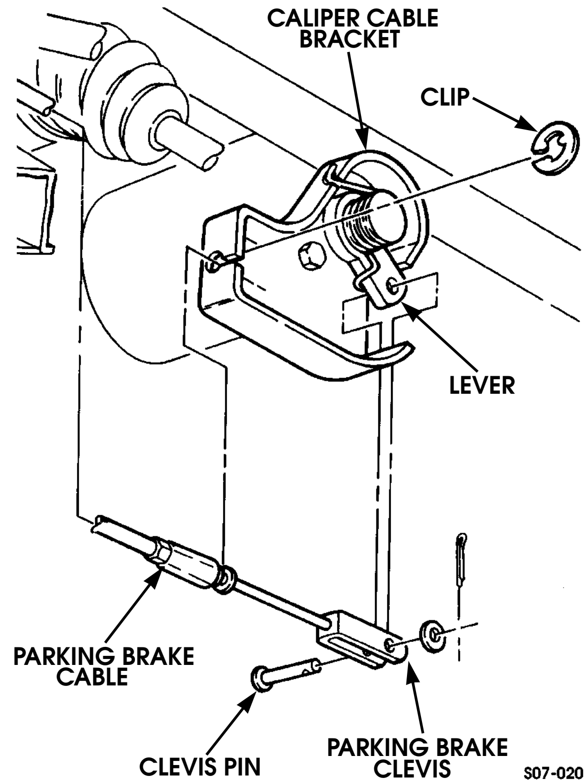

Figure 7-26: Rear Dual Brake Components

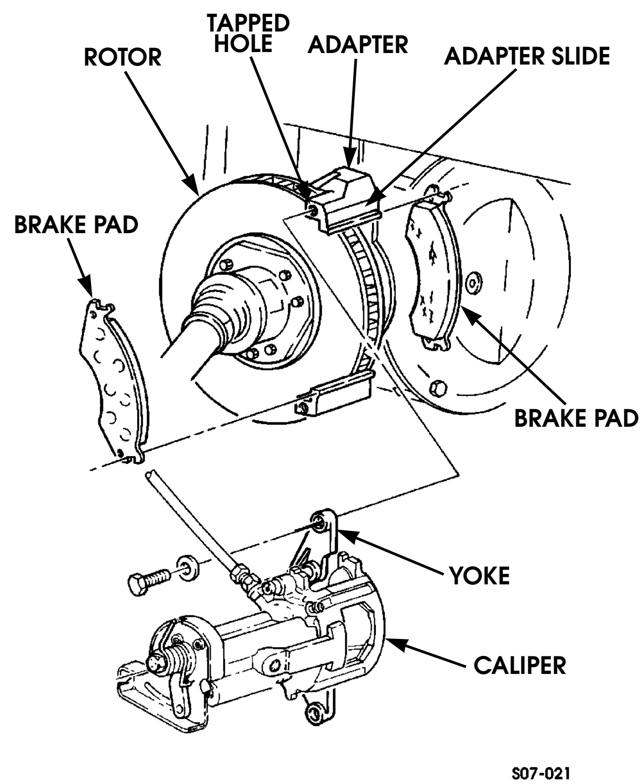

Figure 7-27: Rear Dual Brake Pad and Rotor

2. Inspect caliper and caliper piston face for pitting or damage (Figure 7-28).
3. Inspect piston dust boot and bushings for tears or deterioration.
4. Inspect caliper cable bracket for looseness, damage, and rotation.
5. Thoroughly clean and inspect rotor for heat checks, discoloration, pitting, or scoring (Figure 7-27).

CAUTION: *Ensure that grease and oil are not in contact with rotor and/or brake pad friction surface. Failure to do so will result in damage to equipment and poor performance.*

NOTE: Replace brake pads in sets only. If operation in wet and muddy conditions is expected, replace brake pads if brake lining thickness is less than 1/8 in. (3.2 mm).

6. Inspect brake pads for glazing, oil saturation, or wear. If glazed, oil saturated, or if brake lining thickness is less than 1/8 in. (3.2 mm), replace both pads and pads on opposite caliper.

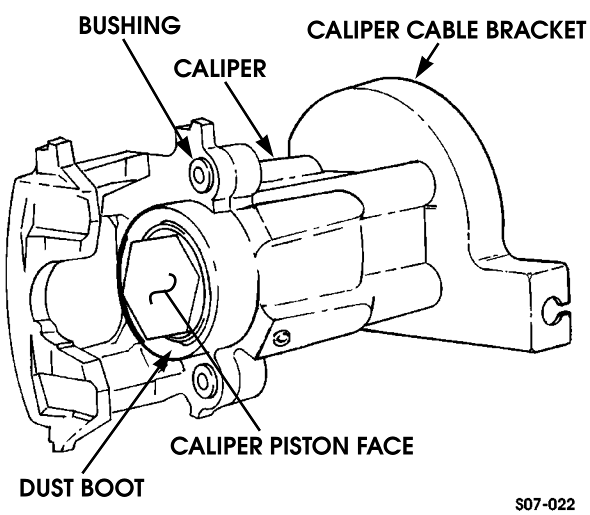

Figure 7-28: Rear Dual Brake Caliper

Installation

WARNING: Ensure brake pads are installed with linings facing rotor. Failure to do this will cause poor performance and damage to equipment and may result in injury.

1. Position linings facing rotor in adapter (Figure 7-27).

NOTE: Always apply thread-locking compound to the tapped holes.

2. Apply thread-locking compound to tapped holes of adapter.
3. Using special tool J42553, rotate caliper piston in a clockwise direction, and at the same time apply force on outer piston face until caliper piston is seated in piston bore (Figure 7-28).
4. Position caliper and yoke on adapter and rotor. Secure yoke to adapter with two washers and capscrews. Using a crowsfoot, tighten capscrews to 40 lb-ft (54 N•m) (Figure 7-27).
5. Install parking brake cable to caliper cable bracket and secure with clip (Figure 7-29).

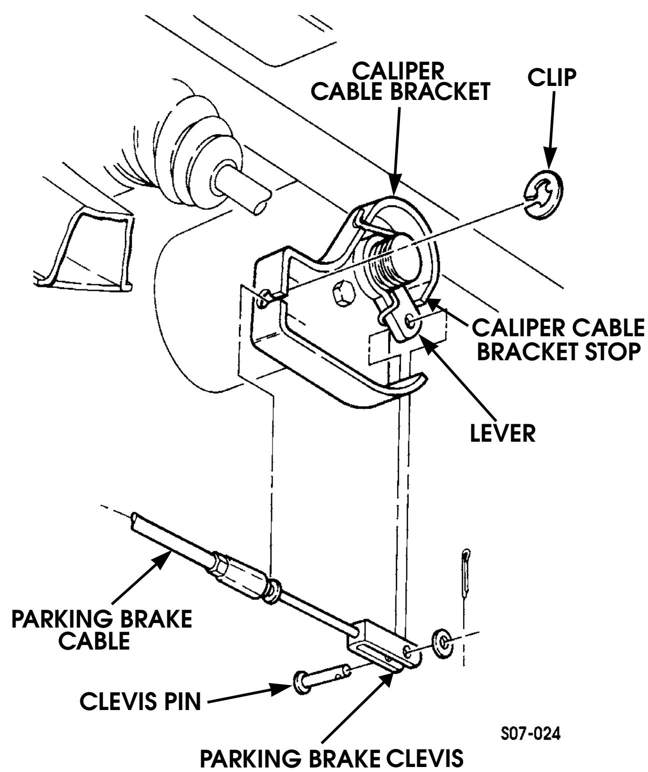

Figure 7-29: Rear Dual Brake Caliper Cable

CAUTION: *Ensure lever is in contact with caliper cable bracket stop. Damage to equipment and poor performance will result if not aligned properly. Ensure that clevis and clevis pin are aligned to the lever. Do not move lever to accommodate a maladjusted clevis. Damage to equipment and poor performance will result.*

6. Install parking brake clevis to lever with clevis pin, washer, and cotter pin. Check position of lever and ensure it is in contact with caliper cable bracket stop.
7. Adjust rear dual service/parking brake.

REAR DUAL SERVICE/PARKING BRAKE CALIPER REPLACEMENT

NOTE: The brake caliper assemblies found on the 12,100 lb. GVWR Hummer have dimensionally different adapters for mounting the calipers to the vehicle chassis. Check the parts manual carefully to be sure the replacement assembly is correct for the application. Service procedures are the same for either caliper assembly.

Removal

1. Put transmission in PARK, chock wheels, and release parking brake.
2. Remove cotter pin, washer, and clevis pin securing parking brake clevis to lever. Discard cotter pin (Figure 7-29).
3. Remove clip and parking brake cable from caliper cable bracket. Discard clip.
4. Disconnect brake line from coupling (Figure 7-30).

NOTE: Vehicles with a 12,100 GVWR are not equipped with a coupling.

5. Remove coupling and copper washer from caliper.

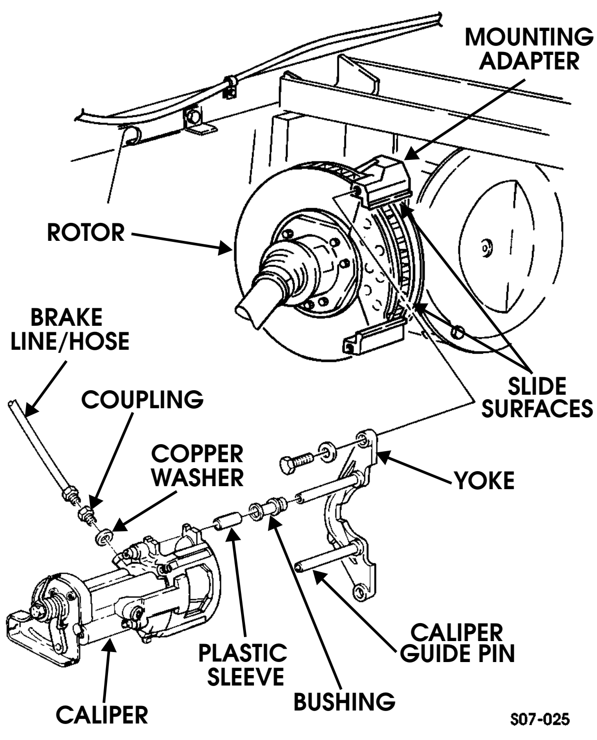

Figure 7-30: Rear Dual Brake Components

***CAUTION:** Caliper must be supported during removal to prevent damage to brake line.*

6. Remove two capscrews, washers, yoke, and caliper from adapter.
7. Slide yoke and caliper guide pins out from caliper.

Cleaning and Inspection

NOTE: Clean all components, examine for wear or damage, and replace if necessary. Apply a light coat of grease on adapter slides.

1. Clean mating surfaces of caliper and adapter and lubricate adapter slides with silicone grease (Figures 7-25 and 7-27).
2. Inspect caliper and caliper piston face for pitting or damage (Figure 7-32).
3. Inspect caliper cable bracket for looseness, damage, and rotation
4. Inspect piston dust boot and bushing for tears or deterioration.
5. Clean cooling fins of rotor (Figure 7-30).
6. Inspect rotor for heat checks, discoloration, pitting, or damage.
7. Inspect yoke and caliper guide pins for corrosion. Perform step 8 if corroded, if not, perform step 9.
8. Remove caliper guide pins from yoke. Discard caliper guide pins.
9. Inspect brake pads for glazing, oil saturation, or wear. If glazed, oil saturated, or if brake lining thickness is less than 1/8 in. (3.2 mm), replace both pads and pads on opposite caliper.

***CAUTION:** Ensure that grease and oil are not in contact with rotor and/or brake pad friction surfaces. Failure to do so will result in damage to equipment and poor performance.*

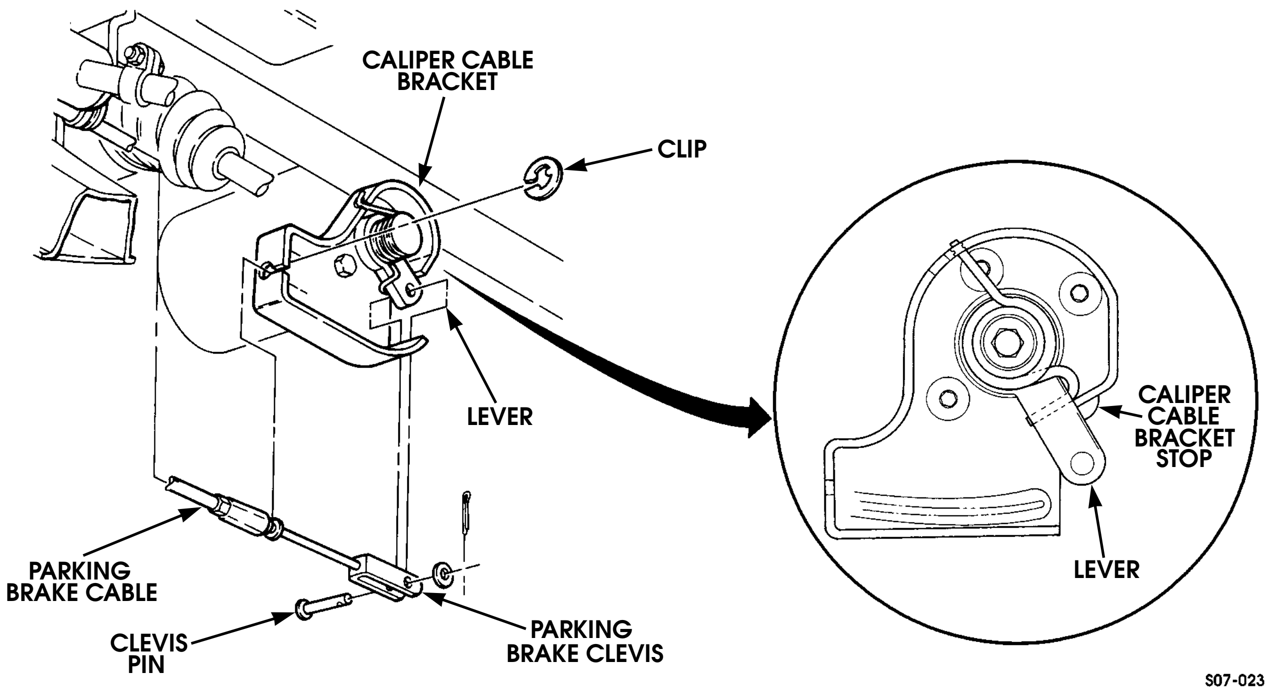

Figure 7-31: Rear Dual Service/Parking Brake Caliper Cable Bracket

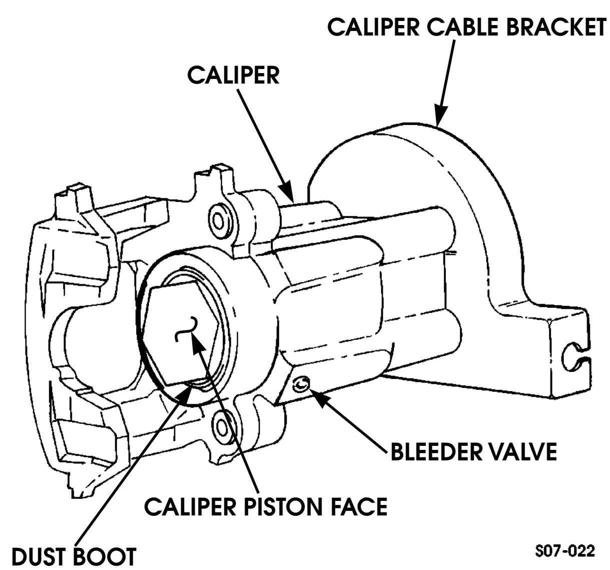

Figure 7-32: Rear Caliper and Bleeder Valve

Installation

1. Open bleeder valve and depress piston into caliper while rotating piston in a clockwise direction, and at the same time apply pressure until piston is seated in piston bore (Figure 7-32).

NOTE: Perform step 2 only if caliper guide pins were replaced.

2. Apply thread-locking compound to threads of caliper guide pins and install caliper guide pins in yoke. Tighten caliper guide pins to 30 lb-ft (41 N•m) (Figure 7-33).
3. Clean caliper guide pins and slide yoke and caliper guide pins into caliper
4. Apply thread-locking compound to tapped holes of adapters.
5. Position caliper and yoke on adapter and rotor. Install caliper and yoke on adapter with two washers and capscrews. Using crowfoot, tighten capscrews to 40 lb-ft (54 N•m).
6. Install copper washer and coupling on caliper and connect brake line to coupling.
7. Install parking brake cable on caliper cable bracket and secure with clip (Figure 7-31).

CAUTION: *Ensure lever is in contact with caliper cable bracket stop. Damage to equipment and poor performance will result if not aligned properly. Ensure that clevis and clevis pin are aligned to lever. Do not move lever to accommodate a misadjusted clevis, or damage to equipment and poor performance will result.*

8. Install parking brake clevis on lever and secure with clevis pin, washer, and cotter pin.
9. Check position of lever and ensure it is in contact with caliper cable bracket stop.
10. Bleed brake system.
11. Adjust rear dual service/parking brake.

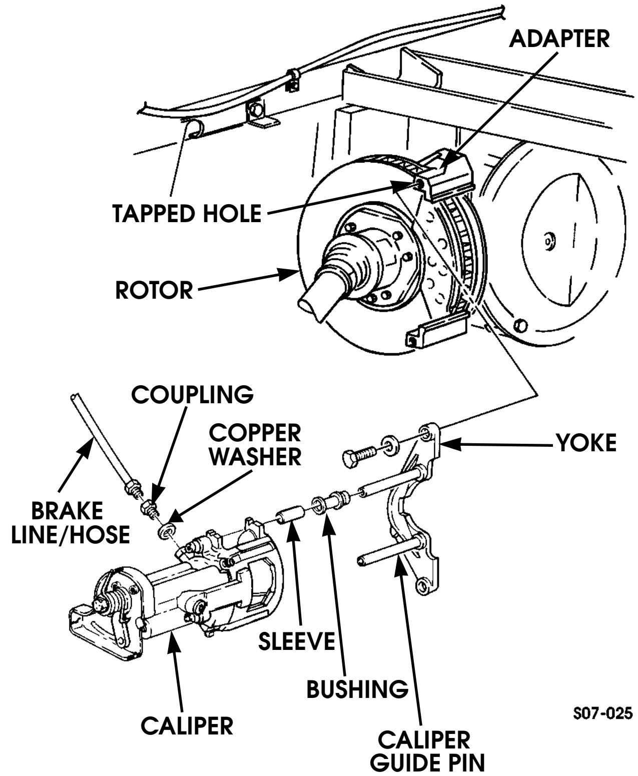

Figure 7-33: Rear Brake Components

RIGHT PARKING BRAKE CABLE REPLACEMENT

Removal

1. Put transmission in PARK, chock wheels, and release parking brake.
2. Remove cotter pin, washer, clevis pin, and brake clevis from lever. Discard cotter pin (Figure 7-34).
3. Remove clip securing cable sleeve to caliper cable bracket and remove parking brake cable assembly from caliper cable bracket. Discard clip.
4. Slide parking brake cable through parking brake cable assembly. Remove clip securing cable sleeve to C-beam. Disconnect parking brake cable from equalizer bar. Discard clip.
5. Remove two capscrews securing two clamps and parking brake cable assembly to frame.
6. Remove capscrew, lockwasher, and clamp from bracket. Discard lockwasher.

NOTE: Perform step 7 if bracket is damaged. If not replacing bracket, proceed to installation. Note position of cable, bracket, and clamp prior to removal.

7. Remove two capscrews and bracket from support bracket.

Installation

NOTE: Perform step 1 if clamp bracket was removed, if not, proceed to step 2.

1. Rotate bracket inward on support bracket and secure with two capscrews.
2. Install clamp on parking brake cable assembly and install clamp to bracket with lockwasher and capscrew.
3. Install two clamps on parking brake cable assembly and install clamps on frame with two capscrews.
4. Install cable sleeve on C-beam and parking brake cable on equalizer bar and secure with cable clip.

CAUTION: *Ensure that the caliper cable bracket is secure with no signs of looseness and the lever is in contact with the caliper cable bracket stop. Damage to equipment and poor performance will result if not aligned properly.*

5. Install cable sleeve on caliper cable bracket with brake cable clip.
6. Install brake clevis on lever with clevis pin, washer, and cotter pin.
7. Adjust parking brake lever.

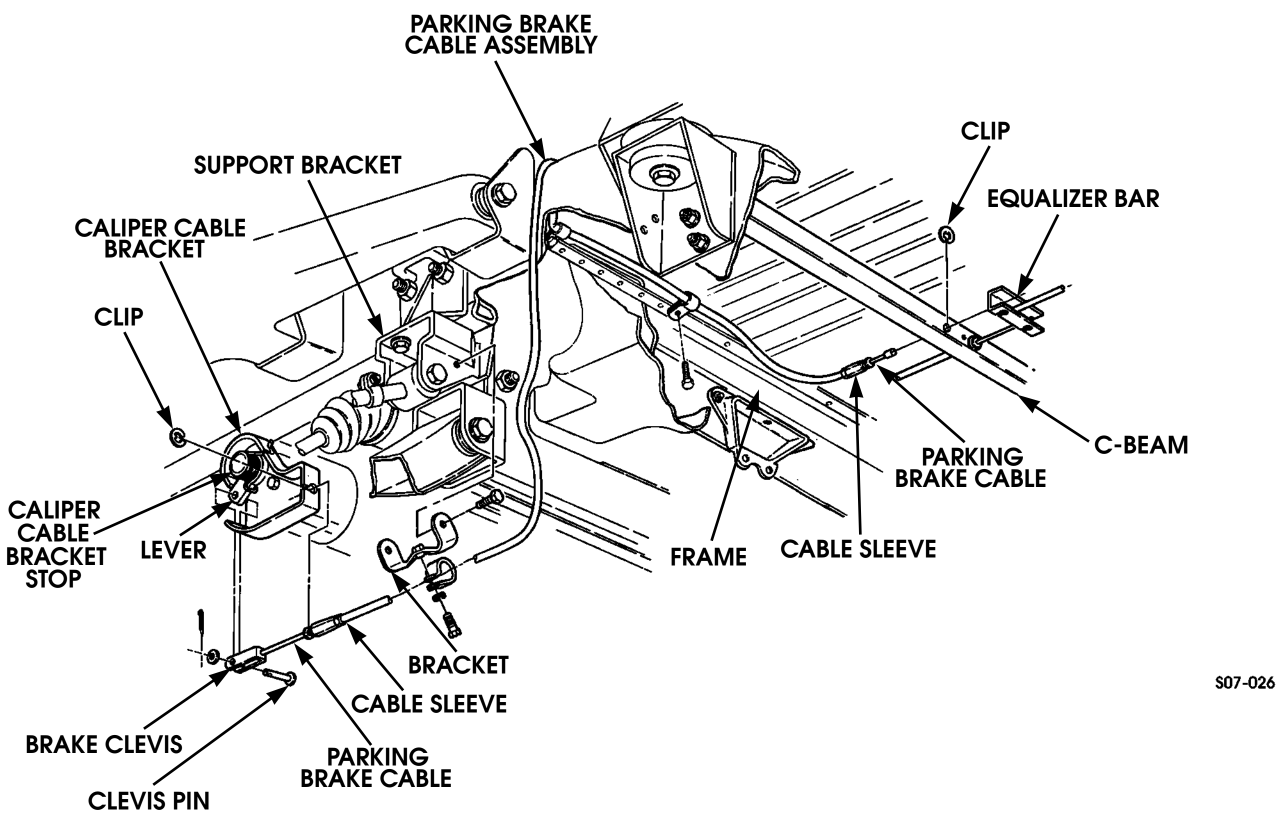

Figure 7-34: Right Parking Brake Cable Components

8. Left Parking Brake Cable Replacement

Removal

1. Put transmission in PARK, chock wheels, and release parking brake.
2. Remove cotter pin, washer, clevis pin, and brake clevis from lever. Discard cotter pin (Figure 7-35).
3. Remove clip and cable sleeve from caliper cable bracket. Discard clip.
4. Slide parking brake cable through parking brake cable assembly. Remove clip securing cable sleeve to C-beam. Disconnect parking brake cable from equalizer bar. Discard clip.
5. Remove capscrew, washer, nut and lockwasher assembly and washer securing clamp to mounting bracket and parking brake cable assembly. Discard nut and lockwasher assembly.
6. Remove capscrew, lockwasher, clamp, and parking brake cable assembly from bracket. Discard lockwasher.

NOTE: Perform step 7 if clamp bracket is damaged. If not replacing bracket, proceed to installation. Note position of cable, bracket, and clamp prior to removal.

7. Remove two capscrews and bracket from support bracket.

Installation

NOTE: Perform step 1 if clamp bracket was removed. If not, proceed to step 2.

1. Rotate bracket inward on support bracket and secure with two capscrews (Figure 7-35).
2. Install clamp on parking brake cable assembly and bracket with lockwasher and capscrew.
3. Install clamp on parking brake cable assembly and mounting bracket with washer, capscrew, washer, and nut and lockwasher assembly.
4. Install cable sleeve on C-beam and parking brake cable to equalizer bar and secure with clip.

***CAUTION:** Ensure that the caliper cable bracket is secure with no signs of looseness and the lever is in contact with the caliper cable bracket stop. Damage to equipment and poor performance will result if not aligned properly.*

5. Install cable sleeve on caliper cable bracket with clip.
6. Install brake clevis on lever with clevis pin, washer, and cotter pin.
7. Adjust parking brake lever.

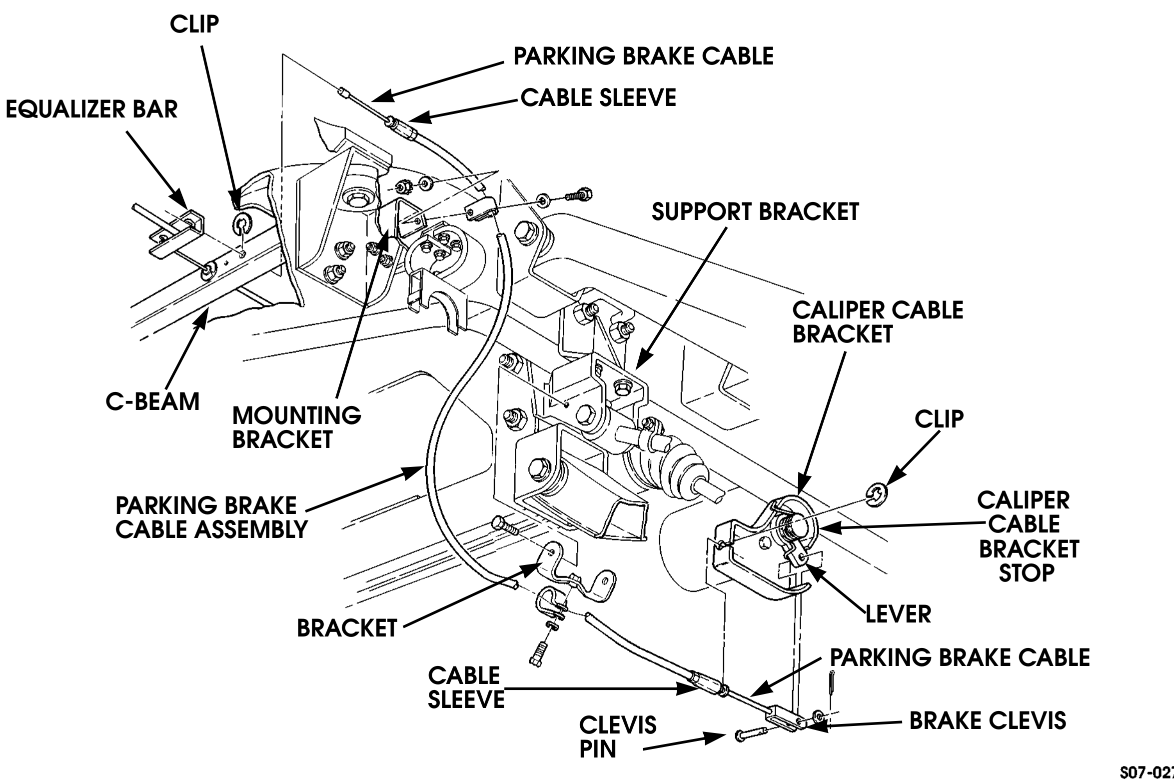

Figure 7-35: Left Parking Brake Cable Components

PARKING BRAKE ROD REPLACEMENT

Removal

1. Put transmission in PARK, chock wheels, and release parking brake.
2. Remove cotter pin, washer, clevis pin, and brake clevis from lever. Discard cotter pin (Figure 7-36).
3. Remove six clips and spread boot to allow access to cotter pin (Figure 7-37).
4. Remove cotter pin, washer, clevis pin, and clevis securing brake rod to bellcrank. Discard cotter pin.
5. Disconnect spring from bracket (Figure 7-37).
6. Remove locknut from conical washer, and brake rod from equalizer bar. Discard locknut.
7. Remove clevis, nut and spring from brake rod.

Installation

1. Install spring, nut, and clevis on brake rod.
2. Install brake rod on equalizer bar with conical washer and locknut. Tighten locknut far enough to expose 3-5 threads on the end of brake rod.
3. Connect spring to bracket.
4. Spread boot and install clevis to bellcrank with clevis pin, washer and cotter pin.
5. Install six clips on boot.

CAUTION: *Ensure that the caliper cable bracket is secure with no signs of looseness and the lever is in contact with the caliper cable bracket stop.*

6. Install brake clevis on lever with clevis pin, washer, and cotter pin (Figure 7-38).
7. Adjust parking brake.

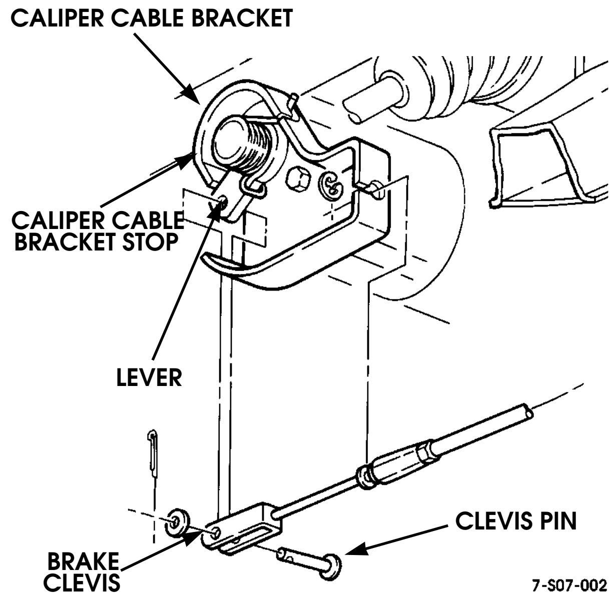

Figure 7-36: Parking Brake Rod Attachment at Caliper

PARKING BRAKE ADJUSTMENT

NOTE: The integral parking/service brake mechanism has an automatic adjusting feature and does not require periodic manual adjustment. When parking brake components or rear brake pads are replaced, the parking brake linkage must be initially positioned to ensure proper parking brake system operation. The only additional adjustment necessary is accomplished with the parking brake hand lever.

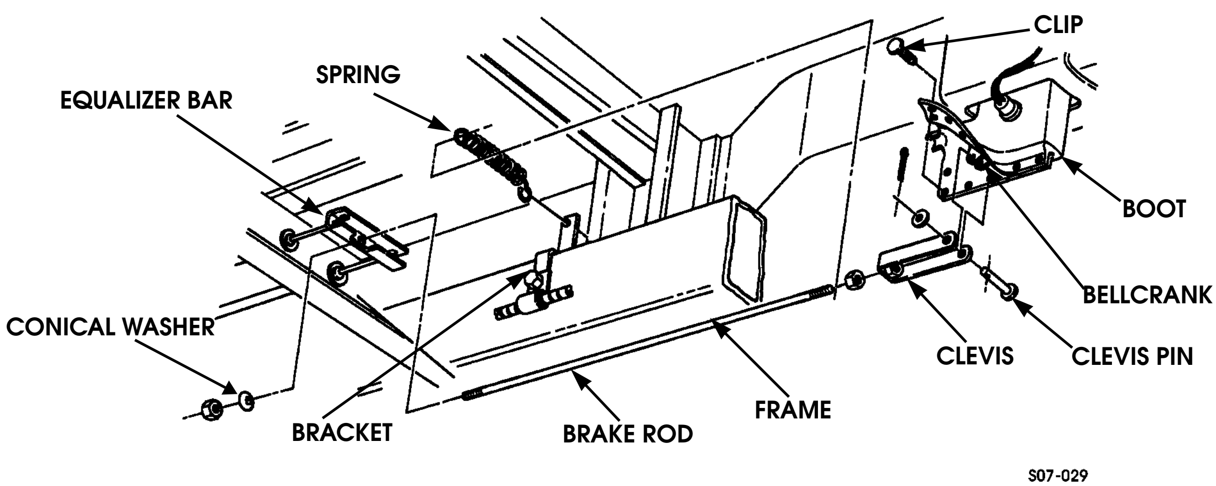

Figure 7-37: Parking Brake Rod Location

Adjustment

1. Put transmission in PARK, chock wheels, and release parking brake.
2. Remove six clips and spread boot to allow access to cotter pin (Figure 7-38).
3. Remove cotter pin, washer, and clevis pin securing clevis to bellcrank. Discard cotter pin.
4. Repeatedly apply and adjust parking brake hand lever until bellcrank linear travel is 0.75 in. (19 mm).

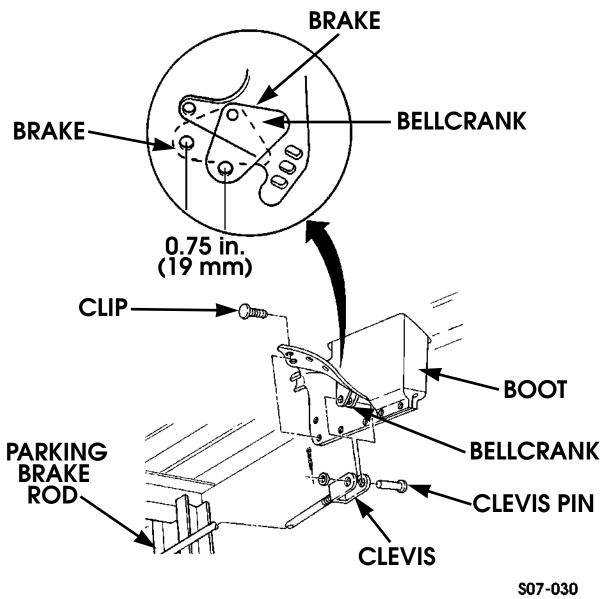

Figure 7-38: Parking Brake Adjustment

CAUTION: *Holes in parking brake clevis must align with holes in adjusting bellcrank without force for proper parking brake adjustment. Failure to do this may result in damage to equipment and poor performance.*

5. Release parking brake. Loosen nut and adjust clevis so holes in clevis align with holes in bellcrank. Secure clevis to bellcrank with clevis pin, washer, and cotter pin.

CAUTION: *Do not overtighten parking brake rod. Overtightening parking brake rod may result in dragging brakes.*

6. If necessary, remove excess slack in parking brake cables by turning the parking brake rod clockwise or counterclockwise into the clevis.

CAUTION: *Ensure that the caliper cable bracket is secure with no signs of looseness and the lever is in contact with the caliper cable bracket stop. Damage to equipment and poor performance will result if not aligned properly.*

NOTE: Perform step 7 on both sides of vehicle.

7. Parking brake rod is properly adjusted if lever is in contact with caliper cable bracket stop (Figure 7-39).
8. Tighten nut against clevis.
9. Install six clips in boot (Figure 7-38)
10. Adjust parking brake lever.

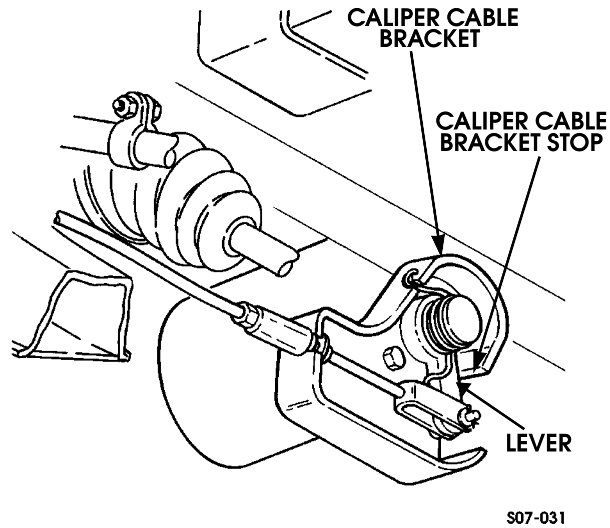

Figure 7-39: Caliper Cable Bracket Stop

PARKING BRAKE HAND LEVER REPLACEMENT

Removal

1. Put transmission in PARK, chock wheels, and release parking brake.
2. Remove parking brake switch.
3. Remove six clips and open lower boot to allow access to clevis pin. Discard clips (Figure 7-40).
4. Remove cotter pin, washer, and clevis pin from clevis and bellcrank. Discard cotter pin.
5. Remove nut and lockwasher assembly, wiring harness clamp, nut and lockwasher assembly, and bolt securing parking brake hand lever to body. Discard nut and lockwasher assemblies (Figure 7-41).
6. Remove three locknuts, washers, and bolts securing parking brake hand lever to body. Discard locknuts.
7. Remove two locknuts, washers, bolts, and washers securing parking brake hand lever to body and remove parking brake lever. Discard locknuts.
8. Remove upper boot from parking brake hand lever.
9. Remove boot from body.

Installation

1. Install boot on body. Install upper boot on parking brake hand lever.
2. Install parking brake hand lever on body and secure with two washers, bolts, washers, and locknuts.
3. Secure parking brake hand lever on body with bolt, nut and lockwasher assembly, wiring harness clamp, and nut and lockwasher assembly.
4. Secure parking brake hand lever on body with three bolts, washers, and locknuts.
5. Apply parking brake hand lever and tighten three bolts to 96 lb-in. (11 N•m).
6. Install clevis on bellcrank with clevis pin, washer, and cotter pin (Figure 7-40).

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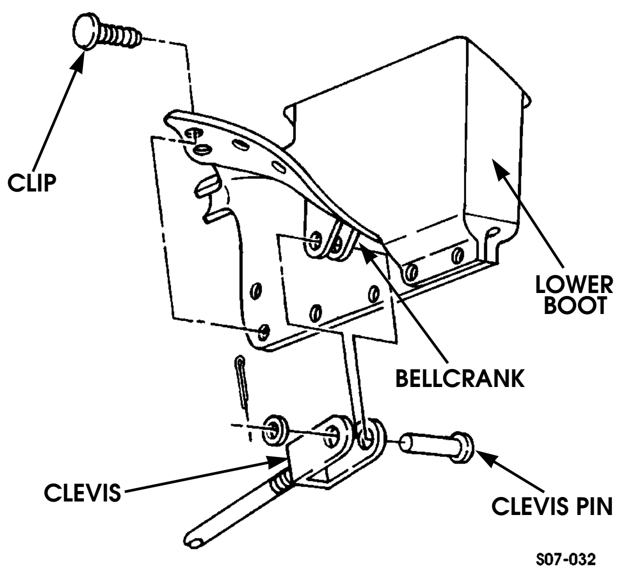


Figure 7-40: Parking Brake Rod Attachment at Hand Lever

7. Install six clips and close lower boot.
8. Install parking brake switch.
9. Adjust parking brake lever.

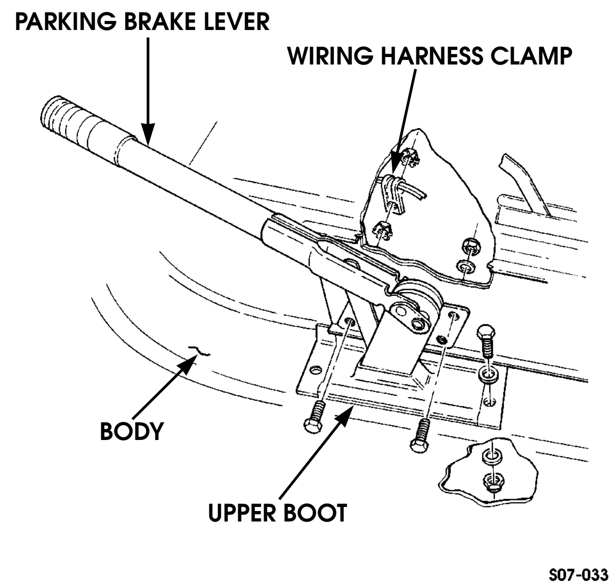


Figure 7-41: Parking Brake Hand Lever Mounting

FRONT DISC BRAKE CALIPER REPAIR

Disassembly

1. Remove disc brake caliper.
2. Insert wood block between jaw of caliper and piston (Figure 7-42).

WARNING: To avoid injury, hold caliper so piston is facing away from your body and keep fingers out of space between piston and wood block. Compressed air used for cleaning should not exceed 30 psi (207 kPa).

3. Remove piston from caliper by applying air pressure to hose inlet of caliper.
4. Remove piston dust boot and seal from caliper bore. Discard dust boot and seal (Figure 7-43).
5. Remove bleeder screw from caliper.

Cleaning and Inspection

NOTE: Clean all components, examine for wear or damage, and replace if necessary (Figure 7-43).

1. Inspect caliper bore for scoring, nicks, or corrosion. Minor corrosion can be polished with abrasive crocus cloth or hone. Replace caliper if bore is not repairable.
2. Inspect piston outside diameter for scoring, nicks, corrosion, and worn or damaged chrome plating. Replace piston if there are any surface defects.
3. Inspect bleeder screw for damage or stripped threads. Replace if damaged.
4. Inspect bushing for damage. Replace if damaged.

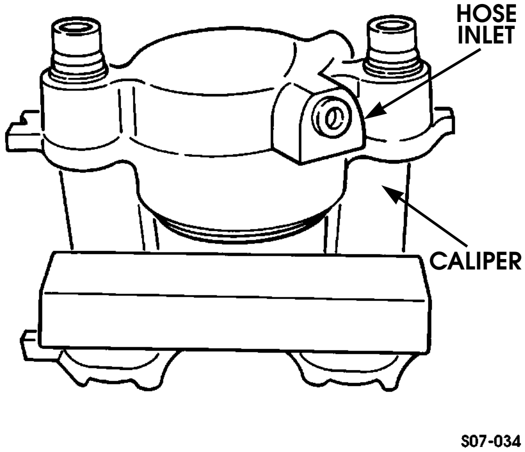


Figure 7-42: Front Disc Brake Caliper

Assembly

***CAUTION:** The HUMMER is equipped with DOT 5 silicone brake fluid. **Do not mix with other brake fluids**. Failure to use the proper brake fluid will damage brake system.*

1. Lubricate caliper bore and seal with Dow Corning 111 or 103 silicone lubricant or equivalent (Figure 7-43).
2. Install seal in groove of caliper bore.
3. Lubricate piston with Dow Corning 111 or 103 silicone lubricant or equivalent and install dust boot on piston.
4. Work piston and dust boot into caliper bore.
5. Seat dust boot in caliper.
6. Install bleeder screw in caliper finger tight.
7. Install disc brake caliper.

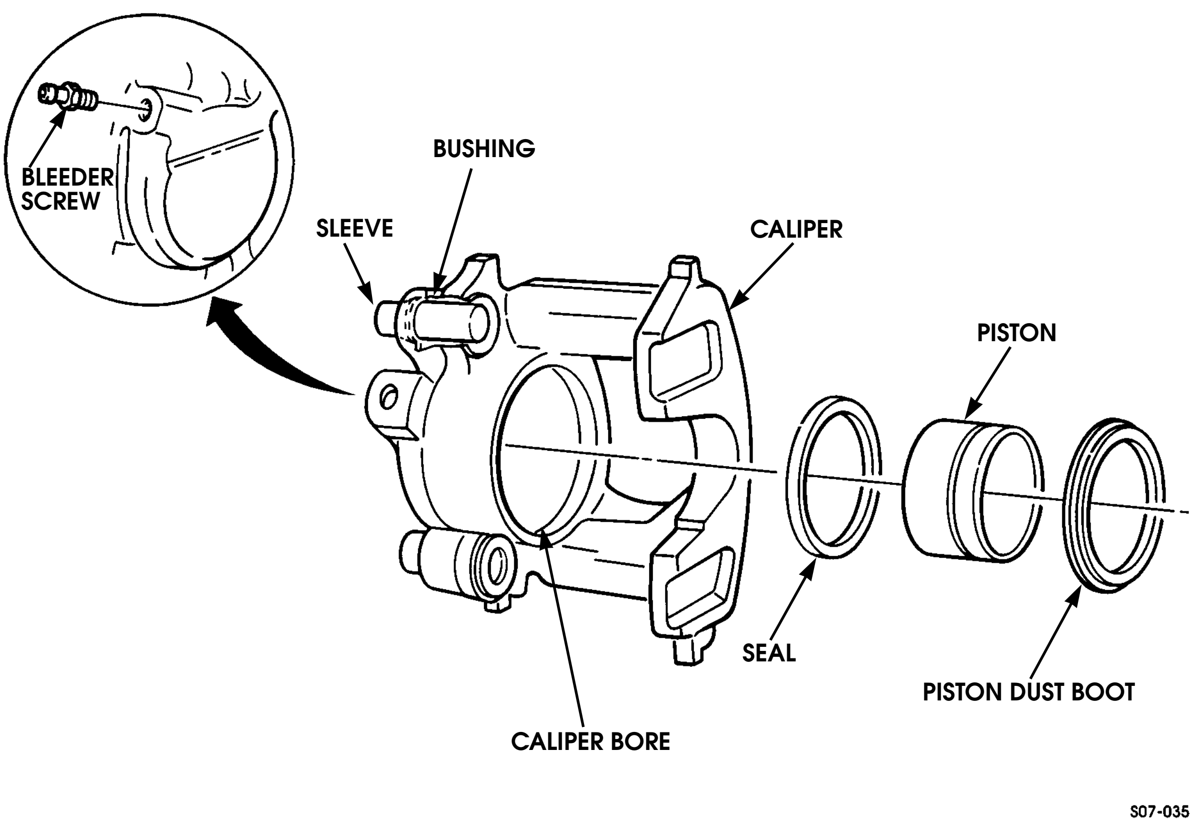


Figure 7-43: Front Disc Brake Caliper Assembly

REAR CALIPER OVERHAUL

Rear Caliper Disassembly (Figure 7-44)

1. Mount caliper in vise so parking brake lever and spring are facing upward.
2. Unseat and remove parking brake lever spring. Use large gripping pliers such as Craftsman Robo-Grip or Channel-Lock.
3. Remove bolt that secures lever retainer to thrust screw. Then remove retainer, but do not remove parking brake lever at this time.
4. Remove caliper piston as follows:
   a. Remove piston retaining screw with hex key and pencil magnet. Use magnet to withdraw screw after loosening it.
   b. Extend piston by rotating parking brake lever.
   c. Rotate caliper piston in counter-clockwise direction until it comes off thrust screw. Rotate piston by hand, or with spanner wrench positioned on piston flats.
   d. Pull piston out of dust boot and remove it from caliper.
5. Remove piston dust boot with pry tool.

***CAUTION:** Exercise care when removing the boot. Do not allow the pry tool to scratch the caliper piston bore.*

6. Remove thrust screw retaining ring. Carefully unseat ring with long, thin, flat blade screwdriver. Apply single wrap of electrical tape around screwdriver blade to avoid scratching bore, or thrust screw spring shield.
7. Grasp thrust screw and slide screw, shield, and spring out of bore as assembly. Rotate brake lever to assist removal.
8. Remove parking brake lever from actuator shaft.
9. Remove actuator shaft bearing balls with pencil magnet.
10. Remove thrust screw centering pin plug and spacer. Then reach inside caliper piston bore and push centering pin out of caliper with finger pressure.
11. Push bearing plate and actuator shaft out of caliper bore using finger pressure.
12. Remove caliper piston seal from groove in piston bore. Use wood pencil to remove seal. Do not use metal tools that will scratch bore.
13. Remove and discard actuator shaft dust seal. Discard seal.
14. Remove and discard centering pin plug O-ring.
15. Remove and discard centering pin O-ring.
16. Remove O-ring from actuator shaft. Then remove thrust bearing and race from shaft. Discard O-ring but retain bearing and race if in good condition.
17. Disassembly caliper piston as follows:
    a. Remove retaining ring with internal type ring pliers.
    b. Remove wave washer.
    c. Remove thrust washer and bearing.
    d. Remove cone clutch.

Caliper Cleaning and Inspection

Clean the caliper parts in standard parts cleaning solvent, or denatured alcohol. Dry the parts with compressed air or lint free shop towels.

Replace the caliper piston if corroded, rusted, or scored. Do not attempt to salvage any piston where rust or scoring has broken through the piston plating. Also, do not use any type of abrasive material on the piston surface. This practice will damage the plating and cause the piston to stick or seize in the bore.

Check condition of the caliper piston bore. Moderate surface discoloration is normal and not a cause for replacement. However, the caliper should be replaced if the bore is corroded, pitted, or scored. The bore can be lightly polished with crocus cloth but must not be honed or sanded.

Inspect the thrust screw and actuator shaft parts. Replace the thrust screw, spring shield, and retaining ring if damaged, or distorted. Replace the actuator shaft, bearing plate, and bearing balls if scored, cracked, worn, corroded, or pitted. Also replace the shaft bearing and race as a set if either part is worn, rough, pitted, or scored.

Replace the caliper piston cone clutch, bearing and race, or wave washer if worn, scored, or damaged.

Assembly (Figure 7-44)

1. Install new actuator shaft dust seal in caliper. Use one-inch socket to seat seal in housing. The open portion of seal metal retainer faces out. Lubricate seal lip with Dow Corning 111 silicone lubricant afterward.
2. Lubricate actuator shaft, bearings, race, and plate with Dow Corning silicone lubricant 111. Then install thrust bearing and race on shaft and secure with new O-ring.
3. Install actuator shaft in caliper. Then install plastic bearing plate and the three ball bearings.
4. Install new O-ring on thrust screw centering pin and install pin in caliper. Position pin so blade will align with slot in thrust screw.
5. Lubricate thrust screw with Dow Corning 111 silicone grease. Then install spring and retaining ring on thrust screw.
6. Install thrust screw as follows:

   a. Align slot in thrust screw with centering pin.

   b. Insert thrust screw in caliper and seat it on centering pin and on ball bearings.

   c. Compress thrust screw retaining ring with fingers and install it in caliper bore below piston seal groove.

CAUTION: *Do not use metal tools to install the retaining ring. Metal tools will score or scratch the caliper bore.*

   d. Push assembly into bore as far as possible.

   e. Seat retaining ring using unassembled caliper piston. Lightly coat piston with silicone grease and insert it in bore. Then push piston sharply downward two or three times to seat retaining ring. Remove piston after ring is seated.

7. Install new O-ring on centering pin plug. Then position spacer on top of centering pin and install plug. Tighten plug securely with hex wrench or socket.
8. Install new caliper piston seal. Start square cut seal into groove at top of bore and work it into place with your fingers. Lubricate seal and bore with fresh brake fluid, or Dow Corning silicone grease.
9. Assembly caliper piston as follows;

   a. Install cone clutch in piston.

   b. Lubricate bearing and race with Dow Corning 111 grease and install them on cone clutch. The open side of bearing goes toward race.

   c. Install wave washer (either side up).

   d. Install retaining ring with internal-type ring pliers. Flat side of ring goes toward wave washer.

10. Install caliper piston as follows:

    a. Install new dust boot on caliper piston.

    b. Lubricate caliper piston with fresh brake fluid. Then insert it through dust boot, into caliper bore, and onto thrust screw.

    c. Install parking brake lever on actuator shaft and rotate lever to extend thrust screw.

    d. Rotate piston onto thrust screw by hand, then with suitable size socket.

    e. Turn parking lever to normal (non-applied) position and complete piston installation as needed.

    f. Seat piston dust boot in groove at top of caliper bore. Use suitable size boot installer tool or flat punch.

11. Install new O-ring on piston retaining screw and install screw. Tighten screw securely.
12. Install parking brake lever retainer and bolt. Apply 1-2 drops Loctite to bolt threads before installation.
13. Install and seat parking brake lever return spring in cable housing slot.
14. Install bleed screw, if removed Apply anti-seize compound to screw threads beforehand.

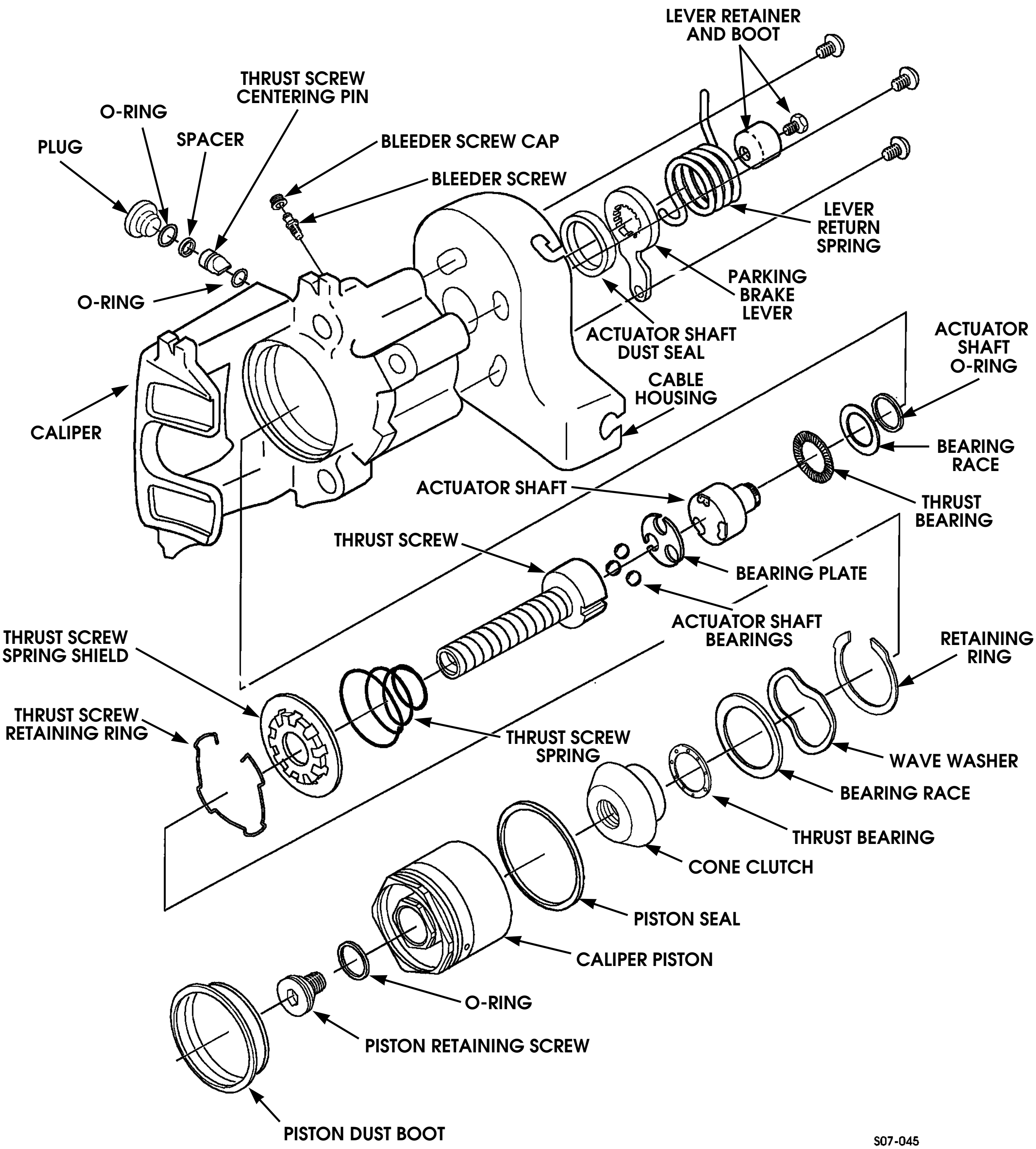


Figure 7-44: Rear Caliper

BRAKE ROTOR

Cleaning and Inspection

NOTE: Clean all components, examine for wear or damage, and replace if necessary (Figure 7-45).

1. Remove brake rotor.

NOTE: Clean rusted or scaled rotor braking surfaces before attempting inspection or measurement.

2. Mount rotor in brake lathe and turn while cleaning surfaces with abrasive crocus cloth.
3. Inspect rotor for heat checks, nicks, broken cooling fins, scoring, discoloration, and pitting. It is not recommended that rotors be turned when spotted or heat checked.

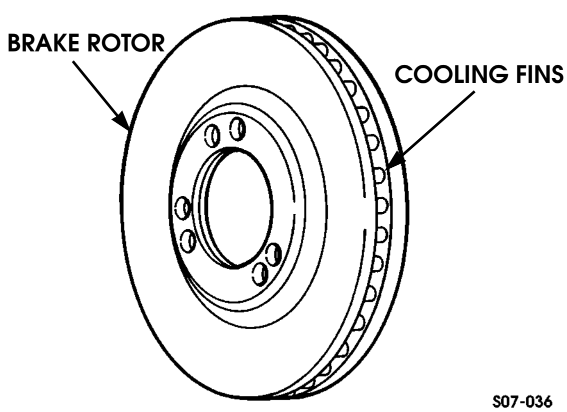


Figure 7-45: Brake Rotor and Cooling Fins

NOTE: Clean debris from cooling fins if necessary.

REFINISHING BRAKE ROTORS

Refinish rotors only under the following circumstances:

1. There is a complaint of brake pulsation.
2. There is excessive scoring.

Brake rotors have a minimum thickness dimension cast into them. This dimension is the minimum wear dimension and not a refinish dimension. Do not use a brake rotor that will not meet the dimensions shown in the specifications. Original equipment rotors are finished to 0.25-1.27 micrometers (10-50 microinches).

Accurate control of rotor tolerances is necessary for the proper performance of disc brakes. Machining should be done only with precision equipment. Service the machining equipment on a regular basis following the manufacturer’s recommended maintenance procedures.

When you refinish rotors, make sure the attaching adapters, tool holders, vibration dampeners, and tool bits are in good condition. Always use sharp cutting tools or bits and use only replacement cutting bits recommended by the equipment manufacturer. Dull or worn tools leave a poor surface finish that will affect initial brake performance. Vibration dampening attachments should always be used when refinishing braking surfaces. These attachments eliminate tool chatter to allow for a better surface finish. Make sure these adaptors are clean and free of nicks. The optional swirl pattern finish will provide the best initial braking effectiveness. For this, use a sanding disc power tool with 120 grit disc for about 10 seconds per side.

Checking Lateral Runout

1. Mount dial indicator with stylus contacting rotor surface 1 in. (25 mm) in from outer edge (Figure 7-46).
2. Turn rotor 360° and note total indicator reading (TIR).

If lateral runout exceeds 0.004 in. (0.10 mm) TIR, replace or refinish rotor.

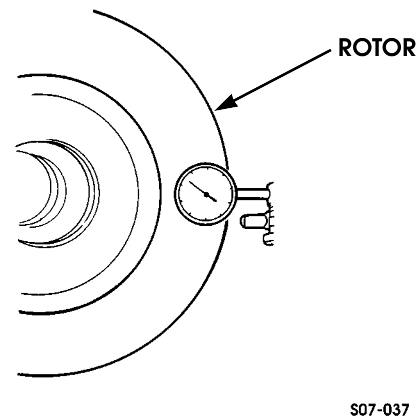


Figure 7-46: Checking Rotor for Lateral Runout

Checking Thickness Variation

1. Measure thickness variation of rotor with micrometer at four equally-spaced points around rotor. Measure 1 in. (25 mm) in from outer edge (Figure 7-47).
2. If thickness variation exceeds 0.005 in. (0.13 mm), replace or refinish rotor.

NOTE: Vehicles with a 12,100 lb. GVWR have 12 inch diameter rotors that measure 26 mm thick when new. The minimum thickness requirement for 12 inch rotors is 24-27 mm. All other model Hummers have 10.5 inch diameter rotors with a thickness of 22 mm. They require a minimum thickness of 20.3 mm.

Refinishing

1. Mount rotor on brake lathe and refinish surface.
2. Replace rotor if refinishing causes rotor to fall below minimum thickness of 0.815 in. (20.7 mm).
3. Install brake rotor.

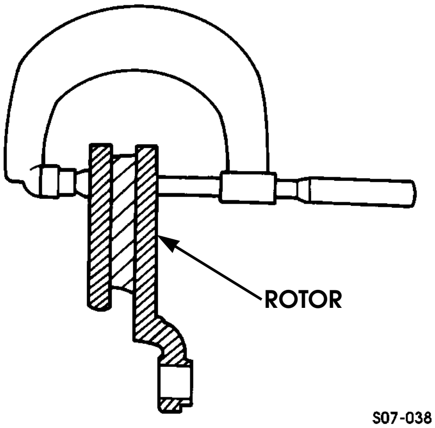


Figure 7-47: Checking Rotor Thickness

PARKING BRAKE LEVER ADJUSTMENT

Adjustment

1. Adjust linkage.
2. Put transmission in PARK, chock wheels, and release parking brake handle.
3. Turn adjusting knob clockwise as tightly as possible by hand (Figure 7-48).

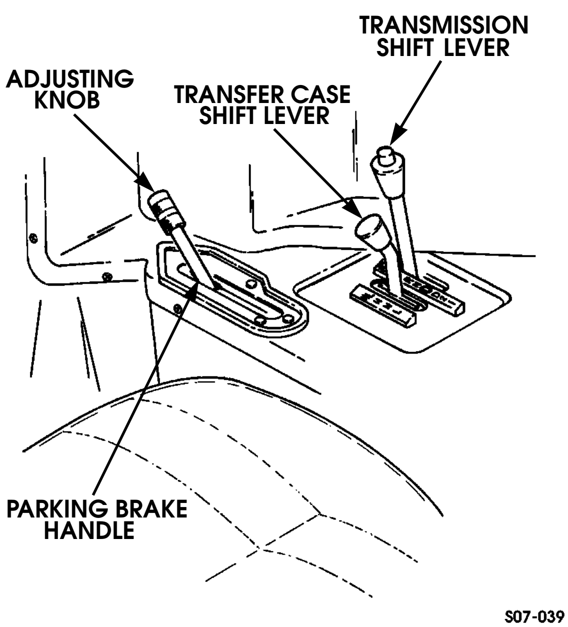


Figure 7-48: Parking Brake Lever Location

4. Apply parking brake handle.
5. If parking brake cannot be applied, turn adjusting knob counterclockwise until parking brake can be applied.
6. Test parking brake.
   a. Remove chocks.
   b. Depress service brake pedal and start engine.
   c. Place transfer case shift lever in “H” (high) and transmission shift lever in “D” (drive).
   d. Slowly let up on service brake pedal. Parking brake should hold vehicle stationary.

CAUTION: *The HUMMER is equipped with DOT 5 silicone brake fluid.* ***Do not mix with other brake fluids****. Failure to use the proper brake fluid will damage brake system.*

NOTE: After operating in mud or sand, use a low pressure water source to ensure that the parking brake pads, rotor, pad-rotor contact areas, actuating lever, and spring are thoroughly cleaned of mud, sand, or other debris. Lubricate actuating lever as soon as possible (Figure 7-49).

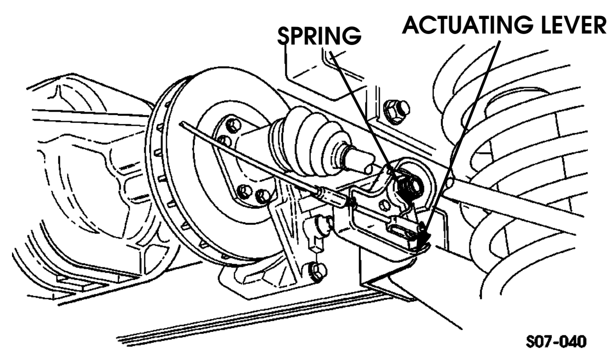


Figure 7-49: Spring and Actuating Lever for Parking Brake

PARKING BRAKE SWITCH REPLACEMENT

Removal

1. Disconnect the two harness leads from the switch leads (Figure 7-50).
2. Remove the switch from the parking brake lever.

Installation

1. Install the switch on the parking brake lever (Figure 7-50).
2. Connect two switch leads to the harness leads.
3. Ensure parking brake switch operates properly.

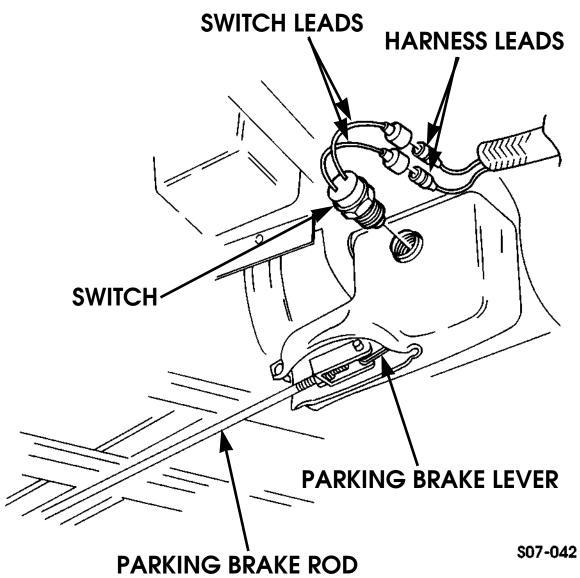
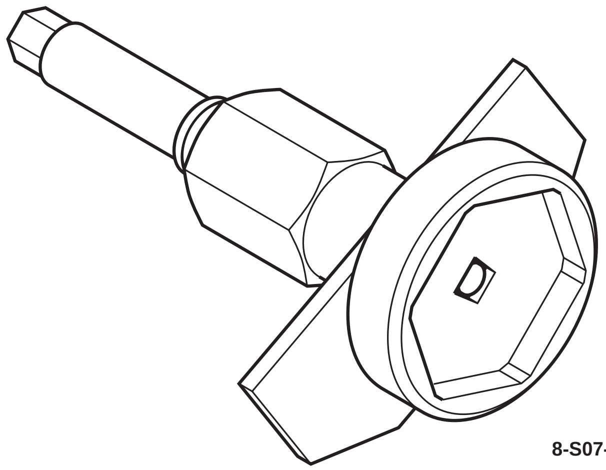


Figure 7-50: Parking Brake Switch

ESSENTIAL TOOLS



8-S07-001

Tool No.	Description
J–42553	Disc Brake Tool Kit

Procure from Kent-Moore.

Section 8 Steering System

TABLE OF CONTENTS

STEERING SYSTEM DESCRIPTION

The power steering system consists of the power steering pump, steering gear, fluid cooler, and interconnecting lines (Figure 8-1). The purpose of the system is to reduce steering effort at all vehicle speeds and during parking maneuvers.

The steering pump used on all models is a constant displacement, rotary pump. The pump has an integral fluid reservoir supplied by Delphi Saginaw Steering Systems, Division of GM (Figure 8-1).

The steering pump on all Hummer vehicles performs two functions. The first function is to provide the necessary fluid pressure for power brake boost to the hydro-boost unit. The second is to provide fluid pressure for steering assist.

A recirculating ball-type steering gear is used for all applications. The gear is also supplied by Delphi Saginaw Steering Systems, Division of GM.

A steering fluid cooler is used on all Hummer models. The vertical mount cooler is located at the driver side of the fan shroud.

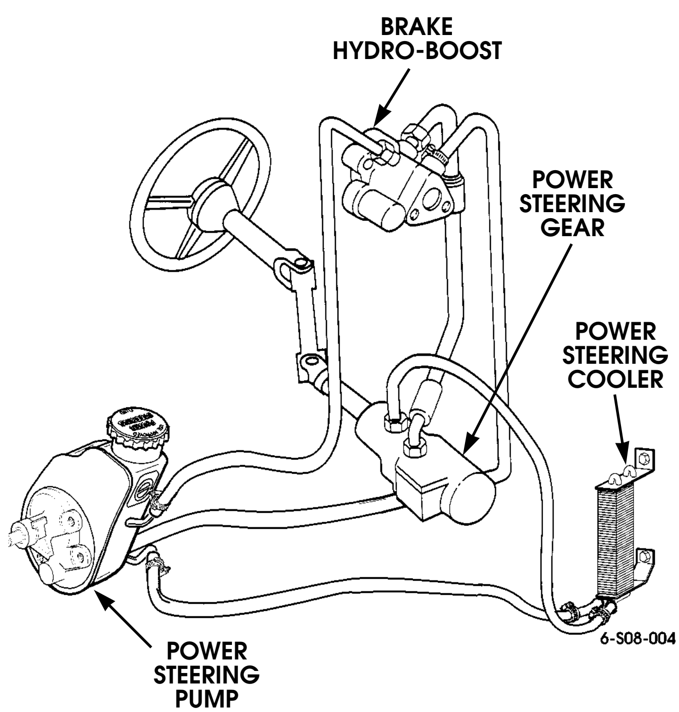


Figure 8-1: Steering System

Power Steering Fluid

Recommended fluid for the power steering system is Dexron III.

Power Steering Component Service

The power steering pump is not a serviceable part. The pump is replaced as an assembly when diagnosis indicates this is necessary.

The steering gear can be removed and overhauled when required. Refer to the overhaul procedure in this section.

The fluid coolers and fluid lines are also replaced as assemblies when diagnosis indicates this is necessary.

Steering Linkage

The steering linkage consists of a steering (Pitman) arm, center link, idler arm, and left/right tie rods (Figure 8-3). The tie rods connect the center link to steering arms on the left and right side geared hubs. The idler arm stabilizes the center link and is attached to the vehicle frame. The steering arm connects the center link to the steering gear.

Steering Linkage Lubricant

Recommended lubricant for linkage lubrication points is NLGI-LB grade lubricating grease. Quality lubricants are available from suppliers such as Mobil, Kendall, and Valvoline.

STEERING (PITMAN) ARM REPLACEMENT

NOTE: Ensure front wheels are in straight-ahead position while steering arm is removed and installed.

Removal

1. Place front wheels in straight-ahead position.
2. Raise and support front of vehicle.
3. Put scribe marks indicating position of steering (Pitman) arm relative to steering gear shaft.
4. Remove nut and lockwasher from steering gear shaft. Using suitable size puller, remove steering arm from steering gear shaft (Figure 8-2).
5. Remove cotter pin and slotted nut from steering arm.
6. Using puller J–24319-B or equivalent, remove steering arm from center link.

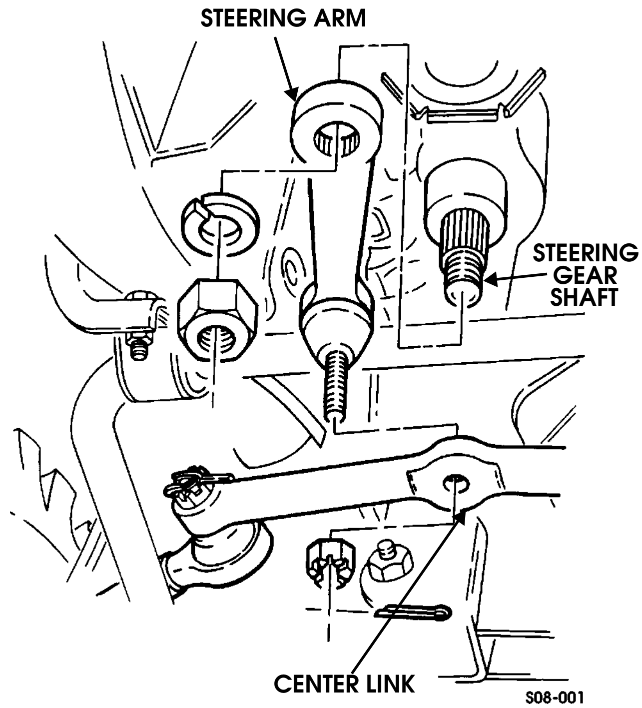


Figure 8-2: Steering (Pitman) Arm Removal

Installation

1. Line up scribe marks and slide steering arm onto steering gear shaft splines.
2. Secure steering arm to steering gear shaft with lockwasher and nut. Tighten nut to 185 lb-ft (251 N•m).
3. Secure steering arm to center link with slotted nut. Tighten slotted nut to 80 lb-ft (108 N•m).
4. Install cotter pin in slotted nut. If necessary, tighten slotted nut to align holes for cotter pin insertion.
5. Lubricate steering arm.
6. Remove supports and lower front of vehicle.
7. Check vehicle wheel alignment.

CENTER LINK REPLACEMENT

Removal

1. Raise and support front of vehicle.
2. Remove cotter pin and slotted nut securing idler arm to center link (Figure 8-3).
3. Remove cotter pin and slotted nut securing steering (Pitman) arm to center link.
4. Remove two cotter pins and slotted nuts securing two tie rods to center link.
5. Using puller J-24319-B or equivalent, remove center link from two tie rods, idler arm, and steering (Pitman) arm.

Installation

1. Secure center link to steering (Pitman) arm and idler arm with two slotted nuts. Tighten slotted nuts to 80 lb-ft (108 N•m) (Figure 8-3).
2. Install two cotter pins in slotted nuts. If necessary, tighten nuts to align holes for cotter pin insertion.
3. Secure two tie rods to center link with two slotted nuts. Tighten slotted nuts to 70 lb-ft (95 N•m).
4. Install two cotter pins in slotted nuts. If necessary, tighten nuts until cotter pin can be inserted.
5. Remove supports and lower front of vehicle.
6. Inspect wheel alignment.

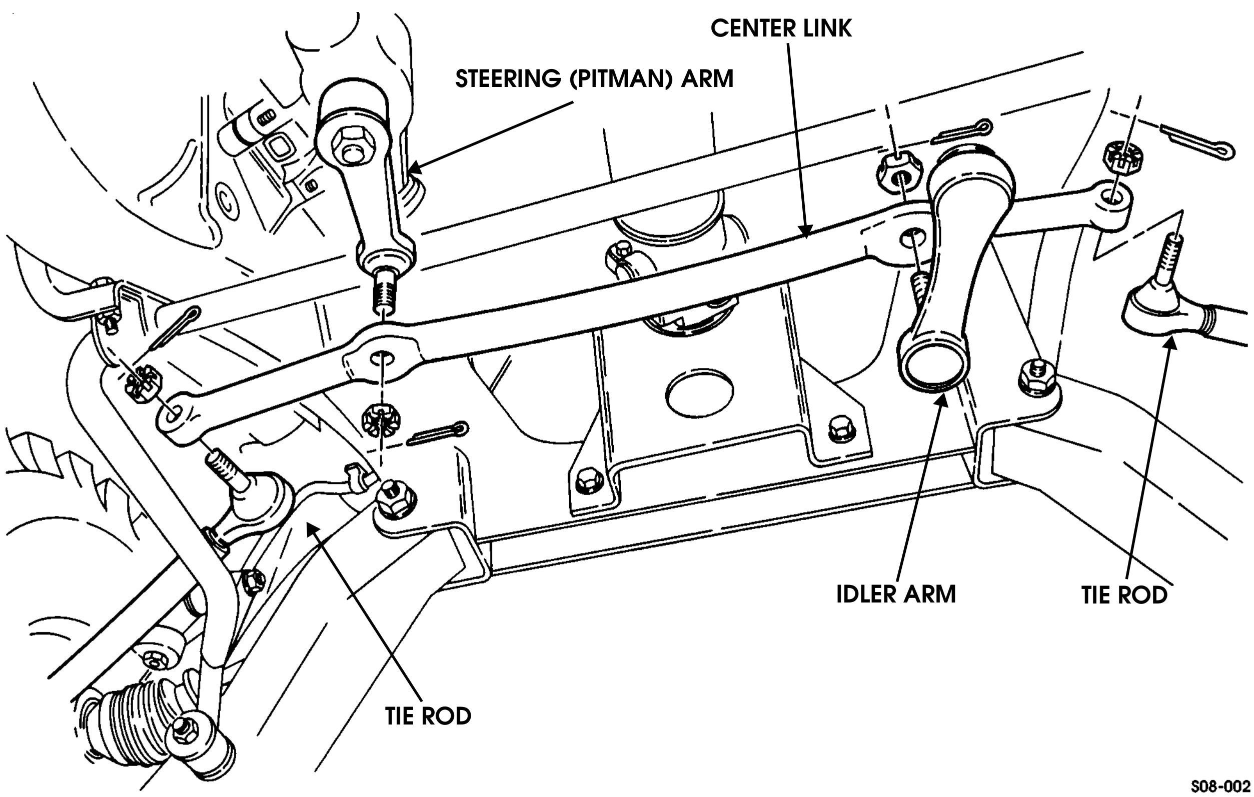


Figure 8-3: Center Link Removal

TIE ROD END REPLACEMENT

Removal

1. Raise and support front of vehicle.
2. Remove cotter pin, slotted nut, and washer securing tie rod end to geared hub (Figure 8-4).
3. Using puller J 24319-B or equivalent, remove tie rod end from geared hub.

NOTE: In step 4, be sure to count the number of turns required to remove the tie rod end from the adjusting sleeve.

4. Loosen locknut on clamp securing tie rod end to adjusting sleeve and remove tie rod end (Figure 8-4).

Installation

CAUTION: *Ensure the outboard clamp faces the halfshaft and the inboard clamp faces away from the stabilizer bar (front only) or damage to equipment may result.*

1. Thread tie rod end into adjusting sleeve the same number of turns that were required for removal. Tighten clamp (Figure 8-4).
2. Secure tie rod end to geared hub with washer and slotted nut. Tighten slotted nut to 70 lb-ft (95 N•m) (Figure 8-4).
3. Install cotter pin in slotted nut. If necessary, tighten nut until cotter pin can be inserted.
4. Lubricate tie rod end.
5. Remove supports and lower front of vehicle.
6. Adjust toe-in (Section 6).

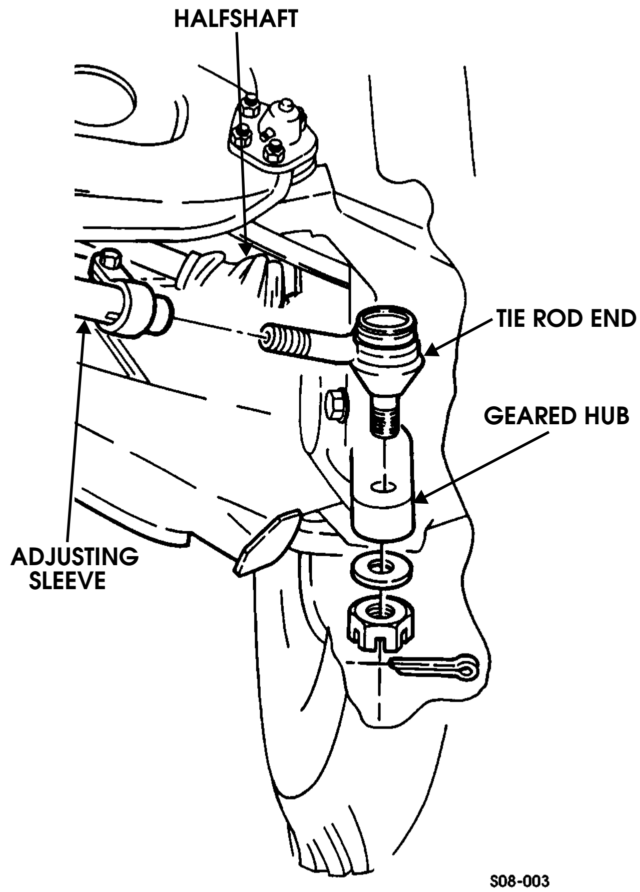


Figure 8-4: Tie Rod End Removal

TIE ROD REPLACEMENT

Removal

1. Raise and support front of vehicle.
2. Remove cotter pin and slotted nut securing tie rod to center link (Figure 8-5).
3. Remove cotter pin, slotted nut, and washer securing tie rod to geared hub.
4. Using suitable size puller, remove tie rod from center link and geared hub.

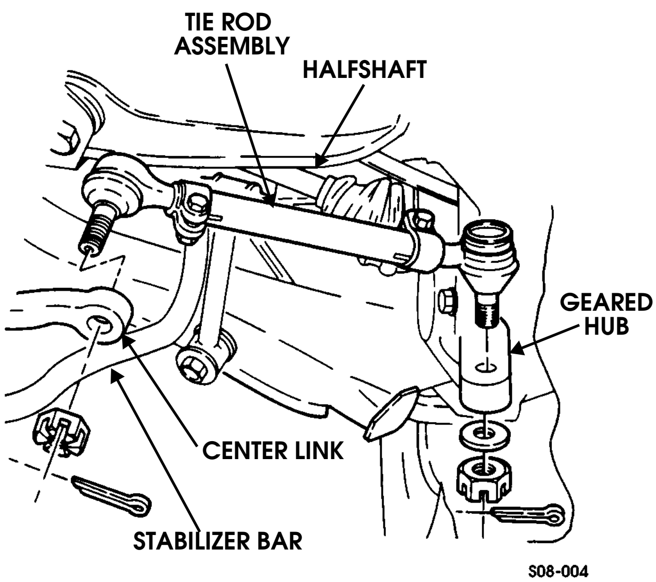


Figure 8-5: Tie Rod Removal

Disassembly

1. Loosen two locknuts and clamps securing tie rod ends to adjusting sleeve (Figure 8-6).

NOTE: In step 2, be sure to count the number of turns required to remove each tie rod end from the adjusting sleeve.

2. Remove two tie rod ends from adjusting sleeve.

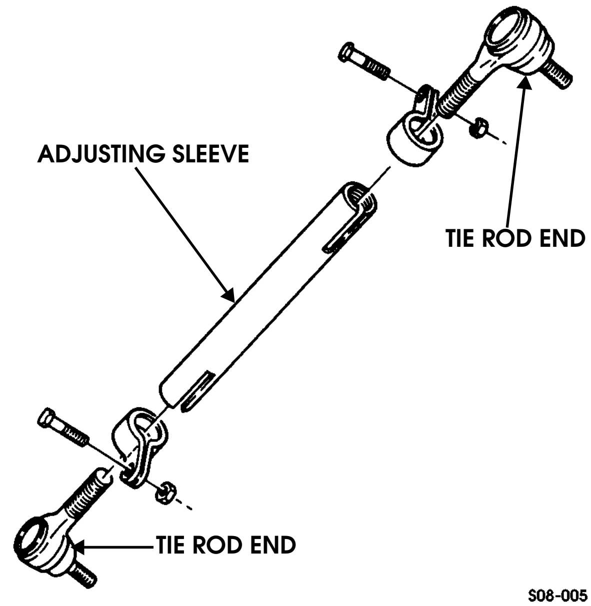


Figure 8-6: Tie Rod Component Parts

Assembly

1. Thread two tie rod ends into adjusting sleeve, turning them the same number of revolutions that were required for removal.

Installation

1. Secure tie rod to center link with slotted nut. Tighten slotted nut to 70 lb-ft (95 N•m) (Figure 8-5).
2. Secure tie rod to geared hub with washer and slotted nut. Tighten slotted nut to 70 lb-ft (95 N•m).
3. Install cotter pins in slotted nuts. If necessary, tighten nuts until cotter pins can be inserted.

CAUTION: *Ensure the outboard clamp faces the halfshaft and the inboard clamp faces away from the stabilizer bar (front only) or damage to equipment may result.*

4. Securely tighten two locknuts on clamps.
5. Lubricate tie rod end.
6. Remove supports and lower front of vehicle.
7. Align toe-in (Section 6).

IDLER ARM REPLACEMENT

Removal

1. Raise and support front of vehicle.
2. Remove cotter pin and slotted nut securing idler arm to center link (Figure 8-7).
3. Using puller J24319-B or equivalent, disconnect idler arm from center link.
4. Remove two locknuts, washers, bolts, washers, and idler arm from frame.

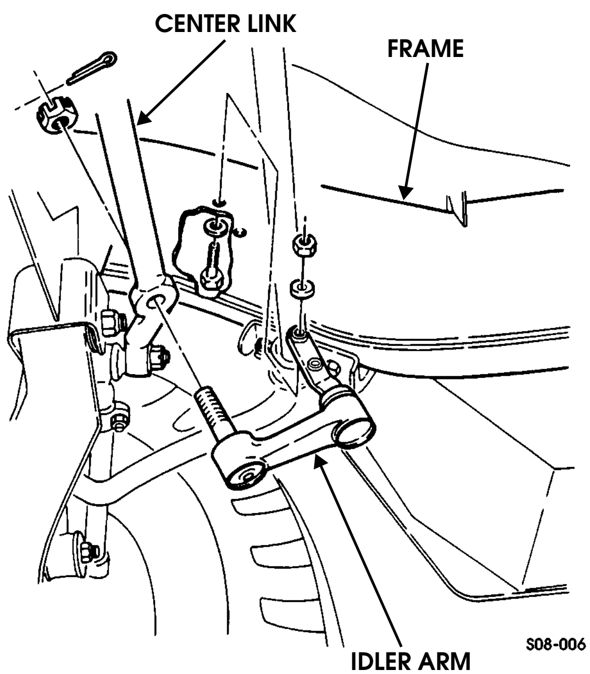


Figure 8-7: Idler Arm Removal

Installation

1. Secure idler arm to frame with two washers, bolts, washers, and locknuts. Tighten locknuts to 60 lb-ft (81 N•m) (Figure 8-7).
2. Secure idler arm to center link with slotted nut. Tighten slotted nut to 80 lb-ft (108 N•m).
3. Install cotter pin in slotted nut. If necessary, advance nut to align holes.
4. Lubricate idler arm.
5. Remove supports and lower front of vehicle.
6. Check vehicle wheel alignment.

STEERING WHEEL REPLACEMENT

NOTE: Ensure front wheels are in a straight ahead position.

Removal

1. Gain access to nut by removing three screws that hold front cover to rear cover (Figure 8-8).
2. Remove nut securing steering wheel to shaft.
3. Remove steering wheel from shaft.

Installation

1. Align splines on steering wheel with splines on shaft.
2. Secure steering wheel to shaft with nut. Tighten nut to 35 lb-ft (47 N•m).
3. Secure front cover to rear cover.
4. Operate vehicle and verify steering wheel alignment.

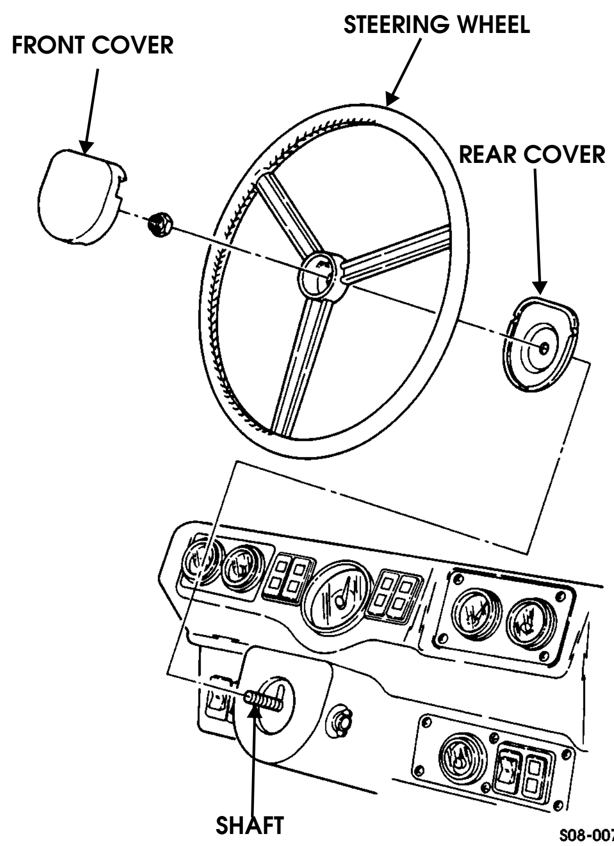


Figure 8-8: Steering Wheel Removal

STEERING COLUMN REPLACEMENT

Removal

NOTE: Before removing steering wheel, turn steering column to gain access to intermediate shaft mounting hardware.

1. Remove steering wheel.
2. Remove close-out panel.
3. Remove locknut, lockwasher, three washers, and thru-bolt from mounting bracket and loosen pivot bolts. Column will drop down as it pivots in bracket (Figure 8-9).

NOTE: Before performing step 4, be certain to put scribe marks that indicate the position of the intermediate shaft yoke relative to the splines.

4. Remove bolt on intermediate shaft yoke and pull yoke from splines (Figure 8-9).
5. Remove five screws and shroud (two halves) from steering column.
6. Disconnect ground wires from steering column.
7. Disconnect two multi-switch connectors from multi-switch.
8. Disconnect two ignition switch connectors from ignition switch.
9. Remove multi-switch and ignition switch from steering column.
10. Remove two locknuts, washers, pivot bolts, and steering column from mounting bracket.

Installation

1. Hang steering column from mounting bracket with two pivot bolts, washers, and locknuts. Finger tighten locknuts.
2. Install ignition switch and multi-switch on steering column (Figure 8-9).
3. Connect two ignition switch connectors to ignition switch.
4. Connect two multi-switch connectors to multi-switch.
5. Secure shrouds to steering column with five screws.
6. Secure ground wires to steering column with bolt and nut/lockwasher assembly.
7. Raise steering column to mounting bracket. Insert thru-bolt, three washers, lockwasher, and locknut. Finger tighten locknut.
8. Slide intermediate shaft yoke onto splines while carefully aligning scribe marks. Insert bolt and tighten locknut to 60 lb-ft (81 N•m).
9. Tighten thru-bolt locknut to 31 lb-ft (42 N•m).
10. Tighten pivot bolt locknuts to 10 lb-ft (14 N•m).
11. Install steering wheel.
12. Install close-out panel.
13. Operate vehicle to verify steering wheel alignment.

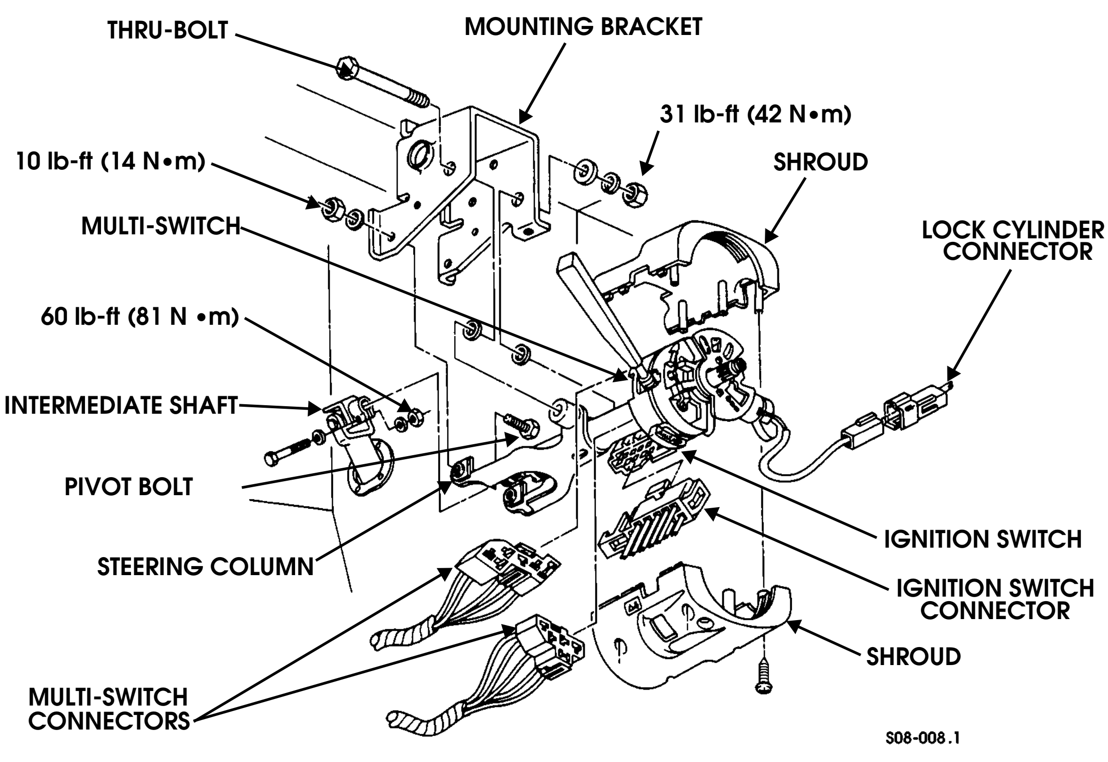


Figure 8-9: Steering Column Components

STEERING COLUMN MULTI-SWITCH REPLACEMENT

NOTE: This procedure covers the directional signal, horn, high beam, and hazard light switches.

Removal

1. Disconnect battery ground cable.
2. Follow steps 2, 3, 5 and 6 of *Steering Column Replacement*.
3. Remove two screws and multi-switch from steering column (Figure 8-10).
4. Remove control handle from multi-switch.

Installation

1. Attach control handle to multi-switch (Figure 8-10).
2. Secure multi-switch to steering column with two screws.
3. Perform reverse of *Removal* Step 2 above.
4. Connect battery ground cable.

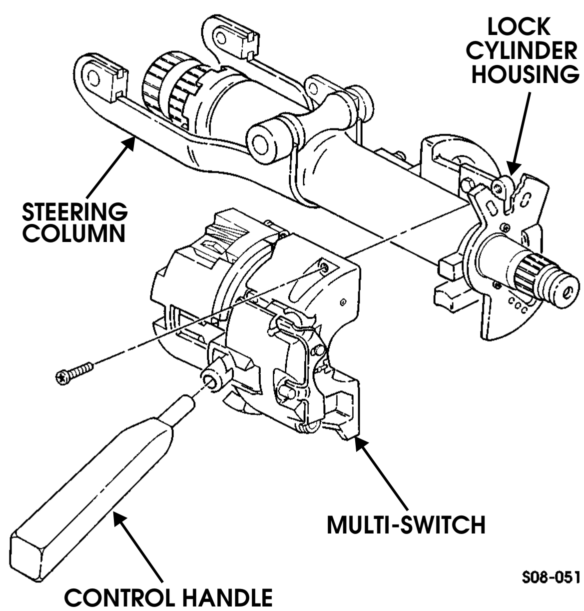


Figure 8-10: Steering Column Multi-Switch Replacement

LOCK AND SWITCH HOUSING ASSEMBLY REPLACEMENT

Removal

1. Disconnect battery ground cable.
2. Follow steps 2, 3, 5 and 6 of *Steering Column Replacement*.
3. Remove two screws and multi-switch from steering column (Figure 8-10).
4. Remove screw and interlock cable from ignition switch (Figure 8-11).
5. Remove two bolts and lock and switch housing assembly from steering column.

Installation

1. Apply thread-locking compound to bolt threads and secure lock and switch housing assembly on steering column with two bolts (Figure 8-11).
2. Secure interlock cable to ignition switch with screw.
3. Install multi-switch.
4. Perform reverse of *Removal* Step 2 above.
5. Connect battery ground cable.
6. Verify that ignition switch operates properly.

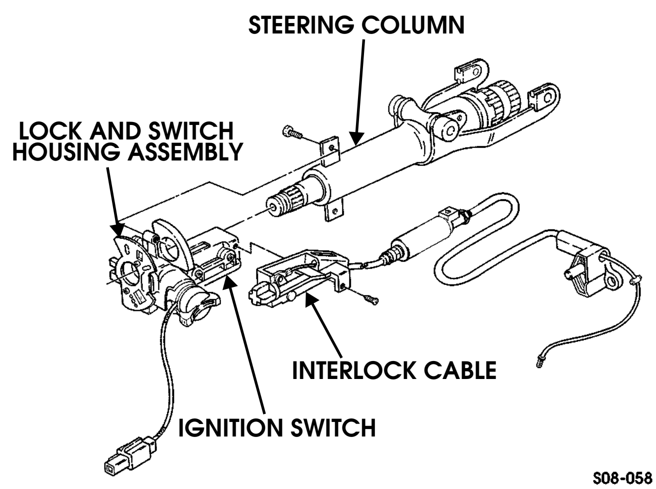


Figure 8-11: Lock and Switch Housing Assembly Replacement

STEERING COLUMN REPAIR

Lock and Switch Housing Assembly

Disassembly

NOTE: The key must stay in the ignition switch at all times.

1. Remove the lock cylinder and key assembly from the lock cylinder housing (Figure 8-12).
2. Remove two screws securing the upper retainer plate to the lock cylinder housing. Remove the retainer plate, the upper bearing assembly and upper bearing sleeve from the lock cylinder housing.
3. Remove two screws and the multi-switch assembly from the lock cylinder housing (Figure 8-10).
4. Remove two screws securing the ignition switch assembly to the lock cylinder housing. Remove the ignition switch assembly (Figure 8-12).
5. Remove six stakes from the tube and bracket assembly (Figure 8-13).
6. Remove two screws and remove the lock cylinder housing from the tube and bracket assembly.
7. Remove the retainer ring, shaft, and bearing from the tube and bracket assembly.

Assembly

1. Install the shaft, bearing, and retainer ring into tube and bracket assembly (Figure 8-13).
2. Secure the lock cylinder housing to the tube and bracket assembly with two screws. Tighten screws to 6-7 lb-ft (8.1-9.4 N•m).
3. Stake bearing securely in six (6) places (Figure 8-13).
4. Secure the ignition switch assembly to the lock cylinder housing with two screws. Tighten screws to 35-40 lb-in. (3.9-4.5 N•m) (Figure 8-12).
5. Secure the multi-switch assembly to the lock cylinder housing with two screws. Tighten screws to 35-40 lb-in. (3.9-4.5 N•m) (Figure 8-10).
6. Install the upper bearing assembly and upper bearing sleeve in the lock cylinder housing (Figure 8-12).
7. Install the retainer plate on the lock cylinder housing with two screws. Tighten screws to 35-40 lb-in. (3.9-4.5 N•m).
8. Install the lock cylinder and key assembly in the lock cylinder housing assembly.
9. Verify that ignition switch operates properly.

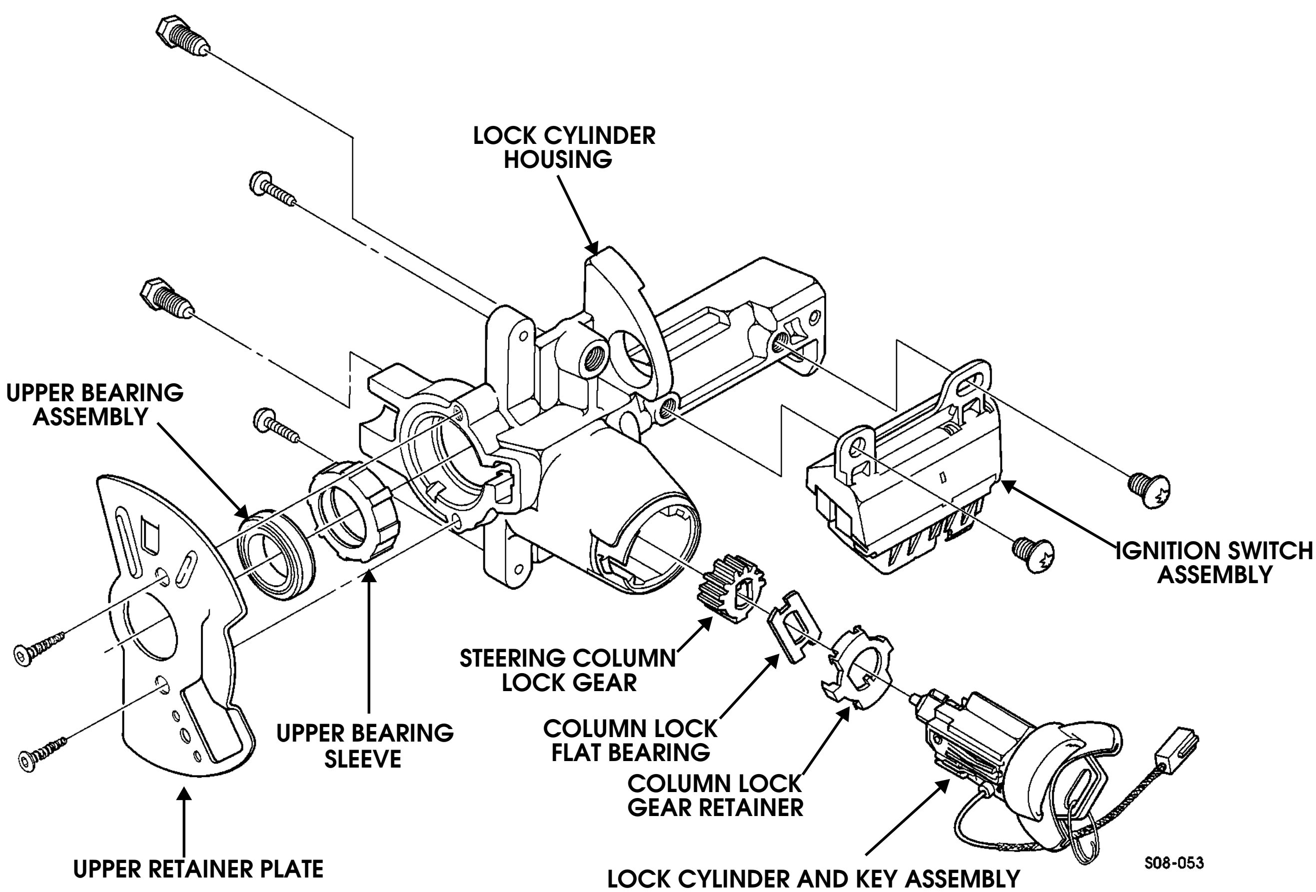


Figure 8-12: Lock and Switch Housing Components

Steering Column and Shaft

Disassembly

1. Remove two screws and the multi-switch assembly from the lock and switch housing (Figure 8-10).
2. Remove two screws and lock and switch housing assembly from steering column (Figure 8-11).
3. Remove six stakes from the tube and bracket assembly (Figure 8-13).
4. Remove the shaft, retainer ring, and bearing from tube and bracket assembly.
5. Remove retainer ring and bearing from the shaft.

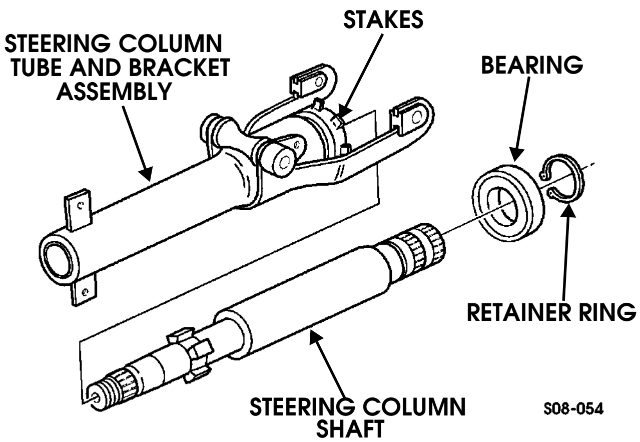


Figure 8-13: Steering Column and Shaft

Assembly

1. Slide bearing onto shaft and secure it with retaining ring (Figure 8-13).
2. Slide the shaft into the tube and bracket assembly.
3. Install six stakes into the tube and bracket assembly.
4. Secure lock and switch housing assembly to steering column with two screws (Figure 8-11).
5. Connect the multi-switch assembly to the lock and switch housing with two screws (Figure 8-10).

STEERING WHEEL HUB COVER AND STEERING COLUMN SHROUD REPLACEMENT

Removal

1. Remove three screws holding front half of steering wheel hub cover to the rear half.
2. Remove steering wheel.
3. Remove rear half of cover.
4. Remove five screws holding lower steering column shroud to upper shroud.
5. Loosen two pivot bolts at rear of steering column mounting bracket.
6. Remove thru-bolt from front of mounting bracket. Steering column will pivot downward.
7. Remove upper shroud.

Installation

1. Place upper shroud in position over top of steering column.
2. Pivot steering column upward and secure with thru-bolt, three washers, lockwasher, and locknut.
3. Tighten locknuts on pivot bolts.
4. Secure lower shroud to upper shroud with five screws.
5. Place rear half of steering wheel hub cover over shaft.
6. Install steering wheel.
7. Secure front half of shroud to rear half with 3 screws.

IGNITION SWITCH LOCK CYLINDER REPLACEMENT

Removal

1. Disconnect battery ground cable.
2. Remove close-out panel.
3. Remove five screws and lower steering column shroud (Figure 8-14).
4. Disconnect lock cylinder connector from ignition switch connector.
5. Turn ignition switch to RUN position.
6. Depress lock cylinder detent pin through detent pin hole and remove lock cylinder from steering column.

Installation

1. Insert lock cylinder into steering column (Figure 8-14).
2. Turn ignition switch to LOCK position.
3. Connect lock cylinder connector to ignition switch connector.
4. Secure lower steering column shroud to steering column with five screws.
5. Install close-out panel.
6. Connect battery ground cable.
7. Verify that ignition switch lock cylinder operates properly.

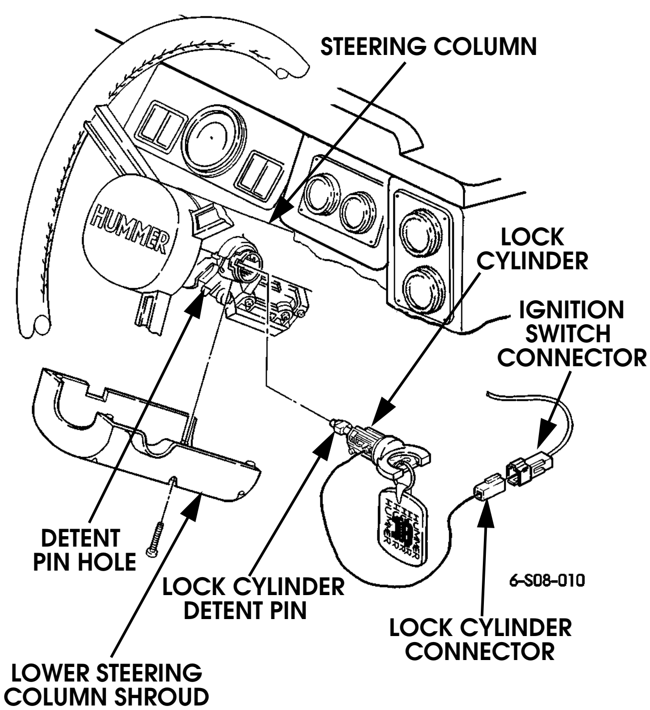


Figure 8-14: Ignition Switch Lock Cylinder Replacement

IGNITION INTERLOCK CABLE REPLACEMENT

Removal

1. Remove five screws and lower shroud from steering column (Figure 8-15).

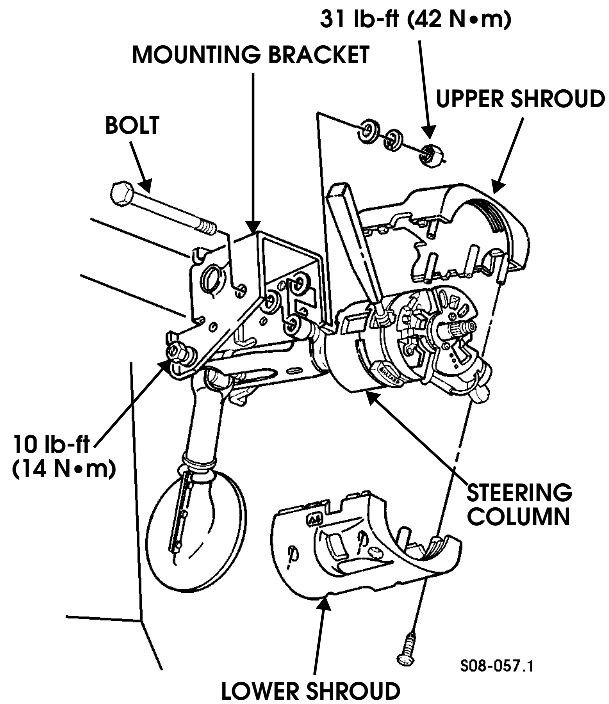


Figure 8-15: Steering Column Shrouds

2. Loosen two locknuts securing steering column to mounting bracket.
3. Remove locknut, lockwasher, three washers, and bolt securing steering column to mounting bracket.
4. Lower steering column and remove upper shroud.
5. Remove screw and interlock cable from ignition switch (Figure 8-16).
6. Disconnect connector from interlock cable.
7. Raise and secure hood.
8. Remove screw securing clamp and interlock cable to bracket. Remove clamp from interlock cable.
9. Remove close-out panel (Section 10).
10. Remove shifter (Section 5).
11. Remove nut and screw securing interlock cable to shifter (Figure 8-17).
12. Remove interlock cable and grommet from vehicle.

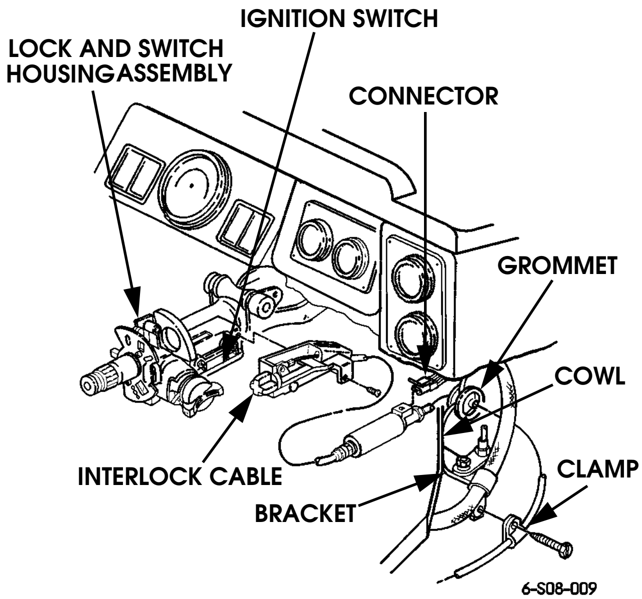


Figure 8-16: Interlock Cable/Ignition Switch

Installation

1. Secure interlock cable to shifter with screw and nut. Tighten nut to 8 lb-ft (11 N•m) (Figure 8-17).

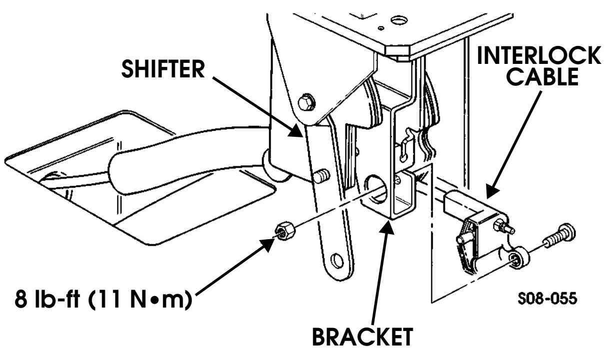


Figure 8-17: Interlock Cable and Shifter

2. Route interlock cable through bracket and install shifter (Section 5).
3. Secure interlock cable to bracket with clamp and screw (Figure 8-16).
4. Route interlock cable through cowl and secure with grommet.
5. Lower and secure hood.
6. Secure interlock cable to ignition switch with screw.
7. Connect connector to interlock cable.
8. Position upper steering column shroud on steering column (Figure 8-15).
9. Raise steering column and secure steering column on mounting bracket with bolt, three washers, lockwasher, and locknut. Tighten locknut to 31 lb-ft. (42 N•m).
10. Tighten two locknuts securing steering column to mounting bracket. Tighten locknuts to 10 lb-ft (14 N•m).
11. Secure lower steering column shroud to upper shroud with five screws.
12. Install close-out panel (Section 10).

Test

1. With transmission lever in P, turn ignition key to run.
2. Activate brake switch and move transmission lever to N.
3. Without turning ignition key off, move transmission shift lever to P.
4. Turn ignition key off. To pass test, it should not be possible to move transmission lever out of P unless an extremely high effort is applied.
5. Turn ignition key on. To pass test, it should not be possible to move transmission lever out of P unless an extremely high effort is applied.
6. Activate brake switch. To pass test, transmission lever should be moved from P to N with normal shift effort.
7. Turn ignition key off. To pass test, it should not be possible to remove ignition key while transmission lever is in N.
8. Move transmission lever to P. To pass test, it must be possible to remove ignition key with normal effort applied to ignition key.

STEERING GEAR REPLACEMENT

Removal

NOTE: Ensure front wheels are in the straight-ahead position. Have drainage container ready to catch fluid.

1. Disconnect two power steering lines from steering gear (Figure 8-18).

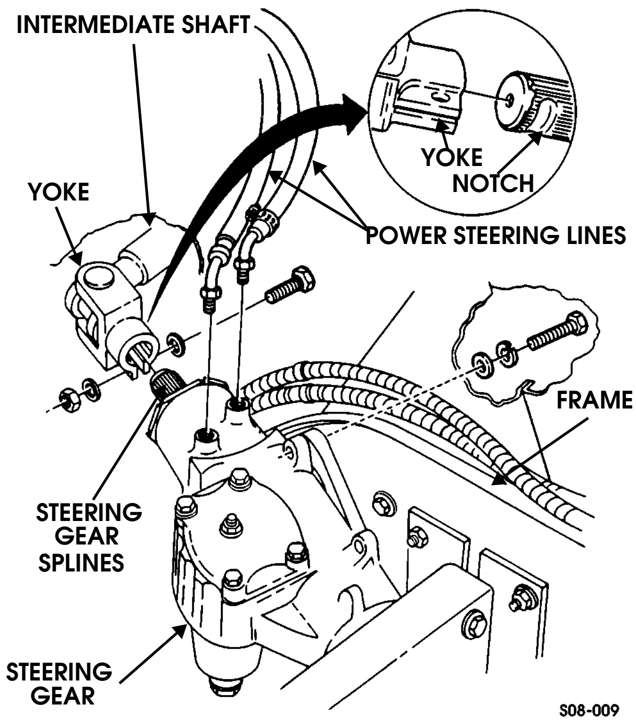


Figure 8-18: Steering Gear Mounting

2. Turn steering wheel left and right several times to bleed off power steering fluid.
3. Remove bolt on intermediate shaft yoke at steering gear and disconnect intermediate shaft from steering gear.
4. Remove nut and lockwasher from steering arm (Figure 8-19).
5. Using puller J–42548, remove steering arm from shaft.
6. Remove three bolts, lockwashers, washers, and steering gear from frame (Figure 8-18).

Installation

1. Align steering gear with mounting holes in frame and secure with three washers, lockwashers, and bolts. Tighten bolts to 54-66 lb-ft (73-89 N•m) (Figure 8-18).
2. Align hole in yoke with notch on steering gear splines and slide intermediate shaft on steering gear splines.
3. Insert bolt in yoke and tighten locknut to 60 lb-ft (81 N•m).
4. Connect two power steering lines to steering gear.

NOTE: Ensure front wheels are in the straight ahead position.

5. Install steering arm on shaft with lockwasher and nut. Tighten nut to 167-203 lb-ft (227-275 N•m) (Figure 8-19).
6. Fill power steering reservoir.
7. Purge air from power steering system (Refer to "Purging Air From the Power Steering System" on page 8–23).
8. Inspect wheel alignment.

INTERMEDIATE STEERING SHAFT REPLACEMENT

NOTE: Ensure front wheels are in straight-ahead position while removing and installing intermediate steering shaft.

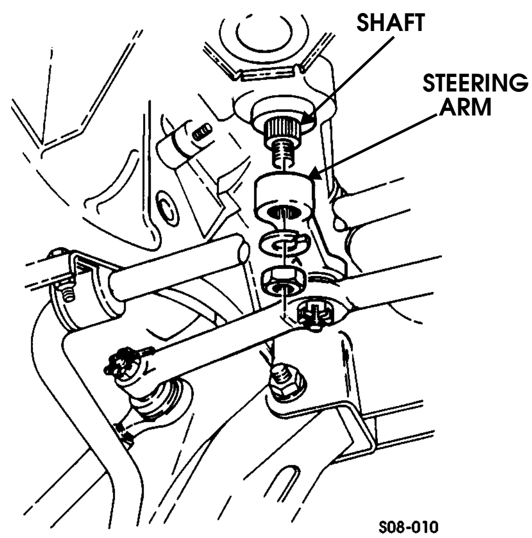


Figure 8-19: Steering Arm Removal

Removal

1. Remove close-out panel.
2. Remove three nuts, six washers, and three screws from dust boot (Figure 8-20).
3. Remove bolt on intermediate steering shaft yoke at steering gear.

NOTE: Before performing step 4, put scribe marks showing the position of the yoke relative to the splines.

4. Remove bolt on intermediate steering shaft yoke at steering column and remove shaft.

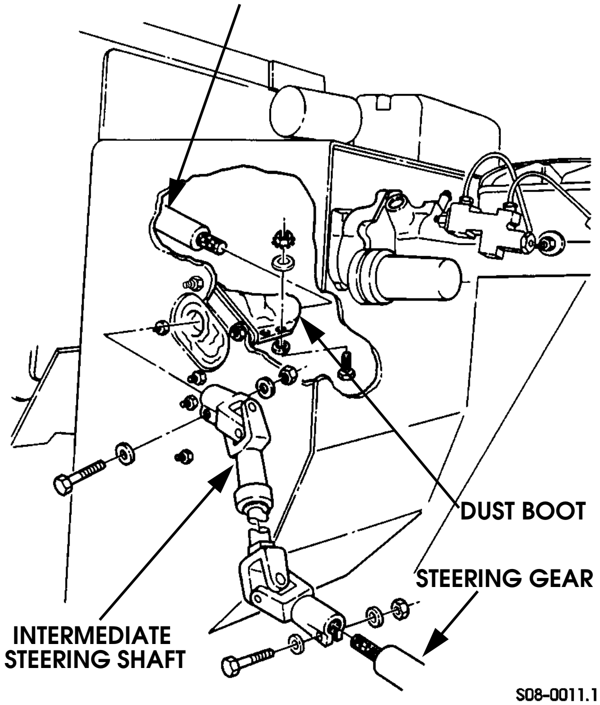


Figure 8-20: Intermediate Steering Shaft Removal

Installation

1. Align hole in yoke with notch on steering gear splines (Figure 8-18). Insert bolt through yoke and tighten locknut to 60 lb-ft (81 N•m) (Figure 8-20).
2. Align scribe marks and slide yoke onto steering column splines. Insert bolt through yoke and tighten locknut to 60 lb-ft (81 N•m).
3. Apply silicone spray or equivalent to end of steering shaft. Secure dust boot with three screws, six washers and three nuts.
4. Lubricate steering shaft at universal joints.
5. Install close-out panel.

INTERMEDIATE STEERING SHAFT DUST BOOT REPLACEMENT

Removal

1. Remove close-out panel.
2. Remove three nuts, six washers, and three screws from dust boot (Figure 8-21).

NOTE: Before performing step 3, put scribe marks showing the position of the yoke relative to the splines.

3. Remove bolt on yoke and pull intermediate steering shaft from steering column.
4. Remove four locknuts, eight washers, four screws, spacer, and dust boot from cowl panel and intermediate steering shaft.

Installation

1. Secure spacer and dust boot to cowl panel with four screws, eight washers, and four locknuts. Tighten locknuts to 60 lb-ft (81 N•m) (Figure 8-21).
2. Insert intermediate steering shaft through dust boot. Align scribe marks and slide yoke onto steering column splines. Tighten locknut on yoke to 60 lb-ft (81 N•m).
3. Apply silicone spray or equivalent to end of steering shaft. Install three screws, six washers, and three nuts on dust boot.
4. Install close-out panel.

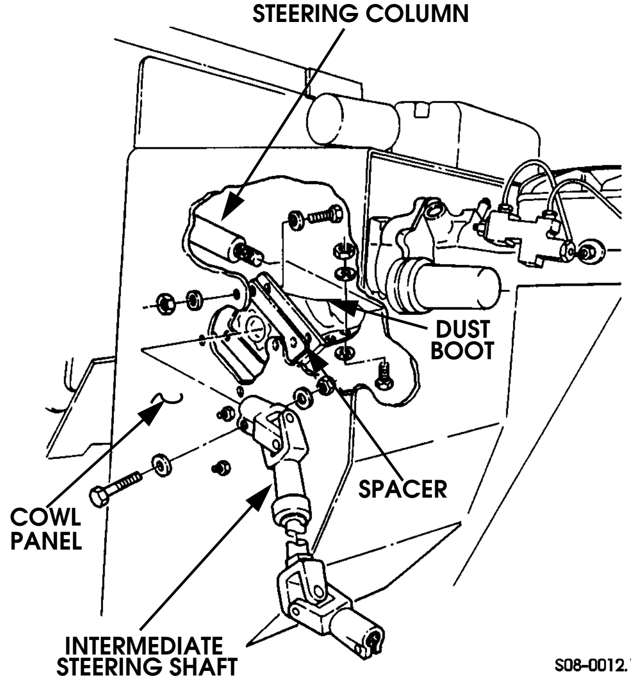


Figure 8-21: Intermediate Steering Shaft Dust Boot Replacement

STEERING STOP ADJUSTMENT

NOTE: Alignment equipment currently used in the automotive field should be used for steering stop adjustment procedure. This procedure should be followed if alignment equipment is not available.

Removal

1. Loosen jamnut and remove bolt and jamnut from geared hub (Figure 8-22).
2. Remove jamnut from bolt.

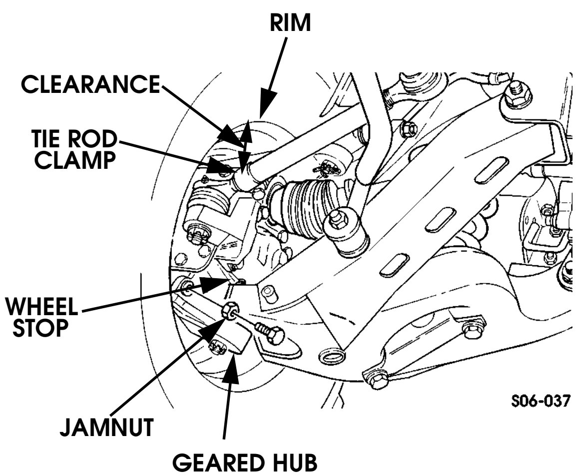


Figure 8-22: Steering Stop Adjustment

Installation

1. Apply thread-locking compound to bolt (Figure 8-22).
2. Thread jamnut on bolt.
3. Secure bolt and jamnut to geared hub. Tighten bolt finger tight.

Adjustment

NOTE: Prior to adjustment, ensure length of each tie rod is the same. If tie rod lengths are not the same ± 1/8 in. (3 mm), check toe-in alignment setting.

1. Draw a reference chalk line 30 feet long. Mark this line A (Figure 8-23).
2. Position vehicle so that center of left rear and left front tires are positioned directly on reference line A.
3. Using a protractor, draw a reference line at 34 degrees from line A. Mark this line B.
4. Again, using a protractor, draw a reference line at 36 degrees from line A. Mark this line C.

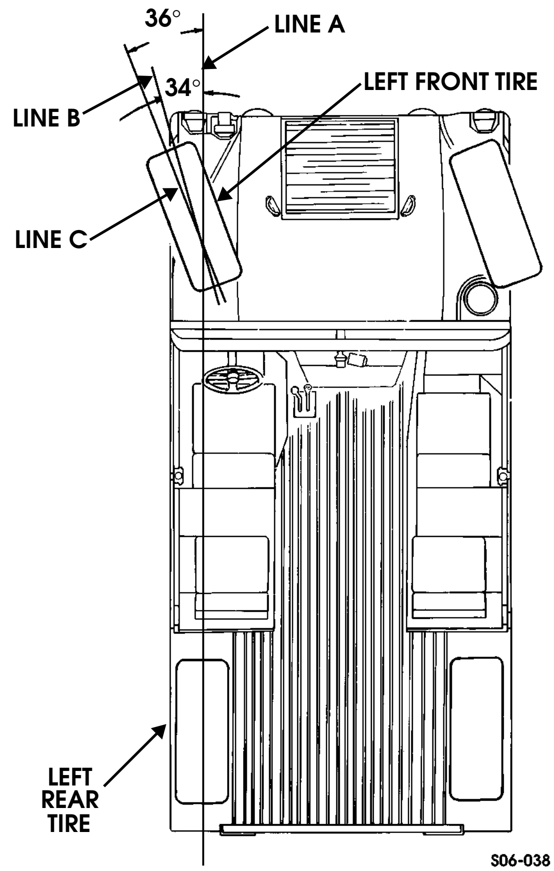


Figure 8-23: Checking Alignment

5. Roll vehicle forward until center of left front tire is over intersection of lines A, B, and C.
6. Turn steering wheel full left.
7. If centerline of front and rear of left front tire is over area between lines B and C, no adjustment is necessary.
8. If centerline of front and rear of left front tire is not over area between lines B and C, loosen jamnut and turn bolt all the way in.
9. Turn steering wheel until centerline of front and rear of left front tire is over area between lines B and C.
10. Unscrew bolt until head makes contact with wheel stop on lower control arm (Figure 8-22).
11. Secure bolt with jamnut.
12. Check for clearance between tie rod clamp and the rim.
13. Repeat adjustment procedure for opposite side.

POWER STEERING PUMP AND PULLEY REPLACEMENT

Removal

1. Disconnect return lines and high pressure line from back of pump (Figure 8-24).
2. Remove serpentine belt from power steering pump pulley.
3. Using puller J–25034-C or equivalent, remove pulley from pump.
4. Remove three bolts going through bracket into front of pump (Figure 8-24).

Installation

1. Apply non-hardening thread sealant to studs on back of pump and secure support bracket with two nuts. Tighten nuts to 45 lb-ft (61 N•m) (Figure 8-24)
2. Maneuver pump into position behind power steering bracket.
3. Secure pump to mounting bracket with three bolts.
4. Secure support bracket to block with bolt.
5. Connect two return lines to power steering pump (Figure 8-24).
6. Check condition of O-ring seal and connect high pressure line to back of pump.

***CAUTION:** In step 7, do not attempt to drive the pulley onto the pump shaft with a hammer. The pulley and pump ring will be damaged.*

7. Press pulley onto pump using pulley installer J–25033-C or equivalent. Pulley should be flush +/- 0.25 mm (0.010 inch) with the end of the power steering pump shaft.
8. Purge air from power steering system.
9. Start engine and check for leaks.

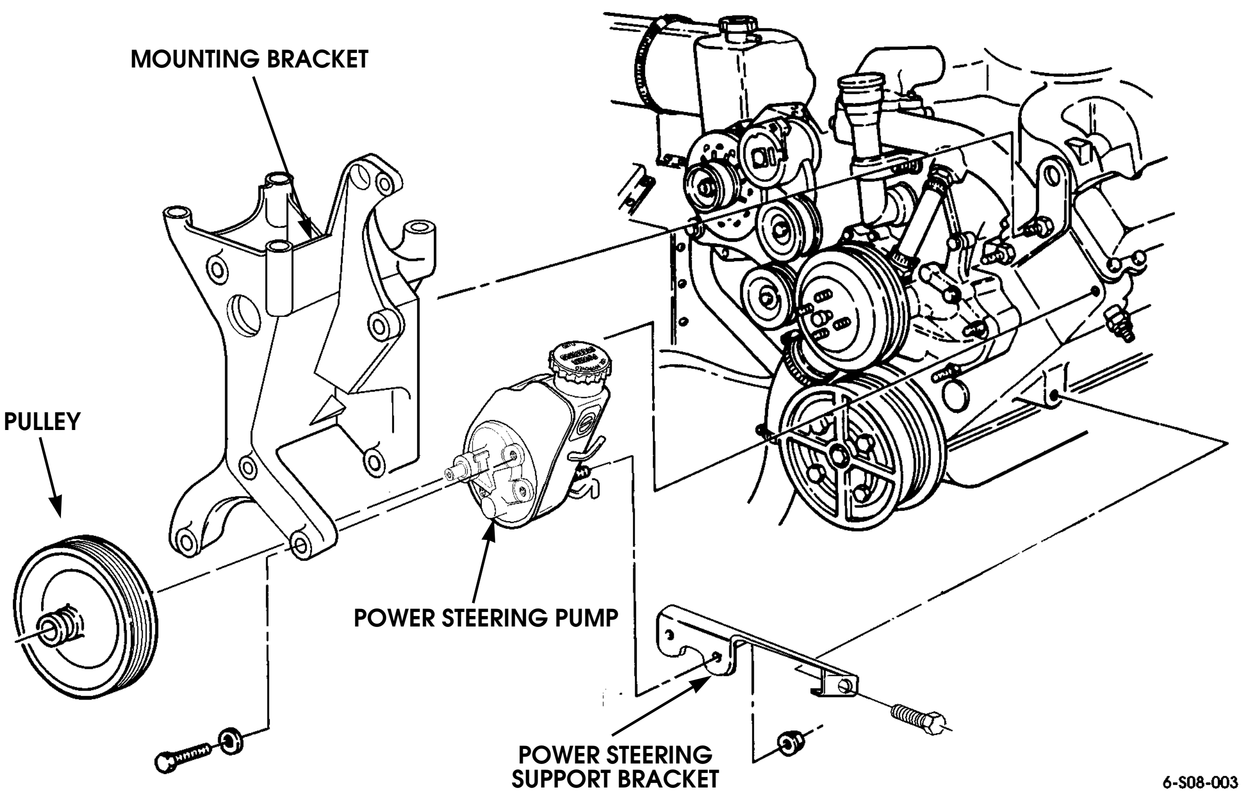


Figure 8-24: Power Steering Pump Mounting

POWER STEERING HYDRAULIC SYSTEM PRESSURE AND RETURN HOSE REPLACEMENT

NOTE: Removal and installation procedures are basically the same for all hydraulic system pressure and return hoses. This procedure covers the power steering pump to hydro-boost return hose and the steering gear to hydro-boost pressure hose.

Removal

1. Disconnect return hose from power steering pump and hydro-boost (Figures 8-25 and 8-26).
2. Remove locknut, washer, bolt, and two clamps from control valve hose and return hose. (Figure 8-25).
3. Remove locknut, two washers, and bolt securing two clamps and harness clamp to power steering line bracket.
4. Disconnect pressure hose from hydro-boost and steering gear and remove pressure hose. Remove two O-ring seals from pressure hose. Check condition of O-ring seals and replace if necessary (Figures 8-25 and 8-26).

Installation

1. Connect pressure hose to steering gear and hydro-boost (Figure 8-26).
2. Connect return hose to power steering pump and hydro-boost with two clamps (Figures 8-25 and 8-26).
3. Install two clamps on return hose and control valve hose. Secure return hose, control valve hose, and two clamps together with bolt, washer, and locknut (Figure 8-25).
4. Install harness clamp and two clamps on power steering lines bracket with bolt, two washers, and locknut.
5. Purge air from power steering system. Refer to (See “Purging Air From the Power Steering System” on page 8-23) .

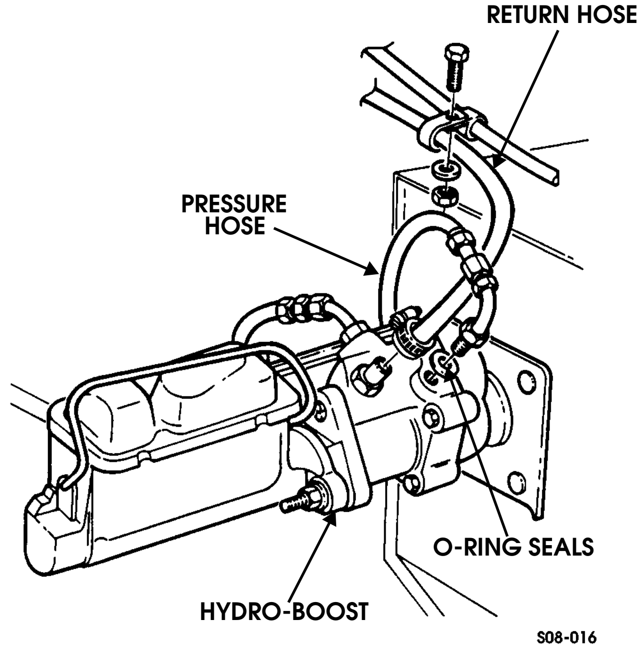


Figure 8-25: Power Steering Hose Replacement at Brake Hydro-Boost

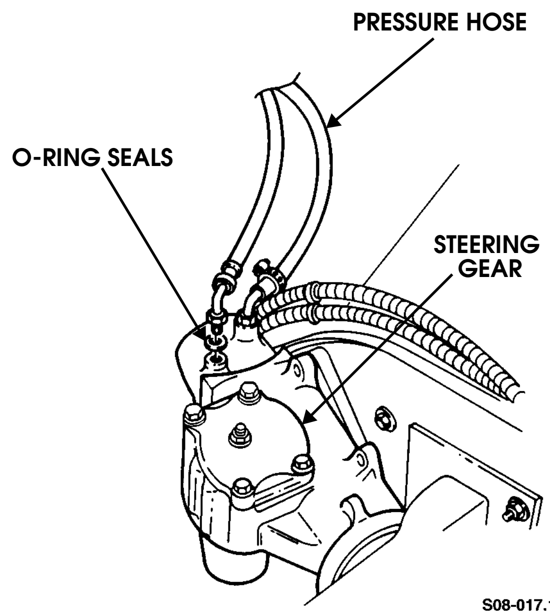


Figure 8-26: Power Steering Hose Replacement at Steering Gear

POWER STEERING COOLER AND COOLER HOSE REPLACEMENT

Removal

1. Disconnect two hoses from cooler (Figure 8-27).
2. Remove cooling fan for access into fan shroud.
3. Remove two nuts, four washers, reinforcement plate, two bolts, and cooler.
4. Disconnect hose at power steering gear and hose at back of pump.
5. Remove P-clamps holding hoses together and remove hoses.

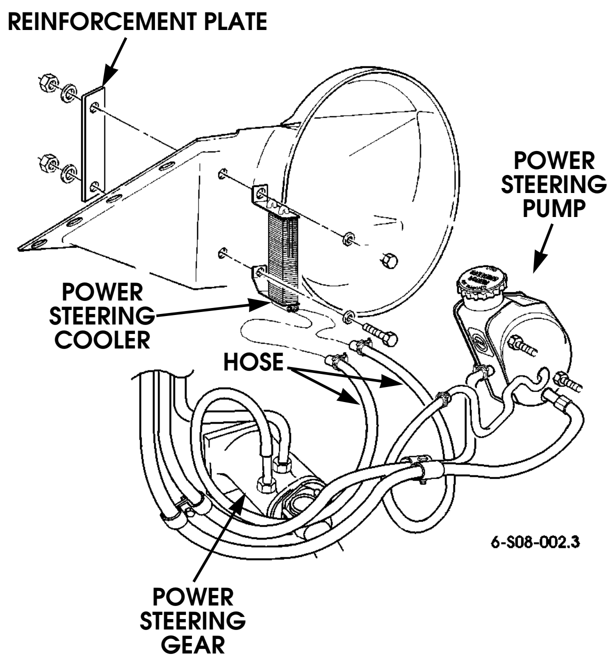


Figure 8-27: Power Steering Cooler and Cooler Hoses

Installation

1. Secure power steering oil cooler to fan shroud with two bolts, reinforcement plate, four washers, and two nuts (Figure 8-27).
2. Reinstall cooling fan.
3. Connect hoses to cooler and secure with clamps
4. Connect other end of each hose to its respective location at steering gear or pump and secure with clamps.
5. Secure hoses together with P-clamps.
6. Purge air from system.

POWER STEERING GEAR SERVICE

The Saginaw recirculating ball, power steering gear (Figure 8-28), is a fully serviceable component. The gear can be adjusted, or overhauled as needed. Overhaul requires that the gear be removed from the vehicle as repair can only be performed on the bench.

The steering gear adjustments described in the overhaul section can be performed on the bench or in the vehicle. Refer to the adjustment section for details.

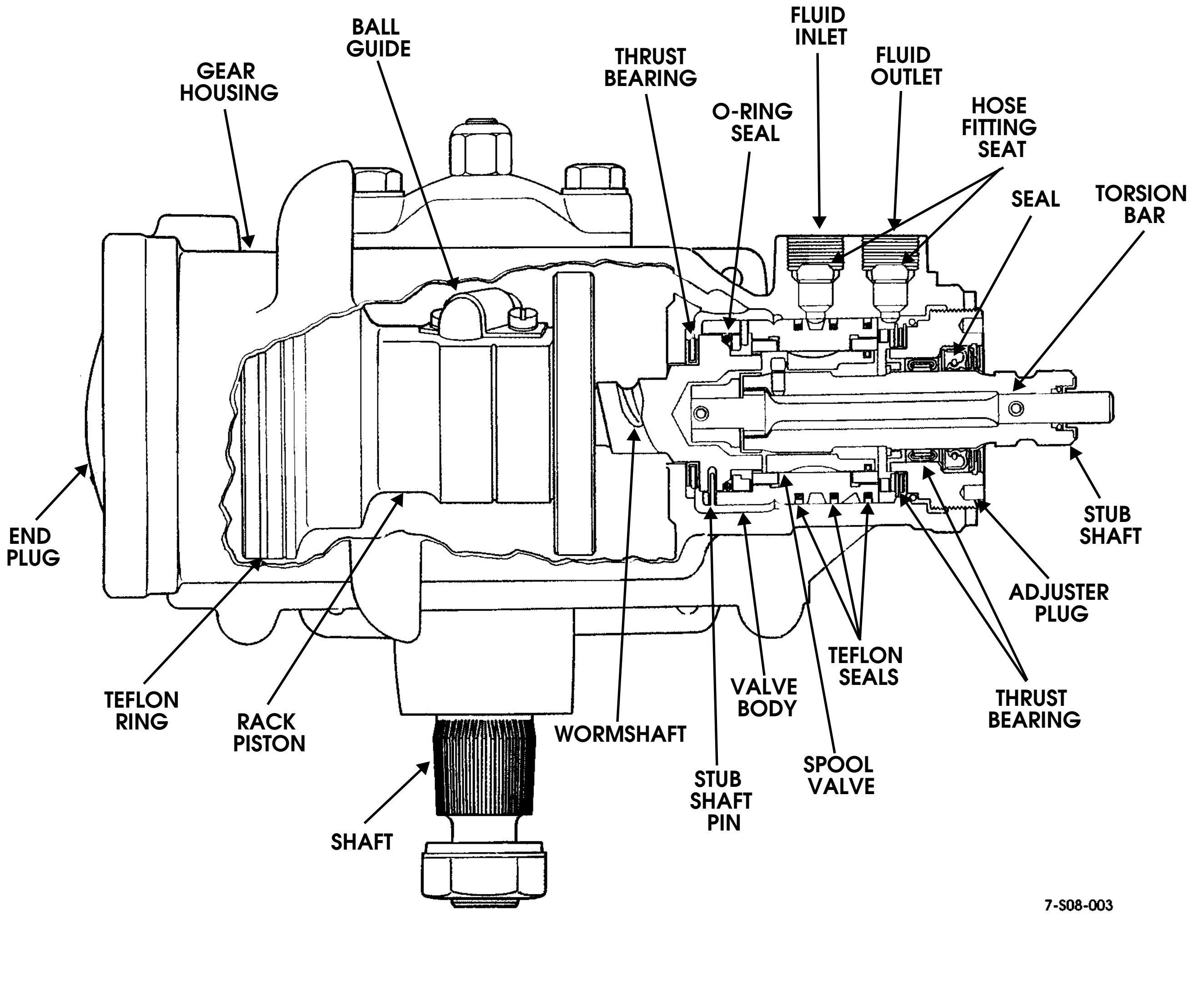


Figure 8-28: Power Steering Gear Cross Section

POWER STEERING SYSTEM DIAGNOSIS CHARTS

The diagnosis charts are guidelines to potential system faults. The charts list potential faults in order of probability (most probable to least probable).

While the charts outline common faults, they may not cover all possible problem causes. Inspection and diagnosis with analyzer set J–25323 should be used to confirm a pump or gear problem.

Table 1 Power Steering Diagnosis Chart - part 1

Problem	Possible Cause	Correction
Poor Return of Steering	1. Tires under-inflated. 2. Lower coupling flange rubbing against the steering gear adjuster plug. 3. Steering wheel rubbing against directional signal housing. 4. Binding steering linkage, or ball joints. 5. Steering gear to column misalignment. 6. Tie rod not centralized. 7. Lack of lubricant in the suspension ball joints and steering linkage. 8. Stuck or plugged valve spool. 9. Improper front wheel alignment. 10. Steering gear adjusted too tightly. 11. Kink in return hose.	1. Inflate to specified pressure. 2. Loosen the pinch bolt and assemble properly. 3. Adjust the steering jacket. 4. Replace the affected parts. 5. Align the column. 6. Adjust tie rod ends as required. 7. Lubricate. 8. Remove, clean, or replace the valve. 9. Check and adjust to specifications. 10. Adjust over-center and thrust bearing preload to specifications. 11. Replace the hose.
Steering Wheel Surges or Jerks When Turning With Engine Running Especially During Parking	1. Low oil level in pump. 2. Loose pump drive belt. 3. Sticky flow control valve. 4. Insufficient pump pressure.	1. Add power steering fluid as required. 2. Adjust bolt. 3. Replace or clean the control valve. 4. Test system with analyzer.
Hard Steering Effort in Both Directions	1. Low tire pressure. 2. Lack of lubricant in suspension or ball joints (Worn/contaminated joints). 3. Binding of steering linkage, or ball joints. 4. Steering gear to column misalignment. 5. Pump belt slipping. 6. Low fluid level in reservoir. 7. High internal leakage (steering gear or pump). 8. Sticky flow control valve. 9. Steering gear adjusted too tight. 10. Improper front wheel alignment	1. Adjust the tire pressure. 2. Lubricate and relubricate at proper intervals or replace joints. 3. Replace all affected parts. 4. Align the steering column. 5. Adjust belt. 6. Fill to proper level. Inspect lines and joints for external leakage. 7. Test system with analyzer. 8. Replace pump. 9. Adjust over-center and thrust bearing reload to specifications. 10. Check and adjust to specifications.
Foaming Milky Looking Power Steering Fluid, Low Level and Possible Low Pressure	1. Air in the fluid and loss of fluid due to internal pump leakage causing overflow. 2. Hose or air leakage in reservoir line.	Check for leak and correct. Bleed system. Extremely cold temperatures will cause system aeration should the oil level be low. If oil level is correct and pump still foams, remove pump from vehicle and separate reservoir from housing. Check welsh plug and housing for cracks. If plug is loose or housing is cracked, replace housing.

Table 2 Power Steering Diagnosis Chart - part 2

Problem	Possible Cause	Correction
"Hiss" Noise	Noisy relief valve in the pump.	There is some noise in all power steering systems. One of the most common is a hissing sound most evident at standstill parking. "Hiss" is a high frequency noise. The noise is present in every valve and results from high velocity fluid passing valve orifice edges. There is no relationship between this noise and steering performance. "Hiss" may be expected when the steering wheel is at end of travel or when slowly turning at standstill. Do not replace the pump unless "hiss" is extremely loud and continuous. A replacement pump will also exhibit slight noise and is not always a cure for hiss.
Rattle or Chuckle Noise in Steering Gear	1. Gear loose on the frame. 2. Steering linkage wear, play, looseness. 3. Pressure hose touching other parts of vehicle. 4. Loose steering arm. 5. Improper over-center adjustment. A slight rattle may occur on turns because of increased clearance off the "high pint". This is normal and clearance must not be reduced below specified limits to eliminate this slight rattle.	1. Check the gear mounting bolts. Torque the bolts to specifications. 2. Check linkage pivot points for wear. Replace if necessary. 3. Adjust the hose position. Do not bend tubing by hand. 4. Tighten the steering arm bolt. 5. Adjust to specification.
Excessive Wheel Kickback or Loose Steering	1. Air in system. 2. Steering gear mounting loose. 3. Steering linkage joints worn. 4. Front wheel bearings incorrectly adjusted or worn. 5. Steering gear improperly adjusted. 6. Damaged or worn steering gear.	1. Add oil to the pump reservoir and bleed. Check hose connectors for proper torque. 2. Tighten attaching bolts to specified torque. 3. Replace loose parts. 4. Adjust the bearings or replace with new parts as necessary. 5. Adjust to specifications. 6. Disassemble and repair the steering gear.
Vehicle Leads to One Side or the Other	1. Keep in mind the road and wind conditions. 2. Front wheels misaligned. 3. Unbalanced steering gear valve. If this is the cause, steering effort will be very light in direction of lead and heavy in opposite direction. 4. Steering shaft binding.	1. Test the vehicle, going in both directions, on a flat road. 2. Adjust to specifications. 3. Replace the gear valve body. 4. Align the column.
Momentary Increase in Effort when Turning the Wheel Quickly to the Right or Left	1. Low oil level in the pump. 2. Pump belt slipping. 3. High internal leakage (steering gear or pump).	1. Add power steering fluid as required. 2. Adjust belt pressure. 3. Refer to "Power Steering System Pressure Test" in this section. Repair as needed.

Table 3 Power Steering Diagnosis Chart - part 3

Problem	Possible Cause	Correction
Low Oil Pressure Due to Restriction in the Hose	1. Check for kinks in hose. 2. Foreign object stuck in the hose.	1. Remove the kinks or replace the hose. 2. Remove the foreign object or replace the hose.
Low Oil Pressure Due to Steering Gear. Refer to "Power Steering System Test" in this Section.	1. Pressure loss in cylinder due to worn rack piston ring or scored housing bore. 2. Leakage at the valve rings and valve body to the worm seal. 3. Leakage at the valve body or a loose fitting spool.	1. Disassemble the steering gear. Inspect the ring and housing bore. Replace the affected parts. 2. Disassemble steering gear and replace seals. 3. Replace the valve.
Low Oil Pressure Due to Steering Pump. Refer to "Power Steering System Test" in this Section.	1. Flow control valve stuck or inoperative. 2. Pressure plate not flat against the cam ring. 3. Extreme wear of cam ring. 4. Scored pressure plate, thrust plate, or rotor. 5. Vanes sticking in rotor slots. 6. Vanes not installed properly. 7. Air in oil. 8. Low oil level. 9. Pump belt slipping. 10. Damaged hoses or steering gear.	1. Replace pump. 2. Replace pump. 3. Replace pump and flush system. 4. Replace pump. Flush the system. 5. Replace pump. 6. Replace pump. 7. Locate source of leak and correct. Bleed the system. 8. Add power steering fluid as required. 9. Adjust belt. 10. Replace as necessary.
Chirp Noise in Steering Pump or Belt Squeal (Particularly Noticeable At Full Wheel Travel and Standstill Parking)	Pump belt slipping.	Replace belt.
Growl Noise in Steering Pump	Excessive back pressure in hoses or steering gear caused by restriction.	Locate restriction and correct.
Growl Noise in Steering Pump (Particularly Noticeable Standstill Parking)	1. Scored pressure plates, thrust plate, or rotor. Extreme wear of cam ring.	1. Replace pump and flush system.
Groan Noise in Steering Pump	1. Low oil level. 2. Air in the oil. Poor pressure hose connection.	1. Add power steering fluid as required. 2. Torque the connector. Bleed the system.
Rattle or Knock Noise in Steering Pump	1. Loose pump pulley. 2. Pump vanes sticking in rotor slots. 3. Pressure hose touching other parts of vehicle.	1. Replace pulley or pump. 2. Replace pump. 3. Adjust hose position.
Swish Noise in Steering Pump	Faulty flow control valve.	Replace pump.
Whine Noise in Steering Pump	Pump shaft bearing scored.	Replace pump.

PURGING AIR FROM THE POWER STEERING SYSTEM

NOTE: Fluid must be at operating temperature.

Air must be bled from the system before pressure testing and anytime the hoses are disconnected or the pump and/or gear is removed for service. Procedure is as follows:

1. All hose connections must be tight. Loose connections might not leak but could allow air into system.
2. Switch ignition off.
3. Turn the steering wheel full left.
4. Top off the reservoir fluid level to "FULL COLD" but do not replace the reservoir filler cap. If fluid was added to the reservoir, allow it to settle for 2-3 minutes before proceeding.
5. Raise and support the vehicle front end. The front tires only have to clear the shop floor.
6. Shift the transmission into Park.
7. With an assistant checking the fluid level and condition, turn steering wheel lock-to-lock at least 40 times. The engine remains off.
   - Trapped air may cause fluid to overflow. Thoroughly clean any spilled fluid to allow for leak check.
   - Keep fluid level at "FULL COLD".
8. While turning wheel, check fluid constantly.
   - There should be no bubbles.
   - If there are any bubbles, recheck the connections and repeat step 7.
9. Start the engine. With engine idling, maintain fluid level. Install reservoir cap.
10. Return wheels to center. Lower front wheels to the ground.
11. Keep engine running for two minutes.
12. Continue turning wheels back and forth until bubbles no longer appear in fluid.
13. Verify the following conditions:
    - smooth power assist
    - noiseless operation
    - proper fluid level
    - no system leaks
    - proper fluid condition
14. If all conditions apply, the procedure is complete.

POWER STEERING SYSTEM PRESSURE TEST

Power steering system performance can be checked with analyzer set J–25323 and hose fitting adapters J–33141. The analyzer checks flow in gallons per minute (gpm) and min/max pressure in psi. Analyzer hose connection is shown in Figure 8-29. Procedure is as follows.

Pressure Test Procedure

1. Purge air from power steering system. Refer to procedure in this section.
2. Position drain pan under pump and gear to catch spilled fluid.
3. Connect J–25323 analyzer hoses to pump and gear (Figure 8-29). Use fitting adapters J–33141 to connect hoses to gear and pump as needed.
4. Add power steering fluid to reservoir required.
5. Shift transmission into Park.
6. Open analyzer valve.
7. Start and run engine at curb idle speed.
8. Note and record flow rate and pressure indicated on analyzer gauge.
   a. If flow is less than 1.32 gpm (5 liters/min.), pump is faulty.
   b. If pressure is above 150 psi, (1035 kPa), either a hose is restricted or a problem exists within the gear.
   c. If flow is greater than 1.32 gpm and pressure is less than 150 psi, continue test.
9. Partially close the analyzer valve, allow pressure to build to 620 psi (4278 kPa), and record flow rate.
   a. If flow rate decreases by more than 1 gpm (3.7 L/ minute) from the reading in step 8, the pump is at fault.
   b. If flow rate remains about the same, continue test.
10. Completely close and partially open the analyzer valve three times in succession. Note and record maximum pressures each time.

CAUTION: *Do not close the analyzer valve for more than 3-4 seconds at a time. Longer periods will result in rapid fluid overheat and pump damage.*

11. If pump maximum pressures recorded in step 10 were less than 1150 psi (7929 kPa), the pump is at fault. However, if pressures are at, or above specified limit, continue with test.
12. Increase engine speed to 1500 rpm and record flow rate.
    a. If flow rate remains within 1 gpm of flow recorded in step 8, continue test.
    b. If flow rate drops by more than 1 gpm (3.7L/ minute), pump control valve is faulty.

13. Turn steering wheel lightly against each stop and record maximum pressure.
    a. If pressure at each stop is about the same as recorded in step 10, and flow drops to 0.5 gpm (1.85 L/min.), continue with test.
    b. If pressures does not reach maximum recorded in step 10, and flow rate does not fall off, overhaul steering gear to correct internal leakage in valve, or past seal rings.
14. Turn steering wheel to the right, release it., and observe the analyzer gauge. Then turn the wheel to the left, release it, and observe the gauge again.
    a. If the gauge needle indicates normal pressure then snaps back as the wheel is released. Continue the test.
    b. If the gauge indicates normal pressure but the needle is slow to return when the wheel is released, the steering gear valve body or spool is sticking. Overhaul will be required to correct the problem.
15. If gear and pump test OK but a problem still exists, check for fluid contamination. Draw off sample with suction gun and empty sample in glass container. Look for burned fluid, foreign material, fluid layering (fluid separates into two layers), foreign material/metal particles in the fluid. Any of these conditions will cause gear and pump problems. Flushing the system with new fluid may correct the problem.
16. If fluid condition is OK but a problem still exists, a problem may exist in the steering linkage, tires/wheels, or suspension part. Further diagnosis will be required.

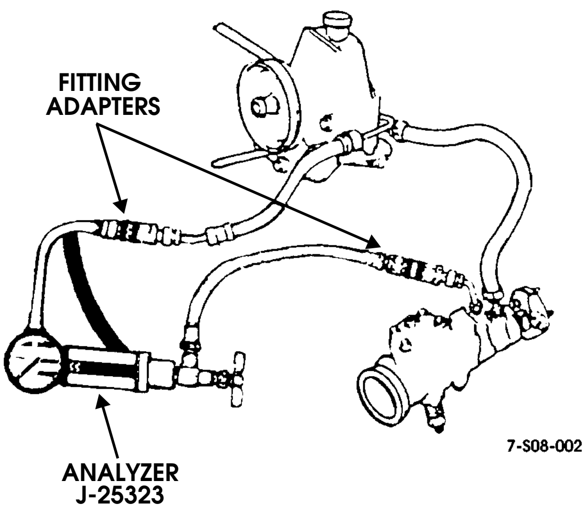


Figure 8-29: Analyzer Pressure Test Connections

POWER STEERING GEAR DISASSEMBLY AND OVERHAUL

Cleanliness is extremely important to a successful gear overhaul. Clean the gear exterior before disassembly and make sure the workbench area is clean and dry. Drain as much of the old fluid from the gear as possible beforehand. Dirt and foreign material must not be allowed to enter the gear internal components. Use lint free shop towels for wiping parts and hands clean. Lint from cotton towels will flow through the system and eventually cause the valve body spool, or pump control valve to stick and bind.

Side Cover and Pitman Shaft Removal

1. Remove side cover attaching bolts.
2. Hold adjuster screw with hex wrench and remove adjuster screw nut.
3. Rotate stub shaft as necessary to center pitman shaft teeth in rack piston. Use 12 point socket and ratchet to turn stub shaft.
4. Remove pitman shaft, side cover, and gasket (Figure 8-30).

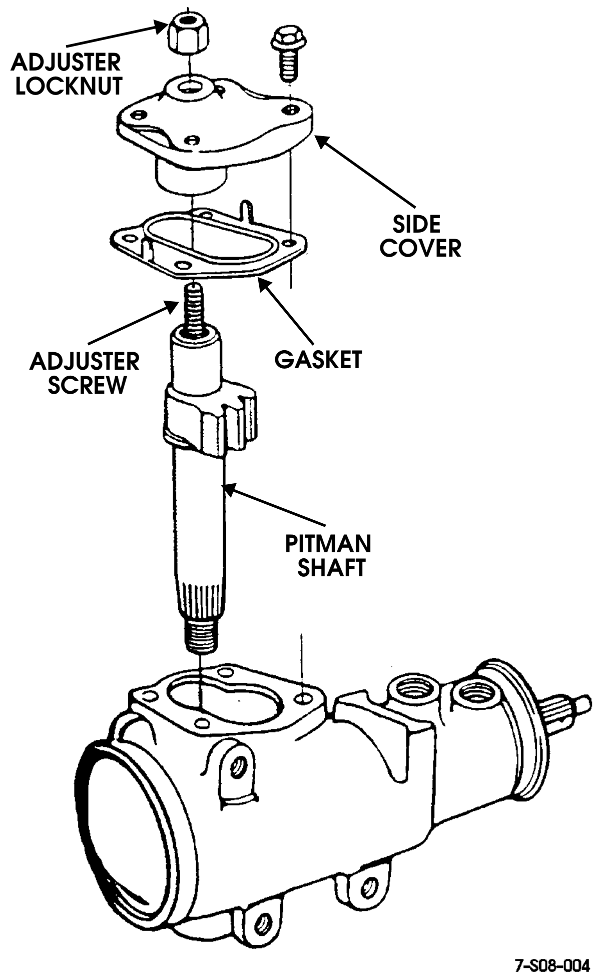


Figure 8-30: Side Cover and Sector Shaft

Gear Housing End Plug Removal

1. Rotate end plug retaining ring until one end is under small access hole in housing (Figure 8-31).

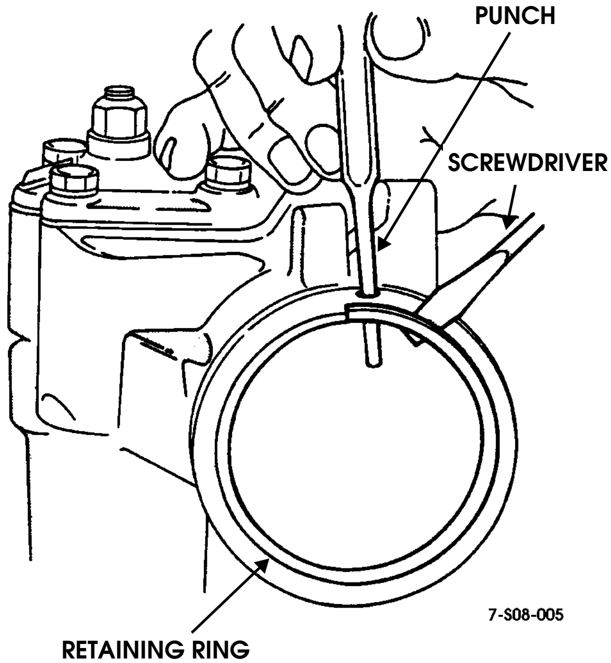


Figure 8-31: End Plug Retaining Ring Removal

2. Unseat end plug retaining ring with small pin punch and screwdriver (Figure 8-31). Insert punch through access hole in housing as shown.
3. Slowly rotate stub shaft counterclockwise to ease end plug out of housing.

CAUTION: *Do not rotate the stub shaft any farther than necessary. The recirculating balls can drop out of the rack piston and fall inside the piston chamber making further disassembly extremely difficult.*

4. Remove end plug (Figure 8-32).
5. Remove O-ring seal from housing (Figure 8-32).

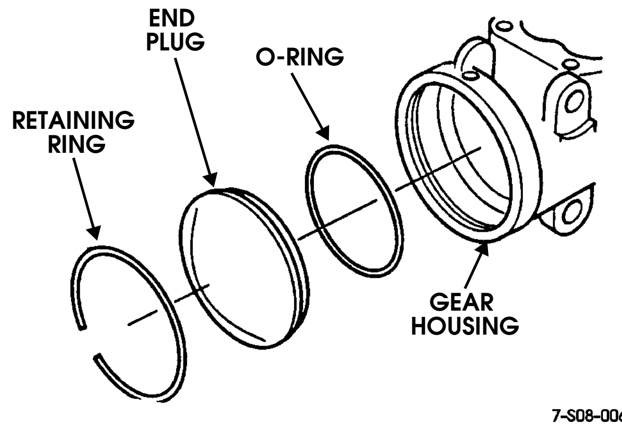


Figure 8-32: End Plug and Seal Removal

Adjuster Plug Removal and Disassembly

1. Remove adjuster plug locknut with punch and hammer (Figure 8-33).

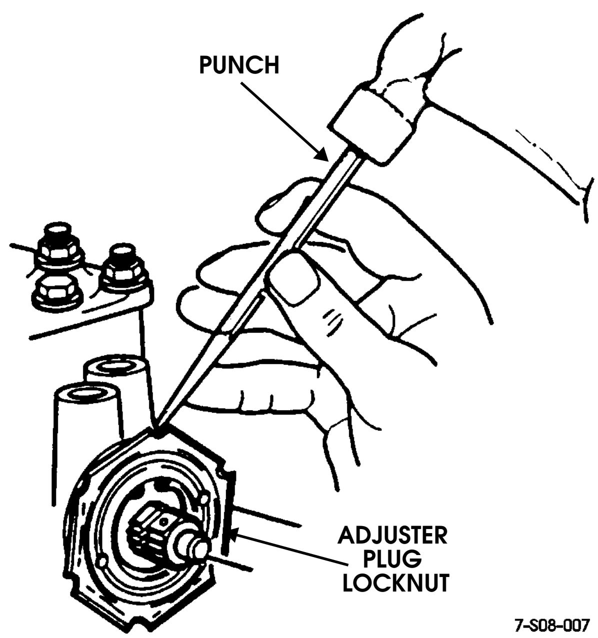


Figure 8-33: Adjuster Plug Locknut Removal

2. Remove adjuster plug from housing with spanner wrench J–7624 (Figure 8-34).

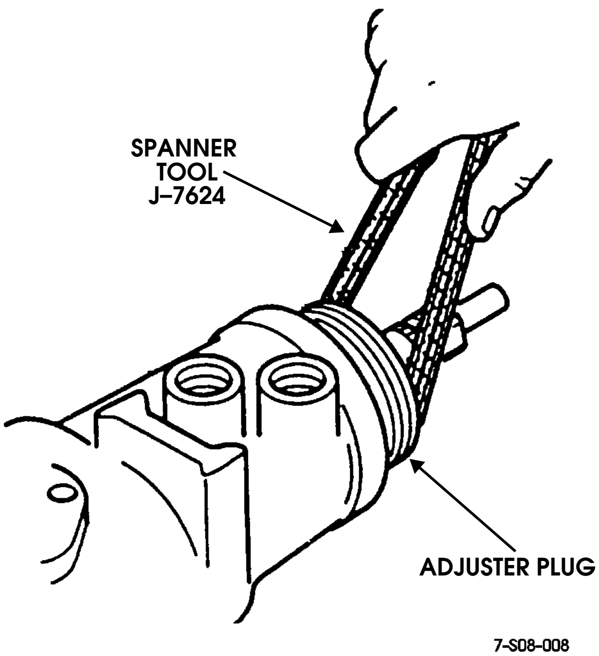


Figure 8-34: Adjuster Plug Removal

3. Remove thrust bearing retainer by prying it up and out at raised point on retainer (Figure 8-35).

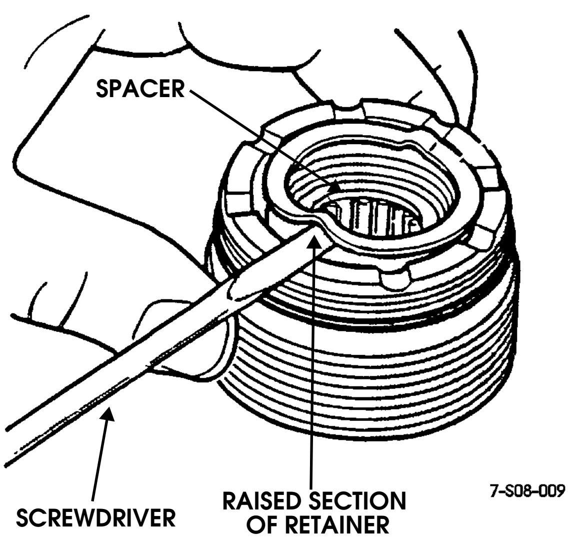


Figure 8-35: Adjuster Plug Thrust Bearing Retainer Removal

4. Remove bearing spacer, thrust bearing and races, and O-ring (Figure 8-36).

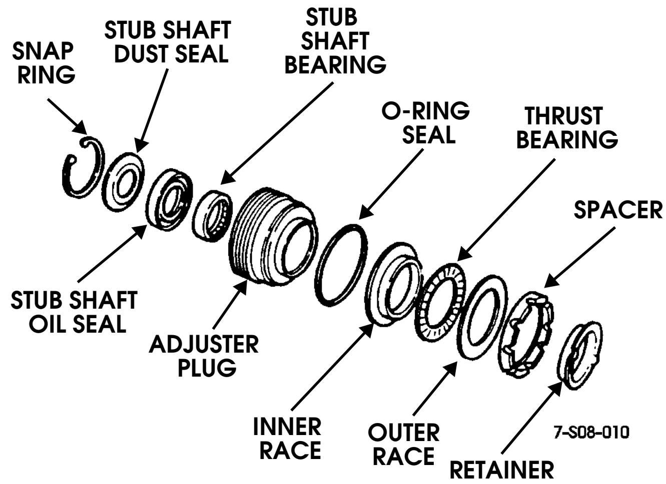


Figure 8-36: Adjuster Plug Components

5. Remove stub shaft seal retainer.
6. Remove dust seal and oil seal (Figure 8-37). Use tool J–6221 to remove seals.

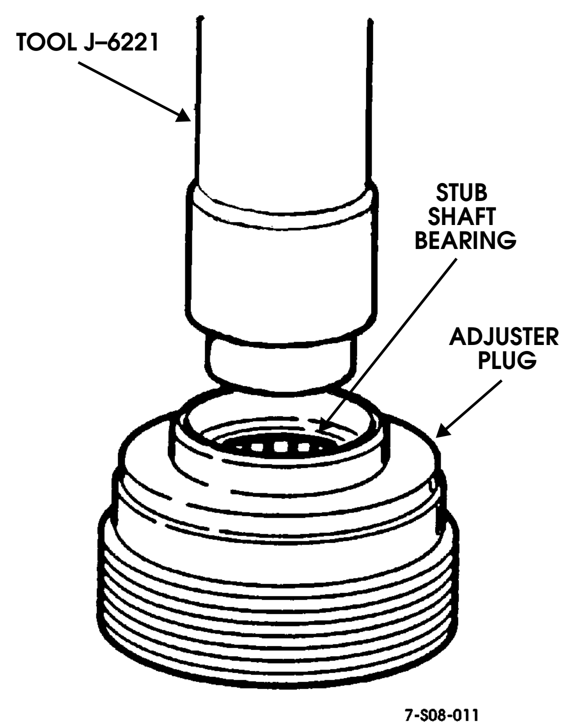


Figure 8-37: Stub Shaft Bearing Removal

7. Remove stub shaft bearing with tool J–6221 (Figure 8-37).

Rack Piston Removal and Disassembly

1. Rotate stub shaft counterclockwise until rack piston is even with seal groove in open end of housing. Do not allow the rack piston to extend out of the housing. It only needs to be about 1/4 inch from the end.
2. Remove rack piston plug (Figure 8-38). Use a ratchet and socket extension to remove the plug as shown.

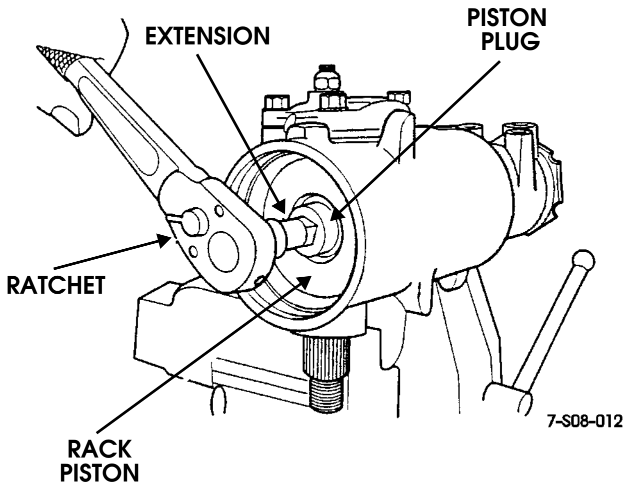


Figure 8-38: Rack Piston Plug Removal

3. Insert arbor tool J–21552 into rack piston (Figure 8-39).

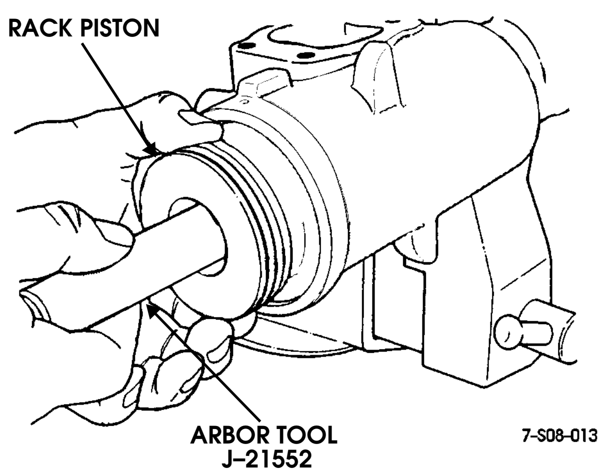


Figure 8-39: Rack Piston Removal

4. Hold arbor tool tightly in rack piston and turn stub shaft counterclockwise to push rack piston out of housing. Then remove rack piston, and arbor tool as assembly (Figure 8-39).
5. Remove wormshaft if it came out of stub shaft (Figure 8-40).

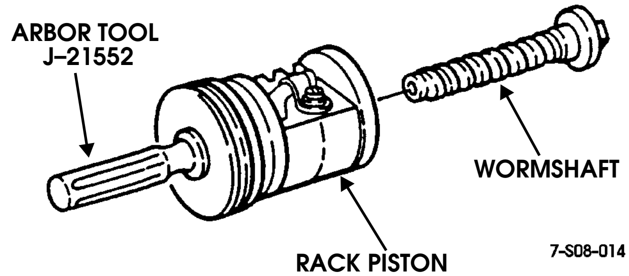


Figure 8-40: Wormshaft Removal

6. Remove thrust bearing and races from wormshaft.
7. Remove teflon seal rings and backup O-rings from rack piston (Figure 8-41).

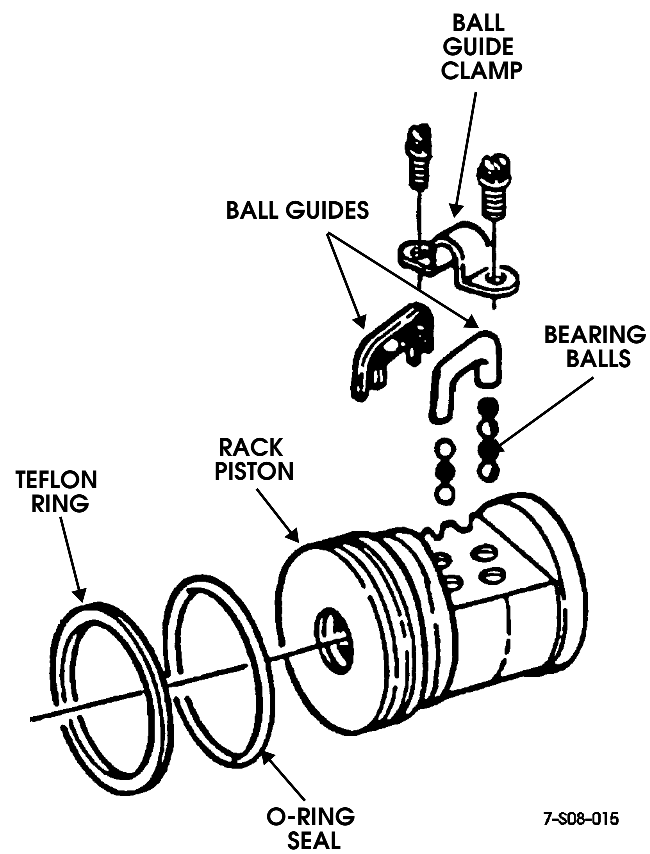


Figure 8-41: Rack Piston Components

8. Remove bolts attaching recirculating ball guide halves to rack piston, remove guides, and remove bearings from rack piston (Figure 8-40). A total of 24 bearings are used; 12 chrome and 12 black.

Valve Body-Stub Shaft-Wormshaft Removal and Disassembly

1. Grasp splined end of stub shaft and carefully rotate valve body/stub shaft assembly out of gear housing.
2. If wormshaft remained engaged in stub shaft cap, disengage and remove wormshaft at this time.
3. Remove O-ring from cap end of stub shaft.
4. Lightly tap splined end of stub shaft on wood block to disengage cap from valve body.
5. Grasp stub shaft cap and pull it upward to expose shaft pin (Figure 8-42). Then disengage shaft pin from valve body and separate two components.

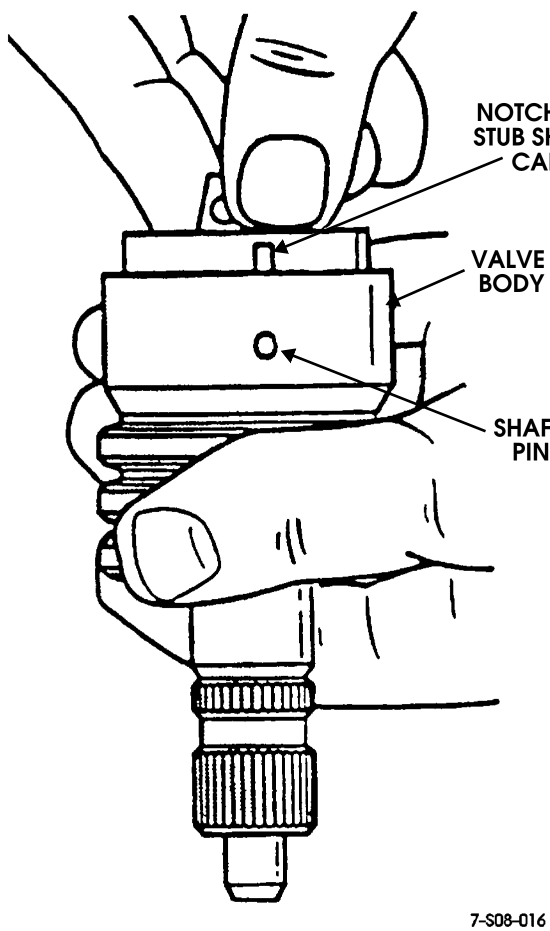


Figure 8-42: Stub Shaft Removal

6. Remove spool from valve body with a rotating motion (Figure 8-43).

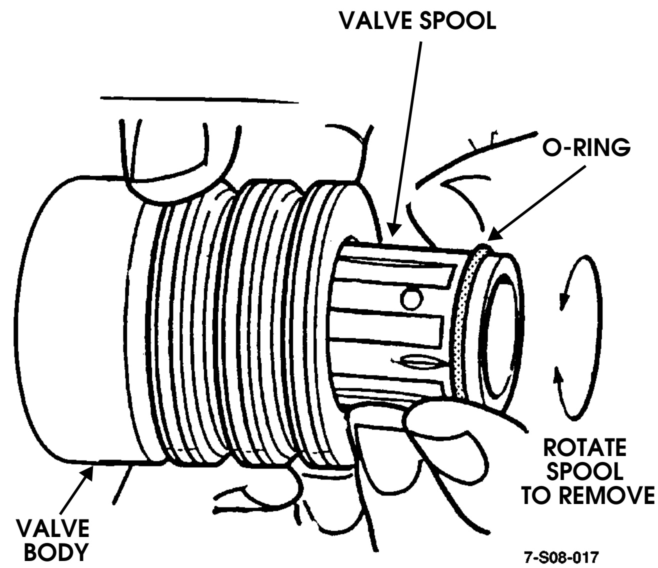


Figure 8-43: Valve Spool Removal

7. Remove O-ring from valve spool.
8. Remove seals and O-rings from valve body (Figure 8-44).

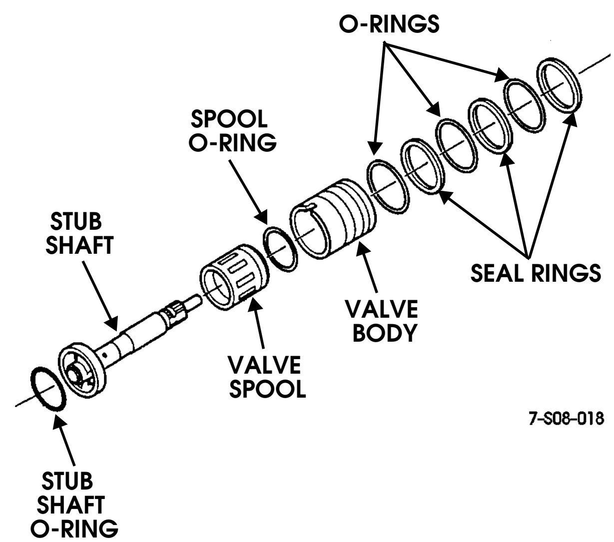


Figure 8-1

Figure 8-44: Stub Shaft/Valve Body Components

Pitman Shaft Bearing and Seal Removal

1. Remove seal retaining ring with internal-type snap ring pliers.
2. Remove first backup washer (Figure 8-45).

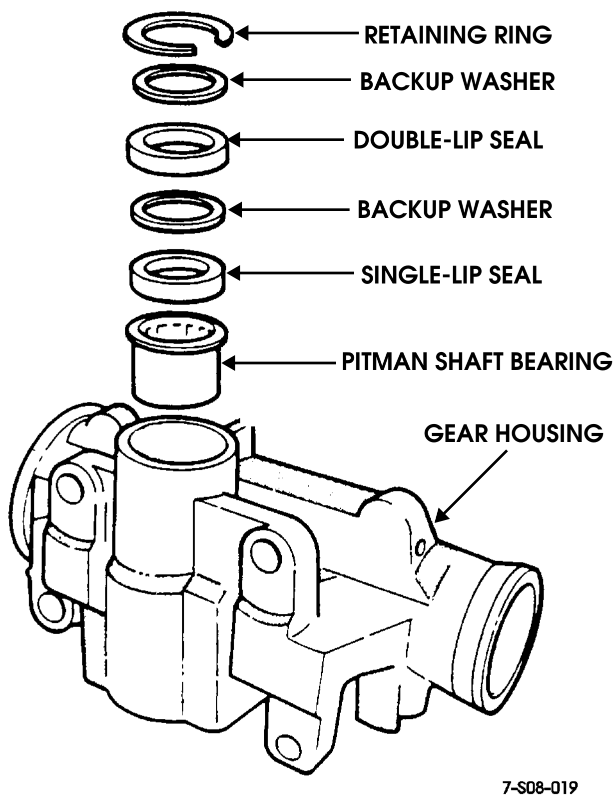


Figure 8-45: Pitman Shaft Bearing and Seal Position

3. Remove seals, second backup washer, and bearing with tool J–6278 (Figure 8-46).

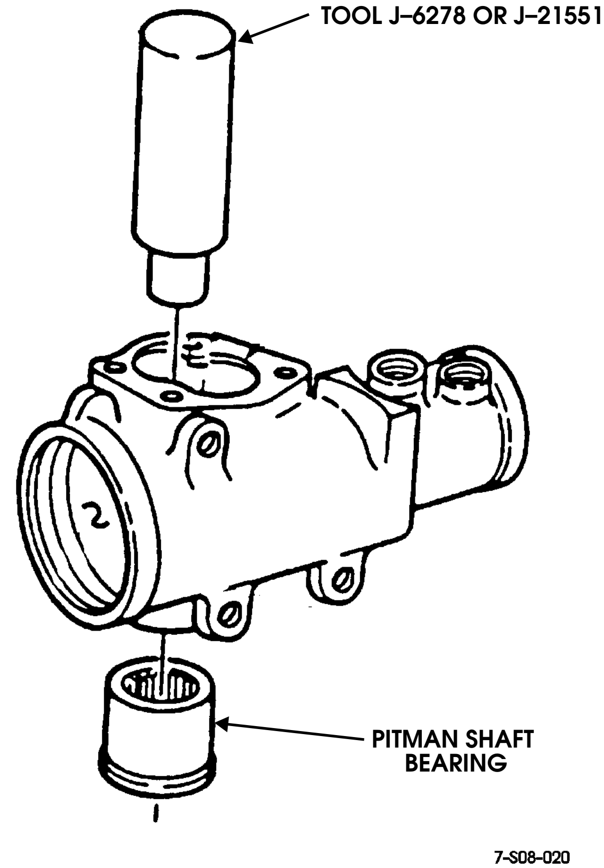


Figure 8-46: Pitman Shaft Bearing Removal

POWER STEERING GEAR CLEANING AND INSPECTION

Discard all the old O-rings, seals, and seal rings. Do not reuse these parts.

Clean the gear housing and components in a standard parts cleaning solution and either wipe them dry with lint-free shop towels or use low pressure compressed air.

Examine the wormshaft, pitman shaft, and stub shaft bearings for wear, galling, flat spots, or loss of bearing material (flaking). Also examine the wormshaft and stub shaft thrust bearing races for wear, grooving, discoloration, scoring, or spalling. Replace bearings and races as necessary. Do not reuse parts in marginal condition.

Check the gear housing for cracks, damaged threads, scored-worn valve bores, and damaged pressure hose seats. Replace the housing if necessary. The hose seats can be replaced if scored, distorted, or loose. Refer to the procedure in the assembly and adjustment section.

Inspect condition of the rack piston, wormshaft, and recirculating bearing balls (Figure 8-47). Replace the bearing balls as a set if any are scored, worn, distorted, have flat spots, or the coating is flaking off. The rack piston should be free from wear and scoring. Also be sure the seal ring groove is in good condition and the edges are not chipped cracked, or peened over. The wormshaft must be smooth and free of scoring or wear to operate properly. Check the ball guide clamp threads in the rack piston. Rough threads can be cleaned up with a tap but damaged threads mean the rack piston will have to be replaced.

Check fit of the spool in the valve body. The spool should move freely with a light coating of power steering fluid on it. Replace the valve body and spool as an assembly if either part is worn, scored, or damaged in any fashion.

Inspect the stub shaft for wear and damage. Minor nicks and scratches on the shaft surface can be dressed off with crocus cloth or 600 grit emery cloth wetted with oil. However, replace the shaft if scored, or distorted.

The adjuster plug threads and bearing bore should be in good condition especially the threads. Replace the plug if the threads are rough, deformed, or chipped. Rough threads will prevent proper preload on the wormshaft thrust bearing.

Examine the pitman shaft, side cover, and gasket. Replace the shaft if the sector teeth are damaged, or the bearing and seal contact surfaces are worn, scored, or damaged in any way. Check condition of the side cover bushing. Replace the cover if the bushing is worn as the bushing is not serviceable. Inspect condition of the lash adjuster screw in the pitman shaft. Replace the shaft if the screw is damaged as the screw is not serviced separately.

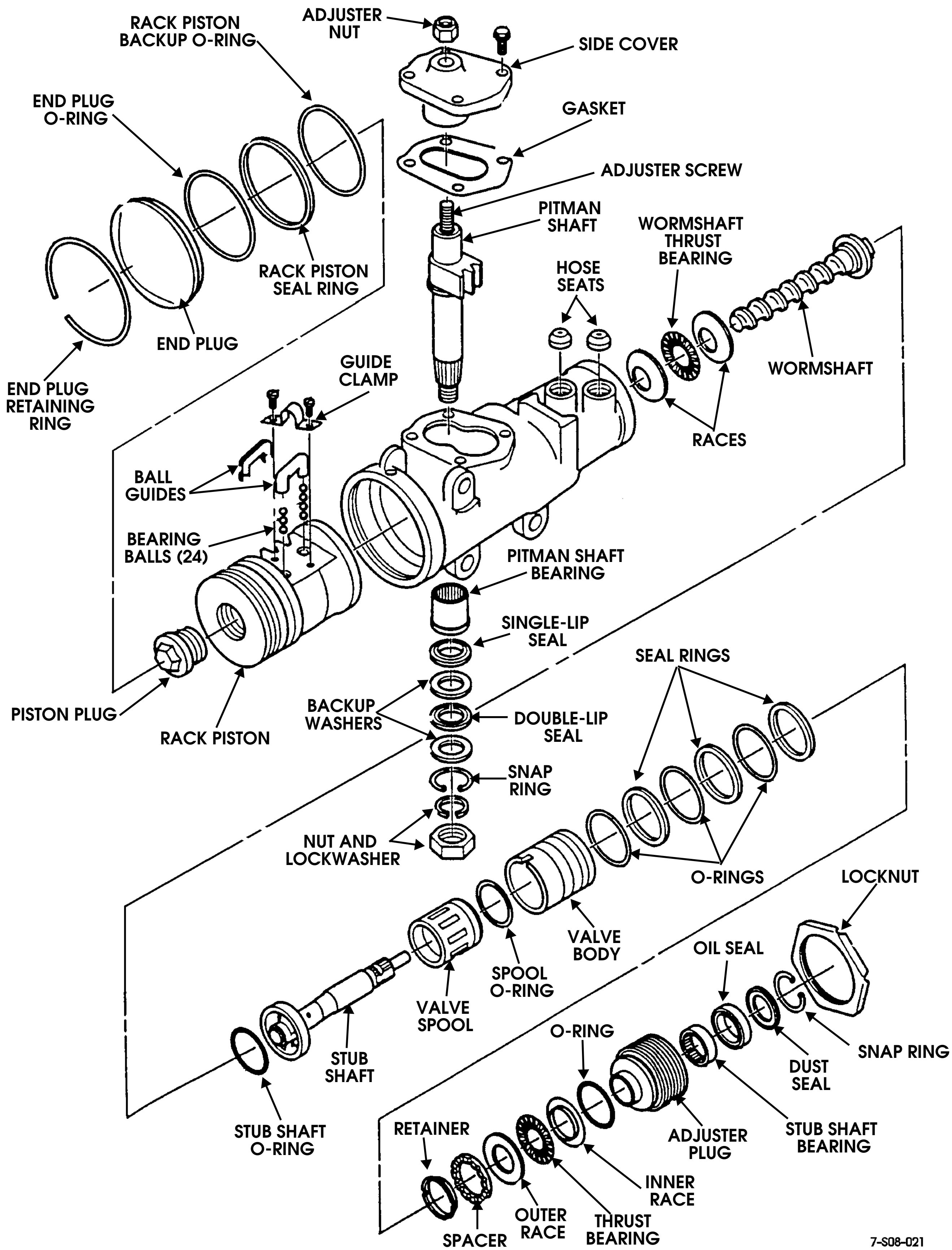


Figure 8-47: Power Steering Gear Components

POWER STEERING GEAR ASSEMBLY AND ADJUSTMENT

Gear Housing Hose Seat Replacement

The hose seats in the gear housing (Figure 8-48), can be replaced when necessary. Procedure is as follows:

1. Thread appropriate size pan head, hardened sheet metal screw into seat.
2. Pry old seat out of housing using pry tools positioned under screw head.
3. Clean gear housing afterward to remove any chips.
4. Install new seat using spare hose fitting and brass punch.

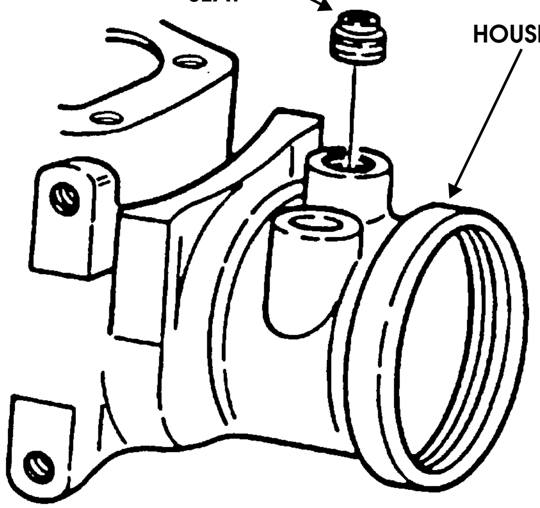


Figure 8-48: Pressure Hose Seat

Pitman Shaft Bearing and Seal Installation

1. Lubricate bearing and seals with power steering fluid, or petroleum jelly.
2. Install bearing in gear housing with handle J 8092 and installer J–6278 or J–21551 (Figure 8-49).

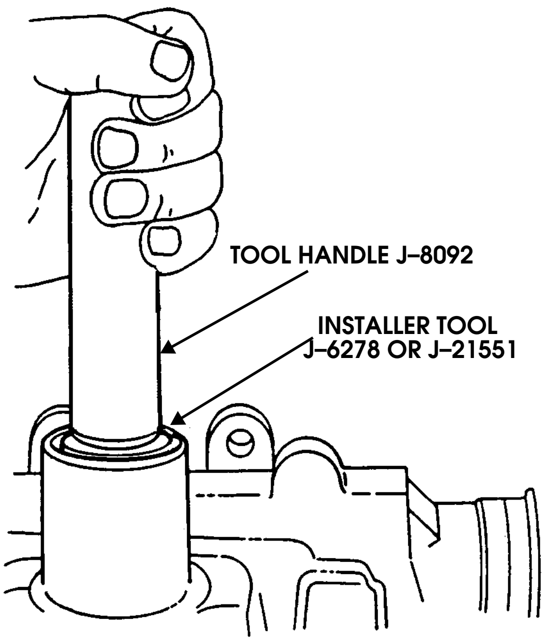


Figure 8-49: Pitman Shaft Bearing Installation

3. Install single lip seal in housing with tool J–6219 (Figure 8-53). Be sure seal lip is toward gear housing.
4. Install backup washer on single lip seal (Figure 8-50).
5. Install double lip seal in housing with tool J–6219 (Figure 8-53). Be sure seal lip is toward gear housing.
6. Install backup washer on double lip seal.
7. Install seal retaining snap ring.

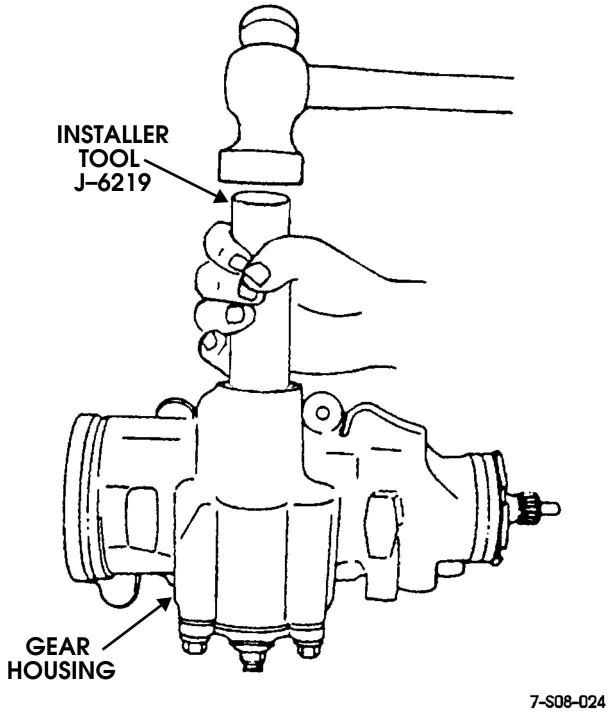


Figure 8-50: Pitman Shaft Seal Installation

Rack Piston Assembly

1. Lubricate rack piston bore in gear housing and new O-ring and seal ring with power steering fluid.
2. Install new backup O-ring in rack piston seal groove.
3. Install new teflon seal ring in groove **over** backup O-ring (Figure 8-51).

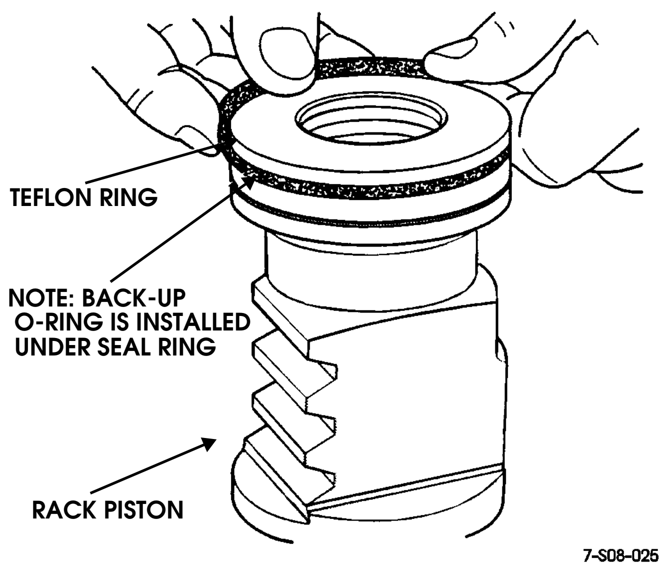


Figure 8-51: Rack Piston Seal Ring Installation

4. Install wormshaft in rack piston. Wormshaft flange should be seated against piston as shown (Figure 8-52).

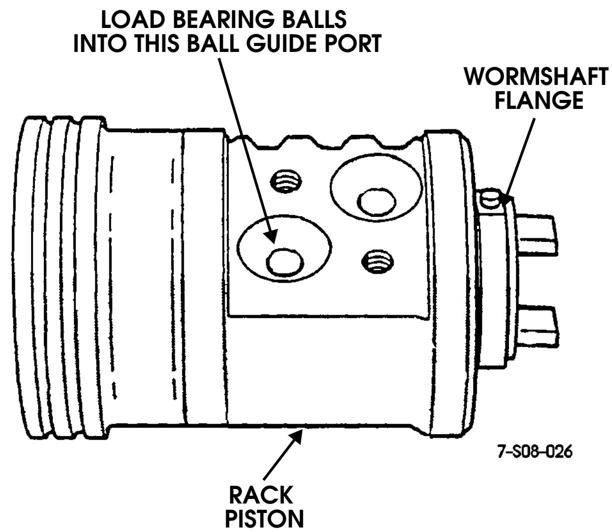


Figure 8-52: Rack Piston Loading Port For Bearing Balls

5. Align worm shaft spiral groove with indicated ball guide circuit port in rack piston (Figure 8-52).
6. Load recirculating bearing balls in rack piston and in ball guides as follows:
   a. Lubricate bearing balls with power steering fluid.
   b. Turn wormshaft **counterclockwise** to load bearing balls in rack piston.
   c. Load balls in rack piston through indicated ball guide port (Figure 8-52).
   d. Load balls alternately. Start with chrome ball followed by black ball until rack piston is full (piston will only accommodate around 18 balls).
   e. Load remaining balls in ball guides. Use petroleum jelly to hold balls and guide halves in place (Figure 8-53).
   f. Verify that 12 black and 12 chrome balls were installed in correct sequence.
   g. Assemble and install ball guides (with enclosed balls) on rack piston and secure guides with clamp. Tighten clamp bolts to 43 lb-ft (58 N•m) torque.

WARNING: The chrome recirculating balls are slightly larger in diameter than the black coated balls. This is required in order to generate and maintain proper wormshaft preload. It is also why the balls must be installed alternately. Incorrect installation, or failure to load all 24 balls will result in loss of preload, bind, and partial loss of steering control. Verify that the balls are correctly loaded before proceeding.

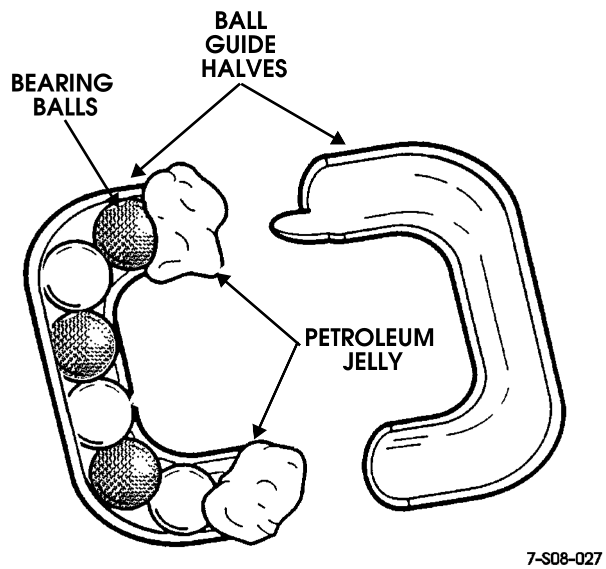


Figure 8-53: Assembling Remaining Bearing Balls and Ball Guides

7. Remove wormshaft and temporarily install arbor tool J–21552 as follows:
   a. Insert arbor tool J–21552 into rack piston end plug hole.
   b. Hold arbor tool firmly against wormshaft and turn wormshaft **counterclockwise**. This allows wormshaft to back out of piston as arbor tool enters and holds recirculating balls in place.
8. Set rack piston aside temporarily for later installation. Do not allow the arbor tool to slip out of the piston. If this occurs, it will be necessary to disassemble and reload the bearing balls.

Valve Body-Stub Shaft-Wormshaft Assembly

1. Lubricate valve body spool, O-rings, and seal rings with power steering fluid.
2. Install new backup O-rings in valve body grooves.
3. Install new teflon coated seal rings in valve body grooves. Note that the seal rings are installed on top of (over) the backup O-rings (Figure 8-54).

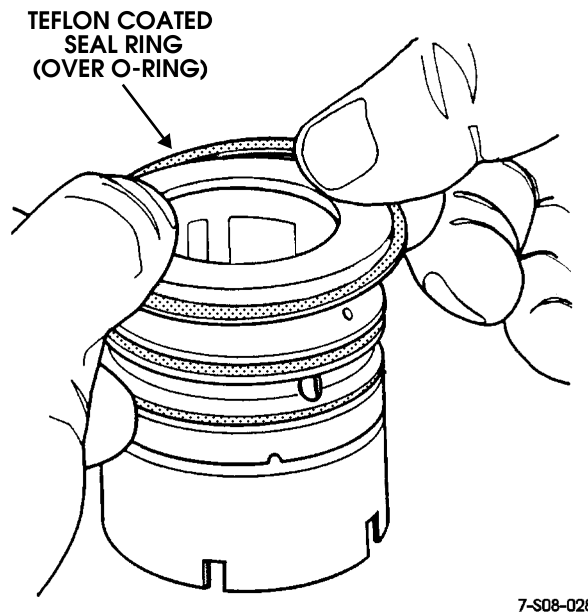


Figure 8-54: Valve Body Seal Ring Installation

4. Install new O-ring on valve spool.
5. Install spool in valve body with a turning motion (Figure 8-58). Note that O-ring end of spool faces out.

CAUTION: *Do not force the spool into the valve. This could score the spool and valve body resulting in steering problems after installation. Install the spool with a push and turn motion only.*

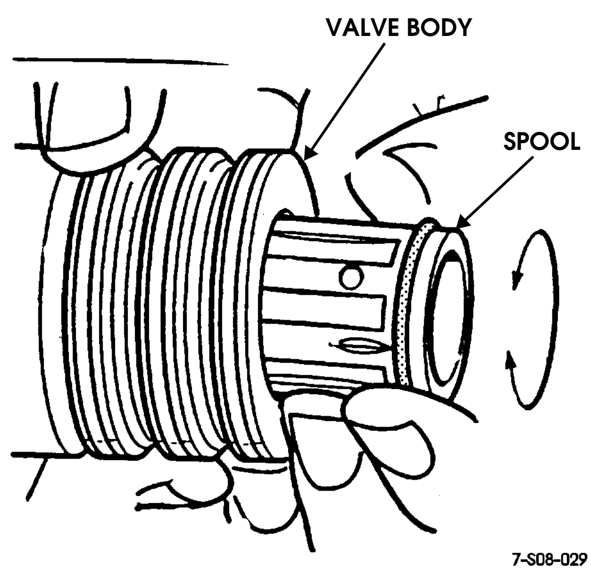


Figure 8-55: Valve Body Seal Ring Installation

6. Install stub shaft in valve body as follows:
   a. Insert stub shaft into valve body.
   b. Leave approximately 1/4 inch (6 mm) space between stub shaft cap and valve body for access to pin (Figure 8-56).
   c. Align and engage stub shaft pin in valve spool pin bore (Figure 8-56).
   d. Align notch in stub shaft cap with pin in valve body (Figure 8-57). Then fully seat stub shaft in valve body. Verify that valve body pin is seated in cap notch before proceeding.

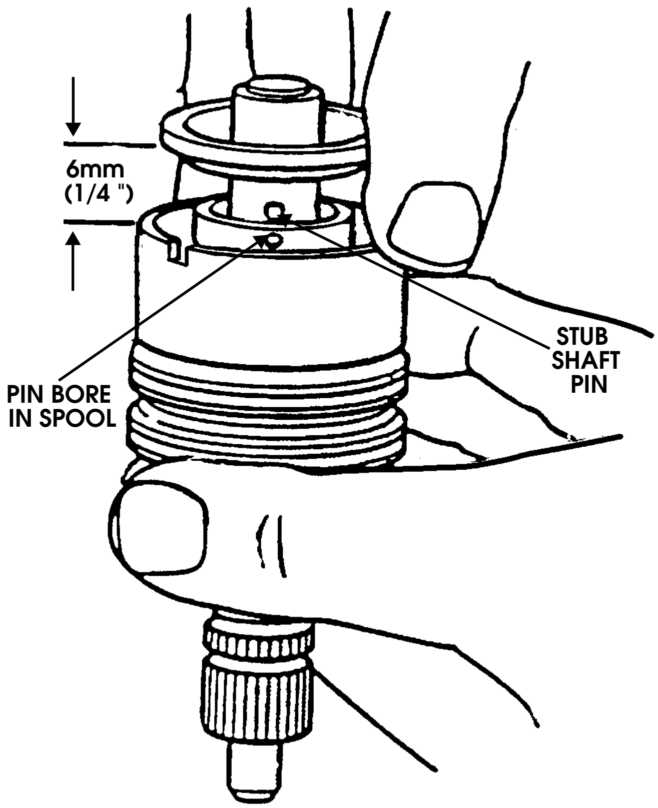


Figure 8-56: Aligning Stub Shaft Pin and Valve Spool Pin Bore

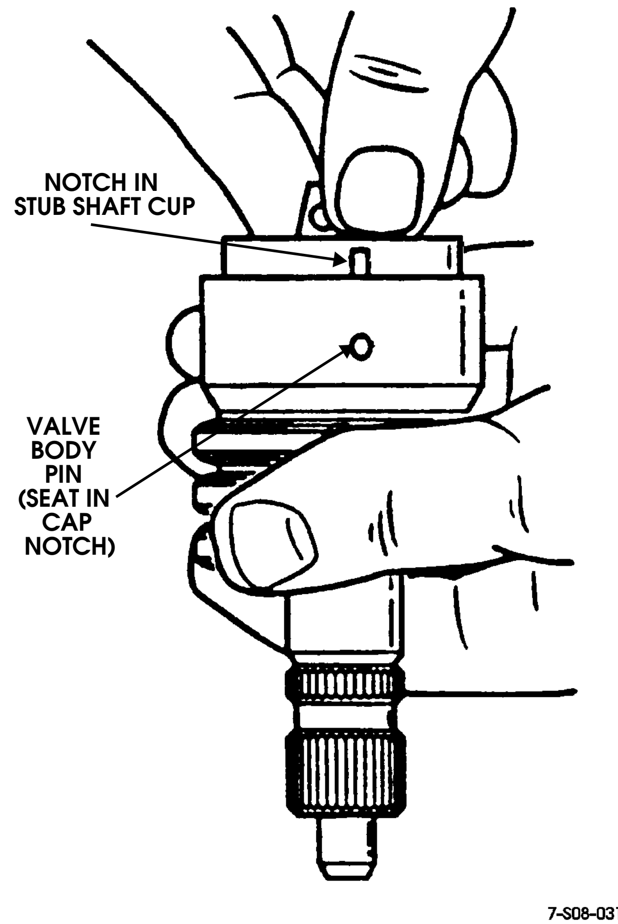


Figure 8-57: Aligning and Seating Stub Shaft In Valve Body

7. Lubricate wormshaft thrust bearings and races with petroleum jelly to hold them in place. Then install first race followed by the bearing and remaining race (Figure 8-58).

CAUTION: *The thrust bearing races both have a concave shape. Be sure the concave side is toward the wormshaft flange as shown. The races will not maintain proper preload on the bearing otherwise.*

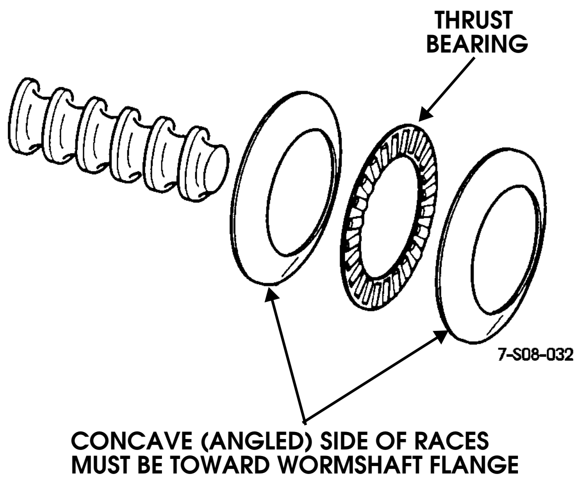


Figure 8-58: Aligning and Seating Stub Shaft In Valve Body

8. Install O-ring on stub shaft cap (Figure 8-62).
9. Align slot in valve body with pin in wormshaft flange and insert wormshaft into valve body (Figure 8-62). Be sure wormshaft flange is fully seated in stub shaft.
10. Set assembly aside for later installation.

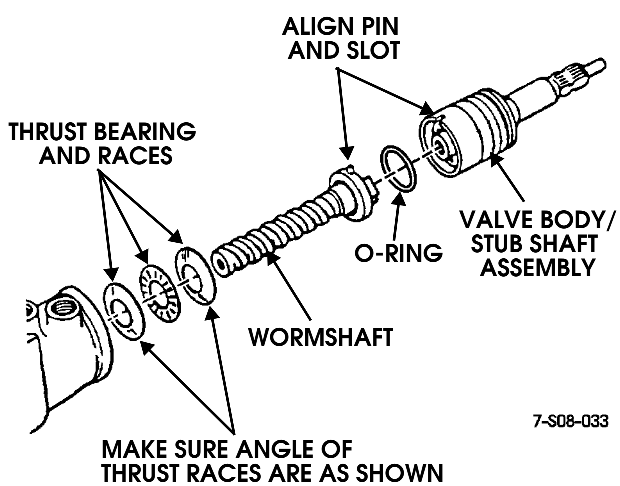


Figure 8-59: Wormshaft and Valve Body/Stub Shaft Assembly

Adjuster Plug Assembly

1. Position new stub shaft bearing on installer tool J–6221. Position bearing so ID number is toward installer tool. This will minimize any chance of damaging the bearing during installation.
2. Install stub shaft bearing in adjuster plug with tool J–6221 (Figure 8-60). Place adjuster plug on wood block as shown.

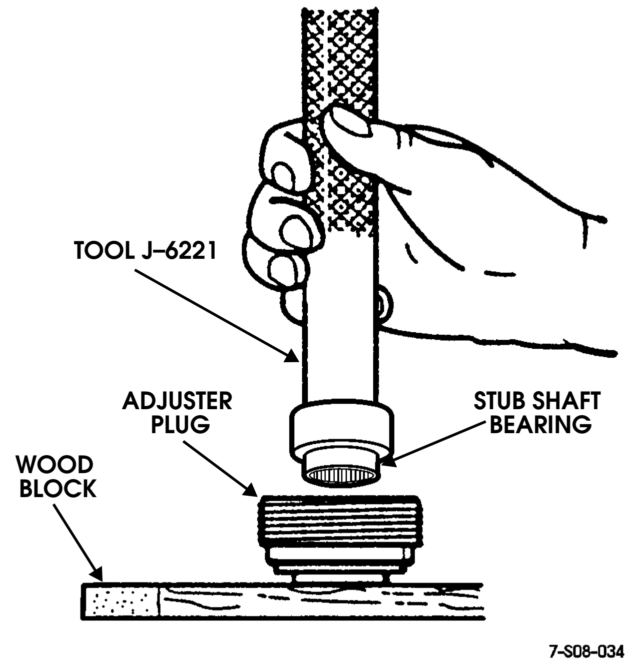


Figure 8-60: Installing Stub Shaft Bearing and Seals In Adjuster Plug

3. Install stub shaft oil seal and dust seal in adjuster plug with tool J–6221. Then install snap ring to secure seals and bearing (Figure 8-61).
4. Assemble and install thrust bearing and races in adjuster plug (Figure 8-61). Be sure races are installed as shown (Figure 8-61).
5. Install spacer and retainer in adjuster plug (Figure 8-61).
6. Seat retainer in adjuster plug with pin punch (Figure 8-62).
7. Install O-ring on adjuster plug (Figure 8-62).

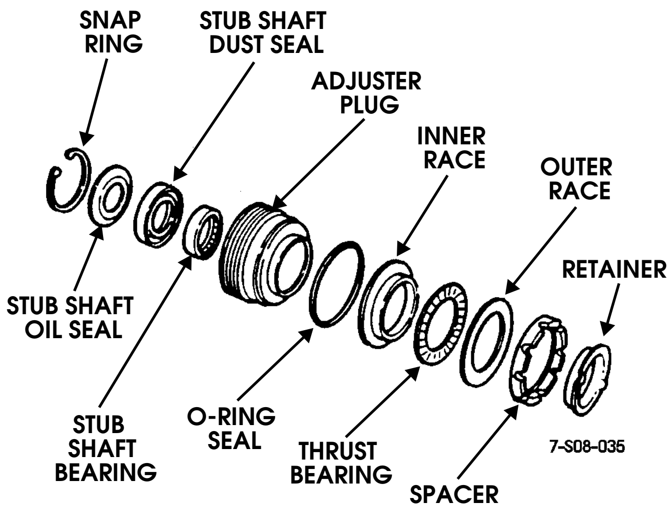


Figure 8-61: Adjuster Plug Assembly Sequence

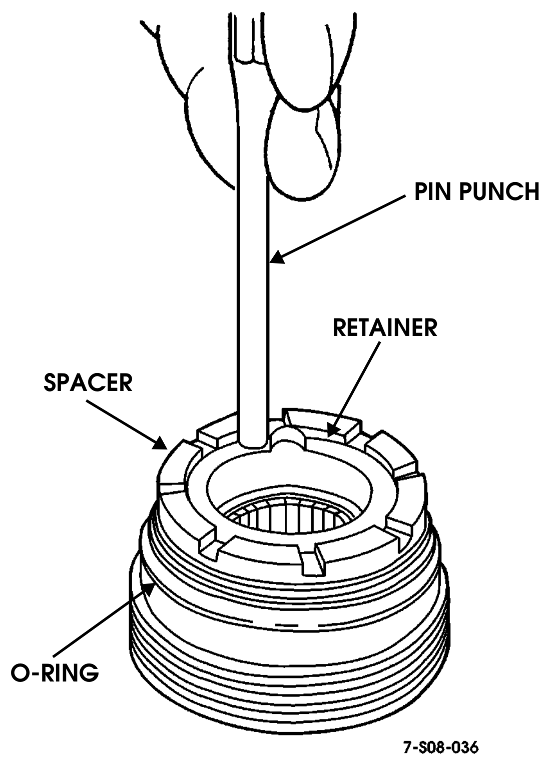


Figure 8-62: Seating Adjuster Plug Retainer

Gear Housing Assembly

1. Lubricate wormshaft, stub shaft-valve body, rack piston, and adjuster plug with power steering fluid.
2. Install wormshaft and stub shaft/valve body assembly in gear housing. Be sure wormshaft thrust bearings are not displaced during installation.
3. Install adjuster plug in gear housing. Tighten plug only enough to secure it in housing (2-3 threads).
4. Install rack piston as follows:
   a. Place socket and ratchet on stub shaft.
   b. Insert rack piston into housing until wormshaft contacts arbor tool previously installed in rack piston (Figure 8-39). Hold arbor tool firmly in place during installation.
   c. Turn stub shaft **clockwise** to feed wormshaft into rack piston. Wormshaft will push arbor tool out as it engages piston and recirculating balls.

NOTE: Maintain pressure on the arbor tool at all times during installation. The rack piston will have to be removed and completely reassembled if even one bearing falls out during assembly.

5. Continue turning stub shaft until wormshaft is fully engaged in rack piston.
6. Install plug in rack piston (Figure 8-38). Tighten plug to 111 lb-ft (150 N•m) torque.
7. Install end plug O-ring in gear housing and install housing end plug (Figure 8-32).
8. Install end plug retaining ring. Position ring ends so neither one is aligned with punch access hole in gear housing (Figure 8-63).
9. Position new gasket on side cover and assemble cover and pitman shaft.
10. Lubricate pitman shaft and sector teeth with power steering fluid.
11. Center rack piston in housing by turning stub shaft as needed.
12. Insert pitman shaft into housing. Be sure that shaft sector teeth are centered in rack piston teeth.
13. Align and seat side cover on gasket and housing.
14. Install and tighten side cover bolts to 44 lb-ft (60 N•m) torque.
15. Install but do not fully tighten adjuster screw lock nut (nut will be tightened during gear adjustment).
16. Adjust steering gear as described in following adjustment procedures.

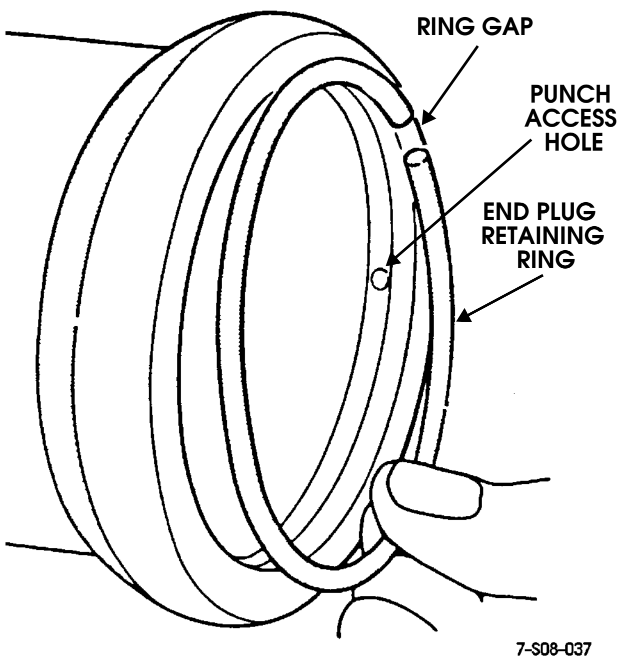


Figure 8-63: Positioning End Plug Retaining Ring in Housing

POWER STEERING GEAR ADJUSTMENTS

There are two steering gear adjustments which are: wormshaft bearing preload and pitman shaft overcenter preload. The adjustments must be performed in the correct sequence which is, bearing preload first and overcenter preload last.

The gear adjustments can be performed on the bench, or with the gear mounted in the vehicle. If adjustment is performed with the gear in the vehicle, the pitman arm and intermediate shaft must be disconnected beforehand.

Wormshaft Bearing Preload Torque Adjustment

1. Mount gear in vise equipped with protective vise jaws. Position gear so adjuster plug is accessible and wormshaft is horizontal.
2. If adjuster plug locknut is installed, loosen nut with punch and hammer and remove it from adjuster plug.
3. Tighten adjuster plug with spanner wrench J–7624 (Figure 8-64). Tighten plug until it and wormshaft bearing and races are fully seated (bottomed) in housing.

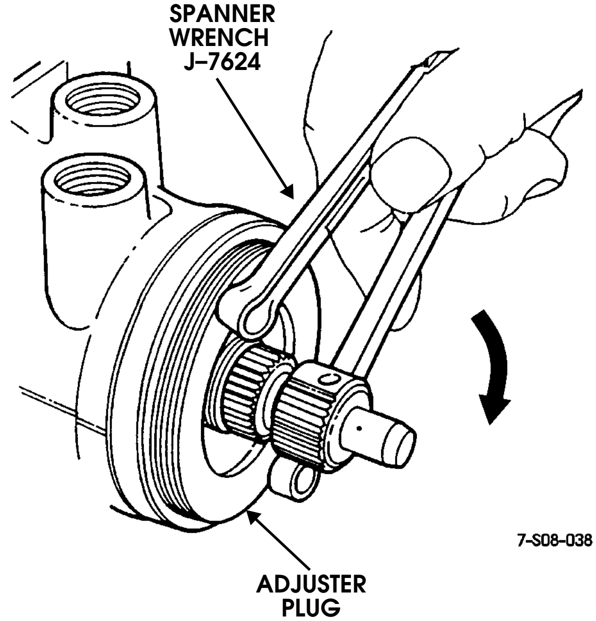


Figure 8-64: Seating Adjuster Plug

4. Tap spanner wrench with mallet to tighten plug to approximately 22 lb-ft (30 N•m) torque.
5. Scribe an index mark on gear housing in line with one of the adjuster plug spanner wrench holes (Figure 8-65). This will be the first index mark.

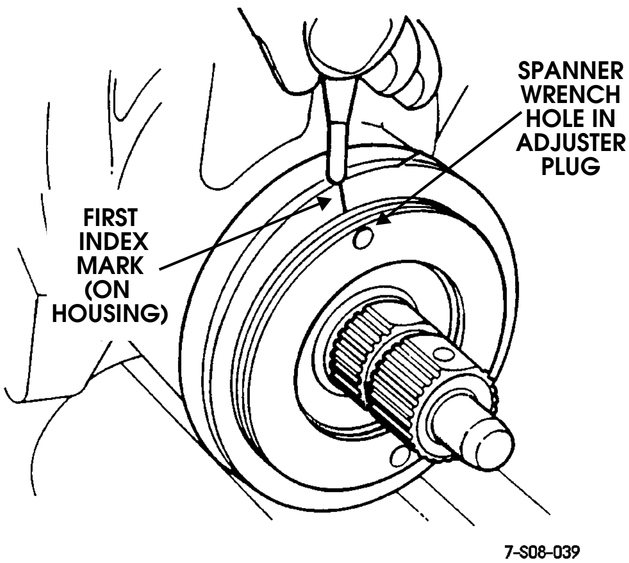


Figure 8-65: Placing First Index Mark On Housing

6. Measure back counterclockwise 1/2 inch (13 mm) from first index mark and scribe a second index mark on gear housing (Figure 8-66).

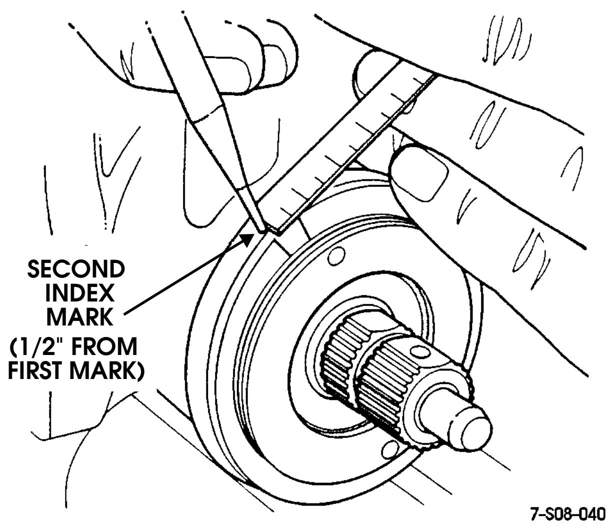


Figure 8-66: Placing Second Index Mark On Housing

7. Back off adjuster plug to second index mark (Figure 8-70). Be sure hole in adjuster plug is aligned with second mark before proceeding.

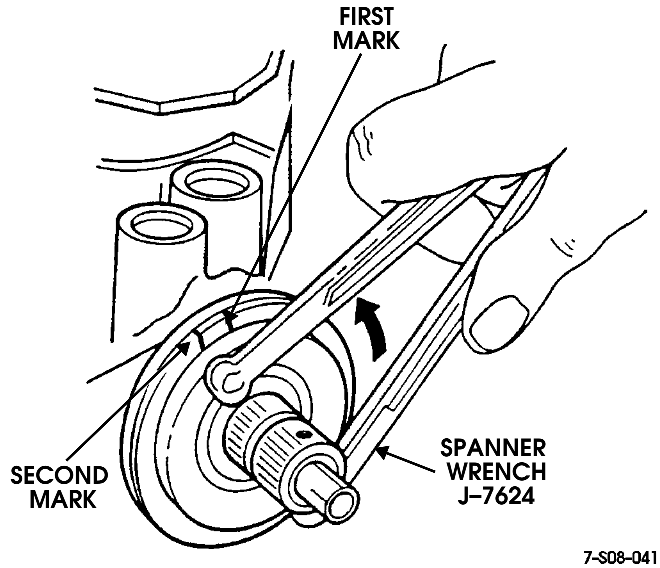


Figure 8-67: Backing Off Adjuster Plug To Second Index Mark

8. Install adjuster plug locknut. Hold adjuster plug from turning with spanner wrench while tightening locknut. Tap locknut with hammer to tighten. Then use punch to secure nut (Figure 8-68).

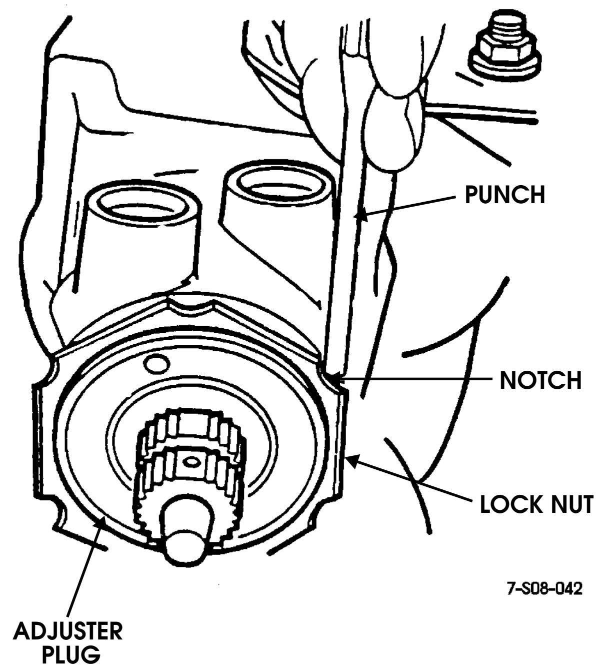


Figure 8-68: Securing Adjuster Plug Locknut

9. Verify that adjuster plug position remained unchanged during installation. Loosen locknut and reset plug position if necessary.

Pitman Shaft Overcenter Preload Torque Adjustment

1. Loosen locknut on pitman shaft adjuster screw.
2. Turn adjuster screw counterclockwise until fully extended. Then turn screw one full turn clockwise.
3. Rotate stub shaft from stop-to-stop and count number of turns. Then turn stub shaft back 1/2 number of turns. This will center rack piston and pitman shaft.
4. Verify that gear is centered. Flat on stub shaft should face upward and be parallel with side cover. In addition, master spline on pitman shaft should be parallel with adjuster screw (Figure 8-69). If gear is not centered, number of turns counted in step 3 may be incorrect, or pitman shaft sector teeth are not centered in rack piston. Make necessary corrections before proceeding.

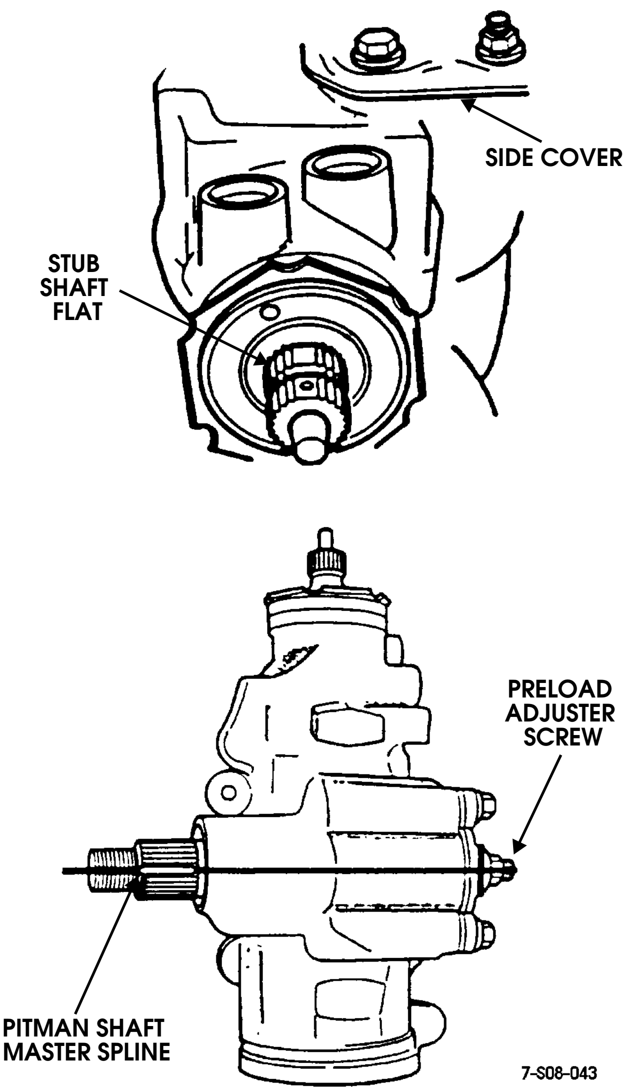


Figure 8-69: Verifying That Gear Is Centered

5. Measure wormshaft bearing preload as follows:
   - Position suitable size 12 point socket and inch pound torque wrench J–7754-C on stub shaft (Figure 8-70).
   - Slowly rotate torque wrench 45 degrees left and right of center. Note torque readings just before and on center in both directions. Correct preload torque is 6 to 15 lb-in (0.7 to 1.7 N•m).
   - If preload torque is within limits, continue with procedure as wormshaft bearing preload is correct.
   - If preload torque is not within limits, wormshaft bearing preload adjustment is incorrect, or wormshaft thrust bearing races were installed backwards. Correct fault before proceeding.

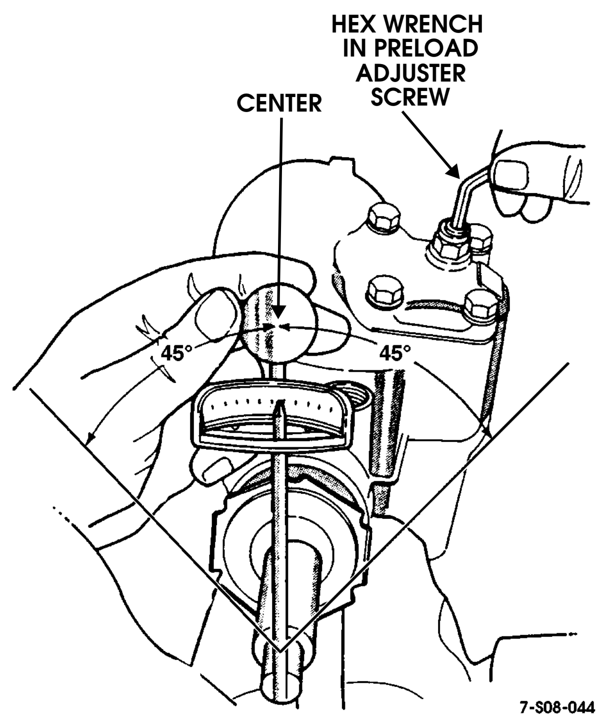


Figure 8-70: Checking /Adjusting Pitman Shaft Over-Center Preload

6. Adjust pitman shaft overcenter preload as follows:
   - Leave torque wrench in place on stub shaft.
   - Note wormshaft bearing preload measured in step 5. Then add additional 6-10 lb-in (0.7 to 1.1 N•m) to this figure for required overcenter preload.
   - Adjust overcenter preload by turning pitman shaft adjuster screw clockwise to increase preload, or counterclockwise to decrease preload.
7. Tighten adjuster screw locknut to 36 lb-ft (49 N•m) torque. Use hex wrench to prevent adjuster screw from turning while nut is tightened.
8. Verify that overcenter preload is still correct before installing gear in vehicle.

POWER STEERING PUMP REPAIR

Disassembly (Figures 8-71 through 8-76)

9. Remove power steering pump pulley and bracket.
10. Remove reservoir filler cap and drain fluid from pump assembly (Figure 8-71).
11. Remove two mounting studs from pump assembly.

NOTE: Fitting assembly is spring loaded. Remove carefully to avoid losing parts.

12. Remove fitting assembly and O-ring seal. Discard O-ring seal.
13. Remove flow control valve and valve spring from pump body.

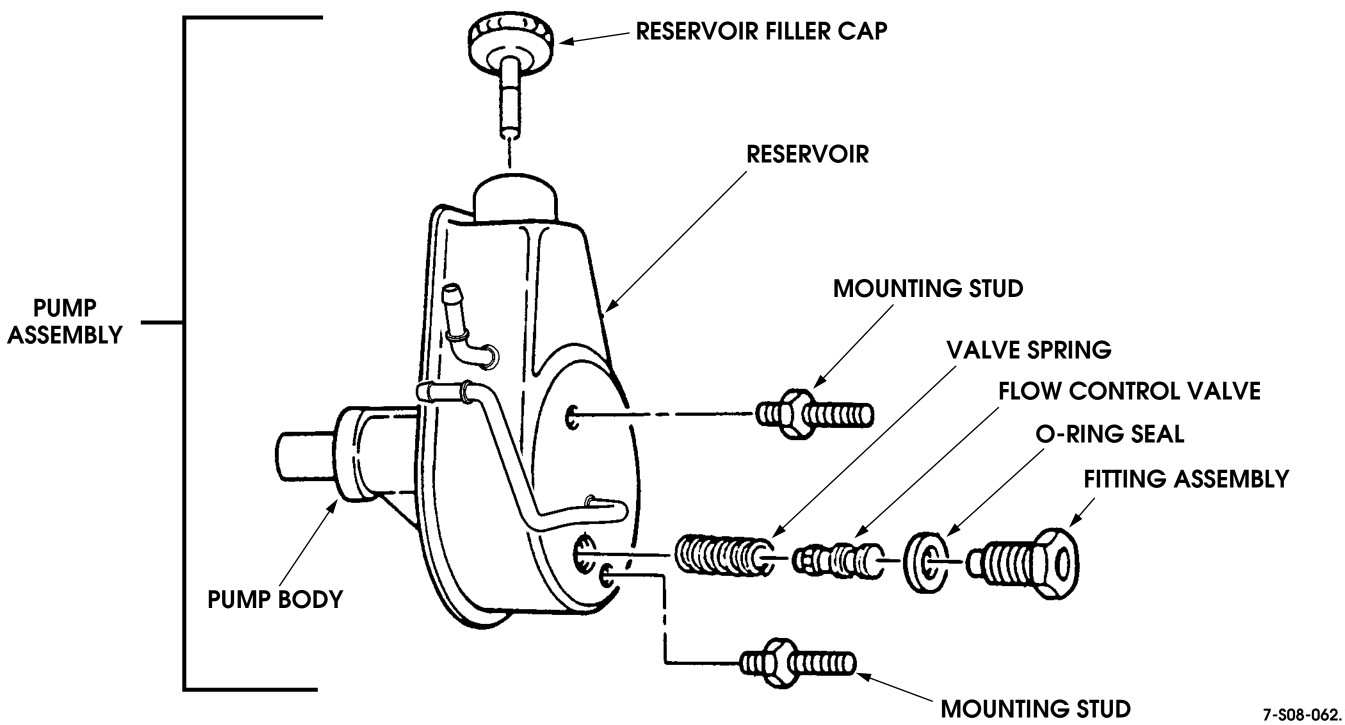


Figure 8-71: Pump Assembly

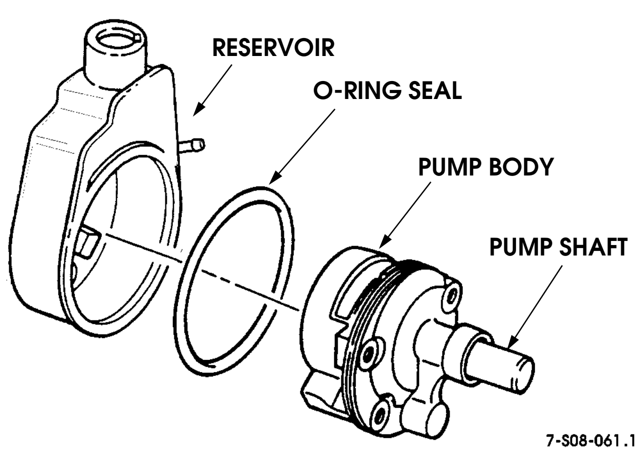


Figure 8-72: Reservoir Removal

CAUTION: *Do not overtighten vise as pump body could be distorted.*

14. Place pump body in vise (Figure 8-72).
15. Tap lightly around edge of reservoir.
16. Remove reservoir and O-ring seal from pump body. Discard O-ring seal.
17. Remove three O-ring seals from pump body and discard. (Figure 8-73).
18. Remove magnet from pump body and discard.

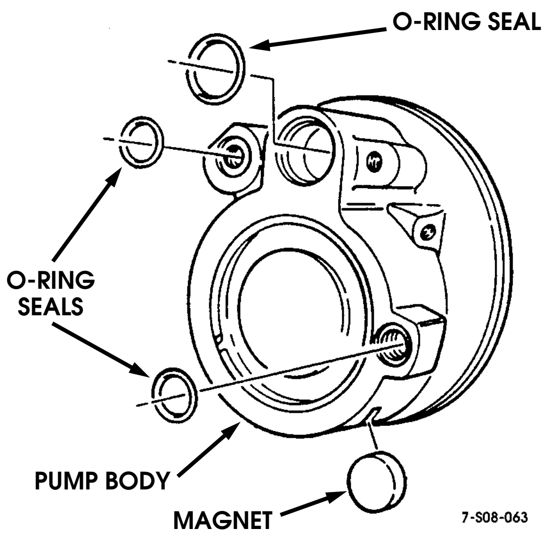


Figure 8-73: "O" Ring Seal Removal

19. Remove retaining ring from pump body (Figure 8-74).
20. Remove end plate and pressure plate spring from pump body.

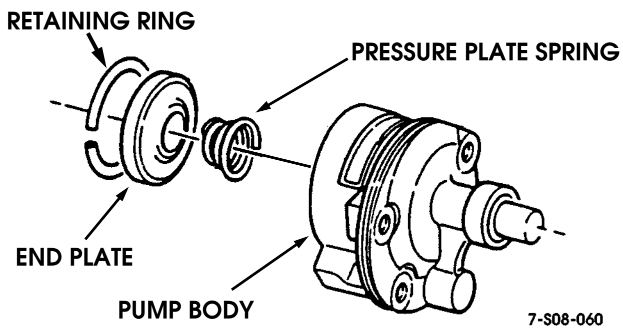


Figure 8-74: End Plate Removal

***CAUTION:** If end of driveshaft in steering pump housing is corroded, clean with an abrasive crocus cloth before removing shaft. Failure to do so may result in damage to shaft bushing. If bushing is damaged, replace power steering purnp assembly.*

21. Tap lightly on driveshaft until pressure plate is free
22. Remove pressure plate (Figure 8-75).
23. Remove pump ring and vanes from pump rotor.
24. Remove driveshaft, rotor, and thrust plate assembly from pump body.
25. Remove retaining ring from driveshaft.
26. Remove rotor from driveshaft.
27. Remove thrust plate from driveshaft.
28. Remove dowel pins from pump body.

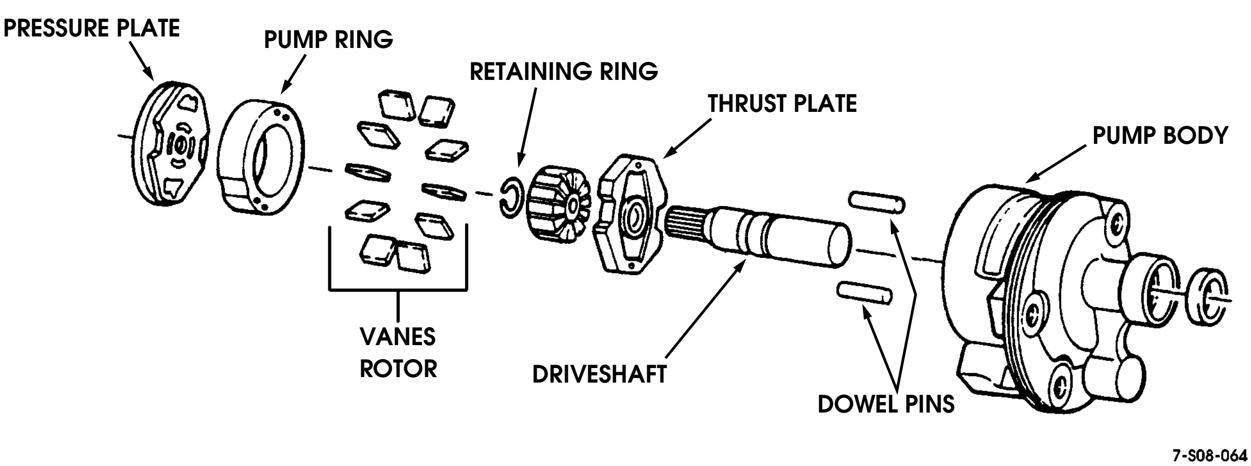


Figure 8-75: Pressure Plate and Rotor Removal

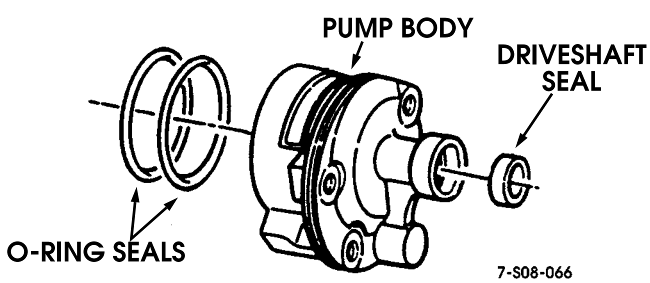


Figure 8-76: Seal Removal

29. Remove two O-ring seals from pump body. Discard O-ring seals (Figure 8-76).
30. Remove driveshaft seal from pump body. Discard driveshaft seal.

Cleaning and Inspection (Figure 8-77)

NOTE: Clean all components, examine for wear or damage, and replace if necessary.

1. Inspect flow control valve and valve spring for damage.
2. Inspect studs for damage.
3. Inspect fitting for damage.
4. Inspect reservoir cap for damage.
5. Inspect remaining components for damage. Replace power steering pump if any component is damaged.

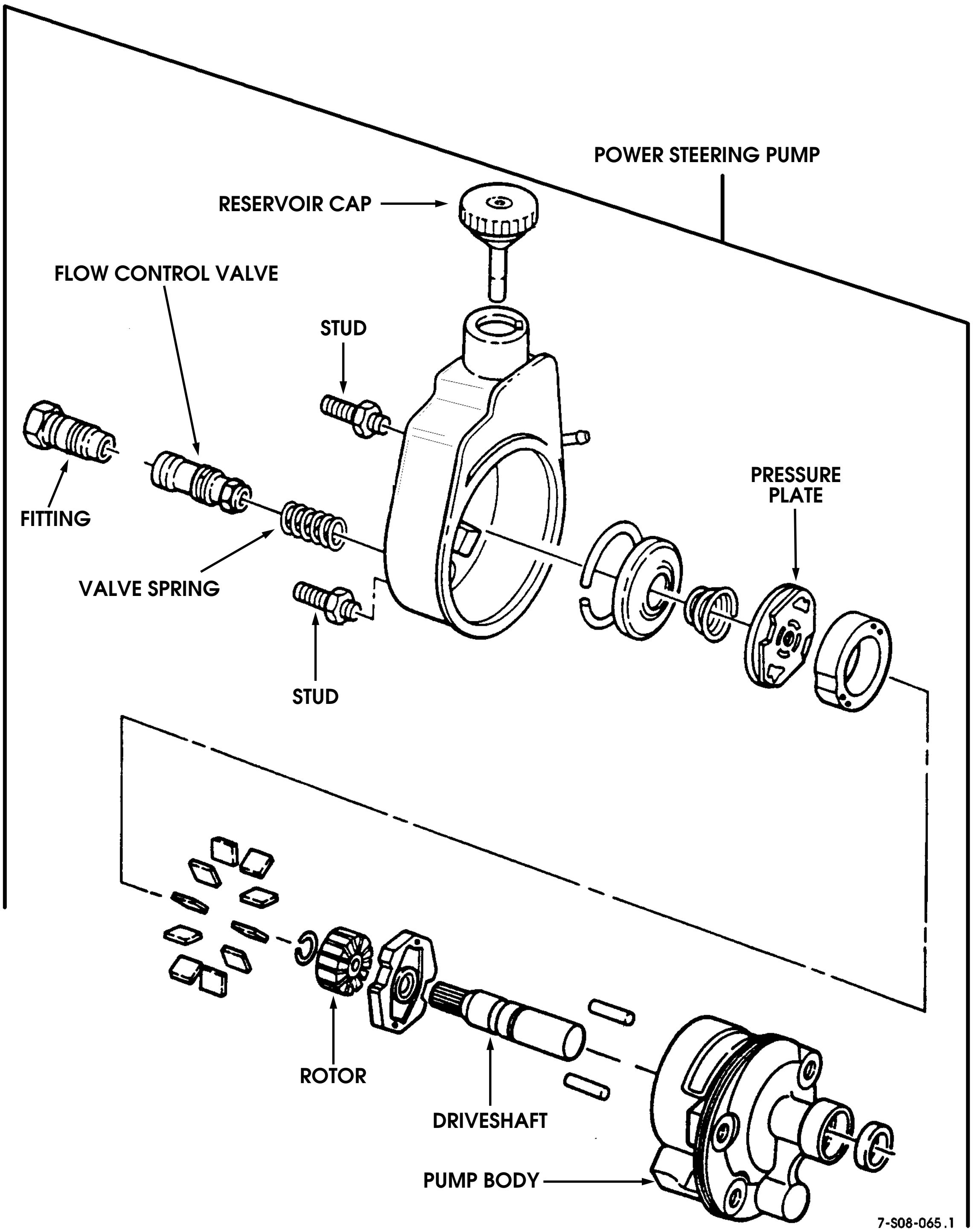


Figure 8-77: Cleaning and Inspection

Assembly (Figures 8-71 through 8-82)

NOTE: For general assembly instructions refer to Section 2.

1. Install O-ring seal in bottom groove of pump body (Figure 8-78).
2. Install driveshaft seal in pump body.
3. Install rotor on thrust plate.
4. Insert splined end of driveshaft through thrust plate and rotor.
5. Install retaining ring on driveshaft.
6. Install dowel pins in pump body.
7. Install driveshaft and rotor assembly in pump body.

***CAUTION:** To avoid damage to equipment, install pump ring with arrow pointing up.*

8. Align dowel pins and small holes In pump ring.
9. Install pump ring in pump body.

***CAUTION:** To avoid damage to equipment, install vanes in rotor with rounded edges facing outward.*

10. Install ten vanes in rotor.

***CAUTION:** To avoid damage to equipment, install pressure plate with spring groove facing upward.*

11. Install pressure plate on pump ring ensuring center notches in pressure plate align with dowel pins.

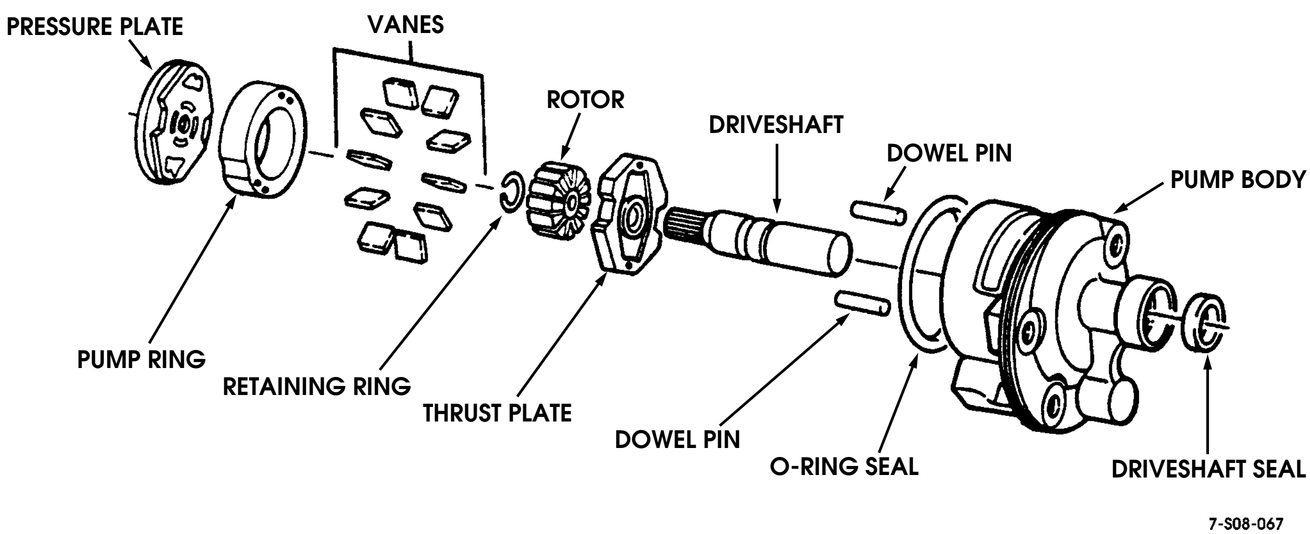


Figure 8-78: Pressure Plate and Rotor Installation

12. Install O-ring seal in center groove In pump body (Figure 8-79).
13. Install pressure plate spring in pump body.
14. Install end plate and retaining ring in pump body.

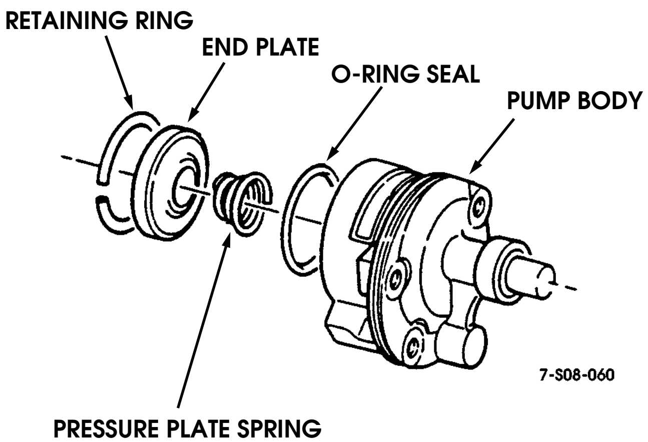


Figure 8-79: End Plate Installation

15. Install magnet in pump body (Figure 8-80).
16. Install O-ring seal into control valve cavity and two O-ring seals into threaded holes.

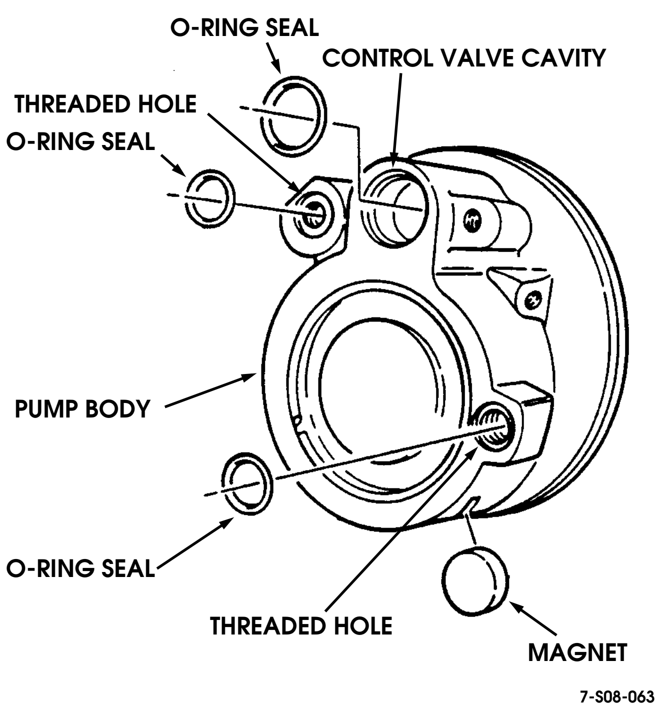


Figure 8-80: "O" Ring Installation

17. Install O-ring seal on pump body (Figure 8-81).
18. Install reservoir on pump body.

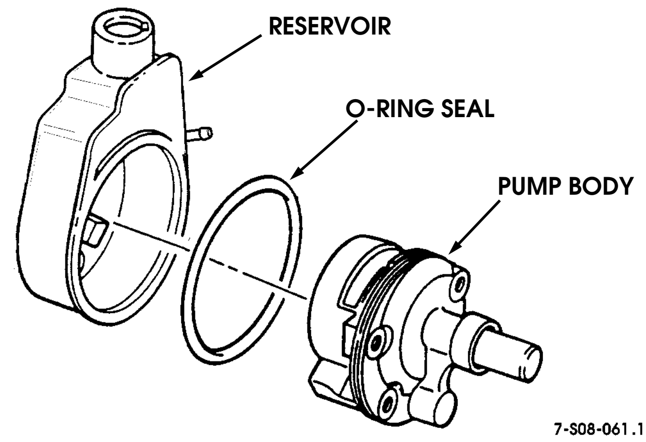


Figure 8-81: "O" Ring Installation

19. Install two mounting studs on pump assembly. Tighten studs to 35 N.m 26 Ib-ft) (Figure 8-82).
20. Install valve spring and flow control valve in pump body.
21. Install O-ring seal and fitting assembly in pump body. Tighten fitting in pump body to 50 N.m (37 Ib-ft.).
22. Install reservoir filler cap on reservoir.
23. Install power steering pump, pulley and bracket.

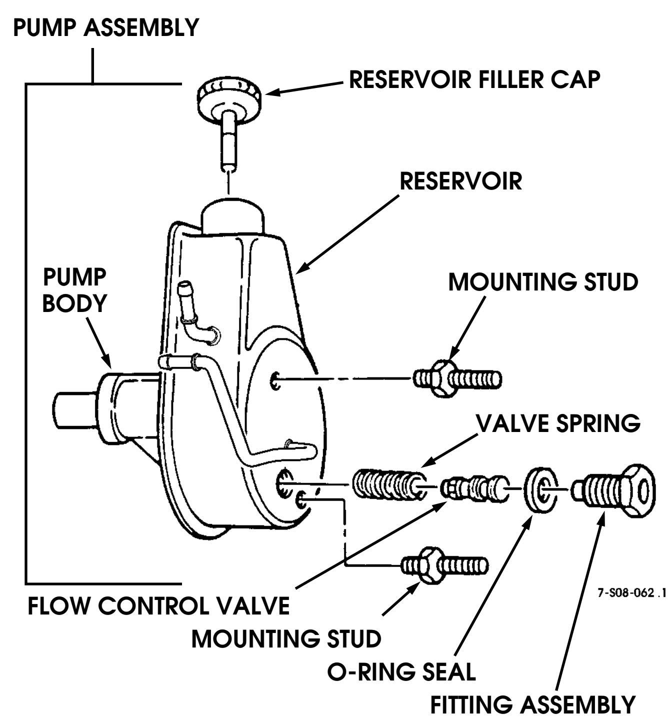


Figure 8-82: Final Assembly

POWER STEERING SYSTEM FLUSHING

The power steering system can be flushed but only when the fluid does not contain metal particles, foreign material, or debris from a gear or pump failure. Flushing is recommended only under the following circumstances:

- incorrect fluid added to system
- system filled with incorrect fluid
- water in the fluid
- burned, overheated fluid

Flushing Procedure

1. Raise front wheels just enough for them to turn freely.
2. Disconnect fluid return line at pump. Then plug pump return port with rubber cap and hose clamp.
3. Position and secure pump return line in drain pan.
4. Have container of fresh power steering fluid handy. Pump reservoir will need refilling as old fluid is pumped into drain pan.
5. Start and run the engine at curb idle speed.
6. Have helper slowly turn steering wheel back and forth about 3/4 turn in each direction.
7. Continue procedure until only fresh fluid comes out of return line.
8. Stop engine, reconnect pump return line, and add power steering fluid as needed.
9. Purge air from system. Refer to procedure in this section.
10. Stop engine and check fluid level and condition. Repeat flushing procedure if any old fluid is still evident in reservoir fluid.

STEERING SPECIFICATIONS

Recommended fluid is GM, or equivalent quality power steering fluid.

Steering Gear Adjustment Preload Torques

Wormshaft bearing .... 6 to 15 lb-in (0.7 to 1.7 N•m)

Pitman shaft overcenter .... 6 to 10 lb-in (0.7 to 1.1 N•m)

NOTE: Overcenter preload is in addition to wormshaft bearing preload. For example, overcenter preload should produce a combined final torque ranging from 12 to 25 inch-pounds.

Torque Specifications

Adjuster Plug Locknut................................. 80 lb-ft (109 N•m)

Adjuster Screw Locknut .... 35 lb-ft (47 N•m)

Ball Guide Clamp Bolts................................. 36 lb-ft (49 N•m)

Pressure Hose Fittings (at gear)..................... 25 lb-ft (34 N•m)

Rack Piston Plug....................................... 111 lb-ft (150 N•m)

Side Cover Bolts... 44 lb-ft (60 N•m)

Steering Pump Flow Rates and Operating Pressures

Minimum Flow Rate In Gallons/Liters Per Minute = 1.32 gpm (5.0 liters/min) @ 465 rpm

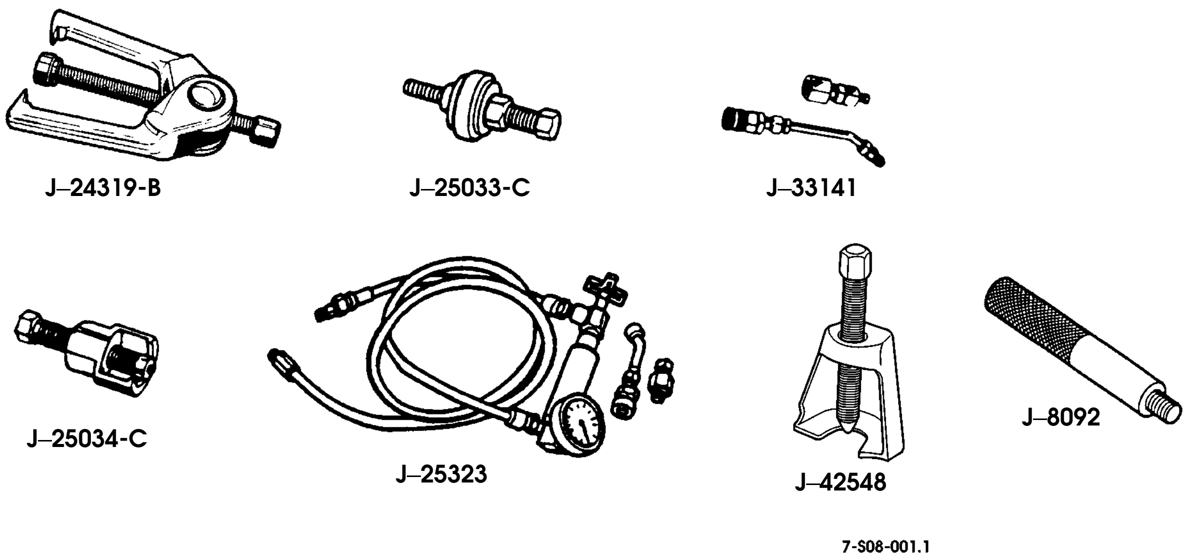
Maximum Flow Rate In Gallons/Liters Per Minute = 3.1 to 3.5 gpm (11.7 to 13.2 liters/min) @ 1500 rpm

Minimum Pump Output Pressure 1200 psi (8274 kPa)

Maximum Pump Output Pressure: 1,475 - 1,515 psi (10,170 - 10,446 kPa)

NOTE: Pump output pressures are controlled by the pump relief valve setting

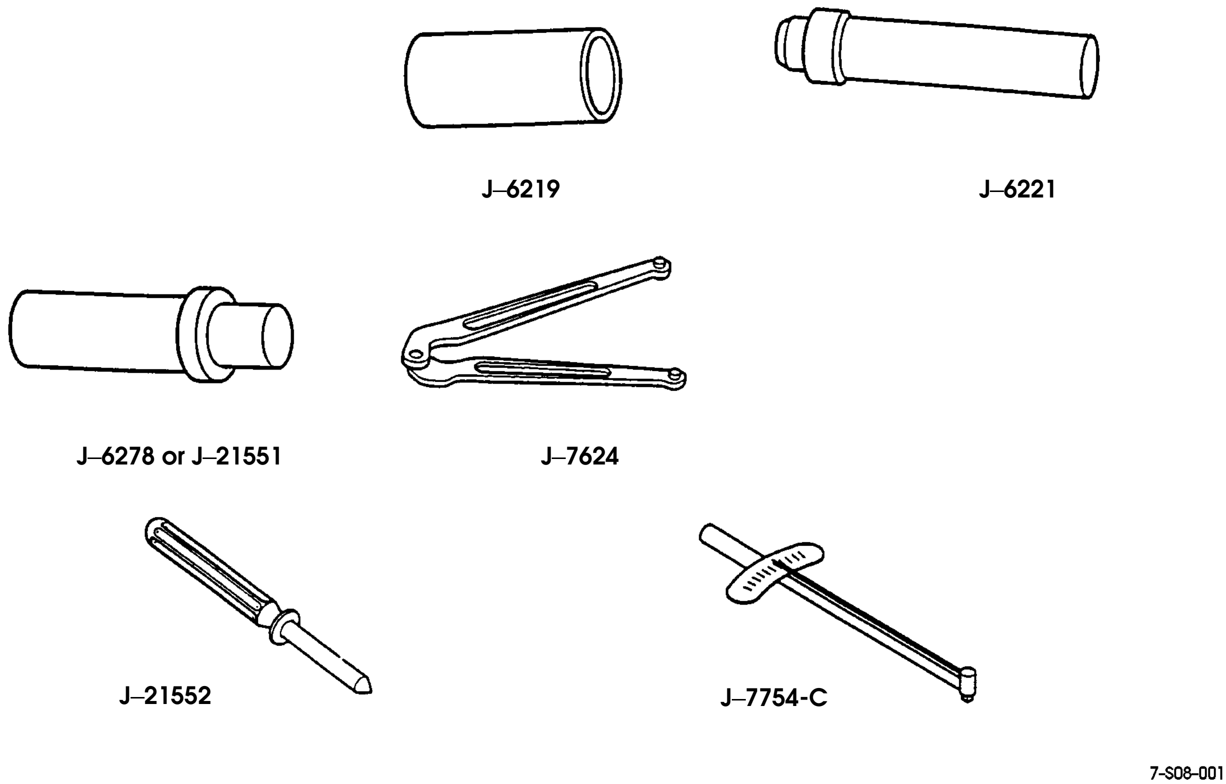
ESSENTIAL TOOLS



Tool	Description
J–24319-B	Steering Linkage and Tie-Rod Puller
J–25033-C	Pump Pulley Installer
J–33141	Adapter Fittings (used with J–25323)
J–25034-C	Pump Pulley Remover
J–25323	Power Steering System Analyzer
J–42548	Puller, Pitman Arm
J–8092	Universal Driver Handle

Procure from Kent-Moore.

SPECIAL TOOLS



Tool	Description
J–6219	Pitman Shaft Seal Installer
J–6221	Stub Shaft Bearing and Seal Remover/Installer
J–6278 (or J–21551)	Pitman Shaft Bearing Remover/Installer
J–7624	Spanner Wrench (Adjuster Plug)
J–7754-C	Inch-Pound Torque Wrench (Over-center Preload)
J–21552	Rack Piston Arbor

Procure from Kent-Moore.

Section 9 Axles, Suspension, and Frame

TABLE OF CONTENTS

SUSPENSION SYSTEM DESCRIPTION

The HUMMER suspension system consists of a heavy-duty coil spring, a heavy-duty hydraulic shock absorber, and an upper and lower control arm at each wheel. This suspension system provides for a smoother ride and allows for more positive control of the vehicle.

Ball joints allow the control arms and geared hubs to change angles for smooth steering during turns. A stabilizer bar is located on the front suspension to aid in stabilizing the vehicle when it is turning. Each end of the stabilizer bar is attached to the lower control arms (Figure 9-1).

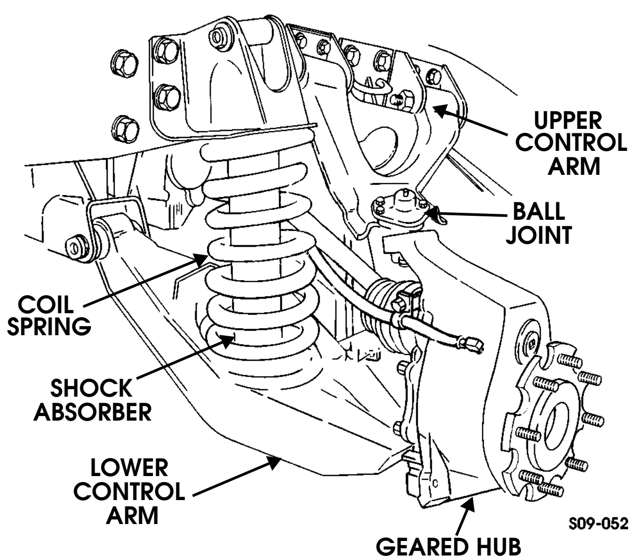


Figure 9-1: Suspension System

STABILIZER BAR REPLACEMENT

Removal

NOTE: Stabilizer bar must be removed from bar links at each end of lower control arms.

1. Remove two locknuts, three washers, and pin securing bar link to stabilizer bar (Figure 9-2).
2. Remove two locknuts, washers, clamp, and stabilizer bar from frame bracket.
3. Remove bushing from stabilizer bar.

Installation

1. Install bushing on stabilizer bar (Figure 9-2).
2. Install stabilizer bar on frame bracket with clamp, two washers, and locknuts. Tighten locknuts to 60 lb-ft (81 N•m).
3. Install stabilizer bar on bar link with pin, three washers, and two locknuts. Tighten locknuts to 75 lb-ft (102 N•m).

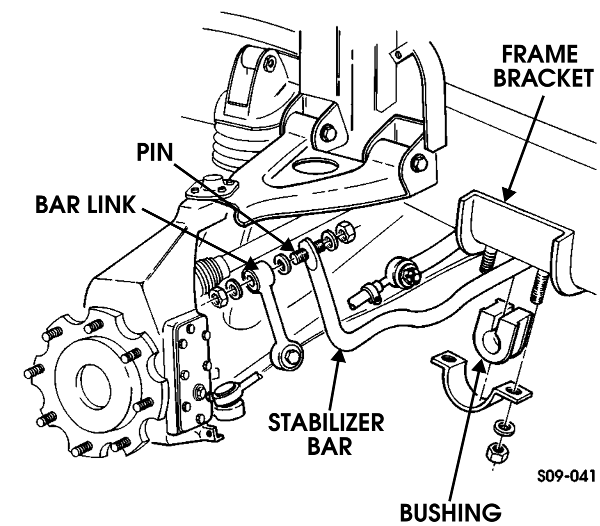


Figure 9-2: Stabilizer Bar Replacement

STABILIZER BAR LINK REPLACEMENT

Removal

1. Remove locknut and two washers securing bar link to stabilizer bar (Figure 9-3).
2. Remove bolt, two washers, and bar link from lower control arm.

Installation

1. Apply thread-locking compound to threads of bolt. Install bar link to lower control arm with two washers and bolt. Tighten bolt to 70 lb-ft (95 N•m) (Figure 9-3).
2. Install bar link on stabilizer bar with two washers and locknut. Tighten locknut to 75 lb-ft (102 N•m).

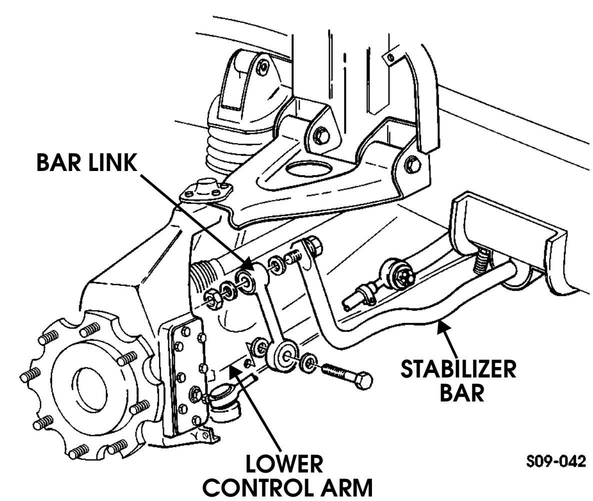


Figure 9-3: Stabilizer Bar Link Replacement

RADIUS ROD REPLACEMENT

Removal

1. Remove wheel.
2. Remove cotter pin, slotted nut, and washer securing radius rod to geared hub (Figure 9-4).
3. Using puller J24319-B or equivalent, separate radius rod from geared hub.
4. Remove locknut, washers, bolt, and radius rod from bracket.

Installation

1. Install radius rod on bracket with washer, bolt, washer, and locknut. Tighten locknut to 260 lb-ft (353 N•m) (Figure 9-4).

***CAUTION:** Do not loosen slotted nut to install cotter pin. Doing this may result in damage to equipment.*

2. Install radius rod on geared hub with washer and slotted nut. Tighten slotted nut to 70 lb-ft (95 N•m). Install cotter pin in slotted nut.
3. Install wheel.

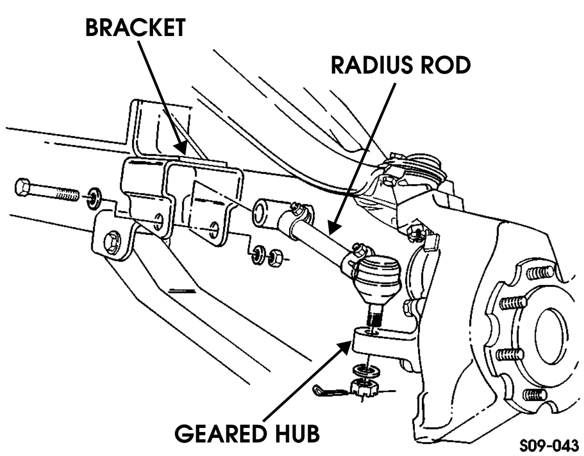


Figure 9-4: Radius Rod Replacement

UPPER BALL JOINT REPLACEMENT

Removal

1. Remove wheel.
2. Raise and support lower control arm.
3. Remove cotter pin and slotted nut from upper ball joint (Figure 9-5).
4. Remove four locknuts, washers, bolts, washers, and upper ball joint from upper control arm.
5. Separate upper ball joint from geared hub using ball joint remover J24319-B or equivalent. Remove ball joint.

Installation

1. Position upper ball joint on upper control arm, ensuring upper ball joint is placed above upper control arm (Figure 9-5).

NOTE: Check upper ball joint torque 15 minutes after initial installation. Adjust if necessary.

2. Install upper ball joint on upper control arm with four washers, bolts, washers, and locknuts. Tighten locknuts to 37 lb-ft (50 N•m).

NOTE: Do not loosen slotted nut to install cotter pin.

3. Install upper ball joint on geared hub with slotted nut. Using crowfoot and adapter, tighten slotted nut to 65 lb-ft (88 N•m). Install cotter pin in slotted nut.
4. Lubricate upper ball joint.
5. Install wheel.
6. Lubricate ball joint.

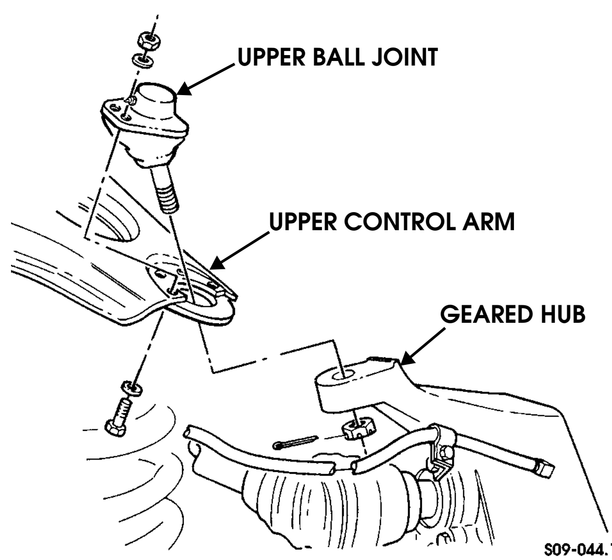


Figure 9-5: Upper Ball Joint Replacement

LOWER BALL JOINT REPLACEMENT

Removal

1. Remove wheel.
2. Raise and support lower control arm (Figure 9-6).
3. Remove cotter pin and slotted nut from lower ball joint. Discard cotter pin.
4. Remove four locknuts, washers, bolts, and lower ball joint from lower control arm.
5. Separate lower ball joint from geared hub using ball joint remover J24319-B or equivalent. Remove lower ball joint.

Installation

1. Install lower ball joint on lower control arm, ensuring lower ball joint is placed below lower control arm and secure with four washers, bolts, washers, and locknuts. Tighten front locknuts to 37 lb-ft (50 N•m) and rear locknuts to 65 lb-ft (80 N•m) (Figure 9-6).

***CAUTION:** Do not loosen slotted nut to install cotter pin. Doing this may result in damage to equipment.*

2. Install ball joint on geared hub with slotted nut. Tighten slotted nut to 60 lb-ft (80 N•m) and install cotter pin in slotted nut.
3. Lubricate lower ball joint.
4. Install wheel (Section 6).
5. Lubricate ball joint.

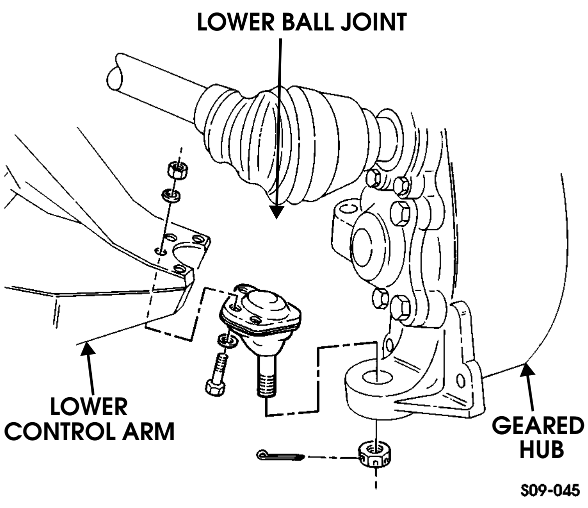


Figure 9-6: Lower Ball Joint Replacement

UPPER CONTROL ARM REPLACEMENT

NOTE: The procedure for removing and installing the front and rear upper control arms is basically the same. This procedure covers the left front upper control arm.

Removal

1. Remove wheel (Section 6).
2. Remove bolt and washer securing vent line bracket to geared hub (Figure 9-7).
3. Disconnect vent line from fitting.
4. Remove bolt, bracket, and vent line from upper control arm (Figure 9-8).
5. Remove four locknuts, washers, and bolts, securing upper ball joint to upper control arm.
6. Remove cotter pin and slotted nut from upper ball joint.
7. Separate upper ball joint from geared hub using ball joint remover. Remove upper ball joint.
8. Remove two locknuts, washers, bolts, and upper control arm from brackets and remove upper control arm.

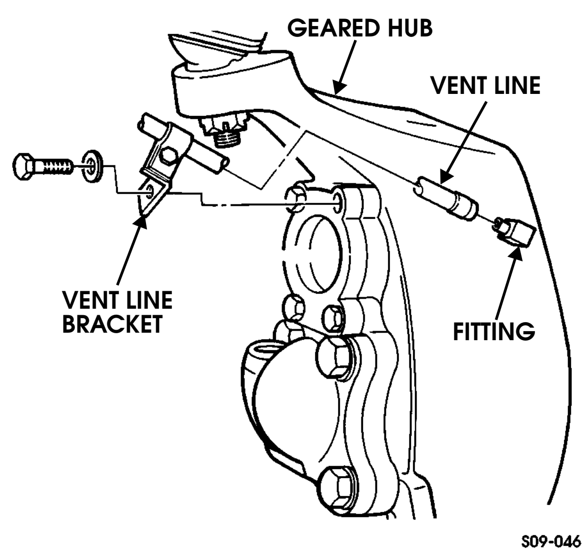


Figure 9-7: Vent Line Connection Replacemen

Installation

NOTE: On front upper control arms, bolt heads are toward rear of vehicle. On rear upper control arms, bolt heads are toward front of vehicle.

1. Install upper control arm on brackets with two washers, bolts, and locknuts. Do not tighten locknuts (Figure 9-8).
2. Secure upper ball joint to upper control arm with four washers, bolts, and locknuts. Tighten 3/8” locknuts to 30 lb-ft (41 N•m).

CAUTION: *Do not loosen slotted nut to install cotter pin. Doing this may result in damage to equipment.*

3. Install upper ball joint on geared hub with slotted nut. Using crowfoot and adapter, tighten slotted nut to 65 lb-ft (88 N•m). Install cotter pin in slotted nut.
4. Tighten locknuts on brackets to 260 lb-ft (353 N•m).
5. Install bracket and vent line on upper control arm with bolt.
6. Connect vent line to fitting (Figure 9-7).
7. Secure vent line bracket to geared hub with clamp, washer, and bolt. Tighten bolt to 37 lb-ft (50 N•m).
8. Install wheel (Section 6).

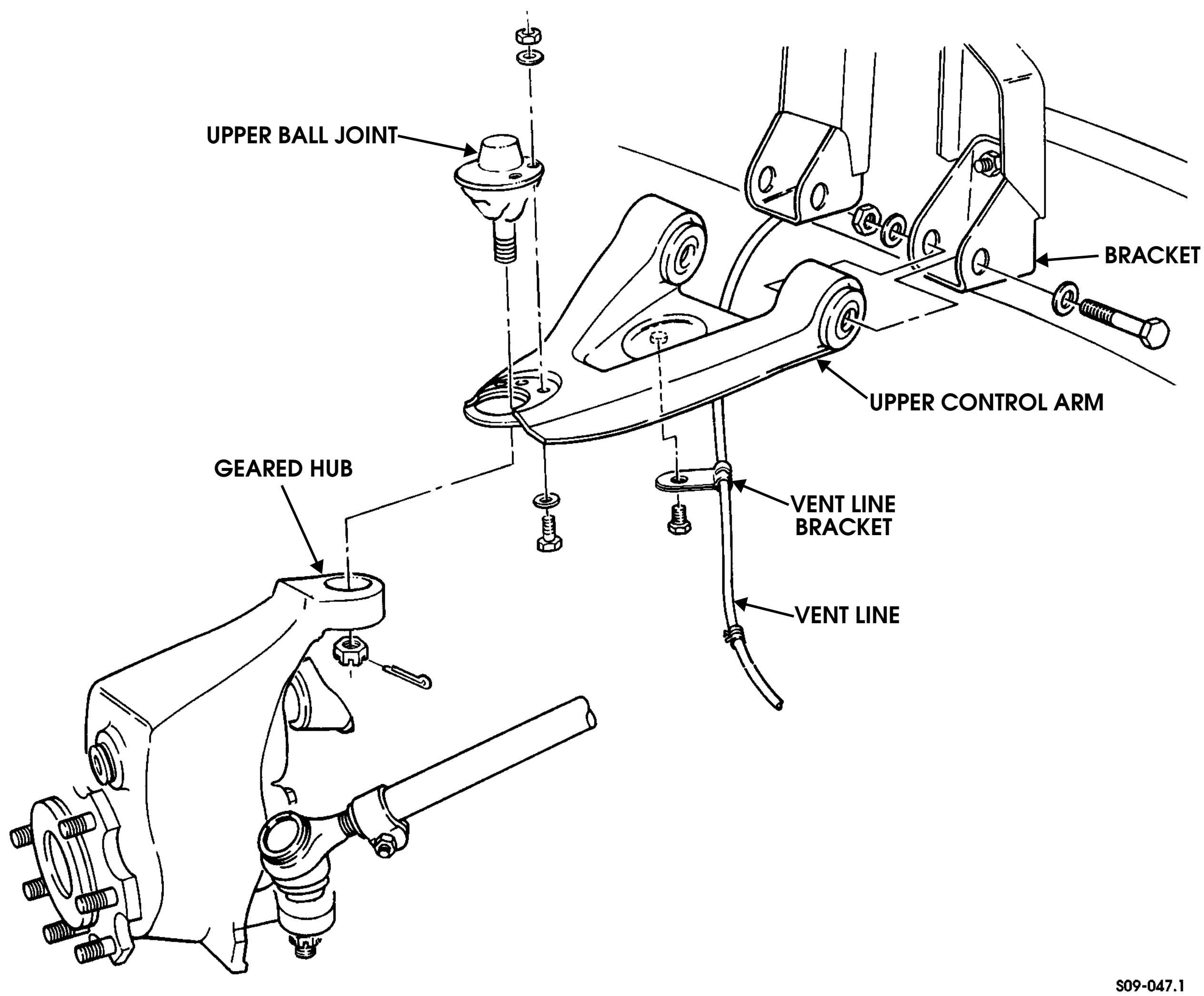


Figure 9-8: Upper Control Arm Assembly Replacement

CONTROL ARM BUSHING REPLACEMENT

Removal

NOTE: Control arm bushings must be replaced as a set (Figure 9-9).

1. Remove control arm.
2. Support control arm and press bushing out of control arm.

Installation

1. Lubricate outside diameter of bushing with grease.
2. Insert bushing in control arm (Figure 9-9).
3. Support control arm and press bushing into control arm until flange on bushing seats on control arm.
4. Install control arm.
5. Adjust caster and camber.

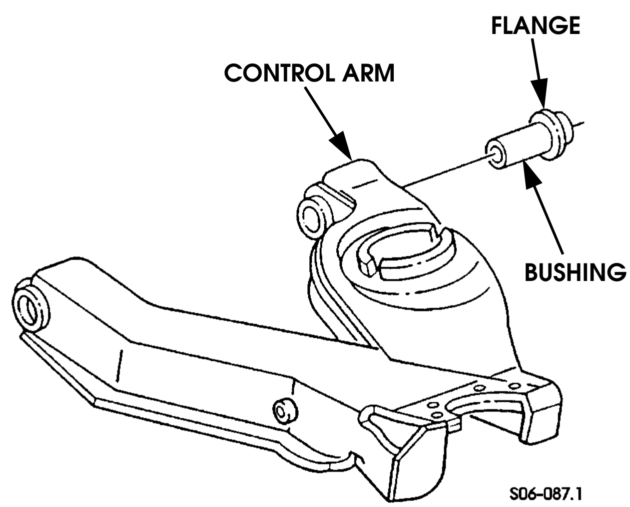


Figure 9-9: Control Arm Bushing Replacement

LOWER CONTROL ARM REPLACEMENT

NOTE: The procedure for removing and installing the front and rear lower control arms is basically the same. This procedure covers the left front lower control arm.

Removal

WARNING: Lower control arm must be supported during removal and installation. Failure to support lower control arm may cause personal injury or damage to equipment.

1. Remove wheel (Section 6).
2. Remove shock absorber.
3. Remove bolt, two washers, and bar link (front only) from lower control arm (Figure 9-10).
4. Remove four locknuts, washers, and bolts, from lower ball joint and lower control arm (Figure 9-11).
5. Raise and support lower control arm. Remove lower ball joint from arm.
6. Lower the lower control arm and remove coil spring.
7. Remove two locknuts, washers, bolts, and lower control arm from brackets.

NOTE: Removing the lower ball joint from the geared hub will ease installation.

8. Remove cotter pin and slotted nut from lower ball joint.
9. Separate lower ball joint from geared hub using ball joint remover. Remove lower ball joint.

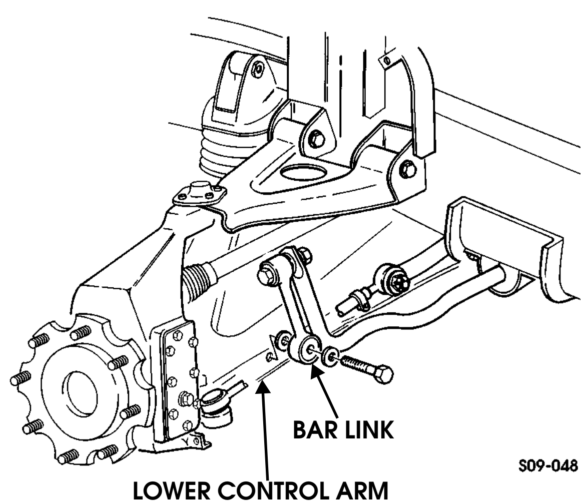


Figure 9-10: Bar Link Replacement

Installation

WARNING: Lower control arm must be supported during removal and installation. Failure to support lower control arm may cause personal injury or damage to equipment.

NOTE: On lower control arms, bolt heads are toward front of vehicle.

1. Install lower control arm on brackets with two washers, bolts, washers, and locknuts. Do not tighten locknuts (Figure 9-11).

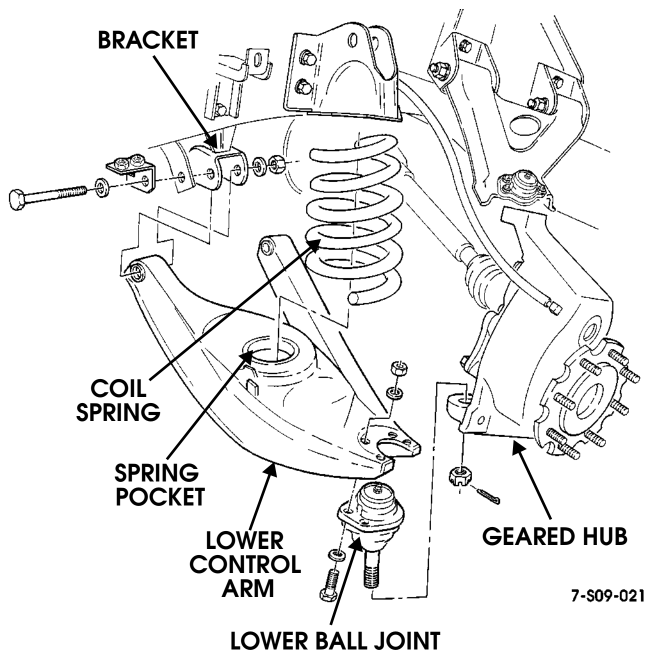


Figure 9-11: Lower Control Arm Replacement

2. Install coil spring on lower control arm ensuring end of coil spring fits in spring pocket of lower control arm.
3. Install lower ball joint on lower control arm, ensuring ball joint is placed below lower control arm.
4. Secure lower ball joint to lower control arm with four washers, bolts, washers, and locknuts. Tighten front locknuts to 37 lb-ft (50 N•m) and rear locknuts to 60 lb-ft (80 N•m).
5. Install lower ball joint on geared hub with slotted nut. Tighten slotted nut to 73 lb-ft (99 N•m), and install cotter pin in slotted nut.
6. Tighten locknuts on brackets to 260 lb-ft (353 N•m).
7. Apply thread-locking compound to threads of bolt. Install bar link on lower control arm with two washers and bolt. Tighten bolt to 70 lb-ft (95 N•m) (Figure 9-10).
8. Install shock absorber.
9. Install wheel (Section 6).

GEARED HUB REPLACEMENT

NOTE: Replacement procedures are basically the same for front and rear geared hubs. This procedure covers the front geared hub.

Removal

1. Remove wheel.
2. Remove drainplug from geared hub and drain geared hub (Figure 9-12).

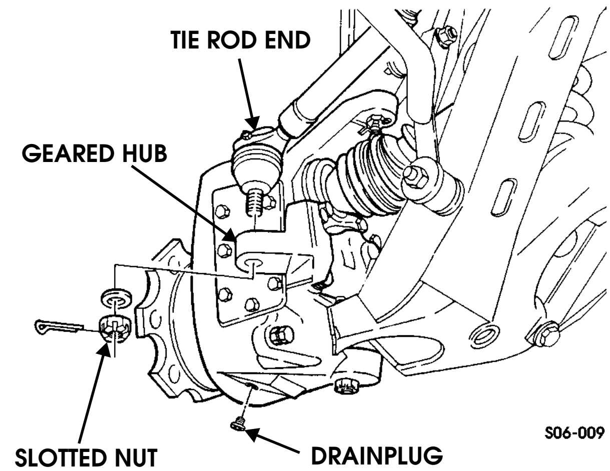


Figure 9-12: Geared Hub Drainplug Location

3. Install drainplug in geared hub.
4. Remove bolt, washer, and vent line bracket from geared hub (Figure 9-13).
5. Disconnect vent line from geared hub fitting.
6. Remove cotter pin, slotted nut, and washer from tie rod end. (Figure 9-12).
7. Using puller 11595179, disconnect tie rod end from geared hub.
8. Remove access plug, washer, halfshaft retaining bolt, lockwasher, and halfshaft from geared hub (Figure 9-13).

WARNING: Geared hub must be supported during removal and installation. Failure to support geared hub may cause injury to personnel or damage to equipment.

9. Remove cotter pin and slotted nut from upper ball joint. Remove ball joint stud from geared hub.
10. Remove cotter pin and slotted nut from lower ball joint. Remove ball joint stud from geared hub.
11. Lower support and remove geared hub.

Installation

WARNING: To avoid injury and damage to equipment, support geared hub during removal and installation.

1. Position geared hub between upper and lower control arms and secure upper ball joint to geared hub with slotted nut, but do not tighten (Figure 9-13).
2. Secure lower ball joint to geared hub with slotted nut, but do not tighten.

NOTE: If necessary, tighten slotted nut to install cotter pin.

3. Tighten slotted nut securing upper ball joint to geared hub to 65 lb-ft (88 N•m). Install cotter pin.
4. Slide halfshaft into geared hub.

NOTE: Make sure mounting hole and bolt are cleared of old Loctite.

5. Apply thread-locking compound to halfshaft retaining bolt and secure halfshaft to geared hub with lockwasher and halfshaft retaining bolt. Tighten halfshaft retaining bolt to 37 lb-ft (50 N•m).
6. Secure washer and access plug to geared hub. Tighten access plug to 8-13 lb-ft (11-18 N•m).

NOTE: If necessary, tighten slotted nut to install cotter pin.

7. Tighten slotted nut securing lower ball joint to geared hub to 73 lb-ft (99 N•m). Install cotter pin.
8. Insert tie rod end into geared hub and secure with washer and slotted nut. Tighten slotted nut to 70 lb-ft (95 N•m). Install cotter pin (Figure 9-12).
9. Connect vent line to geared hub fitting (Figure 9-15).

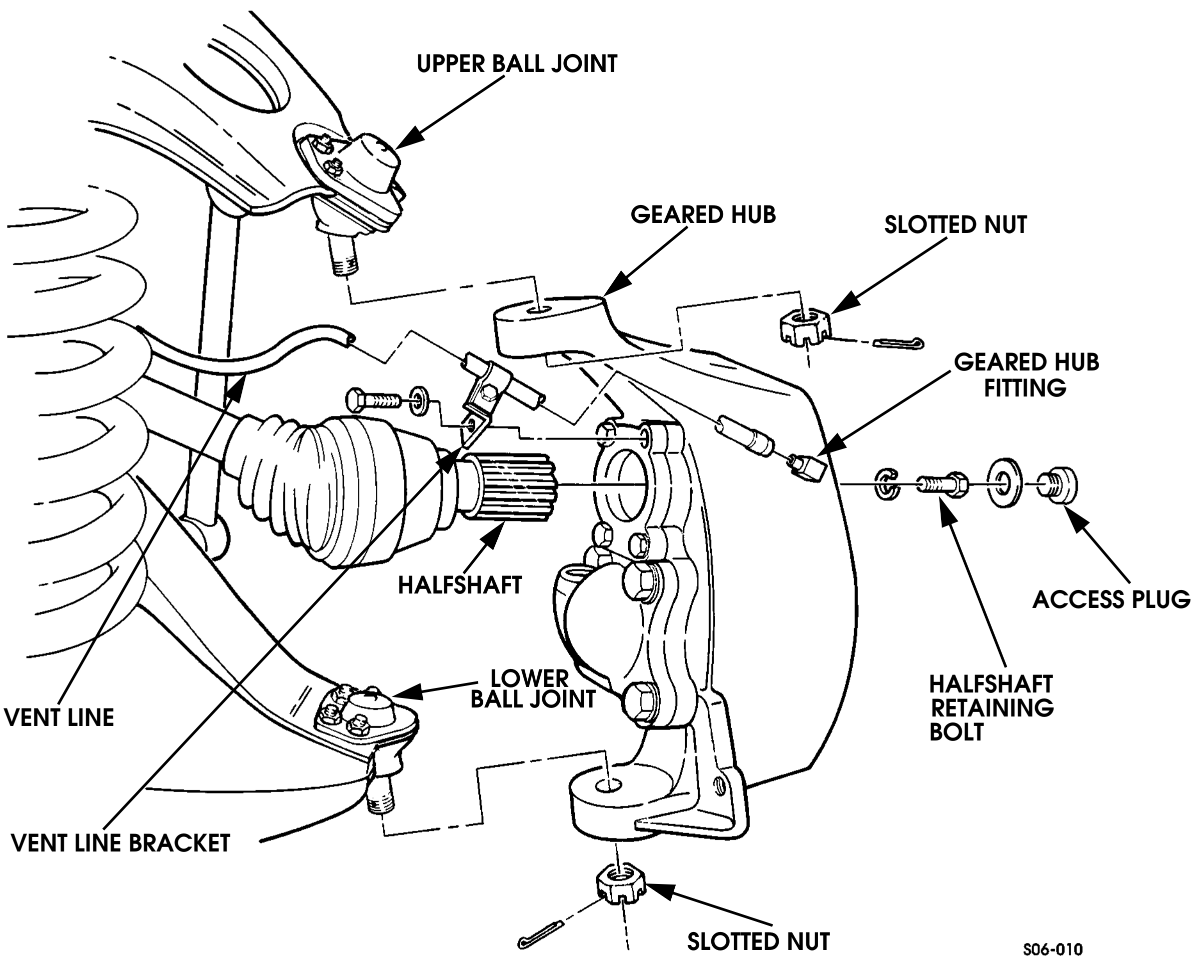


Figure 9-13: Geared Hub Replacement

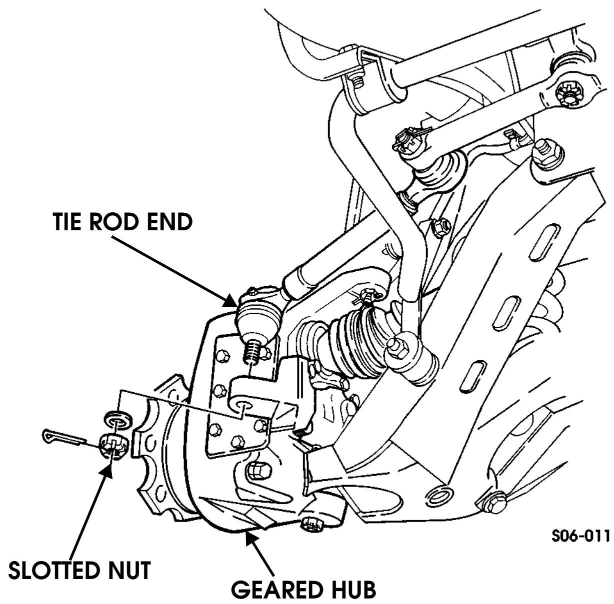


Figure 9-14: Tie Rod End Into Geared Hub

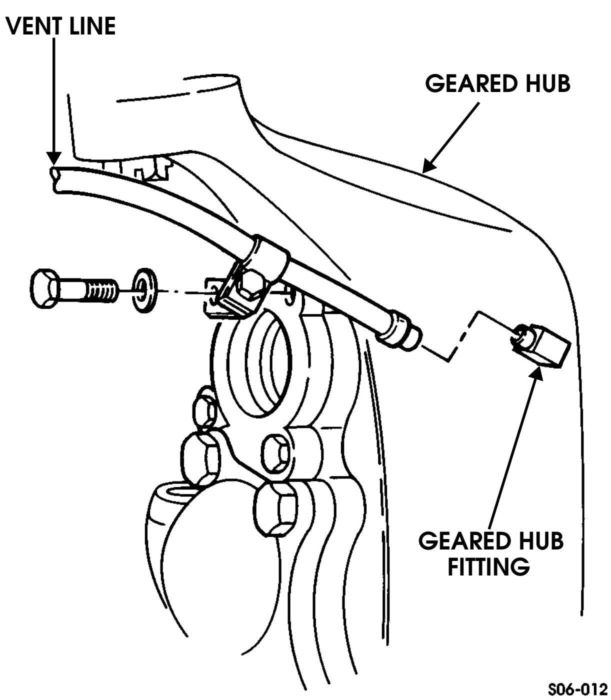


Figure 9-15: Vent Line

10. Secure vent line and clamp to geared hub with washer and bolt. Tighten bolt to 38 lb-ft (52 N•m).
11. Remove fill plug and washer from geared hub (Figure 9-16).

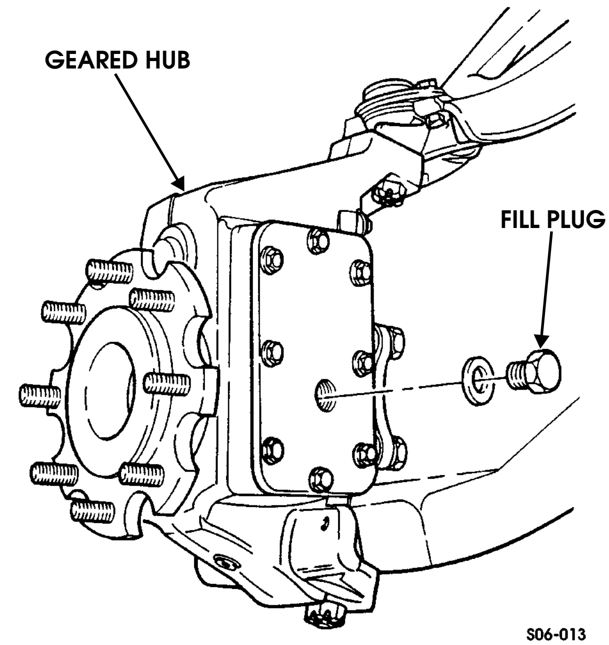


Figure 9-16: Geared Hub Fill Hub

12. Fill geared hub to proper oil level (Section 1).
13. Install washer and fill plug on geared hub. Tighten fill plug to 8-13 lb-ft (11-18 N•m).
14. Install wheel.
15. Check alignment.

GEARED HUB SIDE COVER REPLACEMENT

NOTE: Geared hub side cover replacement procedures are basically the same for front and rear covers. This procedure covers the front side cover.

Removal

1. Remove wheel.
2. Remove drainplug from geared hub and drain geared hub (Figure 9-17).
3. Install drainplug in geared hub.
4. Remove eight bolts, washers, and side cover from geared hub.

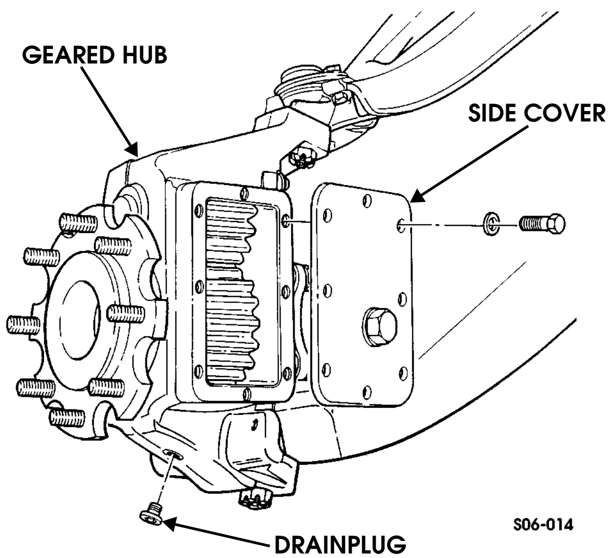


Figure 9-17: Geared Hub Side Cover Replacement

Cleaning and Inspection

NOTE: Clean all components, examine for wear or damage, and replace if necessary.

1. Using solvent, clean and dry side cover.
2. Inspect side cover for damage.

Installation

1. Apply anaerobic sealant to side cover and allow to set until tacky.
2. Apply thread-locking compound to bolts and install side cover to geared hub with eight washers and bolts. Tighten bolts to 15 lb-ft (20 N•m).
3. Fill geared hub to proper oil level (Section 1).
4. Install wheel.

GEARED HUB INPUT SEAL REPLACEMENT

Removal

1. Remove wheel.
2. Remove access plug and washer from geared hub (Figure 9-13).
3. Remove halfshaft retaining bolt, lockwasher, and halfshaft from geared hub.

CAUTION: *Shim gaskets must be reused to maintain proper drive gear bearing adjustment.*

4. Remove bolt, washer, and vent line bracket from drive gear retainer (Figure 9-18).

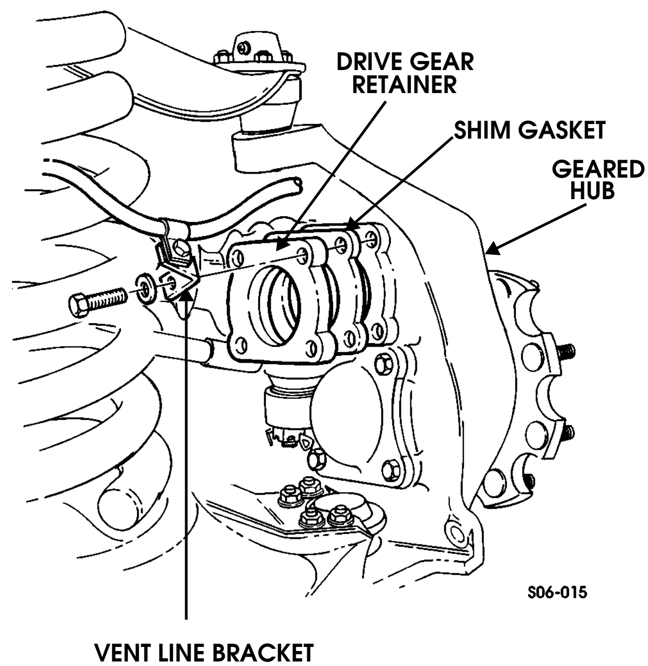


Figure 9-18: Geared Hub Shim Gasket Location

5. Remove remaining three bolts, washers, drive gear retainer, and shim gasket(s) from geared hub.
6. Secure drive gear retainer in vise with inserts and remove input seal. Discard input seal (Figure 9-19).

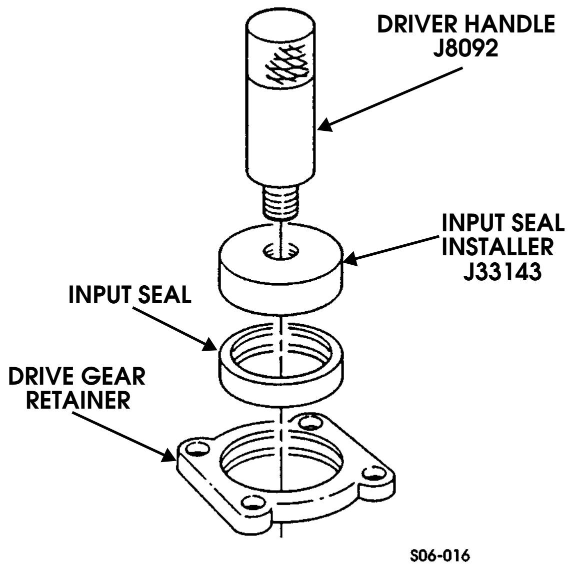


Figure 9-19: Input Seal Installation

Installation

1. Using driver handle J8092 and input seal installer J33143, install input seal in drive gear retainer. Ensure radius on outer diameter of input seal faces toward inside of geared hub (Figure 9-19).
2. Secure shim gasket(s) and drive gear retainer to geared hub with three washers and bolts. Tighten bolts to 38 lb-ft (52 N•m) (Figure 9-18).
3. Secure vent line bracket to drive gear retainer with washer and bolt. Tighten bolt to 38 lb-ft (52 N•m).
4. Coat lip of input seal with gear oil (Figure 9-19).

NOTE: Be sure that bolt and bolt hole are cleaned of old Loctite.

5. Apply thread-locking compound to halfshaft retaining bolt and secure halfshaft to geared hub with lockwasher and halfshaft retaining bolt. Tighten halfshaft retaining bolt to 37 lb-ft (50 N•m) (Figure 9-20).
6. Secure washer and access plug onto geared hub. Tighten access plug to 8-13 lb-ft. (11-18 N•m).
7. Install wheel.

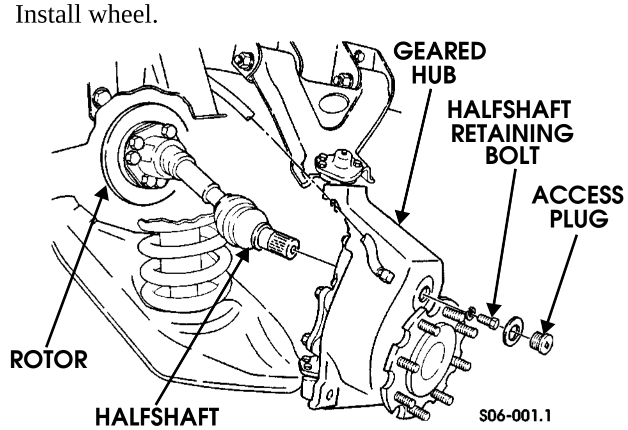


Figure 9-20: Halfshaft and Geared Hub

GEARED HUB REPAIR

Disassembly

1. Remove geared hub.
2. Position geared hub with spindle supporting geared hub (Figure 9-21).

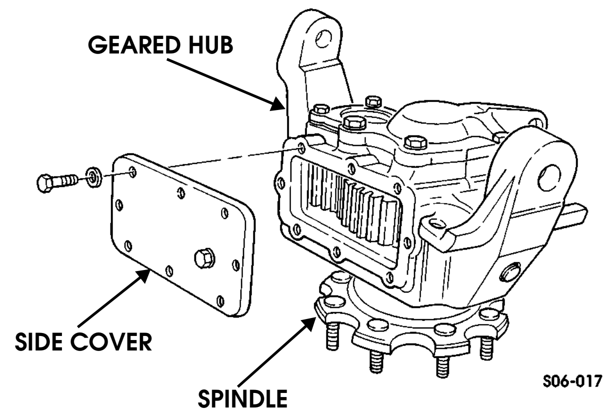


Figure 9-21: Geared Hub Disassembly

3. Remove eight bolts, washers, and side cover from geared hub.

***CAUTION:** If backlash between drive and driven gears is more than 0.018 in. (0.46 mm), both gears must be replaced.*

4. Mount dial indicator J8001 on geared hub and index indicator to register from one drive gear tooth. Move drive gear back and forth while holding driven gear stationary to read backlash (Figure 9-22).

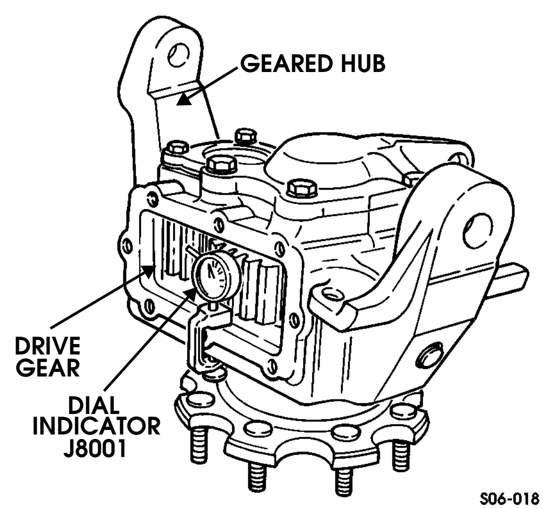


Figure 9-22: Dial Indicator Positioning

5. Remove four bolts, washers, and steering arm cover from geared hub (Figure 9-23).
6. Remove clamp nut lock screw from clamp nut.

7. Using clampnut socket SBAS-07M, remove clamp nut and keyed washer from spindle.

NOTE: It may be necessary to lightly tap threaded end of spindle to release it from the inner spindle bearing.

8. Lift geared hub off spindle.
9. Remove inner bearing, bearing spacer, and driven gear from geared hub.
10. Remove outer bearing spacer from spindle.
11. Remove four bolts, washers, drive gear retainer, shim gasket, inboard bearing cup, and drive gear from geared hub (Figure 9-24).
12. Remove retaining washer from inside drive gear or geared hub.
13. Remove spindle seal from geared hub. Discard seal.
14. Remove input seal from drive gear retainer. Discard seal (Figure 9-25).

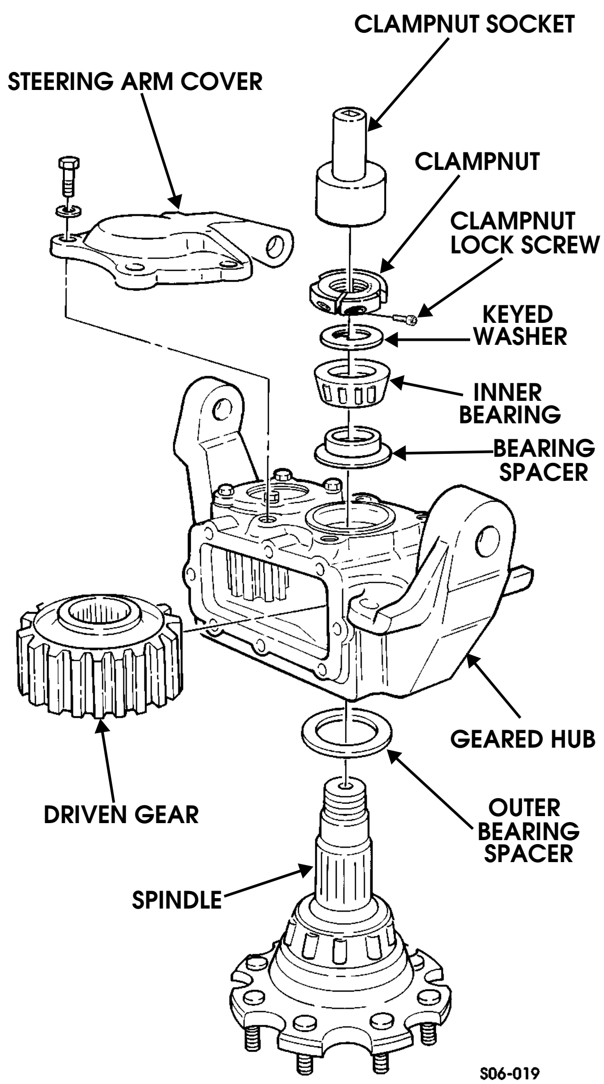


Figure 9-23: Geared Hub Breakdown

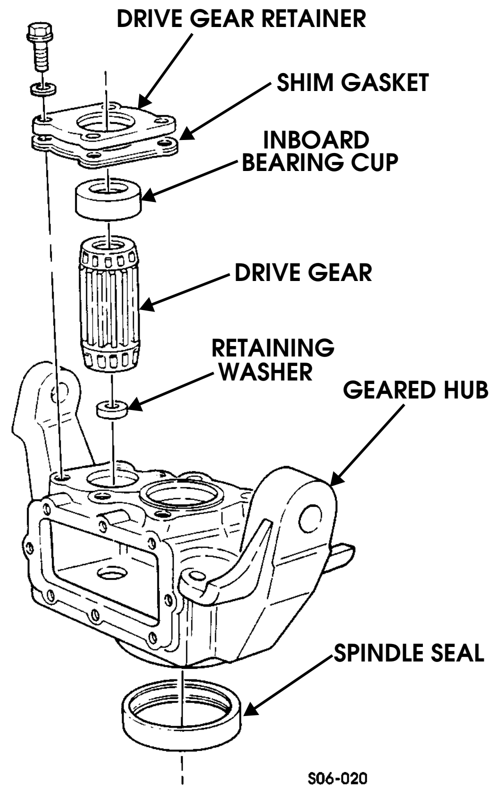


Figure 9-24: Drive Gear Removal

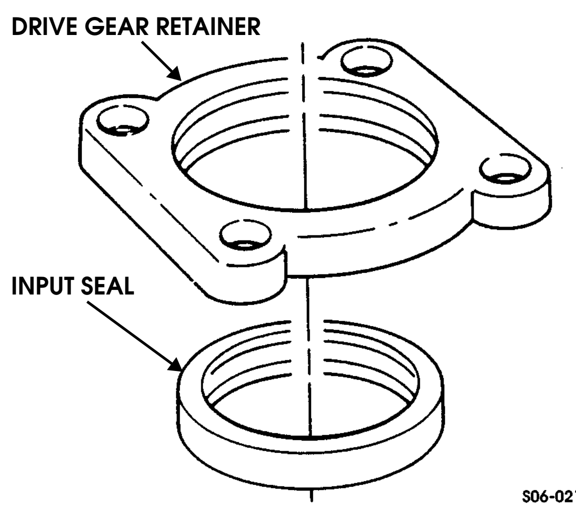


Figure 9-25: Input Seal Removal

Inspection

NOTE: Clean all components, examine for wear or damage, and replace if necessary. Drive and driven gears must be replaced as matched set (Figure 9-26).

1. Inspect splines and gear teeth on drive gear and driven gear for damage.
2. Inspect spindle for damage and rough or corroded sealing surface.
3. Inspect all bearings and bearing races for damage.
4. Inspect steering arm cover for damage.
5. Inspect geared hub and all threaded holes for damage. Repair any damaged holes using thread repair inserts.

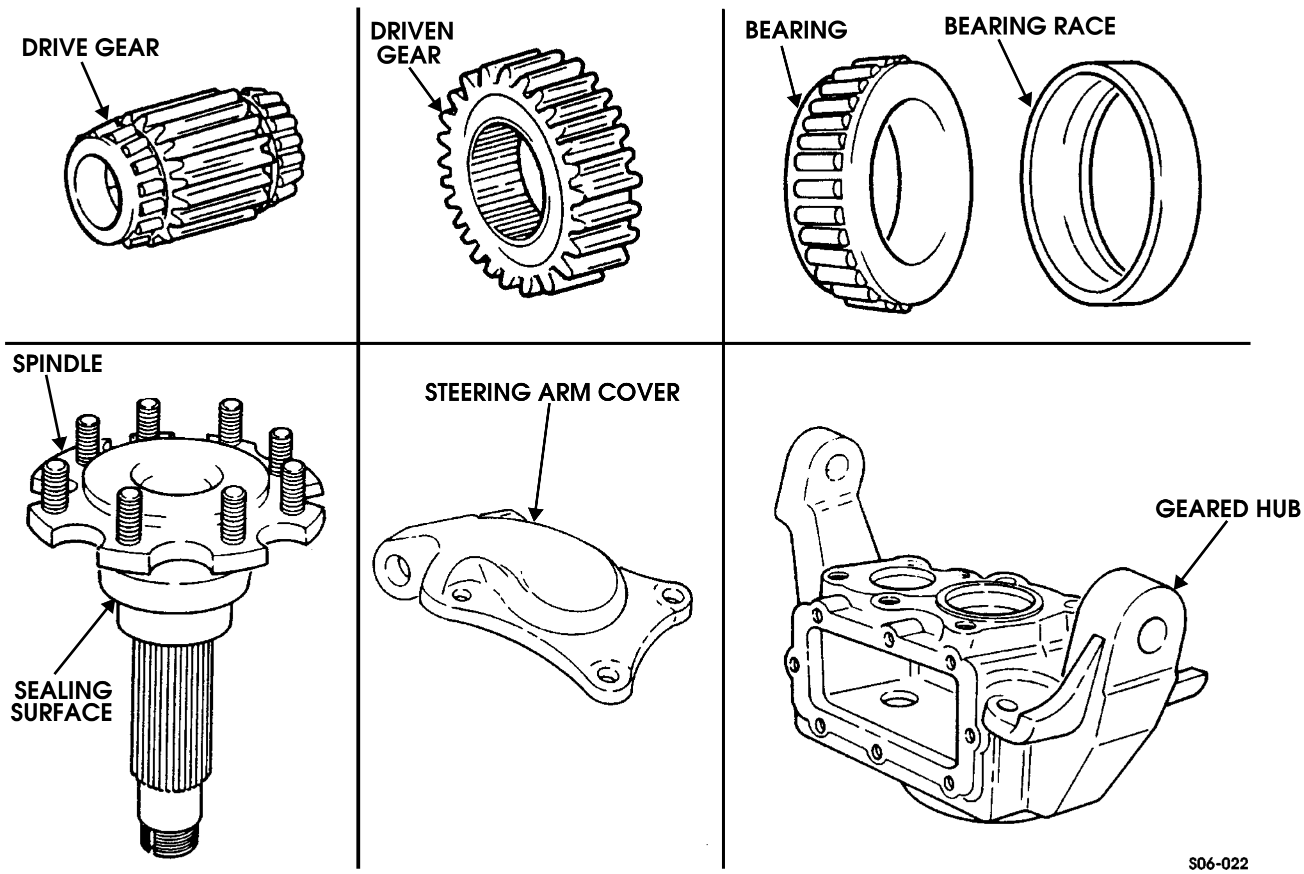


Figure 9-26: Geared Hub Component Appearance

Assembly

1. Using driver handle J8092 and spindle seal installer J33143, install spindle seal in geared hub (Figure 9-27).

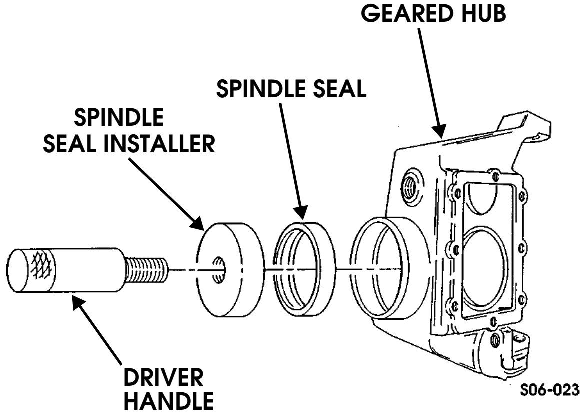


Figure 9-27: Spindle Seal Installation

2. Ensure radius on outer diameter of input seal faces inside drive gear retainer. Using input seal installer J33143 and driver handle J8092, install input seal in drive gear retainer (Figure 9-28).

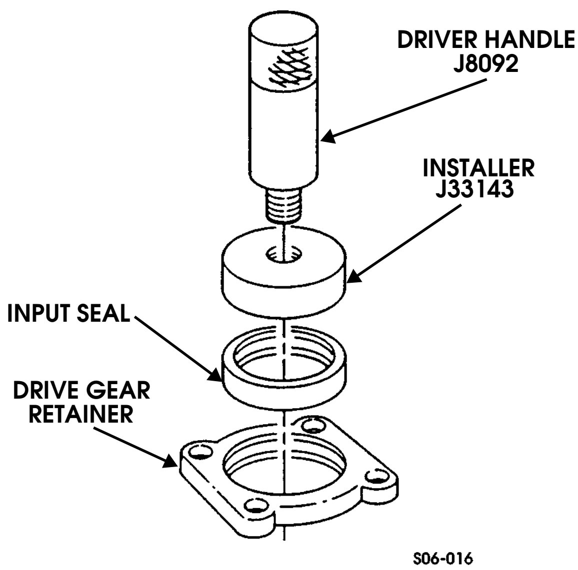


Figure 9-28: Input Seal Installation

3. Install retaining washer in shallow end of drive gear (Figure 9-29).

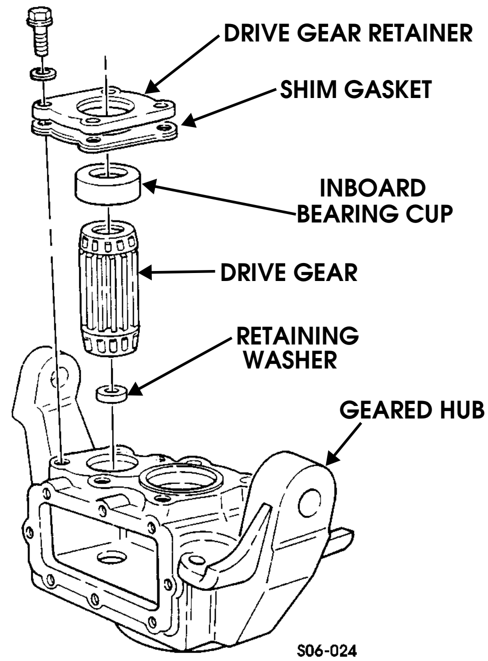


Figure 9-29: Retaining Washer Location

4. Install drive gear and inboard bearing cup in geared hub.
5. Apply thread-locking compound on bolts. Secure shim gasket and drive gear retainer to geared hub with four washers and bolts. Tighten bolts to 25-35 lb-ft (40-48 N•m).
6. Mount dial indicator on geared hub and index indicator to register on end of drive gear (Figure 9-30).

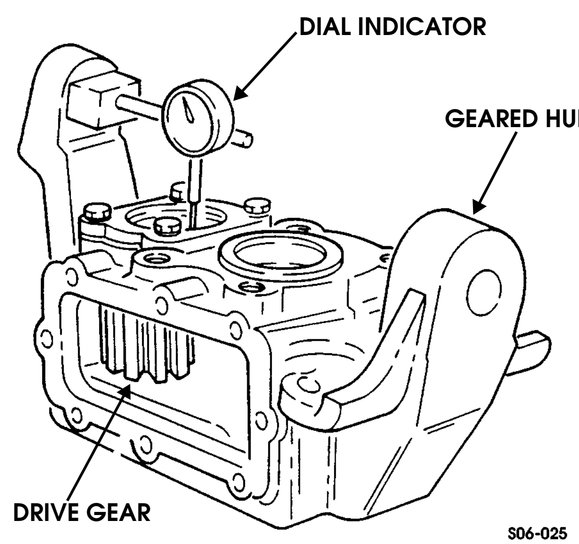


Figure 9-30: Dial Indicator Positioning

7. Move drive gear up and down to read end play. End play should be 0.001-0.006 in. (0.03-0.15 mm). If end play is incorrect, add or subtract shim gaskets and recheck end play.

8. Install driven gear and bearing spacer in geared hub (Figure 9-31).

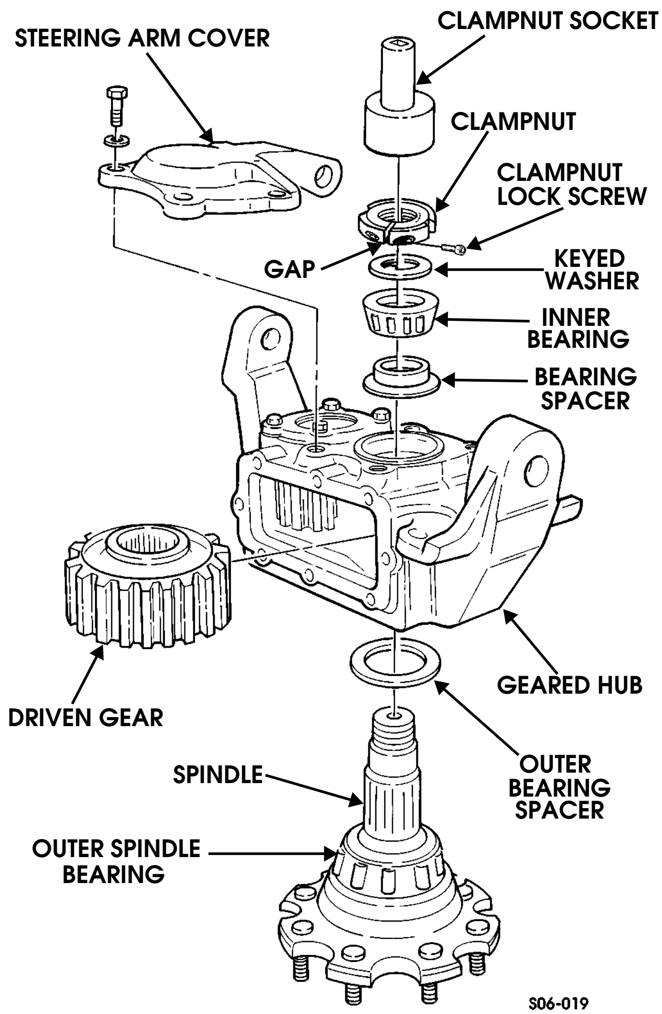


Figure 9-31: Geared Hub Driven Gear Installation

9. Install outer bearing spacer on spindle.
10. Lower geared hub onto spindle and align splines on driven gear with splines on spindle. Ensure outer spindle bearing seats in bearing cup.
11. Install inner bearing and keyed washer on spindle.

NOTE: After clampnut lock screw is installed into clampnut, clampnut must be completely installed on spindle within a ten minute limit.

12. Tighten clampnut lock screw three to five turns into clamp nut.

CAUTION: *Ensure clampnut is installed on spindle with boss (protruding side) facing inward toward bearing and large chamfer side with engraved part number facing away from bearing.*

13. Apply a thin coat of grease to boss (protruding side) of clampnut and install clampnut on spindle.

NOTE: If an excessive amount of torque (18-26 lb-in. (2-3 N•m)) is required to tighten clampnut lock screw to remove clampnut wobble, remove screw. Ensure threads of clampnut are clean and free of Loctite. Replace screw with a new one, or remove all previously applied Loctite from threads of old screw and apply fresh Loctite 272 to old screw threads prior to reinstallation. Use a hexagonhead socket with a calibrated torque wrench to tighten and check torque of screw.

14. Tighten clampnut lock screw until all clampnut wobble is removed and clamp nut can still be rotated by hand.
15. Using clampnut socket SBAS-07M, tighten clamp nut to 40 lb-ft (54 N•m). Rotate spindle five revolutions both clockwise and counterclockwise to seat bearings.
16. Loosen and retighten clampnut to 25 lb-ft (34 N•m).

NOTE: Ensure clampnut does not move while clampnut lock screw is being tightened.

17. Using a hexagon-head socket and pre-set calibrated torque wrench, tighten clampnut lock screw to 90 lb-in. (10 N•m).
18. Mark a temporary line across end of spindle and clampnut.

NOTE: Using a feeler gauge, ensure a gap exists between clampnut gap surfaces. If no gap exists, remove and discard clampnut lock screw and clampnut. Acquire new screw and nut and repeat steps 12-18.

19. Using preset torque wrench, apply pressure to clamp nut in a counterclockwise direction until torque wrench clicks, indicating 90 lb-ft (122 N•m) of loosening torque was applied to clampnut.

NOTE: Clampnut should not move. To verify no movement occurred, check temporary mark across spindle and clampnut. If clampnut moves, remove and discard clampnut lock screw and clampnut. Repeat steps 12-19 with new screw and nut.

20. Paint or scribe a permanent line across end of spindle and clampnut.

NOTE: Immediately install steering arm cover after application of sealer.

21. Clean sealing surfaces on geared hub and steering arm cover. Apply anaerobic sealer to steering arm cover and secure steering arm cover to geared hub.

NOTE: Make sure bolts and holes are free of old Loctite.

22. Apply thread-locking compound to bolts. Secure steering arm cover to geared hub with four washers and bolts. Tighten bolts to 65 lb-ft (88 N•m).
23. Clean sealing surfaces on geared hub and side cover. Apply anaerobic sealer to side cover and install on geared hub (Figure 9-32).

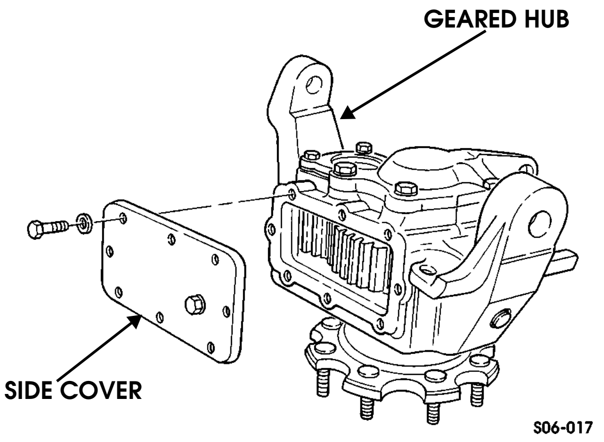


Figure 9-32: Geared Hub Side Cover Removal

NOTE: Make sure bolts and holes are free of old Loctite.

24. Apply thread-locking compound to bolts. Secure side cover to geared hub with eight washers and bolts. Tighten bolts to 8-13 lb-ft (11-18 N•m).
25. Install geared hub.

GEARED HUB SPINDLE SEAL REPLACEMENT

Removal

1. Remove wheel.
2. Remove drainplug from geared hub and drain geared hub oil. Install drainplug in geared hub. Tighten drainplug to 8-13 lb-ft (11-18 N•m) (Figure 9-33).

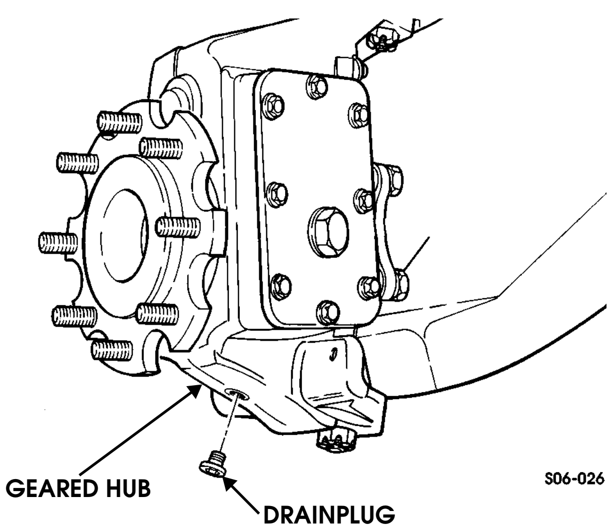


Figure 9-33: Geared Hub Drainplug Removal

3. Remove four bolts, washers, and steering arm cover from geared hub (Figure 9-34).

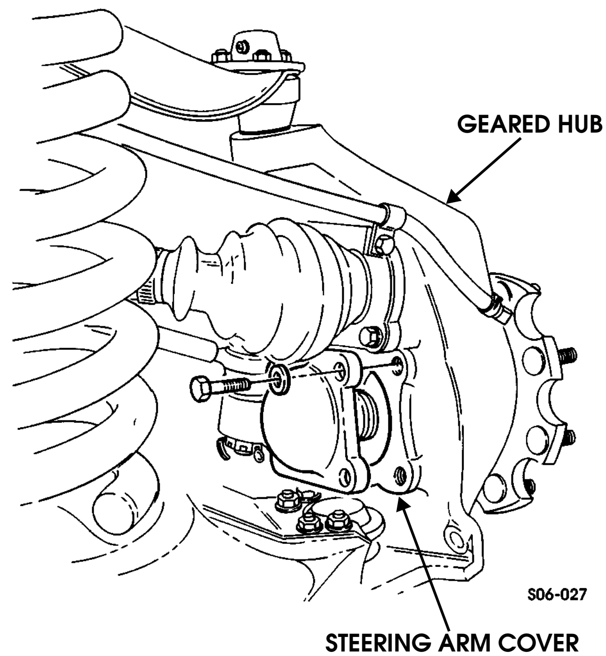


Figure 9-34: Geared Hub Steering Arm Cover Removal

4. Remove clampnut lock screw from clampnut (Figure 9-35).

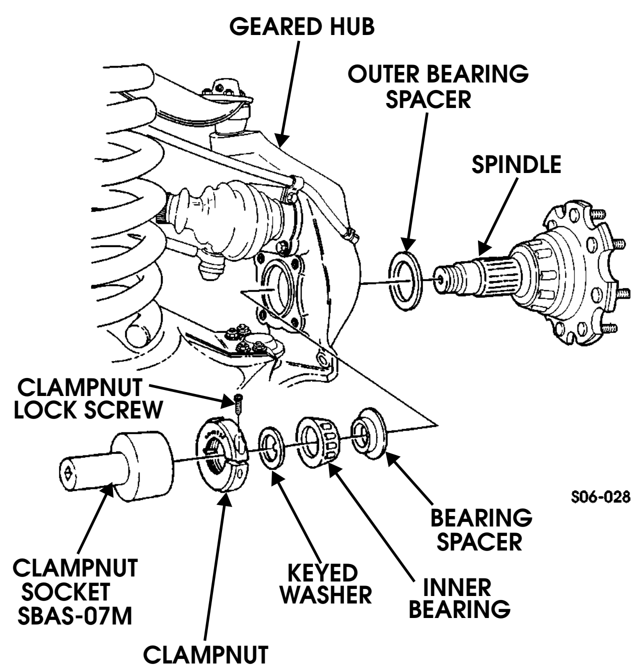


Figure 9-35: Clamp Nut Removal

5. Using clampnut socket SBAS-07M, remove clampnut and keyed washer from spindle.

6. Remove spindle, bearing spacer, inner bearing, and outer bearing spacer from geared hub.
7. Remove spindle seal from geared hub. Discard spindle seal (Figure 9-36).

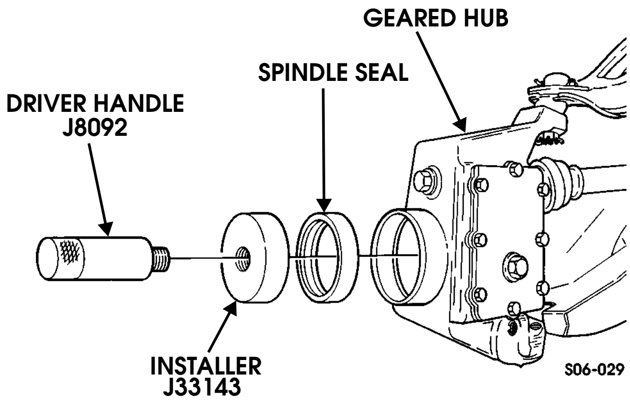


Figure 9-36: Spindle Seal Removal

Cleaning and Inspection

1. Inspect spindle for rough or corroded sealing surface. Replace if damaged (Figure 9-35).
2. Inspect bearings for damage. Replace if damaged.

Installation

1. Using driver handle J8092 and spindle seal installer J33143, install spindle seal in geared hub (Figure 9-36).
2. Coat seal with lubricating oil.
3. Install outer bearing spacer and spindle in geared hub (Figure 9-35).
4. Install bearing spacer, inner bearing, and keyed washer on spindle.

NOTE: After clampnut lock screw is installed into clampnut, clampnut must be completely installed on spindle within a ten minute limit.

5. Tighten clampnut lock screw three to five turns into clampnut.

CAUTION: *Ensure clampnut is installed on spindle with boss (protruding side) facing inward toward bearing and large chamfer side with engraved part number facing away from bearing.*

6. Apply a thin coat of grease to boss (protruding side) of clampnut and install clampnut on spindle.
7. If an excessive amount of torque (18-26 lb-in. (2-3 N•m)) is required to tighten clampnut lock screw to remove clampnut wobble, remove clampnut lock screw. Ensure threads of clampnut are clean and free of Loctite. Replace screw with a new one or remove all previously applied Loctite from threads of old screw and apply fresh Loctite 272 to old screw threads prior to reinstallation. Use hex socket and torque wrench to tighten and check screw torque.
8. Tighten clampnut lock screw until all clampnut wobble is removed but clampnut can still be rotated by hand.
9. Using clampnut socket SBAS-07M, tighten clampnut to 40 lb-ft (54 N•m). Rotate spindle five revolutions both clockwise and counterclockwise to seat bearings.
10. Loosen and retighten clampnut to 25 lb-ft (34 N•m).

NOTE: Ensure clampnut does not move while clampnut lock screw is being tightened.

11. Tighten clamp nut lock screw to 90 lb-in. (10 N•m).
12. Mark a temporary line across end of spindle and clamp nut. Then, using a feeler gauge, ensure a gap exists between clampnut gap surfaces. If no gap exists, remove and discard clampnut lock screw and clampnut. Acquire new screw and nut and repeat steps 5-12.
13. Apply 90 lb-ft (122 N•m) of loosening torque to clampnut. Clampnut should not move. To verify no movement occurred, check temporary mark across spindle and clampnut. If clampnut moved, remove and discard clampnut lock screw and clampnut. Repeat steps 5-13 with new screw and nut.

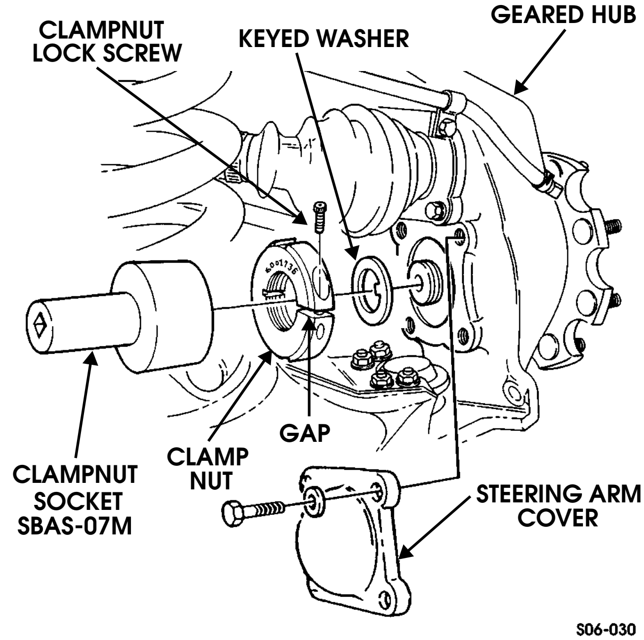


Figure 9-37: Clampnut Removal

14. Paint or scribe a permanent line across end of spindle and clampnut.
15. Clean sealing surfaces on geared hub and steering arm cover. Apply Loctite 518 sealant to steering arm cover and install on geared hub.

16. Apply thread-locking compound to bolt threads and install steering arm cover on geared hub with four washers and bolts. Tighten bolts to 65 lb-ft (88 N•m).
17. Remove fill plug and washer from geared hub (Figure 9-38).

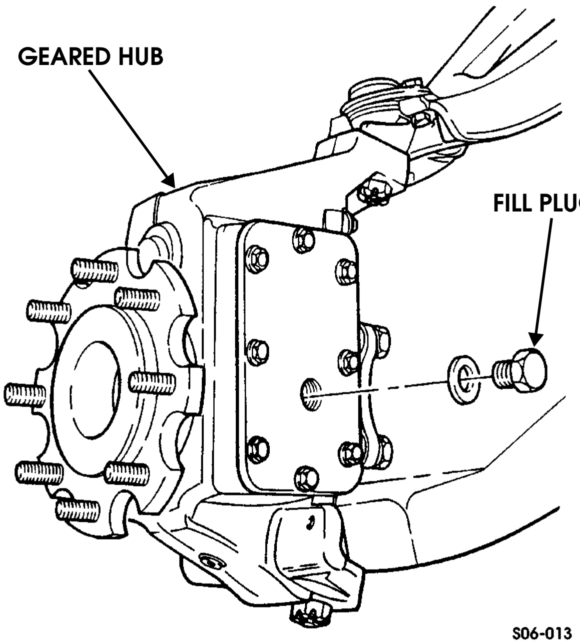


Figure 9-38: Geared Hub Fill Plug Location

18. Fill geared hub to proper oil level (Section 1).
19. Secure washer and fill plug to geared hub. Tighten fill plug to 8-13 lb-ft (11-18 N•m).
20. Install wheel.

GEARED HUB SPINDLE BEARING ADJUSTMENT

Adjustment

1. Remove wheel.
2. Remove drainplug and drain geared hub oil. Install drainplug into geared hub. Tighten drainplug to 8-13 lb-ft (11-18 N•m) (Figure 9-39).
3. Remove four bolts, washers, and steering arm cover from geared hub. Push steering arm cover away from geared hub (Figure 9-41).
4. Remove clampnut lock screw from clampnut.
5. Using clampnut socket, remove clampnut and keyed washer from spindle.
6. After clampnut lock screw is installed into clampnut, clampnut must be completely installed on spindle within a ten minute limit.

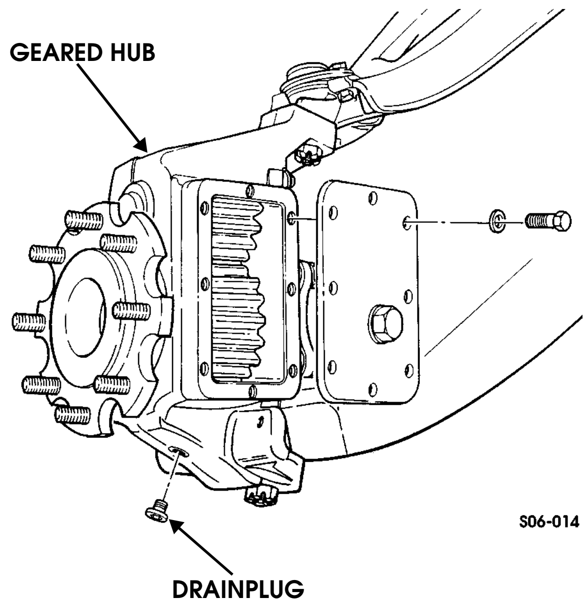


Figure 9-39: Geared Hub Drainplug Location

7. Tighten clampnut lock screw three to five turns into clampnut.

***CAUTION:** Ensure clampnut is installed on spindle with boss (protruding side) facing inward toward bearing and large chamfer side with engraved part number facing away from bearing.*

8. Apply a thin coat of grease to boss (protruding side) of clamp nut and install clamp nut on spindle.

NOTE: If an excessive amount of torque (18-26 lb-in. (2-3 N•m)) is required to tighten clampnut lock screw to remove clampnut wobble, remove screw. Ensure threads of clampnut are clean and free of Loctite. Replace screw with a new one or remove all previously applied Loctite from threads of old screw and apply fresh Loctite 272 to old screw threads prior to reinstallation. Use a hex socket and torque wrench to tighten and check screw torque.

9. Tighten clampnut lock screw until all clampnut wobble is removed and clampnut can still be rotated by hand.
10. Using clampnut socket SBAS-07M, tighten clampnut to 40 lb-ft (54 N•m). Rotate spindle five revolutions both clockwise and counterclockwise to seat bearings (Figure 9-40).

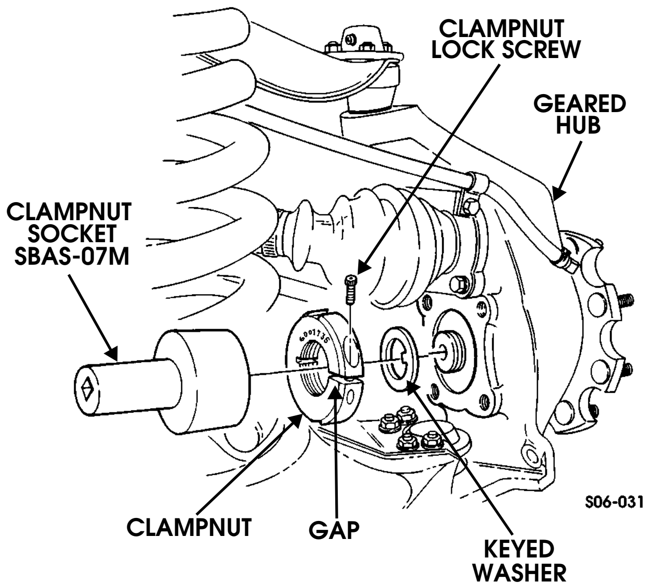


Figure 9-40: Clampnut Installation

11. Loosen and retighten clampnut to 25 lb-ft (34 N•m).

NOTE: Ensure clampnut does not move while clampnut lock screw is being tightened.

12. Using a hexagon-head socket and pre-set calibrated torque wrench, tighten clampnut lock screw to 90 lb-in. (10 N•m).
13. Mark a temporary line across end of spindle and clampnut.

NOTE: Using a feeler gauge, ensure a gap exists between clampnut gap surfaces. If no gap exists, remove and discard clampnut lock screw and clampnut. Acquire new screw and nut and repeat steps 6-12.

14. Using pre-set torque wrench, apply pressure to clampnut in counterclockwise direction until torque wrench clicks, indicating 90 lb-ft (122 N•m) of loosening torque was applied to clampnut.

NOTE: Clampnut should not move. To verify no movement occurred, check temporary mark across spindle and clampnut. If clampnut moved, remove and discard clampnut lock screw and clampnut. Repeat steps 6-13 with new screw and nut.

15. Paint or scribe a permanent line across end of spindle and clampnut.

NOTE: Immediately install steering arm cover after application of sealant.

16. Clean sealing surfaces on geared hub and steering arm cover. Apply anaerobic sealant to steering arm cover and install on geared hub (Figure 9-41).

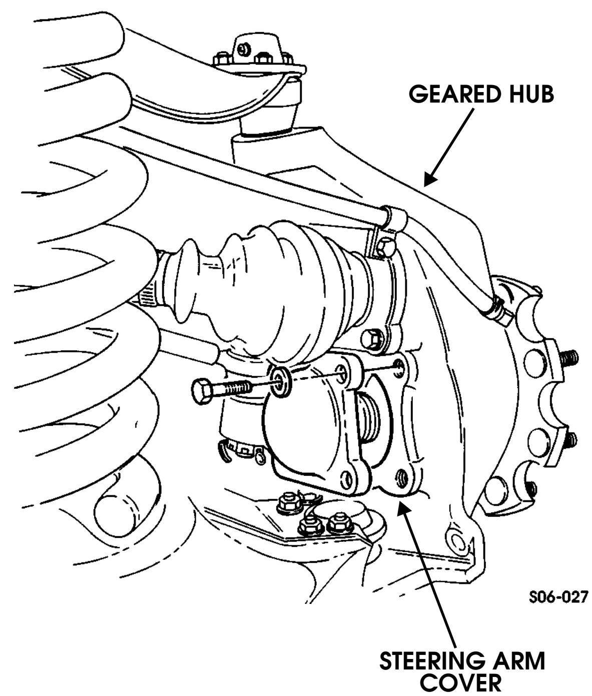


Figure 9-41: Steering Arm Cover Installation

NOTE: Thoroughly clean old Loctite before applying fresh Loctite.

17. Apply thread-locking compound to bolt threads and secure steering arm cover to geared hub with four washers and bolts. Tighten bolts to 65 lb-ft (88 N•m).
18. Remove fill plug and washer from geared hub (Figure 9-38).
19. Fill geared hub to proper oil level (Section 1).
20. Secure washer and fill plug to geared hub. Tighten fill plug to 8-13 lb-ft (11-18 N•m).

GEARED HUB SPINDLE STUD REPLACEMENT

WARNING: Always wear eye protection when replacing spindle studs. Severe eye injury may result if metal chips contact eyes.

Removal

1. Remove wheel.
2. Rotate spindle to allow clearance for removal of stud from spindle (Figure 9-42).
3. Drive stud from spindle. Discard stud.

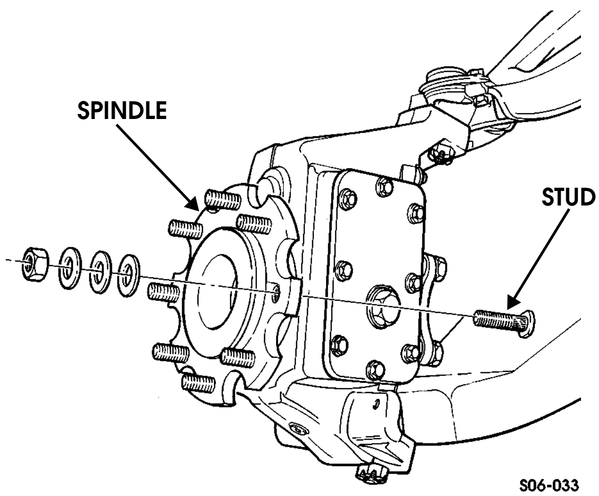


Figure 9-42: Geared Hub Spindle Stud Removal

Installation

1. Install stud in spindle (Figure 9-42).
2. Install three flat washers and hex nut on stud.
3. Tighten hex nut until head on stud seats against spindle.
4. Remove and discard hex nut and three flat washers.

HALFSHAFT BOOT REPLACEMENT

Removal

NOTE: Inner and outer boots are replaced together. The inner CV joint is disassembled to gain access to the halfshaft boots.

1. Remove wheel.
2. Remove access plug and washer from geared hub (Figure 9-43).
3. Remove six bolts, lockwashers, and halfshaft from rotor.
4. Remove halfshaft retaining bolt, lockwasher, and halfshaft from geared hub.

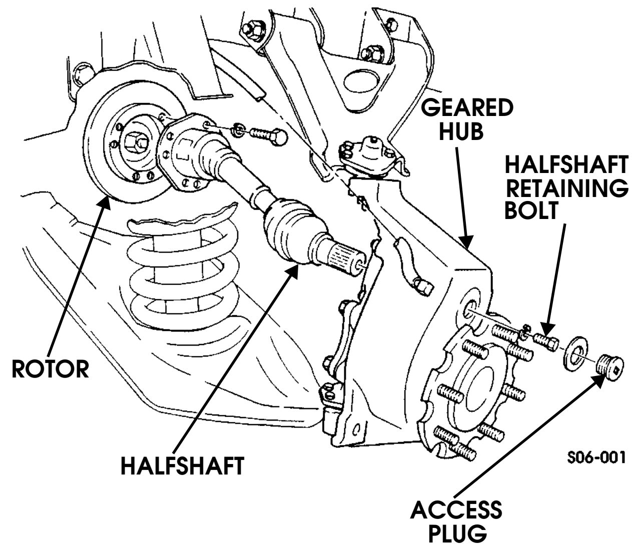


Figure 9-43: Halfshaft Retaining Bolt

5. Loosen two clamps securing inner boot to inner joint housing and shaft (Figure 9-44).
6. Slide inner boot toward outer joint along shaft.

NOTE: Remove excess grease from bearing assembly.

7. Clamp shaft in soft-jawed vise.
8. Remove retaining ring from inner joint housing by forcing clip up chamfer on inside of housing.
9. Remove housing and six ball bearings from bearing assembly.
10. Move outer race up on shaft to allow for better access to inner race (Figure 9-46).
11. Locate snap ring adjacent to inner race. Remove snap ring from groove and slide up on shaft (Figure 9-46).
12. Tap inner race up on shaft to expose retaining clip.
13. Remove retaining clip and inner race from shaft.
14. Remove outer race, snap ring, and inner boot from shaft. (Figure 9-46).
15. Remove two clamps and outer boot from shaft.

Cleaning and Inspection

NOTE: Clean all components, examine for wear or damage, and replace halfshaft if necessary.

1. Clean all metallic parts with solvent.
2. Inspect halfshaft assembly for damage or wear, and replace if damaged or worn.

Installation

1. Position outer boot and two clamps on shaft near outer joint.
2. Apply packet of grease to outer joint.
3. Position outer boot over outer joint housing and secure clamp with boot banding tool J22610.
4. Secure smaller clamp on boot and shaft with tool J22610.
5. Clamp shaft in vise with protective jaws.
6. Position two clamps on shaft (Figure 9-47).
7. Install inner boot on shaft. Push boot past groove on shaft.
8. Install the snap ring and retaining clip into grooves on shaft (Figure 9-46).
9. Align chamfer splines of inner bearing assembly with spline of shaft. Use press or rawhide hammer to install inner race until it snaps in place - flush against spacer ring.
10. Position six ball bearings into bearing assembly and retain with a slight amount of grease (Figure 9-44).

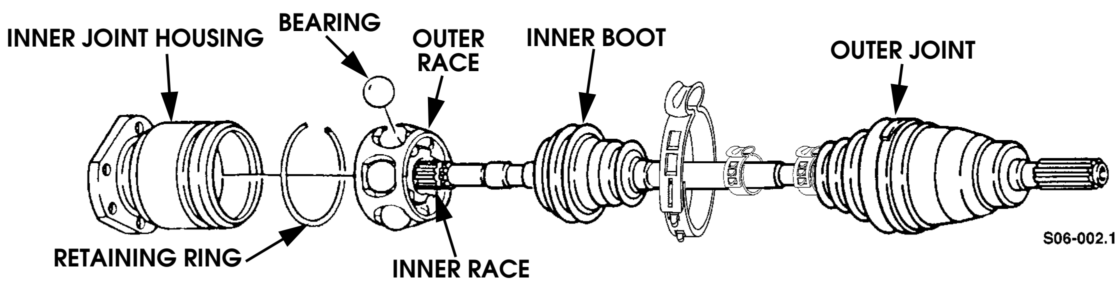


Figure 9-44: Halfshaft Boot Replacement

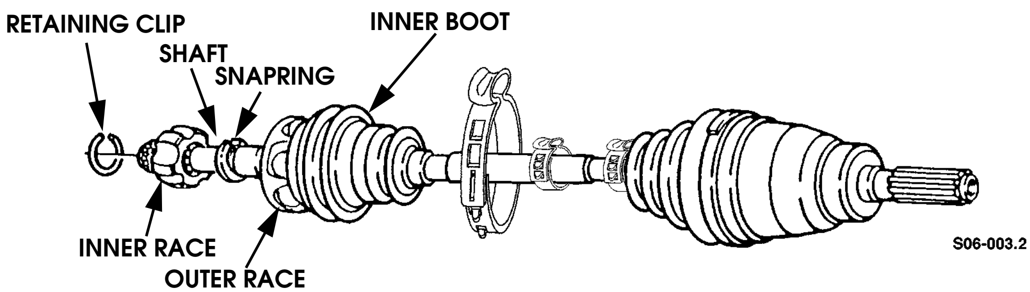


Figure 9-45: Halfshaft Boot Replacement

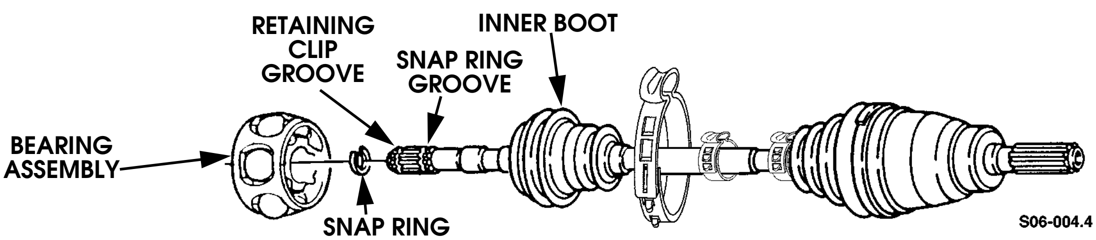


Figure 9-46: Halfshaft Boot Replacement

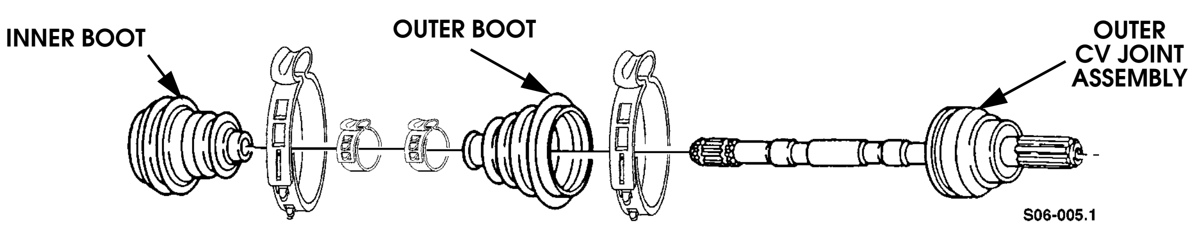


Figure 9-47: Halfshaft Boot Replacement

11. Position joint inner housing over bearing assembly.

NOTE: Ensure all ball bearings are in the tracks of the inner joint.

12. Secure retainer ring in groove of inner joint housing.
13. Fill inner joint with grease from grease packet.
14. Move inner boot on shaft until boot seats in groove of shaft and inner joint housing.
15. Secure inner boot on shaft and housing with clamps. Tighten clamps with crimping tool J22610.
16. Slide halfshaft splines into geared hub.
17. Apply thread-locking compound to halfshaft retaining bolt and secure halfshaft to geared hub with lockwasher and halfshaft retaining bolt. Tighten halfshaft retaining bolt to 37 lb-ft (50 N•m) (Figure 9-43).
18. Install washer and access plug into geared hub. Tighten access plug to 8-13 lb-ft (11-18 N•m).

NOTE: Ensure all six bolt holes in the rotor align with holes in output flange. Make sure mounting holes and bolts are cleared of old Loctite.

19. Apply Loctite 272 to six bolts. Secure halfshaft to rotor with six lockwashers and bolts. Tighten bolts to 48 lb-ft (65 N•m).
20. Install wheel.

AXLE VENT LINE REPLACEMENT

NOTE: Axle vent line replacement procedures are basically the same. This procedure covers the rear axle vent line.

Removal

1. Disconnect vent line from axle fitting and tee fitting and remove vent line (Figure 9-48).
2. Remove two line clips and vent line from brake line.
3. Disconnect vent line from two tee fittings and remove vent line.

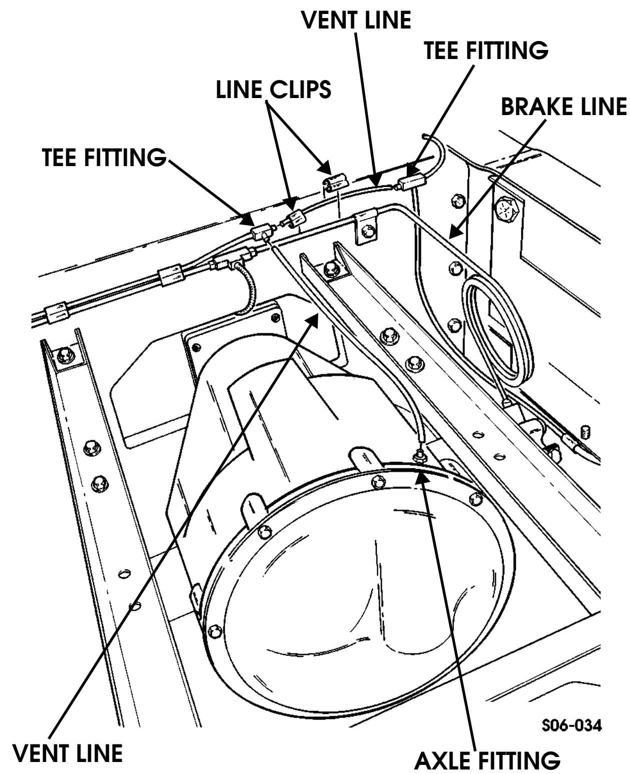


Figure 9-48: Axle Vent Line Location

Installation

1. Install vent line and connect to two tee fittings (Figure 9-48).
2. Secure vent line to brake line with two line clips.
3. Connect vent line to axle fitting and tee fitting.

GEARED HUB VENT LINE REPLACEMENT

NOTE: All geared hub vent line replacement procedures are basically the same. This procedure covers the right rear geared hub vent line.

Removal

1. Disconnect vent line from geared hub fitting (Figure 9-49).
2. Remove bolt, clamp, and vent line from bracket.
3. Remove bolt, clamp, and vent line from control arm.
4. Remove bolt, clamp, and vent line from bracket.
5. Remove bolt, clamp, and vent line from frame (Figure 9-50).
6. Disconnect vent line from tee fitting.

Installation

1. Secure vent line to frame with clamp and bolt (Figure 9-50).
2. Secure vent line to bracket with clamp and bolt (Figure 9-49).
3. Secure vent line to tee fitting and geared hub fitting
4. Secure vent line to control arm with clamp and bolt (Figure 9-49).

NOTE: Position clamp at a 45 degree angle toward the wheel before securing with bolt.

5. Secure vent line to bracket with clamp and bolt.

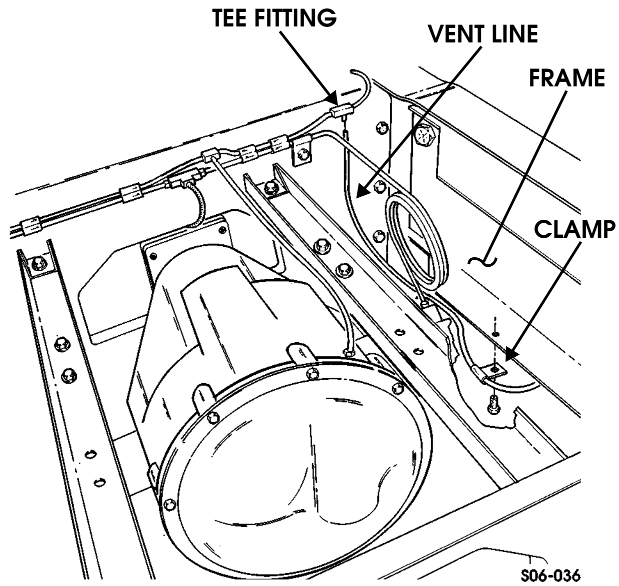


Figure 9-50: Vent Line

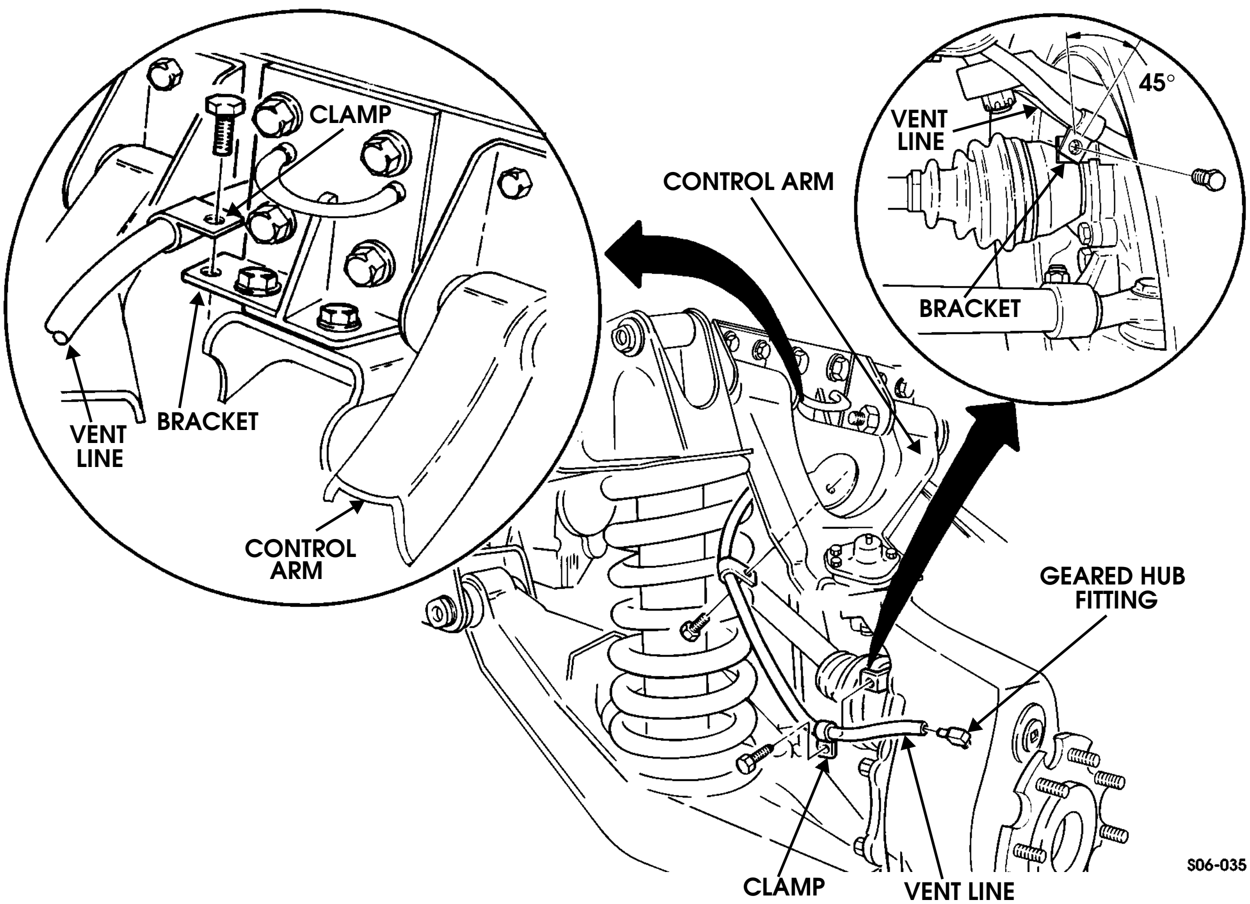


Figure 9-49: Geared Hub Vent Line Positioning

AXLE ASSEMBLY COVER SERVICE

Removal

1. Remove drainplug from axle assembly and drain axle assembly (Figure 9-51).
2. Remove twelve bolts and cover from axle assembly.

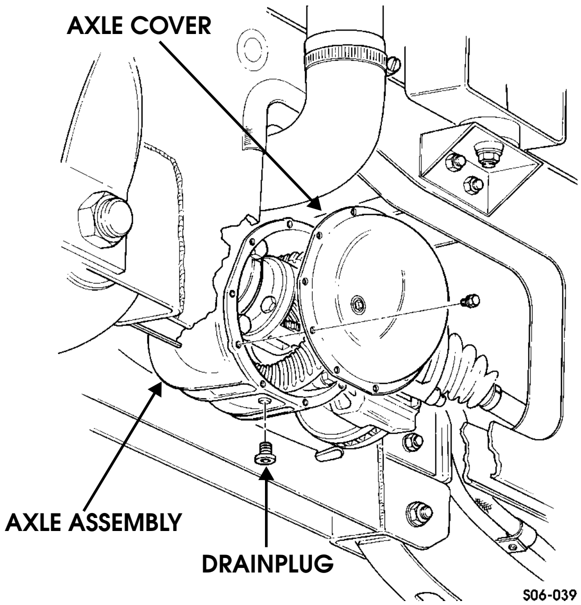


Figure 9-51: Axle Assembly Cover Service

Cleaning and Inspection

NOTE: Clean all components, examine for wear or damage, and replace if necessary.

1. Clean axle assembly cover, bolts, and axle assembly with solvent (Figure 9-51).
2. Inspect axle assembly cover for cracks, wear, or breaks.

Installation

1. Apply RTV sealant to cover sealing surface and secure cover to axle assembly with twelve bolts. Tighten bolts to 16 lb-ft (22 N•m).
2. Thread drainplug into axle assembly and tighten to 13-18 lb-ft (18-25 N•m) (Figure 9-51).
3. Fill axle assembly to proper oil level (Section 1).

AXLE OUTPUT SHAFT SEAL REPLACEMENT

Removal

1. Remove brake caliper and yoke from caliper adaper (disconnect park brake cable from rear calipers) and support caliper to the side being careful not to kink brake line..
2. Disconnect halfshaft at the axle flange and swing off to the side.
3. Remove the brake rotor.
4. Remove the axle output flange retaining nut and the flange.
5. Support the axle assembly, disconnect and move the axle assembly support bracket over to gain access to the output seal.

NOTE: Some 1997 models may have axle assembly support brackets with larger cutouts in the output shaft seal area. It is not necessary to remove these axle assembly support brackets for output shaft seal replacement (Figure 9-51.1).

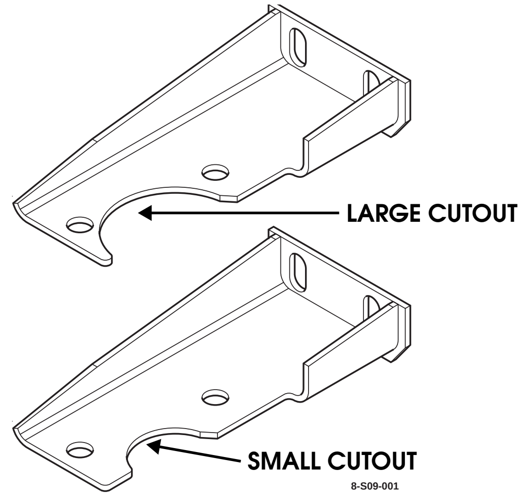


Figure 9-51.1 Axle Assembly Support Brackets

6. Remove output shaft seal from axle (Figure 9-52).

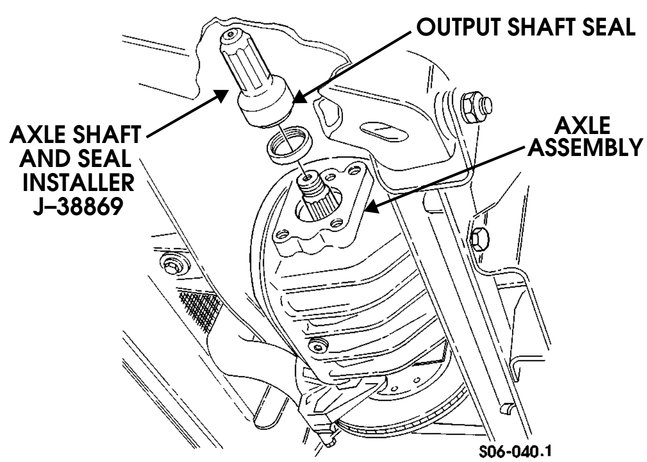


Figure 9-52: Axle Output Shaft Seal Replacement

Installation

1. Using seal installer J–38869, install output shaft seal in axle assembly (Figure 9-52).
2. Reconnect axle assembly support bracket.
3. Install axle output shaft flange and nut using Loctite 272 (or equivalent) and torque to 166-196 lb ft (224-265N•m).
4. Install brake rotor and halfshaft. Use bolts with preapplied Loctite or original bolts with Loctite 272 (or equivalent), cam-lock washers and torque to 57 lb ft (77N•m).
5. Install brake caliper and yoke using Loctite 272 (or equivalent), connect park brake cable on rear calipers and torque to 40 lb ft (54 N•m).

PINION SEAL REPLACEMENT

NOTE: Removal and installation procedures for pinion seals are basically the same for front and rear axle assemblies. This procedure covers the rear axle assembly pinion seal.

Removal

1. Remove six bolts, cam-lock washers, and halfshaft from each output flange rotor.
2. Remove four bolts, two straps, and rear propeller shaft from pinion yoke (Figure 9-53).
3. Using a lb-in torque wrench, measure torque required to rotate pinion and record measurement.
4. Count and record number of exposed threads on end of pinion and mark locknut and pinion for assembly.
5. Remove locknut and pinion yoke from pinion.
6. Remove pinion seal from pinion.

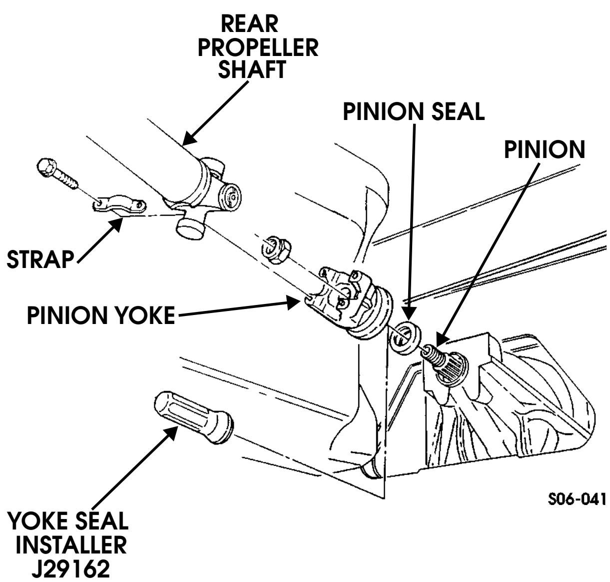


Figure 9-53: Pinion Seal Replacement

Installation

1. Using yoke seal installer J–29162, install pinion seal on pinion (Figure 9-53).
2. Secure pinion yoke to pinion with locknut.
3. Tighten locknut to original position.
4. Tighten locknut in small increments, until torque required to rotate pinion exceeds original measurement by 2 lb-in (0.2 N•m).
5. Secure rear propeller shaft to pinion yoke with four bolts and two straps. Tighten bolts to 27 lb-ft (37 N•m).
6. Apply Loctite 272 to halfshaft mounting bolts.
7. Secure halfshaft to each output flange and rotor with twelve cam-lock washers and six bolts. Tighten to 57 lb-ft (77 N•m).

AXLE ASSEMBLY REPLACEMENT

Removal

NOTE: Removal and installation procedures are basically the same for front and rear axle assemblies. This procedure covers both front and rear axle assemblies except where noted.

1. Remove service brake rotors (Section 7).
2. Remove drainplug from axle assembly. Allow oil to drain and install drainplug (Figure 9-54).

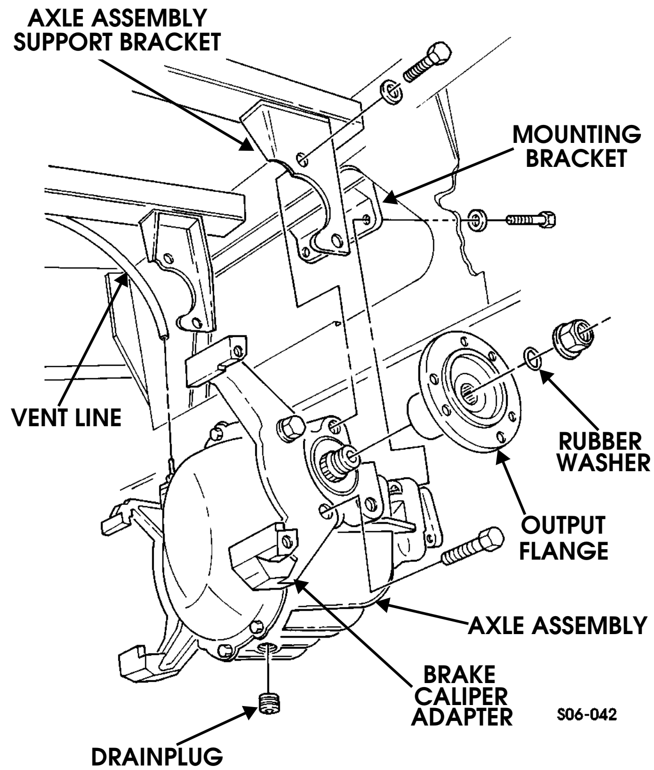


Figure 9-54: Rear Axle Assembly Mounting

3. Remove four bolts, two straps, and rear propeller shaft from pinion yoke (Figure 9-55).
4. Remove rear propeller shaft from transfer case.

NOTE: No washers are required when securing front axle assembly to mounting bracket.

5. Remove two bolts and washers securing axle assembly to mounting bracket (Figure 9-54).
6. Remove two locknuts, four O-ring seals and two output flanges from axle assembly. Discard locknuts and O-ring seals.

WARNING: Axle assembly must be supported during removal and installation. Failure to do this may cause personal injury or damage to equipment.

7. Support axle assembly.
8. Remove four bolts and washers securing axle assembly to side mounting brackets.
9. Lower axle assembly slightly and disconnect vent line from axle assembly.
10. Remove axle assembly.
11. Remove four bolts and two brake caliper adapters from axle assembly.
12. Using a lb-in torque wrench, measure torque required to rotate pinion and record measurement.
13. Count and record number of exposed threads on end of pinion and mark locknut and pinion for assembly.
14. Remove locknut and rear pinion yoke from axle assembly (Figure 9-56).

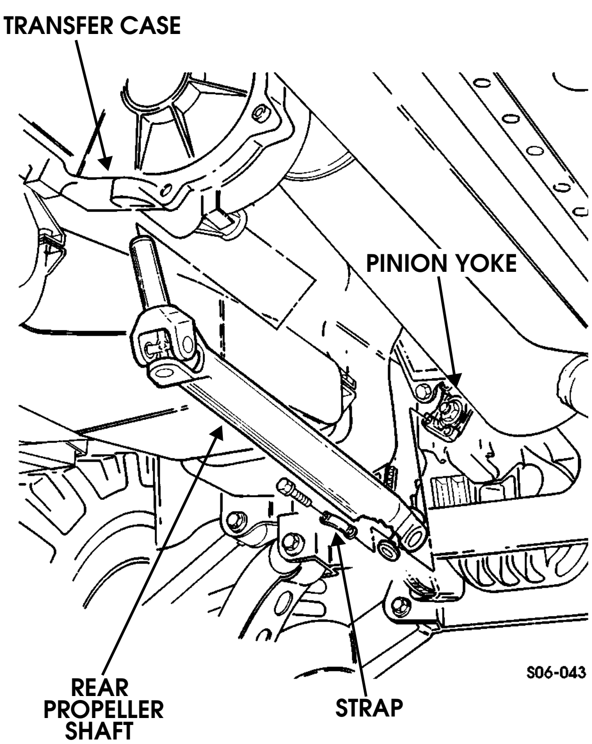


Figure 9-55: Rear Propeller Shaft Removal

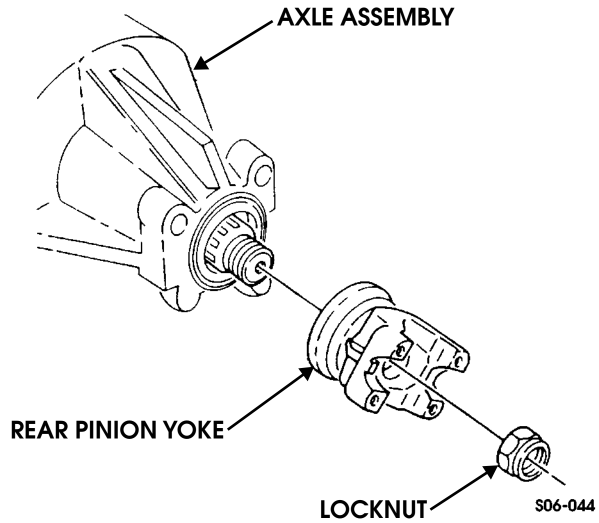


Figure 9-56: Pinion Yoke Removal

Installation

1. Secure rear pinion yoke to axle assembly with locknut (Figure 9-56).
2. Tighten locknut in small increments, until torque required to rotate pinion yoke exceeds original measurement by 2 lb-in (0.2 N•m).
3. Apply thread-locking compound to axle assembly tapped holes. Secure two brake caliper adapters to axle assembly with four bolts. Tighten bolts to 110-140 lb-ft (149-190 N•m) (Figure 9-57).

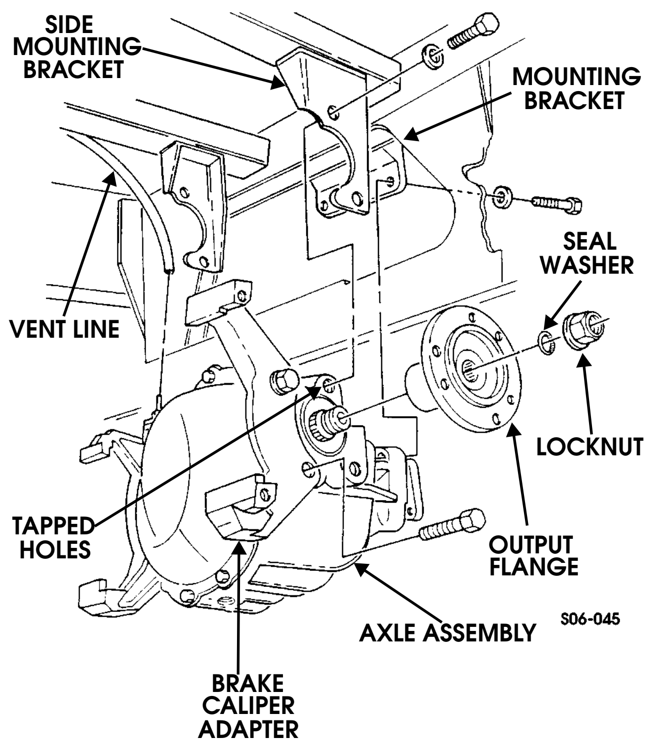


Figure 9-57: Rear Axle Assembly Installation

4. Raise axle assembly into place and connect vent line.
5. Apply thread-locking compound to axle assembly tapped holes. Install axle assembly on side mounting brackets with four washers and bolts.
6. Secure two output flanges and two seals to axle assembly with two locknuts. Tighten locknuts to 165-195 lb-ft (224-264 N•m).

NOTE: No washers required when securing front axle assembly to mounting bracket.

7. Apply thread-locking compound to bolts. Install two washers, bolts, and axle assembly to mounting bracket.
8. Tighten six bolts securing axle assembly to brackets to 110-139 lb-ft (149-188 N•m).
9. Install rear propeller shaft in transfer case (Figure 9-55).
10. Secure rear propeller shaft to pinion yoke with four bolts and two straps. Tighten bolts to 60 lb-ft (81 N•m) (Figure 9-55).
11. Install service brake rotors (Section 7).
12. Fill axle assembly to proper oil level (Section 1).
13. Install vent line to axle assembly.

AXLE ASSEMBLY REPAIR

Disassembly

1. Remove axle assembly.
2. Loosen locknut on output shaft assembly (Figure 9-58).

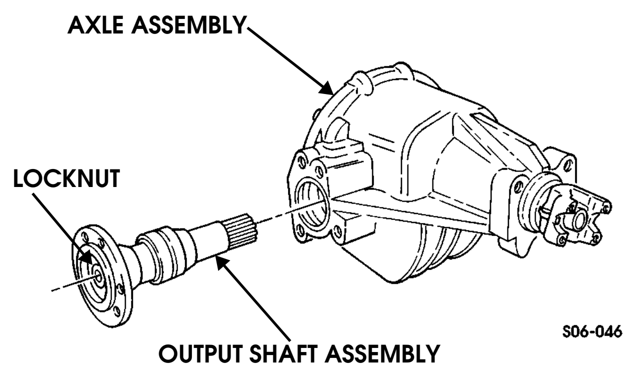


Figure 9-58: Output Shaft Assembly Removal

3. Using a slide hammer, remove output shaft assembly from axle assembly.
4. Remove locknut, seal washer, output flange and output shaft seal from output shaft. Discard seal washer, output shaft seal, and locknut (Figure 9-59).

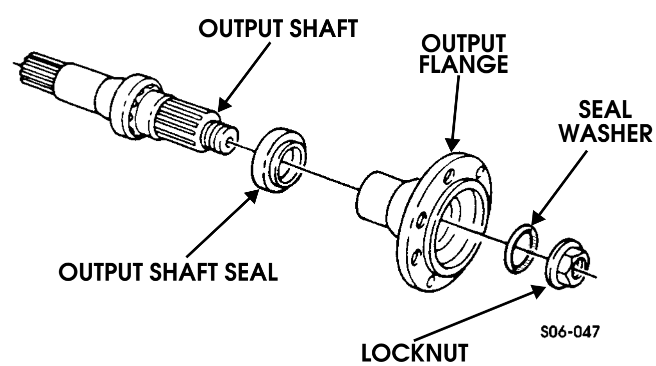


Figure 9-59: Output Shaft Assembly Breakdown

5. Repeat steps 2 through 4 for opposite side.
6. Secure two axle holding fixture adapters to housing with four bolts. Place housing in holding stand (Figure 9-60).

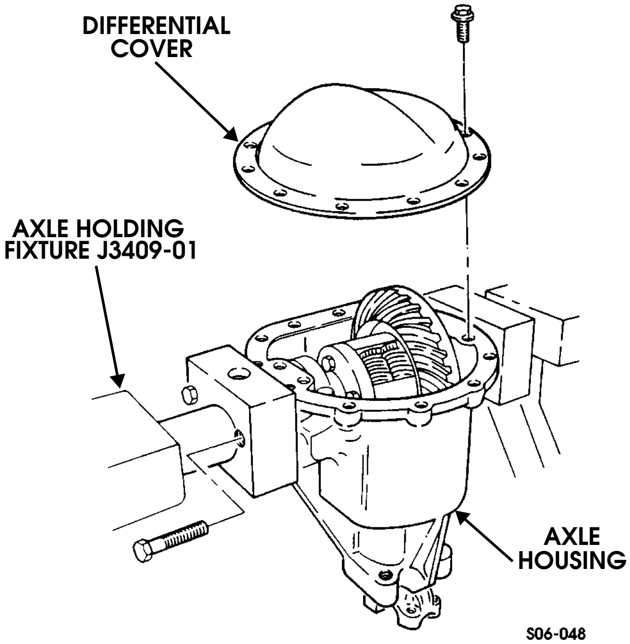


Figure 9-60: Axle Mounted In Holding Fixture

7. Position housing so cover faces up. Remove twelve bolts and cover from housing (Figure 9-60).
8. Mark bearing caps and housing for assembly and remove bearing caps (Figure 9-61).

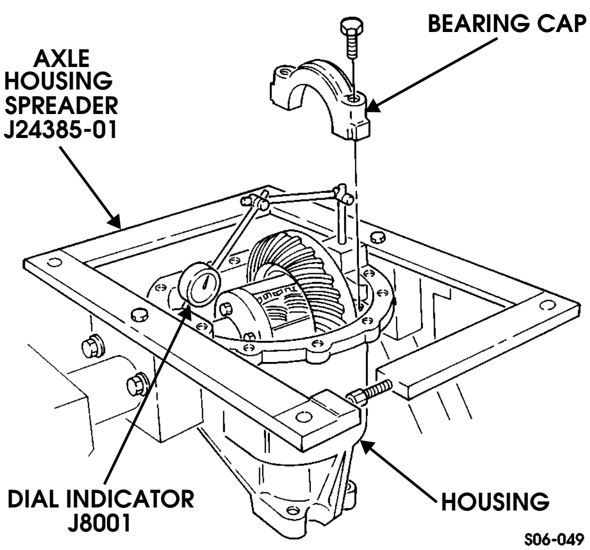


Figure 9-61: Housing Spreader Mounting

9. Install axle housing spreader J3409-01 into holes in axle holding fixture adapters and install dial indicator J8001 to read from each end of housing as shown. Then set dial indicator at 0.020 in. (0.5 mm).

CAUTION: *Over-tightening of axle housing spreader will damage axle housing.*

10. Spread housing 0.010 in. (0.25 mm) and remove dial indicator.
11. Remove differential assembly, two bearing cups, and shims from housing (Figure 9-62). Tag bearing shims and bearing cups for assembly.

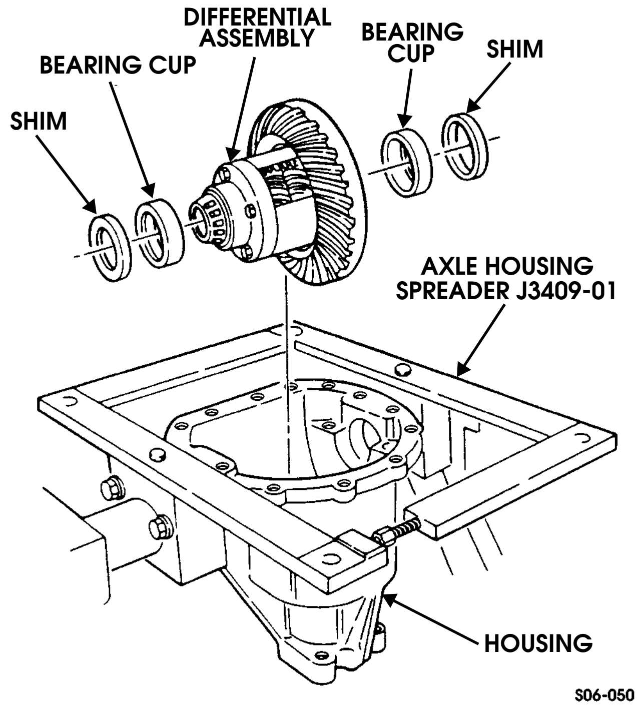


Figure 9-62: Differential Assembly

12. Relieve pressure on axle housing spreader and remove from housing.

CAUTION: *To avoid damage, do not chisel or wedge ring gear from axle assembly.*

13. Remove eight bolts and ring gear from differential assembly (Figure 9-63).

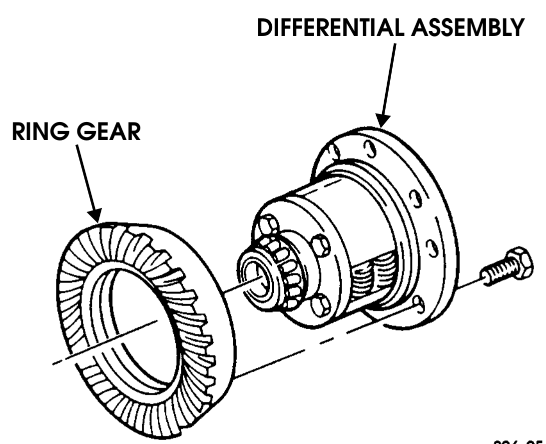


Figure 9-63: Ring Gear Removal

14. Rotate housing 90 degrees. Secure cover to housing with two bolts (Figure 9-64).

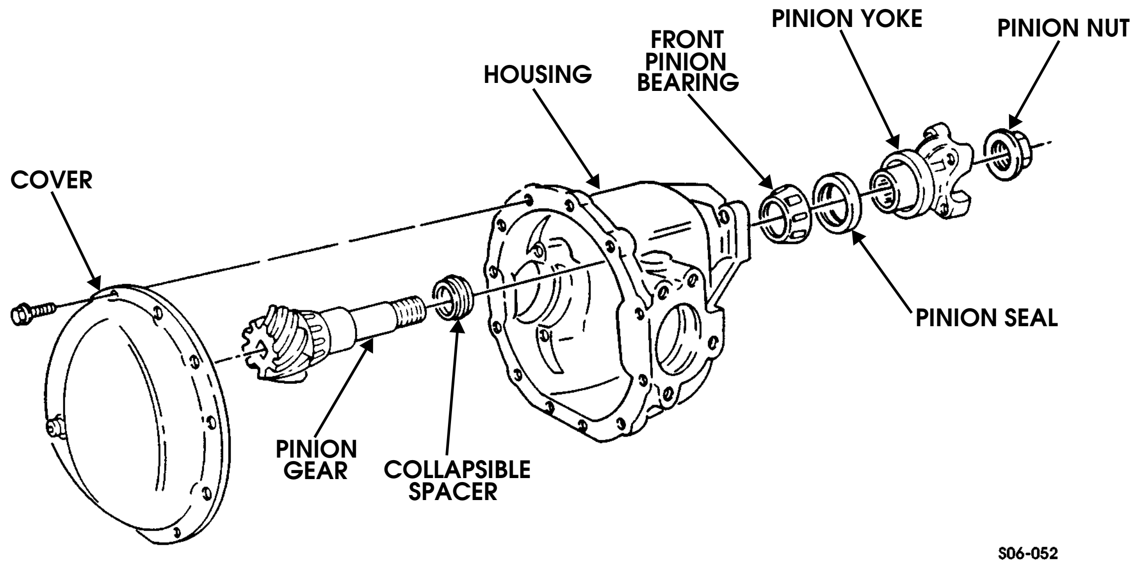


Figure 9-64: Axle Housing

15. Remove pinion nut and pinion yoke from pinion gear.
16. Drive pinion gear out of front pinion bearing.
17. Remove cover, pinion gear, and collapsible spacer from housing. Discard collapsible spacer.
18. Remove pinion seal and front pinion bearing from housing. Discard pinion seal.
19. Rotate front of housing upward 90 degrees. Using driver handle J8092 and bearing cup remover J 21786, remove pinion rear bearing cup and pinion depth shim from housing (Figure 9-65).

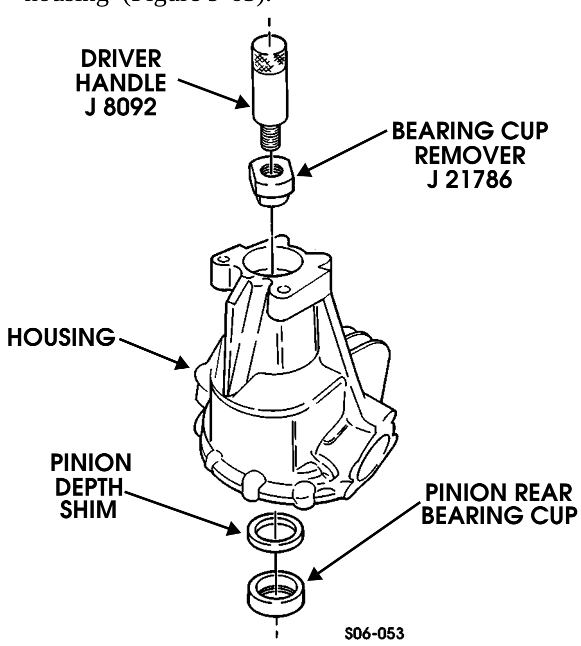


Figure 9-65: Pinion Rear Bearing Cup Removal

20. Rotate housing 180 degrees. Using driver handle J 8092 and pinion front bearing cup remover J 21787, remove front pinion bearing cup from housing (Figure 9-66).

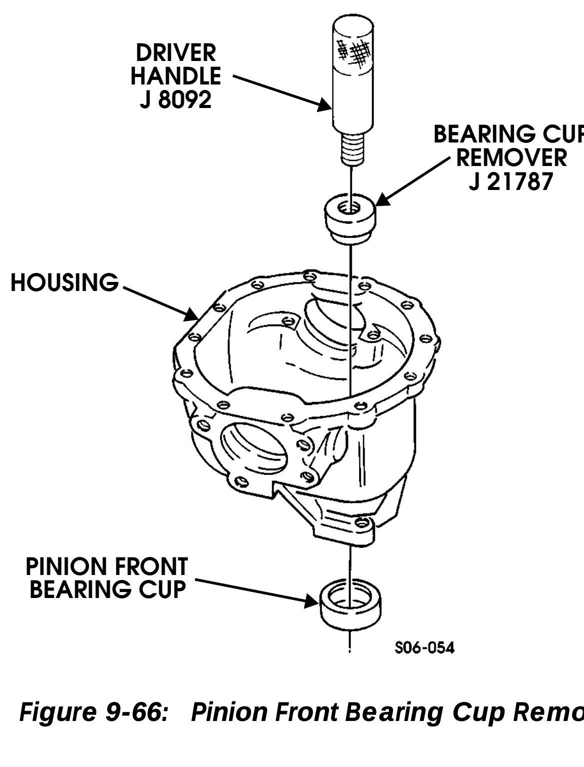


Figure 9-66: Pinion Front Bearing Cup Removal

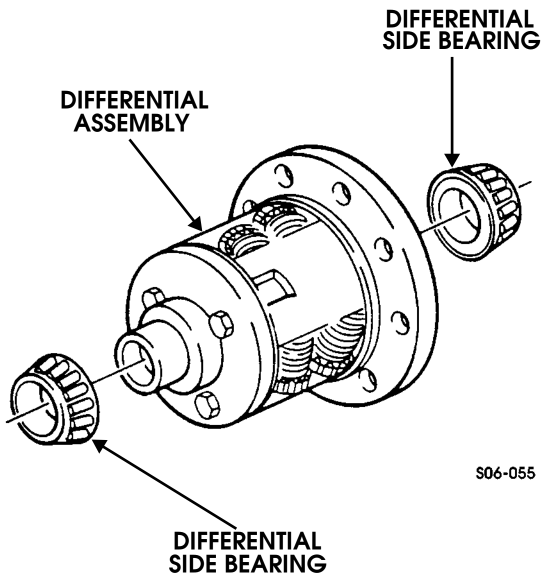


Figure 9-67: Differential Side Bearing Removal

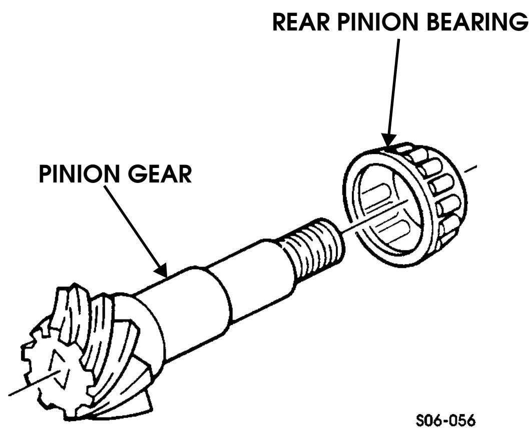


Figure 9-68: Pinion Bearing Removal

21. Remove two differential side bearings from differential assembly (Figure 9-67).
22. Remove rear pinion bearing from pinion gear (Figure 9-68).
23. Remove bearing from output shaft (Figure 9-69).

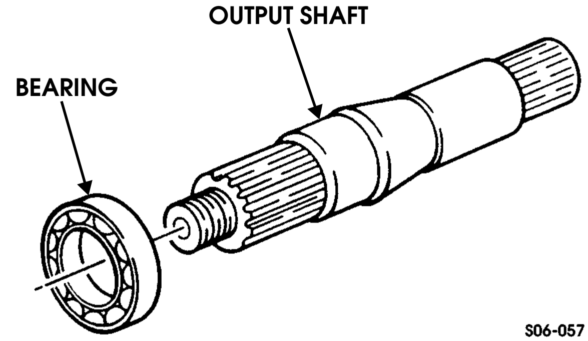


Figure 9-69: Output Shaft Bearing Removal

Cleaning and Inspection

NOTE: Clean all components. Examine for wear or damage and replace if necessary.

1. Inspect housing and all threaded holes for damage. Repair any damaged threads with thread repair inserts. Replace axle assembly if housing is damaged (Figure 9-70).

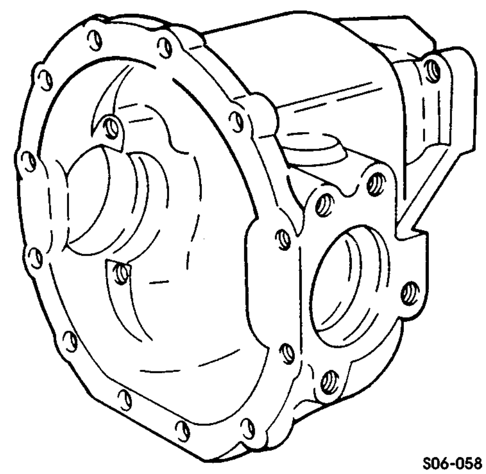


Figure 9-70: Housing

NOTE: Ring and pinion gears must be replaced as matched set.

2. Inspect splines and gear teeth on pinion gear and ring gear for damage. Replace both pinion gear and ring gear if either is damaged (Figure 9-71: and Figure 9-72:).

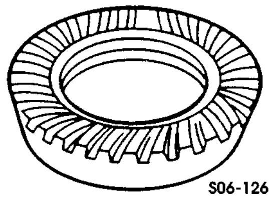


Figure 9-71: Ring Gear

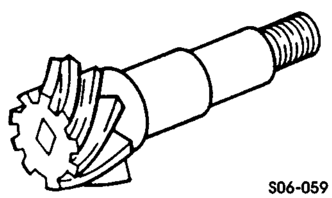


Figure 9-72: Pinion Gear

3. Inspect splines and sealing surfaces on output flanges, pinion yoke, and output shaft for damage (Figure 9-73) through (Figure 9-75).

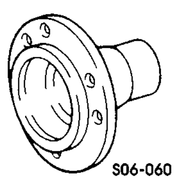


Figure 9-73: Output Flange

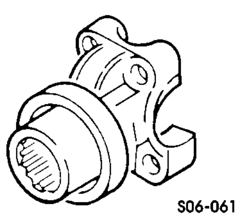


Figure 9-74: Pinion Yoke

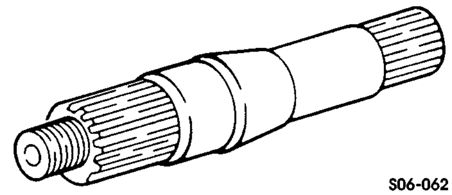


Figure 9-75: Output Shaft

4. Inspect all bearings and bearing cups for damage (Figure 9-76).

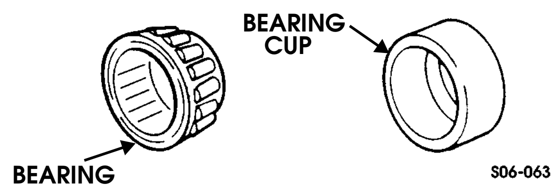


Figure 9-76: Bearing and Bearing Cup

5. Inspect differential assembly case for damage (Figure 9-77).

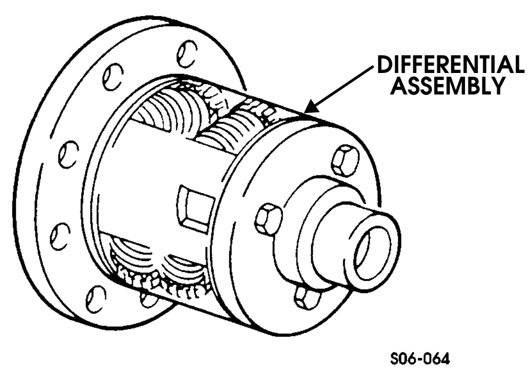


Figure 9-77: Differential Assembly

Axle Assembly

NOTE: PINION DEPTH SETTING: Pinion gear depth is the distance from the end face of the pinion to the center line of the output shafts. The dimension is controlled by shims between pinion gear rear bearing cup and differential housing. The pinion gear is etched with two identifying numbers. The first number identifies ring gear and pinion gear as a matched set, and the second number represents pinion depth variance. The second number is preceded by a plus (+) or minus (-) which represents the amount the gear set varies from the standard setting of 2.547 in. (6.46 cm). If using original gear set, use original pinion depth shim as a starter shim and proceed to step 4.

1. Measure thickness of original pinion depth shim and record for reference (Figure 9-78).

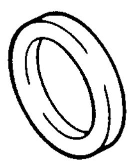


Figure 9-78: Pinion Depth Shim

2. Check pinion depth variance number marked on old and new pinion gears and record (Figure 9-79). Refer to Table 4.

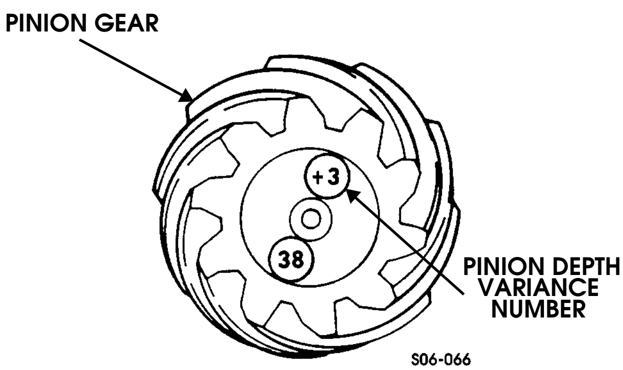


Figure 9-79: Pinion Depth Variance Number Location

NOTE: If the old pinion is marked -3 and the new pinion is marked +2, the procedure would be as follows: Refer to Old Pinion Marking column at left side of table and locate -3 in this column. Then read to right, across table, until under +2 in New Pinion Marking column. The box where two columns intersect is amount of shim thickness change required. In this case, the number in the intersecting box is -0.005 in. (0.13 mm) which represents the amount to be subtracted from the old shim thickness. If the box number had been a (+) figure, this amount would be added to the old shim thickness. The actual pinion depth measurement must be performed and final shim thickness adjusted as necessary. Pinion shims are available from 0.084-0.111 in. (2.13-2.82 mm) in increments of 0.0005 in. (0.0127 mm).

3. Refer to Old and New Pinion Marking columns on pinion variance table. Note on table where old and new pinion depth variances intersect. This will determine amount to be added or subtracted from original pinion depth shim for desired pinion depth starter shim.

Table 4 Pinion Variance Table - Inches (millimeters)

OLD PINION MARKING	NEW PINION MARKING								
	-4	-3	-2	-1	0	+1	+2	+3	+4
+4	+0.008 (0.20)	+0.007 (+0.18)	+0.006 (+0.15)	+0.005 (+0.13)	+0.004 (+0.10)	+0.003 (+0.08)	+0.002 (+0.05)	+0.001 (+0.03)	0 0
+3	+0.007 (+0.18)	+0.006 (+0.15)	+0.005 (+0.13)	+0.004 (+0.10)	+0.003 (+0.08)	+0.002 (+0.05)	+0.001 (+0.03)	0 0	-0.001 (-0.03)
+2	+0.006 (+0.15)	+0.005 (+0.13)	+0.004 (+0.10)	+0.003 (+0.08)	+0.002 (+0.05)	+0.001 (+0.03)	0 0	-0.001 (-0.03)	-0.002 (-0.05)
+1	+0.005 (+0.13)	+0.004 (+0.10)	+0.003 (+0.08)	+0.002 (+0.05)	+0.001 (+0.03)	0 0	-0.001 (-0.03)	-0.002 (-0.05)	-0.003 (-0.08)
0	+0.004 (+0.10)	+0.003 (+0.08)	+0.002 (+0.05)	+0.001 (+0.03)	0 0	-0.001 (-0.03)	-0.002 (-0.05)	-0.003 (-0.08)	-0.004 (-0.10)
-1	+0.003 (+0.08)	+0.002 (+0.05)	+0.001 (+0.03)	0 0	-0.001 (-0.03)	-0.002 (-0.05)	-0.003 (-0.08)	-0.004 (-0.10)	-0.005 (-0.13)
-2	+0.002 (+0.05)	+0.001 (+0.03)	0 0	-0.001 (-0.03)	-0.002 (-0.05)	-0.003 (-0.08)	-0.004 (-0.10)	-0.005 (-0.13)	-0.006 (-0.15)
-3	+0.001 (+0.03)	0 0	-0.001 (-0.03)	-0.002 (-0.05)	-0.003 (-0.08)	-0.004 (-0.10)	-0.005 (-0.13)	-0.006 (-0.15)	-0.007 (-0.18)
-4	0 0	-0.001 (-0.03)	-0.002 (-0.05)	-0.003 (-0.08)	-0.004 (-0.10)	-0.005 (-0.13)	-0.006 (-0.15)	-0.007 (-0.18)	-0.008 (-0.20)

4. Rotate housing so front pinion bearing cup bore faces up (Figure 9-80).

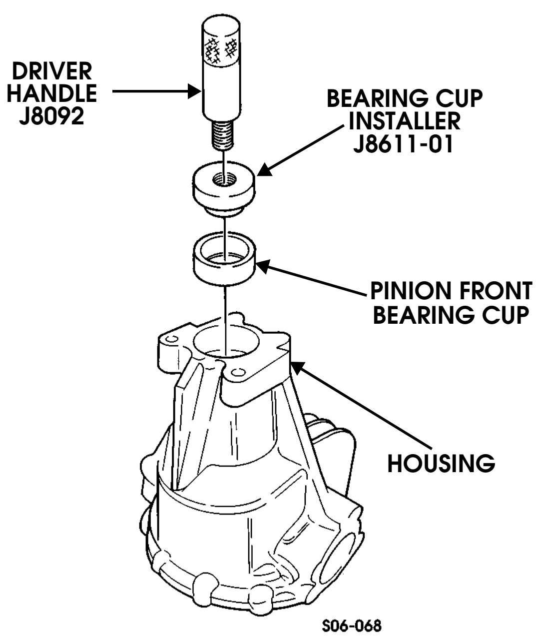


Figure 9-80: Pinion Front Bearing Cup Installation

5. Lubricate outside diameter of front pinion bearing cup with lubricating oil. Using driver handle J 8092 and bearing cup installer J 8611-01, install cup in housing.
6. Install rear pinion bearing on pinion gear (Figure 9-81).

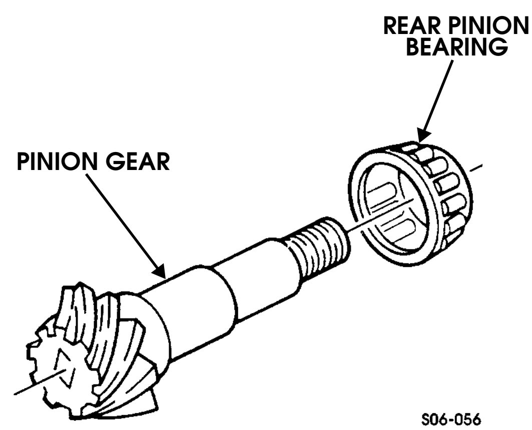


Figure 9-81: Pinion Rear Bearing and Pinion Gear Installation

7. Using pinion setting gauge set, install gauge block, rear pinion bearing cup, rear pinion bearing, and pilot washer on stud and secure with gauge block from set J39524 (Figure 9-82).

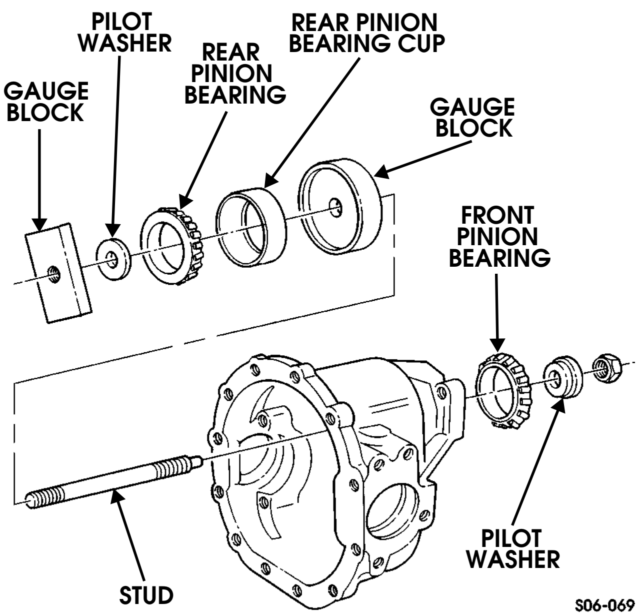


Figure 9-82: Pinion Depth Setting Gauge Installation

8. Position stud assembly in housing and secure with front pinion bearing, pilot washer, and nut. Tighten nut to 10 lb-in (1.1 N•m). Rotate the assembly several revolutions to seat the bearing and recheck the torque.
9. Rotate front of housing downward 90 degrees. Assemble arbor and two discs and install in housing (Figure 9-83).
10. Install two bearing caps and four bolts in housing and finger tighten bolts.
11. Install the dial indicator on the arbor post. Push the dial indicator downward until the needle rotates approximately one full turn clockwise. Tighten the dial indicator in this position and recheck.

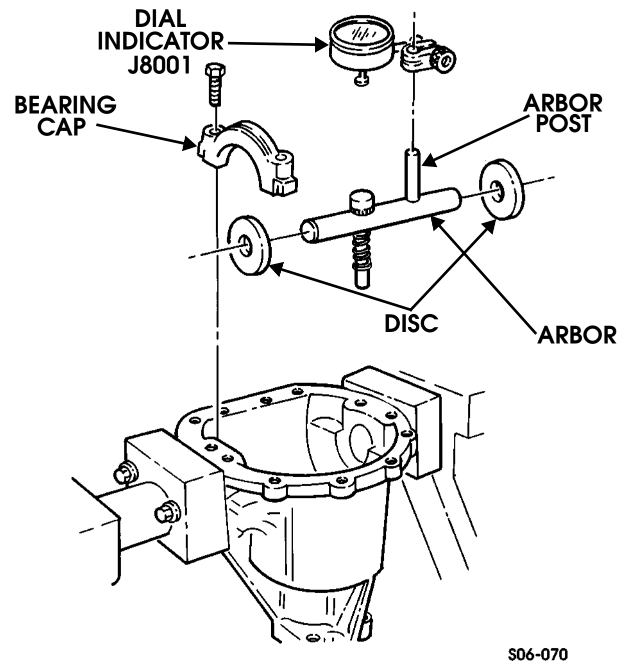


Figure 9-83: Positioning J39524 Arbor and Discs In Housing

12. Rotate the gauge shaft slowly back and forth until the dial indicator reads the greatest deflection. At the point of greatest deflection, set the dial indicator to zero. Repeat the rocking action of the gauge shaft to verify the gauge setting (Figure 9-84).

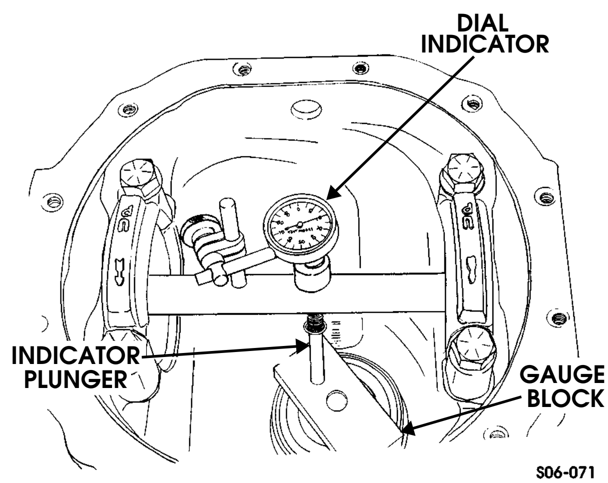


Figure 9-84: Gauge Setting

13. After the zero setting is obtained, rotate the gauge shaft until the dial indicator plunger does not touch the gauge block.
14. Record the dial indicator reading. Example: If the pointer moved counterclockwise and stops between 0 and 11, add

100 inches to measurement for shim thickness. If the pointer moves counterclockwise and stops between 84 and 99, correct shim thickness is indicated.

15. This reading indicates the shim thickness required for a pinion etched with a zero (0) on the pinion head. If the pinion being installed has a plus (+) or minus (-) etching, then an adjustment of the shim thickness is required. Example: If a pinion is etched +3, then 0.003 inches less shim thickness is required. Subtract 0.003 inches from the indicator reading. If a pinion is etched -3, then 0.003 inches more shim thickness is required. Add 0.003 inches to the indicator reading.
16. Remove dial indicator from arbor (Figure 9-83).
17. Remove four bolts, two bearing caps, discs, and arbor from housing.
18. Remove nut, pilot washer, front pinion bearing, and stud assembly from housing (Figure 9-85).

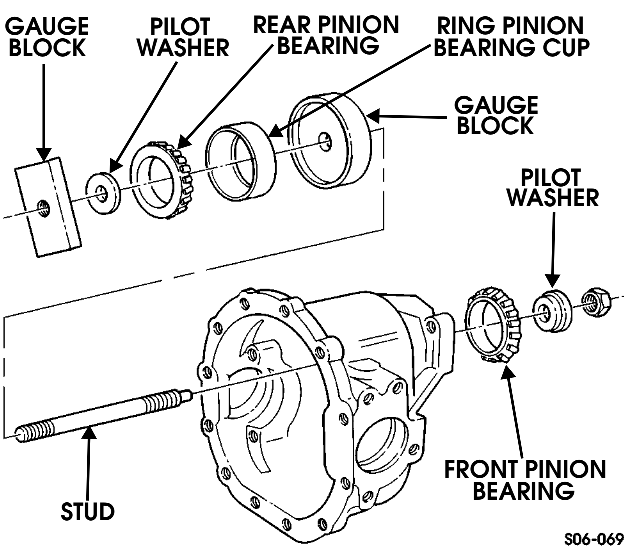


Figure 9-85: Pinion Front Bearing and Depth Tool Removal

19. Remove gauge block, pilot washer, rear pinion bearing, rear pinion bearing cup, and gauge block from stud.
20. Note pinion depth variance marked on pinion gear. If number is preceded by a plus (+) sign, add that amount in thousands to standard setting of 2.547 in. (6.46 cm). If number is preceded by minus (-) sign, subtract that amount in thousands from standard setting of 2.547 in. (6.46 cm). The result of this addition or subtraction is desired pinion depth. Record for reference (Figure 9-86).

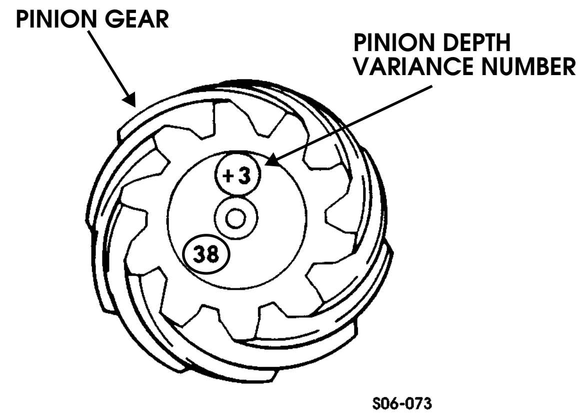


Figure 9-86: Pinion Depth Variance Number Location

21. Subtract desired pinion depth (step 14) from total measured pinion depth (step 15). Result of this subtraction is correct pinion depth shim thickness.
22. Lubricate pinion front bearing and pinion seal with gear oil. Using yoke seal installer, install pinion front bearing and pinion seal in housing (Figure 9-87).

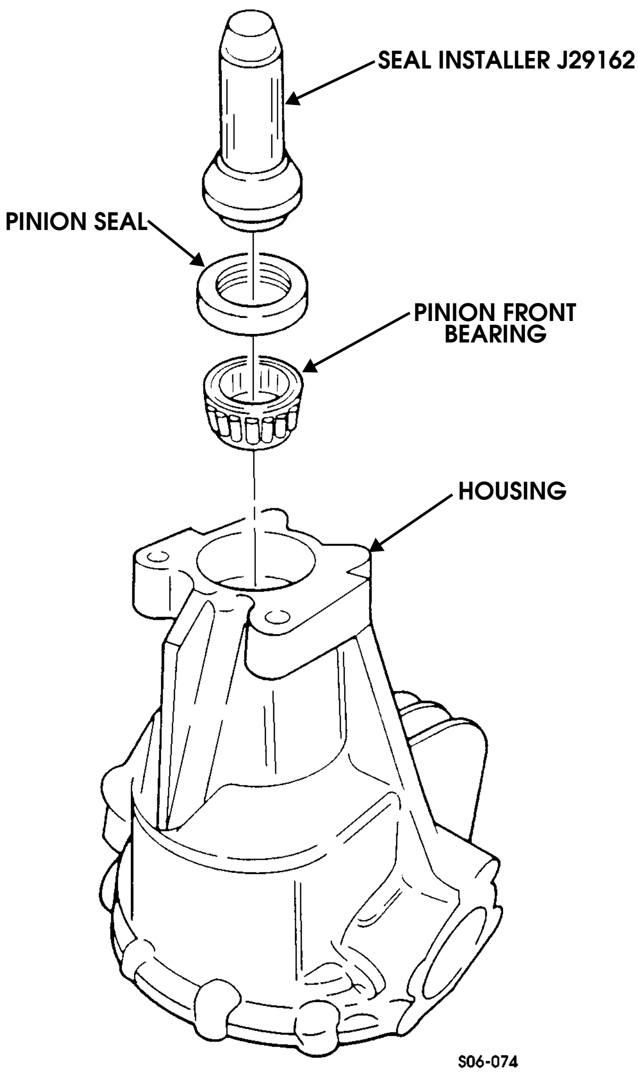


Figure 9-87: Pinion Seal Installation

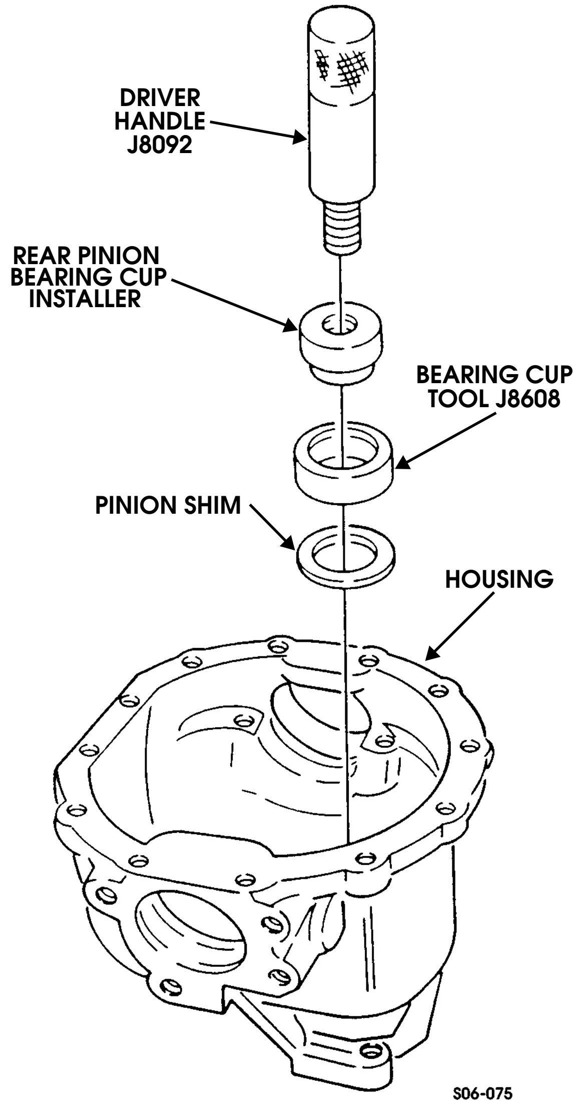


Figure 9-88: Pinion Rear Bearing Installation

23. Rotate housing 180 degrees. Lubricate outside diameter of pinion rear bearing cup with gear oil (Figure 9-88).

NOTE: If pinion shim is beveled, be sure beveled side faces bottom of bearing cup bore.

24. Using driver handle J8092 and bearing cup installer J8608, install correct thickness pinion shim and pinion rear bearing cup in housing.
25. Rotate housing 90 degrees. Lubricate rear pinion bearing with gear oil (Figure 9-89).

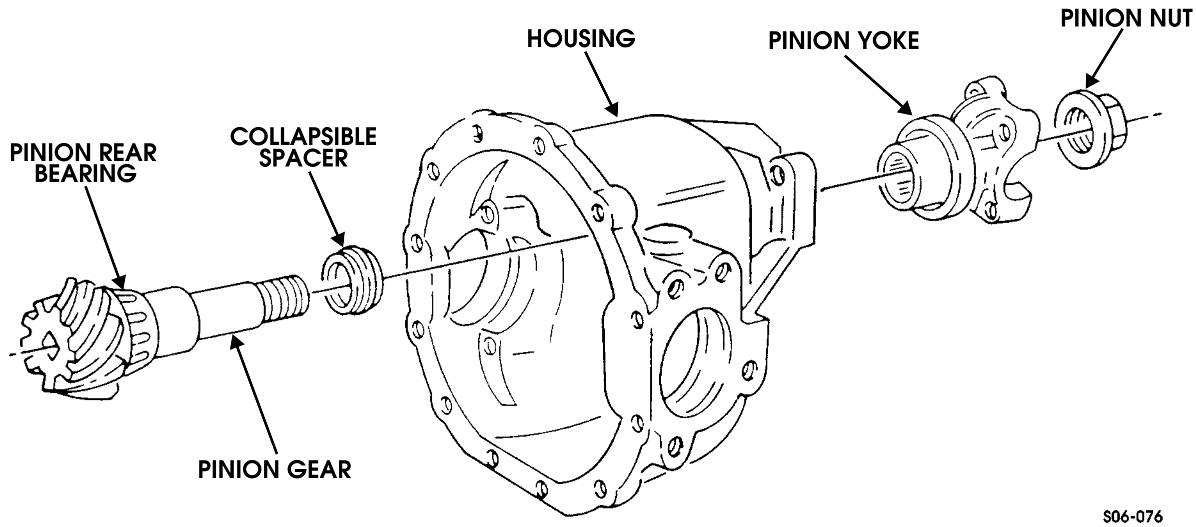


Figure 9-89: Rear Pinion Bearing Location

CAUTION: *Collapsible spacer controls pinion bearing preload. Do not reuse old spacer, or pinion bearing damage may result.*

26. Install collapsible spacer on pinion gear and install pinion gear in housing.
27. Install pinion yoke on pinion gear with pinion nut.

CAUTION: *Do not exceed specified preload torque on pinion bearings. Do not loosen locknut to relieve the preload torque or pinion bearing damage may result. If specified torque is exceeded, remove pinion gear and replace collapsible spacer and locknut and adjust preload again.*

28. Tighten pinion nut only enough to remove end play and seat pinion bearings in housing. Rotate pinion yoke while tightening to seat bearings evenly.
29. Measure torque required to rotate pinion gear. Correct pinion bearing preload torque is 17-25 lb-in (2-3 N•m) with new bearings and 10-15 lb-in (1-2 N•m) with used bearings.
30. Continue to tighten pinion nut in small increments until pinion bearing preload torque meets specifications.
31. Install two side bearings on differential assembly (Figure 9-90).

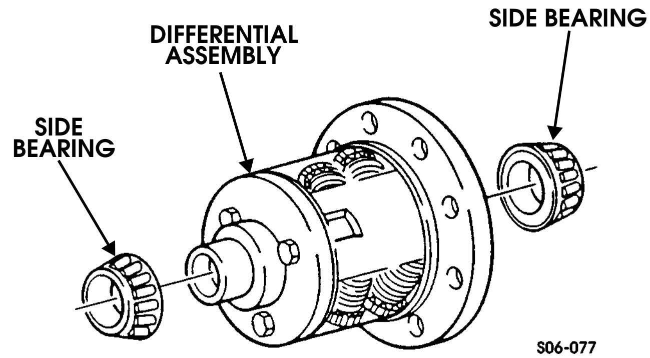


Figure 9-90: Side Bearing Installation

NOTE: Side bearing shims are available in thickness from 0.077-0.117 in. (1.96-2.97 mm) in increments of 0.001 in. (0.025 mm).

32. Rotate housing downward 90 degrees. Install side bearing cups and side bearing shims on side bearings. Use 0.080 in. (2 mm) shims as a starting point (Figure 9-91).

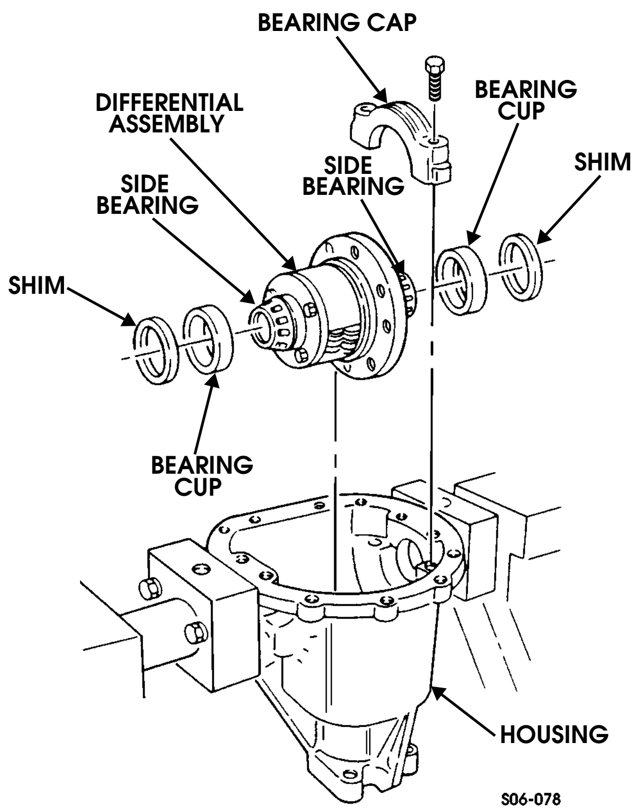


Figure 9-91: Side Bearing Cup and Shim Installation

33. Install differential assembly, bearing cups, and shims in housing.
34. Install two bearing caps and four bolts in housing. Snug bolts.
35. Mount dial indicator on housing and position indicator to read off ring gear mounting surface of differential assembly (Figure 9-92).

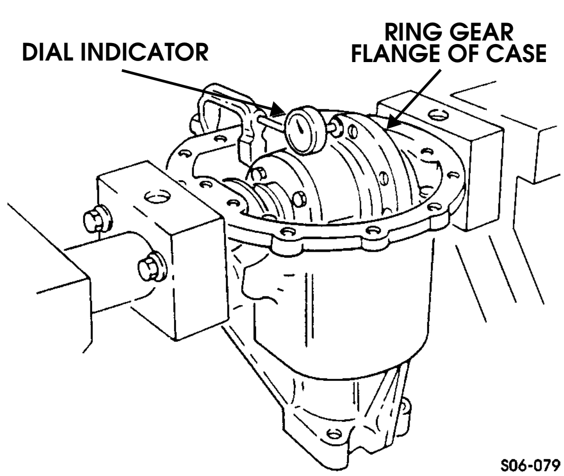


Figure 9-92: Dial Indicator Positioning For Case Runout Check

36. Pry between differential assembly and bearing cap on one side of indicator. Pry on opposite side to read end play.
37. Amount read on indicator is shim thickness that should be added to side bearing shims to arrive at zero end play. Add necessary shims and repeat procedure to ensure accuracy.

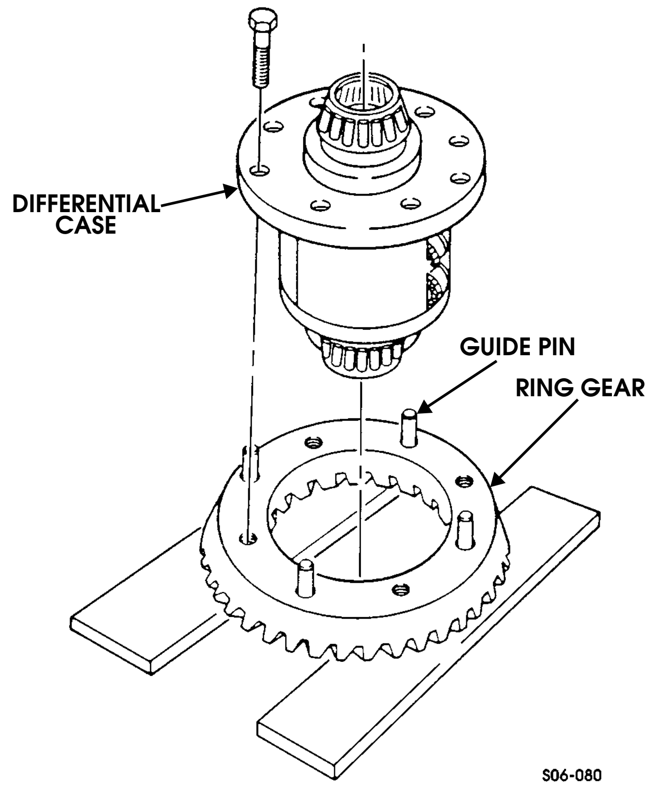


Figure 9-93: Ring Gear Guide Pin Installation

38. Tighten four bolts to 55-70 lb-ft (75-95 N•m).
39. Rotate differential assembly and check runout. Runout should not exceed 0.002 in. (0.05 mm).
40. Remove dial indicator from housing.

NOTE: Tag shims and bearing cups for assembly.

41. Remove four bolts, two bearing caps, bearing cups, shims, and differential assembly from housing (Figure 9-94).
42. Install four guide pins in ring gear (Figure 9-93).

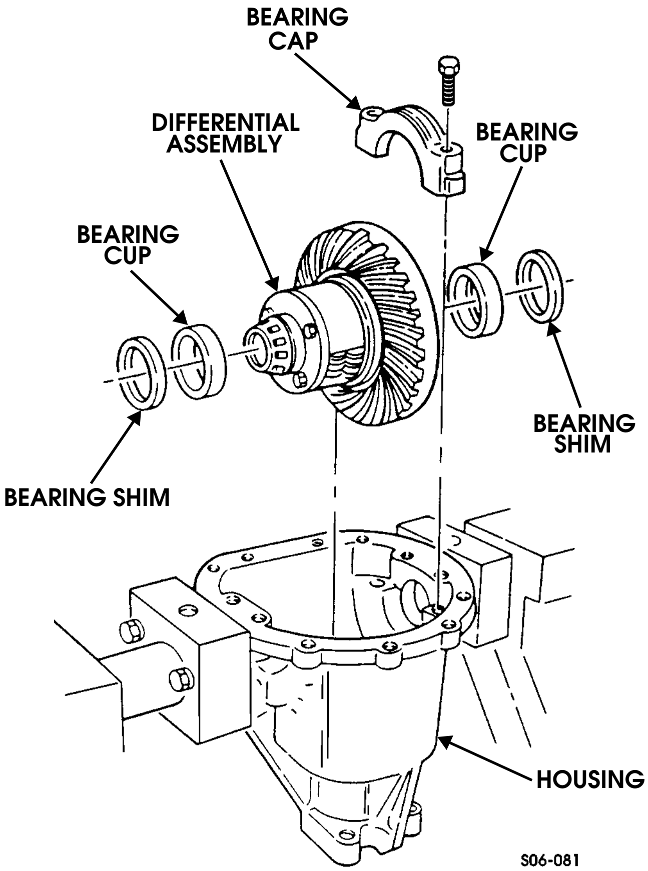


Figure 9-94: Differential Assembly Mounting

43. Support ring gear with wood blocks in press.
44. Press differential assembly on ring gear.
45. Remove four guide pins from ring gear.
46. Install ring gear on differential assembly with eight bolts. Tighten bolts to 95-115 lb-ft (129-156 N•m).
47. Install side bearing shims, previously selected to remove differential assembly side play, slide bearing cups, and differential assembly in housing (Figure 9-94).
48. Install two bearing caps in housing with four bolts. Tighten bolts to 55-70 lb-ft (75-95 N•m).
49. Attach dial indicator to housing and position indicator to read off drive side of ring gear tooth at a right angle (Figure 9-95).

NOTE: Backlash must be checked at four equally spaced points on ring gear and must not vary more than 0.002 in. (0.05 mm) between four points checked.

50. Move ring gear back and forth while holding pinion yoke stationary. Note backlash registered on indicator.
51. Ring gear backlash should be 0.005-0.009 in. (0.13-0.23 mm) with 0.008 in. (0.20 mm) desired. If backlash must be adjusted perform steps 52 through 55, if not go to step 56.

NOTE: Tag shims and bearing cups for assembly.

52. Remove four bolts, two bearing caps, bearing cups, shims, and differential assembly from housing (Figure 9-94).

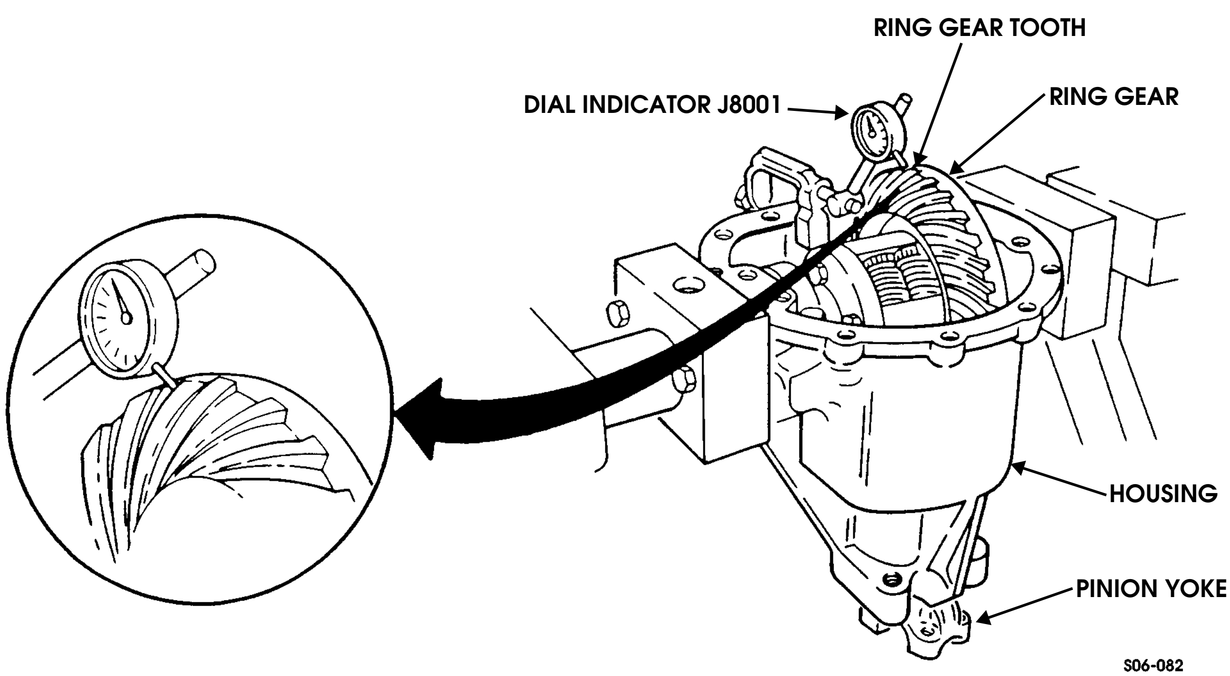


Figure 9-95: Checking Ring Gear Backlash

NOTE: The following example will explain the procedure for adjusting backlash: If side play was removed using 0.090 in. (2.29 mm) shims on each side totaling 0.180 in. (4.57 mm) and backlash, when checked, is found to be 0.011 in. (0.28 mm), add 0.004 in. (0.10 mm) to shim on ring gear side and subtract 0.004 in. (0.10 mm) from shim on opposite side to correct backlash. This will result in 0.094 in. (2.39 mm) shim on ring gear side and 0.086 in. (2.18 mm) shim on other side. Backlash will be approximately 0.007-0.008 in. (0.18 to 0.20 mm). Total Shim Thickness remains 0.180 in. (4.57 mm).

53. To increase backlash, install thinner shim on ring gear side and thicker shim on opposite side. To decrease backlash, install thicker shim on ring gear side and thinner shim on opposite side. Do not change total shim thickness.
54. Install shims, bearing cups, differential assembly, and bearing caps in housing and secure with four bolts. Tighten bolts to 55-70 lb-ft (75-95 N•m).
55. Mount dial indicator and recheck backlash. If necessary, repeat steps 52 through 54.
56. Remove four bolts, bearing caps, bearing cup, shims, and differential assembly from housing. Tag shims and bearing cup for assembly.
57. Install axle housing spreader into holes in axle holding fixture adapters and install dial indicator to read from each end of housing. Indicator must have preload setting of 0.020 in. (0.50 mm) (Figure 9-96).

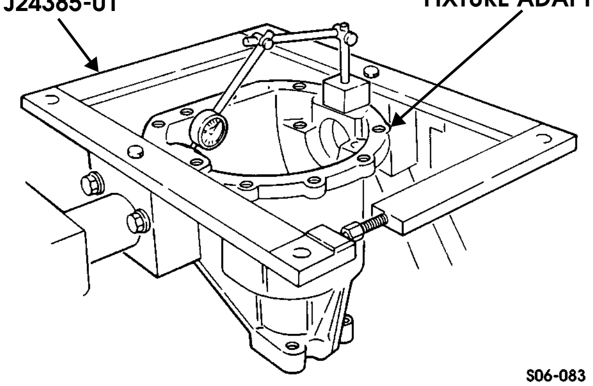


Figure 9-96: Axle Housing Spreader Mounting

CAUTION: *Over-spreading of axle housing will damage housing.*

58. Spread housing 0.010 in. (0.25 mm) and remove dial indicator.

NOTE: Differential bearings must be preloaded to compensate for heat and loads during operation.

59. Preload differential side bearings by increasing shim thickness at each side of differential assembly by 0.004 in. (0.10 mm) for a total bearing preload of 0.008 in. (0.20 mm) (Figure 9-94).
60. Lubricate side bearings with gear oil and install differential assembly, bearing cups, shims, and bearing caps in housing and secure with four bolts (Figure 9-94).

NOTE: Preloaded differential bearings may change backlash setting. Check and correct backlash if necessary.

61. Remove housing spreader and tighten bolts to 55-70 lb-ft (75-95 N•m).
62. Apply silicone sealant to cover sealing surface and secure cover to housing with twelve bolts. Tighten bolts to 16 lb-ft (22 N•m) (Figure 9-97).

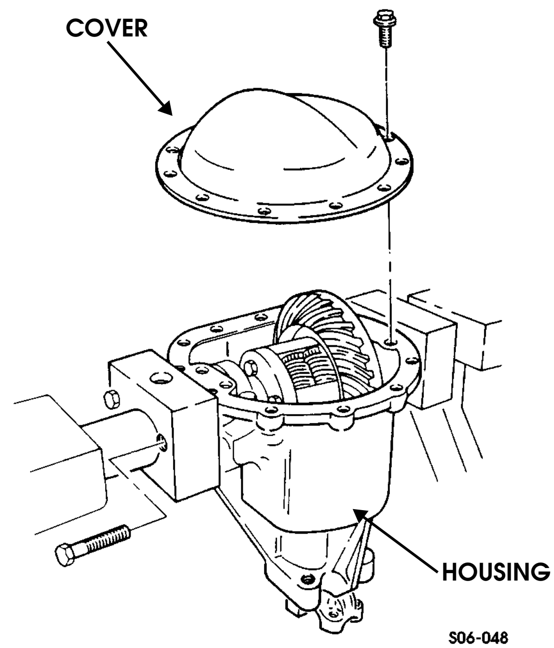


Figure 9-97: Housing Cover Installation

63. Remove housing from holding fixture.
64. Remove four bolts and two axle holding fixture adapters from housing.
65. Using press, install output shaft bearings on output shafts (Figure 9-98).

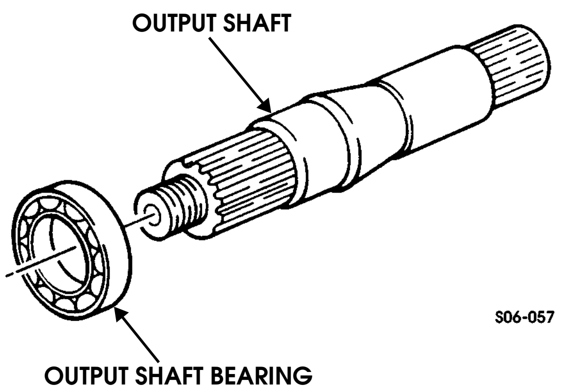


Figure 9-98: Bearing Installation

66. Using axle shaft and seal installer J33142, install output shaft assemblies into axle assembly (Figure 9-99).

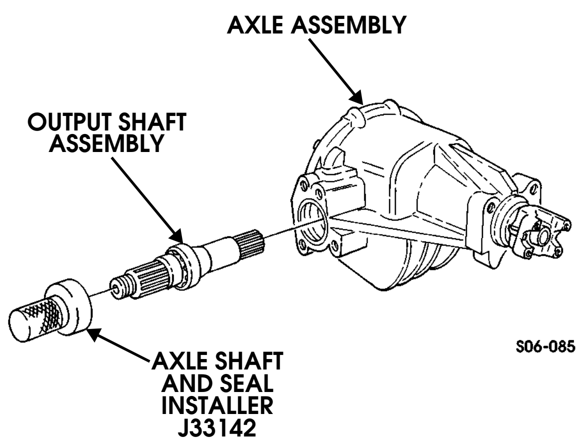


Figure 9-99: Axle Shaft And Seal Installer Usage

67. Using axle shaft and seal installer J33142, install output shaft seals in axle assembly (Figure 9-100).

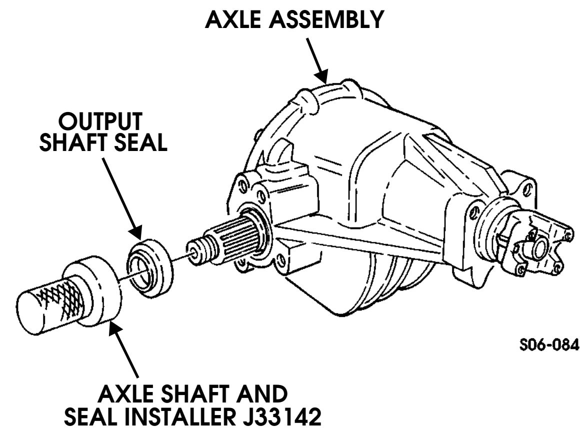


Figure 9-100: Output Shaft Seal Installation

68. Lubricate sealing surface on output flanges with lubricating oil (Figure 9-101).

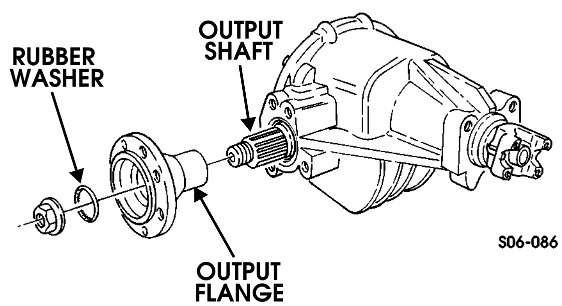


Figure 9-101: Output Shaft Seal Installation

69. Install two output flanges, two seals, and two locknuts on output shafts. Finger tighten locknuts.
70. Install axle assembly.

DETROIT LOCKER DIFFERENTIALS (FLEET ONLY)

WARNING: All NoSPIN/Detroit Locker differential equipped vehicles must be identified by a Caution label, mounted on the instrument panel. A label is supplied with each unit. Contact Tractech if this label was not received.

WARNING: Do not operate the vehicle if both wheels of a NoSPIN/ Detroit Locker differential equipped axle are not driving. Power to only one wheel can cause serious steering problems.

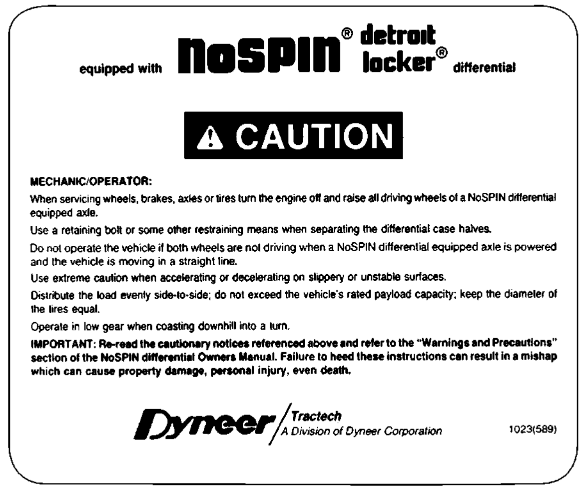
WARNING: Use extreme caution when accelerating or decelerating on slippery or unstable surfaces. Vehicles equipped with traction differentials are inherently more sensitive to side-slip than vehicles equipped with conventional differentials.

WARNING: Distribute the load evenly side-to-side; do not exceed the vehicle's rated payload capacity; keep the diameter of the tires equal. Failure to observe these measures can create a difference in individual wheel speeds which can cause the NoSPIN/Detroit Locker differential to deliver power to only one side of the vehicle and thus cause steering problems.

WARNING: Turn the engine off and raise all driving wheels of a NoSPIN/Detroit Locker differential equipped axle when changing tires to prevent the vehicle from moving. Axles equipped with NoSPIN/Detroit Locker differentials deliver power to both wheels - even when only one wheel is on the ground.

WARNING: Operate in low gear when coasting downhill into a turn. Braking capacity is reduced when a NoSPIN/Detroit Locker differential equipped vehicle makes a turn while coasting downhill because the inside wheel is then disconnected from the driveline.

The objective of differential gearing in most wheeled vehicles is to transmit power (torque) from the engine to the drive axles. It also permits wheels to run ahead or lag behind as required to make turns or overcome obstructions without causing tire scuffing or steering difficulties.


equipped with NoSPIN® detroit locker® differential

CAUTION

MECHANIC/OPERATOR:

When servicing wheels, brakes, axles or tires turn the engine off and raise all driving wheels of a NoSPIN differential equipped axle.

Use a retaining bolt or some other restraining means when separating the differential case halves.

Do not operate the vehicle if both wheels are not driving when a NoSPIN differential equipped axle is powered and the vehicle is moving in a straight line.

Use extreme caution when accelerating or decelerating on slippery or unstable surfaces.

Distribute the load evenly side-to-side; do not exceed the vehicle's rated payload capacity; keep the diameter of the tires equal.

Operate in low gear when coasting downhill into a turn.

IMPORTANT: Re-read the cautionary notices referenced above and refer to the "Warnings and Precautions" section of the NoSPIN differential Owners Manual. Failure to heed these instructions can result in a mishap which can cause property damage, personal injury, even death.

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Figure 9-102: NoSPIN Detroit Locker Label

Conventional Differential

The conventional differential (also called "open" or "standard" differential divides power at the ring gear equally between the two axle half shafts. As long as the vehicle has equal traction under both wheels, the conventional differential performs its function efficiently and economically.

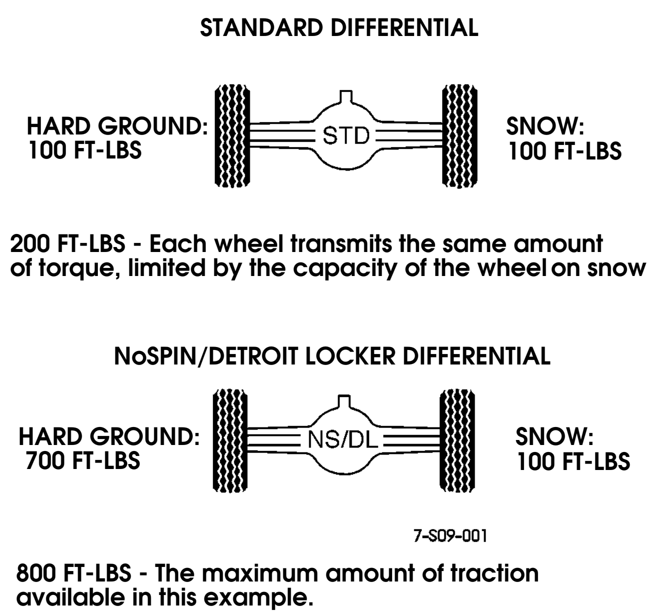

Figure 9-103: NoSPIN Differentials Increase Traction

With a conventional differential, traction is limited by the spinning wheel. But, with a NoSPIN differential, maximum traction is available to both wheels. If one wheel loses traction, the opposite wheel will still drive the vehicle (Figure 9-104).

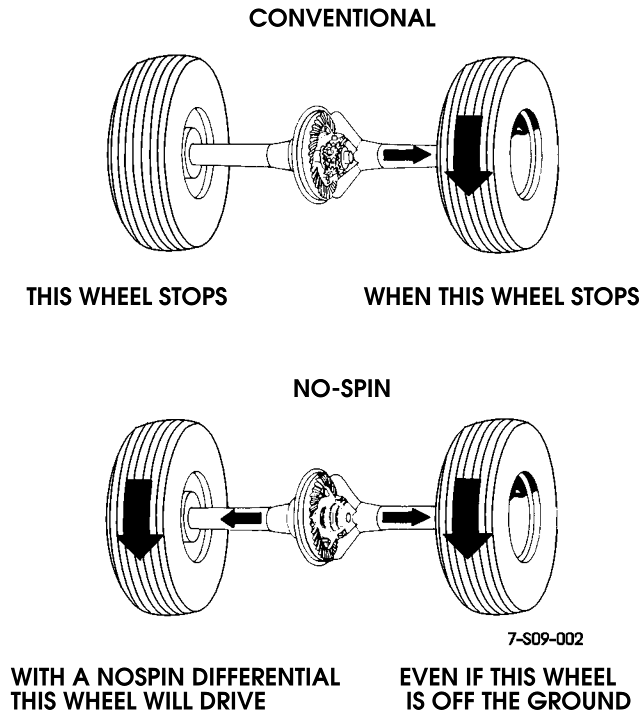

Figure 9-104: Maximum Traction To Both Wheels

MAINTENANCE OF THE NO-SPIN DIFFERENTIAL

WARNING: When servicing any driveline components of a NoSPIN differential equipped axle, ensure that the engine is switched off and all wheels are free of the ground to prevent the vehicle from moving. Axles equipped with NoSPIN/Detroit Locker differentials deliver power to both wheels- even when only one wheel is on the ground. Failure to observe these cautionary measures may cause the vehicle to move which can result in a mishap which can cause property damage, personal injury, even death.

Lubrication

All NoSPIN differentials are designed to operate in those lubricants recommended by the vehicle/axle manufacturer. No special lubricant is needed. For very cold weather applications, use the lightest oil the axle manufacturer will allow to overcome possible sluggish re-engagement of the driven clutch assemblies.

Routine Inspection

Carefully follow the recommended lubrication, preventative maintenance and inspection procedures of the vehicle/axle manufacturer as part of all NoSPIN differential preventative maintenance. Except for testing for proper operation, and a possible change in the way brake adjustments are made (as explained below), maintenance, inspection and lubrication requirements of NoSPIN differential equipped vehicles are the same as for vehicles with standard differentials.

Check for Proper Operation of NoSPIN Differential

At 90 day intervals, the drive axles should be raised and the NoSPIN differential checked to be sure it is operating properly. This test will also determine if both axle shafts are intact.

Adjustments

No adjustments or alterations should be made to the NoSPIN differential. Refer to the vehicle/axle manufacturers instructions for adjustments to other components in the axle.

When making brake adjustments, the wheels on both sides of the vehicle must be raised and the transmission placed in neutral so that the ring gear and opposite wheels are free to rotate with the wheels on the side being adjusted.

Disassembly of the NoSPIN Differential

1. Mark the differential case halves so they can be reassembled in their original position when repair or inspection is completed.
2. Insert the NoSPIN differential retaining bolt and washer assembly. Thread the nut finger tight against the washer. If a retaining bolt and washer assembly is not available, hold the differential case firmly as the last bolts are being removed from the case halves to absorb spring pressure and prevent possible injury.
3. Separate the case halves and remove the NoSPIN differential assembly.
4. Release the retaining bolt and washer assembly while firmly holding the NoSPIN differential to absorb the spring pressure.
5. Remove side gears, springs, spring retainers, driven clutch assemblies and spider (or central driver) assembly.

Inspection of Parts

1. Wash all parts thoroughly with a nonflammable solvent that will not etch, scratch, or oxidize the parts. Rinse in clean solvent and dry.
2. Inspect the splines on the driven clutches. Remove any burrs or small chips with an abrasive stone or electric burr grinder. If sections of the spline are broken away, replace the parts.

Inspect the teeth on the driven clutches, if wear or chipping is present, replace the part.

Check holdout rings for fractures and chipping or excessive wear of the teeth. Replace as required.

NOTE: The holdout ring and driven clutch are serviced as an assembly.

3. Inspect the teeth on the spider (or central driver) and center cam. If wear or chipping is present, replace the part.

   Check the center cam for free movement.

NOTE: The spider and center cam are serviced as an assembly.

4. Inspect the splines on the side gears. Remove any burrs or small chips. If splines are broken or badly chipped, or if hub walls are fractured, replace the part.

   Inspect the side gear spline fit on its mating axle shaft. Be sure the splines do not bind.
5. Check the spring load at the operating height.
6. Carefully examine the differential case. If worn or scored, the case should be replaced.
7. Examine the bearings, ring gear, ring gear bolts and nuts. Replace if necessary with new parts that meet the vehicle/axle manufacturer's specifications.

WARNING: If major components (e.g. spider assembly or driven clutch assemblies) show excessive wear, the complete NoSPIN differential should be replaced. If a part is replaced, mating parts should also be replaced because it is likely that they too are damaged. Use of worn or damaged components can lead to a recurrence of the original problem. Use only Tractech approved parts when repairing NoSPIN/Detroit Locker differentials.

Reassembly Procedure for NoSPIN Differentials

1. Assemble spring retainer over the side gear splines with the retaining lip pointed up. It should seat against the side gear shoulder.

   Place a spring over the side gear spline and against the retainer lip with the smaller diameter of the spring against the retainer (Figure 9-105).

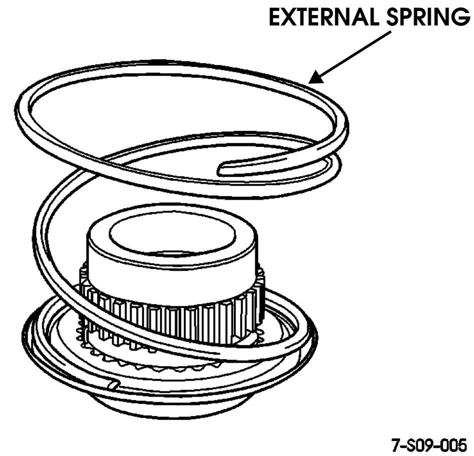

Figure 9-105: External Spring

NOTE: Verify that the spring is functioning freely. Be sure the spring is not binding, that the coils do not overlap and that there is good contact between the end coil and the spring retainer.

2. Assemble the two clutch assemblies to the spider assembly.

NOTE: Be sure the "slot" in each holdout ring is properly aligned over the long tooth of the spider assembly.

3. Position the spider assembly and clutch assembly on top of the spring (Figure 9-106).

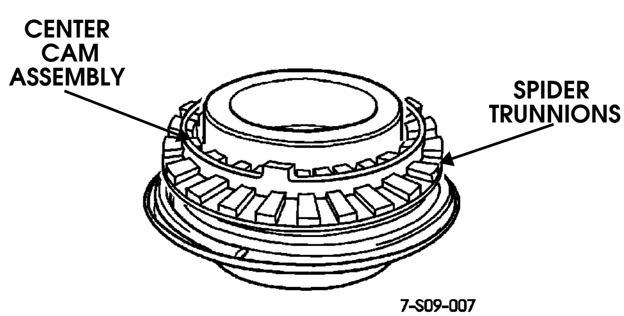

Figure 9-106: Driven Clutch Assembly

4. Assemble the other retainer and spring on the other side gear as previously indicated, and position on top of the spider and clutch assembly.

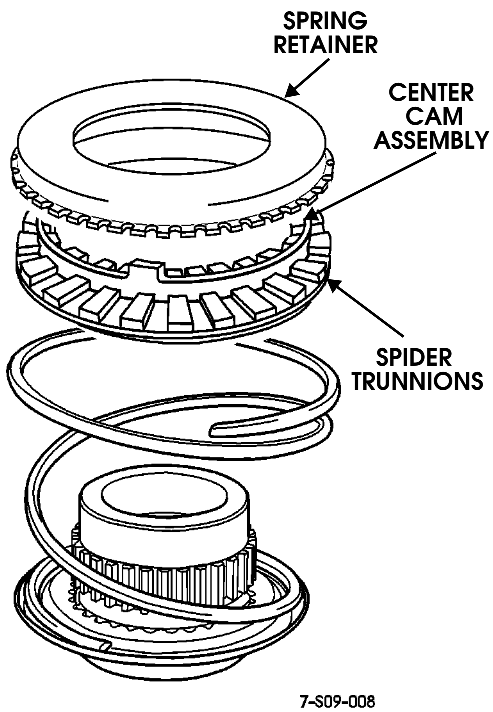

Figure 9-107: Spring Retainer

5. Using a mechanical press (or other safe means) compress the springs and fasten the NoSPIN together with a retaining bolt washers and wing nut. Be sure the side gear splines are completely meshed with the clutch spline.

WARNING: Failure to use a retaining bolt or some other restraining means when assembling the NOSPIN can cause injury because all NoSPIN differentials have compressed springs.

6. Lay the ring gear and flanged half of the differential case on a bench with the bearing end of the case hub down and the inner case facing upward. BE SURE NO THRUST WASHERS ARE INSIDE THE CASE.
7. Install the NoSPIN differential in the flanged differential case half.
8. Mount the plain case halves firmly together with the punch marks aligned and install the case bolts.
9. Position the case halves firmly together with the punch marks aligned and install the case bolts.
10. Tighten case bolts to the torque specified by the vehicle/ axle manufacturer. Check to be certain of a tight fit between the two case halves at all points and between the trunnion mounts in the case and the spider trunnions.

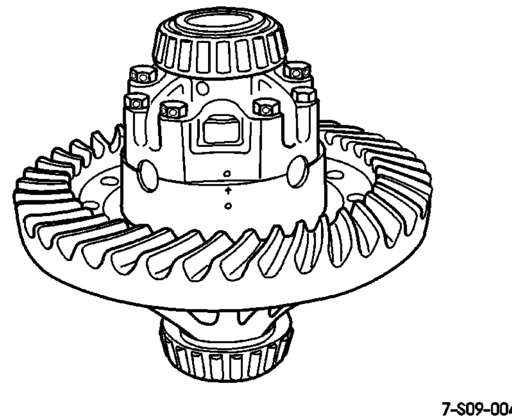

Figure 9-108: Differential Assembly

11. Remove the wing nut, washers and retainer bolt.
12. Follow the vehicle/axle manufacturer's instructions for reinstallation of the ring gear and differential case assembly into the axle carrier.

NOTE: Before operating the vehicle, perform installation and operation test to ensure correct reassembly of components.

Application Guidelines

Adhere to the following guidelines and recommendations when using NoSPIN differentials.

NOTE: Any increase in the size of the vehicle's engine, tires, weight, etc..., may prohibit use of a NoSPIN differential in a previous approved application. Any such modification should be reviewed by Tractech Engineering before continuing to use the product.

NOTE: The NoSPIN Differential does not increase the load-carrying capacity or payload rating of the vehicle or vehicle combination.

The following chart will help owners and operators of NoSPIN differential equipped vehicles diagnose and correct problems related to vehicle performance. Potential problems are stated on the left; possible causes for those problem are listed, by number, on the right. The explanation of these "possible causes" are listed following the chart.

NOTE: NoSPIN differentials will emit occasional "metallic" sounds due to backlash built into the unit. This is normal.

Table 1 Diagnosing vehicles equipped with NoSPIN differentials

Problem	Possible Causes													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Hub studs shearing; rear tire scuffing; axle shaft breakage	•	•			•			•	•					•
Steering difficulty; vehicle pulls on straight forward driving or tends to go straight when making turns	•	•	•	•	•		•		•				•	•
No differential action; binding in turns	•			•	•	•			•					•
Excessive driveline noise*	•	•	•	•	•		•		•					•
Grinding noises	•			•	•			•	•	•				•
Continuous "clicking" sound in straight forward driving	•	•	•		•									
Excessive backlash in vehicle drivetrain; engine lug or vehicle surge during turns	•					•		•		•				
Tending to side-slip or "fishtail" on icy roads											•			
Sluggish reengagement of NoSPIN differential clutch assemblies									•			•		
Difficulty in turning vehicle from standing start	•			•	•								•	•
Erratic operation of NoSPIN differential; premature wear or failure of NoSPIN differential parts	•	•	•	•	•			•	•	•		•		•

Possible Causes for Vehicle Problems

1. **Improper Installation; Defective NoSPIN differential.**
   Follow test procedures outlined in *Tests For Proper Installation and Operation of the NoSPIN Differential.*
2. **Overloading and/or improper weight distribution.**
   Remove excess weight and redistribute the load from side to side, according to the vehicle/axle manufacturer's instructions.
3. **Unequal rolling radii of the drive tires.**
   A smaller radius tire will cause the wheel to overrun constantly when power is applied. The other tire (with the larger radii) will do all the driving. Replace tires or adjust tire pressures until rolling radii are equal.
4. **Broken axle shaft.**
   Replace.

NOTE: It is possible to operate a NoSPIN equipped vehicle on one axle shaft. However, this practice is not recommended because serious damage can occur to other axle parts.

5. **Bent axle shaft or housing; axle shafts on different center lines**.
   Replace bent axle shafts or housing, or realign hub faces and bolt circles in both the differential carrier and axle housing.
6. **Larger than normal steering angle; short turning radius.**
   Vehicles designed with high turning angles may surge, have steering difficulty and cause tire wear during sharp turns. Reduce maximum turning angle and have the driver decelerate when engine surge begins.
7. **Improper wheel alignment.**
   Correct as required.
8. **Worn or defective axle parts.**
   Check the condition of the ring gear, pinion gear, bearings, seals, etc. Replace as required.
9. **Foreign matter in axle housing or improper assembly of axle parts.**
   Inspect for contamination. Check assembly of axle parts.
10. **Incorrect ring and pinion adjustments; worn driveline parts (transmission gears, U-joints, etc.).**
    Replace or adjust parts as required.
11. **High crown in road; poor traction surface under all drive wheels.**
    The tendency to side-slip or "fishtail" on icy roads slipping toward the curb is more pronounced when using a traction differential than when using a conventional differential. Stability can be retained when side-slip occurs by decelerating (letting off the accelerator).

WARNING: Do not apply the brake. To do so may result in loss of vehicle control.

12. **High viscosity lubricant.**
    In sub-zero temperatures, gear lubricant can thicken and impede the normal function of the NoSPIN differential. Tractech recommends that the axle oil be changed for cold weather operation to the lightest acceptable lubricant allowable by the axle manufacturer. Heat control devices, garaging and a warm-up period may also provide relief from this problem.
13. **Low cylinder pressure, undersized cylinder, excessive angle of articulation, excessive vehicle weight.**
    Correct as required.
14. **Improper application of product.**
    Review *"Application Guidelines" on page 9–46* .

TESTS FOR PROPER INSTALLATION AND OPERATION OF THE NOSPIN DIFFERENTIAL

Installation Test

1. With the engine turned off, raise driving axle(s) until all tires are out of contact with any surface.
2. Place the transmission in gear or in Park, so that the driveshaft does not rotate.
3. With a helper on the opposite side, start the installation test by rotating both wheels in a forward direction as far as possible (Figure 9-109). (Both wheels should stop after rotating a short distance.)

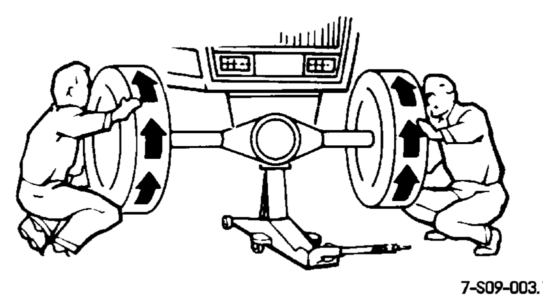

Figure 9-109:

4. With a helper firmly holding the right wheel forward (against the stop), rotate the left wheel rearward while listening for an indexing or clicking sound. (The right wheel must be held firmly against the stop or the left wheel will not disengage freely.) Grasp the left wheel to stop its rotation, and move it slightly forward (in the direction of the stop). The NoSPIN differential should lock up (Figure 9-110).

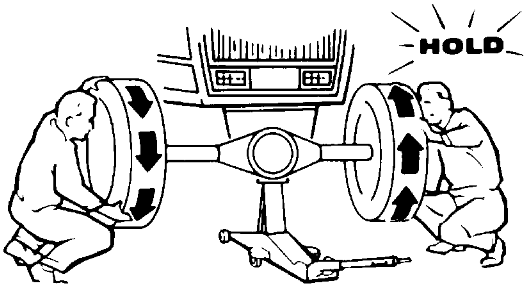

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Figure 9-110:

5. Rotate both wheels rearward as far as possible. (Both wheels should stop after rotating a short distance) (Figure 9-111).

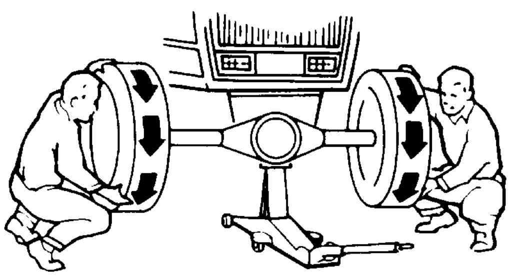

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Figure 9-111:

6. With the helper on the opposite side firmly holding the right wheel rearward (against the stop), rotate the left wheel forward, again listening for an indexing or clicking sound. (Again, the right wheel must be held firmly against the stop or the left wheel will not disengage freely.) Grasp the left wheel to stop its rotation, and move it slightly rearward (in the direction of the stop). The NoSPIN differential should lock up (Figure 9-112).

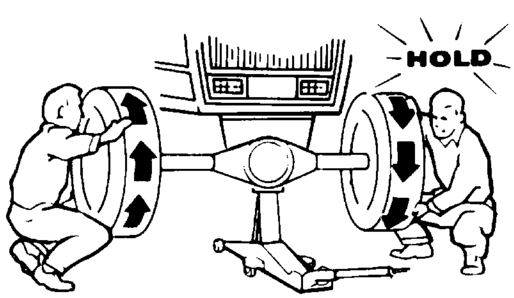

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Figure 9-112:

7. Repeat steps 3, 4, 5 and 6, except hold the left wheel against the stops and rotate the right wheel, in both forward and reverse.

If properly installed, the rotating (or overrunning) wheel should cam out easily by hand, rotate freely in both directions and produce a soft indexing or clicking sound. The NoSPIN differential should not reengage until the direction of rotation is reversed.

If you hear repeated loud indexing or clicking sounds when performing this installation test, one of the driven clutch assemblies may not be properly assembled to the spider.

If either wheel does not rotate freely in both directions, recheck each installation step. Also, check hand and foot brakes for possible drag caused by improper adjustment. Be sure that all thrust washers have been removed from the standard differential support case.

Operation Test

Check to see that both wheels of each NoSPIN differential equipped axle are driving. Make this test under load, so that engine torque is applied through the NoSPIN differential with the wheels on the ground. One way to achieve this load is to drive up against a solid obstruction (on loose dirt or gravel, if possible) and attempt to spin both wheels together. * Perform this test in forward and reverse.

WARNING: o not operate the vehicle if both wheels of a NoSPIN/Detroit Locker equipped axle are not driving. Power to only one wheel can cause serious steering problems and loss of vehicle control and result in a mishap which can cause property damage, injury, even death.

Check camming action. On a flat surface, with good traction, drive the vehicle in a tight circle in forward and reverse to be sure that the outside wheel is free to overrun (i.e., that the outside tire does not scuff).

FRONT PROPELLER SHAFT AND U-JOINT SERVICE

Front Shaft Removal

1. Remove U-joint clamp bolts and straps. Then disconnect shaft yoke (Figure 9-113).

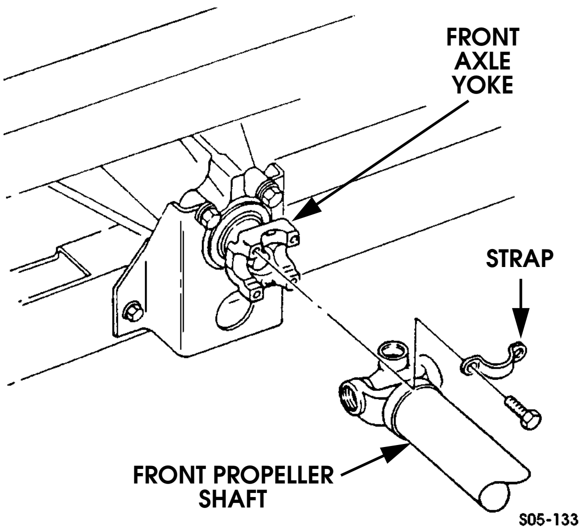


Figure 9-113: Front Propeller Shaft Attachment at Axle

2. Remove U-bolt nuts and disconnect front shaft from transfer case output yoke (Figure 9-114).

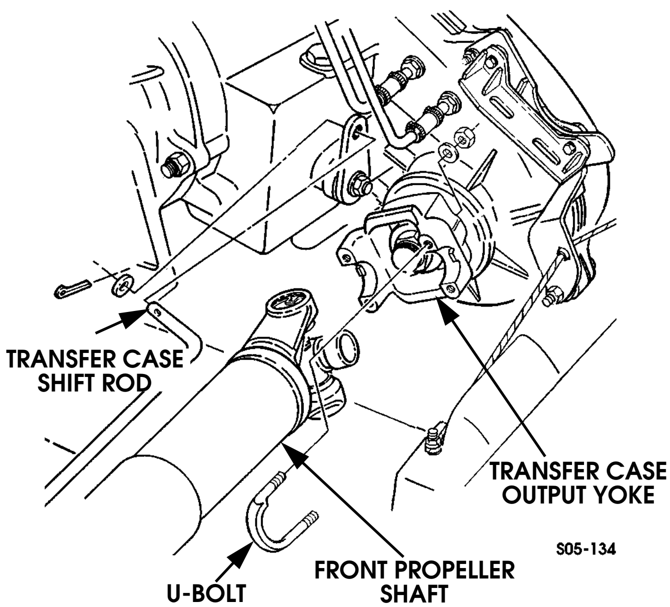


Figure 9-114: Front Propeller Shaft Attachment at Transfer Case

3. Disconnect transfer case shift rod at range lever.
4. Remove bolts attaching center bearing to engine mount (Figure 9-115).

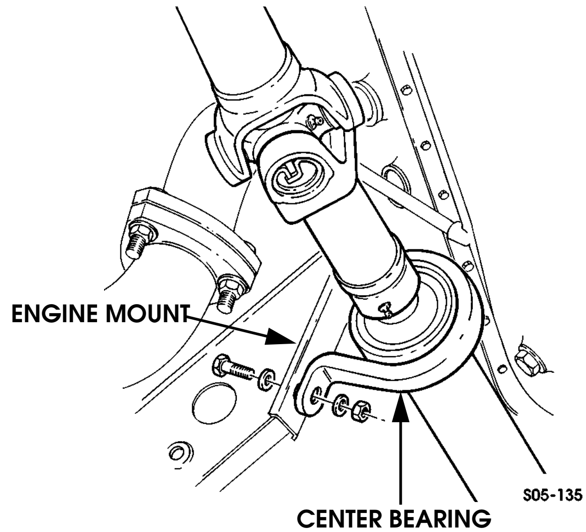


Figure 9-115: Center Bearing Attachment

5. Move front shaft forward, then rearward over top of transfer case and remove from vehicle.

FRONT PROPELLER SHAFT DISASSEMBLY AND OVERHAUL

1. Mark slip yokes for assembly alignment.
2. Mount shaft in vise and remove dust caps (Figure 9-116).
3. Pull slip yokes off propshaft and separate shaft halves.
4. Install standard bearing puller between center bearing and shield.
5. Mount assembly in shop press and press center bearing off shaft.
6. Remove shield from front propeller shaft.

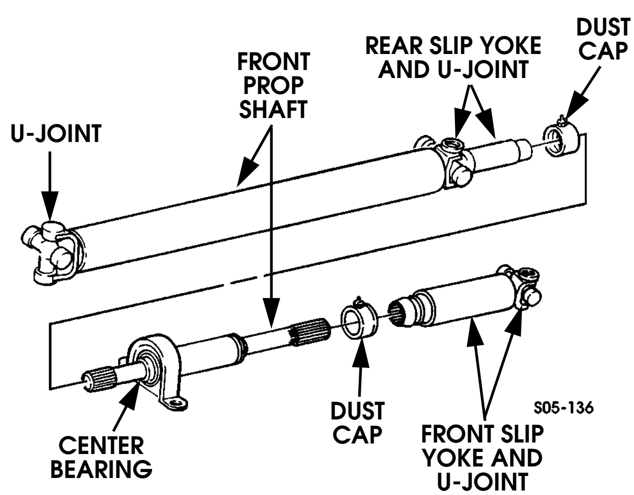


Figure 9-116:

7. Clean part with solvent.
8. Inspect shaft, slip yokes and U-joints for wear or damage.
9. Replace worn U-joints. Refer to procedure in this section.
10. Install shield on shaft.
11. Start new center bearing on shaft.

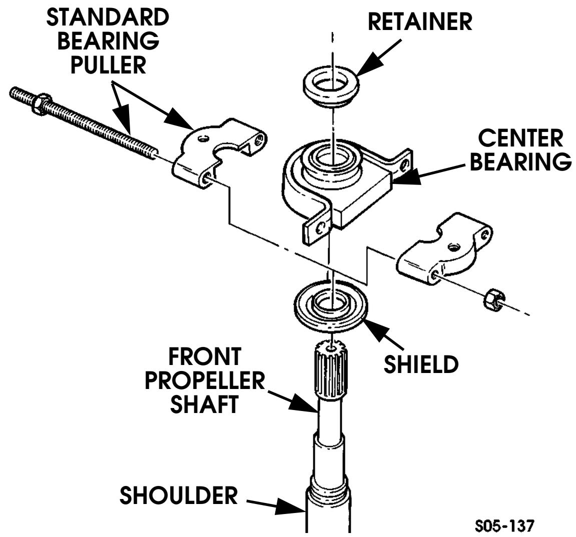


Figure 9-117: Center Bearing Removal/Installation

12. Install retainer on center bearing.
13. Press center bearing on front propeller shaft until seated against shoulder. Ensure flange on center bearing faces up.
14. Install dust caps on yokes.
15. Coat shaft splines with chassis grease.

NOTE: Be sure grease fittings on dust caps are aligned with wide splines in slip yokes.

16. Align and assemble shaft, slip yokes, and dust caps.
17. Lubricate U-joints and slip yokes with chassis grease.

Front Propshaft Installation

1. Position front shaft on engine mount, axle yoke and transfer case yoke.
2. Connect transfer case shift rod to transfer case range lever.
3. Connect front shaft to transfer case yoke with U-bolts and nuts. Tighten nuts to 13-18 lb-ft (18-24 N•m).
4. Connect front shaft to front axle yoke with strap and bolts. Tighten bolts to 13-18 lb-ft (18-24 N•m).
5. Secure center bearing to engine mount with bolts, washers, and locknuts. Tighten bolts to 60 lb-ft (81 N•m).
6. Lubricate propeller shaft U-joints and slip yokes with chassis grease.

REAR PROPELLER SHAFT SERVICE

Removal

1. Remove U-bolts, attaching rear shaft to rear axle yoke (Figure 9-118).
2. Slide shaft slip yoke out of transfer case extension housing and remove shaft from vehicle.

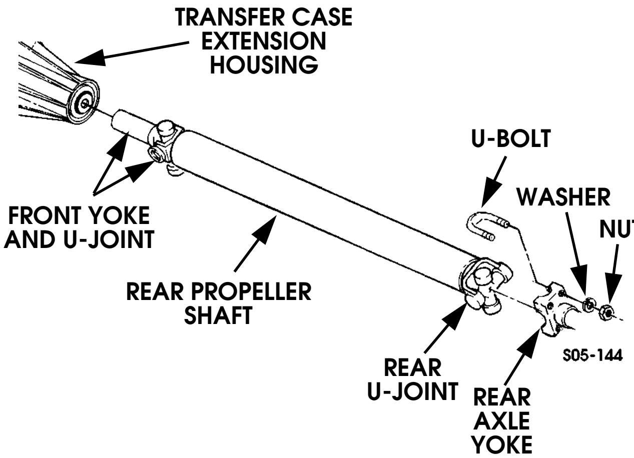


Figure 9-118: Rear Propeller Shaft Attachment

3. Inspect condition of U-joint cross and bearings at each end of shaft (Figure 9-119). Replace either U-joint if worn, loose, seized. Refer to U-joint replacement in this section.

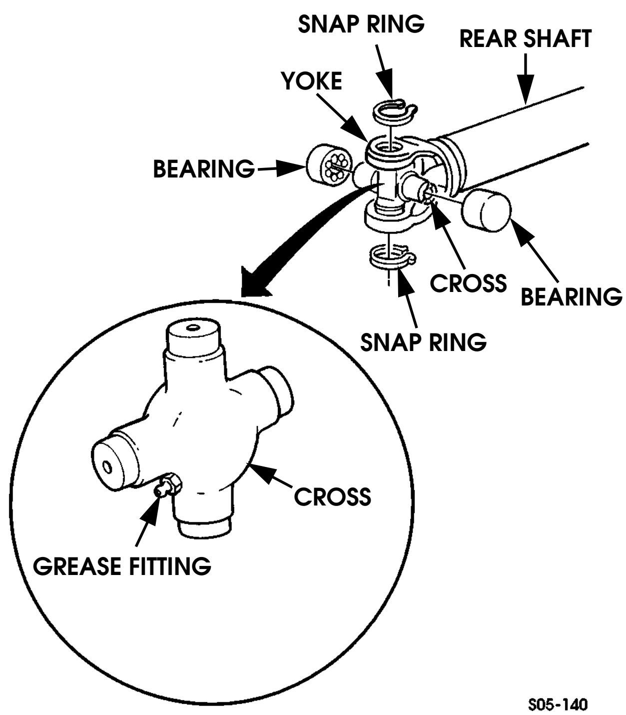


Figure 9-119: U-joint Components (Typical)

Installation

1. Slide propeller shaft slip yoke into extension housing.
2. Connect shaft to axle yoke with U-bolts, lockwashers and nuts. Tighten U-bolt nuts to 13-18 lb-ft (18-24 N•m)
3. Lubricate propeller shaft U-joints.

U-JOINT REPLACEMENT

1. Remove propeller shaft.
2. Remove grease fitting from cross (Figure 9-120).
3. Remove two bearing cups from cross (rear shaft only).
4. Remove snap rings from bearings in yoke.
5. Position propeller shaft in vise with 1-1/8 socket between vise jaw and bearing being removed. Be sure open end of socket is facing bearing cup (Figure 9-120).

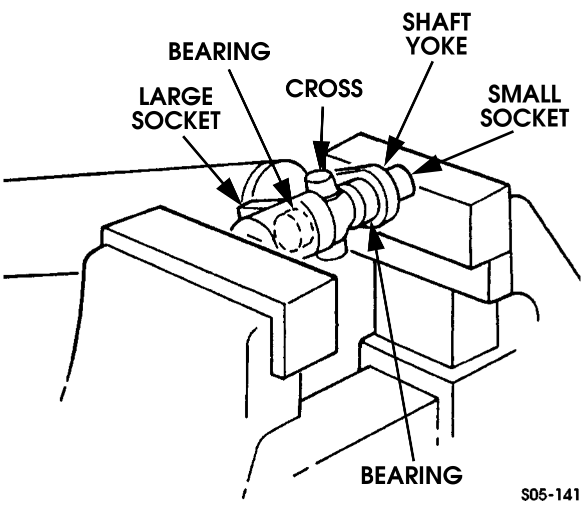


Figure 9-120: U-Joint Cross and Bearing Installation

6. Place 11/16 socket between opposite bearing and vise jaw. Be sure open end of socket is facing vise jaw.
7. Tighten vise to press bearing cup out of yoke. Then remove bearings from cross.
8. Reverse position of sockets and press remaining bearing out of yoke.
9. Remove cross from yoke.
10. Pack bearing grease into bearings to hold needle rollers in place.

CAUTION: *Be sure grease fitting on cross faces yoke. Damage to fitting will result if improperly installed.*

11. Position cross in yoke.
12. Install first bearing in yoke. Verify bearing cup is aligned with yoke before pressing in with vise. Damage to cross and bearing will result if misaligned.
13. Place yoke in vise with 11/16 socket between vise jaw and bearing cup. Then press bearing cup into yoke far enough to install snap ring.
14. Install remaining bearing in yoke.
15. Place yoke in vise with 11/16 socket between bearing cup and vise jaw.
16. Press bearing cup into yoke far enough to install snap ring.
17. Press remaining two bearings in slip yoke and install snap rings.
18. Install two additional bearing cups on cross (rear shaft only).
19. Install grease fitting in cross.
20. Lube joints and yokes as required.

COIL SPRING REPLACEMENT

NOTE: The procedure for removing and installing all four coil springs is basically the same. This procedure covers the left front coil spring.

NOTE: Various load capacity springs are used in the Hummer based on powertrain and option packages. Refer to the parts catalog to select the proper replacement spring for the specific application.

Removal

1. Remove wheel (Section 6).
2. Remove bolt, two washers, and bar link from lower control arm.
3. Remove four locknuts, washers, bolts, washers, lower ball joint, and geared hub from lower control arm (Figure 9-121).
4. Place jack under lower control arm and raise lower control arm slightly to relieve tension on shock pin.
5. Remove locknut, shock pin, washer, and shock absorber from spring seat and collapse shock absorber.

NOTE: It may be necessary to loosen lower control arm bolts to allow lower control arm to be lowered.

6. Pull geared hub and lower ball joint away from lower control arm and remove coil spring from lower control arm and shock absorber.

Installation

NOTE: Index coil spring in spring pocket for a slight gap 1/16 - 1/8 in. (1.59 - 3.18 mm) when spring is in position.

1. Install coil spring over shock absorber and onto lower control arm ensuring end of coil spring fits in spring pocket of lower control arm (Figure 9-121).
2. Ensure coil spring is aligned with spring seat flange, and raise lower control arm.
3. Extend shock absorber into spring seat and install with washer, shock pin, and locknut. Tighten locknut to 300 lb-ft (407 N•m).
4. Install lower ball joint and geared hub on lower control arm ensuring lower ball joint is placed below lower control arm. Secure lower ball joint to lower control arm with four washers, bolts, washers, and locknuts. Tighten front locknuts to 37 lb-ft (50 N•m) and rear locknuts to 60 lb-ft. (80 N•m).
5. Apply thread-locking compound to threads of bolt. Install bar link on lower control arm with two washers and bolt. Tighten bolt to 70 lb-ft (95 N•m).
6. Install wheel (Section 6).

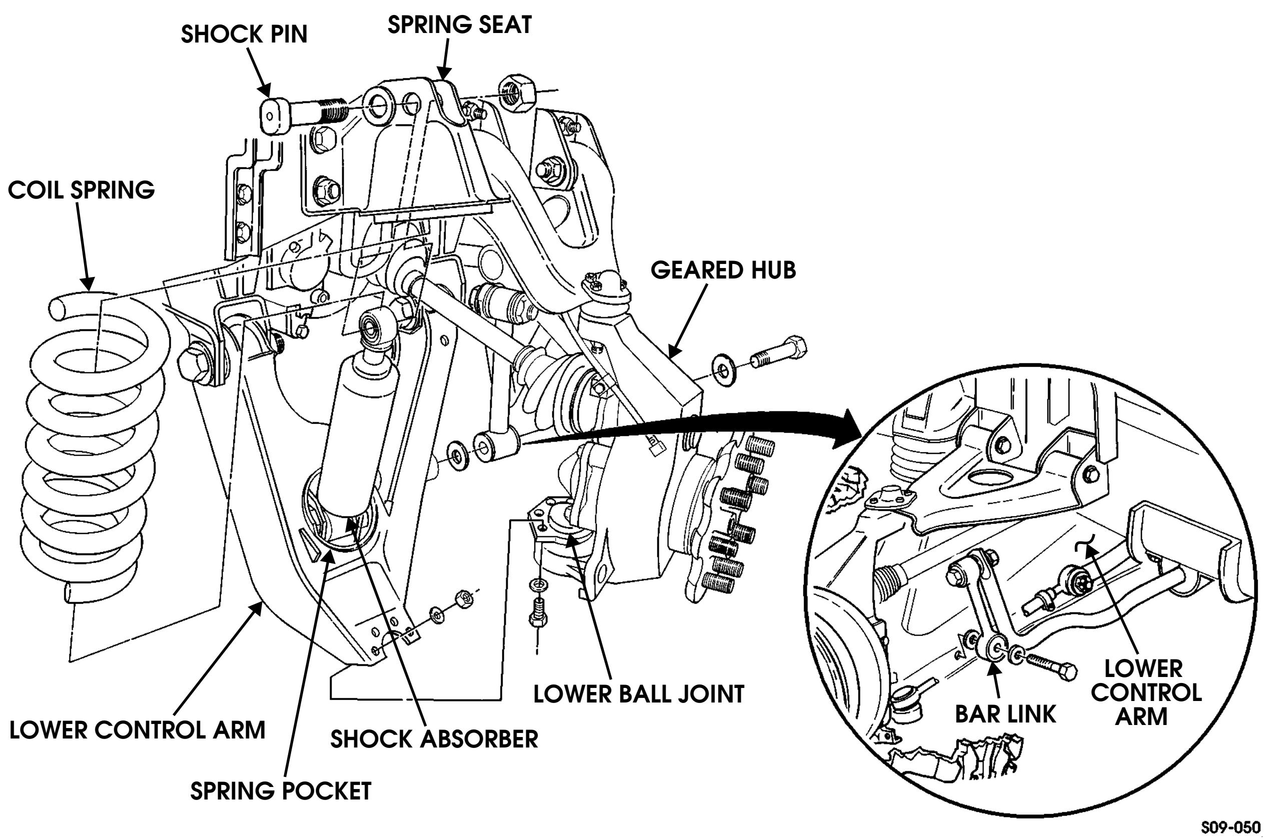


Figure 9-121: Coil Spring Replacement

SHOCK ABSORBER REPLACEMENT

NOTE: The procedure for removing and installing all shock absorbers is the same, except rear lower shock pins must be installed with head of pin facing rearward. This procedure covers the left front shock absorber.

Removal

1. Remove two bolts, lockwashers, washers, shock absorber, and bracket from lower control arm (Figure 9-122).
2. Remove locknut, shock pin, washer, and shock absorber from spring seat. Note position of pin for installation.
3. Compress shock absorber and remove shock absorber and bracket.

NOTE: Note alignment of shock absorber and bracket for installation reference.

4. Position shock absorber in vise and remove locknut, pin, washer, and bracket from shock absorber.

Installation

NOTE: It may be necessary to spread spring seat to allow installation of shock absorber.

1. Position shock absorber in vise, and install bracket on shock absorber with washer, pin, and locknut. Tighten locknut to 300 lb-ft (407 N•m) (Figure 9-122).

CAUTION: *Do not pry or use sharp tools on shock absorber piston rod. A damaged rod will cause shock failure.*

2. Install shock absorber and bracket through lower control arm.
3. Extend shock absorber and secure piston rod end of shock absorber to spring seat with washer, shock pin, and locknut. Tighten locknut to 300 lb-ft (407 N•m).
4. Install bracket on lower control arm with two washers, lockwashers, and bolts. Tighten bolts to 178 lb-ft (241 N•m).

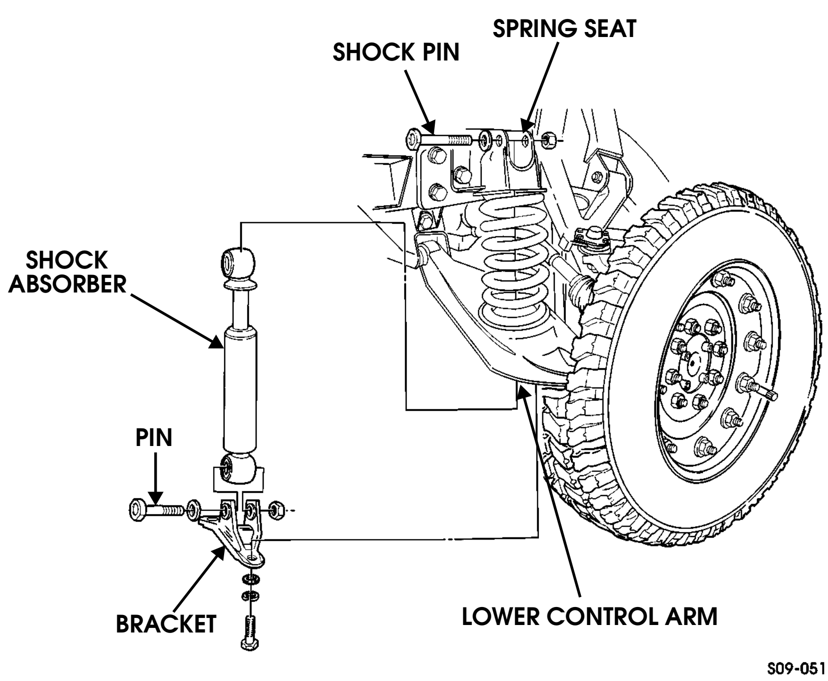


Figure 9-122: Shock Absorber Replacement

FRONT BUMPER AND TOWING BRACKETS REPLACEMENT (VEHICLES WITHOUT WINCH)

Removal

1. Remove brushguard, if equipped.
2. Remove four locknuts, washers, bolts, washers, two towing brackets, and front bumper from mounting brackets (Figure 9-123).

Installation

1. Install front bumper and two towing brackets on mounting brackets with four washers, bolts, washers, and locknuts. Tighten bolts to 90 lb-ft (122 N•m) (Figure 9-123).
2. Install brushguard, if removed (Section 10).

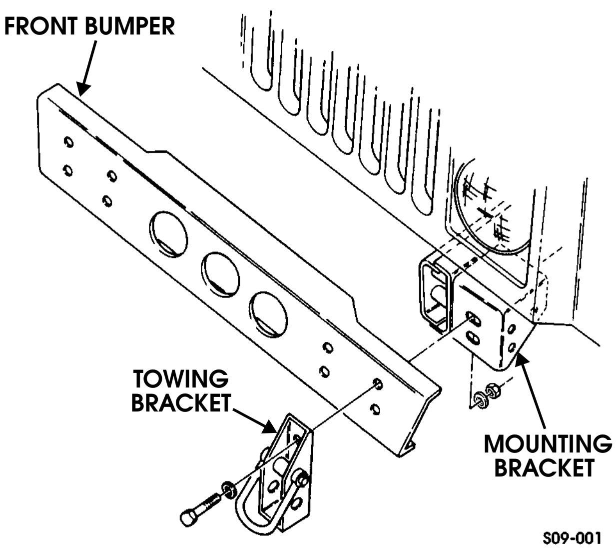


Figure 9-123: Front Bumper and Towing Bracket Replacement for Vehicles Without Winch

FRONT BUMPER AND TOWING BRACKETS REPLACEMENT (VEHICLES WITH WINCH)

Removal

WARNING: Winch must be supported prior to performing step 1. Failure to observe this warning could result in personal injury.

1. Remove four bolts and washers securing winch to front bumper (Figure 9-124).
2. Remove four locknuts, washers, bolts, washers, and two towing brackets from front bumper and frame extensions. Discard locknuts.
3. Remove five locknuts, washers, six bolts, washers, and front bumper from frame extensions.

Installation

1. Install front bumper on frame extensions with six washers, bolts, five washers, and locknuts. Tighten bolts to 90 lb-ft (122 N•m) (Figure 9-124).
2. Install two towing brackets on front bumper and frame extensions with four washers, bolts, washers, and locknuts. Tighten bolts to 90 lb-ft (122 N•m).
3. Install four bolts and washers securing front bumper to winch. Tighten bolts to 60 lb-ft (81 N•m).

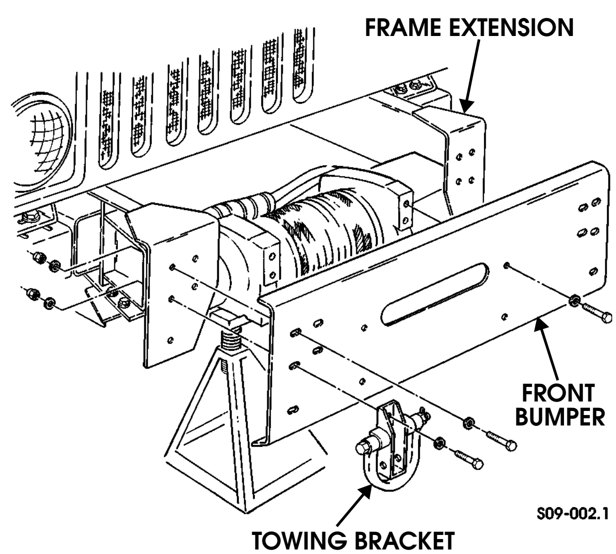


Figure 9-124: Front Bumper and Towing Bracket Replacement for Vehicles With Winch

FRONT BUMPER MOUNTING BRACKET REPLACEMENT

Removal

NOTE: Mark location of bolts for installation.

1. Support hood in position with jacks.
2. Remove three locknuts, washers, bolts, and washers securing mounting bracket to frame rail (Figure 9-125).
3. Remove two locknuts and plate securing mounting bracket to hinge.
4. Remove two locknuts, washers, bolts, washers, towing bracket, and mounting bracket from front bumper.

Installation

1. Install mounting bracket and towing bracket on front bumper with two washers, bolts, washers, and locknuts. Do not tighten locknuts (Figure 9-125).
2. Install mounting bracket on frame rail with three washers, bolts, washers, and locknuts. Do not tighten locknuts.
3. Install mounting bracket on hinge with plate and two locknuts.
4. Tighten hinge locknuts to 28 lb-ft (38 N•m), front bumper locknuts to 90 lb-ft (122 N•m), and frame rail locknuts to 178 lb-ft (241 N•m).
5. Remove jacks supporting hood.

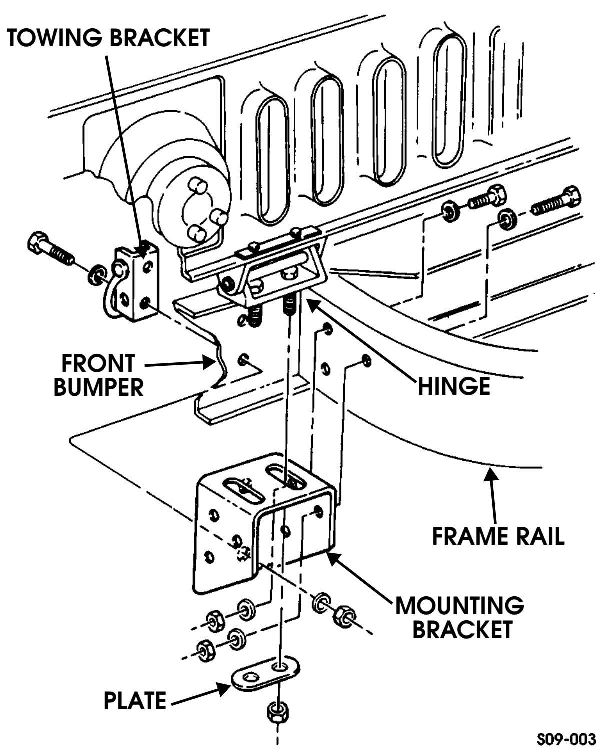


Figure 9-125: Front Bumper Mounting Bracket Replacement

RADIATOR FRONT MOUNT BRACKET REPLACEMENT

Removal

1. Remove locknut, washer, bolt, washer, and spacer securing radiator to front mount bracket (Figure 9-126).
2. Remove two locknuts, washers, bolts, washers, and front mount bracket from suspension crossmember.
3. Remove mount from front mount bracket.

Installation

1. Install mount in front mount bracket (Figure 9-126).
2. Install front mount bracket on suspension crossmember with two washers, bolts, washers, and locknuts. Tighten locknuts to 90 lb-ft (122 N•m).
3. Install radiator on front mount bracket with spacer, washer, bolt, washer, and locknut. Tighten locknut to 30 lb-ft (41 N•m).

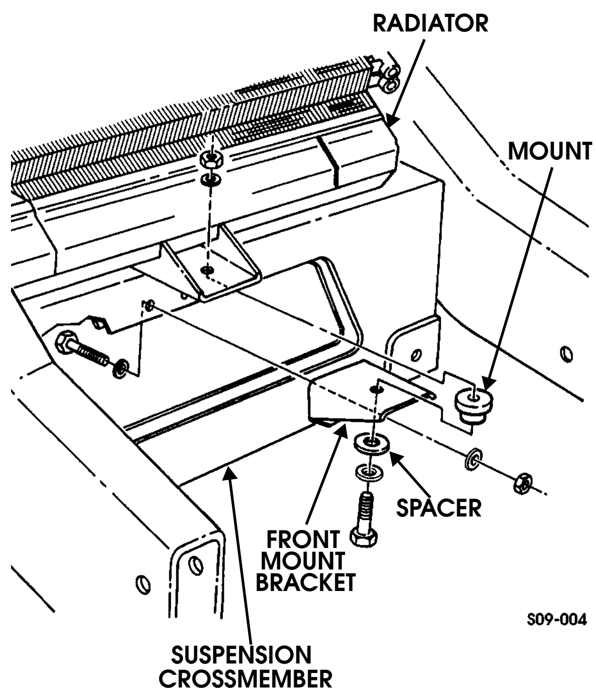


Figure 9-126: Radiator Front Mount Bracket Replacement

LIFTING SHACKLE REPLACEMENT

Removal

Remove cotter pin, slotted nut, bolt, spring washer, and shackle from tiedown bracket. Discard cotter pin (Figure 9-127).

Installation

1. Install shackle on tiedown bracket with spring washer, bolt, and slotted nut. Tighten slotted nut enough to allow movement of shackle (Figure 9-127).
2. Install cotter pin in slotted nut.

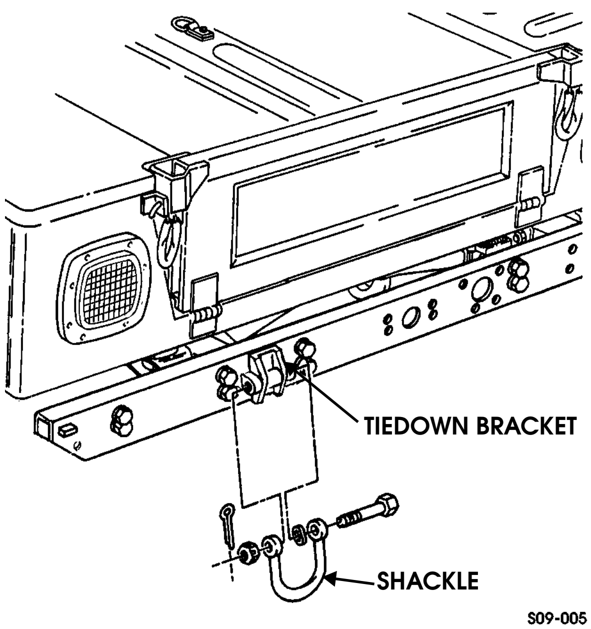


Figure 9-127: Lifting Shackle Replacement

FRAME EXTENSION REPLACEMENT

Removal

1. Remove front bumper.
2. Remove hood and hinge (Section 10).
3. Remove two locknuts, washers, bolts, and washers securing front suspension brace to frame extension (Figure 9-128).

NOTE: Note position of winch cable bracket for installation.

4. Remove three locknuts, washers, bolts, and washers securing clamp mounting bracket, frame extension, and bumper mounting bracket to frame.

Installation

1. Install bumper mounting bracket, frame extension, and clamp mounting bracket on frame with three washers, bolts, washers, and locknuts. Do not tighten locknuts (Figure 9-128).
2. Secure front suspension brace to frame extension with two washers, bolts, washers, and locknuts.
3. Tighten all locknuts to 178 lb-ft (241 N•m).
4. Install hinge and hood.
5. Install front bumper.

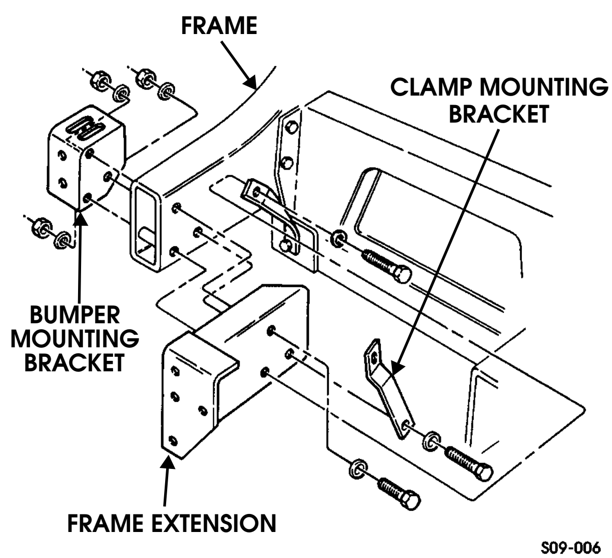


Figure 9-128: Frame Extension Replacement

LEFT AIRLIFT BRACKET AND FRONT UPPER CONTROL ARM BRACKETS REPLACEMENT

Removal

1. Remove left engine splash shield (Section 10).
2. Raise and support front of vehicle.
3. Remove three screws and clamps securing harness to airlift bracket (Figure 9-129).
4. Remove two locknuts, washers, and bolts securing radiator support to airlift bracket.

WARNING: To avoid personal injury or equipment damage, support lower control arm during removal and installation.

5. Remove two locknuts, washers, bolts, washers, and upper control arm from two control arm brackets.

NOTE: Note direction of bolts for installation.

6. Remove eight locknuts, washers, bolts, washers, two control arm brackets and shim(s) from airlift bracket.
7. Remove two bolts, washers, and airlift bracket from frame rail.

Installation

1. Install airlift bracket, shim(s) and two control arm brackets on frame rail with eight washers, bolts, washers, and locknuts. Tighten locknuts to 90 lb-ft (122 N•m) (Figure 9-129).
2. Apply thread-locking compound to two bolt holes and secure airlift bracket and control arm brackets to frame rail with two washers and bolts. Tighten bolts to 90 lb-ft (122 N•m).
3. Install upper control arm on control arm brackets with two washers, bolts, washers, and locknuts. Tighten locknuts to 260 lb-ft (353 N•m).
4. Secure radiator support to airlift bracket with two bolts, washers, and locknuts. Tighten locknuts to 37 lb-ft (50 N•m).
5. Secure harness to airlift bracket with three clamps and screws.
6. Lower front of vehicle.
7. Install left engine splash shield.

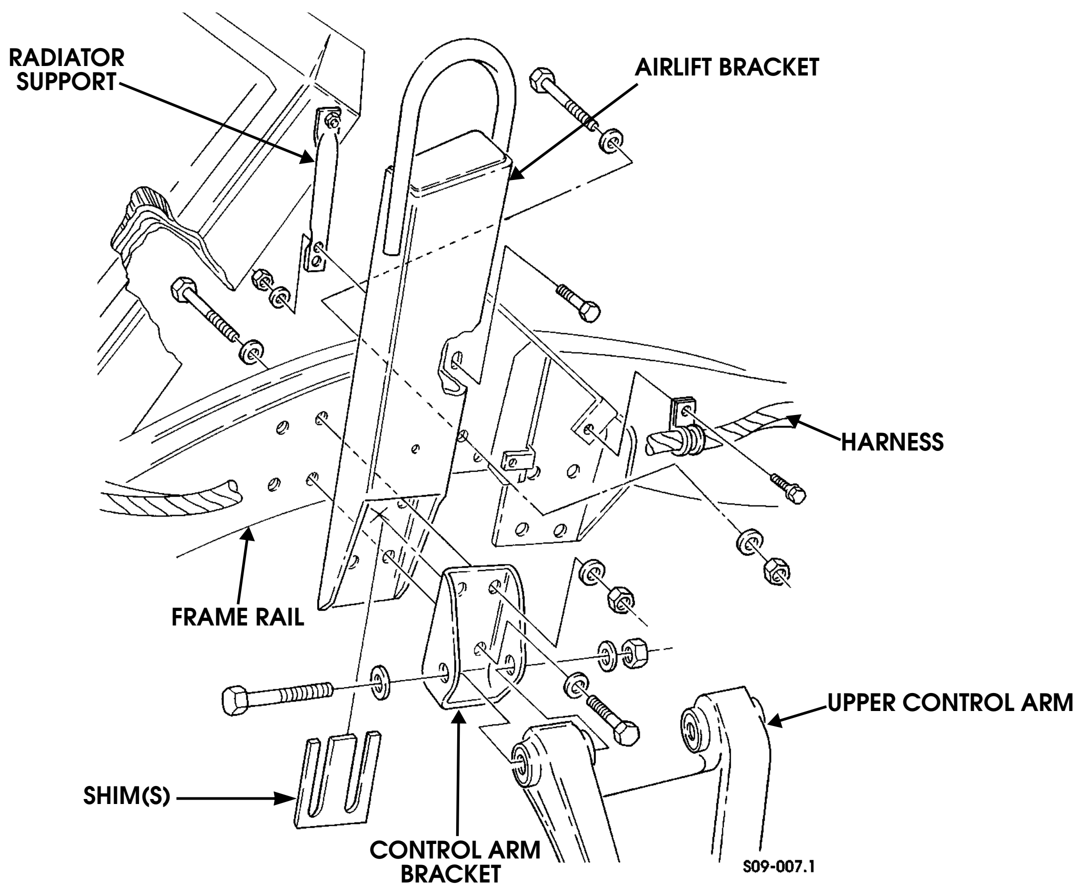


Figure 9-129: Left Airlift Bracket and Front Upper Control Arm Bracket Replacement

RIGHT AIRLIFT BRACKET AND FRONT UPPER CONTROL ARM BRACKETS REPLACEMENT

Removal

1. Remove battery tray (Section 12).
2. Raise and support front of vehicle.
3. Remove two locknuts, washers, and bolts securing radiator support to airlift bracket (Figure 9-130).

WARNING: To avoid personal injury or equipment damage, support lower control arm during removal and installation

4. Remove two locknuts, washers, bolts, washers, and upper control arm from two control arm brackets.

NOTE: Note direction of bolts for installation.

5. Remove ten locknuts, washers, bolts, and washers securing control arm brackets, cooler line bracket, and airlift bracket to frame rail.
6. Remove two control arm brackets, shim(s) and airlift bracket from frame rail.

Installation

1. Install airlift bracket, shim(s), two control arm brackets, and cooler line bracket on frame rail with ten washers, bolts, washers, and locknuts. Tighten locknuts to 90 lb-ft (122 N•m) (Figure 9-130).
2. Secure upper control arm to two control arm brackets with two washers, bolts, washers, and locknuts. Tighten locknuts to 260 lb-ft (353 N•m).
3. Install radiator support on airlift bracket with two bolts, washers, and locknuts. Tighten locknuts to 37 lb-ft (50 N•m).
4. Lower front of vehicle.
5. Install battery tray.

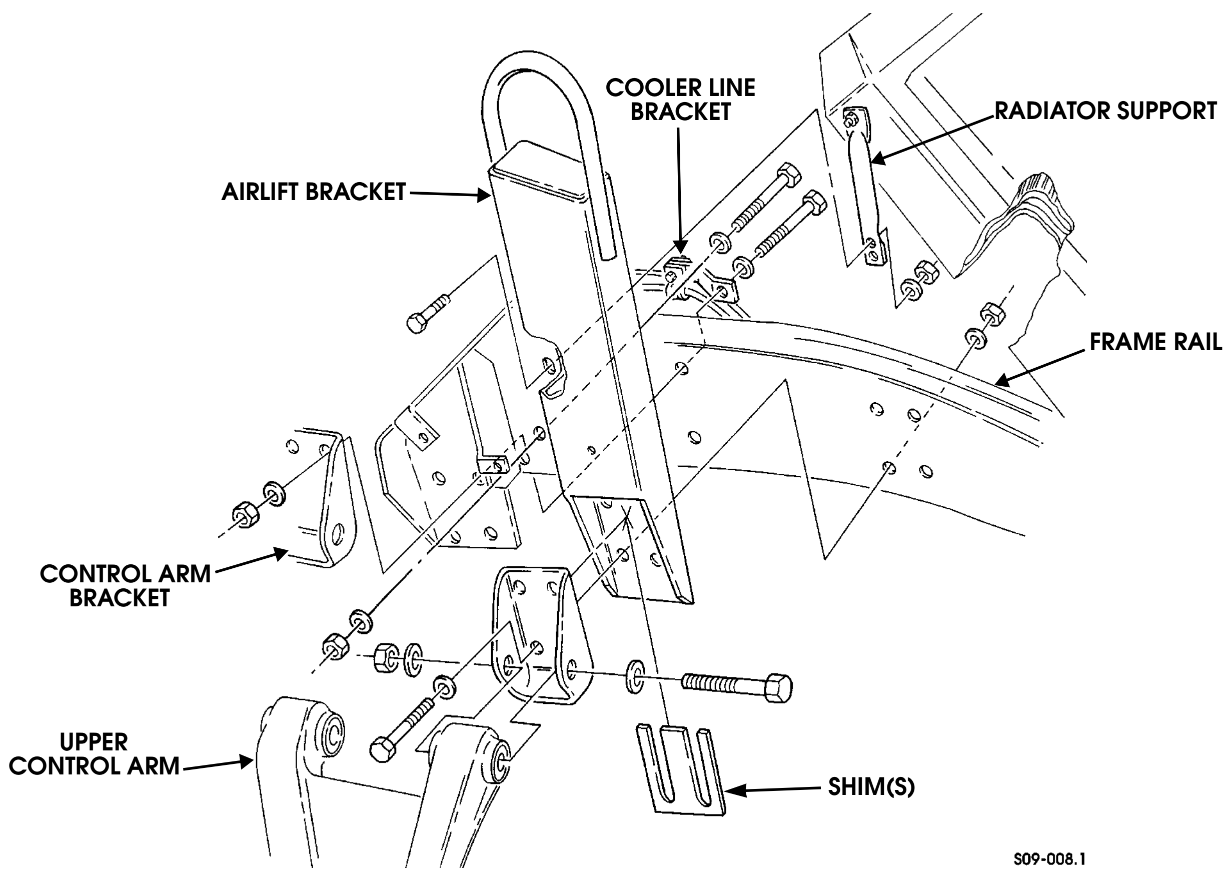


Figure 9-130: Right Airlift Bracket and Front Upper Control Arm Bracket Replacement

FRONT SUSPENSION BRACE REPLACEMENT (VEHICLES WITHOUT WINCH)

Removal

WARNING: To avoid personal injury or equipment damage, support lower control arm during removal and installation.

1. Remove locknut, washer, bolt, and washer securing brace to frame rail (Figure 9-131).
2. Remove locknut, washer, bolt, washer, and brace from crossmember and lower control arm.

Installation

1. Install brace on crossmember and lower control arm with washer, bolt, washer, and locknut. Do not tighten locknuts (Figure 9-131).
2. Install brace on frame rail with washer, bolt, washer, and locknut.
3. Tighten crossmember locknut to 261 lb-ft (354 N•m) and frame rail locknut to 178 lb-ft (241 N•m).

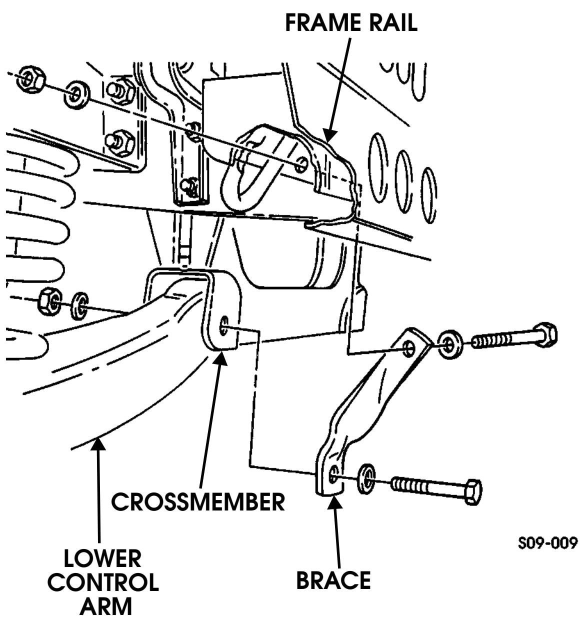


Figure 9-131: Front Suspension Brace Replacement for Vehicles Without Winch

FRONT SUSPENSION BRACE REPLACEMENT (VEHICLES WITH WINCH)

Removal

WARNING: To avoid personal injury or equipment damage, support lower control arm during removal and installation.

NOTE: The left and right front suspension braces are replaced basically the same. This procedure covers the left front suspension brace.

1. Remove two locknuts, washers, bolts, and washers securing front suspension brace to frame extension (Figure 9-132).
2. Remove locknut, washer, bolt, washer, and brace from crossmember and lower control arm.

Installation

1. Install brace on crossmember and lower control arm with washer, bolt, washer, and locknut. Do not tighten locknut (Figure 9-132).
2. Secure brace to frame extension with two washers, bolts, washers, and locknuts.
3. Tighten crossmember locknut to 261 lb-ft (354 N•m) and frame extension locknuts to 178 lb-ft (241 N•m).

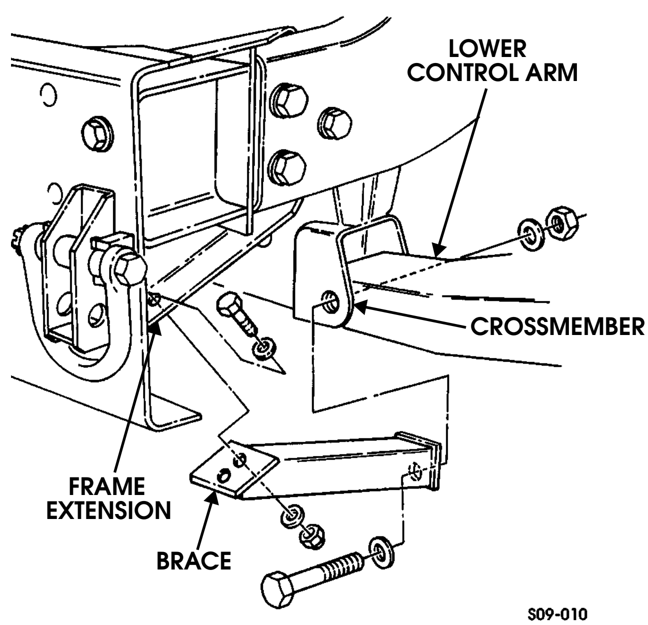


Figure 9-132: Front Suspension Brace Replacement for Vehicles With Winch

SPLASH SHIELD SUPPORT BRACKET REPLACEMENT

Removal

1. Remove locknut, washer, bolt, and washer securing splash shield to bracket (Figure 9-133).

NOTE: Note direction of bolts for installation.

2. Remove two locknuts, washers, bolts, washers, and bracket from frame rail.

Installation

1. Install bracket on frame rail with two washers, bolts, washers, and locknuts. Tighten locknuts to 90 lb-ft (122 N•m) (Figure 9-133).
2. Install splash shield on bracket with washer, bolt, washer, and locknut. Tighten bolt to 15 lb-ft (20 N•m).

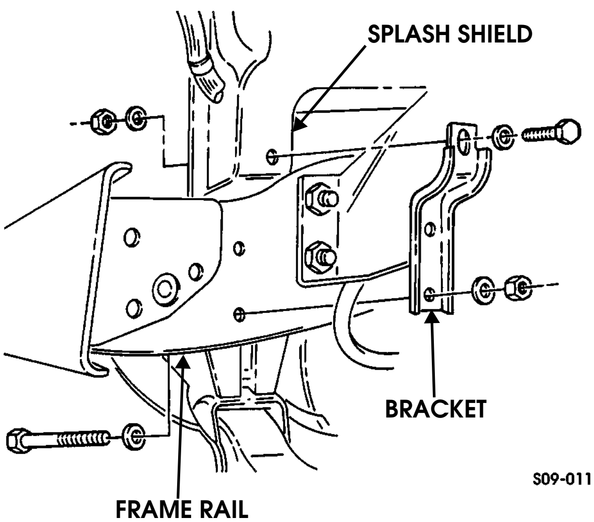


Figure 9-133: Splash Shield Support Bracket Replacement

REAR BUMPER REPLACEMENT

Removal

1. Remove swing-away spare tire carrier, if equipped (Section 6).
2. Remove rear license plate bracket (Section 10).
3. Remove trailer hitch, if equipped (Section 13).
4. Remove two locknuts, washers, bolts, and washers securing trailer harness to rear bumper (Figure 9-134).
5. Disconnect trailer harness from body harness, and pull trailer harness through hole in rear bumper.
6. Remove four locknuts, washers, bolts, and washers securing two tiedown brackets to rear bumper, two mounting brackets, and outer mounting brackets.
7. Remove eight bolts, washers, and rear bumper from two mounting brackets.

Installation

1. Install rear bumper on two mounting brackets and secure with eight washers and bolts. Do not tighten bolts (Figure 9-134).
2. Install two tiedown brackets on rear bumper, two mounting brackets, and outer mounting brackets, with four washers, bolts, washers, and locknuts. Do not tighten locknuts.
3. Tighten bolts installed in step 1 and locknuts installed in steps 2, 3, and 4 to 90 lb-ft (122 N•m).
4. Insert trailer harness through hole in rear bumper and connect trailer harness to body harness.
5. Secure trailer harness to rear bumper with two washers, bolts, washers, and locknuts.
6. Install trailer hitch, if removed.
7. Install rear license plate bracket.
8. Install swing-away spare tire carrier, if removed.

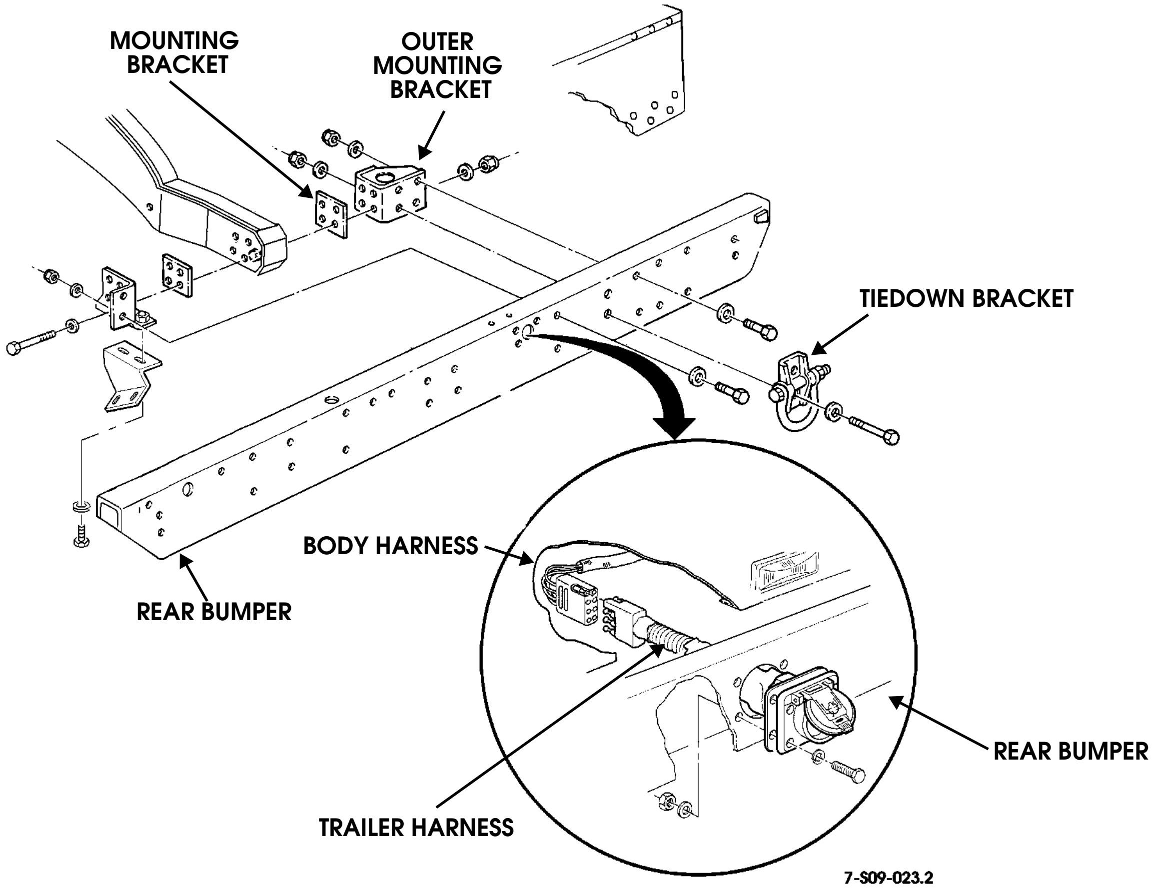


Figure 9-134: Rear Bumper Replacement

SPRING SEAT REPLACEMENT

NOTE: Replacement of the four spring seats is basically the same. This procedure covers the right front spring seat.

Removal

1. Remove coil spring.
2. Remove four locknuts, washers, bolts, spring bracket, and front spring seat from frame rail (Figure 9-135).

Installation

1. Install spring bracket and front spring seat on frame rail with four washers, bolts, washers, and locknuts. Tighten locknuts to 261 lb-ft (354 N•m) (Figure 9-135).
2. Install coil spring.

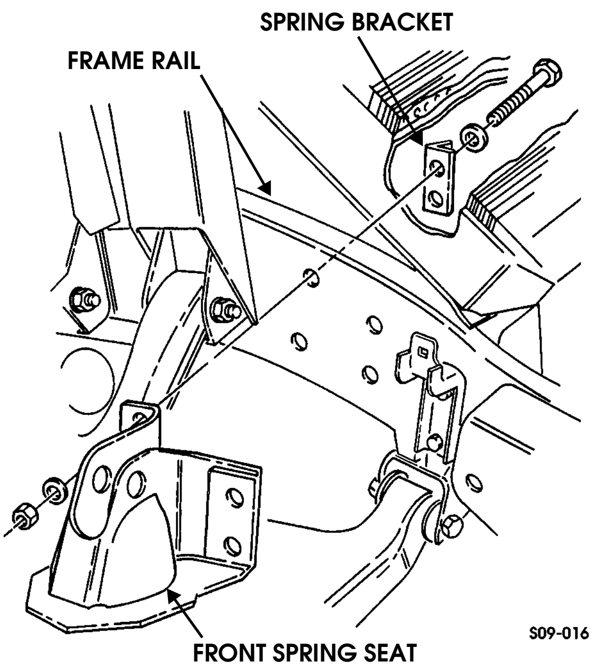


Figure 9-135: Front Spring Seat Replacement

REAR BUMPER OUTER MOUNTING BRACKET AND TIEDOWN BRACKET REPLACEMENT

Removal

1. Remove rear body mount (Section 10).
2. Remove two locknuts, washers, bolts, and washers securing tiedown bracket and outer mounting bracket to mounting bracket and rear bumper (Figure 9-136).
3. Remove two bolts and washers securing outer mounting bracket to mounting bracket.
4. Remove four locknuts, washers, bolts, washers, outer mounting bracket, and spacer from frame rail and inner mounting bracket.

Installation

NOTE: Ensure spacer on inner side of frame rail is in position before installing spacer and outer mounting bracket.

1. Install spacer and outer mounting bracket on frame rail and inner mounting bracket with four washers, bolts, washers, and locknuts. Do not tighten locknuts (Figure 9-136).
2. Secure outer mounting bracket to mounting bracket with two washers and bolts. Do not tighten bolts.
3. Install tiedown bracket on rear bumper and secure tiedown bracket and outer mounting bracket to mounting bracket and rear bumper with two washers, bolts, washers, and locknuts.
4. Tighten all locknuts and bolts to 90 lb-ft (122 N•m).
5. Install rear body mount (Section 10).

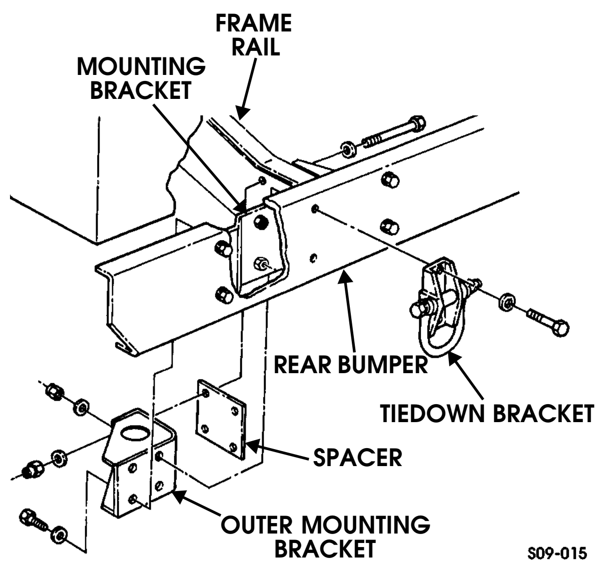


Figure 9-136: Rear Bumper Mounting Bracket Replacement

LEFT ENGINE MOUNT BRACKET REPLACEMENT

Removal

1. Remove two bolts securing brake line and oil line clamps to engine mount bracket (Figure 9-137).
2. Remove two locknuts and washers securing engine mount bracket to insulator.

CAUTION: *To avoid engine oil pan damage, wood block must completely cover bottom of oil pan.*

3. Support engine under engine oil pan with wood block and jack stand (Figure 9-138).
4. Remove four locknuts, washers, bolts, washers, and engine mount bracket from frame rail (Figure 9-137).

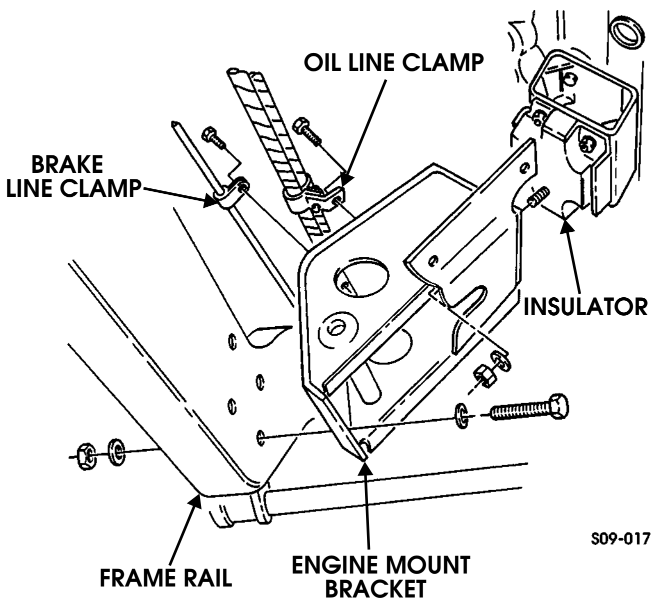


Figure 9-137: Left Engine Mount Bracket Replacement

Installation

1. Install engine mount bracket on frame rail with four washers, bolts, washers, and locknuts. Tighten locknuts to 90 lb-ft (122 N•m) (Figure 9-137).
2. Remove wood block and jack stand from under engine oil pan (Figure 9-138).
3. Secure engine mount bracket to insulator with two washers and locknuts. Tighten locknuts to 90 lb-ft (122 N•m) (Figure 9-137).
4. Secure brake line and oil line clamps to engine mount bracket with two bolts.

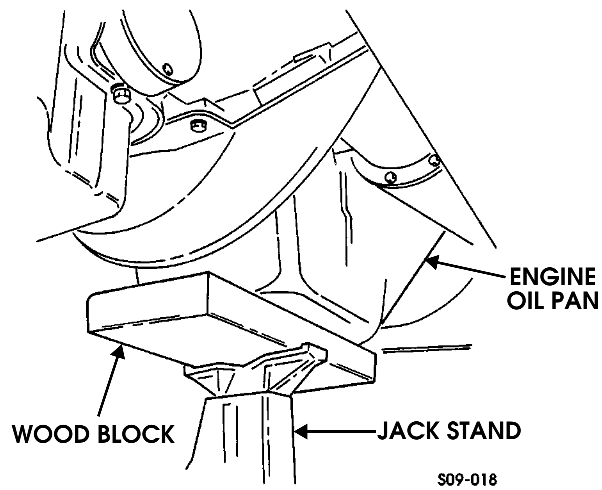


Figure 9-138: Supporting Engine

RIGHT ENGINE MOUNT BRACKET REPLACEMENT

Removal

1. Remove right engine mount and insulator (Section 2).
2. Remove two locknuts, washers, bolts, and washers securing support bracket to engine mount bracket (Figure 9-139).
3. Remove bolt securing vent tube clamp to engine mount bracket.
4. Remove three locknuts, washers, bolts, washers, support bracket, and engine mount bracket from frame rail.

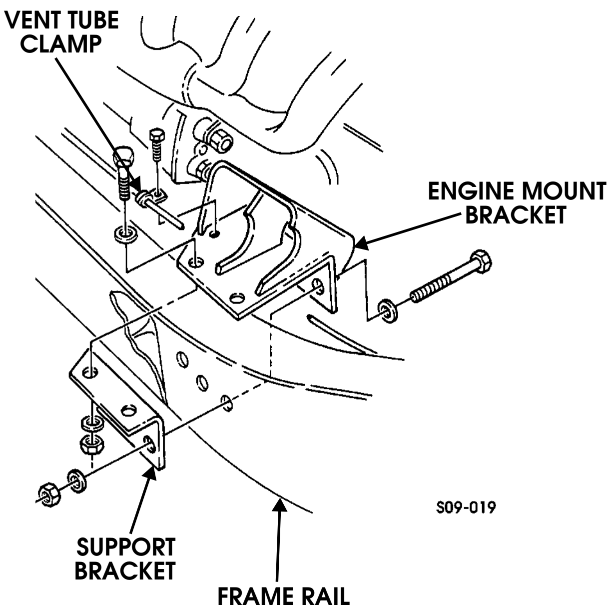


Figure 9-139: Right Engine Mount Bracket Replacement

Installation

1. Install support bracket and engine mount bracket on frame rail with three washers, bolts, washers, and locknuts (Figure 9-139).
2. Install support bracket on engine mount bracket with two washers, bolts, washers, and locknuts. Tighten locknuts to 90 lb-ft (122 N•m).
3. Install vent tube clamp on engine mount bracket with bolt.
4. Install right engine mount and insulator (Section 2).

RIGHT FRONT BODY MOUNT BRACKET REPLACEMENT

Removal

1. Remove right front body mount.
2. Remove three locknuts, washers, bolts, washers, and right front body mount bracket from frame rail (Figure 9-140).

Installation

1. Install right front body mount bracket on frame rail with three washers, bolts, washers, and locknuts. Tighten locknuts to 90 lb-ft (122 N•m) (Figure 9-140).
2. Install right front body mount (Section 10).

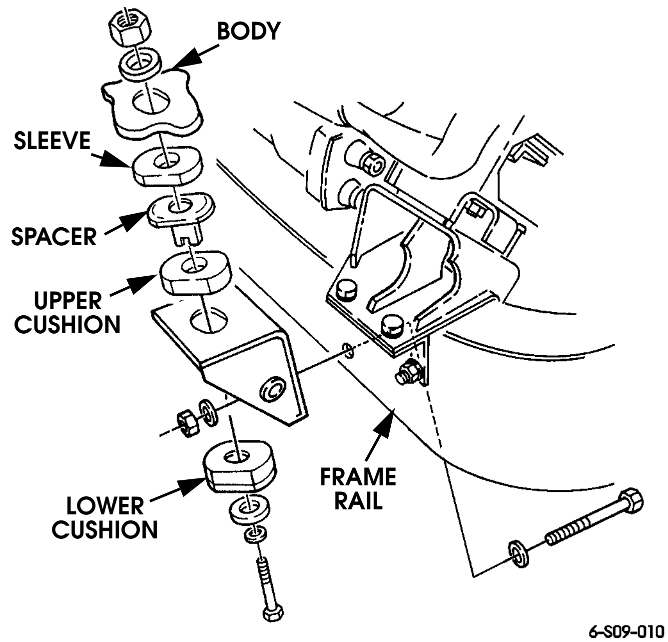


Figure 9-140: Right Front Body Mount Bracket Replacement

TRANSMISSION MOUNT CROSSMEMBER REPLACEMENT

Removal

CAUTION: *To prevent equipment damage during removal and installation of transmission mount crossmember, transmission must be supported.*

1. Place support under transmission and remove two locknuts, washers, bolts, and washers securing transmission mount crossmember to two transmission support brackets (Figure 9-141).
2. Remove two locknuts, washers, and transmission mount crossmember from transmission mount.

Installation

1. Install transmission mount crossmember on two transmission support brackets with two washers, bolts, washers, and locknuts. Tighten locknuts to 90 lb-ft (122 N•m) (Figure 9-141).
2. Install crossmember on transmission mount with two washers and locknuts. Tighten locknuts to 28 lb-ft (38 N•m).
3. Remove support.

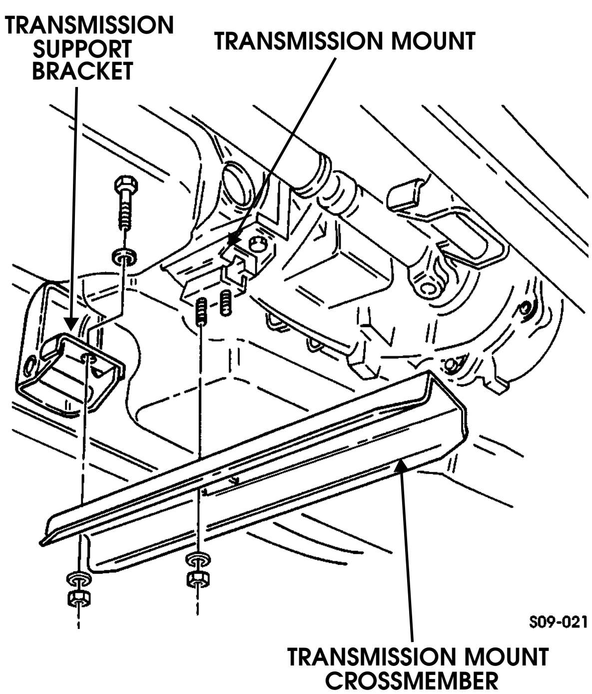


Figure 9-141: Transmission Mount Crossmember Replacement

TRANSMISSION CROSSMEMBER SUPPORT BRACKET REPLACEMENT

Removal

1. Remove transmission mount crossmember.
2. Remove two locknuts and washers securing transmission crossmember support bracket to frame rail (Figure 9-142).

Installation

1. Install transmission crossmember support bracket on two bolts and frame rail with two washers and locknuts. Tighten locknuts to 90 lb-ft (122 N•m) (Figure 9-142).
2. Install transmission mount crossmember.

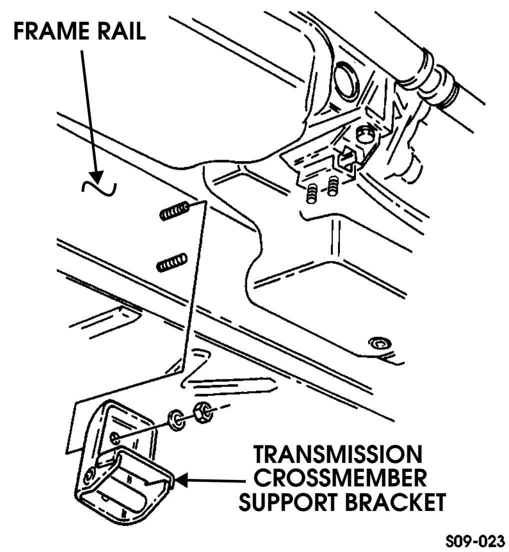


Figure 9-142: Transmission Crossmember Support Bracket Replacement

RIGHT INTERMEDIATE BODY MOUNT BRACKET REPLACEMENT

Removal

1. Remove right intermediate body mount (Section 10).
2. Remove three bolts, washers, and body mount bracket from frame rail (Figure 9-143).

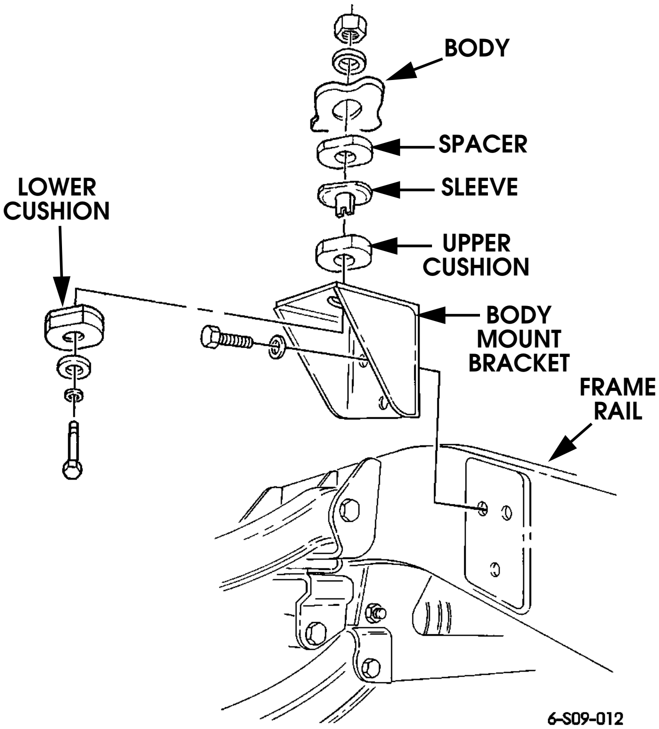


Figure 9-143: Right Intermediate Body Mount Bracket Replacement

Installation

1. Apply thread-locking compound to three bolts and install body mount bracket on frame rail with three washers and bolts. Tighten bolts to 90 lb-ft (122 N•m) (Figure 9-143).
2. Install right intermediate body mount (Section 10).

LEFT INTERMEDIATE BODY MOUNT BRACKET REPLACEMENT

Removal

1. Remove left intermediate body mount (Section 10).
2. Remove tailpipe hanger (Section 11).
3. Remove three locknuts, washers, and body mount bracket from frame rail (Figure 9-144).

Installation

1. Install body mount bracket on three bolts and frame rail with three washers and locknuts. Tighten locknuts to 90 lb-ft (122 N•m) (Figure 9-144).
2. Install tailpipe hanger (Section 11).
3. Install left intermediate body mount (Section 10).

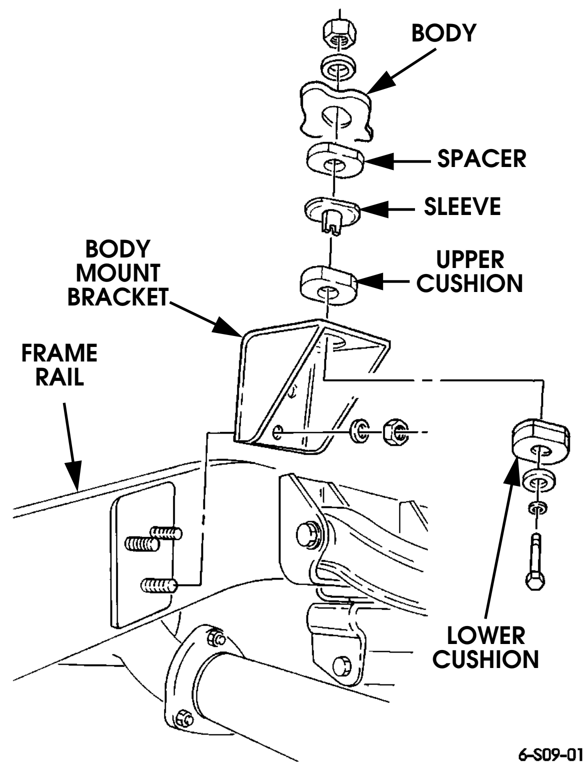


Figure 9-144: Left Intermediate Body Mount Bracket Replacement

REAR-REAR TIEDOWN BRACKET REPLACEMENT

Removal

Remove two locknuts, washers, bolts, washers, and tie-down bracket from frame rail (Figure 9-145).

Installation

Install tiedown bracket on frame rail with two washers, bolts, washers, and locknuts. Tighten locknuts to 261 lb-ft (354 N•m) (Figure 9-145).

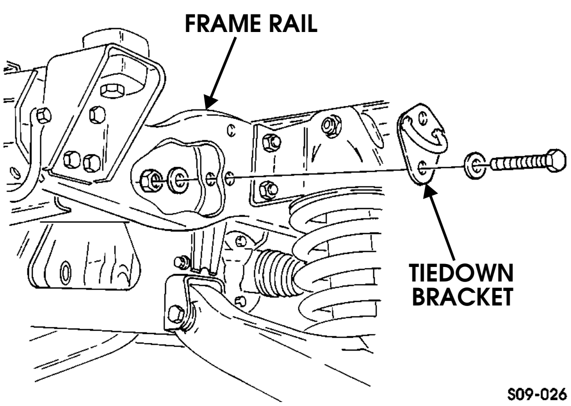


Figure 9-145: Tiedown Bracket Replacement

REAR UPPER CONTROL ARM BRACKET REPLACEMENT

NOTE: The procedure for removing and installing the four rear upper control arm brackets is basically the same. This procedure covers the right rear upper control arm front bracket.

Removal

1. Remove wheel.
2. Remove bolt, clamp, and vent line from bracket, and disconnect vent line from fitting (Figure 9-146).
3. Remove two locknuts, washers, bolts, washers, and upper control arm from two control arm brackets (Figure 9-147).
4. Remove four locknuts, washers, bolts, washers, vent line mounting bracket, and control arm bracket from frame rail.

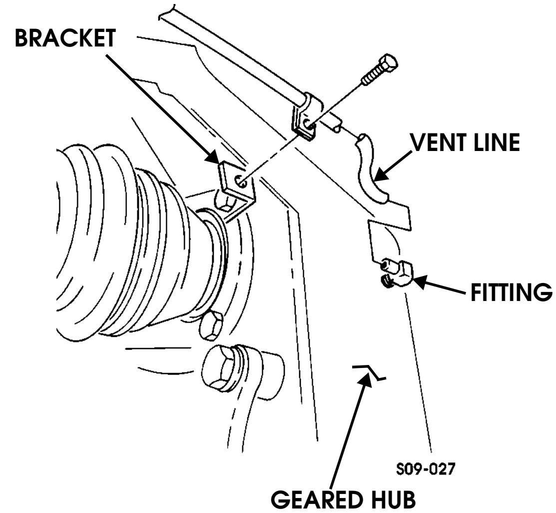


Figure 9-146: Rear Geared Hub Vent Line Location

Installation

1. Install control arm bracket, and vent line mounting bracket on frame rail with four washers, bolts, washers, and locknuts. Tighten locknuts to 172 lb-ft (233 N•m) (Figure 9-147).
2. Attach upper control arm to two upper control arm brackets with two washers, bolts, washers, and locknuts. Tighten locknuts to 260 lb-ft (353 N•m).
3. Connect vent line to fitting and secure clamp and vent line to bracket with bolt (Figure 9-146).
4. Install wheel.

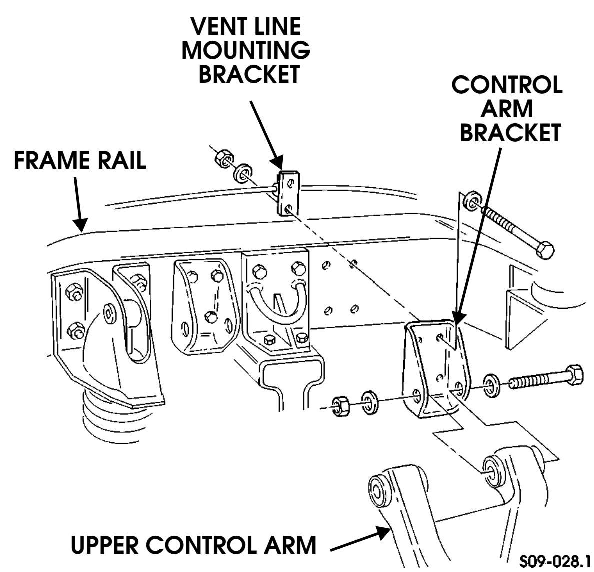


Figure 9-147: Rear Upper Control Arm Bracket Replacement

REAR-FRONT TIEDOWN BRACKET REPLACEMENT

Removal

1. Remove wheel (Section 6).
2. Remove four locknuts, washers, bolts, washers, and tiedown bracket from frame rail (Figure 9-148).
3. Remove two locknuts, washers, bolts, washers, vent tube mounting bracket, and tiedown bracket from rear suspension front crossmember mounting bracket.

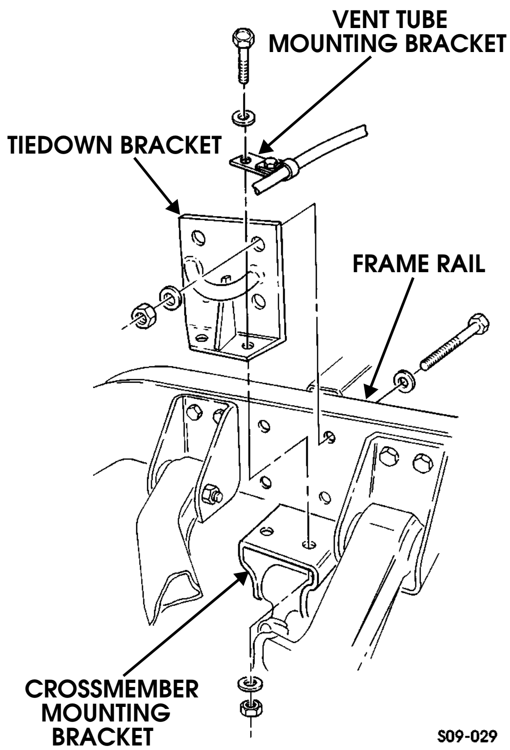


Figure 9-148: Rear-Front Tiedown Bracket Replacement

Installation

1. Install tiedown bracket and vent tube mounting bracket on rear suspension front crossmember mounting bracket with two washers, bolts, washers, and locknuts. Tighten locknuts to 90 lb-ft (122 N•m) (Figure 9-148).
2. Install tiedown bracket on frame rail with four washers, bolts, washers, and locknuts. Tighten locknuts to 261 lb-ft (354 N•m).
3. Install wheel.

AXLE SUPPORT BRACKET AND SIDE MOUNTING BRACKET REPLACEMENT

Removal

1. Remove brake caliper and rotor.
2. Remove locknut, seal washer, and output flange from output shaft. Discard seal washer (Figure 9-149).
3. Remove two bolts and brake adapter from axle.
4. Remove two bolts and washers securing side mounting bracket to axle (Figure 9-150).
5. Remove two locknuts, washers, bolts, washers, support bracket, and side mounting bracket from crossmember.
6. Remove two locknuts, washers, bolts, washers, and side mounting bracket from support bracket (Figure 9-151).

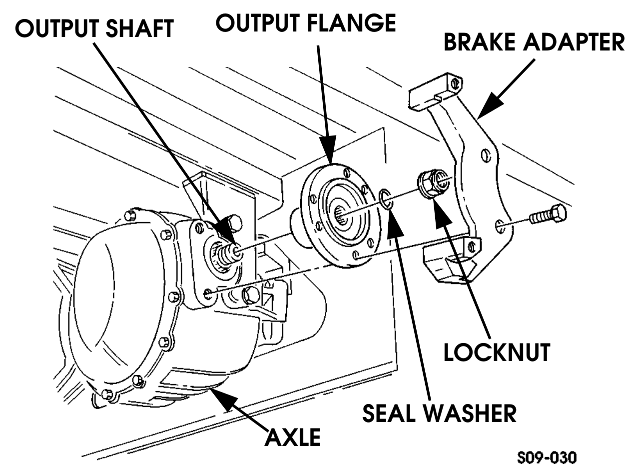


Figure 9-149: Brake Adapter and Output Flange Replacement

Installation

1. Install side mounting bracket on support bracket with two washers, bolts, washers, and locknuts (Figure 9-151).
2. Install support bracket and side mounting bracket on crossmember with two washers, bolts, washers, and locknuts (Figure 9-150). Do not tighten bolts.
3. Apply thread-locking compound to tapped holes of axle and install two washers, bolts, and side mounting bracket on axle. Tighten side mounting bracket bolts to 110-139 lb-ft (149-189 N•m) and support bracket bolts to 90 lb-ft (122 N•m).
4. Apply thread-locking compound to tapped holes of axle and install brake adapter on axle with two bolts. Tighten bolts to 110-139 lb-ft (149-189 N•m) (Figure 9-149).
5. Install output flange on output shaft with seal washer and locknut. Tighten locknut to 170 lb-ft (231 N•m).
6. Install brake caliper and rotor.

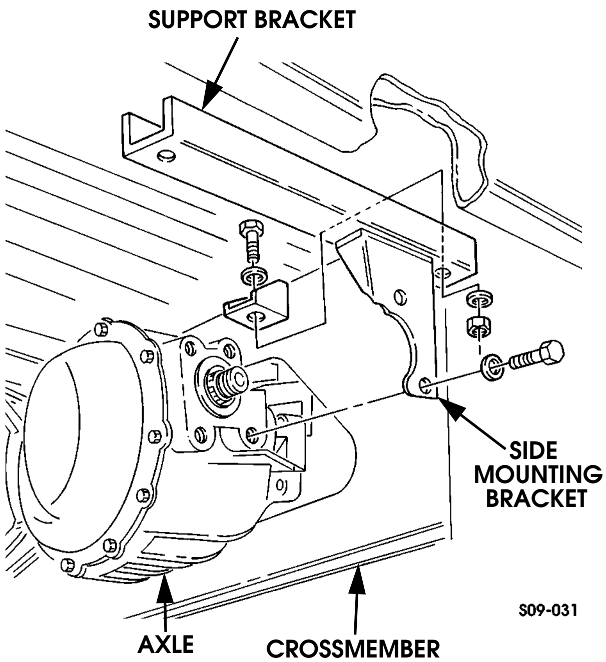


Figure 9-150: Side Mounting Bracket Removal

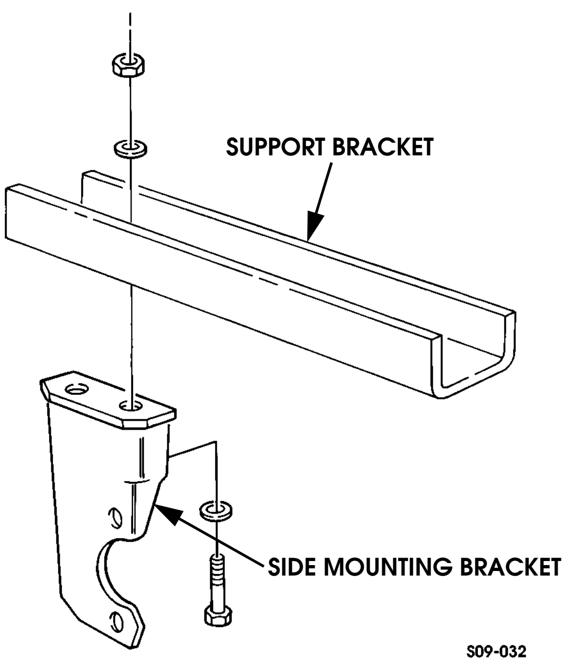


Figure 9-151: Support Bracket Replacement

FRONT SUSPENSION FRONT CROSSMEMBER REPLACEMENT

Removal

1. Remove front lower control arms.
2. Remove lower radiator hose.
3. Remove horn.
4. Remove radiator front mounting bracket.
5. Remove two nuts, washers, bolts, and washers securing front crossmember to support bracket (Figure 9-150).

NOTE: Note direction of bolts for installation.

6. Remove four locknuts, washers, bolts, and washers securing two splash shield brackets to frame rails (Figure 9-152).

WARNING: WARNING: To avoid personal injury, support crossmember during removal.

7. Remove bolt and clamp securing harness to front crossmember (Figure 9-153).
8. Remove four locknuts, washers, bolts, and washers securing crossmember mounting brackets to frame rails.
9. Slide crossmember and mounting brackets down and out from under vehicle.
10. Remove six locknuts, washers, bolts, washers, and left and right mounting brackets from crossmember.

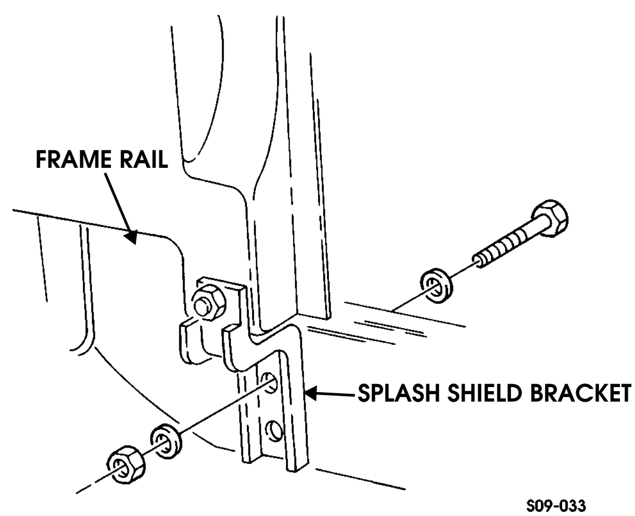


Figure 9-152: Splash Shield Mounting

Installation

1. Position left and right crossmember mounting brackets on crossmember (Figure 9-153).
2. Install crossmember and mounting brackets on frame rails with four washers, bolts, washers, and locknuts. Do not tighten locknuts.
3. Install left and right mounting brackets on crossmember with six washers, bolts, washers, and locknuts. Tighten locknuts to 90 lb-ft (122 N•m).
4. Tighten mounting bracket-to-frame rail locknuts to 261 lb-ft (354 N•m).
5. Secure harness to crossmember with clamp and bolt.
6. Install four washers, bolts, washers, locknuts, and two splash shield brackets on frame rails. Tighten locknuts to 90 lb-ft (122 N•m) (Figure 9-152).
7. Secure front crossmember to support bracket with two washers, bolts, washers, and nuts (Figure 9-150).
8. Install horn.
9. Install lower radiator hose.
10. Install radiator front mounting bracket.
11. Install front lower control arms.

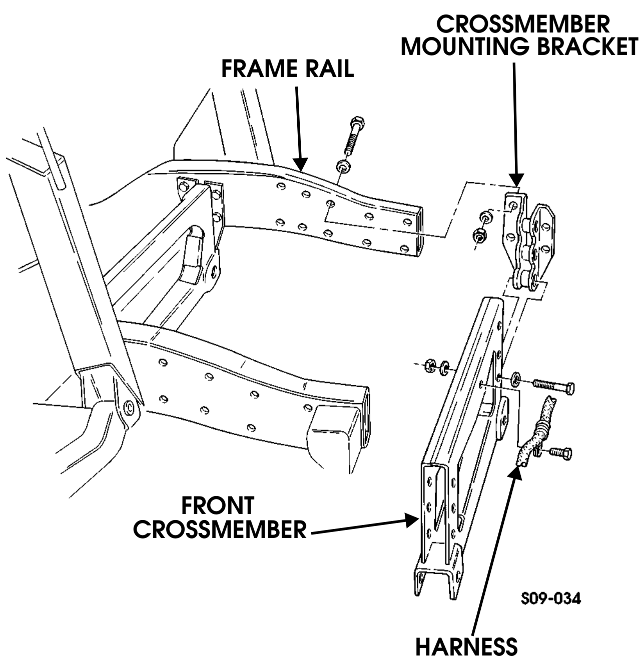


Figure 9-153: Front Crossmember Replacement

FRONT SUSPENSION REAR CROSSMEMBER REPLACEMENT

Removal

1. Remove radiator (Section 4).
2. Remove right front upper control arm.
3. Remove lower radiator tube.
4. Remove right front caliper-to-tee brake line.
5. Remove lower control arms.
6. Remove axle.
7. Remove axle support brackets and side mounting brackets.
8. Remove three bolts, lockwashers, and washers and pull steering gear away from left frame rail (Figure 9-154).
9. Remove three bolts and clamps from two vent line brackets and crossmember (Figure 9-155).

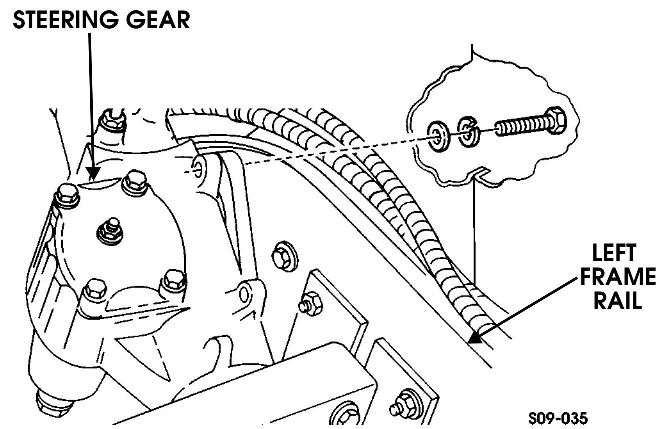


Figure 9-154: Steering Gear and Left Frame Rail Location

WARNING: To avoid personal injury, support crossmember during removal.

NOTE: Note direction of bolts for installation.

10. Remove four locknuts, washers, bolts, washers, and vent line bracket securing rear crossmember to right frame rail.
11. Remove three locknuts, washers, bolts, washers, and vent line bracket securing rear crossmember to left frame rail.
12. Remove bolt and washer securing rear crossmember to left frame rail.
13. Remove six locknuts, washers, bolts, and washers securing rear crossmember to left and right rear crossmember mounting brackets.
14. Slide rear crossmember and mounting brackets down and out from under vehicle.
15. Remove mounting brackets from rear crossmember.

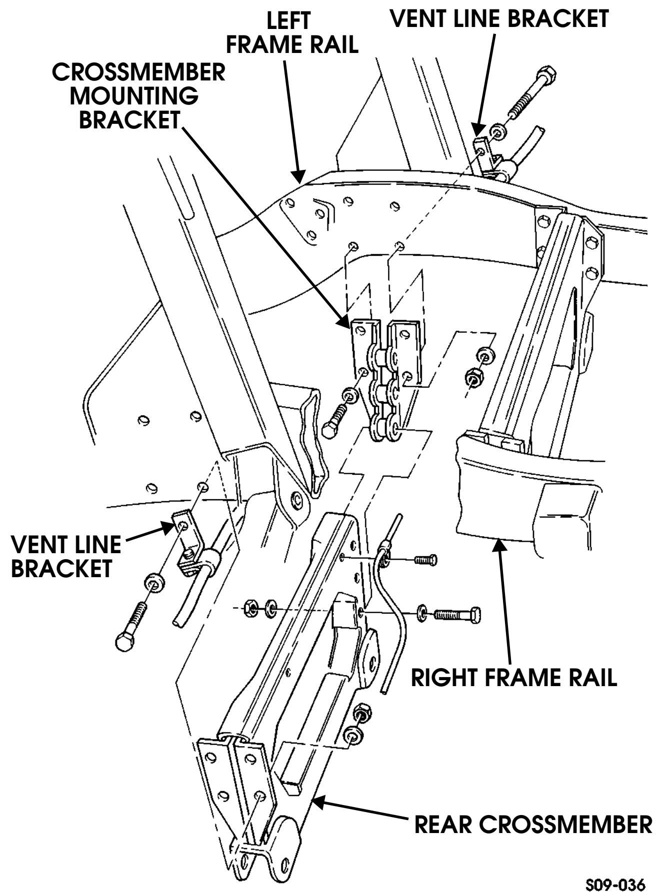


Figure 9-155: Rear Crossmember Replacement

Installation

1. Install left and right rear crossmember mounting brackets on rear crossmember (Figure 9-155).
2. Install rear crossmember and mounting brackets on frame rails.
3. Apply thread-locking compound to hole and secure crossmember mounting bracket to left frame rail with washer and bolt. Tighten bolt to 65-78 lb-ft (88-106 N•m).
4. Secure crossmember mounting bracket to left frame rail with vent line bracket, three washers, bolts, washers, and locknuts. Do not tighten bolts.
5. Secure crossmember mounting bracket to right frame rail with vent line bracket, four washers, bolts, washers, and locknuts. Do not tighten bolts.
6. Install six washers, bolts, washers, and locknuts securing rear crossmember to left and right mounting brackets. Tighten bolts to 90 lb-ft (122 N•m).
7. Tighten three bolts on mounting bracket and left frame rail to 90 lb-ft (122 N•m).
8. Tighten four bolts on mounting bracket and right frame rail to 90 lb-ft (122 N•m).
9. Secure vent line to rear crossmember and two vent line brackets with three clamps and bolts.
10. Secure steering gear to left frame rail with three washers, lockwashers, and bolts. Tighten bolts to 60 lb-ft (81 N•m) (Figure 9-154).
11. Install axle support brackets and side mounting brackets.
12. Install axle.
13. Install lower control arms.
14. Install right front caliper-to-tee brake line.
15. Install right front upper control arm.
16. Install lower radiator tube.
17. Install radiator.

REAR SUSPENSION FRONT CROSSMEMBER REPLACEMENT

Removal

1. Remove rear-front tiedown brackets.
2. Remove axle (Section 6).
3. Remove axle support brackets and side mounting brackets.
4. Remove rear lower control arms.
5. Remove three bolts and clamps securing brake line and two vent lines to front crossmember (Figure 9-156) and (Figure 9-157).
6. Remove brake line from tee and tube coupling.

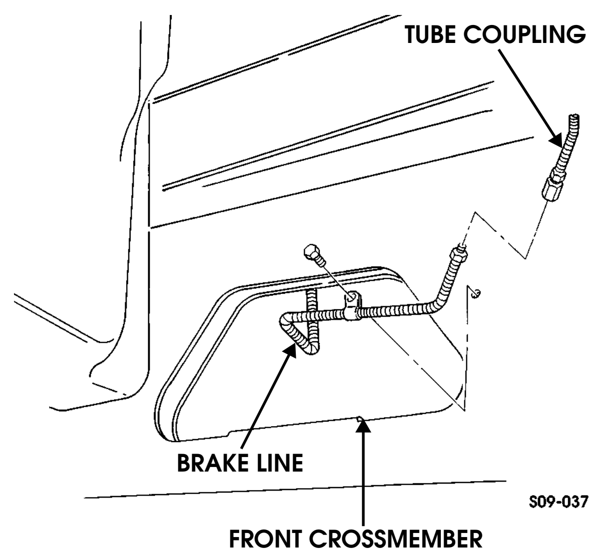


Figure 9-156: Brake Line and Tube Coupling Location

7. Remove two locknuts, washers, bolts, washers, and two radius rods from crossmember mounting brackets (Figure 9-158).

WARNING: To avoid personal injury, support cross-member during removal.

8. Loosen six locknuts securing front crossmember to crossmember mounting brackets.
9. Slide front crossmember down and out from under vehicle.
10. Remove six locknuts, washers, bolts, washers, and two crossmember mounting brackets from front crossmember.

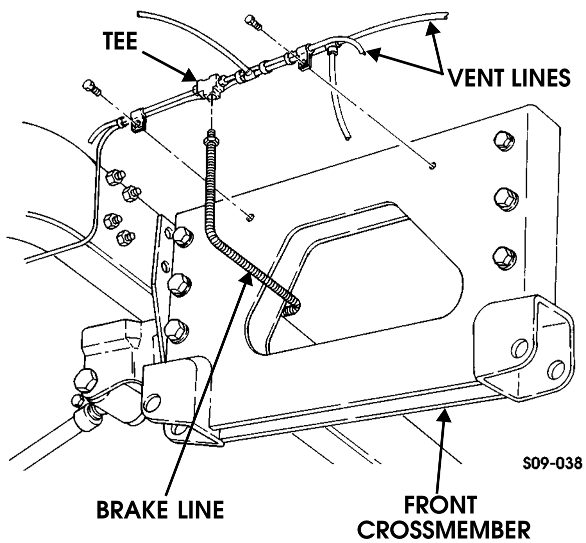


Figure 9-157: Brake Line and Vent Lines Location

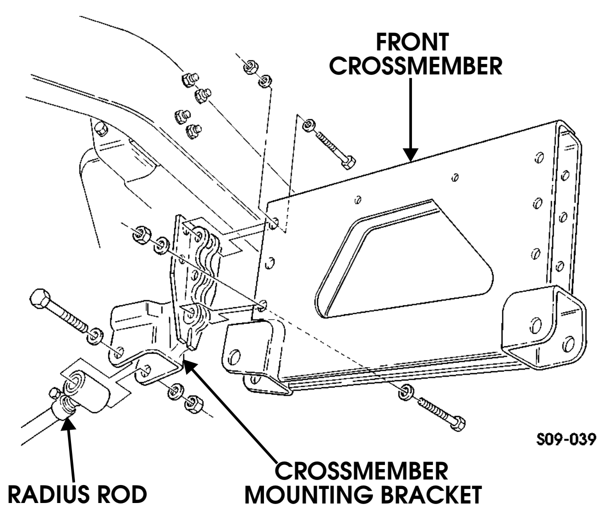


Figure 9-158: Front Crossmember Assembly Replacement

Installation

1. Install two crossmember mounting brackets on front cross-member with six washers, bolts, washers, and locknuts. Tighten locknuts to 90 lb-ft (122 N•m) (Figure 9-158).
2. Install front crossmember on frame rails.
3. Install rear-front tiedown brackets.
4. Install radius rods in crossmember mounting brackets with two washers, bolts, washers, and locknuts. Tighten locknuts to 260 lb-ft (353 N•m).
5. Install brake line on tee and tube coupling (Figure 9-156) and (Figure 9-158).
6. Secure brake line and two vent lines to front crossmember with three clamps and bolts.
7. Install axle support brackets and side mounting brackets.
8. Install axle.
9. Install rear lower control arms.
10. Bleed rear brakes.

FRAME INSPECTION

General Information

The frame rails are constructed by arc-welding two "C" channels of preformed steel together to form a box cross section. The frame rails are internally reinforced at bolt hole locations by bushings or full cross-section spacers to prevent channels from collapsing from attaching load. The frame is made by bolting two non-identical frame rails to crossmembers. Crossmembers are held to stringent dimensional tolerances and therefore must be replaced if damaged.

INSPECTION

The visual inspection is the first and most critical step in forming a decision of whether to repair or replace a damaged frame component (Figure 9-159). Factors to consider when making a visual inspection are:

1. Twisted frame rails are not repairable and must be replaced.
2. Transverse tears or breaks extending across or into both upper or lower corners are not repairable by welding.
3. Short longitudinal cracks up to 6 inches (15.2 cm) or split welds can be repaired by heli-arc welding.

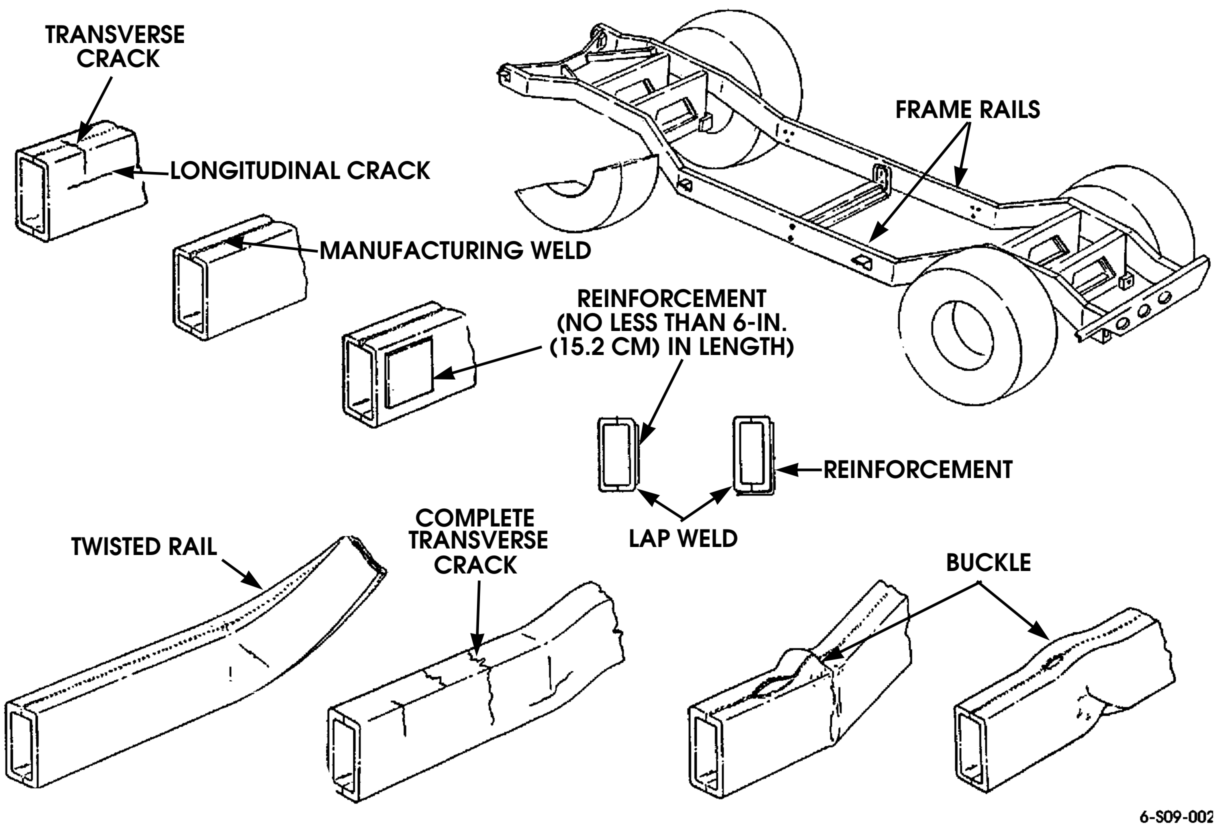


Figure 9-159: Frame Damage

VERTICAL (SIDE VIEW) MEASUREMENT

1. Select a hard and level surface area 1-1/2 times the size of the vehicle.
2. Raise vehicle at four points until all four wheels are off the surface.

WARNING: When using shim material with jackstands, the shim material must be placed squarely and firmly under the jackstand. The vehicle could be knocked off the jackstand resulting in personal injury or equipment damage if shim material is placed on top of jackstand.

3. Measure the distance from the floor to the bottom of the frame near each jackstand. Place shim(s) under jackstands as necessary until the floor-to-frame distances are equal at each jackstand.

NOTE: Measurements must be taken at identical locations on the left and right frame rails. Failure to do so will result in a faulty indication.

4. Select, measure and record the distance from the floor to the frame rail at several different points on either frame rail.
5. Measure and record frame rail height at corresponding points on opposite frame rail.
6. Compare measurements from both frame rails. Measurements from comparable points deviating more than 1/8-inch (3 mm) for each 2 feet of linear distance indicates a vertically bent frame.
7. Lower vehicle from jackstands.

HORIZONTAL (BOWING) MEASUREMENT

1. Position vehicle on a smooth level surface.
2. Measure height of frame rails at each end near center of crossmembers. If heights vary by more than 1/8-5/16-inch (3-8 mm), raise frame rail and install jackstands to bring frame to level.

WARNING: When using shim material with jackstands, the shim material must be placed squarely and firmly under the jackstand. The vehicle could be knocked off the jackstand resulting in personal injury damage if shim material is placed on top of jackstand.

3. Hang a plumb bob at the corner of one frame rail where the frame rail intersects the crossmember. Tape a piece of paper to the floor under plumb bob and mark location where plumb bob stops moving. Repeat procedure for each corner of the frame (Figure 9-162).

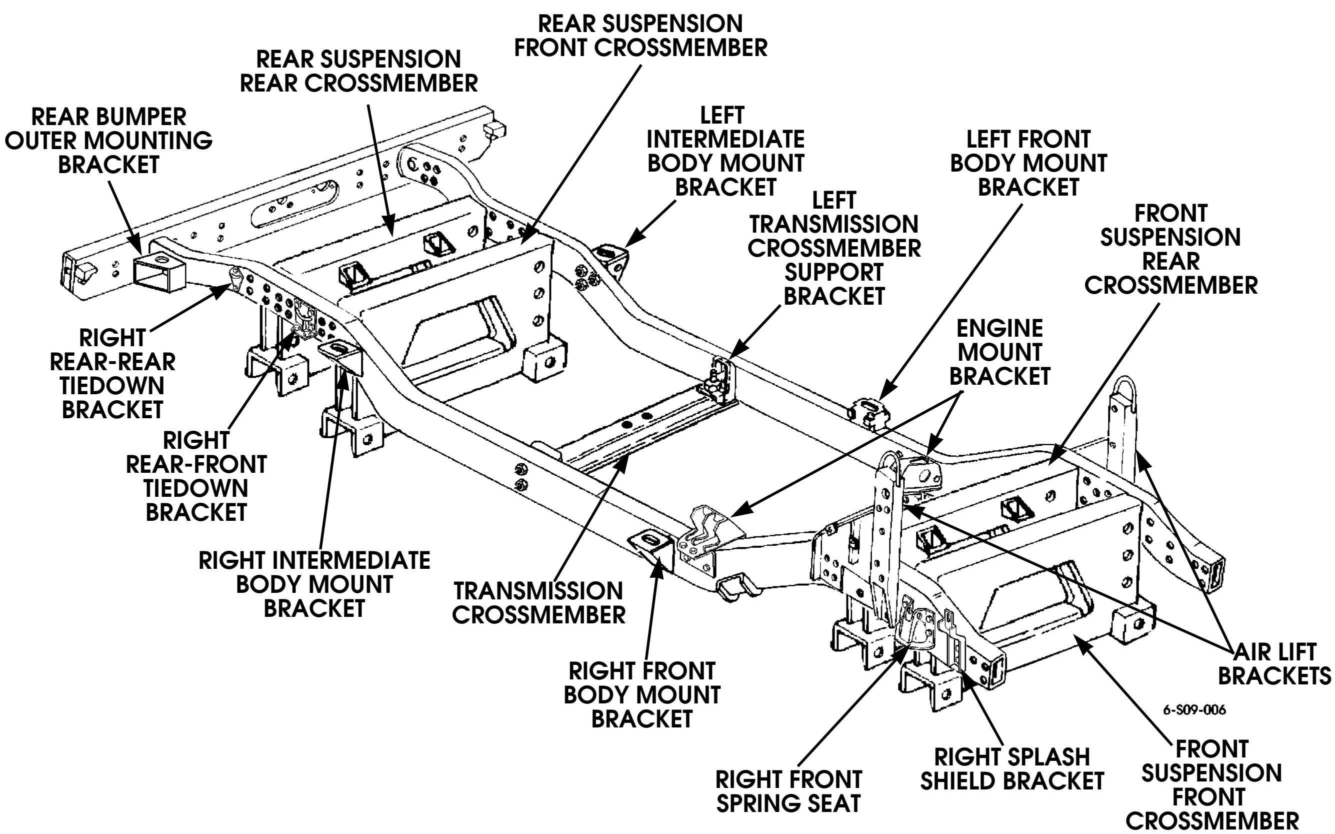


Figure 9-160: Frame Components

NOTE: Strings used for this horizontal bow measurement will remain in place until the next measurement (Frame Skew) is completed. To maintain the integrity of the measurements, the string must be pulled tight and secured.

4. Stretch string tightly on floor between front and rear plumb bob marks under each frame rail (Figure 9-162).
5. Measure front and rear crossmembers to determine center point. Drop a plumb bob from crossmember center points to the floor. Mark location where plumb bob stops moving (Figure 9-162).
6. Stretch a string tightly on floor between front and rear plumb bob marks under crossmembers to determine centerline (Figure 9-162).
7. Select measuring points an equal distance apart along the right and left strings. Measure from these right and left points to the center string. Mark center string. The distance from the right and left points to the center string should be within 1/4-inch (6 mm) of being equal. If measurements are not equal, one frame rail is bowed.

DIAGONAL (SKEW MEASUREMENT)

METHOD 1

1. Measure diagonally from one point on right or left frame rail string to a point on opposite frame rail string (Figure 9-161).
2. Compare to an opposite diagonal measurement.
3. If the two measurements differ by more than 1/4-inch (6 mm), the frame rails are skewed.
4. Repeat this procedure at four other sets of measure points to confirm the skew.

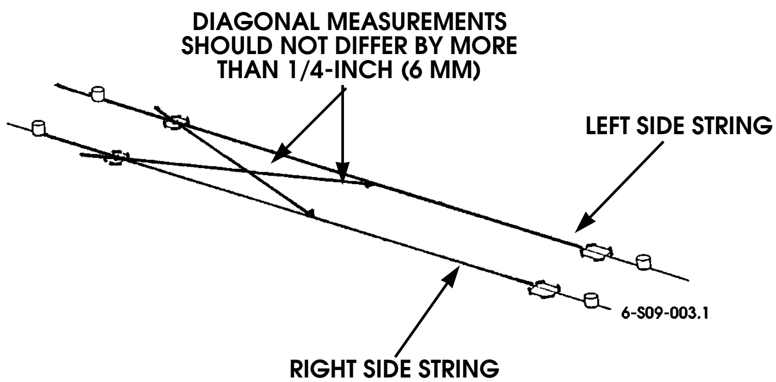


Figure 9-161: Diagonal Skew Measurement Method I

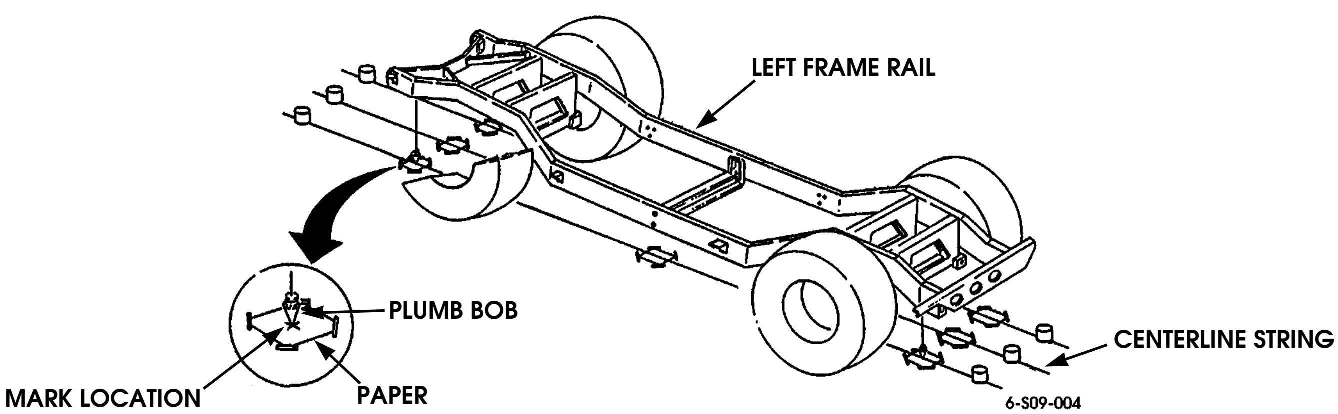


Figure 9-162: Horizontal (Bowing) Measurement

METHOD 2

1. Position a string across a plumb bob point on each of the frame rail strings (Figure 9-163).
2. Place a square with one leg coincident with a frame rail string (Figure 9-163).
3. Run a line or string along other leg of square to opposite frame rail string (Figure 9-163).
4. Measure deviation between string positioned in Step 1 and square leg line or string. Any deviation means the two frame rails are skewed and, consequently, the crossmembers are not at square angles to the frame rails. A deviation of 1/2-inch (12.7 mm) makes a vehicle "dog track" and it is difficult to align the wheels.

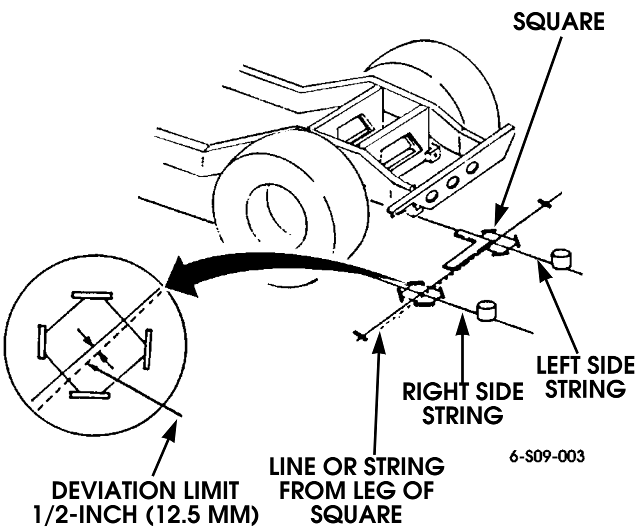


Figure 9-163: Diagonal Skew Measurement Method 2

FRAME REPAIRS

Cracks

NOTE: All frame welding should be heli-arc type.

1. Cracks not extending across two adjacent faces of the frame rail may be welded.
   - Stop-drill crack with 1/8-inch (3 mm) drill (Figure 9-164)
   - Vee-notch crack (Figure 9-164)
   - Heli-arc weld crack with Mig or Tig welder (using a filler metal in accordance with AWS A5.18) (Figure 9-164)
   - If reinforcement or fishplate is to be added, grind weld to a flat surface (Figure 9-164)
   - A reinforcement or fishplate should be added to a frame rail with a crack in the bottom face
   - Longitudinal welding can be performed on any frame rail face
2. Welded reinforcements or fishplates should not be less than 6-inches (15.2 cm) in length along frame rail.
3. Bolt on reinforcements or fishplates should not be less than 8-inches (20.3 mm) in length. The long bottom edge of fishplate should be heli-arc lap welded to frame component.
4. Puncture holes only in side faces of frame rails may be repaired with combinations of fishplates and/or reinforcements. Welded type should only be used. Puncture holes in bottom face are not repairable and therefore the frame rail should be replaced.
5. Bolted-on repairs should use grade 8 bolts with hardened washers and nuts. Use proper torque when tightening nuts.

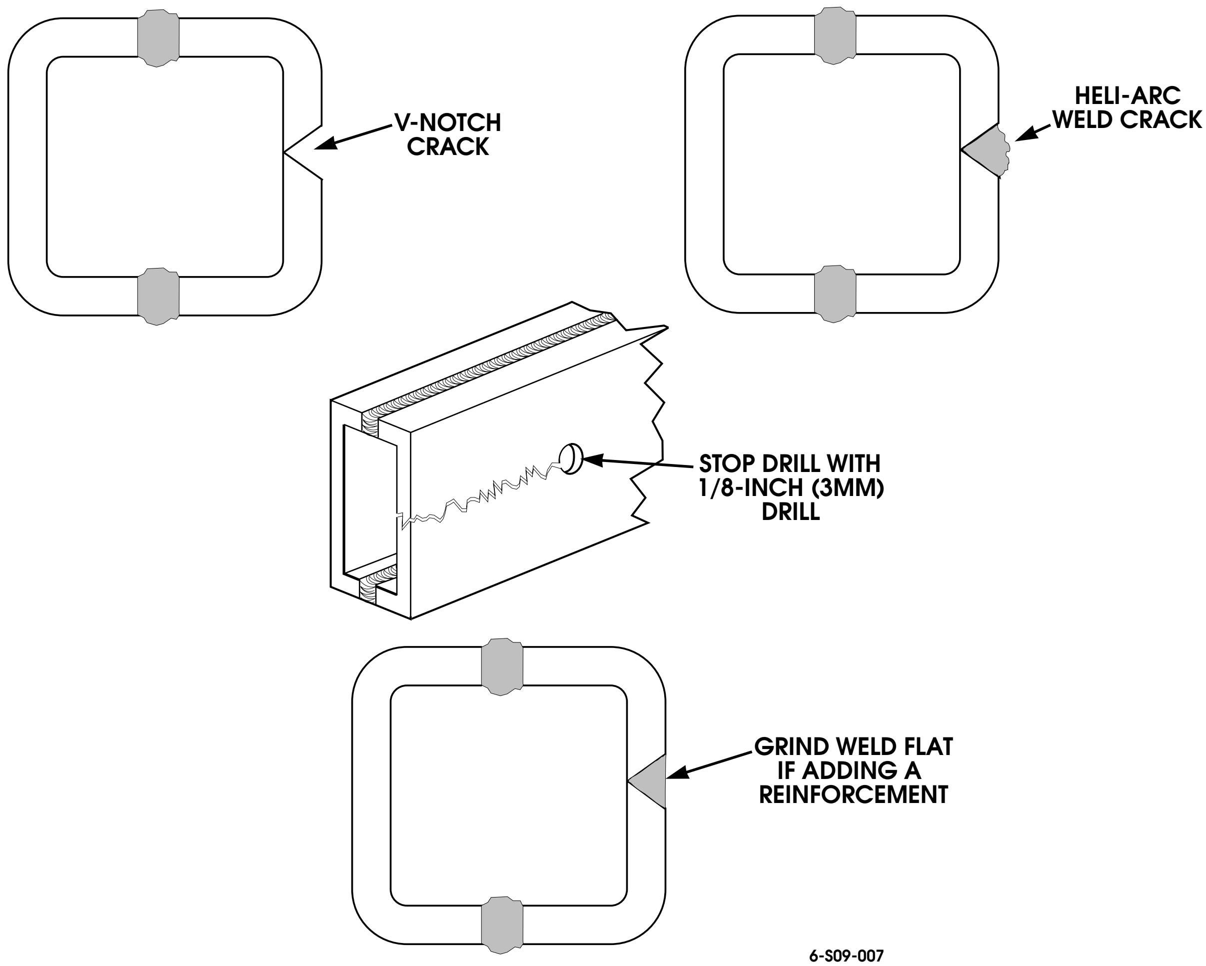


Figure 9-164: Crack Repair

Bends

1. Do not attempt to repair a bend when:
   - Buckling to a height of 1/4-inch (6 mm) on any one face of the frame rail is involved.
   - The bending also includes more than minor twisting.
   - The frame rail is bent in two directions.
   - The bending involves a collapse of one or more faces of the frame rail at a suspension or body attachment point.

Straightening

1. When performing straightening repairs with the frame on the vehicle:
   - Use spreader plates or wood blocking to distribute chain force to avoid damage to frame box section.
   - Be sure to loosen sufficient length of frame to allow frame force points to move without causing other damage.
   - Restrain vehicle movement in both directions along line of force application.
2. Vertical bends, except at end sections, require removal of frame rail from vehicle.
3. Application of bulk heating to frame components is not authorized, metal properties will be irreversibly degraded.
4. At the conclusion of a bend repair, carefully inspect welds in the vicinity of repair and area of force application. Any evidence of cracking or chipping of welds must be repaired.

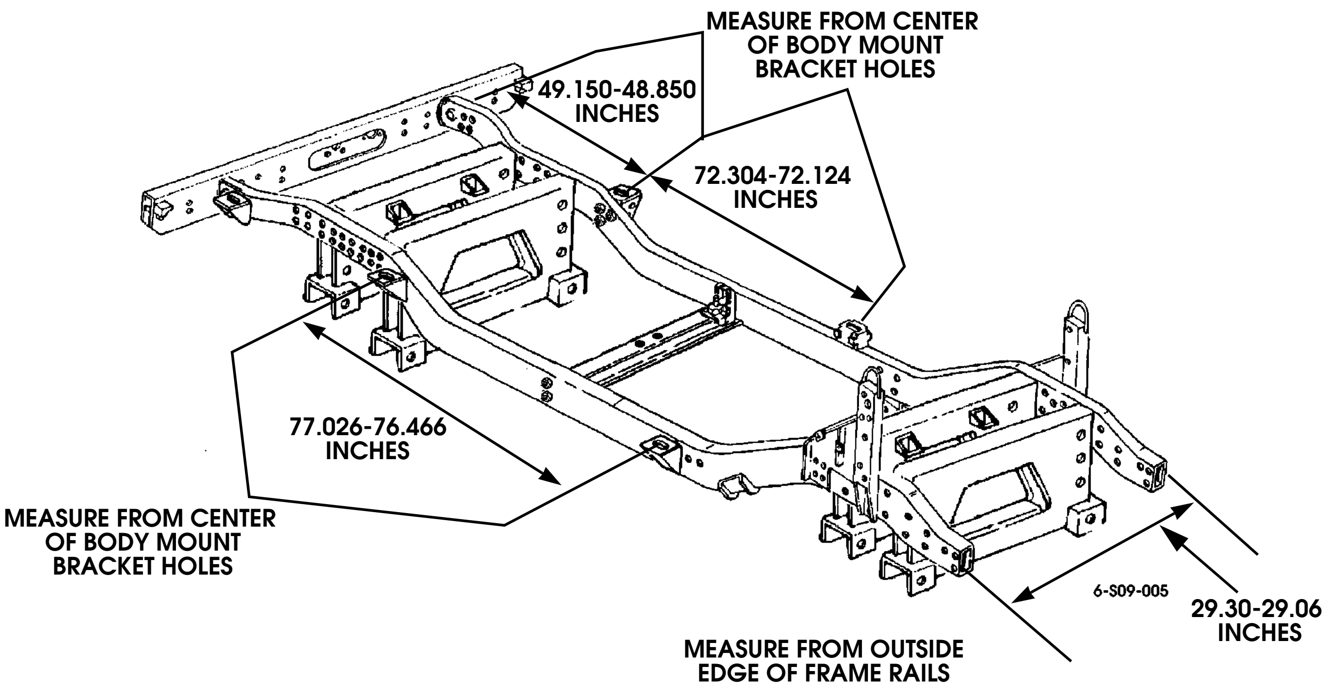
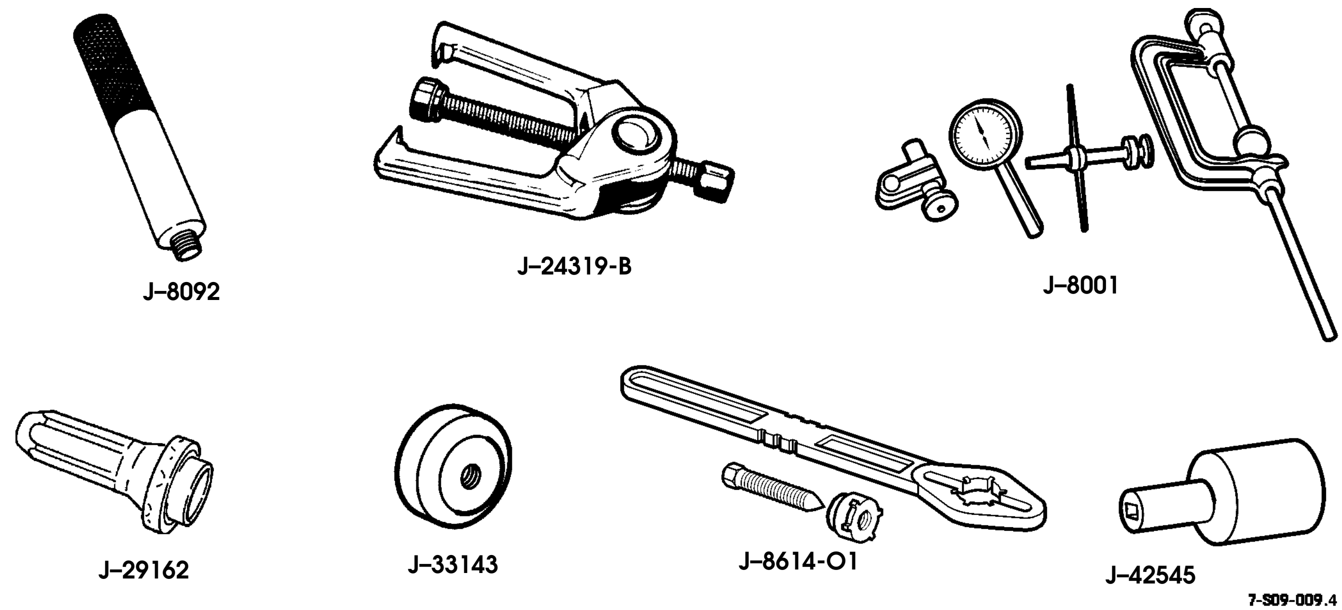


Figure 9-165: Frame Dimensions

ESSENTIAL TOOLS

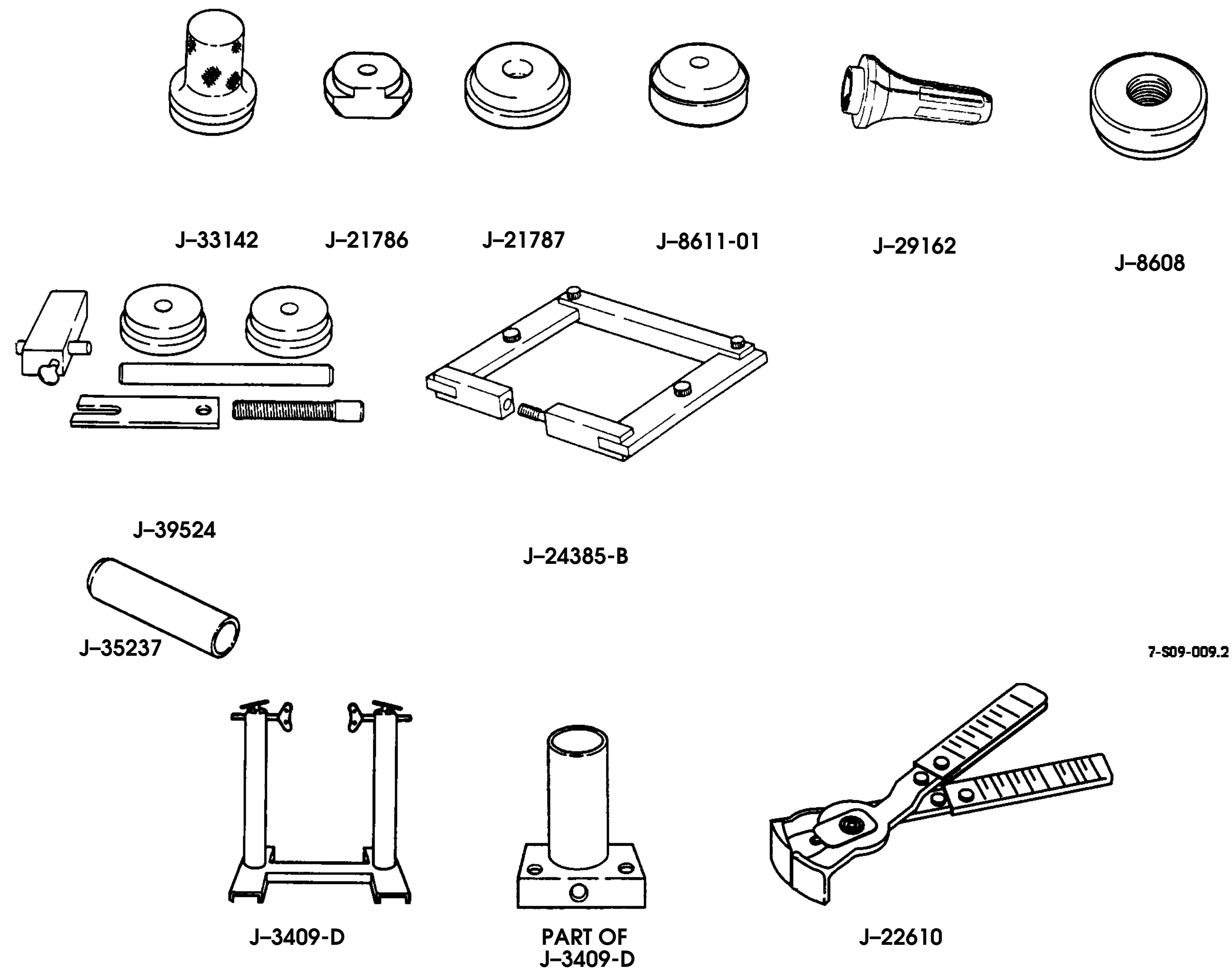


7-S09-009.4

TOOL	DESCRIPTION
J–8092	Universal Driver Handle
J–24319-B	Steering Linkage and Tie Rod Puller
J–8001	Dial Indicator
J–29162	Rear Retainer Seal Installer
J–33143	Input Seal Installer
J–8614-O1	Yoke Holding Tool
J–42545	Clampnut Socket
J–35184	Seal Installer (not shown)
J–35910	Axle Boot Crimping Tool (not shown)
J–38869	Output Shaft Seal Installer (not shown)
J–42546	1/4 in. Drive Torque Wrench (Preset) (not shown)
J–42547	3/8 in. Drive Torque Wrench (Preset) (not shown)
J–42591	Steering Cover Seal Installer (not shown)

Procure from Kent-Moore.

SPECIAL TOOLS



TOOL	DESCRIPTION
J–33142	Axle Shaft and Seal Installer
J–21786	Pinion Rear Bearing Cup Remover
J–21787	Pinion Front Bearing Cup Remover
J–8611-01	Rear Pinion Bearing Race Installer
J–29162	Rear Retaining Seal Installer
J–8608	Rear Pinion Bearing Race Installer
J–39524	Pinion Depth Gauge Set
J–24385-01	Axle Housing Spreader
J–35237	Bearing Installer
J–3409-01	Stand, with Holding Fixtures
Part of J–3409-01	Axle Holding Fixture Adapter
J–22610	Keystone Clamp Pliers

Procure from Kent-Moore.

Section 10 Body

TABLE OF CONTENTS

GENERAL BODY INFORMATION

1. The HUMMER body is constructed from high strength T6 aluminum. Welding should not be performed to make body repairs. Heat generated by welding will reverse the tempering process, causing a reduction in material strength.
2. The hood and engine access covers are made of fiberglass (sheet molding compound). Cracks, splits, or holes may be repaired with a glass-reinforced plastic laminate.
3. Solid 0.1875 in. (4.8 mm) diameter aluminum rivets are the primary method of joining body components. Each rivet is inserted into a hole through two pieces of metal, and a second head is formed by manual or pneumatic impacting, or by squeezing the rivet. When making repairs, use blind rivets of the same size, or oversize, with the appropriate grip length.
4. Blind structural aluminum rivets of 0.1875 in. (4.8 mm) diameter are used in applications where there is access from only one side of the part. Blind rivets are installed using a tool that pulls on the rivet stem causing a bulbed head to form on the back side of the part. Fastening is complete when stem breaks off. High strength is obtained in blind rivets by mechanically locking the remaining stem inside the rivet body.
5. Steel pull-type lockbolt fasteners of 0.1875 in. (4.8 mm) and 0.25 in. (6.4 mm) diameters are used where tension or high-shear loads exist. Lockbolts are two-piece unthreaded fasteners. One part is a high-strength, steel-headed, bolt-like part with serrations on its shank. The mating part is a collar which is swagged over the serrations causing the fastener to be locked in place.
6. To facilitate body repairs, it is acceptable to replace lockbolt fasteners and rivets with 0.25 in. (6.4 mm) series bolts. Do not replace lockbolt fasteners with rivets. Standard threaded fasteners should not be used, as these will quickly wear the aluminum structure. Bolt lengths should be chosen so that the cylinder portion of bolt is bearing on all members being joined. Bolts are designed as AN4-XX or AN4-C-XX, where XX defines grip length. Tighten all bolts to 71 lb in. (8 N•m).
7. Fatigue strength of riveted joints and seams is increased by epoxy adhesive application. Epoxy adhesive requires special material storage and metal preparation along with a low temperature heat cycle for curing. Where possible, extra rivets and thicker metal gauges should be used instead of adhesives when making repairs. Parts may be difficult to separate, even after rivets are removed.

BODY INSPECTION AND REPAIR

General Information

Damaged areas should be thoroughly cleaned and inspected to determine the cause and extent of damage. Body parts should be inspected for holes, cracks, dents, distortion, or breaks. Fasteners should be inspected for breaks, stretching, looseness, cracked heads, or hole elongation. Seams, flanges, and joints should be inspected for straightness or local deformation as an indication that fasteners may have been stretched or holes elongated. It is possible for this to happen and fasteners will still appear to be tight in their holes. In addition, thoroughly inspect adjacent areas to determine if high loads have been transmitted from the damaged area to other areas. This can result in secondary damage in the form of distorted panels or seams, loosened or sheared fasteners, elongated fastener holes, and/or cracks.

Classification

After the extent of damage has been determined, affected parts should be classified into one of the following categories:

- Negligible damage
- Damage repairable by patching
- Damage repairable by insertion
- Damage necessitating replacement of parts

1. Negligible damage.

Minor dents, nicks, scores, cracks, and holes in a body panel which are within, or are brought within, reasonable limits by a simple procedure without extensive rework are considered negligible damage. These defects should be considered more serious if located in main structural members such as frame rails, A-pillars, or floor crossmembers rather than in body panels such as cowls or rear wheelhouses. Deep wrinkles of undetermined origin in body panels should not be classed as negligible until the source of the wrinkles has been investigated and positively identified. Damage other than small dents, holes, nicks, and scratches will require repair or replacement of the part.

- Negligible Cracks. Isolated cracks less than 0.50 in. (1.27 cm) long may be classified as negligible cracks provided they are stop drilled at each end to stop propagation.
- Negligible Holes. Isolated holes no more than 0.50 in. (1.27 cm) in diameter (after they are made round with smooth edges) are classified as negligible holes, provided the distance from the edge of the holes to the nearest line of rivets exceeds the diameter of the hole.
- Negligible Dents and Distortion. Small dents and distorted areas may be classed as negligible if they can be repaired by hammering or bending without causing the material to crack. Heat will not be used for reforming.

2. Damage repairable by patching.

Non-negligible damage must be repaired; or the section must be replaced. Patches can often be applied over damaged body panels, provided the damaged area is first trimmed to remove sharp edges or notches which could cause the start of new cracks. The patch must then be sized to overlap the area to allow for attaching rivets.

3. Damage Repairable by Insertion.

In certain cases, patch repairs may not be desirable because of impracticality or because a flush surface is desired. In this case, the damaged area must be cut away and replaced with equivalent material inserted flush with adjacent areas, and backed up with a doubler.

4. Damage requiring replacement of parts.

Parts too badly damaged for repair, or cases where replacement is easier than repair, fall into this category. Repair of welded assemblies such as body mounts are also included. Welded assemblies cannot be rewelded without destroying the strength of the part, and must be replaced.

Rivet Failure

Signs of rivet failure include tipped heads, looseness, and sometimes chipped or cracked paint. If heads are tipped in the same direction and rivets are loose in consecutive groups, the joint has undergone excessive load. Rivet heads which are tipped in different directions and are not in groups may be improperly installed. With chipped or cracked paint, it may be necessary to remove paint to check the true condition of rivets. Rivets subjected to critical loads, but showing no distortion should be inspected if failure is suspected. The head should be drilled off, and the shank should be carefully punched out. Failure is indicated by notched rivet shanks and misaligned holes. Flush rivets showing head slippage within the dimple or countersink indicate either sheet bearing or rivet shear failure, and must be removed for replacement. If rivet failure cannot be detected by visual inspection, the joint can be checked by drilling and punching out several rivets. If rivet shanks are notched, rivets should be replaced with the next larger size rivets. If rivet holes show elongation due to local failure in tearing of the sheet, the next larger size rivet must be used in replacement. Any deformation of the sheet around the rivet, tear outs, or cracks between rivets usually indicates partially failed or damaged rivets. Complete repair of the joint will require replacement by the next larger size rivets. Use the next 0.031 in. (0.79 mm) larger diameter rivet to obtain a tight joint when original hole has been enlarged. If original size rivet is installed, the rivet will not be able to carry its share of the shear load, and the joint will not meet its strength requirements.

Lockbolt Fastener Failure

Lockbolts are used to withstand tension loads and high-shear loads. These fasteners are installed in their holes with an interference fit. No looseness can be permitted. Lockbolts showing evidence of being stretched, broken, loose in their holes, or having heads that do not set flat against the surface must be replaced. Guidelines used for detecting rivet failures also apply to lockbolts.

Lockbolt Removal

1. Working from head side of lockbolt, if accessible, file a small flat surface on head, if rounded.
2. Center punch the head.
3. Using a hardened drill bit slightly smaller than lockbolt, drill through the head. In cases where lockbolts are too hard to be drilled with available drills, grind the head down using a cutoff wheel or carbide bit in a die grinder. When using grinder method, cut the head down until it is very thin, but do not grind it off completely, or touch the body part with grinding tool.
4. Use a pin punch to pry off head, or shear it off with a sharp chisel. Ensure part is adequately supported while performing this step.
5. Drive lockbolt out of its hole with a pin punch. Care must be taken so that hole or part is not distorted.

NOTE: In cases where the lockbolt head is inaccessible, the locking collar must be removed. Remove collar by grinding, or by splitting axially with a sharp chisel.

Rivet Replacement

NOTE: When removing rivets, care should be taken not to enlarge rivet holes. Enlarged rivet holes require oversize replacement rivets.

Solid Rivet Removal

1. File a flat surface on the manufactured head, if accessible. It is always preferable to work on a manufactured head rather than one that is bucked over, since the former will always be more symmetrical around the shank.
2. Indent center of the filed surface with a center punch.
3. Drill through rivet head, using a drill bit slightly smaller than diameter of rivet shank to avoid oversizing rivet hole.
4. Shear weakened rivet head off with a sharp chisel. To prevent panel distortion, support back side of rivet and cut rivet head along direction of rivet line or panel edge.
5. Firmly support the panel from the opposite side and drive out the shank with a pin punch. If rivet is unduly tight due to swelling between sheets, drill the rivet shank out with an undersized drill bit.

Blind Rivet Removal

1. File a small, flat surface on rivet head.
2. Center punch the flat surface. Support the back side of the rivet, if possible.
3. Using a small drill bit about the size of rivet pin, drill off tapered end of pin which forms the lock.
4. Shear lock, using pin punch to drive out pin.
5. Pry out remainder of locking collar.
6. Using a drill bit slightly smaller than rivet shank, drill almost through rivet head.
7. Pry off rivet head with pin punch.
8. Tap out rivet shank with pin punch.

Rivet Hole Drilling

1. Center punch all new rivet locations. Center punch mark must be large enough to prevent drill from slipping out of position, yet it must not dent the surface of the material. To prevent denting, place a bucking bar behind material during punching.
2. Ensure drill bit is the correct size, and points properly ground (Tables 1 and 2). A no. 10 drill bit is used to install standard 1.875 in. (48 mm) blind rivets.
3. Place drill bit in center mark for new rivet locations, or align drill bit with old hole when replacing old rivets with oversize rivets (Table 3). When using a power drill, give the bit a few turns with fingers before starting motor to ensure drill does not jump out of position when motor is started.

NOTE: Hold drill at 90 degree angle to material surface. Avoid excessive pressure, or letting the drill wobble. Do not push the drill through material.

4. Remove all bumps with metal countersink or file.
5. Clean away all drill chips. Ensure that no chips are trapped between metal sheets.
6. Apply corrosion-resistant sealing compound to hole and surrounding area.

Table 1: DRILL BIT SIZES FOR SOLID SHANK RIVETS

Rivet Diameter	Drill Bit Size	Drill Bit Diameter
0.0625 in. (1.65 mm)	# 51	0.0670 in. (1.70 mm)
0.0938 in. (2.38 mm)	# 41	0.0960 in. (2.44 mm)
0.1250 in. (3.18 mm)	# 30	0.1295 in. (3.29 mm)
0.1563 in. (3.97 mm)	# 21	0.1590 in. (4.04 mm)
0.1875 in. (4.76 mm)	# 10	0.1910 in. (4.85 mm)
0.2500 in. (6.35 mm)	F	0.2570 in. (6.53 mm)
0.3125 in. (7.94 mm)	W	0.3230 in. (8.20 mm)
0.3750 in. (9.53 mm)	W	0.3869 in. (9.83 mm)

.

Table 2: DRILL BIT SIZES FOR BLIND RIVETS

Rivet Diameter	Drill Bit Size	Minimum	Maximum
0.1250 in. (3.18 mm)	#30	0.129 in. (3.28 mm)	0.132 in. (3.35 mm)
0.1563 in. (3.97 mm)	#20	0.160 in. (4.06 mm)	0.164 in. (4.17 mm)
0.1875 in. (4.76 mm)	#10	0.192 in. (4.88 mm)	0.196 in. (4.98 mm)

Table 3: OVERSIZE DIAMETER

Rivet Diameter	Drill Bit Size	Minimum	Maximum
0.1250 in. (3.18 mm)	#27	0.143 in. (3.63 mm)	0.146 in. (3.71 mm)
0.1563 in. (3.97 mm)	#16	0.177 in. (4.50 mm)	0.181 in. (4.60 mm)
0.1875 in. (4.76 mm)	#5	0.205 in. (5.21 mm)	0.209 in. (5.31 mm)

Hole Countersinking

NOTE: Some rivet installations in the body require the rivet to be flush with the rivet material surface. In these instances, countersunk or flush-head rivets are used.

1. When using countersunk rivets, rivet holes must be countersunk with a tool having a 100 degree taper, so rivet head will fit flush with surface.
2. When using a hand-operated countersinker, the hole must be tried with a rivet so the recess will not be too deep or too shallow. It is best to use a countersinker with a stop on it so depth of the countersink can be controlled. Typical countersinking dimensions for blind rivets are shown in Table 4. The minimum sheet thickness that can be machined for 100 degree countersunk rivets is given in Table 5.
3. Do not remove edge of hole on blind side of joint.

Blind Rivet Driving Practices and Precautions

1. Rivets should be inspected for proper installation. The grip length of each rivet is marked on top of its head to provide positive identification. Use of proper grip length will produce a rivet installation where locking collar is flush with top surface of rivet head. Tolerance limit on flushness is 0.020 in. (0.51 mm).
2. For proper rivet installation, it is imperative that holes be properly prepared, tools be in good working order, and rivets properly installed. When problems occur, the source of trouble could be in any of these areas.

Table 4: COUNTERSINKING DIMENSIONS FOR 100 DEGREE COUNTERSUNK BLIND RIVETS

Countersinking Dimensions (100 Degree)		
Rivet Diameter	**Minimum**	**Maximum**
0.1250 in. (3.18 mm)	0.222 in. (5.64 mm)	0.228 in. (5.79 mm)
0.1563 in. (3.97 mm)	0.283 in. (7.19 mm)	0.289 in. (7.34 mm)
0.1875 in. (4.76 mm)	0.350 in. (8.89 mm)	0.356 in. (9.0 mm)

Table 5: Minimum Sheet Gauge for 100 Degree Machine Countersunk Rivets

Rivet Size	0.0938 in. (2.38 mm)	0.1250 in. (3.18 mm)	0.1563 in. (3.97 mm)	0.1875 in. (4.76 mm)	0.2500 in. (6.35 mm)
Gauge	0.040 in. (1.02 mm)	0.050 in. (1.27 mm)	0.064 in. (1.63 mm)	0.072 in. (1.83 mm)	0.072 in. (1.83 mm)

Blind Rivet Installation

NOTE: Ensure the proper rivet grip length is selected for each application (Table 6). Rivets can tolerate only 0.0468 in. (1.19 mm) variation in material thickness for each particular rivet length. For double dimpled sheets, add countersink head height to materials thickness.

1. Insert rivet stem into pulling head of rivet gun or adapter.
2. Hold rivet gun in line with axis of rivet as accurately as possible.
3. Apply a steady, firm pressure against rivet head.
4. Squeeze handles of manual gun. The rivet clamping action will pull sheets together, seat rivet head, and break stem flush with head of rivet.

Table 6: RIVET GRIP

Material Thickness Range		Rivet Grip No.
MINIMUM	MAXIMUM	
Not Applicable	0.0625 in. (1.65 mm)	1
0.0625 in. (1.588 mm)	0.1250 in. (3.18 mm)	2
0.1250 in. (3.18 mm)	0.1875 in. (4.76 mm)	3
0.1875 in. (4.76 mm)	0.2500 in. (6.35 mm)	4
0.2500 in. (6.35 mm)	0.3125 in. (7.94 mm)	5
0.3125 in. (7.94 mm)	0.3750 in. (9.53 mm)	6
0.3750 in. (9.53 mm)	0.4375 in. (11.11 mm)	7
0.4375 in. (11.11 mm)	0.5000 in. (12.70 mm)	8
0.5000 in. (12.70 mm)	0.5625 in. (14.29 mm)	9
0.5625 in. (14.29 mm)	0.6250 in. (15.88 mm)	10
0.6250 in. (15.88 mm)	0.6875 in. (17.46 mm)	11
0.6875 in. (17.46 mm)	0.9750 in. (24.77 mm)	12

Aluminum Repair

***CAUTION:** Body repairs should not be made using welding or heat for forming. Heat will only weaken the material and lead to further problems.*

Material

Aluminum material used for repairs should be of the same alloy and temper as the original if possible. In general, 6061-T6 aluminum alloy should be used. Material thickness must be the same or thicker. This alloy will work well for flat repairs, but is not well suited to bending because it is quite hard and cracks easily when bent sharply. When bends must be made, use softer 6061-T4 aluminum alloy and increase material thickness by at least 50 percent. As a general rule of thumb, 6061-T4 aluminum alloy should be bent with a minimum bend radius of one to two times material thickness, whereas 6061-T6 aluminum alloy requires at least three times material thickness radius for bends. In all cases, bends should be closely inspected for cracks. A suitable method for avoiding bending cracks is to obtain angles that are extruded from 6061-T6 aluminum alloy or use preformed angles for repairs.

Epoxy Adhesive

Where it is necessary to remove parts, note that epoxy adhesive is used in joints. Use care in parts removal to avoid unnecessary distortion. Parts should be separated by peeling action. Before parts are reassembled, it will be necessary to remove any remaining cured epoxy from joints so parts will fit together with good, even contact. Use of epoxy requires special storage and application procedures which do not lend themselves to repair. For this reason, epoxy will not be used for repair. To compensate for the lack of epoxy, additional rivets should be used when making repairs to existing joints.

Rivet Patterns

1. Rivet patterns are denoted by rivet spacing and rivet edge distance. Rivet edge distance is the distance from center of rivet to nearest edge of sheet. Rivet spacing is defined as the distance from center of rivet to center of adjacent rivet (Figure 10-1).
2. Required rivet spacing is determined by strength needed in the joint. A general feel for strength required can be obtained by inspecting rivet patterns in surrounding areas. Body repairs made using single rows of rivets should be performed using rivet spacing not greater than 1.6 in. (4.1 cm) and not less than 0.625 in. (15.9 mm). Use 1 in. (25.4 mm) rivet spacing as a general practice for repairs. Rivet spacing used in original construction may be greater due to additional strength obtained by using epoxy adhesive. Do not use rivet edge distances less than 0.375 in. (9.5 mm).
3. High strength joints or large area patterns may require use of double or multiple rows of rivets to obtain sufficient strength.

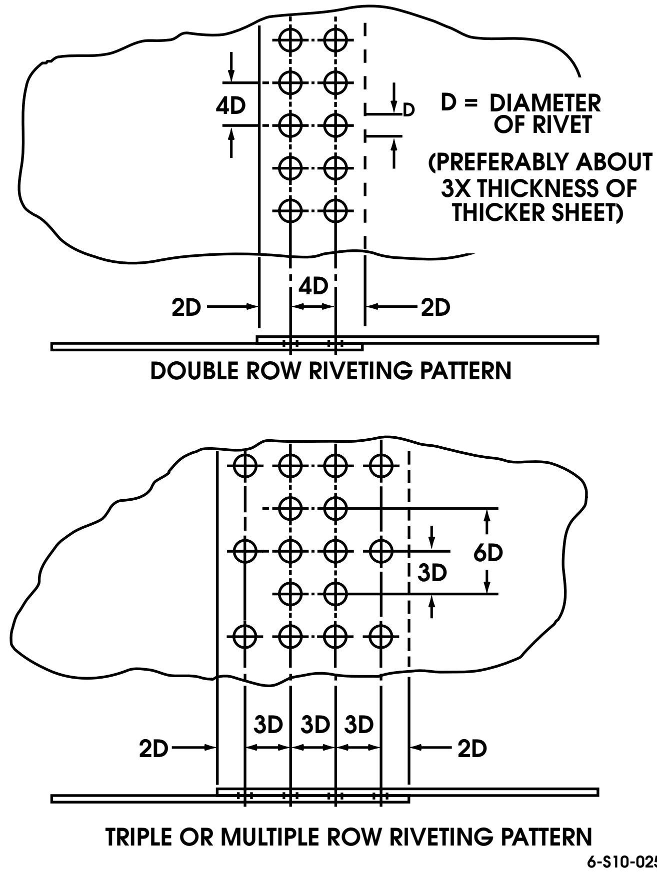


Figure 10-1: Riveting Patterns

4. Care must be taken to assure rivet hole patterns are transferred accurately in cases where a part with no holes is mated to one which already has rivet holes. Hole patterns may be transferred using one of the following patterns:
   a. Lay new part in place, and use holes in mating part as a drill template. This requires the new part to be underneath the mating part. Care must be taken not to distort original holes.
   b. Use the removed part as a drill template by clamping the old and new parts together. This requires that parts rest flat and rivet flange be undistorted.

Joint Design

1. Loads are applied through a joint to fasteners that hold it together. These loads are applied to fasteners in the form of shear loads or tension loads. If load is perpendicular to axis of fasteners, the fasteners are loaded in shear. The fasteners are loaded in tension when load is along axis of fastener, causing a pull on each end of fastener.
2. Rivets are designed to be loaded in shear. Do not create any new joints during repairs which cause rivets to be used in a tension application. Bolts should be used for tension applications or substituted for rivets in very high shear load applications (Figures 10-2 and 10-3).

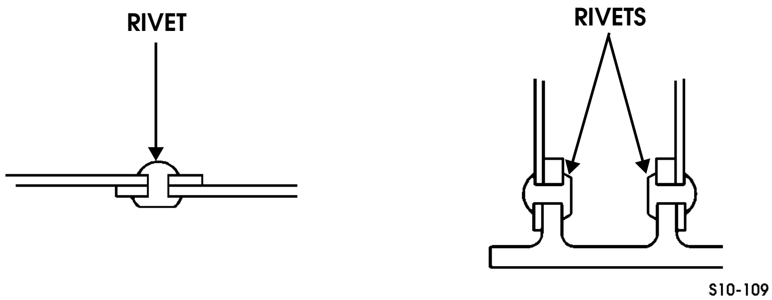


Figure 10-2: Rivet Loads in Shear

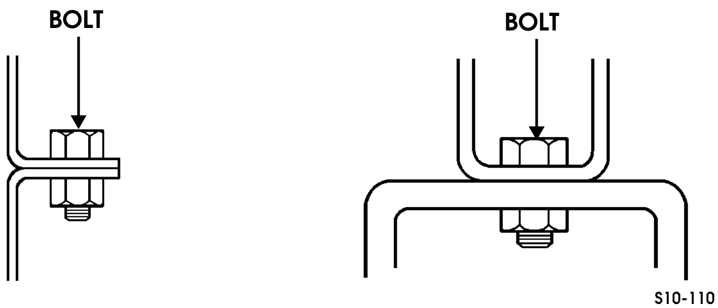


Figure 10-3: Bolts Replacing Rivets

Repair Parts

1. Paint repair parts or patches with epoxy primer before installation.
2. Apply sealing compound to mating surfaces to prevent corrosion.
3. Install part or patch.
4. Paint repaired area with epoxy primer.
5. Paint repaired area with polyurethane as required.

Repair of Negligible Damage

1. Negligible cracks are repaired by drilling a small hole at each end of crack to stop crack propagation. This is called stop-drilling. Table 7 gives proper drill sizes for stop-drilling cracks.
2. Negligible holes are repaired by rounding and smoothing edges of holes to alleviate stress risers caused by sharp notches.

CAUTION: *Never use heat to reform parts. Part strength is greatly reduced.*

3. Small dents and distorted areas may be repaired by bending or hammering as long as the operation does not cause materials to crack or tear. Sharp bends should not be attempted.

Table 7: Stop-Drill Sizes for Negligible Cracks

SHEET THICKNESS	MINIMUM STOP DRILL BIT SIZE NO.
0-0.032 in. (0-081 mm) 0.033 in. (0.84 mm) and thicker	40 30

Repair by Patching

Most body panel damage that exceeds the limits of negligible damage may be repaired by patching. This procedure involves removal of damaged area and application of a patch to cover the area. The damaged area is prepared by rounding or smoothing of all corners and edges to ensure cracks will not spread into undamaged areas (Figure 10-4). In case of a large crack, it may be desirable to stop-drill the crack rather than cut out a portion of the panel or structural member. Repair is completed by applying a large overlapping patch over the damaged area (Figure 10-5). The overlap must be sufficient to allow the observance of proper rivet edge distance (.25 in. or 6.4 mm). Large areas of damage are best repaired by attaching patch with multiple rows of rivets (Figure 10-6).

Repair by Insertion

For damage that is large or more severe in nature than a crack or hole, it is often desirable to remove damaged area, insert a piece of material into removed area and reinforce with a doubler. This is termed repair by insertion. This method of repair is typically stronger and stiffer than an added patch (Figures 10-7 through 10-10).

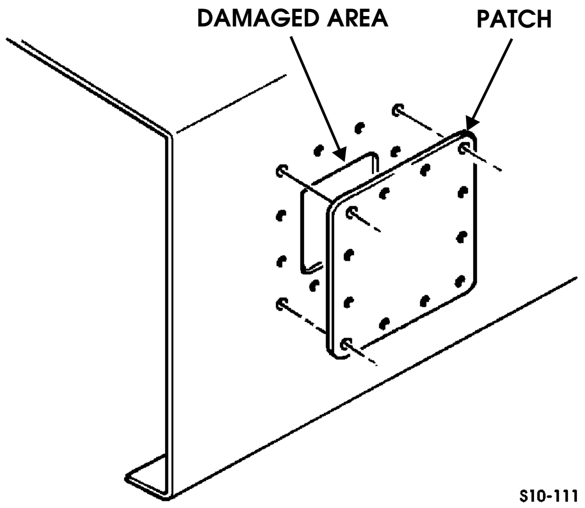


Figure 10-4: Patching

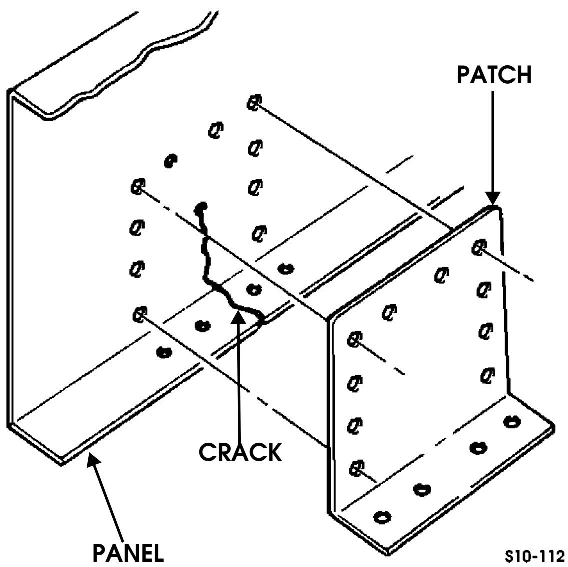


Figure 10-5: Patching Cracked Areas

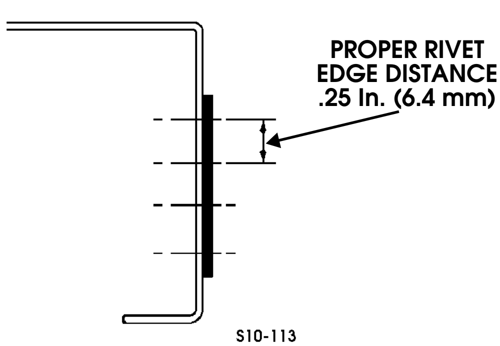


Figure 10-6: Proper Rivet Distance

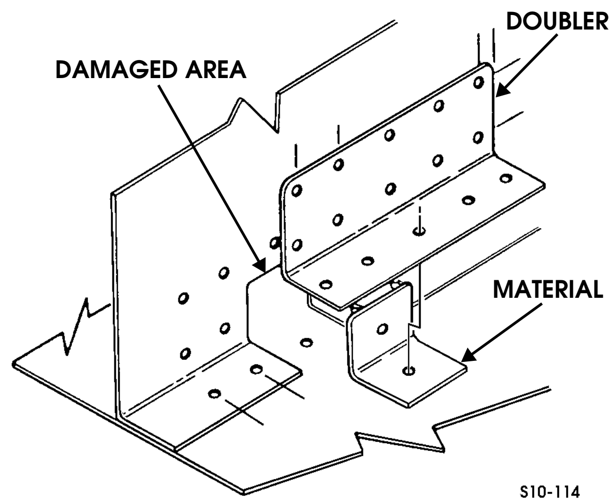


Figure 10-7: Reinforcing Damaged Area

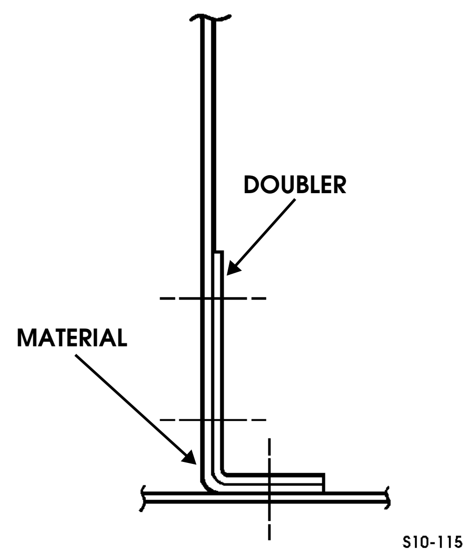


Figure 10-8: Doubler

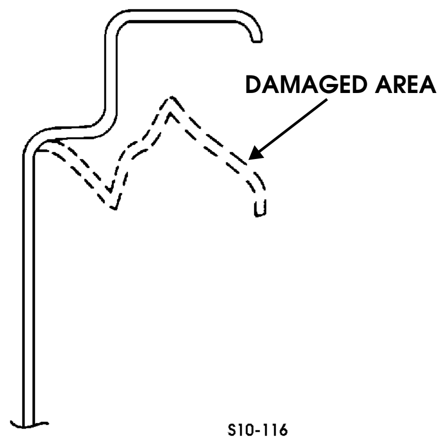


Figure 10-9: Damaged Body Area

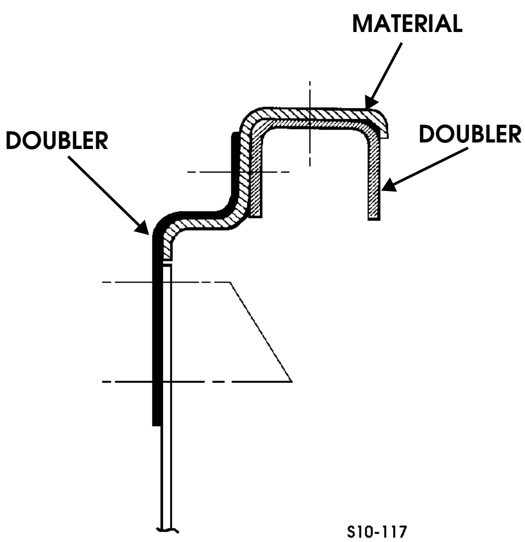


Figure 10-10: sideview of Doubler

Fiberglass Repair

General Information

The HUMMER hood and engine access cover are made of fiberglass (sheet molding compound). Crack, splits, or holes may be repaired with a glass reinforced plastic laminate repair kit.

Inspection

NOTE: Hood surface has a thin layer of gel coat that may appear cracked in a spider web-like pattern due to hood flexing. No repair is required.

1. Examine cracks to determine if they are on surface only, or are deep breaks into material thickness.
2. If filler material chips off at bonding flanges, and appears as cracked but not broken through, the area need not be repaired.
3. If total penetration crack greater than 1 in. (25.4 mm) exists in critical areas: hinges, latches, or hood stop areas, repair immediately (Figure 10-11).
4. If total penetration cracks exist in noncritical areas, do not repair until size is greater than 3 in. (76 mm).
5. If severe breaks develop in one area, remove fragmented material and use repair procedure for holes.

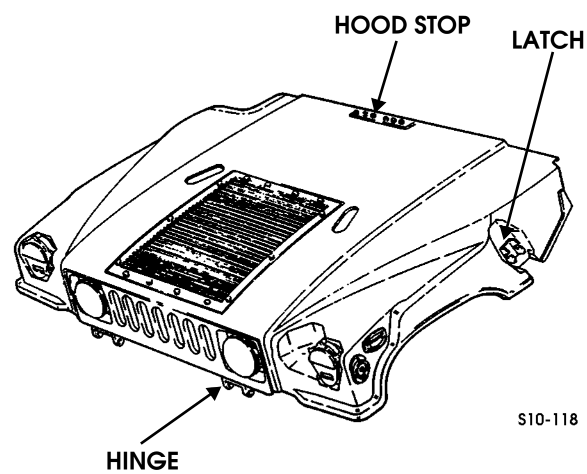


Figure 10-11: Hood Stop and Hinge

Repair

NOTE: Complete procedures for fiberglassing are provided with repair kit (AM General part number 05742835).

1. Repairing cracks or splits.

WARNING: When sanding fiberglass, personal protective equipment (respirator, goggles/shield, gloves, coveralls, etc.) must be used. Failure to do this may result in injury.

   a. Using sandpaper, remove dirt and paint 3-4 in. (8-10 cm) around area of crack.
   b. Rough-sand surface to which mat will be added and underside of surface, if possible. Surface must be dry.
   c. Bevel edges of crack in a broad “V ”.
   d. Cut a piece of mat and apply to underside of surface with resin mixture. Extend patch beyond break about 2 in. (5 cm). Press patch firmly into place. Saturate patch with additional layer of resin and then allow 1-3 hours to cure.
   e. At the same time, cover top exposed surface with resin, allowing 1 to 3 hours to cure.
   f. For stressed areas, lightly sand first patch and add another patch layer, repeating steps a through c.
   g. Finish-sand exposed surface.
   h. Prime and paint.

2. Repairing holes.
   a. Remove damaged material.
   b. Using sandpaper, remove dirt and paint in area of hole extending away 3-4 in. (8-10 cm).
   c. Rough-sand top and underside of surface to which mats will be added.
   d. Cut two same size pieces of fiberglass mat that will extend about 2 in. (5 cm) past edge of hole.
   e. Coat both top and underside of surface, and saturate both pieces of mat with the resin mixture.
   f. When tacky, apply one mat to the inner surface and one to the outer surface. Press the two patches together.
   g. Allow 1-3 hours to cure. Additional coats of resin may be added if necessary for appearance purposes. Sand lightly between coats.
   h. Finish-sand exposed surface.
   i. Prime and paint.

WATER LEAK DETECTION AND REPAIR

If water has leaked into the vehicle, inspect for leakage points. Spray water, under pressure, against the vehicle in the general area where the leak is believed to be located. Have an assistant inside the vehicle locate and mark the point(s) where any water appears.

Water that appears at a certain place inside the vehicle may actually be entering the vehicle from another point. It may be necessary to remove the floor mat, interior trim panels, insulation, dash pad, instrument panel, etc. to gain access and diagnose the leak. Back track the path of water to the point of entry. If it is still not possible to locate the point of entry, try the following:

1. Close all windows and doors.
2. Run a small stream of water over the suspected area(s) of leakage.
3. Using a leak detector-type solution (commercially available), spray a film over the suspect area on the exterior surface.
4. From inside the vehicle, use an air wand and force air onto the suspect leak area and check for pressure bubbles that indicate air is escaping from the vehicle.
5. Repair the leak.

If the leak is between body panels or around rivet heads, use Silaprene sealant (P/N 05593929) and wipe the sealant into and/or around the leak area. Be sure to remove any excess sealant while it is still pliable.

If the leak is around a door, it may be because the door is not properly aligned. Refer to Door Replacement in this section for instructions on door adjustment. If the door is contacting the weather seal correctly, make sure the weather seal is not damaged and is properly sealed on the door. If the weather seal is not properly sealed, rubber cement can be used to hold it in place. If the weather seal is damaged, replace it.

If the leak is around a window held by a weather seal (i.e., door glass), completely dry the area and apply a new window glass seal. If the new seal still does not close out against the glass, the window opening flange may need to be adjusted inward. If the weather seal is damaged, it should be replaced. Check the flange that holds the weather seal for any nicks or burrs that may have caused the damage.

Windshield leaks should be repaired by removing the glass and the weather seal that is leaking. Clean off any remaining sealer on the windshield frame and the weather seal, and lay a new bead of sealer evenly around the windshield frame and between the glass and the weather seal. Install the glass and weather seal as an assembly into the frame. Attach the retainers, and allow sealer to harden.

6. Retest the entire vehicle for leaks.

CENTER CONSOLE REPLACEMENT

Removal

1. Remove four screw/washers from center console. (Figure 10-12).
2. Slide center console back (toward rear seating area) far enough for rear air vents to clear plenum.
3. Lift console from tunnel.

Installation

1. Carefully lower center console over auxiliary A/C-heat unit while making sure that rear air vents clear plenum and line up with cutouts.
2. Slide center console forward so that rear air vents fit into plenum cutouts.
3. Secure center console to tunnel bracket with four screw/ washers.

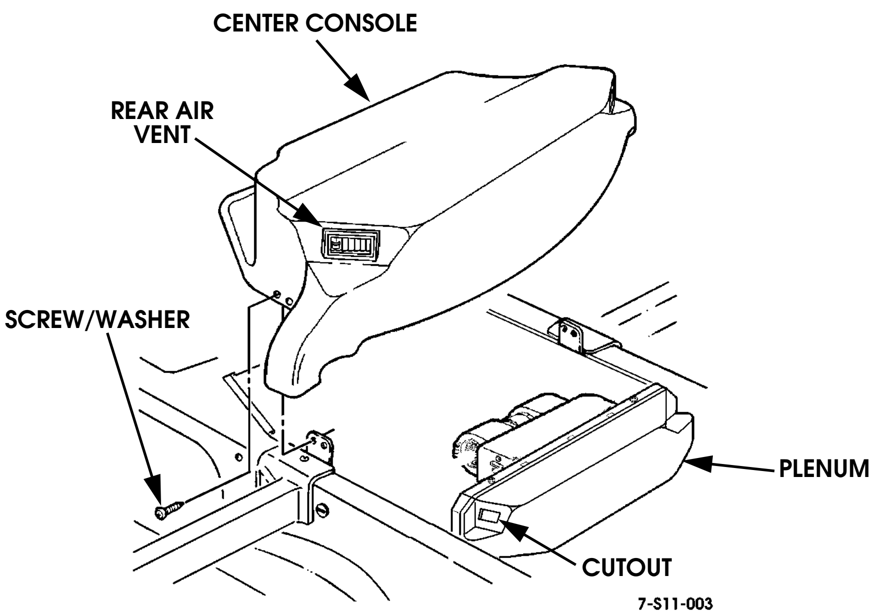


Figure 10-12: Center Console Replacement

FRONT CONSOLE REPLACEMENT

NOTE: Some vehicles may be equipped with an optional heated windshield. If so equipped, the on/off rocker switch and time delay module will be mounted in the power window master switch bezel. Refer to heated windshield procedure in this section of the service manual.

Removal

1. Remove right side crashpad.
2. Remove bolts securing front console to body brackets and screws from top of console (Figure 10-13).

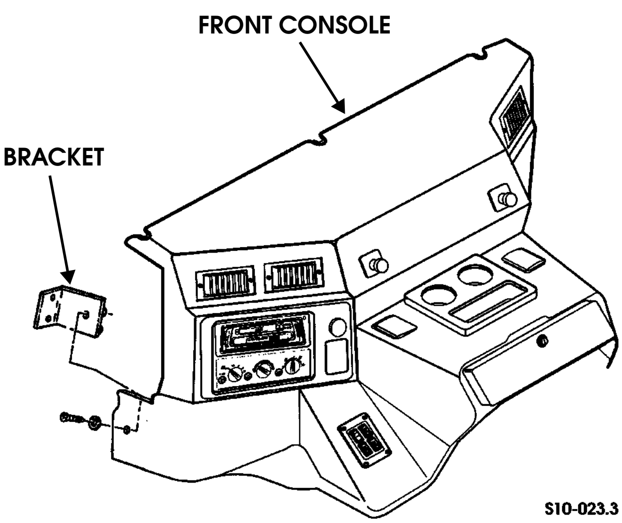


Figure 10-13: Front Console Mounting

3. Pull front console away from dashboard.
4. Unplug antenna and electrical connectors from radio.
5. Unplug all electrical connectors from HVAC control panel.

NOTE: Tag window switch leads prior to removal for installation.

6. Unplug all electrical connectors from power window switches.
7. Locate console harness that supplies power to the cigarette lighters and 12V power supply. Unplug console harness from body electrical harness.
8. Remove front console assembly.
9. Remove transferable components from console assembly as follows:
   a. Disconnect electrical leads from cigarette lighters and 12V power supply.
   b. Remove console harness and mounting clips.
   c. Remove cigarette lighter, elements, heaters, shells. and bezels.
   d. Remove ashtray receptacles and frames.
   e. Remove cup holder.
   f. Remove screws, glovebox, and speednuts (Figure 10-14).
   g. Remove screws and air vents.
   h. From inside of console, remove the upper rear support bracket securing the climate control panel and radio to the HVAC plenum.
   i. Reattach lower support bracket to back of radio.

NOTE: Faceplate, radio, support plate, and climate control panel will come out as an assembly.

   j. Remove screws, faceplate, radio, support plate, and climate control panel.

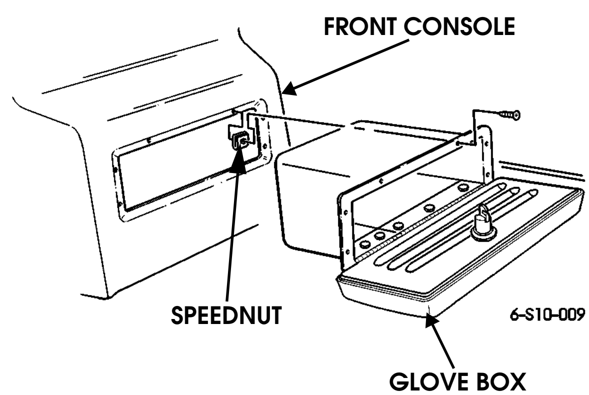


Figure 10-14: Glovebox Mounting

Installation

1. Assemble console as follows:
   a. Insert faceplate, radio, support plate and climate control panel (as one assembly) into front console and secure with screw/washers.
   b. Remove screw from back of radio and use it to secure the upper support bracket to the lower support bracket.
   c. Secure upper support bracket to HVAC plenum with screws.
   d. Insert air vents into console and secure with screws.

e. Install glovebox with screws and speednuts.
f. Install ashtray frames and receptacles.
g. Install cup holder.
h. Install cigarette lighter bezels, shells, heaters and elements.
i. Secure console harness to console with mounting clips.
j. Connect console harness leads to cigarette lighter and 12V power supply.

2. Position console close to dashboard.
3. Plug all electrical connectors into power window switches.
4. Connect console harness to body electrical harness.
5. Plug all electrical connectors into HVAC control panels.
6. Plug antenna and electrical connectors into radio.
7. Fit console carefully into position.
8. Secure console to body brackets with screws.
9. Install right side crashpad.

INSTRUMENT PANEL, GAUGES, AND SWITCHES

Instrument Panel (I.P.) Replacement

Removal

NOTE: Tag all leads prior to removal for installation. If replacing instrument panel, refer to procedures in this section to remove and/or disconnect the various lamps, switches, and gauges.

1. Disconnect negative battery cables (Section 12).
2. Remove left side crashpad.
3. Remove close-out panel.
4. Remove wiring harness close-out plate.
5. Remove tachometer and clock assembly from I.P. to access right side I.P. mounting bolt.
6. Remove right side I.P. mounting bolt.
7. Remove two bolts securing I.P. to steering column.
8. Remove two left side I.P. mounting bolts securing I.P. to A-pillar.
9. Disconnect air hose from side window defrost vent.
10. Remove I.P.

Installation

1. Maneuver I.P. into position between steering wheel and firewall.
2. Connect air hose side window defrost vent.
3. Loosely install left side I.P. mounting bolts.
4. Loosely install I.P. to steering column mounting bolts.
5. Install right side I.P. mounting bolts
6. Tighten loosely installed bolts from steps 3 and 4.
7. Install tachometer and clock assembly.
8. Install wiring harness close-out plate.
9. Install close-out panel.
10. Install left side dashpad.
11. Connect negative battery cables (Section 12).

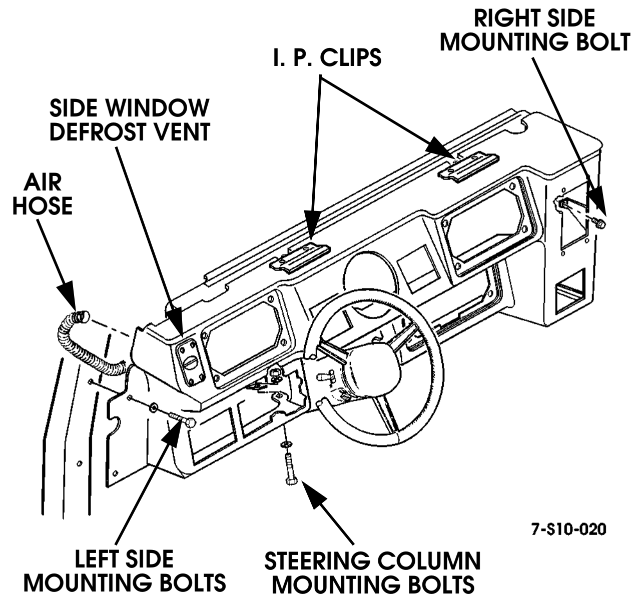


Figure 10-15: Instrument Panel Replacement

Crashpad Replacement (Right Side)

Removal

1. Remove screw/washers, and crashpad from dashboard (Figure 10-16).
2. Disconnect air hose from vent duct.
3. Remove screws, side window vent, and vent duct from crashpad.

Installation

1. Secure vent duct and window vent to crashpad with screws (Figure 10-16).
2. Connect air hose to vent duct.
3. Secure crashpad to dashboard with screw/washers.

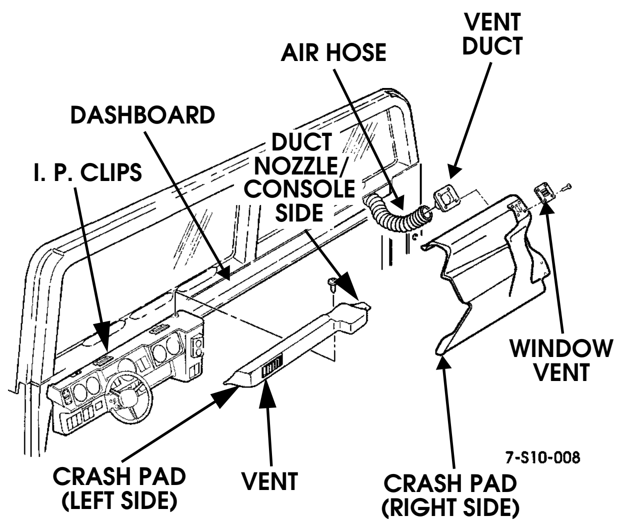


Figure 10-16: Crashpad Replacement

Crashpad Replacement (Left Side)

Removal

1. Remove screw/washers from top of crashpad.
2. Tug gently on crashpad toward steering wheel to free crashpad clips from I. P. clips (Figures 10-15 and 10-16).
3. Lift vent side of crashpad and work console side (duct nozzle) out of front console.

Installation

1. Work console side (duct nozzle) of crashpad into front console plenum.
2. Position crashpad on edge of I. P. closest to steering wheel and push crashpad onto I. P. clips (Figures 10-15 and 10-16).
3. Secure crashpad to I. P. with screw/washers.

Gauge Replacement

NOTE: Gauge replacement is basically the same for all instrument panel gauges.

Removal

1. Remove screws and pull gauge panel away from instrument panel (Figure 10-17).
2. Disconnect lamp connector from gauge.

NOTE: Tag all leads prior to removal for installation.

3. Remove nut and lockwasher assemblies securing three leads to gauge.
4. Remove hold-down bracket.
5. Remove gauge through front of gauge panel.

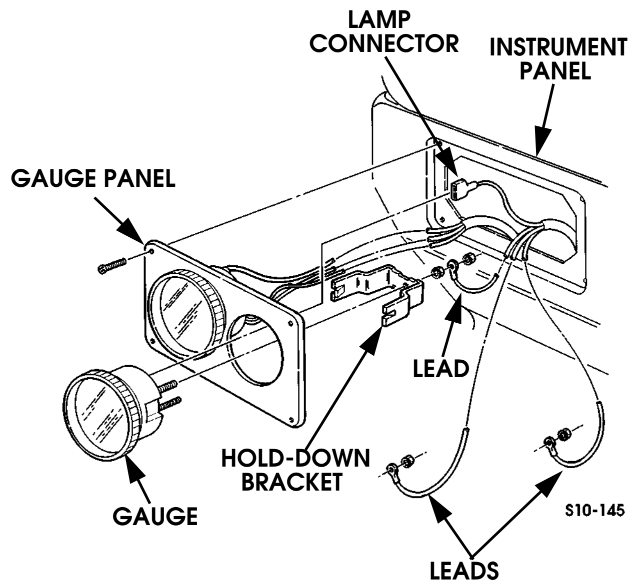


Figure 10-17: Gauge Replacement

Installation

1. Insert gauge through front of gauge panel (Figure 10-17).
2. Secure hold-down bracket and lead to gauge with nut and lockwasher assembly.
3. Secure leads to gauge with nut and lockwasher assemblies.
4. Connect lamp connector to back of gauge.
5. Start engine and ensure gauge operates properly.
6. Secure gauge panel to instrument panel with screws.

Instrument Panel Indicator Lamp Replacement

NOTE: All instrument panel indicator lamps are replaced basically the same.

Removal

1. Remove instrument panel.
2. Turn socket one-quarter turn counterclockwise, and remove socket from indicator light housing.
3. Pull lamp from socket (Figure 10-18).

Installation

1. Push lamp into socket (Figure 10-18).
2. Insert socket into indicator light housing and secure by turning socket clockwise one-quarter turn.
3. Install instrument panel.
4. Start engine and ensure lamp operates properly.

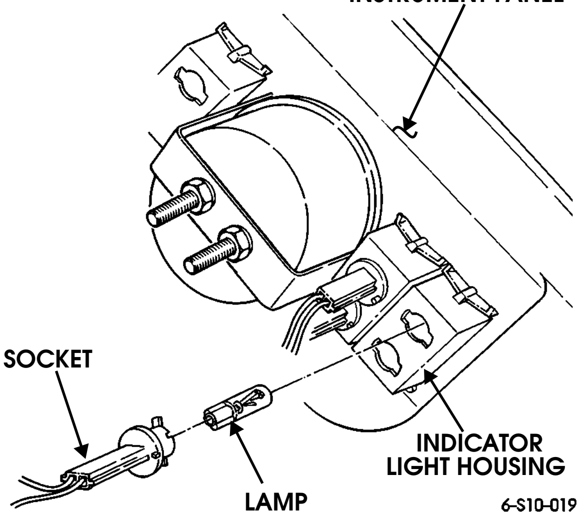


Figure 10-18: Instrument Panel Indicator Light Replacement

Instrument Panel Switch Replacement

NOTE: All instrument panel switches are replaced similarly, with the exception of the dimmer control switch. This procedure covers the main light switch.

CAUTION: *Some connectors can be installed incorrectly and cause damage to the electrical system. Make note of connector position prior to removal.*

Removal

1. Remove closeout panel.
2. Reach up behind IP and push switch from switch housing.
3. Remove connector from switch (Figure 10-19).

Installation

1. Install connector on switch (Figure 10-19).
2. Install switch in switch housing.
3. Install closeout panel.

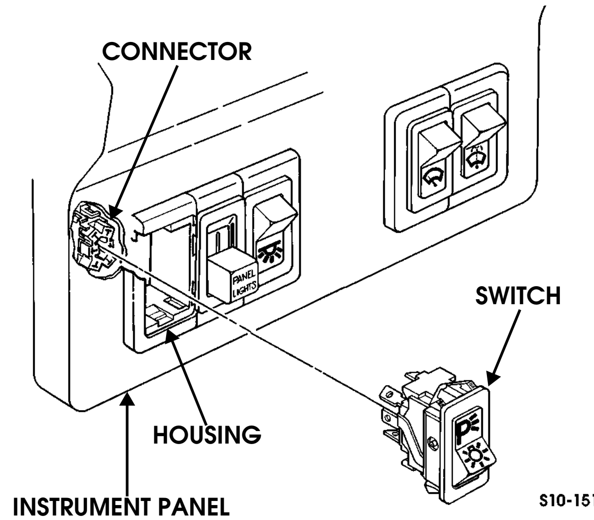


Figure 10-19: Instrument Panel Switch Replacement

Dimmer Control Switch Replacement

Removal

1. Remove closeout panel.
2. Reach up behind IP and push switch from switch housing.
3. Unplug connector from wiring harness (Figure 10-20).

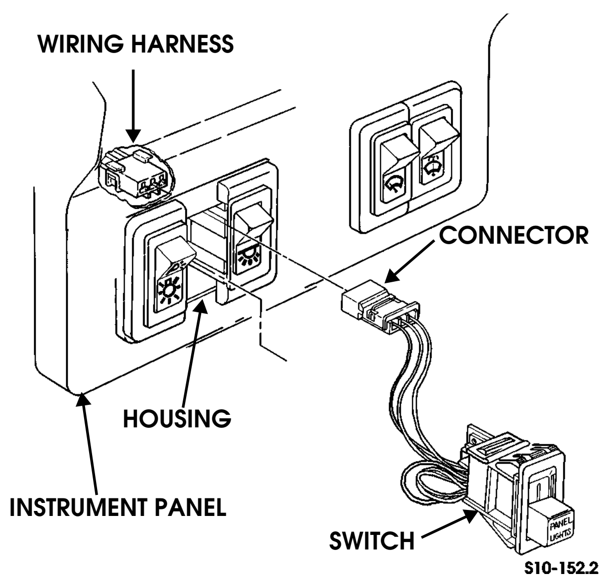


Figure 10-20: Dimmer Control Switch Replacement

Installation

1. Plug connector into wiring harness.
2. Install switch in switch housing (Figure 10-20).
3. Install closeout panel.

Speedometer/Odometer Replacement

Removal

1. Remove the left A-pillar dash trim (closeout).
2. Remove the left footwell closeout panel and disconnect the courtesy light plug, diagnostic link connector and the footwell vent hose from the closeout panel.
3. If equipped with power mirrors, pop the switch from dash and let hang to gain access to the crossbolt nut.
4. Remove the two screws securing the harness hanger to the steering column mount bracket and remove the harness hanger.
5. Loosen the two bolts at the forward steering column pivot point.
6. Remove the steering column crossbolt, nut and washer and tilt the steering column downward.
7. Remove the left and right gauge bezels (with gauges), for access to the rear of the speedometer/odometer, and let the bezels lay loose.
8. Remove two trim screws from the crashpad and pull rearward to release the crashpad.
9. Remove the two plastic protector caps from the rear of the speedometer/odometer mounting studs.

NOTE: Tag all leads prior to removal for installation.

10. Remove the two wire connection nuts and lockwashers from the mounting studs and remove the wires.
11. Remove the two speedometer/odometer hold-down bracket nuts and lockwashers and the hold-down bracket.
12. Pull the speedometer/odometer from the dash and remove the two remaining nuts and lockwashers that secure the ground and sending lead connections.

Installation

1. Insert speedometer/odometer into instrument panel and secure with hold-down bracket, electrical leads, and nut and lockwasher assemblies (Figure 10-21).
2. Secure ground lead and sending lead to speedometer/odometer with nut and lockwasher assemblies.
3. Slide two plastic protector caps onto the speedometer/odometer mount studs.
4. Install the crashpad using two trim screws.
5. Install the left and right gauge bezels.
6. Tilt the steering column up and install the crossbolt, nut and washer.
7. Tighten the two bolts at the forward pivot point of the steering column.
8. Screw the harness hanger to the steering column mount bracket.
9. Install the power mirror switch if removed in step 3 above.
10. Install the footwell vent hose, the DLC, the courtesy light plug and the left footwell closeout panel.
11. Install the left A-pillar dash trim (closeout).

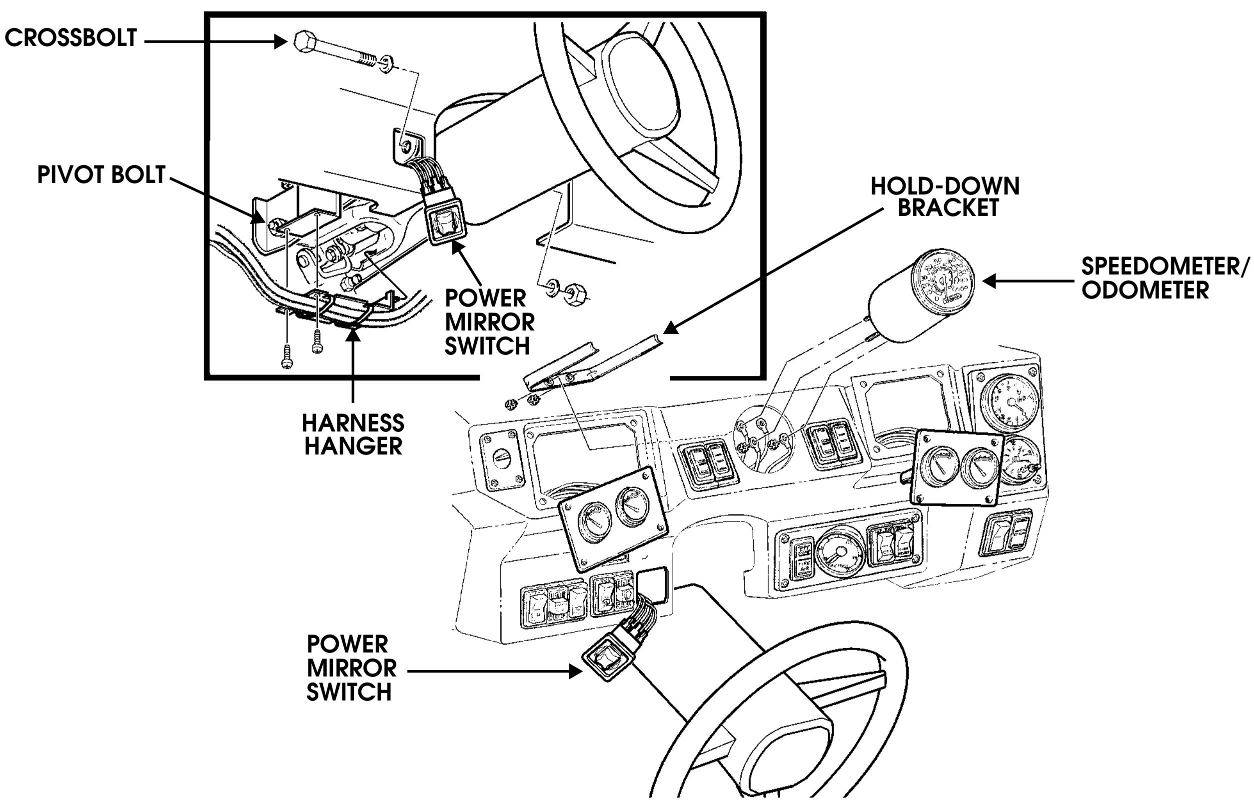


Figure 10-21: Speedometer/Odometer Replacement

Tachometer Replacement

NOTE: Mark position of set screws in relationship to tachometer clock panel before disassembly. Tachometer mounting clamp must be installed in factory position to have proper clearance for reassembly.

NOTE: It may be necessary to remove clock for access to tachometer mounting clamp hardware.

Removal

1. Remove screws and tachometer/clock panel from I.P.
2. Unplug tachometer electrical connector from I.P. wiring harness.
3. Loosen set screws and tachometer mounting clamp hardware. Remove clamp from tachometer housing.
4. Remove tachometer from tachometer/clock panel.

Installation

1. Position tachometer in tachometer/clock panel.
2. Slide tachometer mounting clamp onto tachometer housing; close enough to tachometer/clock panel for set screws to make contact.
3. Tighten clamp securely onto tachometer body and tighten setscrews until they contact tachometer/clock panel.
4. Plug tachometer electrical connector into I.P. wiring harness.
5. Secure tachometer/clock panel to I.P. with screws.

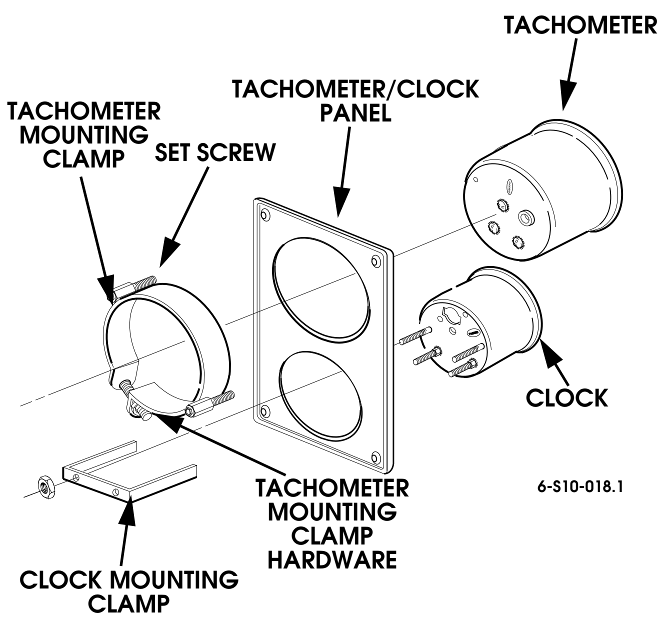


Figure 10-22: Tachometer Mounting

CIGARETTE LIGHTER REPLACEMENT

Removal

1. Pull front console away from dashpad enough to gain access to wiring harness connector.
2. Remove wiring harness connector from lighter assembly.
3. Remove element from lighter assembly heater (Figure 10-23).
4. Remove shell from heater, and remove shell, heater, and bezel from console.

Installation

1. Install bezel and heater in console (Figure 10-23).
2. Install shell on heater.
3. Install wiring harness connector on lighter assembly.
4. Install element in lighter assembly.
5. Engage cigarette lighter to ensure proper operation.
6. Install front console.

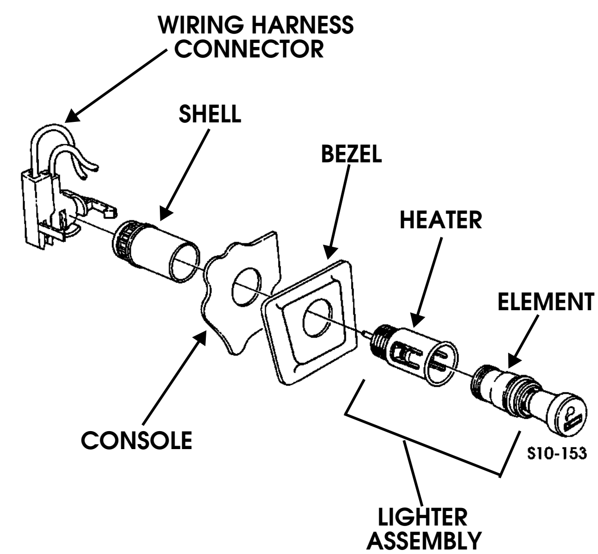


Figure 10-23: Cigarette Lighter Breakdown

ASHTRAY REPLACEMENT

Removal

1. Pull front console away from dashpad to gain access to ashtray frame tabs.
2. Pull ashtray receptacle out of frame (Figure 10-24).
3. Straighten frame tabs and remove frame.

Installation

1. Insert frame into opening on console and secure it by bending tabs around opening.
2. Push ashtray receptacle into frame (Figure 10-24).
3. Install front console.

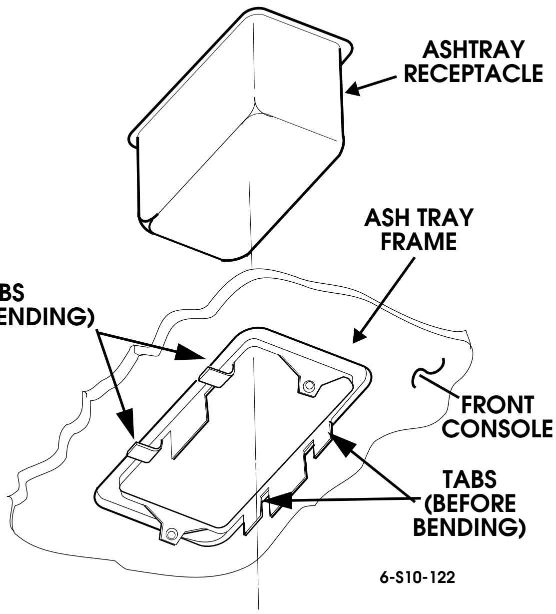


Figure 10-24: Ashtray Mounting

GLOVEBOX REPLACEMENT

Removal

Remove screws and glovebox from front console (Figure 10-25).

Installation

Secure glovebox to front console with screws (Figure 10-25).

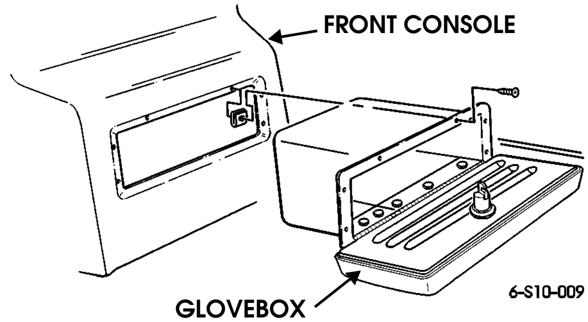


Figure 10-25: Glovebox

ENGINE ACCESS COVER

Inner Engine Access Cover Flexible Latch and Hold-Down Striker Replacement

Removal

1. Remove engine access cover.
2. Remove rivets and hold-down striker from body (Figure 10-26).
3. Remove rivets and flexible latch from cargo floor.

Installation

1. Secure flexible latch to cargo floor with rivets (Figure 10-26).
2. Secure hold-down striker to body with rivets.
3. Install engine access cover.

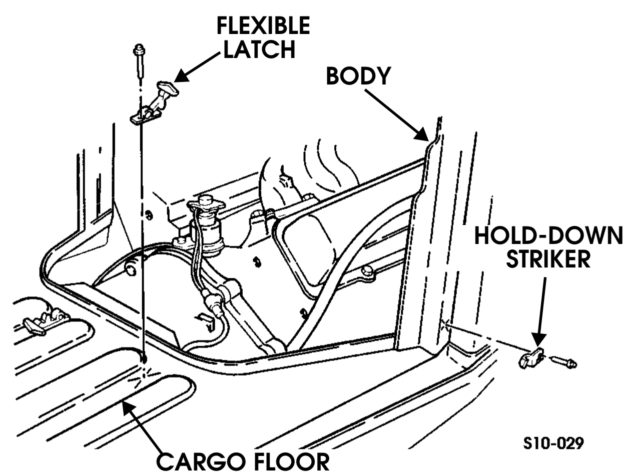


Figure 10-26: Inner Engine Access Cover Latch Location

Engine Access Cover Replacement

Removal

1. Remove console.
2. Unlatch flexible latches from keepers on engine access cover hold-down brackets (Figure 10-27).
3. Unlatch engine access cover hold-down latches from engine access cover hold-down strikers.
4. Turn ring studs and remove access cover.

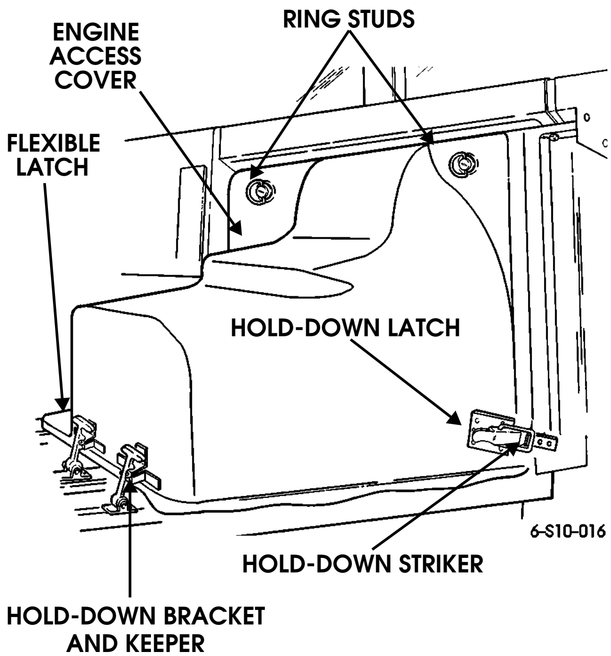


Figure 10-27: Engine Access Cover Replacement

Disassembly

1. Remove rivets, retainers, and insulation from engine access cover (Figure 10-28).
2. Remove seal from access cover.
3. Remove retaining rings, washers, and ring studs from access cover (Figure 10-29).
4. Remove locknuts and shoulder bolts securing latch guide plates and back plates to access cover and remove latches.
5. Remove rivets, latch guide plates, and back plates from access cover.
6. Remove rivets and keepers from hold-down brackets.
7. Remove rivets, nuts, washers, screws, hold-down brackets, and backing plates from access cover.

Assembly

1. Secure hold-down brackets and backing plates to access cover with rivets, screws, washers, and nuts (Figure 10-29).
2. Secure keepers to hold-down brackets with rivets.
3. Secure latch guide plates and back plates to access cover with rivets.
4. Secure latch guide plates to back plates and access cover with shoulder bolts and locknuts. Install latches.
5. Secure washers and ring studs to access cover with washers and retaining rings.
6. Install seal on access cover (Figure 10-28).
7. Secure insulation to access cover with rivets and retainers.

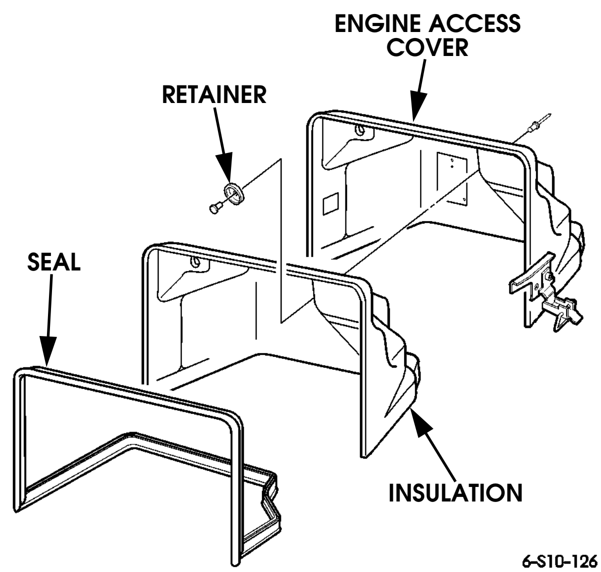


Figure 10-28: Engine Access Cover, Insulation, and Seal Breakdown

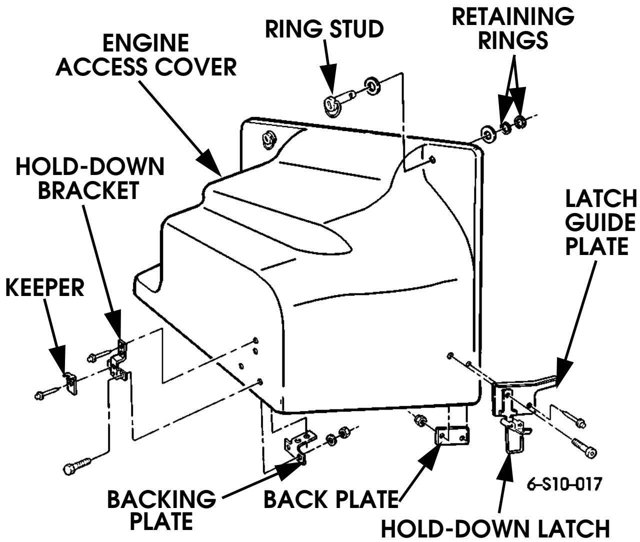


Figure 10-29: Engine Access Cover Fastener Positioning

Installation

1. Position engine access cover and fasten ring studs (Figure 10-29).
2. Secure hold-down latches on hold-down strikers.
3. Latch flexible latches on hold-down bracket keepers.
4. Install console.

SEAT BELT ASSEMBLY REPLACEMENT

NOTE: Replacement of the seat belt assembly is basically the same for all seat locations on all vehicle models. This procedure covers the left front seat belt on four-door hard top vehicles.

Removal

1. Remove seat.
2. Remove screw/washer assembly, seat buckle, and washer from body (Figure 10-30).
3. Remove inner kick panel enough to gain access to seat buckle electrical connector.
4. Disconnect seat buckle electrical connector from roof harness connector and pull seat buckle electrical connector through grommet in inner kick panel.

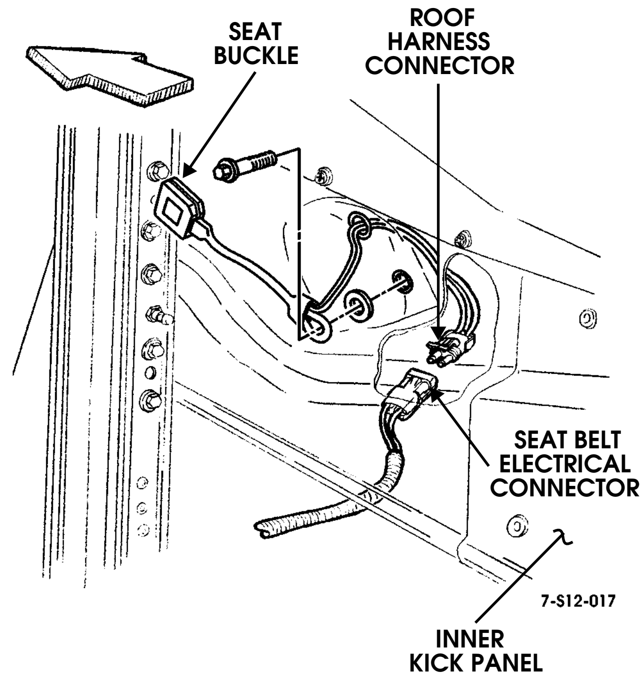


Figure 10-30: Seat Belt Electrical Connector Location

5. Remove screw/washer assembly, D-ring, webbing guide cover, and washer from B-pillar (Figure 10-31).

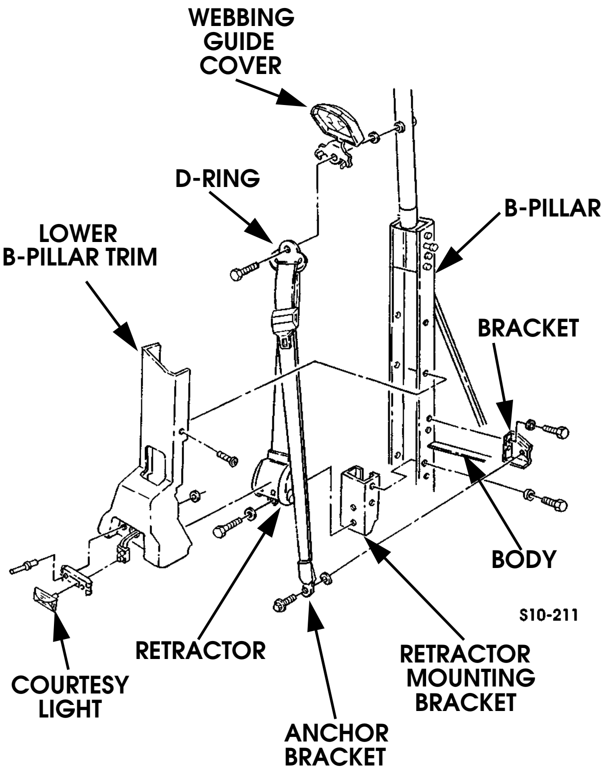


Figure 10-31: Seat Belt Assembly Breakdown

6. Remove screw/washer assembly, anchor bracket, and washer from bracket.

NOTE: Steps 8 and 9 are applicable to all vehicles except two-door vehicles with the enlarged cab.

7. Remove courtesy light lamp assembly, rivets, mounting bracket, and washers from lower B-pillar trim (Figure 10-31).
8. Disconnect body harness connector from courtesy light lamp assembly.
9. Remove screw/washer assemblies securing lower B-pillar trim to B-pillar.
10. Remove bolt, washer, and retractor from retractor mounting bracket. Remove seatbelt assembly from lower B-pillar trim.
11. Remove bolts, washers, and retractor mounting bracket from B-pillar.
12. Remove bolts, washers, and bracket from B-pillar and body.

Installation

1. Secure bracket to B-pillar and body with washers and bolts (Figure 10-31). Tighten bolts to 12 lb-ft (16 N•m).
2. Secure retractor mounting bracket to B-pillar with washers and bolts. Tighten bolts to 24 lb-ft (33 N•m).
3. Route seat belt assembly through opening in lower B-pillar trim and secure retractor to retractor mounting bracket with washer and bolt. Tighten bolts to 35-40 lb-ft (47-55 N•m).
4. Secure lower B-pillar trim to B-pillar with screw/washer assemblies.

NOTE: Steps 5 and 6 are applicable to all vehicles except two-door vehicles with the enlarged cab.

5. Connect body harness connector to courtesy light lamp assembly.
6. Secure courtesy light lamp assembly and mounting bracket to lower B-pillar trim on B-pillar with washers and rivets.
7. Secure anchor bracket to bracket with washer and screw/washer assembly. Tighten screw/washer assembly to 35-40 lb-ft (47-55 N•m).
8. Secure D-ring and webbing guide cover to B-pillar with washer and screw/washer assembly.
9. Route seat buckle electrical connector through grommet in inner kick panel and plug seat buckle electrical connector into roof harness connector (Figure 10-30).
10. Install inner kick panel.
11. Secure seat buckle to body with screw/washer assembly and washer. Tighten screw/washer assembly to 35-40 lb-ft (47-55 N•m).
12. Install seat.

DRIVER'S AND FRONT PASSENGER'S SEATS

Reclining Driver's and Front Passenger's Seat Replacement

NOTE: Reclining driver's and front passenger's seats are replaced similarly. This procedure covers the passenger's seat.

Removal

Remove bolts, washers, and passenger's seat from seat base (Figure 10-32).

Installation

Secure passenger's seat to seat base with washers and bolts. Tighten bolts to 15 lb-ft (20 N•m) (Figure 10-32).

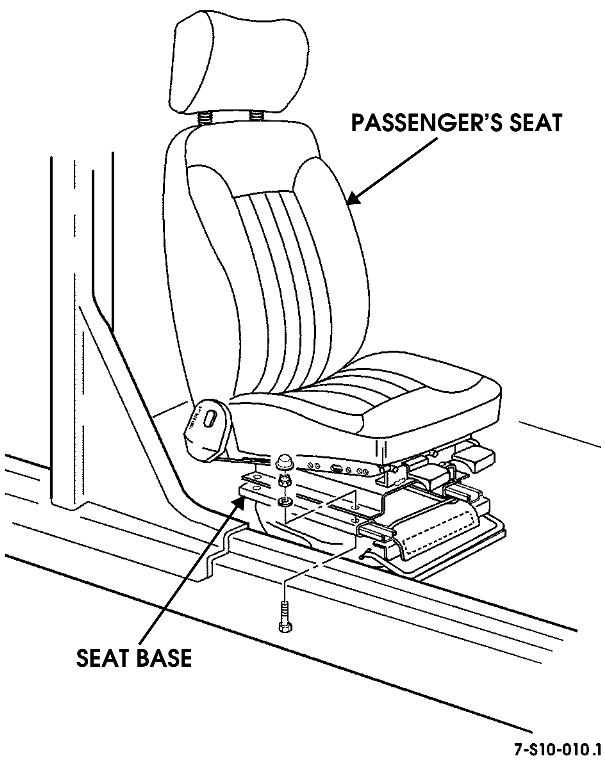


Figure 10-32: Reclining Front Seat Replacement

Standard Driver's and Front Passenger's Seat Pedestal Assembly Replacement

NOTE: Seat pedestal assembly replacement for driver's and front passenger's seats is similar. This procedure covers the driver's seat pedestal.

Removal

1. Remove seat from seat pedestal.
2. Remove four bolts, lockwashers, and washers securing seat pedestal to floor.
3. Remove seat pedestal and four spacers from vehicle.

Installation

1. Install four spacers and seat pedestal in vehicle.
2. Secure seat pedestal to floor with four washers, lockwashers, and bolts. Tighten bolts to 24 lb-ft (33 N•m).
3. Secure seat to seat pedestal.

Standard Driver's and Passenger's Seat Pedestal Repair

NOTE: Seat pedestal repair is similar for driver's and front passenger's seats. This procedure covers the driver's seat pedestal.

Removal

1. Remove driver's seat pedestal.
2. Remove bag from height adjuster (Figure 10-33).
3. Remove nuts, lockwashers, and bolts securing height adjuster to slide set and remove height adjuster and cover.
4. Remove nuts, lockwashers, and bolts securing riser to slide set and remove riser.

Installation

1. Secure riser to slide set with bolts, lockwashers, and nuts (Figure 10-33). Tighten nuts to 24 lb-ft (33 N•m).
2. Secure cover and height adjuster to slide set with bolts, lockwashers, and nuts.
3. Install bag on height adjuster.
4. Install driver's seat pedestal.

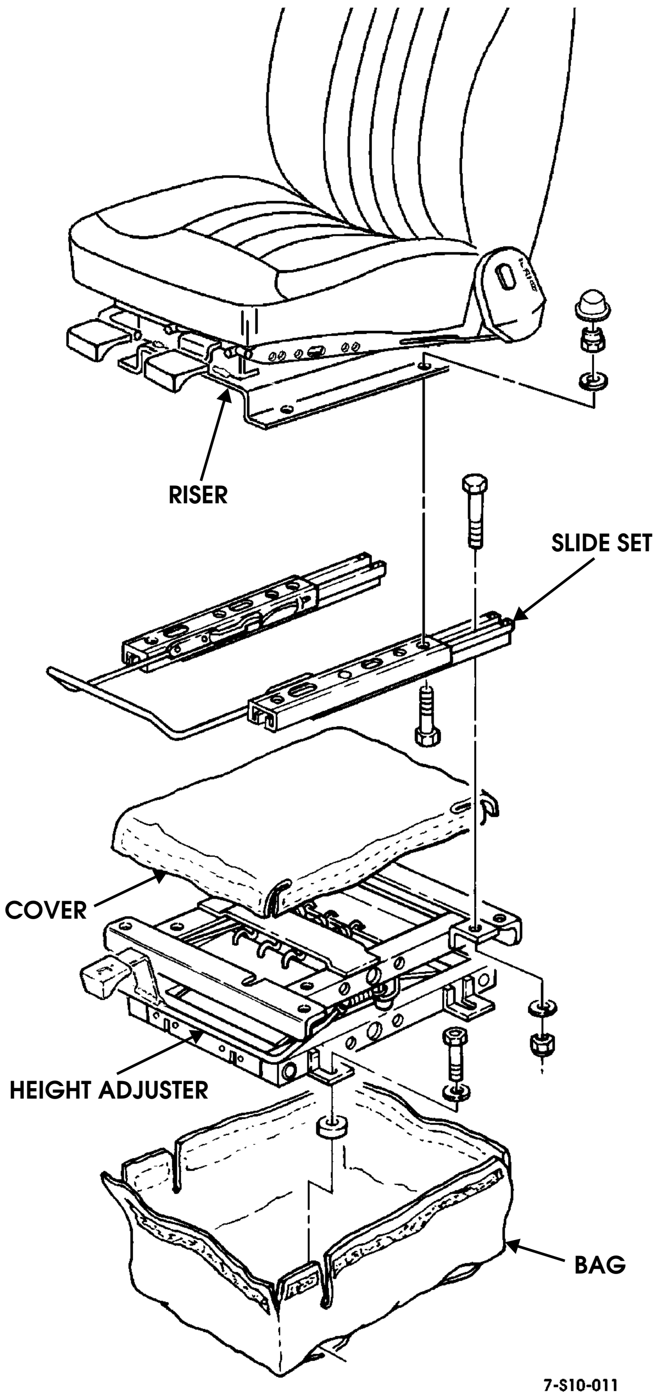


Figure 10-33: Seat Pedestal Assembly Breakdown

Driver's Seat Armrest Replacement

Removal

1. Remove plastic caps covering exposed screws.
2. Remove short screws and lockwashers attaching armrest to bracket (Figure 10-34).
3. If bracket needs to be replaced, remove long screws attaching bracket to seat support.

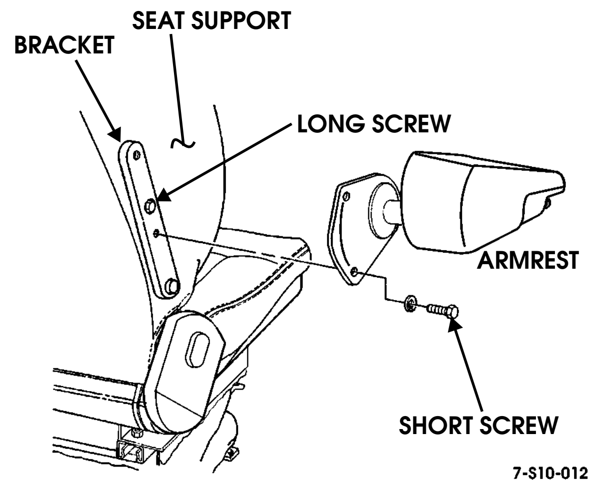


Figure 10-34: Driver's Seat Armrest Mounting

Installation

NOTE: If bracket was removed, perform steps 1 through 3.

1. Secure bracket to seat support with one of the long screws. Do not tighten screw (Figure 10-34).
2. Use large center hole in bracket to locate upper bracket mounting hole in seat support.
3. Secure top section of bracket to seat support with the other long screw. Tighten both long screws to 120 lb-in. (14 N•m).
4. Secure the armrest to the bracket with the short screws and lockwashers. Tighten the short screws to 120 lb-in. (14 N•m).
5. Position the plastic caps over the exposed screw heads.

NOTE: The entire armrest can be positioned vertically or horizontally by pushing the armrest up or down. To adjust the angle of the armrest while it is in the horizontal position, use the adjusting knob located under the front end of the armrest.

6. Use the adjusting knob to position the armrest as necessary.

REMOVABLE LOAD BARRIER AND MOUNTING BRACKETS REPLACEMENT (STATION WAGON)

Removal

1. Remove drive screws and carpet assembly from front and back of removable load barrier (Figure 10-35).
2. Remove necessary interior trim to gain access to mounting brackets.
3. Remove removable load barrier by lifting barrier up and out of mounting brackets on inner wheel house panels.
4. Remove rivets and mounting bracket from left inner wheel house panel.
5. Remove rivets and mounting bracket from right inner wheel house panel.

Inspection

Inspect bumper strips. If damaged, replace.

Installation

1. Secure mounting bracket to left inner wheel house panel with rivets (Figure 10-35).
2. Secure mounting bracket to right inner wheel house panel with rivets.
3. Install removable load barrier in mounting brackets.
4. Install interior trim.
5. Secure carpet assembly to front and back of removable load barrier with drive screws.

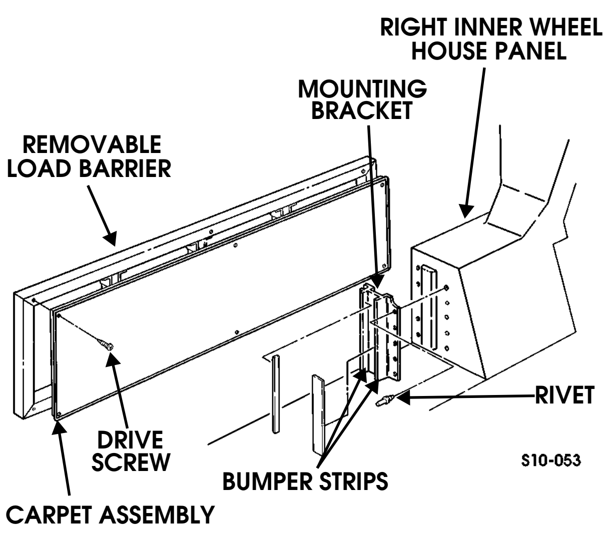


Figure 10-35: Removable Load Barrier Location

INTERIOR TRIM

B-Bar Replacement

NOTE: This procedure covers replacement of the B-bar for all vehicles except open top models and 2-door models without an enlarged cab.

Removal

1. Remove seat belt assemblies.
2. Remove trim from B-bar.
3. Remove domelight.

NOTE: It may be necessary to remove any duct tape or tie straps securing electrical wiring harnesses to B-bar.

4. Remove screws, washers, and headliner support from B-bar (Figure 10-36).
5. Remove screws, lockwashers, and mounting brackets from mounting blocks.
6. Remove B-pillar seals and rabbet seals from B-pillar. Inspect and discard seals if damaged.
7. Remove locknuts, washers, and strikers from B-pillar.
8. Remove six locknuts, washers, bolts and mounting blocks from B-pillar.
9. Remove B-bar.
10. Remove screws, washers, and two trim mounting brackets from B-bar.

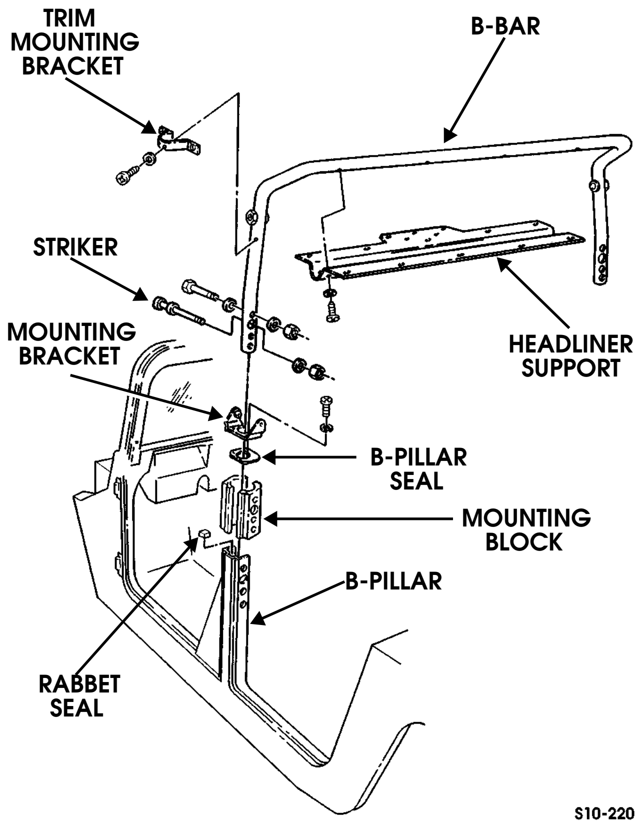


Figure 10-36: B-Bar Mounting

Installation

1. Secure trim mounting brackets to B-bar with four washers and screws (Figure 10-36).
2. Install B-bar.
3. Secure mounting blocks to B-pillar with washers, bolts and locknuts. Tighten locknuts to 24 lb-ft (33 N•m).
4. Secure strikers to B-pillar with washers and locknuts.
5. Install B-pillar seals and rabbet seals on B-pillar.
6. Secure mounting brackets to mounting blocks with lockwashers and screws.
7. Secure headliner support to B-bar with washers and screws.
8. Install domelight.
9. Install trim on B-bar.
10. Install seat belt assemblies.

Driver's Compartment Trim Replacement

Removal

1. Remove overhead speakers from driver's compartment and passenger's compartment (if applicable) (Section 12).
2. Remove visors.
3. Remove seat belt assemblies.
4. Remove covers, screws, and grab handle from trim. (Figure 10-37).

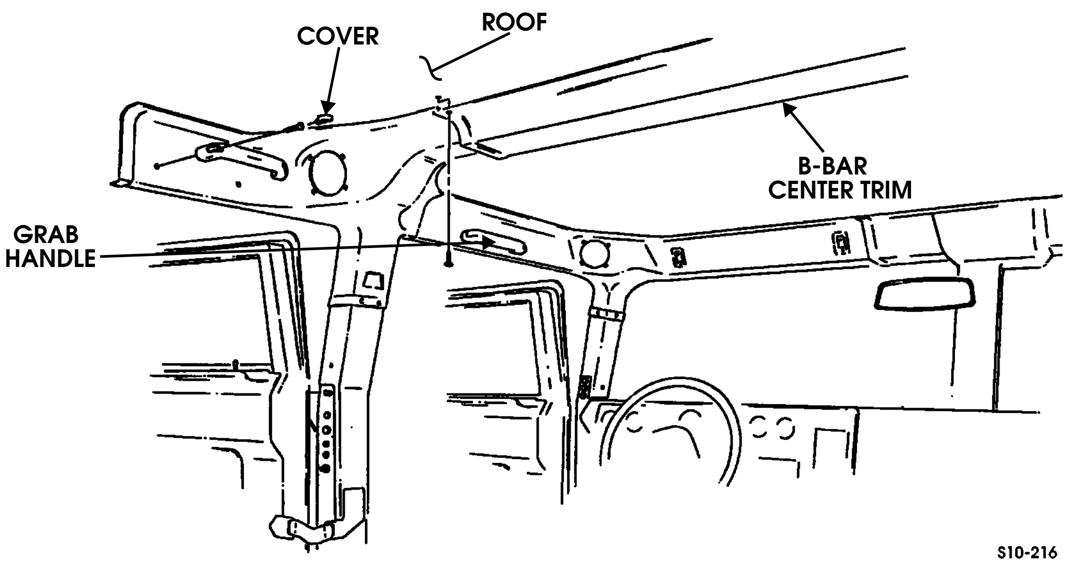


Figure 10-37: Driver's Compartment Trim Replacement

5. Remove screw/washer assemblies and B-bar center trim from roof.
6. Remove screw/washer assemblies and center trim from windshield frame and roof (Figure 10-38).
7. Remove screw/washer assemblies and upper A-pillar trim from roof.
8. Remove screw/washer assembly and lower A-pillar trim from A-pillar.
9. Remove screw/washer assemblies and upper B-bar trim from roof.
10. Remove screws, washers, and B-pillar trim from B-pillar.

NOTE: Replacement of the rear driver's compartment trim for 2-door vehicles with and without an enlarged cab is basically the same. Steps 11 through 13 cover 2-door vehicles without an enlarged cab.

11. Remove seats.
12. Remove screw/washer assemblies and trim from upper rear compartment wall (Figure 10-39).

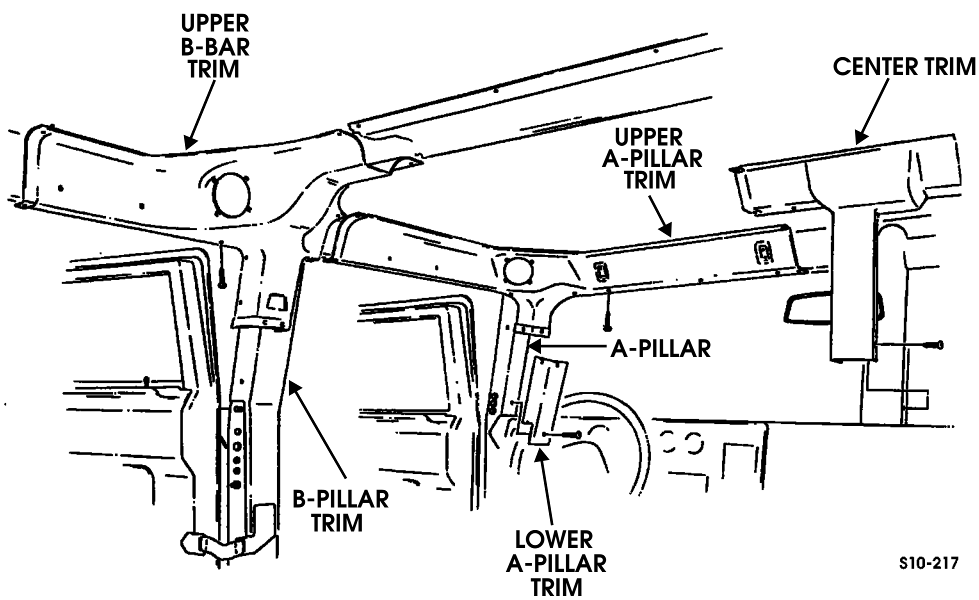


Figure 10-38: A-Pillar and B-Bar Interior Trim Identification

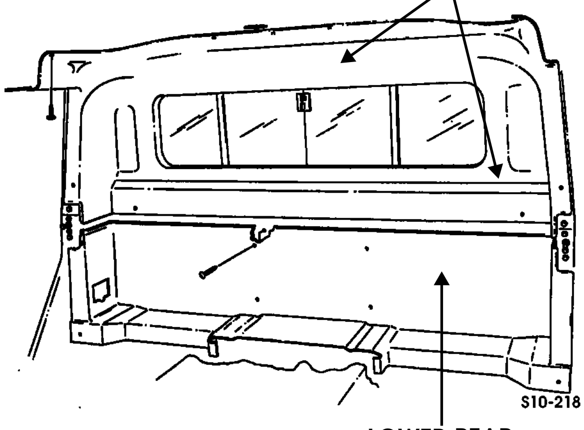


Figure 10-39: Rear Compartment Wall Location

13. Remove screw/washer assemblies, B-beam trim, and rear edge trim from B-beam and lower rear compartment wall.
14. Remove domelight.
15. Remove panel fasteners and headliner from roof (Figure 10-40).

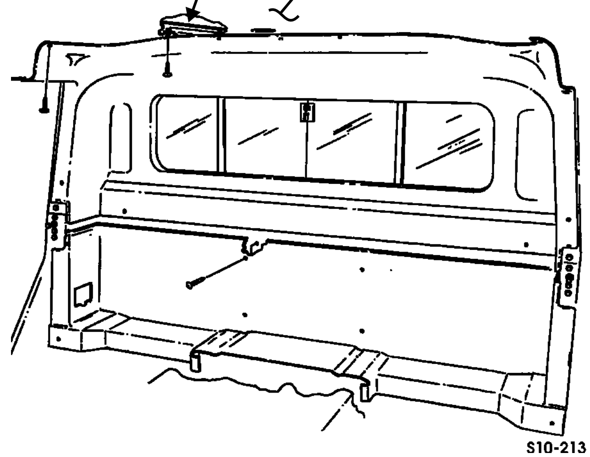


Figure 10-40: Headliner Positioning

Installation

1. Position headliner on roof and install with panel fasteners (Figure 10-40).
2. Install domelight.

NOTE: Perform steps 3 through 5 for 2-door vehicles without an enlarged cab.

3. Secure rear edge trim and B-beam trim to B-beam and rear compartment wall with screw/washer assemblies (Figure 10-39).
4. Secure trim to upper rear compartment wall with screw/washer assemblies.
5. Install seats.
6. Secure B-pillar trim to B-pillar with washers and screws (Figure 10-41).

7. Secure upper B-bar trim to roof with screw/washer assemblies.
8. Secure lower A-pillar trim to A-pillar with screw/washer assembly.
9. Secure upper A-pillar trim to roof with screw/washer assemblies (Figure 10-38).
10. Secure center trim to windshield frame and roof with screw/washer assemblies (Figure 10-41).
11. Secure B-bar center trim to roof with screw/washer assemblies.
12. Secure grab handle to trim with screws and covers.
13. Install seat belt assemblies.
14. Install visors.
15. Install overhead speakers (if equipped) (Section 12).

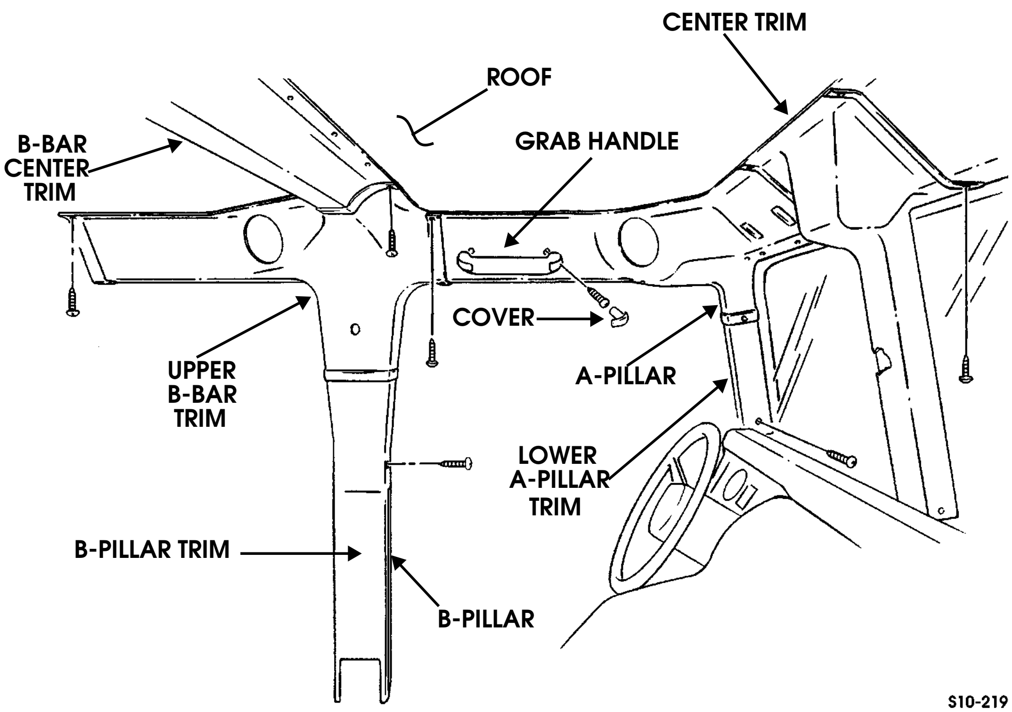


Figure 10-41: A-Pillar and B-Bar Interior Trim Components

Passenger's Compartment Trim Replacement

Removal

1. Remove rear seats.
2. Remove overhead speakers (Section 12).
3. Remove seat belt assemblies.
4. Remove screw/washer assemblies and B-bar center trim from roof (Figure 10-42).

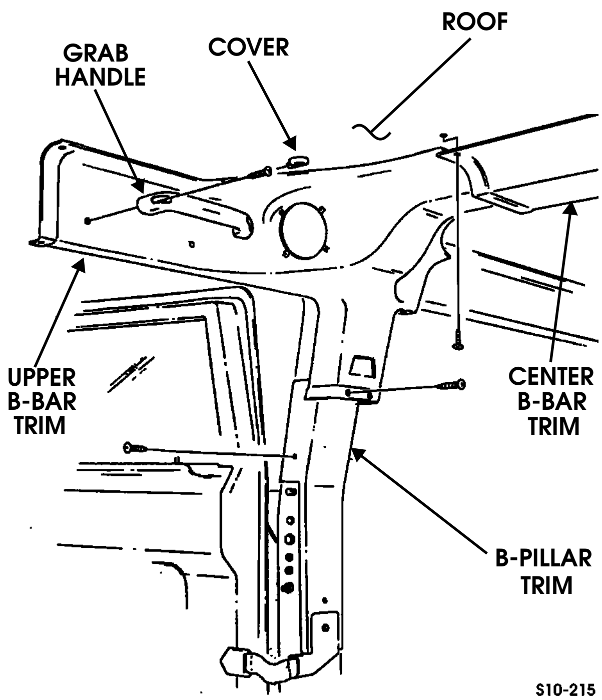


Figure 10-42: Driver Side Interior Trim Component Identification

5. Remove covers, screws, and grab handle from trim.
6. Remove screw/washer assemblies and upper B- bar trim from roof.
7. Remove screws, washers, and lower B-pillar trim from B-pillar.

NOTE: Perform steps 8 through 10 for station wagon models only.

8. Remove screw/washer assemblies and C-pillar center trim from roof (Figure 10-43).
9. Remove screw/washer assemblies and upper C-pillar trim from roof.
10. Remove screw/washer assemblies and lower C-pillar trim from lower C-pillar.

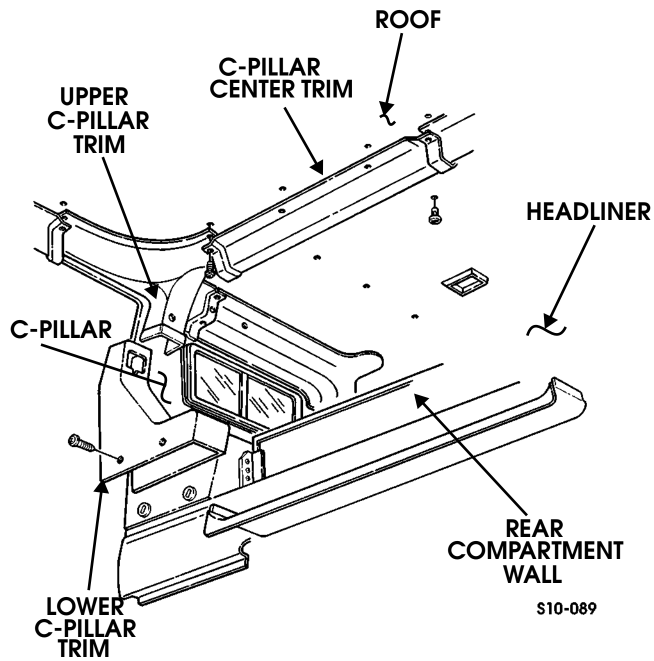


Figure 10-43: Station Wagon Interior Trim Component Identification

11. Remove screw/washer assemblies and trim panel from rear compartment wall (Figure 10-44)

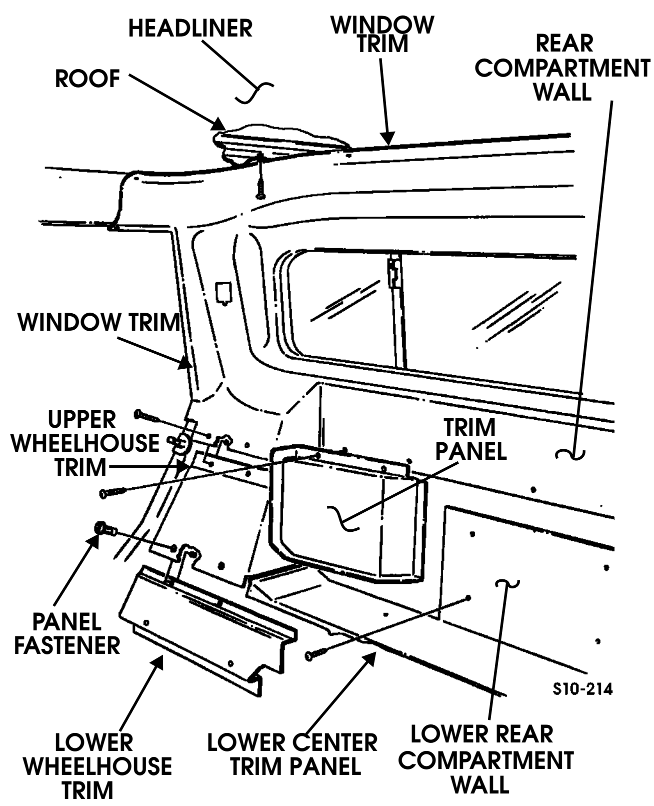


Figure 10-44: Four-Passenger Vehicle Interior Trim Component Identification

12. Remove screw/washer assemblies and window trim from rear compartment wall and roof.
13. Remove panel fasteners and upper wheelhouse trim from wheelhouse.
14. Remove screw/washer assemblies and lower wheelhouse trim from wheelhouse.
15. Remove screw/washer assemblies and lower center trim panel from lower rear compartment wall.
16. Remove domelight.
17. Remove panel fasteners and headliner from roof.

Installation

1. Secure headliner to roof with panel fasteners (Figure 10-44).
2. Secure domelight.
3. Secure lower center trim panel to lower rear compartment wall with screw/washer assemblies.
4. Secure upper and lower wheelhouse trim panels to wheelhouse with screw/washer assemblies and panel fasteners.
5. Secure window trim to rear compartment wall and roof with screw/washer assemblies.
6. Secure trim panel to rear compartment wall with screw/washer assemblies.

NOTE: Perform steps 7 through 9 for station wagon models only.

7. Secure lower C-pillar trim to lower C-pillar with four screw and washer assemblies (Figure 10-43).
8. Secure upper C-pillar trim to roof with nine screw and washer assemblies.
9. Secure C-pillar center trim to roof with eight screw and washer assemblies.
10. Secure B-pillar trim to B-pillar with washers and screws (Figure 10-45).
11. Secure upper B-bar trim to roof with screw/washer assemblies.
12. Secure B-bar center trim to roof with screw/washer assemblies.

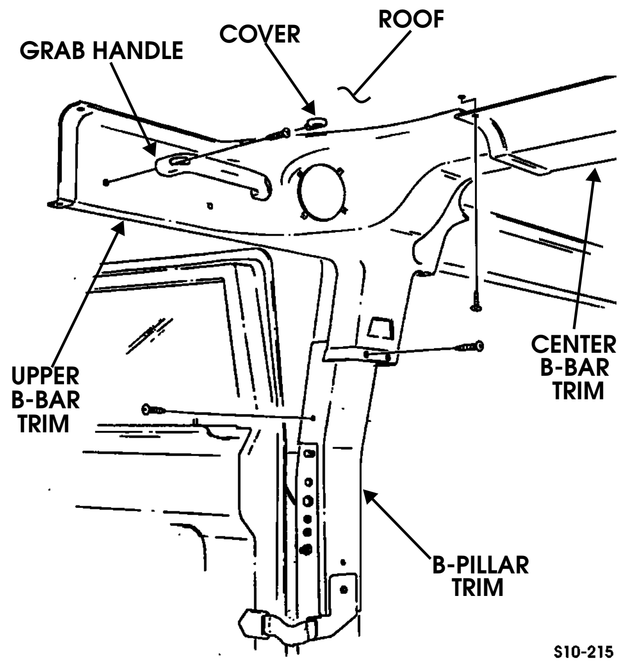


Figure 10-45: B-Pillar and Interior Trim Component Identification

13. Secure grab handle to trim with screws and covers.
14. Install seat belt assemblies.
15. Install overhead speakers (Section 12).
16. Install rear seats.

Station Wagon Rear Compartment Trim Replacement

Removal

1. Remove rear seats.
2. Remove bolts, washers, upper seat belt bracket, and seat belt assembly from C-pillar (Figure 10-46).

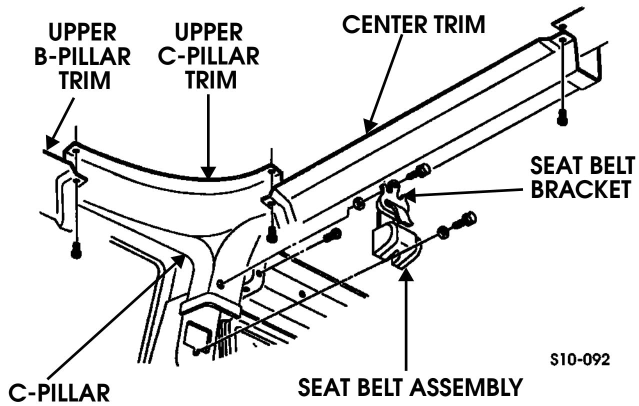


Figure 10-46: C- and B-Pillar Trim Component Identification

3. Remove screw/washer assemblies and center trim from C-pillar.
4. Remove screw/washer assemblies from edge of trim on upper B-pillar trim.
5. Remove screw/washer assemblies and upper C-pillar trim from C-pillar.
6. Remove screw/washer assemblies and trim from station wagon compartment side wall (Figure 10-47).

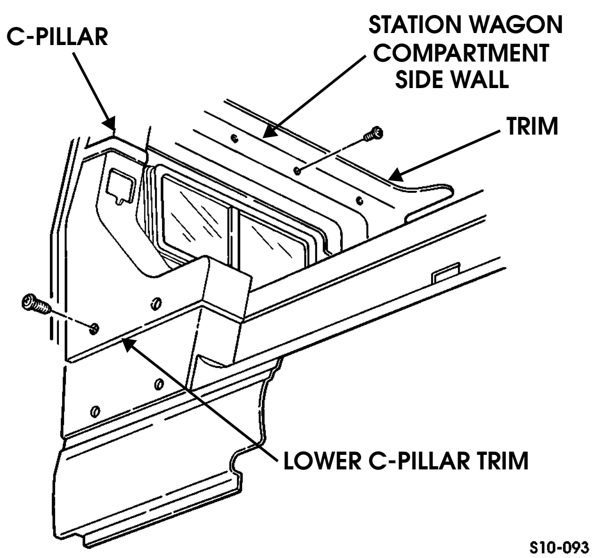


Figure 10-47: C-Pillar Trim Location

7. Remove screw/washer assemblies and lower C-pillar trim from C-pillar.
8. Remove screw/washer assemblies and two trim panels from lower rear compartment wall (Figure 10-48).

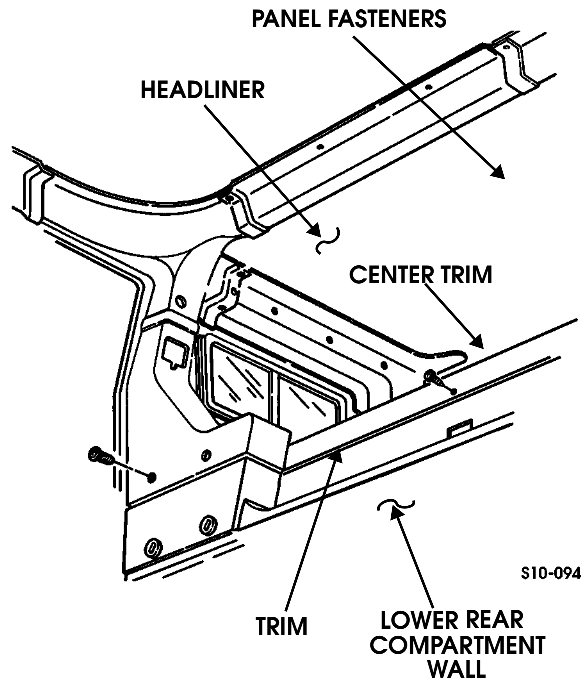


Figure 10-48: Headliner and Trim Removal

9. Remove panel fasteners and trim panel from rear compartment wall.
10. Remove domelight.
11. Remove panel fasteners and rear headliner from roof.

Installation

1. Secure trim to bottom of rear window.
2. Secure rear headliner to roof with panel fasteners (Figure 10-48).
3. Install domelight.
4. Secure trim panel to compartment wall with two panel fasteners.
5. Secure trim panels to lower rear compartment wall with screw/washer assemblies.
6. Secure lower C-pillar trim to lower side of C-pillar with screw/washer assemblies (Figure 10-49).

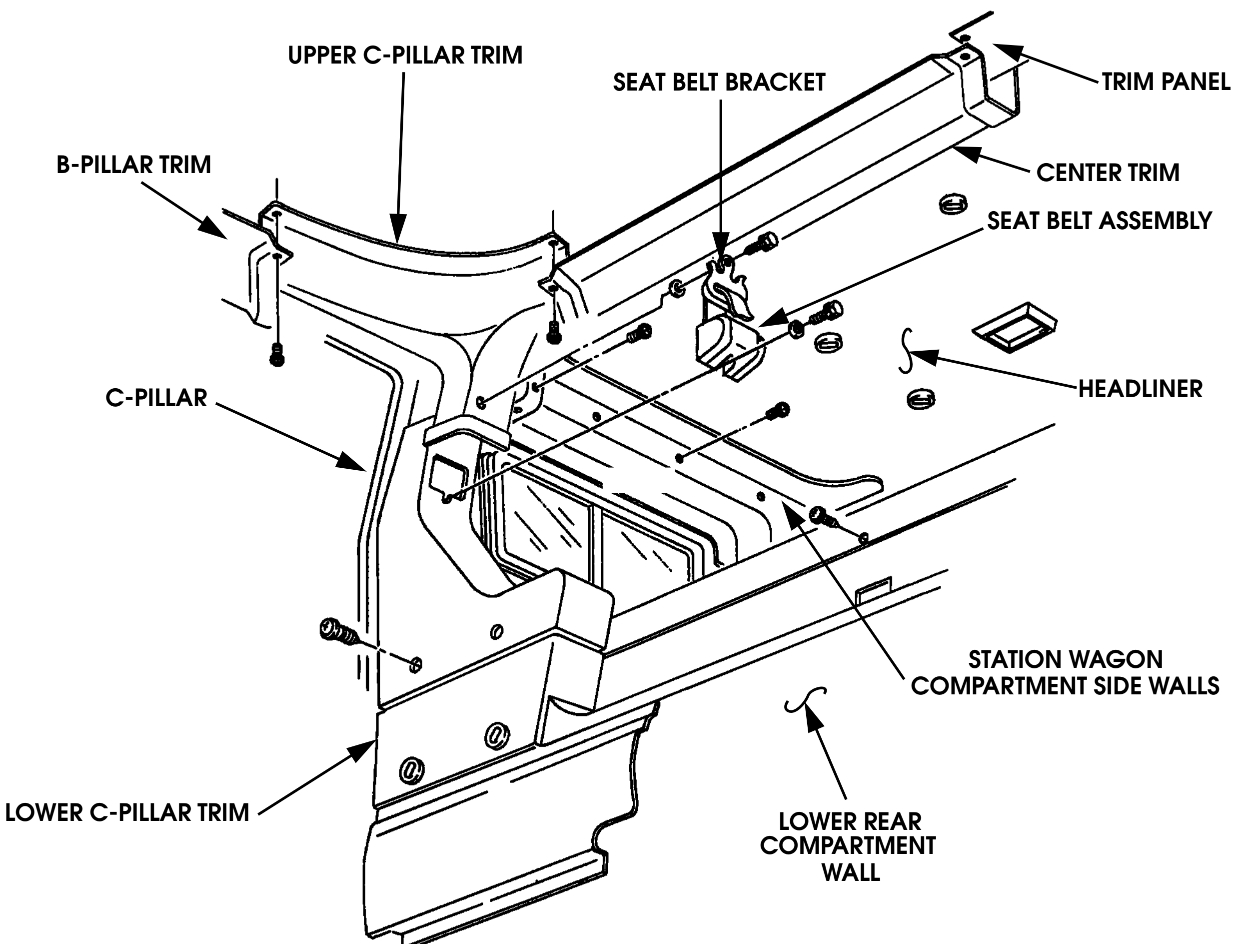


Figure 10-49: Station Wagon Side Wall Component Breakdown

7. Secure trim to upper station wagon compartment side wall with screw/washer assemblies.
8. Secure upper C-pillar trim to C-pillar with screw/washer assemblies.
9. Secure edge of upper trim on B-pillar with screw/washer assemblies.
10. Secure center trim to C-pillar with screw/washer assemblies.
11. Secure seat belt assembly and bracket to C-pillar with washers and bolts. Tighten bolts to 35-40 lb-ft (47-55 N•m).
12. Install rear seat.

Inner Kick Panels Replacement

Removal

1. Remove seats.

NOTE: Remove one bolt, washer, and seat buckle for two-passenger models.

2. Remove bolts, washers, and seat buckles from front and rear of tunnel (Figure 10-50).

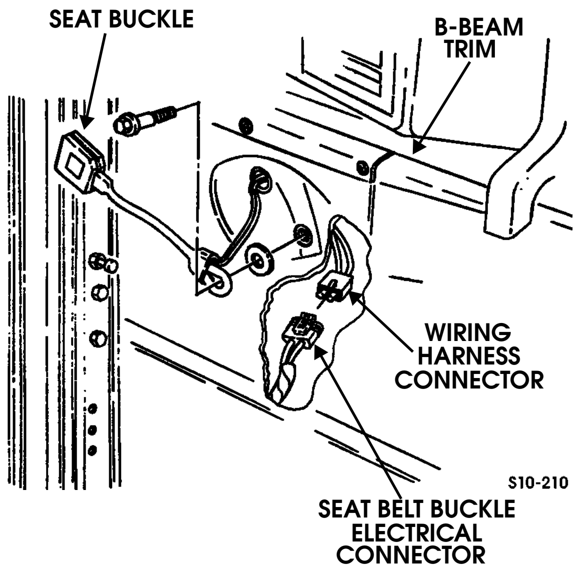


Figure 10-50: Seat Belt Buckle Electrical Connector Location

NOTE: Ensure seat belt buckle electrical connector or wiring harness is pulled out and away from kick panel for ease of installation.

3. Disconnect seat belt buckle electrical connector from wiring harness connector on driver side.

NOTE: Perform steps 4 and 5 for four-passenger models only.

4. Remove panel fasteners, screw/washer assemblies, and rear wall trim from rear compartment wall (Figure 10-51).

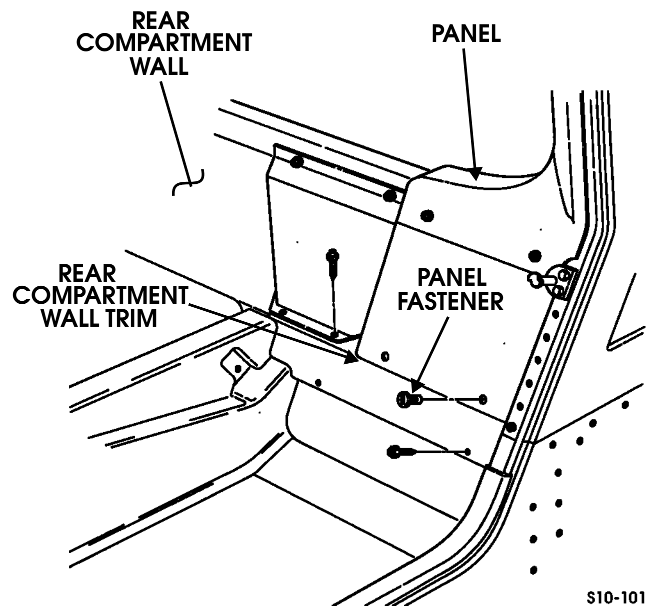


Figure 10-51: Rear Compartment Trim Removal

5. Remove panel fasteners and rear inner kick panel from tunnel (Figure 10-52).

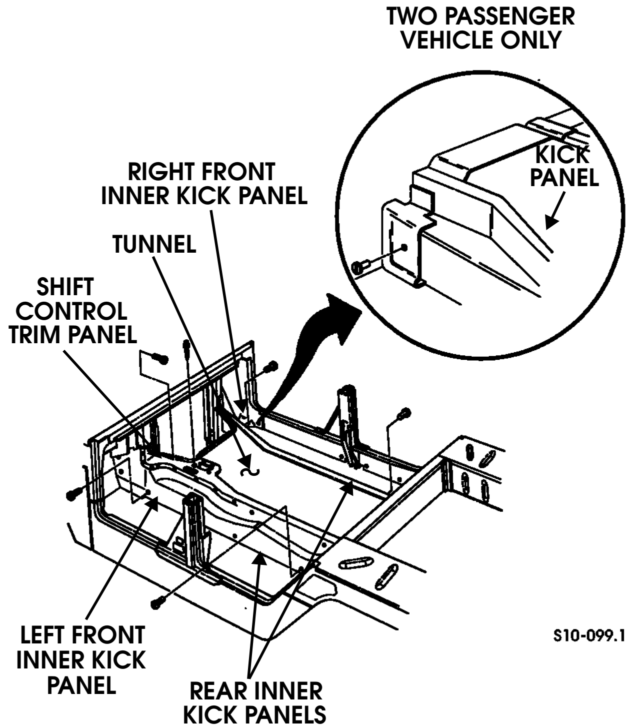


Figure 10-52: Inner Kick Panel Mounting

6. Remove front and center consoles.
7. Remove screw/washer assemblies, panel fastener, and shift control panel from tunnel (Figure 10-52).
8. Remove panel fasteners and left front inner kick panel from tunnel.
9. Remove panel fasteners and right front inner kick panel.

NOTE: Perform step 10 for two-passenger models only.

10. Remove panel fastener and inner kick panel from rear of tunnel.

Installation

NOTE: Perform step 1 for two-passenger models only.

1. Secure rear inner kick panel to right rear of tunnel with panel fastener (Figure 10-52).
2. Secure right front inner kick panel to tunnel with panel fasteners.
3. Secure left front inner kick panel to tunnel with panel fasteners.
4. Secure shift control trim panel to tunnel with screw/ washer assemblies and panel fastener.
5. Install center and front consoles.

NOTE: Perform steps 6 and 7 for four-passenger models only.

6. Secure rear inner kick panels with panel fasteners (Figure 10-51).
7. Secure rear wall trim to rear compartment wall with panel fasteners and screw/washer assemblies.
8. Connect driver side seat belt buckle electrical connector (Figure 10-50).

NOTE: Install one seat buckle on two-passenger models.

9. Secure seat buckles to tunnel with washers and bolts. Tighten bolts to 35-40 lb-ft (47-55 N•m).
10. Install seats.

Outer Kick Panel Replacement

Removal

NOTE: Soft top models require removal of speakers from front outer kick panels before performing the following task.

1. Remove door stop straps.
2. Remove panel fasteners and right front outer kick panel from body (Figure 10-53).
3. Remove panel fasteners and left front outer kick panel from body.
4. Remove panel fasteners and left center outer kick panel from body.
5. Remove panel fastener and right center outer kick panel from body.
6. Remove screws, washers, and rear lower seat belt brackets from body.
7. Remove panel fasteners and left and right rear outer kick panels from body.

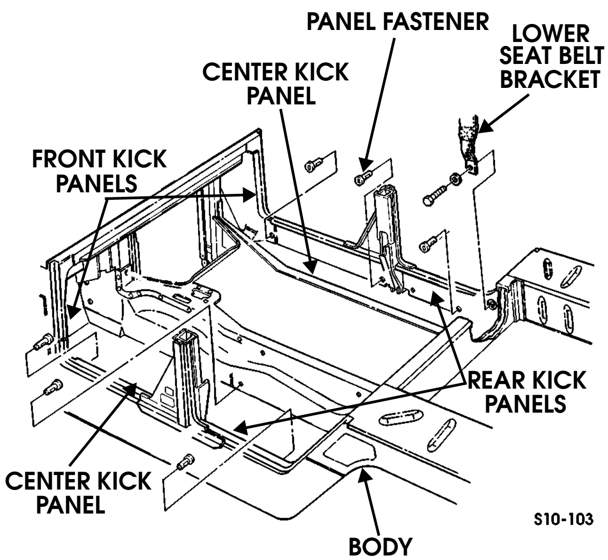


Figure 10-53: Outer Kick Panel Identification

Installation

1. Secure left and right rear outer kick panels to body with panel fasteners (Figure 10-53).
2. Secure rear lower seat belt brackets to body with washers and screws.
3. Secure right center outer kick panel to body with panel fastener.
4. Secure left center outer kick panel to body with panel fasteners.
5. Secure left front outer kick panel to body with panel fasteners.
6. Secure right front outer kick panel to body with panel fasteners.
7. Install door stop straps.

Tunnel Carpet, Padding, and Hardboard Replacement

Removal

NOTE: Tunnel carpet, padding, and hardboard replacement is basically the same for all models. This task represents four-passenger model carpet replacement.

1. Remove inner kick panels.
2. Remove carpet from tunnel (Figure 10-54).
3. Remove padding from tunnel.
4. Remove panel fasteners and hardboard from tunnel.

Installation

1. Secure hardboard to tunnel with panel fasteners (Figure 10-54).
2. Install padding on tunnel.
3. Install carpet on tunnel.
4. Install inner kick panels.

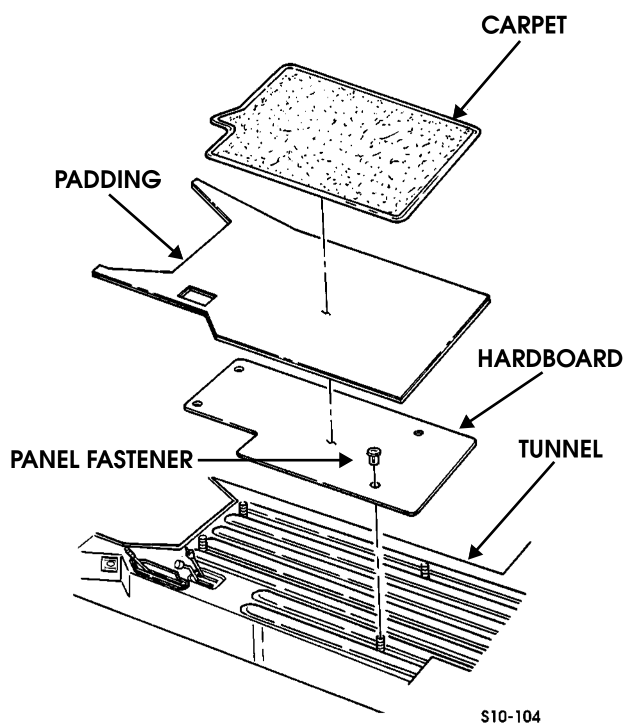


Figure 10-54: Carpet and Padding Installation

VISOR REPLACEMENT

Removal

NOTE: Visor replacement is the same for each side of the vehicle. This procedure covers the driver's side.

NOTE: If your vehicle has the lighted visor mirror, disconnect the visor mirror lead from the roof harness connector before removing the visor (Figure 10-57).

Remove screws, lockwashers, washers, and visor from body (Figure 10-57).

Installation

Secure visor mounting brackets to body with four screws, lockwashers, and washers (Figure 10-57).

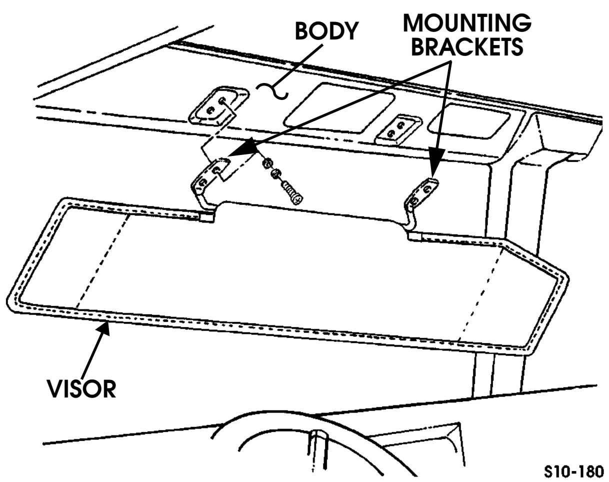


Figure 10-55: Visor Mounting

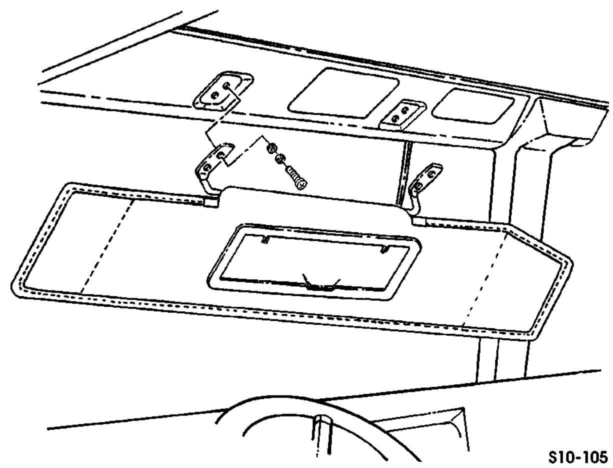


Figure 10-56: Visor With Lighted Mirror

MIRRORS

Side Mirror Replacement

Removal

Remove screws, mirror, and gasket from door hinge (Figure 10-57).

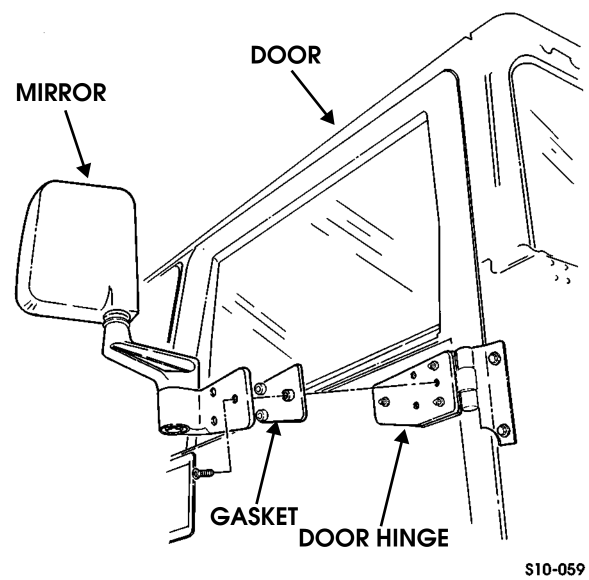


Figure 10-57: Side Mirror Assembly Replacement

Installation

Secure gasket and mirror to door hinge with screws (Figure 10-57).

POWER MIRRORS

Power Mirror Assembly Replacement

Removal

1. Remove three screws securing power mirror assembly and gasket to mounting plate (Figure 10-58).
2. Disconnect power mirror assembly connector from door jumper harness.
3. Inspect gasket, and replace if damaged.

Installation

NOTE: Ensure door jumper harness is routed through gasket before connecting to power mirror assembly.

1. Connect power mirror assembly connector to door jumper harness (Figure 10-58).

NOTE: Wires from power mirror assembly must be coiled in mirror housing to ensure clearance of attachments.

2. Install gasket and power mirror assembly on mounting plate with three screws.

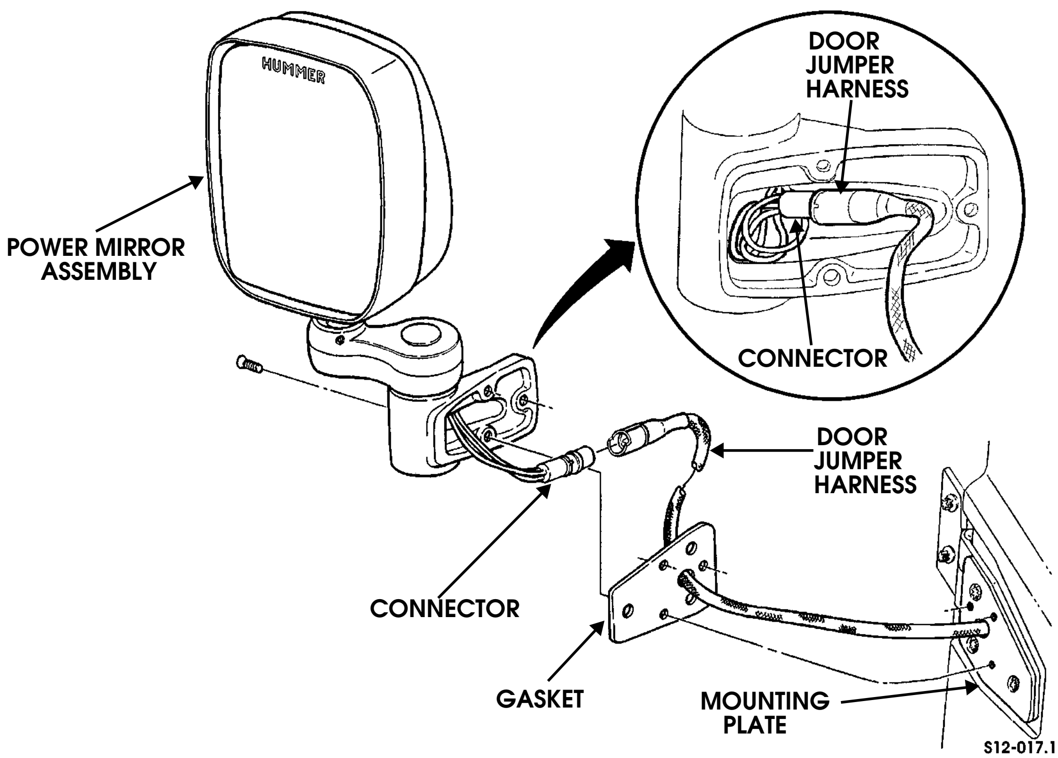


Figure 10-58: Power Mirror Assembly

Rearview Mirror Replacement

Removal

1. Remove screw and rearview mirror from mirror bracket (Figure 10-59).

NOTE: Perform step 2 only if bracket requires replacement. Mark location of bracket prior to removal.

2. Remove bracket from windshield.

Cleaning and Inspection

Clean epoxy remains from windshield.

Installation

NOTE: Perform step 1 only if bracket was removed.

1. Secure mirror bracket to windshield with quick-drying epoxy. Allow to dry (Figure 10-59).
2. Secure rearview mirror to mirror bracket with screw.

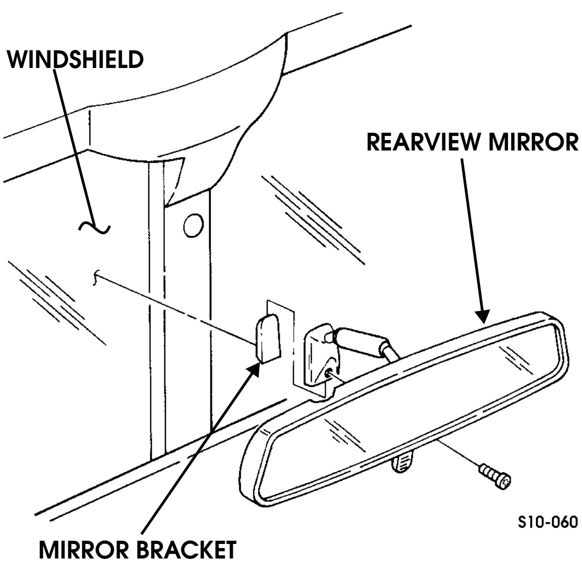


Figure 10-59: Rearview Mirror

DOOR REPLACEMENT

Door replacement varies in complexity depending on the type and number of components that must be removed from the old door and installed on the new door. Power windows and power door locks are standard equipment in 1997. Removal and installation of these components are detailed in the previous pages of this section. Any reference to wiring harness removal and installation is covered in Section 12. The following door replacement procedure is written assuming the presence of power equipment.

When replacing doors with manual equipment, follow this procedure but skip the power/electrical steps. Refer to manual window regulator removal and installation at the end of this procedure when needed.

NOTE: Door replacement is basically the same for all doors.

Removal

CAUTION: *To avoid damage, support door during removal.*

1. Remove sideview mirror (front doors only).
2. Remove door harness from pillar (Section 12).
3. Remove door stop strap assembly.
4. Remove twelve-point bolts and washers securing upper door hinge to pillar (Figure 10-60).

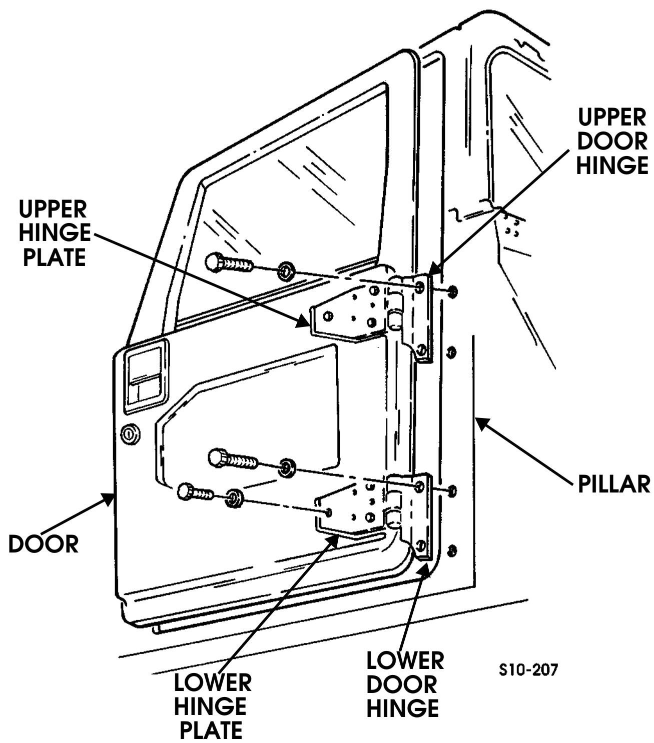


Figure 10-60: Door Mounting

5. Close door.
6. Remove twelve-point bolts and washers securing lower door hinge to pillar and remove door.

Disassembly

1. Remove twelve-point bolts, washers, and upper and lower hinge plates from door (Figure 10-60).

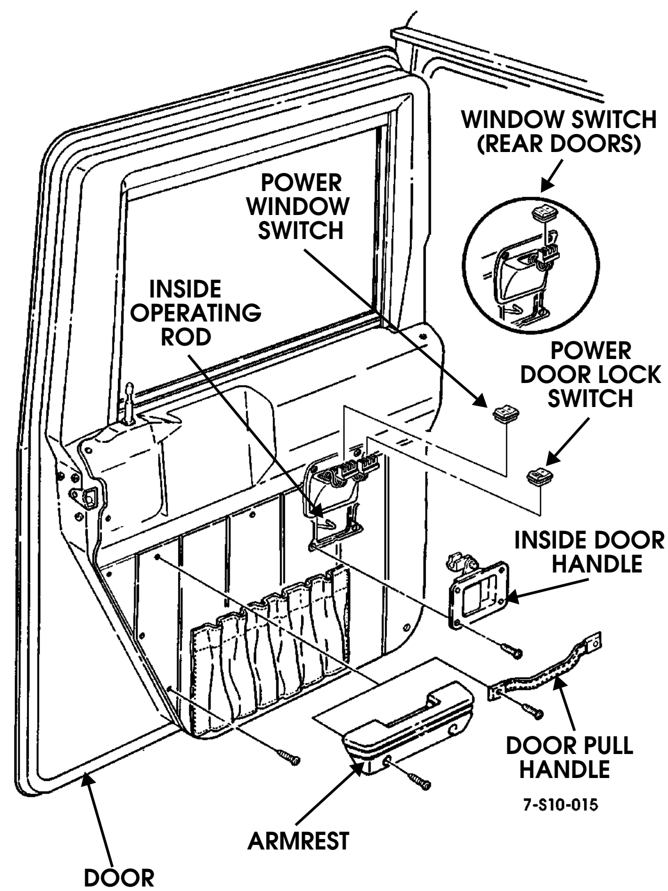


Figure 10-61: Door Trim Breakdown

2. Remove power windows and/or door locks switches from door (refer to procedure in this section).
3. Remove screws and door pull handle or armrest from door trim panel (Figure 10-61).
4. Remove screws securing inside door handle to door trim panel. Pull handle away from trim panel, and disconnect inside operating rod from handle.
5. Remove screw/washer assemblies and door trim panel from door.
6. Remove vapor barrier and moisture barrier flap from door (Figure 10-62).
7. Disconnect inside operating rod from door latch assembly and remove rod (Figure 10-63).
8. Remove lock cylinder clip from lock cylinder.
9. Push lock cylinder through outside of door. Remove clip securing lever and lock operating rod to cylinder and remove cylinder from door (Figure 10-65).

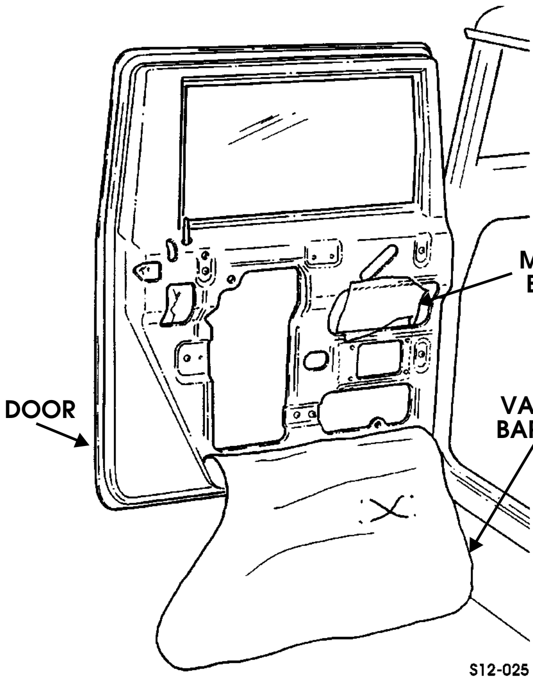


Figure 10-62: Vapor Barrier and Moisture Barrier Flap

10. Remove nuts and lockwashers securing gasket and outside door handle to door. Disconnect outside operating rod from handle, and remove handle.
11. Remove screws, lockwashers, and latch assembly from door (Figure 10-64).
12. Remove all rods from door latch assembly.

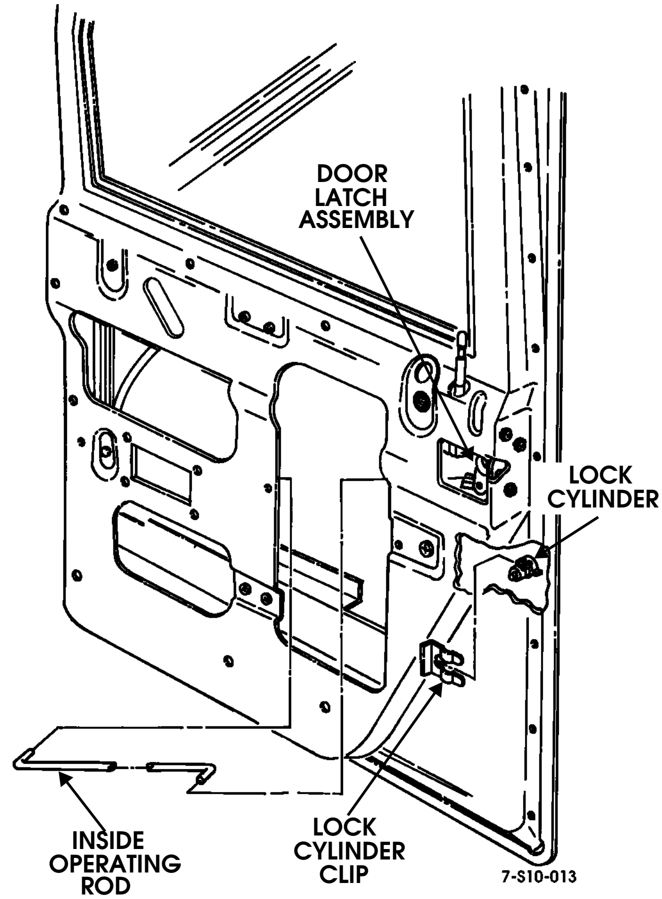


Figure 10-63: Inside Operating Rod Location

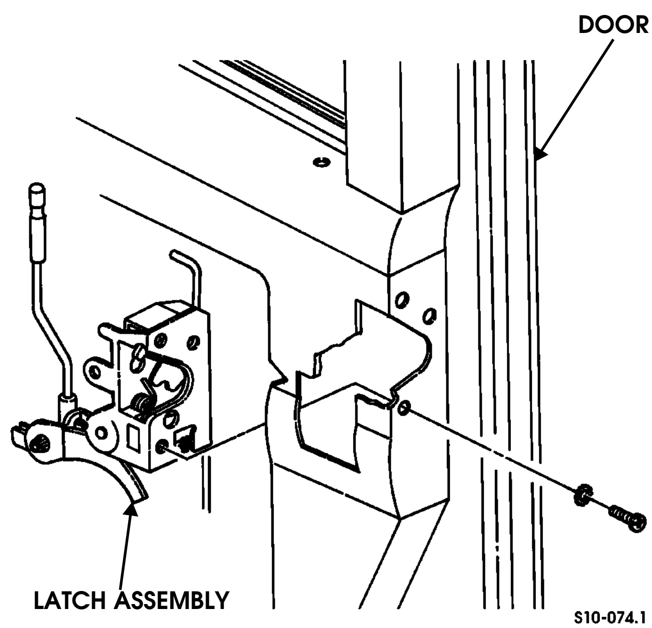


Figure 10-64: Latch Assembly

CAUTION: *Firmly support glass during regulator removal to avoid damage.*

Remove power window regulator (refer to procedure in this section).

Cleaning and Inspection

NOTE: Clean all components, and examine for wear or damage. Replace if necessary.

Assembly

1. Install power windows regulator (refer to procedure in this section).
2. Install all rods on door latch assembly (Figure 10-64).

WARNING: Screws securing latch assembly have metric threads. Substituting non-metric threaded screws can result in door opening during vehicle operation. Do not substitute screws.

3. Secure latch assembly to door with lockwashers and screws.
4. Connect outside operating rod to outside door handle, and secure gasket and outside door handle to door with nuts and lockwashers (Figure 10-65).
5. (Front doors only) Install lock cylinder in door and secure lock operating rod and lever to lock cylinder with clip.

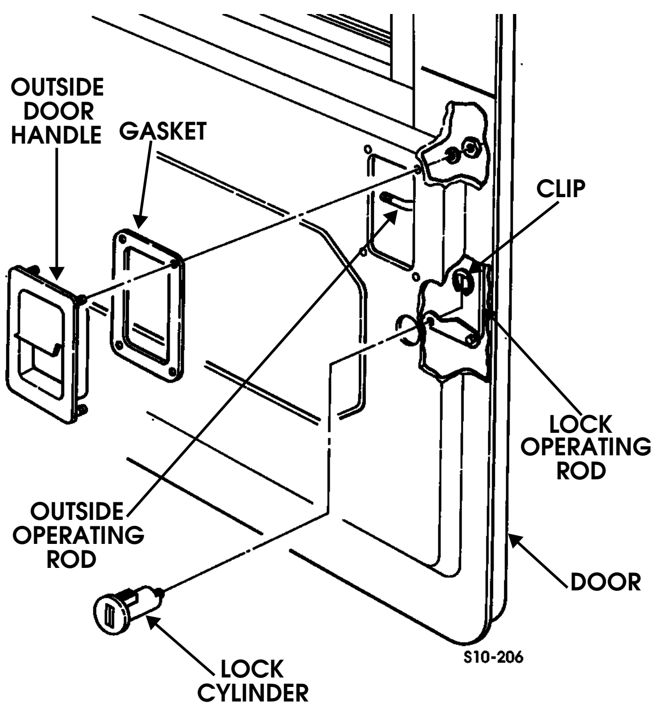


Figure 10-65: Lock Cylinder and Outside Door Handle

6. (Front doors only) Secure lock cylinder in door with lock cylinder clip (Figure 10-63).
7. Install inside operating rod on door latch assembly.

NOTE: Vapor barrier must be completely sealed at all edges to prevent water entry into the interior of the vehicle.

8. Install moisture barrier flap and vapor barrier on door (Figure 10-62).
9. Secure door trim panel to door with screw/washer assemblies (Figure 10-61).
10. Connect inside operating rod to inside door handle, and install inside door handle on door trim panel with screws.
11. Install door pull handle or armrest on door trim panel with screws.
12. Install power window switch.
13. Secure upper and lower hinge plates to door with washers and twelve-point screws (Figure 10-66).

Installation

CAUTION: *To avoid damage, support door during installation.*

1. Secure lower door hinge to pillar with washers and twelve-point screws. Do not tighten screws (Figure 10-66).
2. Secure upper door hinge to pillar with washers and twelve-point screws. Do not tighten screws.
3. Install door stop strap assembly.
4. Install power windows and door locks harness on pillar (Section 12).
5. Install sideview mirror (front doors only).
6. Install sideview mirror (front doors only).

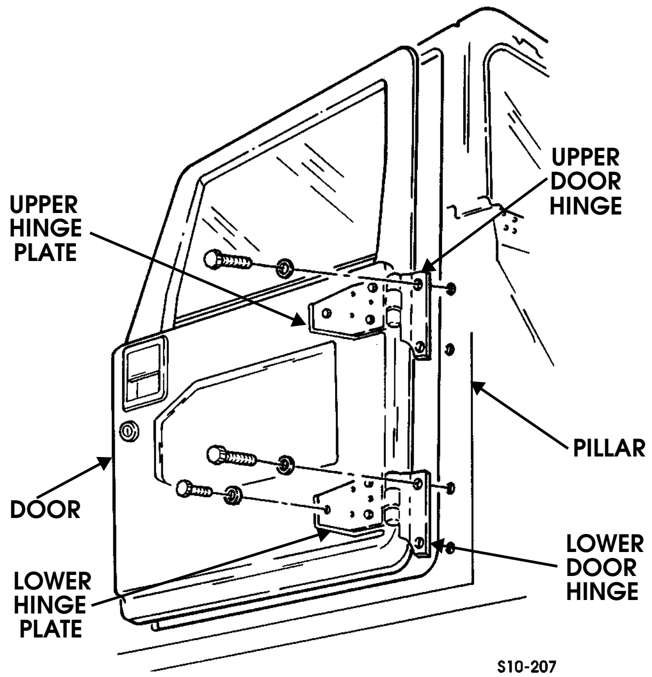


Figure 10-66: Door Hinges

Adjustment

1. Loosen twelve-point screws securing upper and lower door hinges to pillar (Figure 10-66).
2. Raise door as high as possible. Push hinges toward front of vehicle as far as they will go, and tighten twelve-point screws 6 lb-ft (8 N•m).
3. Loosen twelve-point screws securing upper and lower hinge plates to door.
4. Close door and tighten twelve-point screws.

Manual Window Regulator (Optional)

NOTE: At this point it is assumed that door panel has been removed for access to window regulator.

Removal

1. Remove nuts and lockwashers securing regulator post to window assembly (Figure 10-67).
2. Remove screws and lockwashers securing regulator post to door.
3. Remove screws, lockwashers and regulator from door.

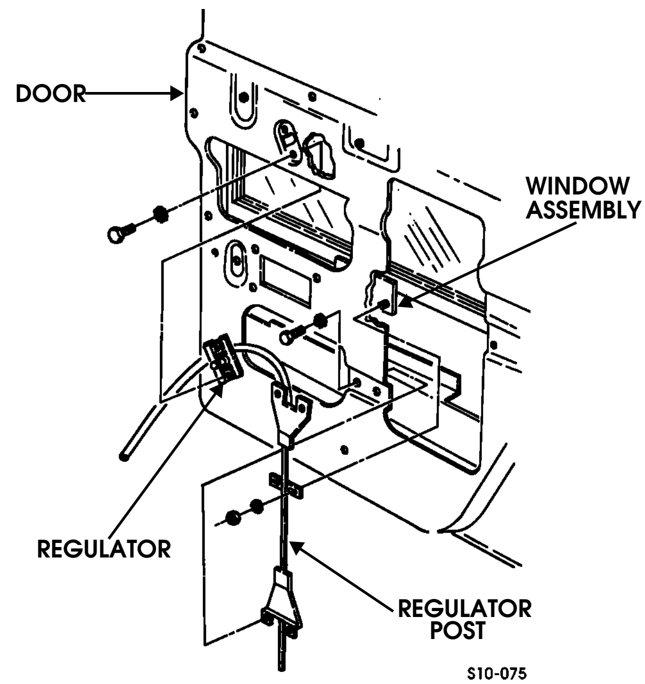


Figure 10-67: Window Regulator Mounting

Installation

1. Secure regulator to door with lockwashers and screws.
2. Secure regulator post to door with lockwashers and screws.
3. Secure regulator post to window assembly with lockwashers and nuts.

POWER WINDOWS

Power Window Regulator Replacement

Removal

NOTE: Operate motor to position glass in opening to provide access to two screws securing glass and its bracket to regulator. If motor is inoperative, other means to remove these screws will be necessary such as drilling access holes in door inner panel.

1. Remove power window and door lock switches from door. Disconnect switches from power window and door lock harness connectors.
2. Remove door trim and vapor barrier .

CAUTION: *Support window in full up position during regulator removal to avoid damage.*

NOTE: Prior to removal, mark location of screws for installation.

3. Disconnect power window and door lock harness connector from regulator motor (Figure 10-68) (push locking tab up on bottom of connector).
4. Remove two screws and lockwashers securing regulator bracket to door. Discard lockwashers.
5. Remove screw, lockwasher, and regulator bracket from regulator. Discard lockwashers.
6. Remove screw securing regulator motor to door.
7. Remove four screws and lockwashers cable and bracket assembly to door. Discard lockwashers.
8. Remove two screws, lockwashers, and washers securing regulator cable and bracket assembly to window bracket. Discard lockwashers.
9. Remove tie strap and regulator from door. Discard tie strap.

Installation

1. Install regulator in door and secure with tie strap (Figure 10-68).
2. Secure regulator cable and bracket assembly to window bracket with two washers, lockwashers, and screws.
3. Secure regulator cable and bracket assembly to door with four lockwashers and screws.
4. Secure regulator motor to door with screw.
5. Install regulator bracket on door with two lockwashers and screws.
6. Secure regulator bracket to regulator with lockwasher and screw.
7. Connect power window and door lock harness connector to regulator motor.
8. Check operation of regulator.
9. Install door trim and vapor barrier.
10. Install power window and door switches on door. Connect power window and door lock harness connectors to switches.

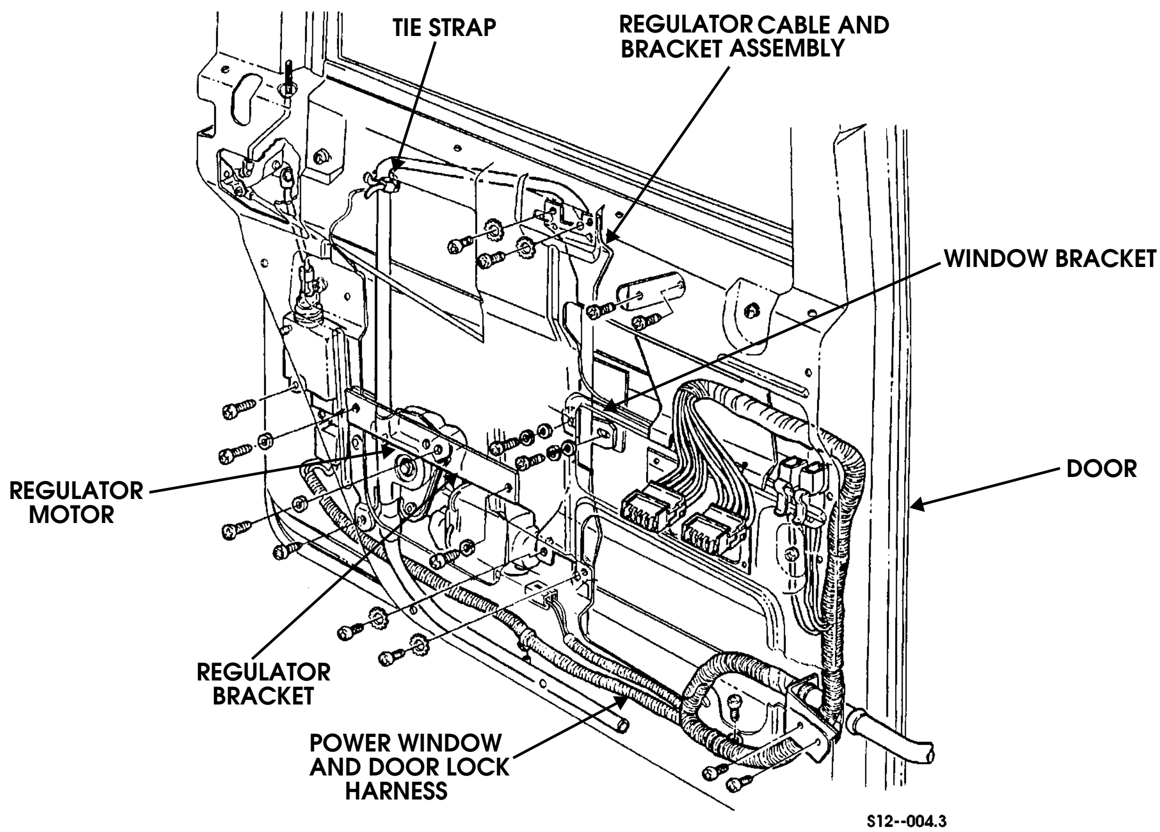


Figure 10-68: Power Window Regulator

DOOR SEALS REPLACEMENT

NOTE: The door seals come in bulk and must be cut to the appropriate lengths. For hard top vehicles, cut 12 feet for the doors and 10 feet for the body opening. For soft-top vehicles, cut 6 feet for the doors and 5 feet for the body opening.

Removal

NOTE: Note position of old seals before removal.

1. Remove door strap so that door will swing open far enough to access seals.
2. Remove the old seal from the door frame and the body area. Clean any remaining adhesive residue from the door surface.

Installation

1. Cut the door and body seals to the proper lengths (see note above).
2. Beginning at the bottom of the door, press door seal around the outside of the door frame (Figure 10-69).

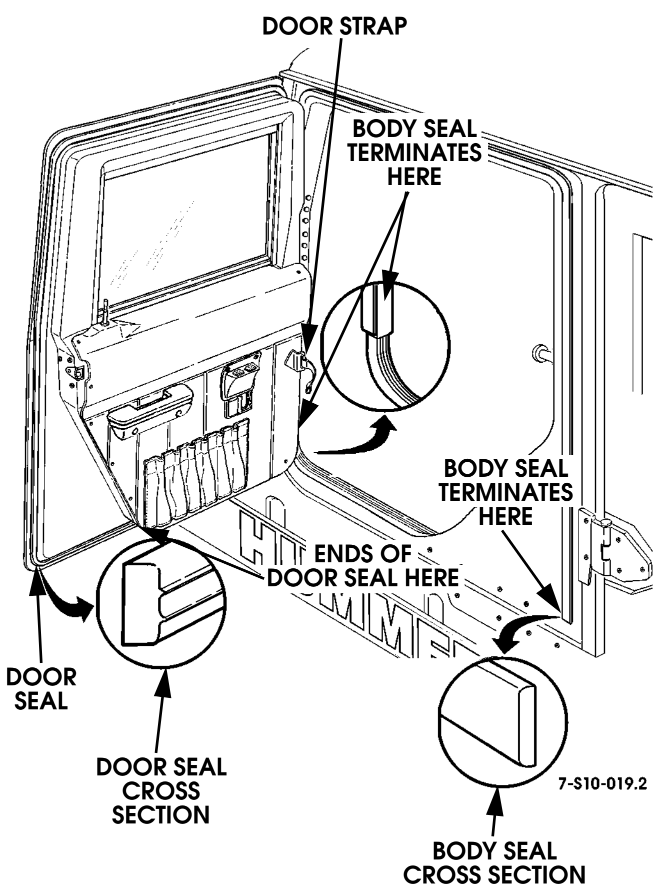


Figure 10-69: Door and Body Seal Replacement

3. Apply body seal in the same location as the seal that was removed.
4. Install door strap.

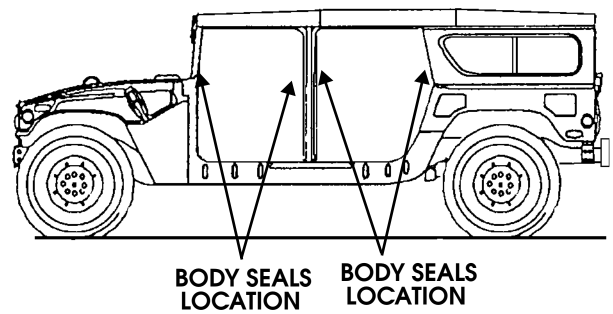


Figure 10-70: Body Seals Location

DOOR STOP STRAP ASSEMBLY REPLACEMENT

Removal

1. Remove bolt, washer, and door stop strap assembly from door (Figure 10-71).
2. Remove two bolts, washers, door stop strap assembly, and courtesy light from A-pillar (**front door only**).
3. Remove bolt, washer, and door stop strap assembly from B-pillar (**rear door only**).

Installation

1. Secure door stop strap assembly to door with washer and bolt. Tighten bolt 12 lb-ft (16 N•m) (Figure 10-71).
2. Secure courtesy light and door stop strap assembly to A-pillar with two washers and bolts. Tighten bolts to 12 lb-ft (16 N•m) (**front door only**).
3. Secure door stop strap assembly to B-pillar with two washers and bolts. Tighten bolts to 78 lb-ft (106 N•m) (**rear door only**).

DOOR GLASS

Door Glass Replacement

NOTE: Door glass replacement is the same for all doors. This procedure covers the right front door.

Removal

1. Remove window regulator.
2. Remove beltline seal (Figure 10-72).

NOTE: Mark location of screws prior to removal for installation.

3. Remove four screws, lockwashers, front and rear channels, and door window seals from door.
4. Rotate glass/lift channel bracket assembly 90 degrees and remove through window opening (Figure 10-73).

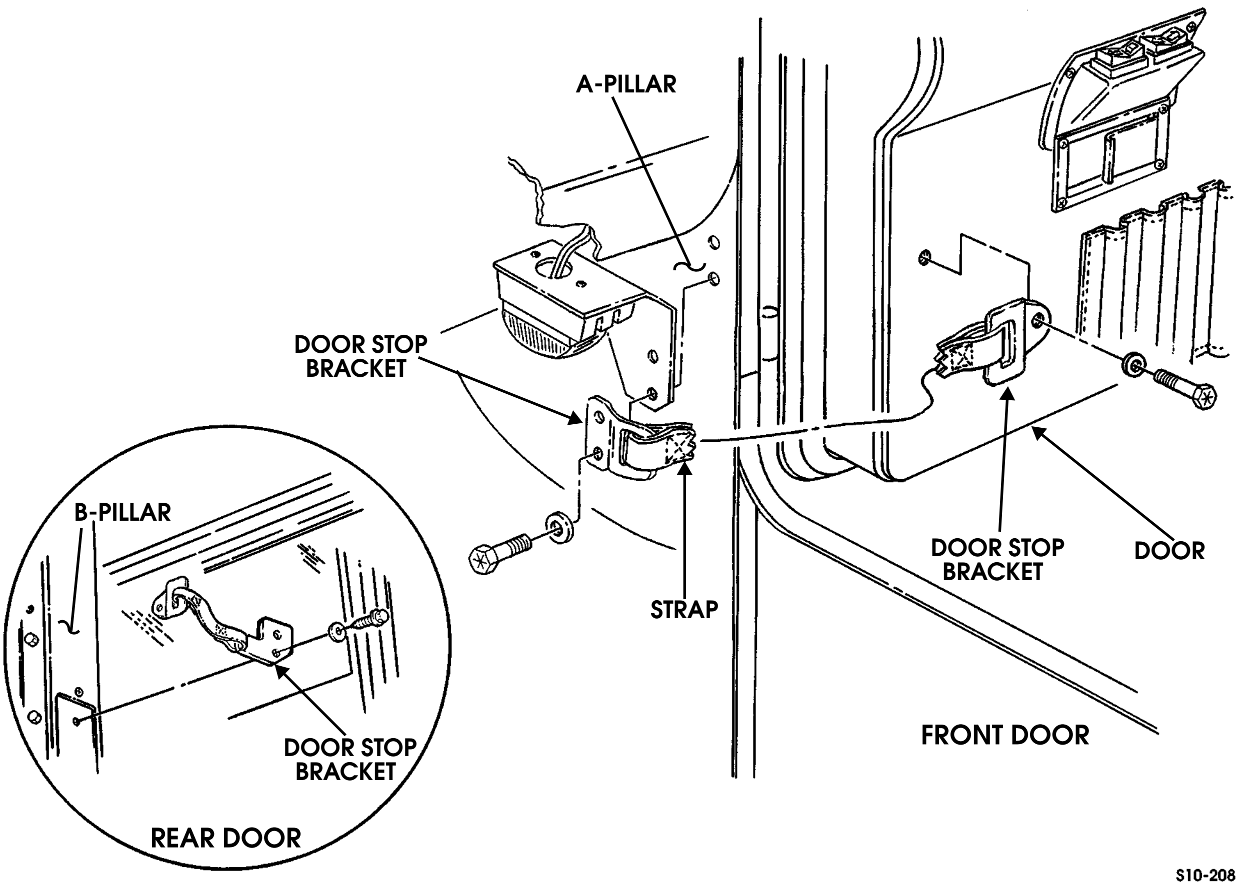


Figure 10-71: Door Stop Strap Assembly

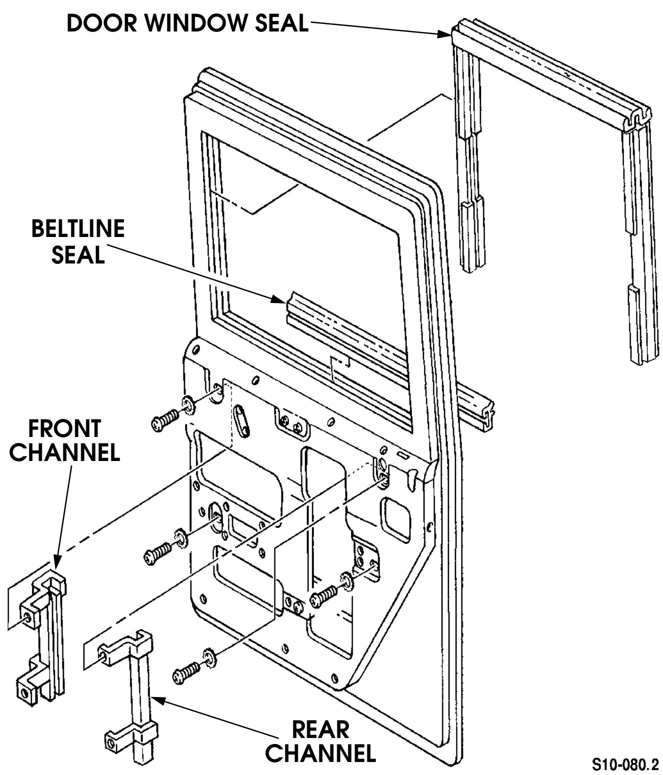


Figure 10-72: Window Channel Locations

Cleaning and Inspection

NOTE: Clean all components, examine for wear or damage, and replace if necessary.

Remove all glass remains from channels and bottom of door (Figures 10-72 and 10-73).

Installation

1. Insert glass/lower channel bracket assembly into door through window opening at 90° from installed position.
2. Rotate glass/lower channel bracket assembly so that it is aligned with the appropriate channels (Figure 10-73)
3. Install glass in front and rear channels and channel brackets, and secure channels and channel brackets to door with four lockwashers and screws (Figure 10-72).
4. Install upper and lower window channels.
5. Install window regulator.
6. Operate window several times to ensure glass is properly aligned.

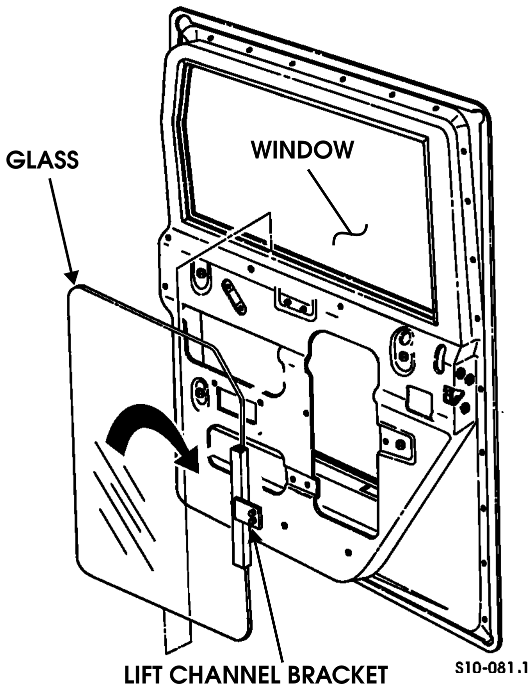


Figure 10-73: Glass/Lift Channel Bracket Location

Door Glass “Wind Noise” Diagnosis and Repair/Side Window Alignment

Wind noise or whistle generating from the side windows at highway speeds is the result of inadequate sealing of the glass at the upper seal. The glass must be properly aligned in the window opening, adjust door glass as follows:.

1. Loosen, but do not remove, lift channel bracket mounting bolts.
2. Place block of wood (or equivalent symmetrical object) across upper seal of window opening.
3. Roll window up so that glass contacts block of wood and squares itself on window opening.
4. Tighten lift channel bracket mounting bolts.
5. Verify proper window operation.

HOOD, HOOD LATCH, AND PROP ROD

Hood Latch and Bracket Replacement

Removal

NOTE: If only the rubber latch is to be replaced, the spring pin does not have to be completely out of base.

1. Remove spring pin and rubber latch from base (Figure 10-74).
2. Remove two locknuts, washers, bolts, washers, and base from body.
3. Remove five locknuts, washers, bolts, latch bracket, latch plate, and hood latch stop bracket from hood. Discard locknuts (Figure 10-74).

Disassembly

Remove cotter pin, spring pin, two rollers, and hood latch from rubber latch (Figure 10-74).

Assembly

Secure hood latch to rubber latch with two rollers, pin, and cotter pin (Figure 10-74).

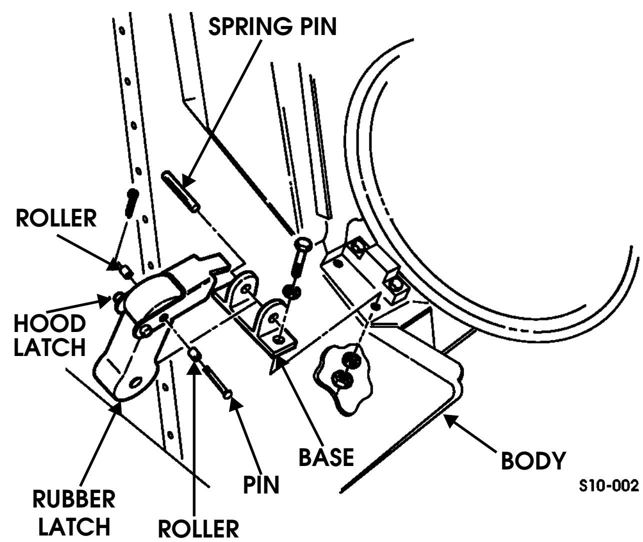


Figure 10-74: Hood Latch Replacement

Installation

1. Secure latch plate and hood latch stop bracket to hood with three bolts, washers, and locknuts. Tighten locknuts to 10 lb-ft (14 N•m) (Figure 10-74).
2. Secure latch bracket to latch plate with two bolts, washers, and locknuts. Tighten locknuts to 10 lb-ft (14 N•m).
3. Apply sealing compound before securing base to body with two washers, bolts, washers, and locknuts. Tighten bolts to 6 lb-ft (8 N•m) (Figure 10-74).
4. Secure rubber latch to base with spring pin.

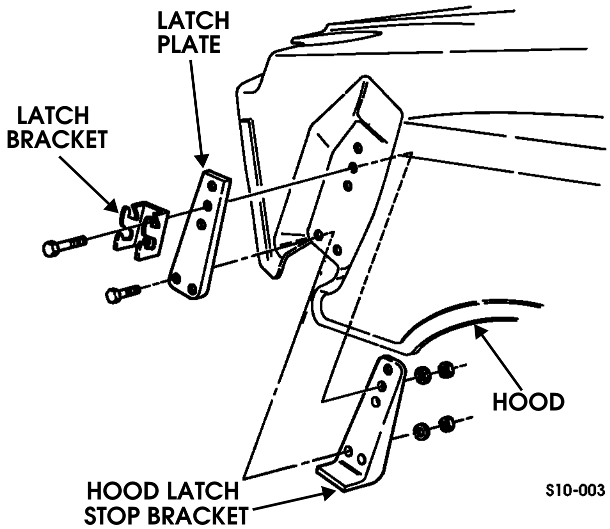


Figure 10-75: Hood Latch Bracket and Latch Plate Replacement

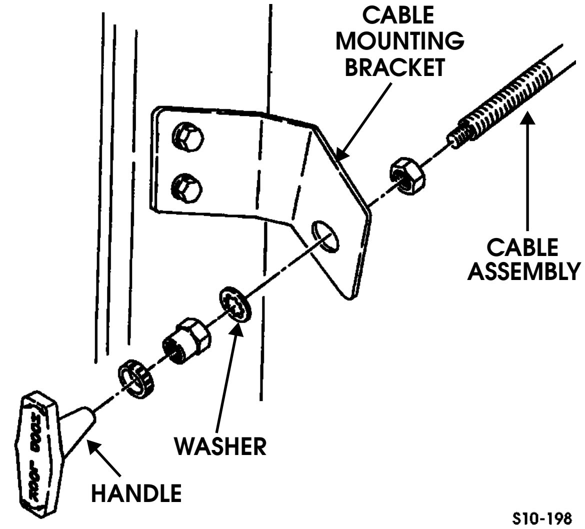


Figure 10-76: Hood Release Handle Assembly Mounting

Hood Release Cable Assembly Replacement

Removal

1. Raise and secure hood.
2. Remove cable handle, two nuts, lockwasher, nut, and cable assembly from cable mounting bracket.
3. Remove cable assembly from cable clamp bracket (Figure 10-77).
4. Remove cable assembly and grommet from body.
5. Remove lock pin from cable assembly.

Installation

1. Install lock pin on cable assembly (Figure 10-77).
2. Secure cable assembly to cable clamp bracket.
3. Secure cable assembly to cable mounting bracket with nut, lockwasher, two nuts, and cable handle (Figure 10-76).
4. Install grommet and cable assembly on body and apply sealer around cable and grommet.
5. Lower hood.

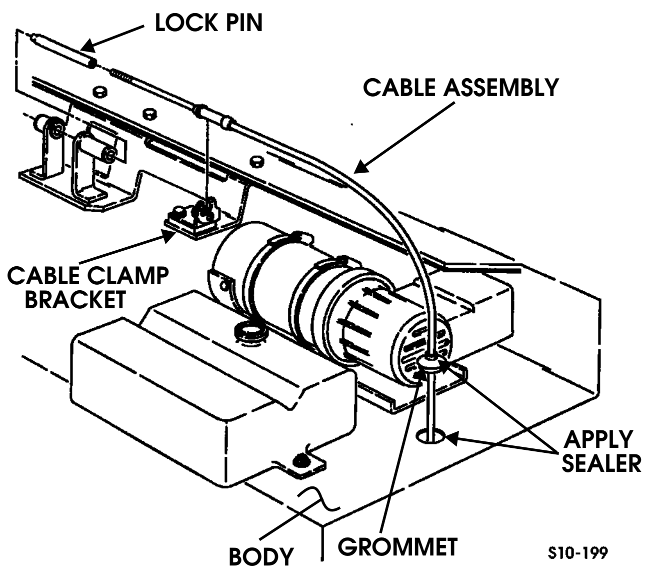


Figure 10-77: Hood Release Cable Assembly

Hood Release Latch and Bracket Assembly Replacement

Removal

1. Raise and secure hood.
2. Remove two bolts, lockwashers, and latch assembly from hood (Figure 10-78).
3. Remove pin, spring, and lock arm from latch assembly (Figure 10-79).
4. Remove cable assembly from cable clamp bracket (Figure 10-77).
5. Remove three nuts, lockwashers, bolts, and bracket assembly from body (Figure 10-80).

6. Remove two nut and lockwasher assemblies, screws, cable clamp bracket, and spacer from bracket assembly.
7. Inspect three nylon bushings in bracket assembly. Remove and discard bushings if damaged.

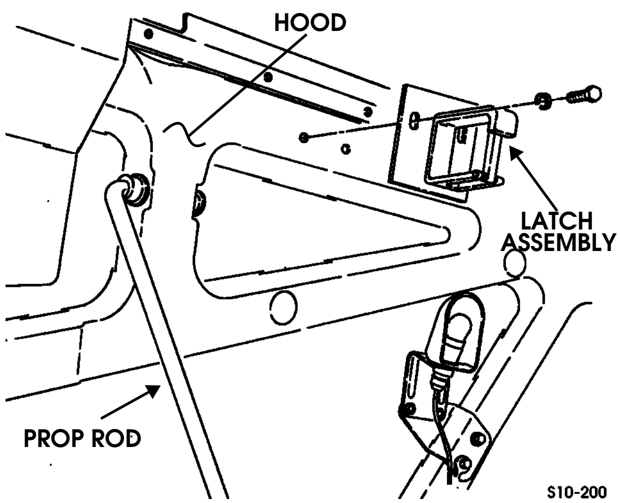


Figure 10-78: Hood Release Latch and Bracket Assembly Mounting

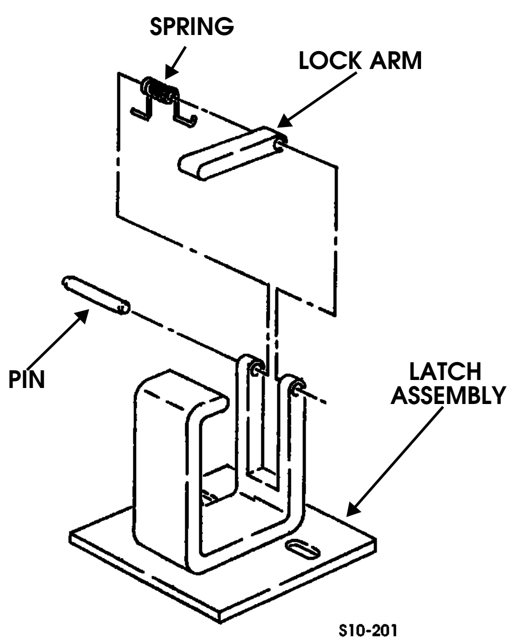


Figure 10-79: Latch Assembly Breakdown

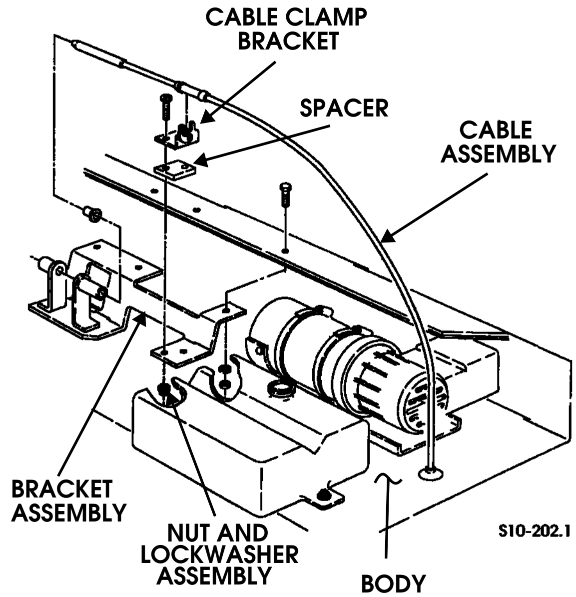


Figure 10-80: Cable Clamp Bracket Assembly Breakdown

Installation

1. Insert three nylon bushings into bracket assembly, if removed (Figure 10-80).
2. Secure spacer and cable clamp bracket to bracket assembly with two screws and nut and lockwasher assemblies.
3. Secure bracket assembly to body with three bolts, lockwashers, and nuts.
4. Secure cable assembly to cable clamp bracket (Figure 10-77). Seal grommet with silicone sealer.
5. Secure spring and lock arm to latch assembly with pin (Figure 10-79).
6. Secure latch assembly to hood with two lockwashers and bolts (Figure 10-78).
7. Lower hood.

Hood Prop Rod and Bracket Replacement

Removal

WARNING: To avoid injury or damage to equipment, support hood during hood prop rod and bracket replacement.

1. Raise and support hood.
2. Remove cotter pin, two washers, and hood prop rod from hood (Figure 10-81).
3. Remove four screws, lockwashers, bracket, and hood prop rod from airlift bracket (Figure 10-82).

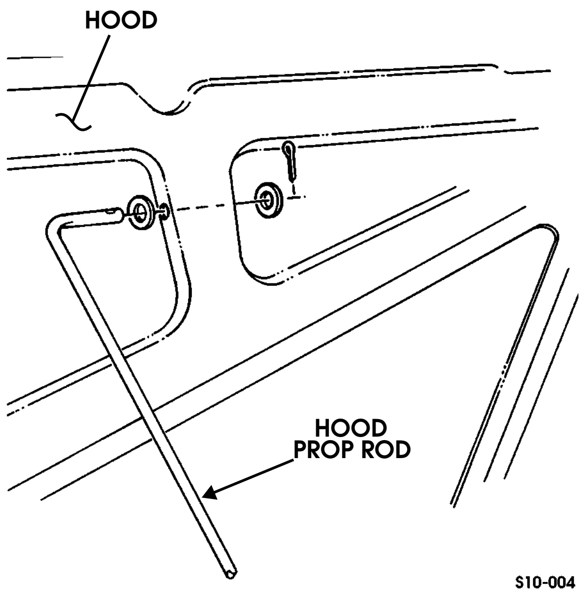


Figure 10-81: Hood Prop Rod Replacement

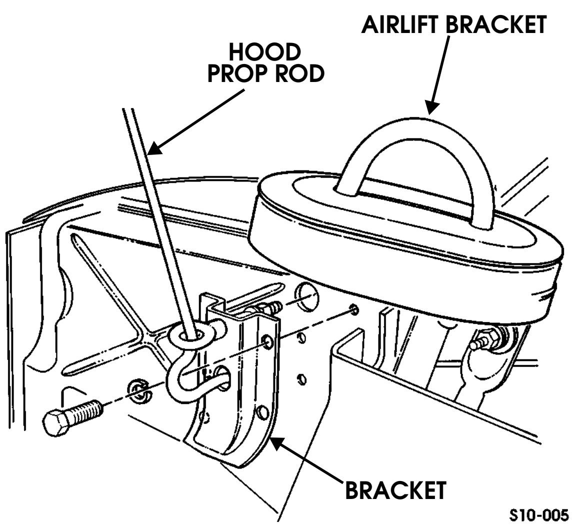


Figure 10-82: Hood Prop Rod and Bracket Replacement

Disassembly

1. Remove hood prop rod from eyebolt (Figure 10-83).
2. Remove locknut, washer, bushing, spring, snapring, bushing, washer, and eyebolt from bracket.

Cleaning and Inspection

NOTE: Clean all components, and examine for wear or damage. Replace if necessary.

Inspect two bushings and spring for cracks, wear, or distortion (Figure 10-83).

Assembly

1. Secure bushing to bracket with snapring (Figure 10-83).

NOTE: Length of spring with bracket assembled is 2-1/4 in. (5.7 cm).

2. Secure washer, eyebolt, spring, bushing, washer, and locknut to bracket.
3. Install hood prop rod into eyebolt.

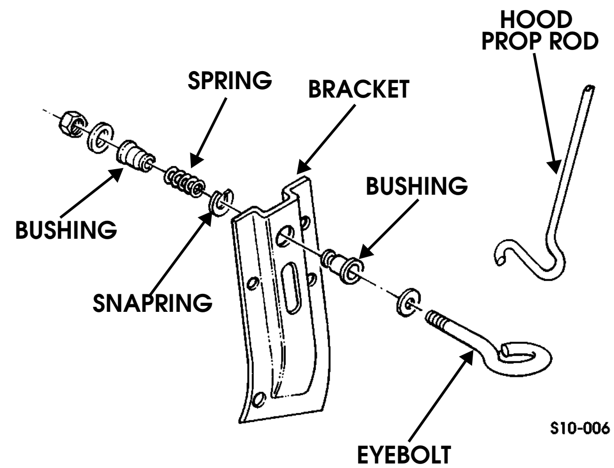


Figure 10-83: Hood Prop Rod and Bracket Assembly Breakdown

Installation

1. Secure hood prop rod and bracket to airlift bracket with four lockwashers and screws. Tighten screws to 6 lb-ft (8 N•m) (Figure 10-82).
2. Secure hood prop rod to hood with two washers and cotter pin (Figure 10-81).
3. Lower hood.

Hood and Hinge Replacement

Removal

1. Raise and secure hood.

WARNING: To avoid injury, or damage to equipment, support hood during removal and installation.

2. Disconnect two connector plugs from connector receptacles (Figure 10-84).
3. Remove four cotter pins, washers, and two hinge pins securing upper hinge halves to lower hinge halves.
4. Remove cotter pin, two washers, and prop rod from hood (Figure 10-84).
5. Remove hood.

NOTE: Perform steps 6 and 7 if replacing hinges.

6. Remove four bolts, washers, two upper hinge halves, and hinge plates from hood (Figure 10-84).
7. Remove four locknuts, washers, two hinge plates, four bolts, washers, two lower hinge halves, and two spacers from brackets.

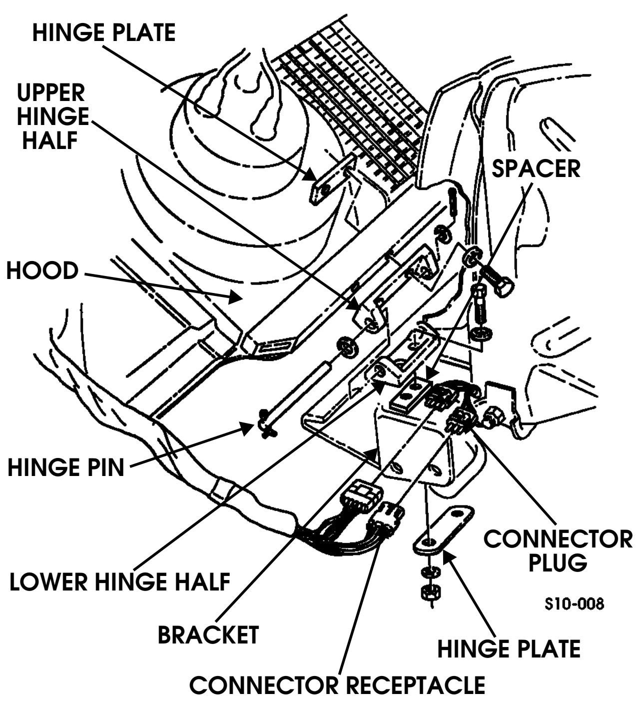


Figure 10-84: Hood and Hinge Assembly Breakdown

Inspection and Repair

NOTE: Refer to Fiberglass Repair for inspection and repair of hood.

Installation

NOTE: Perform steps 1 and 2 if hinges were removed.

1. Secure two spacers, two lower hinge halves and hinge plates to two brackets with four washers, bolts, washers, and locknuts. Do not tighten bolts (Figure 10-84).
2. Secure hinge plates and two upper hinge halves to hood with four washers and bolts. Tighten bolts to 28 lb-ft (38 N•m).
3. Install hood by mating two upper hinge halves to lower hinge halves and securing with washers, hinge pins, washers, and four cotter pins.
4. Connect two connector plugs to connector receptacles.
5. Secure hood prop rod to hood with two washers and cotter pin (Figure 10-84).
6. Align hood.
7. Check headlight aim and adjust if necessary.

Hood Alignment

Alignment should be checked whenever replacing the hood stops, hinges, or latches. Surfaces that adjoin hood seals should be checked for signs of wear from hood movement.

1. Inspect hood prior to adjustment to determine condition of seals, hinges, and stops. Replace or repair any worn parts.

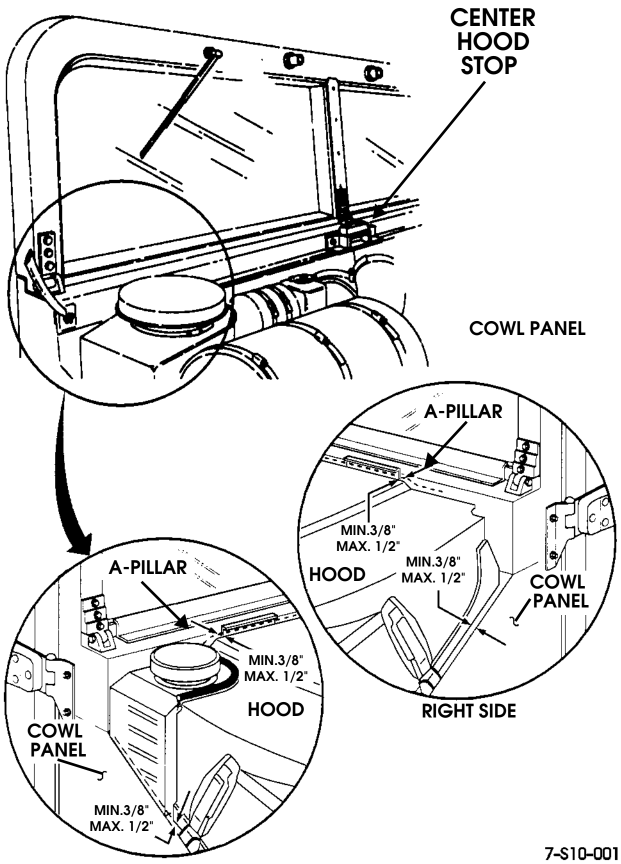


Figure 10-85: Center Hood Stop Location

2. Open hood and loosen center hood stop (Figure 10-85).
3. Gently close hood and loosen lower hinge half locknuts (Figure 10-86).

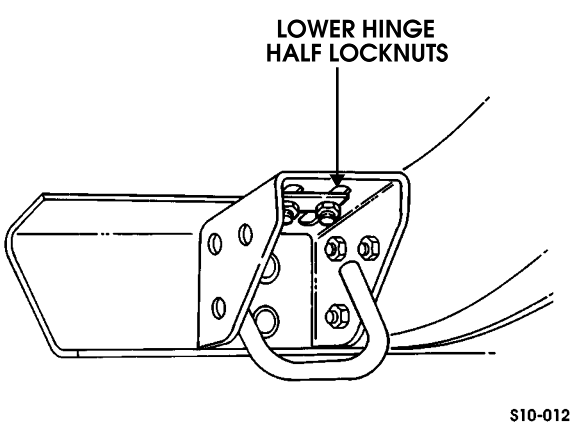


Figure 10-86: Lower Hinge Half Locknut Location

4. Gently position hood to obtain proper and even clearance with A-pillar and both front cowl panels (minimum 3/8" / maximum 1/2") (Figure 10-85).
5. Tighten lower hinge half locknuts to lock adjustment. Open hood gently and position guide bracket assembly to contact center hood stop. Gently close hood to check guide bracket assembly position (Figures 10-85 and 10-87).
6. Tighten and recheck guide bracket assembly position. When properly positioned, tighten to 10 lb-ft (14 N•m) (Figure 10-87).
7. Tighten front lower hinge half locknuts to 28 lb-ft (38 N•m) and recheck hood position (Figure 10-86).

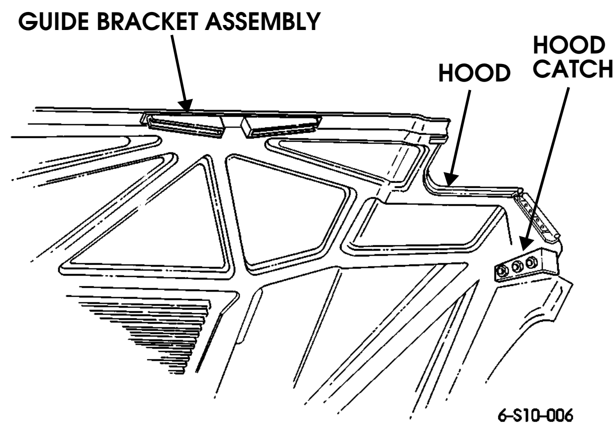


Figure 10-87: Guide Bracket Assembly Location

8. Lube all hood stops, hinges, and guide brackets. Latch hood (Figure 10-88).
9. Test drive to ensure proper alignment (no squeaks).
10. Check headlight aim and adjust if necessary.

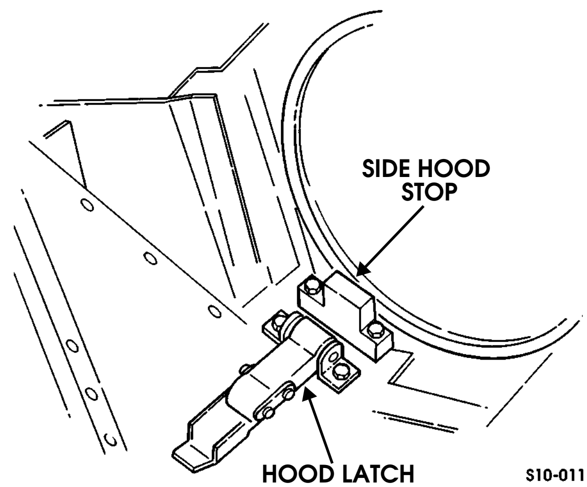


Figure 10-88: Hood Latch and Stop Location

Outer Hood Seal Replacement

Removal

Remove two bolts, seal retainer, and hood seal from body (Figure 10-89).

Installation

Secure hood seal to body with seal retainer and two bolts (Figure 10-89).

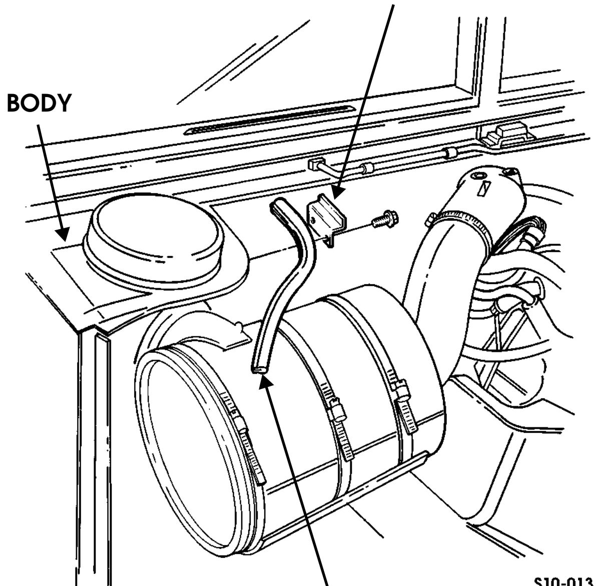


Figure 10-89: Outer Hood Seal Replacement

Side Hood Stop Replacement

Removal

Remove two locknuts, washers, bolts, washers, and side hood stop from body (Figure 10-90).

Installation

Secure side hood stop to body with two washers, bolts, washers, and locknuts. Tighten bolts to 6 lb-ft (8 N•m) (Figure 10-90).

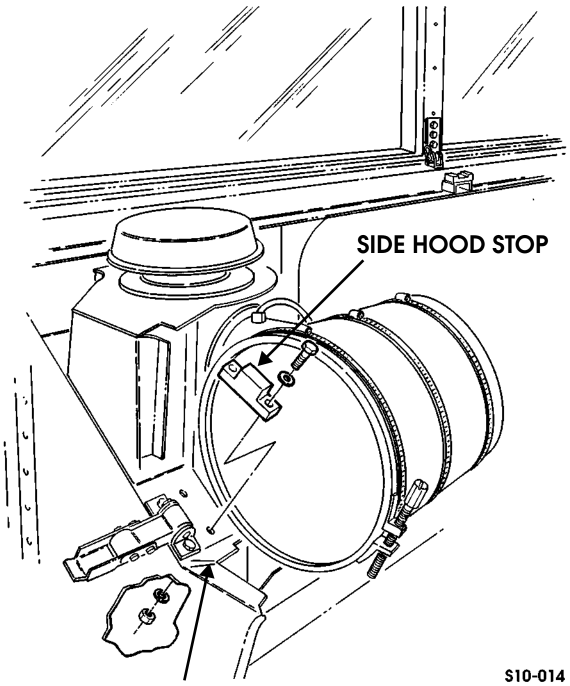


Figure 10-90: Side Hood Stop Replacement

Grille and Screen Replacement

Removal

1. Remove six locknuts, washers, bolts, washers, and grille from hood (Figure 10-91).
2. Remove six locknuts, washers, screws, washers, and screen from grille.

Installation

1. Secure screen to grille with six washers, screws, washers, and locknuts. Tighten locknuts to 6 lb-ft (8 N•m) (Figure 10-91).
2. Secure grille to hood with six washers, screws, washers, and locknuts. Tighten locknuts to 7 lb-ft (9 N•m).

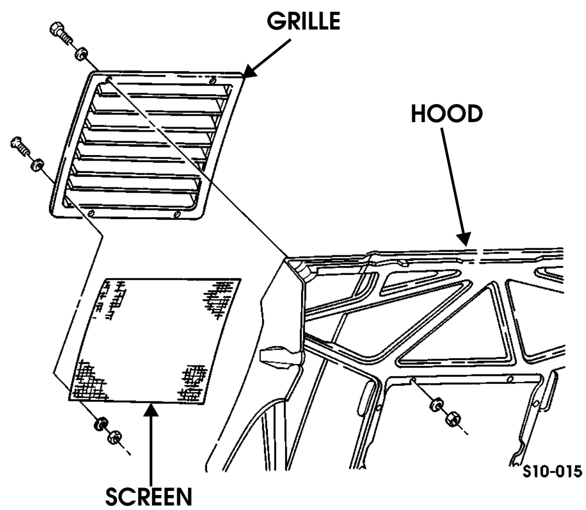


Figure 10-91: Grille and Screen Replacement

Center Hood Stop Replacement

Removal

Remove two bolts, washers, center hood stop, and plate from A-beam (Figure 10-92).

Installation

Secure center hood stop and plate to A-beam with two washers and bolts. Tighten bolts to 12 lb-ft (16 N•m) (Figure 10-92).

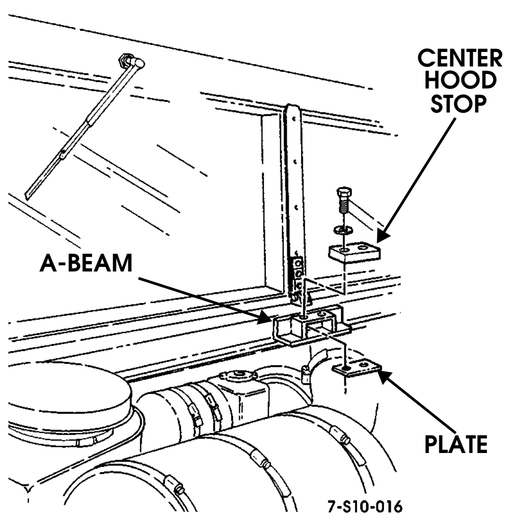


Figure 10-92: Center Hood Stop Replacement

Guide Bracket Assembly Replacement

Removal

Remove six locknuts, twelve washers, guide bracket assembly, guide plate, and six bolts from hood (Figure 10-93).

Installation

1. Loosely attach guide plate and guide bracket assembly to hood with six bolts, twelve washers, and six locknuts. Tighten locknuts to 10 lb-ft (14 N•m) (Figure 10-93).
2. Lower hood and align guide bracket assembly with center hood stop on A-beam (Figure 10-92).
3. Mark guide bracket assembly position, raise hood, and tighten locknuts to 10 lb-ft (14 N•m) (Figure 10-93).

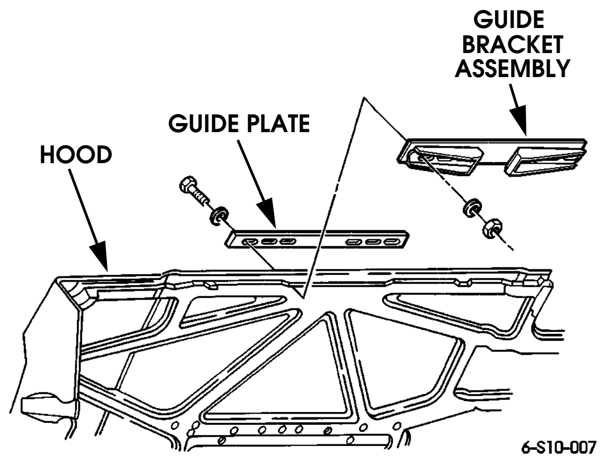


Figure 10-93: Bracket Assembly Replacement

Front Hood Screen Replacement

Removal

1. Remove three locknuts, washers, and carriage bolts securing front hood screen to hood (Figure 10-94).
2. Remove three bolts, harness clamps, washers, and front hood screen from hood.

Installation

1. Secure front hood screen to hood with three washers, harness clamps, and bolts. Tighten bolts to 20-30 lb in. (2-3 N•m) (Figure 10-94).
2. Secure front hood screen to hood with three carriage bolts, washers, and locknuts. Tighten locknuts to 21 lb-ft (29 N•m).

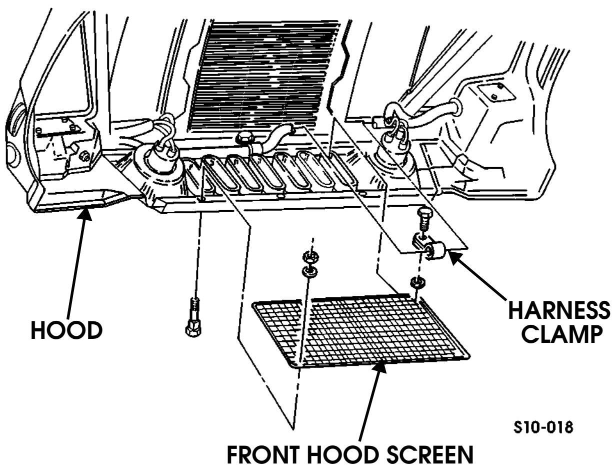


Figure 10-94: Front Hood Screen Replacement

Right Hood Retainer Bracket Replacement

Removal

Remove four bolts, lockwashers, washers, right hood retainer bracket, and spacer from hood (Figure 10-95).

Installation

Secure right hood retainer bracket and spacer to hood with four washers, lockwashers, and bolts (Figure 10-95).

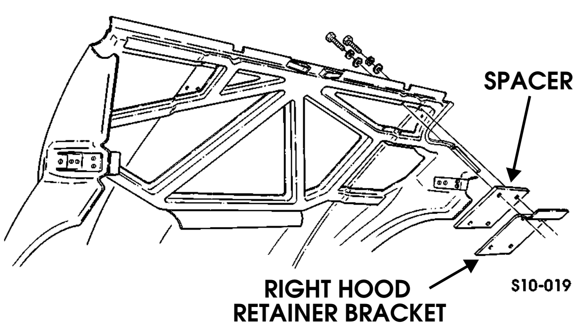


Figure 10-95: Right Hood Retainer Bracket Replacement

Left Hood Retainer Bracket Replacement

Removal

Remove four bolts, lockwashers, washers, left hood retainer bracket, and four washers from hood (Figure 10-96).

Installation

Install left hood retainer bracket on hood with eight washers, four lockwashers, and bolts (Figure 10-96).

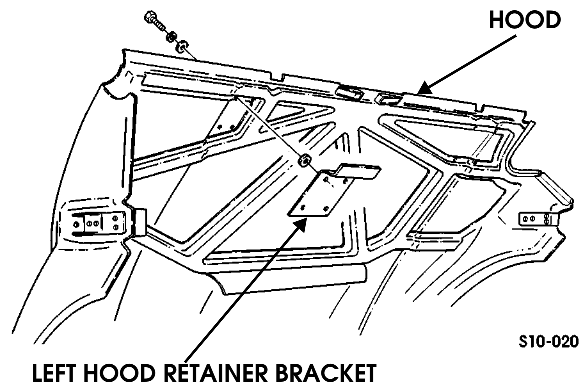


Figure 10-96: Left Hood Retainer Bracket

Right Hood Close-Out Seal and Retainer Replacement

Removal

1. Remove two screws and upper seal retainer from close-out seal and hood (Figure 10-97).
2. Remove two screws, lower seal retainer, and close-out seal from hood.

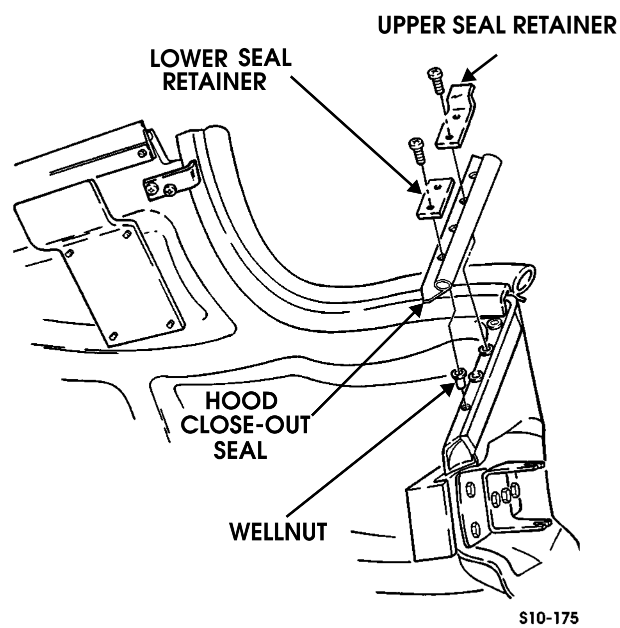


Figure 10-97: Right Hood Close-Out Seal Location

3. Inspect four wellnuts for damage. Replace if defective or damaged.

Installation

1. Secure close-out seal and lower seal retainer to hood with two screws (Figure 10-97).
2. Secure upper seal retainer to close-out seal and hood with two screws.

Airlift Bracket Seal Replacement

NOTE: Turbo Diesel models have thick foam pads around the inside of the hood grille. These pads help to direct air flow through the radiator and provide better engine cooling. The upper pad is held down by the air lift bracket seal and seal protector. (Figure 10-99). Non Turbo vehicles have a spacer in place of the foam pad (Figure 10-98).

Removal

Lift protector and seal from airlift bracket (Figure 10-98).

Installation

Slide seal and protector onto airlift bracket (Figure 10-98).

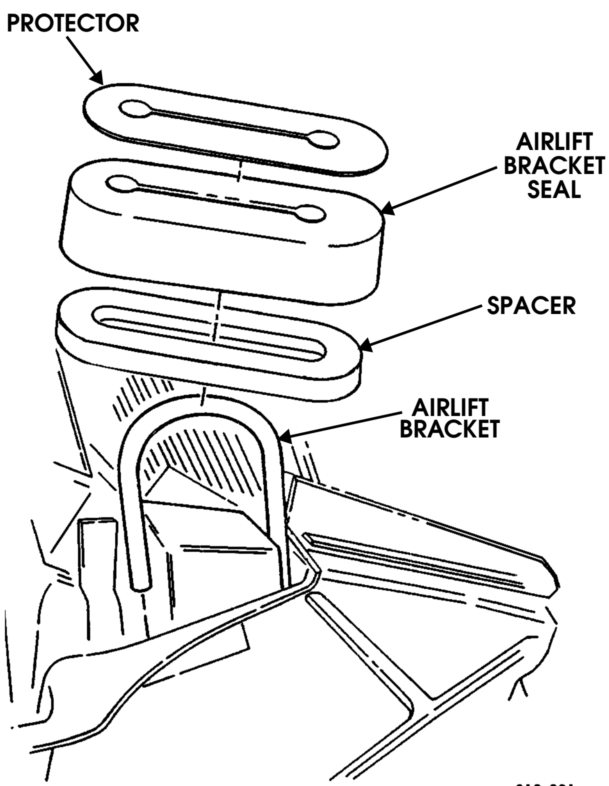


Figure 10-98: Airlift Bracket Seal Mounting (Non-Turbo Models)

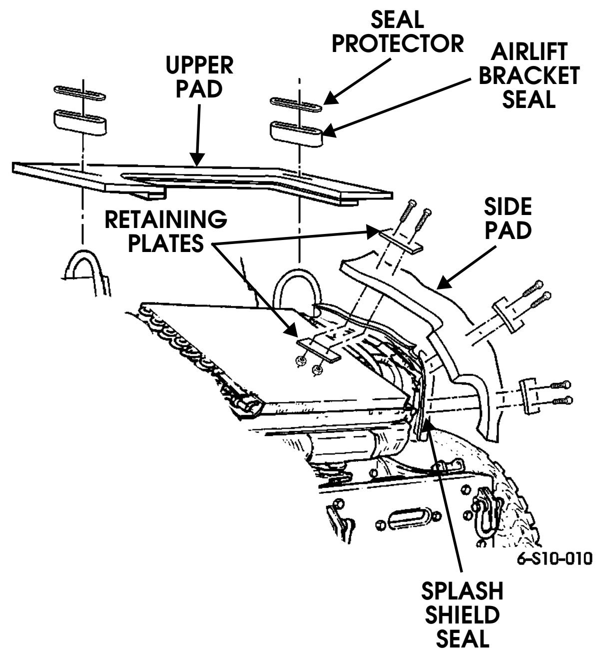


Figure 10-99: Foam Pad Mounting (Turbo Diesel)

ENGINE SPLASH SHIELD REPLACEMENT

NOTE: Turbo Diesel models have thick foam pads around the inside of the hood grille. These pads help to direct air flow through the radiator and provide better engine cooling (Figure 10-99). The side pads are secured to the splash shield seals with retaining plates, screws, and locknuts.

Removal

WARNING: To avoid injury, or damage to equipment, raise and support hood during removal and installation.

1. Remove hood prop rod and bracket.
2. Disconnect hood harness connector receptacles from connector plugs (Figure 10-100).
3. Remove locknut, washer, bolt, and washer securing splash shield to support bracket.
4. Remove locknut, three washers, and bolt securing splash shield to airlift bracket.
5. Remove bolt, lockwasher, and washer securing splash shield to airlift bracket.
6. Remove screw, two washers, locknut, clamp, and two connector plugs from splash shield.
7. Remove nut and lockwasher assembly and screw securing harness and clamp to splash shield (Figure 10-101).
8. Remove locknut, two washers, bolt and splash shield from bracket (Figure 10-100).

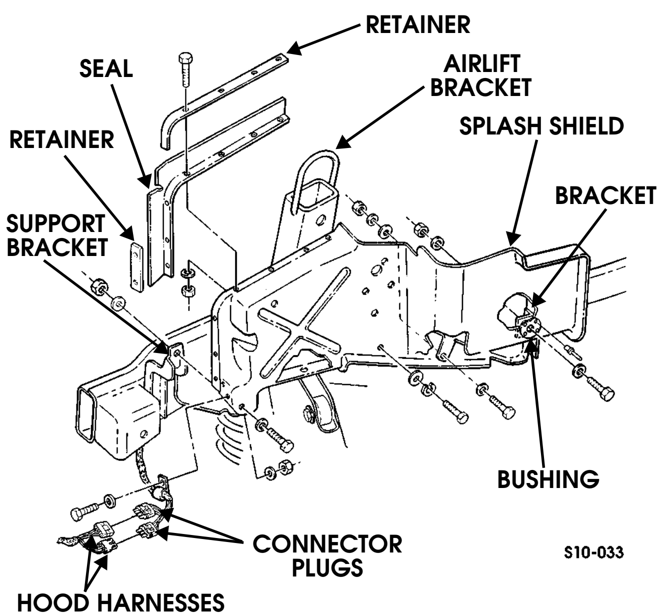


Figure 10-100: Engine (Left) Splash Shield Assembly Replacement

Disassembly

1. Remove seven locknuts, washers, screws, seal, and two retainers from splash shield (Figure 10-100).
2. Remove four rivets and bushing from splash shield.

Assembly

1. Secure bushing to splash shield with four rivets (Figure 10-100).
2. Secure seal and two retainers to splash shield with seven screws, washers, and locknuts.

Installation

1. Secure splash shield to bracket with, bolt, washers, and locknut (Figure 10-100).
2. Secure harness and clamp to splash shield with screw and nut and lockwasher assembly (Figure 10-101).
3. Secure two connector plugs to splash shield with clamp, screw, two washers, and locknut (Figure 10-100).
4. Secure splash shield to airlift bracket with washer, lockwasher, and bolt. Tighten bolt to 10 lb-ft (14 N•m).
5. Secure splash shield on airlift bracket with washer, capscrew, two washers, and locknut. Tighten capscrew to 10 lb-ft (14 N•m).
6. Secure splash shield to support bracket with washer, bolt, washer, and locknut. Tighten bolt to 6 lb-ft (8 N•m).
7. Attach hood harness connector receptacles to connector plugs.
8. Install hood prop rod and bracket.

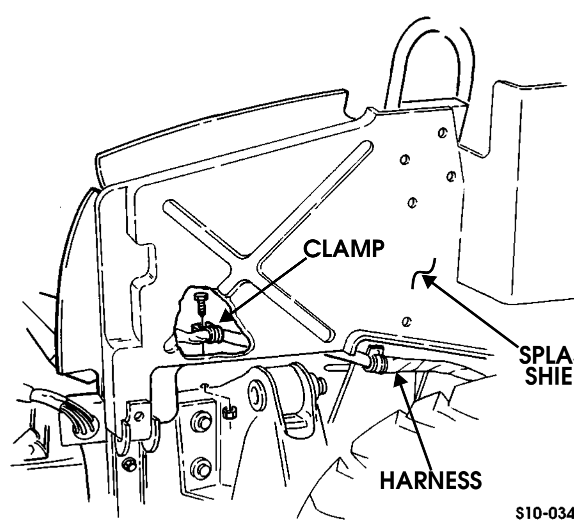


Figure 10-101: Wiring Harness Clamp Location

HORN

Horn Replacement

Removal

1. Remove harness connector from horn.
2. Remove nut and horn from mounting bracket (Figure 10-102).

NOTE: Overtightening horn mounting nut will distort the horn bellows and result in an “off-key” horn tone.

Installation

1. Secure horns to mounting bracket with nuts.
2. Plug harness connector into horns.

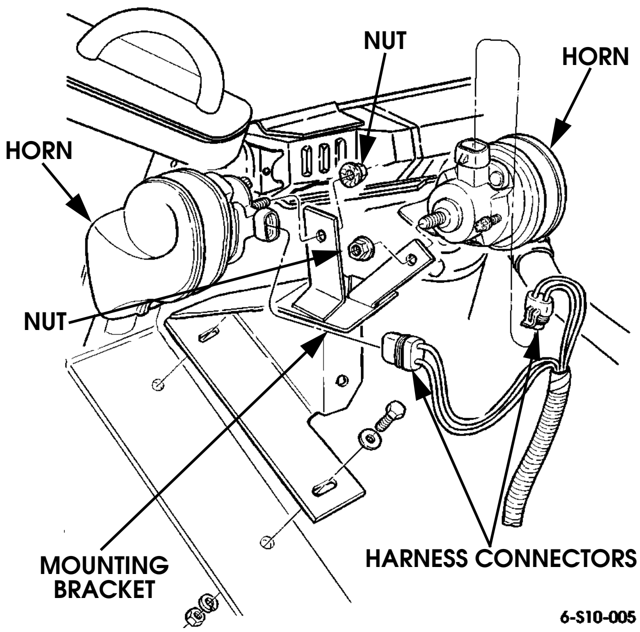


Figure 10-102: Horn and Horn Mounting Bracket Replacement

Horn Mounting Bracket Replacement

Removal

1. Remove two horns.
2. Remove bolts, washers, lockwashers, nuts, and horn mounting bracket from airlift bracket (Figure 10-102).

Installation

1. Secure horn mounting bracket to airlift bracket with bolts, washers, lockwashers, and nuts (Figure 10-102).
2. Install two horns.

WINDSHIELD ASSEMBLY

Windshield Glass and Weatherstrip Replacement

Removal

1. Remove windshield wiper arm and blade.
2. Remove six bolts and upper retainer from windshield frame (Figure 10-103).
3. Remove four bolts and center retainer from windshield frame.
4. Remove four bolts and lower retainer.
5. Remove weatherstrip and glass from windshield frame.
6. Clean sealing compound from windshield frame.

Installation

1. Apply a 1/8 in. (3-mm) bead of sealing compound to edge of glass and windshield frame (Figure 10-103).
2. Position weatherstrip on glass.
3. Position glass and weatherstrip to windshield frame with center retainer and four bolts.
4. Secure upper retainer to windshield frame with six bolts.
5. Secure lower retainer to windshield frame with four bolts
6. Apply a thin bead of sealing compound to top edge of outside weatherstrip.
7. Install windshield wiper arm and blade.

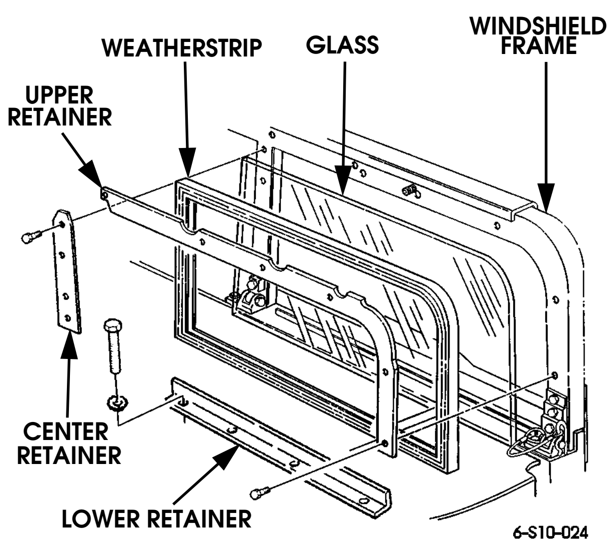


Figure 10-103: Windshield Glass Replacement

Windshield Assembly Replacement

WARNING: WARNING: To avoid injury, or damage to equipment, support windshield during removal and installation.

Removal

1. Remove soft top or loosen roof assembly, as applicable.
2. Remove windshield wiper blade and arm.
3. Remove windshield wiper linkage.
4. Remove windshield wiper arm pivots.
5. Remove two locknuts and bolts securing windshield assembly to A-pillar (Figure 10-104).

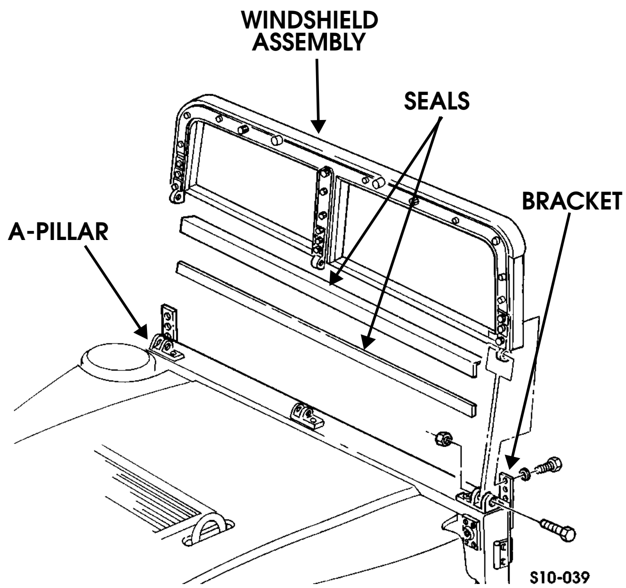


Figure 10-104: Windshield Assembly Mounting

6. Remove grommet from windshield center pillar and disconnect two jumper harness leads from body harness leads (Figure 10-105).
7. Remove six bolts and washers securing windshield assembly to two brackets (Figure 10-104).
8. Remove windshield assembly from A-pillar.
9. Remove two seals from windshield assembly.
10. Clean remains of seals from windshield.

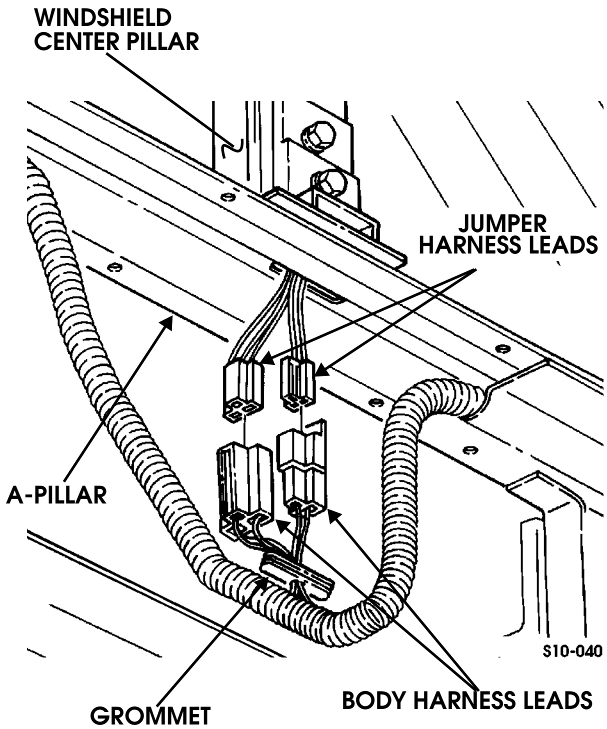


Figure 10-105: Wiring Harness Lead and Grommet Location

Disassembly

NOTE: Perform steps 1 and 2 for open-top models. Perform step 3 for all other models.

1. Remove eleven rivets, former, and seal from windshield assembly (Figure 10-106).
2. Remove eight rivets and two corner caps from windshield assembly, and replace if damaged.
3. Remove thirteen rivets, former, and seal from windshield assembly (Figure 10-106).
4. Clean remains of seal from windshield assembly.

Assembly

NOTE: Perform steps 1 and 2 for open-top models. Perform step 3 for all other models.

1. Secure seal and former to windshield assembly with eleven rivets (Figure 10-106).
2. Secure two corner caps to windshield assembly with eight rivets.
3. Secure seal and former to windshield assembly and secure with thirteen rivets (Figure 10-106).

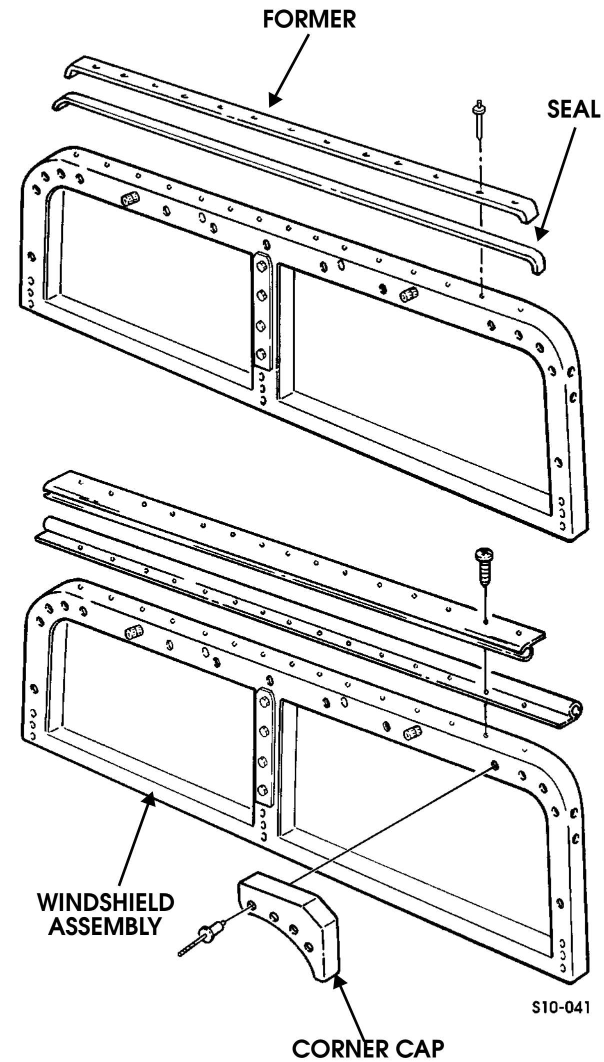


Figure 10-106: Windshield Assembly Seal Replacement

Installation

1. Position two seals on windshield assembly (Figure 10-104).
2. Position windshield assembly over A-pillar.
3. Secure windshield assembly to two brackets with six bolts and washers.
4. Connect two jumper harness leads to body harness leads and insert grommet into windshield center pillar (Figure 10-105).
5. Secure windshield assembly to A-pillar with two bolts and locknuts (Figure 10-104).
6. Install windshield wiper arm pivots.
7. Install windshield wiper linkage.
8. Install windshield wiper arm and blade.
9. Install soft top.

HEATED WINDSHIELD

The optional heated windshield is capable of defrosting the windshield glass in less than 10 minutes at 0° F. The system is comprised of a rocker switch with an integrated time delay module (Figure 10-107), two relays (Figure 10-108), two in-harness fuses (Figure 10-109), and an in-glass heating element.

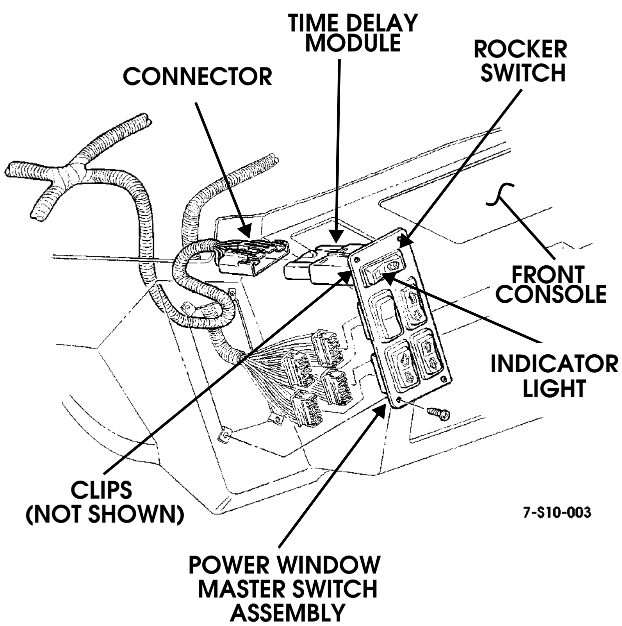


Figure 10-107: Rocker Switch/Time Delay Module Location

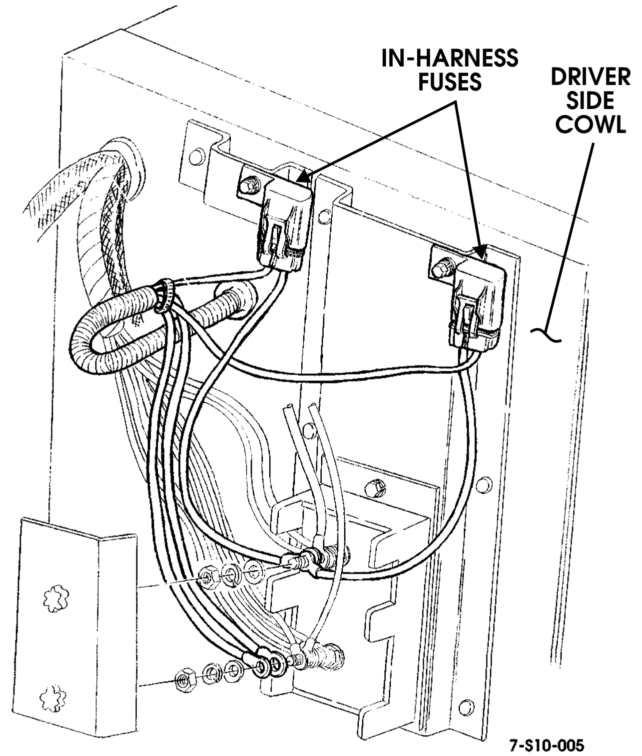


Figure 10-109: In-Harness Fuse Location

When the rocker switch is activated, a small light on the rocker switch will illuminate. The relays will then complete the circuit and apply power to the heating element (via the heating element junction blocks) for approximately 10 minutes (Figure 10-110). The system will then shut off automatically.

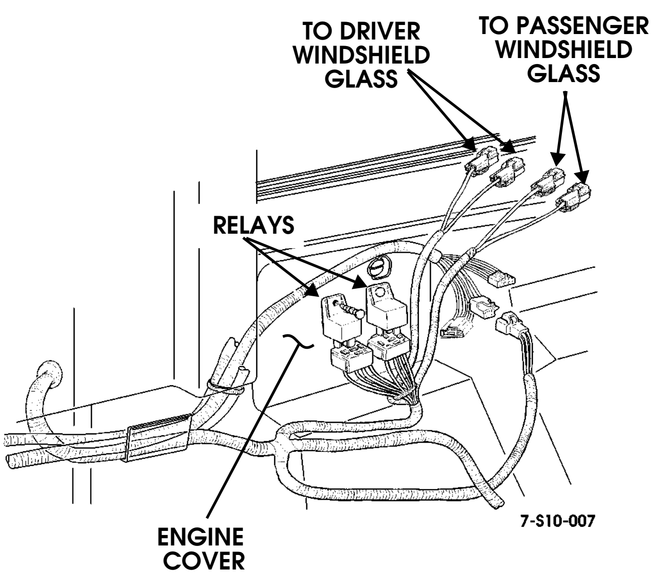


Figure 10-108: Relay Locations on Engine Cover

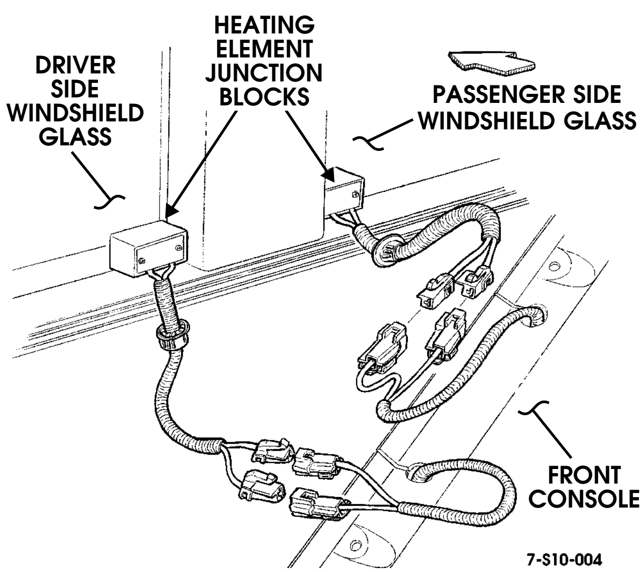


Figure 10-110: Heating Element Junction Block Location

The rocker switch/time delay module is mounted on the power window master switch on the driver side of the front console (Figure 10-107).

Removal

NOTE: Wire harnesses behind console are long enough to allow for power window master switch removal without removing console for access to electrical connectors.

1. Remove screws and pull power window master switch from console (Figure 10-107).
2. Lift connector clip and pull connector from rocker switch/time delay module.
3. Squeeze clips on rocker switch/time delay module and remove switch/module from bezel.

Installation

1. Push rocker switch/time delay module into bezel opening and snap into bezel.
2. Attach electrical connector to rocker switch/time delay module.
3. Install power window master switch in console.

WINDSHIELD WIPER SYSTEM AND COMPONENTS

Windshield Wiper Motor Assembly Replacement

Removal

1. Remove center trim from windshield assembly.
2. Disconnect windshield wiper motor assembly harness from jumper harness (Figure 10-111).
3. Remove three bolts, washers, and lockwashers securing windshield wiper motor assembly to windshield assembly.
4. Remove retainer securing windshield wiper linkage to windshield wiper motor cranking pin and remove windshield wiper motor assembly.

Installation

1. Lubricate windshield wiper motor cranking pin and secure windshield wiper linkage to windshield wiper motor cranking pin with retainer (Figure 10-111).
2. Secure windshield wiper motor assembly to windshield assembly with three lockwashers, washers, and bolts. Tighten bolts to 12 lb-ft (16 N•m).
3. Connect windshield wiper motor assembly harness to jumper harness.
4. Secure center trim to windshield assembly.

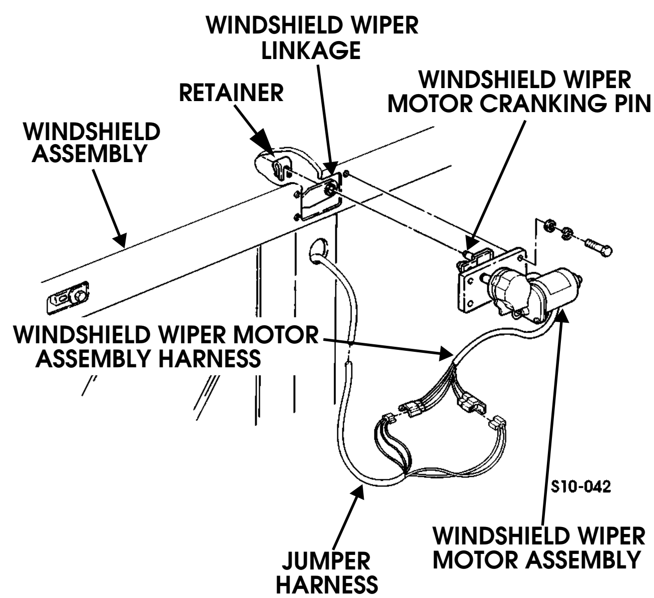


Figure 10-111: Windshield Wiper Motor Assembly Replacement

Windshield Wiper Linkage Replacement

Removal

NOTE: Left and right side windshield wiper linkage replacement procedure is the same. This procedure covers the left side.

1. Remove windshield wiper motor assembly.
2. Remove upper A-pillar trim.
3. Disconnect windshield wiper linkage from windshield wiper pivot cranking lever pin and remove windshield wiper linkage (Figure 10-112).

Installation

1. Secure windshield wiper linkage to windshield wiper pivot cranking lever pin (Figure 10-112).
2. Install upper A-pillar trim.
3. Install windshield wiper motor assembly on windshield assembly.

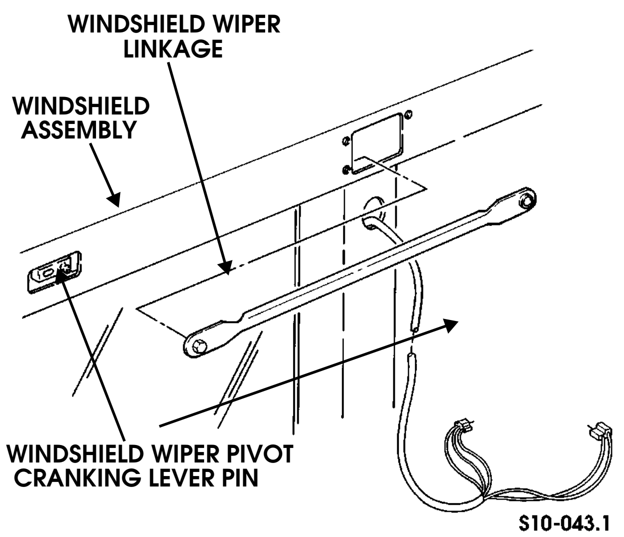


Figure 10-112: Windshield Wiper Linkage Replacement

Windshield Wiper Pivot Replacement

Removal

NOTE: Left and right side windshield wiper pivot replacement procedure is the same. This procedure covers the left side.

1. Remove windshield wiper arm assembly.
2. Remove upper A-pillar trim.
3. Remove windshield wiper linkage from windshield wiper pivot cranking lever pin (Figure 10-113).
4. Remove nut, washer, and rubber washer securing windshield wiper pivot to windshield assembly and remove windshield wiper pivot.

Installation

1. Secure windshield wiper pivot to windshield assembly with rubber washer, washer and nut (Figure 10-113).
2. Secure windshield wiper linkage to windshield wiper pivot cranking lever pin.
3. Install upper A-pillar trim.
4. Install windshield wiper arm assembly.

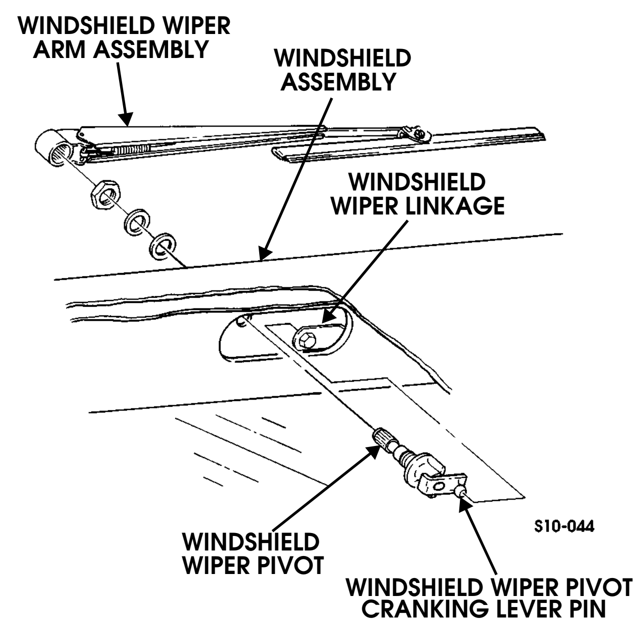


Figure 10-113: Windshield Wiper Pivot Replacement

Windshield Wiper Jumper Harness Replacement

Removal

1. Remove center trim from windshield assembly.
2. Remove windshield wiper motor assembly from windshield assembly.
3. Remove console.
4. Remove engine access cover.
5. Remove eight locknuts, retainer, eight bolts, and screw securing close-out panel to A-beam (Figure 10-114).
6. Remove three locknuts, clamp, three bolts, and clamps securing close-out panel to A-beam and remove close-out panel.
7. Disconnect jumper harness from body electrical harness and remove jumper harness and two grommets from windshield assembly.

Installation

1. Connect jumper harness to body electrical harness and install jumper harness and two grommets in windshield assembly (Figure 10-114).
2. Secure close-out panel to A-beam with three clamps, bolts, clamp, and three locknuts.
3. Secure close-out panel to A-beam with retainer, eight bolts, locknuts, and screw.
4. Install engine access cover.
5. Install console.
6. Secure windshield wiper motor assembly to windshield assembly.
7. Secure center trim to windshield assembly.

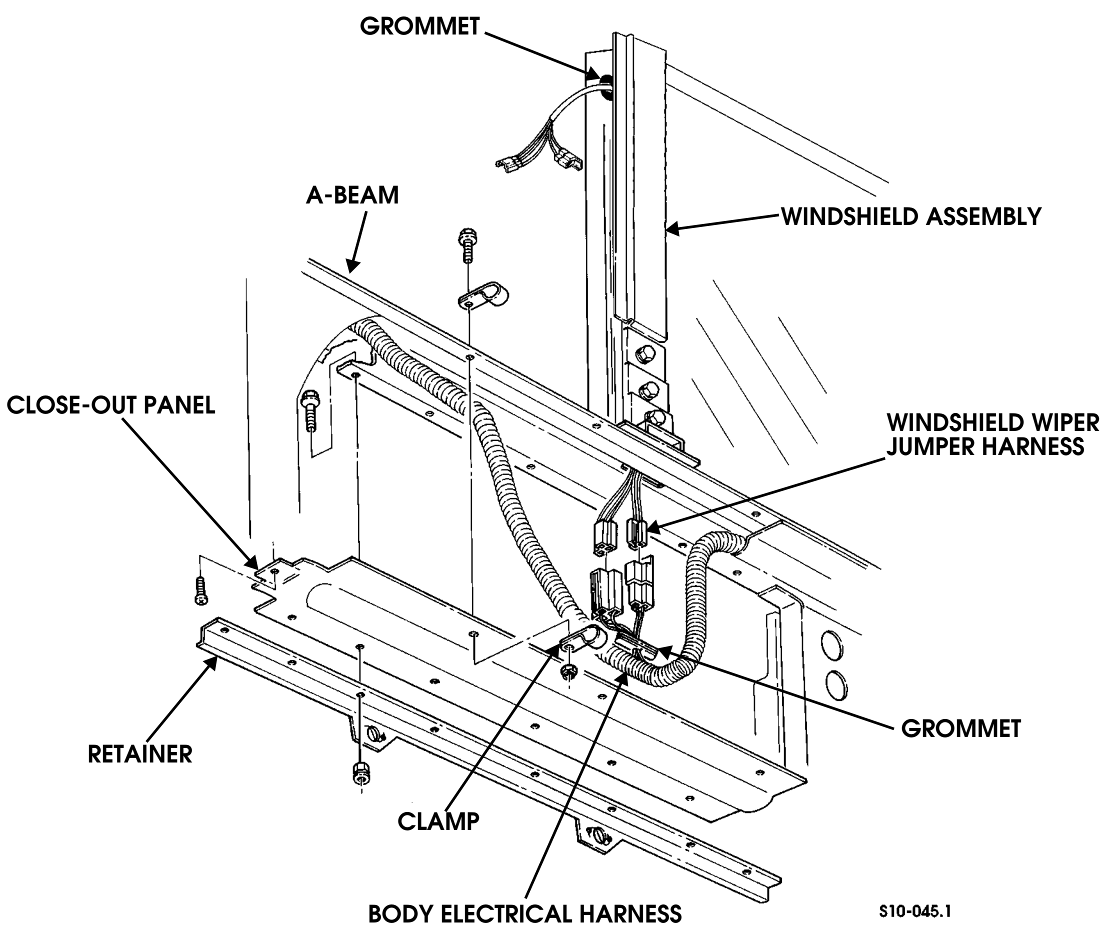


Figure 10-114: Windshield Wiper Jumper Harness Replacement

WINDSHIELD WASHER SYSTEM AND COMPONENTS

Reservoir and Pump Assembly Replacement

Removal

1. Drain reservoir.
2. Disconnect pump connector from reservoir and pump assembly (Figure 10-115).
3. Disconnect windshield washer hose from reservoir and pump assembly.
4. Remove two bolts, lockwashers, and reservoir and pump assembly from cowl.
5. Inspect two wellnuts for damage. Replace if defective or damaged.

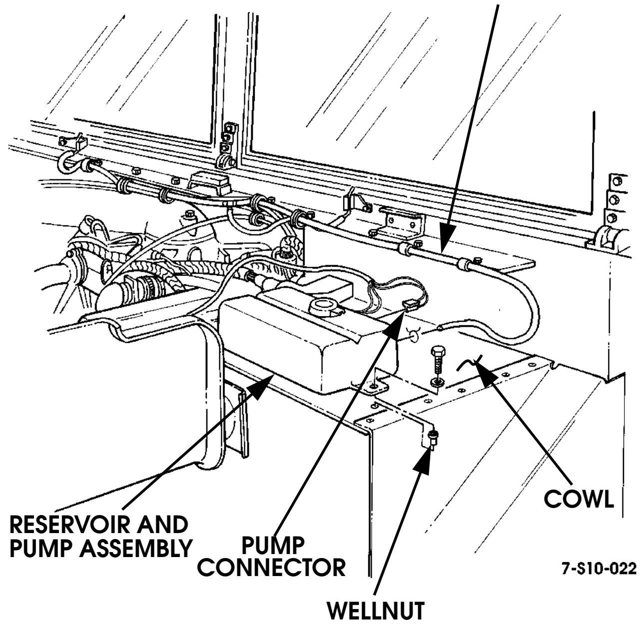


Figure 10-115: Windshield Washer Fluid Reservoir and Pump Replacement

Installation

1. Secure reservoir and pump assembly to cowl with two lockwashers and bolts. Tighten bolts to 8 lb-ft (11 N•m) (Figure 10-115).
2. Connect windshield washer hose to reservoir and pump assembly.
3. Connect pump connector to reservoir and pump assembly.
4. Fill reservoir.

Windshield Washer Hose Replacement

Removal

1. Remove three nuts, washers, screws, washers, and clamps securing hose to body (Figure 10-116).
2. Disconnect washer hose from pump and tee. Remove clamps from hose.
3. Disconnect two hoses from tee and nozzles and remove from clamps.

Installation

1. Slide two hoses through clamps and connect to tee and nozzles (Figure 10-116).
2. Slide hose through clamps and connect to tee and pump.
3. Secure hose to body with three clamps, washers, screws, washers, and nuts.

Windshield Washer Nozzle Replacement

Removal

1. Disconnect hose from nozzle (Figure 10-117).
2. Remove screw and nozzle from body.

Installation

1. Secure nozzle to body with screw (Figure 10-117).
2. Connect hose to nozzle.

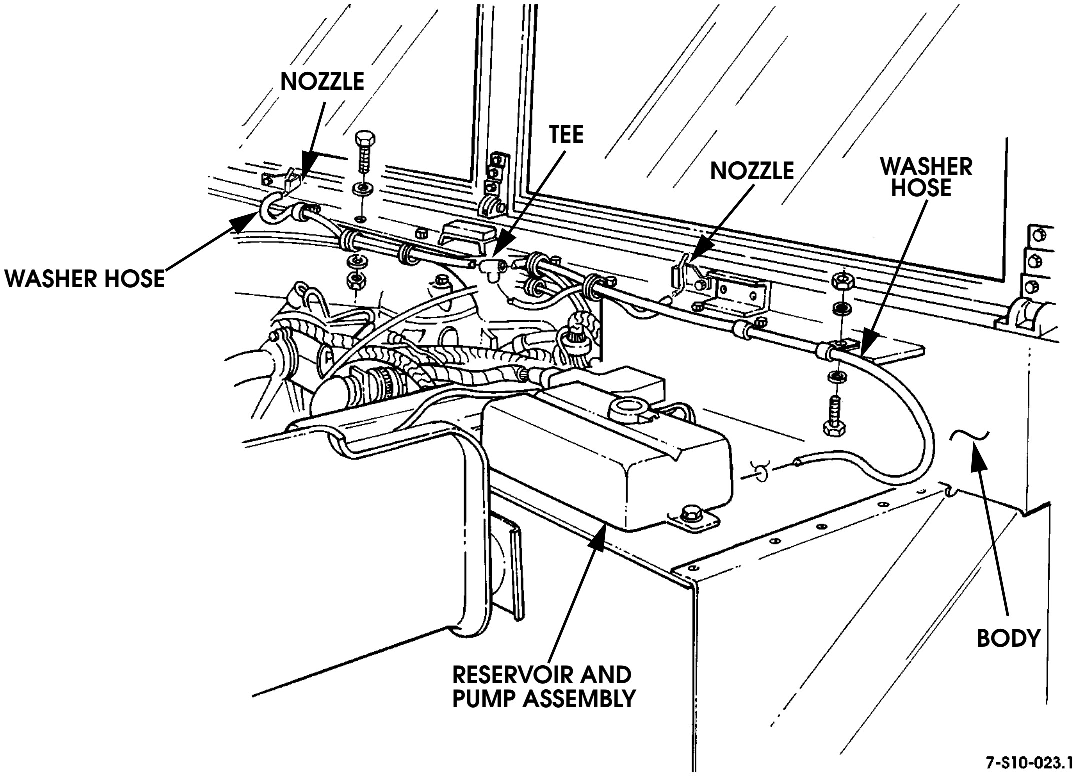


Figure 10-116: Windshield Washer Hose Replacement

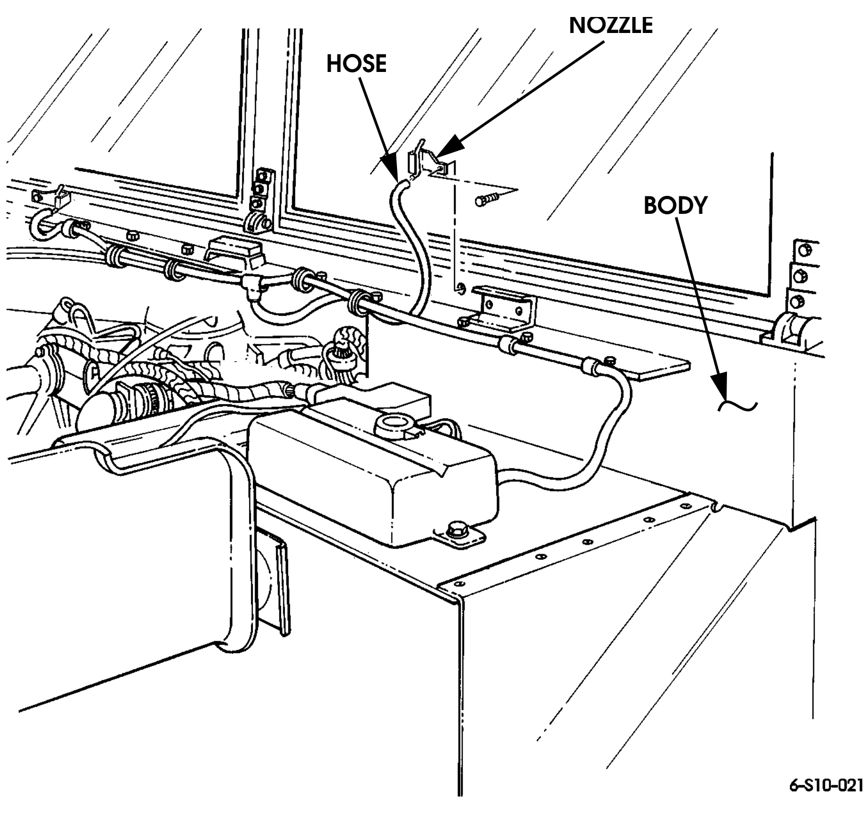


Figure 10-117: Windshield Washer Nozzle Replacement

A-PILLAR FORMER ASSEMBLY REPLACEMENT (SOFT TOP ONLY)

Removal

1. Remove soft top.
2. Remove thirteen screws and A-pillar former from A-pillar (Figure 10-118).
3. Clean mounting surface on A-pillar.

Cleaning and Inspection

NOTE: Clean all components, examine for wear or damage, and replace if necessary.

Inspect wellnuts. Replace if defective or damaged.

Installation

1. Peel backing paper from A-pillar former and secure former to A-pillar with thirteen screws (Figure 10-118).
2. Install soft top.

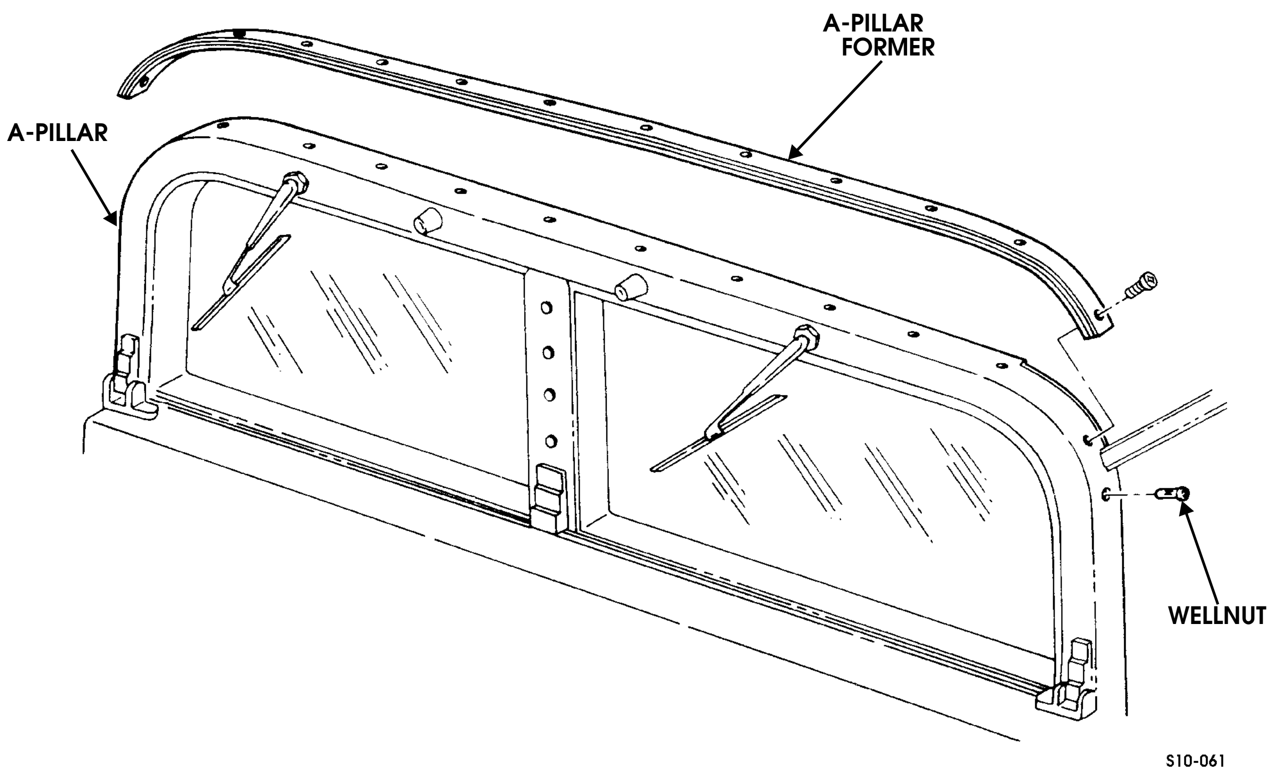


Figure 10-118: A-Pillar Former Assembly Replacement

REAR SUPPORT BOW BRACKET REPLACEMENT

Removal

1. Remove rear support bow assembly.
2. Remove two screws and support bow bracket from body (Figure 10-119).

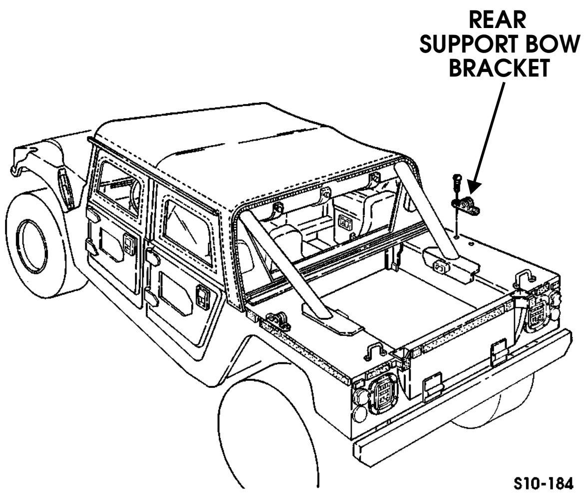


Figure 10-119: Rear Support Bow Bracket Replacement

Installation

1. Secure bracket to body with two screws (Figure 10-119).
2. Install rear support bow assembly.

FRONT STRIKER REPLACEMENT

Removal

Remove locknut, washer, striker guard, and striker from front door pillar (Figure 10-120).

Installation

Secure striker and striker guard to front door pillar with washer and locknut (Figure 10-120). Tighten locknut to 41 lb-ft (56 N•m).

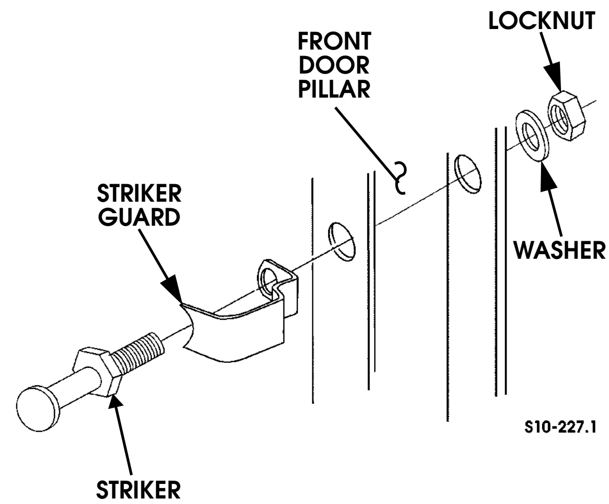


Figure 10-120: Front Striker Assembly Replacement

REAR STRIKER ASSEMBLY REPLACEMENT

Removal

Remove two screws, washers, backing plate, and rear striker assembly from rear door pillar (Figure 10-121).

Installation

Secure rear striker assembly to rear door pillar with backing plate, two washers, and screws (Figure 10-121). Tighten screws to 12 lb-ft (16 N•m).

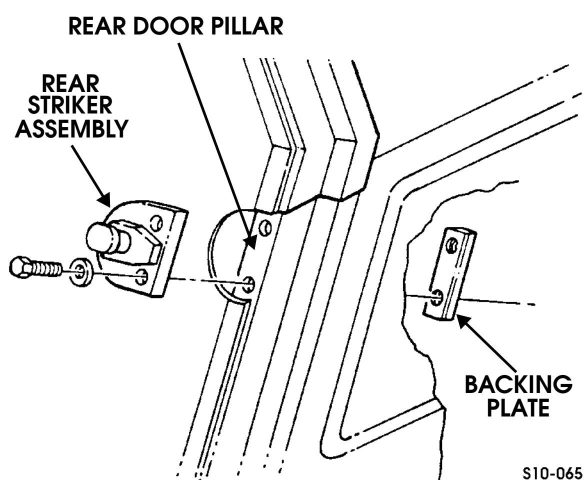


Figure 10-121: Rear Striker Assembly Replacement

BODY MOUNT REPLACEMENT

Removal

NOTE: Removal and installation procedures for intermediate and rear body mounts are the same. This procedure covers the left intermediate body mount.

1. Remove locknut, washer, bolt, washer, and two spacers securing sleeve, upper cushion, and lower cushion to body bracket and frame bracket (Figure 10-122).
2. Raise the vehicle at the body reinforcement adjacent to body mount to be removed (Figure 10-123).
3. Raise the body far enough to separate the upper cushion from lower cushion and remove spacer, sleeve, upper cushion, and lower cushion (Figure 10-122).

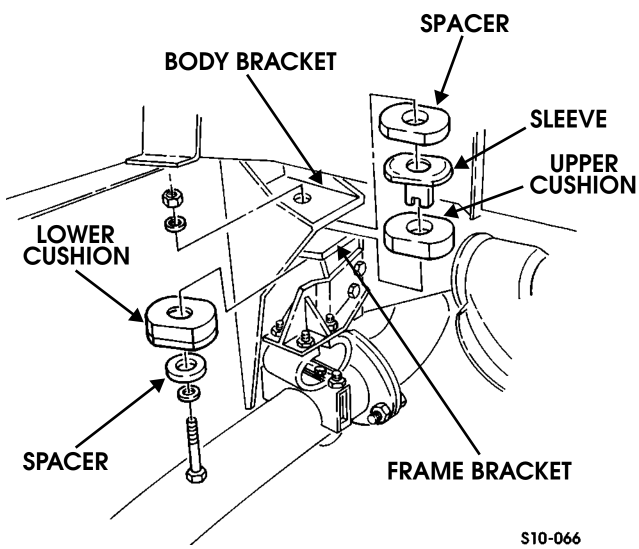


Figure 10-122: Body Mount Cushions Replacement

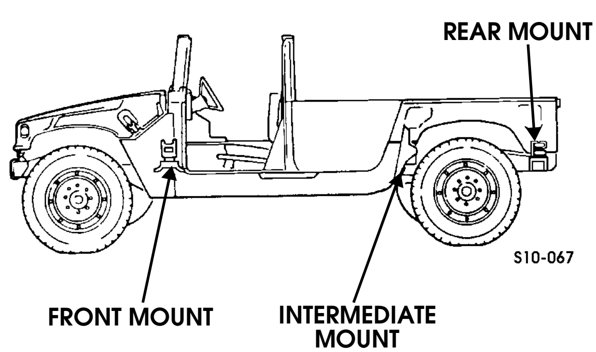


Figure 10-123: Left Side Body Mount Locations

Installation

1. Position lower cushion, upper cushion, sleeve, and spacer between body bracket and frame bracket (Figure 10-122).
2. Lower body and ensure lower cushion, sleeve, upper cushion, spacer and body bracket align. Secure with spacer, washer, bolt, washer, and locknut. Tighten locknut to 90 lb-ft (122 N•m).

LICENSE PLATE BRACKETS

Rear License Plate Bracket Replacement

Removal

1. Remove two screws, lockwashers, license plate, and two grommets from bracket (Figure 10-124).
2. Remove two bolts and lockwashers securing bracket to bumper.
3. Disconnect two leads from light bracket, and remove bracket.
4. Remove two nut and lockwasher assemblies, screws, and light bracket from bracket.

Installation

1. Secure light bracket to bracket with two screws and nut and lockwasher assemblies (Figure 10-124).
2. Connect two leads to light bracket.
3. Secure bracket to bumper with two lockwashers and bolts.
4. Secure license plate to bracket with two grommets, lockwashers, and screws.

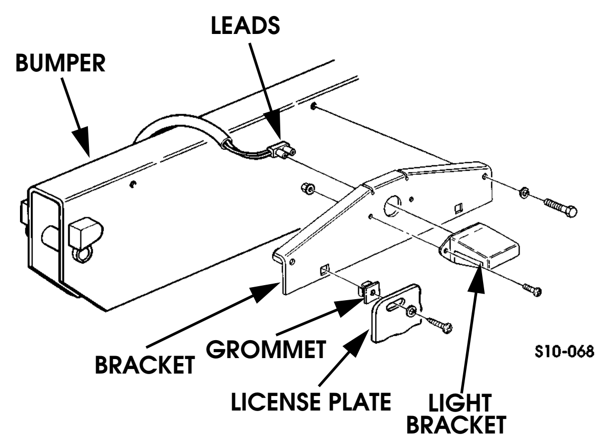


Figure 10-124: Rear License Plate Bracket Replacement

Front License Plate Bracket Replacement

Removal

1. Remove two capscrews, lockwashers, license plate, and two grommets from bracket. Discard lockwashers (Figure 10-125).
2. Remove two screws, lockwashers, and bracket from bumper. Discard lockwashers.

Installation

1. Install bracket on bumper with two lockwashers and screws (Figure 10-125).
2. Install license plate on bracket with two grommets, lockwashers, and capscrews.

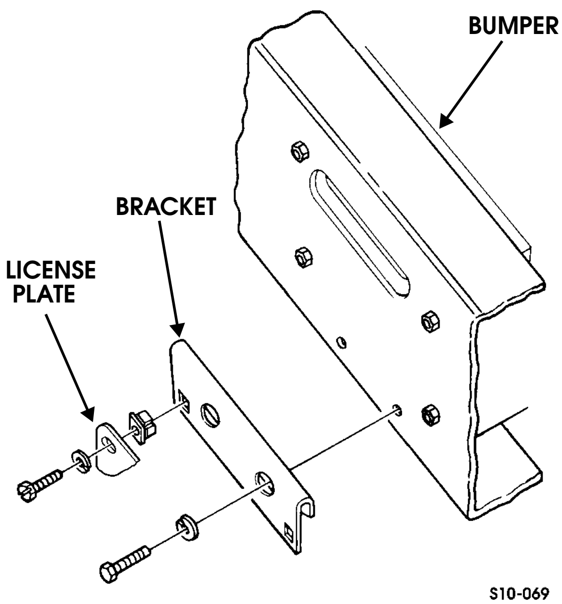


Figure 10-125: Front License Plate Bracket

FUEL FILLER HOUSING REPLACEMENT

Main Fuel Tank

Removal

1. Remove filler cap from filler spout (Figure 10-126).
2. Remove three nuts, washers, capscrews, and washers securing fuel filler housing to filler spout.
3. Remove six screws and washers securing fuel filler housing to right outer wheelhouse panel.
4. Push filler cap through filler housing and remove fuel filler housing.
5. Inspect six speednuts for damage. Replace if defective or missing.

Installation

1. Pull filler cap through fuel filler housing and install housing on right outer wheelhouse panel with six washers and screws.Tighten screws to 18 lb in. (2 N•m) (Figure 10-126).
2. Secure fuel filler housing to filler spout with three washers, capscrews, washers, and nuts.
3. Install filler cap on filler spout.

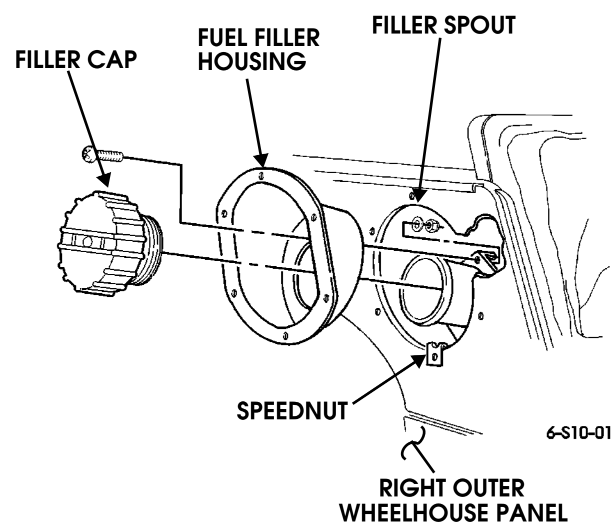


Figure 10-126: Fuel Filler Housing - Main Tank

Auxiliary Fuel Tank

Removal

1. Remove five screws and fuel filler tube splash shield from inside of right rear wheelhouse,
2. Remove filler cap from filler spout (Figure 10-127).
3. Remove three locknuts, washers, bolts, and reinforcement ring securing fuel filler tube to housing.
4. Remove five screws and fuel filler housing from body.

Installation

1. Secure fuel filler housing to body with five screws.
2. Secure fuel filler tube to housing with reinforcement ring, three bolts, washers and locknuts.
3. Screw filler cap into filler spout.
4. Secure fuel filler tube splash shield to brackets in right rear wheelhouse with five screws.

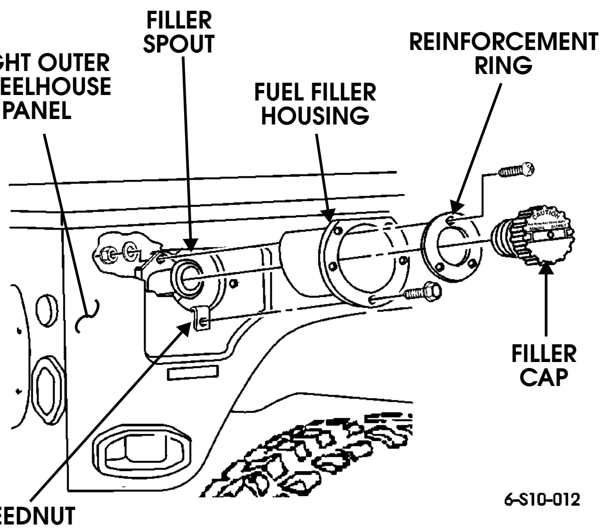


Figure 10-127: Fuel Filler Housing Auxiliary Fuel Tank

ROADSIDE EMERGENCY EQUIPMENT

Tire Jack and Optional Triangle Warning Kit Hold-Down Bracket Replacement (For Two-Passenger Model)

Removal

1. Remove two wingnuts, washers, and hold-down brackets (Figure 10-128).
2. Remove tire jack and triangle warning kit.
3. Remove two studs from bracket.

Installation

1. Place tire jack and triangle warning kit in place (Figure 10-128).
2. Install two studs on bracket.
3. Install two hold-down brackets on studs with two washers and wing nuts.

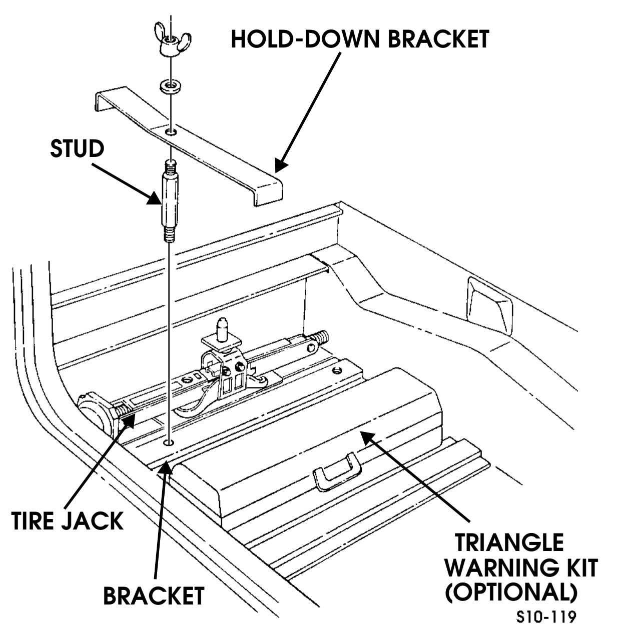


Figure 10-128: Emergency Equipment Hold-Down Bracket - Two-Passenger Vehicle

Tire Jack and Optional Triangle Warning Kit Hold-Down Replacement (Four-Passenger Vehicle, Station Wagon, and Open Body)

Removal

1. Remove triangle warning kit and tire jack from under right rear seat.
2. Remove two wing nuts, washers, screws, clamp bracket, and hold-down bracket from seat support (Figure 10-129).
3. Remove nut, washer, screw, washer, and strap bracket from seat support.
4. Remove nut, washer, screw, washer, and strap from strap bracket.

Installation

1. Secure strap to strap bracket with screw, two washers, and nut (Figure 10-129).
2. Secure strap bracket to seat support with screw, two washers, and nut.
3. Secure hold-down bracket and clamp bracket to seat support with two screws, washers, and wing nuts.
4. Position tire jack and triangle warning kit in place, and secure with strap.

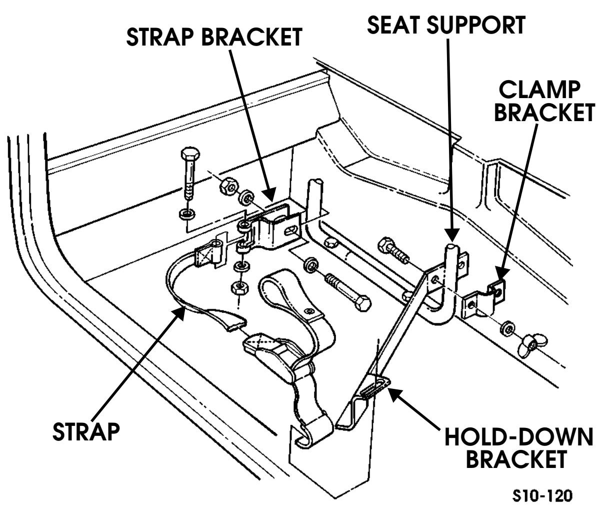


Figure 10-129: Emergency Equipment Hold-Down Bracket Replacement — Four-Passenger Vehicle

FOUR-PASSENGER SOFT TOP

Interior Trim Replacement

Removal

1. Remove front and rear seats.
2. Remove front and center consoles.
3. Remove speakers from rear wall (Section 12).
4. Remove two panel fasteners from upper center trim of windshield frame (Figure 10-131).
5. Remove five screw and washer assemblies and upper center and center trim from windshield frame.
6. Remove four screw and washer assemblies and trim from side of rear compartment wall (Figure 10-132).
7. Remove four screw and washer assemblies and lower B-pillar trim from B-pillar (Figure 10-130).

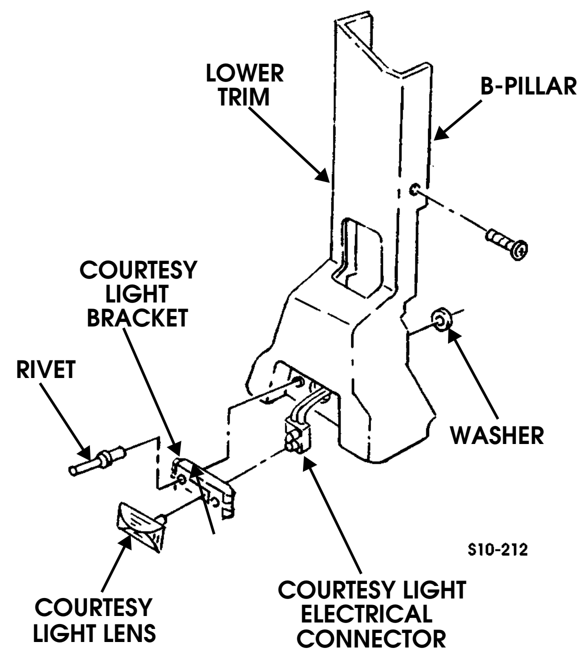


Figure 10-130: Courtesy Light Electrical Connector

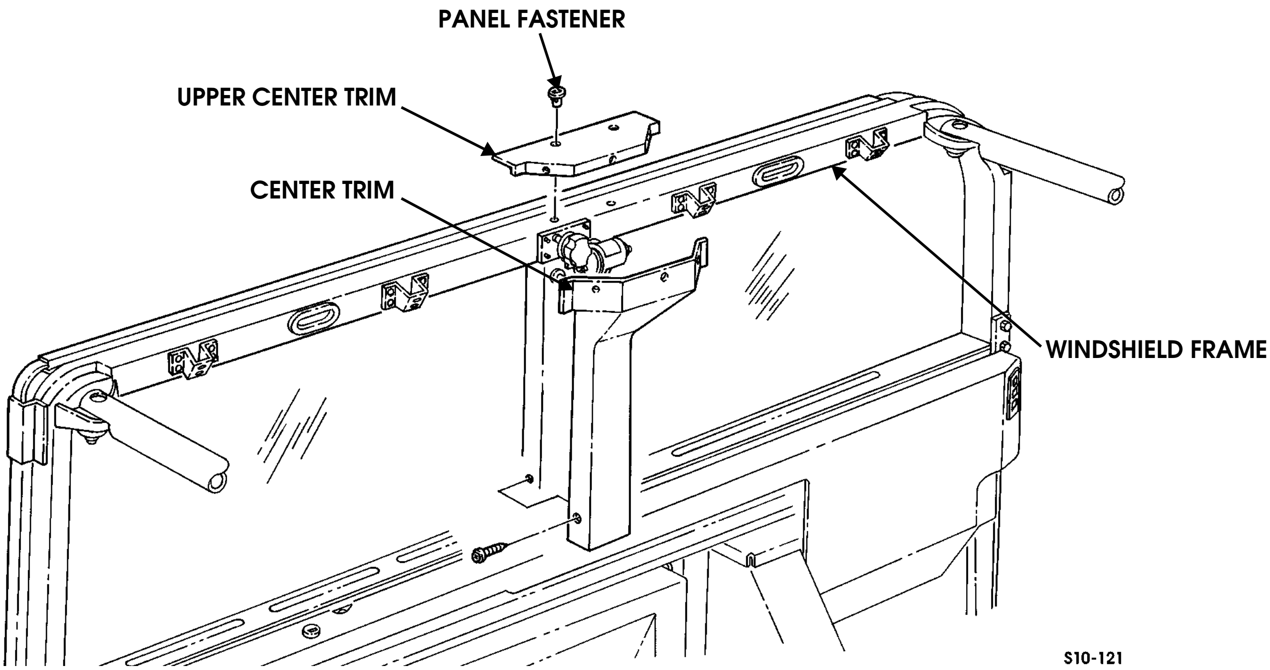


Figure 10-131: Upper Trim Replacement

8. Disconnect courtesy light electrical connector, and remove courtesy light lens, two rivets, washers, and courtesy light from trim.

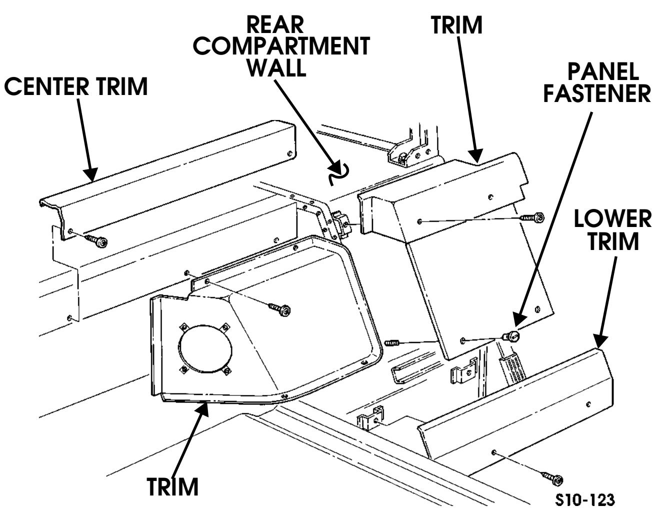


Figure 10-132: Rear Wall Compartment Location

9. Remove four screw and washer assemblies, two panel fasteners, lower trim, and trim from rear compartment wall (Figure 10-132).
10. Remove screw and washer assembly and center trim from rear compartment wall.

Installation

1. Secure center trim to rear compartment wall with screw and washer assembly (Figure 10-132).
2. Secure lower trim and trim to rear compartment wall with two panel fasteners and four screw and washer assemblies.
3. Secure trim to rear compartment wall with four screw and washer assemblies.
4. Connect courtesy light electrical connector, and secure courtesy light to trim with two washers and rivets (Figure 10-130).
5. Secure courtesy light lens to courtesy light bracket.
6. Fasten lower B-pillar trim with four screw and washer assemblies.
7. Secure center trim to windshield frame with two screw and washer assemblies (Figure 10-133).
8. Secure upper center trim to windshield frame and center trim with two panel fasteners and three screw and washer assemblies.
9. Install speakers on rear wall (Section 12).
10. Install front and center consoles.
11. Install front and rear seats.

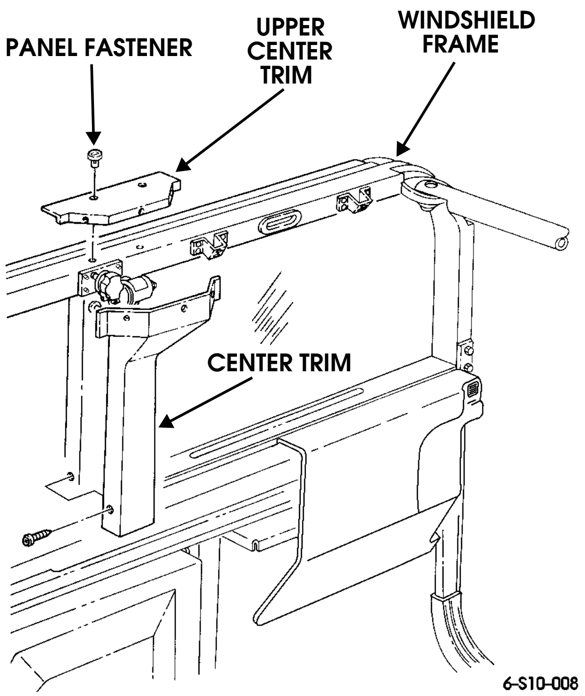


Figure 10-133: Interior Trim Replacement

Soft Top Mounting Components and Accessories Replacement

NOTE: The following removal and installation instructions include replacement of all soft top mounting components and accessories. Use only the applicable steps for replacing specific components.

Removal

1. Remove four-passenger soft top, tonneau cover, or station wagon soft top, if applicable. Refer to the owner's manual for proper procedure.
2. Remove tonneau cover wood bow from two retainer brackets (Figure 10-134).
3. Remove four screws and two bow retainer brackets from wheelhouses.

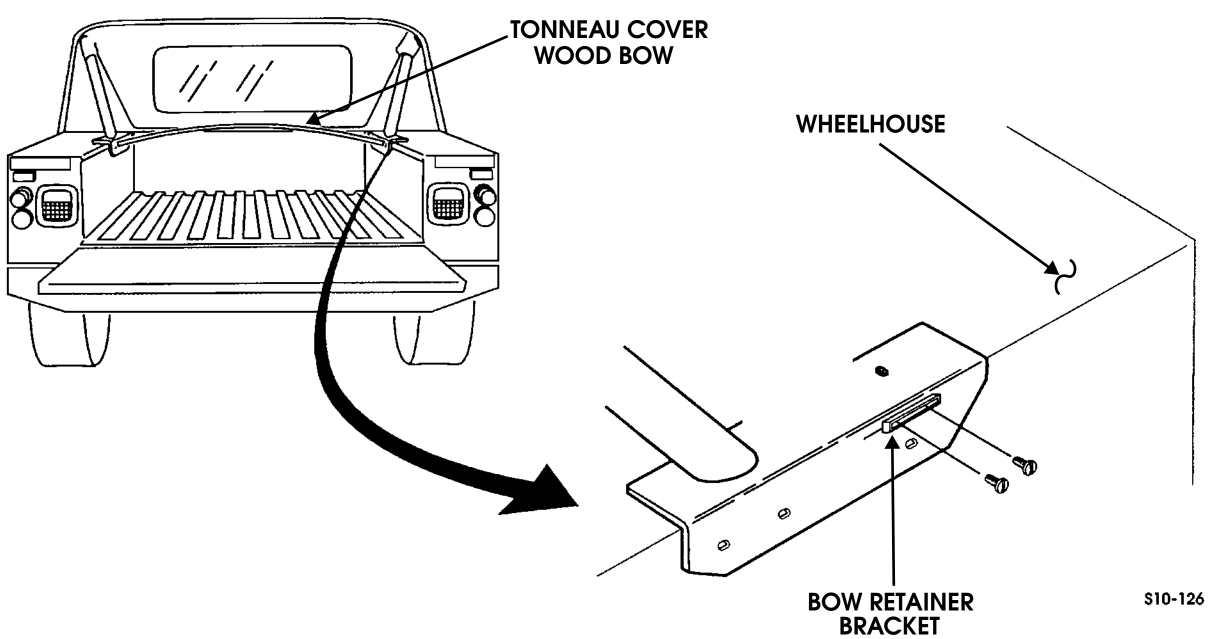


Figure 10-134: Tonneau Cover Wood Bow Removal

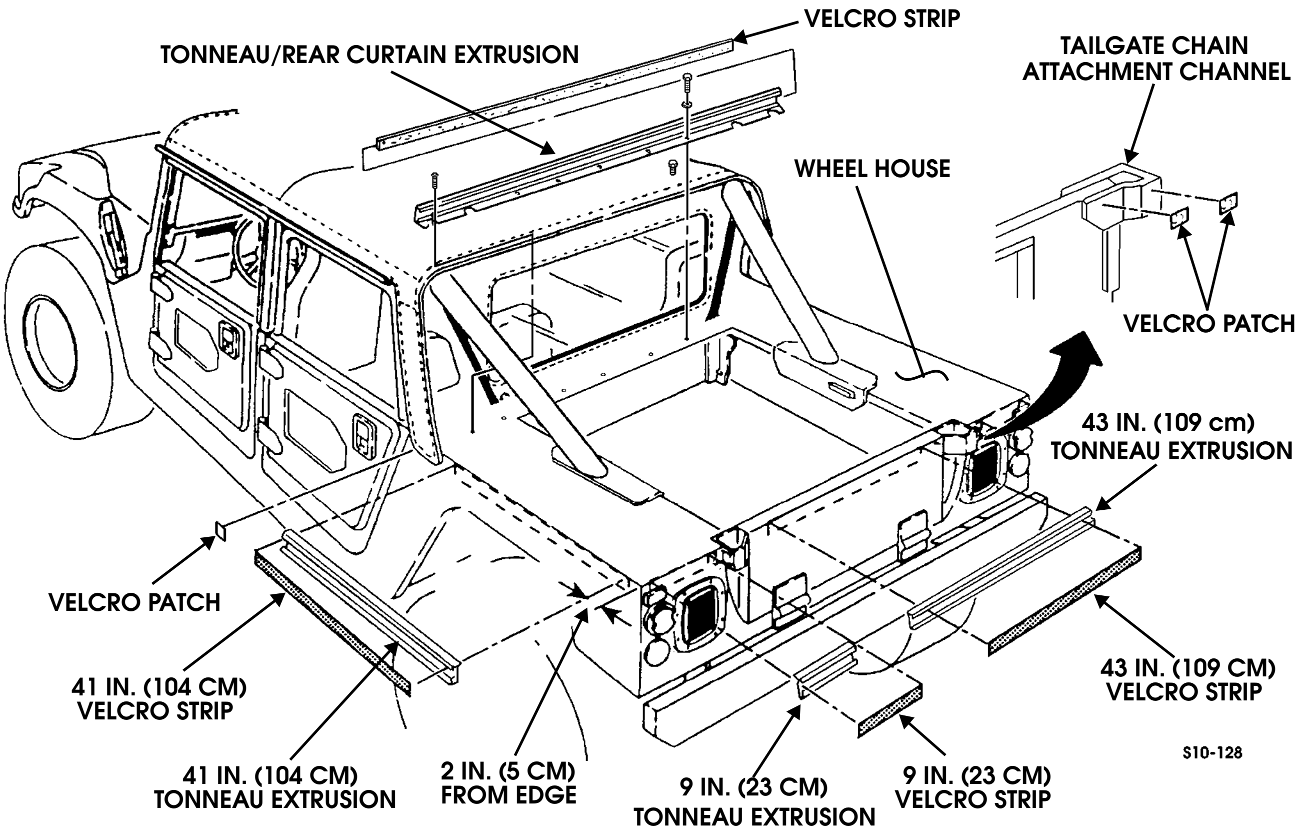


Figure 10-135: Velcro Strip and Patch Removal

4. Remove velcro strips and patches from tonneau area (Figure 10-135).

NOTE: Perform steps 5 and 6 for both sides of the vehicle. The left side is shown.

5. Remove 41 in. (104 cm) tonneau extrusion from side of wheelhouse.
6. Remove 9 in. (23 cm) tonneau extrusion from rear of wheelhouse.
7. Remove 43 in. (109 cm) tonneau extrusion from tailgate.
8. Remove five screws, lockwashers, four self-tapping screws, and tonneau/rear curtain extrusion from body.

NOTE: Perform steps 10 through 13 for both sides of the vehicle. The left side is shown.

9. Remove front and rear door seals (Figure 10-136).

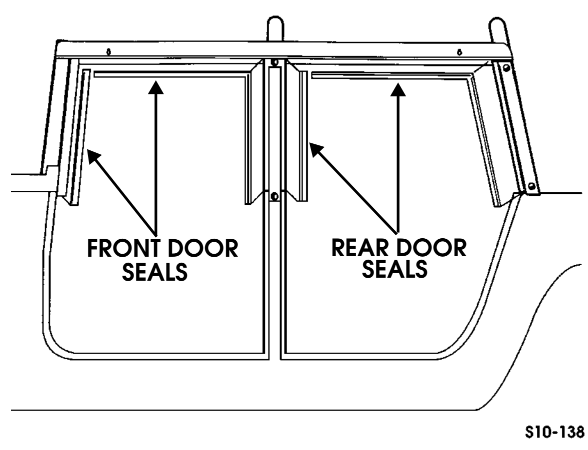


Figure 10-136: Door Seal Removal

10. Remove ten rivets securing front and rear wind deflectors to A-pillar and B-pillar (Figure 10-137).

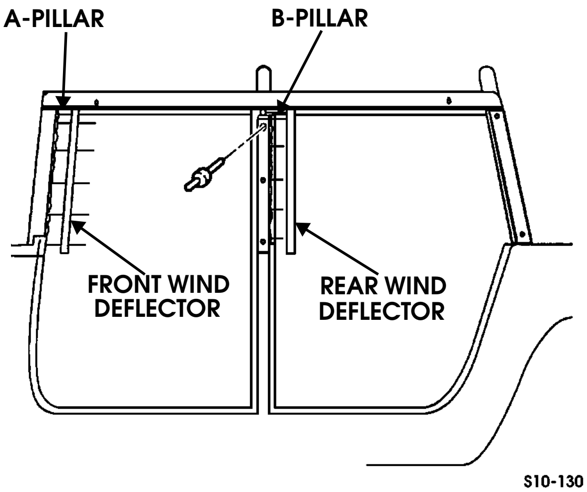


Figure 10-137: Wind Deflector Removal

11. Remove screw, washer, and self-tapping screw securing B-pillar extrusion to B-pillar and remove B-pillar extrusion (Figure 10-138).

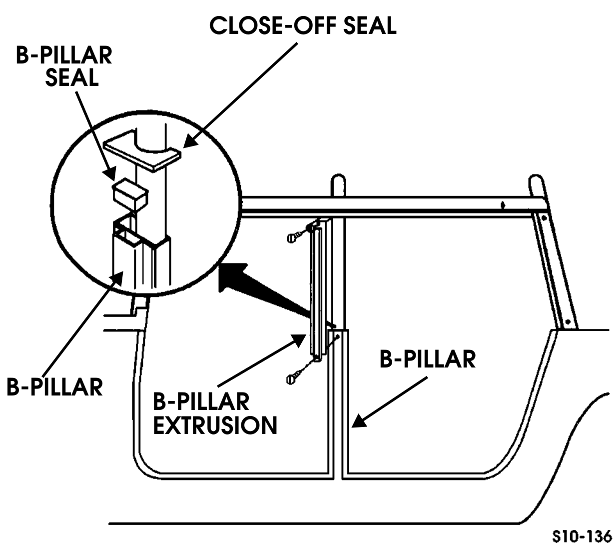


Figure 10-138: B-Pillar Extrusion Removal

12. Remove close-off seal and B-pillar seal from B-pillar.
13. Remove D-strip seal from windshield frame. Do not remove P-strip seal (Figure 10-139).

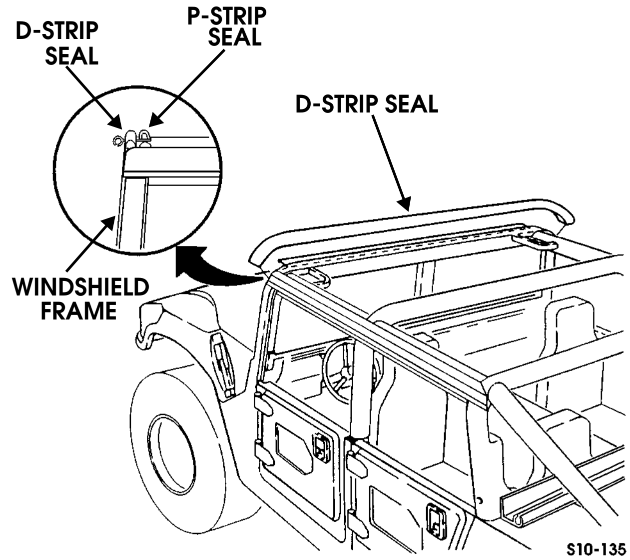


Figure 10-139: D-Strip Seal Removal

NOTE: Perform steps 14 through 16 for both sides of the vehicle. The left side is shown.

14. Remove two screws and spacers securing velcro strip and horizontal rail (H-rail) to support structure (Figure 3). Remove any spacer washers, if applicable.
15. Remove 3 in. (8 cm) piece of P-strip seal from windshield frame.
16. Remove two screws, washers, and C-pillar extrusion from C-pillar.

Installation

NOTE: Perform steps 1 through 3 for both sides of the vehicle. The left side is shown.

1. Secure C-pillar extrusion to C-pillar with two washers and screws (Figure 10-141).

NOTE: Clean all surface residue with an alcohol-based cleaner before installing seals.

2. Install 3 in. (8 cm) piece of D-strip seal on windshield frame at the end of P-strip seal. Do not trim excess seal yet.

NOTE: If shimming is necessary, use spacer washers and longer screws to secure H-rail and to align H-rail door face with windshield frame door face and C-pillar extrusion door face.

3. Secure H-rail and velcro strip to support structure with two spacers and screws. Trim excess seal installed in step 2 to bottom of H-rail.
4. Install D-strip seal on windshield frame in front of P-seal. Trim as necessary (Figure 10-140).

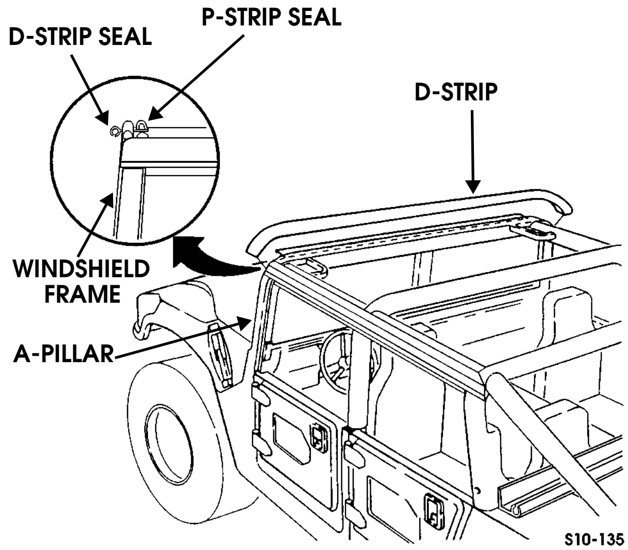


Figure 10-140: Windshield Seal Replacement

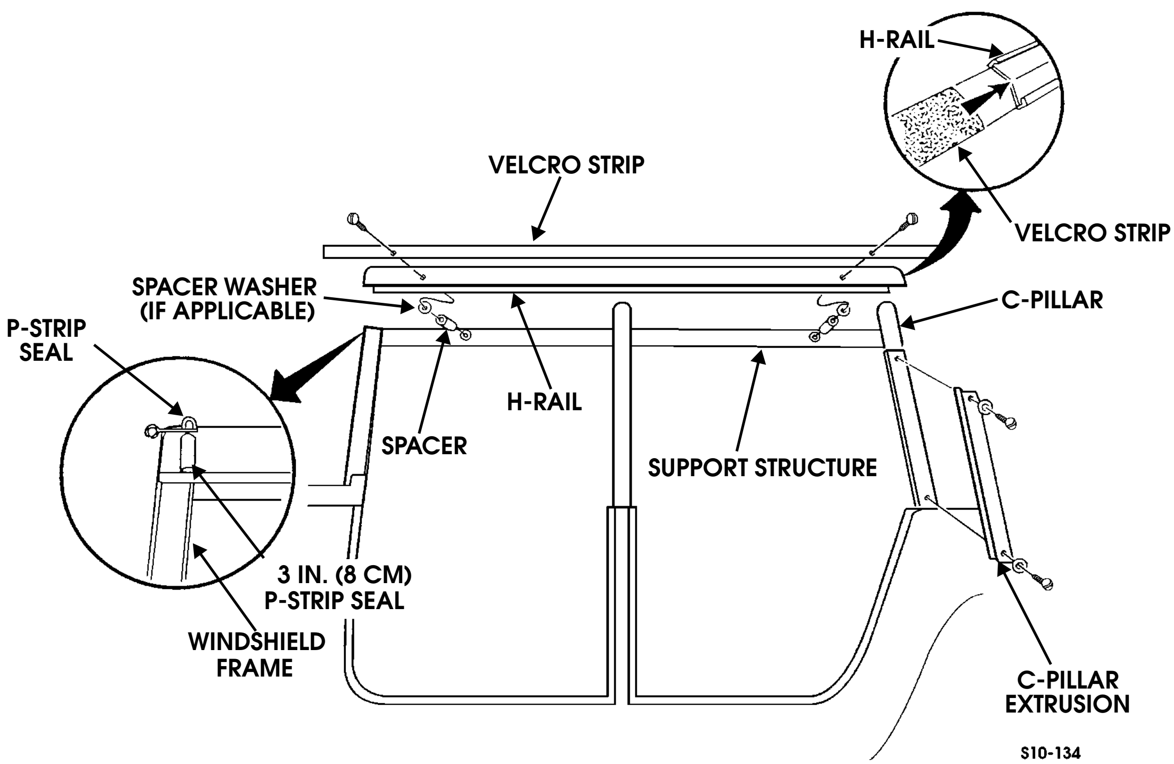


Figure 10-141: Rail and Support Structure Locations

NOTE: Perform steps 5 through 9 for both sides of the vehicle. The left side is shown.

5. Coat mating surfaces of close-off seal and B-pillar seal with silaprene adhesive and install seals on B-pillar (Figure 10-142).

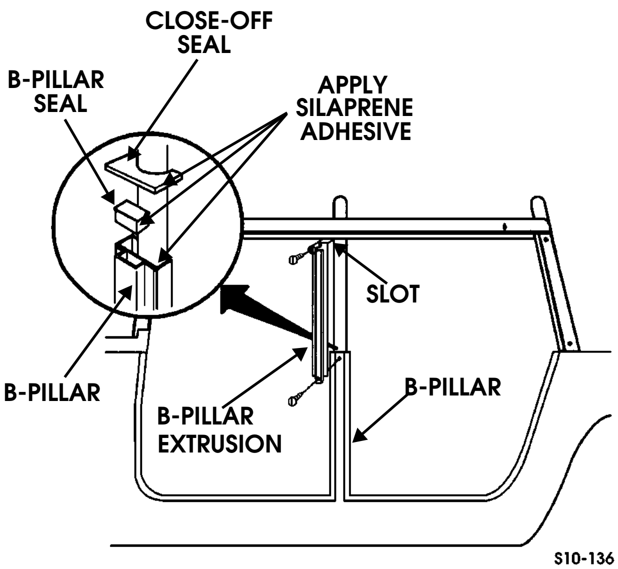


Figure 10-142: B-Pillar and Close-Off Seal Installation

6. Coat mating surface of B-pillar extrusion with silaprene adhesive and secure to B-pillar. Secure with washer, screw, and self-tapping screw. Seal slot in B-pillar extrusion with silaprene adhesive.
7. Coat mating surfaces of front and rear wind deflectors with silaprene adhesive and secure to A-pillar and B-pillar with ten rivets (Figure 10-143).
8. Install shorter seals on front and rear door frames and cut ends to fit. Trim seals at bottom of wind deflector (Figure 10-144).
9. Starting with mitered corner, install longer seals on front and rear door frames and cut ends to fit.

NOTE: Clean all surface residue with an alcohol-based cleaner before installing extrusions.

10. Secure tonneau/rear curtain extrusion to body with five lockwashers, capscrews, and four self-tapping screws (Figure 10-135).
11. Install 43 in. (109 cm) tonneau extrusion on tailgate.

NOTE: Perform steps 12 and 13 for both sides of the vehicle. The left side is shown.

12. Secure 9 in. (23 cm) tonneau extrusion to rear of wheelhouse.
13. Secure 41 in. (104 cm) tonneau extrusion to side of wheelhouse, 2 in. (5 cm) from rear corner edge of wheelhouse.

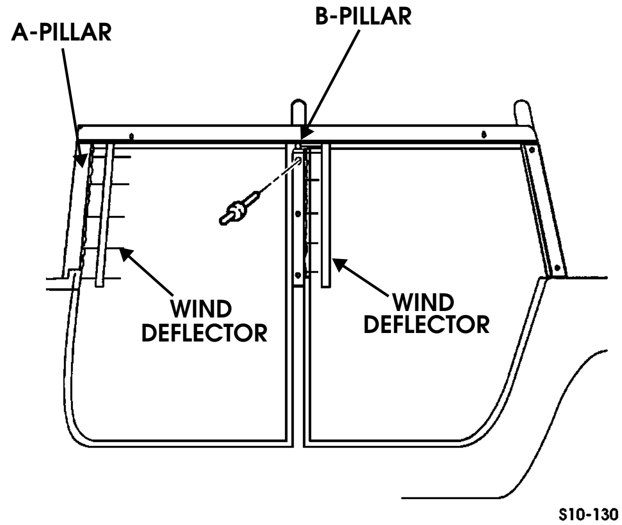


Figure 10-143: Wind Deflector Installation

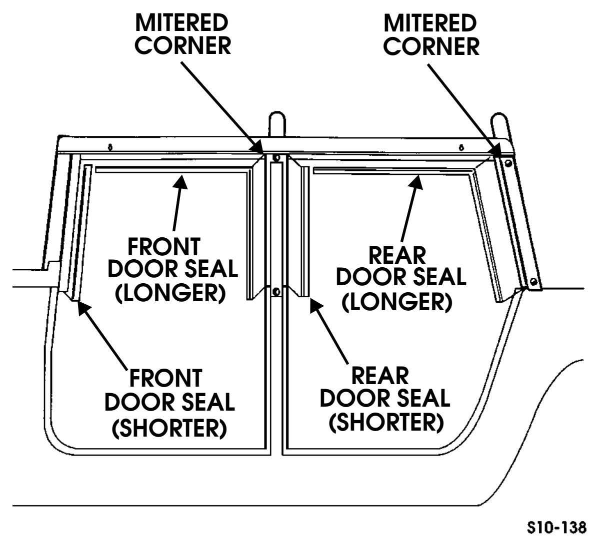


Figure 10-144: Door Seal Installation

NOTE: Before installing a new velcro strip (of larger size), crease the strip approximately 8 in. (20 cm) from each end by folding the strip back on itself. Unfold the strip before inserting it into the rail or extrusion. The crease will keep the velcro strip from moving excessively inside the extrusion channel.

14. Install velcro strips in extrusions.
15. Install one velcro patch on each wheelhouse side and two velcro patches on each tailgate chain attachment channel.
16. Lift the outer flap of each upper door assembly and check for gaps between the upper door assembly and lower door assembly. If a gap exists, unzip the window and tap on the base of the window frame with an open hand to seat the upper door assembly.

17. Check tightness of fit for each upper door assembly by inserting a sheet of paper or similar material between the upper door frame and door opening. Close door. Remove paper or similar material. Slight tension should be felt. Use additional seal material if the fit of the door assembly to the wind deflector is inadequate.
18. Secure two bow retainer brackets to wheelhouses with four screws (Figure 10-145).

CAUTION: *The ideal crown height of the bow is shown. If there is excessive crowning of the bow, cut the end of the wood bow with a saw to reduce the crown. Do not cut more than 0.25 in. (6 mm) at a time, or the bow may become too short.*

19. Measure and record the distance across the cargo bed, between each rear support bar brace. Add 0.25 to 0.50 in. (6 to 13 mm) to this dimension and mark and cut the wood bow to this dimension.
20. Position wood bow in two retainer brackets. Lay a straight edge across the wheel houses as shown (Figure 10-145). The ideal bow height is 1.5 in. from the straight edge to the bow crown.
21. Install the four-passenger soft top, tonneau cover, and slant-back soft top or station wagon soft top, if applicable. Refer to the owner's manual.

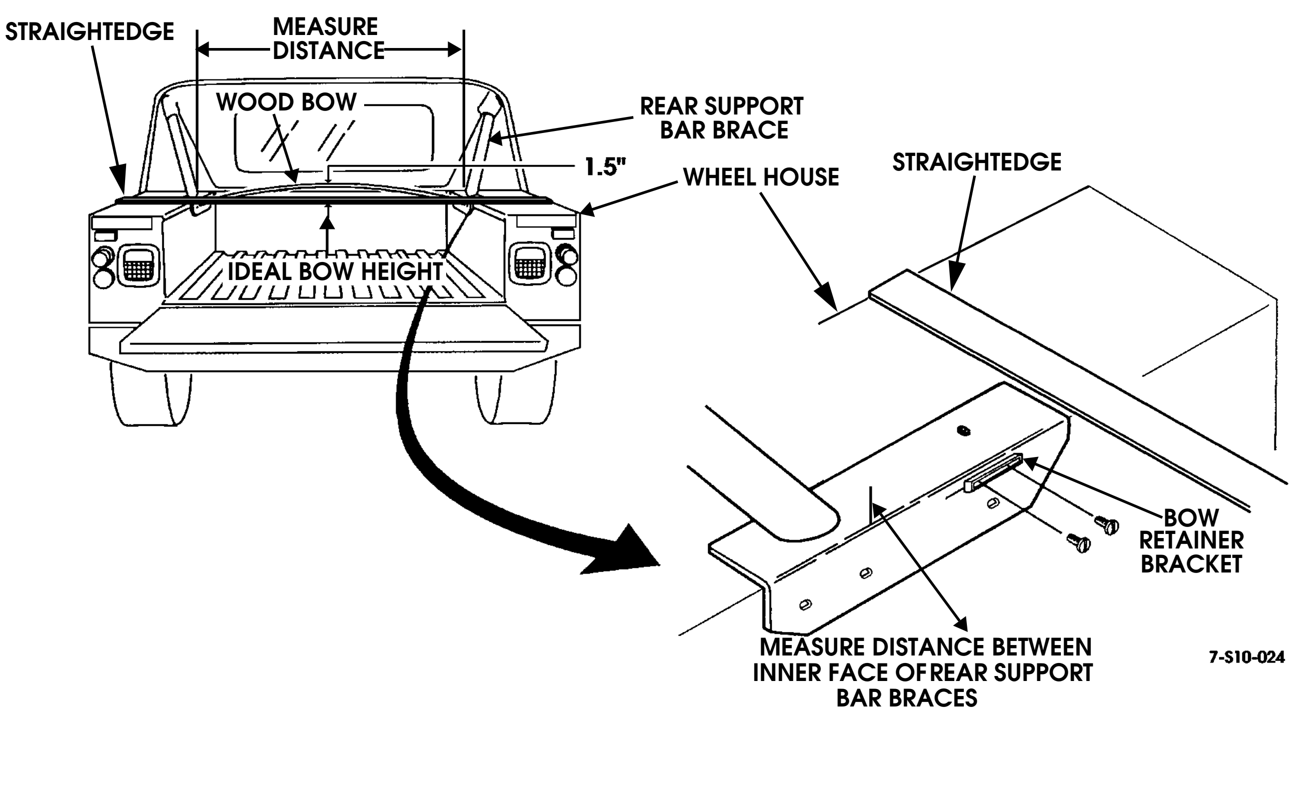


Figure 10-145: Bow Retainer Bracket Installation

ROLL CAGE ASSEMBLY/SOFT TOP SUPPORT

On soft top model Hummers, the roll cage assembly also functions as the soft top support. Roll cage assembly components are held together with common fasteners so that piece parts are replaceable (Figure 10-146).

Removal

1. Remove vinyl wrap and padding foam roll cage assembly.
2. Remove fasteners securing center support bars, side support bars, and C-pillar support assemblies to body and remove support bars from body.

Installation

1. Use fasteners to secure center support bars, side support bars, and C-pillar support assemblies to body.
2. Torque fasteners as specified in general torque chart (Section 1).
3. Install padding and vinyl wrap on roll cage assembly.

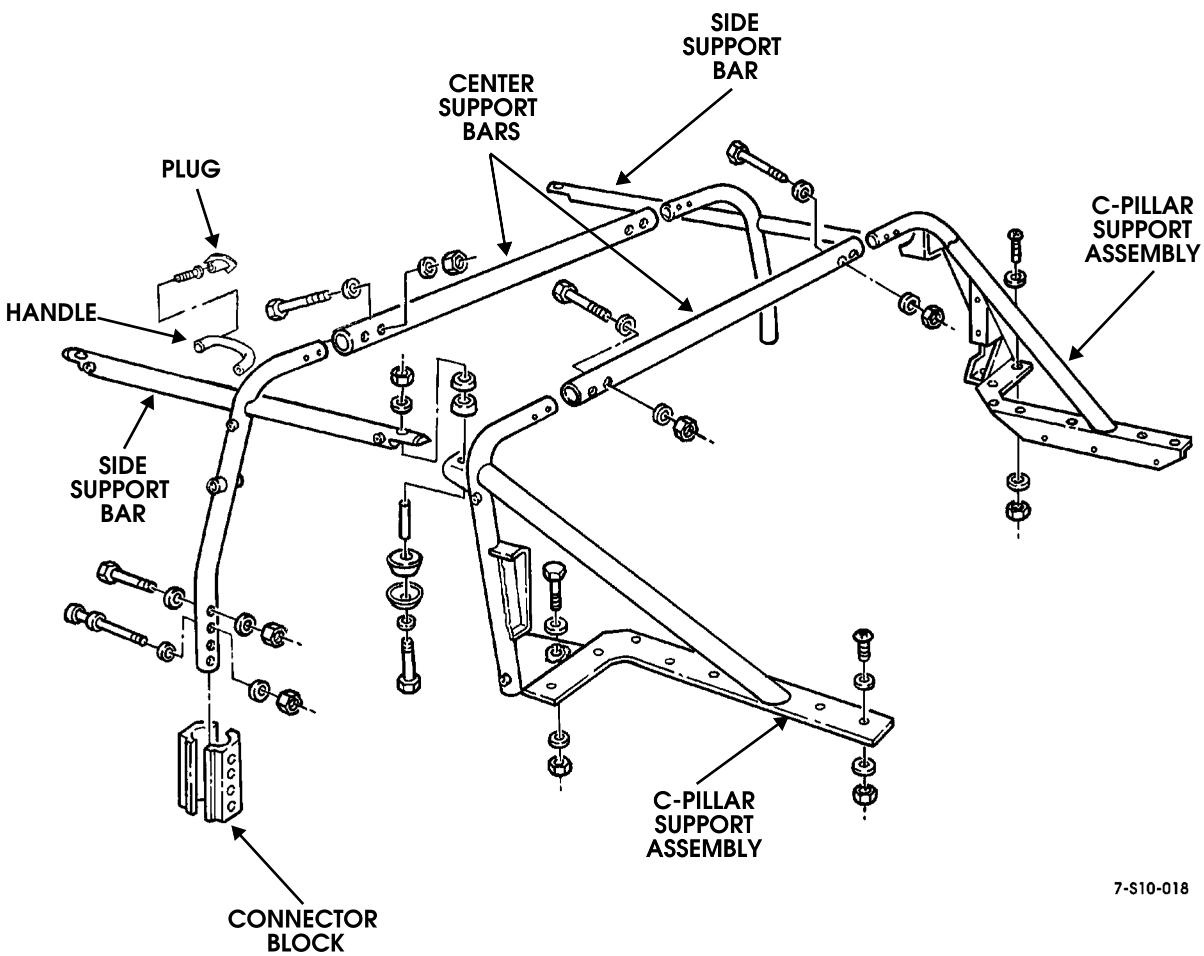


Figure 10-146: Roll Cage Assembly

TAILGATE

Tailgate Chain and Latch Brackets Replacement

Removal

Remove four locknuts, eight washers, four bolts, chain bracket, and latch bracket from body (Figure 10-147).

Installation

Secure chain bracket and latch bracket to body with four bolts, eight washers, and four locknuts. Tighten bolts to 15 lb-ft (20 N•m) (Figure 10-147).

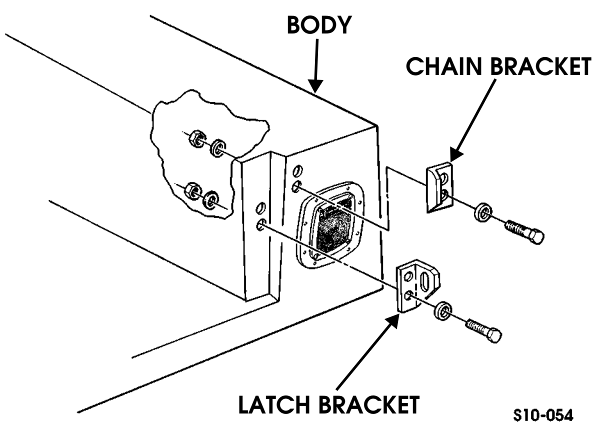


Figure 10-147: Tailgate Bracket Installation

Cargo Tiedown Replacement

NOTE: Cargo tiedown replacement is basically the same for all tiedowns.

Removal

Remove locknut, washer, screw, and cargo tiedown from cargo floor (Figure 10-148).

Installation

Install cargo tiedown on cargo floor with screw, washer, and locknut. Tighten locknut to 65 lb-ft (88 N•m) (Figure 10-148).

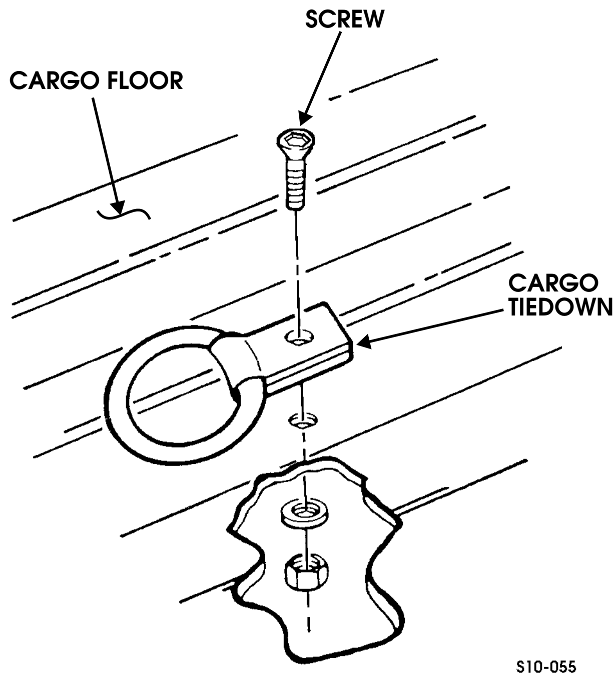


Figure 10-148: Cargo Tiedown Replacement

Tailgate and Seals Replacement

Removal

1. Remove six locknuts, washers, and bolts securing tailgate to body (Figure 10-149).
2. Disconnect two chains from tailgate and remove tailgate and shims from body.

NOTE: Perform step 3 for two- and four-door models. Perform step 4 and 5 for station wagon and open body models.

3. Remove two vertical seals from tailgate. Discard seals.
4. Remove two vertical and horizontal seals from body and four vertical seals and one horizontal seal from tailgate. Remove two corner seals (station wagon model only). Discard seals (Figure 10-150).
5. Remove two corner seals from tailgate (station wagon model only).
6. Remove two grommets from tailgate.
7. Clean adhesive from tailgate and body.

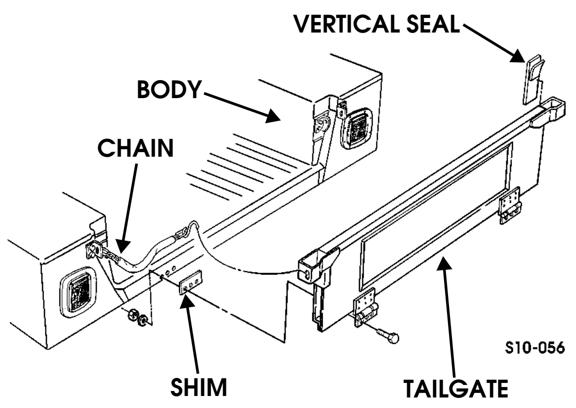


Figure 10-149: Tailgate and Seals Replacement

Installation

1. Install two grommets on tailgate (Figure 10-150).

NOTE: NOTE: Perform steps 2 through 4 for station wagon and open body models. Perform step 5 for two- and four-door models.

2. Remove paper backing and install four vertical seals and one horizontal seal on tailgate. Ensure upper vertical seals overlap lower seals.
3. Remove paper backing from two horizontal and vertical seals and install on body.
4. Remove paper backing from two corner seals and install on tailgate (station wagon model only).
5. Remove paper backing from two vertical seals and install seals on tailgate (Figure 10-149).
6. Secure tailgate to body with six bolts, washers, and locknuts. Shim hinges as needed to align tailgate with body. When aligned, tighten bolts 26 lb-ft (35 N•m).
7. Attach to tailgate two chains from body.

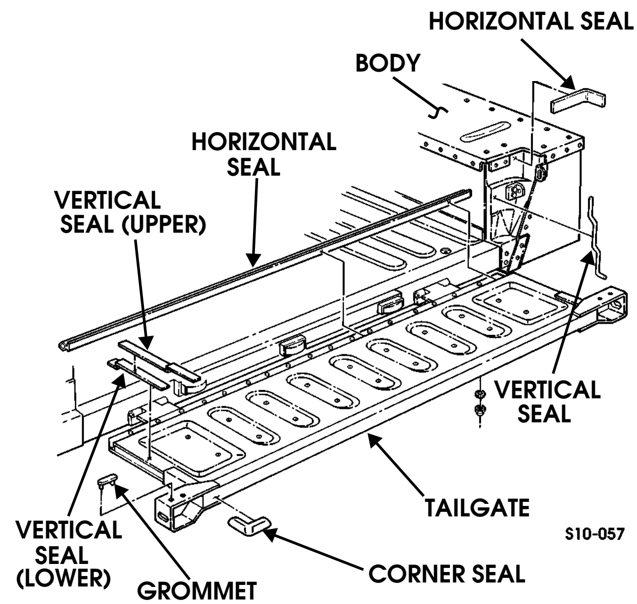


Figure 10-150: Tailgate Mounting Bracketry and Seal Location

Tailgate Chain Replacement

Removal

1. Lower tailgate.
2. Open chain cap link and disconnect chain from bracket (Figure 10-151).
3. Unhook chain from chain bracket.

Installation

1. Hook chain to chain bracket (Figure 10-151).

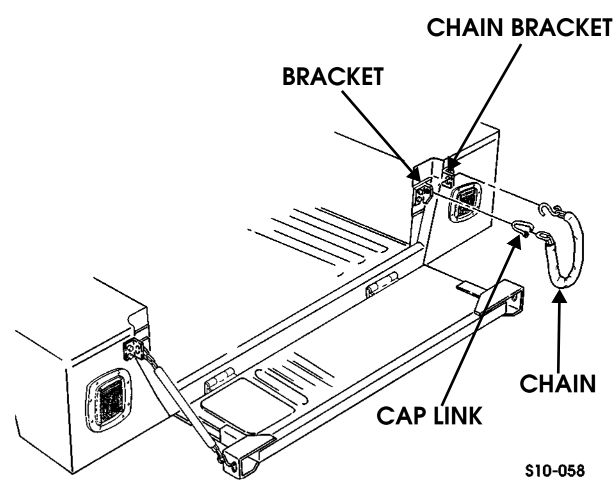


Figure 10-151: Tailgate Chain Replacement

2. Connect chain to bracket.
3. Raise tailgate.

TAILGATE HINGE REPLACEMENT

NOTE: To facilitate alignment when replacing hinges, place a small strip of masking tape along each side and bottom of hinge before removal.

Removal

Remove tailgate by removing six locknuts, washers, and bolts from the tailgate while still closed. Note number of shims under each hinge and set them aside. Remove tailgate by releasing tailgate chains (Figure 10-152).

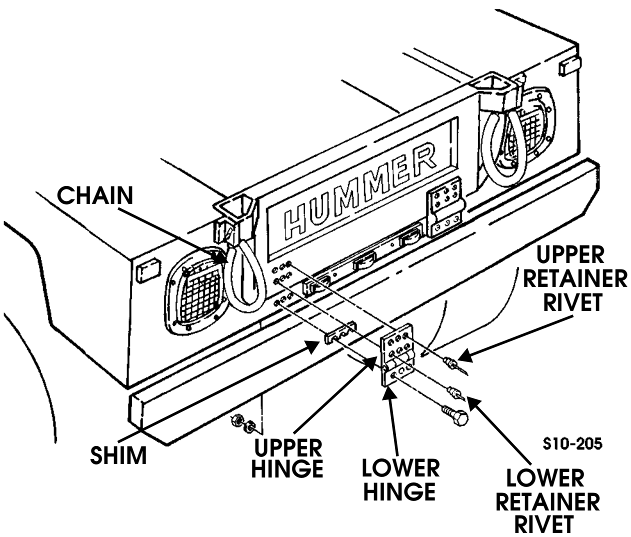


Figure 10-152: Tailgate Hinge Replacement

Disassembly

1. Place tailgate on padded work surface and remove hinge retainer rivets. Remove hinge and clean any debris from rivet holes.
2. Clean tailgate and apply a light coat of seam sealant to hinge mounting area.

Assembly

1. Using three 0.187 in. x 0.626 in. rivets, fasten hinge to lower set of holes on tailgate.
2. Fasten hinge to upper set of holes on tailgate with three 0.187 in. x 0.563 in. rivets.

Installation

1. Position tailgate on bed and secure with tailgate chains. Loosely install bolts, washers, and locknuts into hinges. Insert proper amount of shims under each hinge.
2. Slightly tighten bolts, but not tight enough to restrict movement into alignment with tape marks.
3. Align hinges and tailgate into proper position and torque bolts to 26 lb-ft (35 N•m). Remove any excess sealant from hinges and body.
4. Refinish hinges and fasteners as required.

REAR VERTICAL DOOR REPLACEMENT

Door Replacement

Removal

1. Remove eight screws and rear vertical door from hinge (Figure 10-153).
2. Remove eight screws and hinge from door frame.

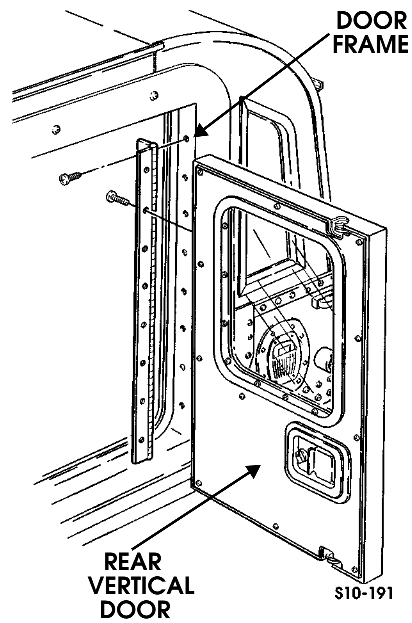


Figure 10-153: Rear Vertical Door Replacement

Installation

1. Secure hinge to door frame with eight screws (Figure 10-153).
2. Secure rear vertical door to hinge with eight screws.

Window Replacement

Removal

Remove eleven screws, window retainer bracket, and window from rear vertical door (Figure 10-154).

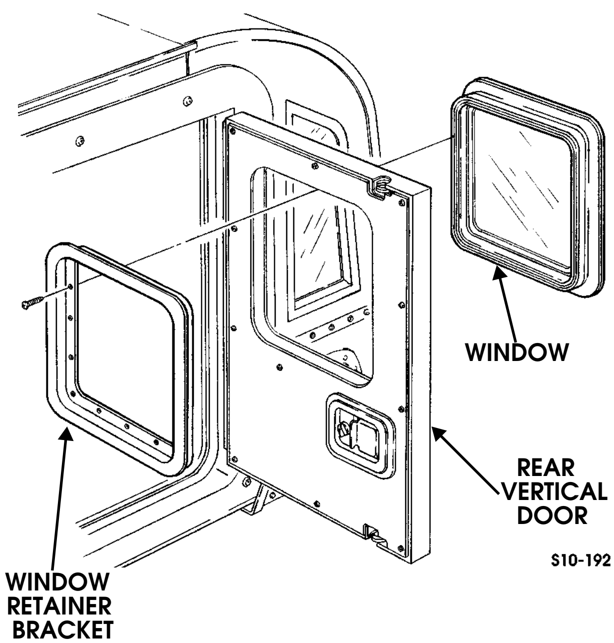


Figure 10-154: Window Replacement

Installation

Secure window to rear vertical door with window retainer bracket and eleven screws (Figure 10-154).

Door Handle Replacement

Removal

1. Remove rear door window.
2. Remove four screws and interior door handle from door (Figure 10-155).
3. Remove twelve screws and close-out panel from door.
4. Remove two cotter pins, washers, and latch rods from exterior door handle.
5. Remove four spacers and exterior door handle from door.

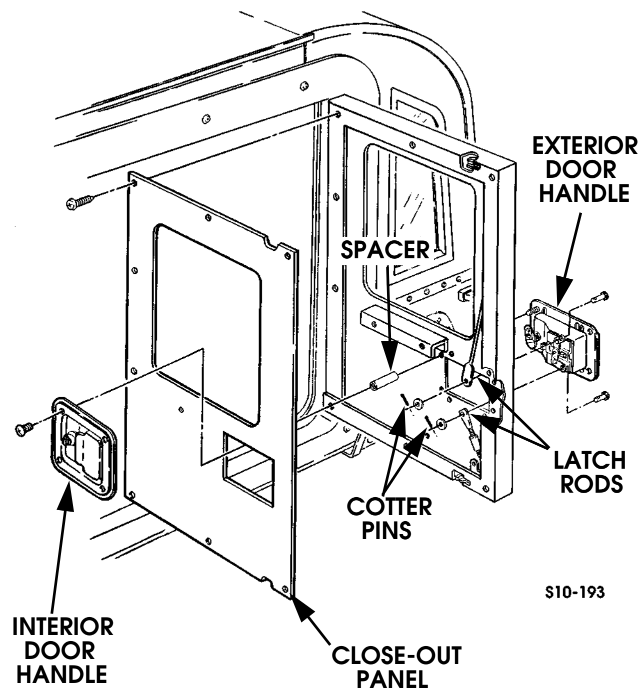


Figure 10-155: Door Handle Replacement

Installation

1. Secure exterior door handle to door with four spacers (Figure 10-155).
2. Secure latch rods to exterior door handle with two washers and cotter pins.
3. Secure close-out panel to door with twelve screws.
4. Secure interior door handle to door with four screws.
5. Install rear door window.

Door Latch and Latch Rod Replacement

Removal

1. Remove rear door window.
2. Remove four screws and interior door handle from door (Figure 10-156).
3. Remove twelve screws and close-out panel from door.
4. Remove cotter pin, washer, and latch rod from exterior door handle.
5. Remove three nuts, lockwashers, screws, and lower door latch from door.
6. Remove locknut, washer, screw, and latch rod from lower door latch.

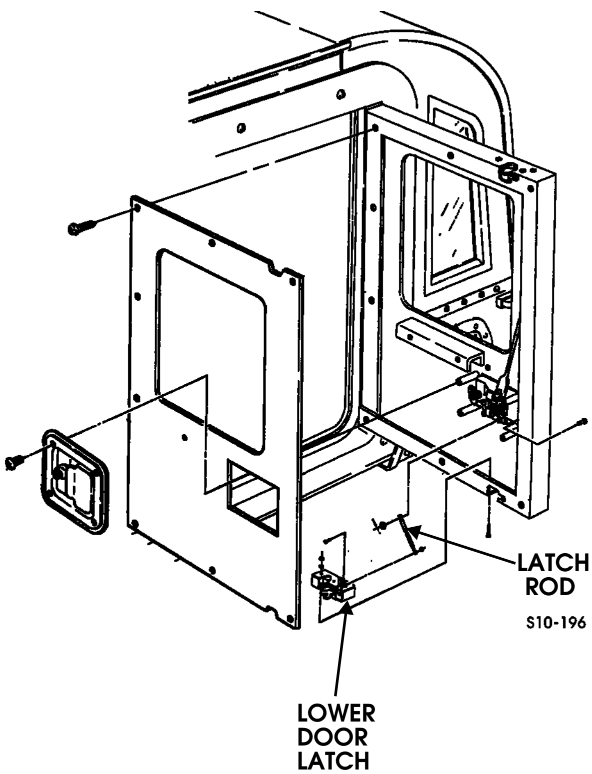


Figure 10-156: Door Latch and Latch Rod Replacement

Installation

1. Secure lower door latch to door with three screws, lock-washers, and nuts (Figure 10-156).
2. Secure latch rod to lower door latch with screw, washer, and locknut.
3. Secure latch rod to exterior door handle with washer and cotter pin.
4. Secure close-out panel to door with twelve screws.
5. Install rear door window.
6. Secure interior door handle to door with four screws.

Door Stop Replacement

Removal

1. Remove rear door window.
2. Remove four screws and interior door handle from door (Figure 10-156).
3. Remove twelve screws and close-out panel from door.
4. Remove bolt, door stop ball, and retainer from door (Figure 10-157).
5. Remove bolt, washer, door stop socket, and retainer from right rear wheelhouse.

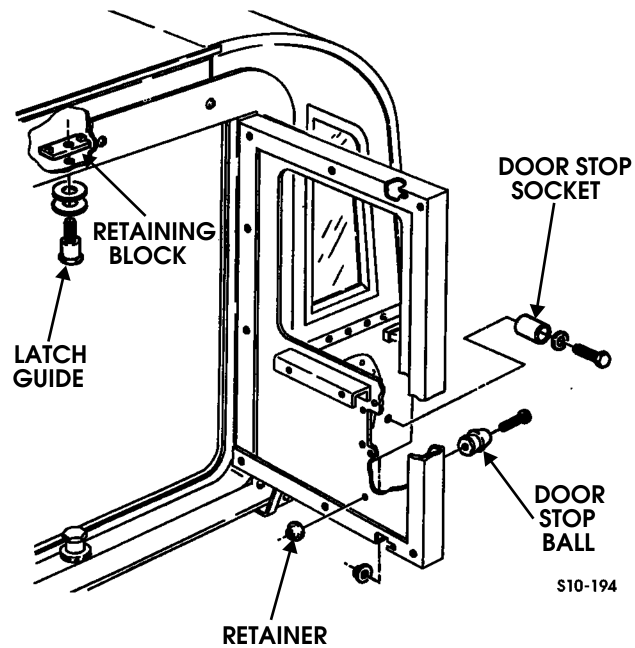


Figure 10-157: Door Stop and Latch Guide Replacement

Installation

1. Secure door stop socket to right rear wheelhouse with washer, bolt, and retainer (Figure 10-157).
2. Secure door stop ball to door with bolt and retainer.
3. Secure close-out panel to door with twelve screws (Figure 10-156).
4. Secure interior door handle to close-out panel with four screws.
5. Install rear door window.

Latch Guide Replacement

Removal

Remove latch guide, two washers, and retaining block from door frame (Figure 10-157).

Installation

Secure latch guide to door frame with two washers and retaining block (Figure 10-157).

Adjustment

Close door and check alignment, then adjust latch guide as necessary.

Door Frame and Seal Replacement

Removal

1. Remove vertical doors from door frame.
2. Remove upper and lower latch guides.
3. Remove fourteen screws and door frame from vehicle (Figure 10-158).
4. Remove seal from door frame.

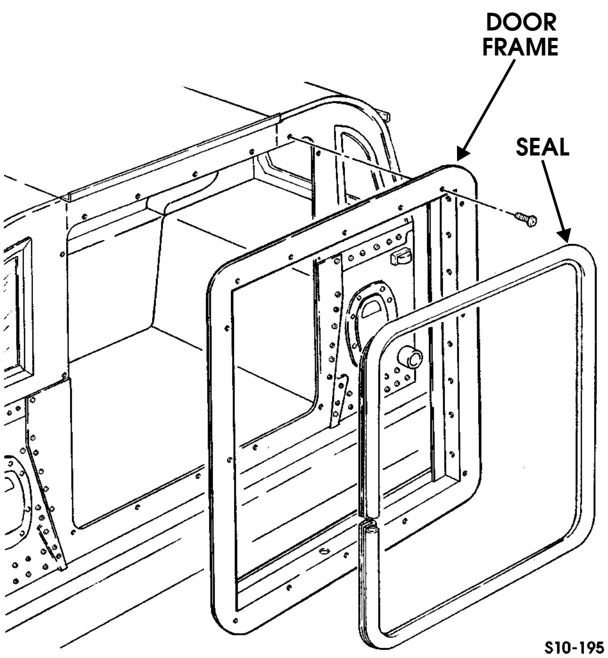


Figure 10-158: Door Frame and Seal Replacement

Installation

1. Position seal on door frame (Figure 10-158).
2. Secure door frame to vehicle with fourteen screws.
3. Install upper and lower latch guides.
4. Install vertical doors on door frame.

INTERIOR AND EXTERIOR LIGHTING REPLACEMENT

Service Headlight Assembly Replacement

Removal

NOTE: To remove headlight only, perform steps 1 and 2. To remove the entire assembly, continue with steps 3 through 6.

1. Loosen three screws and remove retaining ring from headlight mount (Figure 10-159).
2. Disconnect headlight jumper harness from headlight, and remove headlight.
3. Loosen two screws securing headlight mount to headlight housing, and remove mount from housing and spring.
4. Disconnect headlight jumper harness from headlight housing and remove harness.
5. Disconnect three leads from back of housing.
6. Remove three nuts, lockwashers, washers, and housing from hood.

Installation

NOTE: To install headlight only, perform steps 5 and 6. To install entire assembly, perform all steps.

1. Connect three leads to back of housing (Figure 10-159).
2. Secure headlight housing to hood with three washers, lockwashers, and nuts.
3. Secure headlight mount to housing, with spring and two screws.
4. Connect headlight jumper harness to headlight housing.
5. Connect headlight to jumper harness and secure headlight to headlight mount with retaining ring with retaining ring. Tighten three screws.
6. Connect battery ground cable (Section 12).
7. Check headlight for proper operation.

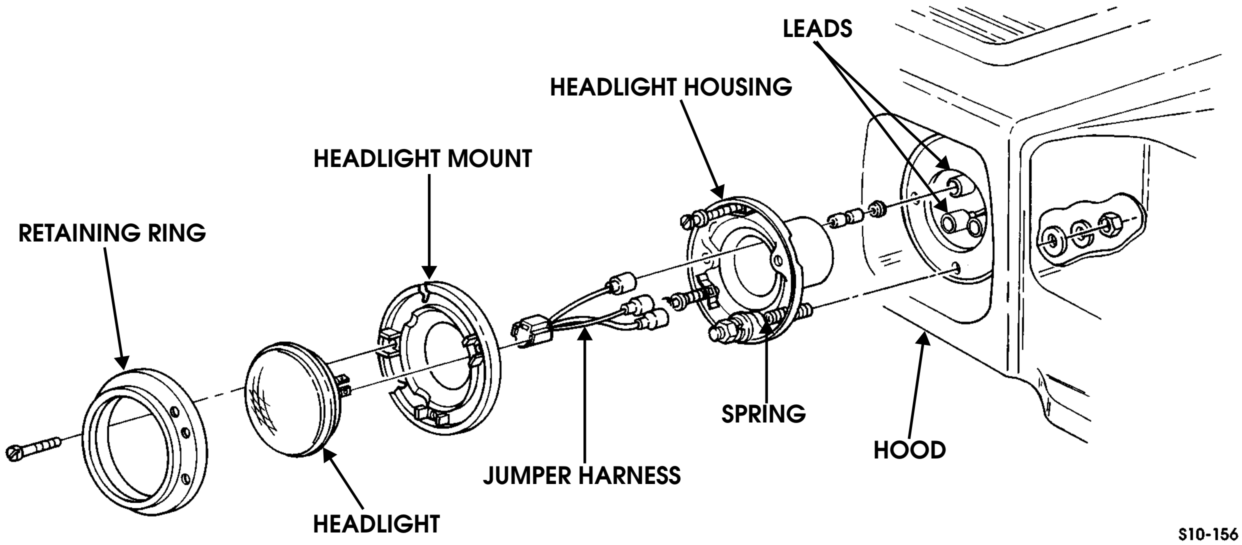


Figure 10-159: Headlight Assembly Replacement

Side Marker Light Lens and Lamp Replacement

Removal

Remove two screws, cover, lens, and lamp from lamp holder (Figure 10-160).

Installation

1. Install lamp. Secure lens, and cover to lamp holder with two screws (Figure 10-160).
2. Ensure side marker light operates properly.

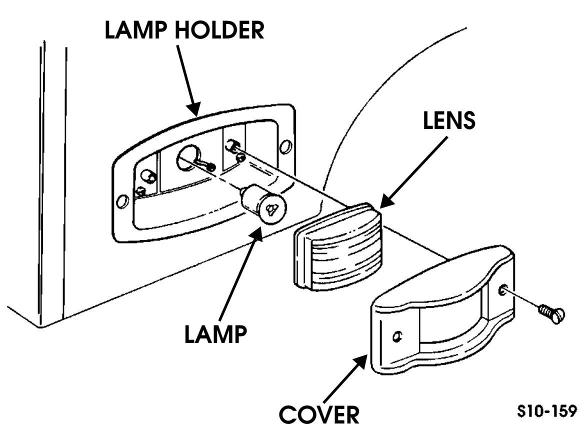


Figure 10-160: Side Marker Light Lens and Lamp Replacement

Identification Light Replacement

NOTE: All identification lights are replaced the same. Bulb is not removable from lens. Light is replaced as an assembly.

Removal

1. Carefully pry tabbed sides of identification light from light bracket (Figure 10-161).
2. Disconnect light from wiring harness.

Installation

1. Connect identification light to wiring harness (Figure 10-161).
2. Snap light into light bracket.

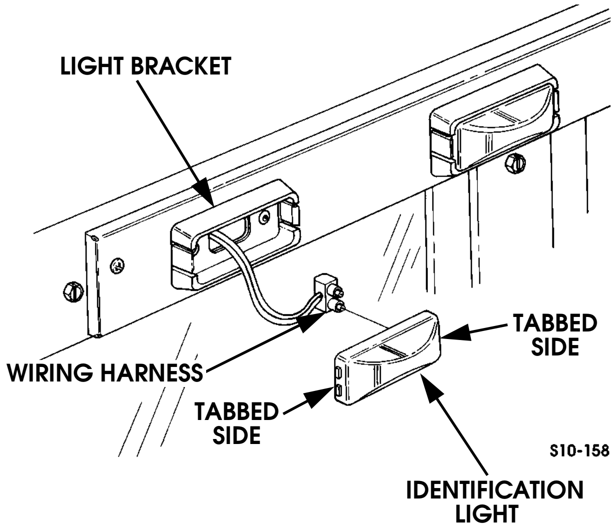


Figure 10-161: Identification Light Replacement

Side Marker Light Assembly Replacement

NOTE: Replacement of front and rear light assemblies is basically the same. This procedure covers the front left side marker.

Removal

1. Remove four screws, washers, and close-off cover from hood (Figure 10-162).
2. Disconnect harness lead from marker light lead (Figure 10-163).
3. Remove two screws, cover, and lens from marker light.
4. Remove four locknuts, washers, ground lead, gasket, four screws, and marker light from hood.

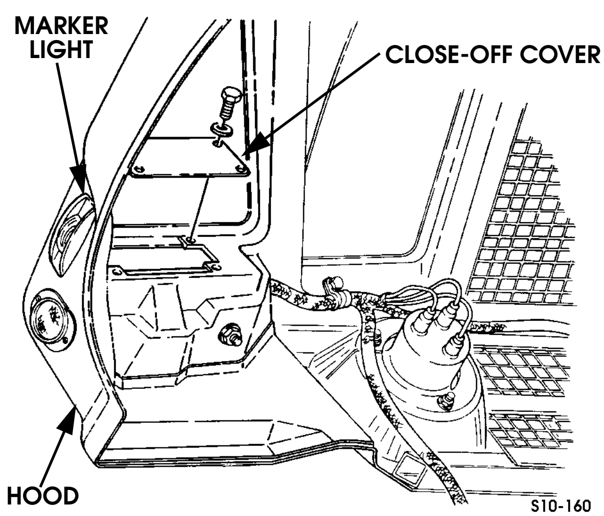


Figure 10-162: Close-Off Cover Location

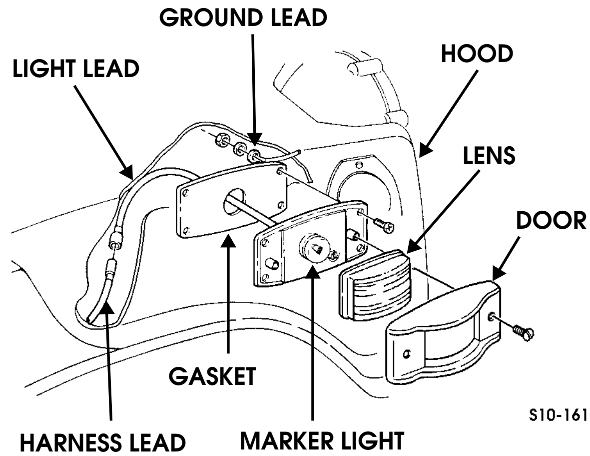


Figure 10-163: Side Marker Light Assembly

Installation

1. Secure gasket, lamp holder, and ground lead on hood with four screws, washers, and locknuts (Figure 10-163).
2. Secure lens and cover to lamp holder with two screws.
3. Connect light lead to harness lead.
4. Secure close-off cover to hood with four washers and screws (Figure 10-162).
5. Ensure side marker light operates properly.

Front Turn Signal Light Replacement

Removal

NOTE: To remove lamp only, perform steps 1 and 2.

1. Remove four screws, lens, and gasket from turn signal light (Figure 10-164).
2. Remove lamp from socket
3. Remove four screws, washers, and close-off cover from hood.
4. Disconnect two connectors from wiring harness.
5. Remove two nut and lockwasher assemblies, washers, bracket, and light from hood (Figure 10-165).
6. Remove two screws, lockwashers, and light from bracket.

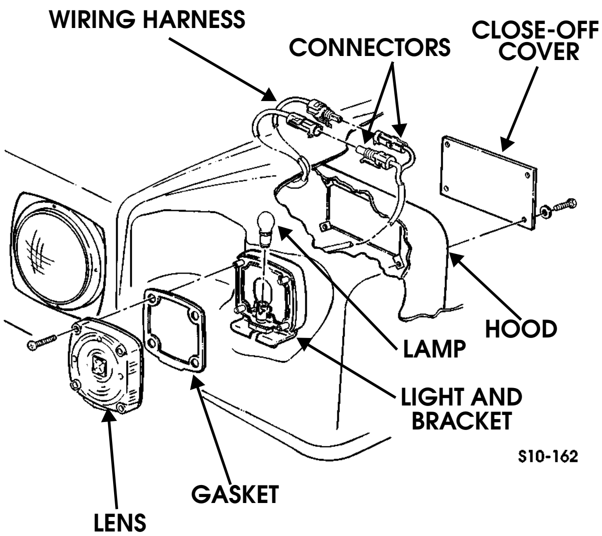


Figure 10-164: Front Turn Signal Assembly Breakdown

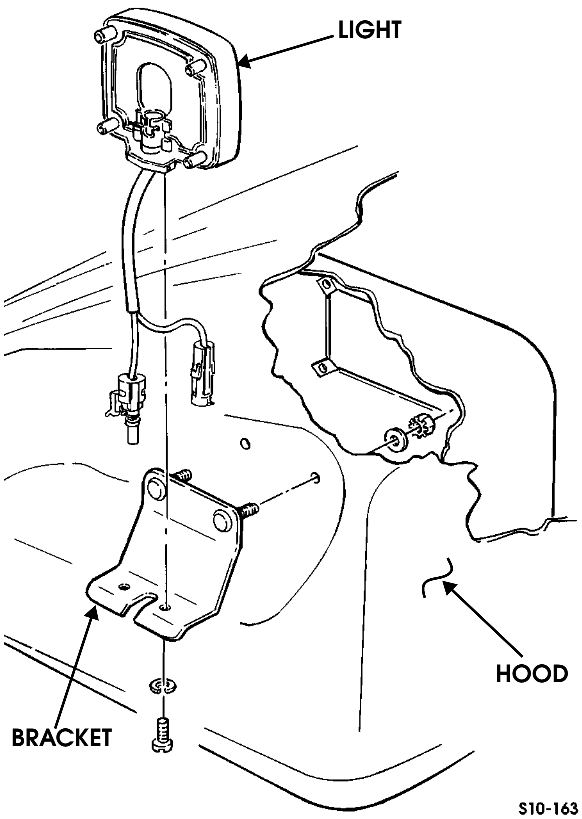


Figure 10-165: Front Turn Signal Bracket

Installation

NOTE: To install lamp only, perform steps 5 and 6.

1. Secure light to bracket with two lockwashers and screws (Figure 10-165).
2. Secure bracket and light to hood with two washers and nut and lockwasher assemblies.
3. Connect two connectors to wiring harness (Figure 10-164).
4. Secure close-off cover to hood with four screws and washers.
5. Install lamp in socket.
6. Secure gasket and lens to light with four screws.
7. Ensure turn signal works properly.

Rear Turn Signal Light Replacement

Removal

NOTE: To remove lamps only, perform steps 1 and 2.

1. Remove four screws, lens, and gasket from turn signal light (Figure 10-166).

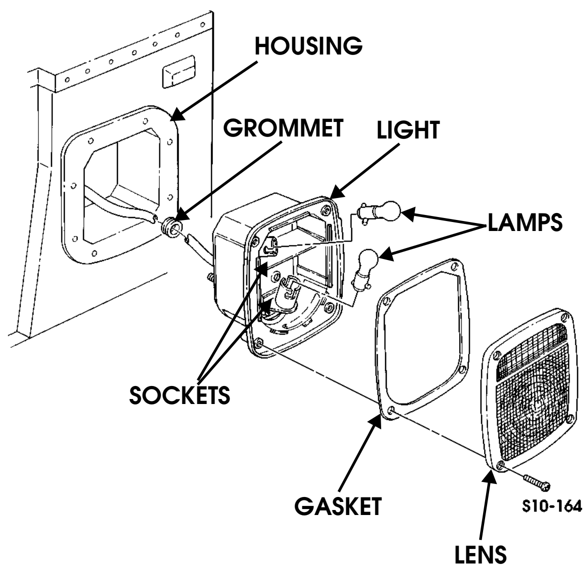


Figure 10-166: Rear Turn Signal Light Assembly

2. Remove two lamps from sockets.
3. From behind the light, remove three nuts, lockwashers, four leads, and three washers securing light to light housing (Figures 10-166 and 10-167).
4. Remove two nuts, clamps, and screws securing harness to shield (Figure 10-167).
5. Remove two screws, lockwashers, and shield from beam.
6. Disconnect two connectors from wiring harness.
7. Remove light and grommet from housing (Figure 10-166).

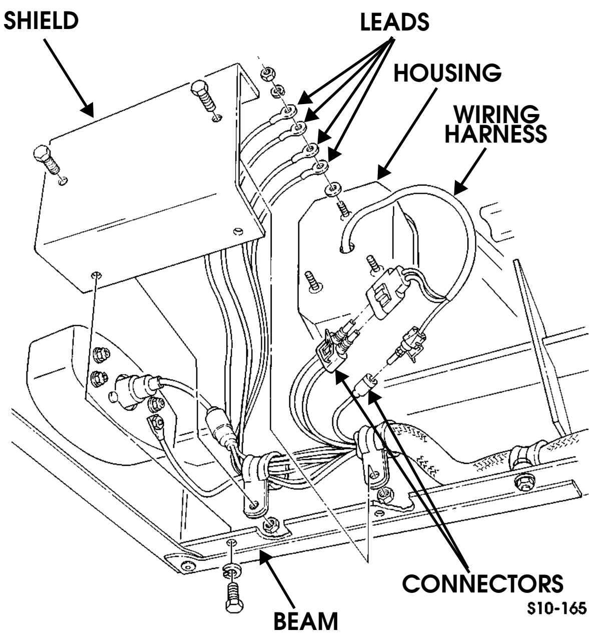


Figure 10-167: Shield and Wiring Location

Installation

NOTE: To install lamps only, perform steps 6 and 7.

1. Install light and grommet in housing (Figure 10-166).
2. Connect two connectors to wiring harness (Figure 10-167).
3. Secure harness to shield with two screws, clamps, and nuts.
4. Secure shield to beam with two lockwashers and screws.
5. Secure light to light housing with three washers, four leads, three lockwashers, and nuts (Figure 10-166) and (Figure 10-167).
6. Install two lamps in sockets (Figure 10-166).
7. Secure gasket and lens to light with four screws.
8. Ensure turn signal and backup lights work properly.

Domelight/Cargo Light Replacement

Removal

1. Remove domelight lens (Figures 10-168 through 10-170).
2. Remove lamp from domelight.
3. Remove screws securing domelight to ground lead and connector.
4. Remove screw and domelight from roof bracket.

Installation

1. Secure domelight, connector, and ground lead to roof bracket with screws (Figures 10-168 through 10-170).
2. Install lamp in domelight.
3. Install domelight lens.

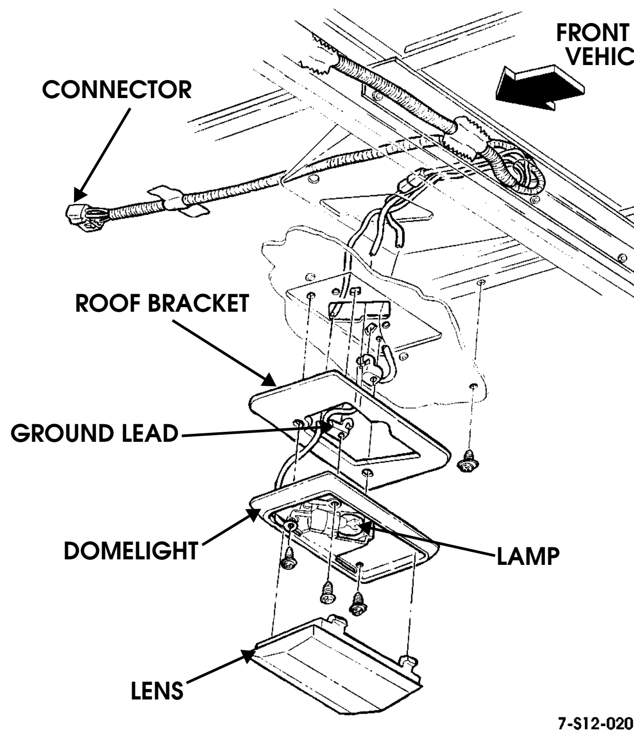


Figure 10-168: Standard Domelight Replacement

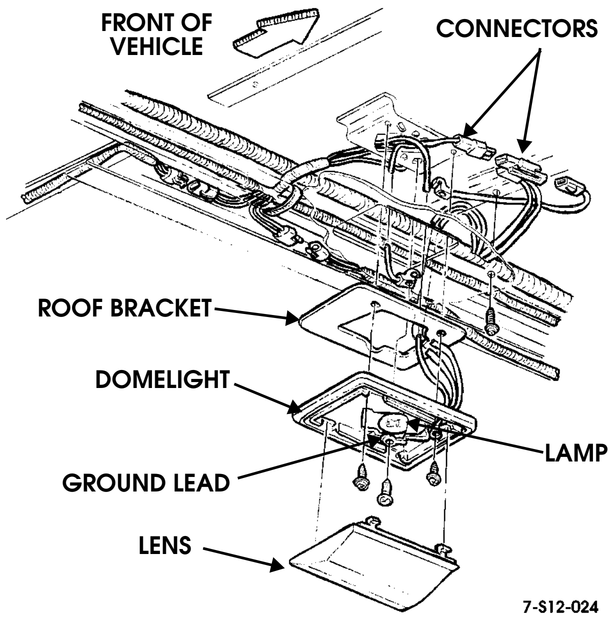


Figure 10-169: Rear Domelight (Station Wagon)

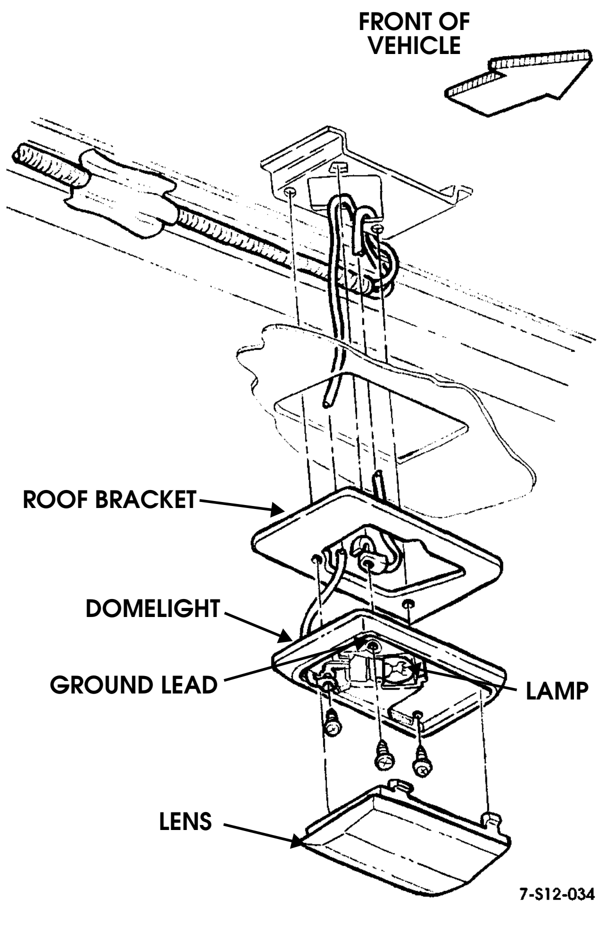


Figure 10-170: Cargo Light (Station Wagon)

Maplight Replacement

NOTE: The maplight will illuminate when the optional remote entry feature is activated.

Removal

Remove maplight assembly from bezel (Figure 10-171).

Installation

Install maplight assembly into bezel.

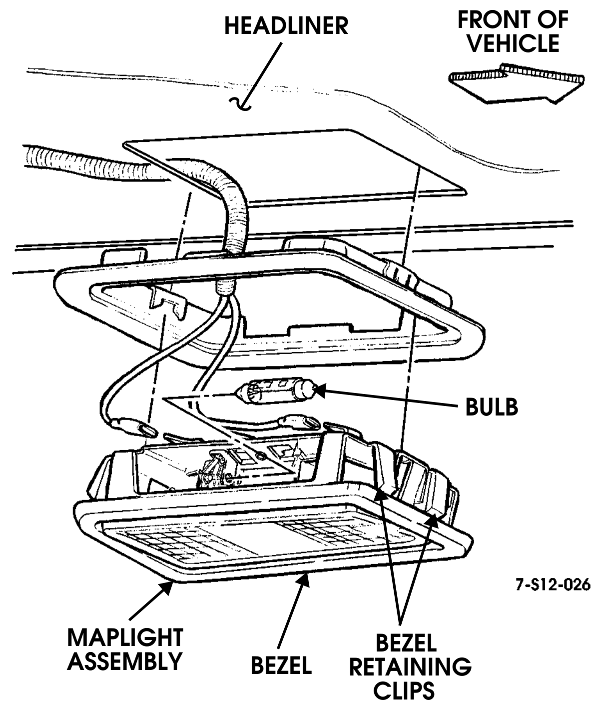


Figure 10-171: Optional Maplight Replacement

Trouble Light Replacement

NOTE: Parking lights or headlights must be on in order to activate the trouble light or the underhood light.

Removal

1. Disconnect wiring harness from trouble light (Figure 10-172).
2. Remove three nut and lockwasher assemblies and trouble light from mounting bracket.

Installation

1. Install trouble light on mounting bracket with three nut and lockwasher assemblies (Figure 10-172).
2. Connect wiring harness to trouble light.

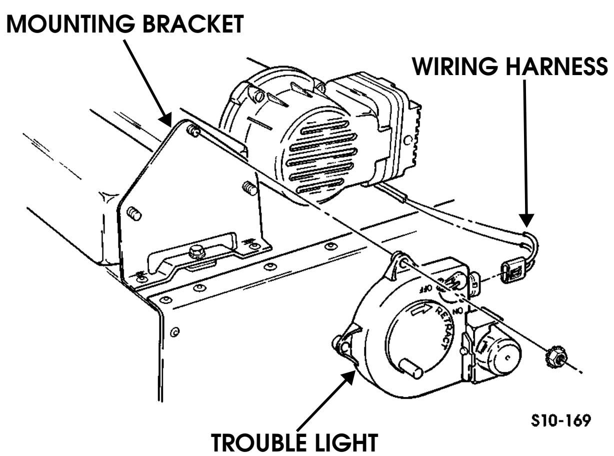


Figure 10-172: Trouble Light Replacement

Underhood Light Replacement

Removal

1. Disconnect two connectors from wiring harness (Figure 10-173).
2. Remove two screws, washers, ground lead, bracket, and light from hood.
3. Remove lamp from light.

Installation

1. Install lamp in light (Figure 10-173).
2. Secure light, bracket, and ground lead to hood with two washers and capscrews.
3. Connect two connectors to wiring harness.

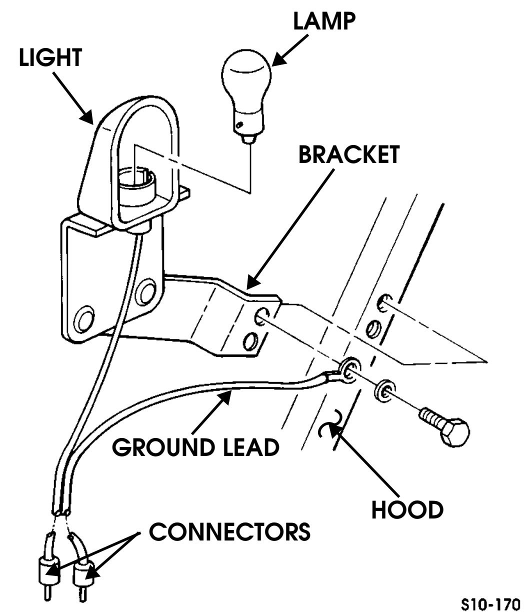


Figure 10-173: Underhood Light Replacement

Lighted Visor Mirror Replacement

Removal

1. Pull mirror assembly from visor (Figure 10-174).
2. Remove lamp.

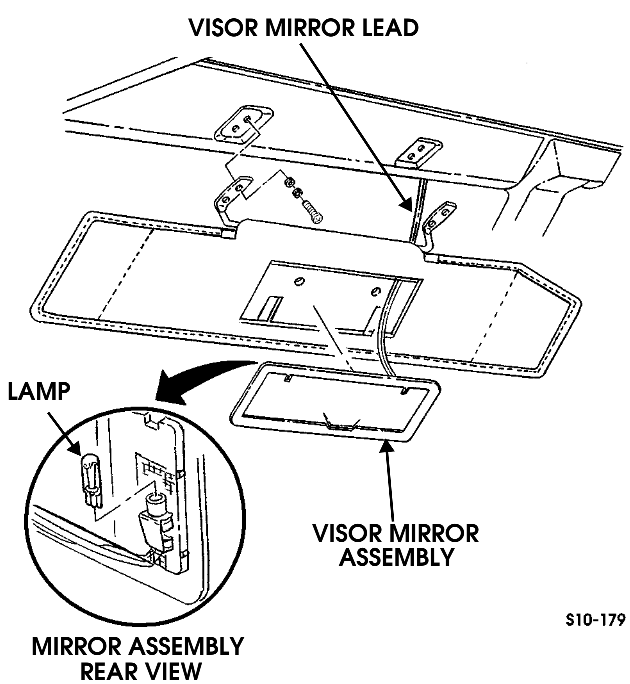


Figure 10-174: Lighted Visor Mirror Replacement

Installation

1. Install lamp (Figure 10-174).
2. Install mirror assembly by pressing it into the visor.

Front Driver and Passenger Courtesy Light Replacement

Removal

1. Carefully pry courtesy light from mounting bracket (Figures 10-175 and 10-176).
2. Disconnect light from wiring harness.

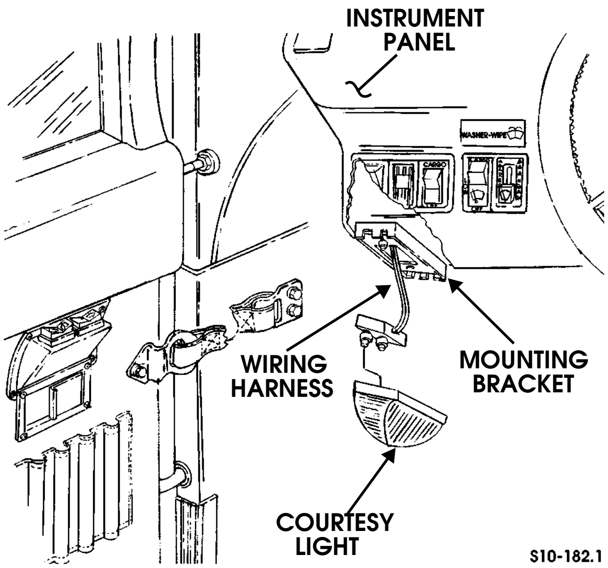


Figure 10-175: Front Driver Side Courtesy Light Replacement

Installation

1. Connect courtesy light to wiring harness (Figures 10-175 and 10-176).
2. Snap light into mounting bracket.

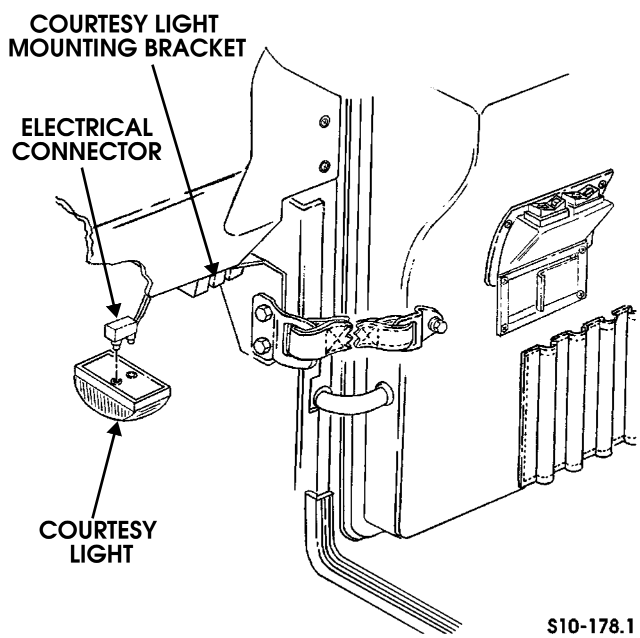


Figure 10-176: Front Passenger Side Courtesy Light Replacement

Rear Seat Courtesy Light Replacement

Removal

1. Carefully pry courtesy light from mounting bracket (Figure 10-177).
2. Disconnect light from electrical connector.

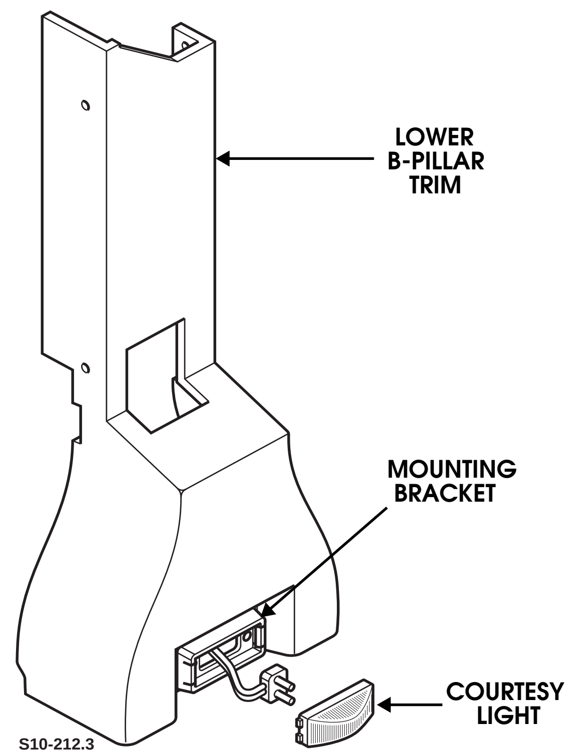


Figure 10-177: Rear Seat Courtesy Light Replacement

Installation

1. Connect courtesy light to the electrical connector (Figure 10-177).
2. Snap courtesy light into mounting bracket.

Daytime Running Lights (DRL) Module Replacement (Canada Only)

Removal

1. Disconnect the Daytime Running Lights (DRL) connector from the harness assembly (Figure 10-178).
2. Remove two screws, washers, nuts, and DRL module from the kick panel.

Installation

1. Secure DRL module to kick panel with two screws, washers, and nuts (Figure 10-178).
2. Connect the DRL connector to the harness assembly.

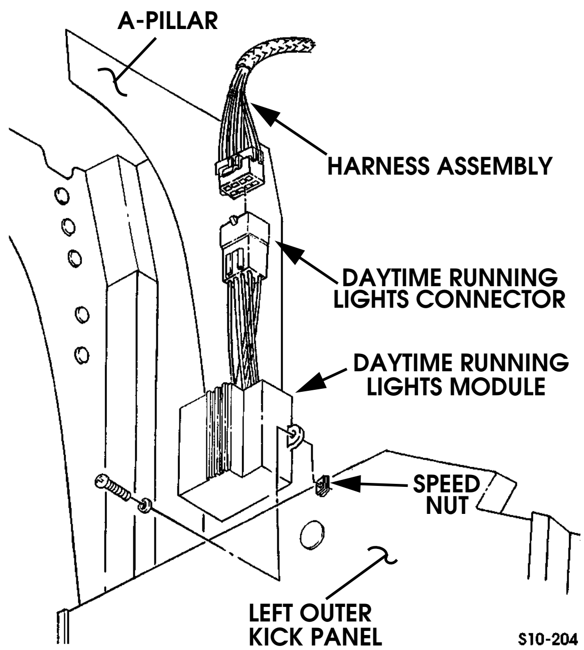


Figure 10-178: Daytime Running LIghts Module

Headlight Electrical Connector and Grommet Replacement

Removal

1. Remove headlight and jumper harness.
2. Remove connector from grommet (Figure 10-179).
3. Remove grommet from headlight housing.

Installation

1. Install grommet in headlight housing (Figure 10-179).
2. Install connector in grommet.
3. Install jumper harness and headlight.

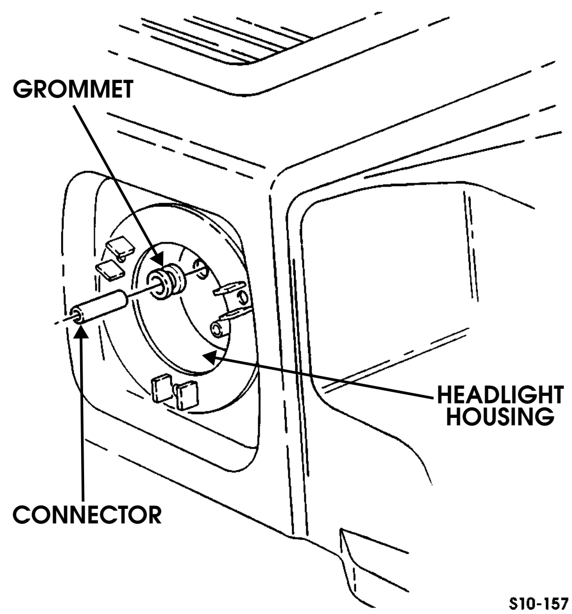


Figure 10-179: Headlight Electrical Connector and Grommet Replacement

BACKUP LIGHT SWITCH REPLACEMENT

Removal

1. Remove shift controls housing (Section 5).
2. Pull neutral start switch leads, backup light switch leads, and light lead through boot and remove boot from shift controls housing (Figure 10-180).
3. Remove two screws and lockwashers securing backup light switch to housing.
4. Remove tiedown strap securing backup light switch to neutral start switch, and remove backup light switch.

Installation

1. Secure backup light switch to neutral start switch with tiedown strap (Figure 10-180).
2. Secure backup light switch to shift controls housing with two lockwashers and screws.
3. Position neutral start switch leads, backup light switch leads, and light lead through boot, and install boot on housing.
4. Install shift controls housing (Section 5).

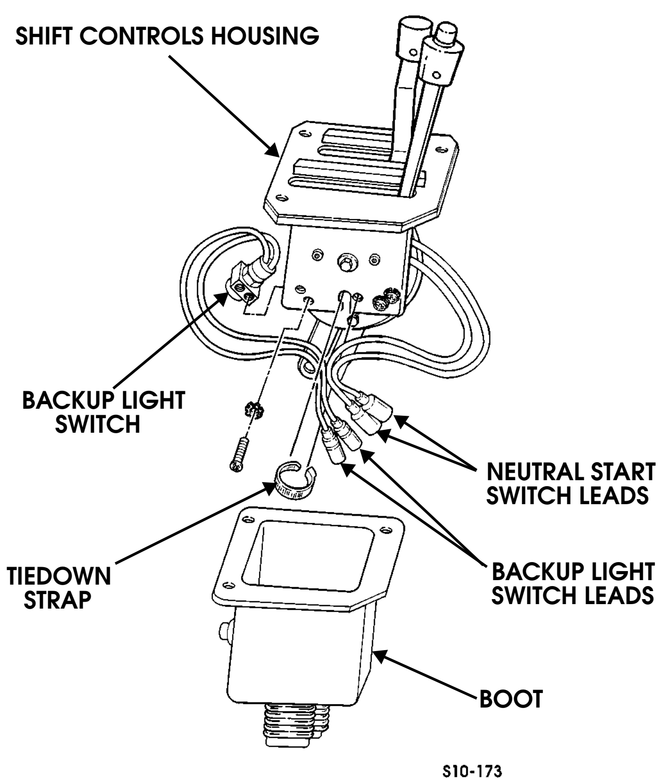


Figure 10-180: Backup Light Switch Replacement

STOPLIGHT SWITCH REPLACEMENT

Removal

1. Disconnect two harness leads from stoplight switch (Figure 10-181).
2. Remove stoplight switch from bracket.

Installation

1. Install stoplight switch into bracket (Figure 10-181).
2. Connect two harness leads to stoplight switch.

Adjustment

1. Push switch into bracket with brake depressed.
2. Pull up on brake pedal. Switch should ratchet outward to proper position.
3. Check function with engine running.

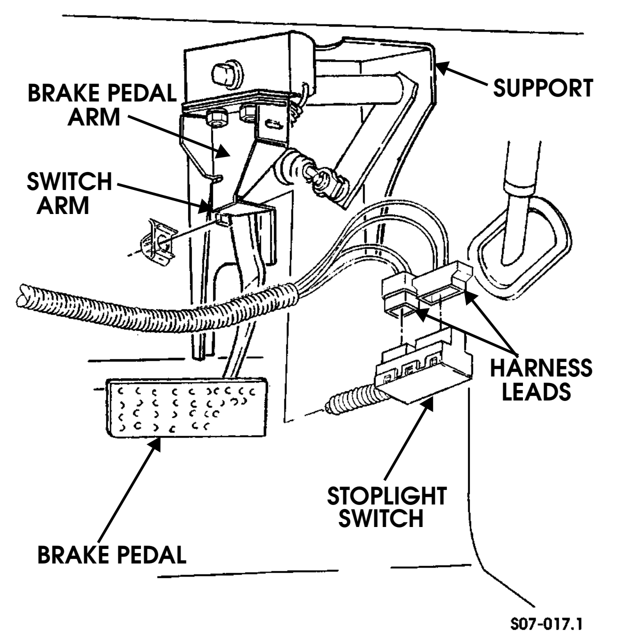


Figure 10-181: Stoplight Switch Replacement

Section 11 Heating/Air Conditioning (HVAC)

TABLE OF CONTENTS

HVAC SYSTEM DESCRIPTION

The heating, ventilating, and air conditioning (HVAC) system consists of the A/C-heating main and auxiliary unit, heat and cooling ducts, heater water control valve, heater hoses, and the A/C compressor, condenser, receiver-dryer, evaporator, expansion valve, and suction/discharge hoses. System controls are all located on the climate control panel in the front console.

Main Heat-A/C Unit

The heater core, A/C evaporator, and blower motor are all mounted within the main A/C-heat unit. The main unit is mounted on the passenger side of the dash panel.

The air doors in the main unit are operated electrically. Actuator motors are used to open and close the main unit air doors. The heater core and A/C evaporator are integral parts of the Heat-A/C main unit and are not serviceable separately. The blower motor can be replaced separately.

Water Control Valve

The water control valve determines coolant flow through the heater core. The valve vacuum diaphragm is operated by a vacuum solenoid. Electrical feed to the solenoid is controlled by position of the temperature control knob on the climate control panel.

In any cool air mode, the solenoid is actuated, opening the solenoid vacuum valve. This action allows vacuum to act on the water valve diaphragm. The diaphragm then closes the valve and stops flow through the heater core.

A/C Compressor

A Harrison model HT6 compressor is used for all applications. It is a belt driven, rotary type with a magnetic clutch pulley. Compressor service is covered at the end of this section.

Condenser-Receiver Dryer-Evaporator-Expansion Valve

The A/C condenser and receiver dryer can be replaced separately when necessary. The expansion valve however, is only serviced as part of the evaporator. The evaporator in turn, is only serviced as part of the complete main heat-A/C unit.

High/Low Pressure

The low pressure switch is located in the receiver/dryer and can be replaced separately when necessary.

The A/C system has a dual high/low pressure switch.

The switch cuts off electrical feed to the compressor clutch when (low) (or high) side pressures are out of the normal range.

A/C System Refrigerant

The required refrigerant for Hummer A/C systems is R-134a. This is a colorless, odorless non-flammable, liquefied gas. It is important to keep the valve closed on a container of R-134a when not in use; otherwise the gas may escape.

A special synthetic refrigerant oil is required for use with R-134a which is polyalkaline glycol (PAG). This is the only oil that can be used with R-134a refrigerant. PAG oil must be kept in sealed containers because it will absorb moisture from the surrounding atmosphere.

***CAUTION:** R12 and R-134a refrigerants are **not** compatible. They must never be intermixed as the result will be unsatisfactory cooling, rapid sludge buildup, and compressor failure.*

A/C Cutout Switch

The over temperature switch will automatically turn off the air conditioning system whenever the engine coolant temperature gets too high. Refer to Over Temperature Switch later in this chapter for more information.

Auxiliary Unit

The auxiliary unit consists of a combination heater and evaporator coil along with a second expansion valve and blower. The temperature is controlled by the main HVAC control panel while a separate two-speed fan switch is provided adjacent to the main controls. This unit is located underneath the center console cover between the driver and right front passenger.

HVAC SYSTEM CONTROLS

The heating, ventilating, air-conditioning (HVAC) system is operated by using the climate control panel located on the console (Figure 11-1). The customer can easily determine the direction of the airflow along with the amount and relative temperature of airflow.

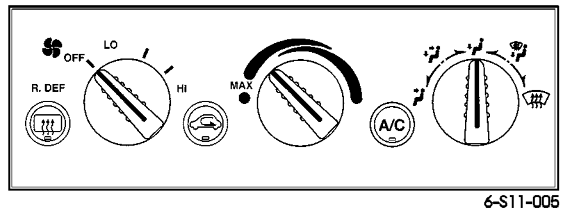


Figure 11-1: Climate Control Panel

Temperature Control Knob

This knob is used to select the temperature of the air flowing into the passenger area of the vehicle. Turn the knob toward the blue (cold) side of the graphic for cooler air and toward the red (hot) side of the graphic for warmer air.

When the knob is turned to the MAX cold setting and the A/C button is depressed, the system will automatically switch to recirculation mode. By re-cooling already cooled interior air, the A/C system can provide exponentially cooler air than by drawing it from the outside.

Figure 11-2: Temperature Control Knob

Air Flow Control Knob

The air flow control knob allows you to control the air flow into the passenger area. There are five different airflow positions: Panel, Panel/Floor Blend, Floor, Floor/Defrost Blend, and Defrost.

Panel position directs air flow from the instrument panel vents. Panel/Floor directs air flow from the floor and panel vents. Floor directs air flow from the floor air vents. Floor/Defrost directs air flow to the floor and windshield. Defrost directs air flow to the windshield only. Moving the knob to any position between the marked settings provides an airflow that is a combination of the two settings.

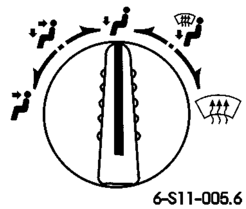


Figure 11-3: Air Flow Control Knob

Fan Control Knob

The fan control knob regulates the force of the air flow. Turn the knob to LO, MED/LOW, MED/HI, or HI until the desired airflow force is achieved.

To turn off the climate control system, turn the fan control knob to the OFF position.

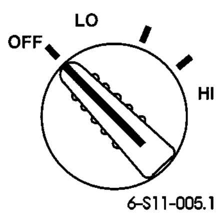


Figure 11-4: Fan Control Knob

Air Conditioning System

Recirculation Button

Depressing this button allows for recirculation of interior air only (Figure 11-5). At all other times, the system uses outside air. Recirculation should only be used when the outside air contains smoke, odors, or high humidity.

When the A/C is on and the coldest temperature setting (MAX) is selected, the system will automatically switch to recirculation mode.

When defrost mode (or defrost blend) is selected, the system automatically overrides the recirculation functions and draws outside air.

Any time interior air is being recirculated by the climate control system, a small lens on the button face will become illuminated.

Figure 11-5: Recirculation Button

A/C Control Button

Press this button to turn air-conditioning ON or OFF (Figure 11-6). The indicator light on the face of the button will illuminate if the button is depressed. Use the other controls to regulate temperature and direction of air flow.

The air-conditioning compressor automatically comes on when the defrost mode is selected to help remove humidity from the air. At lower outside temperatures, however, the compressor will shut off automatically after a short time.

A low refrigerant charge detection feature shuts the air-conditioning system down if the charge drops below a pre-determined level.

NOTE: If the auxiliary air conditioning system is running, and the front unit is put on defroster, the compressor will engage. This will result in potentially cool to cold air out of the rear unit (even if high heat is selected). To prevent cold air from coming out of the rear unit, simply turn off the auxiliary fan.

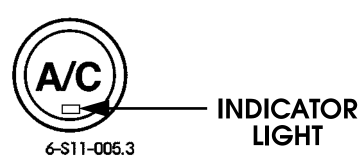


Figure 11-6: A/C Control Button

Over Temperature Switch

The over temperature switch affects compressor operation. It senses engine coolant temperature in the water crossover on non-turbo vehicles. Should coolant temperature exceed 250° F (390° C) the switch will open and shut-off the air conditioning compressor. The subsequent reduction of engine load will help reduce the chance of engine coolant overheating. The switch will close and complete the circuit when coolant temperature cools to below 235° F (365° C).

On turbo diesel vehicles, no switch is necessary since the PCM monitors the engine temperature. The PCM will perform the same function as the over temperature switch should engine temperature become too high with the A/C compressor running.

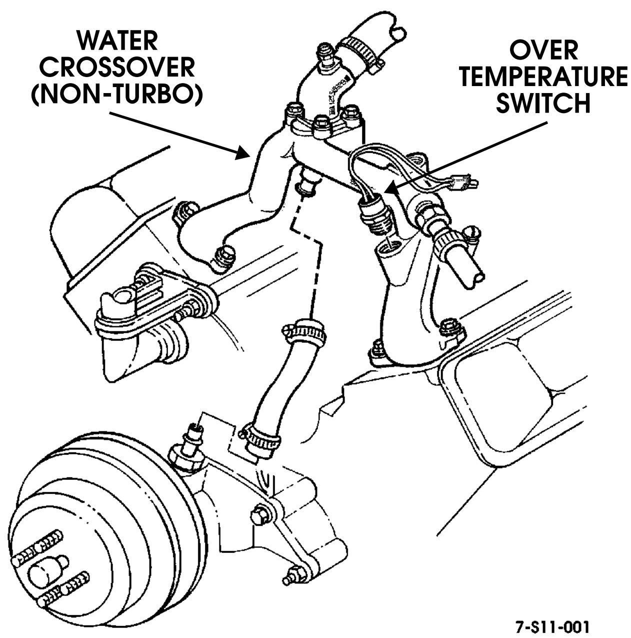


Figure 11-7: Over Temperature Switch

Window Fogging

In mild, but rainy or humid weather, windows will fog on the inside. To help clear the fog off all windows, turn on the air-conditioning. Adjust the temperature and fan control to maintain comfort. Switch the air flow control knob to defrost to quickly remove windshield fogging.

The climate control system works on the reheat principle. This means that the air passing through the system is chilled to near freezing temperatures, quickly reaching dewpoint and condensing excess water. Then the air is reheated to the temperature selected by the operator. If the outside temperature is less than 40°F (4°C), the A/C compressor will not function, and the incoming air will simply be heated.

HEATER/AIR CONDITIONING DIAGNOSIS

System diagnosis should begin with the system performance checks described in this section. The checks will help verify that a problem actually exists as opposed to an incorrect setting by the vehicle operator.

In addition to the performance checks, problem verification will also involve pressure testing, leak testing, individual component testing, air flow and temperature testing, and refrigerant recovery, evacuation, or recharge. The tools and equipment required for this purpose are described in each procedure.

The diagnosis charts outline common heater and A/C problems. The potential causes are listed in order of probability (most-to-least probable). However, the charts are guides only and will not outline all of the possible system faults that might occur. System testing is still required for verification.

The primary diagnostic method of checking A/C system performance is the pressure test. The test is performed with manifold gauge set J39183-C. The gauges allow suction and discharge pressures to be checked while the system is operating. The pressure test diagnosis charts describe common faults that cause incorrect system pressures.

Heater Diagnosis

Condition	Possible Cause	Correction
Inadequate or No Heat	1. Heat control knob not set in heat mode, or engine not warmed up.	1. 1.Advise owner/driver.
	2. Low engine coolant level.	2. Add coolant as needed and check for leaks.
	3. Air in coolant system. Usually occurs after coolant drain and refill.	3. 3.Bleed air from cooling system.
	4. Thermostat faulty.	4. Replace thermostat(s) if stuck closed or remains open continuously.
	5. Kinked or collapsed radiator hose or heater hose.	5. Replace hose.
	6. Water pump failure.	6. Replace pump.
	7. Heater core plugged or leaking.	7. Replace core.
	8. Blower motor fault.	8. Check circuit fuse and wiring. Replace motor if foiled.
	9. Outside air leaking into heater core section of plenum.	9. Seal plenum or realign as needed.
	10. Water control valve or vacuum solenoid fault.	10. Replace valve if stuck closed or partially open. Replace solenoid if closed or shorted.
	11. Blend air door stuck or misadjusted.	11. Replace main unit.
Inadequate Defrost	1. Duct restricted or connecting hose is loose.	1. Repair as needed.
	2. Defroster nozzle misaligned or damaged (bent, cracked, partially closed).	2. Repair as needed.
	3. Insufficient heat.	3. Check for low coolant level, coolant leaks, air in system, faulty thermostat or water valve, collapsed hose, plugged heater core, binding air door in main unit.
	4. Air flow control knob not in defrost position.	4. Advise owner/driver.
	5. Blower motor fault.	5. Check circuit fuse and wiring. Replace motor if open or shorted.

NOTE: Improperly adjusted or binding mode door linkage can also cause low, poor or no airflow to any location.

Air Flow Diagnosis

Condition	Possible Cause	Correction
No Air Flow from Outlets	1. Blower motor fuse blown. 2. Blower motor harness damage (short, open, loose connection). 3. Blower motor fault. 4. Blower motor resistor fault.	1. Replace fuse. 2. Check harness continuity with ohmmeter and repair as needed. 3. Run 12V jumper directly to motor. Motor should run at high speed. If motor fails to run, replace it. If motor runs, check resistor. 4. Replace resistor if motor runs when resistor is bypassed or if blower runs at high speed setting but will not run at one or all of the lower settings.
Air Flows from Incorrect Outlets	1. Actuator motor or linkage fault.	1. Remove passenger side trim to expose both actuator motors and observe linkage operation. Adjust linkage if required. Replace either motor and/or linkage if inoperative.
Low-Weak Air Flow from Outlets	1. Restriction in air ducts. 2. Restriction in intake hose into main unit. 3. Blower motor fault. 4. Misadjusted or binding mode door linkage.	1. Repair as needed. 2. Repair as needed. 3. Replace motor or resistor if either is inoperative. 4. Adjust as necessary.

A/C Pressure Test Diagnosis

Condition	Possible Cause	Correction
Low Side High High Side High (Discharge Air Warm - Discharge Line Warm to Hot)	1. Condenser fins obstructed or distorted. 2. System overcharged. 3. Air in system. 4. Expansion valve failed. 5. Condenser restricted. 6. Compressor drive belt slipping.	1. Clear obstruction with water spray and compressed air. Straighten distorted fins with tool J36847 or equivalent. 2. Recover excess charge with A/C service cart J39500-A. 3. Evacuate and recharge system. 4. Replace valve. 5. Replace condenser. Evacuate and recharge system. 6. Replace belt or belt tensioner as needed.

A/C Pressure Test Diagnosis

Condition	Possible Cause	Correction
Low Side High High Side High (Discharge Air Slightly Cool - Discharge Line Cool)	1. Air and moisture in system. 2. Leak at A/C line of 1/2 ounce or less.	1. Discharge system. Replace receiver/dryer and evacuate - recharge system. 2. Locate with D-Tek leak tester. Recharge system and verify proper operation.
Low Side Low High Side Low	1. System low on refrigerant. 2. Expansion valve failed.	1. Add refrigerant and leak test system. Correct leak source and recharge as needed. **NOTE:** If leak was large, check compressor oil level also and correct as needed. 2. Replace valve, then evacuate and recharge system.
Low Side High High Side Low	1. Internal leak in compressor 2. Expansion valve failure. 3. Drivebelt slip.	1. Replace compressor and evacuate - recharge system. 2. Discharge system. Replace valve and recharge system. 3. Replace belt.
Low Side Low High Side High	1. Expansion valve failed. 2. A/C hose constricted, plugged. 3. Receiver/Dryer restricted or has failed. 4. Condenser problem (blocked, damaged).	1. Discharge system. Replace valve and recharge. 2. Check hose for kinks. Replace hose if plugged and evacuate - recharge system. 3. Evacuate system. Replace receiver/dryer and recharge system. 4. Evacuate system. Replace condenser and recharge system.
Low Side and High Side Normal But Cooling is Inadequate	1. Air and/or moisture in system. 2. Receiver/Dryer fault.	1. Leak test system. Repair leaks if necessary. If leaks are not evident, evacuate and recharge system. 2. Evacuate system, replace receiver/dryer and recharge system.

Compressor Diagnosis

Condition	Possible Cause	Correction
Compressor Noise	1. System overcharge. 2. Drivebelt problem. 3. Compressor clutch fault. 4. Compressor internal fault. 5. Clutch contacting compressor.	1. Recover all R-134a with J39500-A service cart and recharge with proper charge. 2. Replace belt if worn, frayed, cut or torn. 3. Replace core or pulley bearing as needed. 4. Replace compressor if pressure test indicates worn, inoperative condition. 5. Incorrect clutch clearance (air gap). Adjust gap.
Compressor Does Not Engage	1. System fuse blown. 2. Clutch wires damaged. 3. Pressure cycling clutch, or A/C cutout switch fault. 4. Compressor clutch failure. 5. Compressor seized. 6. High engine coolant temperature triggering A/C cutout switch.	1. Replace fuse. Check circuit for shorts, ground. 2. Repair wires 3. Replace switch (s) as needed. 4. Replace clutch core and/or pulley as needed. 5. Replace compressor 6. Let engine cool down and fix engine cooling system problem first.
Compressor Engages but Cooling is Inadequate	1. A/C duct restrictions, loose connections. 2. System leaks (high side pressure below 50 psi (345 kPa)). 3. Expansion valve inoperative. 4. Receiver/Dryer fault. 5. Condenser fault. 6. Compressor internal wear.	1. Repair as needed. 2. Check for leaks with D-Tek tool and repair as needed. 3. Replace valve. 4. Replace receiver/dryer. 5. Replace condenser. 6. Replace compressor if pressure indicates internal wear or damage.

A/C System Diagnosis

Condition	Possible Cause	Correction
Water on passenger Side Floor	1. Evaporator drain hose plugged or installed incorrectly.	1. Open hose with utility knife or trim end off hose. Make sure routing of hose is to outside of passenger compartment.
	2. Coolant leak from heater core.	2. Replace core if leaking. Replace clamps or hoses if leaking at heater core connections.
	3. Road splash entering compartment through evaporator/heater core opening, or through intake air inlet area.	3. Water test and seal off as needed.
	4. Water leaking into passenger compartment.	4. Water test and correct leaks.
Musty Smell	1. Water leaking into passenger compartment.	1. Water test and correct leaks.
	2. Evaporator drain partially or fully plugged.	2. Open or trim off drain hose with utility knife. Correct routing if necessary.
	3. Mold-Mildew development on evaporator surface, coils, fins.	3. Clean evaporator with mild disinfectant soap or replace evaporator as necessary.

SYSTEM PERFORMANCE CHECKS

Before performing any air conditioning repair, perform the following:

1. Check drivebelt for wear, damage, or loss of tension. Replace drivebelt as necessary.
4. Check compressor for secure mounting and proper alignment. Tighten loose hardware and align as necessary.
5. Visually inspect compressor, hoses and other accessible parts of system for damage or leaks. Look for patches of dirt, dust, and oil build-up. Refrigerant leaks usually involve compressor oil loss. This is especially applicable to clutch end of compressor.
6. Verify operation of climate control system by performing following:
   a. With the fan control knob set to OFF, run engine to operating temperature (180°-240°F (82°-116°C)).
   b. Rotate temperature control knob (Figure 11-2) clockwise until it stops at the warmest setting.
   c. Rotate air flow control knob counterclockwise until it stops at the panel setting.
   d. Turn fan control knob to any setting above LO and note direction and temperature of air flow.
   e. Verify that heated air is coming from instrument panel vents.
   f. Rotate air flow control knob clockwise to the next setting, a blend between panel and floor vents, and verify that heated air comes from appropriate vents.
   g. Continue checking the air flow positions; floor, floor/defrost blend, and defrost.

NOTE: Any time the air flow control knob is placed in defrost or a defrost blend position (with an ambient temperature above 40°F), the compressor clutch engages to chill the evaporator and dehumidify the incoming air.

   h. Rotate the temperature control knob counterclockwise to its coldest extreme, MAX cold. Verify that cold air comes from the defrost vents. If the outside air temperature is 40°F or warmer, the refrigeration system will be responsible for cooling the air. If it is cooler than 40°F, the compressor will not cycle and the incoming air will simply be the outside air directed into the passenger compartment.
   i. Rotate the air flow control knob counterclockwise until it stops at the panel setting. Press the A/C button and verify that compressor clutch engages and air becomes colder. Turn the temperature control knob clockwise so that it is still set for cold air but not engaged in the MAX detent. Verify that the air recirculation door closes/system brings in outside air.
   j. Press recirculation button and verify that the recirculation door opens/system recirculates passenger compartment air. Recirculation button light should come on.
   k. Switch recirculation button off and wait until recirculation door closes. Then rotate temperature knob counter clockwise until it stops in the MAX detent. Recirculation button should light and door should open.
   l. Check that blower motor delivers air at four different speeds. If not, perform electrical troubleshooting. Repair or replace blower motor, switch, relay, or blower motor resistor block.
   m. Check water control valve operation. Heater Shutoff Valve should open completely when temperature control knob is rotated into red area of the graphics. Valve should close completely when knob is in the all blue region. If valve is not opening or closing properly, check vacuum lines and electrical connections.

HEATING SYSTEM TESTS

In most cases, a low heat condition means an insufficient quantity of heated engine coolant is flowing through the heater core. Check as follows:

1. Check engine coolant level. If level is low, add coolant and inspect for leaks. If coolant level is correct continue with tests.
2. Check pressure cap on surge tank for improper sealing with tester J 24460-01 or equivalent. If cap is OK, continue with tests. Replace cap if it fails to seal and recheck heater operation.
3. Set heater controls to highest heat setting.
4. Operate engine until coolant is at normal operating temperature (180-220° F or 82-113° C).
5. Check temperature of coolant flowing through heater core inlet and outlet hoses.
   - If both hoses feel hot and are about the same temperature, water control valve is OK and core is not restricted. Continue with test
   - If both hoses are only warm (or even cool), engine is either not at operating temperature, or a water pump or thermostat problem has occurred.
   - If inlet hose is cool, or only slightly warm, water control valve or vacuum solenoid problem has occurred. Test as described in this section.
6. If heat output is still unsatisfactory but all else checks OK, problem is with heat door in main unit, or in outlet ducts.

Water Control Valve And Vacuum Solenoid Test

1. Disconnect the vacuum line at the water control valve diaphragm.
2. Connect hand operated vacuum pump J 23738-A to the control valve diaphragm.

3. Apply 15-20 inches vacuum to valve diaphragm and note action.
   - If diaphragm closes valve, operation is OK. Problem is with vacuum line or solenoid.
   - If diaphragm fails to close valve, replace valve as failure has occurred.
4. Run engine at curb idle speed.
5. Disconnect vacuum solenoid wires and vacuum outlet to valve line. Connect vacuum gauge to solenoid vacuum outlet then energize solenoid with 12 volt jumper wire.
   - If vacuum is present, problem is with controls in console.
   - If vacuum is not present and solenoid will not energize, replace solenoid.

Air Flow Test

The air flow test measures the velocity of air exiting the outlet ducts. Flow meter (anemometer) J42549 and adapter kit J42550 are required for this test. Procedure is as follows:

1. Install adapter on outlet to be checked.
2. Place heat control in highest setting and blower motor at high speed. Then start and run engine at curb idle speed.
3. Measure air flow from each outlet duct as needed.
4. If air flow is less than specified in flow chart at end of this section, either the blower motor is worn, or the ducting and connecting hoses are loose, or restricted.

A/C System Leak Testing

There are two methods of detecting refrigerant leaks. The preferred method is to use an electronic leak detector. The alternative method involves application of a soap and water solution to suspected leak points. Although both methods will locate leaks, the electronic leak detector will locate the more common smaller leaks and provides access to all A/C system components.

Recommended leak detector is the D-Tek, pocket portable model (Figure 11-8:). It is self powered by NiCad batteries, extremely compact, and will locate leaks as small as 1/4 ounce. The Kent-Moore Tool number is J41995.

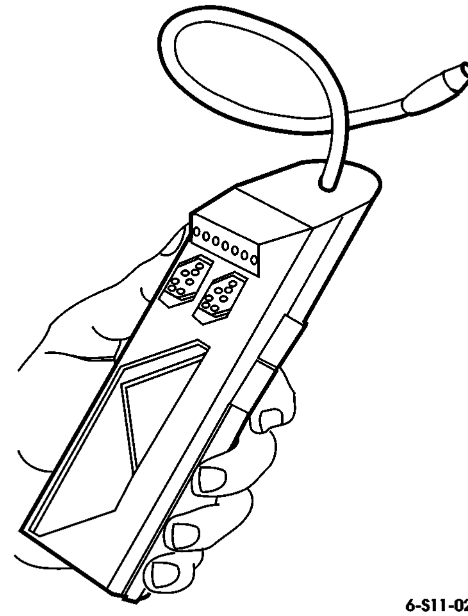


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Figure 11-8: D-Tek Leak Detector

The D-Tek probe is flexible and can be shaped to make a 360^0 check of each hose connector and fitting. The correct method of leak testing fittings is shown in Figure 11-9).

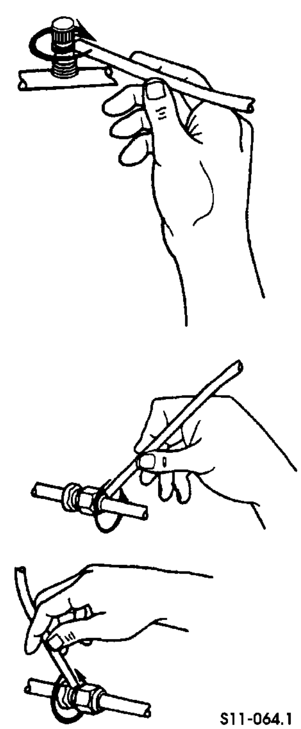

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Figure 11-9: Leak Testing Technique at Connections

A/C system potential leak points are outlined in Figure 11-10. Be sure to check each fitting and connector carefully with the D-Tek tool.

CONNECTOR IDENTIFICATION

1 COMPRESSOR-OUT	9 AUX EVAP - OUT
2 CONDENSER - IN	10 MAIN EVAP - IN
3 CONDENSER - OUT	11 MAIN EVAP - OUT
4 DRIER - IN	12 L/P AUX TEE - IN
5 DRIER - OUT	13 L/P AUX TEE - OUT
6 H/P AUX TEE - IN	14 COMPRESSOR - IN
7 H/P AUX TEE - OUT	15 COMPRESSOR - FRONT SEAL
8 AUX EVAP - IN	16 SCHRADER VALVES

NOTE: Move detector wand at a slow, consistent rate above and below and around fittings/connnections. Carefully inspect all hose connections to metal ferrules on crimp shells. Also test the small inspection holes on the shells.

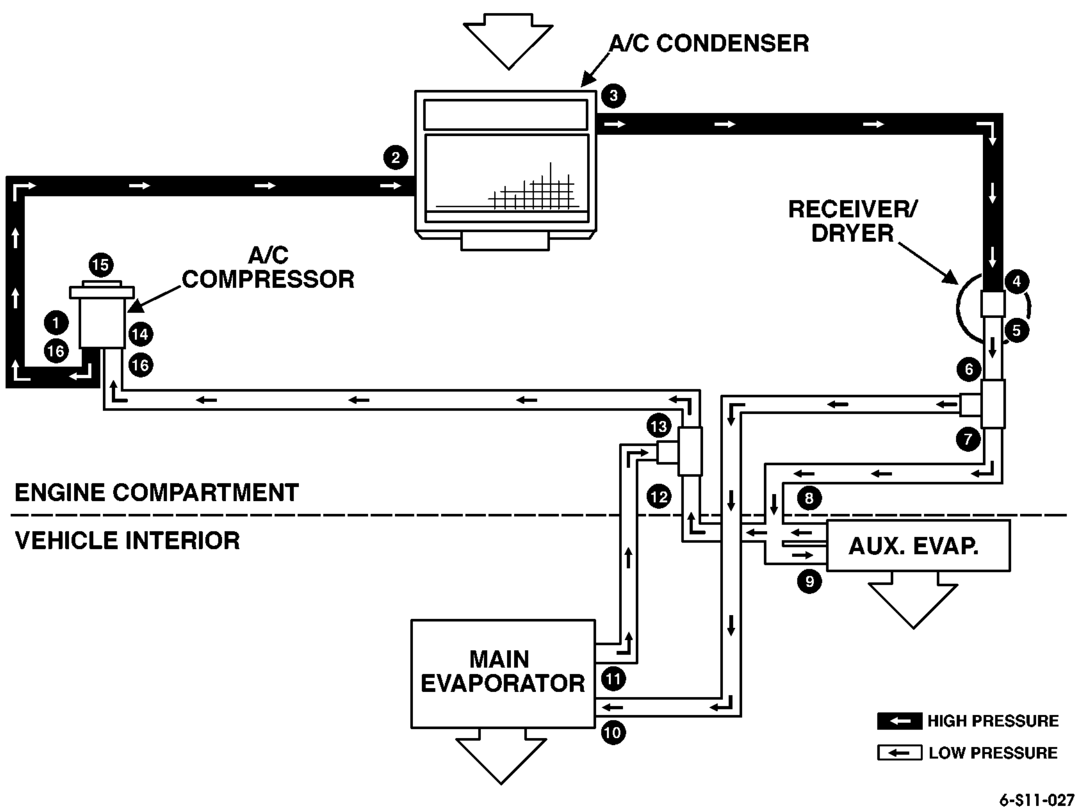

Figure 11-10: A/C System Leak Check Points

A/C System Refrigerant And Capacity

The required refrigerant for Hummer A/C systems is R-134a. This is a colorless, odorless non-flammable, liquefied gas.

A special refrigerant oil is required for use with R-134a which is polyalkaline glycol (PAG). This is the only oil that can be used with R-134a refrigerant.

CAUTION: *R12 and R-134a refrigerants are* ***not*** *compatible. They must never be intermixed as the result will be unsatisfactory cooling, rapid sludge buildup, and compressor failure. In addition, only PAG oil can be used in R-134a systems. Any other oil will cause compressor failure.*

System refrigerant capacity is:

2 lbs., 3 oz. (0.99 kg)

R-134a Refrigerant Precautions

To avoid product damage and personal injury, the following precautions should be followed when working with R-134a refrigerant.

- Wear safety goggles when servicing the A/C system as the refrigerant is under pressure.
- Never mix R-134a and R-12 refrigerants. They are incompatible and will cause severe damage to system components if mixed.
- Use an approved A/C service cart such as the Kent Moore J 39500-A to service the system. Recommended service carts are those capable of evacuation, recovery, recycling, and recharging of systems with R-134a.
- The only compressor lubricant oil that can used with R-134a is polyalkaline glycol (PAG). Use of a non-specified oil will result in rapid compressor failure.
- Lubricate system fittings and o-rings with a 525 viscosity refrigerant oil for leak proof connections.
- Do not heat containers of R-134a above 125° F (52° C).
- Never puncture or incinerate containers of R-134a.
- Avoid breathing R-134a. The gas will irritate the nose, throat, and lungs. In addition, because R-134a is heavier than air, it can displace oxygen in a confined and a poorly ventilated area. Be sure the work area is properly ventilated in case of accidental release into the nearby atmosphere.

A/C Sight Glass

A sight glass is provided at the top of the receiver/dryer. The glass allows a visual check on system charge condition while the system is operating. However, with an R-134a system, charge condition as viewed through the sight glass, should always be verified by a pressure test.

Unlike R12 systems, sight glass condition with R-134a is not always a true indicator of system charge condition. For example, a clear glass may indicate a normal condition but it will not indicate if the system is over, or undercharged (Figure 11-10). Bubbles are a good indicator of air and moisture in the system. Streaks in an older R12 system would indicate a low charge condition, however, with an R-134a system, streaks are a normal condition caused by the synthetic PAG oil required with R-134a systems. A good policy is to verify system charge by pressure testing with gauge and manifold set J 39183-C.

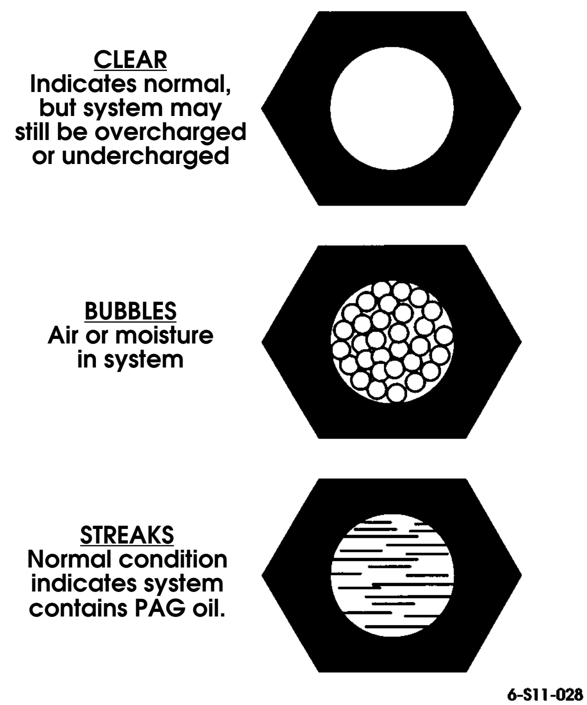

Figure 11-11: Sight Glass Conditions with R-134a

A/C System Pressure Test

System pressure testing involves measuring suction and discharge pressures with manifold gauge set J–39183-C, or with the gauges contained in A/C service cart J–39500-A. One gauge is for high side (discharge) pressures and one for low side (suction) pressures. The gauges allow pressures to be checked while the system is in operation.

On models where access to the service ports is limited, coupler adapters J–39500-20A and J–39500-24A, will make gauge hose connection easier.

Pressure Test Procedure

1. Connect gauge hoses on service cart J–39500-A to service ports on suction and discharge lines (Figure 11-12). Red hose goes to high side (discharge) port and blue hose to low side (suction) port.
2. Note pressure with engine not running and A/C system inoperative. There should be approximately 30 to 50 psi (207 to 345 kPa) in the system. If pressure is lower or zero, a system leak exists. Add a small charge to the system. Then leak test and repair as necessary before proceeding.
3. Start and run engine at 1200 rpm.
4. Set A/C controls to maximum cooling and set blower to highest speed.
5. Verify that compressor clutch engages. If clutch fails to engage, check clutch wires, and low pressure switch for fault.
6. Record low and high side pressures. Depending on engine speed and shop ambient temperature, low side pressure will range from 18 to 35 psi (124 to 241 kPa) and high side pressure from 176 to 390 psi (1214 to 2689 kPa). Refer to system pressure comparison chart at end of this section.
7. If low and high side pressures are OK, check air temperature at outlet duct closest to evaporator with thermometer J–6742-03. Temperature should range from 35 to 55° F (2 to 13° C) depending on ambient temperature. Be sure thermometer tip is inserted into duct to a depth of at least one inch (25 mm).
8. If low and high side pressures are incorrect and air duct outlet temperatures are greater than specified, refer to pressure test diagnosis charts for potential causes.

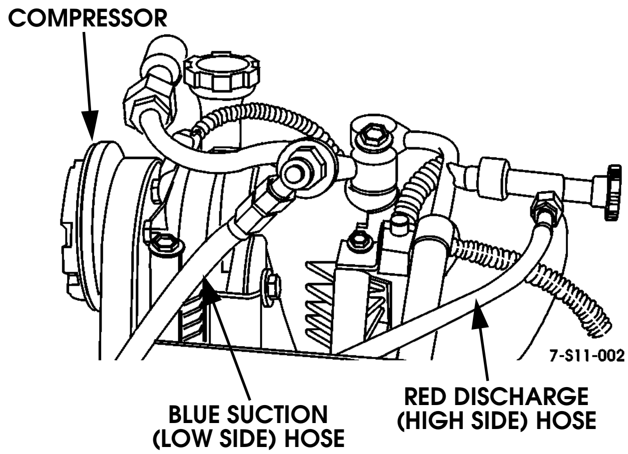

Figure 11-12: Service Hose Connections at Compressor

A/C Servicing Precautions

There are precautions that should be followed when servicing the A/C system. The precautions are necessary to avoid component damage and personal injury.

- Wear eye protection when servicing the system. The refrigerant is under pressure and will cause injury if it contacts the eyes.
- Never perform system repairs until after the system has been fully discharged.
- Do not use refrigerant recovery, recycling, charging, and evacuation/discharge servicing equipment that does not meet SAE J2210 standards.
- Never attempt to replace system components while the engine is running.
- Avoid having R-134a contact the skin. The refrigerant can cause an injury similar to frostbite. Exercise care when handling R-134a.
- Do not allow any type of open flame near R-134a.
- Avoid breathing R-134a fumes. The refrigerant will cause eye, nose, throat, and lung irritation.
- Never mix R-12 and R-134a in the same system. The two refrigerants are **not** compatible. Mixing the two will result in failure of the compressor and other system components.
- Never use PAG oil from an unsealed container. The oil will quickly absorb moisture from the air if not sealed.

Recovering (Discharging) A/C System Refrigerant

1. Shut engine off.
2. Connect hoses from service cart J39500-A to suction and discharge service ports. Red hose goes to discharge side and blue hose to suction side. Use adapter fittings J39500-20 and 24A if necessary. If manifold gauge set J39183-C is being used, connect center hose to a recovery tank, or system.

NOTE: If both gauges indicate a zero reading, the system does not contain any refrigerant. Add a small charge, leak test, and make necessary repairs before proceeding.

3. Begin recovery/discharge cycle as described in service cart instructions.
4. Recovery is complete when service cart gauges read zero.
5. Secure the service cart as described in the manufacturer's instructions.

Recycling System Refrigerant

The J39500-A service cart (from Kent Moore), will recycle R-134a refrigerant when necessary. The original recovered refrigerant is moved through a combination filtration/dryer unit built into the cart. This unit removes impurities allowing refrigerant reuse. Follow the manufacturer's instructions carefully for the recycle process because incorrect use could result in moisture in the refrigerant. The recycle process is accomplished automatically when the service cart is in evacuation mode.

Evacuating the A/C System

CAUTION: *Do not evacuate an A/C system that is not completely discharged. Check system pressures with a gauge set if unsure about charge level.*

The A/C system evacuation process involves applying 29-30 inches vacuum to the system for a minimum of 20 minutes. The applied vacuum removes moisture, and other impurities from the system. A vacuum pump built into the service cart generates the necessary vacuum.

1. Connect service cart J39500-A to service ports.
2. Discharge system.
3. Connect vacuum pump to center hose on manifold if gauge set J39183-C is being used.
4. Turn vacuum pump on, and open gauge valves.

NOTE: High side gauge should drop to zero or below. If not, a blockage in A/C system is indicated. In addition, a properly functioning system may not be able to achieve 29-30 inches vacuum if the service facility is high above sea level. Deduct 1 in. vacuum from maximum attainable reading for each 1000 ft elevation above sea level.

5. Evacuate unit until low pressure gauge reads 29-30 in. vacuum.
6. Turn vacuum pump off and check for vacuum leaks.
7. Continue evacuation for thirty minutes after correct gauge reading of 29-30 in. vacuum has been achieved.
8. Turn gauge valves to closed position after evacuation is complete.
9. Turn off vacuum pump and disconnect center hose from vacuum pump.

NOTE: 29-30 inches of vacuum should be sustained on low pressure gauge for at least ten minutes. If not, a leak in A/C system is indicated.

Checking/Adding Refrigerant Oil

It is not necessary to check or add oil as routine maintenance. It is necessary to add oil when the evaporator, condenser, compressor, or receiver/dryer has been replaced, or there was a large leak. When a system is discharged, it is also necessary to replace any oil carried out with the refrigerant.

CAUTION: *All replacement compressors are shipped with 8 oz. (237 ml) of oil in the crankcase. This oil must be drained completely. Failure to do so will cause an overcharge of oil in the system and will lower cooling efficiency. An extreme overcharge condition may cause early compressor failure.*

1. If a major component was replaced, add clean PAG refrigerant oil as follows.
   a. Condenser – 1 oz. (30 ml).
   b. Evaporator – 3 oz. (84 ml).
   c. Receiver/Dryer – 2 oz. (60 ml).
   d. Auxiliary Unit - 2 oz. (60 ml).
   e. Compressor – see step 3.
   f. Any other known quantity of oil.
2. Add oil to the system. Add directly into component. Oil can also be added directly from the service cart after system evacuation.
3. Check oil in compressor:
   a. Recover/discharge A/C system refrigerant.
   b. Remove compressor.
   c. Tip compressor on hose connection end and drain into a clean container. Allow to drain for ten minutes. Measure and discard oil.
   d. Replace with new oil directly into compressor rear ports. Up to four oz. (118 ml) of oil can collect in the crankcase of the compressor. If less than one ounce (30 ml) is drained, add two ounces (59 ml) to the new compressor. If more than one ounce (30 ml) is drained, add the same amount to the new one.
   e. Plug or block ports and turn compressor over slowly several times.

4. Perform evacuation, recharging, and leak testing of system.

Charging The A/C System

NOTE: If A/C system requires replacement of a major component, refrigerant oil must be added to system to compensate for loss.

1. Evacuate A/C system. Follow manufacturer's recommended service procedures for the equipment being used.
2. Connect refrigerant source to center hose if manifold gauge set J–39183-C is being used.
3. Open refrigerant R-134a source to allow refrigerant to flow into system.
4. Purge center hose, low-pressure hose, and high-pressure hose as follows:
   a. Slightly loosen center hose at manifold gauge set center port until refrigerant escapes, then tighten hose.
   b. Open high-pressure and low-pressure gauge valves to allow refrigerant to flow into high-pressure and low-pressure hoses.
   c. Turn high-pressure and low-pressure gauge valves clockwise to OFF position.
   d. Purge high-pressure and low-pressure hoses at service ports of compressor.

WARNING: Make sure high-pressure gauge valve is in closed position on manifold gauge set during charging. Failure to do so will cause compressor to build pressure in refrigerant container. This could result in injury to personnel or damage to equipment if the container cracks.

5. Start engine and set engine speed at 1500 rpm.
6. Turn A/C system to max cold and blower fan on high speed.

NOTE: Keep refrigerant container upright at all times so refrigerant enters system as a gas.

7. Open low-pressure gauge valve until system is fully charged.
8. Close low-pressure gauge valve.
9. Return engine to normal idle.
10. Check A/C system performance.
11. Disconnect and remove service cart.

CLIMATE CONTROL PANEL REPLACEMENT

Removal

1. Remove front console.
2. Remove screw attaching climate control panel to support plate side bracket (Figure 11-13).
3. Pull climate control panel from behind support plate so that it angles away from longer side bracket.
4. Pull climate control panel from shorter side bracket.

Installation

1. From behind support plate, angle climate control panel behind shorter of two side brackets.
2. Push climate control panel toward longer side bracket until flush, then secure it with a screw.
3. Slide rear bracket onto back lip of climate control panel.
4. Install front console.

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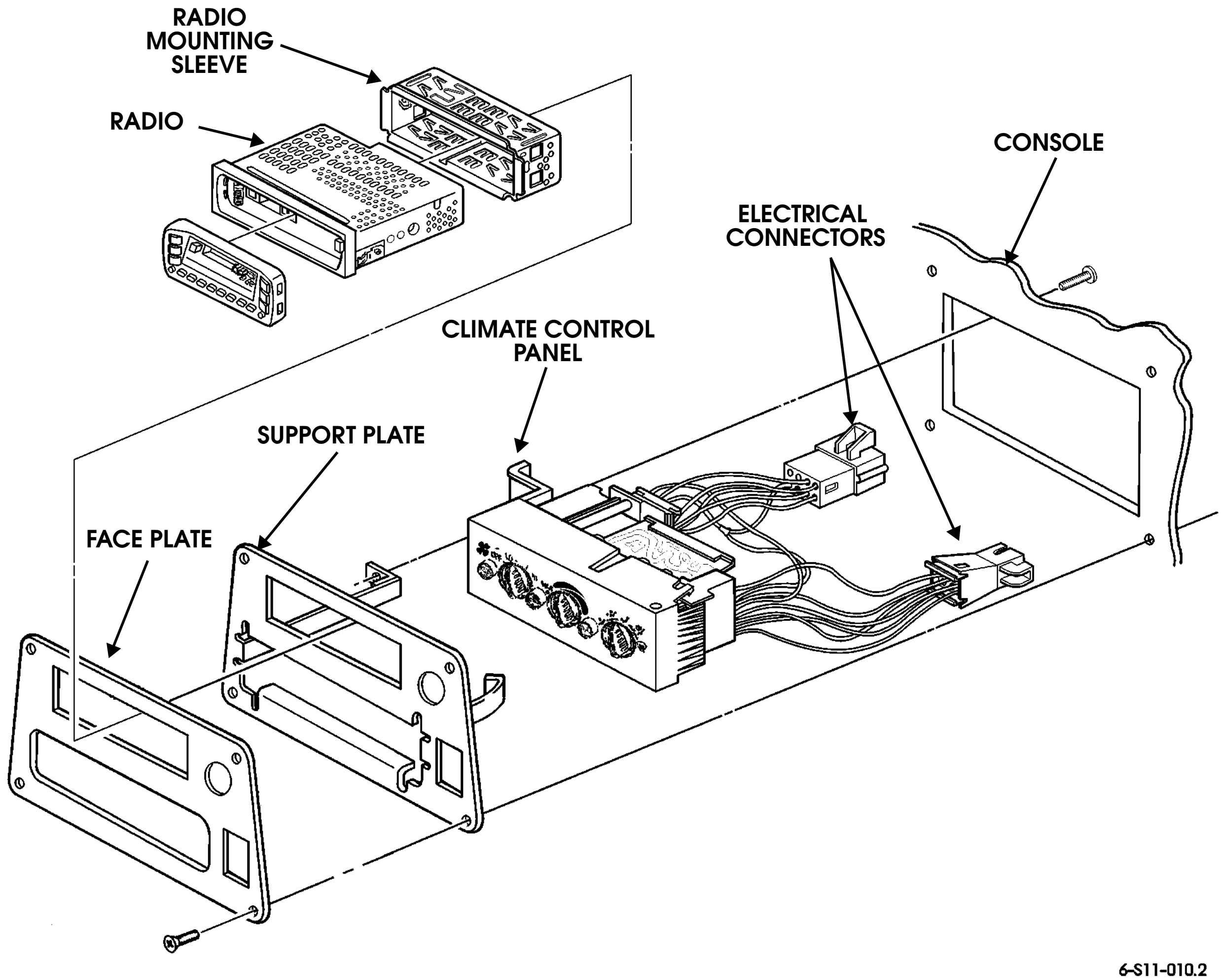


Figure 11-13: Climate Control Panel Replacement

PRESSURE HOSE TORQUE SPECIFICATIONS

CAUTION: *To avoid potential thread or fitting damage, hand start connections before using wrenches.*

Air conditioning System fittings are a common source of refrigerant leaks. When service requires disconnecting and connecting fittings, observe the following:

- When tightening or loosening hose and tube fittings, use two wrenches for equalized support (Figure 11-14).

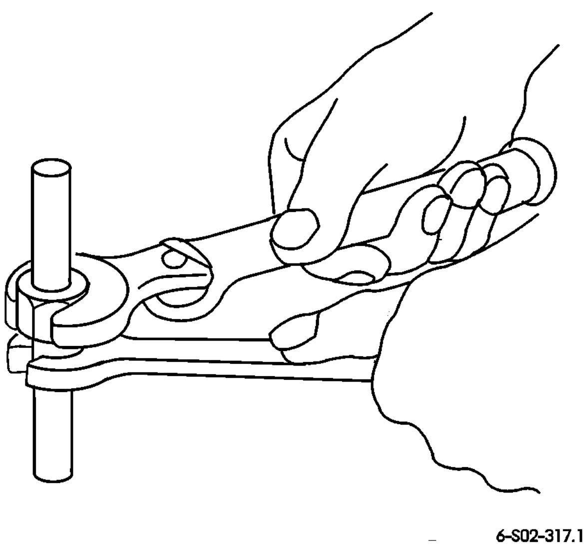


Figure 11-14: Hose and Tube Fittings

- Plug open ends of hoses after disassembly. Do not remove plugs from hose fittings until each component is ready for connection. This will prevent moisture and dirt contamination which can cause compressor wear and system blockage.
- Make sure that O-rings are properly seated before assembly (Figure 11-15).

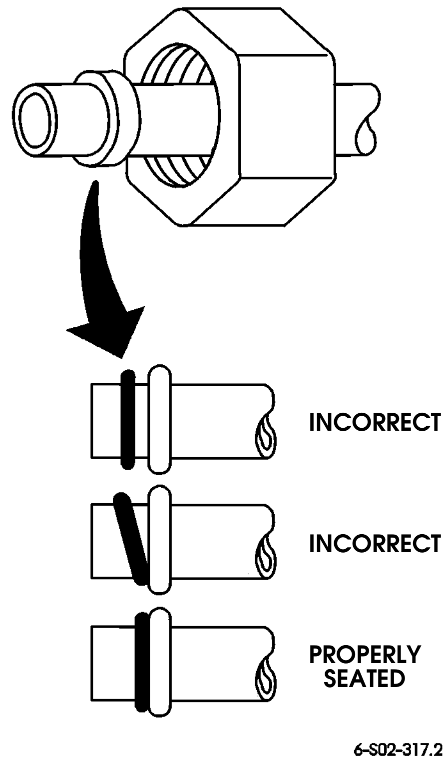


Figure 11-15: Correct Seating O-Rings

- Carefully interlock male and female ends of hoses (Figure 11-16).

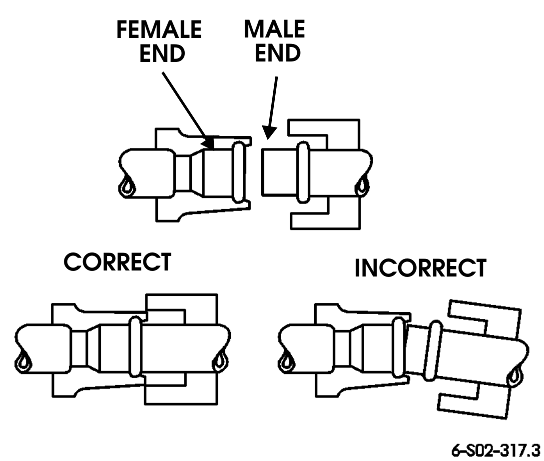


Figure 11-16: Proper Connection of Hose End

- Before making any hose and tube connection, apply a few drops of refrigerant oil to the O-rings and threaded portions of the connector. Make connections quickly.
- Tighten fittings to proper torque specification based on hose size.

Pressure Hose Torque Values.				
HOSE SIZE	Torque (Ft. Lb.)		Torque (Newton Meters)	
	Minimum	Maximum	Minimum	Maximum
#6 Liquid Hose	11	13	15	17
#8 Discharge Hose	15	20	20	27
#10 Section Hose	21	27	28	36
#12 Suction Hose	24	28	33	38

AIR CONDITIONING PRESSURE HOSE REPLACEMENT

WARNING: Air conditioning system components are subject to high-pressure R-134a gas. Always discharge pressure and contain refrigerant using approved service equipment. Use extreme care when handling R-134a. Direct contact with skin may cause frostbite. Do not smoke in areas where R-134a is stored or used. Failure to follow these warnings may result in serious injury.

CAUTION: *Cover all open lines to prevent contamination.*

Suction/Discharge Hose Assembly

Removal and installation of the suction/discharge hose assembly is the same on non-turbo and turbo diesels. The suction hose is serviceable separately from the suction/discharge hose assembly (Figure 11-17). Simply disconnect the suction hose from the junction block.

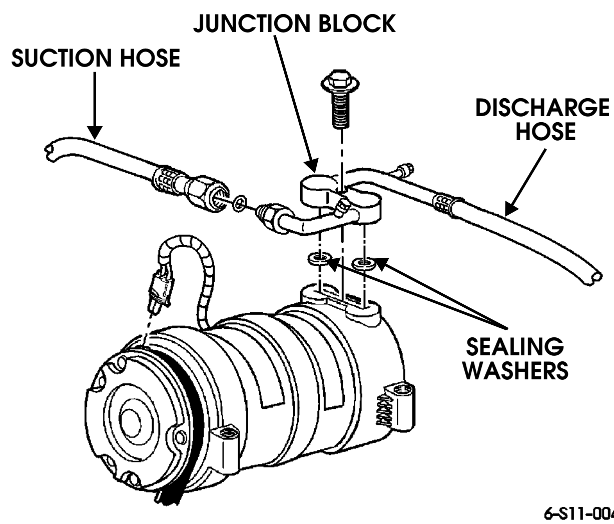


Figure 11-17: Suction/Discharge Hose Assembly Mounting (Turbo-Diesel)

Removal

1. Discharge air conditioning system.
2. Remove air cleaner assembly and air induction tubes (Section 3).

3. Disconnect suction hose from evaporator core and remove O-ring. Discard O-ring (Figure 11-18).

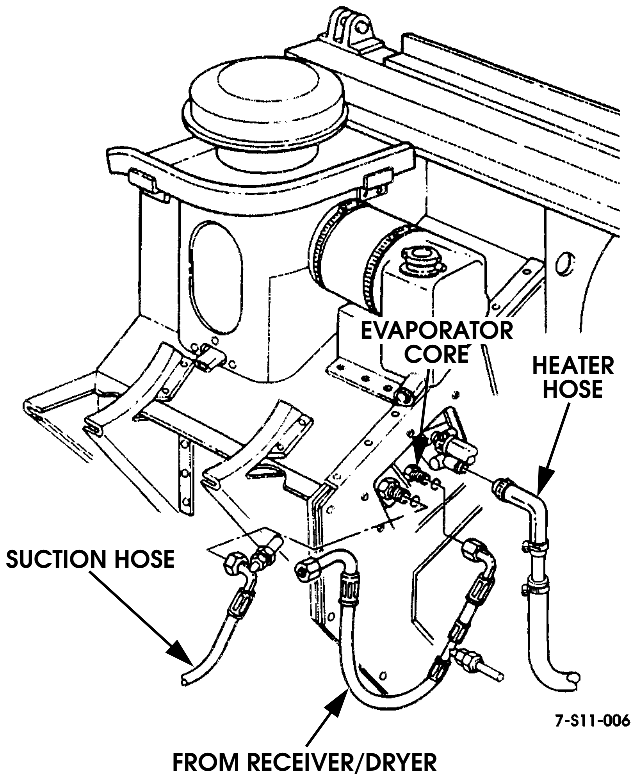


Figure 11-18: Suction Hose Removal

4. Disconnect discharge hose from condenser. Remove and discard O-ring (Figure 11-19).
5. Remove driver side engine splash shield (Section 10).

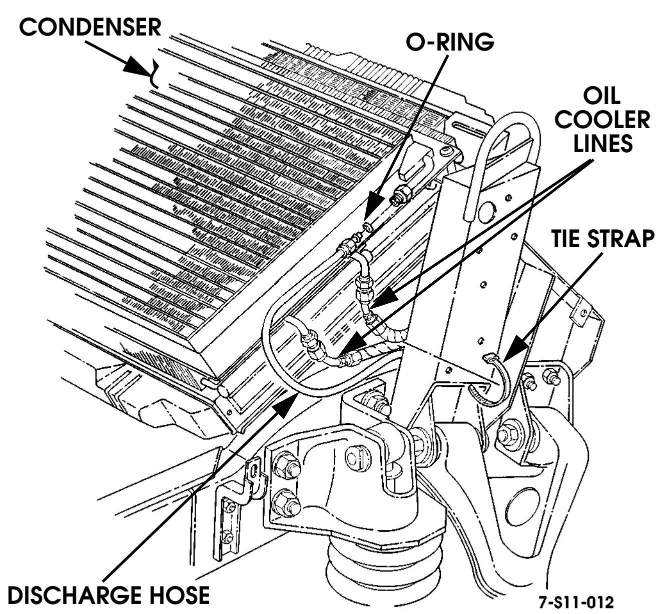


Figure 11-19: Discharge Hose Location

6. Remove tie strap securing discharge hose to oil cooler lines. Discard tie strap.
7. Remove screw, washer, suction/discharge hose assembly, and two sealing washers from compressor (Figure 11-18).

Installation

***CAUTION:** To avoid potential thread or fitting damage, hand start connections before using wrenches.*

1. Position two sealing washers on suction/discharge hose assembly (Figure 11-17).
2. Secure suction/discharge hose assembly to compressor with washer and bolt. Torque bolt to 33 lb-ft (45 N•m).
3. Lubricate O-ring, position on discharge hose, and connect hose to condenser. Using two wrenches for equalized support, tighten to 11-13 ft-lb (15-18 N•m).
4. Secure discharge hose to oil cooler lines with tie strap.
5. Install driver side engine splash shield.
6. Lubricate O-ring, position on suction hose and secure hose to evaporator core. Using two wrenches for equalized support, tighten to 11-13 ft-lb (15-18 N•m).
7. Install air cleaner assembly and induction tubes (Section 3).
8. Evacuate and charge air conditioning system.
9. Check for system leaks.
10. Check A/C operation.

Condenser-to-Receiver/Dryer Hose

WARNING: Air conditioning system components are subject to high pressure R-134a gas. Always discharge pressure and contain refrigerant using approved service equipment. Use extreme care when handling R-134a. Direct contact with skin may cause frostbite. Do not smoke in areas where R-134a is stored or used. Failure to follow these warnings may result in serious injury.

Removal

CAUTION: *To avoid potential thread or fitting damage, hand start connections before using wrenches.*

1. Discharge air conditioning system.
2. Disconnect hose from condenser and remove O-ring. Discard O-ring (Figure 11-20).
3. Remove hose and O-ring from receiver/dryer. Discard O-ring.

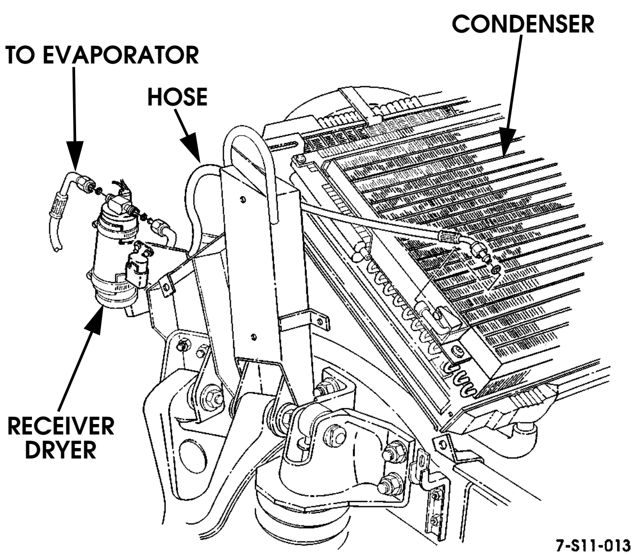


Figure 11-20: Receiver/Dryer Location

Installation

1. Lubricate O-ring with PAG oil, position on hose, and secure hose to condenser. Using two wrenches for equalized support, tighten to 11-13 lb-ft (15-18 N•m).
2. Lubricate O-ring with PAG oil, position on hose, and secure hose to receiver/dryer. Using two wrenches for equalized support, tighten to 11-13 lb-ft (15-18 N•m).
3. Evacuate and charge air conditioning system.
4. Check system for leaks.
5. Check air conditioning system operation.

Receiver/Dryer-To-Evaporator Core Hose

WARNING: Air conditioning system components are subject to high pressure R-134a gas. Always discharge pressure and contain refrigerant using approved service equipment. Use extreme care when handling R-134a. Direct contact with skin may cause frostbite. Do not smoke in areas where R-134a is stored or used. Failure to follow these warnings may result in serious injury.

Removal

1. Discharge air conditioning system.
2. Remove air cleaner assembly and induction tube (Section 3).
3. Disconnect hose from receiver/dryer and remove O-ring. Discard O-ring (Figure 11-20).
4. Remove hose and O-ring from evaporator core. Discard O-ring (Figure 11-18)

Installation

1. Lubricate two O-rings with PAG oil and position on hose (Figure 11-18).
2. Secure hose to evaporator core. Using two wrenches for equalized support, tighten to 11-13 lb-ft (15-18 N•m).
3. Secure hose to receiver/dryer. Using two wrenches for equalized support, tighten to 11-13 lb-ft (15-18 N•m) (Figure 11-20).
4. Install air cleaner assembly and induction tube (section 3).
5. Leak test system.

CONDENSER REPLACEMENT

Removal

WARNING: Air conditioning system components are subject to high pressure R-134a gas. Always discharge pressure and contain refrigerant using approved service equipment. Use extreme care when handling R-134a. Direct contact with skin may cause frostbite. Do not smoke in areas where R-134a is stored or used. Failure to follow these warnings may result in serious injury.

1. Discharge air conditioning system.

NOTE: Cover all open lines to prevent contamination.

2. Disconnect two pressure hoses from condenser and remove O-rings. Discard O-rings.

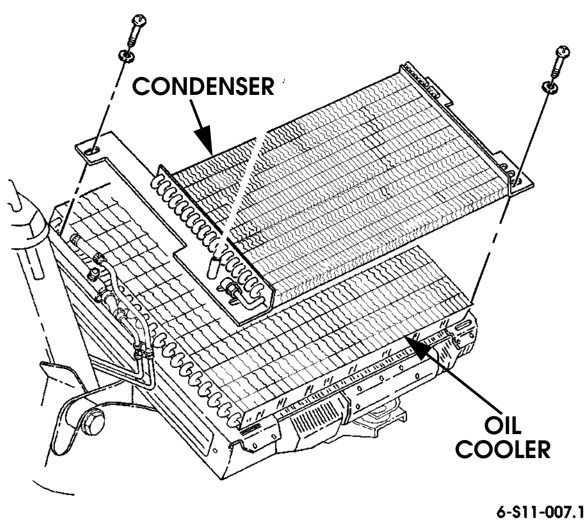


Figure 11-21: Condenser Replacement

3. Remove screws, washers, spacers, and condenser from oil cooler (Figure 11-21).

Installation

1. Secure condenser to oil cooler with spacers, washers, and screws (Figure 11-21).
2. Lubricate two O-rings with PAG oil and install on pressure lines.
3. Connect two pressure hoses to condenser.
4. Evacuate and charge air conditioning system.

RECEIVER/DRYER REPLACEMENT

Removal

WARNING: Air conditioning system components are subject to high-pressure R-134a gas. Always discharge pressure and contain refrigerant using approved service equipment. Use extreme care when handling R-134a. Direct contact with skin may cause frostbite. Do not smoke in areas where R-134a is stored or used. Failure to follow these warnings may result in serious injury.

NOTE: The receiver/dryer will quickly absorb water from the atmosphere when not sealed. Do not leave system open during service. Receiver/Dryer should be replaced any time major components are replaced. If in doubt, replace unit.

1. Discharge air conditioning system.
2. Remove air induction tube.
3. Disconnect electrical connector from high/low pressure switch (Figure 11-22).

NOTE: Cover all open lines to prevent contamination.

4. Disconnect two hoses from receiver/dryer and remove O-rings. Discard O-rings.
5. Remove two clamps and receiver/dryer from bracket.

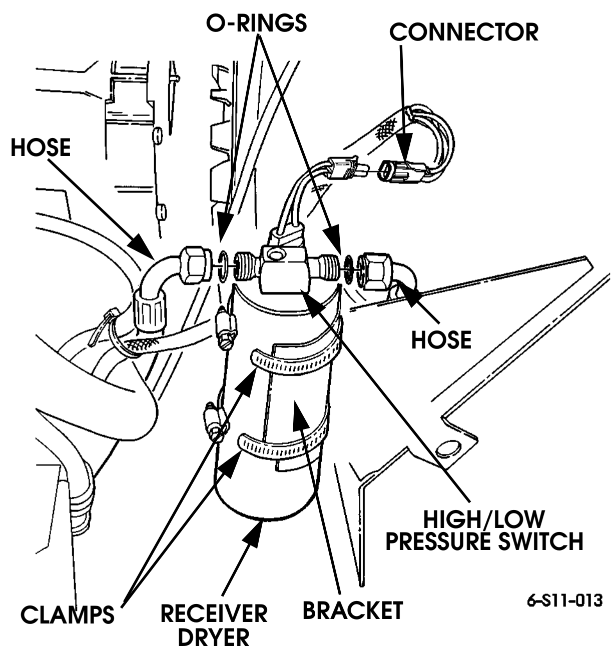


Figure 11-22: Receiver/Dryer

Installation

1. Secure receiver/dryer to bracket with two clamps. Position hose attachment ports to front and rear of vehicle (Figure 11-22).
2. Lubricate two O-rings with PAG oil and position on hose fittings.
3. Connect two hoses to receiver/dryer.
4. Connect electrical connector to high/low pressure switch.
5. Install air induction tube.
6. Test the system for leaks.

RECEIVER/DRYER PRESSURE SWITCH REPLACEMENT

Removal

1. Disconnect pressure switch jumper connector from receiver/dryer pressure switch (Figure 11-23).

NOTE: Unscrew the pressure switch as quickly as possible to avoid excessive loss of refrigerant.

2. Using a wrench, remove the pressure switch from the receiver/dryer.

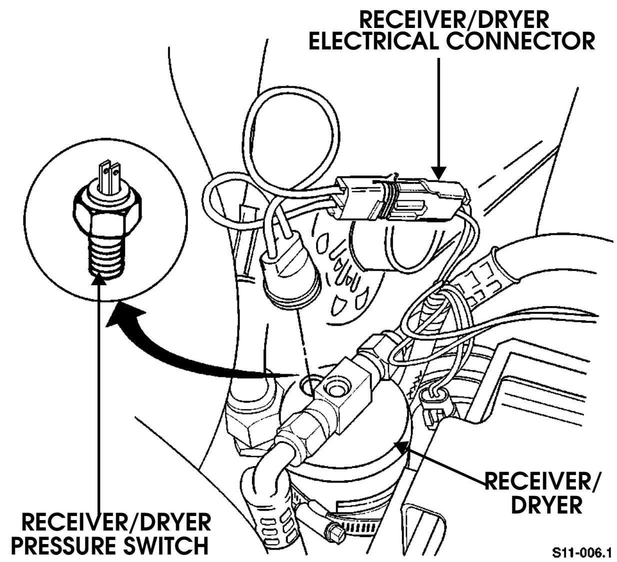


Figure 11-23: Receiver/Dryer Pressure Switch Mounting

Installation

1. Thread the new pressure switch on the receiver/dryer fitting by hand and use a wrench to finish securing the pressure switch. (Figure 11-23).

NOTE: Install the pressure switch as quickly as possible to avoid excessive loss of refrigerant.

2. Connect the pressure switch jumper electrical connector to the pressure switch.
3. Check the pressure switch fitting for leaks using suitable leak-testing equipment.

HEATER HOSE REPLACEMENT

Engine coolant is routed through 5/8 inch diameter heater hose from the engine water crossover to the bottom fitting of the heater shutoff valve. When the valve is open, coolant flows through another length of hose from the valve's rearward lower fitting to the heater core inlet port. The heater outlet hose is routed to the valve's rearward upper fitting on vehicles without an auxiliary A/C - heat unit. On vehicles equipped with an auxiliary unit, the heater outlet hose is routed to the auxiliary heater core inlet—then from the auxiliary heater core outlet to the rearward upper fitting on the heater shutoff valve. The coolant return hose is routed from the forward upper heater shutoff valve fitting to the water pump nipple (Figure 11-24).

Removal

1. Drain cooling system (Section 4).
2. Loosen worm gear clamps on either end of hose to be removed.

NOTE: Damage to the heater core can result if too much force is applied to the ports. If the hose is not easily removed by moderate twisting and pulling, cut the hose just beyond the port. Then cut the hose remaining on the port lengthwise and remove it.

3. Remove hose ends from fittings by twisting and pulling.

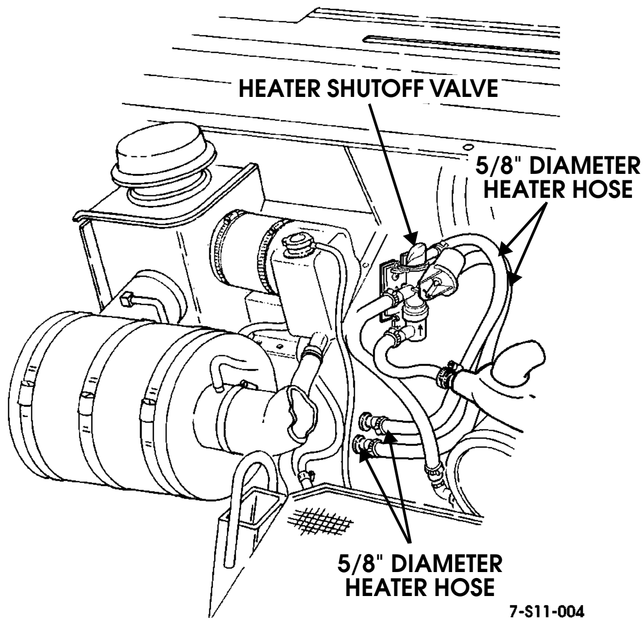


Figure 11-24: Heater Hose Routing Without Auxiliary Unit

Installation

1. With clamps loosely in place, connect hose ends to respective fittings.
2. Tighten clamps.
3. Refill cooling system and check for leaks (Section 4).

VACUUM SOLENOID REPLACEMENT

All 1997 Hummer vehicles use a vacuum solenoid to send vacuum to the heater shutoff valve. The vacuum solenoid receives an electronic signal from the HVAC control panel and applies vacuum to the heater shutoff valve when passengers select cooler interior temperatures. A malfunctioning vacuum solenoid will not apply vacuum and the heater shutoff valve defaults to open mode. In turn, coolant will circulate through the heater core and adequate interior cooling will be unattainable.

Removal

1. Unplug electrical connector from vacuum solenoid (Figure 11-25).
2. Remove vacuum hoses from vacuum solenoid.
3. Remove screw, fuse, and vacuum solenoid from firewall.

NOTE: Vacuum solenoid must be installed at a downward angle so that water cannot seep under the electrical connector boot. The proper installed position is with the electrical connector higher and the vacuum hoses nipples lower.

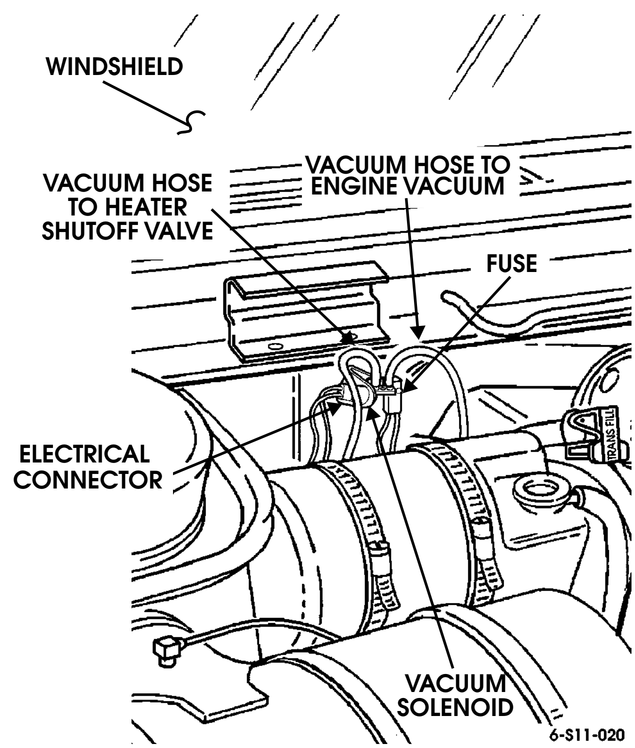


Figure 11-25: Vacuum Hose to Heater Shutoff Valve

Installation

1. Secure vacuum solenoid and fuse to firewall with screw.
2. Attach vacuum hoses to vacuum solenoid (Figure 11-25).
3. Plug electrical connector into vacuum solenoid.
4. Verify proper operation. HVAC control panel set to cold applies vacuum.

WATER CONTROL VALVE REPLACEMENT

Removal

1. Place a drain container under the vehicle directly below the control valve (Figure 11-26).

NOTE: Use extreme caution when working on a hot engine. Let the engine cool down before proceeding.

2. Relieve pressure from cooling system by loosening coolant pressure cap.
3. Remove the air intake hoses.
4. Disconnect the vacuum hose from the control valve diaphragm.
5. Clamp control valve hoses with heater hose clamp pliers or equivalent tool.
6. Remove hoses from valve.
7. Remove clamp and valve from mounting bracket.

Installation

CAUTION: *Do not overtighten the clamp that secures the control valve to the mounting bracket. Overtightening the clamp can deform the valve housing and cause binding. After tightening, push the plunger in and out of the vacuum diaphragm to ensure the valve is moving freely.*

1. Gently secure control valve to mounting bracket with clamp (Figure 11-26).
2. Secure hoses to valve with clamps.
3. Release and remove hose clamp pliers or equivalent tools from valve hoses.
4. Connect the valve vacuum hose (Figure 11-26).
5. Check the coolant level and add coolant if necessary.
6. Tighten coolant pressure cap.
7. Check the valve for proper operation and leaks.

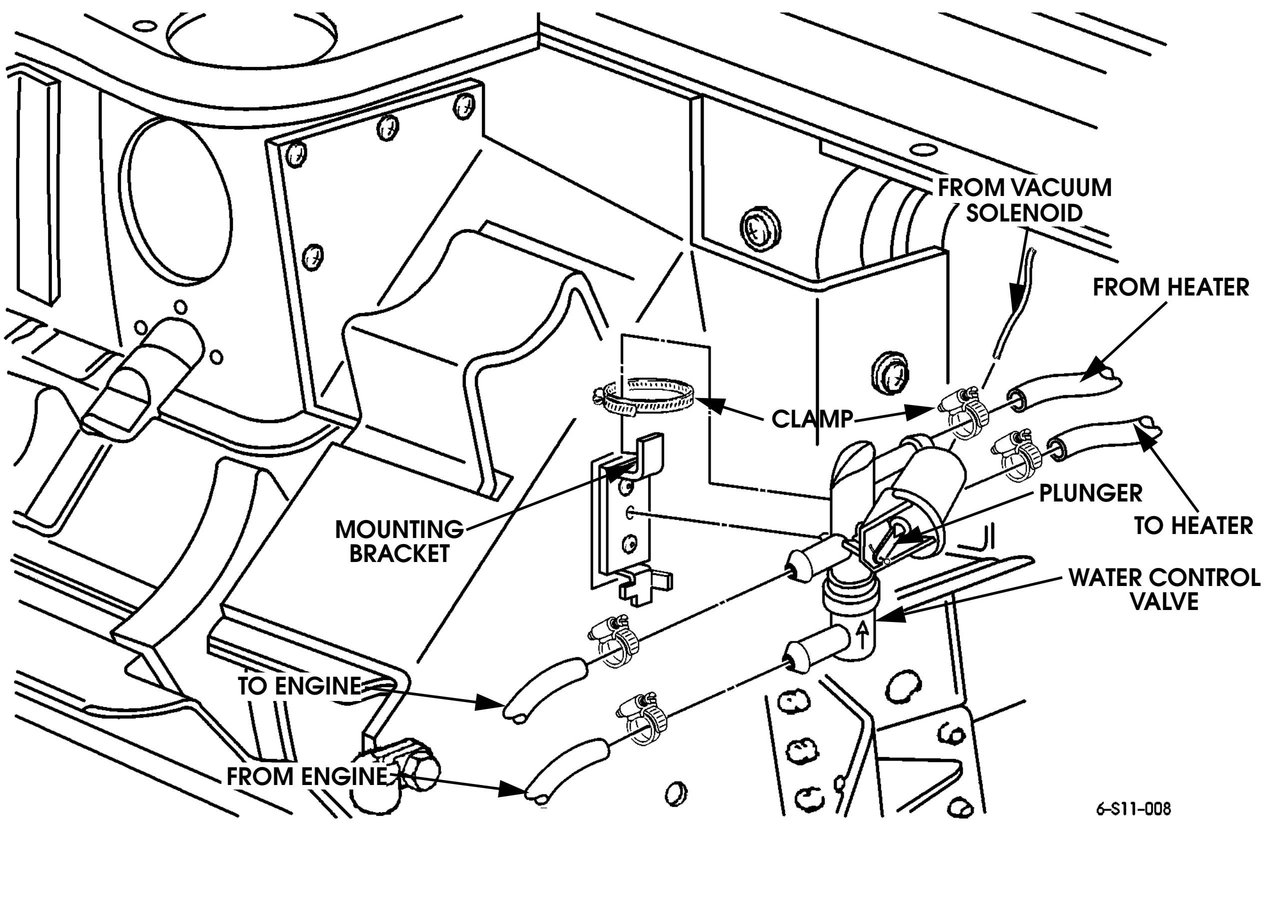


Figure 11-26: Water Control Valve Installation

MAIN A/C - HEAT UNIT REPLACEMENT

NOTE: The main A/C - heat unit is sealed. If the evaporator, heater core, expansion valve, fresh air door or heat door malfunctions, a complete replacement of the main A/C - heat unit is required. Serviceable components of the main A/C - heat unit include the diverter assembly, blower motor housing assembly, blower motor, blower wheel, thermostatic switch, mode door actuators, blower motor relays, air conditioning relay, drain tube, elbow, and duck bill.

Removal

WARNING: Air conditioning system components are subject to high-pressure R-134a gas. Always discharge pressure and contain R-134a using approved service equipment. Use extreme care when handling R-134a. Direct contact with skin may cause frostbite. Do not smoke in areas where R-134a is stored or used. Failure to follow these warnings may result in serious injury.

1. Discharge air conditioning system.
2. Drain cooling system or use hose pinch pliers to pinch off heater hoses to and from engine.
3. Remove air intake bonnet.
4. Remove air cleaner assembly, air induction tube, and air intake elbow (Section 3).
5. Loosen two clamps and move surge tank out of the way.

NOTE: Cover all open hoses to prevent contamination.

6. Loosen two clamps and disconnect heater hoses from the main A/C - heat unit.
7. Disconnect two pressure hoses from main A/C - heat unit and remove O-rings. Discard O-rings.
8. Remove three nuts, washers, and hose clamp from inner cowl area. Inspect for an additional nut on studs.
9. Remove drain tube, elbow, and duck bill.
10. Remove right crash pad (Section 10).
11. Remove front console.
12. Remove front passenger's seat (Section 13).
13. Remove front passenger's side kick panels and lamp assembly (Section 13).
14. Disconnect main A/C - heat unit wiring harness from vehicle body harness and HVAC control head, and mode door actuator.
15. Remove five screws from diverter assembly, and remove assembly.
16. Locate and remove three nuts, bolts, and washers from inside air intake housing securing main A/C - heat unit.
17. Separate main A/C - heat unit from air intake housing by pulling out and down on top of main A/C - heat unit.
18. Remove main A/C - heat unit from the vehicle by shifting assembly to the right. When left side mounting studs are free from the inner cowl, the unit may be lifted out.

Installation

1. Position a strip of permagum around outer circumference of main A/C - heat unit fresh-air intake opening.
2. Install main A/C - heat unit into vehicle, aligning left side mounting studs to holes in inner cowl.
3. Install three nuts, washers, and hose clamp to mounting studs in inner cowl.
4. Install three nuts, bolts, and washers in air intake housing securing main A/C - heat unit.
5. Secure diverter assembly with five screws.
6. Lubricate and position O-ring on the high-pressure hose, and secure high-pressure hose to main A/C - heat unit. Tighten to 11-13 lb-ft (15-18 N•m).
7. Lubricate and position O-ring onto low pressure hose and secure low pressure hose to main A/C - heat unit. Tighten to 21-27 lb-ft (29-37 N•m).
8. Secure heater hoses to main A/C - heat unit with clamps. Remove hose pinch pliers, if used. Install drain tube, elbow, and duck bill.
9. Install surge tank, and secure with two clamps.
10. Install air cleaner assembly, air induction tube, and intake air elbow. Ensure air intake elbow does not restrict entry of fresh air into main A/C - heat unit (Section 3).
11. Connect vent line to air cleaner assembly shield.
12. Install air intake bonnet.
13. Connect main A/C - heat unit wiring harness to vehicle body harness and HVAC control head.
14. Install front passenger side kick panels and lamp assembly (Section 13).
15. Install front console (Section 10).
16. Install crash pad.
17. Perform complete air conditioning service, evacuate, charge, and test for leaks.
18. Add engine coolant as necessary.
19. Check for proper air conditioning operation.

MAIN A/C - HEAT UNIT COWL INSULATION REPLACEMENT

Removal

1. Remove air intake weathercap (Section 3).
2. Remove air cleaner assembly shield.
3. Remove vent line from air cleaner assembly.
4. Remove air cleaner assembly and air induction tube.
5. Loosen and remove two clamps and move surge tank out of the way.
6. Remove drain tube.
7. Remove trim screws, as necessary, from insulation on air intake housing (Figure 11-27).
8. Remove screws and washers, as necessary, from insulation on upper cowl.
9. Remove bolts, nuts, and fasteners, as necessary, from insulation on front of cowl.
10. Remove three nuts and washers from insulation on main A/C - heat unit mounting studs.
11. Remove cowl insulation.

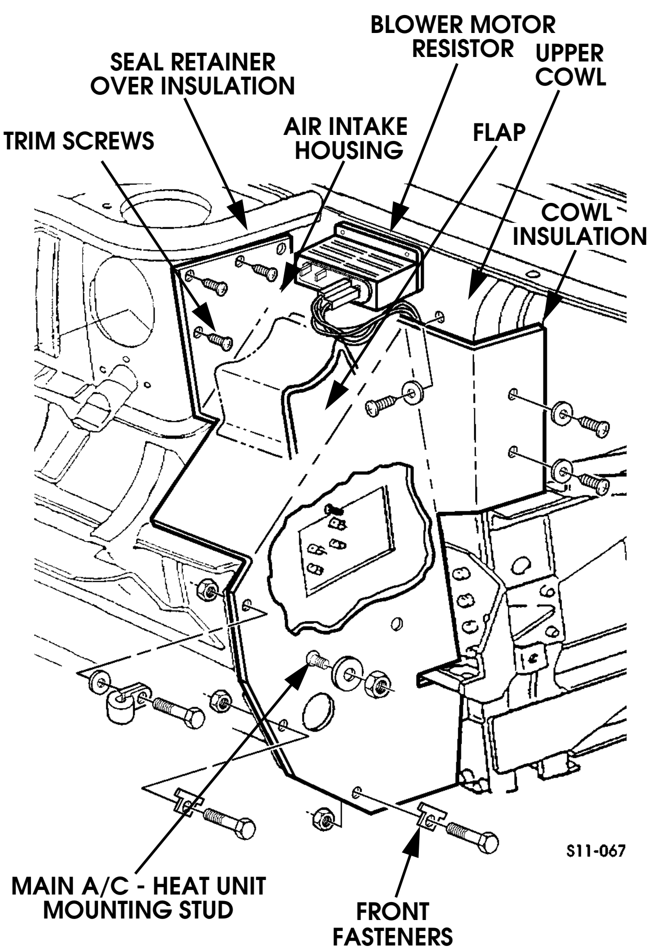


Figure 11-27: Cowl Insulation Mounting

Installation

1. Position cowl insulation so that flap side is inserted under surge tank bracket (Figure 11-27).
2. Install three nuts and washers to secure insulation to main A/C - heat unit mounting studs.
3. Install bolts, nuts, and retainers as necessary to secure insulation to front of cowl.
4. Install screws and washers as necessary to secure insulation to upper cowl.
5. Install trim screws as necessary to secure insulation to air intake housing.
6. Install drain tube.
7. Install two surge tank screw clamps to secure surge tank.
8. Install air cleaner assembly and air induction tube (Section 3).
9. Install air cleaner assembly vent line.
10. Install air cleaner assembly shield.
11. Install air intake weathercap.

DRAIN TUBE REPLACEMENT

Removal

Remove duck bill, elbow, and drain tube from main A/C - heat unit inner cowl area by pulling straight out. If drain tube grommet pulled out with drain tube, it will need to be reinstalled. It may be necessary to loosen drain tube from main A/C - heat unit drain outlet.

Installation

Install drain tube and grommet, if removed, to drain tube outlet on main A/C - heat unit (Figure 11-28). Ensure drain tube is attached to main A/C - heat unit drain outlet.

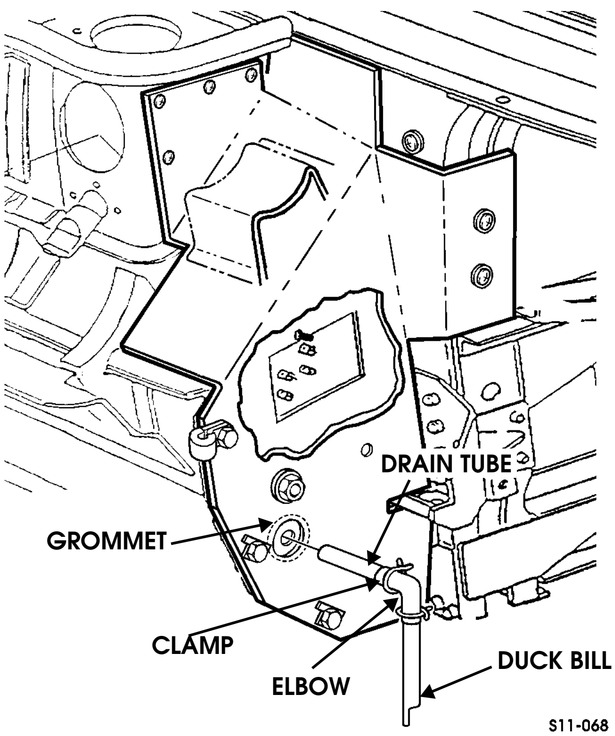


Figure 11-28: Drain Tube Replacement

DIVERTER REPLACEMENT

Removal

NOTE: Mode door actuator is not serviceable. Entire diverter assembly must be replaced to repair mode door actuator.

1. Remove right crash pad (Section 10).
2. Pull back front console.
3. Disconnect mode door actuator electrical connection from mode door actuator (Figure 11-29).
4. Remove five screws and diverter assembly from main A/C - heat unit.

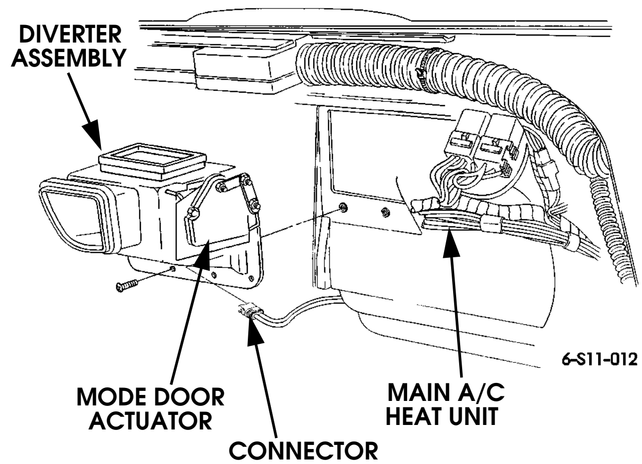


Figure 11-29: Diverter Assembly Mounting

Installation

1. Secure diverter assembly to main A/C - heat unit with five screws (Figure 11-29).
2. Connect mode door actuator electric connection on mode door actuator.
3. Install front console (Section 10).
4. Check operation of diverter assembly.
5. Install crash pad.

BLOWER MOTOR REPLACEMENT

NOTE: The main A/C - heat unit will need to be loosened from its mounting hardware to allow for additional clearance to remove blower housing.

Removal

1. Remove the crash pad (Section 10).
2. Pull front console a few inches back for clearance.
3. Disconnect electrical connector from diverter mode door actuator.
4. Remove five screws and diverter assembly.
5. Remove two screws and blower motor relays from blower housing.
6. Remove eight screws from blower housing and main A/C - heat unit.
7. Pull blower housing rearward separating blower housing from main A/C - heat unit.

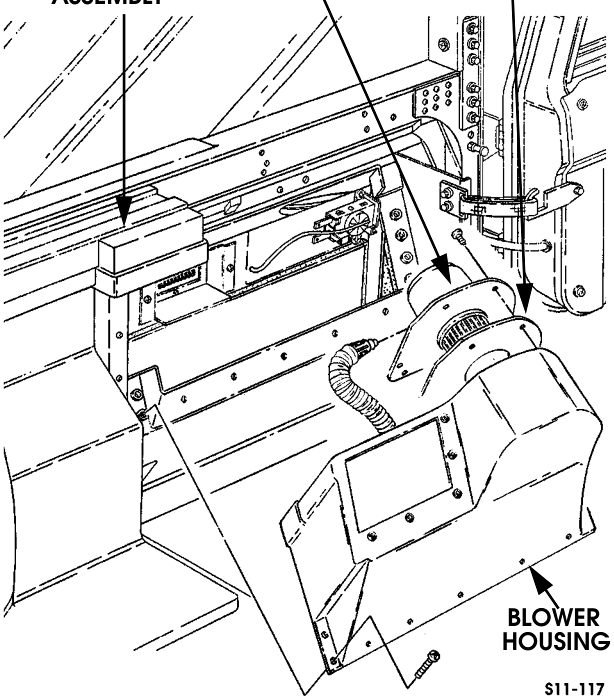


Figure 11-30: Blower Motor Location

8. Disconnect positive and negative electrical connectors from blower motor.
9. Remove blower housing from vehicle (Figure 11-30).
10. Remove six screws, starwasher, electrical spade connector, and blower motor from blower housing.

Installation

1. Secure blower motor to blower housing with six screws, starwasher, and electrical spade connector (Figure 11-30).
2. Connect positive and negative electrical connectors to blower motor and install blower housing on main A/C - heat unit. Insure that housing is well seated to main unit. Secure blower housing to main A/C - heat unit with eight screws.
3. Secure blower motor relays to blower housing with two screws.
4. Secure diverter assembly to blower housing with five screws.
5. Connect electrical connector to distributor mode door actuator.
6. Check operation of blower motor.
7. Install front console (Section 10).
8. Install crash pad.

BLOWER MOTOR RESISTOR REPLACEMENT

Removal

1. Remove HVAC harness connector from resistor (Figure 11-31).
2. Remove screws and resistor from cowl.

Installation

1. Fasten resistor to cowl with screws.
2. Plug HVAC harness connector into resistor.
3. Check blower motor operation.

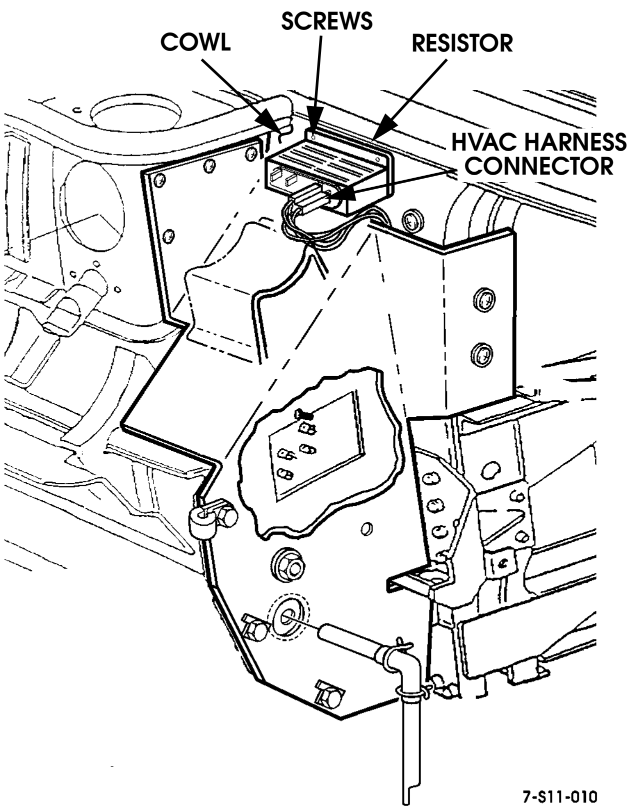


Figure 11-31: Blower Motor Resistor Replacement

THERMOSTAT REPLACEMENT

Removal

1. Remove main A/C - heat unit.
2. Remove eight screws and blower housing from main A/C - heat unit housing (Figure 11-32).
3. Disconnect thermostat electrical connections.
4. Remove seven screws and front cover from main A/C - heat unit housing.
5. Remove thermostat capillary tube from evaporator core.
6. Remove two screws from thermostat, and remove thermostat by pulling capillary tube through platform.

Installation

1. Route thermostat capillary tube through platform and insert tube into evaporator core (Figure 11-32).
2. Secure thermostat to platform with two screws.
3. Secure front cover to main A/C - heat housing with seven screws.
4. Position blower housing so that thermostat electrical connections may be connected.
5. Secure blower housing to main A/C - heat unit housing with eight screws.
6. Install main A/C - heat unit.

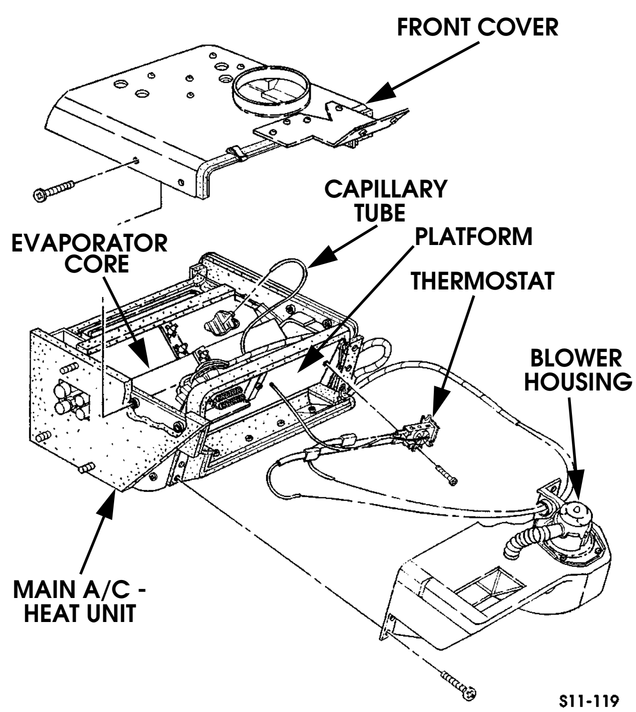


Figure 11-32: Thermostat Replacement

HEAT DOOR ACTUATOR REPLACEMENT

Removal

1. Remove right side passenger's kick panel (Section 10).
2. Disconnect electrical connection (Figure 11-33).
3. Remove three screws and heat door actuator from bracket.

Installation

1. Secure heat door actuator to bracket with three screws.
2. Connect electrical connector (Figure 11-33).
3. Install right side passenger kick panel (Section 10).
4. Check heat door operation.

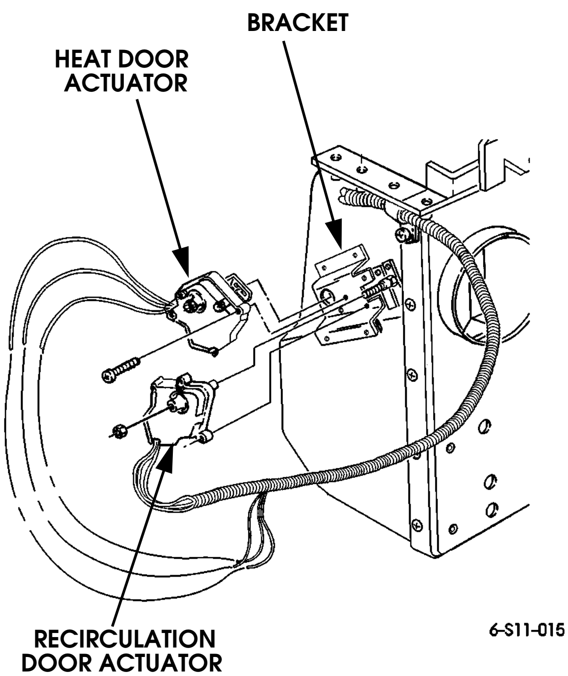


Figure 11-33: Heat Door and Recirculation Door Actuator Locations

Inspection and Adjustment

Perform a visual inspection of the linkage (heat door arm and actuator arm) during operation (Figure 11-34) as follows:

1. Using a light, look up from the front passenger floorboard and behind the actuator mounting bracket to view the linkage.
2. With ignition and heater on, change temperature settings on the climate control panel from cold to hot and from hot back to cold. Observe linkage movement.
3. When placed to full cold position, the linkage should rotate clockwise and the actuator arm should come to rest horizontally.
4. When placed in full hot position, the linkage should rotate counterclockwise and the actuator arm should stop vertically.

If full hot and/or full cold positions are less than vertical or horizontal respectively perform the following:

1. Make scribe marks on the side of the main A/C-heat unit that indicate the actuator arm positions at each extreme.
2. Remove heat door actuator.
3. Rotate heat door arm to clockwise stop position. It must travel further clockwise (past the horizontal scribe mark) than when the heat door actuator is mounted on the bracket.

CAUTION: *Use care not to bend the heat door arm too far past the horizontal scribe mark. Air conditioning performance could be adversely affected. It is only necessary to reposition the arm so that it travels visibly further than the scribe mark.*

4. Using needle nose pliers or suitable tool, grasp heat door arm and bend it clockwise/downward past its original (horizontal) stop position/scribe mark.
5. Install heat door actuator. Check operation and heater output temperature.

RECIRCULATION DOOR ACTUATOR REPLACEMENT

Removal

1. Remove right side kick panel (Section 10).
2. Disconnect electrical connection (Figure 11-34).
3. Remove three screws and actuator from bracket.

Installation

1. Secure recirculation door actuator to bracket with three screws. Ensure actuator arm pin engages recirculation door linkage (Figure 11-34).
2. Install pushnut on actuator arm pin. Connect electrical connection.
3. From climate control panel, operate recirculation actuator to recirculate position and back to fresh air position.
4. Install right side kick panel (Section 10).
5. Check operation of recirculation door actuator.

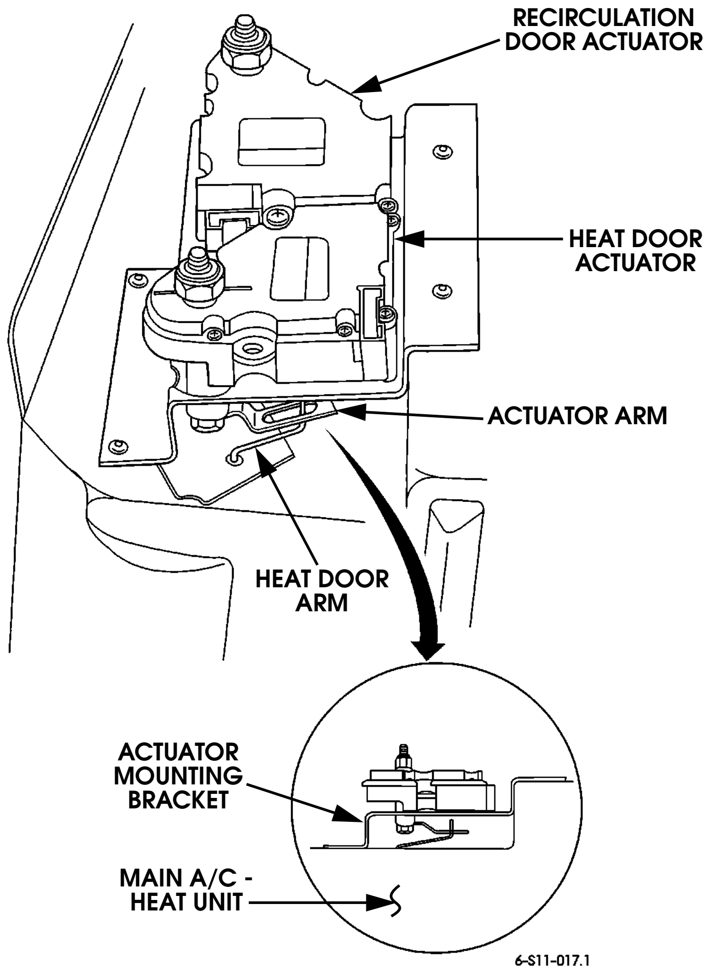


Figure 11-34: Heat Door Actuator Linkage Location

AIR CONDITIONING/HEATER DUCT REPLACEMENT

Passenger Floor Duct

Removal

1. Remove right side crash pad (Section 10).
2. Remove passenger side floor duct hose from floor duct assembly (Figure 11-35).
3. Remove two screws and floor duct from main A/C - heat unit floor outlet.

Installation

1. Route duct from blower housing to main A/C - heat unit floor duct and secure with two screws (Figure 11-35).
2. Route opposite end of duct to floor duct and secure with screw.
3. Check operation of passenger side floor duct.
4. Install crash pad.

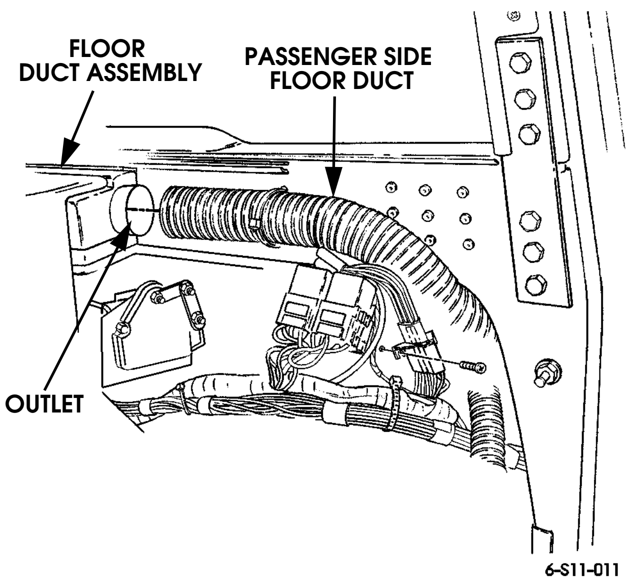


Figure 11-35: Passenger Floor Duct

Driver Floor Duct

The driver floor vent and floor duct are both integrated as part of the closeout panel assembly. Failure of either component constitutes closeout panel assembly replacement.

Removal

1. Remove screws and closeout panel from I. P.
2. Remove duct hose from driver floor duct on back side of closeout panel.

Installation

1. Attach duct hose to driver floor duct on back side of closeout panel.
2. Secure closeout panel to I. P. with screws.

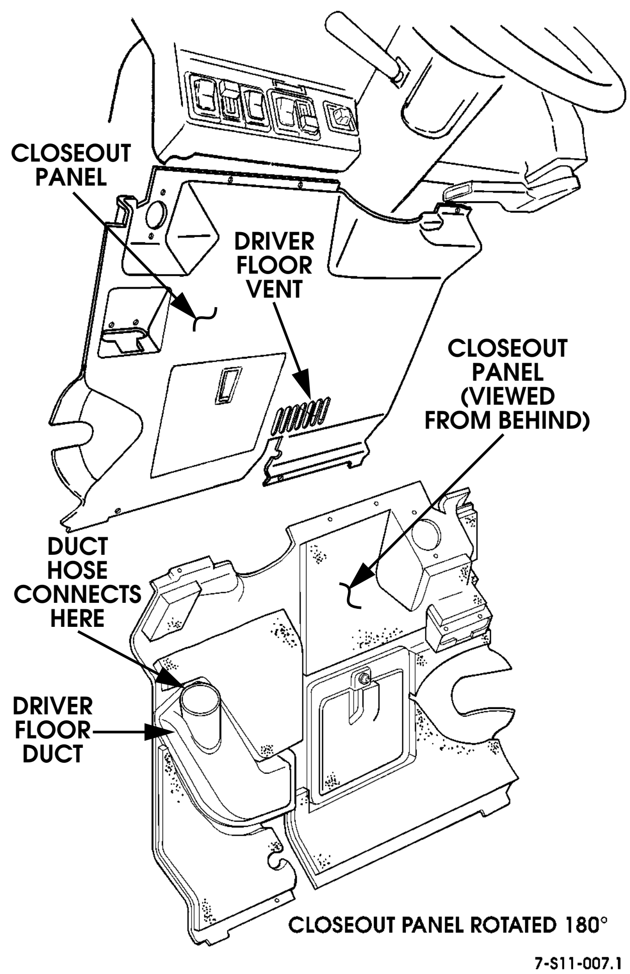


Figure 11-36: Driver floor Duct Appearance

DEFROST DUCT AND WINDSHIELD NOZZLES REPLACEMENT

Center Defrost Duct

Removal

1. Remove right side crash pad (Section 10).
2. Remove front console (Section 10).
3. Remove engine cover (Section 10).
4. Remove twelve screws, nuts, washers, and closeout panel from A-beam (Figure 11-37).
5. Remove eight screws, washers, and driver's and passenger's lower windshield retainers from A-beam.

NOTE: Plusnuts must be drilled out in order to remove ducts. New plusnuts are installed in the same holes.

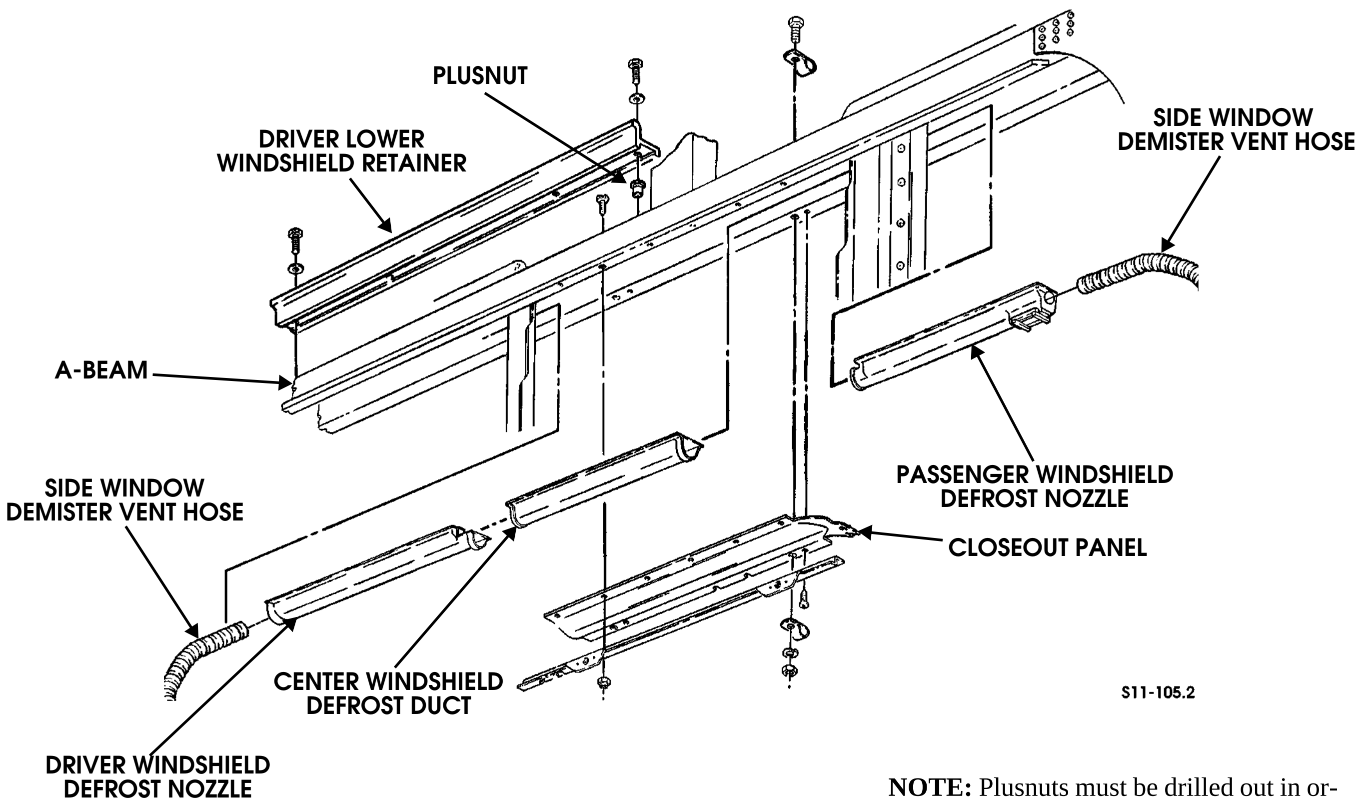
6. Remove center defrost duct from A-beam.

Installation

1. Install center windshield defrost duct into A-beam (Figure 11-37). Align both ends with adjacent duct and insuring a leak-free overlap joint.

NOTE: Apply Silaprene Sealant 05593929 in a continuous bead around the new plusnuts making sure to cover both the edge of the plusnut and the vehicle body. This will provide better sealing.

2. Install new plusnuts into A-beam.
3. Install driver's and passenger's lower windshield retainers on A-beam with eight screws and washers.
4. Secure closeout panel to A-beam with twelve screws, plusnuts, and washers.
5. Install engine cover (Section 10).
6. Install front console (Section 10).
7. Check operation of windshield defrosters.
8. Install right side crash pad (Section 10).



NOTE: Plusnuts must be drilled out in order to remove ducts. New plusnuts are installed in the same holes.

Figure 11-37: Windshield Defrost Ducts and Nozzles

Passenger Side Windshield Defrost Nozzle

Removal

1. Remove right side crash pad (Section 10).
2. Remove front console (Section 10).
3. Remove diverter assembly.
4. Remove main A/C - heat unit blower housing.
5. Remove four screws, lockwashers and passenger side lower windshield retainer from A-beam. Remove plusnuts (Figure 11-37).
6. Remove passenger side windshield defrost nozzle and side window demister vent hose from A-beam.
7. Remove side window demister vent hose from defroster nozzle.

Installation

1. Slide side window demister vent hose on defrost nozzle (Figure 11-37).
2. Carefully fit defroster nozzle and demister vent hose into A-beam while making sure that it aligns and creates a leak-free overlap joint with the center duct (Figure 11-37).
3. Install four screws, lockwashers and lower windshield retainer on A-beam.
4. Install main A/C - heat unit blower housing.
5. Install diverter assembly.
6. Install front console (Section 10).
7. Install right side crash pad.
8. Check operation of windshield defrosters.

Driver Side Windshield Defrost Nozzle

Removal

1. Remove right side crash pad (Section 10).
2. Remove front console (Section 10).
3. Remove four screws, lockwashers and driver's lower windshield retainer from A-beam. Remove plusnuts (Figure 11-37)
4. Remove center windshield defrost duct.
5. Remove side window demister vent hose and defrost nozzle. Pull toward center of vehicle.
6. Remove defrost nozzle from side window demister hose (Figure 11-37).

Installation

1. Slide side window demister hose on defrost nozzle (Figure 11-37).
2. Install side defrost nozzle and window demister vent hose on A-beam. Slide them toward driver's side.
3. Install center windshield defrost duct.
4. Install four screws, lockwashers and lower windshield retainer on A-beam.
5. Ensure correct overlap joint to adjacent ducts.
6. Install front console (Section 10).
7. Check operation of windshield defrosters.
8. Install right side crash pad (Section 10).

AUXILIARY BLOWER SWITCH REPLACEMENT

Removal

1. Pull front console away from dashboard.
2. Depress tabs on blower switch and push through faceplate.
3. Remove connector from back of blower switch (Figure 11-38).

Installation

1. Secure connector to blower switch and check operation (Figure 11-38).
2. Install front console.
3. Push blower switch into opening in faceplate.

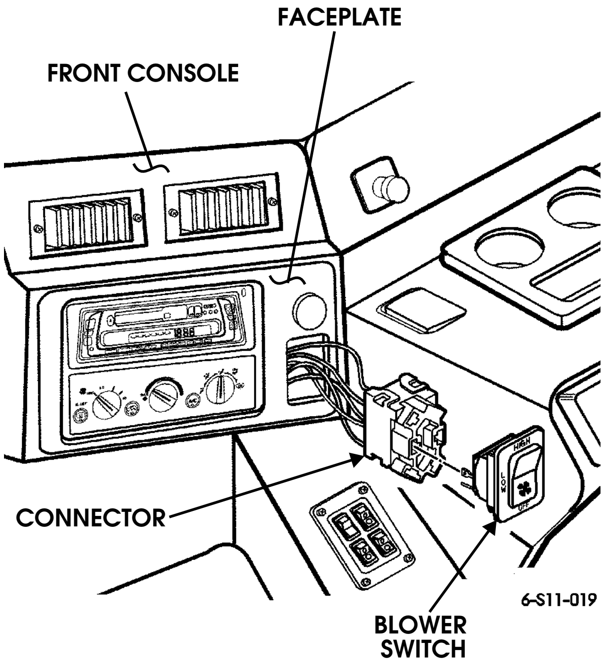


Figure 11-38: Blower Switch Replacement

REAR CONSOLE REPLACEMENT

Removal

1. Remove four screw/washers securing rear console to side brackets (Figure 11-39).
2. Push console rearward so that the vents are clear from the plenum cutouts.
3. Remove rear console.

Installation

1. Position rear console over the auxiliary HVAC unit so that the console vents line up with the plenum cutouts.
2. Push console forward until vents fit into plenum.
3. Secure rear console to side brackets with screw/washers (Figure 11-39).

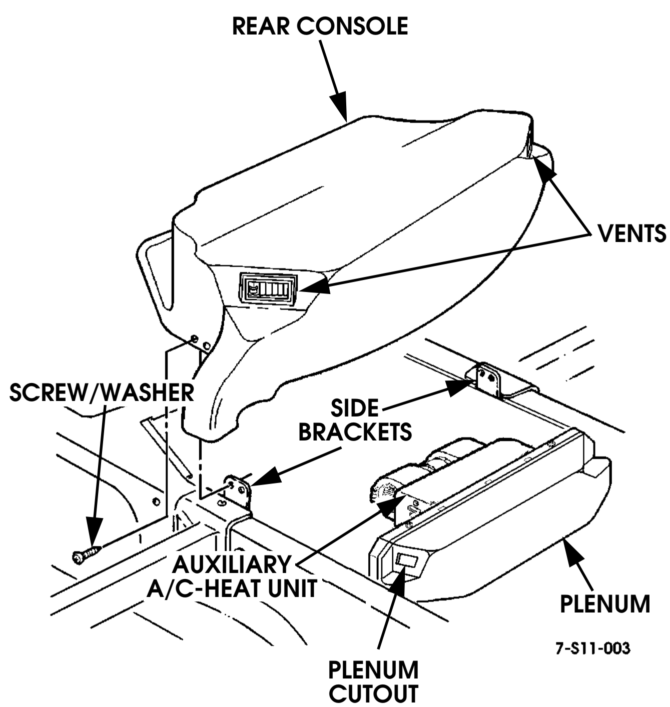


Figure 11-39: Rear Console Installation

AUXILIARY HEATER HOSE REPLACEMENT

NOTE: Heater hose replacement is the same for both heater hoses.

NOTE: Production heater hose will have full underbody length of foil back insulation sleeve. Make sure replacement hose also has this protection.

Removal

1. Drain cooling system (Section 4).
2. Remove air cleaner induction tube (Section 3).
3. Select heater hose to replace, loosen hose clamps, and remove heater hose from hose splice.
4. Remove two P-clamps from underbody securing auxiliary hoses.
5. Remove front and rear consoles.
6. Remove screw clamp securing heater hose to heater core port on auxiliary unit (Figure 11-46).
7. Pull heater hose through tunnel grommet.
8. Remove heater hose.

Installation

1. Attach one hose end to auxiliary unit heater core port and secure with clamp (Figure 11-46).
2. Route hose through grommet to engine area.
3. Connect hose to hose splice and secure with clamp.
4. Install two P-clamps to underbody securing installed hose to existing hoses.
5. Fill cooling system (Section 4).
6. Install air cleaner induction tube (Section 3).
7. Pressure test cooling system and check for leaks.
8. Install front and rear consoles.
9. Start engine and run until engine warms up.
10. Check heating units for proper operation.

AUXILIARY A/C DRAIN TUBE(S) REPLACEMENT

Removal

1. Remove rear console.
2. Remove clamps from drain tube section being replaced (Figure 11-40).
3. Remove drain tube.

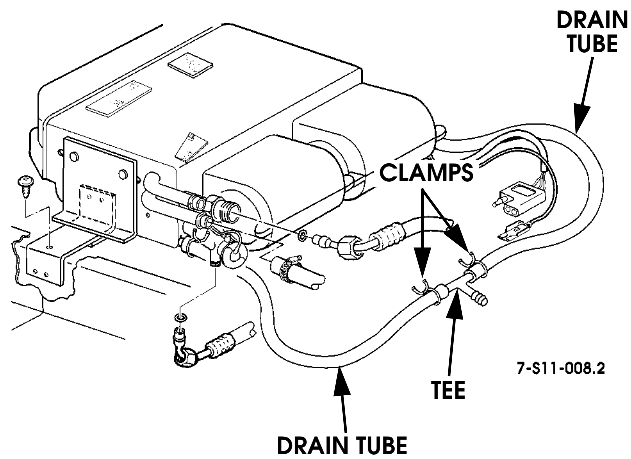


Figure 11-40: Auxiliary A/C Drain Tube Replacement

Installation

1. Install drain tube section and secure with clamps (Figure 11-40).
2. Install rear console.

AUXILIARY HIGH-PRESSURE HOSE REPLACEMENT

NOTE: NOTE: Production hoses have a full underbody length of foil-backed heat-resistant sleeving. Replacement hoses should have the same level of thermal protection.

Removal

1. Discharge air conditioning system.
2. Remove air cleaner assembly and air induction tube (Section 3).
3. Remove rear console.
4. Remove front console.
5. Using two wrenches to equalize support, remove auxiliary high-pressure hose from high pressure hose tee. Remove and discard O-ring (Figure 11-41).
6. Using two wrenches for equalized support, remove auxiliary high pressure hose from auxiliary expansion valve. Remove and discard O-ring (Figure 11-42).

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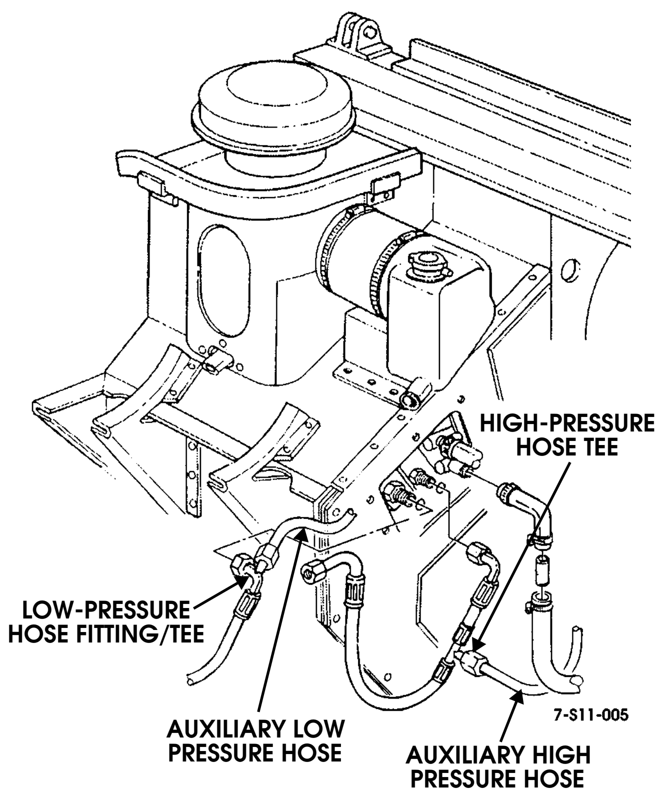


Figure 11-41: High Pressure Hose

7. Remove two P-clamps securing hose to underbody.
8. From under the vehicle pull high-pressure hose through grommet.

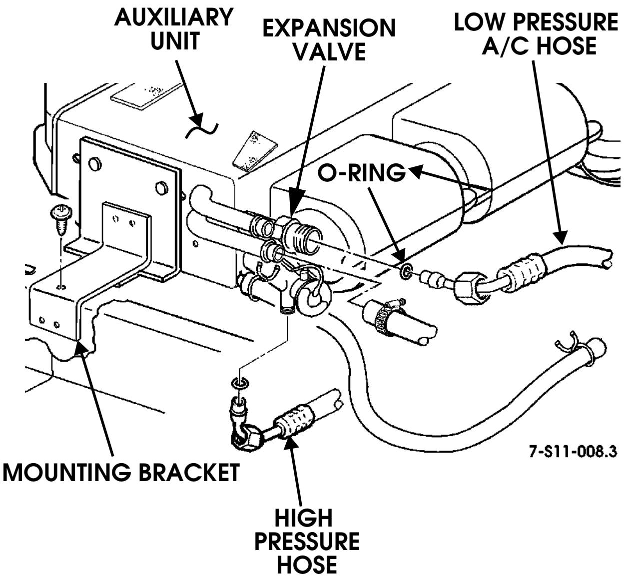


Figure 11-42: Auxiliary High-Pressure Hose

Installation

1. Route expansion valve end of hose through grommet to auxiliary unit.
2. Lubricate and position O-ring on high pressure hose and hand thread hose fitting onto expansion valve. Using two wrenches for equalized support, tighten to 11-13 lb-ft (15-18 N•m) (Figure 11-42).
3. Route other end of hose to high pressure hose tee (Figure 11-41).
4. Lubricate and position O-ring on hose and secure to high pressure hose tee. Using two wrenches for equalized support, tighten to 11-13 lb-ft (15-18 N•m).
5. Install two P-clamps to secure hoses to underbody.
6. Install front and rear consoles.
7. Evacuate, charge, and leak test system.
8. Start engine and check A/C operation.

AUXILIARY LOW-PRESSURE HOSE REPLACEMENT

Removal

1. Discharge air conditioning system.
2. Remove air cleaner assembly and air induction tube (Section 3).
3. Using two wrenches for equalized support, remove auxiliary low-pressure hose from low-pressure hose fitting. Remove and discard O-ring (Figure 11-41).
4. Remove two P-clamps securing hoses to underbody.
5. Remove front and rear consoles.
6. Remove prestite tape from low-pressure hose. Using two wrenches for equalized support, remove hose from auxiliary unit. Remove and discard O-ring (Figure 11-42).
7. From under the vehicle, pull low-pressure hose through grommet.

CAUTION: *To avoid potential thread or fitting damage, hand start connections before using wrenches.*

Installation

1. Route evaporator end of hose through grommet to auxiliary unit.
2. Lubricate and position O-ring on hose and secure to auxiliary unit. Using two wrenches for equalized support, tighten to 21-27 lb-ft (29-37 N•m) (Figure 11-42).
3. Route other end of low-pressure hose to under hood low pressure fittings.
4. Lubricate and position O-ring and secure auxiliary low pressure hose to existing low pressure hose fitting. Using two wrenches for equalized support, tighten to 24-28 lb-ft (33-38 N•m) (Figure 11-41).
5. Install two P-clamps to secure hoses to underbody.
6. Install front and rear consoles.
7. Evacuate, charge, and leak test system.
8. Start engine and check A/C operation.

AUXILIARY EVAPORATOR/HEATER CORE REMOVAL

1. Remove auxiliary unit from vehicle.
2. Remove four screws and plenum from housing.
3. With auxiliary unit on bench, remove six plastic locking pins securing unit housing halves together (Figure 11-43).
4. Remove four screws from blower motor support.
5. Remove four screws securing side brackets to upper housing half.
6. Separate housing halves.
7. Remove blower motor assembly from bottom housing.
8. Remove evaporator/heater core assembly from bottom housing.
9. Remove plastic stick pins and mesh filter from evaporator/heater core assembly.

NOTE: If expansion valve is to be reused, remove from evaporator/heater core assembly and install on replacement unit.

Installation

1. Install mesh filter on evaporator/heater core assembly with plastic stick pins (Figure 11-43).
2. Install evaporator/heater core assembly in bottom housing.
3. Install blower motor assembly in bottom housing.
4. Install upper housing to lower housing with six plastic locking pins, four blower motor support screws, and four screws securing side brackets to upper housing.
5. Install plenum on housing with four screws.
6. Install auxiliary unit into vehicle.
7. Evacuate, charge, and leak test A/C and heating system.

AUXILIARY BLOWER MOTOR REPLACEMENT

Removal

1. Disconnect auxiliary unit mounting hardware and tilt unit up to gain access to blower motor support screws.
2. Remove support screws and screws securing side brackets to upper housing half.
3. Separate housing halves and remove blower motor assembly from bottom housing.

Installation

1. Installation is the reverse of the removal procedure.

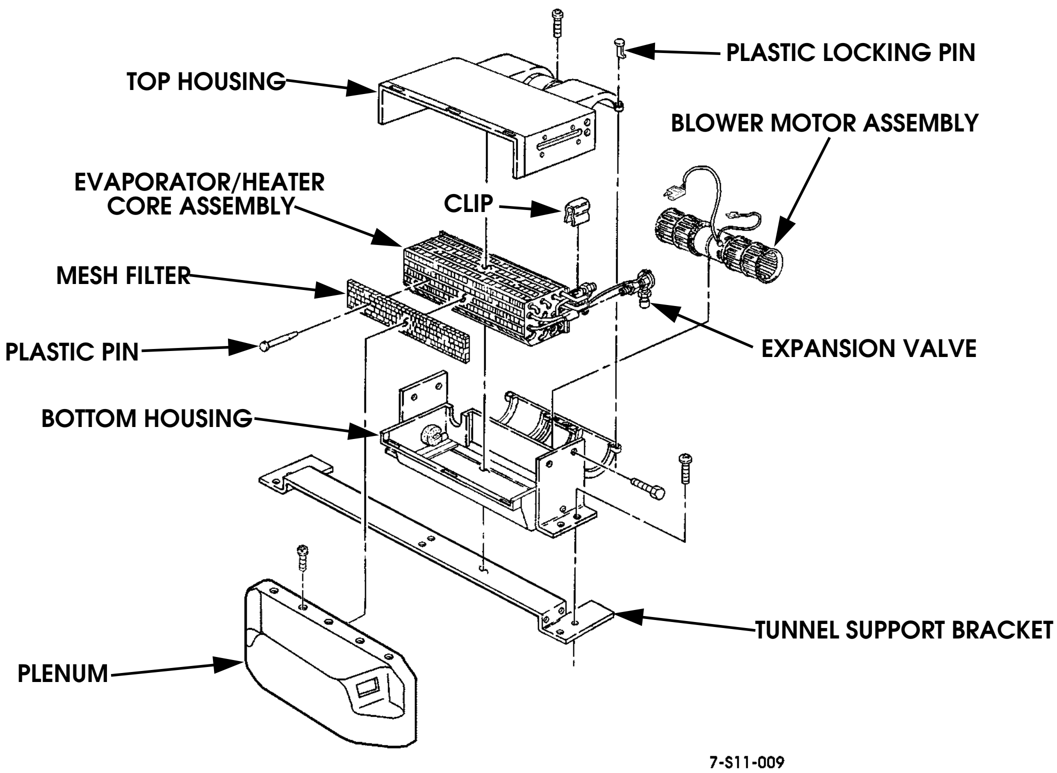


Figure 11-43: Auxiliary Air Conditioning Components

AUXILIARY EXPANSION VALVE REPLACEMENT

Removal

1. Discharge air conditioning system.
2. Remove rear console.
3. Remove prestite tape and bulb clamp.
4. Using two wrenches for equalized support, remove high-pressure hose from expansion valve. Remove O-ring from hose and discard O-ring (Figure 11-44).
5. Using two wrenches for equalized support, remove expansion valve from auxiliary unit. Remove and discard O-ring (Figure 11-45).

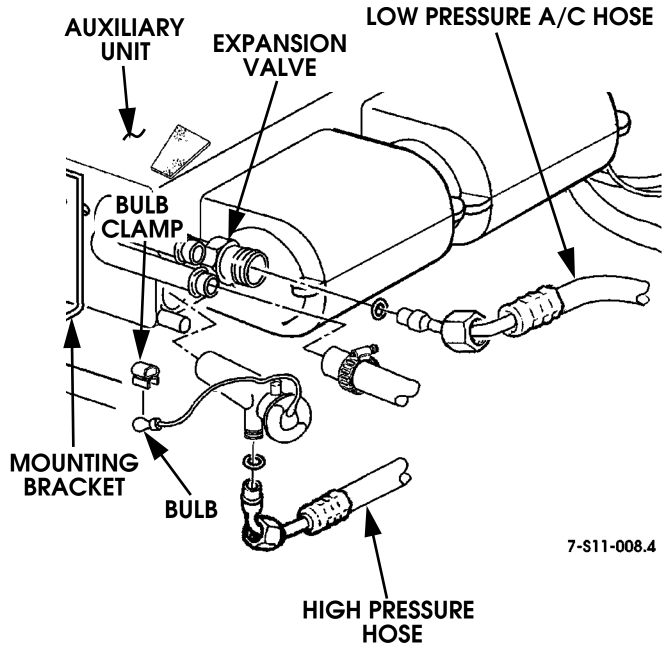


Figure 11-44: Expansion Valve Removal/Installation

Installation

1. Install O-ring and expansion valve on auxiliary unit. Using two wrenches for equalized support, tighten to 15-20 lb-ft (20-27 N•m) (Figure 11-45).
2. Position O-ring onto high pressure hose and hand-thread hose fitting onto the expansion valve. Using two wrenches for equalized support, tighten to 11-13 lb-ft (15-17 N•m) (Figure 11-44).
3. Install prestite tape and bulb clamp.
4. Evacuate, charge, and leak test system.
5. Install rear console.
6. Start engine and check operation of auxiliary unit.

AUXILIARY AIR CONDITIONING/HEATING UNIT REPLACEMENT

Removal

1. Discharge air conditioning system.
2. Remove rear console (Section 10).
3. Remove heater hoses from auxiliary unit heater core ports (Figure 11-46).

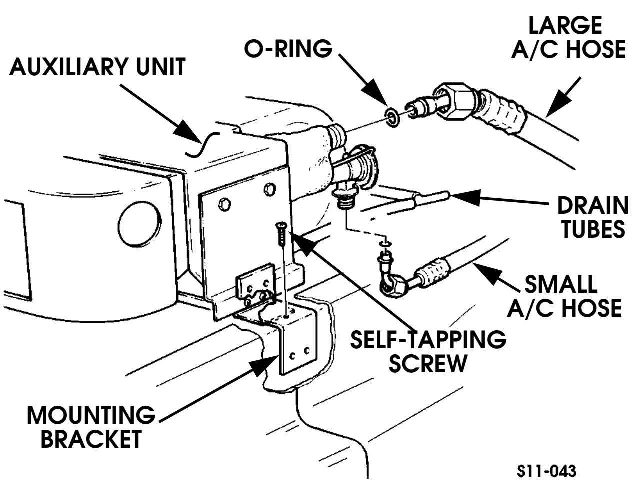


Figure 11-45: Auxiliary A/C Components

4. Remove pressure hoses from auxiliary unit.
5. Remove drain tubes from auxiliary unit (Figure 11-46).

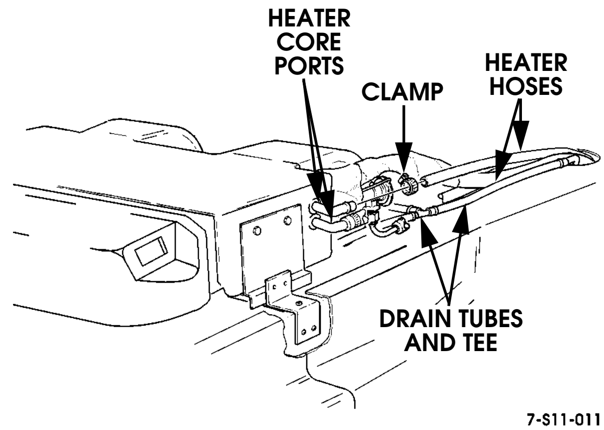


Figure 11-46: Auxiliary Heater Hose Routing

6. Remove screws securing side brackets to tunnel mounting bracket.
7. Remove auxiliary unit from vehicle.

Installation

1. Install auxiliary unit in vehicle and secure side brackets to tunnel mounting bracket with screws (Figure 11-45).
2. Install drain tubes on auxiliary unit (Figure 11-46).
3. Install pressure hoses on auxiliary unit.
4. Wrap low pressure fitting with prestite tape.
5. Secure heater hoses to heater core ports on auxiliary unit with worm gear clamps. Remove hose pinch pliers.
6. Evacuate, charge, and leak test air conditioning system.
7. Check engine coolant level and add coolant as necessary.
8. Start engine and operate auxiliary and front air conditioning system to check for proper operation.
9. Check coolant connections for leakage; repair if necessary.
10. Stop engine, recheck coolant level, and add coolant if necessary.
11. Install rear console (Section 10).

COMPRESSOR REPLACEMENT

WARNING: Air conditioning system components are subject to high-pressure refrigerant R-134a gas. Always discharge pressure and contain R-134a using approved service equipment. Use extreme care when handling R-134a. Direct contact with skin may cause frostbite. Do not smoke in areas where R-134a is stored or used. Failure to follow these warnings may result in serious injury.

Removal

1. Discharge air conditioning system.
2. Disconnect electrical connector from compressor (Figure 11-47).
3. Remove serpentine belt from pulley.
4. Remove suction/discharge hose assembly and sealing washers from top of compressor. Discard sealing washers.
5. Remove four bolts and compressor from compressor support bracket.

Installation

NOTE: Sealing washers, by design, do not require lubrication. Lubricating sealing washers during replacement will increase the possibility of contamination, which may result in refrigerant leaks.

1. Secure compressor to compressor support bracket with four bolts (Figure 11-47).
2. Insert two sealing washers and secure suction/discharge hose assembly to top of compressor with washer and bolt. Tighten bolt to 28 lb-ft (38 N•m).
3. Connect electrical connector to spade terminals on compressor.
4. Evacuate and charge air conditioning system.
5. Perform air conditioning system service, evacuate, charge, and test for leaks.

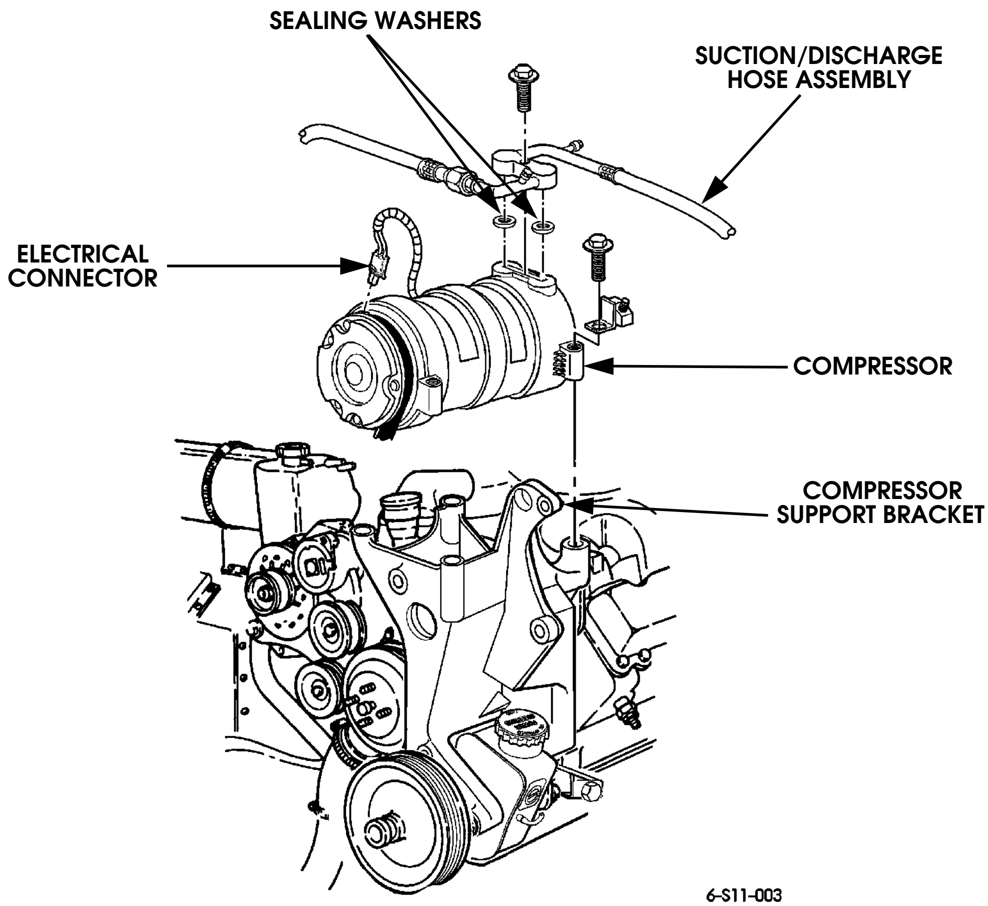


Figure 11-47: Air Conditioner Compressor and Mounting Hardware

Compressor Clutch Plate and Hub Replacement

Removal

NOTE: Removal and installation of external compressor parts, and disassembly and assembly of internal parts, must be performed on a clean workbench. The work area, tools, and parts must be kept clean at all times.

1. Remove compressor.
2. Clamp the holding fixture in a vise and attach compressor to holding fixture from set J34021-A with thumb-screws (Figure 11-48).

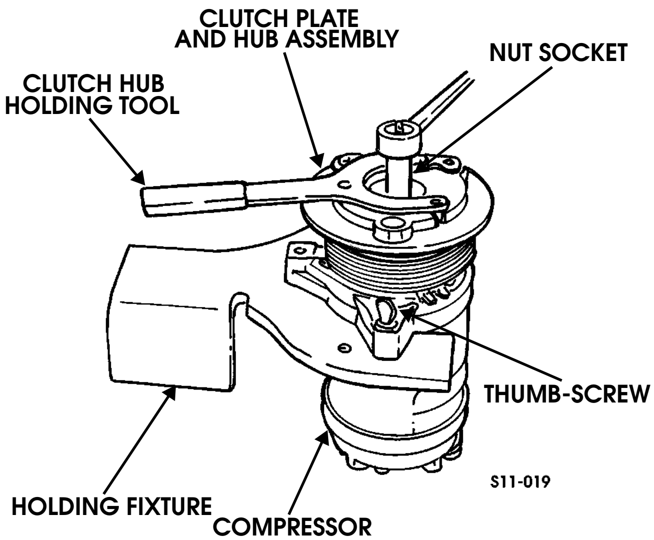


Figure 11-48: Compressor

3. Keep the clutch plate and hub assembly from turning by using the clutch hub holding tool. Remove the shaft nut using nut socket.
4. With center screw forcing tip in place to thrust against the end of the shaft, thread the hub and clutch drive plate assembly remover/installer into the hub. Hold the body of the remover with a wrench, and turn the center screw into the remover body to remove the clutch plate and hub assembly (Figure 11-49).

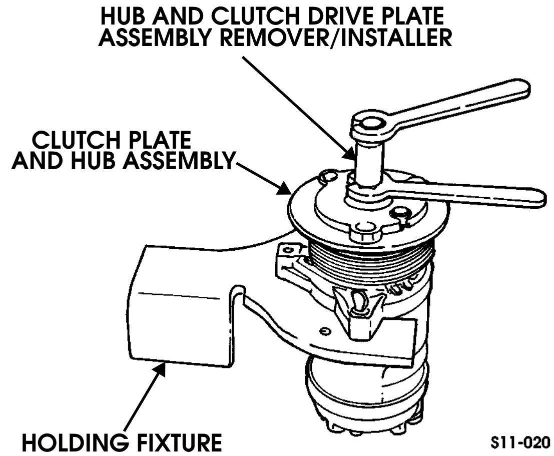


Figure 11-49: Clutch Plate and Hub Assembly

CAUTION: *Do not drive or pound on the clutch hub or shaft. Internal damage to compressor may result. The forcing tip on remover/installer center screw must be flat, or the end of the shaft/axial plate assembly will be damaged.*

5. Remove the shaft key and retain for reassembly (Figure 11-50).

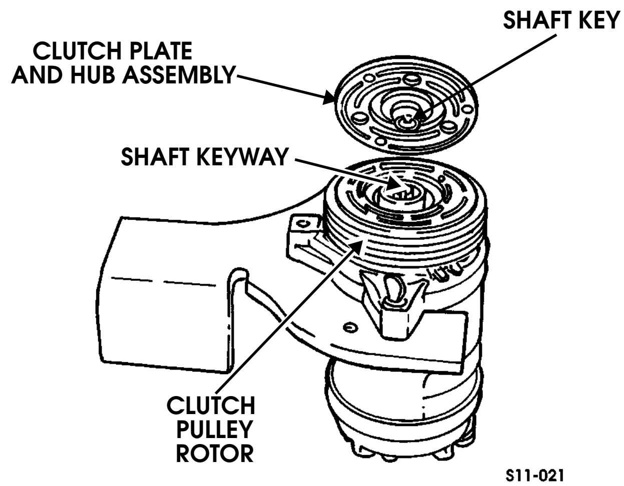


Figure 11-50: Shaft Key

Installation

1. Install the shaft key into the hub key groove. Allow the key to project approximately 1/8 in. (3.2 mm) out of the keyway. The shaft key is curved slightly to provide an interference fit in the hub key groove (Figure 11-50).
2. Be sure the frictional surface of the clutch plate and the clutch pulley rotor are clean before installing the clutch plate and hub assembly.
3. Align the shaft key with the shaft keyway, and place the clutch plate and hub assembly onto the compressor shaft.

4. Remove the forcing tip on clutch plate and hub assembly installer/remover center screw and reverse the body direction on the center screw (Figure 11-51).

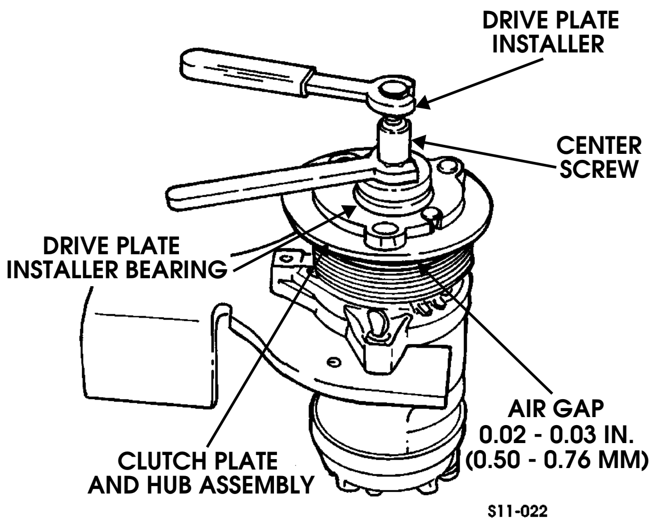


Figure 11-51: Drive Plate Installation

5. Install the clutch plate and hub assembly remover/ installer.

NOTE: The body of the remover/installer should be backed off sufficiently to allow the center screw to be threaded onto the end of the compressor shaft.

6. Hold the center screw with a wrench. Tighten the hex portion of the remover/installer body to press the hub onto the shaft. Tighten the body several turns, remove the installer, and check to see that the shaft key is still in place in the keyway before installing the clutch plate and hub assembly to its final position. The air gap between frictional surfaces of the clutch plate and clutch rotor should be 0.020-0.030 in. (0.50-0.76 mm).

CAUTION: *If the center screw is threaded fully onto the end of the compressor shaft, or if the body of the installer is held and the center screw is rotated, the key will wedge and will break the clutch hub.*

7. Remove the remover/installer and check for proper positioning of the shaft key (even or slightly above the clutch hub). Install the shaft nut. Hold the clutch plate and hub assembly with clutch hub holding tool, and using nut socket, tighten the nut against the compressor shaft shoulder to 8-16 lb-ft (11-22 N•m) (Figure 11-48).
8. Spin the pulley rotor by hand to see that the rotor is not rubbing the clutch drive plate (Figure 11-50).
9. Install compressor.

COMPRESSOR CLUTCH ROTOR AND/OR BEARING REPLACEMENT

Removal

1. Remove the clutch plate and hub assembly.
2. Using snapring pliers, remove retaining ring (Figure 11-52).

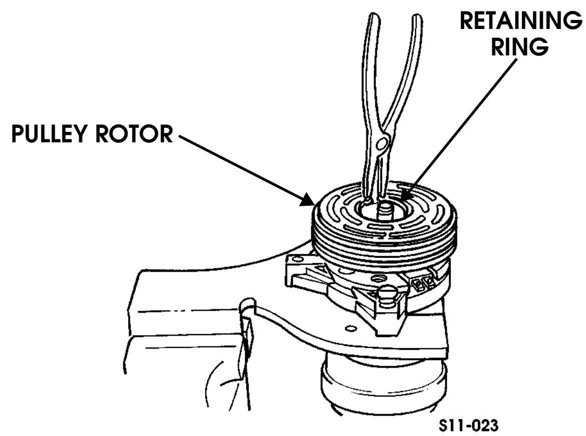


Figure 11-52: Retaining Ring

3. Install pulley rotor and bearing puller guide on the compressor, and install pulley rotor and bearing puller down into the inner circle of slots in the rotor. Turn the puller clockwise in the slots in the rotor (Figures 11-53 and 11-54).

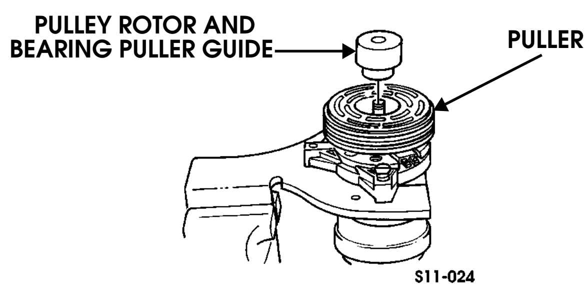


Figure 11-53: Pulley Rotor and Bearing Puller Guide

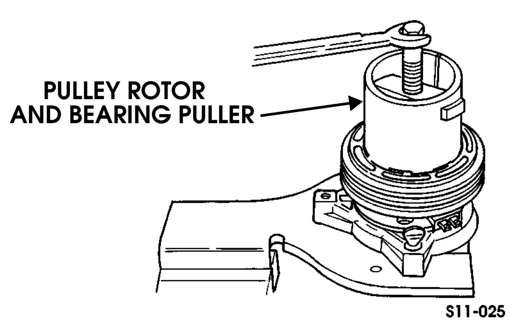


Figure 11-54: Pulley Rotor and Bearing Puller

4. Hold the puller in place and tighten the puller screw against the puller guide to remove the pulley rotor and bearing assembly.
5. To prevent damage to the pulley during bearing removal, the rotor hub must be properly supported. Remove the forcing screw from puller, and with the puller tangs still engaged in the rotor slots, invert the assembly onto a solid flat surface or blocks (Figure 11-55).

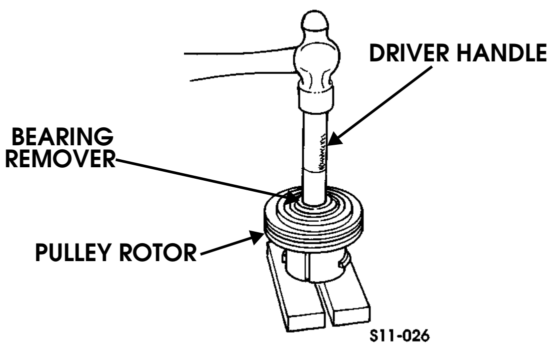


Figure 11-55: Bearing Remover

6. Drive the bearing out of the rotor hub with bearing remover and driver handle.

CAUTION: *It is not necessary to remove the staking in front of the bearing to remove the bearing, however, it will be necessary to file away the old stake metal for proper clearance for the new bearing to be installed into the rotor bore, or the bearing may be damaged.*

Installation

1. Place the pulley rotor on support block to fully support the rotor hub during bearing installation (Figure 11-55).

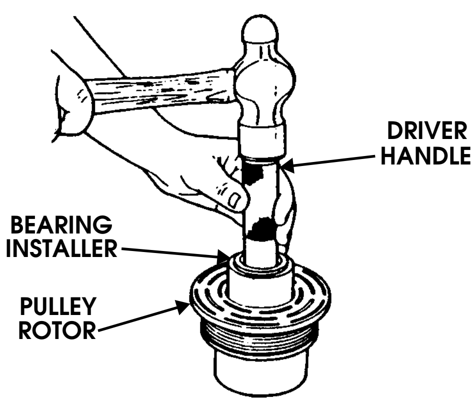


Figure 11-56: Bearing Installer

CAUTION: *Do not support the rotor by resting the pulley rim on a flat surface during the bearing installation or the rotor face will bend.*

2. Align the new bearing squarely with the hub bore, and using puller and bearing installer with driver handle, drive the bearing pulley into the hub. The installer will apply force to the outer race of the bearing if used as shown (Figure 11-56).
3. Place bearing staking guide and bearing staking pin in the hub bore. Shift the rotor and bearing assembly on the support block to give full support of the hub under the staking pin location. A heavy-duty rubber band may be used to hold the stake pin in the guide, and the stake pin should be properly positioned in the guide after each impact on the pin (Figure 11-57).

CAUTION: *Noisy bearing operation and reduced bearing life may result if outer bearing race is deformed while staking. The stake metal should not contact the outer race of the bearing. Stake three places, 120 degrees apart (Figure 11-58).*

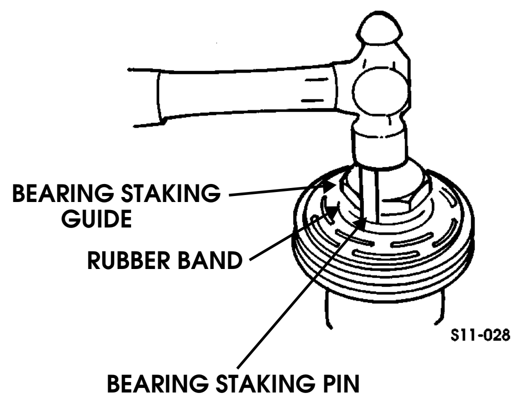


Figure 11-57: Bearing Staking Guide and Pin

4. Using care to prevent personal injury, strike the staking pin with a hammer until a metal stake, similar to the original, is formed down to, but not touching, the bearing.

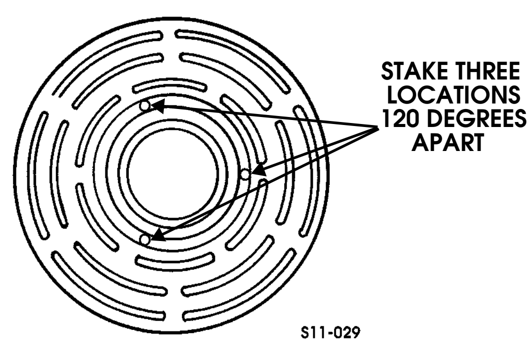


Figure 11-58: Stake Locations

5. With the compressor mounted to the holding fixture, position the rotor and bearing assembly on the front head (Figure 11-59).

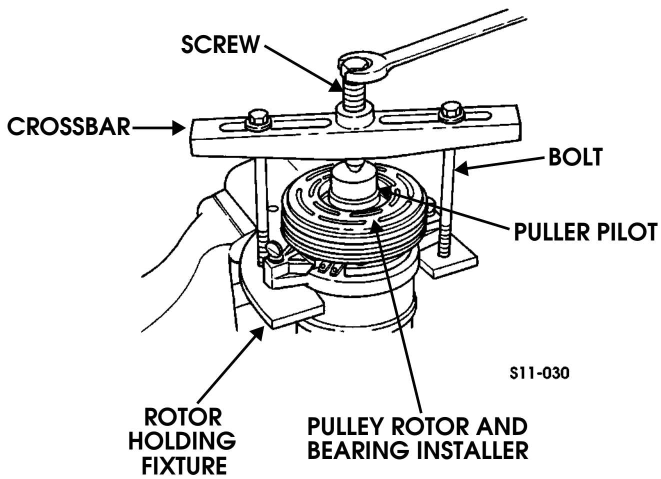


Figure 11-59: Pulley Rotor and Bearing

6. Position the pulley rotor and bearing installer, and puller pilot directly over the inner race of the bearing.
7. Position puller crossbar on the puller pilot, and assemble two through-bolts and washers through the puller bar slots, and thread them into the holding fixture. The thread of the through-bolts should engage the full thickness of the holding fixture.
8. Tighten the center screw in the puller crossbar to force the pulley rotor and bearing assembly onto the compressor. Should the pulley rotor and bearing installer slip off direct in-line contact with the inner race of the bearing, loosen the center forcing screw and realign the installer and pilot so that the installer will properly clear the compressor.
9. Using snapring pliers, install retaining ring (Figure 11-60).
10. Reinstall clutch plate and hub assembly.

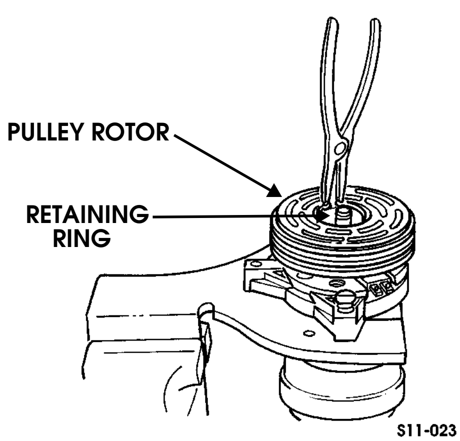


Figure 11-60: Retaining Ring

COMPRESSOR CLUTCH CORE REPLACEMENT

Removal

1. Perform steps 1 through 4 of Clutch Rotor and/or Bearings replacement procedure. Mark clutch core terminal location on compressor.
2. Install puller pilot and puller crossbar with puller legs on compressor (Figure 11-61).
3. Tighten forcing screw against the puller pilot to remove the clutch core.

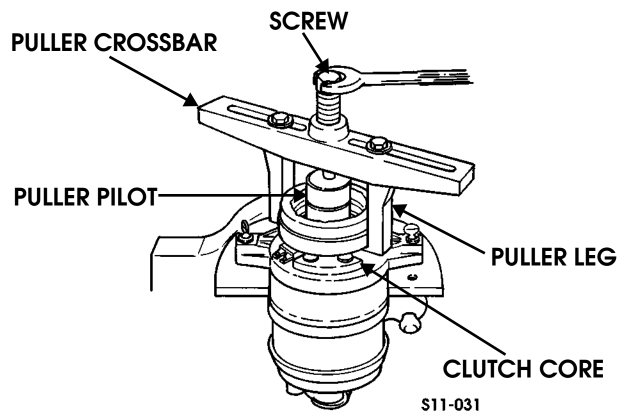


Figure 11-61: Clutch Core

Installation

1. Place the clutch core on compressor with the terminal positioned at the marked location (Figure 11-61).
2. Place the clutch core installer over the internal opening of the clutch core housing and align installer with the compressor.
3. Center the puller crossbar in the countersunk center hole of the clutch core installer. Install the through-bolts and washers through the crossbar slots, and thread them into holding fixture. The thread of the through-bolts should engage the full thickness of the holding fixture. (Figure 11-62).

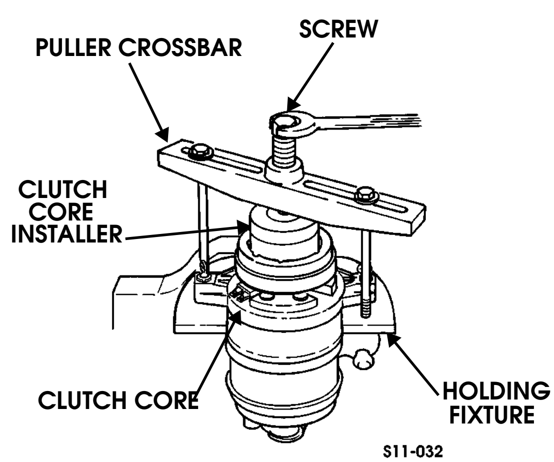


Figure 11-62: Clutch Core Installer

4. Turn the center forcing screw of the puller crossbar to force the clutch core into the compressor. Be sure clutch core and installer stay aligned during installation.
5. When core is fully seated on the compressor, use a 1/8-in. diameter drift punch and stake the front head at three places, 120 degrees apart, to ensure clutch core remains in positioning (Figure 11-63).

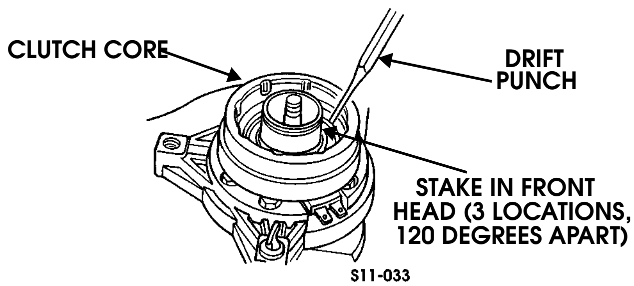


Figure 11-63: Drift Punch

NOTE: Stake size should be only one-half the area of the punch tip and approximately 0.010-0.015 in. (0.25-0.38 mm) deep.

6. Install rotor and bearing assembly and clutch plate and hub assembly.

COMPRESSOR SHAFT SEAL REPLACEMENT

Removal

1. Remove clutch plate and hub assembly.
2. Using snapring pliers, remove the shaft seal retaining ring (Figure 11-64).

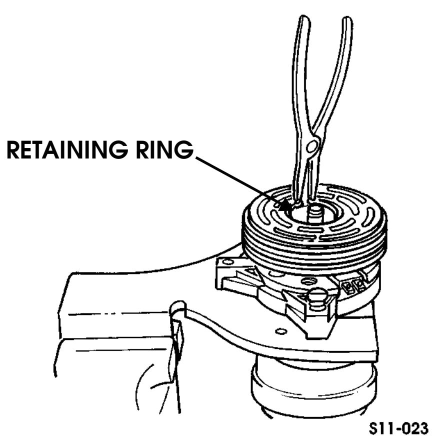


Figure 11-64: Shaft Seal Retainer Ring

CAUTION: *The handle must be hand-tightened securely. Do not use a wrench or pliers.*

NOTE: Thoroughly clean inside of compressor neck area surrounding the shaft, the exposed portion of the seal, the retainer ring groove and the shaft itself. Any dirt or foreign material getting into compressor may cause damage.

3. Fully engage the knurled tangs of seal remover/installer into recessed portion of seal by turning handle clockwise. Remove seal from the compressor with a rotary-pulling motion. Discard seal (Figure 11-65).

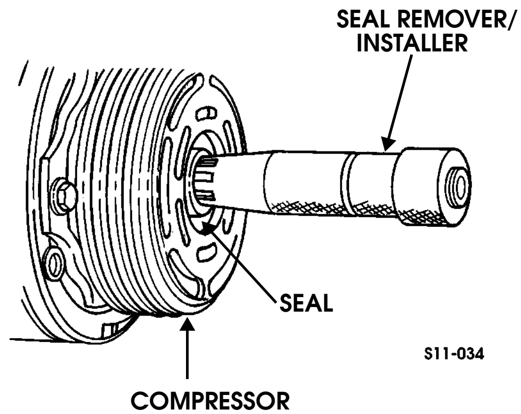


Figure 11-65: Seal Remover

4. Using O-ring remover, remove and discard seal seat O-ring from the compressor neck (Figure 11-66).

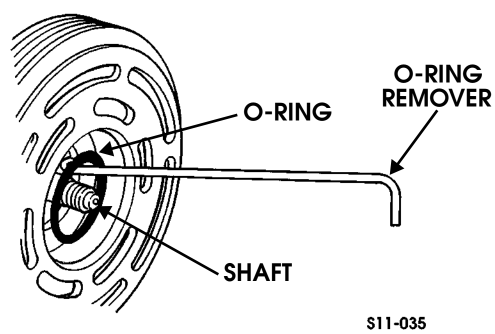


Figure 11-66: O-Ring

5. Recheck shaft and inside of the compressor neck for dirt or foreign material and be sure these areas are clean before installing new parts.

Cleaning

Thoroughly clean seal seat O-ring groove in front head.

Installation

CAUTION: *Seals should not be reused. Always use a new specification service seal. Be sure that the seal to be installed is not scratched or damaged in any way. Make sure that the seal seat and seal are free of lint and dirt that could damage the seal surface or prevent sealing.*

1. Dip new seal seat O-ring in clean PAG oil and install onto O-ring installer (Figure 11-67).

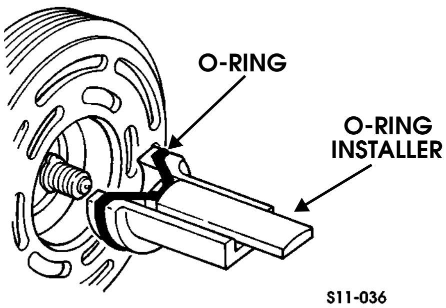


Figure 11-67: O-Ring Installer

2. Insert O-ring installer into the compressor neck until installer bottoms. Lower the moveable slide of the O-ring installer to release the O-ring into the seal seat O-ring lower groove. (The compressor neck top groove is for the shaft seal retainer ring.) Rotate the installer to seat the O-ring and remove the installer.
3. Dip new seal in clean PAG oil and assemble seal onto seal installer by turning handle clockwise. The stamped steel case side of the lip seal must be engaged with knurled tangs of installer so that the flared-out side of lip seal is facing and installed towards the compressor. Install seal protector in the seal lip and place over the compressor shaft, and push the seal in place with a rotary motion, or place the seal protector over end of compressor shaft, and slide the new seal onto the shaft with a rotary motion until it stops. Take care not to dislodge the O-ring. Be sure the seal makes good contact with the O-ring. Disengage the installer from the seal and remove the installer and the seal protector (Figure 11-68).

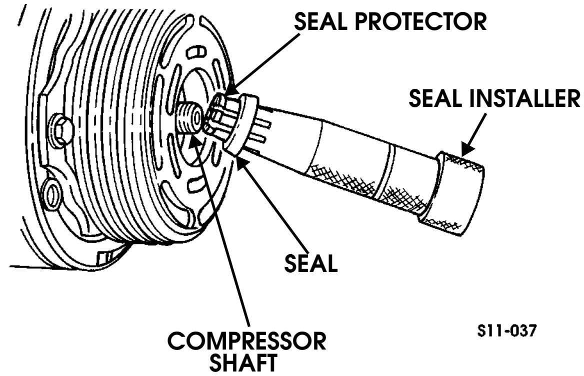


Figure 11-68: Seal Installer

CAUTION: *Handling and care of seal protector is important. If seal protector is nicked or the bottom flared, the new seal may be damaged during installation.*

4. Using snapring pliers, install new seal retaining ring with its flat side against the seal (Figure 11-69).

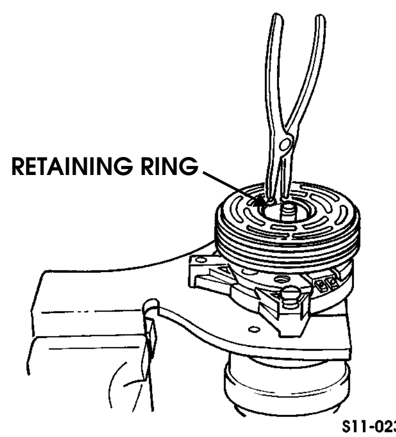


Figure 11-69: Seal Retaining Ring

5. Remove any excess oil from the shaft and inside the compressor neck.
6. Install the clutch plate and hub assembly.

SPECIFICATIONS

System refrigerant — R-134a

Compressor oil — PAG (polyalkaline glycol)

Refrigerant capacity — 1 lb 8 oz. (.51 kg) w/o auxiliary A/C

1 lb. 13 oz. (.71 kg) with auxiliary A/C

Compressor type — Harrison HT6

A/C System Test Pressures

Ambient Temperature		Low Side Pressure Range*		High Side Pressure Range*	
F°	**C°**	**Psi**	**kPa**	**Psi**	**kPa**
70	21	10-32	69-221	112-270	772-1861
75	24	12-33	83-228	120-280	827-1930
80	27	17-34	117-234	131-310	903-2137
85	29	18-35	124-241	185-325	1276-2172
90	32	19-47	131-324	210-330	1448-2275
95	35	21-47	145-324	225-350	1551-2413
100	38	28-51	193-352	240-370	1655-2551
110	43	30-55	207-379	255-390	1758-2689

*Low and high side pressures are affected by relative humidity. Greater humidity will cause higher pressures

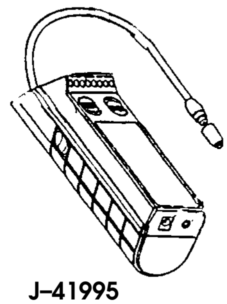
R-134a Pressure-to-Temperature Relationship Chart (with Engine OFF)

Psi	Temp (°F) R-134a	Psi	Temp (°F) R-134a	Psi	Temp (°F) R-134a	Psi	Temp (°F) R-134a
0	-14.7	25	29.3	70	69.6	200	130.1
1	-12.1	26	30.5	75	72.9	210	133.5
2	-9.6	27	31.7	80	76.1	220	136.7
3	-7.2	28	32.9	85	79.2	230	139.8
4	-4.9	29	34.0	90	82.2	240	142.9
5	-2.7	30	35.1	95	85.0	250	145.9
6	-0.6	32	37.4	100	87.8	260	148.8
7	1.4	34	39.5	105	90.5	270	151.6
8	3.4	36	41.6	110	93.1	280	154.3
9	5.3	38	43.6	115	95.6	290	157.0
10	7.1	40	45.6	120	98.0	300	159.6
11	8.9	42	47.4	125	100.4	310	162.2
12	10.6	44	49.2	130	102.7	320	164.7
13	12.3	46	51.0	135	104.9	330	167.2
14	13.9	48	52.8	140	107.1	340	169.6
15	15.4	50	54.5	145	109.3	350	171.9
16	17.0	52	56.4	150	111.4	360	174.2
17	18.5	54	57.8	155	113.3	370	176.5
18	19.9	56	59.3	160	115.4	380	178.7
19	21.4	58	60.8	165	117.4	390	180.7
20	22.8	60	62.4	170	119.3	400	183.1
21	24.1	62	63.9	175	121.2	-	-
22	25.5	64	65.4	180	123.0	-	-
23	26.8	66	66.8	185	124.8	-	-
24	28.0	68	68.2	190	126.6	-	-

Air Flow Chart

MODE	MINI-MUM AIR FLOW	ACTUAL READ-ING	ACCEPT	REJECT	REC. MODE	REPAIR	**HEAT-A/C AIR FLOW TEST BLOWER ADAPTERS = (5)**
DEFROST MODE	475						**1. DRIVERS SIDE DEFROST ADAPTERS (1 & 2)**
DEFROST MODE	AIR PRESENT						**2. DRIVERS SIDE WINDOW VENT VERIFY AIR IS PRESENT**
FACE MODE	300						**3. LEFT FRT DRIVERS SIDE VENT (CONSOLE) ADAPTER (2)**
FACE MODE	350						**4. RT. FRT. DRIVERS SIDE VENT (CONSOLE) ADAPTER (2)**
FLOOR MODE	600						**5. DRIVERS SIDE FOOT VENT ADAPTER (4)**
AUX FAN	250						**6. DRIVERS SIDE FRT. VENT (AUX. UNIT) ADAPTER (2)**
AUX FAN	800						**7. DRIVERS SIDE REAR VENT (AUX. UNIT) ADAPTER (2)**
FACE MODE	400						**8. DRIVERS SIDE UPPER I/P VENT**
AUX FAN	1100						**9. PASS. SIDE REAR VENT (AUX. UNIT) ADAPTER (2)**
DEFROST MODE	800						**10. PASS. SIDE DEFROST ADAPTERS (1 & 2)**
DEFROST MODE	AIR PRESENT						**11. PASS. SIDE WINDOW VENT VERIFY AIR IS PRESENT**
FLOOR MODE	400						**12. PASS SIDE FOOT VENT ADAPTER (8)**
FACE MODE	475						**13. PASS SIDE VENT (FRT. CONSOLE) ADAPTER (2)**

ESSENTIAL TOOLS

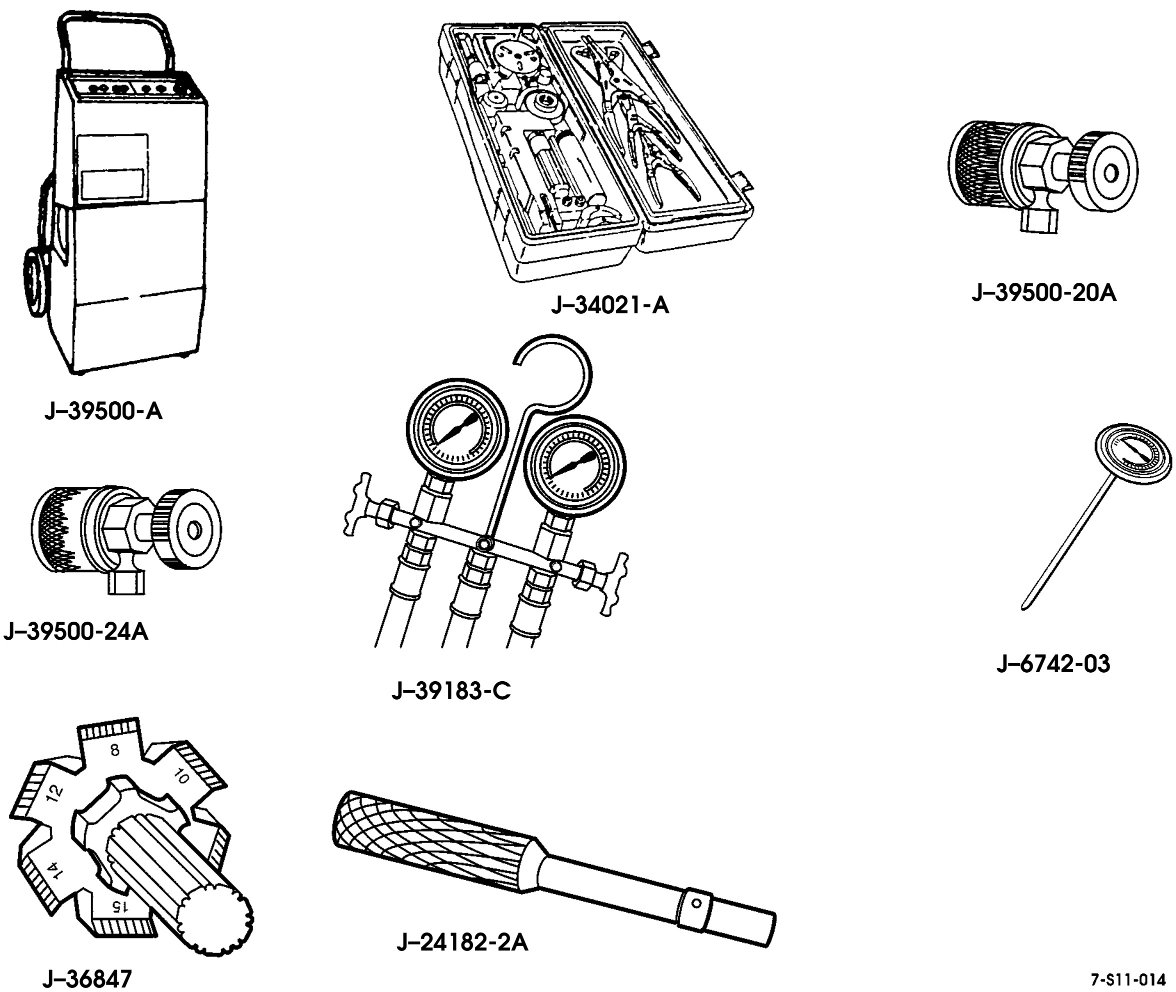


7-S11-015

Tool No.	Description
J–41995 J–42549 J–42550	D-Tek Electronic Leak Detector HVAC Anemometer (not shown) HVAC Flow Meter Adapter Kit (not shown)

Procure from Kent-Moore.

SPECIAL TOOLS



Tool No.	Description
J–39500-A	A/C Recovery, Recycle, Evacuate and Discharge Service Cart (from Robinaire)
J–34021-A	Compressor Clutch Pulley, Core and Bearing Replacement Tool Set
J–39500-20A	High Side Coupler Adapter (Compact Profile)
J–39500-24A	Low Side Coupler Adapter (Compact Profile)
J–39183-C	Manifold Gauge Set
J–6742-03	Thermometer
J–36847	Condenser Fin Straightener Tool
J–24182-2A	Schrader Valve Core Tool

Procure from Kent-Moore.

HVAC SYSTEM DESCRIPTION FOR VIN # 176477 AND UP

The heating, ventilating, and air conditioning system consists of the main unit (heat and A/C, or heat only), auxiliary unit (if equipped), ducting for air, hoses to transport refrigerant, coolant hoses, a water valve, A/C compressor, condenser, receiver drier, expansion valve, safety switches, and vacuum pump. Function of the system is controlled by the vehicle operator using the control panel on the console.

MAIN HVAC UNIT

The main HVAC unit is comprised of a heater core for heating air, and evaporator for cooling air, mode doors to direct airflow, and an electric blower motor and fan to force air through the case to be heated or cooled, then directed to the selected zones in the vehicle (Figure 11-70).

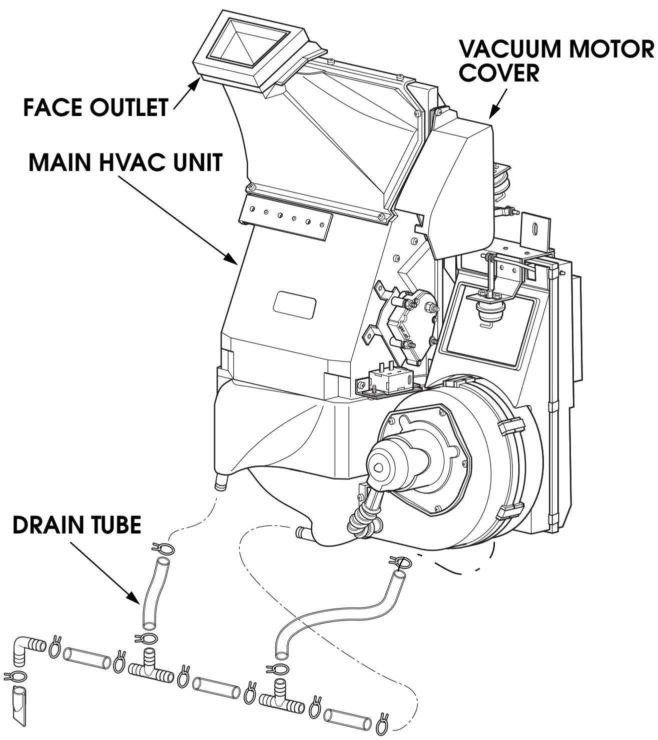


Figure 11-70: Main HVAC Unit

Diverter Doors

Four diverter doors occupy the outlet area of the main unit. Various positions and combinations of 4 doors provide the system with the following mode selections:

- Off
- Maximum A/C - Recirculate
- A/C
- A/C Face/Floor blend
- Face
- Floor
- Defrost/Floor blend
- Defrost

All 5 of the mode doors are operated using vacuum door motors mounted externally to the case (Figure 11-71). The motors are as follows:

- Floor door motor
- Defrost blockoff motor
- Face door motor
- Defrost door motor
- Recirculate door motor

The vacuum motors are capable of 2 positions: fully extended (spring pressure), or fully retracted (vacuum). The face door motor is an exception, having a third position in the middle of travel. A second vacuum inlet is added to the face door motor for this purpose (Figure 11-71).

The temperature blend door motor operates the temperature blend door. This door is responsible for regulating outlet air temperature by directing air through the heater core or by blocking air to the core. The temperature blend door motor is electric, and can be positioned at multiple positions.

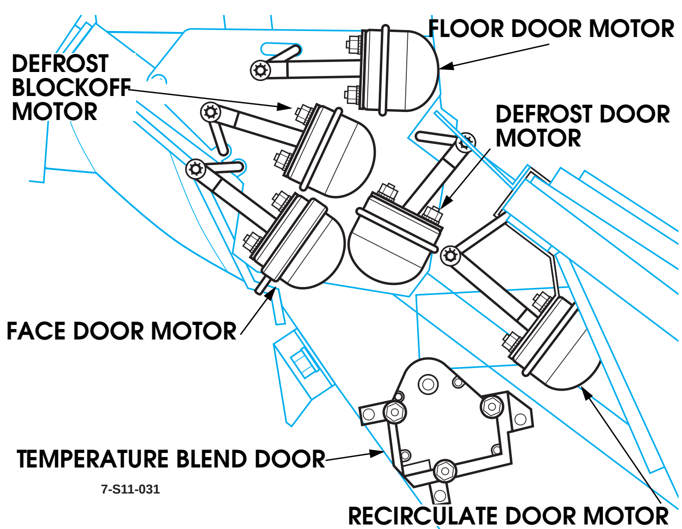


Figure 11-71: Vacuum Door Motors

Heater Core

The heater core is composed of copper and brass with numerous passages allowing heated engine coolant to pass through, transferring heat into the passing air from the blower motor. Coolant flow through the heater core is controlled by the water control valve in the engine compartment (Figure 11-72).

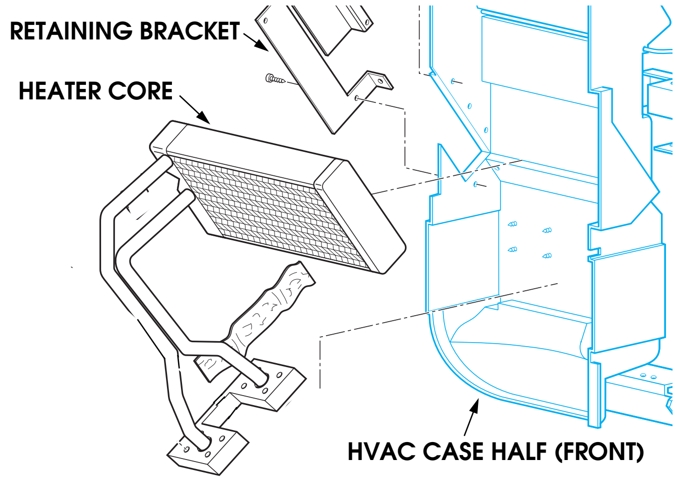


Figure 11-72: Heater Core

Water Control Valve

The water control valve determines when coolant will flow through the heater core(s). The design of the valve allows the engine coolant to flow around (bypass) the HVAC system when the temperature dial on the control head is moved to the cold position. The valve is operated by vacuum directed by the control head. When vacuum is applied, the valve bypasses. When atmospheric pressure is vented in, engine coolant flows through the heater core(s) (Figure 11-73).

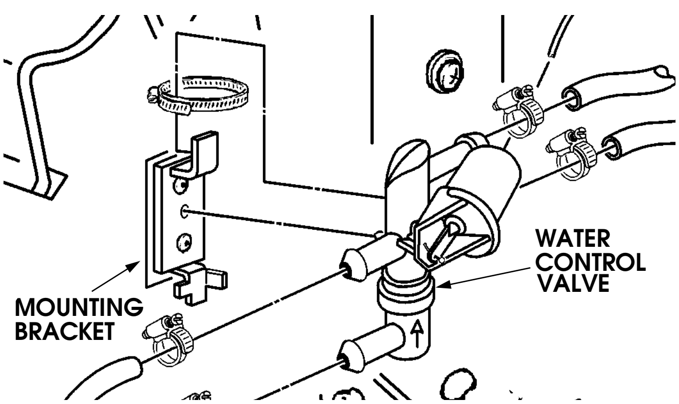


Figure 11-73: Water Control Valve

Evaporator

The evaporator is composed of a wide flat aluminum tube bent in a serpentine pattern. Fins extending out from the tube assist in transferring heat from the passing air into the refrigerant which is evaporating inside of the tubes (Figure 11-74).

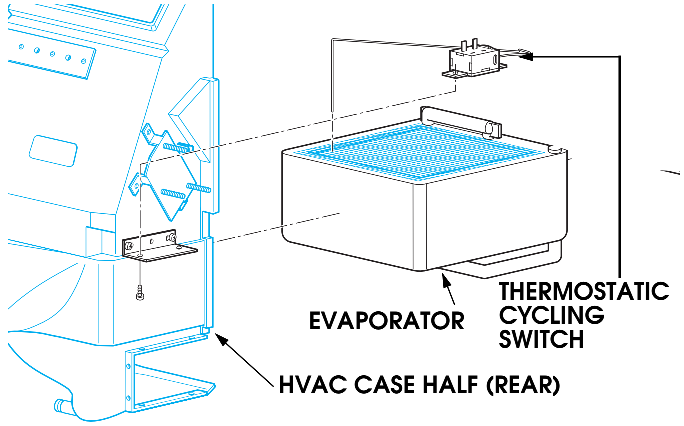


Figure 11-74: Evaporator

Thermostatic Cycling Switch

The thermostatic cycling switch is mounted on the side of the main HVAC unit (Figure 11-74). The thermostatic cycling switch is responsible for turning off the compressor clutch when evaporator temperature approaches freezing. Temperature is sensed by a capillary tube inserted in the fins of the evaporator. Should the evaporator reach freezing temperatures, moisture condensing on the fins of the evaporator will freeze and hinder air flow. The thermostatic cycling switch will interrupt current to the compressor clutch until the temperature rises to about 40° F.

Expansion Valve

The expansion valve controls the flow of refrigerant through the evaporator. Refrigerant must be metered to prevent the liquid refrigerant from flooding the evaporator. The expansion valve is exposed to both low and high pressures, and bases refrigerant flow on the pressure which is exiting the evaporator (Figure 11-75).

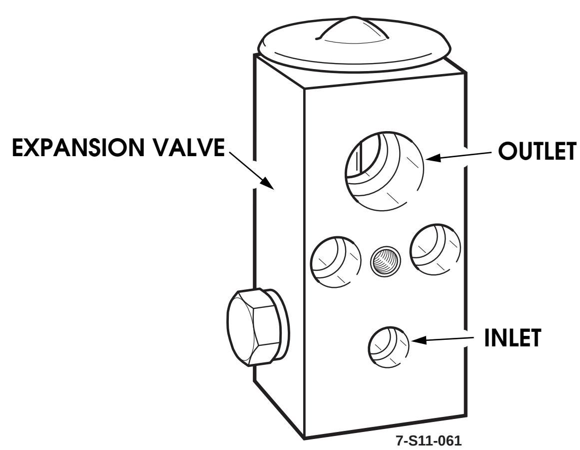


Figure 11-75: Expansion Valve

Blower Motor

The blower motor is a permanent magnet electric motor that drives a wheel type fan. The air enters the unit from the outside air intake, or from a door on the interior of the vehicle. The air is then forced through the evaporator and heater core.

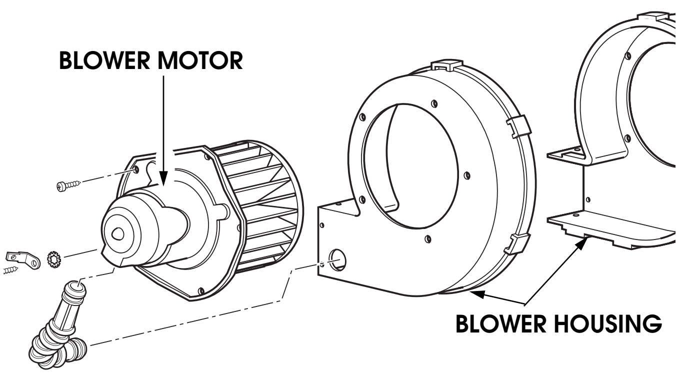


Figure 11-76: Blower Motor and Housing

A/C Compressor

All 1997 vehicles use a common Harrison model HR6 compressor. The compressor is belt driven off the engine accessory drive, and utilizes an electric clutch to engage and disengage the compressor drive. The compressor is lubricated with required GM PAG oil. The compressor is specifically designed to operate with R134a refrigerant.

High Pressure Cutoff Switch

The high pressure cutoff switch is located in the rear of the compressor. The switch is wired in series with the compressor clutch and exposed to high side pressure in the compressor. Should pressure exceed the switch setting, current will be interrupted to the compressor clutch until the pressures drop to safe levels, then the switch will close allowing the clutch to engage (Figure 11-77).

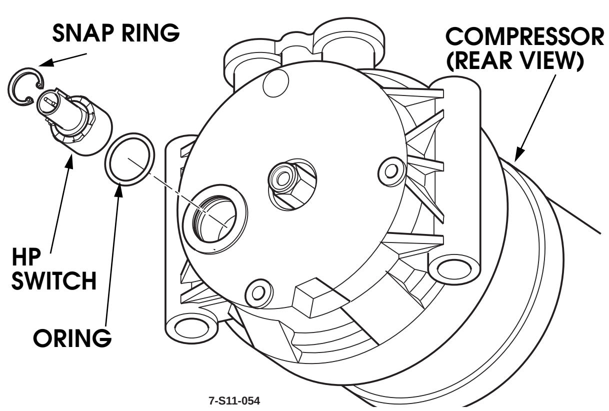


Figure 11-77: High Pressure cutoff switch

LOW PRESSURE CUTOFF SWITCH

The low pressure cutoff switch is mounted on the receiver/drier. The switch is wired in series with the compressor activation circuit. Should pressure drop below the switch's setting, the switch will open and interrupt current flow to the compressor clutch. The switch will prevent damage to the system from lack of oil flow due to inadequate charge or very low ambient temperatures. The switch will close when the system pressure rises to safe levels (Figure 11-78).

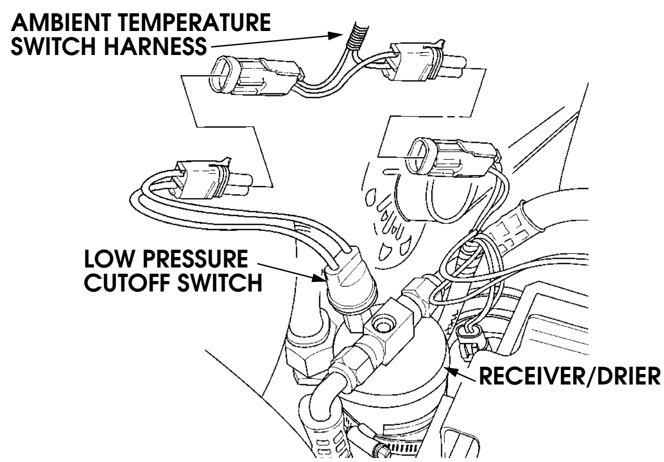


Figure 11-78: Receiver/Drier with Low Pressure Cutoff Switch

Receiver/Drier

The receiver/drier provides storage for high pressure liquid refrigerant. Desiccant inside of the receiver/drier assists in removing moisture from the refrigerant. The receiver/drier also act as a filter, filtering out particles of debris and preventing bubbles of vapor from entering the expansion valve (Figure 11-78).

Ambient Temperature Switch

The ambient temperature switch is mounted on the right front of the condenser. The switch, which monitors ambient air temperature, is wired in series with the compressor activation circuit. The switch interrupts current flow to the compressor clutch when outside temperature drop below 45°F (10°C) (Figure 11-79).

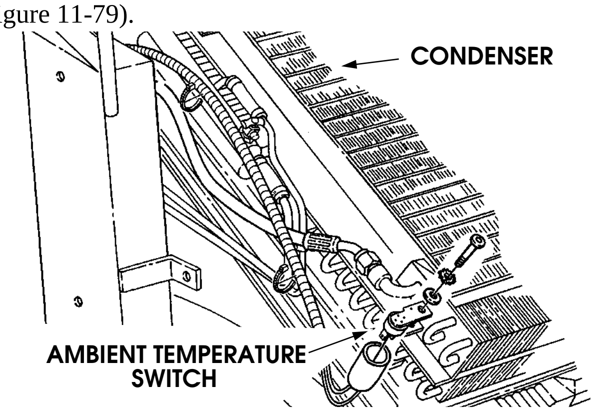


Figure 11-79: Ambient Temperature Sensor

Condenser

The condenser provides heat exchange for the A/C system. The condenser is located on the front of the radiator and cooler assemblies. Air from forward movement, and the engine cooling fan is forced through the fins of the condenser, removing heat from the highly pressurized refrigerant. Refrigerant enters the condenser as a vapor, and exits as a liquid.

A/C High Temperature Cutoff Switch (VIN Y)

The A/C high temperature cutoff switch is threaded into the engine coolant crossover pipe. Exposed directly to the engine coolant, the switch senses engine temperature. Should engine temperature rise too high, the switch will open and interrupt current flow to the compressor clutch. The switch will stay open until engine temperature drops below the unsafe levels. Vehicles using VIN Z engines utilize the PCM to turn off the A/C when temperatures rise too high (Figure 11-80).

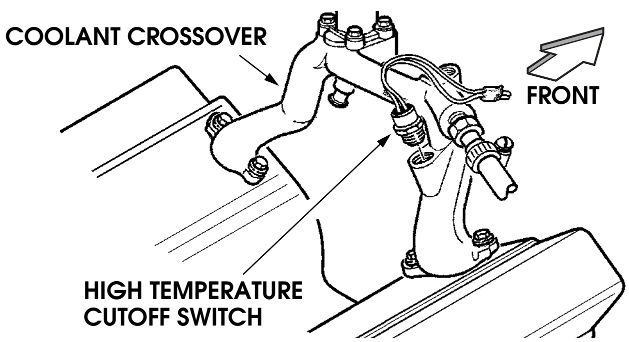


Figure 11-80: High Temperature Cutoff Switch

HVAC CONTROLS

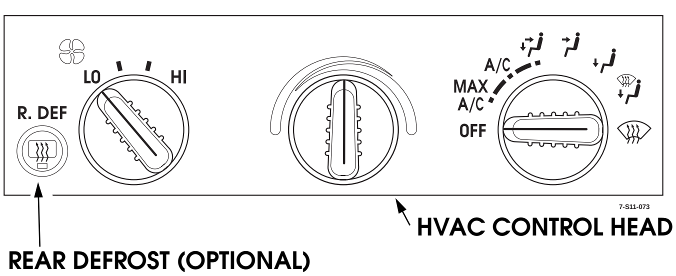


Figure 11-81: HVAC Control Panel

The HVAC system is operated using a control panel. The panel has controls for:

- Blower speed
- Air temperature
- Mode
- Air conditioning
- Rear window defrost (Optional)

Status for all of the controls is shown using painted marks on the faceplate of the control panel. Operation is based on driver input, no automatic function is incorporated. Controls for the HVAC system are based on (vacuum) door motors and water valve controls, and (electric) blower motor and temperature door motor controls (Figure 11-81).

Blower Speed Dial

The blower speed dial has 4 positions.

- Low
- Med 1
- Med 2
- High

The operator selects the fan speed by rotating the dial clockwise (Figure 11-82).

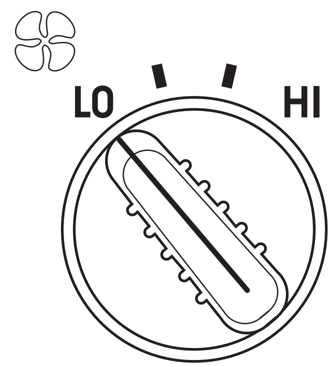


Figure 11-82: Blower Speed Dial

Temperature Dial

The temperature dial controls the temperature of the air exiting the HVAC unit. When the dial is rotated to the cold position, the water valve is shut off and the temperature door isolates the heater core. When the dial is rotated to the HOT position, the water valve opens and the temperature blend door directs air through the heater core. Between COLD and HOT, temperature is regulated by changing the amount of air that passes through the heater core (Figure 11-83).

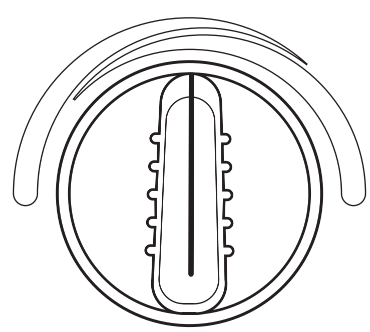


Figure 11-83: Temperature Control Dial

Mode Dial

The mode dial allows the operator to direct air to a selected area. When the driver rotates the dial clockwise and chooses a mode, vacuum is sent to the vacuum motors that must close (Figure 11-84).

NOTE: When the main HVAC unit is without vacuum, air will be directed to the defrost and floor vents, and fresh air will be used. The blower motor on the HVAC unit will not function if the mode dial is set at the OFF position. When the dial is positioned on an A/C position, the compressor clutch will be activated.

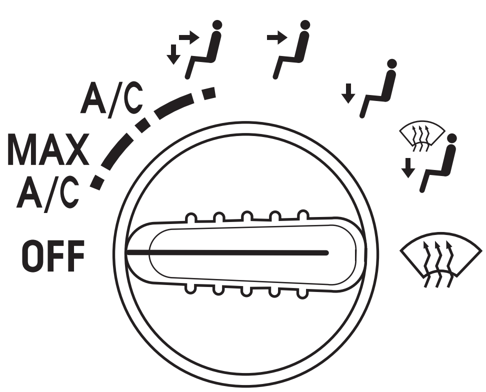


Figure 11-84: Mode Dial

Rear Defrost Button

The vehicle may be equipped with optional rear defrost. The rear defrost is comprised of an electrical grid which is bonded to the rear center glass. When the rear defrost button is pushed, a timed electric current is sent to the grid causing the temperature of the grid and glass to slowly rise, melting frost or evaporating exterior window fogging. The timer in the switch will shut off the current when an adequate amount of time has passed. This option is only available on the XLC2, and HMC4.

Auxiliary Unit

A secondary HVAC unit is used on all 4-passenger vehicles as standard equipment. Two-passenger vehicles can be equipped with an auxiliary unit as an option. The auxiliary unit includes a secondary heater core, evaporator, expansion valve, blower motor and controls. Both the heater and A/C work in parallel with the main unit, requiring that the main system be in operation to activate the auxiliary unit. The blower in the auxiliary unit is operated using a 3-position switch on the console and provides 2 speeds and an off position.

UNIT SERVICE

WARNING: When working with refrigerant, always use protective equipment to prevent injury. Refrigerant handling should be done only by technicians trained and certified in the use of refrigerant and refrigerant service equipment.

CAUTION: *Use only equipment and materials designed to operate with R134a refrigerant. Never substitute parts or materials designed for R12.*

CAUTION: *Never use sealers in or on the HVAC unit that are designed for ventilation systems. Some sealers release noxious or irritating odors that will be offensive to operators of the vehicle. Neutral cure sealers should be used when sealing any area o the HVAC unit that could potentially expose the operator of the vehicle or the passengers to the released chemicals.*

MAIN UNIT

Removal

1. Drain Coolant into an approved container.
2. Recover refrigerant.
3. Remove raincap and adapter.
4. Remove air intake elbow, air cleaner and splash shield.
5. Remove 4 bolts securing heater core extension tubes. Plug all open holes and discard all sealing washers (Figure 11-85).

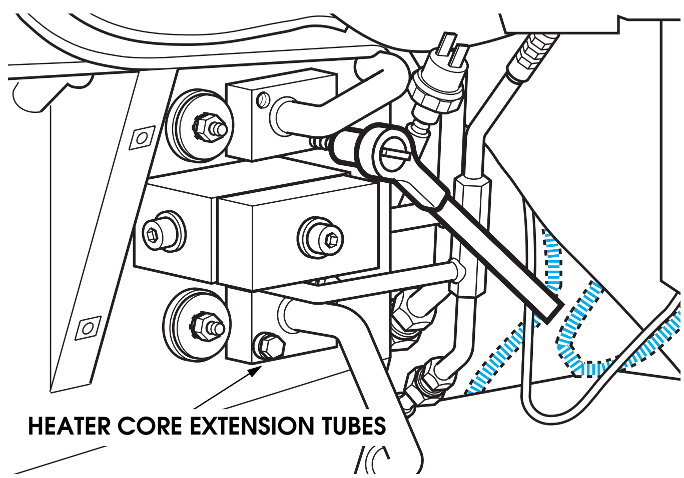


Figure 11-85: Heater Core Extension Tube Removal

6. Remove any pliable sealer from exterior of the passthrough plate.
7. Remove the center console.
8. Remove the right side crash pad.
9. Remove the fastener from passenger side closeout panel.
10. Lower panel down to gain access to the floor outlet hose, remove the screw securing the hose, and remove the closeout panel.
11. Remove 2 screws securing the passenger side of auxiliary heat/cool unit. Raise the cover up approximately 2” and support with a block of wood. Remove the passenger side door strap bracket and seat belt.

12. Remove the front passenger seat, and the right front inner and outer kick panels.

NOTE: Panels are removed to prevent damage that would occur during HVAC unit removal.

13. Note HVAC harness positioning prior to removal/disconnect.
14. Disconnect the vacuum motor harness, engine HVAC harness, water valve harness, temperature blend door connector, cycling switch connections, power mirror harness, resistor harness, power door lock harness, power window harness and blower motor connections (Figure 11-86).

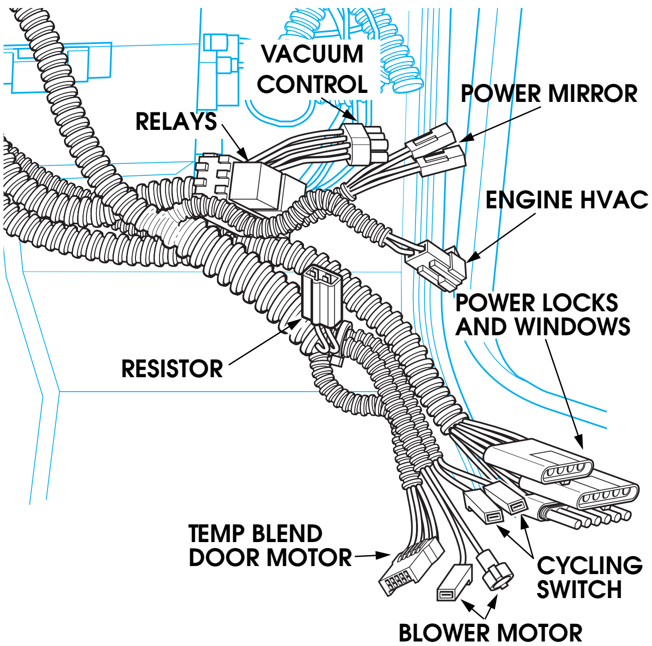


Figure 11-86: Harness/Connector Identification

15. Pull harnesses clear of HVAC unit and secure.
16. Remove screw(s) securing the floor duct to the top of the HVAC unit. Disconnect the hose going to the passenger floor area and remove hose.
17. Remove bolt securing HVAC manifold block to Expansion Valve and discard sealing gasket. Cap all openings (Figure 11-87).
18. Remove 2 nuts, washers, and grommets from pass-through mounts (Figure 11-87).

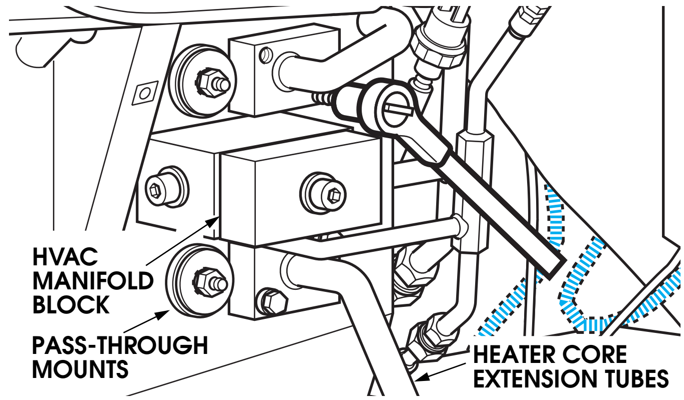


Figure 11-87: Pass-Through Fastener Removal

19. Remove interior bolt securing left and right side of the HVAC unit to the body. Support the unit prior to removing the second fastener to prevent the unit from falling down and causing possible damage or injury (Figure 11-88).
20. Removal of the unit can be accomplished by lowering and pulling straight rearward.

Installation

Lift HVAC unit into the vehicle.

1. Set the lower bracket on HVAC unit on top of the lower body bracket. Ensure that the studs on the pass through plate align with the holes in the body. Harnesses must be positioned to exit to the right side of the HVAC unit.
2. Pivot the unit upwards until it rests against the defrost and floor ducts. Install the right side fastener, and two nuts, washers, and grommets on the pass-through plate. Slowly tighten the front pass-through mounts first. This action will pull the unit forward. Ensure that the defrost and heating ducts align properly with the outlets on the HVAC unit before tightening inside mounts.

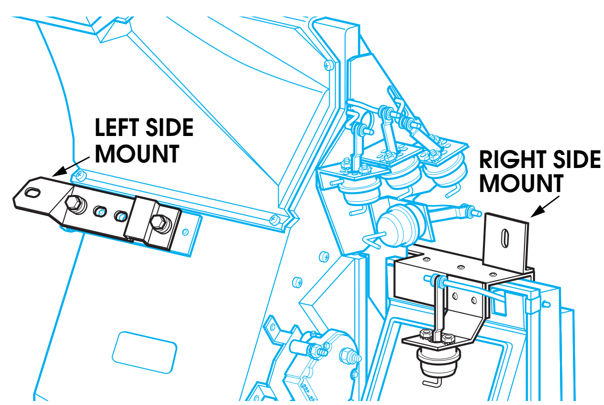


Figure 11-88: Interior Mounting Points

NOTE: The HVAC unit should have a 1/2” inch spacer between the left side bracket and the body. If the spacer was not present when the unit was removed, it should be installed when the unit is taken out of the vehicle for service.

3. Install left hand interior fastener with the 1/2" spacer. It may be necessary to loosen the bracket and slide it left or right to align the hole. Tighten fastener (Figure 11-89).

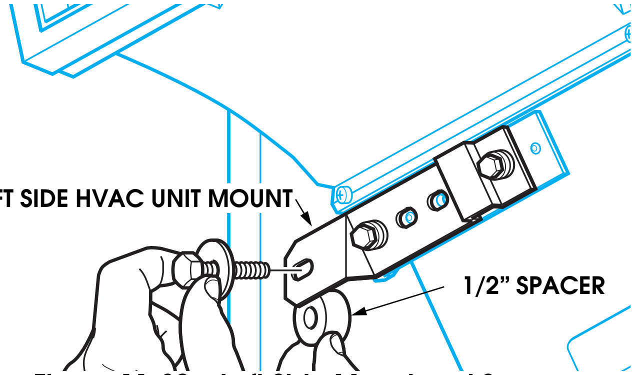


Figure 11-89: Left Side Mount and Spacer

4. Install screw(s) securing drivers floor duct to the main HVAC unit.
5. Install passenger side floor duct and route to the right as previously removed.

CAUTION: *Be sure to remove all of the devices used to plug the openings in the heater lines and the A/C lines.*

6. Install manifold block to expansion valve using a new sealing gasket, torque the fastener to 25 lb ft.
7. Install heater core extension tubes onto passthrough plate using new sealing washers. Torque the fasteners to 32 in lbs.
8. Evacuate A/C system for 45 minutes, with 10 minute hold time for leak check.
9. Refill the cooling system.

NOTE: When refilling, use bleeder screws on engine and radiator to purge as much air as possible from the system. The bleeder screws also allow easier filling of the cooling system.

10. Recharge A/C system to 3lbs 2oz. Add 2oz. oil if the unit is new or evaporator was replaced.
11. Leak check passthrough plate for body leaks using a water hose. If leakage is noted inside vehicle, seal the leaks from the outside using body sealer in small amounts.
12. Leak check the A/C lines using a R134a leak detector.
13. If no leaks are found, install air cleaner housing, elbow, adapter raincap and air cleaner splash shield.
14. Connect vacuum control harness, cycling switch connections, power mirror harness, door lock harness, power window harness, blower motor connections, resistor harness, engine HVAC harness, temperature blend door connector, and water valve harness.
15. Install center console and check operation of A/C and heat.
16. If A/C and heat are functioning properly, install left front and right front passenger side kick panels
17. Install right front seat and crash pad.
18. Install the right side closeout panel.

VACUUM DOOR MOTOR

Replacement

1. Remove right front crash pad.
2. Locate and remove 2 screws securing vacuum motor cover to main HVAC unit.
3. Locate faulty vacuum motor and remove vacuum line. If multiple motors are to be replaced, tag vacuum lines as they are removed.
4. Note position of mounting studs on the motor to be replaced. Mark holes that studs pass through (Figure 11-90).

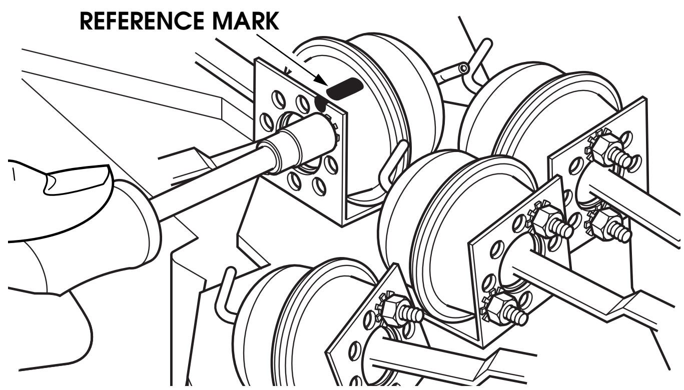


Figure 11-90: Vacuum Door Motor Replacement

5. Note position of motor arm relative to door lever. Mark the side facing away from the HVAC unit.
6. Remove the push clip with side cutting pliers and discard.
7. Remove washer under push clip, do not discard.
8. Remove two mounting nuts and vacuum motor (Figure 11-90).

Installation

Reverse removal procedure

BLEND DOOR MOTOR

Replacement

1. Disconnect motor electrical connection.
2. Remove 3 nuts securing motor to bracket (Figure 11-91).

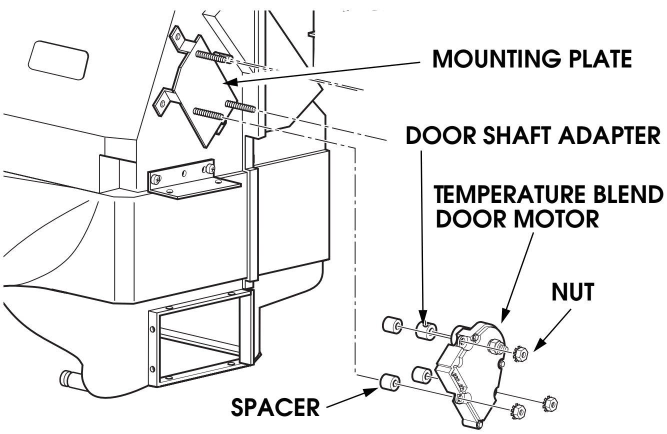


Figure 11-91: Temperature Blend Door Motor Removal

NOTE: Do not loosen set screw on door shaft adapter!

3. Remove motor by pulling it straight off. Do not discard the spacers behind the motor.

Installation

Reverse above removal procedure for installation.

Heater Core Replacement

NOTE: Screws should be noted for length as they are removed to aid in correct reassembly. Some screw lengths are critical to prevent interference with interior parts.

NOTE: Most of the screws used are threaded into the plastic housing of the HVAC unit. Care should be used to prevent over-tightening of the hardware and stripping holes out.

1. Remove the unit from vehicle (Refer to unit removal procedure this section)
2. Set the HVAC unit on a bench so the copper heater tubes are visible and upwards.
3. Remove permagum tape from heater tubes at passthrough plate and discard.

NOTE: Foam tape and permagum tape should always be replaced with new material where it was removed from during disassembly. The tapes are used to insulate hot and cold parts and prevent condensation from dripping on the passenger floor.

4. Remove 4 bolts securing heater tube mounts to passthrough plate (Figure 11-92).

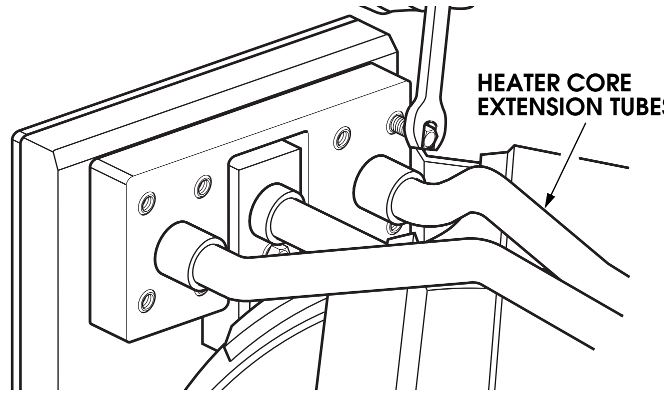


Figure 11-92: Heater Core Tube Removal

5. Cut sealer around heater core retaining plates (Figure 11-93).
6. Remove 2 retaining plates (Figure 11-93).

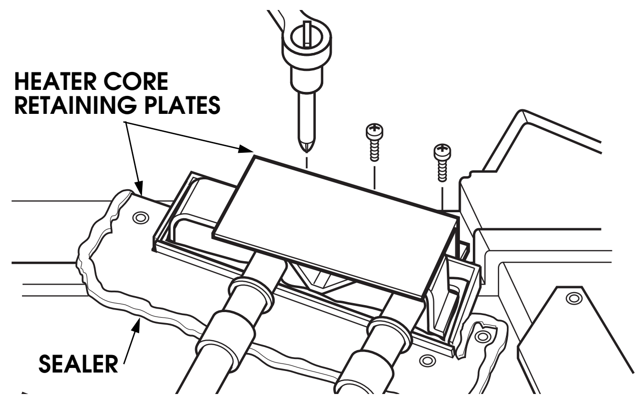


Figure 11-93: Retaining Bracket Removal

7. Pry heater tube mounting plate away from passthrough plate. Pry only in the middle to prevent damaging seal surfaces. Heater tubes extend past the mounting plate and into the passthrough plate (Figure 11-94).

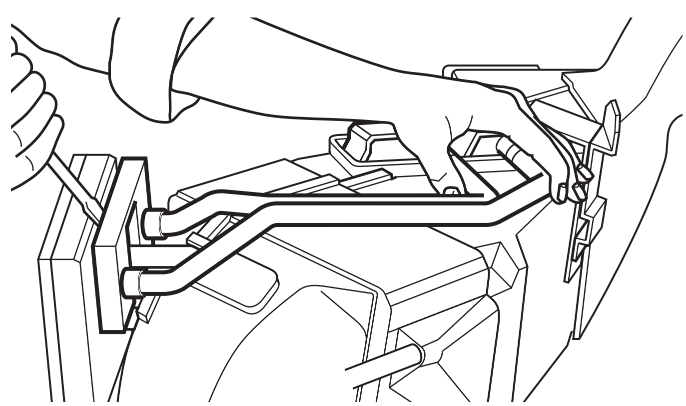


Figure 11-94: Removing Heater Core

8. Pull lightly on heater core to keep heater tubes parallel with the HVAC case. Do not allow the mounting plate end to come away faster than the core. Note positioning of any foam tape on the heater core, and duplicate on new part.

9. Discard the sealing washers on the heater tubes and repair or replace heater core as necessary.

Installation

Reverse removal for installation,

NOTE: Observe screws as they are removed to ensure corrects screws are used in the correct location on assembly.

EVAPORATOR

Replacement

1. Remove HVAC unit from vehicle (refer to HVAC unit replacement).
2. Remove heater core from main unit (refer to heater core replacement).
3. Remove lower support bracket from HVAC case (Figure 11-95).

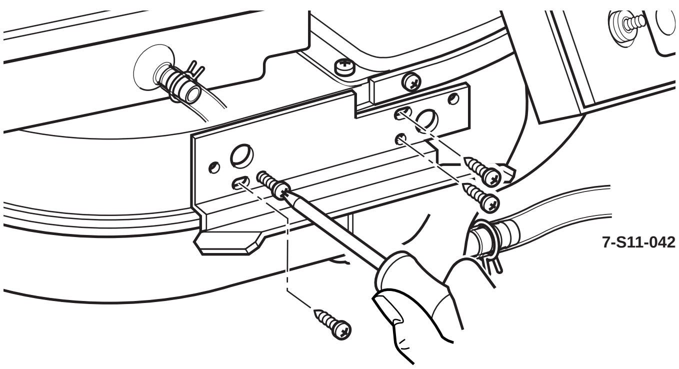


Figure 11-95: Lower Support Bracket Removal

4. Disconnect vacuum harness from vacuum motors. Motors are color coded to vacuum tubing (Figure 11-95).

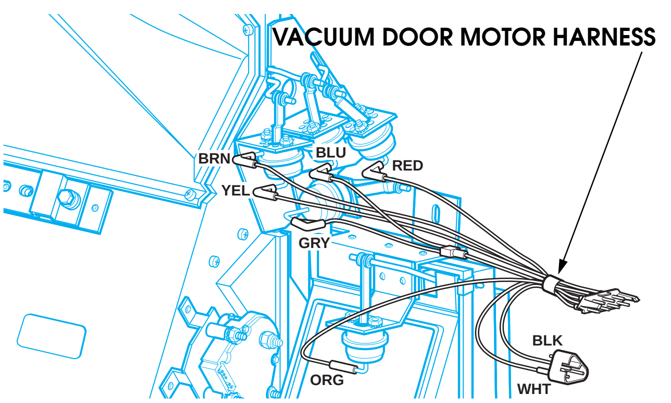


Figure 11-96: Vacuum Door Motor Harness

5. Remove air intake housing from main unit by removing attaching screws at blower housing (Figure 11-98) and bracket at front of unit (Figure 11-97).

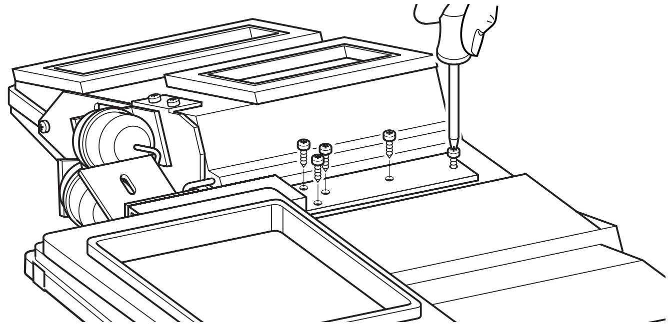


Figure 11-97: Air Intake Box Front Bracket Removal

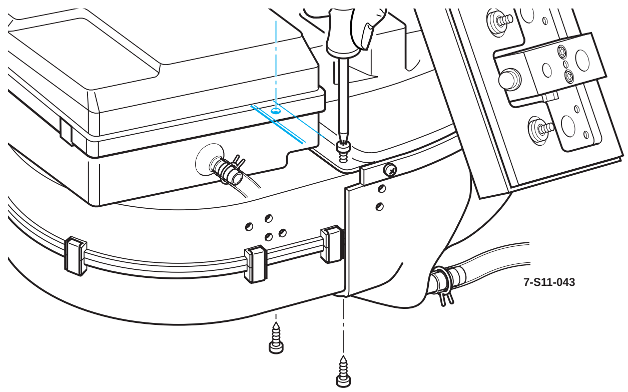


Figure 11-98: Lower Blower Housing Hardware Removal

6. Remove face duct outlet plenum (Figure 11-99).

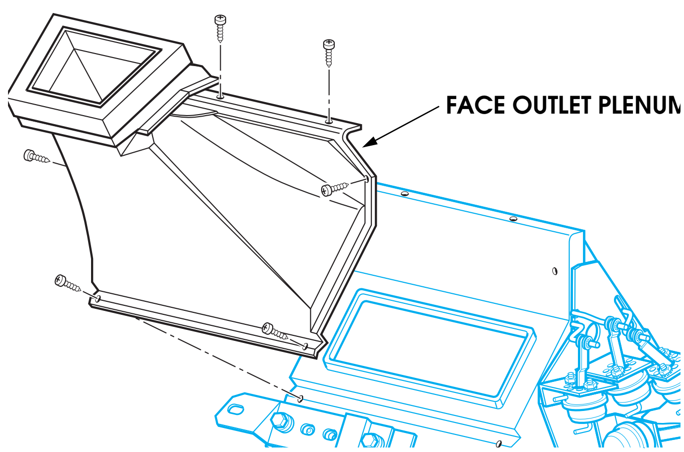


Figure 11-99: Face Duct Outlet Plenum

7. Remove floor door travel limiting rivet by drilling head. Note the side of the rivet the door is resting on (Figure 11-100).

NOTE: Place a reference mark on the case to ensure that the rivet is placed in the same location during reassembly that it was removed from (Figure 11-100).

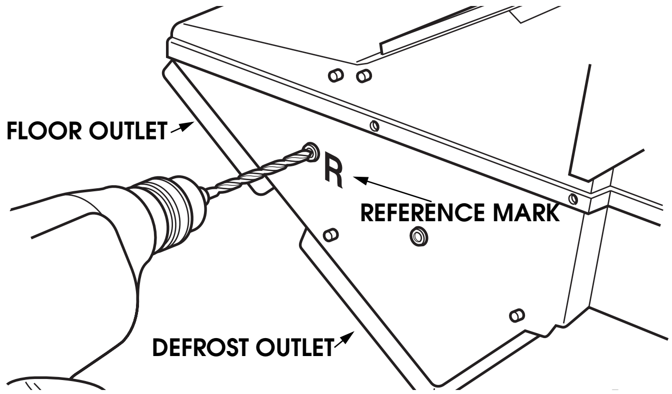


Figure 11-100: Drilling Door Travel Limiting Rivet

8. Remove arm retaining push clip, arm and 2 washers from the floor door and defrost door (Figure 11-101).

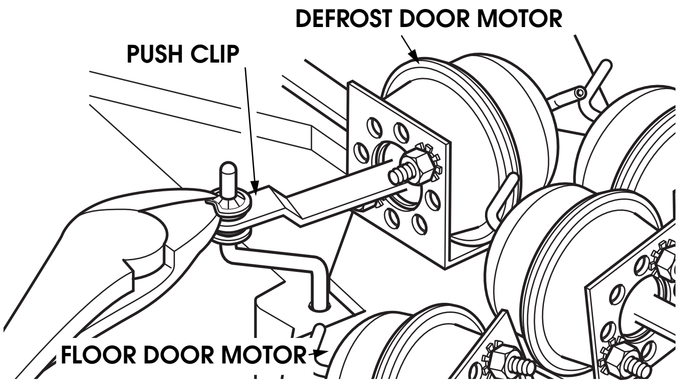


Figure 11-101: Push Clip removal

9. Remove defrost motor from the bracket, note position of mounting studs in mounting plate (Figure 11-102).

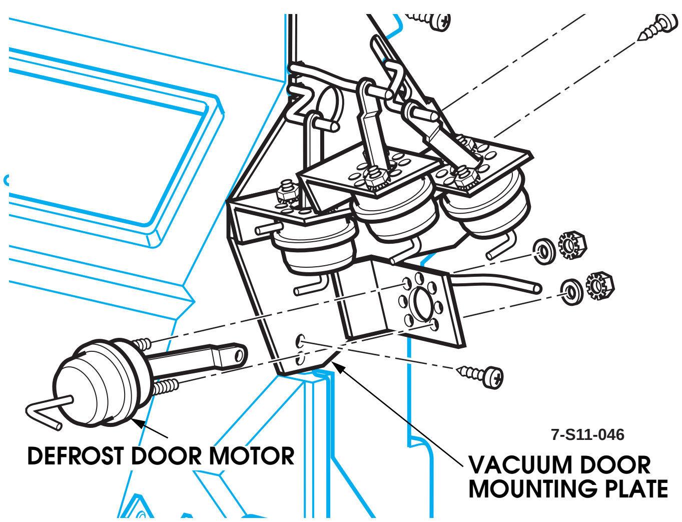


Figure 11-102: Vacuum Door Motor Mounting Plate

10. Remove arm retaining push nuts and washers from remaining vacuum motors.

11. Remove screws securing vacuum motor mounting plate to main HVAC unit, and remove mounting plate. If the floor door travel limiting rivet was not removed, the door arm will prevent removal of the mounting plate by not aligning with the elongated slot (Figure 11-102).
12. Remove screws securing case halves together. Do not attempt to separate case at this time (Figure 11-103).
13. Remove screws securing thermostatic cycling switch to HVAC unit case (Figure 11-103).

CAUTION: *Do not attempt to pull the switch out of the case. The capillary tube is secured to the evaporator.*

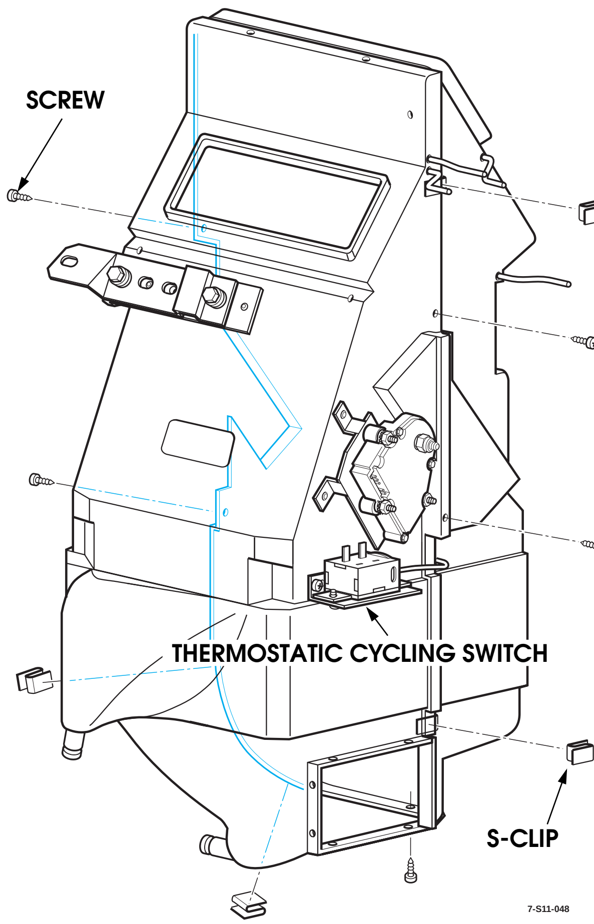


Figure 11-103: Case Half Hardware Removal

14. Using a utility knife, carefully cut through the sealer between the two case halves. Use caution to prevent cutting the case.
15. Using a putty knife or scraper, carefully spread the seam.
16. Separate case halves. Note that the thermostatic cycling switch must stay with the case half containing the evaporator.
17. Remove permagum tape from around liquid and vapor tubes, discard.

18. Remove expansion valve from the passthrough plate, discard gasket (Figure 11-104).

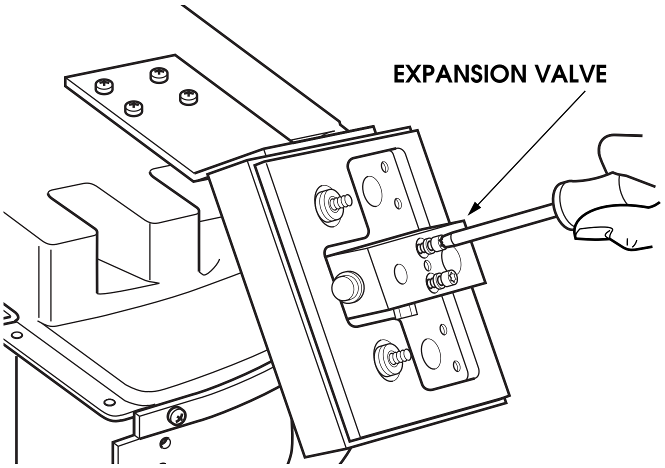


Figure 11-104: Expansion Valve Removal

19. Remove screws securing passthrough plate support bracket to the main unit (Figure 11-105).

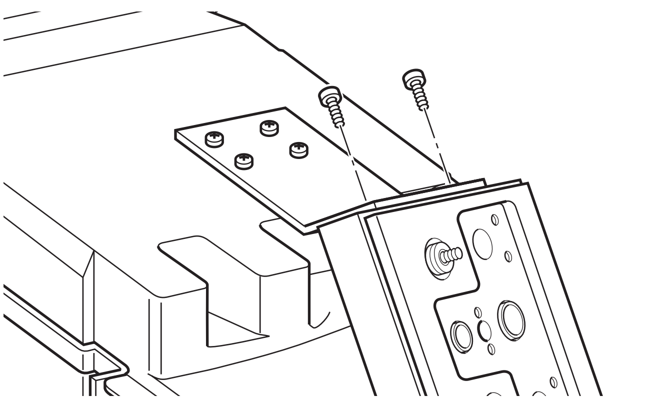


Figure 11-105: Passthrough Plate Support Removal

20. Remove bolt securing passthrough plate to the evaporator manifold connection, remove plate and support bracket.
21. Remove evaporator from unit (Figure 11-106).
22. Carefully remove capillary tube from evaporator, noting positioning in the evaporator fins (Figure 11-106).

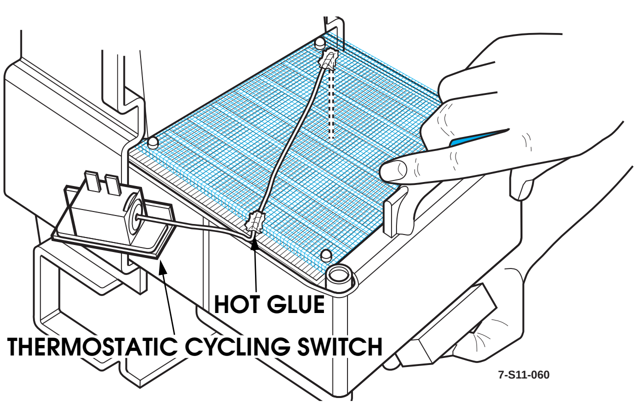


Figure 11-106: Evaporator Removal

23. Disconnect evaporator extension tubes at the o-ring fittings (Figure 11-107). Discard the o-rings.

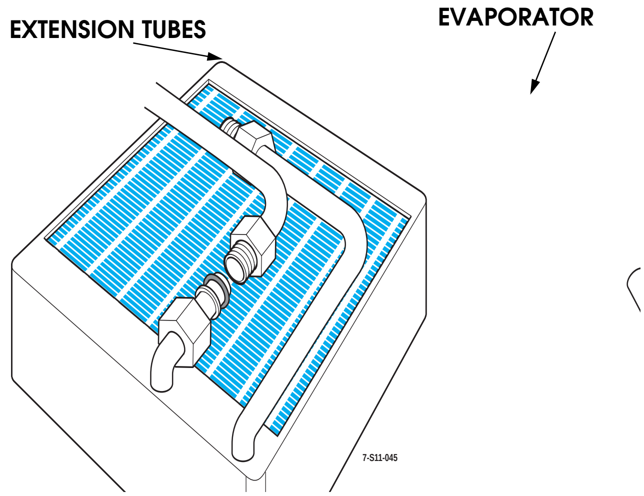


Figure 11-107: Evaporator Extension Tubes Removal

Installation

1. Obtain new evaporator. Ensure that any foam tape found on the previously removed unit is duplicated on the replacement.
2. Install extension tubes onto new evaporator using new o-rings lubricated with refrigerant oil.
3. Install evaporator into the case half the previous evaporator was removed from.
4. Position thermostat capillary tube in the same location it was removed from on the original evaporator. It will be necessary to hot glue the tube near the exit hole (Figure 11-106).
5. Install second half of HVAC unit, ensuring that the edges of the case halves engage the S clips around the seam.
6. Install screws securing the two halves together.
7. Install screws securing cycling switch to the side of the HVAC case.
8. Using neutral cure silicone sealer, seal entire parameter of seam.
9. Install the passthrough plate onto the main unit and evaporator. Install bolt securing evaporator extension tubes to the passthrough plate. Use a new sealing washer between the passthrough plate and the evaporator extension tubes.

NOTE: It may be necessary to trim the middle from the gasket as received. The normal span of the gasket will not fit the evaporator extension tube span.

10. Install expansion valve with a new sealing washer and torque to 100 in lbs.
11. Install vacuum motor bracket onto main unit

12. Install defrost door motor onto mounting plate.
13. Connect all vacuum motors to their perspective door arms using washers and new push clips.
14. Install a new door travel limiting rivet into case, placing the door on the side of the rivet it was originally resting on.
15. Install face duct plenum.
16. Install air intake assembly onto the main case.
17. Install lower support bracket.
18. Install heater core and retaining brackets, using new sealing washers on the heater core tubes. Torque heater manifold to 32 in lbs.
19. Install vacuum harness onto vacuum motors.
20. Install unit into vehicle (refer to HVAC unit removal and installation).
21. Fill the cooling system.
22. Evacuate A/C system for minimum of 45 minutes, with 10 minute hold time for leak check. Recharge with 3 lbs 2oz , adding same amount of oil that was drained from the original evaporator.

Cycling Switch Replacement

Refer to evaporator replacement.

Air Intake Assembly Replacement

Refer to evaporator replacement.

DIAGNOSTICS

Preliminary Checks

The diagnostics in this section are designed to find problems that are not obvious. Before starting any formal diagnostic chart, preliminary checks must be performed. Preliminary checks should include:

- Visual inspection of all components
- Inspection of any fuses related to the system
- Connector inspection
- Inspection of electrical harnesses
- Charging system and batteries
- Inspection of vacuum lines and connections

These types of checks are not included in the diagnostic chart. In fact, most of the charts rely on the fact that you, the technician has performed these initial inspections.

Diagnostic Strategy

Whenever a vehicle is being diagnosed for a problem, a strategy should be used. The following charts are strategy based, meaning they all follow the principle of starting simple and working step by step to more complex tests. This allows prolems which may be small in nature to be found quickly, and not overlooked. NEVER skip steps in a diagnostic chart. Each step relies on a previous step for correct diagnosis. Avoid random diagnostics and parts replacement which can lead to long, expensive diagnostic times and may not reveal the problem.

Intermittent Failures

ALL of the charts in this section are for use on current failures. Do not attempt to use these charts to diagnose a problem unless you are sure the problem currently exists. If the problem is intermittent, parts will be unnecessarily replaced, or no problem will be found.

Loss of High blower speed (Blower operates on L M1 M2)

Step	Action	Value(s)	Yes	No
1	Using a DVOM set to measure voltage, place the negative lead on a good ground, and backprobe the red wire on the blower relay (CKT 364). Is voltage present?	B+	go to step 2	repair open or short in CKT 364 between blower relay and alternator
2	Using a DVOM set to measure voltage, place the negative lead on a good ground and backprobe the blue wire of the blower relay (CKT 757) with the positive lead. Turn the ignition to run and place the mode dial on face with the blower speed dial on high. Is voltage present?	B+	go to step 3	go to step 4
3	Using a DVOM set to measure volts, backprobe blower relay black wire (CKT 58) with the negative lead, and the red wire (CKT 364) with the positive lead. Is voltage present?	B+	replace blower relay and recheck	repair open, short or bad connection in CKT 58 between blower relay and I/P ground point
4	With a DVOM set to measure voltage, and the ground lead on a good ground, backprobe terminal D of the HVAC control head 8 wire connector with the positive lead. With ignition in the run position, the mode dial on face, and blower dial on high, is voltage present?	B+	Repair open or short in CKT 757 between the HVAC control had and the blower relay	go to step 5
5	Check for poor pin tension or connection at HVAC control head 8 wire connector. Is a bad connection found?		Repair or replace HVAC harness as necessary	Replace HVAC control head

Temperature Blend Door Does not Operate

Step	Action	Value(s)	Yes	No
1	With the ignition switch in the run position, operate temperature control dial and observe the motor. Does door move?		Condition is intermittent	go to step 2
2	Remove the temperature blend door motor from the side of the HVAC case. With the ignition switch in the run position, operate the temperature control dial and observe the motor. Is the motor turning?		Mechanical problem in the HVAC case	go to step 4
3	Disconnect electrical connector from the temperature blend door motor. Using a DVOM set to measure voltage, and using J 35616-92 test adapters, probe the grn wire (CKT 399) with the positive lead and the blk wire (CKT 58) with the negative lead. Turn the ignition switch to the run position. Is voltage present?	B+	go to step 6	go to step 4
4	With ignition on, using a DVOM set to measure voltage and using J 35616-92 test adapters probe the grn wire (CKT 399) with the positive lead. Place the negative lead on a known good ground. Is voltage present?	B+	go to step 5	Repair open or short to ground between temperature blend door motor and fuse 7D.
5	With the ignition off, and using a DVOM set to measure ohms, check for resistance between the blk wire (CKT 58) of the temperature blend door, and a good ground. Does resistance exceed specifications?	<.2Ω	Locate open or bad connection between temperature blend door motor and ground at I/P	go to step 6
6	Using a DVOM set to read volts, the ignition switch on the run position, and using J 35616-92 test adapters, probe the blue wire (CKT 402) with the positive lead, and the blk wire (CKT 58) with the negative lead. Rotate temperature control dial on the HVAC control head from cold to hot and back. Is voltage present at the cold setting and 0v on the hot setting?	Cold = 12v Hot = 0v Cold = 12v	Replace the temperature blend door motor.	go to step 7
7	Disconnect the 8 wire connector at the HVAC control head. Using a DVOM set to measure ohms, check resistance between pin F (CKT 402) of the 8 wire connector and the blue wire (CKT 402) of the temperature blend door connector. Does resistance exceed specifications?	62KΩ	go to step 9	go to step 8
8	Check for open or bad connection between the HVAC control head 8 wire connection and the temperature blend door motor connection. Check for loose terminals at the control head. Was a bad connection found?		Repair or replace harness as necessary	go to step 9

Temperature Blend Door Does not Operate

Step	Action	Value(s)	Yes	No
9	Using a DVOM set to measure voltage, probe pin E (CKT 399) of the 8 wire connector on the HVAC control head with the positive lead, and pin B (CKT 58) of the three wire HVAC control head connector with the negative lead. With ignition on is voltage present?	B+	Replace faulty HVAC control head.	go to step 10
10	Using a DVOM set to measure voltage, probe pin E (CKT 399) of the HVAC control head eight wire connector with the positive lead. Attach the negative lead to a known good ground. With the ignition switch in the run position, is voltage present?	B+	go to step 11	Locate short or open between the HVAC control head and fuse 7D.
11	Using a DVOM set to measure ohms, check resistance between pin B (CKT 58) of the HVAC control head connector and a good ground. Does resistance exceed specifications?	$<.2\Omega$	Replace faulty HVAC control head	Locate and repair open or poor connection in the ground circuit between pin B and the I/P ground point

No Blower Motor Operation

Step	Action	Value(s)	Yes	No
1	Using a DVOM set to measure voltage, probe the blower motor purple wire (CKT371) with the positive lead, and the blower motor black wire (CKT58) with the negative lead. Turn the ignition switch to the run position, the HVAC control head mode dial to face and M2. Is voltage present?	9v+	Replace the blower motor	go to step 2
2	Leave Positive lead of DVOM connected to the purple wire (CKT371) place negative lead on a known good ground. Ignition switch in the run position, HVAC control head mode dial on face, blower on M2. Is voltage present?	9v+	Repair open or poor connection in ground CKT between blower motor and engine block.	go to step 3
3	Using a DVOM set to measure voltage, backprobe yel wire (CKT754) at the blower relay with the positive lead. Backprobe the black wire (CKT58) at the blower relay with the negative lead. Ignition in the run position, mode dial on face and fan dial on M2. Is voltage present?	9v+	Replace relay	go to step 4
4	Using a DVOM set to measure voltage, probe pin A of the HVAC control head 3wire connector with the positive lead. Place the ground lead in pin B of the same connector. Turn the ignition switch to run and the mode dial to any position. Is voltage present?	B+	Replace control head	go to step 5
5	Using a DVOM set to measure voltage, backprobe pin E of the HVAC control head 8 wire connector with the positive lead. Probe pin B of the three wire connector with the negative lead. Ignition switch in the run position. Is voltage present?	B+	Replace control head	go to step 6
6	Leave DVOM connected with ignition switch in the run position. Remove the negative lead from pin B of the 3 wire connector and place it on a known good ground. Is voltage now present?	B+	Replace the control head	Repair open short or bad connection in CKT 399

Only HIGH Blower (No L M1 M2)

Step	Action	Value(s)	Yes	No
1	Using a DVOM set to measure voltage, backprobe the yel wire(CKT754) at the blower relay with the positive lead, and backprobe the blk wire (CKT 58) at the blower relay with the negative lead. Ignition switch at run position, mode dial on face and blower dial on M2. Is voltage present?	9v+	Replace relay	go to step 2
2	Using DVOM set to measure voltage, backprobe the gry wire (CKT752) on resistor block connector in engine compartment with the positive lead. Attach the negative lead to a known good ground. Turn the ignition switch to run and the mode dial to face. The blower dial should be at M2. Is voltage present?	B+	Replace resistor block	go to step 3
3	Using a DVOM set to measure voltage, backprobe pin C (CKT 752) of the HVAC control head 8 wire connector with the positive lead. Place the negative lead on a known good ground. Turn ignition key to the run position, the mode dial to face, and the blower dial to M2. Is voltage present?	B+	Repair open or short between HVAC control head and resistors.	go to step 4
4	Leaving the negative lead on a good ground, backprobe pin E of the 8 wire HVAC control head connector with the positive lead. Ignition switch to the run position. Is voltage present.	B+	Replace control head	Repair open short or bad connection between HVAC control head and fuse 7D

Compressor Clutch Does not Operate (VIN Z Only)

Step	Action	Value(s)	Yes	No
1	Has OBD system check been performed?		go to step 2	Perform OBD system check
2	Using Tech 1, go to engine data list and locate A/C request. Turn mode dial on HVAC control head to MAX A/C. Does tech 1 indicate A/C request "yes"?		go to step 11	go to step 3
3	Using a DVOM set to measure voltage, back-probe pin H of the HVAC control head 8 wire connector. Ignition switch to run and the mode dial to Max A/C. Is voltage present?	B+	go to step 5	go to step 4
4	Using a DVOM set to measure voltage, measure voltage of pin E of the 8 wire HVAC control head connector with the ignition switch in the run position. Is voltage present?	B+	Replace control head	Repair open or short in CKT 399 from the control head to fuse 7D
5	Using a DVOM set to measure volts, with the mode dial to MAX A/C and the ignition switch to run, is voltage present at PCM pin BRC2?	B+	Replace PCM	go to step 6
6	Disconnect bulkhead passthrough connector. Using a DVOM set to measure ohms, measure between sockets 10 and 20 of the engine side of the passthrough connector. Is resistance above specifications?	.2Ω	go to step 7	go to step 8
7	Disconnect the following and check resistance using a DVOM set to measure ohms. • High Pressure Cutoff switch • Ambient Temperature switch • Low Pressure Cutoff switch Is resistance above specifications?	.2Ω	Replace individual component	go to step 8
8	Using a DVOM set to measure voltage, mode dial on Max A/C, and ignition on run. Check for voltage at pin 10 on body side of passthrough connector. Is voltage present?	B+	Repair open or poor connection between pin 20 of pass through connector and PCM pin BRC2	go to step 9
9	Using a DVOM set to measure voltage, mode dial on Max A/C, and ignition on run, is voltage present at tan wire(CKT198)?	B+	Repair open or short to ground in CKT 198 between thermostatic cycling switch and bulkhead connector pin 10	go to step 10

Compressor Clutch Does not Operate (VIN Z Only)

Step	Action	Value(s)	Yes	No
10	Using a DVOM set to measure voltage, mode dial on Max A/C, and ignition switch on run, check for voltage at yellow wire(CKT347) of the thermostatic cycling switch.	B+	Replace thermostatic cycling switch	Repair open, short to ground or poor connection in CKT347) between control head and thermostatic cycling switch
11	Using a DVOM set to measure voltage, mode dial still on MAX A/C, and the ignition switch on run, check for voltage at the dk blu wire (CKT440) of the compressor relay. Is voltage present?	B+	go to step 13	go to step 12
12	Using a DVOM set to measure voltage, mode dial still on MAX A/C, and the ignition switch on run, check for voltage at PCM pin BLD5 (CKT440). Is voltage present?	B+	Repair open short to ground or bad connection between PCM and compressor relay	If pin tension is good, replace PCM.
13	Using a DVOM set to measure voltage, ignition on the run position, backprobe the compressor relay grey wire with the positive lead (CKT441) and the black wire with the negative lead. Is voltage present.	B+	go to step15	go to step14
14	With DVOM still connected to the grey wire, move the negative lead to a known good ground. Is voltage present?	B+	Repair open or poor connection in ground CKT between compressor relay and I/P ground point.	Repair open, short to ground, or poor connecton in CKTS 441, and 400 between compressor relay and fuse 2C.
15	Using a DVOM set to measure voltage, ignition on the run position, mode dial on Max A/C, backprobe the compressor relay brown wire (CKT348) with the positive lead, and the blk wire with the negative lead. Is voltage present?	B+	go to step 16	Replace relay
16	Using a DVOM set to measure voltage, mode dial on Max A/C, ignition on run. Disconnect connector from A/C compressor clutch. Check for voltage on the blu wire (CKT348). Is voltage present?	B+	Replace compressor clutch	Repair open, short to ground, or bad connection in CKT 348 between the compressor relay and compressor clutch.

Compressor Clutch Does not Operate (VIN Y Only)

Step	Action	Value(s)	Yes	No
1	Using a DVOM set to measure voltage, the ignition switch to run, and the mode dial on Max, disconnect the connector at the A/C compressor clutch connector and check for voltage at the blue wire. Is voltage present?	B+	Replace the compressor clutch	go to step 2
2	With a DVOM set to measure voltage, back probe the dk blu wire (CKT440) of the compressor relay with the positive lead, and the grey wire (CKT441) with the negative lead. Turn the ignition switch to run, and the mode dial to Max. Is voltage present?	B+	go to step 5	go to step 3
3	Using a DVOM set to measure voltage, the ignition switch to run and the mode dial on Max, leave the positive probe on the dk blue wire (CKT440) of the compressor relay and place the negative on known good ground. Is voltage present?	B+	Repair open or short in CKT 441, and CKT 58 between compressor relay and I/P ground point	go to step 4
4	Using a DVOM set to measure voltage, the ignition switch to run and the mode dial on Max. Back probe the tan wire(CKT198) of the thermostatic cycling switch with the positive probe. Place the negative probe on a known good ground. Is voltage present?	B+	go to step 6	go to step 10
5	Move the positive lead of the meter to back probe the lt.grn wire(CKT400), with the ignition to run and the mode dial on Max. Is voltage present?	B+	Repair open or short to ground in CKT 400 between compressor relay and compressor clutch	Replace the compressor relay
6	Disconnect the bulkhead connector. With a DVOM set to measure voltage, ignition in the run position and mode dial in the Max position. Is voltage present at pin 10?	B+	go to step 7	Repair open or short in CKT 198 between bulkhead connector and thermostatic cycling switch
7	Disconnect the bulkhead connector. Using a DVOM set to measure OHMS, check the resistance between socket 10 and socket 20 on the engine side of the harness. Is resistance above specification?	.2Ω	go to step 8	Repair open or short ground in CKT 439 from bulkhead connector pin 20 to compressor relay

Compressor Clutch Does not Operate (VIN Y Only)

Step	Action	Value(s)	Yes	No
8	Check the resistance of the following items: High pressure cutoff switch Ambient temperature switch Low pressure cutoff switch High temperature cutoff switch Are all of these items below resistance specifications.	.2Ω	Repair open or short to ground in engine harness CKTS 438, 443, or 439	Replace faulty switch
9	Using a DVOM set to measure voltage, the ignition switch to run and the mode dial on Max. Back probe the yel wire of the thermostatic cycling switch with the positive probe. Place the negative probe on a known good ground. Is voltage present?	B+	Replace the thermostatic cycling switch	go to step 10
10	Using a DVOM set to measure voltage, backprobe pin H of the HVAC control head 8 wire connector. Ignition switch to run and the mode dial to Max A/C. Is voltage present?	B+	Repair open or short in CKT from the control head to the thermostatic cycling switch	go to step 11
11	Using a DVOM set to measure voltage, measure voltage of pin E of the 8 wire HVAC control head connector with the ignition switch in the run postion. Is voltage present?	B+	Replace control head	Repair open or short in CKT 399 from the control head to fuse 7D

Vacuum Door Motor Does Not Operate

Step	Action	Value(s)	Yes	No
1	Attempt to actuate the door by hand. Does the door move freely?		go to step 2	Mechanical binding in HVAC unit
2	Using a hand vacuum pump J–35555, apply 18” of vacuum to the door motor in question. Does the door close and hold vacuum for at least 1 minute?	18”Hg	go to step 3	Replace door motor
3	Connect J–35555 to the vacuum supply line of the motor in question. Start the engine, idle rotate mode dial to a position that will actuate the motor. Is sufficient vacuum present? NOTE: If checking the face door motor, 2 lines are used to supply vacuum in different modes, check both lines	18”Hg	No problem exists at this time	go to step 4
4	Remove blk/wht vacuum connector at rear of HVAC control panel. Install J–35555 on blk portion of connector. Start and Idle engine is sufficient vacuum present?	18”Hg	go to step 5	go to step 6
5	Inspect lines and connections between the HVAC control head and the vacuum door motor for kinks, breaks or blockages. Are any problems found?		Repair or replace vacuum harness as necessary	Replace HVAC control head
6	Locate vacuum connection on rear of vacuum pump. Connect J-35555, start and idle engine. Is sufficient vacuum present?	18”Hg	Repair blockage/breakage in vacuum supply harness to control head	Replace vacuum pump

Water Valve Does Not Operate

Step	Action	Value(s)	Yes	No
1	Actuate the water valve lever by hand. Does it move freely, and does spring pressure re-open the valve when you release it.?		go to step 3	go to step 2
2	Loosen the clamp securing the water valve to the body. Does the valve move freely now?		Problem is corrected	Replace the water valve
3	Using a hand vacuum pump J-35555, apply 18”Hg to the water valve vacuum motor. Does the valve close and hold vacuum for at least 1 minute.	18”Hg	go to step 4	Replace water valve
4	Release the vacuum on the water valve. Does the valve return to the open position?		go to step 5	Replace the water valve
5	Attach J-35555 to the vacuum supply line for the water valve. Start and idle the engine. Rotate the temperature control dial to the cold position. Is sufficient vacuum present?	18”Hg	go to step 6	go to step7
6	With J-35555 still attached to water valve vacuum supply line, rotate temperature control dial to the hot position. Does atmosphere vent in?	0” Hg	System is working correctly	go to step 8
7	Check for kinks, breaks and blockages in the vacuum harness between the water valve and the HVAC control head. Are any found		Repair or replace vacuum harness as necessary	go to step 9
8	With J-35555 still attached to water valve vacuum supply line, disconnect HVAC control head 2 hose blk/wht connector. Does atmosphere vent in?	0”Hg	Replace the control head	Remove blockage in white vacuum line to water valve
9	Disconnect 2 hose blk/wht connector at HVAC control head. Install J-35555 onto blk hose. Start and Idle engine. Is sufficient vacuum present?	18”Hg	Replace the control head	go to step 10
10	Locate vacuum connection on rear of vacuum pump. Install J-35555 onto connection and start and idle engine. Is sufficient vacuum present?	18”Hg	Locate and repair blockage/ breakage in vacuum harness between vacuum pump and HVAC control head	Replace vacuum pump

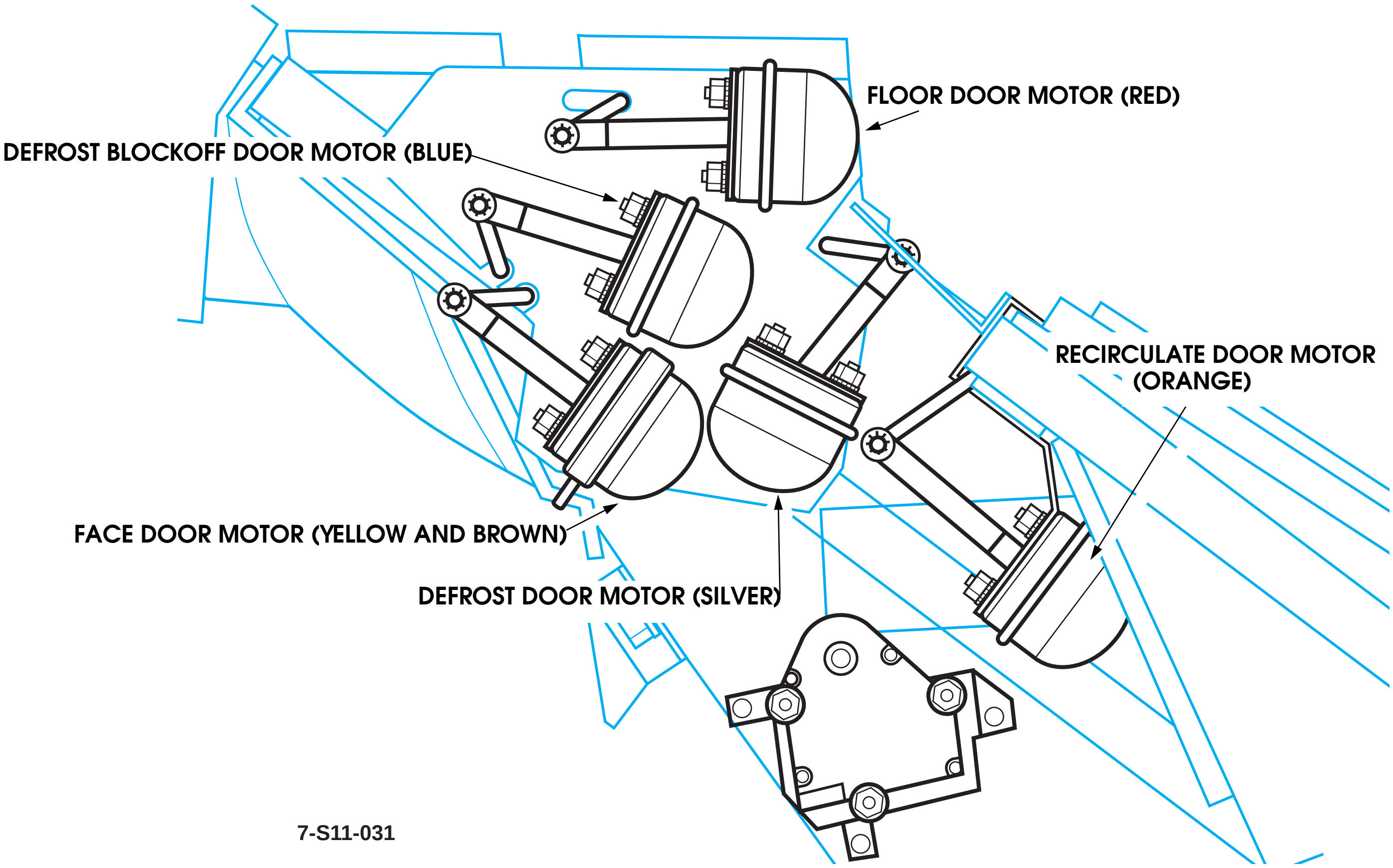


Figure 11-108: Vacuum Door Motors

Vacuum Door Motor Arm Positioning

	OFF	MAX	A/C	A/C Blend	Face	Floor	Defrost/ Floor	Defrost
Floor	out	out	out	in	out	in	out	out
Defrost blockoff	out	out	out	out	out	out	out	in
Face	out	in	in	half	in	out	out	out
Defrost	out	out	out	out	out	out	out	in
Recirculate	out	in	out	out	out	out	out	out

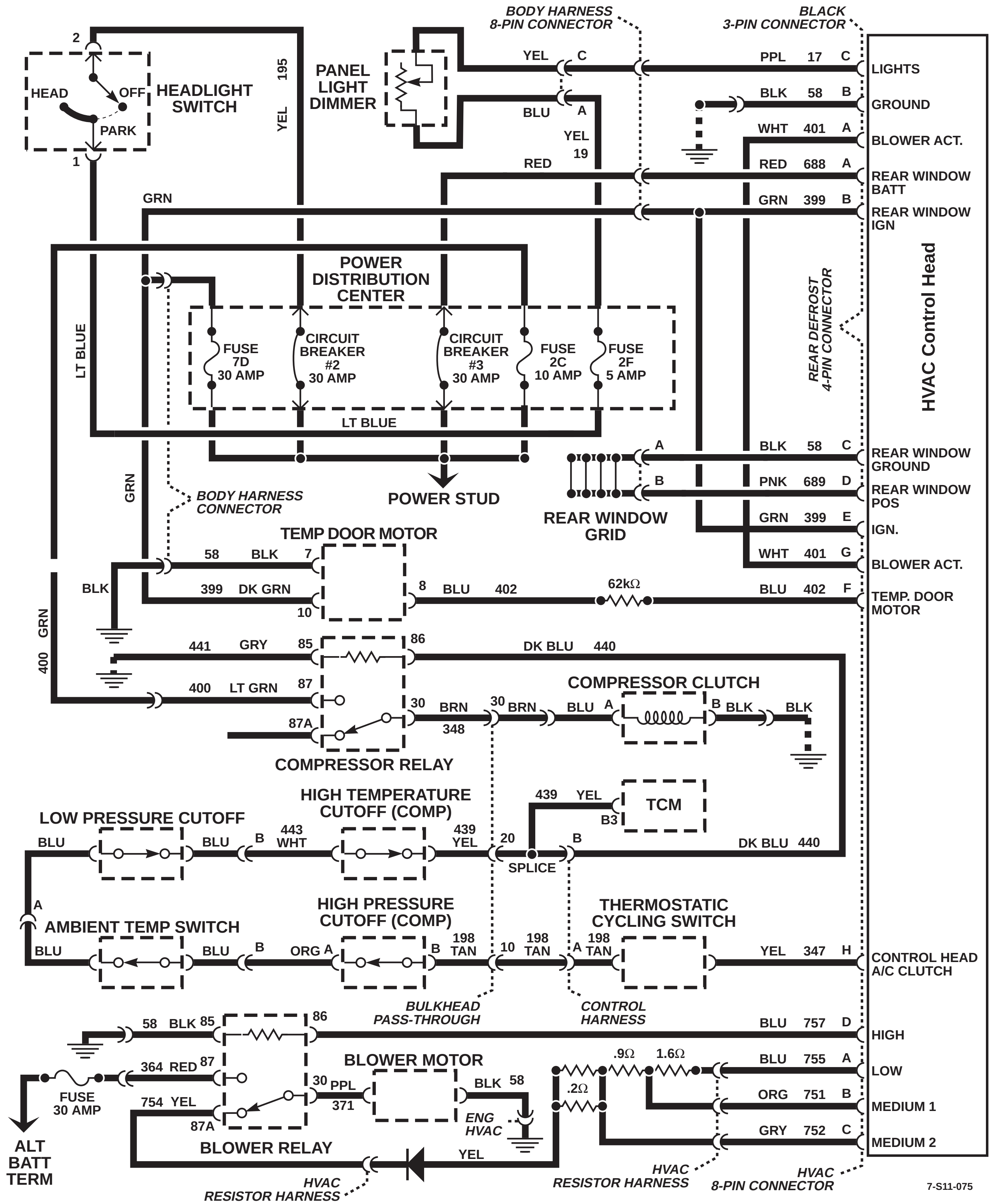


Figure 11-109: HVAC Wiring Diagram, VIN Y (On VIN #176477 and Up)

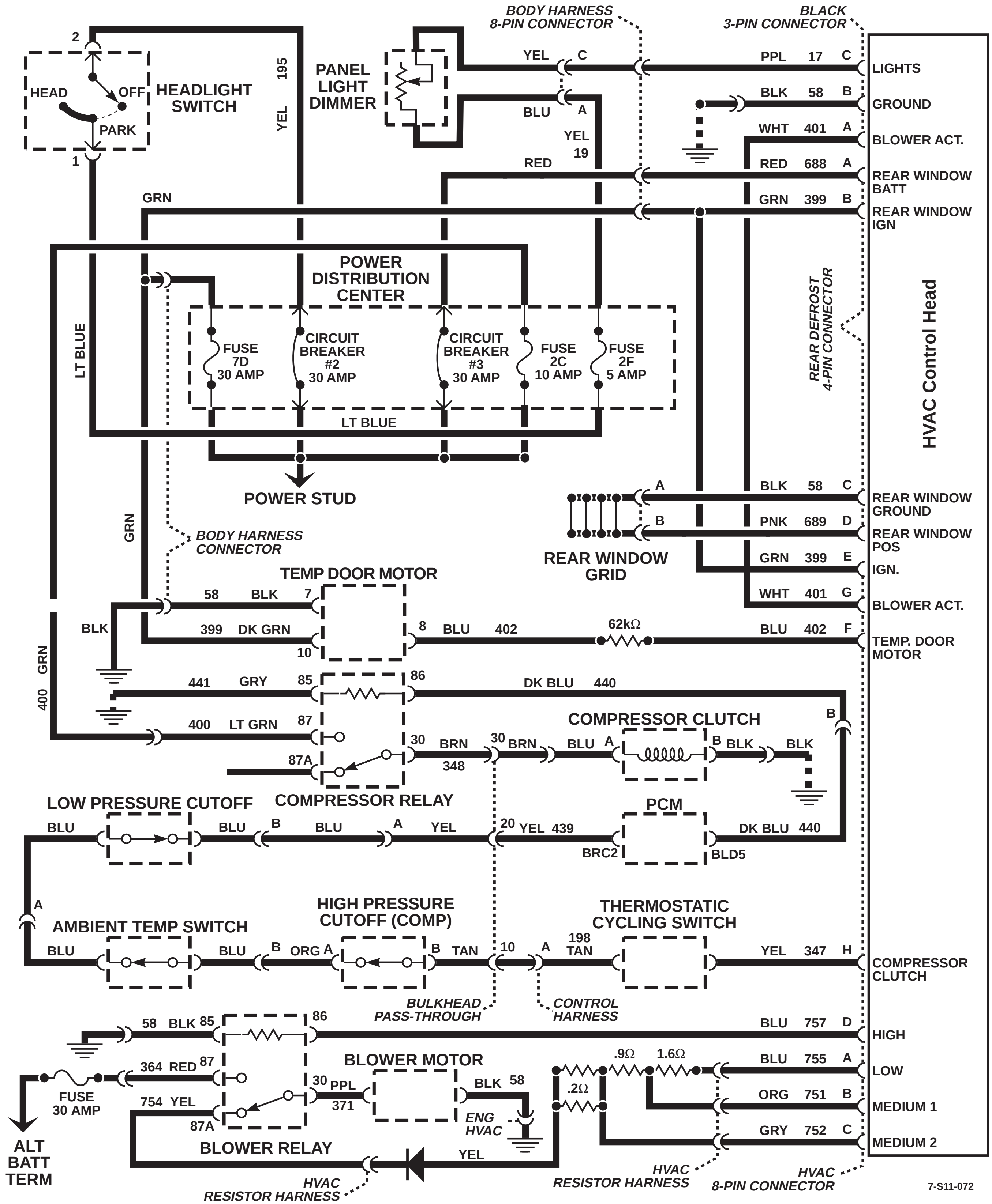


Figure 11-110: HVAC Wiring Diagram, VIN Z (On VIN # 176477 and up).

Section 12 Electrical System

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GENERAL

Initial power for starting is provided by two maintenance-free batteries. The starter motor is a marine-grade sealed unit to allow for the HUMMER's water fording capabilities.

Electricity to recharge the batteries and operate the vehicle while running is provided by a Delco-Remy, internally-regulated alternator. This unit is driven by a serpentine belt for improved reliability and service.

Both the starter and alternator are serviceable. Refer to procedures in this section.

HUMMER vehicles are equipped with a weather-resistant electrical system. Harness connectors have a positive seal to resist water intrusion when operating in wet conditions.

Be sure all connections affected by the fording depth are watertight after repair.

Do not pierce wire insulation when checking circuitry. Back probe connectors, or disconnect and insert jumper wires, into the harness. This is necessary to preserve water resistant capabilities.

NOTE: For trouble-shooting information, refer to the trouble-shooting section in this chapter.

INSTALLATION OF AFTERMARKET ELECTRICAL ACCESSORIES

Three spare accessory circuits are provided. They are for connection to aftermarket electrical accessories. There is one each for battery, ignition, and lights. The circuit wires are at the driver's side of the instrument panel to the left of the steering column near the fuse box (Figure 12-1).

A permanent tag attached to each circuit, indicates the type of circuit available and maximum usable amperage. The spare circuits provide electrical hookup of accessories such as a car phone, or a CB radio.

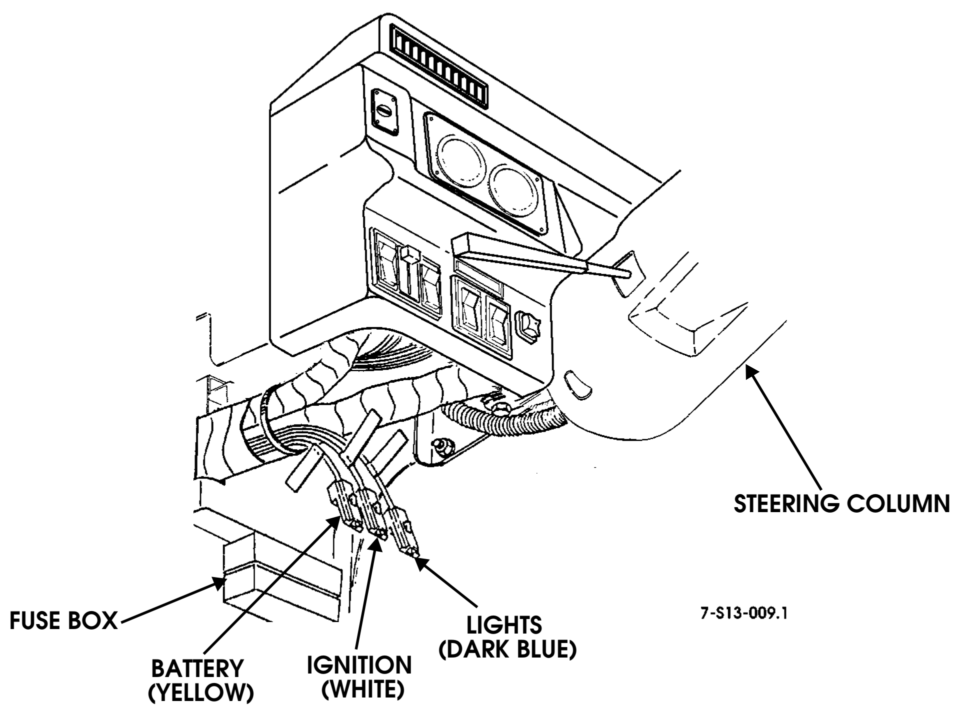

Figure 12-1: Spare Accessory Circuit Wire Location

POWER DOOR LOCK SWITCH REPLACEMENT

NOTE: Switch replacement is the same for all doors.

Removal

1. Remove mounting plate, capscrews, and remove switch from switch bezel (Figure 12-2).
2. Disconnect door harness from switch.
3. Separate switch from mounting plate.

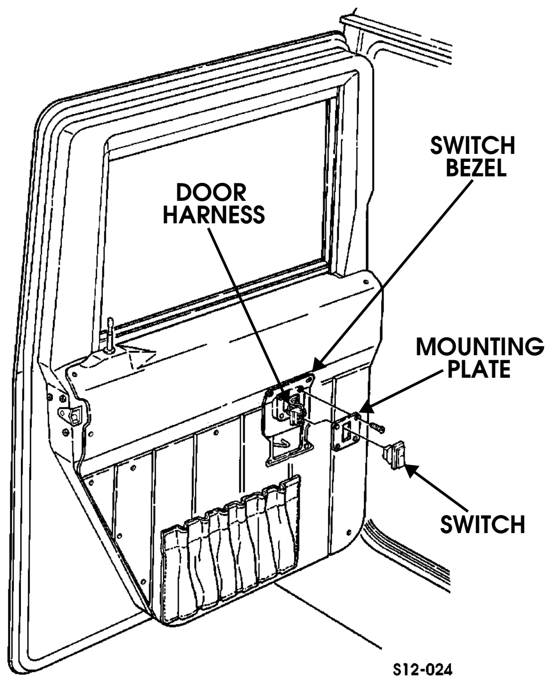

Figure 12-2: Power Door Lock Switch Mounting

Installation

1. Assemble switch and mounting plate.
2. Connect switch to door harness.
3. Install switch and mounting plate on bezel and secure with screws.

POWER DOOR LOCK ACTUATOR REPLACEMENT

Removal

NOTE: Actuator replacement is the same for all doors.

1. Raise window.
2. Remove door trim panel.
3. Remove vapor barrier (Figure 12-3).

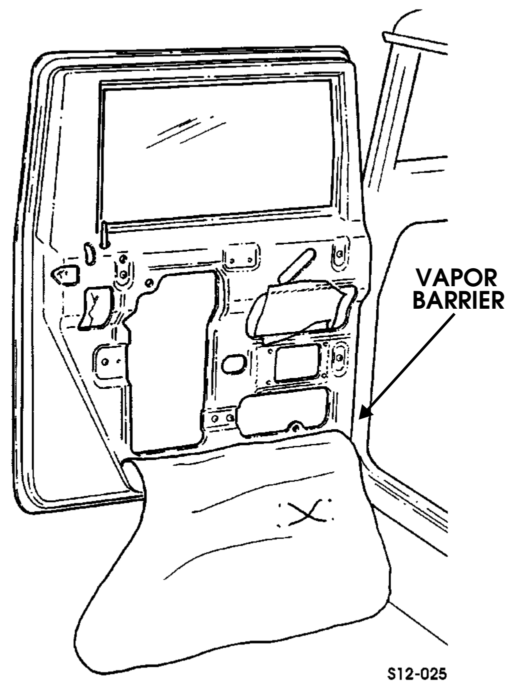

Figure 12-3: Vapor Barrier Removal/Installation

4. Detach door harness connector from door actuator (Figure 12-4).

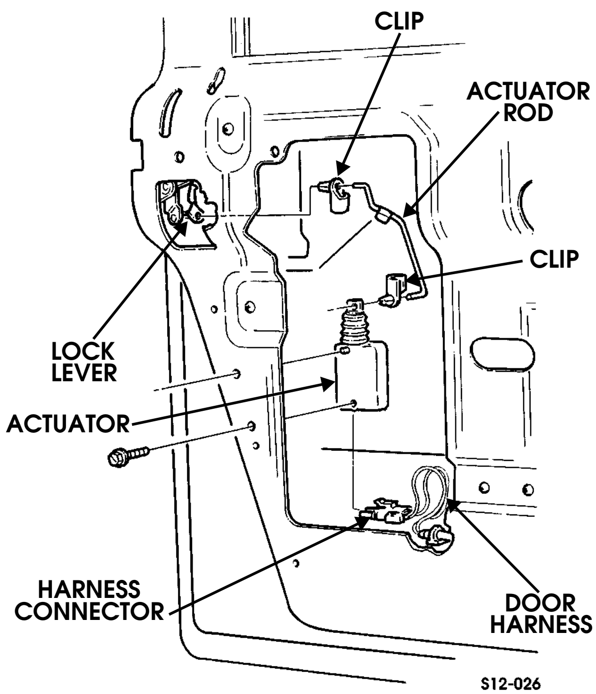

Figure 12-4: Door Lock Actuator Removal/Installation

5. Remove actuator attaching screws.
6. Remove actuator from door and disconnect actuator rod from clips and actuator.

Installation

NOTE: Color coding on actuator rod is positioned away from actuator during installation. Actuator rods are color coded as follows: left front, red; right front, green; left rear, yellow; and right rear, blue.

1. Connect clip and actuator rod to lock lever (Figure 12-4).
2. Install opposite clip on actuator and connect rod to actuator.
3. Secure actuator with mounting screws.

CAUTION: *The actuator threads will strip if overtightened.*

4. Connect harness wires to actuator.

NOTE: Vapor barrier must be completely sealed at all edges to prevent water entry into the interior of the vehicle.

5. Install vapor barrier (Figure 12-3).
6. Install door trim panel.

BATTERY CABLE REPLACEMENT

Battery Negative Cables - Removal

1. Remove caps from battery negative cable (Figure 12-5).
2. Remove battery cable bolts.
3. Disconnect winch negative cable, if equipped (Figure 12-5).

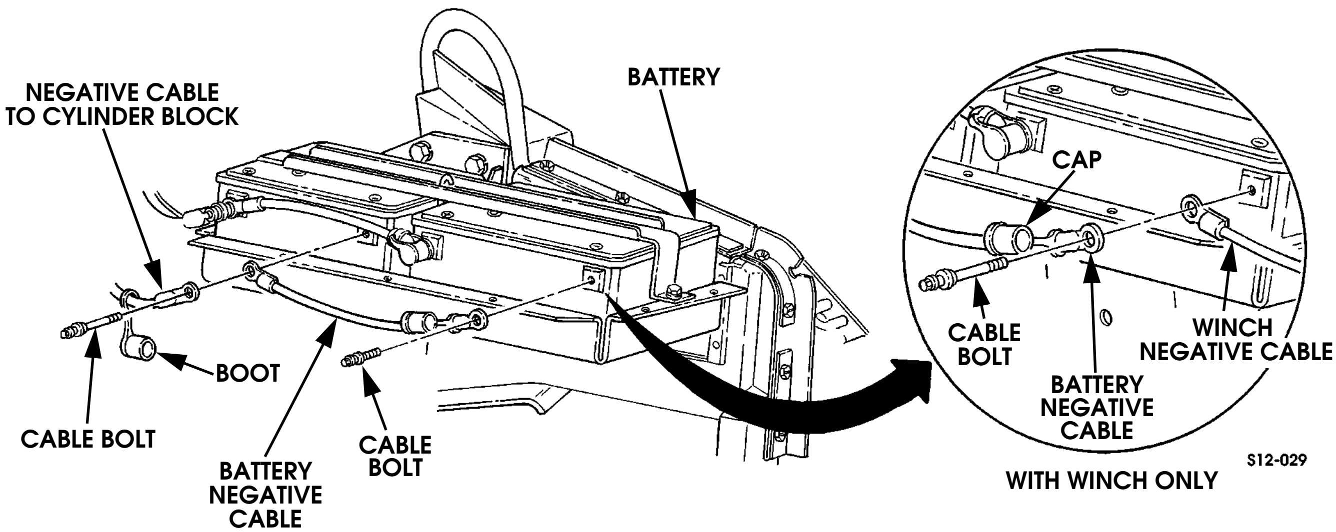

Figure 12-5: Battery Negative Cable Connections

4. Remove nut, lockwasher, clamp, and stud securing engine harness and negative cable to starter (Figure 12-6).

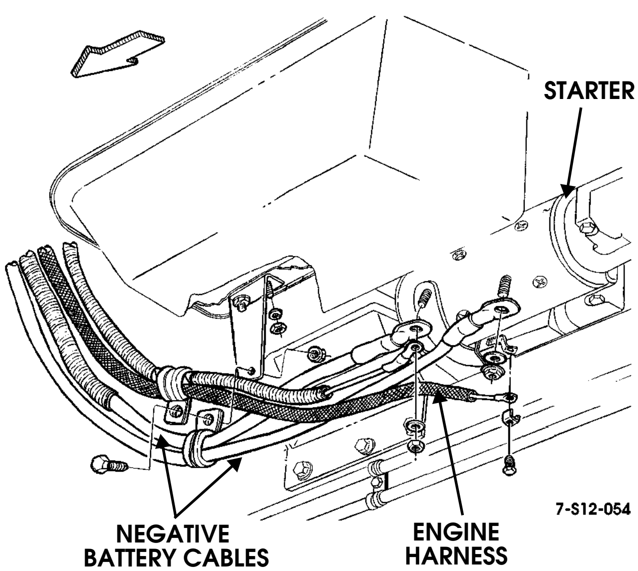

Figure 12-6: Negative Cable to Cylinder Block Attachment

Battery Negative Cables - Installation

1. Connect negative cables to engine and battery wiring.
2. Tighten cable bolts to 8-12 lb-ft. (11-16 N•m).
3. Install caps on battery cable bolts.

Battery Positive Cable - Removal

1. Disconnect battery negative cables.
2. Remove caps from battery positive cable(s) (Figure 12-7).
3. Disconnect starter cable at battery.
4. Disconnect battery positive cable, and winch cable, if equipped, at battery.
5. Remove locknut, washer, capscrew, and clamp securing starter cable to bracket.
6. Disconnect starter cable at starter.

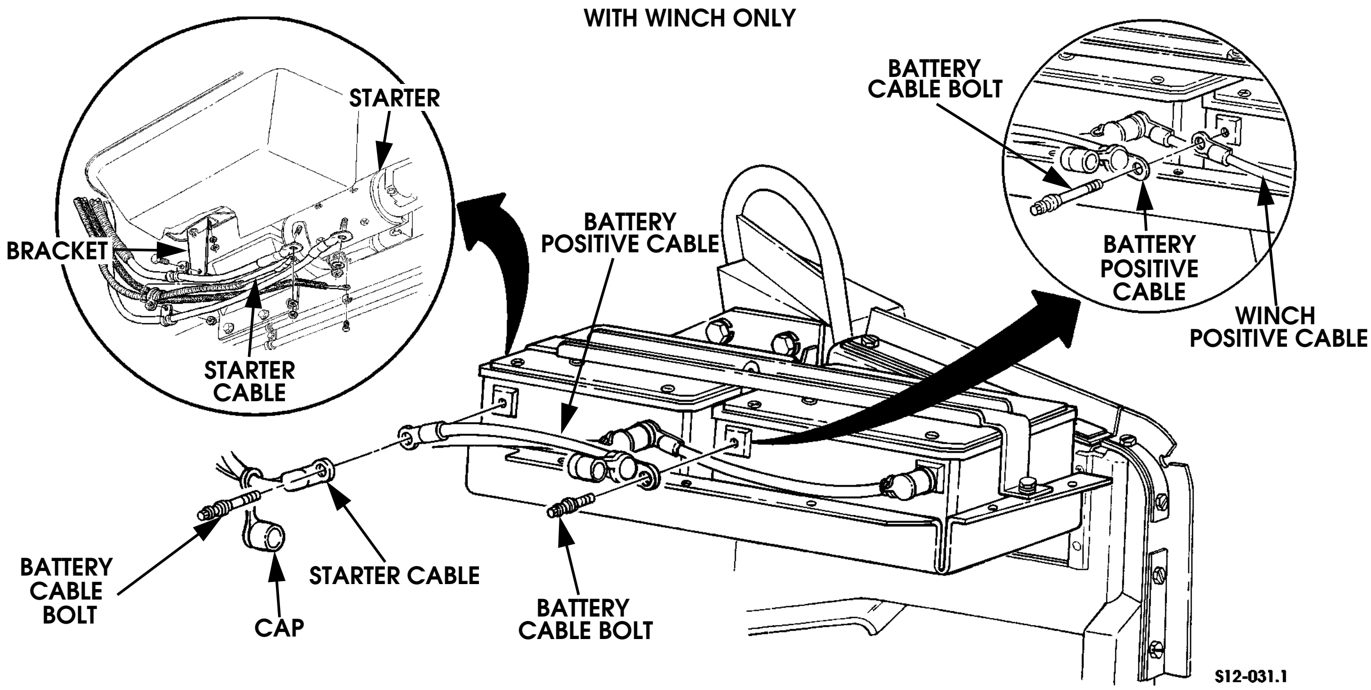

Figure 12-7: Battery Positive Cable Connections

Battery Positive Cables - Installation

1. Connect starter cable to starter with lockwasher and nut. Tighten nut to 12-16 lb-ft (16-22 N•m).
2. Secure starter cable to bracket with clamp, capscrew, washer, and locknut.
3. Connect battery positive cable to battery.
4. Connect winch cable to battery positive post (Figure 12-7).
5. Connect battery negative cables.
6. Tighten cable-to-battery bolts to 8-12 lb-ft. (11-16 N•m).

BATTERY CHARGING

General Information

A low charge or discharged battery can be recharged as long as the cells are not shorted, sulfated, or damaged. Batteries can be recharged quickly at 20 amp charge levels, or for longer periods at 10, 5, or 2 amps. 5 amp charge is preferable.

The battery charger should be equipped with a polarity sensor to avoid damage through incorrect hookup. Charger capacity should range from 5 to 20 amps for slow and fast charge rates.

The time and amp rate of charge required will vary depending on battery condition and temperature. Generally, it takes longer to recharge a cold battery. State of charge will also affect charging time as a partially discharged battery may only require one third the charge time of a fully discharged battery.

There are a number of safety precautions that must be observed before charging a battery. The following precautions are necessary to avoid personal injury:

Battery Charge Warnings

- Battery electrolyte contains sulfuric acid which can cause severe burns. Avoid contact with electrolyte by wearing protective gloves and a face shield. Flush skin or eyes with water if contact occurs and seek medical assistance immediately.
- Always wear eye and facial protection when connecting charging equipment.
- Never attempt to charge a frozen battery. The case could fracture at the first surge of current.
- Never charge a battery with a low electrolyte level. Internal arcing and battery explosion could occur.
- Never exceed a 20 amp charge with a cold battery. Use a lower (5-10 amp) rate until the battery warms up.
- Never use excessive charge rates. Reduce charge rate if the battery becomes overly warm, or if a steady stream of gas starts to exit the vents.
- Do not use high charge rates on a completely discharged battery. Use low rates or a trickle charge only.
- Never allow sparks, or an open flame near a charging battery. The charging process generates hydrogen gas which is highly inflammable.
- Charge batteries in properly ventilated areas only. Do not allow hydrogen gas to accumulate and concentrate in poorly ventilated areas.

Charge Rate and Time

Charge rate will depend on battery temperature and degree of discharge. Ideally, charging should not proceed until battery temperature has reached 60°F (16°C). However, in cases where a cold battery must be charged, start with a 5 amp rate and increase it as battery temperature rises.

In the case of a fully discharged battery, a 24 hour trickle charge of 1-2 amps is recommended. A 20 amp charge rate should be used when a battery is only partially discharged.

Suggested charge times are outlined in the charge rate chart (Figure 12-8). Note that the chart suggested times and rates are for a battery at 70°F (21°C). Charge times will be greater if battery temperature is below 55°F (13°C).

	CHARGE RATE		
	5 Amps	10 Amps	20 Amps
No-Load Test Voltage	Charge Time at 70°F (21°C)		
12.25 to 12.39	6 Hrs.	3 Hrs.	1.5 Hrs.
12.00 to 12.24	8 Hrs.	4 Hrs.	2 Hrs.
11.95 to 12.09	12 Hrs.	6 Hrs.	3 Hrs.
9.80 to 11.95	14 Hrs.	7 Hrs.	3.5 Hrs.

6-S12-105

Figure 12-8: Charge Rate Chart

Battery Testing

There are two methods of checking battery charge state which are: no-load voltage check and a load test.

No-Load Voltage Test

The no-load voltage test only requires a test quality voltmeter. Procedure is as follows:

1. Remove surface charge by turning headlamps on for 10-12 seconds. Then turn lights off and allow battery to stabilize for 5 minutes.
2. Disconnect positive and negative cables at battery terminals.
3. Set voltmeter at D.C. voltage range (if necessary), and connect test leads to battery terminals.
4. Voltage readings will indicate state of charge but not cranking capacity. Common readings are:
   - 12.6 or more volts indicate 100% charge
   - 12.4 volts indicate 75%-80% charge
   - 12.2 volts indicate about 50% charge
   - 12.0 volts indicate about 25%-35% charge
   - 11.7 volts or less indicate zero charge (dead battery)

Battery Load Test

A load test checks cranking capacity of a fully charged battery. The test will reveal battery faults that no-load voltage and specific gravity checks will not pick up (e.g. cell plate damage, sulfated, etc.)

WARNING: When performing a battery load test, be sure to wear protective clothing and eye covering. Battery explosion can occur and result in personal injury.

Test procedure is:

1. Disconnect both battery cables.
2. Charge battery until no-load voltage is a minimum of 12.4 volts.
3. Connect a standard type volt/amp load tester to battery (Figure 12-9).
4. Remove battery surface charge by applying 300 amp load to battery for 15 seconds. Do this by turning load control knob (to carbon pile rheostat) until 300 amp load registers on tester amp gauge. Turn load control knob to OFF position after 15 seconds.
5. Allow battery to stabilize for 5 minutes.
6. Determine correct load amperage for battery being tested. Correct test lead equals 1/2 (50%) of battery cranking amp rating. For example, if cranking amp rating is 770, correct test load is 385 amps. Or, if rating is 900 amps, correct test load would be 450 amps.
7. Apply correct test load to battery for 15 seconds. Then record voltage reading at end of test period.
8. Load test measures voltage drop during 15 second load test. Refer to voltage drop specifications chart (Figure 12-10).
   - Battery is OK if voltage drop does not exceed chart specifications.
   - Replace battery if voltage drop exceeds chart specifications for voltage and temperature.

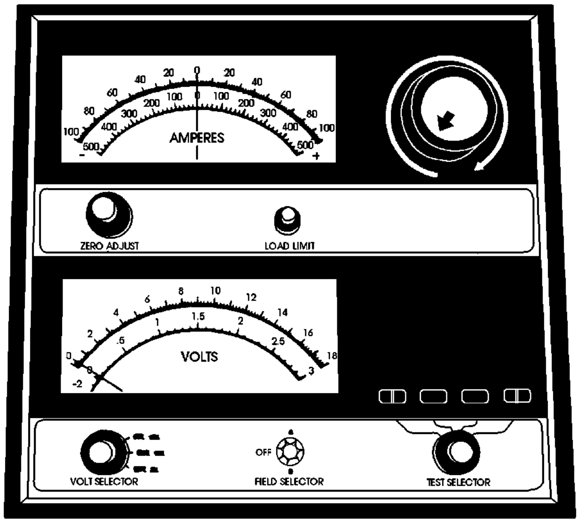

Figure 12-9: Typical Volt/Amp Battery Load Tester

Minimum Allowable Battery Voltage	Battery Temperature	
	F°	C°
9.6	70 and above	21 and above
9.5	60	16
9.4	50	10
9.3	40	4
9.1	30	-1
8.9	20	-7
8.7	10	-12
8.5	0	-18

6-S12-106

Figure 12-10: Voltage Drop Specifications for Battery Load Test

BATTERY REPLACEMENT

WARNING: Battery electrolyte contains sulfuric acid which can cause severe burns. If acid contacts eyes or skin, flush affected areas liberally with water and obtain medical assistance immediately. If acid contacts clothing, flush with water and replace affected clothing. Always wear eye protection, and remove all jewelry before working on batteries.

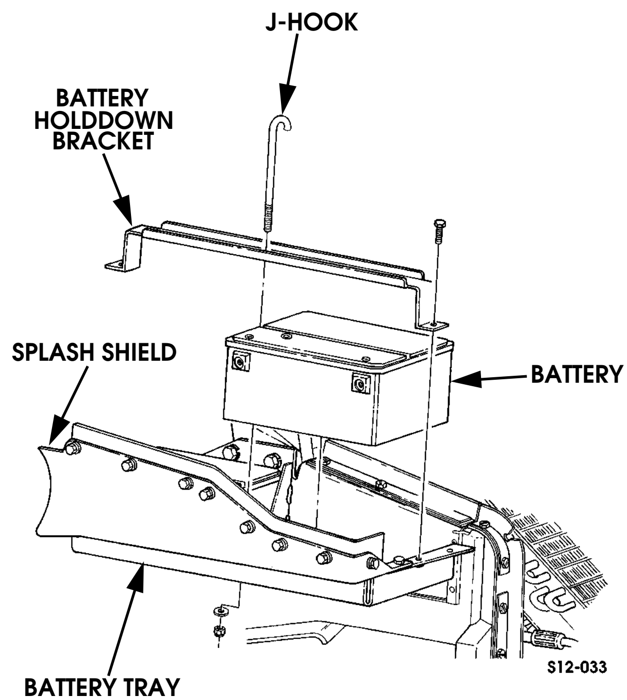

Figure 12-11: Battery Removal/Installation

1. Disconnect battery cables.
2. Remove J-hook, and holddown bracket bolts (Figure 12-11).
3. Remove holddown bracket.
4. Remove one or both batteries as required.
5. Clean battery tray.
6. Install one or both batteries in tray (Figure 12-11).
7. Install holddown bracket and J-hook.
8. Connect battery cables.

BATTERY TRAY REPLACEMENT

1. Disconnect and remove batteries.
2. Remove splash shield and battery tray shield.
3. Remove battery tray from airlift bracket (Figure 12-12).
4. Install battery tray on airlift bracket.
5. Install battery tray shield and splash shields.
6. Install and connect batteries.

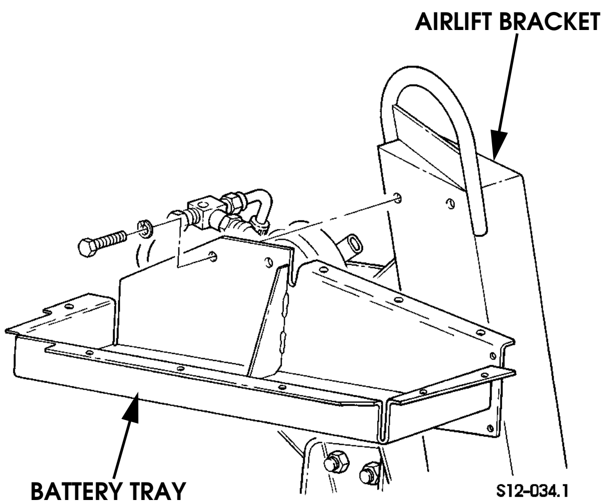

Figure 12-12: Battery Tray

BATTERY SPLASH SHIELD AND SEAL SERVICE

Splash Shield Removal

1. Remove upper splash shield and seal (Figure 12-13).
2. Remove seal attaching bolts and remove seal from upper shield (non-turbo models only).
3. Remove retainer bolts, and remove seal from battery tray and lower shield (Figure 12-14).
4. Remove lower splash shield bolts and remove lower splash shield.

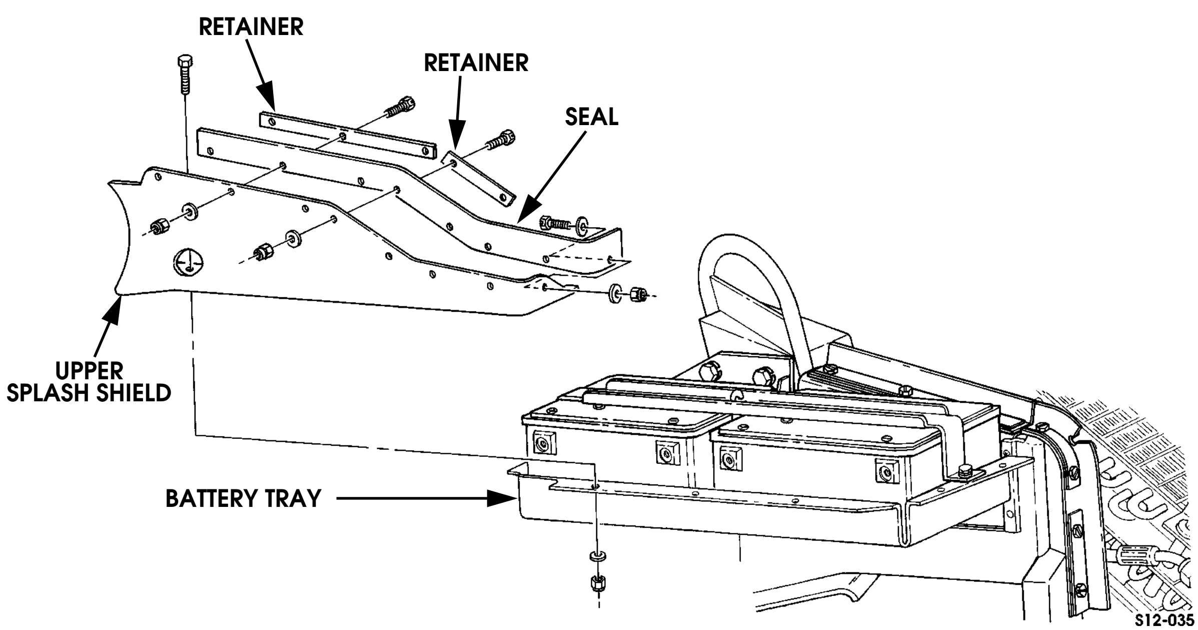

Figure 12-13: Upper Splash Shield Attachment

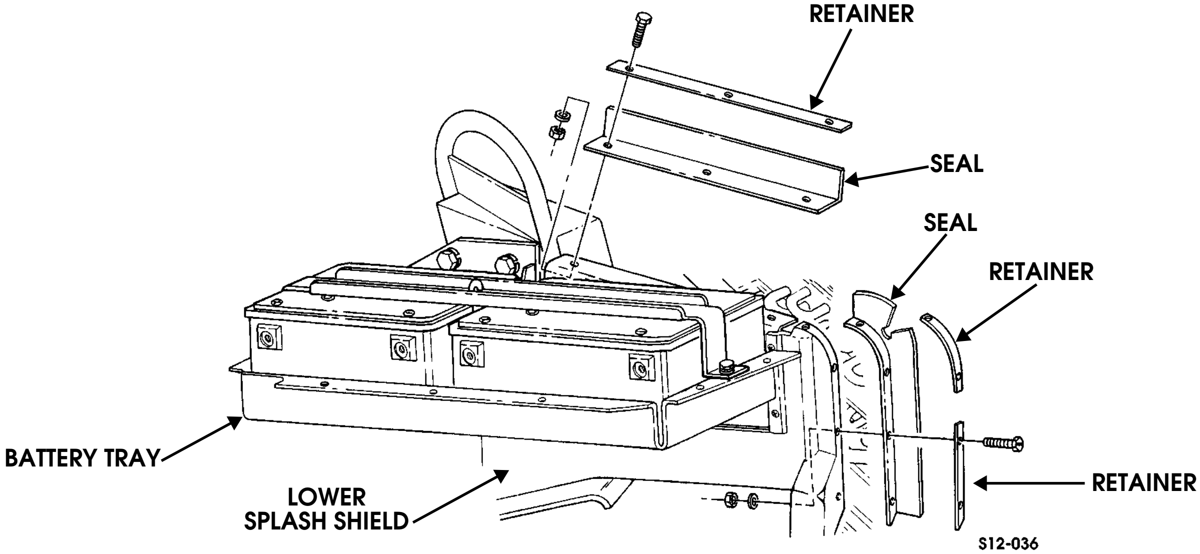

Figure 12-14: Seal and Retainer Attachment

Splash Shield Installation

1. Position lower shield on bracket and install fasteners (Figure 12-15).
2. Install retainer on upper shield.
3. Install upper shield on tray.
4. Install seals and retainers (Figure 12-14).

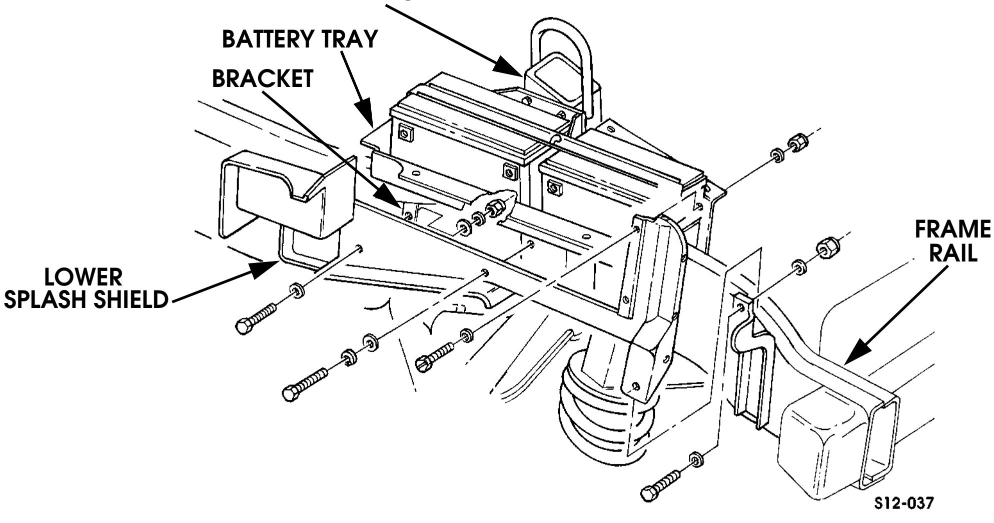

Figure 12-15: Lower Splash Shield Removal/Installation

STARTER

Removal

1. Disconnect battery negative cable(s) and winch negative cable, if equipped.
2. Remove converter housing cover.
3. Remove cap and/or adhesive sealant from starter terminal (Figure 12-16).
4. Disconnect starter cable or cables from starter terminals (Figures 12-16 and 12-17).
5. Disconnect solenoid wire from solenoid.
6. Remove starter cable clamp.
7. Loosen locknut and washer securing stud at front of starter to bracket.
8. Have helper support starter and remove starter bolts. Then lower and remove starter and shim packs (if used).

Installation

1. Position shim pack on starter.
2. Position starter in converter housing.
3. Slide starter stud into chassis bracket. Be sure stud nut and washer are behind bracket.
4. Install and tighten starter bolts to 40 lb-ft (54 N•m).
5. Tighten stud nut to 24 lb-ft (33 N•m).
6. Attach starter cable clamp to chassis.
7. Connect solenoid wire to solenoid terminal with clip and screw. Tighten screw to 22 lb-in. (2 N•m).
8. Connect starter cable to starter terminal. Tighten nut to 25-31 lb-ft (34-42 N•m).
9. Cover starter terminal and solenoid terminal with silicone sealer.
10. Install converter housing covers.
11. Connect battery negative cable.

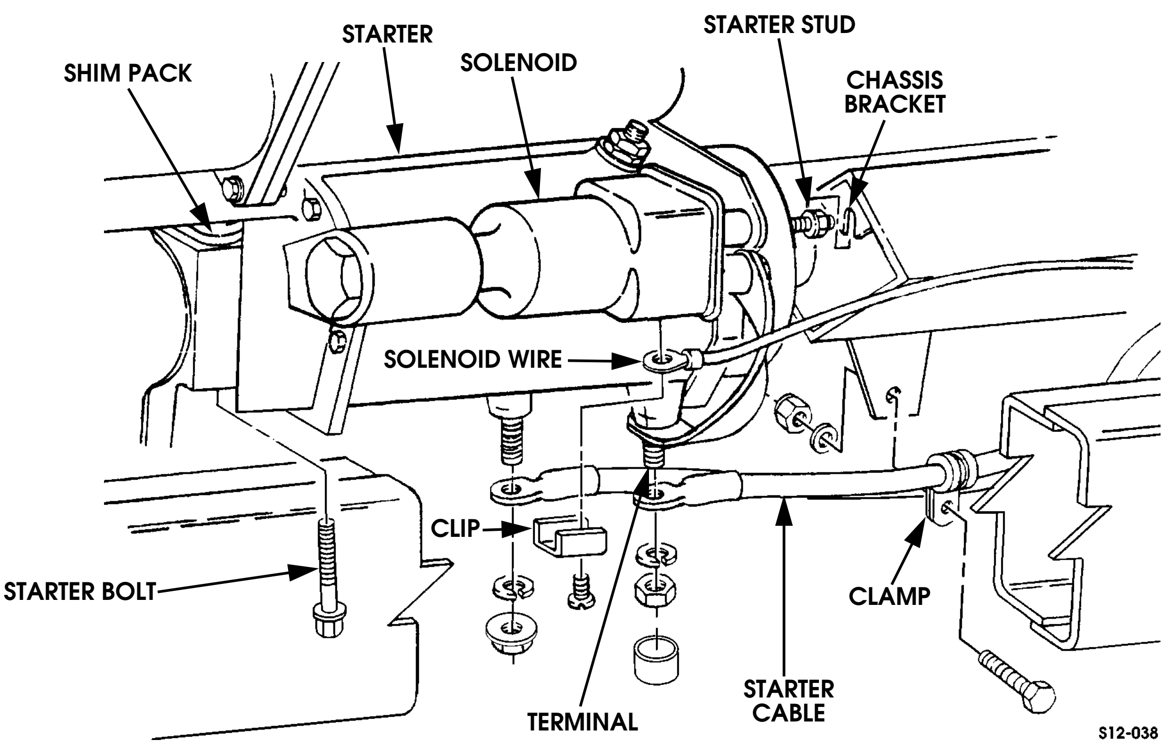

Figure 12-16: Starter Mounting

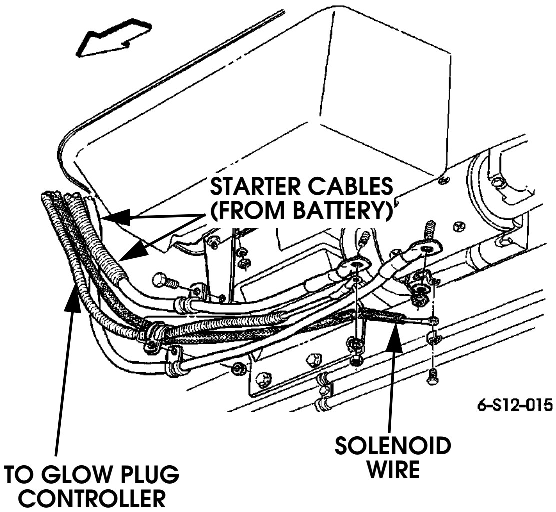

Figure 12-17: Starter Connections (Turbo Diesel)

STARTER OVERHAUL

Disassembly

1. Remove starter.
2. Remove plug and gasket from pinion housing (Figure 12-18).

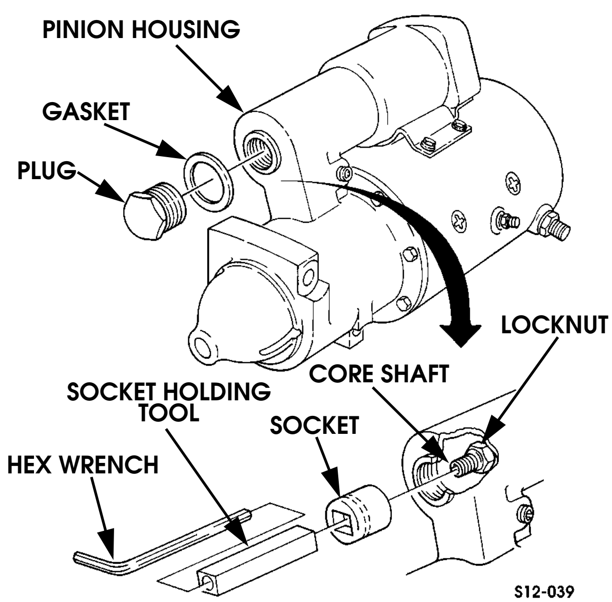

Figure 12-18: Core Shaft Nut Removal

3. Remove core shaft nut with socket, fabricated socket holding tool, and hex wrench (Figure 12-18). Holding tool can be fabricated from suitable size square tube. Or, a suitable size thin wall, deep socket can be used.
4. Remove connector nuts and remove solenoid connectors from frame assembly and solenoid (Figure 12-19).

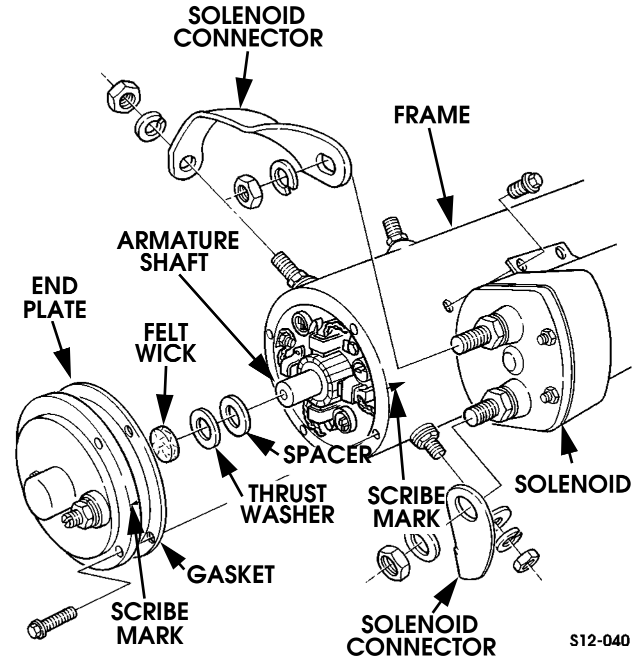

Figure 12-19: End Plate Removal

5. Remove solenoid screws and remove solenoid.
6. Scribe alignment marks on end plate and frame.
7. Remove end plate bolts and remove end plate and gasket.
8. Remove thrust washer and spacer from armature shaft.
9. Remove felt wick from end plate.
10. Scribe alignment marks on pinion housing and frame (Figure 12-20).

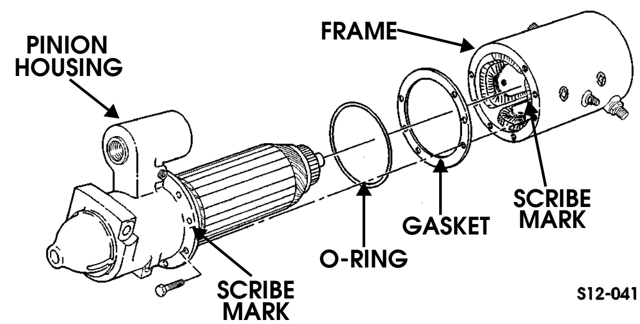

Figure 12-20: Frame Removal

11. Remove screws attaching pinion housing to frame.
12. Remove frame, gasket, and O-ring from pinion housing.
13. Remove two plugs and pin from pinion housing and shift lever (Figure 12-21).

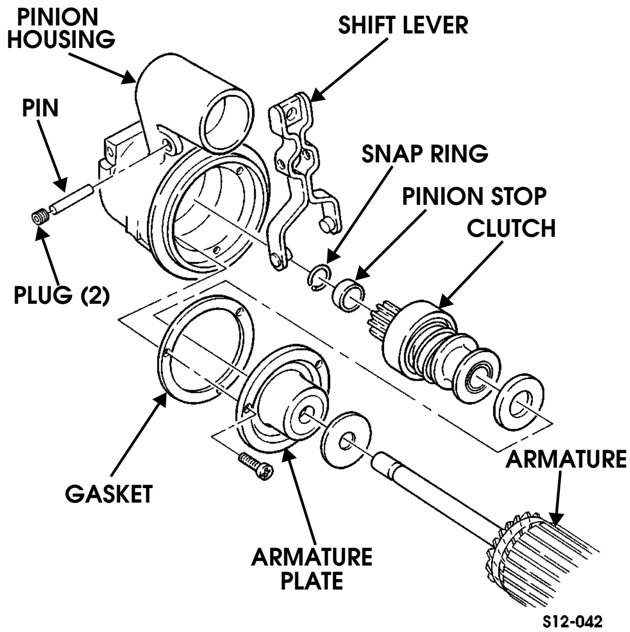

Figure 12-21: Starter Drive Disassembly

14. Clamp pinion housing in vise and remove screws from end plate and pinion housing (Figure 12-22).
15. Slide armature, end plate, and shift lever out of pinion housing.

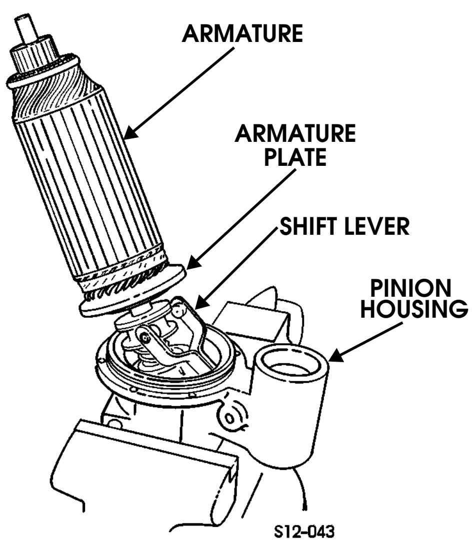

Figure 12-22: Armature Removal/Installation

16. Remove snap ring and pinion stop from armature shaft, and slide clutch off armature shaft (Figure 12-21).
17. Remove washer and plate from armature shaft (Figure 12-21).
18. Remove gasket from armature plate.
19. Remove nuts, lockwashers, screws, copper washers, and negative brush leads from frame. Remove brushes from brush holders (Figure 12-23).

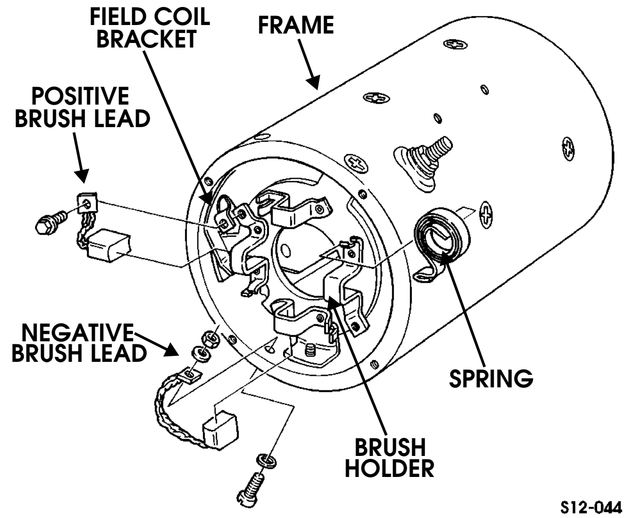

Figure 12-23: Brush and Holder Removal/Installation

20. Remove screws and positive brush leads from field coil brackets. Then remove brushes from holders.
21. Remove springs from brush holders.
22. Remove nut and lockwasher assemblies and rubber washers from solenoid housing. Discard rubber washers (Figure 12-24).

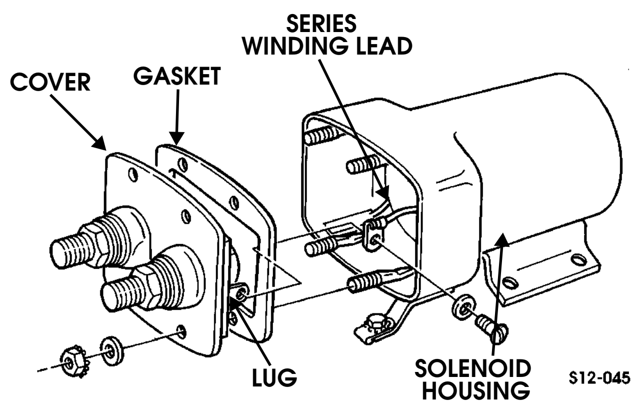

Figure 12-24: Solenoid Housing Disassembly/Reassembly

23. Pull cover away from solenoid housing and remove screw and washer from lug on cover and series winding lead.
24. Remove cover and gasket from solenoid housing.
25. Holding core shaft, remove locknut, washer, and contact from core shaft (Figure 12-25).
26. Remove and separate spring from core shaft and washer.

27. Remove snap ring, spring retainer, spring, spring retainer, rubber boot, and washer from core shaft (Figure 12-25).

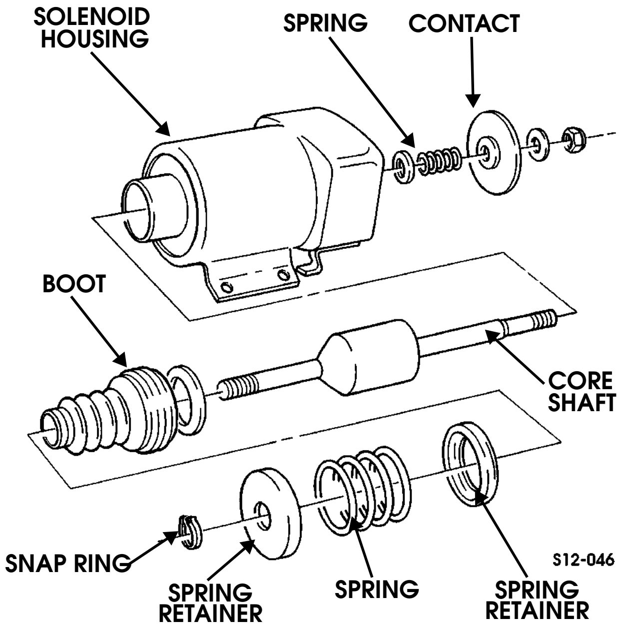

Figure 12-25: Solenoid Components

Inspection

Inspect clutch for broken spring, damaged gear or splines, and non-lockup. Replace clutch if damaged (Figure 12-26).

Inspect brushes for cracks, roughness, galling, wear, or damaged lead. If one brush length is less than 0.315 in. (8 mm) or has other damage, replace all brushes as a set.

Inspect springs for breaks, distortion, or other damage. Replace any damaged springs.

Inspect bearings in head end and pinion housing for cracks, roughness, galling, or damage. Replace bearings if defective (Figure 12-26).

Inspect pinion housing for cracks, damaged pinion bearing, and damaged threads. Repair minor thread damage. Replace starter if otherwise damaged.

Inspect commutator for damage due to arcing (burned spots and pitting), damaged shaft, splines, or threads. Replace starter if commutator is damaged.

Test armature, field coils, and brush holders for shorts, grounds, and open circuits with an armature tester. Replace starter if any one of these parts is defective.

Inspect core spring, core shaft, and rubber boot for damage. Replace parts if damaged (Figure 12-27).

Inspect contact for burns or damage. Replace contact if burned or damaged.

Inspect housing of frame assembly, head end, and solenoid housing for cracks or damage. Replace starter if any part is damaged (Figures 12-27 and 12-28).

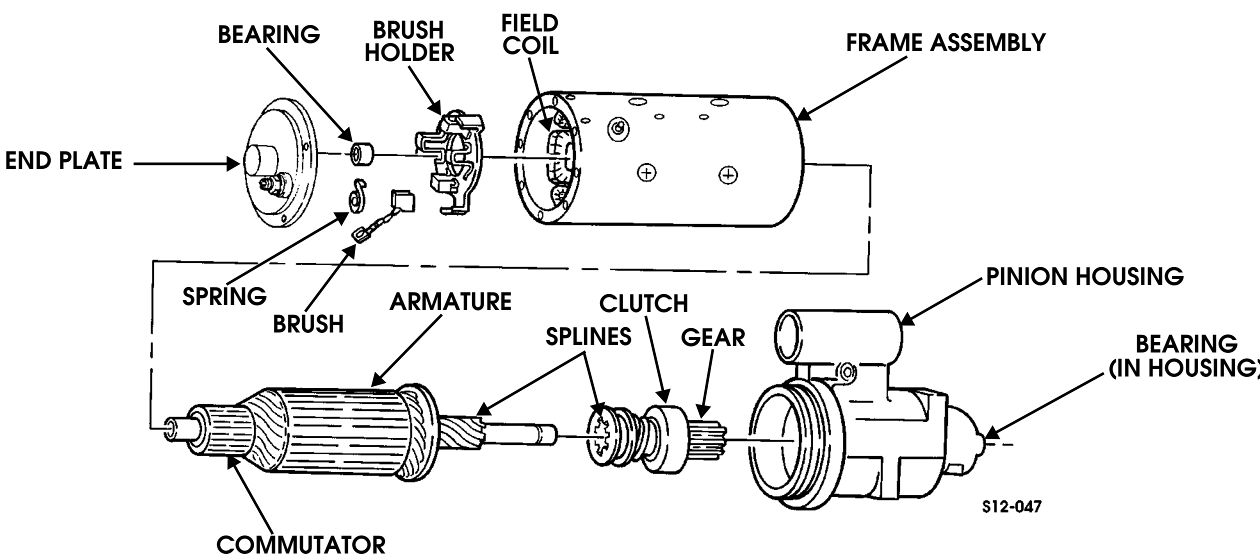

Figure 12-26: Starter Components

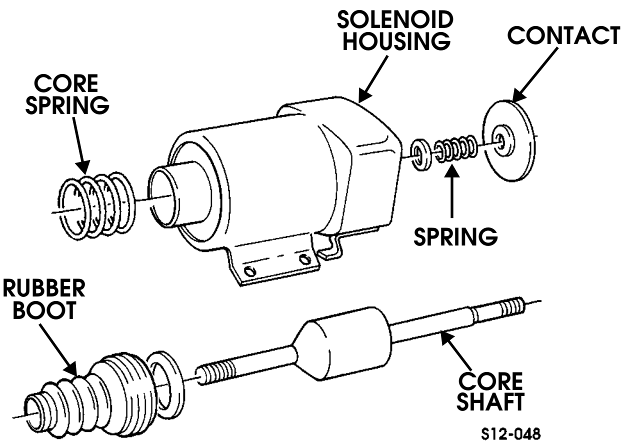

Figure 12-27: Solenoid Components

Starter Assembly

1. Assemble washer, rubber boot, spring retainer, spring, and spring retainer on core shaft and secure with snap ring (Figure 12-24).
2. Place core shaft assembly in solenoid housing.
3. Install washer, spring, contact, washer and locknut on core shaft.
4. Place gasket on cover and secure series winding lead to lug with screw and washer (Figure 12-24).
5. Install cover and gasket on solenoid housing and secure with four rubber washers and nut and lockwasher assemblies.
6. Install negative brushes and positive brushes in brush holders and retain with four springs (Figure 12-23).
7. Connect positive brush leads to field coil brackets with two screws.
8. Connect negative brush leads to frame with copper washers, screws, lockwashers, and nuts.
9. Cover negative lead screw heads with silicone adhesive sealant.
10. Apply chassis grease to armature shaft, shift lever studs, groove of clutch, and inside diameter of end plate (Figure 12-26).
11. Place washer, end plate, and gasket on armature shaft.
12. Place washer, clutch, and pinion stop on armature shaft and retain with snap ring. Position armature and shift lever in position shown for installation (Figure 12-22).
13. Install shift lever on clutch with shift lever studs engaged in clutch groove.
14. Start shift lever into pinion housing as armature is positioned in large bore of pinion housing. Then install screws through armature plate into pinion housing. Tighten screws to 40 lb-in. (5 N•m) (Figure 12-22).
15. Insert pin through pinion housing and shift lever. Then install two plugs in pinion housing (Figure 12-21).
16. Install O-ring and gasket in pinion housing (Figure 12-29).
17. Coat end plate-to-frame screws with adhesive sealant.

***CAUTION:** As armature is inserted into frame assembly, carefully align brushes on commutator. Brushes chip and break easily.*

18. Align scribe marks on frame and pinion housing, and install armature and pinion housing in frame assembly. Install and tighten screws to 50 lb-in. (6 N•m).
19. Saturate felt wick with engine oil and install in end plate (Figure 12-28).

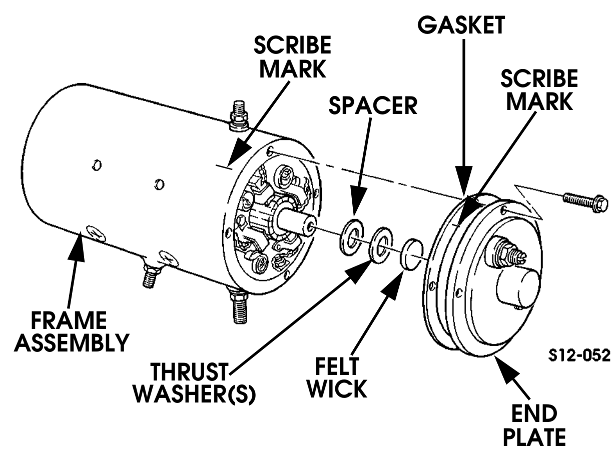

Figure 12-28: Starter End Plate Installation

20. Install spacer and thrust washers on armature shaft.

21. Align scribe marks on end plate and frame and install end plate. Tighten end plate screws to 25 lb-in. (3 N•m).
22. Coat threads of end plate screws with adhesive sealant.
23. Install end plate screws.
24. Check end play as described in following procedure.

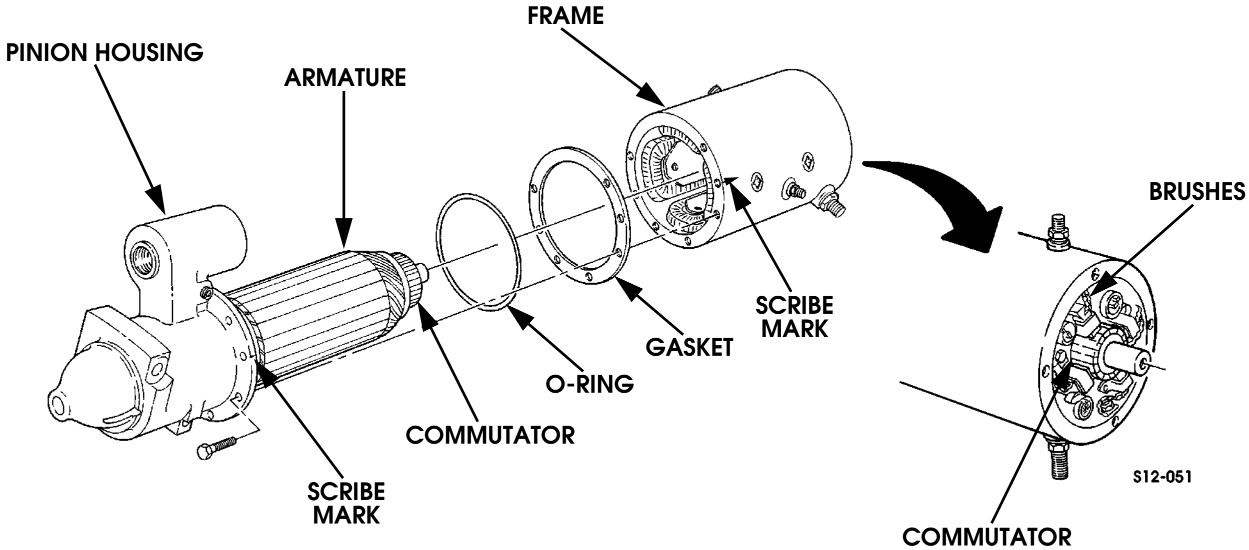

Figure 12-29: Assembling Frame, Armature, and Pinion Housing

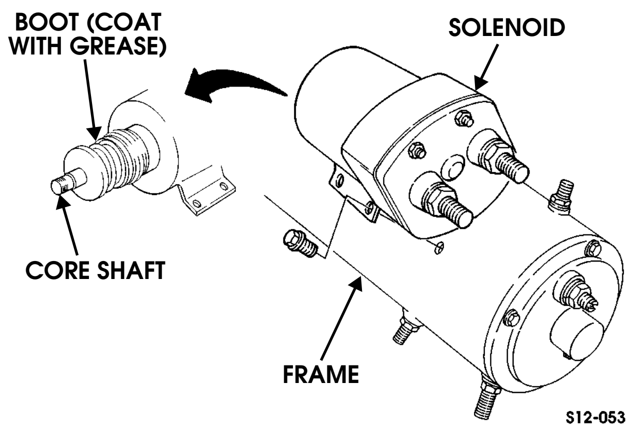

Figure 12-30: Solenoid Boot Installation

25. Coat ribbed area of core shaft boot with lithium grease (Figure 12-30).
26. Align end of core shaft in hole in shift lever and install solenoid on frame. Tighten solenoid screws to 50 lb-in. (6 N•m).
27. Install core shaft nut. Tighten nut with socket, fabricated tool, and hex wrench (Figure 12-18)

Starter Pinion Clearance

Adjustment

1. Connect battery and jumper to starter as shown (Figure 12-31). Momentarily touch jumper to solenoid frame to shift pinion into cranking position.

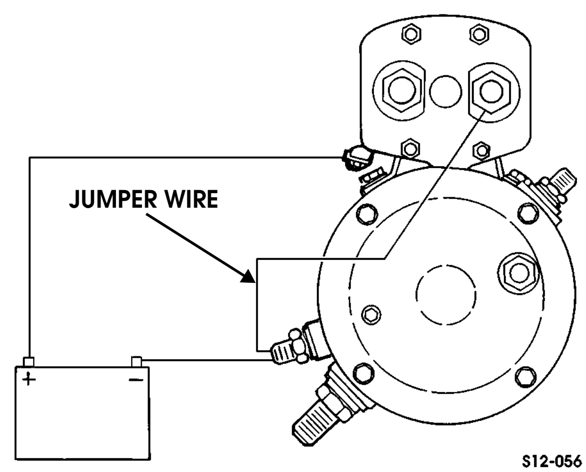

Figure 12-31: Battery and Jumper Connections for Pinion Clearance Check

2. Check clearance between pinion and snap ring with feeler gauge (Figure 12-32).
3. Disconnect battery.
4. Pinion clearance should be 0.005-0.030 in. (0.127-0.762 mm). If adjustment is necessary, remove end plate and add or remove thrust washer(s) (Figure 12-32).

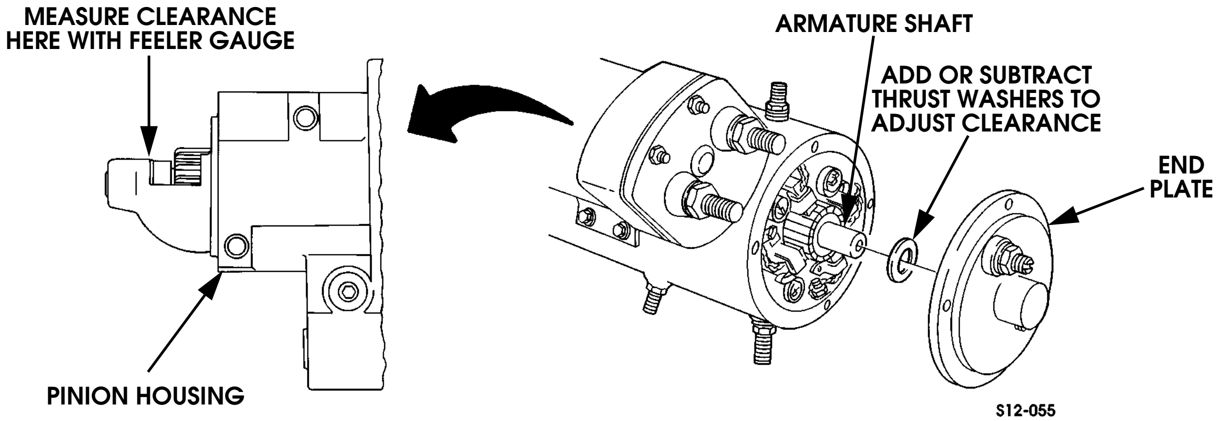

Figure 12-32: Starter Pinion Clearance Measurement and Adjustment

Starter Test

1. Connect voltmeter, ammeter, switch and battery to starter as shown (Figure 12-33).

CAUTION: *Do not operate the starter motor for more than 10 seconds at a time. Allow the starter motor to cool at least 2 minutes between tests to avoid overheat damage.*

WARNING: Starter must be secured to prevent movement from start up torque. Test cables must be of a sufficient gauge size to conduct starter current.

2. Close switch, adjust voltage to 9.5 volts on voltmeter using carbon pile. Check rotating speed of armature with tachometer. Read current draw on ammeter.
3. Maximum current draw should be 65 amps with a minimum armature speed of 5000 rpm. If a low speed, high current condition exists, check armature for shorts or grounds. If a low speed, low current draw exists, inspect starter motor for bad connections or poor brush contact.

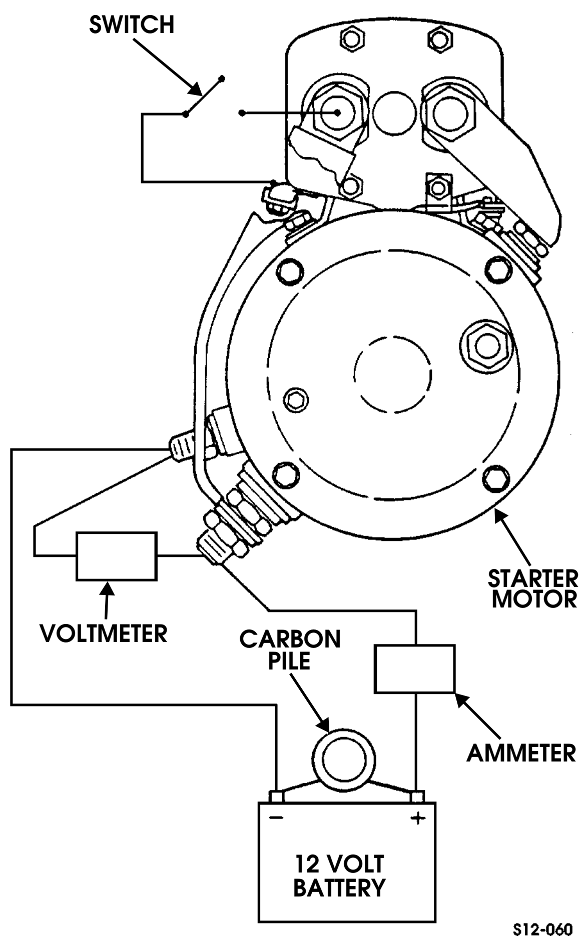

Figure 12-33: Starter Test Connections

ALTERNATOR

Removal

1. Disconnect battery negative cable.
2. Remove serpentine drivebelt from alternator pulley.
3. Loosen pivot bolt and remove front and rear alternator bolts (Figure 12-34).
4. Pull alternator away from engine. Remove nut and lockwasher and disconnect battery wires from battery alternator terminal (Figure 12-35).
5. Unlock and disconnect field wire (Figure 12-35).
6. Remove pivot bolt and alternator from engine.

Installation

1. Position alternator in bracket and install pivot bolt finger tight.
2. Connect battery wires to alternator. Secure with lockwasher and nut. Tighten nut to 62-80 lb-in (7-9 N•m).
3. Connect field wire to alternator.
4. Move alternator into alignment with lower bracket and install front and rear mounting bolts. Tighten bolts 18 lb-ft (25 N•m).
5. Tighten pivot bolt to 37 lb-ft. (50 N•m).
6. Install serpentine drivebelt on pulley and adjust belt.
7. Connect battery negative cable.

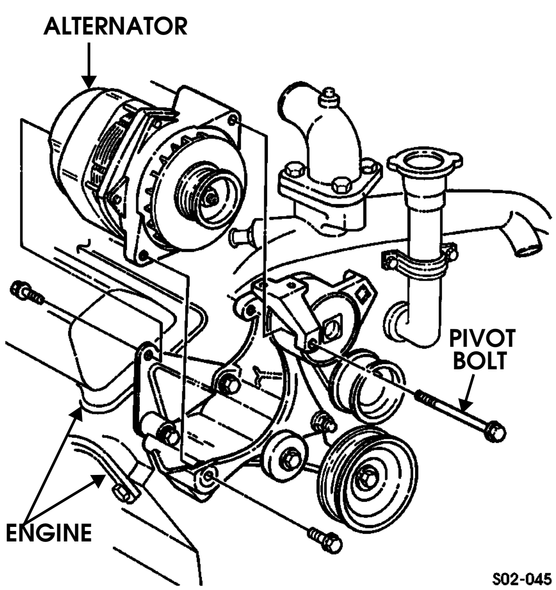

Figure 12-34: Alternator Mounting

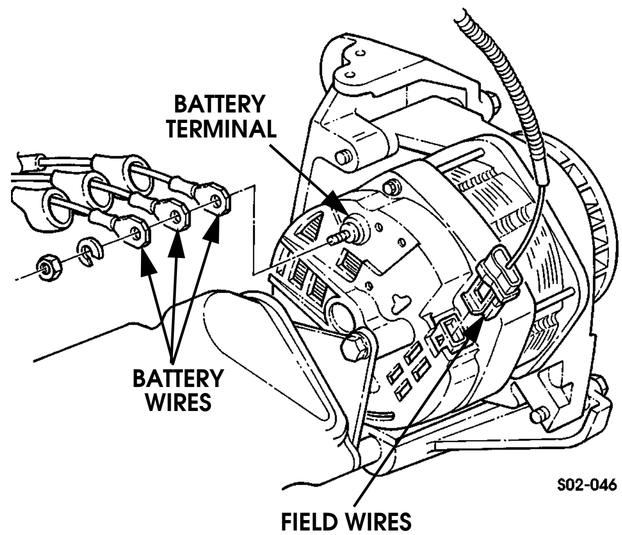

Figure 12-35: Alternator Connections

ALTERNATOR OVERHAUL

Alternator Disassembly

1. Remove alternator.
2. Mark drive end frame and slip ring end frame for assembly alignment reference.
3. Hold rotor shaft with allen wrench and remove nut, washer, pulley, fan, and thin collar from rotor shaft (Figure 12-36).
4. Remove four through-bolts from slip ring end frame and drive end frame.
5. Remove drive end frame and thick collar from rotor shaft.
6. Remove three nuts from stator leads and rectifier bridge.
7. Remove stator from slip ring end frame.
8. Remove standard screws, insulated screws, and washer from components in slip ring end frame.
9. Remove nut and output stud with insulator from slip ring end frame.
10. Remove rectifier bridge, capacitor strap, regulator connector strap, and brush holder from slip ring end frame.
11. Unsolder and separate brush holder and regulator connector.
12. Unsolder and separate connector strap from regulator.

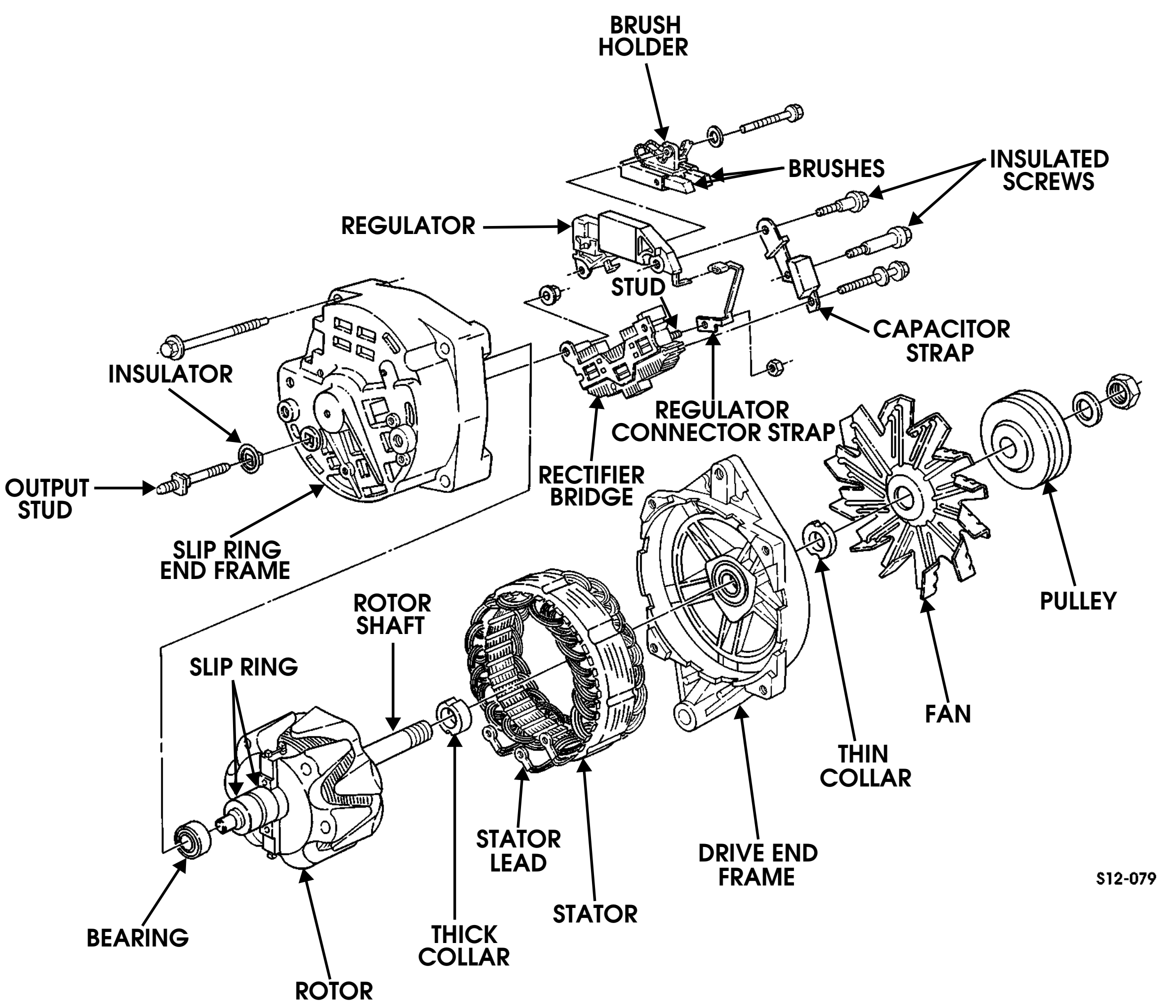

Figure 12-36: Alternator Components

Alternator Parts

Cleaning

Use part cleaning solvents on metal parts only. The insulating coatings on wires in the field coil and stator can be damaged by cleaning solvents. Use solvents on metal items only.

Clean encapsulated and exposed wire items by wiping with a clean cloth.

Inspection and Repair

Rotor

Inspect for cracked slip rings, damaged threads, and galling or scoring on bearing journal surfaces on shaft (Figure 12-37).

Corrosion or light scoring on the slip rings may be removed with 400 grit emery cloth.

Test the slip rings and field coil for opens (high resistance), shorts (very low resistance), and grounds (low resistance) to frame and shaft. Replace the rotor if a fault is detected.

Inspect the ball bearing for free play, roughness, leaking seals, and other damage. Replace the bearing if necessary. Seat the new ball bearing against the rotor shoulder.

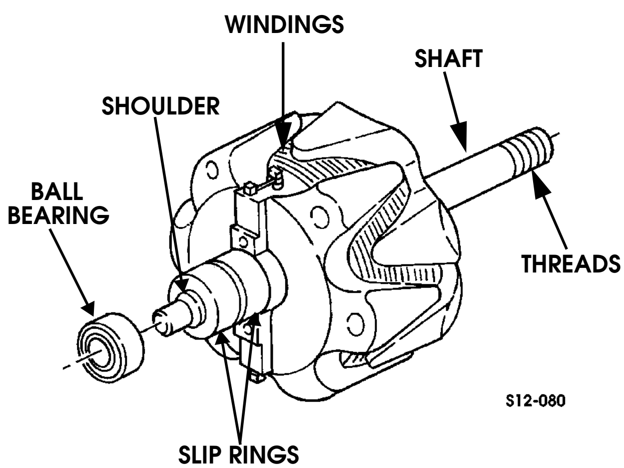

Figure 12-37: Rotor Inspection Points

Stator

Check the stator leads for continuity to ground (laminations). Any continuity indicates a grounded stator which should be replaced (Figure 12-38).

Examine the stator winding for discoloration due to overheating or short to ground. Normal color is reddish brown to purple. Bare copper, dark spots, or dull black color indicates burned spots.

Replace the stator if damaged, shorted or grounded.

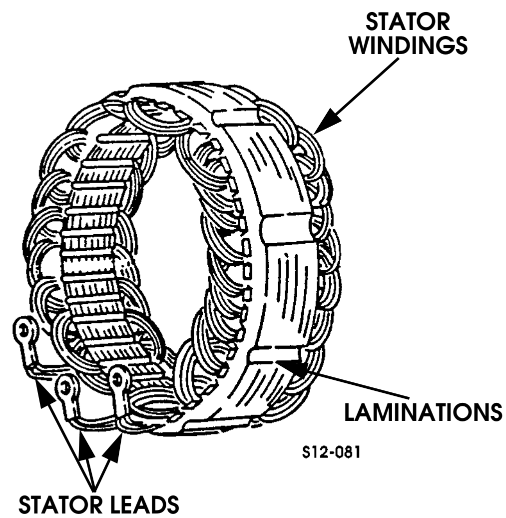

Figure 12-38: Stator Inspection Points

Rectifier Bridge

Test the rectifier bridge as follows:

1. The bridge studs are embedded in insulation. To obtain diode readings, the ohmmeter leads must contact the copper strap.
2. Connect the ohmmeter leads to the grounded side and strap as shown and take readings at each strap (Figure 12-39).
3. Repeat step 1 with test leads reversed.
4. All three readings in steps 1 or 2 should read high resistance in one case and low resistance in other case.
5. Connect ohmmeter leads on positive side and strap as shown, and take readings at each strap (Figure 12-39).
6. Repeat process of step 4 with leads reversed.
7. All three readings in steps 4 and 5 should be the same, with resistance high in one set and low in the other set.
8. If any one reading in steps 1, 2, 3, and 4 is not the same as the other two readings, replace rectifier bridge.

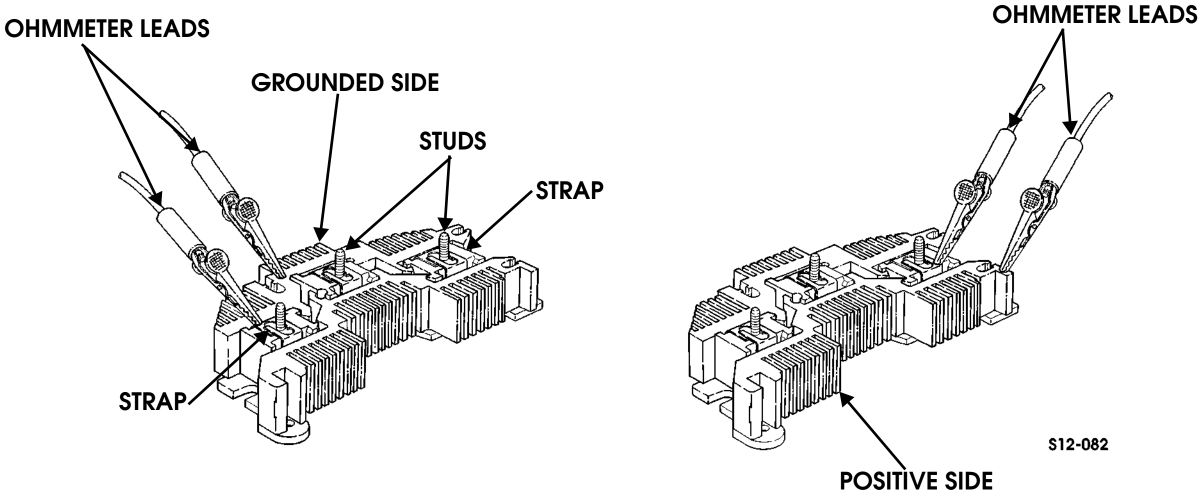

Figure 12-39: Rectifier Bridge Check

Regulator

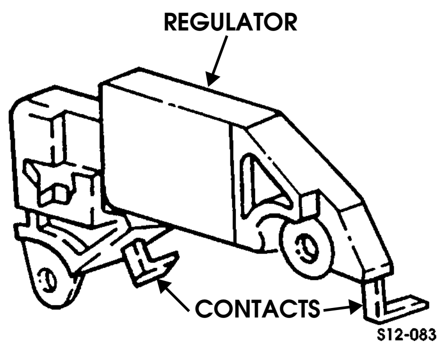

Figure 12-40: Regulator Inspection Points

Inspect the regulator for cracks, breaks, broken contacts, or surface defects and replace if damaged (Figure 12-40).

Brushes and Brush Holders

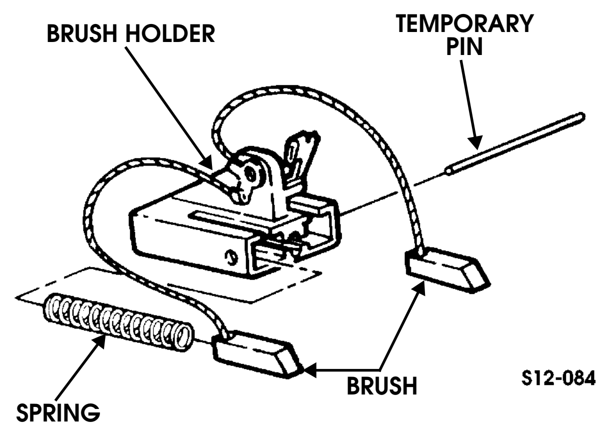

Figure 12-41: Brush Holder and Brushes

Check for broken or disconnected brushes, worn brushes with length less than 0.5 in. (12.7 mm), and broken or distorted springs. Replace brush holder and brushes as an assembly if necessary (Figure 12-41).

NOTE: The pin that retains the brushes temporarily can be made from locally obtained parts. A standard paper clip can be used.

Assemble springs and brushes in the brush holder. Compress the springs and brushes in the holder and hold them in position with the temporary pin (pin will be removed after assembly) (Figure 12-41).

Drive End Frame and Bearing

Inspect the bearing for roughness, looseness in bore, inner race free play, or damaged seals. Replace the end frame and bearing as an assembly if damaged (Figure 12-42).

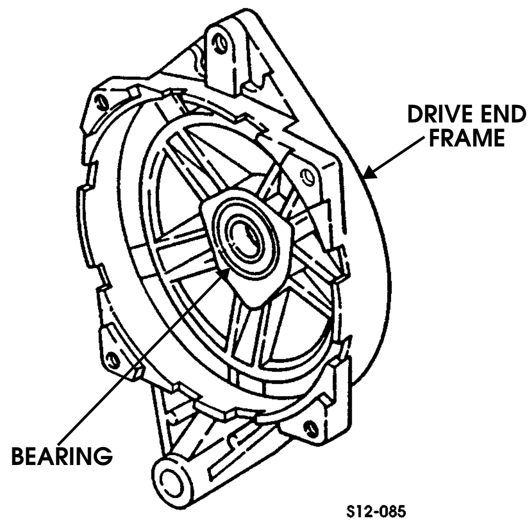

Figure 12-42: Drive End Frame Inspection

Inspect the drive end frame for cracks, breaks, or damaged threads. Replace the assembly if casting is cracked or broken.

Repair minor through-bolt and adjusting bolt thread damage using a tap. For more serious through-bolt thread damage, replace the end frame.

Fan

Inspect the fan for distortion, cracked blades, or broken blades. Minor bending repair is permissible. For broken or missing blade ends, cracks or breaks, replace the fan (Figure 12-43).

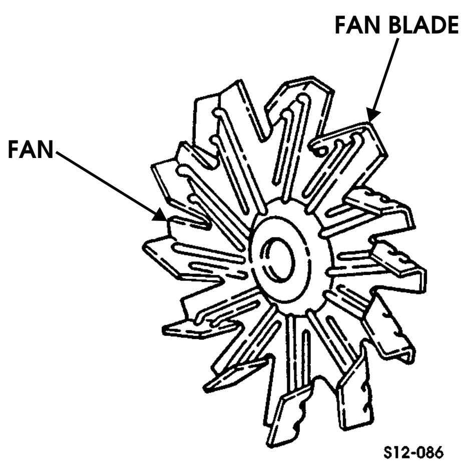

Figure 12-43: Fan Inspection Points

Slip Ring End Frame and Bearing

Inspect the bearing for roughness, looseness in retainer ring, free play, loose inner race, or damaged seals. Replace the bearing if damaged or loose (Figure 12-44).

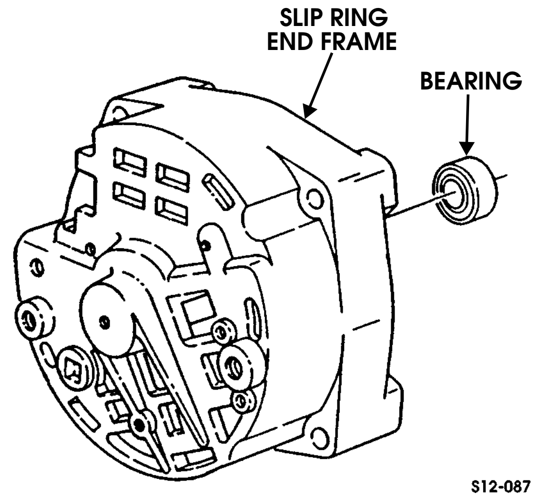

Figure 12-44: Slip Ring End Frame

Inspect the slip ring end frame for breaks, cracks, evidence of spun ball bearing, or damaged threads. Repair minor thread damage. Replace the end frame if otherwise damaged.

Collars

Inspect both collars for cracks, bends, or scoring. Replace either part if damaged (Figure 12-45).

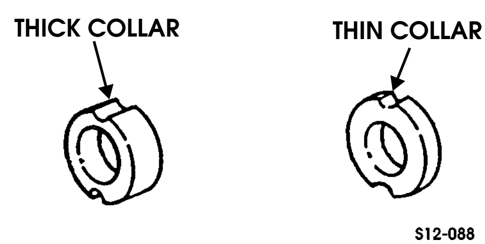

Figure 12-45: Fan Spacers

Output Stud Assembly

Inspect the output stud assembly for cracked, or broken insulator, distortion, or damaged threads. Replace the stud assembly if any part is damaged (Figure 12-46).

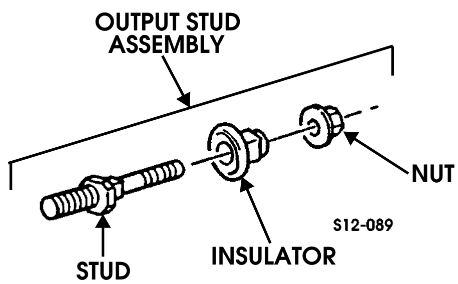

Figure 12-46: Output Stud Inspection

Pulley

Inspect the pulley for distortion, breaks, or sharp edges in the belt grooves. Remove minor burrs and sharp edges with fine tooth file. Replace the pulley if damaged (Figure 12-47).

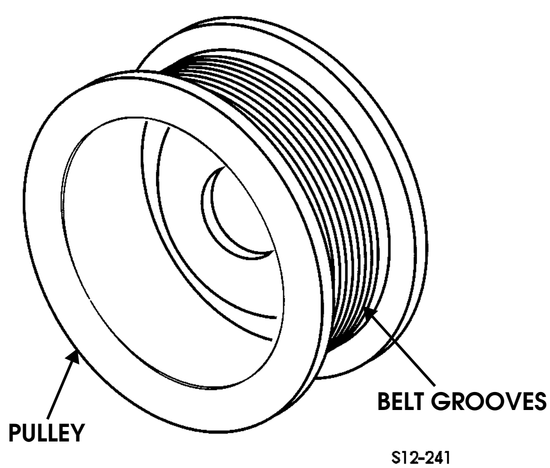

Figure 12-47: Alternator Pulley

Capacitor Strap

Inspect the capacitor strap for breaks, cracks, distorted case, or surface defects. Check capacitor for continuity. Replace if damaged (Figure 12-48).

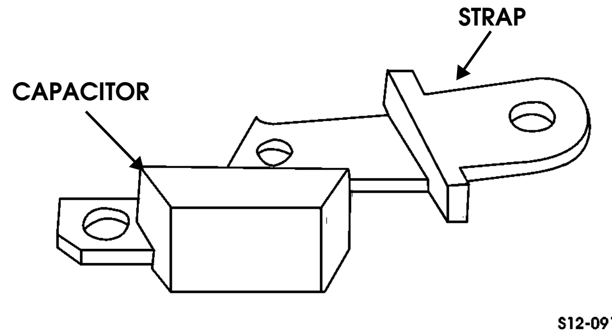

Figure 12-48: Capacitor Strap

Alternator Assembly

1. Install bearing on rotor shaft. Seat bearing against shoulder (Figure 12-36).
2. Assemble springs and brushes in brush holder and retain with fabricated pin. Pin holds brushes compressed in brush holder and will be removed after assembly.
3. Install rectifier bridge in slip ring end frame and install screw, output stud insulator, and nut.
4. Assemble and install brush holder and regulator. Solder connection between brush holder and regulator if either part was replaced.
5. Slide regulator connector strap into regulator contact and solder together.
6. Slip capacitor strap under connector strap and position on rectifier bridge and regulator. Secure capacitor strap with screw and two insulated screws (Figure 12-49).

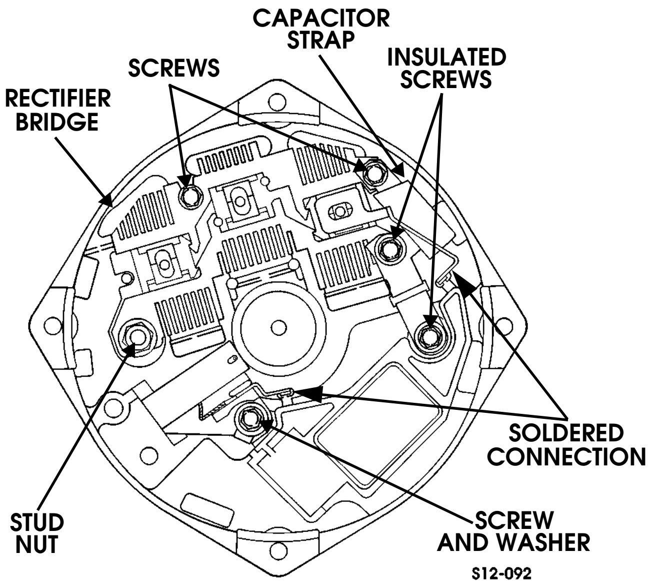

Figure 12-49: Rectifier Bridge and Capacitor Strap Location

7. Attach stator leads to rectifier bridge and secure leads with nuts.
8. Install thick collar on rotor shaft (Figure 12-36).
9. Insert rotor shaft through drive end frame and seat bearing against thick collar.
10. Install thin collar, fan, and pulley on rotor shaft and secure with washer and nut. Tighten nut to 40-80 lb-ft (54-109 N•m).
11. Carefully insert rotor through stator and seat ball bearing in slip ring end frame. Be sure drive end frame and stator are aligned and seated.
12. Install through-bolts. Tighten through-bolts evenly to remove any slack.
13. Verify that rotor turns smoothly.
14. Remove brush retaining pin from brush holder. Be sure brushes extend out brush holder and contact slip rings.

JUNCTION BLOCK REPLACEMENT

Removal

1. Disconnect battery negative cables, and winch negative cable, if equipped.
2. Remove junction block cover (Figure 12-50).
3. Remove top nut, lockwasher, washer, and wires from junction block upper stud.
4. Remove bottom nut, lockwasher, washer and wires from junction block lower stud.
5. Remove junction block from plate.
6. Remove plate from bracket.

Installation

1. Install plate on bracket (Figure 12-50).
2. Secure junction block to plate with nuts and screws.
3. Install wire on bottom stud and secure washer, lockwasher, and nut.
4. Install wires on top stud and secure with washer, lockwasher, and nut.
5. Install junction block cover.
6. Connect battery cables.

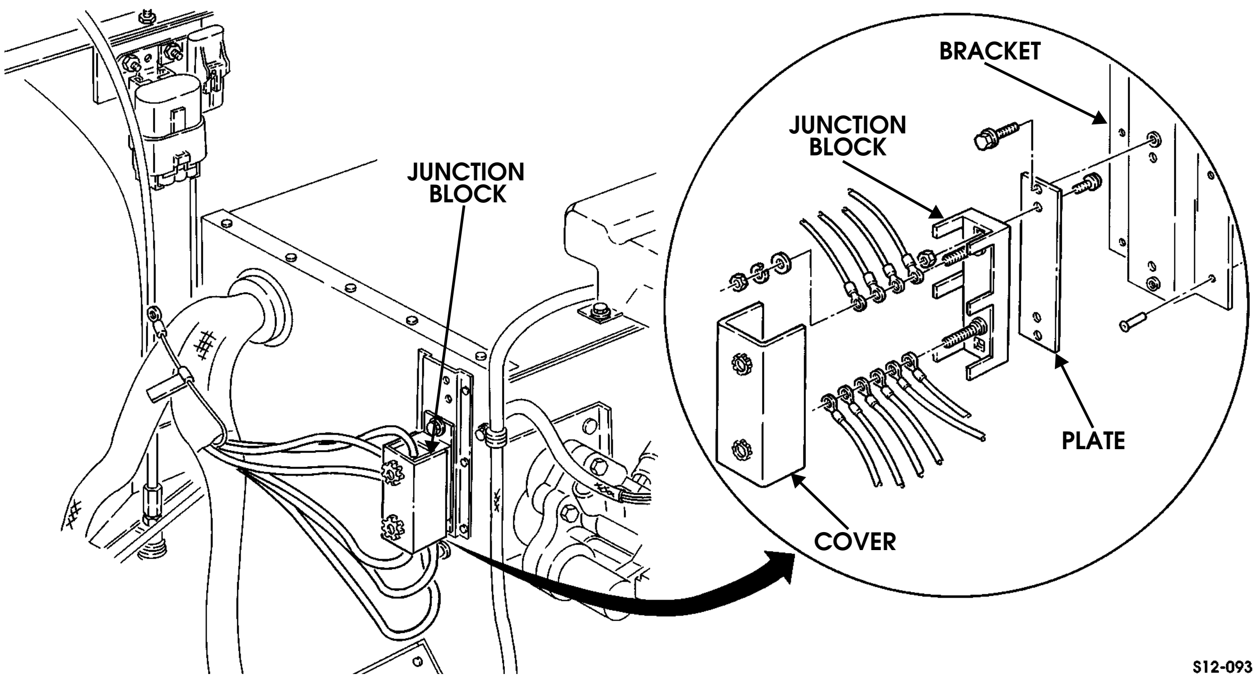

Figure 12-50: Junction Block Components

HOOD HARNESS REPLACEMENT

Removal - Driver Side

1. Disconnect hood harness connectors at body harness connectors.
2. Disconnect driver side headlight wires.
3. Remove side marker cover and clearance lamp cover.
4. Disconnect ground wire and connectors at left-side marker light.
5. Remove ground wire and connector from left side marker light.
6. Disconnect two-wire connector from left side clearance lamp.
7. Disconnect two connectors from under hood lamp.

Removal - Passenger Side

1. Disconnect three connectors at passenger side headlight.
2. Remove marker cover and clearance lamp cover.
3. Remove ground wire and connector at marker light.
4. Remove ground wire and two connectors from marker light.
5. Disconnect two-wire connector from clearance lamp.
6. Remove clamps securing electrical harness to hood.
7. Remove tie straps as required.
8. Remove hood harness.

Installation - Passenger Side

1. Place hood harness in position for installation.
2. Install harness clamps on hood but do not tighten clamps.
3. Connect two-wire connector to clearance lamp.
4. Connect ground and feed wires to marker light.
5. Connect headlight wires.
6. Install marker and clearance lamp covers.

Installation - Driver Side

1. Connect wires to clearance lamp.
2. Connect wires to marker lamp.
3. Connect wires to marker light.
4. Install marker and clearance lamp covers.
5. Connect hood lamp.
6. Connect headlight.
7. Connect hood harness connectors to body harness connectors.
8. Tighten harness clamps and install new tie straps as needed.

ENGINE HARNESS REPLACEMENT

Removal

1. Disconnect both batteries.
2. Remove console and engine cover.

NOTE: Tag or mark wires for installation reference.

3. Disconnect following at rear of engine:
   - glow plug controller wires (Figure 12-51)
   - oil pressure switch (Figure 12-52)
   - engine speed sensor (Figure 12-52)
   - engine ground cables (Figure 12-52)
   - baro sensor (Figure 12-53)
   - glow plug wires and coolant temperature sensor (Figure 12-53)

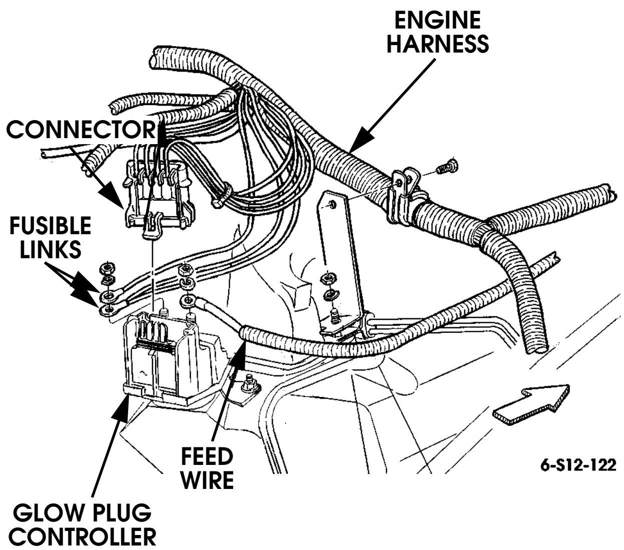

Figure 12-51: Glow Plug Controller Connections

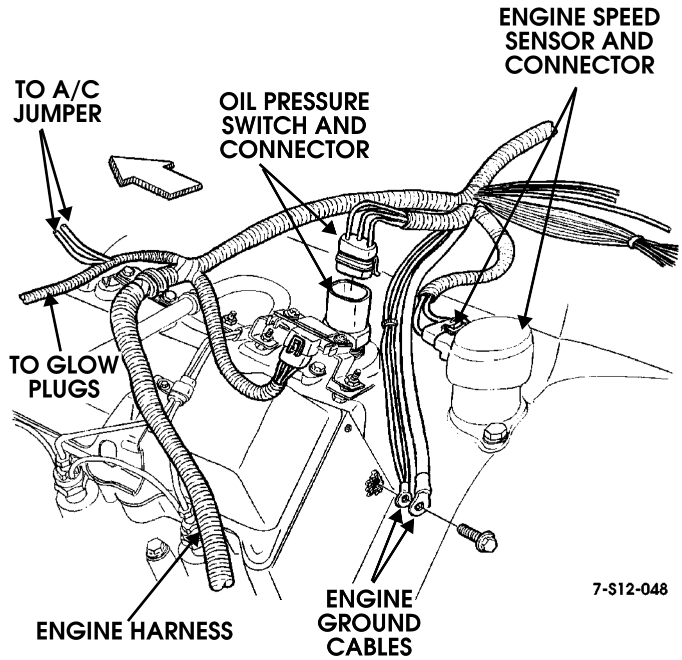

Figure 12-52: Engine Harness Connections at Rear of Engine (Non-Turbo Shown)

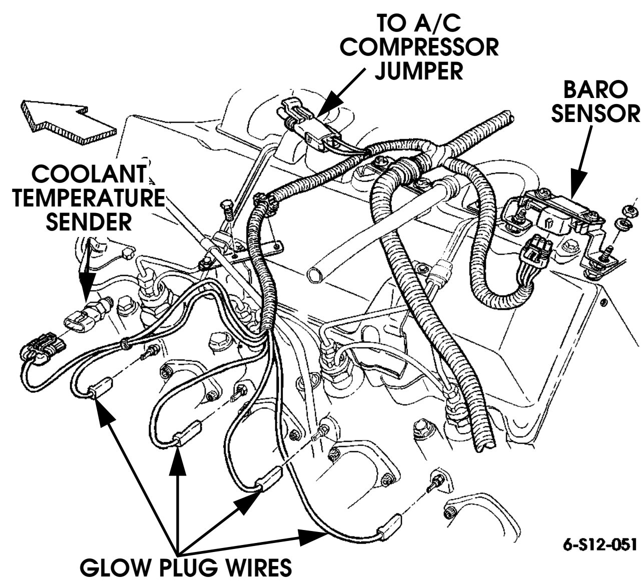

Figure 12-53: Engine Harness Connections at Driver's Side (Non-Turbo Shown)

4. Disconnect following in engine compartment (Figures 12-54 and 12-55)
   - remove connector screw and disconnect engine harness at bulkhead connector
   - fuel pump and relay
   - fuel filter
   - junction block

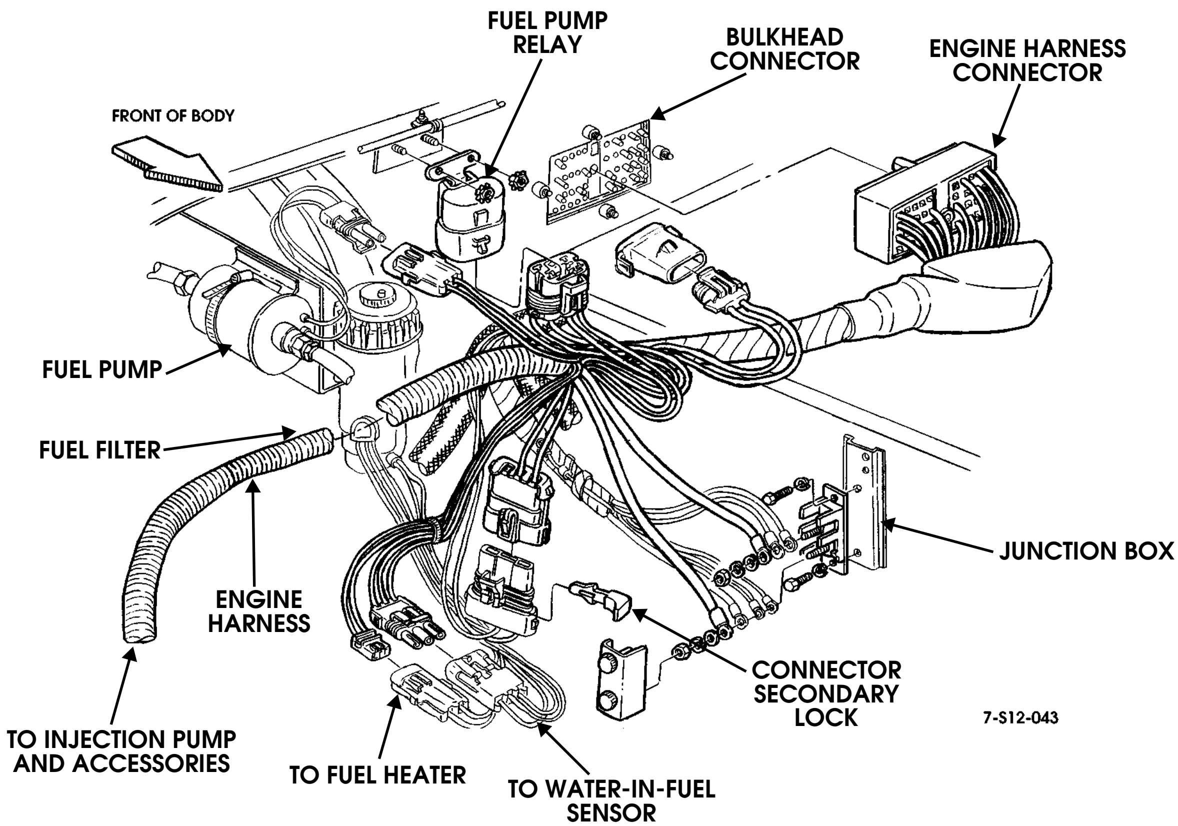

Figure 12-54: Engine Harness (Non-Turbo Diesel)

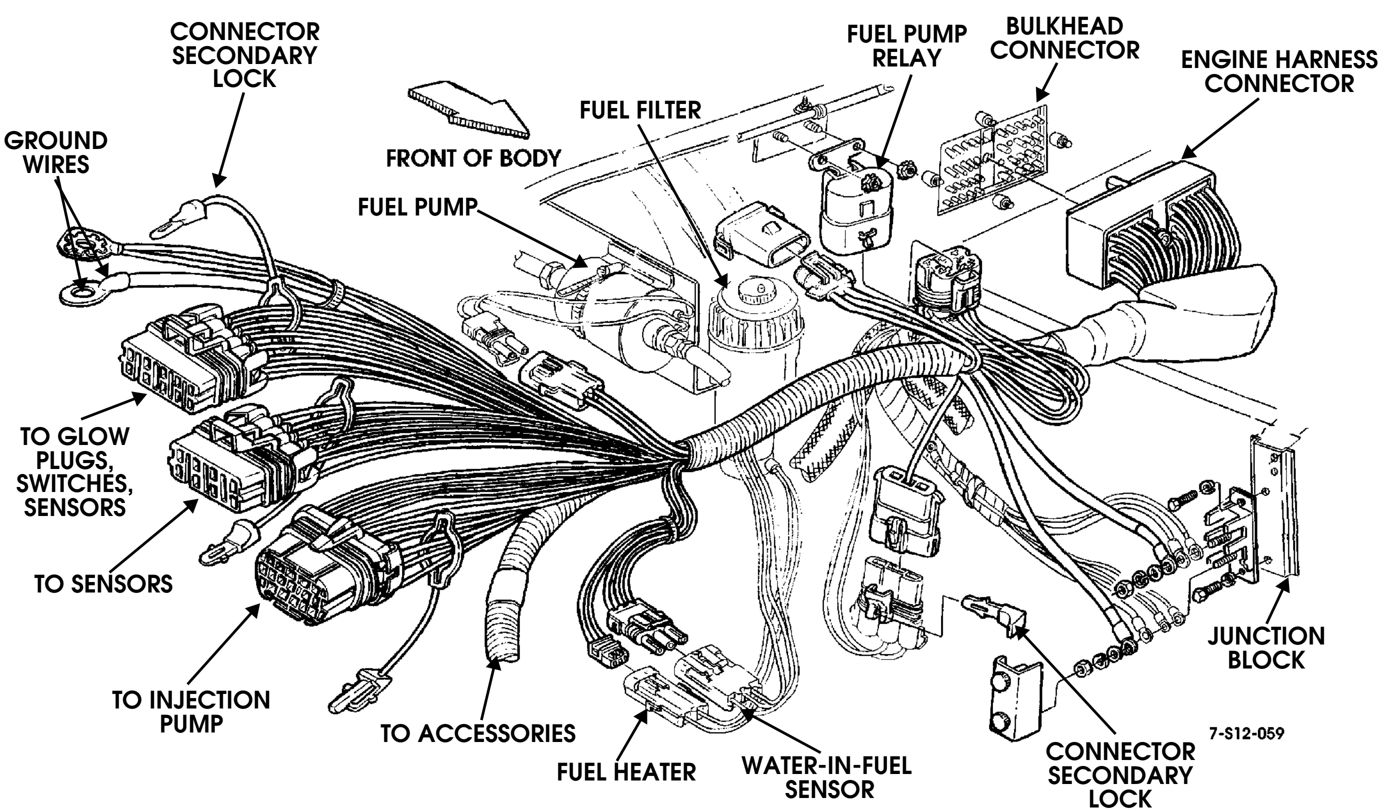

Figure 12-55: Engine Harness (Turbo Diesel)

5. Disconnect following in engine compartment and at accessories:
   - harness wires to injection pump and sensors (Figures 12-56 and 12-57)
   - harness ground wires (Figures 12-56 and 12-57)

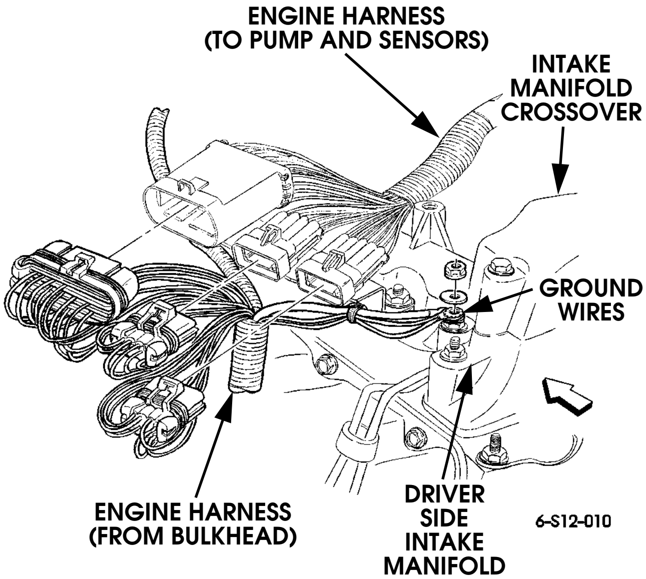

Figure 12-56: Engine Harness Connections at Driver Side of Engine (Turbo Diesel)

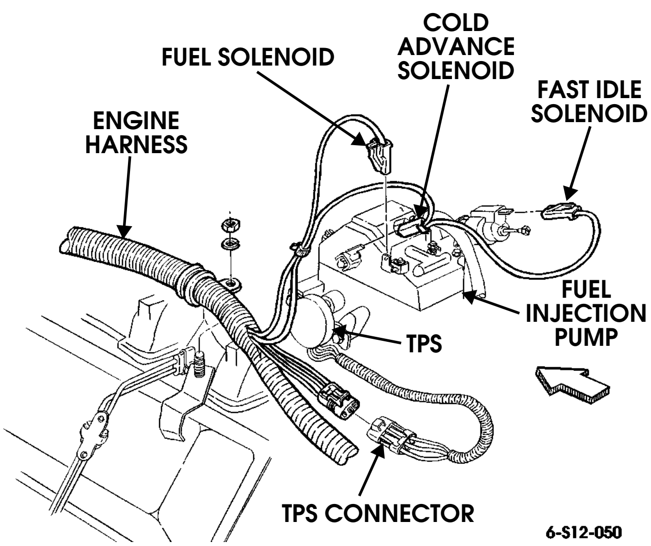

Figure 12-57: Fuel Injection Pump Connections (Non-Turbo)

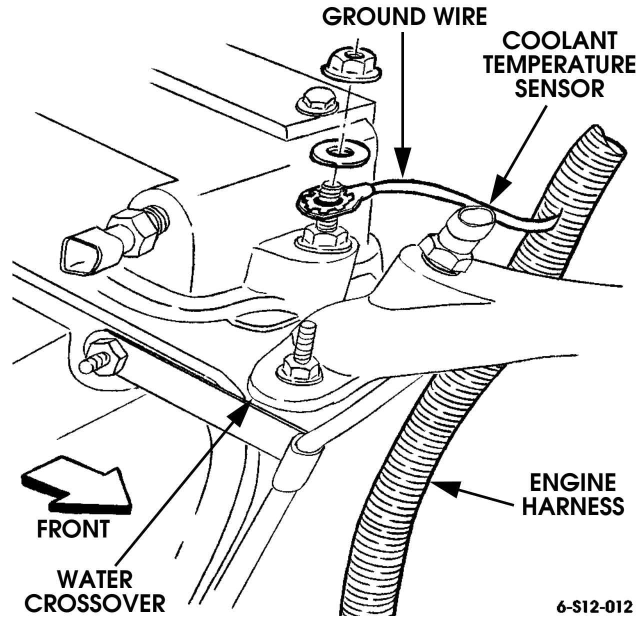

Figure 12-58: Engine Harness Ground Connections at Front (Turbo Diesel Shown)

6. Disconnect following at front of engine:
   - A/C pressure switch and ambient temperature switch wires (Figure 12-59)
   - A/C compressor clutch wires (Figures 12-60 and 12-61)
   - Alternator wire (Figure 12-62)

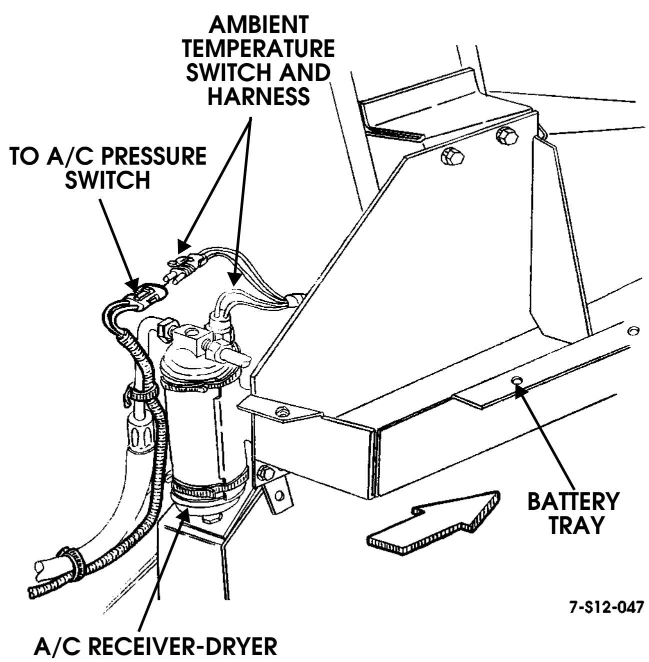

Figure 12-59: Engine Harness Connections at Receiver-Dryer

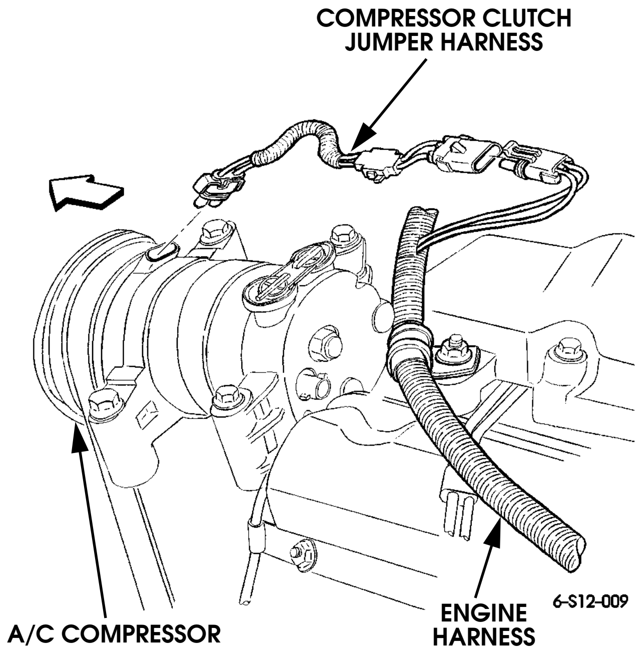

Figure 12-60: Engine Harness Connection at A/C Compressor (Turbo Diesel)

7. Disconnect following at passenger side of engine:
   - glow plug wires
   - wire harness clamps and retainers (Figures 12-63 and 12-64)
8. Remove tie straps and clamps securing harness.
9. Remove harness through console opening in dash panel.

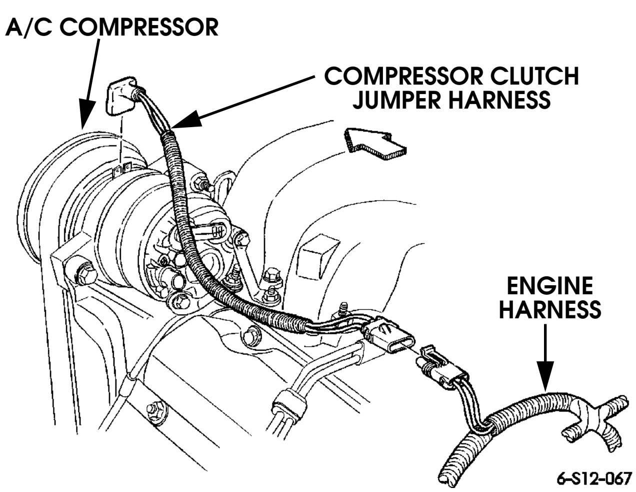

Figure 12-61: Engine Harness Connection at A/C Compressor (Non-Turbo)

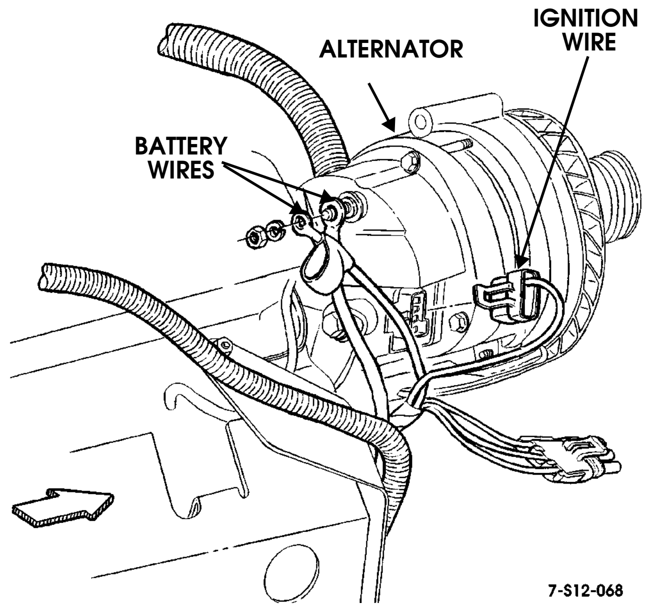

Figure 12-62: Engine Harness Connection at Alternator (Typical)

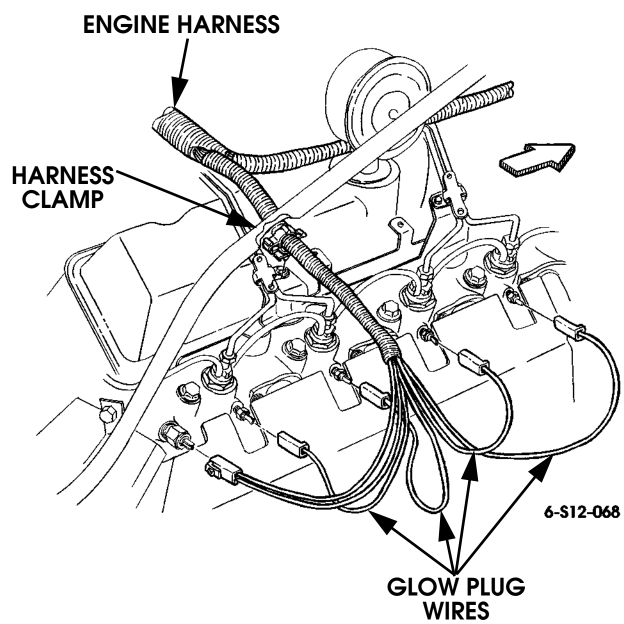

Figure 12-63: Engine Harness Connections at Passenger Side (Non-Turbo)

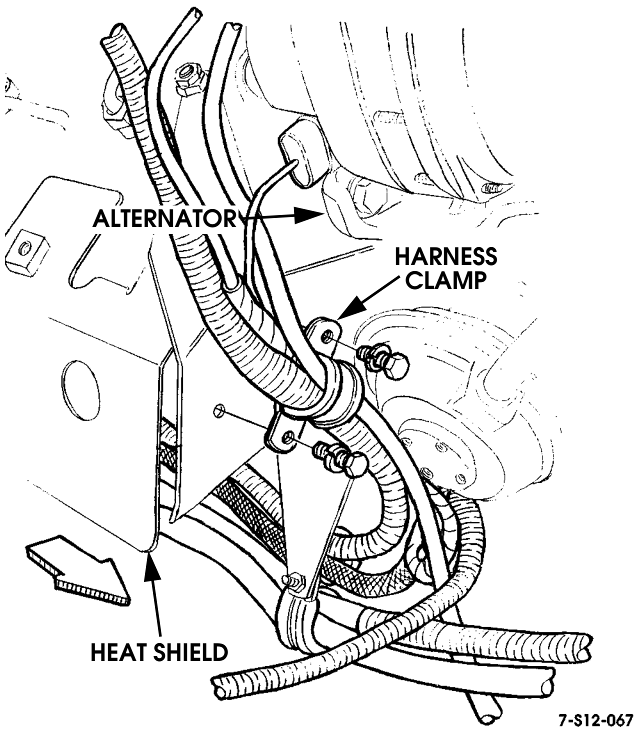

Figure 12-64: Harness Clamp Attachment at Heat Shield

Installation

1. Install new harness through console opening in dash panel.
2. Route harness to sensors, injection pump and accessories.
3. Secure harness with clamps, retainers, and new tie straps.
4. Attach harness connectors to necessary sensors, switches, and accessories (Figures 12-51 through 12-64).
5. Connect engine harness connector to bulkhead connector as follows:
   a. carefully start harness connector into bulkhead connector.
   b. start and tighten connector screw to 25 lb-in. (3 N•m)
   c. slide boot over connector and work into place
6. Install engine cover and console.
7. Connect batteries.
8. Verify proper operation of gauges, starter, accessories, etc.

TRANSMISSION HARNESS REPLACEMENT (ALL)

1. Disconnect both battery cables.
2. Remove console.
3. Disconnect transmission harness from control harness.
4. Unlatch cover lock from harness grommet in floorpan (Figure 12-65).
5. Work harness grommet out of floorpan. Then remove grommet from harness.
6. Push harness through floorpan hole and to vehicle underside.
7. Disengage transmission harness from tie straps, clips, and clamp on transmission/transfer case (Figure 12-66).
8. Disconnect following:
   - input and output speed sensors
   - transmission harness at case connector
   - transfer case low lock switch
   - vehicle speed sensor
   - 4-wheel drive indicator switch
9. Remove harness from vehicle.
10. Position new harness along transmission/transfer case and route it up through floorpan hole.
11. Transfer original grommet to new harness.

12. Connect new harness to sensors and switches in transmission and transfer case.
13. Connect harness to case connector. Be sure harness and case connector are properly aligned before pushing harness connector into place.
14. Secure harness wires to clips and clamp on transmission and transfer case.
15. Seat grommet in floorpan.
16. Connect harness to control harness as required.
17. Install grommet lock cap.
18. Connect batteries and install console.
19. Verify proper transmission operation.

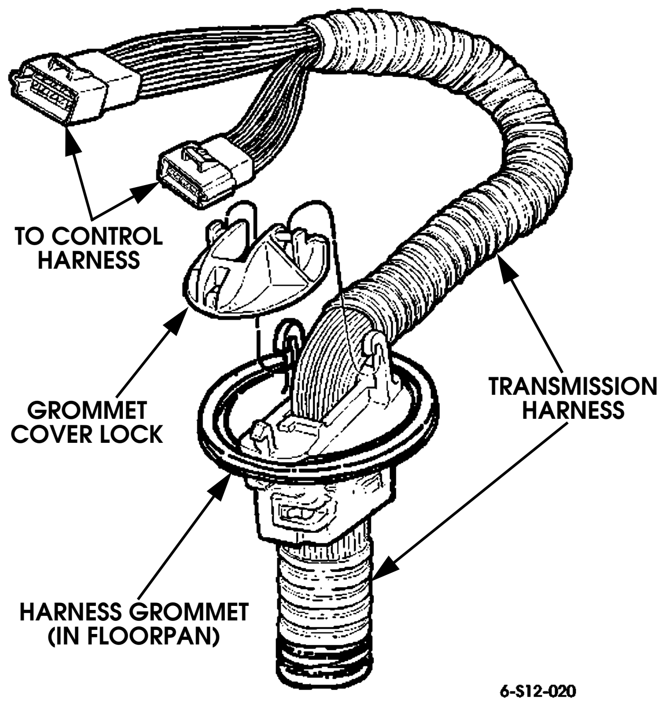

Figure 12-65: Securing Transmission Harness in Floorpan Grommet

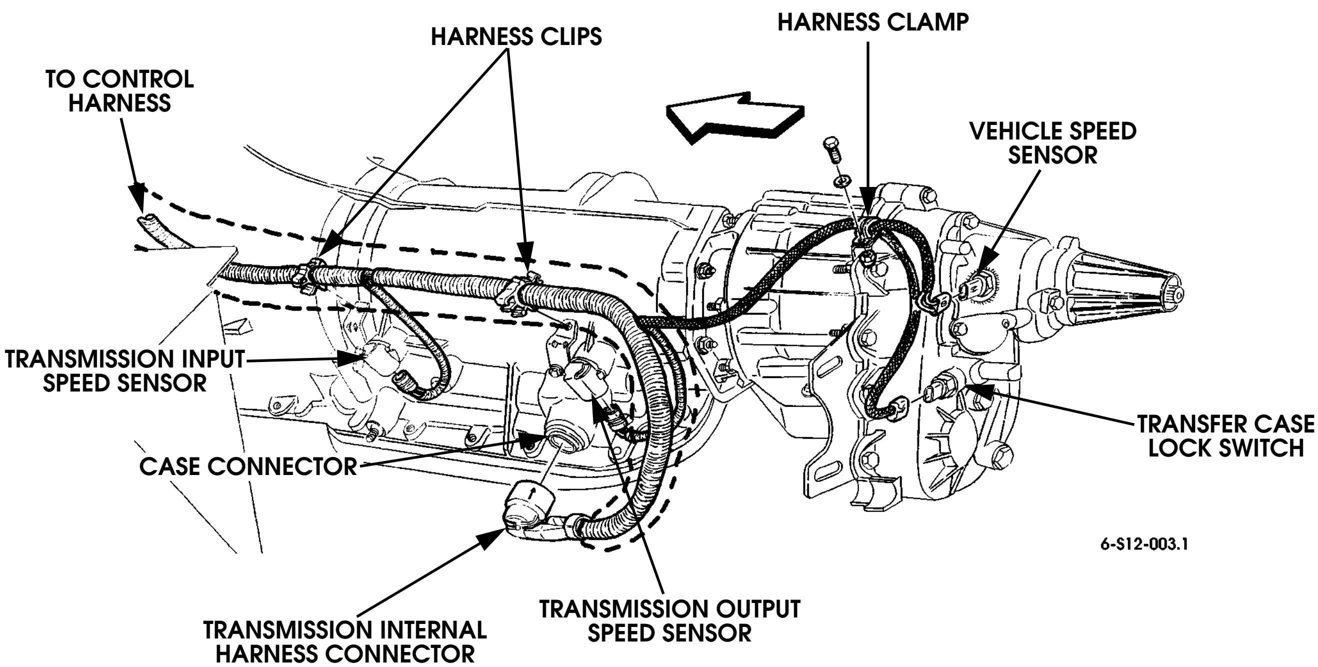

Figure 12-66: Transmission Harness Routing and Connections (Non-Turbo Diesel Shown)

DIGITAL RATIO ADAPTER REPLACEMENT

The digital ratio adapter conditions the vehicle speed sensor signal. The adapter does this prior to transmitting the sensor signal to the PCM.

The adapter is mounted on the engine cover (Figure 12-67). It is attached with a velcro strip. To remove the adapter, pull one side away from the velcro and peel it off the strip. Installation is the reverse of removal.

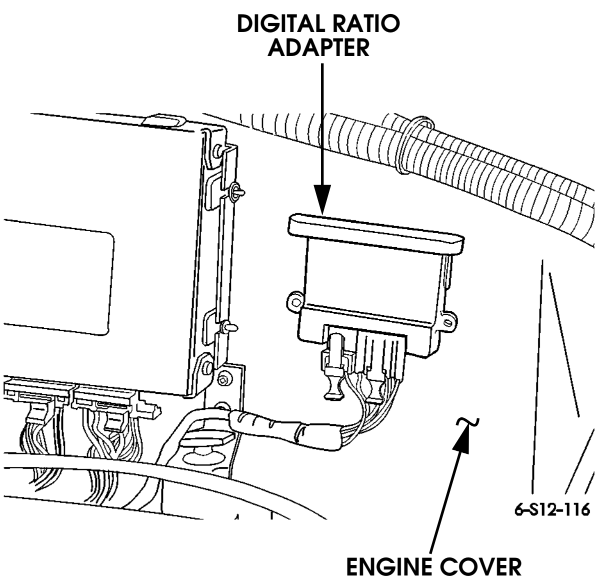

Figure 12-67: Digital Ratio Adapter Location

PCM REPLACEMENT

The PCM is attached to a bracket on the engine cover (Figure 12-68). Replacement is as follows:

1. Remove console.
2. Remove nuts attaching PCM to bracket.
3. Lift PCM out of bracket and disconnect control harness connectors from PCM.
4. Note data on PCM identification tag (Figure 12-68). Data will be necessary for correct parts ordering.
5. Verify that replacement PCM is correct part. Compare information on identification tags.
6. Connect wiring harnesses to new PCM.
7. Secure PCM in bracket.
8. Install console.

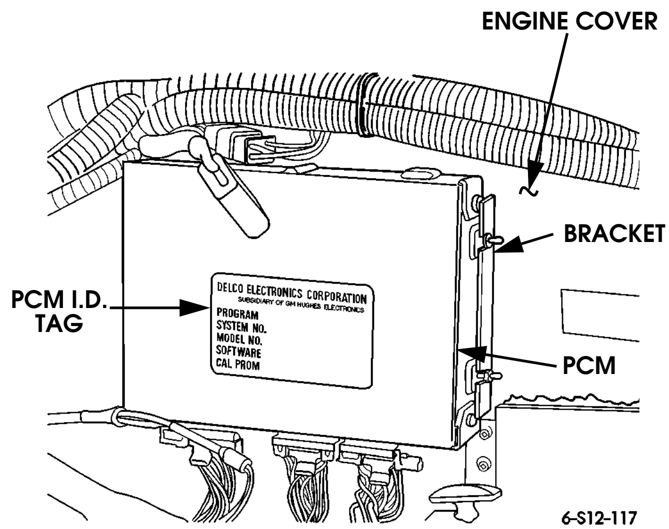

Figure 12-68: PCM Location (Turbo Diesel Shown)

BODY WIRING HARNESS REPLACEMENT

Removal

1. Disconnect battery cables.
2. Remove console and instrument panel (Figure 12-69).
3. Disconnect body wiring harness connectors at rear of instrument panel (Figure 12-69:).

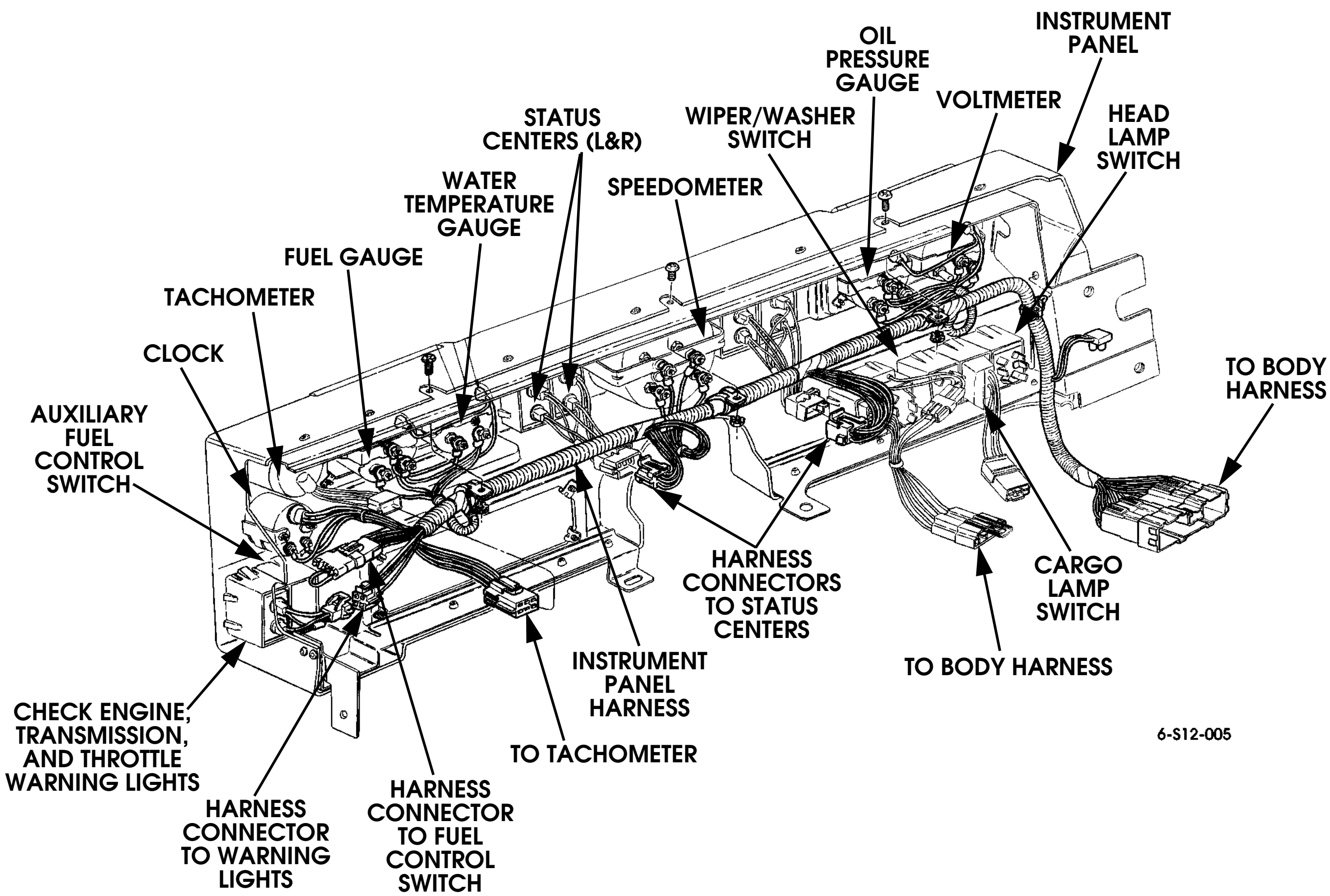

Figure 12-69: Instrument Panel Harness

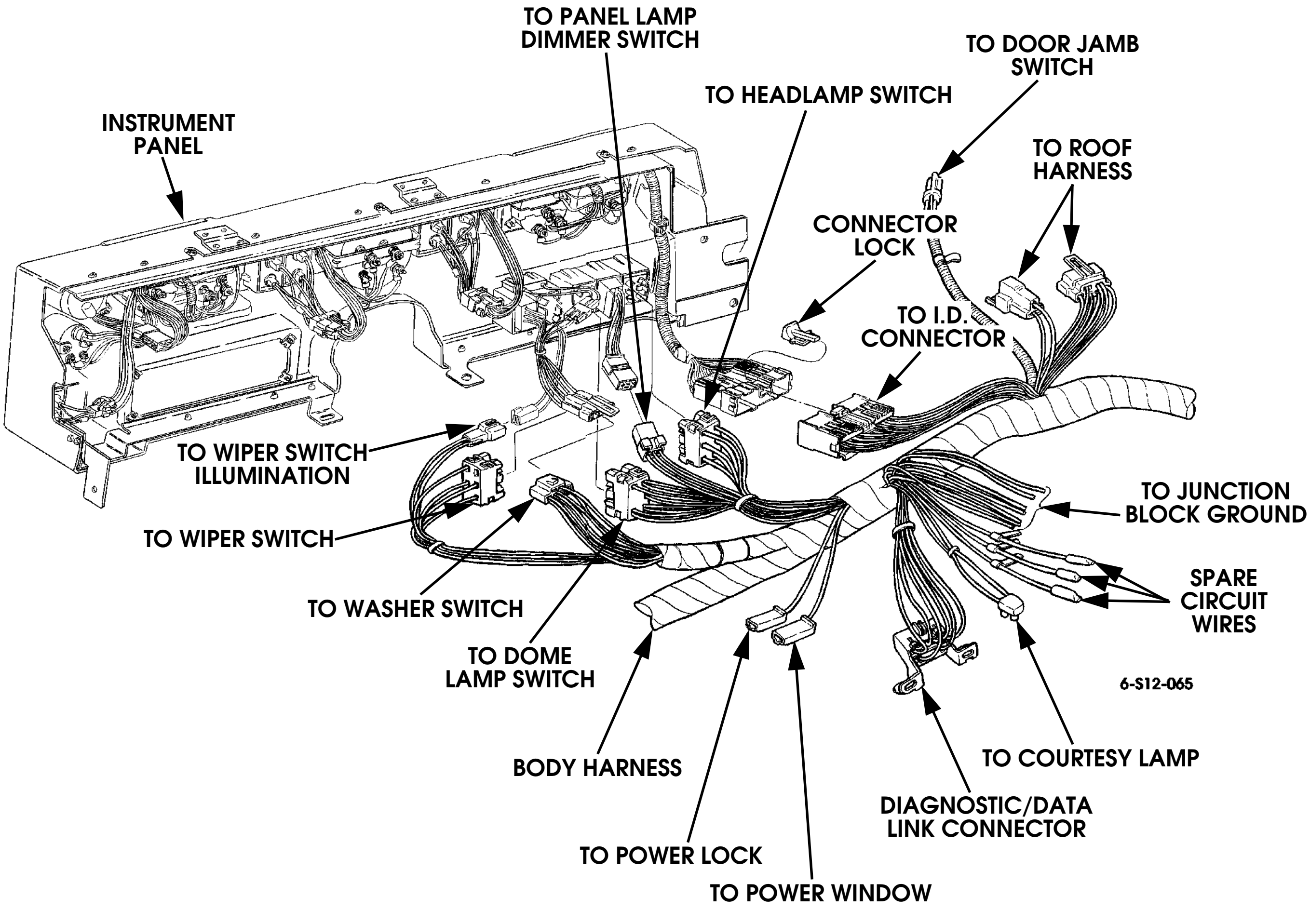

Figure 12-70: Body Harness Connections at Instrument Panel

4. Disconnect control harness (Figure 12-71) and shift lock solenoid connectors (Figure 12-72).
5. Disconnect ground wires at ground stud.
6. Disconnect body wiring harness connectors from radio, engine console, and heating and air conditioning switches (Figure 12-74).

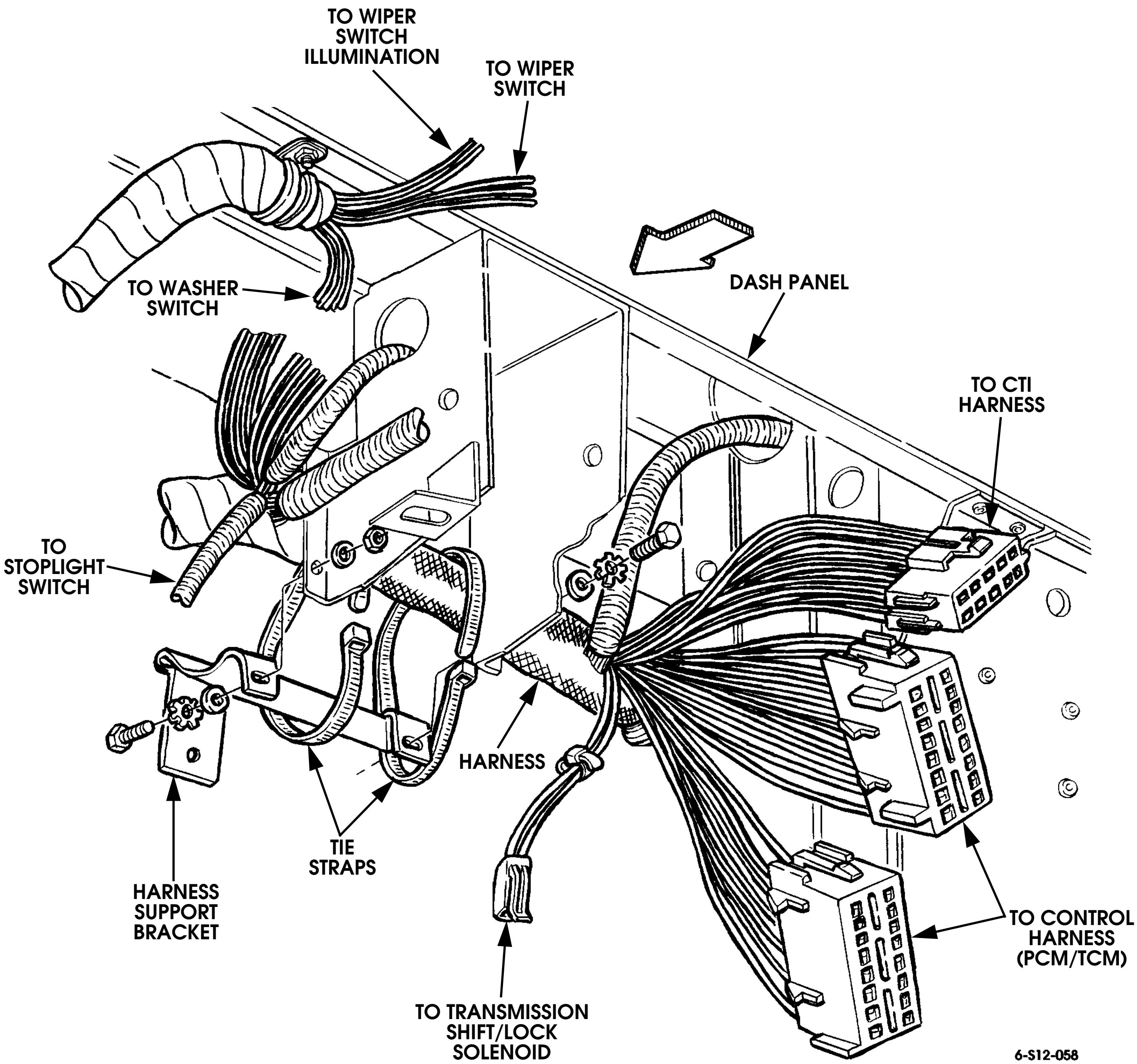

Figure 12-71: Body-to-Control Harness Connector Locations

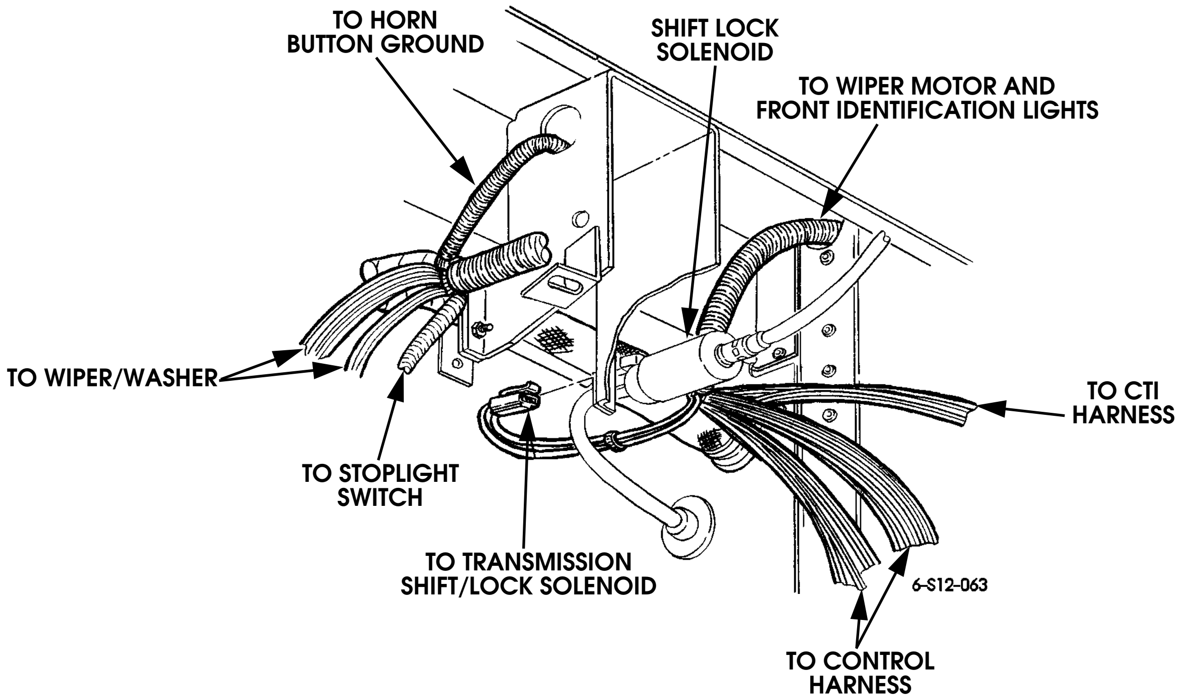

Figure 12-72: Shift Lock Solenoid Location

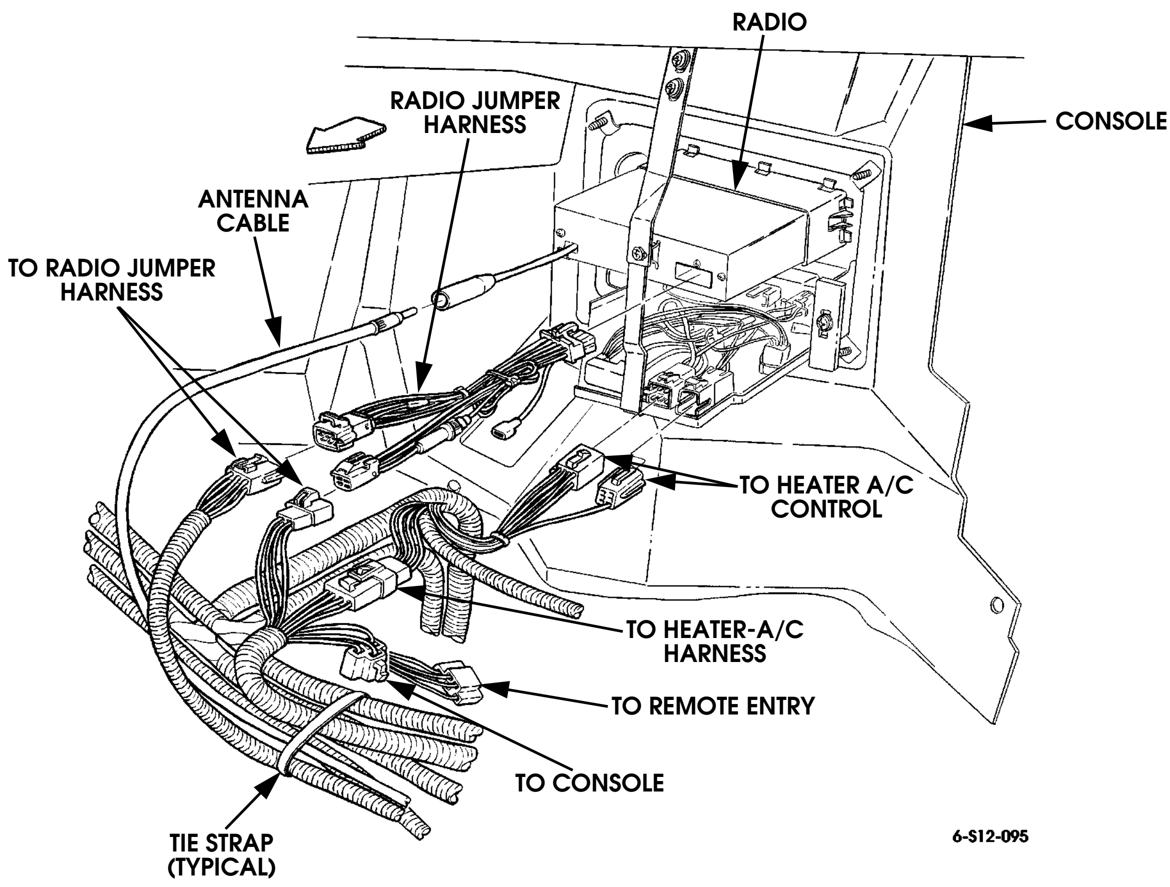

Figure 12-73: Radio/Heater and A/C Harness Connection

0. Remove necessary trim panels and disconnect body wiring harness connectors at turn signals, ignition, and key contact connectors on steering column (Figure 12-74).
1. Remove cable tie securing body harness to steering column support bracket.
2. Disconnect body wiring harness ground lead at steering column (Figure 12-75).
3. Disconnect stoplight switch wires and cruise control harness connectors (Figure 12-74) then disconnect body wiring harness connectors from door jamb switch and roof harness connector (Figures 12-77 and 12-78).
4. Remove body wiring harness connector from stoplight switch (Figure 12-74).
5. Remove and/or disconnect the following:
   - power window switch plate and switches.
   - instrument panel windshield trim
   - body-to-control harness connectors.
6. Remove body wiring harness connectors from wiper motor and front marker light jumper harness (Figure 12-74).

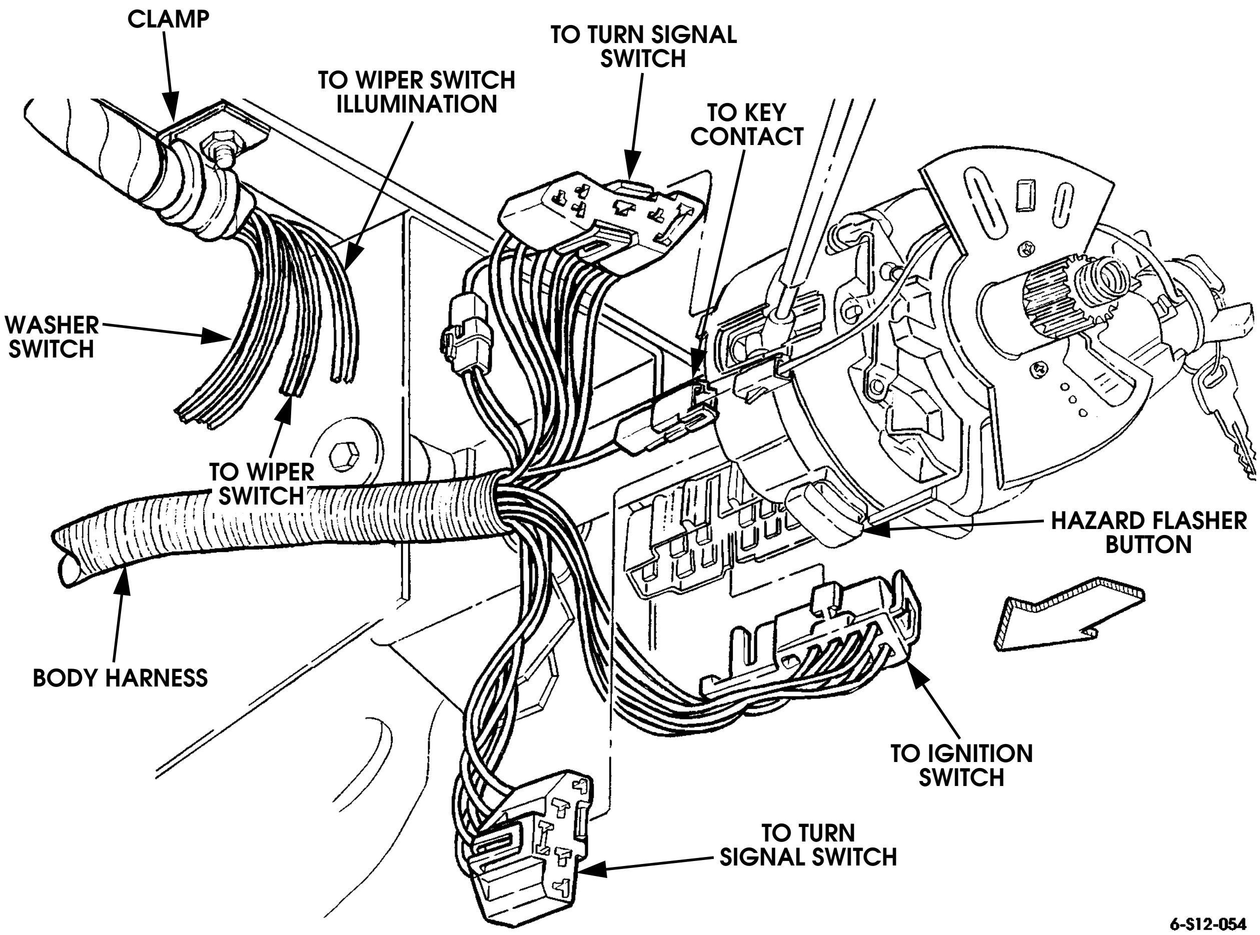

Figure 12-0

Figure 12-74: Body Harness Connections at Steering Column

0. Remove or disconnect the following:
   - courtesy lamp
   - data link/diagnostic connector (Figure 12-75)
   - wiper motor and jumper harness (Figures 12-76 and 12-79)
   - running light connections (Figure 12-92)
1. Disconnect cigar lighters and remove necessary harness clamps (Figure 12-93).
2. Remove body wiring harness connector from cowl panel by first disconnecting engine connector then removing jamnut.

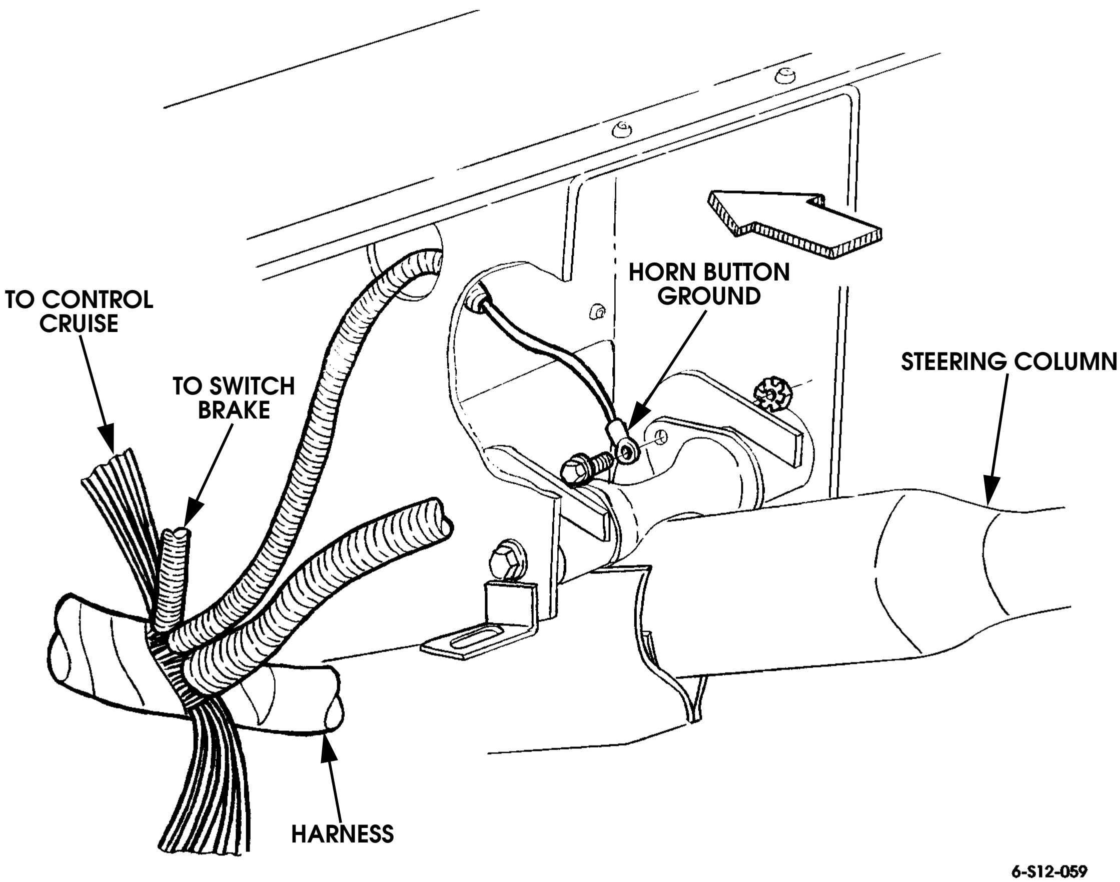

Figure 12-75: Steering Column Ground Wire Location

0. Remove tie straps and clamps body wiring harness to steering column bracket and body.
1. Remove wiring harness from windshield frame
2. Disconnect following (Figures 12-87 and 12-88):
   - control harness
   - window switch wires
   - speaker wires
   - PDC wires
   - roof harness and instrument panel harness
   - heater-A/C wires
3. Remove body wiring harness connector from windshield washer bottle (Figure 12-89).
4. Remove body wiring harness from CTIS harness connector, if installed.
5. Remove body wiring harness from trouble light harness, if installed.
6. Loosen two nuts and remove terminal block cover.
7. Disconnect junction block wires (Figure 12-90).
8. Remove body wiring harness connector from brake warning light switch.
9. Remove three screws, two nuts, three clamps, and two tie straps securing body wiring harness to left cowl inner panel.

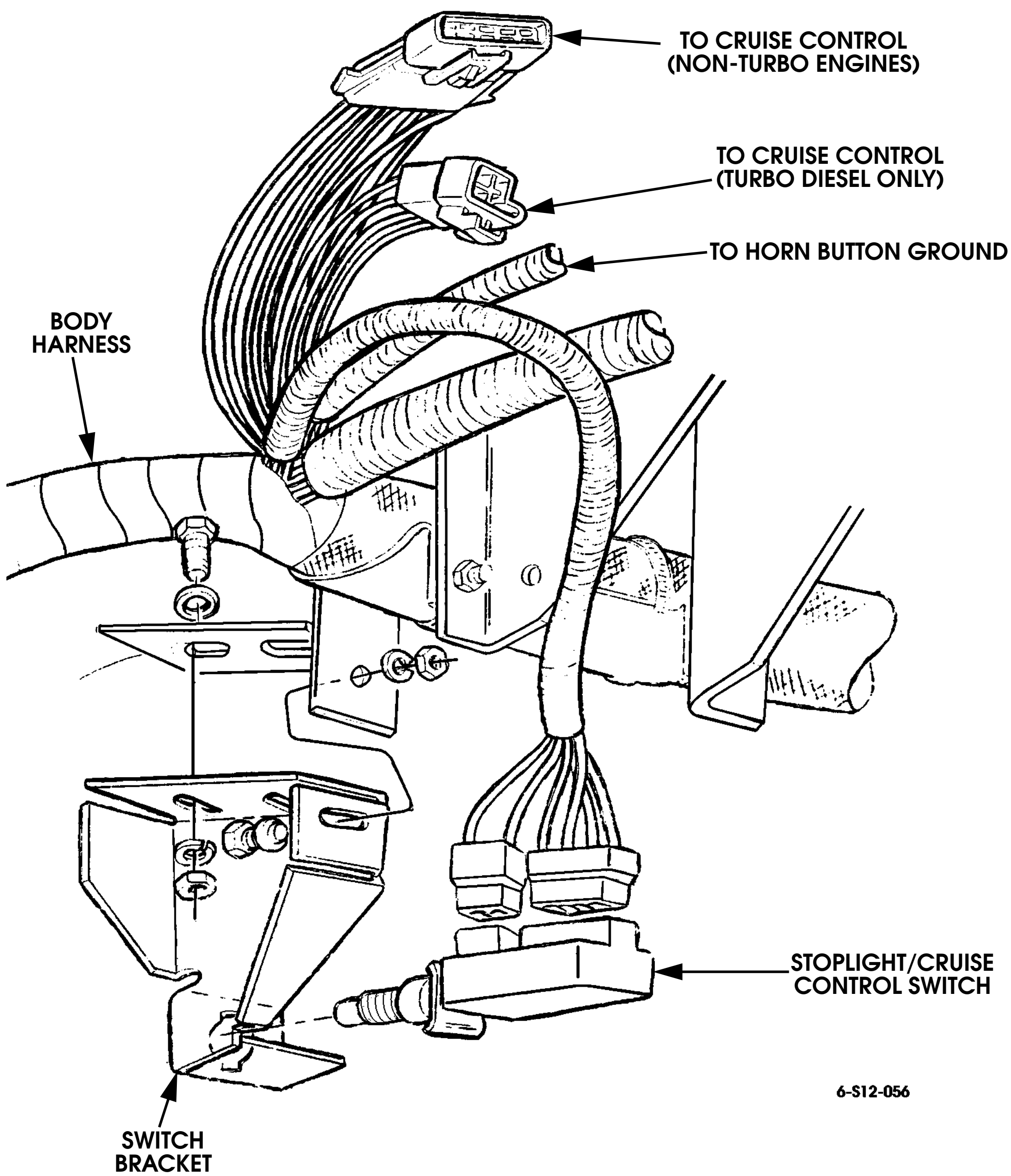

Figure 12-76: Stoplight/Cruise Control Switch Wire Connections

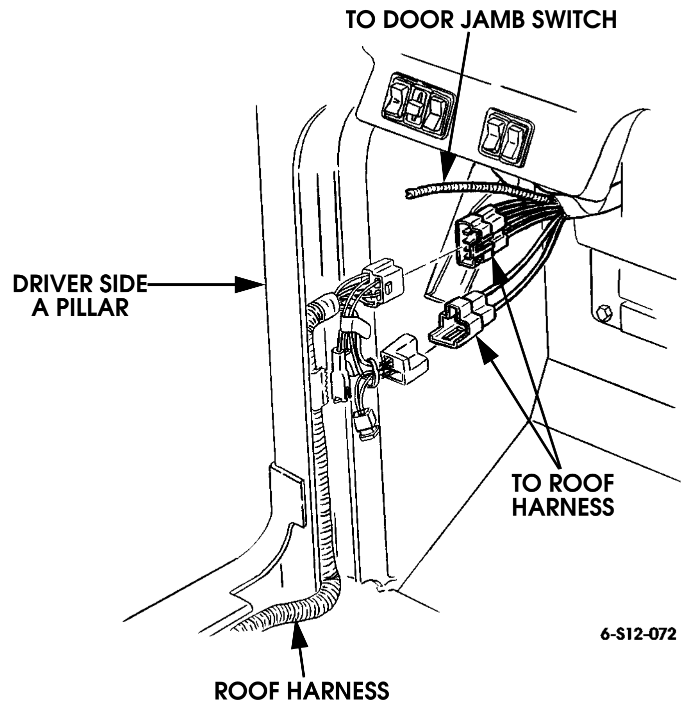

Figure 12-77: Roof Harness Connections at A-Pillar

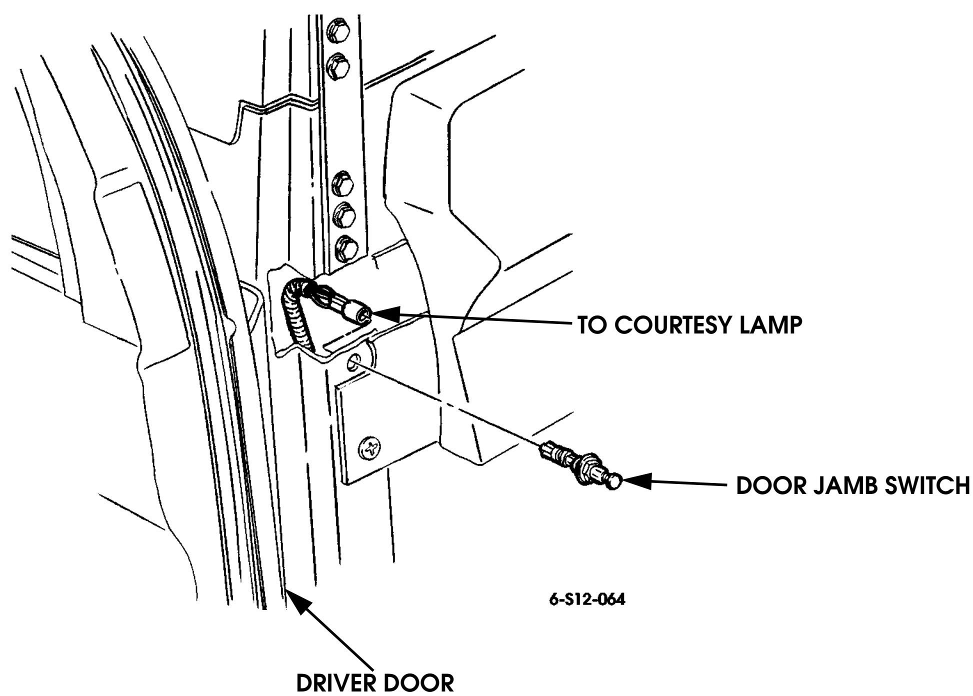

Figure 12-78: Door Jamb Switch Connection

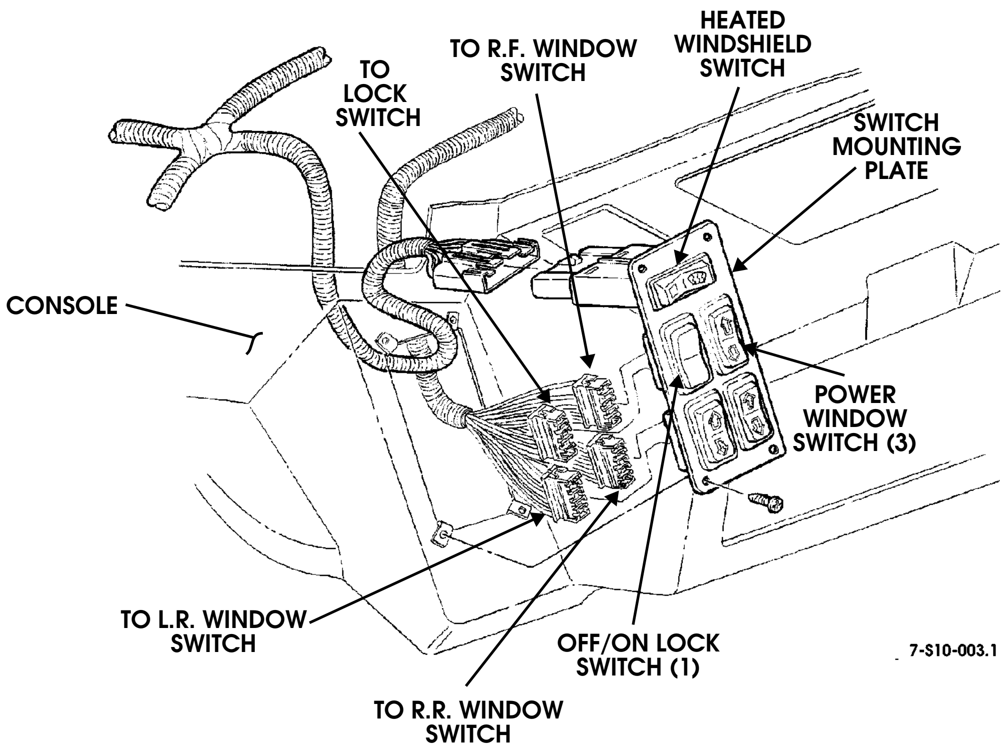

Figure 12-79: Power Window Switch Mounting

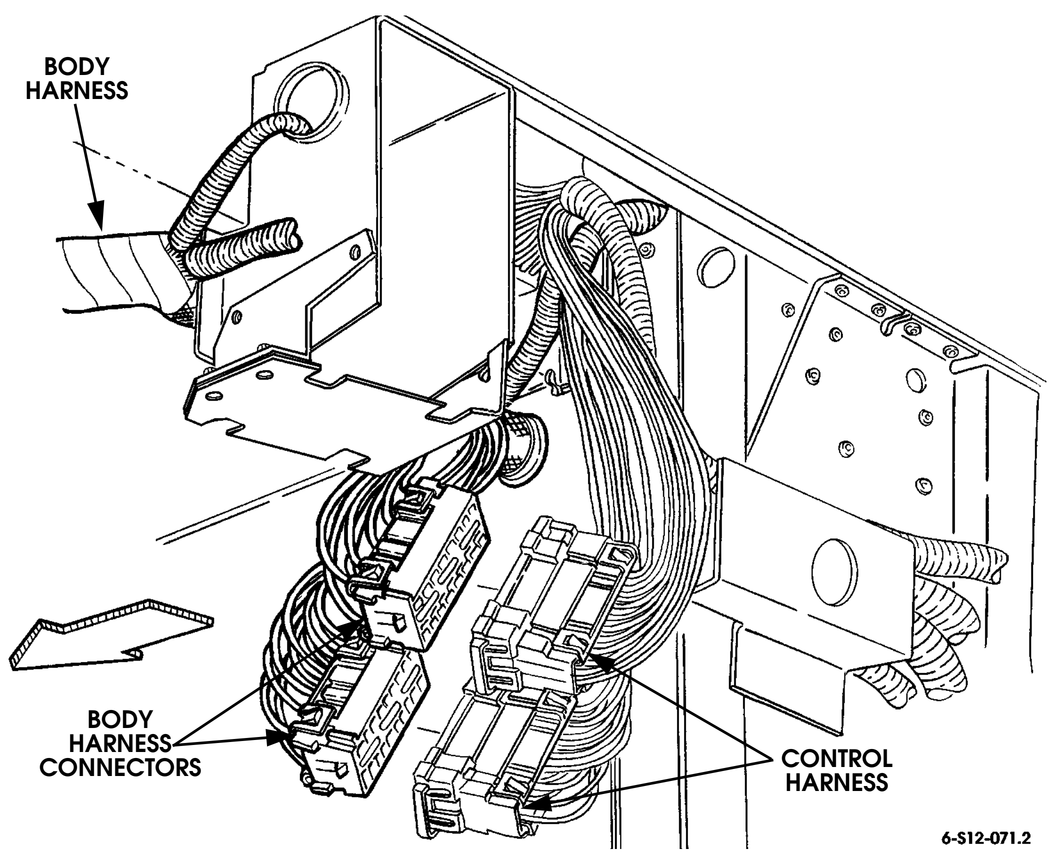

Figure 12-80: Body-to-Control Harness Connections

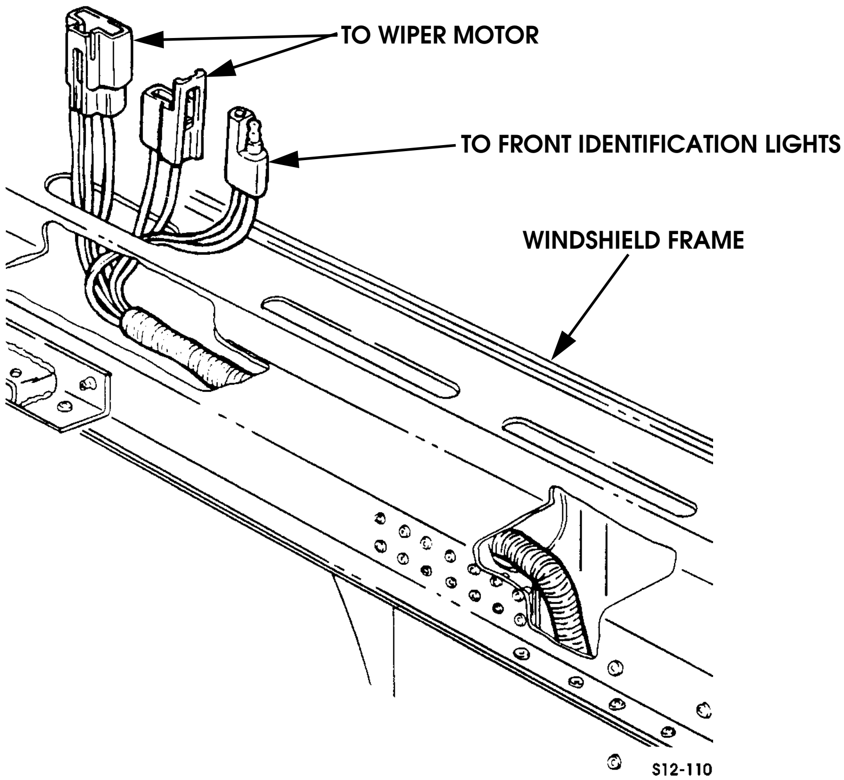

Figure 12-81: Windshield Frame Connections

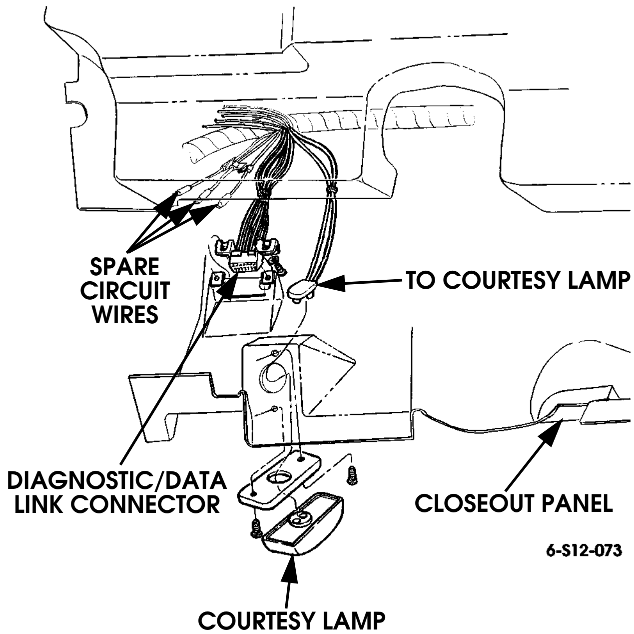

Figure 12-82: Diagnostic/Data Link Connection Location

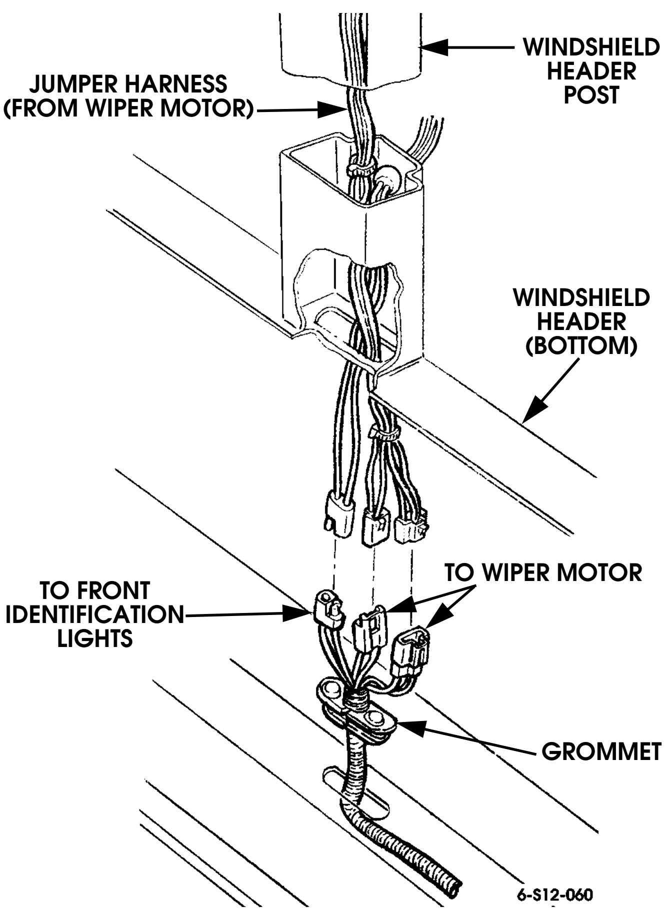

Figure 12-83: Wiper Motor Jumper Harness Routing

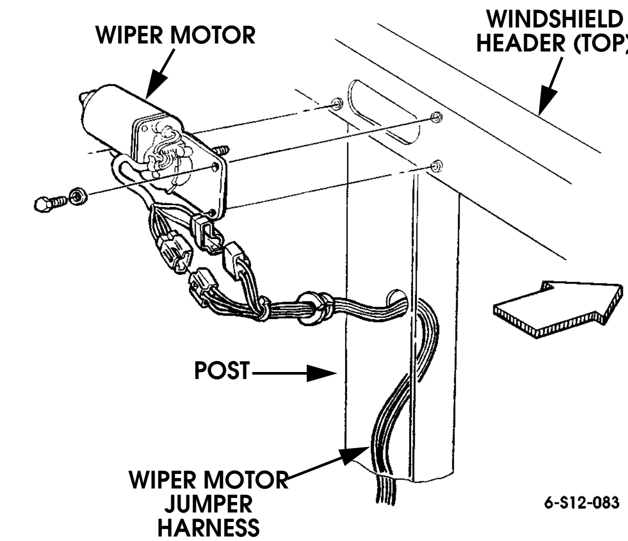

Figure 12-84: Wiper Motor Mounting

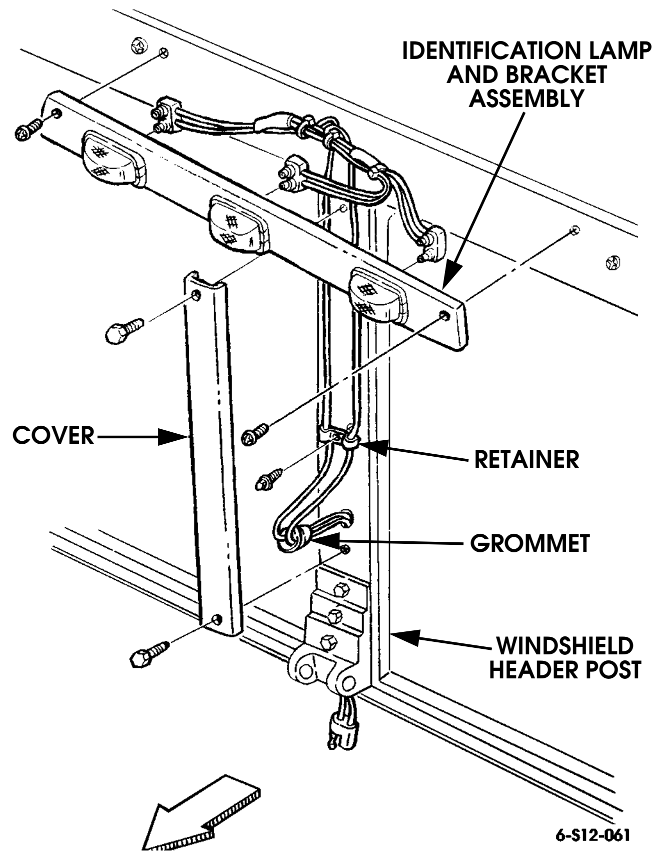

Figure 12-85: Running Light Connection

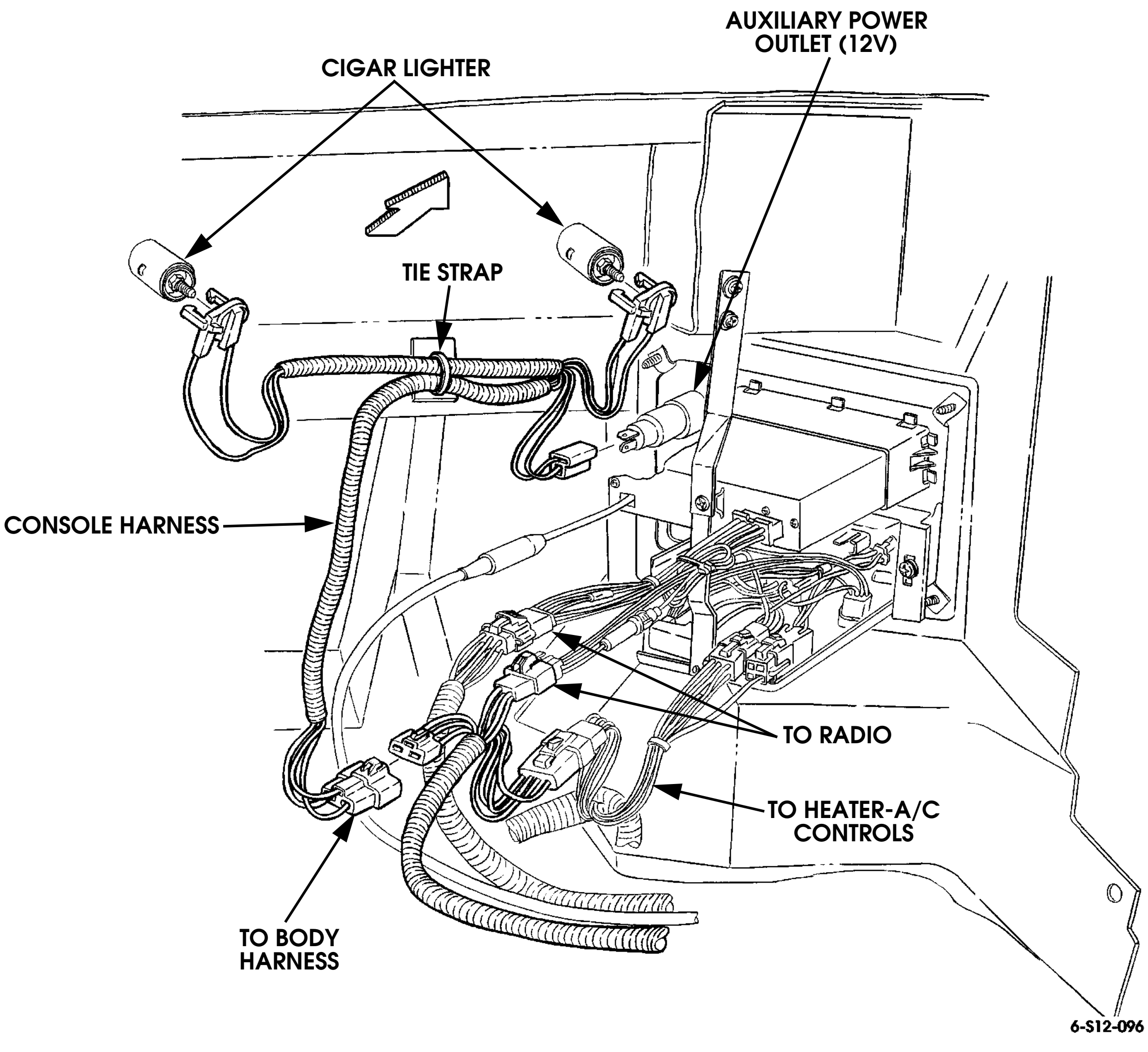

Figure 12-86: Console Harness Routing

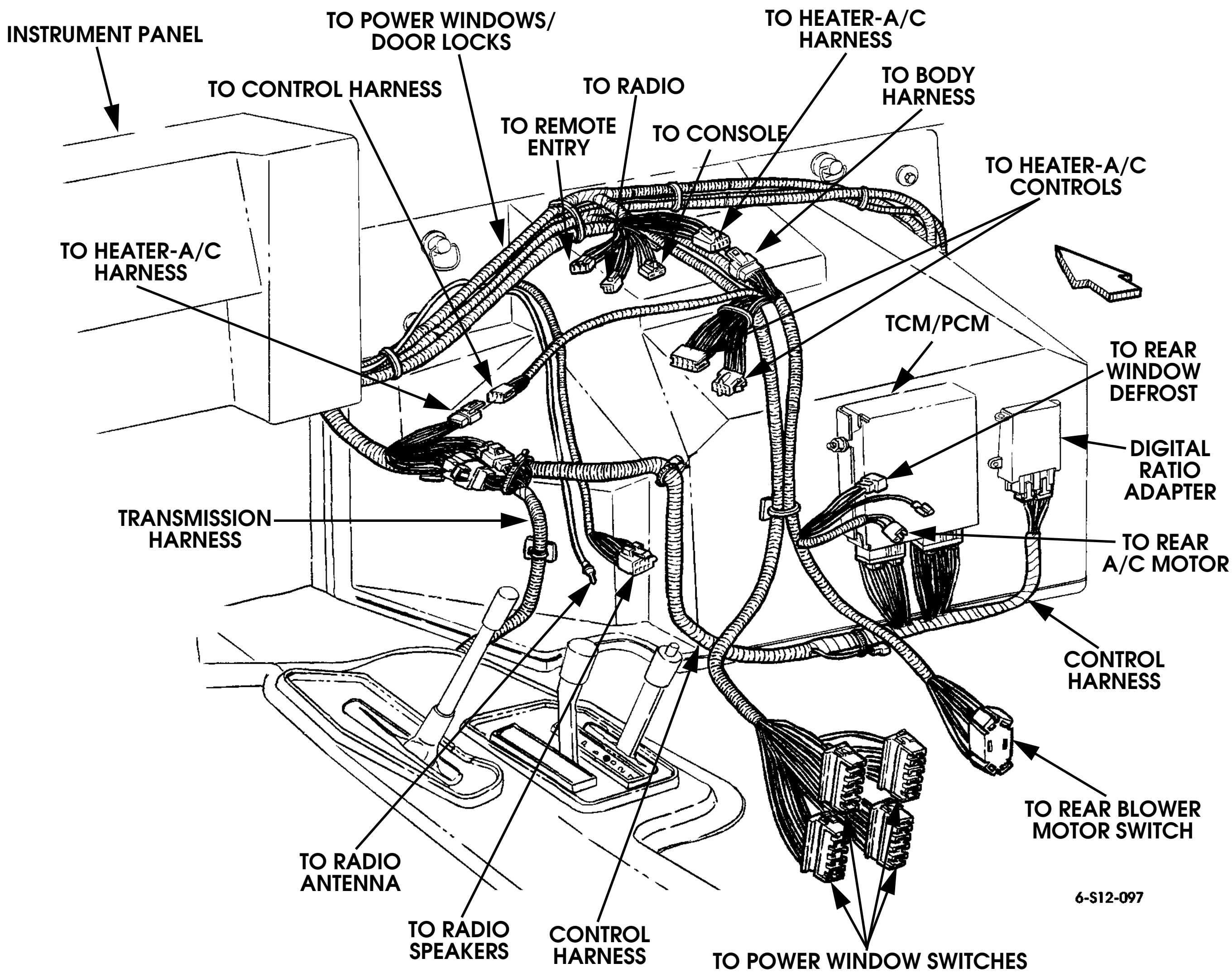

Figure 12-87: Console Harness Routing

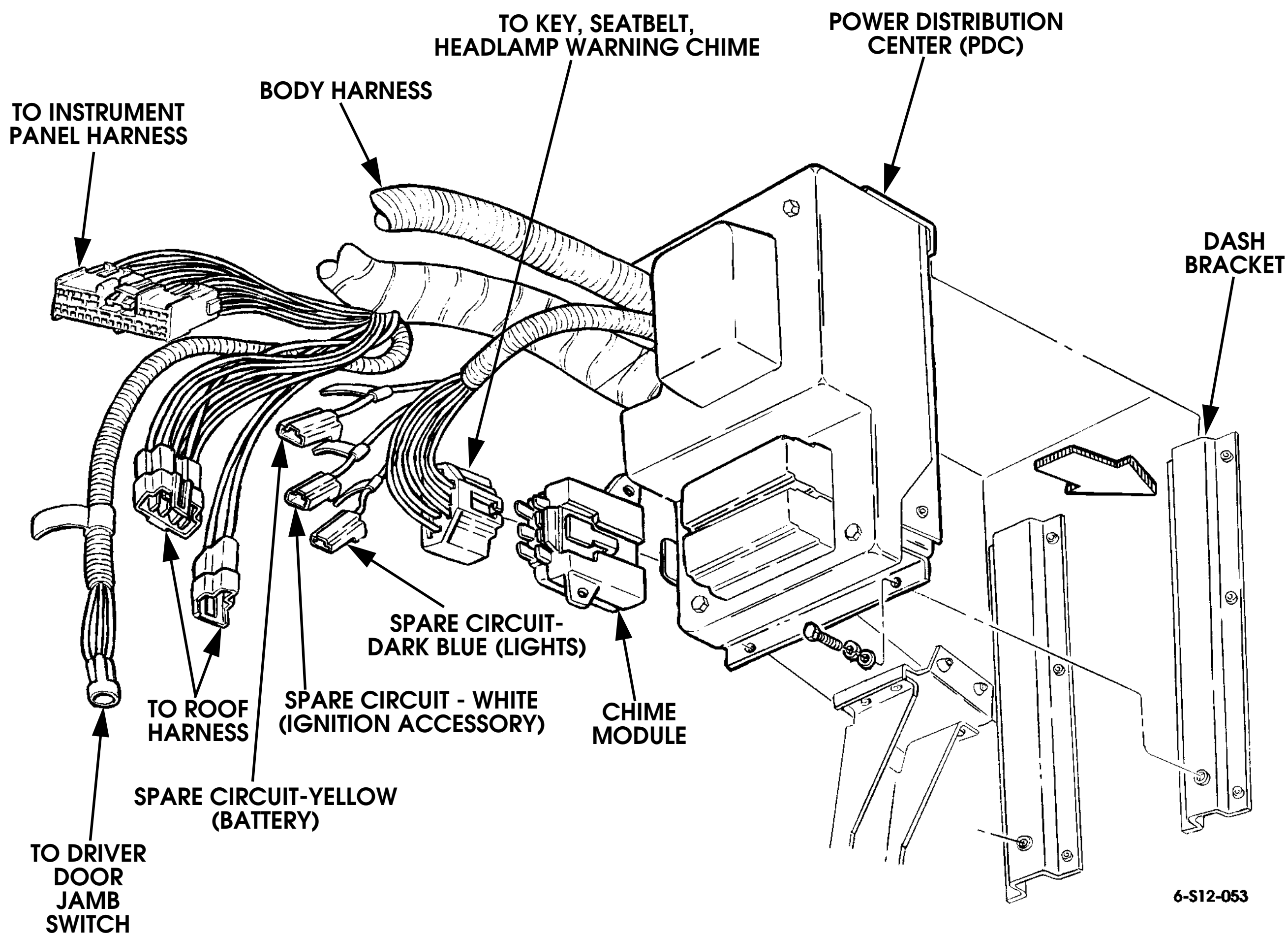

Figure 12-88: PDC Mounting

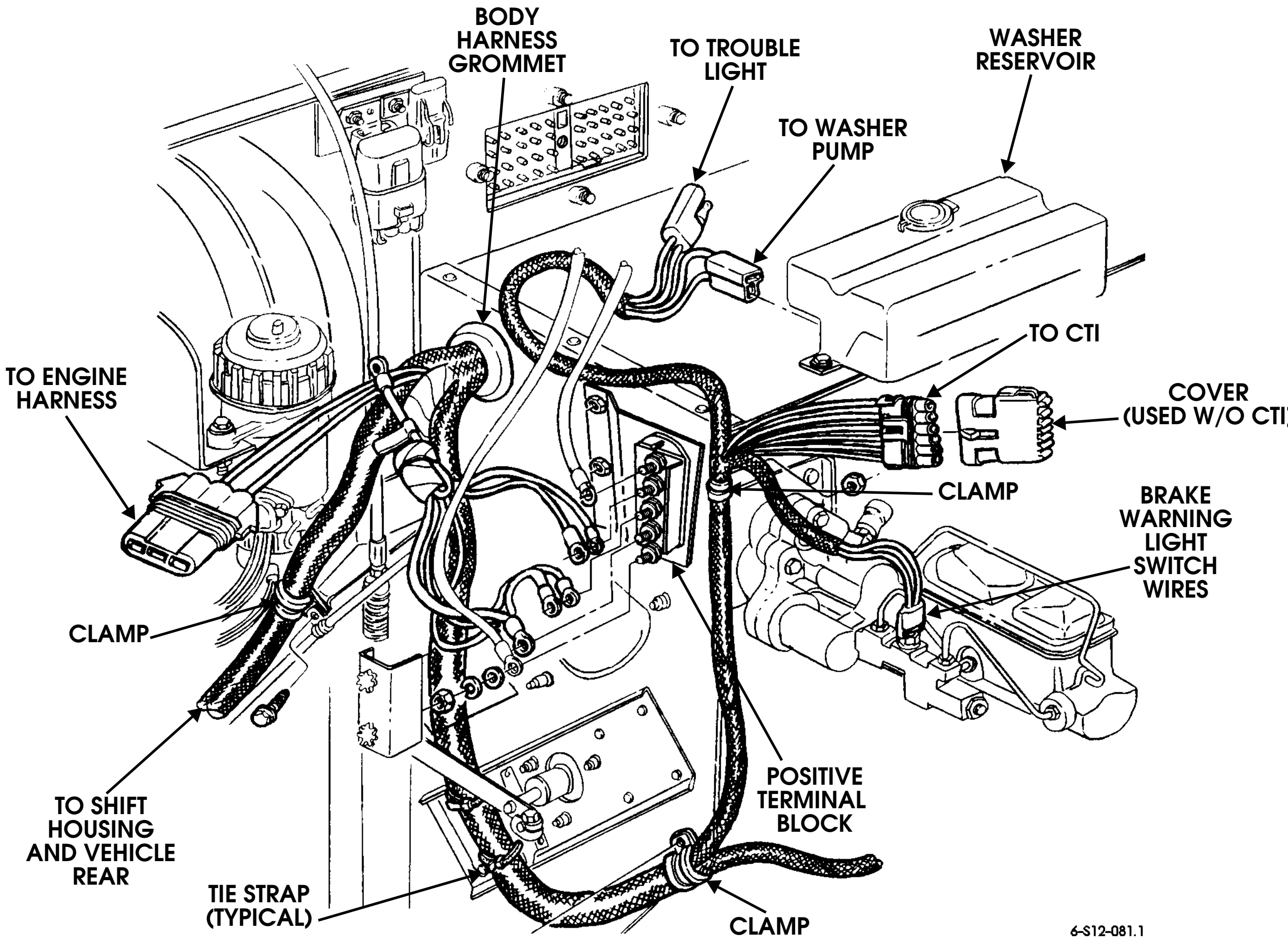

Figure 12-89: Body Harness Routing in Engine Compartment

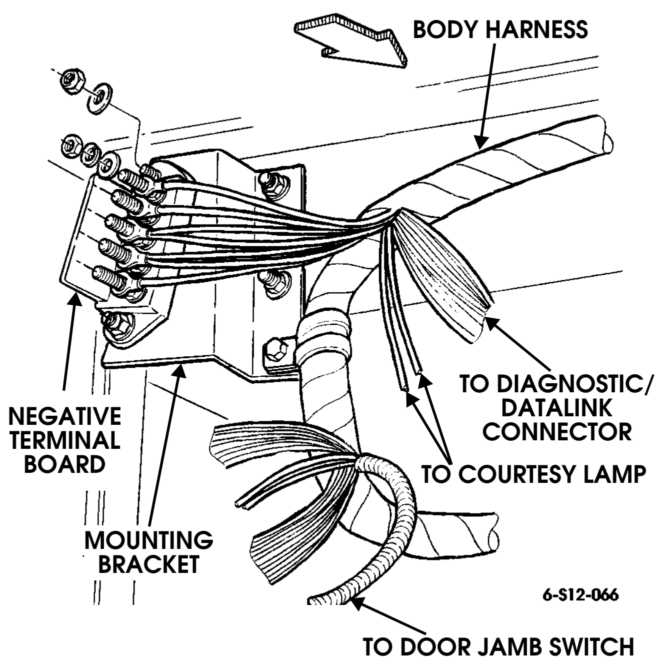

Figure 12-90: Junction Block Connections

0. Remove two body wiring harness connectors from hood harness connectors (Figure 12-91).

1. Remove body wiring harness connector from fog lamp harness connector if installed

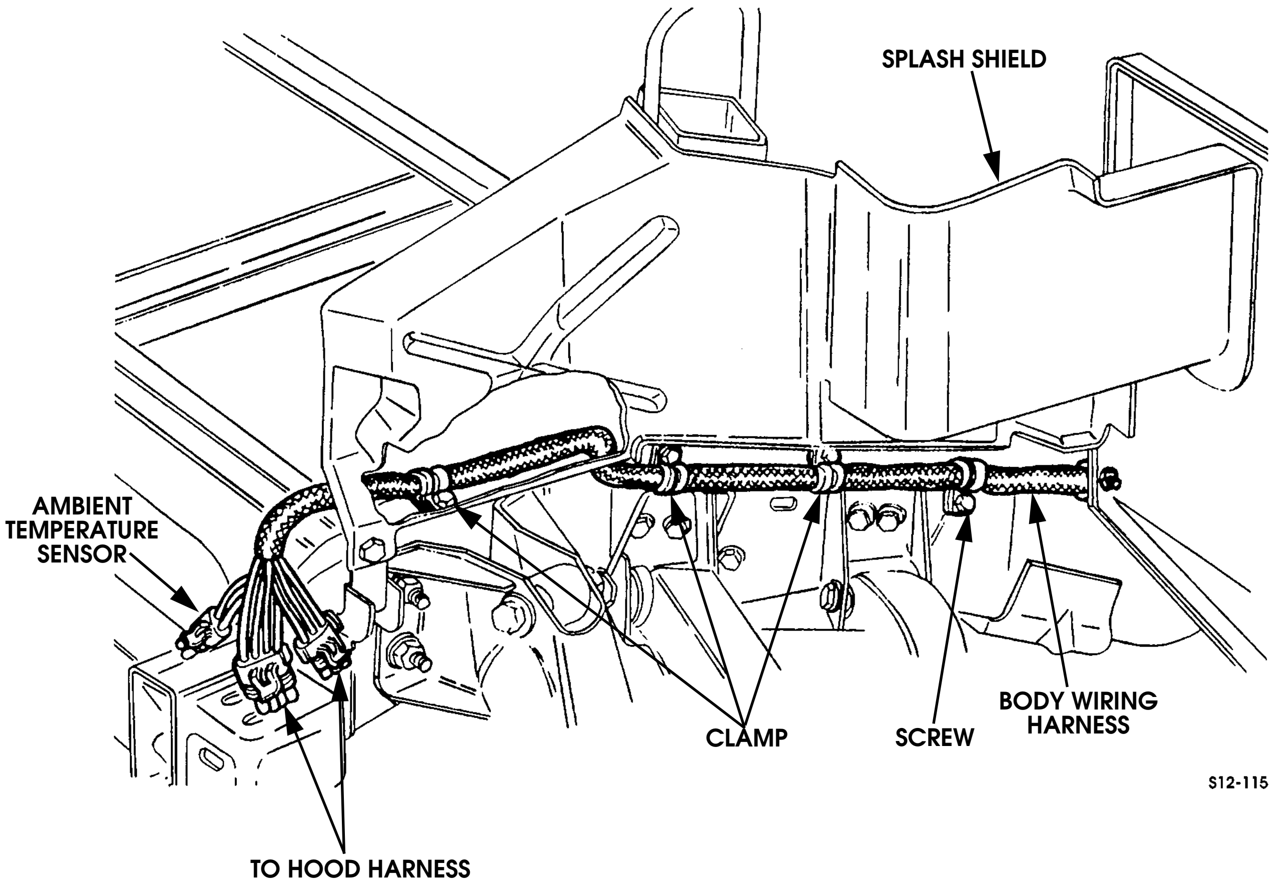

Figure 12-91: Harness to Splash Shield Retainers

0. Remove four screws, three nuts, four clamps and body wiring harness from splash shield and frame.
1. Remove body wiring harness connector at fuel tank sender harness (Figures 12-92 and 12-93).
2. Remove body wiring harness connector from trailer harness connector if installed. If no trailer harness exists, remove dummy plug from body wiring harness trailer connector (Figure 12-92).

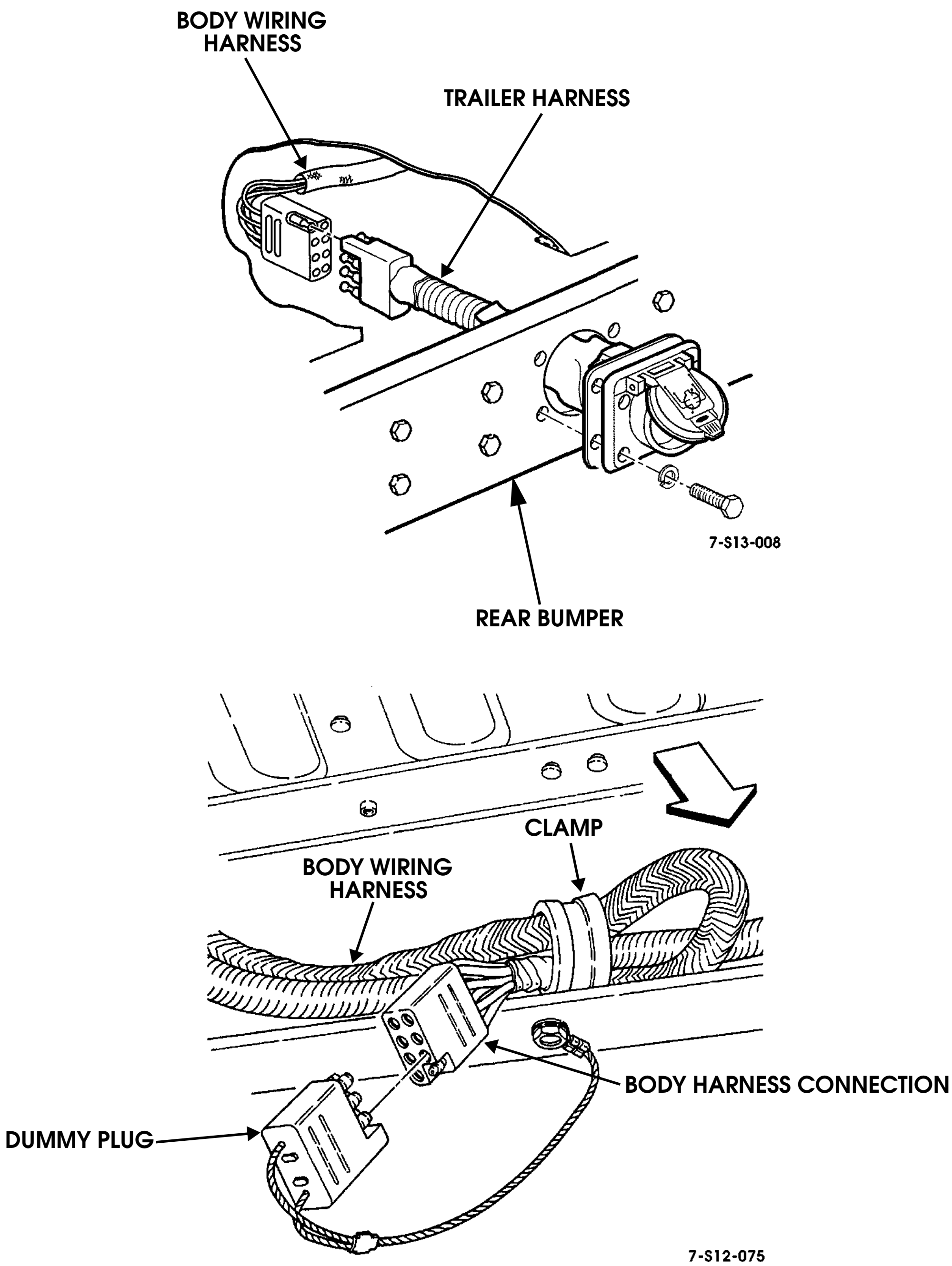

Figure 12-92: Trailer Jumper

0. Remove clamp and hardware.
1. Remove shield from body panel and body wiring harness clamps (Figure 12-93).
2. Remove locknut, washer, four body wiring harness ground leads, and washer from taillight.
3. Remove two body wiring harness taillight connectors from taillight connectors.
4. Remove nut, washer, and body wiring harness ground lead from side marker light. Remove body wiring harness connector from side marker light.

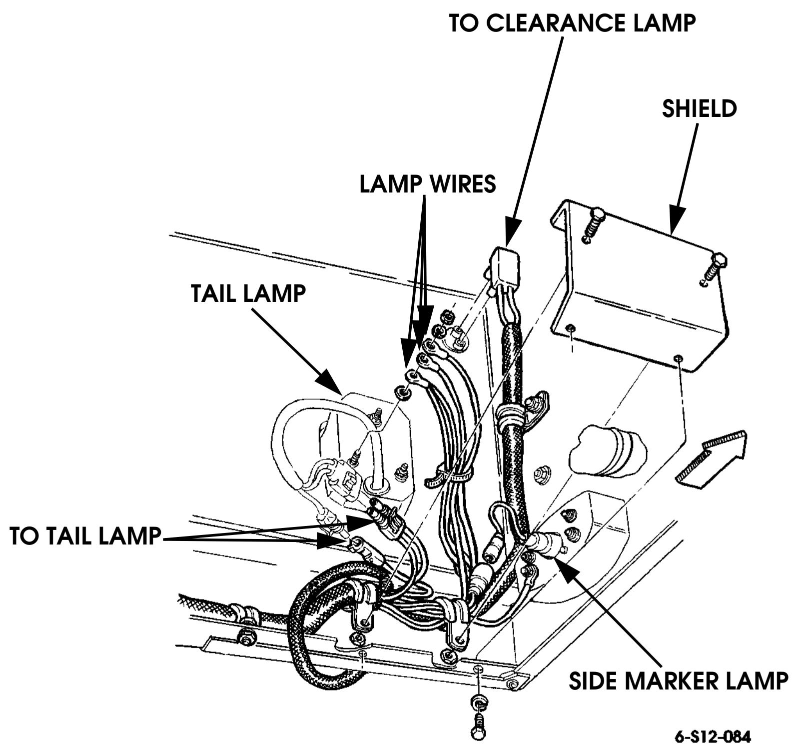

Figure 12-93: Clearance and Marker Lamp Connections

0. Remove clamp, screw, nut and body wiring harness from D-beam.
1. Remove body wiring harness connector from clearance light.
2. Perform steps 35 through 40 for left side body wiring harness removal.
3. Remove rear running light bar from vehicle. Remove body wiring harness connector from light bar (Figure 12-94)
4. Remove body wiring harness connector from rear license plate light (Figure 12-95).

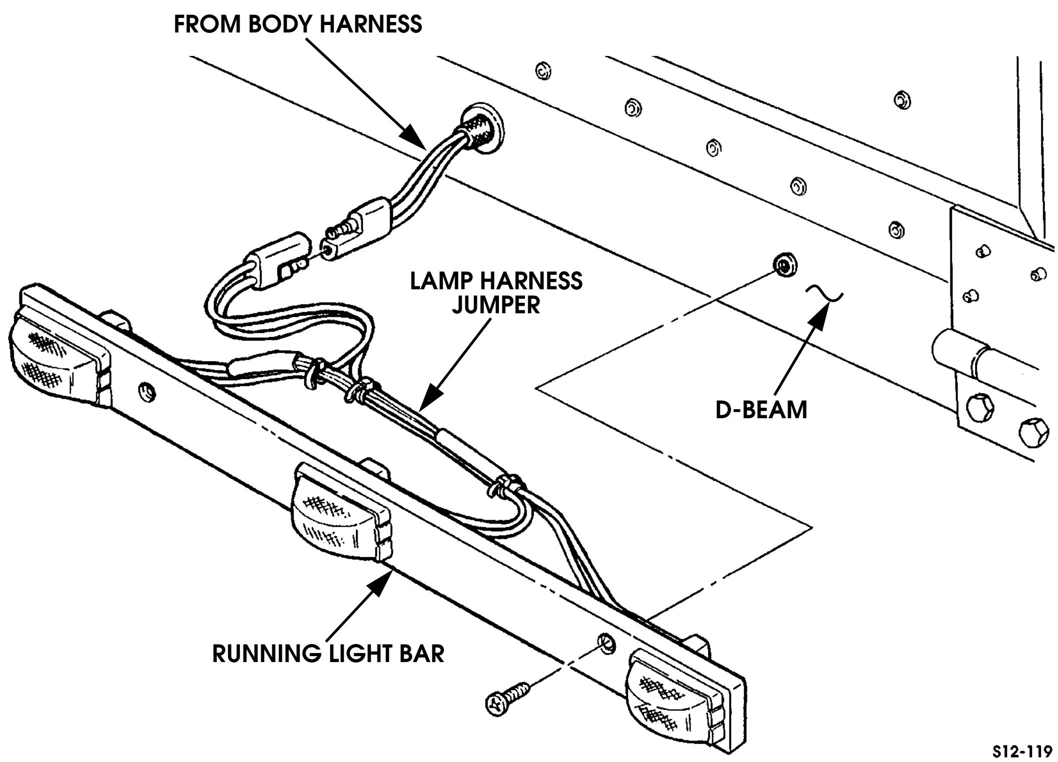

Figure 12-94: Identification LIghts

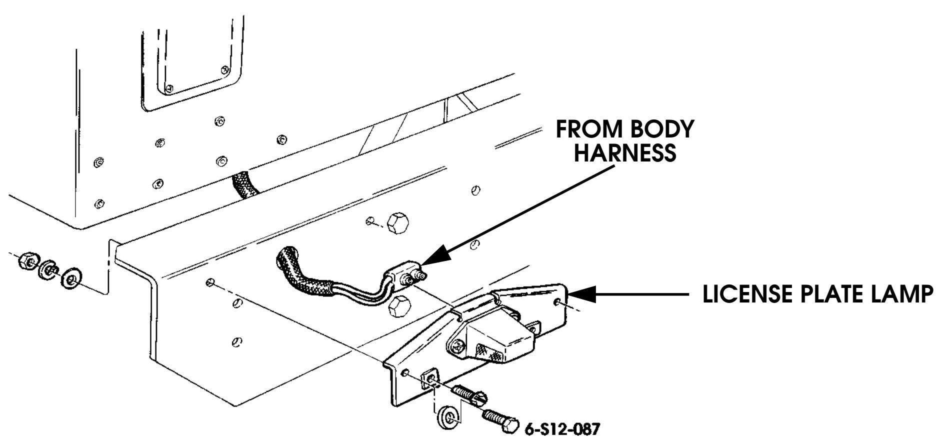

Figure 12-95: License Plate Lamp Mounting

0. Disconnect wires at shift housing (Figure 12-96).
1. Remove body wiring harness clamps from tunnel side floor panel area (Figure 12-97).
2. Remove retaining clamps and body wiring harness from body.
3. Remove screws, clamps and body wiring harness from body.
4. Pull body wiring harness outer branches through body and into vehicle interior.
5. Remove body wiring harness.

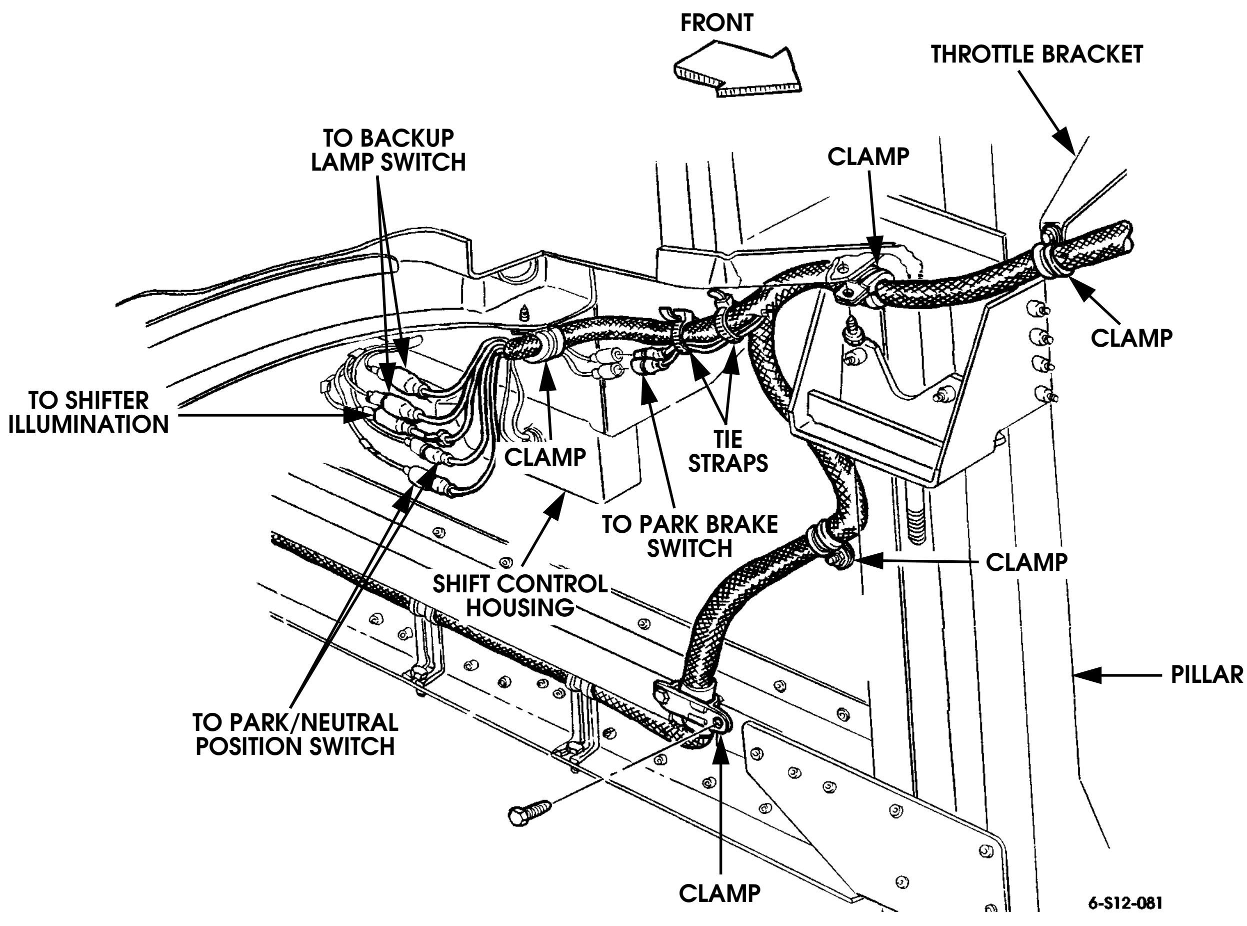

Figure 12-96: Body Harness Connection at Shift Lever Housing

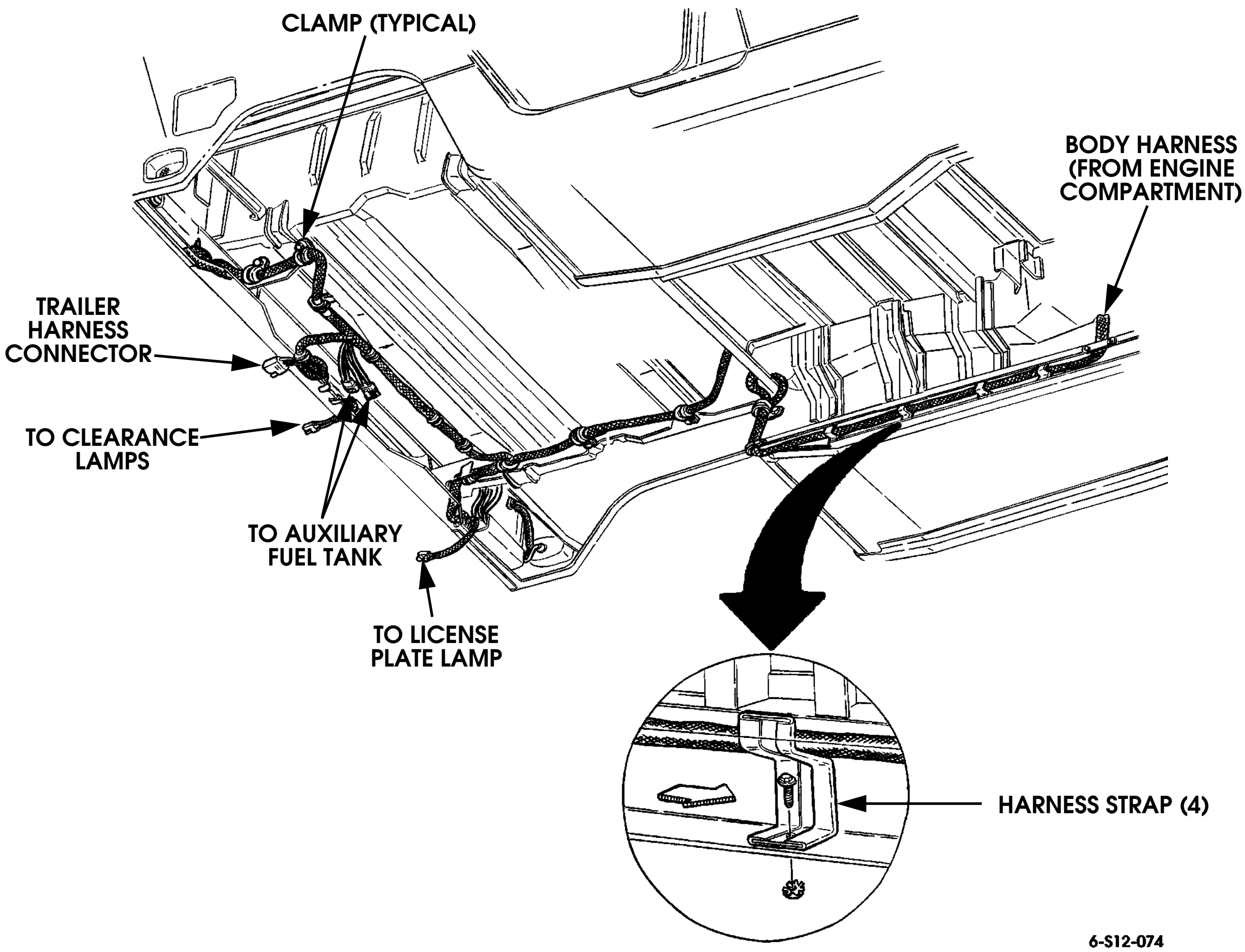

Figure 12-97: Harness Attachment to Floorpan

Body Harness Installation

1. Position body wiring harness in vehicle interior.
2. Position outer branches of body wiring harness through body into underbody area and to center and rear of vehicle.
3. Attach body wiring harness to body with clamps and self-tapping screws.
4. Attach body harness to body with harness retaining clamps, screws, and nuts.
5. Install body wiring harness on left tunnel side floor panel area and secure with clamps, screws, and nuts.
6. Connect harness wires to tail lamps (Figure 12-98).

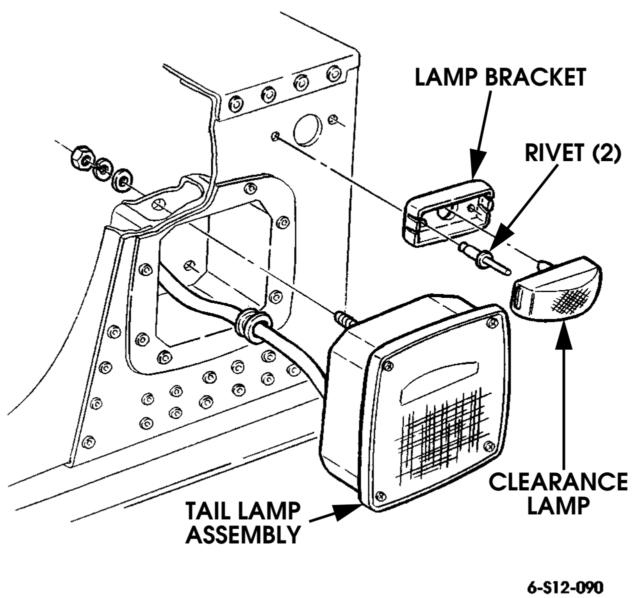

Figure 12-98: Clearance and Tail Lamp

7. Connect body wiring harness to license plate light connector.
8. Connect body wiring harness rear light connector to rear light bar. Install rear light bar on D-beam with screws.
9. Connect body harness connector to clearance light.
10. Install body wiring harness on D-beam with clamp, screw, and nut.
11. Connect body wiring harness connector to side marker light. Secure harness ground lead to side marker light with washer and nut.
12. Connect two body wiring harness connectors to two taillight connectors.
13. Install body wiring harness ground leads on taillight with washer, locknut, and washer.
14. Install shield on body panel and body wiring harness with two clamps, screws, and nuts.
15. Install shield to D-beam with two screws and nuts.
16. Perform steps 10 through 15 for left rear side body wiring harness installation.
17. Connect body harness to trailer harness connector.
18. Install harness clamp.
19. Connect body wiring harness connector to fuel tank sender harness.
20. Secure body wiring harness to splash shield and frame.
21. Connect body wiring harness connector to ambient temperature sensor (if equipped).
22. Connect body wiring harness connectors to hood harness connectors.
23. Secure body wiring harness to left cowl inner panel.
24. Connect body wiring harness connector to brake warning light switch.
25. Loosen nuts and remove junction block cover.
26. Connect body wiring harness cables to junction block studs.
27. Connect body wiring harness connector to trouble light harness.
28. Connect body wiring harness connector to CTIS harness connector.
29. Connect body wiring harness connector to windshield washer bottle.
30. Secure body wiring harness to A-beam with screws and clamps. Secure body wiring harness to harness support bracket with tie straps. Install support bracket on steering column bracket with screws, lockwashers, washers, nuts, and washers.
31. Install body wiring harness engine connector to cowl panel.
32. Connect diagnostic/data link connector.
33. Install PDC on dash supports.
34. Secure body wiring harness connector to transmission shift lock solenoid.
35. Secure body wiring connectors to wiper motor and front marker lamp light connectors.
36. Connect body wiring harness connectors to stoplight switch.
37. Connect body wiring harness connectors to door jamb switch and roof harness connector.
38. Attach body wiring harness ground to steering column with screw and nut.
39. Attach wiring harness turn signal, ignition, and key contact connectors to steering column.
40. Secure body harness to steering column bracket.
41. Connect body wiring harness connectors to radio, engine console, and heat and A/C connectors.
42. Connect body harness grounds.
43. Connect harness connector to power door locks and mirrors.
44. Connect body wiring harness connectors to instrument panel switches.
45. Connect battery.
46. Test electrical system for proper operation.

ROOF ELECTRICAL HARNESS (2-DOOR) REPLACEMENT

NOTE: Prior to removal, tag all wires.

Removal

1. Remove trim as necessary to gain access to roof harness.
2. Remove domelight.
3. Disconnect roof harness connector from body harness (Figure 12-99).

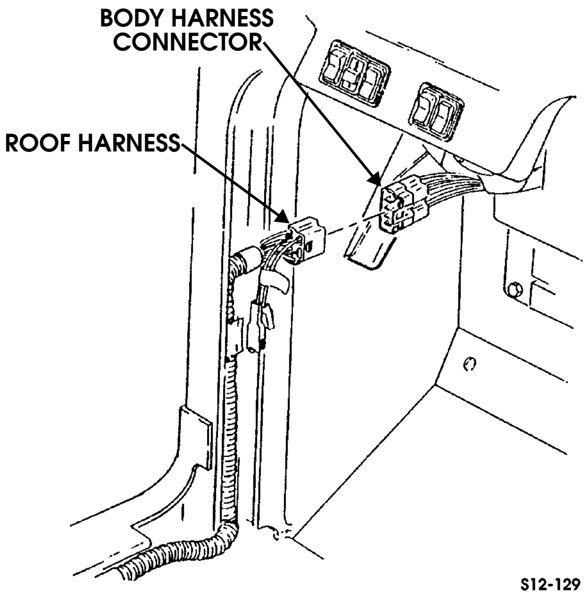

Figure 12-99: Roof Harness Connection

4. Disconnect roof harness connector from seat belt buckle switch (Figure 12-100).

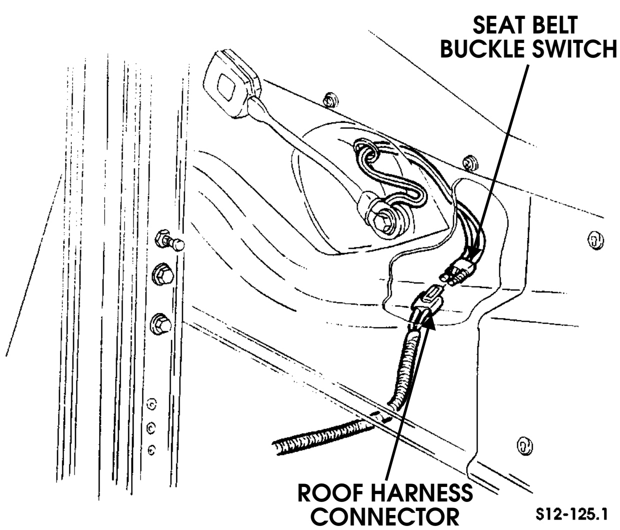

Figure 12-100: Seat Belt Switch Connection

5. Disconnect roof harness connector from right door jamb switch (Figure 12-101).
6. Disconnect roof harness connector from right courtesy light.
7. Remove cargo light from rear bulkhead (Figure 12-101).

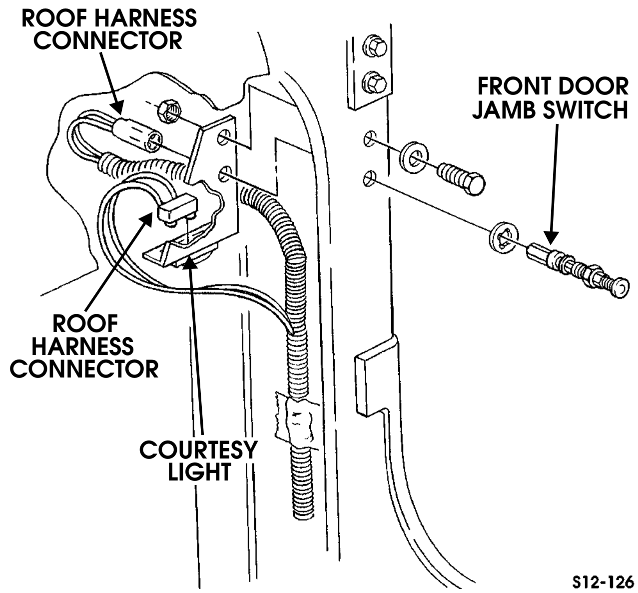

Figure 12-101: Door Jamb Switch

8. Disconnect electronic rear view mirror from roof harness, if equipped.
9. Disconnect roof harness connector from cargo light.
10. Remove roof harness from vehicle.

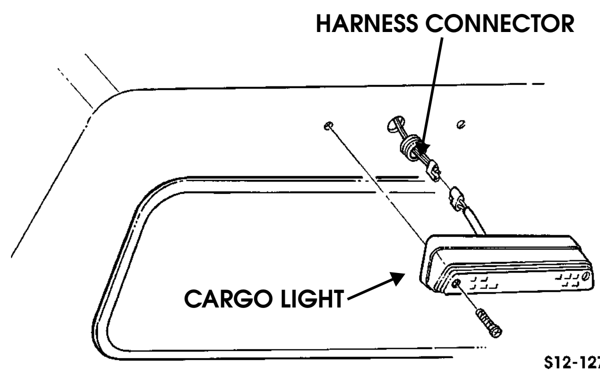

Figure 12-102: Cargo Light

Installation

1. Route roof harness to approximate mounting position.
2. Secure roof harness to vehicle with duct tape, where necessary.
3. Connect roof harness connector to cargo light, if removed (Figure 12-102).
4. Install cargo light on rear bulkhead with two screws, if removed.
5. Connect roof harness connector to right courtesy light, if installed (Figure 12-123).
6. Connect roof harness connector to right door jamb switch.
7. Connect harness connector to seat belt buckle switch (Figure 12-122).
8. Connect roof harness connector to body harness (Figure 12-121).
9. Install domelight.
10. Install trim.
11. Reconnect electronic rear view mirror to roof harness, if equipped.

ROOF ELECTRICAL HARNESS (4-DOOR/ STATION WAGON AND OPEN CAB) REPLACEMENT

Removal

The roof electrical harnesses for the 4-door, station wagon, and open cab are installed the same, except the open cab harness crosses the rear cargo bulkhead. Also, the open cab harness is not equipped with a dome light or cargo light (Figure 12-103).

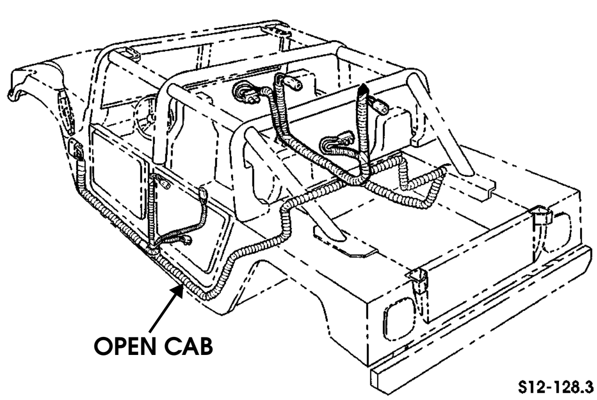

Figure 12-103: Roof Harness Routing

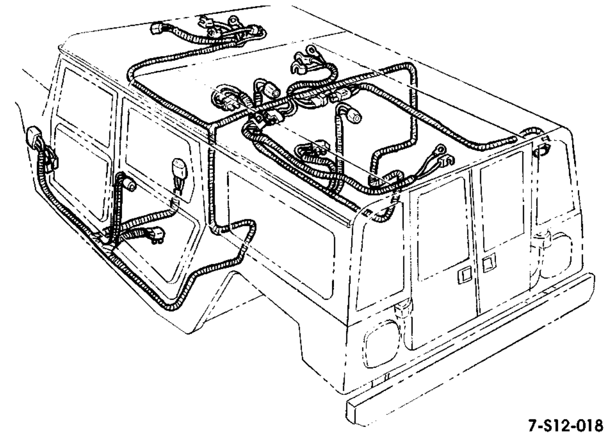

Figure 12-104: Roof Harness Routing (Station Wagon)

1. Remove trim as necessary to gain access to the harness. Prior to removal, tag all leads.
2. Remove domelight.
3. Disconnect roof harness connector from body harness (Figure 12-105).

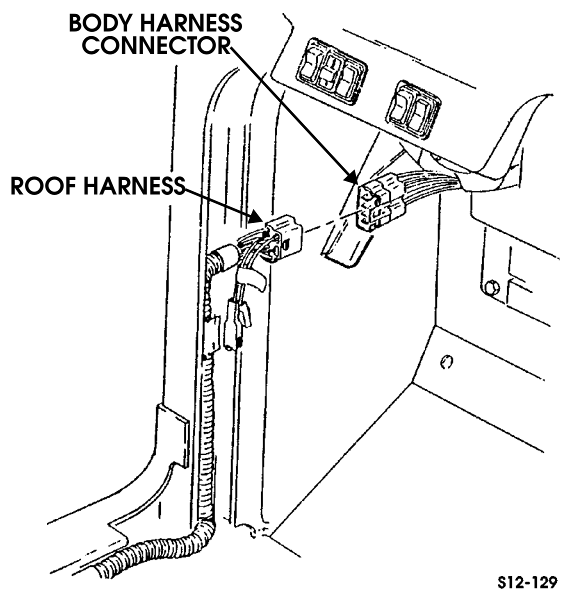

Figure 12-105: Roof Harness Connector

4. Disconnect roof harness connector from seat belt buckle switch (Figure 12-106).

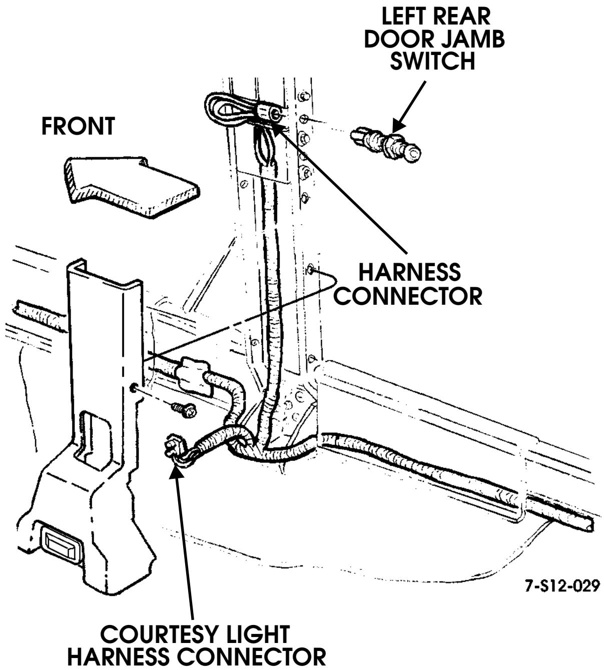

Figure 12-106: Seatbelt Connector

5. Disconnect roof harness connector from left rear courtesy light.
6. Disconnect roof harness connector from left rear door jamb switch.
7. Disconnect roof harness connector from right front door jamb switch (Figure 12-107).

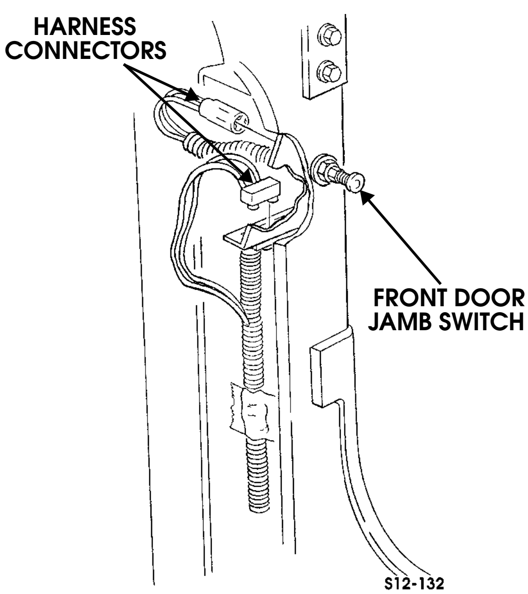

Figure 12-107: Door Jamb Switch

8. Disconnect roof harness connector from right front courtesy light.
9. Disconnect roof harness connector from right rear door jamb switch (Figure 12-108).

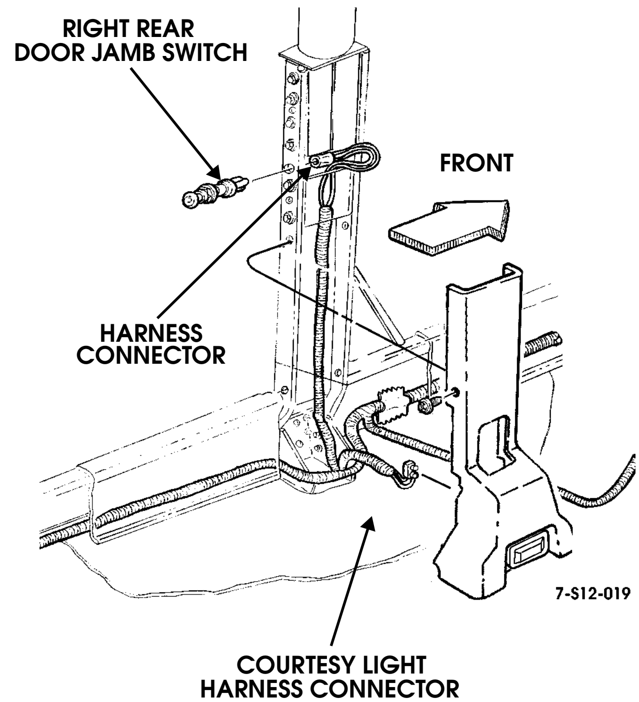

Figure 12-108: Courtesy Light

10. Disconnect roof harness connector from right rear courtesy light.
11. Remove two screws and cargo light from rear bulkhead (Figure 12-110).
12. Disconnect electronic rear view mirror from roof harness, if equipped.
13. Disconnect harness connector from cargo light, if installed.
14. Disconnect roof harness connector from right and left rear vertical door jamb switches, if equipped (Figure 12-109).

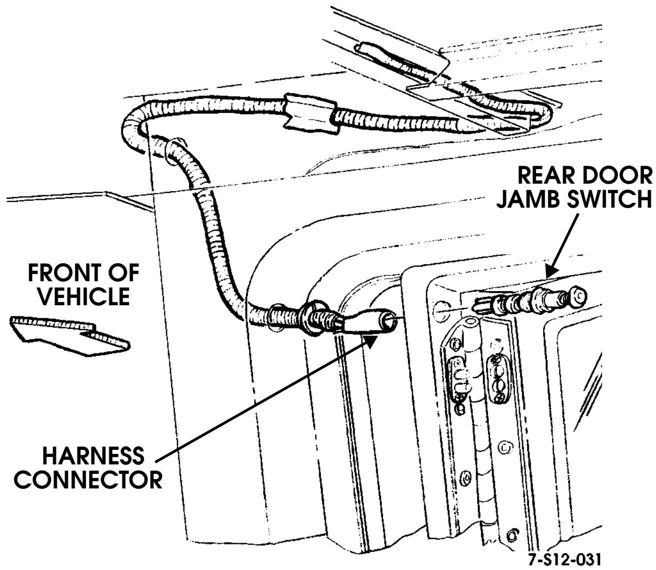

Figure 12-109: Rear Vertical Door Jamb Switches (Station Wagon Models)

15. Remove harness from vehicle.

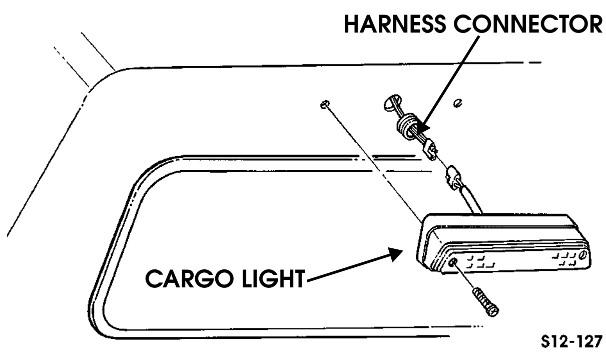

Figure 12-110: Cargo Light

Installation

1. Route roof harness to approximate mounting position.
2. Secure roof harness to vehicle with duct tape, where necessary.
3. Connect roof harness connector to right and left rear vertical door jamb switches, if equipped (Figure 12-109).
4. Connect roof harness connector to cargo light, if removed (Figure 12-110).
5. Install cargo light on rear bulkhead with two screws, if removed.
6. Connect roof harness connector to right rear courtesy light, if installed (Figure 12-108).
7. Connect roof harness connector to right rear door jamb switch.
8. Connect roof harness connector to right front courtesy light, if removed (Figure 12-107).
9. Connect roof harness connector to right front door jamb switch.
10. Connect roof harness connector to left rear door jamb switch (Figure 12-106).
11. Connect roof harness connector to left rear courtesy light, if removed.
12. Connect roof harness connector to seat belt buckle switch.
13. Connect roof harness connector to body harness (Figure 12-105).
14. Install domelights.
15. Install trim.
16. Reconnect electronic rear view mirror to roof harness, if equipped.

STEREO (CLARION BASIC AND DELUXE) ELECTRICAL HARNESS (MODEL 89) REPLACEMENT

Removal

1. Remove front console.
2. Disconnect stereo harness lead from harness connector (Figure 12-111).

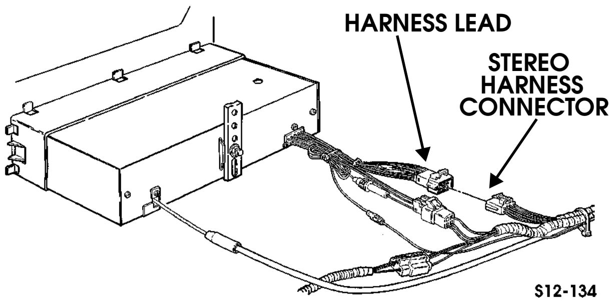

Figure 12-111: Radio Connections

3. Remove four screws, clips, cover, and right speaker from trim (Figure 12-112).

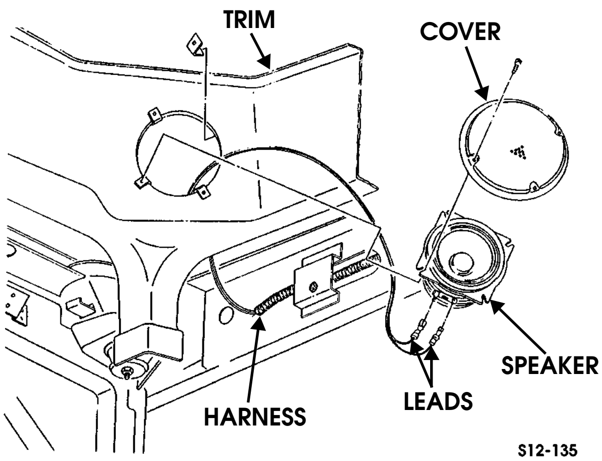

Figure 12-112: Speaker Mounting

4. Disconnect two leads from right speaker.
5. Repeat steps 3 and 4 for left speaker.
6. Remove trim as necessary to gain access to stereo harness.
7. Remove stereo harness from vehicle.

Installation

1. Route stereo harness to approximate mounting position.
2. Secure stereo harness to vehicle with duct tape, where necessary.
3. Install trim.
4. Connect two leads to right speaker (Figure 12-112).
5. Install right speaker and cover on trim with four clips and screws.
6. Repeat steps 4 and 5 for left speaker.
7. Connect harness lead to stereo harness connector (Figure 12-111).
8. Install front console.

STEREO (CLARION BASIC AND DELUXE) ELECTRICAL HARNESS (MODELS 83 AND 84) REPLACEMENT

Removal

1. Remove front console.
2. Disconnect harness lead from stereo harness connector (Figure 12-111).
3. Remove four screws, clips, cover, and right front speaker from trim (Figure 12-112).
4. Disconnect two leads from right front speaker.
5. Repeat steps 3 and 4 for left front speaker.
6. Remove four screws, clips, cover, and right rear speaker from trim.
7. Disconnect two leads from right rear speaker.
8. Repeat steps 7 and 8 for left rear speaker.
9. Remove trim as necessary to gain access to stereo harness.
10. Remove stereo harness from vehicle.

Installation

1. Route stereo harness to approximate mounting position.
2. Secure stereo harness to vehicle with duct tape, where necessary.
3. Install trim.
4. Connect two leads to right rear speaker.
5. Install right rear speaker and cover on trim with four clips and screws.
6. Repeat steps 4 and 5 for left rear speaker.
7. Connect two leads to right front speaker (Figure 12-112).
8. Install right front speaker and cover on trim and secure with four clips and screws.
9. Repeat steps 7 and 8 for left front speaker.
10. Connect harness lead to stereo harness connector.
11. Install front console.

STEREO (CLARION BASIC AND DELUXE) ELECTRICAL HARNESS (MODEL 90) REPLACEMENT

Removal

1. Remove front console.
2. Disconnect harness lead from stereo harness connector (Figure 12-111).
3. Remove four screws, clips, cover, and right front speaker from trim (Figure 12-113).

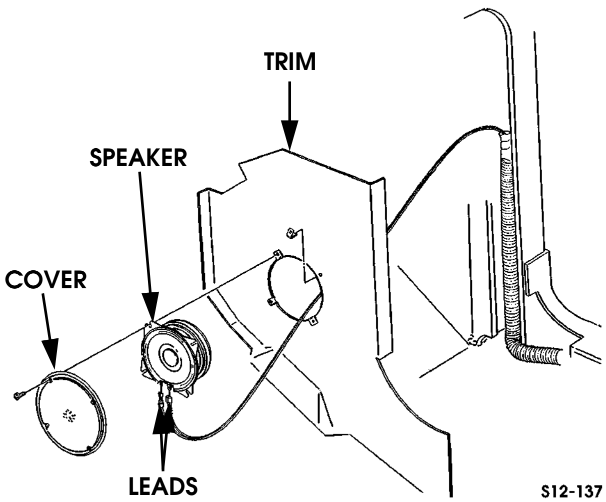

Figure 12-113: Front Speaker Mounting

4. Disconnect two leads from right front speaker.
5. Repeat steps 3 and 4 for left front speaker.
6. Remove four screws, clips, cover, and right rear speaker from trim (Figure 12-114).

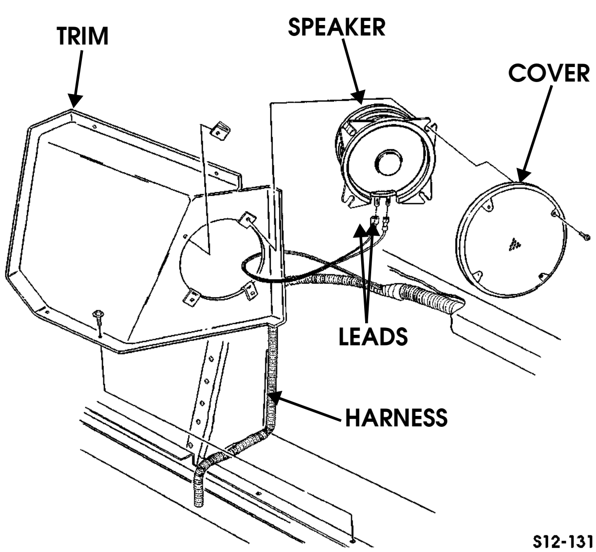

Figure 12-114: Rear Speaker Mounting

7. Disconnect two leads from right rear speaker.
8. Repeat steps 7 and 8 for left rear speaker.
9. Remove trim as necessary to gain access to harness.
10. Remove stereo harness from vehicle.

Installation

1. Route stereo harness to approximate mounting position.
2. Secure harness to vehicle with duct tape, where necessary.
3. Install trim.
4. Connect two leads to right rear speaker (Figure 12-114).
5. Install right rear speaker and cover on trim and secure with four clips and screws.
6. Repeat steps 4 and 5 for left rear speaker.
7. Connect two leads to right front speaker (Figure 12-113).
8. Install right front speaker and cover on trim with four clips and screws.
9. Repeat steps 7 and 8 for left front speaker.
10. Connect harness lead to stereo harness connector.
11. Install front console.

DELCO AUDIO SYSTEM DESCRIPTION

Delco audio systems in Hummers (VIN 176477-up) are available in two configurations:

The standard system (Figure 12–114.1), available on all models, consists of a radio head with cassette player (Delco logo), either two or four coaxial speakers and an optional 6 disc CD changer. An optional infrared remote control for the radio, cassette player and CD changer is available.

The Monsoon system (Figure 12-114.2), available on models 83 and 84, uses a radio head and cassette player (Monsoon logo) with a total of six coaxial speakers and two subwoofers. Two coaxial speakers are located in an overhead console and the two subwoofers are housed in a box located under the left rear seat. An amplifier producing 200 watts on eight channels is mounted in the overhead console. The amplifier is activated by output on the left rear channel from the radio. The 6 disc CD changer is standard with the Monsoon system. A 6 disc stacker magazine inserted in the CD changer is controlled by the radio head and optional remote control. The radio and the cassette player can also be controlled by the remote.

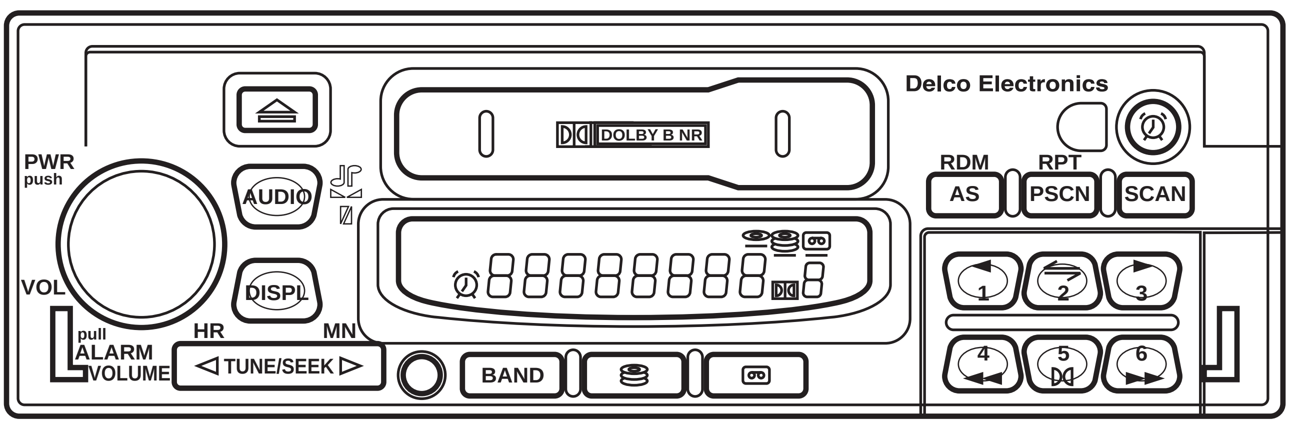

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Figure 12–114.1: Delco Standard Radio Face

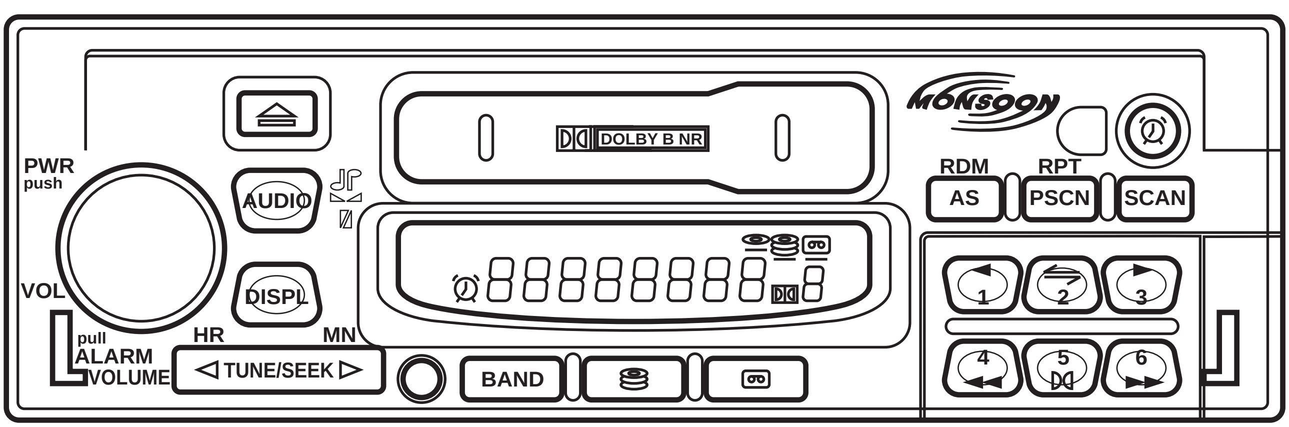

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Figure 12-114.2: Delco Monsoon Radio Face

RADIO (DELCO) REPLACEMENT

Removal

1. Insert right and left radio removal keys in slots in face of radio to disengage locking clips from the mounting sleeve (Figure 12-114.3).
2. Pull radio out of mounting sleeve far enough to expose wire connections and disconnect audio harness connector, antenna cable and CD harness connector if equipped.
3. Straighten locking tabs and pull mounting sleeve out of face plate.

NOTE: Sleeve may not need to be replaced when radio head is replaced.

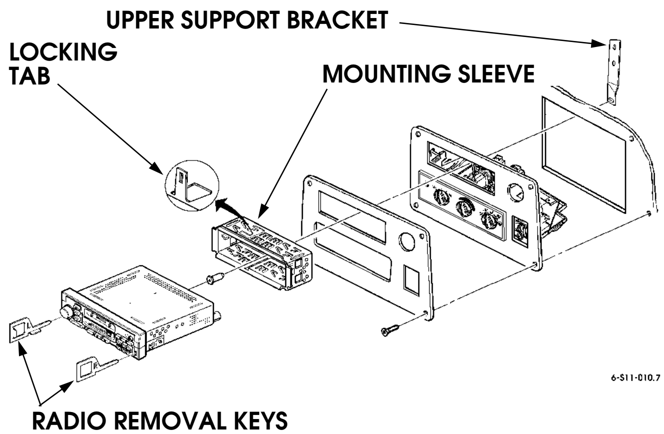

Figure 12-114.3: Radio Removal.

Installation

1. Install mounting sleeve through face plate and support plate and bend locking tabs to secure.
2. Connect harness connectors and antenna cable to radio.
3. Insert radio into mounting sleeve, align rear mount pin with upper support bracket and push in until locking clips engage. Take care not to damage wiring in radio cavity.
4. Advise end user to reprogram theftlock .

CD CHANGER (DELCO) REPLACEMENT

Removal

1. Remove four screws retaining the CD changer bezel to the console and remove bezel (Figure 12–114.4).
2. Remove four screws retaining the CD changer mounting brackets to the console.
3. Pull the CD changer out far enough to remove the wire harness connector from the changer.
4. If CD changer wire harness is to be replaced, radio must be removed to gain access to harness connection at the radio.

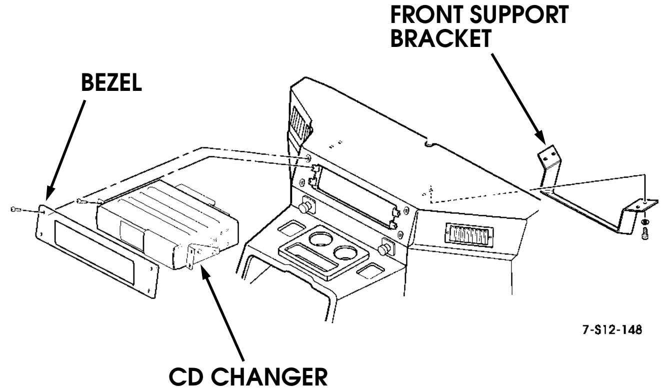

Figure 12–114.4: CD Changer Removal.

Installation

1. Assure angle adjustments on the sides of the changer are set at 22.5° before installation.
2. Connect wire harness connector to the rear of the CD changer and insert changer into the console and the front support bracket.
3. Install four screws in the changer mount brackets and tighten.
4. Install changer bezel with four screws and tighten.

OVERHEAD CONSOLE, SPEAKER AND AMPLIFIER (DELCO MONSOON) REPLACEMENT

Removal

1. Remove upper B-bar cover screws and cover.
2. Remove dome light lens, screws securing ground wires and housing (Figure 12–114.5).
3. Remove bulb holder and dome light housing.

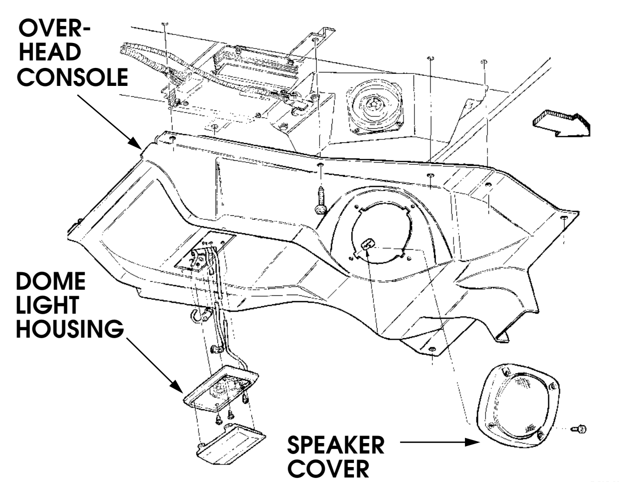

Figure 12–114.5: Overhead Console Removal.

4. Remove windshield divider bar cover.
5. Remove screws securing overhead console and pull console down to gain access to wiring.
6. Remove blue wire and connector from dome light mount plate.
7. Disconnect green wire connection and remove console.
8. Disconnect 32 pin connector from amplifier and four screws securing amplifier to mounting bracket (Figure 12–114.6).
9. Remove amplifier.
10. Disconnect 4 pin connector from overhead console speaker enclosure.
11. Remove speakers and wiring from overhead console speaker enclosure.

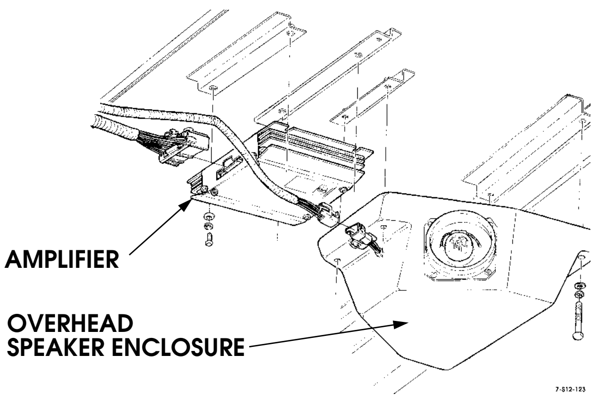

Figure 12–114.6: Overhead Speaker & Amplifier Removal.

Installation

1. Install speakers and wiring in overhead console speaker enclosure and connect 4 pin connector to audio harness.
2. Mount amplifier to mounting bracket with four screws and connect 32 pin connector to audio harness.
3. Connect dome light wiring and screw overhead console to roof.
4. Install windshield divider bar cover.
5. Install dome light housing and bulb holder with 3 screws, and dome light lens.
6. Install upper B-bar cover.

AUDIO (DELCO MONSOON) ELECTRICAL HARNESS (MODELS 83 & 84) REPLACEMENT

Removal

1. Remove engine cover console.
2. Disconnect harness connector from radio head.
3. Remove four screws, clips, cover, and right front speaker from trim (Figure 12–114.7).
4. Disconnect two leads from right front speaker.
5. Repeat steps 3 and 4 for left front speaker.
6. Remove screws from B-bar cover, windshield divider cover, and overhead console. Disconnect dome light wiring connections and overhead console speaker enclosure connector.
7. Remove four screws, clips, cover, and right rear speaker from trim.
8. Disconnect two leads from right rear speaker.
9. Repeat steps 7 and 8 for left rear speaker.
10. Disconnect lead from subwoofer under left rear seat.
11. Remove trim as necessary to gain access to audio harness.
12. Remove audio harness from vehicle.

Installation

1. Route audio harness to approximate mounting position.
2. Secure audio harness to vehicle with duct tape, where necessary.
3. Connect two leads to right rear speaker.
4. Install right rear speaker and cover on trim with four clips and screws.
5. Repeat steps 3 and 4 for left rear speaker.
6. Connect lead to subwoofer.
7. Connect lead to overhead console speaker enclosure.
8. Connect two leads to right front speaker (Figure 12–114.7).
9. Install right front speaker and cover on trim and secure with four clips and screws.
10. Repeat steps 7 and 8 for left front speaker.
11. Connect harness lead to radio head.
12. Install engine cover console.
13. Install trim.

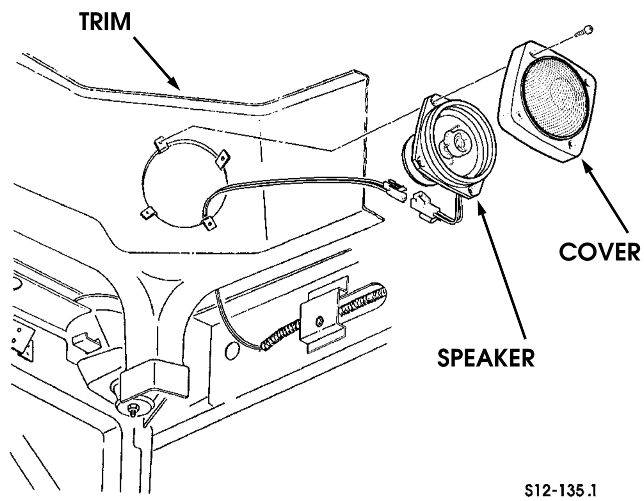

Figure 12–114.7: Right Front Speaker Models 83 & 84.

AUDIO (DELCO STANDARD) ELECTRICAL HARNESS (MODEL 89) REPLACEMENT

Removal

1. Remove engine cover console.
2. Disconnect audio harness lead from harness connector (Figure 12–114.8).

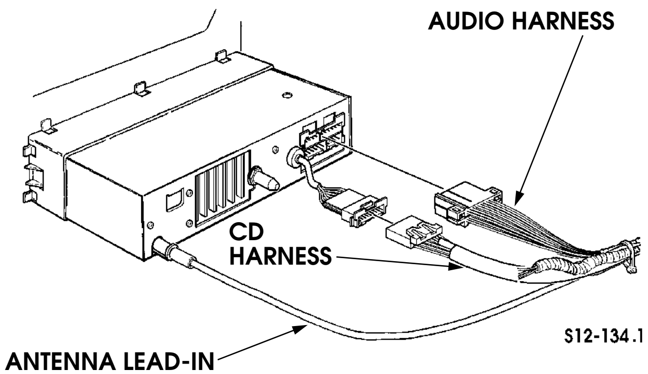

Figure 12–114.8: Audio Harness Connections.

3. Remove four screws, clips, cover, and right speaker from trim (Figure 12–114.9).

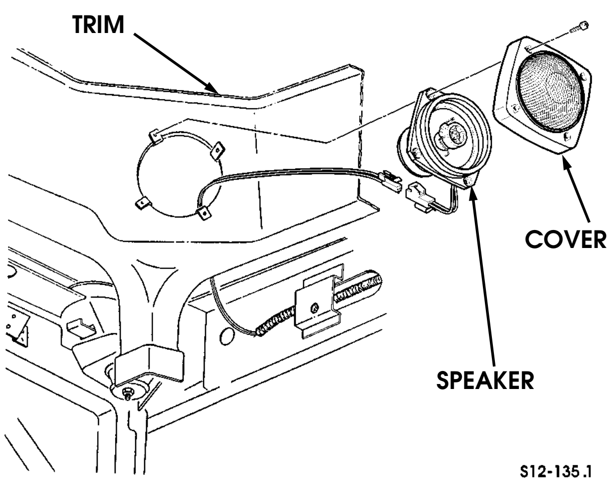

Figure 12–114.9: Right Front Speaker Model 89.

4. Disconnect two leads from right speaker.
5. Repeat steps 3 and 4 for left speaker.
6. Remove trim as necessary to gain access to audio harness.
7. Remove audio harness from vehicle.

Installation

1. Route audio harness to approximate mounting position.
2. Secure audio harness to vehicle with duct tape, where necessary.
3. Install trim.
4. Connect two leads to right speaker (Figure 12–114.9).
5. Install right speaker and cover on trim with four clips and screws.
6. Repeat steps 4 and 5 for left speaker.
7. Connect harness lead to audio harness connector (Figure 12–114.8).
8. Install engine cover console.

AUDIO (DELCO STANDARD) ELECTRICAL HARNESS (MODELS 83 & 84) REPLACEMENT

Removal

1. Remove engine cover console.
2. Disconnect harness lead from audio harness connector (Figure 12–114.8).
3. Remove four screws, clips, cover, and right front speaker from trim (Figure 12–114.9).
4. Disconnect two leads from right front speaker.
5. Repeat steps 3 and 4 for left front speaker.
6. Remove four screws, clips, cover, and right rear speaker from trim.
7. Disconnect two leads from right rear speaker.
8. Repeat steps 7 and 8 for left rear speaker.
9. Remove trim as necessary to gain access to audio harness.
10. Remove audio harness from vehicle.

Installation

1. Route audio harness to approximate mounting position.
2. Secure audio harness to vehicle with duct tape, where necessary.
3. Install trim.
4. Connect two leads to right rear speaker.
5. Install right rear speaker and cover on trim with four clips and screws.
6. Repeat steps 4 and 5 for left rear speaker.
7. Connect two leads to right front speaker (Figure 12–114.9).
8. Install right front speaker and cover on trim and secure with four clips and screws.
9. Repeat steps 7 and 8 for left front speaker.
10. Connect harness lead to audio harness connector.
11. Install engine cover console.

AUDIO (DELCO STANDARD) ELECTRICAL HARNESS (MODEL 90) REPLACEMENT

Removal

1. Remove engine cover console.
2. Disconnect harness lead from radio head (Figure 12–114.8).
3. Remove four screws, clips, cover, backing plate and right front speaker from trim (Figure 12–114.10).

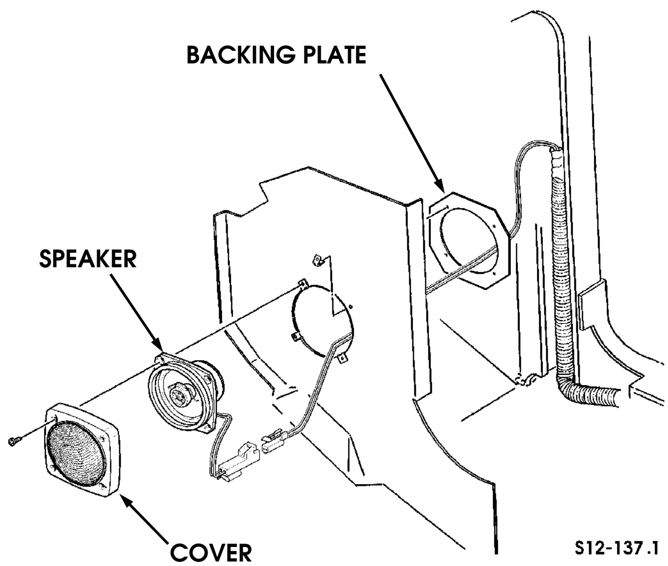

Figure 12–114.10: Right Front Speaker Model 90.

4. Disconnect two leads from right front speaker.
5. Repeat steps 3 and 4 for left front speaker.
6. Remove four screws, clips, cover, and right rear speaker from trim (Figure 12–114.11).

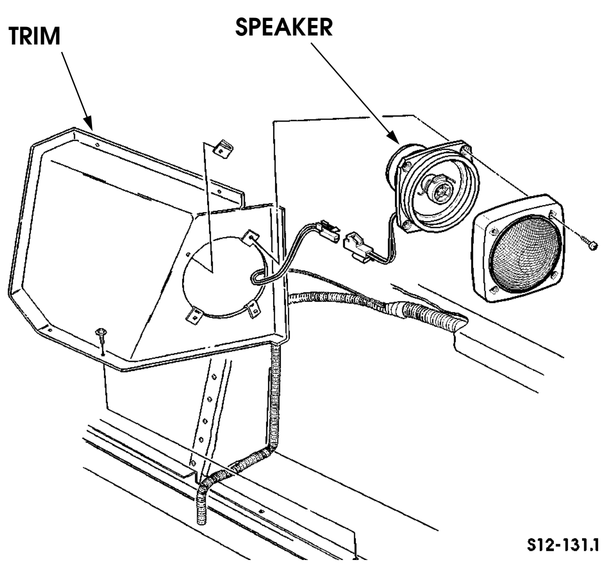

Figure 12–114.11: Right Rear Speaker Model 90.

7. Disconnect two leads from right rear speaker.
8. Repeat steps 7 and 8 for left rear speaker.
9. Remove trim as necessary to gain access to harness.
10. Remove audio harness from vehicle.

Installation

1. Route audio harness to approximate mounting position.
2. Secure harness to vehicle with duct tape, where necessary.
3. Install trim.
4. Connect two leads to right rear speaker (Figure 12–114.11).
5. Install right rear speaker and cover on trim and secure with four clips and screws.
6. Repeat steps 4 and 5 for left rear speaker.
7. Connect two leads to right front speaker (Figure 12–114.10).
8. Install right front speaker and cover on trim with four clips and screws.
9. Repeat steps 7 and 8 for left front speaker.
10. Connect harness lead to radio head.
11. Install engine cover console.

DIAGNOSIS -DELCO AUDIO SYSTEM

1. Verify customer complaint.
2. Follow radio service procedures.
3. If technical service is required, have all the pertinent information ready before placing the call.

NOTE: Before performing any diagnostic procedures or using any diagnostic tools, check wiring schematics for component circuitry to determine the location of fuses and circuit breakers in the circuit. Fuses and circuit breakers must be in good working order to perform proper diagnostic procedures.

Delco Audio System Diagnostic Kit J–39916-A is available from Kent-Moore. The kit contains a diagnostic CD and cassette, a head cleaner cassette and instructions. This kit is designed to isolate the type of malady and the area of its origin by producing tones of various frequencies. By adjusting the fade and balance, a technician can evaluate the sound quality produced in different areas of the system.

Identifying Concerns

- Check for technical service bulletins.
- For reception concerns, determine if the station is obtainable in the customers listening area.
- To test for audio reception/noise, position the vehicle outside the building with the hood down.
- Duplicate the customers complaint before trying to diagnose the system. Have the customer demonstrate the condition. Test drive the vehicle with the customer and then test drive another similar model vehicle (with a similar audio system) to do a comparison of the two vehicles to determine if the condition is abnormal.
- Before diagnosing, identify components, their features and the customer’s complaint.
- Determine if any aftermarket equipment is installed on the vehicle. Disconnect the aftermarket equipment and determine if the customers complaint still exists.
- Perform the following steps to identify a noisy component:

1. Perform antenna check procedure.
2. Identify ignition switch key position in which the noise appears, such as: accessory, key on engine not running, and key on engine running.
3. Remove fuses one at a time until the complaint condition has been eliminated.
4. Mark the complaint fuse(s) and reinstall all fuses and circuit breakers.
5. Identify all systems and components powered by the complaint fuse(s).
6. Disconnect the components powered by the complaint fuse(s) one at a time until the complaint condition has been eliminated and the noisy component has been identified.
7. Check the ground integrity of the complaint causing component.
   - An interference condition is not necessarily an audible noise.
   - Most noises can be found on weak stations near the low end of the band and are considered to be a normal condition.
   - Malfunctioning and marginal components, relays, and solenoids may induce noise and/or poor reception.
8. Check for a broken (or partially broken) wire inside of the insulation which could cause system malfunction but prove “good” in a continuity/voltage check with a system disconnected. These circuits may be intermittent or resistive when loaded, and if possible, should be checked by monitoring for a voltage drop with the system operational (under load).

Corrective Action

- Use proper tools for diagnostics and repairs.
- Follow electrical system diagnostic guidelines.
- Use available noise suppression devices:
  —Filter package P/N 05744279

Utilize the test tape /CD Diagnostic Kit Kent-Moore P/N J–39916-A to optimize proper audio diagnostics.

- If the condition requires the radio to be sent to the service center, describe the symptoms on the warranty form exactly.
- Do not leave a CD disc or tape in the vehicle. Extreme heat could cause permanent damage.
- Cassette tapes could be damaged if not stored in the case. The vibration in the vehicle can cause the tape to unwind inside the cartridge.
- Use available trouble trees.
- Before removing speaker(s), check all connectors and wiring to the speakers. Examine the connectors for bent or loose pins. Refer to troubleshooting procedures.
- If a test antenna is used in diagnostics, ground the antenna base to the vehicle body and do not hold the mast.

NOTE: Check the antenna coax connectors for corrosion or bad connections/crimps. Route coax separately from the other wires. Shield antenna coax interconnections with aluminum or nickel tape. Check all vehicle grounds, not just antenna and radio grounds. Refer to the antenna diagnostic section.

- Coated screws or bolts can act as poor grounds.
- Always use a braided ground strap when applying grounds. Keep the ground strap as short as possible, the shorter the ground strap the better.
- When shielding the dash, wires, hoses (most hoses are conductive unless they have a white stripe), etc., use aluminum foil tape or nickel tape to shield against

magnetically induced interference. For optimum performance try varying the following ground techniques:

—Add a ground at both ends of the tape.

—Add a ground to just one end of the tape.

—Do not add ground to the tape.

- When shielding a harness with tape, attach a ground strap to the end of the tape and then wrap the strap 360 degrees around the tape securing the other end of the strap to a known good chassis ground.
- Any interference is best corrected by suppression at the source of the interference, if possible.
- Care should be used when applying suppression. Signal wires (such as sensor outputs, clock, and communication circuits) cannot be suppressed. After adding any suppression, all vehicle systems (even those not related to the audio system) should be checked for proper operation and function.
- Interference can usually be eliminated by shielding/ grounding or suppressing.
- Capacitors work best on switch pops and low frequency noise. Filters work best on high frequency whines and static.
- Whenever possible, make a test harness that includes filters and capacitors. Always check the effectiveness and operation before permanently installing a fix.
- Recommended capacitor application for an audible pop induced from a switching operation is:

  —Add a capacitor across the contacts of the switch.

  —Add a capacitor from the hot side of the switch to ground.

  —Add a capacitor to each side of the switch to ground.
- If a complaint condition is only present with the ignition key in the run position and the engine running, perform the following checks:

  —Check the integrity of the engine compartment grounds.

  —Check for malfunctioning relays, solenoids, or other components which may be inducing “noise” or poor reception.

  —Check the ground integrity of the complaint causing component.
- For noise and/or poor reception, perform the antenna system test and make the necessary repairs.

TEST ANTENNA

The test antenna is simply an antenna that is not mounted on the vehicle. This tool is used as a substitute for the antenna mounted on the vehicle. The technician should connect the test antenna to the antenna input of the radio. Ground the base of the antenna to the vehicle’s chassis. **Do not hold the mast of the antenna.** This will decrease the capability of the antenna to receive a station.

GENERATOR WHINE CONCERNS

- Check the ground terminal on the battery.
- Check for coated mounting bolts on the generator bracket.
- Check for a faulty mounting of the generator to the engine.
- Make sure grounds at starter and intake manifold are clean and tight.
- Try the following:

1. If noise is still present, check the charging system.
2. If the charging system is functioning normally, check for technical service bulletins on generator whine.
3. Install a filter P/N 05744279 in the battery feed to the radio.
4. Try installing the filter with the following variations if the noise is not eliminated.
   a. Install the filter with the single wire side toward the radio and the ground wire attached to a good ground.
   b. Remove the ground to the filter.
   c. Reverse the filter so the two wire side is toward the radio with the ground wire attached to a good ground.
   d. Remove the ground from the filter.
5. If the noise is still present, install another filter P/N 05744279 in the ignition feed to the radio. Install using the same variations as the first filter. If the installation of this filter causes turn on or turn off delays or other noticeable performance concerns, remove it and install a 0.47 mf (microfarad) capacitor in its place.
6. Remove any unneeded filters after repair, before reassembling the vehicle.

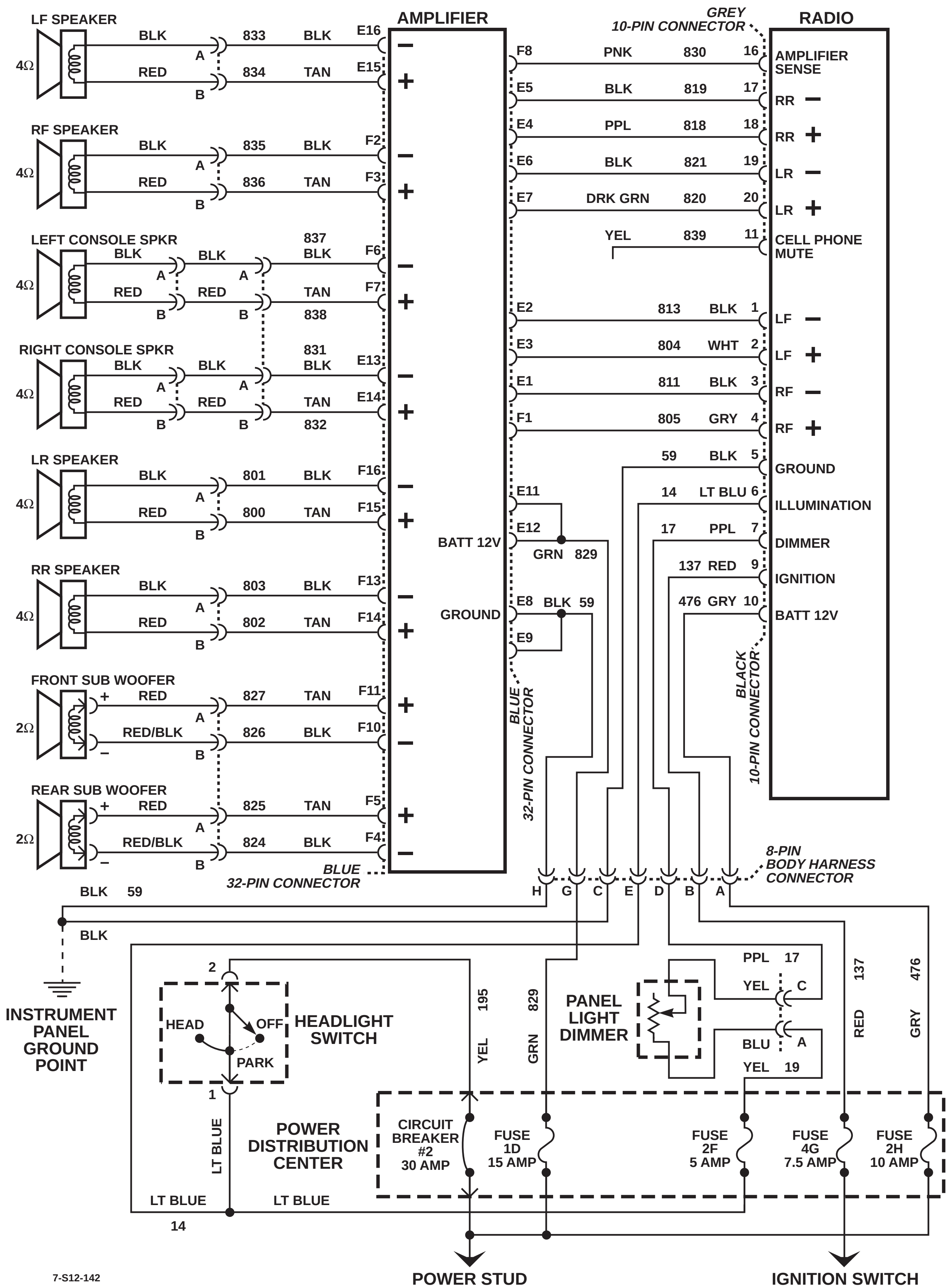

Figure 12–114.14: Monsoon Audio Harness Schematic Models 83 & 84.

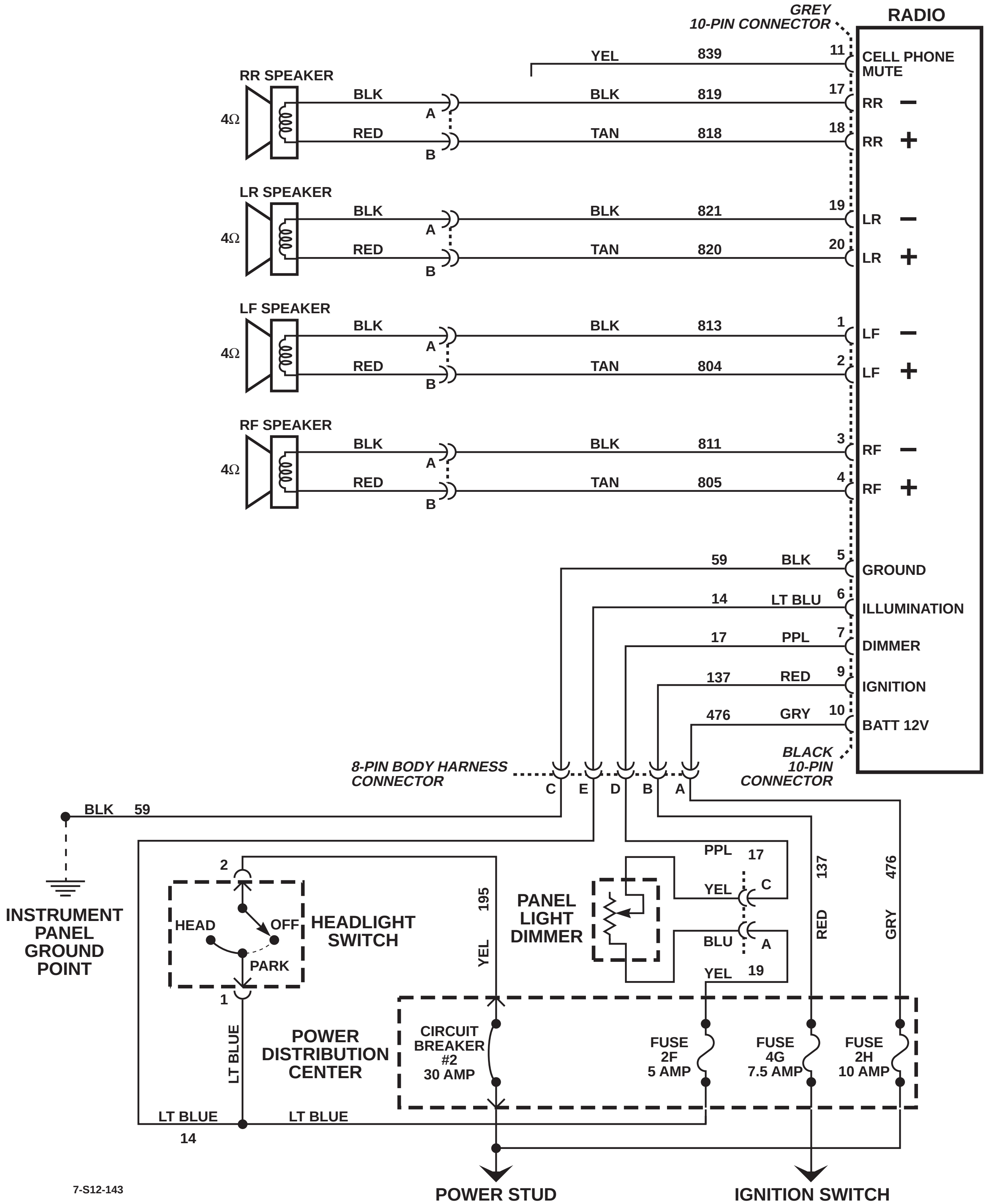

Figure 12–114.15: Standard Audio Harness Schematic Models 83, 84 & 90.

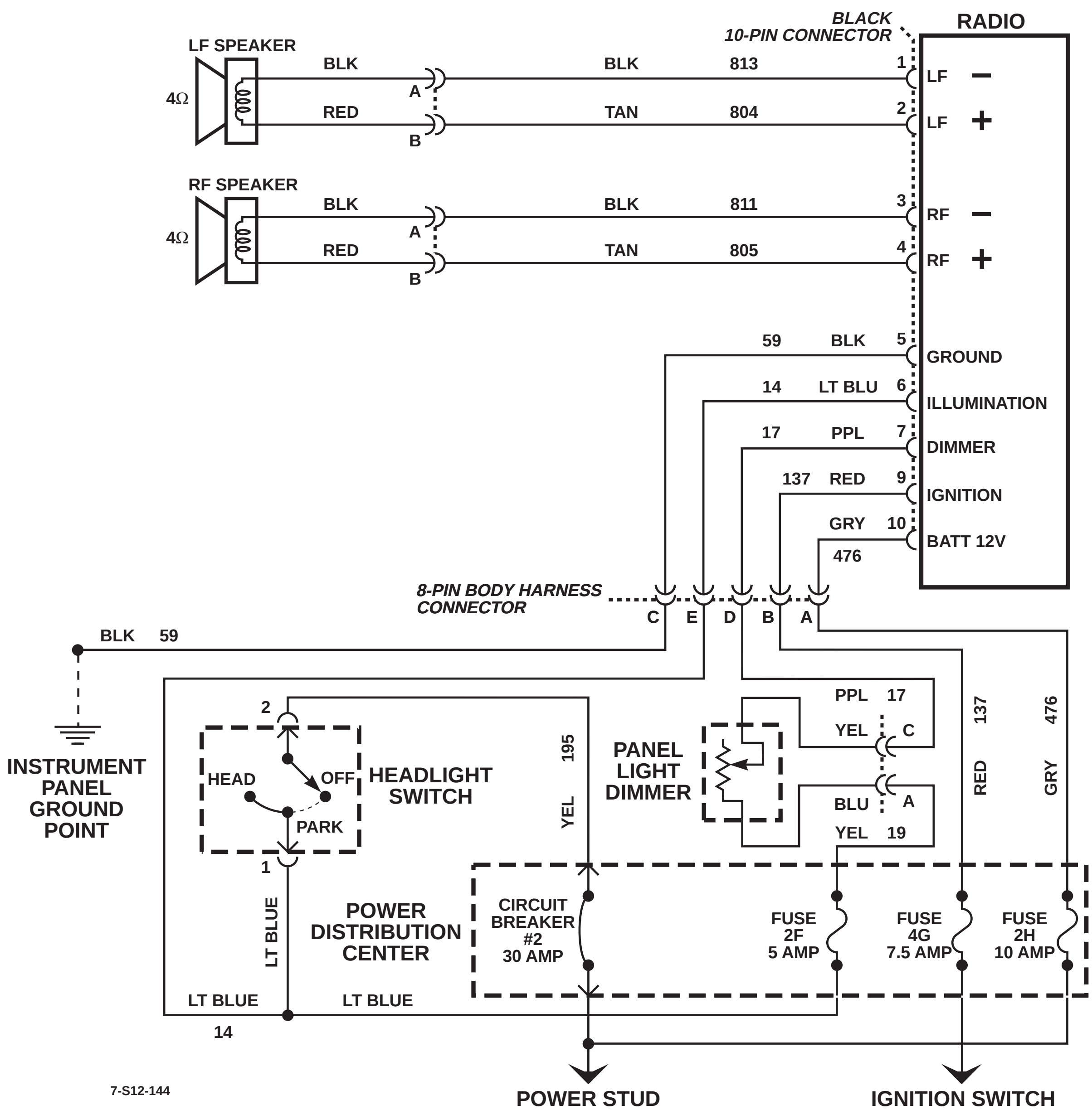

Figure 12–114.16: Standard Audio Harness Schematic Model 89.

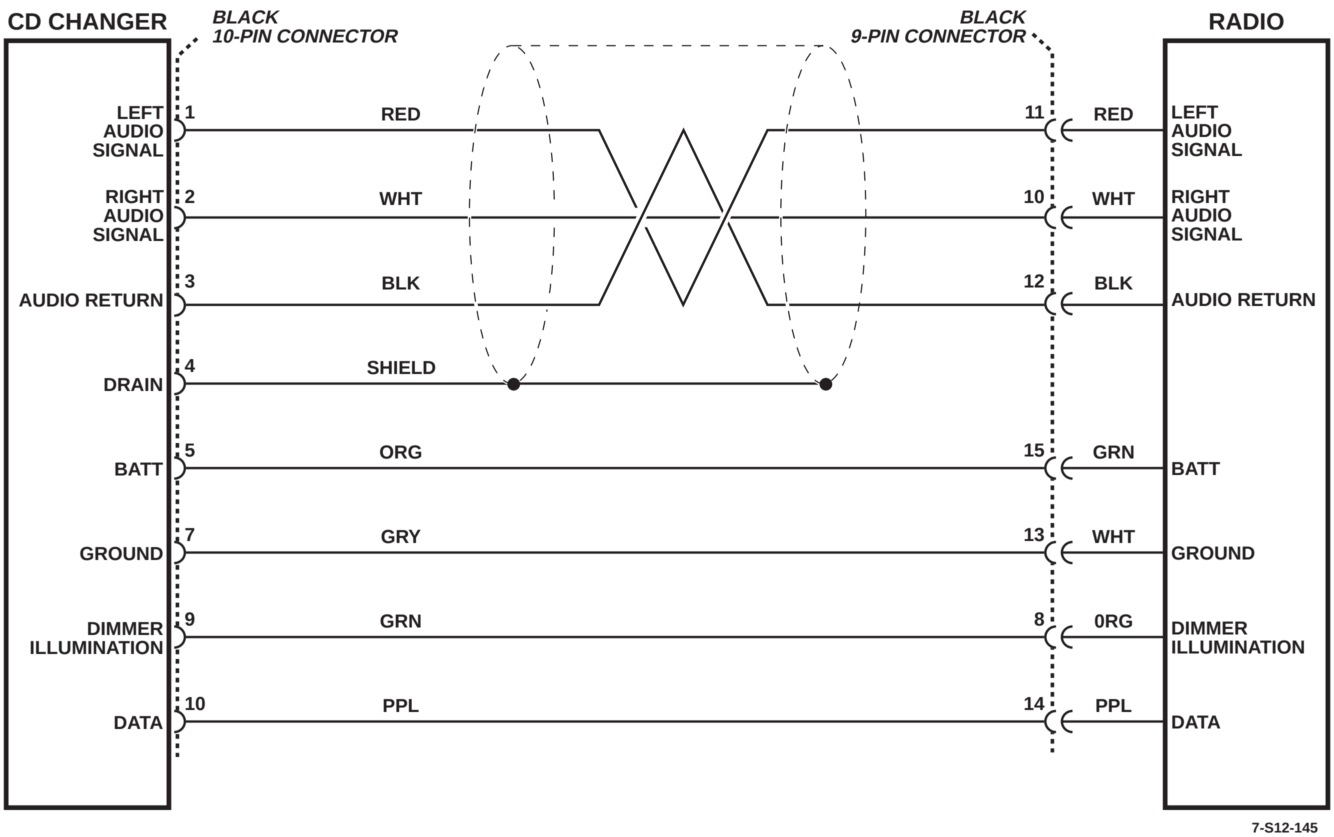

Figure 12–114.17: CD Changer To Radio Harness All Models.

SYMPTOM TABLE

SYMPTOM	PROCEDURE	PAGE NUMBER
Display inoperative, no sound from any speaker.	Chart #1	12-61.13
No sound from one speaker (Delco std.).	Chart #2	12-61.13
No sound from one speaker (Monsoon).	Chart #3	12-61.14
No sound from any speaker, radio display operates normally (Monsoon).	Chart #4	12-61.15
Compact disc player does not operate properly.	Chart #5	12-61.16
Cassette player does not operate properly.	Chart #6	12-61.17
Antenna system test.	Chart #7	12-61.18
Radio controls are inoperative.	Service radio.	
Radio does not turn off.	Service radio.	
Radio memory (clock and station presets) is inoperative.	Check ckt. 476 for an open or high resistance between radio connector terminal “10” and fuse 2H.	
Display dimming does not vary using the I/P dimmer switch (I/P dimming works).	Check ckt. 17 for an open or high resistance between radio connector terminal “7” and the panel light dimmer.	
Speaker output distorted at high volume (Monsoon).	Check for open or poor connection in ckt. 59 from amplifier terminals “E8” and “E9” to the I/P ground point. Check for open or poor connection in ckt. 829 from amplifier terminals “E11” and “E12” to fuse 1D. If OK, replace amplifier.	

DISPLAY IS INOPERATIVE, NO SOUND FROM ANY SPEAKER

CHART #1

STEP	ACTION	VALUE(S)	YES	NO
1	Disconnect radio connector. Ignition switch to “run”. With a DVOM, measure voltage between terminal “10” and ground.	Approxi-mate battery voltage.	Go to step 2.	Repair poor connection or open in ckt. 476 between radio connector terminal “10” and fuse 2H.
2	With a DVOM, measure voltage at radio connector between terminal “10” and terminal “5”.	Approxi-mate battery voltage.	Go to step 3.	Repair poor connection or open in ckt. 59 between radio connector terminal ”5” and IP ground point.
3	With a DVOM measure voltage at radio connector between terminal “9” and terminal “5”.	Approxi-mate battery voltage.	Go to step 4.	Repair open in ckt. 137 between radio connector terminal 9 and fuse 4G.
4	Check for poor connection at radio. If OK, service radio.			

NO SOUND FROM ONE SPEAKER (DELCO STANDARD)

CHART #2

	ACTION	VALUE(S)	YES	NO
1	Ignition switch “off”. Disconnect radio connectors. With a DVOM, measure resistance at the radio connector between speaker + and - circuits (see schematics).	Approxi-mately 4 ohms.	Go to step 3.	Go to step 2.
2	With a DVOM, measure the resistance at the speaker connection from terminal “A” to terminal “B”.	Approxi-mately 4 ohms.	Repair open or short circuit in speaker + and - circuits.	Replace speaker.
3	With a DVOM measure the resistance at the radio connector of the speaker + and - circuits to ground.	Infinite resistance.	Go to step 4.	Repair short to ground in speaker + or - circuit.
4	Check for poor connections at radio or speaker. If OK, service radio.			

NO SOUND FROM ONE SPEAKER (DELCO MONSOON)

CHART #3

STEP	ACTION	VALUE(S)	YES	NO
1	Turn ignition switch to run. Turn radio on. Insert cassette or compact disc from Delco Audio system Diagnostic Kit J 39916-A. Set radio balance and fade controls to the detent (center) position. Set volume at normal listening level. While playing the combination test tone from cassette or compact disc, use a DVOM to backprobe the speaker connector between terminals “A” and “B”. Is the voltage greater than 0V AC?	> 0V AC	Go to step 2.	Go to step 3.
2	Check for a poor connection at the inoperative speaker. If OK, replace the speaker. Is the repair complete?		System OK.	
3	Check the + and - speaker circuits for a short to B+ or ground between the speaker and amplifier. Is there a short?		Repair short to ground or B+.	Go to step 4.
4	Turn ignition switch off. Disconnect amplifier connector. Using a DVOM set to measure resistance, probe the amplifier connector between the + and - speaker circuits of the inoperative speaker (see schematics). Is the resistance approximately 2-4 ohms?	2-4 ohms	Go to step 6.	Go to step 5.
5	Using a DVOM, check the resistance at the speaker connection between terminals “A” and “B”. Is the resistance 2-4 ohms?	2-4 ohms	Repair open in speaker + or - circuit between speaker connection and amplifier connection.	Replace speaker.
6	Check for poor connection at amplifier connector. Is connection OK?		Replace amplifier.	Repair connection.

NO SOUND FROM ANY SPEAKER, RADIO DISPLAY OPERATES NORMALLY (DELCO MONSOON) CHART #4

STEP	ACTION	VALUE(S)	YES	NO
1	Disconnect amplifier connector. Turn ignition switch to run. Turn radio on. Insert cassette or compact disc from Delco Audio System Diagnostic Kit J 39916-A. Set radio balance and fade controls to the detent (center) position. Set radio volume at normal listening level. While playing the combination test tone from the cassette or compact disc, use a DVOM to measure AC voltage between amplifier connector terminals “E6” and “E7”. Is the voltage greater than 0V AC?	> 0V AC	Go to step 2.	Go to step 4.
2	Check for a poor connection at the amplifier connector terminals “E6” and “E7”. Was poor connection found?		Repair connection.	Go to step 3.
3	Using a DVOM, check for B+ between circuits 829 and 59 at the amplifier connection.	Battery +	Replace amplifier.	Repair open or poor connection in circuits 829 and 59.
4	Turn ignition switch to run. Turn radio on. Insert cassette or compact disc from Delco Audio System Diagnostic Kit J 39916-A. Set radio balance and fade controls to the detent (center) position. Set radio volume at normal listening level. While playing the combination test tone from the cassette or compact disc, use a DVOM and backprobe radio connector between terminals “19” and “20”. Is the voltage greater than 0V AC?	> 0V AC	Go to step 5.	Go to step 6.
5	Repair open or short in circuit 821 or 820 between radio and amplifier. Is the repair complete?		System OK.	
6	Check for bad connection at radio connector 19 or 20. Is bad connection found?		Repair connection.	Replace radio.
7	Check for a short to B+ or ground in circuit 821 between radio and amplifier. Check for a poor connection at radio connector terminal “19”. If OK, replace radio. Is the repair complete?		System OK.	

COMPACT DISC PLAYER DOES NOT OPERATE PROPERLY

CHART #5

STEP	ACTION	VALUE(S)	YES	NO
	Player has no function, radio operates normally.		Go to step 1.	
	Skipping or mute complaint.		Go to step 5.	
	Displaying “FOCUS” or disc ejected.		Go to step 6.	
1	Disconnect CD connector. Turn ignition switch to run. Turn radio on. Select CD mode on radio display. Using a DVOM, check for voltage between terminals 5 and 7 in the CD connector. Is voltage present?	Approximate battery + voltage.	Go to step 3.	Go to step 2.
2	Using a DVOM, check for voltage between terminals 15 and 13 at the radio connector. Is voltage present?	Approximate battery + voltage.	Repair power and ground circuits between radio and CD changer. System OK.	Check for a poor connection at the radio. If OK, service radio.
3	Using a DVOM, check for voltage between terminal 10 and ground at the CD connector. Is voltage present?	Approximate battery + voltage.	Check for a poor connection at the CD changer. If OK, service CD changer.	Go to step 4.
4	Using a DVOM, check for voltage between terminal 14 and ground at the radio connector. Is voltage present?	Approximate battery + voltage.	Repair the power control circuit between the radio and the CD changer. System OK.	Check for a poor connection at the radio. If OK, service radio.
5	Check disc for proper insertion, scratches, dirt or finger prints and clean if necessary. Is usual route over a rough road (off road environment)? If so, condition may be normal. Attempt to duplicate on good road surface. Test with known good disc (preferably new disc). Some discs may contain marks not readily visible that may make one track or the entire disc unplayable. Check mounting angle adjustment on both sides of changer. Is angle adjusted to 22.5 degrees? If checks and adjustments do not cure problem, service changer.	22.5 degrees	Service changer.	Loosen screws and adjust mount angle to 22.5 degrees.

CHART #5 (Continued)

STEP	ACTION	VALUE(S)	YES	NO
6	"FOCUS" appears if disc is inserted upside down, dirty, badly scratched or wet. "FOCUS" appears if moisture condenses on the disc (if a cold disc is inserted into a hot player and vice versa). Allow up to an hour to evaporate condensation. Check with known good disc - verify to customer. Very high internal instrument panel temperatures may cause eject. If checks and adjustments do not cure problem, service changer.			

CASSETTE PLAYER DOES NOT OPERATE PROPERLY

CHART #6

STEP	ACTION	VALUE(S)	YES	NO
	Tape plays weak, slow or garbled.		Go to step 1.	
	Tape inoperative.		Go to step 3.	
1	Inspect and clean moving parts and tape head or use Delco Audio System Diagnostic Kit J 39916-A cleaning cassette. Does tape play OK?		Advise periodic cleaning.	Go to step 2.
2	Perform motor speed test with diagnostic test tape from Delco Audio System Diagnostic Kit J 39916-A. Is motor speed OK?		Fault is in tape. System OK.	Service radio.
3	Check player for obstruction through tape door. Is there an obstruction?		Go to step 4.	Service radio.
4	Remove obstruction. CAUTION: improper removal may damage tape player. Inspect and clean moving parts and tape head or use cleaning cassette. Use diagnostic test tape from J39916-A. Does test tape operate?		System OK.	Service radio.

ANTENNA SYSTEM TEST

CHART #7

STEP	ACTION	VALUE(S)	YES	NO
1	Disconnect negative battery cable. Disconnect antenna lead-in cable at the radio receiver. With a DVOM, measure resistance between the coax (outer conductor) connector and the negative battery cable. **NOTE:** To avoid misdiagnosis be sure to zero the meter before taking measurements. Is resistance value greater than .15 ohms?	> .15 ohms	Check the base of the antenna for a good connection to body ground. Check the coaxial cable interconnects for a poor connection or corrosion. Check the ground connection from the battery negative cable to the body. Repair the antenna ground circuit as necessary.	Go to step 2.
2	Grasp the antenna mast. While observing the DVOM, wiggle the antenna and the lead-in cable ground strap. Does the meter indicate intermittent continuity?		Check the lead-in cable ground strap for a good connection to body ground. Check the coaxial cable interconnects for a poor connection or corrosion. Check the ground connection from the battery negative cable to the body. Repair the antenna ground circuit as necessary.	Go to step 3.
3	With a DVOM, measure the resistance between the radio coax lead-in connector (center conductor) and the antenna mast. **NOTE:** To avoid misdiagnosis be sure to zero the meter before taking measurements. Does the measured resistance equal approximately the value listed?	Less than 3.5 ohms	Go to step 4.	Check the coaxial cable interconnects for a poor connection or corrosion. Repair/replace the antenna coaxial circuit as necessary.
4	While observing the DVOM, wiggle the antenna. Does the meter indicate intermittent continuity?		Check the coaxial cable interconnects for a poor connection or corrosion. Repair/replace the antenna coaxial circuit as necessary.	See troubleshooting hints for noise and poor reception.

Checking Lead-in Cables

Usually symptoms of a broken center conductor of the lead-in cable will result in no AM and weak FM. In case of continued reception or noise complaints, always check the lead-in with an ohmmeter. The following chart and diagram (Figure 12–114.18) shows readings which should be obtained.

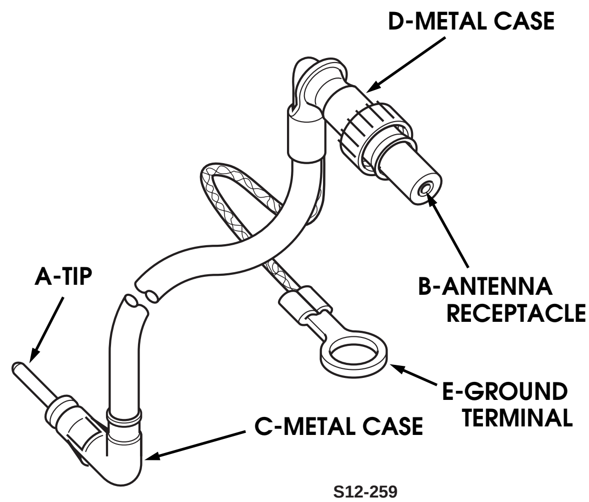

Figure 12–114.18: Lead-in cable.

Ohmmeter probes at points	Resistance measured in ohms
A and B	less than 0.2
C and D	less than 0.2
C and E	less than 0.2
A and D	infinite
C and B	infinite
A and C	infinite
B and D	infinite

When checking resistance, cautiously wiggle the lead-in tip and cable. The chart readings should always be obtained. If not, some portion of the lead-in is intermittent and the lead-in should be replaced.

Checking Antenna

The following chart and diagram (Figure 12–114.19) show ohmmeter readings which should be obtained. Before measuring the resistance of the antenna, disconnect the negative lead of the battery. For best results use a digital ohmmeter. With the ohmmeter probes fastened to each point, wiggle the mast section and antenna housing case. The appropriate readings should always be obtained. If not, replace mast or fix ground. Improperly grounded antennas are usually the cause of poor reception or noise complaints. After checking and correcting the antenna, always make sure lead-in connectors are dirt and corrosion free, and are tightly fastened.

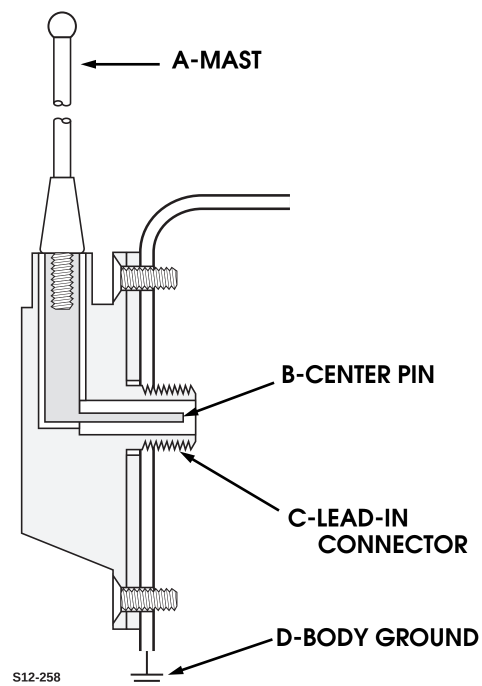

Figure 12–114.19: Antenna.

Ohmmeter probes at points	Resistance measured in ohms
A and B	less than 0.2
A and C	infinite
A and D	infinite
C and D *	less than 0.2

* With lead-in connected to lead-in connector and lead-in ground lead connected to body ground.

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POWER WINDOWS AND LOCKS CROSS BODY HARNESS REPLACEMENT

Removal

1. Remove driver's seat (Section 10).
2. Remove outer kick panels (Section 10).
3. Remove capscrew on left side of front console and two capscrews on right side of console.
4. Slide front console away from dash four inches to allow for routing of dash harness.
5. Remove gauge clusters from instrument panel but do not disconnect gauges.
6. Remove capscrews and two turnbuttons from crashpad.
7. Disconnect defroster hose from crashpad and remove crashpad.
8. Remove capscrews, washers and nuts from instrument panel and dash.
9. Disconnect dash harness from door harnesses and jumper harnesses (4-door only) (Figure 12-115).
10. Disconnect pink power wire on dash harness from yellow spare circuit wire on body harness.

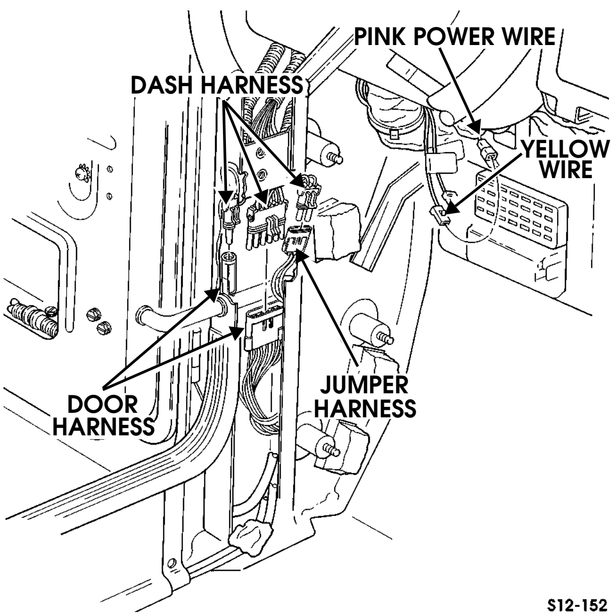


Figure 12-115: Harness Connections

11. Remove nut and washer from instrument panel ground bolt and disconnect dash harness ground wire.
12. Remove two tie straps securing dash harness to defroster hose.
13. Remove instrument panel harness.

Installation

1. Route dash harness to approximate mounting position.
2. Secure dash harness to defroster hose with two tie straps.
3. Install dash harness ground wire on instrument panel ground bolt with nut and washer.
4. Connect pink power wire on dash harness to yellow spare circuit wire on body harness.
5. Connect dash harness to door harnesses and jumper harnesses (4-door only).
6. Install instrument panel on dash with capscrews, washers, and nuts.
7. Install defroster hose in crashpad and install crashpad on instrument panel with five capscrews and two turnbuttons.
8. Install two gauge clusters in instrument panel with eight screws.
9. Install front console on mounting brackets with three capscrews.
10. Install outer kick panels (Section 10).
11. Install driver's seat (Section 10).

POWER DOOR LOCK FRONT DOOR HARNESS REPLACEMENT

Removal

NOTE: Left and right front power door lock harness replacement procedures are similar.

1. Remove front seat.
2. Remove outer kick panels.
3. Remove power door locks switch from door trim.
4. Remove front door trim.

NOTE: Vapor barrier may be positioned under velcro strip, if so, cut around velcro strip to remove vapor barrier.

5. Remove vapor barrier and moisture barrier flap from door (Figure 12-116).

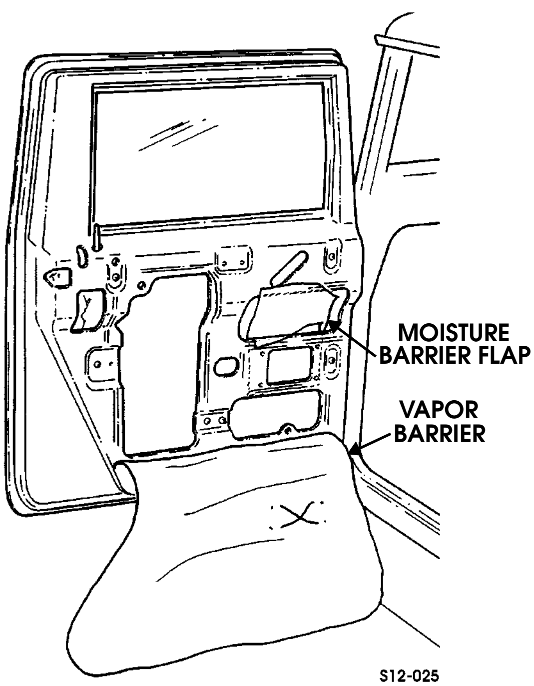


Figure 12-116: Vapor Barrier

6. Remove capscrew and clamp securing door harness to door reinforcement.
7. Remove capscrew, nut and lockwasher assembly, and P-clamp securing door harness to A-pillar.
8. Disconnect one-lead and six-lead connectors. Remove door harness wires from connectors with extraction tool.

NOTE: Lubricate bushings, grommet, and door harness teflon cover with silicone spray.

9. Pull harness through A-pillar rubber grommet.
10. Remove and inspect A-pillar rubber grommet. Discard if damaged.
11. Remove two capscrews and support bracket from inner door.
12. Pull harness through door bushing. Inspect door bushing. Replace if damaged.
13. Pull support bracket from harness. Inspect support bracket bushing. Replace if damaged.
14. Disconnect harness connector from actuator.
15. Disconnect clip from door reinforcement and remove from door harness.
16. Remove tie strap securing door harness to access hole and remove harness. Discard tie strap.

Installation

1. Install harness in support bracket.
2. Install harness through door bushing and support bracket. Install support bracket on inner door with two capscrews.
3. Install rubber grommet in A-pillar.
4. Install harness through grommet until yellow tape touches A-pillar front.
5. Install six-lead and one-lead connectors to door harness leads, matching colors to dash harness. Connect door harness to dash harness.
6. Install P-clamp and door harness on A-pillar with capscrew and nut and lockwasher assembly.
7. Install clamp and door harness at yellow tape area with capscrew.
8. Install clip on door harness and connect harness to actuator. Install clip in door reinforcement. Tighten power window motor mounting screws, if loose.
9. Lower window.
10. Route lock switch lead up through lower access hole between support bracket and window channel. Secure at top access hole with tie strap (left front door only).

NOTE: Vapor barrier must be completely sealed at all edges to prevent water entry into the interior of the vehicle.

11. Route lock switch lead through vapor barrier and moisture barrier flap and install moisture barrier and vapor barrier flap on door.
12. Install front door trim.
13. Install power door locks switch.
14. Install outer kick panels.
15. Install front seat.

POWER DOOR LOCK REAR DOOR AND JUMPER HARNESS REPLACEMENT

Removal

NOTE: Left and right rear power door locks harness replacement procedures are identical.

1. Remove front seat.
2. Remove trim from B-beam and B-pillar (Section 10).
3. Remove side trim and outer kick panel (Section 10).
4. Remove rear door trim (Section 10).

NOTE: Vapor barrier may be positioned under velcro strip If so, cut around velcro strip to remove vapor barrier.

5. Remove vapor barrier and moisture barrier flap.
6. Remove capscrew and clamp securing rear door harness to door reinforcement.
7. Disconnect rear door harness from jumper harness.
8. Remove convoluted tubing from rear door harness.
9. Remove two-lead connector from rear door harness with pin extraction tool.
10. Remove capscrew, washer, nut and lockwasher assembly, and P-clamp from rear door harness and B-pillar.
11. Pull harness through rubber grommet in B-pillar.
12. Remove and inspect grommet. Discard if damaged.
13. Remove two capscrews and support bracket from rear door.
14. Pull harness through door bushing and remove support bracket from harness. Inspect support bracket bushing. Replace if damaged.
15. Inspect bushing in rear door. Replace if damaged.
16. Disconnect door harness connector from actuator lead.
17. Disconnect clip from door reinforcement and remove from rear door harness.
18. Remove rear harness from door.
19. Disconnect jumper harness from dash harness at A-pillar. Remove tie straps and jumper harness (Figure 12-117).

Installation

NOTE: Lubricate bushings, rubber grommet, and door harness teflon cover with silicone spray.

1. Secure jumper harness to existing harness along side panel with tie straps. Connect jumper harness to dash harness at A-pillar (Figure 12-117).

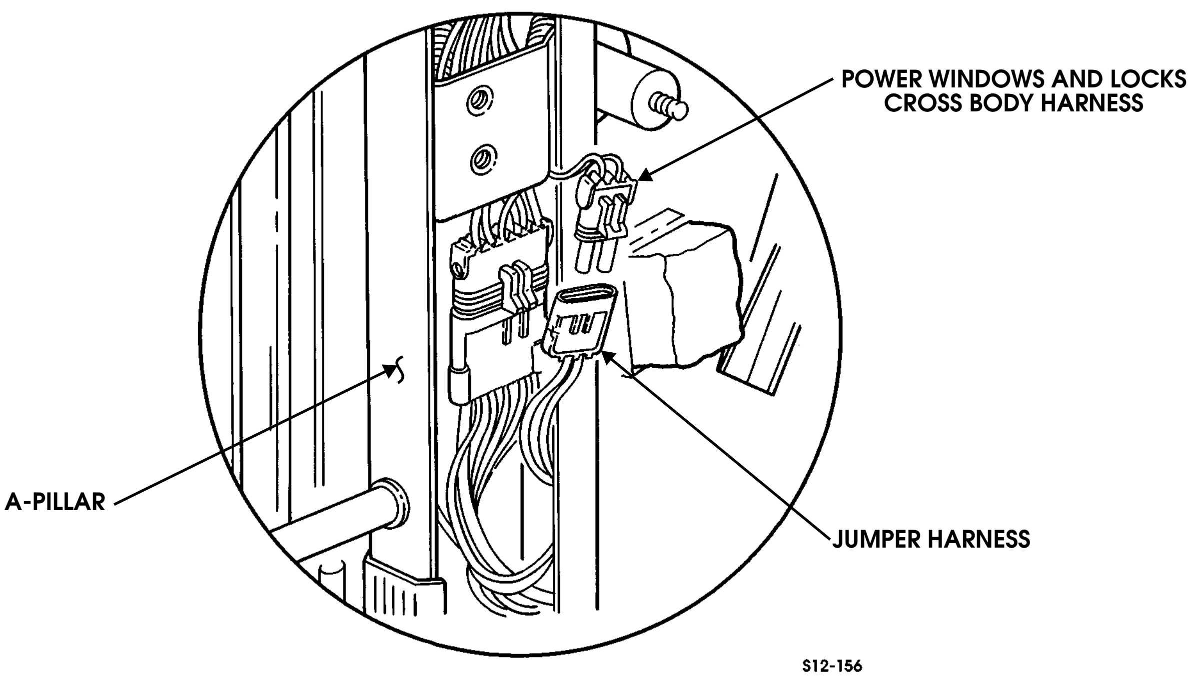


Figure 12-117: Door Harness Connection

2. Install clip and support bracket on rear door harness (Figure 12-118).
3. Install harness in door bushing.
4. Install support bracket in rear door with two capscrews.
5. Install rubber grommet in B-pillar.
6. Install harness through grommet until yellow tape touches the back of B-pillar.
7. Install P-clamp on harness at yellow tape and B-pillar with capscrew, washer and lockwasher and nut assembly.
8. Install two-lead connector on rear door harness, matching wire colors to jumper harness. Connect harness to jumper harness.
9. Route rear door harness along bottom of rear door. Secure harness to door reinforcement with clip.
10. Attach door harness connector to actuator. Tighten power window motor mounting screws, if loose.
11. Install convoluted tubing on rear door harness wires and secure with black electrical tape.
12. Install P-clamp on rear door harness at yellow tape area and secure to door reinforcement with one capscrew.
13. Install vapor barrier and moisture barrier flap.
14. Install rear door trim (Section 10).
15. Install side trim and outer kick panel (Section 10).
16. Install trim on B-pillar and B-beam (Section 10).
17. Install front seat (Section 10).

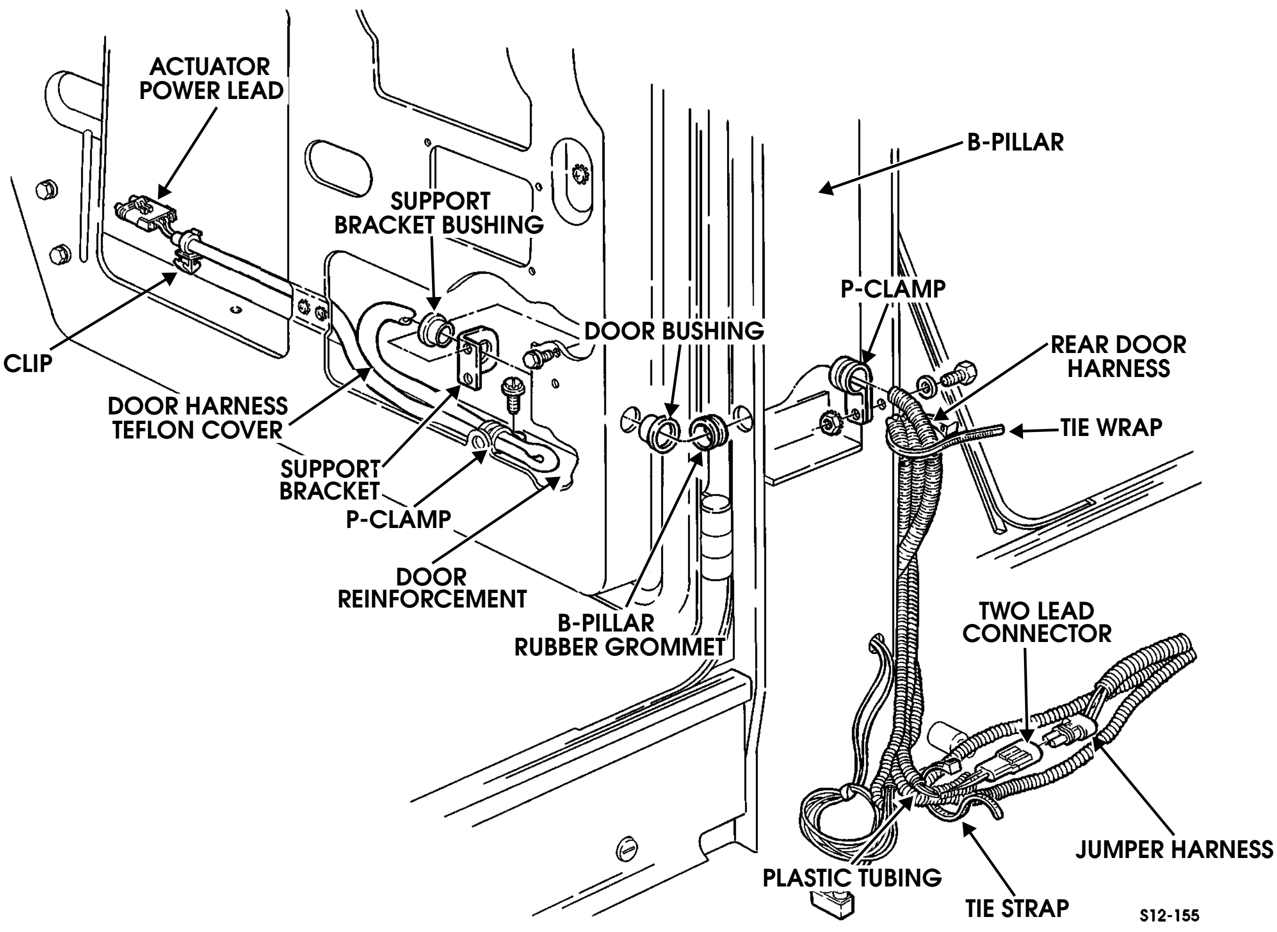


Figure 12-118: Door Harness Routing

REMOTE ENTRY HARNESS REPLACEMENT

Removal

NOTE: NOTE: Tag all harnesses for installation reference.

1. Remove screw from left side and two screws from right side of front console.
2. Slide front console four inches toward rear of vehicle to allow access to dash harness.
3. Disconnect two dash harness connectors from remote entry harness connectors.
4. Disconnect remote entry harness connector from remote entry receiver.
5. Cut tie wraps as required and remove remote entry harness and remote entry receiver from vehicle.

Installation

1. Install remote entry receiver on velcro strips.
2. Connect remote entry harness connector at remote entry receiver (Figure 12-120).
3. Connect two dash harness connectors to remote entry harness connectors.
4. Secure remote entry harness to body and dash harness with tie straps as required.
5. Slide front console forward to dash.
6. Install front console with two screws on right side and one screw on left side.

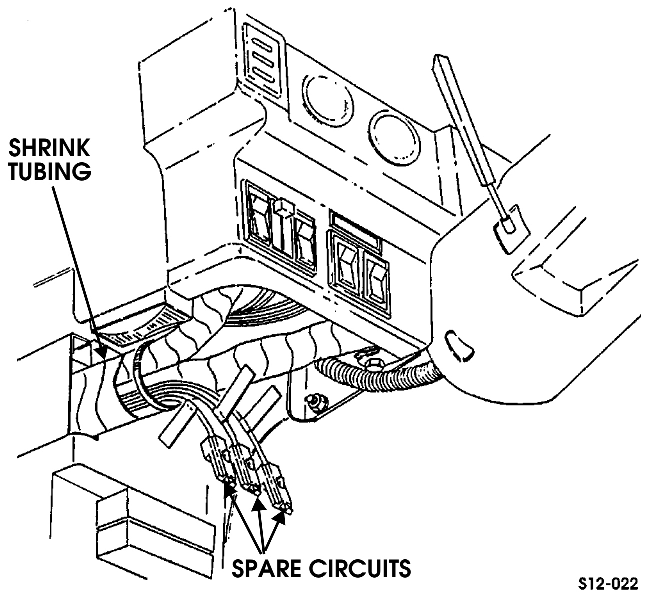


Figure 12-120: Spare Wires Location

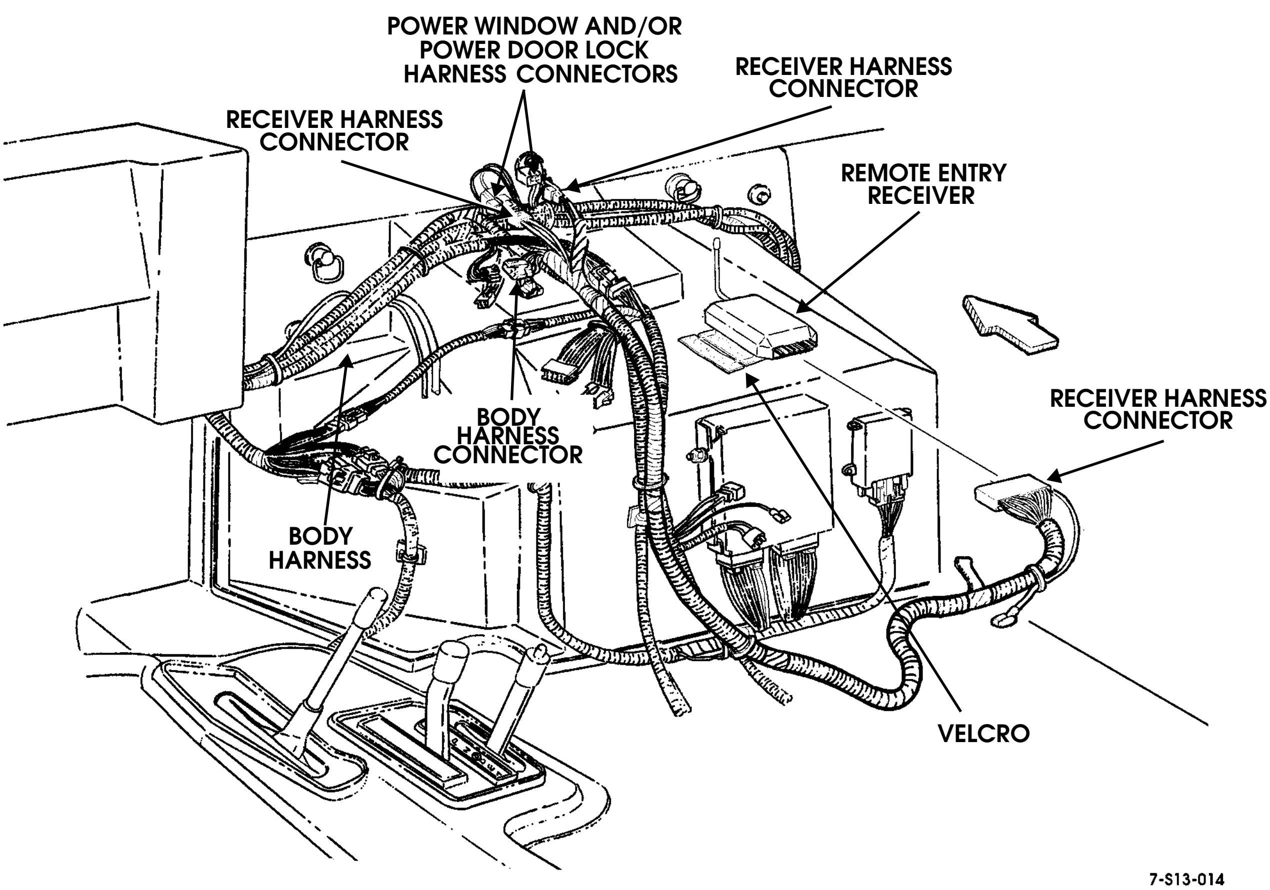


Figure 12-119: Receiver Harness

AUXILIARY AIR-CONDITIONING AND HEATING JUMPER HARNESS REPLACEMENT

NOTE: Tag leads for installation.

Removal

1. Remove auxiliary air-conditioning and heating fan switch.
2. Remove front console enough to gain access to leads.
3. Disconnect jumper harness connector from auxiliary unit blower motor connector.
4. Disconnect jumper harness purple, black, and red connectors from air-conditioning wiring harness connectors.

Installation

1. Connect jumper harness purple, black, and red connectors to air-conditioning wiring harness connectors.
2. Connect jumper harness connector to auxiliary unit blower motor connector.
3. Install front console.
4. Install auxiliary air-conditioning and heating fan switch.

FUSIBLE LINK MAINTENANCE

The following procedure covers the replacement of fusible links encountered through circuit diagnosis.

1. Disconnect battery ground cable.
2. Carefully remove old fusible link from termination (alternator, power stud, starter).
3. Locate original wiring harness splice between fusible link and wiring harness (Figure 12-121).
4. Cut fusible link splice on harness side. Do not splice into original fusible link; this may be weakened and cause a premature failure and repeat problem.
5. Identify the original fuse link size and length of fuse link cut from vehicle.
6. Matching the wire size, cut a length of fusible link wire to the total length cut from vehicle in Step 4. Be sure to compensate for any harness wire removed with original wire. This will avoid overtight wiring that may become separated with normal operation.
7. Install a new crimp on connector of the same type and size as the original lug or connector. Seal connection with low temperature heat shrink tubing.
8. Place a piece of heat shrink tubing onto the wire and install a butt connector onto the fusible link.
9. Install the fusible link by connecting it to the wiring harness with the butt connector and heat shrink tubing.
10. Connect terminal end to original location, alternator, power stud, or starter. Reconnect battery ground cable and check circuit(s) affected for proper operation.

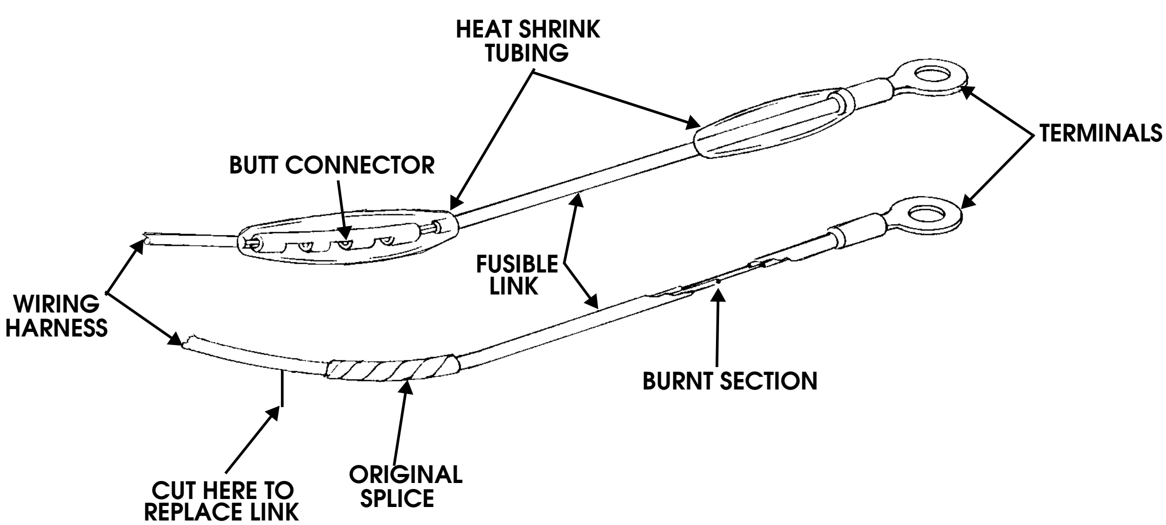


Figure 12-121: Fusible Link

IGNITION SWITCH REPLACEMENT

Removal

1. Remove steering column covers.
2. Remove multi switch.
3. Remove screw and interlock cable from ignition switch (Figure 12-122).
4. Remove two capscrews and ignition switch from steering column.

Installation

1. Apply thread-locking compound to capscrew threads and install ignition switch on steering column with two capscrews.
2. Install interlock cable on ignition switch with screw.
3. Install multi switch.
4. Install steering column covers.
5. Ensure ignition switch operates properly.

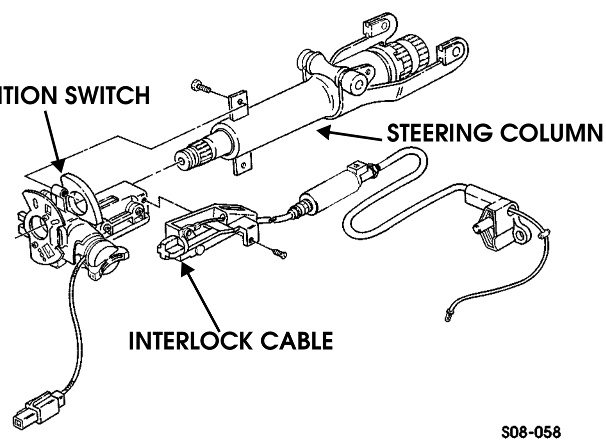


Figure 12-122: Ignition Switch

Power Window and Door Locks Front Door Harness Replacement

Removal

1. Remove front outer kick panels (Section 10).
2. Remove power window and door lock switches from door.
3. Remove front door trim, vapor barrier, and moisture barrier flap from door (Section 10).

NOTE: Tag leads for installation.

4. Disconnect 4-way and 6-way harness connectors from power windows and door locks body harness connectors (Figure 12-123).

NOTE: Perform step 6 for vehicles equipped with power mirrors.

5. Disconnect two harness connectors from power mirrors body harness connectors.
6. Remove screw, nut and lockwasher assembly, and clamp securing harness to A-pillar. Discard nut and lockwasher assembly
7. Remove harness wires from 4-way and 6-way connectors.

NOTE: Lubricate bushings, grommet, and harness teflon cover with silicone spray.

8. Pull harness through A-pillar rubber grommet.
9. Remove and inspect A-pillar rubber grommet. Replace if damaged.

NOTE: Perform step 11 for vehicles equipped with power mirrors.

10. Disconnect two harness connectors from power mirrors door jumper harness connectors (Figure 12-126).

11. Remove self-tapping screw and clamp securing harness to door reinforcement (Figure 12-125).
12. Remove two self-tapping screws and harness mounting bracket from door assembly.
13. Pull harness through door bushing.
14. Inspect door bushing and replace if damaged.
15. Remove harness mounting bracket and mounting bracket bushing from harness. Inspect bushing and replace if damaged.
16. Disconnect harness connector from power window regulator (push locking tab up on bottom of connector).
17. Disconnect harness connector from power door locks actuator.
18. Remove retainer and harness from door assembly.

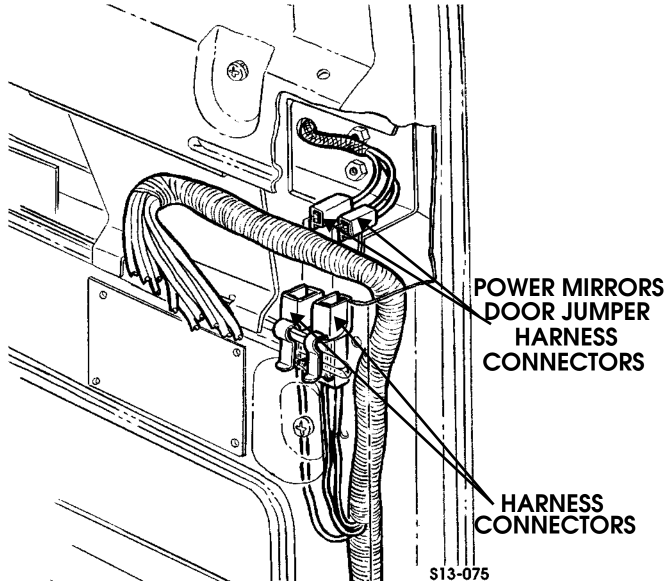


Figure 12-124: Power Mirrors Door Jumper Harness

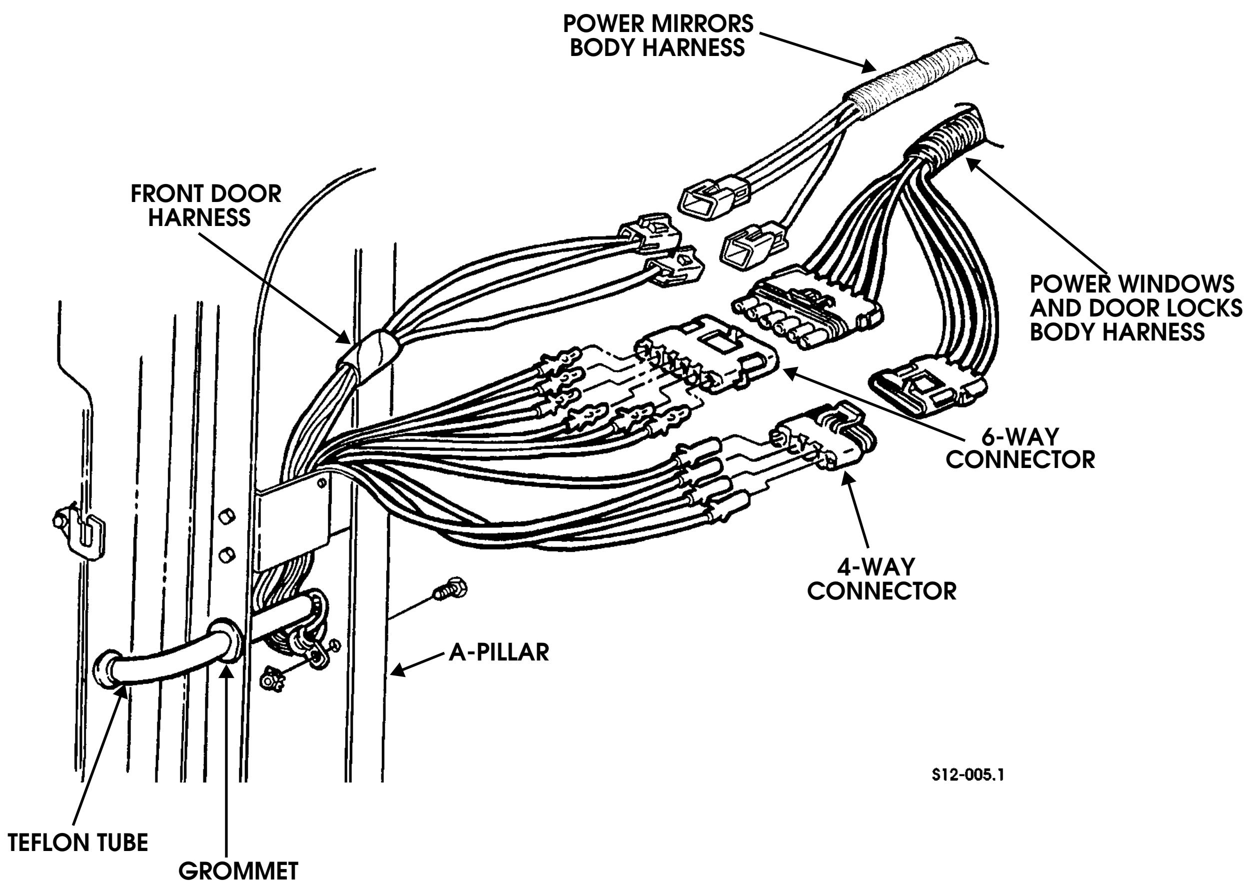


Figure 12-123: Power Windows and Door Locks Harness

Installation

NOTE: Lubricate bushing, grommet, and harness teflon cover with silicone spray.

1. Route harness through harness mounting bracket, mounting bracket bushing, and door bushing (Figure 12-126).
2. Install harness mounting bracket on door assembly with two self-tapping screws (Figure 12-125).
3. Route harness through A-pillar rubber grommet (Figure 12-127).

NOTE: When connecting harness wires to 4-way and 6-way connectors, ensure wire colors align with mating connector wires.

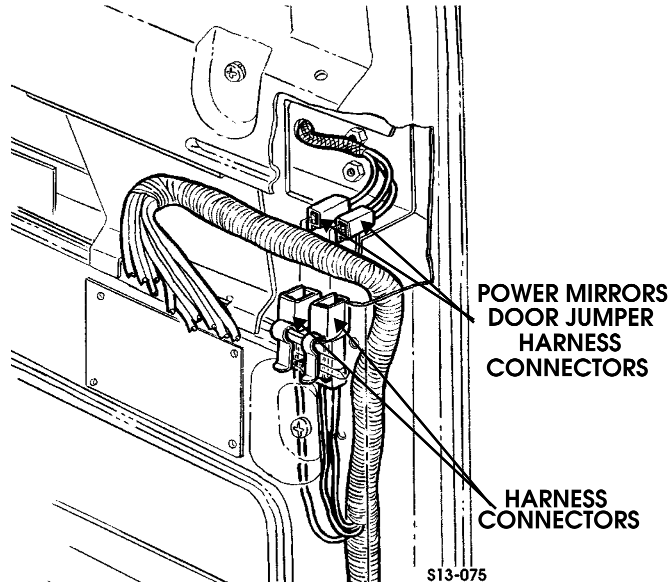


Figure 12-126: Power Mirrors Door Jumper Harness

4. Connect harness wires to 4-way and 6-way connectors.
5. Connect 4-way and 6-way harness connectors to power windows and door locks body harness connectors.

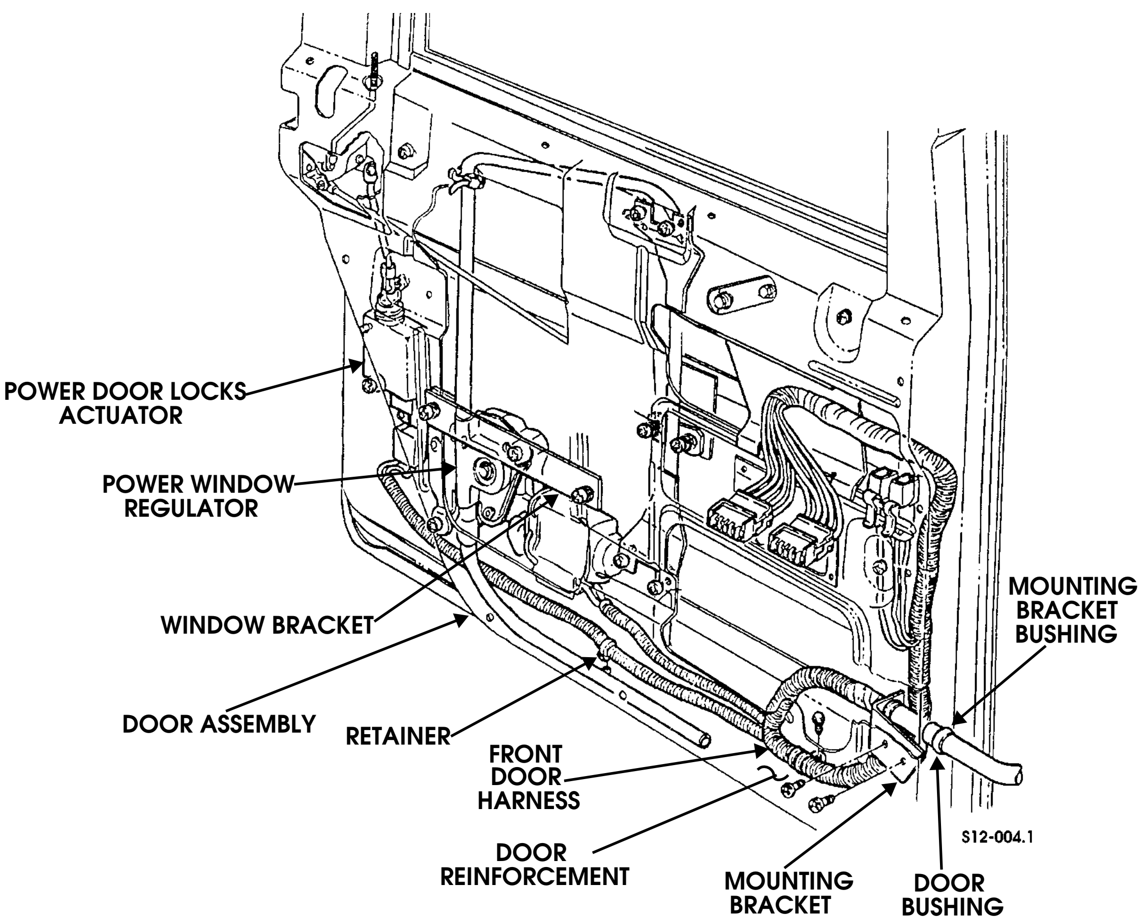


Figure 12-125: Power Windows and Door Locks Harness

NOTE: Perform step 6 for vehicles equipped with power mirrors.

6. Connect two harness connectors to power mirrors body harness connectors.
7. Secure harness to A-pillar with clamp, self-tapping screw, and nut and lockwasher assembly.

NOTE: Perform step 8 for vehicles equipped with power mirrors.

NOTE: Be careful to match the wire colors, since the harness connectors can be interchanged.

8. Connect two harness connectors to power mirrors door jumper harness connectors (Figure 12-127).
9. Connect harness connector to power window regulator (Figure 12-125).
10. Connect harness connector to power door lock actuator.
11. Secure harness to door reinforcement with clamp and self-tapping screw.
12. Secure harness to door assembly with retainer.
13. Install moisture barrier flap, vapor barrier, and door trim panel on door (Section 10).
14. Install power window and door lock switches on door.
15. Install front outer kick panels (Section 10).
16. Connect battery ground cable (Section 12).
17. Check power windows and door locks for proper operation.

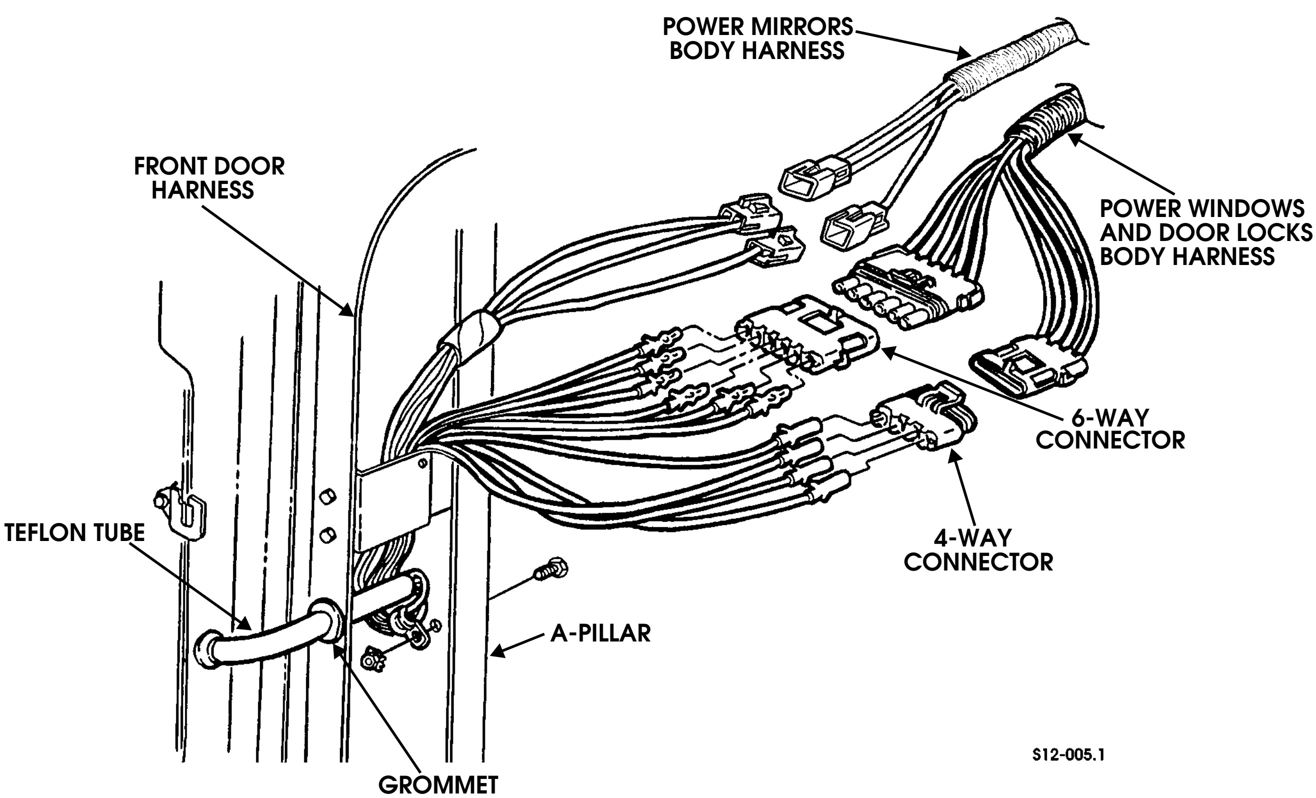


Figure 12-127: Power Windows and Door Locks Harness

Power Windows and Door Locks Rear Door Harness Replacement

Removal

1. Remove center outer kick panel and lower B-pillar trim (Section 10).
2. Remove power windows switch from door.
3. Remove rear door trim, vapor barrier, and moisture barrier flap from door (Section 10).

NOTE: Tag leads for installation.

4. Disconnect 6-way harness connector from power windows and door locks rear door jumper harness connector (Figure 12-128).

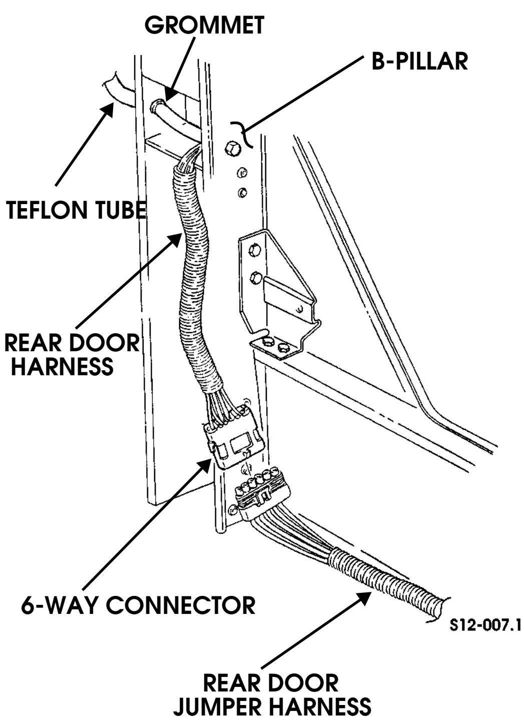


Figure 12-128: Rear Door Harness and Rear Door Jumper Harness

5. Remove harness wires from 6-way connector.
6. Remove screw, nut and lockwasher assembly, and clamp securing harness to B-pillar. Discard nut and lockwasher assembly.

NOTE: Lubricate bushings, grommet, and harness teflon cover with silicone spray.

7. Pull harness through B-pillar rubber grommet.
8. Remove and inspect B-pillar rubber grommet. Replace if damaged.
9. Remove two self-tapping screws and harness mounting bracket from door assembly (Figure 12-129).
10. Pull harness through door bushing.
11. Inspect door bushing and replace if damaged.
12. Remove harness mounting bracket and mounting bracket bushing from harness. Inspect bushing and replace if damaged.
13. Remove self-tapping screw and clamp securing harness to door reinforcement.
14. Disconnect harness connector from power window regulator (push locking tab up on bottom of connector).
15. Disconnect harness connector from power door lock actuator.
16. Remove retainer securing harness to door assembly.
17. Remove tie strap and harness from door assembly. Discard tie strap.

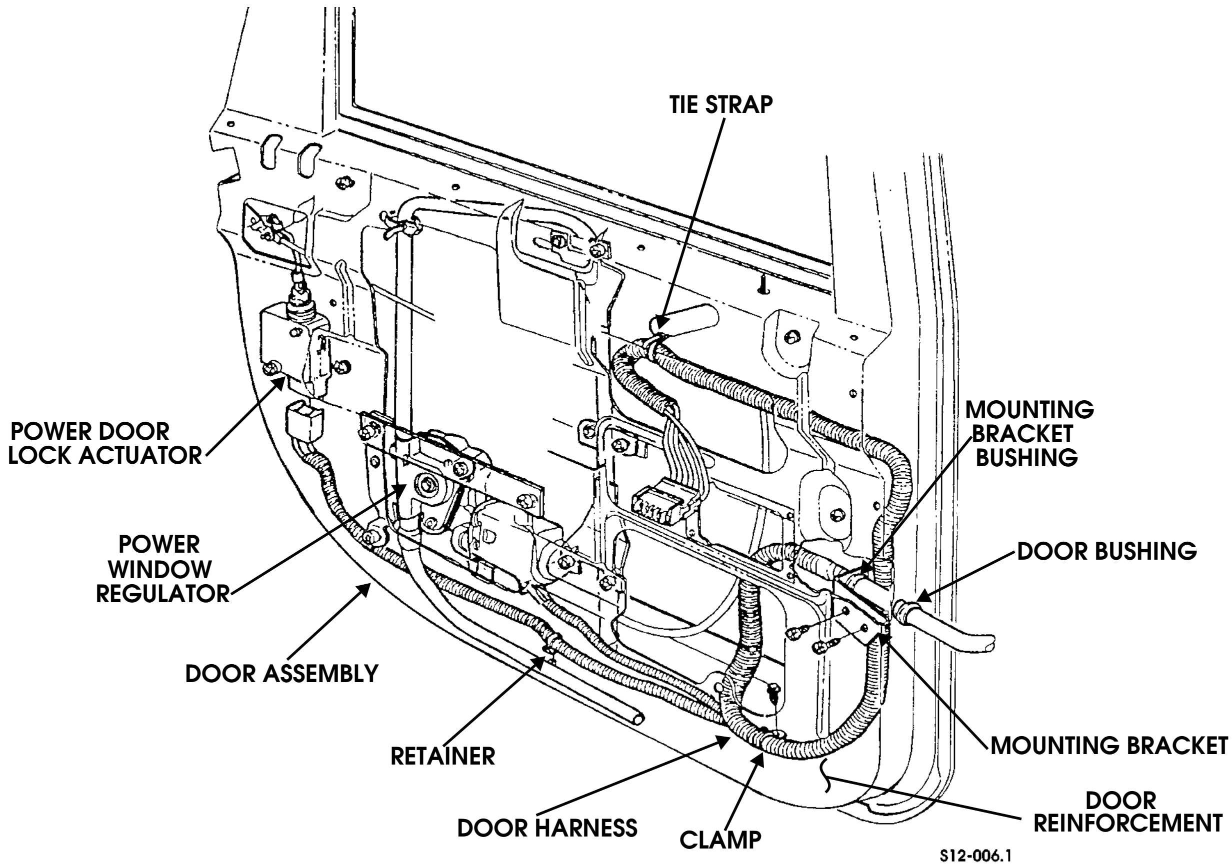


Figure 12-129: Rear Door Harness

Installation

NOTE: Lubricate bushings, grommet, and harness teflon cover with silicone spray.

1. Route harness through harness mounting bracket, mounting bracket bushing, and door bushing (Figure 12-129).
2. Install harness mounting bracket on door assembly with two self-tapping screws
3. Route harness through B-pillar rubber grommet (Figure 12-130).

NOTE: When connecting harness wires to 6-way connector, ensure wire colors align with mating connector wires.

4. Connect harness wires to 6-way connector.
5. Connect 6-way harness connector to power windows and door locks rear door jumper harness connector.
6. Secure harness to B-pillar with clamp, screw, and nut and lockwasher assembly.

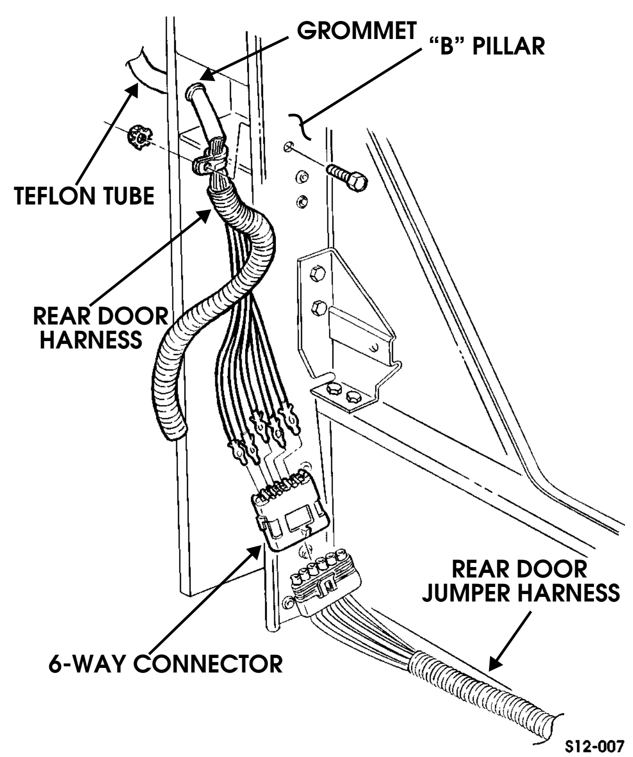


Figure 12-130: Rear Door Harness and Rear Door Jumper Harness

7. Connect harness connector to power window regulator (Figure 12-129).
8. Connect harness connector to power door lock actuator.
9. Secure harness to door reinforcement with clamp and self-tapping screw.
10. Secure harness to door assembly with retainer.
11. Secure harness to door assembly with tie strap.
12. Install moisture barrier flap, vapor barrier, and door trim panel on door (Section 10).
13. Install power windows switch on door.
14. Install lower B-pillar trim and center kick panel (Section 10).
15. Connect battery ground cable (Section 12).
16. Check power windows and door locks for proper operation.

Power Windows and Door Locks Rear Door Jumper Harness Replacement

Removal

1. Remove front and center outer kick panels and lower B-pillar trim (Section 10).
2. Disconnect jumper harness connector from power windows and door locks body harness connector (Figure 12-131).

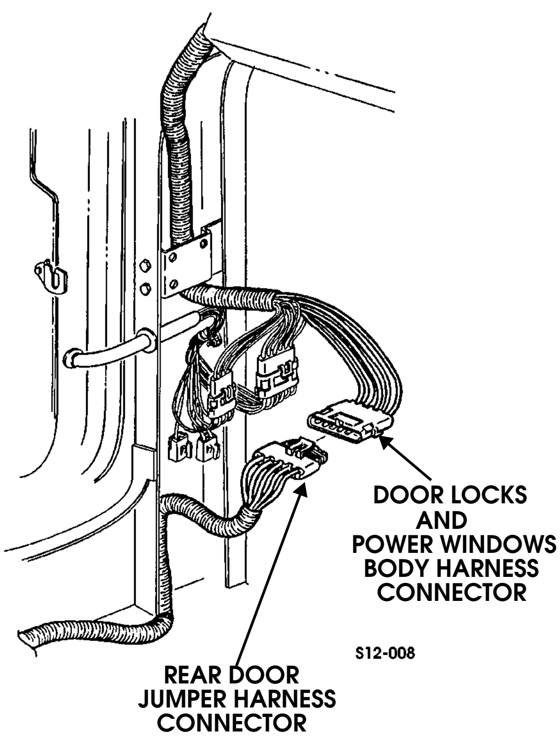


Figure 12-131: Power Windows and Door Locks Body Harness and Rear Door Jumper Harness

3. Disconnect jumper harness connector from power windows and door locks rear door harness connector (Figure 12-132).

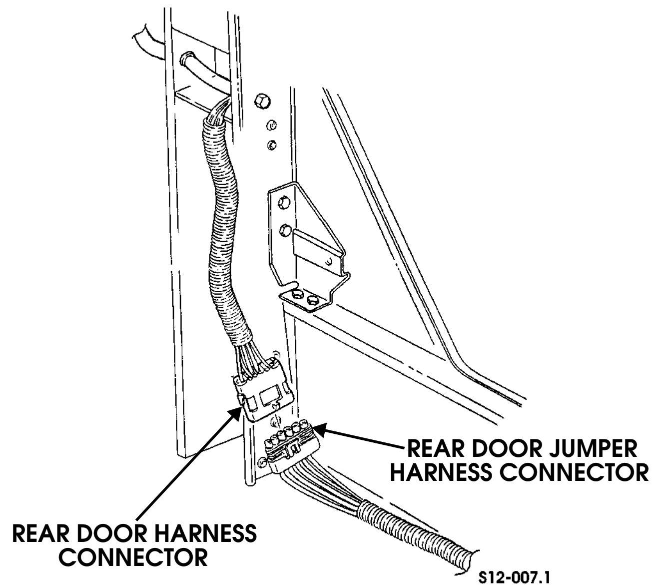


Figure 12-132: Power Windows and Door Locks Rear Door Harness and Rear Door Jumper Harness

Installation

1. Connect jumper harness connector to power windows and door locks rear door harness connector (Figure 12-132).
2. Connect jumper harness connector to power windows and door locks body harness connector (Figure 12-131).
3. Install lower “B” pillar trim and front and center outer kick panels (Section 10).

Power Windows and Door Locks Harness Replacement

Removal

1. Remove crash pad (Section 10).
2. Remove front outer kick panels (Section 10).
3. Remove engine access cover (Section 10).
4. Remove eight screws and two gauge panels from instrument panel (Section 12).
5. Remove power windows and lock switch from instrument panel.

NOTE: Tag leads for installation.

NOTE: Perform step 7 for vehicles equipped with remote entry.

6. Disconnect two power windows and door locks harness connectors from receiver harness connectors (Figure 12-133).

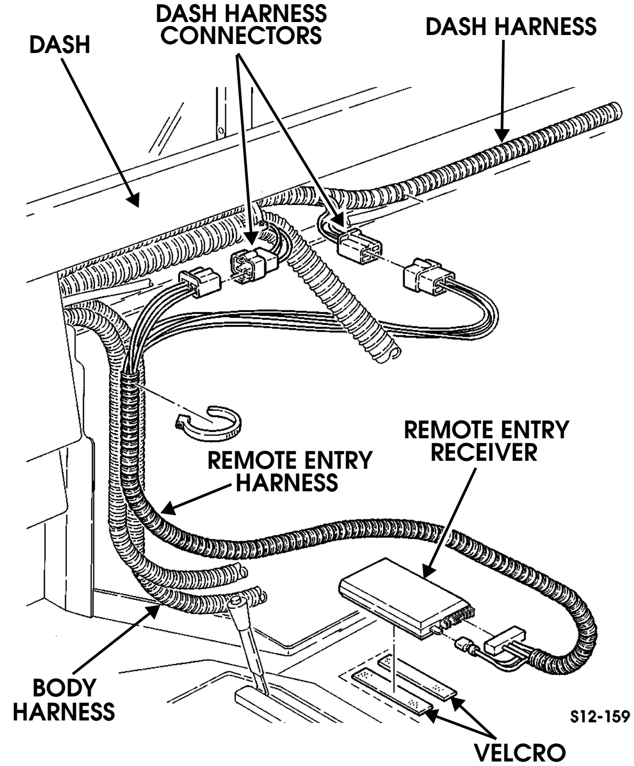


Figure 12-133: Receiver harness

7. Disconnect two harness leads from vehicle body harness power leads (Figure 12-134).

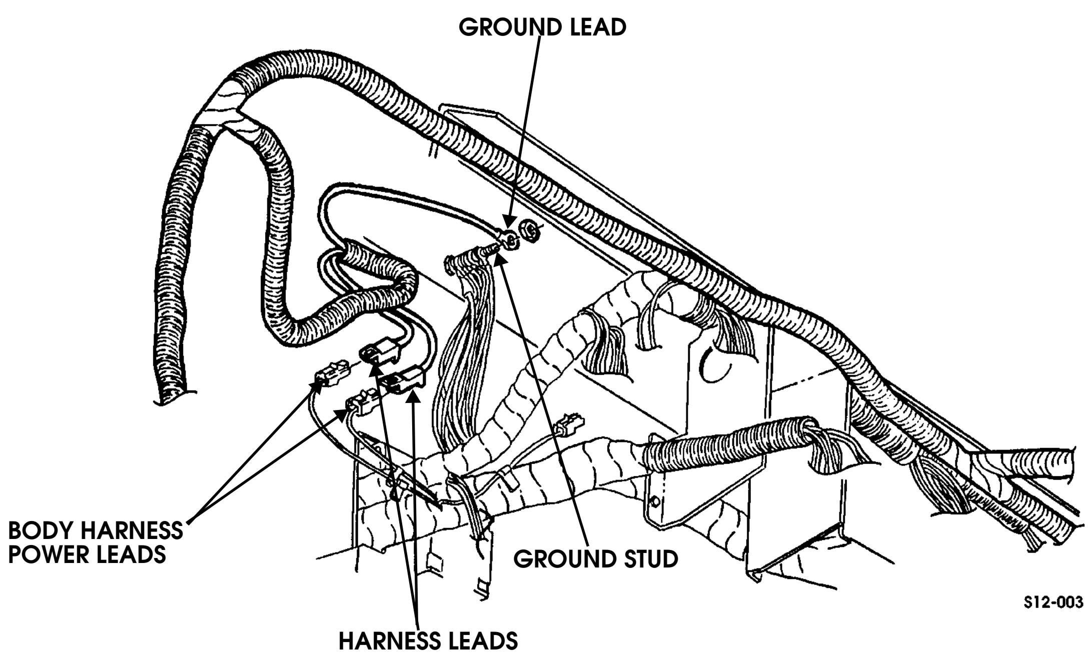


Figure 12-134: Power Windows and Door Locks Body Harness

8. Remove nut and ground lead from ground stud.
9. Disconnect two harness connectors from door harness connectors (Figure 12-135).
10. Repeat step 10 for opposite side.

NOTE: Perform steps 12 and 13 for 4-door vehicles.

11. Disconnect harness connector from rear door jumper harness connector (Figure 12-135).
12. Repeat step 12 for opposite side.
13. Remove seven tie straps securing harness to vehicle body harness and remove harness. Discard tie straps (Figure 12-133).

Installation

1. Route harness through instrument panel and along A- pillar to both sides of vehicle.

NOTE: Perform steps 2 and 3 for 4-door vehicles.

2. Connect harness connector to rear door jumper harness connector (Figure 12-135).
3. Repeat step 2 for opposite side.
4. Connect two harness connectors to door harness connectors.
5. Repeat step 4 for opposite side.
6. Install ground lead on ground stud with nut (Figure 12-134).
7. Connect two harness leads to vehicle body harness power leads.

NOTE: Perform step 8 for vehicles equipped with remote entry.

8. Connect two power windows and door locks harness connectors to receiver harness connectors (Figure 12-133).
9. Secure harness to vehicle body harness with seven tie straps.
10. Install power windows and lock switch on instrument panel.
11. Install two gauge panels on instrument panel with eight screws (Section 12).
12. Install engine access cover (Section 10).
13. Install front outer kick panels (Section 10).
14. Install crash pad (Section 10).
15. Check power windows and door lock for proper operation.

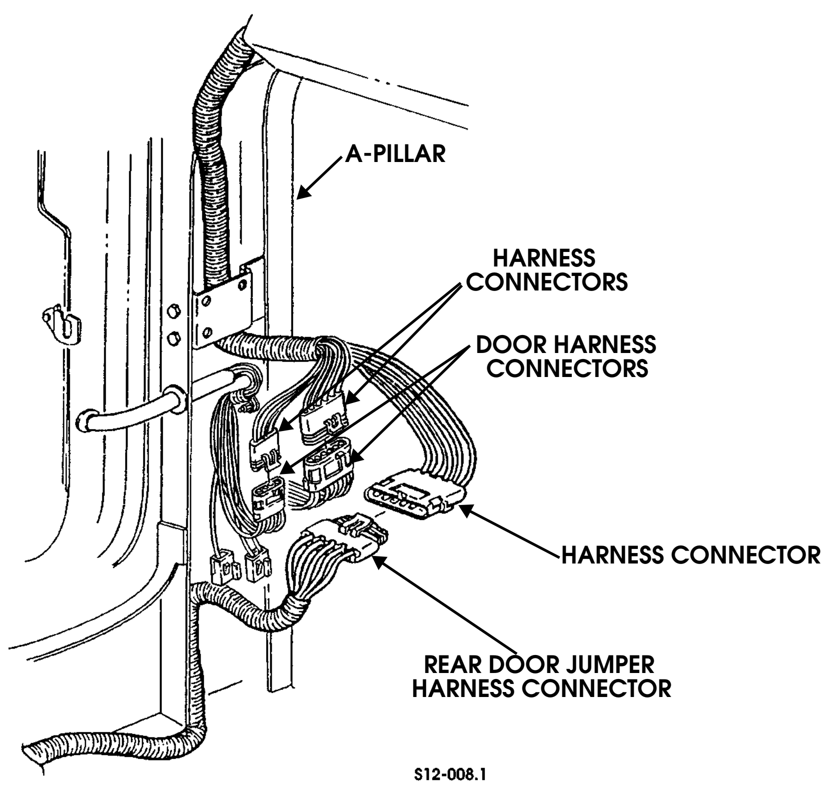


Figure 12-135: Door Harness Connectors

OVERSPEED WARNING HARNESS REPLACEMENT

Removal

1. Disconnect overspeed warning harness lead from control harness connector (Figure 12-136).
2. Remove two cable ties securing overspeed warning harness lead to body harness.
3. Remove connector from overspeed warning module (Figure 12-137).
4. Disconnect overspeed warning harness connector from overspeed alarm connector (Figure 12-138).
5. Disconnect overspeed warning harness connector from the from spare body harness connector.
6. Remove nut securing ground lead to ground stud.
7. Remove overspeed warning harness from vehicle.

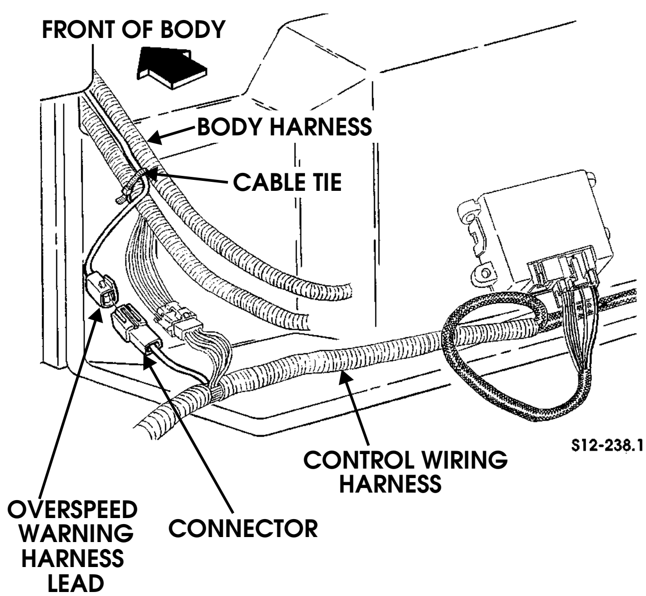


Figure 12-136: Overspeed Warning Harness Lead

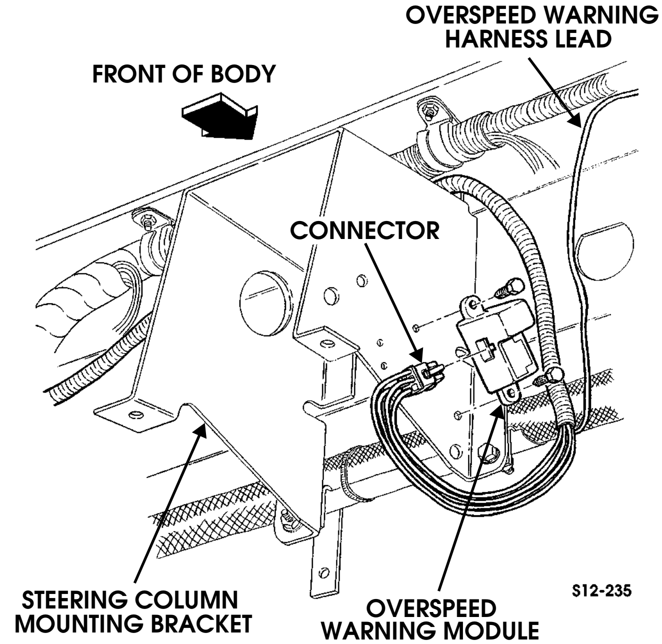


Figure 12-137: Overspeed Warning Module

Installation

1. Attach ground lead to ground stud with nut (Figure 12-138).

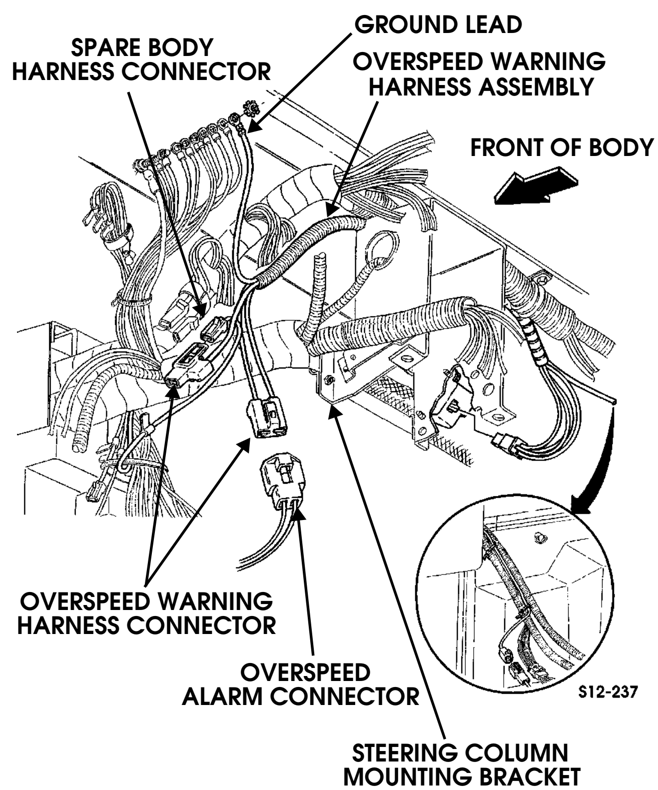


Figure 12-138: Overspeed Warning Harness Connectors

2. Connect overspeed warning harness connector to spare body harness connector.
3. Connect overspeed warning harness connector to overspeed alarm connector.
4. Install connector to overspeed warning module (Figure 12-137).
5. Secure overspeed warning harness lead to the body harness with two cable ties (Figure 12-136).
6. Connect overspeed warning harness lead to engine harness connector.

OVERSPEED WARNING MODULE REPLACEMENT

Removal

Remove velcro and overspeed warning module from steering column mounting bracket (Figure 12-137).

Installation

Install overspeed warning module to steering column mounting bracket with velcro (Figure 12-137).

OVERSPEED WARNING ALARM REPLACEMENT

Removal

1. Disconnect overspeed warning alarm connector from overspeed warning alarm harness connector (Figure 12-139).
2. Remove two nut and lockwasher assemblies, washers and bolts securing overspeed warning alarm to instrument panel.

Installation

1. Install overspeed warning alarm to the instrument panel with two nut and lockwashers assemblies, washers and bolts (Figure 12-139).
2. Connect the overspeed alarm connector to the overspeed warning alarm harness connector.

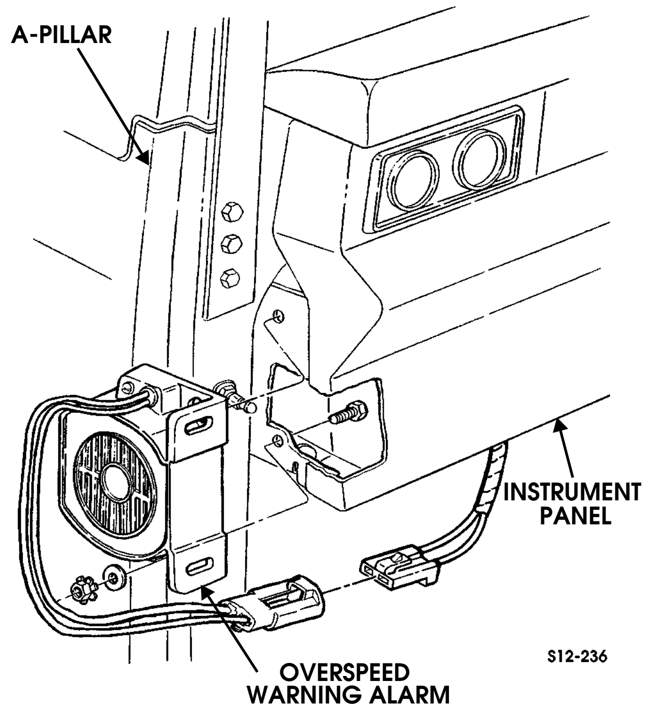
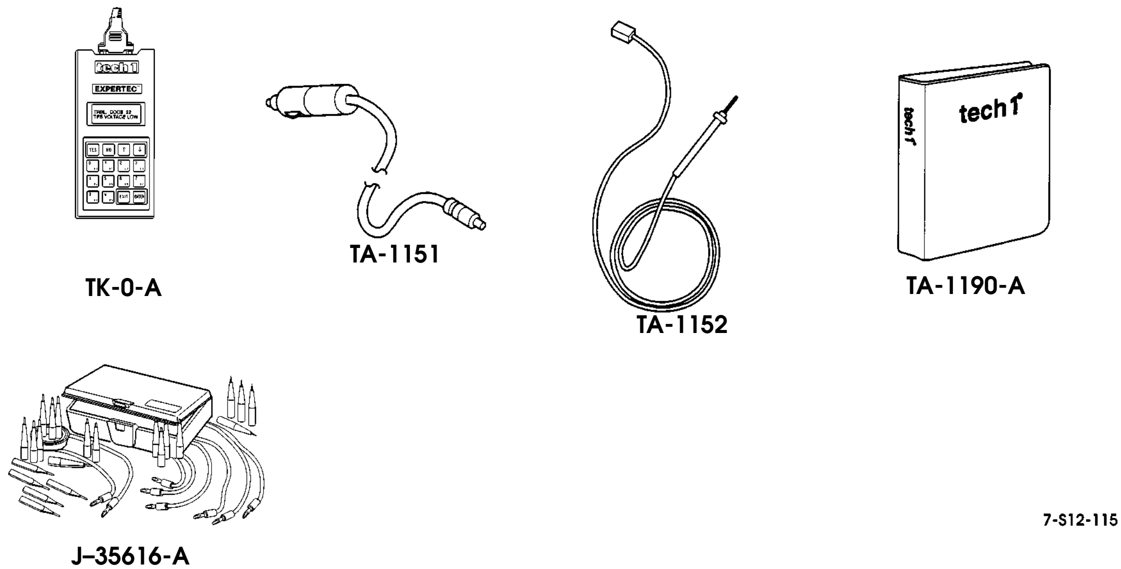


Figure 12-139: Overspeed Warning Alarm

ESSENTIAL TOOLS



Tool No.	Description
TK-0-A	Tech 1 Diagnostic Scanner Kit
TA-1151	Tech 1 Adapter, part of TK-0-A
TA-1152	Tech 1 Test Lead, part of TK-0-A
TA-1190-A	Operators Manual, Tech 1, part of TK-0-A
J–35616-A	Connector Test Adapter Set
J–42538-B	Fuel & Temperature Gauge Tester (not shown)
J–42541	Crimper, 4 pt., field grade, (not shown)
J–42645-A	HUMMER Mass Storage Cartridge (not shown)
J–43160	Tech 1 DC Power Cable (not shown)
7000041	Vehicle Interface Module (VIM) (not shown)

Procure from Kent-Moore.

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TROUBLESHOOTING
TABLE OF CONTENTS

DIAGNOSTICS

Preliminary Checks

The diagnostics in this section are designed to find problems that are not obvious. Before starting any formal diagnostic chart, preliminary checks must be performed. Preliminary checks should include:

- Visual inspection of all components
- Inspection of any fuses related to the system
- Connector inspection
- Inspection of electrical harnesses
- Charging system and batteries

These types of checks are not included in the diagnostic chart. In fact, most of the charts rely on the fact that you, the technician has performed these initial inspections.

Diagnostic Strategy

Whenever a vehicle is being diagnosed for a problem, a strategy should be used. The following charts are strategy based, meaning they all follow the principle of starting simple and working step by step to more complex tests. This allows prolems which may be small in nature to be found quickly, and not overlooked. NEVER skip steps in a diagnostic chart. Each step relies on a previous step for correct diagnosis. Avoid random diagnostics and parts replacement which can lead to long, expensive diagnostic times and may not reveal the problem.

Intermittent Failures

ALL of the charts in this section are for use on current failures. Do not attempt to use these charts to diagnose a problem unless you are sure the problem currently exists. If the problem is intermittent, parts will be unnecessarily replaced, or no problem will be found.

Troubleshooting (General)

Because of its complexity, the electrical system is divided into the following functional systems for troubleshooting:

- Battery
- Starting system
- Fuel system
- Brake system
- Windshield wiper and washer system
- Transmission system
- Indicators, gauges, and warning system
- Lighting system
  - Front
  - Rear
  - Cab
- Trailer connection system
- Heat and air conditioning system
- Winch
- Power door locks
- Power mirrors
- Power windows

The wiring schematics provided with this manual, foldouts 1 through 12, show the interrelationship of all electrical systems and should be used when performing electrical troubleshooting.

BASIC ELECTRICAL CIRCUITS

WARNING: When removing battery cables, disconnect ground cable first. Ensure all switches are off before disconnecting battery ground cable

General

An electrical circuit is a number of electrical devices which are connected in a loop from a positive voltage source (battery positive) to a negative ground source.

Parallel Circuits

The Hummer electrical system is a parallel circuit. In a parallel circuit, the electrical devices form more than one current path to and from the power supply. The supply voltage is the same in each path.

Circuit Components

A normal circuit path starts at the power supply (battery system or alternator). Next in line is the circuit protection: fusible link, fuse, or circuit breaker. The circuit load, such as lights, motors, or solenoid scompletes the circuit to the ground system.

Circuit protection devices

Fusible Links

A fusible link is a section of wire, usually two gauge sizes smaller than the circuit it protects. If the current rating of a fusable link is comprimised, the fusible link will melt open.A special insulation prevents wire fires, and swells when heated to indicate the position of the open in the wire.

Circuit Breakers

Circuit breakers are electrical mechanicl devices that will act as a fuse to prent excess current flow in a circuit. Unlike fuses, the mechanical opening of contacts stops current flow. The contacts will reset in a short period of time. This process willrepeat until the current excess is stopped.

Fuses

The most common protector in the vehicle electrical circuit is a fuse. A fuse is a metallic connector within a circuit that is made of a low melting point metal that acts as a “weak link”. If current rises above the fuses’ rating, the metal will melt and seperate, leaving an open. The fuse is surrounded by a non flammable plastic covering, and will limit current to a specific amperage. Fuses can be found in range from 1A to 30A, and be mini or maxi types. All fuses used on the HUMMER® are blade type.

Circuit Controllers

Circuit controllers are used to turn the current off and on in a circuit. Controllers can be mechanical or solid state.

Solid state controllers combine the use of semi conductors along with electromechanical devices to control current in a circuit. Solid state controllers are tipically associated with computers, and engine control systems. Most solid state controllers are specific to a purpose.

Mechanical controllers are the most common type, and can be seen as switches or relays. Switches are a primary controller while relays are typically secondary controllers.

Primary mechanical controllers are very simple contacts that are either open or closed, and can be changed state. Primary controllers are usually limited in thier ability to handle large current flows due to the restriction of size.

Secondary mechanical controllers are used in conjunction with the primary controllers to handle larger current draws in a circuit. Primary controllers are used to operate the secondary controllers from a remote location, placing less or no restriction on the size of a secondary controller. The secondary controller is usually a relay.

Circuit Faults

The following are the four electrical fault conditions that cause a malfuction in a circuit: open, short, short to ground, and high resistance connection

Open

An open circuit occurs whenever there is a break in the circuit continuity. The break can be caused by a connector disconnect, a broken wire, or a defective component (Figure 12-140).

Short

A short circuit happens when the current bypasses part of the normal circuit. This bypassing is usually caused by wire pinching or chaffing. Usual symptoms are inappropriate activation or deactivation of a load device (Figure 12-141).

Short To Ground

A grounded circuit is also a short circuit, except the current flows directly to ground with very little restriction. This is usually caused by wire pinching or chaffing against the frame or body (Figure 12-142).

High Resistance Connection

A high resistance connection is an electrical connection that is corroded or loose. High resistance connections cause a decrease in current flow that can affect the proper operation of an electrical load.

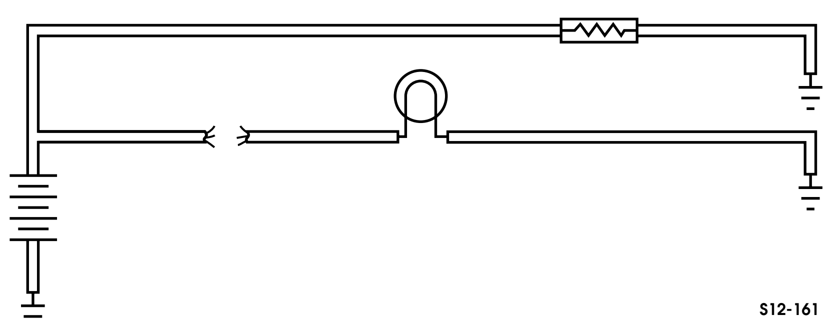


Figure 12-140: Open Circuit

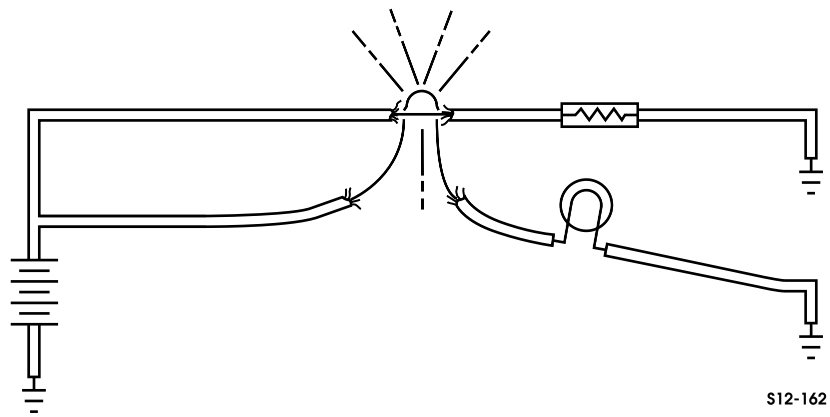


Figure 12-141: Short Circuit

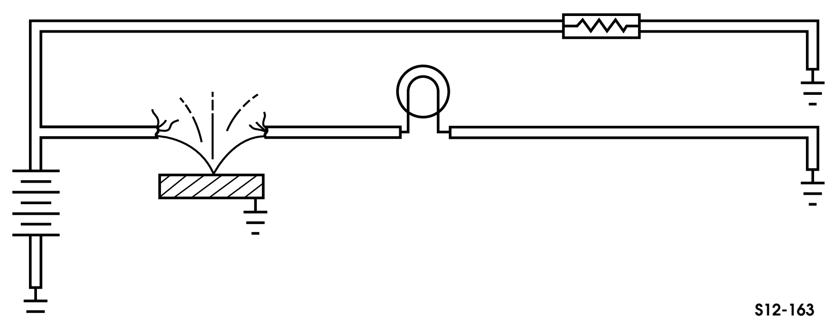


Figure 12-142: Grounded Circuit

DIAGNOSTIC TOOLS

Digital Multimeter

A digital multimeter (J–39200) is required to safely test for electrical malfunctions on the Hummer. Due to the complexity of the electrical system, a test light should not be used to test electrical circuits.

- Test lights do not have current limiting capabilities. The use of a test light may actually cause an electronic component to fail.
- Sharp test light probes may break wire strands, causing circuit failure.
- Breaks in the insulation allow moisture and contaminants to enter connectors and components, increasing the chances for corrosion. Even a small increase in resistance can give false readings from a sensor to an electronic component.

A digital multimeter performs all the tests a test light can perform with a greater degree of accuracy. In addition, a multimeter can be used to test for current in a circuit.

DIAGNOSTIC TESTS

NOTE: Follow all manufacturer’s recommendations when testing for current. All multimeters have a maximum current rating. Not all multimeters contain a fuse that protects the multimeter from excess current draw.

Amperage Test

Use caution when testing for current. Always check multimeter owner's manual for maximum current to be tested. Most multimeters are fuse-protected when measuring current. However, some meters are not protected and therefore can be damaged by excessive current. Position multimeter leads after closed switch and before load (Figure 12-143).

Voltage Test

Multimeters have a number of different voltage scales to choose from. Always use the lowest scale possible to test the circuit. For example, if you select the 200 volt scale and you are testing for battery voltage, most multimeters will display 12 volts. By selecting the next smallest scale, 20 volts, the display will read 12.8 volts, a more accurate measurement. Position multimeter leads on each side of the load (Figure 12-144).

OHM Test

CAUTION: *Before using a multimeter, ensure the circuit is not energized. Even a small voltage applied to an multimeter will damage it.*

Continuity - Testing for continuity in a circuit requires the use of the lowest ohm scale available. Position the multimeter leads on each side of the circuit or component being tested. A reading of less than one ohm is acceptable continuity (Figure 12-145).

Resistance - To test for resistance, first touch the meter leads together to ensure that the meter zeros out, then position the leads of the multimeter on each side of the circuit or component. Adjust the multimeter ohm setting until an acceptable reading is observed. Verify the reading with the specification.

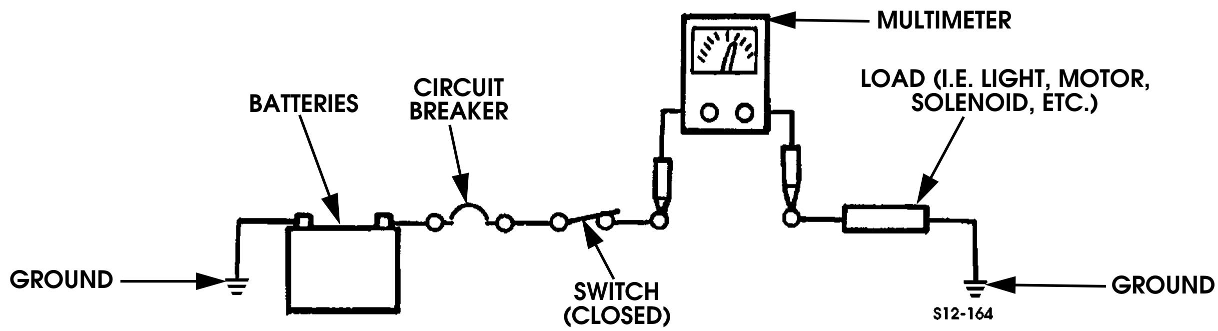


Figure 12-143: Amperage Test

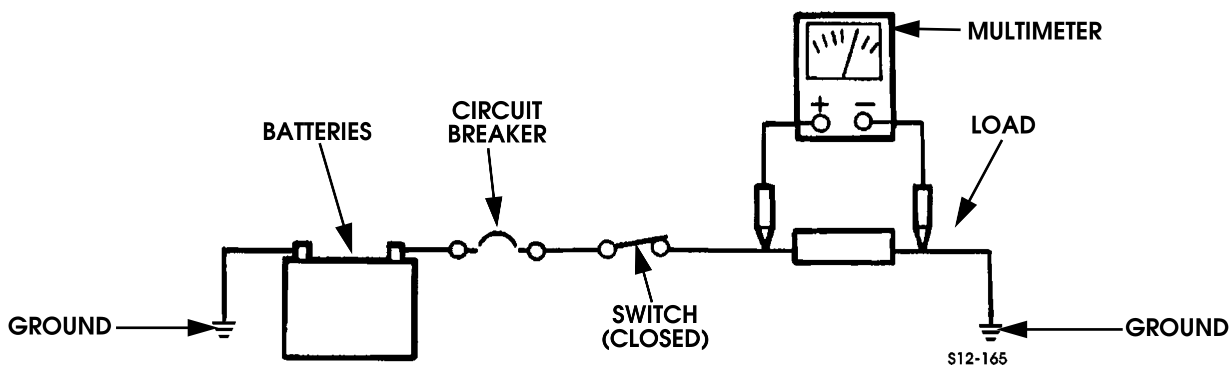


Figure 12-144: Voltage Test

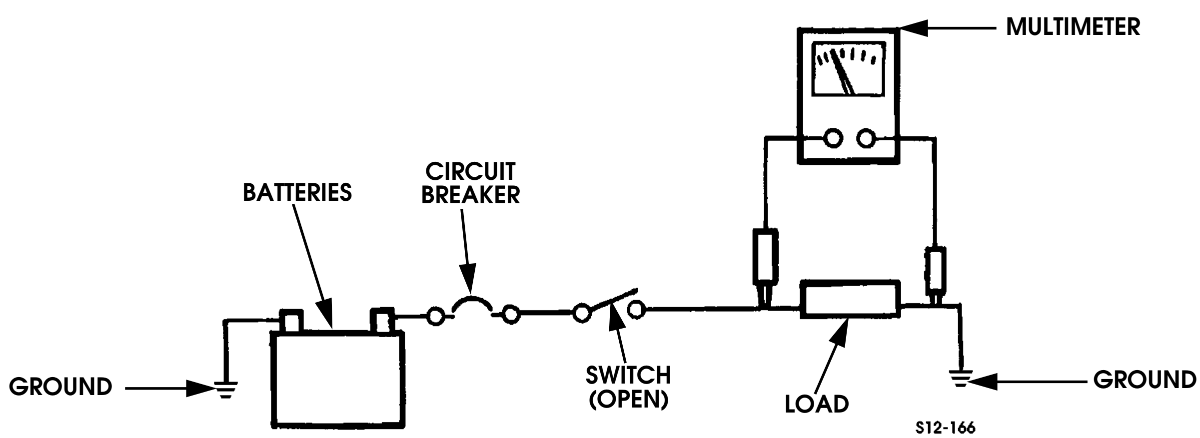


Figure 12-145: Ohm Test

CIRCUIT MAINTENANCE AND REPAIR

All electrical connections must be kept clean and tight. Loose or corroded connections may cause a discharged battery, weak starting, dim lights, or possible electrical system damage.

Wires must be replaced or repaired if insulation becomes burned, cracked, or deteriorated. When replacing a wire, it is important that the same gauge size wire be used. Refer to wiring diagram for proper wire gauge sizes. Never replace a wire with one of a smaller size or replace a fusible link wire with a wire of a larger size. It should also be noted that fusible link wire utilizes a special insulation covering. When replacing a fusible link wire, the replacement wire should be the type in accordance with SAE J156. Further, fusible link wire should never be shortened or spliced. If a repair is necessary, entire fusible link wire must be replaced with one of the proper gauge size, length and insulation type.

Any wire repair must maintain the waterproof integrity of the vehicle. Any splice located below the 30 in. (76 cm.) fording level or in a high splash area must be waterproof and heavy duty adhesive wall shrink tubing should be used as a minimum in these areas.

Each harness or wire must be held securely in position to prevent damage to insulation caused by vibrating and chafing.

NOTE: Before performing any wire repair, disconnect battery ground cable.

Wiring Repair

Wiring harness and wires - All wires are of a specific insulation color indicated on the wiring diagrams. Insulation color helps to identify circuits and make correct connections. Insulation colors and their abbreviations are as follows:

BK - Black	PK - Pink
BR - Brown	PP - Purple
DB - Dark Blue	RD - Red
DG - Dark Green	RT - Rust
GY - Gray	TN - Tan
LB - Light Blue	WH - White
LG - Light Green	YL - Yellow
OR - Orange	

Wire repair is very important for the continued, reliable operation of the vehicle. This repair must be done as described in the following procedure:

Single Wire Repair (Exposed)

1. Remove damaged area, removing as little wire as possible (Figure 12-146).

NOTE: Care should be exercised in stripping the wire insulation to avoid cutting wire conductor strands.

2. Strip wire ends to the appropriate length required by the splice clip (Figure 12-147).

NOTE: Heat shrink tubing is available in various diameters. Typically the heat shrink tubing will shrink to approximately one-half of its original diameter, therefore the tubing diameter selected for the repair should not be greater than twice the wire insulation diameter to ensure a proper seal.

3. Slide heat shrink tubing over one of the wire ends (Figure 12-148).

NOTE: Splice clips are available for different wire gauge sizes. Therefore, it is important to select the appropriate size for the wire gauge being repaired.

4. Slide both ends of wire into splice clip and crimp splice clip to wire ends (Figure 12-149).
5. Pull wires, by hand, in opposite directions to test the crimp of the splice clip.
6. Center heat shrink tubing over splice clip (Figure 12-150).
7. Using a heat gun or equivalent heat source, apply heat to heat shrink tubing until tubing conforms to splice clip and wire insulation (Figure 12-151).
8. After the splice cools, apply two layers of vinyl adhesive electrical tape to complete the repair (Figure 12-152).

Single Wire Repair (In a Harness)

1. Remove harness covering in the affected area (Figure 12-153).
2. Repair damaged wire using the exposed single wire repair procedures. (Go to Step 1.)
3. After completing the wire repair, apply two layers of vinyl adhesive electrical tape over the affected area to complete the repair (Figure 12-154).

Multiple Wire Repair (In a Harness)

NOTE: Since more than one splice is required in this case, stagger the wire splices such that they are no closer than 3 in. (7.6 cm) from each other.

Repair affected wires using the single wire repair (in a harness) procedures.

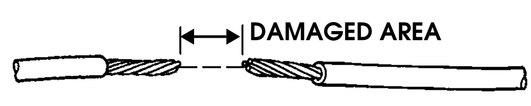


Figure 12-146: Damaged Wire

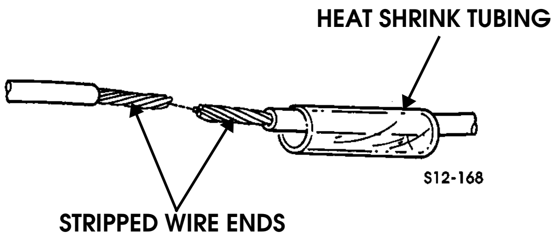


Figure 12-147: Heat Shrink Tubing

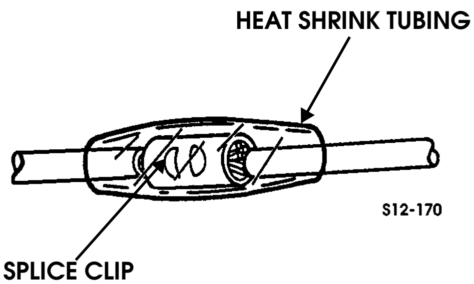


Figure 12-148: Splice Clip

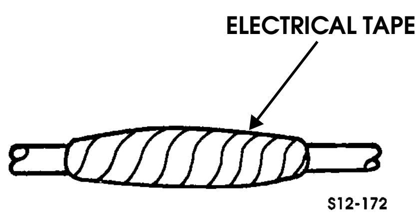


Figure 12-149: Electrical Tape

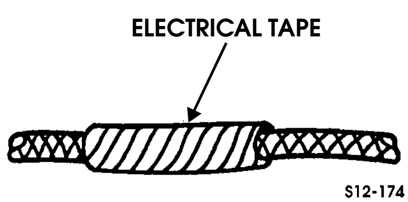


Figure 12-150: Electrical Tape

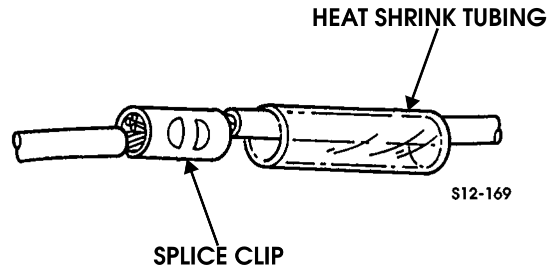


Figure 12-151: Splice Clip

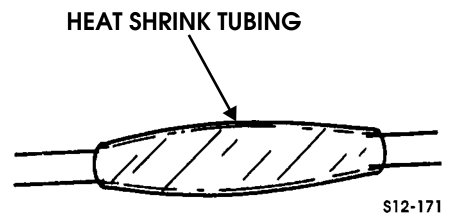


Figure 12-152: Heat Shrink Tubing

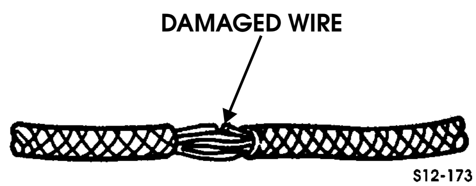


Figure 12-153: Damaged Wire

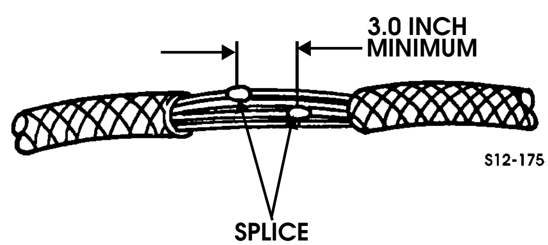


Figure 12-154: Multiple Wire Splice

FUSE/RELAY LOCATION AND IDENTIFICATION

Power Distribution Center

The power distribution center, or fuse box, is located under the instrument panel to the left of the steering column. The fuse box is divided into two mini-fuse junction blocks, a maxi-fuse junction block, five relays, and a convenience center. The mini-fuse blocks may be accessed without removing the main fuse box cover (Figure 12-155).

They have separate upper and lower access covers. To access the maxi-fuse block and relays, the main fuse box cover must be removed. The convenience center, as the name implies, may be conveniently accessed without having to remove any covers. Before removing any of the fuse box access covers, refer to the illustrations and charts in this section for the location of specific fuses, relays, and circuit breakers. Doing this will enable you to go directly to the fuse or circuit breaker you want to inspect.

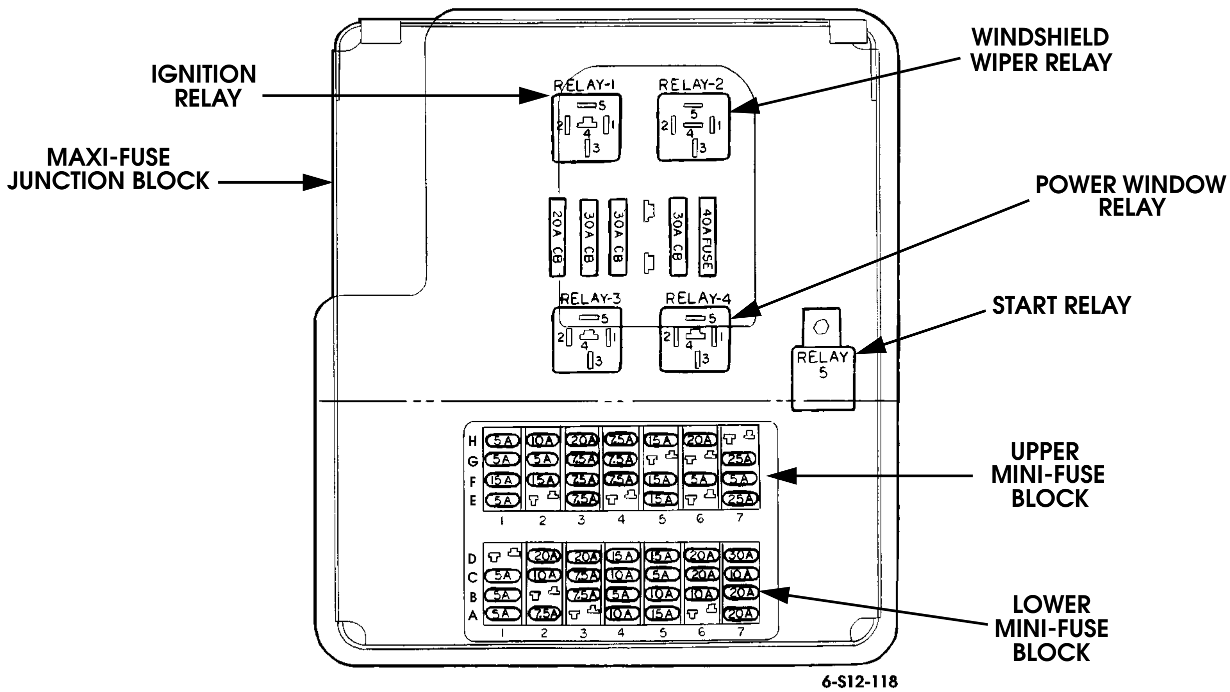


Figure 12-155: Fuse Panel and Convenience Center

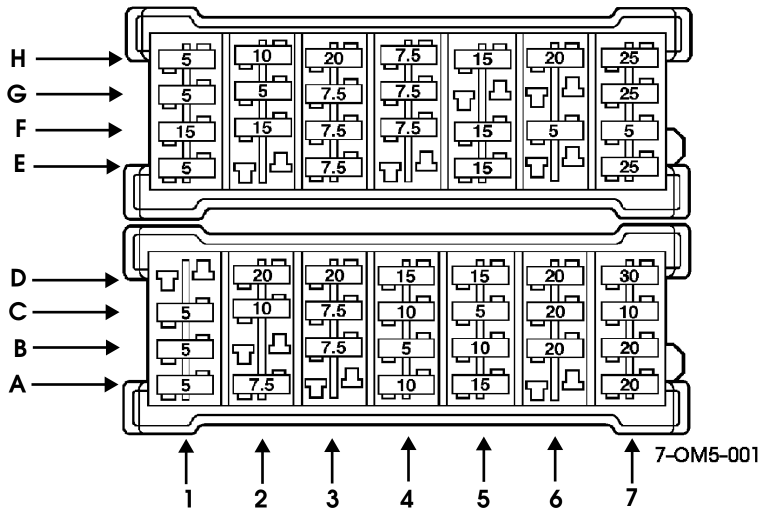
Fuses

Fuses and circuit breakers protect the vehicle's electrical system from damage caused by overloading. An overloaded circuit breaker will switch the circuit on again, causing an intermittent operation. A blown fuse will permentaly disable the circuit until the fuse is replaced.

Whenever a fuse blows or a circuit breaker opens a circuit, all electrical components using that circuit will not operate. Therefore, during diagnosis of any of these electrical components, check the appropriate fuses and circuit breakers for damage (Figure 12-156).

Some fuses are placed in-line with the components they are protecting, meaning they are not located in the fuse box but in the actual wire suppling current to the device. The the following is a list of in-line fuses and thier locations:

1. Power Mirror- under instrament panel
2. Power locks- under instrament panel
3. Heated windshield- engine compartment, left
4. High speed HVAC Blower- A pillar, engine compartment



FUSE	AMPERAGE	CIRCUIT PROTECTED
1E	5	Spare Fuse
2E	–	Blank
3E	7.5	Spare Fuse
4E	–	Blank
5E	15	Spare Fuse
6E	–	Blank
7E	25	Spare Fuse
1F	15	Spare Circuit-Lights
2F	15	Panel Lights Dimmer Module
3F	7.5	Front Parking/Running Lights
4F	7.5	Rear Parking/Running Lights
5F	15	Trailer Lights
6F	5	Underhood and Trouble Lights
7F	5	Light Circuit to Chime and HVAC
1G	5	CTIS/Key Buzzer
2G	5	Power Windows
3G	7.5	Spare Circuit/Ignition Acc
4G	7.5	Radio Ignition
5G	–	Blank
6G	–	Blank
7G	25	Windshield Wiper/Washer
1H	5	DLC Power Terminal 16
2H	10	Radio Memory/Clock
3H	20	Power Door Locks/ Power Mirrors
4H	7.5	Spare Circuit-Battery
5H	15	Dome/Courtesy Lights
6H	20	Auxiliary Power Outlet
7H	25*	Trailer Brake Controller
1A	5	Spare Fuse
2A	7.5	Spare Fuse

* May not be provided

FUSE	AMPERAGE	CIRCUIT PROTECTED
3A	–	Blank
4A	10	Spare Fuse
5A	15	Spare Fuse
6A	–	Blank
7A	20	Spare Fuse
1B	5	Glow Plug Controller
2B	–	Blank
3B	7.5	Glow Plug Controller
4B	5	Gauges/ Indicator Lights/ MIL
5B	10	Transmission/Ignition
6B	20	PCM/TCM Ignition Power/ Brake Switch Ignition/ Fuel Driver/ESO Ignition
7B	20	Engine Ignition Feed
1C	5	Transmission Shift Lock/Heated Windshield/Keyless entry
2C	10	A/C Clutch/Rear Defrost/ HVAC Ignition Feed Relay
3C	7.5	Backup Lights
4C	10	Turn Signals
5C	5	Digital Ratio Adapter/ Speedometer
6C	20	Rear A/C
7C	10	Cruise Control
1D	15	Radio Amplifier-Monsoon only (on VIN VE176477 andup)
2D	20	TCM/PCM Battery/Fuel Lift Pump
3D	20	Lighters
4D	15	Stoplights/Cruise Control
5D	15	Hazard
6D	20	Horn Relay
7D	30	HVAC Blower

Figure 12-156: Fuse Identification

Battery Checking proceedures

Visual Inspection

Check for obvious damage, such as a cracked or broken case or cover or overcharging of the electrical system that could permit loss of electrolyte. If obvious damage is noted, replace the battery.

Load Test

Before proper testing, the battery must be in a fully charged state to obtain an accurate tes. Load testing requires the use of battery side terminal adapters to ensure good connections. Do not attempt to load test a side post battery by screwing bolts into the terminals as connections.

NOTE: When load testing, batteries must be disconnected from each other.

1. Using a battery load tester, measure boltage across the battery terminals. Normal battery voltage should be 12v or higher. Recent cranking or load testing will lower the normal voltage. If no cranking or load testing has been performed, and battery voltage is below 12v, replace the battery.
2. Connect battery load tester to the battery to be tested. If battery has been recently charged, apply a 300 amp load for 15 seconds to remove the surface charge. Skip this step if the battery has not been charged.
3. Wait 15 seconds for the battery to recover. Apply the necessary load test for the battery being tested. The load required should be listed on the battery label, if it is not, use the cold crank amperage divided by 2. (300 cca/2=150 cca)This load should be applied for 30 seconds
4. If the voltage does not drop below th eminimum value, th ebattery is good and should be returned to service. The battery temperature must be estimated by feel and by the temperature the battery has been exposed to for the proceeding few hours. If the battery has been exposed to temperatures below ambient, use the chart below to adjust the minimum test voltage.

Load Test Values vs. Temperature

Estimated Temperature	Minimum Voltage
70°F(21°C)	9.6
50°F(10°C)	9.4
30°F(0°C)	9.1
15°F(-10°C)	8.8
0°F(-18°C)	8.5
0°F(Below -18°C)	8.0

5. If voltage drops below the minimum value listed, replace the battery.

Parasitic Draw Test

Tools Required:

- J–38758 Parasitic Draw Test Switch
- J–39200 Digital Multimeter

1. Remove the negative battery cable from the rear battery.
2. Install the male end of the parasitic draw test switch over the crossover negative battery cable using the long battery bolt from the battery cable removed in step 1.
3. Open the parasitic draw test switch
4. Connect the negative battery cable to female end of the parsitic draw test switch using a short battery bolt.
5. Close the parsitic draw test switch.
6. Road test the vehicle while activating all accessories, such as the radio and air conditioning.
7. Turn the ignition switch to the off position and remove the key.

NOTE: It is important that from this point on, electrical continuity must be maintained in the ground circuit to the battery, either throught J–38758 in the on position, or through J–39200.

8. Some components, such as the PCM or TCM, have timers hat draw several amps of current while they cycle down. This can give a false parasitic drain reading. Wait 15 minutes for these components to power down before continuing this test.

NOTE: If another DVOM is being used other than J–39200, ensure that the ammeter will handle 10 amps of current without damage.

9. Install a jumper wire with a 10 amp fuse between the two terminals on the parasitic draw test switch. Open the switch and wait 10 seconds. If the fuse does not blow, the parasitic load is less than 10 amps and the J 39200 can be used. Close the switch on the tester and remove the jumper wire and fuse.
10. Set J–39200 to the 10 amp scale and place leads in the correct ports in the meter for amperage testing on the 10 amp scale.
11. Connect the meter leads to the two terminals on the parasitic load test switch and open the switch.
12. Wait 60 seconds then take a reading from the meter. If the current reading is at or below 2 amps, turn the test switch to the on position. Reset the meter to read milliamps.
13. Open the switch and take the reading in milliamps.
14. Find the reserve capacity of the batteries on the vehicle. Since there are 2 batteries, add the reserve capacities together. (100 minutes+100 minutes= 200 minuites reserve capacity). Divide the number by 4 and the answer,

given in milliamps, is the maximum allowable parasitic drain the batteries will support.

NOTE: Always turn the switch knob to the “on” position before removing each fuse to maintain continuity in the electrical system and to avoid damaging the meter due to accidental overloading, such as opening a door to change a fuse.

15. If current draw is too high, remove system fuses one at a time until the draw returns to a value less than or equal to the maximum allowable for the batteries.
16. Repeat the test for parasitic drain after any repair has been performed.
17. When the cause of excessive current draw has been located and repaired, remove the meter, test switch and terminal adapters and connect the negative battery cable to the battery.

Alternator Inoperative (No Charging)

Step	Action	Value(s)	Yes	No
1	Perform visual inspection on belt, pullies and battery cables. Is everything in normal operating condition		go to step 2	Repair and recheck system
2	Using a battery load tester, place amp pickup on the alternator fusable link wire. Start and run vehicle at 1500 rpm, load the vehicle batteries with 100 amps for 15 seconds. Does charging system produduce equivilant amperage.	>100 amps	go to step 7	go to step 3
3	Perform battery check, refer to “battery checking proceedure” in this section. Are batteries in good condition		go to step 4	Replace batteries and recheck charging system
4	Using a DVOM set to measure voltage, place the negative lead on a good engine ground. Probe the Batt. terminal on the back of the alternator. Is voltage present?	12v	go to step8	go to step 5
5	Using a DVOM set to measure resistance, measure resistance between the alternator case and a negative battery connection. Is resistance below specification.	$<.2\Omega$	go to step 6	Locate and repair bad ground connnection
6	Disconnect the positive battery cables, using a DVOM set to measure resistance, measure resistance between the positve battery connection and the Batt. terminal. Is resistance below specification.?	$<.2\Omega$	go to step 8	Inspect/repair fusable link at alternator Batt terminal
7	Does voltage gauge indicate a low charge condition?		Replace guage and check operation	No problem found at this time
8	Using a DVOM set to measure voltage, and the pink ignition lead disconnected from the alternator, place the negative lead on a good engine ground and the positve lead on the pink ignition lead. Turn the ignition key to on, is voltage present?	12v	Replace the alternator	Locate and repair open or short to ground in engine ignition feed circuit.

Glow Plug System Inoperative (No “Wait” Light VIN Y)

Step	Action	Value(s)	Yes	No
1	With engine at ambient temperature, turn Ign. switch to the run position. Is the wait light visible?		No problem found at this time	go to step 2
2	Using a DVOM set to measure voltage, place the ground lead on a known good engine ground. Probe the load side of the glow plug controller relay with the positive lead. Cycle the ignition switch to the run position. Does voltage appear?	12v	Repair open in CKT338 fusable link wire.	go to step 3
3	Using a DVOM set to measure voltage, and the ground lead on a known good engine ground, check for voltage at the Batt terminal of the glow plug controller. Is voltage present	12v	go to step 4	Repair fusable link betweent the alternator and the glow plug controller Battery terminal
4	Using a DVOM set to measure ohms, connect meter positive lead to glow plug controller harness terminal E (CKT57). Place the negative lead on a known good engine ground. Ignition switch to the off positon.Is resistance below specified?	<.2Ω	go to step 5	Repair broken wire or bad connection between glow plug controller terminal E and engine-ground.
5	With ignition switch in the run position, and the DVOM set to measure volts, place the ground lead on terminal E of the glow plug controller and the positive lead on terminal D (CKT361) of the engine harness glow plug controller connector.	12v	go to step 6	Repair open or short to ground in CKT361 between the glow plug controller and fuse 3B
5	Using a DVOM set to measure ohms, place the positive lead on glow plug controller harness terminal C(CKT472). Place the negative lead on the glow plug controller harness terminal E(CKT57).With the ignition switch in the off position, is resistance below maximum specifications?	<.2Ω	go to step 6	Repair bad connection or open in fusable link wire from glow plug controller harness and load side of glow plug controller relay.
6	Using a DVOM set to measure voltage, place the positive lead on terminal B (CKT35) of the glow plug controller hareness, and terminal E of the glow plug controller harness(CKT57).Disable vehicle startup by removing fuse 6B. Crank engine. Is voltage present?	11v+	go to step 7	Repair open or bad connection in CKT35 between glow plug controller and fuse1B
7	Replace the glow plug controller.Does the wait lamp operate?		Repair completed	Repeat visual inspection and repeat diagnstic proceedure

Glow Plug System Inoperative (System Check) VIN Z

Step	Action	Value(s)	Yes	No
1	Important: Befor clearing the DTC's, use the scan tool Capture Info in order to record the Freeze Frame and the failure records for reference, as the data will be lost when the Clear Info function is used. Was the Powertrain On-Board Diagnostic (OBD) System check performed?		Go to step 2	Go to Powertrain OBD System Check
2	Is DTC: P0117, P0118, or P0380 stored as history or current codes?		Go to applicable DTC table	go to step 3
3	Turn the ignition swithc off, disconect all of the glow plugs. Using a test lamp conntected to Batt, probe the spade terminal on each glow plug. Do all of the glow plugs turn the test light on?		go to step 4	go to step 5
4	Use a test light connected to ground, probe a glow plug lead and turn the igniton on. Repeat this step for each of the glow plug leads does each lead turn the test lamp on?		go to step 7	go to step 6
5	Replace all of the glow plugs that do not turn the test light ON. Is the action complete?		go to step 7	
6	Repair the open in each circuit that does not turn the test light on. Is the action complete?		go to step 7	
7	Operate the vehicle within the conditions under which failure occured originally. Does the system operate properly?		System is OK or operating intermittently	go to step 1

Starter Inoperative

Step	Action	Value(s)	Yes	No
1	Inspect battery condition and charge (Refer to battery checking proceedure this section). Are batteries in good working condition and charge?		go to step 2	Perform repair on batteries as necessary
2	Using a DVOM set to measure voltage, place the ground lead on a known good ground, and the positive lead on the large blue wire at the starter solenoid (CKT34).Have a helper turn the key to start. Does the meter display adequate voltage?	12v	Repair or replace starter and/or solenoid as necessary	go to step 3
3	Remove fuse box access covers. Using a DVOM set to measure voltage, place the ground lead on a known good ground, and the positive lead on the large blue wire at the start relay(CKT34) Rotate the key to the start position, does the meter display adequate voltage?	12v	Repair open or short to ground in CKT34 between the start realay and the starter solenoid	go to step 4
4	Using a DVOM set to measure voltage, place the ground lead on a known good ground, and the positive lead on the large red wire (CKT37) at the start relay. Does the meter display adequate voltage?	12v	go to step 5	Repair open or short to ground in CKT37 between start relay and batteries
5	Using a DVOM set to measure voltage, place the ground lead on a known good ground, and the positive lead on the small light blue wire at the start relay(CKT32). Rotate the ignition to start. Does the meter display adequate voltage?	12v	go to step 6	go to step 7
6	Using a DVOM set to measure ohms, place the negative lead on a known good ground and probe the black wire at the start relay(CKT59). With the ignition switch off, does resistance read below specified?	$<.2\Omega$	Replace Start Relay	Repair open or bad connection in CKT59 between start relay and ground
7	Disconnect the white wire(CKT33)at the shifter under the vehicle. Using a DVOM set to measure voltage, place the negative lead on a known good ground, and the positive lead on the white wire(CKT33)on the vehicle body harness. Have a helper rotate the key to start. Is adequate voltage displayed?	12v	go to step 8	go to step 10
8	Disconnect the blue wire(CKT32)at the shifter housing. Tag leads for installation. Using a DVOM set to measure ohms, place the ground lead on the shifter wire previously attached to white wire, and the positive lead on the shifter wire attached to the blue wire. Place the shifter in park. Is resistance across the neutral saftey switch below maximum allowable?	$<.2\Omega$	go to step 9	Replace neutral saftey switch and recheck

Starter Inoperative

Step	Action	Value(s)	Yes	No
9	Repair open or bad connection in CKT32 between neutral saftey switch and start relay. Is condition repaired			Go to step 1
10	Remove lower cover of steering column to access the ignition switch connector. Back probe the white wire(CKT33) with the positive lead of a DVOM set to measure voltage. Place the ground lead on a known good ground. Turn the ignition switch to crank. Is voltage present?	12v	Repair open or short to ground in CKT33 between Ignition switch and the neutral saftey switch	go to step 11
11	Using a DVOM set to measure voltage, place the negative lead on known good ground and back-probe the yellow wires (CKT37) at the ignition switch connectors. Is voltage present?	12v/12v	replace ignition switch	Repair open or short to ground in CKT37 between maxi fuse #6 and Ignition switch

HVAC Temperature Blend Door Does not Operate (On VIN VE176477 and up)

Step	Action	Value(s)	Yes	No
1	With the ignition switch in the run position, operate temperature control dial and observe the motor. Does door move?		Condition is intermittent	go to step 2
2	Remove the temperature blend door motor from the side of the HVAC case. With the ignition switch in the run position, operate the temperature control dial and observe the motor. Is the motor turning?		Mechanical problem in the HVAC case	go to step 4
3	Disconnect electrical connector from the temperature blend door motor. Using a DVOM set to measure voltage, and using J–35616-92 test adapters, probe the grn wire (CKT 399) with the positive lead and the blk wire (CKT 58) with the negative lead. Turn the ignition switch to the run position. Is voltage present?	B+	go to step 6	go to step 4
4	With ignition on, using a DVOM set to measure voltage and using J–35616-92 test adapters probe the grn wire (CKT 399) with the positive lead. Place the negative lead on a known good ground. Is voltage present?	B+	go to step 5	Repair open or short to ground between temperature blend door motor and fuse 7D.
5	With the ignition off, and using a DVOM set to measure ohms, check for resistance between the blk wire (CKT 58) of the temperature blend door, and a good ground. Does resistance exceed specifications?	<.2Ω	Locate open or bad connection between temperature blend door motor and ground at I/P	go to step 6
6	Using a DVOM set to read volts, the ignition switch on the run position, and using J–35616-92 test adapters, probe the blue wire (CKT 402) with the positive lead, and the blk wire (CKT 58) with the negative lead. Rotate temperature control dial on the HVAC control head from cold to hot and back. Is voltage present at the cold setting and 0v on the hot setting?	Cold = 12v Hot = 0v Cold = 12v	Replace the temperature blend door motor.	go to step 7
7	Disconnect the 8 wire connector at the HVAC control head. Using a DVOM set to measure ohms, check resistance between pin F (CKT 402) of the 8 wire connector and the blue wire (CKT 402) of the temperature blend door connector. Does resistance exceed specifications?	62KΩ	go to step 9	go to step 8
8	Check for open or bad connection between the HVAC control head 8 wire connection and the temperature blend door motor connection. Check for loose terminals at the control head. Was a bad connection found?		Repair or replace harness as necessary	go to step 9

HVAC Temperature Blend Door Does not Operate (On VIN VE176477 and up)

Step	Action	Value(s)	Yes	No
9	Using a DVOM set to measure voltage, probe pin E (CKT 399) of the 8 wire connector on the HVAC control head with the positive lead, and pin B (CKT 58) of the three wire HVAC control head connector with the negative lead. With ignition on, is voltage present?	B+	Replace faulty HVAC control head.	go to step 10
10	Using a DVOM set to measure voltage, probe pin E (CKT 399) of the HVAC control head eight wire connector with the positive lead. Attach the negative lead to a known good ground. With the ignition switch in the run position, is voltage present?	B+	go to step 11	Locate short or open between the HVAC control head and fuse 7D.
11	Using a DVOM set to measure ohms, check resistance between pin B (CKT 58) of the HVAC control head connector and a good ground. Does resistance exceed specifications?	<.2Ω	Replace faulty HVAC control head	Locate and repair open or poor connection in the ground circuit between pin B and the I/P ground point

HVAC No Blower Motor Operation (On VIN VE176477 and up)

Step	Action	Value(s)	Yes	No
1	Using a DVOM set to measure voltage, probe the blower motor purple wire (CKT371) with the positive lead, and the blower motor black wire (CKT58) with the negative lead. Turn the ignition switch to the run position, the HVAC control head mode dial to face and M2. Is voltage present?	9v+	Replace the blower motor	go to step 2
2	Leave Positive lead of DVOM connected to the purple wire (CKT371) place negative lead on a known good ground. Ignition switch in the run position, HVAC control head mode dial on face, blower on M2. Is voltage present?	9v+	Repair open or poor connection in ground CKT between blower motor and engine block.	go to step 3
3	Using a DVOM set to measure voltage, backprobe yel wire (CKT754) at the blower relay with the positive lead. Backprobe the black wire (CKT58) at the blower relay with the negative lead. Ignition in the run position, mode dial on face and fan dial on M2. Is voltage present?	9v+	Replace relay	go to step 4
4	Using a DVOM set to measure voltage, probe pin A of the HVAC control head 3 wire connector with the positive lead. Place the ground lead in pin B of the same connector. Turn the ignition switch to run and the mode dial to any position. Is voltage present?	B+	Replace Control head	go to step 5
5	Using a DVOM set to measure voltage, backprobe pin E of the HVAC control head 8 wire connector with the positive lead. Probe pin B of the three wire connector with the negative lead. Ignition switch in the run position, is voltage present?	B+	Replace Control head	go to step 6
6	Leave DVOM connected with ignition switch in the run position. Remove the negative lead from pin B of the 3 wire connector and place it on a known good ground. Is voltage now present?	B+	Replace the Control head	Repair open short or bad connection in CKT 399

HVAC Only HIGH Blower (No L M1 M2) (On VIN VE176477 and up)

Step	Action	Value(s)	Yes	No
1	Using a DVOM set to measure voltage, back-probe the yel wire(CKT754) at the blower relay with the positive lead, and backprobe the blk wire (CKT 58) at the blower relay with the negative lead. Ignition switch at run position, mode dial on face and blower dial on M2. Is voltage present?	9v+	Replace relay	go to step 2
2	Using DVOM set to measure voltage, backprobe the gry wire (CKT752) on resistor block connector in engine compartment with the positive lead. Attach the negative lead to a known good ground. Turn the ignition switch to run and the mode dial to face. The blower dial should be at M2.	B+	Replace resistor block	go to step 3
3	Using a DVOM set to measure voltage, back-probe pin C (CKT 752) of the HVAC control head 8 wire connector with the positive lead. Place the negative lead on a known good ground. Turn ignition key to the run position, the mode dial to face, and the blower dial to M2. Is voltage present?	B+	Repair open or short between HVAC control head and resistors.	go to step 4
4	Leaving the negative lead on a good ground, backprobe pin E of the 8 wire HVAC control head connector with the positive lead. Ignition switch to the run position, is voltage present.	B+	Replace control head	Repair open short or bad connection between HVAC control head and fuse 7D

HVAC Compressor Clutch Does not Operate (VIN Z Only) (On VIN VE176477 and up)

Step	Action	Value(s)	Yes	No
1	Has OBD system check been performed?		go to step 2	Perform OBD system check
2	Using Tech 1, go to engine data list and locate A/C request. Turn mode dial on HVAC control head to MAX A/C. Does tech 1 indicate A/C request "yes"?		go to step 11	go to step 3
3	Using a DVOM set to measure voltage, back-probe pin H of the HVAC control head 8 wire connector. Ignition switch to run and the mode dial to Max A/C. Is voltage present?	B+	go to step 5	go to step 4
4	Using a DVOM set to measure voltage, measure voltage of pin E of the 8 wire HVAC control head connector with the ignition switch in the run pos-tion. Is voltage present?	B+	Replace control head	Repair open or short in CKT 399 from the control head to fuse 7D
5	Using a DVOM set to measure volts, with the mode dial to MAX A/C and the ignition switch to run, is voltage present at PCM pin BRC2?	B+	Replace PCM	go to step 6
6	Disconnect bulkhead passthrough connector. Using a DVOM set to measure ohms, measure between sockets 10 and 20 of the engine side of the passthrough connector. Is resistance above specifications?	.2Ω	go to step 7	go to step 8
7	Disconnect the following and check resistance using a DVOM set to measure ohms. • High Pressure Cutoff switch • Ambient Temperature switch • Low Pressure Cutoff switch Is resistance above specifications?	.2Ω	Replace individual component	go to step 8
8	Using a DVOM set to measure voltage, mode dial on Max A/C, and ignition on run. Check for voltage at pin 10 on body side of passthrough connector. Is voltage present?	B+	Repair open or poor connection between pin 20 of pass through connector and PCM pin BRC2	go to step 9
9	Using a DVOM set to measure voltage, mode dial on Max A/C, and ignition on run, is voltage present at tan wire(CKT198)?	B+	Repair open or short to ground in CKT 198 between thermostatic cycling switch and bulkhead connector pin 10	go to step 10

HVAC Compressor Clutch Does not Operate (VIN Z Only) (On VIN VE176477 and up)

Step	Action	Value(s)	Yes	No
10	Using a DVOM set to measure voltage, mode dial on Max A/C, and ignition switch on run, check for voltage at yellow wire(CKT347) of the thermostatic cycling switch.	B+	Replace thermostatic cycling switch	Repair open, short to ground or poor connection in CKT347) between control head and thermostatic cycling switch
11	Using a DVOM set to measure voltage, mode dial still on MAX A/C, and the ignition switch on run, check for voltage at the dk blu wire (CKT440) of the compressor relay. Is voltage present?	B+	go to step 13	go to step 12
12	Using a DVOM set to measure voltage, mode dial still on MAX A/C, and the ignition switch on run, check for voltage at PCM pin BLD5 (CKT440) is voltage present?	B+	Repair open short to ground or bad connection between PCM and compressor relay	If pin tension is good, replace PCM.
13	Using a DVOM set to measure voltage, ignition on the run position, backprobe the compressor relay grey wire with the positive lead (CKT441) and the black wire with the negative lead. Is voltage present.	B+	go to step15	go to step14
14	With DVOM still connected to the grey wire, move the negative lead to a known good ground. Is voltage present?	B+	Repair open or poor connection in ground CKT between compressor relay and I/P ground point.	Repair open, short to ground, or poor connecton in CKTS 441, and 400 between compressor relay and fuse 2C.
15	Using a DVOM set to measure voltage, ignition on the run position, mode dial on MAX A/C, backprobe the compressor relay brown wire (CKT348) with the positive lead, and the blk wire with the negative lead. Is voltage present?	B+	go to step 16	Replace relay
16	Using a DVOM set to measure voltage, mode dial on MAX A/C, ignition on run. Disconnect connector from A/C compressor clutch. Check for voltage on the blu wire (CKT348). Is voltage present?	B+	Replace compressor clutch	Repair open, short to ground, or bad connection in CKT 348 between the compressor relay and compressor clutch.

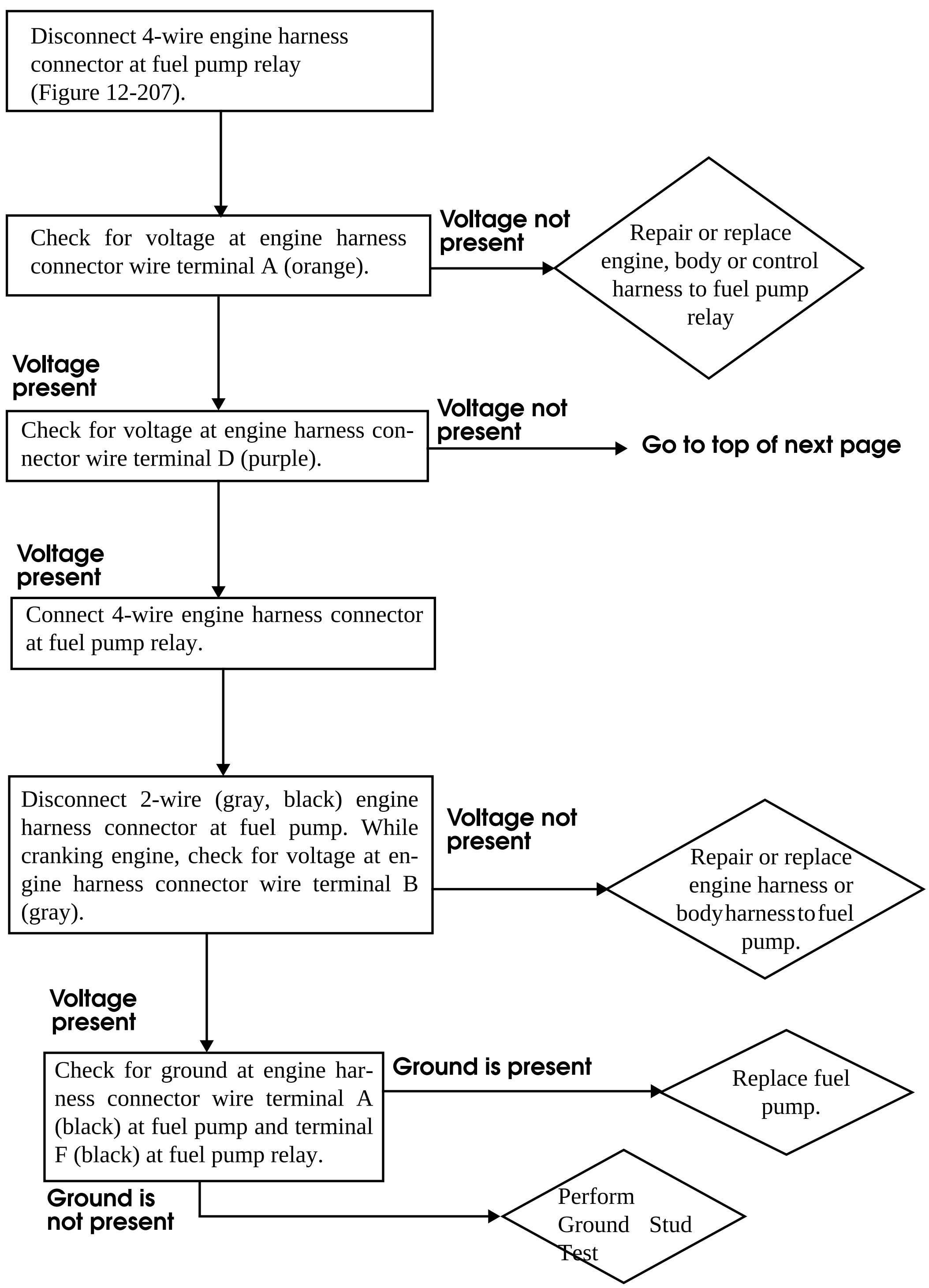
HVAC Compressor Clutch Does not Operate (VIN Y Only) (On VIN VE176477 and up)

Step	Action	Value(s)	Yes	No
1	Using a DVOM set to measure voltage, the ignition switch to run, and the mode dial on Max, disconnect the connector at the A/C compressor clutch connector and check for voltage at the blue wire. Is voltage present?	B+	Replace the compressor clutch	go to step 2
2	With a DVOM set to measure voltage, back probe the dk blu wire (CKT440) of the compressor relay with the positive lead, and the grey wire (CKT441) with the negative lead. Turn the ignition switch to run, and the mode dial to Max. Is voltage present?	B+	go to step 5	go to step 3
3	Using a DVOM set to measure voltage, the ignition switch to run and the mode dial on Max. Leave the positive probe on the dk blue wire(CKT440) of the compressor relay and place the negative on known good ground. Is voltage present?	B+	Repair open or short in CKT 441, and CKT 58 between compressor relay and I/P ground point	go to step 4
4	Using a DVOM set to measure voltage, the ignition switch to run and the mode dial on Max. Back probe the tan wire(CKT198) of the thermostatic cycling switch with the positive probe. Place the negative probe on a known good ground. Is voltage present?	B+	go to step 6	go to step 10
5	Move the positive lead of the meter to back probe the lt.grn wire(CKT400), with the ignition to run and the mode dial on Max, is voltage present?	B+	Repair open or short to ground in CKT 400 between compressor relay and compressor clutch	Replace the compressor relay
6	Disconnect the bulkhead connector. With a DVOM set to measure voltage, ignition in the run position and mode dial in the Max position. Is voltage present at pin10?	B+	go to step 7	Repair open or short in CKT 198 between bulkhead connector and thermostatic cycling switch
7	Disconnect the bulkhead connector. Using a DVOM set to measure OHMS, check the resistance between socket 10 and socket 20 on the engine side of the harness. Is resistance above specification?	.2Ω	go to step 8	Repair open or short ground in CKT 439 from bulkhead connector pin 20 to compressor relay

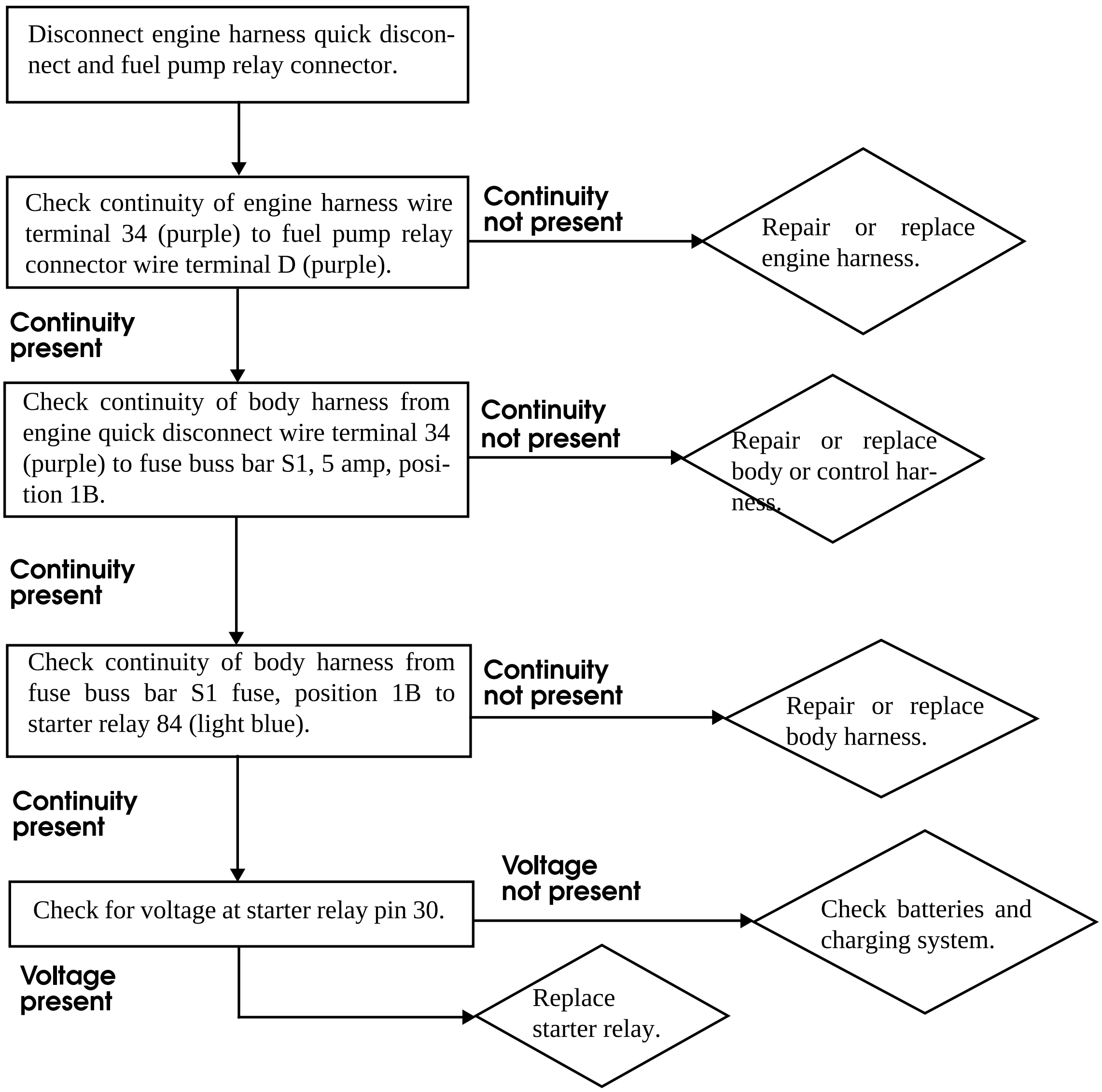
HVAC Compressor Clutch Does not Operate (VIN Y Only) (On VIN VE176477 and up)

Step	Action	Value(s)	Yes	No
8	Check the resistance of the following items: High pressure cutoff switch Ambient temperature switch Low pressure cutoff switch High temperature cutoff switch Are all of these items below resistance specifications.	.2Ω	Repair open or short to ground in engine harness CKTS 438, 443, or 439	Replace faulty switch
9	Using a DVOM set to measure voltage, the ignition switch to run and the mode dial on Max. Back probe the yel wire of the thermostatic cycling switch with the positive probe. Place the negative probe on a known good ground. Is voltage present?	B+	Replace the thermostatic cycling switch	go to step 10
10	Using a DVOM set to measure voltage, backprobe pin H of the HVAC control head 8 wire connector. Ignition switch to run and the mode dial to Max A/C. Is voltage present?	B+	Repair open or short in CKT from the control head to the thermostatic cycling switch	go to step 11
11	Using a DVOM set to measure voltage, measure voltage of pin E of the 8 wire HVAC control head connector with the ignition switch in the run postion. Is voltage present?	B+	Replace control head	Repair open or short in CKT 399 from the control head to fuse 7D

FUEL PUMP NOPERAT VE (ENG NE FA LS TO START OR STALLS) (NON-TURBO D ESEL ONLY)



FUEL PUMP INOPERATIVE (ENGINE FAILS TO START OR STALLS - CONTINUED) (NON-TURBO DIESEL ONLY)



FUEL PUMP INOPERATIVE (TURBO DIESEL ONLY)

Connect a test lamp at the fuel pump relay 4-wire connector between the OR wire and ground (Figure 12-207A).

Does the test lamp light?

No

Repair the open in the OR wire to the fuel pump relay.

Yes

Connect a test lamp at the fuel pump relay 4-wire connector between the OR and BK wires.

Does the test lamp light?

No

Repair the open in the BK wire to the fuel pump relay.

Yes

Connect a fused jumper at the fuel pump relay 4-wire connector between the OR and GY wires.

Does the fuel pump run?

Yes

Disconnect the fuel pump relay 4-wire connector.

Measure resistance between the relay cavities F and D on the relay.

Is the resistance less than 10 ohms?

Yes

Check the DG wire for an open between the relay and the PCM.

If OK, replace the PCM.

No

Replace the fuel pump relay.

No

Leave the fused jumper connected.

Connect a test lamp at the fuel pump 2-wire connector between the GY wire and ground.

Does the test lamp light?

No

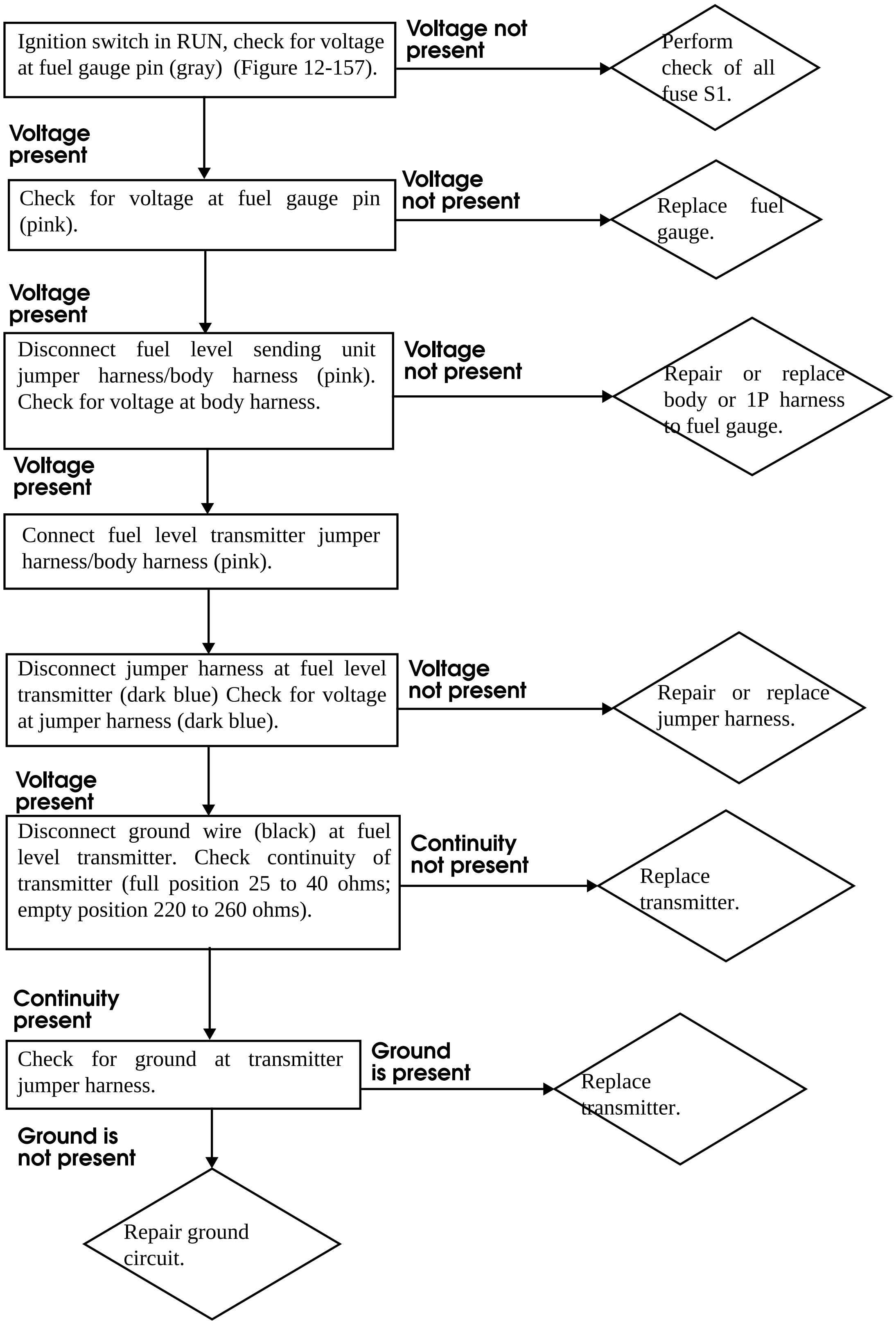
Repair the open in the GY wire between the relay and the fuel selector switch.

Yes

Check for an open in the BK wire between the fuel pump and ground.

If OK, replace the fuel pump.

FUEL TANK SENDING UNIT INOPERATIVE



FUEL TANK SELECTOR SWITCH INOPERATIVE

Place the fuel tank selector switch in the main position.

Disconnect the fuel tank selector switch 4-wire connector.

Measure resistance between the switch cavity A (LG wires) and cavity B (RD wire) (Figures 12-157 and 12-159).

Is the resistance more than 10 ohms?

Yes — Replace fuel tank selector switch.

No

Place the fuel tank selector switch in the main position.

Measure resistance between the switch cavity A (LG wires) and cavity C (BR wire).

Is the resistance less than 10 ohms?

Yes — Replace fuel tank selector switch.

No

Place the fuel tank selector switch in the main position.

Measure resistance between the switch cavity D (BK wires) and cavity C (BR wire).

Is the resistance more than 10 ohms?

Yes — Replace fuel tank selector switch.

No

Place the fuel tank selector switch in the auxiliary position.

Measure resistance between the switch cavity D (LG wires) and cavity B (RD wire).

Is the resistance less than 10 ohms?

Yes — Replace fuel tank selector switch.

No

Check for opens or shorts in the RD and BR wires between the fuel tank selector switch and the fuel pumps.

If OK, repair the open in the BK wire between the fuel tank selector switch and ground.

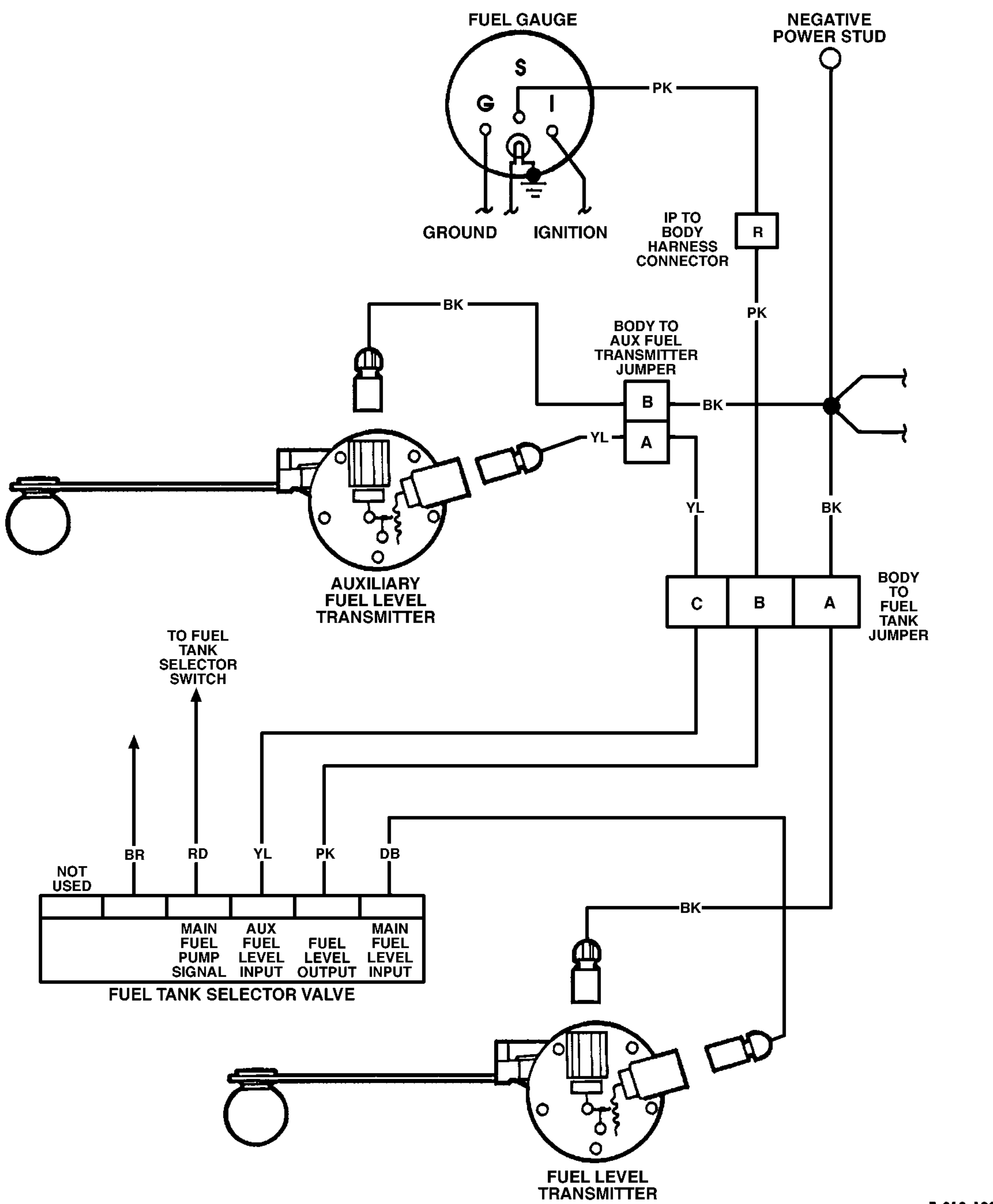


Figure 12-157: Fuel System-Non-Turbo Diesel (Sheet 1 of 2)

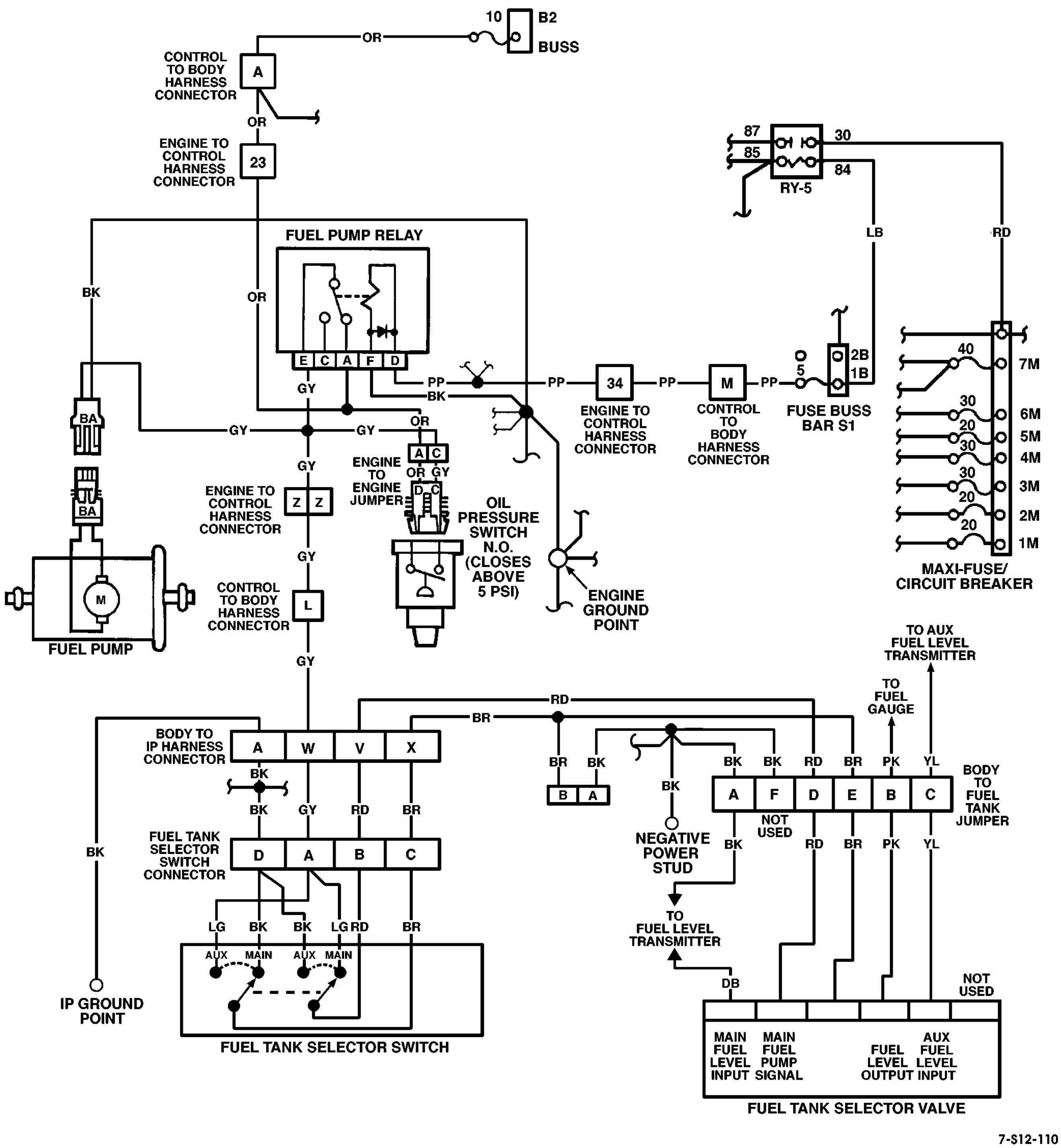


Figure 12-158: Fuel System-Non-Turbo Diesel (Sheet 2 of 2)

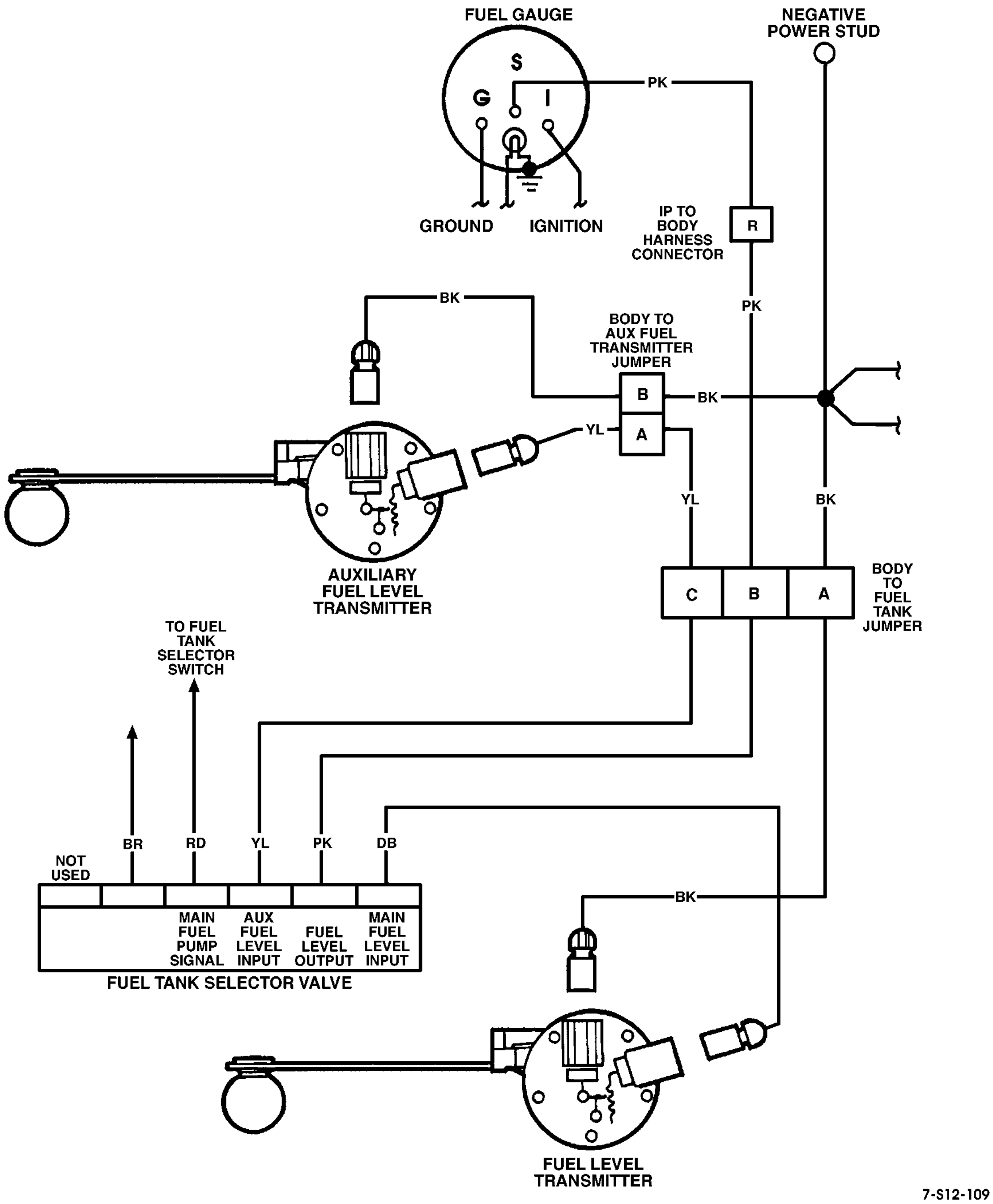


Figure 12-159: Fuel System-Turbo Diesel (Sheet 1 of 2)

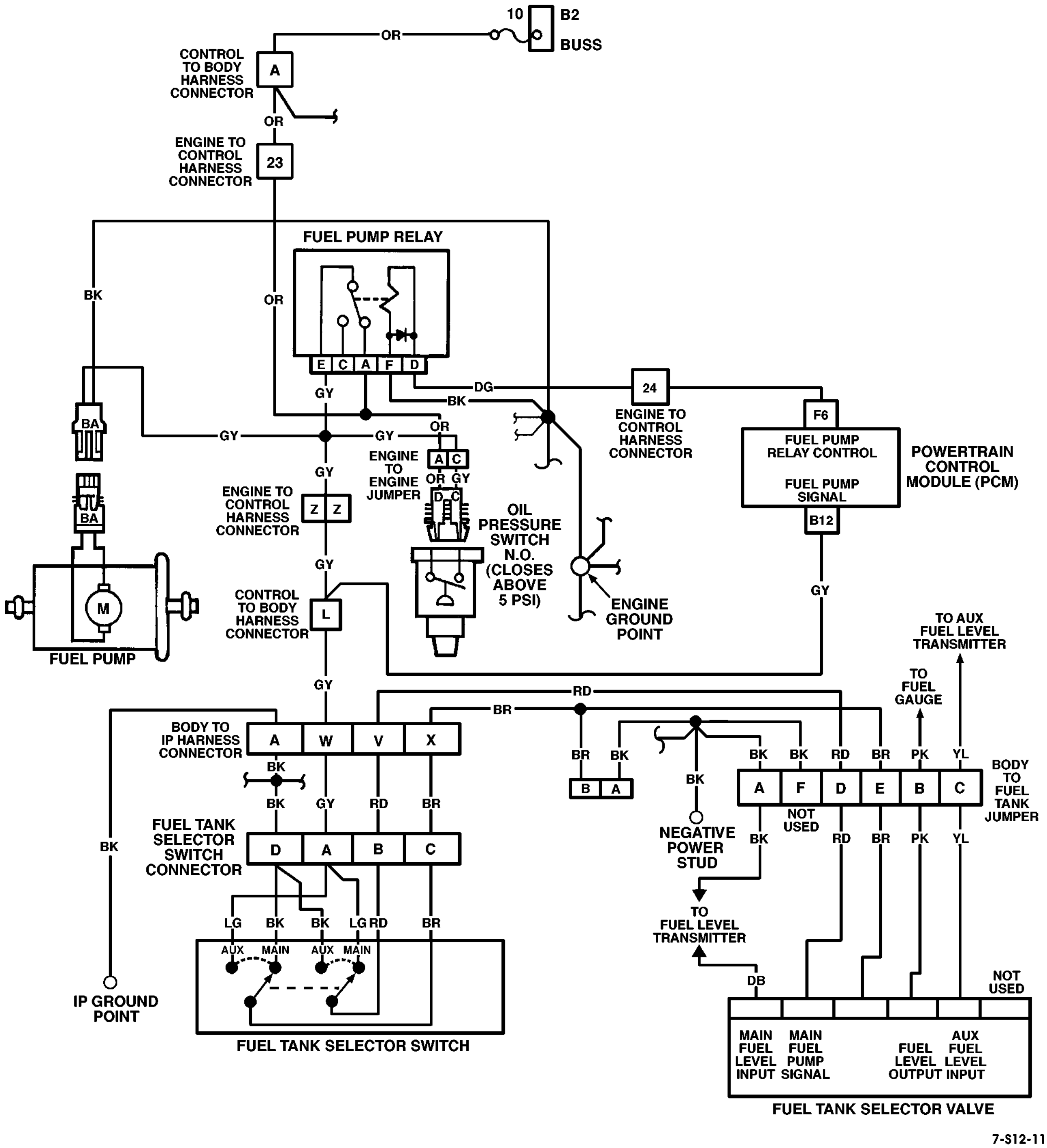
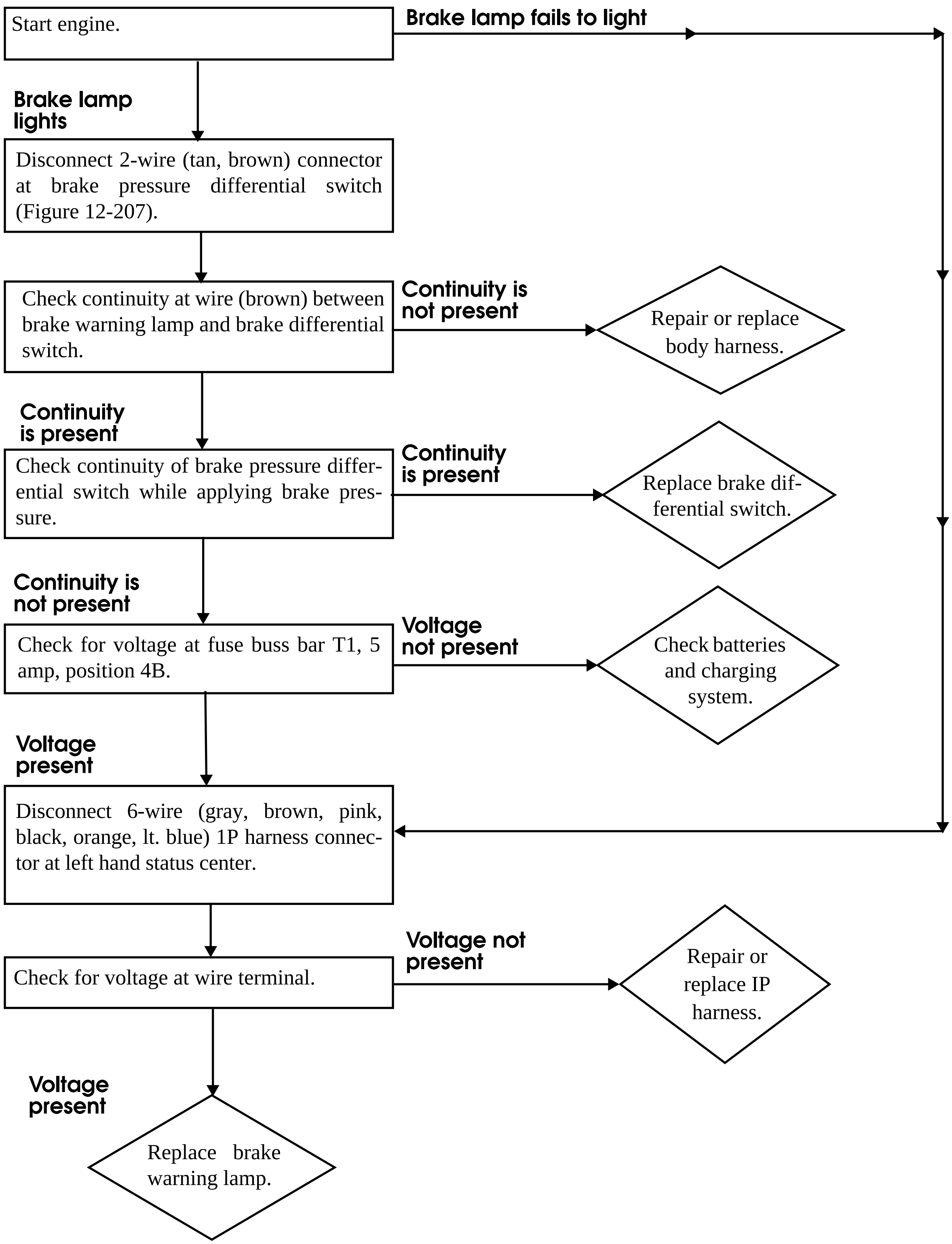
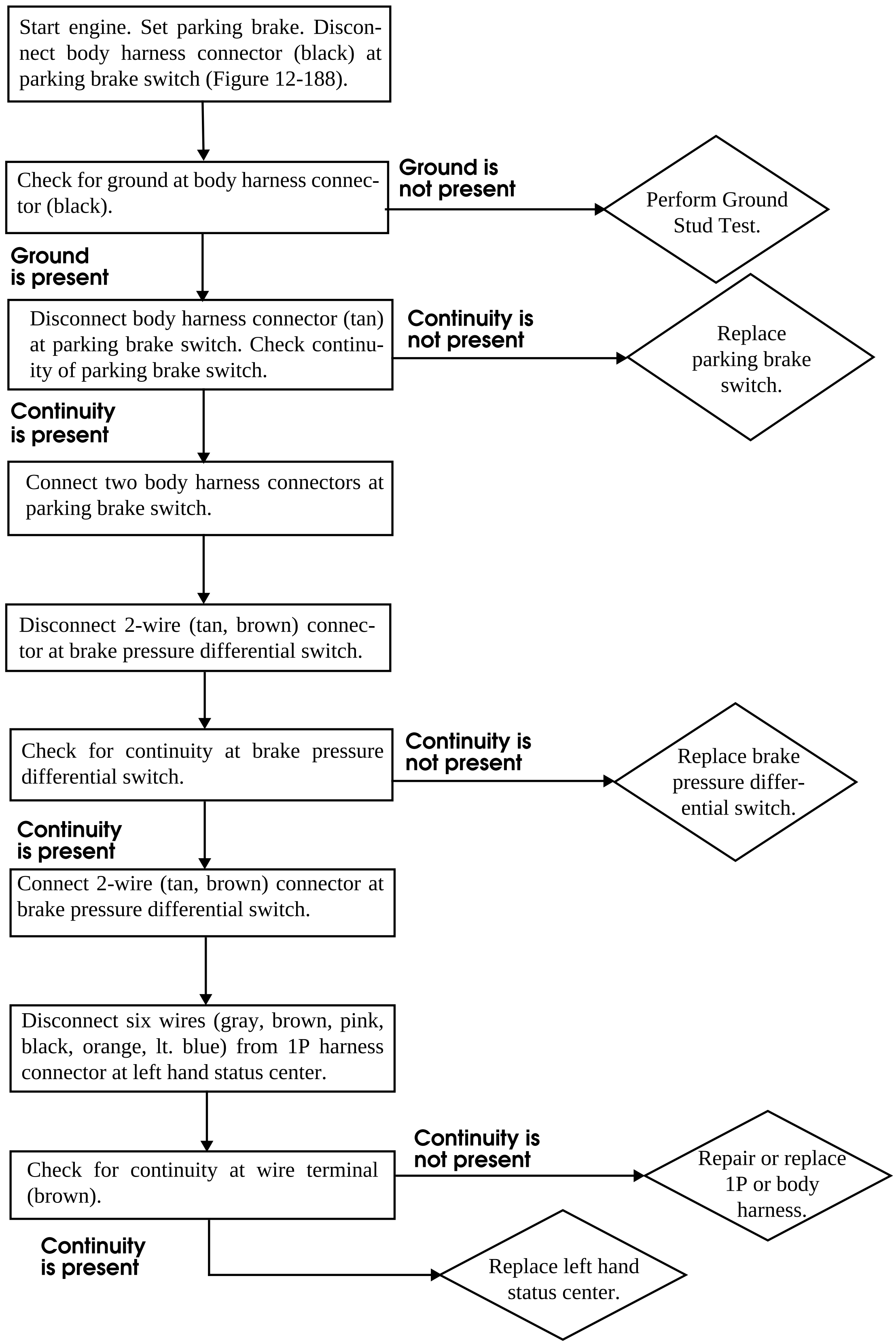


Figure 12-160: Fuel System-Turbo Diesel (Sheet 2 of 2)

BRAKE PRESSURE DIFFERENTIAL SWITCH INOPERATIVE



PARKING BRAKE LIGHT FAILS TO LIGHT



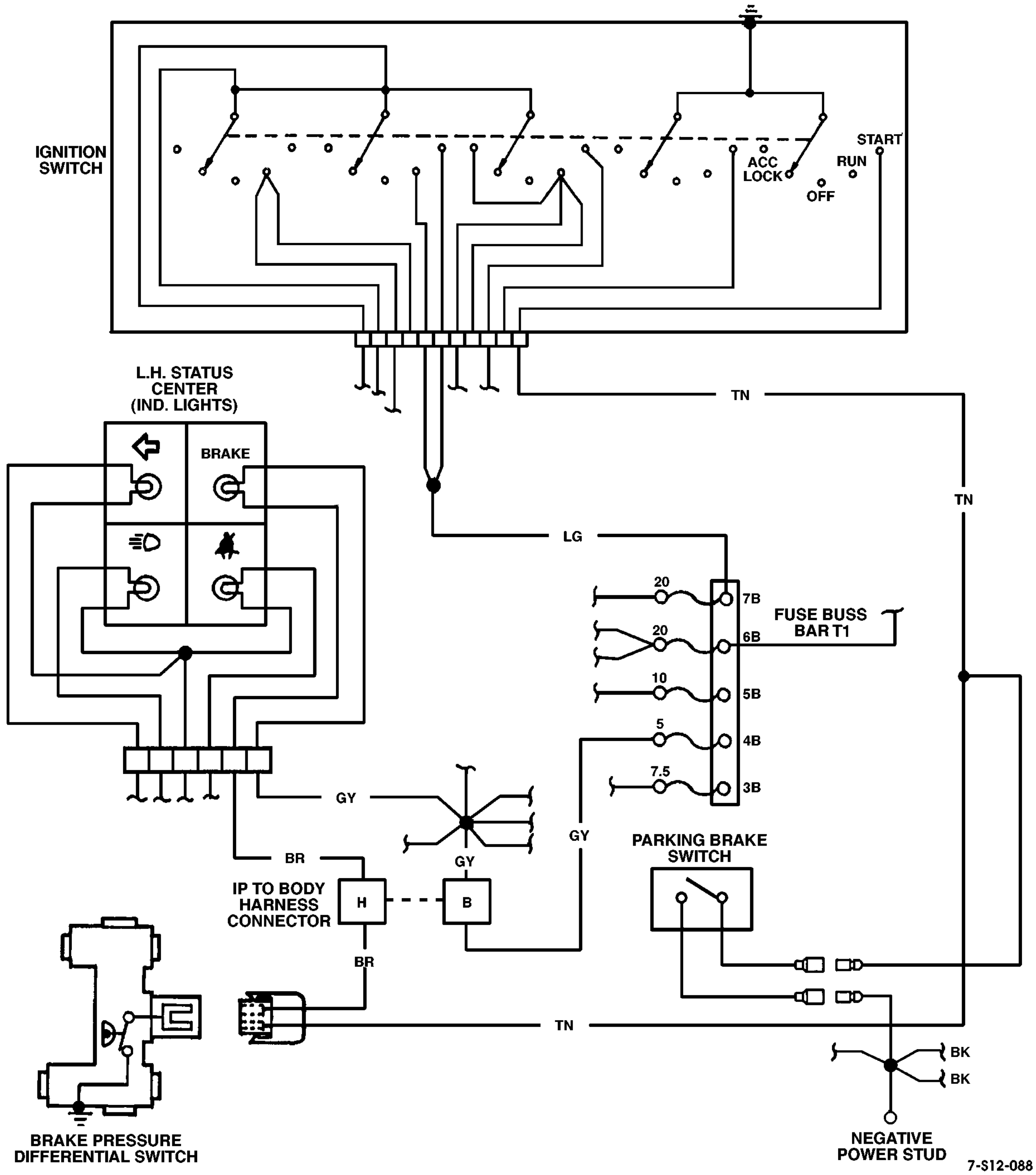
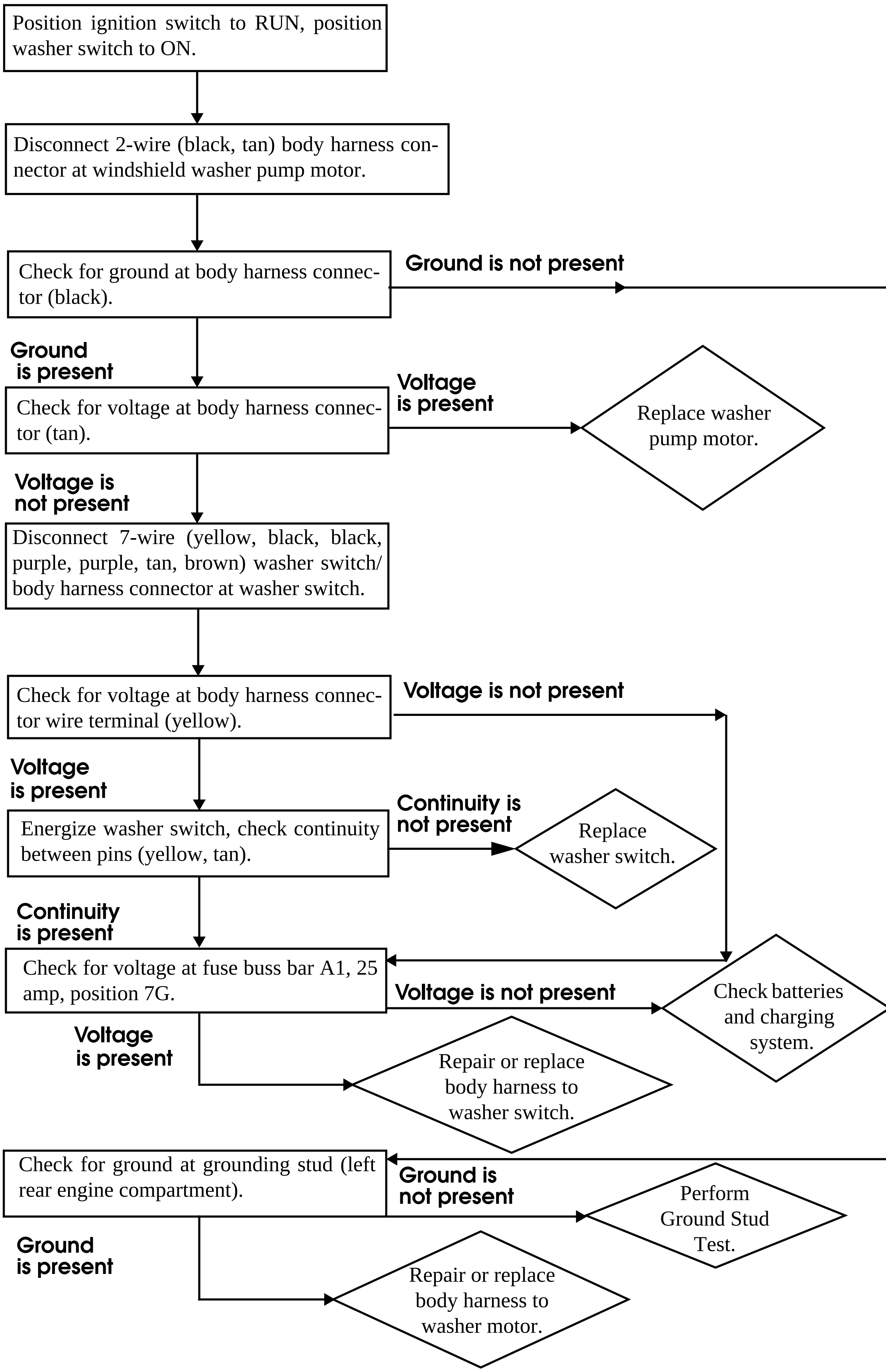
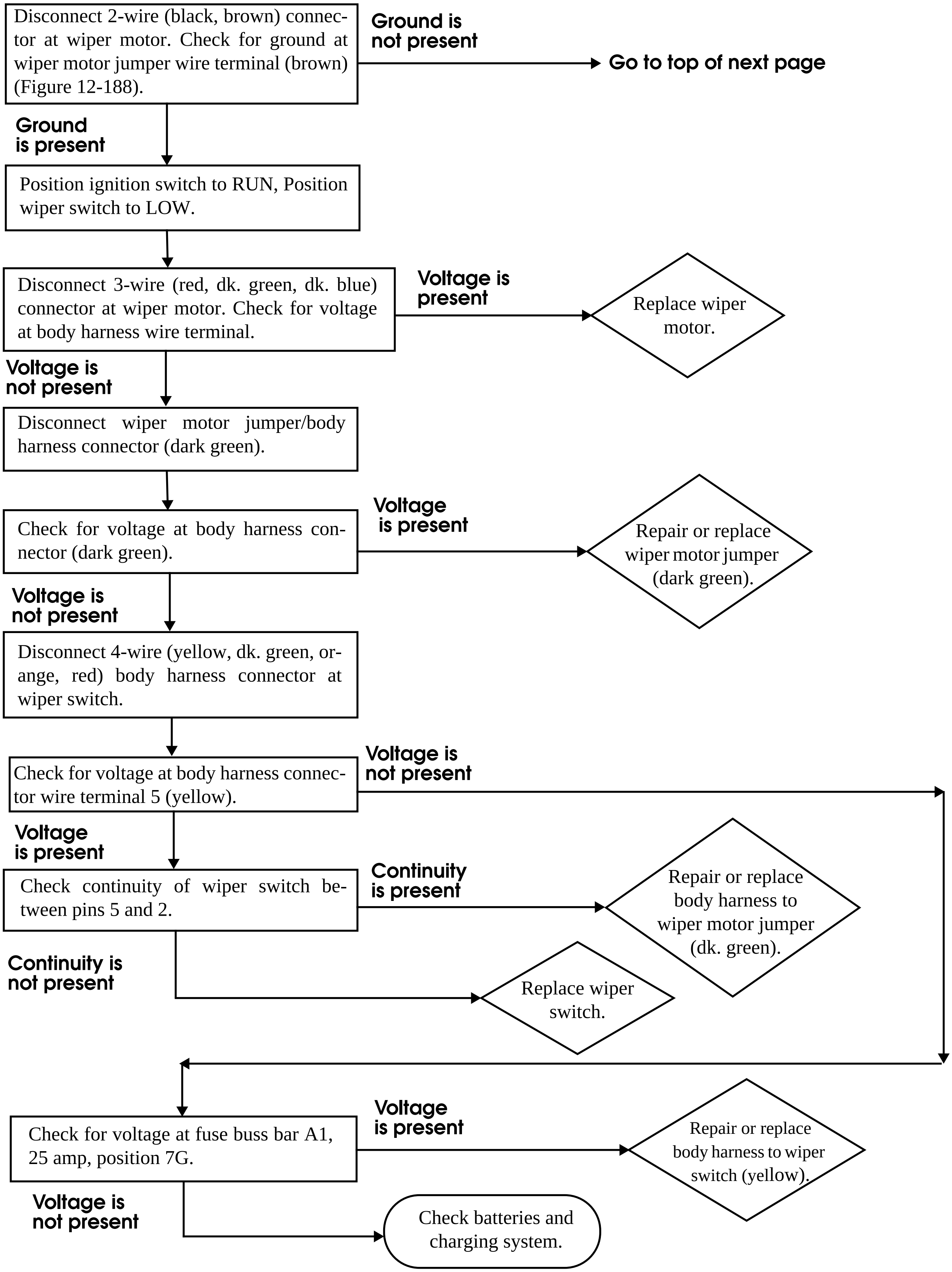


Figure 12-188: Brake System

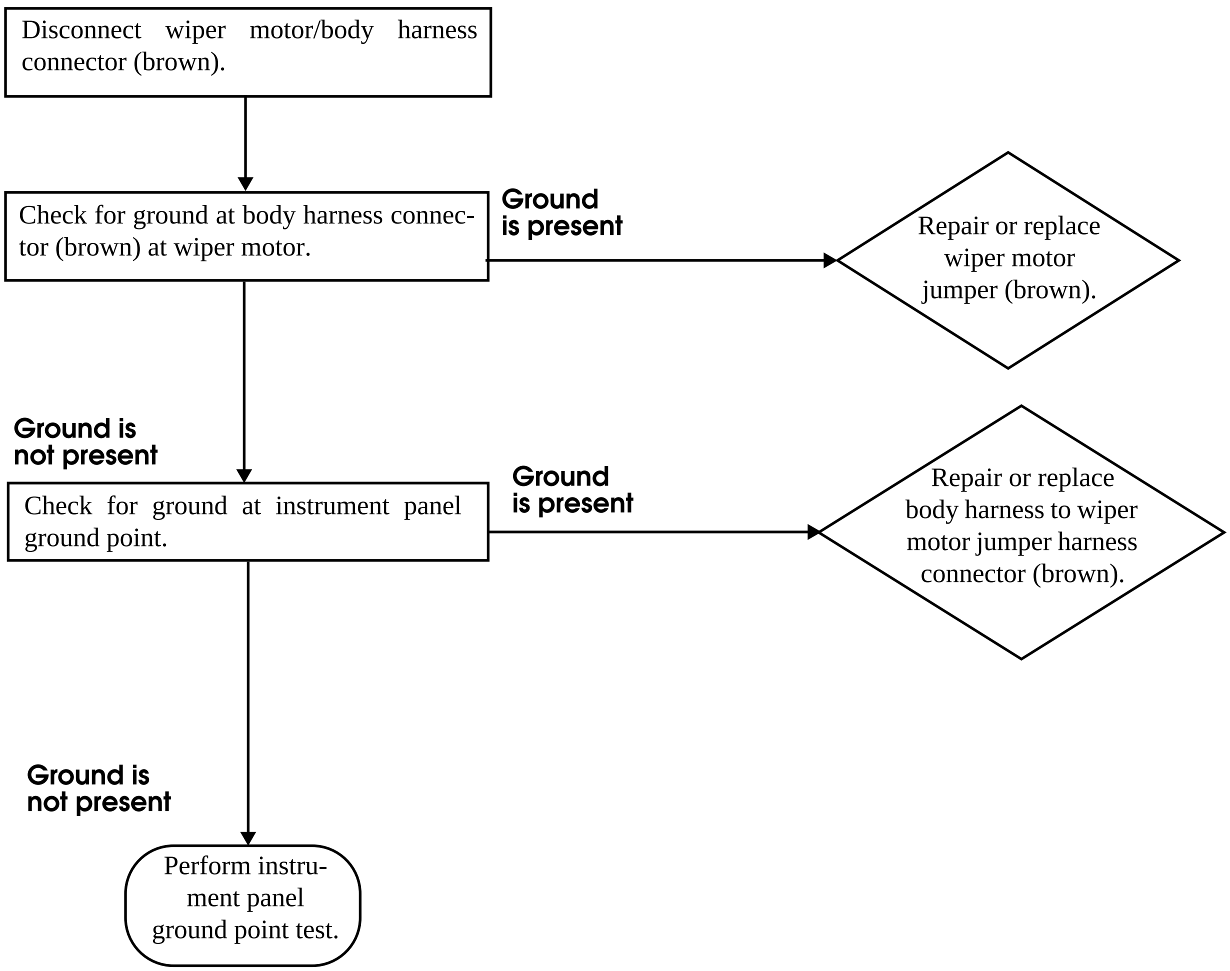
WINDSHIELD WASHER PUMP MOTOR INOPERATIVE


Position ignition switch to RUN, position washer switch to ON.
Disconnect 2-wire (black, tan) body harness connector at windshield washer pump motor.
Check for ground at body harness connector (black).
Ground is not present
Ground is present
Check for voltage at body harness connector (tan).
Voltage is present
Replace washer pump motor.
Voltage is not present
Disconnect 7-wire (yellow, black, black, purple, purple, tan, brown) washer switch/ body harness connector at washer switch.
Check for voltage at body harness connector wire terminal (yellow).
Voltage is not present
Voltage is present
Energize washer switch, check continuity between pins (yellow, tan).
Continuity is not present
Replace washer switch.
Continuity is present
Check for voltage at fuse buss bar A1, 25 amp, position 7G.
Voltage is not present
Check batteries and charging system.
Voltage is present
Repair or replace body harness to washer switch.
Check for ground at grounding stud (left rear engine compartment).
Ground is not present
Perform Ground Stud Test.
Ground is present
Repair or replace body harness to washer motor.

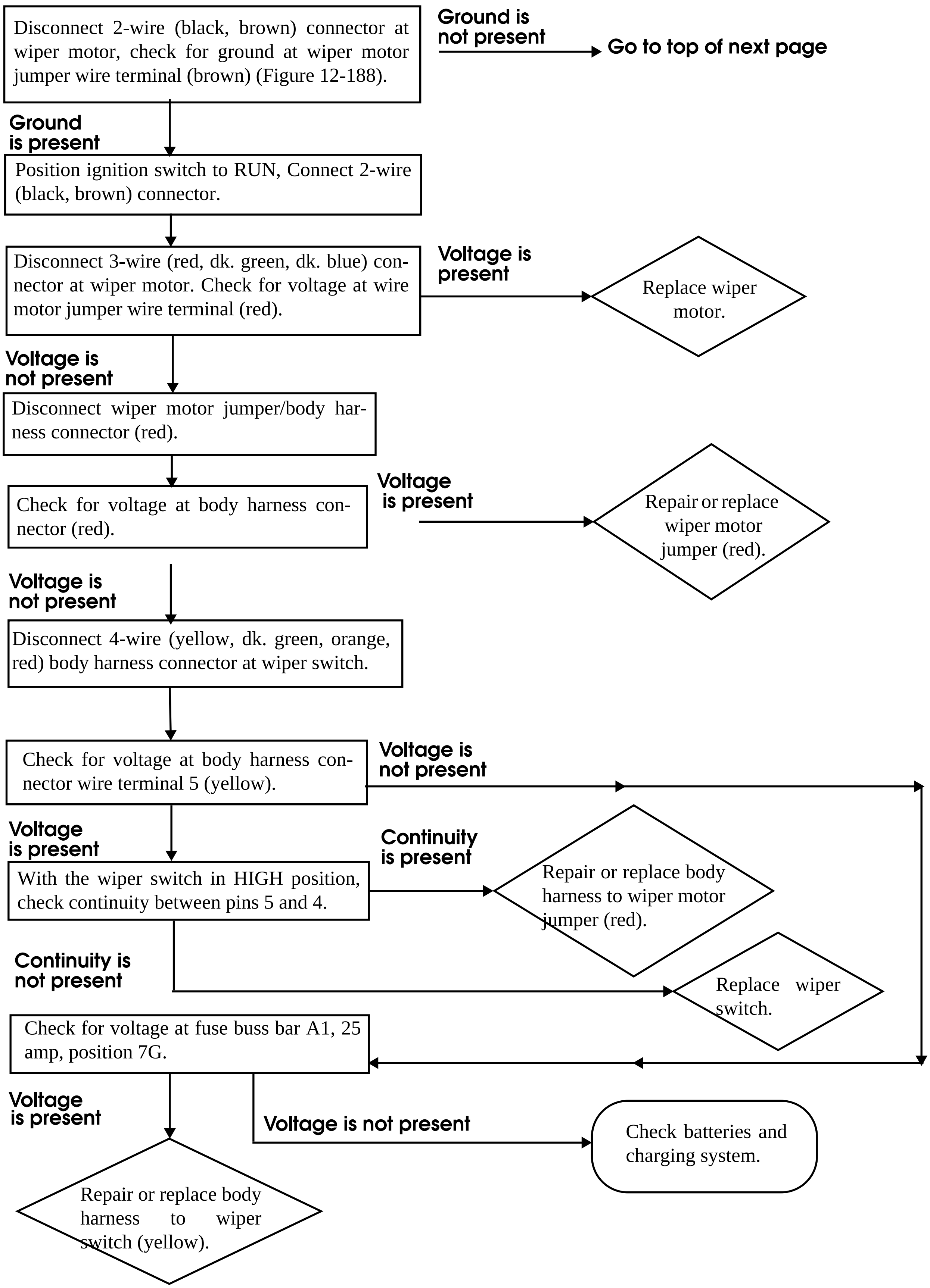
WINDSHIELD WIPERS (LOW) INOPERATIVE



WINDSHIELD WIPERS (LOW) INOPERATIVE — CONTINUED



WINDSHIELD WIPERS (HI) INOPERATIVE



WINDSHIELD WIPERS (HI) INOPERATIVE — CONTINUED

Disconnect wiper motor jumper/body harness connector (brown).

Check for ground at body harness connector (brown) at wiper motor.

Ground is present

Repair or replace ground wire (brown) to wiper motor.

Ground is not present

Check for ground at instrument panel ground point.

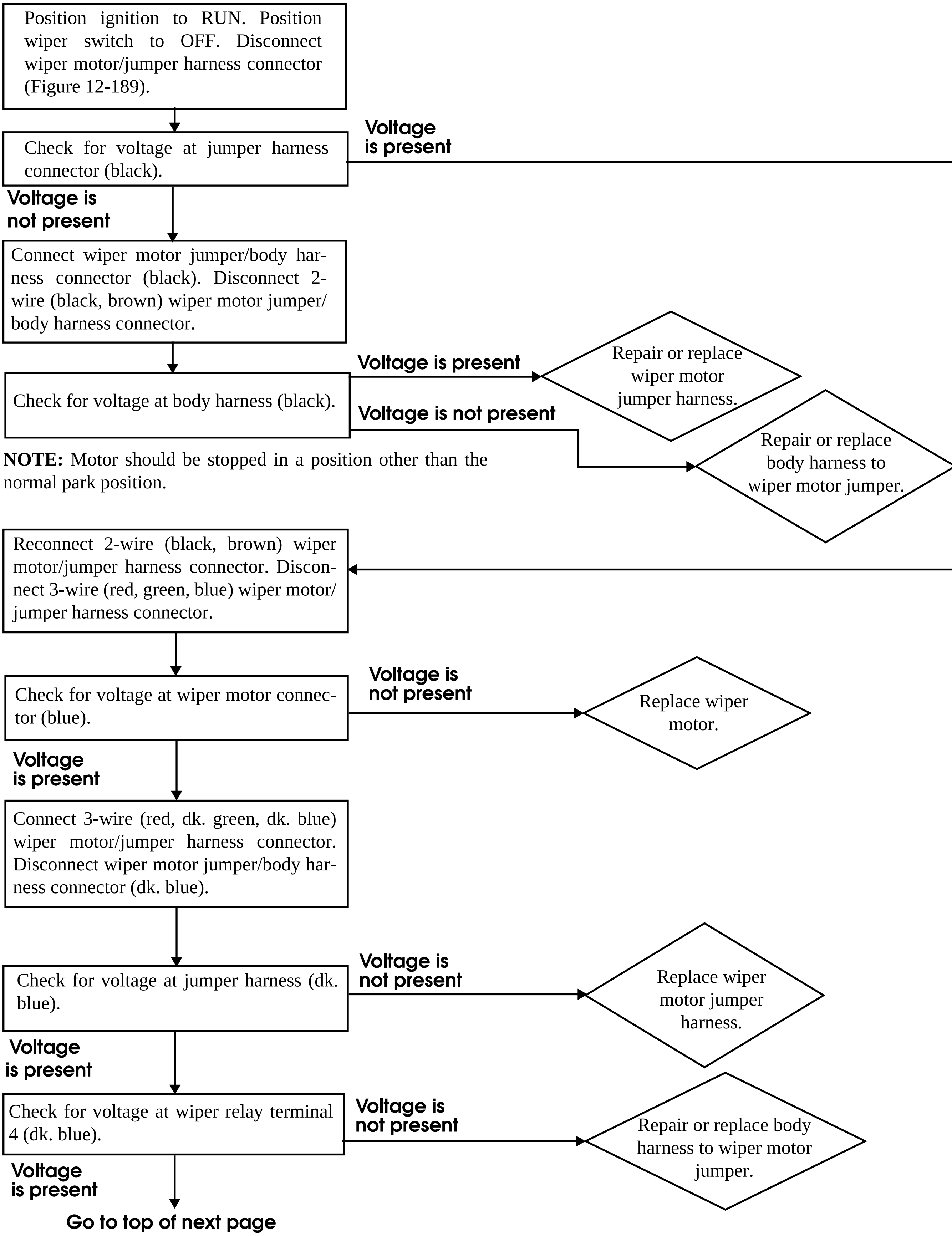
Ground is present

Repair or replace body harness to wiper motor jumper harness connector (brown).

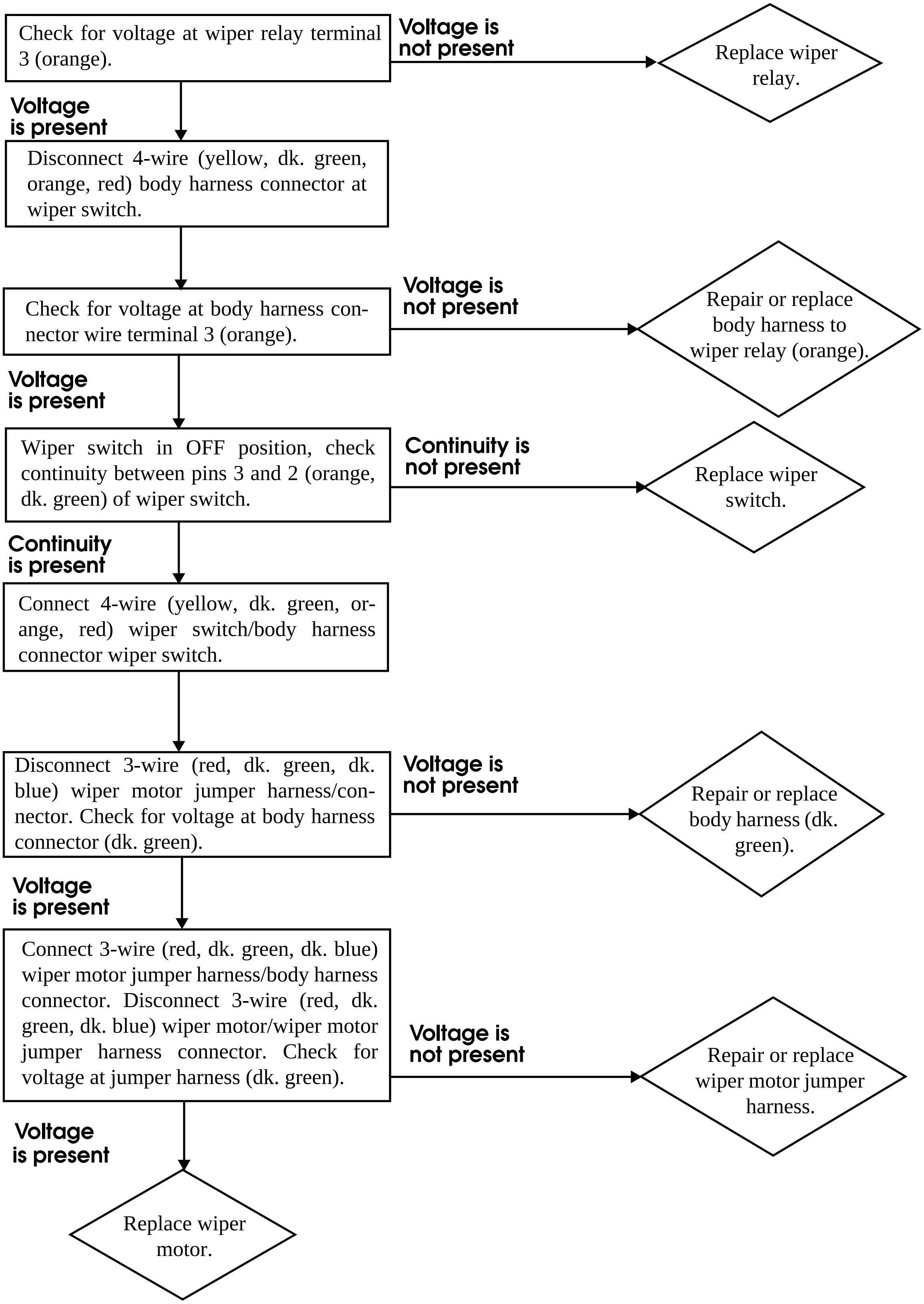
Ground is not present

Perform Instrument Panel Ground Point Test.

WINDSHIELD WIPERS FAIL TO PARK IN PROPER POSITION



WINDSHIELD WIPERS FAIL TO PARK IN PROPER POSITION — CONTINUED



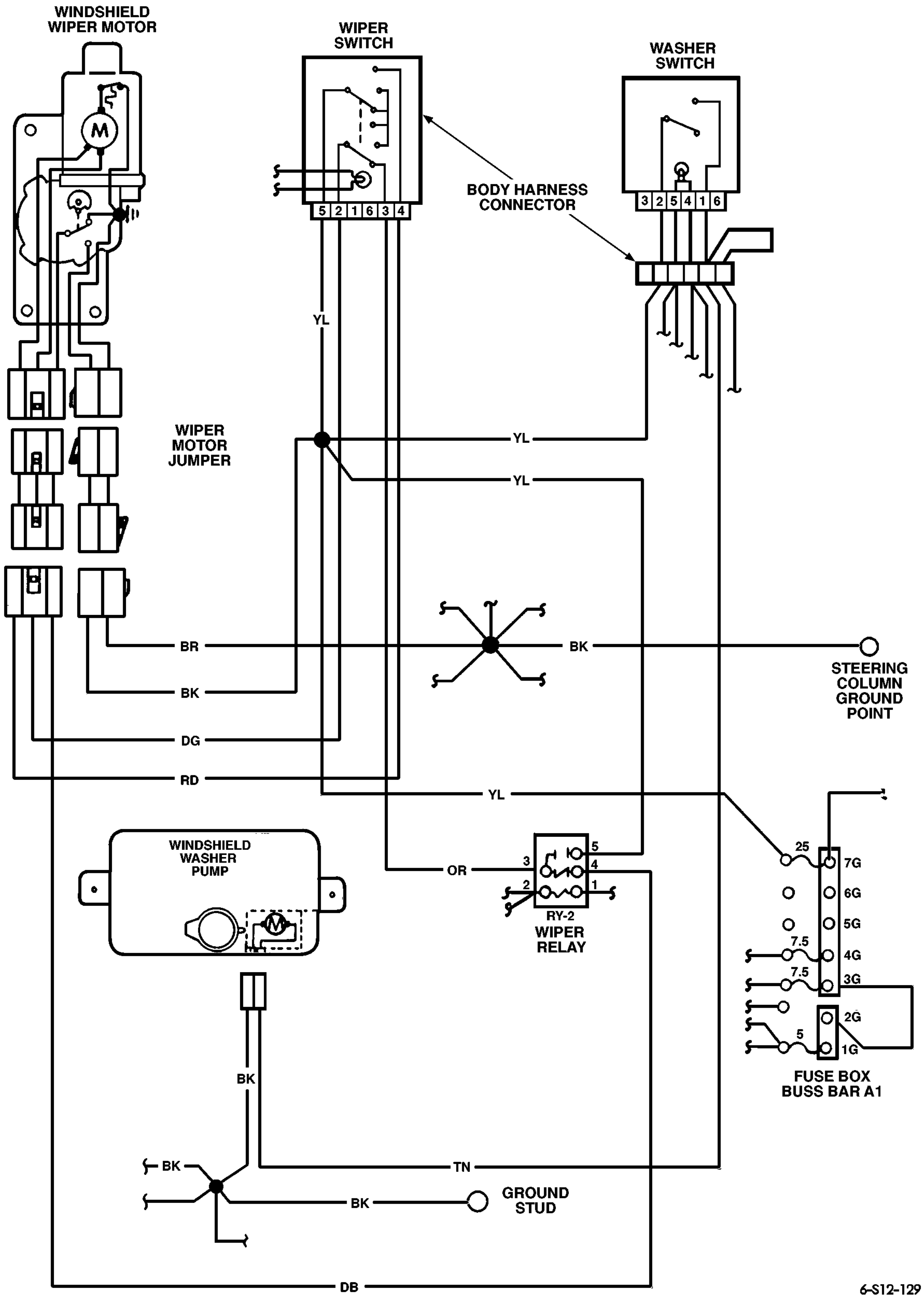
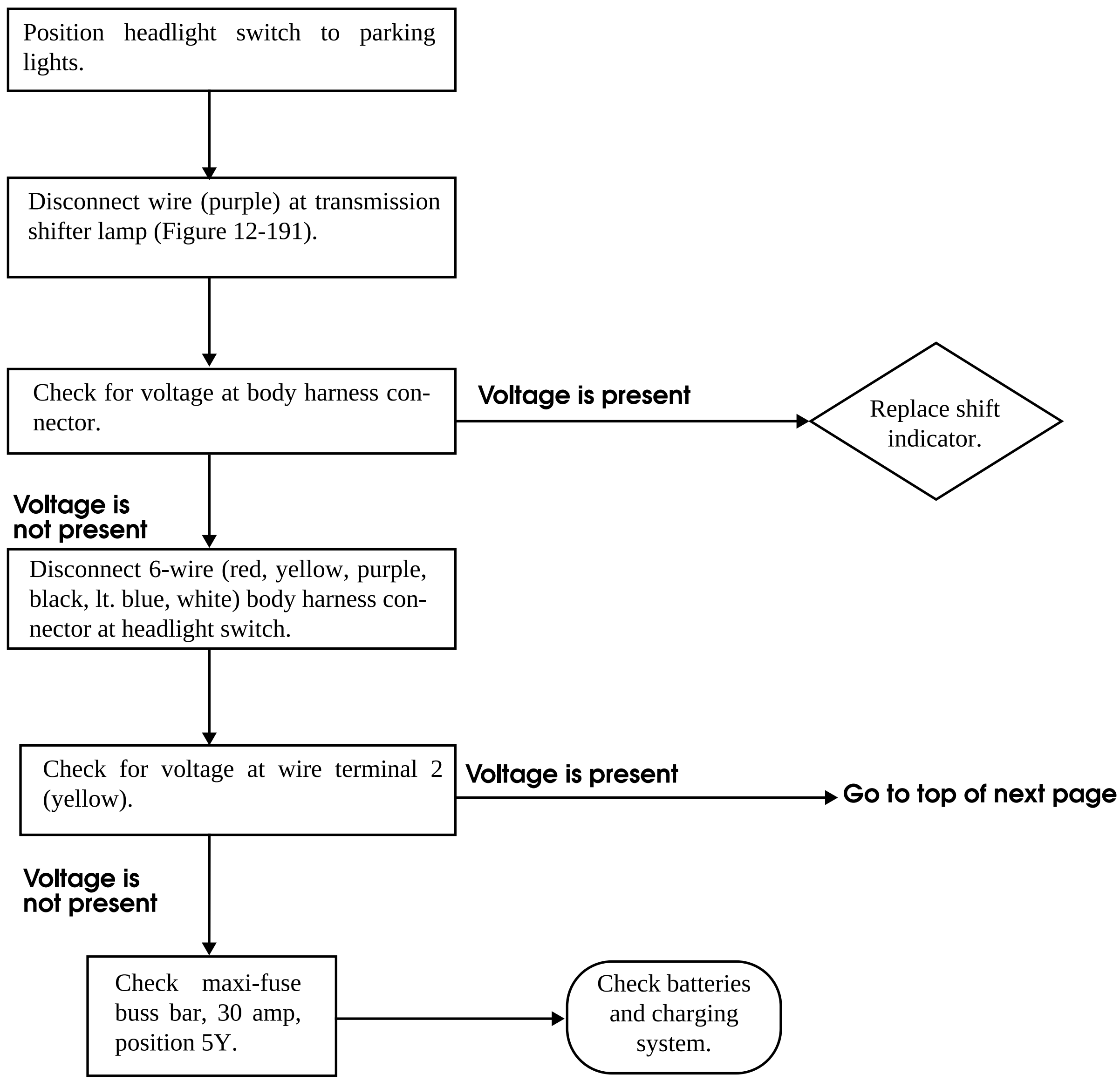
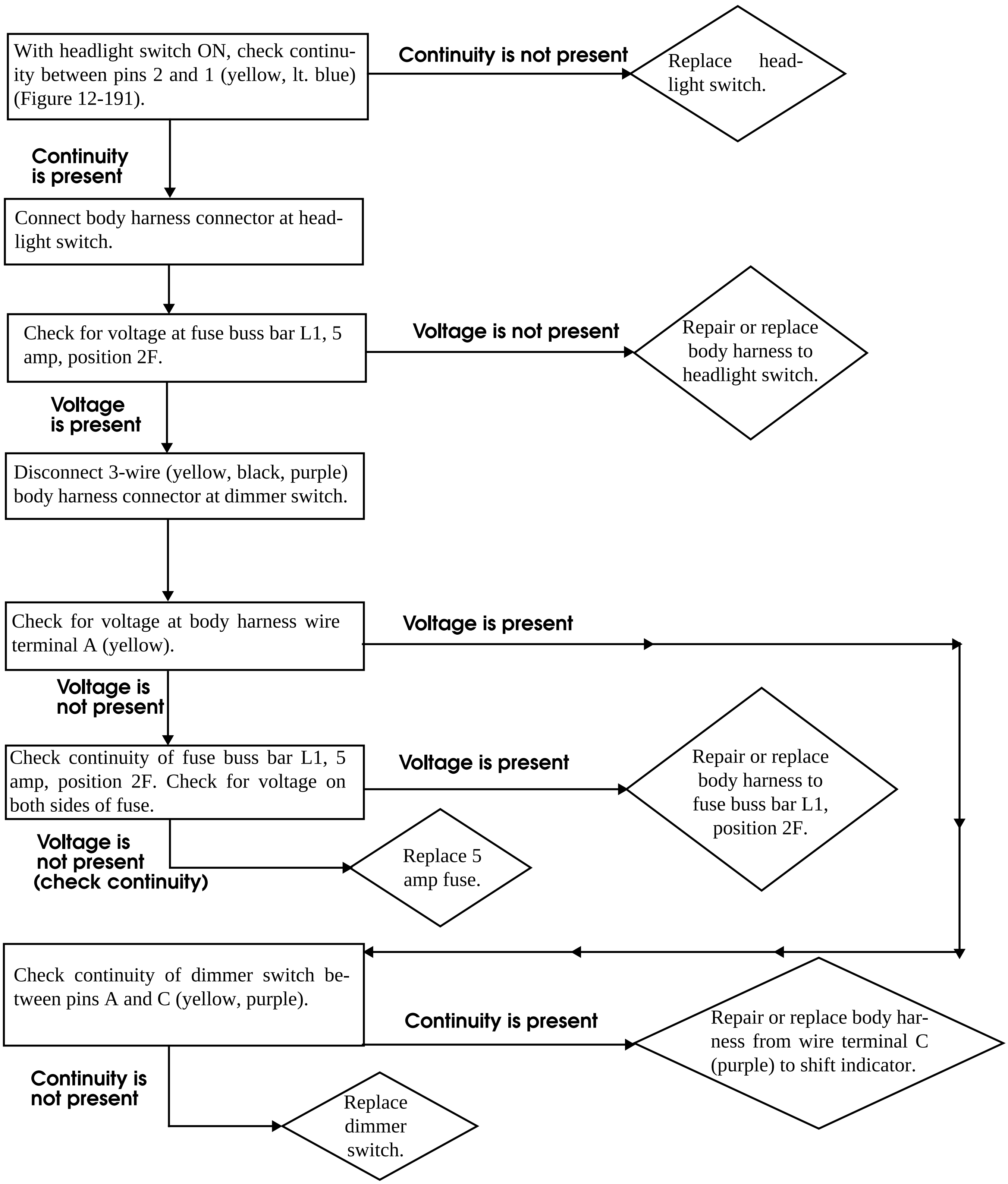


Figure 12-189: Windshield Wiper and Washer System

SHIFT INDICATOR INOPERATIVE



SHIFT INDICATOR INOPERATIVE – CONTINUED



NEUTRAL SAFETY SWITCH INOPERATIVE

Check for voltage at maxi-fuse buss bar, 40 amp, position 1Y (Figure 12-192).

Voltage is not present → Check batteries and charging system.

Voltage is present

Disconnect 8-wire (yellow, yellow, gray, lt. green, lt. green, orange, white, tan) body harness connector at ignition switch.

Check for voltage at body harness connector pins 1 and 2 (yellow, yellow).

Voltage is not present → Repair or replace body harness to maxi-fuse buss bar, 40 amp, position 1Y.

Voltage is present

Check continuity of ignition switch between pins 1 and 9 (yellow, white) and 2 and 9 (yellow, white) with ignition switch in START position.

Continuity is not present → Replace ignition switch.

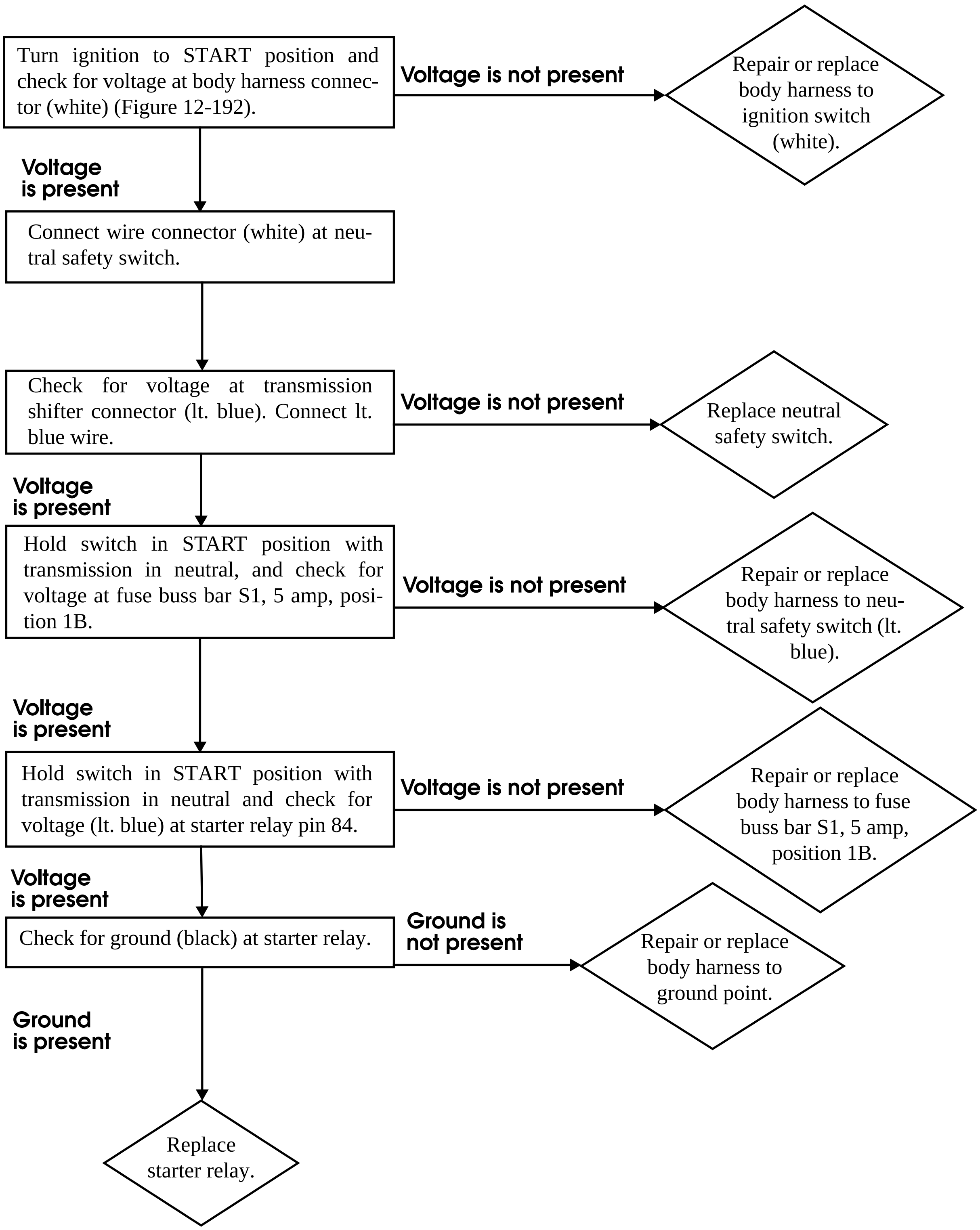
Continuity is present

Connect body harness connector at ignition switch.

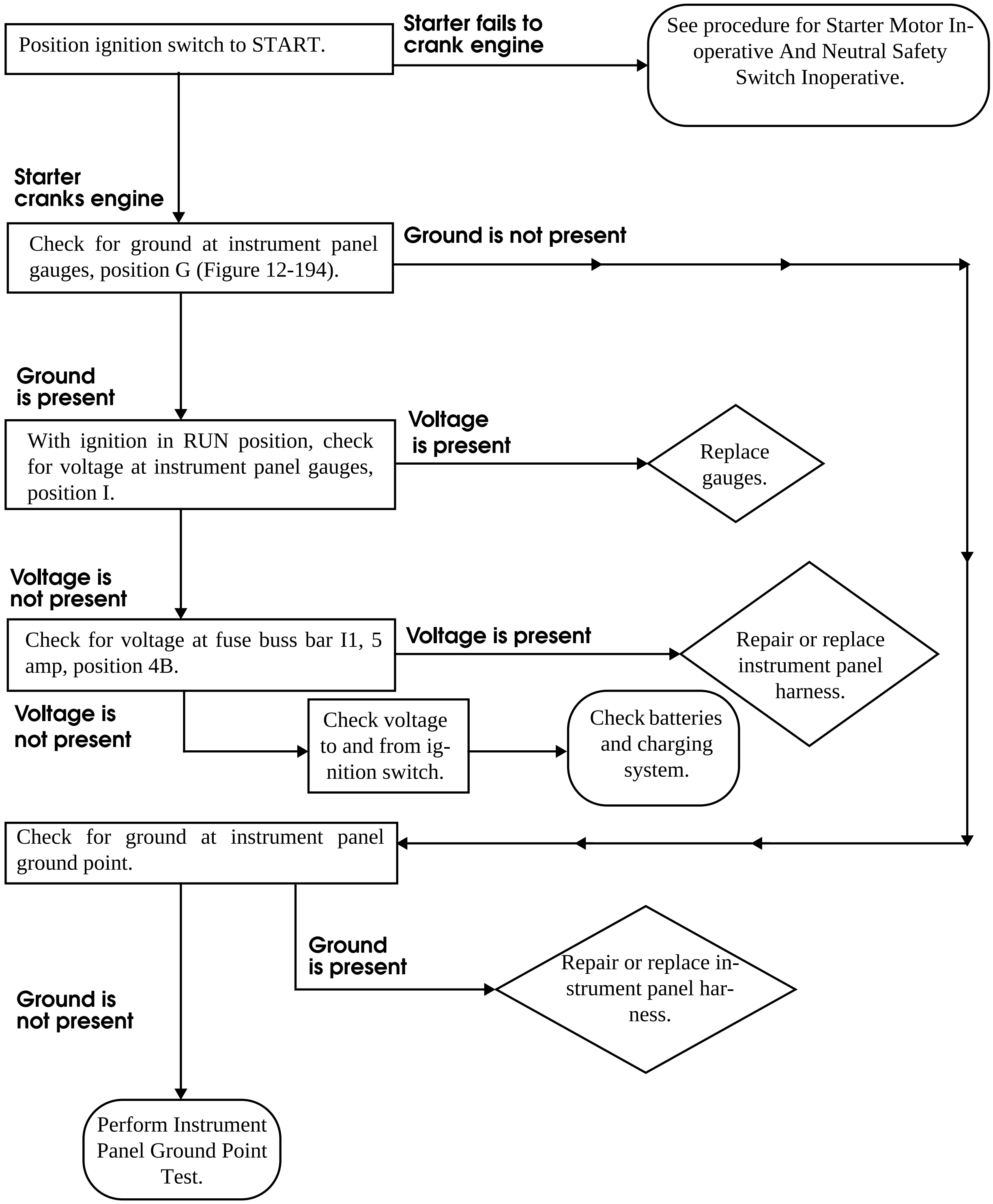
Disconnect wire connectors (lt. blue, white) at neutral safety switch.

→ **Go to top of next page**

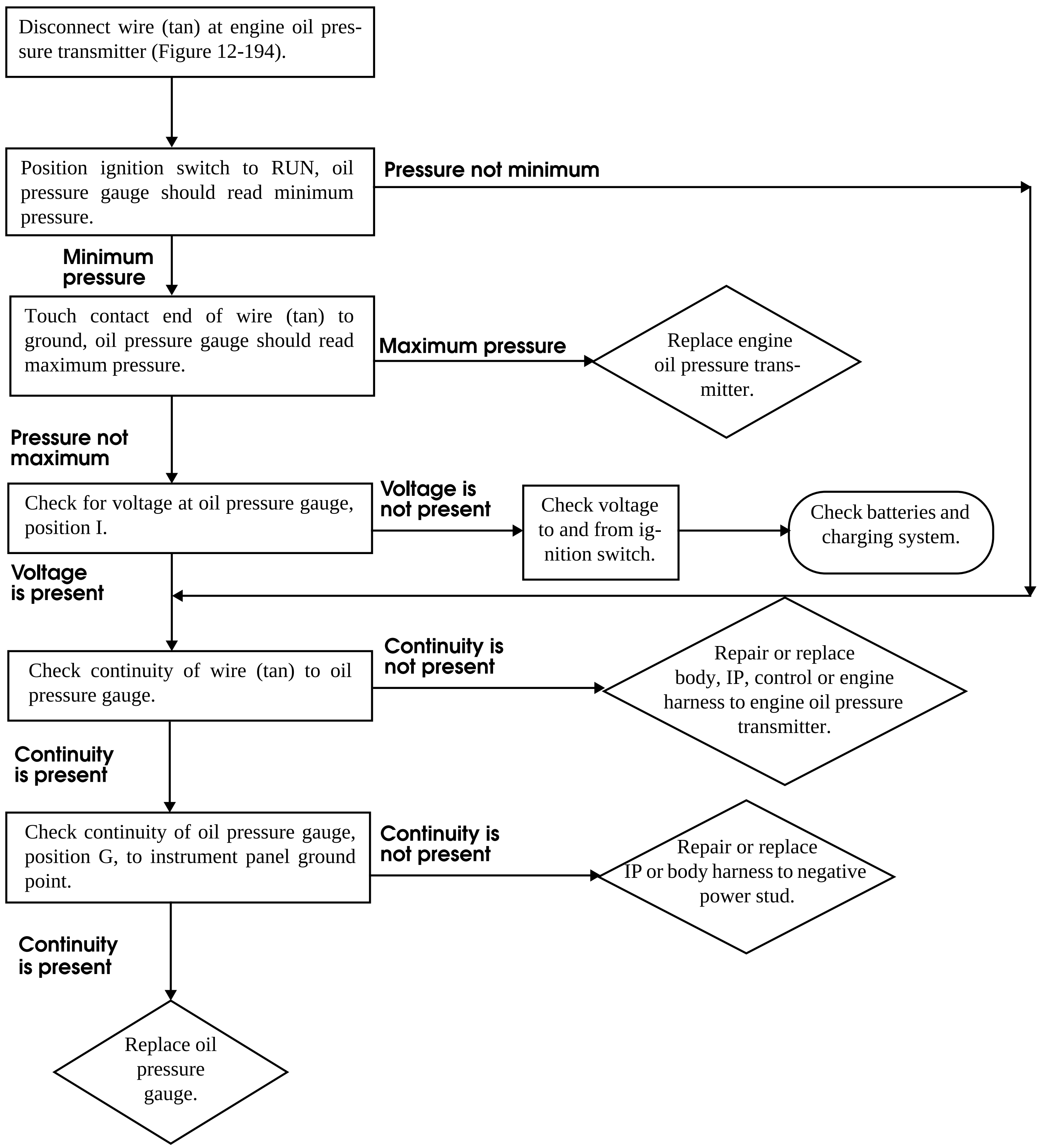
NEUTRAL SAFETY SWITCH INOPERATIVE – CONTINUED



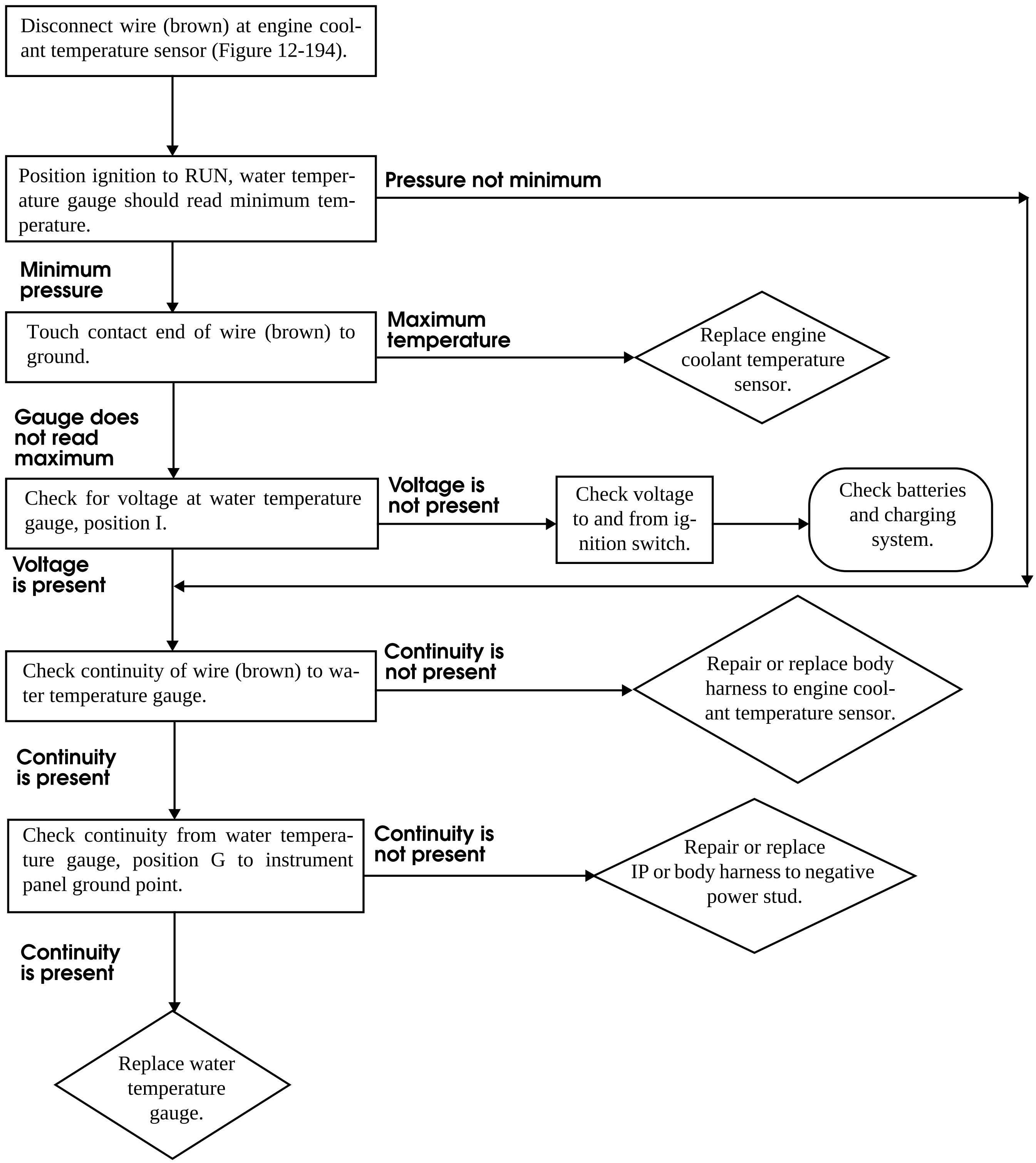
ALL GAUGES INOPERATIVE



OIL PRESSURE GAUGE INOPERATIVE

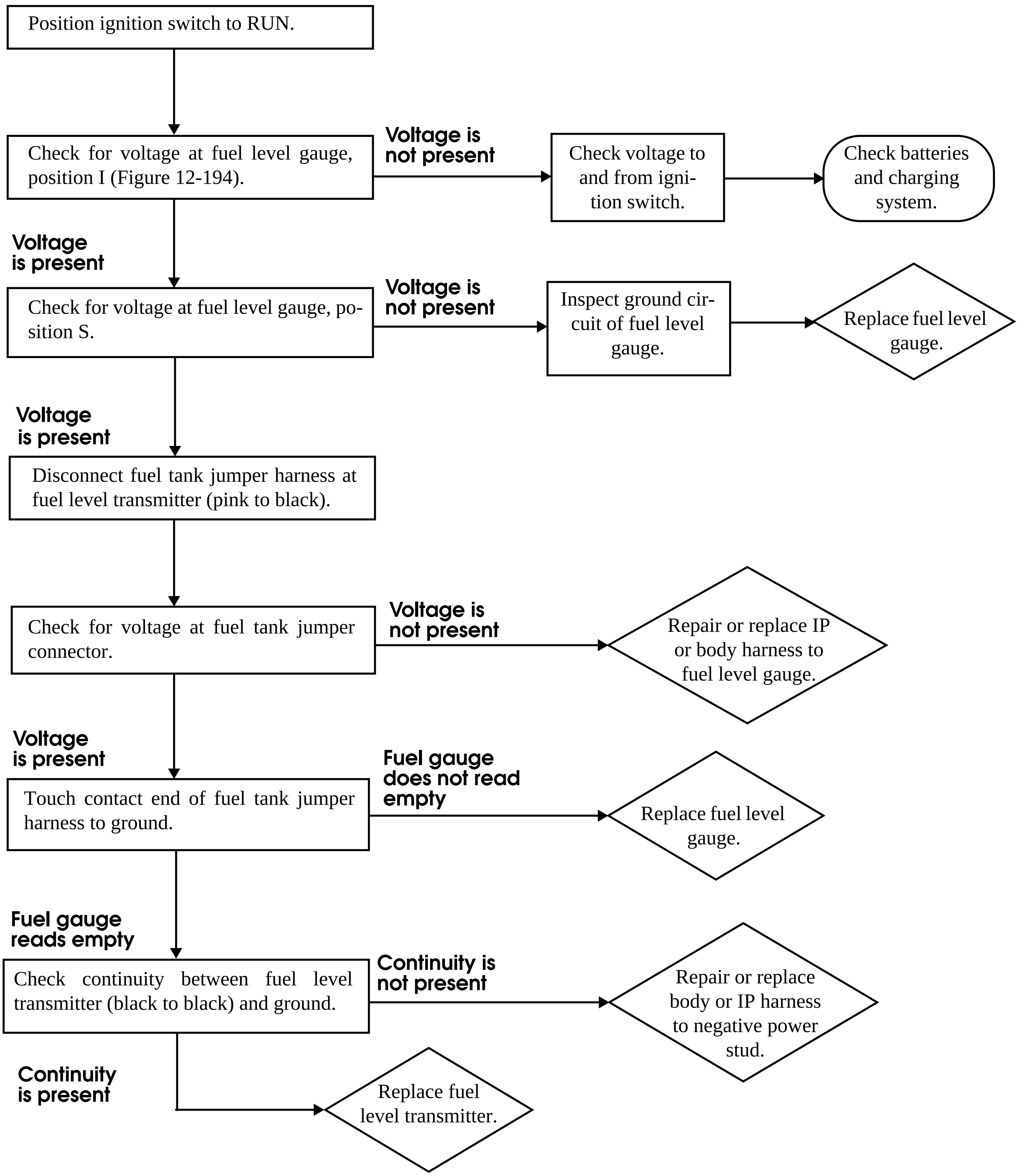


WATER TEMPERATURE GAUGE INOPERATIVE

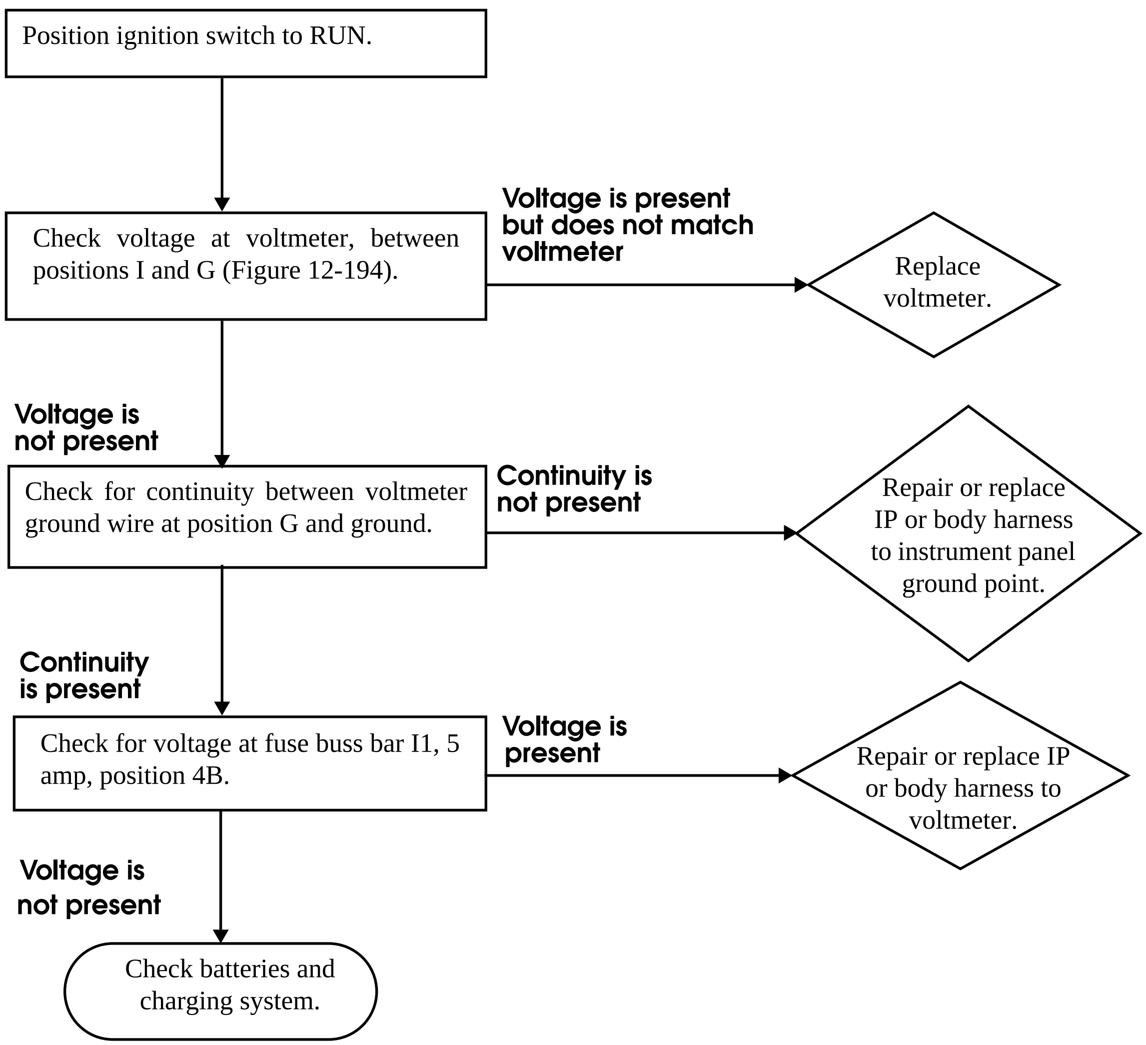


FUEL LEVEL GAUGE INOPERATIVE

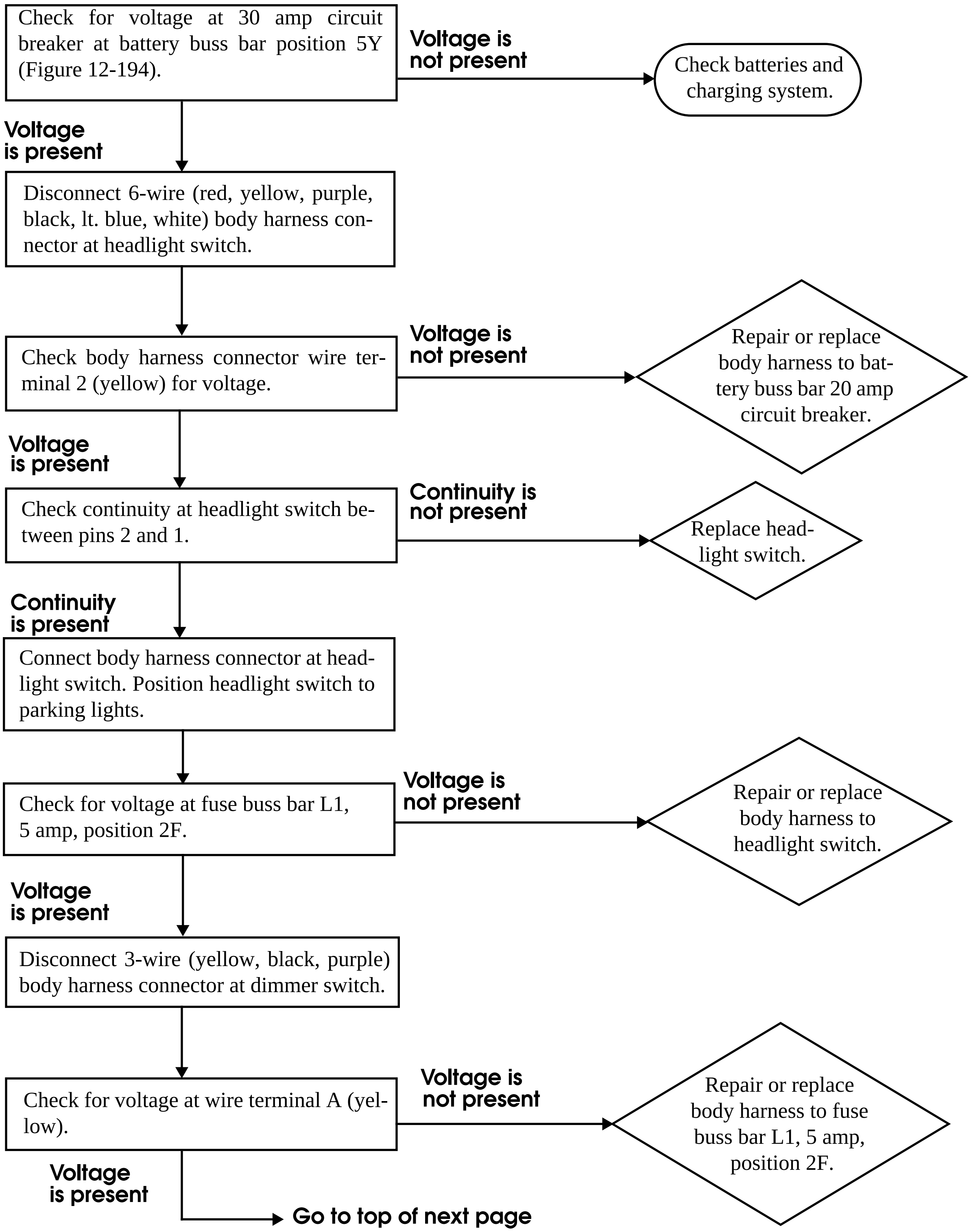
WARNING: Do not perform electrical troubleshooting near fuel tank with fill cap or sending unit removed. Fuel may ignite and cause injury.



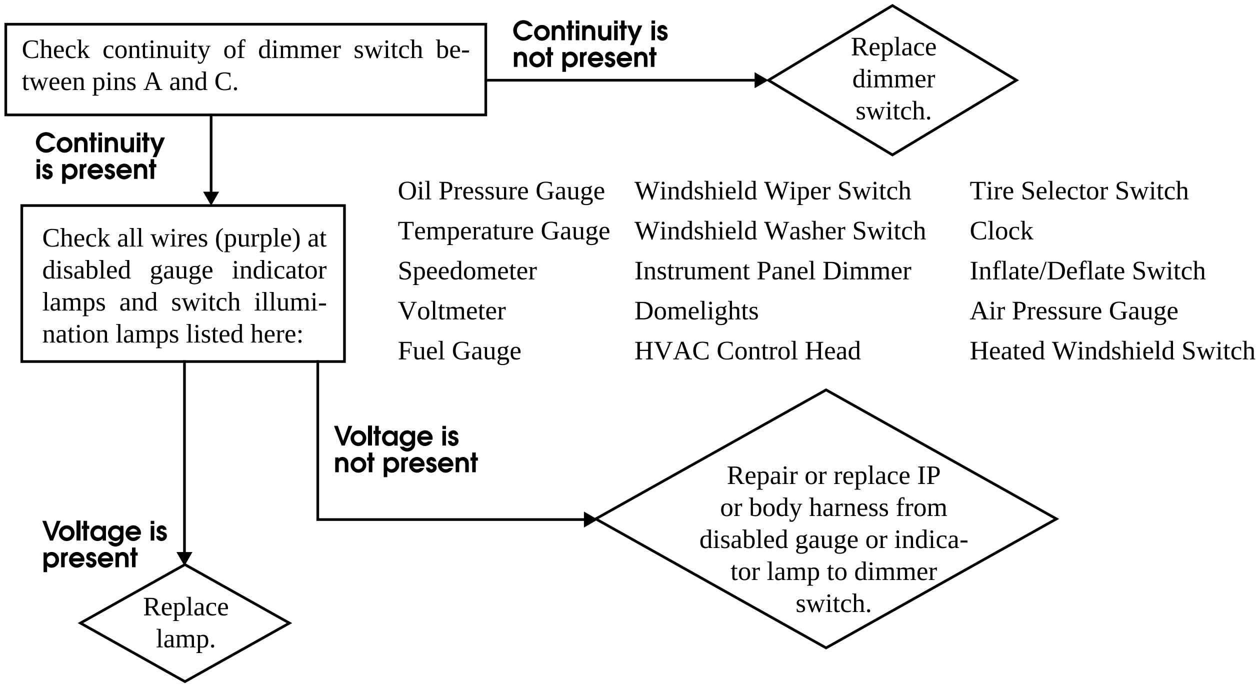
VOLTMETER GAUGE INOPERATIVE



GAUGE INDICATOR LAMP(S) INOPERATIVE



GAUGE INDICATOR LAMP(S) INOPERATIVE – CONTINUED



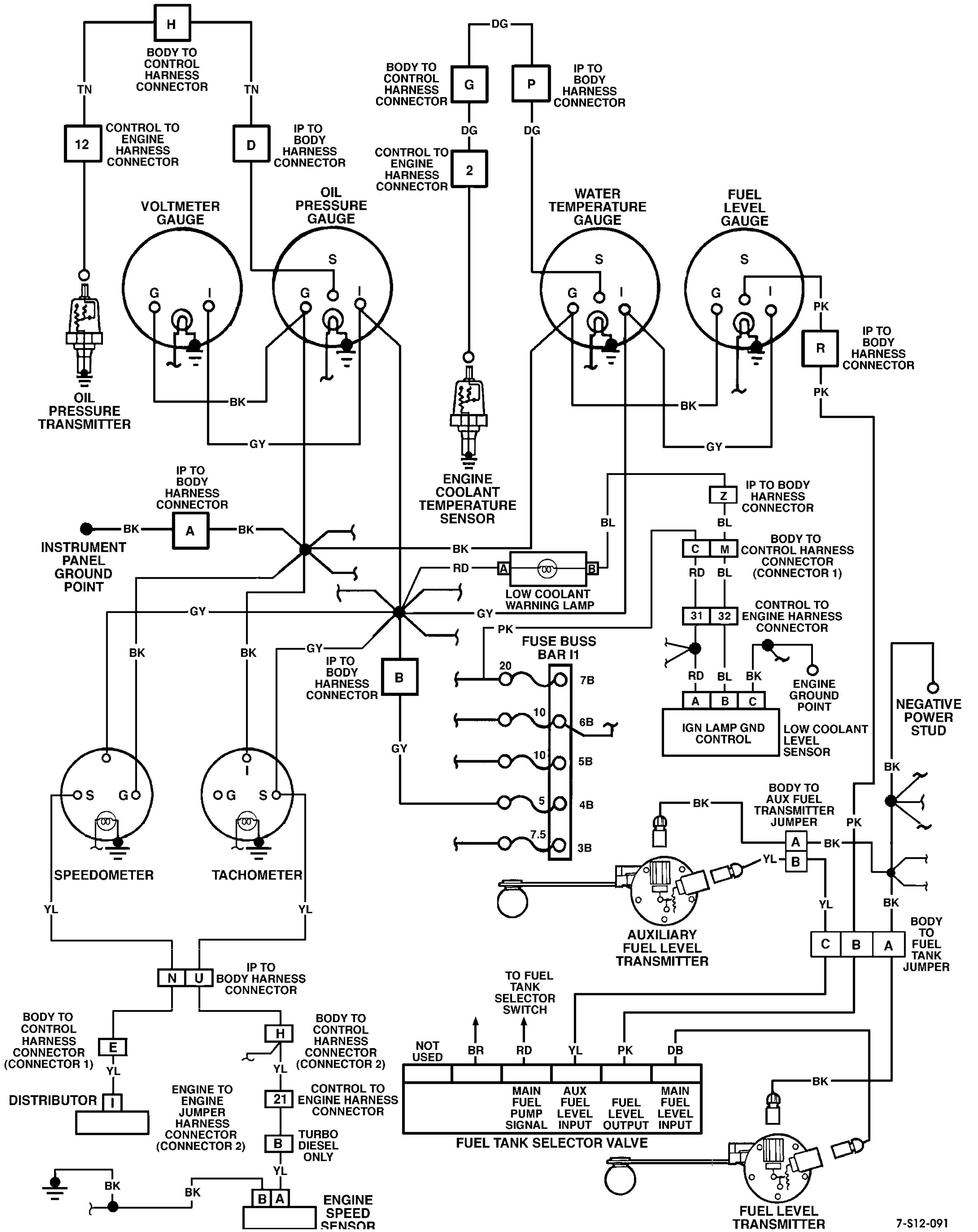
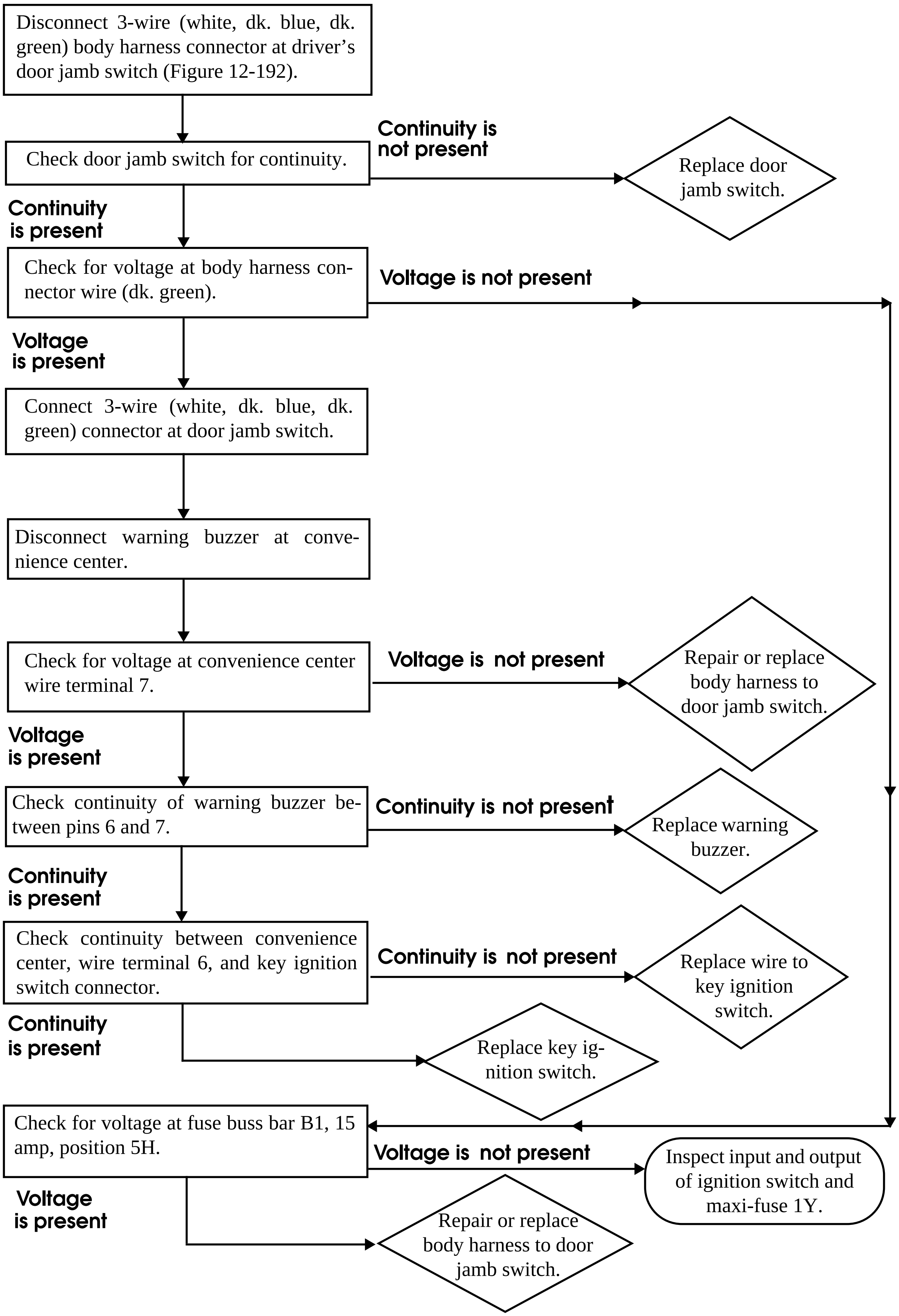
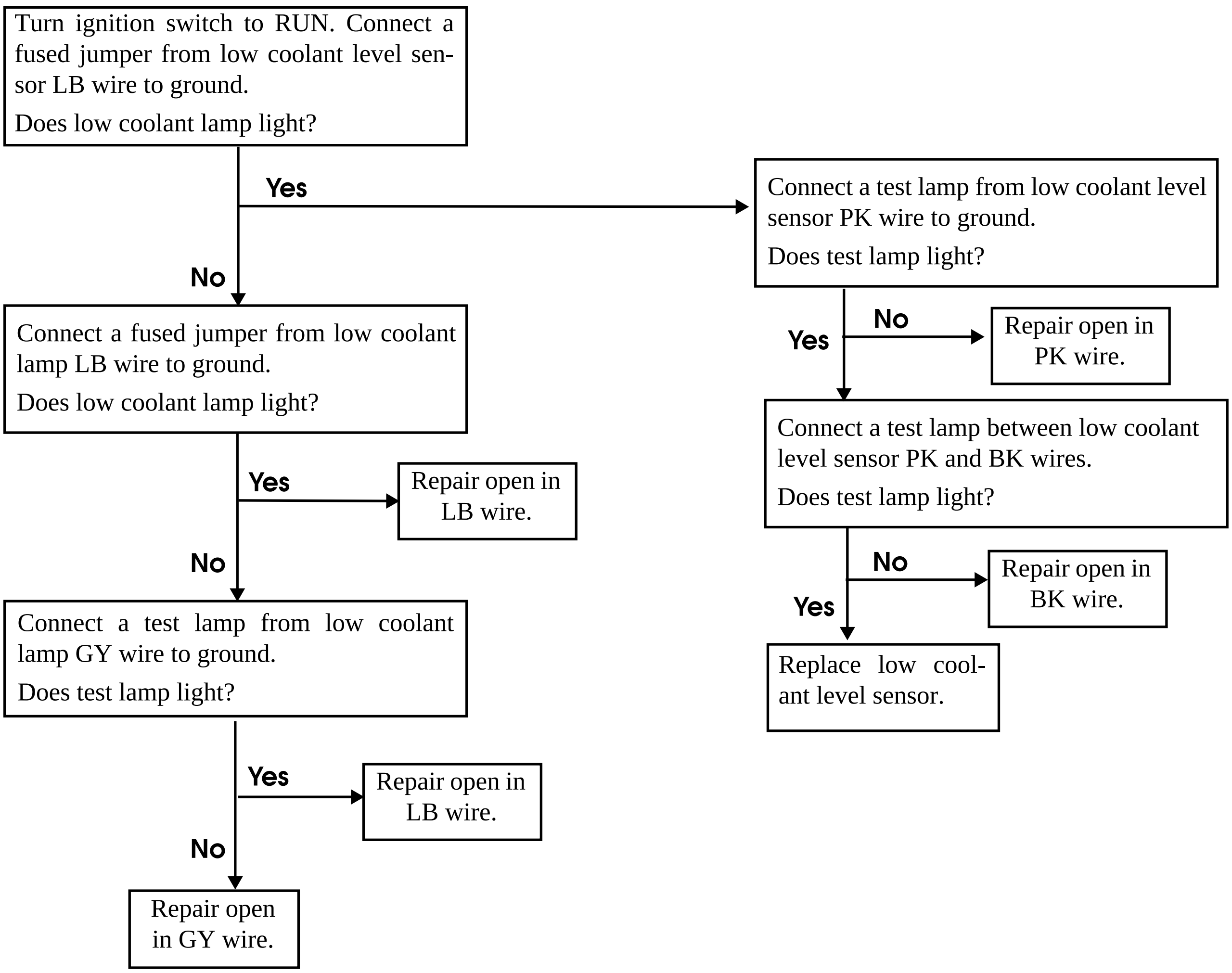


Figure 12-190: Instrument Panel Gauges

ANTI-THEFT KEY BUZZER INOPERATIVE



LOW COOLANT LAMP INOPERATIVE



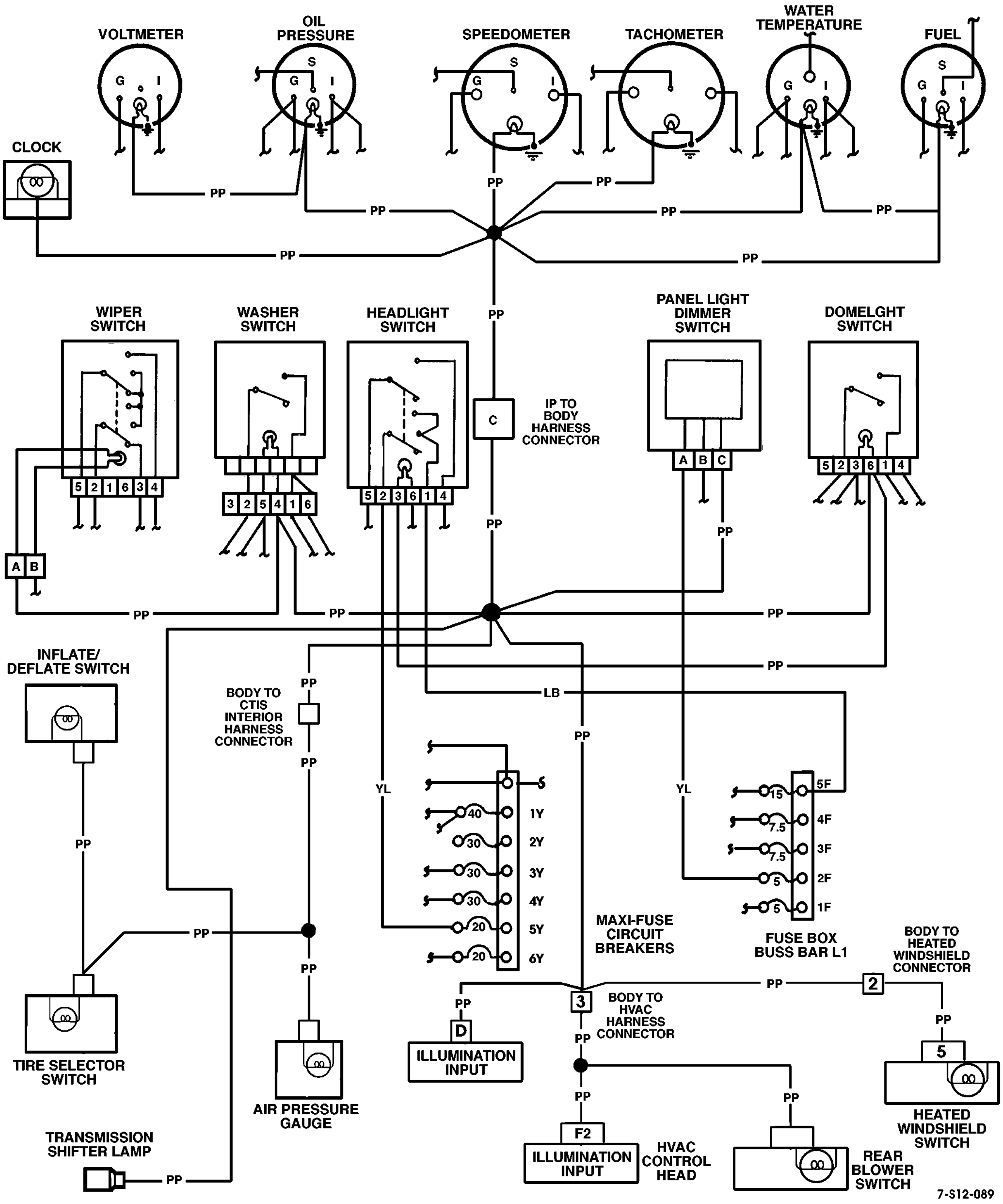
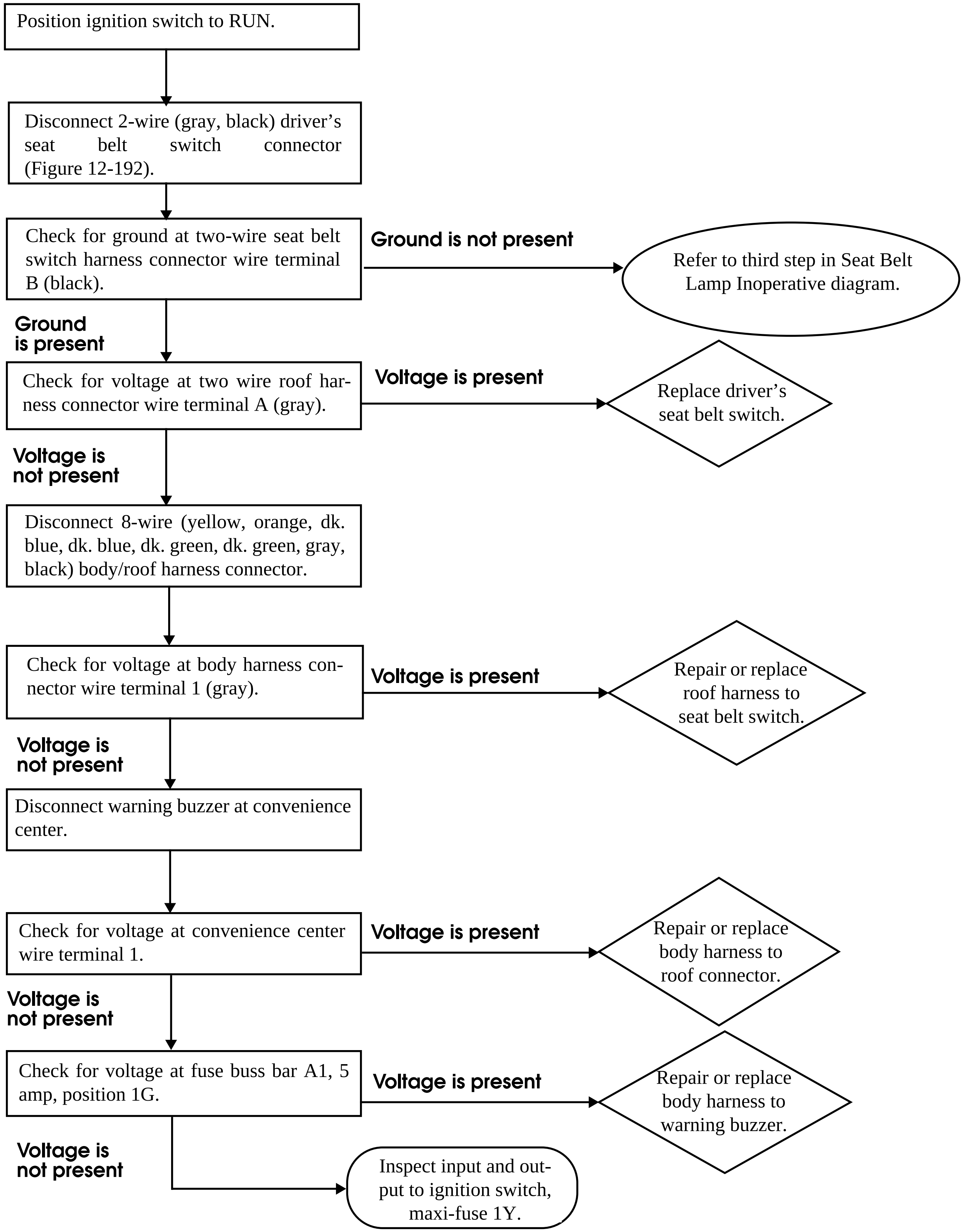


Figure 12-191: Gauge Indicator Lamps

SEAT BELT BUZZER ALARM INOPERATIVE



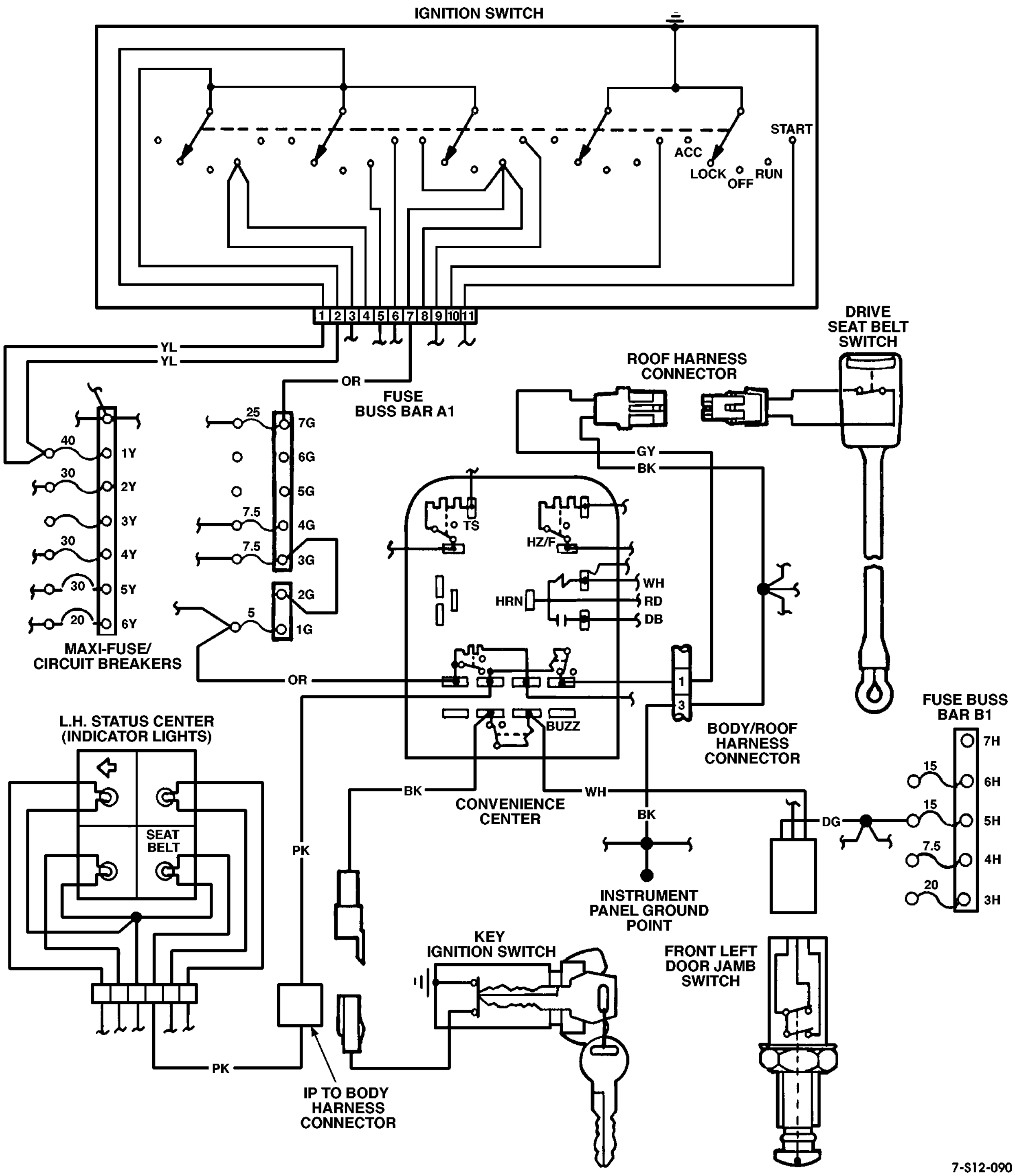
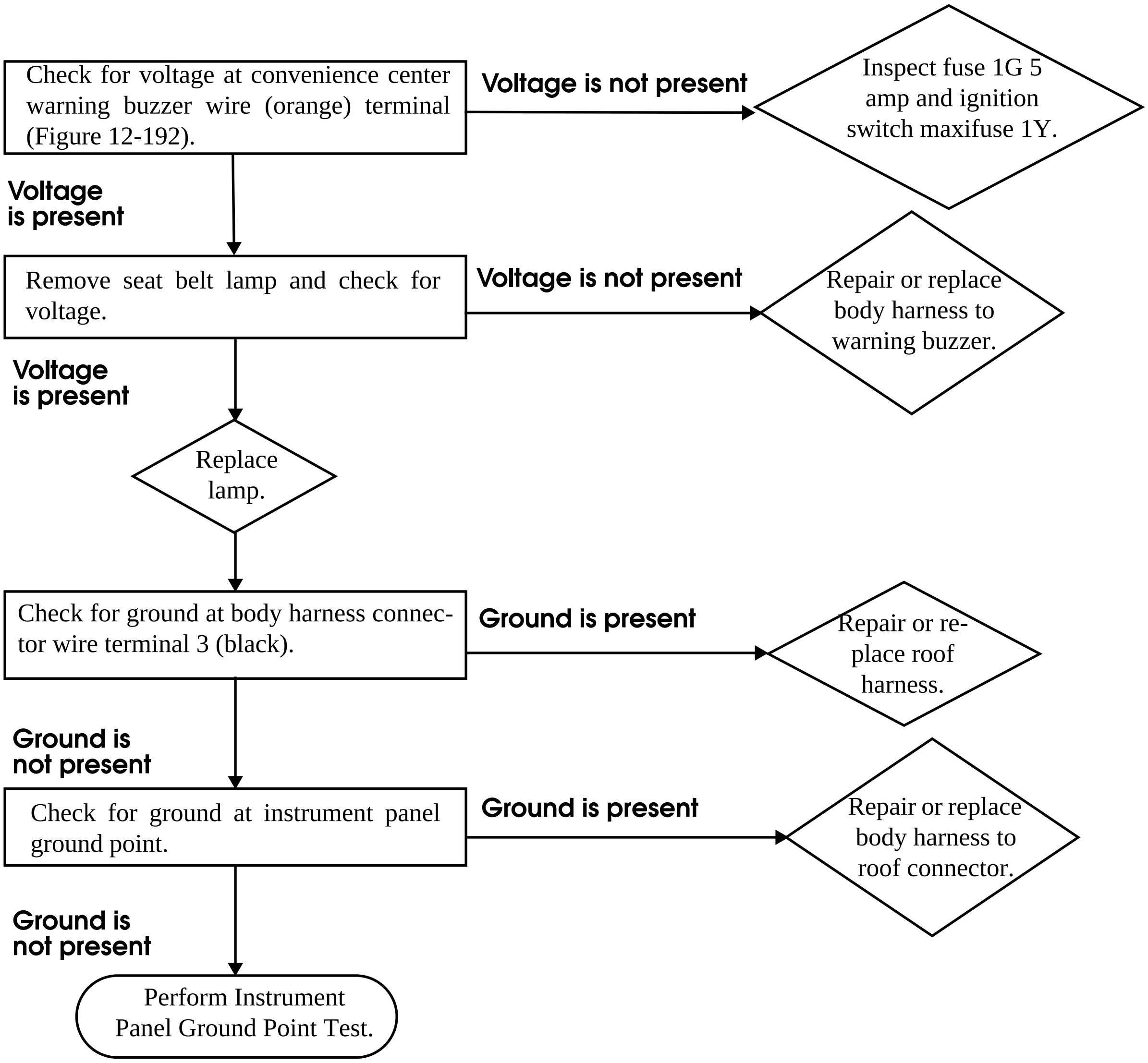


Figure 12-192: Seat Belt Buzzer

SEAT BELT LAMP INOPERATIVE



HORN INOPERATIVE

Connect a fused jumper at turn signal switch connector DB wire to ground.
Do the horns sound?

- Yes → Check for an open in BK wire between turn signal switch and steering column ground.
- No ↓

Connect a test lamp from horn relay RD wire to ground.
Does test lamp light?

- No → Repair open in RD wire between B2 buss and horn relay.
- Yes ↓

Connect a fused jumper between horn relay RD and WH wires.
Do the horns sound?

- Yes → Replace horn relay.
- No ↓

Leave fused jumper connected. Connect a test lamp from horn WH wire to ground.
Does test lamp light?

- No → Repair open in WH wire between horn relay and horns.
- Yes ↓

Check for an open in BK wire between horns and power ground studs.
If OK, replace inoperative horn(s).

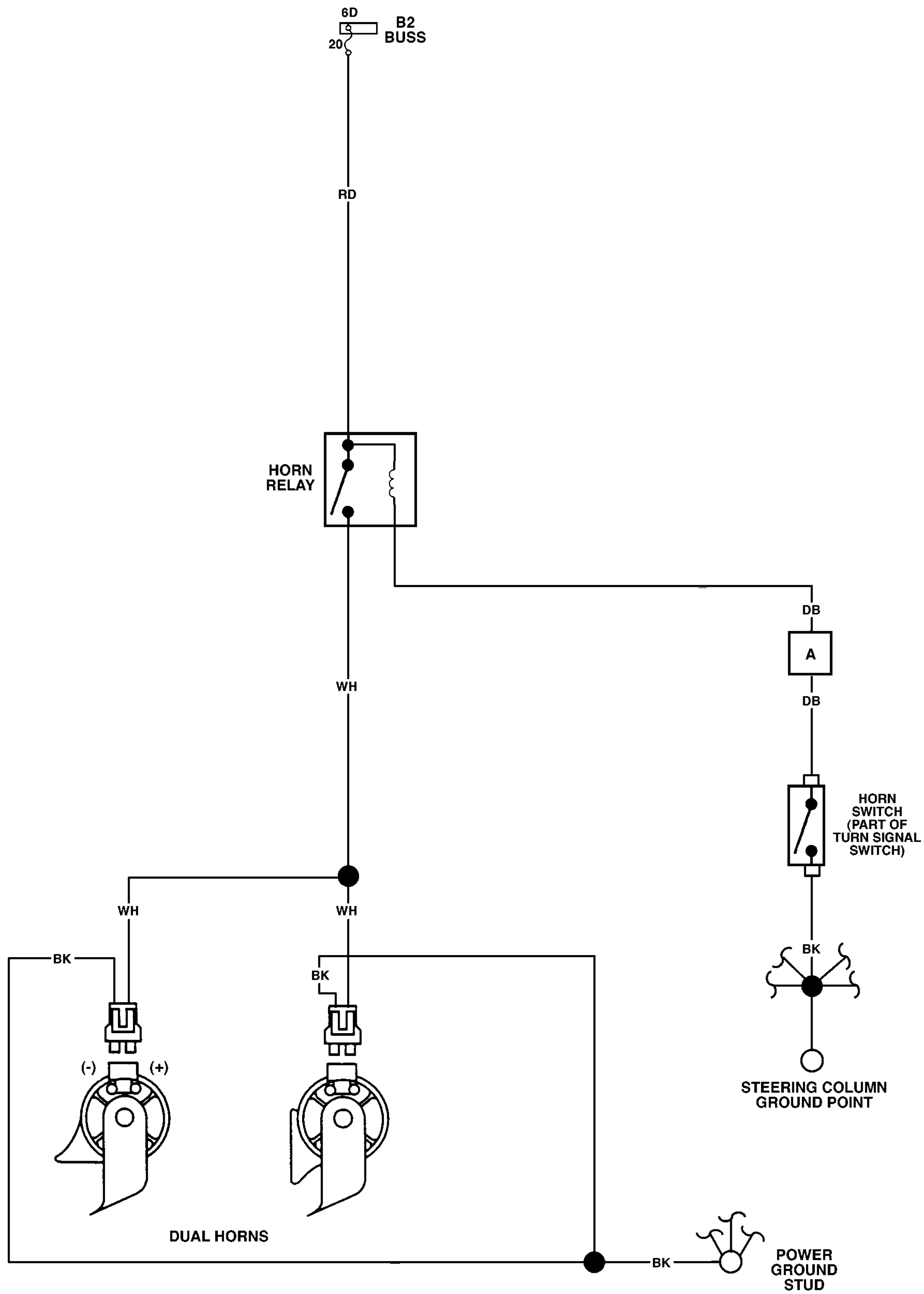
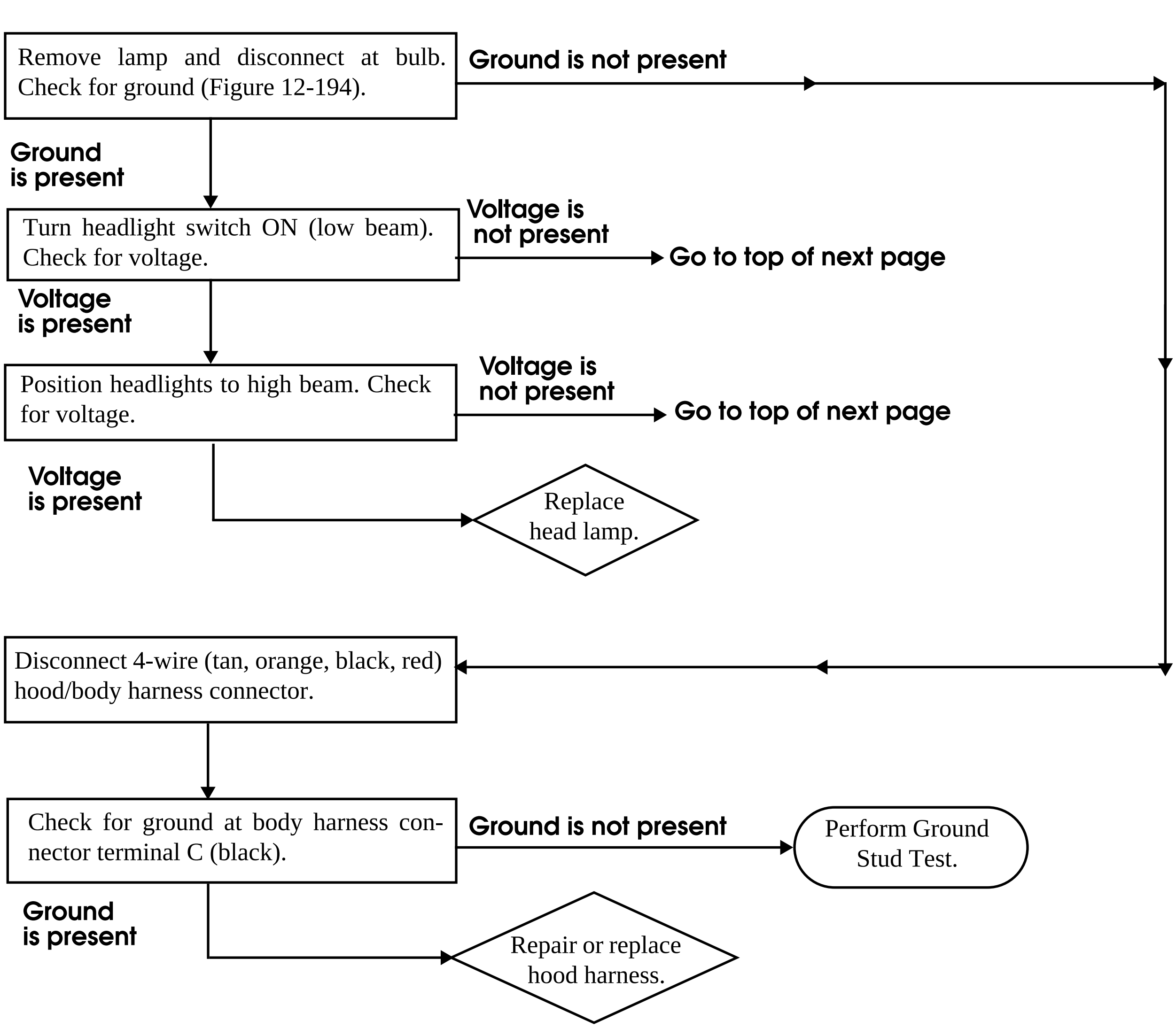
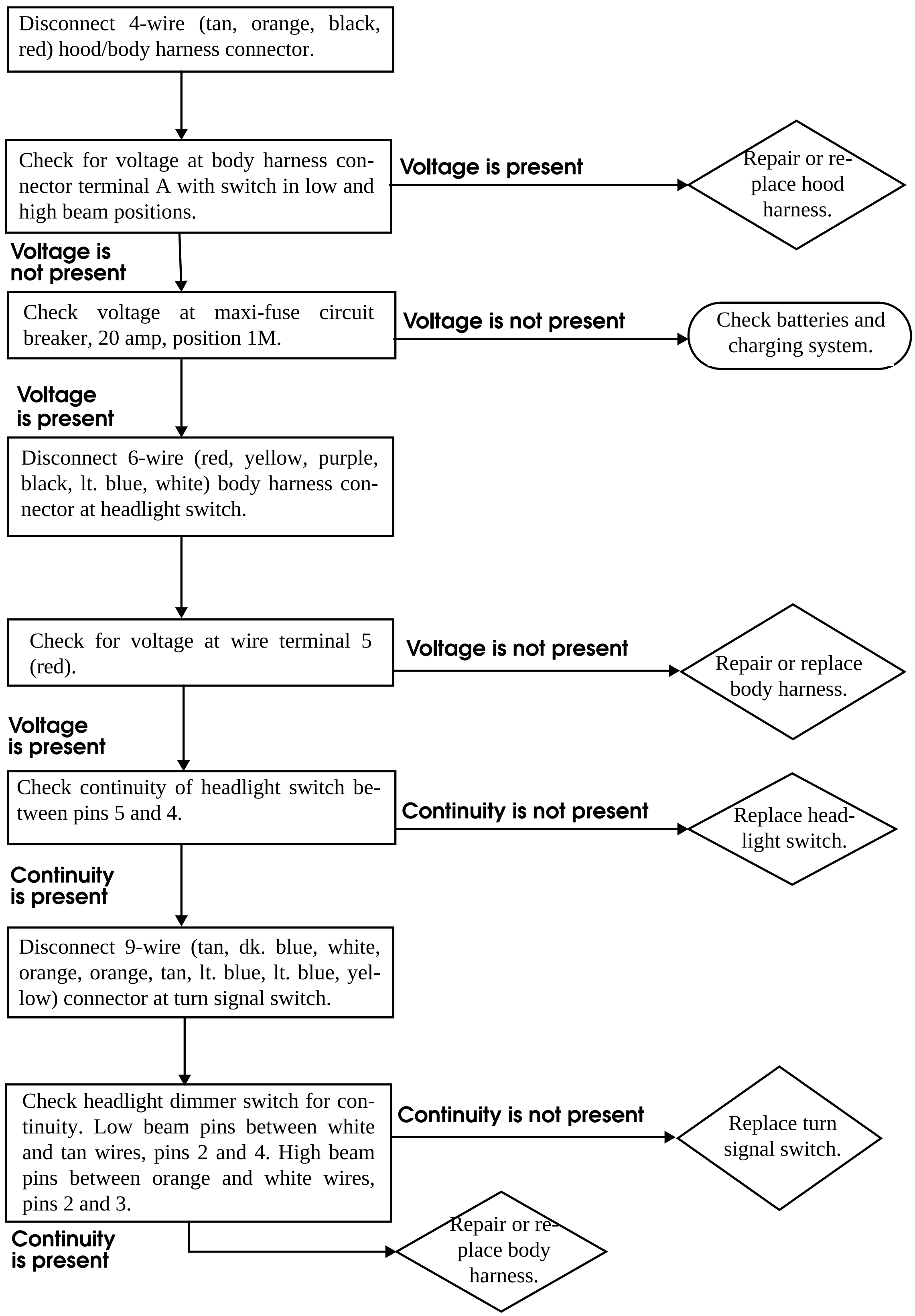


Figure 12-193: Horn

HEADLIGHT(S) INOPERATIVE



HEADLIGHT(S) INOPERATIVE-CONTINUED



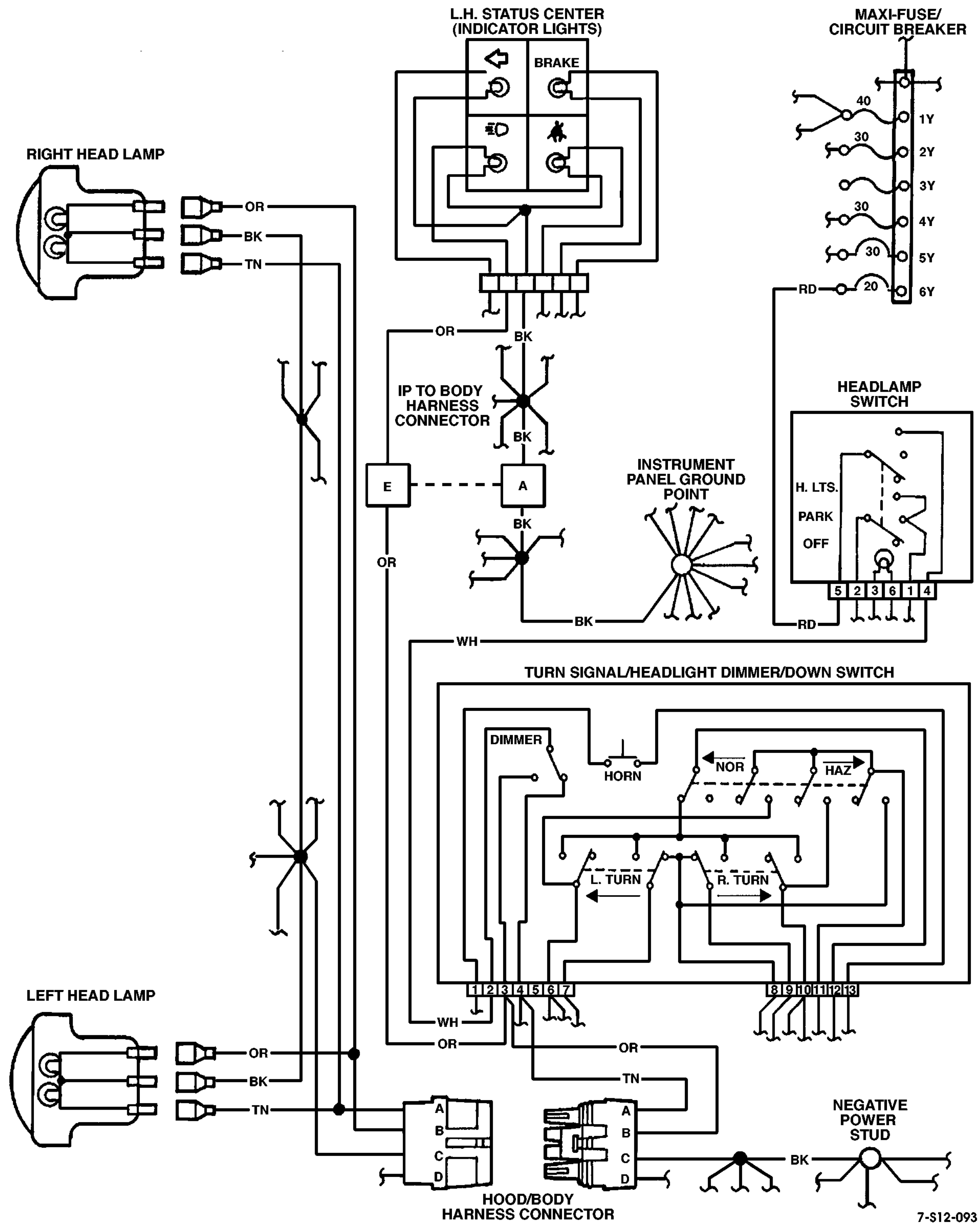
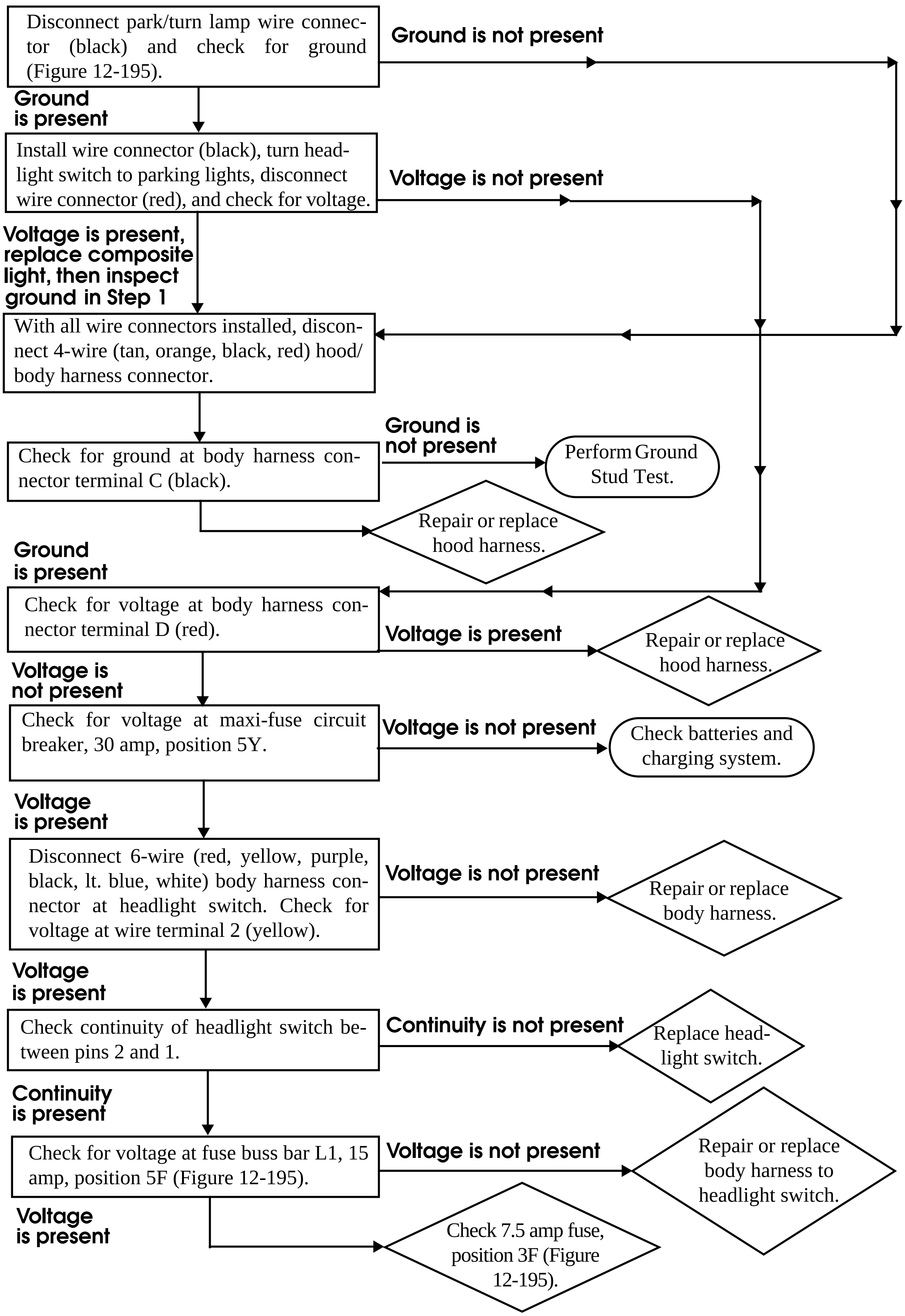


Figure 12-194: Headlights

PARKING LIGHT(S) INOPERATIVE



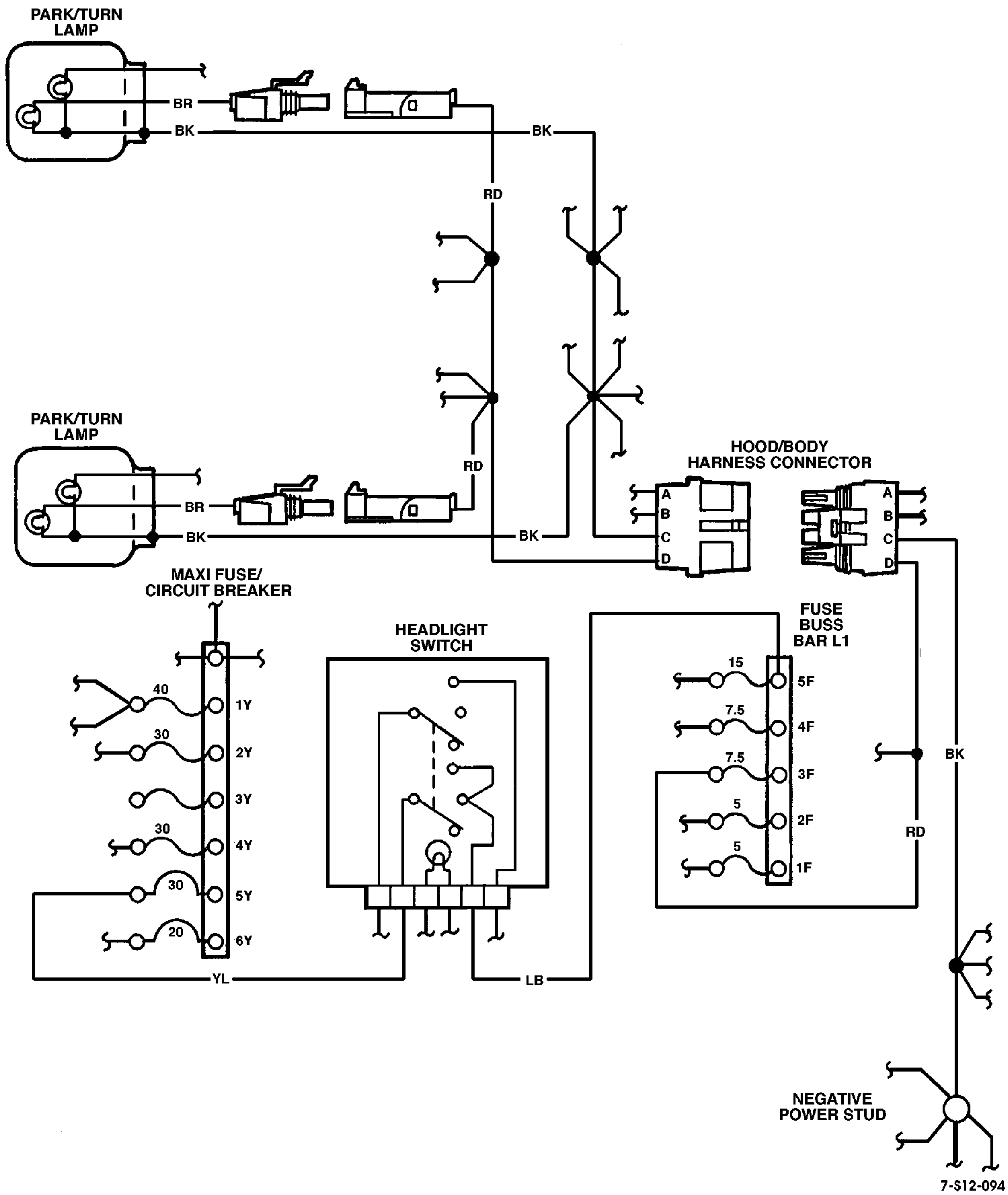


Figure 12-195: Front Parking Lights

TURN SIGNAL(S) INOPERATIVE

Disconnect wire connector (black) at disabled light and check for ground (Figure 12-196).

Ground is not present → **Go to the final step in this procedure**

Ground is present ↓

Install wire connector (black).

↓

Position ignition switch to RUN.

↓

Position turn signal switch to disabled lamp left/right.

↓

Disconnect disabled turn signal wire connector, right side (lt. green)/left side (lt. blue) and check for voltage.

Voltage is present → Replace composite light.

Voltage is not present ↓

Disconnect 3-wire (lt. green, white, lt. blue) hood/body harness connector.

↓

Check for voltage at body harness connector wire terminal A right (lt. green)/C left (lt. blue).

Voltage is present → Repair or replace hood harness.

Voltage is not present ↓ **(right front)**

(left front) go to second step on next page

Disconnect 7-wire (red, dk. green, lt. green, lt. green, tan, lt. blue, black) turn signal/body harness connector.

↓

Check for voltage at body harness connector wire terminal 10 (lt. green).

Voltage is present → Repair or replace body harness.

Voltage is not present → **Go to the top of next page**

TURN SIGNAL(S) INOPERATIVE – CONTINUED

Install two body harness connectors at turn signal switch.

Disconnect wire (lt. blue) at turn signal switch and check pin for voltage (Figure 12-196).

Voltage is present

Repair or replace body harness to turn signal switch.

Voltage is not present

Disconnect wire (purple) at turn signal switch and check for voltage at body harness.

Voltage is present

Replace flasher.

Voltage is not present

Check for voltage at fuse buss bar A2, 10 amp, position 4C.

Voltage is present

Repair or replace body harness to flasher.

Voltage is not present

Check for voltage at ignition relay pin 3 (Figure 12-198).

Voltage is present

Repair or replace body harness.

Voltage is not present

Check for voltage at battery buss bar.

Voltage is present

Replace ignition relay.

Voltage is not present

Check batteries and charging system.

Disconnect 4-wire (tan, orange, black red) hood/body harness connector.

Check for ground at body harness connector wire terminal C (black).

Ground is present

Repair or replace hood harness.

Ground is not present

Perform Ground Stud Test.

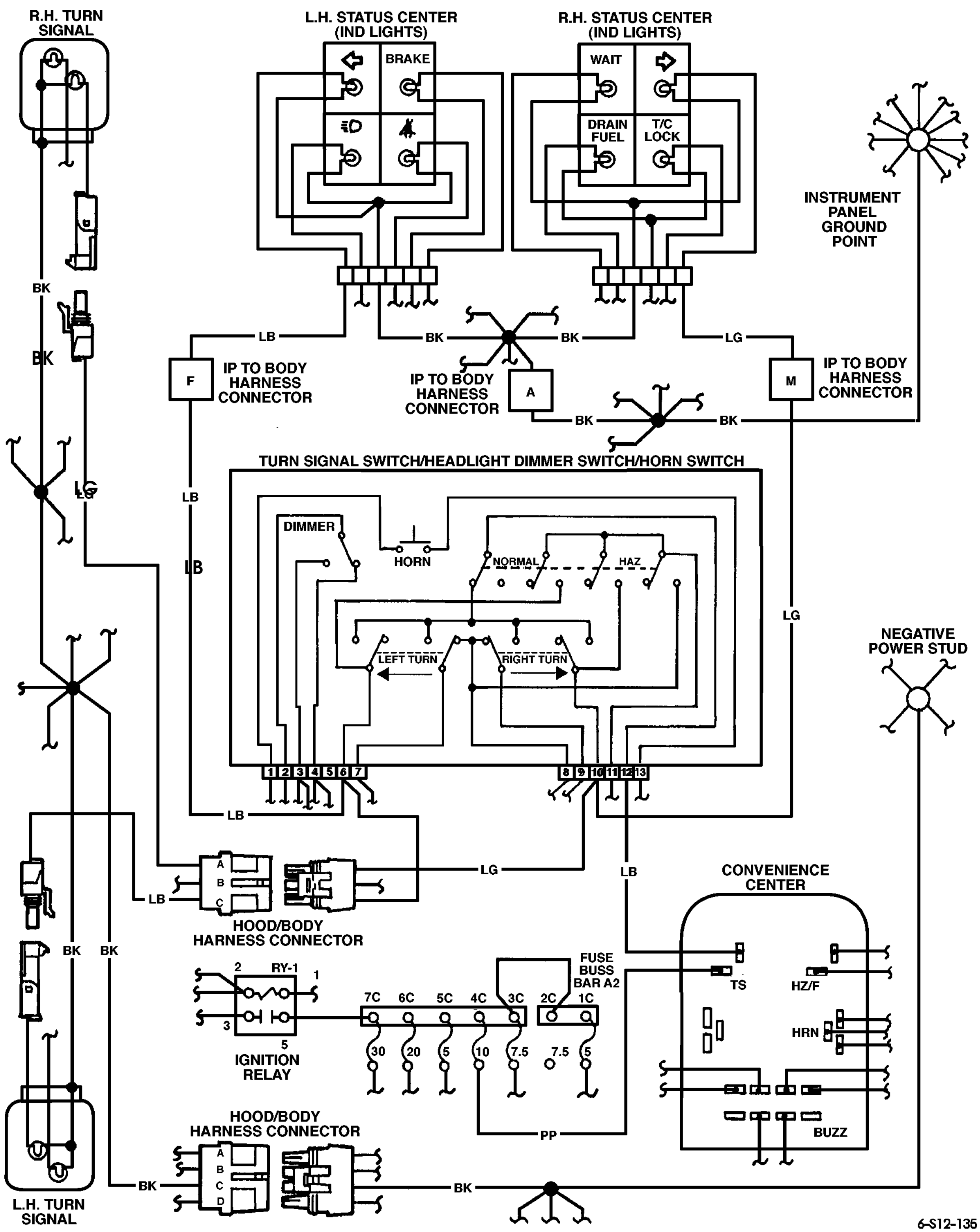
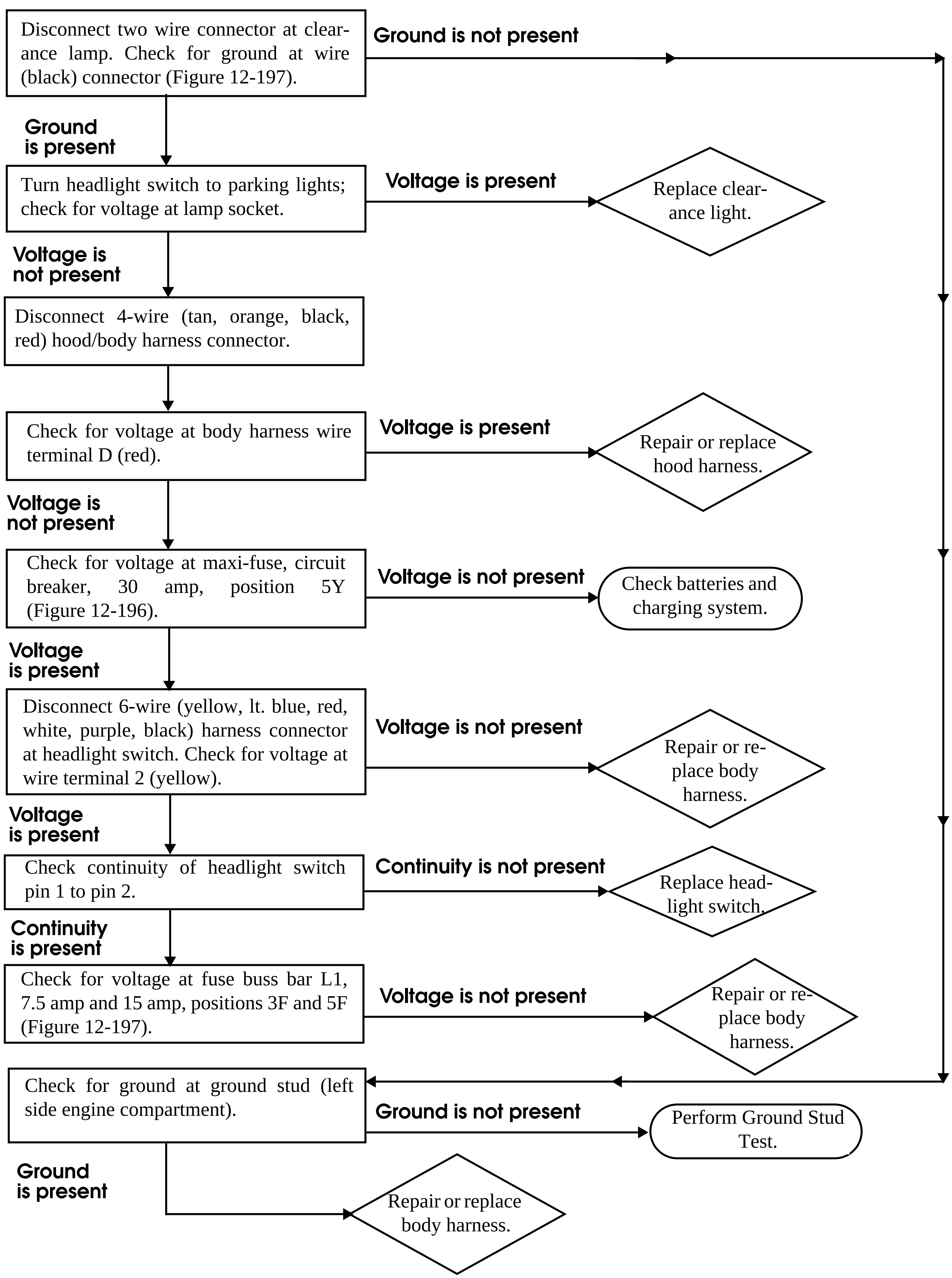
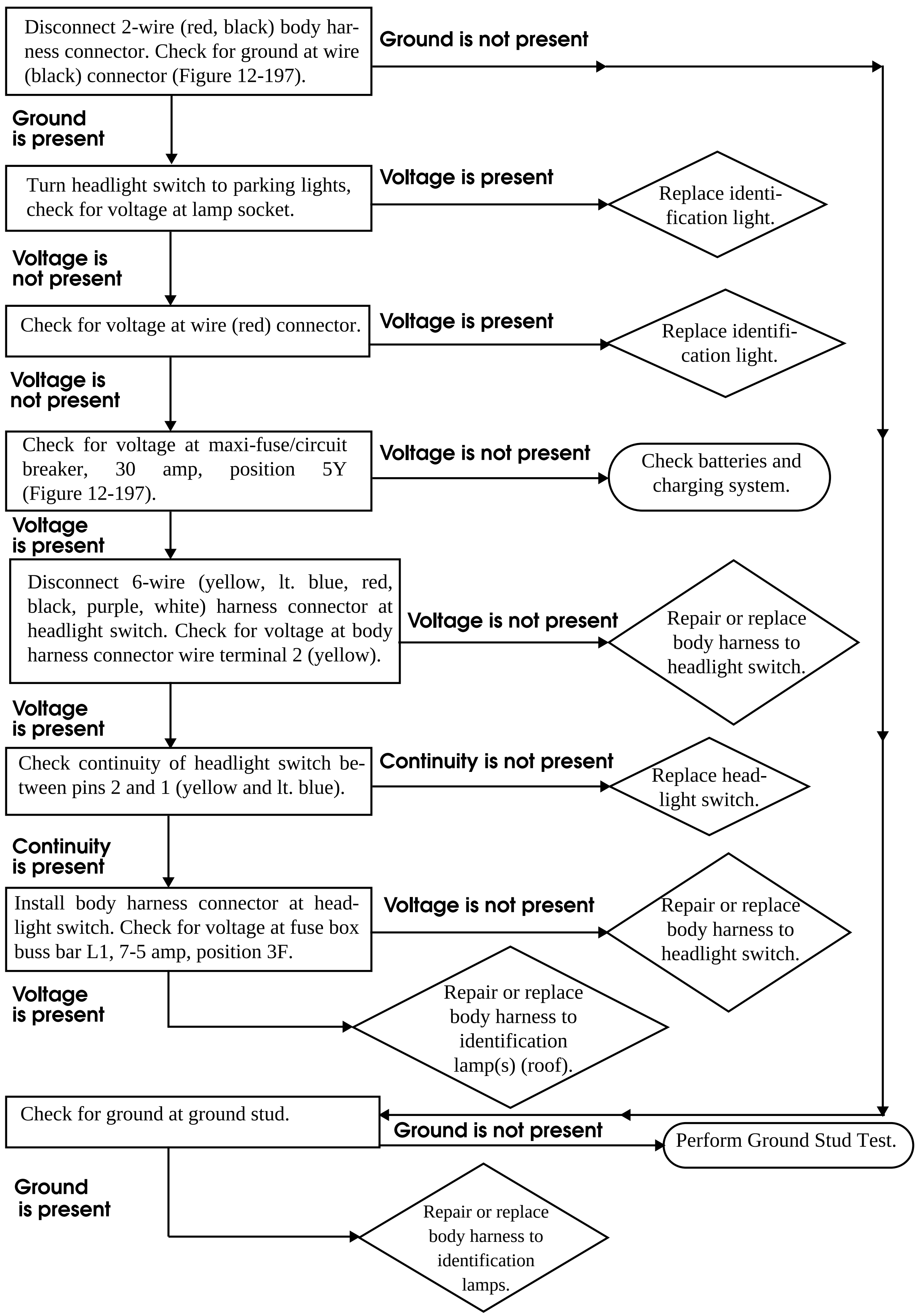


Figure 12-196: Front Turn Signals

HOOD CLEARANCE LIGHT(S) INOPERATIVE



ROOF IDENTIFICATION LIGHT(S)INOPERATIVE



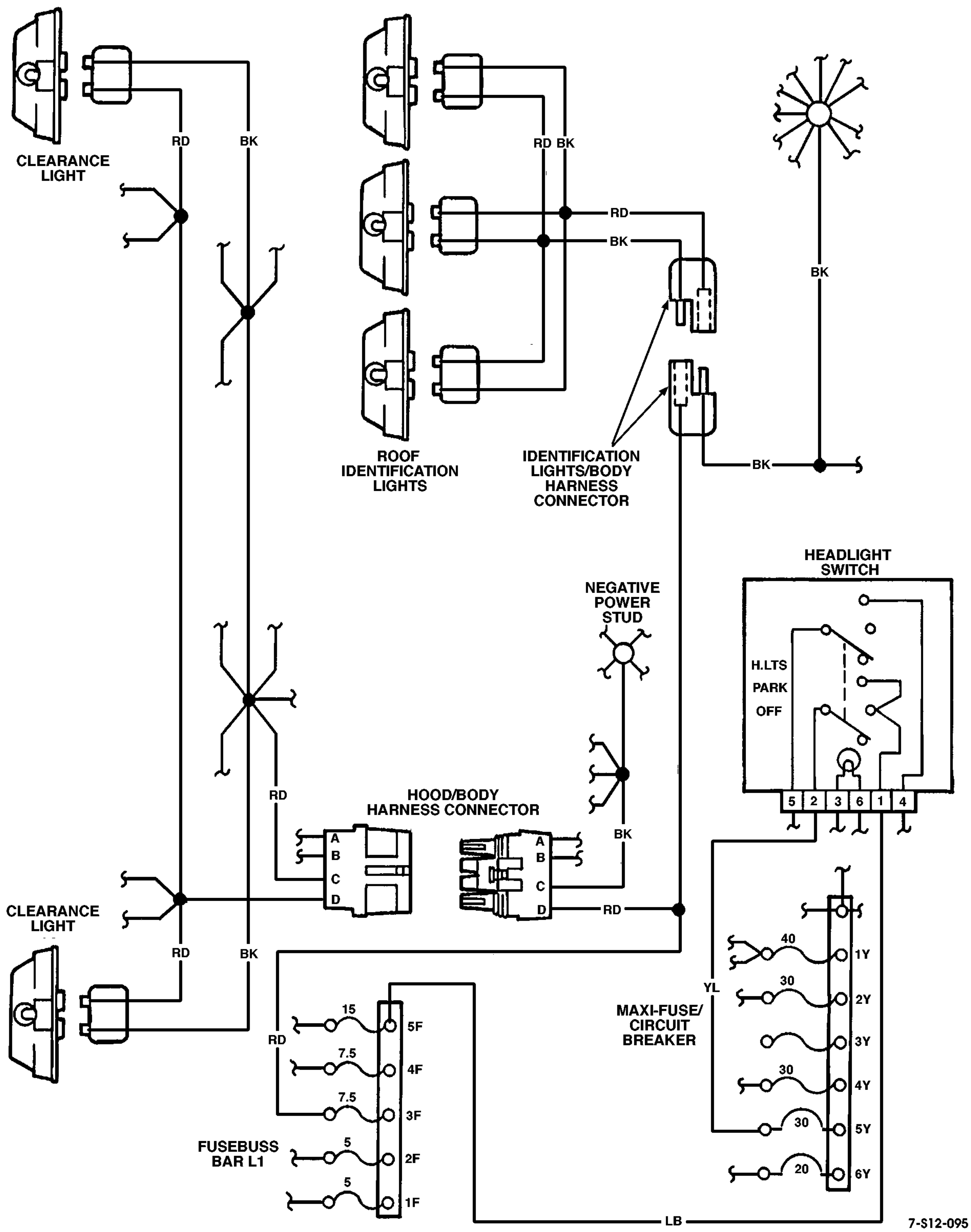


Figure 12-197: Hood and Roof Identification Lights

HAZARD FLASHER(S) (HOOD HARNESS)INOPERATIVE

Disconnect wire (black) at disabled composite light and check for ground (Figure 12-200).

Ground is not present → Go to final step on next page

Ground is present

Reconnect ground wire.

Position hazard flasher to ON.

Disconnect disabled composite light wire connector right side (lt. green) and left side (lt. blue).

Voltage is present → Repair or replace composite light.

Voltage is not present

Disconnect 3-wire (lt. green, white, lt. blue) hood/body harness connector.

Check for voltage at body harness connector for disabled hazard flasher at wire terminal A right (lt. green) or C left (lt. blue).

Voltage is present → Repair or replace hood harness.

Voltage is not present

Disconnect 7-wire (red, dk. green, lt. green, lt. green, tan, lt. blue, black) body harness connector at turn signal switch.

Check for voltage at body harness connector wire terminal 11 (tan).

Voltage is present → Go to top of next page

Voltage is not present

Perform fourth step on next page

HAZARD FLASHER(S) (HOOD HARNESS)INOPERATIVE - CONTINUED

Disconnect 9-wire (dk. blue, white, orange, orange, tan, tan, lt. blue, lt. blue, yellow) body harness connector at turn signal switch (Figure 12-200).

Check continuity of turn signal switch between pins (lt. blue, tan and lt. green, tan).

Continuity is not present

Replace turn signal switch.

Continuity is present

Connect two body harness connectors at turn signal switch.

Disconnect wire (tan) at turn signal switch and check for voltage at hazard flasher.

Voltage is present

Repair or replace body harness to turn signal switch.

Voltage is not present

Connect wire (tan) at hazard flasher.

Disconnect wire (yellow) at hazard flasher and check for voltage at wire.

Voltage is present

Replace flasher.

Voltage is not present

Check for voltage at fuse buss bar B2, 15 amp, position 5D.

Voltage is present

Repair or replace body harness to flasher.

Voltage is not present

Check batteries and charging system.

Disconnect 4-wire (tan, orange, black, red) hood/body harness connector.

Check for ground at body harness connector wire terminal C (black).

Ground is present

Repair or replace hood harness.

Ground is not present

Perform Ground Stud Test.

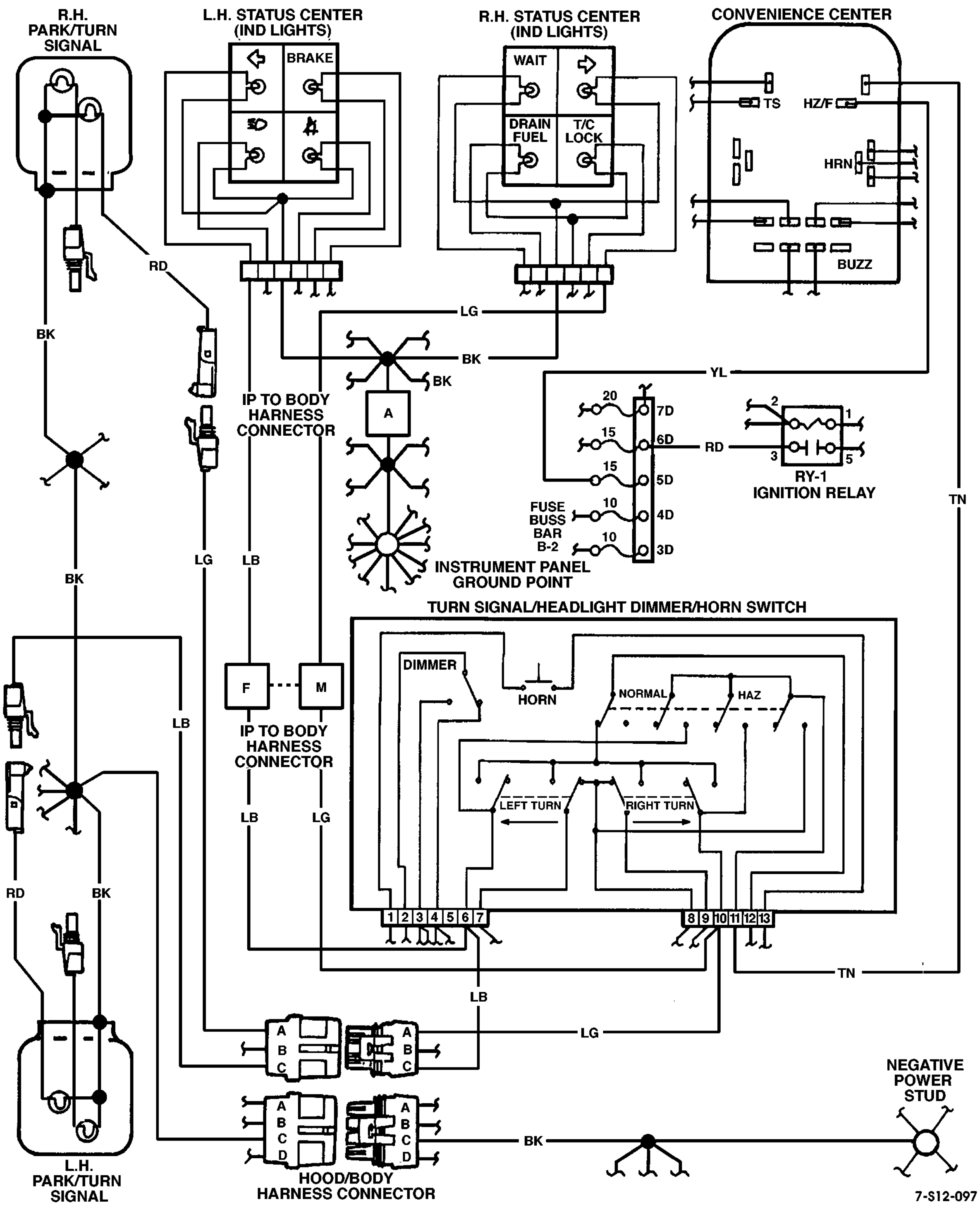
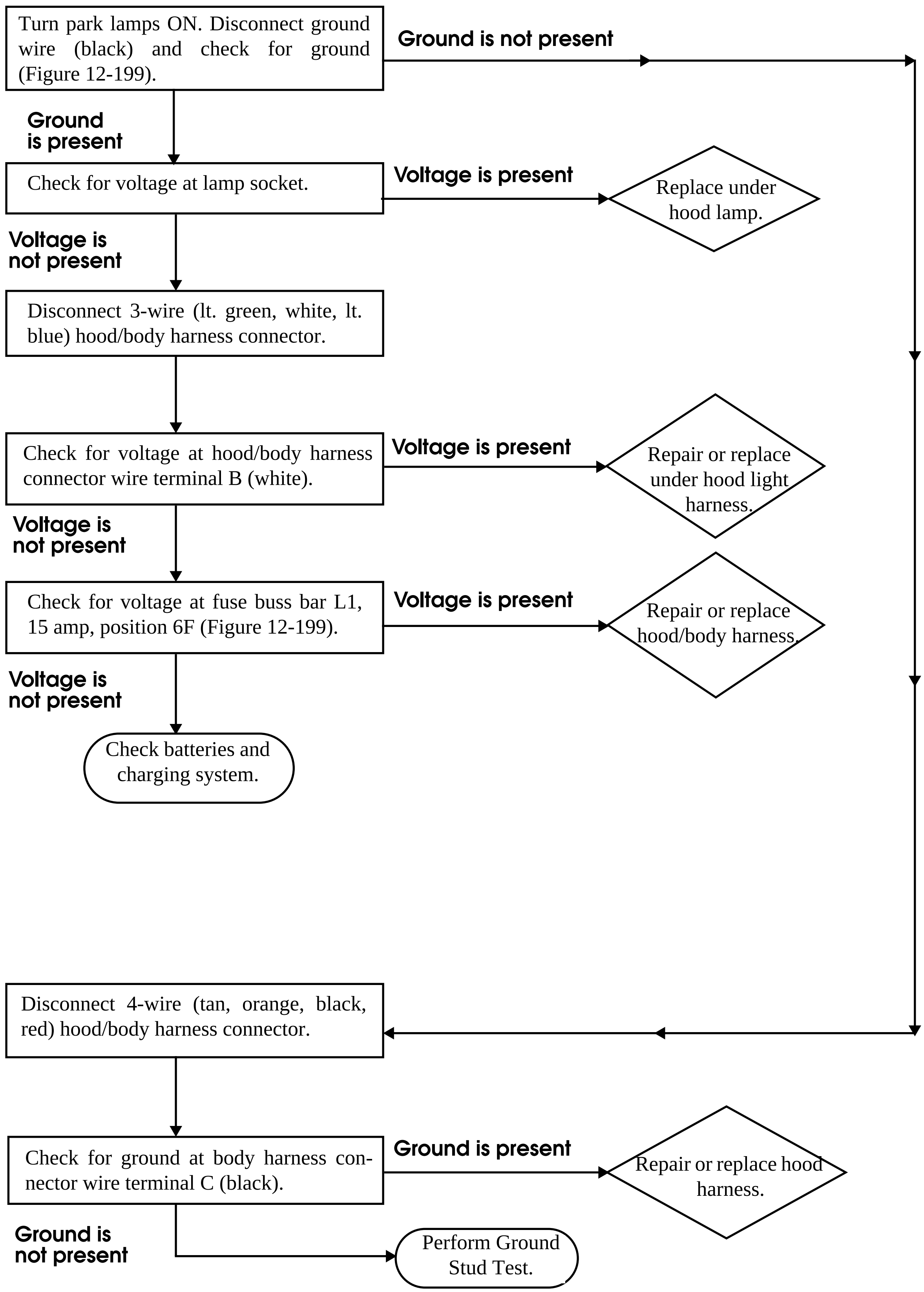


Figure 12-198: Hazard Flashers

TROUBLE LIGHT INOPERATIVE

1. Turn park lights ON. Disconnect 2-wire (white, black) connector at trouble light (Figure 12-199).
2. Check for ground at wire terminal A (black).
   - **Ground is not present** → Perform Ground Stud Test.
   - **Ground is present** → go to 3.
3. Check for voltage at wire terminal B (white).
   - **Voltage is present** → Replace trouble light lamp.
   - **Voltage is not present** → go to 4.
4. Disconnect 3-wire (lt. green, white, lt. blue) hood/body connector.
5. Check for voltage at hood/body connector wire terminal B (white).
   - **Voltage is present** → Repair or replace body harness-to-trouble light lamp.
   - **Voltage is not present** → go to 6.
6. Check for voltage at fuse buss bar L1, 15 amp, position 6F (Figure 12-199).
   - **Voltage is present** → Repair or replace hood harness.
   - **Voltage is not present** → Check batteries and charging system.

UNDER HOOD LIGHT INOPERATIVE



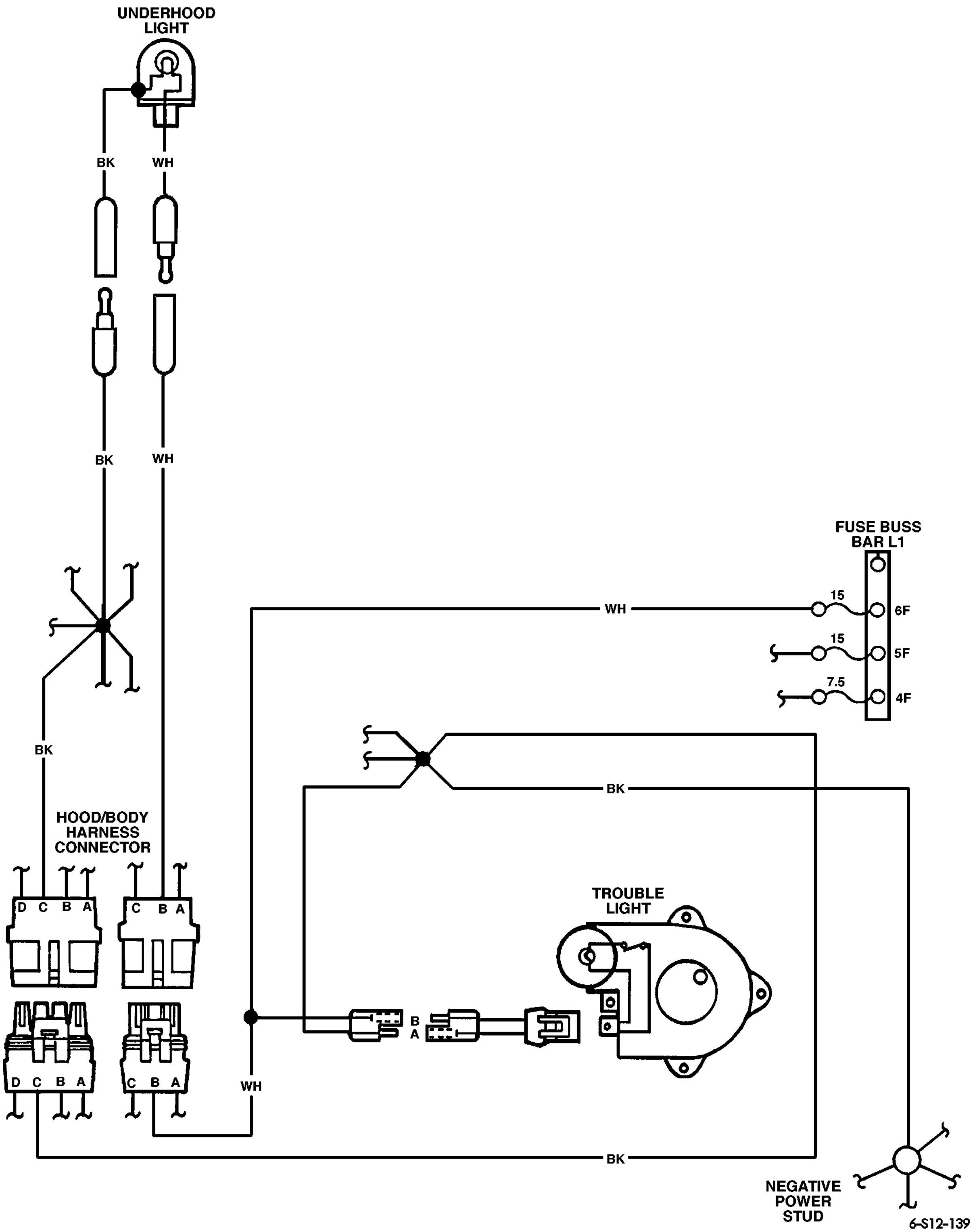
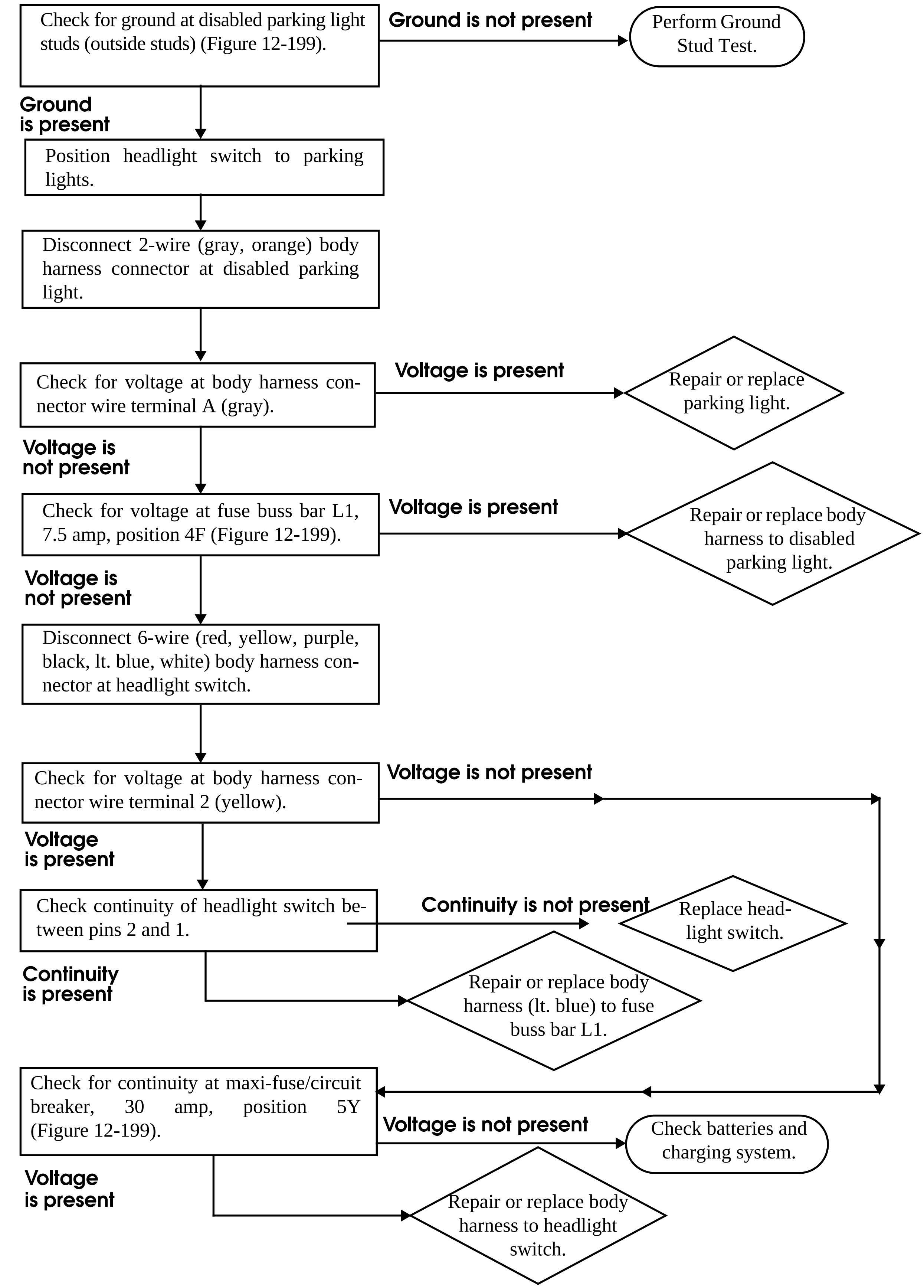


Figure 12-199: Under Hood and Trouble Lights

PARKING LIGHT(S) (REAR) INOPERATIVE



TURN SIGNAL LIGHT(S) (REAR) INOPERATIVE

Check for ground at disabled composite light(s) ground stud (outside stud) (Figure 12-199).

Ground is not present → Perform Ground Stud Test.

Ground is present ↓

Position ignition switch to RUN.

↓

Position turn signal switch to disabled composite light.

↓

Disconnect one wire, right (dk. green) or left (yellow), body harness connector at disabled composite light.

↓

Check for voltage at body harness connector.

Voltage is present → Repair or replace composite light.

Voltage is not present ↓

Disconnect 7-wire (red, dk. green, lt. green, tan, lt. blue, black) body harness connector at turn signal switch.

↓

Check for voltage at body harness wire terminal 12 (lt. blue).

Voltage is not present → **Go to third step on next page**

Voltage is present (right turn) ↓

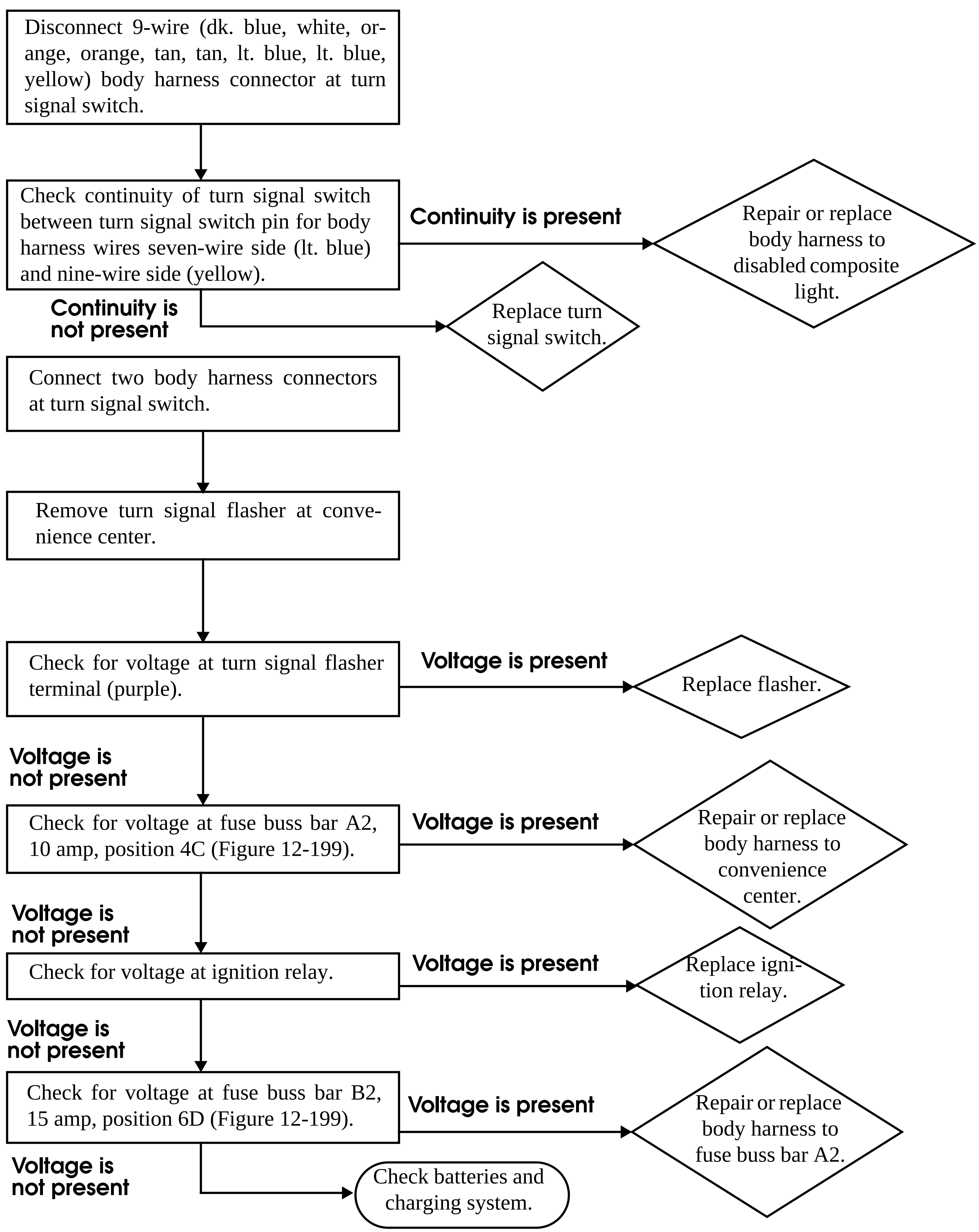
(for left turn signal, go to top of next page)

Check continuity of turn signal switch between turn signal switch pins for body harness wires (lt. blue, dk. green).

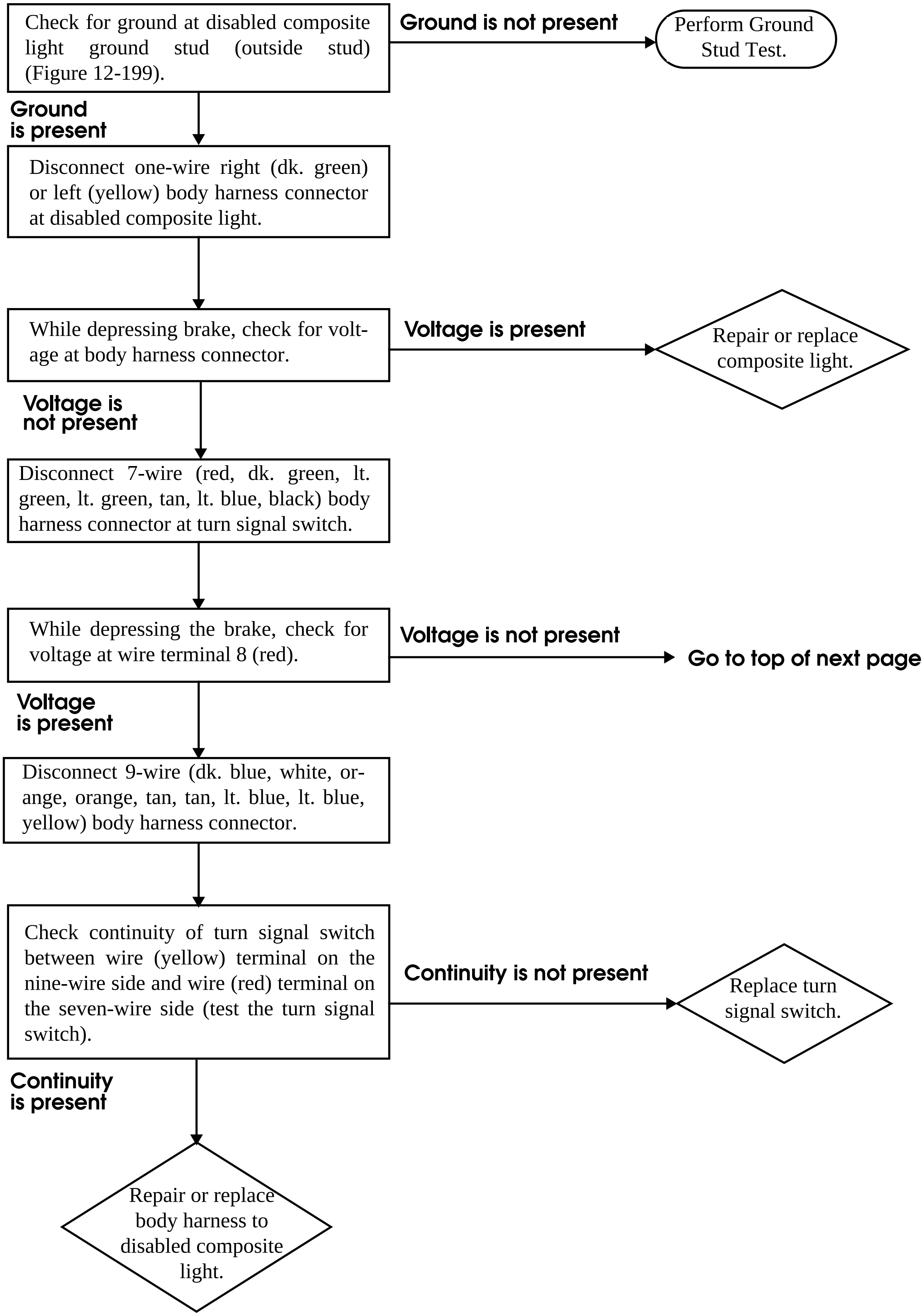
Continuity is not present → Replace turn signal switch.

Continuity is present → Repair or replace body harness to disabled composite light.

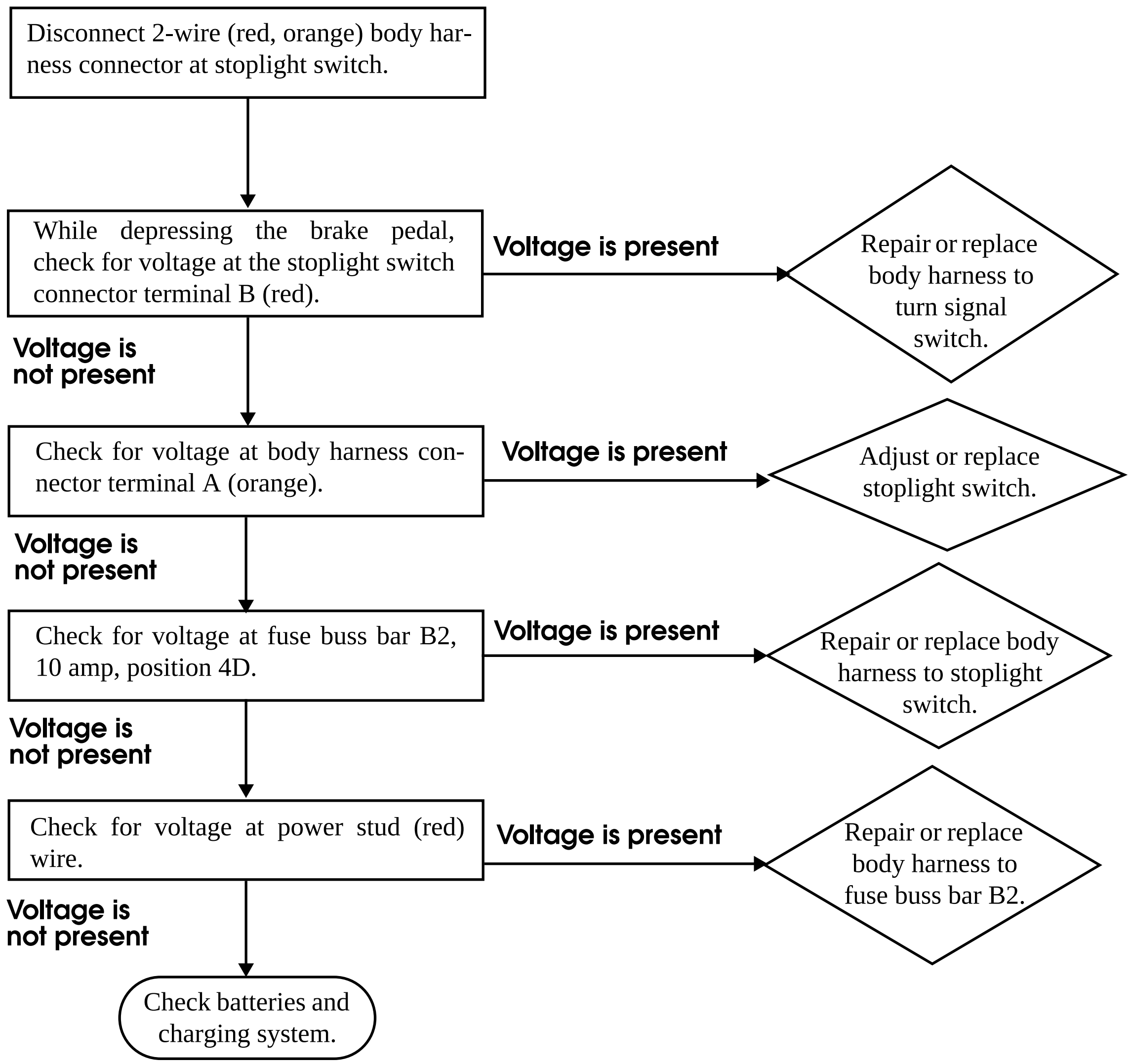
TURN SIGNAL LIGHT(S) (REAR) INOPERATIVE



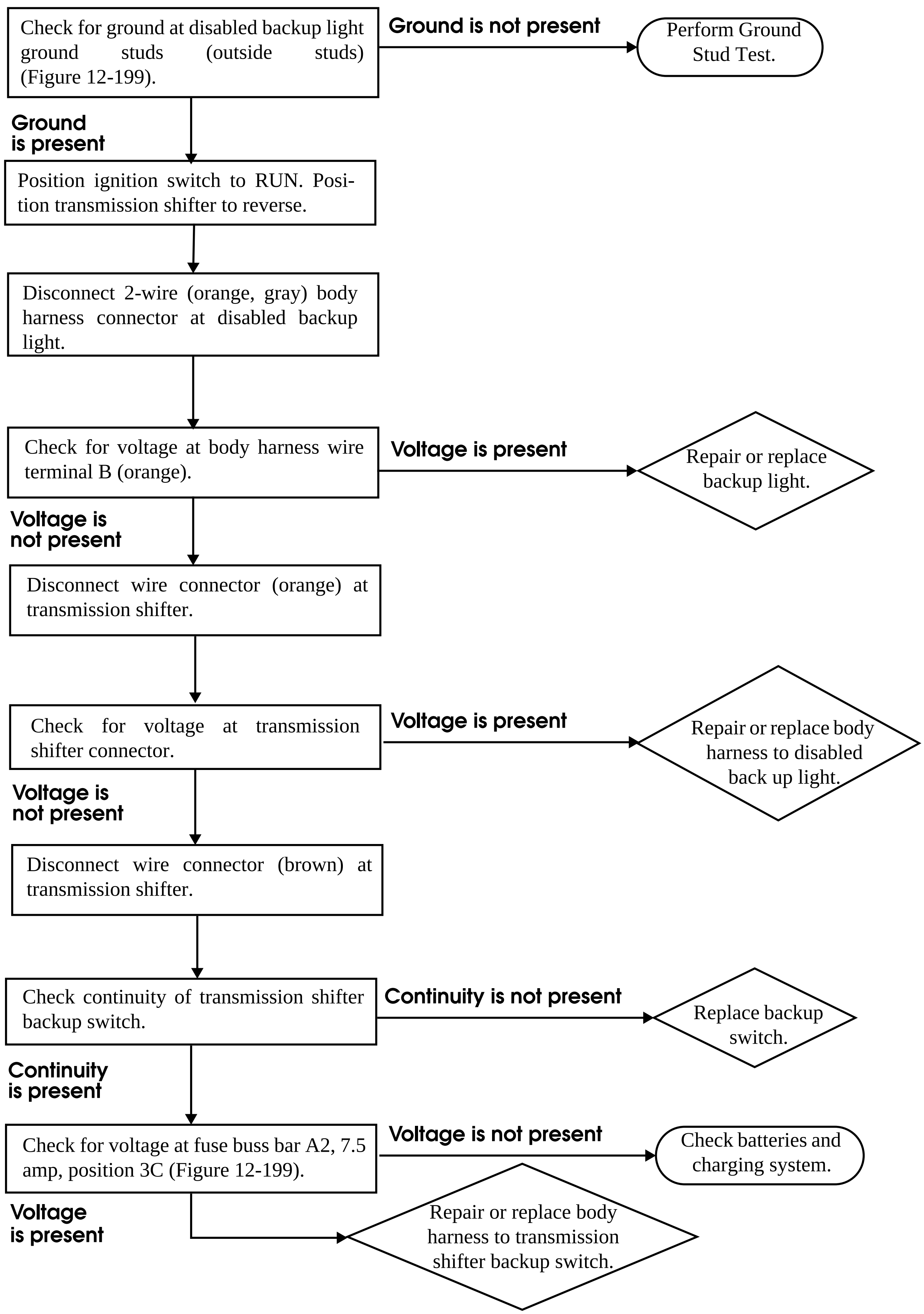
STOPLIGHT(S) INOPERATIVE



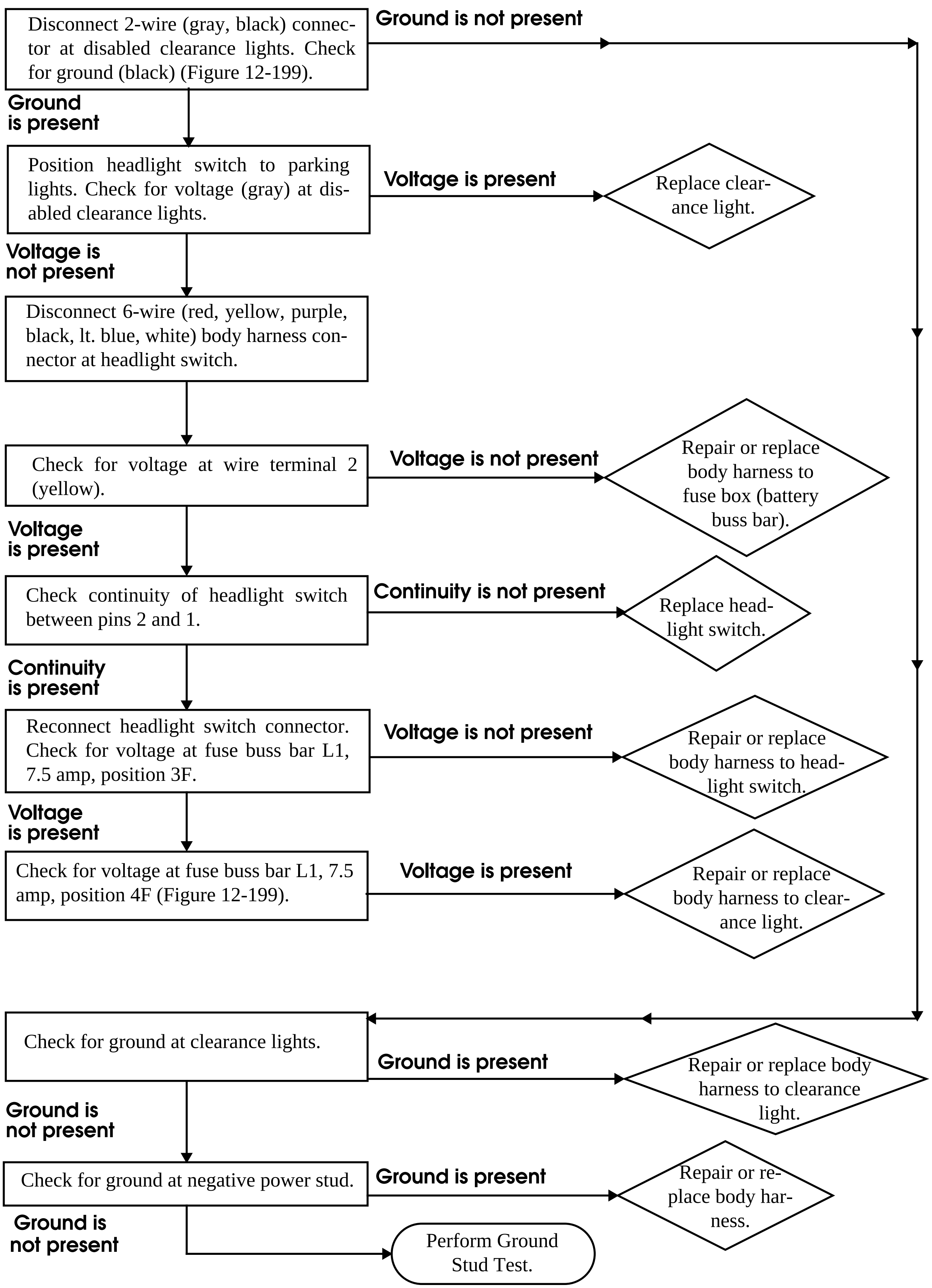
STOPLIGHT(S) INOPERATIVE – CONTINUED



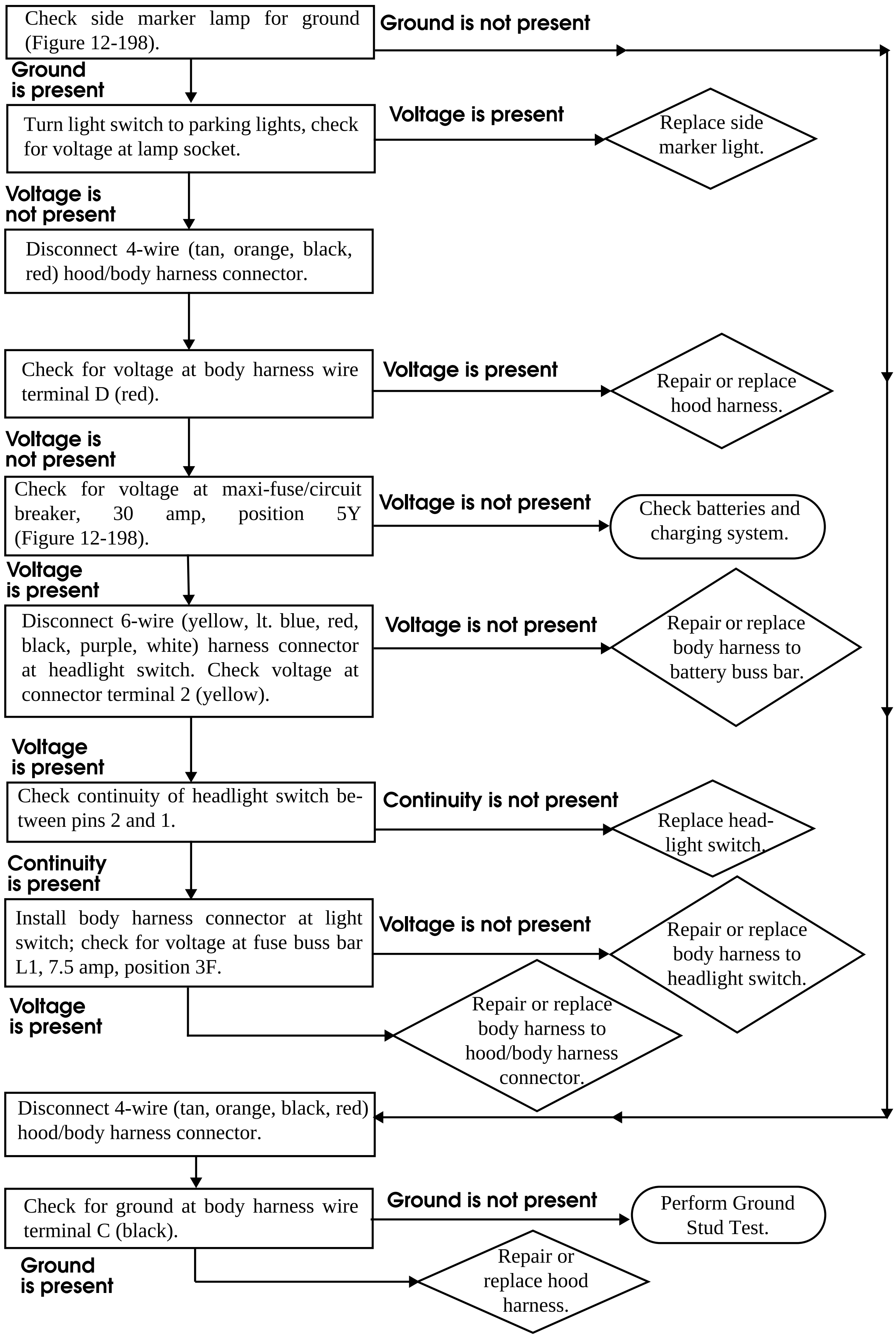
BACKUP LIGHT(S) INOPERATIVE



CLEARANCE LIGHT(S) INOPERATIVE



SIDE MARKER LIGHT(S) INOPERATIVE



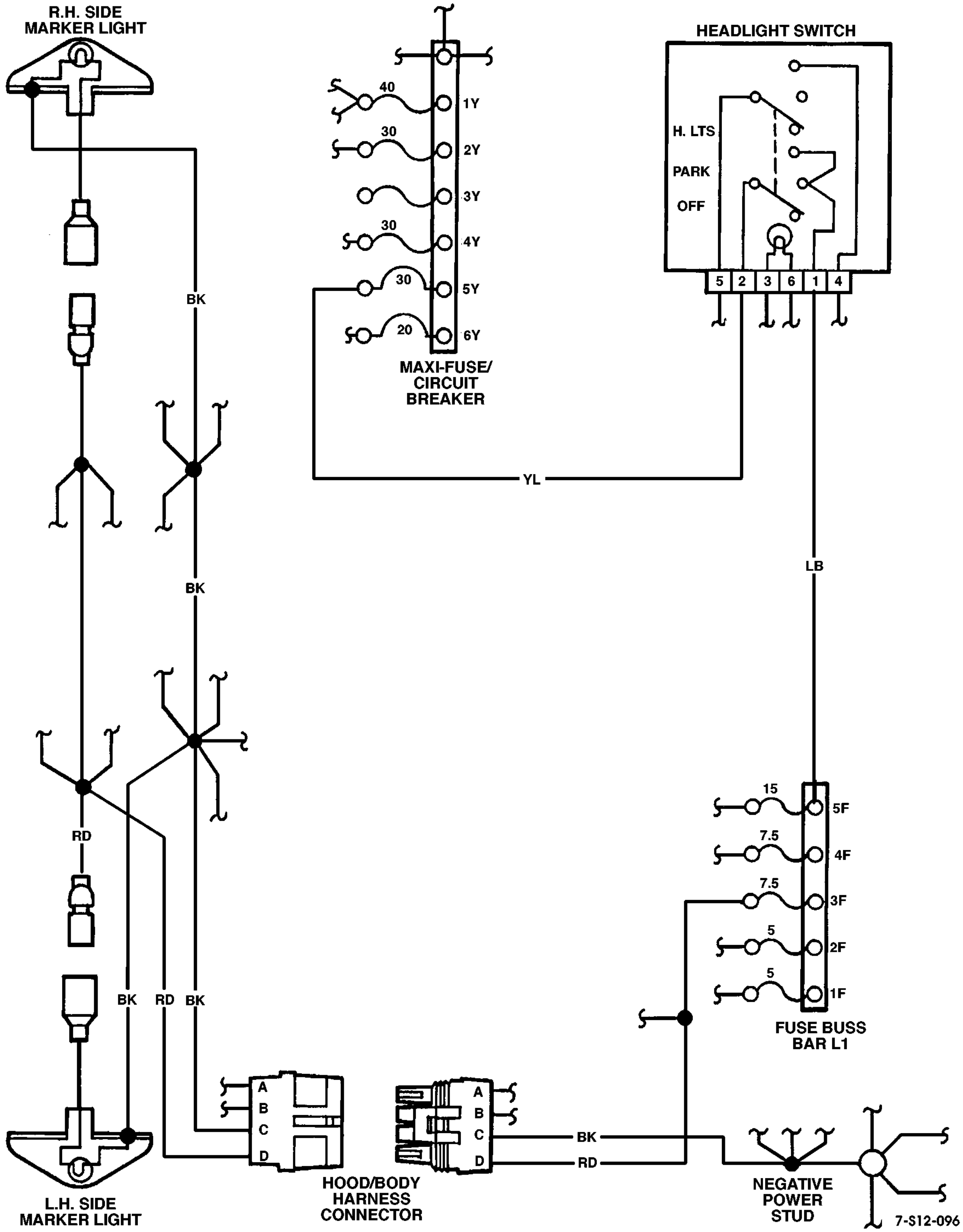
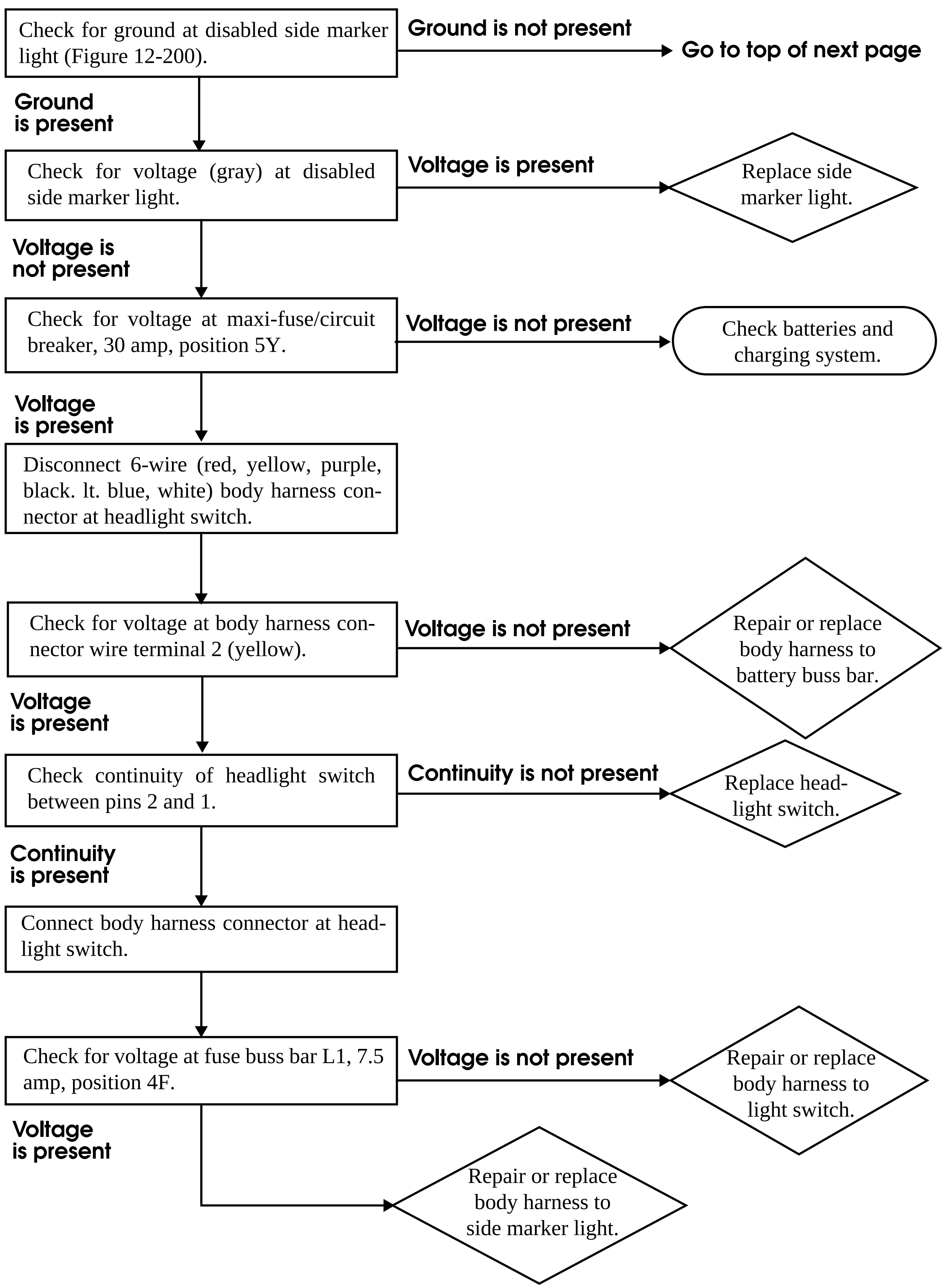
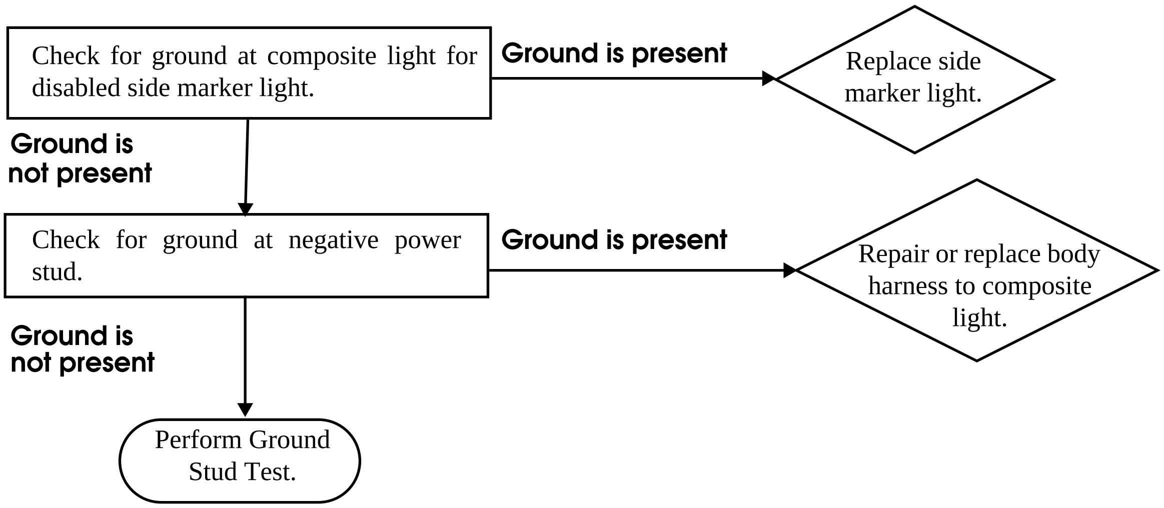


Figure 12-200: Front Side Marker Lights

SIDE MARKER LIGHT(S) (REAR) INOPERATIVE



SIDE MARKER LIGHT(S) (REAR) INOPERATIVE – CONTINUED



LICENSE PLATE LIGHT INOPERATIVE

Disconnect 2-wire (gray, black) connector at license plate light (Figure 12-205).

Check for ground (black).

Ground is not present → **Go to second to last step on next page**

Ground is present

Position light switch to parking lights.

Check for voltage (gray) at license plate lamp.

Voltage is present → Replace license plate lamp.

Voltage is not present

Check for voltage at maxi-fuse/circuit breaker, 30 amp, position 5Y.

Voltage is not present → Check batteries and charging system.

Voltage is present

Disconnect 6-wire (red, yellow, purple, black, lt. blue, white) body harness connector at headlight switch.

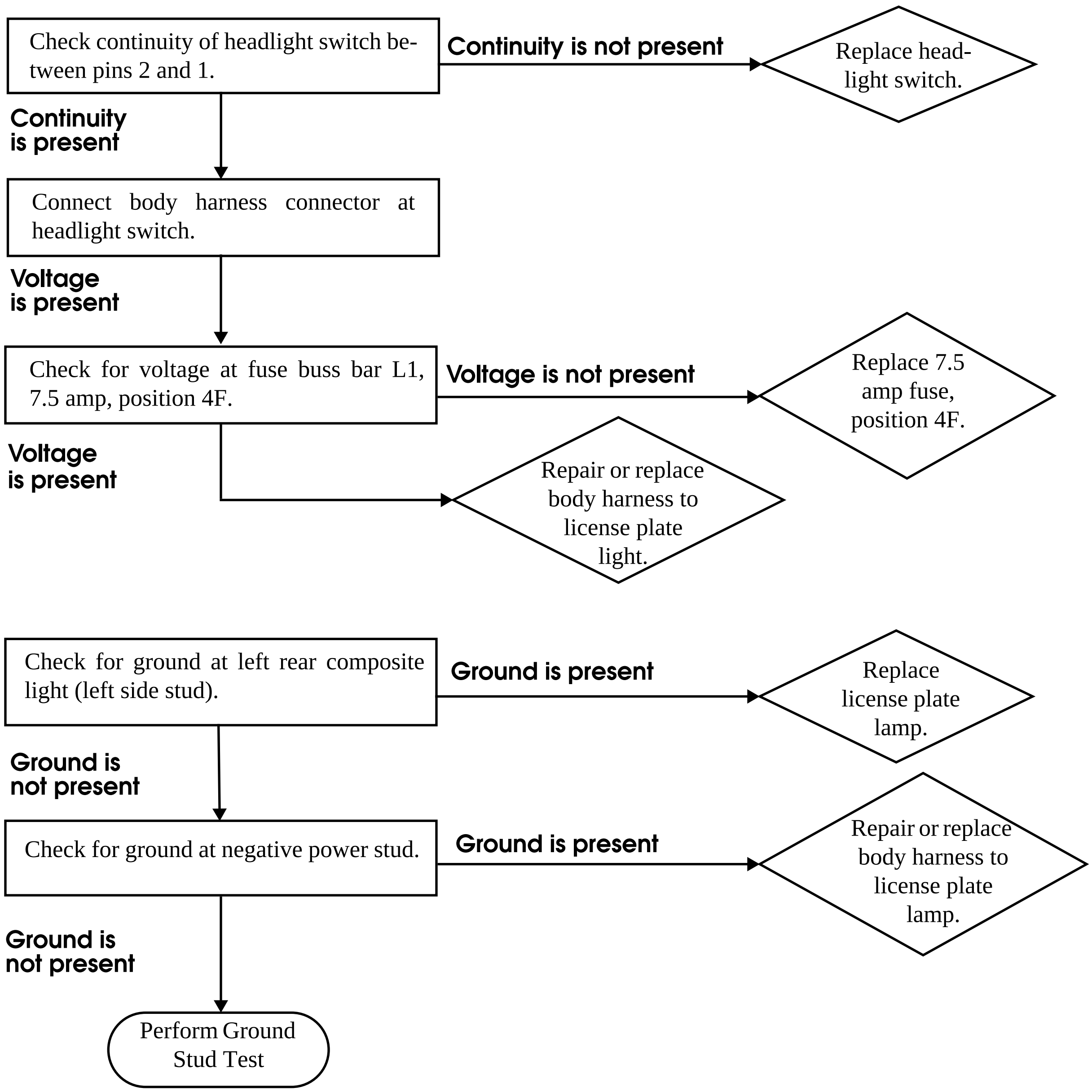
Check for voltage at body harness connector pin 2 (yellow).

Voltage is not present → Repair or replace body harness to battery buss bar.

Voltage is present

Go to top of next page

LICENSE PLATE LIGHT INOPERATIVE – CONTINUED



REAR IDENTIFICATION LIGHT(S) INOPERATIVE

Disconnect 2-wire (gray, black) rear identification light(s) connector from disabled light(s) (Figure 12-207).

Check for ground at wire connector (black).

Ground is not present → **Go to second to the last step on next page**

Ground is present

Position headlight switch to parking lights.

Check for voltage at 2-wire (gray, black) identification light harness connector (gray).

Voltage is present → Repair or replace rear identification light(s).

Voltage is not present

Disconnect 2-wire (gray, black) body identification light harness connector.

Check for voltage at body harness connector (gray).

Voltage is present → Repair or replace identification light harness.

Voltage is not present

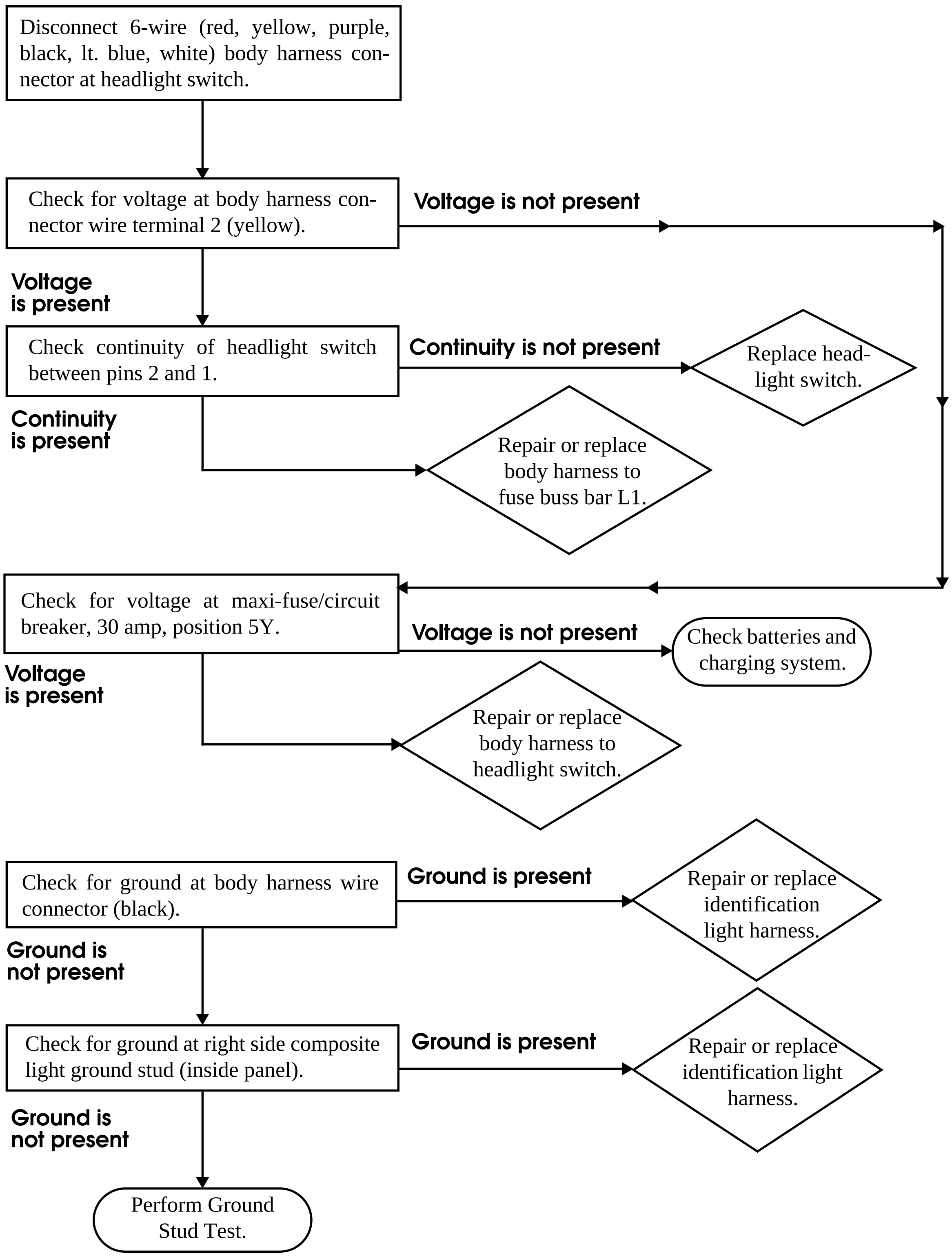
Check for voltage at fuse buss bar L1, 7.5 amp, position 4F.

Voltage is present → Repair or replace body harness to identification light harness.

Voltage is not present

Go to top of next page

REAR IDENTIFICATION LIGHT(S) INOPERATIVE-CONTINUED



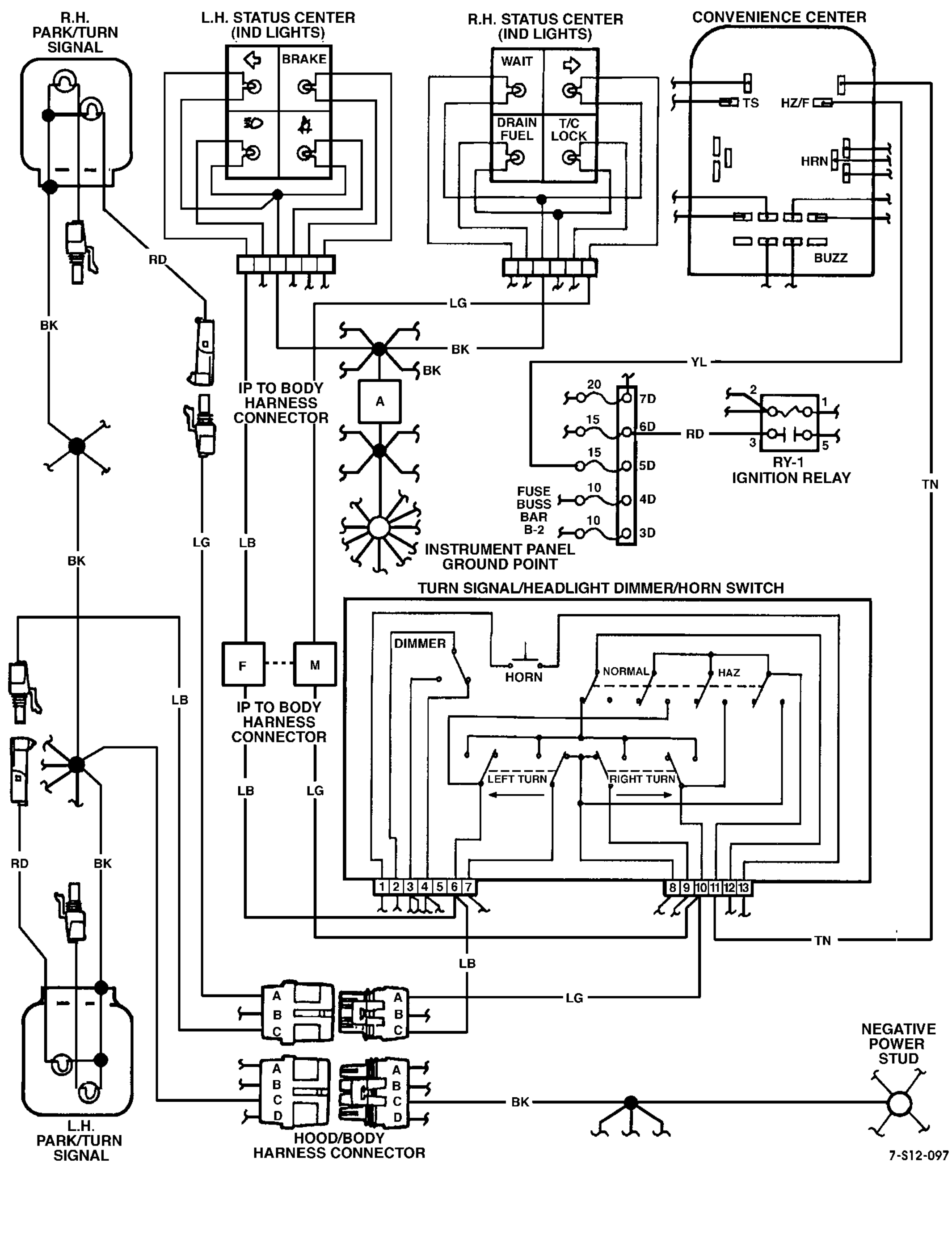


Figure 12-201: Rear Parking Lights

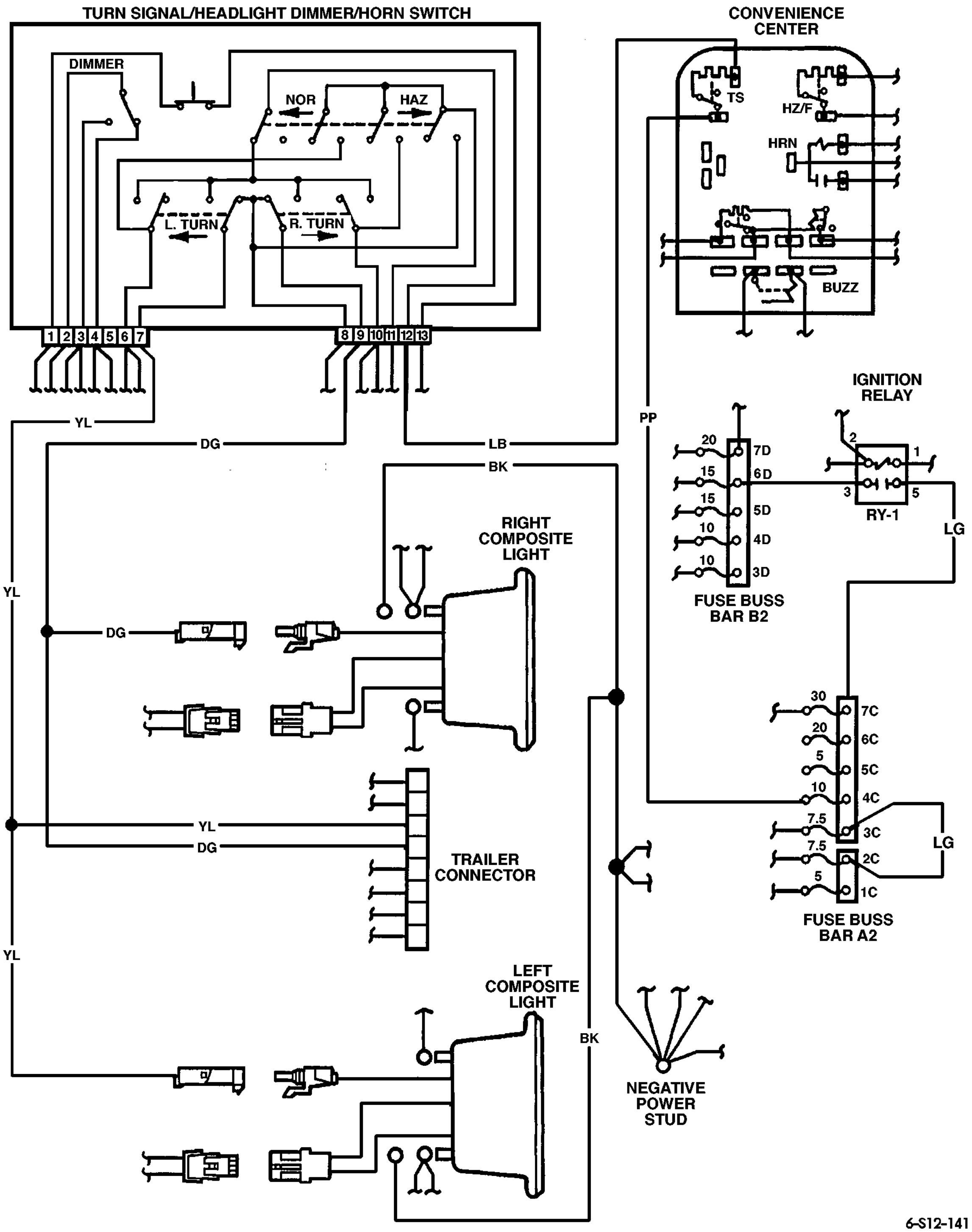


Figure 12-202: Rear Turn Signal

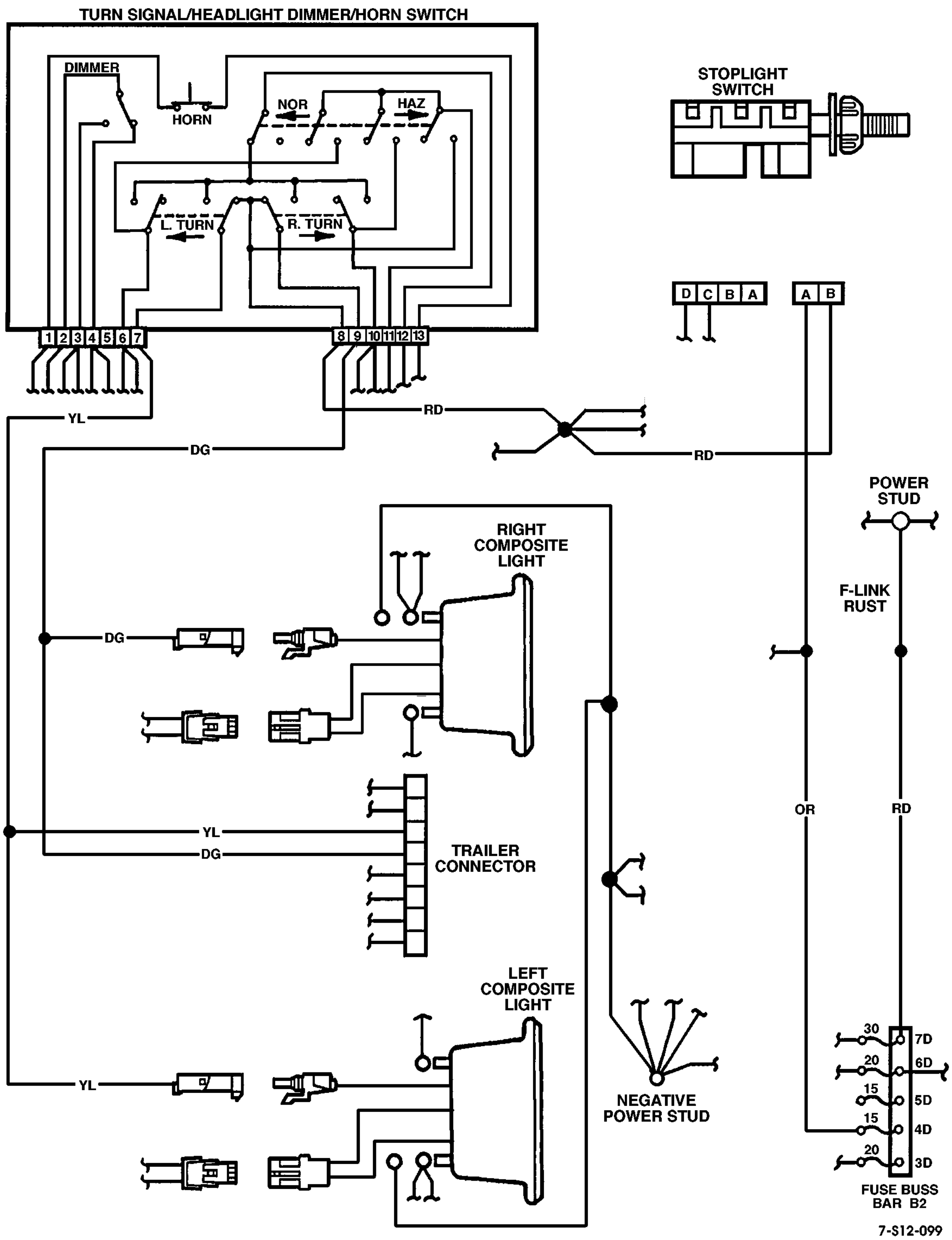


Figure 12-203: Stoplights

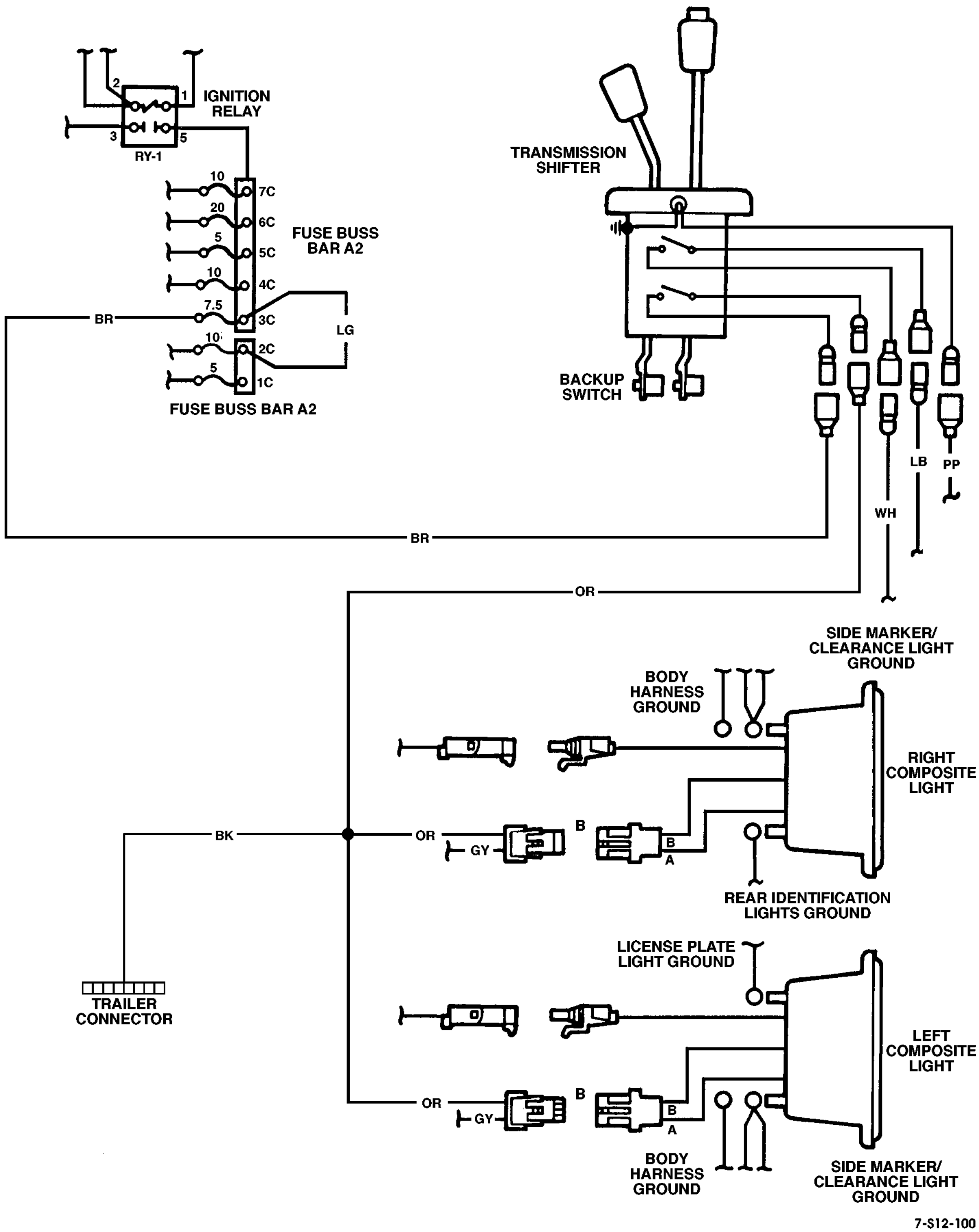


Figure 12-204: Backup Lights

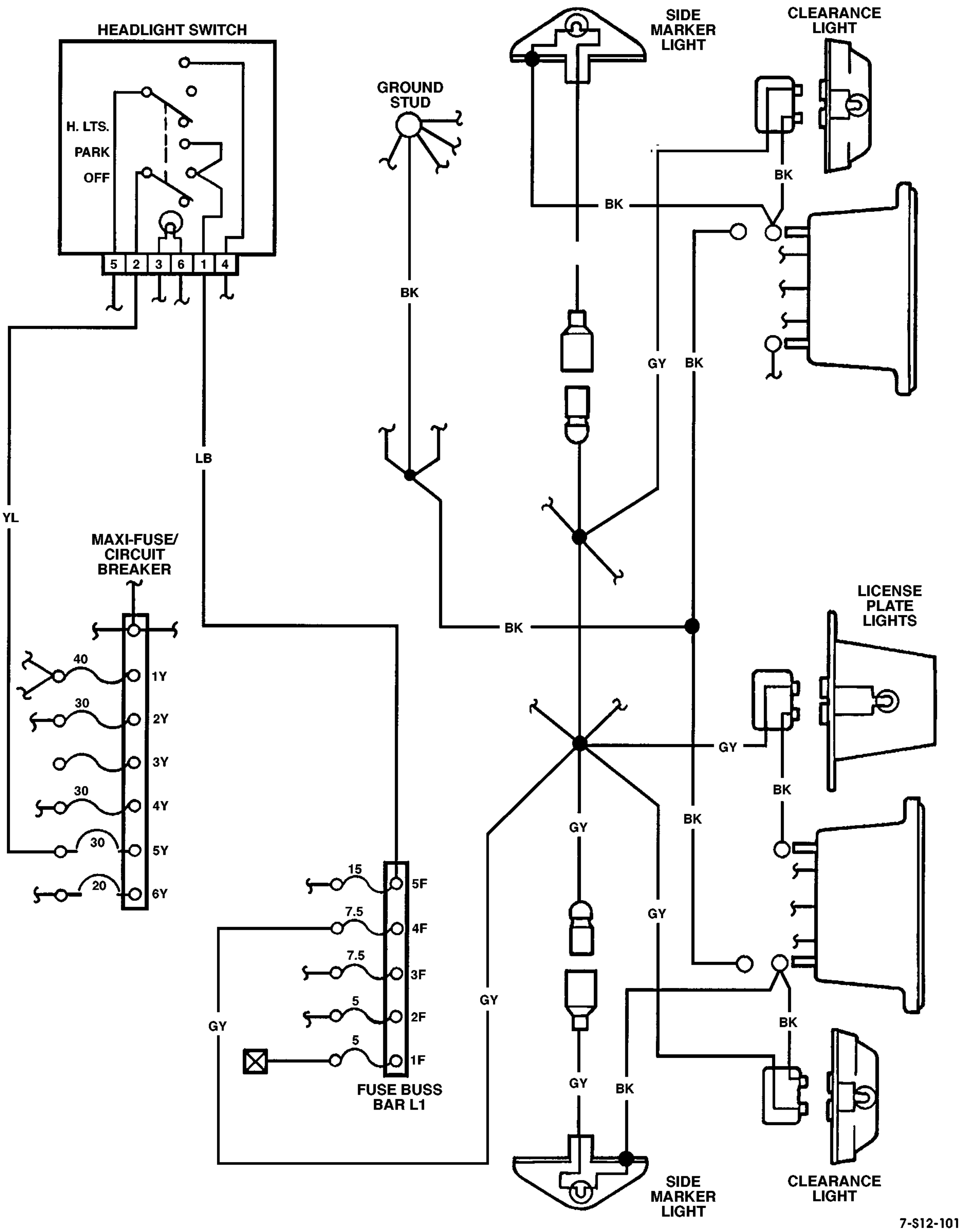


Figure 12-205: Clearance, Side Markers, and License Plate Lights

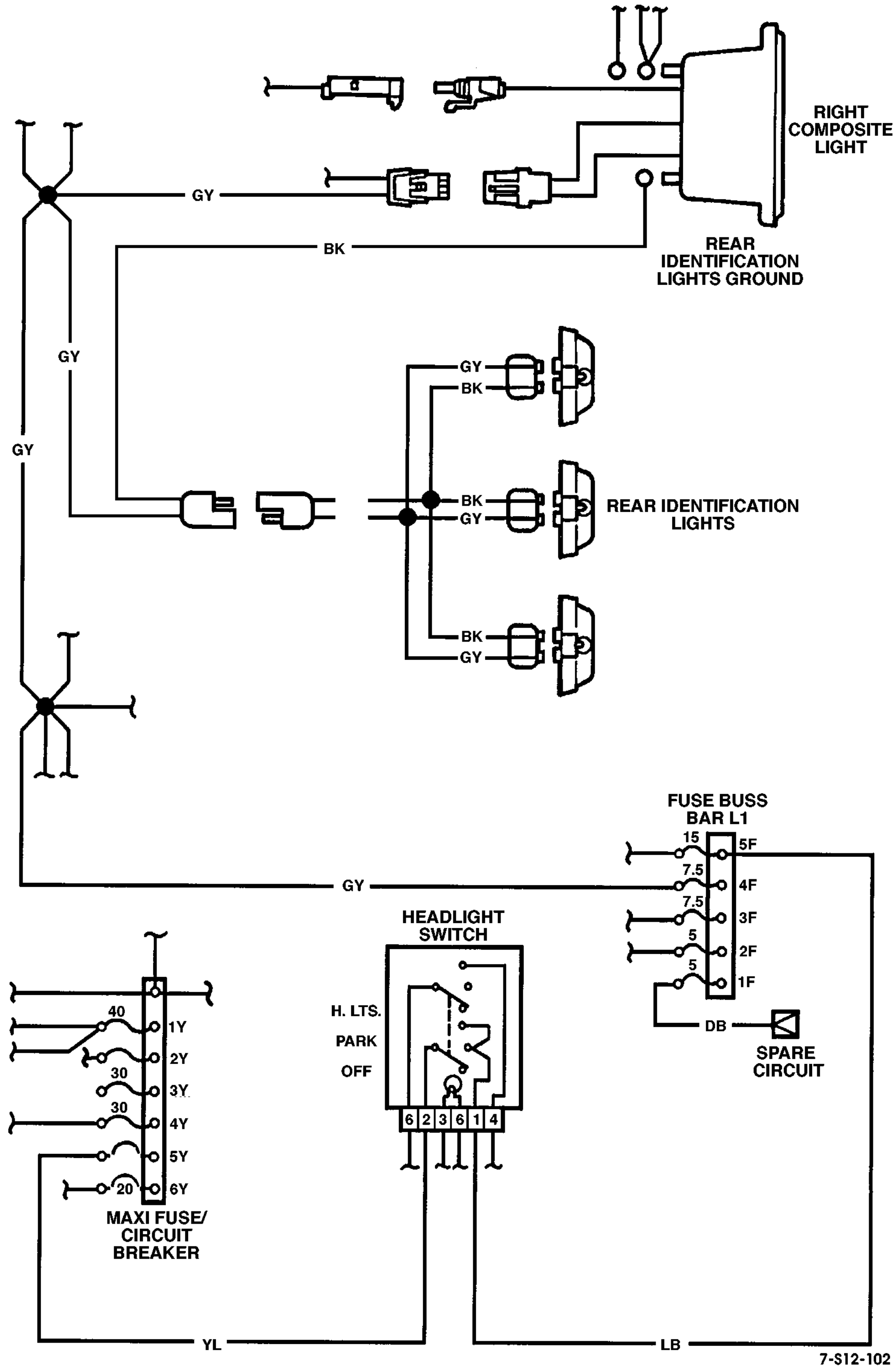
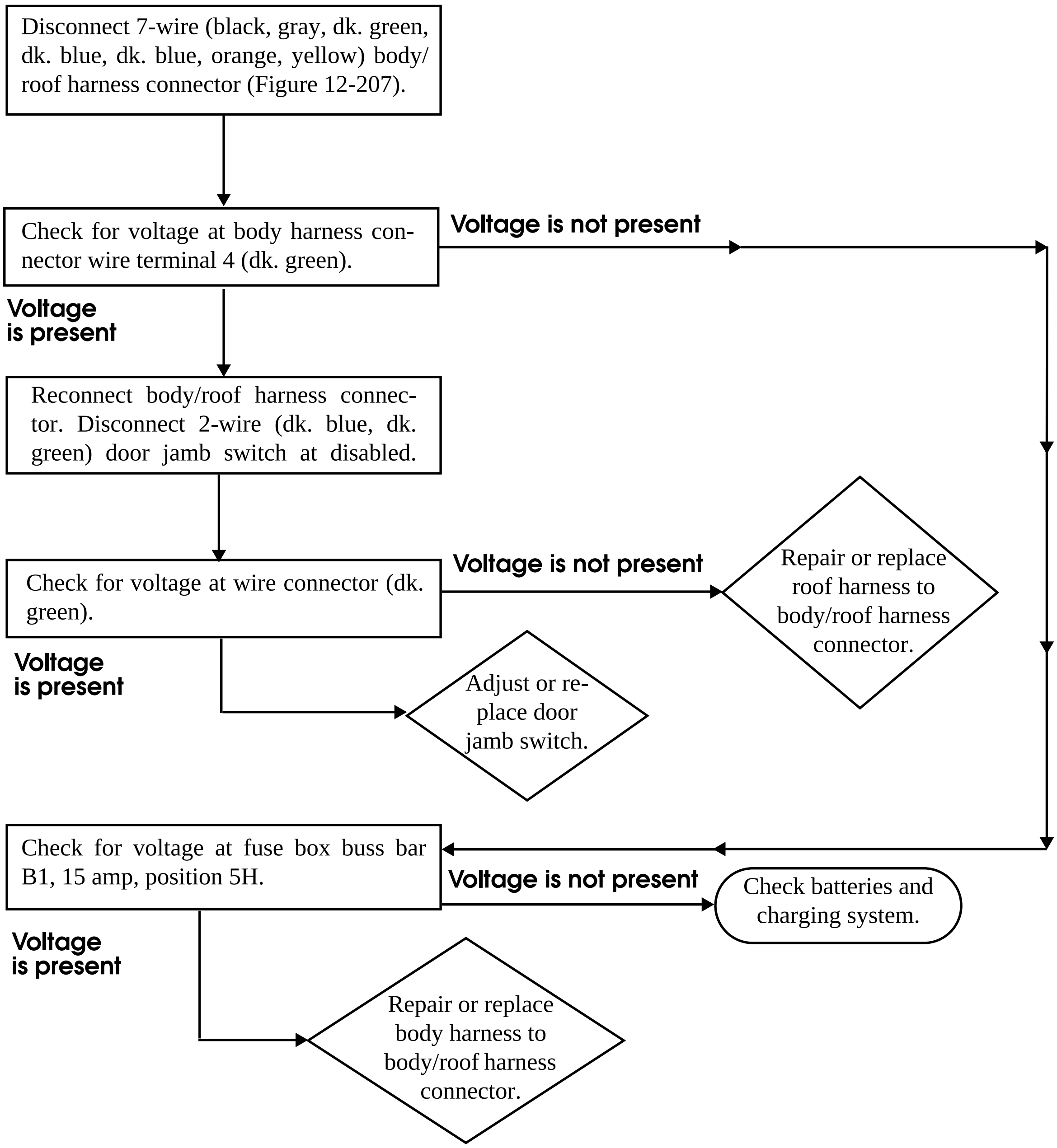


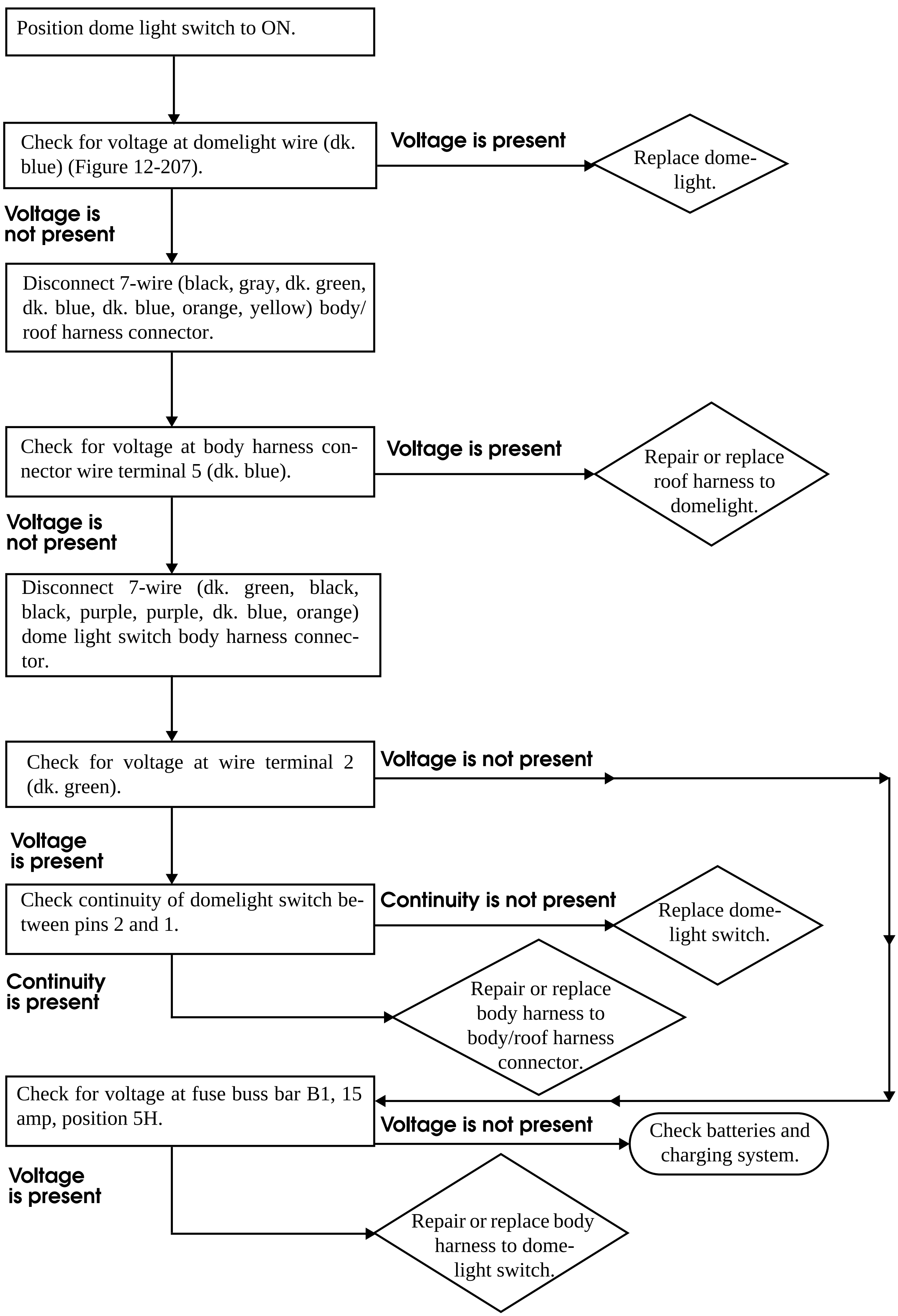
Figure 12-206: Rear Identification Lights

DOMELIGHT(S) (DOOR SWITCH)INOPERATIVE

NOTE: Before testing, check domelight door switches by opening other doors.



DOMELIGHT(S) (DOME SWITCH) INOPERATIVE



COURTESY LIGHT(S) (DRIVER'S) INOPERATIVE

Disconnect 7-wire (black, gray, dk. green, dk. blue, dk. blue, orange, yellow) body/roof harness connector (Figure 12-209).

Check for voltage at body harness connector wire terminal 4 (dk. green).

Voltage is not present → **Go to final step on next page**

Voltage is present

Connect body/roof harness connector.

Disconnect door jamb 3-wire (dk. green, dk. blue, white) connector.

Check for voltage at body harness connector (dk green).

Voltage is not present → Repair or replace body harness to body/roof harness connector.

Voltage is present

Disconnect 7-wire (black, gray, dk. green, dk. blue, dk. blue, orange, yellow) body/roof harness connector.

Check for voltage at body harness connector wire terminal 5 (dk. blue).

Voltage is not present → Repair or replace body harness to door jamb switch.

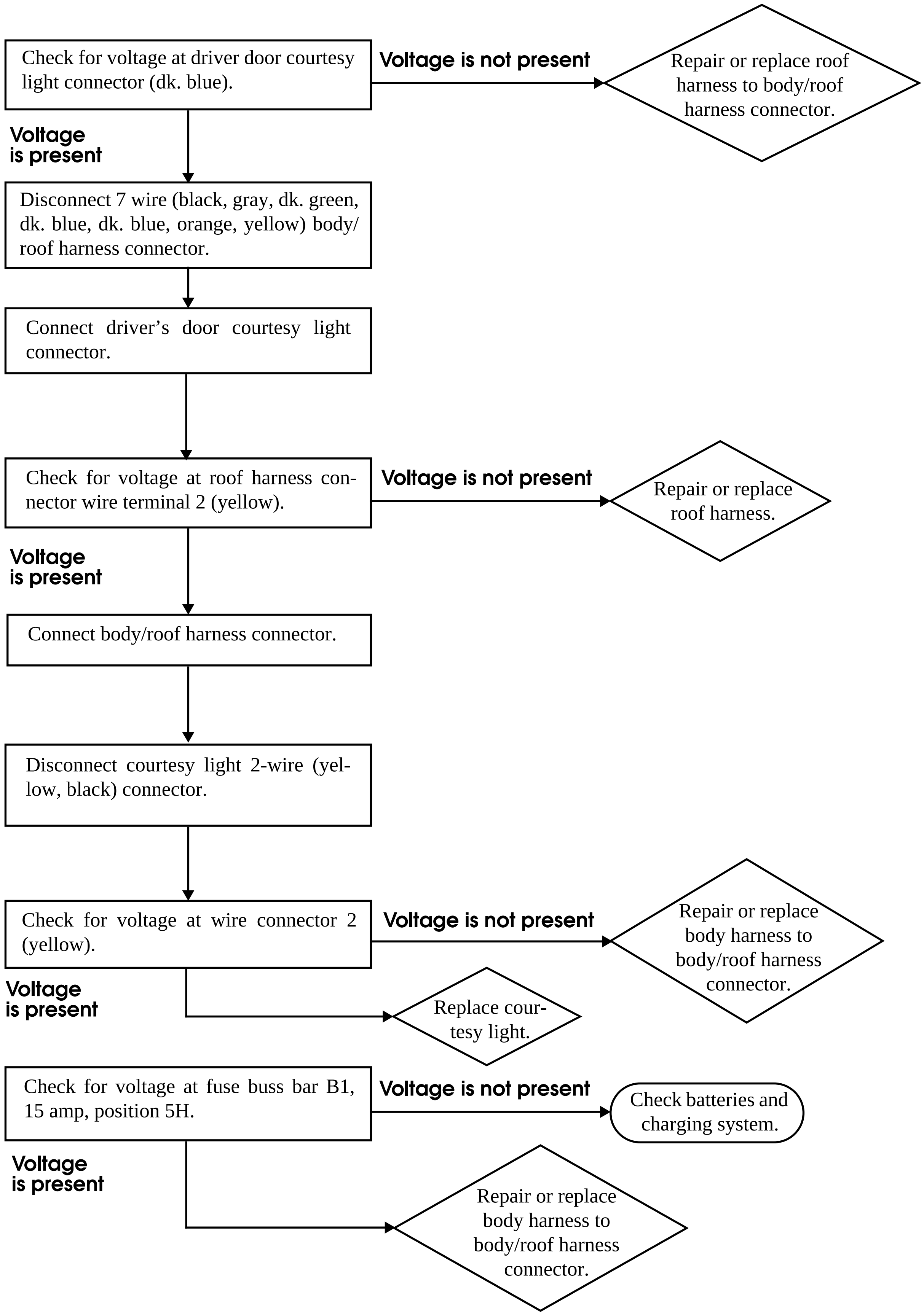
Voltage is present

Connect body/roof harness connector.

Disconnect courtesy light connector single wire connectors (dk. blue, yellow).

→ **Go to the top of the next page**

COURTESY LIGHT(S) (DRIVER'S) INOPERATIVE — CONTINUED



COURTESY LIGHT(S) (PASSENGER'S AND REAR) INOPERATIVE

Disconnect 7-wire (yellow, orange, dk. blue, dk. blue, dk. green, gray, black) body/roof harness connector (Figure 12-207).

Check for voltage at body harness connector wire terminal 4 (dk. green).

Voltage is not present

Voltage is present

Connect body/roof harness connector. Disconnect 2-wire (dk. green, dk. blue) door jamb switch connector.

Check for voltage at door jamb switch connector (dk. green).

Voltage is not present

Repair or replace roof harness to body/roof harness connector.

Voltage is present

Connect connector at door jamb switch. Disconnect driver courtesy light connector (black, yellow).

Check for voltage at wire (yellow).

Voltage is not present

Repair or replace roof harness to door jamb switch.

Voltage is present

Connect driver courtesy light. Disconnect 2-wire (black, yellow) connector at courtesy light.

Check for voltage at roof harness connector (yellow).

Voltage is not present

Repair or replace roof harness to body/roof connector.

Voltage is present

Replace courtesy light.

Check for voltage at fuse buss bar B1, 15 amp, position 5H.

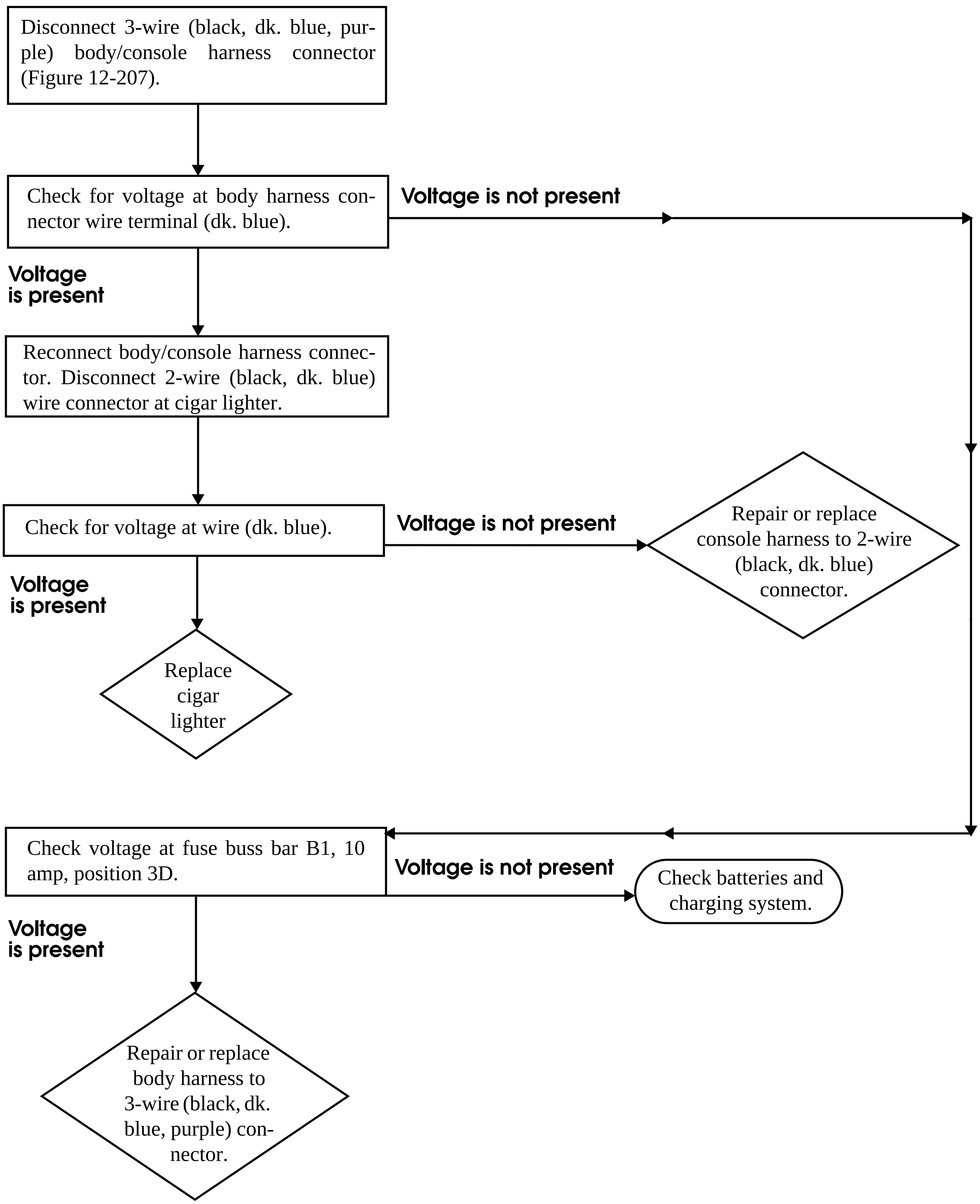
Voltage is not present

Check batteries and charging system.

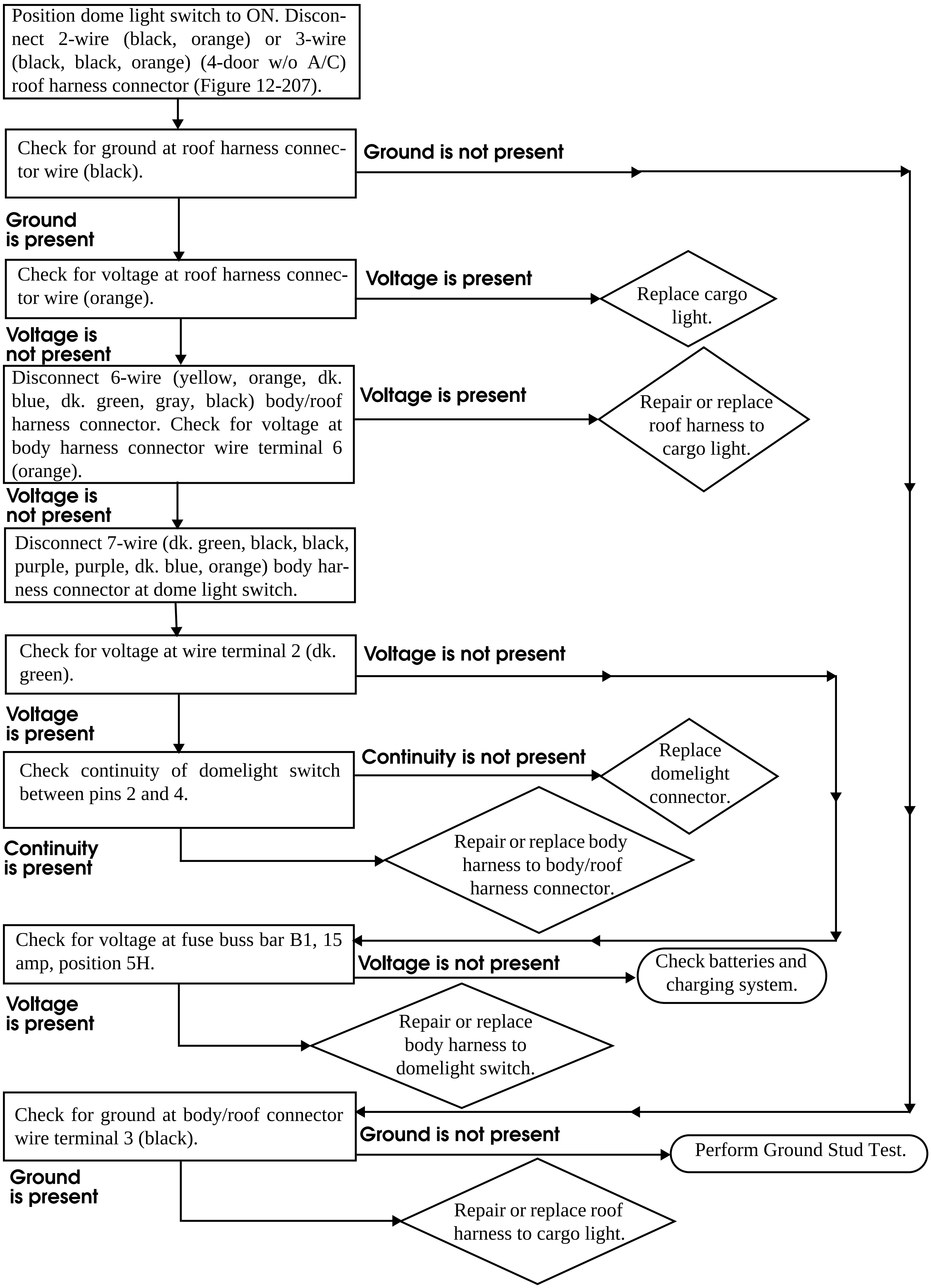
Voltage is present

Repair or replace body harness to roof connector.

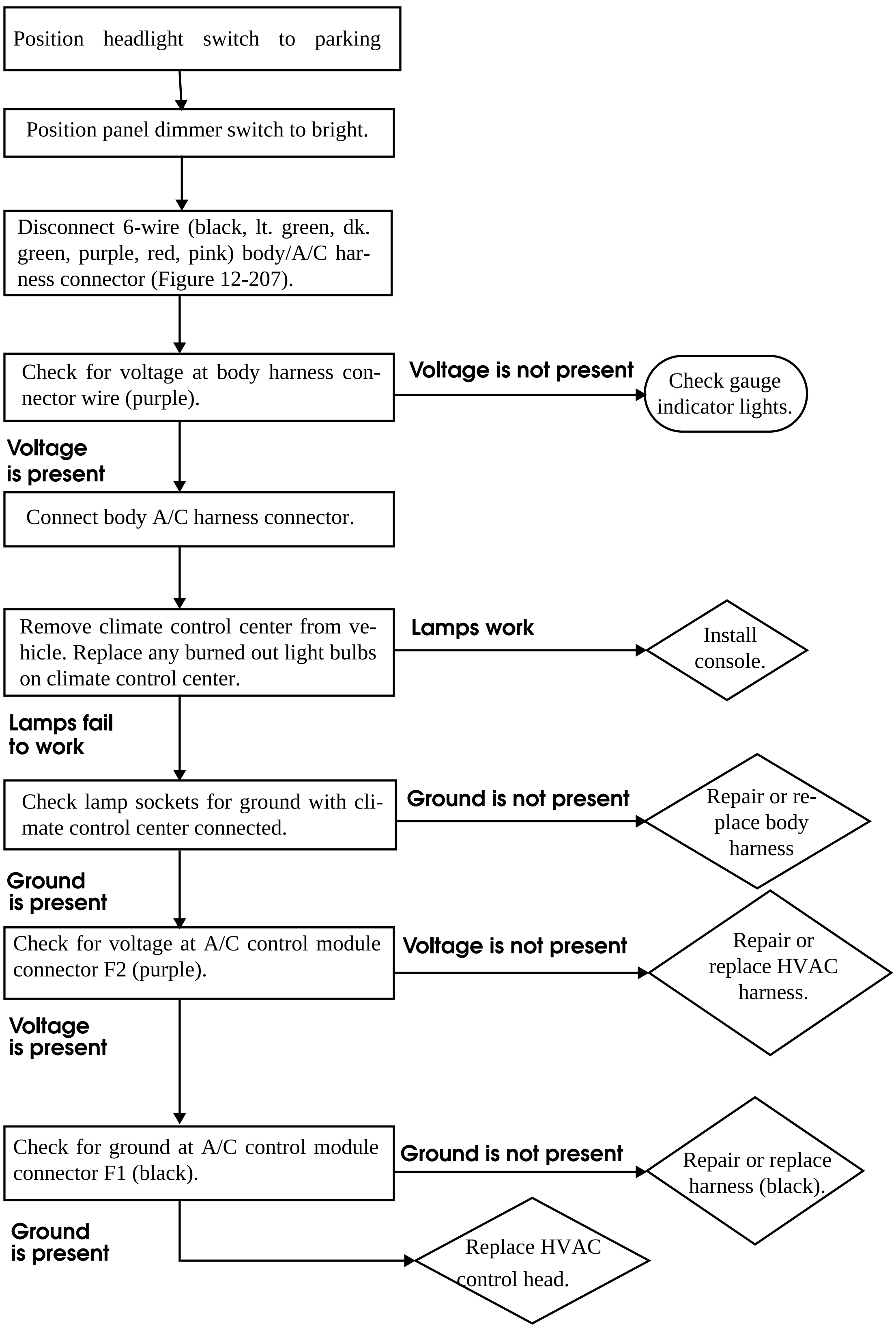
CIGAR LIGHTER INOPERATIVE



CARGO LIGHT INOPERATIVE



CLIMATE CONTROL LAMP(S) INOPERATIVE



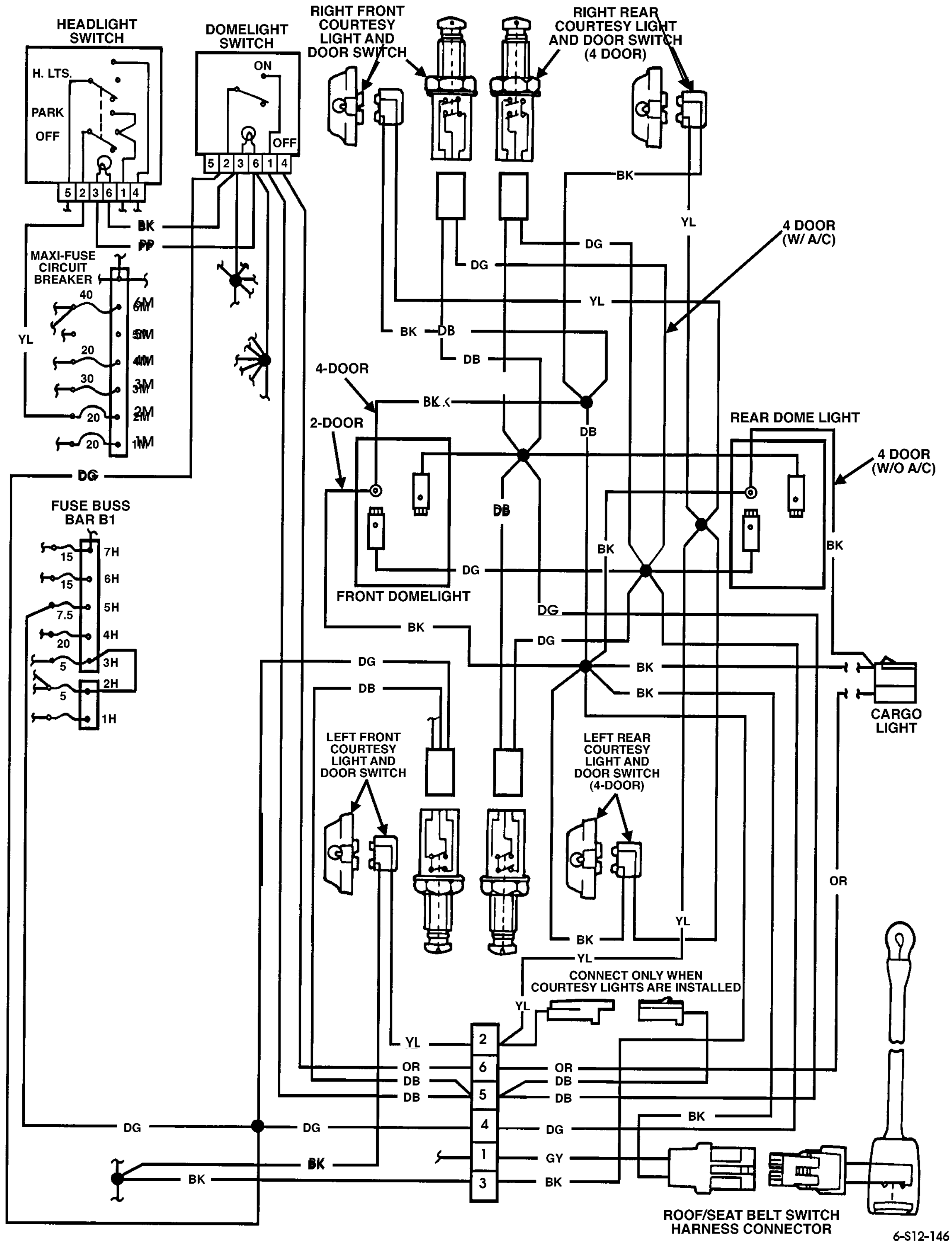


Figure 12-207: Courtesy, Dome, and Cargo Lights

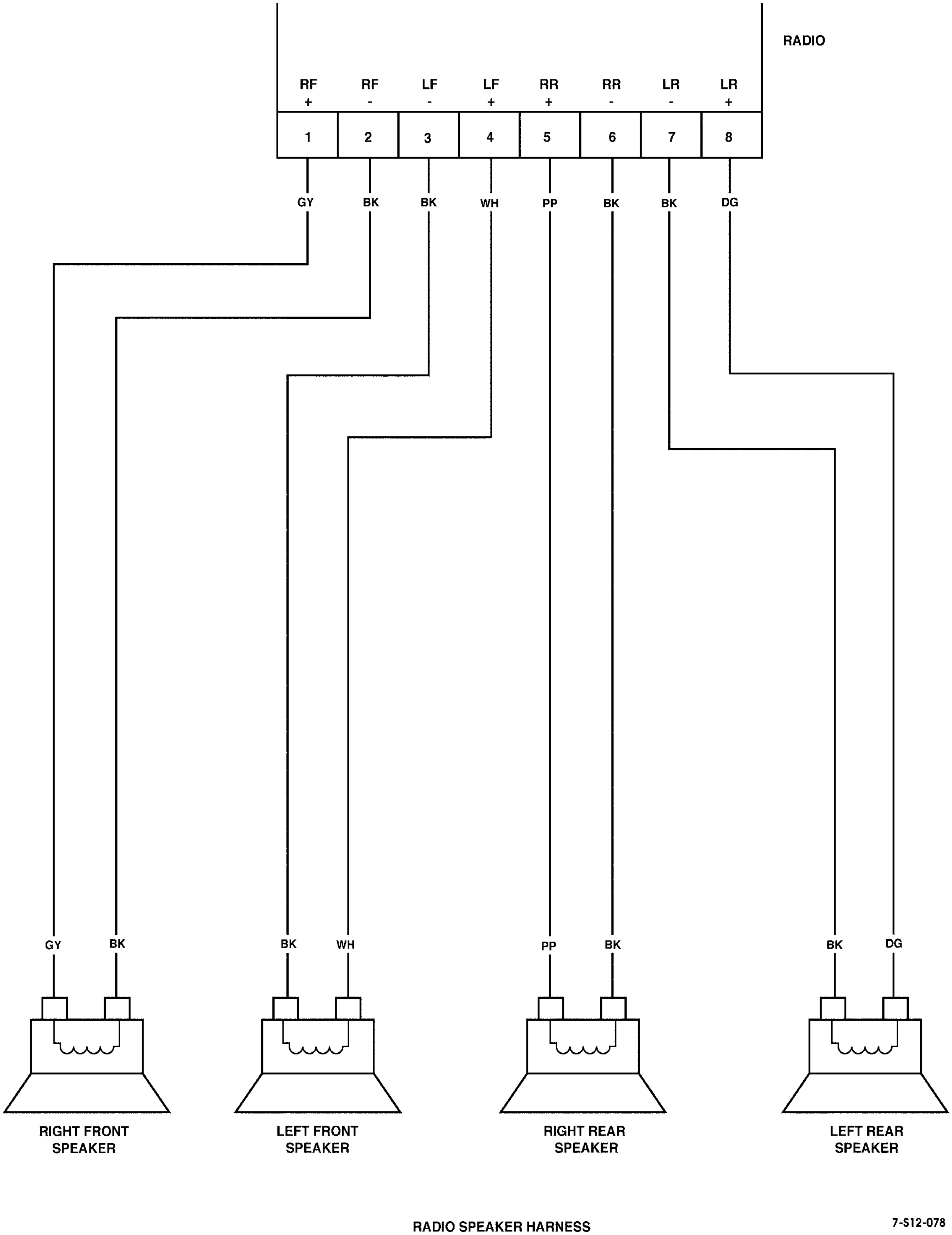


Figure 12-208: Radio Harness

TRAILER CONNECTION SYSTEM

NOTE: Check fuse panel for blown fuse(s) before performing electrical troubleshooting. Ensure inoperative lamp(s) and bulb(s) are replaced or known to be good before performing electrical troubleshooting.

Trailer Connector Inoperative (One Or More Pins)

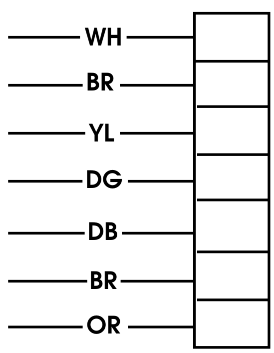
Step 1. Position ignition switch and light switch to circuit being tested (electrical harness foldouts 1-12).

Step 2. Check trailer connector pin (electrical harness foldouts 1-12) for voltage.

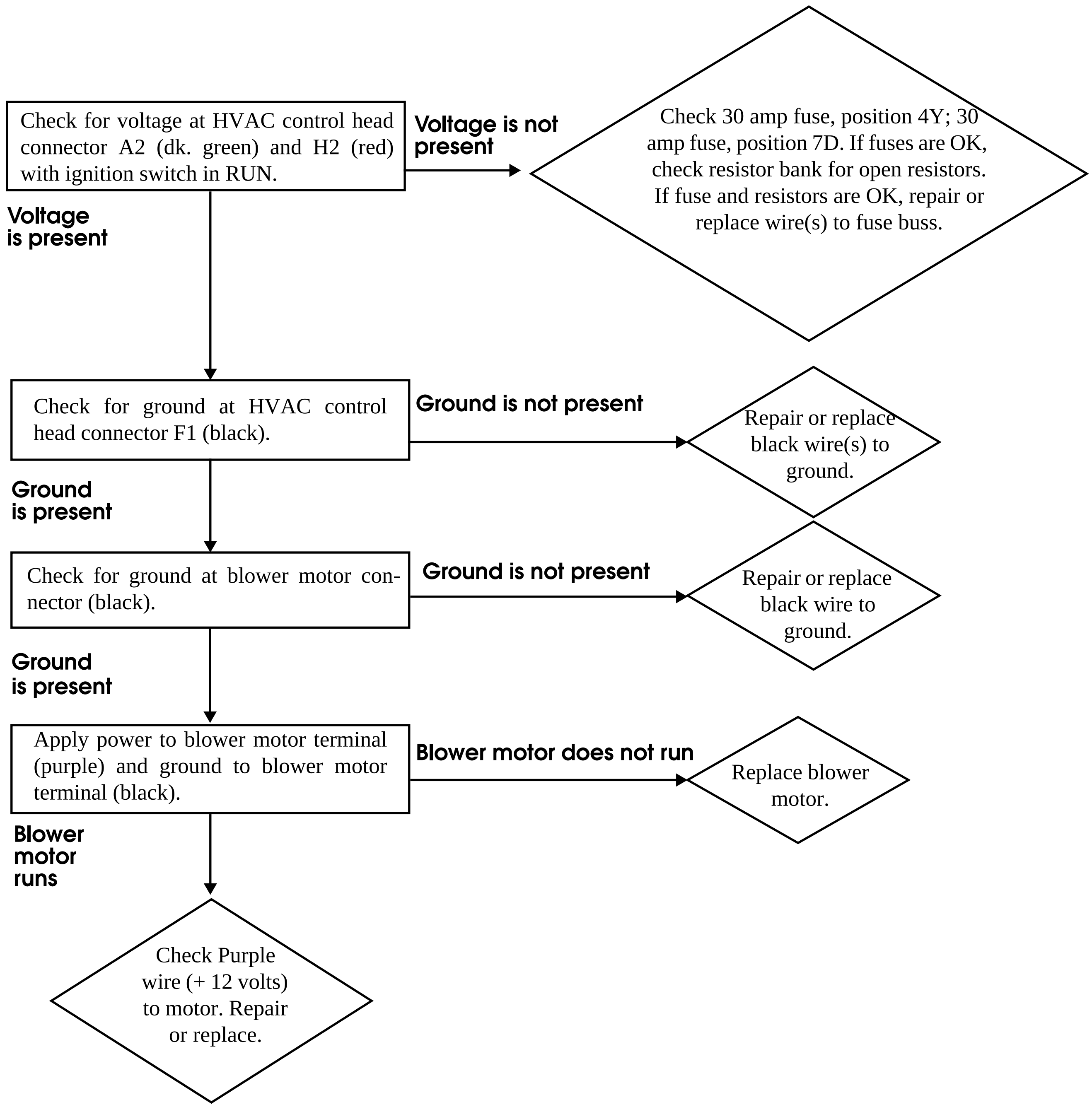
a. Nominal voltage is present, repair or replace trailer wiring harness.

b. Nominal voltage is not present, go to body wiring harness troubleshooting specific to trailer connector circuit being tested.

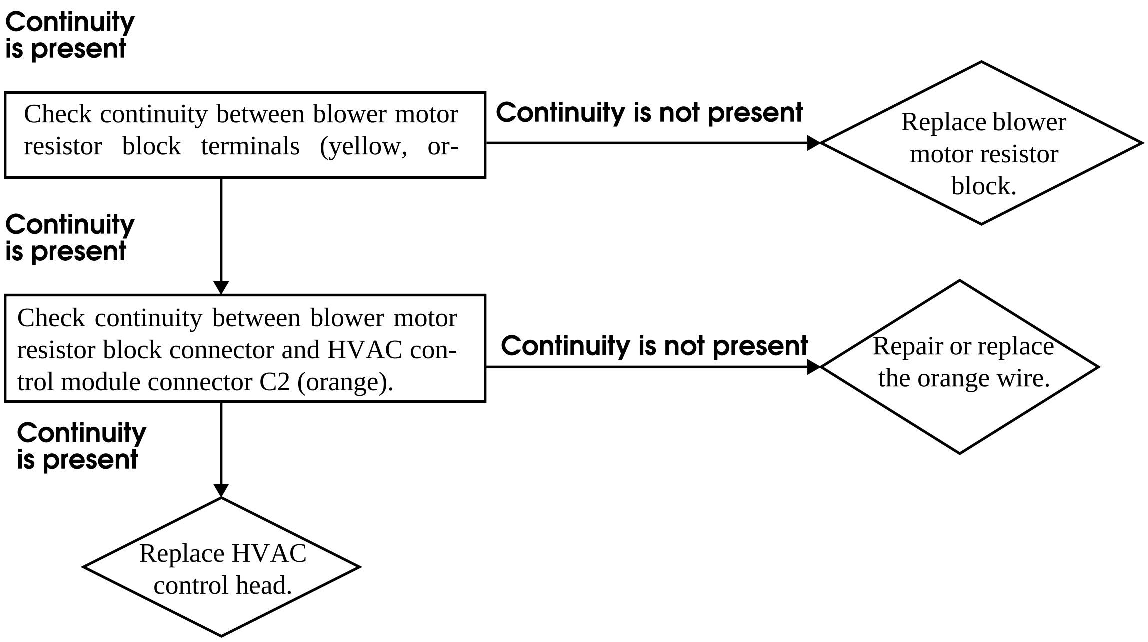
____Ground
____Trailer, I.D. clearance
____Left turn
____Right turn
____Brake control unit
____Auxiliary
____Battery charge



A/C BLOWER MOTOR DOES NOT FUNCTION AT ANY SPEED



A/C BLOWER MOTOR DOES NOT FUNCTION IN “LOW”, “LOW MEDIUM” OR “MEDIUM HIGH” BUT DOES FUNCTION ON “HIGH”



A/C BLOWER MOTOR DOES NOT FUNCTION IN "HIGH" SPEEDS BUT RUNS ON LOWER SPEEDS

Check for voltage at blower motor relay connector 86 (lt. blue) and connector 30 (red) with ignition in RUN and control head on Hi Speed Blower.

- **Voltage is not present** → Repair or replace the lt. blue or red wire.
- **Voltage is present** ↓

Check continuity between blower relay connector 85 (lt. blue) and HVAC control head connector B2 (lt. blue).

- **Continuity is not present** → Repair or replace the lt. blue wire.
- **Continuity is present** ↓

Check for alternator voltage on blower motor relay connector 87 (red) and ground.

- **Voltage is not present** → Repair or replace the red wire.
- **Voltage is present** ↓

Check continuity between blower motor terminal purple wire and relay 30.

- **Continuity is not present** → Repair purple wire.
- **Continuity is present** ↓

Check to see relay closes when ignition switch is in Run and control head is on HI blower. Alternator voltage should appear at blower motor purple wire.

- **Continuity is not present** → Replace relay.

AIR CONDITIONING SYSTEM FAILS TO COOL

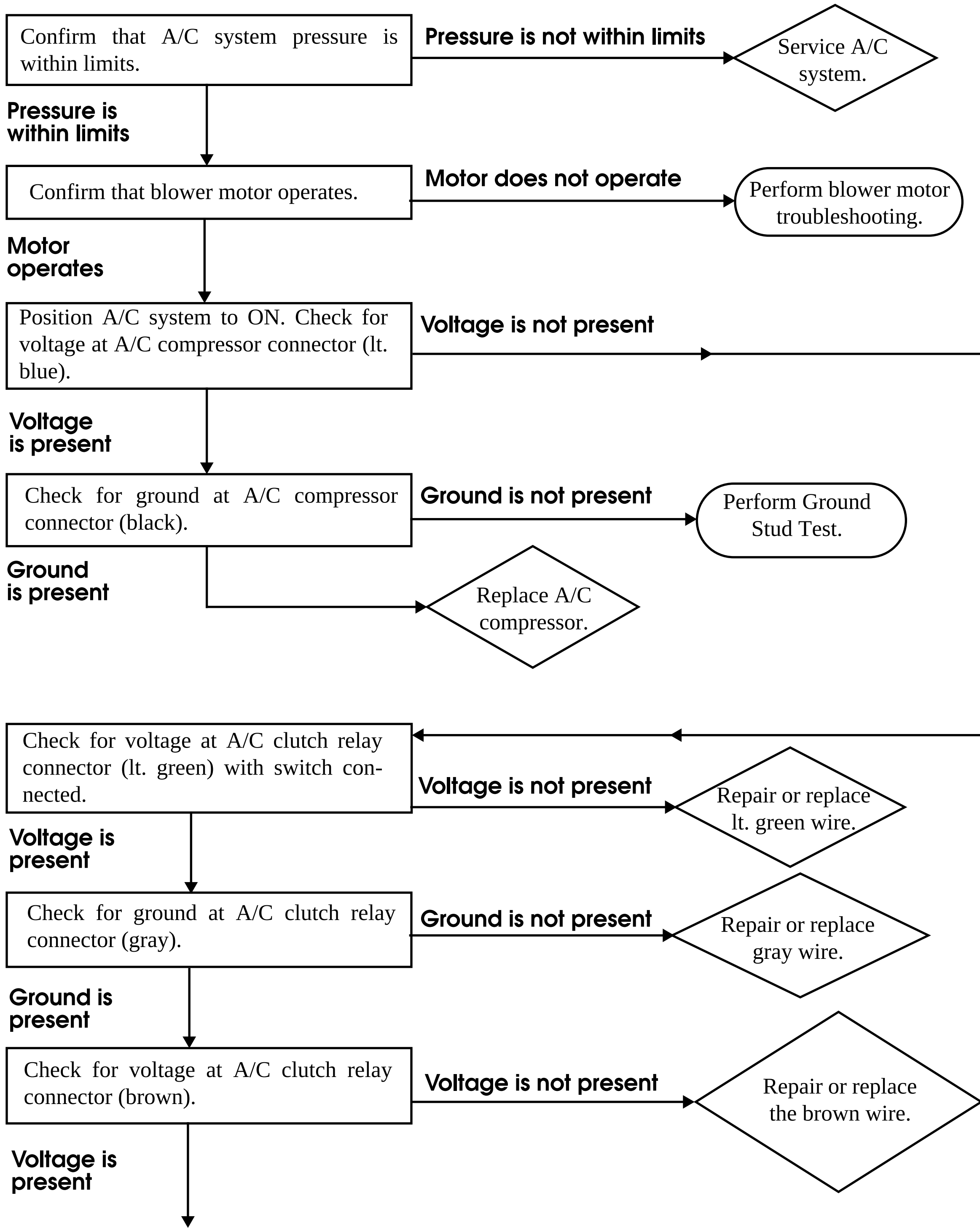
NOTE: Check fuse panel for blown fuse(s) and/or circuit breaker(s) before performing electrical troubleshooting. Check engine accessory drivebelts for wear and tension.

Start engine and position A/C system to ON and blower motor switch to HIGH. Check A/C compressor for clutch engagement.

Clutch does not engage → Perform the procedure on the next page.

Clutch engages → Perform procedure in Mechanical Troubleshooting entitled COMPRESSOR INOPERATIVE.

A/C COMPRESSOR CLUTCH DOESN'T OPERATE (ENGAGE) (N/A DIESEL ONLY)



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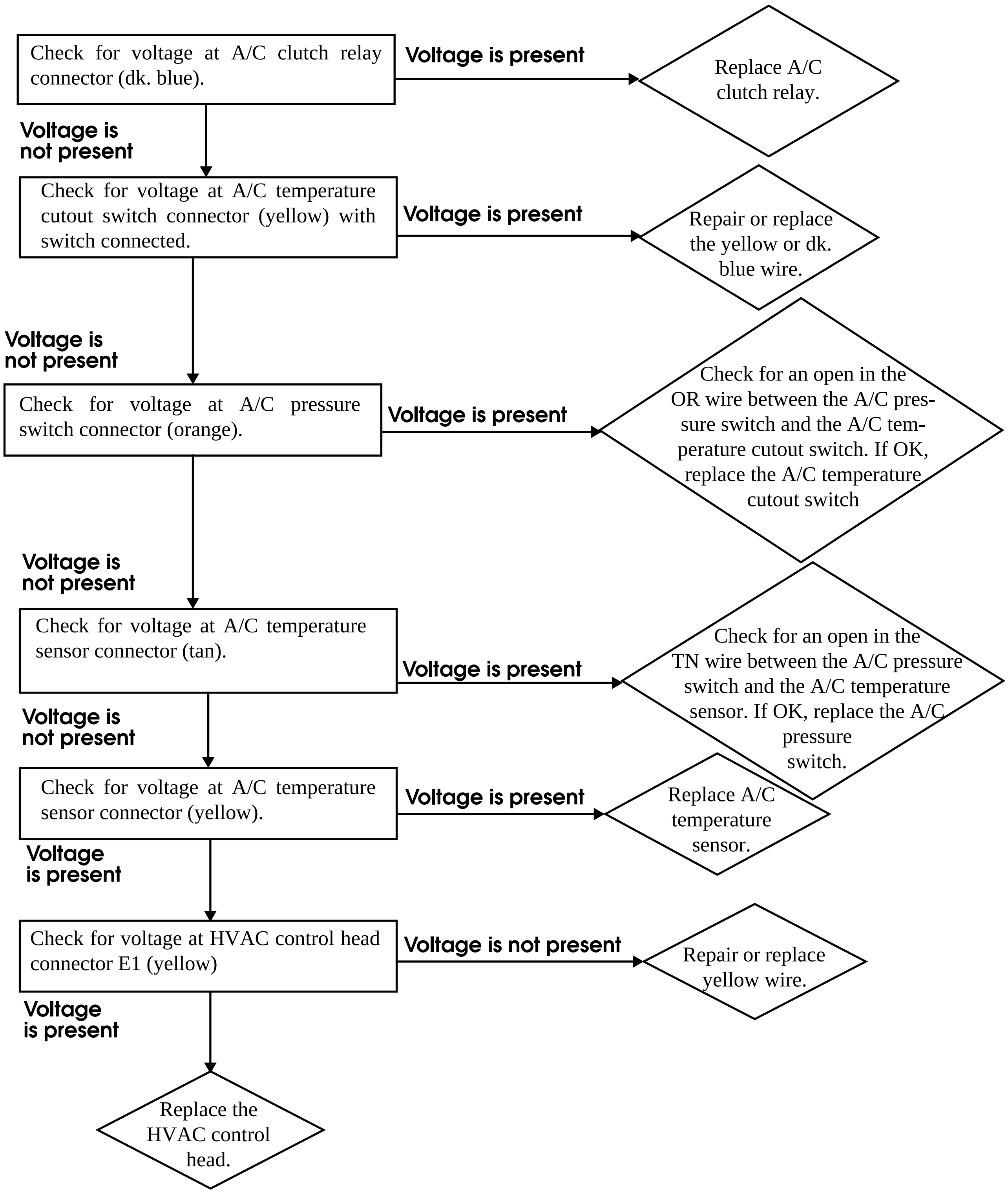
A/C COMPRESSOR CLUTCH DOESN'T OPERATE (ENGAGE) – CONTINUED (N/A DIESEL ONLY)



A/C COMPRESSOR CLUTCH DOESN'T OPERATE (ENGAGE) (TURBO DIESEL ONLY)

Confirm that A/C system pressure is within limits.

Pressure is not within limits

Service A/C system.

Pressure is within limits

Confirm that blower motor operates.

Motor does not operate

Perform blower motor troubleshooting.

Motor operates

Position A/C system to ON. Check for voltage at A/C compressor clutch (lt. blue) wire.

Voltage is present

Check for an open in BK wire between the A/C Compressor Clutch and ground. If OK, replace A/C Compressor Clutch.

Voltage is not present

Check for voltage at the A/C Clutch Relay LG wire.

Voltage is not present

Repair or replace the LG wire

Voltage is present

Check for voltage at the A/C Clutch Relay GY wire.

Voltage is not present

Repair or replace the GY wire

Voltage is present

Check for ground at A/C clutch relay DB wire.

Ground is present

Check for an open in the BR wire between the A/C compressor clutch and the A/C clutch relay. If OK, replace A/C clutch relay.

Ground is not present

Check for voltage at A/C pressure switch YL wire.

Voltage is not present

Check for an open in the YL wire between the A/C pressure switch and the PCM. If OK, replace the PCM.

Voltage is present

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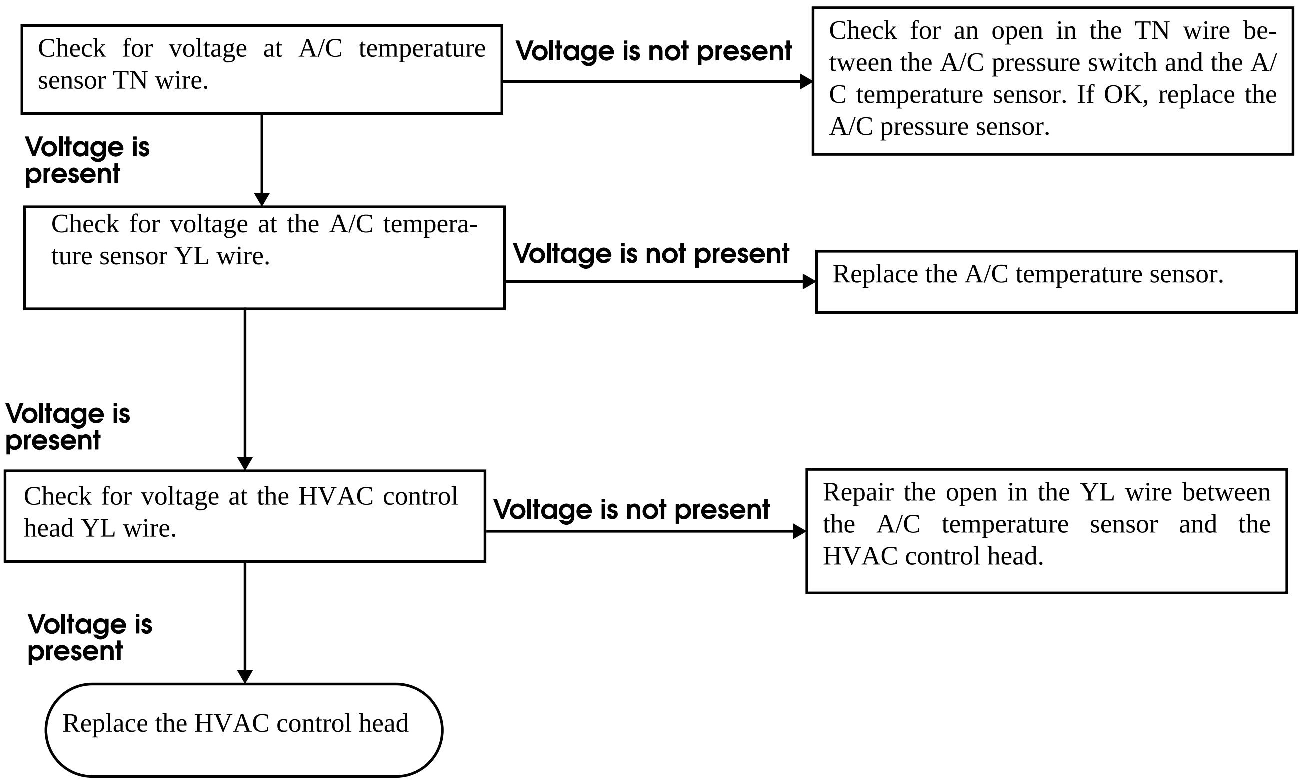
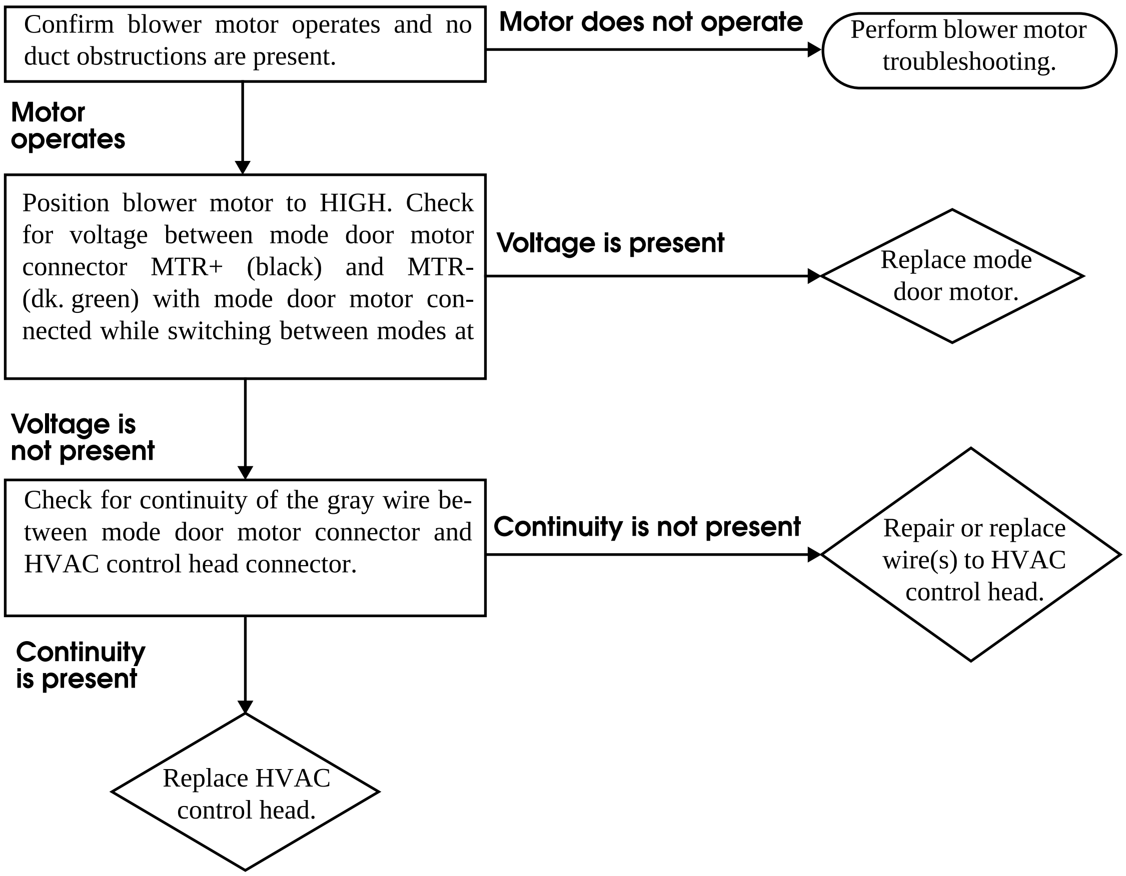
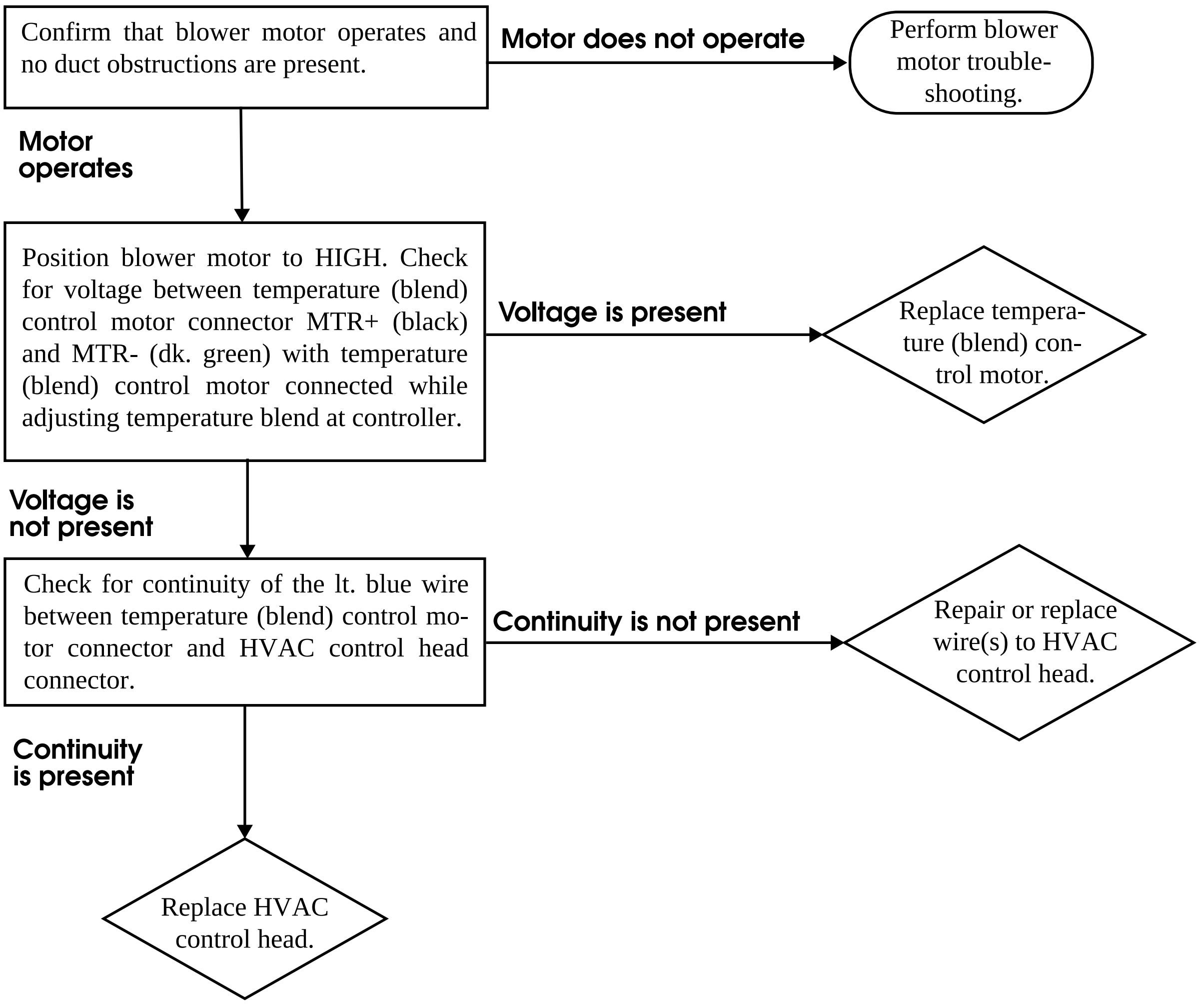
A/C COMPRESSOR CLUTCH DOESN'T OPERATE (ENGAGE) – CONTINUED (TURBO DIESEL ONLY)



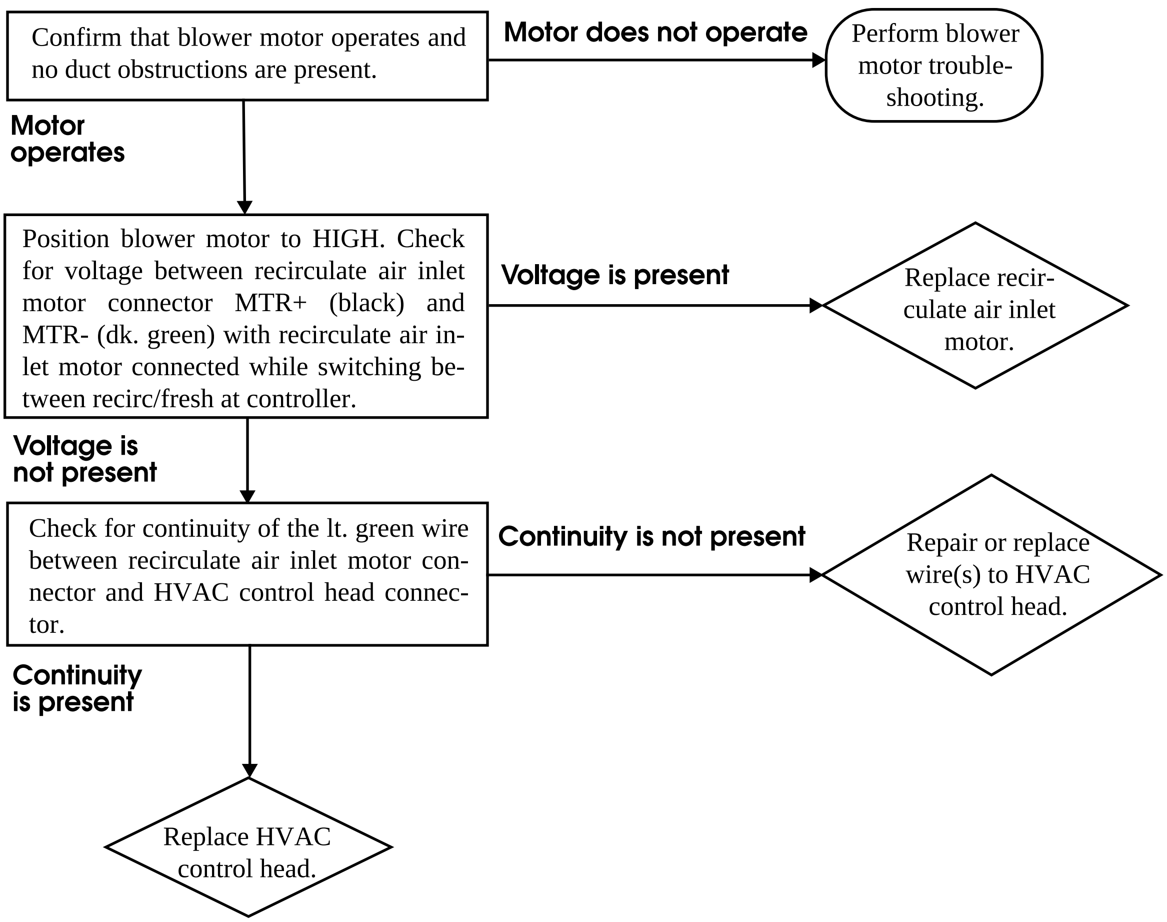
MODE DOOR MOTOR FAILS TO OPERATE



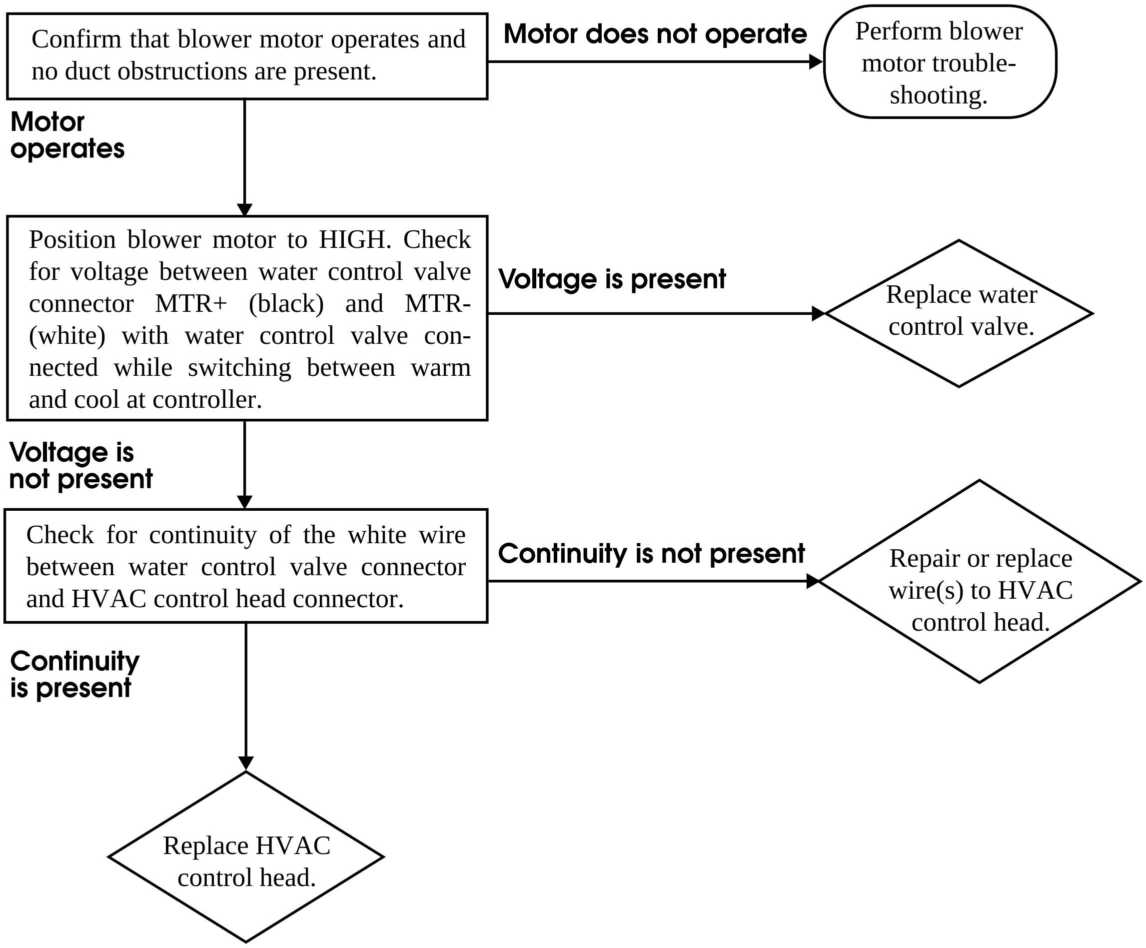
TEMPERATURE (BLEND) CONTROL MOTOR FAILS TO OPERATE



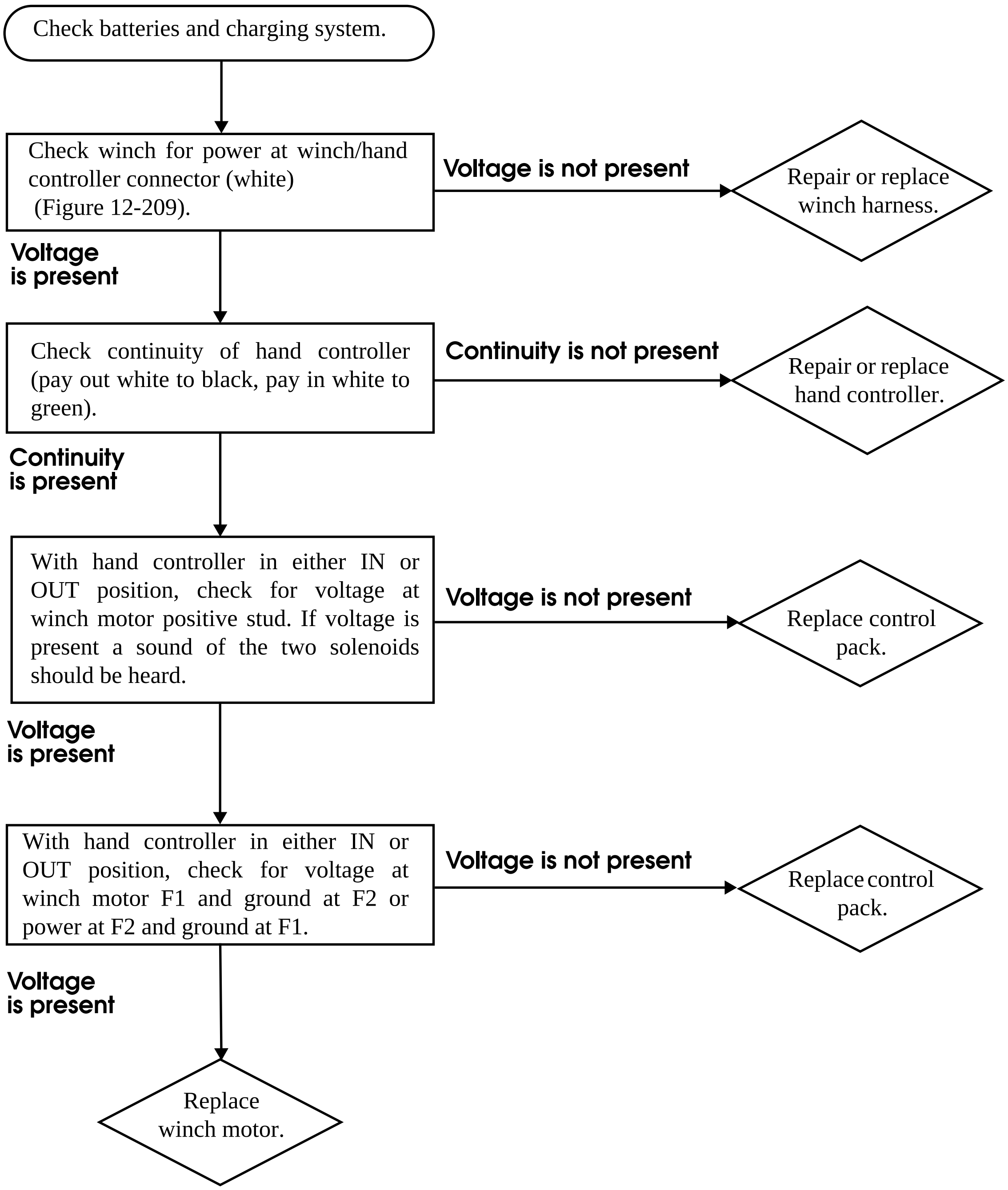
RECIRCULATE AIR INLET MOTOR FAILS TO OPERATE



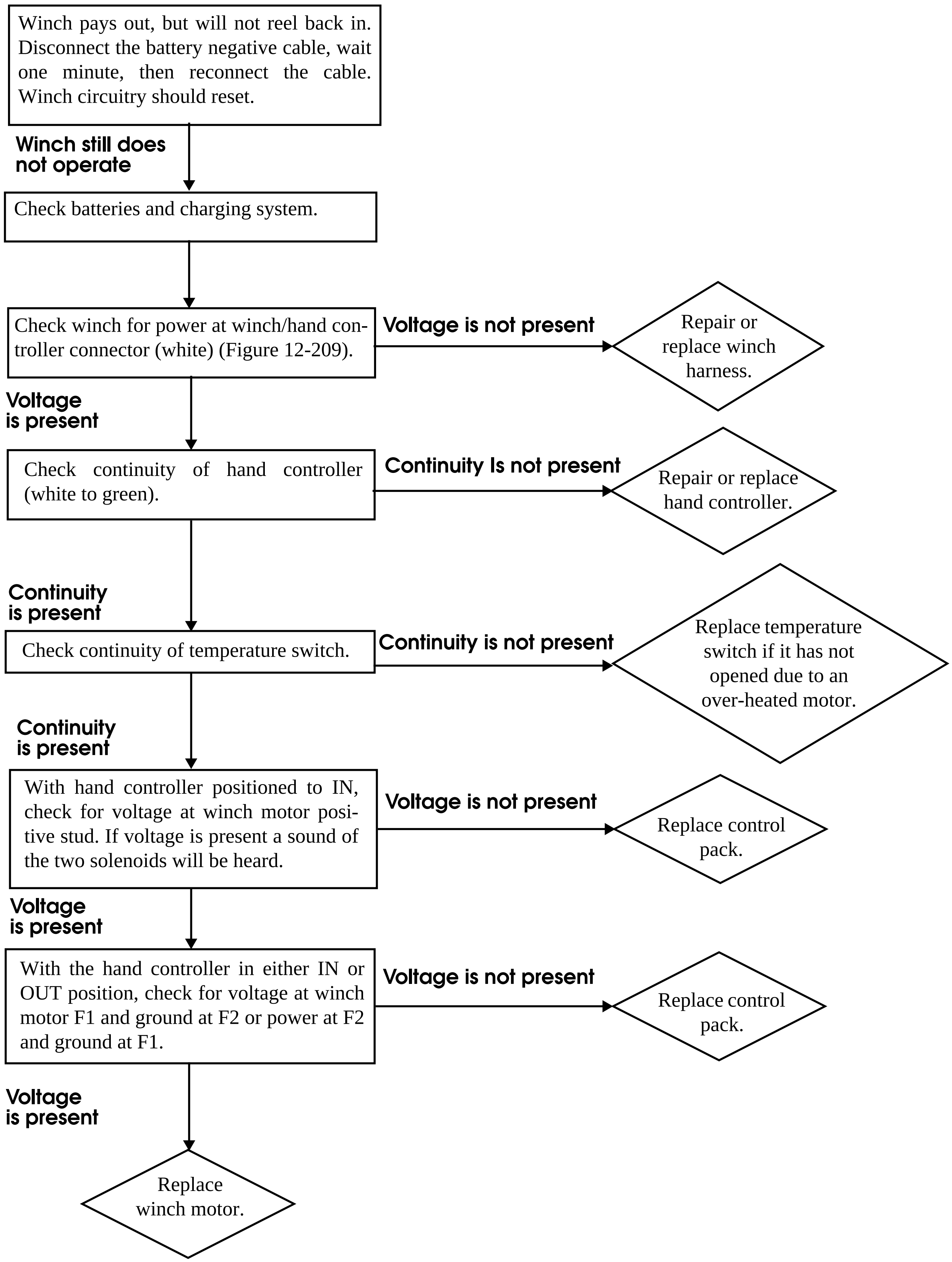
WATER CONTROL VALVE FAILS TO OPERATE



WINCH FAILS TO REEL OUT OR TO OPERATE IN BOTH DIRECTIONS



WINCH FAILS TO REEL IN



WINCH SHUTS OFF DURING OPERATION

1. **Electronic Current Limiter**

   The winch is equipped with an Electronic Current Limiter (ECL). This device will automatically shut off the winch on "power in" operation if the rated capacity of 12,000 lbs. is exceeded. When this occurs, you should "power out" some line to prevent damage to the winch. ("Power out" operation is not affected by the ECL.) The load must somehow be lightened, or a double line may be used in conjunction with a snatch block to reduce the load on the winch. When the ECL has tripped, it will reset itself within 5 to 10 seconds and "power in" will again be available.

2. **Temperature Switch**

   The winch is equipped with a motor temperature switch. When the motor approaches stall speed, a very rapid heat buildup occurs which could cause permanent motor damage. This device will automatically shut off the winch. The switch will automatically reset as the motor cools.

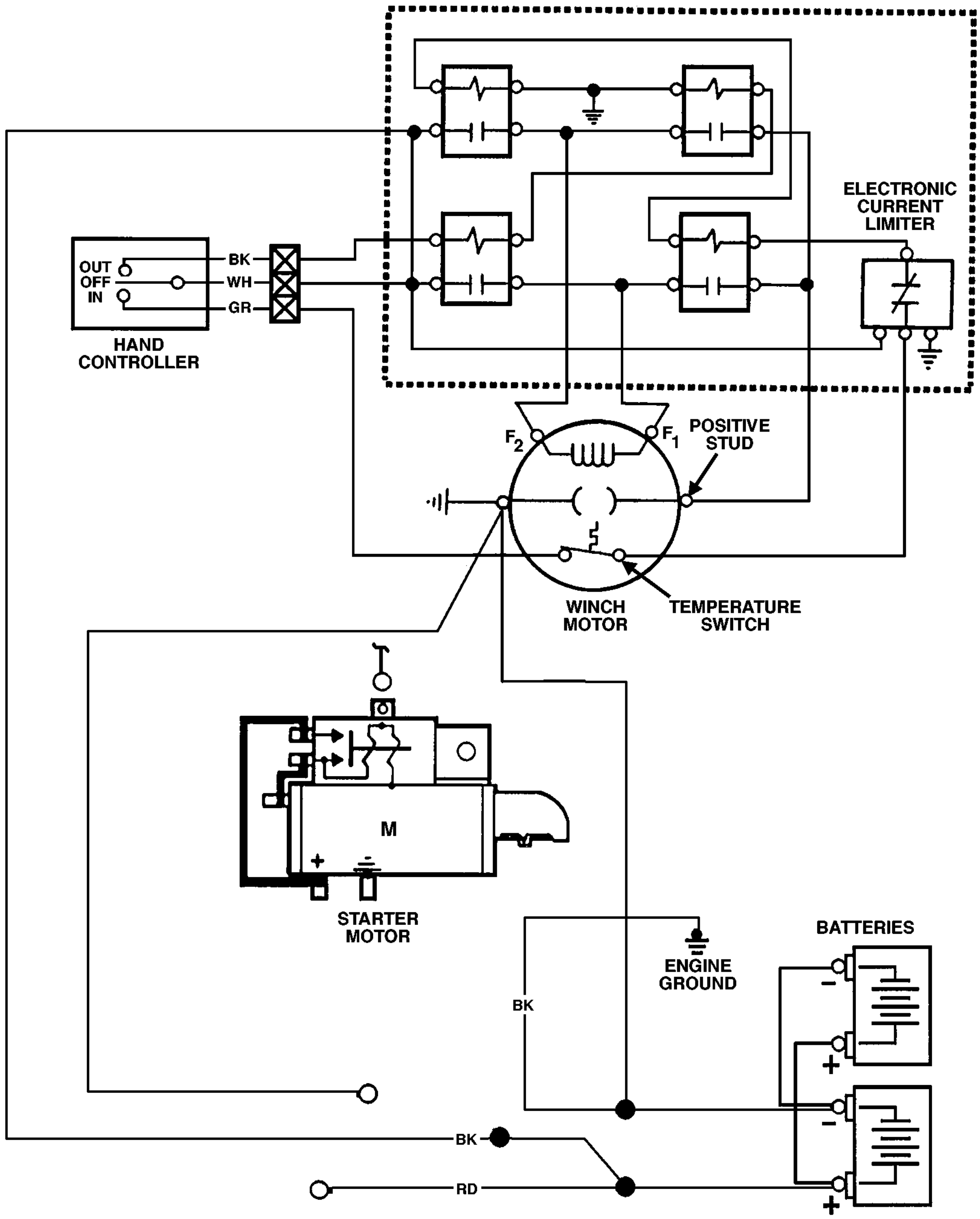


Figure 12-209: Winch System

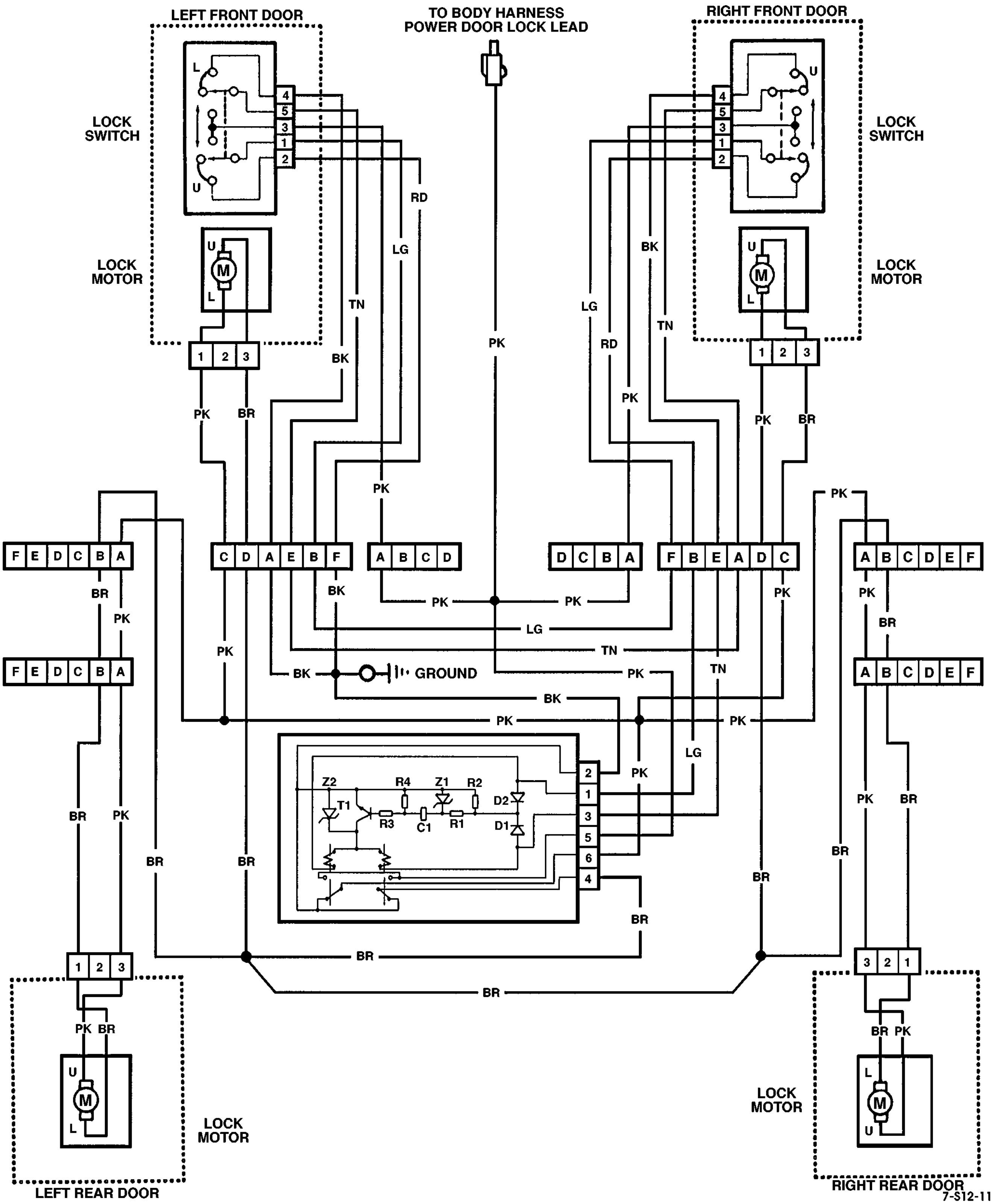


Figure 12-210: Power Door Locks (w/ Remote Entry)

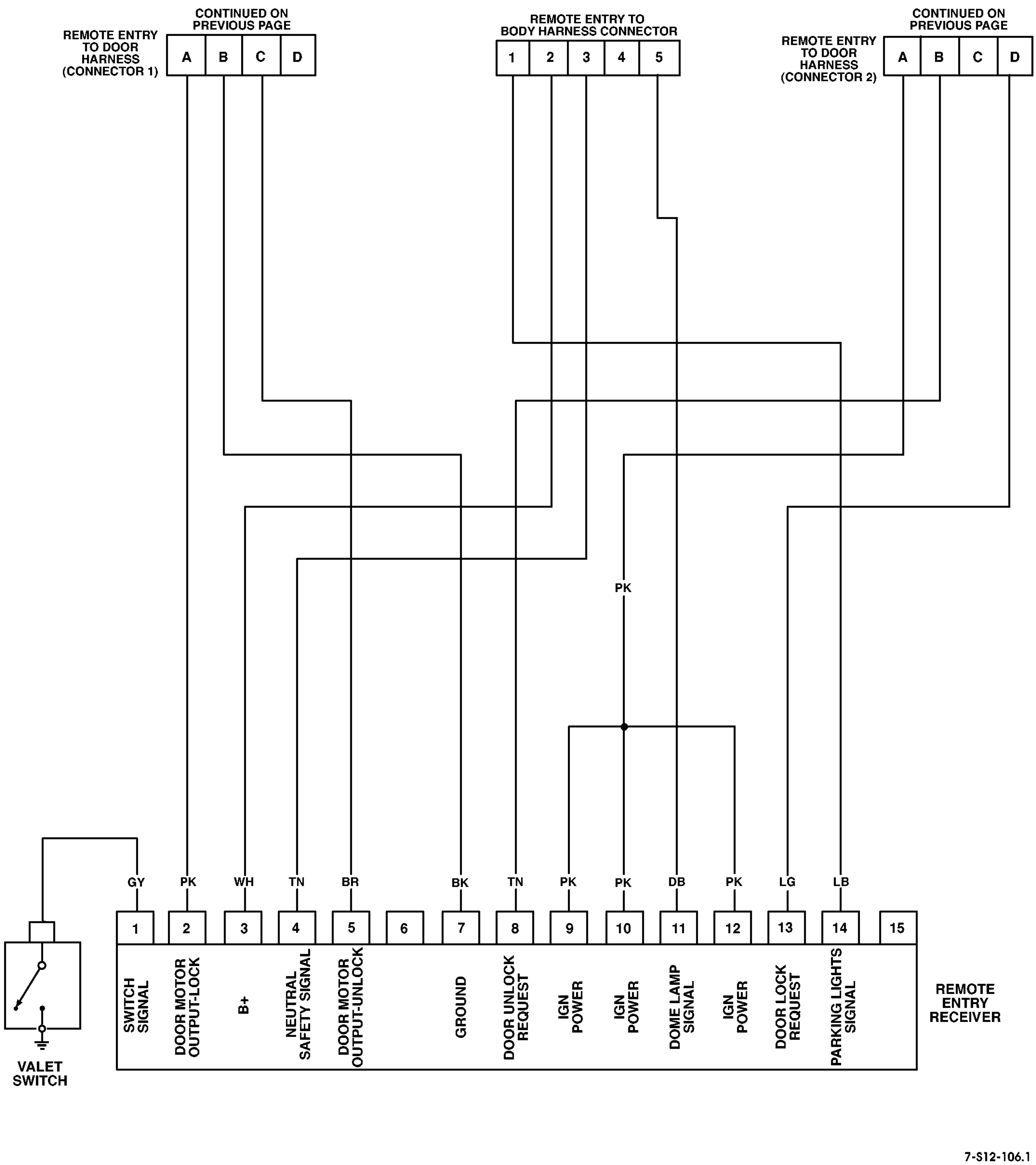


Figure 12-211: Power Door Locks (w/ Remote Entry)

POWER DOOR LOCKS DO NOT LOCK OR UNLOCK FROM EITHER SWITCH OR FROM THE TRANSMITTER

Check 20 amp fuse and voltage at fuse box, position 3H. Is the fuse OK and voltage present?

- **NO** → If the fuse is OK, check the batteries and charging system, otherwise replace the fuse.
- **YES** ↓

Connect a test lamp from the remote entry receiver connector cavities 9, 10, and 12 to ground. Does the test lamp light at all?

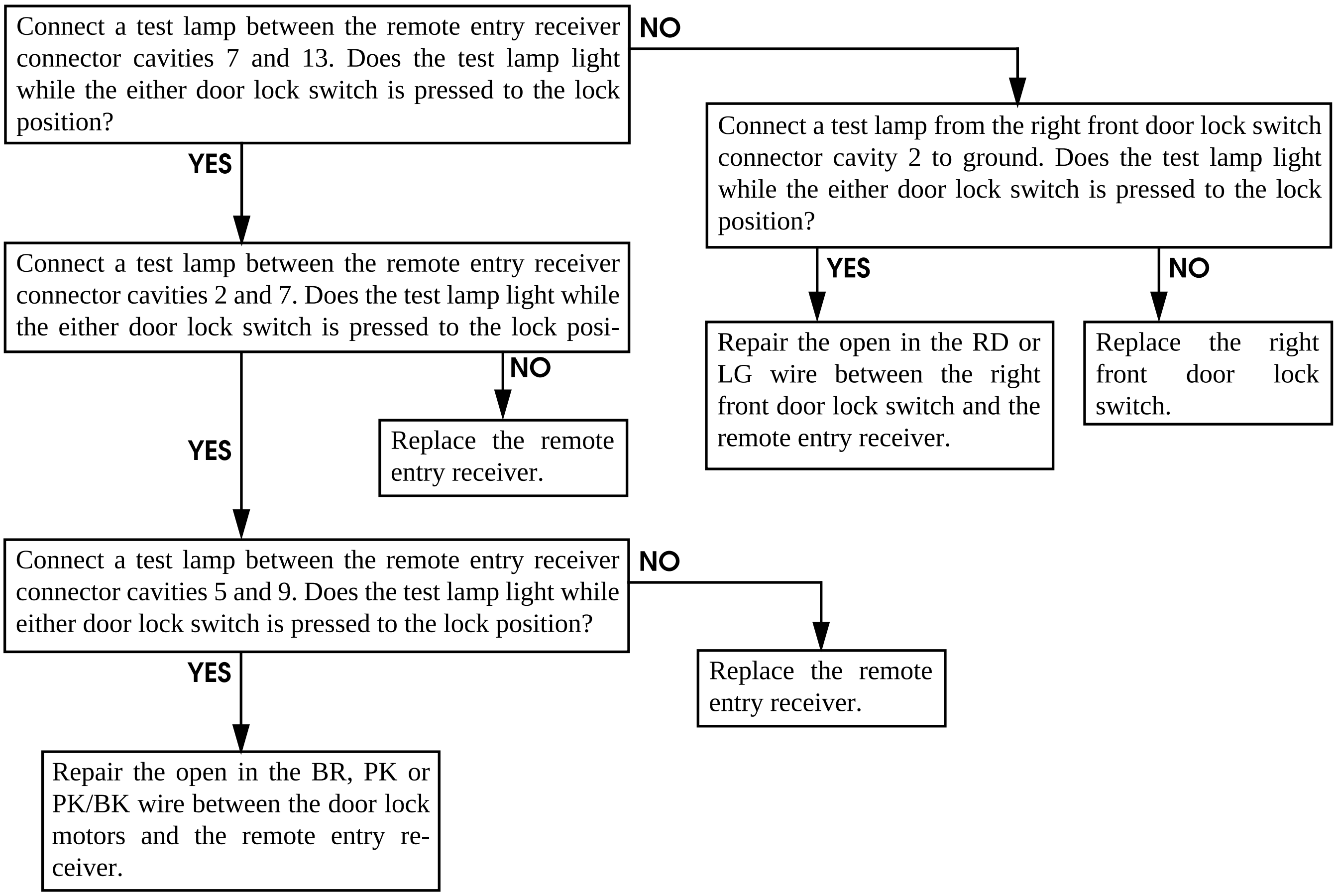
- **NO** → Repair the open in the PK wire between the battery and the remote entry receiver.
- **YES** ↓

Connect a test lamp between the remote entry receiver connector cavities 7 and 9. Does the test lamp light at

- **NO** → Repair the open in the BK wire between the remote entry receiver and ground.
- **YES** ↓

Replace the remote entry receiver.

POWER DOOR LOCKS DO NOT LOCK FROM EITHER SWITCH



POWER DOOR LOCKS DO NOT UNLOCK FROM EITHER SWITCH

Connect a test lamp between the remote entry receiver connector cavities 7 and 8. Does the test lamp light while the either door lock switch is pressed to the unlock position?

NO

Connect a test lamp from the right front door lock switch connector cavity 4 to ground. Does the test lamp light while the either door lock switch is pressed to the unlock position?

YES

Repair the open in the BK or TN wire between the right front door lock switch and the remote entry receiver.

NO

Replace the right front door lock switch.

YES

Connect a test lamp between the remote entry receiver connector cavities 5 and 7. Does the test lamp light while the either door lock switch is pressed to the unlock position?

NO

Replace the remote entry receiver.

YES

Connect a test lamp between the remote entry receiver connector cavities 2 and 9. Does the test lamp light while either door lock switch is pressed to the unlock position?

NO

Replace the remote entry receiver.

YES

Repair the open in the BR, PK or PK/BK wire between the door lock motors and the remote entry receiver.

POWER DOOR LOCKS DO NOT LOCK FROM LH FRONT DOOR LOCK SWITCH

Connect a test lamp from the LH front door lock switch connector cavity 1 to ground. Does the test lamp light while the LH front door lock switch is pressed to the lock position?

- NO → Replace the LH front door lock switch.
- YES → Connect a test lamp from the RH front door lock switch connector cavity 1 to ground. Does the test lamp light while the LH front door lock switch is pressed to the lock position?
  - YES → Replace the RH front door lock switch.
  - NO → Repair the open in the LG wire between the LH front door lock switch and the RH front door lock switch.

POWER DOOR LOCKS DO NOT UNLOCK FROM LH FRONT DOOR LOCK SWITCH

Connect a test lamp from the LH front door lock switch connector cavity 5 to ground. Does the test lamp light while the LH front door lock switch is pressed to the unlock position?

- **NO** → Replace the LH front door lock switch.
- **YES** → Connect a test lamp from the RH front door lock switch connector cavity 5 to ground. Does the test lamp light while the LH front door lock switch is pressed to the unlock position?
  - **YES** → Replace the RH front door lock switch.
  - **NO** → Repair the open in the TN wire between the LH front door lock switch and the RH front door lock switch.

POWER DOOR LOCKS DO NOT LOCK OR UNLOCK FROM LH FRONT DOOR LOCK SWITCH

Connect a test lamp from the LH front door lock switch connector cavity 3 to ground. Does the test lamp light?

YES

Replace the LH front door lock switch.

NO

Repair the open in the PK wire between the fuse box and the LH front door lock switch.

POWER DOOR LOCKS DO NOT LOCK OR UNLOCK FROM RH FRONT DOOR LOCK SWITCH

Connect a test lamp from the RH front door lock switch connector cavity 3 to ground. Does the test lamp light?

YES

Replace the RH front door lock switch.

NO

Repair the open in the PK wire between the fuse box and the RH front door lock switch.

ONE DOOR DOES NOT LOCK OR UNLOCK

Check the inoperative door lock motor for binding linkage. Is it OK?

NO

Repair/replace the linkage to the inoperative door lock motor.

YES

Check for an open in the PK or BR wires to the inoperative door lock motor. If OK, replace the inoperative door lock motor.

DOOR LOCKS DO NOT LOCK OR UNLOCK WITH THE TRANSMITTER

Check the antenna connection at the remote entry receiver. Is it OK?

NO

Repair/replace the antenna to the remote entry receiver.

YES

Attempt to reprogram the inoperative transmitter. Refer to Remote Entry Receiver/Transmitter Replacement. Do the doors lock and unlock after the transmitter has been reprogrammed?

NO

Replace the inoperative transmitters.

YES

The problem was with the transmitter. Repeat the reprogramming for the remaining inoperative transmitters.

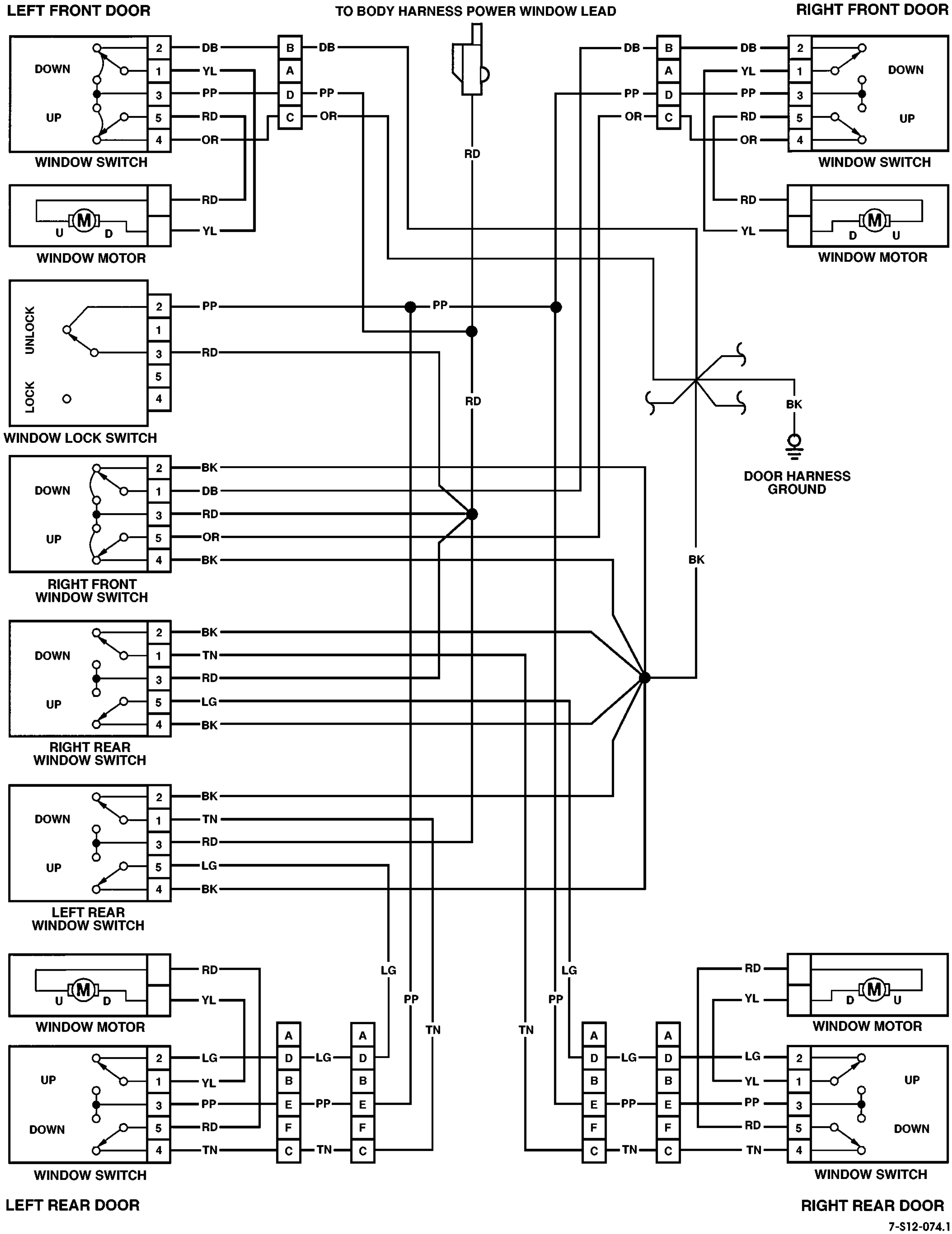


Figure 12-212: Power Windows

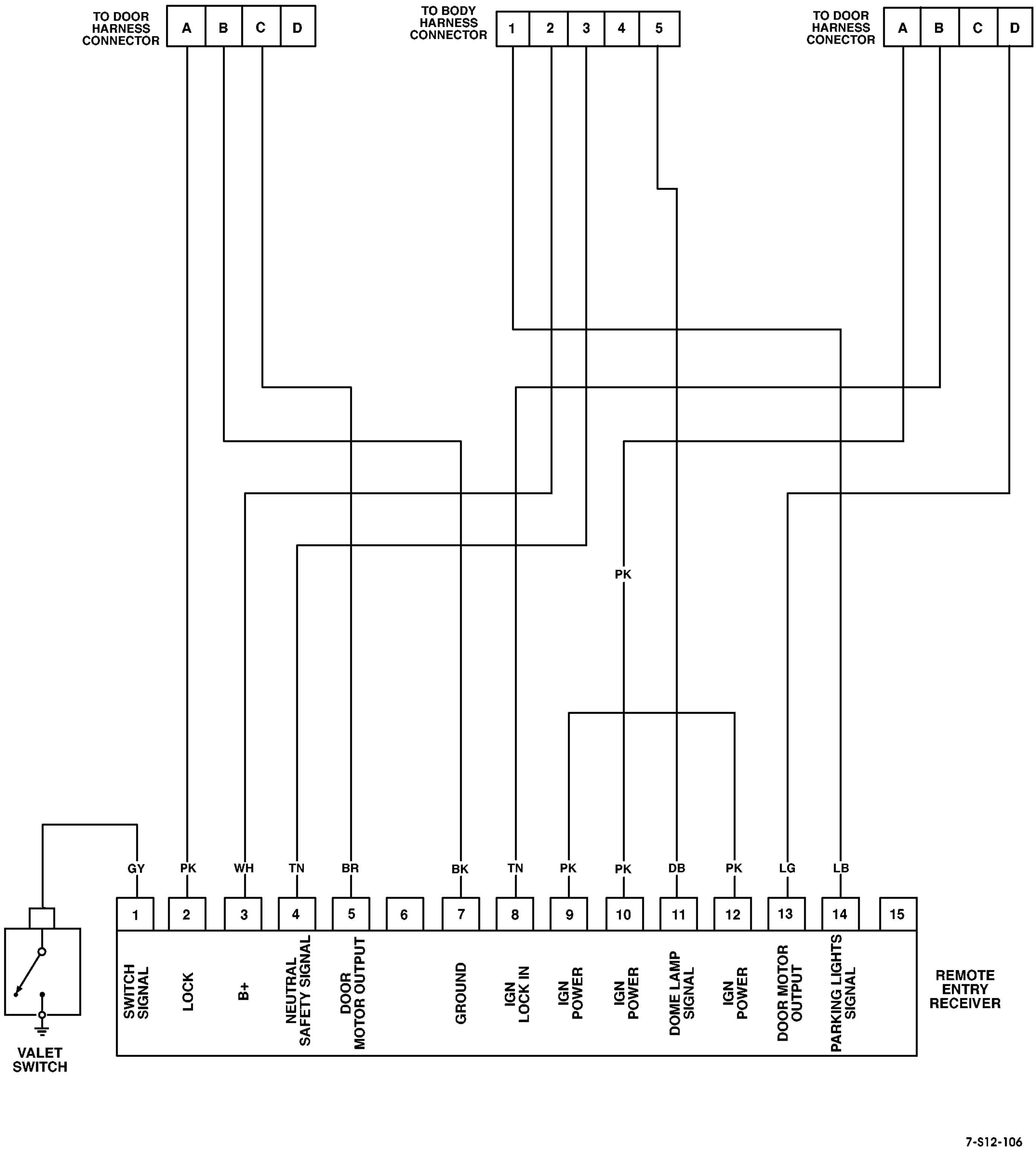
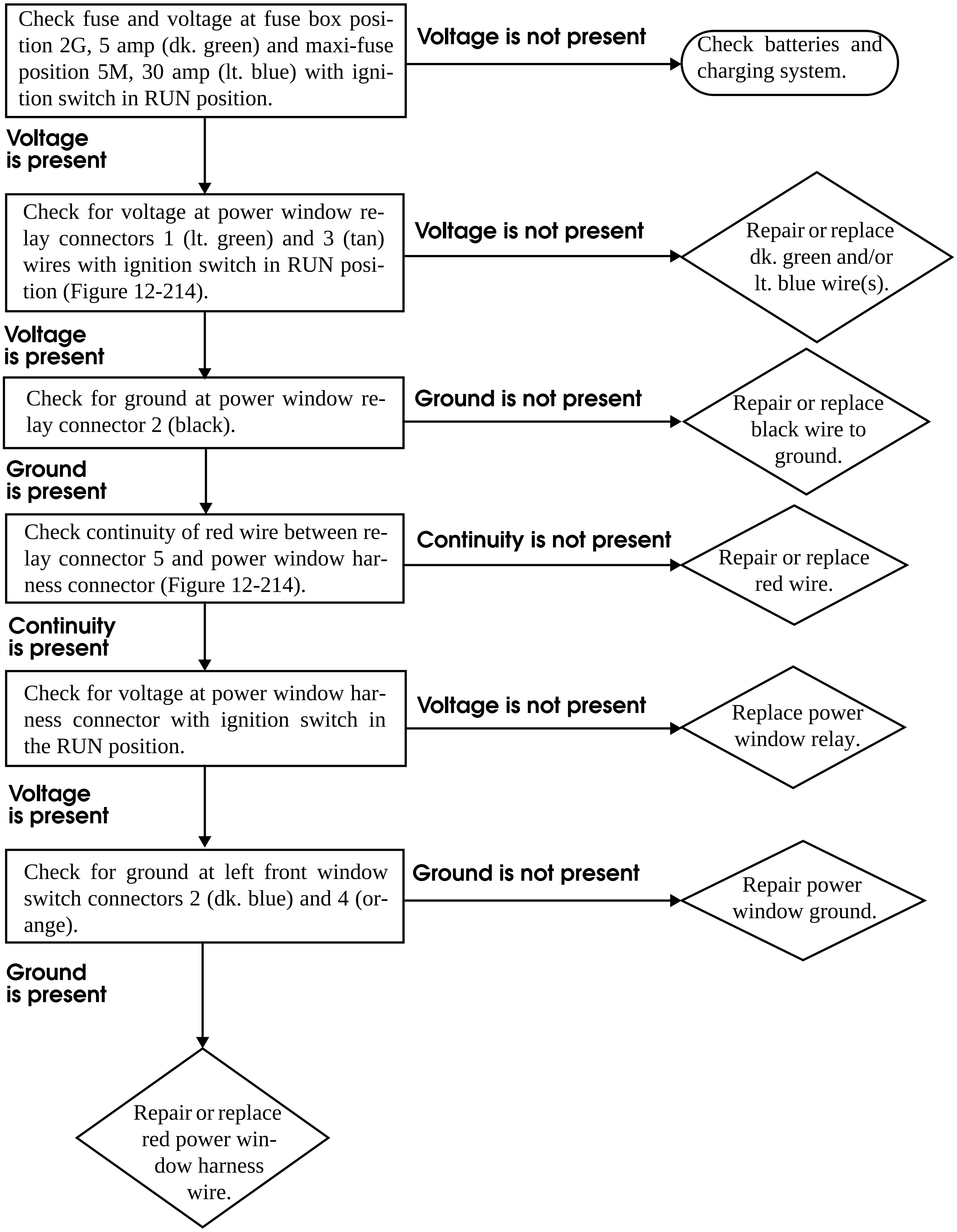
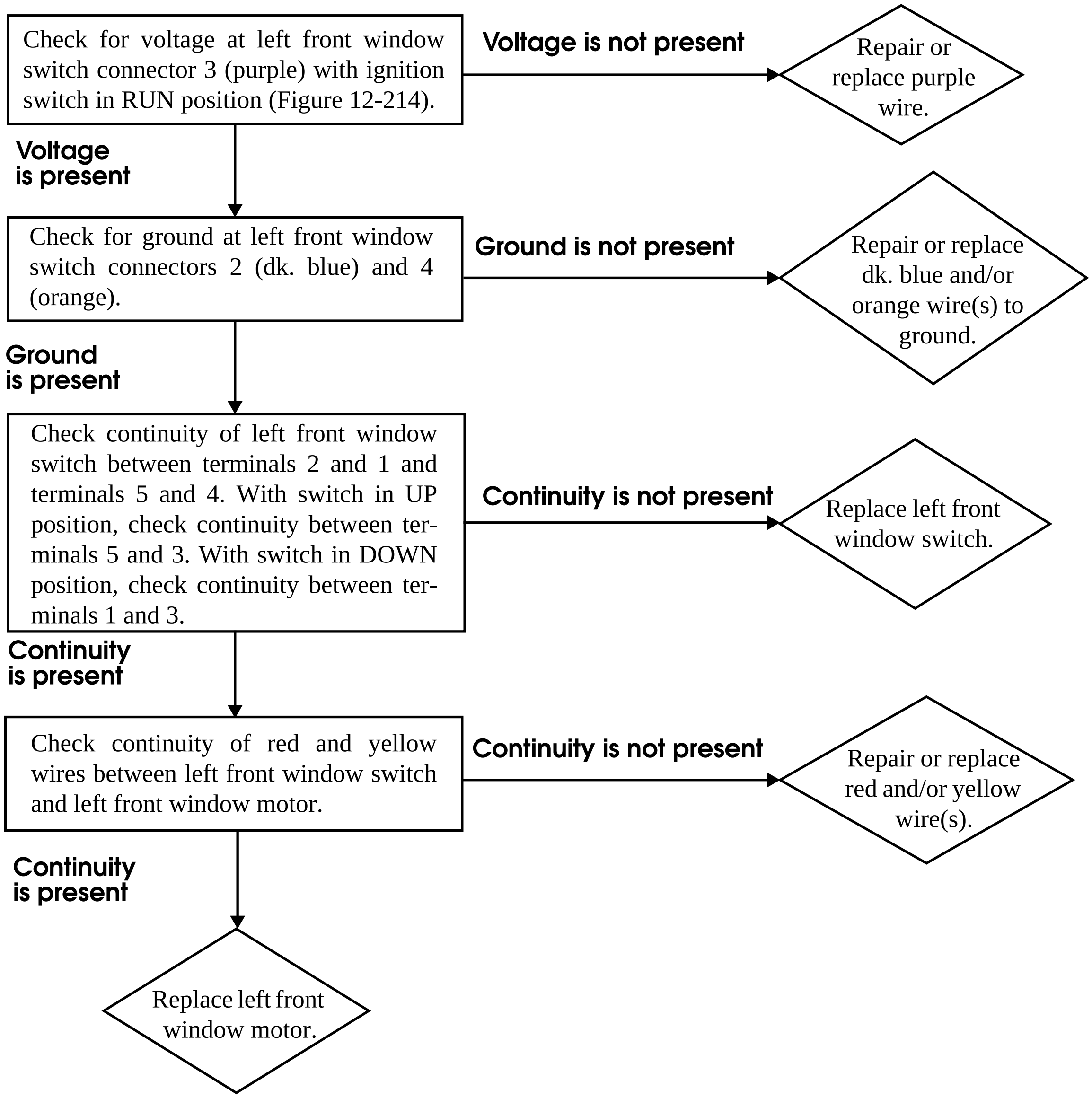


Figure 12-213: Remote Entry Harness

ALL POWER WINDOWS INOPERATIVE



DRIVER'S POWER WINDOW INOPERATIVE



RIGHT FRONT, RIGHT REAR, OR LEFT REAR WINDOW INOPERATIVE

Check for voltage at window lock switch connector 3 (red) with ignition switch in RUN position (Figure 12-214).

Voltage is not present → Repair or replace red wire.

Voltage is present ↓

Check for voltage at driver controlled window switch connector 3 (red) of inoperative window with ignition in RUN position.

Voltage is not present → Repair or replace red wire.

Voltage is present ↓

Check continuity of inoperative window's driver controlled window switch between terminals 1 and 2, and terminals 4 and 5. With switch in UP position, check continuity between terminals 3 and 5. With switch in DOWN position, check continuity between terminals 1 and 3.

Continuity is not present → Replace driver controlled window switch.

Continuity is present ↓

Check continuity of window lock switch between terminals 1 and 3 with the switch in the UNLOCK position.

Continuity is not present → Replace the window lock switch.

Continuity is present ↓

Check continuity between window lock switch connector 1 (purple) and window switch connector 3 (purple) located at inoperative window.

Continuity is not present → Repair or replace purple wire.

Continuity is present ↓

Check continuity of wires between driver controlled window switch and window switch located at inoperative window (rear window wire colors are lt. green and tan; front window wire colors are dk. blue and orange).

Continuity is not present → Repair or replace wires.

Continuity is present ↓

At driver controlled window switch of inoperative window, check for ground at connectors 2 (black) and 4 (black).

Ground is not present → Repair or replace black wire(s) to ground.

Ground is present ↓

Check continuity of window switch located at inoperative window between terminals 1 and 2, and terminals 4 and 5. With switch in UP position, check continuity between terminals 1 and 3. With switch in DOWN position check continuity between terminals 3 and 5.

Continuity is not present → Replace window switch.

Continuity is present ↓

Check continuity of yellow and red wires between window motor and window switch located at inoperative window.

Continuity is not present → Repair or replace red and/or yellow wire(s).

Continuity is present → Replace window motor.

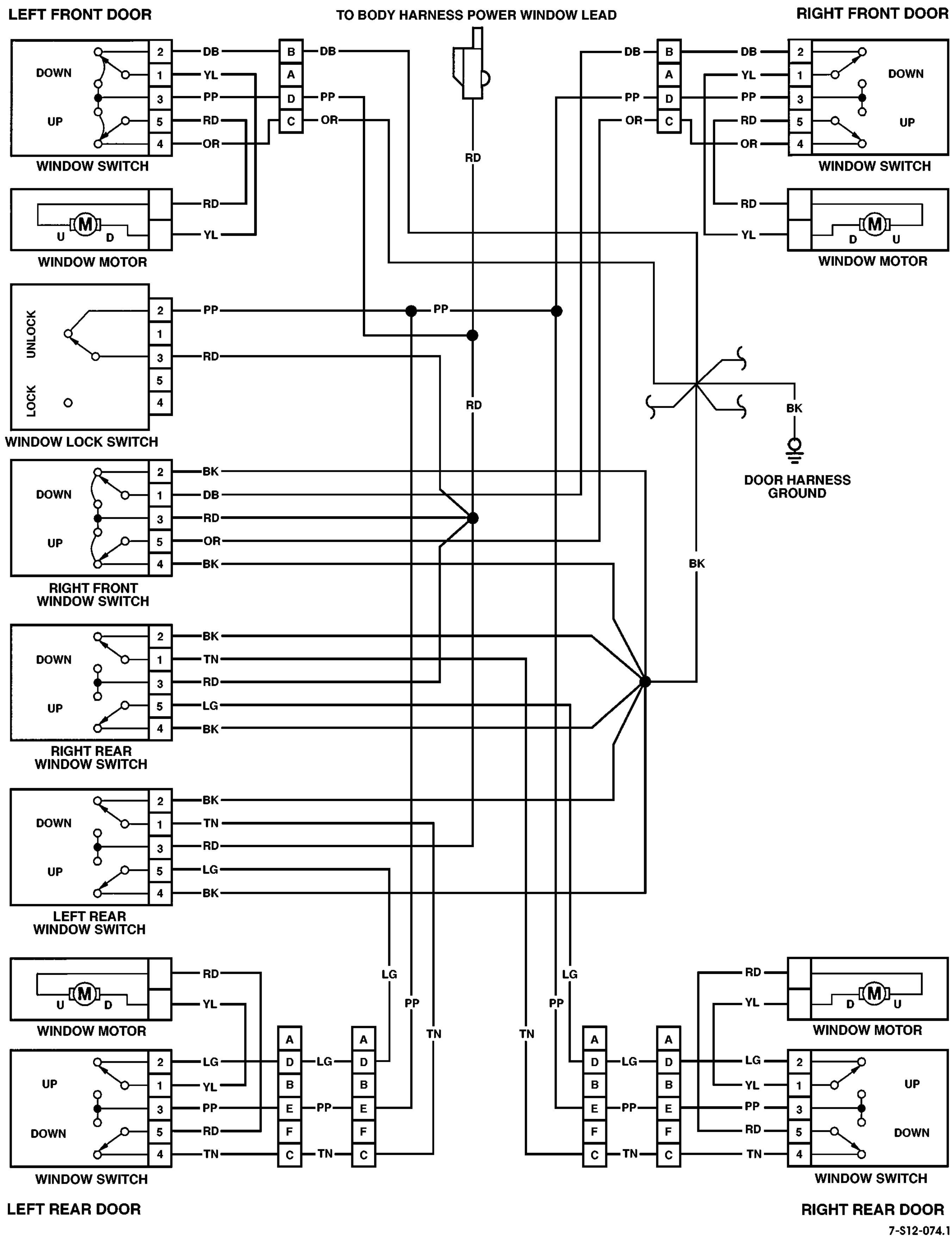
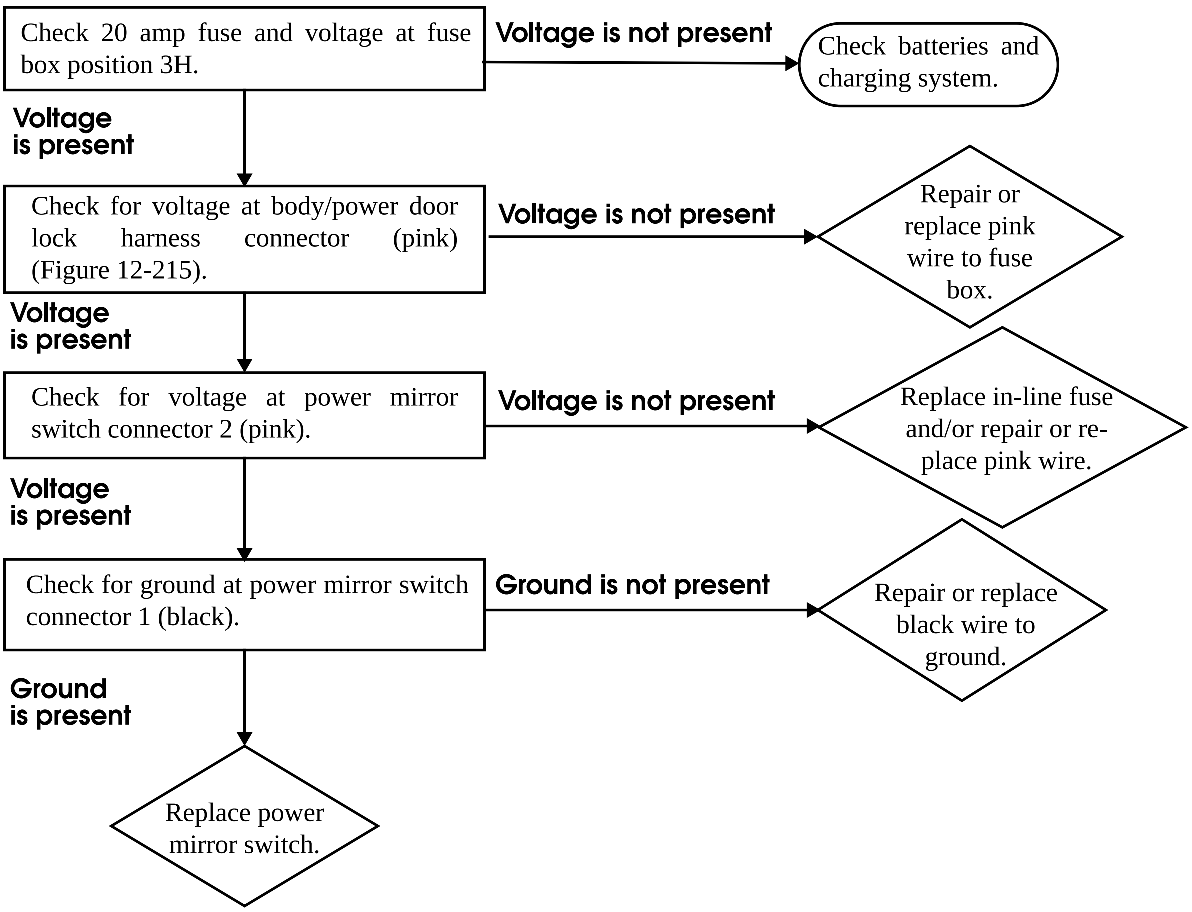
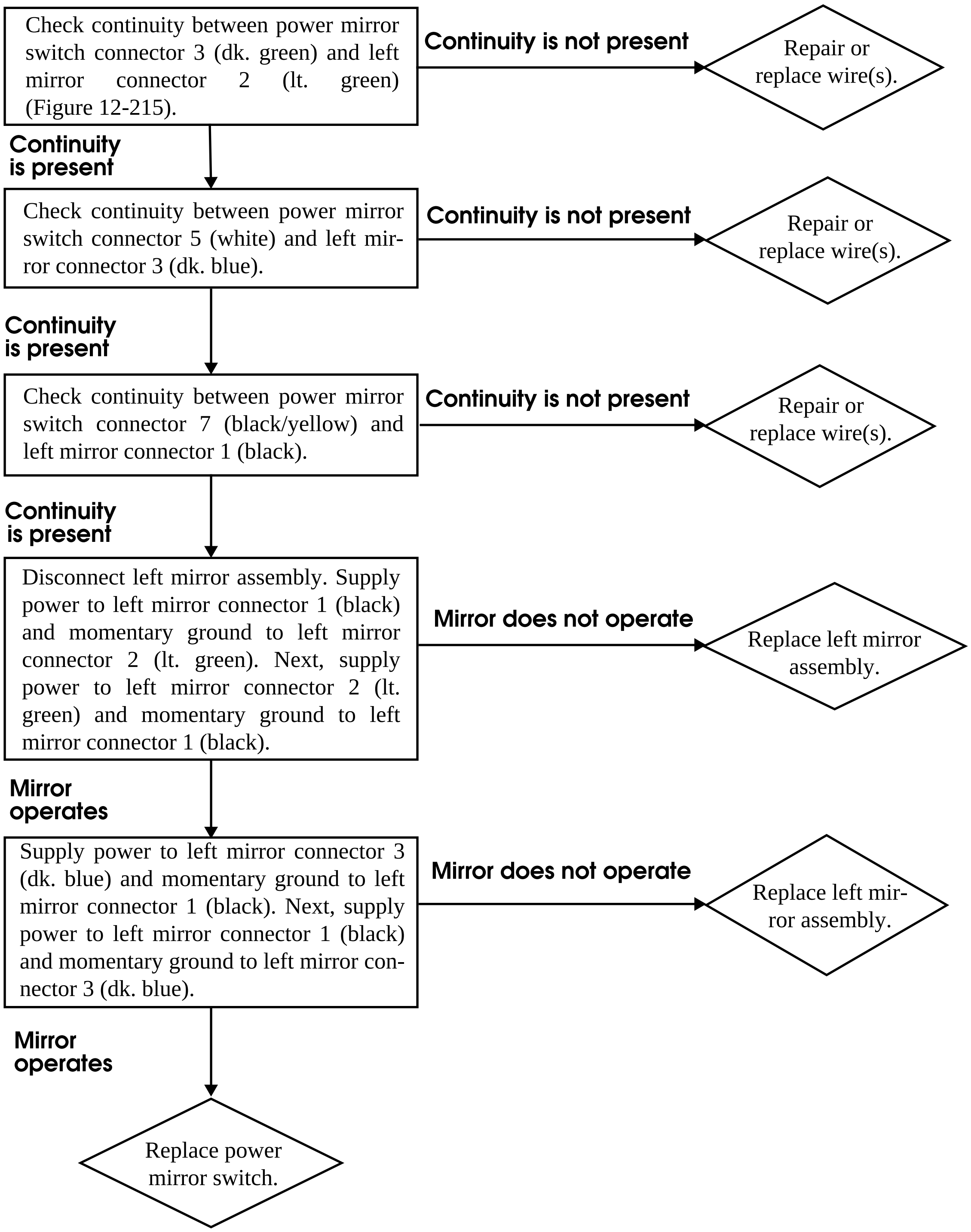


Figure 12-214: Power Windows

BOTH POWER MIRRORS INOPERATIVE



LEFT POWER MIRROR INOPERATIVE



RIGHT POWER MIRROR INOPERATIVE

Check continuity between power mirror switch connector 4 (lt. green) and right mirror connector 2 (lt. green) (Figure 12-215).

- **Continuity is not present** → Repair or replace wire(s).
- **Continuity is present** ↓

Check continuity between power mirror switch connector 6 (dk. blue) and right mirror connector 3 (dk. blue).

- **Continuity is not present** → Repair or replace wire(s).
- **Continuity is present** ↓

Check continuity between power mirror switch connector 8 (black) and right mirror connector 1 (black).

- **Continuity is not present** → Repair or replace wire(s).
- **Continuity is present** ↓

Disconnect right mirror assembly. Supply power to right mirror connector 1 (black) and momentary ground to right mirror connector 2 (lt. green). Next, supply power to right mirror connector 2 (lt. green) and momentary ground to right mirror connector 1 (black).

- **Mirror does not operate** → Replace right mirror assembly.
- **Mirror operates** ↓

Supply power to right mirror connector 3 (dk. blue) and momentary ground to right mirror connector 1 (black). Next, supply power to right mirror connector 1 (black) and momentary ground to right mirror connector 3 (dk. blue).

- **Mirror does not operate** → Replace right mirror assembly.
- **Mirror operates** ↓

Replace power mirror switch.

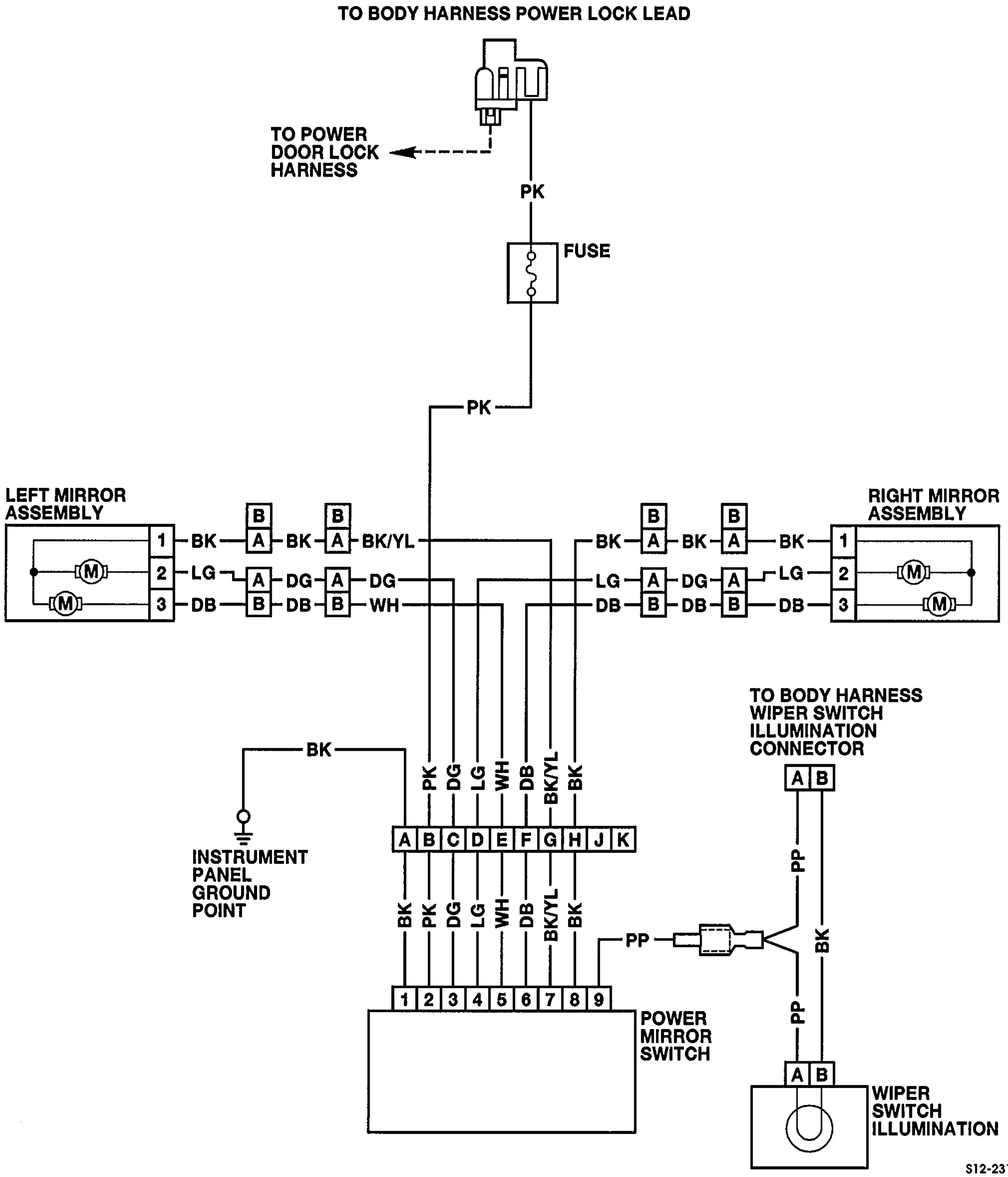
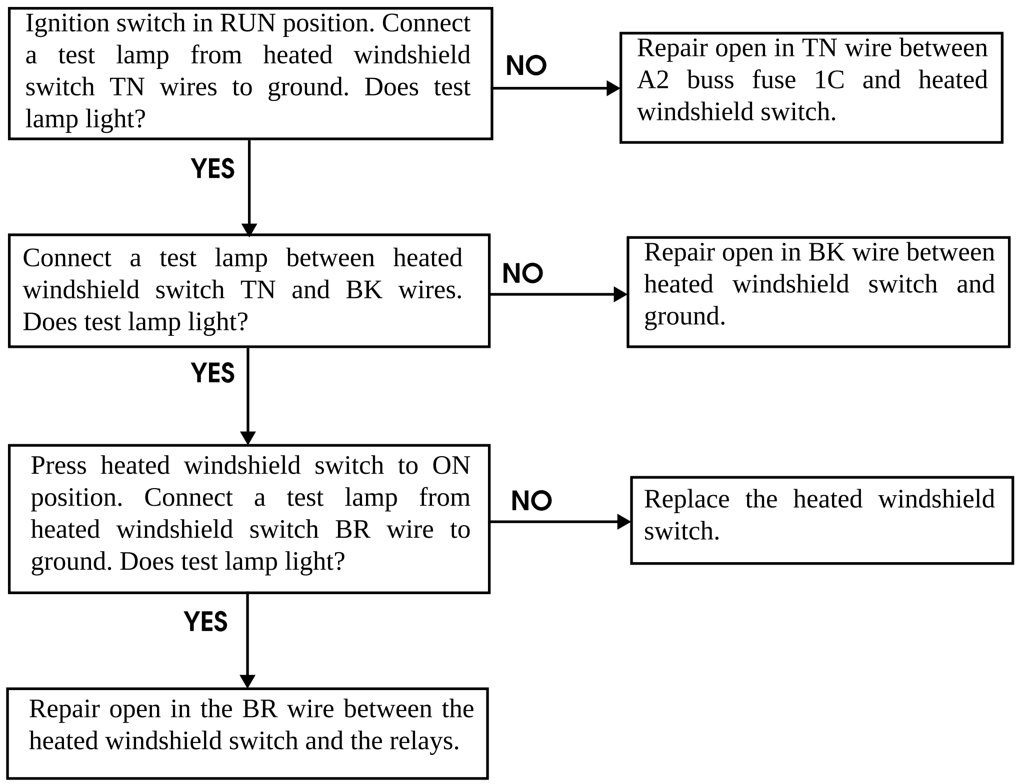


Figure 12-215: Power Mirrors

HEATED WINDSHIELD INOPERATIVE (BOTH SIDES)



HEATED WINDSHIELD INOPERATIVE (LH SIDE)

Turn ignition switch to run position. Press heated windshield switch to on position. Connect a test lamp from LH heated windshield relay BR wire to ground. Does test lamp light

- NO → Repair open in BR wire between switch and relay.
- YES ↓

Connect a test lamp from LH heated windshield relay RD wire to ground. Does test lamp light?

- NO → Repair/replace RD wire or inline fuse between power stud and relay.
- YES ↓

Connect a test lamp between LH heated windshield relay RD and BK wires. Does test lamp light?

- NO → Repair open in BK wire between relay and ground.
- YES ↓

Connect a fused jumper between LH heated windshield relay RD and PP wires. Does windshield begin to heat?

- YES → Replace LH heated windshield relay.
- NO ↓

Leave jumper connected. Connect a test lamp from LH windshield heating element PP wire to ground. Does test lamp light?

- YES → Check for an open in BK wire between LH heating element and ground. If OK, replace LH heating element.
- NO ↓

Repair open in PP wire between LH heated windshield relay and LH heating element.

HEATED WINDSHIELD INOPERATIVE (RH SIDE)

Turn ignition switch to run position. Press heated windshield switch to on position. Connect a test lamp from RH heated windshield relay BR wire to ground. Does test lamp light

- NO → Repair open in BR wire between switch and relay.
- YES ↓

Connect a test lamp from RH heated windshield relay RD wire to ground. Does test lamp light?

- NO → Repair/replace RD wire or inline fuse between power stud and relay.
- YES ↓

Connect a test lamp between RH heated windshield relay RD and BK wires. Does test lamp light?

- NO → Repair open in BK wire between relay and ground.
- YES ↓

Connect a fused jumper between RH heated windshield relay RD and PP wires. Does windshield begin to heat?

- YES → Replace RH heated windshield relay.
- NO ↓

Leave jumper connected. Connect a test lamp from RH windshield heating element PP wire to ground. Does test lamp light?

- YES → Check for an open in BK wire between RH heating element and ground. If OK, replace RH heating element.
- NO ↓

Repair open in PP wire between RH heated windshield relay and RH heating element.

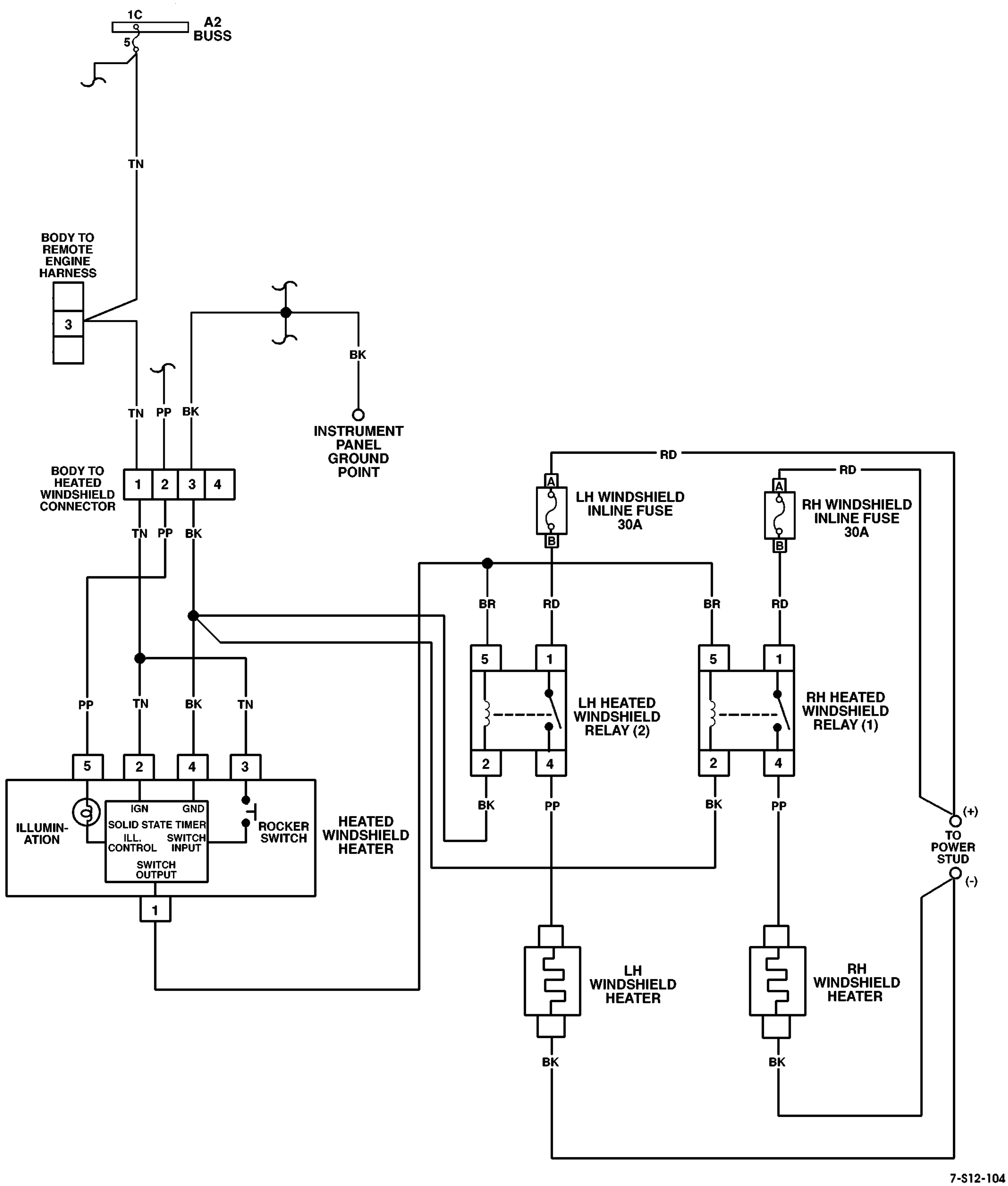


Figure 12-216: Heated Windshield Harness (1 of 2)

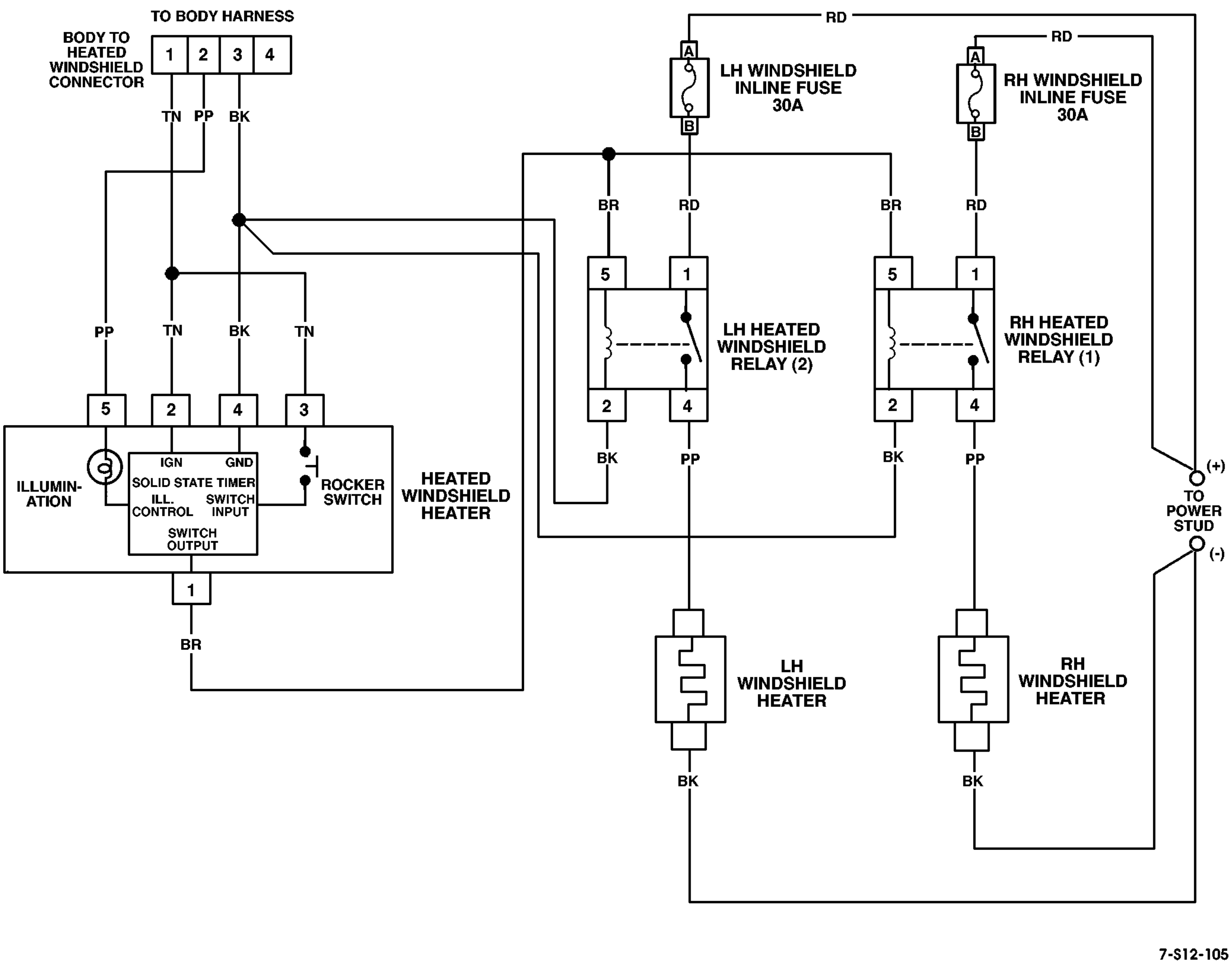


Figure 12-217: Heated Windshield Harness (2 of 2)

ALL FOUR TIRES DO NOT INFLATE (PUMP INOPERATIVE)

Check condition of CTIS maxi fuse.

Is fuse open?

Continuity is not present

Repair source of overload or short to Ground in YL wire to fuse or DG wire to pump relay. Replace the fuse.

Continuity is present

Connect a test lamp to YL wire at fuse holder.

Does test lamp light?

Continuity is not present

Check fuse holder for corrosion. If OK, repair open in RD wire to fuse holder.

Continuity is present

Turn ignition switch to run.

Connect a test lamp to both OR wires at inflate/deflate switch.

Does test lamp light at both?

Continuity is not present

Repair open in OR wire(s) to inflate/deflate switch.

Continuity is present

Place inflate/deflate switch in inflate position.

Connect a test lamp to DB wire at pump relay.

Does test lamp light?

Continuity is not present

Check for open in DB wire between pump relay and inflate/deflate switch. If OK, replace inflate/deflate switch.

Continuity is present

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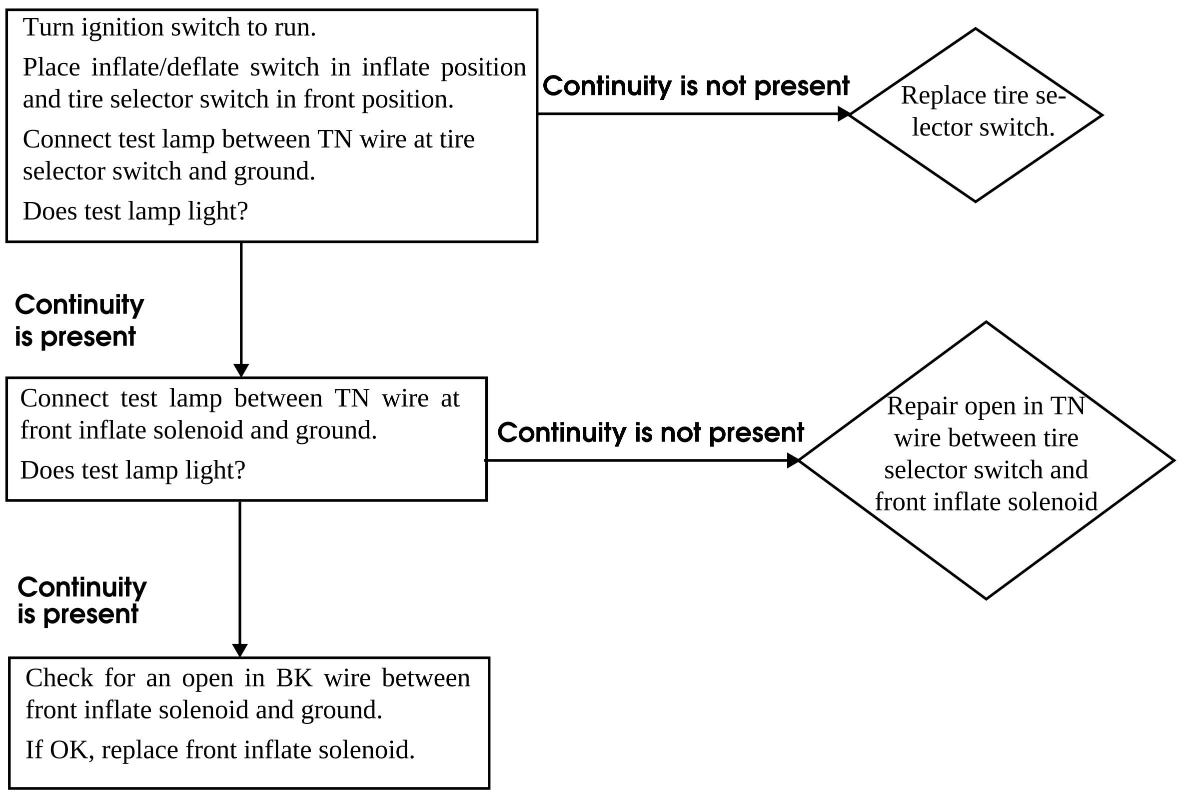
FRONT TIRES DO NOT INFLATE



REAR TIRES DO NOT INFLATE

Turn ignition switch to run.

Place inflate/deflate switch in inflate position and tire selector switch in rear position.

Connect a test lamp between GY wire at tire selector switch and ground.

Does test lamp light?

Continuity is not present → Replace tire selector switch.

Continuity is present ↓

Connect test lamp between GY wire at rear inflate solenoid and ground.

Does test lamp light?

Continuity is not present → Repair open in GY wire between tire selector switch and rear inflate solenoid

Continuity is present ↓

Check for an open in BK wire between rear inflate solenoid and ground.

If OK, replace rear inflate solenoid.

ALL FOUR TIRES DO NOT DEFLATE

Turn ignition switch to run.

Place inflate/deflate switch in deflate position.

Connect a test lamp between LG wire at deflate solenoid and ground.

Does test lamp light?

Continuity is not present

Check for an open in LG wire between the inflate/ deflate switch and deflate solenoid.
If OK, replace inflate/ deflate switch.

Continuity is present

Check for an open in BK wire between deflate solenoid and ground.

If OK, replace deflate solenoid.

INFLATE INDICATOR INOPERATIVE

Turn the ignition switch to run.

Place the inflate/deflate switch in inflate position.

Connect a test lamp between DB wire at CTIS indicator lights and ground.

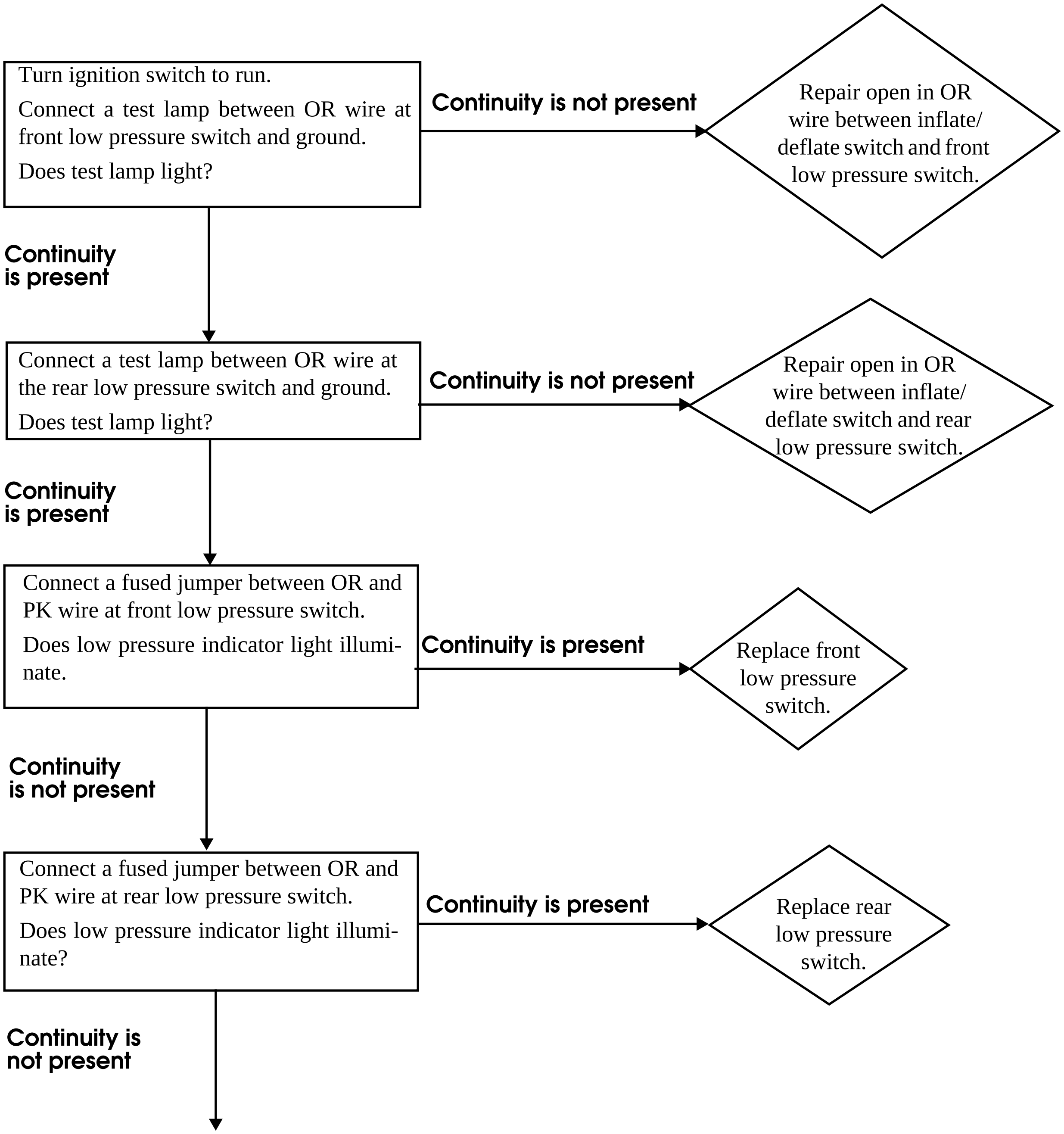
Continuity is not present → Repair open in DB wire between inflate/deflate switch and CTIS indicator lights.

Continuity is present ↓

Check for an open in BK wire between the CTIS indicator lights and ground.

If OK, replace inflate indicator light.

LOW PRESSURE INDICATOR INOPERATIVE



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LOW PRESSURE INDICATOR INOPERATIVE— CONTINUED

Leave fused jumper connected.

Connect test lamp between PK wire at CTIS Indicator lights and ground.

Does test lamp light?

Continuity is not present

Repair open in PK wire between low pressure switches and CTIS indicator lights.

Continuity is present

Check for open in BK wire between CTIS indicator lights and ground.

If OK, replace CTIS indicator lights.

LOW PRESSURE ALARM INOPERATIVE

Turn ignition switch to run.

Connect fused jumper between OR and PK wire at front low pressure switch.

Connect a test lamp between PK wire at CTIS alarm and ground.

Does test lamp light?

Continuity is not present

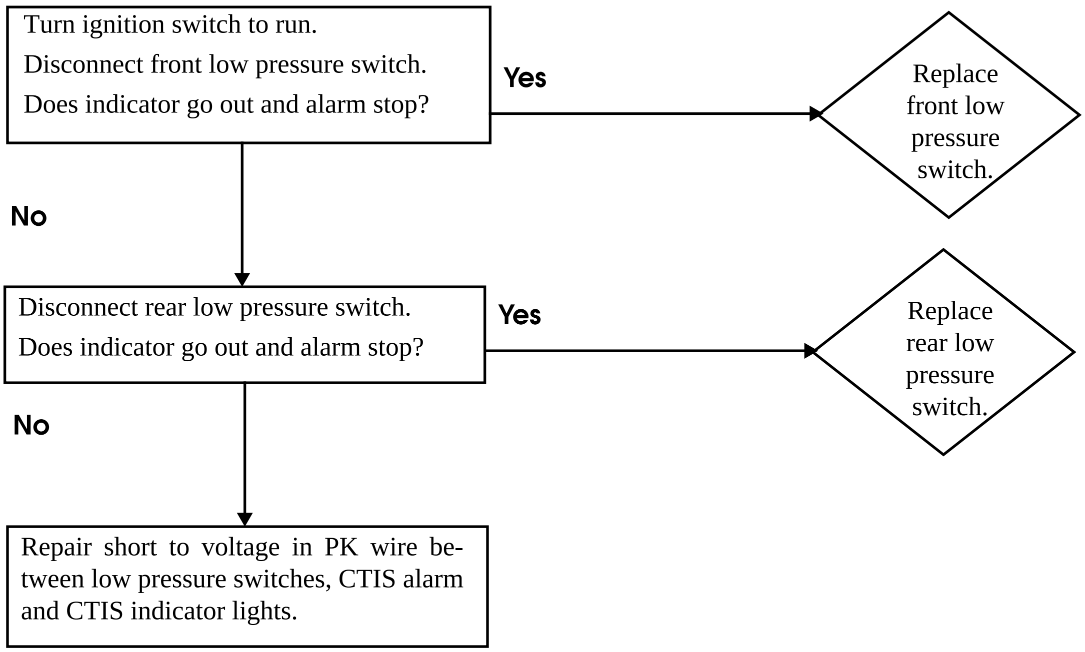
Repair open in PK wire between low pressure switches and CTIS alarm.

Continuity is present

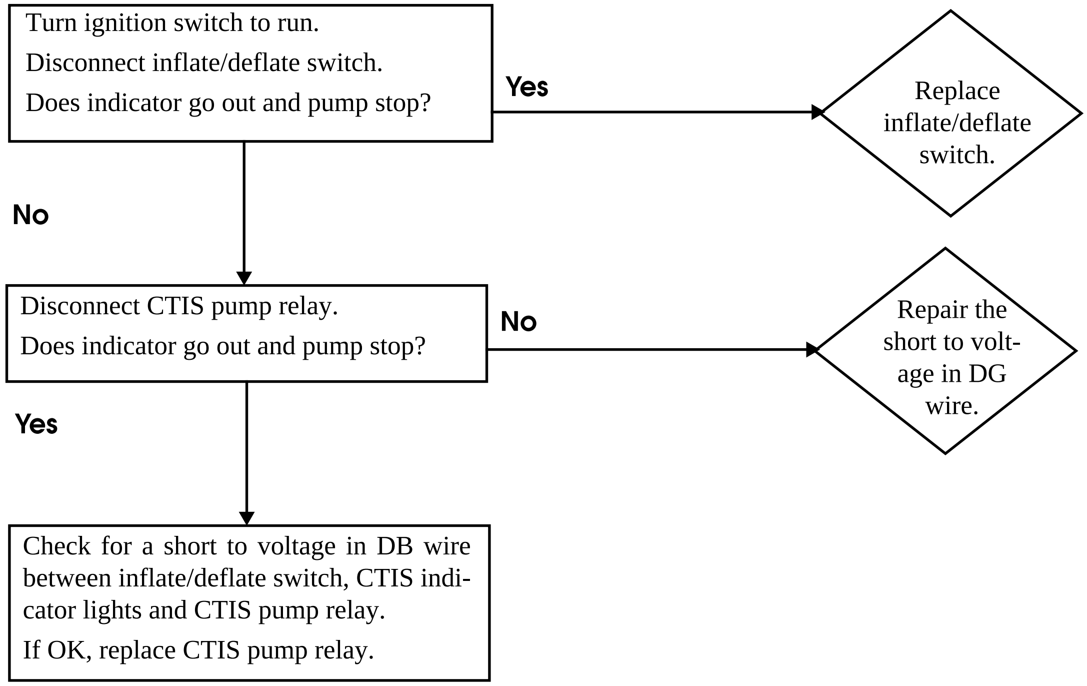
Check for open in BK wire between CTIS alarm and ground.

If OK, replace CTIS alarm.

LOW PRESSURE ALARM OR INDICATOR ON AT ALL TIMES



INFLATE INDICATOR OR PUMP MOTOR ON AT ALL TIMES



WIRING HARNESS REPAIR

Wire Harness

The engine wiring harness electrically connects the control module to the various solenoids, switches, and sensors in the vehicle engine and passenger compartment.

Wire harnesses should be replaced with proper part number harnesses. When signal wires are spliced in a harness, use wire(s) with high temperature insulation only.

With the low current and voltage levels found in the system, it is important that the best possible bond at all wire splices be made by soldering the splices (Figure 12-218).

Molded on connectors require complete replacement of the connector. This means splicing a new connector assembly into the harness.

Refer to Section 12 for wiring diagrams. Replacement connectors and terminals are listed in Section 12 in the Parts Catalog.

Connectors and Terminals

Use care when probing a connector or replacing terminals in them. It is possible to short between opposite terminals. If this happens to the wrong terminal pair, it is possible to damage certain components. Always use jumper wires between connectors for circuit checking. NEVER probe through the Weather-Pack seals. The connector test adapter kit J35616, or equivalent, contains an assortment of flexible connectors used to probe terminals during diagnosis. Fuse remover and test tool BT-8616, or equivalent, is used for removing a fuse and to adapt fuse holder with a meter for diagnosis.

When diagnosing wiring problems, open circuits are often difficult to locate by sight, because oxidation, or terminal misalignment are hidden by the connectors. Merely wiggling a connector on a sensor, or in the wiring harness, may correct the open circuit condition. This should always be considered when an open circuit, or failed sensor is indicated. Intermittent problems may also be caused by oxidized or loose connections.

Before making a connector repair, be certain of the type of connector. Weather-Pack and Compact Three connectors look similar, but are serviced differently.

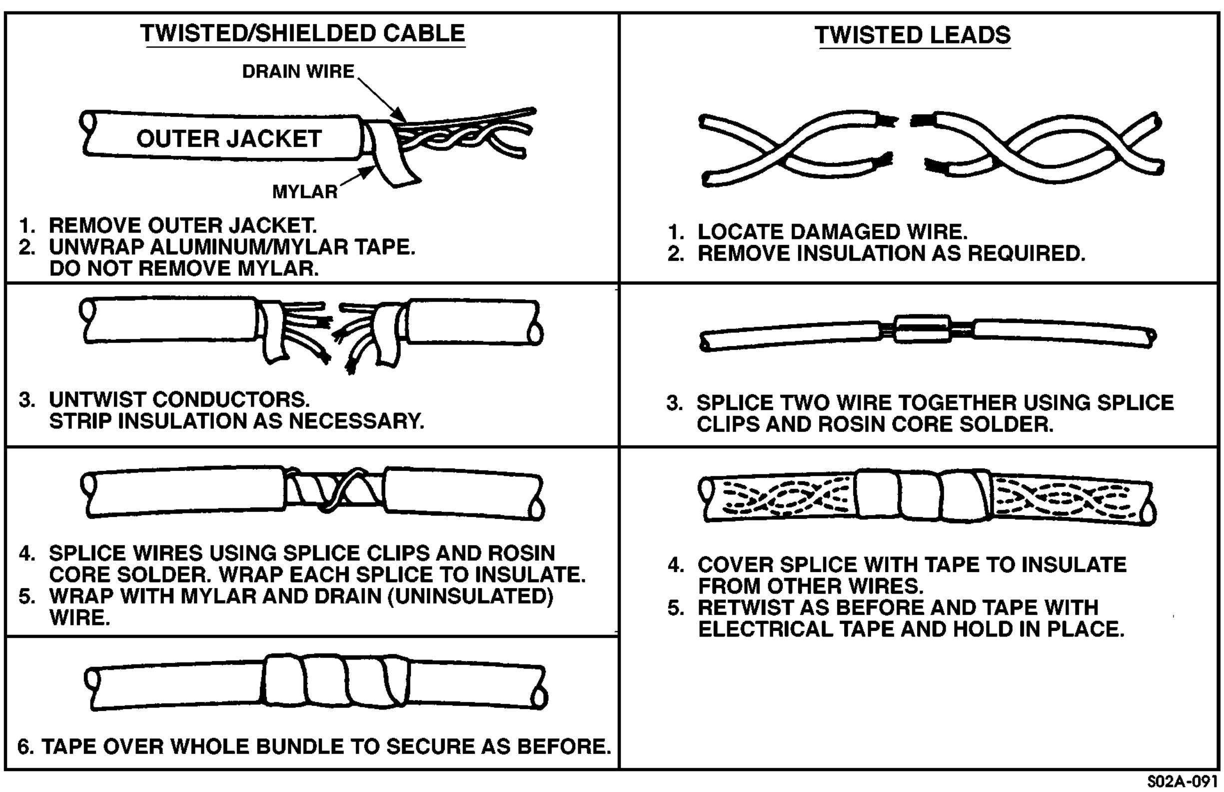
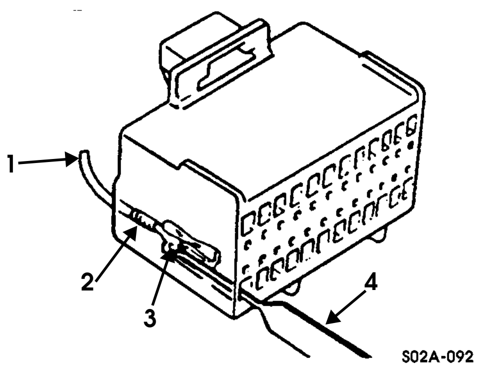


Figure 12-218: Wire Harness Repair

Micro-Pack

Refer to the repair procedure for replacement of a Micro-Pack terminal (Figure 12-219).



1. CABLE
2. TERMINAL
3. LOCKING TANG.
4. TOOL J 33095

Figure 12-219: Micro-Pack Type Connector

Metri-Pack

Some connectors use terminals called Metri-Pack Series 150. (Figure 12-220). These may be used at the coolant sensor.

They are also called Pull-To-Seat terminals, because to install a terminal on a wire, the wire is first inserted through the seal (5) and connector (4). The terminal is then crimped on the wire and the terminal pulled back into the connector to seat it in place. To remove a terminal:

1. Slide the seal (5) back on the wire.
2. Insert tool (3) J35689, as shown to release the terminal locking tang (2).
3. Push the wire and terminal out through the connector.
4. If reusing the terminal, reshape the locking tang (2).

Weather Pack

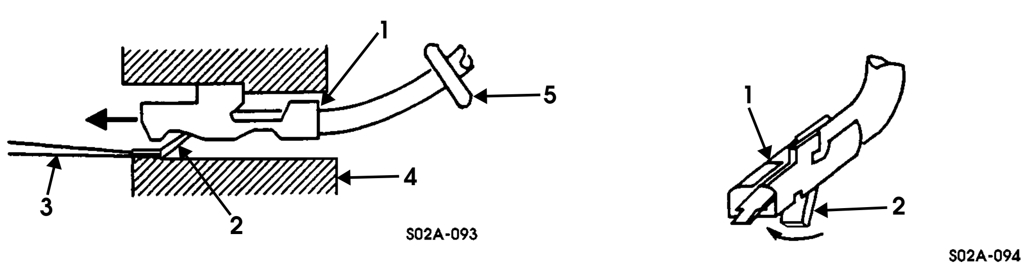
A Weather-Pack connector can be identified by a rubber seal at the rear of the connector. This connector, which is used in the engine compartment, protects against moisture and dirt, which could create oxidation and deposits on the terminals. This protection is important because of the very low voltage and current levels found in the electronic system.

To repair a Weather-Pack terminal, use tool J 28742-A to remove the pin and sleeve terminals (Figure 12-221).

If removal is attempted with an ordinary pick, there is a good chance that the terminal will be bent or deformed. Unlike standard blade-type terminals, these terminals cannot be straightened once they are bent.

Make certain that the connectors are properly seated and all of the sealing rings in place when connecting leads. The hinge-type flap provides a backup, or secondary locking feature for the connector. They are used to improve the connector reliability by retaining the terminals, if the small terminal lock tangs are not positioned properly.

Weather-Pack connections cannot be replaced with standard connections. Instructions are provided with Weather-Pack connector and terminal packages.



1. METRI-PACK SERIES150 FEMALE TERMINAL
2. LOCKING TANG
3. TOOL J35689
4. CONNECTOR BODY
5. SEAL

Figure 12-220: Metri-Pack Series 150 Terminal

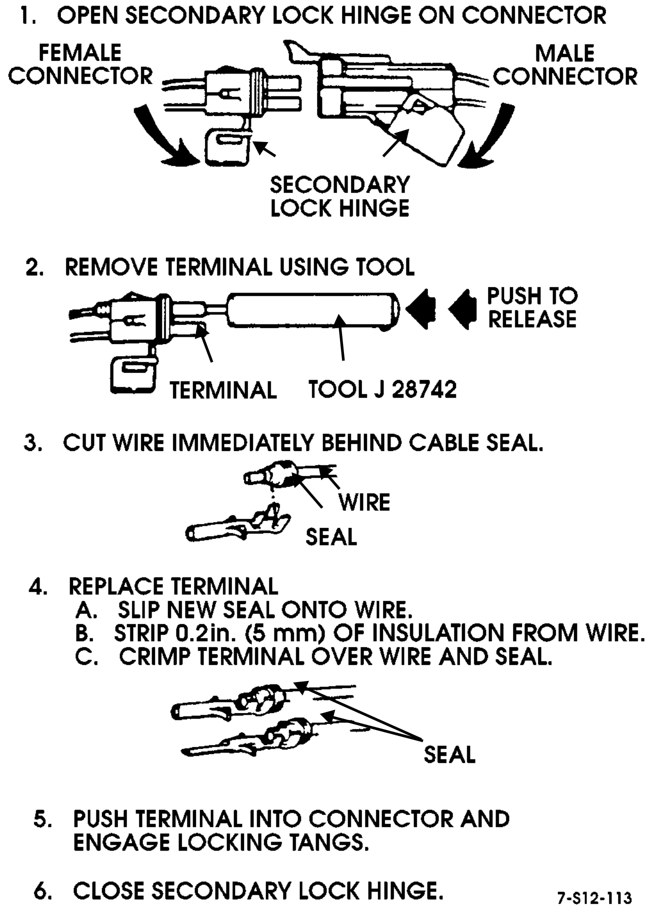
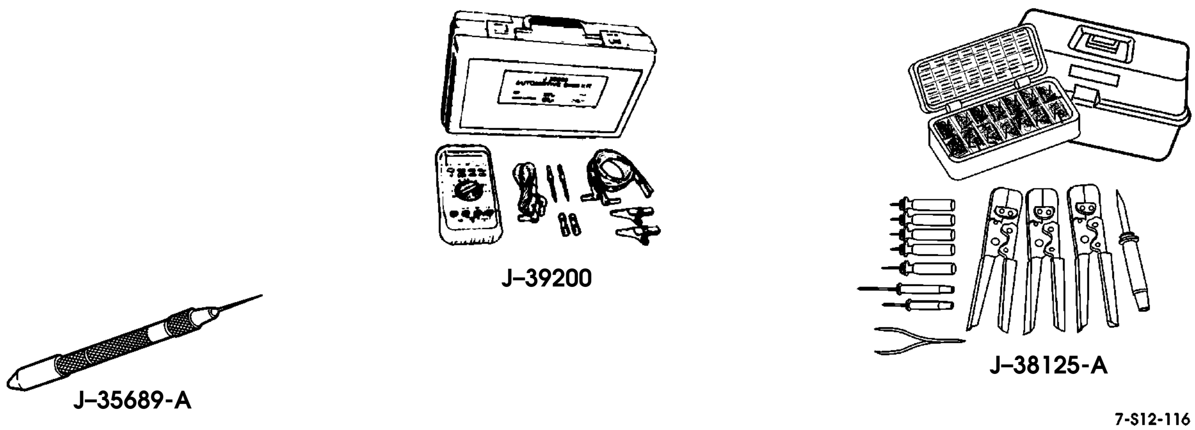


Figure 12-221: Weather-Pack Terminal

Com-Pack III

The Com-Pack III connector, which looks similar to a Weather-Pack connector, is not sealed and is used where resistance to the environment is not required. This type of connector, most likely, is used at the air control solenoid. Use the standard method, when repairing a terminal. Do not use the Weather-Pack terminal tool J-28742 as these will damage the terminals.

ESSENTIAL TOOLS



Tool No.	Description
J–35689-A	Micro-Pack Extract Tool
J–39200	Fluke 87 DVOM
J–38125-A	Electrical Terminal
J–42541	Crimper, 4 pt., field grade (not shown)

Procure from Kent-Moore.

Section 13 Accessories

TABLE OF CONTENTS

WINCH

Winch Troubleshooting

Winch Inoperative

1. Check for jammed winch cable.
2. Check winch control cable connector for corrosion or loose connection. Clean corroded connector or secure loose connection.
3. Check for loose or damaged winch power cables. Using voltmeter, connect positive meter lead to positive power cable (red) at the winch motor, and negative meter lead to the winch motor ground cables (black). If voltage is not present, repair or replace winch power cables.
4. Disconnect winch control from winch. Using an ohmmeter, check for continuity between the common terminal and the other two terminals on winch control cable connector. Check for continuity one at a time, while holding control in the OUT position and in position. If continuity is present in both positions, replace winch. If continuity is not present in both positions, replace winch control.

Winch Replacement

Removal

WARNING: To avoid personal injury or damage, support winch during removal.

1. Disconnect battery ground cables (Section 12).
2. Remove two battery cable bolts, battery cables, and winch cables from battery (Figure 13-1).

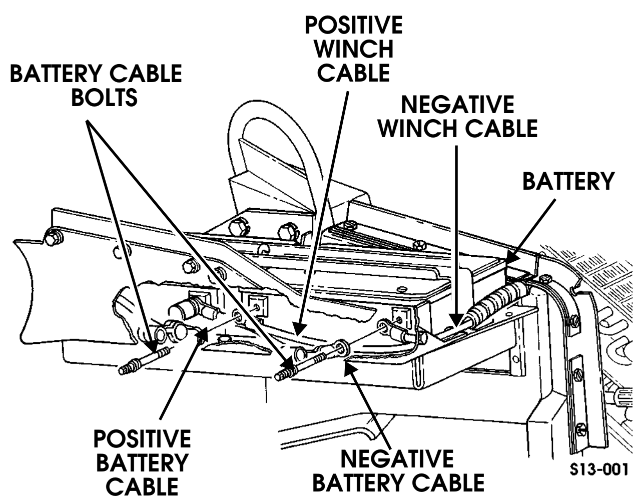


Figure 13-1: Winch Cables On Battery

3. Remove nut, lockwasher, capscrew, and clamp from right frame extension. Discard lockwasher. Pull winch cables through the splash shield to front of vehicle (Figure 13-2).

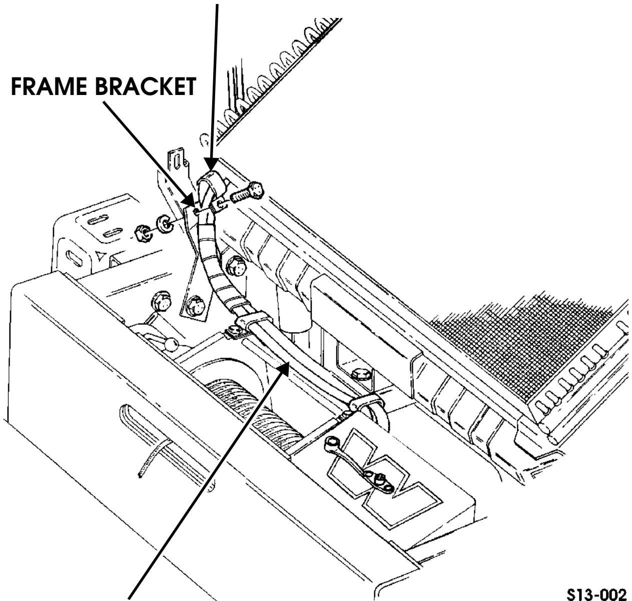


Figure 13-2: Frame Bracket

4. Remove four nuts, washers, bolts, and winch from front bumper (Figure 13-3).

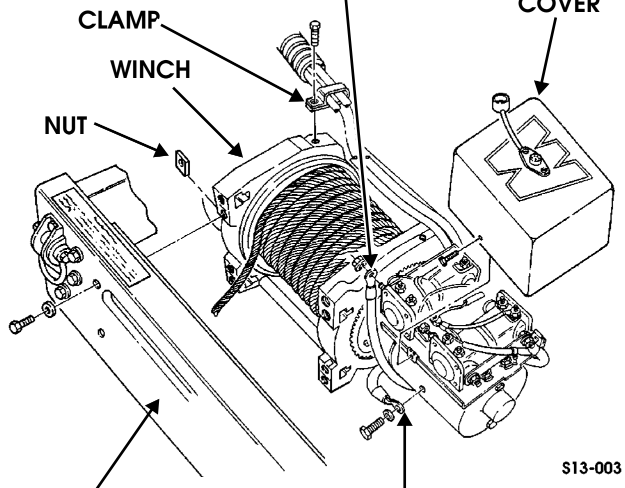


Figure 13-3: Winch and Winch Cables

5. Remove two bolts and clamps securing winch cables to winch.
6. Remove three bolts and control box cover from winch.

NOTE: It may be necessary to remove plastic coating compound from winch in order to perform steps 7 and 8.

7. Remove capscrew, washer, and negative winch cable from winch.
8. Remove locknut and positive winch cable from winch. Discard locknut.

Installation

NOTE: Positive winch cable must be positioned to align with the opening in the control box cover.

1. Install positive winch cable on winch with locknut (Figure 13-3).
2. Install negative winch cable on winch with washer and capscrew.
3. Coat motor end of winch with coating compound.
4. Install control box cover on winch with three bolts.
5. Secure two winch cables to winch with two clamps and bolts.
6. Install winch on front bumper with four washers, bolts, and nuts. Tighten bolts to 60 lb-ft (81 N•m).
7. Route winch power cables through the splash shield.
8. Install winch cables on frame bracket with clamp, capscrew, lockwasher, and nut (Figure 13-2).
9. Connect battery ground cables (Section 12).

Winch Fairlead Replacement (Optional)

The optional winch fairlead provides greater functional versatility. The winch cable can be routed at much sharper angles since the fairlead rollers will keep it from binding on the bumper edges.

Removal

WARNING: To avoid injury or damage, support winch during removal.

1. Disconnect battery ground cables (Section 12).
2. Remove washers, bolts, and fairlead from front bumper (Figure 13-4).

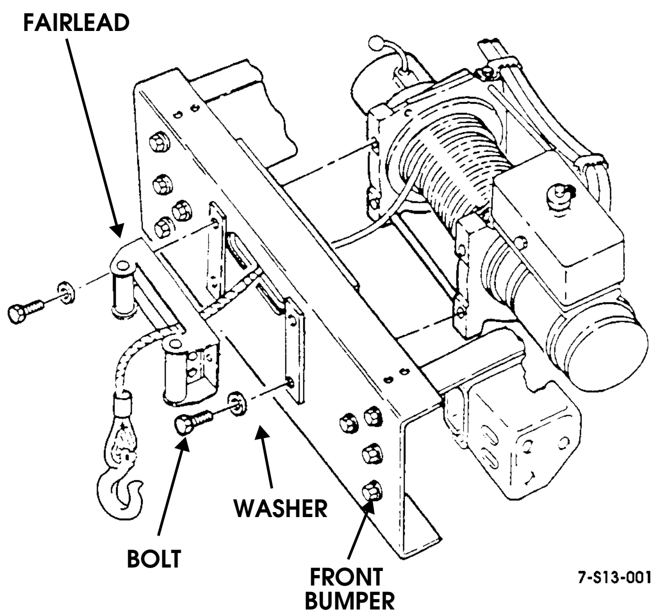


Figure 13-4: Winch Fairlead

Installation

1. Install fairlead on front bumper with washers and bolts. Tighten bolts to 60 lb-ft (81 N•m) (Figure 13-4).

Winch Cable Replacement

WARNING: To avoid injury, wear gloves when handling winch cable.

Removal

1. Unwind winch cable.
2. Remove set screw and winch cable from drum assembly (Figure 13-5).
3. Remove cotter pin, clevis pin and hook from winch cable. Discard cotter pin.

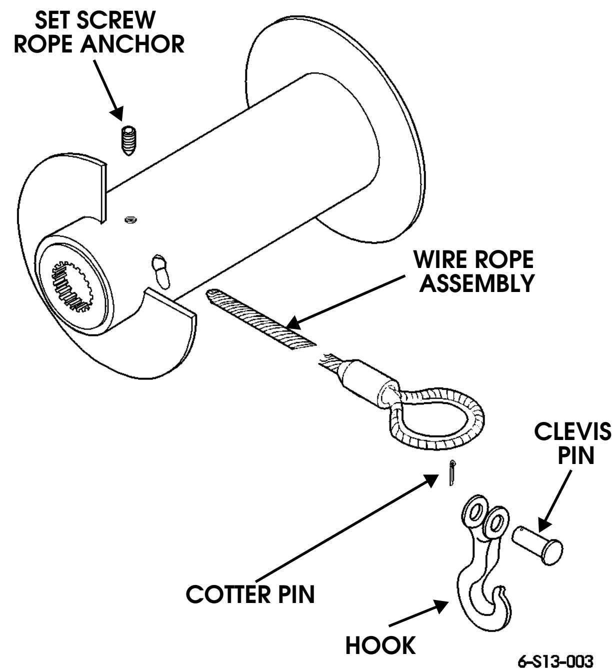


Figure 13-5: Winch Cable

Installation

1. Install hook, clevis pin and cotter pin on winch cable.
2. Install winch cable on drum assembly with set screw.

CAUTION: *Install winch cable on drum under a load of at least 500 lb (227 kg), or outer wraps will draw into inner wraps and damage cable.*

NOTE: Spool winch cable according to rotation label on winch or brake will not function.

3. Rewind and lubricate winch cable.

Winch Assembly Repair

Disassembly

1. Remove winch and winch cable.

NOTE: Tag leads for assembly.

NOTE: It may be necessary to remove plastic coating from winch in order to perform steps 2 through 5.

2. Remove three nuts and control leads from motor (Figure 13-6).

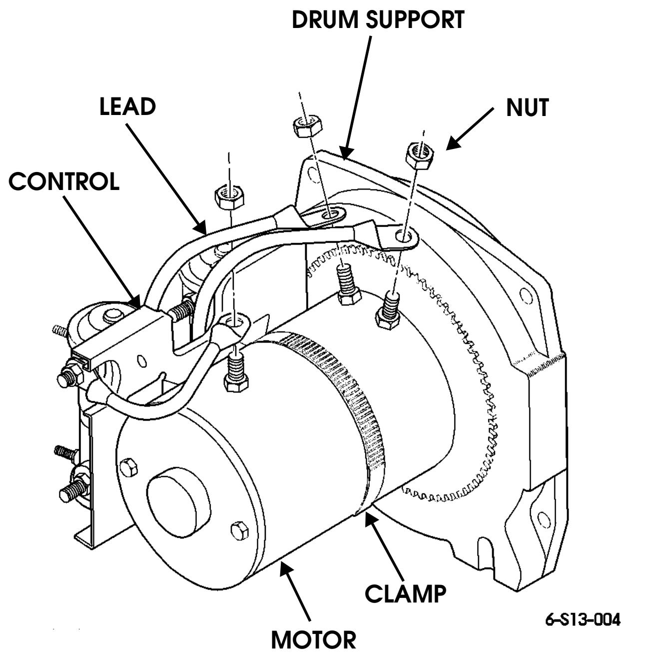


Figure 13-6: Control Leads

3. Loosen clamp and remove control from motor (Figure 13-7).

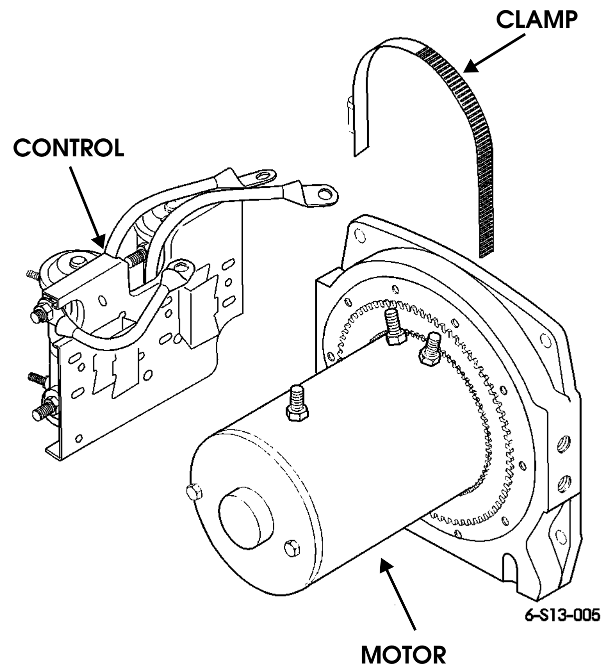


Figure 13-7: Control Unit

4. Remove clamps from motor.
5. Mark motor end drum support, gear train assembly, and gear end drum support for assembly (Figure 13-8).

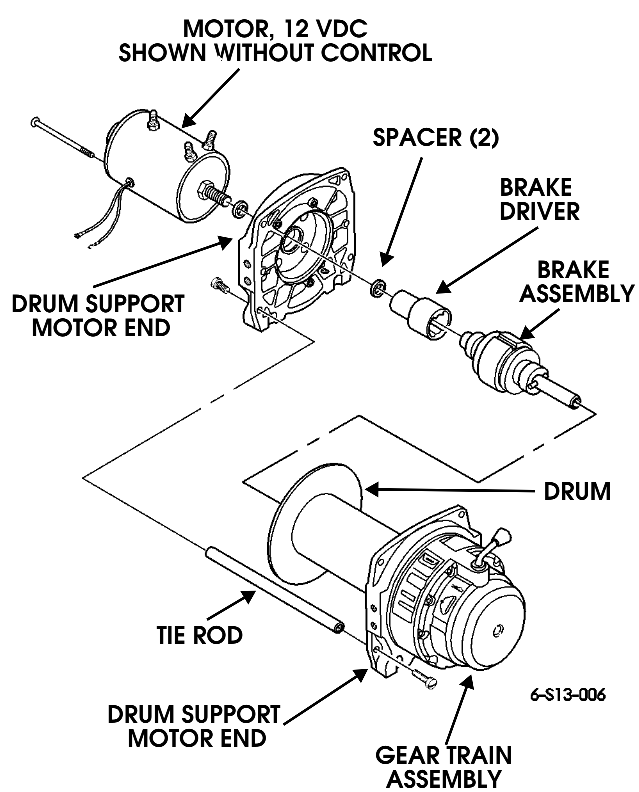


Figure 13-8: Drum Support and Gear Train Assembly

6. Remove six bolts, three tie rods, motor end and gear end drum supports from winch.
7. Remove motor, and motor end drum support from drum assembly.
8. Remove motor brake driver and spacer from motor shaft.
9. Remove drum assembly from gear train assembly (Figure 13-8).
10. Remove two nylon thrust washers from drum (Figure 13-9).

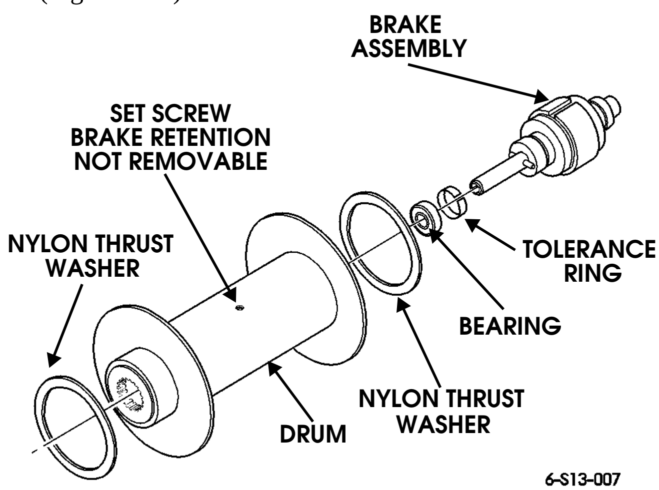


Figure 13-9: Thrust Washers and Brake

11. Loosen set screw that retains brake.
12. Push brake through open end of drum and remove (Figure 13-9).
13. Remove driveshaft from gear train assembly (Figure 13-10).
14. Turn gear train assembly over with gear end drum support down. Remove ten hex-head screws and gear housing from gear end drum support.
15. Remove gasket from gear end drum support. Discard gasket (Figure 13-10).

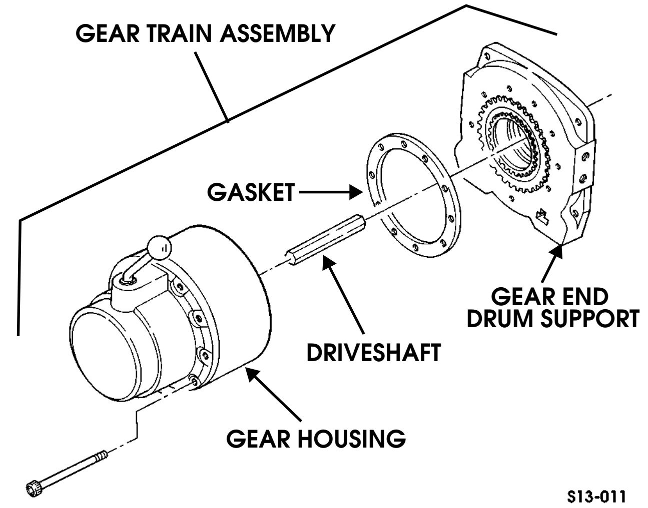


Figure 13-10: Gear Train Assembly

16. Remove detent spacer, spring, and detent ball from gear housing (Figure 13-11).

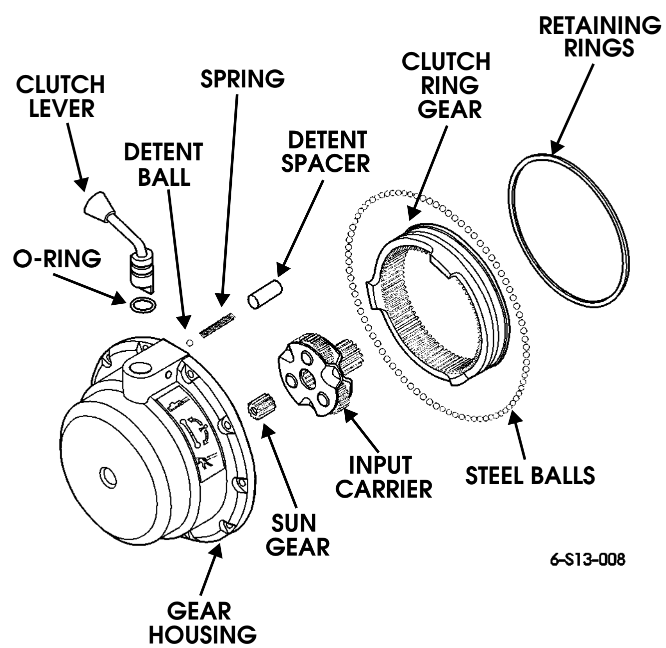


Figure 13-11: Gear Housing

17. Remove clutch lever and O-ring seal from gear housing. Discard O-ring seal.
18. Remove two retaining rings from gear housing (Figure 13-11).

NOTE: Intermediate ring gear comes out with 85 to 87 steel balls. Be sure to catch all 85 to 87 steel balls.

19. Remove intermediate ring gear and 85 to 87 steel balls from gear housing.

20. Remove input gear carrier assembly from gear housing (Figure 13-11).
21. Remove intermediate gear carrier and output gear carrier from output ring gear and gear end drum support (Figure 13-12)

.

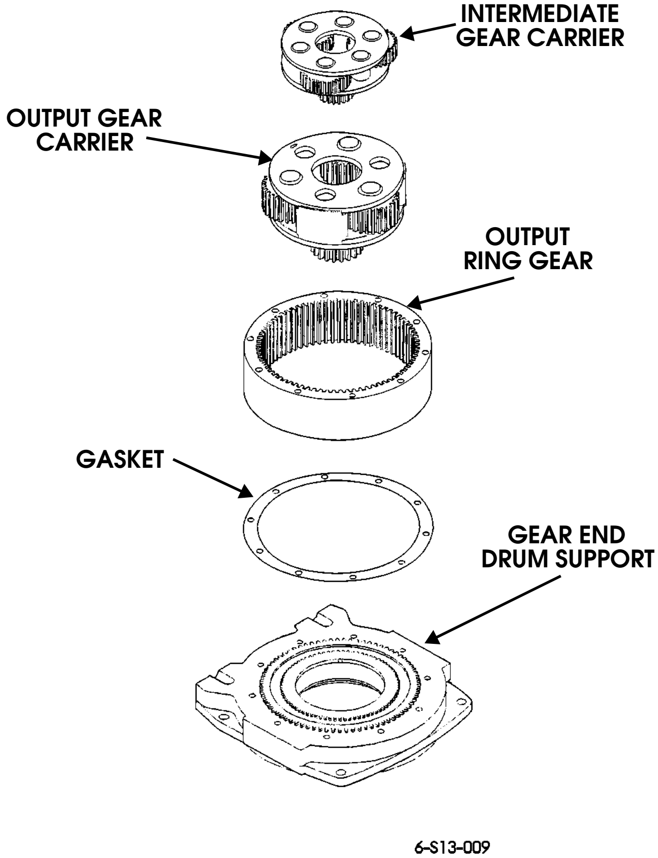


Figure 13-12: Gear Carriers

22. Remove output ring gear and gasket from gear end drum support.

Cleaning

CAUTION: *To avoid damage to equipment, do not clean brake assembly. Clean and inspect all winch components. Replace defective parts.*

Inspection

1. Inspect drum for damage to splined end flanges and tube (Figure 13-13). Replace winch if damaged.

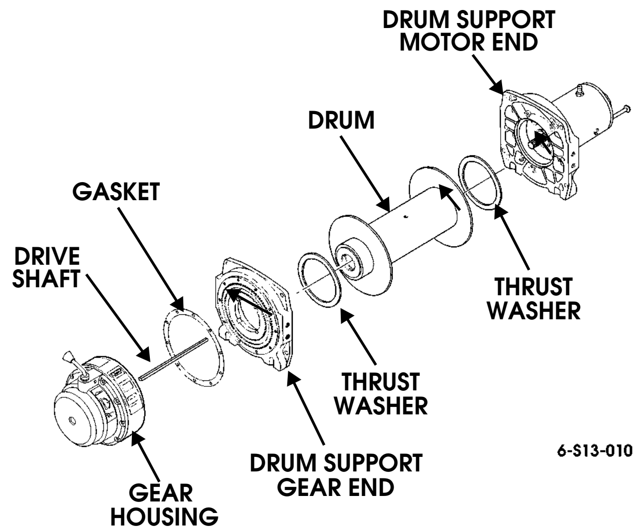


Figure 13-13: Drum Assembly and Gear Housing Assembly

2. Inspect gear end and motor end drum supports for damage. Replace if damaged.
3. Inspect gear housing for damage. Replace if damaged.
4. Inspect thrust plate for damage or wear. Replace if damaged or worn. Apply grease on thrust plate for assembly.
5. Inspect clutch lever and driveshaft for damage. Replace if damaged.
6. Inspect gear teeth and machined surfaces of intermediate ring gear for damage. Replace if damaged.
7. Inspect gear teeth, splines, and machined surfaces of output ring gear, output gear carrier, intermediate gear carrier, and input gear carrier assembly for damage. Replace any damaged parts (Figure 13-14).

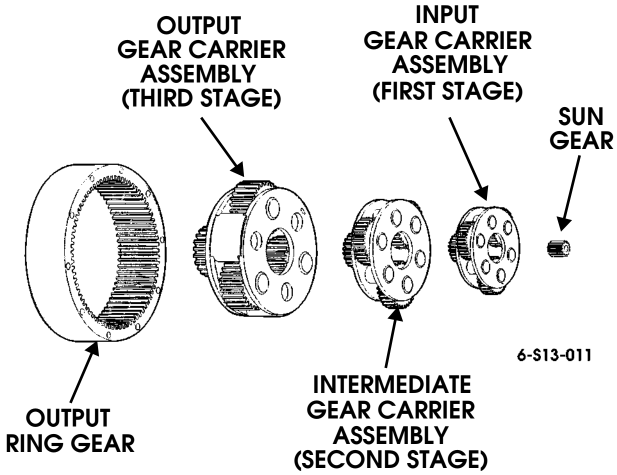


Figure 13-3

Figure 13-14: Gear Carriers

8. Inspect brake assembly for damage (Figure 13-15).
9. Inspect motor, spline, mating surface, and terminals for damage. Replace motor if damaged (Figure 13-15).

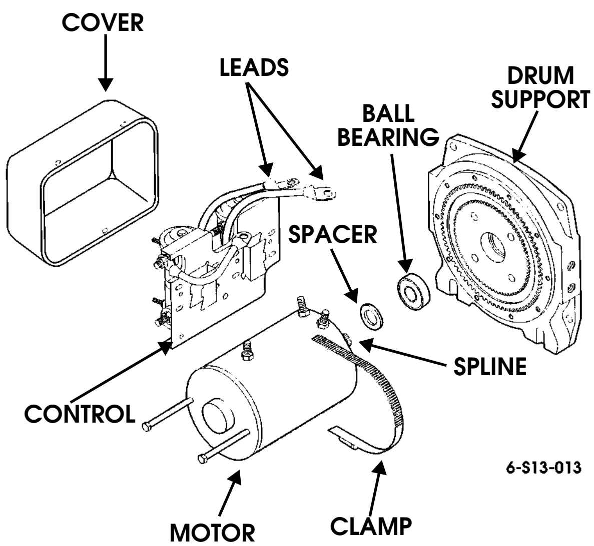


Figure 13-15: Motor and Control Unit

10. Inspect cover for damage. Replace if damaged.
11. Inspect control for damaged leads, breaks in plastic coating, and damaged mounting base. Replace control if damaged or repair plastic coating.

Assembly

1. Position 85 to 87 steel balls in groove of intermediate ring gear and install intermediate ring gear in gear housing (Figure 13-16).

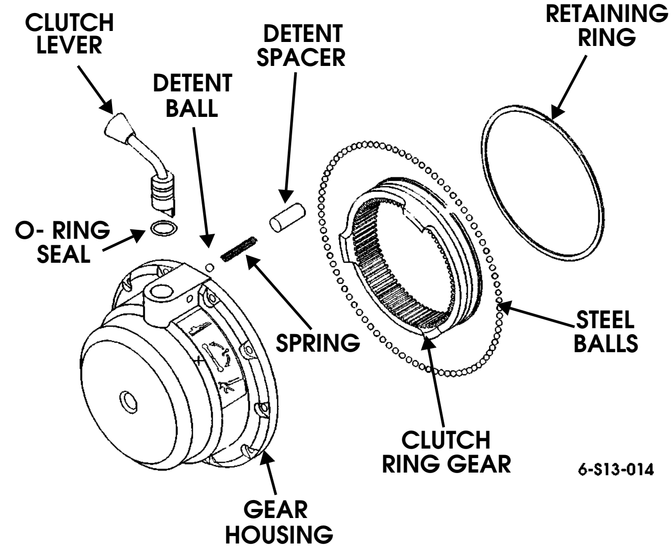


Figure 13-16: Intermediate Ring Gear and Gear Housing

2. Install retaining rings in gear housing.
3. Apply light oil to steel balls through the clutch lever hole.
4. Apply grease to clutch lever hole and install O-ring seal and clutch lever in gear housing.
5. Install detent ball, spring, and detent spacer in gear housing.
6. Apply aircraft grease to output gear carrier, intermediate gear carrier, and input gear carrier assembly (Figure 13-17).

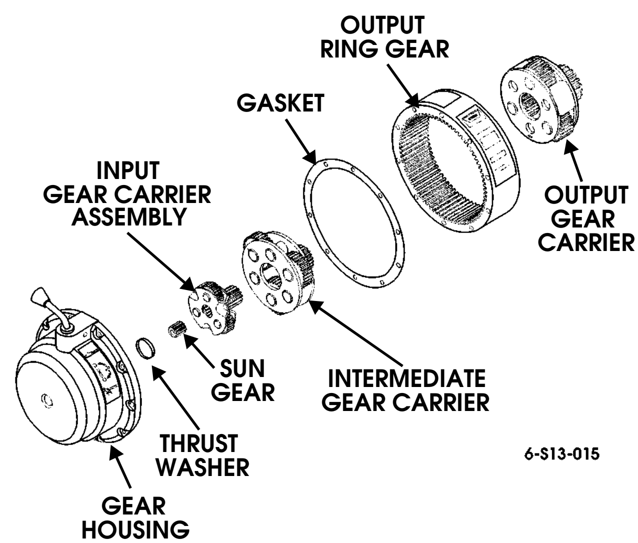


Figure 13-17: Gear Carriers

7. Install input gear carrier assembly in gear housing.

NOTE: Be sure ring gear engages in gear housing.

8. Install gasket and output ring gear on gear housing.
9. Install intermediate gear carrier on gear housing.
10. Install output gear carrier on intermediate gear carrier.
11. Install gasket on output ring gear (Figure 13-18).

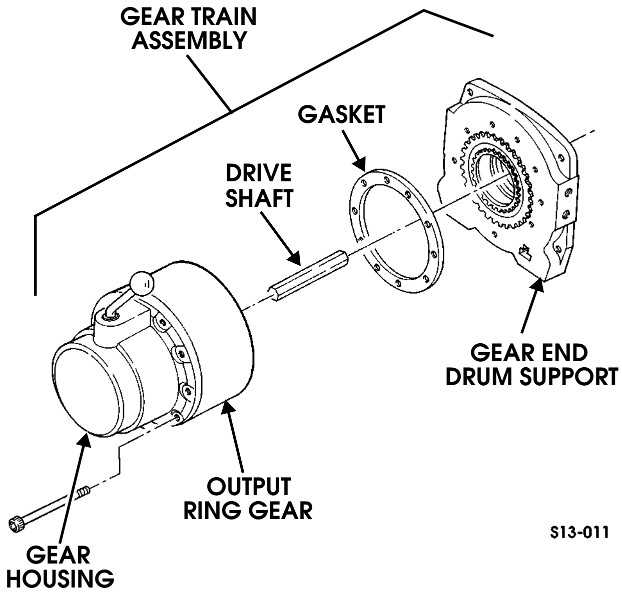


Figure 13-18: Gear Train Assembly

NOTE: Ensure spline on drum support engages in output ring gear.

12. Install gear end drum support on output ring gear and gear housing.
13. Secure gear housing assembly to drum support with ten hex-head screws. Tighten hex-head screws to 100 lb-in. (11 N•m).
14. Turn gear train assembly over with drum support facing up.
15. Install driveshaft in gear train assembly (Figure 13-18).
16. Apply grease to drum bushings, seals, and output spline (Figure 13-19).

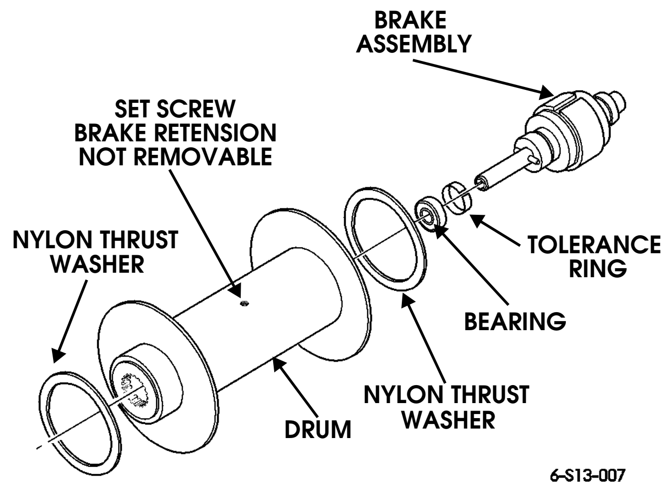


Figure 13-19: Thrust Washers and Brakes

17. With drum horizontal, install brake into drum.
18. Tighten brake retaining set screw to 18-22 ft-lb (24-30 N•m) torque.
19. Install two nylon thrust washers on drum.
20. Install drum assembly on gear train assembly. Rotate drum assembly as needed to engage driveshaft, brake, and output spline (Figure 13-20).

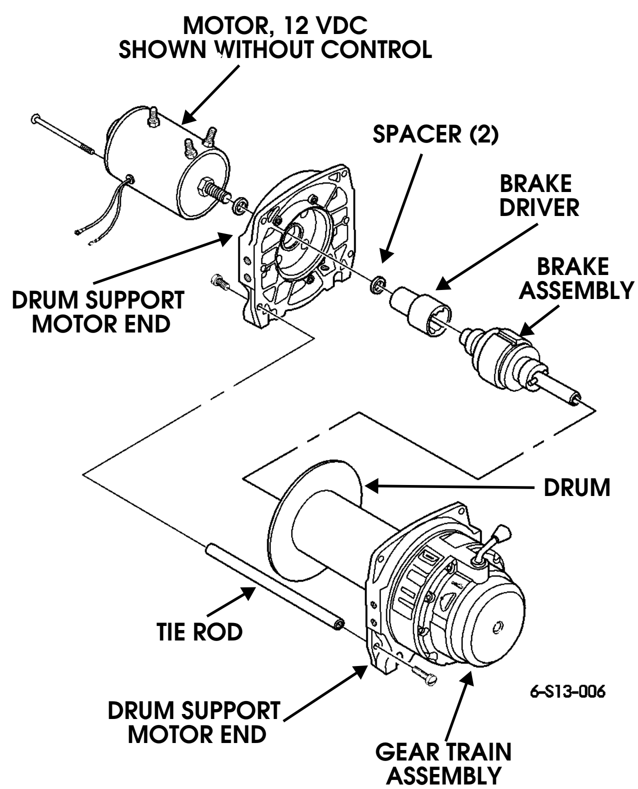


Figure 13-20: Drum Assembly and Gear Train Assembly

21. Install brake drive and spacer to motor shaft.
22. Install motor end drum support on drum assembly.
23. Install motor on motor end drum support, ensuring to engage brake drive with brake shaft end.
24. Install three tie rods between drum supports and secure with six bolts. Tighten bolts to 18 lb-ft (24 N•m).

NOTE: If motor or control have been pre-coated with sealing compound, remove compound from between motor case and control mounting gear contact area. Failure to do so may cause improper grounding of control.

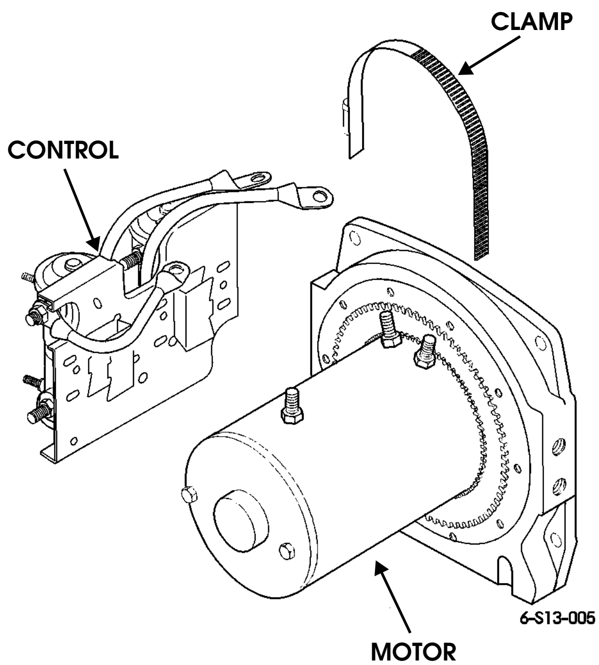


Figure 13-21: Control Unit and Motor

25. Connect three control leads to terminals and secure with nuts (Figure 13-22).
26. Secure control to motor with clamp.
27. Re-coat motor end of winch (including all leads and terminals) with PlastiDip Coating or equivalent waterproofing compound.
28. Install winch assembly and winch cable.

Winch Electric Thermal Switch/Brush Assembly Replacement

Removal

1. Remove winch and winch cable.

NOTE: Tag leads for assembly.

NOTE: It may be necessary to remove plastic coating from winch in order to perform steps 2 through 5.

2. Remove three nuts and control leads from motor (Figure 13-22).
3. Loosen clamp and remove control from motor (Figure 13-23).

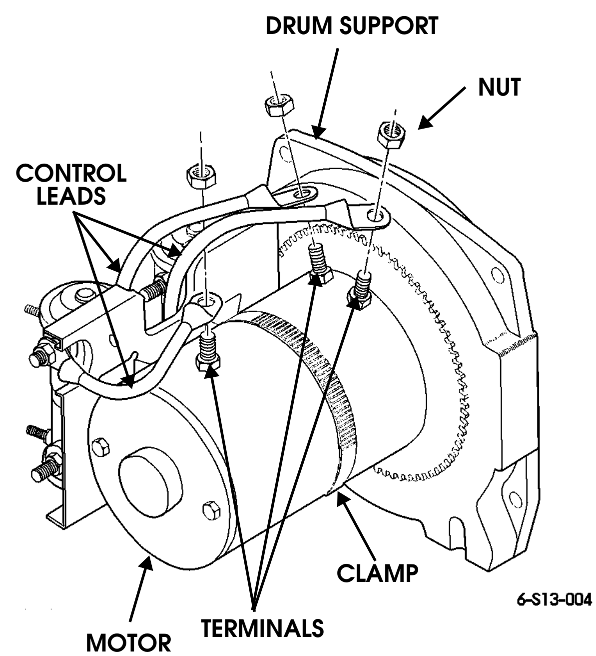


Figure 13-22: Control Leads

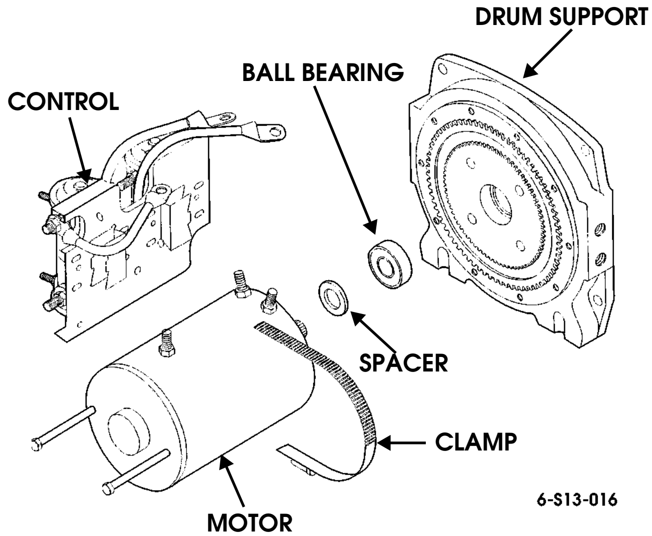


Figure 13-23: Control Unit and Motor

4. Remove clamp from motor.
5. Place winch on end with motor end up (Figure 13-24).
6. Remove two bolt assemblies and rear cover from motor housing.

NOTE: Perform steps 7 through 11 only if replacing brush assembly.

7. Remove electric thermal switch from two electric thermal switch leads.
8. Remove motor housing from drum support and armature assembly from brush assembly (Figure 13-25).
9. Remove nut, lockwasher, washer, and insulator securing brush assembly power stud to motor housing. Discard lockwasher.
10. Remove three nuts, screws, and brush assembly from motor housing.
11. Remove spacer, insulator, and washer from brush assembly power stud.

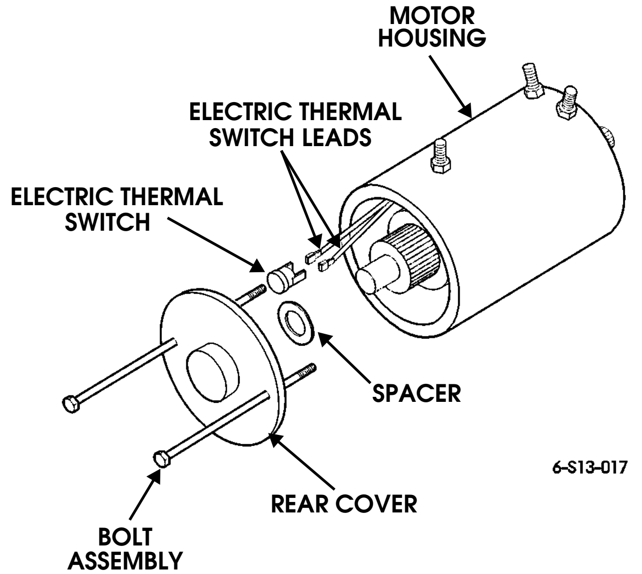


Figure 13-24: Motor and Gasket

Installation

NOTE: Do not apply coating to any electrical contacts of the armature assembly. Perform steps 1 through 5 only if replacing brush assembly.

1. Install washer, insulator, and spacer on brush assembly power stud (Figure 13-25).
2. Install brush assembly in motor housing with three screws and nuts

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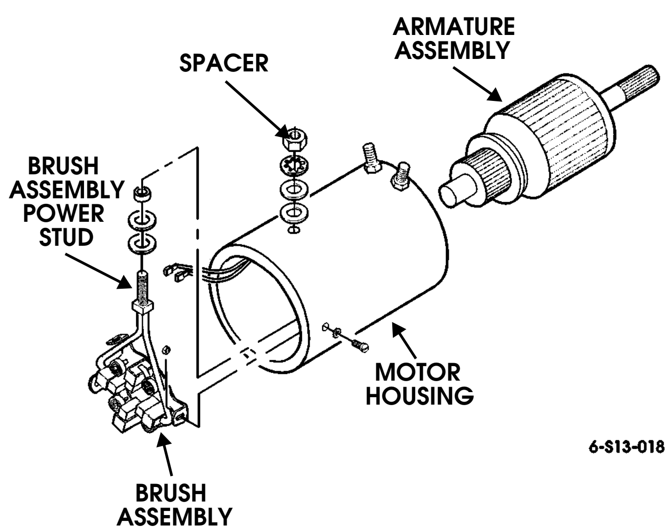


Figure 13-25: Brush Assembly and Armature Assembly

3. Secure brush assembly power stud to motor housing with insulator, washer, lockwasher, and nut.

4. Coat armature shaft with lubricant and install in brush assembly.
5. Coat head of electric thermal switch with lubricant and connect to two electric thermal switch leads (Figure 13-24).
6. Position spacer over bearing on drum support, and install rear cover on motor housing.
7. Install motor on drum support ensuring to engage motor shaft into brake drum.
8. Secure motor to motor end drum support with two bolt assemblies. Tighten hex-head bolt to 60-70 lb-in. (7-8 N•m) (Figure 13-26).

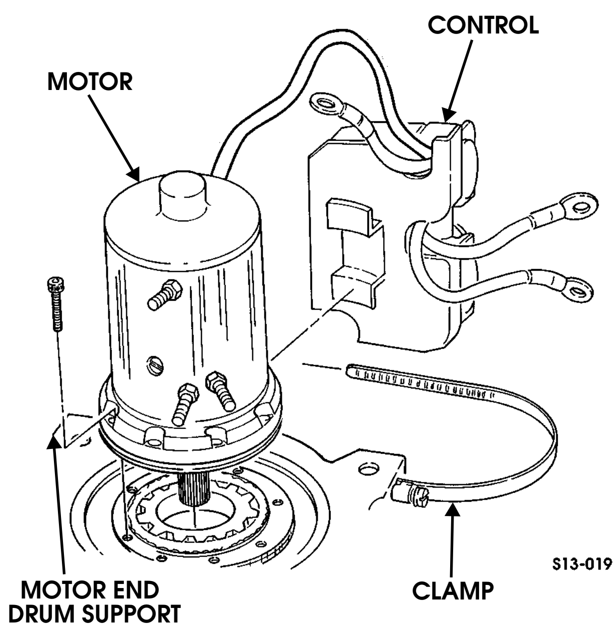


Figure 13-26: Control Unit and Motor

NOTE: If motor or control have been pre-coated with sealing compound, remove compound from between motor and control mounting gear contact area. Failure to do so may cause improper grounding or control.

9. Install clamp on motor.
10. Install control on motor.
11. Connect three control leads to terminals and secure with nuts (Figure 13-22).
12. Secure control to motor with clamp.
13. Re-coat motor end of winch (including all leads and terminals) with PlastiDip Coating or equivalent waterproofing compound.
14. Install winch assembly and winch cable.

BRUSHGUARD ASSEMBLY REPLACEMENT

NOTE: Brushguard assemblies may be used on vehicles with or without a winch assembly. The following procedure applies to vehicles without a winch assembly.

Removal

WARNING: Stand clear of brushguard after removal of locking pins. Brushguard may swing down, causing personal injury.

1. Remove two locking pins from support brackets and lower brushguard.
2. Remove two locknuts, washers, bolts, washers, and brushguard from support brackets.
3. Remove four locknuts, washers, bolts, washers, and two support brackets from bumper.

Installation

1. Install two support brackets on bumper with four washers, bolts, washers, and locknuts. Tighten locknuts to 68 lb-ft (92 N•m) (Figure 13-27).
2. Position brushguard in brackets and secure with two washers, bolts, washers, and locknuts.
3. Secure brushguard in upward position with two locking pins.

SWING-AWAY SPARE TIRE CARRIER REPLACEMENT

Removal

WARNING: Support tire when removing lug nuts. Failure to do so may result in personal injury.

1. Remove lug nuts and wheel/tire assembly from frame assembly (Figure 13-28).
2. Remove self-tapping screw and washer securing lanyard to frame and remove lanyard and lock pin.
3. Remove self-tapping screws and guide block from rear bumper.
4. Remove locknuts, washers, bolts, and stop bracket from rear bumper.
5. Remove bolts, washers, and hold-down bracket from stop bracket.
6. Remove bolt, washer, and retaining plate from mounting bracket.
7. Remove frame assembly from mounting bracket.
8. Remove end caps from frame assembly.
9. Remove locknuts, washers, spacer, bolts, washers, and mounting bracket from rear bumper.
10. Remove grease fitting from mounting bracket.

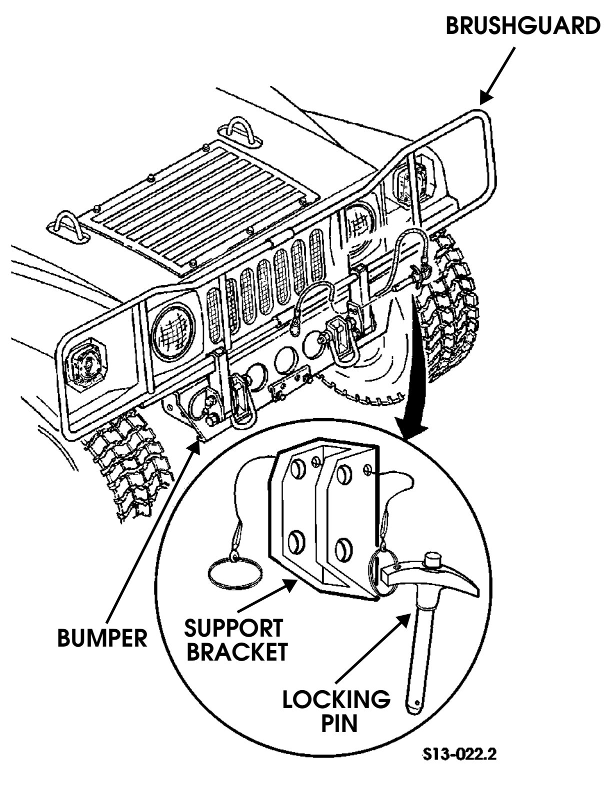


Figure 13-27: Brushguard Assembly

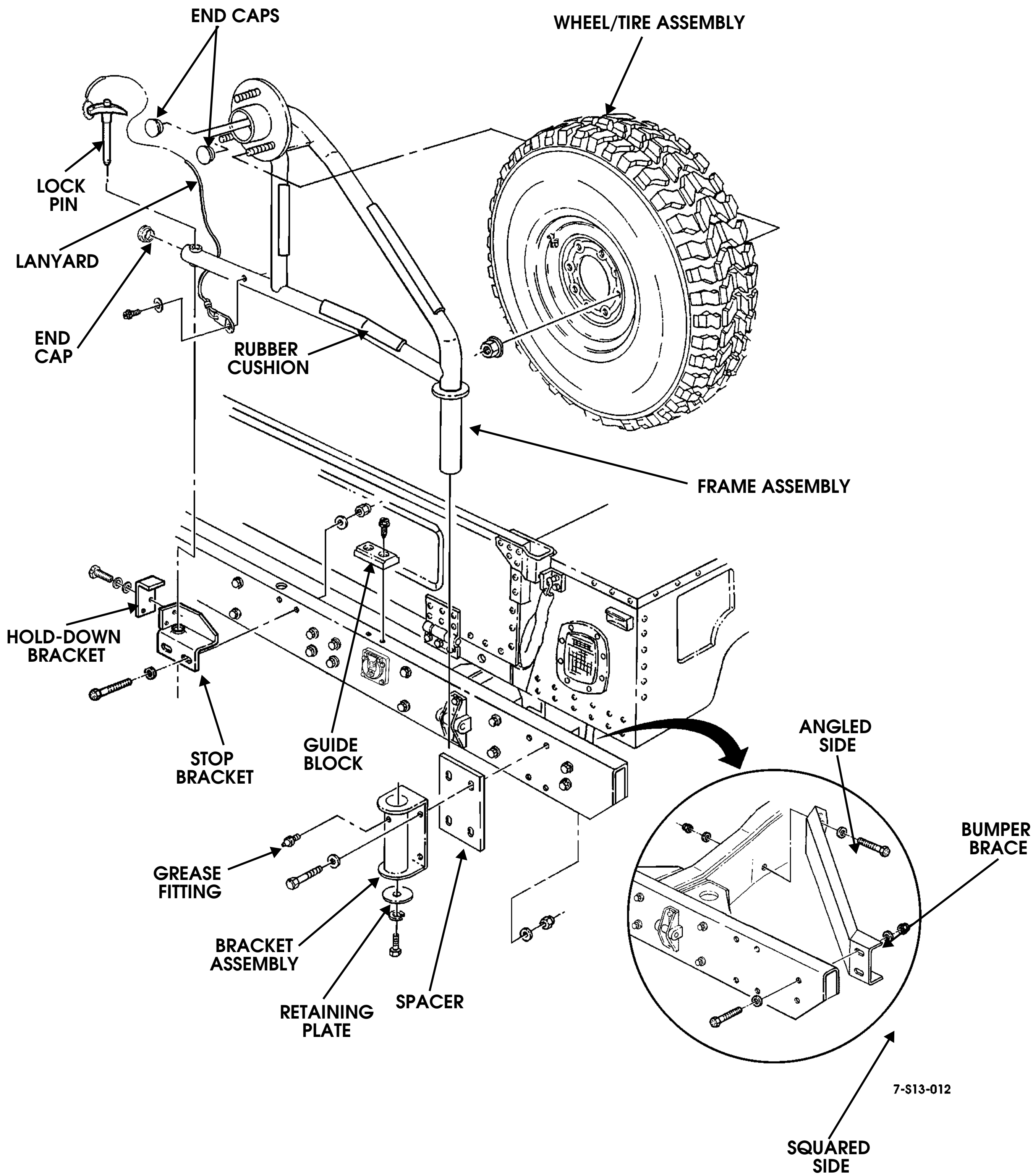


Figure 13-28: Swing-Away Spare Tire Carrier Breakdown

Installation

1. Install grease fitting in mounting bracket (Figure 13-28).
2. Attach mounting bracket and spacer to rear bumper with bolts, washers, and locknuts. Raise mounting bracket to highest position possible and tighten nuts to 90 lb-ft (122 N•m).
3. Secure guide block on rear bumper with self-tapping screws.
4. Attach hold-down bracket to stop bracket with washers, and bolts. Do not tighten.
5. Attach stop bracket to rear bumper with bolts, washers, and locknuts. Do not tighten.
6. Lubricate frame assembly. Slide frame assembly into mounting bracket and fasten with bolt, washer and retaining plate.
7. Push three end caps into open ends of frame assembly.
8. Adjust the stop and hold-down brackets that were previously installed.
   a. Set frame assembly in locked position so that it rests on bumper guide block. If weight of frame assembly does not rest on guide block, lower mounting bracket until it does.
   b. Insert locking pin through frame assembly and into stop bracket.
   c. Mark position of stop bracket.
   d. Move frame assembly out of the way and tighten stop bracket assembly securely.
   e. Move frame assembly back to locked position and align hold-down bracket as close to frame assembly as possible.
   f. Tighten hold-down bracket securely.
9. Secure lanyard assembly to frame assembly with washer and self-tapping screw.
10. Apply cushion tape to frame assembly on surfaces closest to rear of vehicle body.
11. Install lock pin in frame assembly.
12. Secure wheel/tire assembly to frame assembly with lug nuts.
13. Lubricate mounting bracket with multi-purpose grease using the grease fitting.

CARGO BED-MOUNTED SPARE TIRE CARRIER REPLACEMENT

WARNING: Always support the tire and wheel assembly when removing the lug nuts. The tire and wheel assembly weighs approximately 160 lbs (72 kgs) and may cause personal injury if it is not supported properly.

NOTE: Cargo bed-mounted spare tire carrier may be located either directly behind the cab or at the left wheelhouse on two door models. On four door models, spare tire carrier will be located at the left wheelhouse.

Removal

NOTE: Perform steps 1 and 2 on vehicles with frame assembly stowed in down position.

1. Disconnect lock pins and raise frame assembly to upright position (Figure 13-29).

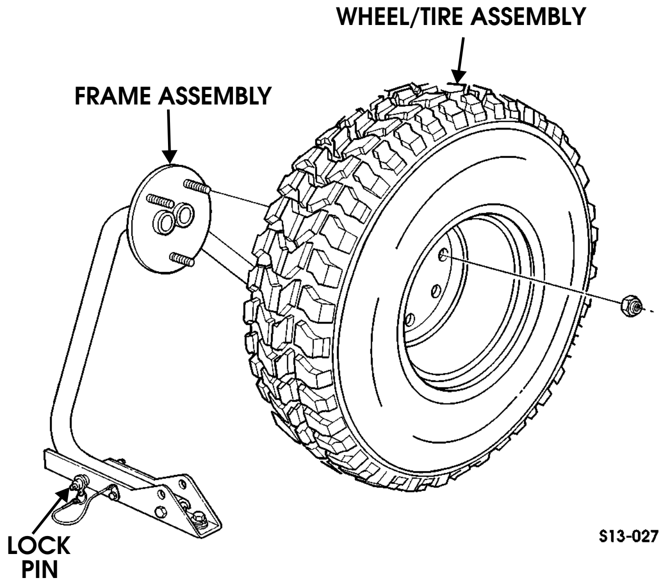


Figure 13-29: Cargo Bed-Mounted Spare Tire Carrier Appearance

2. Secure frame assembly in upright position with lock pins.
3. Remove lug nuts securing tire to frame assembly and remove wheel/tire assembly.
4. Remove self-tapping screws, lockwashers, and lanyard/lock pin assemblies from mounting brackets (Figure 13-30).
5. Remove locknuts, bolts and frame assembly from mounting brackets.
6. Remove screws securing mounting brackets to cargo floor (Figure 13-31).

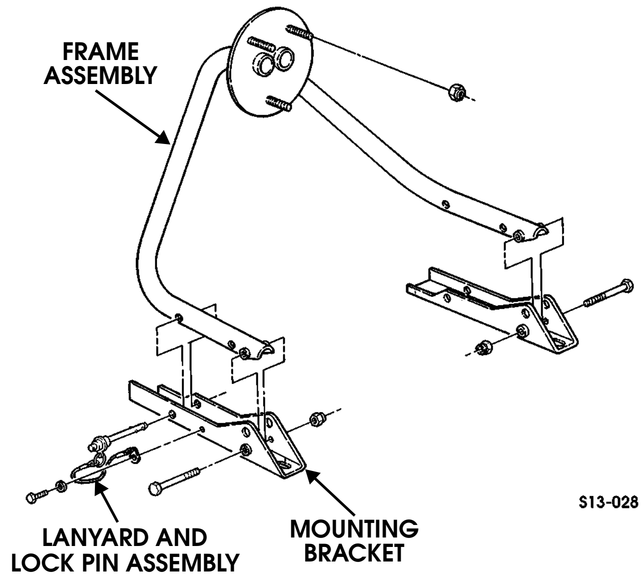


Figure 13-30: Frame Assembly Mounting

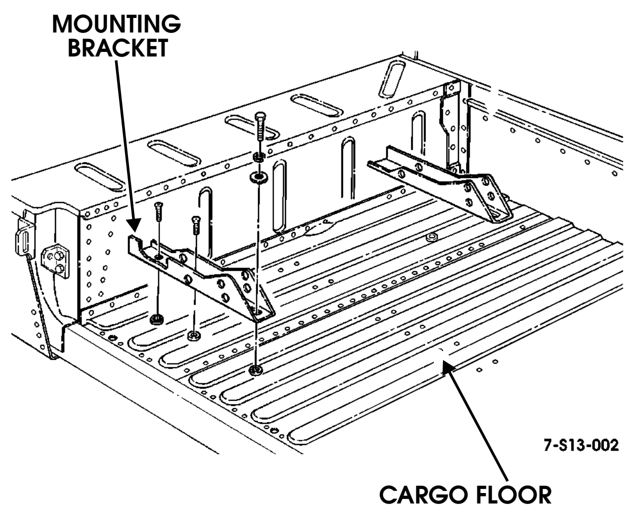


Figure 13-31: Mounting Bracket Positioning

7. Remove bolts, lockwashers, washers, and mounting brackets from cargo floor.

Installation

1. Install mounting brackets on cargo floor with washers, lockwashers, and bolts (Figure 13-31).
2. Secure mounting brackets to cargo floor with screws. Tighten screws to 44 lb-ft (60 N•m).

3. Install frame assembly on mounting brackets with bolts and locknuts (Figure 13-30).
4. Install lanyard/lock pin assemblies on mounting brackets and frame assembly with lockwashers and self-tapping screws.
5. With carrier in the upright position, install tire on frame assembly with three lug nuts (Figure 13-29).

NOTE: Perform steps 6 and 7 to stow frame assembly in down position.

6. Disconnect lock pins and lower frame assembly to down position.
7. Connect lock pins.

UNDERBODY PROTECTION

NOTE: A slightly different style of underbody protection is available for vehicles with a 12,100 lbs (5 489 kgs) GVWR.

Skid Plate Replacement

NOTE: Underbody protection as described below does not apply to 12,100 lb GVWR vehicles.

Removal

1. Remove locknuts, washers, bolts, and washers securing skid plate to front shield (Figure 13-32).

NOTE: Go to step 3 for vehicles equipped with a winch.

2. Remove locknuts, washers, bolts, washers, and skid plate from front bumper.
3. Remove locknuts, washers, bolts, washers, and winch skid plate from winch bumper.

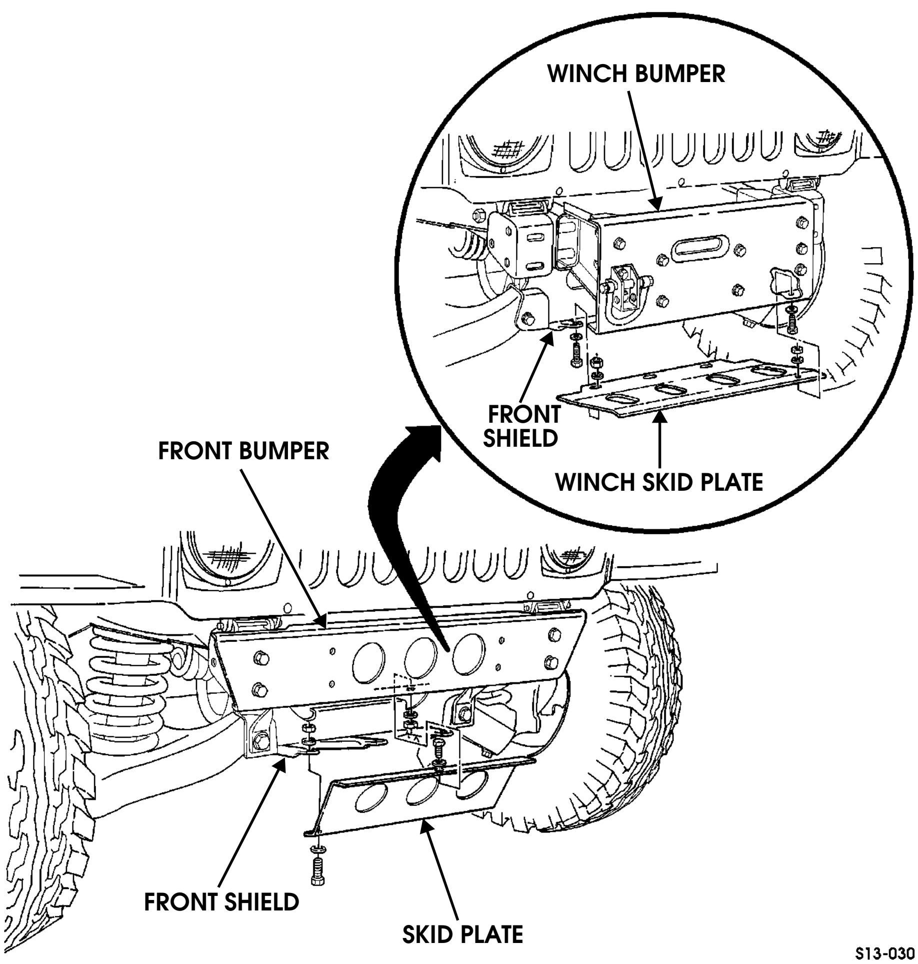


Figure 13-32: Skid Plate Mounting

Installation

NOTE: Go to step 2 for vehicles equipped with a winch.

1. Install skid plate on front bumper with bolts, washers, and locknuts. Tighten locknuts to 24 lb-ft (33 N•m) (Figure 13-32).
2. Install winch skid plate on winch bumper with bolts, washers, and locknuts (Figure 13-32). Tighten locknuts to 24 lb-ft (33 N•m).
3. Secure skid plate to front shield with bolts, washers, and locknuts. Tighten locknuts to 24 lb-ft (33 N•m).

Front Shield Replacement

Removal

1. Remove locknuts, washers, bolts, and spacers securing front shield to front crossmember and intermediate shield (Figure 13-33).
2. Remove locknuts, washers, bolts, and front shield from skid plate.

Installation

1. Install front shield on skid plate with bolts, washers, and locknuts. Do not tighten locknuts (Figure 13-33).
2. Secure front shield to front crossmember and intermediate shield with spacers, bolts, washers, and locknuts.
3. Tighten locknuts securing front shield to skid plate to 24 lb-ft (33 N•m). Tighten locknuts securing front shield to crossmember and intermediate shield to 44 lb-ft (60 N•m).

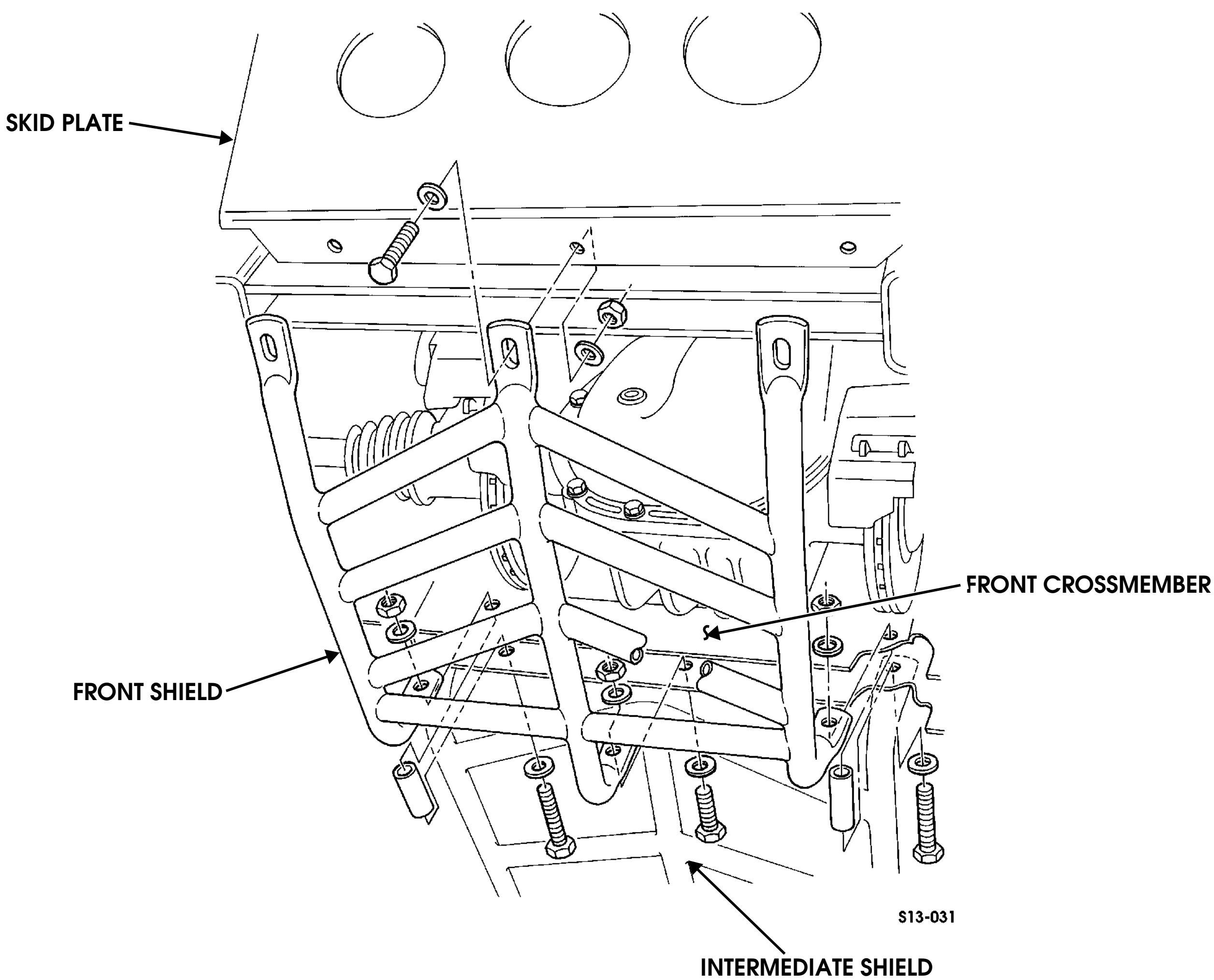


Figure 13-33: Front Shield Mounting

Intermediate Shield Replacement

Removal

1. Remove six locknuts, washers, bolts, washers, and four rubber washers securing two transmission support brackets and intermediate shield to transmission mount crossmember. Remove support brackets. Discard locknuts (Figure 13-34).

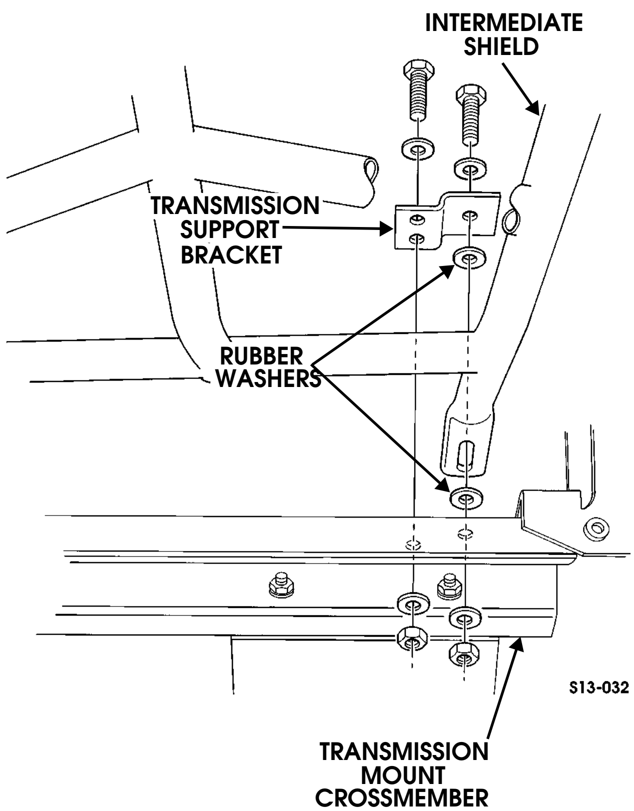


Figure 13-34: Intermediate Shield

2. Remove locknut, washer, capscrew, and washer securing left support bracket to engine mount bracket and frame rail. Discard locknut (Figure 13-35).
3. Remove four locknuts, washers, bolts, washers, and left support bracket from left mounting bracket. Discard locknuts.

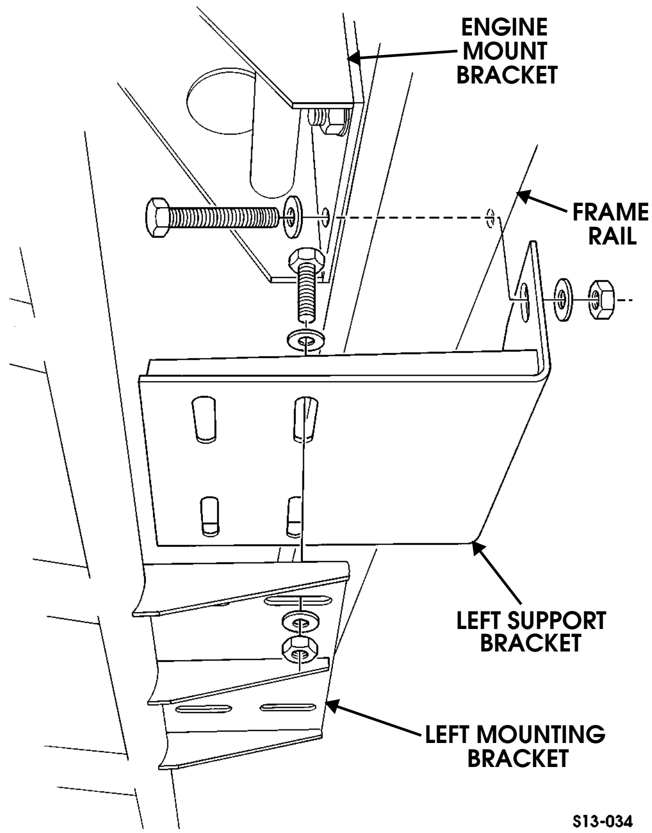


Figure 13-35: Left Support Bracket

4. Remove locknut, washer, capscrew, and washer securing right support bracket to frame rail. Discard locknut (Figure 13-36).
5. Remove four locknuts, washers, bolts, washers, and right support bracket from right mounting bracket. Discard locknuts.
6. Remove two locknuts, washers, bolts, washers, spacers, and intermediate shield from front crossmember and front shield. Discard locknuts (Figure 13-37).

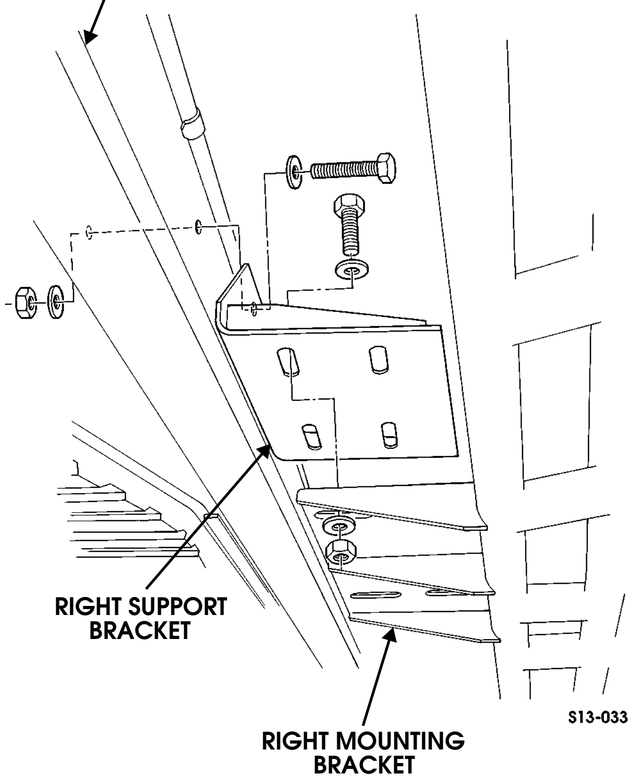


Figure 13-36: Right Support Bracket

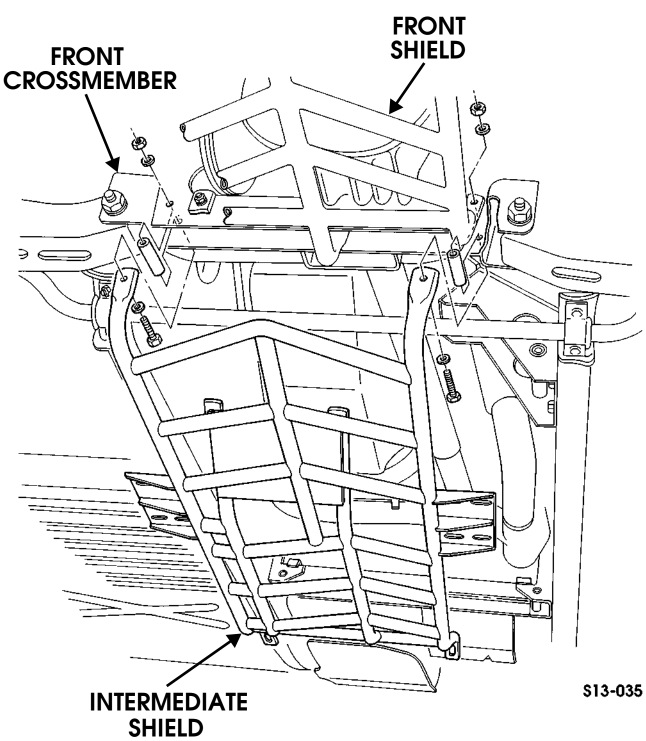


Figure 13-37: Intermediate Shield

Installation

1. Install intermediate shield to front crossmember and front shield with two spacers, washers, bolts, washers, and locknuts. Tighten locknuts to 44 lb-ft (60 N•m) (Figure 13-37).
2. Install right support bracket on right mounting bracket with four washers, bolts, washers, and locknuts. Do not tighten locknuts (Figure 13-36).
3. Secure right support bracket to frame rail with washer, capscrew, washer, and locknut. Tighten locknut to 105 lb-ft (142 N•m).
4. Install left support bracket on left mounting bracket with four washers, bolts, washers, and locknuts. Do not tighten locknuts (Figure 13-35).
5. Secure left support bracket to engine mount bracket and frame rail with washer, capscrew, washer, and locknut. Tighten locknut to 105 lb-ft (142 N•m).
6. Install two transmission support brackets on transmission mount crossmember with four washers, bolts, washers, and locknuts. Tighten locknuts to 24 lb-ft (33 N•m) (Figure 13-34).
7. Secure intermediate shield to transmission mount crossmember and transmission support brackets with four rubber washers, two washers, bolts, washers and locknuts. Tighten locknuts to 26 lb-in. (3 N•m).
8. Tighten locknuts securing support brackets to mounting brackets to 24 lb-ft (33 N•m).

Transfer Case Shield Replacement

Removal

Remove two locknuts, washers, bolts, washers, and transfer case shield from crossmember. Discard locknuts (Figure 13-38).

Installation

Install transfer case shield on crossmember with two washers, bolts, washers, and locknuts (Figure 13-38).

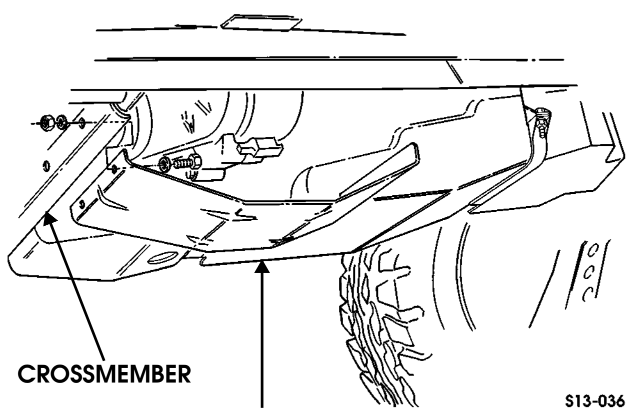


Figure 13-38: Transfer Case Shield

Rear Shield Replacement

NOTE: The rear shield as described below does not apply to 12,100 lb GVWR vehicles. Consult with Hummer Fleet Representative for rear shield availability for these vehicles.

Removal

1. Remove three locknuts, washers, bolts, washers, and spacers securing rear shield to rear-front crossmember. Discard locknuts (Figure 13-39).
2. Remove three locknuts, washers, bolts, washers, and shield from mounting brackets. Discard locknuts.
3. Remove six locknuts, washers, bolts, washers, spacers, and three mounting brackets from rear-rear crossmember. Discard locknuts.

Installation

1. Install three mounting brackets on rear-rear crossmember with six spacers, washers, bolts, washers, and locknuts. Tighten locknuts to 24 lb-ft (33 N•m) (Figure 13-39).
2. Position shield on mounting brackets and secure with three washers, bolts, washers, and locknuts. Do not tighten locknuts.
3. Secure shield to rear-front crossmember with three spacers, washers, bolts, washers, and locknuts. Tighten bolts to 44 lb-ft (60 N•m).
4. Tighten locknuts securing rear shield to mounting brackets to 24 lb-ft (33 N•m).

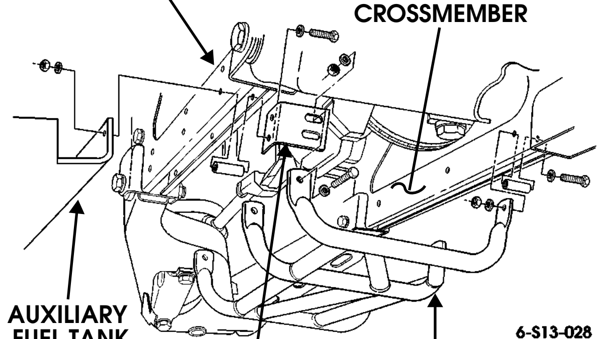


Figure 13-39: Rear Shield

UNDERBODY SKID PANEL REPLACEMENT

Removal

NOTE: Removal of underbody skid panel is similar for both sides. This procedure covers one side only.

1. Remove outer kick panels (Section 10).
2. Pull back carpet from front footwell and rear footwell (4-door models only).

NOTE: Hex-head screws are secured in place with Loctite 242 and may require considerable effort to break loose.

3. Remove nine hex-head screws securing underbody skid panel to body. Support underbody skid panel with floor jack (Figure 13-40).

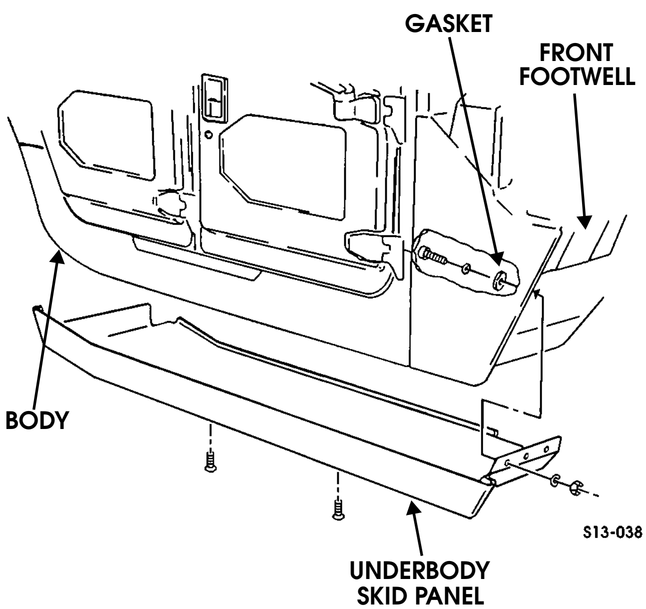


Figure 13-40: Underbody Skid Panel

4. Remove three nuts, washers, bolts, washers, and gaskets securing skid panel to front footwell. Discard gaskets.
5. Remove three nuts, washers, bolts, washers, and gaskets securing spacer (if present) and skid panel to rear footwell (Figure 13-41).

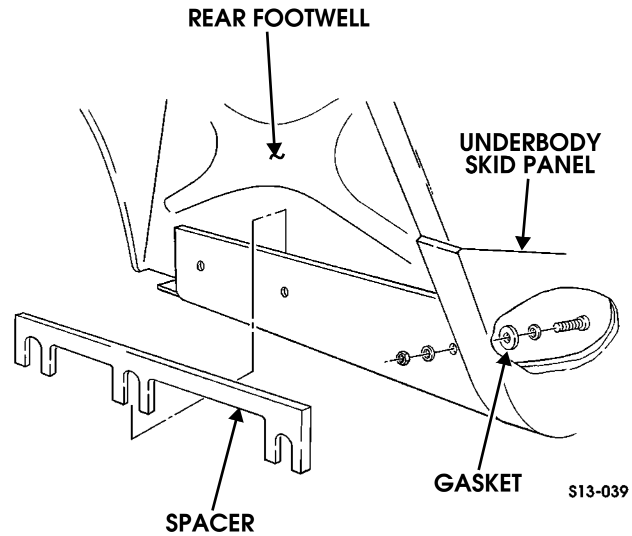


Figure 13-41: Rear Footwell

CAUTION: *Underbody skid panel is heavy. Remove with a floor jack.*

6. Remove underbody skid panel from body.
7. Inspect three retainer nuts on body. Discard if damaged.

Installation

CAUTION: *Underbody skid panel is heavy. Raise into place with a floor jack.*

1. Raise underbody skid panel to body.
2. Secure skid panel to rear footwell with three gaskets, washers, bolts, washers, and nuts. Do not tighten nuts (Figure 13-41).
3. Secure skid panel to front footwell with three gaskets, washers, bolts, washers, and nuts. Do not tighten nuts (Figure 13-40).
4. Install spacer between rear footwell and underbody skid panel if necessary. Tighten nuts at front and rear footwells to 37 lb-ft (50 N•m) (Figures 13-40 and 13-41).

NOTE: Apply Loctite 242 to threads of hex-head screws.

5. Remove floor jack and secure underbody skid panel to body with nine hex-head screws. Tighten hex-head screws to 37 lb-ft (50 N•m) (Figure 13-40).
6. Push carpet back in place.
7. Install outer kick panels (Section 10).

TRAILER TOWING

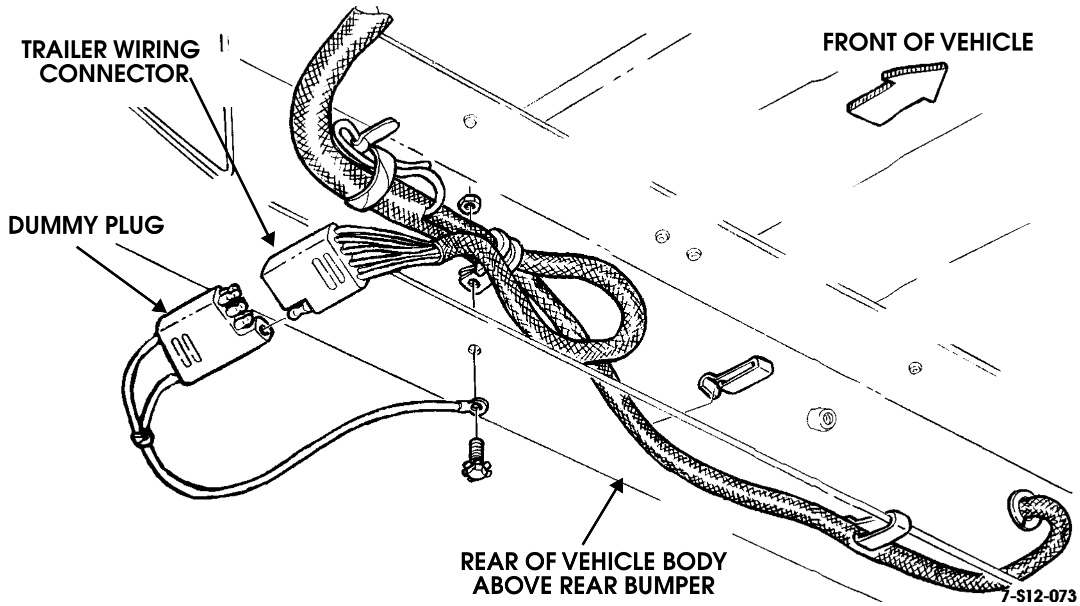


Figure 13-42: Trailer Wiring Connector and Dummy Plug Location

Trailer Jumper Harness

Hummer vehicles come from the factory equipped for easy installation of the trailer jumper harness. The trailer jumper harness may be installed as part of the factory trailer towing package, dealer installed option, or an add-on kit. Body wiring harnesses are designed with a trailer wiring connector at the rear of the vehicle body above the rear bumper (Figure 13-42). Rear bumpers are manufactured with a cut-out for the trailer harness receptacle and fitted with a cover plate should the trailer jumper harness not be installed.

Installation

1. Remove the cover plate in the rear bumper.
2. Insert the trailer jumper harness through the rear bumper cutout and bolt the receptacle in place (Figure 13-43).
3. Remove the dummy plug and plug the trailer jumper harness connector into the trailer wiring connector.

Trailer Brake Controller

Spare wires have been provided in the body harness and routed from the instrument panel/fuse box area to the trailer connector at the rear of the vehicle. Install the trailer brake controller using the manufacturer's instructions.

The following information about the Hummer electrical system is necessary for installation:

1. Three shrink-wrapped wire leads can be found under the instrument panel (Figure 13-44), they are:
   a. Yellow—power
   b. Red—stop light signal
   c. Dark blue—trailer brake

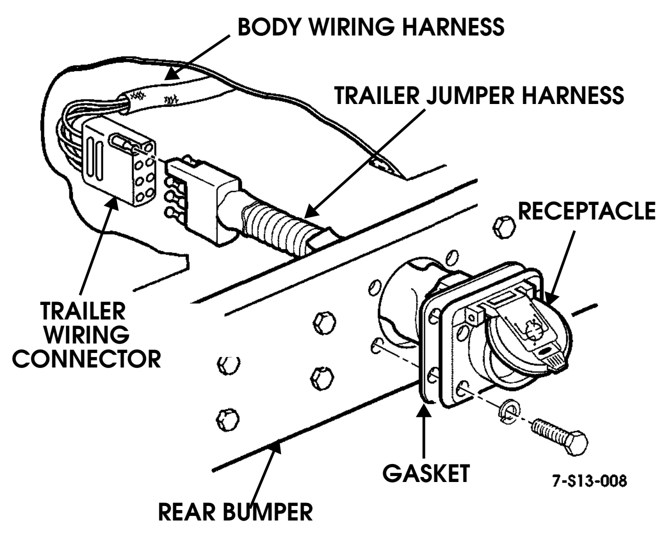


Figure 13-43: Trailer Jumper Harness Mounting

2. The circuit will not have power until a fuse (of required amperage) is installed in fuse block position 7H—the far upper right hand corner of the fuse block.

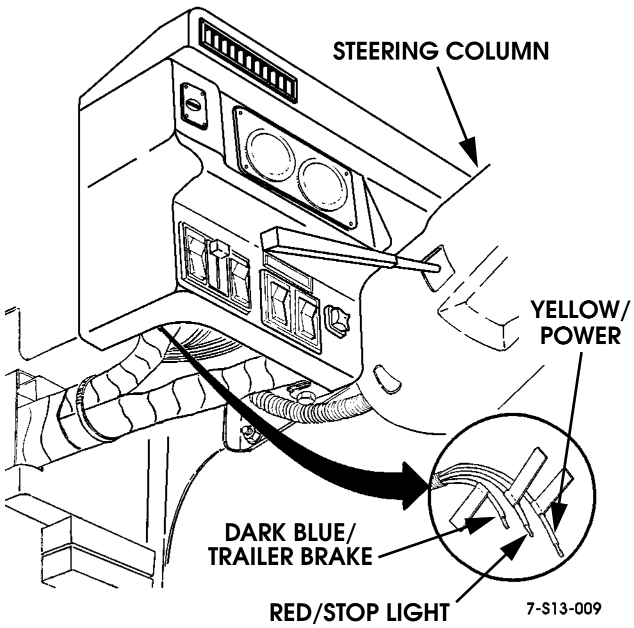


Figure 13-44: Trailer Brake Controller Wiring

TRAILER HITCH REPLACEMENT

Removal

1. Remove locknuts, washers, receiver assembly mounting blocks, bolts, and washers from body mount bracket (Figure 13-45).
2. Remove bolts, lockwashers, washers from lower brace weld nuts. Remove brace from bumper and trailer hitch mounting brackets.
3. Remove bolts, washers, and trailer hitch from rear bumper weld nuts.

Installation

1. Position trailer hitch receiver on rear bumper and secure with weld nuts, bolts and washers (Figure 13-45). Do not tighten at this time.
2. Secure trailer hitch to body mount bracket with locknuts, washers, receiver assembly mounting blocks, bolts, and washers.
3. Install lower brace to bumper and trailer hitch mounting bracket with bolts, lockwashers, washers and weld nuts.
4. Tighten all locknuts to 90 lb-ft (122 N•m).

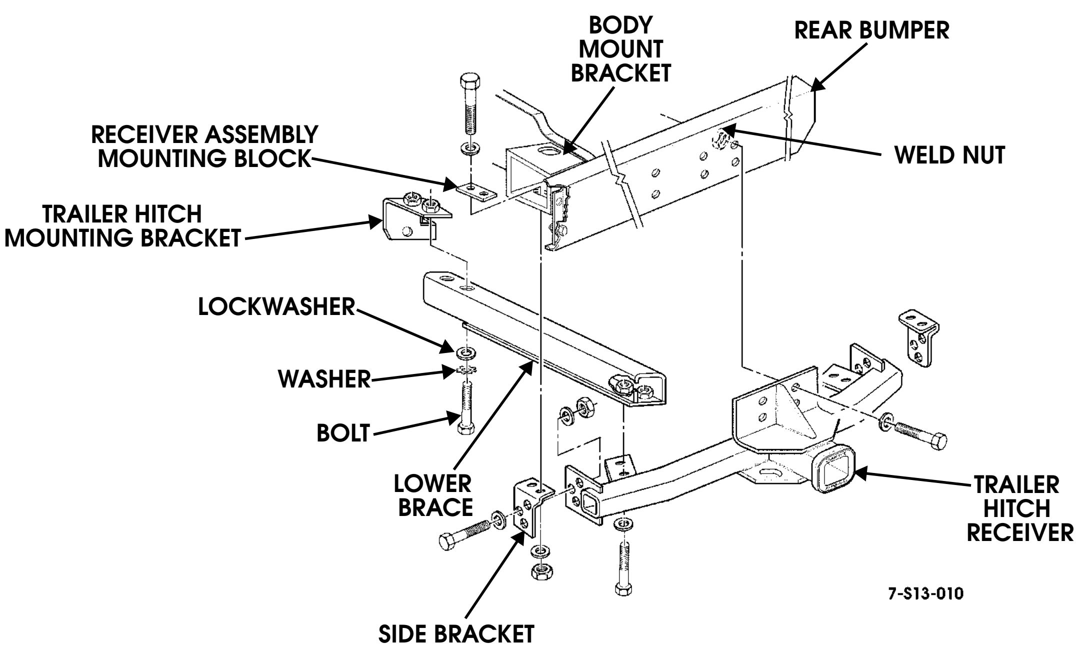


Figure 13-45: Trailer Hitch

RUNNING BOARD REPLACEMENT

Removal

1. Remove two clips and pins securing the right and left curved tubes to the receiver (Figures 13-46 and 13-47).

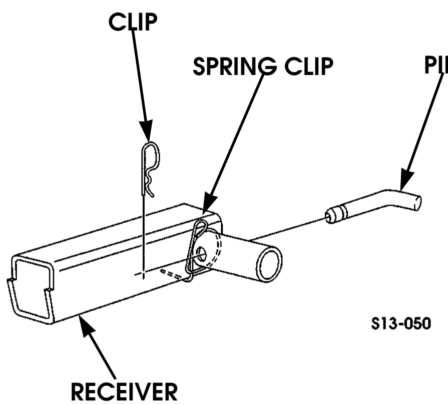


Figure 13-46: Receiver

2. Remove screw, nut, and screw securing the left end cap to the left curved tube (Figure 13-47).

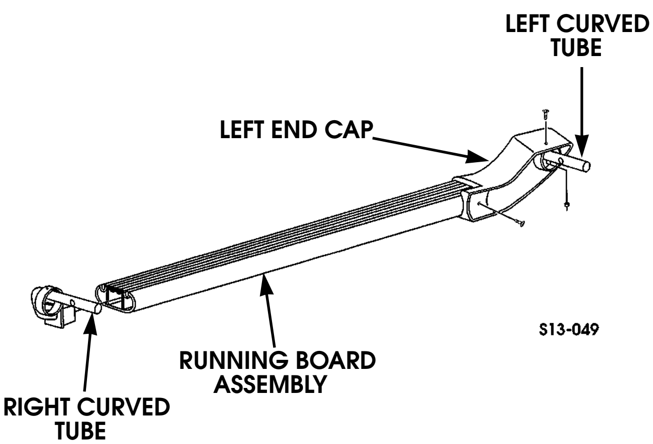


Figure 13-47: Left End Cap Secured to Left Curved Tube

3. Remove screw, nut, and screw securing the right end cap to the right curved tube.
4. Remove left curved tube from running board.
5. Remove right curved tube from running board.

NOTE: If vehicle has underbody skid panels, remove the extra clamp plate used on the forward mounting area between the mounting bracket and receiver.

6. Remove four nuts, washers, and two clamp plates securing two receivers to studs on mounting brackets (Figure 13-48).

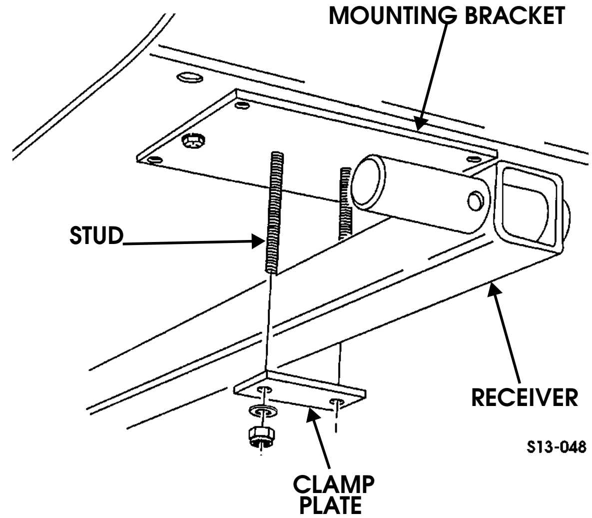


Figure 13-48: Receiver and Clamp Plate

NOTE: If vehicle does not have underbody skid panels, perform steps 7 and 8. If vehicle is equipped with underbody skid panels, perform steps 9 and 10.

7. Remove two bolts, lockwashers, and rear mounting bracket from body (Figure 13-49).

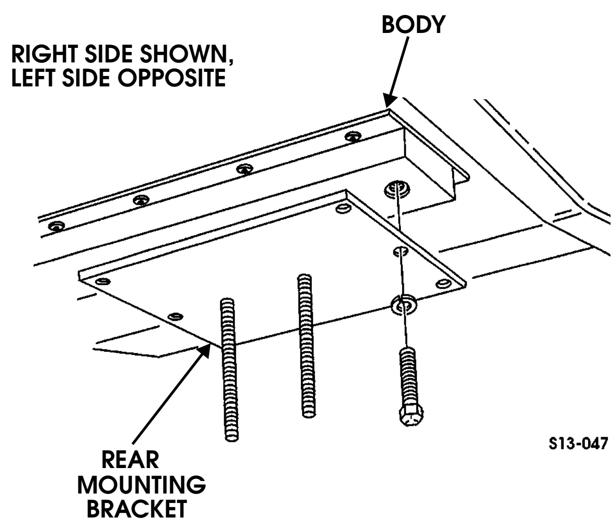


Figure 13-49: Rear Mounting Bracket

8. Remove four bolts, lockwashers, J-nuts, and front mounting bracket from body (Figure 13-50).

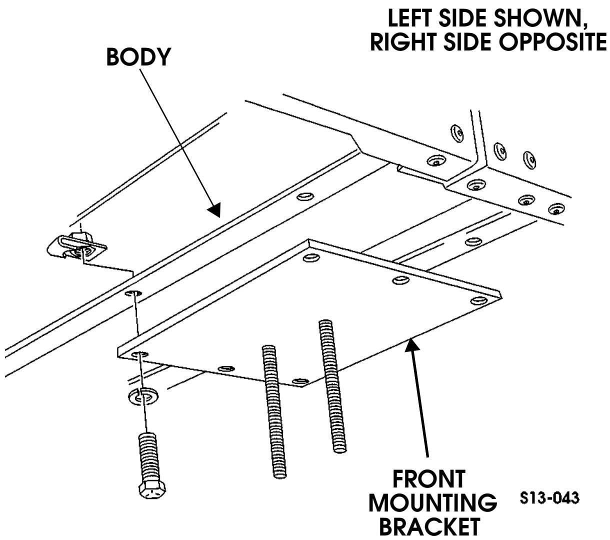


Figure 13-50: Front Mounting Bracket and J-Nut

9. Remove four bolts, lockwashers, and front mounting bracket from underbody skid panel and body (Figure 13-51).

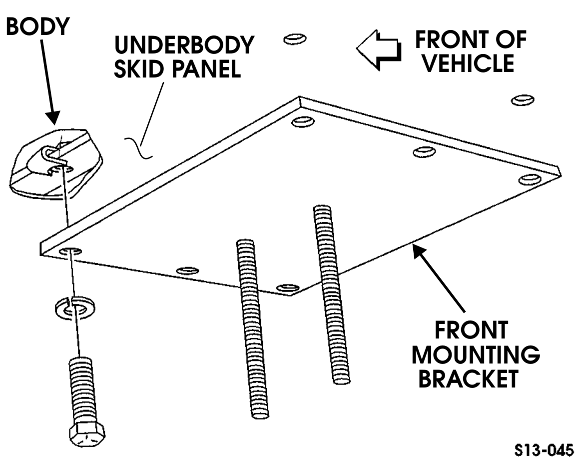


Figure 13-51: Front Mounting Bracket

10. Remove two bolts, lockwashers, and rear mounting bracket from underbody skid panel and body (Figure 13-52).

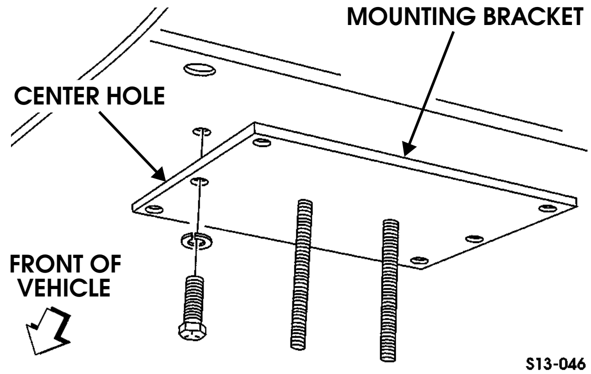


Figure 13-52: Rear Mounting Bracket

Installation

NOTE: If vehicle does not have underbody skid panels, perform steps 1 and 2. If vehicle is equipped with underbody skid panels, perform steps 3 and 4.

1. Install front mounting bracket on body with four J-nuts, lockwashers, and bolts. Tighten bolts to 29-31 lb-ft (39-42 N•m) (Figure 13-50).
2. Install rear mounting bracket on body with two lockwashers and bolts. Tighten bolts to 29-31 lb-ft (39-42 N•m) (Figure 13-49).
3. Install front mounting bracket on underbody skid panel and body with four lockwashers and bolts. Tighten bolts to 29-31 lb-ft (39-42 N•m) (Figure 13-51).

NOTE: If the vehicle does not have underbody protection, an extra clamp plate must be used on the forward mounting area between the mounting bracket and receiver.

4. Install rear mounting bracket on underbody skid panel and body with two lockwashers and bolts. Tighten bolts to 29-31 lb-ft (39-42 N•m) (Figure 13-52).
5. Install receiver to studs on two mounting brackets with two clamp plates, four washers, and nuts (Figure 13-48).
6. Remove any extra mounting bracket stud lengths by cutting the stud four thread lengths from the nut.
7. Position right curved tube (with orange plastic bushing) into running board. Ensure right curved tube points toward the side of the running board with the “this side toward frame” decal (Figure 13-47).
8. Position left curved tube (with black plastic bushing) into running board.
9. Position right end cap on right curved tube with screw, nut, and screw.
10. Position left end cap on the left curved tube with screw, nut, and screw.

11. Position two spring clips on receiver. Ensure the spring clips are positioned 180 degrees from each other (Figure 13-46).
12. Secure the right and left curved tubes to the receiver with two pins and clips.

ROOF RACK

Roof Rack Replacement

NOTE: The roof rack is available in three foot, six foot, and nine foot lengths. The following procedure is for a six foot roof rack installed on a station wagon. Three foot and nine foot procedures are similar.

Removal

WARNING: Roof rack is extremely heavy. Several people may be required to remove and install rack safely. Use care in determining ability to lift the rack. Failure to do so may result in injury.

1. Loosen eight support screws on clamps (Figure 13-53).
2. Loosen eight locknuts securing clips to drip rails.
3. Remove eight clips from under drip rails and remove rack from vehicle.

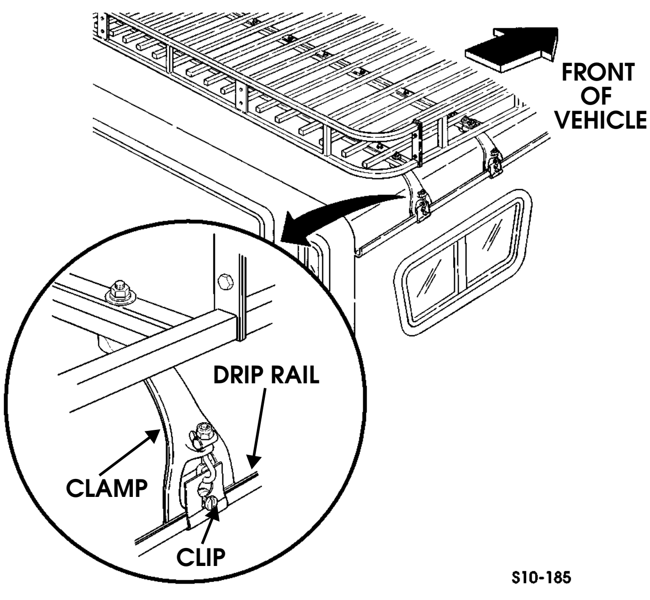


Figure 13-53: Roof Rack Clamp

Installation

CAUTION: *Clamps are made of aluminum. Overtightening may cause the clamps to crack.*

1. Position roof rack on top of vehicle with rack ends toward front and rear of vehicle (Figure 13-53).
2. Position eight clips (on clamps) under drip rails and over support screws. Tighten locknuts to 20-25 lb-in. (2-3 N•m).
3. Tighten support screws on clamps.

Roof Rack Floor Piece Replacement

Removal

1. Remove four end caps on floor piece.
2. Remove four locknuts, washers, bolts, washers, and floor piece from crossbars and rack ends (Figure 13-54).

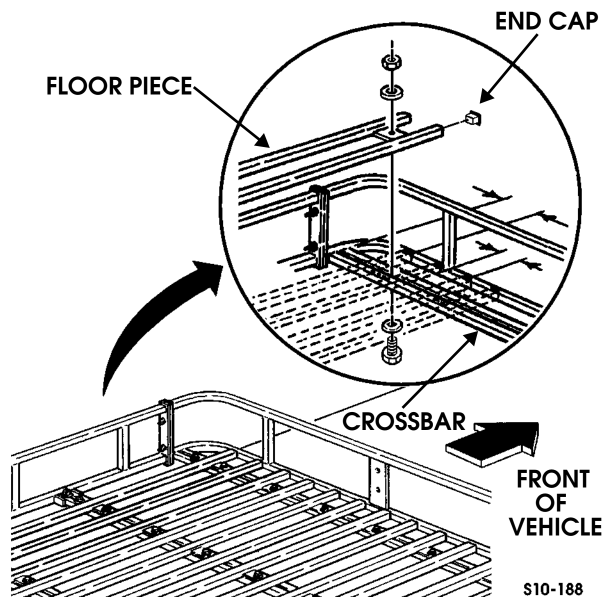


Figure 13-54: Roof Rack Floor Piece

Installation

NOTE: Floor pieces should be positioned 5 inches (13 cm) from the ends and 3 inches (8 cm) apart.

1. Install floor piece on crossbars and rack ends with four washers, bolts, washers, and locknuts. Tighten locknuts to 25 lb-ft (34 N•m) (Figure 13-54).

NOTE: Apply a small amount of adhesive to the inside periphery of each end cap before installing it on the floor piece.

2. Install four end caps on floor piece.

Roof Rack Crossbar Replacement

Removal

1. Remove roof rack from vehicle.
2. Remove ten floor pieces from roof rack.
3. Remove four locknuts, washers, bolts, washers, and crossbar from sides (Figure 13-55).

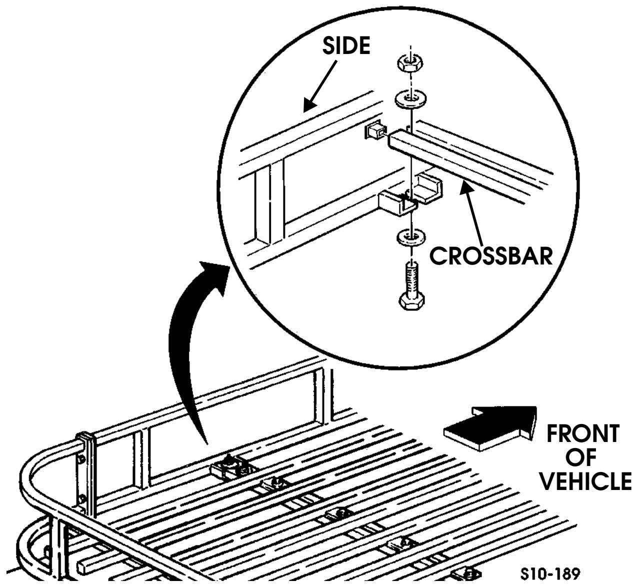


Figure 13-55: Roof Rack Crossbar

Installation

1. Install crossbar on sides with four washers, bolts, washers, and locknuts. Tighten locknuts to 25 lb-ft (34 N•m) (Figure 13-55).
2. Install ten floor pieces on roof rack.
3. Install roof rack onto vehicle.

Roof Rack End Replacement

Removal

Remove four bolts, locknuts, and rack end from sides (Figure 13-56).

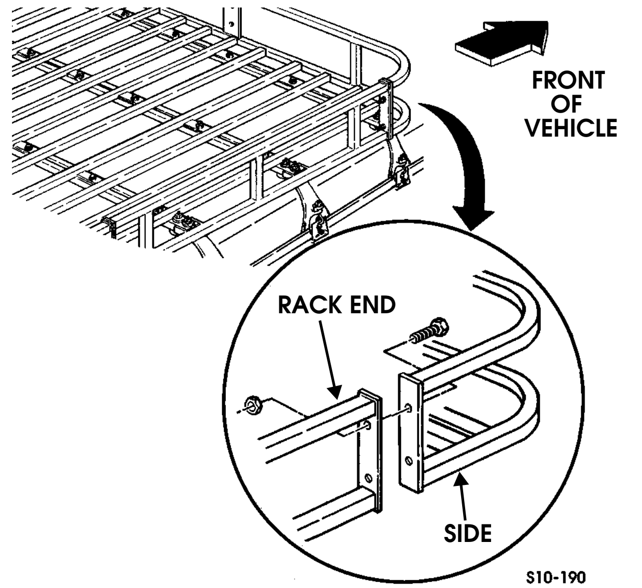


Figure 13-56: Roof Rack End

Installation

Install rack end on sides with four bolts and locknuts. Tighten locknuts to 15 lb-ft (20 N•m) (Figure 13-56).

Roof Rack Clamp Replacement

Removal

1. Loosen support screw on clamp securing clip to clamp (Figure 13-57).
2. Loosen locknut securing clip to drip rail.
3. Remove clip from under drip rail.
4. Remove locknut, washer, capscrew, and clamp from roof rack.

Installation

1. Install clamp on roof rack with capscrew, washer, and locknut.
2. Position clip under drip rail and over support capscrew.
3. Tighten locknut securing clip to drip rail to 20-25 lb-in (2-3 N•m).
4. Tighten support screw on clamp. Tighten locknut installed in step 1 to 25 lb-ft (34 N•m).

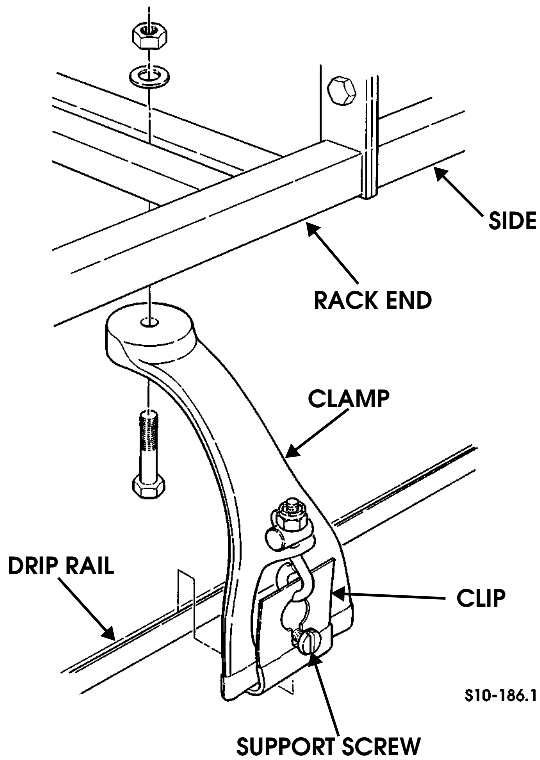


Figure 13-57: Roof Rack Clamp

AUXILIARY AIR HOSE REPLACEMENT

Removal

1. Raise and secure hood.

WARNING: The CTIS air system contains air under high pressure. Always relieve air pressure before loosening or removing air system component(s) by disconnecting quick-disconnect valves. Failure to follow this warning may result in personal injury.

2. Isolate tire by depressing metal tab on quick-disconnect valve body. The valve body will pop out approximately 1/4 in. (6 mm) from shuttle. Perform this procedure on remaining three wheels (Figure 13-58).

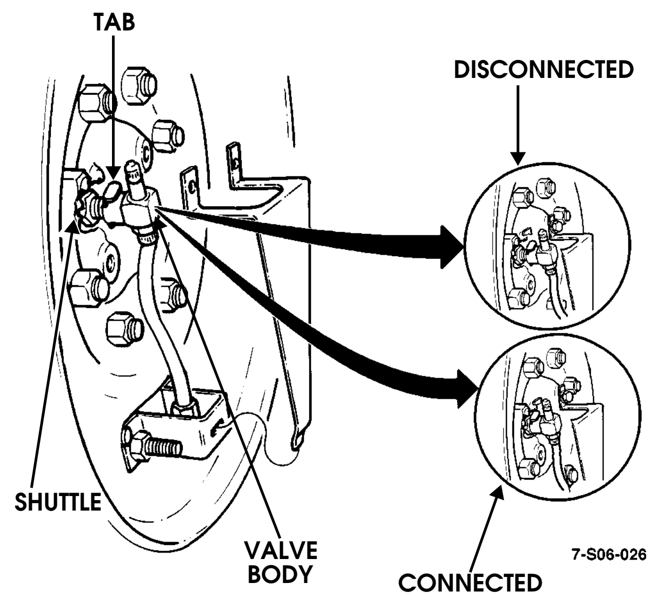


Figure 13-58: CTIS Quick-Disconnect Valve

3. Depress the red plastic retainer toward the connector to remove the hose from the connector (Figure 13-59).
4. Remove connector and auxiliary air valve from tee.

Installation

NOTE: Ensure that any new fittings have pipe sealant pre-applied to threads. If none is present, apply a pipe sealant to fitting threads.

1. Secure connector and auxiliary air valve to existing tee (Figure 13-59).
2. Secure CTIS hose to connector with the plastic retainer.
3. Connect tires to CTIS by pushing in quick-disconnect valve body until valve tee section locks (clicks) into place. Perform this procedure on remaining three wheels (Figure 13-58).
4. Start engine and check CTIS for air leaks around installed fittings.
5. Lower and secure hood.

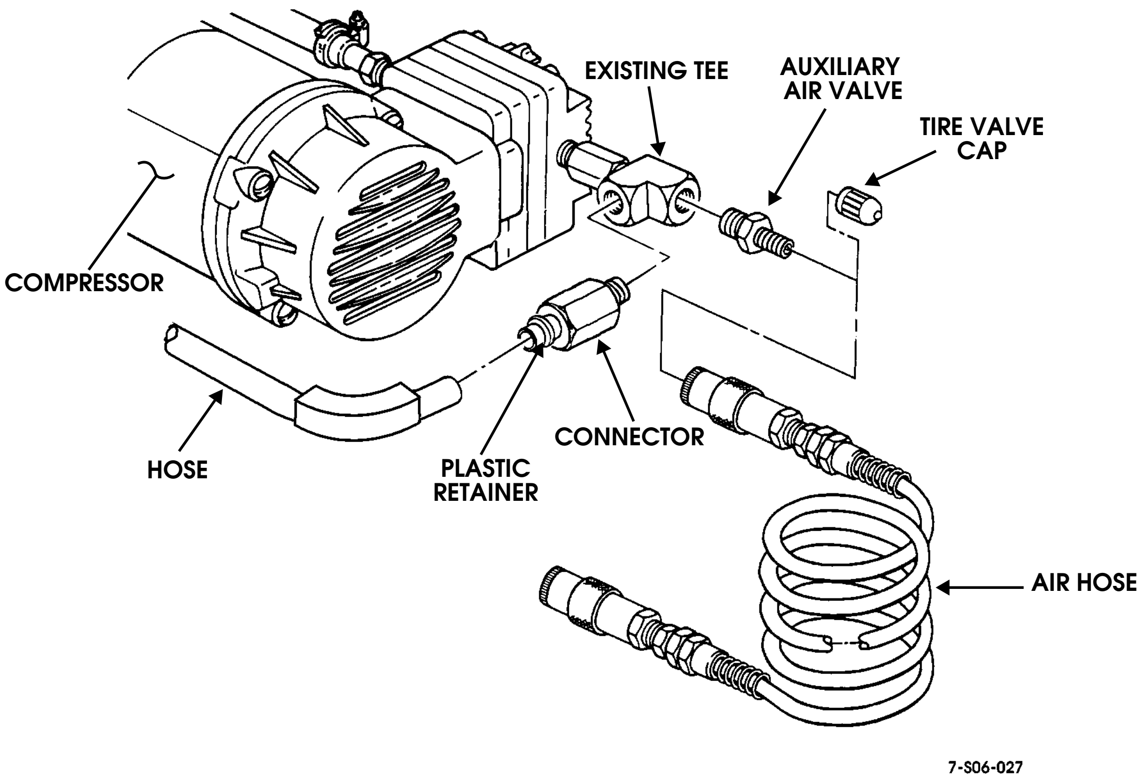


Figure 13-59: CTIS Auxiliary Air Hose

CRUISE CONTROL SYSTEM

General

HUMMERS may be equipped with an optional electronic cruise control system. Aside from using the same turn signal lever assembly (Figure 13-60), turbo and non-turbo cruise control systems are substantially different.

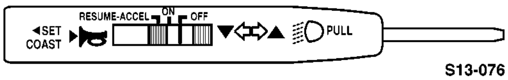


Figure 13-60: Turn Signal Lever With Cruise Control (All Vehicles)

The turn signal lever assembly (Figure 13-60) contains the switches that initiate cruise control functions. They are as follows:

ON/OFF Switch

The "ON" and "OFF" position slide switch, located on the turn signal lever assembly, controls electrical power to the cruise control system. When the switch is "OFF" the system cannot be engaged. When the switch is "ON" the system may be engaged by either the "SET" or "RESUME" switch at any speed above approximately 25 mph (40 km/h).

SET/COAST Button

The "SET/COAST" button controls three functions.

- **The Set Function**—When the "SET/COAST" switch is depressed and then released, with vehicle speed above the low speed limit point, and the "ON/OFF" switch in the "ON" position, cruise speed will be set at the particular speed the vehicle was at when the button was released. Cruise speed will be within ± 1 mph (1.6 km/h) of actual vehicle speed when engaged. The system will cruise until either the "ON/OFF" switch is moved to "OFF," the ignition switch is turned off, and/or the "SET/COAST" button is pushed in fully and held. Pushing the brake pedal disengages the system, but the set speed is retained in memory allowing a "RESUME" at a later time.
- **The Coast (Trim) Function**—When the "SET/COAST" button switch is fully depressed, the driver can raise or lower the control speed. To increase control speed, the driver would accelerate to a new speed and fully depress the switch. The PCM releases the previously set speed. Then release the button. Upon releasing the button, a new speed is set. An increased control speed can also be more easily set by the "RESUME/ACCEL" switch as described later. To decrease the cruise speed, the "SET/COAST" switch is held in (depressed position) to disengage the cruise system, and allowing the throttle to return to the idle position. When the vehicle has slowed to the desired lower cruise system, releasing the switch will cause the system to cruise at the new speed.
- **The "Tap Down" Function**—For this function to operate, the cruise must be engaged and operating. "Tapping down" means quickly pressing the "SET/COAST" button to the depressed button and quickly releasing it, or "tapping" the button. Do not hold the button in the depressed position or the system will revert to the "coast" mode. "Tap down" is a function in which cruise speed can be decreased by 1 mph (1.6 km/h) increments (one tap=1 mph (1.6 km/h) decrease). The system can "tap down" to the engage lockout of 25 mph (40 km/h), below this speed, cruise control will not operate.

The accelerator may be depressed at any time to override the cruise system. Release of the accelerator will return will return the vehicle to the previous set cruise speed.

RESUME/ACCEL "R/A" Switch

The RESUME/ACCEL switch controls three functions.

- **The Resume Function**—If the cruise system has been disengaged by depressing the brake pedal, it may be reactivated by momentarily holding the "RESUME/ACCEL" switch. This will cause the vehicle to accelerate to the previously set speed and cruise at that speed. The resume function will not work if the cruise "ON/OFF" switch or the ignition switch has been cycled since the last time cruise was active or the vehicle speed is below the low speed lockout 25 mph (40 km/h).
- **The Accelerate Function**—By sliding the "RESUME/ACCEL" switch and holding it, the vehicle will accelerate until the switch is released. The cruise "ON/OFF" switch must be on and the vehicle speed must be above the low speed lockout 25 mph (40 km/h) for this function to operate.
- **The "Tap Up" Function**—For this function to operate, the cruise must be engaged and operating. "Tapping up" means quickly pressing the slide switch toward the "R/A" position and quickly releasing it, or "tapping" the lever. Do not hold the lever in the "R/A" or the system will revert to the "Accel" mode. "Tap up" is a function in which cruise speed can be increased by 1 mph (1.6 km/h) increments (1 tap=1mph (1.6 km/h) increase). The system cannot "tap up" beyond 125 mph (201 km/h).

Turbo Diesel Cruise Control System

The Turbo Diesel cruise control system is comprised of the following components:

- Powertrain Control Module (PCM)
- Electronic Throttle System/Accelerator Pedal
- Digital Ratio Adapter
- Turn Signal lever Assembly
- Brake Release Switch

The PCM receives commands from the turn signal lever assembly and gets vehicle speed information from the Digital Ratio Adapter. Based on input commands and vehicle speed, the PCM sends information to the electronic throttle system/accelerator pedal to govern vehicle speed.

The Brake Release Switch is an electronic brake switch that contains one normally open and one normally closed switch contact. When the brake pedal is depressed, the two brake switch contacts change the input to the PCM. The PCM will then cancel all cruise control outputs to the electronic accelerator pedal.

The Digital Ratio Adapter, shown in Section 12 of the Service Manual, translates the signal from the Vehicle Speed Sensor to the PCM. The PCM can then properly interpret speed of travel and govern cruise control speed accordingly.

The Electronic Throttle System/Accelerator Pedal, covered in Section 3 of this manual, responds to input from the PCM. The PCM and throttle position then control engine and subsequent vehicle speed by determining proper fuel rate delivery.

Non-Turbo Diesel Cruise Control System

The primary difference in non-turbo systems is the use of a Cruise Control Actuator.

The Cruise Control Actuator is capable of controlling the throttle movement and has the ability to release the throttle to idle rapidly when brakes are applied (Figure 13-61).

Contained within the actuator is the Cruise Control Module. This module collects data and inputs from several areas of the vehicle and sends appropriate commands to the actuator. Modules and actuators are not serviceable. Failure constitutes replacement of the Cruise Control Actuator Assembly.

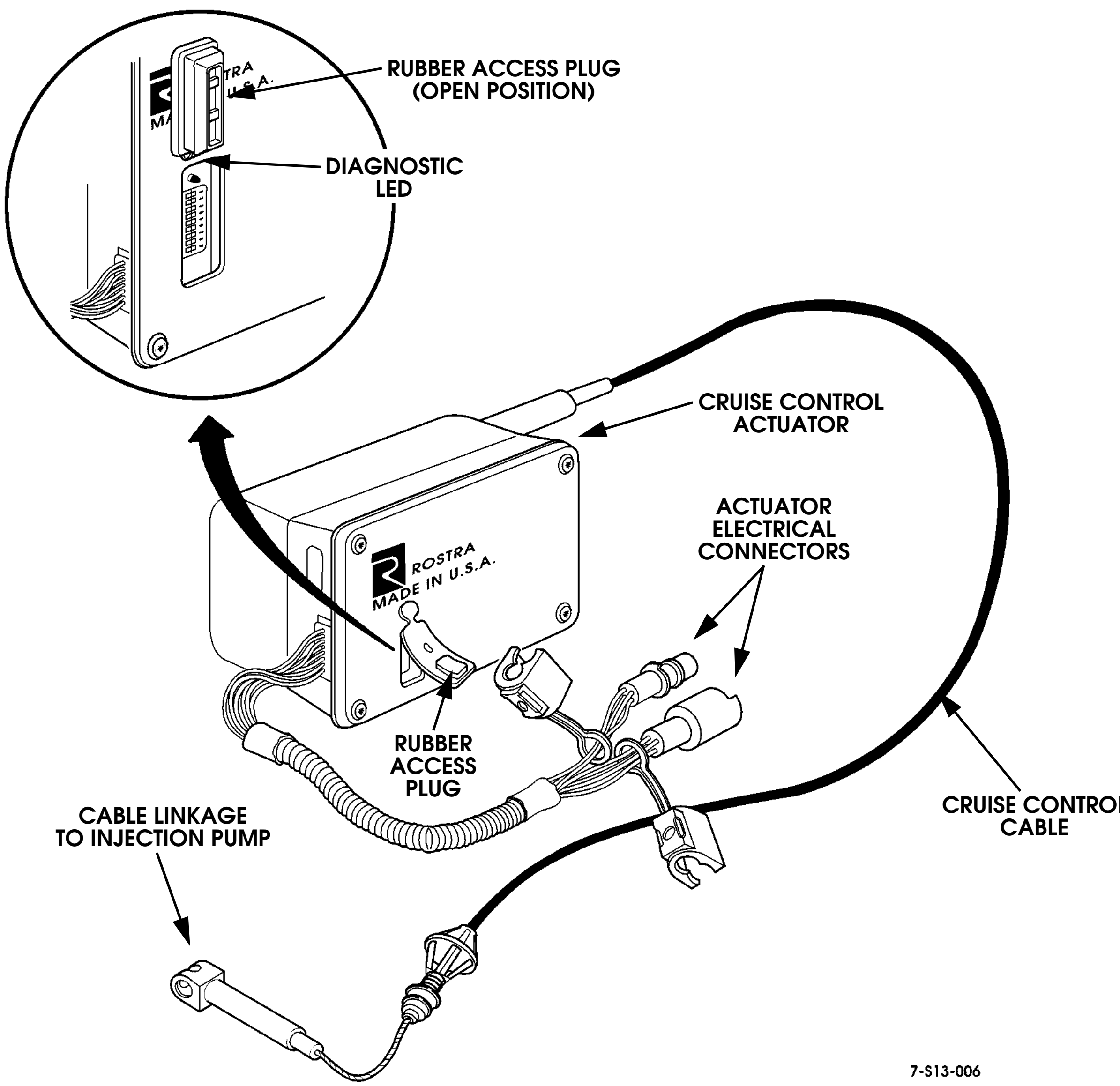


Figure 13-61: Cruise Control Actuator Appearance (NA Diesel)

Diagnosing Problems (NA Diesel)

1. Road test vehicle to determine if cruise is operating and verify complaint. Use the following procedure to check the operating modes of the cruise control system. Always use this procedure after repair work has been completed on the cruise system.
   a. Slide the turn signal lever cruise switch to the “ON” position.
   b. Check the Low Speed Inhibit: Drive the vehicle at 20 mph (32 km/h). Depress “SET” push button and release. Cruise control must not engage.
   c. Check Set Speed: Drive the vehicle at a steady speed of 55 mph (89 km/h). Depress the “SET” push button completely and release. Cruise control should engage at approximately 55 mph (89 km/h).
   d. Check Brake Release: Depress the brake pedal. The cruise control must release the throttle, allowing the vehicle speed to drop. The system must not re-engage when the brake is released.
   e. Check Resume Feature: With the vehicle speed at approximately 45 mph (72 km/h), slide the cruise switch momentarily (less than 1 second) to the “R/A” position. The vehicle should accelerate to approximately 55 mph (89 km/h).
   f. Check Coast Feature: Depress the “SET” push button and hold. Allow the vehicle speed to drop to 50 mph (80 km/h) and release the push button. Cruise control should hold vehicle speed at approximately 50 mph (80 km/h).
   g. Check Accelerate Feature: Slide the cruise switch to the “R/A” position and hold. The vehicle speed should begin to increase. Allow the speed to increase to 55 mph (89 km/h) and release the switch. The cruise control should hold the vehicle at approximately 55 mph (89 km/h).
   h. Check Off Switch: Turn the turn signal lever cruise switch to the “OFF” position. This must disengage the cruise control system.
2. Check Brake Switch Adjustment by performing the following:
   a. Turn key to the on position, but **DO NOT START**.
   b. Pull the four-way hazard light switch located on the bottom left side of the steering column to the on position.
   c. Locate the plastic brake switch positioned above the brake pedal and lightly push the brake switch in until the four-way flasher light arrows begin to flash. (You should hear several clicks during adjustment.)
   d. Move the brake pedal and have an observer check if the stop lamps are actuated in the free-play position. If actuated, move the switch in one additional notch forward into its bracket.
   e. If the switch has been moved in too far, pull the switch back out with a putty knife or anything flat and repeat the above procedure.
   f. Once the brake switch is correctly in position, perform the following static test.
3. Put the cruise control system in diagnostic mode by performing the following:
   a. Turn the cruise switch to off.
   b. Turn the ignition switch to on, step on brake and put the vehicle in overdrive.
   c. Turn the ignition switch to off.
   d. Press and hold the resume/accelerate slide button to the resume/accelerate position while you turn on the ignition switch (without starting the engine).
   e. Now release the resume/accelerate slide button, you are now in the diagnostic mode.

NOTE: A second person will be required for visual observation of the LED during the following procedure.

4. Test the control switch, brake, wiring and digital ratio adapter (speed signal) as follows. Refer to troubleshooting Guide at the end of this procedure when necessary.
   a. The diagnostic LED should be off at this time.
   b. Press and release the Set/Coast key. The LED should light each time the key is pressed and goes out when the key is released. See Item “A” of “Troubleshooting Guide” if problems occur.
   c. Press and release the Resume/Accel key. The LED should light each time the key is pressed and goes out when the key is released. See Item “B” of “Troubleshooting Guide” if problems occur.
   d. Place the vehicle in neutral. The LED should light each time the shift lever is moved from overdrive to neutral. See Item “E” of “Troubleshooting Guide” if problems occur.
   e. Press and release the brake. The LED should light each time the brake is pressed and goes out when the brake is released. See Item “C” of “Troubleshooting Guide” if problems occur.
   f. If all of the previous functions are correct, check the Digital Ratio Adapter (speed signal).
   g. Release parking brake handle. On a level surface, push the vehicle at least two meters forward or reverse and the LED should flash at least one time. See Item “D” of “Troubleshooting Guide” if problems occur.

Troubleshooting Guide

Item “A”

1. Check the steps to enter into diagnostic mode and try again.

2. Check programming switch #7. Switch #7 must be in the "ON" position. If the switch position is incorrect, reposition switch #7 and re-enter diagnostic mode.
3. Check the power and ground to the module if none of the diagnostic commands are functioning.
4. Check the control switch.

Item "B"

1. Check the steps to enter into diagnostic mode and try again.
2. Check the power and ground to the module if none of the diagnostic commands are functioning.
3. Check the control switch.

Item "C"

1. Check the steps to enter into diagnostic mode and try again.
2. Check the power and ground to the module if none of the diagnostic commands are functioning.
3. Check the power to the red wire.
4. Check the brake switch and the wiring to the brake switch.

Item "D"

1. Check the steps to enter into diagnostic mode and try again.
2. Check programming switch #10. Switch #10 must be in the "ON" position.
3. Connection to the signal source (Digital Ratio Adapter) is bad.

Item "E"

1. Check the steps to enter into diagnostic mode and try again.
2. Check the power and ground to the module if none of the diagnostic commands are functioning.
3. Check the power to the red wire.
4. Check the neutral/safety switch and the wiring to it.

NOTE: Anytime a programming switch is set incorrectly and you change the switch setting, you must power down and then re-enter into the diagnostic mode.

Proper Programming Switch Setting on HUMMER Cruise Control (NA Diesel)

Switch	1	2	3	4	5	6	7	8	9	10
"ON"				•			•	•	•	•
"OFF"	•	•	•		•	•				

Programming Switch Functions

Switches	Functions		
SW1	These two dip switches are used for three different gain settings		
SW2	Gain Setting	SW2	SW1
	High Gain	On	On
	Mid Gain	On	Off
	Low Gain	Off	Off
SW3	These two dip switches are used to set the number of pulses per mile		
SW4	Number of Pulses	SW4	SW3
	2000	On	On
	4000	On	Off
	5000	Off	On
	8000	Off	Off
SW5	These two dip switches are used to set the number of cylinders		
SW6	Number of Cylinders	SW6	SW5
	4	Off	On
	6	On	Off
	8	Off	Off
SW7	On: Normally closed control switch Off: Normally open control switch		
SW8	On: High setup timer Off: Low setup timer		
SW9	On: Automatic Transmission Off: Manual transmission (Hummer vehicles are not equipped with manual transmissions)		
SW10	On: Square Wave Digital Ratio Adapter Off: Sign Wave Digital Ratio Adapter (Signal generator)		

5. Perform functional test per following steps:
   a. With transmission in overdrive, set parking brake, and block wheels.
   b. Turn cruise control switch to OFF. Turn ignition to RUN. Do not start.
   c. Depress and hold SET button, and slide cruise switch to ON position.
   d. Release then depress the SET button to activate the actuator unit. The actuator will slowly move the throttle to Wide Open Throttle (WOT).
   e. Verify that throttle is in WOT position when actuator stops movement.
   f. When unit has reached WOT, slide the switch to the RESUME/ACCEL position. The throttle should slowly return to idle position. Release when throttle returns to idle.
   g. Press and hold SET button until WOT is obtained. Step on brake pedal. Throttle should quickly return to idle.
   h. Press SET button again to achieve WOT. Place transmission in P or N. Throttle should return to idle quickly.

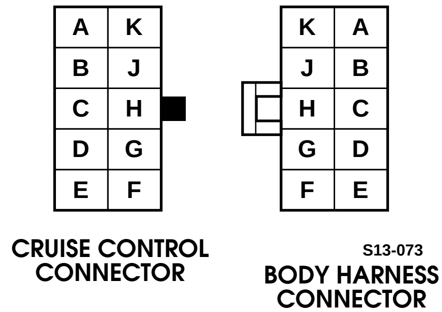


Figure 13-62: Cruise Control Harness

6. Should a unit pass the LED test but fail the functional test procedures, check the actuator module for a disconnected or broken cable. If no mechanical problems found, replace actuator and retest system.
7. Should a unit not pass LED testing, refer to each test and check the designated switch or circuit. See Table 13-1 for more information on the Cruise Control Harness Connector.
8. If the unit passes both tests but does not operate on road, drive vehicle with module LED where it can be seen. The LED should flash with vehicle moving down the road (speed approximately 30 mph.)
9. If no LED flash is noted in step 6, check connections to Digital Ratio Adapter.

Table 13-1 Cruise Control Harness Connector

PIN	Circuit Description	Body Harness Wire Color	Cruise Control Harness Wire Color
A	Brake Switch	DK Green	Violet
B	Brake Switch	DK Blue	Pink/White
C	Blank	Blank	Blank
D	Brake Switch - Cold Side	Red	Pink/White
E	Brake Switch - Hot Side	Orange	Red/White
F	Neutral Switch	White	DK Blue
G	Speed Signal	Gray	Gray
H	Ground	Black	Black
J	Blank	Blank	Blank
K	Ignition +12 Volt DC	Brown	Brown

Cruise Control Actuator and Mounting Bracket Replacement (Non-Turbo Diesel)

Removal

1. Remove two clamps covering the cruise control harness and actuator connectors (Figure 13-64).
2. Disconnect the actuator/cruise control cable electrical connectors from the cruise control harness connectors (Figure 13-63).
3. Remove cable retainer and actuator/cruise control cable from injector tube retainer on engine valve cover (Figure 13-63).
4. Remove retaining clip, accelerator cable and cruise control cable linkage from throttle shaft stud (Figure 13-65).
5. Depress plastic tabs on cable mounting grommet. Pull grommet and actuator/cruise control cable from cruise control bracket (Figure 13-65).
6. Remove two bolts and two lockwashers securing actuator to mounting bracket (Figure 13-66).

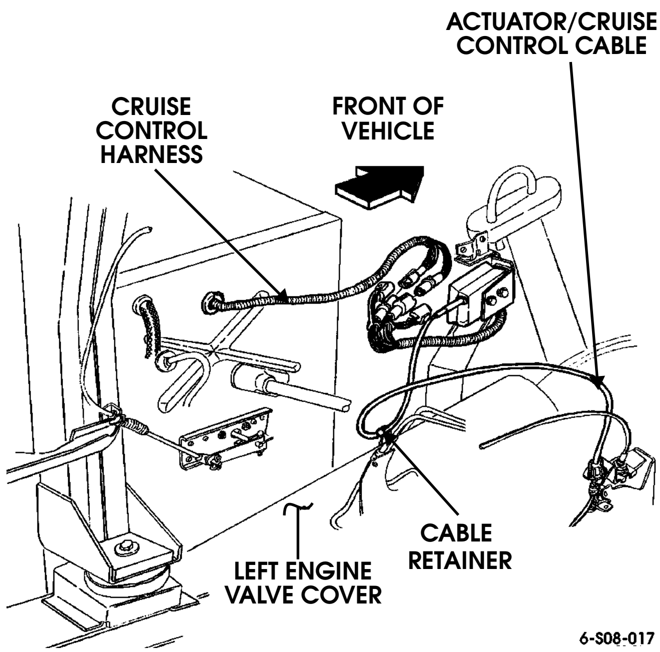


Figure 13-63: Actuator Connectors

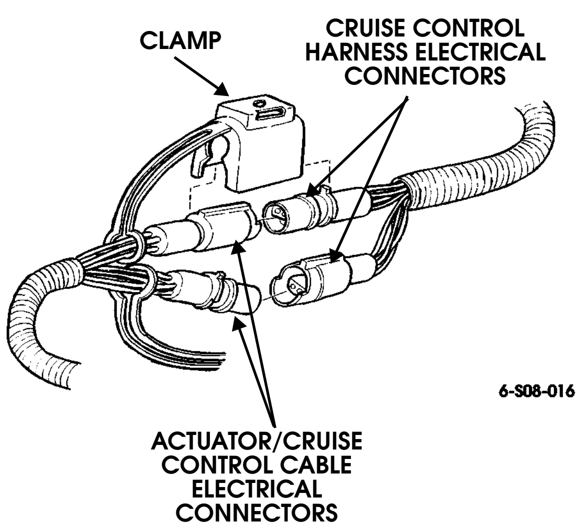
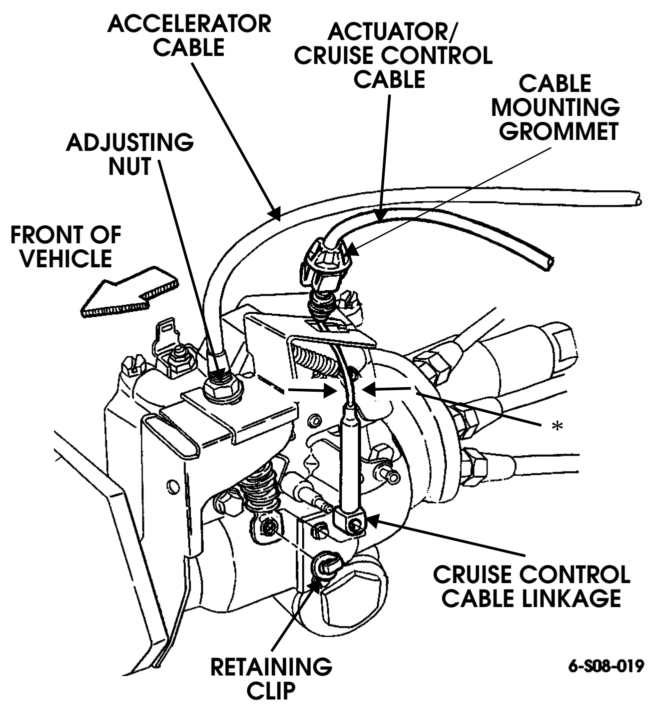


Figure 13-64: Connector Clamps



* Adjust for 1/4 inch horizontal movement in idle position.

Figure 13-65: Actuator Cable and Accelerator Pedal

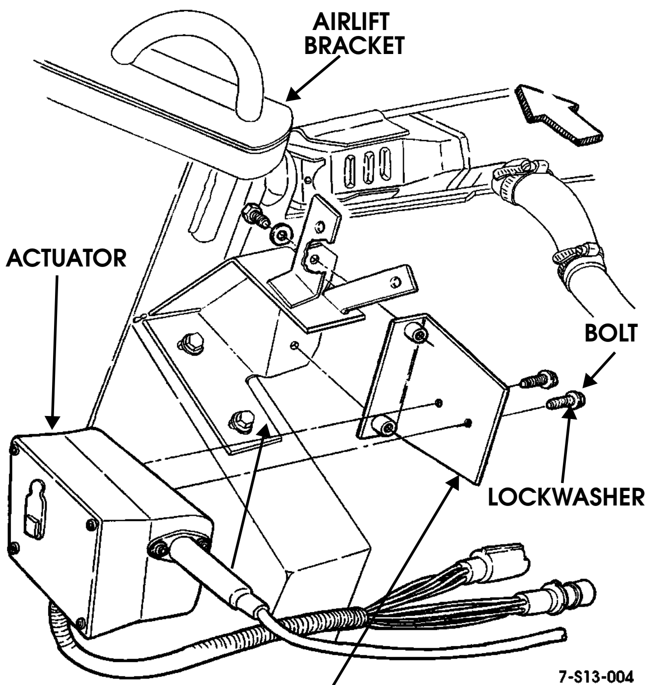


Figure 13-66: Actuator and Mounting Bracket

Installation

1. Install two bolts and two lockwashers, and actuator to actuator and horn mounting bracket (Figure 13-66).
2. Connect two actuator connectors to cruise control harness connectors (Figure 13-63).
3. Cover connectors with two clamps (Figure 13-64).
4. Position cruise control bracket between injection pump bracket and top accelerator cable adjusting nut.
5. Route actuator/cruise control cable to the top of the engine and secure cable to cruise control bracket on injector pump with adjusting nuts (Figure 13-67).
6. Install spacer, cruise control cable linkage, washer, accelerator cable and retaining clip on throttle shaft stud (Figure 13-65).

NOTE: Actuator/Cruise control cable eyelet must face the front of the vehicle.

7. Connect actuator/cruise control cable electrical connectors to cruise control harness connectors.
8. Install cable retainer and actuator/cruise control cable to injector tube retainer on engine valve cover (Figure 13-63).

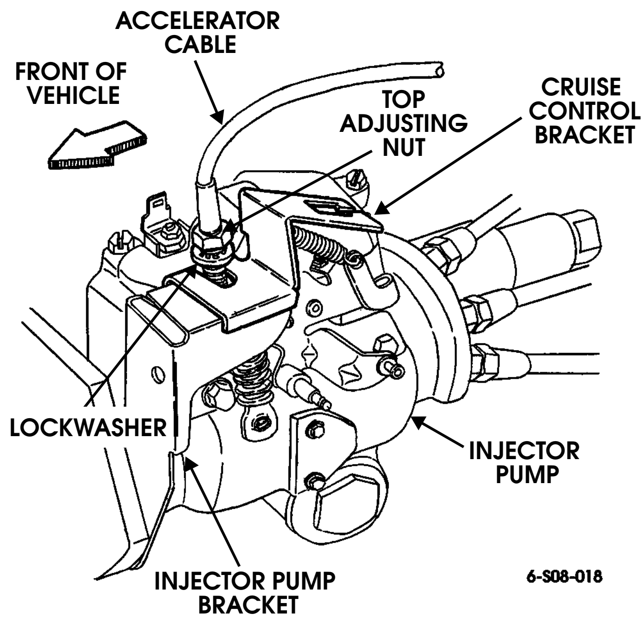


Figure 13-67: Cruise Control Bracket

Adjustment

1. Depress accelerator pedal, and hold throttle shaft lever in full throttle position.
2. Adjust accelerator cable adjusting nuts so cable end holds throttle shaft lever in full throttle position. Tighten adjusting nuts (Figure 13-65).
3. Release accelerator pedal. Ensure throttle shaft lever returns to idle position.
4. Loosen actuator/cruise control cable adjusting nuts and position cable in cruise control bracket with one adjusting nut and lockwasher on either side of bracket (Figure 13-67).
5. Adjust cable in bracket to allow for 1/4 inch of horizontal movement of cable at idle. Tighten adjusting nuts (Figure 13-65).

Cruise Control/Turn Signal Switch Replacement

Removal

1. Remove steering column covers from steering column (Section 8).
2. Disconnect switch connector from cruise control harness connector (Figure 13-68).
3. Pull switch out of steering column.

Installation

1. Install switch in steering column (Figure 13-68).
2. Route switch connector through hole in steering column mounting bracket and connect to cruise control harness connector.
3. Install steering column covers on steering column (Section 8).

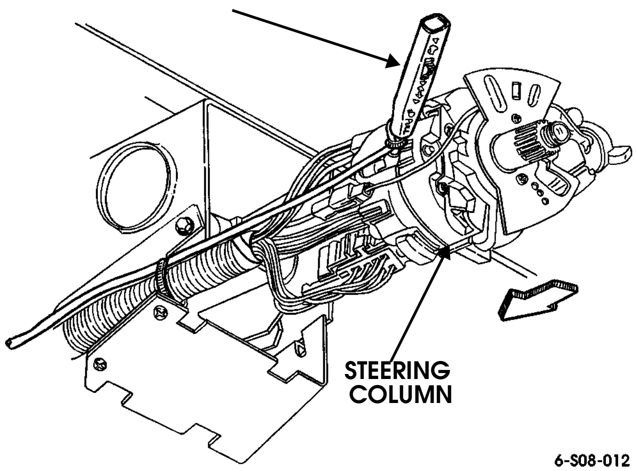


Figure 13-68: Cruise Control/Turn Signal Switch

Cruise Control Harness Replacement

NOTE: Tag leads for installation.

Removal

1. Disconnect two harness connectors from actuator connectors (Figure 13-69).
2. Disconnect harness connector from cruise control/turn signal switch connector.
3. Disconnect harness connector from body wiring harness connector.
4. Remove harness and grommet from body.

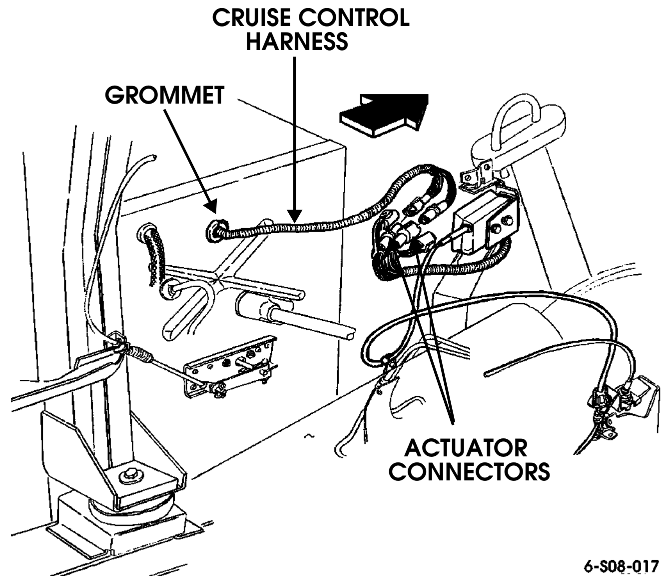


Figure 13-69: Actuator Connectors

Installation

1. Install grommet and harness on body (Figure 13-70).
2. Connect harness connector to body wiring harness connector.
3. Connect harness connector to cruise control/turn signal switch connector.
4. Connect two harness connectors to actuator connectors (Figure 13-69).

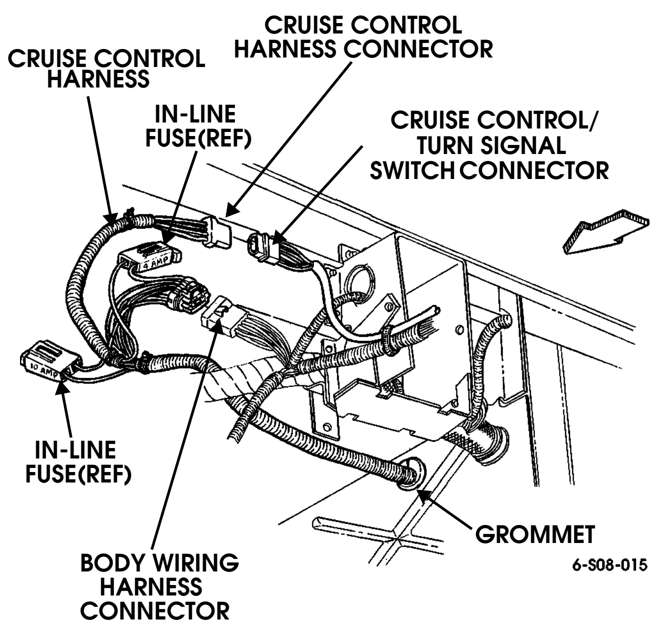


Figure 13-70: Cruise Control Harness

Static Test for Proper Operation of Cruise Control System

This static test should determine that the cruise control system:

- is operating correctly
- is adjusted so that it is capable of near wide open throttle (WOT)
- will disengage when the brake pedal is depressed and when the transmission is shifted to Neutral.

NOTE: This is a static test and is to be performed with the engine not running and with the parking brake applied.

Static Test of Cruise Control System

1. Turn cruise control to OFF using turn signal stalk control and place transmission shift lever to Park position.
2. Turn ignition switch to the ON position, BUT DO NOT START THE ENGINE.
3. Put the transmission in Overdrive (engine is OFF).
4. Press the SET/COAST button on stalk control and hold it in.
5. Turn cruise control to the ON position on the stalk control.
6. Release the SET/COAST button; press it again and hold it in.
7. Throttle should move slowly to WOT (35-40 seconds).
8. Check for WOT.
9. Release SET/COAST button, press and hold the RESUME/ ACCEL button. Observe throttle pedal moving back to idle position.
10. Release RESUME/ ACCEL button when throttle pedal is returned to idle position.
11. Press SET/COAST button and hold until throttle pedal begins moving.
12. Step on brake and note that throttle pedal is returned to idle position.
13. Press SET/COAST button and hold until throttle begins to move.
14. Move transmission shift lever from Overdrive to Neutral and note that throttle pedal is returned to idle position.
15. Turn off cruise control and ignition switch and return shift lever to Park position.

Road Test of Cruise Control System

NOTE: Road test should be performed only when weather conditions permit and all traffic laws are obeyed.

1. Accelerate vehicle speed to 40-50 MPH with transmission in Overdrive.
2. Engage the cruise system by depressing the SET/COAST button and then releasing it (slider switch must be in the ON position). The cruise speed will be the vehicle speed at the time the push button is released.
3. Move the slider to the OFF position. The cruise should become disengaged and vehicle speed should decrease.
4. Repeat steps 1 and 2.
5. Depress the brake pedal. The cruise system should disengage and vehicle speed should decrease.
6. Repeat steps 1 and 2.
7. Move transmission shift lever into neutral position. The cruise system should disengage and vehicle speed should decrease. Cruise control system should not engage when transmission is shifted back into Overdrive.
8. Repeat steps 1 and 2.
9. Depress the accelerator pedal to accelerate vehicle speed then release accelerator pedal. Vehicle speed should return to set cruise speed.
10. Hold in SET/COAST button. Vehicle speed should decrease.
11. Release SET/COAST button. Vehicle speed should set at the time the SET/COAST button is released.
12. Accelerate vehicle to 40-50 MPH by moving and holding the slider to RESUME/ACCEL position. Vehicle should accelerate at a controlled rate. The cruise should set at the time the slider is released.
13. Depress the brake pedal allowing the vehicle speed to drop 5-10 MPH. Move and hold the slider to the RESUME/ ACCEL position for less than 1.5 seconds then release. Vehicle should accelerate at a controlled rate until vehicle speed returned to the last speed stored in memory.
14. With the cruise control engaged and maintaining a speed of 50 MPH, tap and release set button; vehicle speed should decrease 1 MPH. For additional speed reduction, tap and release again for an additional 1 MPH decrease. To increase the speed in 1 MPH increments, move the RESUME/ACCEL switch to the left and release, and repeat for additional speed increases.

NOTE: If you have static tested and road tested the Cruise Control System and the system still isn't operating properly, refer to the diagnostic portion of Section 13 in the Service Manual.

REMOTE ENTRY SYSTEM

Remote Entry Receiver and Harness Assembly Replacement

NOTE: NOTE: This procedure covers the replacement of the remote entry receiver and harness assembly for vehicles equipped with power windows.

Removal

NOTE: NOTE: Tag leads for installation.

1. Remove front console enough to gain access to receiver and harness assembly (Section 10).
2. Disconnect two receiver harness connectors from power windows and locks harness connectors (Figure 13-71).
3. Disconnect receiver harness connector from receiver.
4. Remove receiver from two velcro strips.
5. Disconnect receiver harness connector from body harness connector.
6. Remove all tie straps securing receiver harness to power windows and door locks body harness and body wiring harness, and remove receiver harness. Discard tie straps.

Installation

1. Install receiver harness and connect two receiver harness connectors to power windows and door locks harness connectors (Figure 13-71).
2. Install receiver on two velcro strips.
3. Connect receiver harness connector to receiver.
4. Connect body harness connector to receiver harness connector.
5. Secure receiver harness to power windows and door locks body harness, and body wiring harness with tie straps.
6. Program receiver to accept remotes.
7. Check remote entry system for proper operation.
8. Install front console (Section 10).

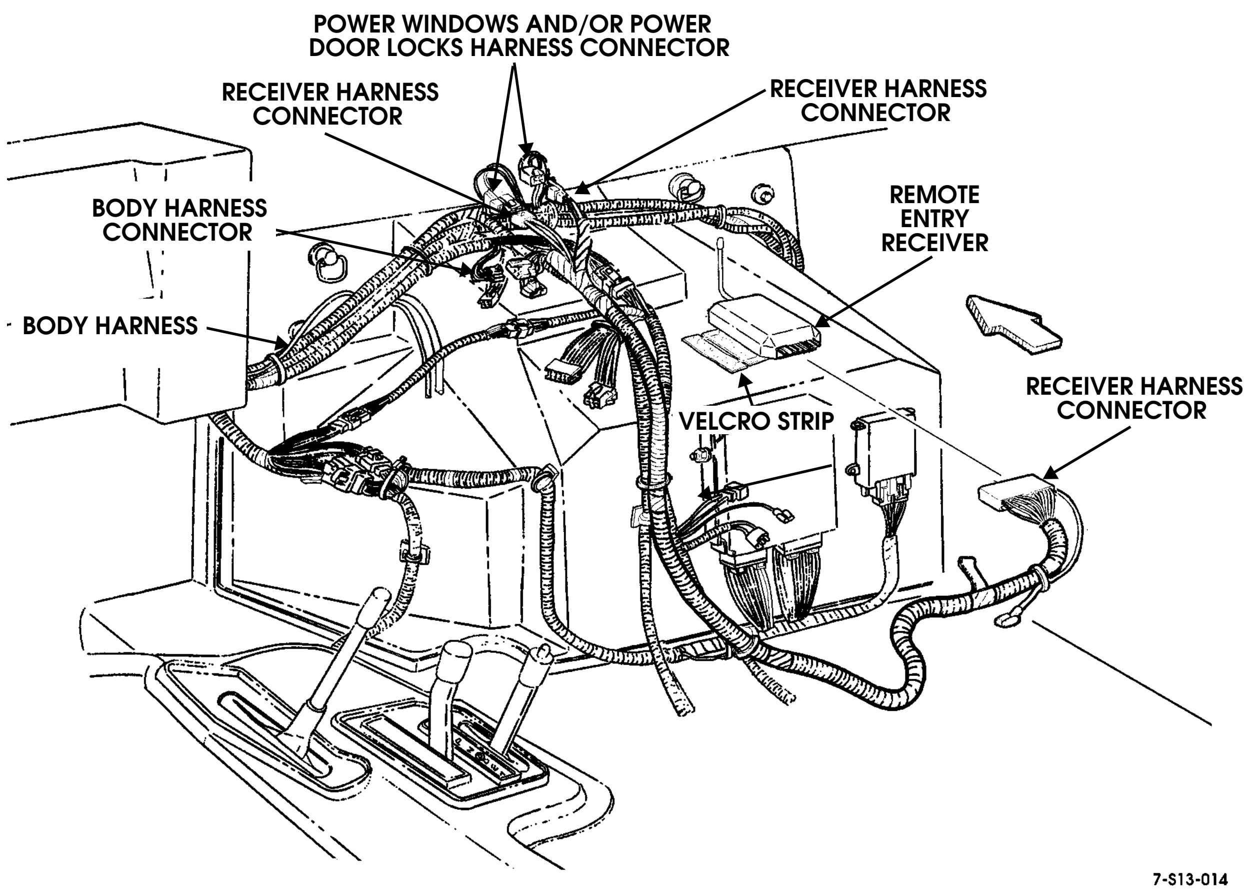


Figure 13-71: Remote Entry Receiver and Harness

REMOTE ENTRY RECEIVER/TRANSMITTER REPLACEMENT

The receiver can be programmed to work with up to four transmitters. To add, replace and/or delete transmitter:

1. Locate the unconnected gray wire with a pink or red connector taped to the remote entry harness connected to the receiver module beneath the console cover.
2. Assemble all the transmitters to be used.
3. Turn on the ignition switch.
4. Ground the pink-red connector four times in succession. The parking lamps will flash four times and the system will reset itself in the program mode.
5. Push the button on any transmitter and the lights will flash once.
6. Repeat this for the remaining transmitters for up to four transmitters. The above must be accomplished within 30 seconds from grounding the gray wire connector or the system will exit the programming mode and the procedure will have to be repeated.
7. Turn the ignition switch off following the above and check each transmitter for correct function.

Power Mirrors Body Harness Replacement

Removal

1. Remove crash pad (Section 10).
2. Remove instrument panel (Section 12).
3. Remove front outer kick panels (Section 10).

NOTE: Tag leads for installation.

4. Disconnect harness switch connector from switch connector on jumper harness (Figure 13-72).
5. Disconnect two power lock leads from harness connector (Figure 13-73).
6. Remove nut and ground lead from ground stud.
7. Disconnect two harness leads from door harness leads (Figure 13-74).
8. Repeat step 7 for opposite side.
9. Remove five tie straps securing harness to power windows and door locks harness and remove harness. Discard tie straps.

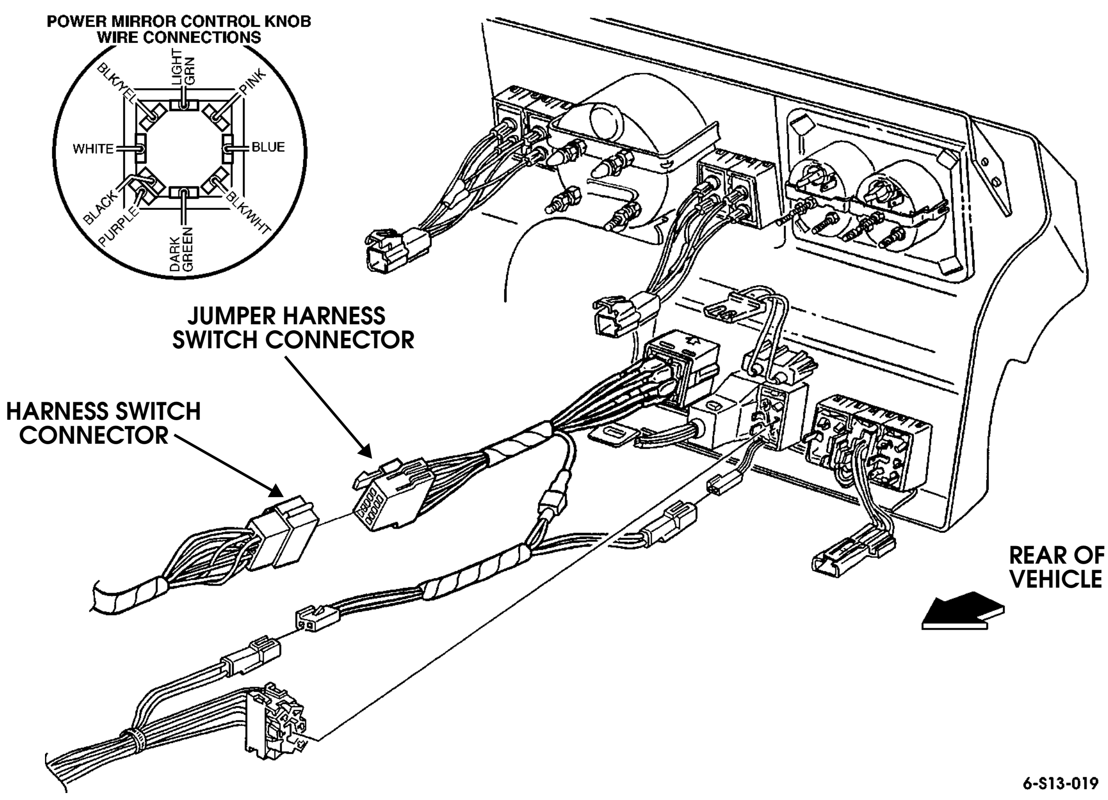


Figure 13-72: Jumper Harness Switch Connector

Installation

1. Route harness along A-pillar (Figure 13-74).
2. Connect two harness leads to door harness leads.
3. Repeat step 2 for opposite side.
4. Secure ground lead to ground stud with nut (Figure 13-73).
5. Connect two power lock leads to harness connector.
6. Connect harness switch connector to switch connector on jumper harness (Figure 13-72).
7. Secure harness to power windows and door locks harness with five tie straps (Figure 13-73).
8. Test mirror operation.
9. Install front outer kick panels (Section 10).
10. Install instrument panel (Section 10).
11. Install crash pad (Section 10).

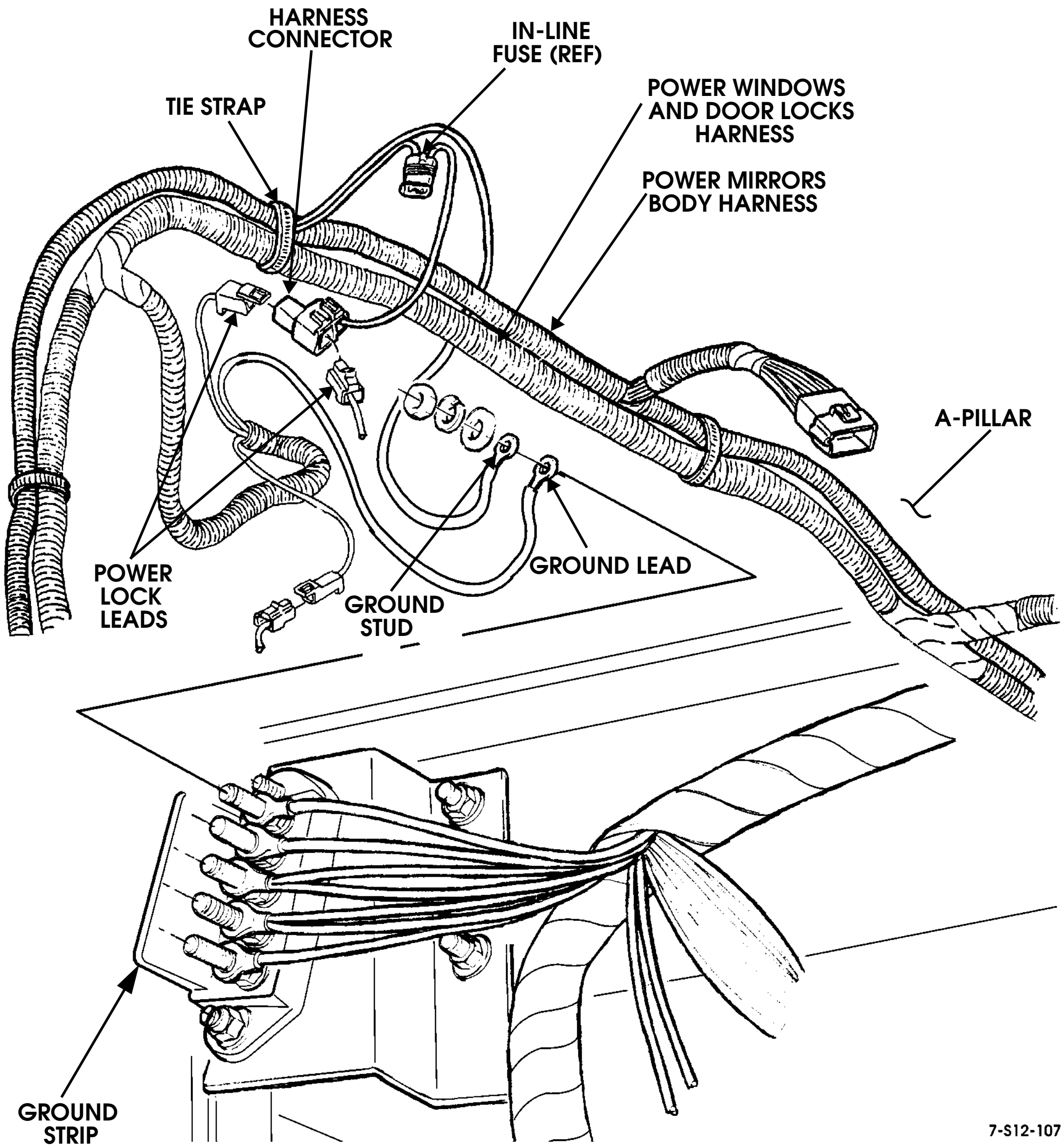


Figure 13-73: Power Mirrors Body Harness

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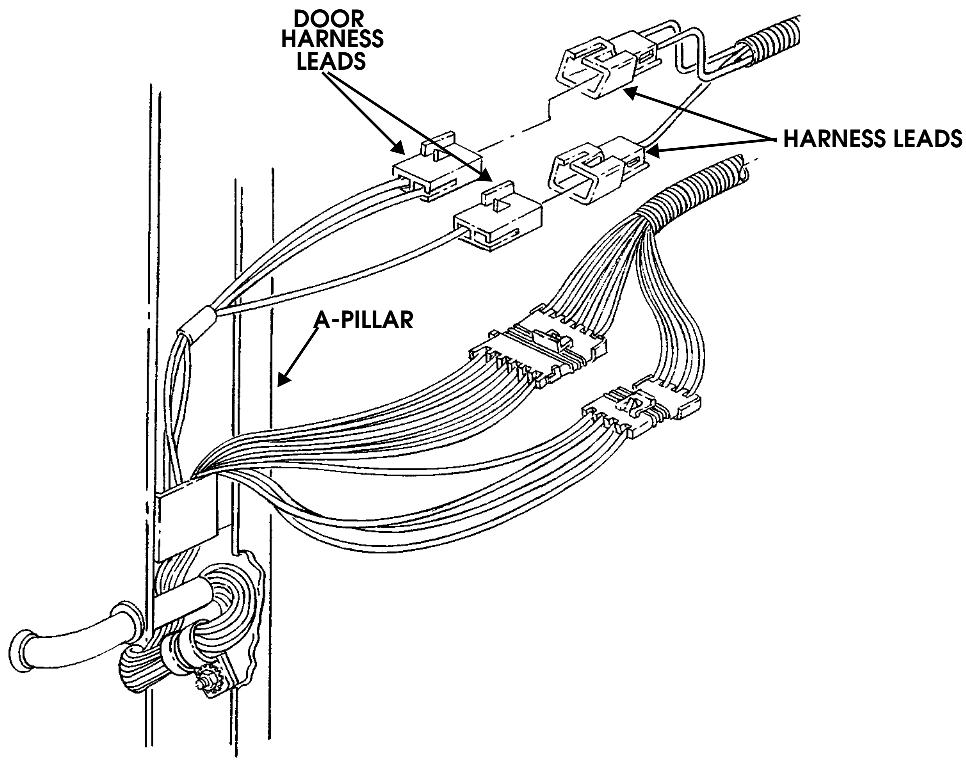

Figure 13-74: Door Harness Leads

Power Mirrors Door Jumper Harness Replacement

Removal

1. Remove power mirror assembly.
2. Remove door trim panel. Peel back portion of vapor barrier to gain access to harness (Section 10).

NOTE: Tag leads for installation.

3. Disconnect two door jumper harness leads from door harness leads (Figure 13-75). Pull door jumper harness through door

Installation

1. Route door jumper harness through door (Figure 13-75).
2. Connect two door jumper harness leads to door harness leads.
3. Install power mirror assembly.
4. Test mirror operation.
5. Secure vapor barrier back into position and install door trim panel (Section 10).

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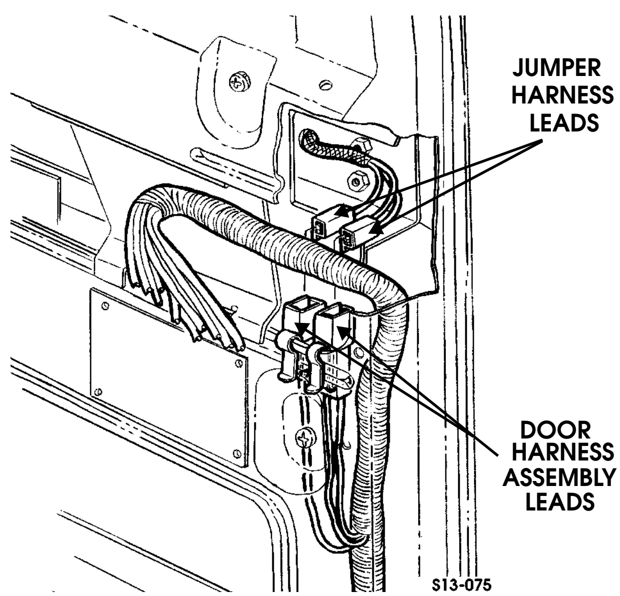

Figure 13-75: Power Mirrors Door Jumper Harness

Power Mirrors Switch Jumper Harness Replacement

Removal

1. Remove instrument panel (Section 12).
2. Disconnect jumper harness connector from connector on power mirrors body harness connector (Figure 13-76).
3. Disconnect jumper harness connector from wiper switch illumination connector on vehicle body harness.
4. Disconnect jumper harness connector from wiper switch illumination connector.
5. Push power mirrors control knob forward and pull jumper harness through square hole in instrument panel

Installation

NOTE: Ensure the top of the power mirrors control knob is positioned upward when installed.

1. Feed jumper harness through square hole in instrument panel until control knob on end of jumper harness snaps into place (Figure 13-76).
2. Connect jumper harness connector to wiper switch illumination connector.
3. Connect jumper harness connector to wiper switch illumination connector on body harness.
4. Connect jumper harness connector on power mirrors body harness connector.
5. Test mirror operation.
6. Install instrument panel (Section 10).

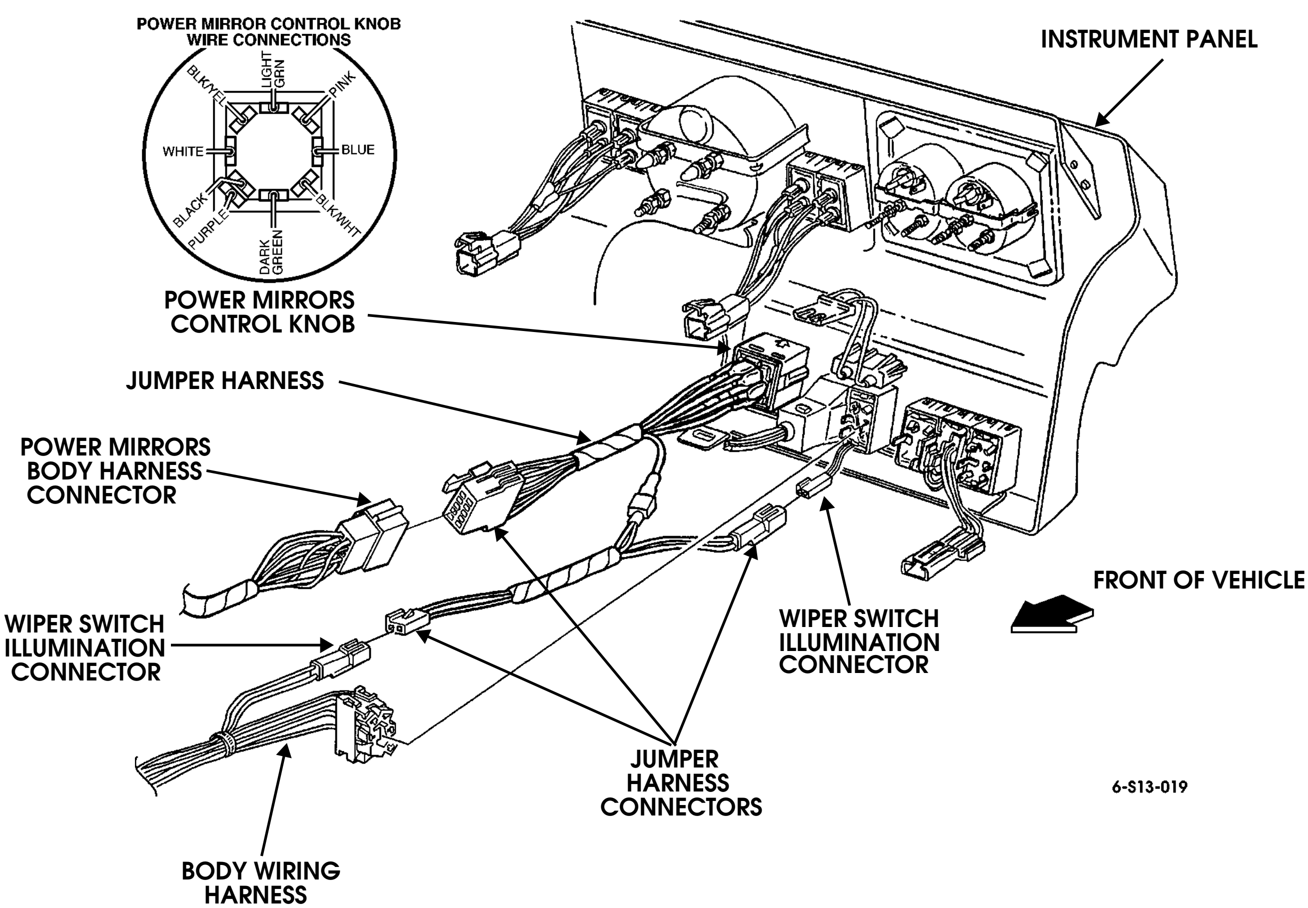

Figure 13-76: Power Mirrors Switch Jumper Harness

REARVIEW MIRROR WITH ELECTRONIC COMPASS

Removal

1. Remove center pillar trim.
2. Disconnect the rearview mirror connector from the roof harness connector (Figure 13-77).

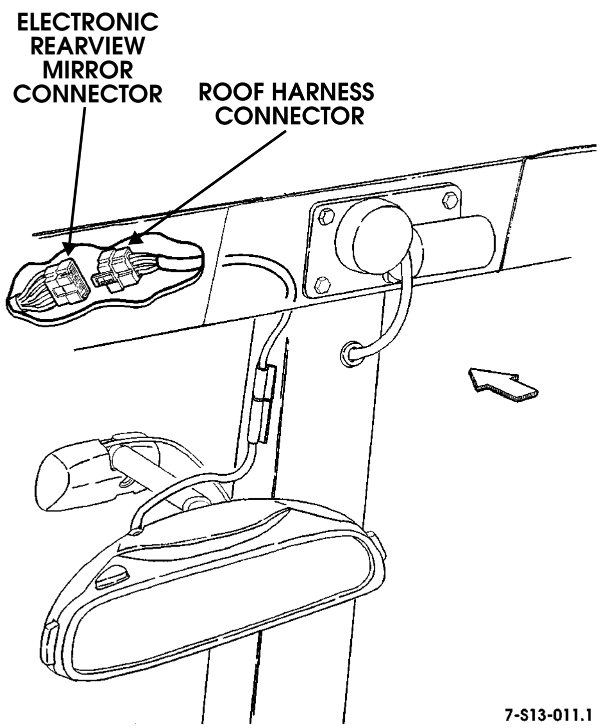

Figure 13-77: Electronic Rearview Mirror Connector

3. Remove one screw and rearview mirror from the windshield bracket (Figure 13-78).

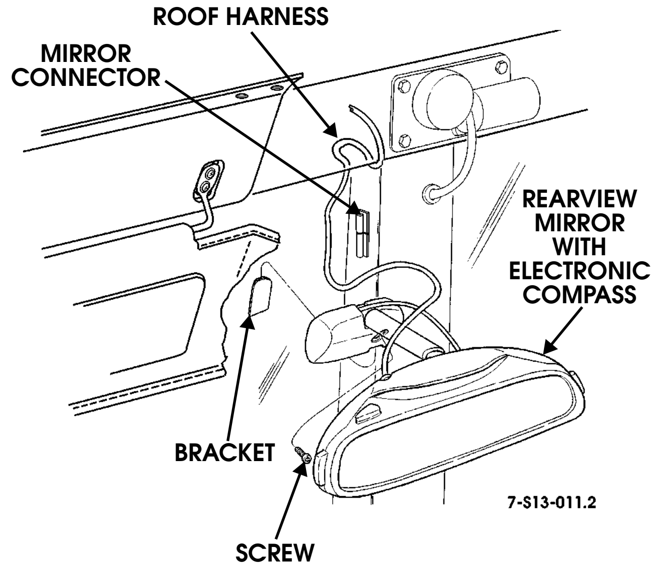

Figure 13-78: Rearview Mirror with Electronic Compass

Installation

1. Secure rearview mirror to windshield bracket with one screw.
2. Connect the rearview mirror harness connector to the roof harness connector.
3. Install center pillar trim.

AMBIENT TEMPERATURE SENSOR

Removal

1. Remove existing nut, cushioned clamp, and ambient temperature sensor jumper harness from the body harness (Figure 13-79).
2. Disconnect the ambient temperature sensor jumper harness from the sensor.
3. Remove self-tapping screw and ambient temperature sensor from the frame.

Installation

1. Install ambient temperature sensor to the frame with self-tapping screw (Figure 13-79).
2. Connect the ambient temperature sensor harness to the sensor.
3. Connect the ambient temperature sensor harness to the body harness.
4. Using cushioned clamp, secure jumper harness to body harness mounting clamp with existing nut and bolt.

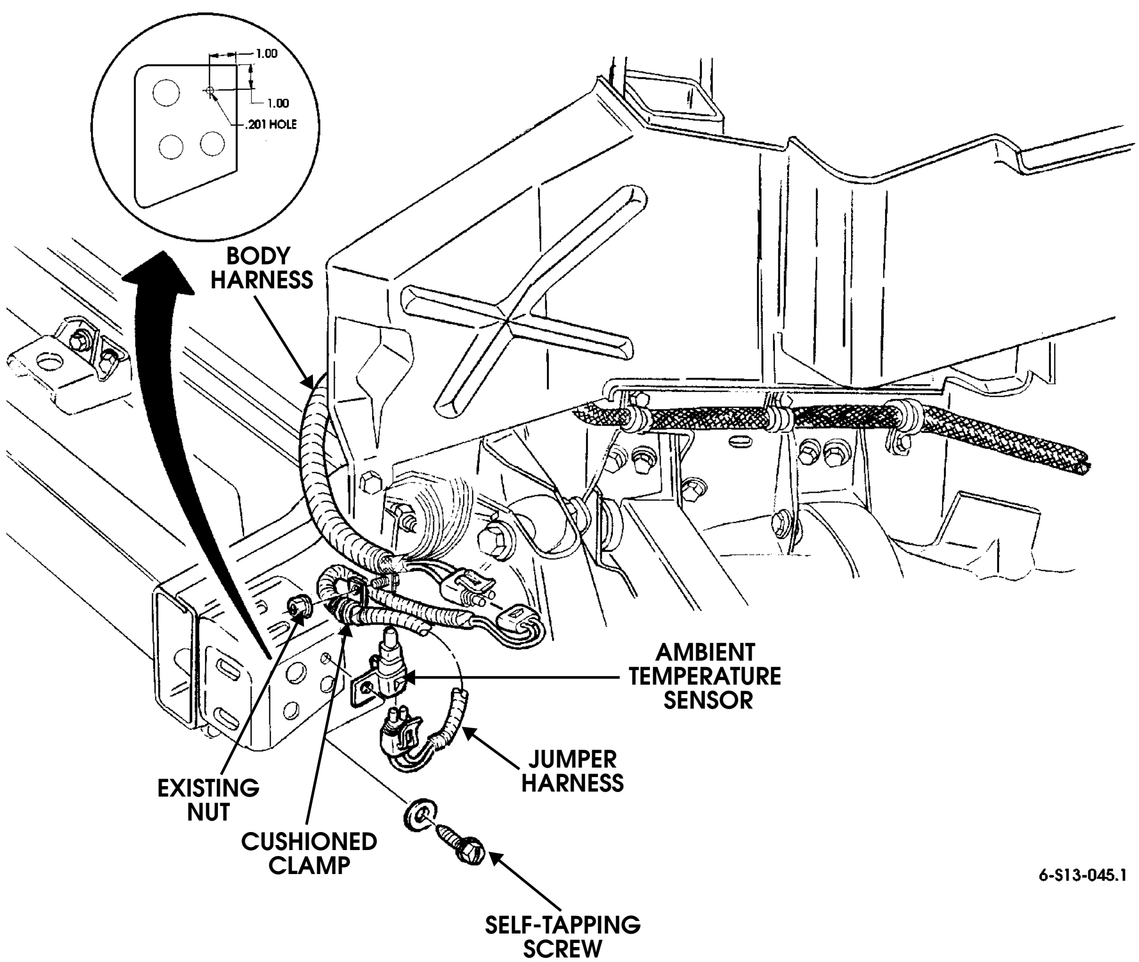

Figure 13-79: Ambient Temperature Sensor

AUXILIARY SEAT

Auxiliary Seat Replacement

Removal

1. Release and remove four locking pins from auxiliary seat frame and auxiliary seat (Figure 13-80).
2. Remove auxiliary seat from auxiliary seat frame.

Installation

1. Install auxiliary seat on auxiliary seat frame.
2. Install and fasten four locking pins to auxiliary seat frame and auxiliary seat. (Locking pins are properly installed when balls near end of pins are visible.)

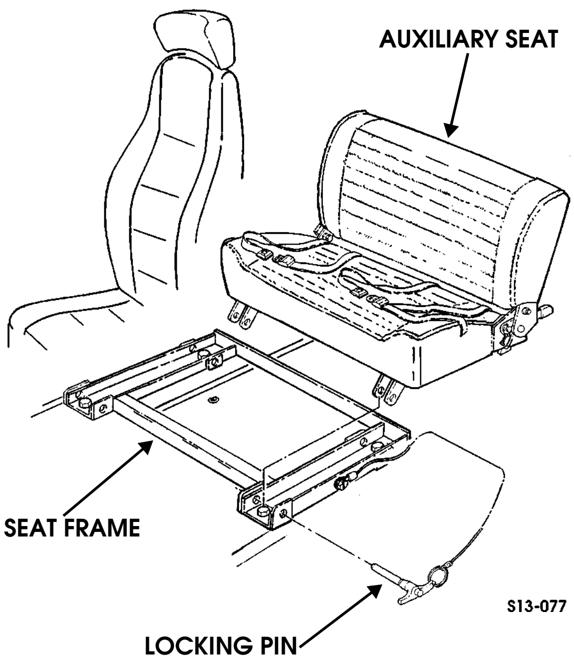

Figure 13-80: Auxiliary Seat

Auxiliary Seat Frame Replacement

Removal

1. Remove auxiliary seat locking pins.
2. Remove auxiliary seat.
3. Remove four bolts, washers, and auxiliary seat frame from tunnel floor (Figure 13-82).

Auxiliary Seat Belt Replacement

Removal

1. Release and tilt forward auxiliary seat.

NOTE: Retain initial seat belt mounting positions during installation.

2. Remove four bolts, washers, and two auxiliary seat belt assemblies from auxiliary seat (Figure 13-81).

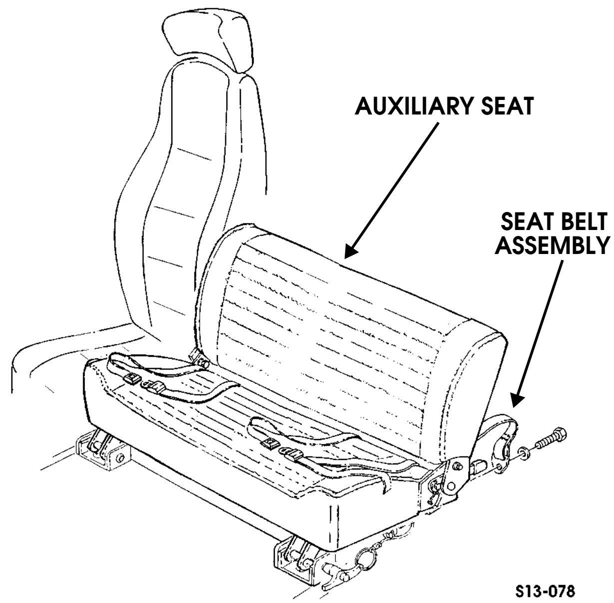

Figure 13-81: Auxiliary Seat Belt

Installation

1. Install two auxiliary seat belt assemblies on auxiliary seat with four washers and bolts (Figure 13-81). Torque to 72-78 ft-lb (98-106 N•m).
2. Tilt and fasten auxiliary seat back to normal position.

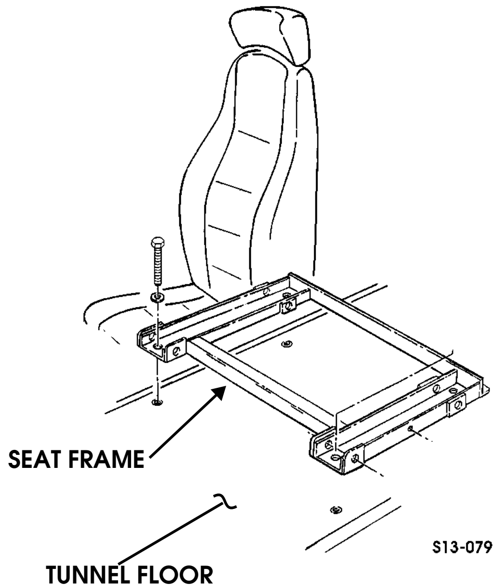

Figure 13-82: Auxiliary Seat Frame

Installation

1. Install auxiliary seat frame on tunnel floor with four washers and bolts (Figure 13-82). Torque bolts to 27-30 lb-ft (36-40 N•m).
2. Install auxiliary seat.
3. Attach auxiliary seat locking pins to seat frame.

Auxiliary Seat Locking Pin Replacement

Removal

NOTE: Left and right side locking pins are replaced the same. This procedure covers the left side only.

1. Remove two screws and locking pin cables from auxiliary seat frame (Figure 13-83).
2. Release and remove two locking pins from auxiliary seat frame and auxiliary seat.

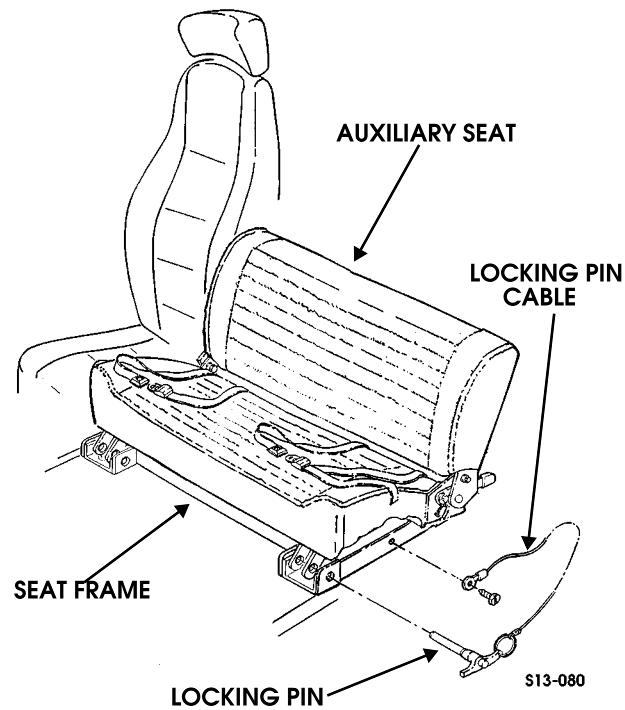

Figure 13-83: Auxiliary Seat Locking Pin

Installation

1. Install and fasten two locking pins on auxiliary seat frame and auxiliary seat (Figure 13-83).
2. Install two locking pin cables on auxiliary seat frame with two screws.

REAR WINDOW DEFROSTER

Rear Window Defroster On/Off Switch

The rear window defroster switch is located on the climate control panel and is not serviced separately. Switch failure results in climate control panel removal and replacement. Refer to Section 11 Heating/Air Conditioning (HVAC) for climate control panel service procedures.

Rear Defrost Harness Replacement

Removal

1. Remove front console (Section 10).
2. Disconnect the rear window defroster connector on the HVAC interior harness from the rear defrost harness (Figure 13-84).
3. Remove the front seats (Section 10).

NOTE: Steps 3 and 4 are for four passenger vehicles.

4. Remove center console (Section 10).
5. Remove rear seats (Section 10).
6. Remove rear wall trim (Section 10).
7. Remove trim from rear window (Section 10).
8. Remove carpeting and floor covering (Section 10).
9. Remove tape securing rear defrost harness to body (Figures 13-84 through 13-88).

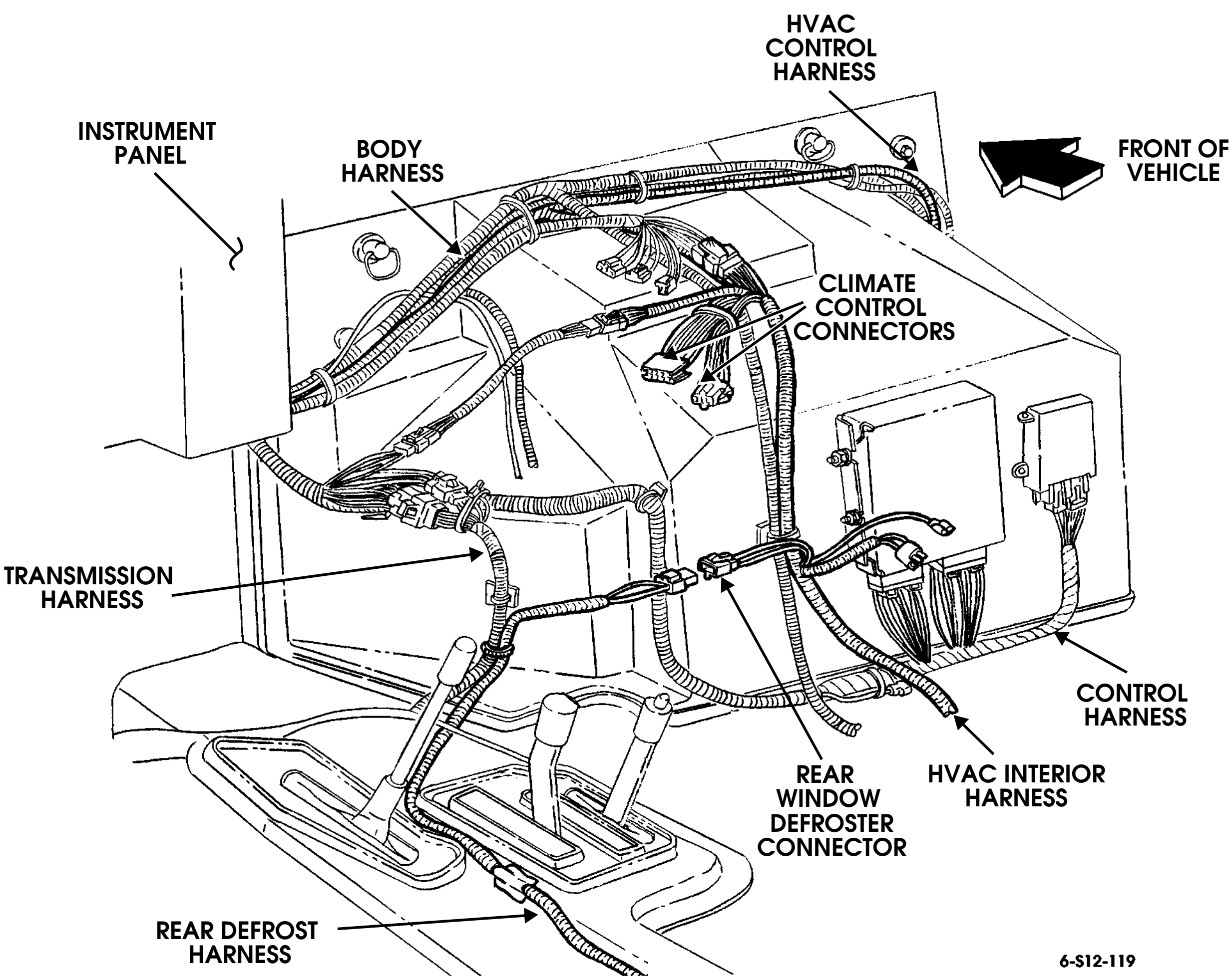

Figure 13-84: HVAC Interior Harness

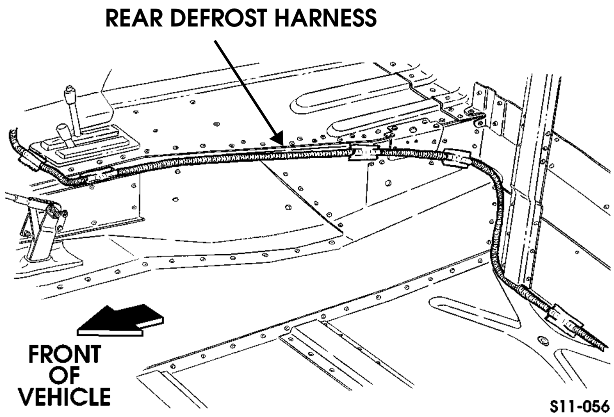

Figure 13-85: Rear Defrost Harness - Two Passenger Vehicle

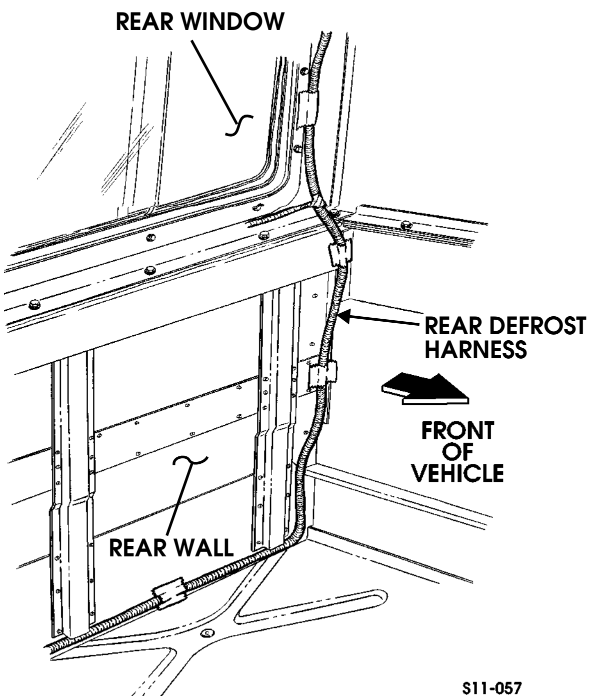

Figure 13-86: Rear Defrost Harness - Two Passenger Vehicle

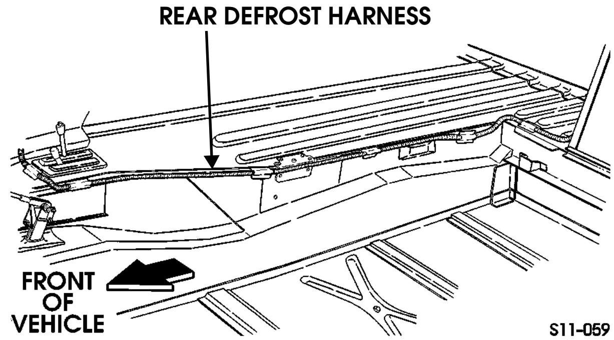

Figure 13-87: Rear Defrost Harness - Four Passenger Vehicle

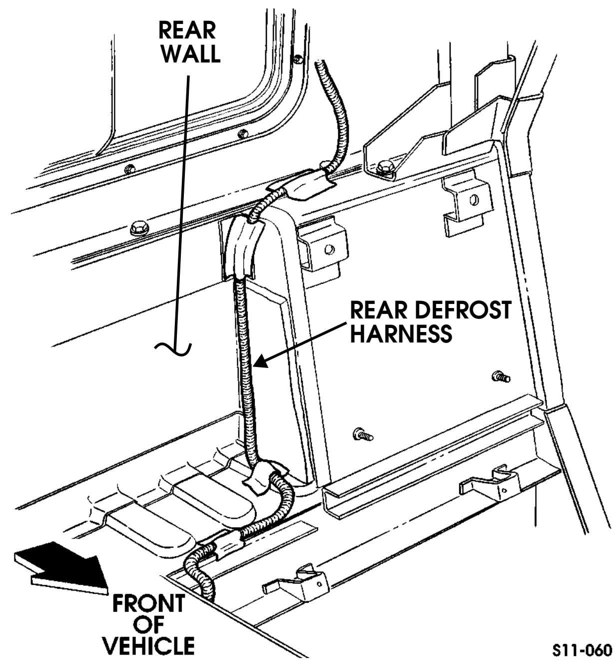

Figure 13-88: Rear Defrost Harness - Four Passenger Vehicle

10. Remove tape securing rear defrost harness around rear window and disconnect two harness connectors from rear window connectors (Figures 13-89 and 13-90).

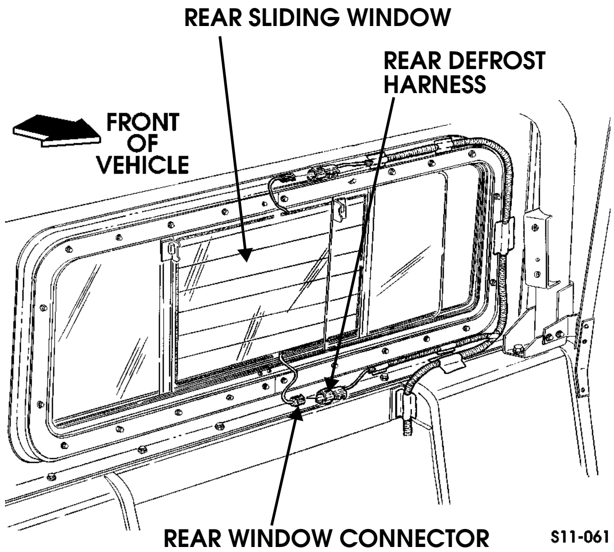

Figure 13-89: Four Passenger Vehicle with Sliding Windows

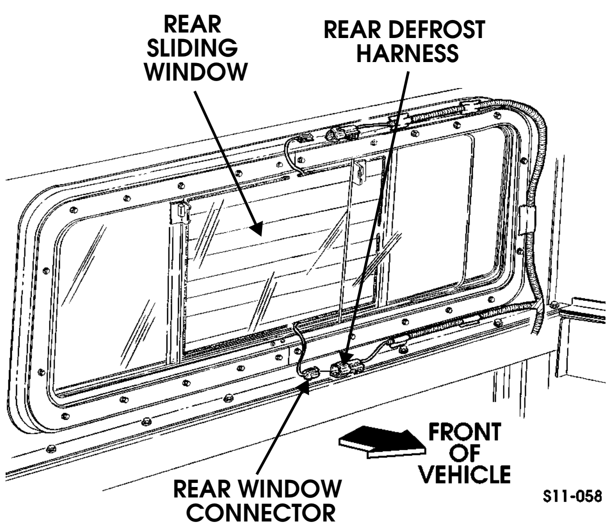

Figure 13-90: Two Passenger Vehicle with Sliding Windows

Installation

1. Tape rear defrost harness around rear window and connect two harness connectors to rear window connectors (Figures 13-89 and 13-90).
2. Secure rear defrost harness with tape to body (Figures 13-85 through 13-88).
3. Install the carpeting and floor covering (Section 10).
4. Install trim on rear window (Section 10).
5. Install trim on rear wall (Section 10).

NOTE: Steps 6 and 7 are for 4-passenger vehicles.

6. Install rear seats (Section 10).
7. Install center console (Section 10).
8. Install front seats (Section 10).
9. Connect the rear window defroster connector on the HVAC interior harness to the rear defrost harness.
10. Install front console (Section 10).

COMPACT DISC (CD) CHANGER REPLACEMENT

Compact Disc Changer

Removal

1. Remove the four screw and washer assemblies securing the compact disc (CD) changer cover to the roof (Figure 13-91).
2. Disconnect the CD changer cable connector from the CD changer.
3. Remove four screws, flatwashers, lockwashers and CD changer and bracket from the roof.

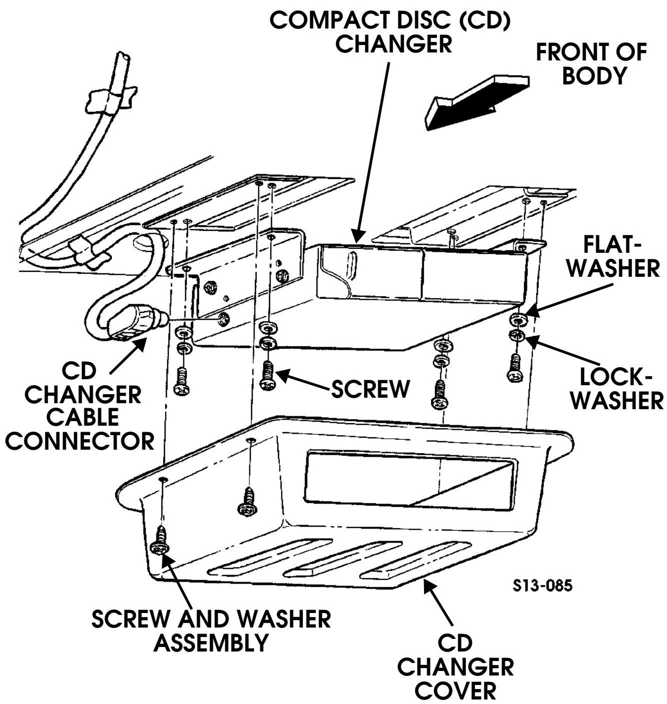

Figure 13-91: CD Changer

Installation

1. Secure CD changer and bracket to roof with four flatwashers, lockwashers, and screws (Figure 13-91).
2. Connect CD changer cable connector to the CD changer.
3. Secure CD changer cover to the roof with four screw and washer assemblies.

Compact Disc (CD) Changer Cable (Standard Four-Door Vehicles)

Removal

1. Remove front console (Section 10).
2. Remove the seats (Section 10).
3. Remove the center console (Section 10).
4. Remove the rear wall trim (Section 10).
5. Remove the carpeting and floor covering (Section 10).
6. Remove the headliner (Section 10).
7. Disconnect the CD changer cable from the CD jack on the back of the stereo receiver (Figure 13-92).
8. Remove the tape securing the CD changer cable to the body (Figure 13-93).

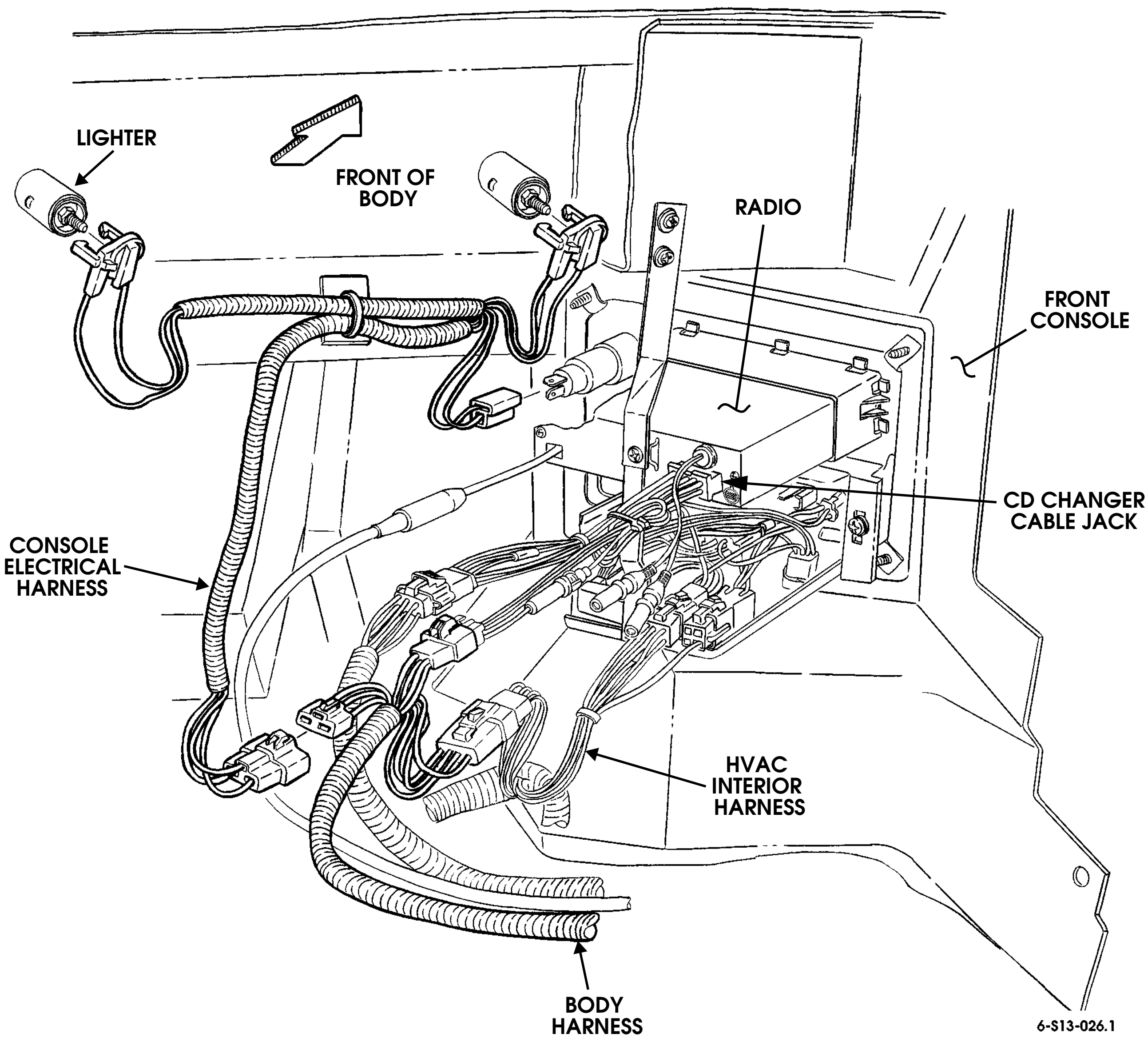

Figure 13-92: CD Jack Location

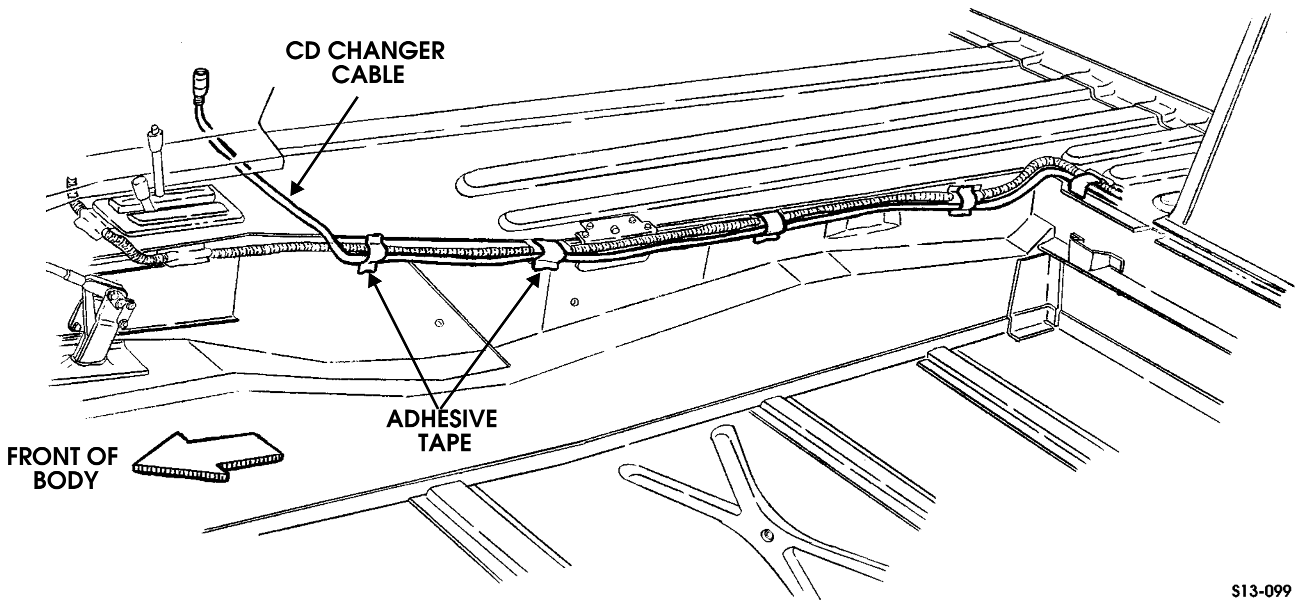

Figure 13-93: CD Changer Cable Routing - Four-Door and Station Wagon Vehicles

9. Remove tape securing the CD changer cable to the rear wall, B-pillar and roof (Figures 13-94 through 13-96).

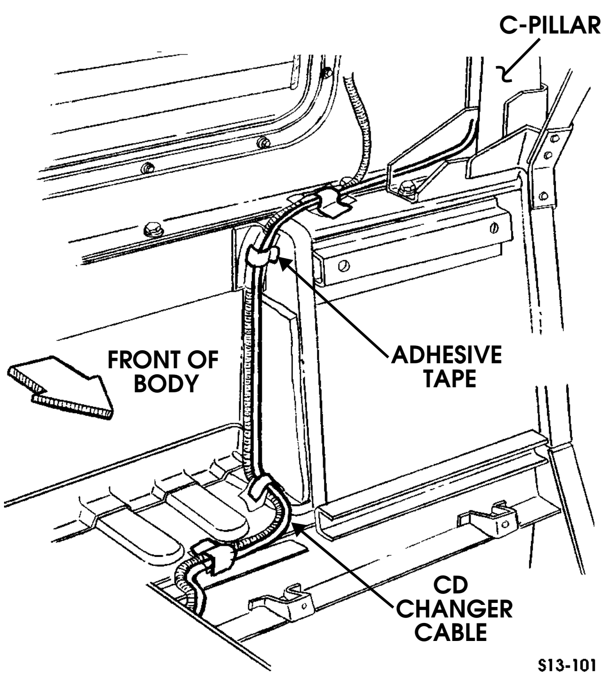

Figure 13-94: Cable Routing Along C-Pillar and Rear Wall - Standard Four-Door Vehicles

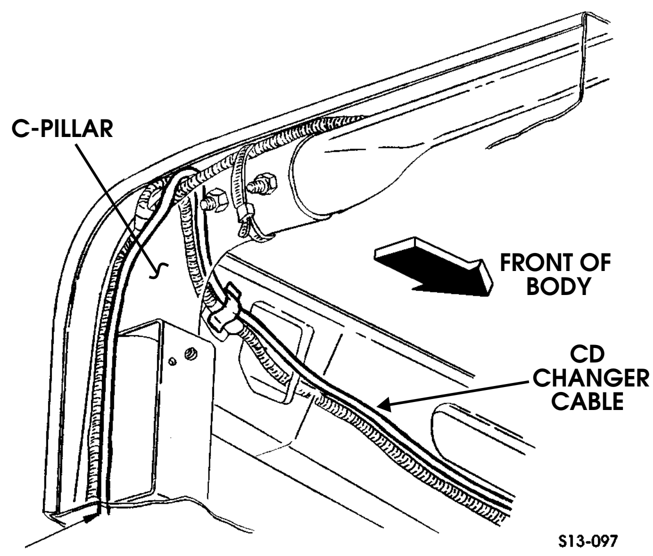

Figure 13-95: Cable Routing Along C-Pillar and Roof - Standard Four-Door Vehicles

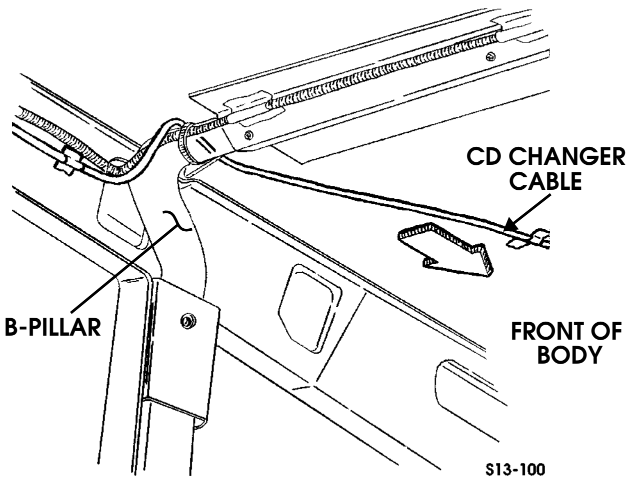

Figure 13-96: Cable Routing Along Roof Standard Four-Door Vehicles

Installation

1. Connect the CD changer cable to the CD jack on the back of the stereo receiver (Figure 13-92).
2. Secure CD changer cable to the body with adhesive tape as shown (Figure 13-93).
3. Secure CD changer cable to roof, B-Pillar, and rear wall with adhesive tape as shown (Figures 13-94 through 13-96).
4. Install compact disc changer to roof.
5. Connect CD changer connector to CD changer.
6. Verify operation of CD changer.
7. Install carpeting and floor covering (Section 10).
8. Install rear wall trim (Section 10).
9. Install the center console (Section 10).
10. Install the seats (Section 10).
11. Install front console (Section 10).
12. Install headliner (Section 10).

Compact Disc (CD) Changer Cable (Four-Door Station Wagon Vehicles)

Removal

1. Remove front console (Section 10).
2. Remove the seats (Section 10).
3. Remove the center console (Section 10).
4. Remove the rear wall trim (Section 10).
5. Remove the carpeting and floor covering (Section 10).
6. Remove the headliner (Section 10).
7. Disconnect the CD changer cable from the CD jack on the back of the stereo receiver (Figure 13-92).
8. Remove the tape securing the CD changer cable to the body (Figure 13-93).
9. Remove tape securing the CD changer cable to the rear wall, C-pillar and roof (Figures 13-94 and 13-95).

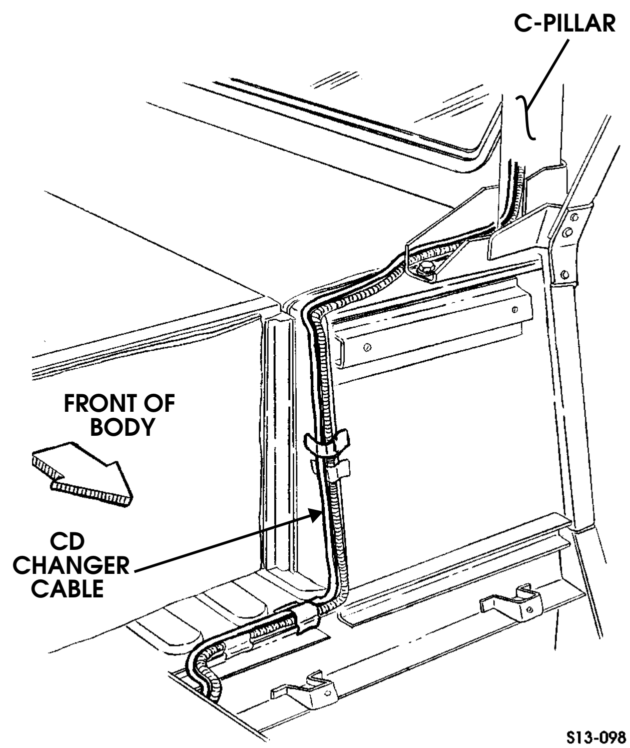

Figure 13-97: Cable Routing Along C-Pillar and Rear Wall - Four-Door Station Wagon Vehicles

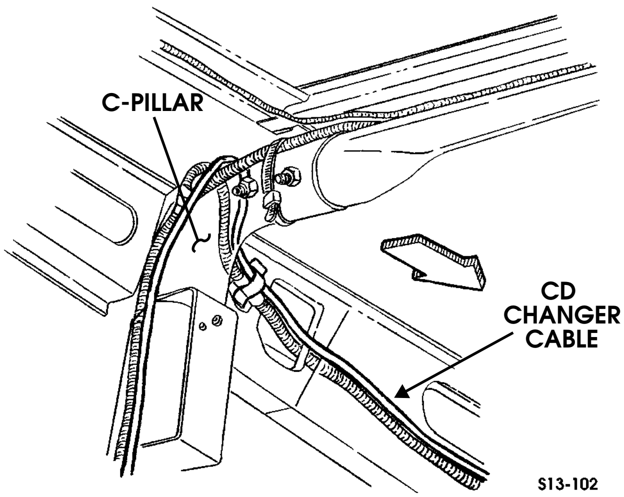

Figure 13-98: Cable Routing Along C-Pillar and Headliner - Four-Door Station Wagon Vehicles

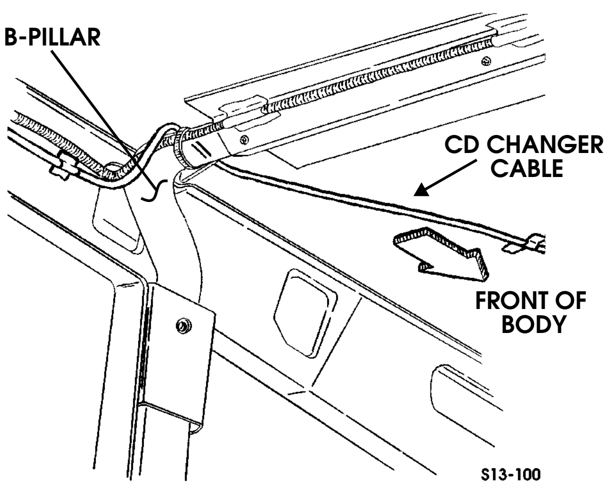

Figure 13-99: Cable Routing Along Roof Four-Door Station Wagon Vehicles

Installation

1. Connect the CD changer cable to the CD jack on the back of the stereo receiver (Figure 13-92).
2. Secure CD changer cable to the body with adhesive tape as shown (Figure 13-93).
3. Secure CD changer cable to roof, B-Pillar, and rear wall with adhesive tape as shown (Figures 13-94 and 13-95).
4. Install compact disc changer to roof.
5. Connect CD changer connector to CD changer.
6. Verify operation of the CD changer.
7. Install headliner (Section 10).
8. Install carpeting and floor covering (Section 10).
9. Install rear wall trim (Section 10).
10. Install the center console (Section 10).
11. Install the seats (Section 10).
12. Install front console (Section 10).

HOURMETER

By tying into the fuel pump relay hot lead, the hourmeter records engine running time. This is especially useful in fleet applications where vehicles experience extensive idling. The electrical connector is wired into the engine harness, ready for hourmeter installation.

Removal

1. Pull tabs on either side of spring clip while simultaneously pulling spring clip away from mounting bracket (Figure 13-100).

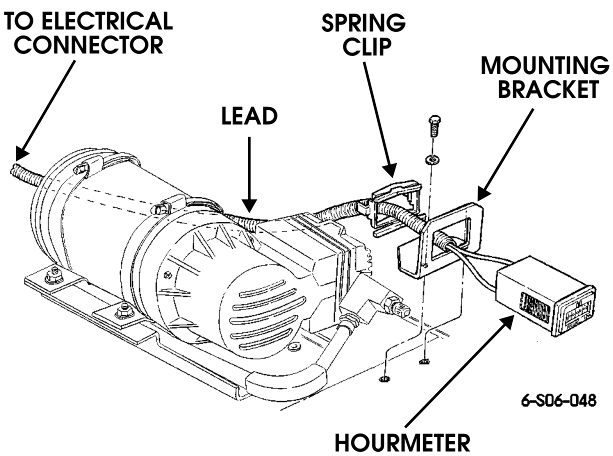

Figure 13-100: Hourmeter Removal

2. Pull hourmeter out of mounting bracket far enough to access mounting bracket bolts.
3. Remove bolts and washers securing mounting bracket to cowl.
4. Follow lead from hourmeter to electrical connectors and unplug connectors (Figure 13-101).

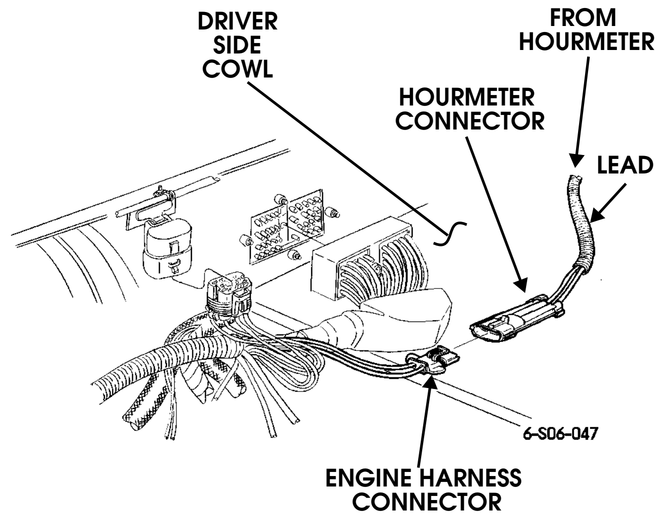

Figure 13-101: Electrical Connector Location

5. Remove hourmeter assembly from vehicle.

Installation

1. Secure mounting bracket to driver side cowl with bolts and washers (Figure 13-100).
2. Push hourmeter into mounting bracket and secure with spring clip.
3. Plug engine harness connector into hourmeter connector (Figure 13-101).
4. Verify that hourmeter records engine running time.

AIR RESTRICTION GAUGE

Removal

1. Disconnect the hose from the air restriction gauge and the hose barb in the air cleaner and remove the hose (Figure 13-102).
2. Remove two screws securing the gauge and bezel to the mounting bracket and remove the gauge and bezel.
3. Remove the hose barb from the air cleaner housing.
4. Using a 1/8” drill bit, drill out two rivets securing the mounting bracket to the A-frame and remove the mounting bracket.

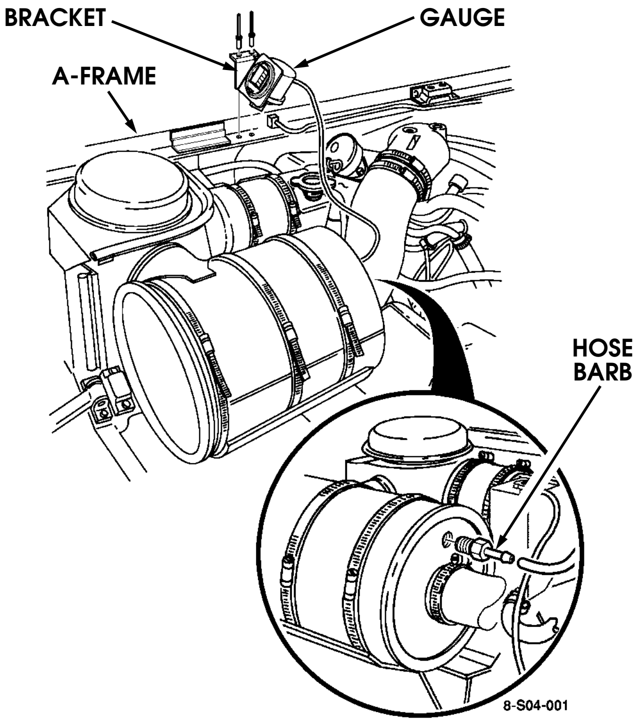

Figure 13-102: Air Filter Restriction Gauge Mounting

Installation

1. Position the mounting bracket on the A-frame and secure with two 1/8” pop rivets.
2. Install the air restriction gauge from the engine side and the bezel from the street side of the bracket and secure with two screws through the bezel into the gauge.
3. Use pipe thread sealant (Loctite 592) and install the brass hose barb in the air cleaner housing.
4. Install the hose from the gauge to the hose barb in the air cleaner housing.

OFF ROAD LIGHT PACKAGE

KC HiLites High Intensity Discharge Lighting System

Removal

1. Disconnect battery ground cables.
2. Remove switch from dash, disconnect spare power and ground wires under dash and pull wires through cowl.
3. Remove relay from mount point above power and ground studs and wire connections on power and ground studs.
4. Loosen battery hold down bracket and slide ballast mounting brackets out.
5. Disconnect the wire connections upstream of each light and remove the ballasts and related wiring.
6. Remove lights from bumper mount brackets.

Installation

1. Begin by mounting your HID lights to the front bumper mount brackets on each side of the vehicle. The lights are labeled "*driver*" and "*passenger*" which will orient the ceramic cover on the bulb downward. Use of the front lower hole in the bumper mount bracket should afford ample clearance to the hood and brush guard (Figure 13-103). Assure the steering stops are adjusted correctly to maintain adequate clearance between the tires and the lights.
   Suspension deflection during off-road driving will affect this clearance. If the steering stops need adjustment, have an authorized Hummer service center perform the operation.

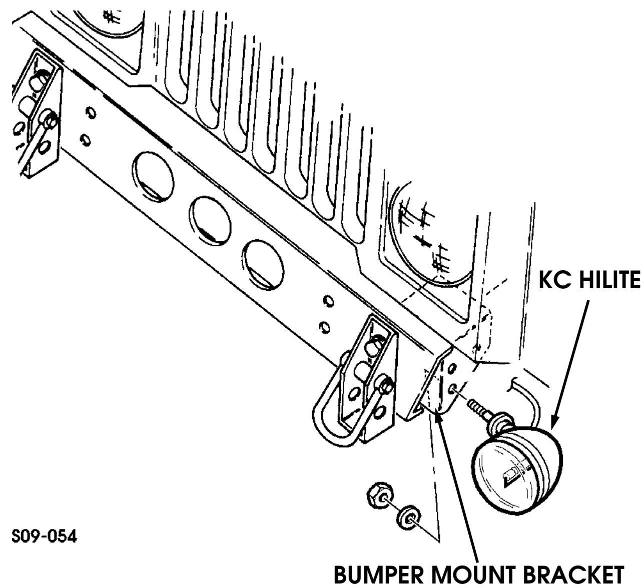

Figure 13-103: Light Mounting Point

2. The ballasts mount above the vehicles batteries. Loosen the battery hold-down hardware, and slide two ballast mounting brackets between the batteries and the battery hold-down on the inboard side and two on the outboard side (Figure 13-104). The ballast marked "passenger" mounts forward of, and close to, the center battery hold-down stud with the long wire lead toward the front of the vehicle. This mounting position is important to maintain good hood to ballast clearance. Secure the ballasts to the brackets with the screws and washers provided. Tighten the battery hold-down hardware.

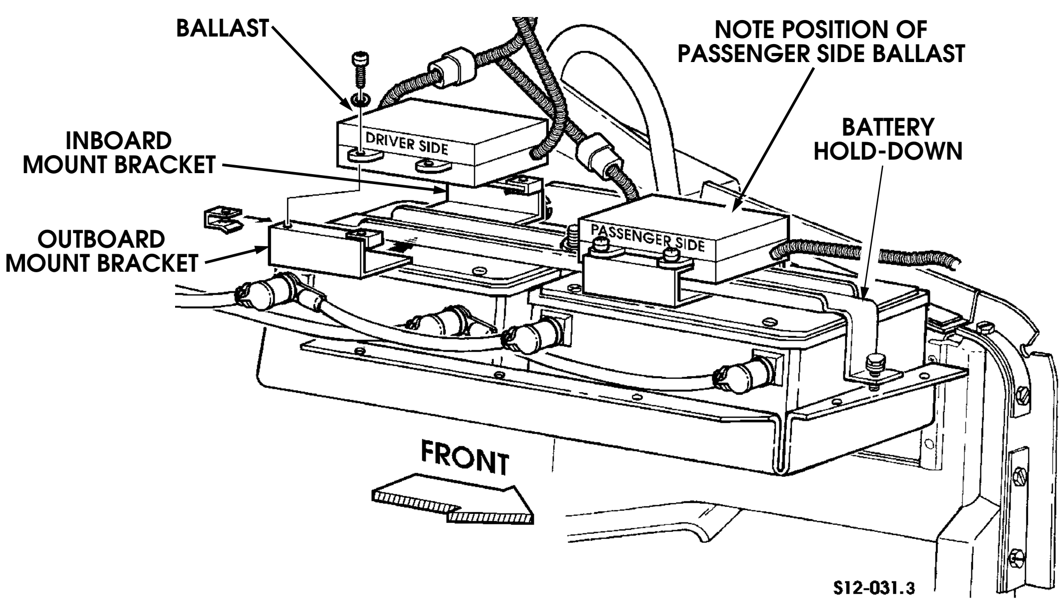

Figure 13-104: Ballast Mounting Point

3. Mount the relay above the power and ground distribution studs on the left cowl (Figure 13-105). Some vehicle models may require securing the relay with wire ties to another component in the mounting point area. Mount the relay with the wires facing down to prevent moisture intrusion into the relay.
4. Mount the switch in the dash or in the panel provided for under dash mounting.
   a. For in dash mounting, a 1/2 inch hole must be drilled and care must be taken not to damage wiring or other components behind the dash. It is easier to connect the wiring to the switch terminals before snapping the switch into its hole.
   b. For panel mounting, select a suitable position under the dash that won’t interfere with the drivers knees. Mark (using panel as template), center punch and drill 5/64” holes for mounting of the panel. Mount the panel to the dash with the screws provided and install the switch.

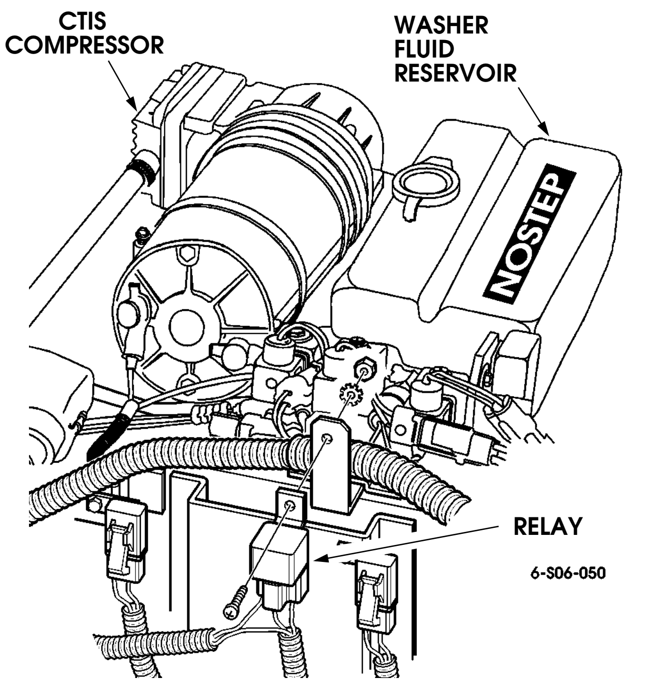

Figure 13-105: Relay Mounting Point, Left Cowl Area

NOTE: On vehicles so equipped, it will be necessary to remove the closeout panel under the left side of the dashboard to make some of the wire connections. Route wiring away from all moving components and excessive heat. Secure harnesses to the vehicle with wire ties.

5. Route the harness from the ballast along the passenger side of the radiators, under the foam hood seal, to the passenger side light. The driver side light harness routes from the ballast across the top of the radiators, under the foam hood seal, and down the driver side of the radiators to the light. The harness connecting the ballasts and the relay should be routed from the ballasts across the top of the radiators, under the foam hood seal, to the relay mount point on the left cowl. From the relay, the power and ground wiring connects just below at the power and ground distribution studs and the blue wire routes through the body harness grommet in the cowl to the switch. The white and black wires connect the switch to the spare power wire and the instrument panel ground point under the dash.
6. The red wire (Figure 13-106) containing a 30 amp in-line fuse, supplies power to the relay on terminal 30 and connects to the power distribution stud (+) on the left cowl. The blue wire connects terminal 86 of the relay to either of the outside terminals on the switch. The red wire connects terminal 87 of the relay to the ballasts. The black wire is the ground for the ballasts and the relay. The black ground wire connects terminal 85 of the relay to the ground distribution stud (-) on the cowl. The center (ground) terminal of the switch connects to the instrument panel ground point under the left side of the dash. The white wire connects the remaining outside terminal of the switch to either of the spare power wires under the dash to the left of the steering column. The yellow spare power wire is tagged “*battery power*” and will allow use of the lights any time the switch is activated. The white spare power wire is tagged “*ignition power*” and will allow use of the lights only when the ignition switch is in the run position. Both of these power circuits are fused in the power distribution center of the Hummer.

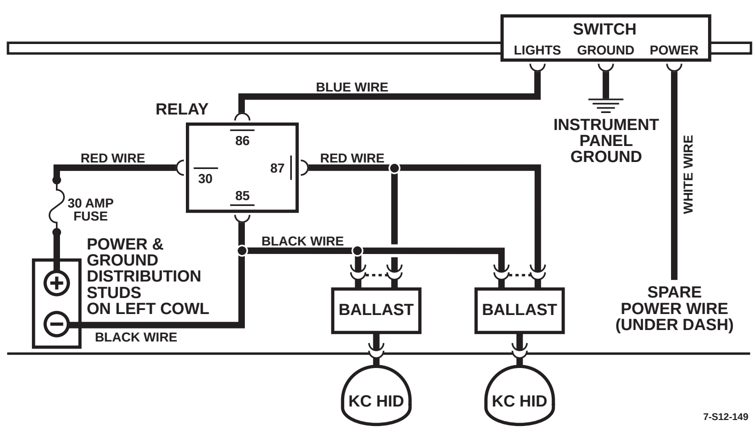

Figure 13-106: Wiring Schematic

Diagnostics

Table 2: Off Road Light Package Inoperative

STEP	ACTION	VALUE(S)	YES	NO
1	Turn ignition to "ON" position. Using a DVOM, check for approximate battery voltage at the white supply wire to the dash switch. Is voltage present?	Approximate battery + voltage.	Go to step 2.	Replace/repair fuse/circuit of spare power circuit used (ignition circuit fuse 3G - battery circuit fuse 4H).
2	Turn HID light switch to the "ON" position. Check for approximate battery voltage at terminal 86 of relay. Is voltage present?	Approximate battery + voltage.	Go to step 3.	Replace/repair switch/circuit between switch and relay terminal 86 (blue wire).
3	Check for approximate battery voltage at terminal 87 of relay. Is voltage present?	Approximate battery + voltage.	Go to step 4.	Repair relay ground circuit (terminal 85), relay power supply circuit with 30 amp in-line fuse (terminal 30). If OK, replace relay.
4	Check red wires at the ballast connectors for voltage. Is voltage present?	Approximate battery + voltage.	Go to step 5.	Repair circuit from relay terminal 87.
5	Using a DVOM, check resistance of the ground circuit (black wire) between the ballast connector and the ground stud at the power and ground distribution point. Is the resistance less than .2Ω?	< .2 Ω.	Go to step 6.	Repair ground circuit/connections.
6	***WARNING: Do not attempt to take voltage readings at the light connectors. Extreme high voltage (approximately 1250 volts) may be present which could cause personal injury or damage to equipment.*** Turn HID light switch to the "OFF" position before disconnecting light connectors. If one light operates and one does not, disconnect light connectors and connect right light to left ballast and left light to right ballast. Does the inoperative light now shine and the other one not?	Light "ON"	Replace the ballast connected to the presently inoperative light.	Replace the original inoperative light.
7	For additional diagnostic information call KC HiLites customer service at 1-800-528-0950.			

DUAL OIL FILTER

Removal

1. Remove oil filters from oil filter adapter.
2. Remove bolt, gasket and two small o-rings securing adapter to engine block and remove adapter.
3. Remove large o-ring, plug and two connectors from adapter.

Installation

1. Use pipe thread sealant (Loctite 592) on the threads of the pipe plug and install the pipe plug in the oil filter adapter. Remove any sealant that might have gotten into the oil passage during the pipe plug installation (Figure 13-107).
2. Install two oil filter connectors in the oil filter adapter and tighten to 25 lb ft (34 Nm).
3. Install the large o-ring in the groove on the oil filter adapter.
4. Install two small o-rings in the grooves in the oil filter bolt.
5. Install the oil filter adapter gasket onto the oil filter bolt with the smooth side facing the bolt head.
6. Lubricate all the o-rings and the oil filter gasket with clean engine oil, insert the oil filter bolt through the oil filter adapter and mount the adapter to the engine block. Position the adapter for easy removal and replacement of the oil filters and tighten the oil filter bolt to 50 lb ft (68 Nm).
7. Lubricate the rubber sealing surface on both oil filters and install the filters on the oil filter adapter. Tighten the oil filters until the sealing surface contacts the adapter then 3/4 turn tighter.
8. Refill the engine with fresh oil if previously drained, or top up the oil level if not previously drained and run the engine until warm while checking for leaks. Your oil capacity should increase by approximately one quart (2.8 ml).

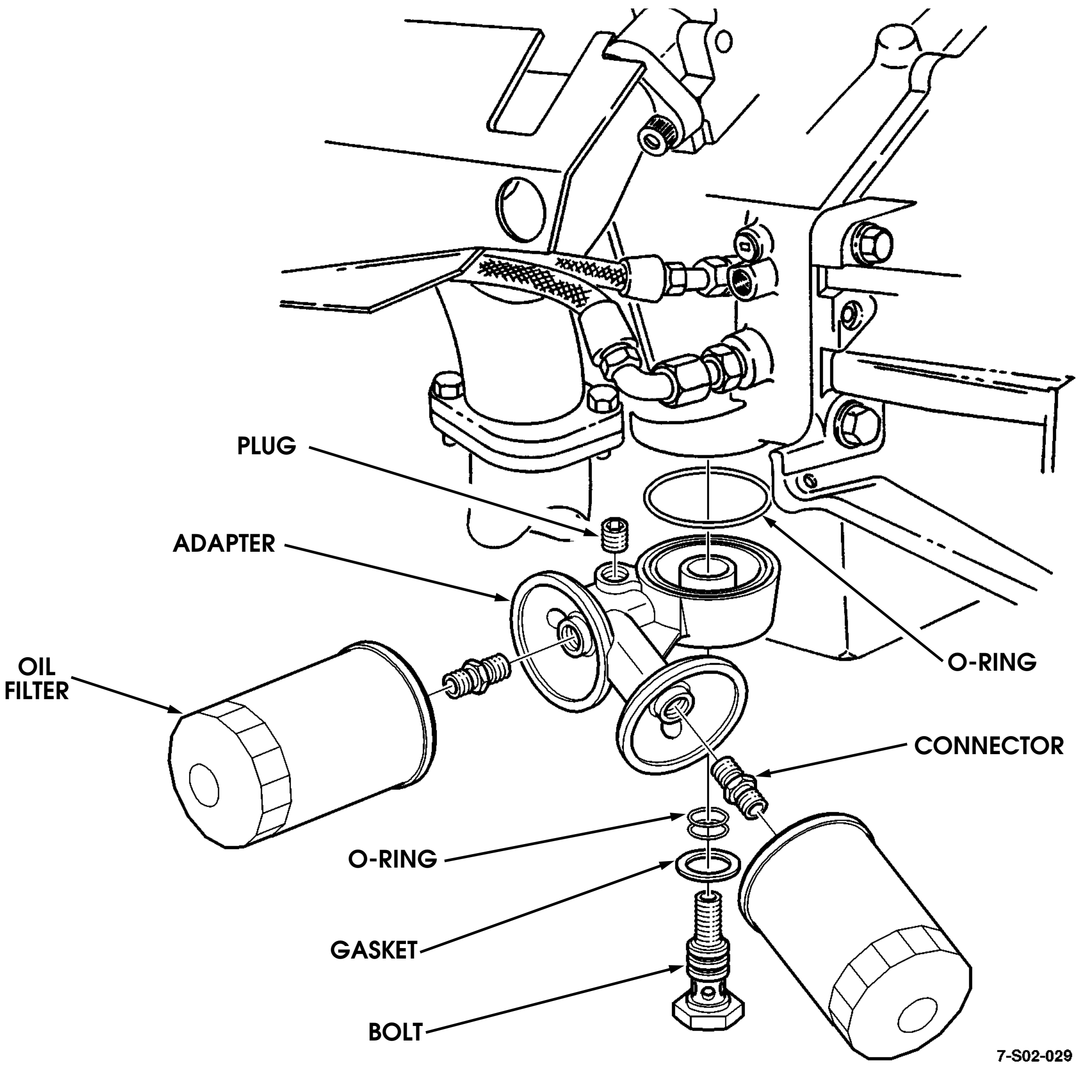

Figure 13-107: Dual Oil Filter Assembly

DELCO COMPACT DISC CHANGER REPLACEMENT

Removal

1. Remove four screws retaining the CD changer bezel to the console and remove bezel (Figure 13-108).
2. Remove four screws retaining the CD changer mounting brackets to the console.
3. Pull the CD changer out far enough to remove the wire harness connector from the changer (Figure 13-109).
4. If CD changer wire harness is to be replaced, radio must be removed to gain access to harness connection at the radio (Figure 13-110).

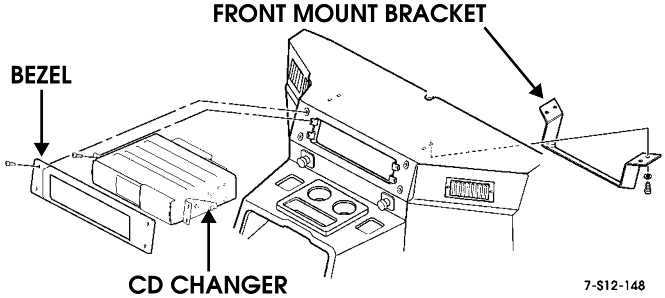

Figure 13-108: CD Changer Installation

Installation

1. Connect wire harness connector to the rear of the CD changer and insert changer into the console and the front support bracket.
2. Install four screws in the changer mount brackets and tighten.
3. Install changer bezel with four screws and tighten.

Radio Removal

1. Insert right and left radio removal keys in slots in face of radio to disengage locking clips from the mounting sleeve.
2. Pull radio out of mounting sleeve far enough to expose wire connections and disconnect audio harness connector, antenna cable and CD harness connector if equipped.
3. Straighten locking tabs and pull mounting sleeve out of face plate.

Radio Installation

1. Install mounting sleeve through face plate and support plate and bend locking tabs to secure.
2. Connect harness connectors and antenna cable to radio.
3. Insert radio into mounting sleeve, align rear mount pin with upper support bracket and push in until locking clips engage.
4. Advise end user to reprogram theftlock.

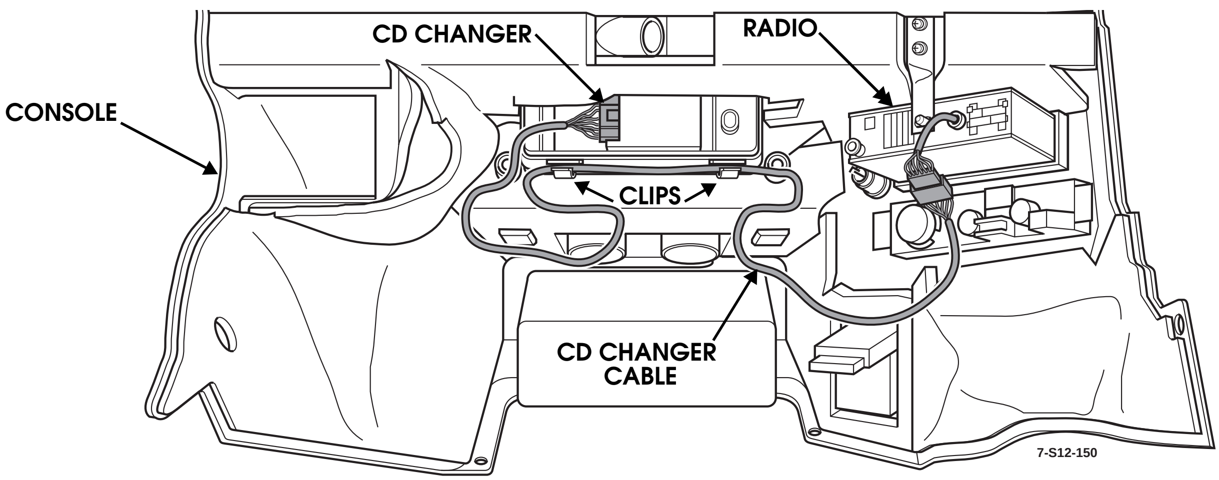

Figure 13-109: CD Changer Harness Routing

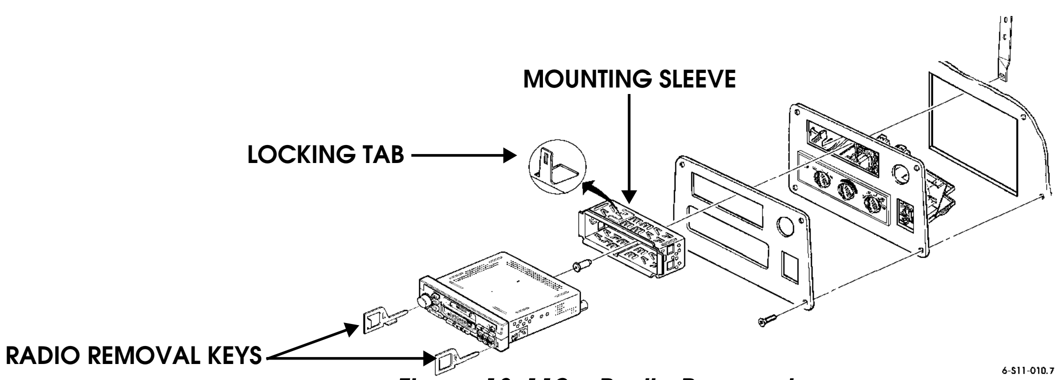

Figure 13-110: Radio Removal

SEAT HEATER

NOTE: The following procedures apply to either the left or the right front seat.

Removal

1. Disconnect two wire connectors at the lower rear of the seat back and clip the wire ties securing the wires to the seat frame.
2. Remove four seat retaining bolts, washers and seat from vehicle.
3. Remove two screws at the front of the seat cushion and remove the cushion.
4. Using a screwdriver, release the fabric retaining clips and pull the fabric back to expose the fabric hold down wire and hog rings. Clip the hog rings and remove the fabric from the seat cushion (Figure 13-111).
5. Peel the heating element off the foam padding.
6. Remove two bolts, washers and the arm rest from the seat back.
7. Remove the arm rest side hinge cover and center cover.
8. Pry the metal fabric retainer channels open on the seat back frame and remove the fabric from the channels.
9. Remove the connector from the seat back wire harness and pull the wires through the hole in the fabric and the seat frame.
10. Roll the fabric up approximately 14” on both sides.
11. Remove the heating element from the foam padding of the seat back (Figure 13-112).
12. Remove the center console cover.
13. Pull the harness through the hole in the trim panel near the seat belt mount point. Disconnect the harness from the switch, pull the control box from its velcro mount on the body and remove the control box and the harness.
14. Remove the switch from the center console cover.
15. Remove the drivers side dash closeout panel.
16. Disconnect the harness from the spare power lead and the instrument ground point at the left of the steering column and remove the harness from the dash area.

Installation

1. Installation is the reverse of the removal using new hog rings that were clipped in step 4 and inserting the brown wire in position “B” and the blue wire in position “A” of the connector in step 9.

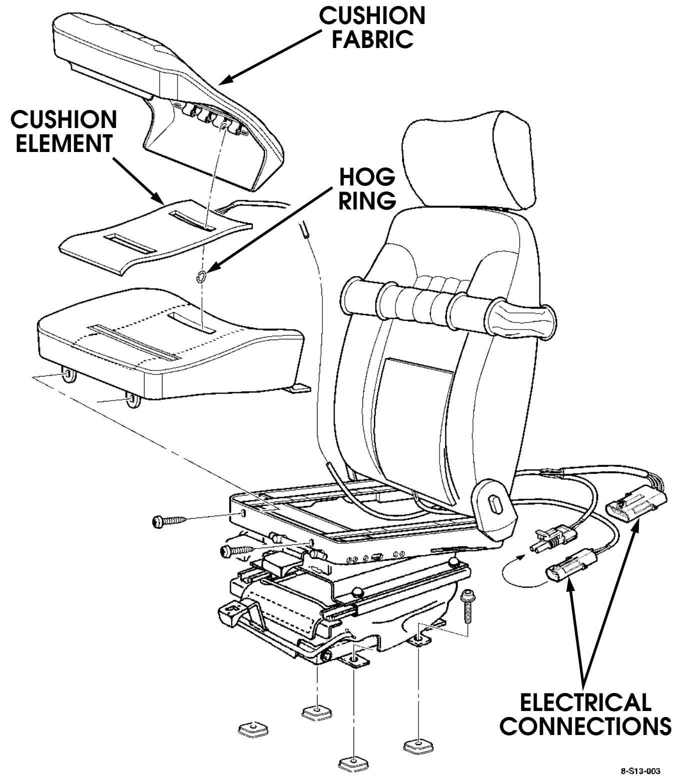

Figure 13-111: Seat Cushion Element Removal.

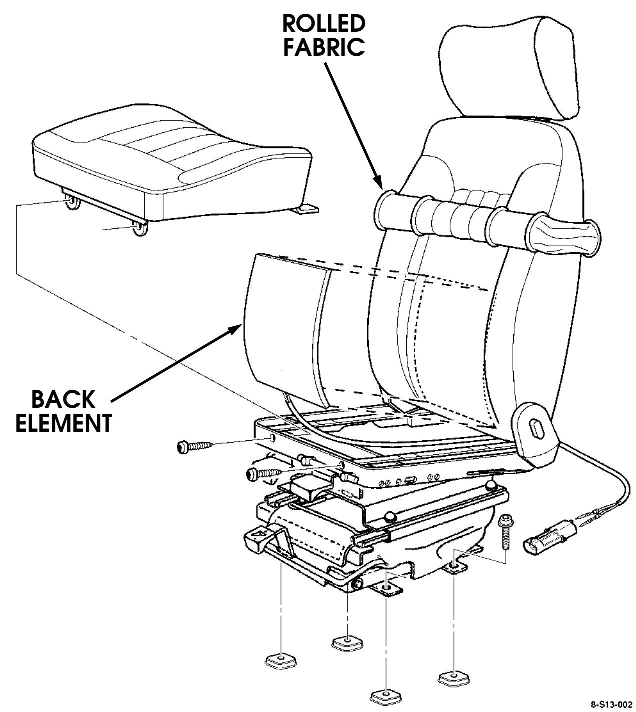

Figure 13-112: Back Element Removal.

Diagnostics

Seat Heater Does Not Heat

Step	Action	Value(S)	Yes	No
1	**NOTE:** The control box contains a timer that will shut the heater off after one hour of use. The switch must be cycled "OFF" and "ON" to restart the heat cycle. Turn ignition to the "ON" position. Position the seat heater switch to one of the heat positions. Does the switch illuminate?	Switch light "ON"	Go to step 2.	Check/repair fuse 3G circuit to the switch "2B" and "3B" (red wire) and ground circuit from IP ground point to the control terminal "2B" (black wire). Check circuit between control "2C" and switch terminals "7" and "8"(black wire). If circuits OK and switch is not illuminated, replace the switch.
2	Cycle seat heater switch "OFF and "ON". Do you hear an audible click coming from the control box?	Audible relay click.	Go to step 4.	Go to step 3.
3	Check switch output power at the control box connection. In high position check for voltage on white and orange wires. In low position check for voltage on white wires.	Approximate battery + voltage.	Go to step 4.	Replace the switch.
4	Check resistance at terminals "A" and "D" of 4 position cushion connector. Is the resistance within specification?	3.2 Ω +-10% (resistance of back and cushion element in series)	Go to step 6.	Go to step 5.
5	Isolate the back element and check its resistance. Is the resistance within specification?	1.2 Ω +- 10%	Replace the cushion element.	Replace the back element.
6	Check resistance of NTC heat sensor in the cushion element. Is the resistance within specification?	10K Ω +- 10% at 77° F	Replace the control box.	Replace cushion element.
	Call 1-800-927-6787 for additional troubleshooting assistance.			

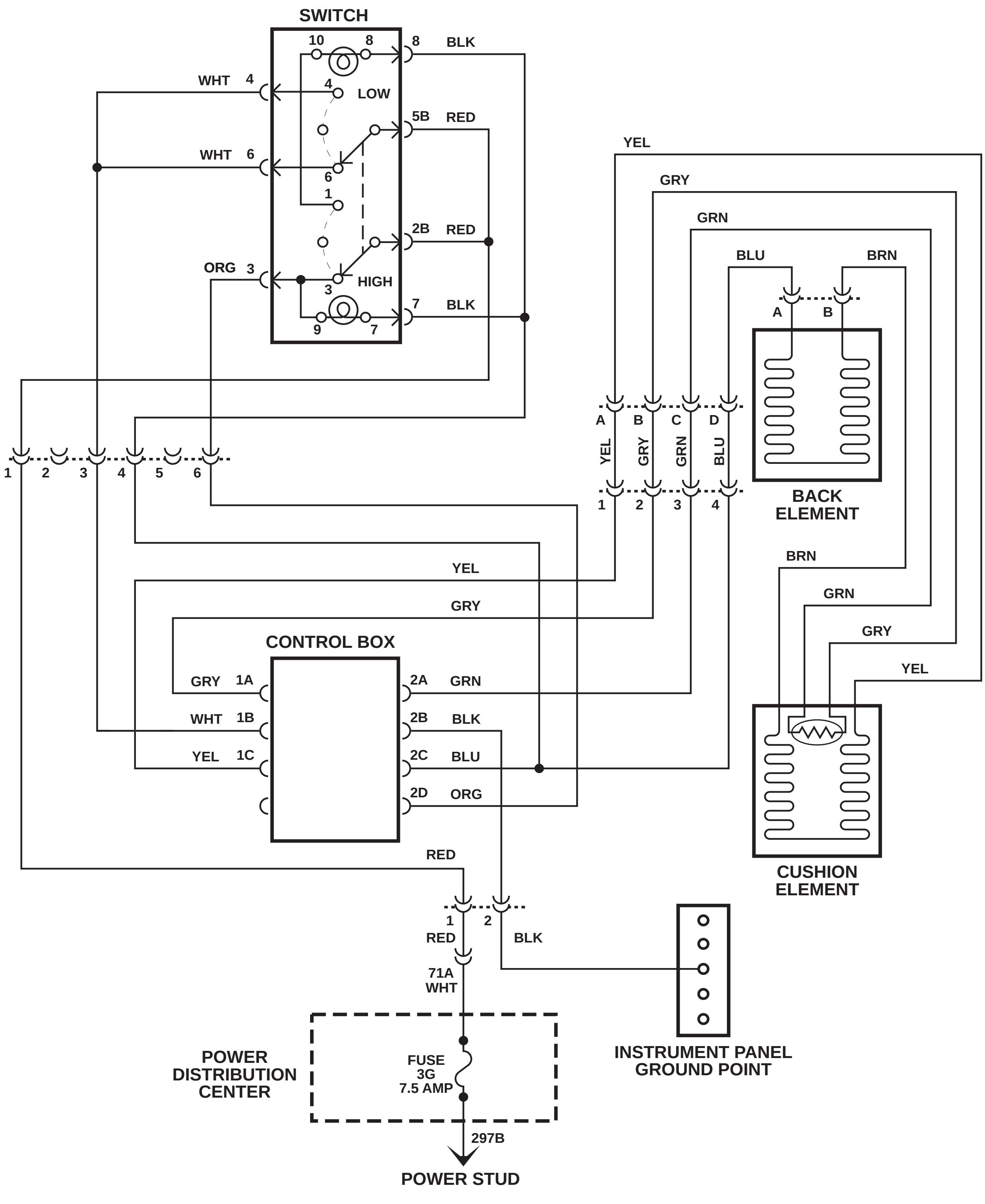

Figure 13-113: Seat Heater Schematic

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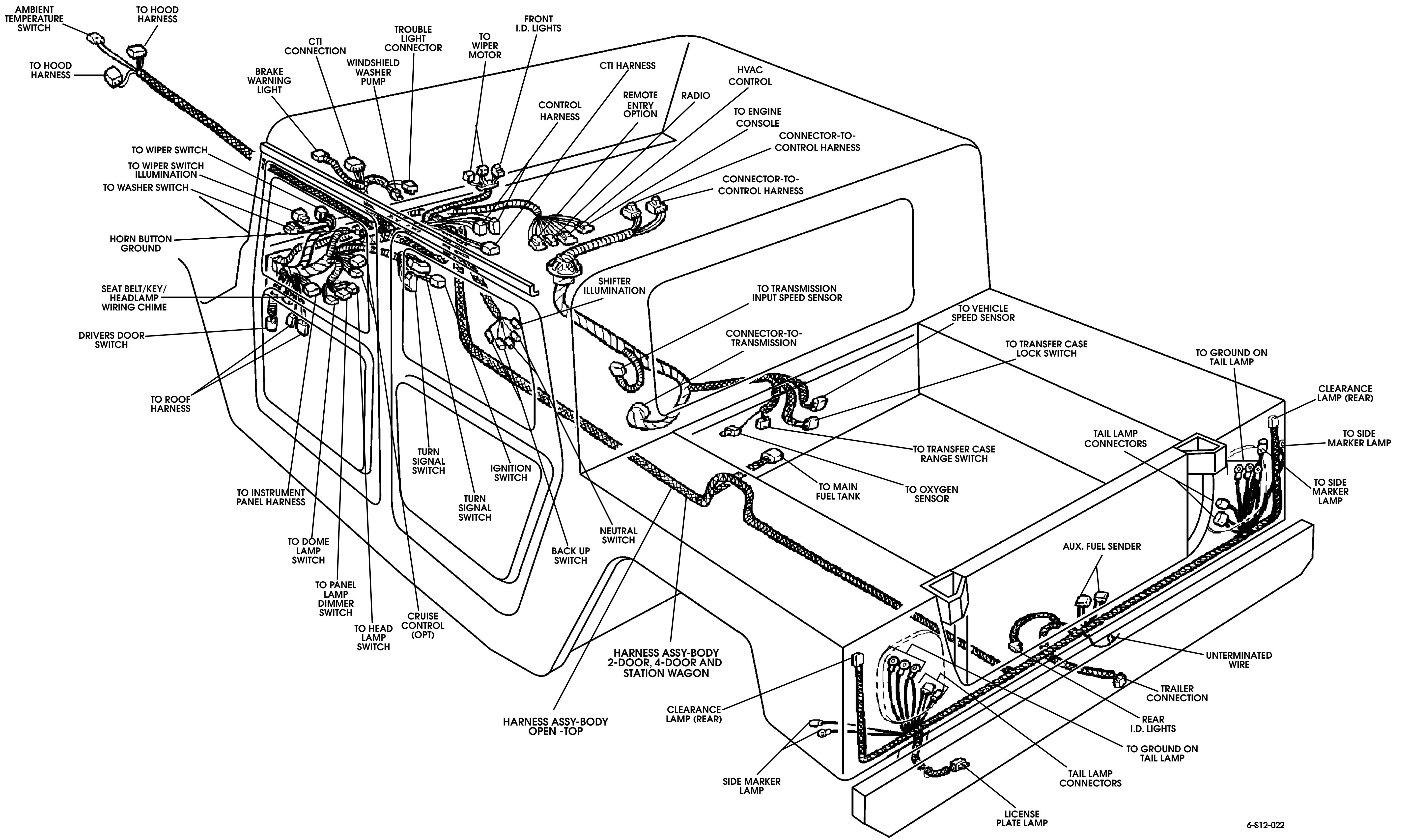
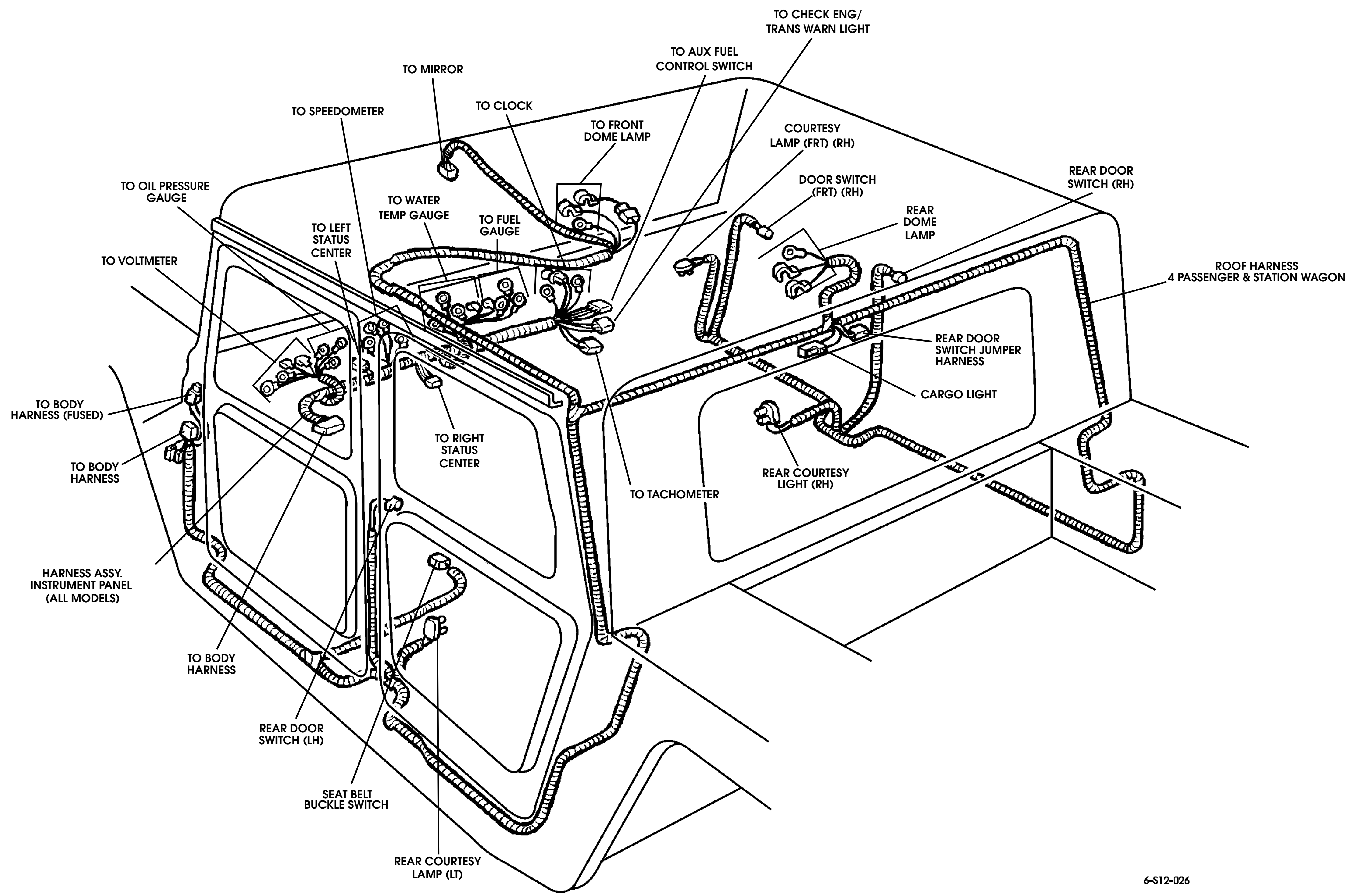
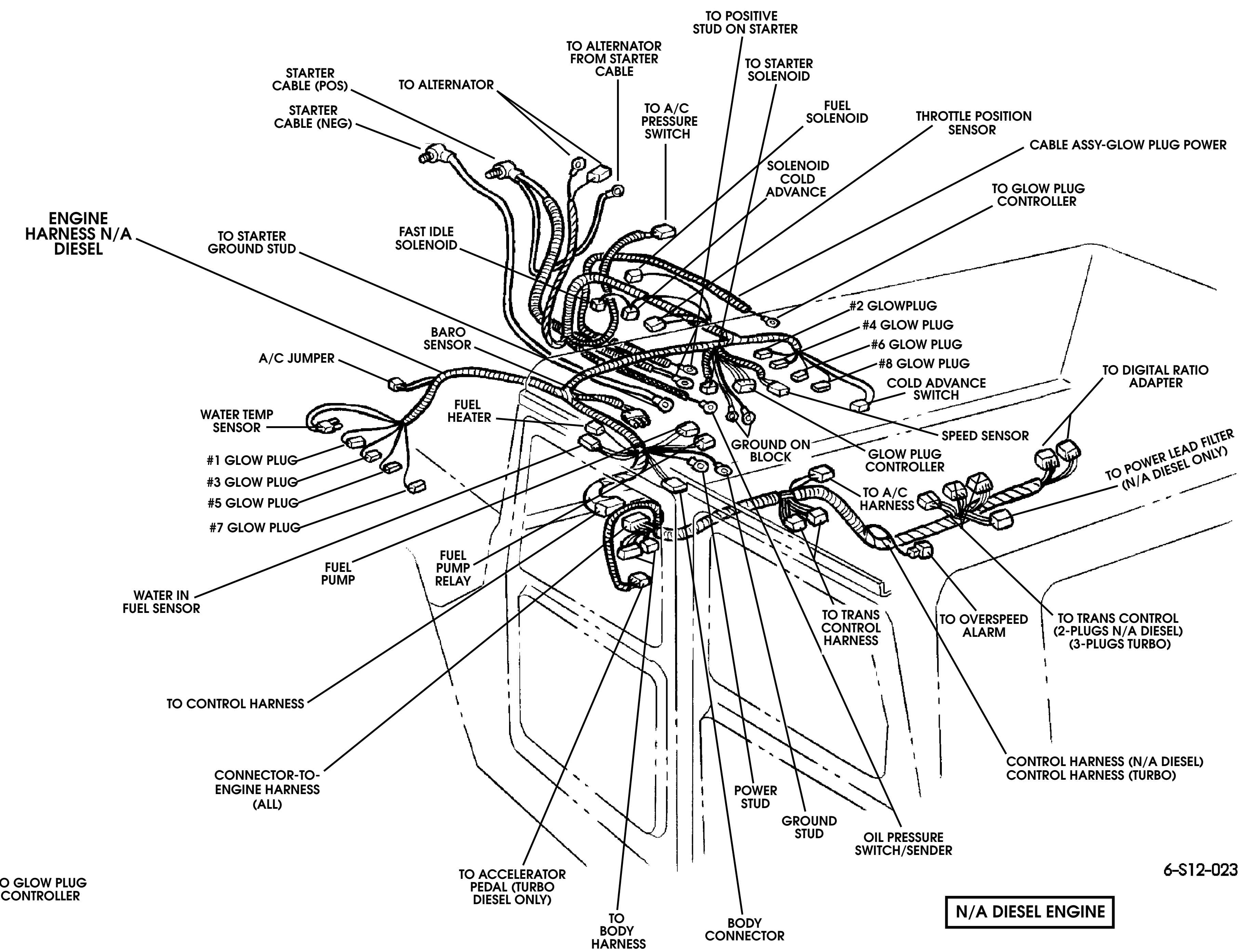


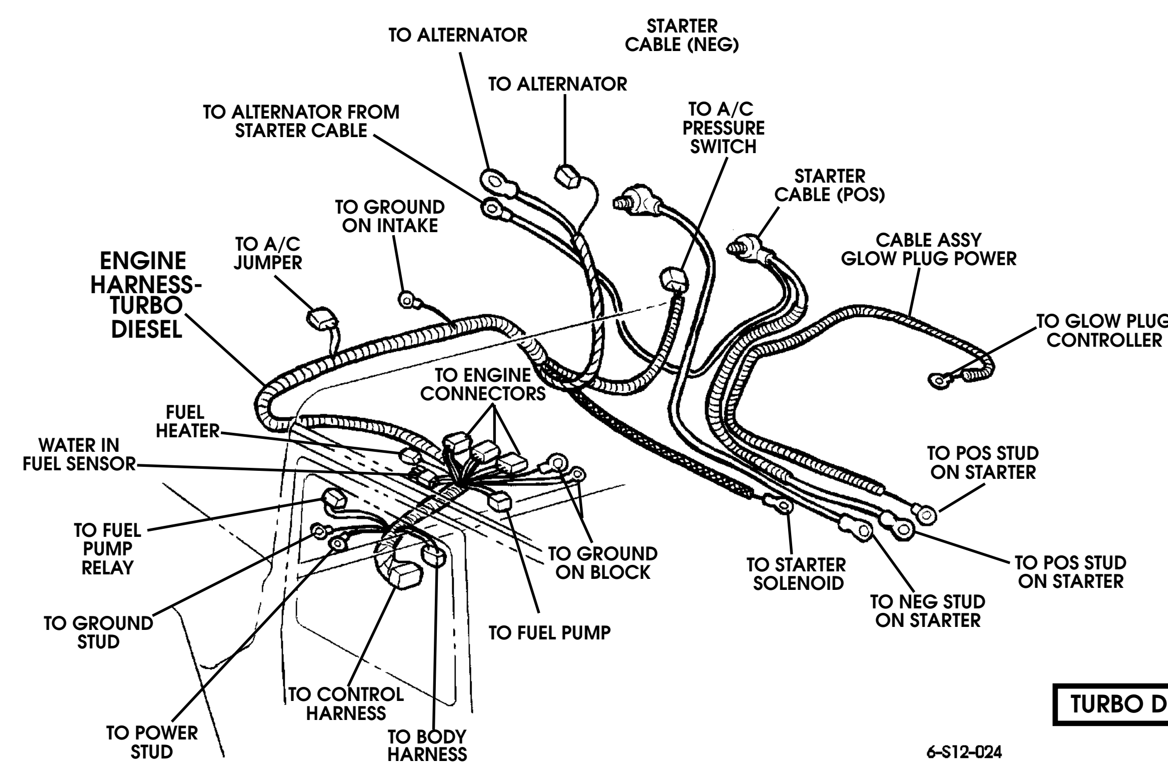
FO-1 Body Harness



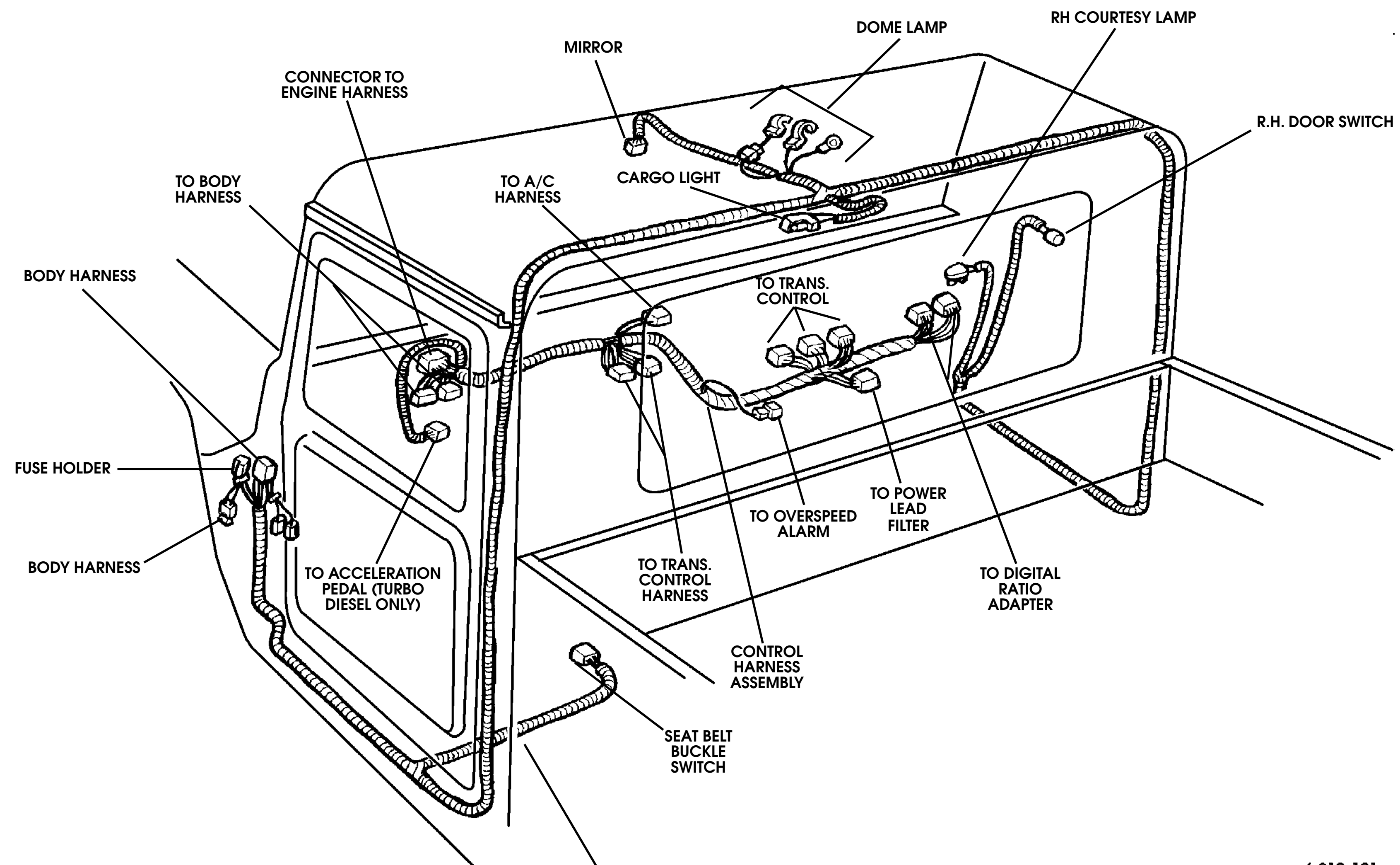
FO-2 Roof and Instrument Panel, 4-Passenger



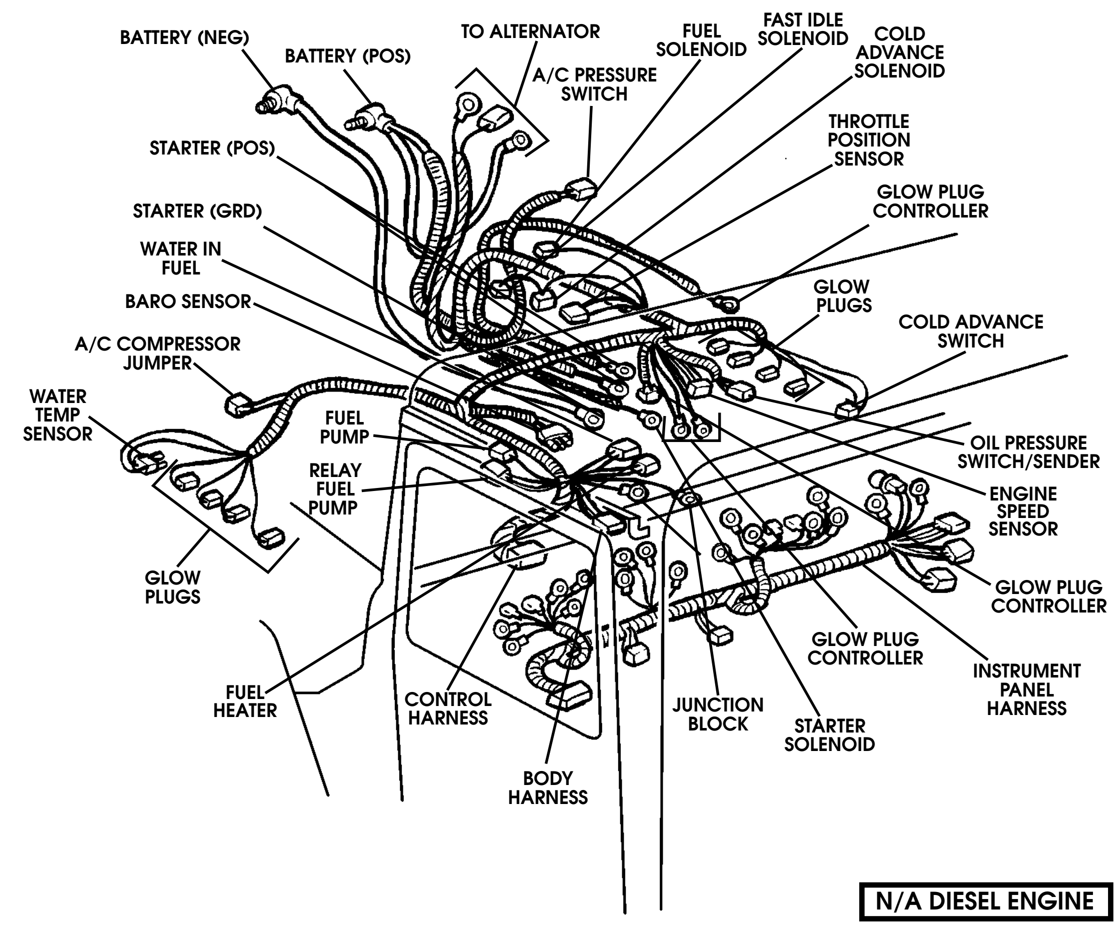
N/A DIESEL ENGINE



TURBO DIESEL ENGINE

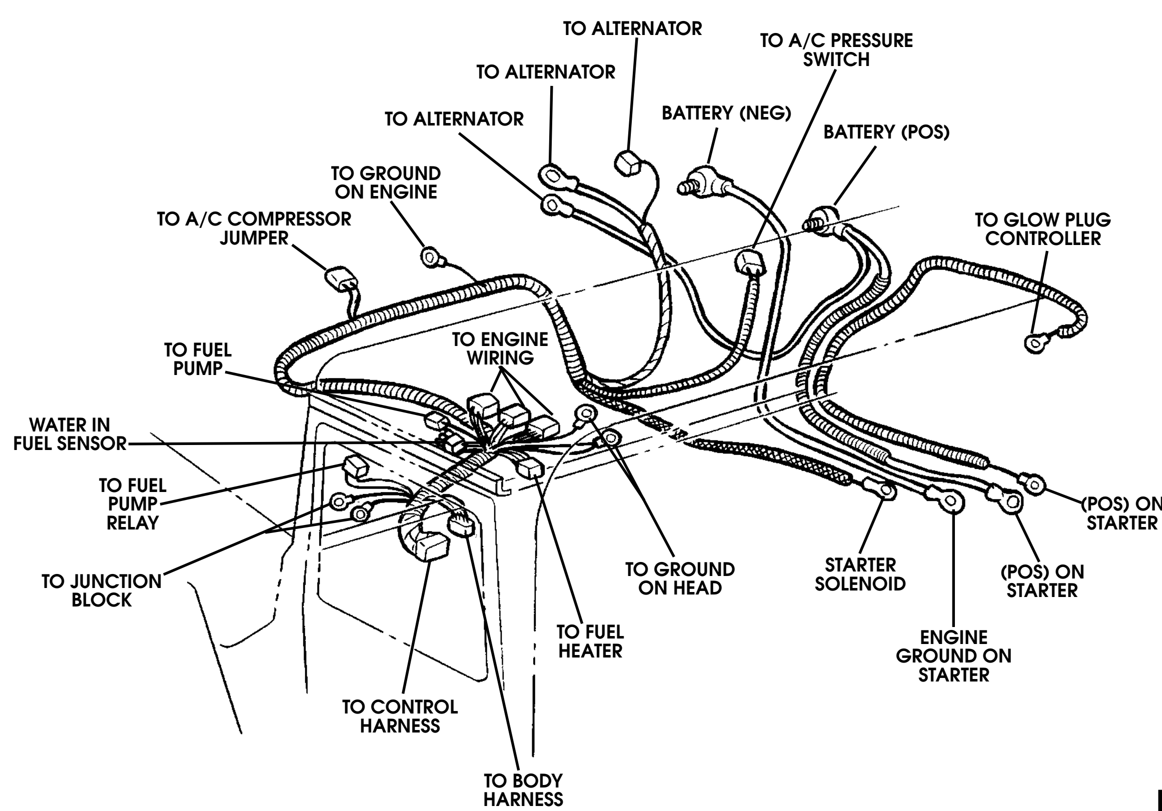


HARNESS ASSY
ROOF 2-PASSENGER CAB



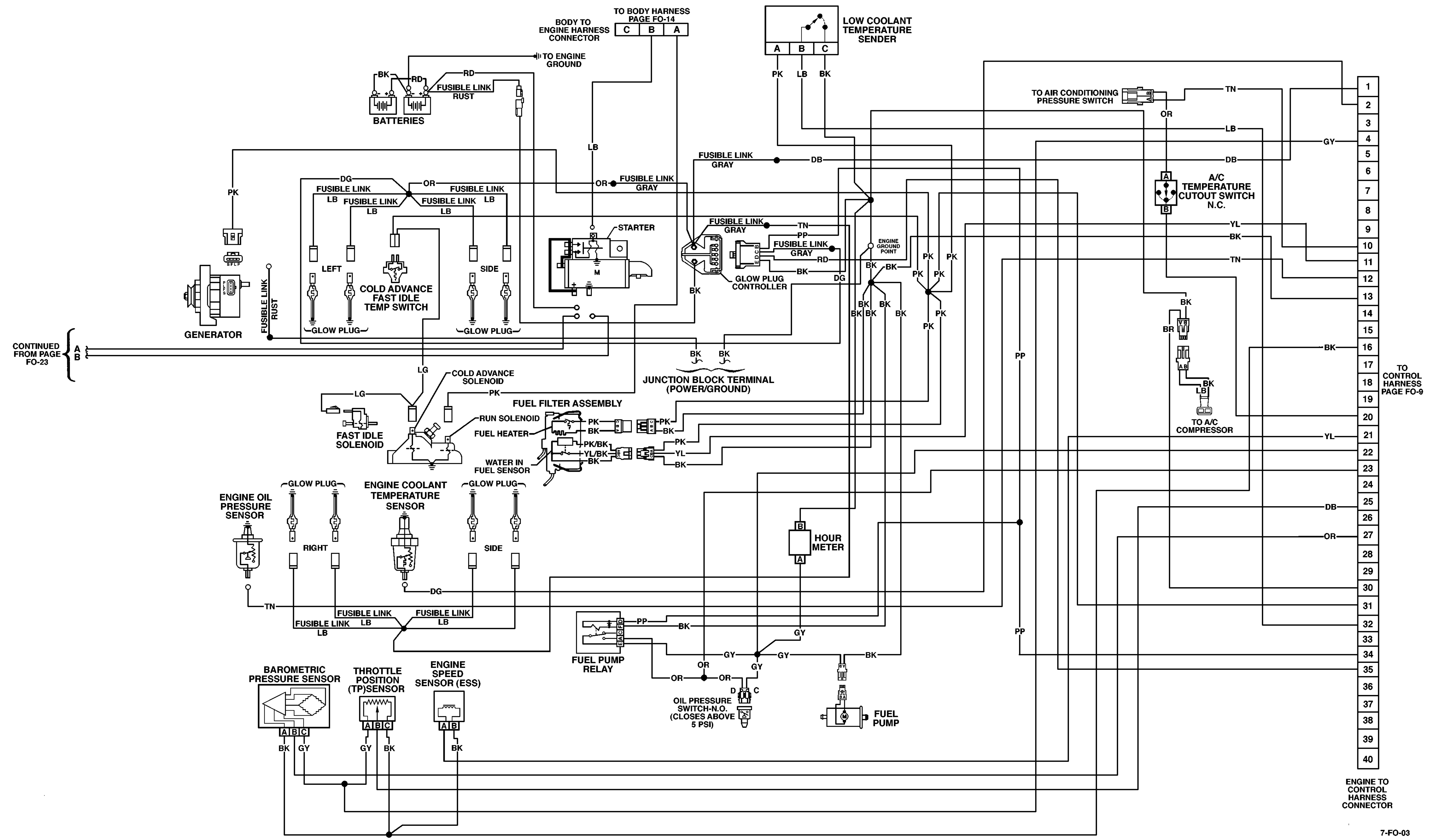
N/A DIESEL ENGINE

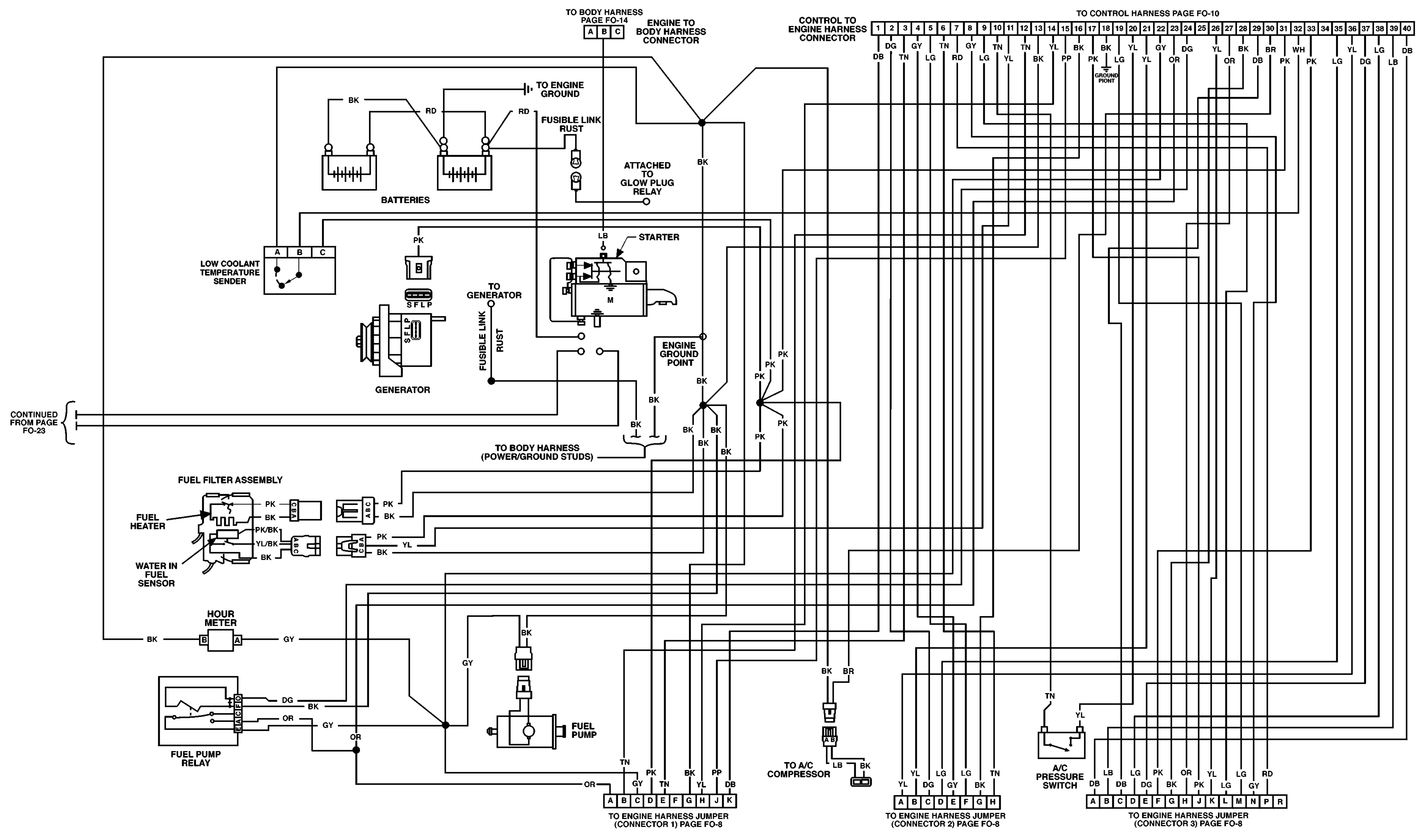
6-S12-098

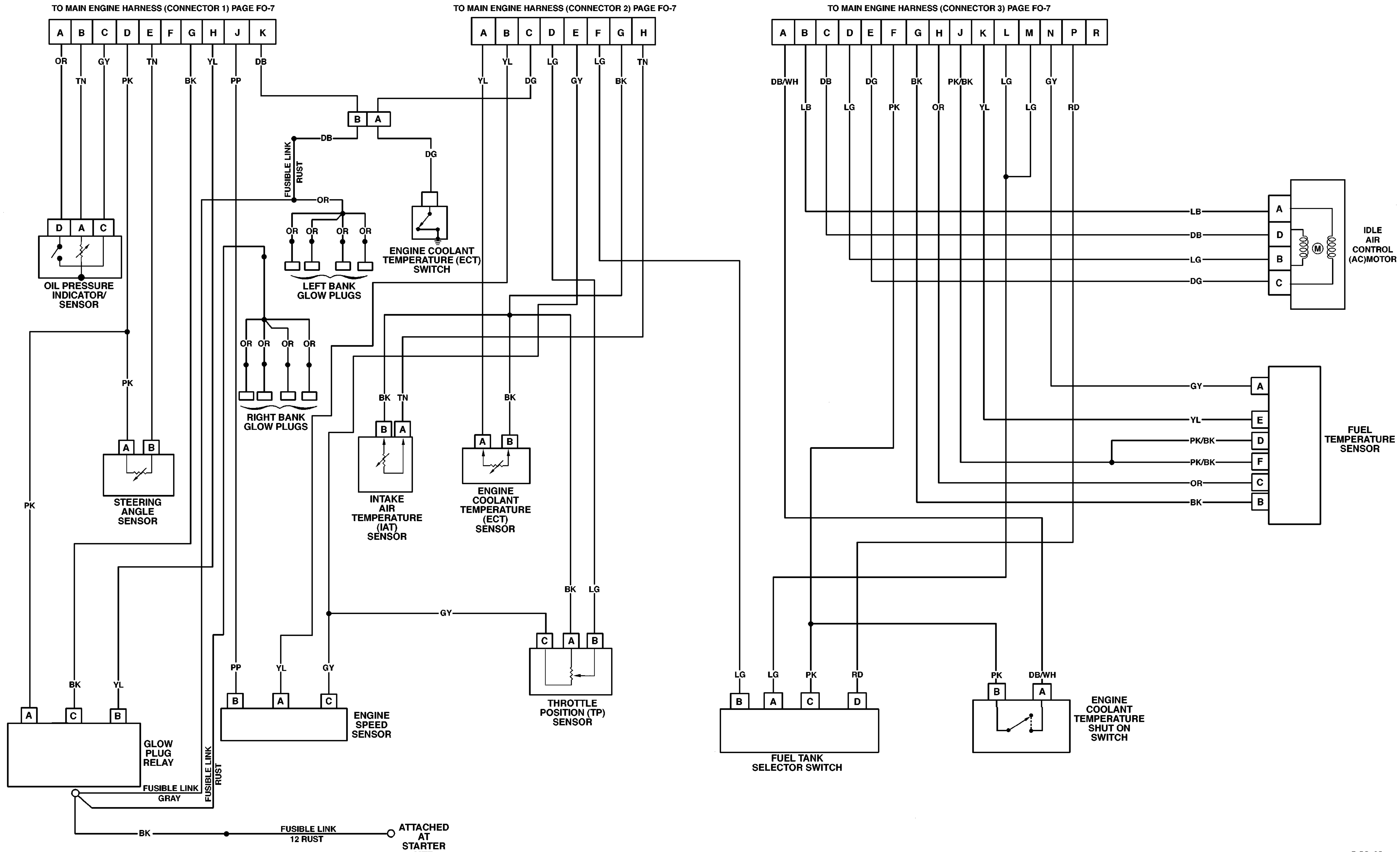


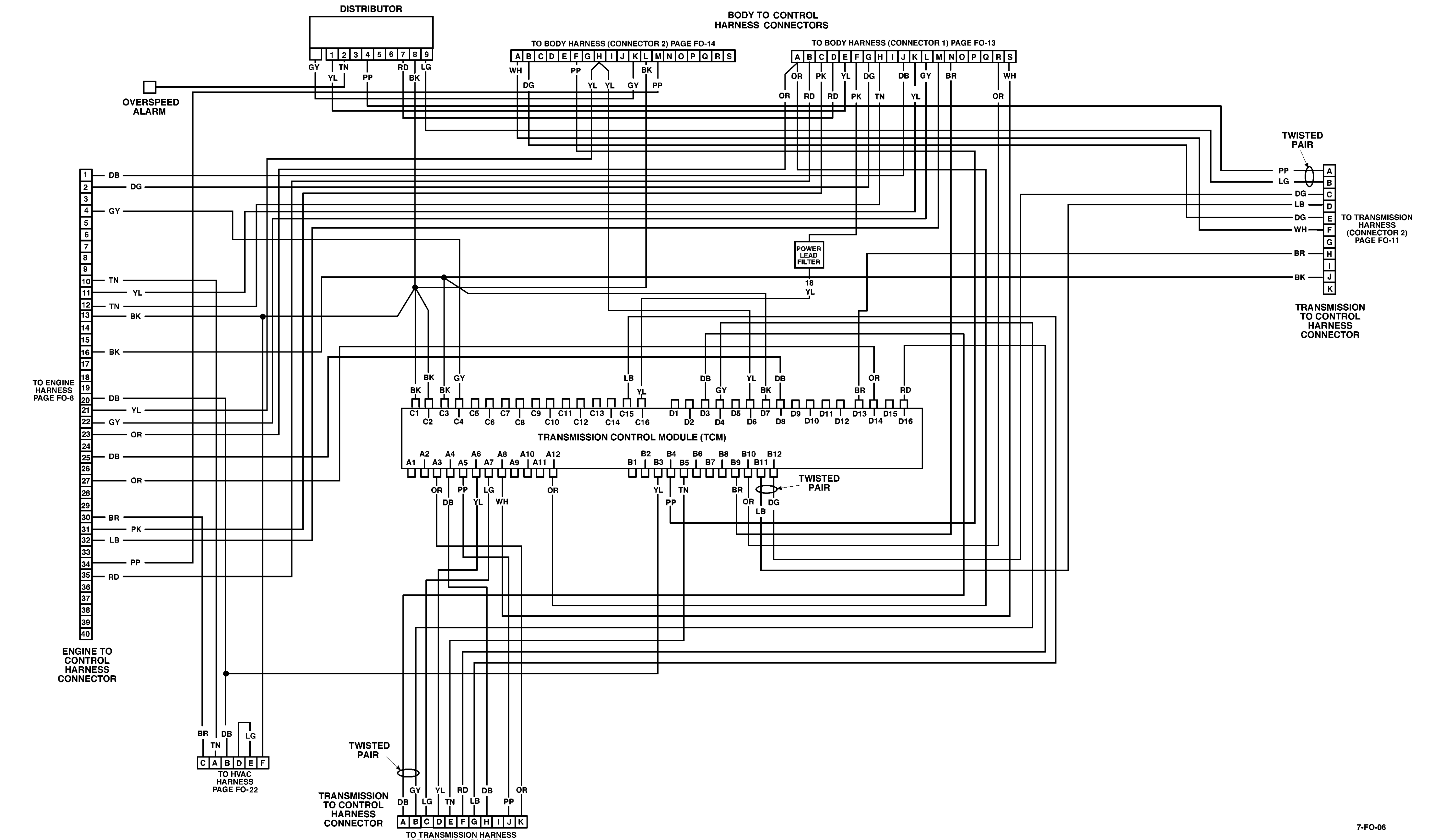
6-S12-099

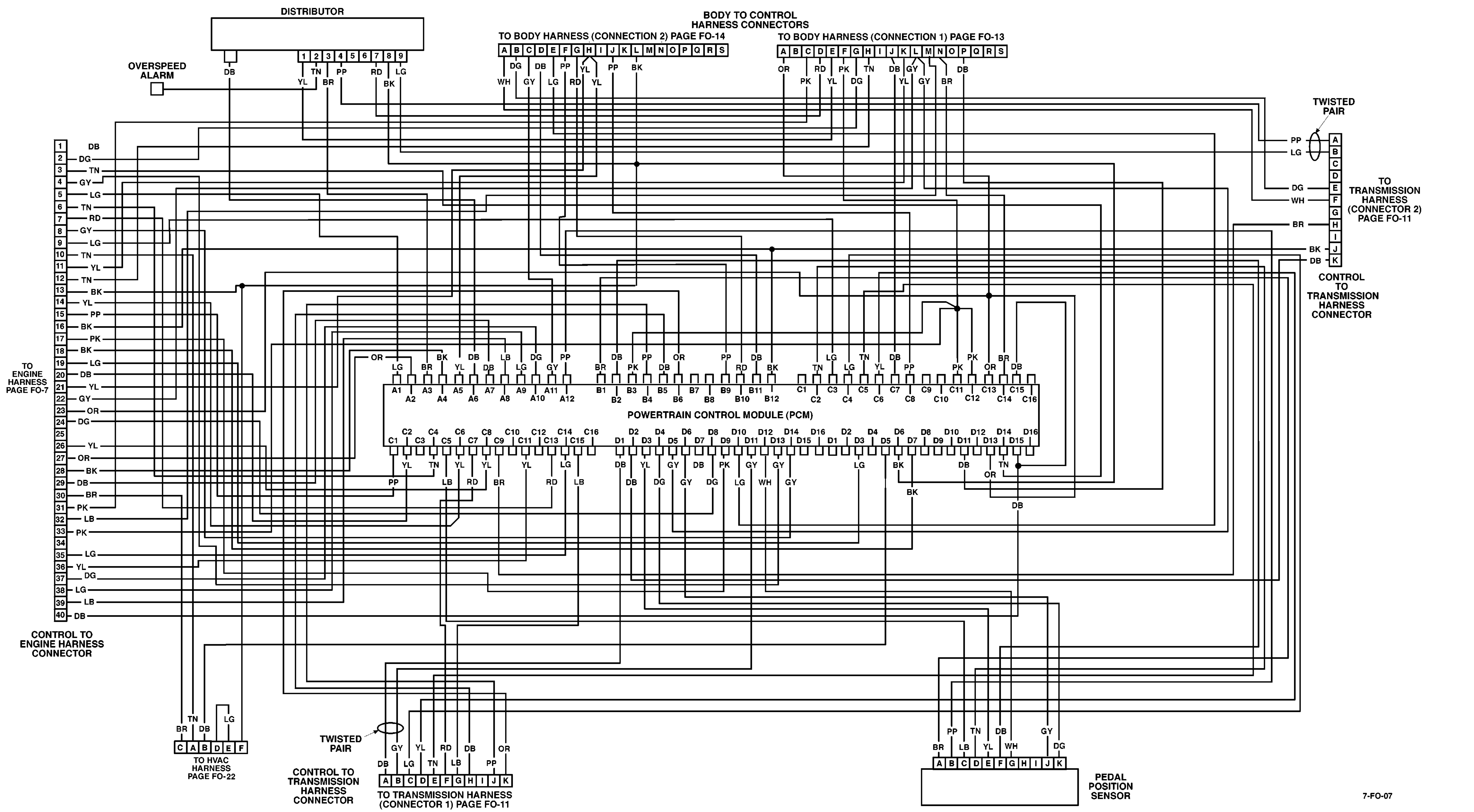
TURBO DIESEL ENGINE

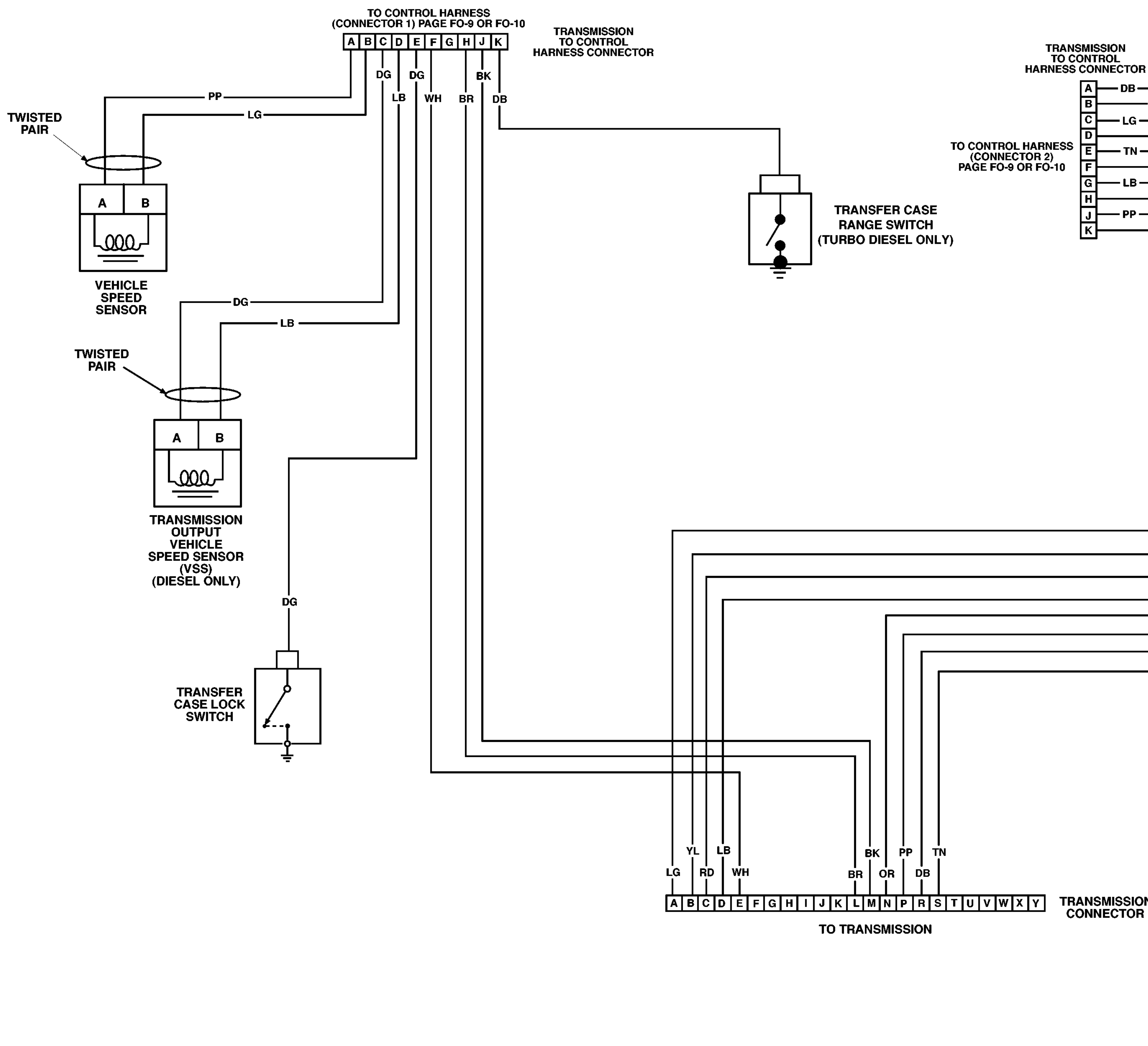

TO BODY HARNESS PAGE FO-14
BODY TO ENGINE HARNESS CONNECTOR
TO ENGINE GROUND
BATTERIES
FUSIBLE LINK RUST
LOW COOLANT TEMPERATURE SENDER
TO AIR CONDITIONING PRESSURE SWITCH
A/C TEMPERATURE CUTOUT SWITCH N.C.
STARTER
GLOW PLUG CONTROLLER
ENGINE GROUND POINT
GENERATOR
COLD ADVANCE FAST IDLE TEMP SWITCH
GLOW PLUG
LEFT
SIDE
CONTINUED FROM PAGE FO-23
JUNCTION BLOCK TERMINAL (POWER/GROUND)
COLD ADVANCE SOLENOID
FUEL FILTER ASSEMBLY
RUN SOLENOID
FUEL HEATER
WATER IN FUEL SENSOR
FAST IDLE SOLENOID
TO A/C COMPRESSOR
TO CONTROL HARNESS PAGE FO-9
ENGINE OIL PRESSURE SENSOR
RIGHT
ENGINE COOLANT TEMPERATURE SENSOR
HOUR METER
FUEL PUMP RELAY
OIL PRESSURE SWITCH-N.O. (CLOSES ABOVE 5 PSI)
FUEL PUMP
BAROMETRIC PRESSURE SENSOR
THROTTLE POSITION (TP)SENSOR
ENGINE SPEED SENSOR (ESS)
ENGINE TO CONTROL HARNESS CONNECTOR
7-FO-03


TO BODY HARNESS PAGE FO-14
ENGINE TO BODY HARNESS CONNECTOR
CONTROL TO ENGINE HARNESS CONNECTOR
TO CONTROL HARNESS PAGE FO-10
TO ENGINE GROUND
FUSIBLE LINK RUST
ATTACHED TO GLOW PLUG RELAY
BATTERIES
STARTER
LOW COOLANT TEMPERATURE SENDER
TO GENERATOR
FUSIBLE LINK
RUST
GENERATOR
ENGINE GROUND POINT
CONTINUED FROM PAGE FO-23
TO BODY HARNESS (POWER/GROUND STUDS)
FUEL FILTER ASSEMBLY
FUEL HEATER
WATER IN FUEL SENSOR
HOUR METER
FUEL PUMP
FUEL PUMP RELAY
TO A/C COMPRESSOR
A/C PRESSURE SWITCH
GROUND POINT
TO ENGINE HARNESS JUMPER (CONNECTOR 1) PAGE FO-8
TO ENGINE HARNESS JUMPER (CONNECTOR 2) PAGE FO-8
TO ENGINE HARNESS JUMPER (CONNECTOR 3) PAGE FO-8
7-FO-04

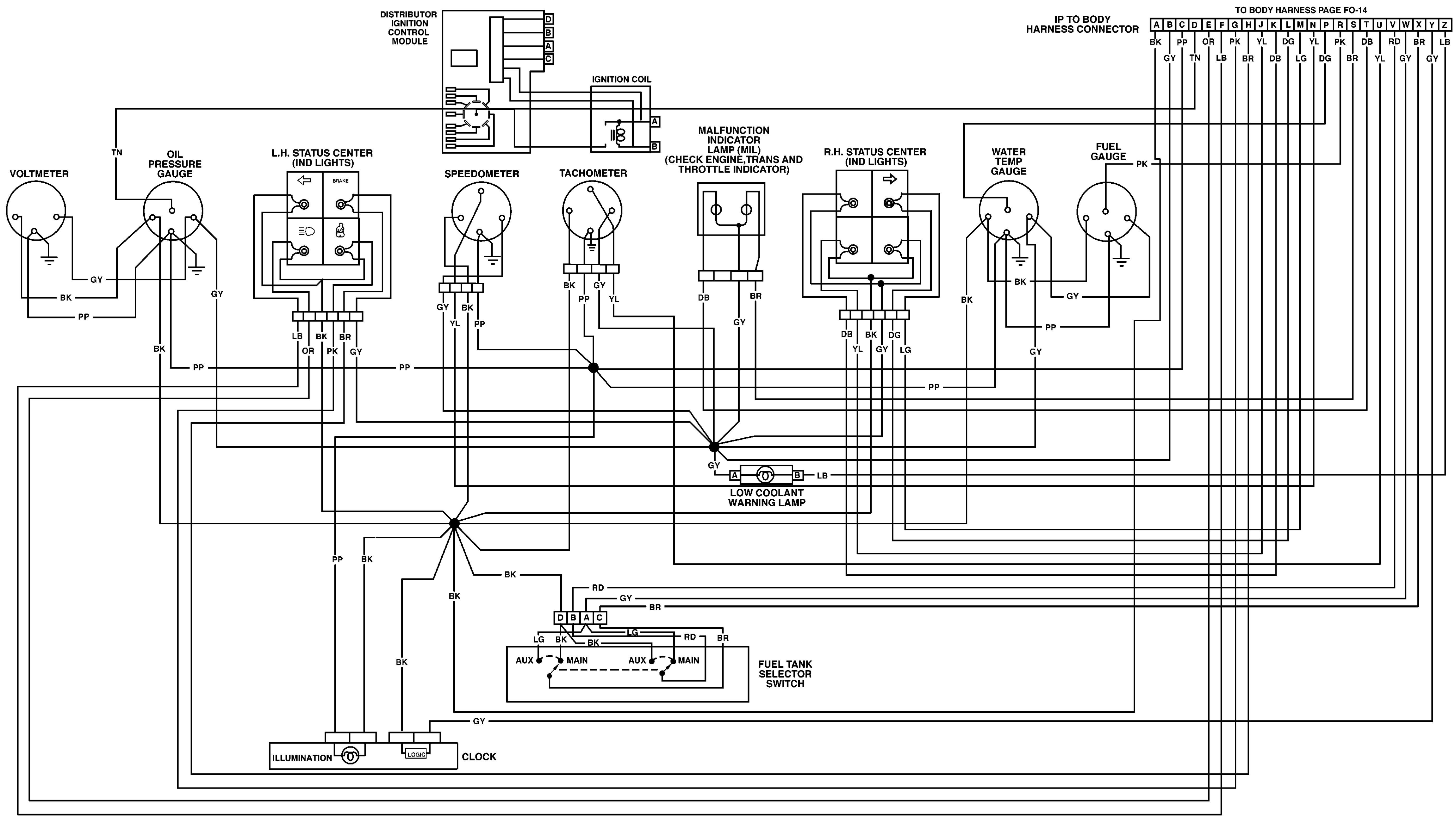

TO MAIN ENGINE HARNESS (CONNECTOR 1) PAGE FO-7
TO MAIN ENGINE HARNESS (CONNECTOR 2) PAGE FO-7
TO MAIN ENGINE HARNESS (CONNECTOR 3) PAGE FO-7
FUSIBLE LINK RUST
ENGINE COOLANT TEMPERATURE (ECT) SWITCH
LEFT BANK GLOW PLUGS
OIL PRESSURE INDICATOR/ SENSOR
RIGHT BANK GLOW PLUGS
IDLE AIR CONTROL (AC)MOTOR
STEERING ANGLE SENSOR
INTAKE AIR TEMPERATURE (IAT) SENSOR
ENGINE COOLANT TEMPERATURE (ECT) SENSOR
FUEL TEMPERATURE SENSOR
THROTTLE POSITION (TP) SENSOR
ENGINE SPEED SENSOR
GLOW PLUG RELAY
FUSIBLE LINK GRAY
FUEL TANK SELECTOR SWITCH
ENGINE COOLANT TEMPERATURE SHUT ON SWITCH
FUSIBLE LINK 12 RUST
ATTACHED AT STARTER MTR
7-FO-05


DISTRIBUTOR
BODY TO CONTROL HARNESS CONNECTORS
TO BODY HARNESS (CONNECTOR 2) PAGE FO-14
TO BODY HARNESS (CONNECTOR 1) PAGE FO-13
OVERSPEED ALARM
TWISTED PAIR
TO TRANSMISSION HARNESS (CONNECTOR 2) PAGE FO-11
TRANSMISSION TO CONTROL HARNESS CONNECTOR
POWER LEAD FILTER
18 YL
TO ENGINE HARNESS PAGE FO-6
TRANSMISSION CONTROL MODULE (TCM)
TWISTED PAIR
ENGINE TO CONTROL HARNESS CONNECTOR
TO HVAC HARNESS PAGE FO-22
TWISTED PAIR
TRANSMISSION TO CONTROL HARNESS CONNECTOR
TO TRANSMISSION HARNESS (CONNECTOR 1) PAGE FO-11
7-FO-06

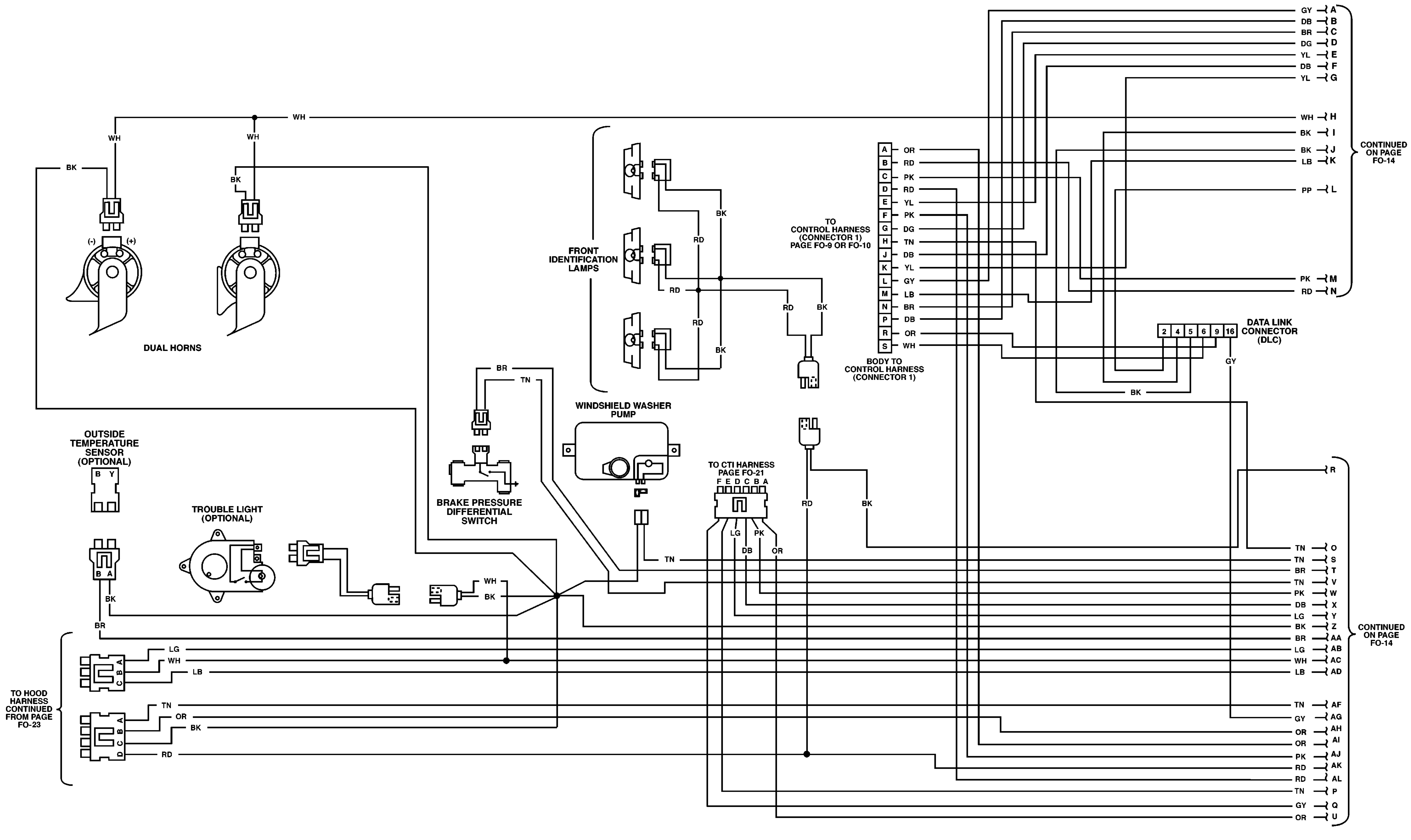

DISTRIBUTOR
OVERSPEED ALARM
BODY TO CONTROL HARNESS CONNECTORS
TO BODY HARNESS (CONNECTION 2) PAGE FO-14
TO BODY HARNESS (CONNECTION 1) PAGE FO-13
TWISTED PAIR
TO TRANSMISSION HARNESS (CONNECTOR 2) PAGE FO-11
CONTROL TO TRANSMISSION HARNESS CONNECTOR
TO ENGINE HARNESS PAGE FO-7
POWERTRAIN CONTROL MODULE (PCM)
CONTROL TO ENGINE HARNESS CONNECTOR
TO HVAC HARNESS PAGE FO-22
TWISTED PAIR
CONTROL TO TRANSMISSION HARNESS CONNECTOR
TO TRANSMISSION HARNESS (CONNECTOR 1) PAGE FO-11
PEDAL POSITION SENSOR
7-FO-07

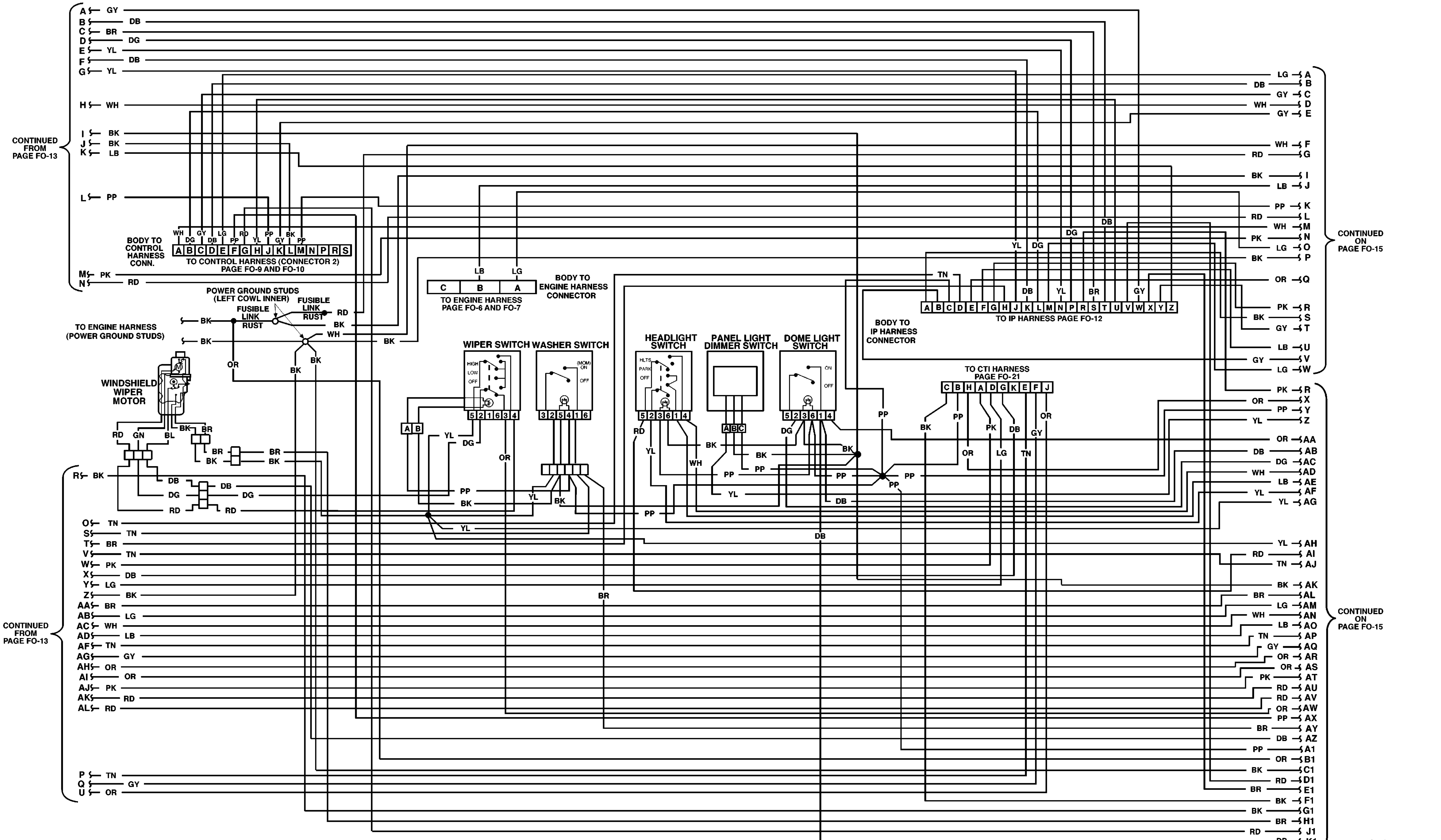


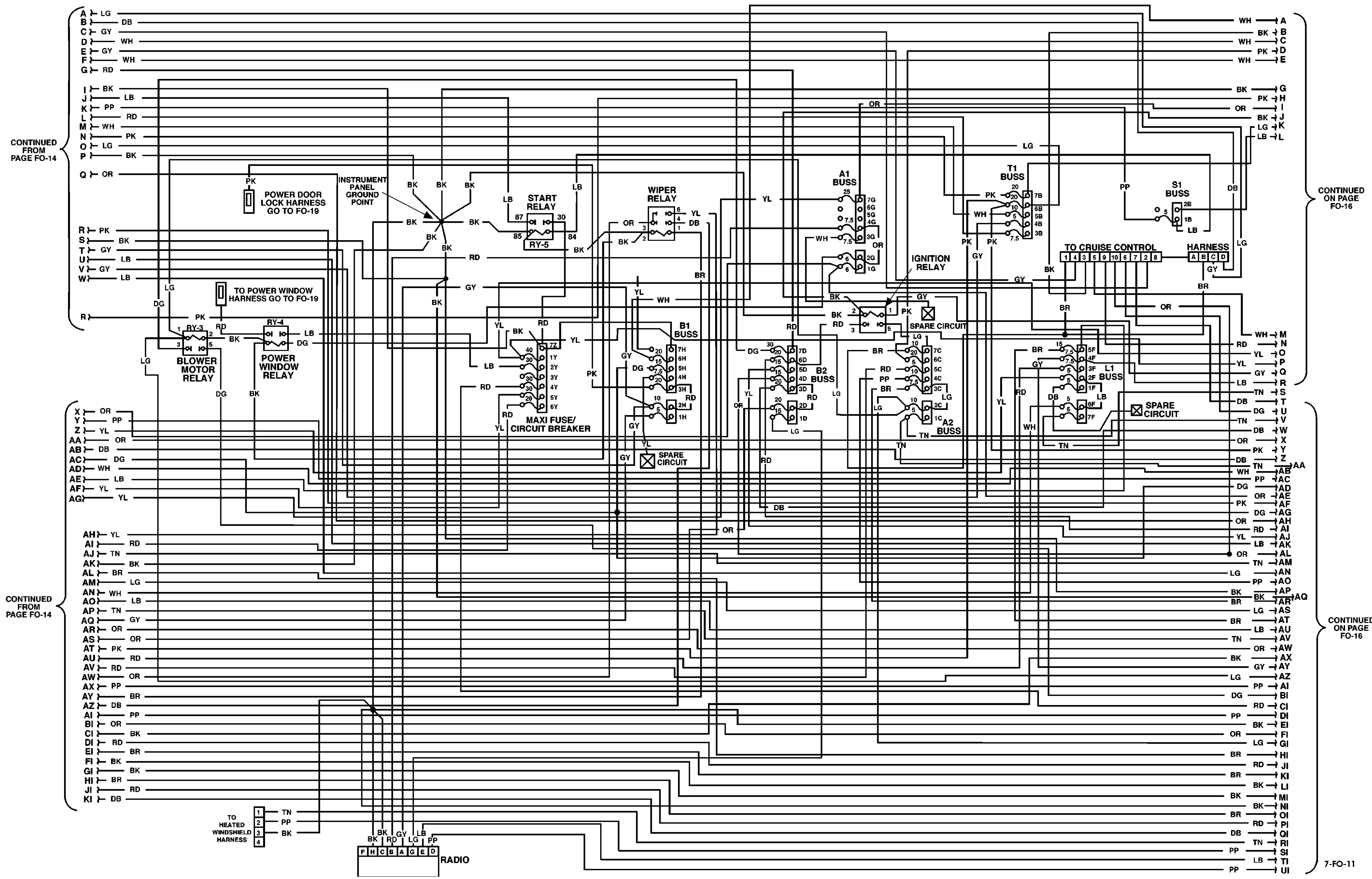
TO CONTROL HARNESS (CONNECTOR 1) PAGE FO-9 OR FO-10
TRANSMISSION TO CONTROL HARNESS CONNECTOR
TWISTED PAIR
VEHICLE SPEED SENSOR
TRANSMISSION OUTPUT VEHICLE SPEED SENSOR (VSS) (DIESEL ONLY)
TRANSFER CASE LOCK SWITCH
TRANSFER CASE RANGE SWITCH (TURBO DIESEL ONLY)
TO CONTROL HARNESS (CONNECTOR 2) PAGE FO-9 OR FO-10
TRANSMISSION INPUT VEHICLE SPEED SENSOR (VSS)
TRANSMISSION CONNECTOR
TO TRANSMISSION
7-FO-15

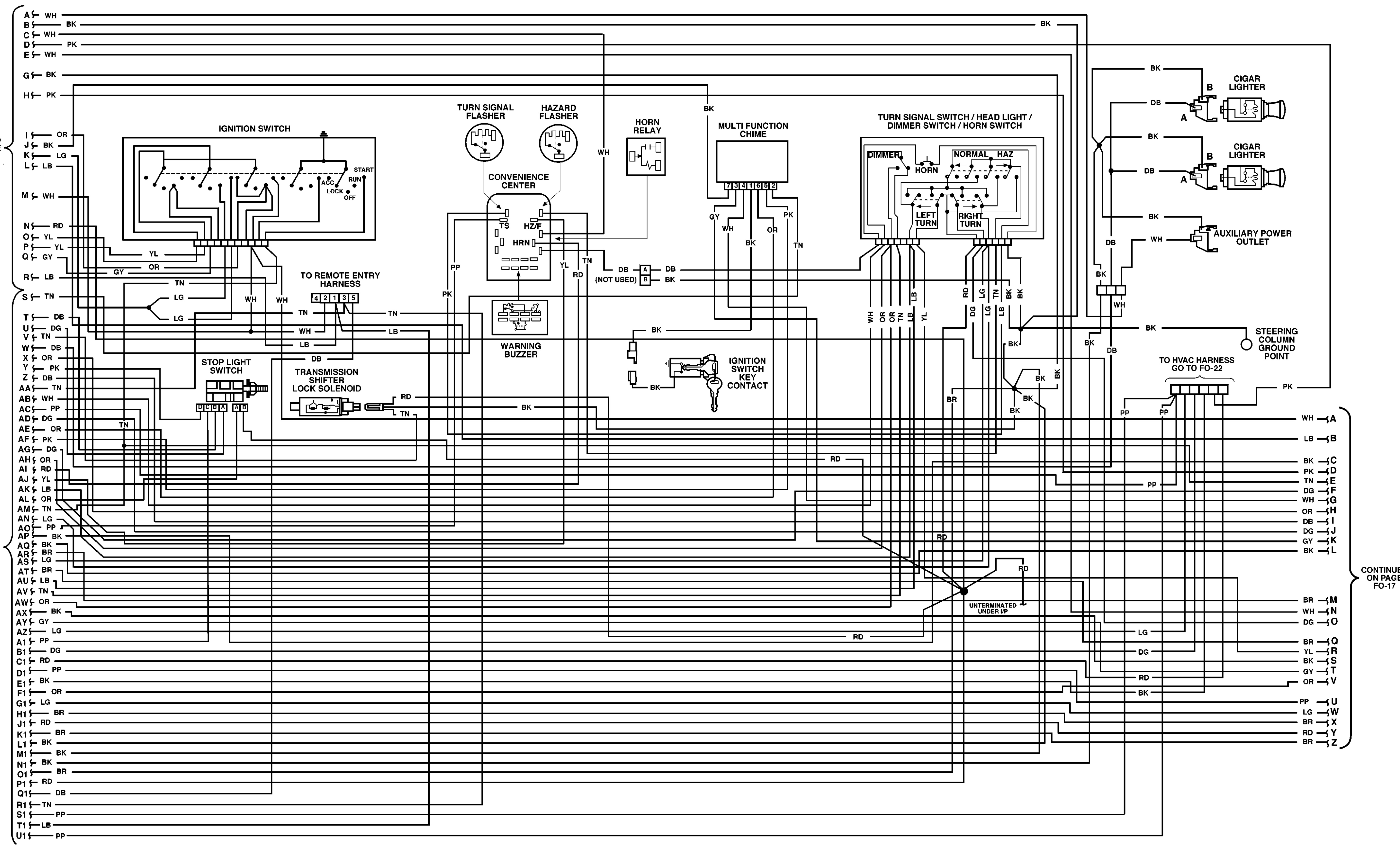


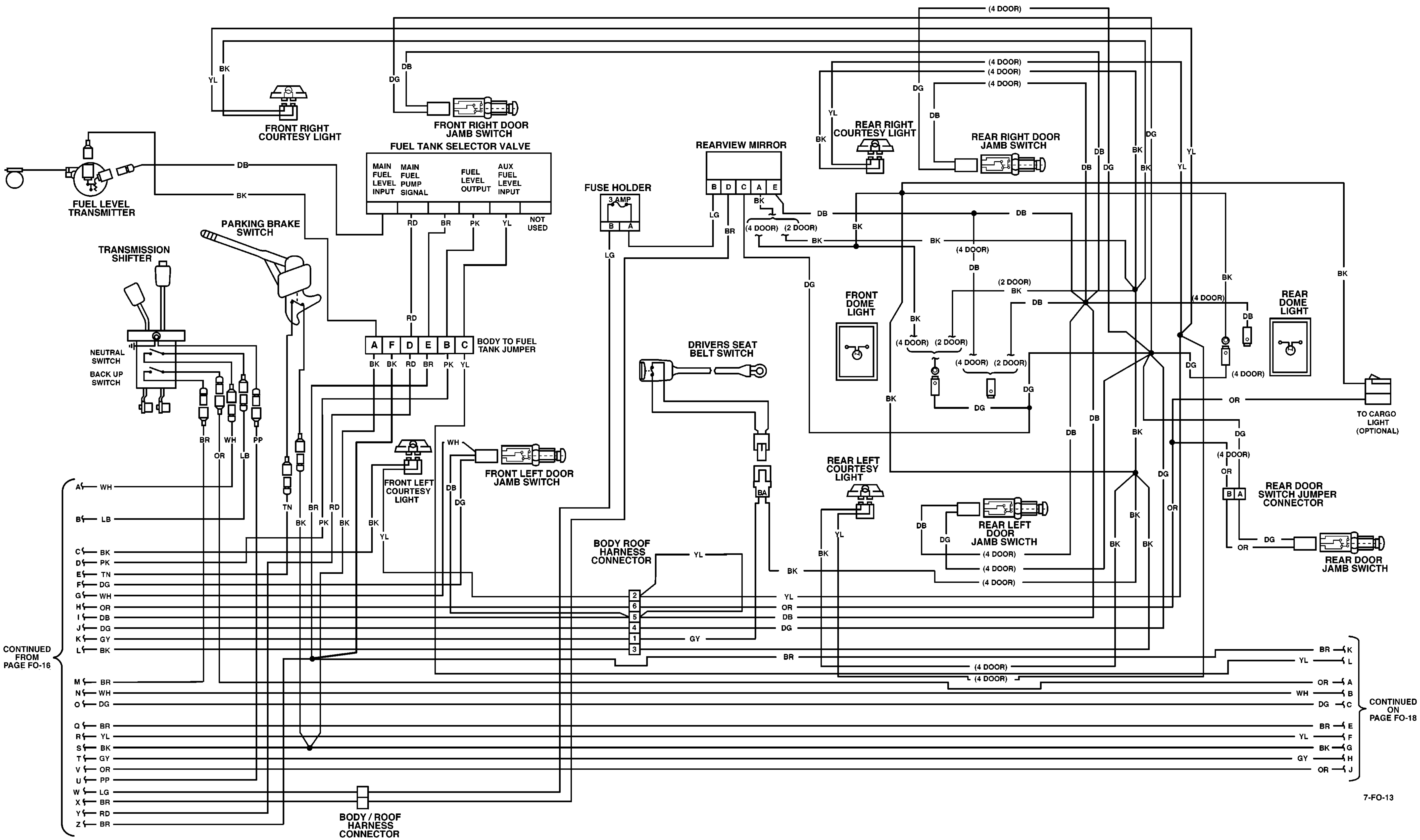
DISTRIBUTOR IGNITION CONTROL MODULE
IGNITION COIL
TO BODY HARNESS PAGE FO-14
IP TO BODY HARNESS CONNECTOR
A B C D E F G H J K L M N P R S T U V W X Y Z
BK PP OR PK YL DG YL PK DB RD BR LB
GY TN LB BR DB LG DG BR YL GY GY
VOLTMETER
OIL PRESSURE GAUGE
L.H. STATUS CENTER (IND LIGHTS)
BRAKE
SPEEDOMETER
TACHOMETER
MALFUNCTION INDICATOR LAMP (MIL) (CHECK ENGINE,TRANS AND THROTTLE INDICATOR)
R.H. STATUS CENTER (IND LIGHTS)
WATER TEMP GAUGE
FUEL GAUGE
LOW COOLANT WARNING LAMP
FUEL TANK SELECTOR SWITCH
AUX MAIN AUX MAIN
D B A C
ILLUMINATION
LOGIC
CLOCK

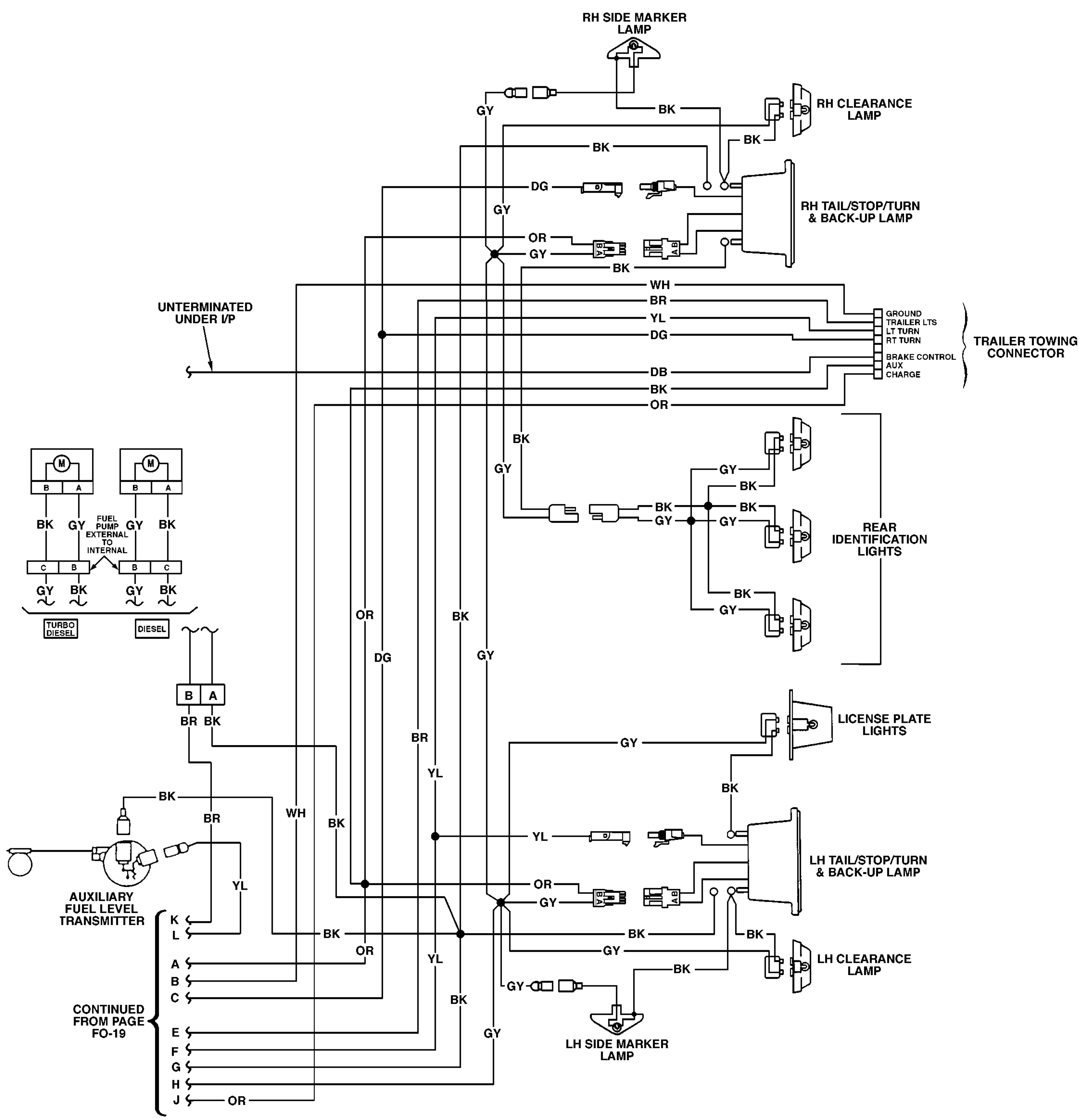

DUAL HORNS
FRONT IDENTIFICATION LAMPS
TO CONTROL HARNESS (CONNECTOR 1) PAGE FO-9 OR FO-10
BODY TO CONTROL HARNESS (CONNECTOR 1)
DATA LINK CONNECTOR (DLC)
CONTINUED ON PAGE FO-14
WINDSHIELD WASHER PUMP
BRAKE PRESSURE DIFFERENTIAL SWITCH
OUTSIDE TEMPERATURE SENSOR (OPTIONAL)
TROUBLE LIGHT (OPTIONAL)
TO CTI HARNESS PAGE FO-21
TO HOOD HARNESS CONTINUED FROM PAGE FO-23
CONTINUED ON PAGE FO-14
7-FO-09


CONTINUED FROM PAGE FO-13
BODY TO CONTROL HARNESS CONN.
TO CONTROL HARNESS (CONNECTOR 2) PAGE FO-9 AND FO-10
BODY TO ENGINE HARNESS CONNECTOR
TO ENGINE HARNESS PAGE FO-6 AND FO-7
POWER GROUND STUDS (LEFT COWL INNER)
FUSIBLE LINK
RUST
TO ENGINE HARNESS (POWER GROUND STUDS)
WINDSHIELD WIPER MOTOR
WIPER SWITCH
WASHER SWITCH
HEADLIGHT SWITCH
PANEL LIGHT DIMMER SWITCH
DOME LIGHT SWITCH
BODY TO IP HARNESS CONNECTOR
TO IP HARNESS PAGE FO-12
TO CTI HARNESS PAGE FO-21
CONTINUED ON PAGE FO-15
7-FO-10




CONTINUED FROM PAGE FO-15
IGNITION SWITCH
START
RUN
ACC
LOCK
OFF
TURN SIGNAL FLASHER
HAZARD FLASHER
CONVENIENCE CENTER
TS
HZ/F
HRN
HORN RELAY
MULTI FUNCTION CHIME
TURN SIGNAL SWITCH / HEAD LIGHT / DIMMER SWITCH / HORN SWITCH
DIMMER
HORN
NORMAL
HAZ
LEFT TURN
RIGHT TURN
CIGAR LIGHTER
AUXILIARY POWER OUTLET
STEERING COLUMN GROUND POINT
TO HVAC HARNESS GO TO FO-22
TO REMOTE ENTRY HARNESS
(NOT USED)
WARNING BUZZER
IGNITION SWITCH KEY CONTACT
STOP LIGHT SWITCH
TRANSMISSION SHIFTER LOCK SOLENOID
UNTERMINATED UNDER I/P
CONTINUED ON PAGE FO-17
7-FO-12


FRONT RIGHT COURTESY LIGHT
FRONT RIGHT DOOR JAMB SWITCH
FUEL TANK SELECTOR VALVE
MAIN FUEL LEVEL INPUT
MAIN FUEL PUMP SIGNAL
FUEL LEVEL OUTPUT
AUX FUEL LEVEL INPUT
NOT USED
FUEL LEVEL TRANSMITTER
PARKING BRAKE SWITCH
TRANSMISSION SHIFTER
NEUTRAL SWITCH
BACK UP SWITCH
BODY TO FUEL TANK JUMPER
FUSE HOLDER
3 AMP
REARVIEW MIRROR
DRIVERS SEAT BELT SWITCH
FRONT DOME LIGHT
REAR RIGHT COURTESY LIGHT
REAR RIGHT DOOR JAMB SWITCH
REAR DOME LIGHT
TO CARGO LIGHT (OPTIONAL)
FRONT LEFT COURTESY LIGHT
FRONT LEFT DOOR JAMB SWITCH
BODY ROOF HARNESS CONNECTOR
REAR LEFT COURTESY LIGHT
REAR LEFT DOOR JAMB SWICTH
REAR DOOR SWITCH JUMPER CONNECTOR
REAR DOOR JAMB SWITCH
(4 DOOR)
(2 DOOR)
CONTINUED FROM PAGE FO-16
CONTINUED ON PAGE FO-18
BODY / ROOF HARNESS CONNECTOR
7-FO-13



LEGEND

THE FOLLOWING IS AN EXAMPLE OF WIRING SCHEMATIC HARNESS AND COLOR ABBREVIATIONS:

BK	BLACK
BL	BLUE
BR	BROWN
DB	DARK BLUE
DG	DARK GREEN
GR	GREEN
GY	GRAY
LB	LIGHT BLUE
LG	LIGHT GREEN
OR	ORANGE
PK	PINK
PP	PURPLE
RD	RED
TN	TAN
WH	WHITE
YL	YELLOW

SPLICE

GROUND

GROUND

LAMP

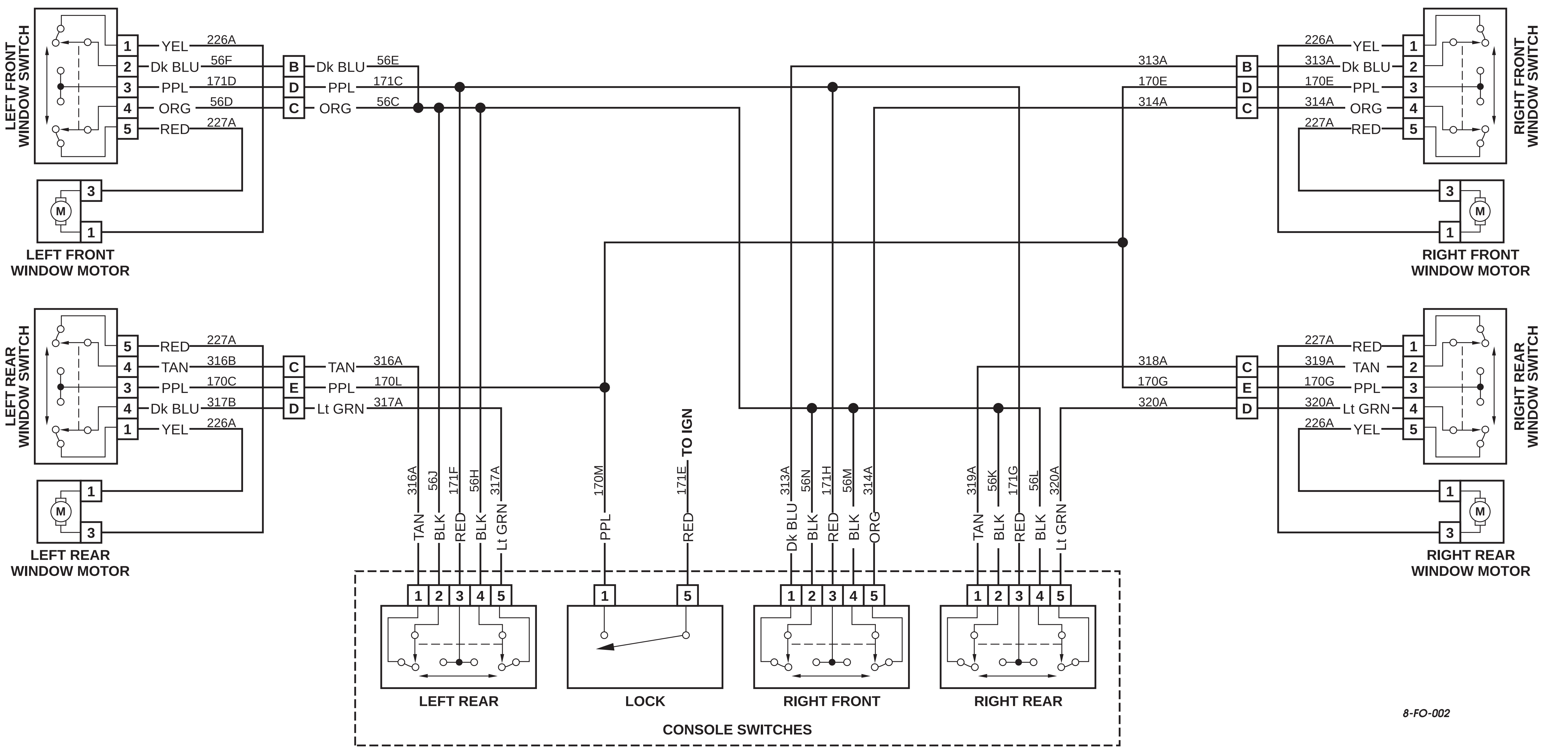
M MOTOR

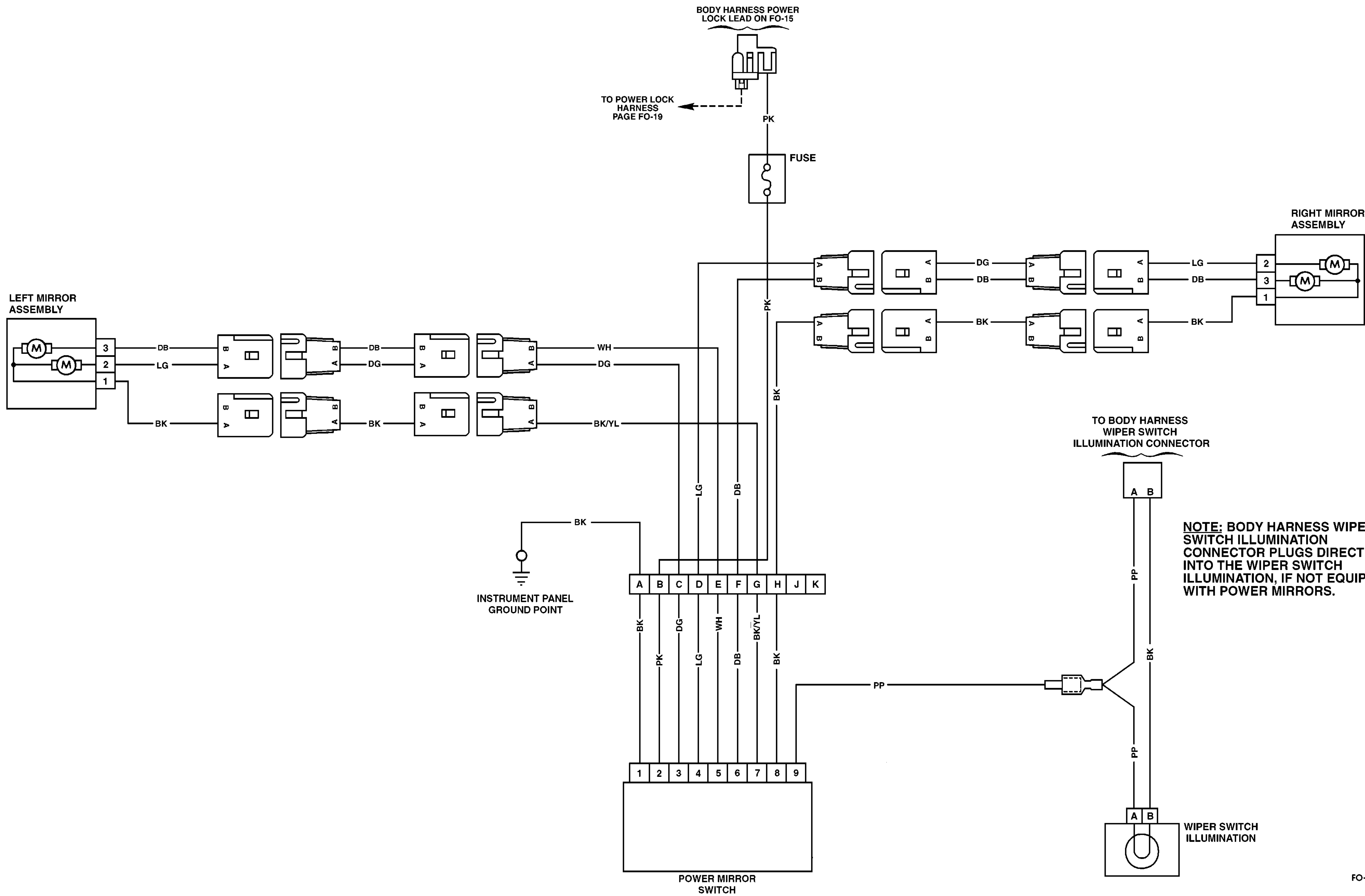
FUSE

CIRCUIT BREAKER

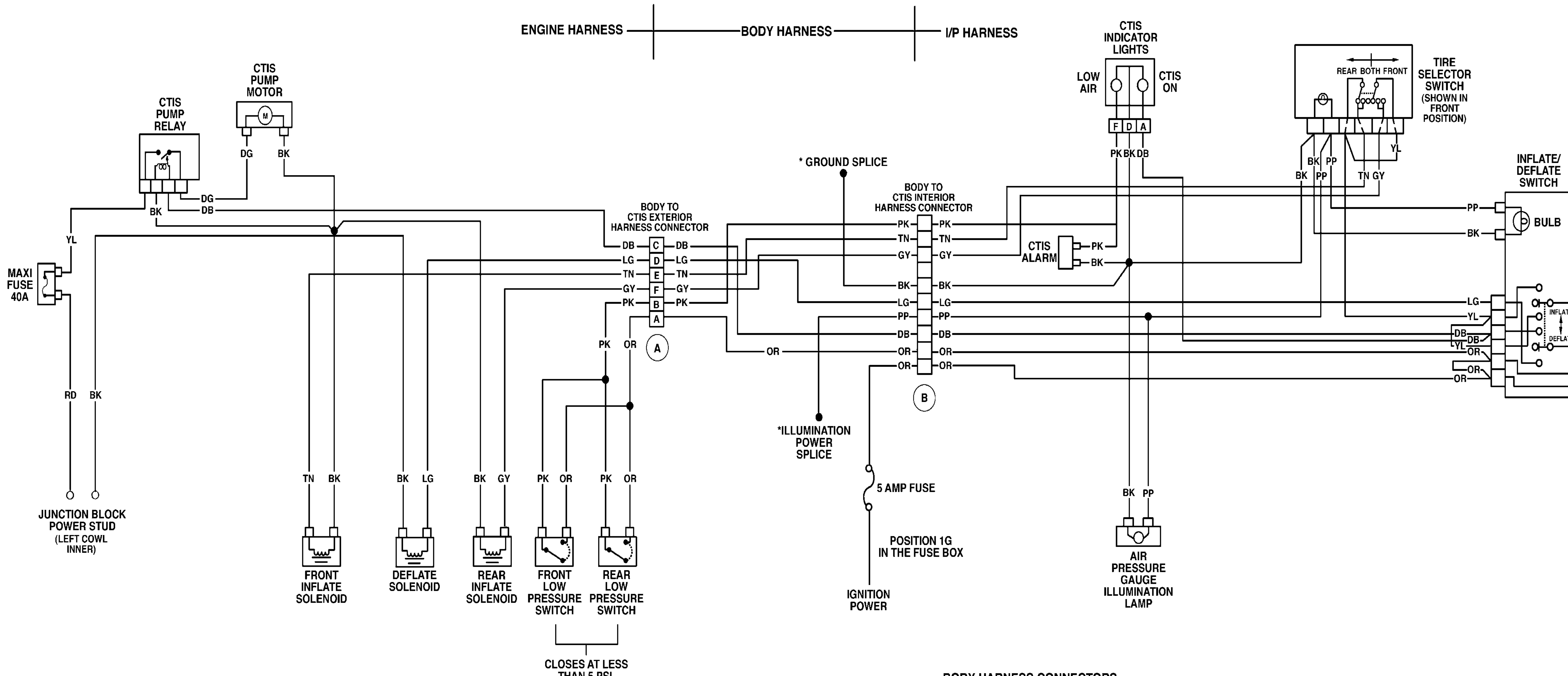
NOTES

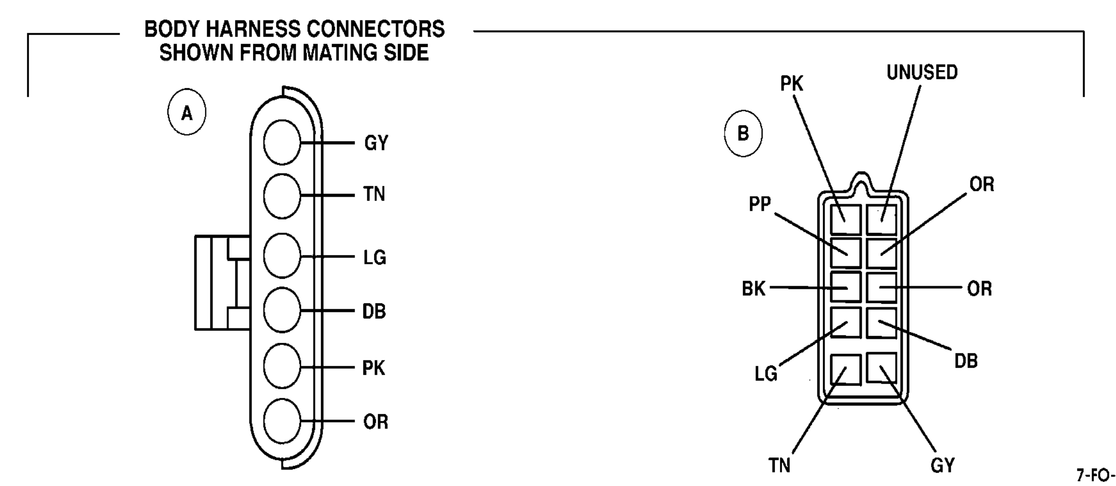
7-FO-14


LEFT FRONT WINDOW SWITCH
YEL 226A
Dk BLU 56F
PPL 171D
ORG 56D
RED 227A
Dk BLU 56E
PPL 171C
ORG 56C
LEFT FRONT WINDOW MOTOR
LEFT REAR WINDOW SWITCH
RED 227A
TAN 316B
PPL 170C
Dk BLU 317B
YEL 226A
TAN 316A
PPL 170L
Lt GRN 317A
LEFT REAR WINDOW MOTOR
RIGHT FRONT WINDOW SWITCH
313A
170E
314A
226A YEL
313A Dk BLU
170E PPL
314A ORG
227A RED
RIGHT FRONT WINDOW MOTOR
RIGHT REAR WINDOW SWITCH
318A
170G
320A
227A RED
319A TAN
170G PPL
320A Lt GRN
226A YEL
RIGHT REAR WINDOW MOTOR
316A TAN
56J BLK
171F RED
56H BLK
317A Lt GRN
170M PPL
171E RED
TO IGN
313A Dk BLU
56N BLK
171H RED
56M BLK
314A ORG
319A TAN
56K BLK
171G RED
56L BLK
320A Lt GRN
LEFT REAR
LOCK
RIGHT FRONT
RIGHT REAR
CONSOLE SWITCHES
8-FO-002



NOTE: BODY HARNESS WIPER SWITCH ILLUMINATION CONNECTOR PLUGS DIRECTLY INTO THE WIPER SWITCH ILLUMINATION, IF NOT EQUIPPED WITH POWER MIRRORS.



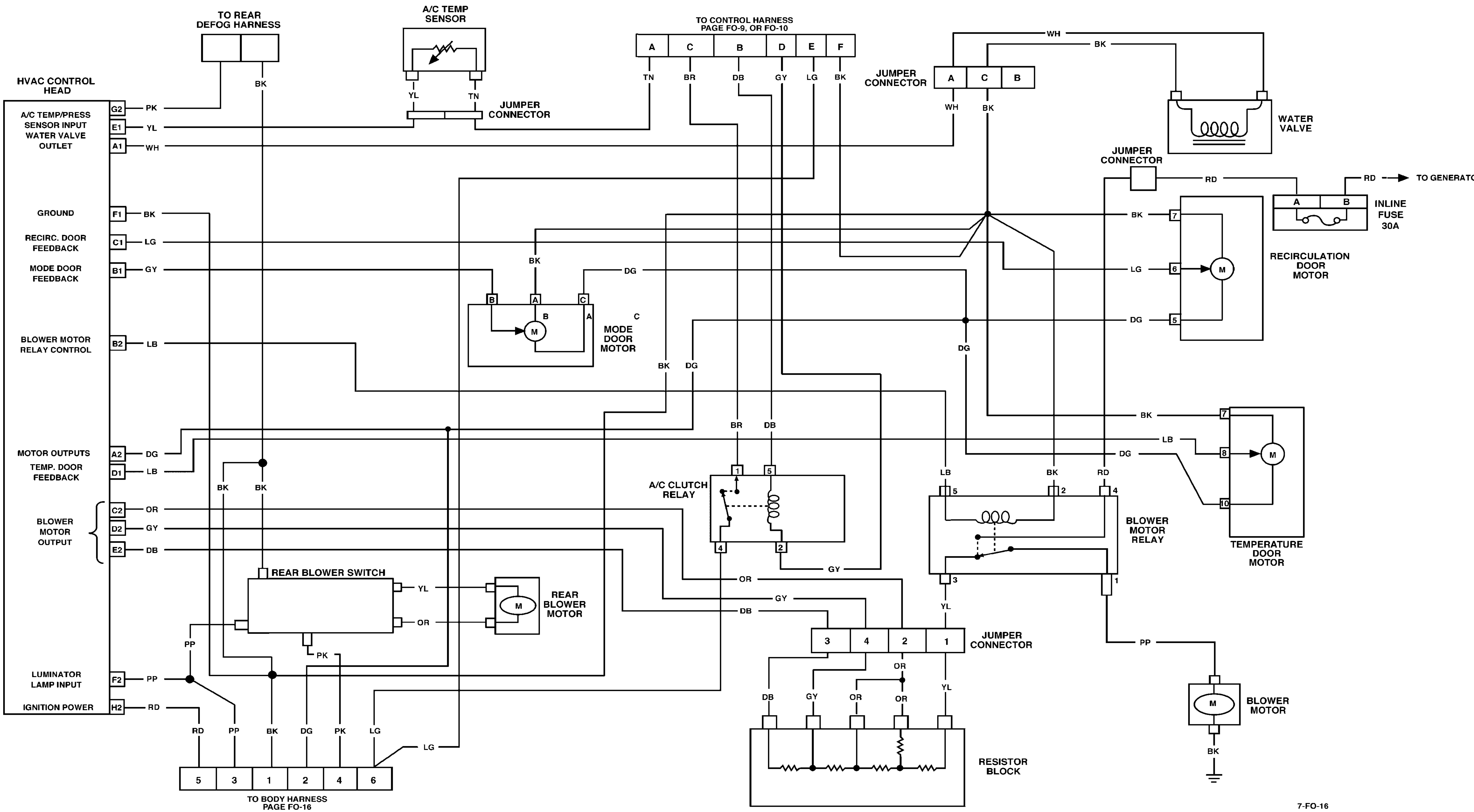


CIRCUIT COLORS

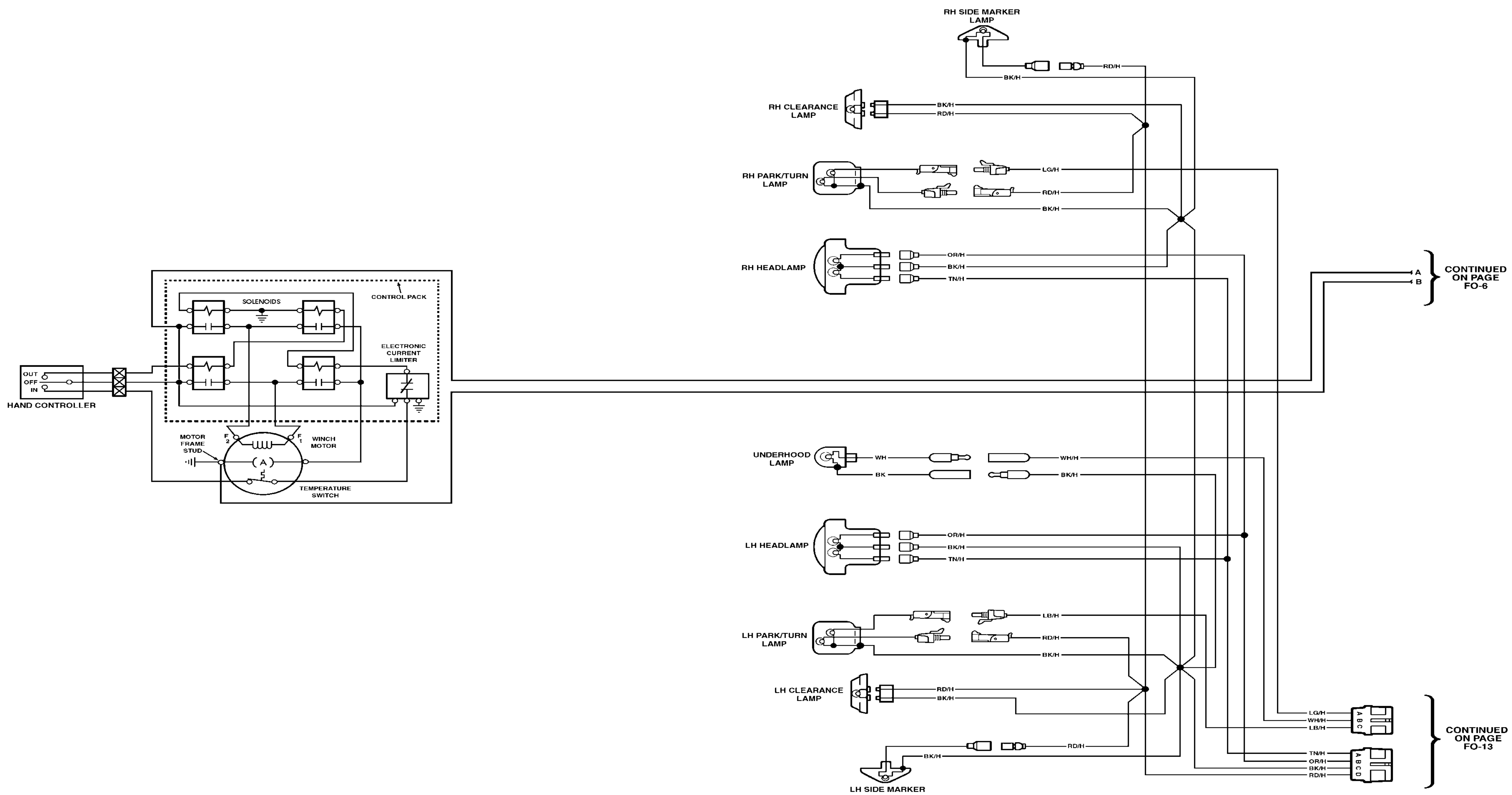
OR-ORANGE
RD-RED
BK-BLACK
YL-YELLOW
DB-DARK BLUE
DG-DARK GREEN
TN-TAN
LG-LIGHT GREEN
GY-GREY
PK-PINK
PP-PURPLE

* GROUND SPLICE LOCATED IN BODY HARNESS IN WINDSHIELD WIPER MOTOR TAKE OUT

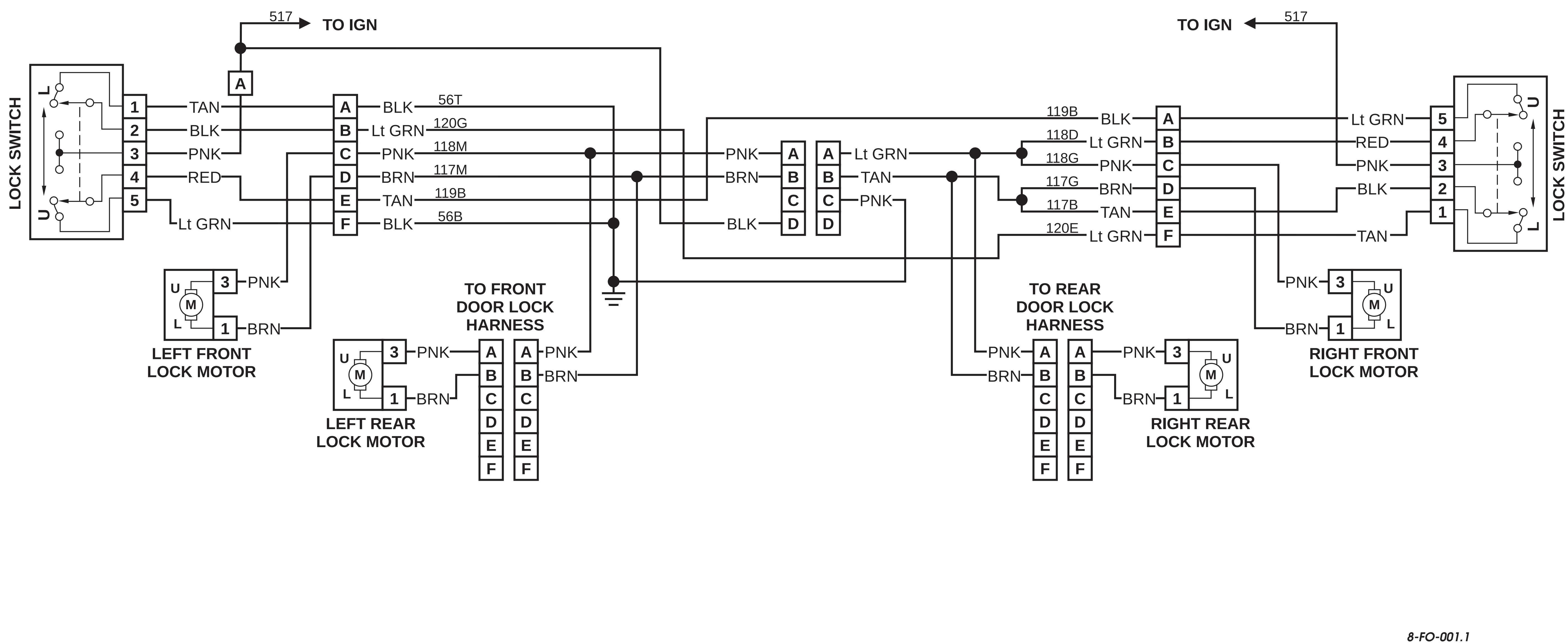
* POWER SPLICE LOCATED IN BODY HARNESS THREE INCHES FROM DOME LAMP SWITCH CONNECTOR



TO REAR DEFOG HARNESS
A/C TEMP SENSOR
TO CONTROL HARNESS PAGE FO-9, OR FO-10
JUMPER CONNECTOR
HVAC CONTROL HEAD
A/C TEMP/PRESS SENSOR INPUT WATER VALVE OUTLET
GROUND
RECIRC. DOOR FEEDBACK
MODE DOOR FEEDBACK
BLOWER MOTOR RELAY CONTROL
MOTOR OUTPUTS
TEMP. DOOR FEEDBACK
BLOWER MOTOR OUTPUT
LUMINATOR LAMP INPUT
IGNITION POWER
WATER VALVE
TO GENERATOR
INLINE FUSE 30A
RECIRCULATION DOOR MOTOR
MODE DOOR MOTOR
A/C CLUTCH RELAY
BLOWER MOTOR RELAY
TEMPERATURE DOOR MOTOR
REAR BLOWER SWITCH
REAR BLOWER MOTOR
RESISTOR BLOCK
BLOWER MOTOR
TO BODY HARNESS PAGE FO-16
7-FO-16


RH SIDE MARKER LAMP
RH CLEARANCE LAMP
RH PARK/TURN LAMP
RH HEADLAMP
CONTROL PACK
SOLENOIDS
ELECTRONIC CURRENT LIMITER
OUT
OFF
IN
HAND CONTROLLER
MOTOR FRAME STUD
WINCH MOTOR
TEMPERATURE SWITCH
UNDERHOOD LAMP
LH HEADLAMP
LH PARK/TURN LAMP
LH CLEARANCE LAMP
LH SIDE MARKER LAMP
BK/H
RD/H
LG/H
OR/H
TN/H
WH
BK
WH/H
LB/H
CONTINUED ON PAGE FO-6
CONTINUED ON PAGE FO-13

6-FO-26


517
TO IGN
LOCK SWITCH
TAN
BLK
PNK
RED
Lt GRN
BLK 56T
Lt GRN 120G
PNK 118M
BRN 117M
TAN 119B
BLK 56B
LEFT FRONT LOCK MOTOR
LEFT REAR LOCK MOTOR
TO FRONT DOOR LOCK HARNESS
TO REAR DOOR LOCK HARNESS
RIGHT FRONT LOCK MOTOR
RIGHT REAR LOCK MOTOR
119B BLK
118D Lt GRN
118G PNK
117G BRN
117B TAN
120E Lt GRN
8-FO-001.1