

2002

Workshop Manual



COUGAR VOLUME 1

Ford Motor Company

INTRODUCTION

NOTE: The descriptions and specifications contained in this manual were in effect at the time this manual was approved for printing. Ford Motor Company reserves the right to discontinue models at any time, or change specifications or design without notice and without incurring any obligation.

IMPORTANT SAFETY NOTICE

Appropriate service methods and procedures are essential for the safe, reliable operation of all motor vehicles as well as the personal safety of the individual doing the work. This manual provides general directions for performing service with tested, effective techniques. Following them will help assure reliability.

There are numerous variations in procedure, techniques, tools and parts for servicing vehicles, as well as in the skill of the individual doing the work. This manual cannot possibly anticipate all such variations and provide advice or cautions as to each. Accordingly, anyone who departs from the instructions provided in this manual must first establish that he compromises neither his personal safety nor the vehicle integrity by his choice of methods, tools or parts.

NOTES, CAUTIONS, AND WARNINGS

As you read through the procedures, you will come across **NOTES**, **CAUTIONS**, and **WARNINGS**. Each one is there for a specific purpose. **NOTES** give you added information that will help you to perform a particular procedure. **CAUTIONS** are given to prevent you from making an error that could damage the vehicle. **WARNINGS** remind you to be especially careful in those areas where carelessness can cause you personal injury. The following list contains some general **WARNINGS** that you should follow when you work on a vehicle.

- **ALWAYS WEAR SAFETY GLASSES FOR EYE PROTECTION.**
- **USE SAFETY STANDS WHENEVER A PROCEDURE REQUIRES YOU TO BE UNDER THE VEHICLE.**
- **MAKE SURE THAT THE IGNITION SWITCH IS ALWAYS IN THE OFF POSITION, UNLESS OTHERWISE REQUIRED BY THE PROCEDURE.**
- **SET THE PARKING BRAKE WHEN WORKING ON THE VEHICLE. IF YOU HAVE AN AUTOMATIC TRANSMISSION, SET IN PARK UNLESS INSTRUCTED OTHERWISE FOR A SPECIFIC OPERATION. IF YOU HAVE A MANUAL TRANSMISSION, IT SHOULD BE IN REVERSE (ENGINE OFF) OR NEUTRAL (ENGINE ON) UNLESS INSTRUCTED OTHERWISE FOR A SPECIFIC OPERATION. PLACE WOOD BLOCKS (4" X 4" OR LARGER) AGAINST THE FRONT AND REAR SURFACES OF THE TIRES TO HELP PREVENT THE VEHICLE FROM MOVING.**
- **OPERATE THE ENGINE ONLY IN A WELL-VENTILATED AREA TO AVOID THE DANGER OF CARBON MONOXIDE POISONING.**
- **KEEP YOURSELF AND YOUR CLOTHING AWAY FROM MOVING PARTS WHEN THE ENGINE IS RUNNING, ESPECIALLY THE DRIVE BELTS.**
- **TO PREVENT SERIOUS BURNS, AVOID CONTACT WITH HOT METAL PARTS SUCH AS THE RADIATOR, EXHAUST MANIFOLD, TAIL PIPE, THREE-WAY CATALYTIC CONVERTER AND MUFFLER.**
- **DO NOT SMOKE WHILE WORKING ON A VEHICLE.**
- **TO AVOID INJURY, ALWAYS REMOVE RINGS, WATCHES, LOOSE HANGING JEWELRY AND LOOSE CLOTHING BEFORE BEGINNING TO WORK ON A VEHICLE.**
- **WHEN IT IS NECESSARY TO WORK UNDER THE HOOD, KEEP HANDS AND OTHER OBJECTS CLEAR OF THE RADIATOR FAN BLADES!**

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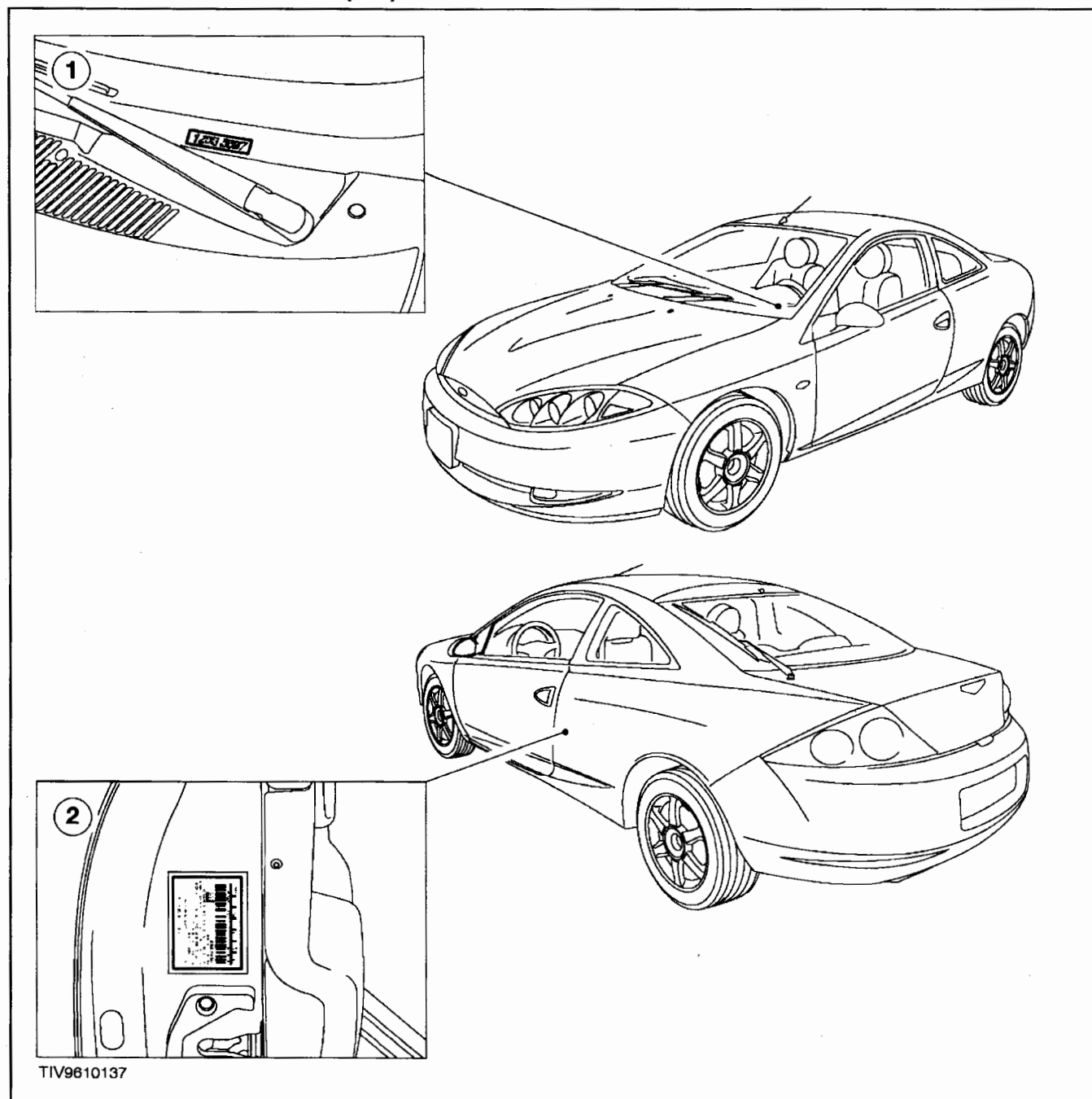
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DESCRIPTION AND OPERATION

Identification Codes

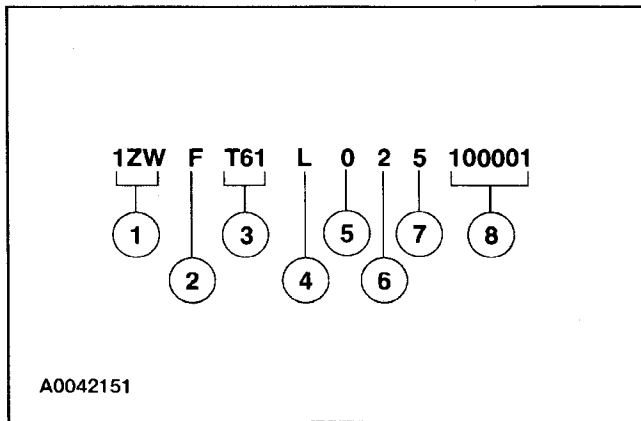
Vehicle Identification Number (VIN)



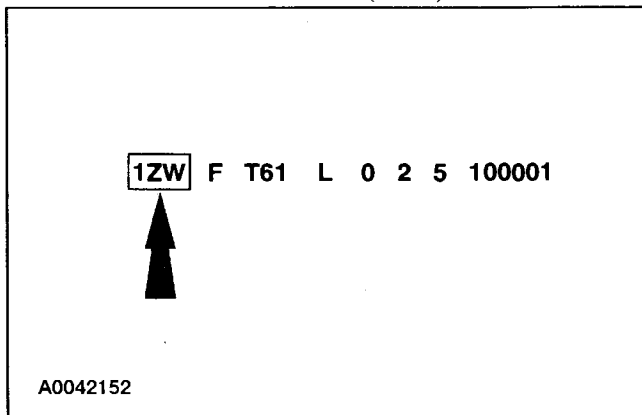
Item	Description
1	Vehicle identification number (VIN)
2	Vehicle certification (VC) label

DESCRIPTION AND OPERATION (Continued)

The vehicle identification number (VIN) is a seventeen-digit alphanumeric code. The VIN is stamped on a metal tab riveted to the instrument panel, top upper left of the dash. The VIN is also found on the vehicle certification (VC) label.

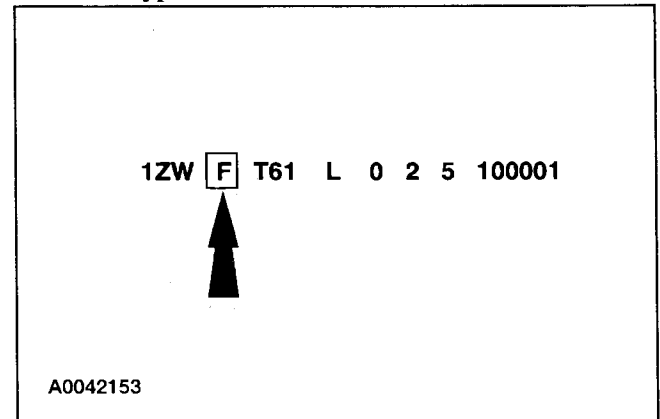


Item	Description
1	World manufacturer identifier
2	Restraint type code
3	Line, series, body type
4	Engine code
5	Computer generated VIN check digit
6	Model year code
7	Assembly plant
8	Production sequence number

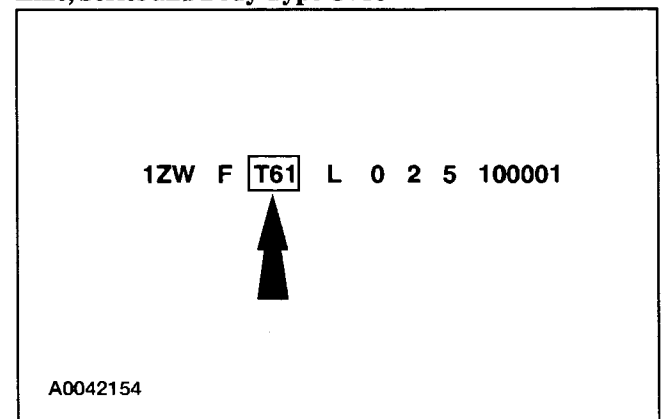
World Manufacturer Identifier (WMI)

The first three vehicle identification number (VIN) positions are the world manufacturer identifier (WMI).

- 1ZW — Auto Alliance International, Inc. (passenger car)

Restraint Type Code

- F — Active safety belts — all positions — driver and front passenger air bags
- H — Active safety belts — all positions — driver and front passenger air bags and driver and front passenger side impact air bags

Line, Series and Body Type Code

Positions five through seven indicate vehicle line, series and body type.

- T60 — Cougar, three-door coupe, in-line four-cylinder engine
- T61 — Cougar, three-door coupe, V-6 engine

DESCRIPTION AND OPERATION (Continued)**Engine Code**1ZW F T61 **L** 0 2 5 100001

A0042155

The eighth VIN position is the engine displacement and number of cylinders code.

- 3 — 2.0L, EFI (DOHC), in-line four cylinder
- L — 2.5L, EFI (DOHC), V-6

Computer Generated Check Digit1ZW F T61 L **0** 2 5 100001

A0042156

The ninth VIN position is a government assigned, computer-generated check digit code (0-9).

Model Year Code1ZW F T61 L 0 **2** 5 100001

A0042157

The tenth VIN position is the model year code.

- W — 1998
- X — 1999
- Y — 2000
- 1 — 2001
- 2 — 2002

Assembly Plant Code1ZW F T61 L 0 2 **5** 100001

A0042158

The eleventh VIN position is the assembly plant code.

- 5 — Auto Alliance International (AAI) — Flat Rock, Michigan

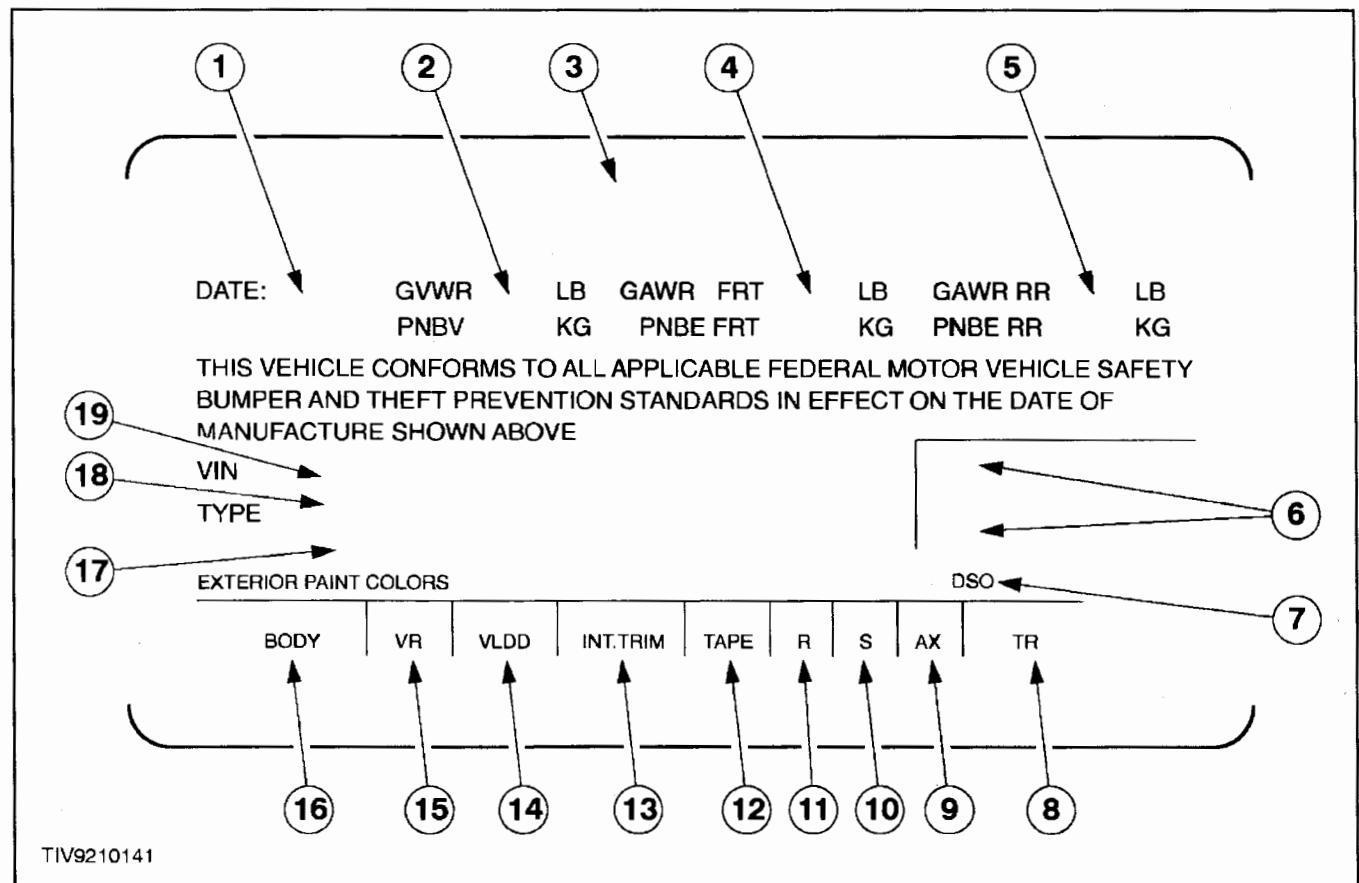
Production Sequence Number1ZW F T61 L 0 2 5 **100001**

A0042159

The last six VIN positions are the production sequence number. This number is also used as the vehicle serial and warranty number.

DESCRIPTION AND OPERATION (Continued)**Vehicle Certification (VC) Codes**

The upper portion of the vehicle certification (VC) label contains the manufacturer name, date of manufacture, the certification statement and the vehicle identification number (VIN). It also includes the gross vehicle weight rating (GVWR). The VC label is located in the left-hand door opening.



Item	Description
1	Build date
2	Gross vehicle weight ratings in pounds (LB) and kilograms (KG)
3	Name and location of manufacturer
4	Front gross axle ratings in pounds (LB) and kilograms (KG)
5	Rear gross axle ratio ratings in pounds (LB) and kilograms (KG)
6	Front/rear spring codes
7	District/special order codes
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Item	Description
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12	Tape stripe/paint stripe codes
13	Interior trim codes
14	Brake type codes
15	Sales region codes
16	Body type codes
17	Exterior paint colors
18	Type
19	Vehicle identification number

DESCRIPTION AND OPERATION (Continued)**Exterior Paint Codes**

DATE: GVWR LB GAWR FRT LB GAWR RR LB
PNBV KG PNBE FRT KG PNBE RR KG

THIS VEHICLE CONFORMS TO ALL APPLICABLE FEDERAL MOTOR VEHICLE SAFETY BUMPER AND THEFT PREVENTION STANDARDS EFFECT ON THE DATE OF MANUFACTURE SHOWN ABOVE.

VIN XXXXXXXXXXXXXXXX

TYPE PASSENGER

XX

EXTERIOR PAINT COLORS

BODY	VR	MLDG	INT. TRIM	TAPE	R	S	AX	TR
XXX	X		XX				X	XX

A0042448

Exterior paint codes may be listed as a two-part code. The first set of letters/numbers listed identify the vehicle primary body color. The second set of letters/numbers (if applicable), identify two-tone or accent body color code.

- ES — Red (clear coat)
- HL — Laser Tint Red (clear coat)
- W4 — White (clear coat)
- UB — Ebony (clear coat)
- TU — Silver Frost
- TG — Dark Shadow Gray Metallic (clear coat)
- BQ — Light Parchment Gold Metallic (clear coat)
- M9 — French Blue Metallic (clear coat)
- F5 — Grabber Green Metallic (clear coat)

Body Type Codes

DATE: GVWR LB GAWR FRT LB GAWR RR LB
PNBV KG PNBE FRT KG PNBE RR KG

THIS VEHICLE CONFORMS TO ALL APPLICABLE FEDERAL MOTOR VEHICLE SAFETY BUMPER AND THEFT PREVENTION STANDARDS EFFECT ON THE DATE OF MANUFACTURE SHOWN ABOVE.

VIN XXXXXXXXXXXXXXXX

TYPE PASSENGER

XX

EXTERIOR PAINT COLORS

BODY	VR	MLDG	INT. TRIM	TAPE	R	S	AX	TR
XXX	X		XX				X	XX

A0042160

- T60 — Coupe, in-line four-cylinder engine
- T61 — Coupe, V-6 engine

Moulding Codes

DATE: GVWR LB GAWR FRT LB GAWR RR LB
PNBV KG PNBE FRT KG PNBE RR KG

THIS VEHICLE CONFORMS TO ALL APPLICABLE FEDERAL MOTOR VEHICLE SAFETY BUMPER AND THEFT PREVENTION STANDARDS EFFECT ON THE DATE OF MANUFACTURE SHOWN ABOVE.

VIN XXXXXXXXXXXXXXXX

TYPE PASSENGER

XX

EXTERIOR PAINT COLORS

BODY	VR	MLDG	INT. TRIM	TAPE	R	S	AX	TR
XXX		X	XX				X	XX

A0042161

Moulding type codes no longer appear on the VC label.

Interior Trim Codes

DATE: GVWR LB GAWR FRT LB GAWR RR LB
PNBV KG PNBE FRT KG PNBE RR KG

THIS VEHICLE CONFORMS TO ALL APPLICABLE FEDERAL MOTOR VEHICLE SAFETY BUMPER AND THEFT PREVENTION STANDARDS EFFECT ON THE DATE OF MANUFACTURE SHOWN ABOVE.

VIN XXXXXXXXXXXXXXXX

TYPE PASSENGER

XX

EXTERIOR PAINT COLORS

BODY	VR	MLDG	INT. TRIM	TAPE	R	S	AX	TR
XXX		X	XX				X	XX

A0042162

Interior trim codes are listed below. The first letter/number identifies the interior fabric. The second letter/number identifies the interior trim color.

- A — Cloth — individual seating
- B — Sport Cloth — individual seating
- 8 — Leather — individual seating

Interior trim colors are:

- W — Midnight Black
- A — Medium Graphite
- H — Medium Parchment
- G — Dark Graphite
- B — French Blue
- R — Colorado Red

DESCRIPTION AND OPERATION (Continued)**Radio Codes**

DATE:	GVWR PNBV	LB KG	GAWR PNBE	FRT FRT	LB KG	GAWR PNBE	RR RR	LB KG
THIS VEHICLE CONFORMS TO ALL APPLICABLE FEDERAL MOTOR VEHICLE SAFETY BUMPER AND THEFT PREVENTION STANDARDS EFFECT ON THE DATE OF MANUFACTURE SHOWN ABOVE.								
VIN XXXXXXXXXXXXXXXXXX								
TYPE PASSENGER XX								
EXTERIOR PAINT COLORS								
BODY XXX	VR	MLDG X	INT.TRIM XX	TAPE	R	S X	AX X	TR XX
DSO.								

A0042163

The radio type codes are:

- K — AM/FM stereo with cassette and compact disc (CD) player
- 3 — AM/FM stereo with compact disc (CD) player
- 6 — AM/FM stereo with six-disc CD changer
- 7 — AM/FM stereo MACH 1000 with six-disc (CD) changer

Transaxle Code

DATE:	GVWR PNBV	LB KG	GAWR PNBE	FRT FRT	LB KG	GAWR PNBE	RR RR	LB KG
THIS VEHICLE CONFORMS TO ALL APPLICABLE FEDERAL MOTOR VEHICLE SAFETY BUMPER AND THEFT PREVENTION STANDARDS EFFECT ON THE DATE OF MANUFACTURE SHOWN ABOVE.								
VIN XXXXXXXXXXXXXXXXXX								
TYPE PASSENGER XX								
EXTERIOR PAINT COLORS								
BODY XXX	VR	MLDG X	INT.TRIM XX	TAPE	R	S X	AX X	TR XX
DSO.								

A0042166

The transaxle codes are:

- 5 — Five-speed manual (MTX-75)
- T — Automatic (CD4E)

Axle Ratio Codes

DATE:	GVWR PNBV	LB KG	GAWR PNBE	FRT FRT	LB KG	GAWR PNBE	RR RR	LB KG
THIS VEHICLE CONFORMS TO ALL APPLICABLE FEDERAL MOTOR VEHICLE SAFETY BUMPER AND THEFT PREVENTION STANDARDS EFFECT ON THE DATE OF MANUFACTURE SHOWN ABOVE.								
VIN XXXXXXXXXXXXXXXXXX								
TYPE PASSENGER XX								
EXTERIOR PAINT COLORS								
BODY XXX	VR	MLDG X	INT.TRIM XX	TAPE	R	S X	AX X	TR XX
DSO.								

A0042165

The axle ratios are:

- B — 4.06
- C — 3.84

Spring Codes

DATE:	GVWR PNBV	LB KG	GAWR PNBE	FRT FRT	LB KG	GAWR PNBE	RR RR	LB KG
THIS VEHICLE CONFORMS TO ALL APPLICABLE FEDERAL MOTOR VEHICLE SAFETY BUMPER AND THEFT PREVENTION STANDARDS EFFECT ON THE DATE OF MANUFACTURE SHOWN ABOVE.								
VIN XXXXXXXXXXXXXXXXXX								
TYPE PASSENGER XX								
EXTERIOR PAINT COLORS								
BODY XXX	VR	MLDG X	INT.TRIM XX	TAPE	R	S X	AX X	TR XX
DSO.								

A0042164

Spring codes are listed as a two-part code. The first character listed identifies the front springs code. The second character listed identifies the rear springs code.

The front springs codes are:

- J — 94BB-5310-JA — catchword JAP
- K — 94BB-5310-KA — catchword MSR
- L — 94BB-5310-LA — catchword NYA
- M — 94BB-5310-MA — catchword ARA
- N — 94BB-5310-NA — catchword DZM

The rear springs codes are:

- A — 94BB-5560-AA — catchword STB
- B — 94BB-5560-BA — catchword HNA
- C — 94BB-5560-CA — catchword CBT
- D — 94BB-5560-DA — catchword ZWT

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DESCRIPTION AND OPERATION

Jacking

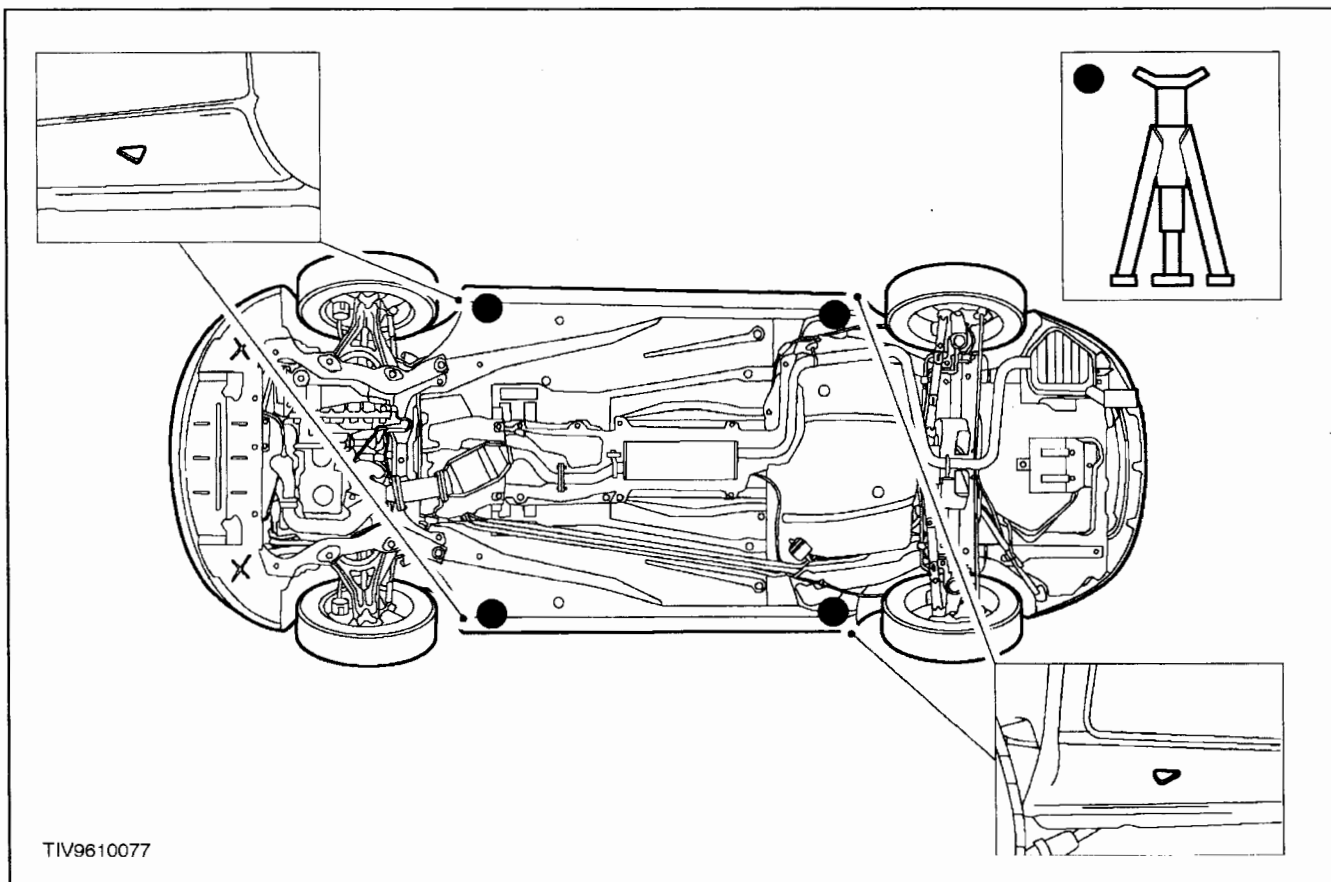
Jacking Points

⚠ WARNING: Always position the vehicle on a hard level surface. If the vehicle must be jacked up on a soft surface use load spreading blocks under the jack. Failure to follow these instructions may result in personal injury.

Before commencing any repairs that involve jacking the vehicle, it is essential that the following instructions are fully understood.

It is important that only the correct jacking and support locations are used at all times.

The vehicle may be lifted by positioning a floor jack under the outer rocker panel and supported by vehicle axle stands. The location is identified by an arrow symbol stamped in the outer rocker panel. Use a cushioned pad, if possible, to avoid damaging body paint.

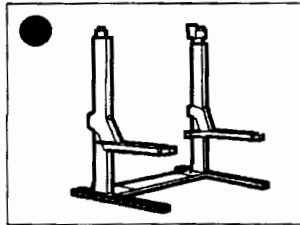
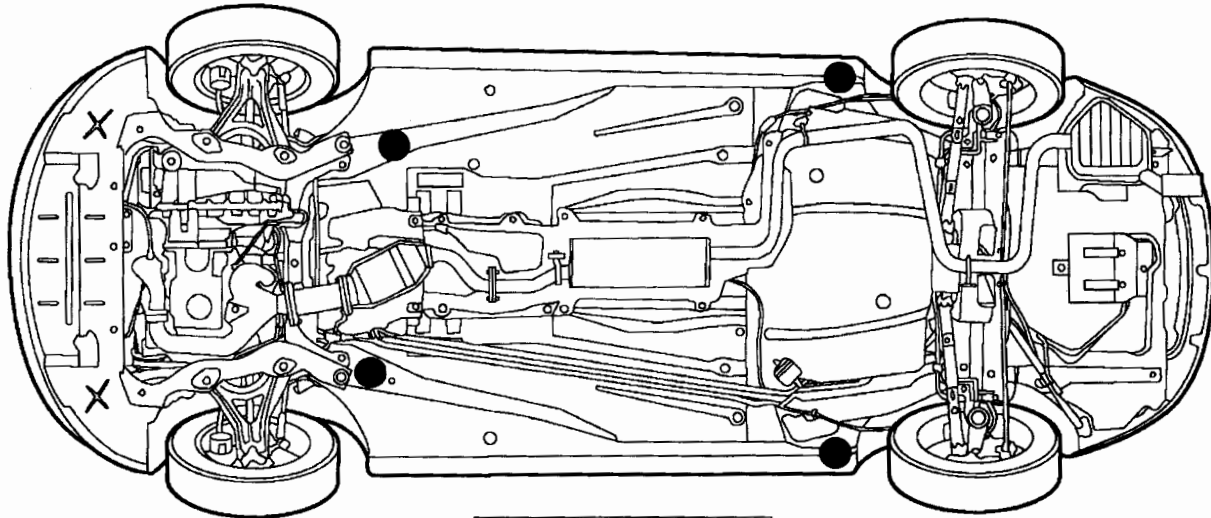


Lifting

Lifting Points

NOTE: When lifting a vehicle with a twin-post lift, vehicle levelling pads must be used under the lifting points.

It is important that only the correct lifting and support locations are used at all times.

DESCRIPTION AND OPERATION (Continued)

TIV9510077

SECTION 100-04 Noise, Vibration and Harshness

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DESCRIPTION AND OPERATION

Noise, Vibration And Harshness (NVH)

Noise is any undesirable sound, usually unpleasant in nature. Vibration is any motion, shaking or trembling, that can be felt or seen when an object moves back and forth or up and down. Harshness is a ride quality issue where the vehicle's response to the road transmits sharply to the customer. Harshness normally describes a firmer than usual response from the suspension system. Noise, vibration and harshness (NVH) is a term used to describe these conditions, which result in varying degrees of dissatisfaction. Although, a certain level of NVH caused by road and environmental conditions is normal. This section is designed to aid in the diagnosis, testing and repair of NVH concerns.

Acceptable Noise, Vibration and Harshness

All internal combustion engines and drivelines produce some noise and vibration; operating in a real world environment adds noise that is not subject to control. Vibration isolators, mufflers and dampers reduce these to acceptable levels. A driver who is unfamiliar with a vehicle can think that some sounds are abnormal when actually the sounds are normal for the vehicle type. For example, Traction-Lok® differentials produce a slight noise on slow turns after extended highway driving. This is acceptable and has no detrimental effect on the locking axle function. As a technician, it is very important to be familiar with vehicle features and know how they relate to NVH concerns and their diagnosis. If, for example, the vehicle has automatic overdrive it is important to test drive the vehicle both in and out of overdrive mode.

Diagnostic Theory

The shortest route to an accurate diagnosis results from:

- system knowledge, including comparison with a known good system.
- system history, including repair history and usage patterns.
- condition history, especially any relationship to repairs or sudden change.
- knowledge of possible sources.
- using a systematic diagnostic method that divides the system into related areas.

The diagnosis and correction of noise, vibration and harshness concerns requires:

- a road or system test to determine the exact nature of the concern.
- an analysis of the possible causes.
- testing to verify the cause.
- repairing any concerns found.
- a road test or system test to make sure the concern has been corrected or brought back to within an acceptable range.

Glossary of Terms

Acceleration-Light

An increase in speed at less than half throttle.

Acceleration-Medium

An increase in speed at half to nearly full throttle, such as 0-97 km/h (0-60 mph) in approximately 30 seconds.

Acceleration-Heavy

An increase in speed at one-half to full throttle, such as 0-97 km/h (0-60 mph) in approximately 20 seconds.

Ambient Temperature

The surrounding or prevailing temperature.

Amplitude

The quantity or amount of energy produced by a vibrating component (G force). An extreme vibration has a high amplitude. A mild vibration has a low amplitude.

Backlash

Gear teeth clearance.

Boom

Low frequency or low pitched noise often accompanied by a vibration. Also refer to Drumming.

Bound Up

An overstressed isolation (rubber) mount that transmits vibration/noise instead of absorbing it.

Brakes Applied

When the service brakes are applied with enough force to hold the vehicle against movement with the transmission in gear.

DESCRIPTION AND OPERATION (Continued)**Buffet/Buffering**

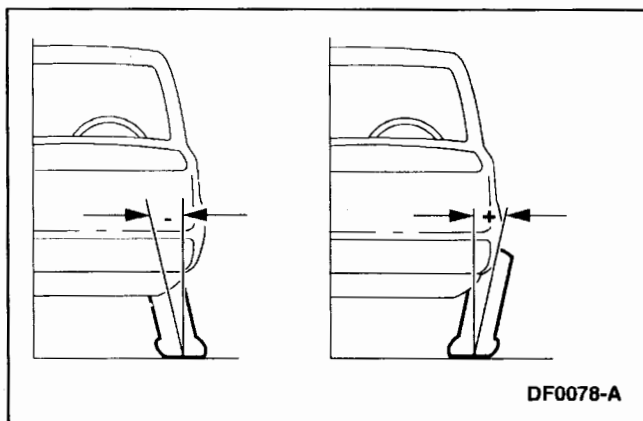
Strong noise fluctuations (less than 1000 Hz) caused by gusting winds. An example would be wind gusts against the side glass.

Buzz

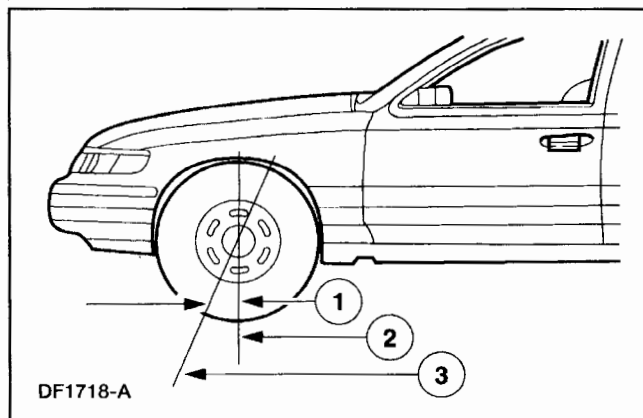
A low-pitched sound like (200-5000 Hz) that from a bee. Often a metallic or hard plastic humming sound. Also describes a high frequency (200-800 Hz) vibration. Vibration feels similar to an electric razor.

Camber

The angle of the wheel in relation to the true vertical as measured looking from the front of the vehicle. Camber is positive when the wheel angle is offset so that the top of the wheel is positioned away from the vehicle.

**Caster**

The angle of the steering knuckle in relation to the true vertical as measured looking from the side of the vehicle.



Item	Description
1	Positive caster
2	True vertical
3	Steering axis

Chatter

A pronounced series of rapidly repeating rattling or clicking sounds.

Chirp

A short-duration high-pitched noise associated with a slipping drive belt.

Chuckle

A repetitious low-pitched sound. A loud chuckle is usually described as a knock.

Click

A sharp, brief, non-resonant sound, similar to actuating a ball point pen.

Clonk

A hydraulic knocking sound. Sound occurs with air pockets in a hydraulic system. Also described as hammering.

Clunk/Driveline Clunk

A heavy or dull, short-duration, low-frequency sound. Occurs mostly on a vehicle that is accelerating or decelerating abruptly. Also described as a thunk.

Coast/Deceleration

Releasing the accelerator pedal at cruise, allowing the engine to reduce vehicle speed without applying the brakes.

Coast/Neutral Coast

Placing the transmission range selector in NEUTRAL (N) or depressing the clutch pedal while at cruise.

Constant Velocity (CV) Joint

A joint used to absorb vibrations caused by driving power being transmitted at an angle.

Controlled Rear Suspension Height

The height at which a designated vehicle element must be when driveline angle measurements are made.

Coupling Shaft

The shaft between the transfer case and the front drive axle or, in a two-piece rear driveshaft, the front section.

CPS

Cycles per second. Same as hertz (Hz).

Cracks

A mid-frequency sound, related to squeak. Sound varies with temperature conditions.

Creak

A metallic squeak.

DESCRIPTION AND OPERATION (Continued)

Cruise

Constant speed on level ground; neither accelerating nor decelerating.

Cycle

The process of a vibrating component going through a complete range of motion and returning to the starting point.

Decibel

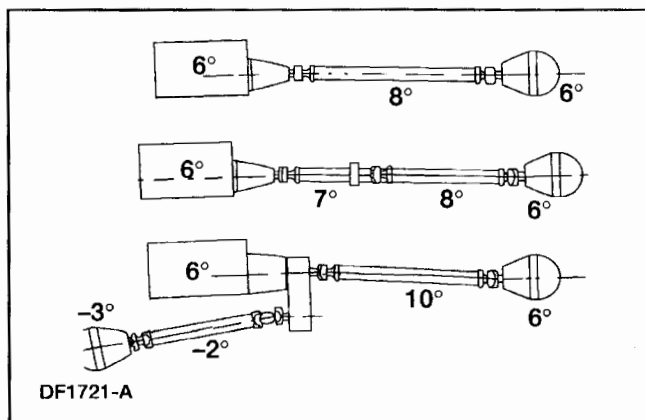
A unit of measurement, referring to sound pressure level, abbreviated dB.

Drive Engine Run-Up (DERU) Test

The operation of the engine through the normal rpm range with the vehicle standing still, the brakes applied and the transmission engaged. This test is used for noise and vibration checks.

Driveline Angles

The differences of alignment between the transmission output shaft, the driveshaft, and the rear axle pinion centerline.



Driveshaft

The shaft that transmits power to the rear axle input shaft (pinion shaft). In a two-piece driveshaft, it is the rearmost shaft.

Drivetrain

All power transmitting components from the engine to the wheels; includes the clutch or torque converter, the transmission, the transfer case, the driveshaft, and the front or rear drive axle.

Drivetrain Damper

A weight attached to the engine, the transmission, the transfer case, or the axle. It is tuned by weight and placement to absorb vibration.

Drone

A low frequency (100-200 Hz) steady sound, like a freezer compressor. Also described as a moan.

Drumming

A cycling, low-frequency (20-100 Hz), rhythmic noise often accompanied by a sensation of pressure on the ear drums. Also described as a low rumble, boom, or rolling thunder.

Dynamic Balance

The equal distribution of weight on each side of the centerline, so that when the wheel and tire assembly spins, there is no tendency for the assembly to move from side-to-side (wobble). Dynamically unbalanced wheel and tire assemblies can cause wheel shimmy.

Engine Imbalance

A condition in which an engine's center mass is not concentric to the rotation center, causing excessive motion.

Engine Misfire

When combustion in one or more cylinders does not occur or occurs at the wrong time.

Engine Shake

An exaggerated engine movement or vibration that directly increases in frequency as the engine speed increases. It is caused by non-equal distribution of mass in the rotating or reciprocating components.

Flexible Coupling

A flexible joint.

Float

A drive mode on the dividing line between cruise and coast where the throttle setting matches the engine speed with the road speed.

Flutter

Mid to high (100-2000 Hz) intermittent sound due to air flow. Similar to a flag flapping in the wind.

Frequency

The rate at which a cycle occurs within a given time.

Gravelly Feel

A grinding or growl in a component, similar to the feel experienced when driving on gravel.

Grind

An abrasive sound, similar to using a grinding wheel, or rubbing sand paper against wood.

Hiss

Steady high frequency (200-800 Hz) noise. Vacuum leak sound.

Hoot

A steady low frequency tone (50-500 Hz), sounds like blowing over a long neck bottle.

DESCRIPTION AND OPERATION (Continued)**Howl**

A mid-range frequency (200-800 Hz) noise between drumming and whine. Also described as a hum.

Hum

Mid-frequency (200-800 Hz) steady sound, like a small fan motor. Also described as a howl.

Hz

Hertz; a frequency measured in cycles per second.

Imbalance

Out of balance; heavier on one side than the other. In a rotating component, imbalance often causes vibration.

Inboard

Toward the centerline of the vehicle.

Intensity

The physical quality of sound that relates to the strength of the vibration (measured in decibels). The higher the sound's amplitude, the higher the intensity and vice versa.

Isolate

To separate the influence of one component to another.

Knock

A heavy, loud, repetitious sound, like a knock on the door.

Moan

A constant, low-frequency (100-200 Hz) tone. Also described as a hum.

Neutral Engine Run-Up (NERU) Test

The operation of the engine through the normal rpm range with the vehicle standing still and the transmission disengaged. This test is used to identify engine related vibrations.

Neutralize/Normalize

To return to an unstressed position. Used to describe mounts. Refer to Bound Up.

Outboard

Away from the centerline of the vehicle.

Ping

A short duration, high-frequency sound, which has a slight echo.

Pinion Shaft

The input shaft in a driving axle that is usually a part of the smaller driving or input hypoid gear of a ring and pinion gearset.

Pitch

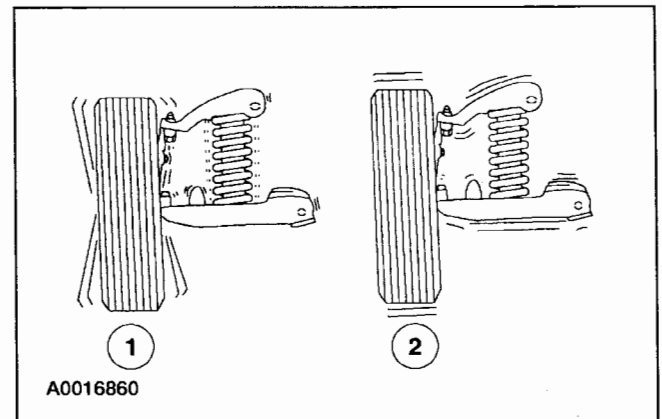
The physical quality of sound that relates to its frequency. Pitch increases as frequency increases and vice versa.

Pumping Feel

A slow, pulsing movement.

Radial/Lateral

Radial is in the plane of rotation; lateral is at 90 degrees to the plane of rotation.



Item	Description
1	Lateral runout
2	Radial runout

Rattle

A random and momentary or short duration noise.

Ring Gear

The large, circular, driven gear in a ring and pinion gearset.

Road Test

The operation of the vehicle under conditions intended to produce the concern under investigation.

Roughness

A medium-frequency vibration. A slightly higher frequency (20 to 50 Hz) than a shake. This type of vibration is usually related to drivetrain components.

Runout

Lateral runout means measuring the movement or "wobble" of a wheel or tire at the sidewall. Radial runout means measuring the out-of-round at the tread surface.

DESCRIPTION AND OPERATION (Continued)**Rustling**

Intermittent sound of varying frequency (100-2000 Hz), sounds similar to shuffling through leaves.

Shake

A low-frequency vibration (5-20 Hz), usually with visible component movement. Usually relates to tires, wheels, brake drums or brake discs if it is vehicle speed sensitive, or engine if it is engine speed sensitive. Also referred to as a shimmy or wobble.

Shimmy

An abnormal vibration or wobbling, felt as a side-to-side motion of the steering wheel in the driveshaft rotation. Also described as waddle.

Shudder

A low-frequency vibration that is felt through the steering wheel or seat during light brake application.

Slap

A resonance from flat surfaces, such as safety belt webbing or door trim panels.

Slip Yoke/Slip Spline

The driveshaft coupling that allows length changes to occur while the suspension articulates and while the driveshaft rotates.

Squeak

A high-pitched transient sound, similar to rubbing fingers against a clean window.

Squeal

A long-duration, high-pitched noise.

Static Balance

The equal distribution of weight around the wheel. Statically unbalanced wheel and tire assemblies can cause a bouncing action called wheel tramp. This condition will eventually cause uneven tire wear.

Tap

A light, rhythmic, or intermittent hammering sound, similar to tapping a pencil on a table edge.

Thump

A dull beat caused by two items striking together.

Tick

A rhythmic tap, similar to a clock noise.

Tip-In Moan

A light moaning noise heard during light vehicle acceleration, usually between 40-100 km/h (25-65 mph).

TIR

The acronym for total indicated runout is TIR.

Tire Deflection

The change in tire diameter in the area where the tire contacts the ground.

Tire Flat Spots

A condition commonly caused by letting the vehicle stand while the tires cool off. This condition can be corrected by driving the vehicle until the tires are warm. Also, irregular tire wear patterns in the tire tread resulting from wheel-locked skids.

Tire Force Vibration

A tire vibration caused by variations in the construction of the tire that is noticeable when the tire rotates against the pavement. This condition can be present on perfectly round tires because of variations in the inner tire construction. This condition can occur at wheel rotation frequency or twice rotation frequency.

Transient

A noise or vibration that is momentary, a short duration.

Two-Plane Balance

Radial and lateral balance.

Vibration

Any motion, shaking or trembling, that can be felt or seen when an object moves back and forth or up and down.

Whine

A constant, high-pitched noise. Also described as a screech.

Whistle

High-pitched noise (above 500 Hz) with a very narrow frequency band. Examples of whistle noises are a turbocharger or airflow around an antenna.

Wind Noise

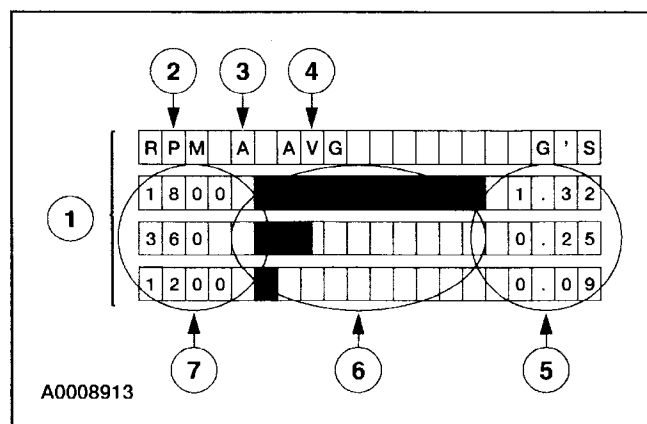
Any noise caused by air movement in, out or around the vehicle.

WOT

The acronym for wide open throttle is WOT.

DESCRIPTION AND OPERATION (Continued)**Tools and Techniques****Electronic Vibration Analyzer (EVA)**

The EVA is a hand-held electronic diagnostic tool which will assist in locating the source of unacceptable vibrations. The vibration sensor can be remotely mounted anywhere in the vehicle for testing purposes. The unit displays the three most common vibration frequencies and their corresponding amplitudes simultaneously. A bar graph provides a visual reference of the relative signal strength (amplitude) of each vibration being displayed and its relative G force. The keypad is arranged to make the EVA simple to program and use. Some of the functions include the ability to average readings as well as record, play back and freeze readings. The EVA has a strobe balancing function that can be used to detect imbalance on rotating components such as a driveshaft or engine accessories.



Item	Description
1	EVA screen
2	Frequency mode displayed in rpm or Hz
3	Active sensor input (A or B)
4	Current active mode
5	G force indicators or the strongest frequencies in descending strength of each vibration

(Continued)

Item	Description
6	Strength of each vibration
7	Frequency in rpm/Hz of each vibration

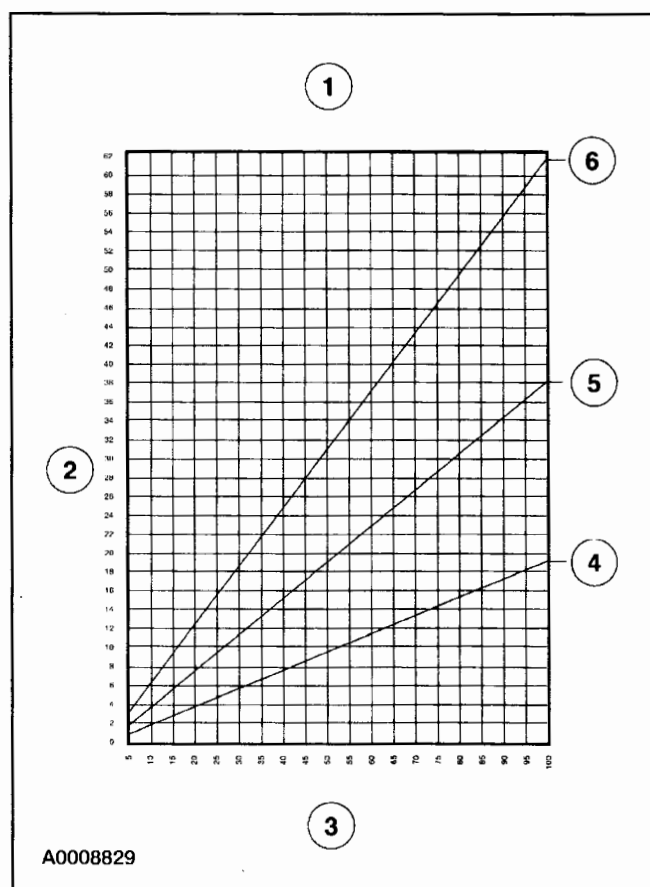
The EVA allows for a systematic collection of information that is necessary to accurately diagnose and repair NVH problems. For the best results, carry out the test as follows:

- Test drive the vehicle with the vibration sensor inside the vehicle.
- Place the sensor in the vehicle according to feel.
 - If the condition is felt through the steering wheel, the source is most likely in the front of the vehicle.
 - A vibration that is felt in the seat or floor only will most likely be found in the driveline, drive axle or rear wheels and tires.
- Record the readings. Also note when the condition begins, when it reaches maximum intensity, and if it tends to diminish above/below a certain speed.
 - Frequencies should be read in the "average" mode.
 - Frequencies have a range of plus or minus 2. A reading of 10 Hz can be displayed as an 8 Hz through 12 Hz.
- Determine what the normal frequency is for the vehicle at a specified speed. Multiply the rear axle ratio by the Hz (1 Hz per every 5 mph). Example: A vehicle travelling 50 mph with a 3.08 rear axle ratio, the acceptable amount of Hz for the vehicle at that speed would be 10 (1 Hz per every 5 mph) X 3.08 (rear axle ratio) = 30.8 Hz.
- Place the vibration sensor on or near the suspect area outside the vehicle.
- Continue the road test, driving the vehicle at the speed the symptom occurs, and take another reading.

DESCRIPTION AND OPERATION (Continued)

g. Compare the readings.

- A match in frequency indicates the problem component or area.
- An unmatched test could indicate the concern is caused by the engine, torque converter, or engine accessory. Use the EVA in the rpm mode and check if concern is rpm related.
- Example: A vibration is felt in the seat. Place the sensor on the console. Record the readings. Place the vibration sensor on the rear axle. Compare the readings. If the frequencies are the same, the axle is the problem component. Also refer to the following chart as a reference to acceptable vibration and noise ranges for the specified components.



Item	Description
1	Acceptable vibration ranges for specified components
2	Hertz (Hz)

(Continued)

Item	Description
3	Miles per hour (mph)
4	First order tire (one disturbance for each revolution)
5	Second order tire (two disturbances for each revolution)
6	Driveline

Vibrate Software®

Vibrate Software® (Rotunda tool number 215-00003) is a diagnostic aid which will assist in pinpointing the source of unacceptable vibrations. The engine's crankshaft is the point of reference for vibration diagnosis. Every rotating component will have an angular velocity that is faster, slower, or the same as the engine's crankshaft. Vibrate Software® calculates the angular velocity of each component and graphically represents these velocities on a computer screen and on a printed vibration worksheet. The following steps outline how Vibrate Software® helps diagnose a vibration concern:

- Enter the vehicle information. Vibrate will do all the calculations and display a graph showing tire, driveshaft and engine vibrations.
- Print a Vibration Worksheet graph. The printed graph is to be used during the road test.
- Road test the vehicle at the speed where the vibration is most noticeable. Record the vibration frequency (rpm) and the engine rpm on the worksheet graph. The point on the graph where the vibration frequency (rpm) reading and the engine rpm reading intersect indicates the specific component group causing the concern.
 - An EVA or equivalent tool capable of measuring vibration frequency and engine rpm will be needed.
- Provide pictures of diagnostic procedures to aid in testing components.

Combination EngineEAR/ChassisEAR

An electronic listening device used to quickly identify noise and the location under the chassis while the vehicle is being road tested. The ChassisEARs can identify the noise and location of damaged/worn wheel bearings, CV joints, brakes, springs, axle bearings or driveshaft carrier bearings.

DESCRIPTION AND OPERATION (Continued)**EngineEAR Basic Unit**

An electronic listening device used to detect even the faintest noises. The EngineEARs can detect the noise of damaged/worn bearings in generators, water pumps, A/C compressors and power steering pumps. They are also used to identify noisy lifters, exhaust manifold leaks, chipped gear teeth and for detecting wind noise. The EngineEAR has a sensing tip, amplifier, and headphones. The directional sensing tip is used to listen to the various components. Point the sensing tip at the suspect component and adjust the volume with the amplifier. Placing the tip in direct contact with a component will reveal structure-borne noise and vibrations, generated by or passing through, the component. Various volume levels can reveal different sounds.

Ultrasonic Leak Detector

The Ultrasonic Leak Detector is used to detect wind noises caused by leaks and gaps in areas where there is weather-stripping or other sealing material. It is also used to identify A/C leaks, vacuum leaks and evaporative emission noises. The Ultrasonic Leak Detector includes a multi-directional transmitter (operating in the ultrasonic range) and a hand-held detector. The transmitter is placed inside the vehicle. On the outside of the vehicle, the hand-held detector is used to sweep the area of the suspected leak. As the source of the leak is approached, a beeping sound is produced which increases in both speed and frequency.

Squeak and Rattle Repair Kit

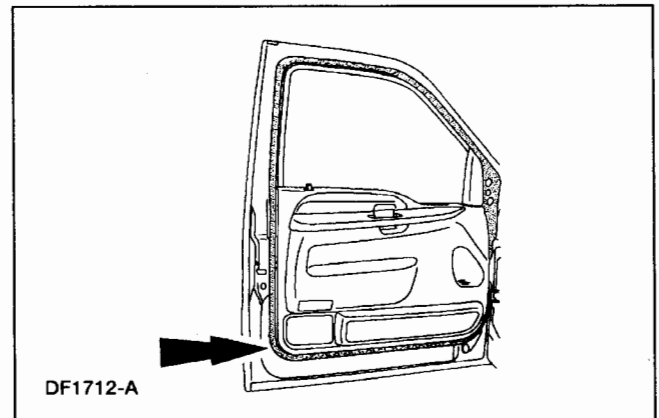
The squeak and rattle repair kit (Rotunda tool number 164-R4900) contains lubricants and self-adhesive materials that can be used to eliminate interior and exterior squeaks and rattles. The kit consists of the following materials:

- PVC (soft foam) tape
- Urethane (hard foam) tape

- Flocked (black fuzzy) tape
- UHMW (frosted) tape
- Squeak and rattle oil tube
- Squeak and rattle grease tube

Tracing Powder

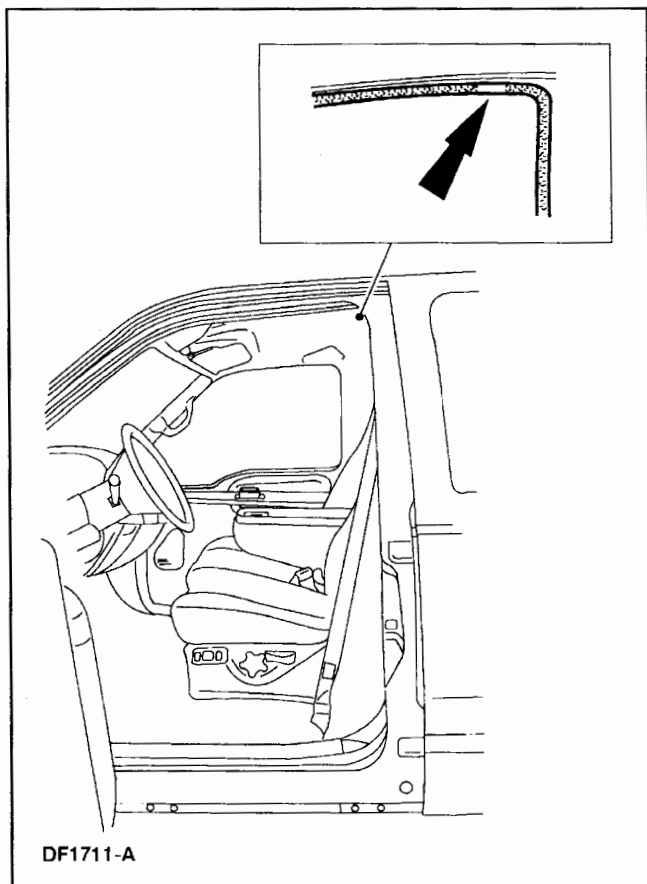
Tracing powder is used to check both the uniformity of contact and the tension of a seal against its sealing surface. These tests are usually done when a suspected air leak/noise appears to originate from the seal area or during the alignment and adjustment of a component to a weatherstrip. Tracing powder can be ordered from Crest Industries as ATR Leak Trace. Carry out the tracing powder test as follows:



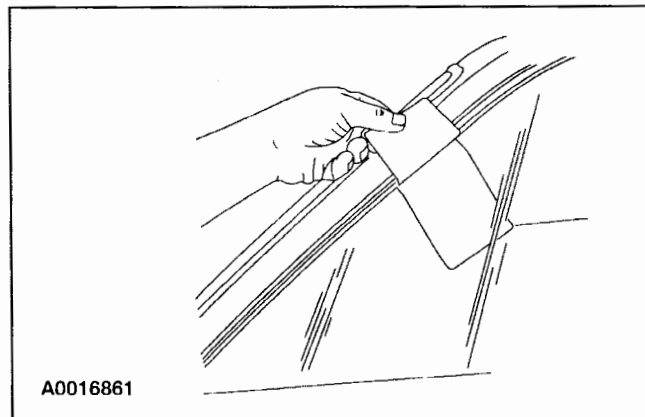
- a. Clean the weatherstrip.
- b. Spray the tracing powder on the mating surface only.
- c. Close the door completely. Do not slam the door.

DESCRIPTION AND OPERATION (Continued)

- d. Open the door. An imprint is made where the weatherstrip contacted the mating surface seal. Gaps or a faint imprint will show where there is poor contact with the weatherstrip.

**Index Card**

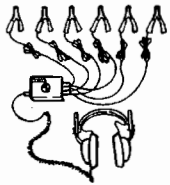
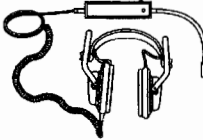
Place an index card or a piece of paper between the weatherstrip and the sealing surface, then close the door. Slowly withdraw the index card or paper after the door is closed and check the amount of pressure on the weatherstrip. There should be a medium amount of resistance as it is withdrawn. Continue around the entire seal area. If there is little or no resistance, this indicates insufficient contact to form a good seal. At these points, the door, the glass, or the weatherstrip is out of alignment.



DIAGNOSIS AND TESTING

Noise, Vibration And Harshness (NVH)

Special Tool(s)

 ST2048-A	EngineEAR/ChassisEAR 107-R2102 or equivalent
 ST2311-A	Electronic Vibration Analyzer 100-F027 (014-00344) or equivalent
 ST2312-A	EngineEAR 107-R2100 or equivalent
 ST2314-A	Ultrasonic Leak Detector 134-R0135 or equivalent

To assist the service advisor and the technician, a Write-up Job Aid and an NVH Diagnostic Guide are included with this material. The Write-up Job Aid serves as a place to record all important symptom information. The NVH Diagnostic Guide serves as a place to record information reported on the Write-up Job Aid as well as data from the testing to be carried out.

DIAGNOSIS AND TESTING (Continued)

To begin a successful diagnosis, fill out the NVH Diagnostic Guide, record the reported findings, then proceed to each of the numbered process steps to complete the diagnosis.

[illegible]

DIAGNOSIS AND TESTING (Continued)**NVH DIAGNOSTIC GUIDE**

Dealer: _____ Date: _____

P.A. Code: _____ Order No. _____ Technician: _____

Owner's Name: _____ Address: _____

Phone No. Home: _____ Work: _____

Vehicle Make: _____ Model: _____ Year: _____

VIN: _____ Mileage: _____ Engine: _____ Trans: _____ Axle: _____

OWNER'S DESCRIPTION OF COMPLAINT:Did Condition Exist When Vehicle Was New? **Yes / No** (circle one)How Did Condition Begin? Gradually ☐ Suddenly ☐

At What Mileage Did It Occur Or Begin Occuring? _____

Which Driving Conditions Affect The Vehicle?

Light Accel ☐	Closed Throttle Decel ☐	Brakes Applied/Released ☐
Medium Accel ☐	Coast (Float) ☐	Driving The Vehicle: Straight ☐
Heavy Accel ☐	Constant Speed ☐	Cornering ☐

Is Vibration Noticed? If So, Where:

Seat ☐ Steering Wheel ☐ Instrument Panel ☐ Floor ☐ Body Panels ☐ Ft/Rr of Vehicle ☐Is There Sound Or Sensation Of Sound? **Yes / No** (circle one)

If So, Describe The Sound :

Boom ☐	Hum ☐	Whine ☐	Growl ☐	Other: _____
Drone ☐	Tip-In-Moan ☐	Squeak ☐	Rattle ☐	

PREDRIVE CHECKS

Tire Condition/Pressure: _____

Vehicle Body Damage? _____

Other: _____

ROAD TEST:

Vibration/Noise Occurs:

Vehicle Speed _____ Accel _____ Vibration Frequency _____ Hz/RPM

Gear Range _____ Decel/Coast _____ Engine Speed _____ RPM

ENGINE RUN-UP TESTSNeutral Engine Run-Up (NERU) **Yes / No** Engine RPM _____ Vibration/Frequency _____ Hz/RPMDrive Engine Run-Up (DERU) **Yes / No** Engine RPM _____ Vibration/Frequency _____ Hz/RPMDrivetrain Run-Up (DTRU) **Yes / No** Engine RPM _____ Vibration/Frequency _____ Hz/RPM

Indicate Suspected Area of Concern:

Tire/Wheel/Brakes ☐	Engine/Accessory ☐	Rear ☐
Driveline/Axle ☐	Susp/Steering ☐	Right ☐
Body ☐	Front ☐	Left ☐
Other _____		

Equipment Used:

Reed Tachometer ☐	Electronic Noise Detector ☐	Tape ☐
Engine Tachometer ☐	Ultrasonic Leak Detector ☐	Other _____

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DIAGNOSIS AND TESTING (Continued)**WHEEL/TIRE/BRAKES CHECK:**Balance Check **Yes / No**

Maximum Runout Allowed:

Wheel: Radial _____ Lateral _____

Tire: Radial _____ Lateral _____

Measured Runout:

Tire/Wheel Radial: LF _____ LR _____ RF _____ RR _____

Lateral: LF _____ LR _____ RF _____ RR _____

Wheel Only Radial: LF _____ LR _____ RF _____ RR _____

Lateral: LF _____ LR _____ RF _____ RR _____

SUSPENSION INSPECTION:Can Cause: Shimmy ☐ Clunk ☐ Squeak ☐ Harshness ☐Suspension Bushings: Loose ☐ Worn ☐ Missing ☐ OK ☐Front Upper Control Arm ☐ Stabilizer (sway bar) ☐ Rear Lower Control Arm ☐Front Lower Control Arm ☐ Rear Upper Control Arm ☐ Rear Upper Control Arm ☐

Other _____

Suspension/Steering Components:

Loose Worn Missing OK

Ball Joints ☐ Idler Arm ☐ Pitman Arm ☐Shock Absorbers F/R ☐ Center Link ☐ Steering Gear ☐Springs F/R ☐ Tie Rod Ends/Sleeve ☐ Steering Coupler ☐**DRIVESHAFT CONDITION:** Noise ☐ Vibration ☐Balance Weights Missing/Other Visual Defects? **Yes / No**

Maximum Allowable Runout: _____

Actual Runout: Front _____ Middle _____ Rear _____

Two-Piece Driveshaft Runout: Front _____ Rear _____

Middle Support Bearing: Loose ☐ Damaged ☐ Worn ☐ Other _____Suspect Driveshaft Balanced? **Yes / No****Pinion Angle:** Engine Height: Specification _____ Actual _____

Pinion Angle: Specification _____ Actual _____

Driveline Angle - Truck: Specification _____ Actual _____**ENGINE/ACCESSORY CHECK:**

Visual Inspection for Damage or Grounded Condition:

Powertrain Mounts ☐ Fuel Lines ☐ A/C Lines ☐ Power Steering/Cooler Lines ☐Air Intake ☐ Accessories ☐ Exhaust ☐ Radiator/Condensor ☐**BODY (NOISE/RATTLE)**Indicate Suspected Area of Concern: Doors ☐ Windows ☐ Dash Panel ☐ Other _____

Tests Used to Isolate

NVH Concern: Vacuum/Leak Detector ☐ Ultrasonic Leak Detector ☐ Tracing Powder ☐Electronic Noise Detector ☐ Other _____**ROAD/ENGINE RUN-UP TESTS:** Improved? **Yes / No** Vehicle Acceptable? **Yes / No**

Comments: _____

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DIAGNOSIS AND TESTING (Continued)**1: Customer Interview**

The diagnostic process starts with the customer interview. The service advisor must obtain as much information as possible about the problem and take a test drive with the customer. There are many ways a customer will describe NVH concerns and this will help minimize confusion arising from descriptive language differences. It is important that the concern is correctly interpreted and the customer descriptions are recorded. During the interview, ask the following questions:

- When was it first noticed?
- Did it appear suddenly or gradually?
- Did any abnormal occurrence coincide with or proceed its appearance?

Use the information gained from the customer to accurately begin the diagnostic process.

2: Pre-Drive Check

It is important to do a pre-drive check before road testing the vehicle. A pre-drive check verifies that the vehicle is relatively safe to drive and eliminates any obvious faults on the vehicle.

The pre-drive check consists of a brief visual inspection. During this brief inspection, take note of anything that will compromise safety during the road test and make those repairs/adjustments before taking the vehicle on the road.

3: Preparing for the Road Test

Observe the following when preparing for the road test:

- Review the information recorded on the NVH Diagnostic Guide. It is important to know the specific concern the customer has with the vehicle.
- Do not be misled by the reported location of the noise/vibration. The cause can actually be some distance away.

- Remember that the vibrating source component (originator) may only generate a small vibration. This small vibration can in turn cause a larger vibration/noise to emanate from another receiving component (reactor), due to contact with other components (transfer path).
- Conduct the road test on a quiet street where it is safe to duplicate the vibration/noise. The ideal testing route is an open, low-traffic area where it is possible to operate the vehicle at the speed in which the condition occurs.
- If possible, lower the radio antenna in order to minimize turbulence. Identify anything that could potentially make noise or be a source of wind noise. Inspect the vehicle for add-on items that create vibration/noise. Turn off the radio and the heating and cooling system blower.
- The engine speed is an important factor in arriving at a final conclusion. Therefore, connect an accurate tachometer to the engine, even if the vehicle has a tachometer. Use a tachometer that has clearly defined increments of less than 50 rpm. This ensures an exact engine speed reading.

4: Verify the Customer Concern

Verify the customer concern by carrying out a road test, an engine run-up test, or both.

The decision to carry out a road test, an engine run-up test, or both depends on the type of NVH concern. A road test may be necessary if the symptom relates to the suspension system or is sensitive to torque. A drive engine run-up (DERU) or a neutral engine run-up (NERU) test identifies noises and vibrations relating to engine and drivetrain rpm. Remember, a condition will not always be identifiable by carrying out these tests, however, they will eliminate many possibilities if carried out correctly.

DIAGNOSIS AND TESTING (Continued)**5: Road Test**

NOTE: It may be necessary to have the customer ride along or drive the vehicle to point out the concern. During the road test, take into consideration the customer's driving habits and the driving conditions. The customer's concern just may be an acceptable operating condition for that vehicle.

The following is a brief overview of each test in the order in which it appears. A review of this information helps to quickly identify the most appropriate process necessary to make a successful diagnosis. After reviewing this information, select and carry out the appropriate test(s), proceeding to the next step of this process.

- The Slow Acceleration Test is normally the first test to carry out when identifying an NVH concern, especially when a road test with the customer is not possible.
- The Heavy Acceleration Test helps to determine if the concern is torque-related.
- The Neutral Coast Down Speed Test helps to determine if the concern is vehicle speed-related.
- The Downshift Speed Test helps to determine if the concern is engine speed-related.
- The Steering Input Test helps to determine how the wheel bearings and other suspension components contribute to a vehicle speed-related concern.
- The Brake Test helps to identify vibrations or noise that are brake related.
- The Road Test Over Bumps helps isolate a noise that occurs when driving over a rough or bumpy surface.
- The Engine Run-Up Tests consist of the Neutral Run-up Test and the Engine Load Test. These tests help to determine if the concern is engine speed-related.
- The Neutral Run-up Test is used as a follow-up test to the Downshift Speed Test when the concern occurs at idle.
- The Engine Load Test helps to identify vibration/noise sensitive to engine load or torque. It also helps to reproduce engine speed-related concerns that cannot be duplicated when carrying out the Neutral Run-up Test or the Neutral Coast Down Test.
- The Engine Accessory Test helps to locate faulty belts and accessories that cause engine speed-related concerns.

- The Vehicle Cold Soak Procedure helps to identify concerns occurring during initial start-up and when an extended time lapse occurs between vehicle usage.

Slow Acceleration Test

To carry out this test, proceed as follows:

- Slowly accelerate to the speed where the reported concern occurs. Note the vehicle speed, the engine rpm and, if possible, determine the vibration frequency.
- Attempt to identify from what part of the vehicle the concern is coming.
- Attempt to identify the source of the concern.
- Proceed as necessary.

Heavy Acceleration Test

To carry out this test, proceed as follows:

- Accelerate hard from 0-64 km/h (0-40 mph).
- Decelerate in a lower gear.
- The concern is torque related if duplicated while carrying out this test.
- Proceed as necessary.

Neutral Coast Down Speed Test

To carry out this test, proceed as follows:

- Drive at a higher rate of speed than where the concern occurred when carrying out the Slow Acceleration Test.
- Place the transmission in NEUTRAL and coast down past the speed where the concern occurs.
- The concern is vehicle speed-related if duplicated while carrying out this test. This eliminates the engine and the torque converter as sources.
- If the concern was not duplicated while carrying out this test, carry out the Downshift Speed Test to verify if the concern is engine speed related.
- Proceed as necessary.

Downshift Speed Test

To carry out this test, proceed as follows:

- Shift into a lower gear than the gear used when carrying out the Slow Acceleration Test.
- Drive at the engine rpm where the concern occurs.

DIAGNOSIS AND TESTING (Continued)

- The concern is engine speed related if duplicated while carrying out this test. This eliminates the tires, wheels, brakes and the suspension components as sources.
- If necessary, repeat this test using other gears and NEUTRAL to verify the results.
- Proceed as necessary.

Steering Input Test

To carry out this test, proceed as follows:

- Drive at the speed where the concern occurs, while making sweeping turns in both directions.
- If the concern goes away or gets worse, the wheel bearings, hubs, U-joints (contained in the axles of 4WD applications), and tire tread wear are all possible sources.
- Proceed as necessary.

Brake Test

To carry out this test, proceed as follows:

- Warm the brakes by slowing the vehicle a few times from 80-32 km/h (50-20 mph) using light braking applications. At highway speeds of 89-97 km/h (50-60 mph), apply the brake using a light pedal force.
- Accelerate to 89-97 km/h (55-60 mph).
- Lightly apply the brakes and slow the vehicle to 30 km/h (20 mph).
- A brake vibration noise can be felt in the steering wheel, seat or brake pedal. A brake noise can be heard upon brake application and diminish when the brake is released.

Road Test Over Bumps

To carry out this test, proceed as follows:

- Drive the vehicle over a bump or rough surface one wheel at a time to determine if the noise is coming from the front or the back and the left or the right side of the vehicle.
- Proceed as necessary.

Neutral Engine Run-Up (NERU) Test

To carry out this test, proceed as follows:

- Install a tachometer.
- Increase the engine rpm up from an idle to approximately 4000 rpm while in PARK on front wheel drive vehicles with automatic transmissions, or NEUTRAL for all other vehicles. Note the engine rpm and, if possible, determine the vibration frequency.
- Attempt to identify what part of the vehicle the concern is coming from.
- Attempt to identify the source of the concern.
- Proceed as necessary.

Drive Engine Run-Up (DERU) Load Test

To carry out this test, proceed as follows:

-  **WARNING:** Block the front and rear wheels, and apply the parking brake and the service brake, or injury to personnel can result.

 **CAUTION:** Do not carry out the Engine Load Test for more than five seconds or damage to the transmission or transaxle can result. Block the front and rear wheels.

- Apply the parking brake and the service brake.
- Install a tachometer.
- Shift the transmission into DRIVE, and increase and decrease the engine rpm between an idle to approximately 2000 rpm. Note the engine rpm and, if possible, determine the vibration frequency.
- Repeat the test in REVERSE.
- If the vibration/noise is duplicated when carrying out this test, inspect the engine and transmission or transaxle mounts.
- If the concern is definitely engine speed-related, carry out the Engine Accessory Test to narrow down the source.
- Proceed as necessary.

DIAGNOSIS AND TESTING (Continued)

Engine Accessory Test

To carry out this test, proceed as follows:

-  **WARNING:** Block the front and rear wheels, and apply the parking brake and the service brake, or injury to personnel can result.

 **CAUTION:** Limit engine running time to one minute or less with belts removed or serious engine damage will result.

NOTE: A serpentine drive belt decreases the usefulness of this test. In these cases, use a vibration analyzer, such as the electronic vibration analyzer (EVA), to pinpoint accessory vibrations. An electronic listening device, such as an EngineEAR, will also help to identify noises from specific accessories. Remove the accessory drive belts.

- Increase the engine rpm to where the concern occurs.
- If the vibration/noise is duplicated when carrying out this test, the belts and accessories are not sources.
- If the vibration/noise was not duplicated when carrying out this test, install each accessory belt, one at a time, to locate the source.

Vehicle Cold Soak Procedure

To carry out this procedure, proceed as follows:

- Test preparations include matching customer conditions (if known). If not known, document the test conditions: gear selection and engine rpm. Monitor the vibration/noise duration with a watch for up to three minutes.
- Park the vehicle where testing will occur. The vehicle must remain at or below the concern temperature (if known) for 6-8 hours.
- Before starting the engine, conduct a visual inspection under the hood.
- Turn the key on, but do not start the engine. Listen for the fuel pump, anti-lock brake system (ABS) and air suspension system noises.
- Start the engine.

-  **CAUTION:** Never probe moving parts.

Isolate the vibration/noise by carefully listening. Move around the vehicle while listening to find the general location of the vibration/noise. Then, search for a more precise location by using a stethoscope or EngineEAR.

- Refer to Idle Noise/Vibration in the Symptom Chart to assist with the diagnosis.

6: Check OASIS/TSBs/Repair History

After verifying the customer concern, check for OASIS reports, TSBs and the vehicle repair history for related concerns. If information relating to a diagnosis/repair is found, carry out the procedure(s) specified in that information.

If no information is available from these sources, carry out the vehicle preliminary inspection to eliminate any obvious faults.

7: Diagnostic Procedure

Qualifying the concern by the particular sensation present can help narrow down the concern. Always use the “symptom” to “system” to “component” to “cause” diagnosis technique. This diagnostic method divides the problem into related areas to correct the customer concern.

- Verify the “symptom”.
- Determine which “system(s)” can cause the “symptom”.
 - If a vibration concern is vehicle speed related, the tire and wheel rpm/frequency or driveshaft frequency should be calculated.
 - If a vibration concern is engine speed related, the engine, engine accessory or engine firing frequencies should be calculated.
- After determining the “system”, use the diagnostic tools to identify the worn or damaged “components”.
- After identifying the “components”, try to find the “cause” of the failure.

Once the concern is narrowed down to a symptom/condition, proceed to NVH Condition and Symptom Categories.

NVH Condition and Symptom Categories

A good diagnostic process is a logical sequence of steps that lead to the identification of a causal system. Use the condition and symptom categories as follows:

- Identify the operating condition that the vehicle is exhibiting.
- Match the operating condition to the symptom.
- Verify the symptom.
- Identify which category or system could cause the symptom.
- Refer to the diagnostic symptom chart that is referred to.

DIAGNOSIS AND TESTING (Continued)**Operating Condition—Vehicle is Not Moving**

1. Static operation
 - Noise occurs during part/system functioning. GO to **Symptom Chart — Squeak and Rattle**.
2. While cranking
 - 1 Grinding or whine, differential ring gear or starter motor pinion noise. GO to **Symptom Chart — Engine Noise/Vibration**.
 - 2 Rattle. Exhaust hanger, exhaust heat shield or A/C line noise. GO to **Symptom Chart — Squeak and Rattle**.
 - 3 Vibration. Acceptable condition.
3. At idle
 - Idle noise. GO to **Symptom Chart — Idle Noise/Vibration**.
 - Idle vibration or shake. GO to **Symptom Chart — Idle Noise/Vibration**.
4. During Gear Selection
 - 1 Vehicle parked on a steep incline. Acceptable noise.
 - 2 Vehicle parked on a flat surface. GO to **Symptom Chart — Driveline Noise/Vibration**.
 - 3 Vehicle with a manual transmission. GO to **Symptom Chart — Transmission (Manual) and Transfer Case Noise/Vibration**.

Operating Condition—Vehicle is Moving

1. Depends more on how the vehicle is operated
 - 1 Speed related
 - Related to vehicle speed
 - Pitch increases with vehicle speed. GO to **Symptom Chart — Tire Noise/Vibration**.
 - Noise occurs at specific vehicle speed. A high-pitched noise (whine). GO to **Symptom Chart — Driveline Noise/Vibration**.
 - Loudness proportional to vehicle speed. Low-frequency noise at high speeds, noise and loudness increase with speed. GO to **Symptom Chart — Driveline Noise/Vibration**.

- A low-pitched noise (drumming). GO to **Symptom Chart — Engine Noise/Vibration**.
- Vibration occurs at a particular speed (mph) regardless of acceleration or deceleration. GO to **Symptom Chart — Tire Noise/Vibration**.
- Noise varies with wind/vehicle speed and direction. GO to **Symptom Chart — Air Leak and Wind Noise**.

- Related to engine speed.

- Noise varies with engine rpm. GO to **Symptom Chart — Engine Noise/Vibration**.
- Vibration occurs at a particular speed (mph) regardless of engine speed (rpm).

2 Acceleration

- Wide open throttle (WOT)

- Engine induced contact between components. Inspect and repair as necessary.
- Noise is continuous throughout WOT. Exhaust system or engine ground out. GO to **Symptom Chart — Engine Noise/Vibration**.

- Light/moderate acceleration

- Tip-in moan. Engine/exhaust noise. GO to **Symptom Chart — Engine Noise/Vibration**.
- Knock-type noise. GO to **Symptom Chart — Engine Noise/Vibration**.
- Driveline shudder. GO to **Symptom Chart — Driveline Noise/Vibration**.
- Engine vibration. GO to **Symptom Chart — Engine Noise/Vibration**.

3 Turning noise. GO to **Symptom Chart — Steering Noise/Vibration**.

4 Braking

- Clicking sound is signaling ABS is active. Acceptable ABS sound.

DIAGNOSIS AND TESTING (Continued)

- A continuous grinding/squeal. GO to **Symptom Chart — Brake Noise/Vibration.**
 - Brake vibration/shudder. GO to **Symptom Chart — Brake Noise/Vibration.**
- 5 Clutching
- A noise occurring during clutch operation. GO to **Symptom Chart — Transmission (Manual) and Transfer Case Noise/Vibration.**
 - Vibration. GO to **Symptom Chart — Transmission (Manual) and Transfer Case Noise/Vibration.**
- 6 Shifting
- Noise or vibration condition related to the transmission (automatic). GO to **Symptom Chart — Transmission (Automatic) Noise/Vibration.**
 - Noise or vibration related to the transmission (manual). GO to **Symptom Chart — Transmission (Manual) and Transfer Case Noise/Vibration.**
- 7 Engaged in four-wheel drive. GO to **Symptom Chart — Transmission (Manual) and Transfer Case Noise/Vibration.**
- 8 Cruising speeds
- Accelerator pedal vibration. GO to **Symptom Chart — Engine Noise/Vibration.**
 - Driveline vibration. GO to **Symptom Chart — Driveline Noise/Vibration.**
 - A shimmy or shake. GO to **Symptom Chart — Tire Noise/Vibration.**
- 9 Driving at low/medium speeds
- A wobble or shudder. GO to **Symptom Chart — Tire Noise/Vibration.**
2. Depends more on where the vehicle is operated
- 1 Bump/pothole, rough road or smooth road. GO to **Symptom Chart — Suspension Noise/Vibration.**
- Noise is random or intermittent occurring from road irregularities. GO to **Symptom Chart — Squeak and Rattle.**
 - Noise or vibration changes from one road surface to another. Normal sound changes.
 - Noise or vibration associated with a hard/firm ride. GO to **Symptom Chart — Suspension Noise/Vibration.**

Symptom Charts**Symptom Chart — Air Leak and Wind Noise**

Condition	Possible Sources	Action
Air leak around door perimeter	- Loose fit seal. - Seal installed incorrectly. - Door misaligned. - Scuff plate installed incorrectly. - Seal or seal push pins damaged.	- PINCH the seal carrier to improve retention on the seal flange. - REINSTALL the seal. - REALIGN the door. CHECK door gaps and fit in the door opening and ADJUST as necessary. - REINSTALL the scuff plate. - INSTALL a new seal.

DIAGNOSIS AND TESTING (Continued)**Symptom Chart — Air Leak and Wind Noise (Continued)**

Condition	Possible Sources	Action
Air leak around glass run	- Door glass misaligned. - Glass run installed incorrectly. - Leak path behind glass run. - Glass run channel spread wide. - Blow-out clip bent or contacting door glass. - Glass run damaged.	- ADJUST the door glass. - ADJUST the glass run. - INSERT foam in the glass run carrier. - INSTALL foam rope behind the glass run. - PINCH the glass run channel to reduce the size of the opening. - ADJUST the blow-out clip or INSTALL a new glass run/blow-out clip molding assembly. - INSTALL a new glass run.
Air leak at inner belt line	- Belt line seal installed incorrectly on flange. - Belt line seal integrated with door trim installed incorrectly (no glass contact). - No contact with side glass. - No contact with glass runs at both ends of belt line seal. - Belt line seal damaged.	- ADJUST the seal. (Do not bend the flange.) - REINSTALL the door trim. - ADJUST the door glass. - ADJUST the belt line seal or ADD foam at the seal ends. - INSTALL a new seal.
Air leak at outer belt line	- Belt line seal installed incorrectly on flange (no glass contact). - Belt line seal does not contact the glass. - No contact with glass runs at both ends of belt line seal. - Belt line seal damaged.	- ADJUST the seal. - ADJUST the door glass. - ADJUST the belt line seal/ADD foam at the seal ends. - INSTALL a new seal.
Draft at inner door handle/speaker opening	- Hole in watershield. - Watershield misaligned. - Exterior door handle seal misaligned/damaged.	- SEAL the hole with a suitable tape. - REALIGN the watershield. - INSTALL a new watershield if the pressure sensitive adhesive fails. - REALIGN or INSTALL a new seal as necessary.

DIAGNOSIS AND TESTING (Continued)**Symptom Chart — Air Leak and Wind Noise (Continued)**

Condition	Possible Sources	Action
Wind noise from side view mirror	- Outside mirror housing misaligned. - Mirror sail gasket folded/misaligned. - Mirror housing trim cap installed incorrectly. - Air leak through mirror housing hinge. - Inner sail trim installed incorrectly. - Inner sail gasket/barrier installed incorrectly. - Air path through wiring bundle/fastener access holes. - Exposed fastener access hole on mirror housing/sail.	- REALIGN with the edges shingled correctly and no gaps. - REINSTALL with the gasket unfolded and aligned correctly. - REINSTALL with the edges shingled to the air flow. - Fully ENGAGE the mirror into its operating position/USE foam to block the air path through the hinge. - REINSTALL the sail trim/ADJUST the door trim. - REINSTALL the trim cover with the gasket/barrier aligned correctly. - BLOCK the air path(s) with foam/tape. - INSTALL a new cap if it is missing.
Air leak around perimeter of fixed glass	- Gaps in the sealant bead. - Air traveling up windshield molding along A-pillar. - Windshield/backlite misaligned or not installed correctly. - Rear hood seal at base of windshield misaligned/damaged.	- APPLY approved sealant. - INSTALL foam rope the full length of the A-pillar. - REINSTALL the windshield/backlite. - REALIGN or INSTALL a new seal as necessary.
Air leak at cowl	Cowl gasket misaligned/damaged.	REALIGN or INSTALL a new seal as necessary.
Air leak around liftgate perimeter	- Loose fit seal. - Seal misaligned. - Liftgate misaligned. - Scuff plate misaligned. - Seal or seal push pins damaged.	- PINCH the seal carrier to improve retention on the seal flange or INSERT foam in the carrier. - REINSTALL the seal. - REALIGN the liftgate. CHECK the liftgate fit in the body opening and ADJUST as necessary. - REINSTALL the scuff plate. - INSTALL a new seal.
Air leak around the liftgate flip window perimeter	- Loose fit seal. - Seal misaligned. - Glass misaligned. - Seal damaged.	- PINCH the seal carrier to improve the retention to the seal flange. - REINSTALL the seal. - REALIGN the glass. - INSTALL a new seal.
Wind noise from antenna	- Shape of antenna. - Air leak around antenna cable access hole.	- INSTALL an antenna boot or a spiral antenna. - INSPECT the antenna access hole grommet. REPAIR as necessary.

DIAGNOSIS AND TESTING (Continued)**Symptom Chart — Air Leak and Wind Noise (Continued)**

Condition	Possible Sources	Action
Air leak from closed roof opening panel	- Seal installed incorrectly. - Roof opening panel glass/door misaligned. - Roof opening panel damaged.	- REINSTALL the seal. - REALIGN the roof opening panel glass/door. - INSTALL a new roof opening panel.
Buffeting from an open roof opening panel	- Wind deflector inoperative/damaged. - Wind deflector height incorrect.	- REPAIR or INSTALL a new wind deflector as necessary. - ADJUST the wind deflector higher.
Wind noise created by airflow over or behind body panels	- Fender splash shield misaligned. - Body panel misaligned (exposed edge). - Hood misaligned (front margin). - Front grille edge noise.	- REALIGN the fender splash shield. - REALIGN the appropriate body panel. - CHECK hood gaps and fit. ADJUST the hood as necessary. - APPLY foam in the hollow areas behind the louvers.
Wind noise created by grille opening panel	- Grille relationship to leading edge on hood. - Sharp edges due to material imperfections.	- ADJUST the grille opening panel forward to eliminate wind noise. - REMOVE the sharp edges (no damage to visible surface).
Wind noise from air extractor	- Air extractor housing seated incorrectly. - Air extractor housing or flaps damaged.	- REINSTALL the air extractor housing. - INSTALL a new air extractor.
Air leak at top of A-pillar — vehicles with a convertible top	- Seal at windshield header installed incorrectly. - Seal pinched. - Gap between side rail and header seal at A-pillar.	- REINSTALL the seal. - FILL the seal with foam to reshape it. - ADJUST the J-hook/vinyl top.
Air leak at rear quarter glass (division bar) — vehicles with a convertible top	No contact between front side glass and quarter glass division bar.	ADJUST the front side glass regulator and the rear quarter glass regulator.
Air leak or wind noise from top of side glass — vehicles with a convertible top	- Gap between side rail and vinyl top. - Seal at windshield header installed incorrectly. - Seal damaged between side rail and vinyl top. - Vinyl top damaged.	- ADD additional foam tape to seal between the side rail and the vinyl top. - REINSTALL the seal. - INSTALL a new seal. - INSPECT the vinyl top. INSTALL a new vinyl top as necessary.
Air leak or wind noise at windshield header — vehicles with a convertible top	- Vinyl top not flush with header. - Seal at windshield header installed incorrectly. - Header seal not flush with header.	- ADJUST the J-hook to lower the top to achieve a flush condition. - REINSTALL the seal. - REINSTALL the seal.

DIAGNOSIS AND TESTING (Continued)**Symptom Chart — Air Leak and Wind Noise (Continued)**

Condition	Possible Sources	Action
Convertible top flapping with the top up	Vinyl top contacting interior headliner.	Working from front to back, INSTALL a 6.35 mm (0.25 in) foam sheet between the headliner and the vinyl top at the suspected area. Allow a clearance of 50 mm (2 in) - 75 mm (3 in) away from the roof bows and the side rails.
Noise from roof rack	- Roof rack rails or crossbars loose. - Roof rack fasteners missing. - Roof rack crossbars installed backward. - Roof rack rub strips partially lifting from roof. - Roof rack gaskets loose or misaligned.	TIGHTEN the fasteners. INSTALL the approved fasteners. REINSTALL the crossbars. REAPPLY adhesive or fasteners or INSTALL new rub strips as necessary. REINSTALL the gasket.
Wind noise from bug shield/exterior windshield sun visor	Turbulence created by location and shape.	REMOVE per customer direction if it is a dealer installed option.

Symptom Chart—Brake Noise/Vibration

Condition	Possible Sources	Action
Rattling noise	- Caliper mounting bolts loose. - Damaged or worn caliper pins or retainers. - Missing or damaged anti-rattle clips or springs. - Loose brake disc shield.	CHECK the caliper bolts. TIGHTEN to specifications. CHECK the caliper pins and retainers for lubrication and correct fit. LUBRICATE or INSTALL new components as necessary. REFER to Section 206-03 for front disc brake pads or Section 206-04 for rear disc brake pads. CHECK the brake pads for missing clips or broken springs. INSTALL new components as necessary. REFER to Section 206-03 for front disc brake pads or Section 206-04 for rear disc brake pads. TIGHTEN the brake disc shield bolts to specification. REFER to Section 206-03 for front disc brake pads or Section 206-04 for rear disc brake pads.
Clicking noise—with brakes applied with ABS brakes	ABS hydraulic control unit.	Acceptable condition.
Squealing noise—occurs on first (morning) brake application	Disc brake pads.	Acceptable condition. Caused by humidity and low disc brake pad temperature.

DIAGNOSIS AND TESTING (Continued)**Symptom Chart—Brake Noise/Vibration (Continued)**

Condition	Possible Sources	Action
Squealing noise—a continuous squeal	Disc brake pads or linings worn below minimum thickness.	INSTALL new disc brake pads. REFER to Section 206-03 for front disc brake pads or Section 206-04 for rear disc brake pads.
Squealing noise—an intermittent squeal brought on by cold, heat, water, mud or snow	Disc brake pad.	Acceptable condition.
Groaning noise — occurs at low speeds with brake lightly applied (creeping)	Disc brake pads.	Acceptable condition.
Grinding noise—continuous	Disc brake pads or linings worn below minimum thickness.	INSPECT the disc brake pads, brake discs/drums and attaching hardware for damage. REPAIR or INSTALL new components as necessary. REFER to Section 206-03 for front disc brake pads or Section 206-04 for rear disc brake pads.
Moaning noise	Brake linings contaminated with grease or oil.	INSPECT the brake pads and shoes for contamination. REPAIR or INSTALL new components as necessary.
Brake vibration/shudder—occurs when brakes are applied	- Uneven disc or drum wear. - Uneven disc brake pad or lining transfer. - Suspension components.	GO to Pinpoint Test A.
Brake vibration/shudder — occurs when the brake pedal is released	Brake drag.	INSPECT the disc brake pads or linings for premature wear. REPAIR or INSTALL a new caliper or wheel cylinder as necessary. REFER to Section 206-03 for front disc brake pads or Section 206-04 for rear disc brake pads

DIAGNOSIS AND TESTING (Continued)**Symptom Chart—Driveline Noise/Vibration**

Condition	Possible Sources	Action
• Axle howling or whine — front or rear axle	• Axle lubricant low. • Axle housing damage. • Damaged or worn wheel bearings or axle bearings. • Damaged or worn differential ring and pinion. • Damaged or worn differential side or pinion bearings. • Damaged or worn differential side gears and pinion gears.	• CHECK the lubricant level. FILL the axle to specification. • INSPECT the axle housing for damage. REPAIR or INSTALL a new axle as necessary. • CHECK for abnormal wheel bearing play or roughness. REFER to Wheel Bearing Check in this section. ADJUST or INSTALL new wheel bearings as necessary. • INSPECT the ring and pinion ring for abnormal wear patterns or broken teeth. INSTALL a new ring and pinion as necessary. REFER to Section 307-01. • CHECK for abnormal bearing play or roughness. INSTALL new bearings as necessary. REFER to Section 307-01. • DISASSEMBLE the differential carrier. INSPECT the side and pinion gears for abnormal wear patterns or broken teeth. INSTALL new gears as necessary. REFER to Section 307-01.
• Driveline clunk—loud clunk when shifting from reverse to drive	• Incorrect axle lubricant level. • Excessive backlash in the axle or transmission. • Damaged or worn pinion bearings. • Damaged or worn universal joints (U-joints). • Loose suspension components. • Broken powertrain mounts. • Idle speed too high.	• CHECK the lubricant level. FILL the axle to specification. • CARRY OUT a total backlash check. REFER to the appropriate workshop manual for the service and diagnostic procedures. • CHECK for abnormal bearing play or roughness. INSTALL new bearings as necessary. REFER to Section 307-01. • INSPECT the U-joints for wear or damage. INSTALL new U-joints as necessary. • INSPECT the suspension for damage or wear. REPAIR or INSTALL new components as necessary. • INSPECT the powertrain mounts. REFER to Section 303-01A, Section 303-01B or Section 307-01. INSTALL new mounts as necessary. • CHECK for the correct idle speed.

DIAGNOSIS AND TESTING (Continued)**Symptom Chart—Driveline Noise/Vibration (Continued)**

Condition	Possible Sources	Action
• Driveline clunk—occurs as the vehicle starts to move forward following a stop	• Worn or galled driveshaft slip-yoke splines. • Worn or galled driveshaft and coupling shaft splines. • Loose rear leaf spring U-bolts.	• CLEAN and INSPECT the splines of the yoke for a worn or galled condition. INSTALL a new yoke as necessary. • CLEAN and INSPECT the splines of the driveshaft and coupling shaft for a worn or galled condition. INSTALL a new driveshaft assembly as necessary. • CHECK the U-bolts for loose nuts. TIGHTEN to specification.
• Driveline clunk (FWD vehicles)—occurs during acceleration or from cruise to coast/deceleration	• Damaged or worn inboard constant velocity (CV) joint.	• INSPECT the inboard CV joint and boot. REPAIR or INSTALL a new CV joint as necessary. REFER to Section 205-04.
• Driveline clunk (4WD vehicles)—occurs during shift-on-the-fly engagement	• Clutch relay. • Shift motor. • Transfer case. • GEM.	• CHECK the 4WD engagement system. REPAIR or INSTALL new components as necessary.
• Clicking, popping or grinding—occurs while vehicle is turning	• Inadequate or contaminated lubrication in the (CV) joints. • Another component contacting the halfshaft • Brake components. • Steering components. • Suspension components. • Damaged or worn wheel bearings	• CHECK the CV boots and joints for wear or damage. REPAIR or INSTALL new components as necessary. REFER to Section 205-04. • CHECK the halfshafts and the area around the halfshafts. REPAIR as necessary. • INSPECT the front brakes for wear or damage. REPAIR as necessary. REFER to Section 206-03. • INSPECT the drag link, inner and outer tie-rods or idler arm for wear or damage. REPAIR as necessary. REFER to Section 211-02. • INSPECT the upper and lower ball joints for wear or damage. REPAIR as necessary. REFER to Section 204-01. • CHECK for abnormal wheel bearing play or roughness. REFER to Wheel Bearing Check in this section. ADJUST or INSTALL new wheel bearings as necessary.
• Clicking or snapping—occurs when accelerating around a corner	• Damaged or worn outboard CV joint.	• INSPECT the outboard CV joint and boot. REPAIR or INSTALL a new CV joint as necessary. REFER to Section 205-04.

DIAGNOSIS AND TESTING (Continued)**Symptom Chart—Driveline Noise/Vibration (Continued)**

Condition	Possible Sources	Action
High pitched chattering—noise from the rear axle when the vehicle is turning	- Incorrect or contaminated lubricant. - Damaged or worn differential (differential side gears and pinion gears).	- CHECK the vehicle by driving in tight circles (5 clockwise, 5 counterclockwise). FLUSH and REFILL with the specified rear axle lubricant and friction modifier as necessary. - DISASSEMBLE the differential assembly. INSPECT the differential case, pin and gears for wear or damage. REPAIR or INSTALL a new differential as necessary. REFER to Section 307-01.
Buzz—buzzing noise is the same at cruise or coast/deceleration	- Damaged or worn tires. - Incorrect driveline angles.	- CHECK for abnormal tire wear or damage. INSTALL a new tire as necessary. REFER to Section 204-04. - CHECK for correct driveline angles. REPAIR as necessary.
Rumble or boom—noise occurs at coast/deceleration, usually driveshaft speed related and noticeable over a wide range of speeds	- Driveshaft is out-of-balance. - U-joints binding or seized. - Excessive pinion flange runout.	- CHECK the driveshaft for damage, missing balance weights or undercoating. CHECK the driveshaft balance. CARRY OUT a driveline vibration test. - ROTATE the driveshaft and CHECK for rough operation or seized U-joints. INSTALL new U-joints as necessary. - CARRY OUT a runout check. REPAIR as necessary.
Grunting—normally associated with a shudder experienced during acceleration from a dead stop	- Driveshaft slip yoke binding. - Loose rear spring U-bolts.	- CLEAN and LUBRICATE the male and female splines. - INSPECT the rear suspension. TIGHTEN the U-bolt nuts to specification.
Howl—can occur at various speeds and driving conditions. Affected by acceleration and deceleration	Incorrect ring and pinion contact, incorrect bearing preload or gear damage.	CHECK the ring and pinion and bearings for damage. INSPECT the ring and pinion wear pattern. REFER to Checking Tooth Contact Pattern and Condition of the Ring and Pinion component test in this section. ADJUST or INSTALL new components as necessary.
Chuckle—heard at coast/deceleration. Also described as a knock	Incorrect ring and pinion contact or by damaged teeth on the coast side of the ring and pinion.	CHECK the ring and pinion for damage. INSPECT the ring and pinion wear pattern. REFER to Checking Tooth Contact Pattern and Condition of the Ring and Pinion component test in this section. ADJUST or INSTALL new components as necessary.

DIAGNOSIS AND TESTING (Continued)**Symptom Chart—Driveline Noise/Vibration (Continued)**

Condition	Possible Sources	Action
• Knock—noise occurs at various speeds. Not affected by acceleration or deceleration	• Gear tooth damage to the drive side of the ring and pinion. • Excessive axle shaft end play. (Vehicles with integral axles).	• CHECK the differential case and ring and pinion for damage. INSTALL new components as necessary. • CHECK the axle end play using a dial indicator. INSTALL a new axle shaft or side gears as necessary.
• Scraping noise—a continuous low pitched noise starting at low speeds	• Worn or damaged pinion bearings.	• CHECK the pinion bearings. INSTALL new pinion bearings as necessary. REFER to Section 307-01.
• Driveline shudder—occurs during acceleration from a slow speed or stop	• Rear drive axle assembly mispositioned. • Loose rear spring U-bolts. • Incorrect or high CV joint operating angle. • Damaged or worn front suspension components. • Driveline angles out of specification. • U-joints binding or seized. • Binding, damaged or galled splines on the driveshaft slip-yoke.	• CHECK the axle mounts and the rear suspension for damage or wear. REPAIR as necessary. • INSPECT the U-bolts. TIGHTEN the U-bolt nuts to specification. • CHECK vehicle ride height is within limits. REPAIR as necessary. • CHECK for a loose stabilizer bar, damaged or loose strut/strut bushings or loose or worn ball joints. INSPECT the steering linkage for wear or damage. REPAIR or INSTALL new components as necessary. REFER to Section 204-01. • CHECK for correct driveline angles. REPAIR as necessary. • ROTATE the driveshaft and CHECK for rough operation or seized U-joints. INSTALL new U-joints as necessary. • CLEAN and INSPECT the splines of the slip-yoke, driveshaft and coupling shaft for a worn, damaged or galled condition. INSTALL a new slip-yoke or driveshaft assembly as necessary. REPAIR as necessary.

DIAGNOSIS AND TESTING (Continued)**Symptom Chart—Driveline Noise/Vibration (Continued)**

Condition	Possible Sources	Action
• Driveline vibration—occurs at cruising speeds	• U-joints are worn. • Worn or damaged driveshaft center bearing support. • Loose axle pinion flange bolts. • Excessive axle pinion flange runout. • Driveshaft is out-of-balance. • Binding or damaged splines on the driveshaft slip-yoke. • Driveshaft runout. • Incorrect lateral and radial tire/wheel runout. • Driveline angles out of specification. • Incorrectly seated CV joint in the front wheel hub.	• CHECK for wear or incorrect seating. INSTALL new U-joints as necessary. • CHECK the insulator for damage or wear. ROTATE the driveshaft and CHECK for rough operation. INSTALL a new center bearing support as necessary. • INSPECT the axle pinion flange. TIGHTEN the pinion flange bolts to specification. • CARRY OUT a Runout Check. REPAIR as necessary. • CHECK the driveshaft for damage, missing balance weights or undercoating. CHECK driveshaft balance. CARRY OUT a driveline vibration test. REPAIR as necessary. • CLEAN and INSPECT the splines of the slip-yoke, driveshaft and coupling shaft for wear or damage. INSTALL a new slip-yoke or driveshaft assembly as necessary. REPAIR as necessary. • CARRY OUT a Runout Check. REPAIR as necessary. • INSPECT the tire and wheels. MEASURE tire runouts. REPAIR or INSTALL new components as necessary. REFER to Section 204-04. • CHECK for correct driveline angles. REPAIR as necessary. • CHECK the outer CV joint for correct seating into the hub. REPAIR as necessary. REFER to Section 205-04.

DIAGNOSIS AND TESTING (Continued)**Symptom Chart — Engine Noise/Vibration**

Condition	Possible Sources	Action
Grinding noise—occurs during engine cranking	- Incorrect starter motor mounting. - Starter motor. - Incorrect starter motor drive engagement.	- INSPECT the starter motor for correct mounting. REPAIR as necessary. REFER to Section 303-06. - CHECK the starter motor. REPAIR or INSTALL a new starter motor as necessary. REFER to Section 303-06. - INSPECT the starter motor drive and flexplate/flywheel for wear or damage. INSTALL a new starter motor drive or flywheel as necessary. REFER to Section 303-06.
Engine ticking noise	- Fuel injector. - Fuel line. - Oil pump. - Valve lifter. - Belt tensioner. - Water pump. - Obstruction of cooling fan.	GO to Pinpoint Test B.
Engine drumming noise—normally accompanied by vibration	- Powertrain mount. - Damaged or misaligned exhaust system.	- CARRY OUT Powertrain/Drivetrain Mount Neutralizing in this section. - INSPECT the exhaust system for loose or broken clamps and brackets. CARRY OUT Exhaust System Neutralizing in this section.
Whistling noise—normally accompanied with poor idle condition	Air intake system.	CHECK the air intake ducts, air cleaner, throttle body and vacuum hoses for leaks and correct fit. REPAIR or ADJUST as necessary. REFER to Section 303-12A or Section 303-12B.
Clunking noise	- Water pump has excessive end play or imbalance. - Generator has excessive end play.	- CHECK the water pump for excessive end play. INSPECT the water pump with the drive belt off for imbalance. INSTALL a new water pump as necessary. REFER to Section 303-03. - CHECK the generator for excessive end play. REPAIR or INSTALL a new generator. REFER to Section 414-02.

DIAGNOSIS AND TESTING (Continued)**Symptom Chart — Engine Noise/Vibration (Continued)**

Condition	Possible Sources	Action
Pinging noise	- Exhaust system leak. - Gasoline octane too low. - Knock sensor operation. - Incorrect spark timing. - High operating temperature. - Foul-out spark plug. - Catalytic converter.	- INSPECT the exhaust system for leaks. REPAIR as necessary. - VERIFY with customer the type of gasoline used. CORRECT as necessary. - CHECK the knock sensor. INSTALL a new knock sensor as necessary. REFER to Section 303-14A or Section 303-14B. - CHECK the spark timing. REPAIR as necessary. - INSPECT cooling system for leaks. CHECK the coolant level. REFILL as necessary. CHECK the coolant for the correct mix ratio. DRAIN and REFILL as needed. CHECK engine operating temperature is within specifications. REPAIR as necessary. - CHECK the spark plugs. REPAIR or INSTALL new spark plugs as necessary. - Acceptable noise.
Knocking noise—light knocking noise, also described as piston slap. Noise is most noticeable when engine is cold with light to medium acceleration. Noise disappears as engine warms	Excessive clearance between the piston and the cylinder wall.	Engine cold and at high idle. Using an EngineEAR, PULL a spark plug or fuel injector connector until the noise goes away. CARRY OUT a cylinder bore clearance to piston check. INSTALL a new piston. REFER to Section 303-01A or Section 303-01B.
Knocking noise—light double knock or sharp rap sound. Occurs mostly with warm engine at idle or low speeds in DRIVE. Increases in relation to engine load. Associated with poor lubrication history	Excessive clearance between the piston and the piston pin.	CHECK the piston and piston pin clearance. INSTALL a new piston or piston pin. REFER to Section 303-01A or Section 303-01B.
Knocking noise—light knocking noise is most noticeable when engine is warm. Noise tends to decrease when vehicle is coasting or in NEUTRAL	Excessive clearance between the connecting rod bearings and the crankshaft.	Engine warm and at idle. Using an EngineEAR, PULL a spark plug or fuel injector connector until the noise goes away. INSTALL new bearings. REFER to Section 303-01A or Section 303-01B.

DIAGNOSIS AND TESTING (Continued)**Symptom Chart — Engine Noise/Vibration (Continued)**

Condition	Possible Sources	Action
Knocking—deep knocking noise. Noise is most noticeable when engine is warm, at lower rpm and under a light load and then at float	Worn or damaged crankshaft main bearings.	CARRY OUT Drive Engine Run-Up (DERU) Test. CHECK for noise with vehicle at operating temperature, during medium to heavy acceleration. CHECK at idle with injector disconnected, noise does not change. INSTALL new main bearings. REFER to Section 303-01A or Section 303-01B.
Knocking noise—occurs mostly with warm engine at light/medium acceleration	- Spark plugs. - Carbon accumulation in combustion chamber.	- CHECK the spark plug for damage or wear. INSTALL new spark plugs as necessary. - REMOVE carbon from combustion chamber.
Whine or moaning noise	- Air intake system. - Generator electrical field or bearings.	- CHECK the air cleaner and ducts for correct fit. INSPECT the air intake system for leaks or damage. REPAIR as necessary. - CARRY OUT generator load test. REPAIR or INSTALL a new generator as necessary. REFER to Section 414-02.
Drone type noise	- Exhaust system. - A/C compressor. - Powertrain mounts.	- CARRY OUT Exhaust System Neutralizing in this section. REPAIR as necessary. - CHECK for noise with vehicle at constant speeds. CYCLE the compressor on and off and listen for a change in pitch. REPAIR as necessary. REFER to Section 412-03. - CARRY OUT Powertrain/Drivetrain Mount Neutralizing in this section.
Sputter type noise—noise worse when cold, lessens or disappears when vehicle is at operating temperature	Damaged or worn exhaust system components.	INSPECT the exhaust system for leaks or damage. REPAIR as necessary. REFER to Section 309-00.

DIAGNOSIS AND TESTING (Continued)**Symptom Chart — Engine Noise/Vibration (Continued)**

Condition	Possible Sources	Action
Rattling noise—noise from the upper engine (valve train). Worse when engine is cold	- Low oil level. - Thin or diluted oil. - Low oil pressure. - Worn rocker arms/fulcrums or followers. - Worn valve guides. - Excessive runout of valve seats on the valve face.	- CHECK oil level. FILL as necessary. - INSPECT the oil for contamination. If oil is contaminated, CHECK for the source. REPAIR as necessary. CHANGE the oil and filter. - CARRY OUT an oil pressure test. If not within specifications, REPAIR as necessary. REFER to Section 303-00. - CARRY OUT a valve train analysis. INSTALL new valve train components as necessary. REFER to Section 303-01A or Section 303-01B. - CARRY OUT a valve train analysis. INSTALL new valve guides as necessary. REFER to Section 303-01A or Section 303-01B. - CARRY OUT a valve seat runout test. INSPECT the valve face and seat. INSTALL new valves as necessary. REFER to Section 303-01A or Section 303-01B.
Rattling noise—from the bottom of the vehicle	Loose muffler shields or catalytic converter shields.	CHECK the exhaust system for loose exhaust shields. REPAIR as necessary.
Thumping noise—from the bottom of the vehicle, worse at acceleration	Exhaust pipe/muffler grounded to chassis.	CHECK the exhaust system to chassis clearance. CHECK the exhaust system hangers for damage. REPAIR as necessary. REFER to Section 309-00.
Whoosh—occurs during light vehicle acceleration. Heard inside the vehicle	Throttling late, creating turbulence transmitted through the plastic manifold.	CHECK for leaks or missing seal in the dash panel.
Engine vibration—increases intensity as engine rpm is increased	Engine out-of-balance.	CARRY OUT Neutral Engine Run-Up (NERU) Test. ROTATE the torque converter, 120° for 3 bolt and 180° for 4 bolt. INSPECT the torque converter pilot outer diameter to crankshaft pilot inner diameter. REPAIR as necessary. REFER to Section 307-01.

DIAGNOSIS AND TESTING (Continued)**Symptom Chart — Engine Noise/Vibration (Continued)**

Condition	Possible Sources	Action
Engine vibration—is felt with increases and decreases in engine rpm	- Strain on exhaust mounts. - Damaged or worn powertrain/drivetrain mounts. - Engine or transmission grounded to chassis.	- CARRY OUT Exhaust System Neutralizing in this section. REPAIR as necessary. - CHECK the powertrain/drivetrain mounts for damage. REFER to Section 303-01A, Section 303-01B or Section 307-01. REPAIR as necessary. - INSPECT the powertrain/drivetrain for correct clearances. REPAIR as necessary.
Engine vibration—vibration felt at all times	- Excessive engine pulley runout. - Damaged or worn accessory component.	- CARRY OUT Engine Accessory Test. INSTALL a new engine pulley as necessary. REFER to Section 303-01A or Section 303-01B. - CARRY OUT Engine Accessory Test. REPAIR or INSTALL a new component as necessary.
Accelerator pedal vibration—felt through the pedal as a buzz	Throttle cable loose or misrouted.	INSPECT the throttle cable. REPAIR as necessary. REFER to Section 310-02.
Engine vibration—mostly at coast/neutral coast. Condition improves with vehicle accelerating	Combustion instability.	CHECK the ignition system. INSTALL new components as necessary.
Engine vibration or shudder—occurs with light to medium acceleration above 56 km/h (35 mph)	- Worn or damaged spark plugs. - Plugged fuel injector. - Damaged spark plug wire. - Contaminated fuel. - Worn or damaged torque converter.	- INSPECT the spark plugs for cracks, high resistance or broken insulator. INSTALL a new spark plug(s) as necessary. - REPAIR or INSTALL a new injector as necessary. - INSPECT the spark plug wires for damage. INSTALL a new spark plug wire(s) as necessary. - INSPECT the fuel for contamination. DRAIN the fuel system and refill. - CHECK the torque converter. INSTALL a new torque converter as necessary. REFER to Section 307-01.

DIAGNOSIS AND TESTING (Continued)**Symptom Chart—Idle Noise/Vibration**

Condition	Possible Sources	Action
Idle air control (IAC) valve moan — occurs on throttle tip-out	IAC valve is contaminated with oil.	GO to Component Tests in this section.
Accessory drive belt chirp — occurs at idle or high idle, cold or hot. Most common occurrence is during humid weather	Accessory drive belt worn, or pulley is misaligned or loose.	INSPECT for loose or misaligned pulleys. CHECK the drive belt for wear or damage. INSTALL new pulley(s)/accessory drive belt, as necessary. REFER to Section 303-05.
Accessory drive bearing hoot — occurs at idle or high idle in cold temperatures of approximately +4°C (+40°F) or colder at first start of the day	Accessory drive idler or tensioner pulley bearing is experiencing stick/slip between ball bearings and bearing race.	GO to Pinpoint Test C.
Power steering moan — occurs at high idle and possibly at idle during the first cold start of the day in temperatures of approximately -18°C (0°F) or colder. Noise can even be a severe screech for less than one minute in very cold temperatures of approximately -29°C (-20°F) or colder	High fluid viscosity, or plugged reservoir screen in power steering reservoir starves pump causing cavitation.	GO to Pinpoint Test D.
Generator whine — during high electrical loads at idle or high idle, a high pitch whine or moan is emitted from the generator	Generator electrical field noise.	Using an EngineEAR, PROBE near the generator housing. LISTEN for changes in the noise level while changing electrical loads (such as rear defrost, headlamps, etc.). CARRY OUT a generator load test. If the system passes the load test, the noise is from the generator bearings, INSTALL new bearings. If the system fails the load test, INSTALL a new generator. REFER to Section 414-02.
Engine-driven cooling fan moan — occurs during the first start of the day. It is most objectionable near idle speeds up to 2000 rpm. The noise increases with rpm	The viscous cooling fan clutch engages until the fluid in the clutch reaches normal operating temperature, causing the fan to fully engage.	GO to Pinpoint Test E.
Drumming noise — occurs inside the vehicle during idle or high idle, hot or cold. Very low-frequency drumming is very rpm dependent	- Exhaust system vibration excites the body resonances inducing interior noise. - Engine vibration excites the body resonances inducing interior noise.	GO to Pinpoint Test F.

DIAGNOSIS AND TESTING (Continued)**Symptom Chart—Idle Noise/Vibration (Continued)**

Condition	Possible Sources	Action
Hissing noise — occurs during idle or high idle that is apparent with the hood open	- Vacuum leak or idle air control (IAC) valve flow noise. - Vehicles with a plastic intake manifold.	- USE the Ultrasonic Leak Detector/EngineEAR to locate the source. SCAN the air intake system from the inlet to each cylinder intake port. DISCARD the leaking parts, and INSTALL a new component. - Acceptable condition. Some plastic manifolds exhibit this noise, which is the effect of the plastic manifold.
Automatic transmission buzz or hiss	- Incorrect driveline angles. - Worn or damaged main control solenoids or valves.	- CHECK for correct driveline angles. REPAIR as necessary. - Using a transmission tester, ACTIVATE the solenoids to duplicate sound. INSTALL new components as necessary. REFER to Section 307-01.
Manual Transmission Clutch throw-out bearing whine. A change in noise pitch or loudness while depressing the clutch pedal	Worn throw-out bearing.	INSTALL a new throw-out bearing.
Heating, vacuum and air conditioning (HVAC) system chirp — most audible inside the vehicle. Listen for a change in noise pitch or loudness while changing the HVAC system blower speed	Damaged or worn HVAC blower bearing.	INSTALL a new blower motor. REFER to Section 412-02.
Air conditioning (A/C) clutch ticking — occurs when the compressor clutch engages	- Acceptable noise. - Incorrect air gap.	LISTEN to the clutch to determine if the noise occurs with clutch engagement. A small amount of noise is acceptable. If the noise is excessive, CHECK the A/C clutch air gap. INSPECT the A/C clutch for wear or damage. INSTALL a new clutch as necessary. REFER to Section 412-03.
Intermittent rattle, or scraping/rubbing noise	- Loose exhaust heat shield(s). - Wiring, hose or other part interfering with accessory drive belt or pulley.	- INSPECT the exhaust system for loose parts using a glove or clamps to verify cause. REPAIR as necessary. REFER to Section 309-00. - INSPECT FEAD system closely verifying there is adequate clearance to all rotating components. REPAIR as necessary.
Engine ticking or knocking noise — occurs during idle or high idle during the first cold start of the day	Piston noise or valvetrain noise (bled down lifter/lash adjuster).	GO to Pinpoint Test G.

DIAGNOSIS AND TESTING (Continued)**Symptom Chart—Idle Noise/Vibration (Continued)**

Condition	Possible Sources	Action
A continuous, speed-dependent rattle from the engine — occurs during idle or high idle during the first cold start of the day and disappears as the engine warms up	Piston noise or valvetrain noise (bled down lifter/lash adjuster).	GO to Pinpoint Test G.
Idle vibration—a low-frequency vibration (5-20 Hz) or mild shake that is felt through the seat/floorpan	- Cylinder misfire. - Engine or torque converter out of balance.	- Using a scan tool, CHECK the ignition system. CARRY OUT a cylinder power test. REFER to Section 303-00. - VERIFY the torque converter to crankshaft pilot clearance is correct, REPAIR as necessary. RE-INDEX the torque converter on the flex plate by 120° on a 3 bolt converter or 180° for a 4 bolt converter. REFER to Section 307-01. RETEST the vehicle.
Idle vibration—a high-frequency vibration (20-80 Hz) or buzz, that is felt through the steering wheel or seat	- Exhaust system mounts bound up. - Body mounts loose. - Power steering lines grounded out.	- VERIFY concern occurs at engine firing frequency. CHECK that the exhaust system vibrates at the same frequency as the engine. ADD 9-14 km (20-30 lb.) to the tail pipe to test, CARRY OUT Exhaust System Neutralizing in this section. - INSPECT the body mounts. CARRY OUT a Neutral Engine Run-Up (NERU) Test. REPAIR as necessary. REFER to Section 303-01A, Section 303-01B or Section 307-01. - INSPECT that the power steering lines are not contacting the chassis or each other. REPAIR as necessary.

Symptom Chart—Squeak and Rattle

Condition	Possible Sources	Action
Squeak—heard inside the vehicle when closing/opening the door	- Insufficient lubrication on the door hinge or check strap. - Internal door components loose, rubbing or misaligned.	- LUBRICATE the hinge or check strap. - CHECK the inside of the door. TIGHTEN or ALIGN as necessary. USE the Rotunda Squeak and Rattle Kit to isolate any rubbing components.
Squeak—heard inside the vehicle when closing/opening the window	Worn or damaged glass run/channel.	REPAIR or INSTALL a new glass run/channel. REFER to Section 501-11.
Squeak—heard outside of vehicle when closing/opening the door	Exhaust shield rubbing against the chassis or exhaust pipe.	CHECK the exhaust system. REPAIR as necessary. REFER to Section 309-00.

DIAGNOSIS AND TESTING (Continued)**Symptom Chart—Squeak and Rattle (Continued)**

Condition	Possible Sources	Action
Squeak—occurs with initial brake pedal application	Disc brake pads.	Under certain conditions, asbestos free pads can generate a squeak noise. This noise is normal and does not indicate a concern.
Squeak—a constant noise that occurs with brake pedal applications	Damaged or worn disc brake pads.	INSPECT the pads for oil, grease or brake fluid contamination. CHECK for glazed linings. A brake disc with hard spots will also cause a squeak type noise. REPAIR or INSTALL new pads as necessary. REFER to Section 206-03 for front disc brakes or Section 206-04 for rear disc brakes.
Squeak—noise occurs over bumps or when turning	- Worn control arm bushings. - Worn or damaged shock absorber/strut.	- INSPECT the control arm bushings. Spray with lubricant and CARRY OUT a “bounce test” to determine which bushing. REPAIR as necessary. REFER to Section 204-01 for the front suspension or Section 204-02 for the rear suspension. - INSPECT the shock absorber/strut for damage. CARRY OUT a “bounce test” to isolate the noise. INSTALL a new shock absorber/strut as necessary. REFER to Section 204-01 for the front shock absorber/strut or Section 204-02 for the rear shock absorber/strut.
Rattle—heard when closing/opening the door or window	Loose internal door mechanism, bracket or attachment.	REPEAT the motion or CARRY OUT a “tap test” to duplicate the noise. INSPECT the door for loose components. TIGHTEN loose components or USE the Rotunda Squeak and Rattle Kit to isolate any rattling components.
Squeak or rattle—heard inside the vehicle over rough roads/bumps	- Misaligned glove compartment door/hinge. - Instrument panel trim loose or misaligned. - Loose interior component or trim.	- ALIGN the glove compartment door. - INSPECT the instrument panel trim for missing or loose clips or screws. REPAIR as necessary. - CARRY OUT a “touch test”. ELIMINATE the noise by pressing or pulling on interior trim and components. USE the Rotunda Squeak and Rattle Kit to isolate any rattling/squeaking components.

DIAGNOSIS AND TESTING (Continued)**Symptom Chart—Squeak and Rattle (Continued)**

Condition	Possible Sources	Action
Squeak or rattle—noise with a vibration concern	- Damaged or worn body mounts. - Damaged or worn sub-frame mounts.	- INSPECT the upper and lower absorbers and washers for damage or wear. CHECK the body mount brackets for damage. CHECK the nuts and bolts are tightened to specifications. TIGHTEN as necessary. - INSPECT the upper and lower absorbers for damage or wear. CHECK the sub-frame for damage. CHECK the nuts and bolts are tightened to specifications. TIGHTEN as necessary.

Symptom Chart—Steering Noise/Vibration

Condition	Possible Sources	Action
Steering grunt or shudder — occurs when turning into or out of a turn at low speeds (temperature sensitive)	Steering gear or power steering hoses.	GO to Steering Gear Grunt/Shudder Test component test in this section.
Steering system clunk—hydraulic knocking sound	Air in the steering hydraulic system.	CHECK for leaks in the system. PURGE the air from the system. REFER to Section 211-00.
Power steering pump moan — loud humming noise occurs when the steering wheel is rotated to the stop position. Produces a 120-600 Hz frequency that changes with rpm	- Power steering hose grounded out to chassis. - Aerated fluid. - Steering gear isolators. - Low fluid. - Power steering pump brackets loose or misaligned.	- INSPECT the power steering hoses. REPAIR as necessary. - CHECK for leaks in the system. PURGE the air from the system. REFER to Section 211-00. - INSPECT the isolators for wear or damage. REPAIR as necessary. - CHECK the fluid level. REFILL as necessary. - CHECK bolts, brackets and bracket alignment. TIGHTEN bolts to specification. REPAIR or INSTALL new brackets as necessary. REFER to Section 211-02.
Steering gear clunk — occurs only while cornering over a bump (can be temperature sensitive)	Steering gear.	INSPECT the steering gear for loose mounting bolts. TIGHTEN as necessary. REFER to Section 211-02.

DIAGNOSIS AND TESTING (Continued)**Symptom Chart—Steering Noise/Vibration (Continued)**

Condition	Possible Sources	Action
Feedback (rattle, chuckle or knocking noise in the steering gear) — a condition where roughness is felt in the steering wheel when the vehicle is driven over rough surfaces	- Column intermediate/flexible shaft joints damaged or worn. - Loose, damaged or worn tie-rod ends. - Steering gear insulators or mounting bolts loose or damaged. - Steering column intermediate shaft bolts are loose. - Steering column damaged or worn. - Loose suspension bushings, bolts or ball joints.	- INSTALL a new intermediate/flexible shaft. REFER to Section 211-04. - TIGHTEN the nuts to specification or INSTALL new tie-rod ends as necessary. REFER to Section 211-02. - TIGHTEN the bolts or INSTALL new bolts as necessary. REFER to Section 211-02. - TIGHTEN the bolts to specification. REFER to Section 211-04. - REPAIR or INSTALL a new steering column as necessary. REFER to Section 211-04. - INSPECT the suspension system. TIGHTEN or INSTALL new components as necessary. REFER to Section 204-01.
Feedback (nibble at the steering wheel) — a condition where slight rotational movement is felt in the steering wheel when the vehicle is driven over rough or grooved surfaces	- Lateral runout in the tire or wheel. - Yoke spring in the steering gear.	- GO to Pinpoint Test H. - CHECK TSBs for revised yoke spring for applicable vehicles.
Accessory drive belt squeal/chirp—when rotating the steering wheel from stop to stop	Loose or worn accessory drive belt.	ADJUST or INSTALL a new accessory belt as necessary. REFER to Section 303-05.
Power steering gear hiss	- Steering column intermediate/flexible shaft-to-steering gear is binding or misaligned. - Grounded or loose steering column boot at the dash panel. - Damaged or worn steering gear input shaft and valve.	- REPAIR or INSTALL a new intermediate/flexible shaft as necessary. REFER to Section 211-04. - REPAIR as necessary. - REPAIR or INSTALL a new steering gear as necessary. REFER to Section 211-02.

DIAGNOSIS AND TESTING (Continued)**Symptom Chart—Steering Noise/Vibration (Continued)**

Condition	Possible Sources	Action
Steering column rattle	- Loose bolts or attaching brackets. - Loose, worn or insufficiently lubricated column bearings. - Steering shaft insulators damaged or worn. - Intermediate/flexible shaft compressed or extended.	- TIGHTEN the bolts to specifications. - LUBRICATE or INSTALL new steering column bearings as necessary. REFER to Section 211-04. - INSTALL new insulators. REFER to Section 211-04. - INSPECT the rubber spider coupling for damage. INSTALL a new intermediate/flexible shaft. REFER to Section 211-04.
Steering column squeak or cracks	- Insufficient lubricated steering shaft bushings. - Loose or misaligned steering column shrouds. - Steering wheel rubbing against steering column shrouds. - Insufficient lubricated speed control slip ring. - Upper or lower bearing sleeve out of position.	- LUBRICATE the steering shaft and shaft tube seals. - TIGHTEN or ALIGN the steering column shrouds. - REPOSITION the steering column shrouds. - LUBRICATE the speed control slip ring. - REPOSITION the bearing sleeves.
Power steering pump noisy	- Incorrect assembly of components. - Imperfections on the outside diameter or end surface of the power steering pump rotor. - Damaged or worn power steering pump rotor splines. - A crack on the inner surface of the power steering pump cam. - Interference between the power steering pump rotor and cam. - Damaged or worn power steering pump rotor and pressure plates.	REPAIR or INSTALL a new power steering pump as necessary. REFER to Section 211-02.
Power steering pump swish noise	Power steering fluid flow into the bypass valve of the pump valve housing with fluid temperature below 54°C (130°F).	Acceptable condition.
Power steering pump whine noise	- Aerated fluid. - Damaged power steering pump cam. - Damaged valve cover O-ring seal.	- CHECK for a leak in the system. PURGE the air from the system. REFER to Section 211-00. - REPAIR or INSTALL a new power steering pump as necessary. REFER to Section 211-02. - REPAIR or INSTALL a new power steering pump as necessary. REFER to Section 211-02.

DIAGNOSIS AND TESTING (Continued)**Symptom Chart—Steering Noise/Vibration (Continued)**

Condition	Possible Sources	Action
Power steering pump clicking (mechanical) noise	Power steering pump rotor slippers too long, excessive rotor slipper-to-slot clearance or damaged or worn rotor assembly.	REPAIR or INSTALL a new power steering pump as necessary. REFER to Section 211-02.
Power steering pump clatter noise	Damaged corners on the outside diameter or the power steering rotor or distorted rotor slipper ring.	REPAIR or INSTALL a new power steering pump as necessary. REFER to Section 211-02.

Symptom Chart—Suspension Noise/Vibration

Condition	Possible Sources	Action
Squeak or grunt—noise from the front suspension, occurs more in cold ambient temperatures. More noticeable over rough roads or when turning	Front stabilizer bar insulators.	Under these conditions, the noise is acceptable. CHECK TSBs for applicable vehicle.
Clunk—noise from the front suspension, occurs in and out of turns	Loose front struts or shocks.	INSPECT for loose nuts or bolts. TIGHTEN to specifications. REFER to Section 204-01.
Clunk—noise from the rear suspension, occurs when shifting from reverse to drive	Loose rear suspension components.	INSPECT for loose or damaged rear suspension components. REPAIR or INSTALL new components as necessary. REFER to Section 204-02.
Click or pop—noise from the front suspension. More noticeable over rough roads or over bumps	Worn or damaged ball joints.	CARRY OUT a ball joint inspection. INSTALL new ball joints or control arms as necessary. REFER to Section 204-01.
Click or pop (FWD vehicles)—noise occurs when vehicle is turning	Worn or damaged ball joints.	CARRY OUT a ball joint inspection. INSTALL new ball joints or control arms as necessary. REFER to Section 204-01.
Click or snap—occurs when accelerating around a corner	Damaged or worn outboard CV joint.	INSPECT the outboard CV joint and boot. REPAIR or INSTALL a new CV joint as necessary. Section 205-04.
Front suspension noise—a squeak, creak or rattle noise. Occurs mostly over bumps or rough roads	- Steering components. - Loose or bent front struts or shock absorbers. - Damaged spring or spring mounts. - Damaged or worn control/radius arm bushings. - Worn or damaged stabilizer bar bushings or links.	GO to Pinpoint Test H.

DIAGNOSIS AND TESTING (Continued)**Symptom Chart—Suspension Noise/Vibration (Continued)**

Condition	Possible Sources	Action
Rear suspension noise—a squeak, creak or rattle noise. Occurs mostly over bumps or rough roads	- Loose or bent rear shock absorbers. - Damaged spring or spring mounts. - Damaged or worn control arm bushings. - Worn or damaged stabilizer bar bushings or links.	GO to Pinpoint Test I.
Shudder—occurs during acceleration from a slow speed or stop	- Rear drive axle assembly mispositioned. - Incorrect or high CV joint operating angle. - Damaged or worn front suspension components.	- CHECK the axle mounts and the rear suspension for damage or wear. REPAIR as necessary. - CHECK vehicle ride height is within limits. REPAIR as necessary. - CHECK for a loose stabilizer bar, damaged or loose strut/strut bushings or loose or worn ball joints. INSPECT the steering linkage for wear or damage. REPAIR or INSTALL new components as necessary.
Shimmy—most noticeable on coast/deceleration. Also hard steering condition	Excessive positive caster.	CHECK the caster alignment angle. CORRECT as necessary. REFER to Section 204-00.

Symptom Chart—Tire Noise/Vibration

Condition	Possible Sources	Action
Tire noise—hum/moan at constant speeds	Abnormal wear patterns.	SPIN the tire and CHECK for tire wear. INSTALL a new tire as necessary. INSPECT for damaged/worn suspension components. CARRY OUT wheel alignment.
Tire noise—noise tone lowers as the vehicle speed is lowered	Out-of-balance tire.	BALANCE the tire and ROAD TEST. INSTALL a new tire as necessary. REFER to Section 204-04.
Tire noise — ticking noise, changes with speed	Nail puncture or stone in tire tread.	INSPECT the tire. REPAIR as necessary.
Wheel and tire—vibration and noise concern is directly related to vehicle speed and is not affected by acceleration, coasting or decelerating	Damaged or worn tire.	GO to Pinpoint Test J.

DIAGNOSIS AND TESTING (Continued)**Symptom Chart—Tire Noise/Vibration (Continued)**

Condition	Possible Sources	Action
Tire wobble or shudder — occurs at lower speeds	- Damaged wheel bearings. - Damaged wheel. - Damaged or worn suspension components. - Loose wheel nuts. - Damaged or uneven tire wear.	- SPIN the tire and CHECK for abnormal wheel bearing play or roughness. ADJUST or INSTALL new wheel bearings as necessary. REFER to Section 204-01. - INSPECT the wheel for damage. INSTALL a new wheel as necessary. REFER to Section 204-04. - INSPECT the suspension components for wear or damage. REPAIR as necessary. - CHECK the wheel nuts. TIGHTEN to specification. REFER to Section 204-04. - SPIN the tire and CHECK for abnormal tire wear or damage. INSTALL a new tire as necessary. REFER to Section 204-04.
Tire shimmy or shake — occurs at lower speeds	- Wheel/tire out of balance. - Uneven tire wear. - Excessive radial runout of wheel or tire. - Worn or damaged wheel studs or elongated stud holes. - Excessive lateral runout of the wheel or tire. - Foreign material between the brake disc and hub or in the brake disc fins.	- BALANCE the wheel/tire assembly. - CHECK for abnormal tire wear. INSTALL a new tire as necessary. REFER to Section 204-04. - CARRY OUT a radial runout test of the wheel and tire. INSTALL a new tire as necessary. REFER to Section 204-04. - INSPECT the wheel studs and wheels. INSTALL new components as necessary. REFER to Section 204-01 for the front wheels or Section 204-02 for the rear wheels. - CARRY OUT a lateral runout test of the wheel and tire. REFER to Section 204-04. CHECK the wheel, tire and hub. REPAIR or INSTALL new components as necessary. - CLEAN the mounting surfaces of the brake disc and hub. CHECK the brake disc fins for material.
High speed shake or shimmy — occurs at high speeds	- Excessive wheel hub runout. - Damaged or worn tires. - Damaged or worn wheel bearings. - Worn or damaged suspension or steering linkage components. - Brake disc or drum imbalance.	GO to Pinpoint Test K.

DIAGNOSIS AND TESTING (Continued)**Symptom Chart—Transmission (Manual) and Transfer Case Noise/Vibration**

Condition	Possible Sources	Action
Clutch rattling noise—occurs with clutch engaged, noise changes/disappears with clutch pedal depressed	Flywheel bolts, clutch housing bolts or clutch pressure plate bolts loose.	TIGHTEN the bolts to specifications. CHECK the bolts for damage.
Clutch squeaking noise—noise is heard when the clutch is operated. Vehicle moves slowly or creeps when the clutch is disengaged. Can also be difficult to shift into first and reverse gear	Pilot bearing seized or damaged.	INSTALL a new pilot bearing.
Clutch squeaking noise—occurs with clutch pedal depressed/released	Worn clutch pedal shaft or bushings.	INSPECT the clutch pedal for wear or damage. REPAIR as necessary.
Clutch whirring/rattle noise—occurs when clutch pedal is depressed	Worn, damaged or misaligned clutch release bearing.	INSTALL a new clutch release bearing.
Clutch grating/grinding noise—occurs when clutch pedal is depressed	- Clutch pressure plate fingers bent or worn. - Contact surface of clutch release bearing worn or damaged.	- INSPECT the clutch pressure plate release fingers. INSTALL a new pressure plate as necessary. - INSTALL a new clutch release bearing.
Clutch chatter—a small amount of noise when clutch pedal is released at initial take-off	Clutch engagement.	Acceptable operating condition.

DIAGNOSIS AND TESTING (Continued)**Symptom Chart—Transmission (Manual) and Transfer Case Noise/Vibration (Continued)**

Condition	Possible Sources	Action
Clutch chatter/grabs—in some cases a shudder is felt. Occurs with clutch pedal depressed/released	- Damaged or worn powertrain/driveline mounts. - Binding or dragging plunger of the clutch master cylinder or slave cylinder. - Grease or oil on the clutch disc facing. - Clutch disc surface glazed or damaged. - Damaged or worn clutch pressure plate. - Flywheel surface damaged or glazed.	- INSPECT the powertrain/drivetrain mounts. REFER to Section 303-01A, Section 303-01B or Section 307-01. INSTALL new mounts as necessary. - CHECK the master and slave cylinder operation. INSPECT the components for damage or wear. INSTALL a new master or slave cylinder as necessary. - CHECK the input shaft seal and rear main oil seal. REPAIR as necessary. INSTALL a new clutch disc. - INSPECT the clutch disc surface for a glazed, hardened or damage condition. CARRY OUT a disc check. INSTALL a new clutch disc as necessary. - INSPECT the clutch pressure plate for wear or damage. INSTALL a new clutch pressure plate as necessary. - INSPECT the flywheel for damage or wear. CARRY OUT a flywheel runout check. INSTALL a new flywheel as necessary.
Clutch chatter noise—noise when clutch pedal is released at initial take-off. Clutch is hard to engage and disengage	Pilot bearing worn, damaged or not correctly aligned in bore.	INSPECT the clutch pressure plate release fingers for uneven wear, clutch components burnt or a seized pilot bearing. INSTALL a new pilot bearing as necessary.
Clutch vibration	- Loose flywheel bolts. - Damaged or loose clutch pressure plate. - Excessive flywheel runout.	GO to Pinpoint Test L.
Transmission rattling/clattering noise—noise at idle or on light acceleration from a stop. Gear selection difficult.	- Gearshift lever joint worn or damaged. - Gearshift lever loose. - Gearshift linkage rods worn or damaged.	- INSTALL a new gearshift lever. - TIGHTEN the bolts to specification. - CHECK the linkage bushings for wear. INSTALL new linkage rods as necessary.
Transmission rattling/clattering noise—occurs in neutral or in gear, at idle	Incorrect fluid level or fluid quality.	CHECK that the transmission is filled to the correct level and with the specified fluid.

DIAGNOSIS AND TESTING (Continued)**Symptom Chart—Transmission (Manual) and Transfer Case Noise/Vibration (Continued)**

Condition	Possible Sources	Action
Transmission rattling/clattering noise—noise at idle in neutral	- Worn or rough reverse idler gear. - Rough running engine, cylinder misfire. - Excessive backlash in gears. - Worn countershaft gears.	- CHECK the reverse idler gear. REPAIR as necessary. - CHECK the ignition system. CARRY OUT a cylinder power test. - CHECK the gear backlash. ADJUST as necessary. - REPAIR as necessary.
Transmission whine—a mild whine at extreme speeds or high rpm	Rotating gears/geartrain.	Acceptable noise.
Transmission whine—a high pitched whine, also described as a squeal	- Transmission gears are worn (high mileage vehicle). - Mismatched gear sets. - Damaged or worn transmission bearing.	- Result of normal gear wear. REPAIR as necessary. - INSPECT the gear sets for an uneven wear pattern on the face of the gear teeth. REPAIR as necessary. - INSPECT the transmission bearings. INSTALL new bearings as necessary.
Transmission growling/humming—noise occurs in the forward gears. The noise is more prominent when the gear is loaded. The problem gear can be located as the noise occurs in a specific gear position	Gear is cracked, chipped or rough.	INSPECT the transmission gears for damage or wear. INSTALL new gears as necessary.
Transmission hissing—noise in neutral or in forward gears. As bearings wear or break up, the noise changes to a thumping noise	Damaged or worn bearings.	INSPECT the transmission bearings. INSTALL new bearings as necessary.
Transmission knocking/thudding—noise at low speeds in forward gears	Bearings with damaged balls or rollers or with pitted and spalled races.	INSPECT the transmission bearings. INSTALL new bearings as necessary.
Transmission rumble/growl—noise at higher speeds in forward gears, more pronounced in a coast/deceleration condition	- Incorrect driveline angle. - Driveshaft out of balance or damaged.	- CHECK the driveline angle. REPAIR as necessary. - CHECK the driveshaft for damage, missing balance weights or undercoating. Using the electronic vibration analyzer (EVA), CHECK the driveshaft balance. CARRY OUT a driveline vibration test. REPAIR as necessary.
Transmission rumble/growl—noise at all speeds in forward gears, more pronounced in a heavy acceleration condition	Damaged or worn transmission bearing or gears (high mileage vehicles).	CHECK transmission fluid for excessive metal particles. REPAIR as necessary.

DIAGNOSIS AND TESTING (Continued)**Symptom Chart—Transmission (Manual) and Transfer Case Noise/Vibration (Continued)**

Condition	Possible Sources	Action
Transfer case whine—noise at all ranges	- Incorrect fluid level or fluid quality. - Worn oil pump. - Under-inflated or oversized tires.	- CHECK that the transfer case is filled to the correct level and with the specified fluid. - DISASSEMBLE the transfer case. CHECK the oil pump for wear or damage. REPAIR as necessary. - CONFIRM that the tires and wheels are correct for the vehicle. CHECK that the tire inflation pressures are correct.
Transfer case growl/rumble—noise at all ranges (A small amount of planetary noise can be heard when the transfer case is operated in low range.)	Damaged or worn bearings or planetary gear.	DISASSEMBLE the transfer case. CHECK the bearings or planetary gear for wear or damage. REPAIR as necessary.
Transfer case scraping/grating—noise at all ranges	Excessively stretched drive chain hitting the case.	DISASSEMBLE the transfer case. CHECK the drive chain for wear or damage. REPAIR as necessary.
Transfer case howl/hum—noise at all ranges or high range only	Worn or damaged sun (input) gear, clutch pack (intermediate) gear or output shaft gear.	DISASSEMBLE the transfer case. CHECK the gears for wear or damage. REPAIR as necessary.
Transfer case howl/hum—noise at low range only	Worn or damaged intermediate gear and sliding gears (clutch pack).	DISASSEMBLE the transfer case. CHECK the gears for wear or damage. REPAIR as necessary.
Transfer case vibration—vibration felt with vehicle in 4WD	- Transfer case mounting. - Driveshaft out of balance. - Excessive pinion flange runout.	GO to Pinpoint Test M.

Symptom Chart—Transmission (Automatic) Noise/Vibration

Condition	Possible Sources	Action
Rattle—occurs at idle or at light acceleration from a stop	- Damaged engine or transmission mounts. - A loose front exhaust pipe heat shield. - Loose inspection plate or dust cover plate. - Loose flexplate to converter nuts.	- CHECK the powertrain/drivetrain mounts for damage. REFER to Section 303-01A, Section 303-01B or Section 307-01. - REPAIR or INSTALL a new heat shield as necessary. - CHECK for loose bolts. TIGHTEN to specifications. REFER to Section 307-01. - CHECK for loose nuts. TIGHTEN to specifications. REFER to Section 307-01.
Whine—pitch increases with vehicle speed. Starts in first and second gear, decreases or goes away at higher gears	- Damaged or worn low one-way clutch. - Damaged or worn intermediate one-way clutch. - Friction elements. - Damaged or worn planetary or sun gear.	INSPECT the transmission for wear or damage. REPAIR or INSTALL new components as necessary. REFER to Section 307-01.

DIAGNOSIS AND TESTING (Continued)**Symptom Chart—Transmission (Automatic) Noise/Vibration (Continued)**

Condition	Possible Sources	Action
Whine—the pitch changes with engine speed	- A worn or damaged accessory drive component. - Incorrect fluid level. - Partially blocked filter. - Worn or damaged torque converter. - Worn or damaged front pump.	- CARRY OUT the Engine Accessory Test. REPAIR or INSTALL new components as necessary. - CHECK that the transmission is filled to the correct level. ADD fluid as necessary. REFER to Section 307-01. - INSPECT the filter. CLEAN or INSTALL a new filter as necessary. REFER to Section 307-01. - CARRY OUT the torque converter service and replacement check. REFER to Section 307-01. - INSPECT the front pump. INSTALL a new front pump as necessary. REFER to Section 307-01.
Whine—pitch changes with vehicle speed	Speedometer cable or gears.	REPAIR or INSTALL new cables or gears as necessary.
Whine/moan type noise—pitch increases or changes with vehicle speed	- Damaged engine or transmission mount. - U-joints worn or damaged. - Damaged or worn differential ring and pinion. - Planetary gears nicked or chipped.	- CHECK the powertrain/drivetrain mounts for damage. REFER to Section 303-01A, Section 303-01B or Section 307-01. - INSPECT the U-joints for wear or damage. INSTALL new U-joints as necessary. - INSPECT the differential ring and pinion for damage. CARRY OUT the Checking Tooth Contact Pattern and Condition of the Ring and Pinion component test in this section. REPAIR or INSTALL a new differential ring and pinion as necessary. - CHECK the planetary gears for damage. INSTALL new components as necessary. REFER to Section 307-01.
Whistle—noise is high pitched, constant. Changes in pitch with throttle position	- Hydraulic pressure in the main control. - Incorrect band/clutch apply pressure. - Worn or damaged torque converter.	- INSPECT the main control. REPAIR or INSTALL new components as necessary. REFER to Section 307-01. - CARRY OUT the line pressure tests. REPAIR or INSTALL components as necessary. REFER to Section 307-01. - CARRY OUT the torque converter service and replacement check. REFER to Section 307-01.

DIAGNOSIS AND TESTING (Continued)**Symptom Chart—Transmission (Automatic) Noise/Vibration (Continued)**

Condition	Possible Sources	Action
Clunk—occurs when shifting from PARK to a drive or reverse position	- Damaged powertrain mounts. - Damaged or worn pinion bearings. - Worn or galled driveshaft slip yoke splines. - Worn friction elements or excessive clutch pack end plate play.	- INSPECT the powertrain mounts for damage. INSTALL new mounts as necessary. REFER to Section 307-01. - CHECK for abnormal bearing play or roughness. INSTALL new bearings as necessary. REFER to Section 307-01. - CLEAN and INSPECT the splines of the yoke. INSTALL a new slip yoke as necessary. - INSPECT the transmission for wear. CHECK that all end play and clearances are within specification. REPAIR or INSTALL new components as necessary. REFER to Section 307-01.
Bump—occurs when shifting from PARK to a drive or reverse position. Similar to Clunk but with no sound	Initial gear engagement.	Acceptable condition.
Buzz or hiss	- Incorrect driveline angles. - Worn or damaged main control solenoids or valves.	- CHECK for correct driveline angles. REPAIR as necessary. - Using a transmission tester, ACTIVATE the solenoids to duplicate sound. INSTALL new components as necessary. REFER to Section 307-01.
Vibration—a high frequency (20-80 Hz) that is felt through the seat or gear shifter. Changes with engine speed	- Transmission cooler lines grounded out. - Flexplate to torque converter nuts loose. - Fluid filler tube grounded out. - Shift cable incorrectly routed, grounded out or loose.	- CHECK the transmission cooler lines. REPAIR as necessary. - CHECK the flexplate nuts. TIGHTEN to specification. REFER to Section 307-01. - CHECK the fluid filler tube. REPAIR as necessary. - CHECK the shift cable. REPAIR as necessary. Section 307-05.
Shutter or chatter—occurs with light to medium acceleration from low speeds or a stop	- Electrical inputs/outputs. - Vehicle wiring harness. - Incorrect inputs/outputs from the powertrain control module (PCM), digital transmission range (TR) sensor, brake pedal position (BPP) sensor, throttle position (TP) sensor, transmission speed sensor (TSS), output speed shaft (OSS) sensor or the torque converter clutch (TCC).	CARRY OUT a Torque Converter Clutch Operation Test. RUN on-board diagnostics or self-test. REFER to Section 307-01. CLEAR the DTC's, ROAD TEST and RERUN on-board diagnostics or self-test.

DIAGNOSIS AND TESTING (Continued)**Pinpoint Tests**

The pinpoint tests are a step-by-step diagnostic process designed to determine the cause of a condition. It may not always be necessary to follow a pinpoint test to its conclusion. Carry out only the steps necessary to correct the condition. Then, test the system for normal operation. Sometimes, it is necessary to remove various vehicle components to gain access to the component requiring testing. Reinstall all components after verifying system operation is normal.

PINPOINT TEST A: BRAKE VIBRATION/SHUDDER

CONDITIONS	DETAILS/RESULTS/ACTIONS
A1 ROAD TEST THE VEHICLE—LIGHT BRAKING	
	1 Check that the wheel and tires are correct for the vehicle. Inspect the tires for abnormal wear patterns. 2 Road test the vehicle. Warm the brakes by slowing the vehicle a few times from 80-32 km/h (50 to 20 mph) using light braking applications. At highway speeds of 89-97 km/h (55-60 mph), apply the brake using a light pedal force. • Is there a vibration/shudder felt in the steering wheel, seat or brake pedal? → Yes GO to A4. → No GO to A2.
A2 ROAD TEST THE VEHICLE—MODERATE TO HEAVY BRAKING	
	1 Road test the vehicle. At highway speeds of 89-97 km/h (55-60 mph), apply the brake using a moderate to heavy pedal force. • Is there a vibration/shudder? → Yes For vehicles with ABS, GO to A3. - For vehicles with standard brakes, GO to A4. → No Vehicle is OK. VERIFY condition with customer. TEST the vehicle for normal operation.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST A: BRAKE VIBRATION/SHUDDER (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
A3 NORMAL ACTUATION OF THE ABS SYSTEM DIAGNOSIS	
	1 During moderate to heavy braking, noise from the hydraulic control unit (HCU) and pulsation in the brake pedal can be observed. Pedal pulsation coupled with noise during heavy braking or on loose gravel, bumps, wet or snowy surfaces is acceptable and indicates correct functioning of the ABS system. Pedal pulsation or steering wheel nibble (frequency is proportioned to the vehicle speed) indicates a concern with a brake or suspension component. • Is the vibration/shudder vehicle speed sensitive? → Yes GO to A5. → No The brake system is operating correctly.
A4 APPLICATION OF THE PARKING BRAKE	
	1 NOTE: Begin at the front of the vehicle unless the vibration or shudder has been isolated to the rear. This test is not applicable to vehicles with drum-in-hat type parking brakes. For vehicles with drum-in-hat parking brakes, proceed to the next test. For all other vehicles, apply the parking brake to identify if the problem is in the front or rear brake. At highway speeds of 89-97 km/h (55-60 mph), lightly apply the parking brake until the vehicle slows down. Release the parking brake immediately after the test. • Is there a vibration/shudder? → Yes GO to A7. → No GO to A5.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST A: BRAKE VIBRATION/SHUDDER (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
A5 CHECK THE FRONT WHEEL BEARINGS	
	1 Check the front wheel bearings. Refer to Wheel Bearing Check in this section. • Are the wheel bearings OK? → Yes GO to A6. → No INSPECT the wheel bearings. ADJUST or REPAIR as necessary. TEST the system for normal operation.
A6 CHECK THE FRONT SUSPENSION	
	1 Check the front suspension for: • Broken or loose bolts. • Damaged springs. • Worn or damaged upper and lower control arm bushings. • Loose or rough front bearings. • Uneven tire wear. • Are all the suspension components in satisfactory condition? → Yes GO to A7. → No REPAIR or INSTALL new components as necessary. TEST the system for normal operation.
A7 RESURFACE THE FRONT BRAKE DISCS	
	1  CAUTION: Do not use a bench lathe to machine brake discs. NOTE: Follow the manufacturer's instructions to machine the brake discs. After machining, make sure the brake disc meets the thickness specification. Resurface the front brake discs. Refer to Brake Disc Machining in this section. Road test the vehicle. • Is the vibration/shudder present? → Yes GO to A8. → No Vehicle is OK.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST A: BRAKE VIBRATION/SHUDDER (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
A8 CHECK THE REAR SUSPENSION	1 Check the rear suspension for: • Broken or loose bolts. • Damaged or worn springs or spring bushings. • Worn or damaged upper and lower control arm bushings. • Worn or damaged trailing arms. • Loose or rough rear bearings. • Uneven tire wear. • Are all the suspension components in satisfactory condition? → Yes GO to A9. → No REPAIR or INSTALL new components as necessary. TEST the system for normal operation.
A9 RESURFACE THE REAR BRAKE DISC OR DRUM	1  CAUTION: Do not use a bench lathe to machine brake discs. NOTE: Follow the manufacturers instructions to machine the brake discs. After machining, make sure the brake disc meets the thickness specification. Resurface the rear brake discs or drums. Refer to Brake Disc Machining in this section. Road test the vehicle. • Is the vibration/shudder present? → Yes CHECK the front suspension for wear or damage, RESURFACE the front brake discs. TEST the system for normal operation. → No Vehicle is OK.

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST B: ENGINE TICKING NOISE**

CONDITIONS	DETAILS/RESULTS/ACTIONS
B1 CHECK FOR TICKING NOISE AT THE FUEL RAIL	
	1 Disconnect the first fuel line clip. • Is the ticking noise gone? → Yes CHECK for TSB for applicable vehicle. REPAIR as necessary. TEST the system for normal operation. → No GO to B2.
B2 CHECK FOR TICKING NOISE AT THE FUEL INJECTOR	
	1 Using an EngineEAR, listen at the fuel injectors by placing a probe on each injector. To isolate the faulty injector, disconnect the injector electrical connector and listen for the noise. • Is the fuel injector the source of the ticking noise? → Yes INSTALL a new fuel injector. REFER to Section 303-04A or Section 303-04B. TEST the system for normal operation. → No GO to B3.
B3 CHECK THE BELT TENSIONER FOR TICKING NOISE	
	1 Inspect the accessory drive belt. Check for the belt tensioner bottoming at end of travel or not at end of stroke. 2 Using an EngineEAR, listen at the belt tensioner. • Is the belt tensioner the source of the noise? → Yes INSTALL a new belt tensioner. TEST the system for normal operation. → No GO to B4.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST B: ENGINE TICKING NOISE (Continued)**

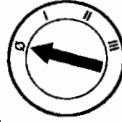
CONDITIONS	DETAILS/RESULTS/ACTIONS
B4 CHECK THE WATER PUMP FOR TICKING NOISE	
	1 Using an EngineEAR, listen at the water pump for ticking noise. • Is the water pump the source of the noise? → Yes INSTALL a new water pump. REFER to Section 303-03. TEST the system for normal operation. → No GO to B5.
B5 CHECK FOR AN OBSTRUCTION OF THE COOLING FAN	
	1 Inspect the cooling fan for obstructions. 2 Check the cooling fan and shroud for wear or damage. • Was there an obstruction or does the cooling fan show signs of damage? → Yes REPAIR or INSTALL a new cooling fan. REFER to Section 303-03. TEST the system for normal operation. → No GO to B6.
B6 CHECK THE OIL PUMP FOR TICKING NOISE	
	1 Check the oil pump using EngineEARs and probe at the oil filter adapter to verify the oil pump as a source. • Is the oil pump the source of the noise? → Yes INSTALL a new oil pump. REFER to Section 303-03. TEST the system for normal operation. → No GO to B7.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST B: ENGINE TICKING NOISE (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
B7 CHECK VALVE LIFTERS OR LASH ADJUSTERS FOR CORRECT OPERATION	
	1 Check valve lifter/lash adjuster for correct operation, using EngineEARS. • Are the valve lifters/lash adjusters operating correctly? → Yes VERIFY customer concern. CONDUCT a diagnosis of other suspect components. → No INSTALL a new valve lifter/lash adjuster(s). REFER to Section 303-01A or Section 303-01B. TEST the system for normal operation.

PINPOINT TEST C: ACCESSORY DRIVE BEARING HOOT

CONDITIONS	DETAILS/RESULTS/ACTIONS
C1 CHECK THE ACCESSORY DRIVE IDLER AND TENSIONER PULLEY BEARINGS	
2  4 	1 Carry out the Vehicle Cold Soak Procedure in this section. 3 Place an EngineEAR probe directly on the pulley center post or bolt to verify which bearing is making the noise. • Is either bearing making the noise? → Yes INSTALL a new pulley/idler. CARRY OUT the Vehicle Cold Soak Procedure and TEST the system for normal operation. → No CONDUCT a diagnosis on other suspect accessory drive components.

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST D: POWER STEERING MOAN**

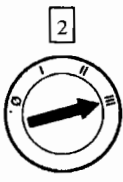
CONDITIONS	DETAILS/RESULTS/ACTIONS
D1 CHECK THE POWER STEERING SYSTEM 2 4	1 Carry out the Vehicle Cold Soak Procedure in this section. 3 Turn the steering wheel while the noise is occurring and listen for changes in sound pitch or loudness. Does the sound pitch or loudness change while turning the steering wheel? → Yes GO to D2. → No CONDUCT a diagnosis on other suspect accessory drive components.
D2 VERIFY THE SOURCE 1 3	2 Place an EngineEAR probe near the power steering pump/reservoir while the noise is occurring. While an assistant turns the steering wheel, listen for changes in sound pitch or loudness.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST D: POWER STEERING MOAN (Continued)**

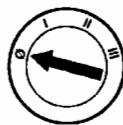
CONDITIONS	DETAILS/RESULTS/ACTIONS
D2 VERIFY THE SOURCE (Continued)	
	Does the sound pitch or loudness change while turning the steering wheel? → Yes VERIFY that the supply tube to the pump is unobstructed. CHECK the fluid condition and level. DRAIN the fluid and REFILL. REFER to Section 211-02. CARRY OUT the Vehicle Cold Soak Procedure and TEST the system for normal operation. → No Normal system operation.

PINPOINT TEST E: ENGINE DRIVEN COOLING FAN MOAN

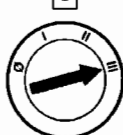
CONDITIONS	DETAILS/RESULTS/ACTIONS
E1 CHECK THE ENGINE DRIVEN COOLING FAN AFTER A COLD SOAK	
 	1 Carry out the Vehicle Cold Soak Procedure in this section. 3 Assess the airflow. 4 Raise the engine speed to 1500 rpm while listening for the moan to increase in proportion to the airflow. Does the moan increase in proportion to the airflow? → Yes TEST the fan for normal operation. If the fan tests normal, GO to E2. Otherwise, REPAIR as necessary. → No Normal system operation.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST E: ENGINE DRIVEN COOLING FAN MOAN (Continued)**

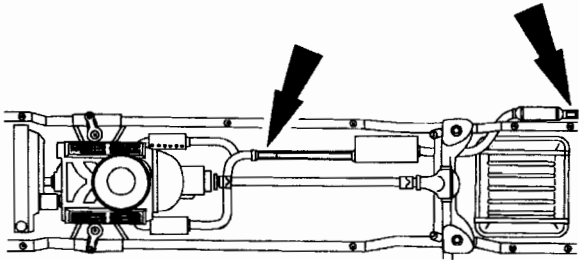
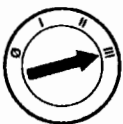
CONDITIONS	DETAILS/RESULTS/ACTIONS
E2 CHECK THE ENGINE DRIVEN COOLING FAN AT NORMAL OPERATING TEMPERATURE	
1  3 	2 Run the engine to normal operating temperature while listening for the moan to stop. • Does the moan stop? → Yes Normal clutch operation. → No INSTALL a new fan clutch. TEST the system for normal operation.

PINPOINT TEST F: DRUMMING NOISE

CONDITIONS	DETAILS/RESULTS/ACTIONS
F1 CHECK THE EXHAUST SYSTEM	
1  3 	2 Increase the engine rpm until the noise is the loudest. Note the engine rpm.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST F: DRUMMING NOISE (Continued)**

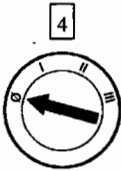
CONDITIONS	DETAILS/RESULTS/ACTIONS
F1 CHECK THE EXHAUST SYSTEM (Continued)	
4  DF1768-A 5  7 	4 Add approximately 9 kg (20 lb) of weight to the exhaust system. First place the weight at the tail pipe and test, then at the front pipe. 6 Increase the engine rpm and listen for the drumming noise. Note the engine rpm if the noise occurs. 8 Using an electronic vibration analyzer (EVA), determine the amount of vibration that occurs with the drumming noise. • Is the noise/vibration reduced or eliminated, or does the noise/vibration occur at a different rpm? → Yes CARRY OUT Exhaust System Neutralizing in this section. TEST the system for normal operation. → No GO to F2.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST F: DRUMMING NOISE (Continued)**

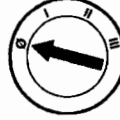
CONDITIONS	DETAILS/RESULTS/ACTIONS
F2 POWERTRAIN/DRIVETRAIN MOUNT NEUTRALIZING	
	1 Carry out Powertrain/Drivetrain Mount Neutralizing in this section. Test the system for normal operation. Is the noise reduced or eliminated? → Yes Vehicle OK. TEST the system for normal operation. → No CONDUCT diagnosis of other suspect components.

PINPOINT TEST G: ENGINE TICKING, KNOCKING OR CONTINUOUS RATTLE

CONDITIONS	DETAILS/RESULTS/ACTIONS
G1 CHECK FOR NOISE AT THE VALVE COVERS AND THE FRONT COVERS (OHC ENGINES)	
2  4 	1 Carry out the Vehicle Cold Soak Procedure in this section. 3 NOTE: For a short-duration ticking noise, multiple engine starts may be necessary. Using an EngineEAR, listen closely at the valve covers and the front covers (OHC engines) by placing the probe near the surface of the valve cover and then on the surface front cover. Is the noise source apparent? → Yes REMOVE the appropriate cover and INSPECT for loose, worn/broken components. REPAIR as necessary. TEST the system for normal operation. → No GO to G2.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST G: ENGINE TICKING, KNOCKING OR CONTINUOUS RATTLE (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
G2 CHECK FOR NOISE AT THE CYLINDER BLOCK	
1  3 	2 Using an EngineEAR, listen closely at the cylinder block by placing a probe on or near each freeze plug. - Is the noise source apparent? → Yes REPAIR or INSTALL new components as necessary. → No GO to G3.
G3 CHECK FOR NOISE WHILE DISCONNECTING EACH FUEL INJECTOR ELECTRICAL CONNECTOR, ONE AT A TIME	
1  3 	2 Disconnect each fuel injector electrical connector, one at a time, to decrease piston force and listen for the noise.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST G: ENGINE TICKING, KNOCKING OR CONTINUOUS RATTLE (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
G3 CHECK FOR NOISE WHILE DISCONNECTING EACH FUEL INJECTOR ELECTRICAL CONNECTOR, ONE AT A TIME (Continued)	
	• Is the noise reduced or eliminated? → Yes INSTALL a new fuel injector. TEST the system for normal operation. → No INSPECT accessory drive system or the transmission as a possible source.

PINPOINT TEST H: FRONT SUSPENSION NOISE

CONDITIONS	DETAILS/RESULTS/ACTIONS
H1 ROAD TEST THE VEHICLE	
	1 Test drive the vehicle. 2 NOTE: An assistant will be needed for this road test. During the road test, drive the vehicle over a rough road. Using ChassisEARS, determine from which area/component the noise is originating. • Is there a squeak, creak or rattle noise? → Yes GO to H2. → No The suspension system is OK. CONDUCT a diagnosis on other suspect systems.
H2 INSPECT THE STEERING SYSTEM	
	1  WARNING: The electrical power to the air suspension system must be shut off prior to hoisting, jacking or towing an air suspension vehicle. This can be accomplished by turning off the air suspension switch. Failure to do so can result in unexpected inflation or deflation of the air springs, which can result in shifting of the vehicle during these operations. Raise and support the vehicle. 2 Check the steering system for wear or damage. Carry out a steering linkage test. Refer Section 211-00.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST H: FRONT SUSPENSION NOISE (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
H2 INSPECT THE STEERING SYSTEM (Continued)	
	3 Inspect the tire wear pattern. Refer to Tire Wear Patterns chart in this section. • Are the steering components worn or damaged? → Yes REPAIR the steering system. INSTALL new components as necessary. TEST the system for normal operation. → No GO to H3.
H3 FRONT SHOCK ABSORBER/STRUT CHECK	
	1 Check the front shock absorbers/strut mounts for loose bolts or nuts. 2 Check the front shock absorbers/struts for wear or damage. Carry out a "bounce test". • Are the front shock absorbers/struts loose or damaged? → Yes TIGHTEN to specifications if loose. INSTALL new front shock absorbers/struts if damaged. TEST the system for normal operation. → No GO to H4.
H4 CHECK THE FRONT SPRINGS	
	1 Check the front spring and front spring mounts/brackets for wear or damage. • Are the front springs or spring mounts/brackets worn or damaged? → Yes REPAIR or INSTALL new components as necessary. TEST the system for normal operation. → No GO to H5.
H5 CHECK THE CONTROL ARMS/RADIUS ARMS	
	1 Inspect the control arm bushings for wear or damage.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST H: FRONT SUSPENSION NOISE (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
H5 CHECK THE CONTROL ARMS/RADIUS ARMS (Continued)	
	2 Inspect for twisted or bent control/radius arm. • Are the control/radius arms damaged or worn? → Yes REPAIR or INSTALL new components as necessary. TEST the system for normal operation. → No GO to H6.
H6 CHECK THE STABILIZER BAR/TRACK BAR	
	1 Check the stabilizer bar/track bar bushings and links for damage or wear. 2 Check the stabilizer bar/track bar for damage. 3 Check for loose or damaged stabilizer bar isolators or brackets. • Are the stabilizer bar/track bar components loose, worn or damaged? → Yes REPAIR or INSTALL new components as necessary. TEST the system for normal operation. → No Suspension system OK. CONDUCT diagnosis on other suspect systems.

PINPOINT TEST I: REAR SUSPENSION NOISE

CONDITIONS	DETAILS/RESULTS/ACTIONS
I1 ROAD TEST THE VEHICLE	
	1 Test drive the vehicle.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST I: REAR SUSPENSION NOISE (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
I1 ROAD TEST THE VEHICLE (Continued)	
	2 NOTE: An assistant will be needed for this road test. During the road test, drive the vehicle over a rough road. Using ChassisEARS, determine from which area/component the noise is originating. • Is there a squeak, creak or rattle noise? → Yes GO to I2. → No The suspension system is OK. CONDUCT a diagnosis on other suspect systems.
I2 REAR SHOCK ABSORBER/STRUT CHECK	
	1  WARNING: The electrical power to the air suspension system must be shut off prior to hoisting, jacking or towing an air suspension vehicle. This can be accomplished by turning off the air suspension switch. Failure to do so can result in unexpected inflation or deflation of the air springs, which can result in shifting of the vehicle during these operations. Raise and support the vehicle. 2 Check the rear shock absorber/strut mounts for loose bolts or nuts. 3 Check the rear shock absorbers/struts for damage. Carry out a shock absorber check. • Are the rear shock absorbers/struts loose or damaged? → Yes TIGHTEN to specifications if loose. INSTALL new rear shock absorbers/struts if damaged. TEST the system for normal operation. → No GO to I3.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST I: REAR SUSPENSION NOISE (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
I3 CHECK THE REAR SPRINGS	
	1 Check the rear springs and rear spring mounts/brackets for wear or damage. • Are the rear springs or spring mounts/brackets worn or damaged? → Yes REPAIR or INSTALL new components as necessary. TEST the system for normal operation. → No GO to I4.
I4 CHECK THE CONTROL ARMS/TRAILING ARMS	
	1 Inspect the control arm/trailing arm bushings for wear or damage. Check for loose control/trailing arm bolts. 2 Inspect for twisted or bent control arm/trailing arms. • Are the control arm/trailing arms loose, damaged or worn? → Yes REPAIR or INSTALL new components as necessary. TEST the system for normal operation. → No GO to I5.
I5 CHECK THE STABILIZER BAR/TRACK BAR	
	1 Check the stabilizer bar/track bar bushings and links for damage or wear. 2 Check the stabilizer bar/track bar for damage.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST I: REAR SUSPENSION NOISE (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
I5 CHECK THE STABILIZER BAR/TRACK BAR (Continued)	
	3 Check for loose or damaged stabilizer bar isolators or brackets. • Are the stabilizer bar/track bar components loose, worn or damaged? → Yes REPAIR or INSTALL new components as necessary. TEST the system for normal operation. → No Suspension system OK. CONDUCT diagnosis on other suspect systems.

PINPOINT TEST J: WHEEL AND TIRE

CONDITIONS	DETAILS/RESULTS/ACTIONS
J1 ROAD TEST THE VEHICLE	
	1 NOTE: Wheel or tire vibrations felt in the steering wheel are most likely related to the front wheel or tire. Vibration felt through the seat are most likely related to the rear wheel or tire. This may not always be true, but it can help to isolate the problem to the front or rear of the vehicle. Test drive the vehicle at different speed ranges. 2 During the road test, if the vibration can be eliminated by placing the vehicle in neutral or is affected by the speed of the engine, the cause is not the wheels or tires. • Is there a vibration and noise? → Yes GO to J2. → No The wheel and tires are OK. CONDUCT a diagnosis on other suspect systems.

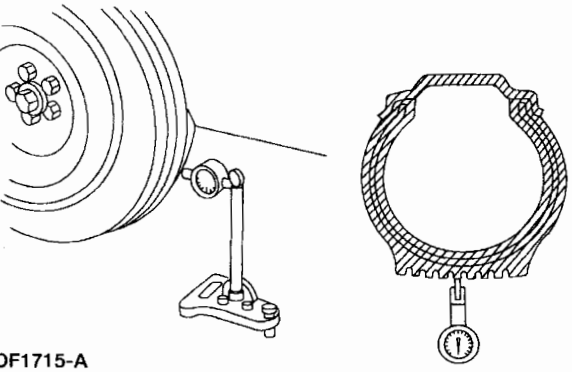
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DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST J: WHEEL AND TIRE (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
J2 CHECK THE FRONT WHEEL BEARINGS	
	1 Check the front wheel bearings. Refer to Wheel Bearing Check in this section. • Are the wheel bearings OK? → Yes GO to J3. → No INSPECT the wheel bearings. ADJUST or REPAIR as necessary. TEST the system for normal operation.
J3 INSPECT THE TIRES	
	1 Check the tires for missing weights. 2 Check the wheels for damage. 3 Inspect the tire wear pattern. Refer to the Tire Wear Patterns chart in this section. • Do the tires have an abnormal wear pattern? → Yes CORRECT the condition that caused the abnormal wear. INSTALL new tire(s). TEST the system for normal operation. → No GO to J4.
J4 TIRE ROTATION DIAGNOSIS	
1  DF1713-A	1 Spin the tires slowly and watch for signs of lateral runout.

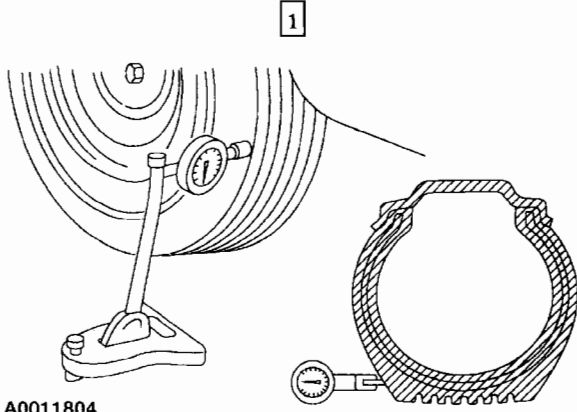
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DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST J: WHEEL AND TIRE (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
J4 TIRE ROTATION DIAGNOSIS (Continued) 2  DF1714-A	2 Spin the tires slowly and watch for signs of radial runout. Are there signs of visual runout? → Yes GO to J5 . → No CHECK the wheel and tire balance. CORRECT as necessary. TEST the system for normal operation.
J5 RADIAL RUNOUT CHECK ON THE TIRE 1  DF1715-A	1 Measure the radial runout of the wheel and tire assembly. A typical specification for total radial runout is 0.045 inch. Is the radial runout within specifications? → Yes GO to J8 . → No GO to J6 .
J6 RADIAL RUNOUT CHECK ON THE WHEEL	1 Measure the radial runout of the wheel. A typical specification for total radial runout is 0.045 inch. Is the radial runout within specifications? → Yes . INSTALL a new tire. TEST the system for normal operation. → No GO to J7 .

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST J: WHEEL AND TIRE (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
J7 CHECK THE HUB/BRAKE DISC OR DRUM PILOT RUNOUT OR BOLT CIRCLE RUNOUT	
	1 Measure the pilot or bolt circle runout. A typical specification for radial runout is: • Pilot runout— less than 0.15 mm (0.006 inch). • Bolt circle runout — less than 0.38 mm (0.015 inch). • Is the radial runout within specifications? → Yes INSTALL a new wheel. TEST the system for normal operation. → No REPAIR or INSTALL new components as necessary. REFER to Section 204-01 for the front wheels or Section 204-02 for the rear wheels.
J8 LATERAL RUNOUT CHECK ON THE TIRE	
 A0011804	1 Measure the lateral runout of the wheel and tire assembly. A typical specification for total lateral runout is 1.14 mm (0.045 inch). • Is the lateral runout within specifications? → Yes Wheel and tires OK. CONDUCT diagnosis on other suspect systems. → No GO to J9.
J9 LATERAL RUNOUT CHECK ON THE WHEEL	
	1 Measure the lateral runout of the wheel. A typical specification for total radial runout is 1.14 mm (0.045 inch). • Is the lateral runout within specifications? → Yes INSTALL a new tire. TEST the system for normal operation. → No GO to J10.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST J: WHEEL AND TIRE (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
J10 CHECK THE FLANGE FACE LATERAL RUNOUT	
	1 Measure the flange face lateral runout. A typical specification for lateral runout is: • Hub/brake disc— less than 0.13 mm (0.005 inch). • Axle shaft — less than 0.25 mm (0.010 inch). • Is the lateral runout within specifications? → Yes INSTALL a new wheel. TEST the system for normal operation. → No REPAIR or INSTALL new components as necessary. REFER to Section 204-01 for the front wheels or Section 204-02 for the rear wheels.

PINPOINT TEST K: HIGH SPEED SHAKE OR SHIMMY

CONDITIONS	DETAILS/RESULTS/ACTIONS
K1 CHECK FOR FRONT WHEEL BEARING ROUGHNESS	
	1 Chock the rear wheels. 2 Raise and support the front end of the vehicle so that the front wheel and tire assemblies can spin. 3 Spin the front tires by hand. Refer to Wheel Bearing Check in this section. • Do the wheel bearings feel rough? → Yes INSPECT the wheel bearings. REPAIR as necessary. TEST the system for normal operation. → No GO to K2.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST K: HIGH SPEED SHAKE OR SHIMMY (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
K2 CHECK THE END PLAY OF THE FRONT WHEEL BEARINGS	
	1 Check the end play of the front wheel bearings. Refer to Section 204-00. • Is the end play OK? → Yes GO to K3. → No ADJUST or REPAIR as necessary. TEST the system for normal operation.
K3 MEASURE THE LATERAL RUNOUT AND THE RADIAL RUNOUT OF THE FRONT WHEELS ON THE VEHICLE	
	1 Measure the lateral runout and the radial runout of the front wheels on the vehicle. GO to Pinpoint Test J. • Are the measurements within specifications? → Yes GO to K4. → No INSTALL new wheels as necessary and BALANCE the assembly. TEST the system for normal operation.
K4 MEASURE THE LATERAL RUNOUT OF THE FRONT TIRES ON THE VEHICLE	
	1 Measure the lateral runout of the front tires on the vehicle. GO to Pinpoint Test F. • Is the runout within specifications? → Yes GO to K5. → No INSTALL new tires as necessary and BALANCE the assembly. TEST the system for normal operation.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST K: HIGH SPEED SHAKE OR SHIMMY (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
K5 MEASURE THE RADIAL RUNOUT OF THE FRONT TIRES ON THE VEHICLE	
	1 Measure the radial runout of the front tires on the vehicle. Refer to the appropriate workshop manual for the service procedures. GO to Pinpoint Test J. • Is the runout within specifications? → Yes BALANCE the front wheel and tire assemblies. If any tire cannot be balanced, INSTALL a new tire. TEST the system for normal operation. → No GO to K6.
K6 MATCH MOUNT THE TIRE AND WHEEL ASSEMBLY	
	1 Mark the high runout location on the tire and also on the wheel. Break the assembly down and rotate the tire 180 degrees (halfway around) on the wheel. Inflate the tire and measure the radial runout. • Is the runout within specifications? → Yes BALANCE the assembly. TEST the system for normal operation. → No If the high spot is not within 101.6 mm (4 inches) of the first high spot on the tire, GO to K7.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST K: HIGH SPEED SHAKE OR SHIMMY (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
K7 MEASURE THE WHEEL FLANGE RUNOUT DG0199-A	1 Dismount the tire and mount the wheel on a wheel balancer. Measure the runout on both wheel flanges. Refer to Section 204-04. • Is the runout within specifications? → Yes LOCATE and MARK the low spot on the wheel. INSTALL the tire, matching the high spot on the tire with the low spot on the wheel. BALANCE the assembly. TEST the system for normal operation. If the condition persists, GO to K8. → No INSTALL a new wheel. CHECK the runout on the new wheel. If the new wheel is within limits, LOCATE and MARK the low spot. INSTALL the tire, matching the high spot on the tire with the low spot on the wheel. BALANCE the assembly. TEST the system for normal operation. If the condition persists, GO to K8.
K8 CHECK FOR VIBRATION FROM THE FRONT OF THE VEHICLE	
⚠ WARNING: If only one drive wheel is allowed to rotate, speed must be limited to 55 km/h (34 mph) using the speedometer reading, since actual wheel speed will be twice that indicated on the speedometer. Exceeding a speed of 55 km/h (34 mph) or allowing the drive wheel to hang unsupported can result in tire disintegration or differential failure, which can cause serious personal injury and extensive vehicle damage.	
	1 Spin the front wheel and tire assemblies with a wheel balancer while the vehicle is raised on a hoist. Feel for vibration in the front fender or while seated in the vehicle. • Is the vibration present? → Yes SUBSTITUTE known good wheel and tire assemblies as necessary. TEST the system for normal operation. → No GO to K9.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST K: HIGH SPEED SHAKE OR SHIMMY (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
K9 CHECK FOR VIBRATION FROM THE REAR OF THE VEHICLE	
 WARNING: If only one drive wheel is allowed to rotate, speed must be limited to 55 km/h (34 mph) using the speedometer reading, since actual wheel speed will be twice that indicated on the speedometer. Exceeding a speed of 55 km/h (34 mph) or allowing the drive wheel to hang unsupported can result in tire disintegration or differential failure, which can cause serious personal injury and extensive vehicle damage.	
	1 Chock the front wheels. 2 Raise and support the rear end of the vehicle so that the rear wheel and tire assemblies can spin. 3 Engage the drivetrain and carefully accelerate the drive wheels while checking for vibration. • Is the vibration present? → Yes GO to K10. → No TEST the system for normal operation.
K10 CHECK THE DRIVETRAIN	
 WARNING: If only one drive wheel is allowed to rotate, speed must be limited to 55 km/h (34 mph) using the speedometer reading, since actual wheel speed will be twice that indicated on the speedometer. Exceeding a speed of 55 km/h (34 mph) or allowing the drive wheel to hang unsupported can result in tire disintegration or differential failure, which can cause serious personal injury and extensive vehicle damage.	
	1 Remove the rear wheel and tire assemblies. Refer to Section 204-04. 2 Secure the brake drums (if so equipped), by installing wheel hub bolt nuts, reversed. 3 Carefully accelerate the drivetrain while checking for vibration. • Is the vibration present? → Yes CHECK/TEST the drivetrain and driveline components. TEST the system for normal operation. → No SUBSTITUTE known good wheel and tire assemblies as necessary. TEST the system for normal operation.

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST L: CLUTCH VIBRATION**

CONDITIONS	DETAILS/RESULTS/ACTIONS
L1 CHECK ENGINE COMPONENTS FOR GROUNDING	
	1 NOTE: Make sure the clutch is the cause of the vibration concern. The vibration should occur during clutch operation. The clutch can also be difficult to engage or disengage. Eliminate all related systems before checking the clutch components. NOTE: Check the driveline angles and driveshaft runout before disassembling the clutch system. Check the powertrain/drivetrain mounts, exhaust manifolds or other engine components for grounding on the chassis. • Are any mounts or engine components grounded? → Yes REPAIR as necessary. TEST the system for normal operation. → No GO to L2.
L2 CHECK THE ACCESSORY DRIVE SYSTEM	
	1 Remove the accessory drive belt. • Does the vibration stop with the accessory drive belt removed? → Yes DIAGNOSE the accessory drive components. → No GO to L3.
L3 CHECK FOR LOOSE CLUTCH PRESSURE PLATE BOLTS	
	1 Check for loose clutch pressure plate bolts. Inspect the clutch pressure plate for damage or for material between the pressure plate and flywheel. • Are there any loose bolts or damage? → Yes TIGHTEN the bolts to specifications or if damaged, INSTALL a new clutch pressure plate. TEST the system for normal operation. → No GO to L4.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST L: CLUTCH VIBRATION (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
L4 CHECK THE CLUTCH DISC SPRINGS	
	1 Check for worn, broken or loose clutch disc springs. • Are the clutch springs worn, broken or loose? → Yes INSTALL a new clutch disc. TEST the system for normal operation. → No GO to L5.
L5 CHECK THE CLUTCH DISC SPLINES	
	1 Inspect the clutch disc splines for damage or wear. • Is there damage or wear? → Yes INSTALL a new clutch disc. TEST the system for normal operation. → No GO to L6.
L6 CHECK THE FLYWHEEL BOLTS	
	1 Check for loose flywheel bolts. • Are the bolts loose? → Yes TIGHTEN the bolts to specifications. TEST the system for normal operation. → No GO to L7.
L7 CHECK THE FLYWHEEL SURFACE	
	1 Inspect the flywheel surface for wear or damage. Check the flywheel runout. • Is there any damage or excessive wear? → Yes INSTALL a new flywheel. TEST the system for normal operation. → No Clutch system normal. CONDUCT a diagnosis on other suspect systems.

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST M: TRANSFER CASE VIBRATION**

CONDITIONS	DETAILS/RESULTS/ACTIONS
M1 INSPECT THE TRANSFER CASE	1  WARNING: The electrical power to the air suspension system must be shut off prior to hoisting, jacking or towing an air suspension vehicle. This can be accomplished by turning off the air suspension switch. Failure to do so can result in unexpected inflation or deflation of the air springs, which can result in shifting of the vehicle during these operations. Inspect the transfer case for loose or missing mounting bolts. Check for fluid seepage between the transfer case and the transmission. Are the mounting bolts missing or loose? → Yes TIGHTEN to specifications or INSTALL new bolts as necessary. TEST the system for normal operation. → No GO to M2.
M2 INSPECT THE REAR DRIVESHAFT	1 NOTE: Verify that the driveshaft and pinion flange index marks are aligned. Inspect the driveshaft for missing weights, damage or undercoating. 2 Inspect the U-joints for freedom of movement. 3 Check driveshaft runout and, if necessary, check the pinion flange runout. Is the driveshaft or U-joints worn or damaged or misaligned? → Yes REPAIR or INSTALL a new driveshaft as necessary. TEST the system for normal operation. → No GO to M3.
M3 CHECK THE DRIVELINE ANGLES	1 Measure the rear driveshaft and pinion angles.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST M: TRANSFER CASE VIBRATION (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
M3 CHECK THE DRIVELINE ANGLES (Continued)	
	2 Measure the front driveshaft and pinion angles. • Are the driveline angles incorrect? → Yes REPAIR as necessary. TEST the system for normal operation. → No GO to M4.
M4 INSPECT THE FRONT DRIVESHAFT	
	1 NOTE: Verify that the driveshaft and pinion flange index marks are aligned. Inspect the front driveshaft for missing weights, damage or undercoating. 2 Inspect the U-joints and slip yoke for freedom of movement. 3 Check driveshaft runout and, if necessary, check the pinion flange runout. • Is the driveshaft or U-joints worn or damaged? → Yes REPAIR or INSTALL a new driveshaft as necessary. TEST the system for normal operation. → No GO to M5.
M5 ROAD TEST WITH THE FRONT DRIVESHAFT ONLY	
	1 NOTE: Index mark the driveshaft to the pinion flange and to the output shaft before removal. Remove the rear driveshaft. 2 Plug the transfer case with an output shaft seal plug.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST M: TRANSFER CASE VIBRATION (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
M5 ROAD TEST WITH THE FRONT DRIVESHAFT ONLY (Continued)	
	3 NOTE: Shift the transfer case into 4WD high so the vehicle is driven by the front driveshaft only. Test drive the vehicle. • Is the vibration gone? → Yes INSTALL and BALANCE the rear driveshaft. TEST the system for normal operation. → No GO to M6.
M6 ROAD TEST WITH THE REAR DRIVESHAFT ONLY	
	1 NOTE: Index mark the front driveshaft to the pinion flange. Remove the front driveshaft. 2 Test drive the vehicle. • Is the vibration gone? → Yes INSTALL and BALANCE the front driveshaft. TEST the system for normal operation. → No GO to M7.
M7 TRANSFER CASE TAIL SHAFT INSPECTION	
	1 Inspect the splines of the output shaft for wear or damage. 2 Inspect the splines of the driveshaft slip yoke for wear or damage. • Are the splines worn or damaged? → Yes REPAIR or INSTALL new components as necessary. TEST the system for normal operation. → No The transfer case is OK. CONDUCT a diagnosis on other suspect systems.

DIAGNOSIS AND TESTING (Continued)**Component Tests****Idle Air Control (IAC) Valve**

1. Open the hood.
2. **NOTE:** Key symptom is elevated idle speed while noise is occurring.

NOTE: "Snapping" the throttle can induce the noise.

Verify the condition by operating the vehicle for a short time.

3. Inspect the IAC valve. If physical evidence of contamination exists, install a new IAC valve.
4. While the noise is occurring, either place an EngineEAR probe near the IAC valve and the inlet tube, or create a 6.35 mm (0.25 in)-12.7 mm (0.50 in) air gap between the inlet tube and the clean air tube. If the IAC valve is making the noise, install a new IAC valve.
5. Test the vehicle for normal operation.

Steering Gear Grunt/Shudder Test

1. Start and run the vehicle to operating temperature.

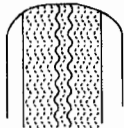
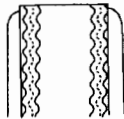
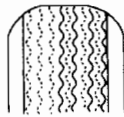
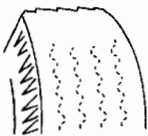
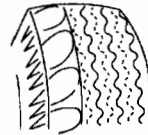
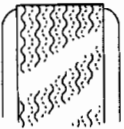
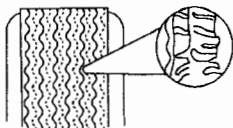
2. Set engine idle speed to 1200 rpm.

3.  **CAUTION:** Do not hold the steering wheel against the stops for more than three to five seconds at a time. Damage to the power steering pump will occur.

Rotate the steering wheel to the RH stop, then turn the steering wheel 90 degrees back from that position. Turn the steering wheel slowly in a 15 degree to 30 degree arc.

4. Turn the steering wheel another 90 degrees. Turn the steering wheel slowly in a 15 degree to 30 degree arc.
5. Repeat the test with power steering fluid at different temperatures.
6. If a light grunt is heard or a low (50-200 Hz) shudder is present, this is a normal steering system condition.
7. If a loud grunt is heard, or a strong shudder is felt, fill and purge the power steering system.

DIAGNOSIS AND TESTING (Continued)**Tire Wear Patterns and frequency calculations****Tire Wear Chart**

TIRE WEAR	CONDITION	POSSIBLE CAUSES
	• Rapid wear at both shoulders.	• Tires underinflated. • Worn suspension components. • Excessive cornering speeds. • Lack of rotation.
	• Rapid wear at the center.	• Tires overinflated. • Lack of rotation. • Excessive toe on drive wheels. • Heavy acceleration on drive wheels.
	• Wear at one shoulder.	• Toe adjustment out of specification. • Camber out of specification. • Damaged strut. • Damaged lower control arm.
	• Feather edges.	• Toe adjustment out of specification. • Damaged or worn tie rods. • Damaged spindle or knuckle.
	• Bald spots or cupping.	• Unbalanced wheel. • Excessive radial runout. • Worn strut or shock absorber.
	• Tire scalloped.	• Toe adjustment out of specification. • Camber out of specification. • Worn or damaged suspension components.
	• Wear pattern - FWD vehicles.	• Excessive toe on non-drive wheels. • Lack of rotation.
	• Wear pattern - FWD vehicles. - Edge of tread blocks worn.	• Excessive toe on non-drive wheels. • Lack of rotation.

DF1717-A

DIAGNOSIS AND TESTING (Continued)

Wheel and tire NVH concerns are directly related to vehicle speed and are not generally affected by acceleration, coasting or decelerating. Also, out-of-balance wheel and tires can vibrate at more than one speed. A vibration that is affected by the engine rpm, or is eliminated by placing the transmission in NEUTRAL is not related to the tire and wheel. As a general rule, tire and wheel vibrations felt in the steering wheel are related to the front tire and wheel assemblies. Vibrations felt in the seat or floor are related to the rear tire and wheel assemblies. This can initially isolate a concern to the front or rear.

Careful attention must be paid to the tire and wheels. There are several symptoms that can be caused by damaged or worn tire and wheels. Carry out a careful visual inspection of the tires and wheel assemblies. Spin the tires slowly and watch for signs of lateral or radial runout. Refer to the tire wear chart to determine the tire wear conditions and actions.

For a vibration concern, use the vehicle speed to determine tire/wheel frequency and rpm. Calculate tire and wheel rpm and frequency by carrying out the following:

- Measure the diameter of the tire.
- Record the speed at which the vibration occurs.
- Obtain the corresponding tire and wheel rpm and frequency from the Tire Speed and Frequency Chart.
 - If the vehicle speed is not listed, divide the vehicle speed at which the vibration occurs by 16 (km/h (10 mph)). Multiply that number by 16 km/h (10 mph) tire rpm listed for that tire diameter in the chart. Then divide that number by 60. For example: a 40 mph vibration with 835 mm (33 in) tires. $40 \div 10 = 4$. Multiply 4 by 105 = 420 rpm. Divide 420 rpm by 60 seconds = 7 Hz at 40 mph.

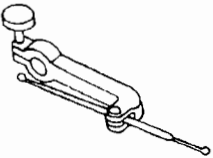
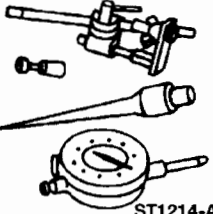
Tire Speed and Frequency Chart

Tire Diameter	Tire RPM/Hz	Tire RPM/Hz	Tire RPM/Hz	Tire RPM/Hz
mm (inch)	@ 16 km/h (10 mph)	@ 80 km/h (50 mph)	@ 97 km/h (60 mph)	@ 113 km/h (70 mph)
483 (19)	182	910/15	1092/18	1274/21
508 (20)	173	865/14	1038/17	1211/20
533 (21)	165	825/14	990/16	1155/19
560 (22)	158	790/13	948/16	1106/18
585 (23)	151	755/13	906/15	1057/18
610 (24)	145	725/12	870/14	1015/17
635 (25)	139	695/12	834/14	973/16
660 (26)	134	670/11	804/13	938/16
685 (27)	129	645/11	774/13	903/15
710 (28)	124	620/10	744/12	868/14
735 (29)	119	595/10	714/12	833/14
760 (30)	115	575/10	690/11	805/13
785 (31)	111	555/9	666/11	777/13
810 (32)	108	540/9	648/11	756/13
835 (33)	105	525/9	630/10	735/12
864 (34)	102	510/8	612/10	714/12

GENERAL PROCEDURES

Brake Disc Machining

Special Tool(s)

 ST1348-A	Gauge, Clutch Housing 308-021 (T75L-4201-A)
 ST1214-A	Dial Indicator Gauge with Holding Fixture 100-002 (TOOL-4201-C) or equivalent

Materials

Item	Specification
Metal Surface Cleaner F4AZ-19A536-RA or equivalent	WSE-M5B392-A
High Temperature Nickel Anti-Seize Lubricant F6AZ-9L494-AA or equivalent	ESE-M12A4-A

⚠ WARNING: The electrical power to the air suspension system must be shut off prior to hoisting, jacking or towing an air suspension vehicle. This can be accomplished by turning off the air suspension switch. Failure to do so can result in unexpected inflation or deflation of the air springs, which can result in shifting of the vehicle during these operations.

⚠ CAUTION: Do not install brake discs that are less than the minimum thickness specified. Do not machine a brake disc below the minimum thickness specification.

1. Check wheel bearing end-play and correct as necessary.
2. **NOTE:** Begin at the front of the vehicle unless the vibration has been isolated to the rear.
Remove the tire and wheel assembly.
3. Remove the brake caliper and the brake caliper anchor plate. Refer to the appropriate section in Group 206 for the procedure.
4. Inspect the brake linings. Install new brake linings if below specification. For additional information, refer to the appropriate brake section.

GENERAL PROCEDURES (Continued)

5. Measure and record the brake disc thickness. Install a new brake disc if the thickness after machining will be at or below specification. The specification is molded into the brake disc.
 - Do not machine a new brake disc.
6. For vehicles with a two-piece hub and brake disc assembly:
 - Match-mark before disassembly.
 - Remove the brake disc.
 - Clean the hub and brake disc mounting surfaces with metal surface cleaner.
 - Using a die grinder with a mild abrasive (Scotch Brite® type), remove any rust or corrosion from the hub and brake disc mounting surfaces.
 - Align the match-marks and reinstall the brake disc on the hub.
7.  **CAUTION: Do not use a bench lathe to machine brake discs.**

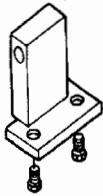
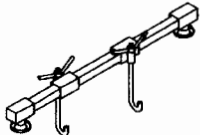
NOTE: The depth of cut must be between 0.10 and 0.20 mm (0.004 and 0.008 inch). Lighter cuts will cause heat and wear. Heavier cuts will cause poor brake disc surface finish.

Using an on-car brake lathe, machine the brake discs. Follow the manufacturer's instructions. After machining, make sure the brake disc still meets the thickness specification.
8. Using the special tools, verify that the brake disc lateral runout is now within specification. For additional information, refer to Section 206-00.
9. Remove the special tool hub adapter.
10. Remove any remaining metal chips from the machining operation.

GENERAL PROCEDURES (Continued)

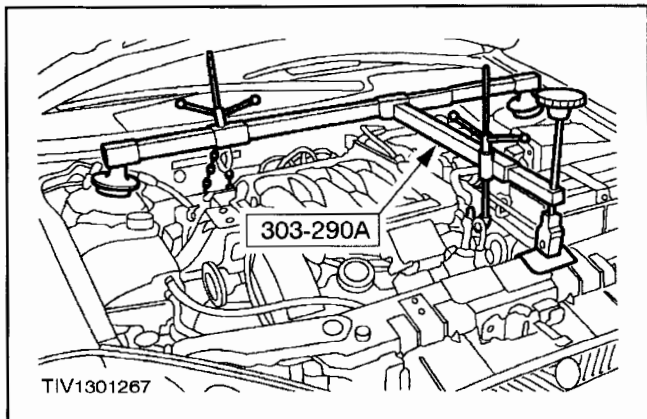
11. For vehicles with a two-piece hub and brake disc assembly:
 - Remove the brake disc from the hub.
 - Remove any remaining metal chips from hub and brake disc mounting surfaces and from the ABS sensor.
 - Apply a liberal amount of lubricant to the hub flange, pilot area and to the brake disc-to-hub mounting surface.
 - Using the match marks, mount the brake disc on the hub.
12. Install the brake caliper anchor plate and the brake caliper.
13. Install the tire and wheel assembly.
14. Test the system for normal operation.

Powertrain/Drivetrain Mount Neutralizing**Special Tool(s)**

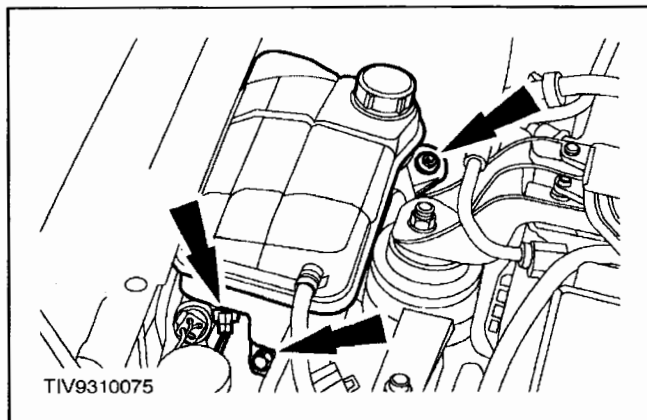
 T94P-6000-AH	Alignment Gauge, Powertrain 502-003 (T94P-6000-AH)
 21140	Support Bar, Engine 303-290A or equivalent

GENERAL PROCEDURES (Continued)

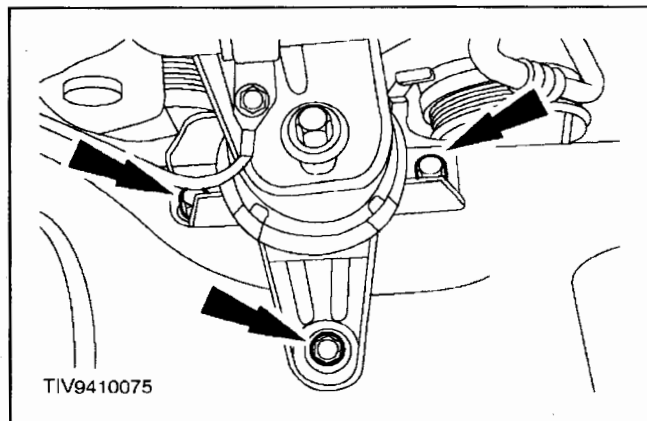
NOTE: An abnormal vibration can be caused by a component, such as an engine or transaxle support insulator mount, which is acting in a rigid manner because of a distorted or twisted mounting position. As a result, the support insulator does not absorb vibration as it should.



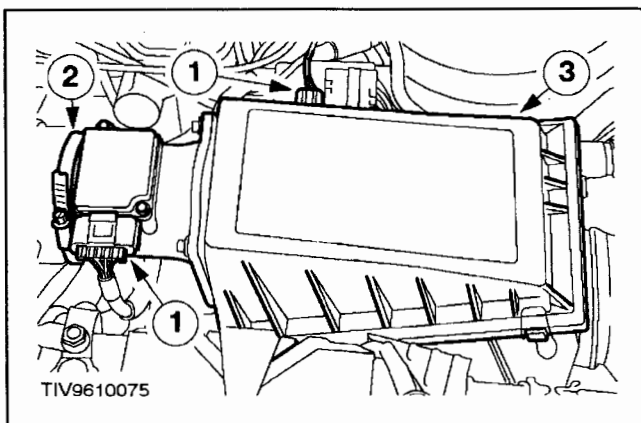
1. **NOTE:** 2.5L shown, 2.0L similar.
Using the special tool, support the engine.



2. Detach the coolant reservoir.
 - Remove the bolts.
 - Disconnect the electrical connector.



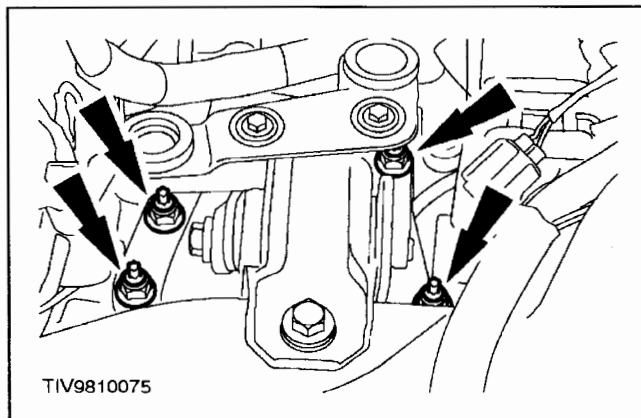
3. **NOTE:** 2.5L shown, 2.0L similar.
Loosen the engine mount bolts.

GENERAL PROCEDURES (Continued)

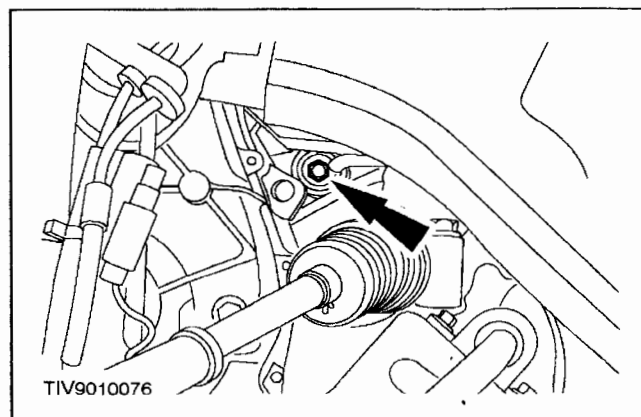
4. **NOTE:** 2.5L shown, 2.0L similar.

Remove the air cleaner and mass air flow (MAF) sensor.

- 1 Disconnect the electrical connectors.
- 2 Detach the intake duct.
- 3 Remove the air cleaner and MAF sensor.



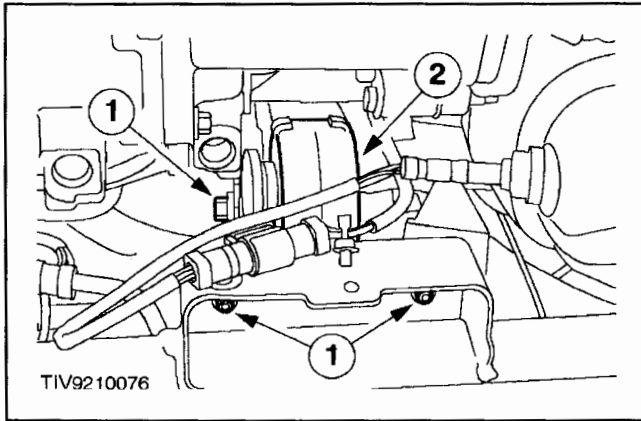
5. Loosen the transaxle mount nuts.



6. Raise and support the vehicle. For additional information, refer to Section 100-02.

7. **NOTE:** Automatic transaxle shown, manual transaxle similar.

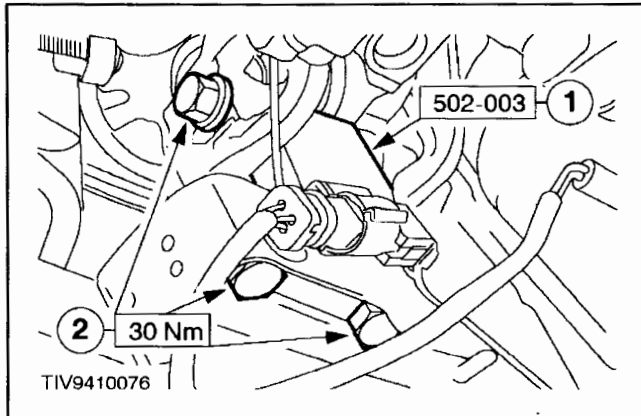
Loosen the rear roll restrictor bolt.

GENERAL PROCEDURES (Continued)

8. Remove the front roll restrictor.

1 Remove the bolts.

2 Remove the roll restrictor.

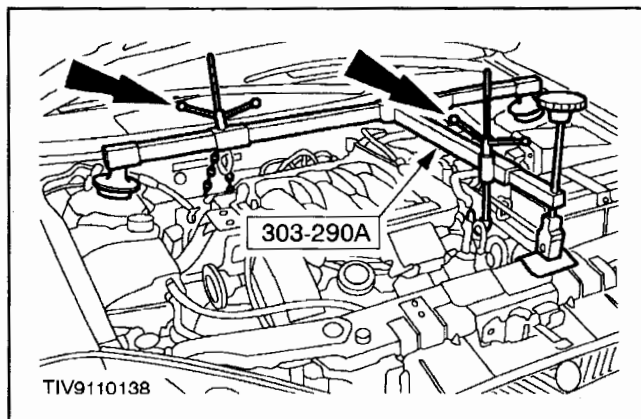


9. **NOTE:** The special tool is marked with an arrow and "Front".

Using the special tool, align the powertrain.

1 Install the special tool.

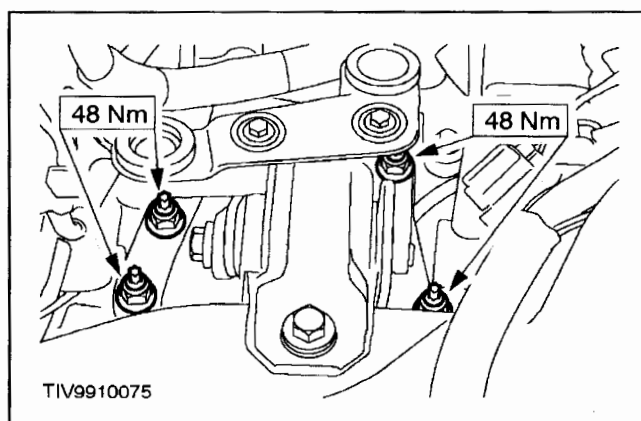
2 Tighten the bolts.



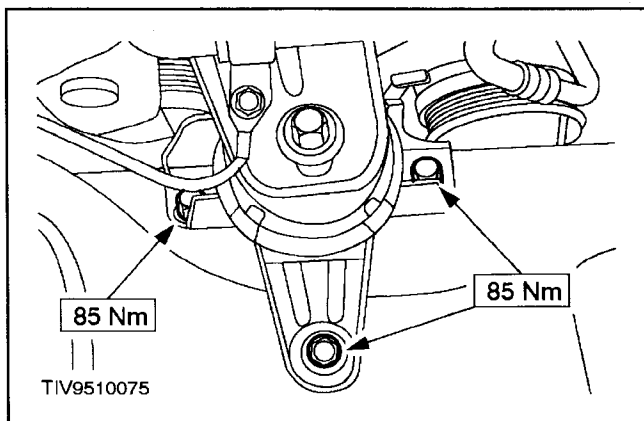
10. Lower the vehicle.

11. **NOTE:** 2.5L shown, 2.0L similar.

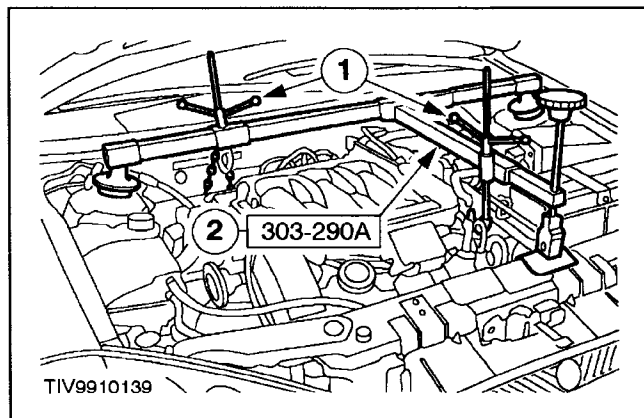
Partially raise the powertrain to allow the mounts to move freely.



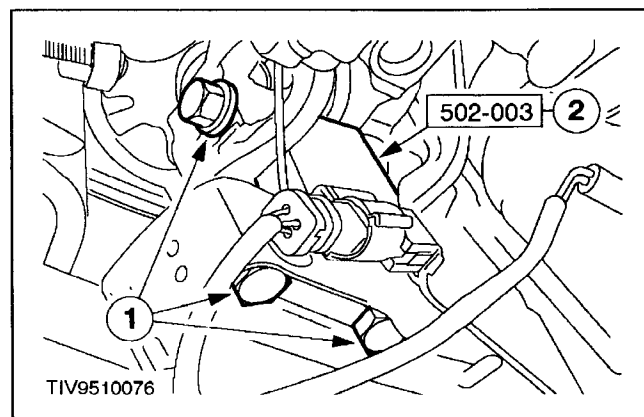
12. Tighten the transaxle mount nuts.

GENERAL PROCEDURES (Continued)

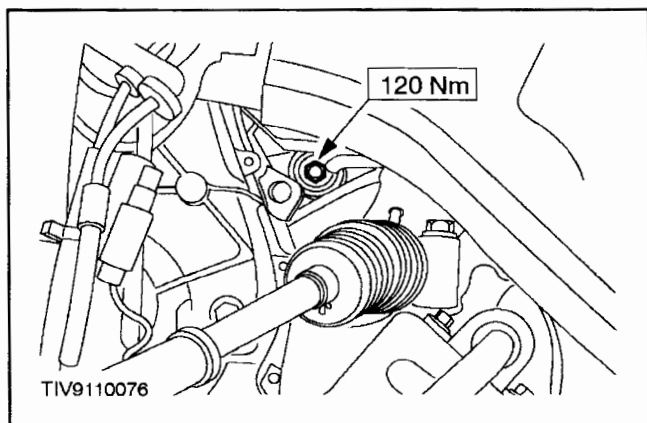
13. **NOTE:** 2.5L shown, 2.0L similar.
Tighten the engine mount bolts.



14. **NOTE:** 2.5L shown, 2.0L similar.
Remove the special tool.
- 1 Lower the powertrain.
 - 2 Remove the special tool.

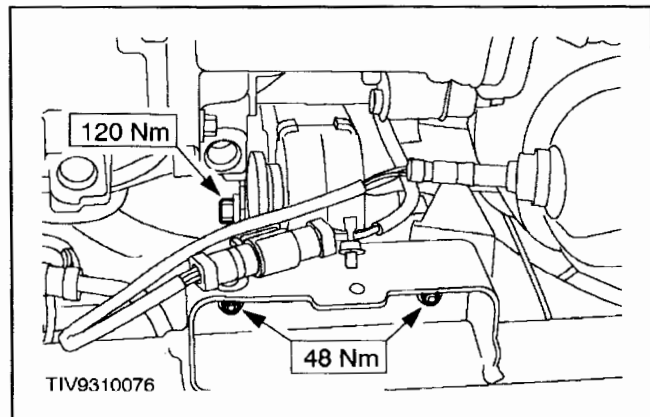


15. Raise and support the vehicle. For additional information, refer to Section 100-02.
16. Remove the special tool.
- 1 Remove the bolts.
 - 2 Remove the special tool.

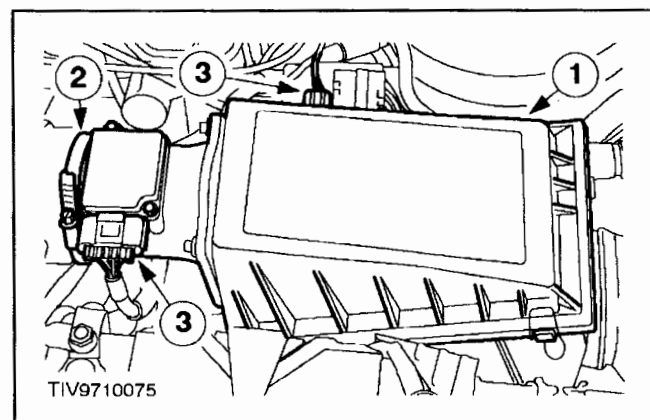
GENERAL PROCEDURES (Continued)

17. **NOTE:** Automatic transaxle shown, manual transaxle similar.

Tighten the rear roll restrictor bolt.



18. Install the front roll restrictor.

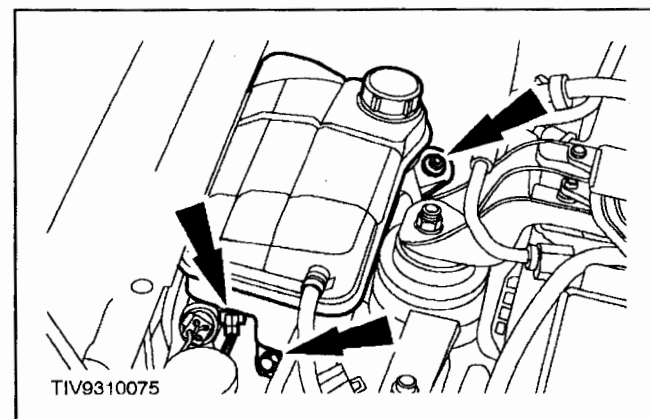


19. Lower the vehicle.

20. **NOTE:** 2.5L shown, 2.0L similar.

Install the air cleaner and MAF sensor.

- 1 Install the air cleaner and MAF sensor.
- 2 Connect the intake duct.
- 3 Connect the electrical connectors.



21. Install the coolant reservoir.

GENERAL PROCEDURES (Continued)**Exhaust System Neutralizing**

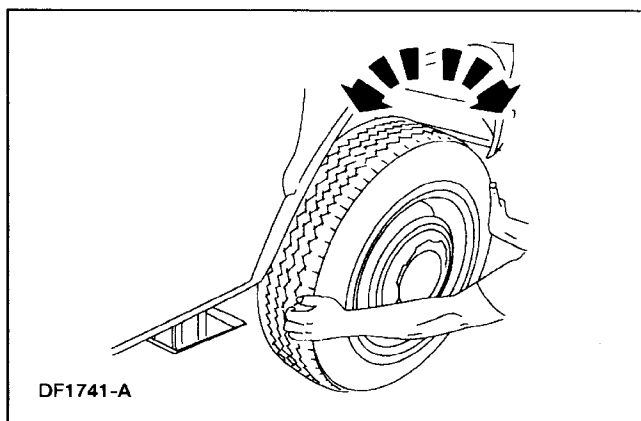
1. Loosen the muffler inlet pipe and resonator pipe to exhaust manifold fasteners at the flanges and the muffler inlet connection.
2. Place a stand to support the muffler parallel to the vehicle frame with the muffler pipe bracket free of stress.
3. Tighten the muffler connection.
4. Position the exhaust pipes to the manifolds and tighten. Make sure that the catalytic converter and heat shield do not contact the frame rails.
5. With the complete exhaust system tight (and cooled) the rear hanger insulator should be angled forward, to allow the system to expand rearward when heated during normal running.

Wheel Bearing Check

1.  **WARNING:** The electrical power to the air suspension system must be shut off prior to hoisting, jacking or towing an air suspension vehicle. This can be accomplished by turning off the air suspension switch. Failure to do so can result in unexpected inflation or deflation of the air springs, which can result in shifting of the vehicle during these operations.

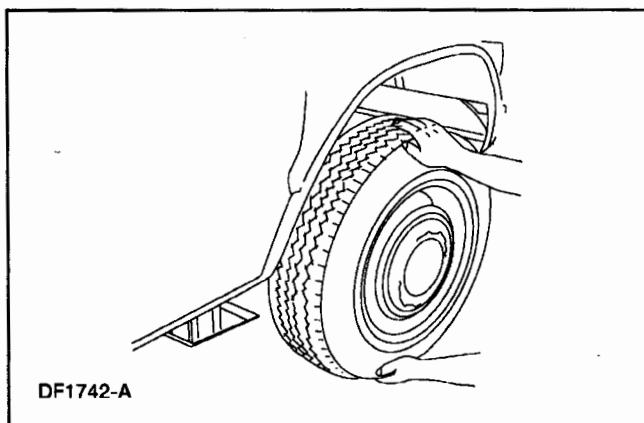
Raise the vehicle until the front tires are off the floor.

- Make sure the wheels are in a straight forward position.

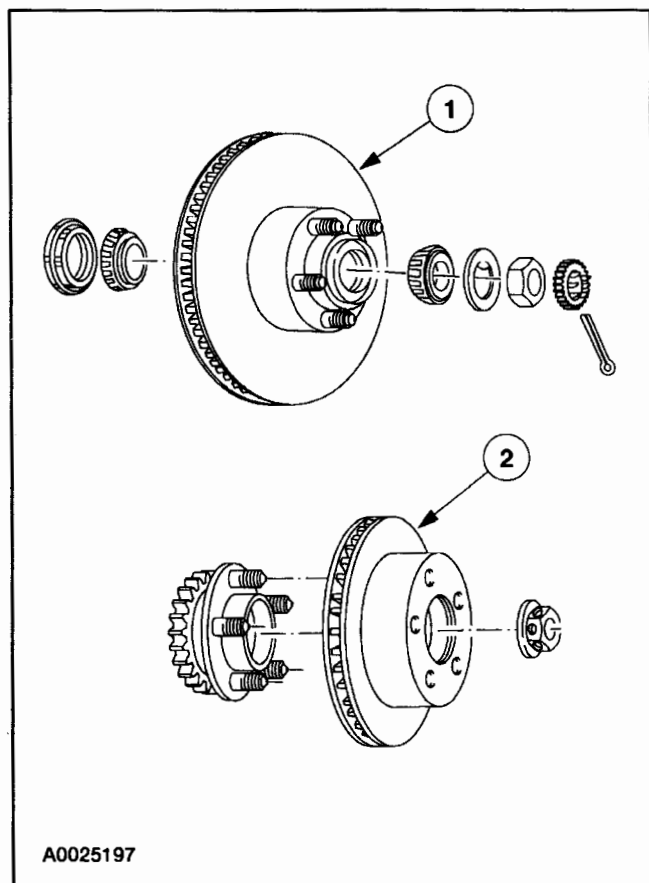


2. **NOTE:** Make sure the wheel rotates freely and that the brake pads are retracted sufficiently to allow free movement of the tire and wheel assembly.

Spin the tire by hand to check the wheel bearings for roughness.

GENERAL PROCEDURES (Continued)

3. Grip each front tire at the top and bottom and move the wheel inward and outward while lifting the weight of the tire off the front wheel bearing.



4. If the tire and wheel (hub) is loose on the spindle, does not rotate freely, or has a rough feeling when spun, carry out one of the following:
 - 1 On vehicles with inner and outer bearings, inspect the bearings and cups for wear or damage. Adjust or install new bearings and cups as necessary.
 - 2 On vehicles with one sealed bearing, install a new wheel hub.

GROUP

Chassis

2

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Rear Suspension	204-02-1
Wheels and Tires	204-04-1
Front Drive Halfshafts	205-04-1
Brake System — General Information	206-00-1
Drum Brake	206-02-1
Front Disc Brake	206-03-1
Rear Disc Brake	206-04-1
Parking Brake and Actuation	206-05-1
Hydraulic Brake Actuation	206-06-1
Power Brake Actuation	206-07-1
Anti-Lock Control	206-09A-1
Anti-Lock Control — Traction Control	206-09B-1
Steering System — General Information	211-00-1
Power Steering	211-02-1
Steering Linkage	211-03-1
Steering Column	211-04-1
Steering Column Switches	211-05-1

SECTION 204-00 Suspension System — General Information

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Front Toe Adjustment	204-00-16
Rear Toe Adjustment	204-00-18

SPECIFICATIONS

General Specifications

Item	Specification
Strut and spring assembly overall length — front	541-533 mm
Strut and spring assembly overall length — rear	646-636 mm

Front Wheel Alignment — Castor and Camber

Derivative	Values in	Castor Nominal	Tolerance Range	Camber Nominal	Tolerance Range
All	Decimal Degrees	2.52°	1.42° to 3.62°	-0.61°	0.77° to -1.99°
All	Degrees and Minutes	2°31'	1°25' to 3°37'	-0°37'	0°46' to -1°59'

Maximum variation — left to right-hand side — 1.00° (1°00') Camber 1.25° (1°15')

Front Wheel Alignment — Toe Setting

Allowable tolerance	Setting adjustment, if required
0.25° Toe in to -0.59° Toe out	-0.00° Toe out $\pm$ 0.17°
0°15' Toe in to -0°35' Toe out	-0°00' Toe out $\pm$ 0°10'
1.5 mm Toe in to -3.5 Toe out	-0.0 mm Toe out $\pm$ 1.0 mm

Rear Wheel Alignment — Camber

Derivative	Values in	Camber Nominal	Tolerance Range
All	Decimal Degrees	-0.70°	0.58° to -1.98°
All	Degrees and Minutes	-0°42'	0°35' to -1°59'

Maximum variation — left to right-hand side — Camber 1.25° (1°15')

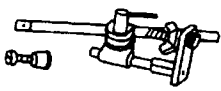
Rear Wheel Alignment — Toe Setting — All Variants

Allowable Tolerance before resetting is required	Setting Adjustment, if required
3.9 mm Toe in to -0.1 mm Toe out	1.9 mm Toe in $\pm$ 1.2 mm
0°39' Toe in to -0°01' Toe out	0°19' Toe in $\pm$ 0°12'
0.66° Toe in to -0.02° Toe out	0.32° Toe in $\pm$ 0.20°

DIAGNOSIS AND TESTING

Suspension System

Special Tool(s)

 ST1182-A	Bracketry, Dial Indicator Gauge 100-D004 (D78P-4201-F) or equivalent
 ST1183-A	Dial Indicator Gauge 100-D005 (D78P-4201-G) or equivalent

Inspection and Verification

1. Verify the customer concern by operating the system.

Symptom Chart

Symptom Chart

Condition	Possible Sources	Action
• Drift left or right	• Incorrect wheel alignment. • Vehicle attitude incorrect (front or rear, high or low). • Steering gear or linkage worn or damaged. • Tire(s). • Brake system.	• GO to Pinpoint Test A. • CHECK for abnormal loading, front coil spring sag, or non-standard springs. • CHECK the steering system. REFER to Section 211-00. • CHECK and ADJUST the tire air pressure. INSPECT the tire for excessive wear. • CHECK brakes. REFER to Section 206-00.
• Steering wheel off center	• Vehicle attitude incorrect (front or rear, high or low). • Power steering gear or linkage. • Suspension lower arm ball joint. • Incorrect wheel alignment. • Wheels/tires.	• CHECK for abnormal loading, spring sag or non-standard springs. • CHECK the steering system. REFER to Section 211-00. • GO to Component Test (Ball joint-Lower, Inspection). • GO to Pinpoint Test B. • CHECK the wheels/tires. BALANCE or INSTALL new wheels/tires as necessary. REFER to Section 204-04.
• Tracks incorrectly	• Rear suspension damage.	• GO to Pinpoint Test C.

2. Visually inspect for obvious signs of mechanical damage.

Visual Inspection Chart

Mechanical
• Tires • Wheel damage • Front lower arm ball joint • Lower arm bushing • Strut and spring assembly • Stabilizer bar • Tie-bar • Rear suspension front and rear arms • Wheel knuckle and tie-rod end • Wheel spindle

3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
4. If the concern is not visually evident, verify the symptom. GO to **Symptom Chart**.

DIAGNOSIS AND TESTING (Continued)**Symptom Chart (Continued)**

Condition	Possible Sources	Action
• Rough ride	• Front or rear stabilizer bar, links or bushings. • Front lower suspension arm bushing. • Rear suspension arm bushing. • Front strut and spring assembly. • Rear strut and spring assembly. • Incorrect tire pressure.	• CHECK and INSTALL new components as necessary. REFER to Section 204-01 or Section 204-02. • CHECK and INSTALL new bushing as necessary. REFER to Section 204-01. • CHECK and INSTALL new bushing as necessary. REFER to Section 204-02. • CHECK front strut and spring assembly. REFER to Section 204-01. • CHECK the rear strut and spring assembly. REFER to Section 204-02. • CHECK the tire pressure. REFER to Section 204-04.
• Excessive noise	• Wear of front wheel bearings. • Wear of front suspension lower arm ball joint.	• GO to Pinpoint Test E. • INSTALL a new lower arm as necessary. REFER to Section 204-01.
• Incorrect tire wear	• Incorrect wheel alignment. • Incorrect tire pressure.	• GO to Pinpoint Test F. • CHECK the tire pressure. REFER to Section 204-04.
• Vibration	• Wheel/tire imbalance or excessive runout. • Wheels/tires. • Incorrect wheel alignment. • Steering system. • Front strut and spring assembly. • Front shock absorber mounting. • Damaged front suspension lower arm. • Damaged or worn front suspension arm bushing. • Damaged or worn front wheel bearing.	• GO to Pinpoint Test G. • CHECK the tires. BALANCE or INSTALL new the wheels/tires as necessary. REFER to Section 204-04. • GO to Pinpoint Test A. • CHECK the steering system. REFER to Section 211-00. • GO to Pinpoint Test D. • TIGHTEN the front strut and spring assembly mounting. REPAIR or INSTALL new components as necessary. • GO to Pinpoint Test E. • GO to Pinpoint Test E. • GO to Pinpoint Test G.

DIAGNOSIS AND TESTING (Continued)**Pinpoint Tests****PINPOINT TEST A: DRIFT LEFT OR RIGHT**

CONDITIONS	DETAILS/RESULTS/ACTIONS
A1 CHECK DRIFT LEFT OR RIGHT	
 WARNING: To avoid personal injury due to the loss of vehicle control, the inspection should be carried out by two people to maintain safe driving conditions. One person should drive while the other checks the time. Adequate grip should always be maintained on the steering wheel. Failure to follow these instructions may result in personal injury. NOTE: The following conditions must be met when evaluating the vehicle.	
	1 Check the cold tire pressure. — Drive the vehicle at 90 km/h (55 mph) on a level and straight road. Drive in the center lane of a three lane highway. — Be sure that no crosswinds or gusting breezes are present. — Drive the vehicle in both (opposing) directions at least twice. — If the vehicle changes one complete 12 foot wide lane within 7 seconds, it has a drift. • Does the vehicle have drift? → Yes GO to A2. → No GO to B2.
A2 CHECK STEERING LINKAGE	
	1 Raise and support the vehicle. Refer to Section 100-02. — Check steering linkage for indications of excessive wear or damage. • Is there indication of excessive wear or damage? → Yes INSTALL new components as necessary. REFER to Section 211-00 or Section 204-01. → No GO to A3.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST A: DRIFT LEFT OR RIGHT (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
A3 CHECK VEHICLE ALIGNMENT	
	1 Place the vehicle on an alignment rack. — Check the vehicle alignment. • Is the steering wheel straight and alignment within specification? → Yes GO to A4. → No INSTALL new suspension components as necessary. ADJUST the alignment to specification.
A4 CHECK TIRES	
	1 Inspect the tires for excessive wear or damage. • Are the tires excessively worn or damaged? → Yes INSTALL new tires as necessary. → No GO to A5.
A5 ROTATE TIRES	
	1 Raise and support the vehicle. Refer to Section 100-02. — Rotate the wheels in a cross pattern. • Does the vehicle drift? → Yes CHECK the wheel alignment. INSTALL new suspension components as necessary. ADJUST the alignment to specification. → No System OK.

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST B: STEERING WHEEL OFF — CENTER**

CONDITIONS	DETAILS/RESULTS/ACTIONS
B1 INSPECT STEERING COMPONENTS	
	1 Raise and support the vehicle. Refer to Section 100-02. — Inspect steering components for excessive wear or damage. • Are steering components excessively worn or damaged? → Yes INSTALL new component as necessary. REFER to Section 211-00 or Section 204-01. → No GO to B2.
B2 CHECK VEHICLE ALIGNMENT	
	1 Place the vehicle on an alignment rack. • Is steering wheel centered? → Yes GO to Pinpoint Test C. → No INSTALL new worn or damaged suspension components as necessary. ADJUST alignment to the specification.

PINPOINT TEST C: TRACKS INCORRECTLY

CONDITIONS	DETAILS/RESULTS/ACTIONS
C1 CHECK CASTER	
	1 Place the vehicle on an alignment rack. • Is the caster angle within specification? → Yes GO to C2. → No INSTALL new suspension components as necessary. ADJUST the alignment to specification.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST C: TRACKS INCORRECTLY (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
C2 CHECK REAR SUSPENSION	
	1 Measure the vehicle wheel base left-hand and right-hand. — Compare the measurements. • Are the measurements the same? → Yes GO to Pinpoint Test D. → No INSPECT the rear suspension components for wear or damage. INSTALL new components as necessary. REFER to Section 204-02.

PINPOINT TEST D: ROUGH RIDE

CONDITIONS	DETAILS/RESULTS/ACTIONS
D1 CHECK STRUT AND SPRING ASSEMBLIES	
	1 Make sure the tires are at the correct pressure. — Raise vehicle on hoist. Refer to Section 100-02. — Inspect strut and spring assemblies for oil leaks or damage. • Are strut and spring assemblies damaged or leaking? → Yes INSTALL new components as necessary. REFER to Section 204-01 (Front) or Section 204-02 (Rear). → No System OK.

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST E: EXCESSIVE NOISE**

CONDITIONS	DETAILS/RESULTS/ACTIONS
E1 INSPECT SUSPENSION	
	1 Raise and support the vehicle. Refer to Section 100-02. — Inspect the suspension mounting bolts. • Are the mounting bolts loose or broken? → Yes TIGHTEN or INSTALL new suspension mounting bolts. REFER to Section 204-01 (Front) or Section 204-02 (Rear). → No GO to E2.
E2 INSPECT SPRINGS	
	1 With vehicle supported on a hoist, inspect the springs for damage. • Are the springs damaged? → Yes INSTALL new springs. REFER to Section 204-01 (Front) or Section 204-02 (Rear). → No GO to E3.
E3 INSPECT FRONT SUSPENSION LOWER ARM	
	1 Inspect the front suspension lower arm bushings for excessive wear or damage. • Are the front suspension lower arm bushings worn or damaged? → Yes INSTALL new lower arm bushings. REFER to Section 204-01. → No GO to E4.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST E: EXCESSIVE NOISE (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
E4 INSPECT TIRES	
	1 Raise and support the vehicle. Refer to Section 100-02. — Inspect the tires for uneven wear. • Is there uneven wear? → Yes INSTALL new tires. ADJUST wheel alignment to specification. RETEST the system for normal operation. → No GO to E5.
E5 INSPECT FRONT WHEEL BEARINGS	
	1 Raise and support the vehicle. Refer to Section 100-02. — Rock each front wheel by gripping the top and bottom and alternately pushing and pulling in and out. Feel for excess looseness of the bearings. — Spin each front wheel by hand checking for roughness. • Are the bearings loose or rough? → Yes INSTALL new wheel bearings as required. TEST the system for normal operation. → No System OK.

PINPOINT TEST F: INCORRECT TIRE WEAR

CONDITIONS	DETAILS/RESULTS/ACTIONS
F1 INSPECT TIRES	
	1 Raise and support the vehicle. Refer to Section 100-02. — Inspect the tires for uneven wear on inner or outer shoulder, or saw tooth pattern. • Is there uneven tire wear? → Yes INSTALL new tires if badly worn. → No GO to F2.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST F: INCORRECT TIRE WEAR (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
F2 CHECK FOR CUPPED OR DISHED TIRE	
	1 With vehicle supported on a hoist, inspect the tires for cupping or dishing. • Are tires cupped or dished? → Yes INSTALL new tire(s) as necessary. REFER to Section 204-04. → No System OK.

PINPOINT TEST G: VIBRATION

CONDITIONS	DETAILS/RESULTS/ACTIONS
G1 INSPECT TIRES	
	1 Raise and support the vehicle. Refer to Section 100-02. — Inspect the tires for damage or excessive wear. • Are tires damaged or worn? → Yes INSTALL new tires. TEST the system for normal operation. → No GO to G2.
G2 INSPECT FRONT WHEEL BEARINGS	
	1 Raise and support the vehicle. Refer to Section 100-02. — Rock each front wheel by gripping the top and bottom and alternately push/pull the wheel in and out. Feel for excessive looseness of the bearings. — Spin each front wheel by hand checking for roughness. • Are the bearings loose or rough? → Yes GO to G3. → No GO to G4.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST G: VIBRATION (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
G3 MEASURE FRONT WHEEL BEARING END PLAY	
	1 Remove the wheel and the front disc brake caliper. — Position a Dial Indicator Gauge 100-D005 (D78P-4201-G) with Dial Indicator Gauge Bracketry 100-D004 (D78P-4201-F) against the wheel hub. — Push and pull the wheel hub in the axial direction and measure the end play of the wheel hub and front wheel bearing assembly. There should be no end play. • Is the front wheel bearing end play within limits? → Yes CHECK ball joint as outlined. GO to G4. → No INSTALL a new bearing as necessary. TEST the system for normal operation.
G4 INSPECT REAR WHEEL BEARINGS	
	1 Rock each rear wheel by gripping the top and bottom, then alternately push/pull the wheel in and out. Feel for excessive looseness of the bearings. — Spin each wheel by hand and check for roughness. • Are bearings loose or rough? → Yes GO to G5. → No GO to G6.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST G: VIBRATION (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
G5 MEASURE REAR WHEEL BEARING END PLAY	
	1 Raise the vehicle and remove the rear tire and brake drum or rear disc brake rotor. — Position a Dial Indicator Gauge 100-D005 (D78P-4201-G) with Dial Indicator Gauge Bracketry 100-D004 (D78P-4201-F) against the wheel hub. — Push and pull the wheel hub by hand in the axial direction and measure the wheel bearing end play. There should be no end play. • Is the rear wheel bearing end play within limits? → Yes GO to G6. → No INSTALL a new wheel bearing as necessary. TEST the system for normal operation. REFER to Section 204-01.
G6 MEASURE WHEEL/TIRE RUNOUT ON VEHICLE	
	1 Measure the wheel and tire runouts on the vehicle using suitable equipment. Assembly runout should be less than 1.14 mm (0.045 inch) radial and lateral. • Is the measurement in specification? → Yes GO to G12. → No GO to G7.
G7 MEASURE WHEEL/TIRE RUNOUT OFF VEHICLE	
	1 Measure the wheel and tire from any position that exceeds 1.14 mm (0.045 inch) radial or lateral. Before removing the wheel, mark a wheel stud and corresponding stud hole so the wheel can be installed in same position. Remove the wheel and mount on a wheel balancer. Measure the runout as in Step G4. Wheel and tire runout should be less than 1.14 mm (0.045 inch) radial and lateral. • Is measurement in specification? → Yes GO to G10. → No GO to G8.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST G: VIBRATION (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
G8 MATCHMOUNTING	
	1 Mark the high runout location on the tire and also on the wheel. Deflate the tire and rotate the tire 180 degrees (half-way around) on the wheel. Inflate the tire and measure the runouts. • Are the wheels and tires balanced? → Yes INSTALL on the vehicle. TEST the system for normal operation. → No If high spot is not within 101.6 mm (4 inches) of first high spot on the tire. GO to G9.
G9 MEASURE WHEEL RUNOUT	
	1 Remove the tire and mount the wheel on a wheel balancer. Measure the runout on both flanges. Runout should be less than 1.14 mm (0.045 inch) radial and lateral. • Is there correct runout? → Yes LOCATE and MARK low spot on wheel and INSTALL tire matching high spot on wheel. BALANCE the assembly and TEST the system for normal operation. → No INSTALL a new wheel. CHECK the runout on the new wheel. If the new wheel is within limits, LOCATE and MARK the low spot. INSTALL the tire, matching high spot of tire with low spot of wheel. BALANCE the assembly and INSTALL on the vehicle. TEST the system for normal operation.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST G: VIBRATION (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
G10 REAR HUB AND STUD CIRCLE RUNOUT	
	1 Remove the rear wheel. — Remove the rear brake disc or brake drum. — Measure the hub flange face runout (greater than 0.254 mm). Bolt circle runout (greater than 0.08 mm) and pilot radial runout (greater than 0.05 mm). • Are measurements correct? → Yes GO to G11. → No INSTALL a new rear hub. REFER to Section 204-02.
G11 FRONT HUB AND STUD CIRCLE RUNOUT	
	1 Remove the front wheel. — Remove the front brake disc. — Measure the stud circle runout (greater than 0.06 mm) and disc radial runout (greater than 0.05 mm). • Are the measurements correct? → Yes CHECK the front brake disc, rear brake disc or rear drum brake runout. REFER to Section 206-00. → No INSTALL a new hub. REFER to Section 204-01.
G12 WHEEL BALANCE	
	1 Balance all wheels. Road test the vehicle. • Is a vibration felt? → Yes REFER to Section 100-04. → No System OK.

Component Tests**Ball Joint Inspection**

1. Raise and support the vehicle. Refer to Section 100-02.

DIAGNOSIS AND TESTING (Continued)

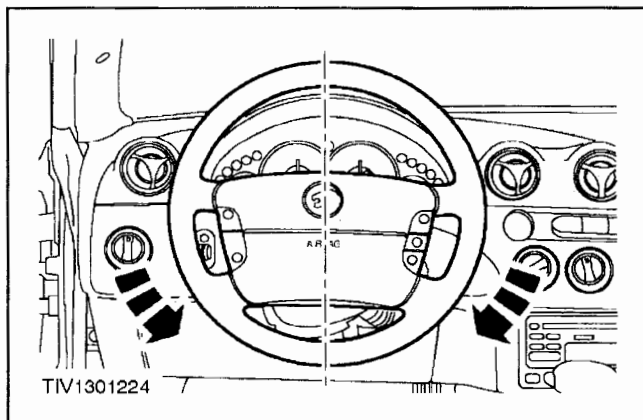
2. Firmly grasp the outer end of the lower suspension arm and try to move it up and down, watching and feeling for any movement. Free movement will usually be accompanied by an audible "click". There should be no free movement.
3. If there is any free movement install a new lower arm. Refer to Section 204-01.
4. If a new lower arm is installed it will be necessary to check and adjust the front wheel alignment. Refer to Specifications.

GENERAL PROCEDURES**Front Toe Adjustment****General Equipment**

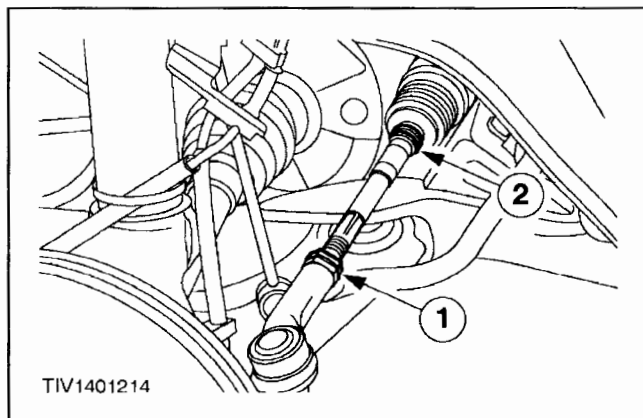
Wheel alignment gauge — Dunlop Optiflex, Churchill etc.

Adjustment

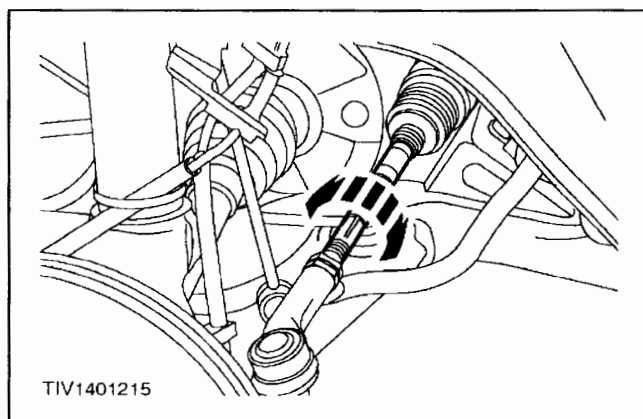
1. **NOTE:** This operation should be carried out on a flat surface and in accordance with the manufacturers instructions for the particular wheel alignment equipment used.
Examine all suspension and steering components for signs of damage or wear.
2. Check and, if necessary, adjust the tire pressures to specification.
3. Make sure the vehicle is at curb weight and that the spare wheel, jack and vehicle tools are stowed in their designated positions. Additional items should be removed from the vehicle.
4. Bounce the vehicle to make sure that the suspension is in its normal resting position.
5. Check the toe setting using suitable wheel alignment equipment.

GENERAL PROCEDURES (Continued)

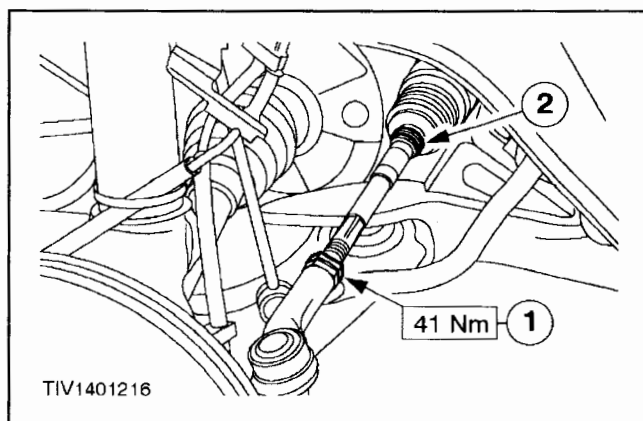
6. Center the steering wheel and lock in position.



7. Loosen both tie-rod end locknuts.
- 1 Loosen the lock-nuts.
 - 2 Remove the boot outer clamps.



8. Rotate each tie-rod equally clockwise or counterclockwise to adjust the toe setting.



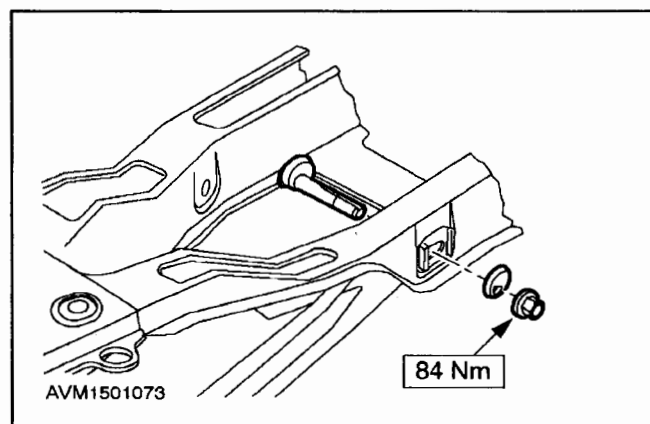
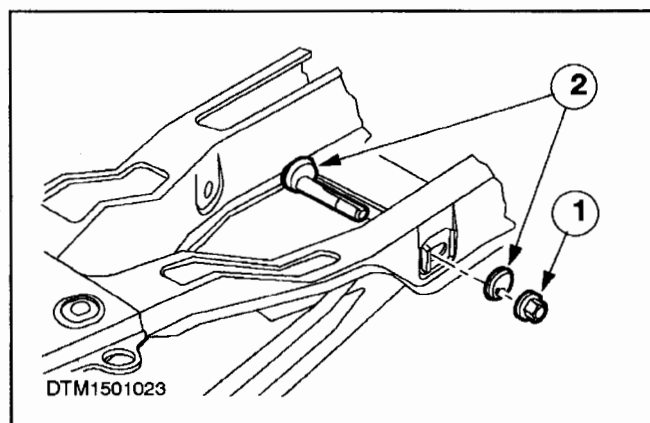
9. Tighten the tie-rod end locknuts and install the boot outer retaining clamps.
- 1 Tighten the lock-nuts.
 - 2 Install the boot outer clamps.

GENERAL PROCEDURES (Continued)**Rear Toe Adjustment****Adjustment**

1. **NOTE:** This operation should be carried out on a flat surface and in accordance with the manufacturers instructions for the particular wheel alignment equipment used.

Examine all suspension components for signs of damage or wear.

2. Check and, if necessary, adjust the tire pressures to specification.
3. Make sure the vehicle is at curb weight and that the spare wheel, jack and vehicle tools are stowed in their designated positions. Additional items should be removed from the vehicle.
4. Bounce the vehicle to make sure that the suspension is in its normal resting position.
5. Check the toe setting using suitable wheel alignment equipment.
6. Adjust the toe setting.
 - 1 Loosen the nut.
 - 2 Turn the bolt and eccentric washer to achieve the required setting.



7. Tighten the nut.

SECTION 204-01 Front Suspension

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DISASSEMBLY AND ASSEMBLY	
Strut And Spring Assembly	204-01-48

SPECIFICATIONS

Torque Specifications

Description	Nm	Lb-Ft	Lb-In
Lower arm to wheel knuckle pinch bolt and nut	84	62	—
Wheel knuckle to strut and spring assembly pinch bolt	85	63	—
Wheel hub nut	290	214	—
ABS sensor	10	—	89
Tie-rod end to wheel knuckle nut	47	35	—
Stabilizer bar to connecting link nuts	48	35	—
Strut tower nut	46	34	—
Strut and spring assembly thrust bearing nut	59	44	—
Disc brake caliper to wheel knuckle bolts	120	89	—
Wheel nuts — steel/alloy wheels	128	94	—
Lower arm to subframe nuts (M10)	70	52	—
Lower arm to subframe nuts (M12)	115	85	—

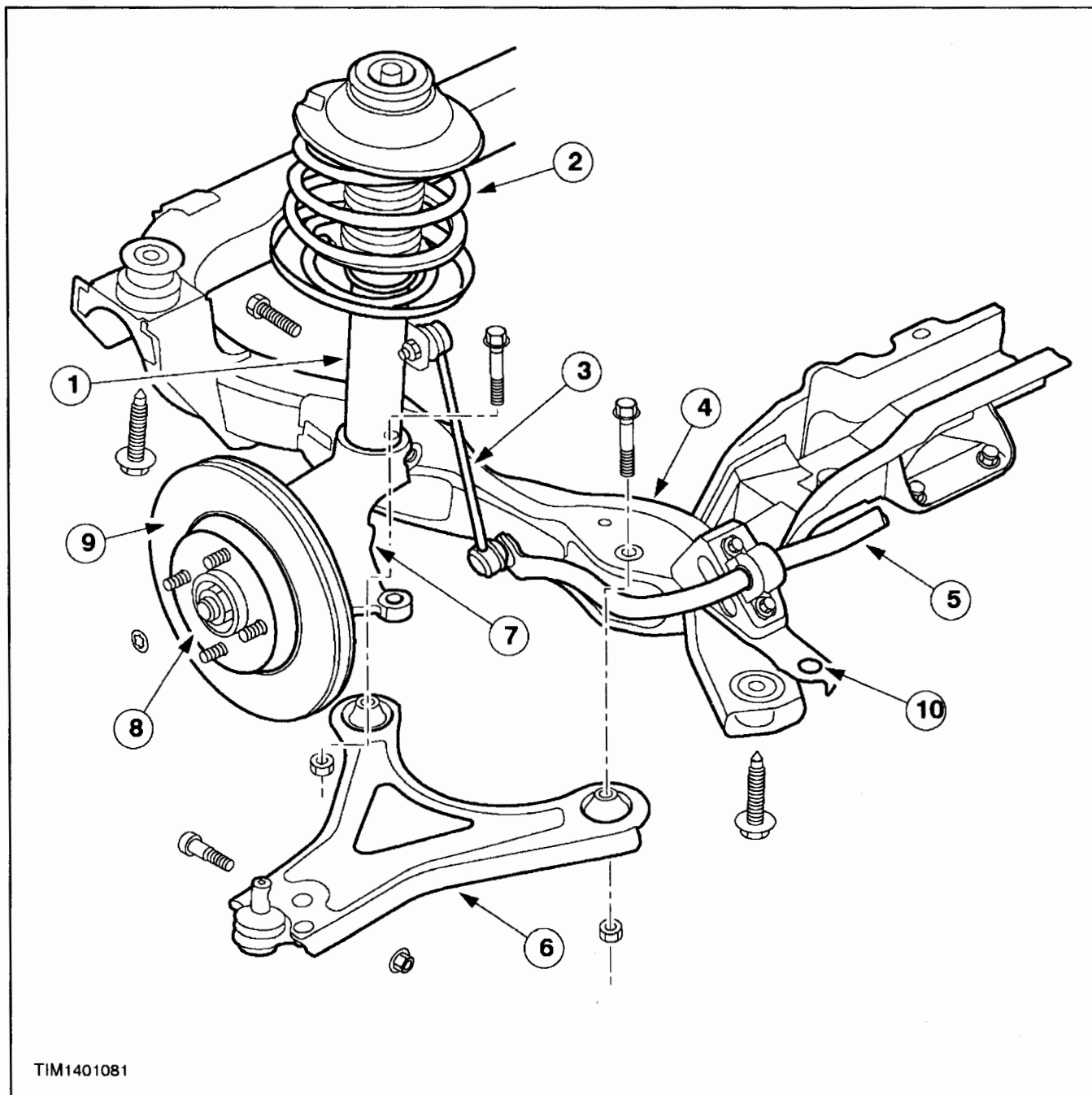
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Torque Specifications

Description	Nm	Lb-Ft	Lb-In
Stabilizer bar clamp bolts	48	35	—
Subframe mounting bolts	135	100	—
Radiator support bracket bolts	10	—	89
Air conditioning condenser nuts	24	18	—
Bumper support bracket bolts	9	—	80
Steering column shaft to flexible coupling bolt	24	18	—
Support insulator center bolt	120	89	—
Front support insulator bolts	48	35	—
Rear support insulator to subframe bolts	48	35	—
Brake tube and brake pad wear cable mounting bracket to strut and spring assembly	50	37	—
Connecting link to strut and spring assembly nut	50	37	—

DESCRIPTION AND OPERATION

Front Suspension



Item	Part Number	Description
1	—	Strut
2	—	Spring
3	—	Connecting link
4	—	Subframe
5	—	Stabilizer bar

(Continued)

Item	Part Number	Description
6	—	Lower arm
7	—	Wheel knuckle
8	—	Wheel hub
9	—	Brake disc
10	—	Alignment hole

DIAGNOSIS AND TESTING

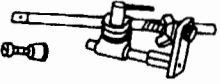
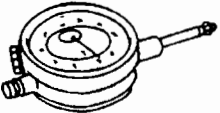
Front Suspension

Refer to Section 204-00.

GENERAL PROCEDURES

Wheel Bearing Adjustment

Special Tool(s)

 ST1182-A	Dial Indicator Gauge Bracketry 100-D004 (D78P-4201-F) or equivalent
 ST1183-A	Dial Indicator Gauge 100-D005 (D78P-4201-G) or equivalent

Check

1. Installation of new front wheel bearings may be required if a wheel bearing noise occurs only when turning. To diagnose the front wheel bearings, refer to Section 204-00.
2. Road test the vehicle on a smooth road. Make sharp turns to the right and left.
 - Installation of a new left front wheel bearing may be required if the vehicle makes abnormal noises on right turns.
 - Installation of a new right front wheel bearing may be required if the vehicle makes noises on left turns.
 - If front wheel bearing noise is heard on either right or left turns, the wheel hub and front wheel bearing assembly on the side with the most noise should be disassembled and inspected.

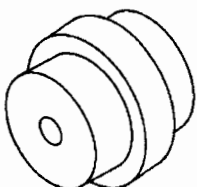
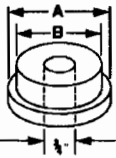
GENERAL PROCEDURES (Continued)

3. **NOTE:** Be careful not to confuse lower arm ball joint looseness with bearing looseness.
Raise and support the front of the vehicle and check for loose front wheel bearings by rocking the wheels at the top and bottom.
4. Spin the wheel quickly by hand and make sure the wheel turns smoothly without noise from the front wheel bearings.
5. Remove the front brake caliper anchor plate. For additional information, refer to Section 206-03.
6. Position Dial Indicator Gauge Bracketry 100-D004 (D78P-4201-F) or equivalent and Dial Indicator Gauge 100-D005 (D78P-4201-G) or equivalent, against the wheel hub, then push and pull the wheel hub. Measure the end play of the wheel hub and front wheel bearing assembly. There should be no end play. If end play exist install new front wheel bearings.
7. The hub nut torque restricts bearing/ hub relative movement and maintains axial position of the wheel hub. Due to the importance of the hub nut torque/tension relationship, take the following precautions during repair.
8. Since the wheel bearing cannot be adjusted, the hub nut must not be backed off after reaching the required torque during installation.
9. If the front axle wheel hub nut is loosened or removed a new nut must be installed.
10. Power tools must not be used to tighten or loosen the front wheel hub nut or bearing damage may result.
11. To remove the front wheel hub nut, apply sufficient torque to the front wheel hub nut to overcome the prevailing torque feature.

REMOVAL AND INSTALLATION

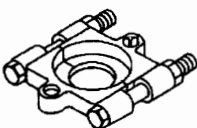
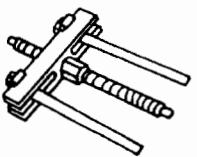
Wheel Bearing

Special Tool(s)

 ST2062-A	Trust Pad 205-D016 (D80L-630-5) or equivalent
 ST2063-A	Installer, Pinion Bearing Cup 205-139 (T80T-4000-E)

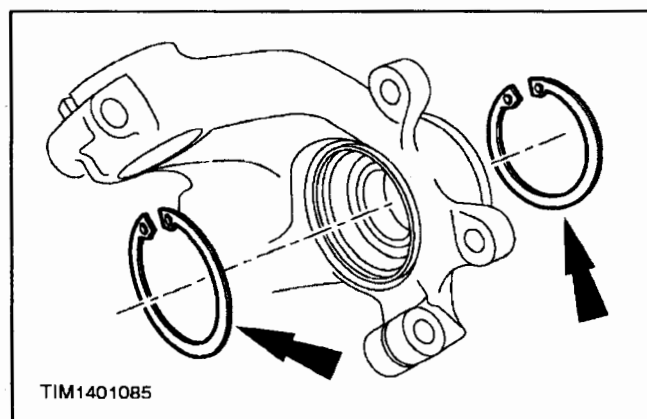
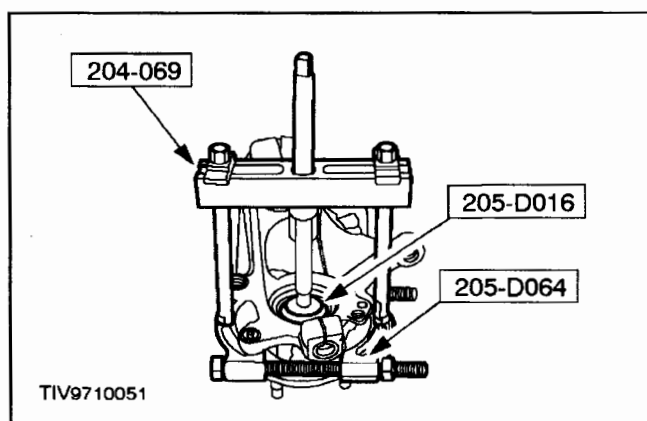
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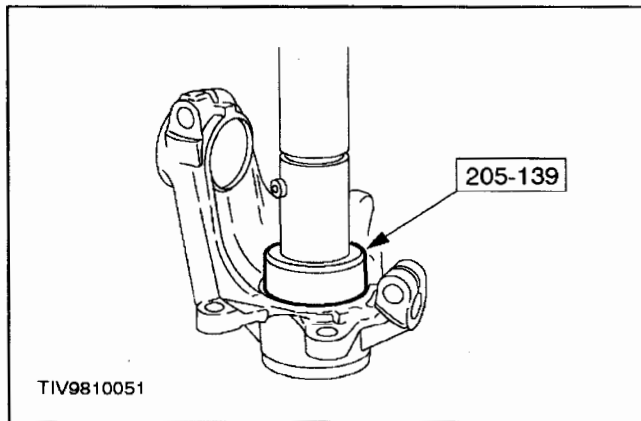
Special Tool(s)

 ST2064-A	Remover, Bearing/Gear 205-D064 (D84L-1123-A) or equivalent
 ST1516-A	Remove/Installer, Front Hub 204-069 (T81P-1104-C)

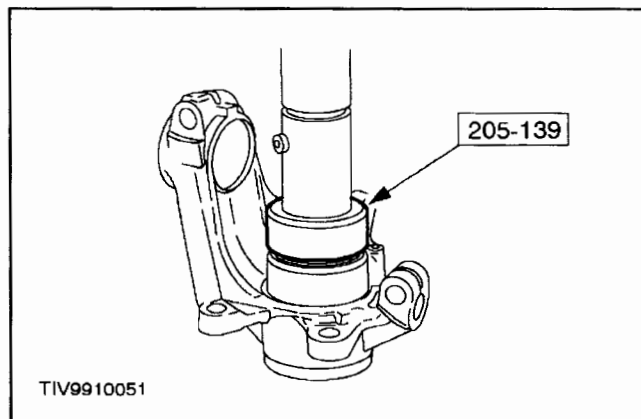
Removal

1. Remove the wheel knuckle. For additional information, refer to Wheel Knuckle in this section.
2. Using the special tools, remove the wheel hub from the wheel knuckle.
3. Remove the inner and outer circlips.

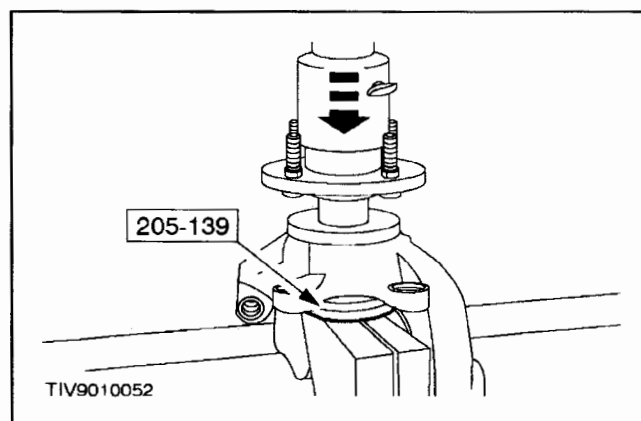


REMOVAL AND INSTALLATION (Continued)

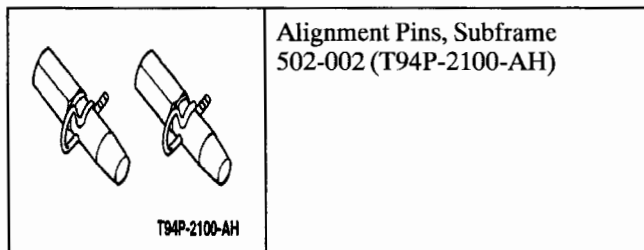
4. Using the special tool, press out the wheel bearing.

Installation

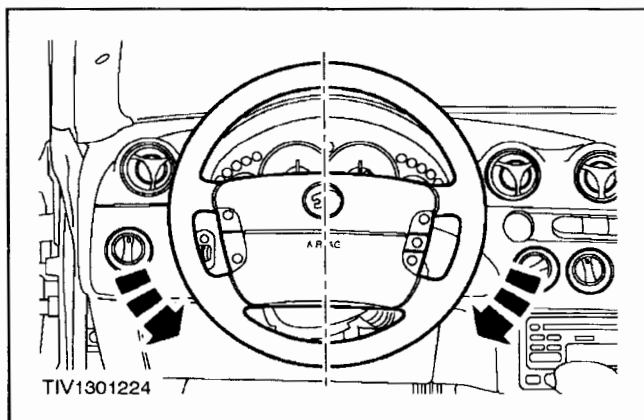
1. Install the outer circlip.
2. Using the special tool, press in the new wheel bearing.



3. Install the inner circlip.
4. Using the special tool, install the wheel hub to the wheel knuckle.
5. Install the wheel knuckle. For additional information refer to Wheel Knuckle in this section.

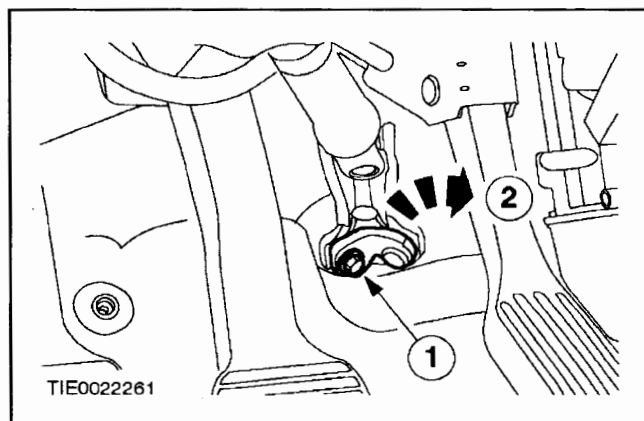
REMOVAL AND INSTALLATION (Continued)**Lower Arm — LH****Special Tool(s)****Removal****All vehicles**

1. Center the steering wheel and lock in position.



2. Disconnect the steering column shaft from the flexible coupling.

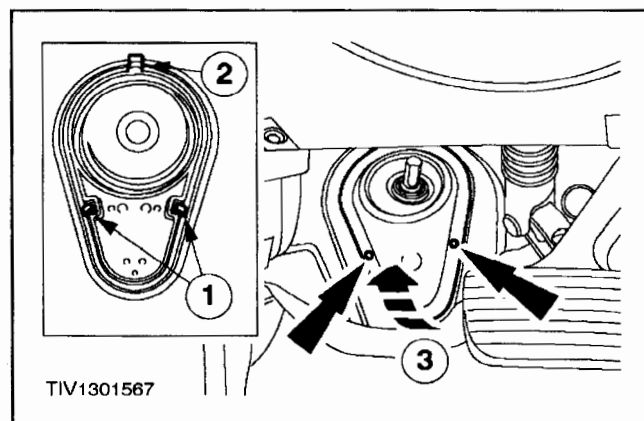
- 1 Discard the retaining bolt.
- 2 Rotate the clamp plate.

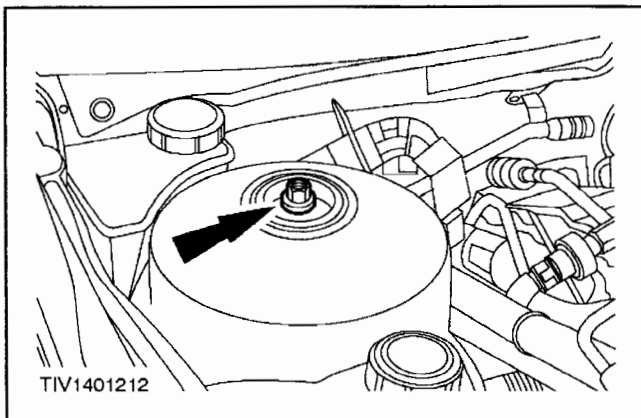


3. **CAUTION:** When removing the floor seal do not damage the sealing clips.

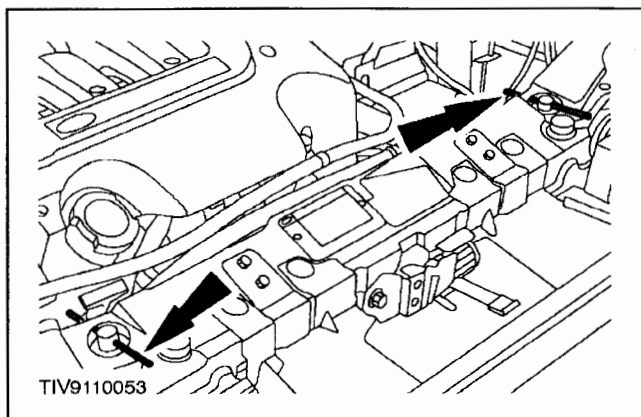
Remove the floor seal from the bulkhead.

- 1 Release the retaining clips.
- 2 Disconnect the upper retainer.
- 3 Remove the floor seal.

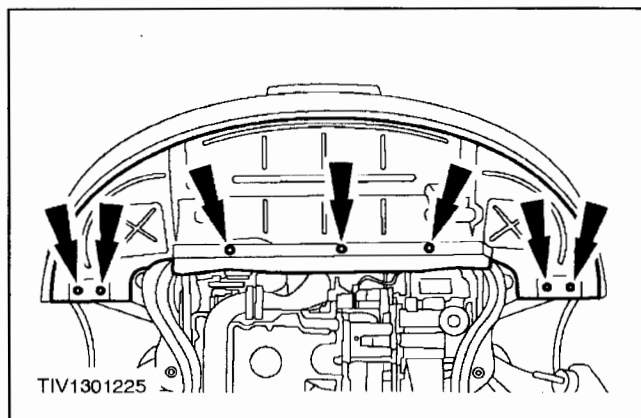


REMOVAL AND INSTALLATION (Continued)

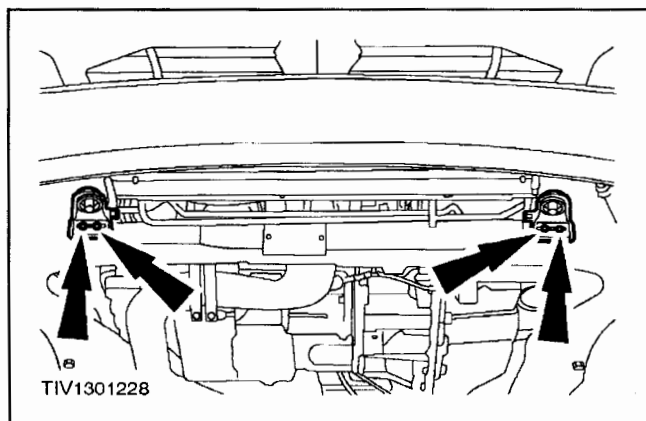
4.  **CAUTION:** Use an Allen key to prevent the piston rod from rotating.
Loosen the suspension strut top mount nut by five turns.



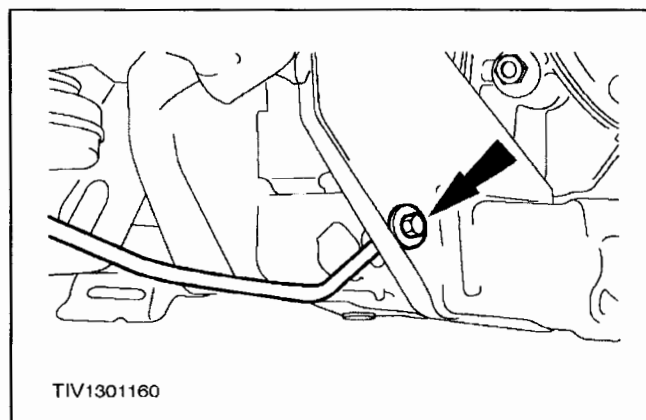
5. Support the radiator on both sides using suitable pins.



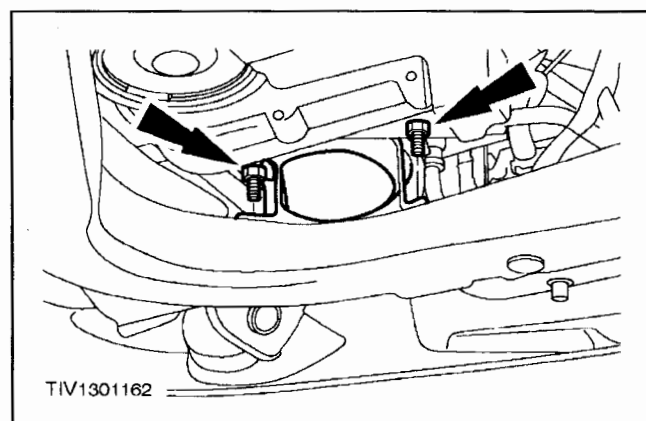
6. Remove the wheel and tire. For additional information, refer to Section 204-04.
7. Remove the radiator splash shield.

REMOVAL AND INSTALLATION (Continued)

8. Detach the radiator support brackets.



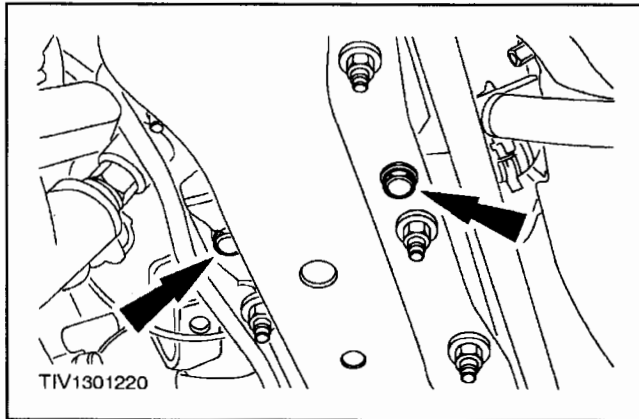
9. Detach the bumper support brackets.

**Vehicles with air conditioning**

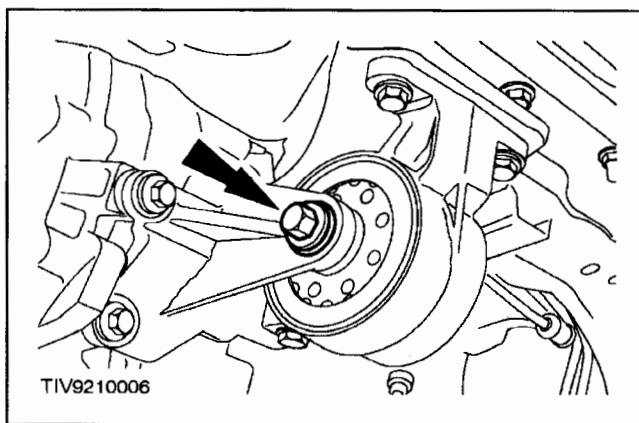
10. Detach the air conditioning condenser.

REMOVAL AND INSTALLATION (Continued)**Vehicles with automatic transaxle**

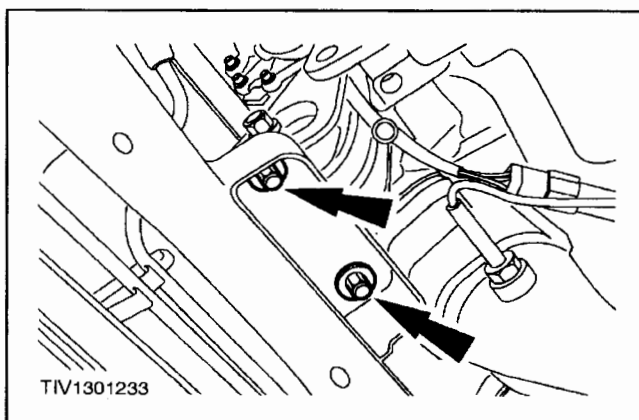
11. Detach the rear support insulator.

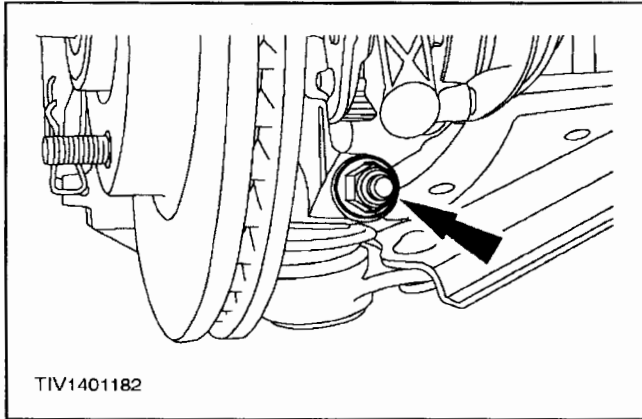
**Vehicles with manual transaxle**

12. Remove the rear support insulator center bolt.

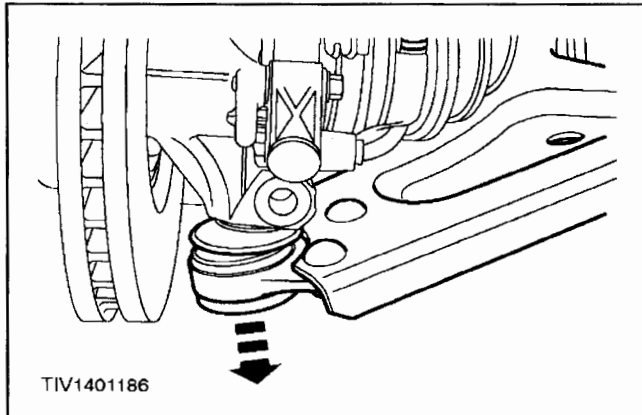
**All vehicles**

13. Remove the front support insulator retaining bolts.



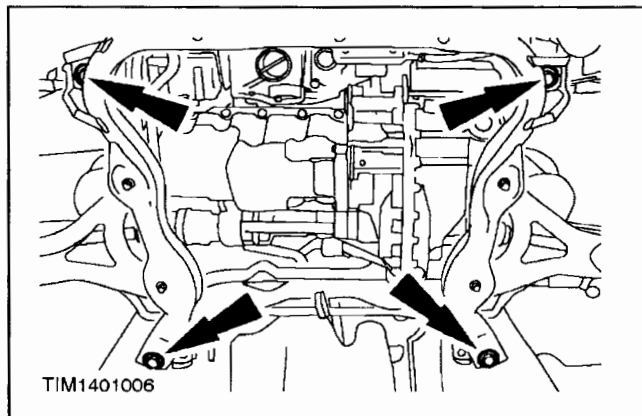
REMOVAL AND INSTALLATION (Continued)

14. Remove the lower arm to wheel knuckle pinch bolt.



15.  **CAUTION: Protect the ball joint seal using a soft cloth to prevent damage.**

Detach the lower arm ball joint from the wheel knuckle.



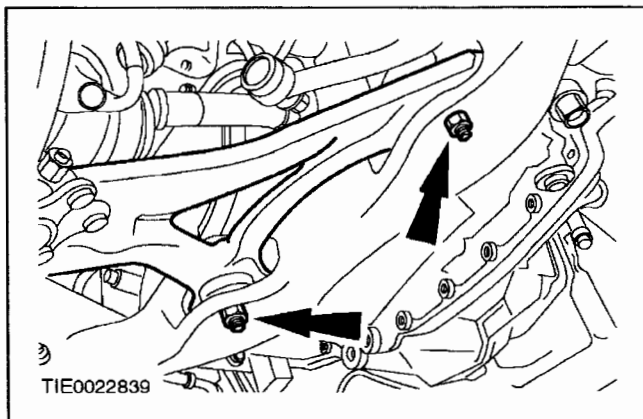
16. Using a suitable transmission jack, support the subframe.

17. Remove the subframe bolts.

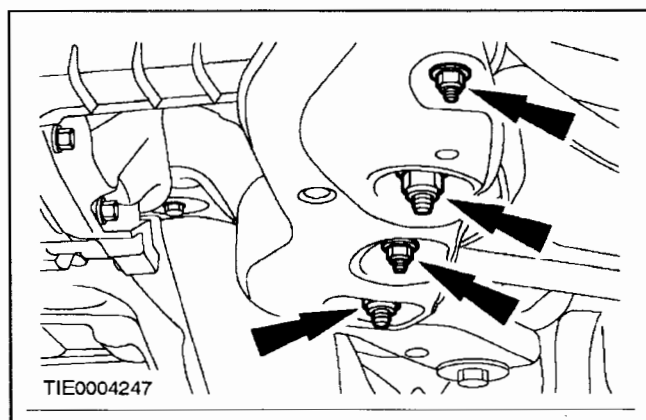
18. Lower the subframe to gain access to the lower arm bolts.

REMOVAL AND INSTALLATION (Continued)**Lower arms with vertical bushings**

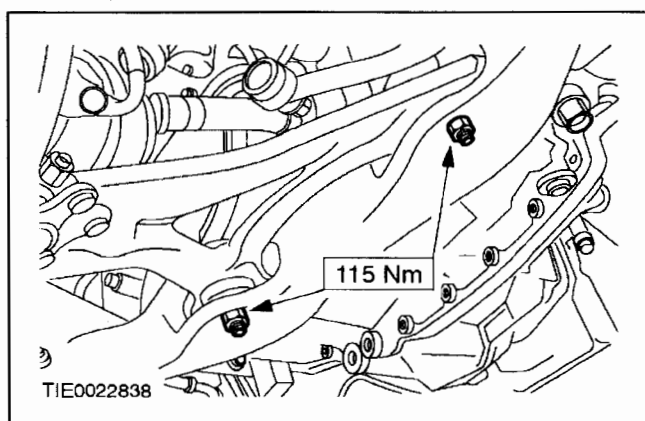
19. Remove the lower arm.

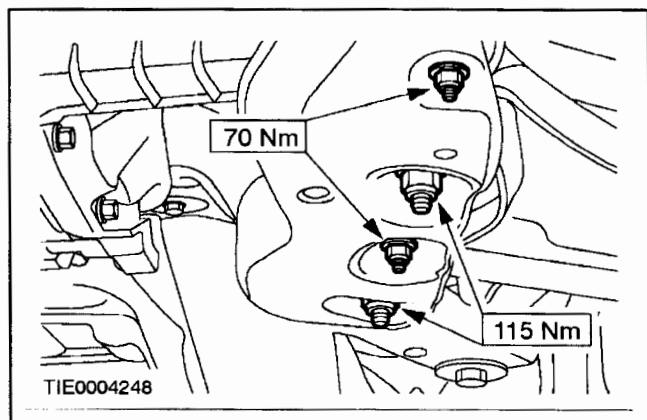
**Lower arms with horizontal bushings**

20. Remove the lower arm.

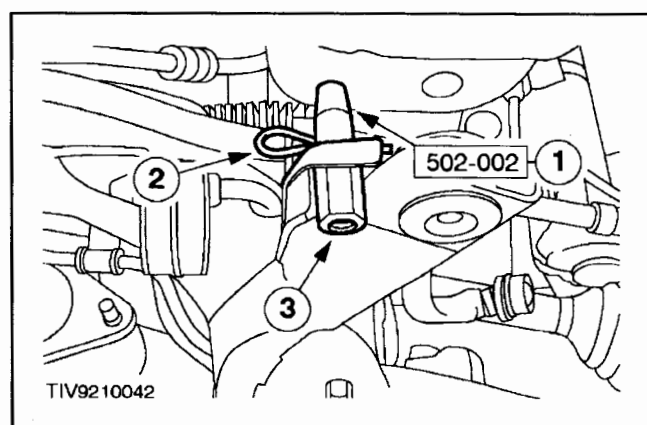
**Installation****Lower arms with vertical bushings**

1.  **CAUTION:** Make sure the bolt heads are uppermost.
Install the lower arm.

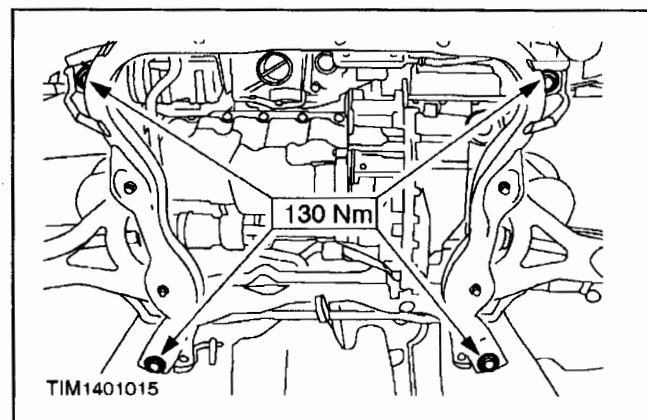


REMOVAL AND INSTALLATION (Continued)**Lower arms with horizontal bushings**

2.  **CAUTION:** Make sure the bolt heads are uppermost.
Install the lower arm.

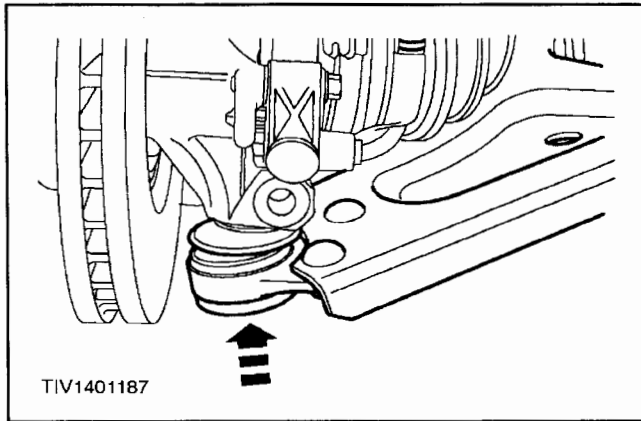
**All vehicles**

3. Using the special tools align the subframe.
- 1 Push the guide pins through the subframe aligning holes.
 - 2 Engage the locking pins.
 - 3 Tighten the guide pin sleeve.

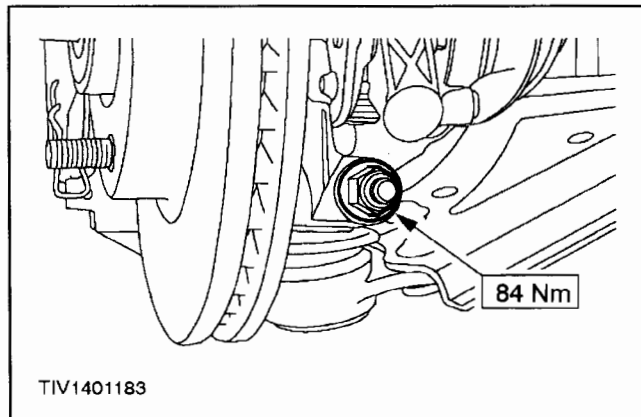


4. **NOTE:** Make sure the blue colored bolts are installed to the front of the subframe.
Install the subframe bolts.

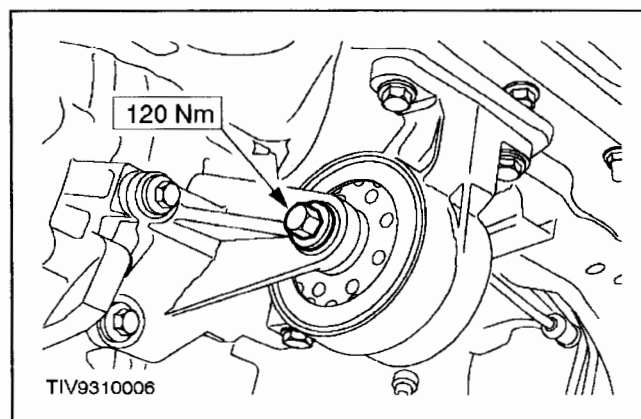
5. Remove the special tools.

REMOVAL AND INSTALLATION (Continued)

6. Attach the lower arm ball joint to the wheel knuckle.



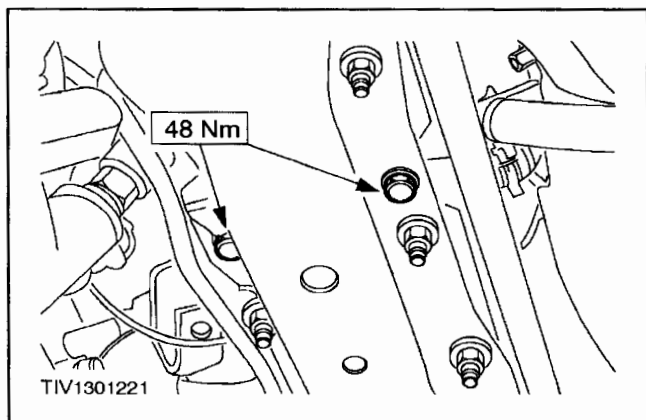
7. Install the lower arm to wheel knuckle pinch bolt.

**Vehicles with manual transaxle**

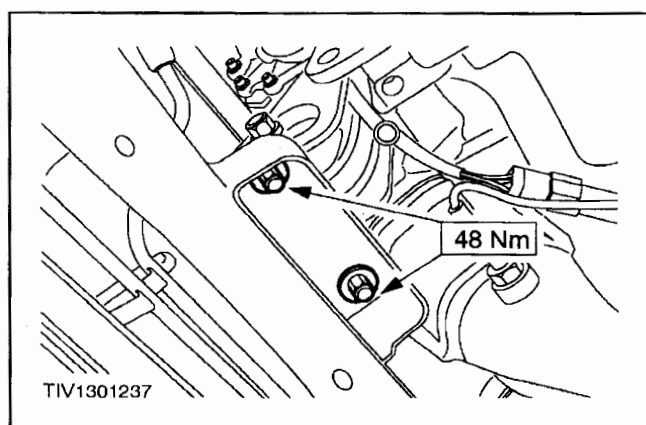
8. Install the rear support insulator center bolt.

REMOVAL AND INSTALLATION (Continued)**Vehicles with automatic transaxle**

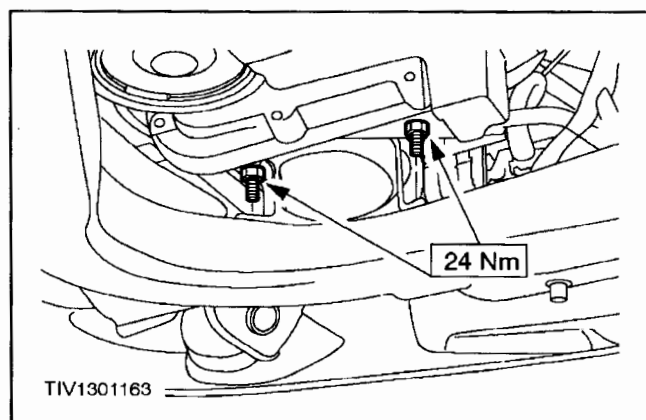
9. Install the rear support insulator.

**All vehicles**

10. Install the front support insulator retaining bolts.

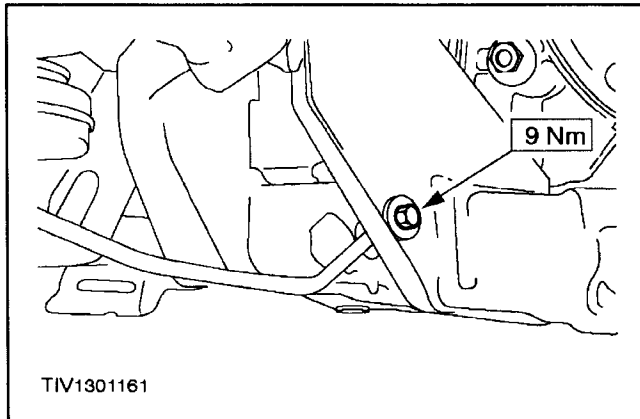
**Vehicles with air conditioning**

11. Attach the air conditioning condenser.

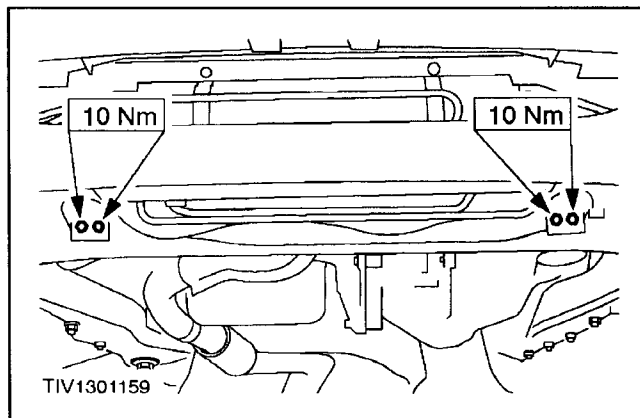


REMOVAL AND INSTALLATION (Continued)**All vehicles**

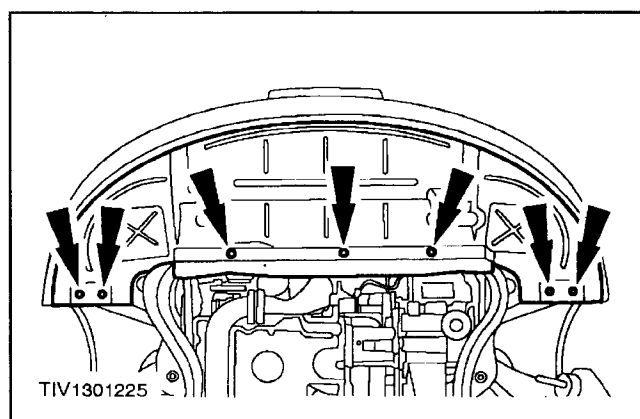
12. Attach the bumper support brackets.



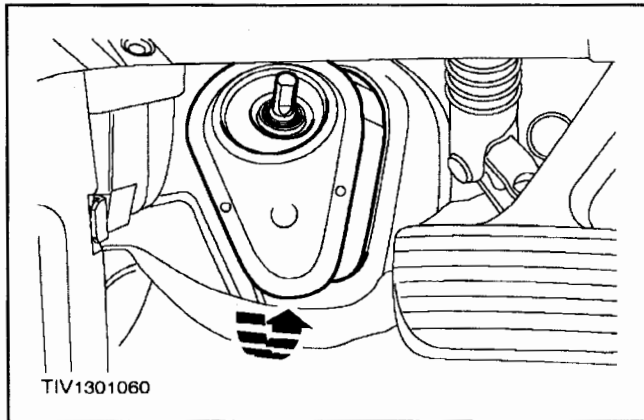
13. Attach the radiator support brackets.



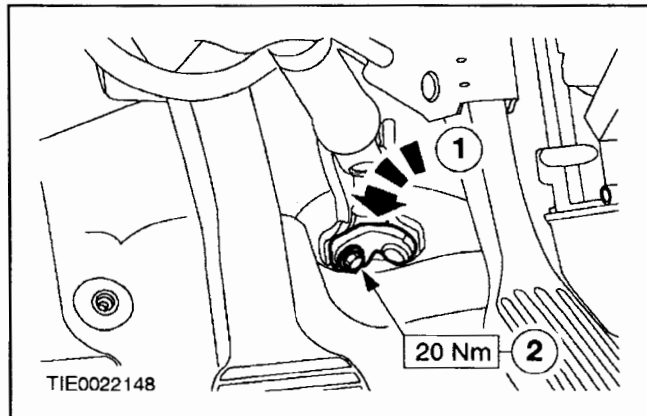
14. Install the radiator splash shield.



15. Install the front wheel and tire. For additional information, refer to Section 204-04.

REMOVAL AND INSTALLATION (Continued)

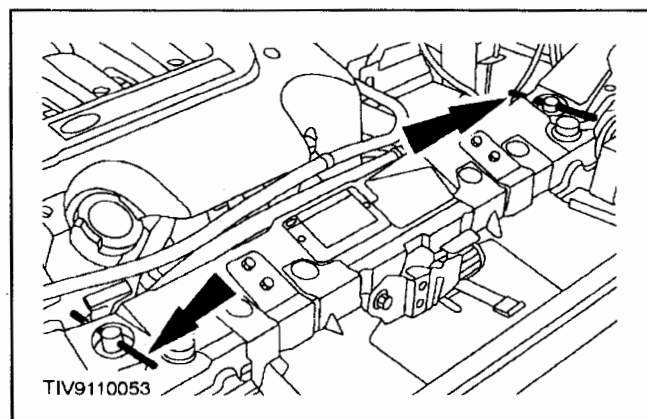
16. Install the floor seal.



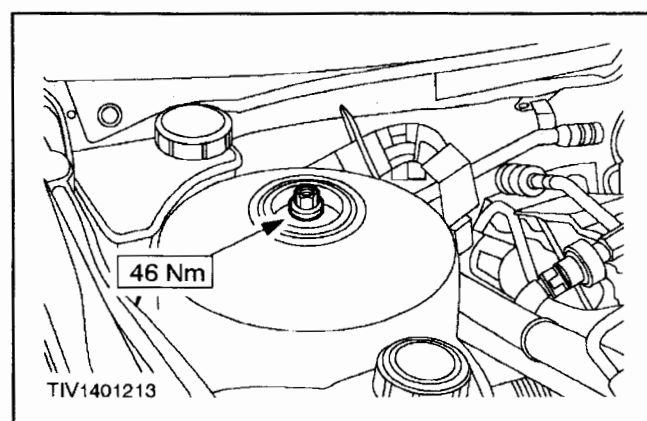
17. **WARNING:** Install a new steering column coupling retaining bolt. Failure to follow this instruction may result in personal injury.

Connect the steering column shaft to the flexible coupling.

- 1 Rotate the clamp plate.
- 2 Install the retaining bolt.



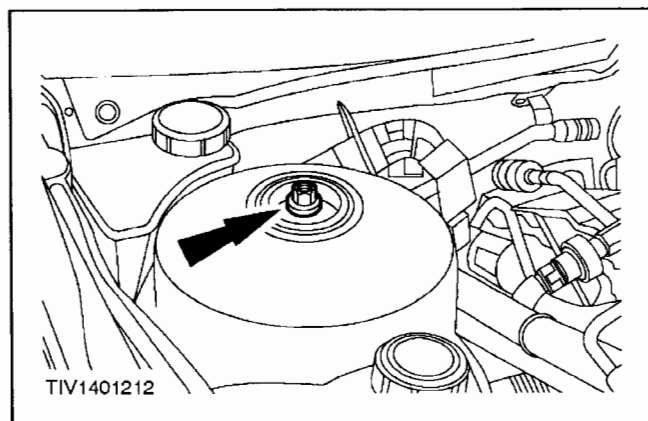
18. Remove the radiator supports.



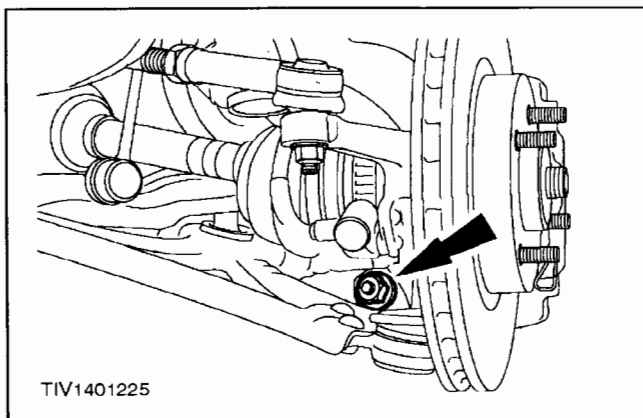
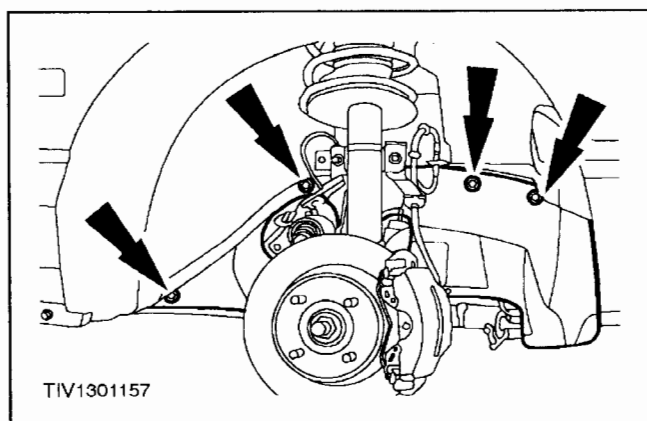
19. **CAUTION:** Use an Allen key to prevent the piston rod from rotating.
- Tighten the suspension strut top mount nut.

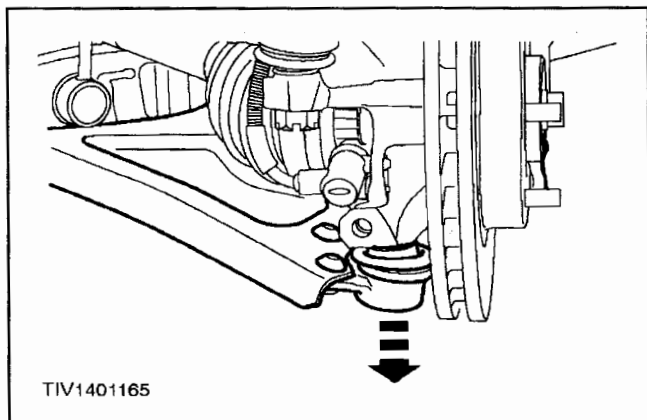
REMOVAL AND INSTALLATION (Continued)

20. Check the front wheel alignment. For additional information, refer to Section 204-00.

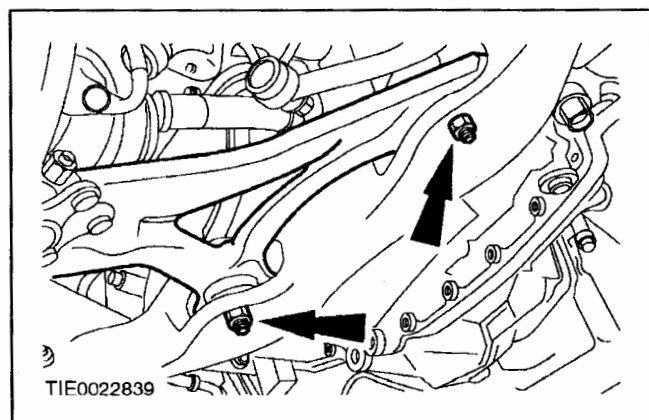
Lower Arm — RH**Removal****All vehicles**

1.  **CAUTION:** Use an Allen key to prevent the piston rod from rotating.
Loosen the suspension strut top mount nut by five turns.
2. Remove the wheel and tire. For additional information, refer to Section 204-04.
3. Remove the splash shield.
4. Remove the lower arm to wheel knuckle pinch bolt.

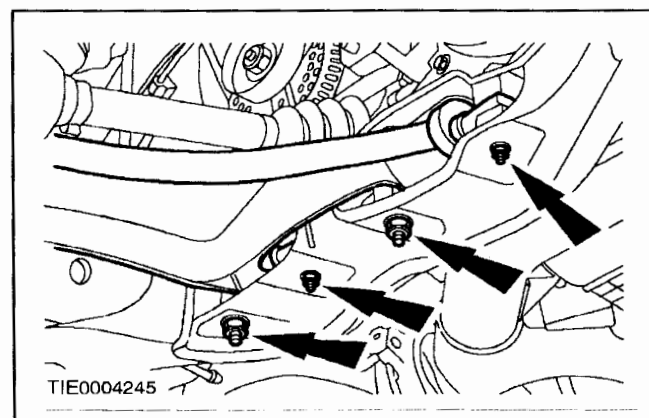


REMOVAL AND INSTALLATION (Continued)

5.  **CAUTION:** Protect the ball joint seal using a soft cloth to prevent damage. Detach the lower arm ball joint from the wheel knuckle.

Lower arms with vertical bushings

6. Remove the lower arm.

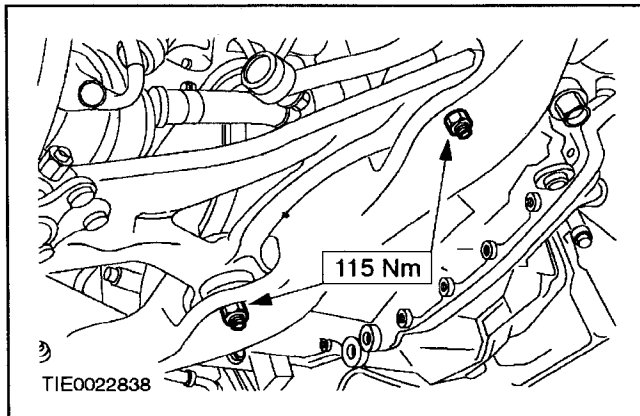
Lower arms with horizontal bushings

7. Remove the lower arm.

REMOVAL AND INSTALLATION (Continued)**Installation****Lower arms with vertical bushings**

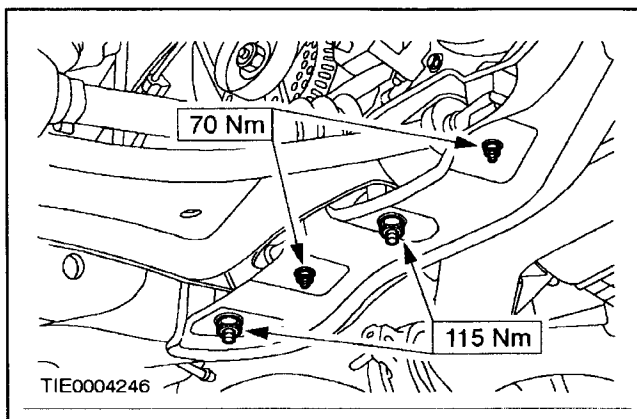
1.  **CAUTION:** Make sure the bolt heads are uppermost.

Install the lower arm.

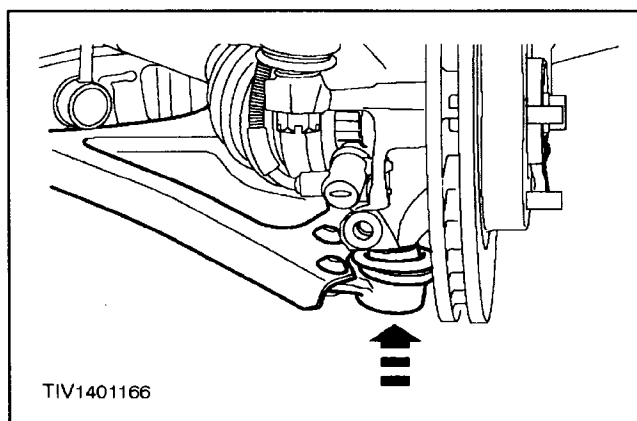
**Lower arms with horizontal bushings**

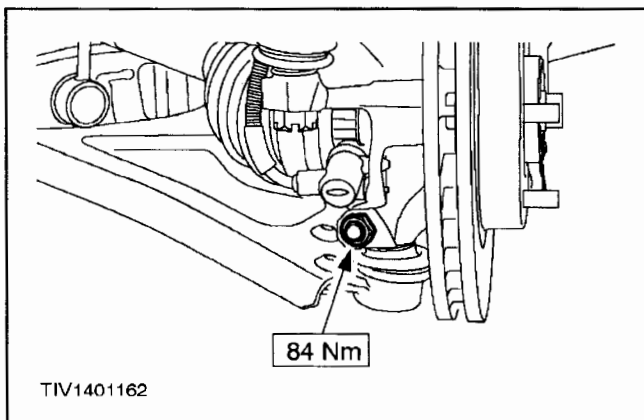
2.  **CAUTION:** Make sure the bolt heads are uppermost.

Install the lower arm.

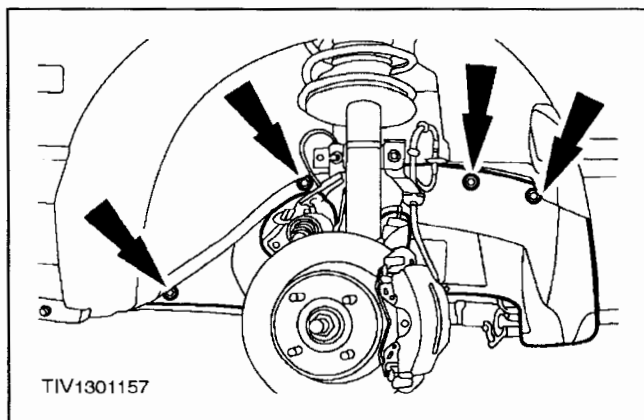
**All vehicles**

3. Attach the lower arm ball joint to the wheel knuckle.

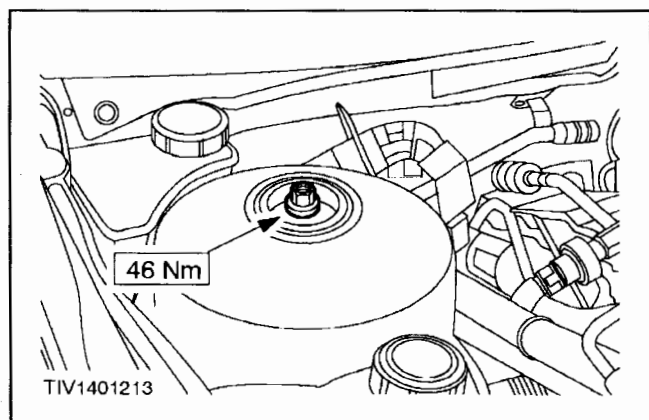


REMOVAL AND INSTALLATION (Continued)

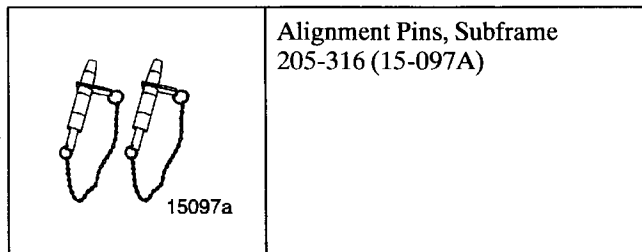
4. Install the lower arm to wheel knuckle pinch bolt.



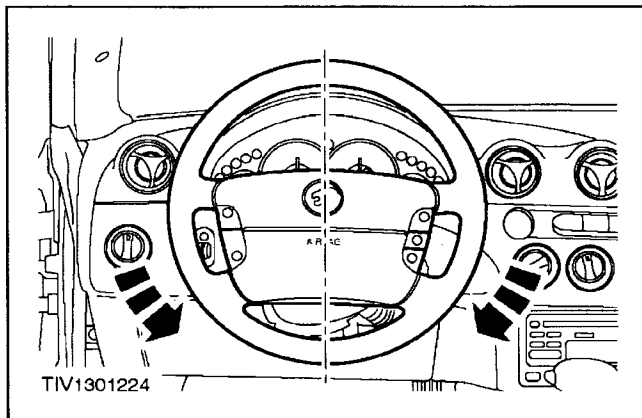
5. Install the splash shield.



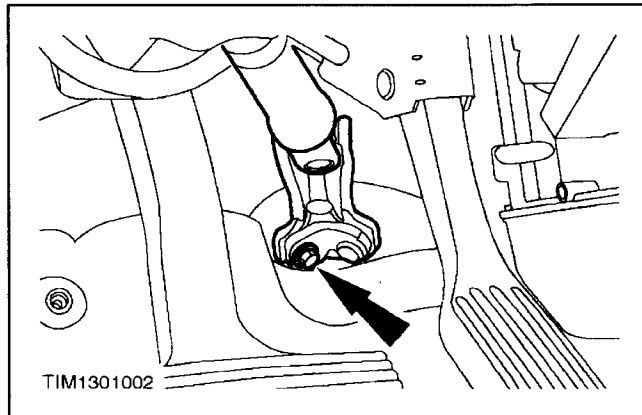
6. Install the wheel and tire. For additional information, refer to Section 204-04.
7.  **CAUTION:** Use an Allen key to prevent the piston rod from rotating.
Tighten the suspension strut top mount nut.
8. Check the front wheel alignment. For additional information, refer to Section 204-00.

REMOVAL AND INSTALLATION (Continued)**Stabilizer Bar****Special Tool(s)****Removal****All vehicles**

1. Center the steering wheel and lock in position.



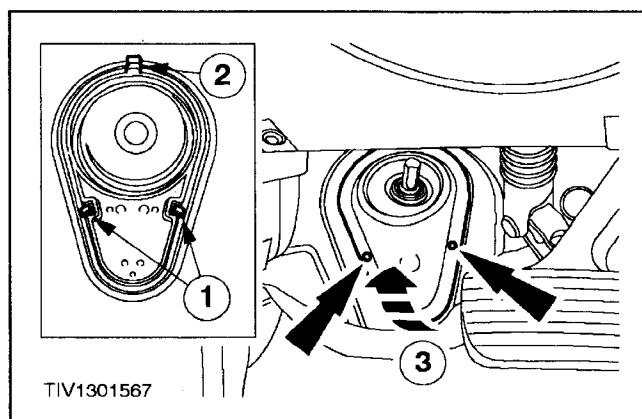
2. Disconnect the steering column shaft from the flexible coupling.
 - Rotate the clamp plate to disengage.



3.  **CAUTION:** When removing the floor seal do not damage the sealing clips.

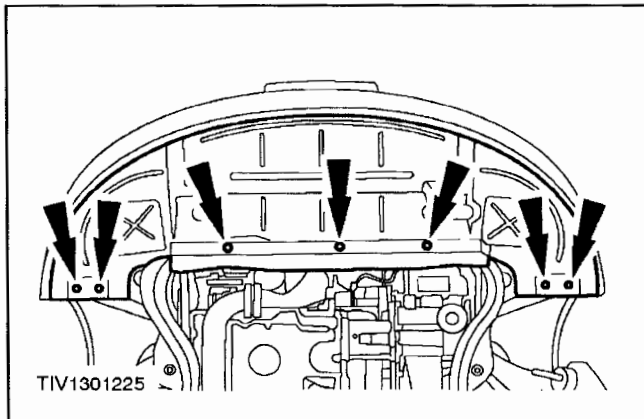
Remove the floor seal from the bulkhead.

- 1 Release the retaining clips.
- 2 Disconnect the upper retaining clip.
- 3 Remove the floor seal.

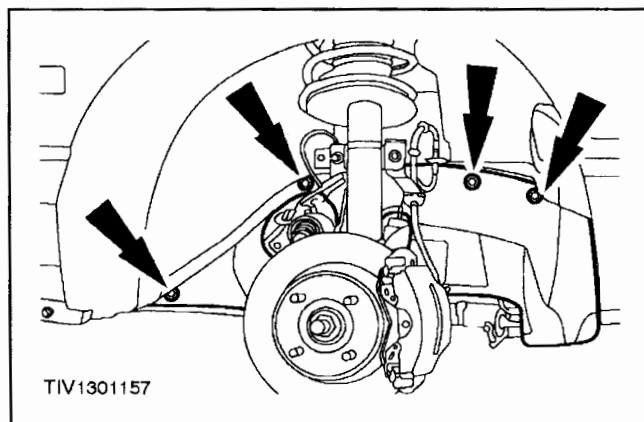


REMOVAL AND INSTALLATION (Continued)

4. Remove the front wheel and tire. For additional information, refer to Section 204-04.
5. Remove the radiator splash shield.



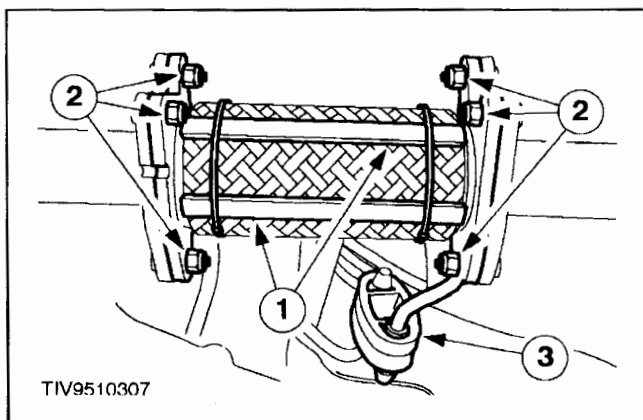
6. Remove the splash shields.

**Vehicles with 2.5L engine**

7.  **CAUTION: Over bending of the flexible pipe may cause damage resulting in failure.**

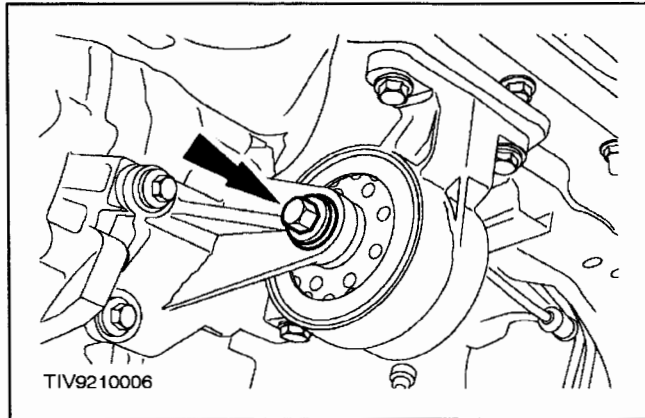
Remove the exhaust flexible pipe.

- 1 Support the flexible pipe with a support wrap or suitable splint assembly.
- 2 Remove the nuts.
- 3 Detach the exhaust hanger insulator.

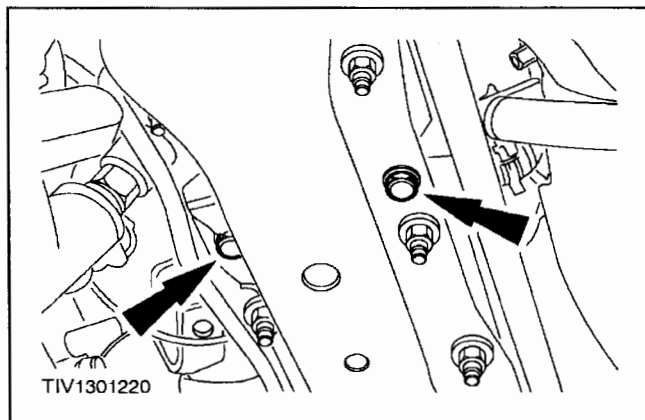


REMOVAL AND INSTALLATION (Continued)**Vehicles with manual transaxle**

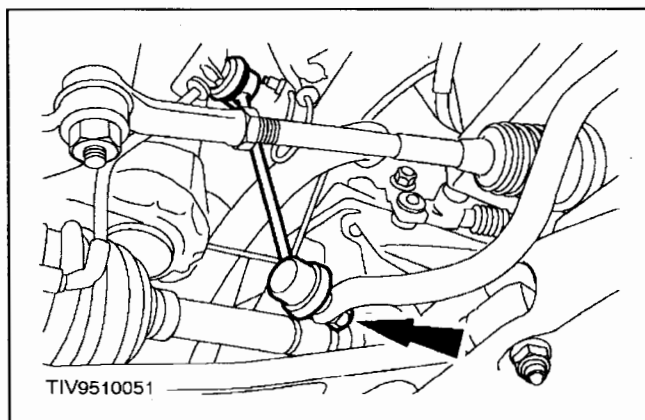
8. Remove the rear support insulator center bolt.

**Vehicles with automatic transaxle**

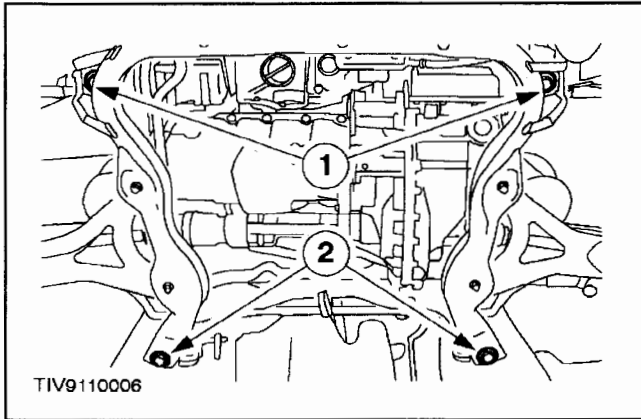
9. Detach the rear support insulator.

**All vehicles**

10. Detach the stabilizer bar connecting links.

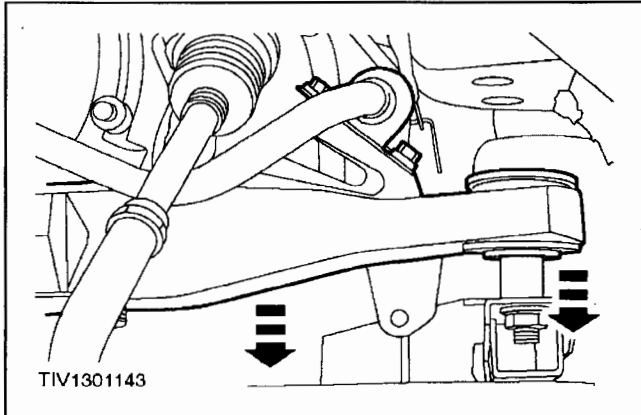


11. Using a suitable transmission jack support the subframe assembly.

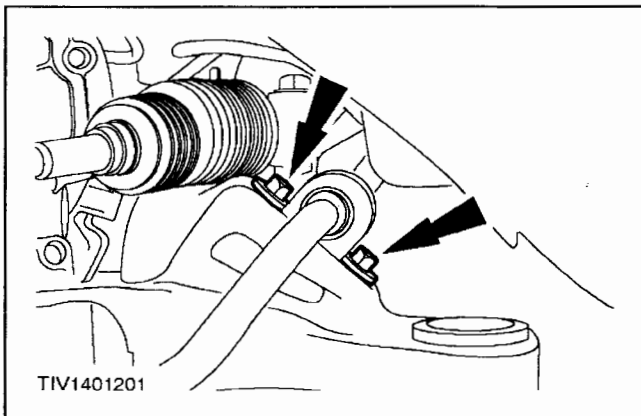
REMOVAL AND INSTALLATION (Continued)

12. Detach the subframe.

- 1 Loosen the front bolts by five turns.
- 2 Remove the rear bolts.



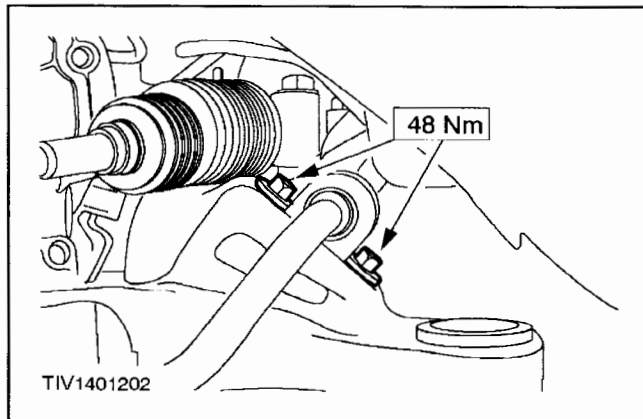
13. Lower the subframe to gain access to the stabilizer bar retaining clamp bolts.



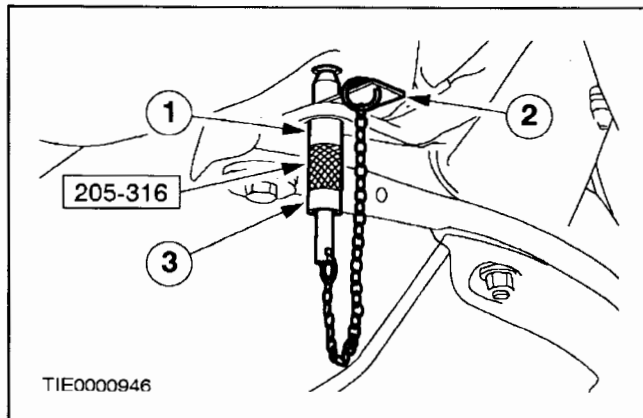
14. Remove the stabilizer bar (two clamp bolts each side).

REMOVAL AND INSTALLATION (Continued)**Installation****All vehicles**

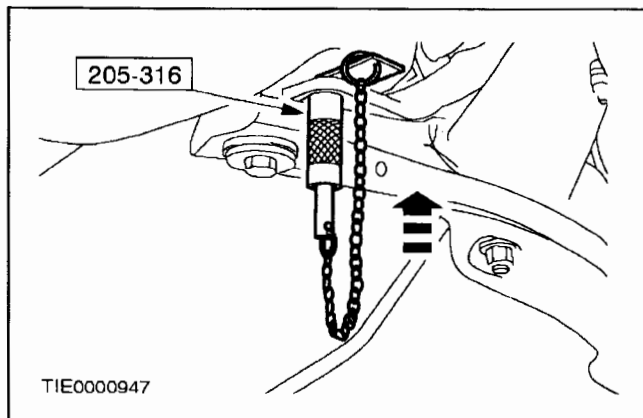
1. Install the stabilizer bar (two clamp bolts each side).

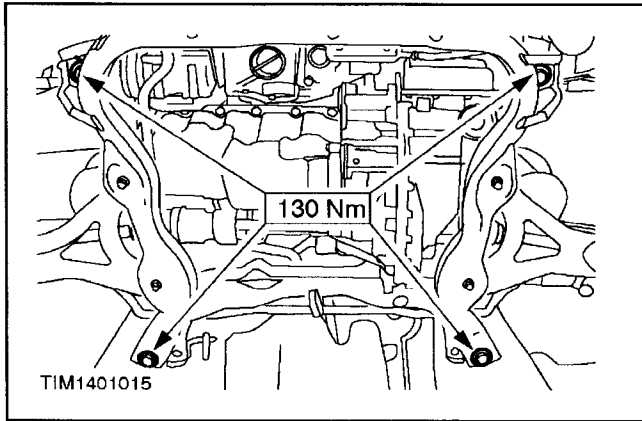


2. Using the special tools, align the subframe.
 - 1 Install the alignment pins in the subframe alignment holes (one each side).
 - 2 Install the locking pins.
 - 3 Tighten the alignment pin sleeves.

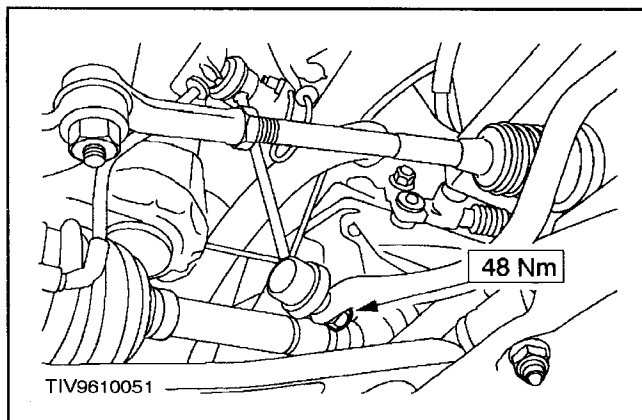


3. Raise the subframe engaging the special tools in the alignment holes.

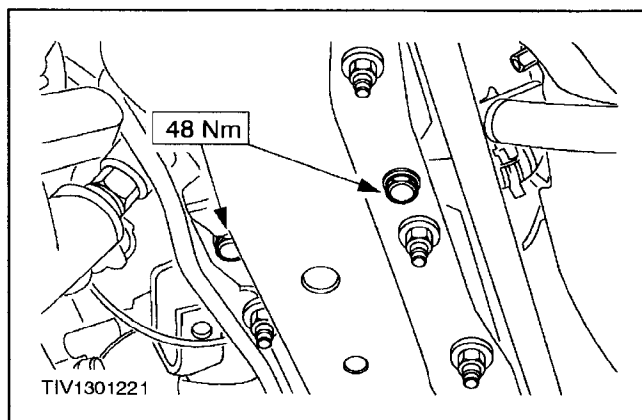


REMOVAL AND INSTALLATION (Continued)

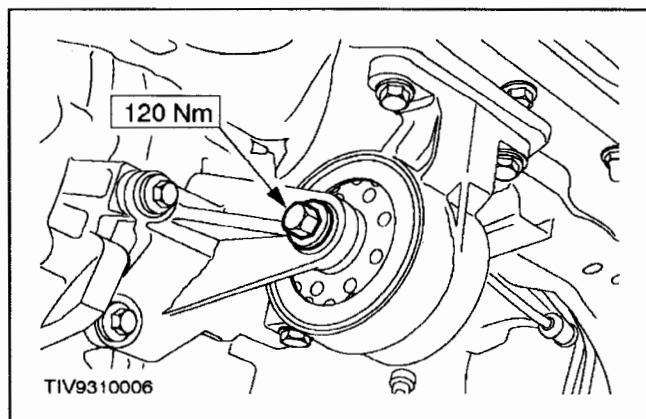
4. Install the subframe bolts.



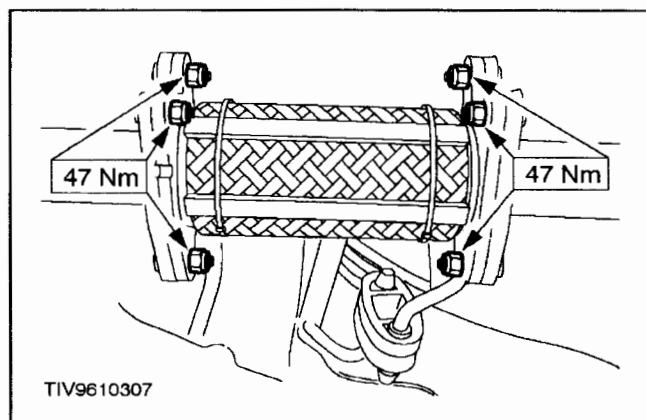
5. Remove the special tools (reverse the installation procedure).
6. Install the stabilizer bar connecting links.

**Vehicles with automatic transaxle**

7. Install the rear support insulator.

REMOVAL AND INSTALLATION (Continued)**Vehicles with manual transaxle**

8. Install the rear support insulator center bolt.

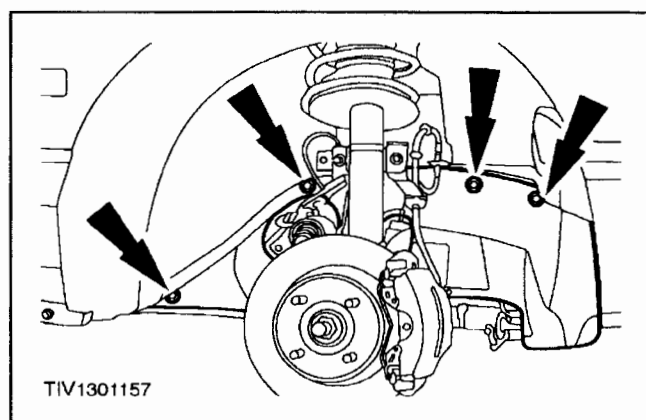
**Vehicles with 2.5L engine**

9.  **CAUTION:** Over bending of the flexible pipe may cause damage resulting in failure.

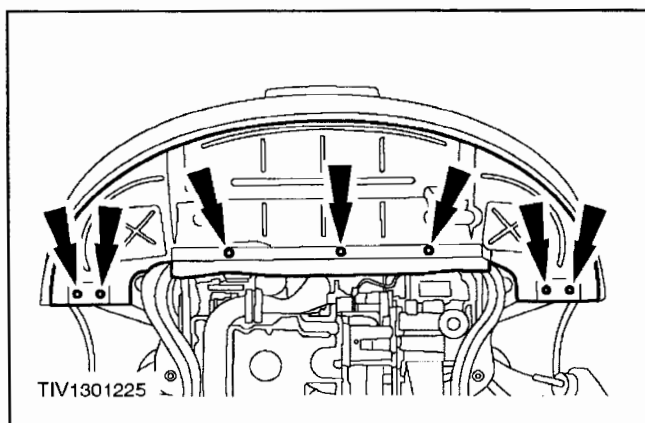
NOTE: Install new gaskets.

Install exhaust flexible pipe.

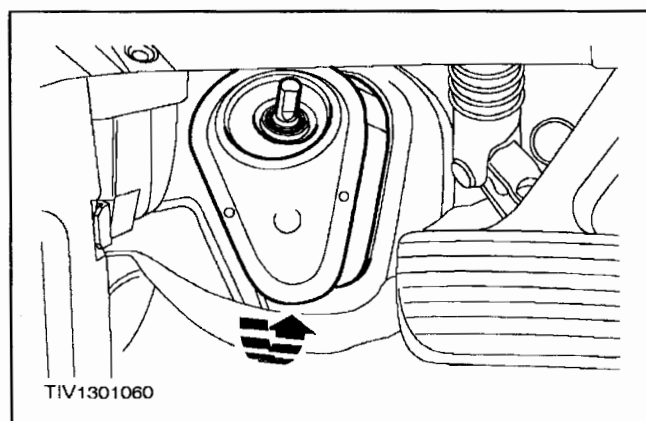
- After installation, remove the flexible pipe support.

**All vehicles**

10. Install the splash shields.

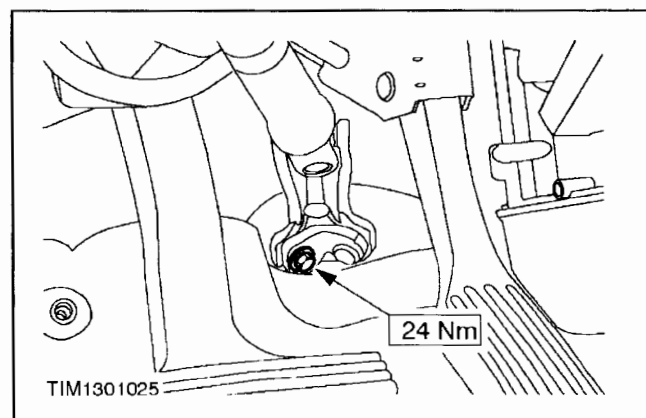
REMOVAL AND INSTALLATION (Continued)

11. Install the radiator splash shield.



12. Install the front wheel and tire. For additional information, refer to Section 204-04.

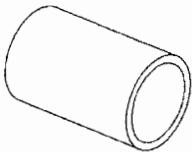
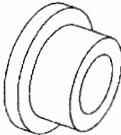
13. Install the floor seal.



14.  **WARNING: Install a new pinch bolt. Failure to follow these instructions may result in personal injury.**

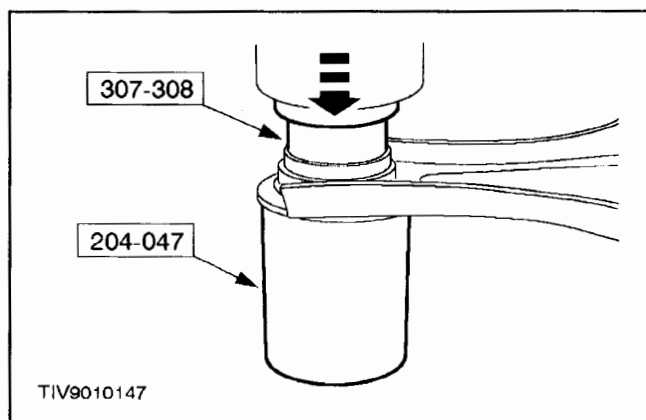
Install the steering column shaft to the flexible coupling with a new bolt.

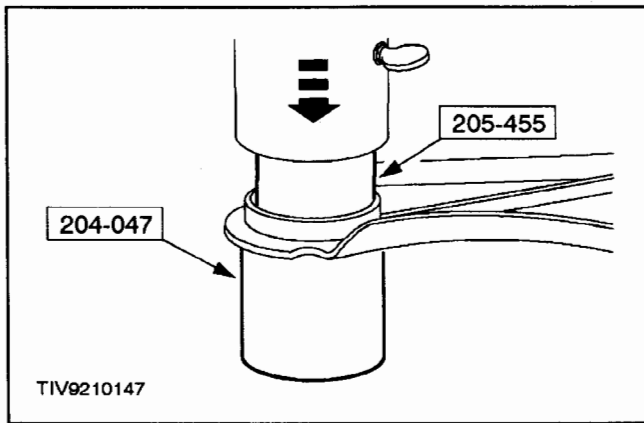
REMOVAL AND INSTALLATION (Continued)**Lower Arm Bushing****Special Tool(s)**

 T79P-5638-A4	Receiving Cup 204-047 (T79P-5638-A4)
 T94P-77000	Aligner — End Play Gauge 307-308 (T94P-77000-V)
 T85M-5638-A3	Rear Bushing Replacing Cup 205-455 (T85M-5638-A3)

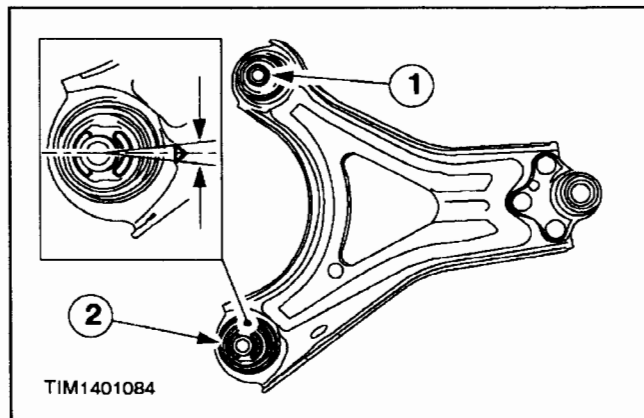
Removal

1. Remove the lower arm assembly. For additional information, refer to Lower Arm—LH or Lower Arm—RH in this section.
2. Using the special tools, remove the front solid bush.



REMOVAL AND INSTALLATION (Continued)

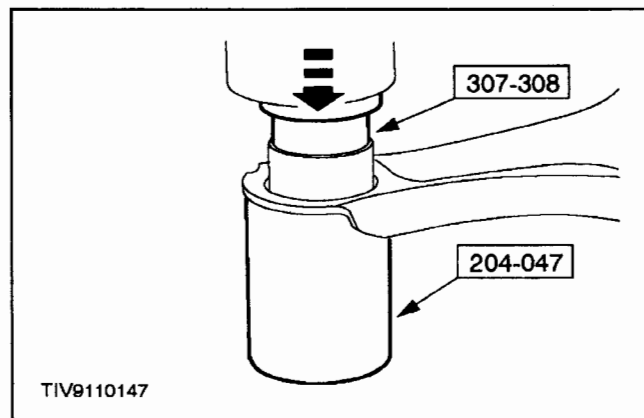
3. Using the special tools, remove the rear voided bush.

Installation

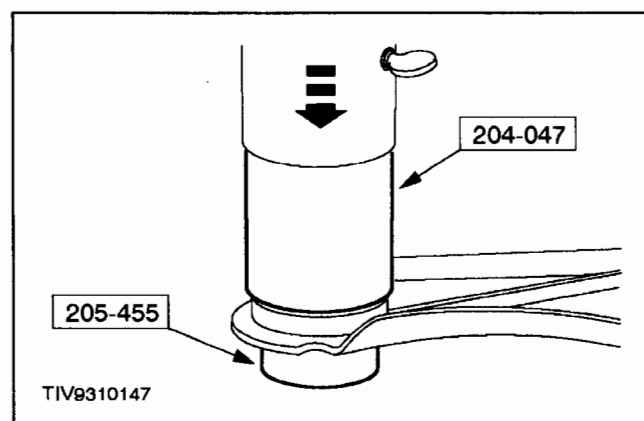
1. **CAUTION:** Make sure that the nipples on the rear voided bush are in line with the triangular alignment marks on the arm.

Position the bushes.

- 1 Locate the front solid bush.
- 2 Locate the rear voided bush.



2. Using the special tools, install the front solid bush.

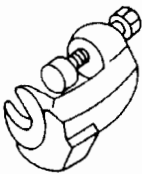
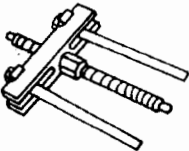
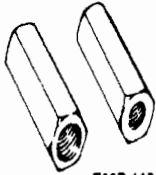


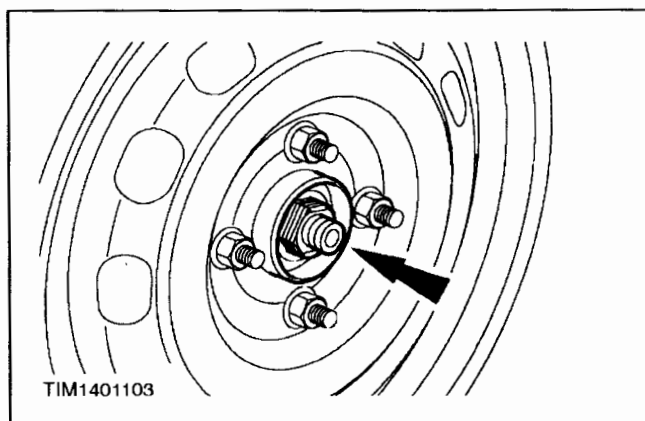
3. Using the special tools, install the rear voided bush.

REMOVAL AND INSTALLATION (Continued)

4. Install the arm. For additional information, refer to Lower Arm—LH or Lower Arm—RH in this section.

Wheel Knuckle**Special Tool(s)**

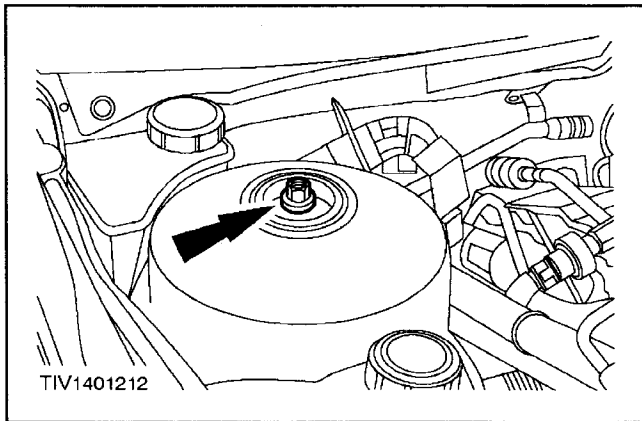
 ST1408-A	Separator, Ball Joint 211-001 (TOOL-3290-D)
 ST1516-A	Remover/Installer, Front Hub 204-069 (T81P-1104-C)
 T83P-1104-BH	Remover, Hub (Metric Stud) 204-085 (T83P-1104-BH)

Removal

1.  **CAUTION:** Use a socket to remove the nut to prevent damage.

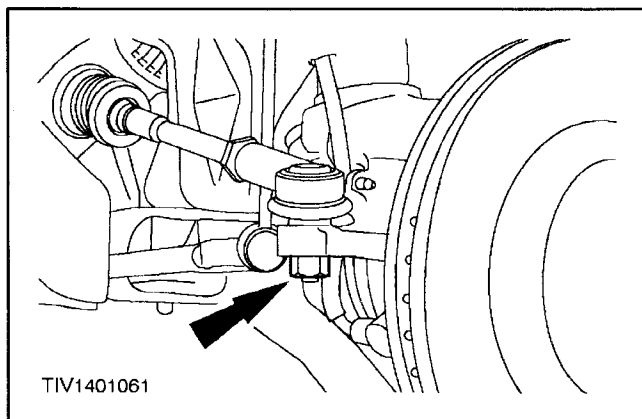
Loosen the wheel hub nut.

2. Loosen the wheel nuts.

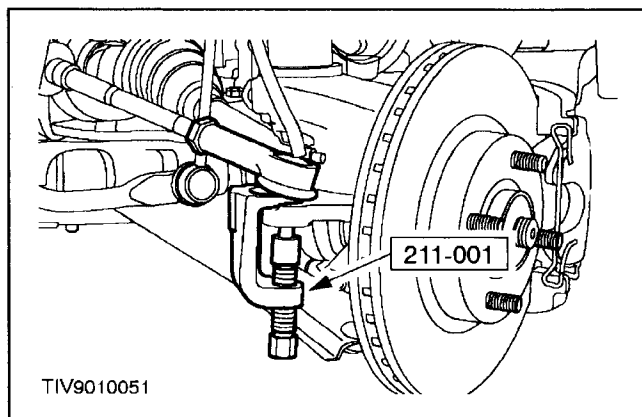
REMOVAL AND INSTALLATION (Continued)

3.  **CAUTION:** Use an Allen key to prevent the piston rod from rotating and causing damage.

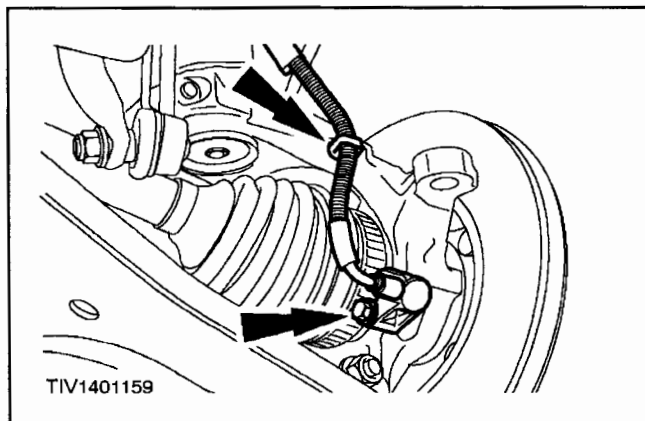
Loosen the strut tower nut by five turns.



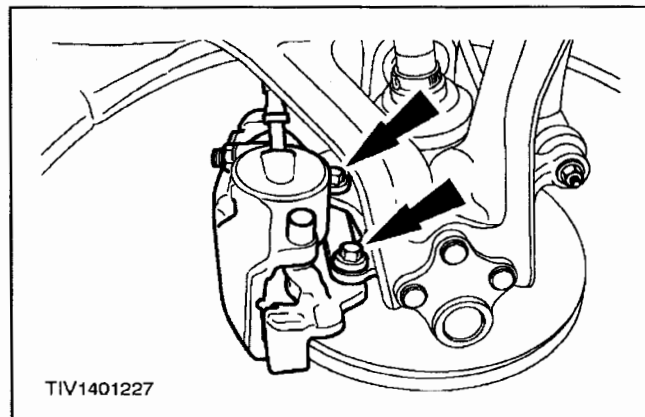
4. Raise and support the vehicle. For additional information, refer to Section 100-02.
5. Remove the wheel.
6. Remove the tie-rod end nut.



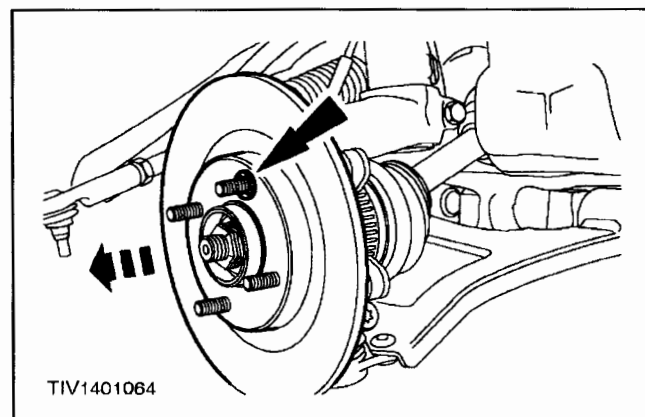
7.  **CAUTION:** Protect the ball joint seal to prevent damage.
- Using the special tool, detach the tie-rod end from the wheel knuckle.

REMOVAL AND INSTALLATION (Continued)

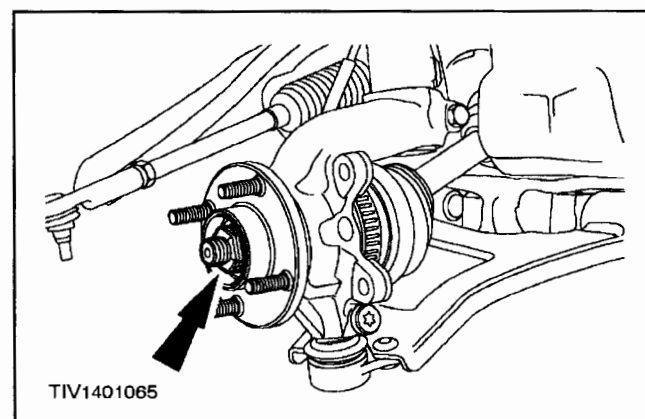
8. Remove the anti-lock brake system (ABS) sensor and cable.



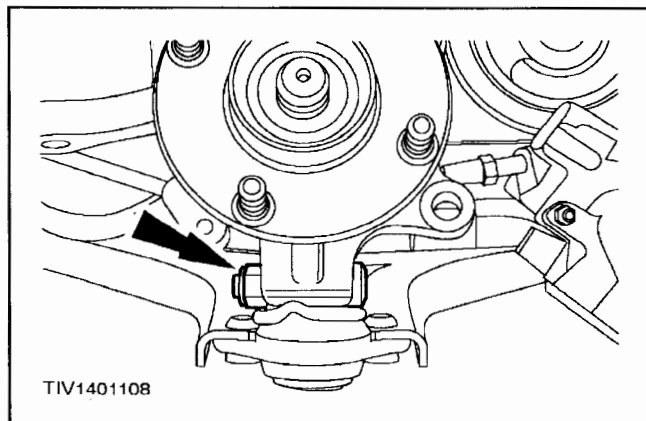
9. Detach the caliper and anchor plate assembly.
- Secure the caliper and anchor plate assembly out of the way to prevent damage to the flexible brake hose.



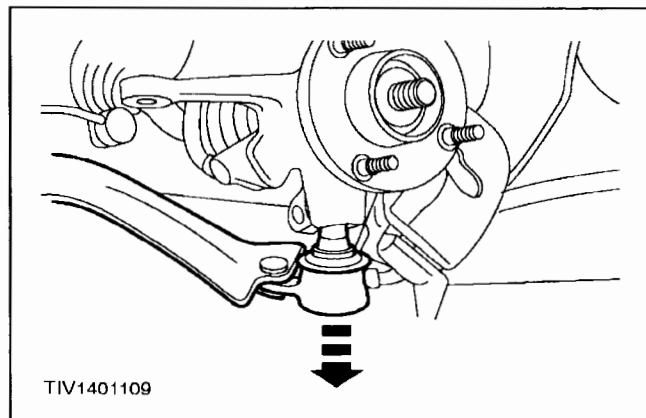
10. Remove the brake disc.
- Remove the retainers (if equipped).



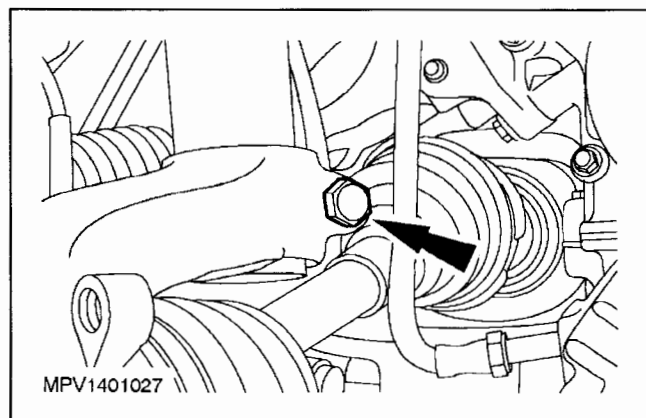
11.  **CAUTION:** Use a socket to remove the nut to prevent damage.
Remove the wheel hub nut.

REMOVAL AND INSTALLATION (Continued)

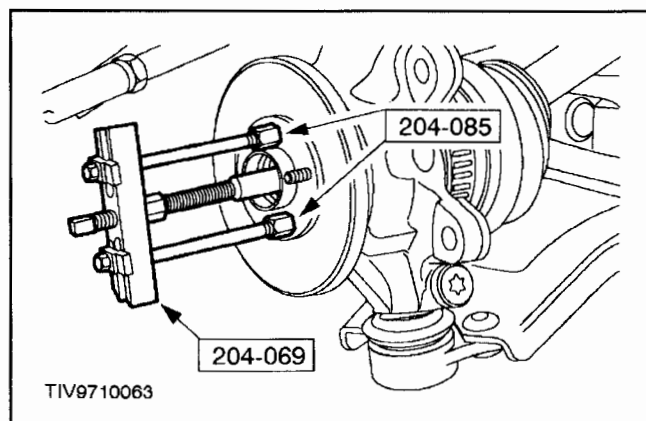
12. Remove the lower arm to wheel knuckle pinch nut and bolt.



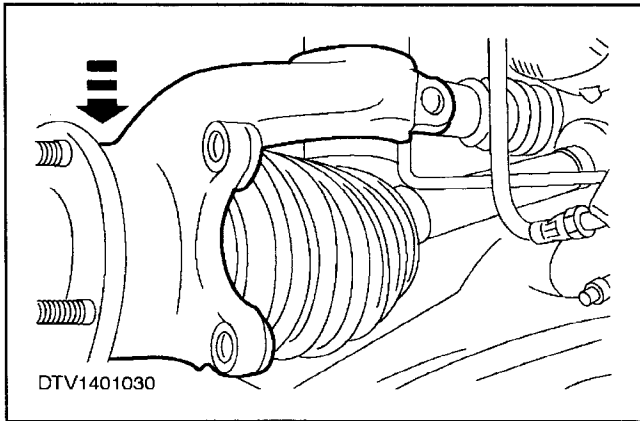
13.  **CAUTION: Protect the ball joint seal to prevent damage.**
Detach the lower arm from the wheel knuckle.



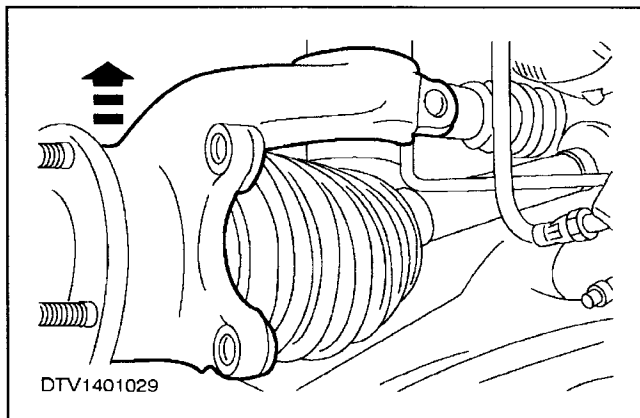
14. Remove the wheel knuckle strut and spring assembly pinch bolt.



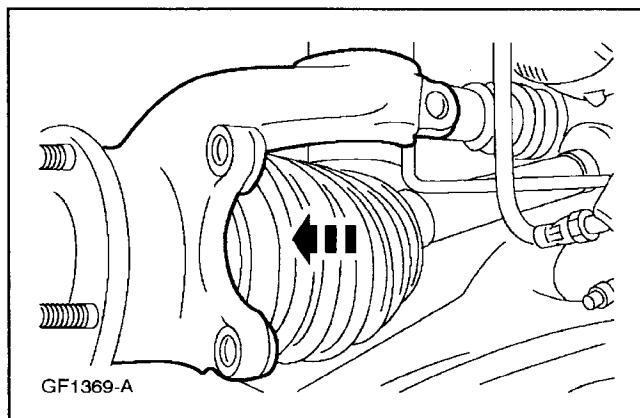
15. Using the special tools, detach the halfshaft from the wheel hub using the special tools.

REMOVAL AND INSTALLATION (Continued)

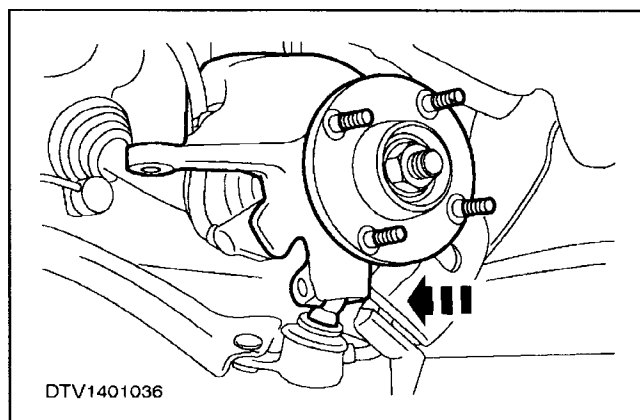
16. Remove the wheel knuckle.
 - Secure the halfshaft out of the way.

Installation

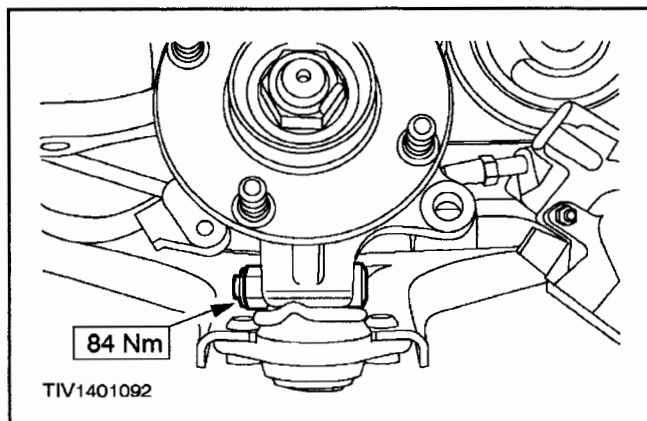
1. Position the wheel knuckle on the strut and spring assembly.



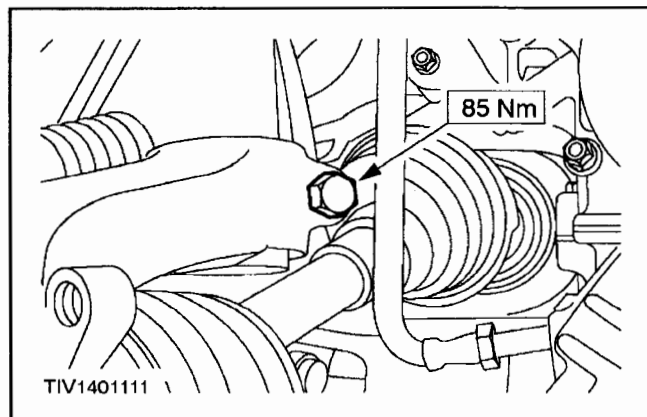
2. Position the halfshaft to the wheel hub.
 - Install the wheel hub retaining nut finger-tight.



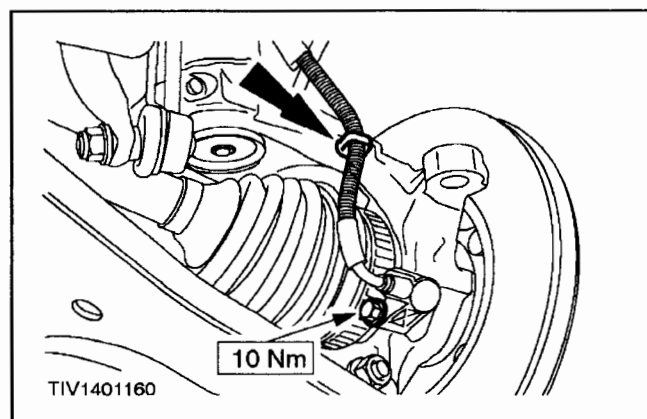
3. Install the lower arm to the wheel knuckle.

REMOVAL AND INSTALLATION (Continued)

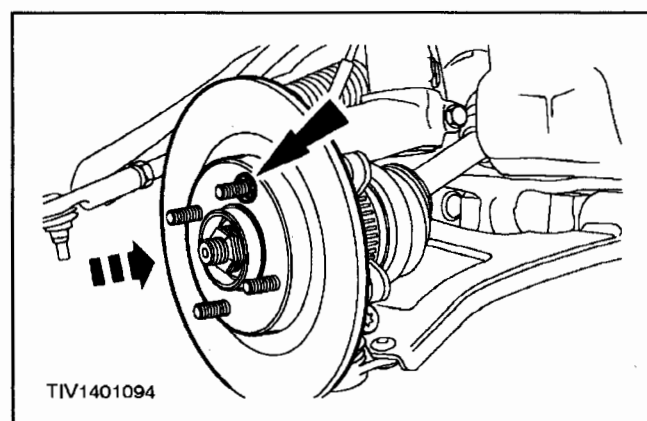
4. Install the pinch bolt and nut.



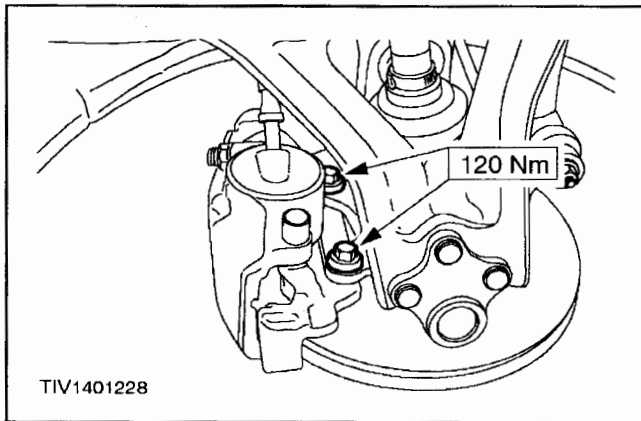
5. Install the pinch bolt.



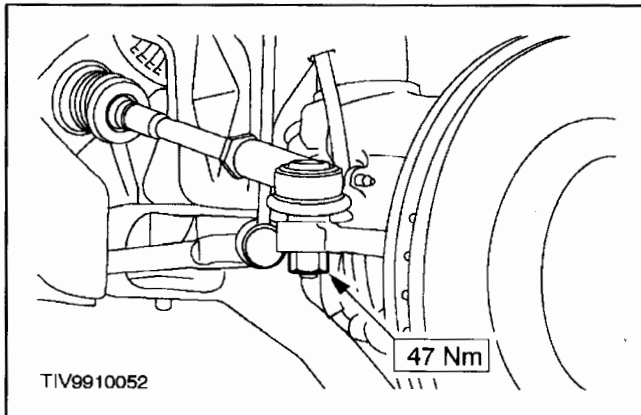
6. Install the ABS sensor.



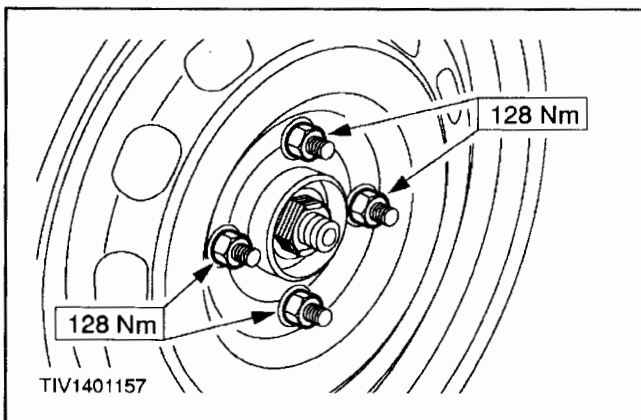
7. Install the brake disc.
- Install the retainers (if equipped).

REMOVAL AND INSTALLATION (Continued)

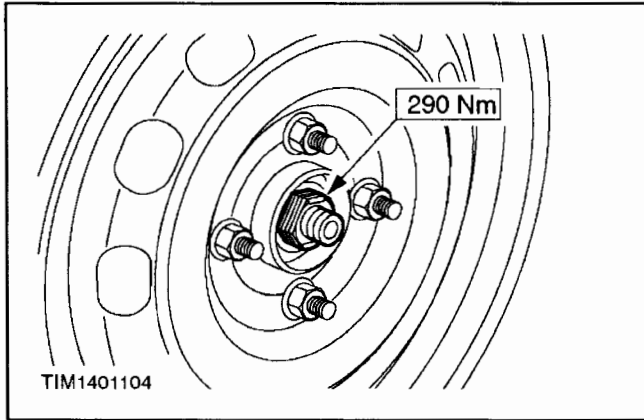
8. Install the caliper and anchor plate assembly.



9. Install the tie-rod end.

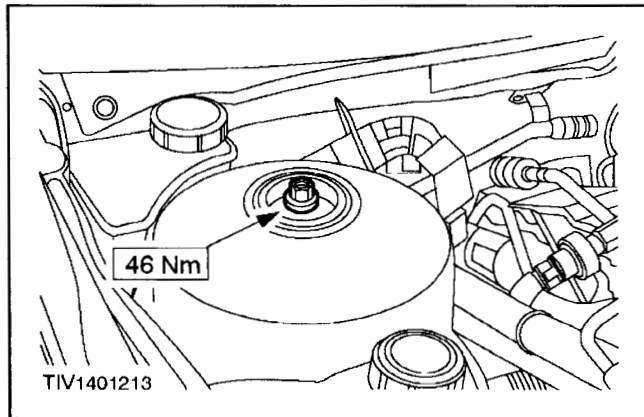


10. Install the wheel.
11. Lower the vehicle.
12. Tighten the wheel nuts.

REMOVAL AND INSTALLATION (Continued)

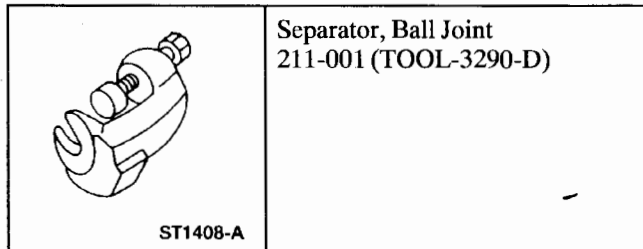
13.  **CAUTION:** Use a socket to install the nut to prevent damage.

Tighten the wheel hub retaining nut.



14.  **CAUTION:** Use an Allen key to prevent the piston rod from rotating and causing damage.

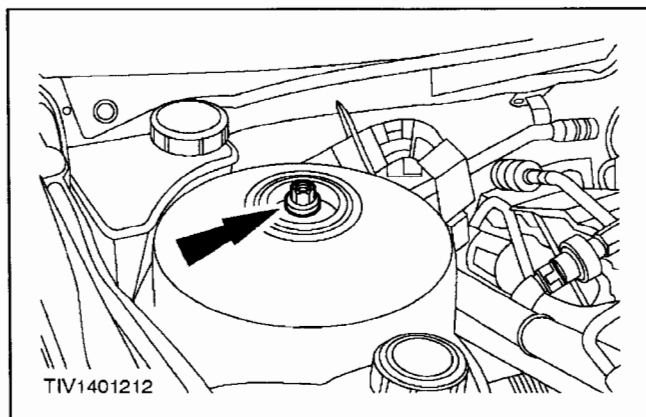
Install the strut tower nut.

Strut And Spring Assembly**Special Tool(s)**

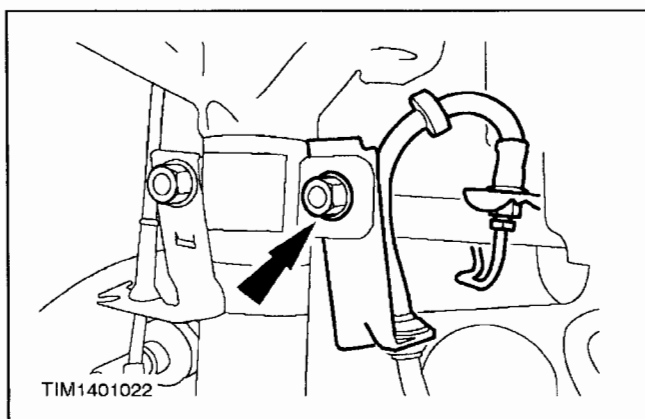
REMOVAL AND INSTALLATION (Continued)**Removal****All vehicles**

1.  **CAUTION:** Use an Allen key to prevent the piston rod from rotating and causing damage.

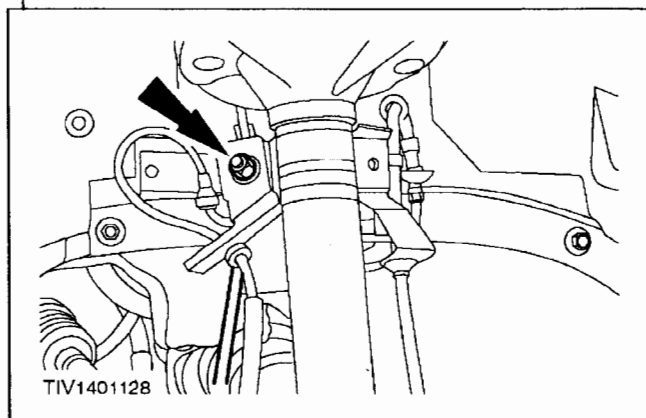
Loosen the strut tower nut by five turns.

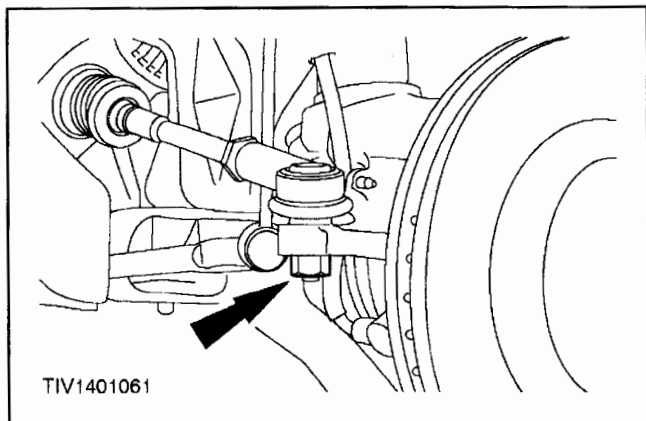


2. Loosen the wheel nuts.
3. Raise and support the vehicle. For additional information, refer to Section 100-02.
4. Remove the wheel.
5. Detach the brake hose support bracket.

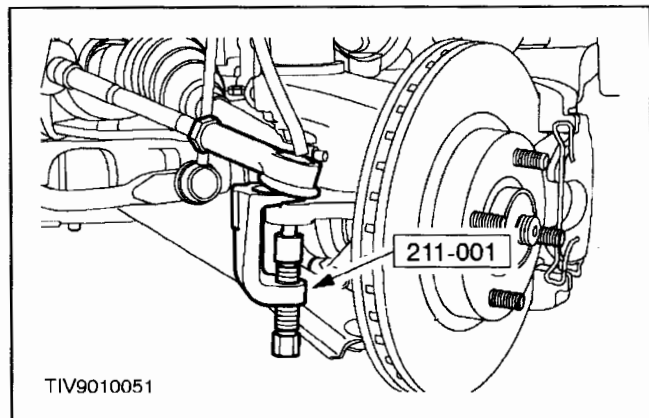


6. Detach the stabilizer bar connecting link.



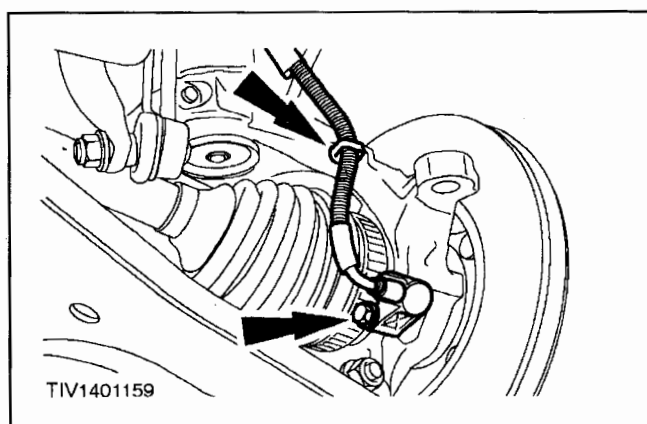
REMOVAL AND INSTALLATION (Continued)

7. Remove the tie-rod end nut.



8.  **CAUTION: Protect the ball joint seal to prevent damage.**

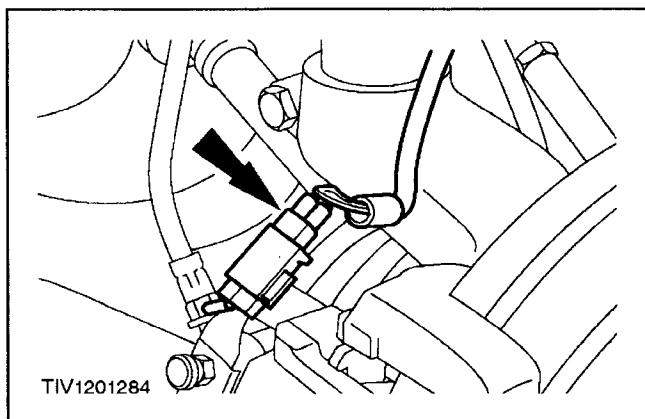
Using the special tool, detach the tie-rod end from the wheel knuckle.

**Vehicles with anti-lock brakes**

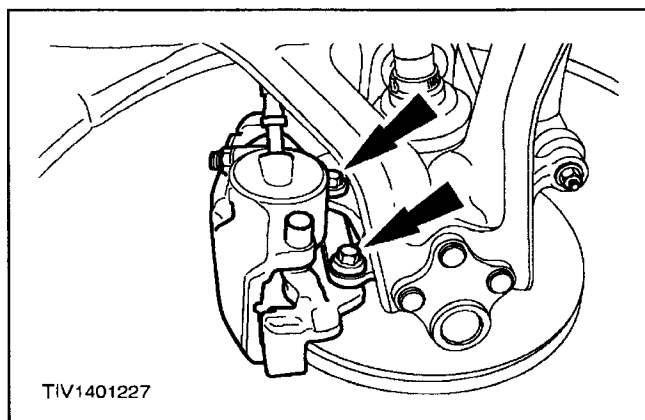
9. Disconnect the anti-lock brake system (ABS) sensor and cable.

REMOVAL AND INSTALLATION (Continued)**All vehicles**

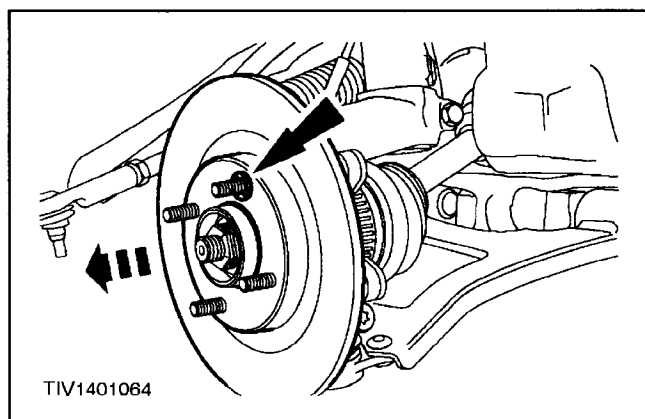
10. Disconnect the brake pad wear sensor electrical connector (if equipped).



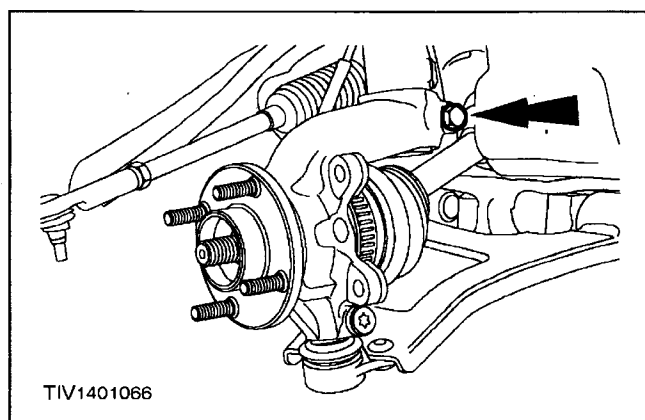
11.  **CAUTION:** Secure the caliper and anchor plate assembly out of the way to prevent damage to the flexible brake hose.
Detach the caliper and anchor plate assembly.

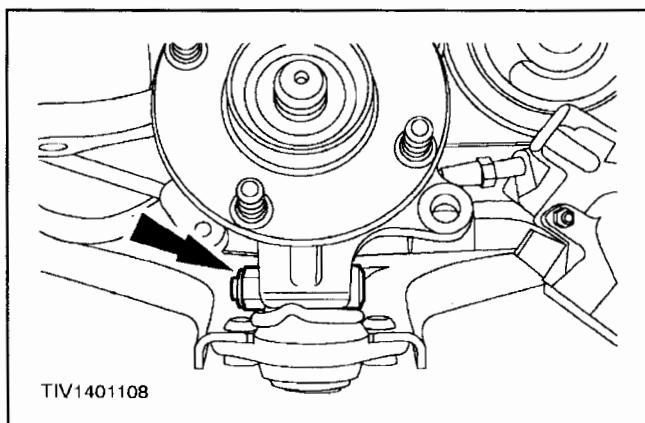


12. Remove the brake disc.
- Remove the retainers (if equipped).

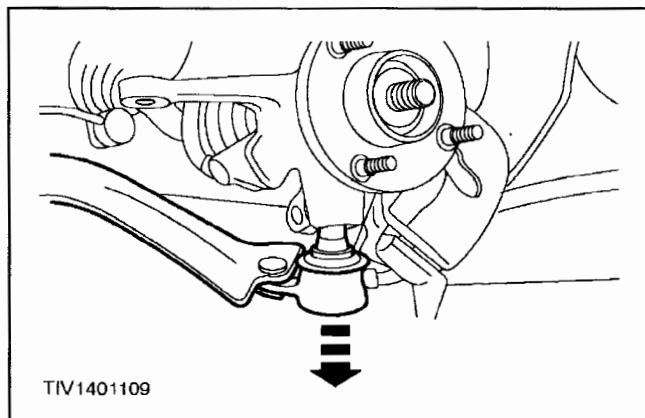


13. Remove the wheel knuckle to strut and spring assembly pinch bolt.

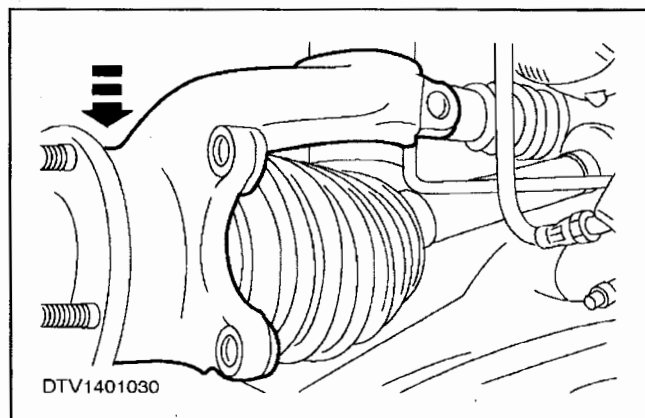


REMOVAL AND INSTALLATION (Continued)

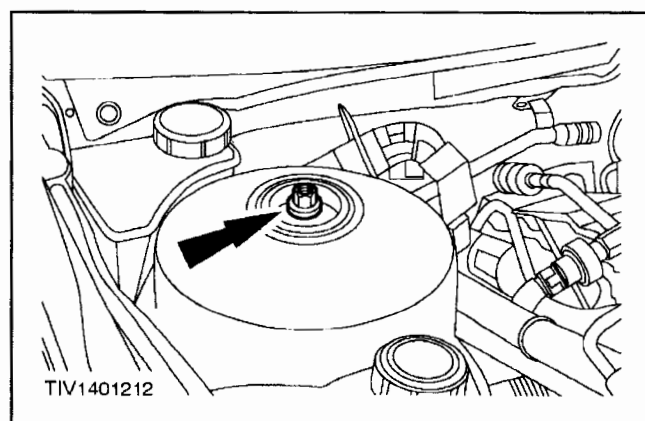
14. Remove the lower arm to wheel knuckle pinch bolt and nut.



15.  **CAUTION: Protect the ball joint seal to prevent damage.**
Detach the lower arm from the wheel knuckle.



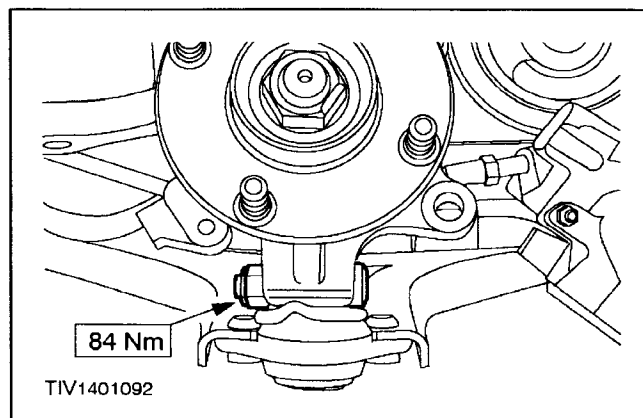
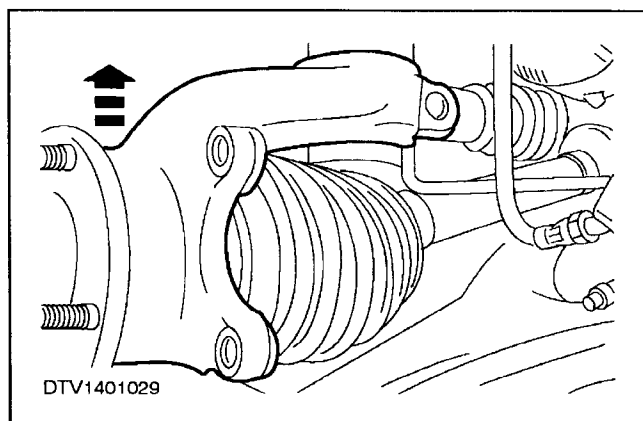
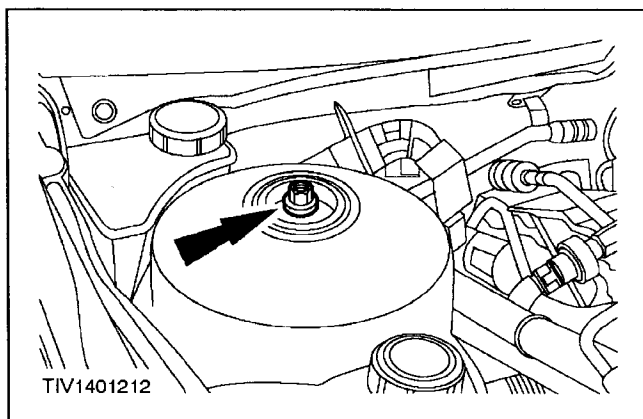
16.  **CAUTION: Secure the wheel knuckle to prevent damage to the halfshaft.**
Detach the wheel knuckle.

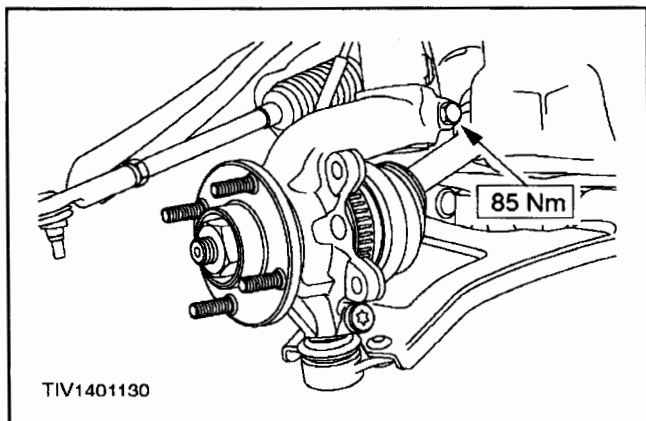


17.  **WARNING: Support the strut and spring assembly. Failure to follow these instructions may result in personal injury.**
 **CAUTION: Use an Allen key to prevent the piston rod from rotating and causing damage.**
Detach the strut and spring assembly.

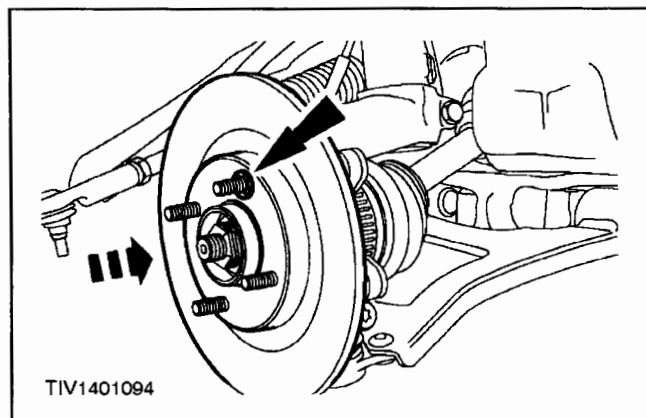
REMOVAL AND INSTALLATION (Continued)**Installation****All vehicles**

1. Position the strut and spring assembly.
 - Loosely fit the nut.
2. Position the wheel knuckle on the strut and spring assembly.
3. Install the pinch bolt and nut.

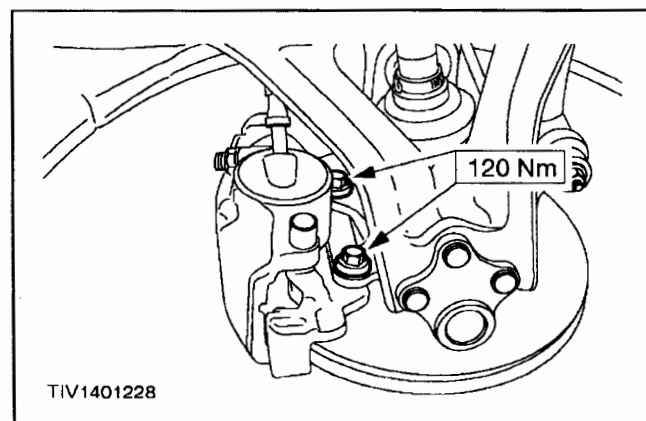


REMOVAL AND INSTALLATION (Continued)

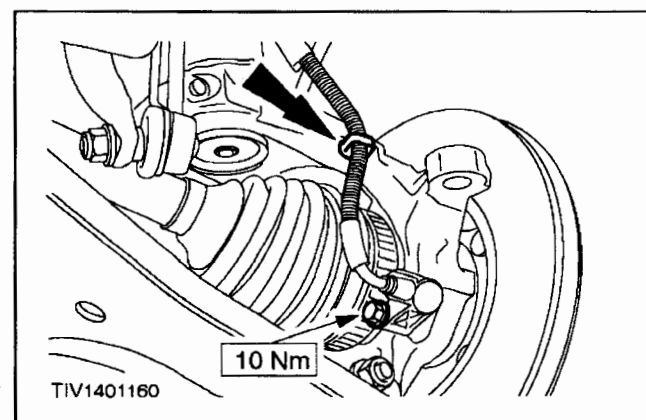
4. Install the pinch bolt.



5. Install the brake disc.
- Install the retainers (if equipped).



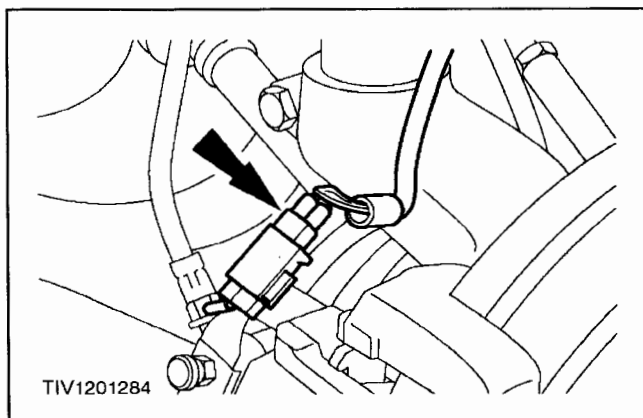
6. Install the caliper and anchor plate assembly.

**Vehicles with anti-lock brakes**

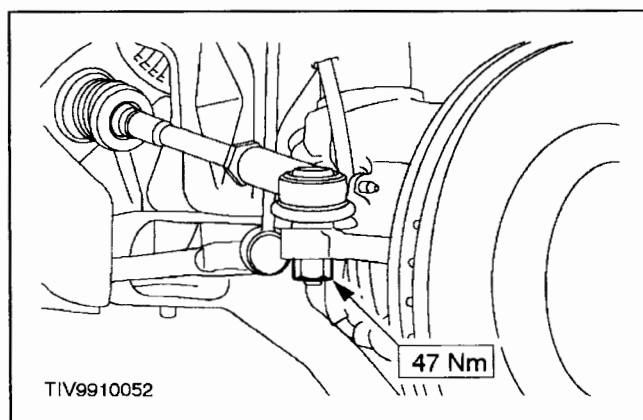
7. Install the ABS sensor and cable.

REMOVAL AND INSTALLATION (Continued)**All vehicles**

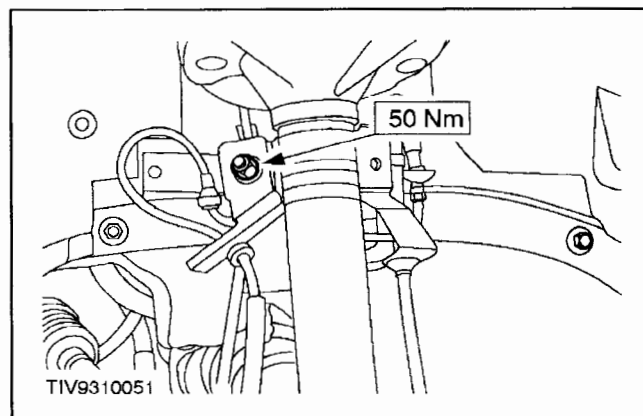
8. Connect the brake pad wear sensor electrical connector (if equipped).



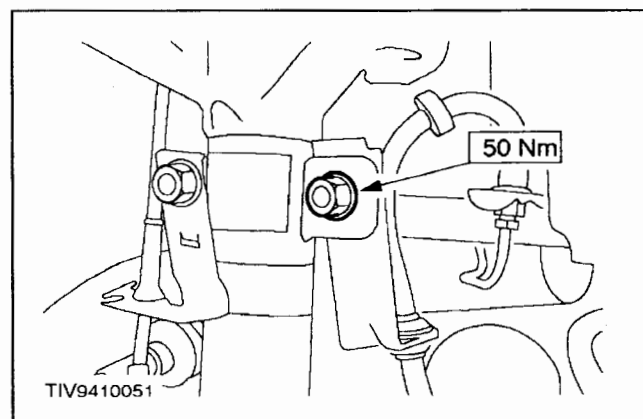
9. Install the tie-rod end.

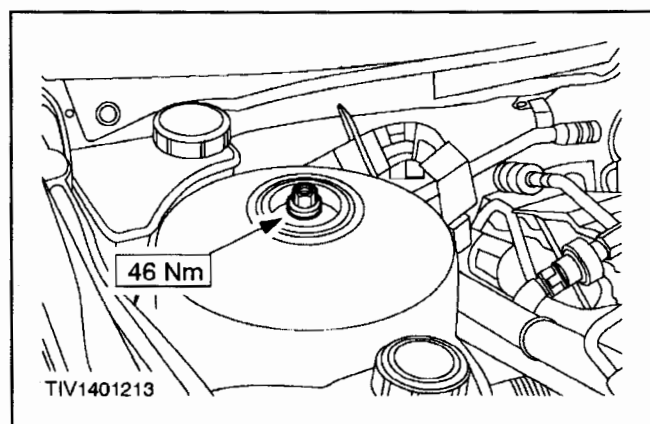
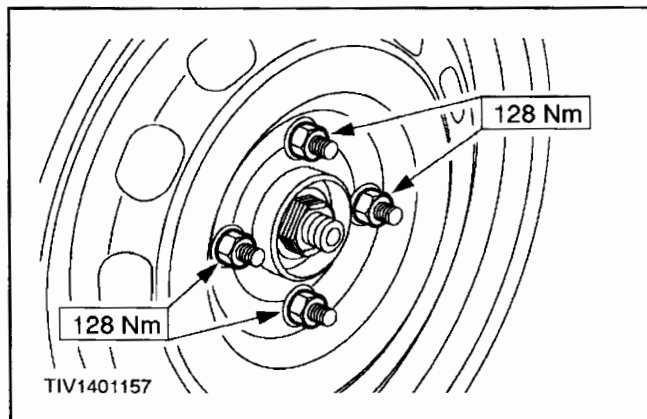


10. Install the stabilizer bar connecting link to the strut and spring assembly.



11. Install the brake hose support bracket.



REMOVAL AND INSTALLATION (Continued)

12. Install the wheel.
13. Lower the vehicle.
14. Tighten the wheel nuts

15.  **CAUTION:** Use an Allen key to prevent the piston rod from rotating and causing damage.

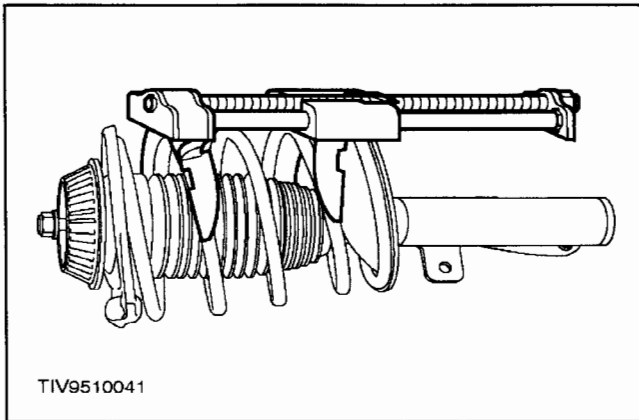
Tighten the strut tower nut.

DISASSEMBLY AND ASSEMBLY**Strut And Spring Assembly****General Equipment**

Coil spring compressor

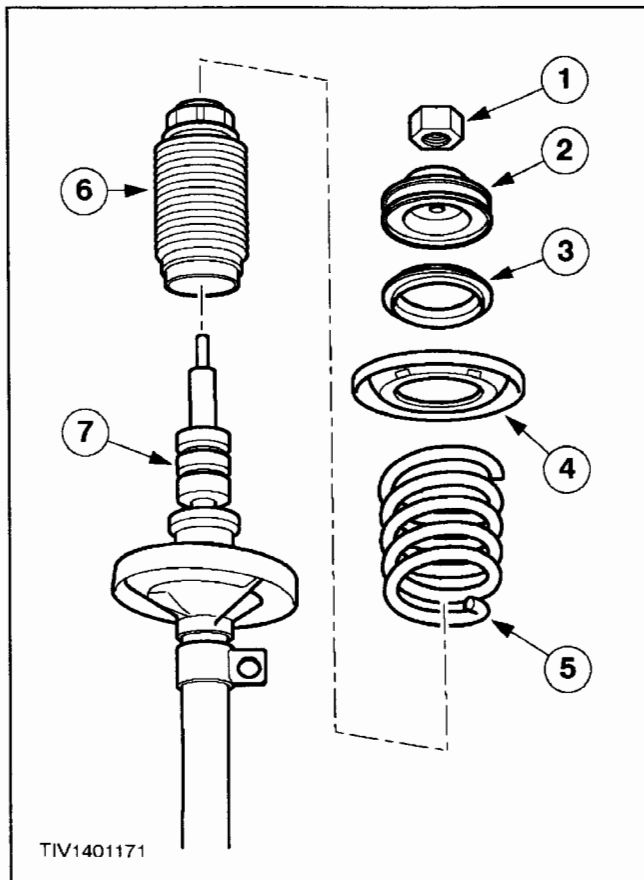
Disassembly and Assembly

1. Remove the strut and spring assembly. For additional information, refer to Strut And Spring Assembly in this section.

DISASSEMBLY AND ASSEMBLY (Continued)

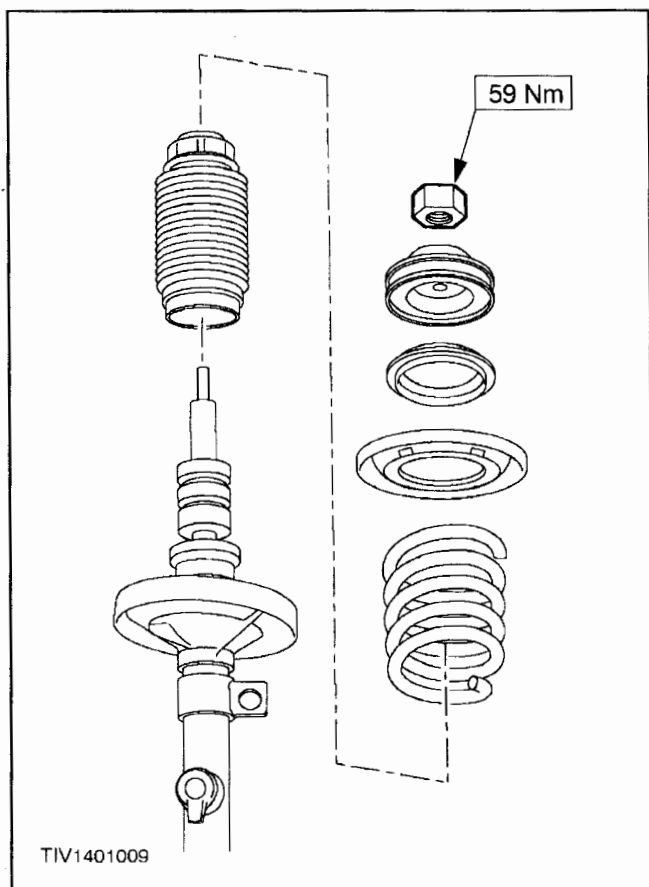
2.  **WARNING:** As the spring is under extreme tension care must be taken at all times. Failure to follow these instructions may result in personal injury.

Compress the spring using a suitable coil spring compressor.



3. Disassemble the strut and spring assembly.

- 1 Remove the thrust bearing nut.
- 2 Remove the top mount.
- 3 Remove the thrust bearing.
- 4 Remove the spring seat.
- 5 Remove the spring.
- 6 Remove the boot.
- 7 Remove the bump stop.

DISASSEMBLY AND ASSEMBLY (Continued)

4.  **CAUTION:** Make sure the spring ends butt correctly against the spring seats.
To assemble, reverse the disassembly procedure.

SECTION 204-02 Rear Suspension

CONTENTS	PAGE
SPECIFICATIONS	204-02-2
DESCRIPTION AND OPERATION	
Rear Suspension	204-02-3
DIAGNOSIS AND TESTING	
Rear Suspension	204-02-4
GENERAL PROCEDURES	
Wheel Bearing End Play	204-02-4
REMOVAL AND INSTALLATION	
Hub	204-02-5

SPECIFICATIONS

Torque Specifications

Description	Nm	Lb-Ft	Lb-In
Stabilizer bar to crossmember retaining bolts	23	17	—
Stabilizer bar link to front lateral arm retaining nut	36	27	—
Front lateral arm to wheel knuckle nut and bolt	84	62	—
Front lateral arm to crossmember bolt	84	62	—
Rear lateral arm to wheel knuckle bolt	120	89	—
Rear lateral arm to crossmember cam bolt nut	84	62	—
ABS sensor retaining bolt	10	—	89
Brake caliper assembly retaining bolts	58	43	—
Wheel knuckle to strut and spring assembly bolt	85	63	—
Hub retaining nut	290	214	—

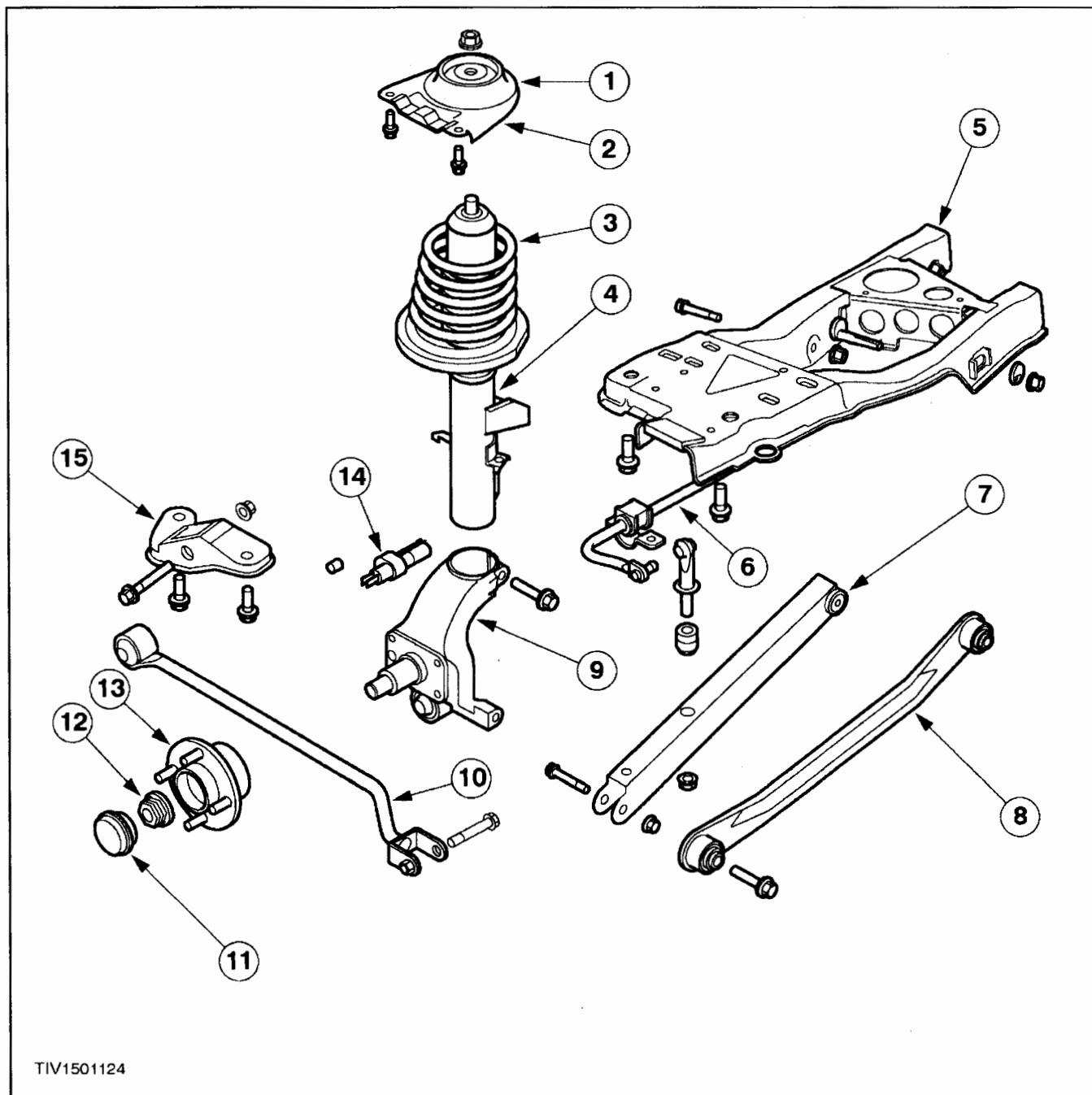
(Continued)

Torque Specifications

Description	Nm	Lb-Ft	Lb-In
Tie-bar mounting bracket nut and bolt	120	89	—
Tie-bar bracket to body retaining bolts	120	89	—
Tie bar to wheel knuckle retaining bolts	120	89	—
Strut and spring assembly retaining bolts	27	20	—
Strut tower nut	50	37	—
Wheel nuts — steel/alloy wheels	128	94	—
Crossmember retaining bolts	120	89	—
ABS cable retaining bracket bolt	7	—	62
Brake backing plate bolts	50	37	—
Brake tube union	13	10	—
Disc brake splash shield retaining bolts	23	17	—

DESCRIPTION AND OPERATION

Rear Suspension



TIV1501124

Item	Part Number	Description
1	—	Body mounting cup
2	—	Spring seat
3	—	Spring
4	—	Strut
5	—	Crossmember
6	—	Stabilizer bar

(Continued)

Item	Part Number	Description
7	—	Front arm
8	—	Rear arm
9	—	Wheel spindle
10	—	Tie-bar
11	—	Dust cap
12	—	Brake drum

(Continued)

DESCRIPTION AND OPERATION (Continued)

Item	Part Number	Description
13	—	Hub retaining nut
14	—	Hub and bearing assembly
15	—	Backing plate

(Continued)

Item	Part Number	Description
16	—	ABS sensor
17	—	Tie-bar mounting bracket

DIAGNOSIS AND TESTING**Rear Suspension**

Refer to Section 204-00.

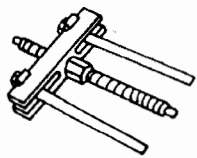
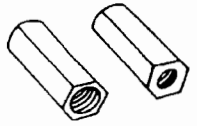
GENERAL PROCEDURES**Wheel Bearing End Play****Check**

1. Raise the rear of the vehicle and check for loose rear wheel bearings by rocking the wheels at the top and bottom.
2. Spin the wheel quickly by hand and make sure the wheel turns smoothly without abnormal noises from the rear wheel bearings.
3. The rear wheel bearings are built into the hub and are of a cartridge design, are pregreased, sealed and require no scheduled maintenance. The wheel bearings are preset and cannot be adjusted. No individual parts are available. The hub nut torque of 290 Nm restricts bearing/hub relative movement and maintains axial position of the wheel hub. Due to the importance of the hub nut torque/tension relationship, take the following precautions during repair.
4. Since the wheel bearing cannot be adjusted, the hub nut must not be backed off after reaching the required torque of 290 Nm during installation.
5. If the rear axle wheel hub nut is loosened or removed a new nut must be installed.

GENERAL PROCEDURES (Continued)

6. Power tools must not be used to tighten or loosen the rear wheel hub nut or bearing or rear wheel spindle damage may result.
7. To remove the rear wheel hub nut, apply sufficient torque to the rear wheel hub nut to overcome the prevailing torque feature.

REMOVAL AND INSTALLATION**Hub****Special Tool(s)**

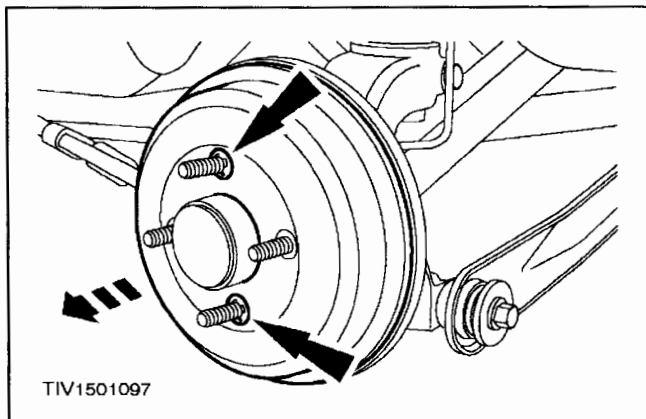
 ST1516-A	Remover/Installer, Front Hub 204-069 (T81P-1104-C)
 ST1518-A	Remover, Hub (Metric Stud) 204-085 (T83P-1104-BH)

Removal**All vehicles**

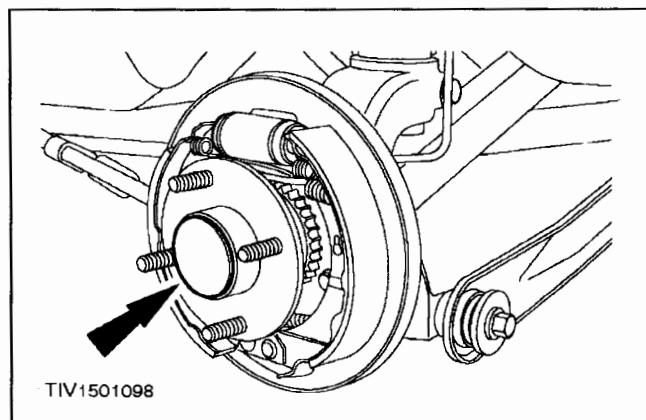
1. Loosen the wheel nuts.
2. Raise and support the vehicle. For additional information, refer to Section 100-02.
3. Remove the wheel.

REMOVAL AND INSTALLATION (Continued)**Vehicles with rear drum brakes**

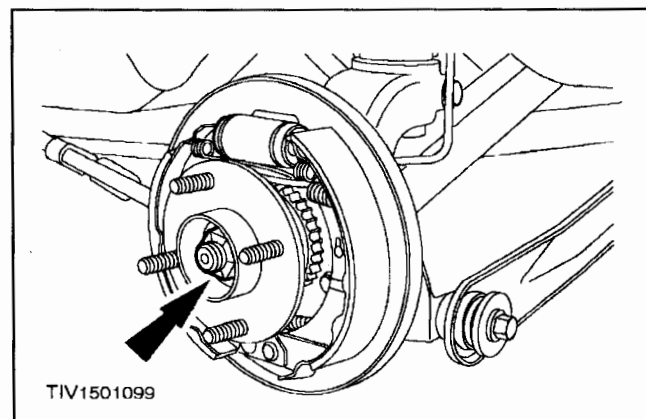
4. Remove the brake drum.
 - Remove the retainers (if equipped).



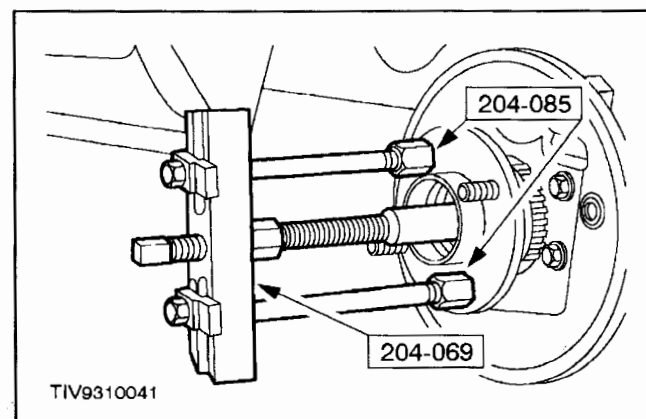
5. Remove the hub dust cap.

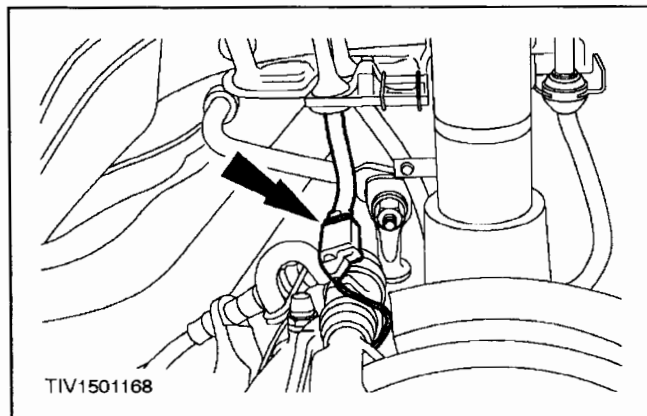


6.  **CAUTION:** Use a socket to remove the hub nut to prevent damage.
Remove the hub nut.

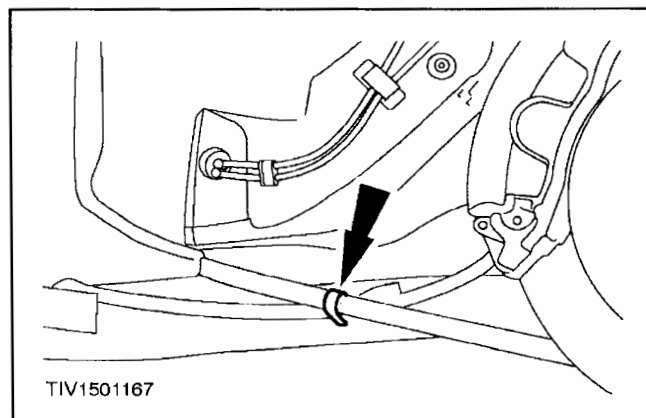


7.  **CAUTION:** If the wheel bearing inner ring bore clip is displaced a complete new bearing must be installed.
Using the special tools, remove the hub.

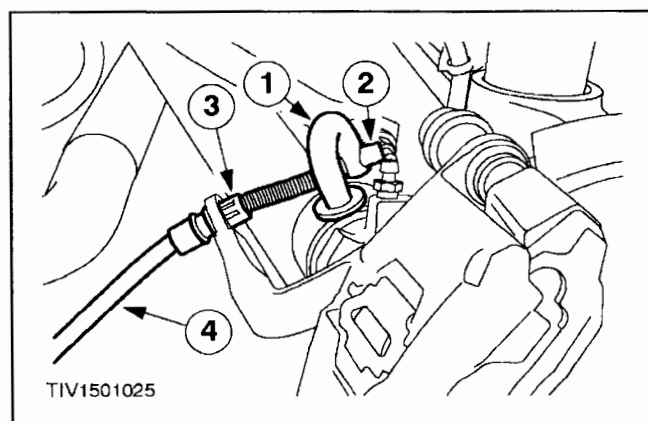


REMOVAL AND INSTALLATION (Continued)**Vehicles with rear disc brakes**

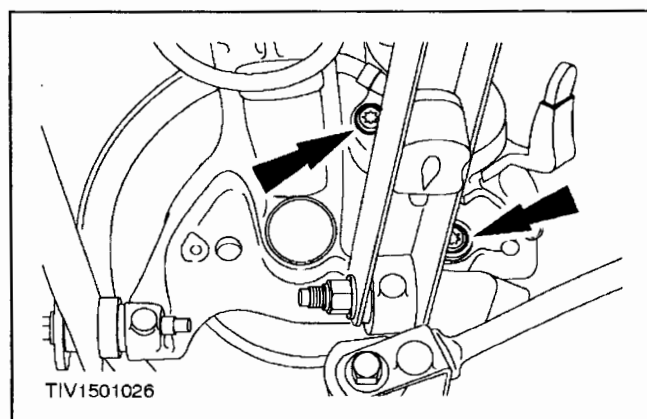
8. Disconnect the disc brake pad wear indicator electrical connector (if equipped).



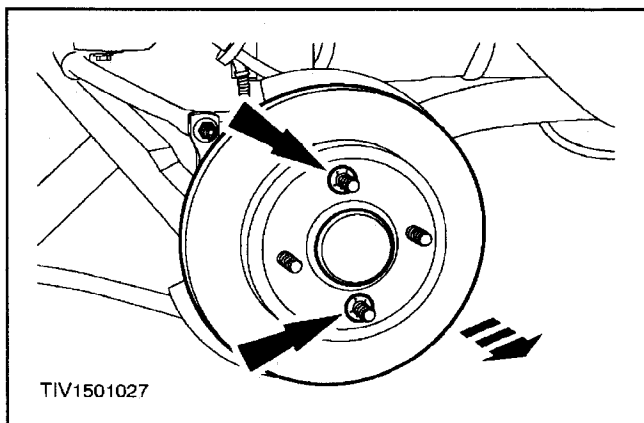
9. Remove the parking brake cable retaining clip.



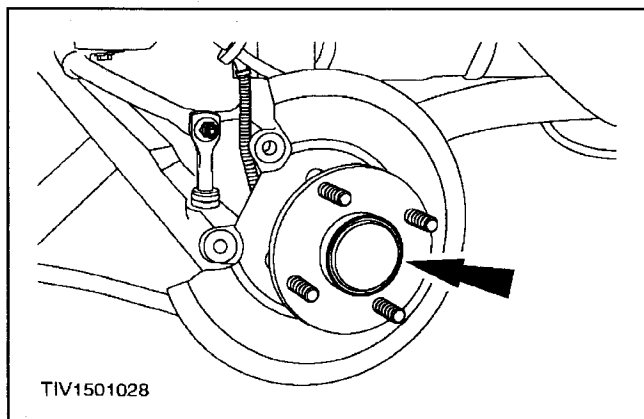
10. Detach the parking brake cable.
 - 1 Pull back the parking brake lever.
 - 2 Detach the cable from the parking brake lever.
 - 3 Detach the conduit retaining clip.
 - 4 Detach the cable and conduit.



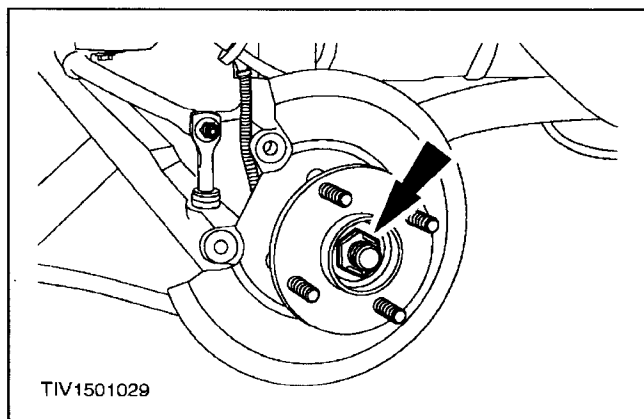
11. Detach the caliper and anchor plate assembly.
 - Secure the caliper and anchor plate assembly to prevent damage to the flexible brake hose.

REMOVAL AND INSTALLATION (Continued)

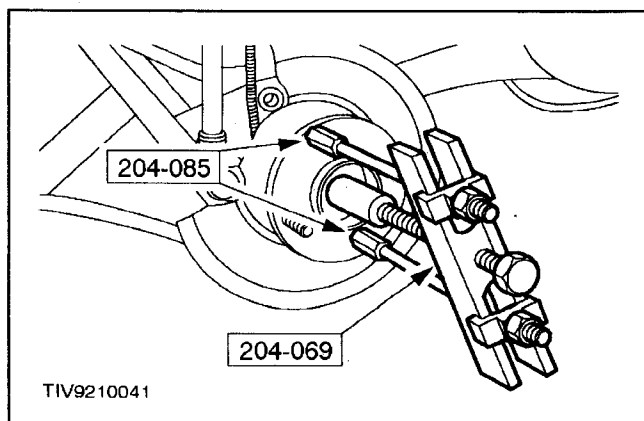
12. Remove the brake disc.
- Remove the retainers (if equipped).



13. Remove the hub dust cap.



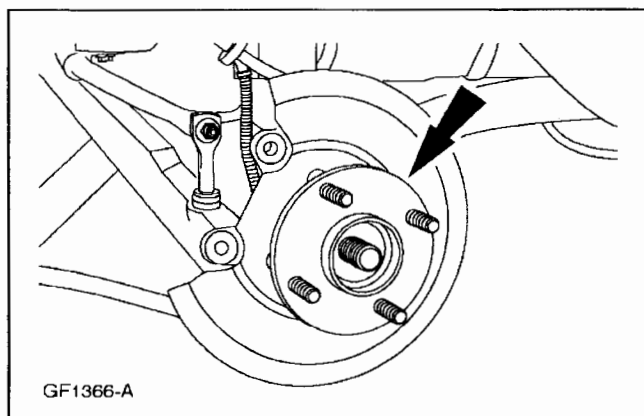
14.  **CAUTION: Use a socket to remove the hub nut to prevent damage.**
Remove the hub nut.



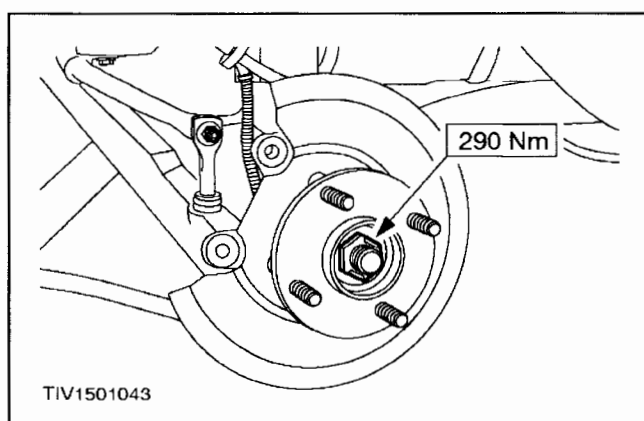
15.  **CAUTION: If the wheel bearing inner ring bore clip is displaced a complete new bearing must be installed.**
Using the special tools, remove the hub.

REMOVAL AND INSTALLATION (Continued)**Installation****Vehicles with rear disc brakes**

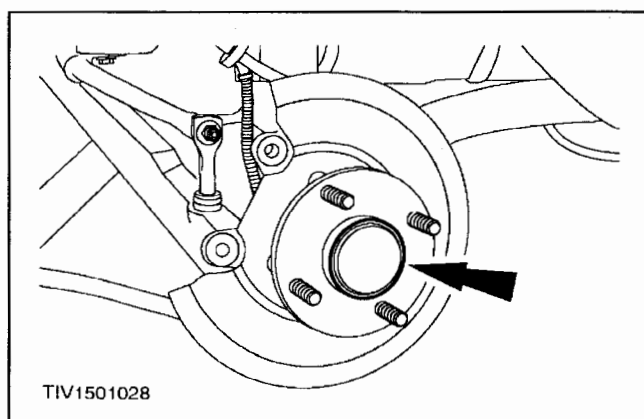
1. Install the hub.

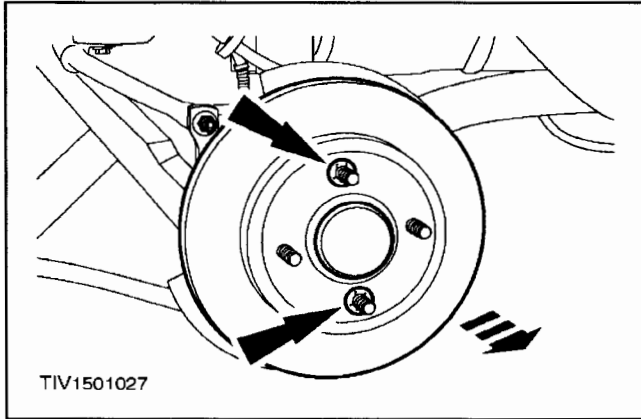


2.  **CAUTION:** Use a socket to install the hub nut to prevent damage.
Install the hub nut.

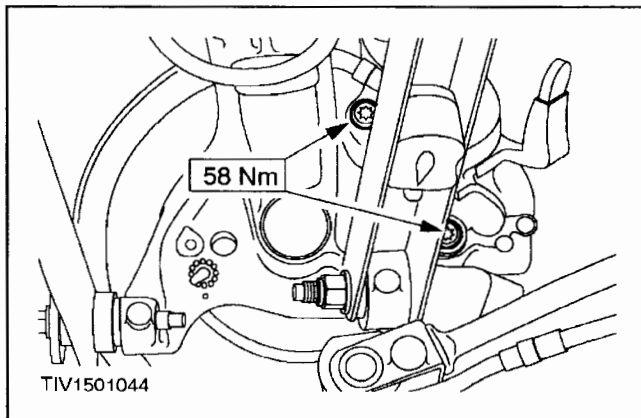


3. Install the hub dust cap.

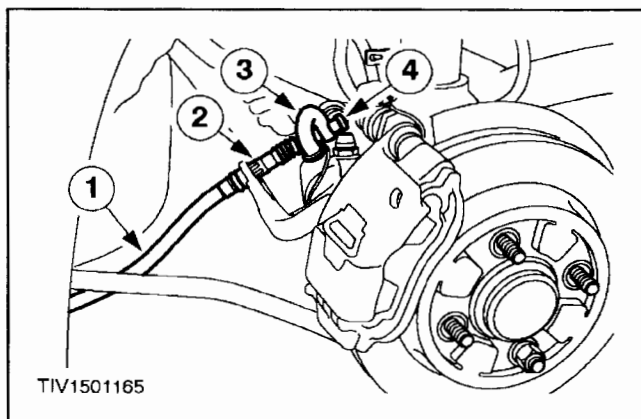


REMOVAL AND INSTALLATION (Continued)

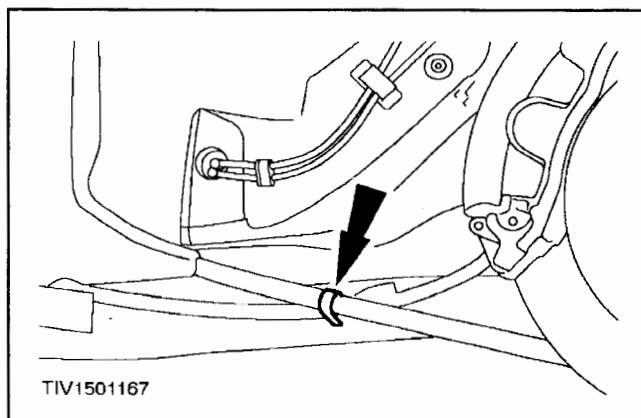
4. Install the brake disc.
 - Install the retainers (if equipped).



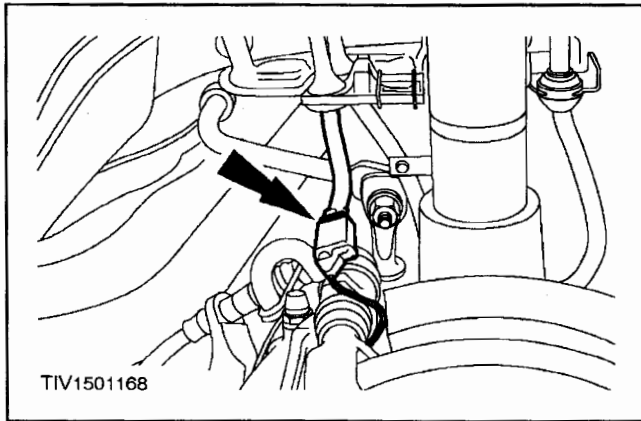
5. Install the disc brake caliper and anchor plate assembly.



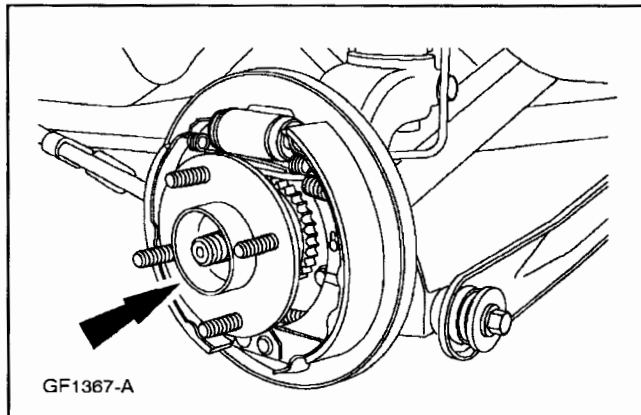
6. Install the parking brake cable.
 - 1 Install the cable and conduit.
 - 2 Install the conduit retaining clip.
 - 3 Pull back the parking brake lever.
 - 4 Install the cable to the parking brake lever.



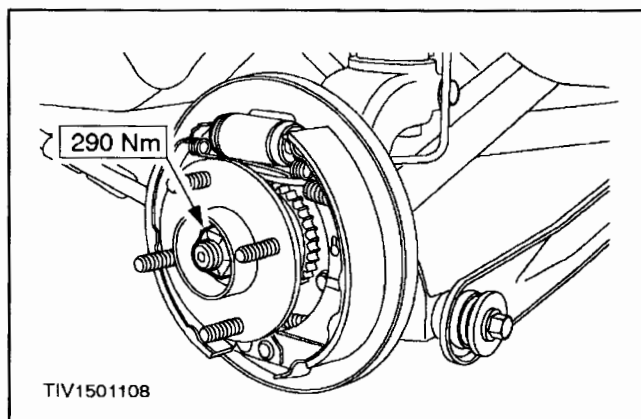
7. Install the parking brake cable retaining clip.

REMOVAL AND INSTALLATION (Continued)

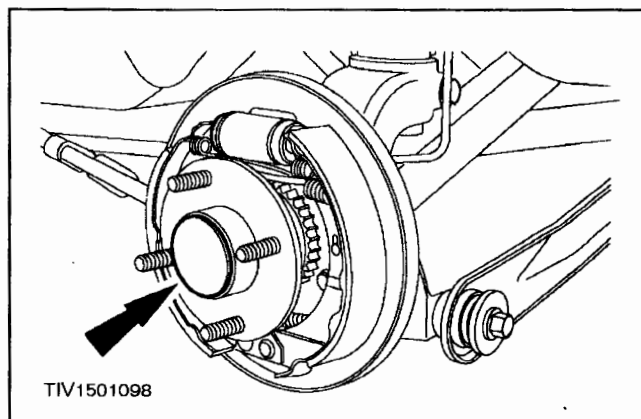
8. Connect the disc brake pad wear indicator electrical connector (if equipped).

Vehicles with rear drum brakes

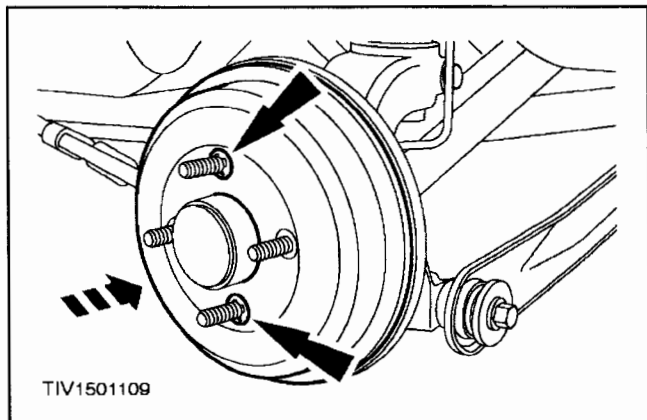
9. Install the hub.



10.  **CAUTION:** Use a socket to install the hub nut to prevent damage.
Install the hub nut.



11. Install the hub dust cap.

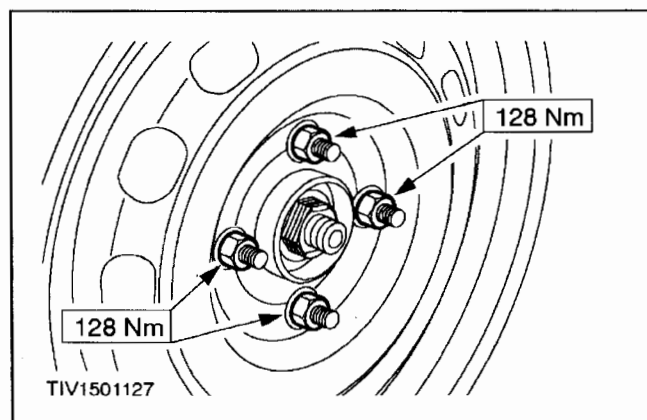
REMOVAL AND INSTALLATION (Continued)

12. Install the brake drum.

- Install the retainers (if equipped).

All vehicles

13. Install the wheel.



SECTION 204-04 Wheels and Tires

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Symptom Chart	204-04-4
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SPECIFICATIONS

General Specifications

Wheel Type	Rim Size	Tire Size
Steel	15 x 6 inch	P205/60 R15 T
Alloy	15 x 6 inch	P205/60 R15 T
Alloy	15 x 6.5 inch	P215/50 R16 V
Temporary spare	15 x 4 inch	T125/90 R15

Tire Pressures

Tire Type	Normal loading with up to 3 per- sons	Normal loading with up to 3 per- sons	Fully loaded with more than 3 per- sons	Fully loaded with more than 3 per- sons
	Front bar (psi)	Rear bar (psi)	Front bar (psi)	Rear bar (psi)
P205/60 R15T	2.0 (30)	2.0 (30)	2.0 (30)	2.0 (30)
P215/50 R16 V	2.2 (32)	2.2 (32)	2.2 (32)	2.2 (32)
T125/90 R15 Temporary Spare ^a	4.1 (60)	4.1 (60)	4.1 (60)	4.1 (60)

a Do not exceed the maximum speed limit of 80 km/h (50 mph).

The above tire pressures should be used when the tire is cold (when approximately at ambient temperature, not warm to the touch as is usual after operation).

The above tire pressures should be used for all conditions and speeds.

Torque Specifications

Description	Nm	Lb-Ft
Wheel nuts — steel/alloy wheels	128	94

DESCRIPTION AND OPERATION

Safety Precautions

Temporary Spare Wheel

All vehicles are equipped with a temporary spare wheel with a T125/90 R15 tire. When the temporary spare wheel is in use the following points must be adhered to:

- drive with caution.
- do not exceed maximum speed limit of 80 km/h (50 mph).
- only use the spare on a temporary basis.
- install a normal wheel and tire as soon as possible.
- do not drive the vehicle with more than one temporary spare wheel at a time.

Wheels And Tires

Winter Tires

The vehicle is equipped with all weather treads to provide traction in rain and snow. However, in some climates using snow tires may be necessary.

Always install winter tires to all four wheels. Do not exceed the maximum speed specified by the tire manufacturer. When using winter tires, the tire pressures supplied by the tire manufacturer must be adhered to.

Snow Chains

Snow chains cannot be used on the tire sizes supplied with the vehicle.

DIAGNOSIS AND TESTING

Wheels And Tires

Inspection and Verification

To maximize tire performance, inspect the tires for signs of incorrect inflation and uneven wear which may indicate a need for balancing, rotation or front suspension alignment. Tires should also be checked frequently for cuts, stone bruises, abrasions, blisters, and for objects that may have become embedded in the tread. More frequent inspections are recommended when rapid or extreme temperature changes occur or when road surfaces are rough or occasionally littered with foreign material.

As a further visible check of tire condition, tread wear indicators are molded into the bottom of the tread grooves. When these indicator bands become visible, new tires should be installed.

Tire Wear Diagnosis

New tires should be installed if the wear indicators are exposed or if there is severe shoulder wear. Shoulder wear is usually caused by either excessive camber or excessive toe on tires.

Sometimes incorrect rear toe settings or worn struts will cause severe "cupped" or "scalloped" tire wear on non-driven wheels.

Severely misadjusted rear toe will also cause other unusual wear patterns.

Tire Vibration Diagnosis

A tire vibration diagnostic procedure always begins with a road test. Refer to Section 100-04. The road test and customer interview (if available) will provide much of the information needed to find the source of a vibration.

During the road test, drive the vehicle on a road that is smooth and free of undulations. If vibration is apparent, note and record the following:

- the speed at which the vibration occurs.
- what type of vibration occurs in each speed range.
 - mechanical or audible

- How the vibration is affected by changes in the following:

- engine torque
- vehicle speed
- engine speed

- type of vibration — sensitivity: torque sensitive, vehicle speed sensitive or engine speed sensitive.

The following explanations help isolate the source of the vibration.

Torque Sensitive

This means that the condition can be improved or made worse by accelerating, decelerating, coasting, maintaining a steady vehicle speed or applying engine torque.

Vehicle Speed Sensitive

This means that the vibration always occurs at the same vehicle speed and is not affected by engine torque, engine speed or the transaxle gear selected.

Engine Speed Sensitive

This means that the vibration occurs at varying vehicle speeds when a different transaxle gear is selected. It can sometimes be isolated by increasing or decreasing engine speed with the transaxle in NEUTRAL or by stall testing with the transaxle in gear. If the condition is engine speed sensitive, the cause is probably not related to the tires.

If the road test indicates that there is tire whine, but no shake or vibration, the noise originates with the contact between the tire and the road surface.

A thumping noise usually means that the tire is flat or has soft spots making a noise as they slap the roadway. Tire whine can be distinguished from axle noise. Tire whine remains the same over a range of speeds.

DIAGNOSIS AND TESTING (Continued)**Symptom Chart****Symptom Chart**

Condition	Possible Sources	Action
Tires show excessive wear on edge of tread	- Under-inflated tires. - Vehicle overloaded. - High-speed cornering. - Incorrect toe setting. - Incorrect camber setting.	- ADJUST air pressure in tires. - CORRECT as necessary. - CORRECT as necessary. - SET toe to specification. REFER to Section 204-00.
Tires show excess wear in center of tread	- Tires over-inflated. - Excessive acceleration or braking.	- ADJUST air pressure in tires. - CORRECT as necessary.
Other excessive tire wear concerns	- Incorrect tire pressure. - Wheels need rotating. - Front end out of alignment. - Vehicle overloaded. - Loose or leaking front or rear strut and spring assembly. - Wheel bearings worn. - Suspension components, bushings and ball joints. - Excessive lateral or radial runout of wheel or tire.	- ADJUST air pressure in tires. - ROTATE wheels. - ALIGN front end. REFER to Section 204-00. - CHECK load specification against work load requirement. - TIGHTEN or INSTALL new parts as necessary. REFER to Section 204-01 or Section 204-02. - INSTALL new wheel bearings. REFER to Section 204-01 or Section 204-02. - INSPECT, REPAIR or INSTALL new parts as necessary. - CHECK, REPAIR or INSTALL new parts as necessary. Use a dial indicator gauge to determine runout accurately.
Wheel mounting is difficult	Incorrect application or mismatched parts, including wheel studs and nuts.	FOLLOW manufacturers specifications.
Wheel rust or corrosion	Poor maintenance.	CLEAN and PROTECT with paint.
Wobble or shimmy affecting wheel runout	- Damaged wheel. - Front wheel bearing.	- INSPECT wheel rims for dents. INSTALL new parts as necessary. - INSTALL new wheel bearings as necessary. REFER to Section 204-01.
Excessive vehicle vibration, rough steering	Suspension components.	TIGHTEN or INSTALL new parts. REFER to Section 204-01 (Front) or Section 204-02 (Rear).

DIAGNOSIS AND TESTING (Continued)**Symptom Chart (Continued)**

Condition	Possible Sources	Action
Vehicle vibrations from wheels and tires	- Tire pressure. - Wheel or tire imbalance. - Uneven tire wear. - Brake disc imbalance. - Water in tires. - Bent wheel. - Incorrectly seated tire bead. - Radial runout of wheel or tire. - Wheel stud, wheel nut or enlarged stud holes. - Foreign material between wheel mounting face and hub mounting surface. - Lateral runout of wheel or tire. - Front wheel bearing.	- ADJUST air pressure in tires. - BALANCE wheel and tire assembly. - INSTALL a new tire(s) if necessary to correct vibration. - CHECK brake disc fins for mud or foreign material. If no damage or foreign material is seen, brake disc may have a heavy spot. REFER to Section 206-00. - REMOVE water. - INSTALL new wheel. Attempts to straighten a wheel can cause fractures in the wheel and weaken the wheel strength. - SPIN wheel on vehicle. EXAMINE area where the tire and the wheel meet. If that section of the tire appears to waver while being rotated, the tire bead may not be seated on the wheel. REMOVE the tire and CLEAN bead seat areas on both wheel and tire. REFER to Cleaning and Inspection in repair procedures. - Use a dial indicator gauge to check the radial runouts of both the wheel and the tire. If either the tire or wheel is out of specification, also CHECK the radial runout of the wheel stud. When components are out of specification INSTALL new components. - TIGHTEN or INSTALL new parts as necessary. - CLEAN mounting surfaces. - Use a dial indicator gauge to check the lateral runouts of both the wheel and the tire. If either the tire or wheel is out of specification, also CHECK the lateral runout of the wheel hub. When components are out of specification, INSTALL new components. - Install new as necessary. REFER to Section 204-01.

DIAGNOSIS AND TESTING (Continued)**Symptom Chart (Continued)**

Condition	Possible Sources	Action
Cracks develop in rim base back (rim bead seat) or the gutter area (drop well radii)	- Overloading or abusive use. - Incorrect use of tools.	- INSTALL new wheel. CHECK loading and operating conditions. Avoid over inflation of tires. CHECK specifications for rim load capacity, working load, tire size, ply rating and tire construction. - CHECK mounting, demounting, and maintenance procedures.
Damaged wheel stud threads	Sliding wheel across wheel studs during assembly.	INSTALL new wheel studs. INSTALL wheel as outlined.
Broken wheel studs	- Loose wheel nuts. - Overloading.	- INSTALL new wheel stud. TIGHTEN to specification. - INSTALL new wheel studs. TIGHTEN to specification. COMPARE actual load against vehicle load ratings.
Stripped threads	Excessive torque.	INSTALL new wheel studs and nuts. TIGHTEN to specification.
Rust streaks from wheel stud holes	Wheel nuts.	CHECK complete assembly. If parts are damaged INSTALL new parts. TIGHTEN to specification.
Damaged wheel nuts	- Wheel assembly. - Over tightened wheel nuts.	- INSTALL new wheel nuts. TIGHTEN to specification. - FOLLOW correct tightening procedure.
Seized wheel nuts	- Corrosion. - Overloading.	CAUTION: Do not permit lubricant to get on cone sets of stud holes or on cone angle of wheel nuts. If corrosion is slight, wire brush away corrosion. If corrosion is excessive, INSTALL new wheel studs and nuts. If condition persists, LUBRICATE first three threads of each wheel stud with a graphite-based lubricant. - REDUCE weight.

REMOVAL AND INSTALLATION

Wheel And Tire

Removal

 **CAUTION:** Do not use heat to loosen a seized wheel nut. Heat may damage the wheel and wheel hub.

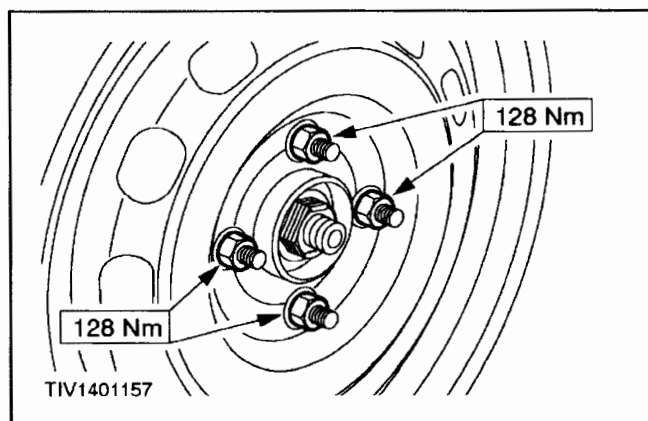
1. Loosen the wheel nuts.
2. Raise and support the vehicle. For additional information, refer to Section 100-02.
3. Remove the wheel and tire assembly.

Installation

1.  **WARNING:** Remove the corrosion or dirt from the mounting surfaces of the wheel, wheel hub, brake drum or brake disc, as this may cause the wheel nuts to loosen and the wheel to come off while the vehicle is in motion. Failure to follow this instruction may result in personal injury.

Clean the wheel, wheel hub and mounting surfaces.

2. Install the wheel and tire assembly.
 - Install the wheel nuts.
3. Lower the vehicle.
4. Tighten the wheel nuts in a diagonally opposed pattern.



SECTION 205-04 Front Drive Halfshafts

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Handling front drive halfshafts	205-04-4
Wheel balancing, front.....	205-04-4
Underbody protection and corrosion prevention	205-04-4
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Halfshaft — RH	205-04-13
Intermediate Shaft	205-04-18
DISASSEMBLY AND ASSEMBLY	
Halfshaft	205-04-24

SPECIFICATIONS

General Specifications

Item	Specification
Lubricants	
Manual Transmission Fluid	WSD-M2C200-C
MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX	MERCON®
Constant Velocity Joint Grease (High Temp)	ESP-M1C207-AH
Capacity	
Merkur Manual Transmission Fluid (transmission with cable shift)	1,9 (0-5 mm below the lower edge of the level check bore)
MERCON® Multi-Purpose Automatic Transmission Fluid (with oil cooler)	2.5L Engine: 9.5

Torque Specifications

Description	Nm	Lb-Ft
Tie-rod end to wheel knuckle	26	19
Lower arm ball joint to wheel knuckle	83	61
Stabilizer bar link rod to suspension strut	47	35
Bearing — right-hand intermediate shaft	27	20
Halfshaft stub nut	290	214
Wheel nut	128	94
Oil check bolt — manual transaxle	35	26
Locking nut — suspension strut top mount	46	34

DESCRIPTION AND OPERATION

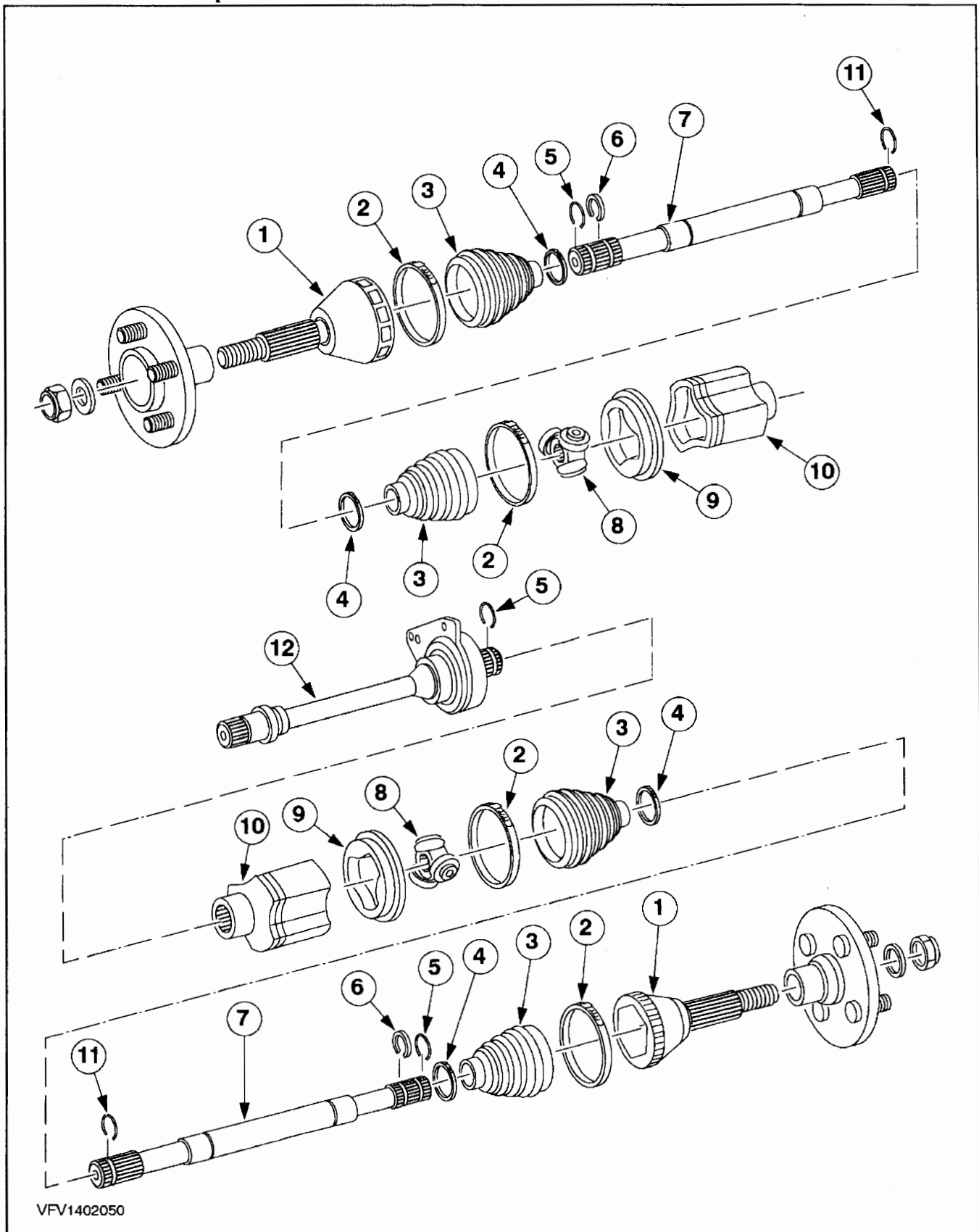
Front Drive Halfshafts

- The front drive halfshafts transmit torque from the engine to the wheels.
- In order to allow vertical movement of the wheels and engine, the front drive halfshafts operate at varying lengths and angles.
- The tripod joints allow for changes in driveshaft length during axial movements.

Halfshaft Joint

- To reduce running friction, the front drive halfshafts are fitted with constant velocity (CV) joints at both ends.
- Tripode joints (with tripode, running rollers and tripode housing) are fitted on the transaxle side.

- Constant velocity joints (with ball star, ball cage and ball shell) are fitted on the wheel side.
- The left-hand tripod joint is secured in the differential with a snap ring.
- The intermediate shaft (right-hand side) is not secured in the differential, but is secured by the intermediate shaft bearing bracket.
- The tripod joint of the right-hand front drive halfshaft is secured in the intermediate shaft with a snap ring.
- The wheel-side constant velocity joints are attached to the wheel hubs.

DESCRIPTION AND OPERATION (Continued)**Front Drive Halfshafts Exploded View**

DESCRIPTION AND OPERATION (Continued)

Item	Part Number	Description
1	—	Fix joint
2	—	Boot clamp (large)
3	—	Boot
4	—	Boot clamp (small)
5	—	Halfshaft joint snap ring
6	—	Snap ring

(Continued)

Item	Part Number	Description
7	—	Front drive halfshaft
8	—	Tripode
9	—	Tripode housing insert
10	—	Tripode housing
11	—	Halfshaft joint snap ring
12	—	Intermediate shaft

Handling front drive halfshafts

 **CAUTION:** To avoid to damage the halfshaft joints and boots, do not bend the inner halfshaft joint by more than 18 degrees, the outer one by not more than 45 degrees.

NOTE: Never hold the front drive halfshaft just by the tripod joint.

Utmost care should be taken while removing/installing and disassembling/assembling the front drive halfshafts. The following points should be observed:

- When removing front drive halfshafts do not pull on the tripod joints.
- Check polished surfaces and splines for damage.
- Do not allow the boots to come into contact with sharp edges, the engine when it is hot or the exhaust system.
- Do not drop the front drive halfshafts, as this can cause interior damage to the boots which may not be visible from the outside.
- Do not use front drive halfshafts as levering tools for the installation of other components. The front drive halfshafts must always hang freely.
- The tripod joint can be damaged by knocks outside the joint housing.

Wheel balancing, front

 **CAUTION:** Using a portable wheel balancing unit when the vehicle is lifted completely off the ground will result in damage to the tripod joints or boots, as the joint is bent a large angle and therefore overheats.

To use a portable wheel balancing unit position a trolley jack under the suspension arm opposite the wheel which is being balanced. This prevents the joint from being bent too much when the vehicle is raised.

 **CAUTION:** Never use the joints or front drive halfshafts as jacking points.

 **CAUTION:** Do not attach the tow rope to the front drive halfshaft.

If possible, wheels should be removed from the vehicle and balanced in a stationary balancing machine.

Underbody protection and corrosion prevention

NOTE: The boots should be covered during application of underbody protection or corrosion prevention.

Foreign bodies can be the cause of premature material wear. Foreign bodies on shafts can cause imbalances.

DIAGNOSIS AND TESTING**Front Drive Halfshafts**

NOTE: New front wheel drive halfshafts should not be installed unless disassembly and inspection reveals unusual wear.

1. Inspect front wheel halfshaft joint boots for evidence of cracks, tears or splits.

DIAGNOSIS AND TESTING (Continued)

NOTE: While inspecting the front wheel halfshaft joint boots, watch for indentations (dimples) in the boot convolutions. If an indentation is observed, it must be removed.

2. Inspect underbody for any indication of grease splatter in vicinity of front wheel halfshaft joint boots outboard and inboard locations, which is an indication of front wheel halfshaft joint boot and/or front wheel halfshaft joint boot clamp damage.
3. Carry out a check of the joint housing for leaks.

4. Make sure front axle wheel hub retainer is the correct prevailing torque type.
5. The silicone front wheel halfshaft joint boot will sweat during operation, causing a light film of grease to show on the outside of the front wheel halfshaft joint boot. This condition is normal.

NOTE: Halfshafts are not balanced and do not contribute to rotational vibration.

6. If the concerns remain after the inspection, determine the symptoms and go to the Symptom Chart. Refer to Section 100-04.

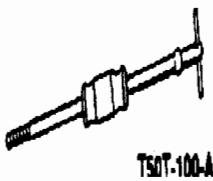
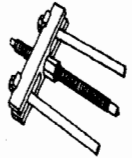
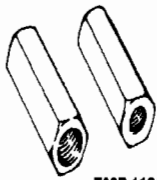
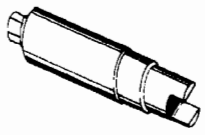
Symptom Chart

Condition	Possible Sources	Action
Clicking, popping or grinding noises while turning	- Another component contacting halfshaft assembly. - Wheel bearings, brakes, suspension or steering components. - Inadequate or contaminated lube in outboard/inboard front wheel halfshaft joint.	- INSPECT and REPAIR as necessary. - INSPECT and REPAIR as necessary. - INSPECT, CLEAN and LUBRICATE with new grease as necessary.
Vibration at highway speeds	- Out of balance front wheels or tires. - Out-of-round tires. - Incorrectly seated outboard front wheel halfshaft joint in front wheel hub.	- Balance the wheels. REFER to Section 204-04. - REPAIR or INSTALL new as necessary. REFER to Section 204-04. - REPAIR or INSTALL new as necessary. REFER to Halfshaft.
Shudder vibration during acceleration.	- Excessively high CV joint operating angles caused by incorrect ride height. - Excessively worn or damaged inboard front wheel halfshaft joint or outboard front wheel halfshaft joint.	- CHECK ride height, VERIFY correct spring rate and CHECK items under Halfshaft Joint Pullout. REPAIR or INSTALL new as necessary. - INSPECT and INSTALL new as necessary.
Halfshaft joint pullout	- Inboard halfshaft bearing retainer circlip missing or not correctly seated in differential side gear. - Engine/transaxle assembly misaligned. - Frame rail or strut tower out of position or damaged. - Front suspension components worn or damaged.	- INSPECT and REPAIR or INSTALL new as necessary. - CHECK engine mounts for damage or wear. REPAIR or INSTALL new as necessary. - CHECK underbody dimensions. REFER to Section 501-00. - CHECK for worn bushings or bent components (front stabilizer bar, front suspension lower arm). REPAIR or INSTALL new as necessary.

REMOVAL AND INSTALLATION

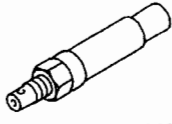
Halfshaft — LH

Special Tool(s)

 T50T-100-A	Slide Hammer 100-001 (T50T-100-A)
 T81P-1104-C	Remover/Installer, Front Hub 204-069 (T81P-1104-C)
 T83P-1104-BH	Remover, Hub (Metric Stud) 204-085 (T83P-1104-BH)
 T81P-4026-A	Remover, Halfshaft 205-164 (T81P-4026-A)

(Continued)

Special Tool(s)

 ST1582-A	Remover, Halfshaft 205-241 (T86P-3514-A)
 14041	Installer, Halfshaft 205-379 (T97P-1175-A)

General Equipment

Plug for transaxle opening

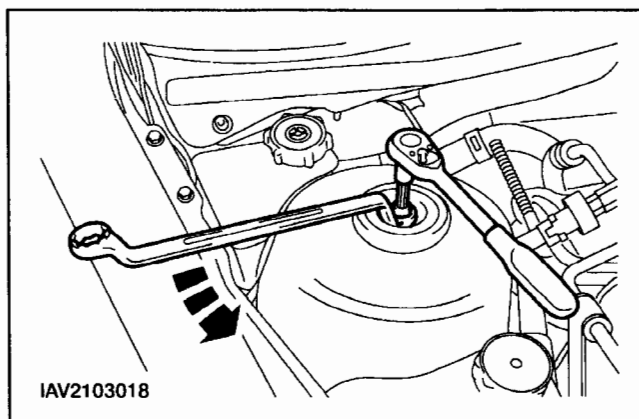
Materials

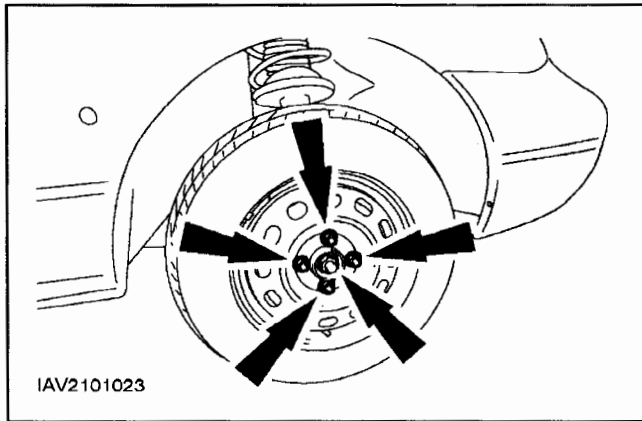
Item	Specification
MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX	MERCON®
Manual Transmission Fluid —	MERCON® WSD-M2C200-C

Removal

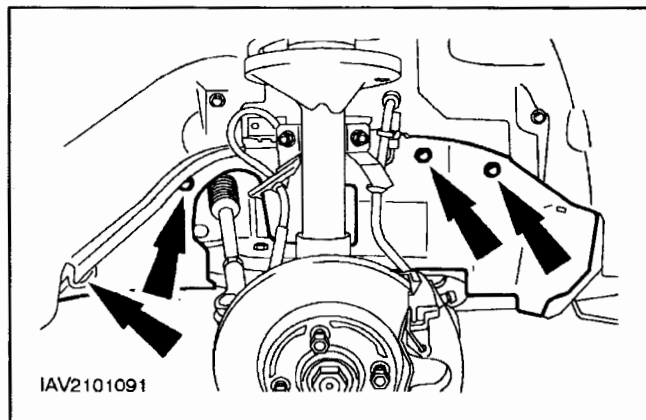
All vehicles

- NOTE:** Use an Allen key to stop the piston rod from turning.
Loosen the left-hand suspension strut locknut five turns (right-hand side shown).

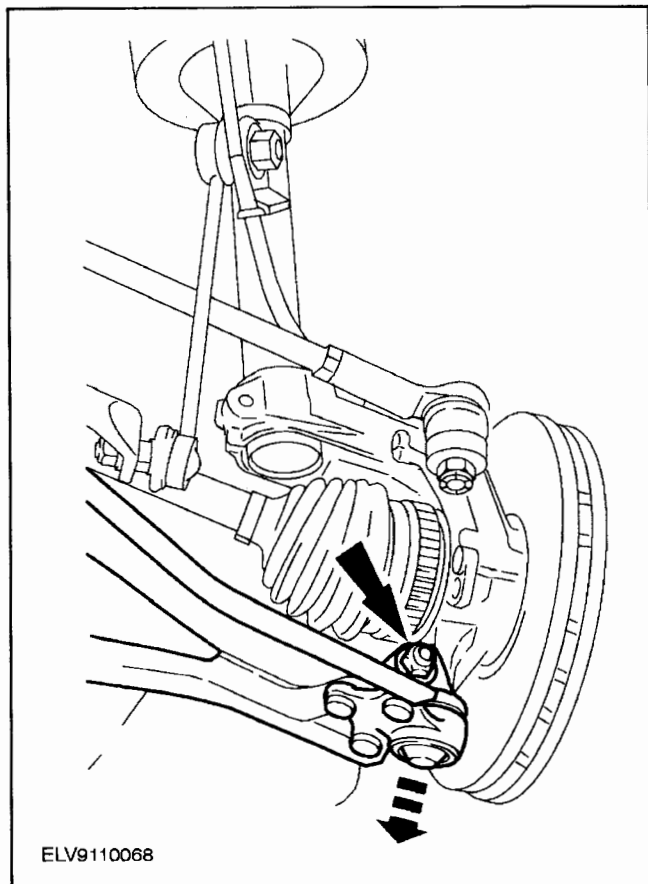


REMOVAL AND INSTALLATION (Continued)

2. Loosen the halfshaft stub nut and the front left-hand wheel nuts (right-hand side shown).



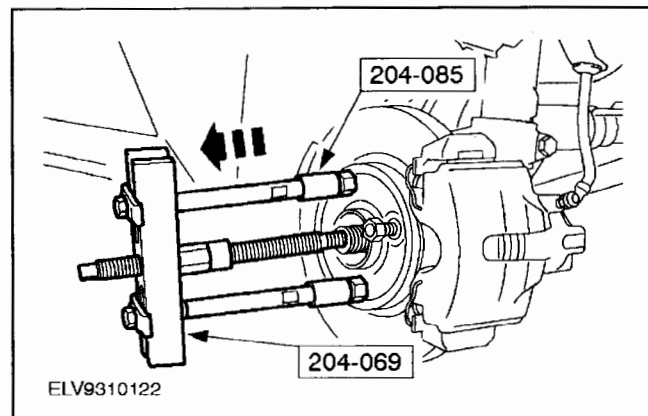
3. Raise and support the vehicle. For additional information, refer to Section 100-02.
4. Remove the left-hand front wheel and remove the axle driveshaft stub nut.
5. Remove the fender splash shields (right-hand side shown).

REMOVAL AND INSTALLATION (Continued)

6.  **CAUTION:** Do not damage the boot and ABS sensor ring

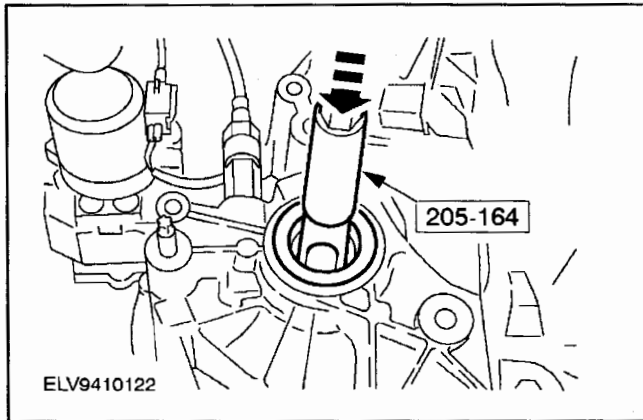
Disconnect the left-hand suspension (right-hand side shown).

- Disconnect the ABS wiring harness bracket from the strut.



7.  **CAUTION:** To avoid to damage halfshaft joints and boots, do not bend the inner halfshaft joint by more than 18 degrees, the outer one by not more than 45 degrees.

Using the special tools, disconnect the left-hand halfshaft from the hub (right-hand side shown).

REMOVAL AND INSTALLATION (Continued)**Vehicles with manual transaxle**

8. **CAUTION:** To avoid to damage the halfshaft joints and boots, do not bend the inner halfshaft joint by more than 18 degrees, the outer one by not more than 45 degrees.

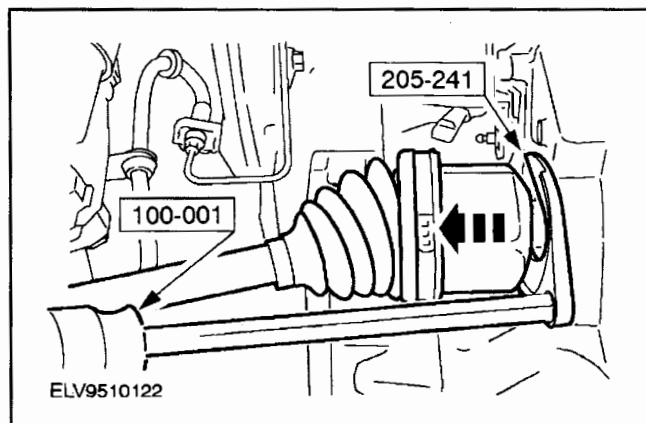
CAUTION: Do not damage the oil seal.

NOTE: Disconnect the left-hand halfshaft only, if the intermediate shaft has already been removed.

NOTE: Oil escapes.

Using the special tool, disconnect the left-hand halfshaft.

- Close the transaxle opening with a Plug for transaxle opening.

**All vehicles**

9. **CAUTION:** To avoid to damage the halfshaft joints and boots, do not bend the inner halfshaft joint by more than 18 degrees, the outer one by not more than 45 degrees.

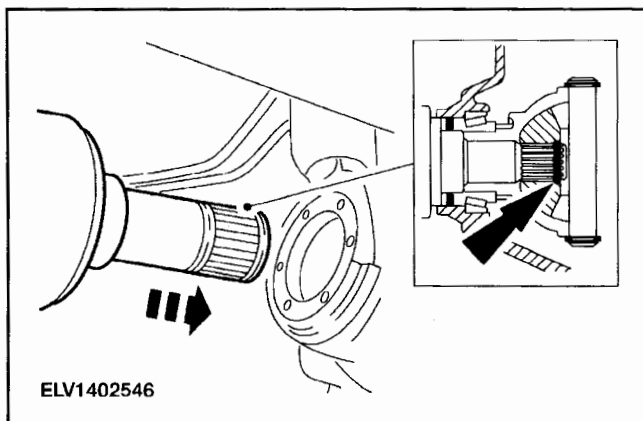
CAUTION: Do not damage the oil seal.

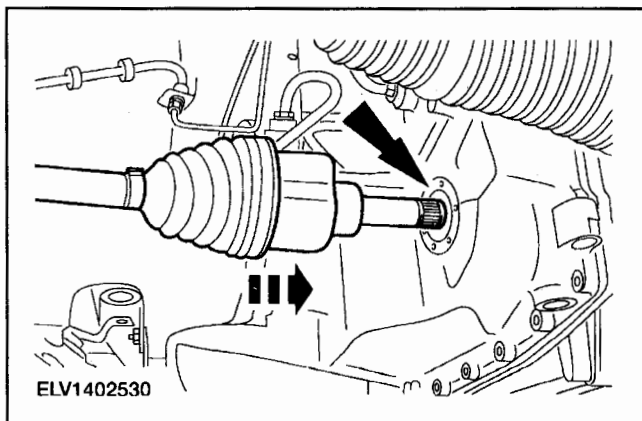
NOTE: Collect escaping oil. Close off the transaxle opening with a Plug.

Using the special tool, remove the left-hand halfshaft (vehicle with manual transaxle shown).

Installation**All vehicles**

1. **NOTE:** Renew self-locking nuts and snap-rings. Halfshaft location.



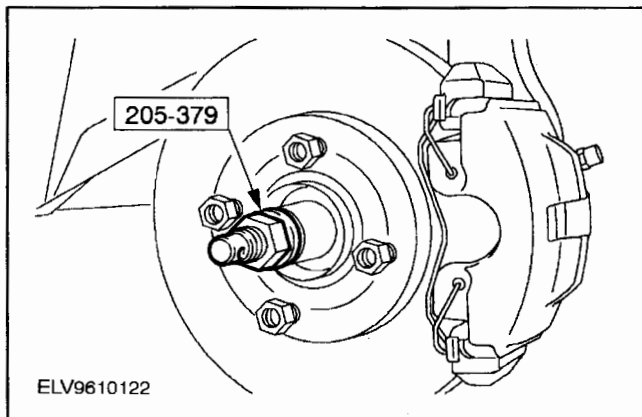
REMOVAL AND INSTALLATION (Continued)

2. **CAUTION:** To avoid to damage the halfshaft joints and boots, do not bend the inner halfshaft joint by more than 18 degrees, the outer one by not more than 45 degrees.

CAUTION: Do not damage the oil seal.

Install the LH halfshaft.

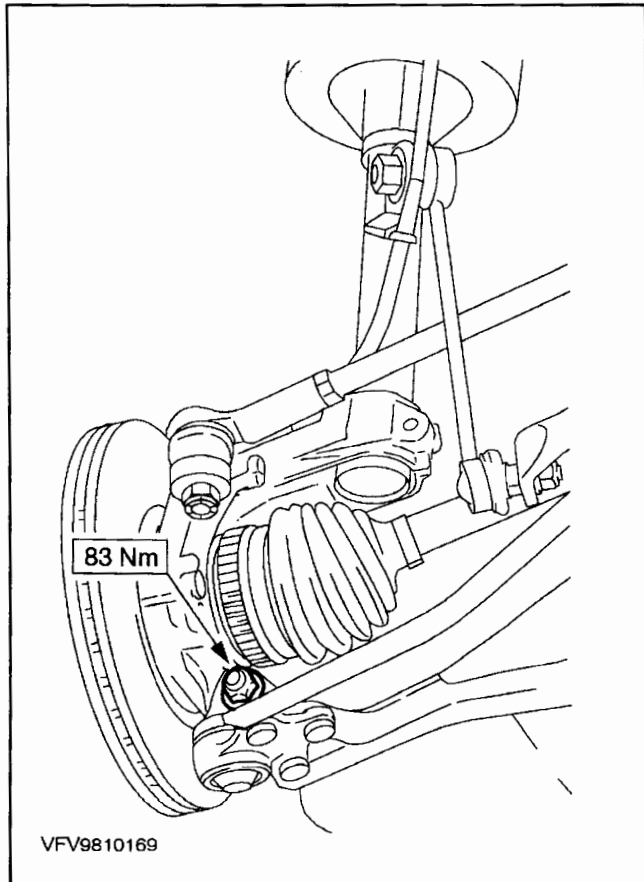
- Check that the snap ring engages correctly.



3. **CAUTION:** To avoid to damage the halfshaft joints and boots, do not bend the inner halfshaft joint by more than 18 degrees, the outer one by not more than 45 degrees.

Using the special tool, install the halfshaft to the hub.

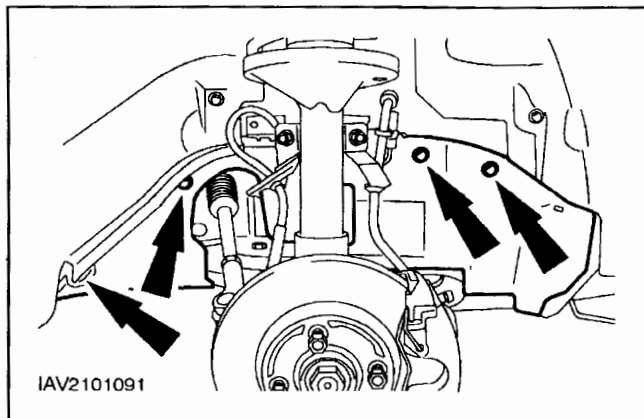
4. Install the halfshaft stub nut.

REMOVAL AND INSTALLATION (Continued)

5. **CAUTION:** Do not damage boot and ABS sensor ring.

Install the left-hand suspension.

- Attach the ABS wiring harness bracket to the strut.



6. Install the fender splash shields (right-hand side shown).

7. Install the left-hand front wheel.

Vehicles with manual transaxle

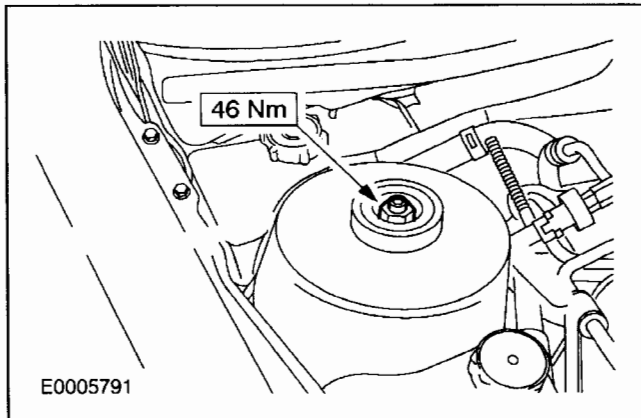
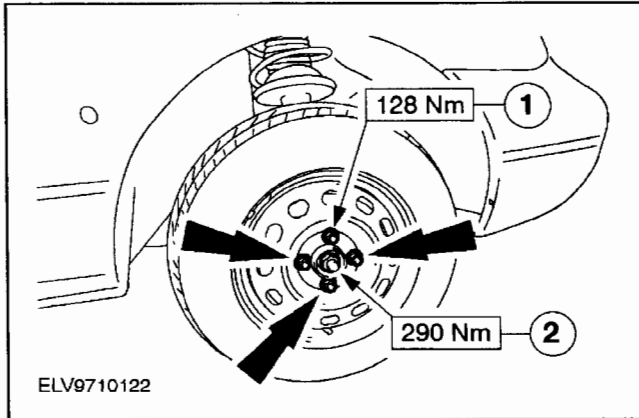
8. **NOTE:** The fill level is 0-5 mm below the lower edge of the filler hole.

Check the transmission fluid level and fill with Merkur manual transmission fluid. For additional information, refer to Section 308-03.

REMOVAL AND INSTALLATION (Continued)**All vehicles**

9. Lower the vehicle, tighten the left-hand front wheel nuts (right-hand side shown).

- 1 Wheel nuts
- 2 Hub nut

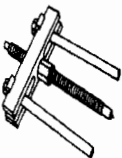
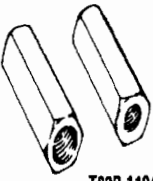


10. Tighten the left-hand suspension strut locknut (right-hand side shown).
- Use an Allen key as back-stop.
 - Tighten finger-tight using ring spanner.
 - Tighten to torque specification using torque wrench.

Vehicles with automatic transaxle

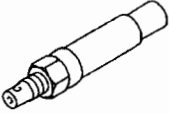
11. Fill the automatic transaxle with MERCON® Multi-purpose automatic transmission fluid. For additional information, refer to Section 307-01.

REMOVAL AND INSTALLATION (Continued)**Halfshaft — RH****Special Tool(s)**

 T81P-1104-C	Remover/Installer, Front Hub 204-069 (T81P-1104-C)
 T83P-1104-BH	Remover, Hub (Metric Stud) 204-085 (T83P-1104-BH)
 ST1185-A	Slide Hammer 100-001 (T50T-100-A)

(Continued)

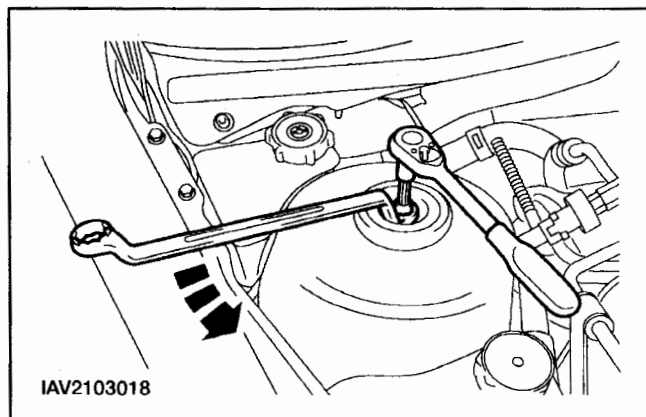
Special Tool(s)

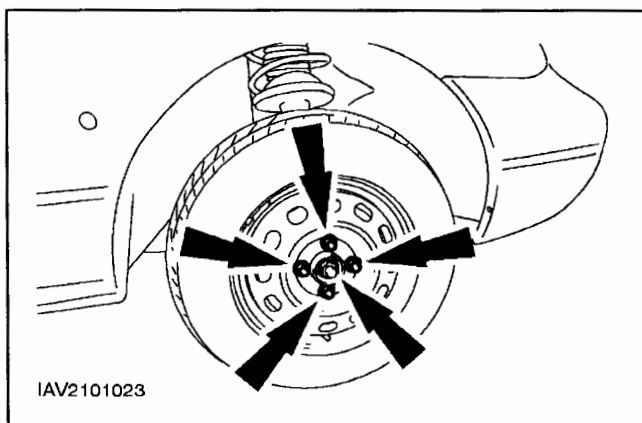
 ST1582-A	Remover, Halfshaft 205-241 (T86P-3514-A)
 14041	Installer, Halfshaft 205-379 (T97P-1175-A)

Removal

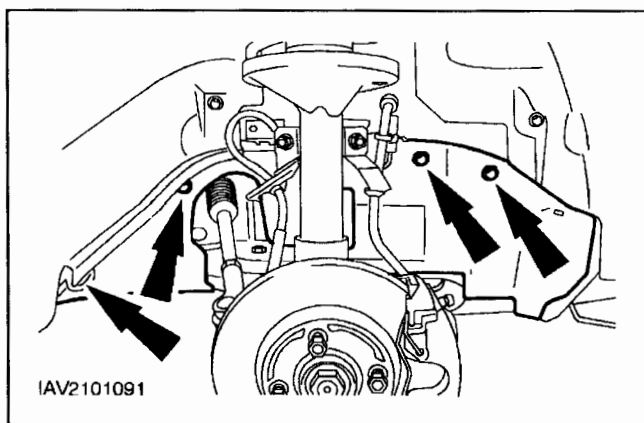
- NOTE:** Use an Allen key to stop the piston rod from turning.

Loosen the right-hand suspension strut locknut five turns.

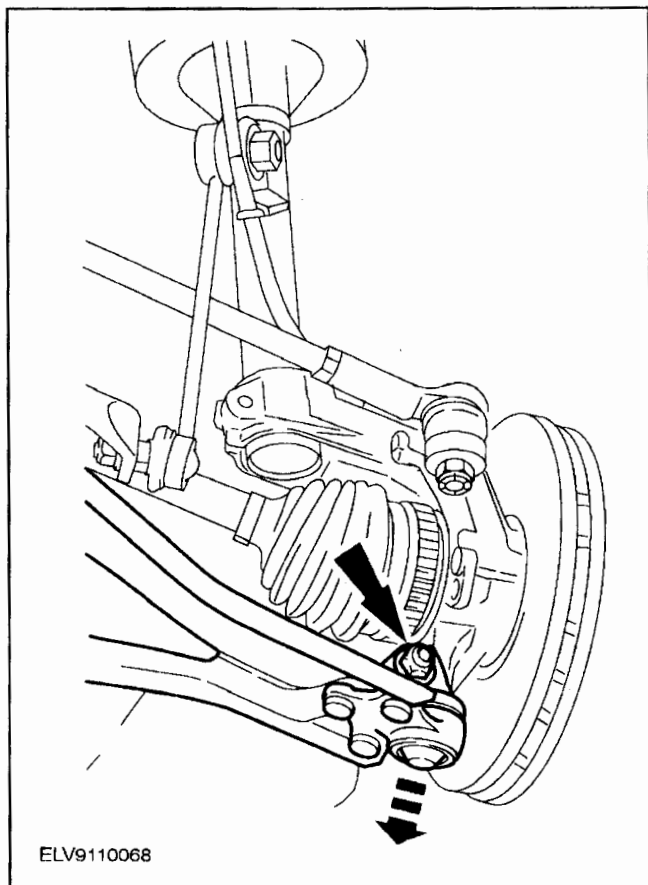


REMOVAL AND INSTALLATION (Continued)

2. Loosen the halfshaft stub nut and the right-hand front wheel nuts.



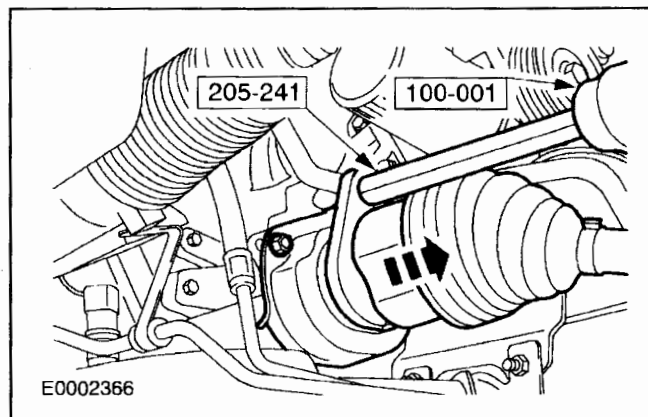
3. Raise and support the vehicle. For additional information, refer to Section 100-02.
4. Remove the right-hand front wheel and remove the halfshaft stub nut.
5. Remove the fender splash shields.

REMOVAL AND INSTALLATION (Continued)

6. **CAUTION:** Do not damage boot and ABS sensor ring.

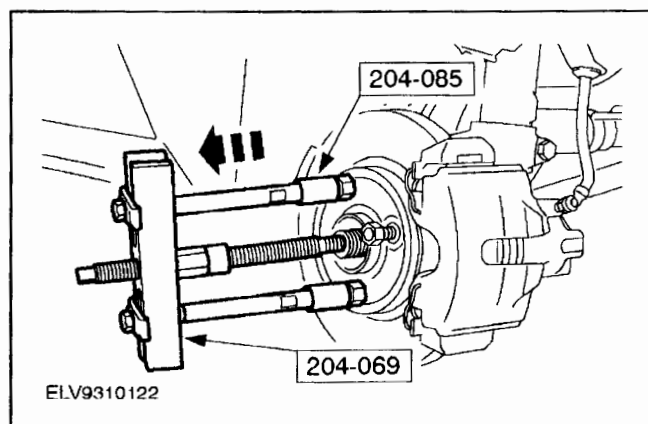
Disconnect the lower right-hand suspension arm ball joint from the wheel knuckle.

- Disconnect the ABS wiring harness bracket from the suspension strut.

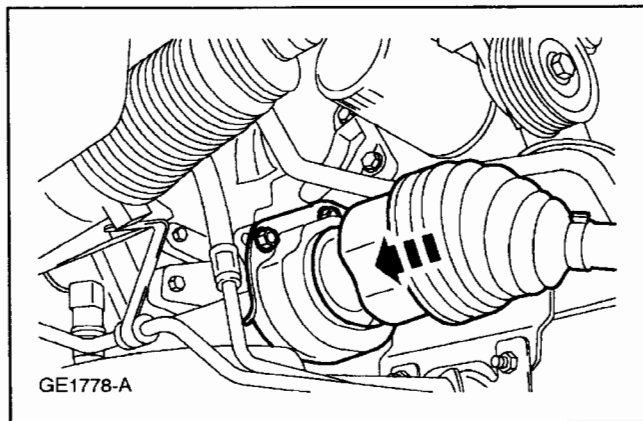


7. **CAUTION:** To avoid to damage the halfshaft joints and boots, do not bend the inner halfshaft joint by more than 18 degrees, the outer one by not more than 45 degrees.

Using the special tools, disconnect the right-hand halfshaft.



8. Using the special tools, remove the right-hand halfshaft.

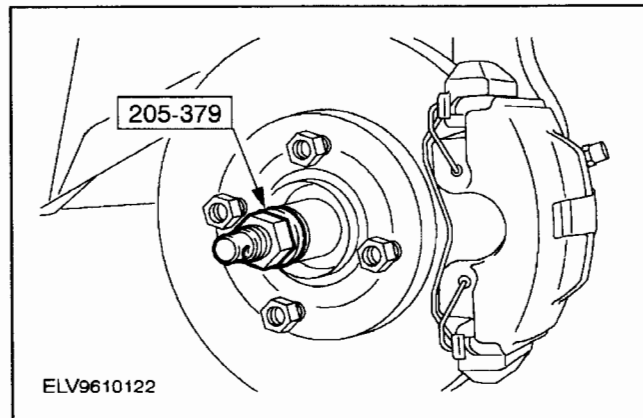
REMOVAL AND INSTALLATION (Continued)**Installation**

1.  **CAUTION:** To avoid to damage the halfshaft joints and boots, do not bend the inner halfshaft joint by more than 18 degrees, the outer one by not more than 45 degrees.

NOTE: Install a new snap ring.

Install the right-hand halfshaft.

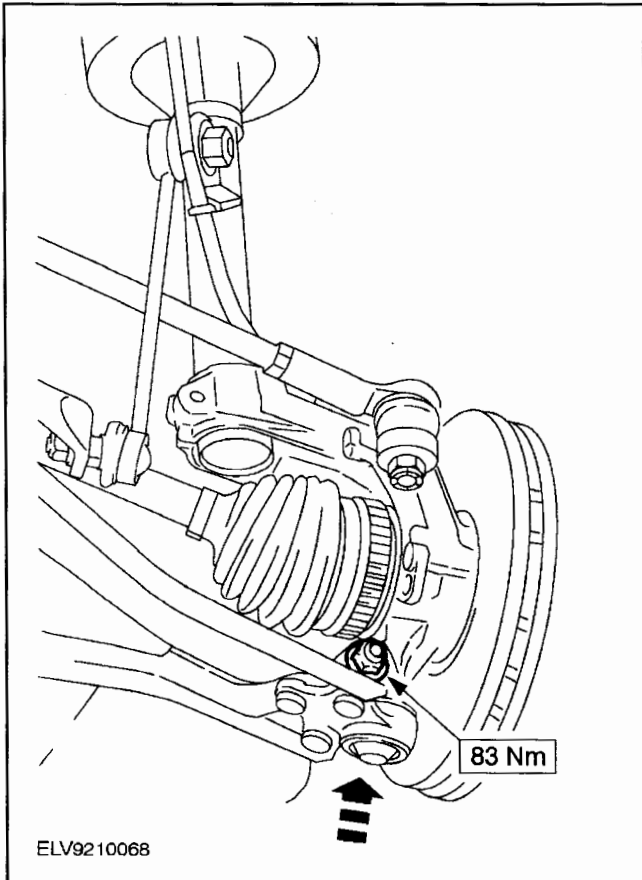
- Check that the snap ring engages correctly.



2.  **CAUTION:** To avoid to damage halfshaft joints and boots, do not bend the inner halfshaft joint by more than 18 degrees, the outer one by not more than 45 degrees.

Using the special tool, install the halfshaft to the hub.

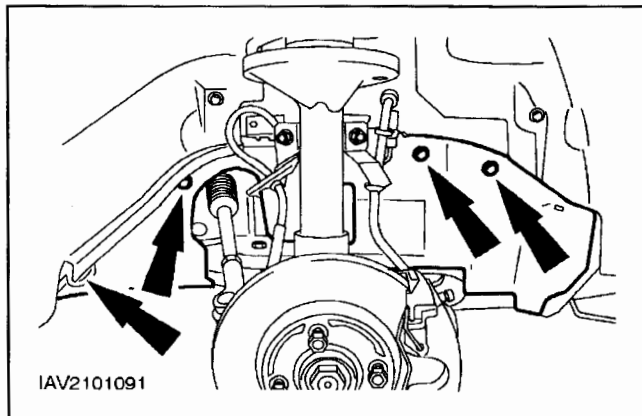
3. Install the hub nut.

REMOVAL AND INSTALLATION (Continued)

4.  **CAUTION:** Do not damage boot and ABS sensor ring

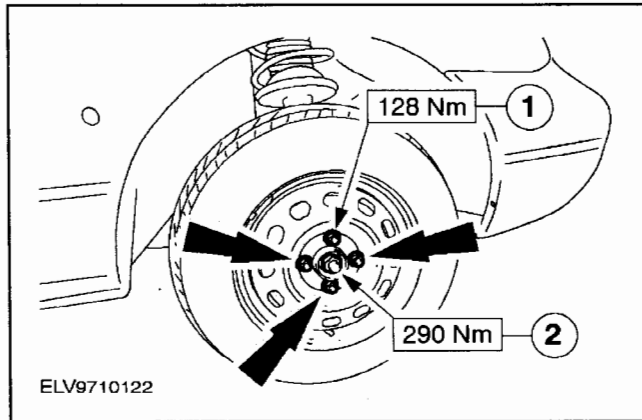
Connect the lower right-hand suspension arm ball joint.

- Attach the ABS wiring harness bracket to the suspension strut.



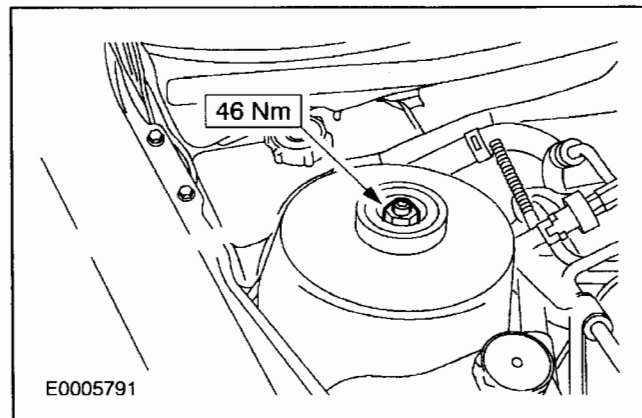
5. Install the fender splash shields (right-hand side shown).

6. Install the right-hand front wheel.

REMOVAL AND INSTALLATION (Continued)

7. Lower the vehicle, tighten the halfshaft stub nut and the left-hand front wheel nuts.

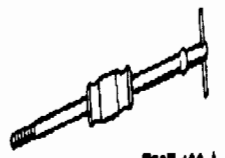
- 1 Wheel nuts
- 2 Halfshaft stub nut



8. Tighten the right-hand suspension strut locknut.

- Use an Allen key as back-stop.
- Tighten finger-tight using ring spanner.
- Tighten to torque specification using torque wrench.

Intermediate Shaft**Special Tool(s)**

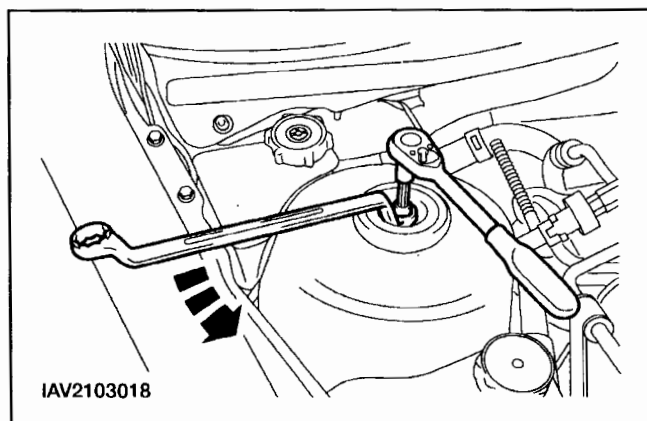
 ST1582-A	Remover, Halfshaft 205-241 (T86P-3514-A)
 T50T-100-A	Slide Hammer 100-001 (T50T-100-A)

Materials

Item	Specification
MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX	MERCON®
Manual Transmission Fluid —	MERCON® WSD-M2C200-C

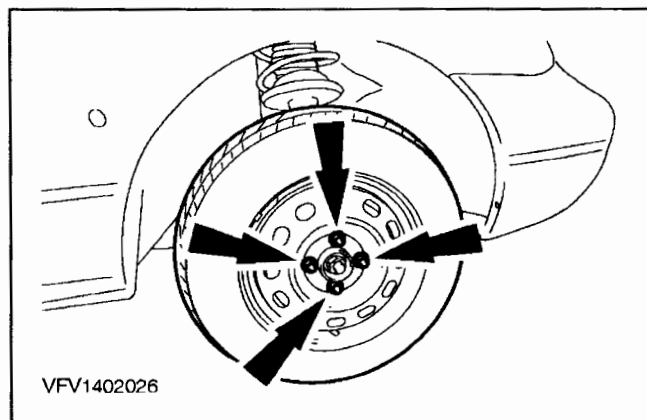
General Equipment

Plug for transaxle opening

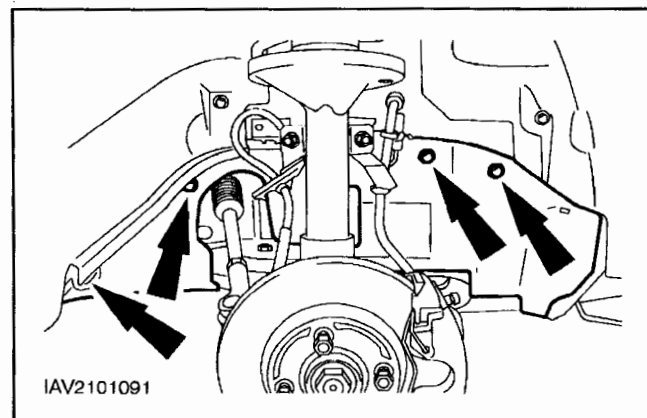
REMOVAL AND INSTALLATION (Continued)**Removal**

1. **NOTE:** Use an Allen key to stop the piston rod from turning.

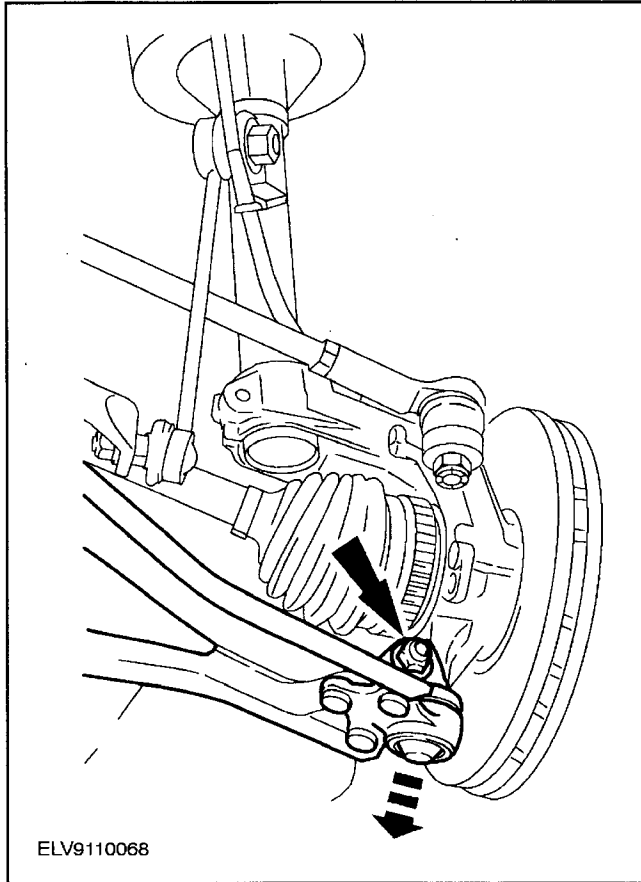
Loosen the right-hand suspension strut locknut five turns.



2. Loosen the right-hand front wheel nuts.



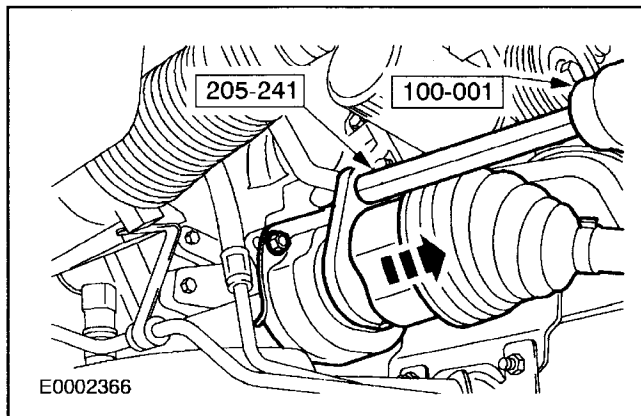
3. Raise and support the vehicle. For additional information, refer to Section 100-02.
4. Remove the right-hand front wheel.
5. Remove the fender splash shields (right-hand side shown).

REMOVAL AND INSTALLATION (Continued)

6. **CAUTION:** Do not damage boot and ABS sensor ring

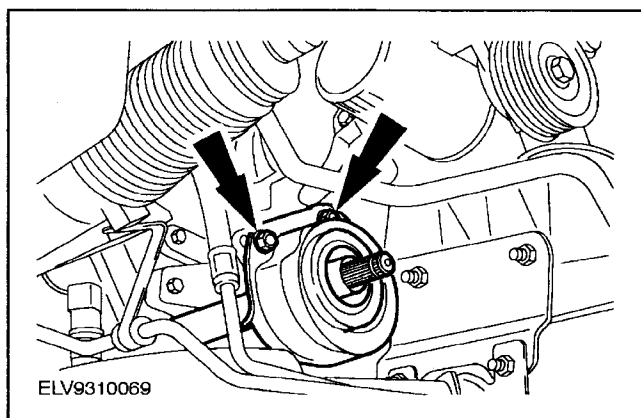
Disconnect the lower right-hand suspension arm ball joint from the wheel knuckle.

- Disconnect the ABS wiring harness bracket from the suspension strut.



7. **CAUTION:** To avoid damage to the halfshaft joints and boots, do not bend the inner halfshaft joint by more than 18 degrees, the outer one by not more than 45 degrees.

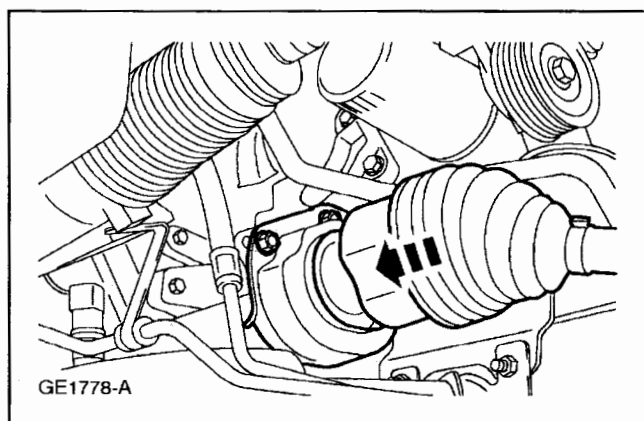
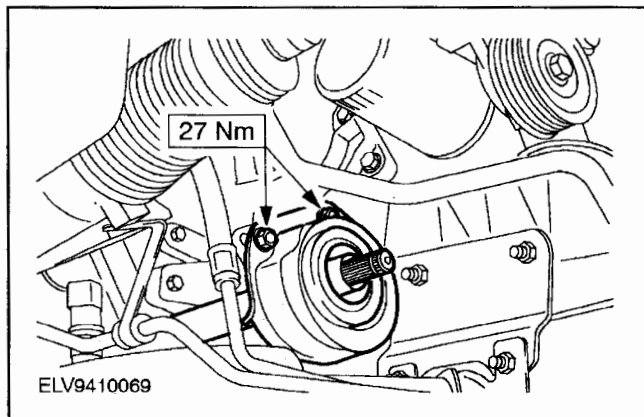
Using the special tools, remove the right-hand halfshaft.



8. **NOTE:** Collect escaping oil.

Remove the intermediate shaft.

- Close off the transmission opening with a plug for transaxle opening.

REMOVAL AND INSTALLATION (Continued)**Installation****All vehicles**

1. **CAUTION:** Do not damage the oil seal.
 CAUTION: If an intermediate shaft bracket with two sets of holes (one set for automatic transaxle application and one set for manual transaxle application) is installed, install the mounting bolts into the correct holes.

NOTE: Use new nuts.

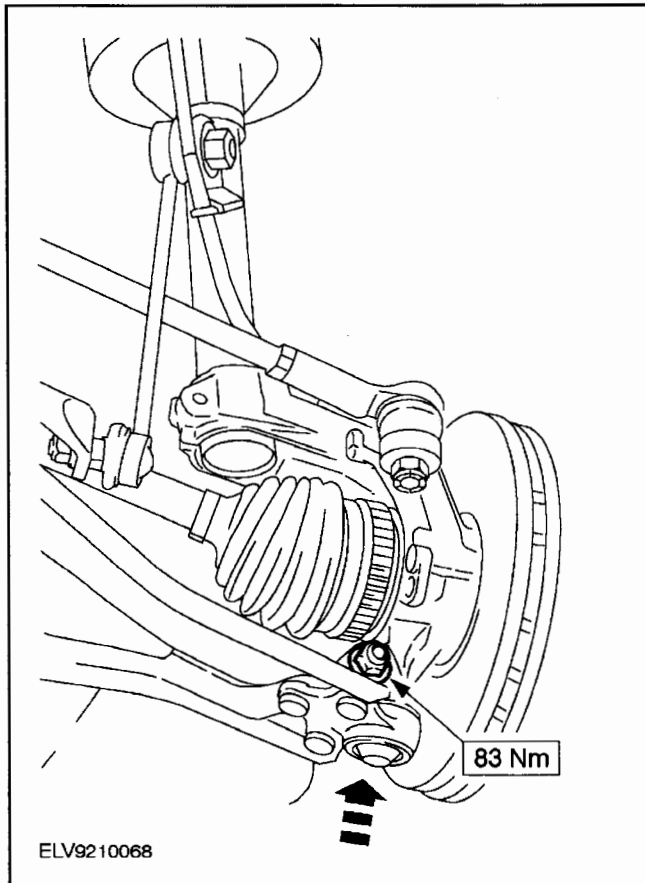
Install the intermediate shaft.

2. **CAUTION:** To avoid damage to the halfshaft joints and boots, do not bend the inner halfshaft joint by more than 18 degrees, the outer one by not more than 45 degrees.

NOTE: Install a new snap ring.

Install the right-hand halfshaft.

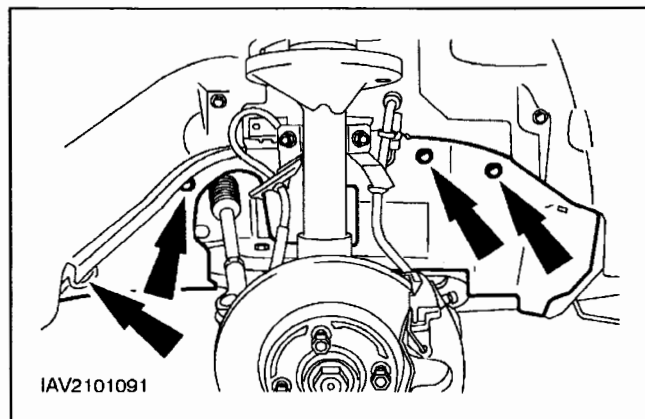
- Check that the snap ring engages correctly.

REMOVAL AND INSTALLATION (Continued)

3.  **CAUTION:** Do not damage boot and ABS sensor ring.

Connect the lower right-hand suspension arm ball joint to the wheel knuckle.

- Attach the ABS wiring harness bracket to the suspension strut.



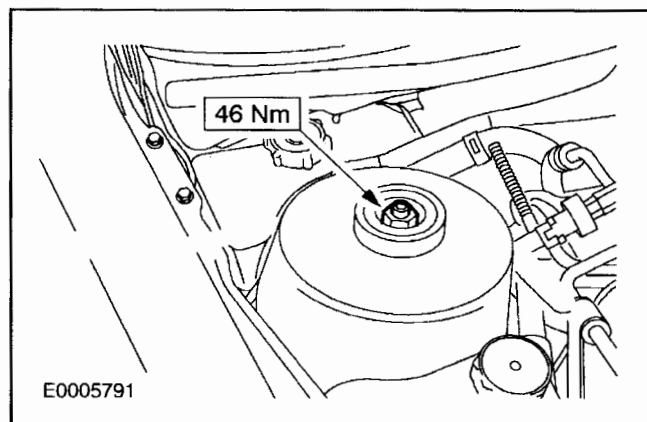
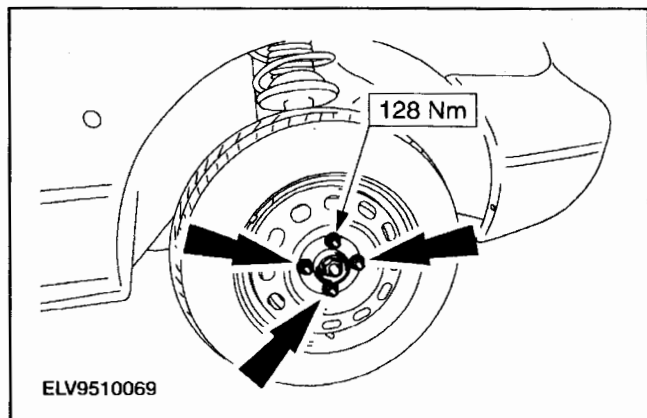
4. Install the fender splash shields (right-hand side shown).

5. Install the right-hand front wheel.

Vehicles with manual transaxle

6. **NOTE:** The fill level is 0-5 mm below the lower edge of the filler hole.

Check the transmission fluid level and fill with manual transmission fluid. For additional information, refer to Section 308-03.

REMOVAL AND INSTALLATION (Continued)**All vehicles**

7. Lower the vehicle and tighten the left-hand front wheel nuts.
8. Tighten the right-hand suspension strut locknut.
 - Use an Allen key as back-stop.
 - Tighten finger-tight using ring spanner.
 - Tighten to torque specification using torque wrench.

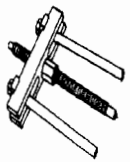
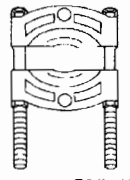
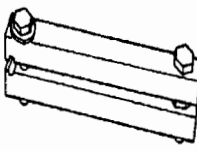
Vehicles with automatic transaxle

9. Fill the automatic transaxle with MERCON® Multi-purpose automatic transmission fluid. For additional information, refer to Section 307-01.

DISASSEMBLY AND ASSEMBLY

Halfshaft

Special Tool(s)

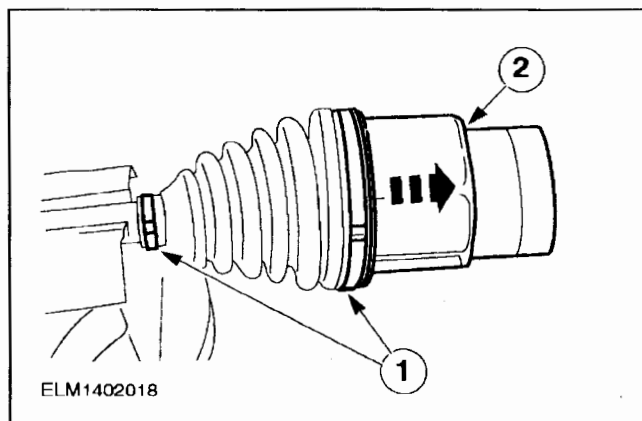
 T81P-1104-C	Remover/Installer, Front Hub 204-069 (T81P-1104-C)
 D84L-1123-A	Remover, Bearing/Gear 205-D064 (D84L-1123-A)
 T95P-3514-A	Clamping Tool, Boot Retaining Clamp 205-343 (T95P-3514-A)

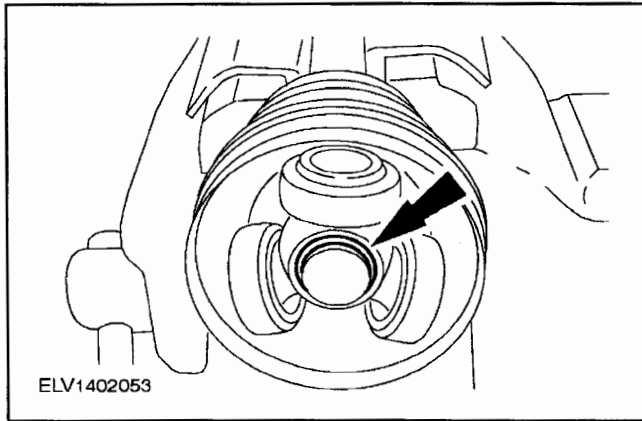
Materials

Item	Specification
High-Temp Constant Velocity Joint Grease E43Z-19590-A	ESP-M1C207-A

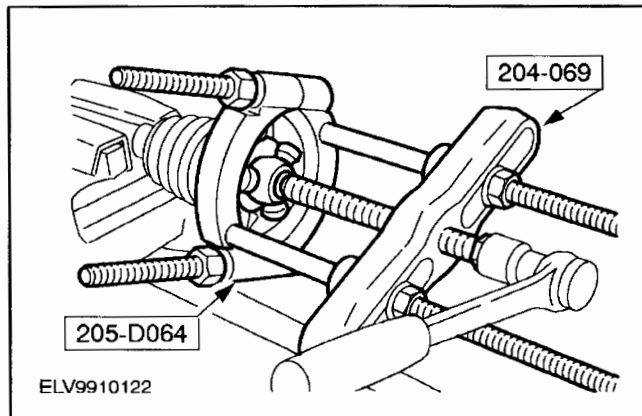
Disassembly

1. Remove the front drive halfshaft. For additional information, refer to Halfshaft—LH or Halfshaft—RH in this section.
2. **NOTE:** Use a vise with vise jaw protectors.
Disconnect the halfshaft joint at the transaxle end.
 - Clamp the halfshaft in a vise.
 - 1 Cut the small and large boot clamps and discard them. Slide the boot back.
 - 2 Pull out the tripod joint.

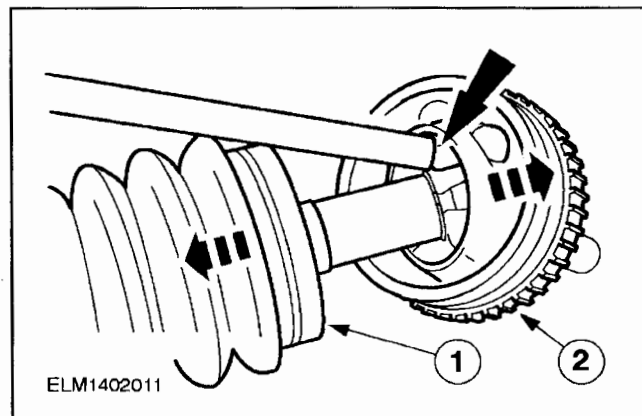


DISASSEMBLY AND ASSEMBLY (Continued)

3. Remove and discard the snap ring.



4. Using the special tools pull off the tripode assembly.
- Remove the boot.

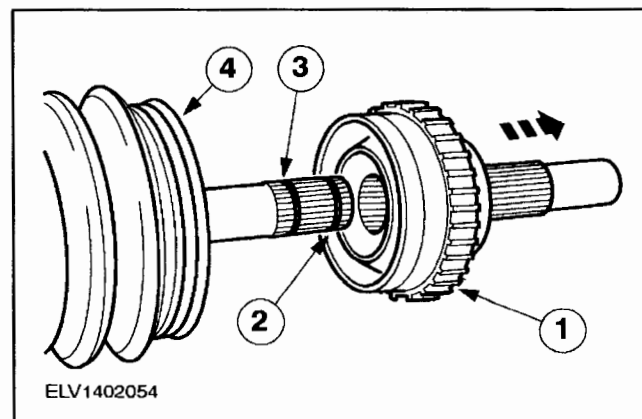


5.  **CAUTION: Do not damage the bearing cage.**

NOTE: Halfshaft joint at the wheel end only.

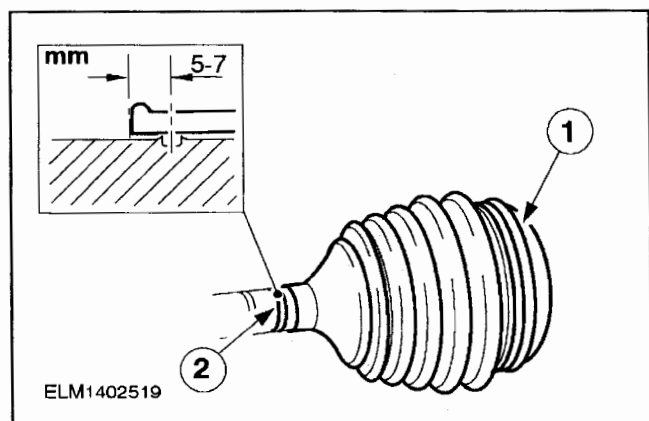
Loosen the halfshaft joint at the wheel end.

- 1 Cut the boot clamps and remove them. Slide the boot back.
- 2 Unseat the halfshaft joint from the snap ring seat using a brass drift.



6. **NOTE:** Halfshaft joint at the wheel end only.
- Remove the halfshaft joint.

- 1 Remove the halfshaft joint.
- 2 Remove snap ring.
- 3 Remove the stop ring.
- 4 Pull off the boot.

DISASSEMBLY AND ASSEMBLY (Continued)**Assembly**

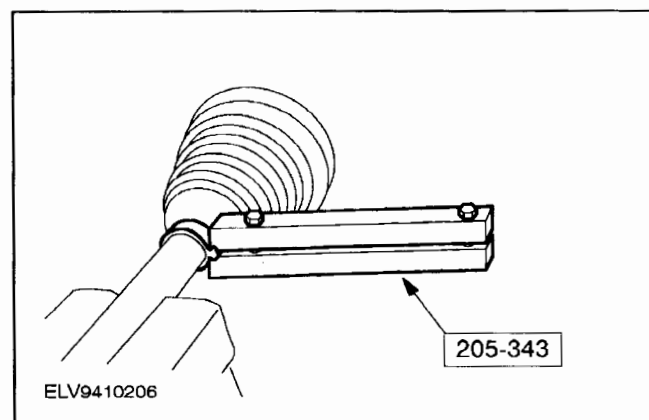
1. **NOTE:** Halfshaft joint at the wheel end only.

NOTE: Install a new boot clamp.

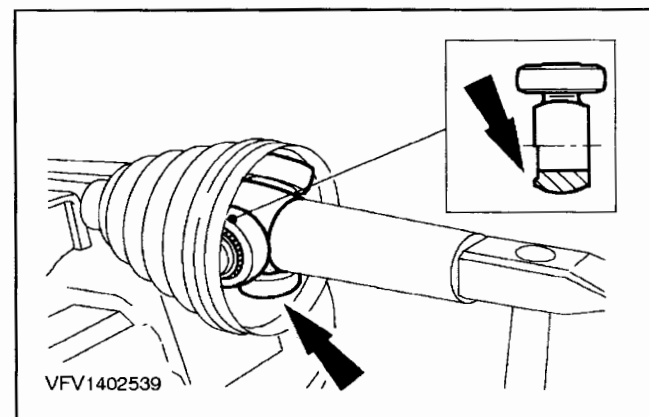
Install the boot at the transaxle end.

- 1 Install the large boot clamp.

- 2 Position the boot.



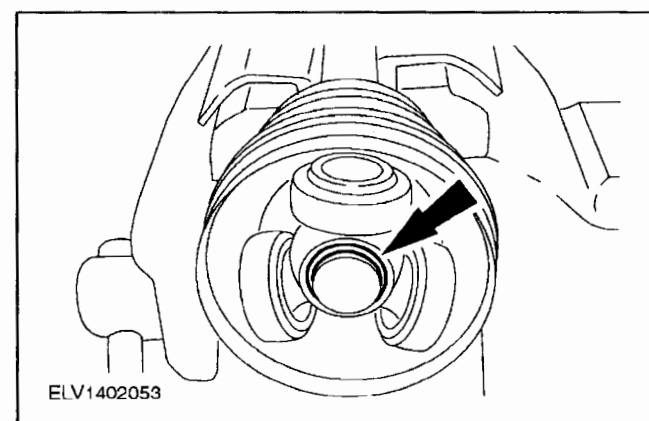
2. Using the special tool, tighten the boot clamp.
 - Position the small clamp at the transaxle end in the annular groove of the boot.



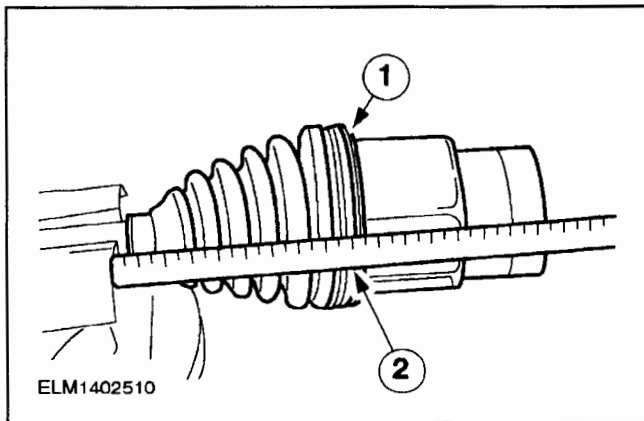
3. **CAUTION:** Do not damage the bearing seat of the tripod.

Install the tripod assembly.

- Drive the tripod assembly onto the front halfshaft as far as it will go, using a suitable tube.



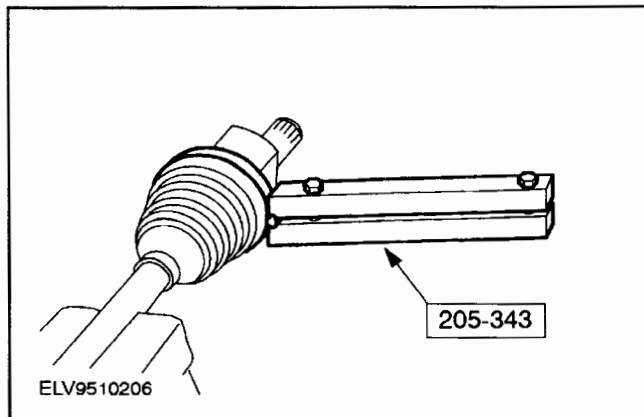
4. Install a new snap ring.

DISASSEMBLY AND ASSEMBLY (Continued)

5. Install halfshaft joint at the transaxle end.

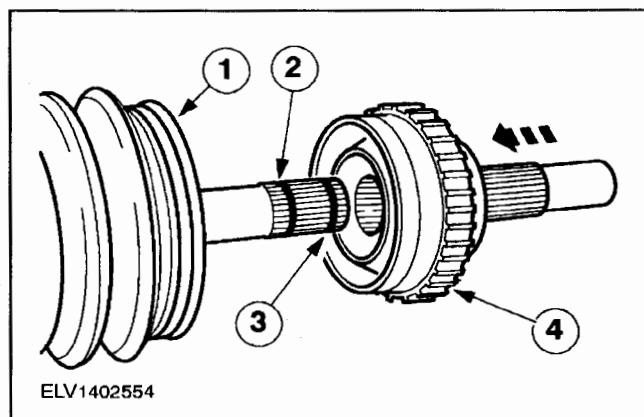
- Pack the tripod joint with 180 grams of High-Temp Constant Velocity Joint Grease E43Z-19590-A meeting Ford specification ESP-M1C207-A and install it.

- 1 Insert a small screwdriver under the boot seat to allow the air to escape.
- 2 Slide the tripod joint inwards as far as the stop, then pull it out 20 mm.
- Remove the screwdriver.



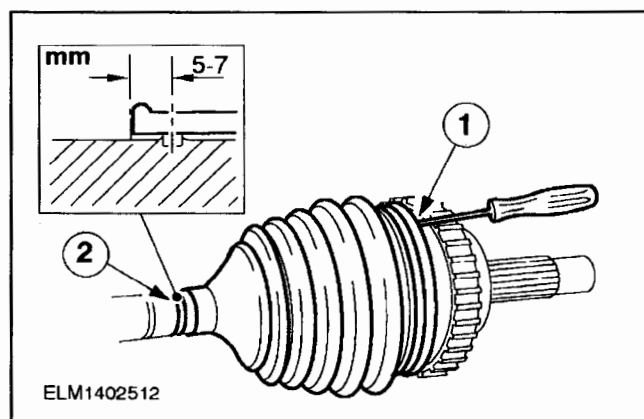
6. Using the special tool, tighten the large boot clamp.

- Position the large boot clamp at the transaxle end in the annular groove of the boot.



7. Install halfshaft joint at the wheel end.

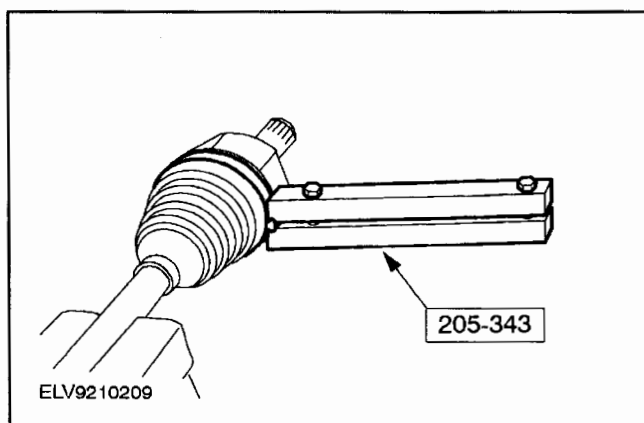
- 1 Slide on the boot and the small boot clamp.
- 2 Install a new stop ring.
- 3 Install a new snap ring.
- 4 Pack the halfshaft joint with 170 grams of High-Temp Constant Velocity Joint Grease E43Z-19590-A meeting Ford specification ESP-M1C207-A and slide onto the halfshaft.



8. Install the boot at the wheel end.

- Press the boot into the groove in the halfshaft joint.

- 1 Slide a small screwdriver under the boot seat to allow the air to escape.
- 2 Locate the boot in position and install the small boot clamp.
- Remove the screwdriver.

DISASSEMBLY AND ASSEMBLY (Continued)

9. Using the special tool, tighten the large and small boot clamps at the wheel end (large boot clamp shown).

SECTION 206-00 Brake System — General Information

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DESCRIPTION AND OPERATION

Brake System

 **WARNING:** Brake fluid contains polyglycol ethers and polyglycols. Avoid contact with the eyes. Wash hands thoroughly after handling. If brake fluid contacts the eyes, flush the eyes for 15 minutes with cold running water. Get medical attention if irritation persists. If taken internally, drink water and induce vomiting. Get medical attention immediately. Failure to follow these instructions may result in personal injury.

The braking system is a diagonally split, dual circuit design featuring front disc brakes and rear drum brakes as standard and disc brakes all round on 2.5L vehicles.

The hydraulic system provides separate circuits for each pair of diagonally opposed wheels (left front, right rear and right front, left rear). The front calipers, mounted on the wheel knuckle, are of single sliding piston design which make sure that equal effort is applied through both brake pads. The rear calipers of vehicles with discs all round are of a single piston, floating caliper design. The pads in all cases are asbestos free.

DIAGNOSIS AND TESTING

Brake System

Principles of Operations

The brake system operates by transferring effort applied to the brake pedal, by the driver to the brakes at each wheel.

The braking effort is distributed to each wheel, using a hydraulic system. The system is assisted using a vacuum brake booster that reduces pedal effort and increases hydraulic pressure. The parking brake operates on the rear wheels and is applied using a hand operated control.

The rear drum brakes are of conventional design. They feature one primary and one secondary shoe with bonded thick/thin asbestos free linings. The thick/thin linings allow the shoes to wear at proportional rates. The brakes self adjust during foot brake operation.

The parking brake control is located between the front seats and operates the rear brakes through a cable system. The cable features automatic adjustment through a ratchet and pawl mechanism on the parking brake control.

The master cylinder is of a tandem design and is linked to a brake booster to reduce the brake pedal effort. The tandem design will make sure that in the event of one brake circuit failure the other will remain fully operational. The master cylinder and brake booster are located on the left-hand side of the engine compartment. The booster operating rod is connected directly to the brake pedal.

Vehicles fitted with the standard braking system have pressure conscious reducing valves (PCRVs) These are fitted in the brake tubes at the rear wheels. The PCRVs control the hydraulic pressure applied to the rear brakes thereby reducing the risk of rear wheel lock-up under braking.

Inspection and Verification

NOTE: Prior to carrying out any diagnosis, make sure that the brake system warning indicator is functional.

Visually examine the front and rear tire and wheel assemblies for damage such as uneven wear patterns, tread worn out or sidewall damage. Verify the tires are the same size, type and, where possible, same manufacture. Install a new wheel or tire that is damaged or excessively worn. Refer to Section 204-04.

Wheels and tires must be cleared of any foreign matter and tire pressures adjusted to the correct specification.

DIAGNOSIS AND TESTING (Continued)

If tires exhibit uneven wear or feathering, the cause must be corrected. Check the steering and suspension components for damage or wear and, if necessary, check and adjust front wheel alignment. Refer to Section 204-00.

Road Test

Carry out a road test to compare actual vehicle braking performance with the performance standards expected by the driver. The ability of the test driver to make valid comparisons and detect performance deficiencies will depend on experience.

The driver should have a thorough knowledge of brake system operation and accepted general performance guidelines to make good comparisons and detect performance concerns.

An experienced brake technician will always establish a route that will be used for all brake diagnosis road tests. The roads selected will be reasonably smooth and level. Gravel or bumpy roads are not suitable because the surface does not allow the tires to grip the road equally. Crowned roads should be avoided because of the large amount of weight shifted to the low set of wheels on this type of road. Once the route is established and consistently used, the road surface variable can be eliminated from the test results.

Before a road test, obtain a complete description of the customer concerns or suspected condition. From the description, the technician's experience will allow the technician to match possible causes with symptoms. Certain components will be tagged as possible suspects while others will be eliminated by the evidence. More importantly, the customer description can reveal unsafe conditions which should be checked or corrected before the road test. The description will also help form the basic approach to the road test by narrowing the concern to specific components, vehicle speed or conditions.

Begin the road test with a general brake performance check. Keeping the description of the concern in mind, test the brakes at different vehicle speeds using both light and heavy pedal pressure. To determine if the concern is in the front or rear braking system, use the brake pedal and then use the parking brake control. If the condition (pull, vibration, pulsation) occurs only with the parking brake, the concern is in the rear brake system.

Avoid locking the brakes and sliding the tires. Locked brakes and sliding tires do not indicate brake efficiency. A heavily braked and turning wheel will stop the vehicle in a shorter distance than locked brakes.

If the concern becomes evident during this check, verify it fits the description given before the road test. If the concern is not evident, attempt to duplicate the condition using the information from the description.

If a concern exists, use the Symptom Chart in order to isolate it to a specific sub-system and condition description. From this description, a list of possible sources can be used to further narrow the cause to a specific component or condition.

DIAGNOSIS AND TESTING (Continued)**Symptom Chart****Symptom Chart**

Condition	Possible Sources	Action
The brakes pull or drift	- Brake pads or shoes. - Front brake disc. - Rear disc brake caliper. - Rear brake adjustment. - Wheel alignment adjustment. - Brake disc shield bolts. - Wheel bearing. - Tire pressures. - Grease or fluid on brake pads or shoes; glazed linings. - Calipers.	- CHECK the brake pads and shoes. REFER to Section 206-03, Section 206-04 or Section 206-02. REPAIR or INSTALL new brake pads or shoes as necessary. - REPAIR the front brake disc. REFER to Section 206-03. - INSTALL a new caliper. REFER to Section 206-04. - CHECK the automatic adjustment. REFER to Section 206-05. - CARRY OUT a wheel alignment adjustment. REFER to Section 204-00. - TIGHTEN or INSTALL new brake disc shield bolts. REFER to Section 206-04. - CHECK or INSTALL a new wheel bearing. REFER to Section 204-01. - INFLATE the tires to the correct pressure. - INSTALL new brake pads or shoes. REFER to Section 206-03, Section 206-04 or Section 206-02. - GO to Pinpoint Test A.
The red brake warning indicator is always on	- Fluid level. - Brake master cylinder primary piston cup. - Parking brake control. - Circuit. - ABS.	- FILL the system to specification. CHECK for leaks. - INSTALL a new brake master cylinder. REFER to Section 206-06. - RELEASE and ADJUST the parking brake. REFER to Section 206-05. - GO to Pinpoint Test B. - GO to Pinpoint Test B.

DIAGNOSIS AND TESTING (Continued)**Symptom Chart (Continued)**

Condition	Possible Sources	Action
Vibration when brakes are applied	- Grease or fluid on brake pads or shoes; glazed linings. - Brake pads or shoes. - Caliper mounting bolts. - Insufficient grease on sliding parts. - Foreign material or scratches on front brake disc contact surfaces. - Drum contact surface. - Rear brake disc contact surfaces. - Wheel hub bolt nuts.	- INSTALL new brake pads or shoes. REFER to Section 206-03, Section 206-04 or Section 206-02. - CHECK the brake pads or shoes. REFER to Section 206-03, Section 206-04 or Section 206-02. REPAIR or INSTALL new as necessary. - TIGHTEN the caliper mounting bolts. - APPLY grease where necessary. - INSTALL a new brake disc or REFINISH disc contact surfaces. REFER to Section 206-03. - INSTALL a new brake drum. REFER to Section 206-02. - INSTALL new brake discs or REFINISH the disc contact surfaces. REFER to Section 206-04. - TIGHTEN or INSTALL new wheel hub nuts. - GO to Pinpoint Test C.
The pedal goes down fast	- Leak in hydraulic system. - Air in system. - Brake master cylinder. - Disc brake "knock back" (Pads push caliper piston back into caliper. Caused by excessive brake disc lateral runout). - Brake pads and shoes.	- REPAIR leak. CHECK entire hydraulic system. REFILL and BLEED. REFER to Brake System Bleeding in this section. - BLEED the brakes. REFER to Brake System Bleeding in this section. - INSTALL a new brake master cylinder. REFER to Section 206-06. - CHECK the brake disc runout. REFER to Brake Disc Runout Check in this section. - CHECK the brake pads and shoes. REFER to Section 206-03, Section 206-04 or Section 206-02. REPAIR or INSTALL new as necessary. - GO to Pinpoint Test D.
The pedal eases down slowly	- Air in system. - Brake master cylinder.	- BLEED the brakes. REFER to Brake System Bleeding in this section. - GO to Pinpoint Test E.

DIAGNOSIS AND TESTING (Continued)**Symptom Chart (Continued)**

Condition	Possible Sources	Action
The pedal is low or feels spongy	- Brake pads or shoes. - Hydraulic system.	- CHECK the brake pads and shoes. REFER to Section 206-03, Section 206-04 or Section 206-02. INSTALL new as necessary. - GO to Pinpoint Test F.
Brake lock-up during light brake pedal force	- Brake pads or shoes. - Calipers.	- CHECK the brake pads and shoes. REFER to Section 206-03, Section 206-04 or Section 206-02. REPAIR or INSTALL new brake pads or shoes as necessary. - GO to Pinpoint Test G.
Excessive/erratic brake pedal travel	- Brake pads or shoes. - Brake discs.	- CHECK the brake pads and shoes. REFER to Section 206-03, Section 206-04 or Section 206-02. REPAIR or INSTALL new brake pads or shoes as necessary. - GO to Pinpoint Test H.
Brakes drag	- Brake booster. - Seized caliper/wheel cylinder. - Parking brake control applied/malfunction - Seized parking brake cables. - Seized caliper slide pins.	GO to Pinpoint Test I.
Excessive brake pedal effort	- Brake booster. - Brake pads on shoes.	- REFER to Section 206-07. - CHECK the brake pads and shoes. REFER to Section 206-03, Section 206-04 or Section 206-02. REPAIR or INSTALL new brake pads or shoes as necessary. - GO to Pinpoint Test J.
Slow or incomplete brake pedal return	- Brake booster. - Brake master cylinder.	GO to Pinpoint Test K.

Pinpoint Tests**PINPOINT TEST A: THE BRAKES PULL OR DRIFT**

CONDITIONS	DETAILS/RESULTS/ACTIONS
A1 ROAD TEST VEHICLE	
	1 Road test the vehicle and apply the brake pedal. Does the vehicle pull or drift? → Yes GO to A2. → No Vehicle is OK.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST A: THE BRAKES PULL OR DRIFT (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
A2 INSPECT TIRE PRESSURE	
	1 Check for excessive tire wear or incorrect pressures. • Are the tires in good condition? → Yes If equipped with rear drum brakes, GO to A3. If equipped with rear disc brakes, GO to A4. → No ADJUST the tire pressures or INSTALL new tires if excessively worn. TEST the system for normal operation.
A3 INSPECT BRAKE SHOE AND LINING	
	1 Check the brake shoes and lining for grease or fluid on linings and wear concerns. • Are any concerns present? → Yes INSTALL new brake shoes. REFER to Section 206-02. TEST the system for normal operation. ROAD TEST if necessary. → No GO to A4.
A4 CHECK CALIPERS	
	1 Check the caliper pistons and pins for binding, leaking or sticking. Refer to Section 206-03 and Section 206-04. • Do the disc brake caliper pistons and pins bind, leak or stick? → Yes REPAIR or INSTALL new pistons or pins as necessary. TEST the system for normal operation. → No GO to A5.

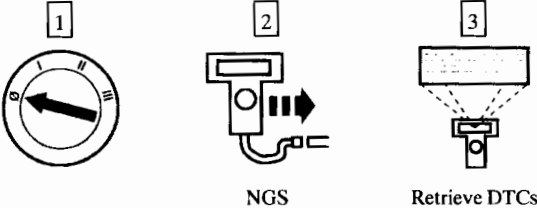
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DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST A: THE BRAKES PULL OR DRIFT (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
A5 INSPECT BRAKE DISCS	
	1 Check the brake discs for excessive runout or damage. Refer to Brake Disc Runout Check in this section. • Does excessive runout or damage exist? → Yes REPAIR or INSTALL new brake discs as necessary. TEST the system for normal operation. → No GO to A6.
A6 INSPECT WHEEL BEARINGS	
	1 Check the front wheel bearings. Refer to Section 204-00. • Are the wheel bearings OK? → Yes GO to A7. → No INSTALL new wheel bearings. REFER to Section 204-01. TEST the system for normal operation.
A7 CHECK VEHICLE ALIGNMENT	
	1 Check the vehicle alignment. Refer to Section 204-00. • Is the alignment within specification? → Yes Vehicle is OK. → No Adjust the alignment as necessary. REFER to Section 204-00.

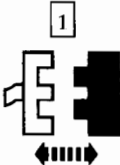
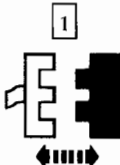
DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST B: THE RED BRAKE WARNING INDICATOR IS ALWAYS ON**

NOTE: The brake warning indicator will illuminate for a period of approximately five seconds on key on and then extinguish.

CONDITIONS	DETAILS/RESULTS/ACTIONS
B1 CHECK RED BRAKE WARNING INDICATOR 	- Is the red brake warning indicator on? → Yes If equipped with ABS, GO to B2. If not equipped with ABS, GO to B3. → No Vehicle is OK.
B2 CHECK FOR ABS DTC(S) NOTE: Record all DTCs. Failure to do so may result in incorrect diagnosis. 	4 Note and record any stored DTCs. - Are any ABS DTCs recorded? → Yes REFER to Section 206-09A. → No GO to B3.
B3 CHECK PARKING BRAKE	1 Check the parking brake is fully released. - Does the red brake warning indicator go out? → Yes Vehicle is OK. → No GO to B4.

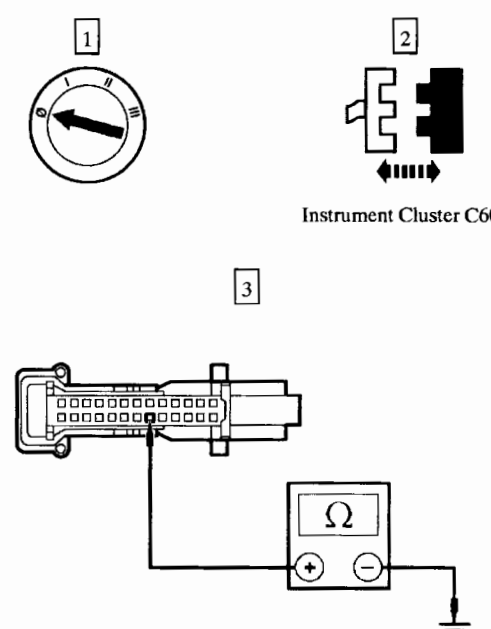
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DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST B: THE RED BRAKE WARNING INDICATOR IS ALWAYS ON (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
B4 CHECK BRAKE FLUID LEVEL	
	1 Check the fluid level of the brake master cylinder reservoir. Is the fluid level of the brake master cylinder reservoir normal? → Yes GO to B5. → No Fill the brake master cylinder reservoir to the MAX level. REFER to General Procedures.
B5 CHECK THE BRAKE FLUID LEVEL SWITCH FOR SHORT TO GROUND	
 Brake Fluid Level Switch C711	Does the red brake warning indicator go out? → Yes INSTALL a new brake fluid level switch. TEST the system for normal operation. → No GO to B6.
B6 CHECK THE PARKING BRAKE SWITCH FOR SHORT TO GROUND	
 Parking Brake Switch C409	Does the red brake warning indicator go out? → Yes INSTALL a new parking brake switch. TEST the system for normal operation. → No GO to B7.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST B: THE RED BRAKE WARNING INDICATOR IS ALWAYS ON (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
B7 CHECK CIRCUIT 31S - WB6 (BK/YE) /31S - WB6A (BK/YE) /31S WB7 (BK/BU) /31S WC18 (BK/RD) FOR SHORT TO GROUND  TIV9310063	3 Measure the resistance between instrument cluster C606 pin 6, circuit 31S-WB6 (BK/YE), and ground. • Is the resistance greater than 10,000 ohms? → Yes INSTALL a new instrument cluster. TEST the system for normal operation. → No REPAIR circuit 31S-WB6 (BK/YE) / 31S-WB6A (BK/YE) / 31S-WB7 (BK/BU) / 31S-WC18 (BK/RD). TEST the system for normal operation.

PINPOINT TEST C: VIBRATION WHEN BRAKES ARE APPLIED

CONDITIONS	DETAILS/RESULTS/ACTIONS
C1 ROAD TEST VEHICLE	1 Road test the vehicle between 40-80 km/h (25-50 mph) without applying brakes. • Is the vibration present? → Yes TEST for noise vibration and harshness. REFER to Section 100-04. REPEAT the Road Test if necessary. → No GO to C2.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST C: VIBRATION WHEN BRAKES ARE APPLIED (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
C2 CHECK FOR REAR BRAKE VIBRATION	
NOTE: With manual release parking brake control, hold the parking brake control in release position during parking brake control application.	
	1 Road test the vehicle between 40-80 km/h (25-50 mph) with medium application on the parking brake control only. • Is a vibration present? → Yes CHECK the rear brake discs or drums for excessive wear or runout. REFER to Section 206-04 and Section 206-02. → No GO to C3.
C3 CHECK FOR FRONT BRAKE VIBRATION	
	1 Road test the vehicle between 40-80 km/h (25-50 mph) with light and medium application on the brake pedal. • Is a vibration present? → Yes CHECK the front brake discs for excessive runout or cracks. REFER to Brake Disc Runout Check. TEST the system for normal operation. → No Vehicle is OK.

PINPOINT TEST D: THE PEDAL GOES DOWN FAST

CONDITIONS	DETAILS/RESULTS/ACTIONS
D1 CHECK PEDAL EFFORT	
	1 Road test vehicle and apply the brake pedal. • Is the brake pedal effort OK? → Yes Vehicle is OK. → No GO to D2.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST D: THE PEDAL GOES DOWN FAST (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
D2 CHECK BRAKE FLUID LEVEL	
	1 Check the brake master cylinder reservoir fluid level. • Is the fluid level within specification? → Yes GO to D3. → No CHECK the brake master cylinder reservoir sealing points. REFER to Brake Master Cylinder Component Test in this section. ADD fluid and BLEED brake system. REFER to General Procedures. TEST the system for normal operation. REPEAT the road test if necessary.
D3 CHECK BRAKE PEDAL HEIGHT-PRESSURIZE SYSTEM	
	1 Pump the brake pedal rapidly (five times). • Does the brake pedal height build up and then hold? → Yes BLEED the brake system. REFER to Brake System Bleeding in this section. TEST the system for normal operation. REPEAT the road test if necessary. REFER to Section 206-06. → No GO to D4.
D4 CHECK FOR BRAKE SYSTEM LEAKS	
	1 Check for external brake system leaks. Refer to Master Cylinder in this section. • Are leaks found? → Yes REPAIR as necessary, ADD fluid and BLEED brake system. REFER to Brake System Bleeding in this section. TEST the system for normal operation. REPEAT the road test if necessary. → No GO to D5.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST D: THE PEDAL GOES DOWN FAST (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
D5 CHECK CYLINDER BYPASS CONDITION	
	1 Test for brake master cylinder bypass. Refer to Brake Master Cylinder in this section. • Are any concerns found? → Yes INSTALL a new brake master cylinder, ADD fluid and BLEED the brake system. REFER to Brake System Bleeding in this section. TEST the system for normal operation. → No System is OK.

PINPOINT TEST E: THE PEDAL GOES DOWN SLOWLY

CONDITIONS	DETAILS/RESULTS/ACTIONS
E1 CARRY OUT A ROAD TEST - CHECK BRAKE PEDAL OPERATION	
	1 Check if the condition occurs during actual stopping application by depressing the brake pedal while the vehicle is moving. • Does the condition occur when the vehicle is moving? → Yes GO to E2. → No GO to E3.
E2 CHECK FOR BRAKE SYSTEM LEAKS	
	1 Check for external brake system leaks. Refer to Master Cylinder in this section. • Are there any external brake system leaks? → Yes REPAIR as necessary. ADD fluid and BLEED the brake system. REFER to Brake System Bleeding in this section. TEST the system for normal operation. → No GO to E3.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST E: THE PEDAL GOES DOWN SLOWLY (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
E3 CARRY OUT A BRAKE MASTER CYLINDER BYPASS TEST	
	1 Test for brake master cylinder bypass condition. Refer to Brake Master Cylinder Component Test in this section. Are concerns found? → Yes INSTALL a new brake master cylinder, ADD fluid and BLEED the brake system. REFER to Brake System Bleeding in this section. TEST the system for normal operation. → No System OK.

PINPOINT TEST F: THE PEDAL IS LOW OR FEELS SPONGY

CONDITIONS	DETAILS/RESULTS/ACTIONS
F1 CHECK FOR SPONGY PEDAL	
	1 Road test the vehicle and apply the brake pedal. Is the brake pedal effort normal? → Yes Vehicle is OK. → No GO to F2.
F2 CHECK BRAKE PEDAL RESERVE	
NOTE: The increased resistance may feel like the pedal has bottomed out.	
	1 Engine at idle. 2 Depress the brake pedal lightly three or four times. 3 Wait 15 seconds for the vacuum to replenish. 4 Push down on the brake pedal until it stops moving downward or an increased resistance to the brake pedal travel occurs. 5 Hold the brake pedal in the applied position while increasing the engine speed to 2000 rpm.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST F: THE PEDAL IS LOW OR FEELS SPONGY (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
F2 CHECK BRAKE PEDAL RESERVE (Continued)	
	6 Release the accelerator pedal. Does the brake pedal move downward as the engine speed returns to idle? → Yes GO to F3. → No CHECK the vacuum to brake booster. REFER to Section 206-07.
F3 CHECK BRAKE FLUID LEVEL	
	1 Check the brake master cylinder reservoir fluid level. Is the fluid level OK? → Yes BLEED the brake system. REFER to Brake System Bleeding in this section. TEST the system for normal operation. → No CHECK brake master cylinder reservoir sealing points. REFER to Brake Master Cylinder in this section. ADD fluid and BLEED the brake system. REFER to Brake System Bleeding in this section. TEST the system for normal operation. REPEAT Road Test if necessary.

PINPOINT TEST G: BRAKE LOCK-UP DURING LIGHT BRAKE PEDAL FORCE

CONDITIONS	DETAILS/RESULTS/ACTIONS
G1 TEST BRAKE LOCK-UP	
	1 Road test the vehicle and apply the brake pedal lightly. Do the rear brakes lock up? → Yes GO to G2. → No Vehicle is OK.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST G: BRAKE LOCK-UP DURING LIGHT BRAKE PEDAL FORCE (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
G2 INSPECT BRAKE PADS OR SHOES	
	1 Inspect brake shoes for grease or fluid on linings and wear concerns, or inspect brake pads for contamination, correct installation, damage, correct size, and type. • Are any concerns found? → Yes INSTALL new brake shoes. REFER to Section 206-02 or install new brake pads. REFER to Section 206-04. TEST the system for normal operation. REPEAT the road test if necessary. → No GO to G3.
G3 TEST PRESSURE CONTROL VALVE - RR	
	1 Install pressure gauges in LF and RR bleeder screws. 2 Apply the brake pedal to read 6895 kPa (1000 psi) at LF wheel. 3 Read pressure at RR wheel. • Does the pressure gauge read between 4692-5164 kPa (680-750 psi) at RR wheel? → Yes INSPECT the calipers (disc) or wheel cylinders (drum) and INSTALL as necessary. REFER to Section 206-04 or Section 206-02. → No INSTALL a new RR brake pressure control valve. GO to G4.
G4 TEST PRESSURE CONTROL VALVE - LR	
	1 Install pressure gauges in RF and LR bleeder screws. 2 Apply brake the pedal to read 6895 kPa (1000 psi) at RF wheel.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST G: BRAKE LOCK-UP DURING LIGHT BRAKE PEDAL FORCE (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
G4 TEST PRESSURE CONTROL VALVE - LR (Continued)	
	3 Read pressure at LR wheel. • Does the pressure gauge read between 4692-5164 kPa (680-750 psi) at LR wheel? → Yes INSPECT the calipers (disc) or wheel cylinders (drum) and INSTALL new caliper or cylinders as necessary. REFER to Section 206-04 or Section 206-02. TEST the system for normal operation. → No INSTALL a new LR brake pressure control valve. TEST the system for normal operation.

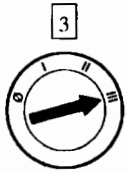
PINPOINT TEST H: EXCESSIVE/ERRATIC BRAKE PEDAL TRAVEL

CONDITIONS	DETAILS/RESULTS/ACTIONS
H1 TEST ON ROUGH ROAD	
	1 Road test the vehicle under rough road conditions. 2 Apply the brakes slowly. • Are the brakes OK? → Yes Vehicle is OK. → No GO to H2.
H2 CHECK WHEEL BEARING	
	1 Check for loose front wheel bearings. Refer to Section 204-01. • Are the front wheel bearings loose? → Yes INSTALL a new front wheel bearing if damaged. REFER to Section 204-01. TEST the system for normal operation. → No CHECK the front brake discs for thickness variances. REFER to General Procedures.

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST I: BRAKES DRAG**

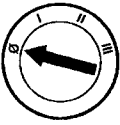
CONDITIONS	DETAILS/RESULTS/ACTIONS
I1 ROAD TEST VEHICLE	
	1 Road test the vehicle and apply brakes. Are the brakes functioning correctly? → Yes Vehicle is OK. → No INSPECT individual wheel cylinders or calipers and INSTALL new wheel cylinders or calipers as necessary. GO to I2.
I2 CHECK BRAKE BOOSTER	
	1 Check the brake booster connecting rod alignment and travel. Refer to Section 206-07. Is the connecting rod OK? → Yes Vehicle is OK. → No INSTALL a new brake booster. REFER to Section 206-07. TEST the system for normal operation.

PINPOINT TEST J: EXCESSIVE BRAKE PEDAL EFFORT

CONDITIONS	DETAILS/RESULTS/ACTIONS
J1 CHECK VACUUM	
	1 Disconnect the vacuum booster hose from the booster. 2 Connect a vacuum/pressure tester to the vacuum hose. 4 Run the engine at normal operating temperature.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST J: EXCESSIVE BRAKE PEDAL EFFORT (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
J1 CHECK VACUUM (Continued)	
	5 Record the vacuum reading. Is the vacuum reading 40.5kPa (12 in-Hg)? → Yes GO to J2. → No LOCATE and REPAIR the source of low vacuum. TEST the system for normal operation.
J2 INSPECT SYSTEM	
1 	2 Reconnect the vacuum hose. 3 Inspect the brake booster, rubber grommet, and all vacuum plumbing for cracks, holes, bad connections, or missing clamps. 4 Pump the brake pedal several times to exhaust the vacuum. Push down on the brake pedal and hold. Does the brake pedal move down when the engine is started? → Yes Vacuum system is OK. → No GO to J3.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST J: EXCESSIVE BRAKE PEDAL EFFORT (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
J3 CHECK POWER BRAKE BOOSTER CHECK VALVE	
	1 Check the brake booster check valve. Refer to Section 206-07. • Is the power brake booster check valve OK? → Yes CHECK the brake booster. REFER to Section 206-07. INSTALL a new brake booster as necessary. TEST the system for normal operation. → No INSTALL a new brake booster check valve. TEST the system for normal operation.

PINPOINT TEST K: SLOW OR INCOMPLETE BRAKE PEDAL RETURN

CONDITIONS	DETAILS/RESULTS/ACTIONS
K1 CHECK FOR BRAKE PEDAL RETURN	
	1 Run the engine at fast idle while making several brake applications. 2 Pull the brake pedal rearward with approximately 44.5 N (10 lb) force. 3 Release the brake pedal and measure the distance to the toe board. 4 Make a hard brake application. 5 Release the brake pedal and measure the brake pedal to toe board distance. The brake pedal should return to its original position. • Does the brake pedal return to its original position? → Yes Vehicle is OK. → No GO to K2.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST K: SLOW OR INCOMPLETE BRAKE PEDAL RETURN (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
K2 CHECK FOR BRAKE PEDAL BINDING	
	1 Check the brake pedal to be sure it is operating freely. • Is the brake pedal operating freely? → Yes INSTALL a new brake booster. REFER to Section 206-07. TEST the system for normal operation. → No REPAIR or INSTALL new brake pedal bushings. TEST the system for normal operation.

Component Tests**Brake Booster**

1. Check all hoses and connections. All unused vacuum connectors should be capped. Hoses and their connections should be correctly secured and in good condition with no holes and no collapsed areas. Inspect the check valve on the brake booster for damage.
2. Check the hydraulic brake system for leaks or low fluid.
3. With the transaxle in PARK (automatic transaxle) or in NEUTRAL (manual transaxle), stop the engine and apply the parking brake. Pump the brake pedal several times to exhaust all vacuum in the system.
4. With the engine turned off and all vacuum in the system exhausted, apply the brake pedal and hold it down. Start the engine. If the vacuum system is operating, the brake pedal will tend to move downward under constant foot pressure. If no motion is felt, the vacuum booster system is not functioning.
5. Remove the vacuum hose from the brake booster. Manifold vacuum should be available at the brake booster end of the hose with the engine at idle speed and the transaxle in PARK or NEUTRAL. Make sure that all unused vacuum outlets are correctly capped, hose connectors are correctly secured and vacuum hoses are in good condition. When it is established that manifold vacuum is available to the brake booster, connect the vacuum hose to the brake booster and repeat Step 3. If no downward movement of the brake pedal is felt, install a new brake booster.
6. Operate the engine a minimum of 10 seconds at fast idle. Stop the engine and let the vehicle stand for 10 minutes. Then, apply the brake pedal with approximately 89N (20 lb) of force. The pedal feel (brake application) should be the same as that noted with the engine running. If the brake pedal feels hard (no power assist), install a new check valve and then repeat the test. If the brake pedal still feels hard, install a new brake booster. If the brake pedal movement feels spongy, bleed the brake system. Refer to General Procedures.

DIAGNOSIS AND TESTING (Continued)

Brake Master Cylinder

Usually, the first and strongest indicator of anything wrong in the brake system is a feeling through the brake pedal. In diagnosing the condition of the brake master cylinder, check pedal feel as evidence of a brake concern. Check for brake warning lamp illumination and the brake fluid level in the brake master cylinder reservoir.

Normal Conditions

The following conditions are considered normal and are not indications that the brake master cylinder is in need of repair.

- New brake systems are not designed to produce as hard a pedal effort as in the past. Complaints of light pedal efforts should be compared to pedal efforts of another vehicle, same model and year.
- During normal operation of the brake master cylinder, the fluid level in the reservoir will rise during brake application and fall during release. The net fluid level (after brake application and release) will remain unchanged.
- A trace of brake fluid exists on the brake booster shell below the master cylinder mounting flange. This results from the normal lubricating action of the master cylinder bore end seal.
- Fluid level will fall with brake pad or shoe wear.

Abnormal Conditions

NOTE: Prior to carrying out any diagnosis, make sure the brake system warning indicator is functional.

Changes in brake pedal feel or travel are indicators that something could be wrong in the brake system. The diagnostic procedure and techniques use brake pedal feel, warning indicator illumination and low brake fluid level as indicators in diagnosing brake system concerns. The following conditions are considered abnormal and indicate that the brake master cylinder is in need of repair.

- Brake pedal goes down fast. This could be caused by an external or internal leak.
- Brake pedal goes down slowly. This could be caused by an external or internal leak.
- Brake pedal is low or feels spongy. This condition may be caused by no fluid in the brake master cylinder reservoir, reservoir cap vent holes clogged or air in the hydraulic system.

- Brake pedal effort is excessive. This may be caused by a bind or obstruction in pedal/linkage, clogged fluid control valve or insufficient booster vacuum.
- Rear brakes lock up during light pedal force. This may be caused by grease or fluid on brake pads or shoes, damaged brake pads or shoes, incorrectly adjusted parking brake.
- Brake pedal effort is erratic. This condition could be caused by the brake booster, extreme caliper piston knock back or incorrectly installed brake pads or shoes.
- Brake warning indicator is ON. This may be caused by low fluid level, ignition wire routing too close to fluid level indicator assembly, or float assembly damage.

Bypass Condition Test

1. Check the fluid in the brake master cylinder. Fill the brake master cylinder reservoir if low or empty.
2. Observe fluid level in brake master cylinder reservoir. If after several brake applications, the fluid level remains the same, measure wheel turning torque required to rotate wheels with the brakes applied as follows:

Place the transaxle in PARK or NEUTRAL and raise and support the vehicle on a hoist. Refer to Section 100-02.

Apply the brakes with a minimum of 445 N (100 lb) and hold for approximately 15 seconds. With the brakes still applied, exert torque on the front wheels to 10 Nm (74 lb-ft). If either wheel rotates, install a new brake master cylinder.

Non Pressure Leaks

Any empty brake master cylinder reservoir condition may be caused by two types of non pressure external leaks.

Type 1: An external leak may occur at the master cylinder reservoir cap because of incorrect positioning of the gasket and cap. Reposition cap and gasket.

Type 2: An external leak may occur at the reservoir mounting seals. Repair such a leak by installing new seals.

DIAGNOSIS AND TESTING (Continued)

Check Value

Remove the vacuum tube from the vehicle. Check the vacuum tube for cracks, splits and collapsed sections. If no concerns are found, using a suitable adaptor, connect a hand operated vacuum tester to the brake booster end of the tube. Reduce the pressure to 40.5 kPa (12 in-Hg). The pressure should hold to this setting. If the pressure cannot be reduced or does not hold install a new check valve.

GENERAL PROCEDURES

Brake System Bleeding

Bleeding

 **WARNING:** Brake fluid contains polyglycol ethers and polyglycols. Avoid contact with the eyes. Wash hands thoroughly after handling. If brake fluid contacts the eyes, flush the eyes for 15 minutes with cold running water. Get medical attention if irritation persists. If taken internally, drink water and induce vomiting. Get medical attention immediately. Failure to follow these instructions may result in personal injury.

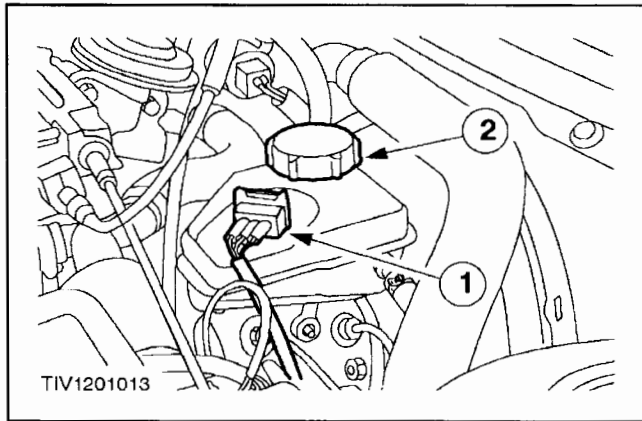
 **CAUTION:** Make sure that the vehicle is standing on a level surface or supported on a non-wheel free lift.

 **CAUTION:** If brake fluid is split on the paint work, the affected area must be immediately washed down with cold water.

NOTE: The system consists of separate circuits for each front and diagonally opposite rear wheel. Each front to rear circuit and each wheel circuit can be bled individually of each other.

NOTE: The service ABS hydraulic control unit (HCU) is supplied filled with brake fluid. Therefore, a conventional bleed procedure should be adequate to remove all air from the brake system. However, if air in the HCU is suspected, use the vehicle specific step-by-step FDS2000 instructions.

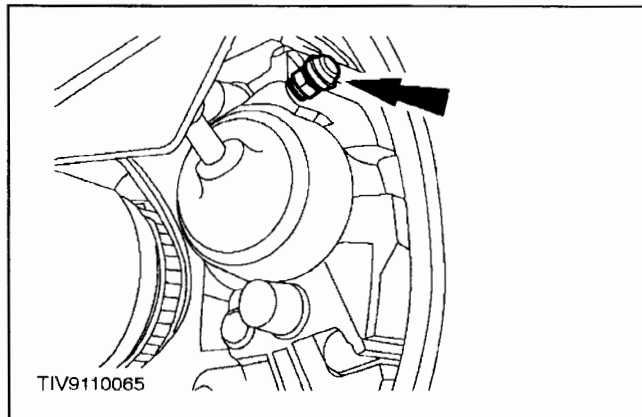
1. Disconnect the battery ground cable.

GENERAL PROCEDURES (Continued)

2.  **CAUTION:** Make sure that the filler cap does not become contaminated.

Remove the master cylinder reservoir filler cap.

- 1 Disconnect the electrical connector.
- 2 Remove the cap.

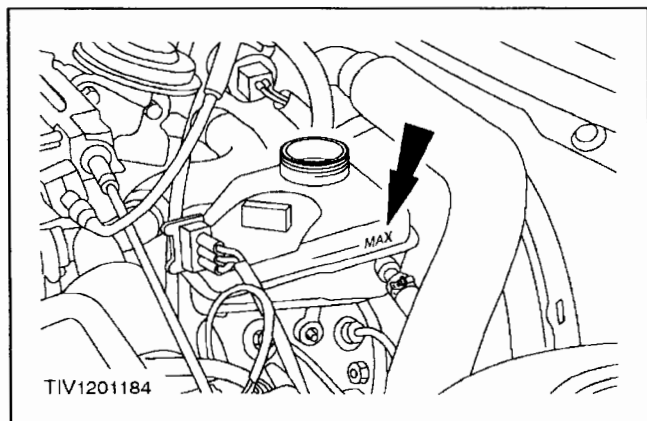


3. Fit a bleed tube to the front left-hand caliper bleed nipple.

4. **NOTE:** The master cylinder reservoir must remain full with new, clean brake fluid at all times during bleeding.

Bleed the circuit.

- Make sure the bleed tube is a firm fit.
- Immerse the end of the tube in a bleed jar containing a small quantity of approved brake fluid.
- Position the bleed jar base at least 30 mm above the bleed nipple to maintain fluid pressure and prevent air leaking past the threads of the bleed nipple.
- Unscrew the bleed nipple by half a turn.
- Depress the brake pedal fully (pumping brake fluid and air into the bleed jar) and allow the pedal to quickly return to the rest position.
- Fill the master cylinder reservoir.
- Continue pumping the brake pedal until air-free fluid is being pumped into the jar.
- With the pedal fully depressed tighten the bleed nipple.

GENERAL PROCEDURES (Continued)

5. Repeat the procedure for the rear right, front right and rear left.
6. Fill the master cylinder reservoir to the MAX mark.
7. Install the master cylinder reservoir cap.
8. Reconnect the low fluid level warning light switch electrical connector.
9. Reconnect the battery ground cable.

Brake System Pressure Bleeding**Bleeding**

⚠ WARNING: Brake fluid contains polyglycol ethers and polyglycols. Avoid contact with the eyes. Wash hands thoroughly after handling. If brake fluid contacts the eyes, flush the eyes for 15 minutes with cold running water. Get medical attention if irritation persists. If taken internally, drink water and induce vomiting. Get medical attention immediately. Failure to follow these instructions may result in personal injury.

⚠ CAUTION: Make sure that the vehicle is standing on a level surface or supported on a non-wheel free lift.

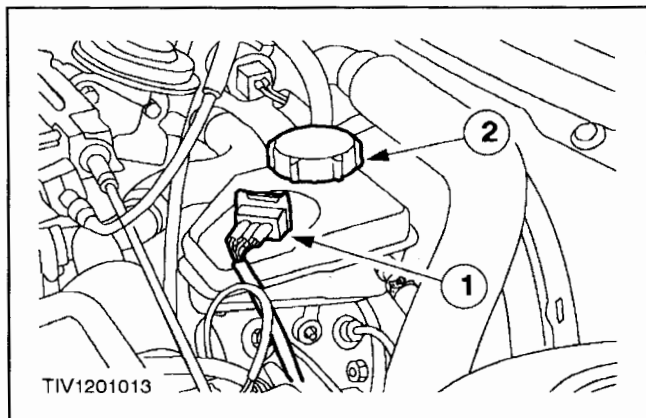
⚠ CAUTION: If brake fluid is split on the paint work, the affected areas must be immediately washed down with cold water.

NOTE: The system consists of separate circuits for each front and diagonally opposite rear wheel. Each front to rear circuit and each wheel circuit can be bled individually of each other.

GENERAL PROCEDURES (Continued)

NOTE: The service ABS hydraulic control unit (HCU) is supplied filled with brake fluid. Therefore, a conventional bleed procedure should be adequate to remove all air from the brake system. However, if air in the HCU is suspected, use the vehicle specific step-by-step FDS 2000 instructions.

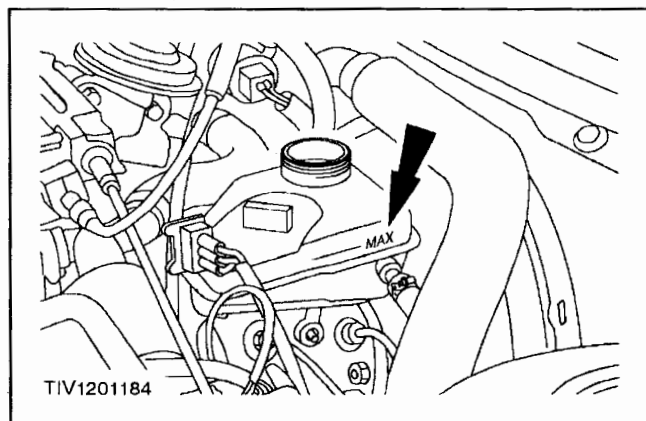
1. Disconnect the battery ground cable.



2.  **CAUTION: Make sure that the filler cap does not become contaminated.**

Remove the master cylinder reservoir filler cap.

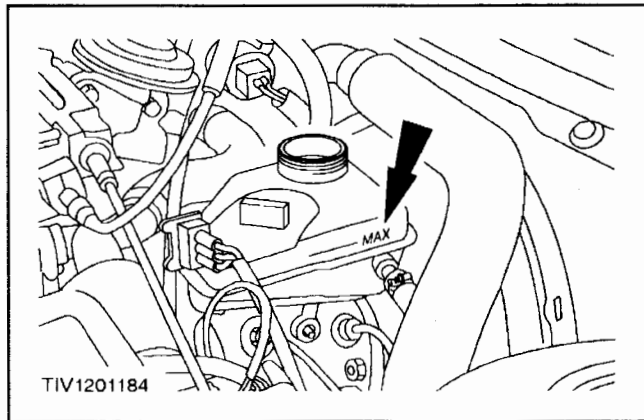
- 1 Disconnect the electrical connector.
- 2 Remove the cap.



3. Fill the master cylinder reservoir to the MAX mark.

4.  **CAUTION: The manufacturers instructions must be strictly adhered to.**

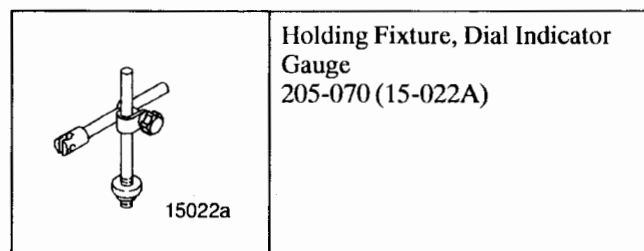
Pressure bleed the system using a suitable pressure bleeder and the equipment manufacturers instructions.

GENERAL PROCEDURES (Continued)

5. Fill up the master cylinder reservoir to the MAX mark.
6. Install the master cylinder reservoir cap.
7. Reconnect the low fluid level warning light switch electrical connector.
8. Reconnect the battery ground cable.

Brake System Hydraulic Leak Check**Check**

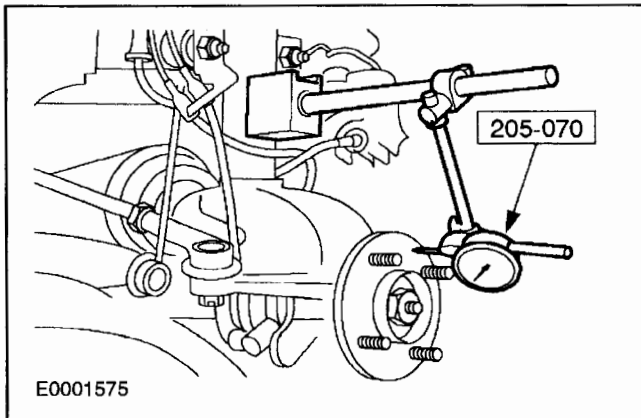
1. It is possible that all evidence of fluid leakage may have washed off if the vehicle has been operated in rain or snow, as brake fluid is water-soluble. Refill the system, bleed and apply the brakes several times. Examine the system to verify that the reservoir fluid level is actually dropping. Locate and correct the external leak. If fluid level drops and no external leak can be found, check for a brake master cylinder bore end seal leak.

Brake Disc Runout Check**Special Tool(s)****Check**

1. Remove the wheel and tire. For additional information, refer to Section 204-04.

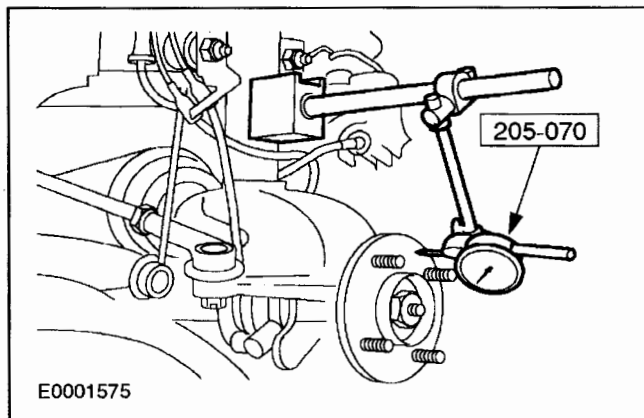
GENERAL PROCEDURES (Continued)

2. Detach the caliper and anchor plate assembly. For additional information, refer to Section 206-03 or Section 206-04.
3. Reverse and install the wheel nuts to hold the brake disc in place.
4. Install a dial indicator gauge and holding fixture to the suspension unit.



5. **NOTE:** If the runout is outside specification, check the hub face runout.
Using the special tool, measure the inner and outer faces of the disc.
 - 1 Position the gauge so that it contacts the disc 10 mm (0.4 inch) from the outer edge.
 - 2 Slowly rotate the hub/disc assembly. The total dial reading should not exceed 0.075 mm (0.003 inch).

6. Remove the brake disc. For additional information, refer to Section 206-03 or Section 206-04.



7. Using the special tool, check the hub face runout.
 - Slowly rotate the hub and check the runout. If the runout exceeds 0.05 mm (0.002 inch) install a new hub and recheck. For additional information, refer to Section 204-01.
8. If the hub face runout is within specification install a new disc and recheck disc run-out. For additional information, refer to Section 206-03 or Section 206-04.

GENERAL PROCEDURES (Continued)

1. The first step in the process is to determine the type of grain system that is being used. This is done by looking at the grain system's design and the type of grain that is being processed. The design of the grain system will determine the type of grain that can be processed and the type of processing that is required. The type of grain that is being processed will determine the type of processing that is required.

2. The second step in the process is to determine the type of processing that is required. This is done by looking at the grain system's design and the type of grain that is being processed. The design of the grain system will determine the type of processing that is required and the type of grain that can be processed.

3. The third step in the process is to determine the type of grain that is being processed. This is done by looking at the grain system's design and the type of processing that is required. The design of the grain system will determine the type of grain that can be processed and the type of processing that is required.

SECTION 206-02 Drum Brake

CONTENTS	PAGE
SPECIFICATIONS	206-02-2
DESCRIPTION AND OPERATION	
Drum Brake	206-02-2
DIAGNOSIS AND TESTING	
Drum Brake	206-02-4
REMOVAL AND INSTALLATION	
Brake Drum	206-02-4
Brake Shoes	206-02-5
Wheel Cylinder	206-02-12
Brake Backing Plate	206-02-13

SPECIFICATIONS

General Specifications

Item	Specification
Silicone Dielectric Compound D742-18A331-A	ESA-M1C171-A
High Performance Dot 3 Brake Fluid C6AZ-19542-AB	ESA-M6C25-A Dot 3

General Specifications

Description	mm	inches
New drum nominal diameter	228.6	9.0
Worn drum discard diameter ^a	229.6	9.04
Shoe width	57.1	2.25
Wheel cylinder bore diameter	20.6	0.81

- ^a When the discard diameter has been reached install a new drum. Particular care must be taken when refinishing drums that they do not exceed the maximum diameter dimensions.

Torque Specifications

Description	Nm	Lb-Ft	Lb-In
Wheel nuts — steel/alloy wheels	128	94	—
Wheel cylinder bolts	12	9	—
Wheel cylinder brake tube union	13	10	—
Backing plate bolts	50	37	—
Rear hub nut	290	214	—
ABS sensor bolt	10	—	89

DESCRIPTION AND OPERATION

Drum Brake

 **WARNING: Brake fluid contains polyglycol ethers and polyglycols. Avoid contact with the eyes. Wash hands thoroughly after handling. If brake fluid contacts the eyes, flush the eyes for 15 minutes with cold running water. Get medical attention if irritation persists. If taken internally, drink water and induce vomiting. Get medical attention immediately. Failure to follow these instructions may result in personal injury.**

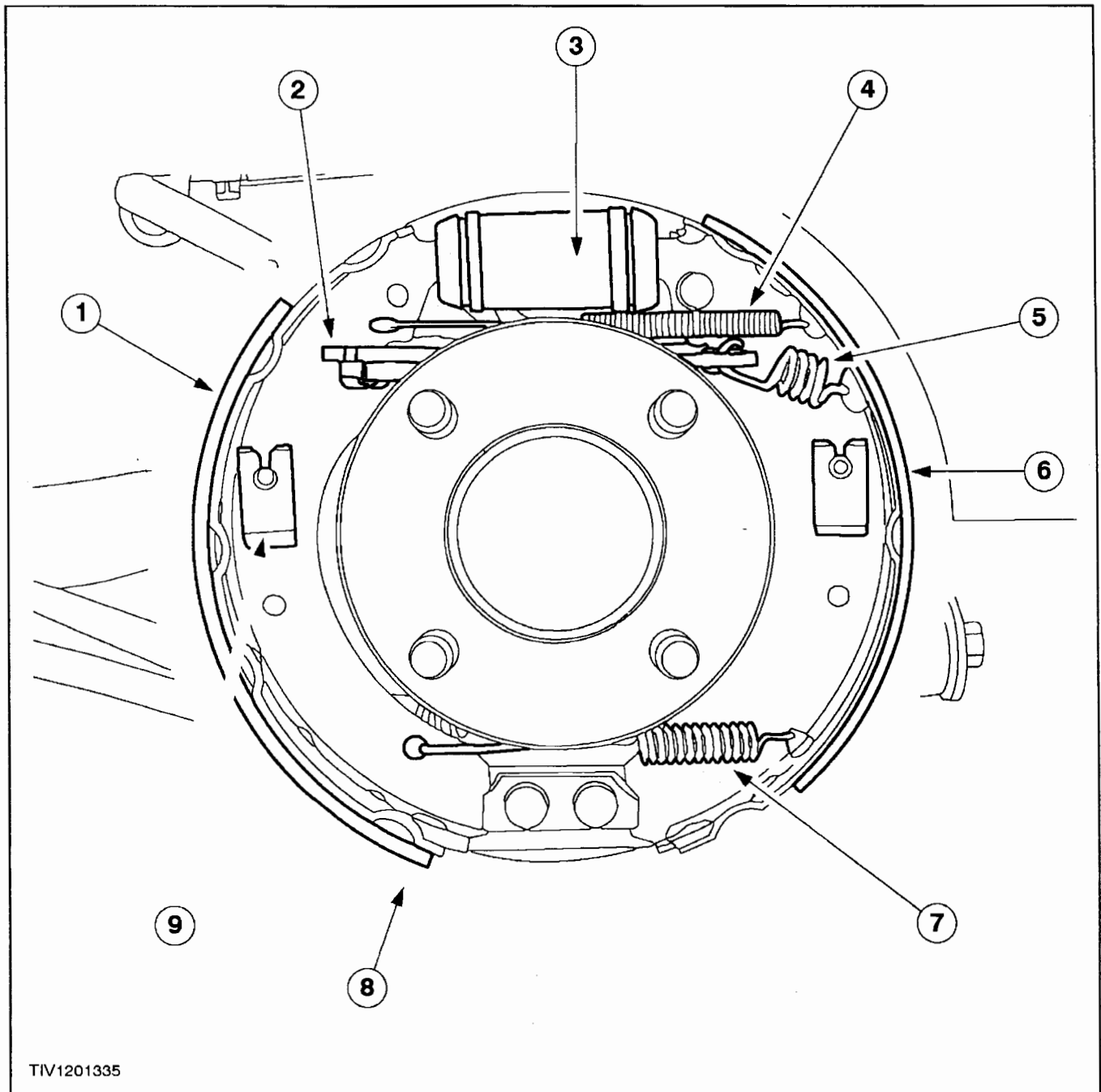
The rear drum brakes are a standard booster assisted system with rear wheel cylinders mounted on the backing plates. The brake shoes are operated by the parking brake cable and for parking brake function and adjusted by the rear brake strut and shoe adjuster that compensate for normal lining wear.

The drum brake system consists of the following components:

- Drums
- Brake shoes

- Shoe return springs
- Shoe hold down springs
- Shoe hold down spring pins
- Wheel cylinders
- Strut and brake shoe adjuster
- Backing plates
- Parking brake cables

Using the parking brake control automatically adjusts the rear brake shoes. As the parking brake control is applied a cam on the rear brake strut and brake shoe adjuster will move and adjust the rear brakes.

DESCRIPTION AND OPERATION (Continued)

Item	Part Number	Description
1	—	Primary shoe
2	—	Strut and brake shoe adjuster
3	—	Wheel cylinder
4	—	Upper return spring
5	—	Parking brake return spring

(Continued)

Item	Part Number	Description
6	—	Secondary shoe
7	—	Lower return spring
8	—	Backing plate
9	—	Hold down spring

DIAGNOSIS AND TESTING

Drum Brake

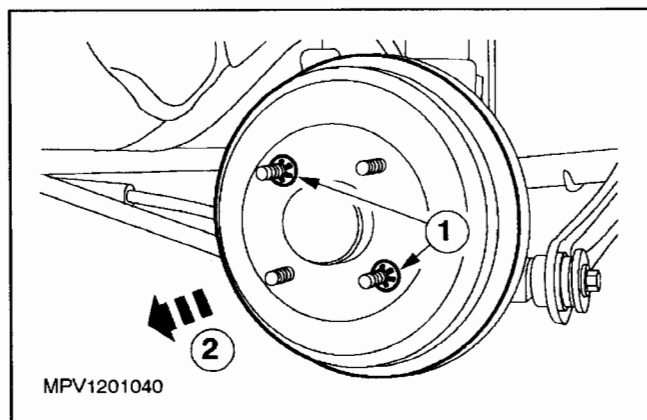
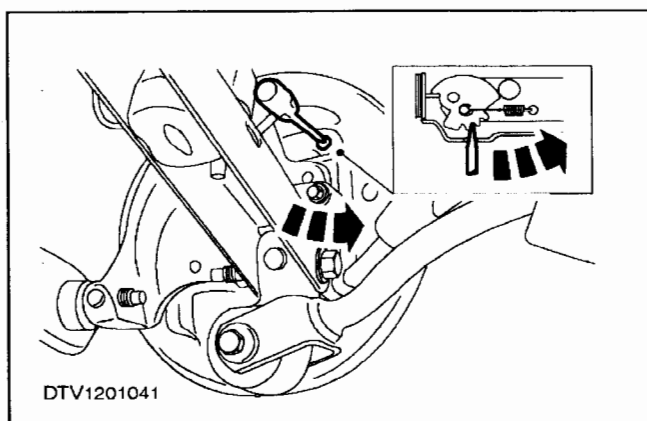
Refer to Section 206-00.

REMOVAL AND INSTALLATION

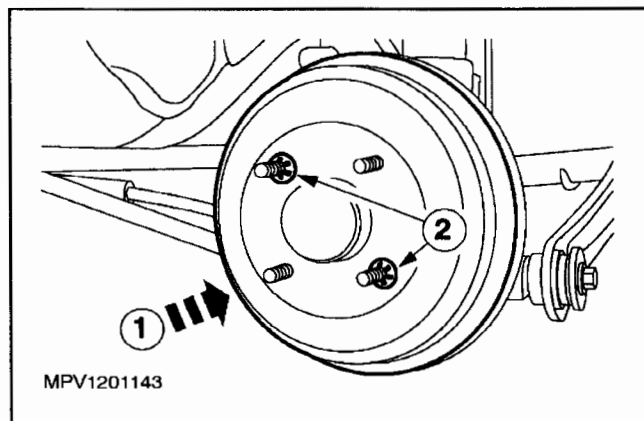
Brake Drum

Removal

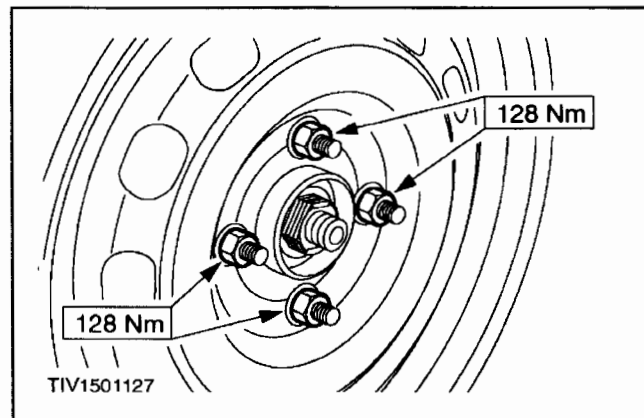
1. Loosen the wheel nuts.
2. Raise and support the vehicle. For additional information, refer to Section 100-02.
3. Remove the wheel.
4. Release the brake shoe automatic adjuster.



5. Remove the brake drum.
 - 1 Remove the retainers (if equipped).
 - 2 Remove the drum.

REMOVAL AND INSTALLATION (Continued)**Installation**

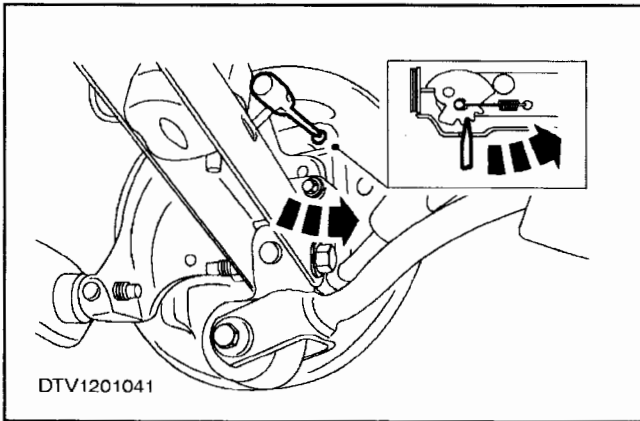
1. Install the brake drum.
 - 1 Install the drum.
 - 2 Install the retainers (if equipped).



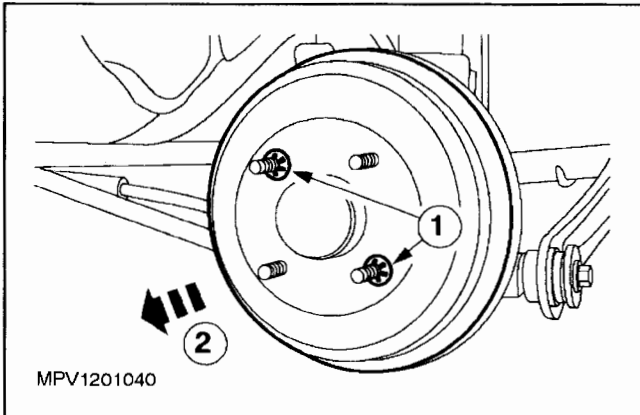
2. Install the wheel.
3. Operate the brake pedal to achieve automatic adjustment.

Brake Shoes**Removal**

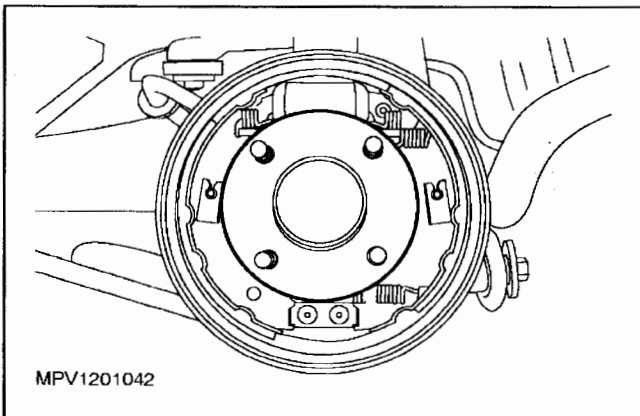
1. Loosen the wheel nuts.
2. Raise and support the vehicle. For additional information, refer to Section 100-02.
3. Remove the wheel.

REMOVAL AND INSTALLATION (Continued)

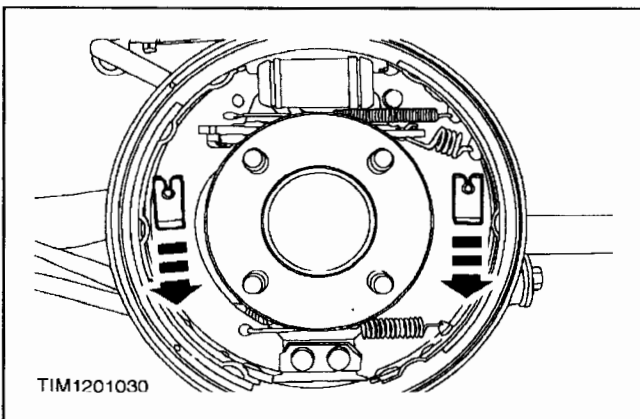
4. Release the brake shoe automatic adjuster.



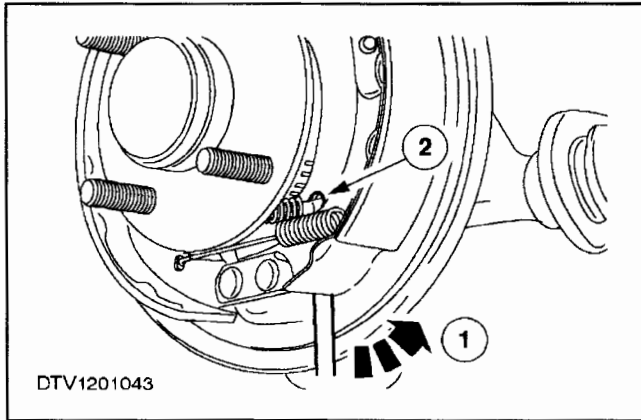
5. Remove the brake drum.
- 1 Remove the retainers (if equipped).
 - 2 Remove the drum.



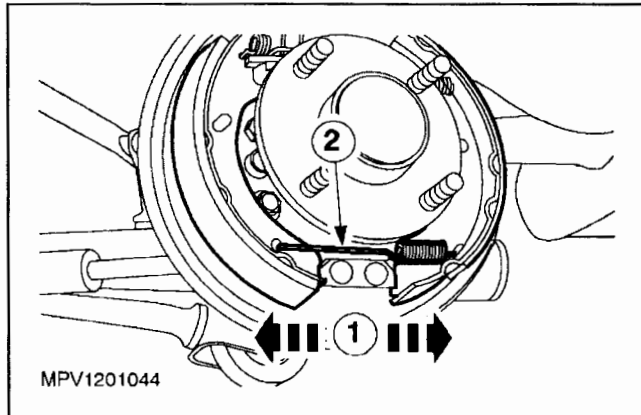
6. Make sure that the hub flange is in the correct position as shown.



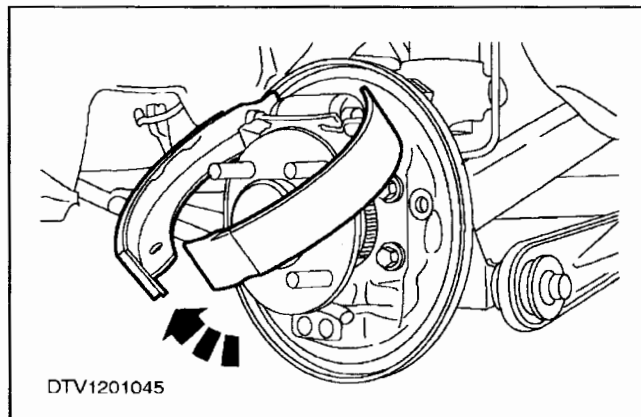
7. Remove the hold down springs.

REMOVAL AND INSTALLATION (Continued)

8. Disconnect the parking brake cable.
 - 1 Lever the secondary shoe outwards.
 - 2 Disconnect the cable from the secondary shoe.

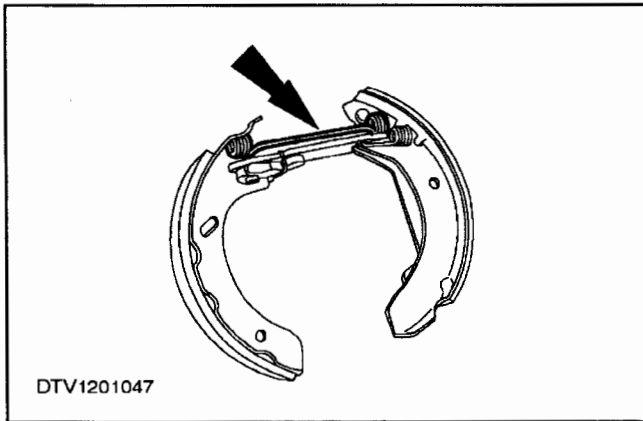


9. Disconnect the shoes from the anchor block.
 - 1 Disconnect the shoes from the anchor block.
 - 2 Remove the lower return spring.

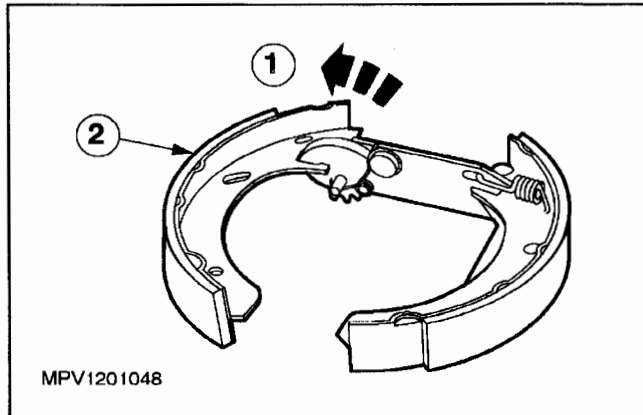


10.  **CAUTION: Do not damage the wheel cylinder boots.**
Detach the shoes from the wheel cylinder.

11. Hold the wheel cylinder pistons in place with a rubber band.

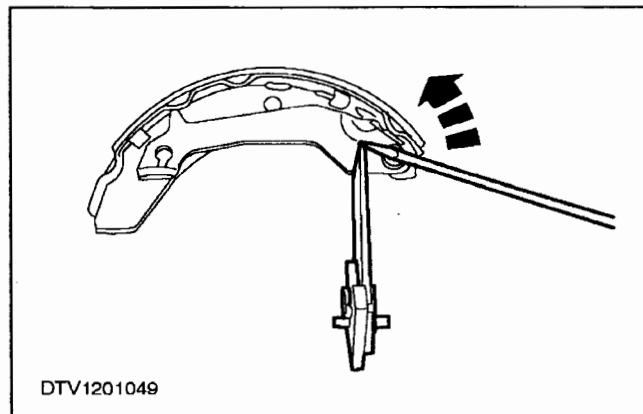
REMOVAL AND INSTALLATION (Continued)

12. Remove the upper return spring.



13. Remove the primary shoe from the strut and brake shoe adjuster.

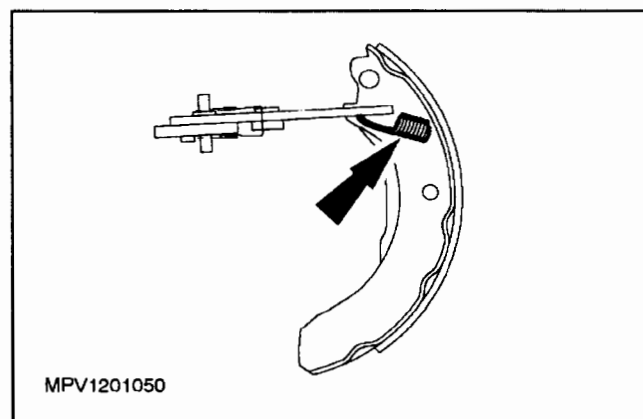
- 1 Rotate the adjuster counterclockwise.
- 2 Remove the primary shoe.



14.  **CAUTION: Take care as the strut support spring is under tension.**

Detach the secondary shoe from the strut support.

- Detach the strut from the shoe by levering the strut against the shoe.

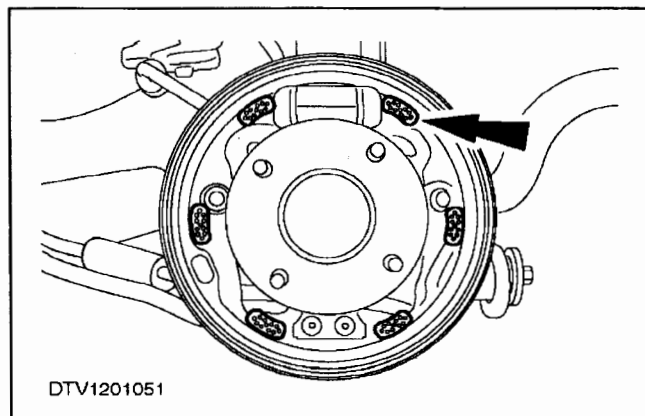


15. Remove the parking brake return spring.

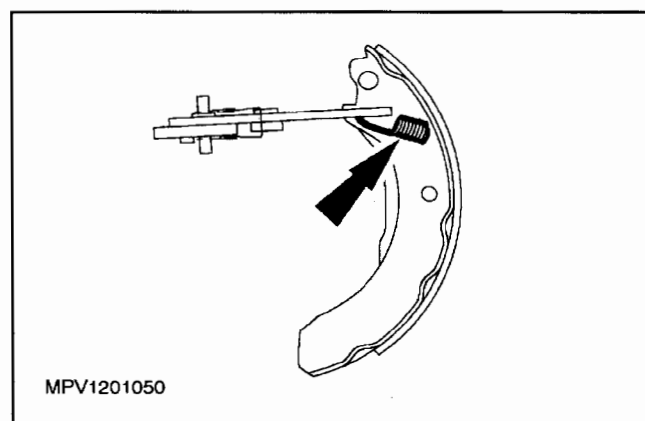
REMOVAL AND INSTALLATION (Continued)**Installation**

NOTE: Install new shoes as axle sets.

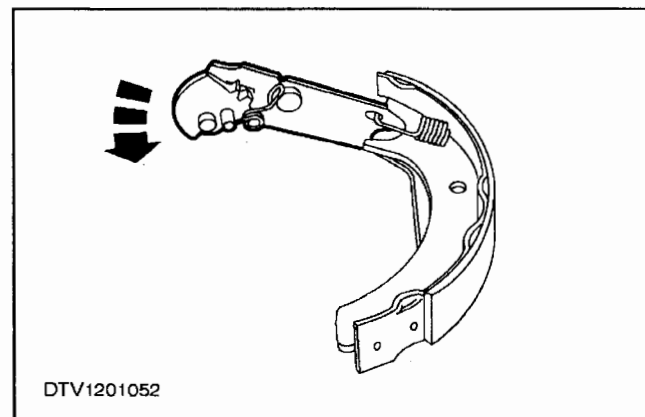
1. Clean, check and apply Silicone Dielectric Compound D742-18A331-A or equivalent meeting Ford specification ESA-M1C171-A to the backing plate contact points.

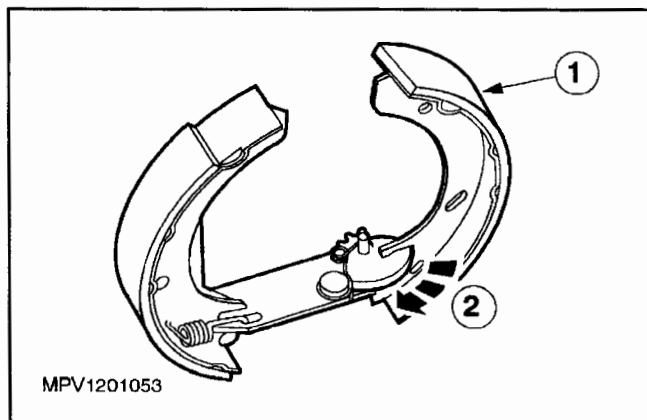


2. Install the parking brake return spring.



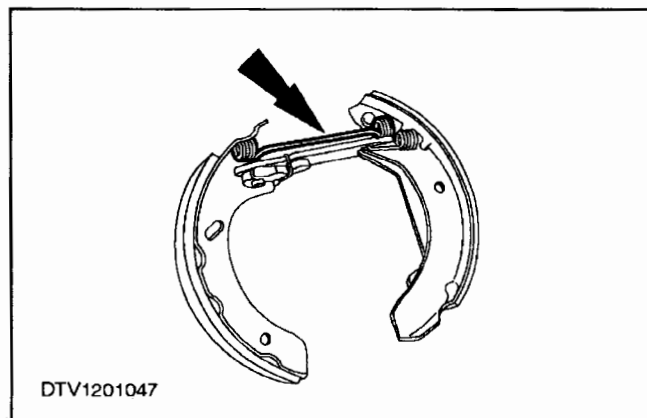
3. Install the secondary shoe to the strut and brake shoe adjuster.



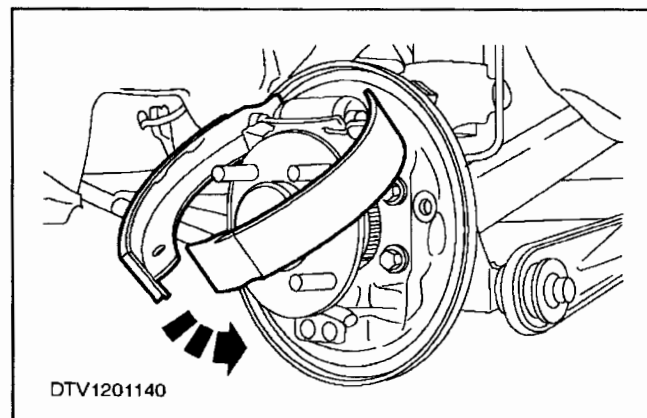
REMOVAL AND INSTALLATION (Continued)

4. Install the primary shoe to the strut and brake shoe adjuster.

- 1 Install the primary shoe.
- 2 Rotate the adjuster fully clockwise.



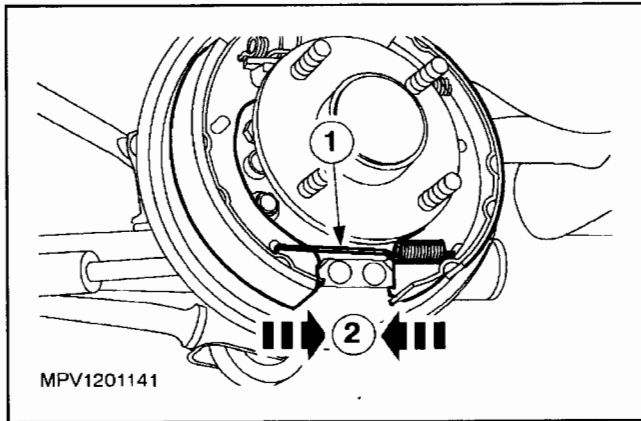
5. Install the upper return spring.



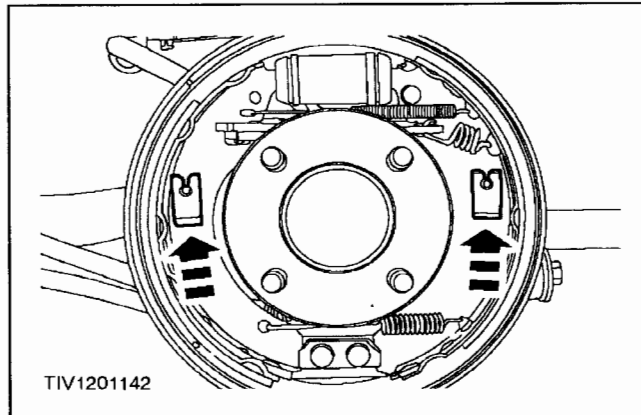
6. Remove the rubber band holding the wheel cylinder pistons in place.

7.  **CAUTION: Do not damage the wheel cylinder boots.**

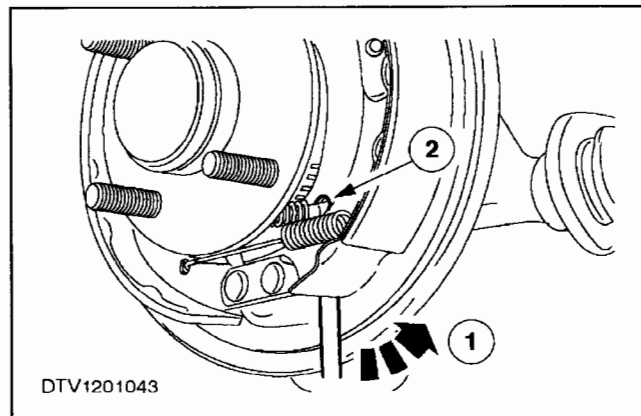
Position the shoes to the wheel cylinder.

REMOVAL AND INSTALLATION (Continued)

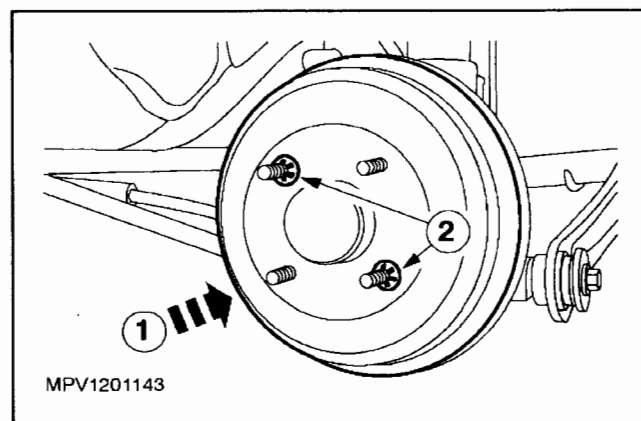
8. Position the shoes to the anchor block.
 - 1 Install the lower return spring.
 - 2 Position the shoes to the anchor block.



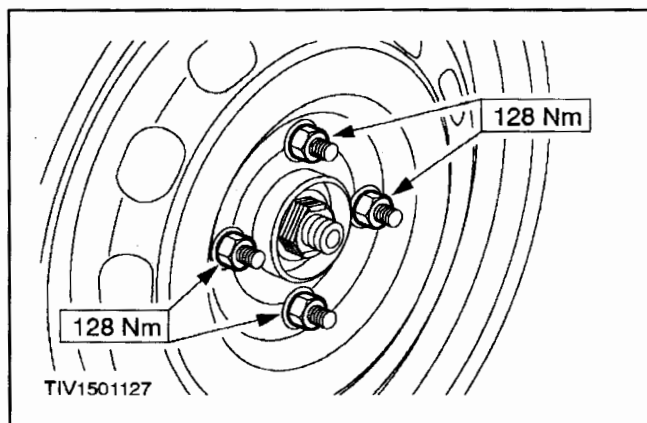
9. Install the hold down springs.



10. Install the parking brake cable.
 - 1 Lever the secondary shoe outwards.
 - 2 Install the cable to the secondary shoe.



11. Install the brake drum.
 - 1 Install the drum.
 - 2 Install the retainers (if equipped).

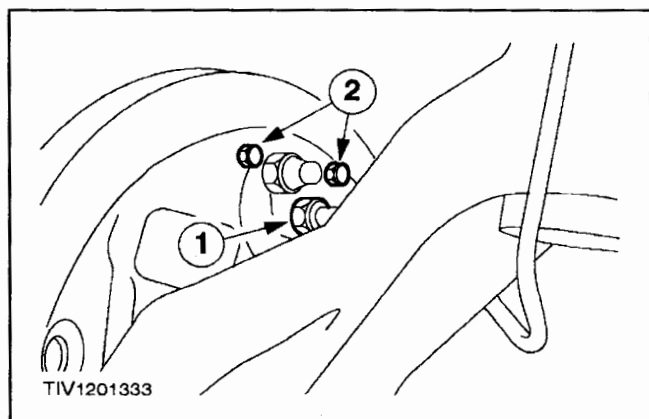
REMOVAL AND INSTALLATION (Continued)

12. Install the wheel.

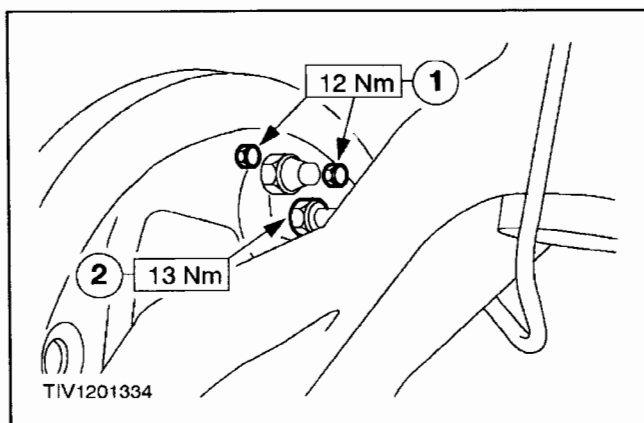
13. Operate the brake pedal to achieve automatic adjustment.

Wheel Cylinder**Removal**

1.  **CAUTION: If brake fluid is spilled on the paintwork, the effected area must be immediately washed down with cold water.**
Remove the brake shoes. For additional information, refer to Brake Shoes in this section.

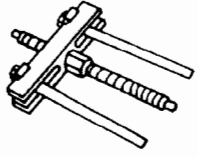
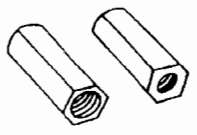


2. Remove the wheel cylinder.
 - 1 Disconnect the brake tube union.
 - 2 Remove the bolts.

REMOVAL AND INSTALLATION (Continued)**Installation**

1. Install the wheel cylinder.
 - 1 Install the bolts.
 - 2 Connect the brake tube union.
2. Install the brake shoes. For additional information, refer to Brake Shoes in this section.
3. Bleed the brake system. For additional information, refer to Section 206-00.
4. Operate the brake pedal to achieve automatic adjustment.

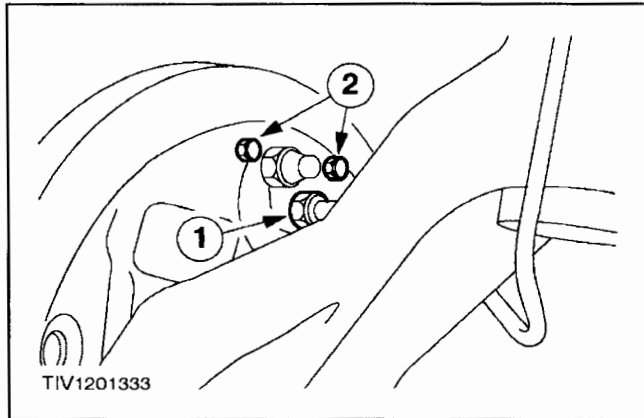
Brake Backing Plate**Special Tool(s)**

 ST1516-A	Remover/Installer, Hub 204-069 (T81P-1104-C)
 ST1518-A	Remover, Hub (Metric Stud) 204-085 (T83P-1104-BH)

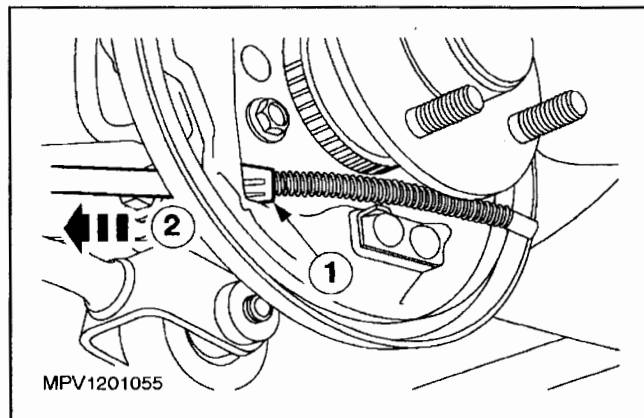
REMOVAL AND INSTALLATION (Continued)**Removal**

1.  **CAUTION:** If brake fluid is spilled on the paintwork, the effected area must be immediately washed down with cold water.

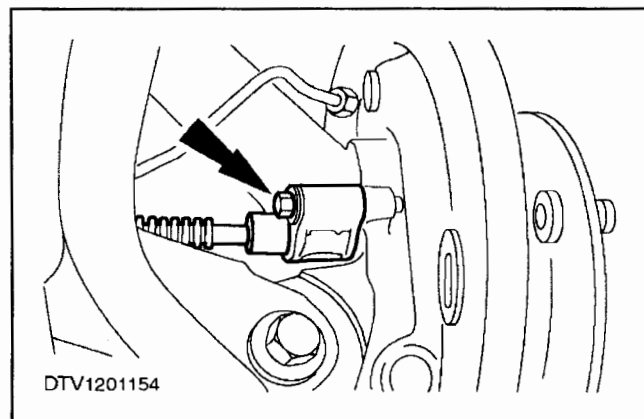
Remove the brake shoes. For additional information, refer to Brake Shoes in this section.



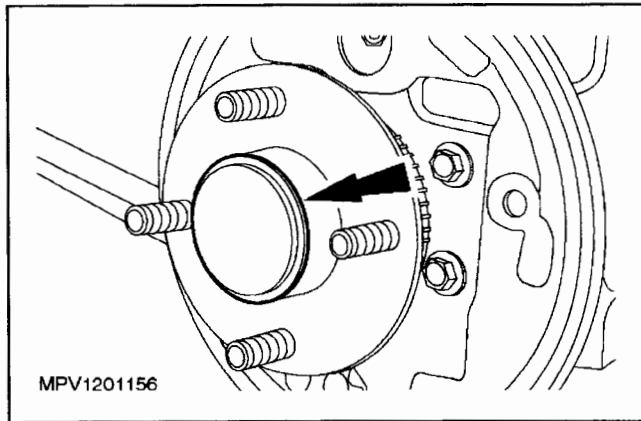
2. Remove the wheel cylinder.
 - 1 Disconnect the brake tube union.
 - 2 Remove the bolts.



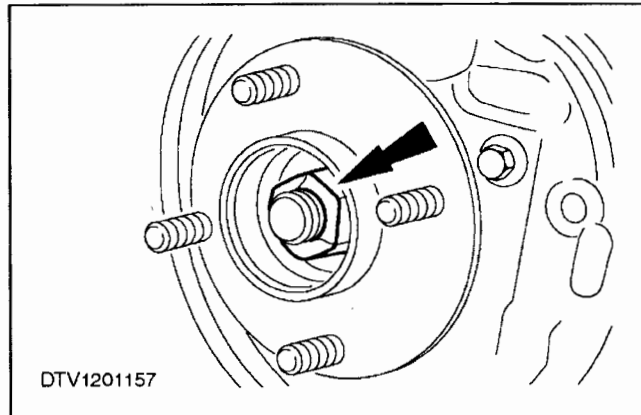
3. Detach the parking brake conduit from the backing plate.
 - 1 Depress the retaining clip.
 - 2 Detach the conduit.



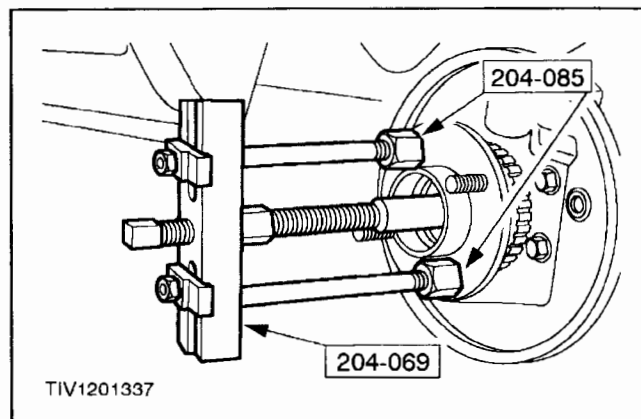
4. Disconnect the anti-lock brake system (ABS) sensor.

REMOVAL AND INSTALLATION (Continued)

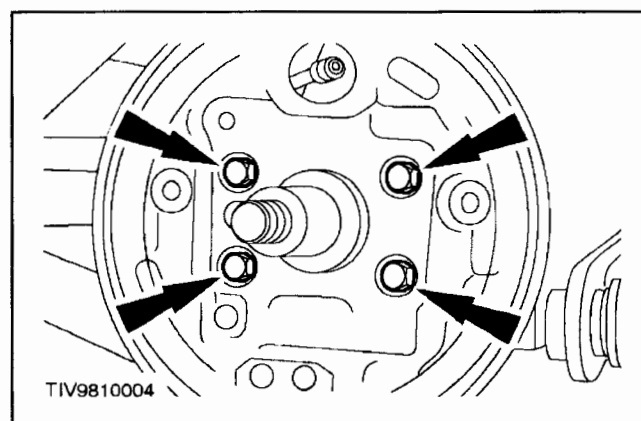
5. Remove the hub dust cap.



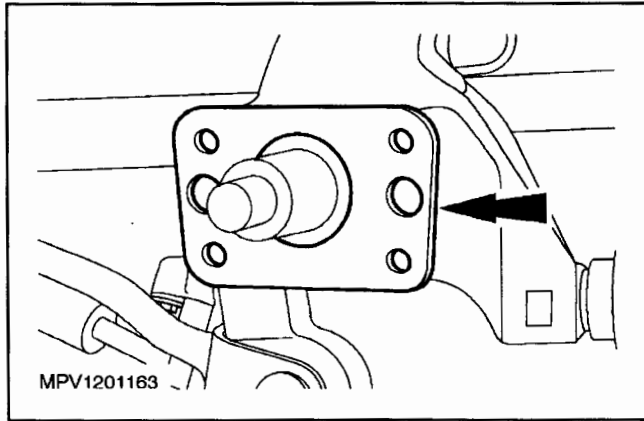
6.  **CAUTION:** Use a socket to protect the hub nut.
Remove the hub nut.



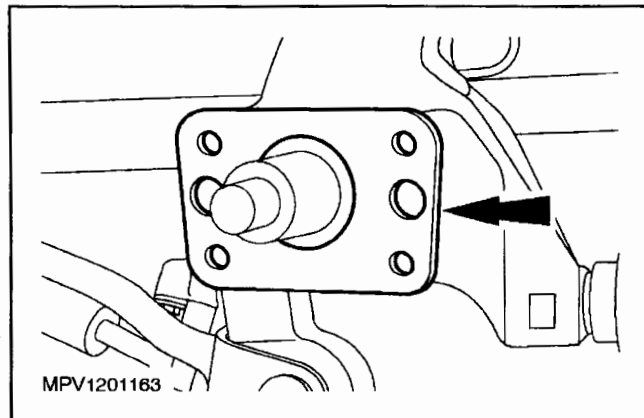
7.  **CAUTION:** If the wheel bearing inner ring bore clip is displaced a complete new hub and bearing assembly will need to be installed.
Using the special tools, remove the hub.



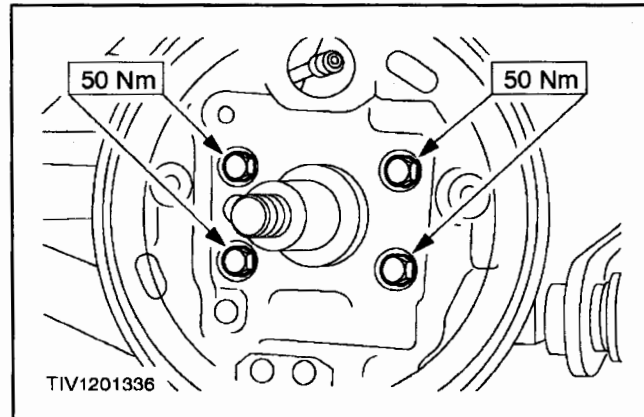
8. Remove the backing plate.

REMOVAL AND INSTALLATION (Continued)

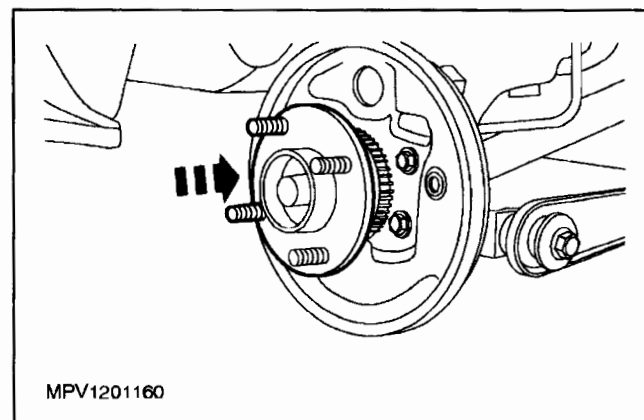
9. Remove the backing plate seal.

Installation

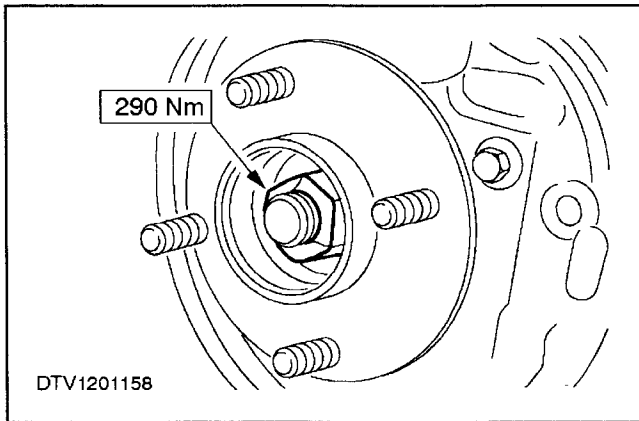
1. Install the backing plate seal.



2. Install the backing plate.

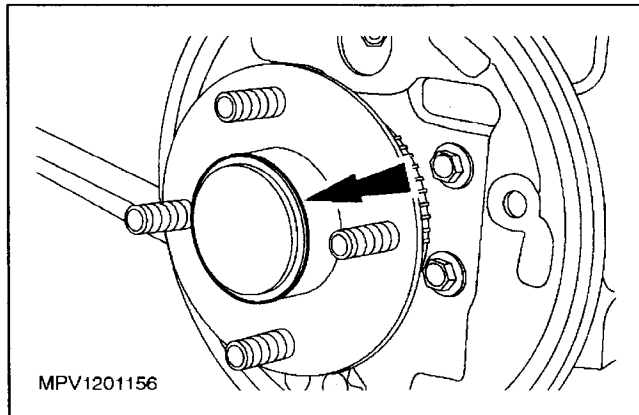


3. Install the hub.

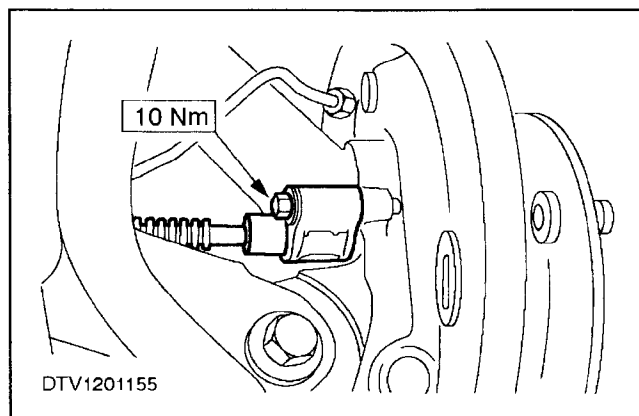
REMOVAL AND INSTALLATION (Continued)

4.  **CAUTION:** Use a socket to protect the hub nut.

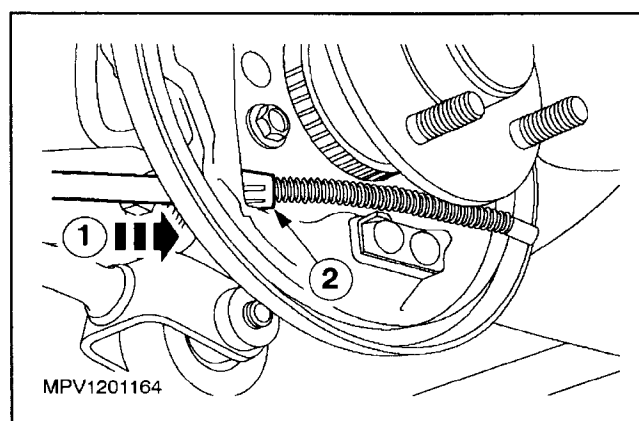
Install the hub nut.



5. Install the hub dust cap.

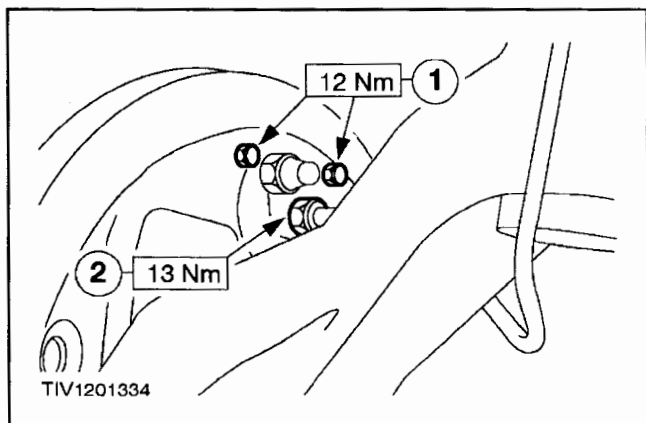


6. Install the ABS sensor.



7. Install the parking brake conduit to the backing plate.

- 1 Install the conduit.
- 2 Secure the retaining clip.

REMOVAL AND INSTALLATION (Continued)

8. Install the wheel cylinder.
 - 1 Install the bolts.
 - 2 Connect the brake tube union.
9. Install the brake shoes. For additional information, refer to Brake Shoes in this section.
10. Bleed the brake system. For additional information, refer to Section 206-00.
11. Operate the brake pedal to achieve automatic adjustment.

SECTION 206-03 Front Disc Brake

CONTENTS	PAGE
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DESCRIPTION AND OPERATION	
Front Disc Brake	206-03-3
DIAGNOSIS AND TESTING	
Front Disc Brake	206-03-4
REMOVAL AND INSTALLATION	
Brake Pads	206-03-4
Brake Caliper	206-03-8
Brake Disc	206-03-13
DISASSEMBLY AND ASSEMBLY	
Brake Caliper	206-03-15

SPECIFICATIONS

General Specifications

Item	Specification
Silicone Dielectric Compound D742-18A331-A	ESA-M1C171-A
High Performance Dot 3 Brake Fluid C6AZ-19542-AB	ESA-M6C25-A Dot 3

Brake Lining and Disc Specifications

Description	Front (2.5L)		Front (2.0L)	
	mm	inches	mm	inches
Disc diameter	278	10.95	260	10.25
New disc nominal thickness	24.15	0.95	24.15	0.95
Worn disc discard thickness ^a	22.2	0.87	22.2	0.87
Maximum disc runout (installed)	0.075	0.003	0.075	0.003
Maximum thickness variation	0.015	0.0006	0.015	0.0006
Caliper piston diameter	60	2.36	60	2.36

- a When the discard thickness has been reached the disc must be replaced. Particular care must be taken when refacing discs that they are not below the minimum thickness dimensions.

Torque Specifications

Description	Nm	Lb-Ft	Lb-In
Wheel nuts — steel/alloy wheels	128	94	—
Wheel cylinder bolts	12	9	—
Wheel cylinder brake tube union	13	10	—

(Continued)

Torque Specifications

Description	Nm	Lb-Ft	Lb-In
Backing plate bolts	50	37	—
Brake caliper and anchor plate bolts	120	89	—
Rear hub nut	290	214	—
ABS sensor bolt	10	—	89

DESCRIPTION AND OPERATION

Front Disc Brake

⚠ WARNING: Brake fluid contains polyglycol ethers and polyglycols. Avoid contact with the eyes. Wash hands thoroughly after handling. If brake fluid contacts the eyes, flush the eyes for 15 minutes with cold running water. Get medical attention if irritation persists. If taken internally, drink water and induce vomiting. Get medical attention immediately. Failure to follow these instructions may result in personal injury.

NOTE: Brake system materials inherently generate noise and heat in order to dissipate energy. As a result, occasional squeal is possible, which may be enhanced by severe environmental conditions, such as cold, heat, rain, snow, salt and mud.

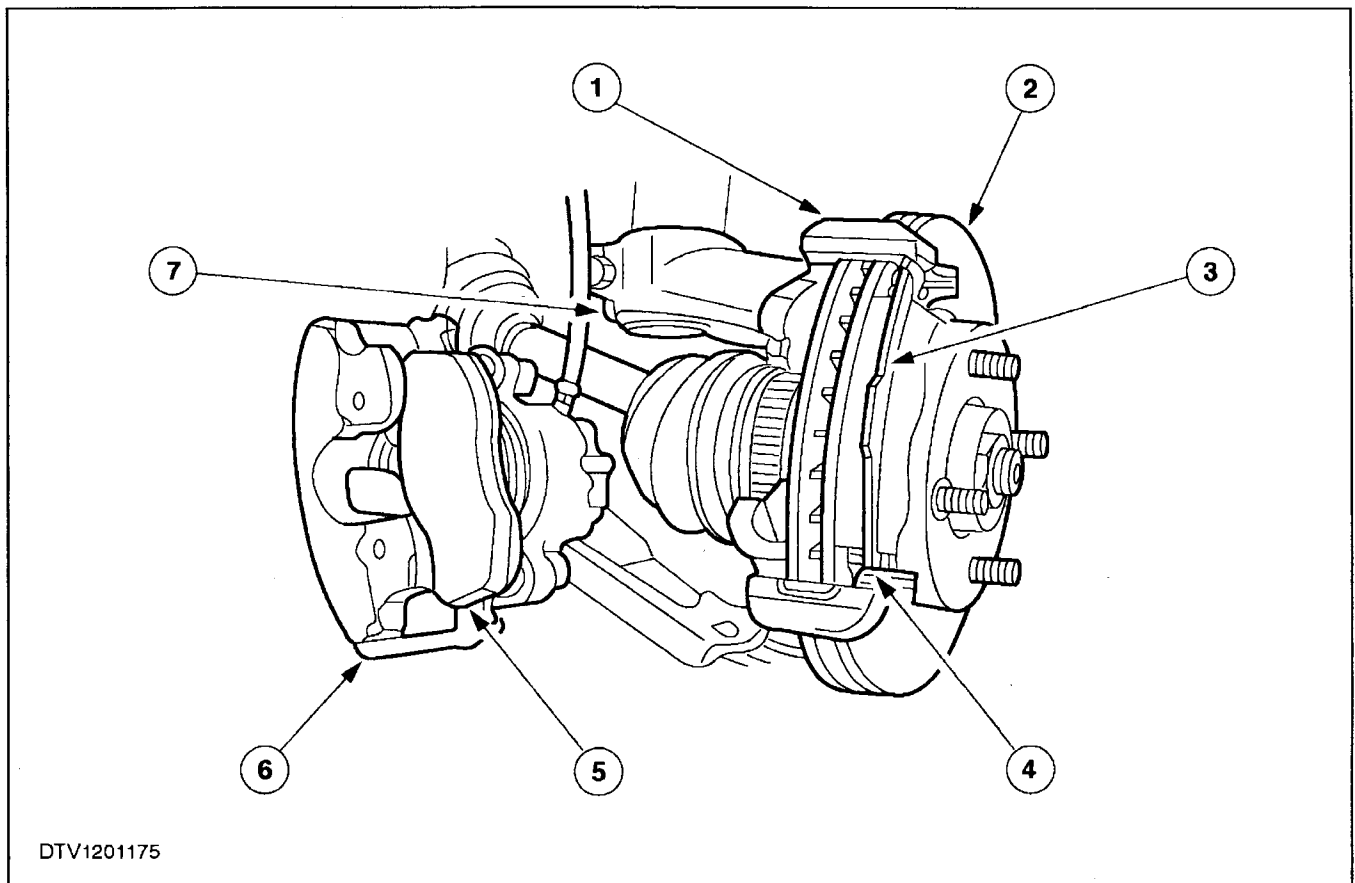
The front disc brake system consists of the following components:

- brake pads.
- single piston, floating disc calipers.

- brake discs.
- caliper anchor plates.
- brake hoses.

The caliper has two stainless steel retaining bolts that attach the caliper to the anchor plate. The anchor plate is attached to the knuckle with two bolts.

The inner pad is held in place on the caliper with clips. The outer pad is held in place on the anchor plate by a spring clip.



DESCRIPTION AND OPERATION (Continued)

Item	Part Number	Description
1	—	Caliper anchor plate
2	—	Brake disc
3	—	Brake pad clip
4	—	Outer brake pad

(Continued)

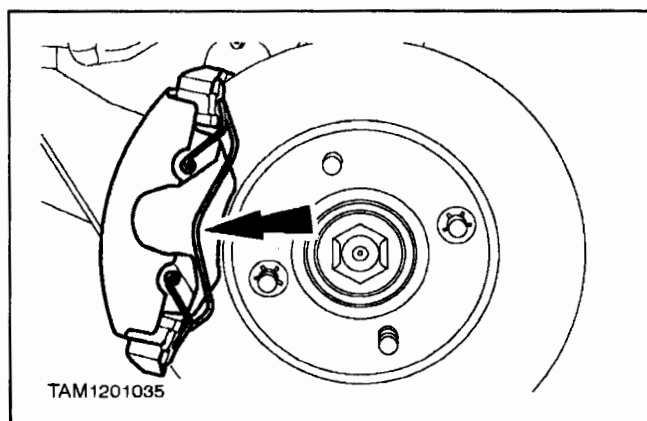
Item	Part Number	Description
5	—	Inner brake pad
6	—	Caliper
7	—	Wheel knuckle

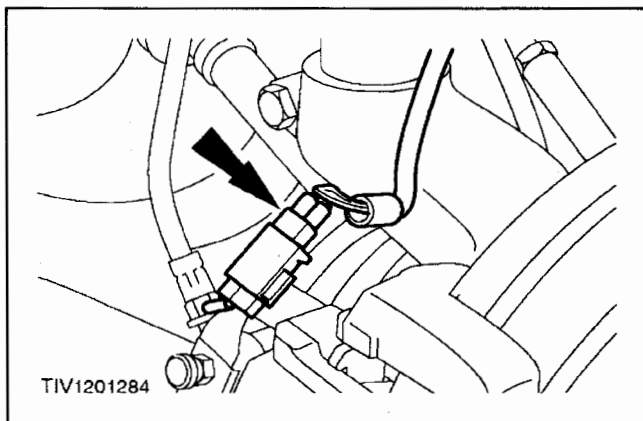
DIAGNOSIS AND TESTING**Front Disc Brake**

Refer to Section 206-00.

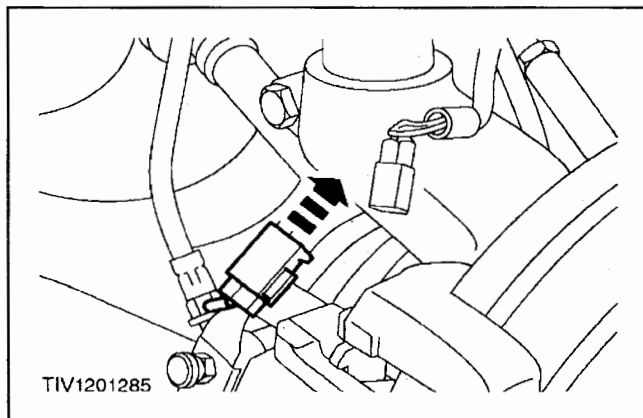
REMOVAL AND INSTALLATION**Brake Pads****Removal**

1. Loosen the wheel nuts.
2. Raise and support the vehicle. For additional information, refer to Section 100-02.
3. Remove the wheel.
4. Remove the brake pad retaining clip.

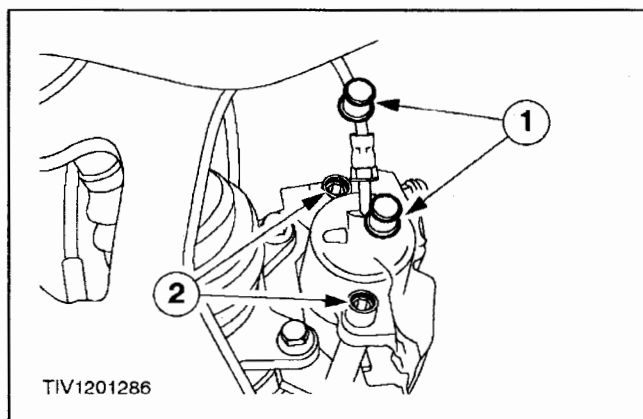


REMOVAL AND INSTALLATION (Continued)

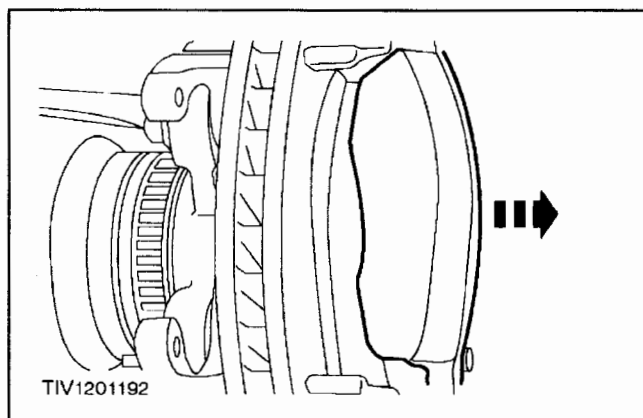
5. Disconnect the brake pad wear sensor electrical connector (if equipped).



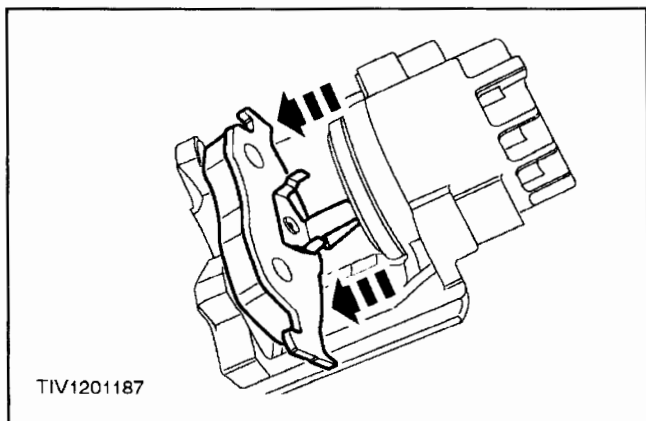
6. Detach the brake pad wear sensor electrical connector (if equipped).



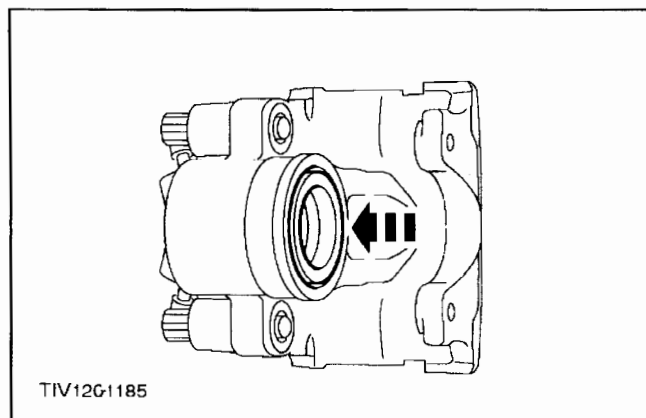
7. Detach the caliper.
- 1 Remove the bolt covers.
 - 2 Remove the bolts.
- Secure the caliper out of the way to prevent damage to the flexible brake hose.



8. Remove the outer brake pad.

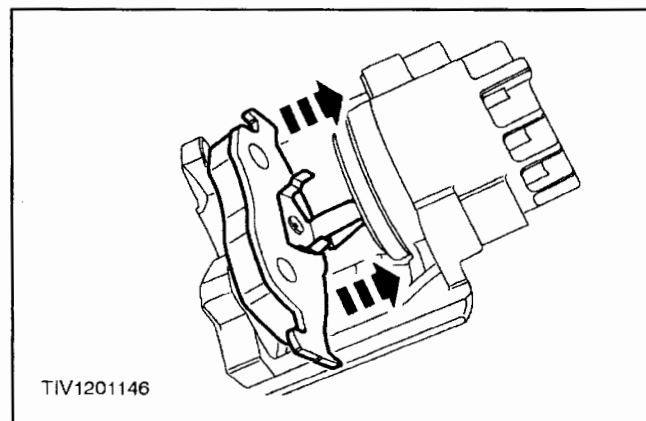
REMOVAL AND INSTALLATION (Continued)

9. Remove the inner brake pad.

Installation

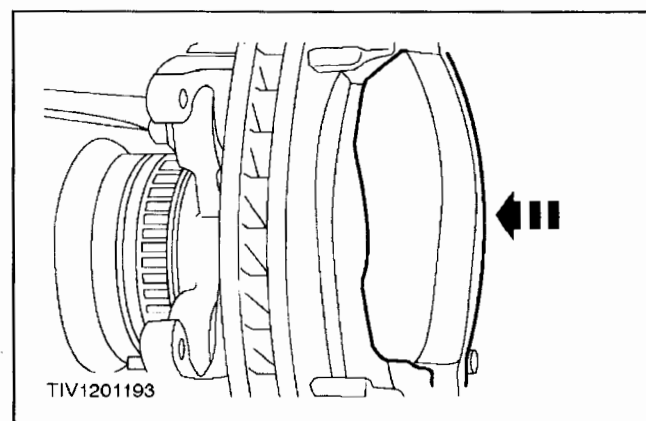
1. **CAUTION:** If the pistons are retracted into the housing, brake fluid will be displaced from the master cylinder.

Fully retract the brake disc caliper piston.



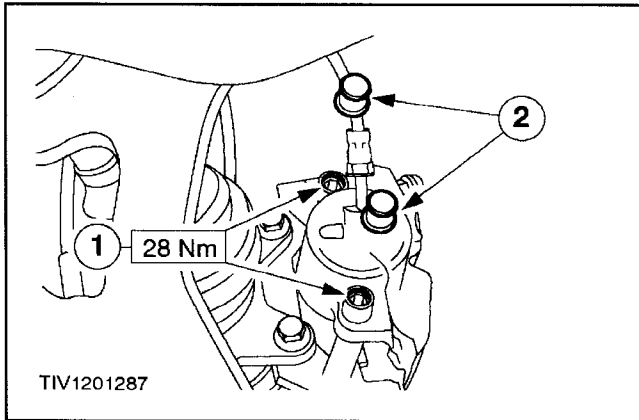
2. **CAUTION:** Make sure that the brake disc faces are clean before installation.

Install the inner brake pad.

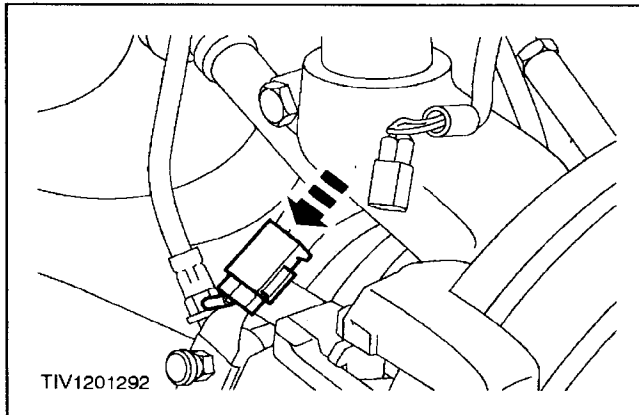


3. **CAUTION:** Make sure that the brake disc faces are clean before installation.

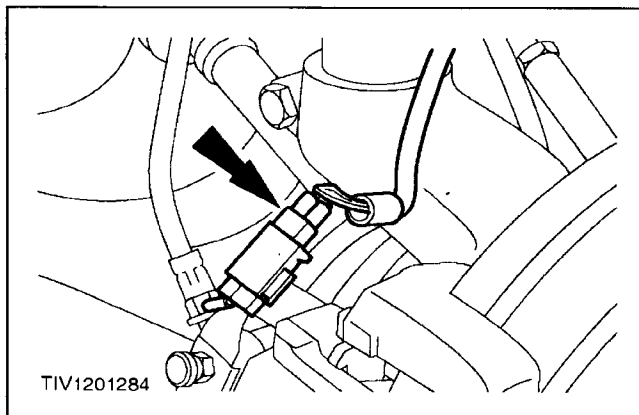
Install the outer brake pad.

REMOVAL AND INSTALLATION (Continued)

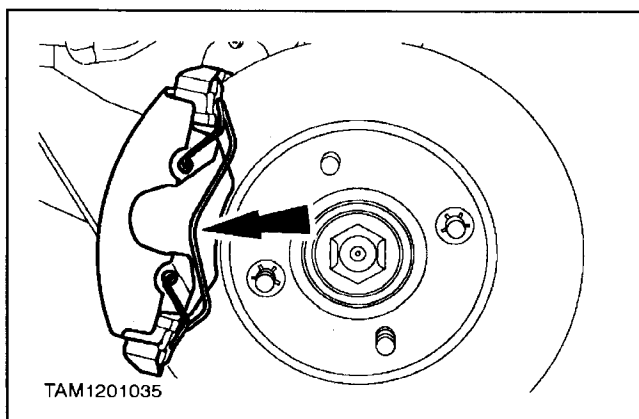
4. Install the caliper.
 - 1 Install the bolts.
 - 2 Install the bolt covers.



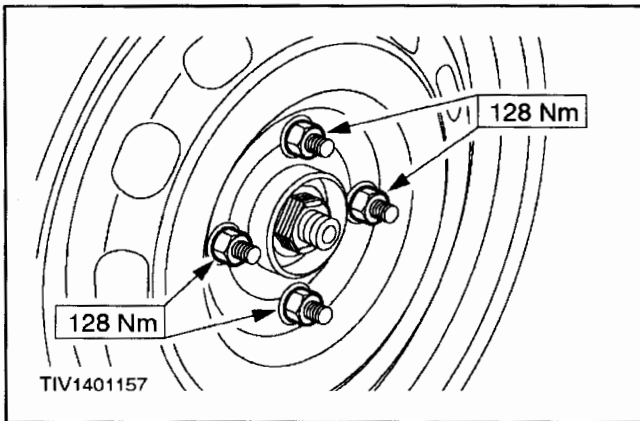
5. Attach the brake pad wear sensor electrical connector (if equipped).



6. Connect the brake pad wear sensor electrical connector (if equipped).

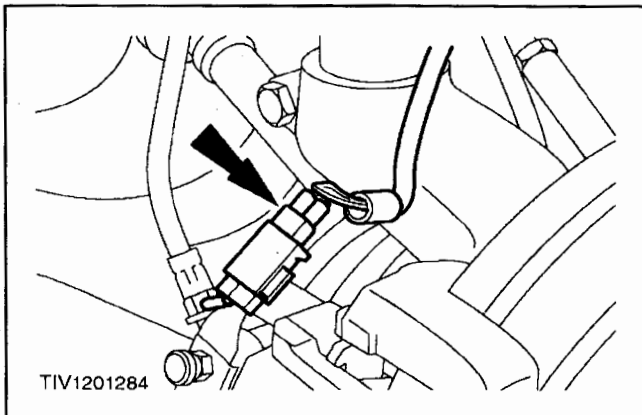


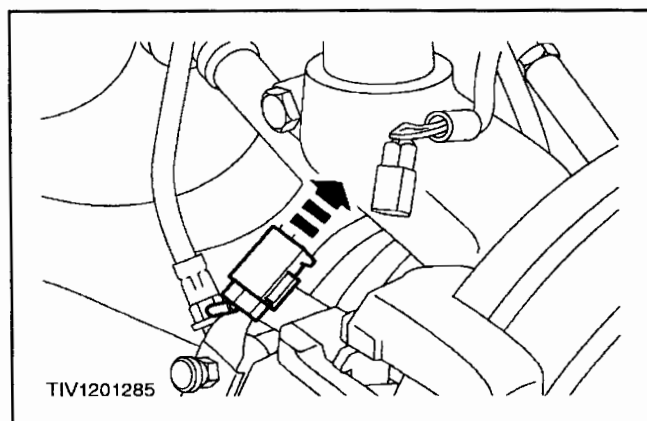
7. Install the pad retaining clip.

REMOVAL AND INSTALLATION (Continued)**Brake Caliper****Removal**

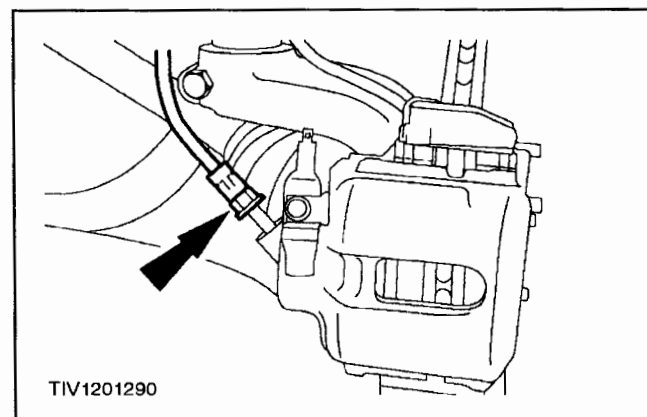
 **CAUTION:** If brake fluid is spilled on the paintwork, the affected area must be immediately washed down with cold water.

1. Loosen the wheel nuts.
2. Raise and support the vehicle. For additional information, refer to Section 100-02.
3. Remove the wheel.
4. Disconnect the brake pad wear sensor electrical connector (if equipped).

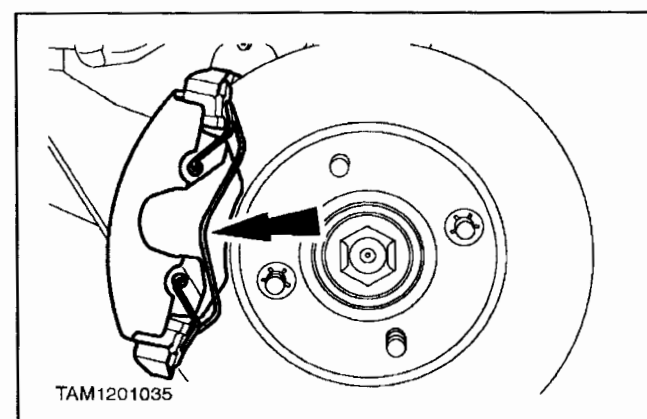


REMOVAL AND INSTALLATION (Continued)

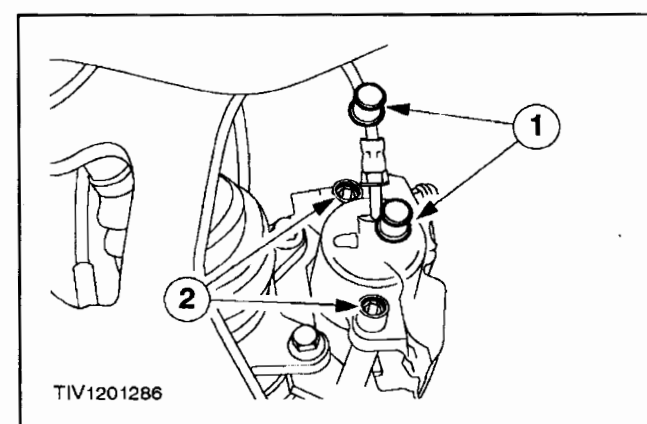
5. Detach the brake pad wear sensor electrical connector (if equipped).



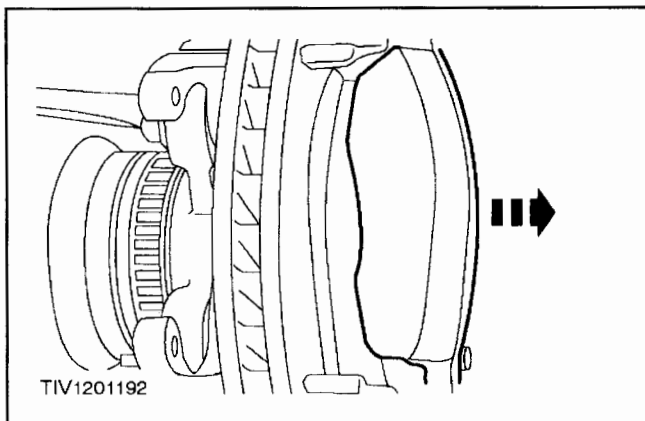
6. Loosen the brake hose union.



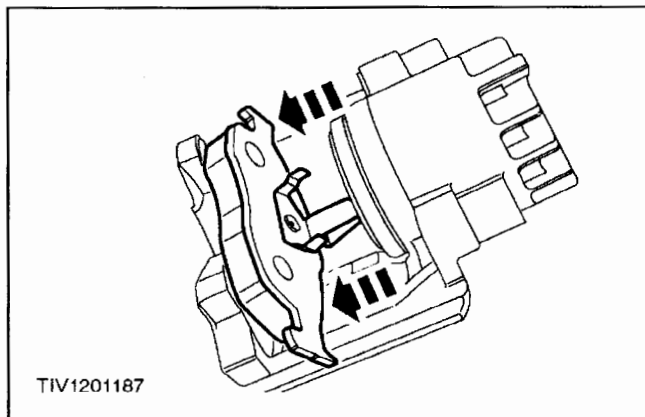
7. Remove the brake pad retaining clip.



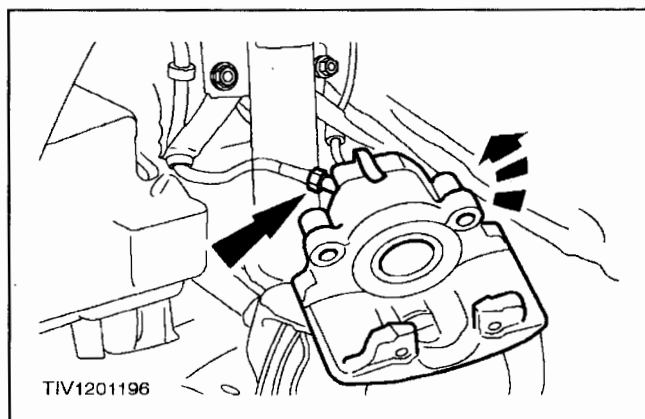
8. Detach the caliper.
- 1 Remove the bolt covers.
 - 2 Remove the bolts.

REMOVAL AND INSTALLATION (Continued)

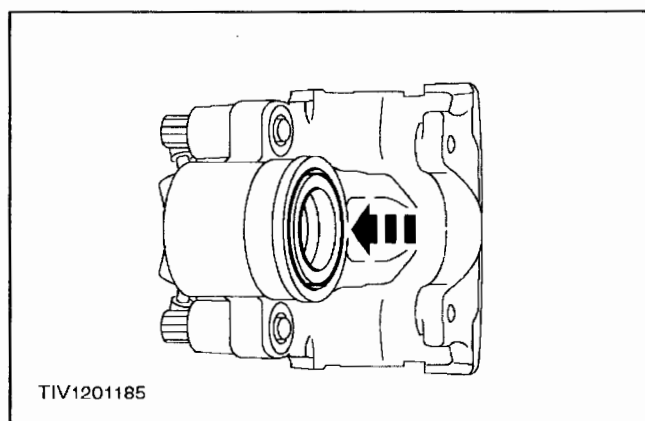
9. Remove the outer brake pad.



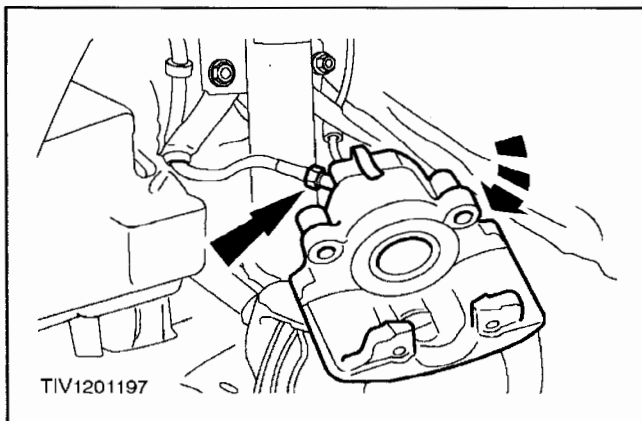
10. Remove the inner brake pad.



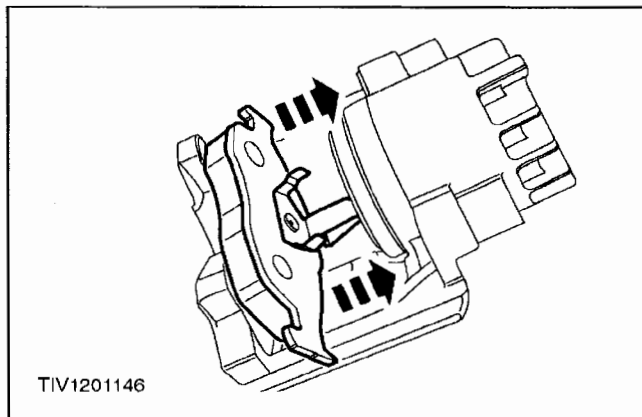
11. Disconnect the brake hose from the caliper.
- Plug the brake hose.

Installation

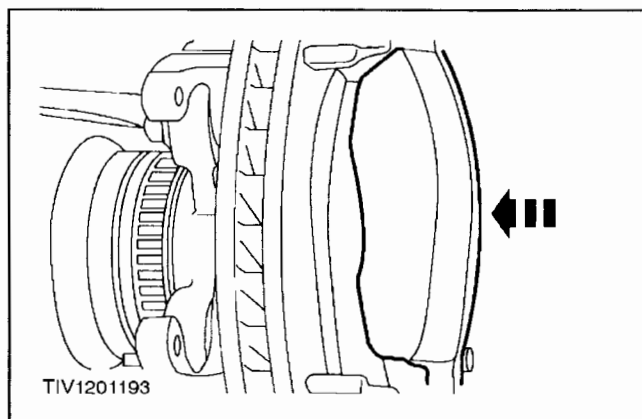
1.  **CAUTION: If the pistons are retracted into the housing, brake fluid will be displaced from the master cylinder.**
Fully retract the brake disc caliper piston.

REMOVAL AND INSTALLATION (Continued)

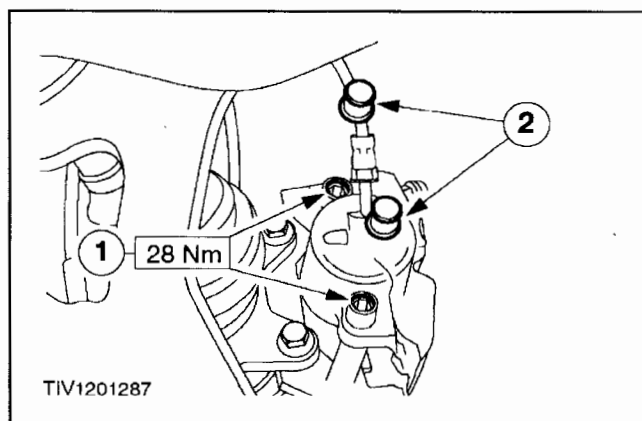
2. Loosely connect the brake hose to the caliper.
 - Remove the brake hose plug.



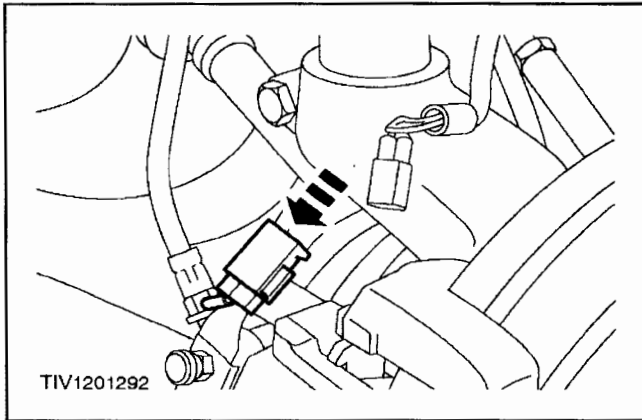
3. **CAUTION: Make sure that the brake disc faces are clean before installation.**
Install the inner brake pad.



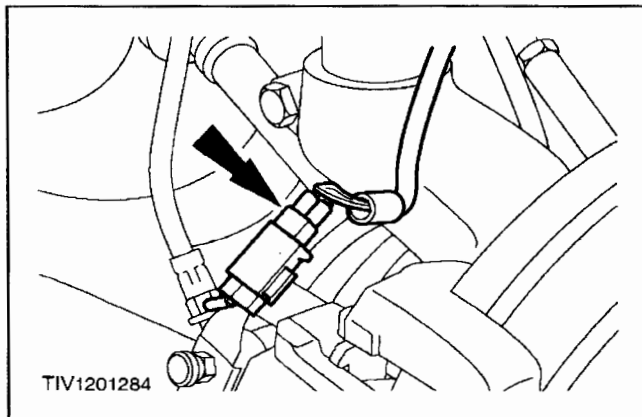
4. **CAUTION: Make sure that the brake disc faces are clean before installation.**
Install the outer brake pad.



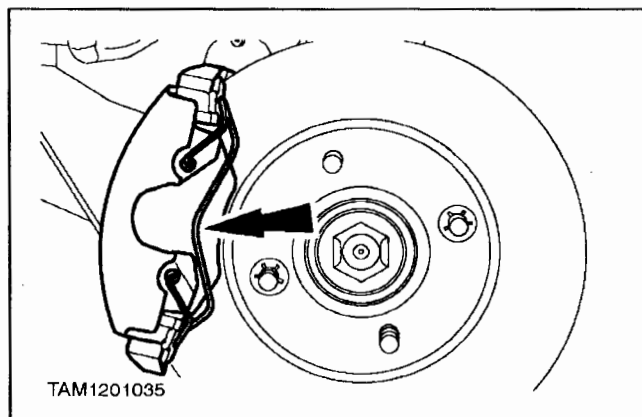
5. Install the caliper.
 - 1 Install the bolts.
 - 2 Install the bolt covers.

REMOVAL AND INSTALLATION (Continued)

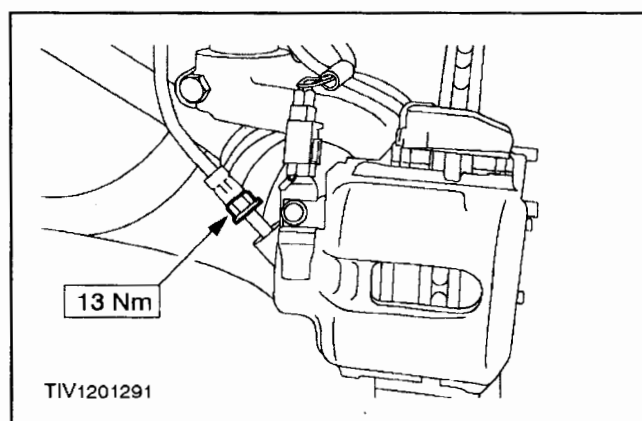
6. Attach the brake pad wear sensor electrical connector (if equipped).



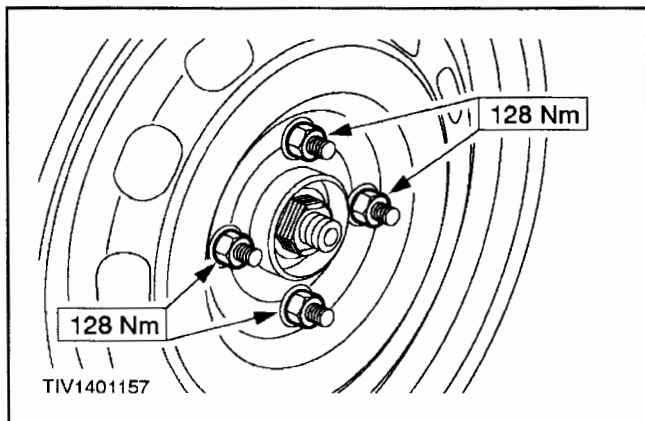
7. Connect the brake pad wear sensor electrical connector (if equipped).



8. Install the brake pad retaining clip.



9. Tighten the brake hose union.

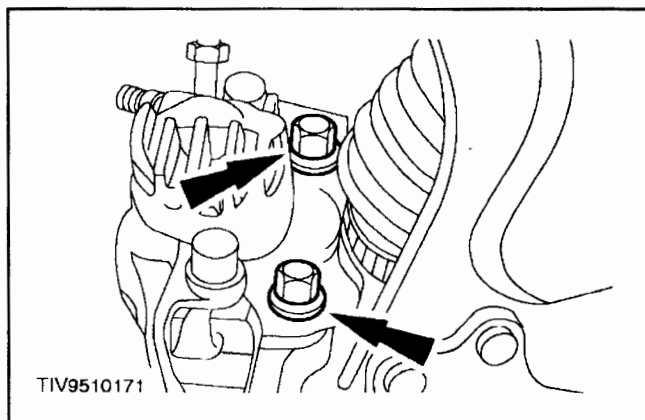
REMOVAL AND INSTALLATION (Continued)

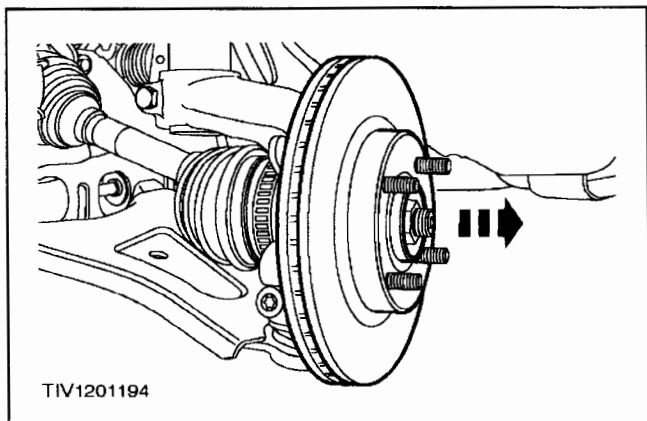
10. Install the wheel.

11. Bleed the brake system. For additional information, refer to Section 206-00.

Brake Disc**Removal**

1. Loosen the wheel nuts.
2. Raise and support the vehicle. For additional information, refer to Section 100-02.
3. Remove the wheel.
4. Detach the caliper and anchor plate assembly.
 - Secure the caliper and anchor plate assembly out of the way to prevent damage to the flexible brake hose.

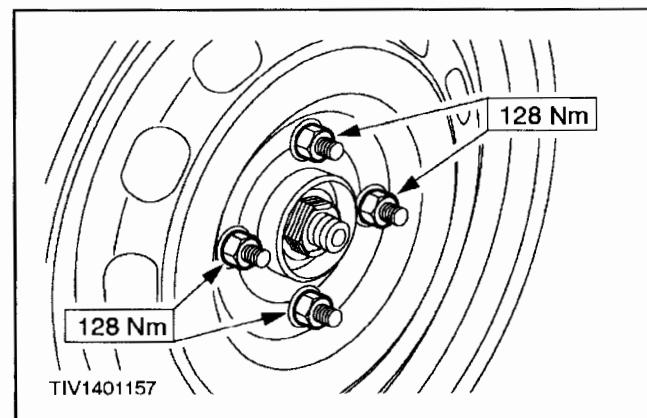
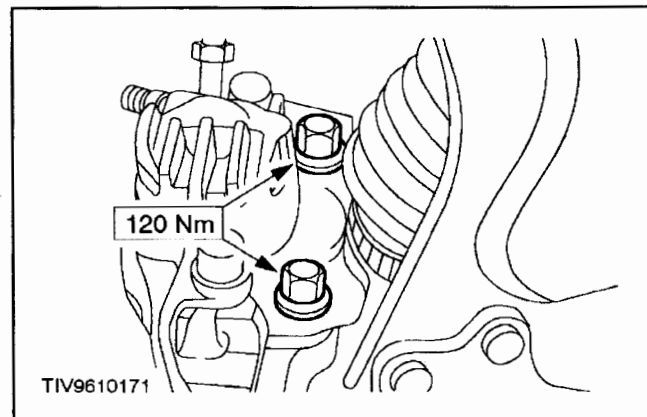
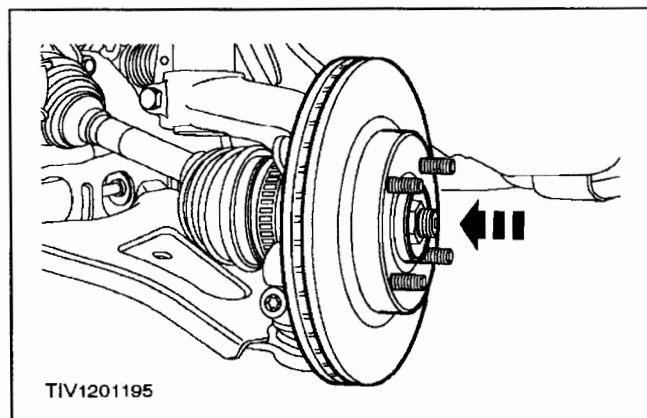


REMOVAL AND INSTALLATION (Continued)

5. Remove the brake disc.
 - Remove the retainers (if equipped).

Installation

1. To install, reverse the removal procedure.



DISASSEMBLY AND ASSEMBLY

Brake Caliper

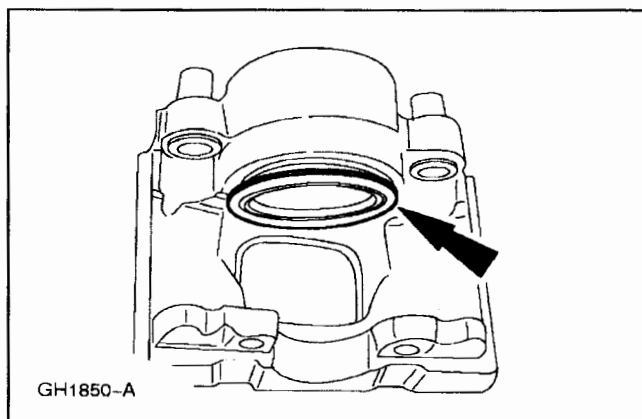
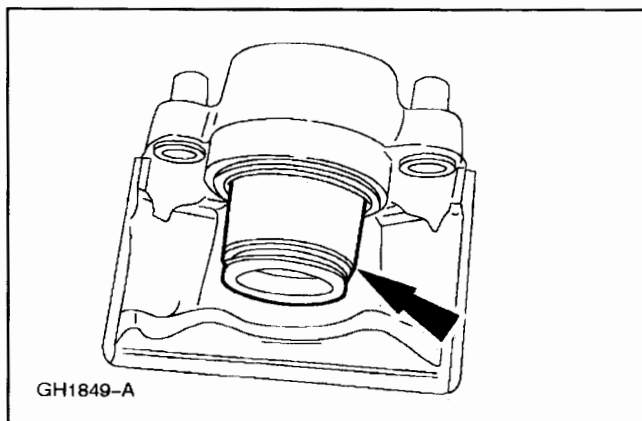
Disassembly

1. Remove the brake caliper. For additional information, refer to Brake Caliper in this section.

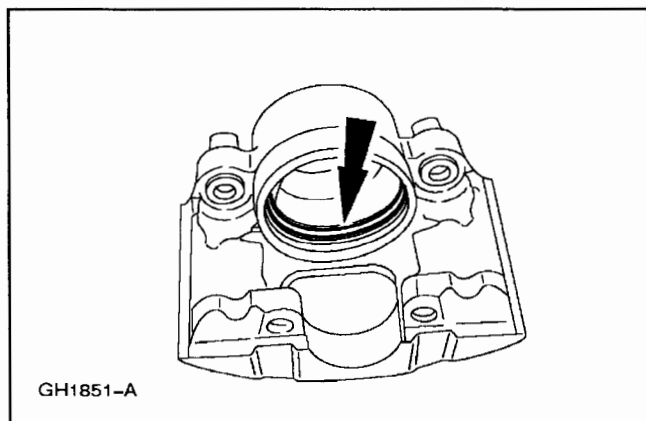
2.  **CAUTION:** Place a block of wood or some shop rags between the caliper piston and the caliper housing or damage to the caliper piston may result.

Extract the caliper piston from the caliper housing using compressed air.

3. Remove the caliper piston.



4. Remove and discard the dust seal.

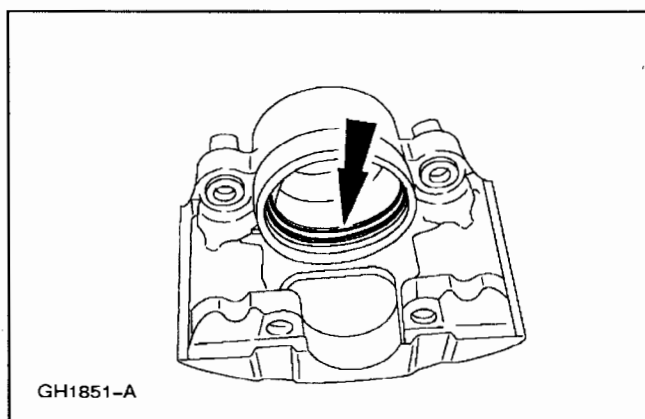
DISASSEMBLY AND ASSEMBLY (Continued)

5. Remove and discard the piston seal.

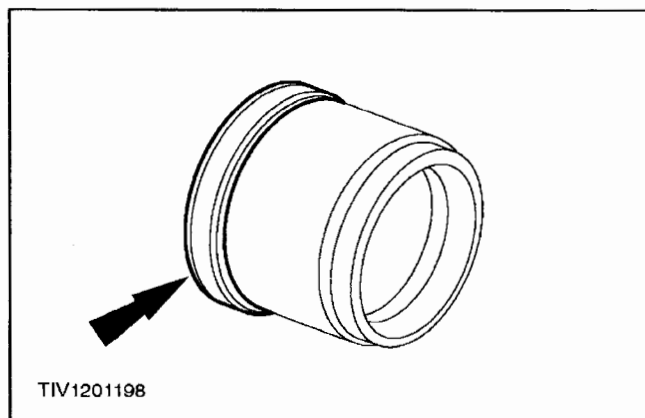
6. Inspect the caliper piston and the piston bore for pitting or scoring and install a new piston as necessary.

Assembly

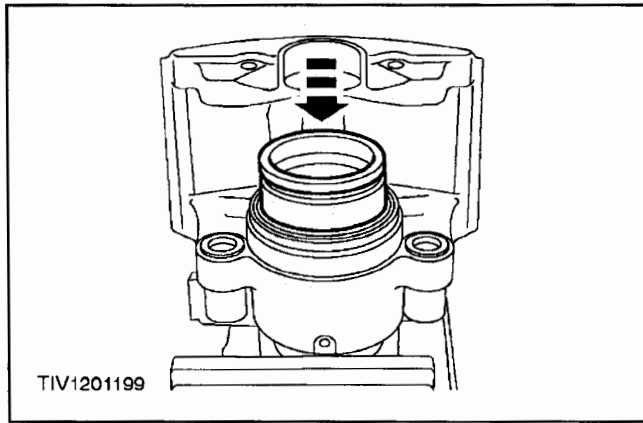
1. Lubricate the piston bore, piston seal and the caliper piston with High Performance Dot 3 Brake Fluid C6AZ-19542-AB or Dot 3 equivalent meeting Ford specifications ESA-M6C25-A.



2. **NOTE:** The caliper seal fits into a machined groove in the piston bore.
Install a new piston seal into the piston bore.



3. Install a new dust seal onto the caliper piston.

DISASSEMBLY AND ASSEMBLY (Continued)

4.  **CAUTION:** Do not scratch or damage the caliper piston when installing it into the caliper bore.

Install the caliper piston into the caliper bore.

5. Seat the dust seal.
6. Install the brake caliper. For additional information, refer to Brake Caliper in this section.

SECTION 206-04 Rear Disc Brake

CONTENTS	PAGE
SPECIFICATIONS	206-04-2
DESCRIPTION AND OPERATION	
Rear Disc Brake.....	206-04-2
DIAGNOSIS AND TESTING	
Rear Disc Brake.....	206-04-3
REMOVAL AND INSTALLATION	
Brake Caliper	206-04-3
Brake Pads	206-04-8
Brake Disc	206-04-11

SPECIFICATIONS

General Specifications

Item	Specification
Silicone Dielectric Compound D742-18A331-A	ESA-M1C171-A
High Performance Dot 3 Brake Fluid C6AZ-19542-AB	ESA-M6C25-A Dot 3

Brake Disc Specifications

Description	Rear	
	mm	inches
Disc diameter	252	9.90
New disc nominal thickness	20	0.79
Worn disc discard thickness *	18	0.71
Maximum disc runout (installed)	0.075	0.003
Maximum disc thickness variation	0.015	0.0006

(Continued)

Brake Disc Specifications

Description	Rear	
	mm	inches
Caliper piston diameter	36	1.42

- a When the discard thickness has been reached install a new disc. Particular care must be taken when refacing discs that they are not below the minimum thickness dimensions.

Torque Specifications

Description	Nm	Lb-Ft
Anchor plate bolts	120	89
Caliper locating bolt	41	30
Wheel nuts — steel/alloy wheels	128	94
Caliper brake hose union	13	10
Shield bolts	23	17

DESCRIPTION AND OPERATION

Rear Disc Brake

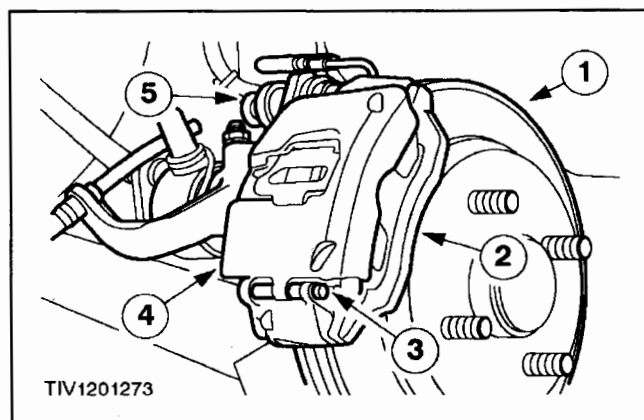
⚠ WARNING: Brake fluid contains polyglycol ethers and polyglycols. Avoid contact with the eyes. Wash hands thoroughly after handling. If brake fluid contacts the eyes, flush the eyes for 15 minutes with cold running water. Get medical attention if irritation persists. If taken internally, drink water and induce vomiting. Get medical attention immediately. Failure to follow these instructions may result in personal injury.

NOTE: Brake system materials inherently generate noise and heat in order to dissipate energy. As a result, occasional squeal is possible, which may be increased by severe environmental conditions, such as cold, heat, rain, snow, salt and mud.

The rear disc brake system consists of the following components:

- brake pads.
- single piston, floating disc calipers.
- brake discs.

- caliper anchor plates.
- brake hoses.
- parking brake cable and conduit.



Item	Part Number	Description
1	—	Brake disc
2	—	Caliper anchor plate
3	—	Pin
4	—	Caliper
5	—	Caliper locating bolt

DIAGNOSIS AND TESTING

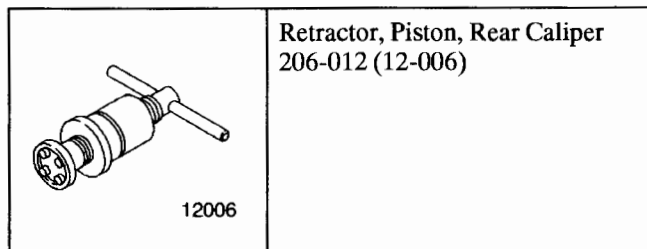
Rear Disc Brake

Refer to Section 206-00.

REMOVAL AND INSTALLATION

Brake Caliper

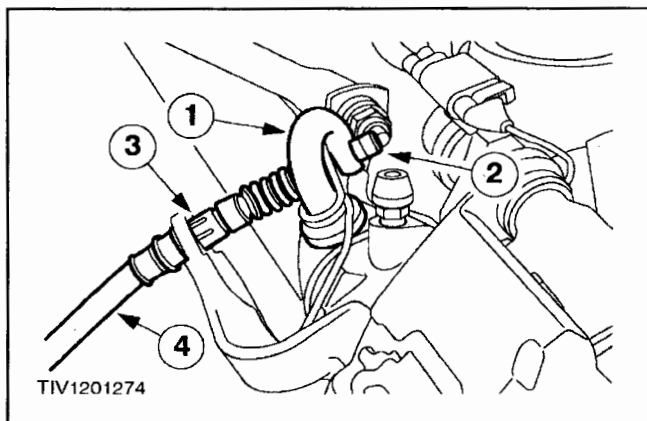
Special Tool(s)

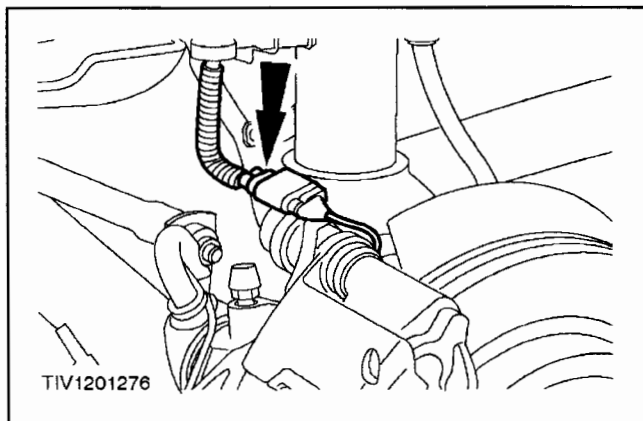


Removal

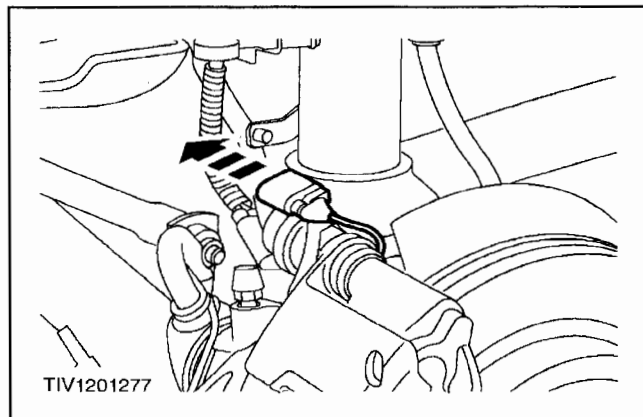
 **CAUTION:** If brake fluid is spilled on the paintwork, the affected area must be immediately washed down with cold water.

1. Loosen the wheel nuts.
2. Raise and support the vehicle. For additional information, refer to Section 100-02.
3. Remove the wheel.
4. Disconnect the parking brake cable.
 - 1 Pull back the parking brake lever.
 - 2 Disconnect the cable from the parking brake lever.
 - 3 Detach the conduit retaining clip.
 - 4 Detach the cable and conduit.

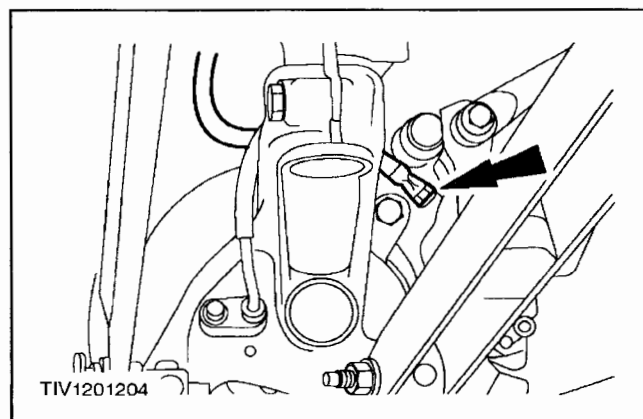


REMOVAL AND INSTALLATION (Continued)

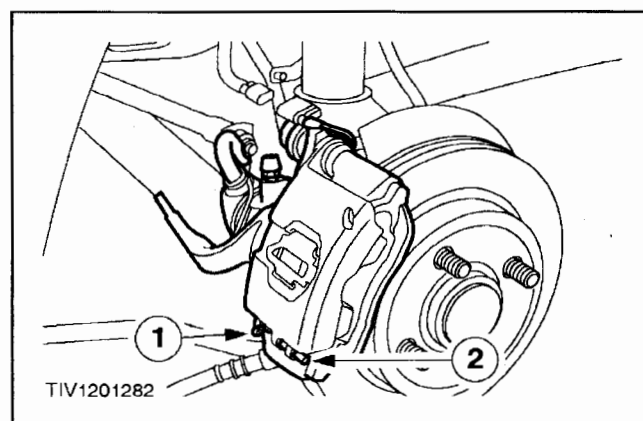
5. Disconnect the brake pad wear sensor electrical connector (if equipped).



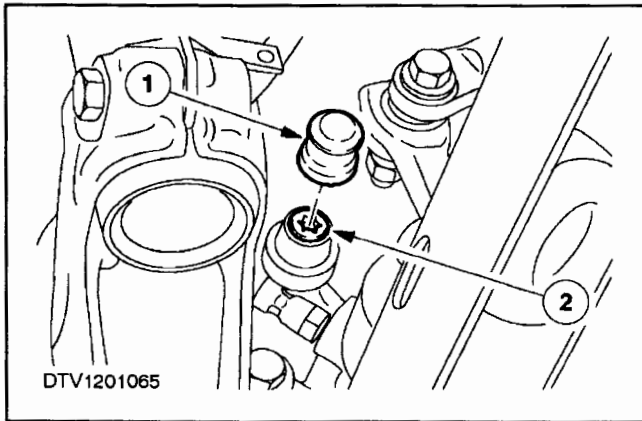
6. Detach the brake pad wear sensor electrical connector (if equipped).



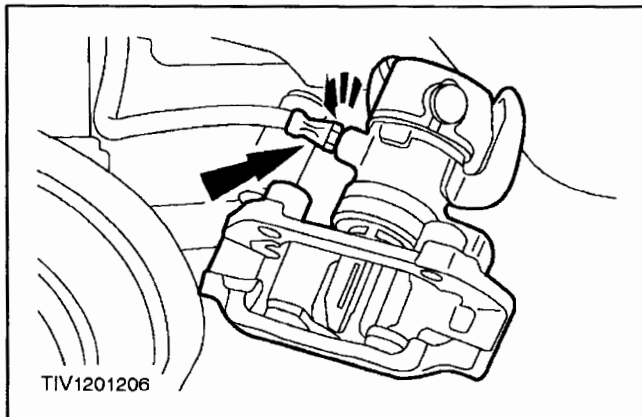
7. Loosen the brake hose union.



8. Remove the caliper guide pin.
- 1 Remove the clip.
 - 2 Remove the pin.

REMOVAL AND INSTALLATION (Continued)

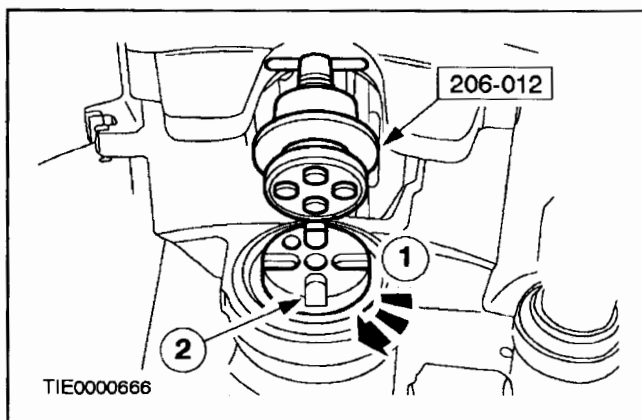
9. Remove the caliper.
 - 1 Remove the bolt cover.
 - 2 Remove the bolt.



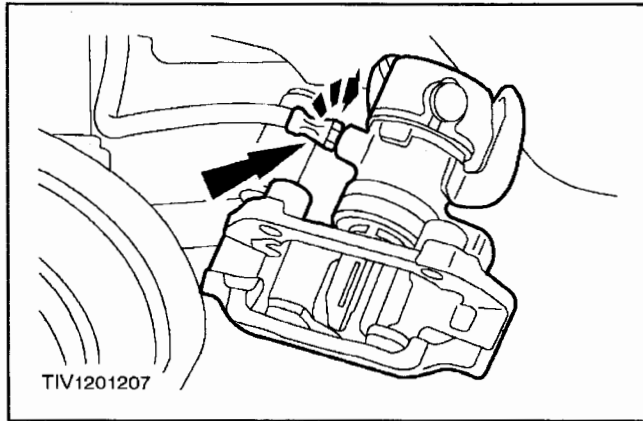
10. Disconnect the caliper from the brake hose.
 - Plug the brake hose.

Installation

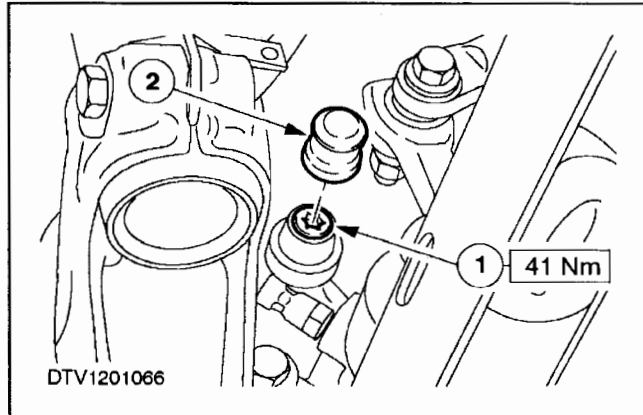
NOTE: After installation, bleed the brake system. For additional information, refer to Section 206-00.



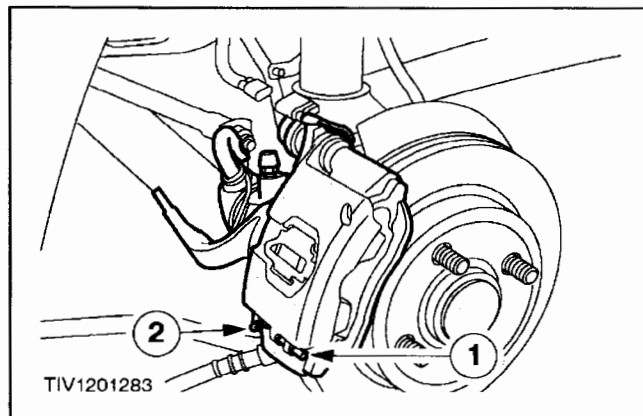
1. Using the special tool, fully retract the caliper piston.
 - 1 Fully retract the piston.
 - 2 Make sure the piston location mark is in the correct position so that the locator pin on the brake pad backplate locates correctly into the piston.

REMOVAL AND INSTALLATION (Continued)

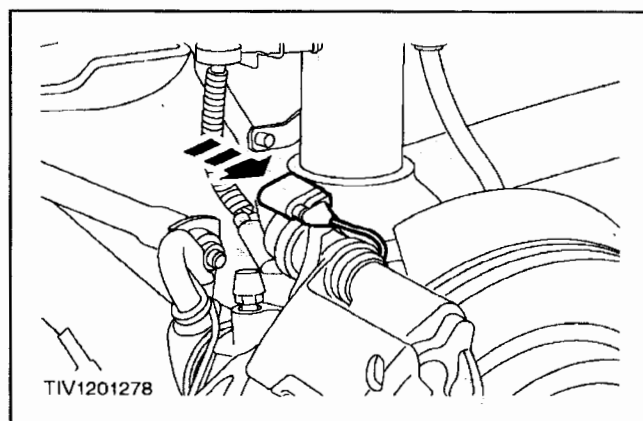
2. Loosely connect the brake hose to the caliper.
 - Remove the brake hose plug.



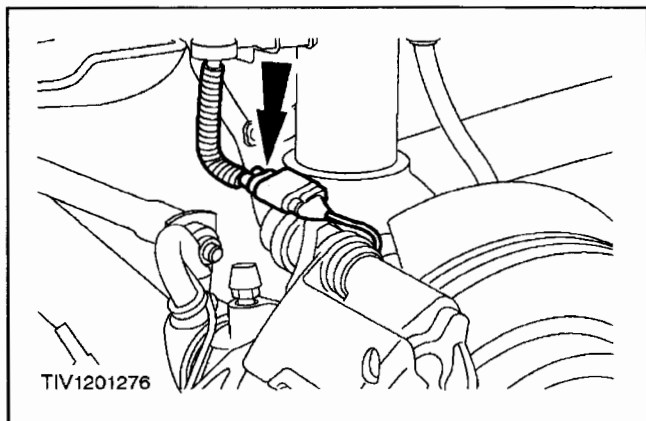
3. Install the caliper.
 - 1 Install the bolt.
 - 2 Install the bolt cover.



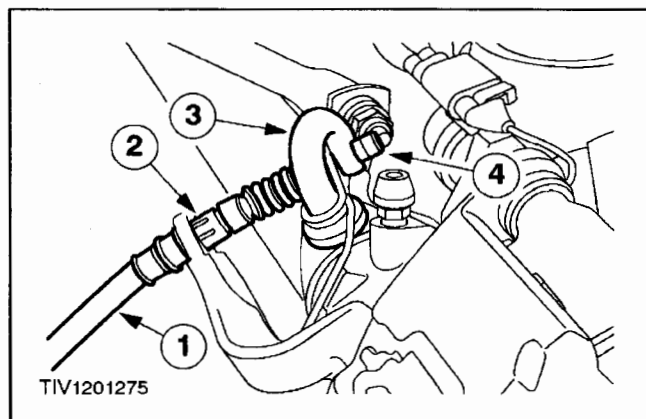
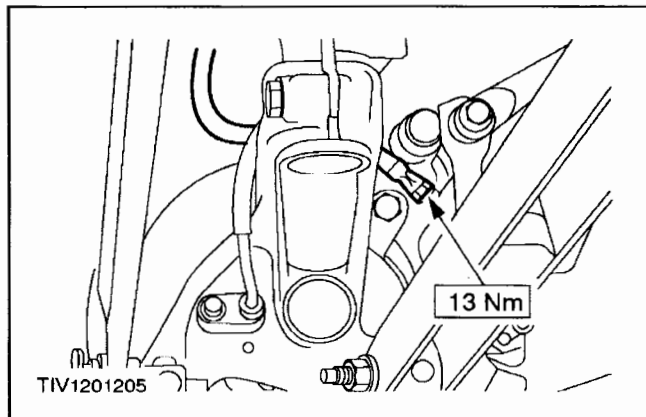
4. Install the caliper pin.
 - 1 Install the pin.
 - 2 Install the clip.



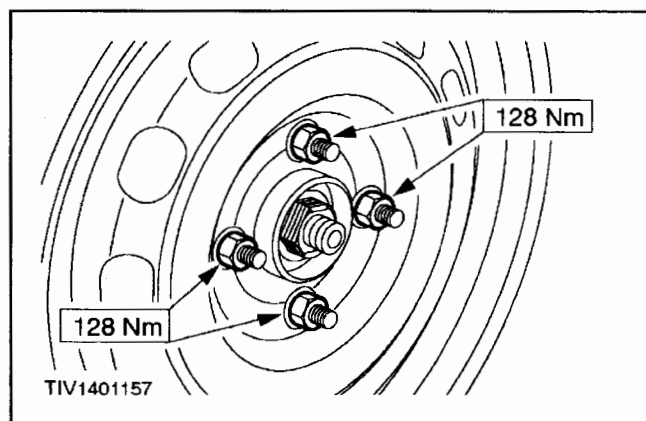
5. Attach the brake pad wear sensor electrical connector (if equipped).

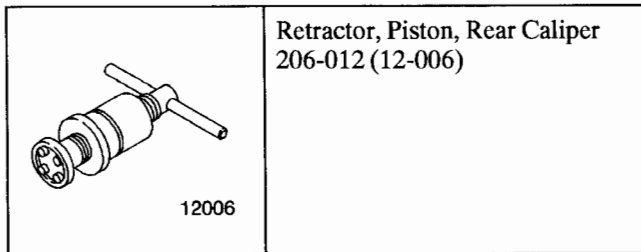
REMOVAL AND INSTALLATION (Continued)

6. Connect the brake pad wear sensor electrical connector (if equipped).

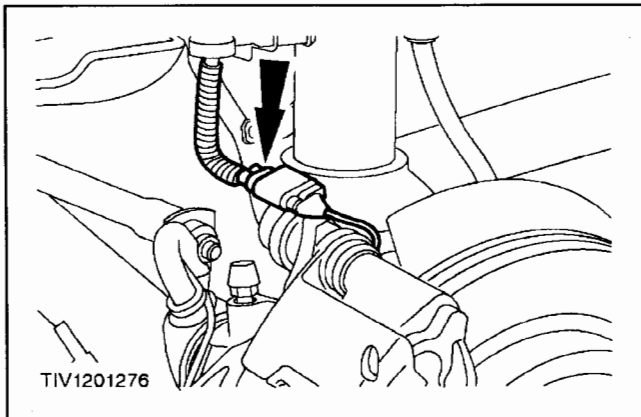
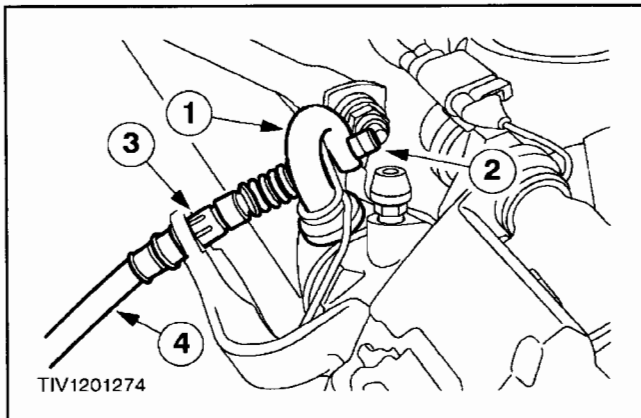


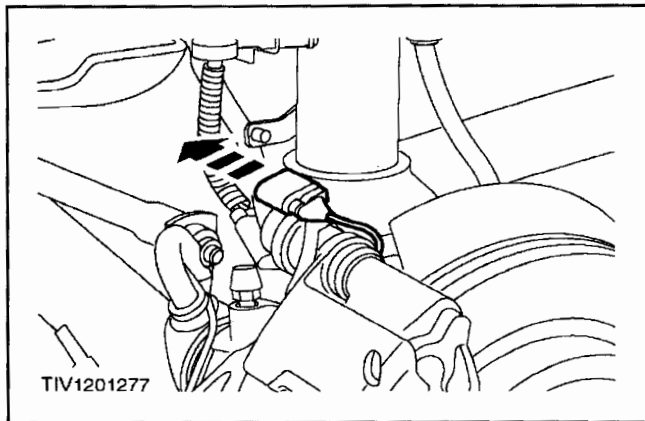
7. Install the parking brake cable.
- 1 Install the cable and conduit.
 - 2 Secure the cable retaining clip.
 - 3 Pull back the parking brake lever.
 - 4 Install the cable to the parking brake lever.



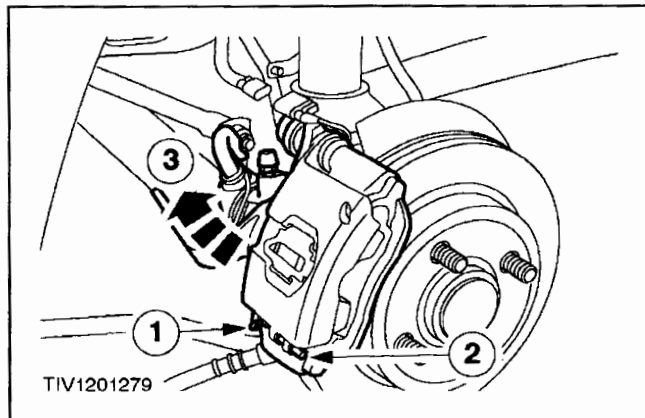
REMOVALANDINSTALLATION (Continued)**Brake Pads****Special Tool(s)****Removal**

1. Loosen the wheel nuts.
2. Raise and support the vehicle. For additional information, refer to Section 100-02.
3. Remove the wheel.
4. Disconnect the parking brake cable.
 - 1 Pull back the parking brake lever.
 - 2 Disconnect the cable from the parking brake lever.
 - 3 Detach the conduit retaining clip.
 - 4 Detach the cable and conduit.
5. Disconnect the brake pad wear sensor electrical connector (if equipped).

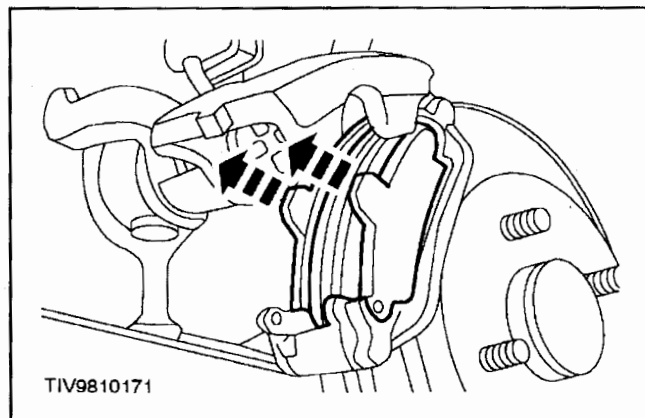


REMOVAL AND INSTALLATION (Continued)

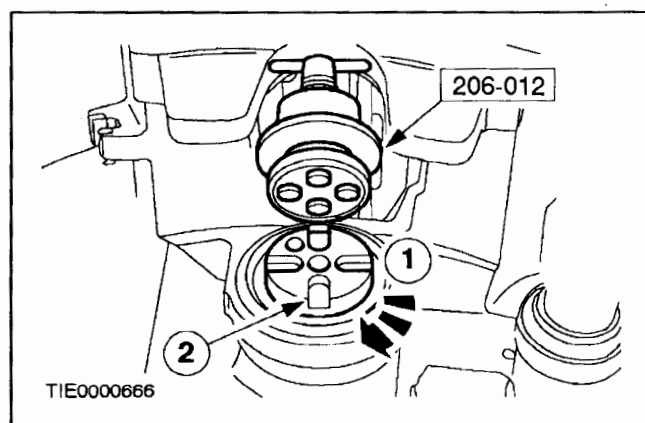
6. Detach the brake pad wear sensor electrical connector (if equipped).



7. Pivot the caliper away from the caliper anchor plate.
 - 1 Remove the clip.
 - 2 Remove the pin.
 - 3 Pivot the caliper upwards.



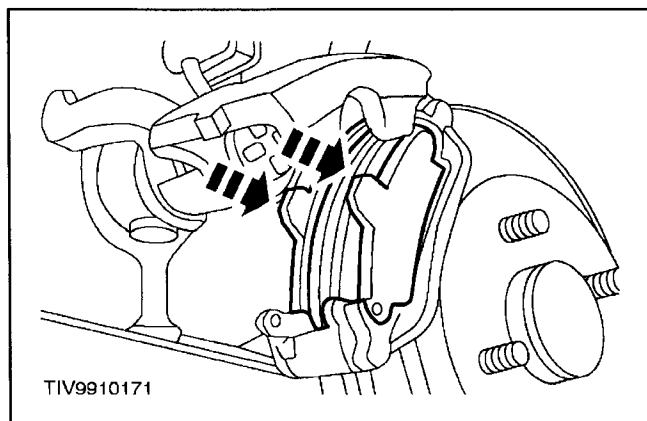
8. Remove the brake pads.

Installation

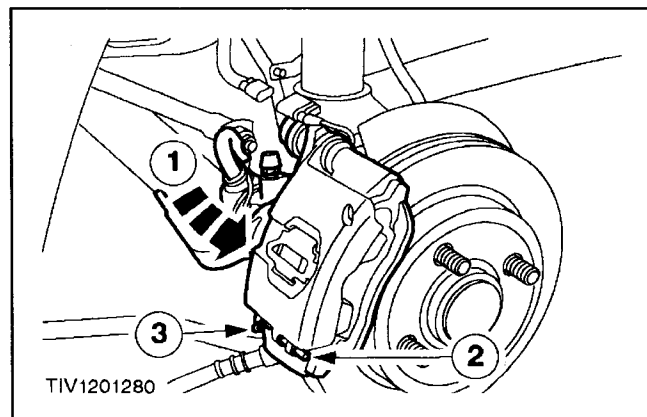
1. **CAUTION:** If the pistons are retracted into the housing, brake fluid will be displaced from the master cylinder.

Using the special tool, fully retract the caliper piston.

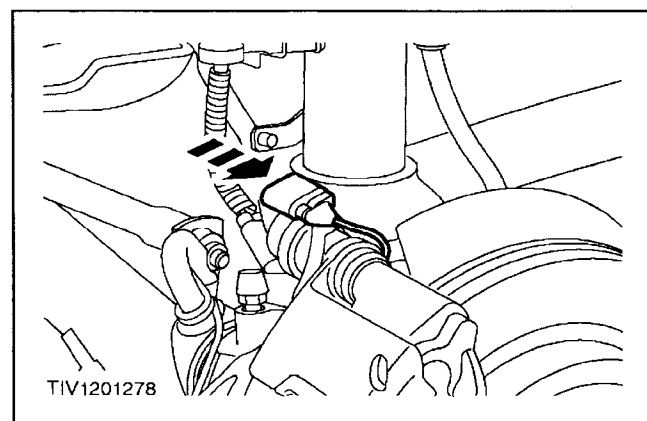
- 1 Fully retract the piston.
- 2 Make sure the piston locating mark is in the correct position so that the locator pin on the brake pad backplate locates correctly into the piston.

REMOVAL AND INSTALLATION (Continued)

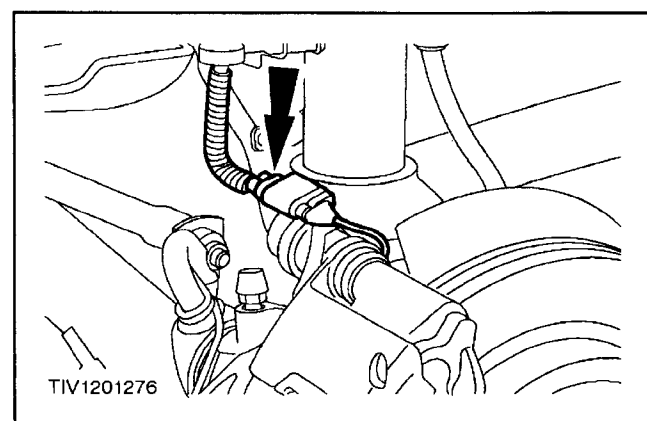
2. Install the brake pads.



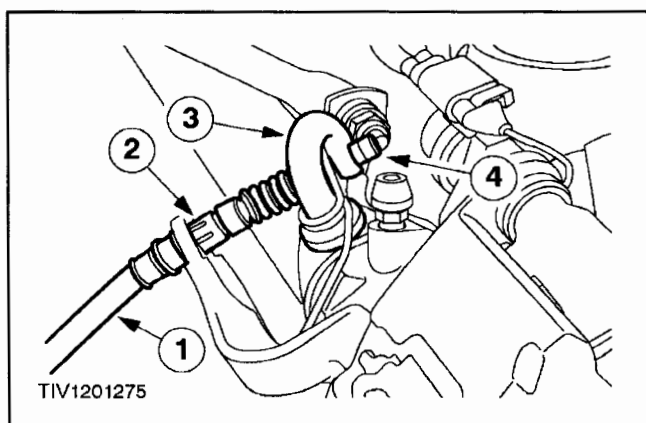
3. Pivot the caliper into the caliper anchor bracket and secure.
 - 1 Pivot the caliper downwards.
 - 2 Install the pin.
 - 3 Install the clip.



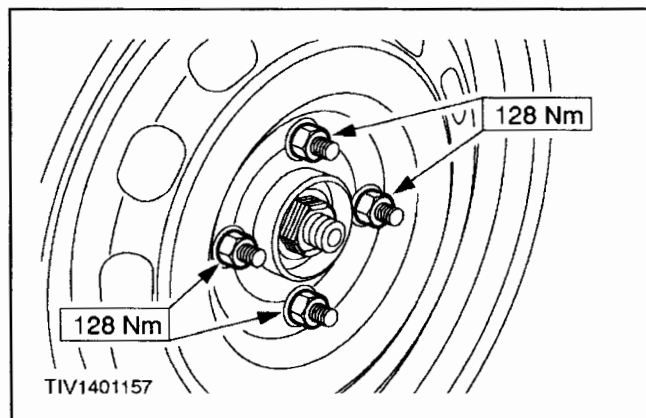
4. Attach the brake pad wear sensor electrical connector (if equipped).



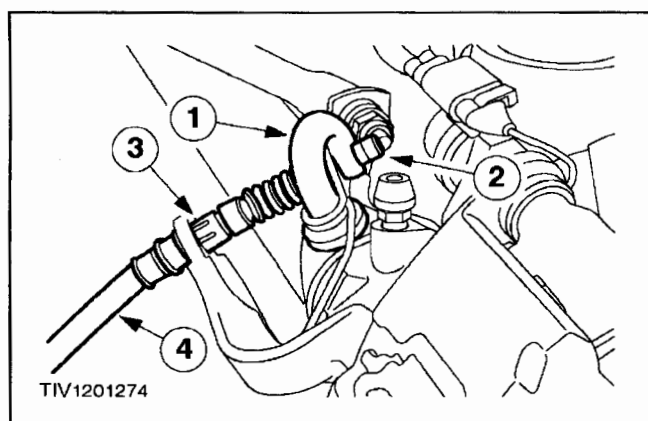
5. Connect the brake pad wear sensor electrical connector (if equipped).

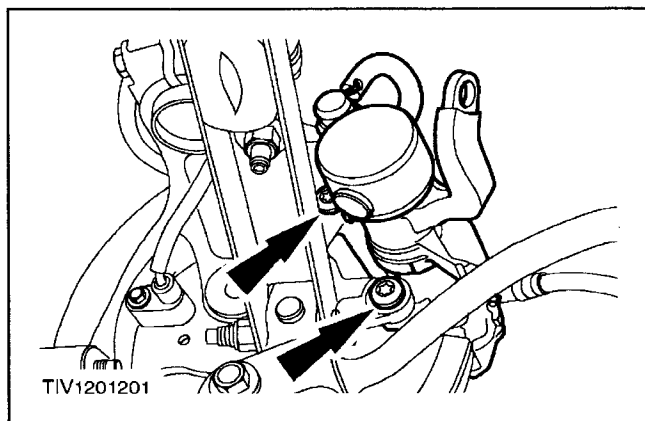
REMOVAL AND INSTALLATION (Continued)

6. Install the parking brake cable.
 - 1 Install the cable and conduit.
 - 2 Secure the cable retaining clip.
 - 3 Pull back the parking brake lever.
 - 4 Install the cable to the parking brake lever.

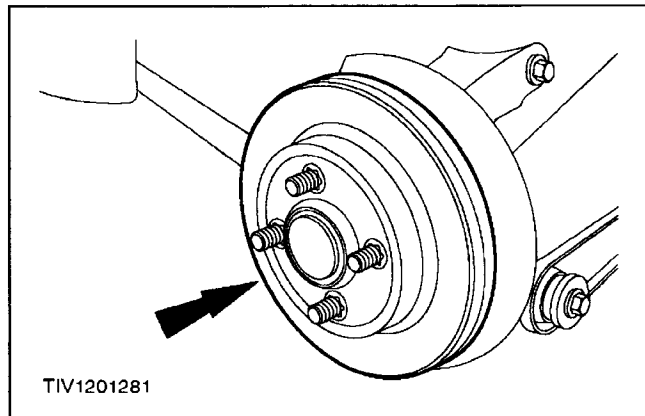
**Brake Disc****Removal**

1. Loosen the wheel nuts.
2. Raise and support the vehicle. For additional information, refer to Section 100-02.
3. Remove the wheel.
4. Disconnect the parking brake cable.
 - 1 Pull back the parking brake lever.
 - 2 Disconnect the cable from the lever.
 - 3 Detach the conduit retaining clip.
 - 4 Detach the cable and conduit.

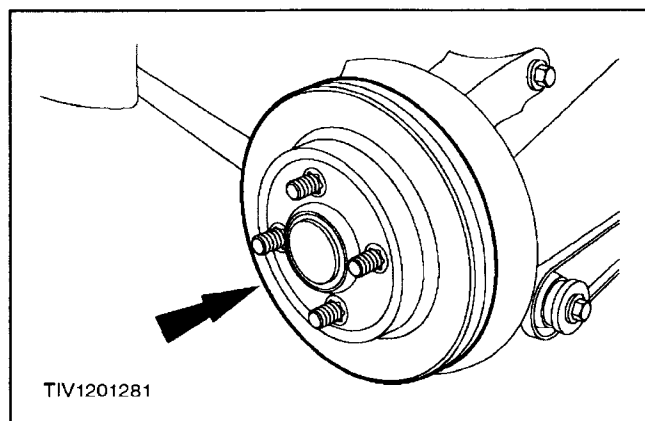


REMOVAL AND INSTALLATION (Continued)

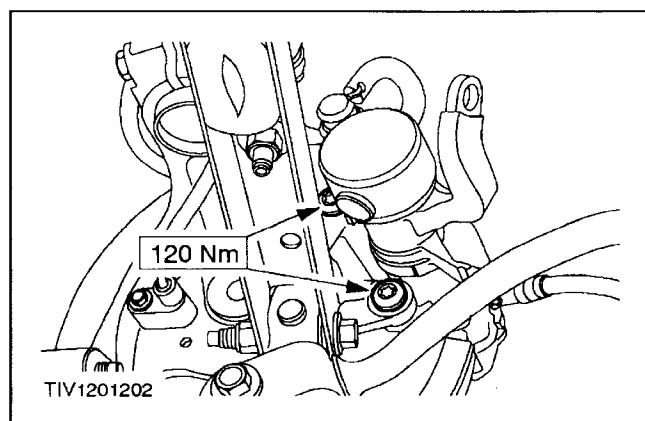
5. Detach the caliper and anchor plate assembly.
 - Secure the caliper and anchor plate assembly out of the way to prevent damage to the brake hose.

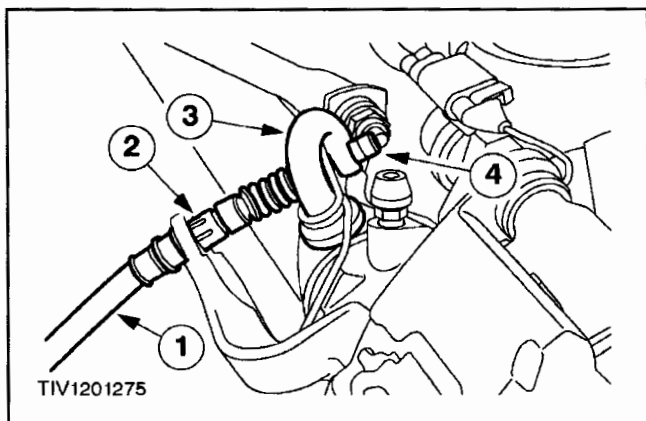


6. Remove the brake disc.
 - Remove the retainers (if equipped).

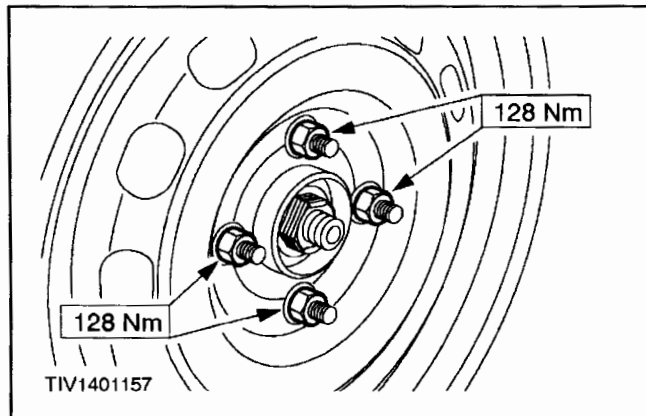
Installation

1. Install the brake disc.
 - Install the retainers (if equipped).



REMOVAL AND INSTALLATION (Continued)

2. Install the parking brake cable.
 - 1 Install the cable and conduit.
 - 2 Secure the cable retaining clip.
 - 3 Pull back the parking brake lever.
 - 4 Install the cable to the parking brake lever.



SECTION 206-05 Parking Brake and Actuation

CONTENTS	PAGE
SPECIFICATIONS	206-05-2
DESCRIPTION AND OPERATION	
Parking Brake	206-05-2
DIAGNOSIS AND TESTING	
Parking Brake	206-05-3
Inspection and Verification	206-05-3
Symptom Chart	206-05-4
Pinpoint Tests.....	206-05-4
REMOVAL AND INSTALLATION	
Parking Brake Control	206-05-6
Cable and Conduit — Parking Brake	206-05-11

SPECIFICATIONS

Torque Specifications

Description	Nm	Lb-Ft
Parking brake control bolts	23	17
Wheel nuts — steel/alloy wheels	128	94

DESCRIPTION AND OPERATION

Parking Brake

The parking brake system is cable operated and controlled by an independent hand-operated parking brake control.

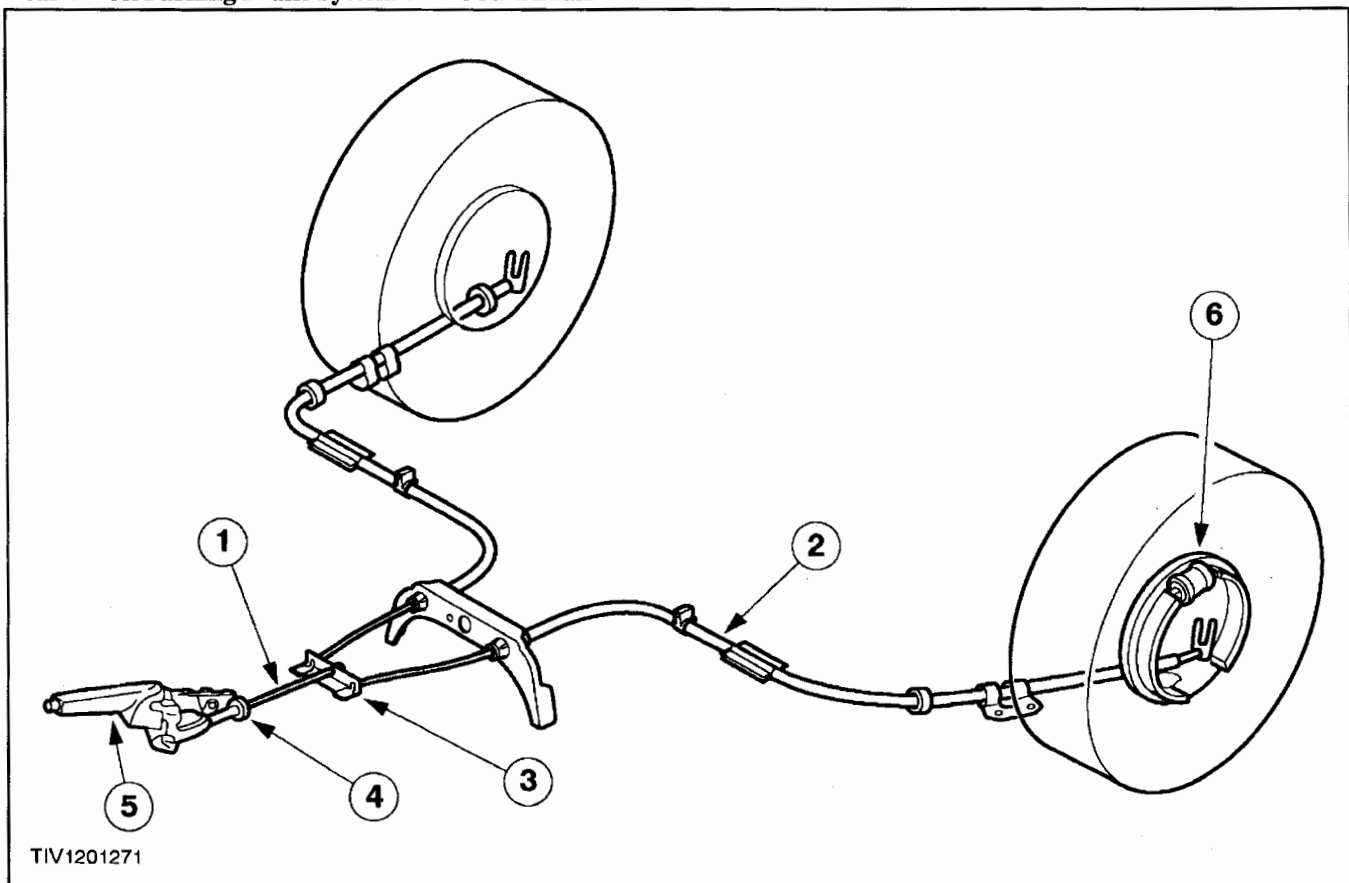
The parking brake system operates the rear drum or rear disc brake systems as follows:

- On vehicles with rear brake drums an independent hand-operated parking brake control lever actuates the rear brake shoes directly through a cable system.

- On vehicles with rear disc brakes the parking brake control lever activates the rear brake calipers through a cable and rear caliper lever with an integral cam. A pawl within the rear brake caliper rotates the piston adjustment screw to compensate for pad wear.

To adjust the cable, operate the parking brake control several times.

Rear Wheel Parking Brake System with Drum Brakes

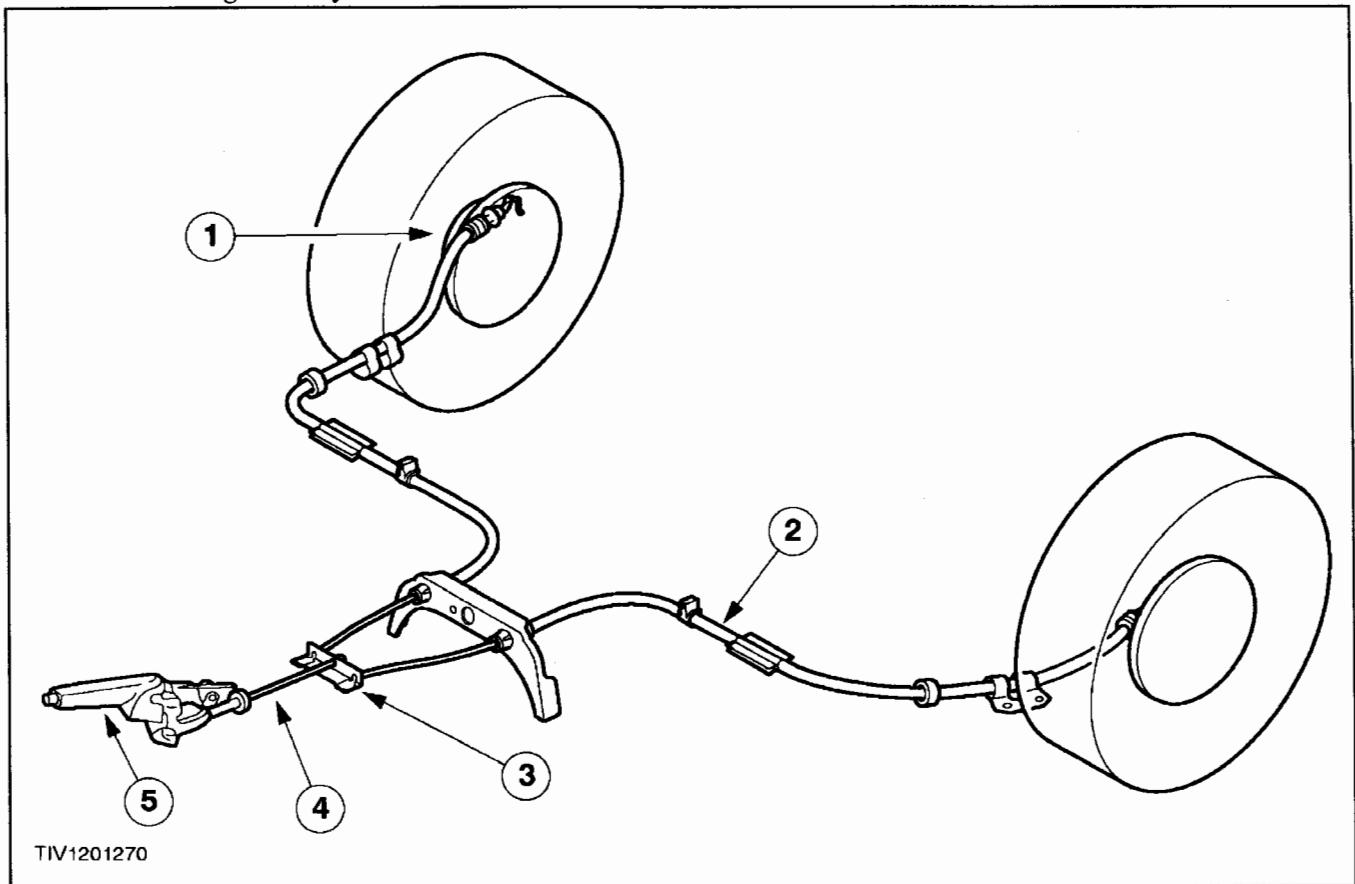


DESCRIPTION AND OPERATION (Continued)

Item	Part Number	Description
1	—	Front cable and conduit
2	—	Rear cable and conduit
3	—	Boot

(Continued)

Item	Part Number	Description
5	—	Parking brake control
6	—	Brake shoe

Rear Wheel Parking Brake System with Disc Brakes

Item	Part Number	Description
1	—	Brake disc
2	—	Rear cable and conduit
3	—	Equalizer

(Continued)

Item	Part Number	Description
4	—	Front cable and conduit
5	—	Parking brake control

DIAGNOSIS AND TESTING**Parking Brake****Inspection and Verification**

1. Verify the customer concern by operating the parking brake system to duplicate the condition.

2. Inspect and determine if one of the following mechanical or electrical concerns apply:

DIAGNOSIS AND TESTING (Continued)**Visual Inspection Chart**

Mechanical	Electrical
• Parking brake control • Cable and conduit	• Parking brake warning circuit. Refer to Section 413-01.

3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
4. If the concern is not visually evident, verify the symptom. GO to **Symptom Chart**.

Symptom Chart**Symptom Chart**

Condition	Possible Sources	Action
• The parking brake will not engage	• Parking brake control. • Cable and conduit.	• GO to Pinpoint Test A.
• The parking brake will not release	• Cable and conduit. • Parking brake control.	• GO to Pinpoint Test B.

Pinpoint Tests**PINPOINT TEST A: THE PARKING BRAKE WILL NOT APPLY**

CONDITIONS	DETAILS/RESULTS/ACTIONS
A1 CHECK FOR MISADJUSTED REAR PARKING BRAKE CABLE	
	1 Operate the parking brake control several times to adjust the cable. • Does the parking brake now apply correctly? → Yes Vehicle OK. → No GO to A2.
A2 CHECK FOR WORN BRAKE PADS	
	1 Inspect the brake pads for excessive wear. Refer to Section 206-00. • Are the brake pads OK? → Yes GO to A3. → No INSTALL new brake pads. TEST the system for normal operation.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST A: THE PARKING BRAKE WILL NOT APPLY (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
A3 CHECK FOR DAMAGED PARKING BRAKE CABLES	
	1 Inspect the parking brake cables and conduit for damage, rust or fraying. • Are the parking brake cables and conduits OK? → Yes CHECK for other causes such as loose parking brake control or conventional brake system components. → No REPAIR or INSTALL new cables and conduit as necessary. TEST the system for normal operation.

PINPOINT TEST B: THE PARKING BRAKE WILL NOT RELEASE

CONDITIONS	DETAILS/RESULTS/ACTIONS
B1 CHECK PARKING BRAKE CONTROL	
	1 Raise and support the vehicle on a lift with the parking brake fully applied. Refer to Section 100-02. — Release the parking brake by pulling upwards on the control lever and pushing the release button. • Did the parking brake release? → Yes CHECK for other causes such as conventional brake system components, REPAIR or INSTALL new as necessary. → No GO to B2.
B2 CHECK PARKING BRAKE CABLES	
	1 Loosen the parking brake cable tension. — Rotate the rear wheels by hand. • Did the rear wheels turn freely? → Yes INSTALL a new parking brake control. REFER to Parking Brake Control in this section. TEST the system for normal operation. → No GO to B3.

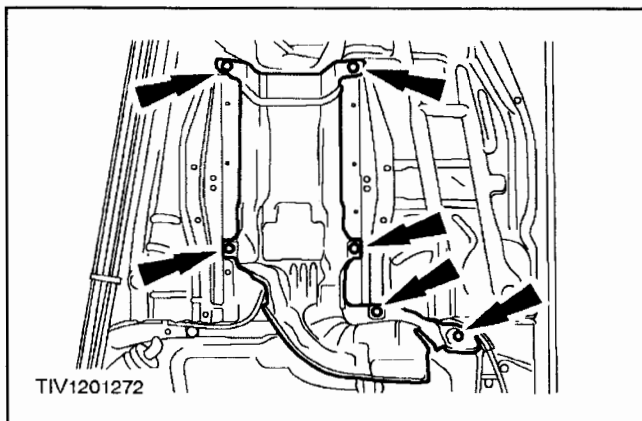
(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST B: THE PARKING BRAKE WILL NOT RELEASE (Continued)**

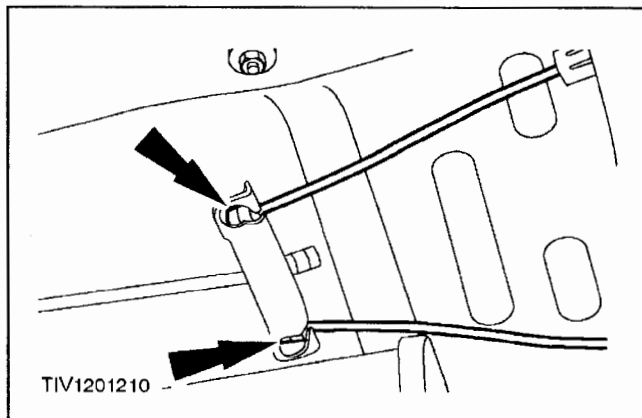
CONDITIONS	DETAILS/RESULTS/ACTIONS
B3 CHECK FRONT PARKING BRAKE CABLE	
	1 Disconnect the parking brake front cable and conduit from the rear brake cable and conduit at the equalizer. — Rotate the rear wheels by hand. • Did the rear wheels turn freely? → Yes INSTALL a new front parking brake cable and conduit. REFER to Cable and Conduit—Parking Brake in this section. TEST the system for normal operation. → No GO to B4.
B4 CHECK REAR PARKING BRAKE CABLES	
	1 Disconnect the parking brake at the rear brakes, one at a time. — Rotate the wheel affected by the disconnected parking brake • Did the wheel turn freely? → Yes INSTALL a new caliper assembly. TEST the system for normal operation. → No REFER to Section 206-00.

REMOVAL AND INSTALLATION**Parking Brake Control****Removal**

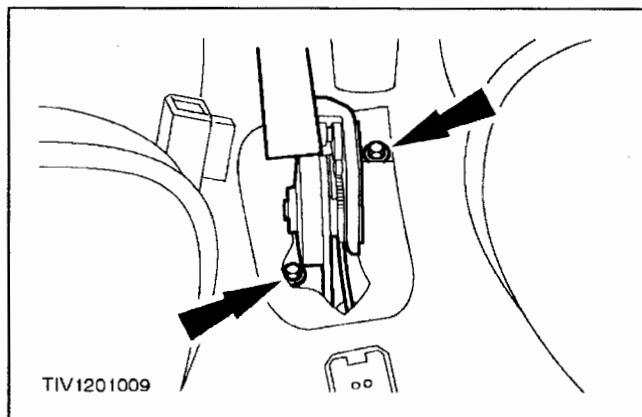
1. Release the parking brake.
2. Remove the rear muffler. For additional information, refer to Section 309-00.

REMOVAL AND INSTALLATION (Continued)

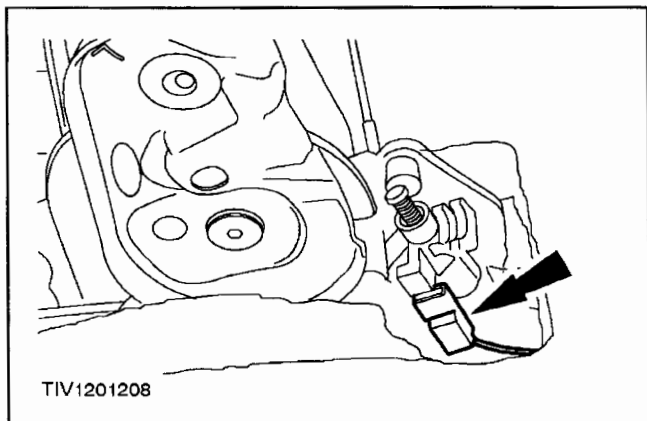
3. Remove the rear section of the exhaust heat shield.



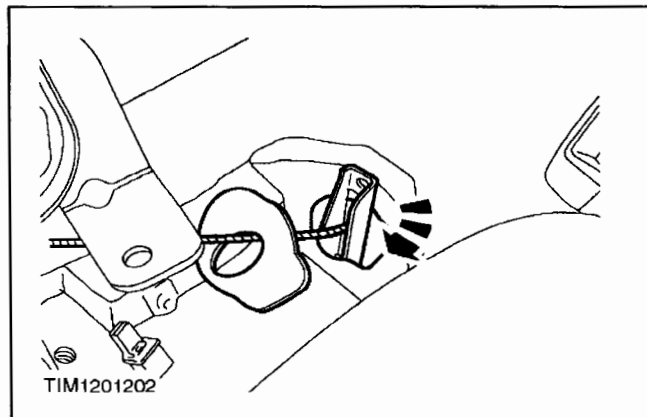
4. Detach the parking brake cables from the parking brake cable equalizer.



5. Lower the vehicle.
6. Remove the floor console. For additional information, refer to Section 501-12.
7. Detach the parking brake control.

REMOVAL AND INSTALLATION (Continued)

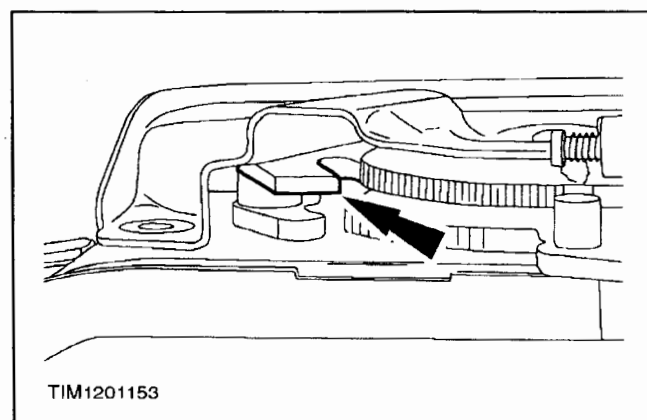
8. Disconnect the parking brake warning indicator switch electrical connector.



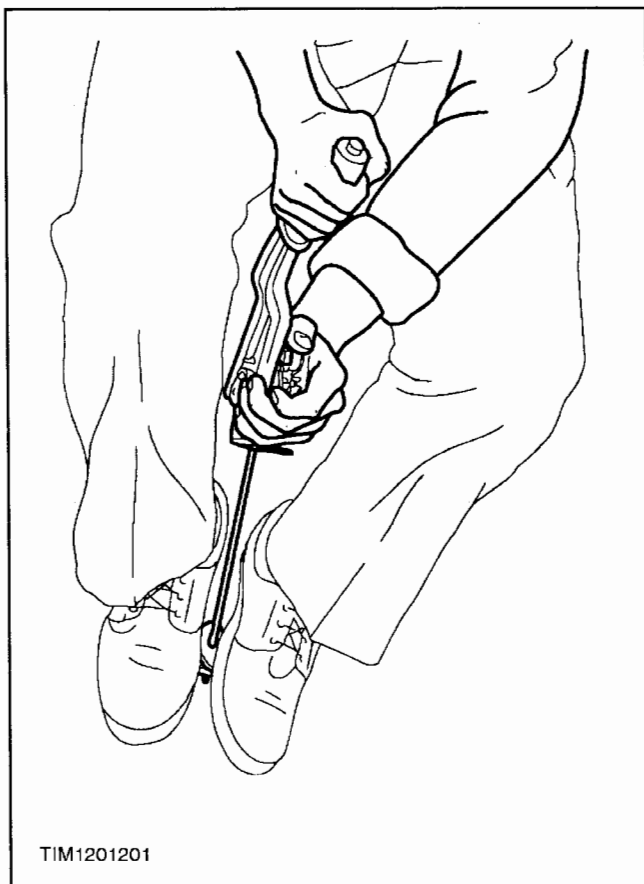
9. Remove the parking brake control.
 - Pull the parking brake cable equalizer through the opening in the floor.

Installation

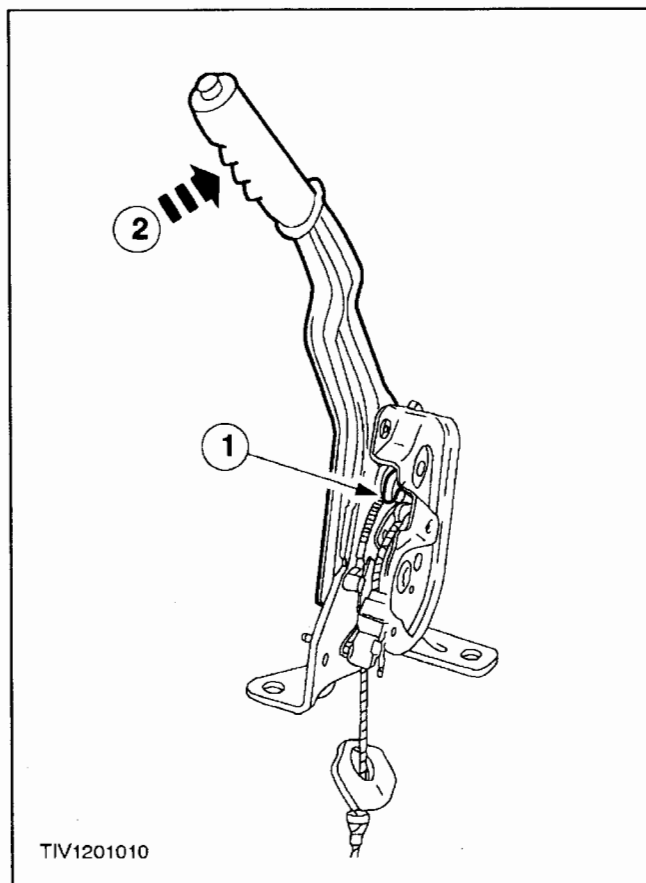
NOTE: New parking brake control assemblies are supplied with the self-adjust mechanism pre-set.



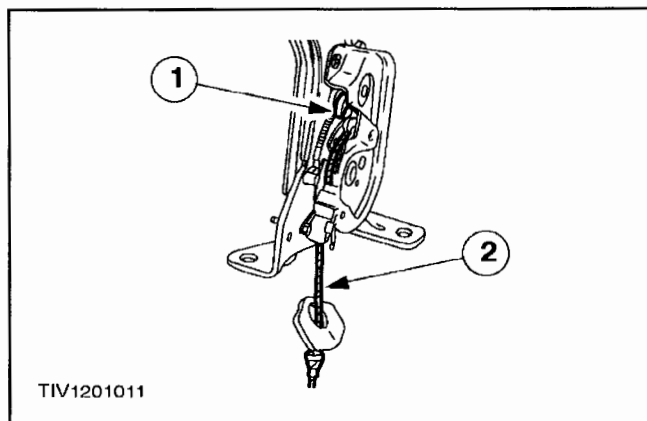
1. To set the preload of the parking brake control self-adjust mechanism, lift the parking brake control lever to the fully raised position.

REMOVAL AND INSTALLATION (Continued)

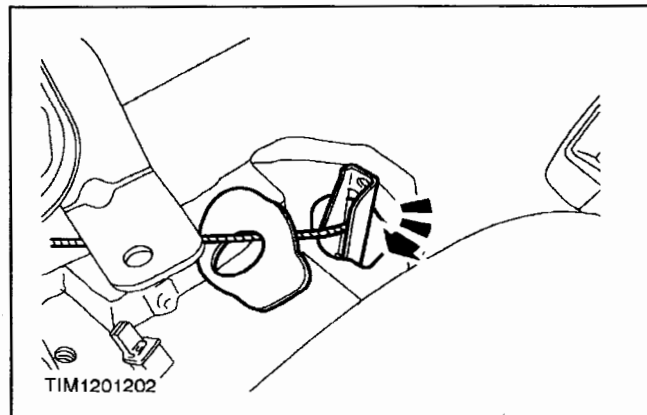
2. Locate the parking brake cable equalizer between your feet.



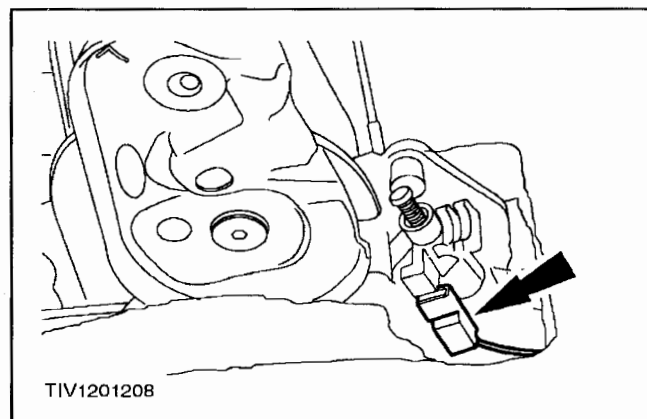
3. Extract 40 mm of parking brake cable.
 - 1 Press down the pawl.
 - 2 Simultaneously pull the parking brake control to extract 40 mm of parking brake cable.

REMOVAL AND INSTALLATION (Continued)

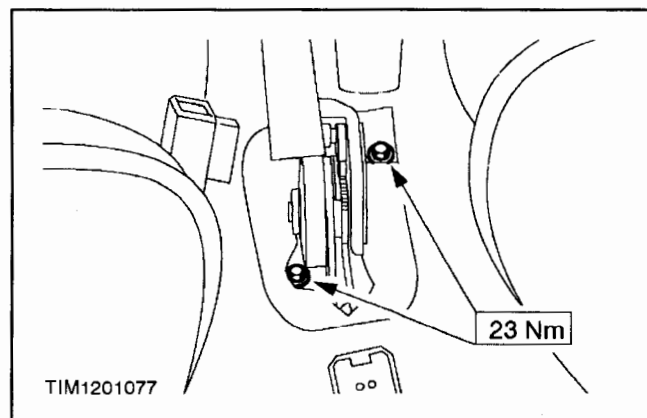
4. Release the tension on the parking brake cable.
 - 1 Press down the pawl.
 - 2 Simultaneously release the tension on the cable.
 - The cable self-adjust mechanism will hold the cable until load is applied to the cable.



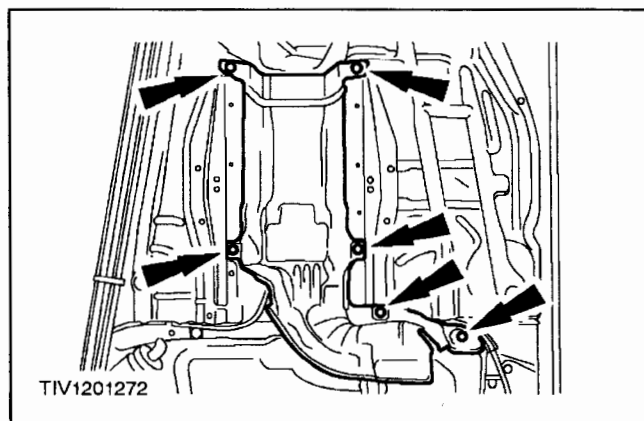
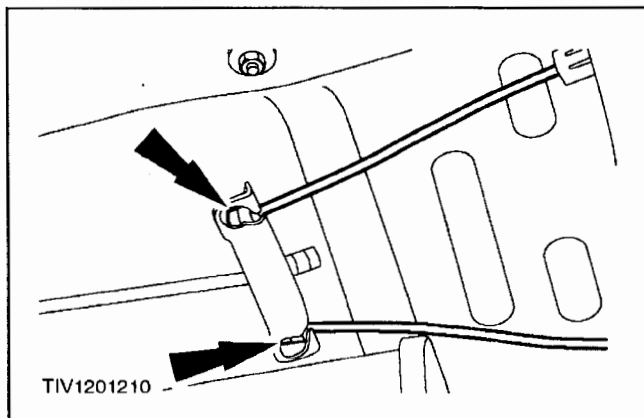
5. Insert the parking brake cable equalizer through the opening in the floor.



6. Connect the parking brake warning indicator switch electrical connector.



7. Install the parking brake control

REMOVAL AND INSTALLATION (Continued)

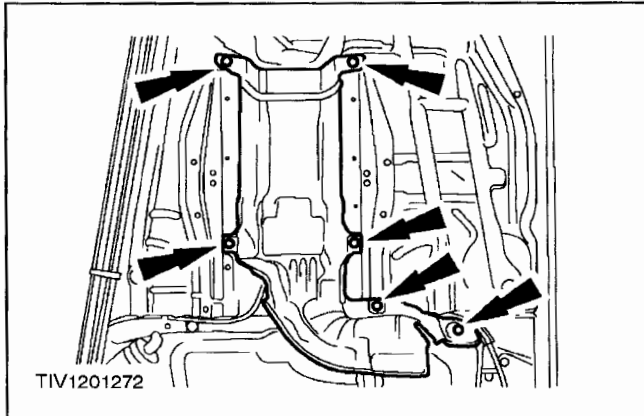
8. Install the floor console. For additional information, refer to Section 501-12.
9. Raise and support the vehicle. For additional information, refer to Section 100-02.
10. Reconnect the parking brake cables to the parking brake cable equalizer.
11. Install the rear section of the exhaust system heat shield.
12. Install the rear muffler. For additional information, refer to Section 309-00.

Cable and Conduit — Parking Brake**Removal****All vehicles**

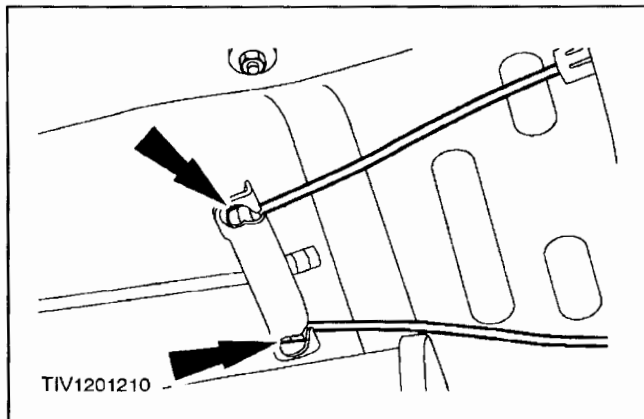
1. Release the parking brake.
2. Loosen the wheel nuts.
3. Raise and support the vehicle. For additional information, refer to Section 100-02.
4. Remove the wheel.

REMOVAL AND INSTALLATION (Continued)

5.  **CAUTION: Support the exhaust pipe.**
Remove the rear muffler. For additional information, refer to Section 309-00.



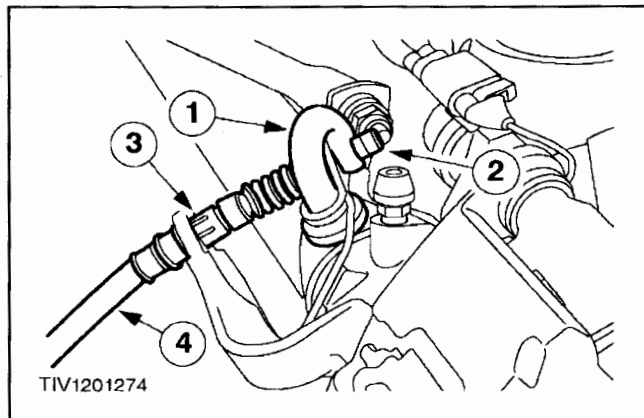
6. Remove the rear section of the exhaust system heat shield.



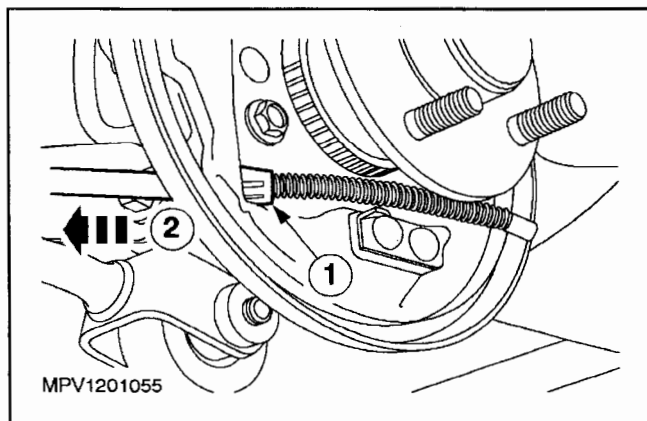
7. Detach the rear cables from the equalizer.

Vehicles with rear disc brakes

8. Disconnect the parking brake cable.
- 1 Pull back the parking brake lever.
 - 2 Disconnect the cable from the parking brake lever.
 - 3 Detach the conduit retaining clip.
 - 4 Detach the cable and conduit.

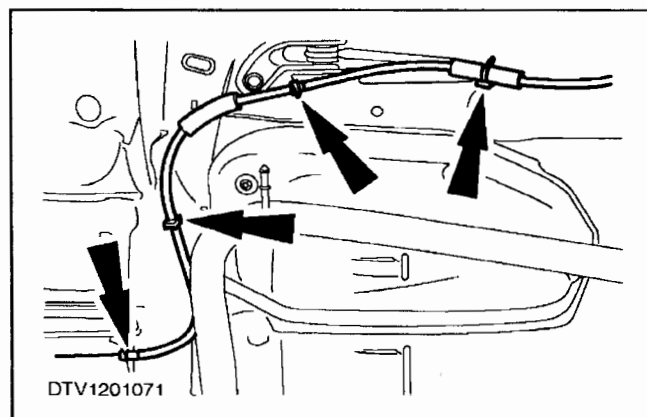
**Vehicles with rear drum brakes**

9. Remove the rear brake shoes. For additional information, refer to Section 206-02.

REMOVAL AND INSTALLATION (Continued)

10. Detach the parking brake conduit from the backing plate.

- 1 Depress the retaining clip.
- 2 Detach the cable and conduit.

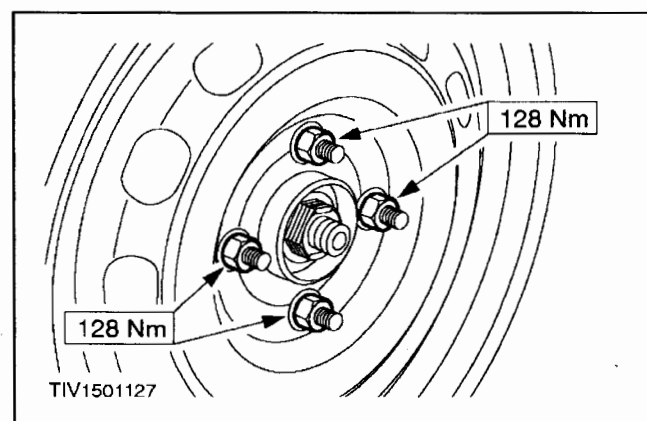
**All vehicles**

11. Remove the rear cable and conduit from the body clips.

Installation

NOTE: After installation, adjust the parking brake by lifting the control lever to the fully raised position.

1. To install, reverse the removal procedure.



SECTION 206-06 Hydraulic Brake Actuation

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SPECIFICATIONS	206-06-2
DESCRIPTION AND OPERATION	
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Brake Master Cylinder	206-06-2
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DIAGNOSIS AND TESTING	
Hydraulic Brake Actuation.....	206-06-3
REMOVAL AND INSTALLATION	
Brake Pedal And Bracket — Vehicles with Manual Transaxle.....	206-06-3
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Brake Master Cylinder	206-06-16
Brake Fluid Reservoir	206-06-18

SPECIFICATIONS

General Specifications

Item	Specification
High Performance Dot 3 Brake Fluid C6AZ-19542-AB	ESA-M6C25-A Dot 3

Torque Specifications

Description	Nm	Lb-Ft
Master cylinder to brake booster nuts	25	18
Master cylinder brake tube union	13	10

(Continued)

Torque Specifications

Description	Nm	Lb-Ft
Pedal box bolts	25	18
Pedal box nuts	25	18
Clutch master cylinder bolts	25	18
Accelerator pedal bracket nuts	25	18
Brake pedal nut (automatic transmission)	18	13
Steering column shaft pinch bolt	24	18
Steering column support bracket nuts	25	18

DESCRIPTION AND OPERATION

Hydraulic Brake Actuation

⚠ WARNING: Brake fluid contains polyglycol ethers and polyglycols. Avoid contact with the eyes. Wash hands thoroughly after handling. If brake fluid contacts the eyes, flush the eyes for 15 minutes with cold running water. Get medical attention if irritation persists. If taken internally, drink water and induce vomiting. Get medical attention immediately. Failure to follow these instructions may result in personal injury.

The hydraulic brake system is of a pedal operated, diagonally split dual line brake system that consists of the following components:

- A brake booster.
- A master cylinder.
- Front disc brake calipers.
- Front brake discs.
- Rear disc brake calipers.
- Rear brake discs.
- Rear drums (2.0L).
- Rear wheel cylinders (rear drum brakes, 2.0L).
- Brake tubes and hoses.
- Anti-lock brake system (ABS).

Brake Master Cylinder

The brake master cylinder is a dual piston type. The master cylinder operates as follows;

- When the brake pedal is applied, pressure is applied by mechanical linkage to the primary and secondary systems.
- Brake master cylinder pistons apply hydraulic pressure to the two circuits.

The master cylinder consists of the following components:

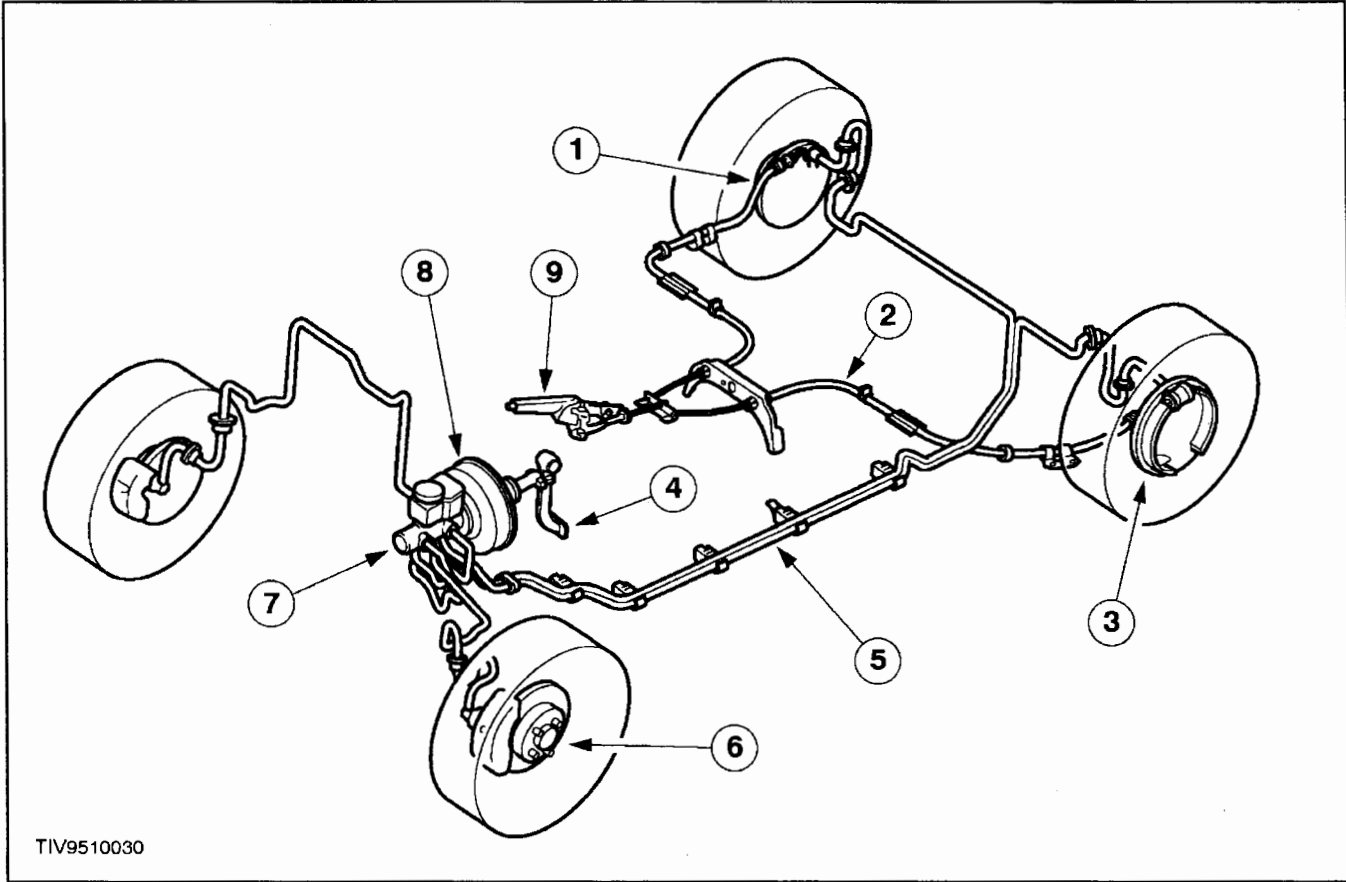
- Primary and secondary pistons.
- Brake master cylinder reservoir with integral fluid level warning indicator.

Dual Hydraulic Brake System

The dual hydraulic brake system is a conventional pedal actuated system. The system consists of the following components:

- Brake master cylinder reservoir with fluid level indicator.
- Anti-lock brake system hydraulic control unit (HCU).
- Brake tubes and hoses.
- A brake master cylinder.
- Diagonally split brake circuits (left-hand front to right-hand rear and right-hand front to left-hand rear).

DESCRIPTION AND OPERATION (Continued)



TIV9510030

Item	Part Number	Description
1	—	Rear brake disc
2	—	Parking brake cable and conduit
3	—	Rear brake shoe
4	—	Brake pedal

Item	Part Number	Description
5	—	Brake hydraulic tubes
6	—	Front brake disc
7	—	Brake master cylinder
8	—	Brake booster
9	—	Parking brake control

(Continued)

DIAGNOSIS AND TESTING

Hydraulic Brake Actuation

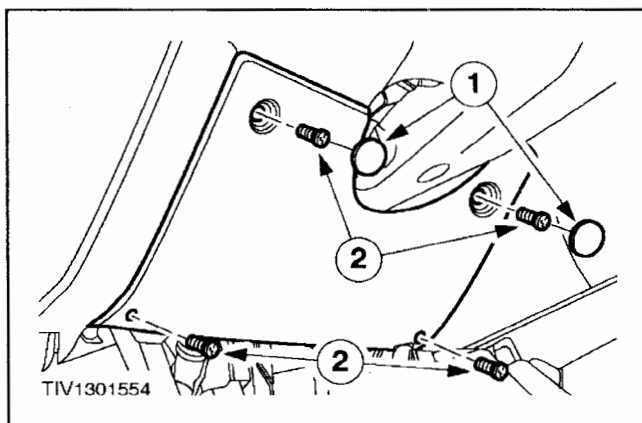
Refer to Section 206-00.

REMOVAL AND INSTALLATION

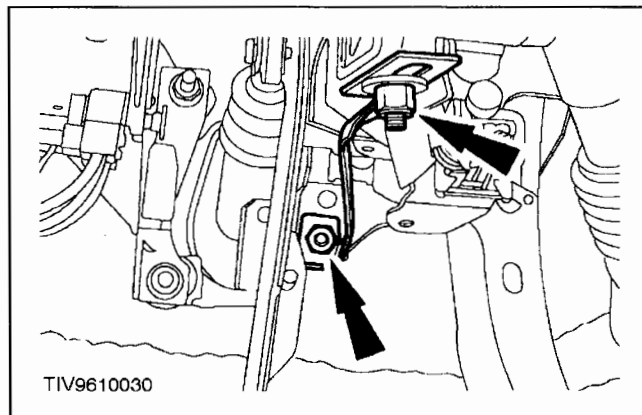
Brake Pedal And Bracket — Vehicles with Manual Transaxle

Removal

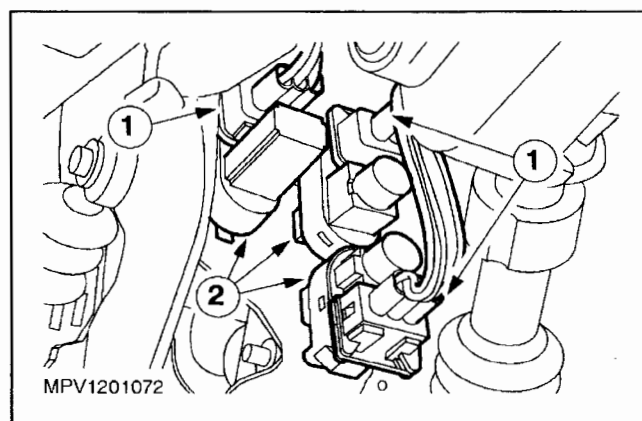
- 1. Disconnect the battery ground cable.

REMOVAL AND INSTALLATION (Continued)

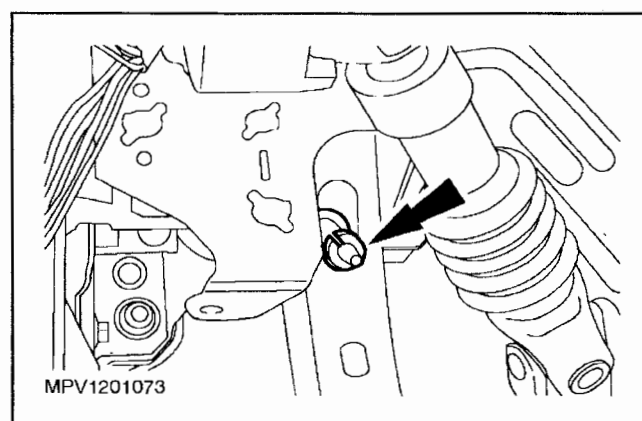
2. Remove the lower instrument panel lower panel.
 - 1 Remove the screw covers.
 - 2 Remove the screws.



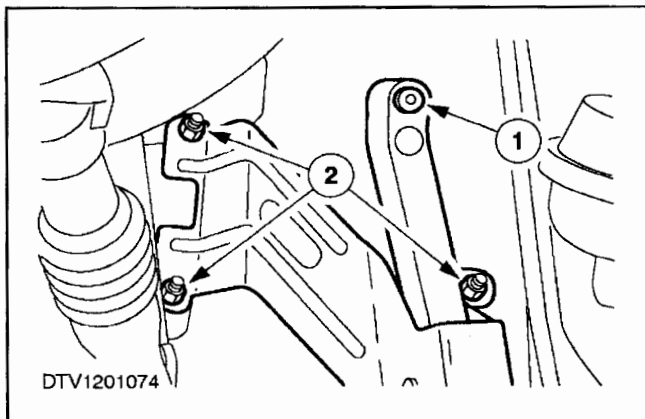
3. Remove the steering column support bracket.



4. Remove the pedal switches.
 - 1 Disconnect the electrical connectors.
 - 2 Remove the switches.

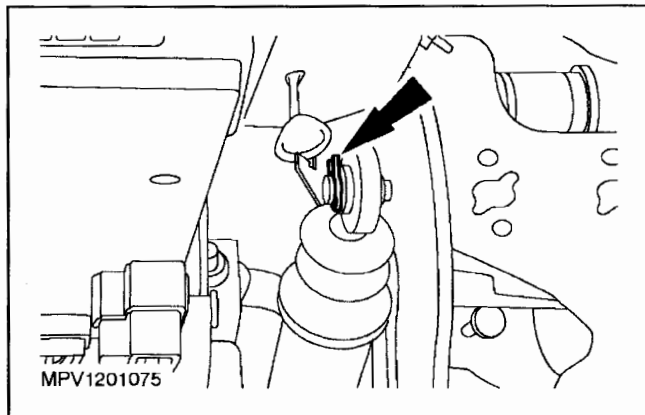


5. Remove the brake booster actuator rod retaining clip.

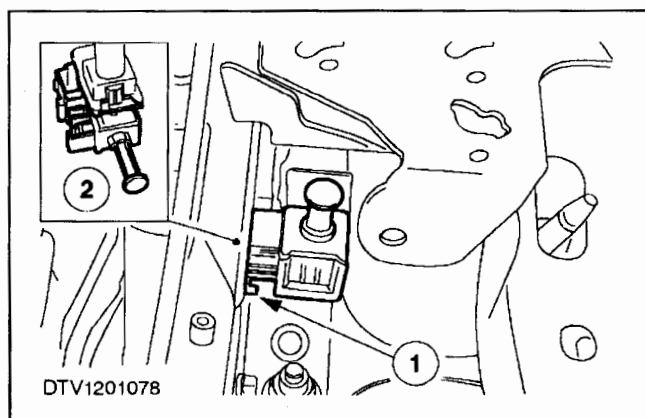
REMOVAL AND INSTALLATION (Continued)

6. Remove the accelerator pedal and bracket assembly.

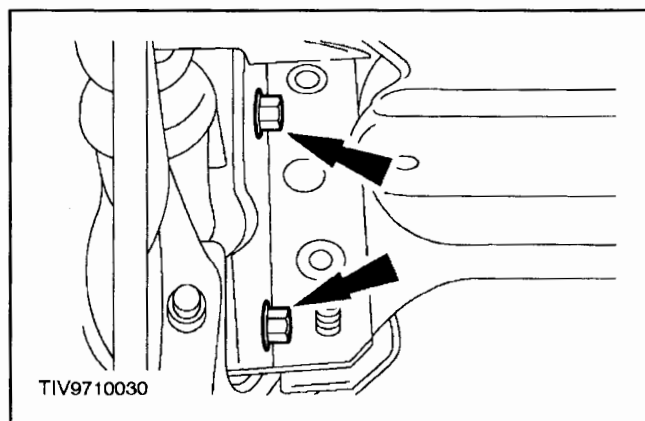
- 1 Disconnect the accelerator cable.
- 2 Remove the nuts.



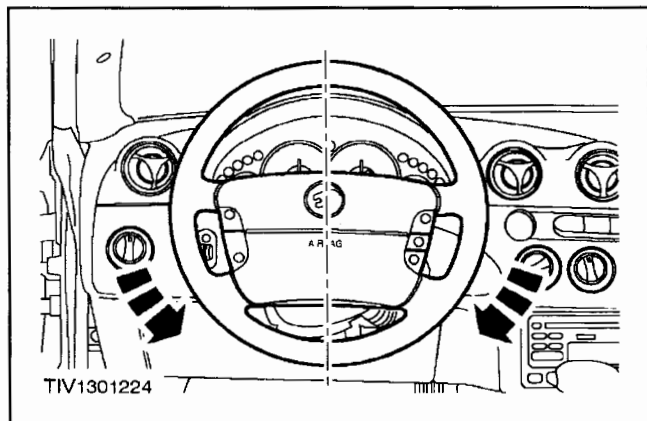
7. Remove the clutch master cylinder to clutch pedal retaining clip.



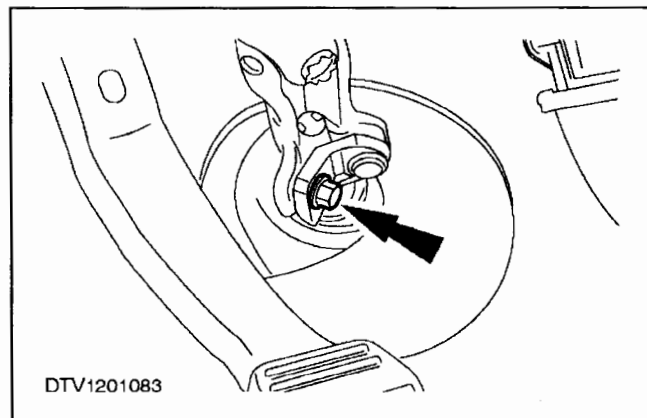
8. Remove the start inhibitor switch.
- 1 Depress the lug and detach the switch.
 - 2 Disconnect the electrical connector.



9. Loosen the clutch master cylinder bolts.

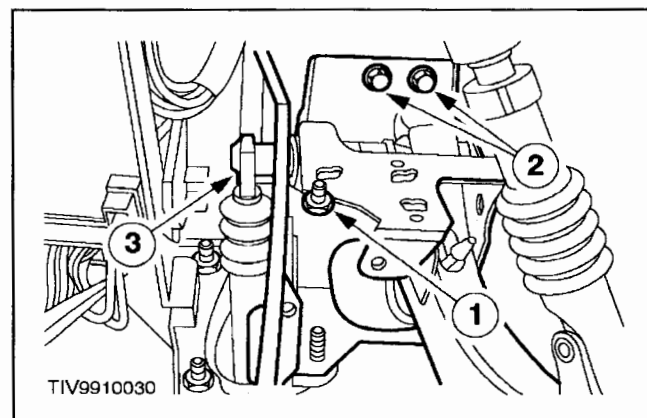
REMOVAL AND INSTALLATION (Continued)

10. Center the steering wheel and lock in position.



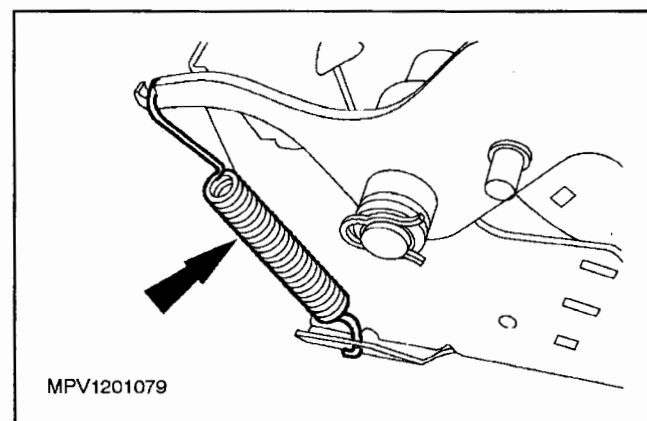
11. Remove the steering column shaft to flexible coupling clamp plate bolt.

- Rotate the clamp plate to disengage.

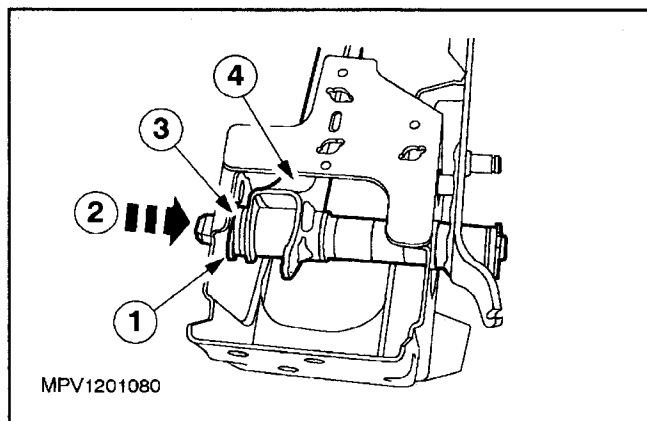


12. Remove the pedal box assembly.

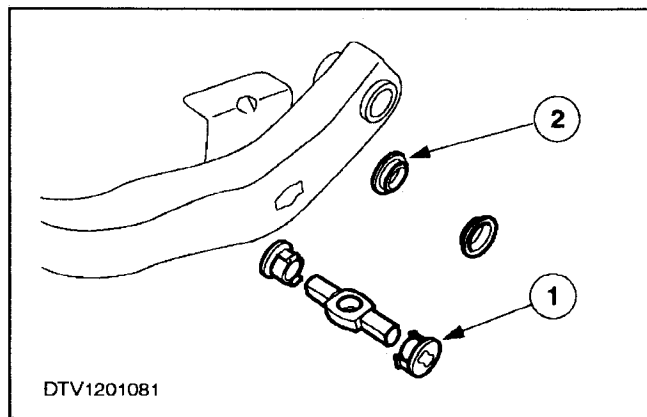
- 1 Remove the nut.
- 2 Remove the bolts.
- 3 Detach the clutch master cylinder from the pedal box assembly.



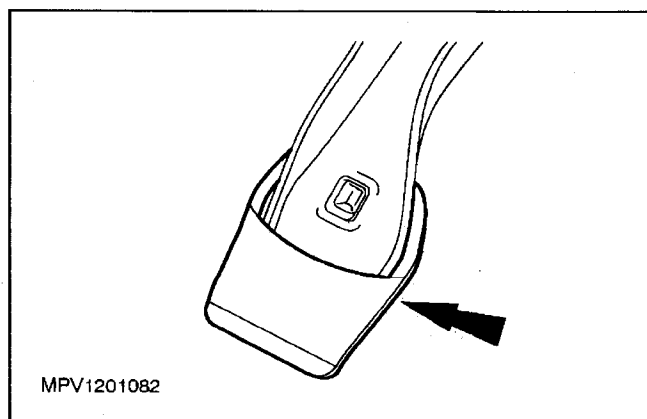
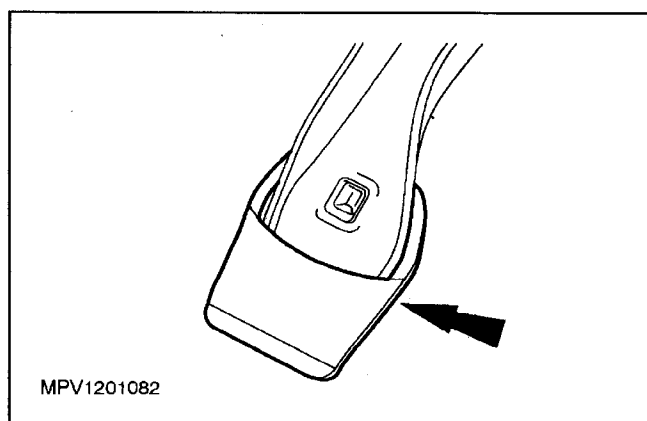
13. Remove the clutch pedal return spring.

REMOVAL AND INSTALLATION (Continued)**14. Remove the brake pedal.**

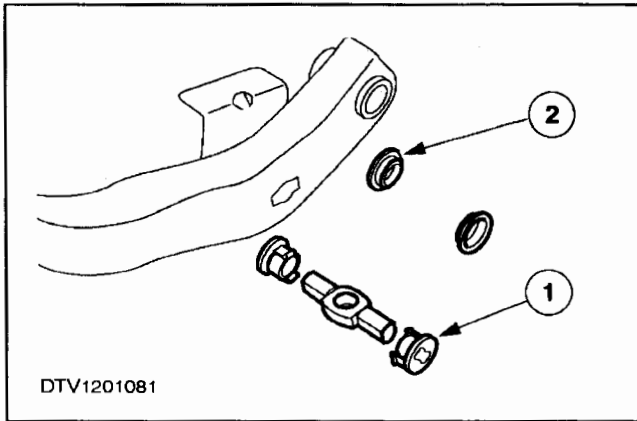
- 1 Remove the pivot shaft retaining clip.
- 2 Push the pivot shaft through the brake pedal towards the clutch pedal.
- 3 Remove the spacer.
- 4 Remove the brake pedal.

**15. Remove the actuator rod support and pedal bushing.**

- 1 Remove the support.
- 2 Remove the bushings.

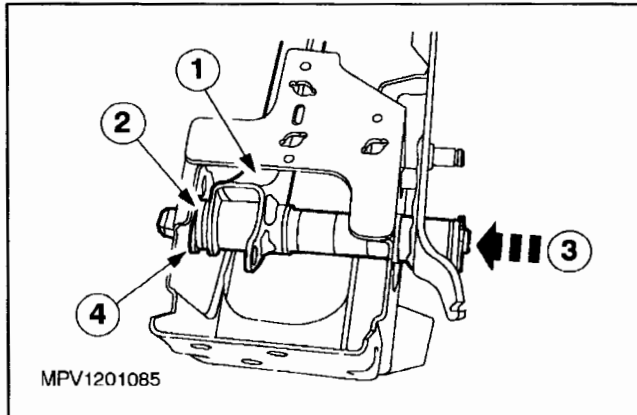
**16. Remove the pedal rubber.****Installation**

1. Install the pedal rubber.

REMOVAL AND INSTALLATION (Continued)

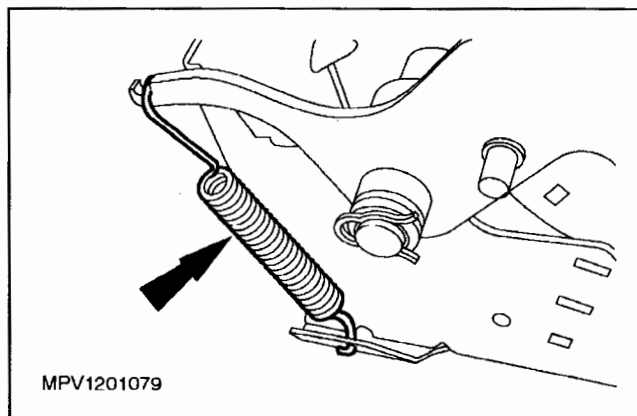
2. Install the actuator rod support and pedal bushing.

- 1 Install the support.
- 2 Install the bushings.

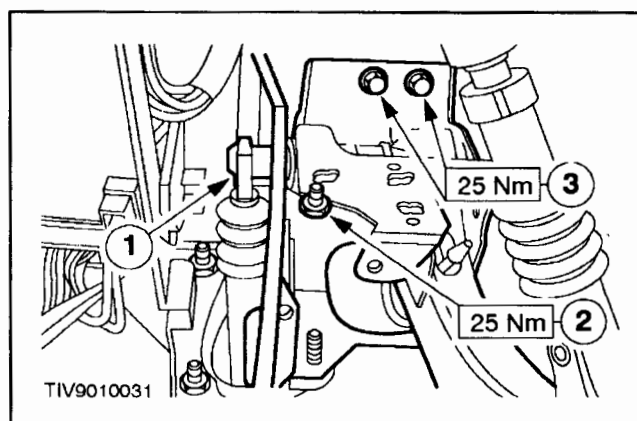


3. Install the brake pedal.

- 1 Locate the pedal.
- 2 Install the spacer
- 3 Push the pivot shaft through the brake pedal.
- 4 Install the pivot shaft retaining clip.

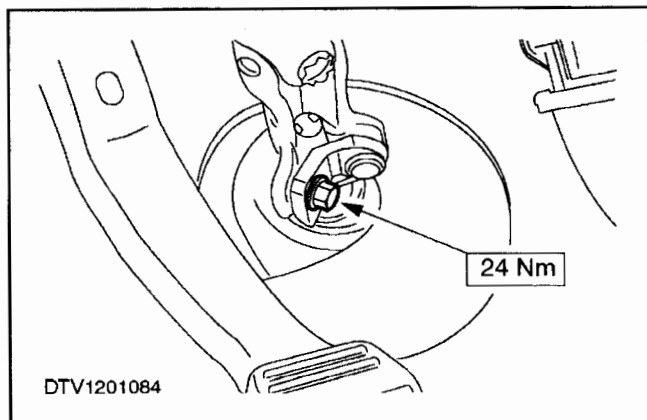


4. Install the clutch pedal return spring.



5. Install the pedal box assembly.

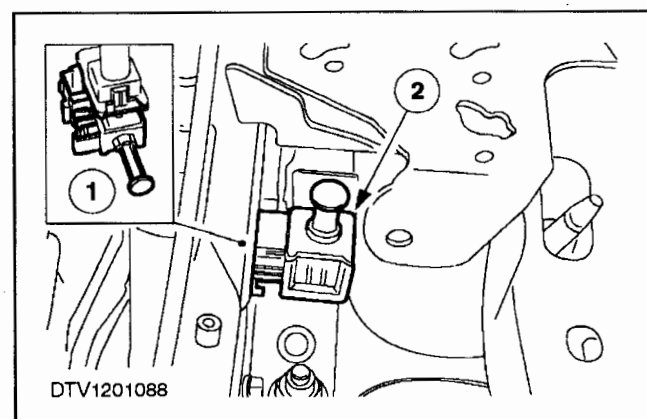
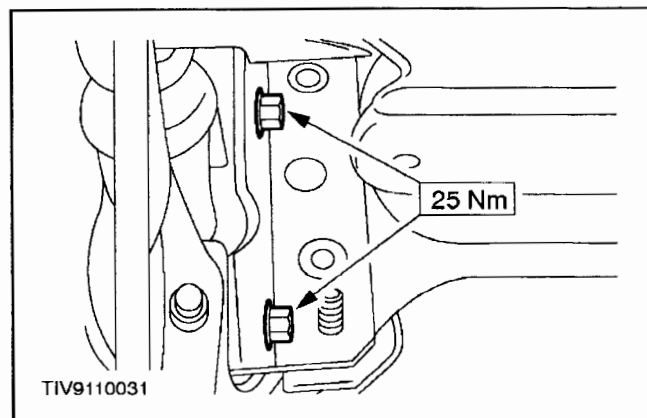
- 1 Install the clutch master cylinder to the pedal box assembly.
- 2 Install the nut.
- 3 Install the bolts.

REMOVAL AND INSTALLATION (Continued)

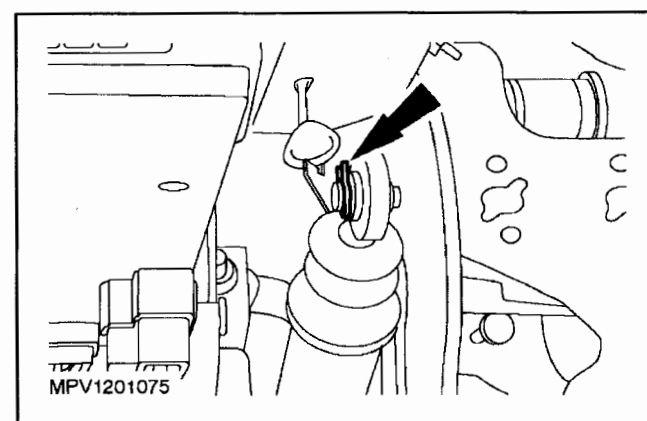
6.  **WARNING: Install a new pinch bolt. Failure to follow these instructions may result in personal injury.**

Install the steering column shaft to flexible coupling clamp plate bolt.

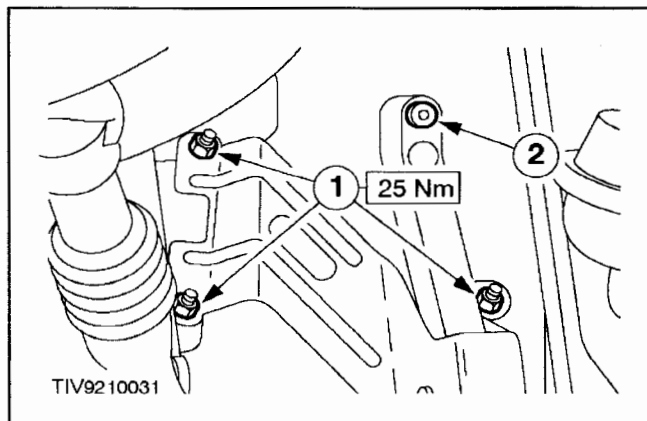
- Rotate the clamp plate to engage.



7. Install the start inhibitor switch.
- 1 Connect the electrical connector.
 - 2 Install the switch.

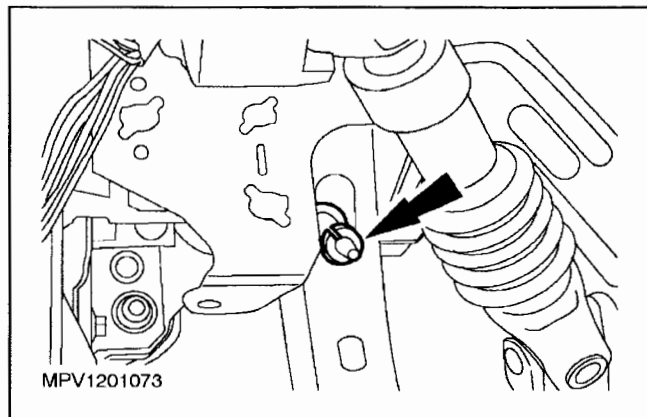


8. Install the clutch master cylinder to clutch pedal retaining clip.

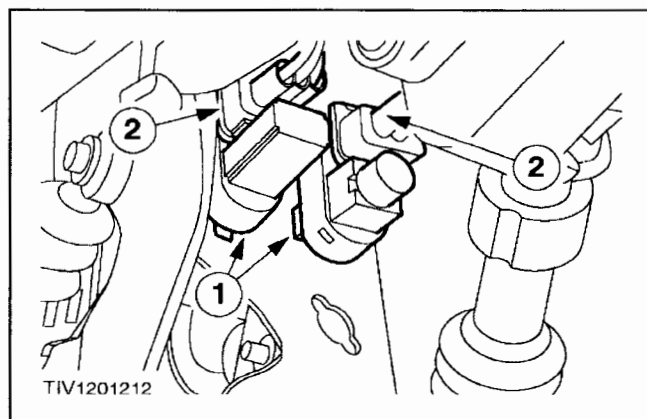
REMOVAL AND INSTALLATION (Continued)

9. Install the accelerator pedal and bracket assembly.

- 1 Install the nuts.
- 2 Connect the accelerator cable.

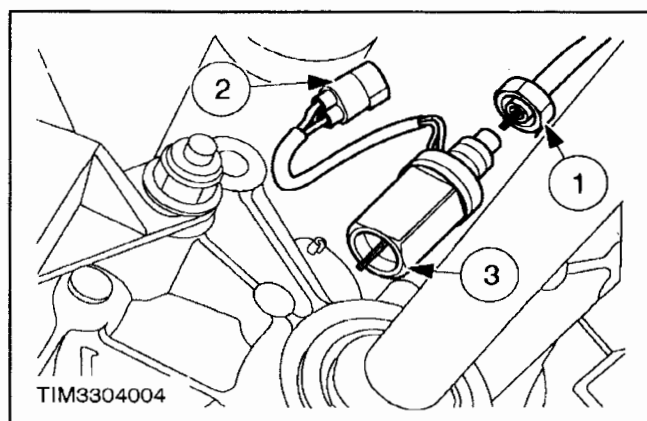


10. Install the brake booster actuator rod retaining clip.



11. Install the brake and clutch pedal position switches.

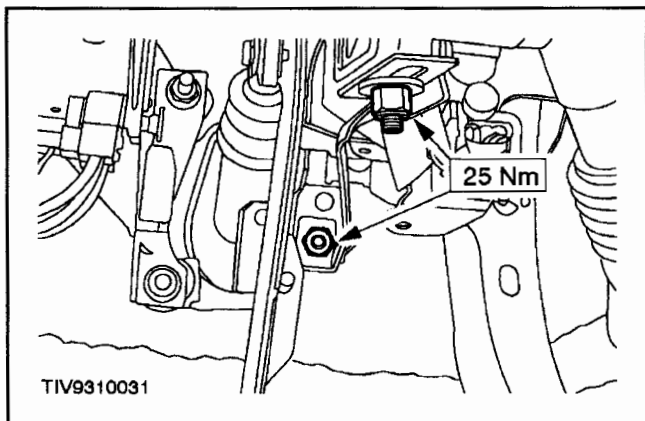
- 1 Install the pedal switches.
- 2 Connect the electrical connectors.



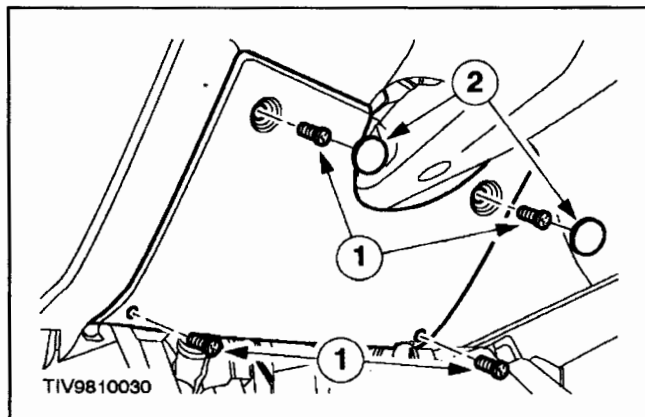
12. Install the stop lamp switch.

- 1 Pull the switch plunger out to its full extent.
- 2 Depress the brake pedal.
- 3 Install the stop lamp switch.
- 4 Slowly release the brake pedal.

13. Connect the electrical connector.

REMOVAL AND INSTALLATION (Continued)

14. Install the steering column support bracket.



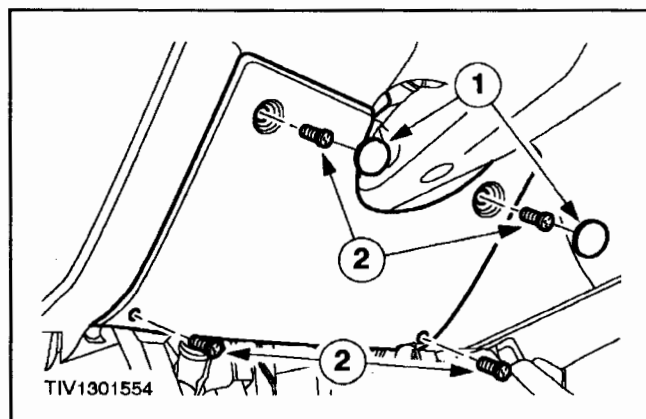
15. Install the instrument panel lower panel.

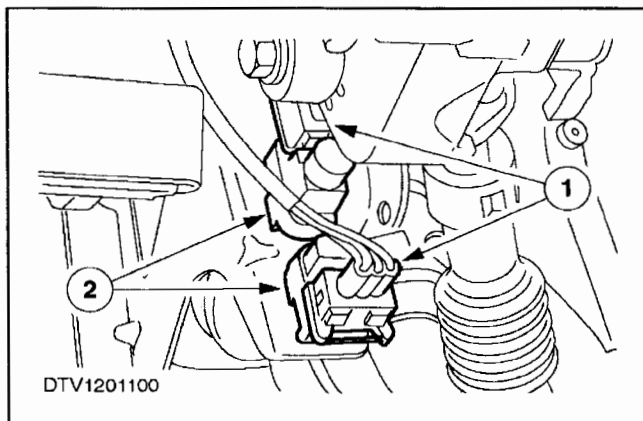
- 1 Install the screws.
- 2 Install the screw covers.

16. Connect the battery ground cable.

Brake Pedal And Bracket — Vehicles with Automatic Transaxle**Removal**

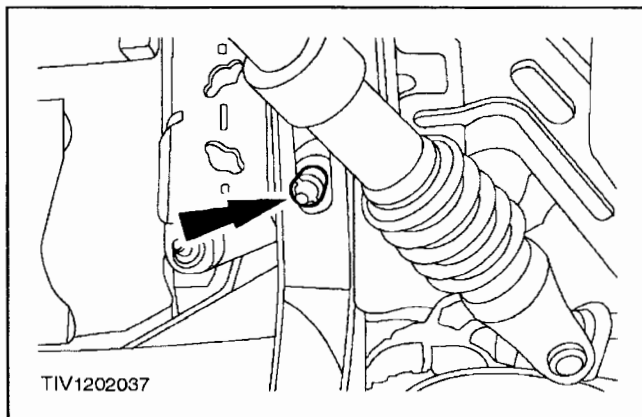
1. Disconnect the battery ground cable.
2. Remove the instrument panel lower panel.
 - 1 Remove the screw covers.
 - 2 Remove the screws.



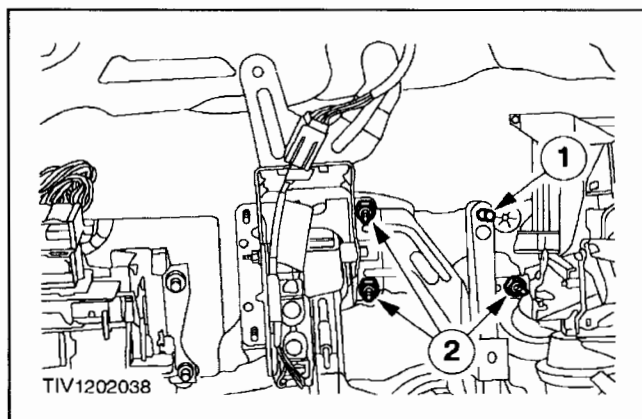
REMOVAL AND INSTALLATION (Continued)

3. Remove the stop lamp and brake pedal position switches.

- 1 Disconnect the electrical connectors.
- 2 Remove the switches.

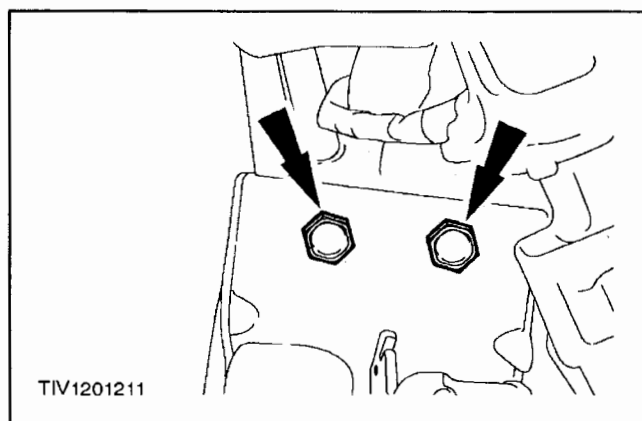


4. Remove the brake booster actuator rod retaining clip.

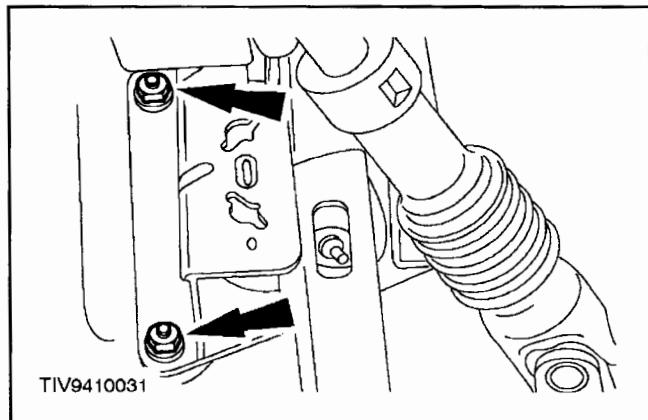


5. Remove the accelerator pedal and bracket assembly (steering column shown removed for clarity).

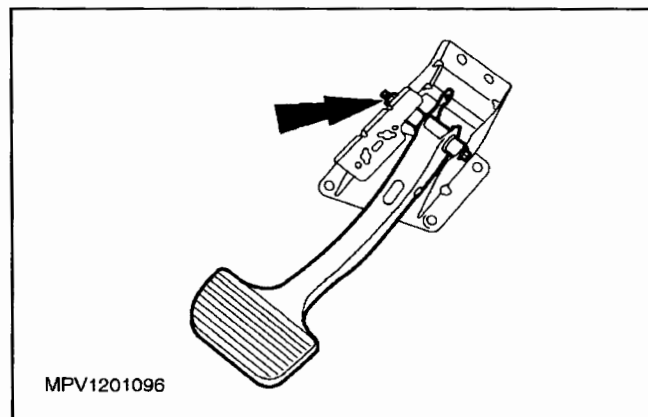
- 1 Disconnect the accelerator cable.
- 2 Remove the nuts.



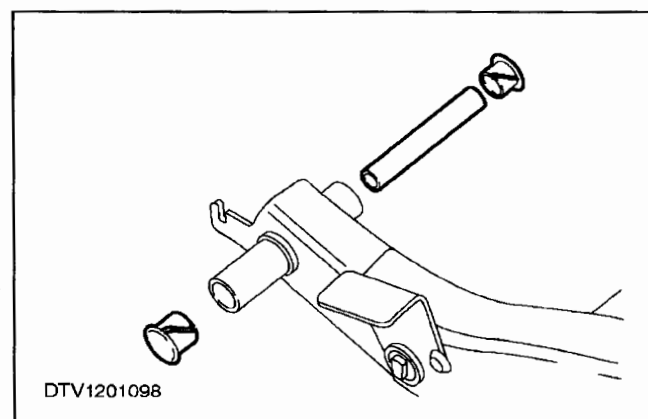
6. Remove the pedal box assembly top bolts.

REMOVAL AND INSTALLATION (Continued)

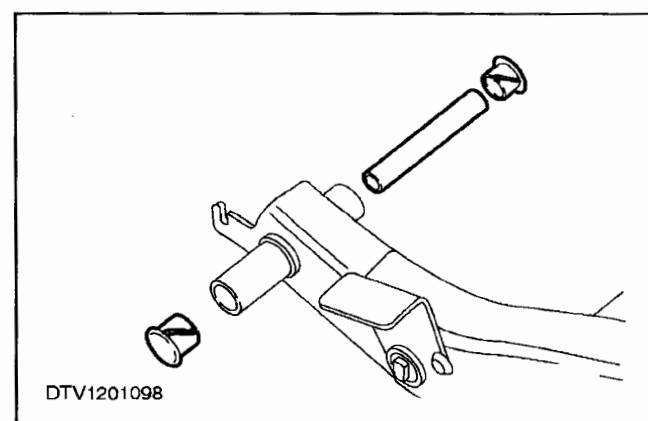
7. Remove the pedal box assembly side nuts.



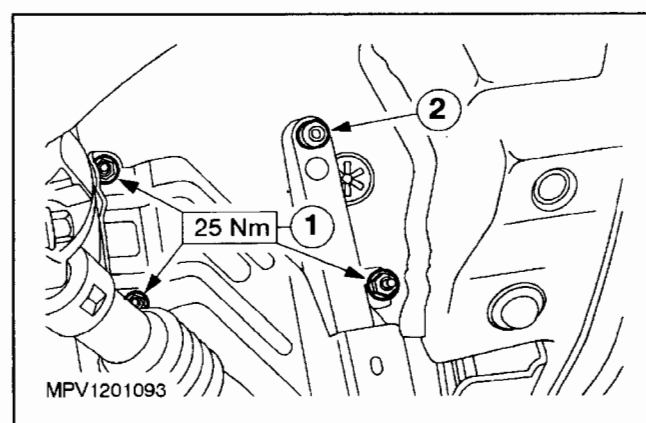
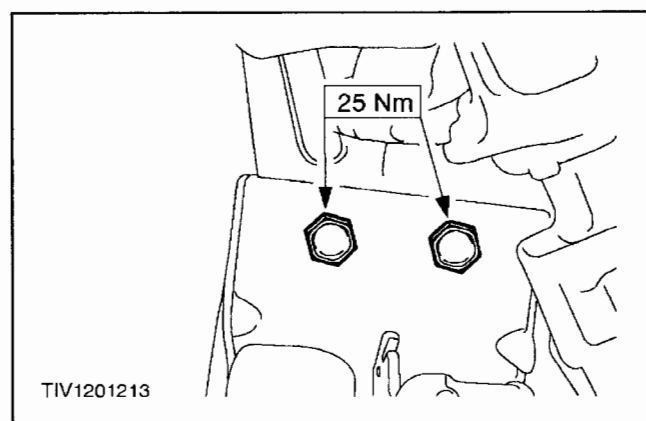
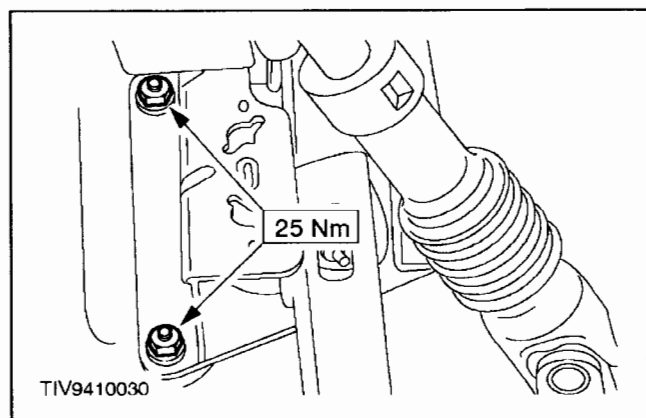
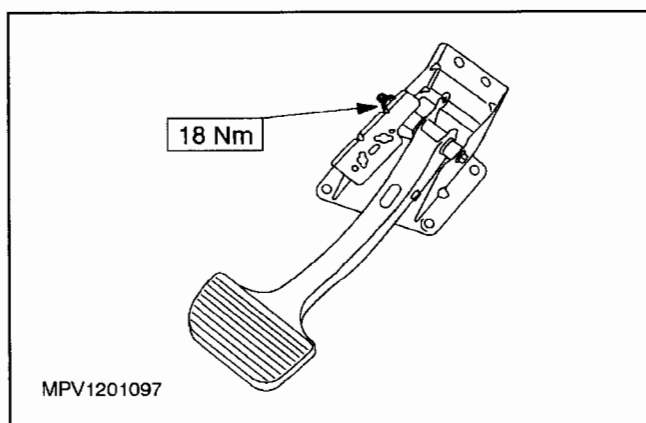
8. Remove the brake pedal from the pedal box.



9. Remove the brake pedal sleeve and bushings.

Installation

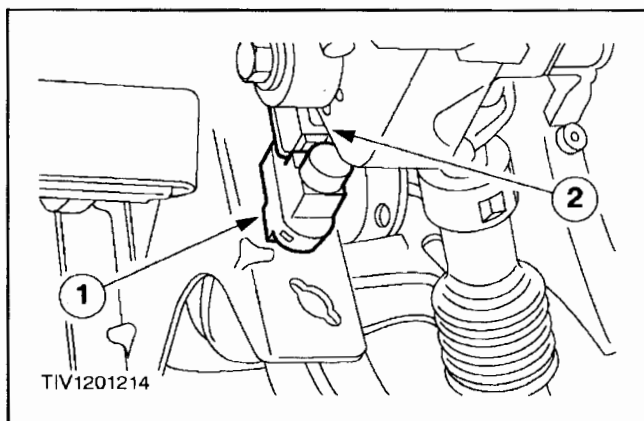
1. Install the brake pedal sleeve and bushings.

REMOVAL AND INSTALLATION (Continued)

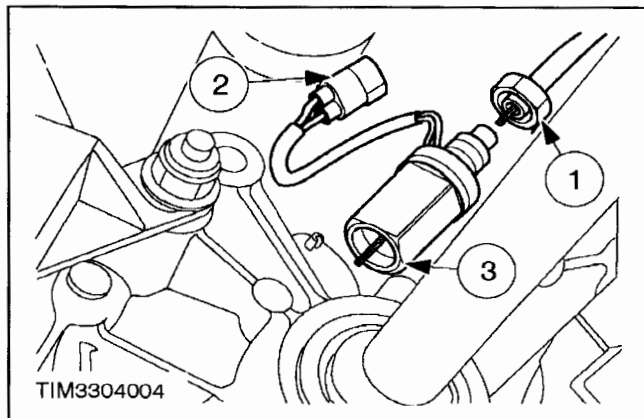
2. Install the accelerator pedal assembly.

1 Install the nuts.

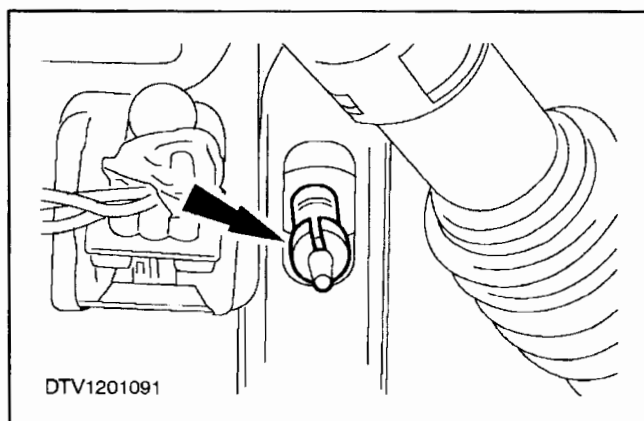
2 Connect the accelerator cable.

REMOVAL AND INSTALLATION (Continued)

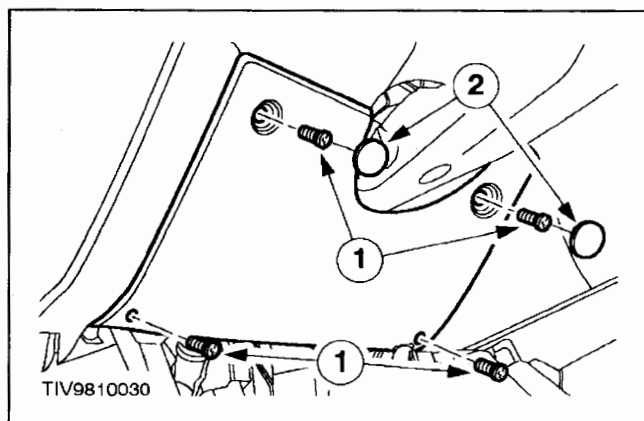
3. Install the brake pedal position switch.
 - 1 Install the switch.
 - 2 Connect the electrical connector.



4. Install the stop lamp switch.
 - 1 Pull the switch plunger out to its full extent.
 - 2 Depress the brake pedal.
 - 3 Install the stop lamp switch.
 - 4 Slowly release the brake pedal.



5. Connect the electrical connector.
6. Install the brake booster actuator rod retaining clip.



7. Install the instrument panel lower panel.
 - 1 Install the screws.
 - 2 Install the screw covers.

REMOVAL AND INSTALLATION (Continued)

8. Connect the battery ground cable.

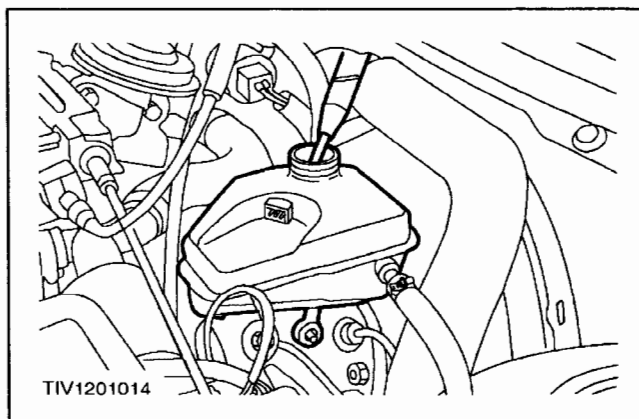
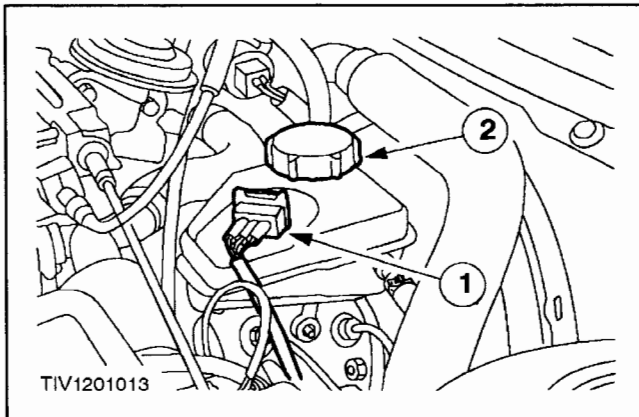
Brake Master Cylinder**Removal****All vehicles**

1.  **CAUTION: If brake fluid is spilled on the paintwork, the affected area must be immediately washed down with cold water.**

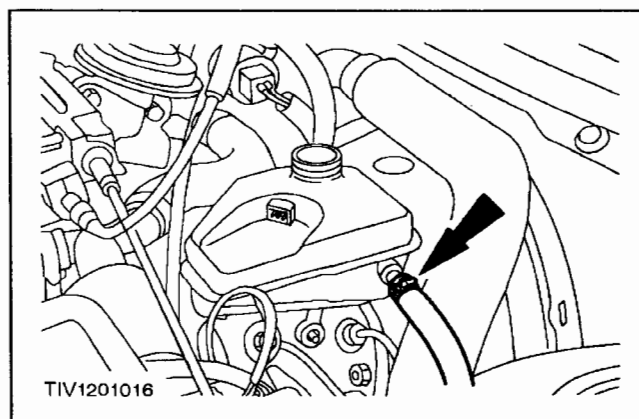
NOTE: Make sure the filler cap does not become contaminated.

Remove the reservoir filler cap.

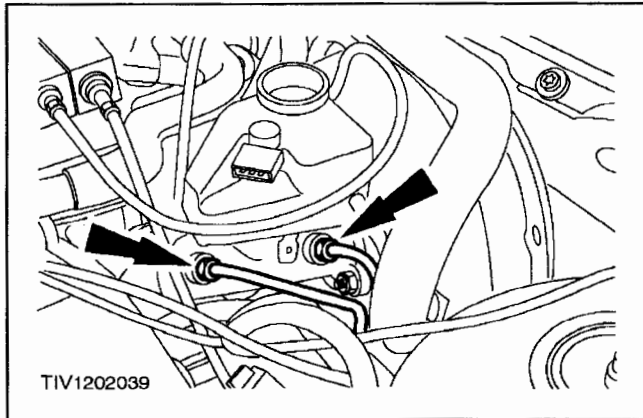
- 1 Disconnect the electrical connector.
- 2 Remove the cap.



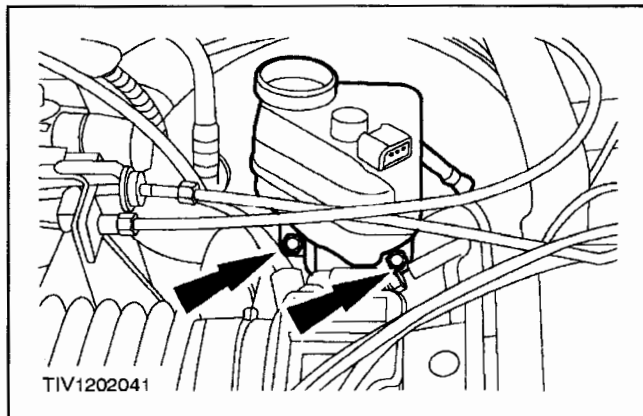
2. Using a suitable suction device drain the reservoir.

**Vehicles with manual transaxle**

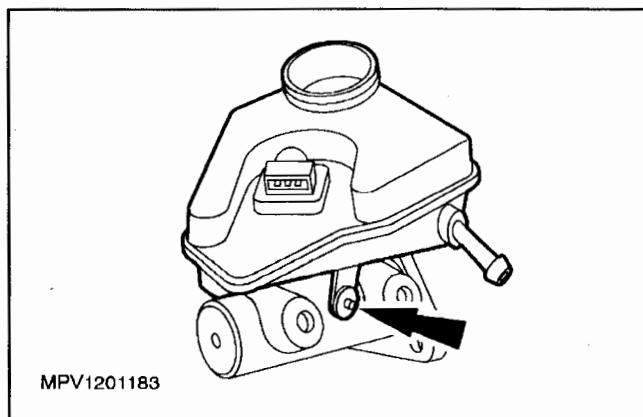
3. Disconnect the clutch master cylinder feed hose.

REMOVAL AND INSTALLATION (Continued)**All vehicles**

4.  **CAUTION:** Cap the tube connections to prevent fluid loss or dirt contamination. Disconnect the master cylinder brake tubes.



5. Release the brake booster vacuum by removing the vacuum hose.
6. Remove the fluid reservoir and master cylinder assembly.



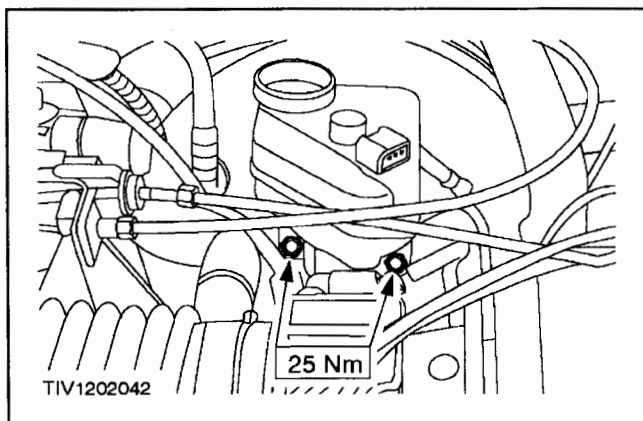
7. Remove the reservoir from the master cylinder.
- Lift the two retaining clips and pull off the reservoir.

8. Remove and discard the O-ring seals.

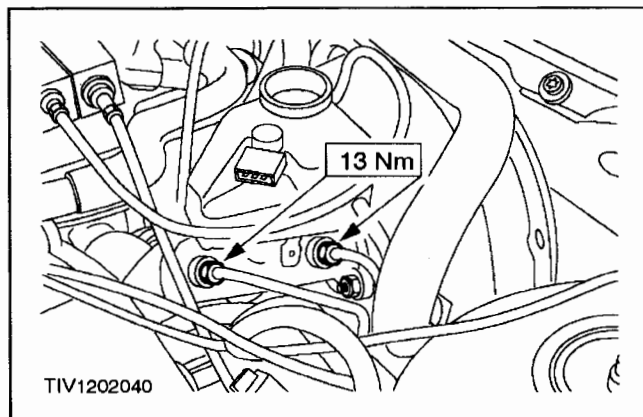
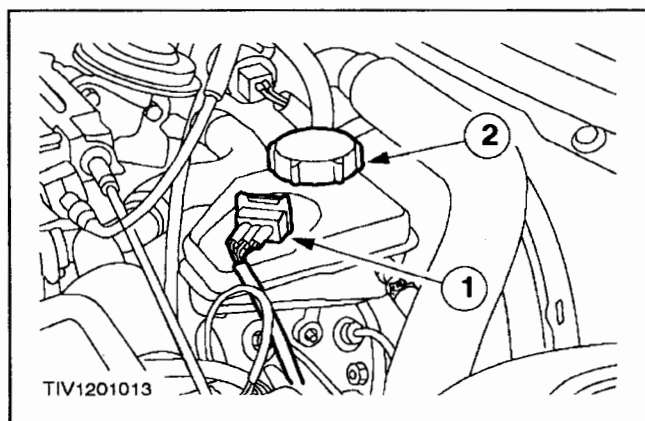
Installation

NOTE: After installation, bleed the brake system. For additional information, refer to Section 206-00.

1. Install new O-ring seals.

REMOVAL AND INSTALLATION (Continued)

2.  **CAUTION:** Before installing the master cylinder make sure that the vacuum seal is in place and that the mating faces are clean.
To install, reverse the removal procedure.

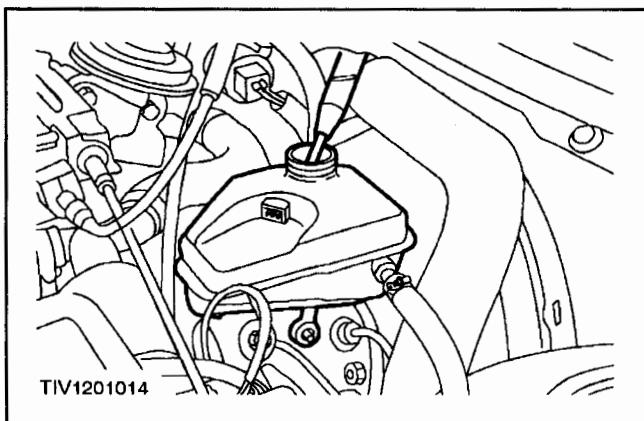
**Brake Fluid Reservoir****Removal and Installation****All vehicles**

1.  **CAUTION:** If brake fluid is spilt on the paintwork, the affected area must be immediately washed down with cold water.

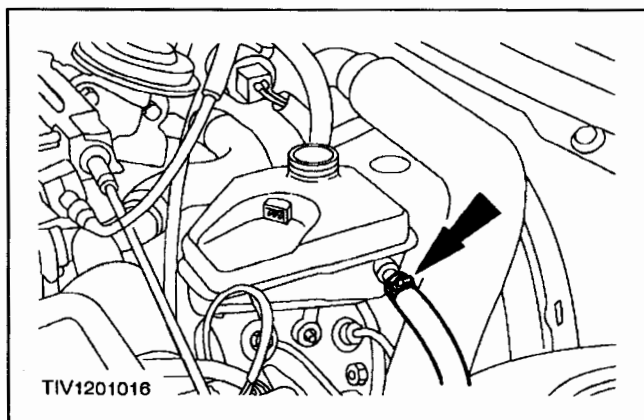
NOTE: Make sure the filler cap does not become contaminated.

Remove the reservoir filler cap.

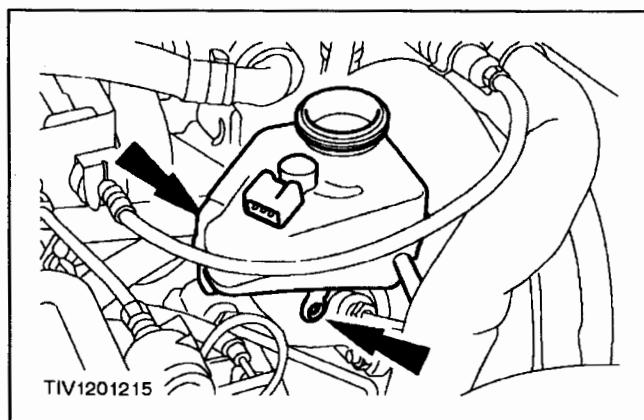
- 1 Disconnect the electrical connector.
- 2 Remove the cap.

REMOVAL AND INSTALLATION (Continued)

2. Using a suitable suction device drain the reservoir.

**Vehicles with manual transaxle**

3. Disconnect the clutch master cylinder feed hose.

**All vehicles**

4. Remove the brake fluid reservoir.
 - Detach the two retaining clips.
5. Remove and discard the O-ring seals.
6. **NOTE:** After installation, bleed the brake system. For additional information, refer to Section 206-00.
NOTE: Install new O-ring seals.
To install, reverse the removal procedure.

SECTION 206-07 Power Brake Actuation

CONTENTS	PAGE
SPECIFICATIONS	206-07-2
DESCRIPTION AND OPERATION	
Brake Booster	206-07-2
DIAGNOSIS AND TESTING	
Power Brake System	206-07-3
REMOVAL AND INSTALLATION	
Brake Booster — Vehicles with 2.0L Engine	206-07-3
Brake Booster — Vehicles with 2.5L Engine	206-07-5

SPECIFICATIONS

Torque Specifications

Description	Nm	Lb-Ft
Brake booster nuts	25	18
Brake tube union	13	10
Gear selector cable bracket bolts	24	18

DESCRIPTION AND OPERATION

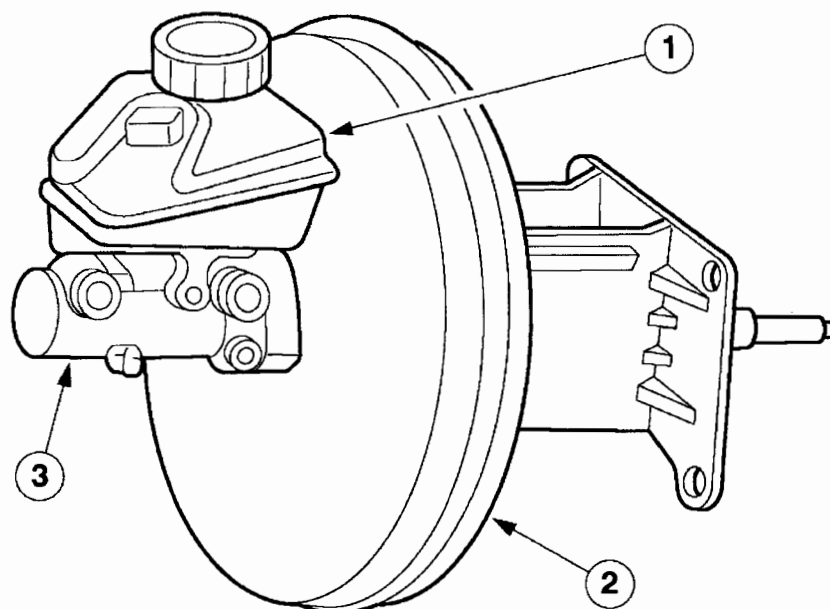
Brake Booster

 **WARNING:** Brake fluid contains polyglycol ethers and polyglycols. Avoid contact with eyes. Wash hands thoroughly after handling. If brake fluid contacts the eyes, flush the eyes for 15 minutes with cold running water. Get medical attention if irritation persists. If taken internally, drink water and induce vomiting. Get medical attention immediately. Failure to follow these instructions may result in personal injury.

The diaphragm-type power brake booster:

- is self contained.
- is mounted on the engine side of the bulkhead.

- uses engine intake manifold vacuum and atmospheric pressure for its power.
- utilizes a check valve to provide temporary pressure when its vacuum is reduced.

DESCRIPTION AND OPERATION (Continued)

TIV1201174

Item	Part Number	Description
1	—	Brake fluid reservoir
2	—	Brake booster
3	—	Brake master cylinder

DIAGNOSIS AND TESTING**Power Brake System**

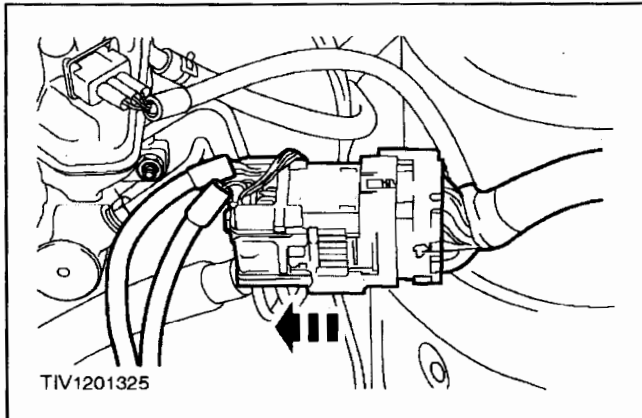
Refer to Section 206-00.

REMOVAL AND INSTALLATION**Brake Booster — Vehicles with 2.0L Engine****Removal and Installation****All vehicles**

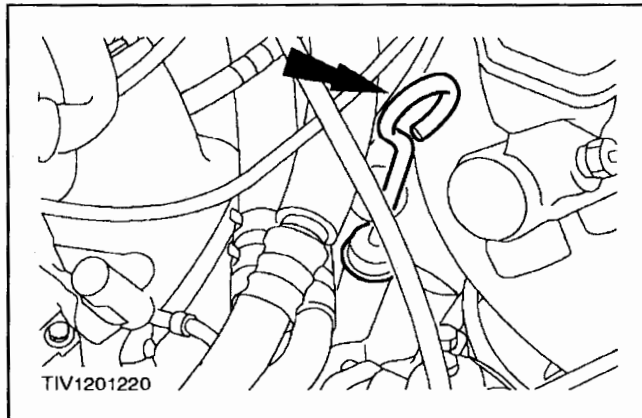
1. Remove the air cleaner. For additional information, refer to Section 303-12A.

REMOVAL AND INSTALLATION (Continued)

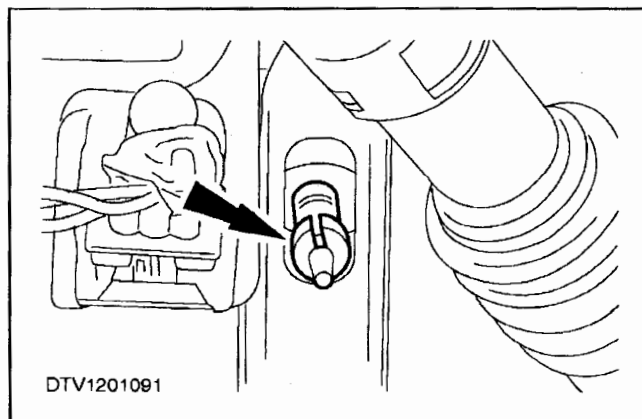
2. Remove the mass air flow sensor. For additional information, refer to Section 303-14A.
3. Remove the air cleaner outlet tube. For additional information, refer to Section 303-12A.
4. Detach the engine wiring harness electrical connector.

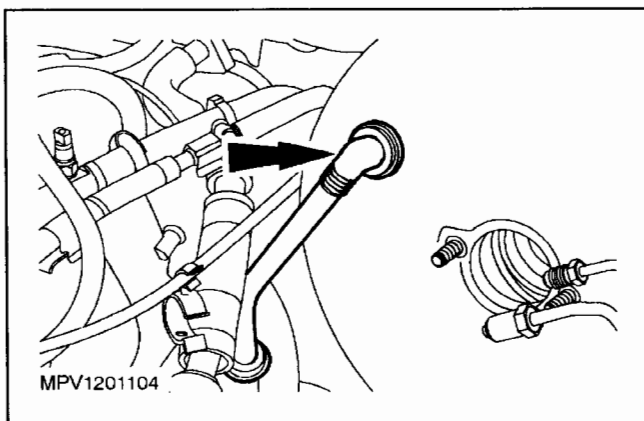
**Vehicles with automatic transaxle**

5. Remove the automatic transaxle fluid dipstick.

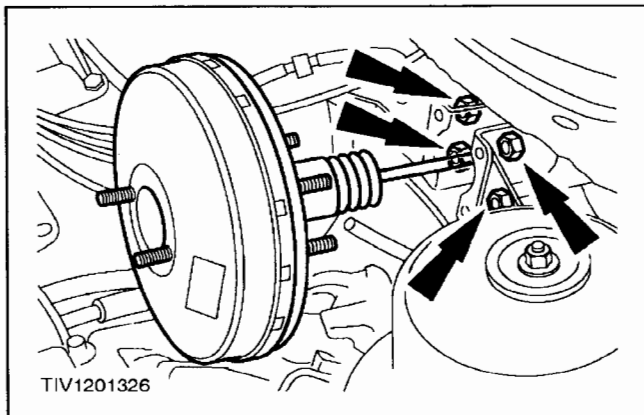
**All vehicles**

6. Remove the master cylinder. For additional information, refer to Section 206-06.
7. Remove the brake booster actuator rod retaining clip.



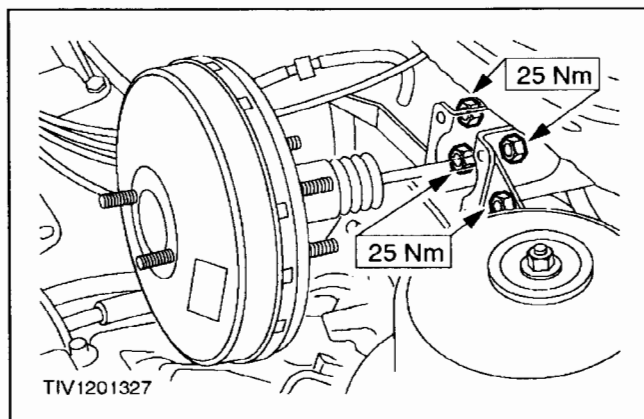
REMOVAL AND INSTALLATION (Continued)

8. Disconnect the vacuum hose from the brake booster.



9. **CAUTION:** Do not pull on the accelerator or speed control cable (if equipped).

Remove the brake booster.



10. **CAUTION:** Make sure that the brake booster connecting rod is correctly positioned through the bulkhead rubber boot.

NOTE: After installation, bleed the brake system. For additional information, refer to Section 206-00.

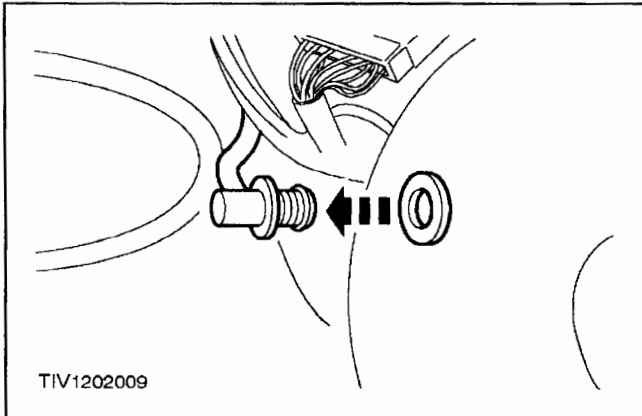
To install, reverse the removal procedure.

Brake Booster — Vehicles with 2.5L Engine**Removal and Installation****All vehicles**

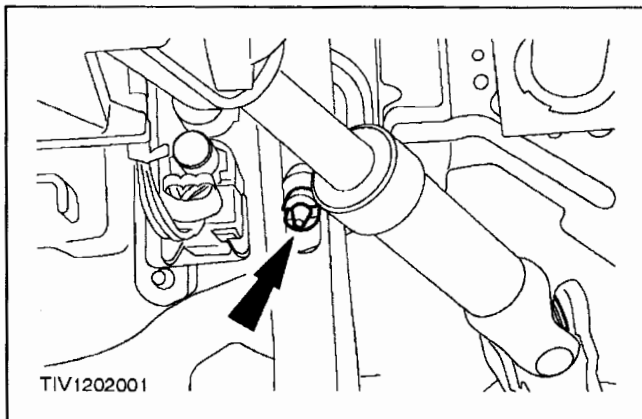
1. Disconnect the battery ground cable.
2. Remove the air cleaner. For additional information, refer to Section 303-12B.

REMOVAL AND INSTALLATION (Continued)

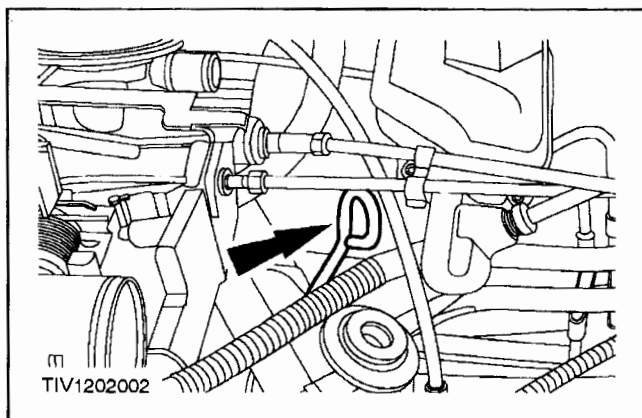
3. Remove the air cleaner outlet tube. For additional information, refer to Section 303-12B.
4. Remove the master cylinder. For additional information, refer to Section 206-06.
5. Disconnect the vacuum hose from the brake booster.



6. Remove the brake booster actuator rod retaining clip.

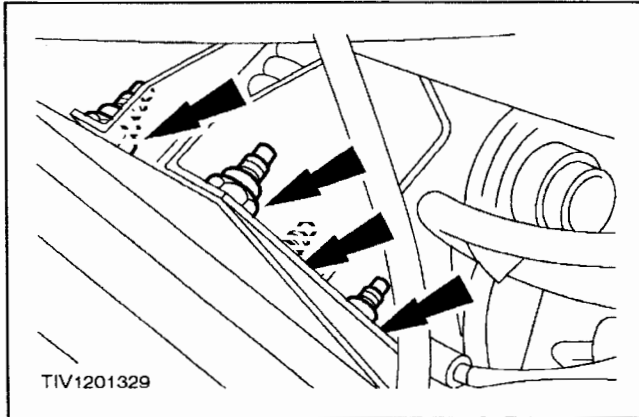
**Vehicles with automatic transaxle**

7. Remove the automatic transaxle fluid dipstick.

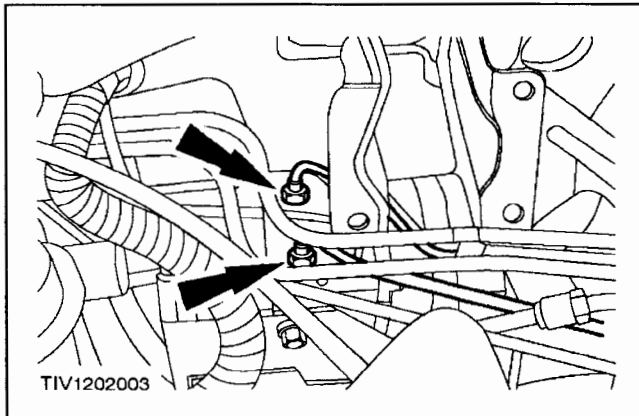


REMOVAL AND INSTALLATION (Continued)**All vehicles**

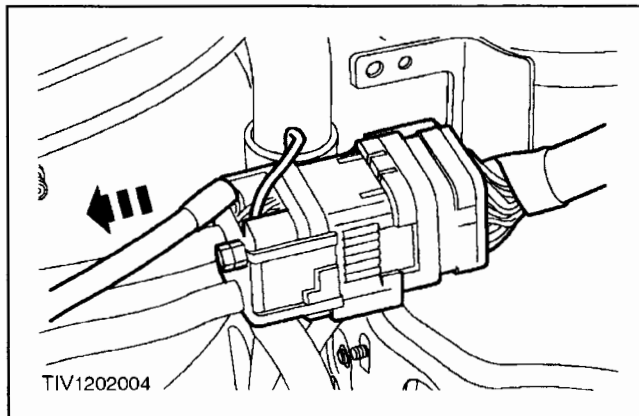
8. Detach the brake booster (four nuts).



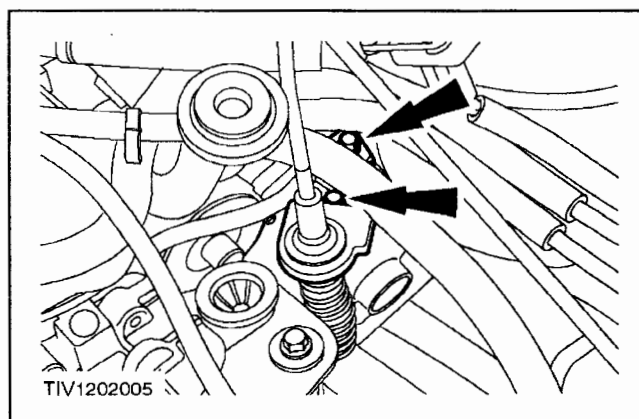
9. Follow the master cylinder brake tubes back to the hydraulic control unit and remove the tubes, (brake booster shown removed for clarity).

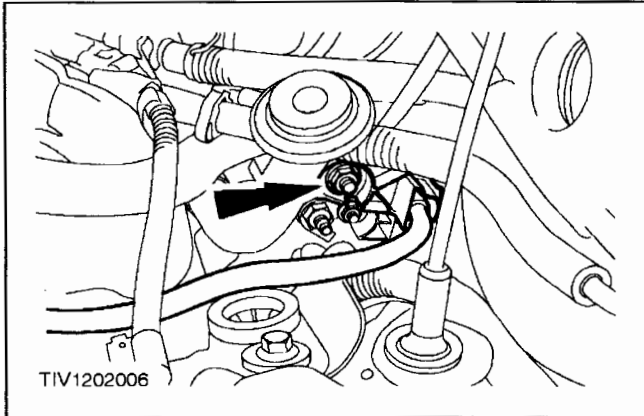


10. Detach the engine wiring harness electrical connector.

**Vehicles with automatic transaxle**

11. Detach the gear selector cable and bracket.



REMOVAL AND INSTALLATION (Continued)**All vehicles**

12. Disconnect the starter motor power cable.

13.  **WARNING:** Do not smoke or carry lighted tobacco or open flame of any type when working on or near any fuel related components. Highly flammable mixtures are always present and may be ignited. Failure to follow these instructions may result in personal injury.

 **WARNING:** Fuel in the fuel system remains under high pressure even when the engine is not running.

Depressurize the fuel system. For additional information, refer to Section 310-00.

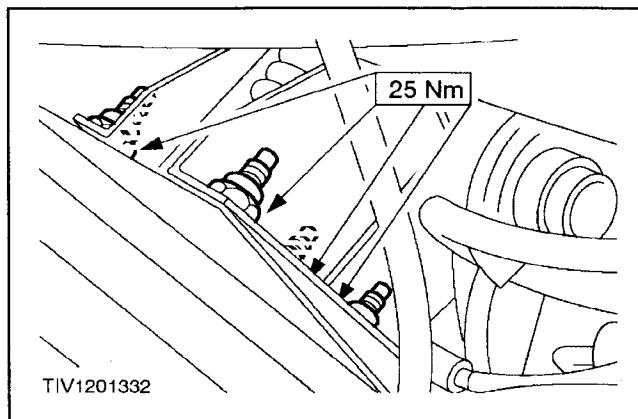
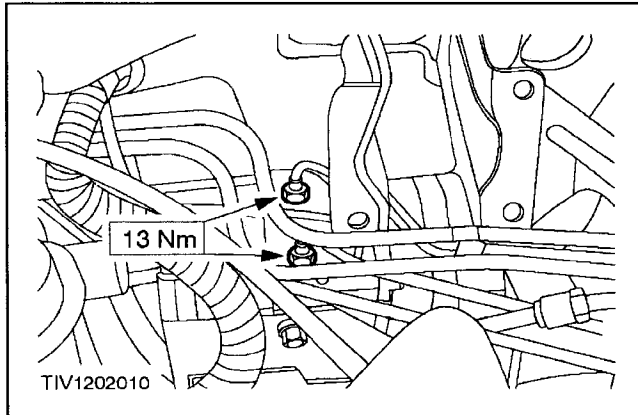
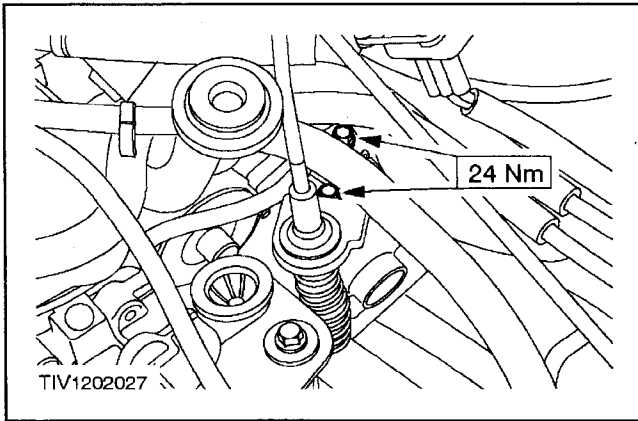
14. Disconnect the fuel flow and return tubes. For additional information, refer to Section 310-00.

15. Remove the brake booster from the vehicle.

NOTE: After installation, bleed the brake system. For additional information, refer to Section 206-00.

16.  **CAUTION:** Make sure that the brake booster actuator rod is correctly positioned through the bulkhead rubber boot.

To install, reverse the removal procedure.

REMOVAL AND INSTALLATION (Continued)

SECTION 206-09A Anti-Lock Control

CONTENTS	PAGE
SPECIFICATIONS	206-09A-2
DESCRIPTION AND OPERATION	
Anti-Lock Control	206-09A-2
Hydraulic Control Unit	206-09A-2
DIAGNOSIS AND TESTING	
Anti-Lock Control	206-09A-4
Principles of Operations	206-09A-4
Inspection and Verification	206-09A-4
ABS Control Module Diagnostic Trouble Code (DTC) Index	206-09A-5
ABS Control Module Parameter Identification (PID) Index	206-09A-5
ABS Control Module Active Command Index	206-09A-6
Symptom Chart	206-09A-7
Pinpoint Tests	206-09A-7
Pinpoint Tests	206-09A-8
REMOVAL AND INSTALLATION	
Hydraulic Control Unit (HCU) — Vehicles with 2.0L Engine	206-09A-25
Hydraulic Control Unit (HCU) — Vehicles with 2.5L Engine	206-09A-30
Front Wheel Speed Sensor	206-09A-33
Rear Wheel Speed Sensor	206-09A-34

SPECIFICATIONS

Torque Specifications

Description	Nm	Lb-Ft	Lb-In
Hydraulic control unit nuts	11	8	—
Brake tube unions	15	11	—

(Continued)

Torque Specifications

Description	Nm	Lb-Ft	Lb-In
Hydraulic control unit bracket bolts	24	18	—
Wheel sensor bolts	10	—	89
Brake booster support bracket nuts	40	30	—

DESCRIPTION AND OPERATION

Anti-Lock Control

 **WARNING:** Brake fluid contains polyglycol ethers and polyglycols. Avoid contact with eyes. Wash hands thoroughly after handling. If brake fluid contacts the eyes, flush the eyes for 15 minutes with cold running water. Get medical attention if irritation persists. If taken internally, drink water and induce vomiting. Get medical attention immediately. Failure to follow these instructions may result in personal injury.

The anti-lock brake system operates as follows:

- Wheel lock-up is prevented during heavy braking by modulating brake pressure.
- The system permits the driver to maintain steering control and stop the vehicle in the shortest possible distance under most conditions.
- During the anti-lock brake operation, the driver will sense a pulsation in the brake pedal and hear a clicking sound.

- The pedal effort and pedal feel during normal braking are similar to that of a conventional power brake system.

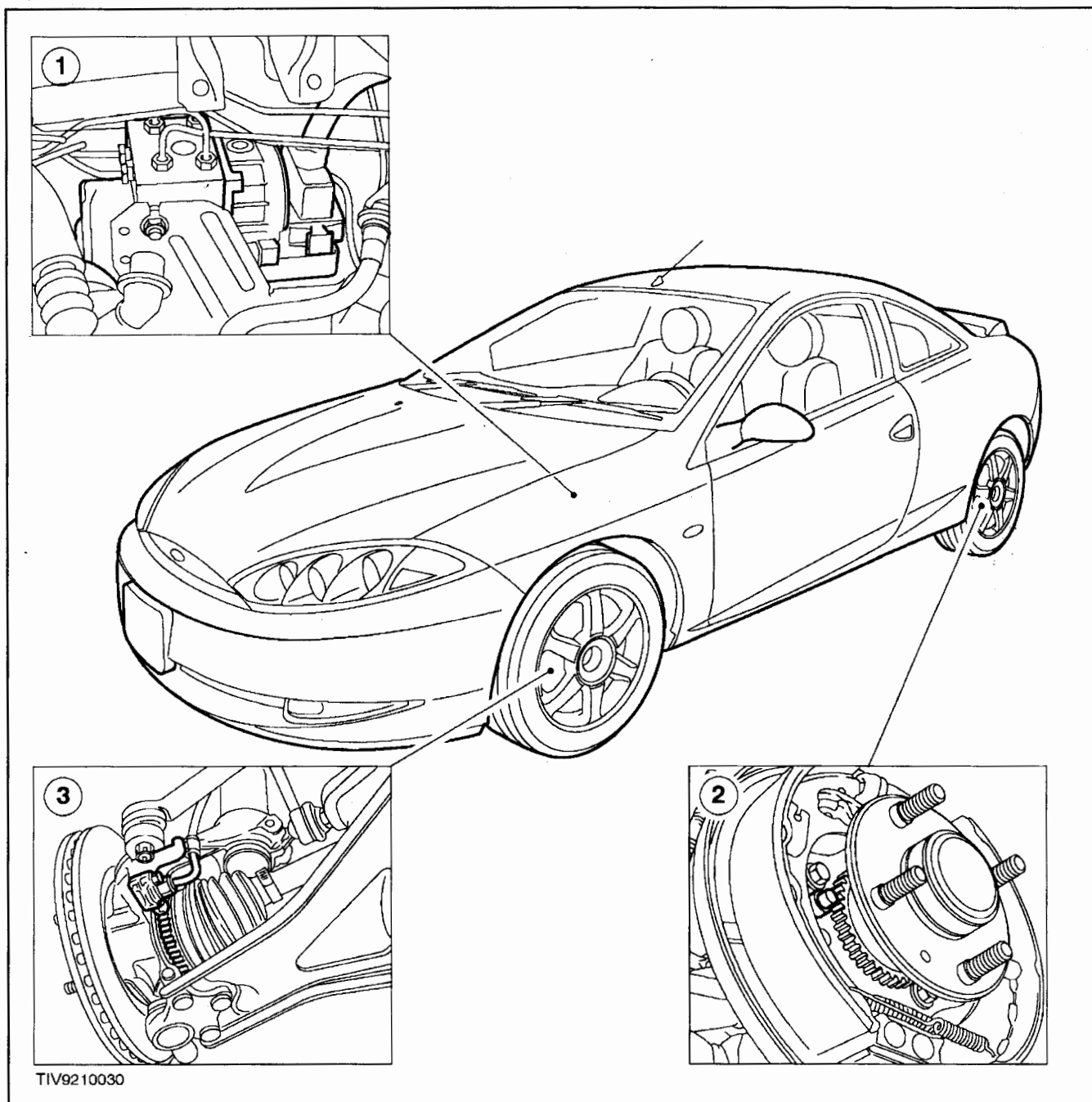
Hydraulic Control Unit

The Hydraulic Control Unit (HCU) is an integrated unit and is located below the brake booster. The HCU consists of the following components:

- An electronic control unit with relays.
- An eight solenoid valve body.
- A pump motor.
- An anti-lock control module.
- An anti-lock brake relay.

The HCU is a non-repairable unit.

DESCRIPTION AND OPERATION (Continued)



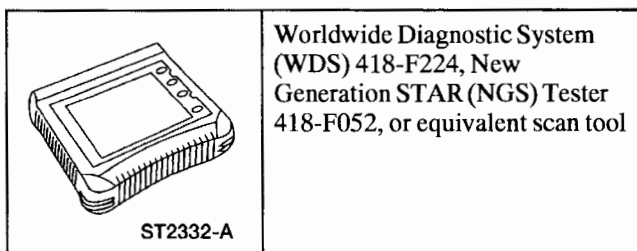
Item	Part Number	Description
1	—	Hydraulic control unit
2	—	Rear wheel sensor
3	—	Front wheel sensor

DIAGNOSIS AND TESTING

Anti-Lock Control

Refer to Wiring Diagrams Cell 42 for schematic and connector information.

Special Tool(s)



Principles of Operations

The ABS control module receives wheel speed readings from each wheel speed sensor and processes this information to determine if an ABS event is necessary. The wheel speed sensor electrically senses each tooth of the ABS sensor indicators as it passes through the wheel speed sensor's magnetic field.

The ABS control module continuously monitors and compares the rotational speed of each wheel. When the module detects an impending wheel lock, it modulates brake pressure to the appropriate brake caliper. This is accomplished by triggering the hydraulic control unit (HCU) to open and close the appropriate solenoid valves. Once the effected wheel returns to normal speed, the ABS control module returns the solenoid valves to their normal position and normal (base) braking resumes.

The ABS control module is self-monitoring. When the ignition switch is turned to the RUN position, the ABS control module will do a preliminary electrical check. At approximately 20 km/h (12 mph) the pump motor is turned on for approximately a 1/2 second. Also, during all phases of operation the ABS control module (after the vehicle is in motion) checks for correct operation of the wheel speed sensors. Any malfunction of the ABS system will cause the ABS to shut off however, normal power assisted braking is maintained.

The ABS control module has the ability to store three DTCs in memory.

Inspection and Verification

1. Verify the customer concern by operating the system.

2. Visually inspect for obvious signs of mechanical or electrical damage.

Visual Inspection Chart

Mechanical	Electrical
• Low brake fluid • Wheel speed sensor(s) • ABS sensor indicator(s) • Base brake system • Wheel bearings	• Fuse(s) • ABS warning indicator lamp • Wiring harness • Loose or corroded connections

3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
4. If the concern remains after the inspection, connect the scan tool to the data link connector (DLC) located beneath the instrument panel and select the vehicle to be tested from the scan tool menu. If the scan tool does not communicate with the vehicle:
 - check that the program card is correctly installed.
 - check the connections to the vehicle.
 - check the ignition switch position.
5. If the scan tool still does not communicate with the vehicle, refer to the scan tool manual.
6. Carry out the DATA LINK DIAGNOSTIC TEST. If the scan tool responds with:
 - CKT914, CKT915 or CKT70 — ALL ECUS NO RESP/NOT EQUIP, Refer to Section 418-00.
 - NO RESP/NOT EQUIP for anti-lock brake control module, GO to Pinpoint Test A.
 - SYSTEM PASSED, retrieve and record the continuous diagnostic trouble codes (DTCs), erase the continuous DTCs and carry out self-test diagnostics for the anti-lock brake control module.
7. If the DTCs retrieved and related to the concern, go to Anti-Lock Brake Module Diagnostic Trouble Code (DTC) Index to continue diagnostics.
8. If no DTCs related to the concern are retrieved, GO to **Symptom Chart** to continue diagnostics.

DIAGNOSIS AND TESTING (Continued)**ABS Control Module Diagnostic Trouble Code (DTC) Index**

NOTE: The wheel speed DTCs can be cleared but the warning indicator will remain illuminated until the vehicle is driven over 12 Km/h (7 mph).

ABS Control Module Diagnostic Trouble Code (DTC) Index

DTC	Description	Source	Action
B1318	Battery Voltage Low	ABS/TC	GO to Pinpoint Test C.
B1342	ABS Control Module Internal Failure	ABS/TC	CLEAR the DTCs. REPEAT the self test. If DTC B1342 is retrieved again, INSTALL a new hydraulic control unit (HCU). REPEAT the self-test.
B1484	Brake Pedal Input Open Circuit	ABS/TC	GO to Pinpoint Test D.
B1596	Repair Continuous Codes	ABS/TC	REPAIR DTCs retrieved.
C1095	ABS Hydraulic Pump Motor Circuit Failure	ABS/TC	GO to Pinpoint Test E.
C1145	RF Wheel Speed Sensor Input Circuit Failure	ABS/TC	GO to Pinpoint Test F.
C1155	LF Wheel Speed Sensor Input Circuit Failure	ABS/TC	GO to Pinpoint Test F.
C1165	RR Wheel Speed Sensor Input Circuit Failure	ABS/TC	GO to Pinpoint Test F.
C1175	LR Wheel Speed Sensor Input Circuit Failure	ABS/TC	GO to Pinpoint Test F.
C1222	Wheel Speed Signal Mismatch	ABS/TC	GO to Pinpoint Test G.
C1233	LF Wheel Speed Input Signal Missing	ABS/TC	GO to Pinpoint Test H.
C1234	RF Wheel Speed Input Signal Missing	ABS/TC	GO to Pinpoint Test H.
C1235	RR Wheel Speed Input Signal Missing	ABS/TC	GO to Pinpoint Test H.
C1236	LR Wheel Speed Input Signal Missing	ABS/TC	GO to Pinpoint Test H.
C1266	ABS Valve Power Relay Circuit Failure	ABS/TC	INSTALL a new hydraulic control unit (HCU). REPEAT the self-test.

ABS Control Module Parameter Identification (PID) Index**ABS Control Module Parameter Identification (PID) Index**

PID	Description	Expected Value
CCNTABS	Number of Continuous DTCs on ABS Control Module	one count per bit
BOO__	Brake Pedal Position (BPP) Switch Input	ON, OFF
PMP__MTR	ABS Pump Motor	OFF ---, OFFO --, OFF-B-, OFF -- G, OFFO-G, OFFOB-, OFF-BG, OFFOBG, ON ---, ONO --, ON-B-, ON -- G, ONO-G, ONOB-, ON-BG, ONOBG
VLV__CTR	ABS Valve Control Relay	OFF ---, OFFO --, OFF-B-, OFF -- G, OFFO-G, OFFOB-, OFF-BG, OFFOBG, ON ---, ONO --, ON-B-, ON -- G, ONO-G, ONOB-, ON-BG, ONOBG
LF__WSPD	LF Wheel Speed Signal	0-255 KPH
RF__WSPD	RF Wheel Speed Signal	0-255 KPH

(Continued)

DIAGNOSIS AND TESTING (Continued)**ABS Control Module Parameter Identification (PID) Index**

PID	Description	Expected Value
LR__WSPD	LR Wheel Speed Signal	0-255 KPH
RR__WSPD	RR Wheel Speed Signal	0-255 KPH
ABSLF_I	LF ABS Inlet Valve	OFF ---, OFFO --, OFF-B-, OFF -- G, OFFO-G, OFFOB-, OFF-BG, OFFOBG, ON ---, ONO --, ON-B-, ON -- G, ONO-G, ONOB-, ON-BG, ONOBG
ABSLF_O	LF ABS Outlet Valve	OFF ---, OFFO --, OFF-B-, OFF -- G, OFFO-G, OFFOB-, OFF-BG, OFFOBG, ON ---, ONO --, ON-B-, ON -- G, ONO-G, ONOB-, ON-BG, ONOBG
ABSRF_I	RF ABS Inlet Valve	OFF ---, OFFO --, OFF-B-, OFF -- G, OFFO-G, OFFOB-, OFF-BG, OFFOBG, ON ---, ONO --, ON-B-, ON -- G, ONO-G, ONOB-, ON-BG, ONOBG
ABSRF_O	RF ABS Outlet Valve	OFF ---, OFFO --, OFF-B-, OFF -- G, OFFO-G, OFFOB-, OFF-BG, OFFOBG, ON ---, ONO --, ON-B-, ON -- G, ONO-G, ONOB-, ON-BG, ONOBG
ABSLR_I	LR ABS Inlet Valve	OFF ---, OFFO --, OFF-B-, OFF -- G, OFFO-G, OFFOB-, OFF-BG, OFFOBG, ON ---, ONO --, ON-B-, ON -- G, ONO-G, ONOB-, ON-BG, ONOBG
ABSLR_O	LR ABS Outlet Valve	OFF ---, OFFO --, OFF-B-, OFF -- G, OFFO-G, OFFOB-, OFF-BG, OFFOBG, ON ---, ONO --, ON-B-, ON -- G, ONO-G, ONOB-, ON-BG, ONOBG
ABSRR_I	RR ABS Inlet Valve	OFF ---, OFFO --, OFF-B-, OFF -- G, OFFO-G, OFFOB-, OFF-BG, OFFOBG, ON ---, ONO --, ON-B-, ON -- G, ONO-G, ONOB-, ON-BG, ONOBG
ABSRR_O	RR ABS Outlet Valve	OFF ---, OFFO --, OFF-B-, OFF -- G, OFFO-G, OFFOB-, OFF-BG, OFFOBG, ON ---, ONO --, ON-B-, ON -- G, ONO-G, ONOB-, ON-BG, ONOBG

ABS Control Module Active Command Index**ABS Control Module Active Command Index**

Active Com-mand	Display	Action
ABS OUTPUT CONTROL	ABS POWER	ON, OFF
	LF INLET	ON, OFF
	LF OUTLET	ON, OFF
	RF INLET	ON, OFF

(Continued)

ABS Control Module Active Command Index

Active Com-mand	Display	Action
	RF OUTLET	ON, OFF
	LR INLET	ON, OFF
	LR OUTLET	ON, OFF
	RR INLET	ON, OFF
	RR OUTLET	ON, OFF

DIAGNOSIS AND TESTING (Continued)**Symptom Chart****Symptom Chart**

Condition	Possible Sources	Action
No communication with the anti-lock brake control module	- Fuse. - Circuit. - ABS control module.	GO to Pinpoint Test A.
Unable to enter self-test — communication OK	ABS control module.	GO to Pinpoint Test B.
The red brake warning indicator does not self-check	- Low brake fluid warning switch. - Circuit. - Hybrid electronic cluster (HEC). - Ignition switch. - Parking brake.	REFER to Section 413-01.
The red brake warning indicator stays on when the ignition switch is in RUN	- Low brake fluid warning switch. - Circuit. - Hybrid electronic cluster (HEC). - Ignition switch. - Parking brake.	REFER to Section 413-01.
The yellow ABS warning indicator does not self-check — always on, no DTCs	- Circuit. - ABS control module. - Hybrid electronic cluster (HEC).	GO to Pinpoint Test I.
Spongy brake pedal with no warning indicator	- Air in hydraulic brake system. - Base brake system.	- GO to Pinpoint Test J. - REFER to Section 206-00.
Poor vehicle tracking during anti-lock function	- Air in hydraulic brake system. - Hydraulic control unit, - Base brake system.	- GO to Pinpoint Test K. - REFER to Section 206-00.

Pinpoint Tests

 **CAUTION:** Use the correct probe adapter(s) when making measurements. Failure to use correct probe adapter(s) may damage the connector.

Do not carry out any of the following pinpoint tests unless instructed to do so. It is assumed that a fault has been detected in the system that directs entrance to a specific diagnostic routine. Carrying out any pinpoint test without direction to do so may result in inaccurate diagnosis and possible replacement of functioning components. Correct test results are dependent on the correct operation of related components/systems.

Do not install any new parts unless the test results indicate that they should be replaced.

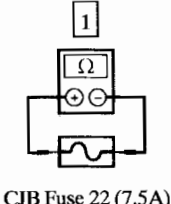
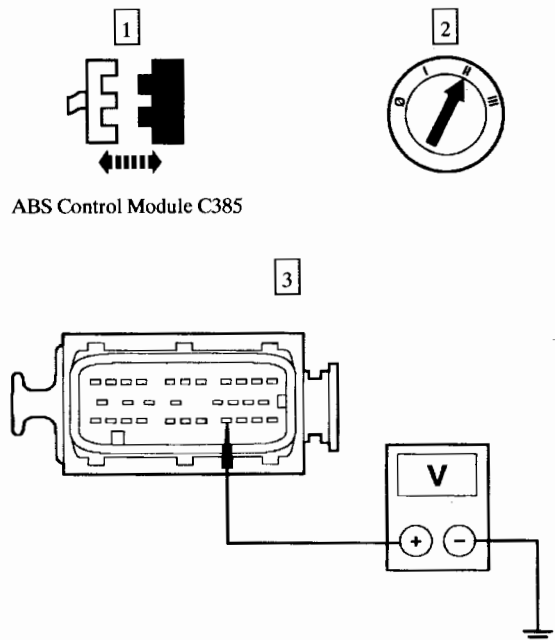
When more than one diagnostic trouble code (DTC) is received, always start with the first DTC received.

For correct pinpoint test procedures, follow the steps in order as listed. Follow each step until a fault is found.

After completing any repair to the anti-lock brake system, verify that all components are correctly reconnected; then clear all DTCs.

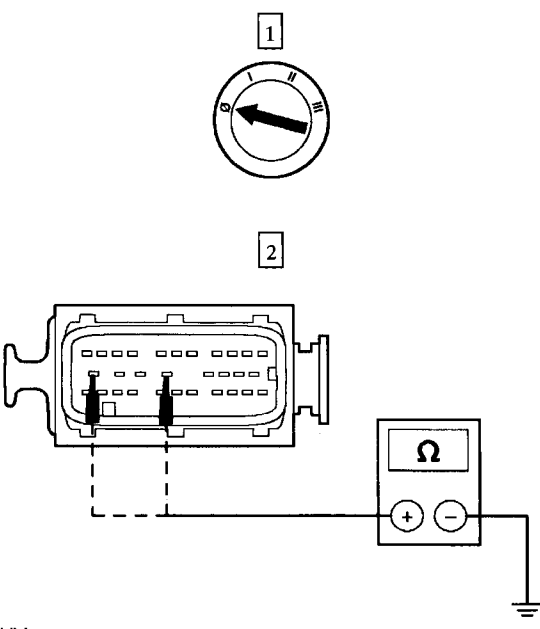
The scan tool can be used to take voltage and resistance measurements. Necessary probes and adapters are included in the scan tool kit.

DIAGNOSIS AND TESTING (Continued)**Pinpoint Tests****PINPOINT TEST A: NO COMMUNICATION WITH THE ANTI-LOCK BRAKE CONTROL MODULE**

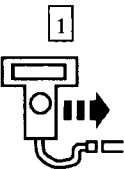
CONDITIONS	DETAILS/RESULTS/ACTIONS
A1 CHECK THE CENTRAL JUNCTION BOX (CJB) FUSE 22 (7.5A)  CJB Fuse 22 (7.5A)	Is the fuse OK? → Yes GO to A2. → No INSTALL a new fuse. CLEAR the DTCs. REPEAT the self-test. If the fuse fails again, CHECK for short to ground. REPAIR as necessary. CLEAR the DTCs. REPEAT the self-test.
A2 CHECK CIRCUIT 15-CF6 (GN/YE) FOR AN OPEN  ABS Control Module C385 VUV9110002	3 Using a digital multimeter, measure the voltage between ABS control module C385 pin 8, circuit 15-CF6 (GN/YE), harness side and ground. Is the voltage greater than 10 volts? → Yes GO to A3. → No REPAIR the circuit. CLEAR the DTCs. REPEAT the self-test.

(Continued)

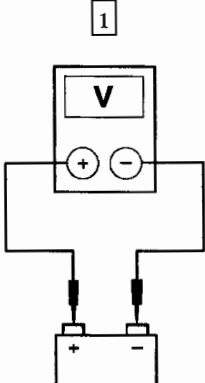
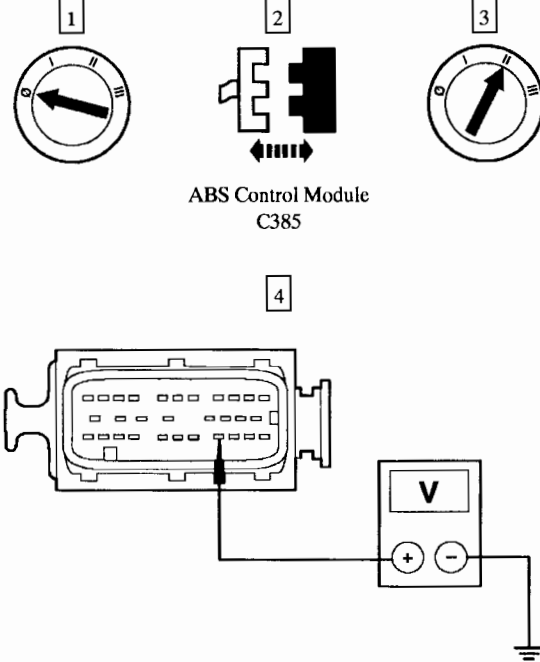
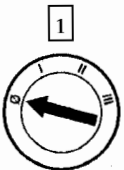
DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST A: NO COMMUNICATION WITH THE ANTI-LOCK BRAKE CONTROL MODULE (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
A3 CHECK CIRCUIT 31-CF6A (BK) AND CIRCUIT 31-CF6B (BK) FOR AN OPEN  VUV3801729	2 Using a digital multimeter, measure the resistance between ABS control module C385 pin 12, circuit 31-CF6A (BK), harness side and ground; and between ABS control module C385 pin 15, circuit 31-CF6B (BK), harness side and ground. • Are the resistances less than 5 ohms? → Yes REFER to Section 418-00. → No REPAIR circuit 31-CF6A (BLK), or circuit 31-CF6B (BK). CLEAR the DTCs. REPEAT the self-test.

PINPOINT TEST B: UNABLE TO ENTER SELF-TEST

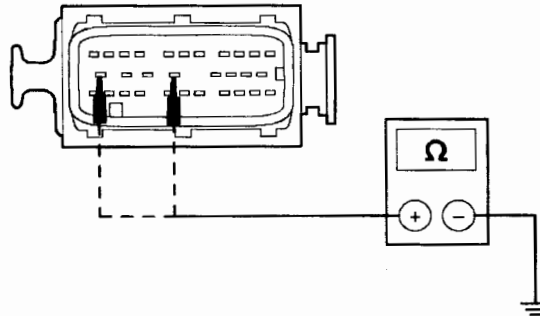
CONDITIONS	DETAILS/RESULTS/ACTIONS
B1 CHECK THE COMMUNICATION TO THE ABS CONTROL MODULE 	2 Check the communication to the ABS control module. • Does the scan tool communicate with the ABS control module? → Yes INSTALL a new hydraulic control unit (HCU). REPEAT the self-test. → No GO to Pinpoint Test A.

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST C: DTC B1318 — BATTERY VOLTAGE LOW**

CONDITIONS	DETAILS/RESULTS/ACTIONS
C1 CHECK THE BATTERY VOLTAGE  VUV9310002	1 Using a digital multimeter, measure the voltage between the positive and negative battery posts. Is the voltage greater than 10 volts? → Yes GO to C2. → No REPAIR the charging system. REFER to Section 414-00.
C2 CHECK CIRCUIT 15-CF6 (GN/YE)  VUV9110002	4 Using a digital multimeter, measure the voltage between ABS control module C385 pin 8, circuit 15-CF6 (GN/YE), harness side and ground. Is the voltage greater than 10 volts? → Yes GO to C3. → No REPAIR the circuit, CLEAR the DTCs. REPEAT the self test.
C3 CHECK CIRCUIT 31-CF6A (BK) AND CIRCUIT 31-CF6B (BK) FOR AN OPEN 	

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST C: DTC B1318 — BATTERY VOLTAGE LOW (Continued)**

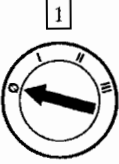
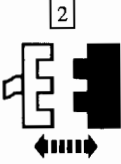
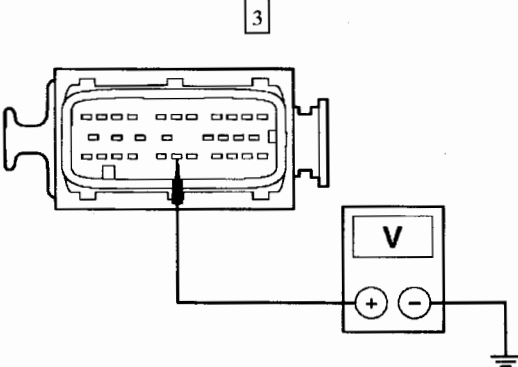
CONDITIONS	DETAILS/RESULTS/ACTIONS
C3 CHECK CIRCUIT 31-CF6A (BK) AND CIRCUIT 31-CF6B (BK) FOR AN OPEN (Continued)	
2  VUV3801729	2 Using a digital multimeter, measure the resistance between ABS control module C385 pin 12, circuit 31-CF6A (BK), harness side and ground; and between ABS control module C385 pin 15, circuit 31-CF6B (BK), harness side and ground. • Are the resistances less than 5 ohms? → Yes CLEAR the DTCs. REPEAT the self test. If DTC B1318 is retrieved again, INSTALL a new hydraulic control unit (HCU). REPEAT the self test. If no DTCs are retrieved, system is OK. → No REPAIR circuit 31-CF6A (BK), or circuit 31-CF6B (BK). CLEAR the DTCs. REPEAT the self test.

PINPOINT TEST D: DTC B1484 — BRAKE PEDAL INPUT OPEN CIRCUIT

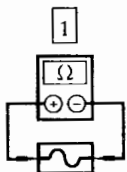
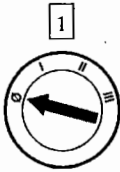
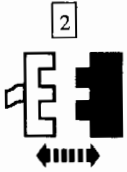
CONDITIONS	DETAILS/RESULTS/ACTIONS
D1 CHECK THE STOPLAMPS	
	1 Depress the brake pedal while checking the stoplamps. • Do the stoplamps illuminate? → Yes GO to D2. → No REFER to Section 417-01.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST D: DTC B1484 — BRAKE PEDAL INPUT OPEN CIRCUIT (Continued)**

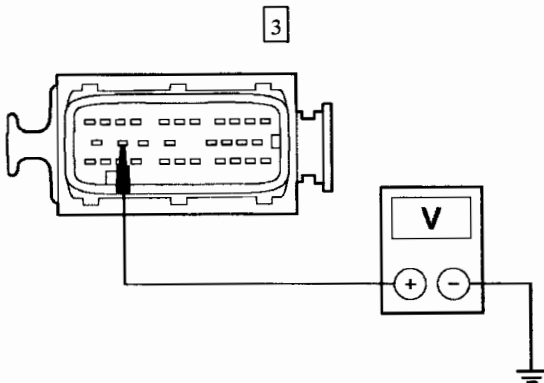
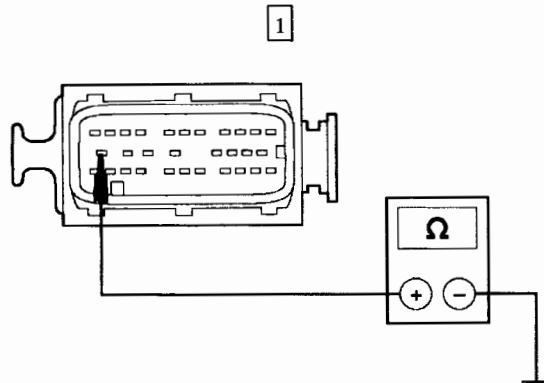
CONDITIONS	DETAILS/RESULTS/ACTIONS
D2 CHECK THE ABS CONTROL MODULE BOO__ABS PID 	2 Monitor the ABS control module PID BOO__ABS, while depressing and releasing the brake pedal. Does the ABS control module PID BOO__ABS indicate ON with the brake pedal depressed and OFF with the brake pedal released? → Yes CLEAR the DTCs. REPEAT the self test. If DTC B1484 is retrieved, INSTALL a new hydraulic control unit (HCU). REPEAT the self test. → No GO to D3.
D3 CHECK CIRCUIT 15S-CF58 (GN/OG) FOR AN OPEN   ABS Control Module C385  VUV9210003	3 Using a digital multimeter, measure the voltage between ABS control module C385 pin 6, circuit 15S-CF58 (GN/OG), harness side and ground while depressing the brake pedal. Is the voltage greater than 10 volts? → Yes INSTALL a new hydraulic control unit (HCU). REPEAT the self-test. → No REPAIR the circuit. CLEAR the DTCs. REPEAT the self-test.

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST E: DTC C1095 — ABS HYDRAULIC PUMP MOTOR CIRCUIT FAILURE**

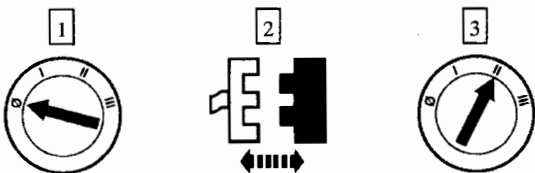
CONDITIONS	DETAILS/RESULTS/ACTIONS
E1 CHECK FOR CONTINUOUS OPERATION OF THE ABS PUMP MOTOR 	 2 Check the ABS pump for continuous operation. - Is the ABS pump motor running continuously? → Yes INSTALL a new hydraulic control unit (HCU). REPEAT the self-test. → No GO to E2.
E2 CHECK THE BATTERY JUNCTION BOX (BJB) FUSE 51 (60A)  BJB fuse 51 (60A)	- Is the fuse OK? → Yes GO to E3. → No INSTALL a new fuse. CLEAR the DTCs. REPEAT the self-test. If the fuse fails again, CHECK for short to ground. REPAIR as necessary. CLEAR the DTCs. REPEAT the self-test.
E3 CHECK CIRCUIT 30-CF6A (RD) FOR AN OPEN   ABS Control Module C385	

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST E: DTC C1095 — ABS HYDRAULIC PUMP MOTOR CIRCUIT FAILURE (Continued)**

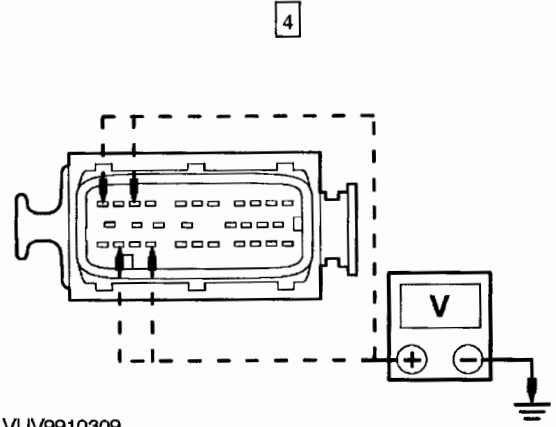
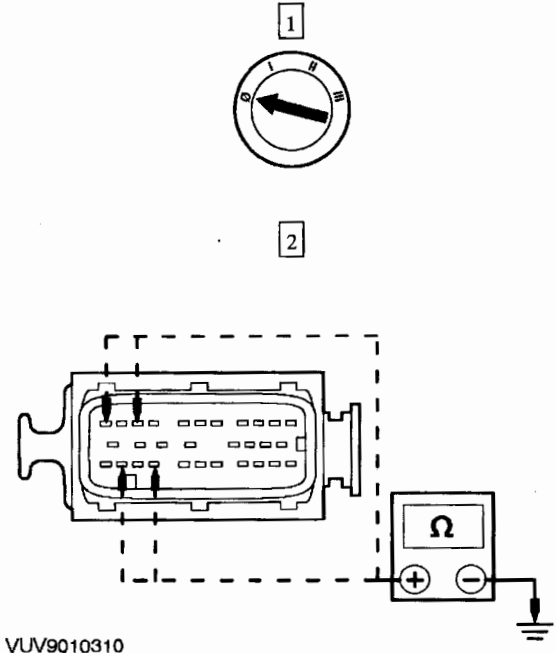
CONDITIONS	DETAILS/RESULTS/ACTIONS
E3 CHECK CIRCUIT 30-CF6A (RD) FOR AN OPEN (Continued)	
 VUV9410002	3 Using a digital multimeter, measure the voltage between ABS control module C385 pin 13, circuit 30-CF6A (RD), harness side and ground. Is the voltage greater than 10 volts? → Yes GO to E4. → No REPAIR the circuit. CLEAR the DTCs. REPEAT the self-test.
E4 CHECK CIRCUIT 31-CF6A (BK) FOR AN OPEN	
 VUV9510002	1 Using a digital multimeter, measure the resistance between ABS control module C385 pin 12, circuit 31-CF6A (BK), harness side and ground. Is the resistance less than 5 ohms? → Yes INSTALL a new hydraulic control unit (HCU). REPEAT the self-test. → No REPAIR the circuit. CLEAR the DTCs. REPEAT the self-test.

PINPOINT TEST F: DTC C1145 (RF), C1155 (LF), C1165 (RR), C1175 (LR) — WHEEL SPEED SENSOR INPUT CIRCUIT FAILURE

CONDITIONS	DETAILS/RESULTS/ACTIONS
F1 CHECK THE SUSPECT WHEEL SPEED CIRCUIT FOR SHORT TO POWER	
 ABS Control Module C385	

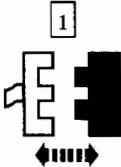
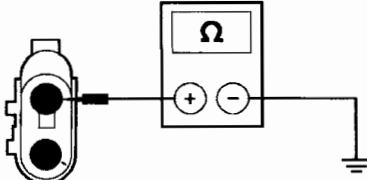
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DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST F: DTC C1145 (RF), C1155 (LF), C1165 (RR), C1175 (LR) — WHEEL SPEED SENSOR INPUT CIRCUIT FAILURE (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
F1 CHECK THE SUSPECT WHEEL SPEED CIRCUIT FOR SHORT TO POWER (Continued) 4  VUV9910309	4 Using a digital multimeter, measure the voltage of the suspect wheel speed sensor circuit between: — (RF) ABS control module C385 pin 4, circuit 8-CF38 (WH/RD), harness side and ground. — (LF) ABS control module C385 pin 20, circuit 8-CF32 (WH), harness side and ground. — (RR) ABS control module C385 pin 2, circuit 8-CF40 (WH/GN), harness side and ground. — (LR) ABS control module C385 pin 22, circuit 8-CF34 (WH/BU), harness side and ground. • Is voltage present? → Yes REPAIR the circuit. CLEAR the DTCs. REPEAT the self-test. → No GO to F2.
F2 CHECK THE SUSPECT WHEEL SPEED SENSOR CIRCUIT FOR SHORT TO GROUND 1  VUV9010310	2 Using a digital multimeter, measure the resistance of the suspect wheel speed sensor circuit between: — (RF) ABS control module C385 pin 4, circuit 8-CF38 (WH/RD), harness side and ground. — (LF) ABS control module C385 pin 20, circuit 8-CF32 (WH), harness side and ground. — (RR) ABS control module C385 pin 2, circuit 8-CF40 (WH/GN), harness side and ground. — (LR) ABS control module C385 pin 22, circuit 8-CF34 (WH/BU), harness side and ground. • Is the resistance infinite? → Yes GO to F4. → No GO to F3.

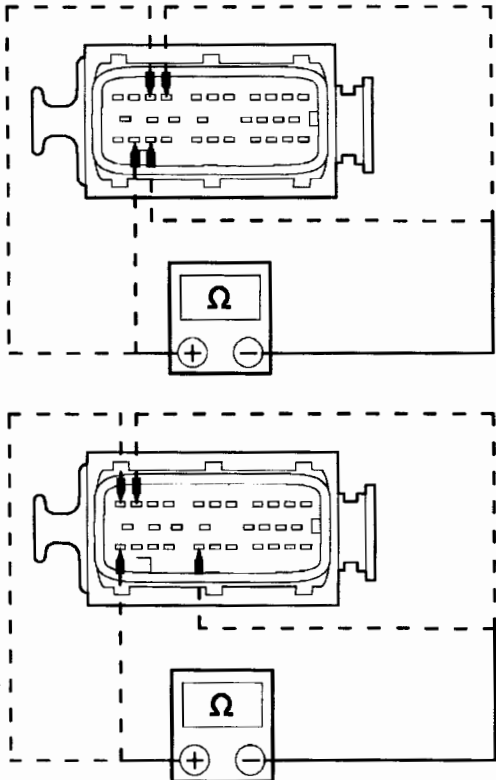
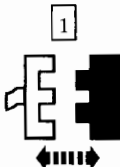
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DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST F: DTC C1145 (RF), C1155 (LF), C1165 (RR), C1175 (LR) — WHEEL SPEED SENSOR INPUT CIRCUIT FAILURE (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
F3 CHECK THE SUSPECT WHEEL SPEED SENSOR FOR SHORT TO GROUND	
1  Suspect Wheel Speed Sensor 2  VUV9810002	2 Using a digital multimeter, measure the resistance between either suspect wheel speed sensor pin (component side) and ground. • Is the resistance infinite? → Yes REPAIR the circuit. CLEAR the DTCs. REPEAT the self-test. → No INSTALL a new wheel speed sensor. CLEAR the DTCs. REPEAT the self-test.

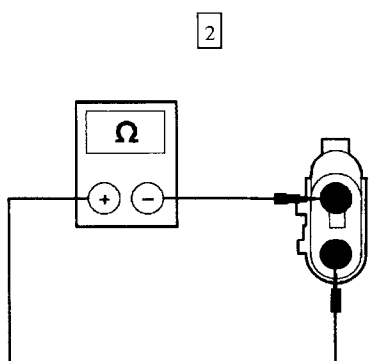
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DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST F: DTC C1145 (RF), C1155 (LF), C1165 (RR), C1175 (LR) — WHEEL SPEED SENSOR INPUT CIRCUIT FAILURE (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
F4 CHECK THE WHEEL SPEED CIRCUIT FOR OPEN OR SHORT TOGETHER 1  VUV9810309	1 Using a digital multimeter, measure the resistance between: — (RF) ABS control module C385 pin 4, circuit 8-CF38 (WH/RD), harness side and ABS control module C385 pin 5, circuit 9-CF38 (BN/RD), harness side. — (LF) ABS control module C385 pin 20, circuit 8-CF32 (WH), harness side and ABS control module C385 pin 21, circuit 9-CF32 (BN), harness side. — (RR) ABS control module C385 pin 2, circuit 8-CF40 (WH/GN), harness side and ABS control module C385 pin 3, circuit 9-CF40 (BN/GN), harness side. — (LR) ABS control module C385 pin 22, circuit 8-CF34 (WH/BU), harness side and ABS control module C385 pin 23, circuit 9-CF34 (BN/BU), harness side. • Is the resistance between 1,000 and 1,500 ohms? → Yes RECONNECT all connectors. CLEAR the DTCs. REPEAT the self test. If DTC C1145, C1155, C1165 or C1175 is retrieved, INSTALL a new hydraulic control unit (HCU). REPEAT the self-test. If no DTCs are retrieved, system is OK. → No GO to F5.
F5 CHECK THE SUSPECT WHEEL SPEED SENSOR FOR AN OPEN OR SHORT TOGETHER 1  Suspect Wheel Speed Sensor	

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST F: DTC C1145 (RF), C1155 (LF), C1165 (RR), C1175 (LR) — WHEEL SPEED SENSOR INPUT CIRCUIT FAILURE (Continued)**

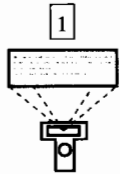
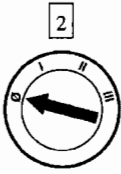
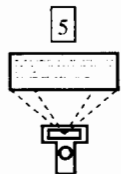
CONDITIONS	DETAILS/RESULTS/ACTIONS
F5 CHECK THE SUSPECT WHEEL SPEED SENSOR FOR AN OPEN OR SHORT TOGETHER (Continued)	
 VUV9010003	2 Using a digital multimeter, measure the resistance between the suspect wheel speed sensor pins (component side). Is the resistance between 1,000 and 1,500 ohms? → Yes REPAIR the circuit. CLEAR the DTC. REPEAT the self-test. → No INSTALL a new wheel speed sensor. CLEAR the DTC. REPEAT the self-test.

PINPOINT TEST G: DTC1222 — WHEEL SPEED SIGNAL MISMATCH

CONDITIONS	DETAILS/RESULTS/ACTIONS
G1 CHECK VEHICLE COMPONENTS	
NOTE: Any other wheel speed DTC must be diagnosed before proceeding. This DTC can be set during certain procedures with key on, vehicle towing, on vehicle wheel balance, or dynamometer testing with no actual fault.	
	1 Check for correct wheel and tire size, front-to-rear and side-to-side. 2 Check for excessive bearing end play. 3 Check the ABS sensor indicator for a bent sensor ring or missing teeth. Are all the conditions OK? → Yes GO to G2. → No REPAIR as necessary. CLEAR the DTCs. REPEAT the self-test.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST G: DTC1222 — WHEEL SPEED SIGNAL MISMATCH (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
G2 TEST DRIVE THE VEHICLE	
 1 Clear the DTCs  2  3  5 Retrieve DTCs	4 Test drive the vehicle over 24 km/h (15 mph). - Is DTC C1222 retrieved? → Yes INSTALL a new hydraulic control unit (HCU). REPEAT the self-test. → No If another DTC is retrieved, GO to the ABS Control Module Diagnostic Trouble Code (DTC) Index. If no DTCs are retrieved, system is OK.

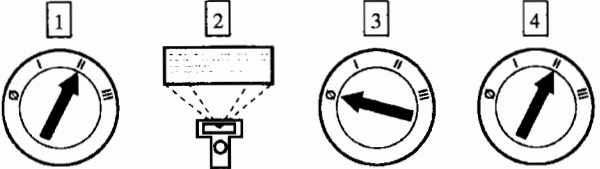
PINPOINT TEST H: DTC 1233 (LF), C1234 (RF), C1235 (RR), C1236 (LR) — WHEEL SPEED INPUT SIGNAL MISSING

CONDITIONS	DETAILS/RESULTS/ACTIONS
H1 CHECK THE SUSPECT WHEEL SPEED SENSOR	
	1 Inspect the suspect wheel speed sensor mounting. Check the wheel speed sensor for excessive dirt build up. Check for metal obstructions. Check the wheel speed sensor for damage. - Is the suspect wheel speed sensor and mounting OK? → Yes GO to H2. → No REPAIR or INSTALL a new wheel speed sensor. CLEAR the DTCs. REPEAT the self-test.

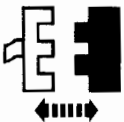
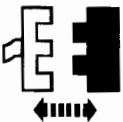
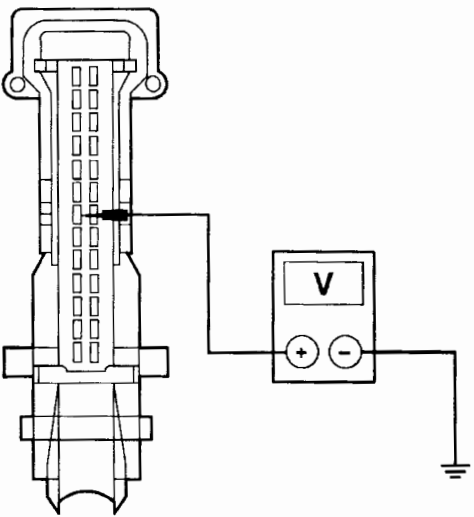
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DIAGNOSIS AND TESTING (Continued)

PINPOINT TEST H: DTC 1233 (LF), C1234 (RF), C1235 (RR), C1236 (LR) — WHEEL SPEED INPUT SIGNAL MISSING (Continued)

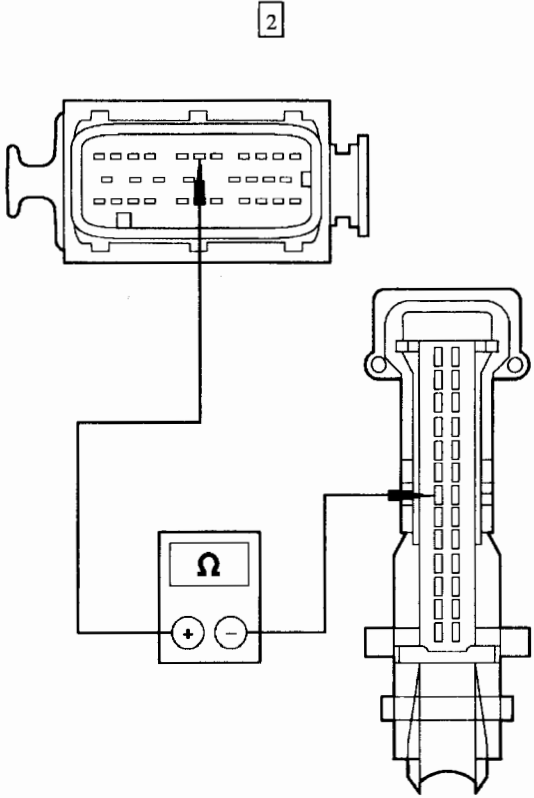
CONDITIONS	DETAILS/RESULTS/ACTIONS
H2 CHECK THE SUSPECT ABS SENSOR INDICATOR	
	1 Check the suspect ABS sensor indicator for corrosion, nicks, bridged teeth, damaged teeth and correct mounting and alignment with the wheel speed sensor. Check the air gap (less than 1 mm). Check the bearing end play. Is the suspect ABS sensor indicator OK? → Yes GO to H3. → No INSTALL a new ABS sensor indicator. CLEAR the DTCs. REPEAT the self-test.
H3 CHECK THE SUSPECT WHEEL SPEED PIDS	
 Clear the DTCs	5 Have an assistant monitor the ABS control module PIDs LF__WSPD, RF__WSPD, LR__WSPD and RR__WSPD while driving at various speeds during the test. 6 Test drive the vehicle for 16 km (10 miles). Are the ABS control module PIDs reading approximately the same at all times? → Yes CLEAR the DTCs. REPEAT the self test. If DTC C1233, C1234, C1235, or C1236 is retrieved. INSTALL a new hydraulic control unit (HCU). REPEAT the self-test. If no DTC is retrieved, system is OK. → No INSTALL a new wheel speed sensor. CLEAR the DTCs. REPEAT the self-test.

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST I: THE YELLOW ABS WARNING INDICATOR DOES NOT SELF-CHECK-ALWAYS ON, NO DTCS**

CONDITIONS	DETAILS/RESULTS/ACTIONS
I1 CHECK CIRCUIT 31S-CF28 (BK/RD) FOR SHORT TO POWER 1  2  ABS Control Module C385 3  HEC C808b 4  5  VUV9810188	5 Using a digital multimeter, measure the voltage between hybrid electronic cluster (HEC) C808b pin 7, circuit 31S-CF28 (BK/RD), harness side and ground. • Is voltage present? → Yes REPAIR circuit 31S-CF28 (BK/RD). REPEAT the self test. → No GO to I2.
I2 CHECK CIRCUIT 31S-CF28 (BK/RD) FOR AN OPEN 1 	

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST I: THE YELLOW ABS WARNING INDICATOR DOES NOT SELF-CHECK-ALWAYS ON, NO DTCS (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
I2 CHECK CIRCUIT 31S-CF28 (BK/RD) FOR AN OPEN (Continued)  VUV9710188	2 Using a digital multimeter, measure the resistance between ABS control module C385 pin 25, circuit 31S-CF28 (BK/RD), harness side and HEC C808b pin 7, circuit 31S-CF28 (BK/RD), harness side. • Is the resistance less than 5 ohms? → Yes INSTALL a new hydraulic control unit (HCU). REPEAT the self test. → No REPAIR circuit 31S-CF28 (BK/RD). REPEAT the self test.

PINPOINT TEST J: SPONGY BRAKE PEDAL WITH NO WARNING INDICATOR

CONDITIONS	DETAILS/RESULTS/ACTIONS
J1 CHECK THE VEHICLE COMPONENT MOUNTING	1 Inspect the brake pedal and the power booster/brake master cylinder for correct attachment. 2 Bleed the brake system. Refer to Section 206-00. • Is the brake pedal spongy? → Yes GO to J2. → No The brake system is operating correctly. REPEAT the self-test.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST J: SPONGY BRAKE PEDAL WITH NO WARNING INDICATOR (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
J2 REBLEED THE BRAKE SYSTEM	
	1 Rebleed the brake system using the scan tool bleed procedure. Refer to Section 206-00. Is the brake pedal spongy? → Yes REFER to Section 206-00. → No The brake system is operating correctly. REPEAT the self-test.

PINPOINT TEST K: POOR VEHICLE TRACKING DURING ANTI-LOCK FUNCTION

CONDITIONS	DETAILS/RESULTS/ACTIONS
K1 BLEED THE BRAKE SYSTEM	
	1 Bleed the brake system. Refer to Section 206-00. Does the vehicle track poorly? → Yes GO to K2. → No The brake system is operating correctly. REPEAT the self-test.
K2 CHECK THE ABS INLET VALVE (CLOSED POSITION)	
	1 Lift the vehicle and rotate all the wheels to make sure they rotate freely (the vehicle must be in neutral). 2 Apply moderate brake pedal effort. 3 Trigger ABS control module active command LF INLET ON. 4 Have an assistant attempt to rotate the LF wheel. Does the LF wheel rotate? → Yes TRIGGER active command LF INLET OFF. GO to K3. → No INSTALL a new hydraulic control unit (HCU). REPEAT the self test.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST K: POOR VEHICLE TRACKING DURING ANTI-LOCK FUNCTION (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
K3 CHECK THE ABS INLET VALVE (OPEN POSITION)	
	1 Apply moderate brake pedal effort. 2 Have an assistant attempt to rotate the LF wheel. • Does the LF wheel rotate? → Yes INSTALL a new hydraulic control unit (HCU). REPEAT the self test. → No GO to K4.
K4 CHECK ABS OUTLET VALVE (OPEN POSITION)	
	1 Carry out the ABS control module self-test. 2 Trigger the ABS control module active command LF INLET ON. 3 Trigger the ABS control module active command ABS POWER ON (turns on pump motor) for 6 seconds. (Trigger must be depressed 3 times. Each press runs the pump for 2 seconds). 4 Trigger the ABS control module active command LF OUTLET ON and then OFF. Repeat 3 times. 5 Have an assistant attempt to rotate the LF wheel. • Does the LF wheel rotate? → Yes TRIGGER all active commands. GO to K5. → No INSTALL a new hydraulic control unit (HCU). REPEAT the self-test.
K5 CHECK ABS INLET AND OUTLET VALVE (CLOSED POSITION)	
	1 Apply moderate brake pedal effort.

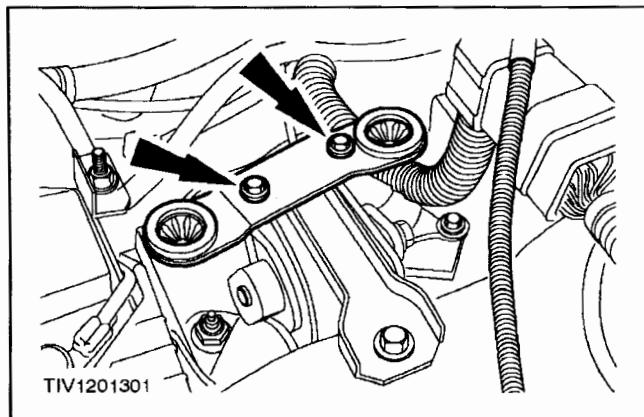
(Continued)

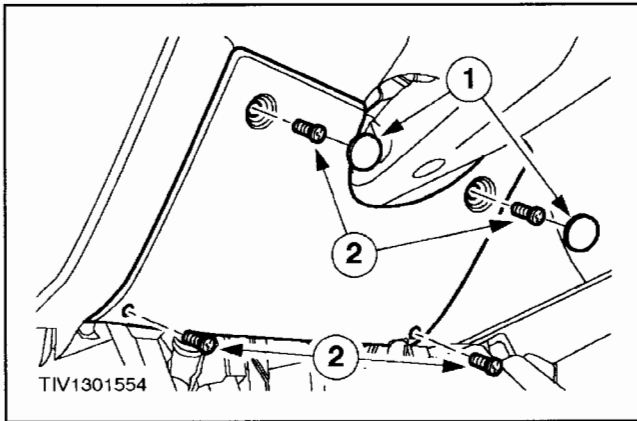
DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST K: POOR VEHICLE TRACKING DURING ANTI-LOCK FUNCTION (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
K5 CHECK ABS INLET AND OUTLET VALVE (CLOSED POSITION) (Continued)	
	2 Have an assistant attempt to rotate the LF wheel. Does the LF wheel rotate? → Yes INSTALL a new hydraulic control unit (HCU). REPEAT the self-test. → No REPEAT this procedure (beginning with K2) for the RF, LR, and RR wheels using the appropriate active commands. If no failure is found, the system is OK.

REMOVAL AND INSTALLATION**Hydraulic Control Unit (HCU) — Vehicles with 2.0L Engine****Removal****All vehicles**

1. Disconnect the battery ground cable.
2. Remove the brake booster. For additional information, refer to Section 206-07.
3. Remove the air cleaner support bracket.

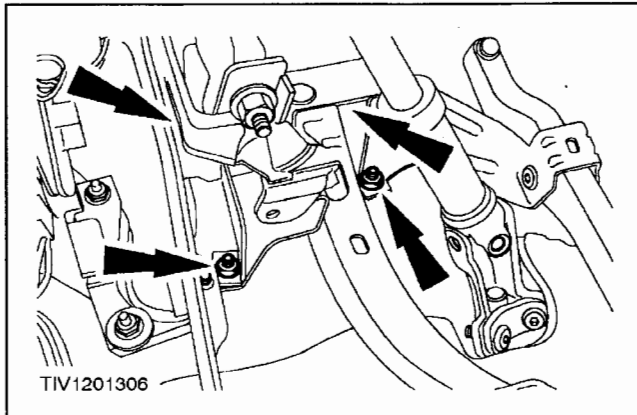


REMOVALANDINSTALLATION (Continued)

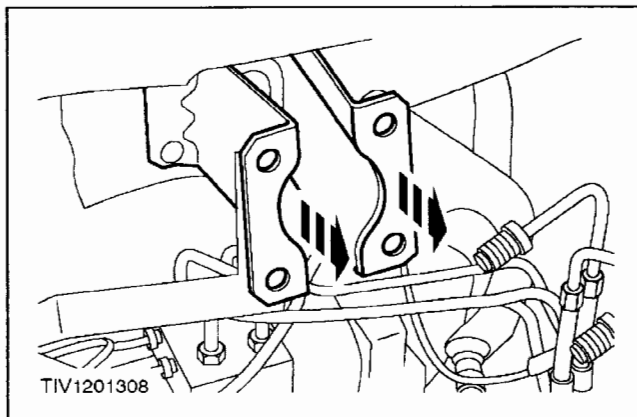
4. Remove the instrument panel lower panel.

1 Remove the screw covers.

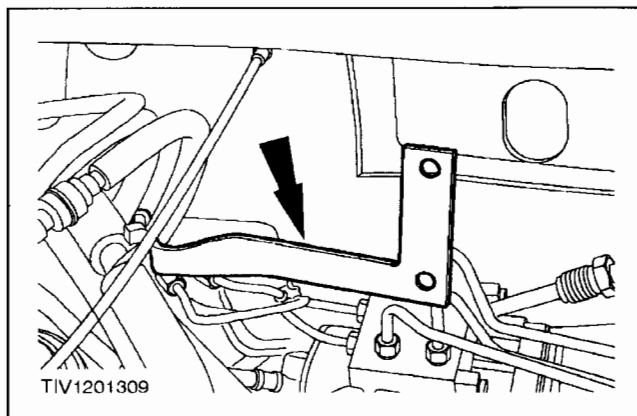
2 Remove the screws.



5. Detach the brake booster support brackets.



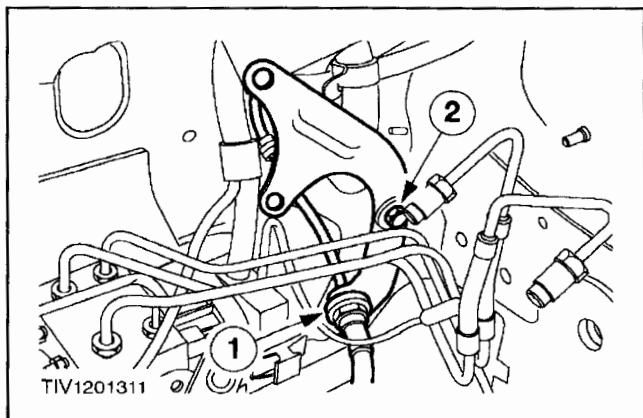
6. Remove the brackets.

**Vehicles with air conditioning**

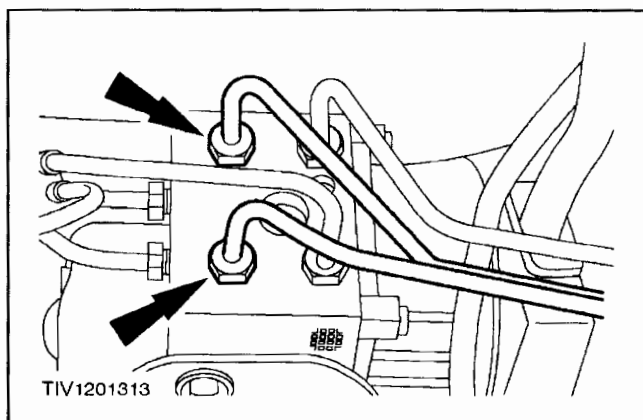
7. Move the air conditioning tube support bracket to the side.

REMOVAL AND INSTALLATION (Continued)**All vehicles**

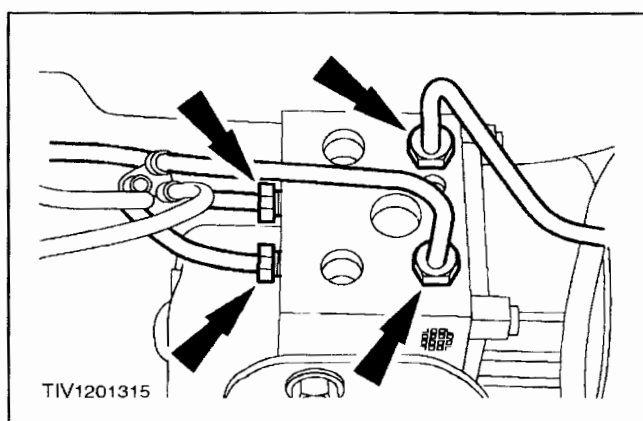
8. Remove the booster side support bracket.
 - 1 Disconnect the clutch tube (if equipped).
 - 2 Remove the bolt.



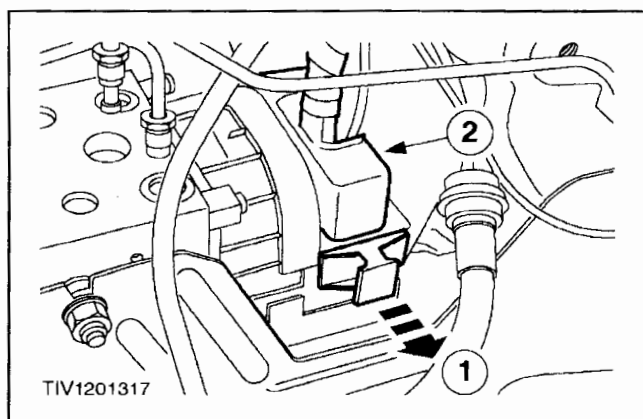
9. Remove the master cylinder fluid feed tubes.

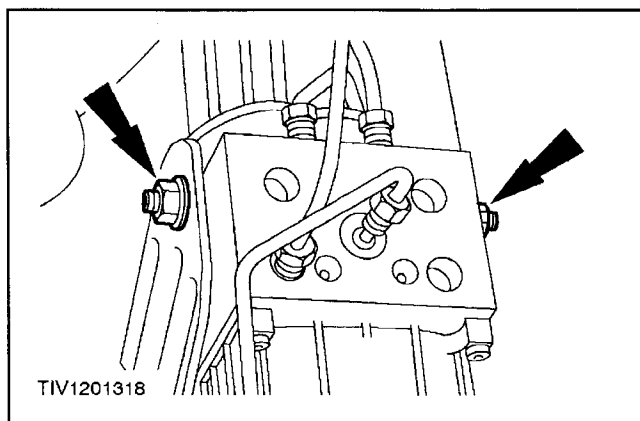


10. Disconnect the hydraulic unit brake tubes.

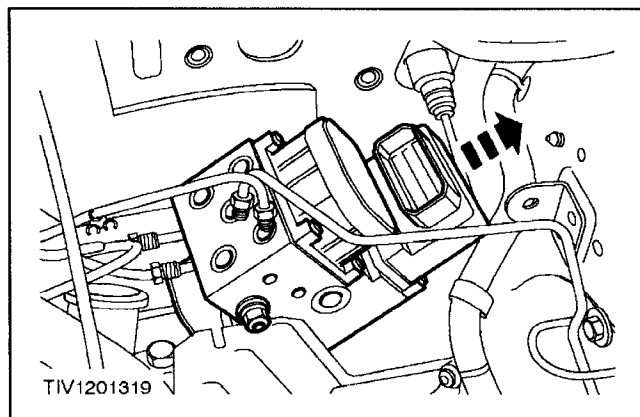


11. Disconnect the hydraulic control unit electrical connector.
 - 1 Release the retainer.
 - 2 Disconnect the electrical connector.



REMOVAL AND INSTALLATION (Continued)

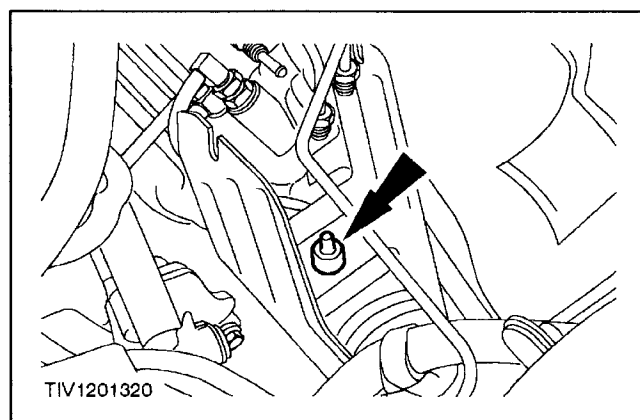
12. Slacken the nuts.



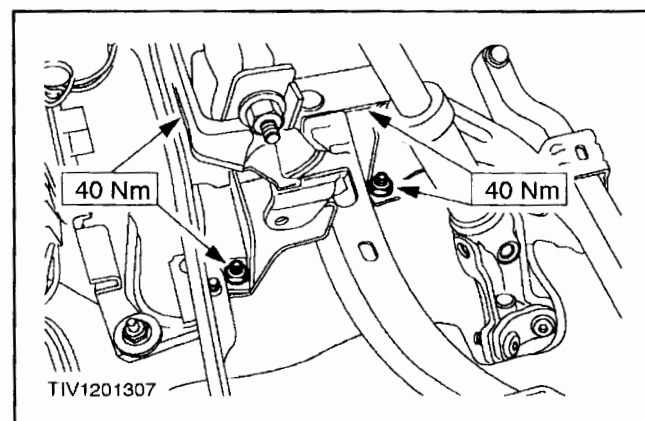
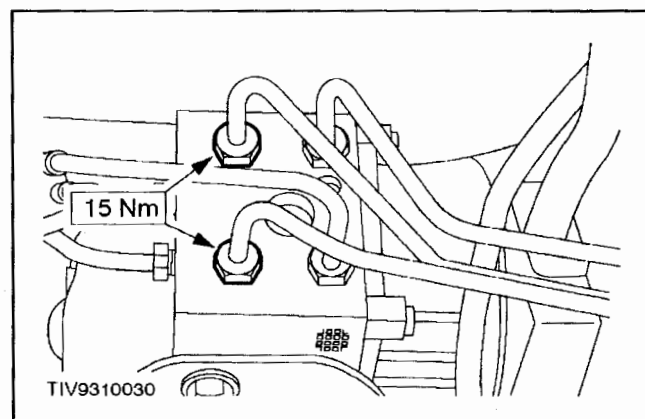
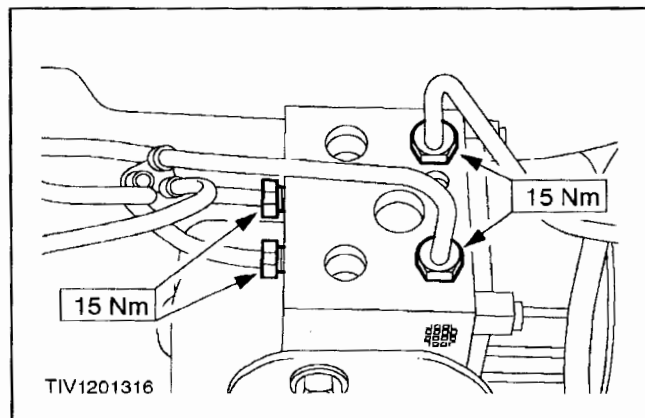
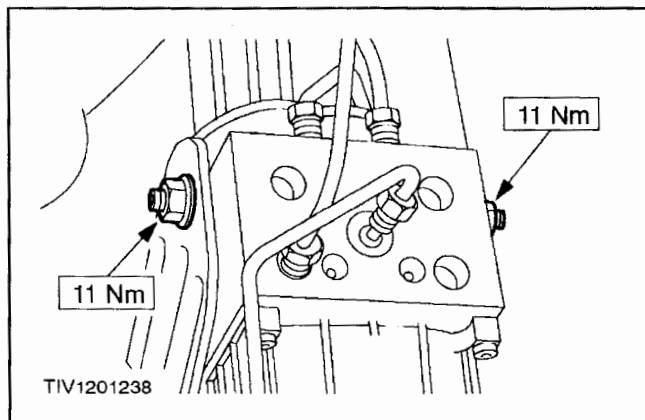
13. Lift the hydraulic control unit off the bracket and maneuver off the vehicle.

Installation

NOTE: After installation, bleed the brake system. For additional information, refer to Section 206-00.

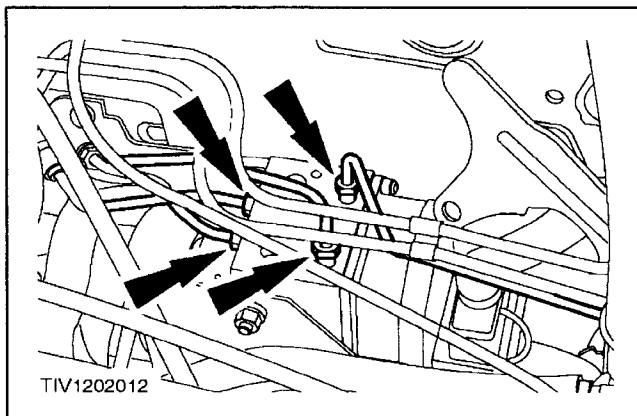
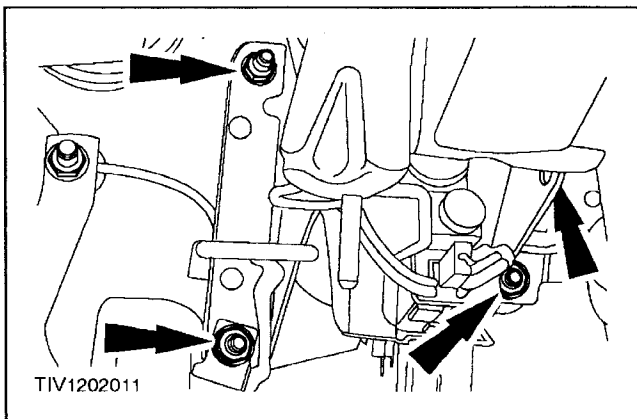


1. **NOTE:** Ensure the hydraulic control unit is correctly fitted to the locating peg.
To install, reverse the removal procedure.

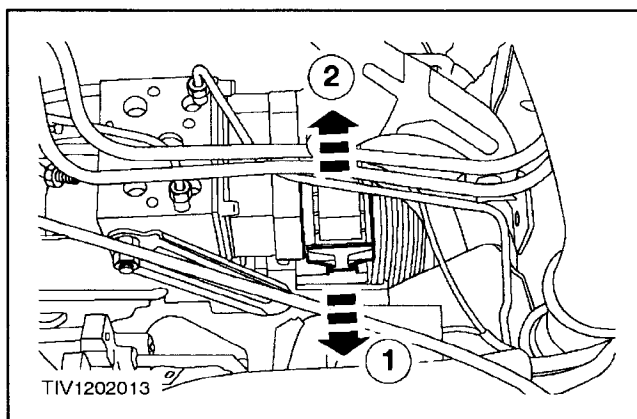
REMOVAL AND INSTALLATION (Continued)

REMOVAL AND INSTALLATION (Continued)**Hydraulic Control Unit (HCU) — Vehicles with 2.5L Engine****Removal**

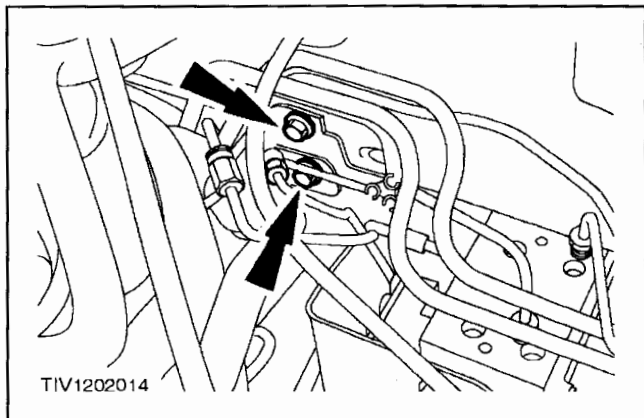
1. Disconnect the battery ground cable.
2. Remove the brake booster. For additional information, refer to Section 206-07.
3. Remove the brake booster support brackets.



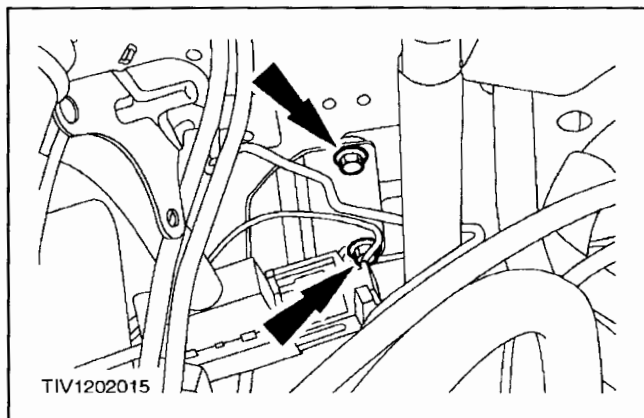
4. Disconnect the hydraulic unit brake tubes.



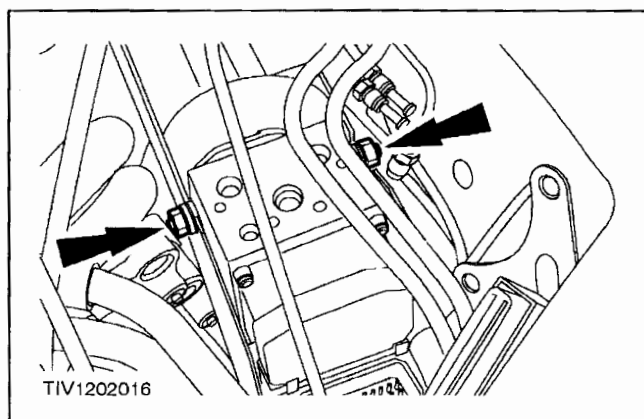
5. Disconnect the hydraulic unit electrical connector.
 - 1 Release the retainer
 - 2 Disconnect the electrical connector.

REMOVAL AND INSTALLATION (Continued)

6. Remove the hydraulic control unit support bracket rear bolts.



7. **NOTE:** Observe the earth wire behind the lower bolt.
Remove the hydraulic control unit support bracket side bolts.
 - Pull the bracket and HCU forwards.

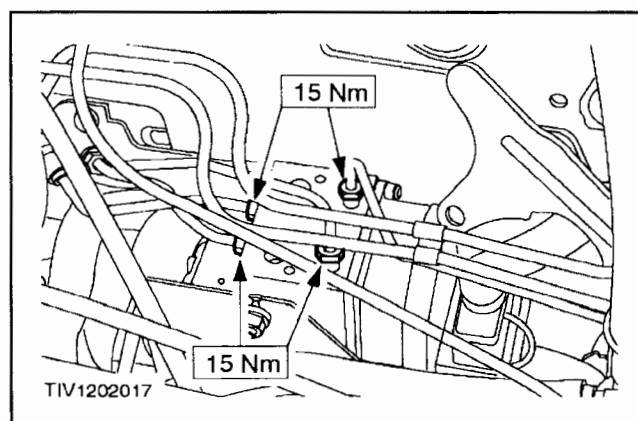
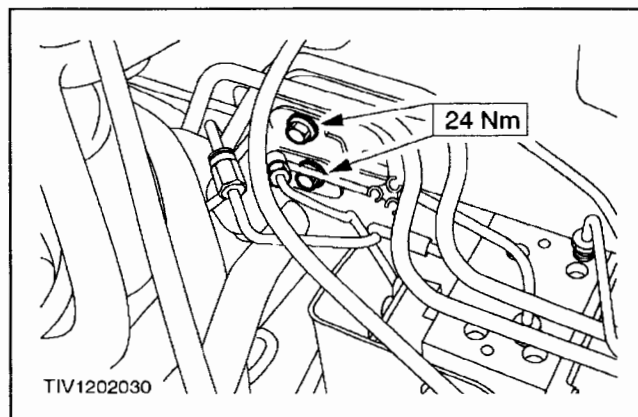
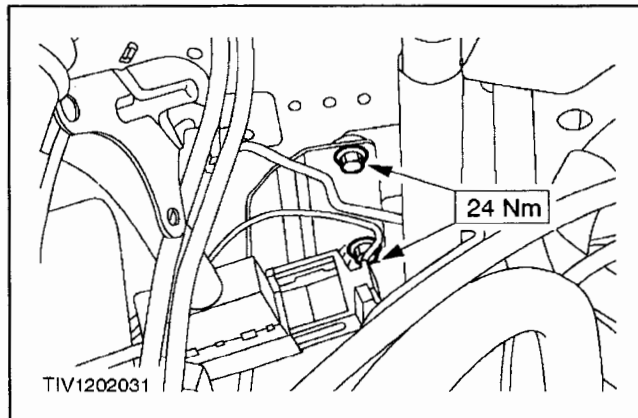
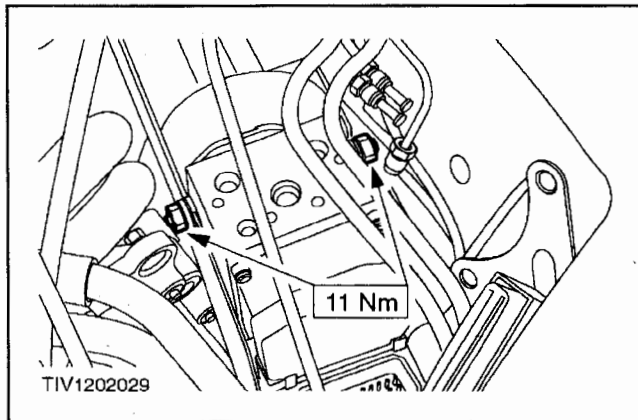


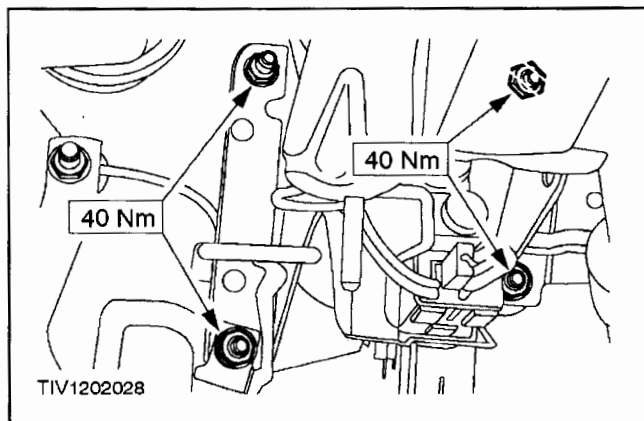
8. Remove the hydraulic control unit.
 - Slacken the nuts.

Installation

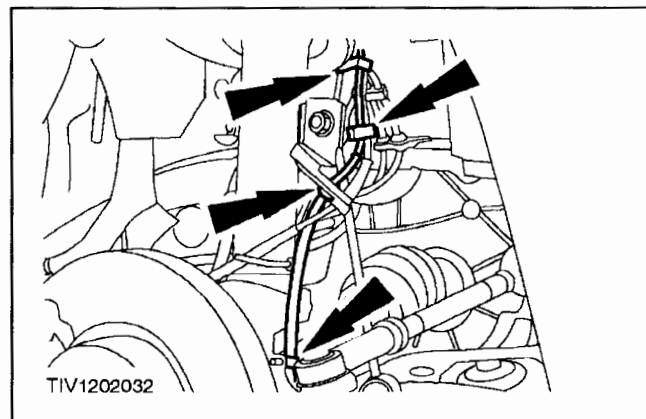
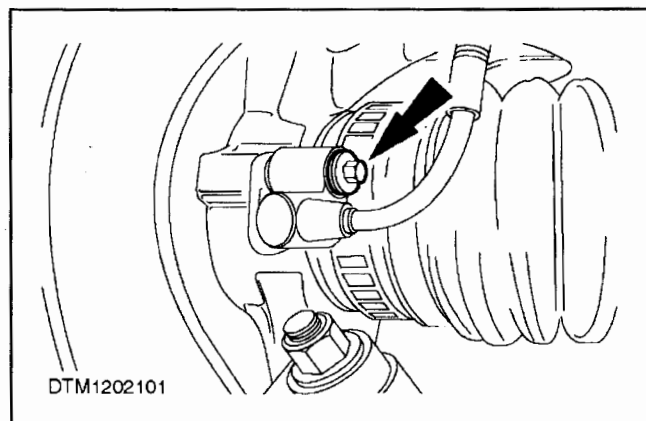
NOTE: After installation, bleed the brake system. For additional information, refer to Section 206-00.

1. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION (Continued)

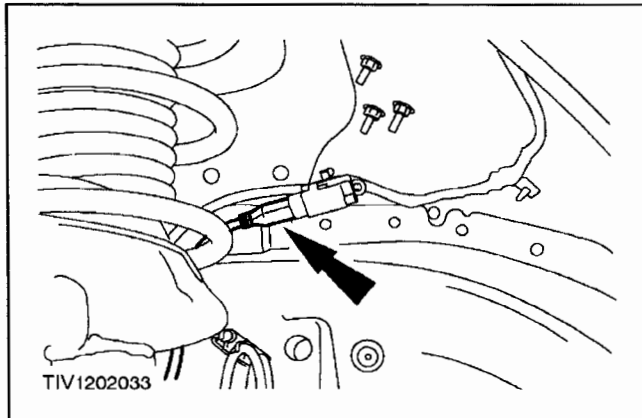
REMOVAL AND INSTALLATION (Continued)**Front Wheel Speed Sensor****Removal**

1. Loosen the wheel nuts.
2. Raise and support the vehicle. For additional information, refer to Section 100-02.
3. Remove the wheel.
4. Remove the wheel sensor.
5. Disconnect the wheel sensor wiring from the support bracket and clips.

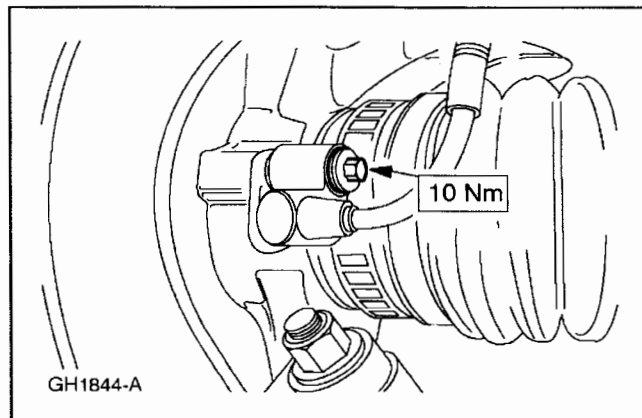


REMOVAL AND INSTALLATION (Continued)

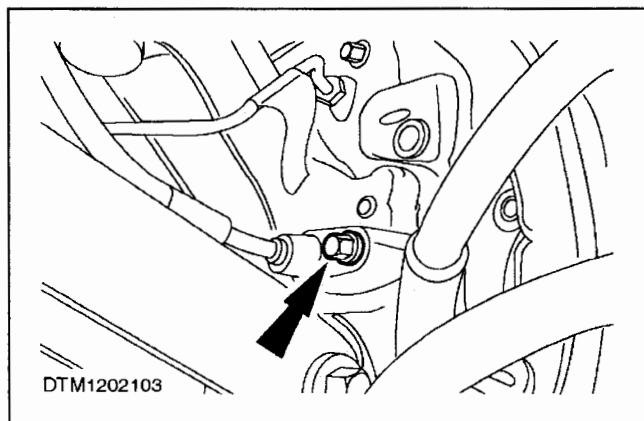
6. Remove the fender splash shield. For additional information, refer to Section 501-02.
7. Disconnect the wheel sensor electrical connector.

**Installation**

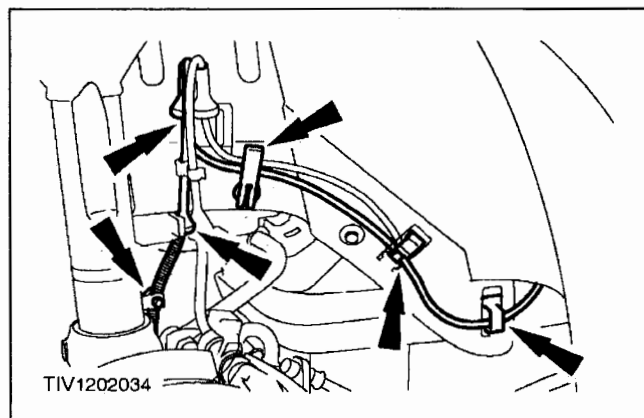
1. To install, reverse the removal procedure.

**Rear Wheel Speed Sensor****Removal**

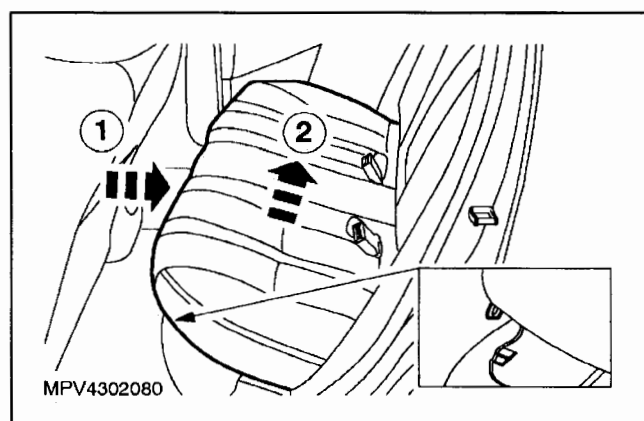
1. Loosen the wheel nuts.
2. Raise and support the vehicle. For additional information, refer to Section 100-02.
3. Remove the wheel.

REMOVAL AND INSTALLATION (Continued)

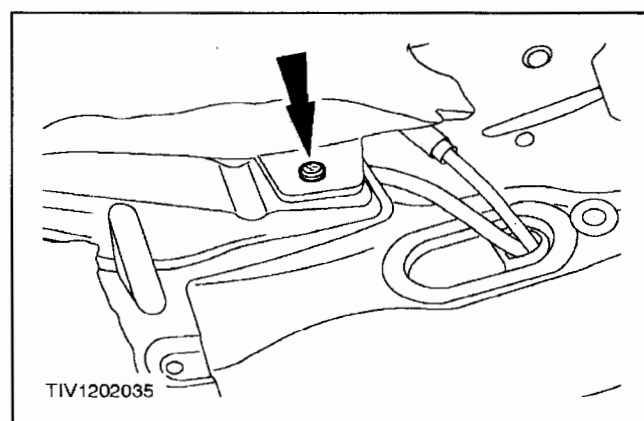
4. Remove the wheel sensor.



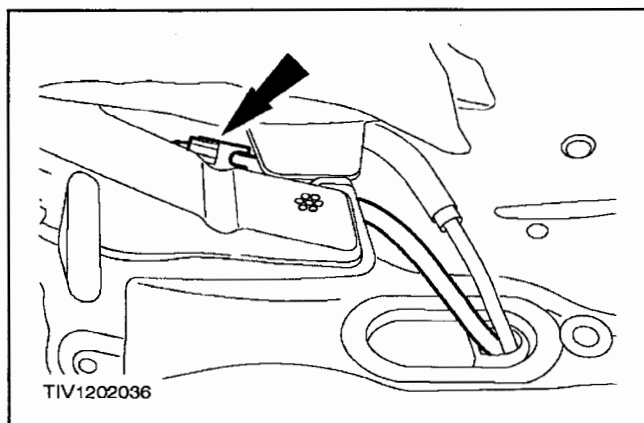
5. Disconnect the wheel sensor wiring from the support brackets and clips.



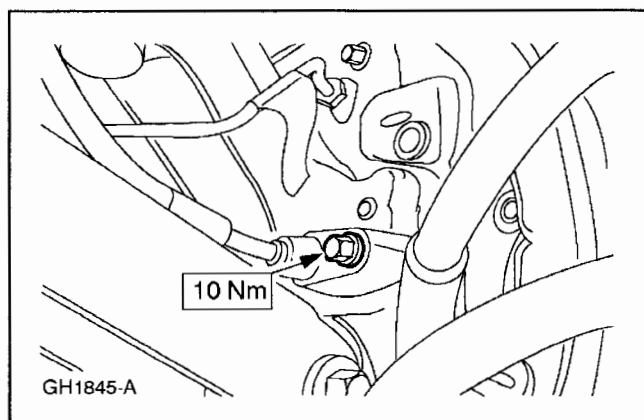
6. Lower the vehicle.
7. Raise the rear seat cushion.
- 1 Push the cushion towards the backrest.
 - 2 Pull the cushion up.



8. Remove the screw.
- Push the trim to one side.

REMOVAL AND INSTALLATION (Continued)

9. Disconnect the wheel sensor electrical connector.
 - Pull the cable through the grommet.

Installation

1. To install, reverse the removal procedure.

SECTION 206-09B Anti-Lock Control — Traction Control

CONTENTS	PAGE
DESCRIPTION AND OPERATION	
Anti-Lock Control — Traction Control	206-09B-2
DIAGNOSIS AND TESTING	
Anti-Lock Control — Traction Control	206-09B-2
Principles of Operations	206-09B-2
Inspection and Verification	206-09B-3
ABS Control Module Diagnostic Trouble Code (DTC) Index	206-09B-3
ABS Control Module Parameter Identification (PID) Index	206-09B-4
ABS Control Module Active Command Index	206-09B-6
Symptom Chart	206-09B-7
Pinpoint Tests	206-09B-8
Pinpoint Tests	206-09B-8
REMOVAL AND INSTALLATION	
Hydraulic Control Unit	206-09B-31
Front Wheel Speed Sensor	206-09B-32
Rear Wheel Speed Sensor	206-09B-32

DESCRIPTION AND OPERATION

Anti-Lock Control — Traction Control

⚠ WARNING: Brake fluid contains polyglycol ethers and polyglycols. Avoid contact with the eyes. Wash hands thoroughly after handling. If brake fluid contacts the eyes, flush the eyes for 15 minutes with cold running water. Get medical attention if irritation persists. If taken internally, drink water and induce vomiting. Get medical attention immediately. Failure to follow these instructions may result in personal injury.

The anti-lock control - anti-wheelspin control is an expanded version of the anti-lock brake system. The system is integrated with the anti-lock brake system and uses the same wheel speed sensors and similar hydraulic control unit.

The hydraulic control unit has additional internal solenoid valves incorporated to enable control modulation of the wheel brake pressures.

The system works by transferring torque from the spinning wheel(s) to the wheel(s) with the most traction. This torque transfer is achieved by the hydraulic control unit applying the relevant brake(s).

The system is only active at road speeds up to 85 km/h (53 mph). When the system is active the driver is made aware of the fact by the illumination of a warning indicator located in the instrument cluster.

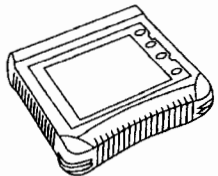
Anti-wheelspin control, after a road speed of 85 km/h (53 mph) is controlled by a combination of fuel and spark adjustment using the vehicle engine management system. For additional information, refer to Section 303-14A (2.0L) or Section 303-14B (2.5L).

DIAGNOSIS AND TESTING

Anti-Lock Control — Traction Control

Refer to Wiring Diagrams Cell 42 for schematic and connector information.

Special Tool(s)

 ST2332-A	Worldwide Diagnostic System (WDS) 418-F224, New Generation STAR (NGS) Tester 418-F052, or equivalent scan tool
---	---

Principles of Operations

Anti-Lock Control - Anti-Wheelspin Control

The anti-lock-brake system (ABS) control module receives wheel speed readings from each wheel speed sensor and processes this information to determine if an ABS event is necessary. The wheel speed sensor electrically senses each tooth of the ABS sensor indicators as it passes through the wheel speed sensors magnetic field.

The ABS control module continuously monitors and compares the rotational speed of each wheel and when it detects an impending wheel lock, modulates brake pressure to the appropriate brake caliper. This is accomplished by triggering the hydraulic control unit (HCU) to open and close the appropriate solenoid valves. Once the affected wheel returns to normal speed, the ABS control module returns the solenoid valves to their normal position, and normal (base) braking resumes.

The ABS control module is self monitoring. When the ignition switch is turned to the RUN position, the ABS control module will do a preliminary electrical check, and at approximately 20 Km/h (12 mph) the pump motor is turned on for approximately one half-second. Also, during all phases of operation the ABS control module (after the vehicle is in motion) checks for correct operation of the wheel speed sensors. Any malfunction of the ABS will cause the ABS to shut off, normal power assisted braking, however, remains.

The ABS control module has the ability to store three DTCs in its memory.

DIAGNOSIS AND TESTING (Continued)

The traction control system controls wheel spin by modulating the engine torque by communicating to the powertrain control module (PCM) and by applying, then releasing, the appropriate brake to restore traction when one or both drive wheels lose traction and begin to spin during acceleration.

The traction control system can be disabled by depressing the traction control switch and is indicated by an LED in the traction control switch. The traction control will reset and return to normal traction assist when the ignition switch is cycled or when the traction control switch is depressed.

Inspection and Verification

1. Verify the customer concern by operating the system.
2. Visually inspect for obvious signs of mechanical or electrical damage.

Visual Inspection Chart

Mechanical	Electrical
• Low brake fluid • ABS wheel speed sensor(s) • ABS sensor indicator • Base brake system • Wheel bearings	• Fuse(s) • ABS indicator lamp • Wiring harness • Loose or corroded connections

3. If the inspection reveals an obvious concern(s) that can be readily identified, repair as required.
4. If a concern remains after the inspection, connect the scan tool to the data link connector (DLC) located beneath the instrument panel and select the vehicle to be tested from the scan tool menu. If the scan tool does not communicate with the vehicle:
 - check that the program card is properly installed.
 - check the connections to the vehicle.
 - check the ignition switch position.

5. If the scan tool still does not communicate with the vehicle, refer to the scan tool manual.
6. Carry out the DATA LINK DIAGNOSTIC TEST. If the scan tool responds with:
 - CKT914, CKT915 or CKT70 = ALL ECUS NO RESP/NOT EQUIP, Refer to Section 418-00.
 - NO RESP/NOT EQUIP for anti-lock brake control module, GO to Pinpoint Test A.
 - SYSTEM PASSED, retrieve and record the continuous diagnostic trouble codes (DTCs), erase the continuous DTCs and carry out self-test diagnostics for the anti-lock brake control module.
7. If the DTCs retrieved are related to the concern, go to Anti-Lock Brake Control Module Diagnostic Trouble Code (DTC) Index to continue diagnostics.
8. If no DTCs related to the concern are retrieved, proceed to the Symptom Chart to continue diagnostics.

ABS Control Module Diagnostic Trouble Code (DTC) Index

NOTE: The wheel speed DTCs can be cleared but the warning indicator will remain illuminated until the vehicle is driven over 12 Km/h (7 mph).

ABS Control Module Diagnostic Trouble Code (DTC) Index

DTC	Description	Source	Action
B1318	Battery Voltage Low	ABS/TC	GO to Pinpoint Test C.
B1342	ABS Control Module Internal Failure	ABS/TC	CLEAR the DTCs. REPEAT the self-Test. If DTC B1342 is retrieved again, INSTALL a New Hydraulic Control Unit (HCU). REPEAT the Self-Test.
B1484	Brake Pedal Input open Circuit	ABS/TC	GO to Pinpoint Test D.
B1596	Repair Continuous Codes	ABS/TC	REPAIR DTCs Retrieved.

(Continued)

DIAGNOSIS AND TESTING (Continued)**ABS Control Module Diagnostic Trouble Code (DTC) Index**

DTC	Description	Source	Action
C1095	ABS Hydraulic Pump Motor Circuit Failure	ABS/TC	GO to Pinpoint Test E.
C1145	RF Wheel Speed Sensor Input Circuit Failure	ABS/TC	GO to Pinpoint Test F.
C1155	LF Wheel Speed Sensor Input Circuit Failure	ABS/TC	GO to Pinpoint Test F.
C1165	RR Wheel Speed Sensor Input Circuit Failure	ABS/TC	GO to Pinpoint Test F.
C1175	LR Wheel Speed Sensor Input Circuit Failure	ABS/TC	GO to Pinpoint Test F.
C1222	Wheel Speed Signal Mismatch	ABS/TC	GO to Pinpoint Test G.
C1233	LF Wheel Speed Input Signal Missing	ABS/TC	GO to Pinpoint Test H.
C1234	RF Wheel Speed Input Signal Missing	ABS/TC	GO to Pinpoint Test H.
C1235	RR Wheel Speed Input Signal Missing	ABS/TC	GO to Pinpoint Test H.
C1236	LR Wheel Speed Input Signal Missing	ABS/TC	GO to Pinpoint Test H.
C1266	ABS Valve Power Relay Circuit Failure	ABS/TC	INSTALL a New Hydraulic Control Unit (HCU). REPEAT the Self-Test.
U1009	SCP Invalid or Missing Data for Engine Torque	PCM	CARRY OUT the PCM Self-Test.
U1027	SCP Invalid or Missing Data for Engine RPM	PCM	CARRY OUT the PCM Self-Test.
U1262	SCP Communication Bus Fault	SCP Network	REFER to Section 418-00.

ABS Control Module Parameter Identification (PID) Index**ABS Control Module Parameter Identification (PID) Index**

PID	Description	Expected Value
CCNTABS	Number of Continuous DTCs on ABS Control Module	One count per bit
BOO	Brake Pedal Position (BPP) Switch Input	ON, OFF
PMPMTR	ABS Pump Motor	OFF ---, OFFO --, OFF-B-, OFF -- G, OFFO-G, OFFOB-, OFF-BG, OFFOBG, ON ---, ONO --, ON-B-, ON -- G, ONO-G, ONOB-, ON-BG, ONOBG
VLVCTR	ABS Valve Control Relay	OFF ---, OFFO --, OFF-B-, OFF -- G, OFFO-G, OFFOB-, OFF-BG, OFFOBG, ON ---, ONO --, ON-B-, ON -- G, ONO-G, ONOB-, ON-BG, ONOBG
LFWSPD	LF Wheel Speed Signal	0-255 KPH
RFWSPD	RF Wheel Speed Signal	0-255 KPH
LRWSPD	LR Wheel Speed Signal	0-255 KPH
RRWSPD	RR Wheel Speed Signal	0-255 KPH

(Continued)

DIAGNOSIS AND TESTING (Continued)**ABS Control Module Parameter Identification (PID) Index**

PID	Description	Expected Value
ABSLFI	LF ABS Inlet Valve	OFF ---, OFFO --, OFF-B-, OFF -- G, OFFO-G, OFFOB-, OFF-BG, OFFOBG, ON ---, ONO --, ON-B-, ON -- G, ONO-G, ONOB-, ON-BG, ONOBG
ABSLFO	LF ABS Outlet Valve	OFF ---, OFFO --, OFF-B-, OFF -- G, OFFO-G, OFFOB-, OFF-BG, OFFOBG, ON ---, ONO --, ON-B-, ON -- G, ONO-G, ONOB-, ON-BG, ONOBG
ABSRFI	RF ABS Inlet Valve	OFF ---, OFFO --, OFF-B-, OFF -- G, OFFO-G, OFFOB-, OFF-BG, OFFOBG, ON ---, ONO --, ON-B-, ON -- G, ONO-G, ONOB-, ON-BG, ONOBG
ABSRFO	RF ABS Outlet Valve	OFF ---, OFFO --, OFF-B-, OFF -- G, OFFO-G, OFFOB-, OFF-BG, OFFOBG, ON ---, ONO --, ON-B-, ON -- G, ONO-G, ONOB-, ON-BG, ONOBG
ABSLRI	LR ABS Inlet Valve	OFF ---, OFFO --, OFF-B-, OFF -- G, OFFO-G, OFFOB-, OFF-BG, OFFOBG, ON ---, ONO --, ON-B-, ON -- G, ONO-G, ONOB-, ON-BG, ONOBG
ABSLRO	LR ABS Outlet Valve	OFF ---, OFFO --, OFF-B-, OFF -- G, OFFO-G, OFFOB-, OFF-BG, OFFOBG, ON ---, ONO --, ON-B-, ON -- G, ONO-G, ONOB-, ON-BG, ONOBG

(Continued)

DIAGNOSIS AND TESTING (Continued)**ABS Control Module Parameter Identification (PID) Index**

PID	Description	Expected Value
ABSRRI	RR ABS Inlet Valve	OFF ---, OFFO --, OFF-B-, OFF -- G, OFFO-G, OFFOB-, OFF-BG, OFFOBG, ON ---, ONO --, ON-B-, ON -- G, ONO-G, ONOB-, ON-BG, ONOBG
ABSRRO	RR ABS Outlet Valve	OFF ---, OFFO --, OFF-B-, OFF -- G, OFFO-G, OFFOB-, OFF-BG, OFFOBG, ON ---, ONO --, ON-B-, ON -- G, ONO-G, ONOB-, ON-BG, ONOBG
LFTCP	LF Traction Control Primary Valves	ON, OFF
RFTCP	RF Traction Control Primary Valves	ON, OFF
LRTCP	LR Traction Control Primary Valves	ON, OFF
RRTCP	RR Traction Control Primary Valves	ON, OFF
LFTCS	LF Traction Control Switching Valves	ON, OFF
RFTCS	RF Traction Control Switching Valves	ON, OFF
LRTCS	LR Traction Control Switching Valves	ON, OFF
RRTCS	RR Traction Control Switching Valves	ON, OFF
T/ALVAL	Left Traction Control Valve Output Status	OFF ---, OFFO --, OFF-B-, OFF -- G, OFFO-G, OFFOB-, OFF-BG, OFFOBG, ON ---, ONO --, ON-B-, ON -- G, ONO-G, ONOB-, ON-BG, ONOBG
T/ARVAL	Right Traction Control Valve Output Status	OFF ---, OFFO --, OFF-B-, OFF -- G, OFFO-G, OFFOB-, OFF-BG, OFFOBG, ON ---, ONO --, ON-B-, ON -- G, ONO-G, ONOB-, ON-BG, ONOBG

ABS Control Module Active Command Index**ABS Control Module Active Command Index**

Active Com- mand	Display	Action
ABS OUTPUT CONTROL	ABS POWER	ON, OFF
	LF INLET	ON, OFF
	LF OUTLET	ON, OFF

(Continued)

ABS Control Module Active Command Index

Active Com- mand	Display	Action
	RF INLET	ON, OFF
	RF OUTLET	ON, OFF
	LR INLET	ON, OFF
	LR OUTLET	ON, OFF
	RR INLET	ON, OFF

(Continued)

DIAGNOSIS AND TESTING (Continued)**ABS Control Module Active Command Index**

Active Command	Display	Action
	RR OUTLET	ON, OFF
	DSBL TOG	ON, OFF
TRACTION CONTROL PRIMARY AND SWITCHING VALVE CONTROL	LF TC PRV	ON, OFF

(Continued)

ABS Control Module Active Command Index

Active Command	Display	Action
	RFTC PRV	ON, OFF
	LR TC PRV	ON, OFF
	RR TC PRV	ON, OFF
	LFTC SWV	ON, OFF
	RFTC SWV	ON, OFF
	LR TC SWV	ON, OFF
	RR TC SWV	ON, OFF

Symptom Chart**Symptom Chart**

Condition	Possible Sources	Action
No communication with the anti-lock brake control module	- Fuse. - Circuit. - ABS control module.	GO to Pinpoint Test A.
Unable to enter self-test - communication OK	ABS control module.	GO to Pinpoint Test B.
The red brake warning indicator does not self-check	- Low brake fluid warning switch. - Circuit. - Hybrid electronic cluster (HEC). - Ignition switch. - Parking brake.	REFER to Section 413-01.
The red brake warning indicator stays on when the ignition switch is in RUN	- Low brake fluid warning switch. - Circuit. - Hybrid electronic cluster (HEC). - Ignition switch. - Parking brake.	REFER to Section 413-01.
The yellow ABS warning indicator does not self-check - Always on NO DTCs	- Circuit. - ABS control module. - Hybrid electronic cluster (HEC).	GO to Pinpoint Test I.
Spongy brake pedal with no warning indicator	- Air in hydraulic brake system. - Base brake system.	- GO to Pinpoint Test J. - REFER to Section 206-00.
Poor vehicle tracking during anti-lock function	- Air in hydraulic brake system. - Hydraulic control unit. - Base brake system.	- GO to Pinpoint Test K. - REFER to Section 206-00.
The traction control is inoperative	- Circuit. - ABS control module. - Hydraulic control unit.	GO to Pinpoint Test L.
The traction control switch indicator is inoperative	- Circuit. - Traction control switch. - ABS control module.	GO to Pinpoint Test M.
The traction control cannot be disabled	- Circuit. - Traction control switch. - ABS control module.	GO to Pinpoint Test N.

DIAGNOSIS AND TESTING (Continued)**Symptom Chart (Continued)**

Condition	Possible Sources	Action
The traction control indicator stays on continuously with no DTCs retrieved	- Circuit. - Hybrid electronic cluster (HEC). - ABS control module.	REFER to Section 413-01.

Pinpoint Tests

 **CAUTION:** Use the correct probe adapter(s) when making measurements. Failure to use the correct probe adapter(s) may damage the connector.

Do not carry out any of the following pinpoint tests unless instructed to do so. It is assumed that a fault has been detected in the system that directs entry to a specific diagnostic routine. Carrying out any pinpoint test without direction to do so may result in inaccurate diagnosis and possible replacement of functioning components. Correct test results are dependant on the correct operation of related components/systems.

Do not replace any parts unless the results indicate that they should be replaced.

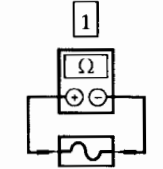
When more than one diagnostic trouble code (DTC) is received, always start with the first DTC received.

For correct pinpoint test procedures, follow the steps in order as listed. Follow each step until a fault is found.

After completing any repair to the anti-lock brake system, verify that all components are correctly reconnected, then clear all DTCs.

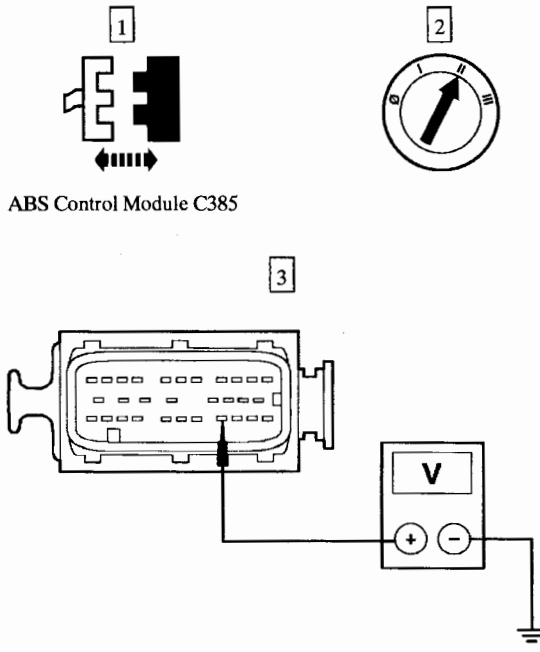
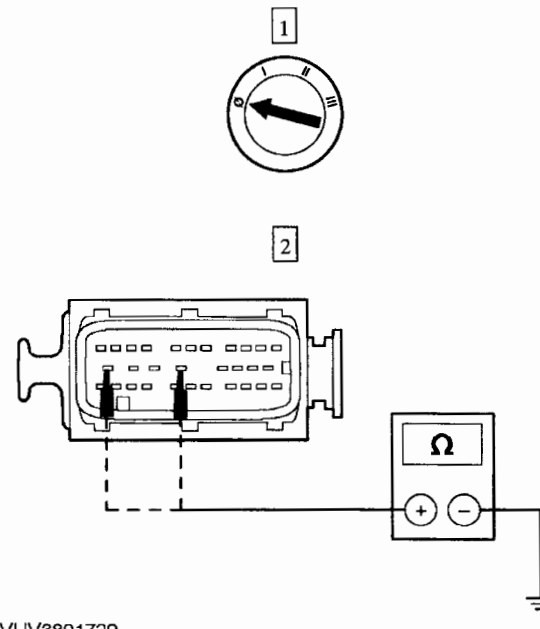
The scan tool can be used to take voltage and resistance measurements. Necessary probes and adapters are included in the scan tool kit.

Pinpoint Tests**PINPOINT TEST A: NO COMMUNICATION WITH THE ANTI-LOCK BRAKE CONTROL MODULE**

CONDITIONS	DETAILS/RESULTS/ACTIONS
A1 CHECK THE CENTRAL JUNCTION BOX (CJB) FUSE 22 (7.5A)	
 CJB fuse 22 (7.5A)	Is the fuse OK? → Yes GO to A2. → No INSTALL a new fuse. CLEAR the DTCs. REPEAT the self-test. If the fuse fails again, CHECK for short to ground. REPAIR as necessary. CLEAR the DTCs. REPEAT the self-test.

(Continued)

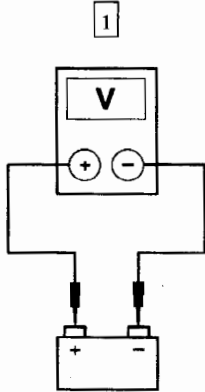
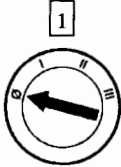
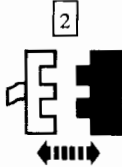
DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST A: NO COMMUNICATION WITH THE ANTI-LOCK BRAKE CONTROL MODULE (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
A2 CHECK CIRCUIT 14-CF6 (VT/YE) FOR AN OPEN  1 2 3 ABS Control Module C385 VUV9110002	3 Using a digital multimeter, measure the voltage between ABS control module C385 pin 8, circuit 14-CF6 (VT/YE), wiring harness side and ground. Is the voltage greater than 10 volts? → Yes GO to A3. → No REPAIR the circuit. CLEAR the DTCs. REPEAT the self-test.
A3 CHECK CIRCUIT 31-CF6A (BK) AND CIRCUIT 31-CF6B (BK) FOR AN OPEN  1 2 VUV3801729	2 Using a digital multimeter, measure the resistance between ABS control module C385 pin 12, circuit 31-CF6A (BK), harness side and ground, and between ABS control module C385 pin 15, circuit 31-CF6B (BK), harness side and ground. Are the resistances less than 5 ohms? → Yes REFER to Section 418-00. → No REPAIR the circuit. CLEAR the DTCs. REPEAT the self-test.

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST B: UNABLE TO ENTER SELF-TEST - COMMUNICATION OK**

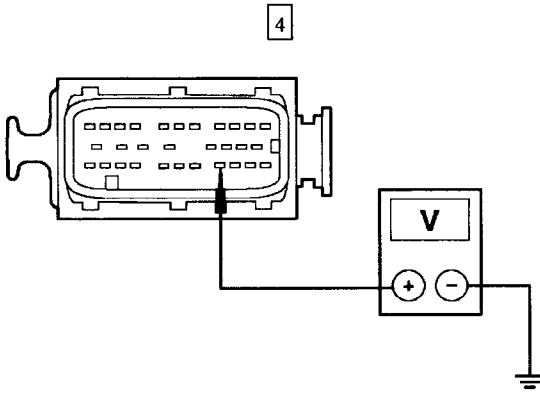
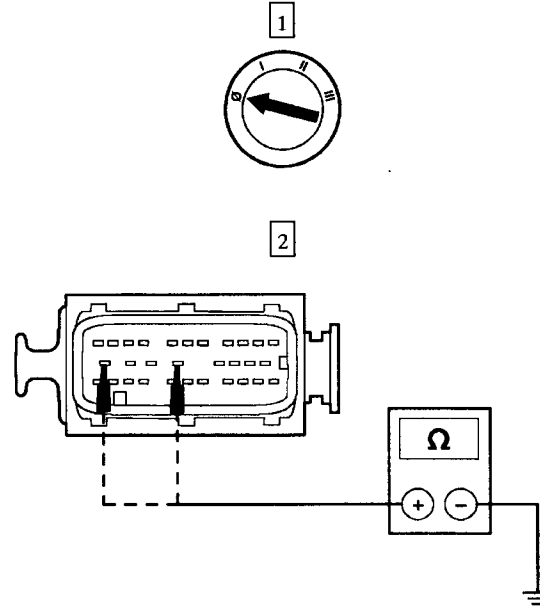
CONDITIONS	DETAILS/RESULTS/ACTIONS
B1 CHECK THE COMMUNICATION TO THE ABS CONTROL MODULE	
	1 Check the communication to the ABS control module. Does scan tool communicate with the ABS control module? → Yes INSTALL a new hydraulic control unit (HCU). REPEAT the self-test → No GO to Pinpoint Test A.

PINPOINT TEST C: DTC B1318, BATTERY VOLTAGE LOW

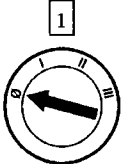
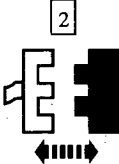
CONDITIONS	DETAILS/RESULTS/ACTIONS
C1 CHECK THE BATTERY VOLTAGE	
1  VUV9310002	1 Using a digital multimeter, measure the voltage between the positive and negative battery posts. Is the voltage greater than 10 volts? → Yes GO to C2. → No REPAIR the charging system. REFER to Section 414-00.
C2 CHECK CIRCUIT 15-CF6 (GN/YE)	
1  2  ABS Control Module C385 3 	

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST C: DTC B1318, BATTERY VOLTAGE LOW (Continued)**

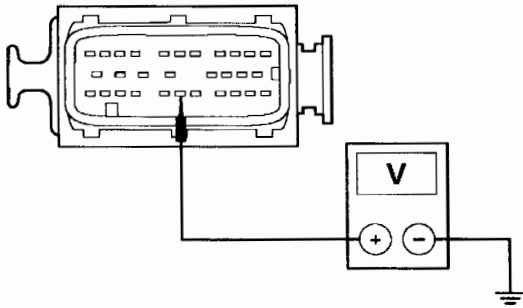
CONDITIONS	DETAILS/RESULTS/ACTIONS
C2 CHECK CIRCUIT 15-CF6 (GN/YE) (Continued)  VUV9110002	4 Using a digital multimeter, measure the voltage between ABS control module C385 pin 8, circuit 14-CF6 (VT/YE), wiring harness side and ground. - Is the voltage greater than 10 volts? → Yes GO to C3. No REPAIR the circuit. CLEAR the DTCs. REPEAT the self-test.
C3 CHECK CIRCUIT 31-CF6A (BK) AND CIRCUIT 31-CF6B (BK) FOR AN OPENR  VUV3801729	2 Using a digital multimeter, measure the resistance between ABS control module C385 pin 12, circuit 31-CF6A (BK), harness side and ground, and between ABS control module C385 pin 15, circuit 31-CF6B (BK), harness side and ground. - Are the resistances less than 5 ohms? → Yes CLEAR the DTCs. REPEAT the self-test. If DTC B1318 is retrieved again INSTALL a new hydraulic control unit (HCU). REPEAT the self-test. If no DTCs are retrieved the system is operating normally. No REPAIR circuit 31-CF6A (BK), or circuit 31-CF6B (BK). CLEAR the DTCs. REPEAT the self-test.

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST D: DTC B1484, BRAKE PEDAL INPUT OPEN CIRCUIT**

CONDITIONS	DETAILS/RESULTS/ACTIONS
D1 CHECK THE STOPLAMPS	
	1 Depress the brake pedal while checking the stoplamps. Do the stoplamps illuminate? → Yes GO to D2. → No REFER to Section 417-01.
D2 CHECK THE ABS CONTROL MODULE BOOABS PID	
1 	2 Monitor the ABS control module PID BOOABS, while depressing and releasing the brake pedal. Does the ABS control module PID BOOABS indicate ON with the brake pedal depressed and OFF with the brake pedal released? → Yes CLEAR the DTCs. REPEAT the self-test. If the DTC B1484 is retrieved, INSTALL a new hydraulic control unit (HCU). REPEAT the self-test. → No GO to D3.
D3 CHECK CIRCUIT 14S-CF58 (VT/OG) FOR AN OPENR	
1  2  ABS Control Module C385	

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST D: DTC B1484, BRAKE PEDAL INPUT OPEN CIRCUIT (Continued)**

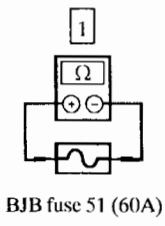
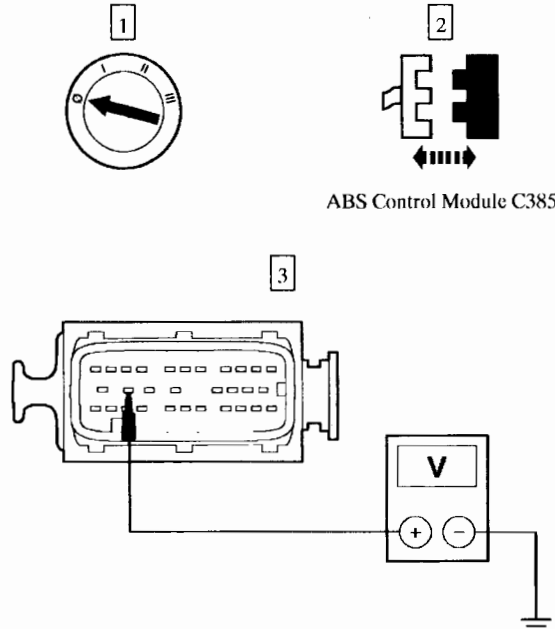
CONDITIONS	DETAILS/RESULTS/ACTIONS
D3 CHECK CIRCUIT 14S-CF58 (VT/OG) FOR AN OPENR (Continued)	
3  VUV9210003	3 Using a digital multimeter, measure the voltage between ABS control module C385 pin 6, circuit 14S-CF58 (VT/OG), harness side and ground while depressing the brake pedal. • Is the voltage greater than 10 volts? → Yes INSTALL a new hydraulic control unit (HCU). REPEAT the self-test. → No REPAIR the circuit. CLEAR the DTCs. REPEAT the self-test.

PINPOINT TEST E: DTC C1095, ABS HYDRAULIC PUMP MOTOR CIRCUIT FAILURE

CONDITIONS	DETAILS/RESULTS/ACTIONS
E1 CHECK FOR CONTINUOUS OPERATION OF THE ABS PUMP MOTOR	
1 	2 Check the ABS pump motor for continuous operation. • Is the ABS pump motor running continuously? → Yes INSTALL a new hydraulic control unit (HCU). REPEAT the self-test. → No GO to E2.

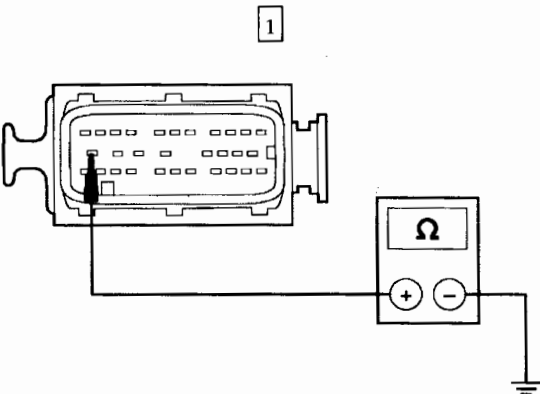
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DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST E: DTC C1095, ABS HYDRAULIC PUMP MOTOR CIRCUIT FAILURE (Continued)**

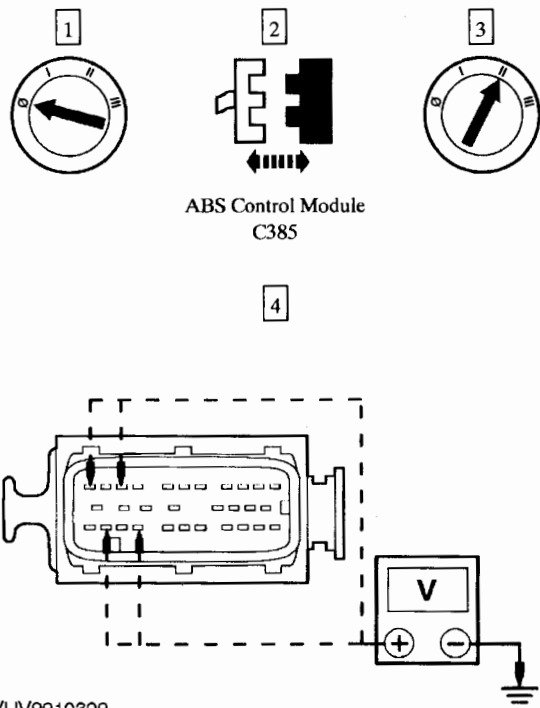
CONDITIONS	DETAILS/RESULTS/ACTIONS
E2 CHECK THE BATTERY JUNCTION BOX (BJB) FUSE 51 (60A)  BJB fuse 51 (60A)	• Is the fuse OK? → Yes GO to E3. → No INSTALL a new fuse. CLEAR the DTCs. REPEAT the self-test. If the fuse fails again, CHECK for short to ground. REPAIR as necessary. CLEAR the DTCs. REPEAT the self-test.
E3 CHECK CIRCUIT 30-CF6A (RD/YE) FOR AN OPEN  ABS Control Module C385 VUV9410002	3 Using a digital multimeter, measure the voltage between ABS control module C385 pin 13, circuit 30-CF6A (RD/YE), harness side and ground. • Is the voltage greater than 10 volts? → Yes GO to E4. → No REPAIR the circuit. CLEAR the DTCs. REPEAT the self test.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST E: DTC C1095, ABS HYDRAULIC PUMP MOTOR CIRCUIT FAILURE (Continued)**

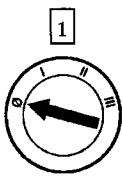
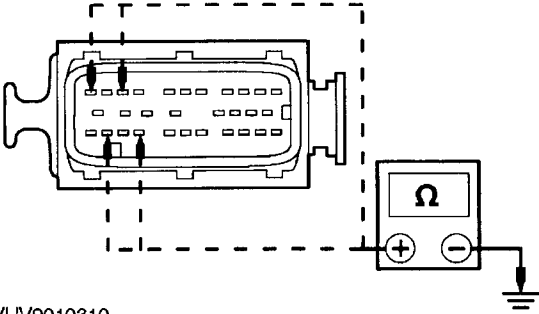
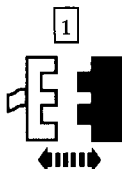
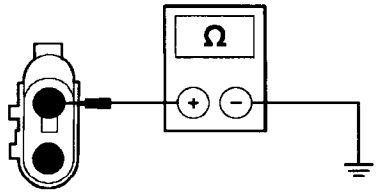
CONDITIONS	DETAILS/RESULTS/ACTIONS
E4 CHECK CIRCUIT 31-CF6A (BK) FOR AN OPEN	
 VUV9510002	1 Using a digital multimeter, measure the resistance between ABS control module C385 pin 12, circuit 31-CF6A (BK), harness side and ground. Is the resistance less than 5 ohms? → Yes INSTALL a new hydraulic control unit (HCU). REPEAT the self-test. → No REPAIR the circuit. CLEAR the DTCs. REPEAT the self-test.

PINPOINT TEST F: DTC C1145 (RF), C1155 (LF), C1165(RR), C1175 (LR), WHEEL SPEED SENSOR INPUT CIRCUIT FAILURE

CONDITIONS	DETAILS/RESULTS/ACTIONS
F1 CHECK THE SUSPECT WHEEL SPEED CIRCUIT FOR SHORT TO POWER	
 VUV9910309	4 Using a digital multimeter, measure the voltage of the suspect wheel speed sensor circuit between: (RF) ABS control module C385 pin 4, circuit 8-CF38 (WH/RD), harness side and ground. (LF) ABS control module C385 pin 20, circuit 8-CF32 (WH), harness side and ground. (RR) ABS control module C385 pin 2, circuit 8-CF40 (WH/GN), harness side and ground. (LR) ABS control module C385 pin 22, circuit 8-CF34 (WH/BU), harness side and ground. - Is voltage present? → Yes REPAIR the circuit. CLEAR the DTCs. REPEAT the self-test. → No GO to F2.

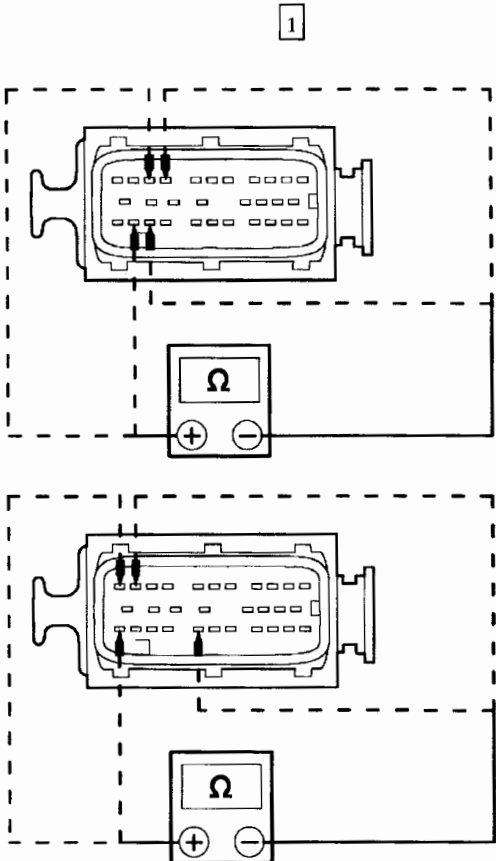
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DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST F: DTC C1145 (RF), C1155 (LF), C1165(RR), C1175 (LR), WHEEL SPEED SENSOR INPUT CIRCUIT FAILURE (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
F2 CHECK THE SUSPECT WHEEL SPEED SENSOR CIRCUIT FOR SHORT TO GROUND  2  VUV9010310	2 Using a digital multimeter, measure the resistance of the suspect wheel speed sensor circuit between: — (RF) ABS control module C385 pin 4, circuit 8-CF38 (WH/RD), harness side and ground. — (LF) ABS control module C385 pin 20, circuit 8-CF32 (WH), harness side and ground. — (RR) ABS control module C385 pin 2, circuit 8-CF40 (WH/GN), harness side and ground. — (LR) ABS control module C385 pin 22, circuit 8-CF34 (WH/BU), harness side and ground. • Is the resistance infinite? → Yes GO to F4. → No GO to F3.
F3 CHECK THE SUSPECT WHEEL SPEED SENSOR FOR SHORT TO GROUND  Suspect Wheel Speed Sensor Connector 2  VUV9810002	2 Using a digital multimeter, measure the resistance between either suspect wheel speed sensor pin (component side) and ground. • Is the resistance infinite? → Yes REPAIR the circuit. CLEAR the DTCs. REPEAT the self-test. → No INSTALL a new wheel speed sensor. CLEAR the DTCs. REPEAT the self-test.

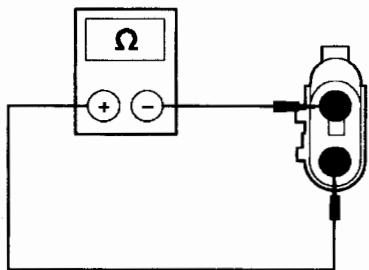
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DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST F: DTC C1145 (RF), C1155 (LF), C1165(RR), C1175 (LR), WHEEL SPEED SENSOR INPUT CIRCUIT FAILURE (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
F4 CHECK THE WHEEL SPEED CIRCUITRY FOR AN OPEN OR SHORT TOGETHER 1  VUV9810309	1 Using a digital multimeter, measure the resistance between: — (RF) ABS control module C385 pin 4, circuit 8-CF38 (WH/RD), harness side and ABS control module C385 pin 5, circuit 9-CF38 (BN/RD), harness side. — (LF) ABS control module C385 pin 20, circuit 8-CF32 (WH), harness side and ABS control module C385 pin 21, circuit 9-CF32 (BN), harness side. — (RR) ABS control module C385 pin 2, circuit 8-CF40 (WH/GN), harness side and ABS control module C385 pin 3, circuit 9-CF40 (BN/GN), harness side. — (LR) ABS control module C385 pin 22, circuit 8-CF34 (WH/BU), harness side and ABS control module C385 pin 23, circuit 9-CF34 (BN/BU), harness side. • Is the resistance between 1,000 and 1,500 ohms? → Yes Reconnect all connections. CLEAR the DTCs. REPEAT the self-test. If DTC C1145, C1155 C1165 or C1175 is retrieved INSTALL a new hydraulic control unit (HCU). REPEAT the self-test. If no DTCs are retrieved the system is operating normally. → No GO to F5.
F5 CHECK THE SUSPECT WHEEL SPEED SENSOR FOR AN OPEN OR SHORT TOGETHER 1  Suspect Wheel Speed Sensor Connector	

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST F: DTC C1145 (RF), C1155 (LF), C1165(RR), C1175 (LR), WHEEL SPEED SENSOR INPUT CIRCUIT FAILURE (Continued)**

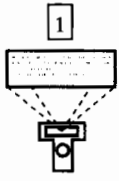
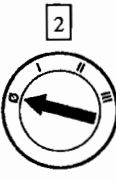
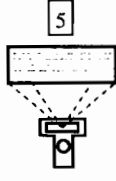
CONDITIONS	DETAILS/RESULTS/ACTIONS
F5 CHECK THE SUSPECT WHEEL SPEED SENSOR FOR AN OPEN OR SHORT TOGETHER (Continued)	
2  VUV9010003	2 Using a digital multimeter, measure the resistance between the suspect wheel speed sensor pins (component side). • Is resistance between 1,000 and 1,500 ohms? → Yes REPAIR the circuit. CLEAR the DTCs. REPEAT the self-test. → No INSTALL a new wheel speed sensor. CLEAR the DTCs. REPEAT the self-test.

PINPOINT TEST G: DTC C1222, WHEEL SPEED SIGNAL MISMATCH.

CONDITIONS	DETAILS/RESULTS/ACTIONS
G1 CHECK VEHICLE COMPONENTS	
NOTE: Any other wheel speed DTC must be diagnosed before proceeding. This DTC C1222 can be set during certain repair procedures with key ON, vehicle towing, on vehicle wheel balance or dynamometer testing with no actual fault.	
	1 Check for correct wheel and tire size, front-to-rear and side-to-side. 2 Check for excessive bearing end play. 3 Check the ABS sensor indicator for a bent sensor ring or missing teeth. • Are all the conditions OK? → Yes GO to G2. → No REPAIR as necessary. CLEAR the DTCs. REPEAT the self-test.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST G: DTC C1222, WHEEL SPEED SIGNAL MISMATCH. (Continued)**

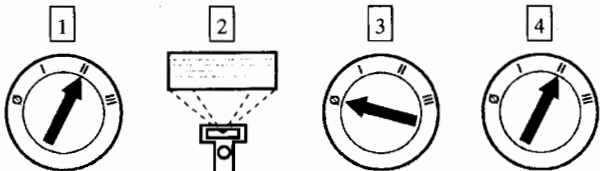
CONDITIONS	DETAILS/RESULTS/ACTIONS
G2 TEST DRIVE THE VEHICLE	
 1  2  3 Clear the DTCs  5 Retrieve DTCs	4 Test drive the vehicle over 24 Km/h (15 mph). • Is DTC C1222 retrieved? → Yes INSTALL a new hydraulic control unit (HCU). REPEAT the self-test. → No If another DTC is retrieved, GO to the ABS Control Module Diagnostic Trouble Code (DTC) Index. If no DTCs are retrieved, system is OK. If no DTCs are retrieved, system is OK.

PINPOINT TEST H: DTC C1233 (LF), C1234 (RF), C1235 (RR), C1236 (LR), WHEEL SPEED INPUT SIGNAL MISSING

CONDITIONS	DETAILS/RESULTS/ACTIONS
H1 CHECK THE SUSPECT WHEEL SPEED SENSOR	
	1 Inspect the suspect wheel speed sensor mounting. Check the wheel speed sensor for excessive dirt build-up. Check for metal obstructions. Check the wheel speed sensor for damage. • Is the suspect wheel speed sensor and mounting OK? → Yes GO to H2. → No REPAIR or INSTALL a new wheel speed sensor. CLEAR the DTCs. REPEAT the self-test.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST H: DTC C1233 (LF), C1234 (RF), C1235 (RR), C1236 (LR), WHEEL SPEED INPUT SIGNAL MISSING (Continued)**

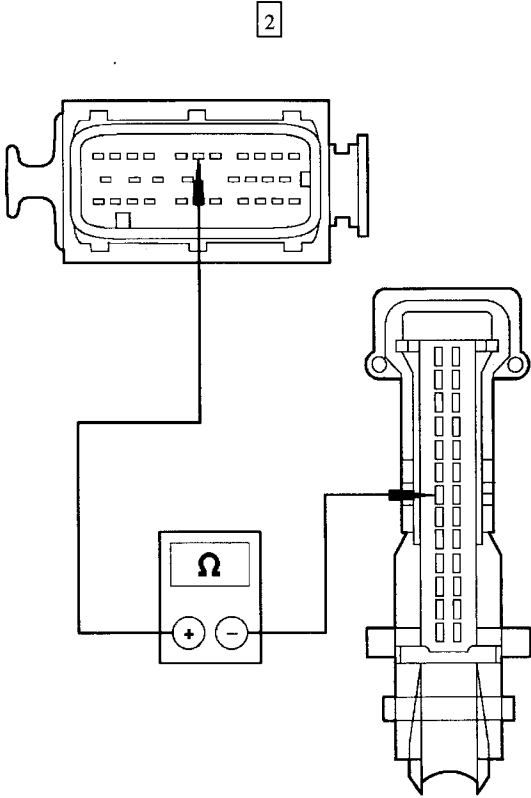
CONDITIONS	DETAILS/RESULTS/ACTIONS
H2 CHECK THE SUSPECT ABS SENSOR INDICATOR	
	1 Check the suspect ABS sensor indicator for corrosion, nicks, bridged teeth, damaged teeth, and correct mounting and alignment with the wheel speed sensor. Check the air gap (less than 1 mm). Check the bearing end play. • Is the suspect ABS sensor indicator OK? → Yes GO to H3. → No INSTALL a new ABS sensor indicator. CLEAR the DTCs. REPEAT the self-test.
H3 CHECK THE SUSPECT WHEEL SPEED SENSOR PIDS	
 Clear the DTCs	5 Have an assistant monitor the ABS control module PIDs LFWSPD, RFWSPD, LRWSPD, and RRWSPD while driving at various speeds. 6 Test drive the vehicle for 16 km (10 miles). • Are the ABS control module PIDs reading approximately the same at all times? → Yes CLEAR the DTCs. REPEAT the self-test. If DTC C1233, C1234, C1235 or C1236 is retrieved INSTALL a new hydraulic control unit (HCU). REPEAT the self-test. If no DTCs are retrieved the system is operating normally. → No INSTALL a new wheel speed sensor. CLEAR the DTCs. REPEAT the self-test.

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST I: THE YELLOW ABS WARNING INDICATOR DOES NOT SELF-CHECK - ALWAYS ON, NO DTCS**

CONDITIONS	DETAILS/RESULTS/ACTIONS
I1 CHECK CIRCUIT 31S-CF28 (BK/RD) FOR SHORT TO POWER 1 2 3 4 ABS Control Module C385 HEC C808b 5 VUV9810188	5 Using a digital multimeter, measure the voltage between hybrid electronic cluster (HEC) C808b pin 7, circuit 31S-CF28 (BK/RD), harness side and ground. Is voltage present? → Yes REPAIR the circuit. REPEAT the self-test. → No GO to I2.
I2 CHECK CIRCUIT 31S-CF28 (BK/RD) FOR OPEN CIRCUIT 1	

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST I: THE YELLOW ABS WARNING INDICATOR DOES NOT SELF-CHECK - ALWAYS ON, NO DTCS (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
I2 CHECK CIRCUIT 31S-CF28 (BK/RD) FOR OPEN CIRCUIT (Continued)  VUV9710188	2 Using a digital multimeter, measure the resistance between ABS control module C385 pin 25, circuit 31S-CF28 (BK/RD), harness side and HEC C808b pin 7, circuit 31S-CF28 (BK/RD), harness side. • Is the resistance less than 5 ohms? → Yes INSTALL a new hydraulic control unit (HCU). REPEAT the self-test. → No REPAIR the circuit. REPEAT the self-test.

PINPOINT TEST J: SPONGY BRAKE PEDAL WITH NO WARNING INDICATOR

CONDITIONS	DETAILS/RESULTS/ACTIONS
J1 CHECK THE VEHICLE COMPONENT MOUNTING	1 Inspect the brake pedal and power booster/brake master cylinder for proper attachment. 2 Bleed the brake system. Refer to Section 206-00. • Is the brake pedal spongy? → Yes GO to J2. → No The brake system is operating correctly. REPEAT the self-test.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST J: SPONGY BRAKE PEDAL WITH NO WARNING INDICATOR (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
J2 REBLEED THE BRAKE SYSTEM	
	1 Rebleed the brake system using the scan tool. Refer to Section 206-00. • Is the brake pedal spongy? → Yes REFER to Section 206-00. → No The brake system is operating correctly. REPEAT the self-test.

PINPOINT TEST K: POOR VEHICLE TRACKING DURING ANTI-LOCK FUNCTION

CONDITIONS	DETAILS/RESULTS/ACTIONS
K1 BLEED THE BRAKE SYSTEM	
	1 Bleed the brake system. Refer to Section 206-00. • Does the vehicle track poorly? → Yes GO to K2. → No The brake system is operating correctly. REPEAT the self-test.
K2 CHECK THE ABS INLET VALVE (CLOSED POSITION)	
	1 Raise and support the vehicle. Refer to Section 100-02. 2 Rotate all the wheels to make sure they rotate freely (the vehicle must be in neutral). 3 Apply moderate brake pedal effort. 4 Trigger ABS control module active command LF INLET ON.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST K: POOR VEHICLE TRACKING DURING ANTI-LOCK FUNCTION (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
K2 CHECK THE ABS INLET VALVE (CLOSED POSITION) (Continued)	
	5 Have an assistant attempt to rotate the LF wheel. • Does the LF wheel rotate? → Yes TRIGGER active command LF INLET OFF. GO to K3. → No INSTALL a new hydraulic control unit (HCU). REPEAT the self-test.
K3 CHECK THE ABS INLET VALVE (OPEN POSITION)	
	1 Apply moderate brake pedal effort. 2 Have an assistant attempt to rotate the LF wheel. • Does the LF wheel rotate? → Yes INSTALL a new hydraulic control unit (HCU). REPEAT the self-test. → No GO to K4.
K4 CHECK ABS OUTLET VALVE (OPEN POSITION)	
	1 Apply moderate brake pedal effort. 2 Trigger ABS control module active command LF INLET ON. 3 Trigger ABS control module active command ABS POWER ON (turns on pump motor) for 6 seconds. (Trigger must be depressed 3 times. Each press runs the pump for 2 seconds.) 4 Trigger the ABS control module active command LF OUTLET ON and then OFF, repeat 3 times.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST K: POOR VEHICLE TRACKING DURING ANTI-LOCK FUNCTION (Continued)**

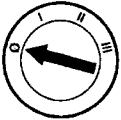
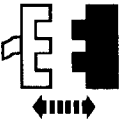
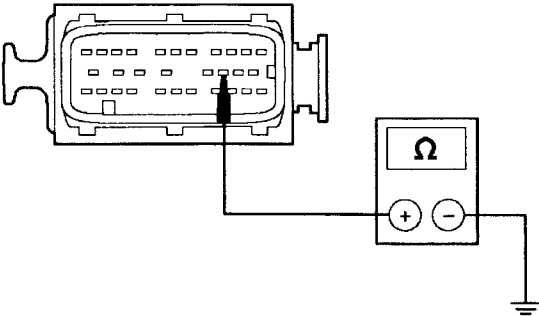
CONDITIONS	DETAILS/RESULTS/ACTIONS
K4 CHECK ABS OUTLET VALVE (OPEN POSITION) (Continued)	
	5 Have an assistant attempt to rotate the LF wheel. Does the LF wheel rotate? → Yes TRIGGER all active commands OFF. GO to K5. → No INSTALL a new hydraulic control unit (HCU). REPEAT the self-test.
K5 CHECK ABS INLET AND OUTLET VALVE (CLOSED POSITION)	
	1 Apply moderate brake pedal effort. 2 Have an assistant attempt to rotate the LF wheel. Does the LF wheel rotate? → Yes INSTALL a new hydraulic control unit (HCU). REPEAT the self-test. → No REPEAT this procedure (beginning with K2) for the RF, LR and RR wheels using the appropriate active commands. If no failure occurs the system is operating normally.

PINPOINT TEST L: THE TRACTION CONTROL IS INOPERATIVE

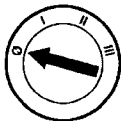
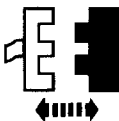
CONDITIONS	DETAILS/RESULTS/ACTIONS
L1 CHECK FOR DIAGNOSTIC TROUBLE CODES (DTCS)	
	1 Carry out the ABS control module self-test. Are any DTCs retrieved? → Yes GO to the ABS Control Module Diagnostic Trouble Code (DTC) Index. → No GO to L2.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST L: THE TRACTION CONTROL IS INOPERATIVE (Continued)**

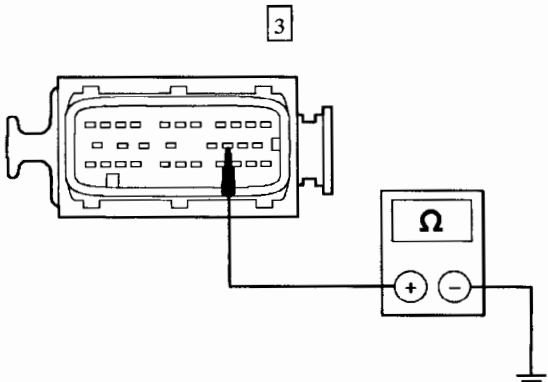
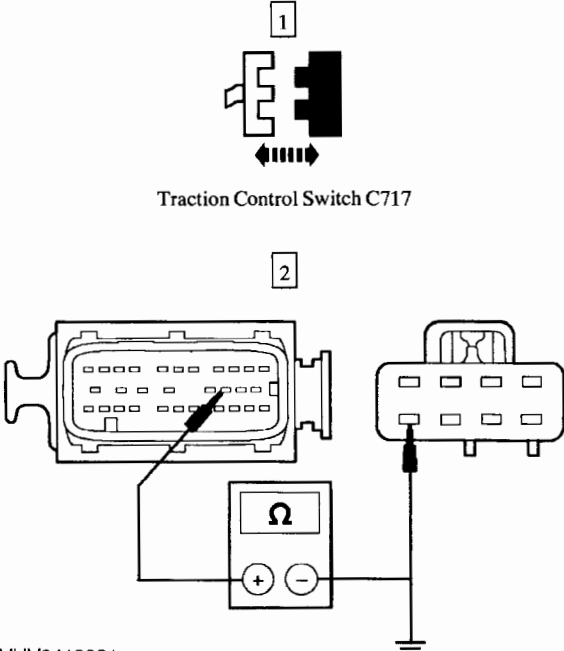
CONDITIONS	DETAILS/RESULTS/ACTIONS
L2 CHECK THE ABS OPERATION	
	1 Test drive the vehicle. Check the ABS operation Does the ABS operate correctly? → Yes GO to L3. → No GO to Symptom Chart.
L3 CHECK THE TRACTION CONTROL SWITCH CIRCUIT	
1  2  ABS Control Module C385 3  VUV9310001	3 Using a digital multimeter, measure the resistance between ABS control module C385 pin 17, circuit 31S-CF54 (BK/WH), harness side and ground while depressing and releasing the traction control switch. Is the resistance less than 5 ohms with the traction control switch depressed and greater than 10,000 ohms with the traction control switch released? → Yes INSTALL a new hydraulic control unit (HCU). REPEAT the self-test. → No GO to Pinpoint Test N.

PINPOINT TEST M: THE TRACTION CONTROL SWITCH INDICATOR IS INOPERATIVE

CONDITIONS	DETAILS/RESULTS/ACTIONS
M1 CHECK TRACTION CONTROL SWITCH CIRCUIT	
1  2  ABS Control Module C385	

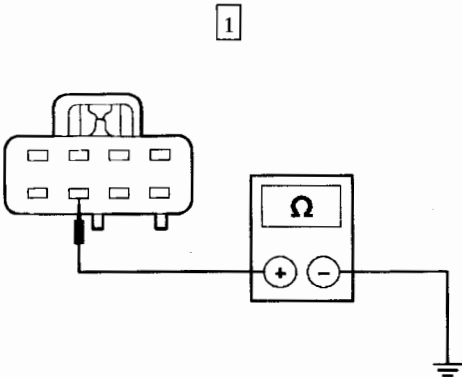
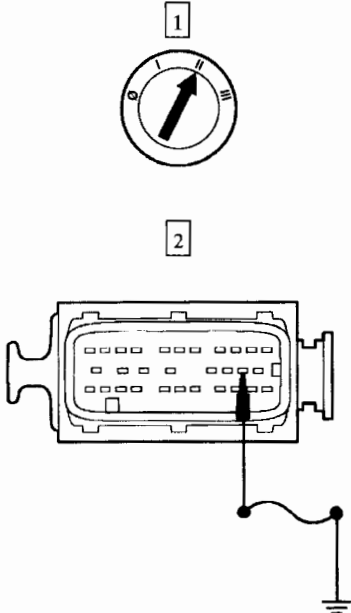
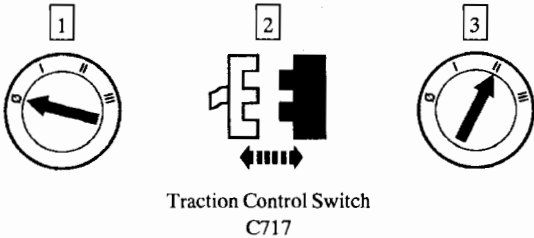
(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST M: THE TRACTION CONTROL SWITCH INDICATOR IS INOPERATIVE (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
M1 CHECK TRACTION CONTROL SWITCH CIRCUIT (Continued)  VUV9310001	3 Using a digital multimeter, measure the resistance between ABS control module C385 pin 17, circuit 31S-CF54 (BK/WH), harness side and ground while depressing and releasing the traction control switch. Is the resistance less than 5 ohms with the traction control switch depressed and greater than 10,000 ohms with the traction control switch released? → Yes GO to M4. → No GO to M2.
M2 CHECK CIRCUIT 31S-CF54 (BK/WH) FOR AN OPEN OR SHORT TO GROUND  VUV9410001	2 Using a digital multimeter, measure the resistance between ABS control module C385 pin 17, circuit 31S-CF54 (BK/WH), harness side and traction control switch C717 pin 1, circuit 31S-CF54 (BK/WH), harness side, and between ABS control module C385 pin 17, circuit 31S-CF54 (BK/WH), harness side and ground. Is the resistance less than 5 ohms between the ABS control module and traction control switch, and greater than 10,000 ohms between the ABS control module and ground? → Yes GO to M3. → No REPAIR the circuit. REPEAT the self-test.

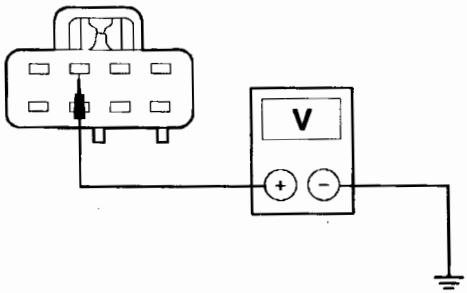
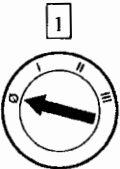
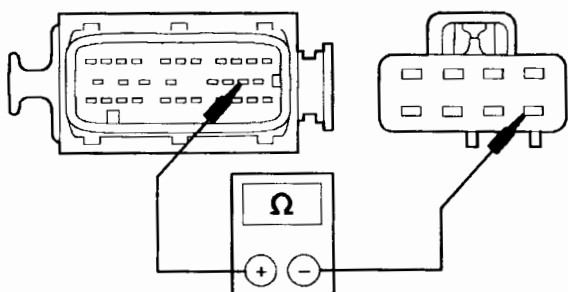
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DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST M: THE TRACTION CONTROL SWITCH INDICATOR IS INOPERATIVE (Continued)**

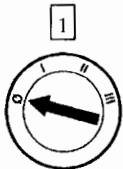
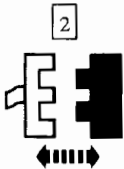
CONDITIONS	DETAILS/RESULTS/ACTIONS
M3 CHECK CIRCUIT 91-CF54 (BK/WH) FOR AN OPEN  VUV9510001	1 Using a digital multimeter, measure the resistance between traction control switch C717 pin 2, circuit 31-CF54 (BK/WH), harness side and ground. • Is the resistance less than 5 ohms? → Yes INSTALL a new traction control switch. REPEAT the self-test. → No REPAIR the circuit. REPEAT the self-test.
M4 CHECK THE TRACTION CONTROL SWITCH INDICATOR CIRCUIT  VUV9610001	2 NOTE: The jumper wire must be fused with a 10A in-line fuse. Momentarily connect a jumper wire between ABS control module C385 pin 18, circuit 31S-CF54A (BK/GN), harness side and ground while checking the traction control switch indicator. • Does the traction control switch indicator illuminate? → Yes INSTALL a new hydraulic control unit (HCU). REPEAT the self-test. → No GO to M5.
M5 CHECK CIRCUIT 15-CF45 (GN/BK) FOR AN OPEN  Traction Control Switch C717	

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST M: THE TRACTION CONTROL SWITCH INDICATOR IS INOPERATIVE (Continued)**

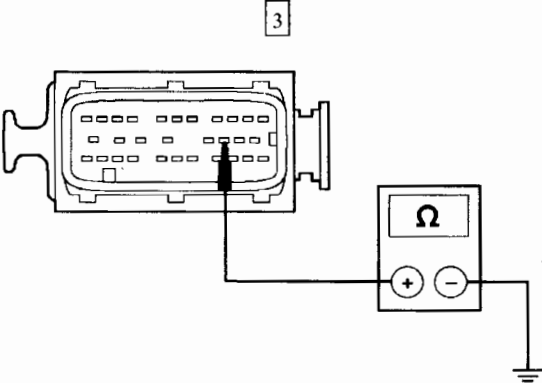
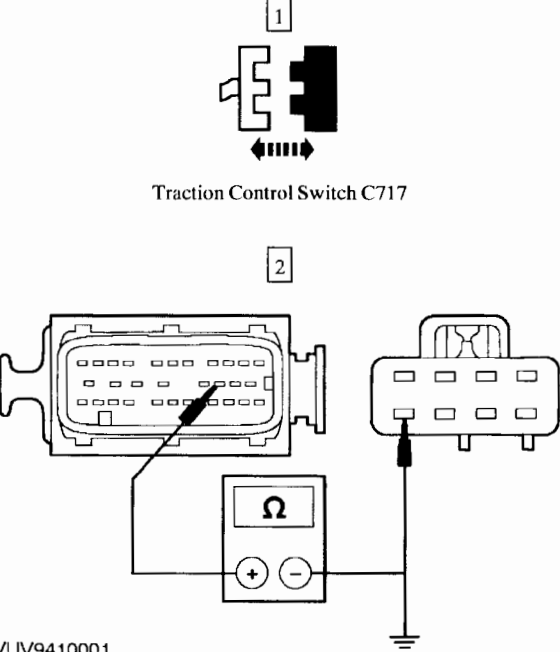
CONDITIONS	DETAILS/RESULTS/ACTIONS
M5 CHECK CIRCUIT 15-CF45 (GN/BK) FOR AN OPEN (Continued)	
4  VUV9710001	4 Using a digital multimeter, measure the voltage between traction control switch C717 pin 6, circuit 15-CF45 (GN/BK), harness side and ground. Is the voltage greater than 10 volts? → Yes GO to M6. → No REPAIR the circuit. REPEAT the self-test.
M6 CHECK CIRCUIT 31S-CF45A (BK/GN) FOR AN OPEN	
1  2  VUV9810001	2 Using a digital multimeter, measure the resistance between ABS control module C385 pin 18, circuit 31S-CF45A (BK/GN), harness side and traction control switch C717 pin 4, circuit 31S-CF45A (BK/GN), harness side. Is the resistance less than 5 ohms? → Yes INSTALL a new traction control switch. REPEAT the self-test. → No REPAIR the circuit. REPEAT the self-test.

PINPOINT TEST N: THE TRACTION CONTROL CANNOT BE DISABLED

CONDITIONS	DETAILS/RESULTS/ACTIONS
N1 CHECK TRACTION CONTROL SWITCH CIRCUIT	
1  2  ABS Control Module C385	

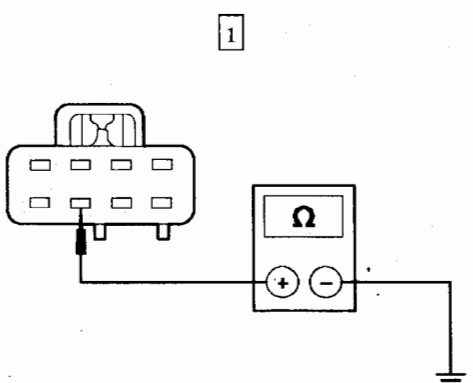
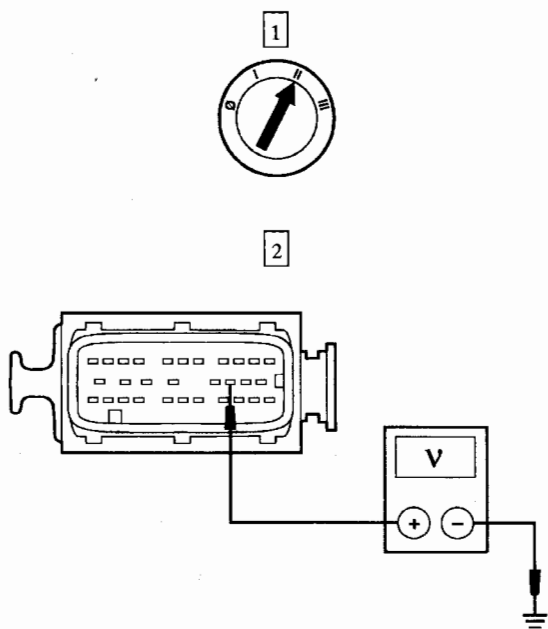
(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST N: THE TRACTION CONTROL CANNOT BE DISABLED (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
N1 CHECK TRACTION CONTROL SWITCH CIRCUIT (Continued) 3  VUV9310001	3 Using a digital multimeter, measure the resistance between ABS control module C385 pin 17, circuit 31S-CF54 (BK/WH), harness side and ground while depressing and releasing the traction control switch. Is the resistance less than 5 ohms with the traction control switch depressed and greater than 10,000 ohms with the traction control switch released? → Yes GO to N4. → No GO to N2.
N2 CHECK CIRCUIT 31S-CF54 (BK/WH) FOR AN OPEN OR SHORT TO GROUND 1  Traction Control Switch C717 2 VUV9410001	2 Using a digital multimeter, measure the resistance between ABS control module C385 pin 17, circuit 31S-CF54 (BK/WH), harness side and traction control switch C717 pin 1, circuit 31S-CF54 (BK/WH), harness side, and between ABS control module C385 pin 17, circuit 31S-CF54 (BK/WH), harness side and ground. Is the resistance less than 5 ohms between the ABS control module and traction control switch, and greater than 10,000 ohms between the ABS control module and ground? → Yes GO to N3. → No REPAIR the circuit. REPEAT the self-test.

(Continued)

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST N: THE TRACTION CONTROL CANNOT BE DISABLED (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
N3 CHECK CIRCUIT 91-CF54 (BK/WH) FOR AN OPEN  VUV9510001	1 Using a digital multimeter, measure the resistance between traction control switch C717 pin 2, circuit 31-CF54 (BK/WH), harness side and ground. • Is the resistance less than 5 ohms? → Yes INSTALL a new traction control switch. REPEAT the self-test. → No REPAIR the circuit. REPEAT the self-test.
N4 CHECK CIRCUIT 31S-CF54 (BK/WH) FOR SHORT TO POWER  A0017487	2 Using a digital multimeter, measure the voltage between ABS control module C385 pin 17, circuit 31S-CF54 (BK/WH), harness side and ground. • Is voltage present? → Yes REPAIR the circuit. REPEAT the self-test. → No INSTALL a new hydraulic control unit (HCU). REPEAT the self-test.

REMOVAL AND INSTALLATION**Hydraulic Control Unit****Removal and Installation**

For additional information, refer to Section 206-09A.

REMOVAL AND INSTALLATION (Continued)**Front Wheel Speed Sensor****Removal and Installation**

For additional information, refer to Section 206-09A.

Rear Wheel Speed Sensor**Removal and Installation**

For additional information, refer to Section 206-09A.

SECTION 211-00 Steering System — General Information

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Steering System	211-00-4
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SPECIFICATIONS

Steering Linkage Freeplay

Description	Measurement	
	mm	inch
Free play (Measured at the steering wheel rim)	0-6	0-0.25

Turning Effort Test

Description	Effort (Kg)	Effort (lbs)
Effort (measured at the steering wheel rim)	3.15-3.6	7-8

Tie-Rod Articulation Torque

Description	Kg	lbs
Maximum torque (no free play permitted)	5	11

Power Steering Pump Specifications

Engine	Minimum Flow @ 5100 kPa (740psi)		Maximum Free Flow @ 2500 rpm Pump Speed		Pump Model
	Liters/Minute	Gallons/Minute	Liters/Minute	Gallons/Minute	
2.0L	4.35	1.13	7.6-9.1	2-2.4	HBD-AE
2.5L	4.35	1.13	7.6-9.1	2-2.4	HBD-AE

Power Steering Pump Relief Pressure

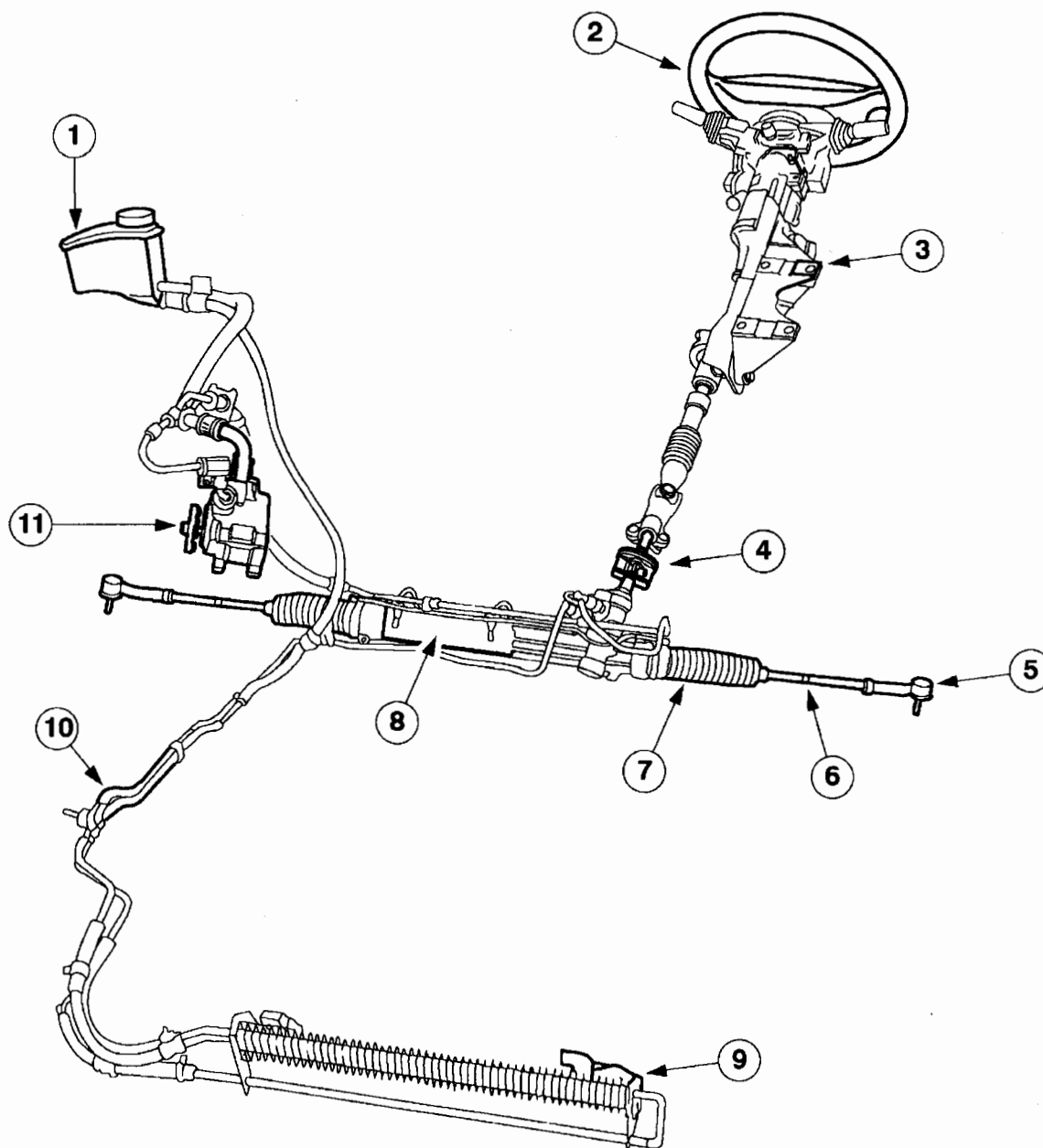
Engine	Maximum Pump Relief Pressure @ 670 rpm Pump Speed	
	kPa	psi
2.0L	9514	1380
2.5L	9514	1380

General Specifications

Item	Specification
Lubricants	
MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX	MERCON®
Gear Grease C3AZ-19578-A	ESW-M1C87-A

DESCRIPTION AND OPERATION

Steering System



TIV1301276

Item	Part Number	Description
1	—	Fluid reservoir
2	—	Steering wheel
3	—	Steering column assembly
4	—	Flexible coupling
5	—	Tie-rod end

(Continued)

Item	Part Number	Description
6	—	Tie-rod
7	—	Steering gear boot
8	—	Steering gear
9	—	Fluid Cooler

(Continued)

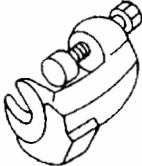
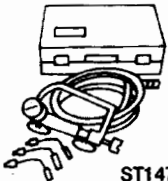
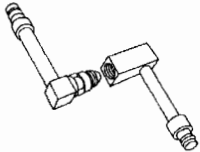
DESCRIPTION AND OPERATION (Continued)

Item	Part Number	Description
10	—	Steering gear hoses

(Continued)

Item	Part Number	Description
11	—	Power steering pump

DIAGNOSIS AND TESTING**Steering System****Special Tool(s)**

 ST1408-A	Separator, Ball Joint 211-001 (TOOL-3290-D)
 ST1477-A	Car Power Steering Analyzing Kit 211-D001 (78L-33610-A) or equivalent
 D89P-33610-A	Adapter Power Steering 211-D019 (D89P-33610-A) or equivalent
 T74P-3504-Y	Spring Scale 211-034 (T74P-3504-Y)

General Equipment

Digital tachometer
Dial thermometer

Inspection and Verification

1. Verify the customer concern by driving the vehicle.
2. Visually inspect for obvious signs of mechanical or electrical damage.

Visual Inspection Chart

Mechanical	Electrical
• Incorrect tire pressure, loose wheels • Loose tie-rod ends, inner ball joints • Loose strut and spring assemblies or ball joints • Loose steering column shaft universal joints • Loose pinch bolts on steering column shaft flexible coupling • Loose steering gear assembly • Incorrect accessory drive belt tension • Binding or misaligned steering column, pump, steering gear • Incorrect power steering pump • Incorrect fluid level • Hose leak or line restrictions	• Power steering pressure (PSP) switch • Wiring harness • Circuit

3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
4. If the concern is not visually evident, verify the symptom. **GO to Symptom Chart.**

DIAGNOSIS AND TESTING (Continued)**Symptom Chart****Symptom Chart**

Condition	Possible Sources	Action
Condition where the vehicle wanders side-to-side on the road. When it is driven straight ahead while the steering wheel is held in a firm position.	- Incorrect tire size or pressure. - Vehicle is unevenly loaded or overloaded. - Loose or worn tie-rods or tie-rod ends. - Steering gear bolts loose or damaged. - Loose or worn suspension ball joint(s). - Steering column shaft flexible coupling to pinion shaft bolt loose. - Steering column shaft flexible coupling joints loose or worn. - Incorrect toe adjustment. - Loose or worn rear suspension.	- CHECK for correct tire sizes and adjust tire pressures. REFER to Section 204-04. - ADJUST the load. - INSTALL a new steering gear or tie-rod end as necessary. REFER to Section 211-02 or Section 211-03. - TIGHTEN or INSTALL new bolts. - INSTALL a new suspension ball joint assembly. REFER to Section 204-01. - TIGHTEN the pinion shaft bolts. - TIGHTEN the steering column shaft flexible coupling. REFER to Section 211-04. - INSTALL a new steering column shaft flexible coupling. REFER to Section 211-04. - ADJUST as necessary. REFER to Section 204-00. - TIGHTEN loose, or INSTALL new rear suspension components. REFER to Section 204-02.

DIAGNOSIS AND TESTING (Continued)**Symptom Chart (Continued)**

Condition	Possible Sources	Action
Vehicle tends to pull to one side when driven on a level surface.	- Incorrect tire pressure. - Incorrect tire size or different tire/tread type. - Vehicle is unevenly or excessively loaded. - Incorrect toe adjustment. - Damaged front suspension components. - Damaged rear suspension components. - Steering gear valve effort out of balance. - Check front and rear brakes for correct operation. - Check for bent rear suspension components and for damaged or sagging coil springs in the front or the rear suspension. - Check the rear suspension for loose or worn suspension components or rear suspension bolts.	- ADJUST the tire pressure. - INSTALL a new tire as necessary. REFER to Section 204-04. - ADJUST the load evenly. - ADJUST as necessary. REFER to Section 204-00. - INSTALL new front suspension component as necessary. REFER to Section 204-01. - INSTALL new rear suspension components as necessary. REFER to Section 204-02. - SHIFT transaxle into NEUTRAL while driving at not more than 50 km/h (30mph) and turn ignition to position I, (engine OFF - coasting). If the vehicle does not pull with the engine off, INSTALL a new steering gear. REFER to Section 211-02. - If vehicle does drift with engine off, CROSS SWITCH front wheel assemblies. - If the vehicle pulls to the opposite side, SWITCH wheels that were on the rear to same side on the front. - If the vehicle pull direction is not changed, CHECK the front suspension components and toe adjustment. REFER to Section 204-01. - ADJUST as necessary. REFER to Section 206-00. - INSTALL new rear suspension components as necessary. REFER to Section 204-01 or Section 204-02. - INSTALL new rear suspension components as necessary. REFER to Section 204-02. - TIGHTEN all bolts. REFER to Section 204-02.

DIAGNOSIS AND TESTING (Continued)**Symptom Chart (Continued)**

Condition	Possible Sources	Action
Feedback (whining or knocking noises in the steering gear) - condition where roughness is felt in the steering wheel by the driver when the vehicle is driven over rough surfaces.	- Steering gear input shaft coupling joints. - Loose/worn tie-rods. - Steering gear bolts loose or damaged. - Steering column shaft to flexible coupling pinch bolt loose. - Loose suspension bushing, bolts or ball joints. - Steering column shaft in bad condition.	- INSTALL a new flexible coupling as necessary. REFER to Section 211-04. - INSTALL a new steering gear as necessary. REFER to Section 211-02. - TIGHTEN or INSTALL new retaining bolts as necessary. REFER to Section 211-02. - TIGHTEN the bolt. REFER to Section 211-04. - TIGHTEN or INSTALL new bolts or ball joint as necessary. REFER to Section 204-01. - INSTALL a new steering column as necessary. REFER to Section 211-04.
Steering fails to return to center, following a turn, without manual effort from the driver. In addition, when the driver returns the steering wheel to center, it may have a sticky or catchy feel.	- Incorrect tire pressure. - Incorrect tire size or incorrect type. - Misaligned steering column tube or column shroud rubbing steering wheel. - Steering column shaft flexible coupling, universal joints binding. - Steering column shaft floor seal may be torn. - Binding or damage to tie-rods. - Damaged or worn front suspension components. - Incorrect toe adjustment. - Column bearing binding. - Fluid contamination.	- ADJUST tire pressures. - INSTALL a new tire as necessary. REFER to Section 204-04. - ALIGN the steering column tube. REFER to Section 211-04. - INSTALL a new flexible coupling. REFER to Section 211-04. - INSTALL a new floor seal as necessary. REFER to Section 211-04. - INSTALL a new steering gear as necessary. REFER to Section 211-02. - INSTALL new front suspension components as necessary. REFER to Section 204-01. - ADJUST as necessary. REFER to Section 204-00. - INSTALL a new steering column. REFER to Section 211-04. - FLUSH the power steering system. REFER to Power Steering System Flushing in this section.

DIAGNOSIS AND TESTING (Continued)**Symptom Chart (Continued)**

Condition	Possible Sources	Action
Heavy steering efforts while turning corners and during parking manoeuvres	- Low power steering pump fluid. - Incorrect accessory drive belt tension. - Hose or cooler external leak. - Incorrect engine idle speed. - Power steering pump pulley loose or warped. - Power steering pump flow or pressure not to specifications. - Hose or cooler line restriction. - Fluid contamination. - Fluid aeration. - PSP switch open circuit.	- FILL as necessary and check for system leaks. REFER to Power Steering System Filling in this section. - CHECK the accessory drive belt tension. REFER to Section 303-05. - REPAIR or INSTALL a new hose or cooler as necessary. - REFER to the Powertrain Control/Emissions Diagnosis (PC/ED) manual ¹. - INSTALL a new power steering pump pulley. REFER to Section 211-02. - REFER to Pump Flow and Pressure Test in this section. - CLEAN or INSTALL a new hose or cooler as necessary. - INSPECT system for foreign objects, contamination. FLUSH the power steering system. REFER to Power Steering System Flushing in this section. - BLEED the system. REFER to Power Steering System Bleeding in this section. - REFER to Section 303-14A (2.0L) or Section 303-14B (2.5L).
Fluid leakage	- Overfilled system. - Component leak.	- CORRECT the fluid level as necessary. - LOCATE the suspect component, and repair as necessary.
Accessory drive belt squeal (particularly at full steering wheel travel and stand still parking)	Check accessory drive belt for correct tension or glazing.	TIGHTEN or INSTALL a new accessory drive belt as necessary. REFER to Section 303-05.
Chirp noise in steering pump	Loose or worn accessory drive belt.	INSTALL a new accessory drive belt. REFER to Section 303-05.
Power steering pump noisy	- Low fluid level and possible leak. - Power steering pump.	- REFILL to the specified level. PURGE the air from the system. REFER to Power Steering System Purging in this section. - CHECK for leaks. Repair as necessary. - INSTALL a new power steering pump as necessary. REFER to Section 211-02.

¹ Can be purchased as a separate item.

DIAGNOSIS AND TESTING (Continued)**Symptom Chart (Continued)**

Condition	Possible Sources	Action
Swish type noise	Fluid flow into the bypass valve of the pump valve housing with fluid temperature below 54°C (130°F).	Normal noise.
Whine type noise	- Aerated fluid, air leak in system. - Check valve cover O-ring seal.	- PURGE the air from the system. REFER to Power Steering System Purging in this section. - INSTALL a new power steering pump as necessary. REFER to Section 211-02.
Power steering pump or reservoir leaks	- Excessive fluid fill. - Fluid cap missing, loose, damaged or missing O-ring seal. - Loose or damaged hose fittings. - Leakage at shaft seal: - Seal damage. - Rotor shaft damage, such as grooving or scratches. - Shaft bush or bushing worn. - Inlet tube. - Housing porosity. - Loose outlet fitting nut or plug valve. - Outlet fitting, nut or plug damaged.	- CORRECT the fluid level as necessary. - INSTALL a new fluid cap or O-ring, as necessary. - INSTALL a new hose fitting as necessary. - INSTALL a new power steering pump. REFER to Section 211-02. - INSTALL a new power steering pump. REFER to Section 211-02. - INSTALL a new power steering pump. REFER to Section 211-02. - TIGHTEN as necessary. - INSTALL a new power steering pump. REFER to Section 211-02.

Component Tests**Steering Linkage**

 **CAUTION: Boots must be handled carefully to avoid damage. Use new steering gear boot clamps when installing boots.**

Inspect the boots for cuts, deterioration, twisting or distortion. Check the steering gear boots to make sure they are tight. Install new boots or clamps as necessary.

- With the wheels in the straight ahead position, gently turn the steering wheel to the left and right to check free play.
- Free play should be between 0 and 6 mm (0 and 0.25 inch) at the steering wheel rim. If the free play exceeds this limit, either the steering joints are worn or the backlash of the rack and pinion steering gear is excessive.
- Backlash cannot be adjusted, install a new steering gear. Refer to Section 211-02.
- Grasp the steering wheel firmly and move it up and down and to the left and right without turning the wheel to check for column bearing wear, steering column shaft joint play, steering wheel or steering column looseness. Refer to Section 211-04. for steering column repair procedures.

DIAGNOSIS AND TESTING (Continued)**Pump Flow and Pressure Test**

 **WARNING:** The power steering analyzer will become hot during testing, do not touch the analyzer with bare hands. Failure to follow this instruction may result in personal injury.

NOTE: Before carrying out the pump flow and pressure test, complete the Inspection and Verification in this section.

1. Disconnect the power steering high-pressure tube between the power steering pump and the steering gear.
 - Allow the fluid to drain into a suitable container.

2. Connect the car power steering analyzer kit 211-D001 in line with the high-pressure tube.

3. Attach the digital tachometer.

4. Fill the reservoir to the MAX mark.

5. Place the dial thermometer in the power steering pump reservoir.

6.  **CAUTION:** Make sure the valve on the power steering analyzer is open allowing the system to operate normally.

 **CAUTION:** Do not hold the steering wheel against the stops for more than five seconds, as damage to the power steering pump may result.

Start the engine and raise the fluid temperature to 74°-79°C (165°-175°F) by turning the steering wheel from lock to lock.

7. **NOTE:** If the system back pressure is greater than 1034 kPa (150 psi) check the hoses for restrictions.

Record the following, with the engine at idle and the gate valve fully open:

- Minimum pump flow liters/minute (gallons/minute) at 74°-79°C (165°-175°F).
- System back pressure kPa (psi) 74°-79°C (165°-175°F) with the gate valve fully open.

8.  **CAUTION:** Do not leave the valve on the power steering analyzer closed for more than five seconds, as damage to the power steering pump may result.

Partially close the gate valve to build the pressure up to 5100 kPa (740 psi). Observe and record the minimum pump flow liters per minute (gallons per minute) at 74°-79°C (165°-175°F).

9. Completely close and partially open the gate valve three times, record the pressure kPa (psi).
10. Fully open the gate valve, increase the pump speed to 2500 rpm. Record the pump flow liters per minute (gallons per minute).
11. Turn the steering wheel to the left and right stops and record the pressure kPa (psi) and flow and flow liters per minute (gallons per minute) at 74°-79°C (165°-175°F).
 - Pressured developed at both stops should be nearly the same as maximum pressure output pressure. At the same time flow should drop below 1.9 liters a minute (0.5 gallon per minute).

Turning Effort Test

NOTE: Before carrying out this test, make sure the toe adjustment and tire pressures are correct. Refer to Section 204-00.

1. Park the vehicle on a dry, even surface and apply the parking brake.
2. Start the engine and turn the steering wheel from lock to lock several times until the power steering fluid has reached a temperature of 74°-79°C (165°-175°F).
3. With the steering in the straight ahead position, attach the spring scale 211-034 to the steering wheel rim. Measure the effort required to turn the steering wheel one complete revolution in each direction, compare the result with the specifications listed in this section.

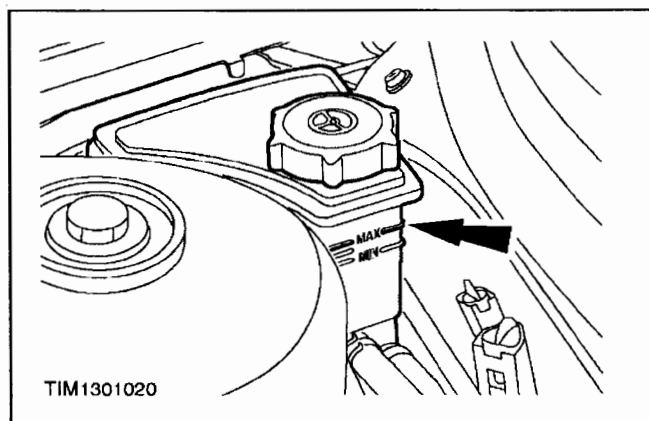
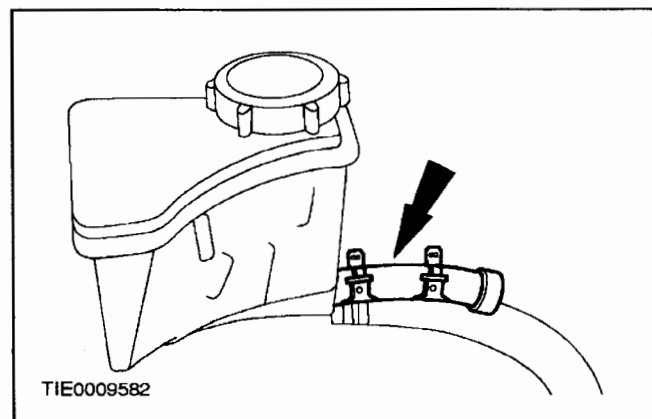
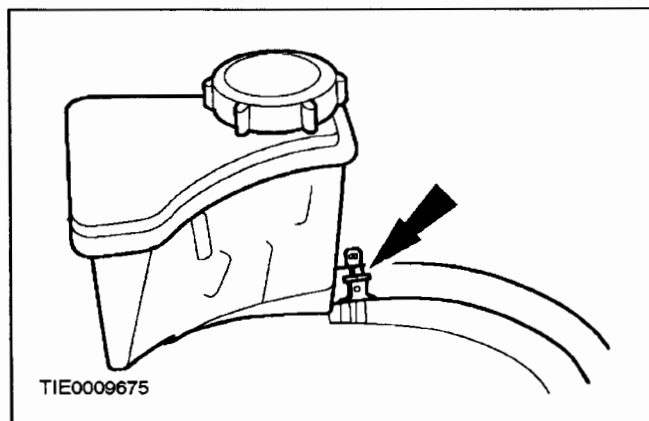
Tie-Rod Articulation Torques

1. Detach both tie-rod ends from the wheel knuckles.
2. Attach the spring scale 211-043 to a tie-rod end, pull on the spring scale in line with the steering gear and measure the effort required to move the tie-rod.
3. No free play is allowed, if the force required to move the tie-rod is greater than listed in the specifications in this section, install a new steering gear. Refer to Section 211-02.

GENERAL PROCEDURES

Power Steering System Flushing

1. Disconnect the crankshaft position (CKP) sensor. For additional information, refer to Section 303-14A (2.0L) or Section 303-14B (2.5L).
2. Disconnect the return line from the power steering fluid reservoir.
 - Allow the fluid to drain into a suitable container.
3. Cap the power steering fluid reservoir with a suitable piece of hose.
 - Place the end of the return line into a suitable container.
4. Fill the power steering fluid reservoir to the MAX mark with power steering fluid.

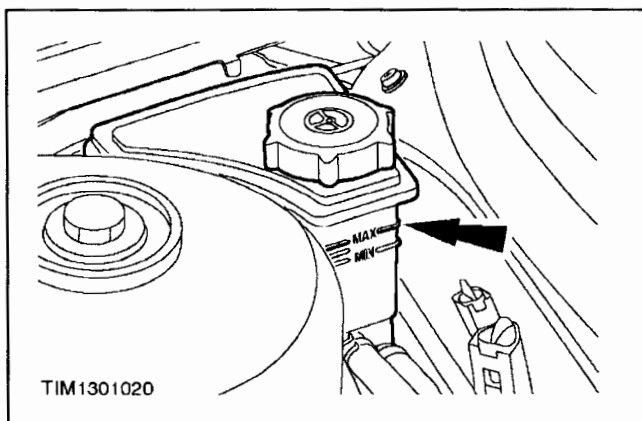


GENERAL PROCEDURES (Continued)

5.  **CAUTION:** Do not continuously crank the engine for more than 30 seconds. Failure to follow this instruction may result in damage to the starter motor.

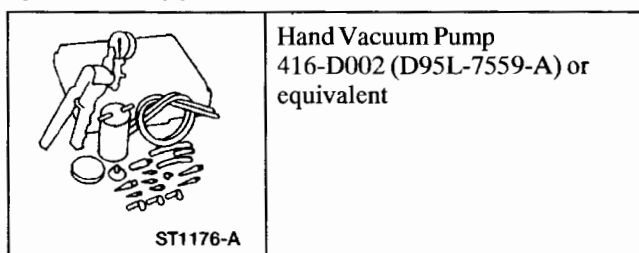
While adding 1.9 liters (0.50 gallon) of power steering fluid turn the ignition switch to the START position.

6. When all the fluid has been used, turn the ignition switch to the OFF position.
7. Connect the fluid return line to the power steering fluid reservoir.
- Remove the cap from the reservoir.

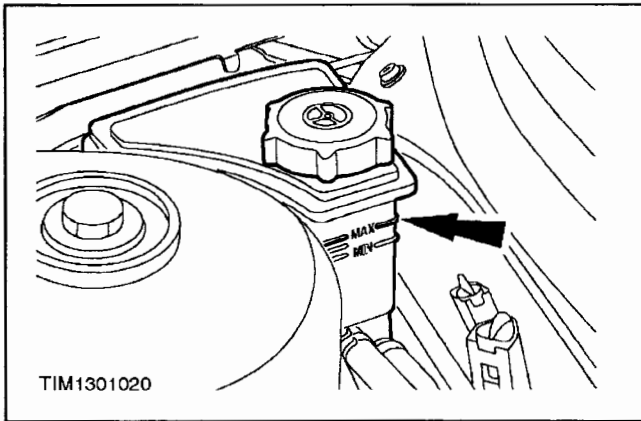


8. **NOTE:** When filling the reservoir, make sure the fluid is clean and not agitated prior to use. The fluid should be poured slowly into the reservoir to minimize the possibility of aeration. The fluid level should be checked with the fluid cold.
- Fill the power steering fluid reservoir to the MAX mark with power steering fluid.

9. Connect the CKP sensor. For additional information, refer to Section 303-14A (2.0L) or Section 303-14B (2.5L).

Power Steering System Bleeding**Special Tool(s)**

Hand Vacuum Pump
416-D002 (D95L-7559-A) or
equivalent

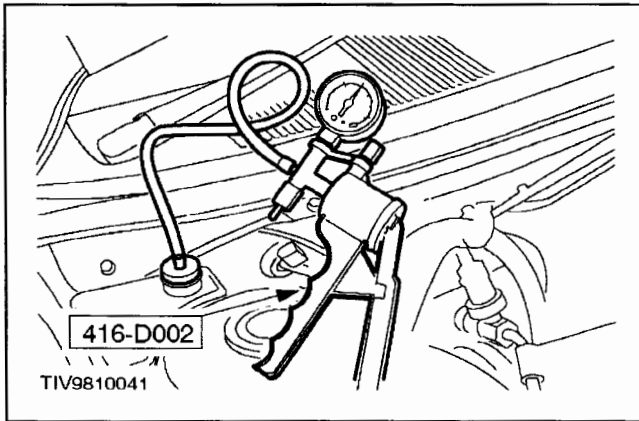
GENERAL PROCEDURES (Continued)

1. **NOTE:** When filling the reservoir, make sure that the power steering fluid is clean and not agitated prior to use. The fluid should be poured slowly into the reservoir to minimize the possibility of aeration. The fluid level should be checked with the fluid cold.

Fill the power steering fluid reservoir to the MAX mark with power steering fluid.

 **CAUTION:** Do not hold the steering wheel against the lock stops for more than five seconds. Failure to follow this instruction may result in damage to the power steering pump.

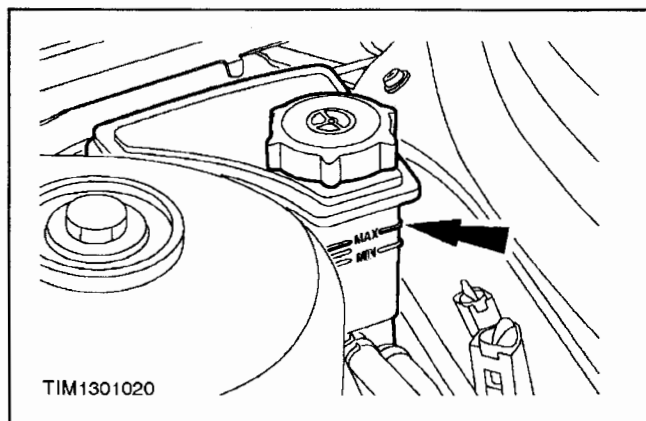
2. **NOTE:** Make sure that the fluid in the reservoir does not fall below the MIN mark, as air could enter the system.
Start the engine and slowly turn the steering wheel from lock to lock once.
3. Switch OFF the engine and examine the hose connections, steering gear boots, steering gear valve body and power steering pump for external leaks.
4. Check the power steering fluid reservoir fluid level. Fill as necessary.

GENERAL PROCEDURES (Continued)

5. **NOTE:** When bleeding the system, the vacuum will decrease. Using the special tool, maintain a vacuum of 51 kPa (15 in-Hg). If the vacuum decreases by more than 7 kPa (2 in-Hg) in five minutes the system should be checked for leaks. Using the special tool, bleed the power steering system.
 - Start the engine and slowly turn the steering wheel from lock to lock once; then turn the steering wheel to the right, just off the lock stop.
 - Switch OFF the engine and apply a vacuum of 51 kPa (15 in-Hg). Maintain the vacuum (minimum of five minutes) until the air is evacuated from the system.
 - Release the vacuum at the special tool.
 - Repeat the bleed procedure, turning the steering wheel to the left, just off the lock stop.
6. Remove the special tool and fill the power steering fluid reservoir as necessary.
7. Start the engine, turn the steering wheel from lock to lock. If excessive noise is apparent, repeat the bleed procedure.
8. If the noise level is still unacceptable, leave the vehicle standing overnight then repeat the bleed procedure.

Power Steering System Purging

1. Park the vehicle on an even surface and apply the parking brake.
2. Raise and support the vehicle until the front wheels are clear of the ground. For additional information, refer to Section 100-02.
3. Disconnect the crankshaft position (CKP) sensor. For additional information, refer to Section 303-14A (2.0L) or Section 303-14B (2.5L).

GENERAL PROCEDURES (Continued)

4. **NOTE:** When filling the reservoir with power steering fluid, make sure that the fluid is clean and not agitated prior to use. The fluid should be poured slowly into the reservoir to minimize the possibility of aeration.

Fill the power steering fluid reservoir to the MAX mark with power steering fluid.

5. **CAUTION:** Do not continuously crank the engine for more than 30 seconds. Failure to follow this instruction may result in damage to the starter motor.

Turn the ignition switch to the START position. Continue adding fluid to the power steering fluid reservoir until the level remains constant.

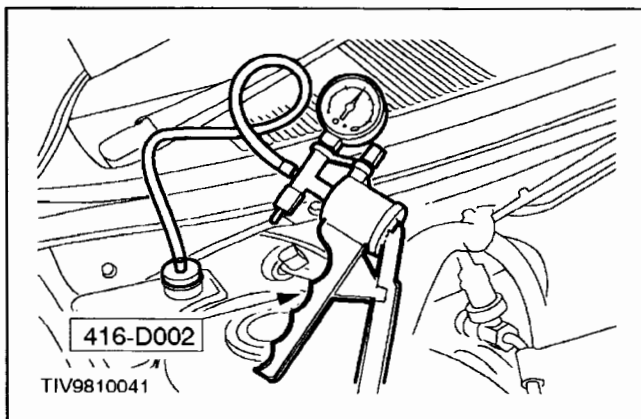
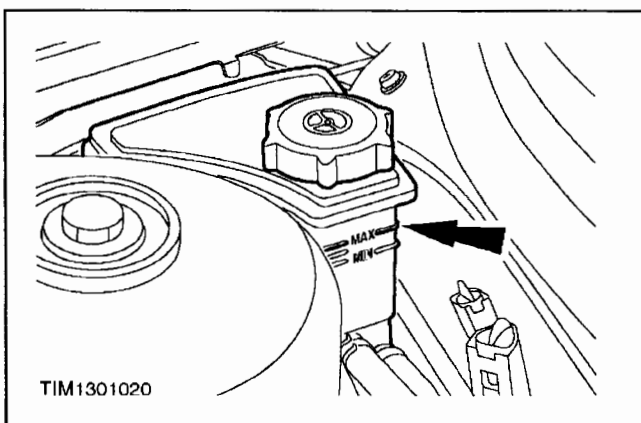
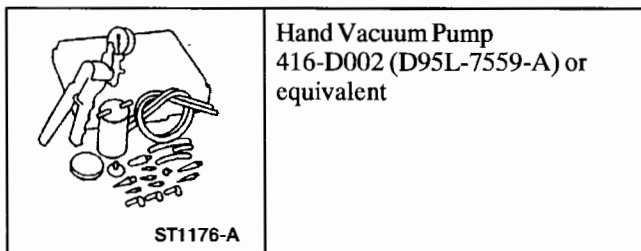
6. **CAUTION:** Do not hold the steering wheel against the lock stops for more than five seconds. Failure to follow this instruction may result in damage to the power steering pump.

While cranking the engine for 30 seconds, turn the steering wheel from lock to lock.

7. Turn the ignition switch to the OFF position. Check the power steering fluid reservoir fluid level and add fluid as necessary.
8. Connect the CKP sensor. For additional information, refer to Section 303-14A (2.0L) or Section 303-14B (2.5L).
9. Start the engine and allow it to run for several minutes.
10. Turn the steering wheel from lock to lock.
11. Switch OFF the engine and check the power steering reservoir fluid level. Add fluid as necessary.
12. If air is still present bleed the power steering system. For additional information, refer to Power Steering System Bleeding in this section.

GENERAL PROCEDURES (Continued)

13. Lower the vehicle.

Power Steering System Filling**Special Tool(s)**

1. **NOTE:** When filling the power steering fluid reservoir, make sure that the power steering fluid is clean and not agitated prior to use. The fluid should be poured slowly into the reservoir to minimize the possibility of aeration. The fluid level should be checked with the fluid cold. Fill the power steering fluid reservoir to the MAX mark with power steering fluid.
2. Using the special tool, apply a vacuum of 84-101 kPa (25-30 in-Hg) for 30 seconds.
3. Observe the vacuum gauge reading.
 - If the vacuum decreases by more than 7 kPa (2 in-Hg) in five minutes, the system should be checked for leaks.
4. Remove the special tool.
5. Fill the power steering fluid reservoir to the MAX mark with power steering fluid.

SECTION 211-02 Power Steering

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SPECIFICATIONS

Torque Specifications

Description	Nm	Lb-Ft	Lb-In
Tie-rod end to wheel knuckle retaining nut	47	35	—
Tie-rod end locknut	41	30	—
Tie-rod	110	81	—
Power steering tube unions to steering gear	31	23	—
Power steering pump bolts (2.0L)	25	18	—
Power steering pump high-pressure line union (2.5L)	65	48	—
Power steering high-pressure tube union (2.5L)	17	13	—
Power steering pump bolts (2.5L)	48	35	—
Power steering pump plate bolts (2.5L)	25	18	—
Power steering pump plate nuts (2.5L)	10	—	89
Power steering pump pulley bolts (2.5L)	25	18	—
Engine mount bolts (2.5L)	83	61	—
Engine mount bracket nuts (2.5L)	83	61	—
Steering gear cover plate bolts	50	37	—
Steering wheel bolt	50	37	—
Flexible coupling to steering column shaft clamp plate bolt	24	18	—
Flexible coupling to steering gear pinion pinch bolt	28	21	—
Subframe bolts	130	96	—
Lower splash shield bolts	6	—	53
Power steering line union (2.5L)	65	48	—

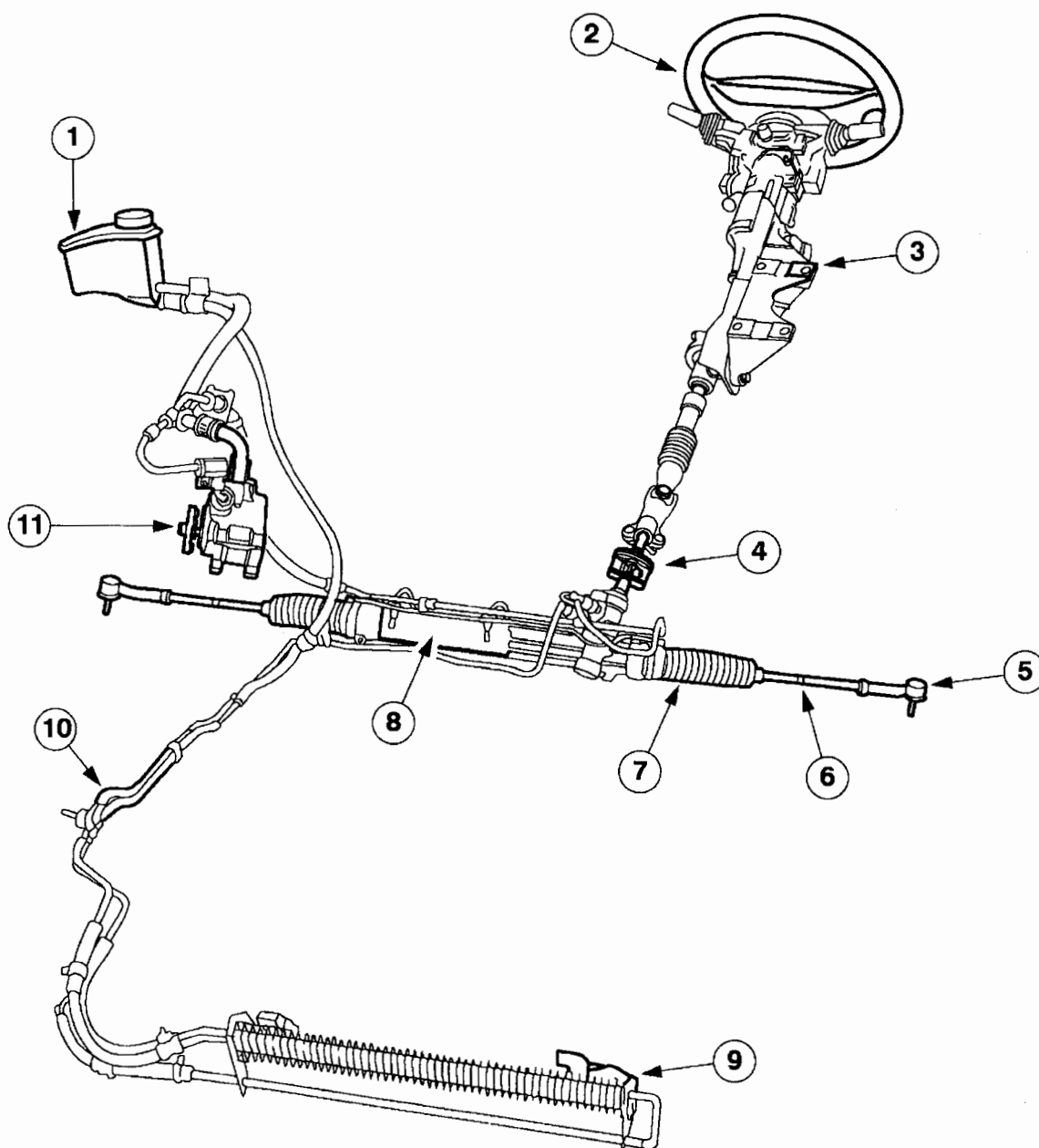
(Continued)

Torque Specifications

Description	Nm	Lb-Ft	Lb-In
Return tube support bracket bolt	50	37	—
High-pressure tube support bracket bolt	50	37	—
Fluid cooler bolts	6	—	53
Wheel nuts alloy/steel wheels	128	94	—
Bumper support bracket bolt	9	—	80
Fluid cooler lines securing bracket nut	9	—	80
PSP switch (2.0L)	10	—	89
PSP switch (2.5L)	11	8	—
Radiator support bracket bolts	10	—	89
Air conditioning condenser bolts	24	18	—
Accessory drive belt upper guard bolts	24	18	—
Power steering pump high-pressure tube union (2.0L)	65	48	—
Coolant hose clamp bolt	6	—	53
Engine cover bolts (2.5L)	8	—	71
Rear support insulator bolt (vehicle with manual transaxle)	120	89	—
Rear support insulator bolt (vehicle with automatic transaxle)	48	35	—
High pressure tube support bracket bolt	24	18	—
Front support insulator nut	48	35	—
Steering gear retaining bolts	137	101	—

DESCRIPTION AND OPERATION

Power Steering



TIV1301276

Item	Part Number	Description
1	—	Fluid reservoir
2	—	Steering wheel
3	—	Steering column assembly
4	—	Flexible coupling
5	—	Tie-rod end

(Continued)

Item	Part Number	Description
6	—	Tie-rod
7	—	Steering gear boot
8	—	Steering gear
9	—	Fluid cooler

(Continued)

DESCRIPTION AND OPERATION (Continued)

Item	Part Number	Description
10	—	Steering gear hoses

(Continued)

Item	Part Number	Description
11	—	Power steering pump

DIAGNOSIS AND TESTING**Power Steering**

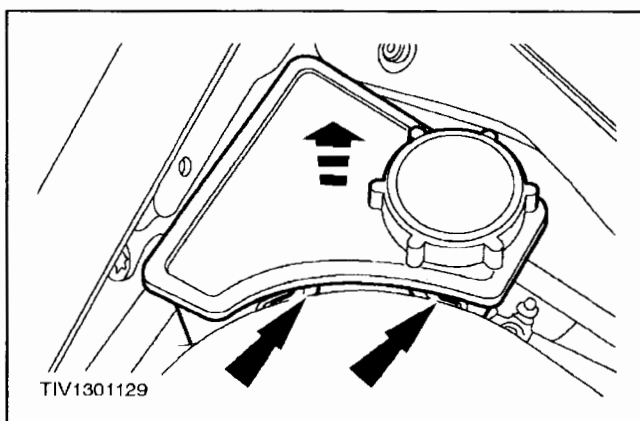
Refer to Section 211-00.

GENERAL PROCEDURES**Start Up Procedure After Power Steering Pump/Gear Overhaul****Refill**

1. Purge the air from the power steering system. For additional information, refer to Section 211-00.
2. If air is still present, bleed the system. For additional information, refer to Section 211-00.

REMOVAL AND INSTALLATION**Power Steering Fluid Reservoir****Removal**

1. Detach the power steering reservoir.



REMOVAL AND INSTALLATION (Continued)

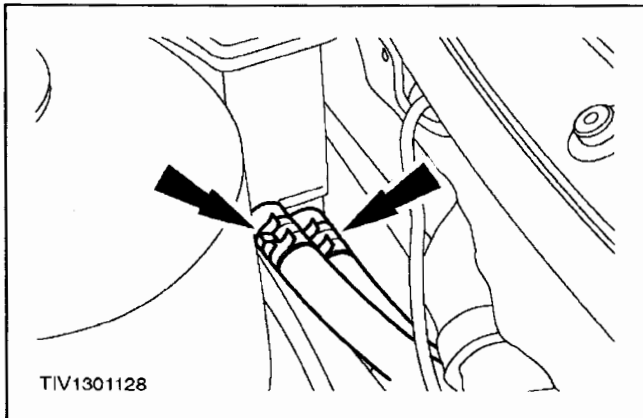
2.  **CAUTION:** If power steering fluid is spilled on the paintwork, the affected area must be immediately washed down with cold water.

Drain the fluid into a suitable container.

- Remove the reservoir filler cap.

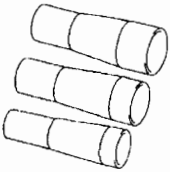
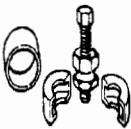
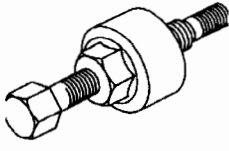
3. Remove the power steering reservoir.

- Disconnect the hoses.

**Installation**

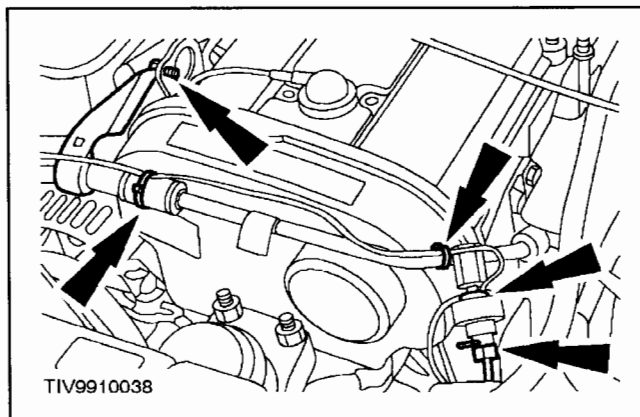
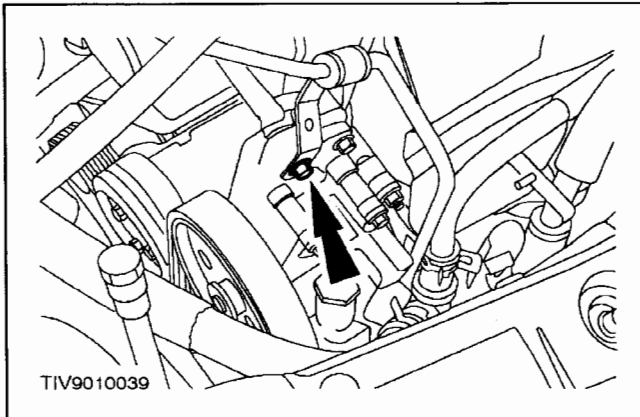
1. To install, reverse the removal procedure.

Power Steering Pump — Vehicles With 2.0L Engine**Special Tool(s)**

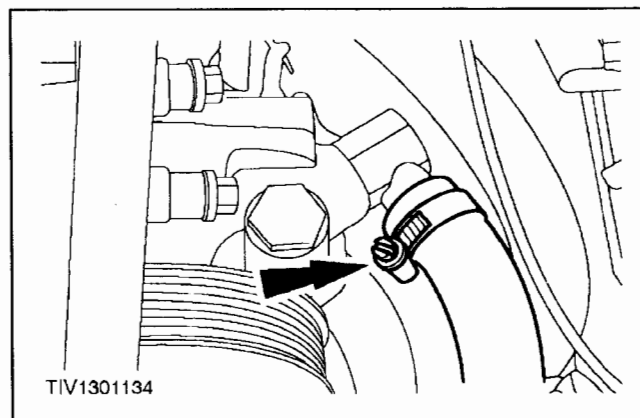
 D90P-3517-A	Expander, Teflon Seal 211-D027 (D90P-3517-A) or equivalent
 T69L-10300-B	Remover, Pulley, Power Steering Pump 211-016 (T69L-10300-B)
 ST1586-A	Installer, Pulley, Power Steering Pump 211-185 (T91P-3A733-A)

REMOVAL AND INSTALLATION (Continued)**Removal**

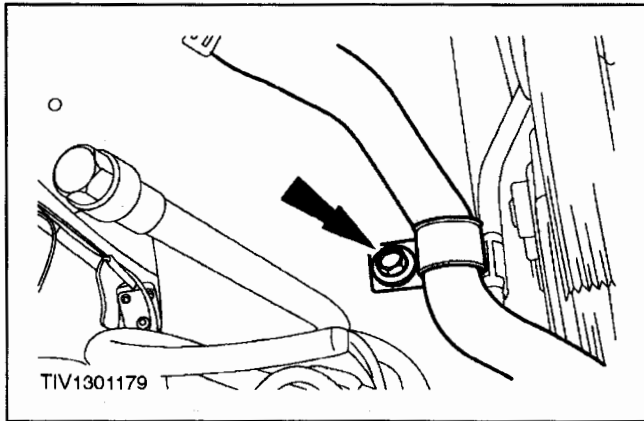
1. Disconnect the battery ground cable.
2. Remove the accessory drive belt. For additional information, refer to Section 303-05.
3. Lower the vehicle.
4. Detach the high-pressure tube support bracket.



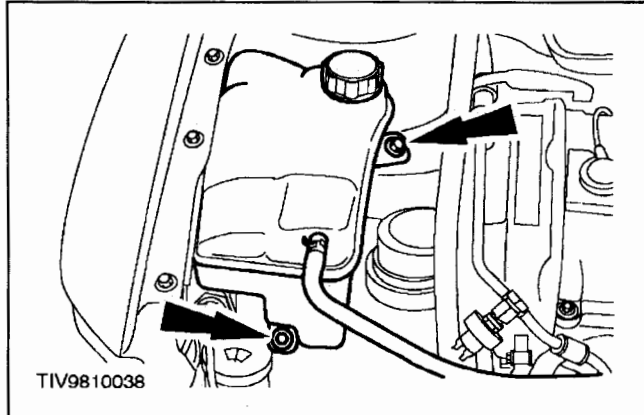
5. Detach the high-pressure tube.
 - Disconnect the power steering pressure (PSP) switch electrical connector.
 - Detach the tube support bracket.
 - Cut the three cable ties.



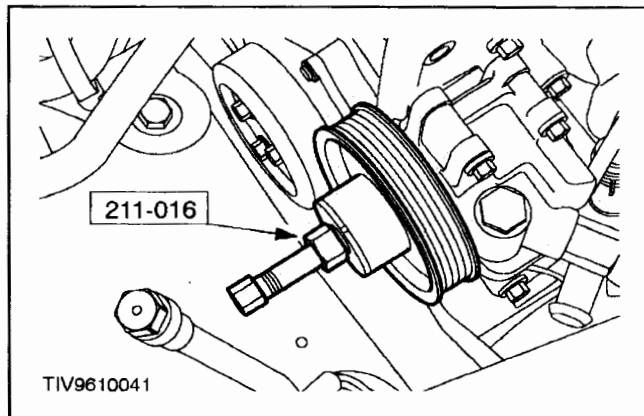
6. Disconnect the power steering pump supply hose.
 - Allow the fluid to drain into a suitable container.

REMOVAL AND INSTALLATION (Continued)

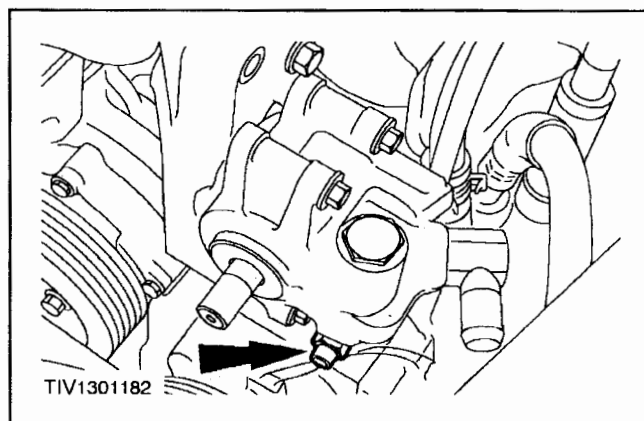
7. Detach the coolant hose clamp.



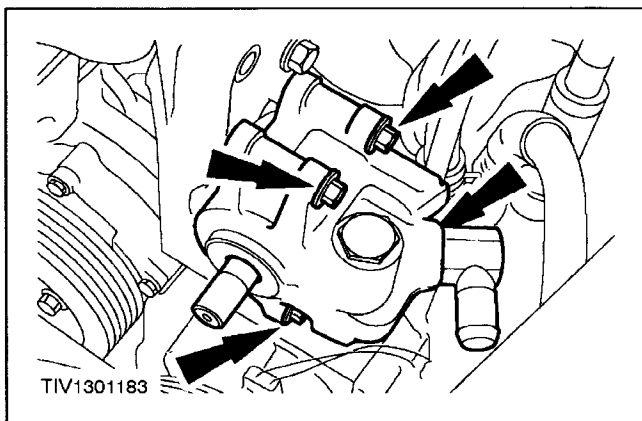
8. Detach the coolant expansion tank.
- Position the tank to one side.



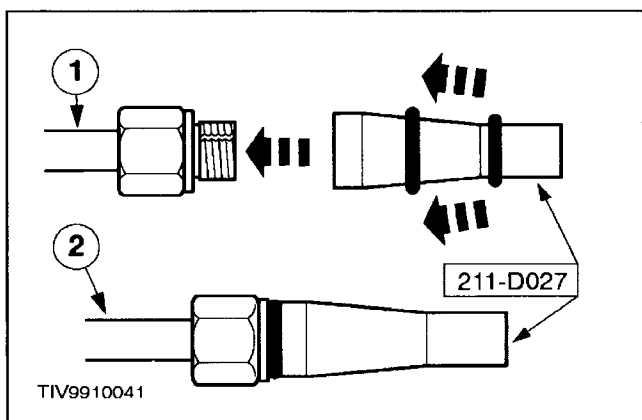
9. Using the special tool, remove the power steering pump pulley.



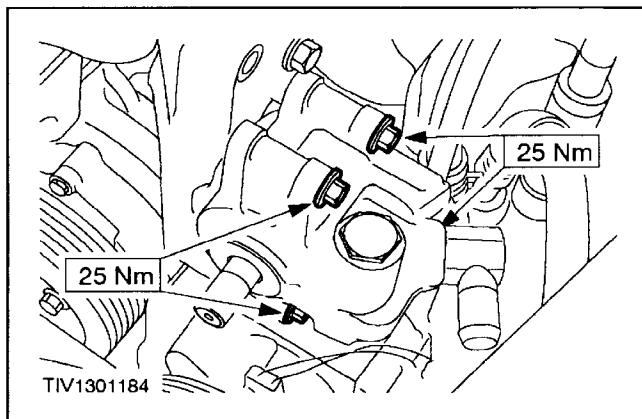
10. Disconnect the power steering pump high-pressure tube union.
- Allow the fluid to drain into a suitable container.

REMOVAL AND INSTALLATION (Continued)

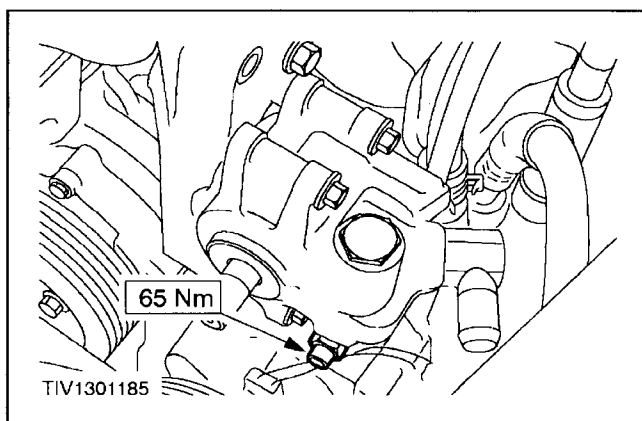
11. Remove the power steering pump.

Installation

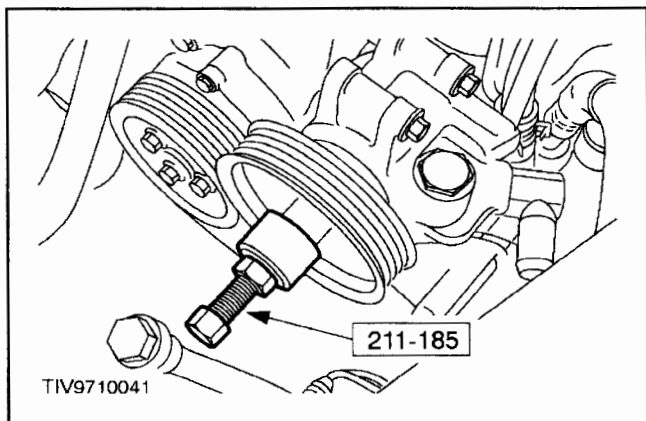
1. **NOTE:** If a new power steering pump is to be installed, the unions that are supplied fitted to the pump should be removed and saved for future use.
Using the special tool, install a new O-ring seal.
- 1 Push the new O-ring seal onto the special tool.
- 2 Locate the tool over the union and ease the O-ring seal onto the union.



2. Install the power steering pump.

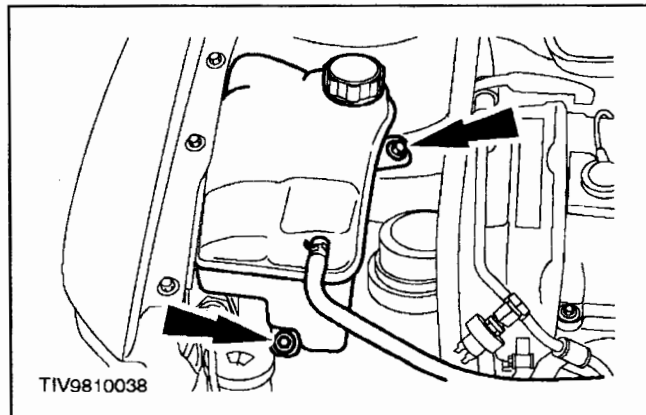


3. Install the power steering pump high-pressure tube union.

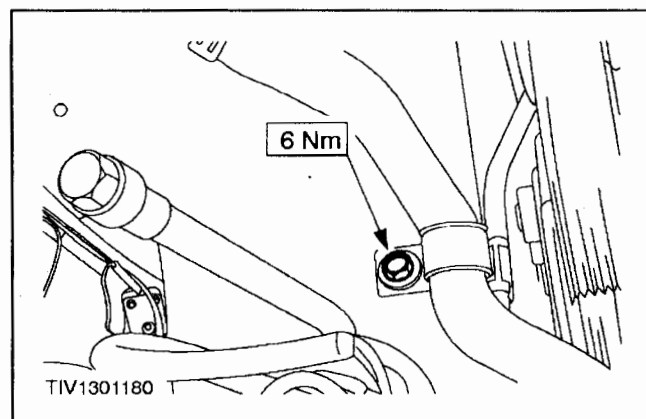
REMOVAL AND INSTALLATION (Continued)

4. **NOTE:** Make sure the pulley is flush with the end of the pump shaft.

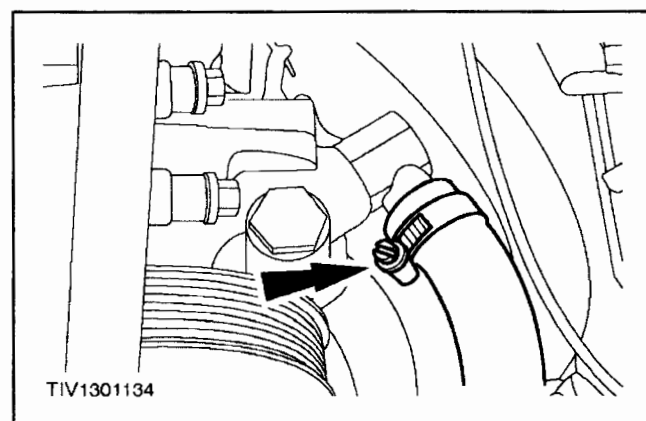
Using the special tool, install the power steering pump pulley.



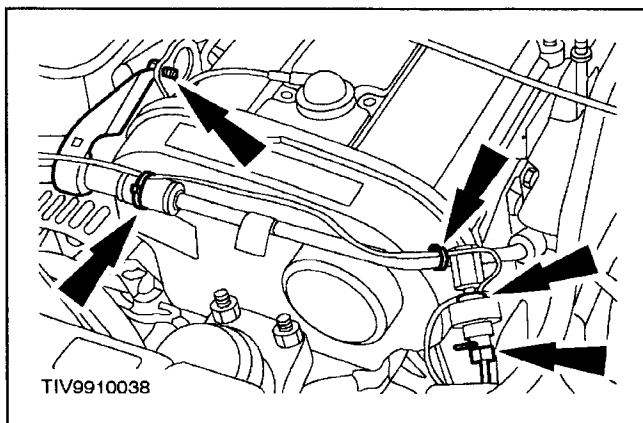
5. Attach the coolant expansion tank.



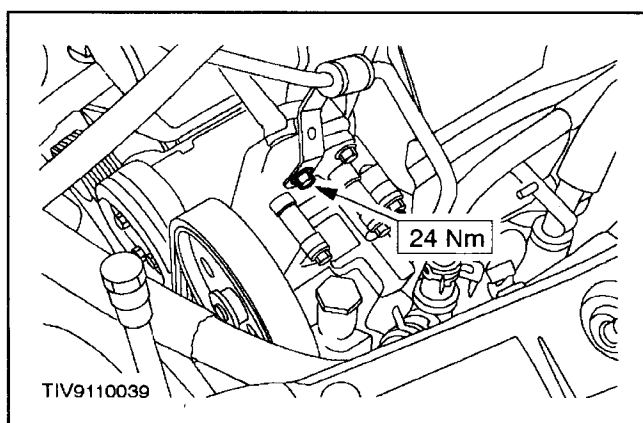
6. Install the coolant hose clamp.



7. Connect the power steering pump supply hose.

REMOVAL AND INSTALLATION (Continued)

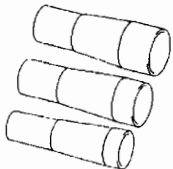
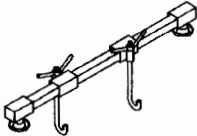
8. Install the high-pressure tube.
 - Install the PSP switch electrical connector.
 - Install the tube support bracket.
 - Install three new cable ties.



9. Install the accessory drive belt. For additional information, refer to Section 303-05.
10. Install the high-pressure tube support bracket.

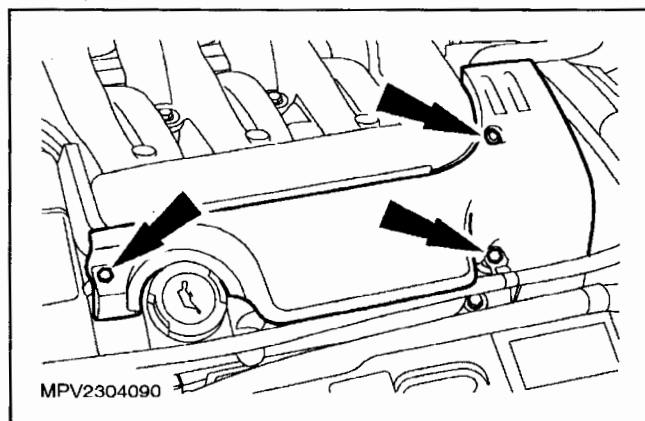
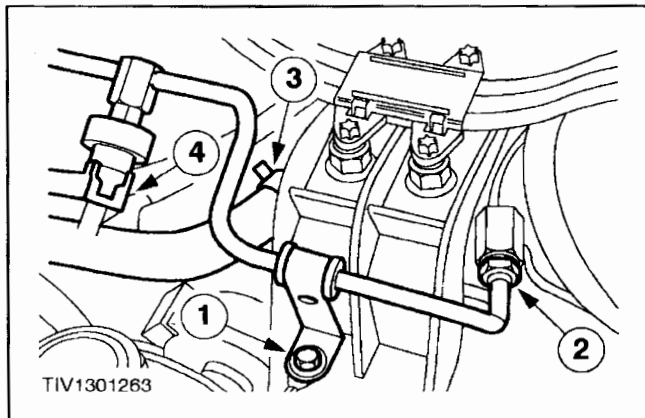
11. Connect the battery ground cable.
12. Fill the power steering system. For additional information, refer to Start Up Procedure After Power Steering Pump/Gear Overhaul in this section.

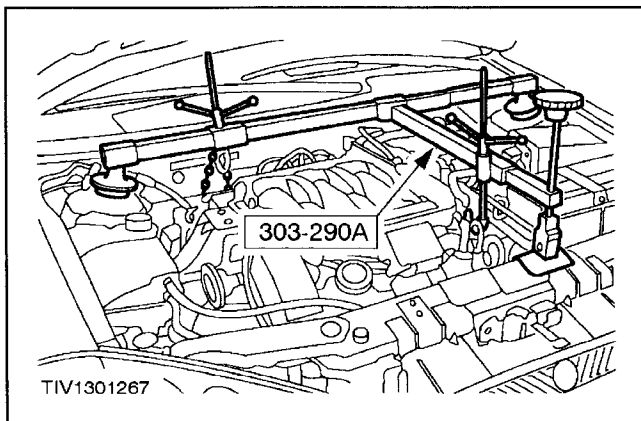
REMOVAL AND INSTALLATION (Continued)**Power Steering Pump — Vehicles With 2.5L Engine****Special Tool(s)**

 D90P-3517-A	Expander, Teflon Seal 211-D027 (D90P-3517-A) or equivalent
 21140	Three Bar Engine Support 303-290A or equivalent

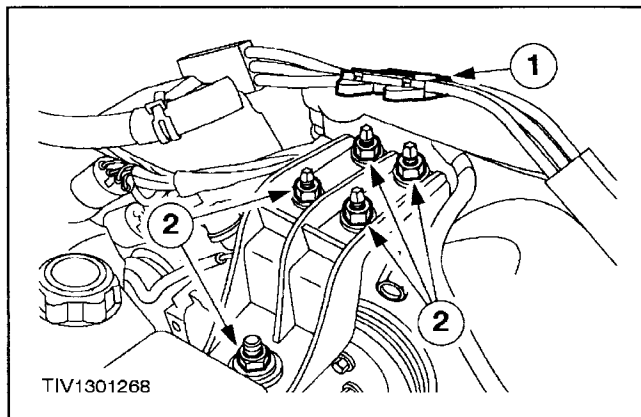
Removal

1. Disconnect the battery ground cable.
2. Remove the accessory drive belt. For additional information, refer to Section 303-05.
3. Disconnect the power steering lines from the power steering pump.
 - 1 Detach the tube retaining bracket.
 - 2 Disconnect the power steering high-pressure tube.
 - Allow the fluid to drain into a suitable container.
 - 3 Disconnect the power steering pump supply hose.
 - 4 Disconnect the power steering pressure (PSP) switch electrical connector.
4. Remove the engine cover.



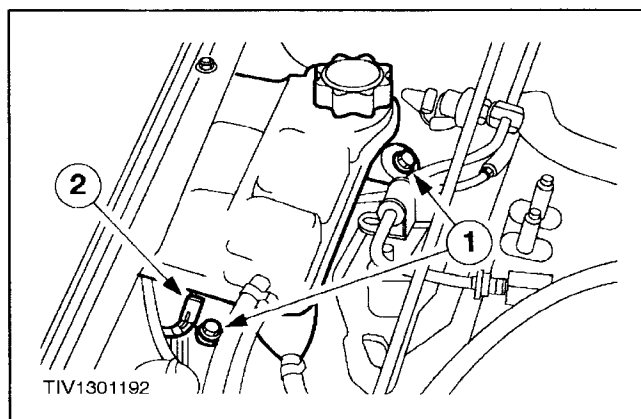
REMOVAL AND INSTALLATION (Continued)

5. Using the special tool, support the engine.



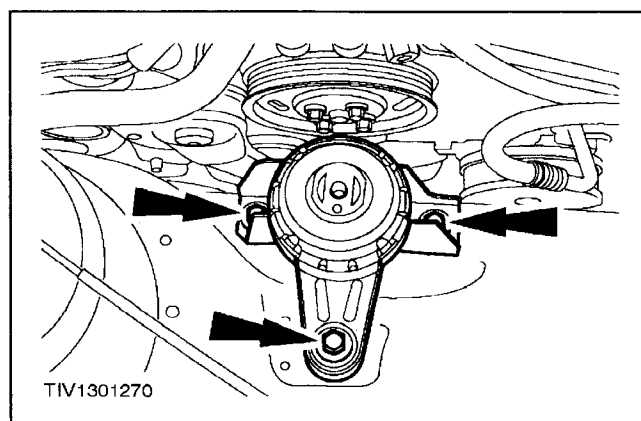
6. Remove the engine mount bracket.

- 1 Unclip the ignition wire clamp.
- 2 Remove the nuts.

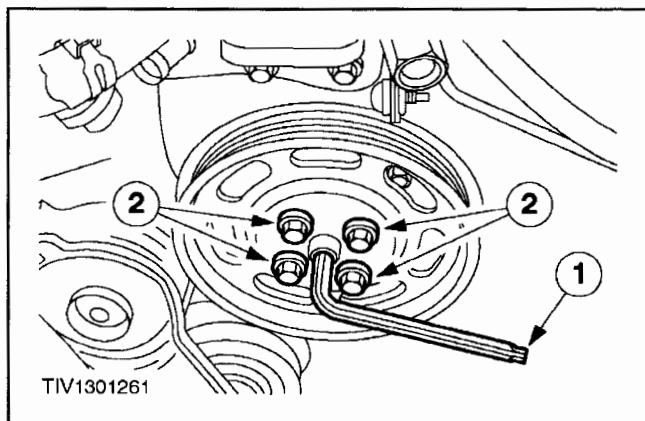


7. Detach the coolant expansion tank.

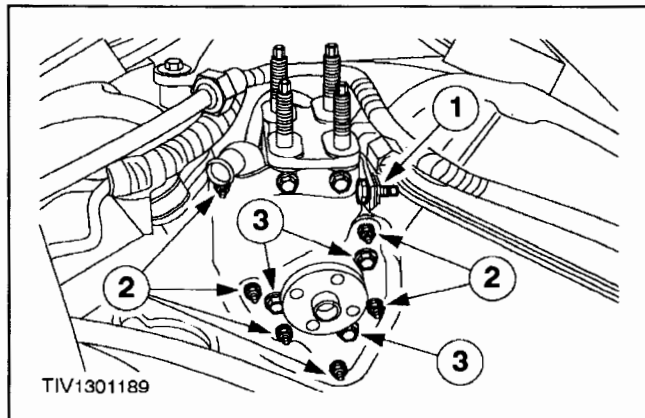
- 1 Remove the retaining bolts.
 - 2 Disconnect the electrical connector.
- Position the tank to one side.



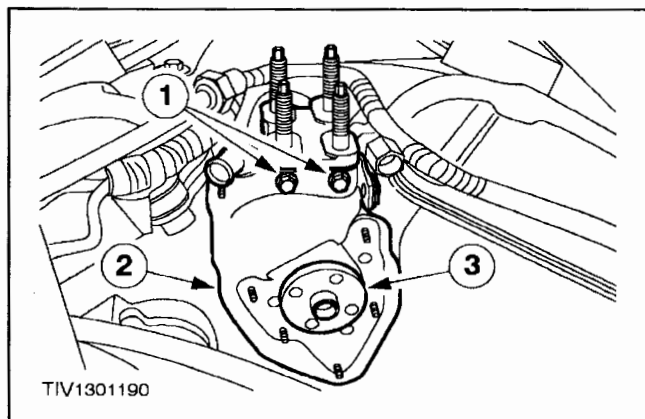
8. Remove the engine mount.

REMOVAL AND INSTALLATION (Continued)

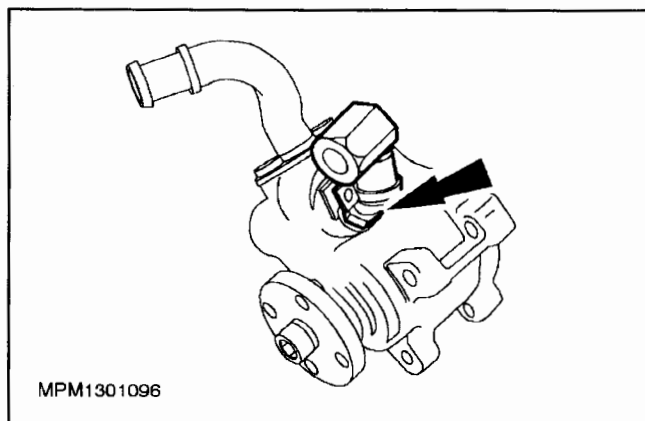
9. Remove the power steering pump pulley.
 - 1 Hold the pump shaft with an Allen key.
 - 2 Remove the bolts.



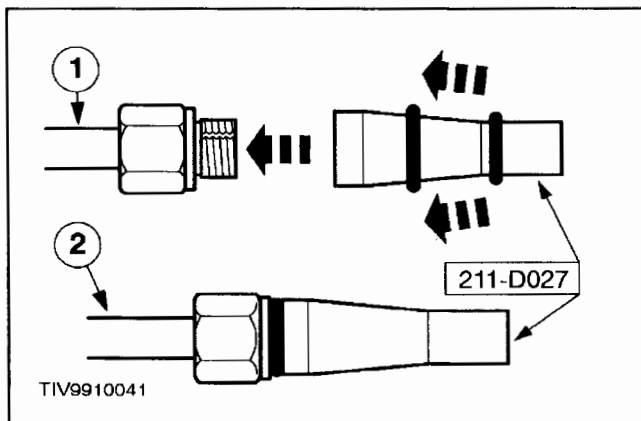
10. Disconnect the power steering pump retaining plate.
 - 1 Remove the steering line support bracket bolt.
 - 2 Remove the nuts.
 - 3 Remove the lower bolts.



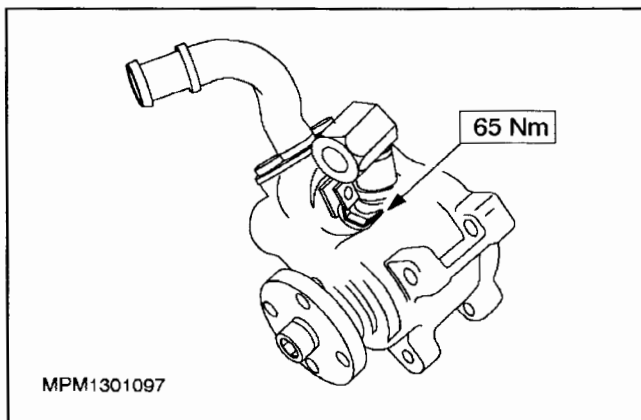
11. Remove the power steering pump.
 - 1 Remove the bolts.
 - 2 Remove the plate.
 - 3 Remove the pump.



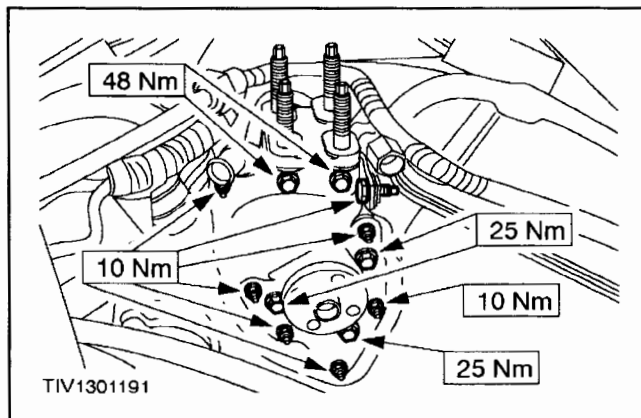
12. Disconnect the power steering line.

REMOVAL AND INSTALLATION (Continued)**Installation**

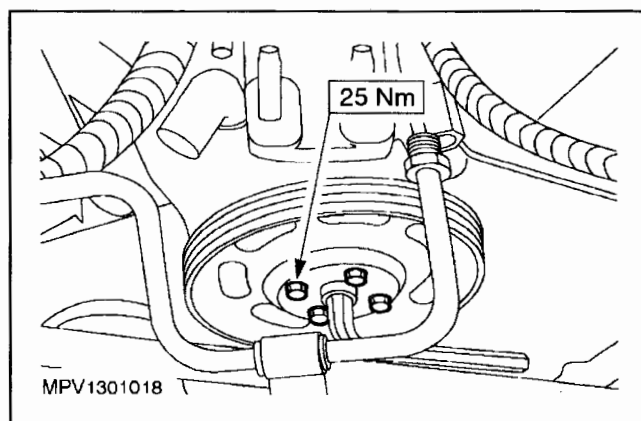
1. **NOTE:** If a new power steering pump is being installed, the unions that are supplied fitted to the pump should be removed and saved for future use. Using the special tool, install a new union O-ring seal.
 - 1 Push the new O-ring seal onto the special tool.
 - 2 Locate the tool over the union and ease the O-ring seal onto the union.



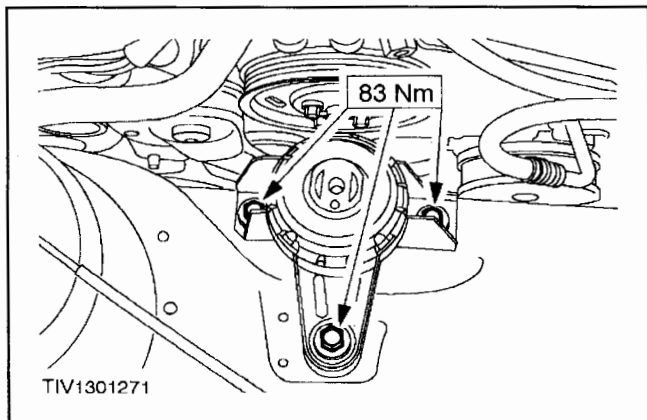
2. Connect the power steering line.



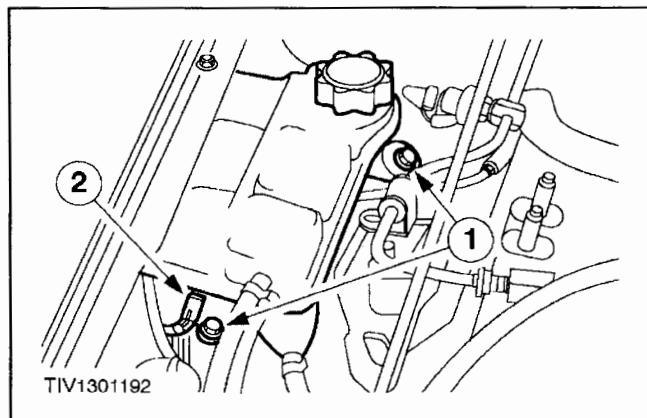
3. Install the power steering pump.



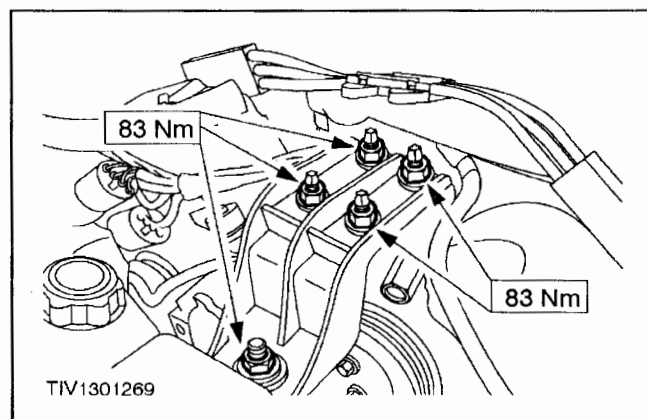
4. Install the power steering pump pulley.

REMOVAL AND INSTALLATION (Continued)

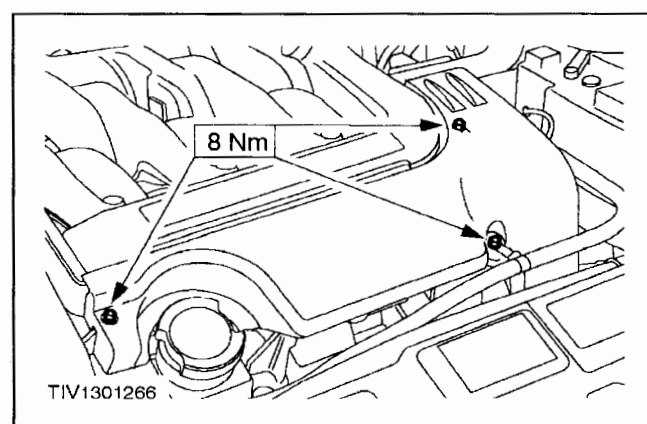
5. Install the engine mount.



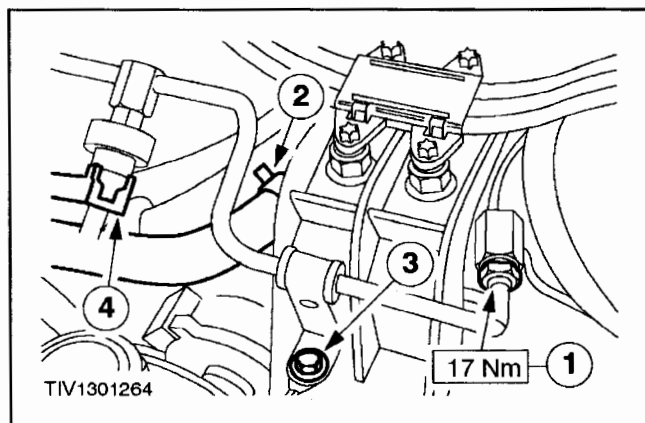
6. Install the coolant expansion tank.
- 1 Install the bolts.
 - 2 Connect the electrical connector.



7. Install the engine mount bracket.



8. Remove the special tool (engine support).
9. Install the engine cover.

REMOVAL AND INSTALLATION (Continued)

10. Install the power steering lines to the power steering pump.

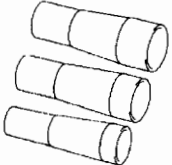
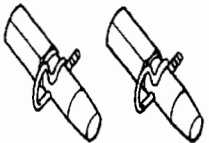
- 1 Install the high-pressure tube.
- 2 Install the power steering pump supply hose.
- 3 Install the tube retaining bracket.
- 4 Install the PSP switch electrical connector.

11. Install the accessory drive belt. For additional information, refer to Section 303-05.

12. Connect the battery ground cable.

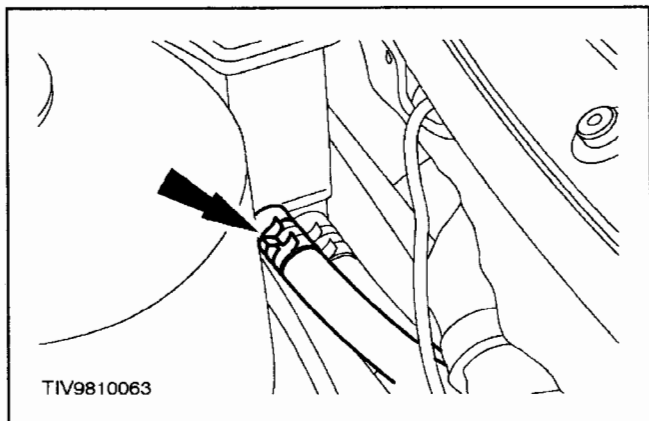
13. Fill the power steering system. For additional information, refer to Start Up Procedure After Power Steering Pump/Gear Overhaul in this section.

Steering Gear to Fluid Cooler Return Hose**Special Tool(s)**

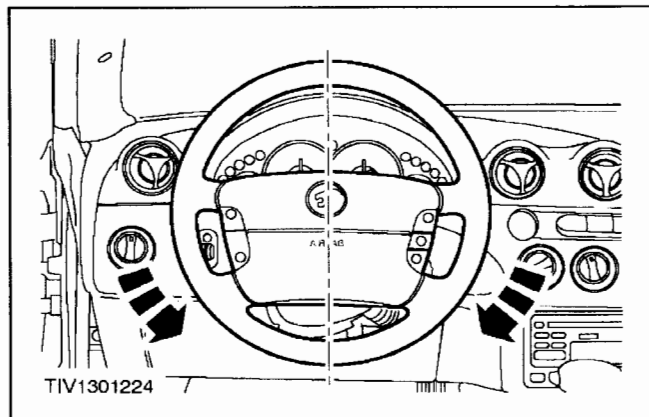
 D90P-3517-A	Expander, Teflon Seal 211-D027 (D90P-3517-A) or equivalent
 T94P-2100-AH	Alignment Pins, Subframe 502-002 (T94P-2100-AH)

Removal**All vehicles**

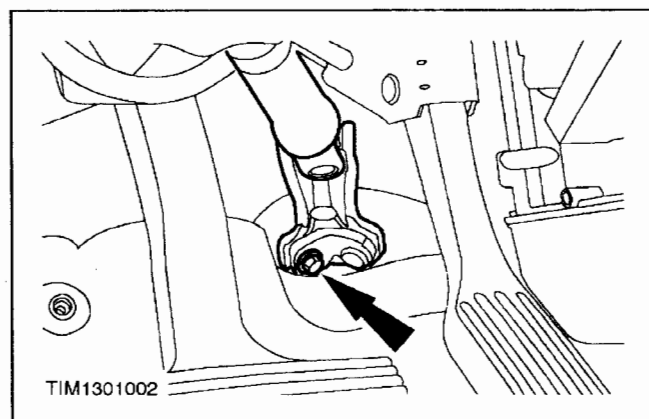
1. Disconnect the battery ground cable.

REMOVAL AND INSTALLATION (Continued)

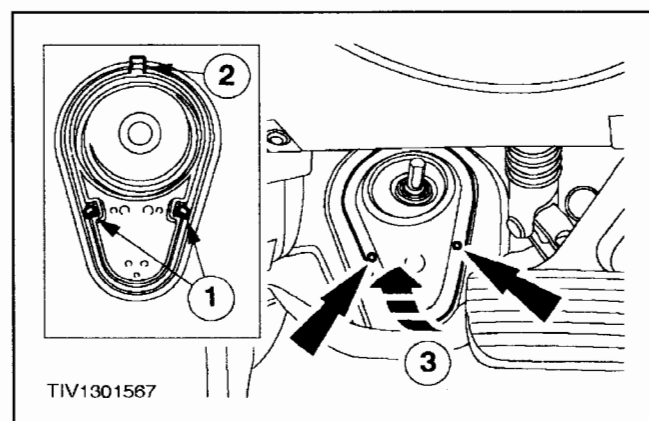
2. Disconnect the hose from the power steering fluid reservoir.
 - Allow the fluid to drain into a suitable container.



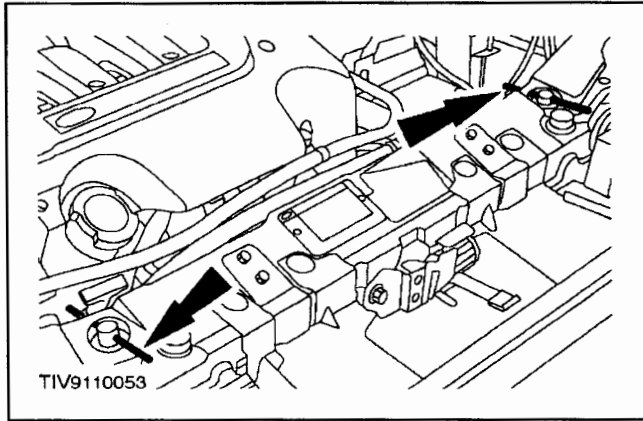
3. Center the steering wheel.
 - Lock in position, remove the ignition key.



4. Disconnect the steering column shaft from the flexible coupling.
 - Rotate the clamp plate to disengage.



5. **⚠ CAUTION: When removing the floor seal do not damage the sealing clips.**
 Remove the floor seal from the bulkhead.
 - 1 Release the retaining clips.
 - 2 Disconnect the upper retaining clip.
 - 3 Remove the floor seal.

REMOVAL AND INSTALLATION (Continued)

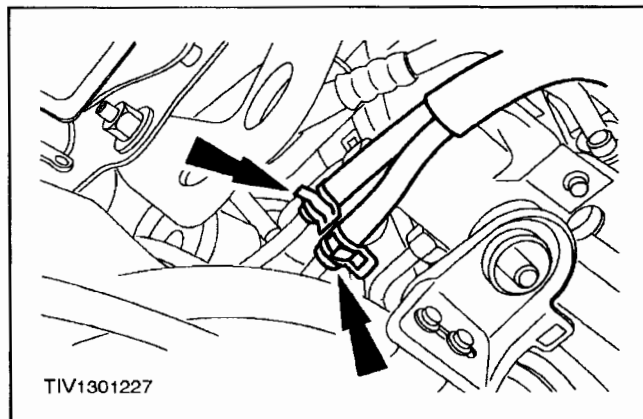
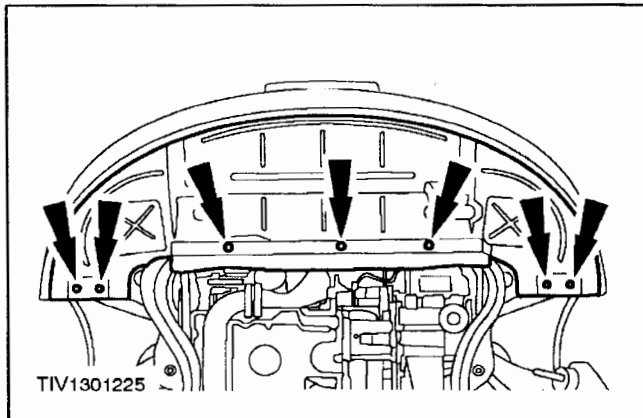
6. Support the radiator.

7. Loosen the left-hand front wheel nuts.

8. Raise and support the vehicle. For additional information, refer to Section 100-02.

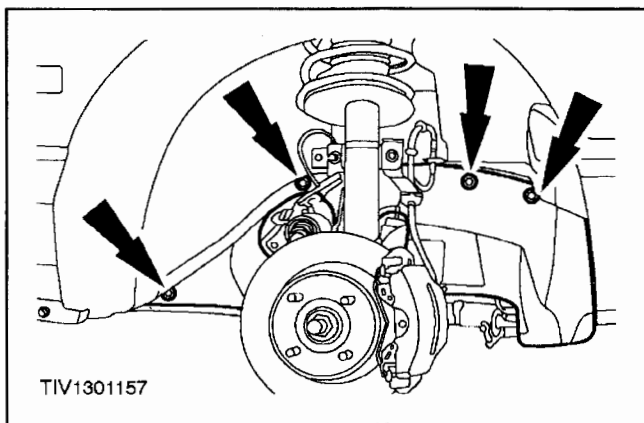
9. Remove the wheel.

10. Remove the radiator splash shield.

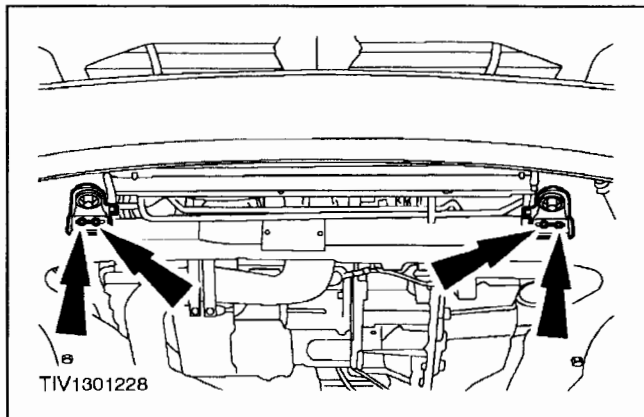


11. Disconnect the fluid cooler lines.

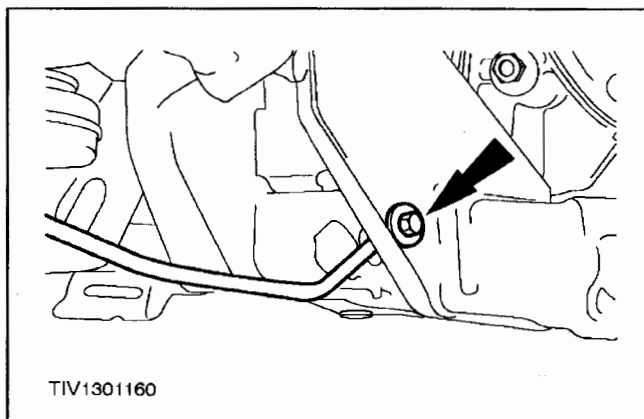
- Allow the fluid to drain into a suitable container.

REMOVAL AND INSTALLATION (Continued)

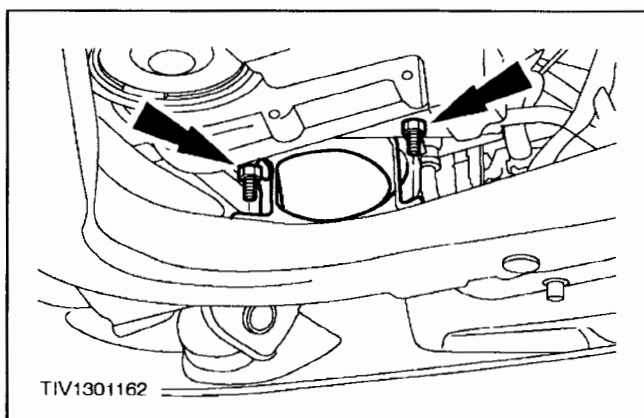
12. Remove the two splash shields (wheel removed for clarity).



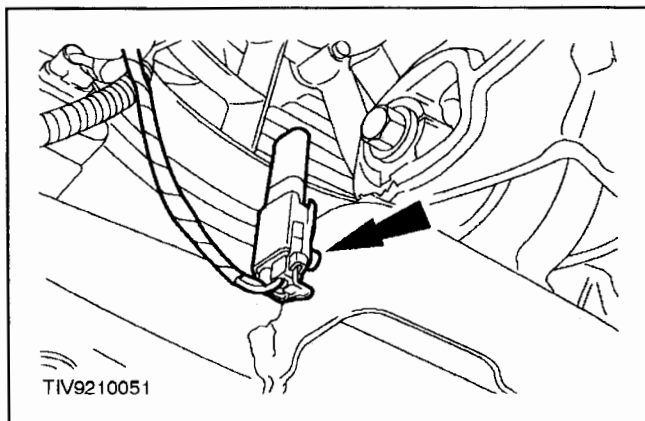
13. Detach the radiator support brackets.



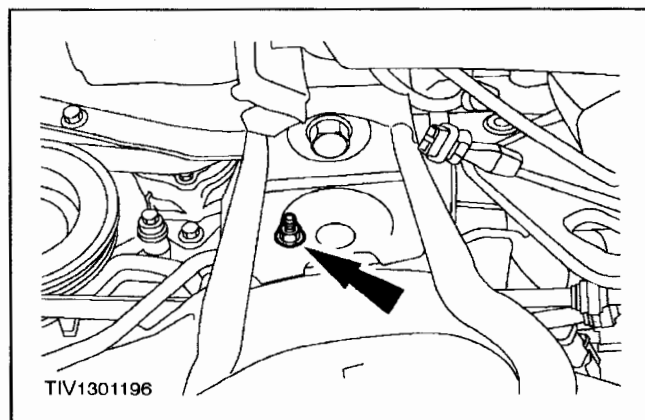
14. Detach the bumper support brackets.

**Vehicles with air conditioning**

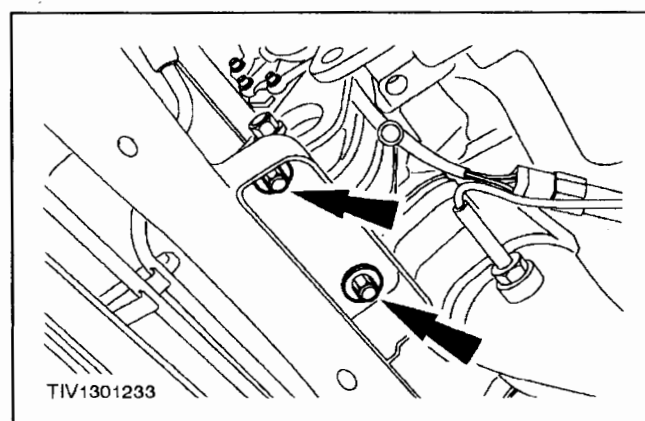
15. **NOTE:** 2.0L shown 2.5L similar.
Detach the air conditioning accumulator.

REMOVAL AND INSTALLATION (Continued)

16. Detach the air conditioning compressor diode wiring harness.

All vehicles

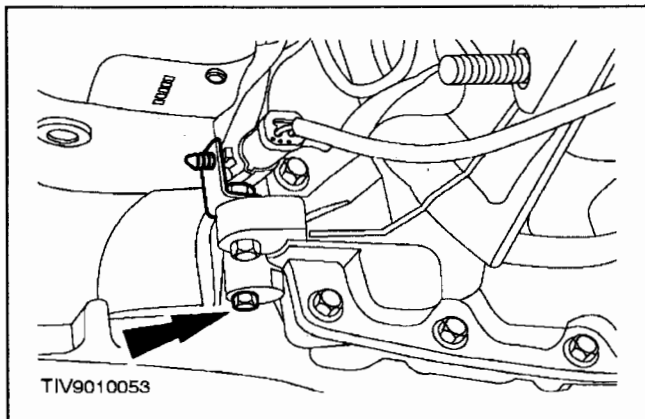
17. Detach the fluid cooler lines retaining bracket.



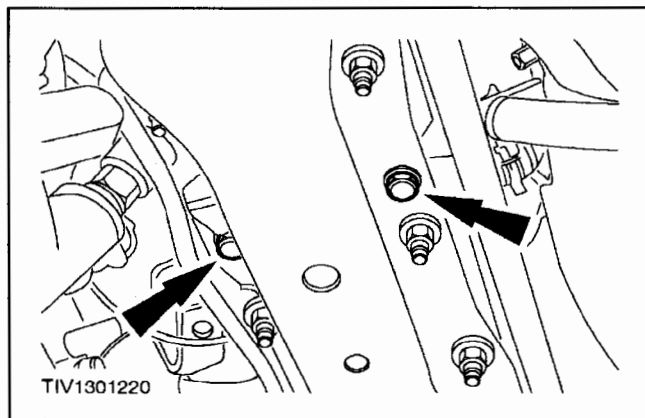
18. Detach the front support insulator.

REMOVAL AND INSTALLATION (Continued)**Vehicles with 2.5L engine**

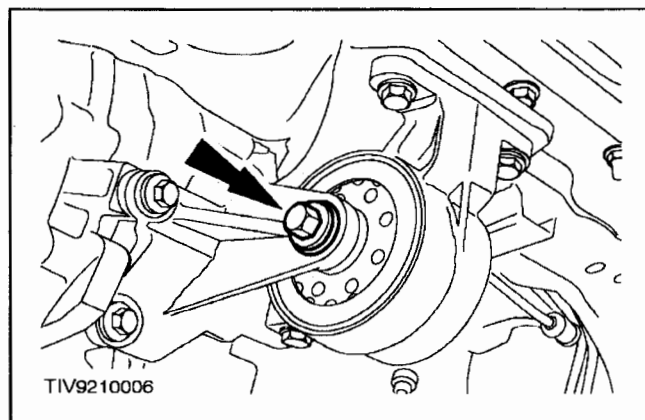
19. Detach the rear heated oxygen sensor wiring harness.

**Vehicles with automatic transaxle**

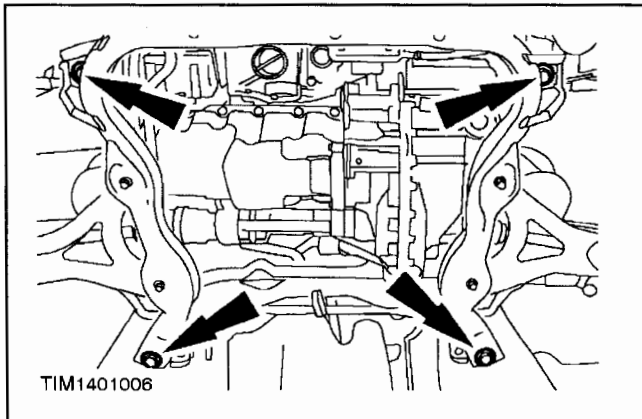
20. Detach the rear support insulator.

**Vehicles with manual transaxle**

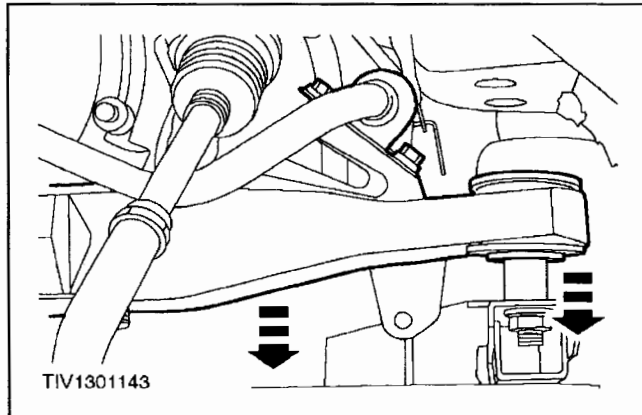
21. Remove the rear support insulator center bolt.

**All vehicles**

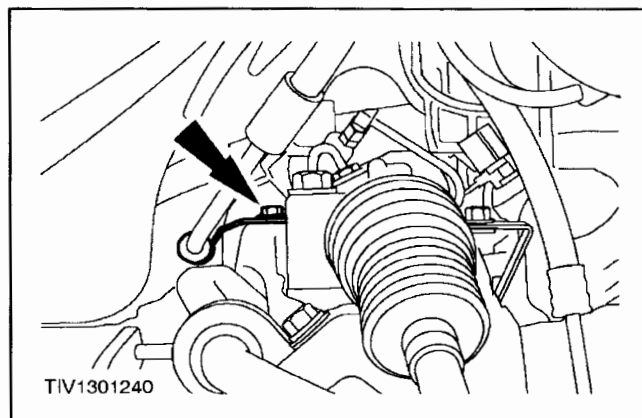
22. Support the subframe using a suitable transmission jack.

REMOVAL AND INSTALLATION (Continued)

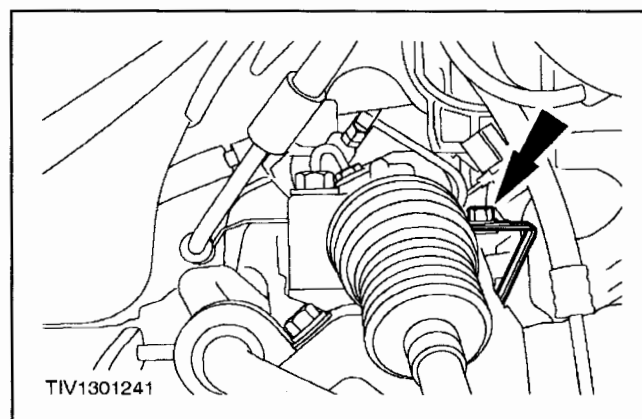
23. Remove the subframe bolts (support removed for clarity).



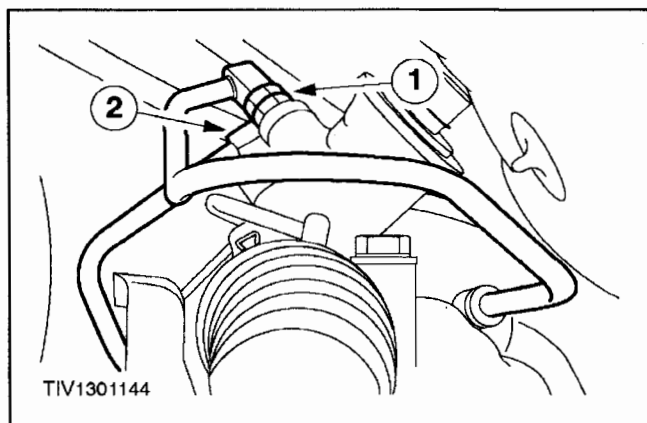
24. Lower the subframe to gain access to the steering gear lines.



25. Detach the high-pressure tube support bracket.



26. Detach the return tube support bracket.

REMOVAL AND INSTALLATION (Continued)

27. **CAUTION:** Whenever the steering gear unions are disconnected the steering gear valve body ports should be plugged to prevent dirt ingress.

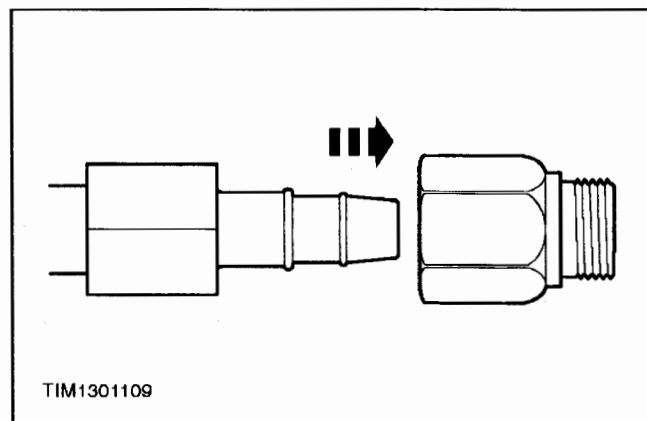
Disconnect the tube unions from the steering gear.

- 1 Disconnect the high-pressure tube union.
 - Allow the fluid to drain into a suitable container.
- 2 Disconnect the return tube union.

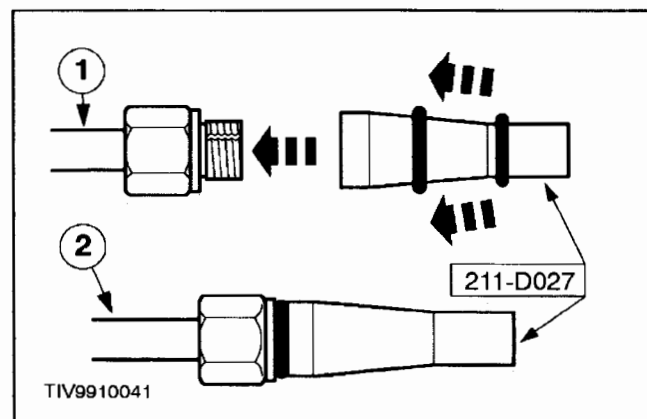
28. Remove the fluid tubes.

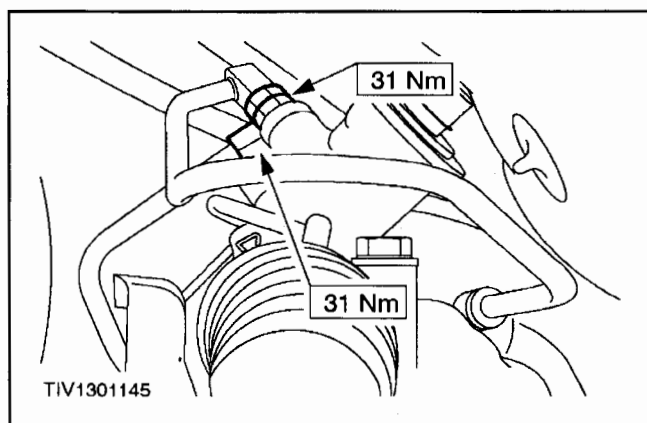
Installation**All vehicles**

1. If new tubes are to be installed, push the tubes into the new unions.

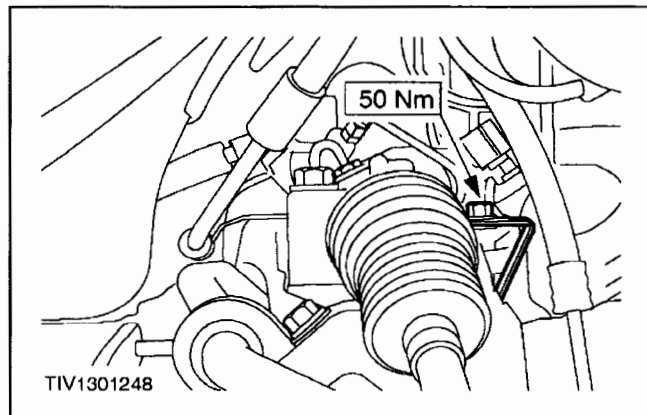


2. Using the special tool, Install new union O-ring seals.
 - 1 Push the new O-ring seal onto the special tool.
 - 2 Locate the tool on the union and ease the O-ring seal onto the union.

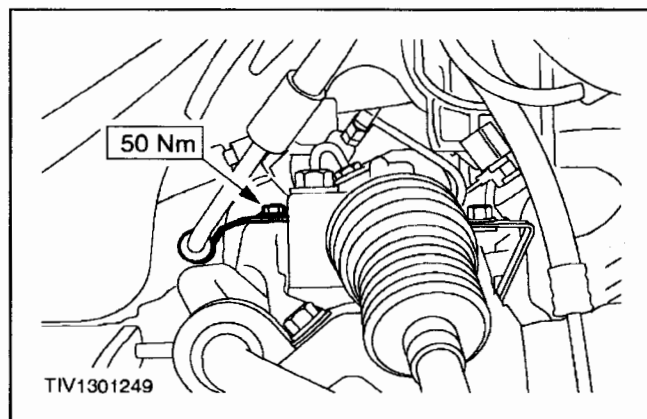


REMOVAL AND INSTALLATION (Continued)

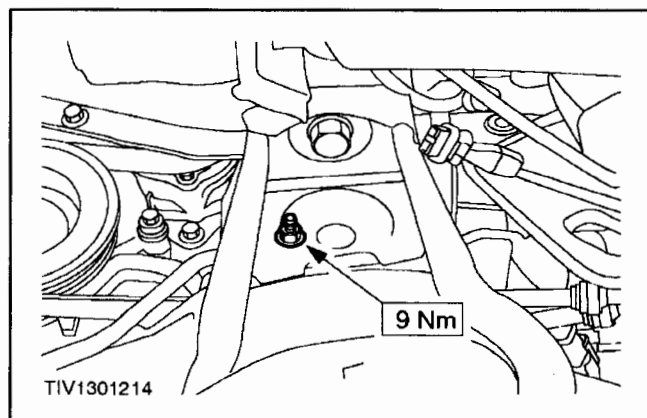
3. Connect the tube unions.



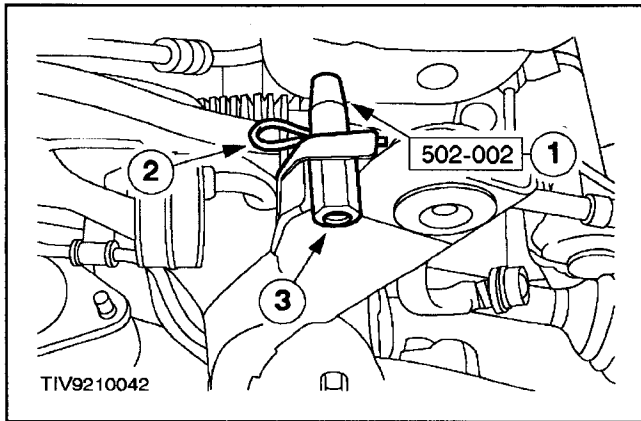
4. Install the return tube support bracket.



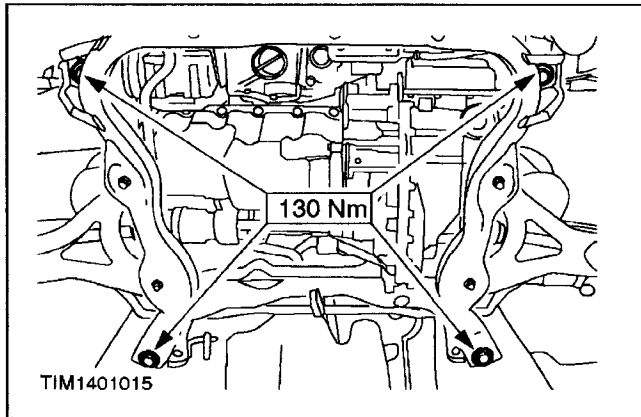
5. Install the high-pressure tube support bracket.



6. Install the fluid cooler lines retaining bracket.

REMOVAL AND INSTALLATION (Continued)

7. Using the special tool, align the subframe.
 - 1 Install the alignment pins in the subframe aligning holes.
 - 2 Install the locking pins.
 - 3 Tighten the alignment pin sleeves.



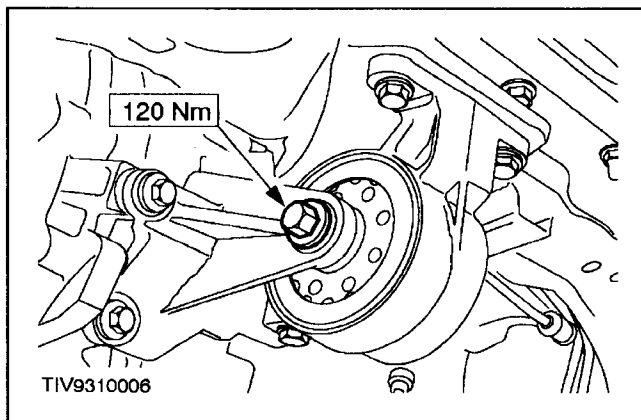
8. **NOTE:** Make sure the blue colored bolts are installed to the front.
Install the subframe retaining bolts.

9. Remove the special tool (subframe alignment pins).

10. Remove the subframe support.

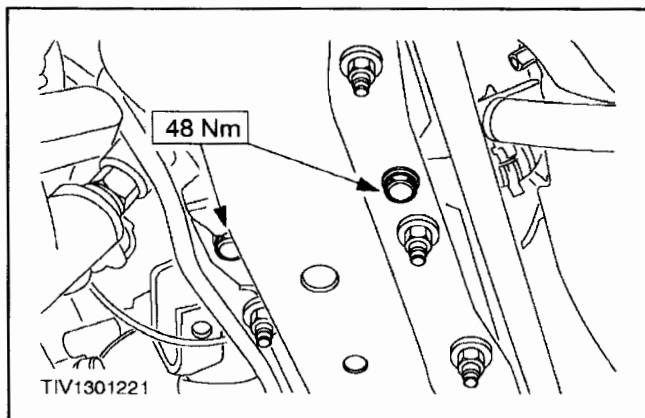
Vehicles with manual transaxle

11. Install the rear support insulator center bolt.

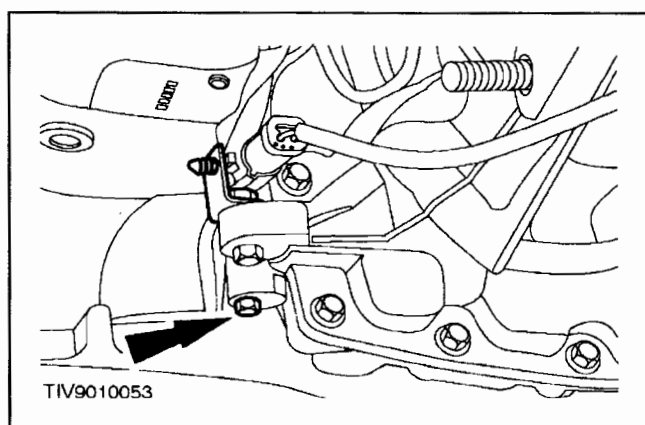


REMOVAL AND INSTALLATION (Continued)**Vehicles with automatic transaxle**

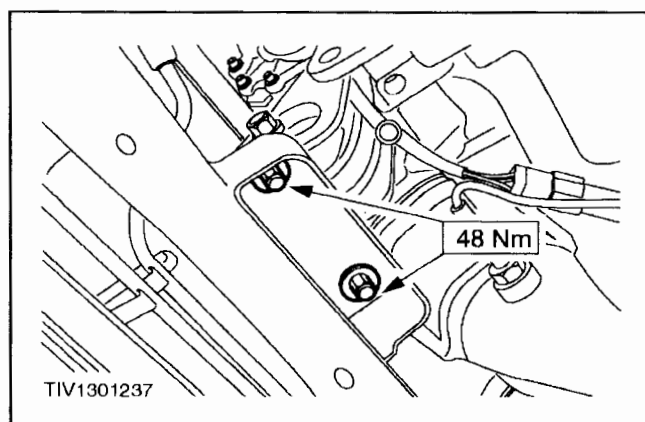
12. Install the rear support insulator.

**Vehicles with 2.5L engine**

13. Install the rear heated oxygen sensor wiring harness.

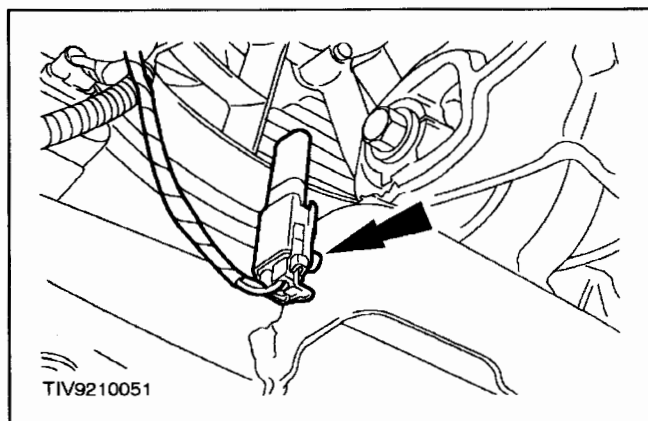
**All vehicles**

14. Install the front support insulator.

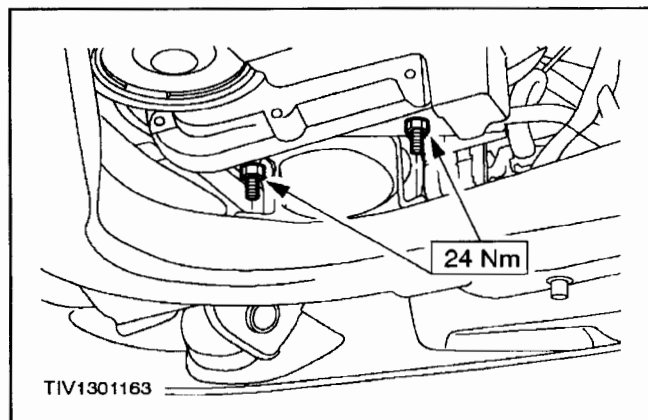


REMOVAL AND INSTALLATION (Continued)**Vehicles with air conditioning**

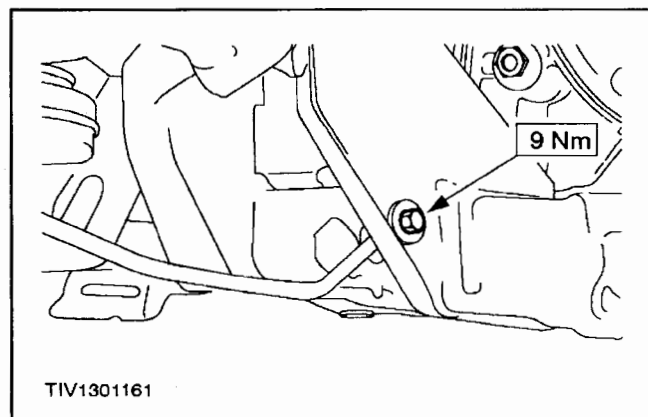
15. Install the air conditioning compressor diode wiring harness.



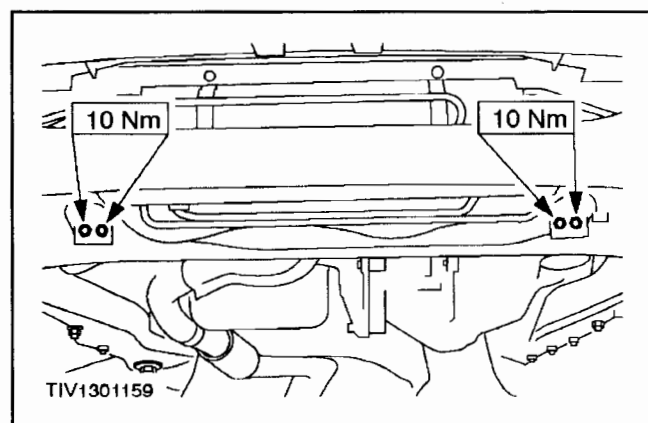
16. Install the air conditioning condenser.

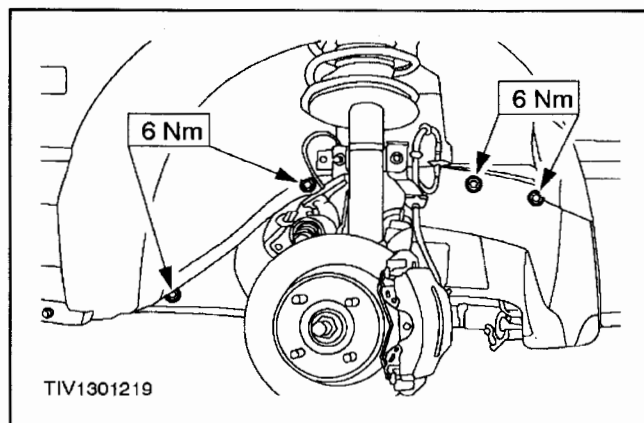
**All vehicles**

17. Install the bumper support brackets.

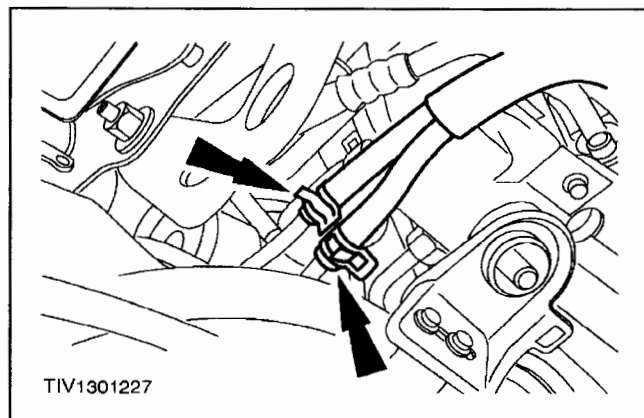


18. Install the radiator support brackets.

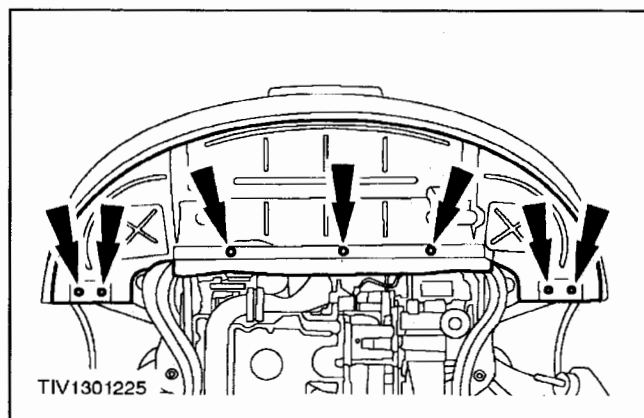


REMOVAL AND INSTALLATION (Continued)

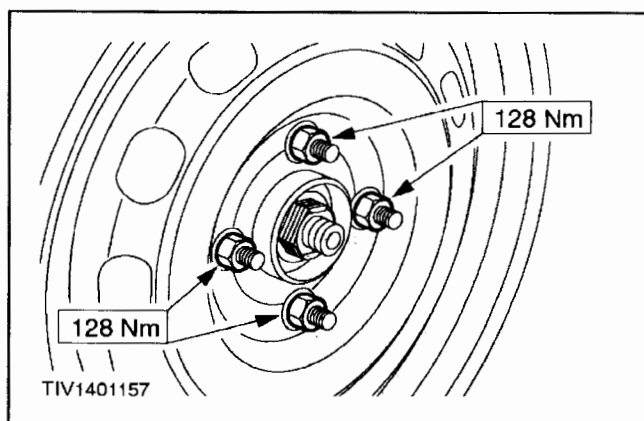
19. Install the two splash shields.



20. Connect the fluid cooler lines.



21. Install the radiator splash shield.

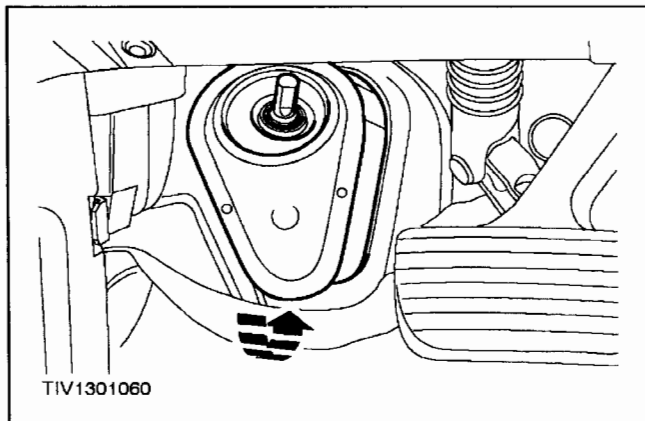


22. Install the driver side front wheel.

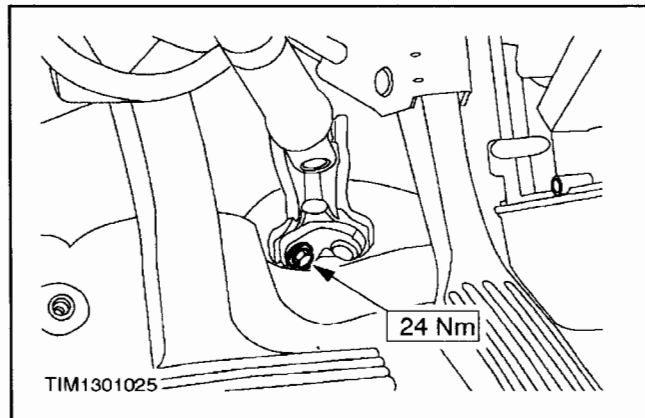
REMOVAL AND INSTALLATION (Continued)

23.  **CAUTION:** Before lowering the vehicle, make sure the steering is in the straight ahead position.

Lower the vehicle.

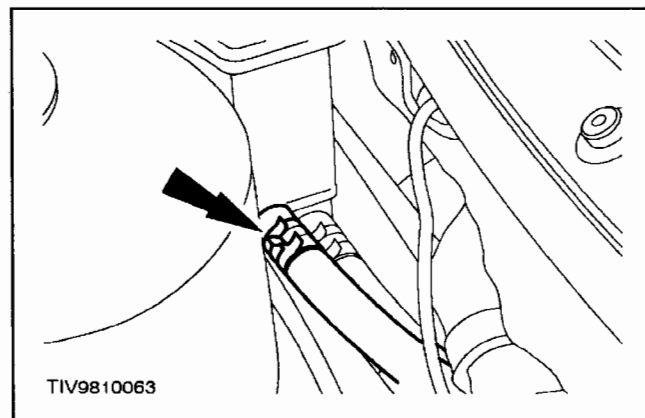


24. Install the floor seal.



25.  **WARNING:** Install a new pinch bolt. Failure to follow this instruction may result in personal injury.

Connect the steering column shaft to the flexible coupling.



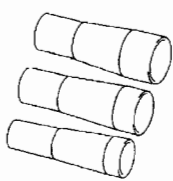
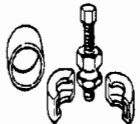
26. Connect the hose to the power steering fluid reservoir.

27. Remove the radiator supports.

28. Connect the battery ground cable.

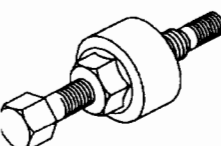
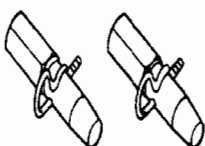
29. Bleed the power steering system. For additional information, refer to Section 211-00.

REMOVAL AND INSTALLATION (Continued)**Power Steering Pump to Steering Gear Pressure Line****Special Tool(s)**

 D90P-3517-A	Expander, Teflon Seal 211-D027 (D90P-3517-A) or equivalent
 ST1408-A	Separator, Ball Joint 211-001 (TOOL-3290-D)
 T69L-10300-B	Remover, Power Steering Pump Pulley 211-016 (T69L-10300-B)

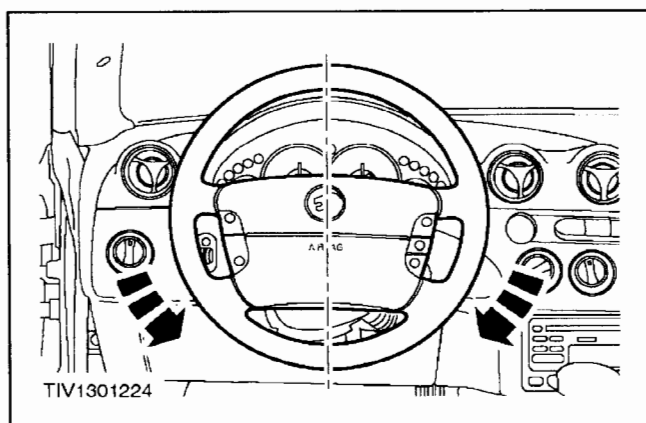
(Continued)

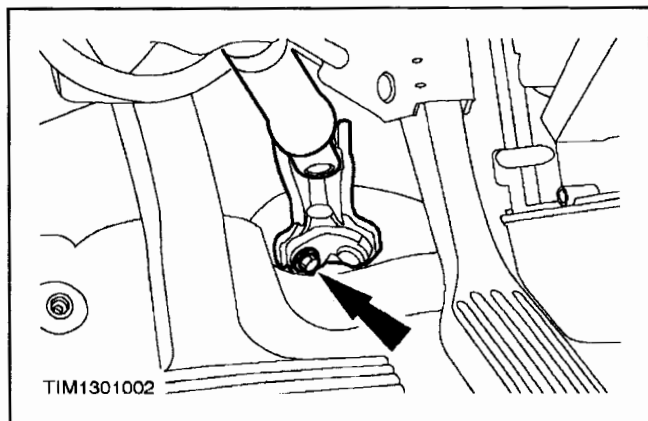
Special Tool(s)

 ST1586-A	Installer, Power Steering Pump Pulley 211-185 (T91P-3A733-A)
 T94P-2100-AH	Alignment Pins, Subframe 502-002 (T94P-2100-AH)

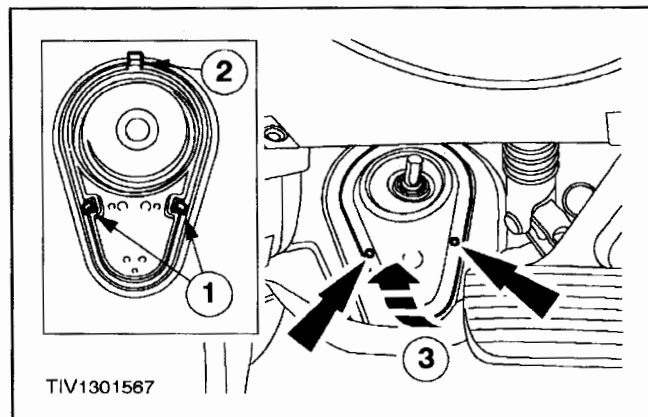
Removal**All vehicles**

1. Disconnect the battery ground cable.
2. Center the steering wheel.
 - Lock in position, remove the ignition key.



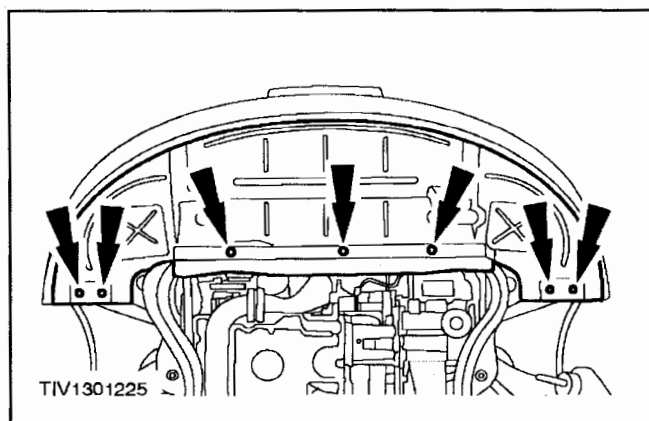
REMOVAL AND INSTALLATION (Continued)

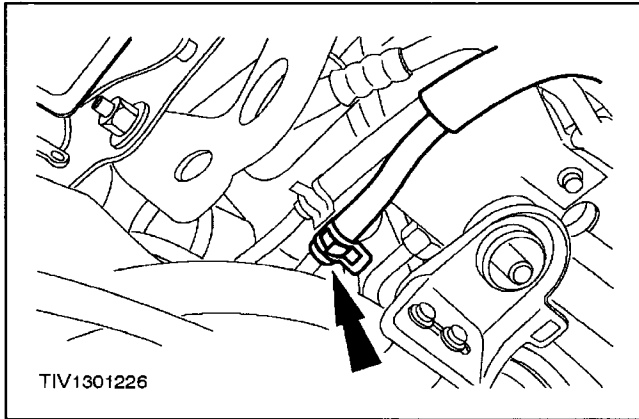
3. Disconnect the steering column shaft from the flexible coupling.
 - Rotate the clamp plate to disengage.



4. **CAUTION: When removing the floor seal do not damage the sealing clips.**
Remove the floor seal from the bulkhead.
 - 1 Release the retaining clips.
 - 2 Disconnect the upper retaining clip.
 - 3 Remove the floor seal.

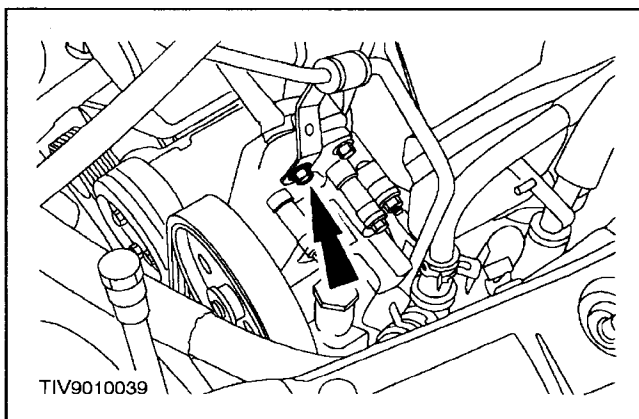
5. Loosen the left-hand side front wheel nuts.
6. Raise and support the vehicle. For additional information, refer to Section 100-02.
7. Remove the wheel.
8. Remove the radiator splash shield.



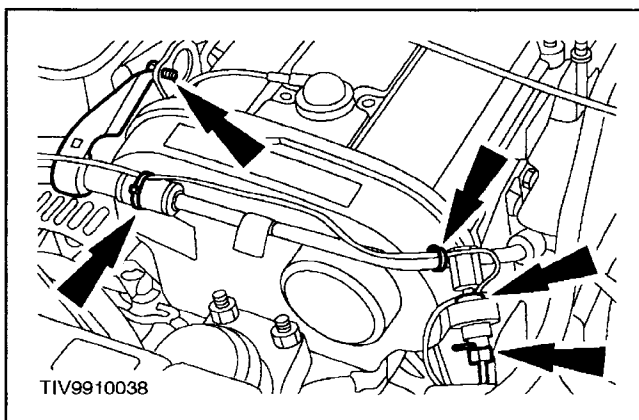
REMOVAL AND INSTALLATION (Continued)

9. Disconnect the fluid cooler line.
 - Allow the fluid to drain into a suitable container.

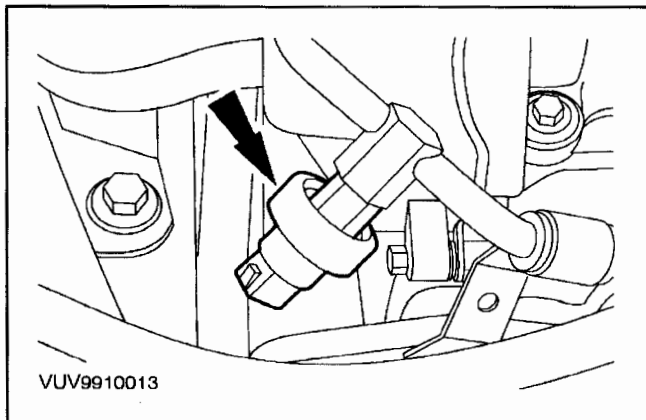
10. Lower the vehicle.

Vehicles with 2.0L engine

11. Detach the high-pressure tube support bracket.



12. Detach the high-pressure tube.
 - Disconnect the power steering pressure (PSP) switch electrical connector.
 - Detach the tube support bracket.
 - Cut the three cable ties.

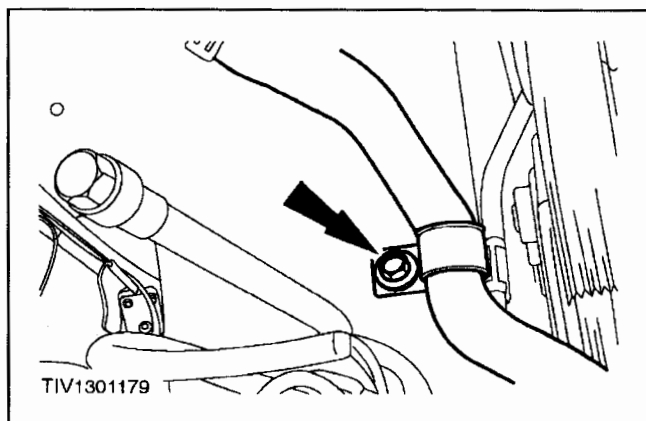
REMOVAL AND INSTALLATION (Continued)

13. Remove the PSP switch.

14. Remove the accessory drive belt. For additional information, refer to Section 303-05.

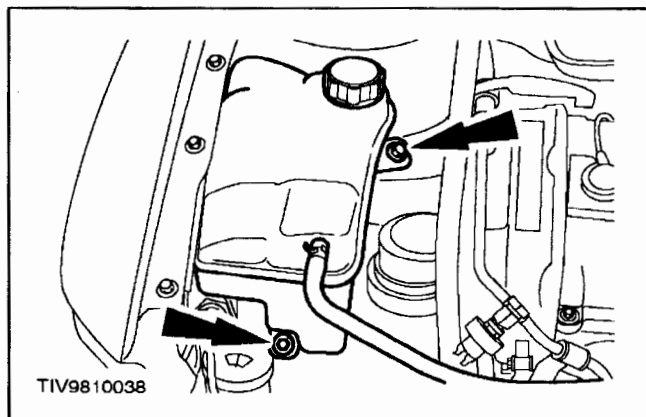
15. Lower the vehicle.

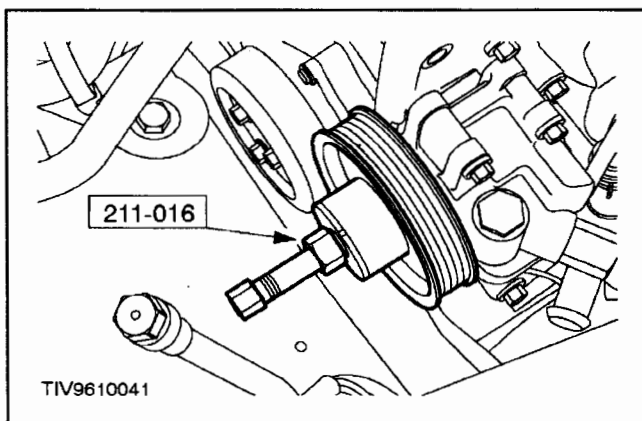
16. Detach the coolant hose clamp.



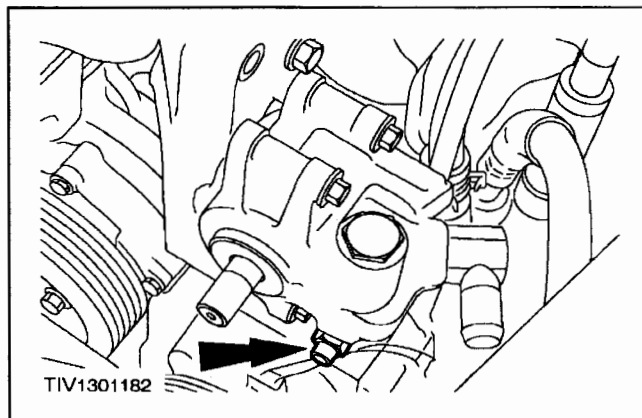
17. Detach the coolant expansion tank.

- Position the tank to one side.

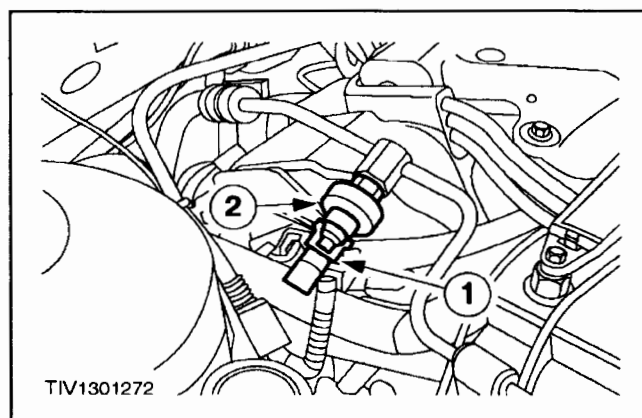


REMOVAL AND INSTALLATION (Continued)

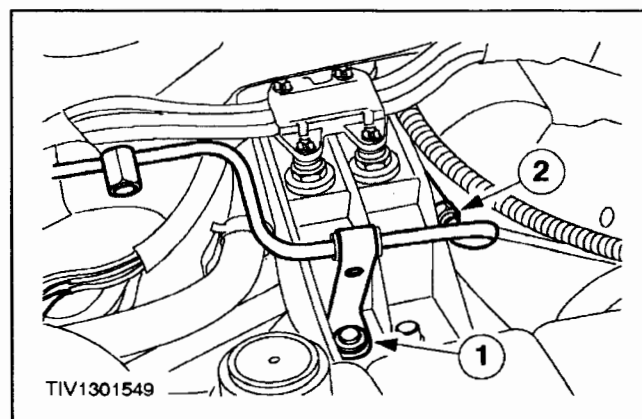
18. Using the special tool, remove the power steering pump pulley.



19. Disconnect the power steering pump high-pressure tube union.
- Allow the fluid to drain into a suitable container.

**Vehicles with 2.5L engine**

20. Remove the power steering pressure (PSP) switch.
- 1 Disconnect the electrical connector.
 - 2 Remove the switch.



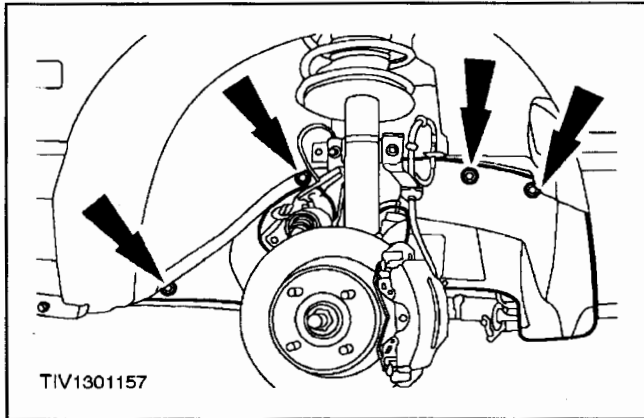
21. **CAUTION:** Make sure the power steering fluid does not contaminate the accessory drive belt.

Disconnect the high-pressure tube union.

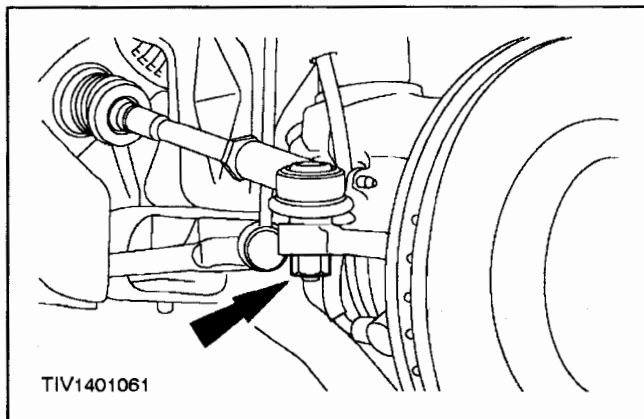
- 1 Detach the clamp.
 - 2 Disconnect the tube union.
- Allow the fluid to drain into a suitable container.

REMOVAL AND INSTALLATION (Continued)**All vehicles**

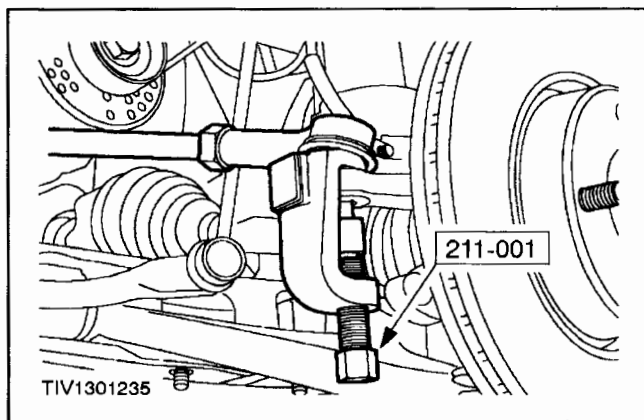
22. Raise and support the vehicle.
23. Remove the two splash shields (wheel removed for clarity).

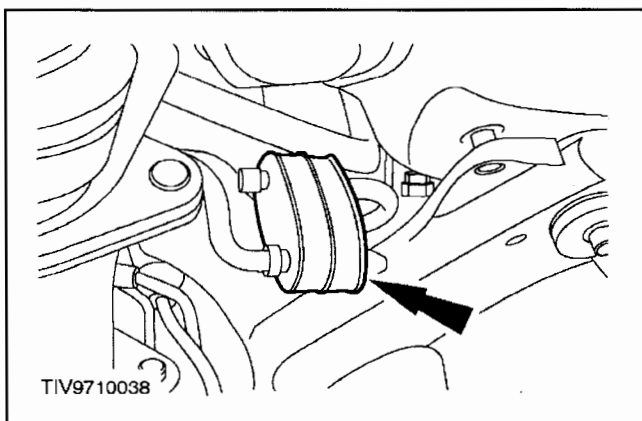
**Vehicles with 2.5L engine**

24. Remove the right-hand side tie-rod end retaining nut.

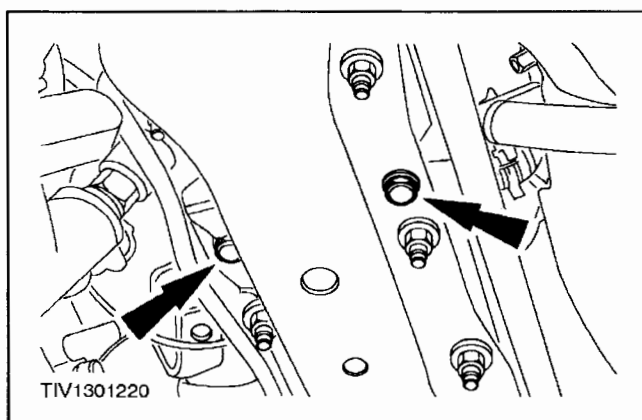


25. **NOTE:** When the tie-rod end is separated from the wheel knuckle the ball joint seal should be protected to prevent damage.
Using the special tool, separate the right-hand tie-rod end from the wheel knuckle.

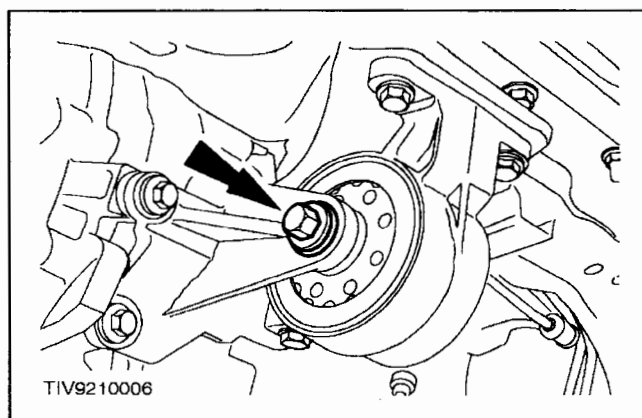


REMOVAL AND INSTALLATION (Continued)

26. Remove the front exhaust hanger insulator.

**Vehicles with automatic transaxle**

27. Detach the rear support insulator.

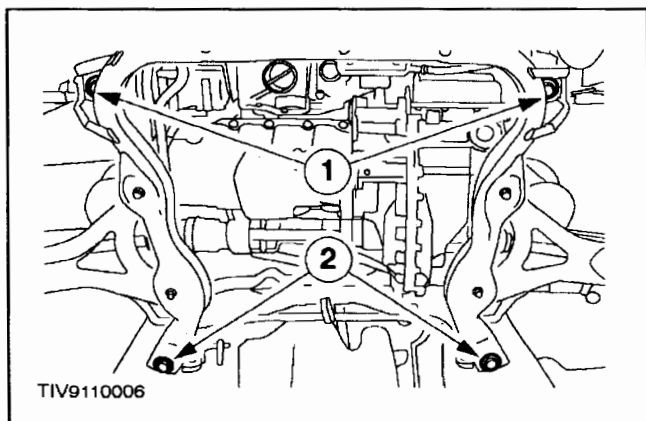
**Vehicles with manual transaxle**

28. Remove the rear support insulator center bolt.

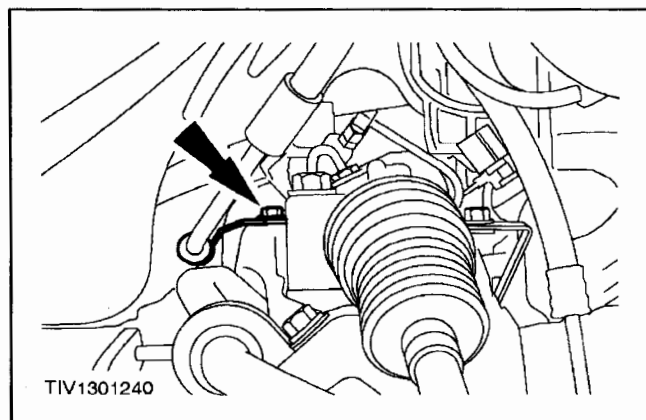
REMOVAL AND INSTALLATION (Continued)**All vehicles**

29. Lower the subframe.

- 1 Loosen the subframe front bolts two complete turns.
- 2 Remove the subframe rear bolts.

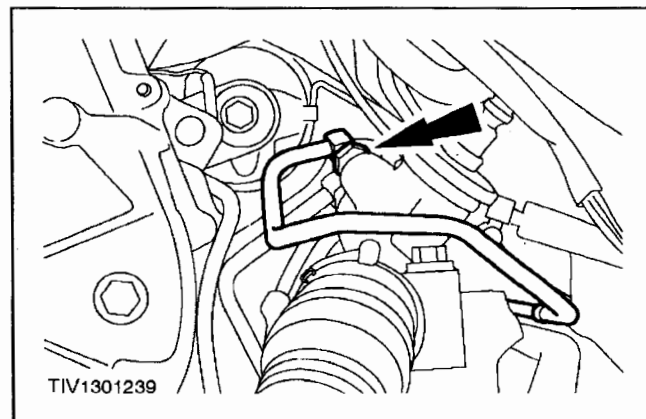


30. Detach the high-pressure tube support bracket.



31.  **CAUTION:** Where the steering gear unions are disconnected, the steering gear valve body ports should be plugged to prevent dirt ingress.

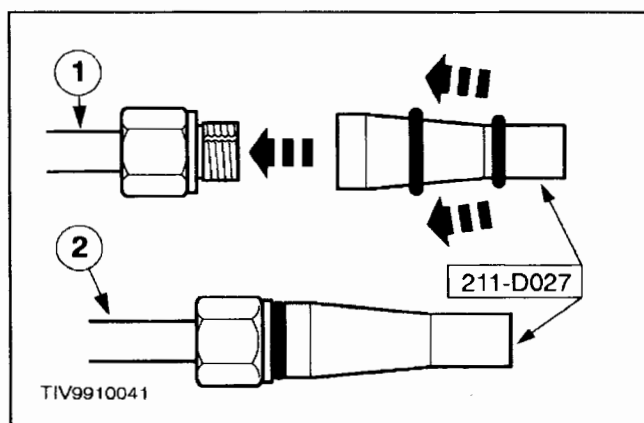
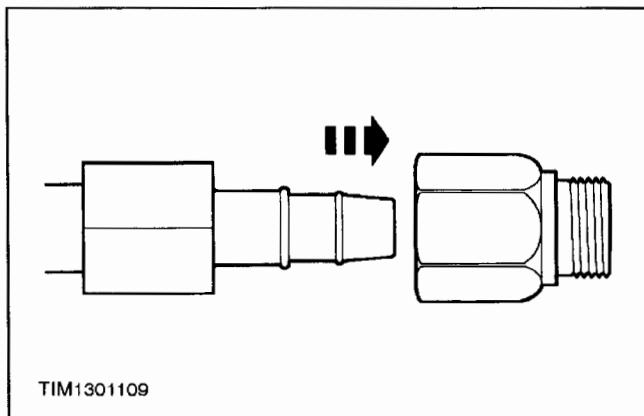
Disconnect the high-pressure tube union.



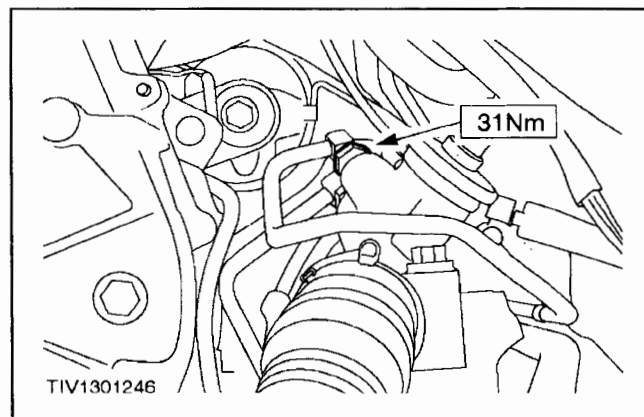
32. Remove the high-pressure tube.

REMOVAL AND INSTALLATION (Continued)**Installation****All vehicles**

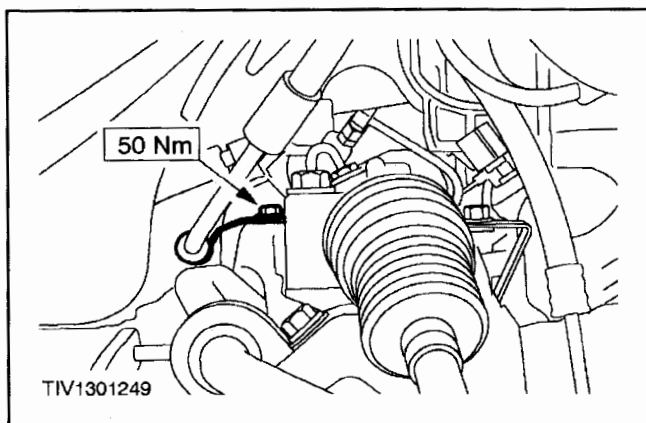
1. If a new tube is to be installed, push the new tube into the new union.



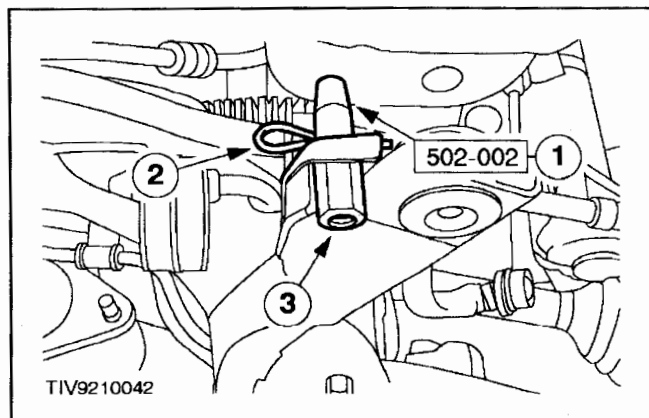
2. Using the special tool, install a new union O-ring seal.
 - 1 Push the new O-ring seal onto the special tool.
 - 2 Locate the tool on the union and push on the new O-ring seal.



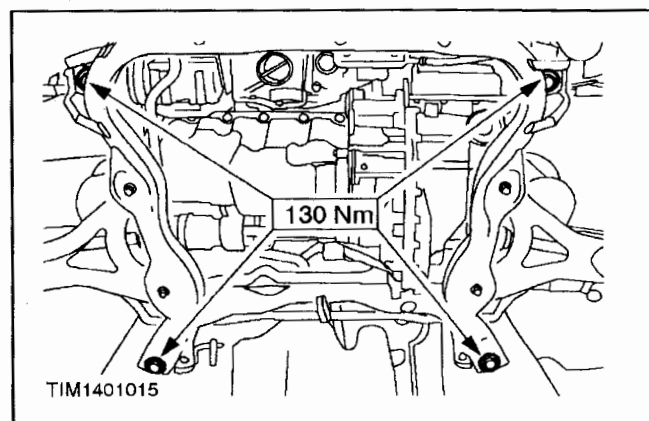
3. Connect the high-pressure tube union.

REMOVALANDINSTALLATION (Continued)

4. Install the high-pressure tube support bracket.



5. Using the special tool, align the subframe.
- 1 Install the alignment pins in the subframe aligning pins.
 - 2 Install the locking pins.
 - 3 Tighten the alignment pin sleeve.

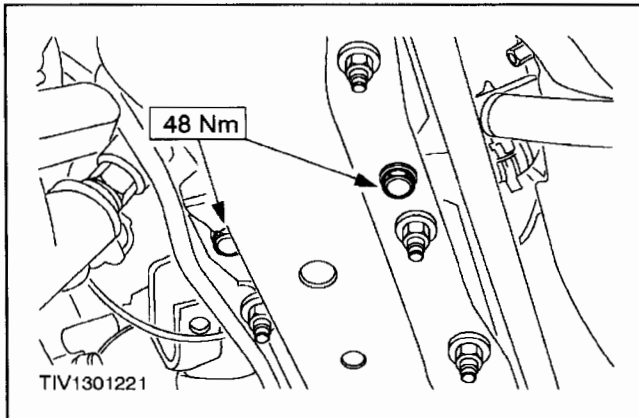


6. Install and secure the subframe bolts.

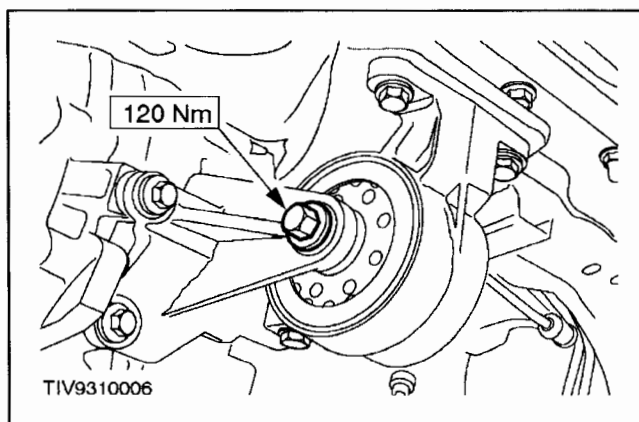
7. Remove the special tool (subframe alignment pins).

REMOVAL AND INSTALLATION (Continued)**Vehicles with automatic transaxle**

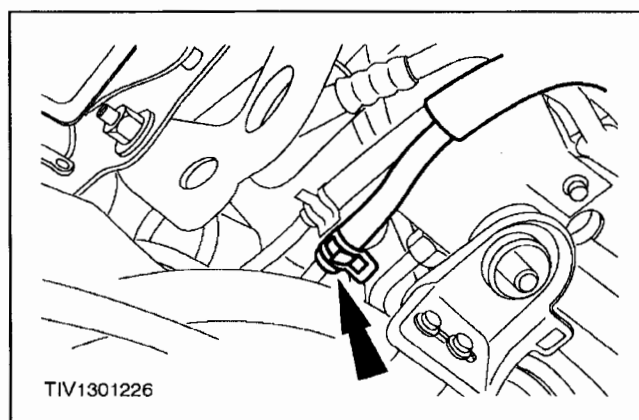
8. Install the rear support insulator.

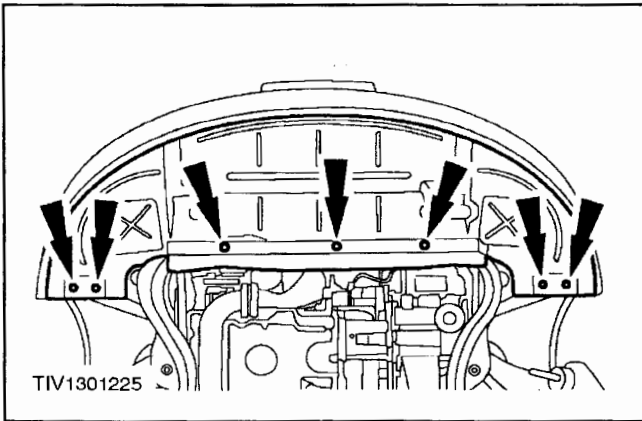
**Vehicles with manual transaxle**

9. Install the rear support insulator center bolt.

**All vehicles**

10. Connect the fluid cooler line.



REMOVAL AND INSTALLATION (Continued)

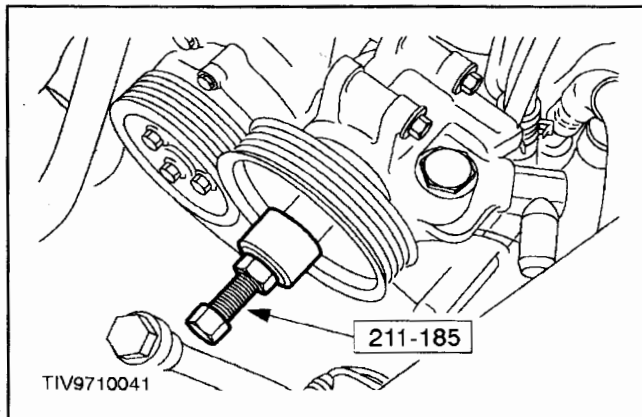
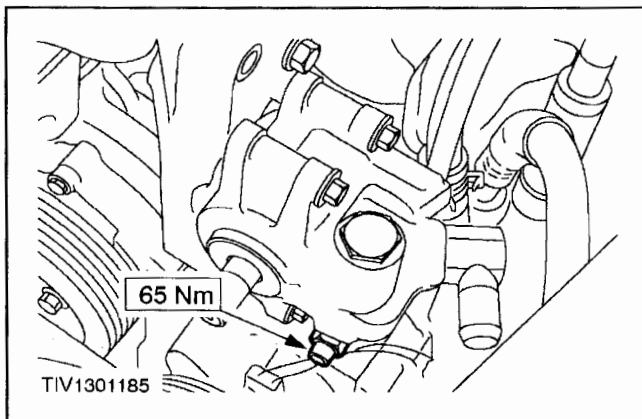
11. Install the radiator splash shield.

Vehicles with 2.0L engine

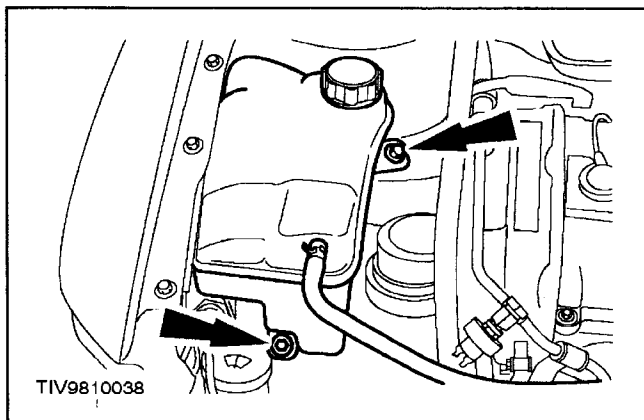
12. Lower the vehicle.

All vehicles

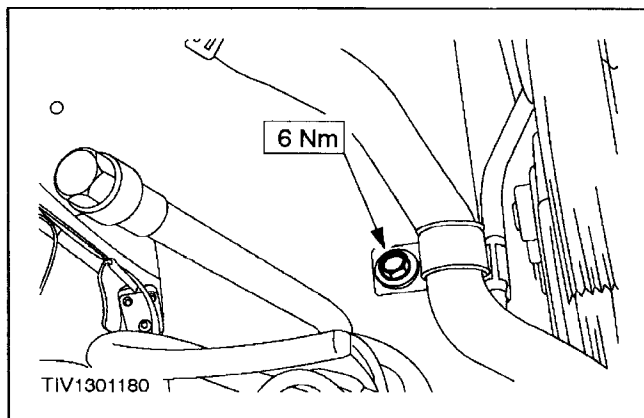
13. Install the high-pressure tube union to the power steering pump.



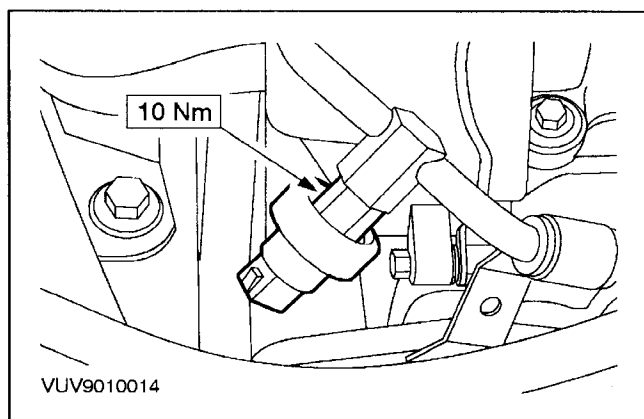
14. **NOTE:** Make sure the pulley is flush with the end of the pump shaft.
Using the special tool, install the power steering pump pulley.

REMOVAL AND INSTALLATION (Continued)

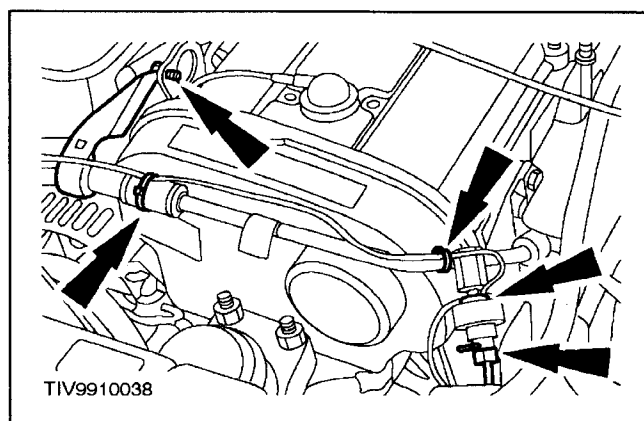
15. Install the coolant expansion tank.



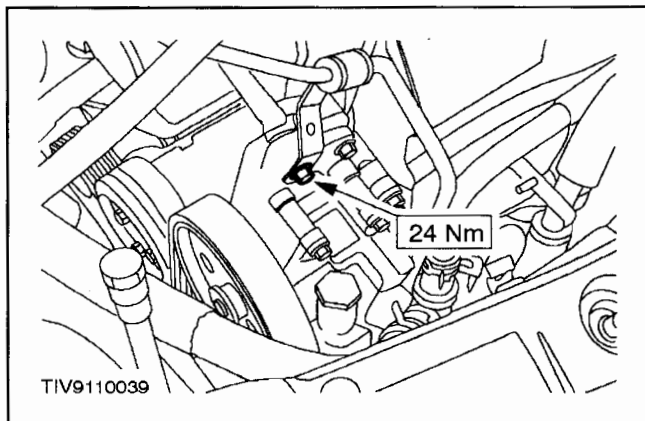
16. Install the coolant hose clamp.



17. Install the PSP switch.



18. Install the high-pressure tube.
- Connect the PSP switch electrical connector.
 - Install the tube support bracket.
 - Install three new cable ties.

REMOVALANDINSTALLATION (Continued)

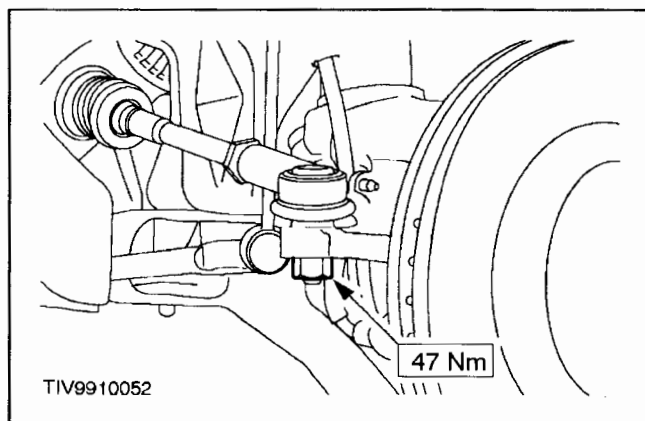
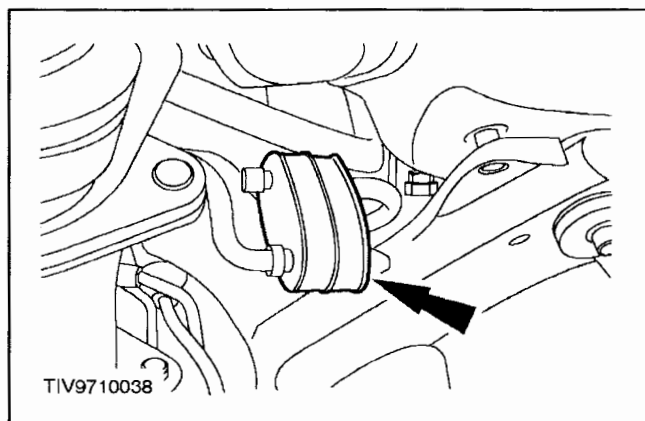
19. Install the high-pressure tube support bracket.

20. Raise and support the vehicle. For additional information, refer to Section 100-02.

21. Install the accessory drive belt. For additional information, refer to Section 303-05.

Vehicles with 2.5L engine

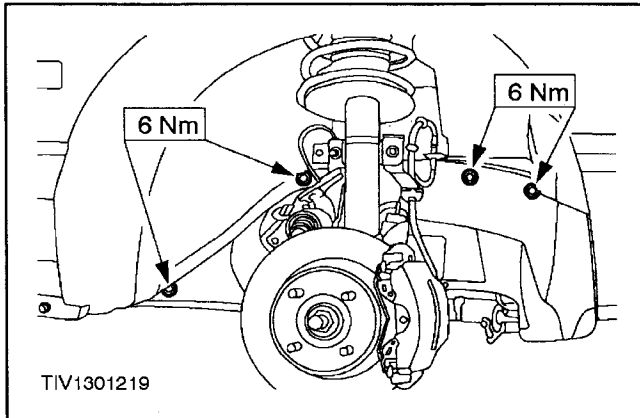
22. Install the front exhaust hanger insulator.



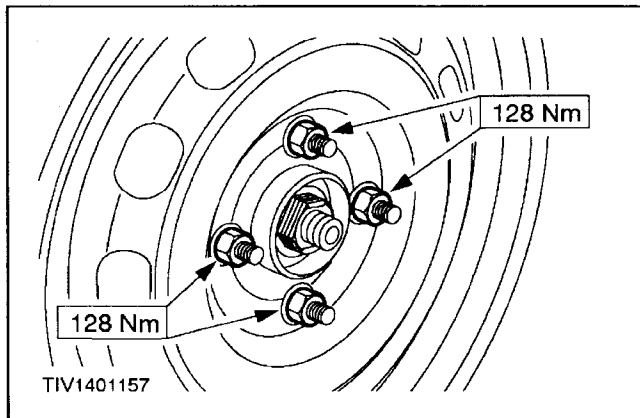
23. Connect the tie-rod end.

REMOVAL AND INSTALLATION (Continued)**All vehicles**

24. Install the two splash shields.



25. Install the front wheel.

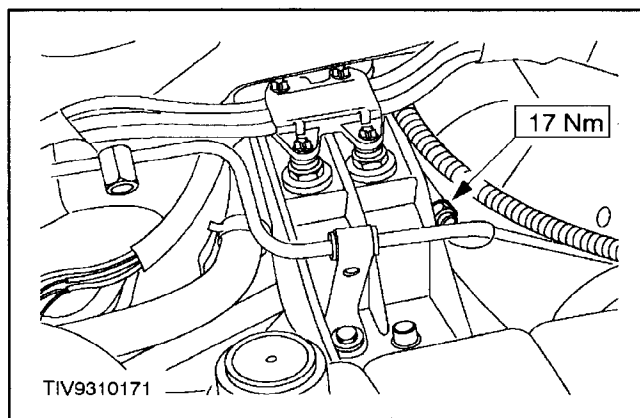


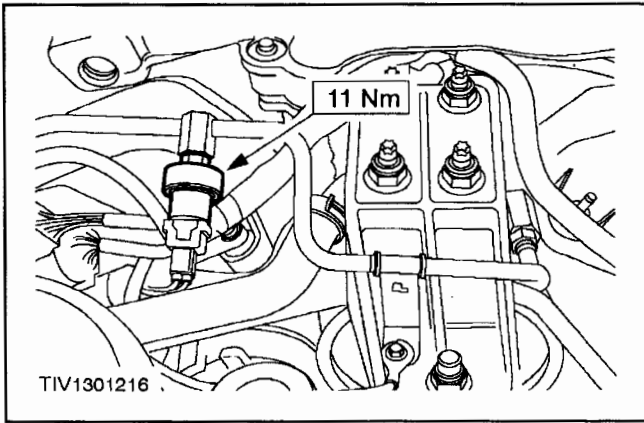
26.  **CAUTION: Make sure the steering is in the straight-ahead position.**

Lower the vehicle.

Vehicles with 2.5L engine

27. Install the high-pressure tube union.



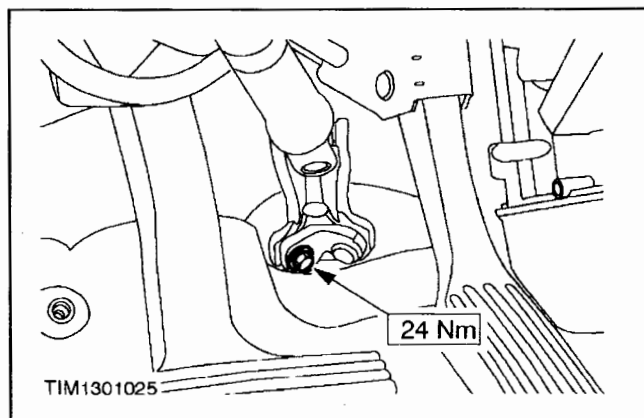
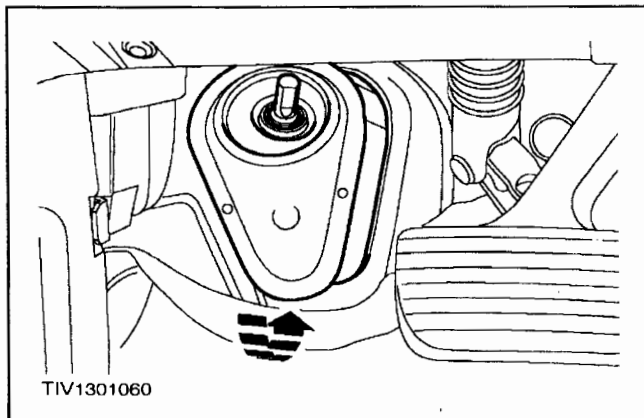
REMOVAL AND INSTALLATION (Continued)

28. Install the PSP switch.

- Connect the electrical connector.

All vehicles

29. Install the floor seal.



30.  **WARNING:** Install a new pinch bolt. Failure to follow this instruction may result in personal injury.

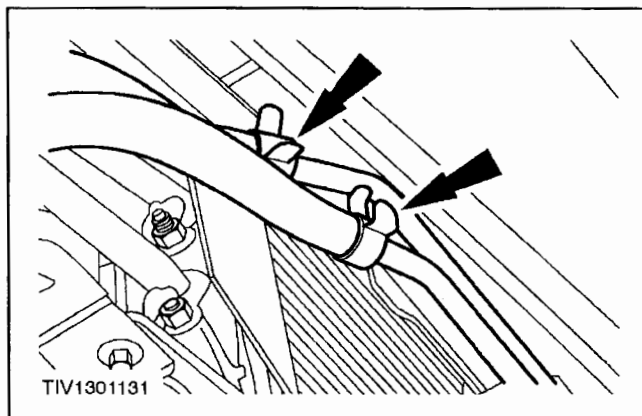
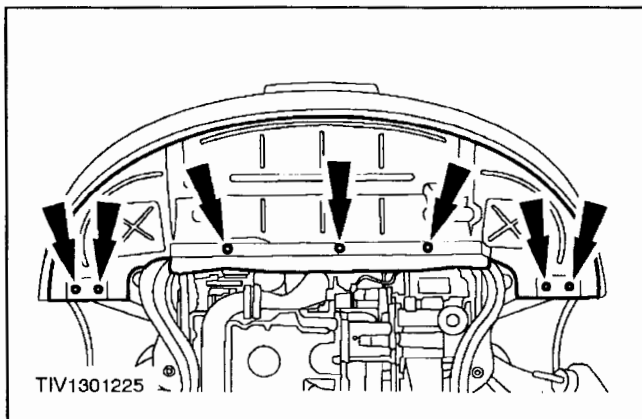
Connect the steering column shaft to the flexible coupling.

31. Connect the battery ground cable.

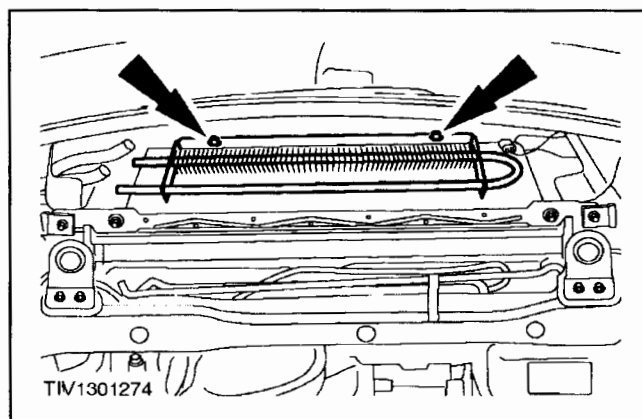
32. Bleed the power steering system. For additional information, refer to Section 211-00.

REMOVAL AND INSTALLATION (Continued)**Power Steering Fluid Cooler****Removal**

1. Disconnect the battery ground cable.
2. Raise and support the vehicle. For additional information, refer to Section 100-02.
3. Remove the radiator splash shield.



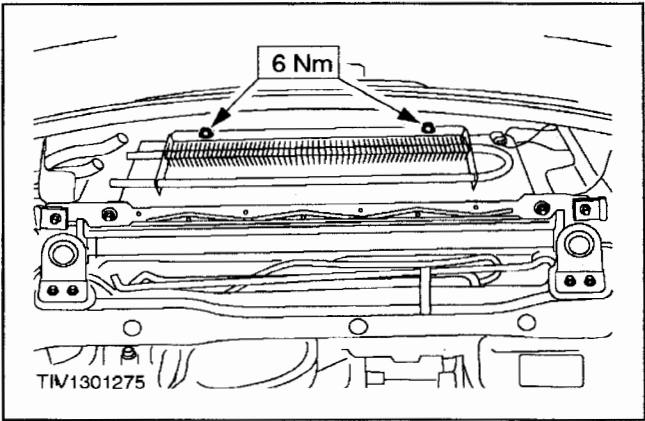
4. Disconnect the fluid cooler lines.
 - Allow the fluid to drain into a suitable container.



5. Remove the fluid cooler.

REMOVALANDINSTALLATION (Continued)

Installation



1. **NOTE:** After installation, bleed the power steering system. For additional information, refer to Section 211-00.
- To install, reverse the removal procedure.

Steering Gear

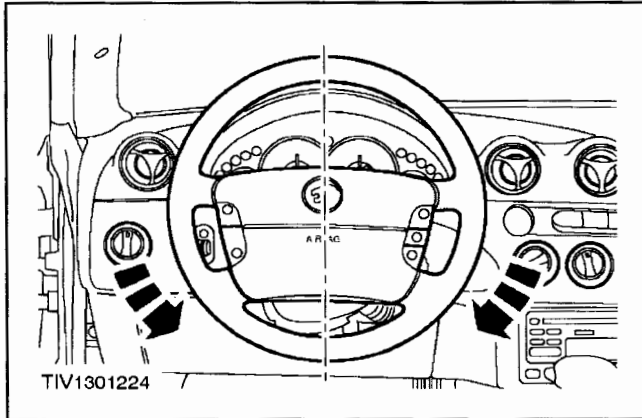
Special Tool(s)

 ST1408-A	Separator, Ball Joint 211-001 (TOOL-3290-D)
 D90P-3517-A	Expander, Teflon Seal 211-D027 (D90P-3517-A) or equivalent
 T94P-2100-AH	Alignment Pins, Subframe 502-002 (T94P-2100-AH)

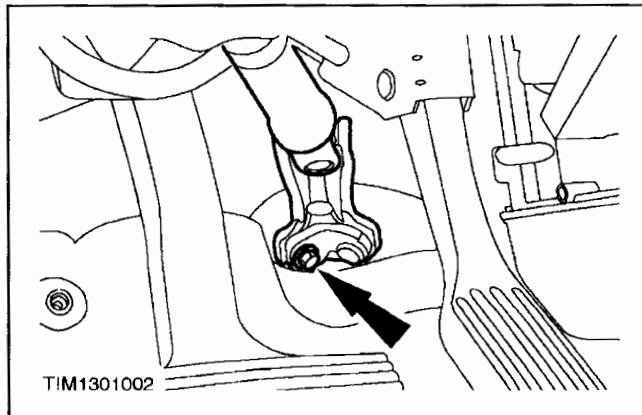
Removal

All vehicles

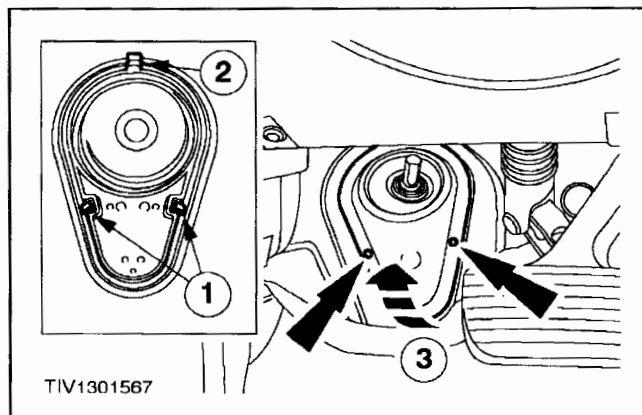
1. Disconnect the battery ground cable.

REMOVAL AND INSTALLATION (Continued)

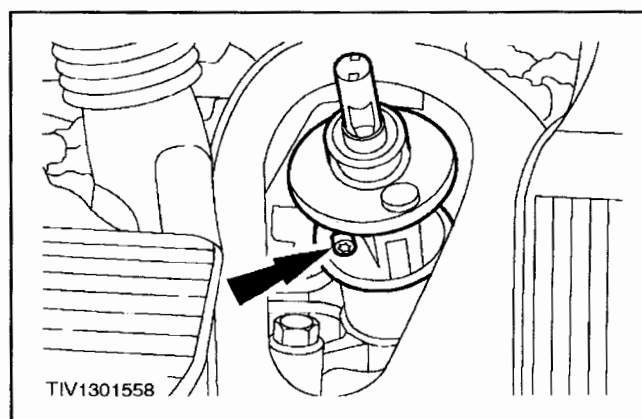
2. Center the steering wheel.
 - Lock in position, remove the ignition key.



3. Disconnect the steering column shaft from the flexible coupling.
 - Rotate the clamp plate to disengage.



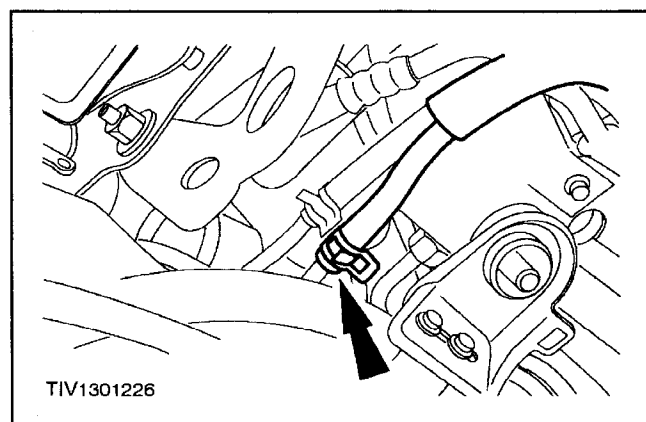
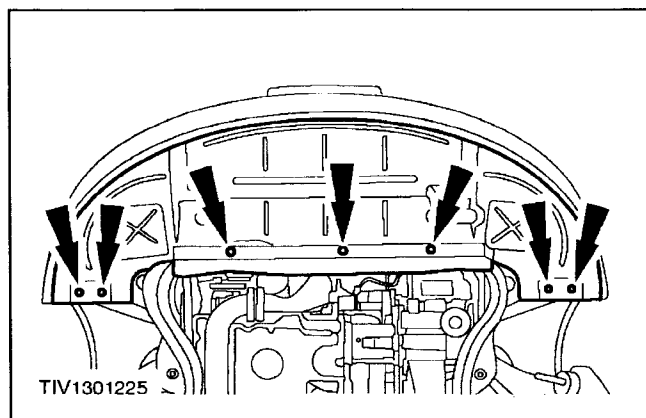
4.  **CAUTION: When removing the floor seal do not damage the sealing clips.**
Remove the floor seal from the bulkhead.
 - 1 Release the retaining clips.
 - 2 Disconnect the upper retaining clip.
 - 3 Remove the floor seal.



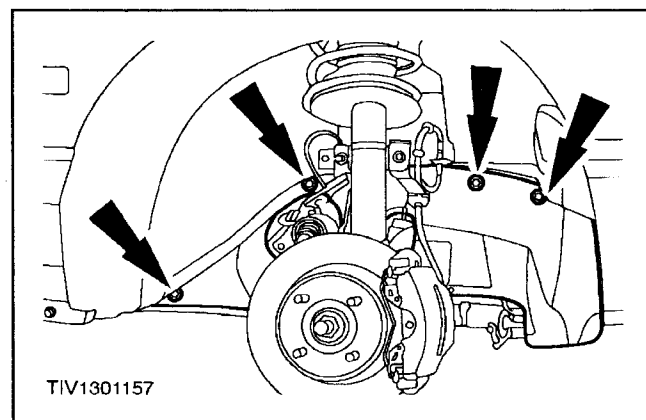
5. Remove the steering column shaft flexible coupling.

REMOVAL AND INSTALLATION (Continued)

6. Remove the front wheel and tire. For additional information, refer to Section 204-04.
7. Remove the radiator splash shield.



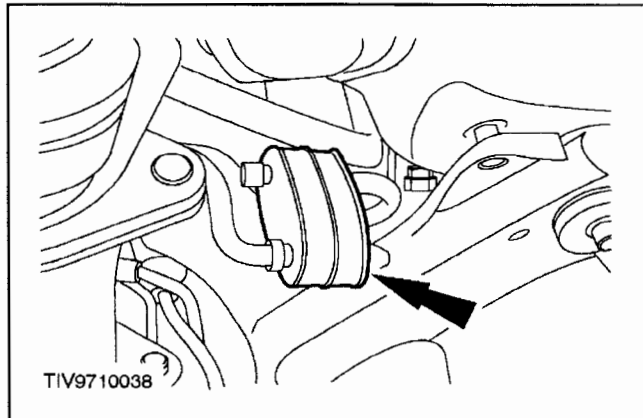
8. Disconnect the fluid cooler line.
 - Allow the fluid to drain into a suitable container.



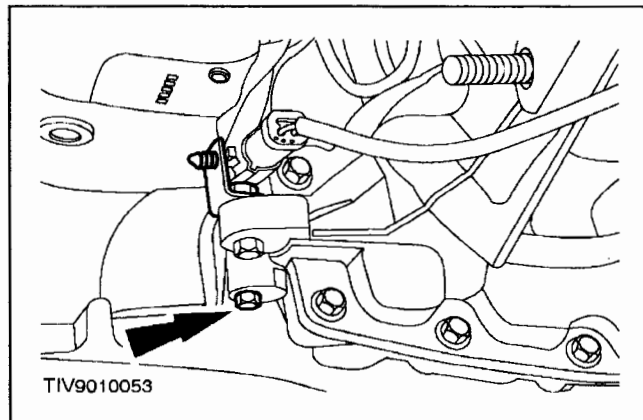
9. Remove the two splash shields (wheel removed for clarity).

REMOVAL AND INSTALLATION (Continued)**Vehicles with 2.5L engine**

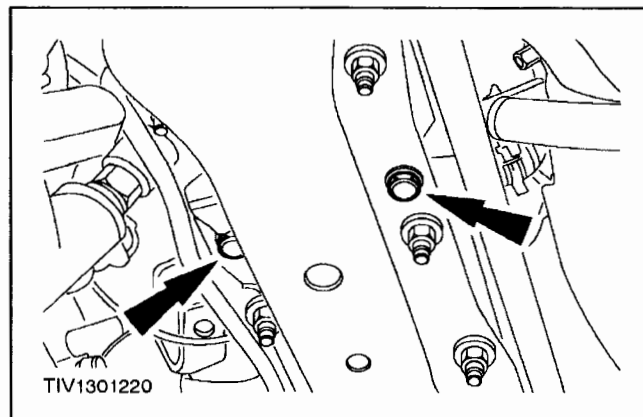
10. Remove the front exhaust hanger insulator.



11. Detach the rear heated oxygen sensor wiring harness.

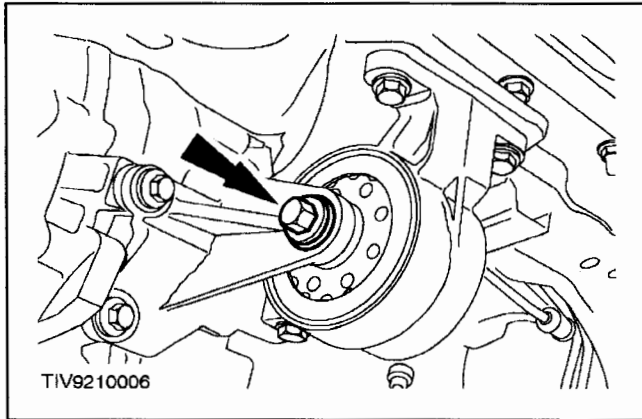
**Vehicles with automatic transaxle**

12. Detach the rear support insulator.

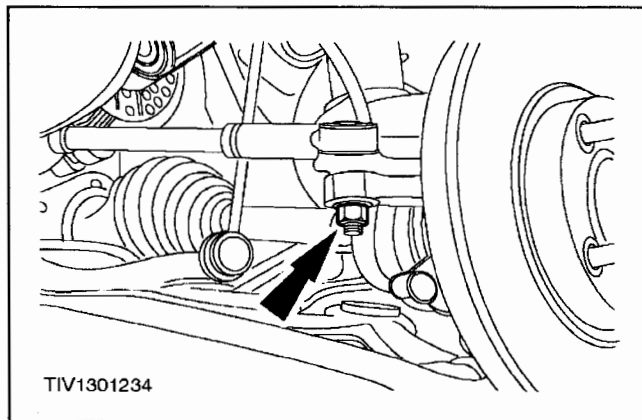


REMOVAL AND INSTALLATION (Continued)**Vehicles with manual transaxle**

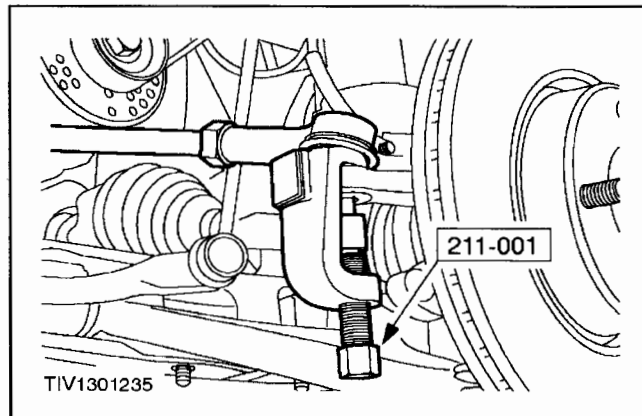
13. Remove the rear support insulator center bolt.

**All vehicles**

14. Remove the tie-rod end nuts.

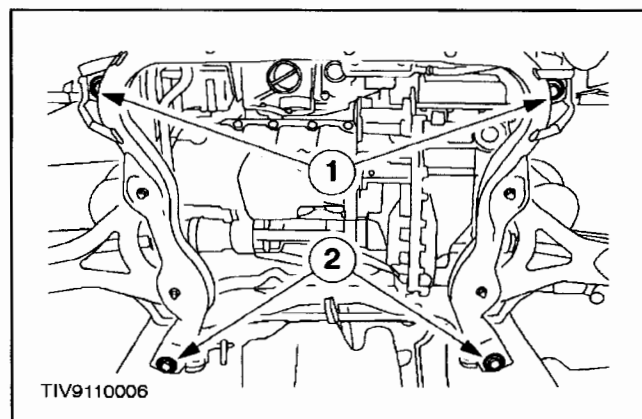


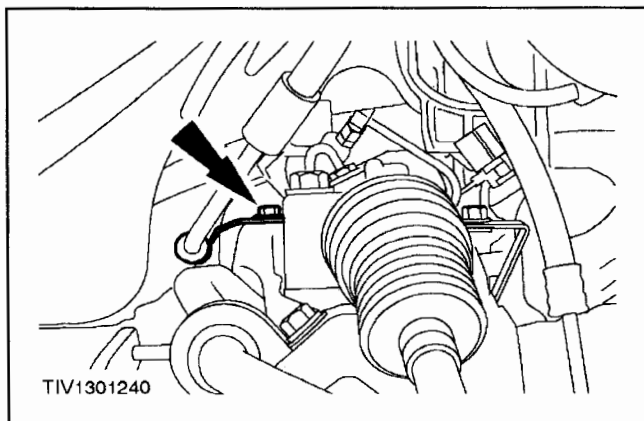
15. Using the special tool, separate the tie-rod ends from the wheel knuckles.



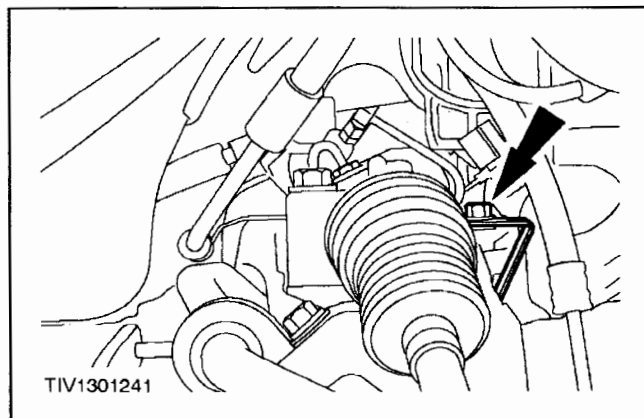
16. Lower the subframe to gain access to the steering gear tubes.

- 1 Loosen the subframe front bolts two complete turns.
- 2 Remove the subframe rear bolts.

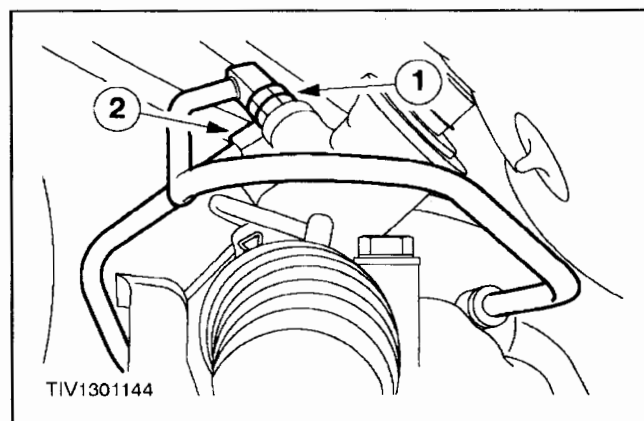


REMOVAL AND INSTALLATION (Continued)

17. Detach the high-pressure tube support bracket.



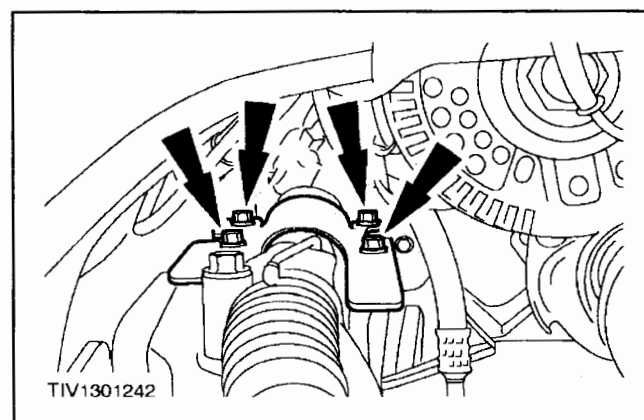
18. Detach the return tube support bracket.



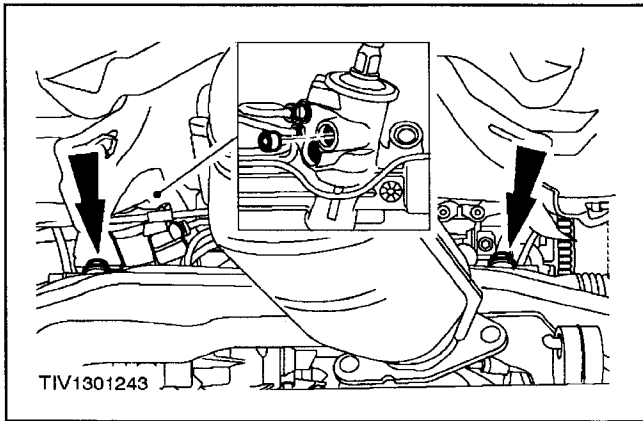
19.  **CAUTION:** Whenever the steering gear unions are disconnected the steering gear valve body ports should be plugged to prevent dirt ingress.

Disconnect the tube unions from the steering gear.

- 1 Disconnect the high-pressure tube union.
 - 2 Disconnect the return tube union.
- Allow the fluid to drain into a suitable container.



20. Remove the steering gear cover plate.

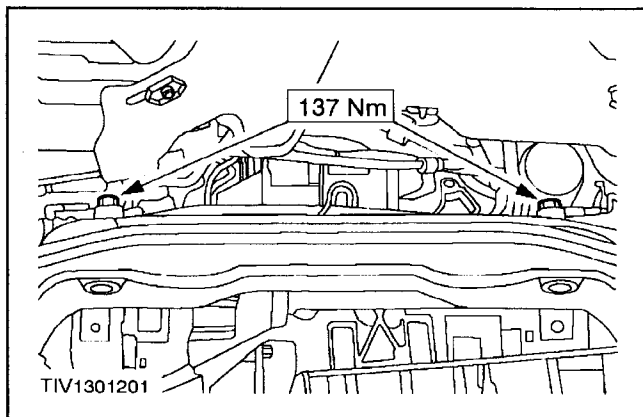
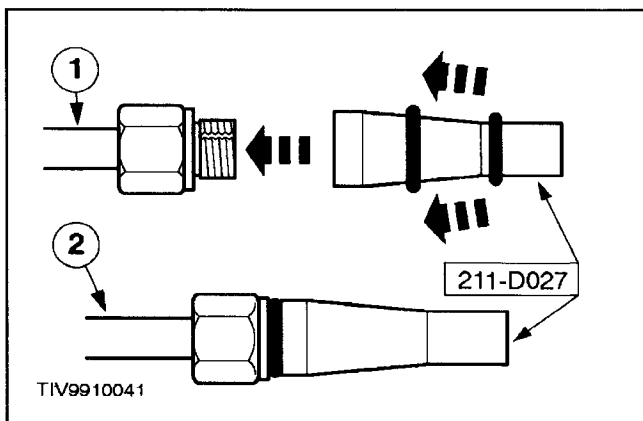
REMOVAL AND INSTALLATION (Continued)

21. **CAUTION:** Make sure that the pressure check valve does not fall out of the valve body pressure port when the steering gear is being removed.

Remove the steering gear.

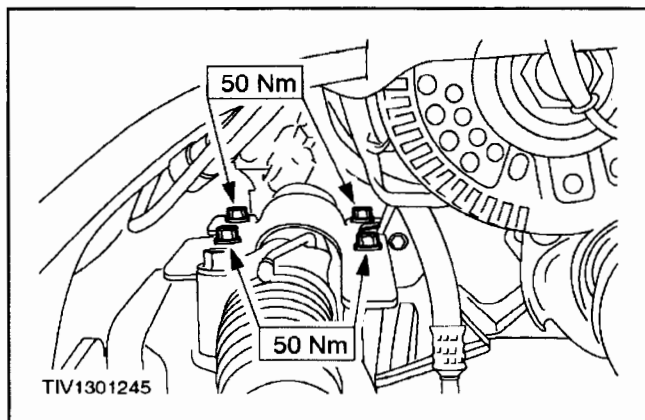
Installation**All vehicles**

1. Using the special tool, Install new union O-ring seals.
 - 1 Push the new O-ring seal onto the special tool.
 - 2 Locate the tool over the union and ease the O-ring seal onto the union.

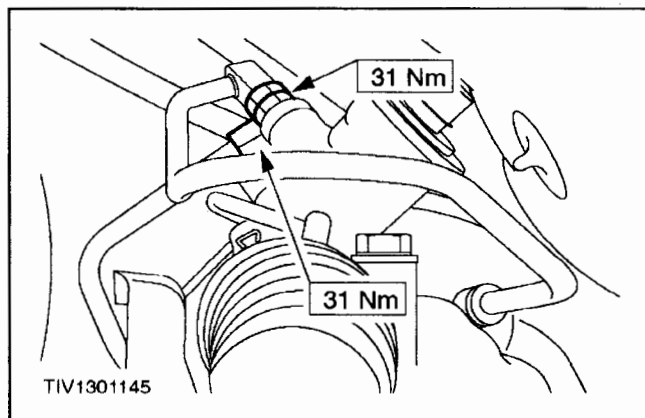


2. **CAUTION:** Make sure the pressure check valve is correctly located.

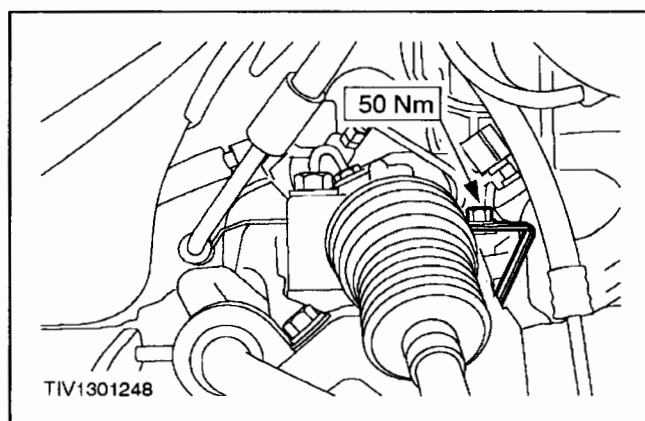
Install the steering gear.

REMOVAL AND INSTALLATION (Continued)

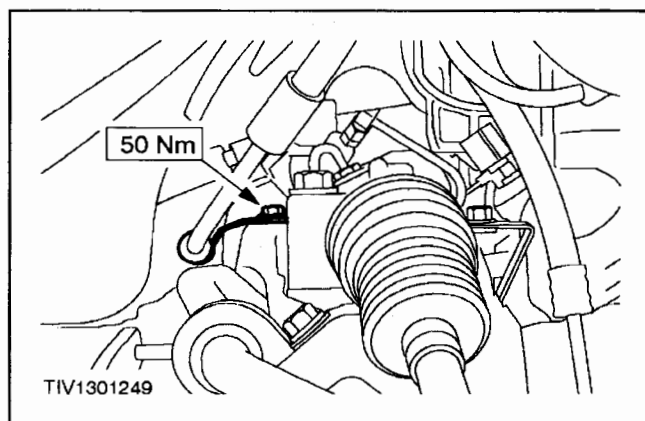
3. Install the steering gear cover plate.



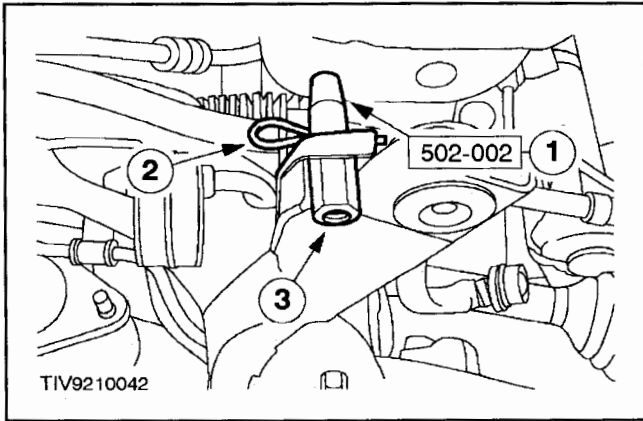
4. Connect the tube unions.



5. Install the return tube support bracket.

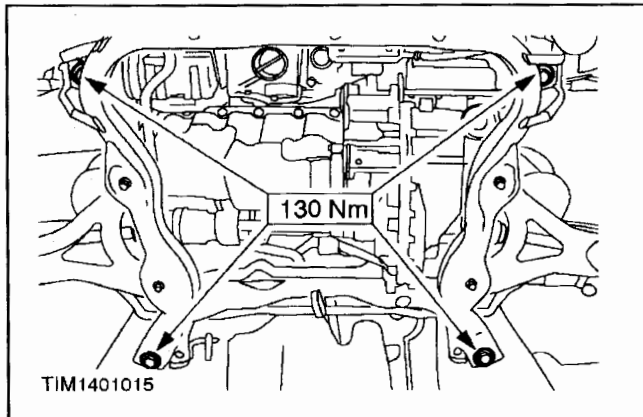


6. Install the high-pressure tube support bracket.

REMOVAL AND INSTALLATION (Continued)

7. Using the special tool, align the subframe.

- 1 Install the alignment pins through the subframe aligning holes.
- 2 Install the locking pins.
- 3 Tighten the alignment pin sleeves.

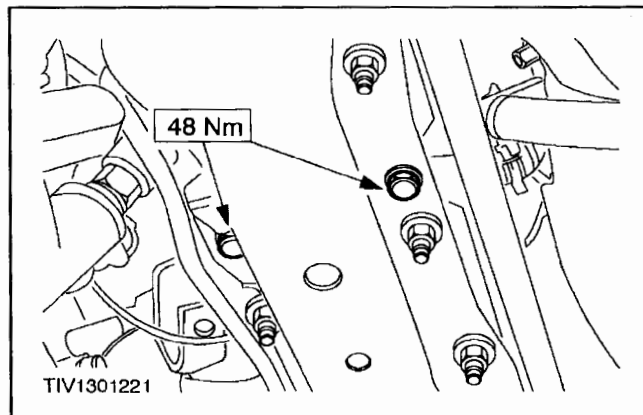


8. Install and secure the subframe bolts.

9. Remove the special tool (subframe alignment pins).

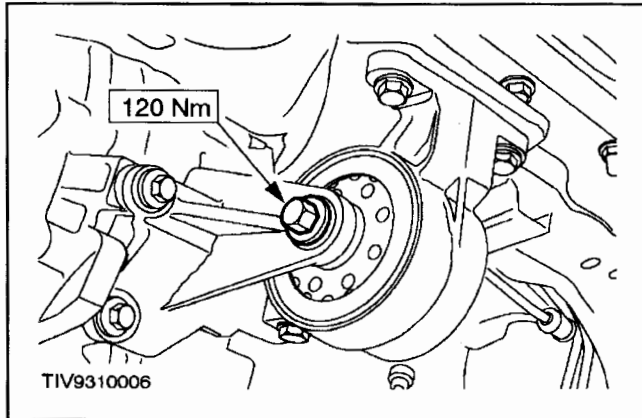
Vehicles with automatic transaxle

10. Install the rear support insulator.

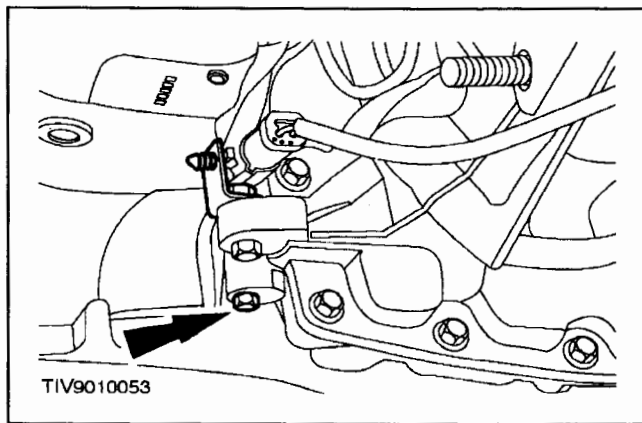


REMOVALANDINSTALLATION (Continued)**Vehicles with manual transaxle**

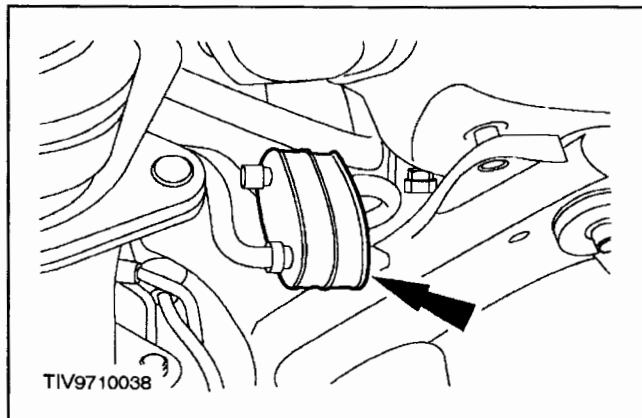
11. Install the rear support insulator center bolt.

**Vehicles with 2.5L engine**

12. Secure the rear heated oxygen sensor wiring harness.

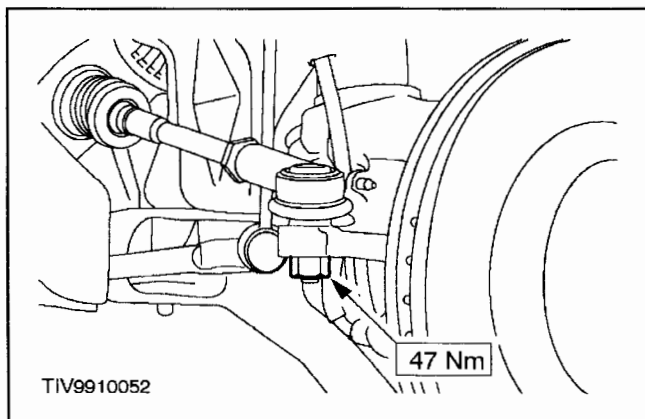


13. Install the front exhaust hanger insulator.

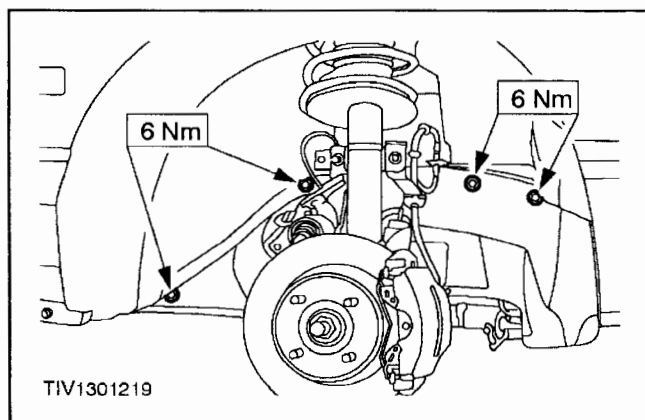


REMOVAL AND INSTALLATION (Continued)**All vehicles**

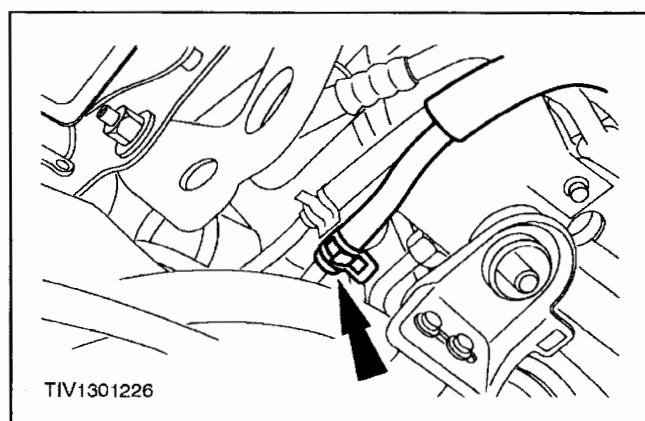
14. Connect the tie-rod ends.



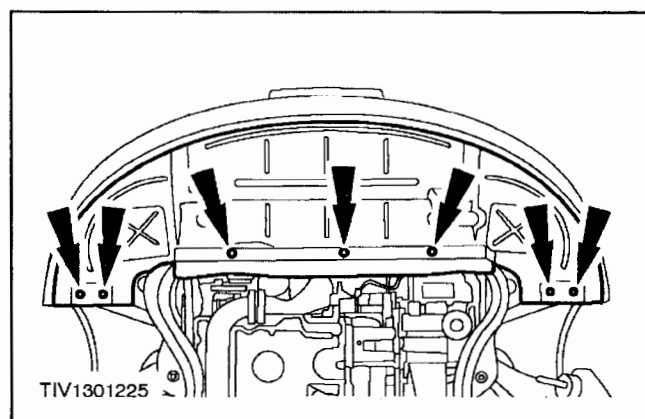
15. Install the two splash shields.

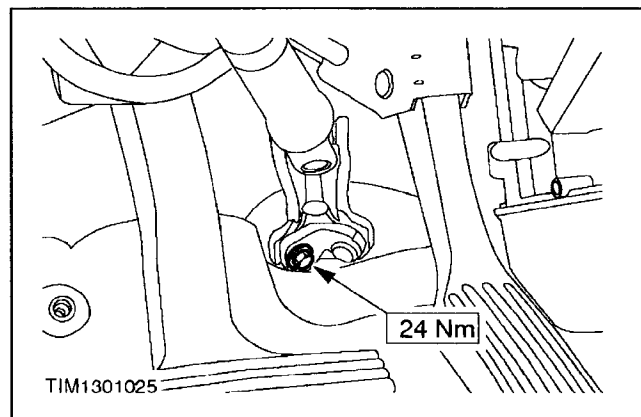
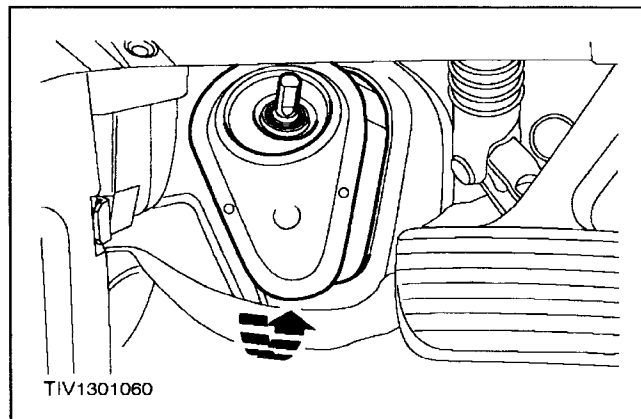
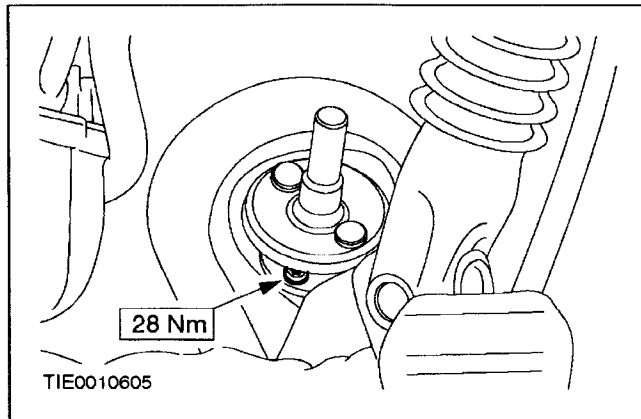


16. Connect the fluid cooler line.



17. Install the radiator splash shield.



REMOVAL AND INSTALLATION (Continued)

18. **NOTE:** Make sure the steering is in the straight ahead position before lowering the vehicle.

Install the front wheel and tire. For additional information, refer to Section 204-04.

19. **WARNING:** Install a new pinch bolt. Failure to follow this instruction may result in personal injury.
Install the steering column shaft flexible coupling.

20. Install the floor seal.

21. **WARNING:** Install a new pinch bolt. Failure to follow this instruction may result in personal injury.
Connect the steering column shaft to the flexible coupling.

22. Connect the battery ground cable.

23. Fill the power steering system. For additional information, refer to Start Up Procedure After Power Steering Pump/Gear Overhaul in this section.

SECTION 211-03 Steering Linkage

CONTENTS	PAGE
SPECIFICATIONS	211-03-2
DESCRIPTION AND OPERATION	
Steering Linkage.....	211-03-2
DIAGNOSIS AND TESTING	
Steering Linkage.....	211-03-3
REMOVAL AND INSTALLATION	
Tie Rod End	211-03-3
Steering Gear Boot	211-03-4

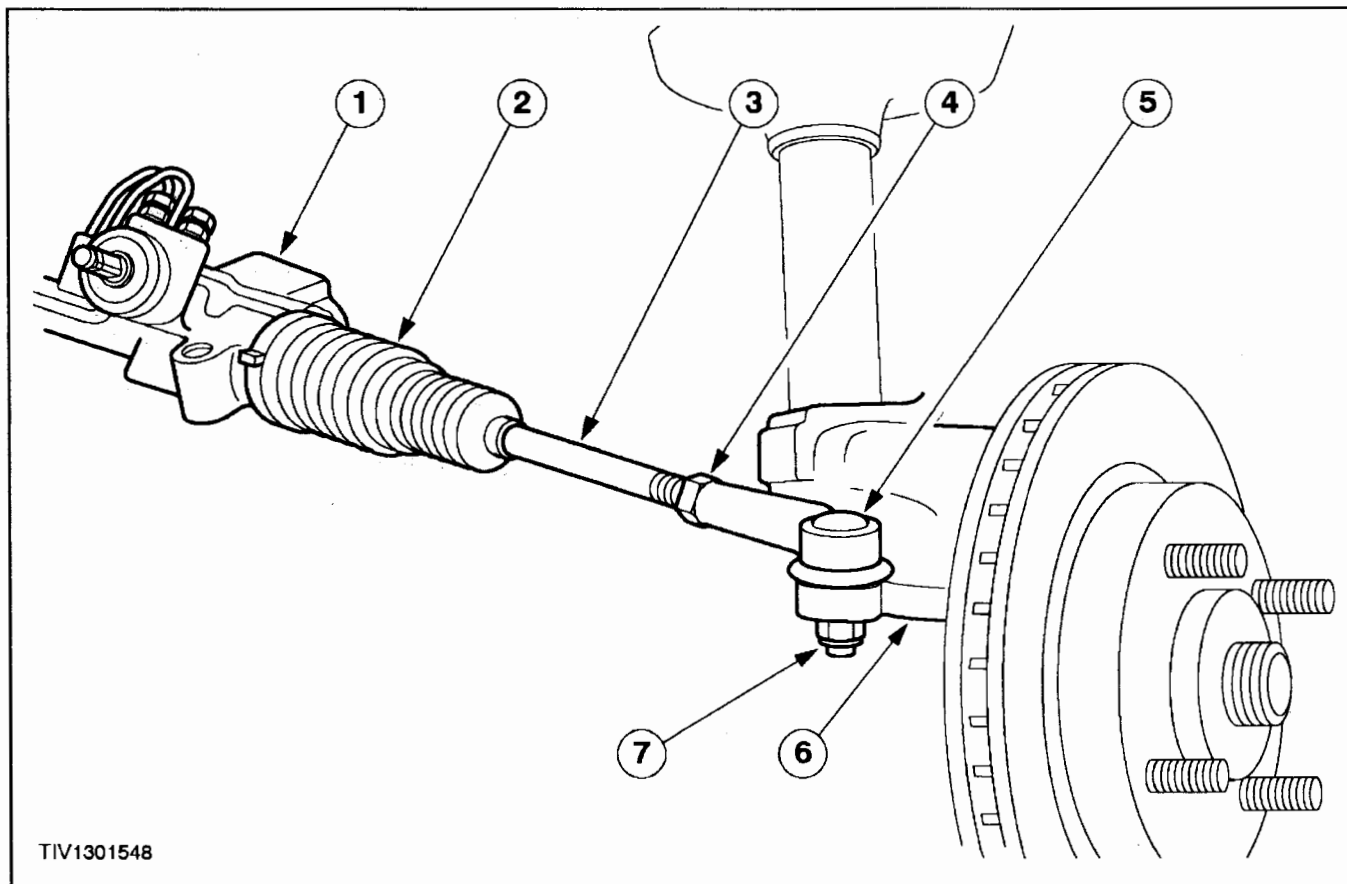
SPECIFICATIONS

Torque Specifications

Description	Nm	Lb-Ft
Tie-rod end retaining nut	47	35
Tie-rod end locknut	41	30
Wheel nuts — steel/alloy wheels	128	94

DESCRIPTION AND OPERATION

Steering Linkage



Item	Part Number	Description
1	—	Steering gear
2	—	Boot
3	—	Tie-rod
4	—	Tie-rod end locknut

(Continued)

Item	Part Number	Description
5	—	Tie-rod end
6	—	Wheel knuckle
7	—	Tie-rod end retaining nut

DIAGNOSIS AND TESTING

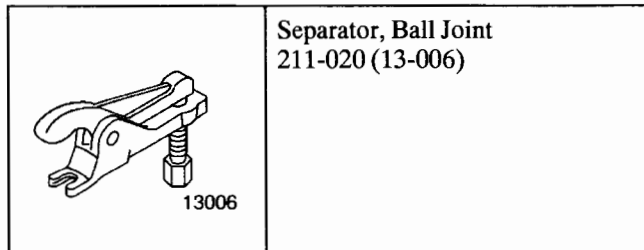
Steering Linkage

Refer to Section 211-00.

REMOVAL AND INSTALLATION

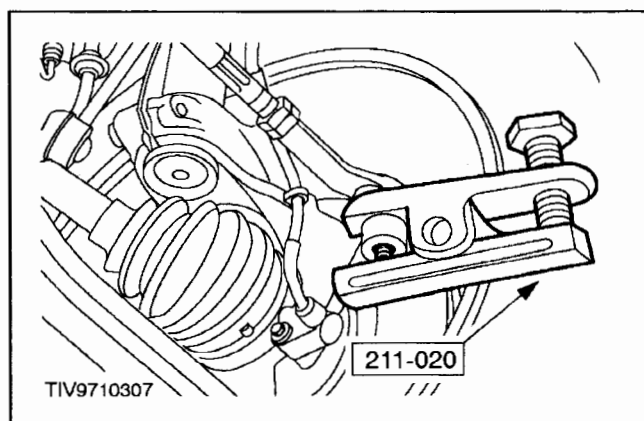
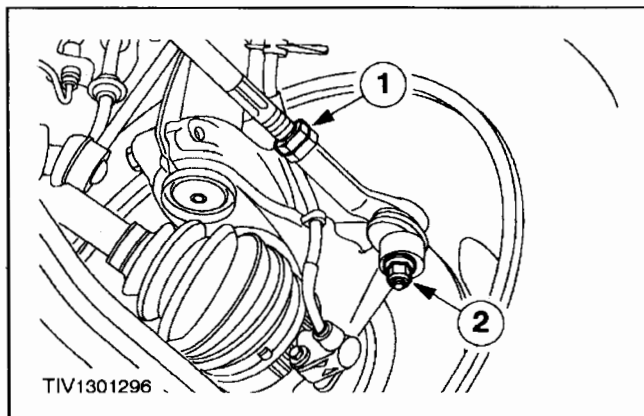
Tie Rod End

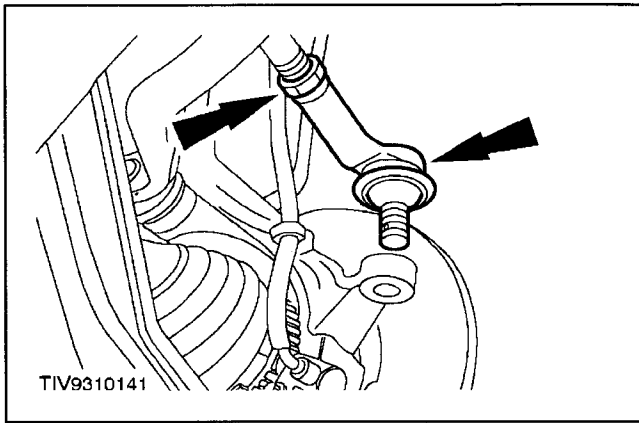
Special Tool(s)



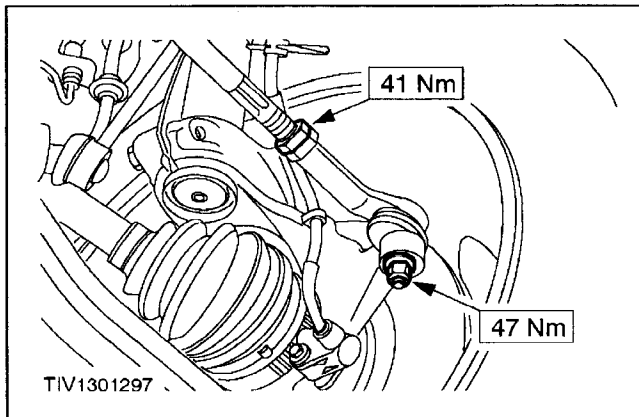
Removal

1. Raise and support vehicle. For additional information, refer to Section 100-02.
2. Loosen the tie-rod end locknut and remove the retaining nut.
 - 1 Loosen the locknut.
 - 2 Remove the retaining nut.
3. **NOTE:** When the tie-rod end is separated from the wheel knuckle the ball joint seal should be protected to prevent damage.
Using the special tool, detach the tie-rod end from the wheel knuckle.



REMOVAL AND INSTALLATION (Continued)

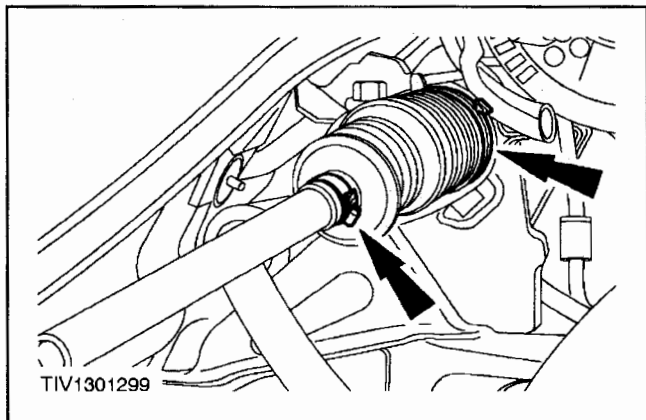
4. **NOTE:** Make a note of the number of turns required to remove the tie-rod end.
Remove the tie-rod end and locknut.

Installation

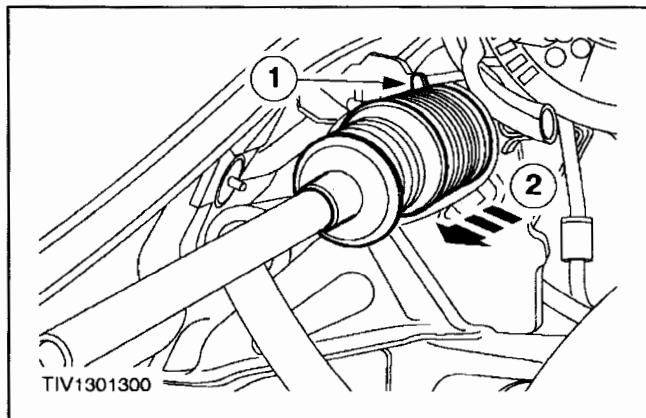
1. **NOTE:** Make sure the tie-rod end is secured by the same number of turns used to remove it.
To install, reverse the removal procedure.
 - After installation, check the toe adjustment. For additional information, refer to Section 204-00.

Steering Gear Boot**Removal**

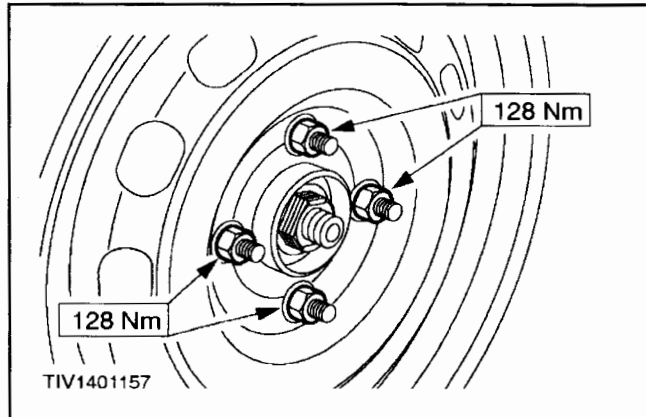
1. Loosen the front wheel nuts.
2. Raise and support the vehicle. For additional information, refer to Section 100-02.
3. Remove the front wheel.
4. Remove the tie-rod end. For additional information, refer to Tie Rod End in this section.

REMOVAL AND INSTALLATION (Continued)

5. Remove the boot clamps.



6. Remove the boot.
- 1 Disconnect the breather pipe.
 - 2 Ease the boot off the tie-rod.

Installation

1.  **CAUTION:** Make sure the tie-rod is clean before installing the boot.
- NOTE:** Install the boot using new clamps.
- To install, reverse the removal procedure.

SECTION 211-04 Steering Column

CONTENTS	PAGE
SPECIFICATIONS	211-04-2
DESCRIPTION AND OPERATION	
Steering Column	211-04-2
DIAGNOSIS AND TESTING	
Steering Column	211-04-3
REMOVAL AND INSTALLATION	
Steering Wheel	211-04-3
Air Bag Sliding Contact	211-04-4
Steering Column	211-04-4
Steering Column Flexible Coupling	211-04-7

SPECIFICATIONS

Torque Specifications

Description	Nm	Lb-Ft
Steering wheel bolt	50	37
Steering column bolts	24	18
Flexible coupling to steering column shaft clamp plate bolt	24	18

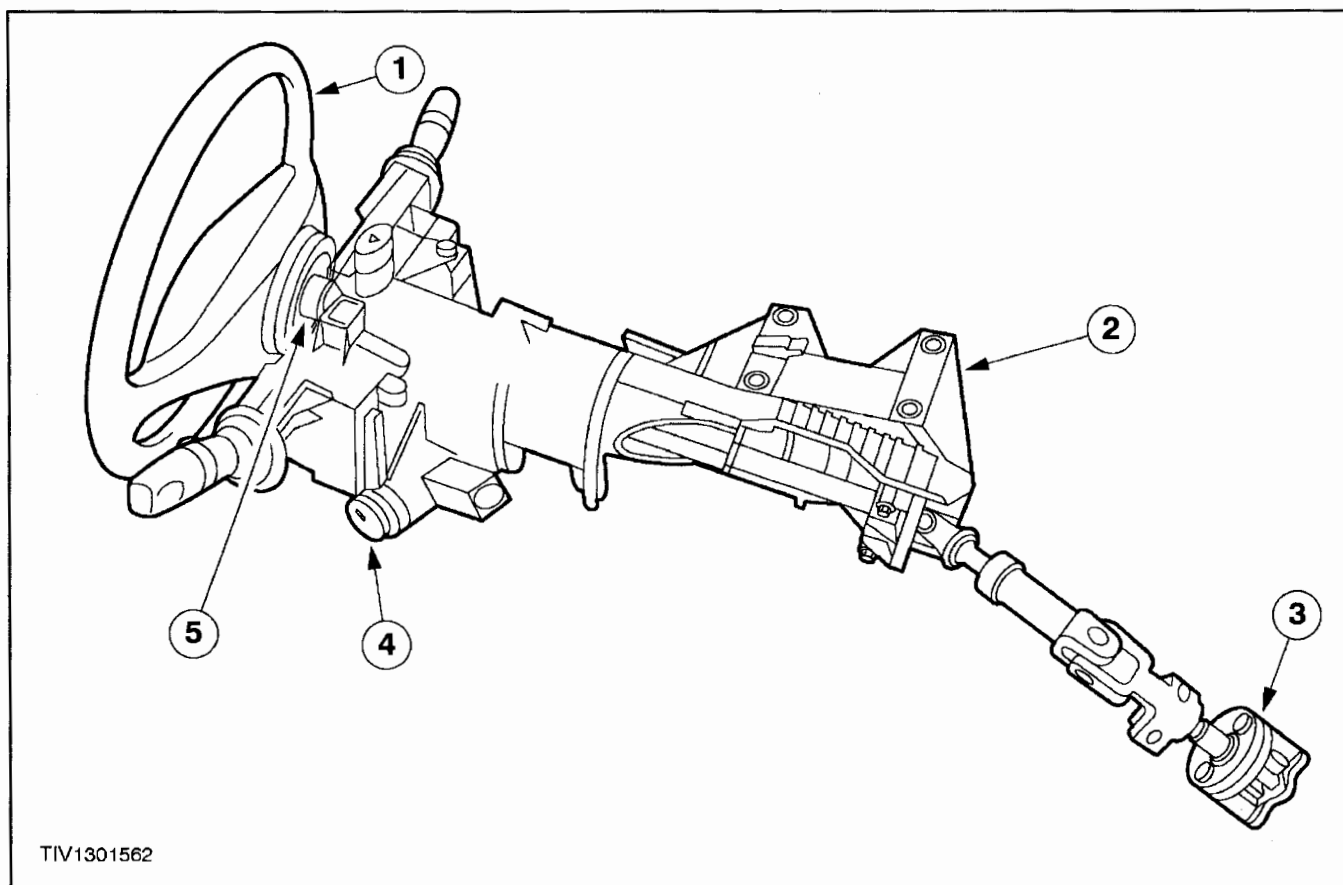
(Continued)

Torque Specifications

Description	Nm	Lb-Ft
Flexible coupling to steering gear pinion shaft pinch bolt	19	14
Lower bearing retaining collar bolts	23	17

DESCRIPTION AND OPERATION

Steering Column



TIV1301562

Item	Part Number	Description
1	—	Steering wheel
2	—	Steering column assembly
3	—	Flexible coupling

(Continued)

Item	Part Number	Description
4	—	Ignition switch lock cylinder
5	—	Air bag sliding contact

DIAGNOSIS AND TESTING

Steering Column

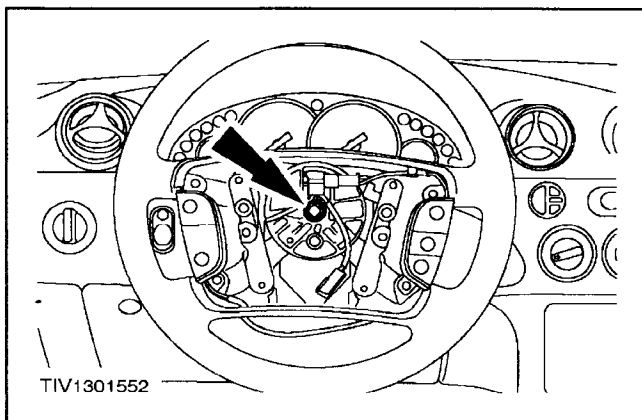
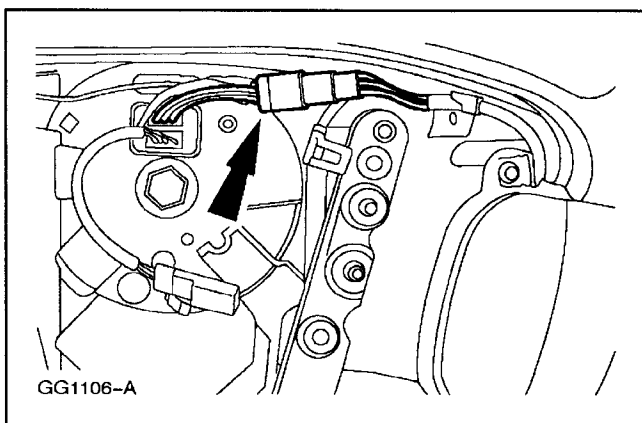
Refer to Section 211-00.

REMOVAL AND INSTALLATION

Steering Wheel

Removal

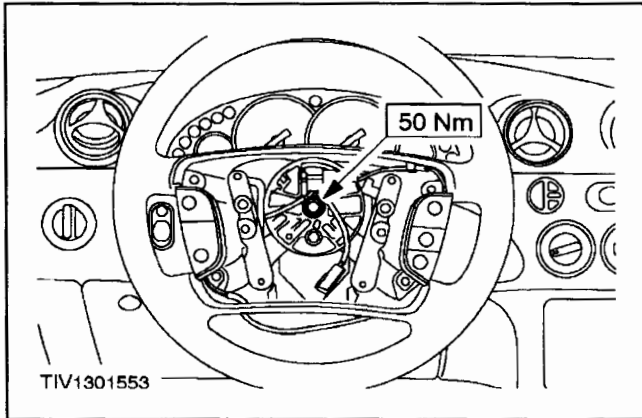
1. Remove the air bag module. For additional information, refer to Section 501-20B.
2. Disconnect the speed control electrical connector.



3. Remove the steering wheel.

REMOVAL AND INSTALLATION (Continued)**Installation**

1. To install, reverse the removal procedure.

**Air Bag Sliding Contact****Removal and Installation**

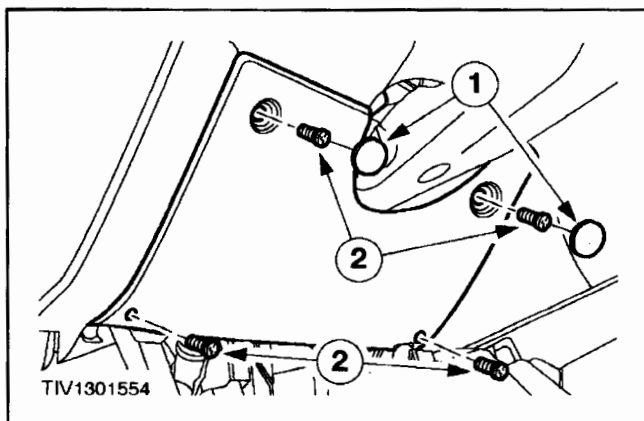
For additional information, refer to Section 501-20B.

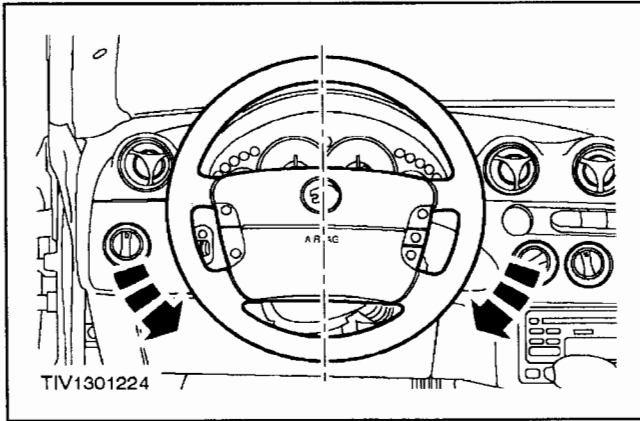
Steering Column**Removal**

1.  **WARNING:** When the battery ground cable has been disconnected wait at least two minutes before proceeding to avoid the possibility of accidentally deploying the air bag(s). Disconnect the battery ground cable. Failure to follow these instructions may result in personal injury.

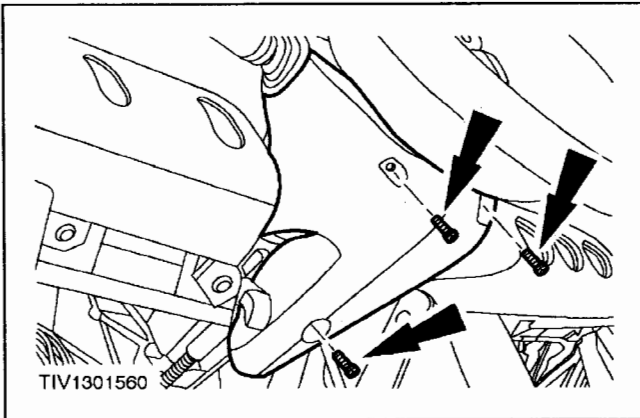
Disconnect the battery ground cable.

2. Remove the driver side instrument panel lower panel.
 - 1 Remove the screw covers.
 - 2 Remove the screws.

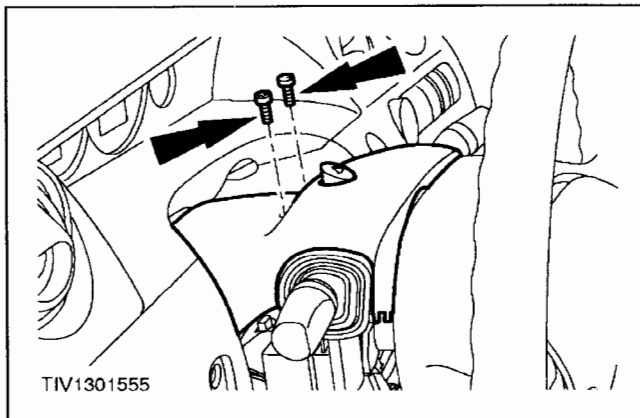


REMOVAL AND INSTALLATION (Continued)

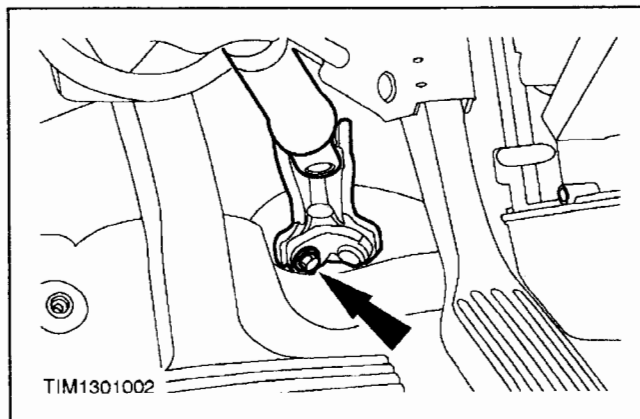
3. Center the steering wheel.
 - Lock in position, remove the ignition key.



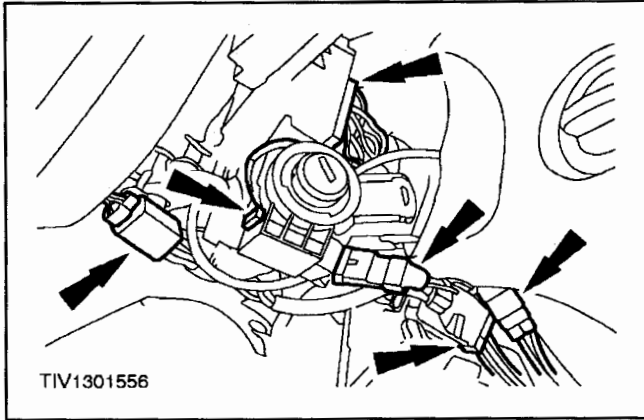
4. Remove the steering column lower shroud.



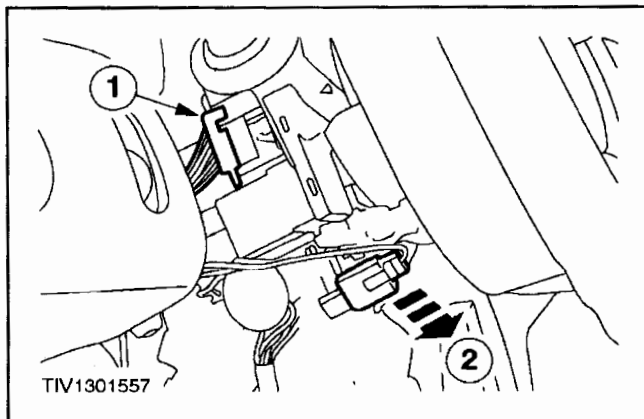
5. Remove the steering column upper shroud.



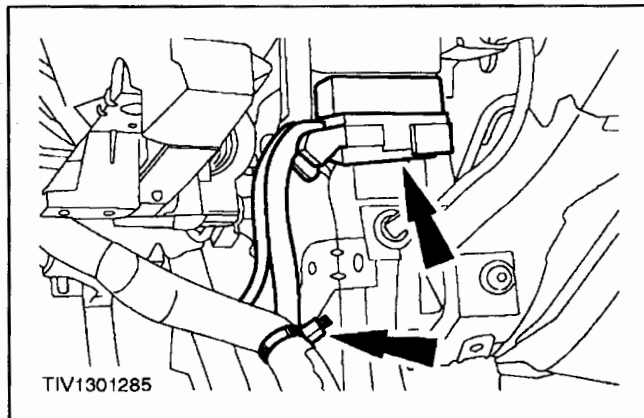
6. Disconnect the steering column shaft from the flexible coupling.
 - Rotate the clamp plate to disengage.

REMOVAL AND INSTALLATION (Continued)

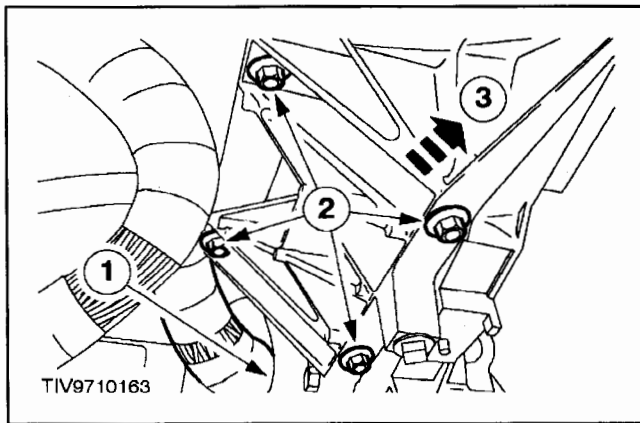
7. Disconnect the electrical connectors on the right-hand side of the steering column.
 - Disconnect the windshield wiper switch electrical connector.
 - Disconnect the air bag module electrical connector.
 - Disconnect the ignition switch electrical connector.
 - Disconnect the passive anti-theft system transceiver electrical connector.
 - Disconnect the speed control electrical connector.
 - Disconnect the key release interlock actuator electrical connector (if equipped).



8. Disconnect the electrical connectors on the left-hand side of the steering column.
 - 1 Disconnect the turn signal/flash to pass switch electrical connector.
 - 2 Detach the speed control electrical connector.

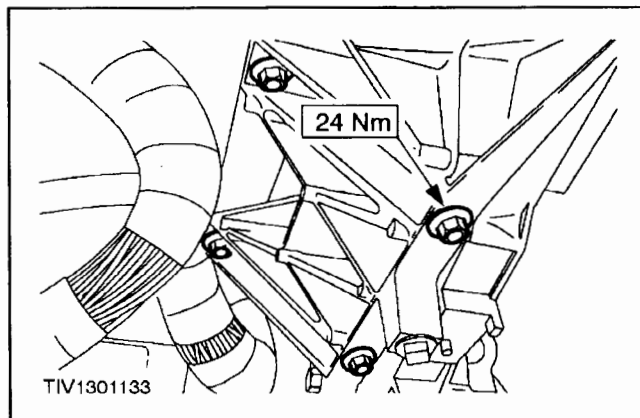


9. Disconnect the air bag control module electrical connector.
 - Cut the cable tie.

REMOVAL AND INSTALLATION (Continued)

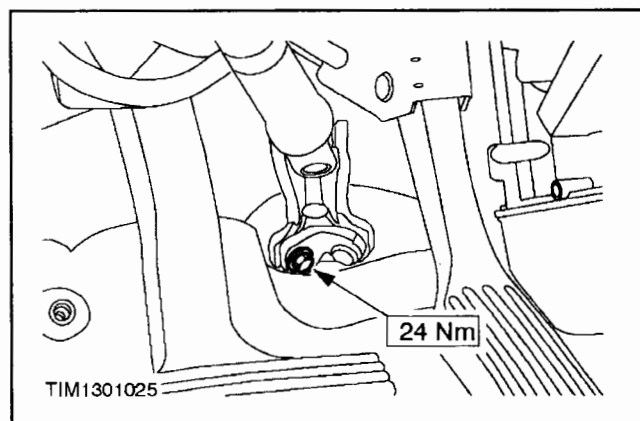
10. Remove the steering column.

- 1 Unclip the wiring harness.
- 2 Remove the bolts.
- 3 Slide the steering column outwards to disengage the retaining tab.

Installation

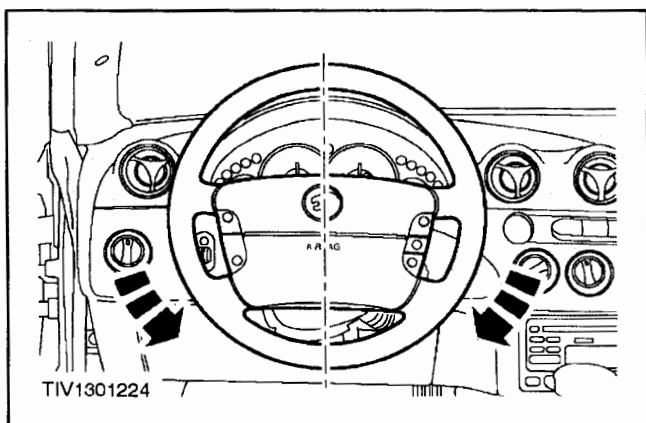
1.  **WARNING: Install a new pinch bolt.**
Failure to follow this instruction may result in personal injury.

To install, reverse the removal procedure.

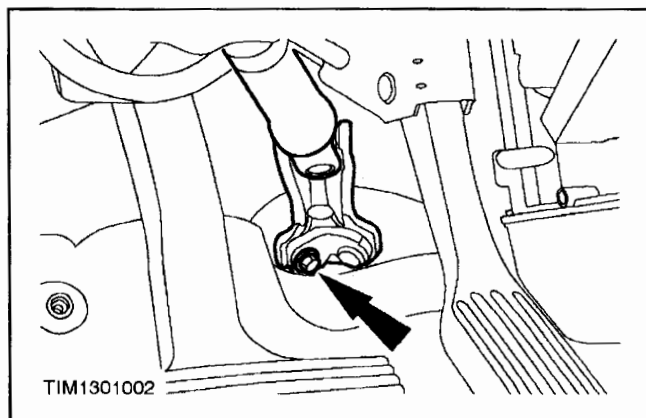
**Steering Column Flexible Coupling****Removal**

NOTE: Left-hand drive shown, right-hand drive similar

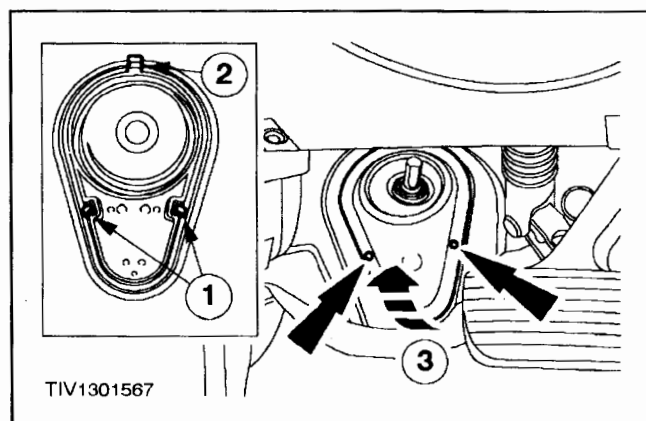
1. Disconnect the battery ground cable.

REMOVAL AND INSTALLATION (Continued)

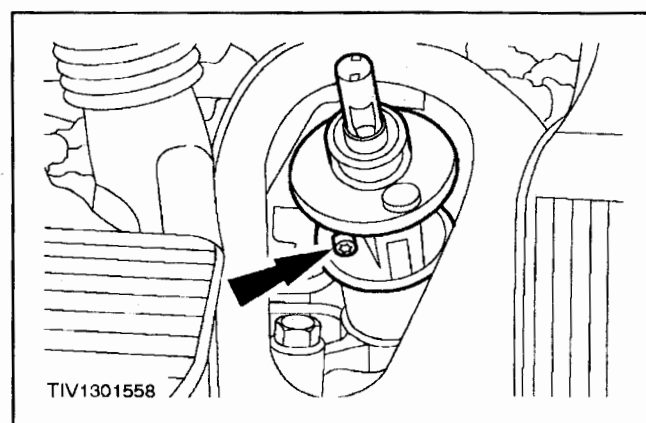
2. Center the steering wheel.
 - Lock in position, remove the ignition key.



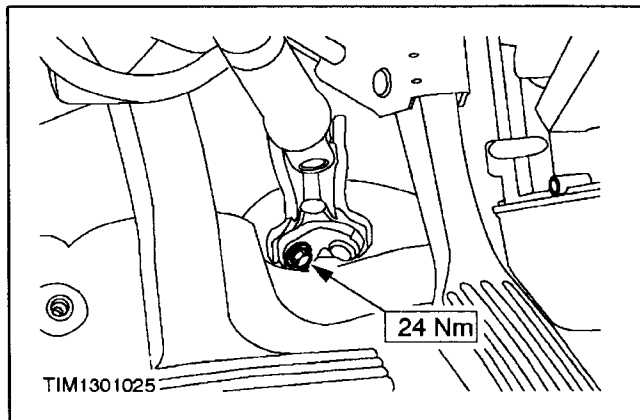
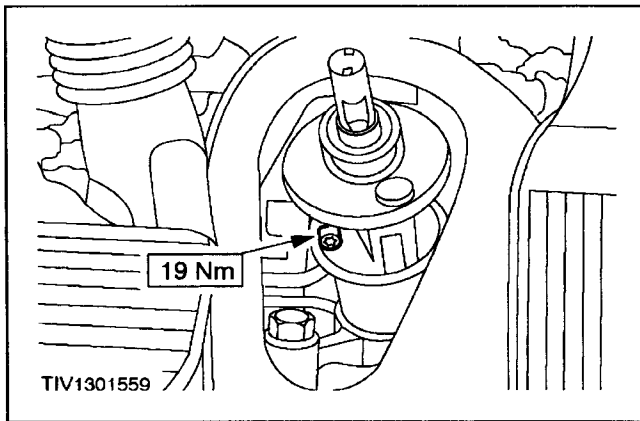
3. Disconnect the steering column shaft from the flexible coupling.
 - Rotate the clamp plate to disengage.



4.  **CAUTION: When removing the floor seal do not damage the sealing clips.**
Remove the floor seal from the bulkhead.
 - 1 Release the retaining clips.
 - 2 Disconnect the upper retaining clip.
 - 3 Remove the floor seal.



5. Remove the steering column shaft flexible coupling.

REMOVAL AND INSTALLATION (Continued)**Installation**

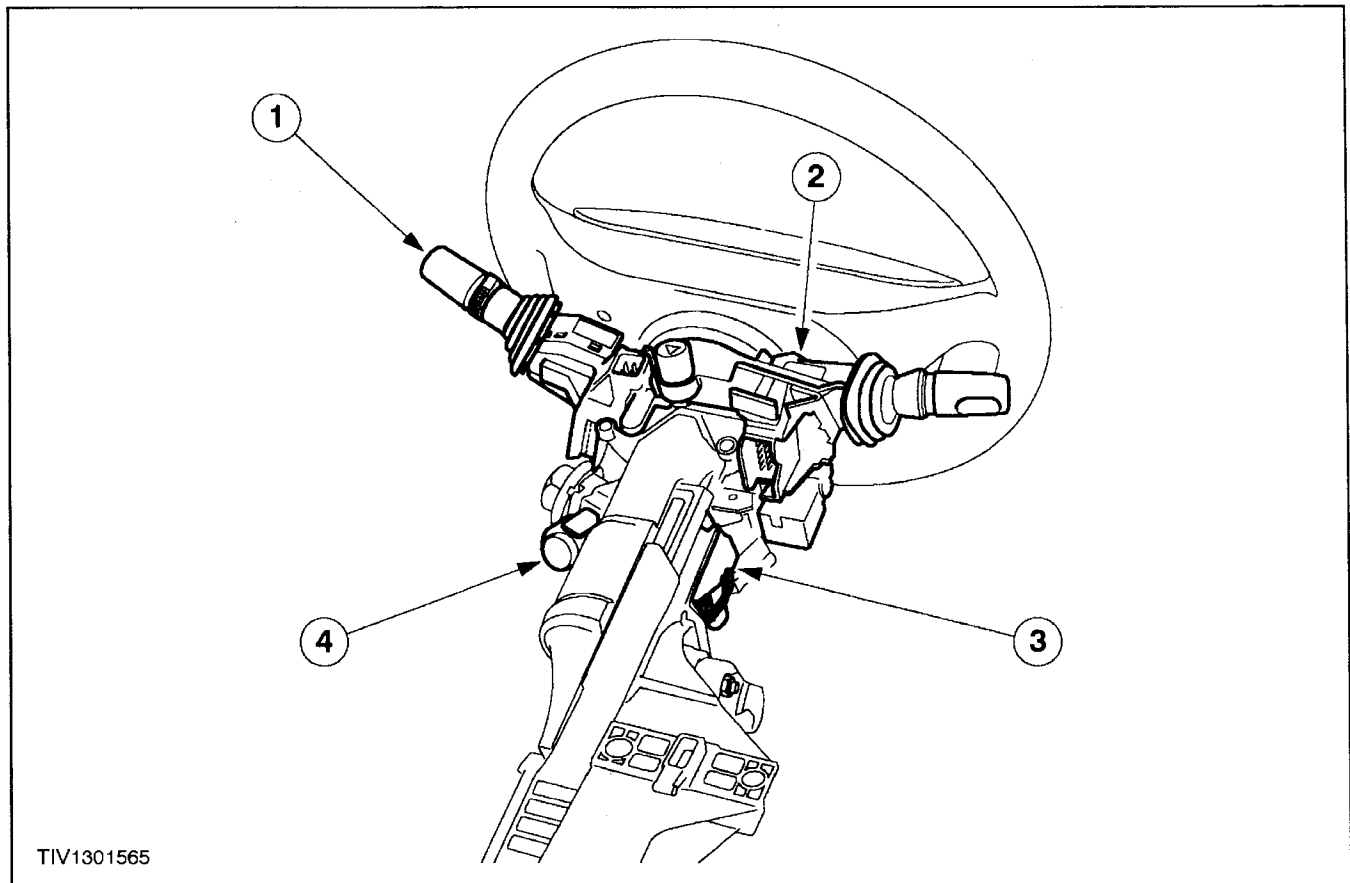
1.  **WARNING:** Install new pinch bolts. Failure to follow this instruction may result in personal injury.
To install, reverse the removal procedure.

SECTION 211-05 Steering Column Switches

CONTENTS	PAGE
DESCRIPTION AND OPERATION	
Steering Column Switches	211-05-2
DIAGNOSIS AND TESTING	
Steering Column Switches	211-05-2
Inspection and Verification	211-05-2
Symptom Chart	211-05-3
Pinpoint Tests	211-05-3
REMOVAL AND INSTALLATION	
Ignition Switch	211-05-6
Key Release Interlock Actuator	211-05-6

DESCRIPTION AND OPERATION

Steering Column Switches



Item	Part Number	Description
1		Wiper/washer switch
2		Turn signal/flash to pass switch

(Continued)

Item	Part Number	Description
3		Ignition switch
4		Key release interlock actuator

DIAGNOSIS AND TESTING

Steering Column Switches

Inspection and Verification

1. Verify the customer concern.
2. Visually inspect for obvious signs of mechanical or electrical damage.

Visual Inspection Chart

Electrical
— Fuse(s).
— Wiring harness.
— Electrical connector(s).
— Switch(es).
— Battery.

3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
4. If the cause is not visually evident, verify the cause and refer to the Symptom Chart.

DIAGNOSIS AND TESTING (Continued)**Symptom Chart****Symptom Chart**

Condition	Possible Sources	Action
The ignition switch is inoperative	- Ignition switch. - Circuit(s).	- CARRY OUT the Ignition Switch Component Test. REFER to the Wiring Diagram. - GO to Pinpoint Test A.
No power in ACC	- Ignition switch. - Circuit(s).	- CARRY OUT the Ignition Switch Component Test. REFER to the Wiring Diagrams. - GO to Pinpoint Test B.
No power in RUN	- Ignition switch. - Circuit(s).	- CARRY OUT the Ignition Switch Component Test. REFER to the Wiring Diagrams. - GO to Pinpoint Test C.
No power in START	- Ignition Switch. - Circuit(s).	- CARRY OUT the Ignition Switch Component Test. REFER to the Wiring Diagrams - GO to Pinpoint Test D.
The multifunction switch does not operate correctly	- Switch(es). - Circuit(s).	- REFER to Section 417-01. - REFER to Section 501-16. - REFER to Section 417-01. - REFER to Section 501-16.

Pinpoint Tests

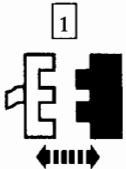
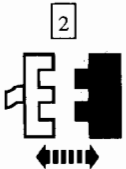
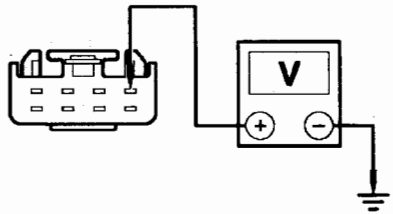
NOTE: Use a digital multimeter for all electrical measurements.

PINPOINT TEST A: THE IGNITION SWITCH IS INOPERATIVE

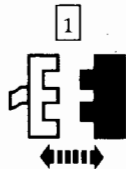
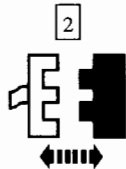
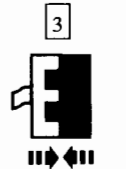
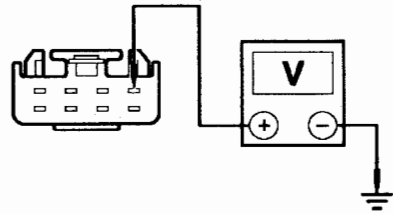
CONDITIONS	DETAILS/RESULTS/ACTIONS
A1 CHECK THE IGNITION SWITCH ELECTRICAL CONNECTOR	
	1 Remove the steering column shrouds. 2 Check the ignition switch electrical connector. - Is the ignition switch electrical connector clean and secure? → Yes GO to A2. → No CLEAN and SECURE the ignition switch electrical connector. TEST the system for normal operation.

(Continued)

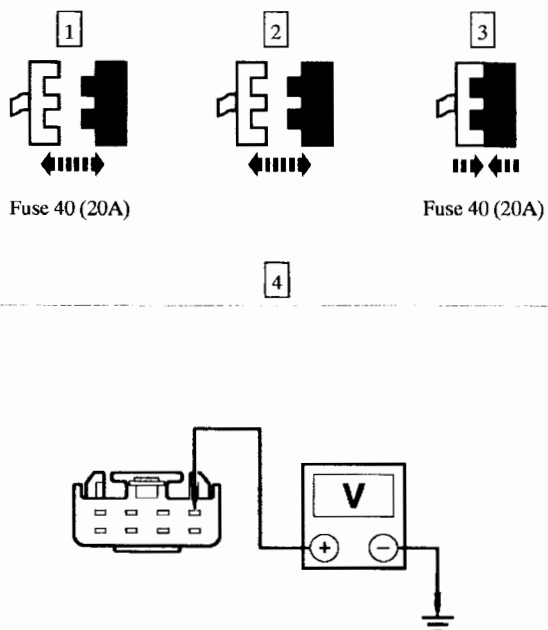
DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST A: THE IGNITION SWITCH IS INOPERATIVE (Continued)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
A2 CHECK FOR VOLTAGE IN CIRCUIT 30-BB9 (RD)	
 1 Fuse 40 (20A)  2 Ignition Switch C456  3 Fuse 40 (20A)  4 TIE0014973	4 Measure the voltage between the ignition switch C456 pin 1, circuit 30-BB9 (RD) harness side and ground. • Is the voltage greater than 10 volts? → Yes VERIFY the customers concern. → No REPAIR the circuit. TEST the system for normal operation.

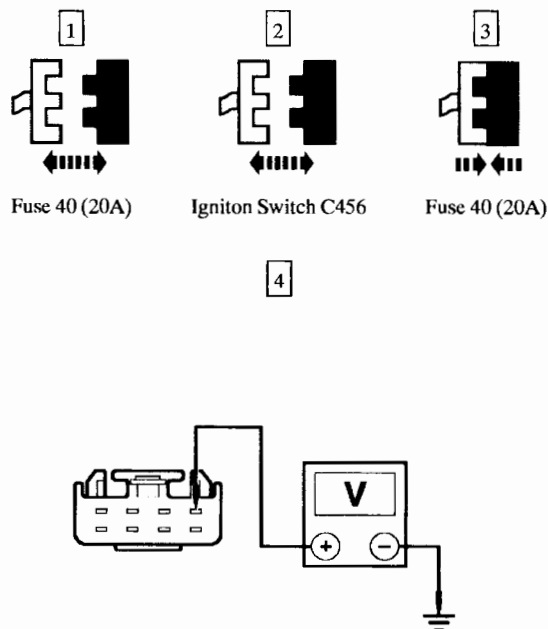
PINPOINT TEST B: NO POWER IN ACC

CONDITIONS	DETAILS/RESULTS/ACTIONS
B1 CHECK FOR VOLTAGE ON CIRCUIT 30-BB9 (RD)	
 1 Fuse 40 (20A)  2 Ignition Switch C456  3 Fuse 40 (20A)  4 TIE0014973	4 Measure the voltage between the ignition switch C456 pin 1, circuit 30-BB9 (RD) harness side and ground. • Is the voltage greater than 10 volts? → Yes REPAIR circuit 75-MD15 (YE/GN). TEST the system for normal operation. → No REPAIR circuit 30-BB9 (RD). TEST the system for normal operation.

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST C: NO POWER IN RUN**

CONDITIONS	DETAILS/RESULTS/ACTIONS
C1 CHECK FOR VOLTAGE ON CIRCUIT 30-BB9 (RD)	
 1 2 3 Fuse 40 (20A) Fuse 40 (20A) 4 TIE0014973	4 Measure the voltage between the ignition switch C456 pin 1, circuit 30-BB9 (RD) harness side and ground. Is the voltage greater than 10 volts? → Yes REPAIR the circuits 15-DA1 (GN/YE) and 15-DA2 (GN/BU). TEST the system for normal operation. → No REPAIR the circuit 30-BB9 (RD). TEST the system for normal operation.

PINPOINT TEST D: NO POWER IN START

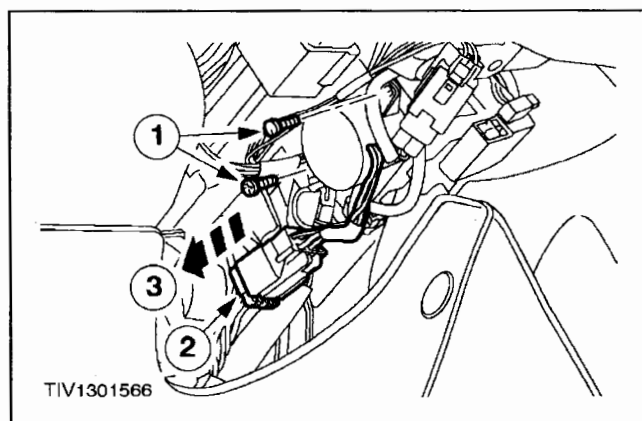
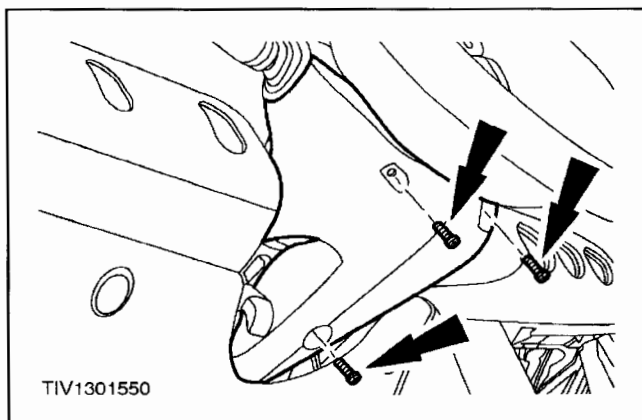
CONDITIONS	DETAILS/RESULTS/ACTIONS
D1 CHECK FOR VOLTAGE ON CIRCUIT 30-BB9 (RD)	
 1 2 3 Fuse 40 (20A) Igniton Switch C456 Fuse 40 (20A) 4 TIF0014973	4 Measure the voltage between the ignition switch C456 pin 1, circuit 30-BB9 (RD) harness side and ground. Is the voltage greater than 10 volts? → Yes REPAIR circuit 50-BB11 (GY/WH). TEST the system for normal operation. → No REPAIR circuit 30-BB9 (RD). TEST the system for normal operation.

REMOVAL AND INSTALLATION

Ignition Switch

Removal

1. Disconnect the battery ground cable.
2. Remove the steering column lower shroud.



3. Remove the ignition switch.
 - 1 Remove the two screws.
 - 2 Disconnect the electrical connector.
 - 3 Detach the electrical connector.

Installation

1. To install, reverse the removal procedure.

Key Release Interlock Actuator

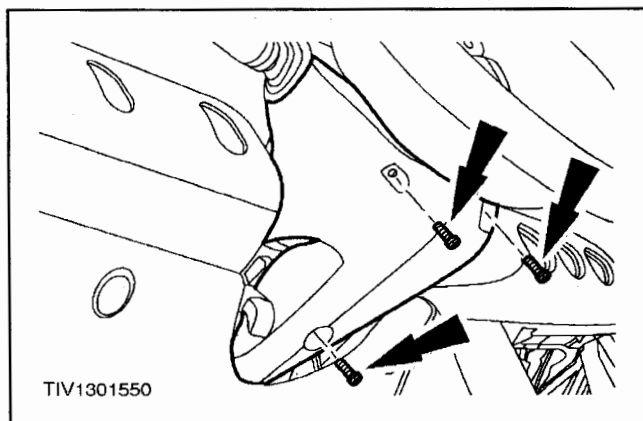
General Equipment

Electric hand drill
Stud extractor

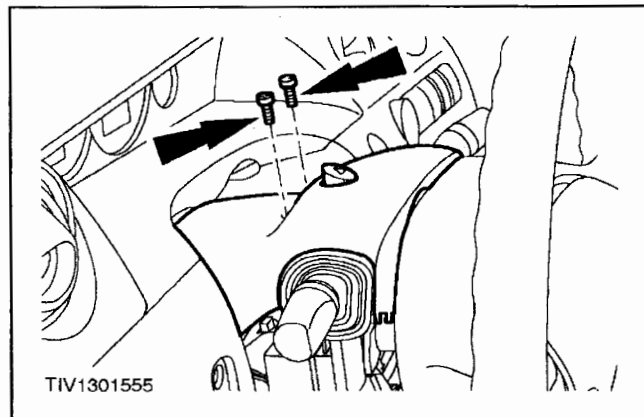
Removal

Vehicles with 2.0L engine

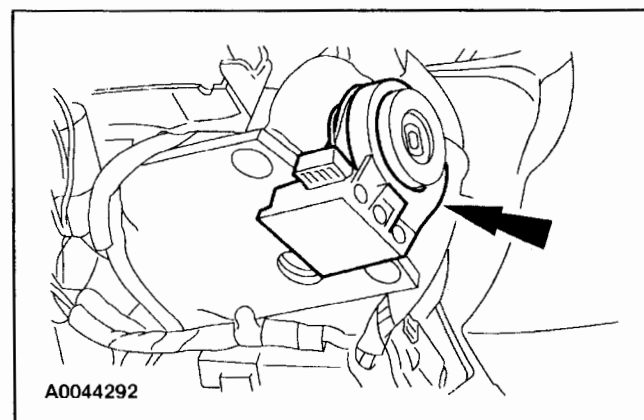
1. Disconnect the battery ground cable. For additional information, refer to Section 414-01.

REMOVAL AND INSTALLATION (Continued)

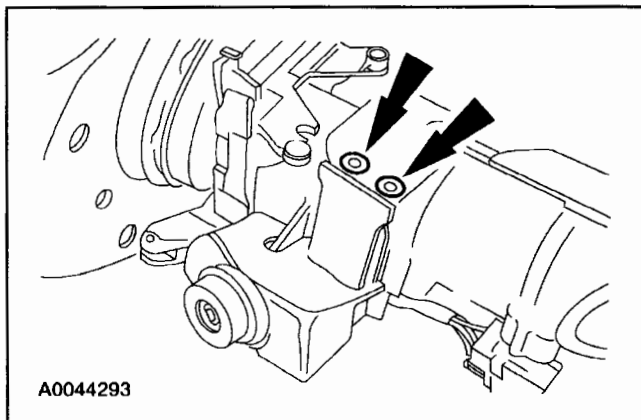
2. Remove the steering column lower shroud from the steering column.



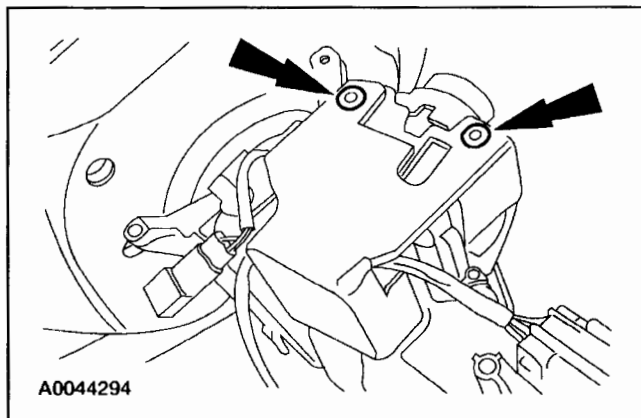
3. Remove the steering column upper shroud from the steering column.

**Vehicles with 2.5L engine**

4. Remove the steering column. For additional information, refer to Section 211-04.
5. Remove the passive anti-theft system (PATS) transceiver ignition switch assembly.

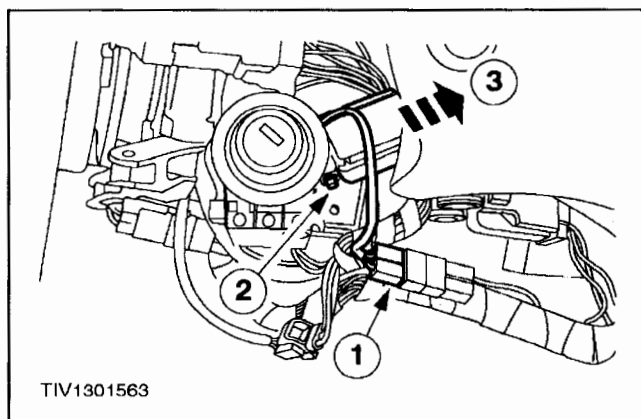
REMOVAL AND INSTALLATION (Continued)

6. Using a suitable electric hand drill and stud extractor, remove the upper steering lock shield retaining bolts.

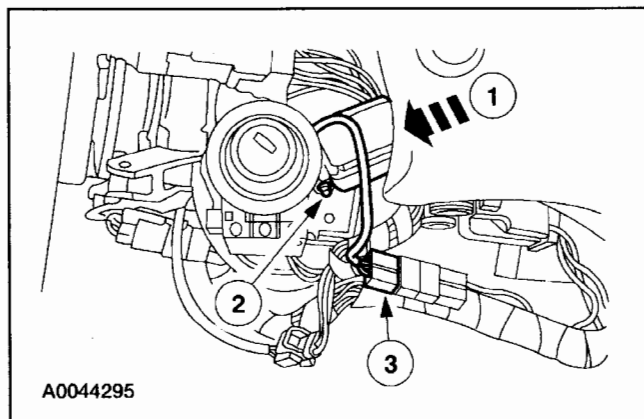


7. Using a suitable electric drill and stud extractor, remove the lower steering lock shield retaining bolts.

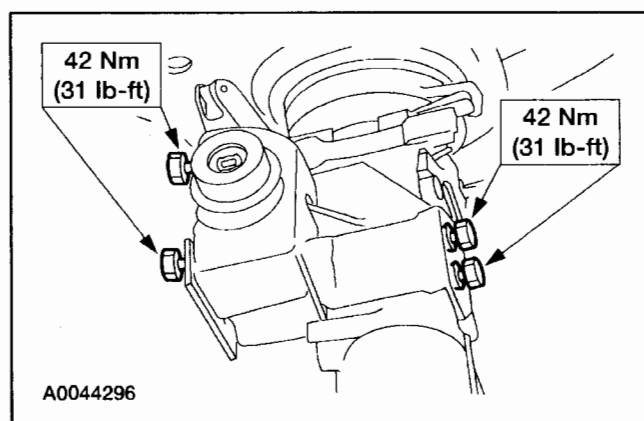
8. Remove the steering lock shield.

All vehicles

9. Remove the key release interlock actuator.
- 1 Disconnect the key release interlock actuator electrical connector.
 - 2 Remove the key release interlock actuator.
 - 3 Remove the key release interlock actuator retaining screw.

REMOVAL AND INSTALLATION (Continued)**Installation****All vehicles**

1. Install the key release interlock actuator.
 - 1 Install the key release interlock actuator.
 - 2 Install the key release interlock actuator screw.
 - 3 Connect the key release interlock actuator electrical connector.

Vehicles with 2.5L engine

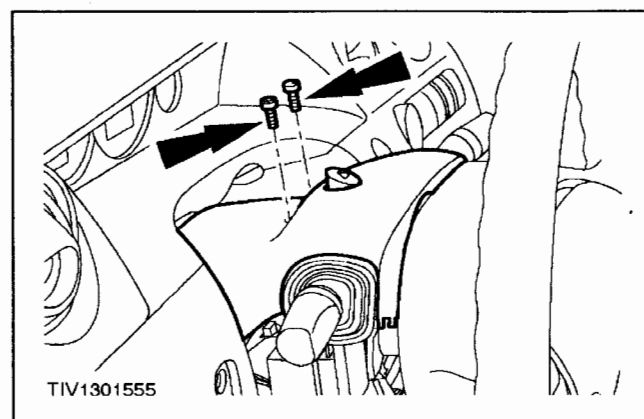
2.  **CAUTION:** When installing the steering lock shield make sure that no cables are trapped or damaged.

NOTE: The steering lock shield retaining bolts are designed to shear at the specified torque.

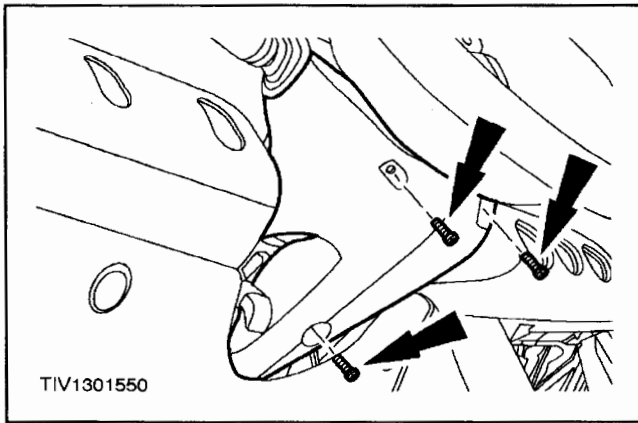
NOTE: The steering lock shield retaining bolts must be hand started before tightening with a power tool.

Install the steering lock shield.

3. Install the steering column. For additional information, refer to Section 211-04.

Vehicles with 2.0L engine

4. Install the steering column upper shroud to the steering column.

REMOVAL AND INSTALLATION (Continued)

5. Install the steering column lower shroud to the steering column.
6. Connect the battery ground cable. For additional information, refer to Section 414-01.

