SERVICE MANUAL SECTION

CF 500, CF 600 — General

Truck Model: CF 500
Truck Model: CF 600

S10019

05/03/2005

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Safety Information

NOTE: Read the following before starting the service procedure.

The information contained in this International Service Manual Section was current at the time of printing and is subject to change without notice or liability.

You must follow your company safety procedures when you service or repair equipment. Be sure to understand all of the procedures and instructions before you begin work on the unit.

International uses the following types of notations to give warning of possible safety problems and to give information that will prevent damage to the equipment being serviced or repaired.

WARNING: A warning indicates procedures that must be followed exactly. Personal injury or possible death can occur if the procedure is not followed.

CAUTION: A caution indicates procedures that must be followed exactly. If the procedure is not followed, damage to equipment or components can occur.

NOTE: A note indicates an operation, procedure or instruction that is important for correct service.

Some procedures require the use of special tools for safe and correct service. Failure to use these special tools when required can cause injury to service personnel or damage to vehicle components.

This service manual section is intended for use by professional technicians, NOT a "**do-it-yourselfer**." It is written to inform these technicians of conditions that may occur on some vehicles, or to provide information that could assist in the proper service of a vehicle. Properly trained technicians have the equipment, tools, safety instructions, and know-how to do a job properly and safely. If a condition is described, DO NOT assume that the service section applies to your vehicle. See your International Truck Dealer for information on whether this service section applies to your vehicle.

Jacking and Lifting

Description and Operation

Jacking Points

WARNING: Do not run the engine when jacking the vehicle. The wheels contacting the ground could cause the vehicle to move.

WARNING: Make sure the jack is correctly positioned to prevent the vehicle from falling.

WARNING: Wheel chocks should be used to prevent the vehicle from rolling and falling off the jack.

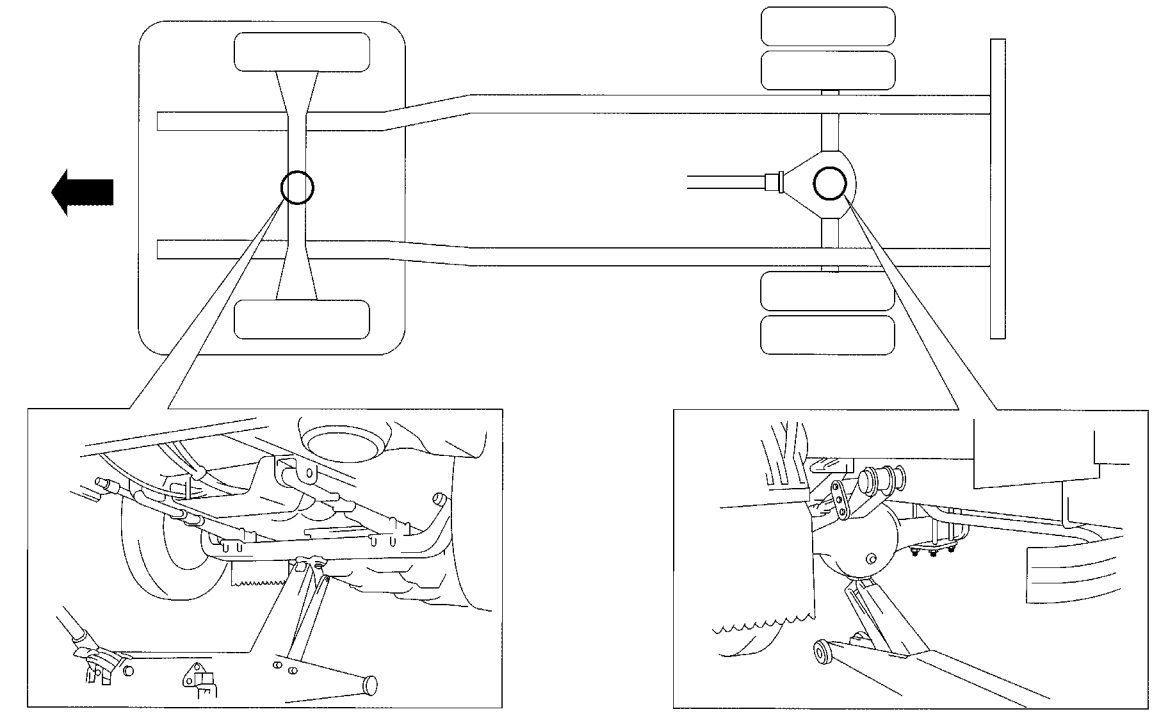

Figure 1 Jacking Points

Position the floor jack and raise the vehicle at the points shown.

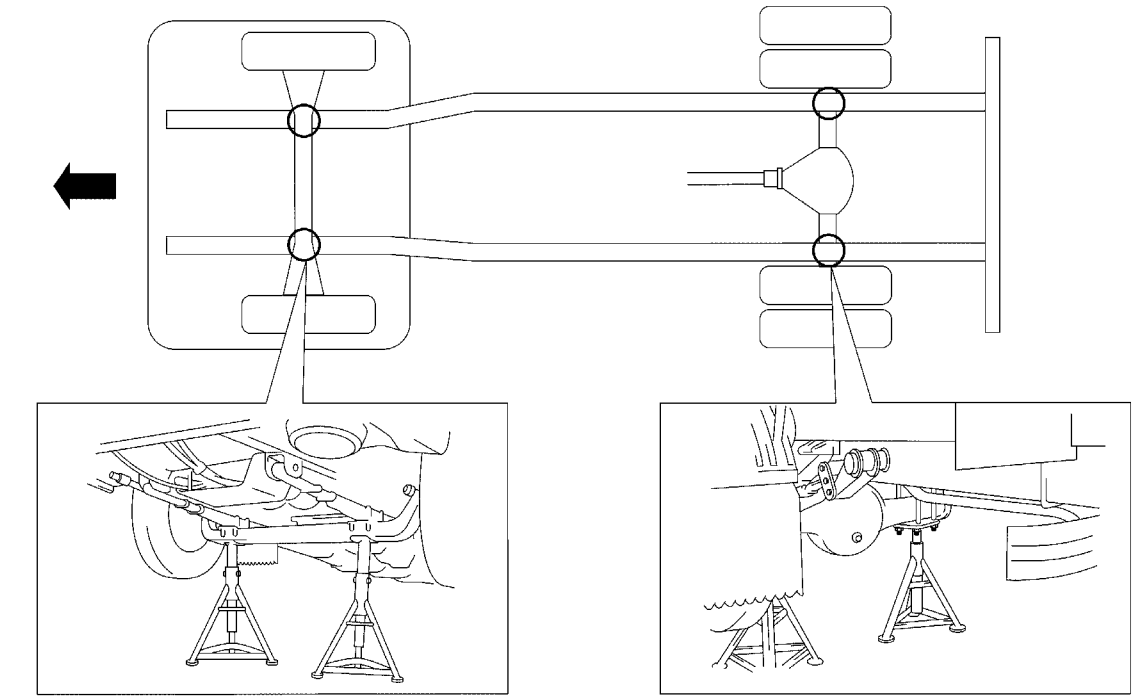

Figure 2 Support Points

After the vehicle is raised, properly support the vehicle with jack stands at the support points shown.

Refer to the owner guide for additional information on vehicle jacking.

CAUTION: Damage to suspension, exhaust and steering linkage components can occur if care is not exercised when positioning the hoist adapters prior to lifting the vehicle.

Lifting

CAUTION: When raising a vehicle on a twin-post hoist, use care when positioning the vehicle so that the hoisting forks do not interfere with the shock absorber mounting brackets or stabilizer mounting brackets (if so equipped) or cause damage to the axle carrier or rear cover.

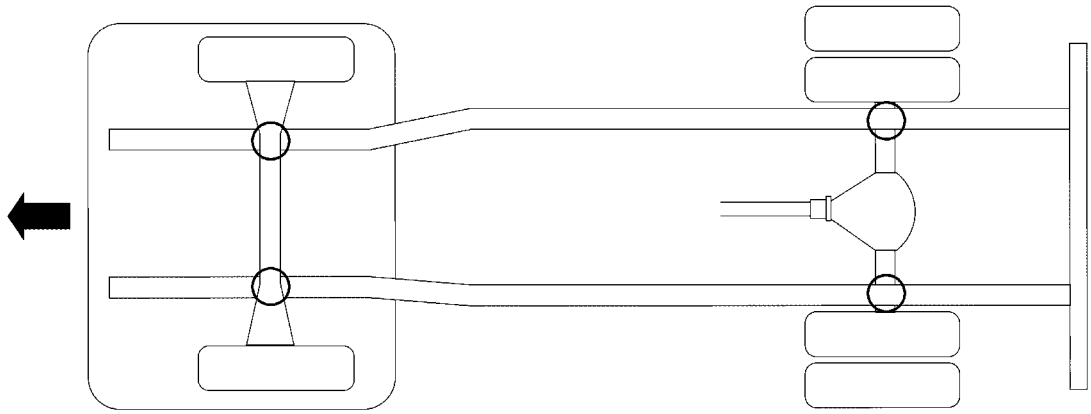

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Figure 3 Lifting Points

Raise the vehicle at the lifting points shown.

Hoist adapters for heavy-duty hoists must be positioned according to the hoist manufacturer's recommendations. Make sure the hoist has an adequate lifting capacity for the vehicle being lifted.

Noise, Vibration and Harshness (NVH)

Description and Operation

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. As a technician, it is very important to be familiar with vehicle features and know how they relate to NVH concerns and their diagnosis.

Diagnosis and Testing

Road test the vehicle to verify the NVH concern. Use the following Symptom Charts as an aid in diagnoising the NVH problem.

Symptom Charts

Table 1 Symptom Chart — Air Leak and Wind Noise

Condition	Possible Sources	Action
Air leak around door perimeter	A. Loose fit seal. B. Seal installed incorrectly. C. Door misaligned. D. Scuff plate installed incorrectly. E. Seal or seal push pins damaged.	A. PINCH the seal carrier to improve retention on the seal flange. B. REINSTALL the seal. C. REALIGN the door. CHECK door gaps and fit in the door opening and ADJUST as necessary. D. REINSTALL the scuff plate. E. INSTALL a new seal.
Air leak around glass run	A. Door glass misaligned. B. Glass run installed incorrectly. C. Leak path behind glass run. D. Glass run channel spread wide. E. Blow-out clip bent or contacting door glass. F. Glass run damaged.	A. ADJUST the door glass. B. ADJUST the glass run. INSERT foam in the glass run carrier. C. INSTALL foam rope behind the glass run. D. PINCH the glass run channel to reduce the size of the opening. E. ADJUST the blow-out clip or INSTALL a new glass run/blow-out clip molding assembly. F. INSTALL a new glass run.
Air leak at inner belt line	A. Belt line seal installed incorrectly on flange. B. Belt line seal integrated with door trim installed incorrectly (no glass contact). C. No contact with side glass. D. No contact with glass runs at both ends of belt line seal. E. Belt line seal damaged.	A. ADJUST the seal. (Do not bend the flange.) B. REINSTALL the door trim. C. ADJUST the door glass. D. ADJUST the belt line seal or ADD foam at the seal ends. E. INSTALL a new seal.

Table 1 Symptom Chart — Air Leak and Wind Noise (cont.)

Condition	Possible Sources	Action
Air leak at outer belt line	A. Belt line seal installed incorrectly on flange (no glass contact). B. Belt line seal does not contact the glass. C. No contact with glass runs at both ends of belt line seal. D. Belt line seal damaged.	A. ADJUST the seal. B. ADJUST the door glass. C. ADJUST the belt line seal or ADD foam at the seal ends. D. INSTALL a new seal.
Draft at inner door handle/ speaker opening	A. Hole in watershield. B. Watershield misaligned. C. Exterior door handle seal misaligned/ damaged.	A. SEAL the hole with a suitable tape. B. REALIGN the watershield. INSTALL a new watershield if the pressure sensitive adhesive fails. C. REALIGN or INSTALL a new seal as necessary.
Wind noise from side view mirror	A. Outside mirror housing misaligned. B. Mirror sail gasket folded/misaligned. C. Mirror housing trim cap installed incorrectly. D. Air leak through mirror housing hinge. E. Inner sail trim installed incorrectly. F. Inner sail gasket/barrier installed incorrectly. G. Air path through wiring bundle/ fastener access holes. H. Exposed fastener access hole on mirror housing/sail.	A. REALIGN with the edges shingled correctly and no gaps. B. REINSTALL with the gasket unfolded and aligned correctly. C. REINSTALL with the edges shingled to the air flow. D. Fully ENGAGE the mirror into its operating position/USE foam to block the air path through the hinge. E. REINSTALL the sail trim/ADJUST the door trim. F. REINSTALL the trim cover with the gasket/barrier aligned correctly. G. BLOCK the air path(s) with foam/tape. H. INSTALL a new cap if it is missing.

Table 1 Symptom Chart — Air Leak and Wind Noise (cont.)

Condition	Possible Sources	Action
Air leak around perimeter of fixed glass	A. Gaps in the sealant bead. B. Air traveling up windshield molding along A-pillar. C. Windshield/ backlite misaligned or not installed correctly. D. Rear hood seal at base of windshield misaligned/damaged.	A. APPLY approved sealant. B. INSTALL foam rope the full length of the A-pillar. C. REINSTALL the windshield/ backlite. D. 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	A. Loose fit seal. B. Seal misaligned. C. Liftgate misaligned. D. Scuff plate misaligned. E. Seal or seal push pins damaged.	A. PINCH the seal carrier to improve retention on the seal flange or INSERT foam in the carrier. B. REINSTALL the seal. C. REALIGN the liftgate. CHECK the liftgate fit in the body opening and ADJUST as necessary. D. REINSTALL the scuff plate. E. INSTALL a new seal.
Air leak around the liftgate flip window perimeter	A. Loose fit seal. B. Seal misaligned. C. Glass misaligned. D. Seal damaged.	A. PINCH the seal carrier to improve retention to the seal flange. B. REINSTALL the seal. C. REALIGN the glass. D. INSTALL a new seal.
Wind noise from antenna	A. Shape of antenna. B. Air leak around antenna cable access hole.	A. INSTALL an antenna boot or a spiral antenna. B. INSPECT the antenna access hole grommet. REPAIR as necessary.
Air leak from closed roof opening panel	A. Seal installed incorrectly. B. Roof opening panel glass/door misaligned. C. Roof opening panel damaged.	A. REINSTALL the seal. B. REALIGN the roof opening panel glass/door. C. INSTALL a new roof opening panel.

Table 1 Symptom Chart — Air Leak and Wind Noise (cont.)

Condition	Possible Sources	Action
Buffeting from an open roof opening panel	A. Wind deflector inoperative/ damaged. B. Wind deflector height incorrect.	A. REPAIR or INSTALL a new wind deflector as necessary. B. ADJUST the wind deflector higher.
Wind noise created by airflow over or behind body panels	A. Fender splash shield misaligned. B. Body panel misaligned (exposed edge). C. Hood misaligned (front margin). D. Front grille edge noise.	A. REALIGN the fender splash shield. B. REALIGN the appropriate body panel. C. CHECK hood gaps and fit. ADJUST the hood as necessary. D. APPLY foam in the hollow areas behind the louvers.
Wind noise created by grille opening panel	A. Grille relationship to leading edge on hood. B. Sharp edges due to material imperfections.	A. ADJUST the grille opening panel forward to eliminate wind noise. B. REMOVE the sharp edges (no damage to visible surface).
Wind noise from air extractor	A. Air extractor housing seated incorrectly. B. Air extractor housing or flaps damaged.	A. REINSTALL the air extractor housing. B. INSTALL a new air extractor.
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.

Table 2 Symptom Chart — Brake Noise/Vibration

Condition	Possible Sources	Action
Rattling noise	A. Caliper mounting bolts loose. B. Damaged or worn caliper pins or retainers. C. Missing or damaged anti-rattle clips or springs. D. Loose brake disc shield.	A. CHECK the caliper bolts. TIGHTEN to specifications. REFER to S04049 for the front disc brake or the rear disc brake. B. CHECK the caliper pins and retainers for lubrication and correct fit. LUBRICATE or INSTALL new components as necessary. REFER to S04049 for the front disc brake or the rear disc brake. C. CHECK the brake pads for missing clips or broken springs. INSTALL new components as necessary. REFER to S04049 for the front disc brake or the rear disc brake. D. TIGHTEN the brake disc shield bolts to specification. REFER to Front Disc Brake in S04049.
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.
Squealing noise — a continuous squeal	Disc brake pads or linings worn below minimum thickness.	INSTALL new disc brake pads. REFER to Front Disc Brakes or Rear Disc Brakes in S04049.
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 Front Disc Brakes or Rear Disc Brakes in S04049.
Moaning noise	Brake linings contaminated with grease or oil.	INSPECT the brake pads and shoes for contamination. REPAIR or INSTALL new components as necessary.

Table 2 Symptom Chart — Brake Noise/Vibration (cont.)

Condition	Possible Sources	Action
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 as necessary. REFER to Front Disc Brakes or Rear Disc Brakes in S04049.

Table 3 Symptom Chart — Driveline Noise/Vibration

Condition	Possible Sources	Action
Axle howling or whine — front or rear axle	A. Axle lubricant low. B. Axle housing damage. C. Damaged or worn wheel bearings or axle bearings. D. Damaged or worn differential ring and pinion. E. Damaged or worn differential side or pinion bearings. F. Damaged or worn differential side gears and pinion gears.	A. CHECK the lubricant level. FILL the axle to specification. B. INSPECT the axle housing for damage. REPAIR or INSTALL a new axle as necessary. REFER to Rear Drive Axle/ Differential in S14020. C. CHECK for abnormal wheel bearing play or roughness. REFER to Wheel Bearing Check in this section. ADJUST or INSTALL new wheel bearings as necessary. D. INSPECT the ring and pinion ring for abnormal wear patterns or broken teeth. INSTALL a new ring and pinion as necessary. REFER to Rear Drive Axle/ Differential in S14020. E. CHECK for abnormal bearing play or roughness. INSTALL new bearings as necessary. REFER to Rear Drive Axle/ Differential in S14020. F. DISASSEMBLE the differential carrier. INSPECT the side and pinion gears for abnormal wear patterns or broken teeth. INSTALL new gears as necessary. REFER to Rear Drive Axle/ Differential in S14020.

Table 3 Symptom Chart — Driveline Noise/Vibration (cont.)

Condition	Possible Sources	Action
Driveline clunk — loud clunk when shifting from reverse to drive	A. Incorrect axle lubricant level. B. Excessive backlash in the axle or transmission. C. Damaged or worn pinion bearings. D. Damaged or worn universal joints (U-joints). E. Loose suspension components. F. Broken powertrain mounts. G. Idle speed too high.	A. CHECK the lubricant level. FILL the axle to specification. B. CARRY OUT a total backlash check. REFER to Driveline System(Driveline System — General Information, page 48). C. CHECK for abnormal bearing play or roughness. INSTALL new bearings as necessary. REFER to Rear Drive Axle/ Differential in S14020. D. INSPECT the U-joints for wear or damage. INSTALL new U-joints as necessary. REFER to Driveshaft in S06002. E. INSPECT the suspension for damage or wear. REPAIR or INSTALL new components as necessary. F. INSPECT the powertrain mounts. CARRY OUT Powertrain/ Drivetrain Mount Neutralizing in this section. INSTALL new mounts as necessary. G. CHECK for the correct idle speed.
Driveline clunk — occurs as the vehicle starts to move forward following a stop	A. Worn or galled driveshaft slip-yoke splines. B. Worn or galled driveshaft and coupling shaft splines. C. Loose rear leaf spring U-bolts.	A. CLEAN and INSPECT the splines of the yoke for a worn or galled condition. INSTALL a new yoke as necessary. REFER to Driveshaft in S06002. B. CLEAN and INSPECT the splines of the driveshaft and coupling shaft for a worn or galled condition. INSTALL a new driveshaft assembly as necessary. REFER to Driveshaft in S06002. C. CHECK the U-bolts for loose nuts. TIGHTEN to specification. REFER to Rear Suspension in S03014.

Table 3 Symptom Chart — Driveline Noise/Vibration (cont.)

Condition	Possible Sources	Action
Clicking, popping or grinding — occurs while vehicle is turning	A. Brake components. B. Steering components. C. Suspension components. D. Damaged or worn wheel bearings.	A. INSPECT the front brakes for wear or damage. REPAIR as necessary. REFER to Front Disc Brakes in S04049. B. INSPECT the drag link, inner and outer tie-rods or idler arm for wear or damage. REPAIR as necessary. REFER to Steering Linkage in S05017. C. INSPECT the spindle pins for wear or damage. REPAIR as necessary. REFER to Front Suspension in S03014. D. CHECK for abnormal wheel bearing play or roughness. REFER to Wheel Bearing Check in this section. ADJUST or INSTALL new wheel bearings as necessary.
High pitched chattering — noise from the rear axle when the vehicle is turning	A. Incorrect or contaminated lubricant. B. Damaged or worn differential (differential side gears and pinion gears).	A. 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. B. 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 Rear Drive Axle/ Differential in S14020.
Buzz — buzzing noise is the same at cruise or coast/deceleration	A. Damaged or worn tires. B. Incorrect driveline angles.	A. CHECK for abnormal tire wear or damage. INSTALL new tire(s) as necessary. REFER to Wheels and Tires in S17002. B. CHECK for correct driveline angles. REPAIR as necessary. REFER to Driveline System(Driveline System — General Information, page 48).

Table 3 Symptom Chart — Driveline Noise/Vibration (cont.)

Condition	Possible Sources	Action
Rumble or boom — noise occurs at coast/deceleration, usually driveshaft speed related and noticeable over a wide range of speeds	A. Driveshaft is out-of-balance. B. U-joints binding or seized. C. Excessive pinion flange runout.	A. CHECK the driveshaft for damage, missing balance weights or undercoating. CHECK the driveshaft balance. CARRY OUT a driveline vibration test. REFER to Driveline System(Driveline System — General Information, page 48). B. ROTATE the driveshaft and CHECK for rough operation or seized U-joints. INSTALL new U-joints as necessary. REFER to Driveshaft in S06002. C. CARRY OUT a runout check. REPAIR as necessary. REFER to Driveline System(Driveline System — General Information, page 48).
Grunting — normally associated with a shudder experienced during acceleration from a dead stop	A. Driveshaft slip yoke binding. B. Loose rear spring U-bolts.	A. CLEAN and LUBRICATE the male and female splines. B. INSPECT the rear suspension. TIGHTEN the U-bolt nuts to specification. REFER to Rear Suspension in S03014.
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. REFER to Rear Drive Axle/ Differential in S14020.
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. REFER to Rear Drive Axle/ Differential in S14020.

Table 3 Symptom Chart — Driveline Noise/Vibration (cont.)

Condition	Possible Sources	Action
Knock — noise occurs at various speeds. Not affected by acceleration or deceleration	A. Gear tooth damage to the drive side of the ring and pinion. B. Excessive axle shaft end play. (Vehicles with integral axles.)	A. CHECK the differential case and ring and pinion for damage. INSTALL new components as necessary. REFER to Rear Drive Axle/ Differential in S14020. B. CHECK the axle end play using a dial indicator. INSTALL a new axle shaft or side gears as necessary. REFER to Rear Drive Axle/ Differential in S14020.
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 Rear Drive Axle/ Differential in S14020.

Table 3 Symptom Chart — Driveline Noise/Vibration (cont.)

Condition	Possible Sources	Action
Driveline shudder — occurs during acceleration from a slow speed or stop	A. Rear drive axle assembly mispositioned. B. Loose rear spring U-bolts. C. Damaged or worn front suspension components. D. Driveline angles out of specification. E. U-joints binding or seized. F. Binding, damaged or galled splines on the driveshaft slip-yoke.	A. CHECK the axle mounts and the rear suspension for damage or wear. REPAIR as necessary. B. INSPECT the U-bolts. TIGHTEN the U-bolt nuts to specification. REFER to Rear Suspension in S03014. C. 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. D. CHECK for correct driveline angles. REPAIR as necessary. REFER to Driveline System(Driveline System — General Information, page 48). E. ROTATE the driveshaft and CHECK for rough operation or seized U-joints. INSTALL new U-joints as necessary. REFER to Driveshaft in S06002. F. 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. REFER to Driveshaft in S06002.

Table 3 Symptom Chart — Driveline Noise/Vibration (cont.)

Condition	Possible Sources	Action
Driveline vibration — occurs at cruising speeds	A. U-joints are worn.	A. CHECK for wear or incorrect seating. INSTALL new U-joints as necessary. REFER to Driveshaft in S06002.
	B. Worn or damaged driveshaft center bearing support.	B. CHECK the insulator for damage or wear. ROTATE the driveshaft and CHECK for rough operation. INSTALL a new center bearing support as necessary. REFER to Driveshaft in S06002.
	C. Loose axle pinion flange bolts.	C. INSPECT the axle pinion flange. TIGHTEN the pinion flange bolts to specification. REFER to Driveshaft in S06002.
	D. Excessive axle pinion flange runout.	D. CARRY OUT a runout check. REPAIR as necessary. REFER to Driveshaft in S06002.
	E. Driveshaft is out-of-balance.	E. CHECK the driveshaft for damage, missing balance weights or undercoating. CHECK driveshaft balance. CARRY OUT a driveline vibration test. REFER to Driveline System(Driveline System — General Information, page 48). REPAIR as necessary.
	F. Binding or damaged splines on the driveshaft slip-yoke.	F. 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. REFER to Driveline System(Driveline System — General Information, page 48). REPAIR as necessary.
	G. Driveshaft runout.	G. CARRY OUT a Runout Check. REFER to Driveline System(Driveline System — General Information, page 48). REPAIR as necessary.
	H. Incorrect lateral and radial tire/wheel runout.	H. INSPECT the tire and wheels. MEASURE tire runouts. REPAIR or INSTALL new components as necessary. REFER to Wheels and Tires in S17002.
	I. Driveline angles out of specification.	I. CHECK for correct driveline angles. REPAIR as necessary. REFER to Driveline System(Driveline System — General Information, page 48)

Table 4 Symptom Chart — Squeak and Rattle

Condition	Possible Sources	Action
Squeak — heard inside the vehicle when closing/opening the door	A. Insufficient lubrication on the door hinge or check strap. B. Internal door components loose, rubbing or misaligned.	A. LUBRICATE the hinge or check strap. B. 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.
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 Exhaust System in S07002.
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 Front Disc Brakes or Rear Disc Brakes in S04049.
Squeak — noise occurs over bumps or when turning	A. Worn control arm bushings. B. Worn or damaged shock absorber/strut.	A. INSPECT the control arm bushings. Spray with lubricant and CARRY OUT a "bounce test" to determine which bushing. REPAIR as necessary. REFER to Front Suspension in S03014. B. INSPECT the shock absorber for damage. CARRY OUT a "bounce test" to isolate the noise. INSTALL a new shock absorber/strut as necessary. REFER to S03014, Front Suspension for the front shock absorbers/strut, or Rear Suspension for the rear shock absorber/strut.

Table 4 Symptom Chart — Squeak and Rattle (cont.)

Condition	Possible Sources	Action
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 Squeak and Rattle Kit to isolate any rattling components.
Squeak or rattle — heard inside the vehicle over rough roads/bumps	A. Misaligned glove compartment door/hinge. B. Instrument panel trim loose or misaligned. C. Loose interior component or trim.	A. ALIGN the glove compartment door. B. INSPECT the instrument panel trim for missing or loose clips or screws. REPAIR as necessary. C. CARRY OUT a "touch test". ELIMINATE the noise by pressing or pulling on interior trim and components. USE the Squeak and Rattle Kit to isolate any rattling/squeaking components.
Squeak or rattle — noise with a vibration concern	Damaged or worn body 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.

Table 5 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 clonk — hydraulic knocking sound	Air in the steering hydraulic system.	CHECK for leaks in the system. PURGE the air from the system. REFER to Steering System in S05017.

Table 5 Symptom Chart — Steering Noise/Vibration (cont.)

Condition	Possible Sources	Action
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	A. Power steering hose grounded out to chassis. B. Aerated fluid. C. Steering gear isolators. D. Low fluid. E. Power steering pump brackets loose or misaligned.	A. INSPECT the power steering hoses. REPAIR as necessary. B. CHECK for leaks in the system. PURGE the air from the system. REFER to Steering System in S05017. C. INSPECT the isolators for wear or damage. REPAIR as necessary. D. CHECK the fluid level. REFILL as necessary. E. CHECK bolts, brackets and bracket alignment. TIGHTEN bolts to specification. REPAIR or INSTALL new brackets as necessary. REFER to Power Steering in S05017.
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 Power Steering in S05017.

Table 5 Symptom Chart — Steering Noise/Vibration (cont.)

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	A. Column intermediate/flexible shaft joints damaged or worn. B. Loose, damaged or worn tie-rod ends. C. Steering gear insulators or mounting bolts loose or damaged. D. Steering column intermediate shaft bolts are loose. E. Steering column damaged or worn. F. Loose suspension bushings, bolts or ball joints.	A. INSTALL a new intermediate/flexible shaft. REFER to Steering Column in S05017. B. TIGHTEN the nuts to specification or INSTALL new tie-rod ends as necessary. REFER to Steering Linkage in S05017. C. TIGHTEN the bolts or INSTALL new bolts as necessary. REFER to Power Steering in S05017. D. TIGHTEN the bolts to specification. REFER to Steering Column in S05017. E. REPAIR or INSTALL a new steering column as necessary. REFER to Steering Columng in S05017. F. INSPECT the suspension system. TIGHTEN or INSTALL new components as necessary. REFER to Front Suspension in S03014.
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	A. Lateral runout in the tire or wheel. B. Yoke spring in the steering gear.	A. GO to Pinpoint Test B. B. CHECK TSIs for revised yoke spring for applicable vehicles.
Accessory drive belt squeal/chirp — when rotating the steering wheel from stop to stop	Loose or worn belt.	ADJUST or INSTALL a new accessory drive belt as necessary. REFER to the Engine Service Manual.
Power steering gear hiss	A. Steering column intermediate/flexible shaft-to-steering gear is binding or misaligned. B. Grounded or loose steering column boot at the dash panel. C. Damaged or worn steering gear input shaft and valve.	A. REPAIR or INSTALL a new intermediate/flexible shaft as necessary. REFER to Steering Column in S05017. B. REPAIR as necessary. C. REPAIR or INSTALL a new steering gear as necessary. REFER to Power Steering in S05017.

Table 5 Symptom Chart — Steering Noise/Vibration (cont.)

Condition	Possible Sources	Action
Steering column rattle	A. Loose bolts or attaching brackets. B. Loose, worn or insufficiently lubricated column bearings. C. Steering shaft insulators damaged or worn. D. Intermediate/flexible shaft compressed or extended.	A. TIGHTEN the bolts to specifications. B. LUBRICATE or INSTALL new steering column bearings as necessary. REFER to Steering Column in S05017. C. INSTALL new insulators. REFER to Steering Column in S05017. D. INSPECT the rubber spider coupling for damage. INSTALL a new intermediate/flexible shaft. REFER to Steering Column in S05017.
Steering column squeak or cracks	A. Insufficient lubricated steering shaft bushings. B. Loose or misaligned steering column shrouds. C. Steering wheel rubbing against steering column shrouds. D. Insufficient lubricated speed control slip ring. E. Upper or lower bearing sleeve out of position.	A. LUBRICATE the steering shaft and shaft tube seals. B. TIGHTEN or ALIGN the steering column shrouds. C. REPOSITION the steering column shrouds. D. LUBRICATE the speed control slip ring. E. 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 Power Steering in S05017.

Table 5 Symptom Chart — Steering Noise/Vibration (cont.)

Condition	Possible Sources	Action
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	A. Aerated fluid. B. Damaged power steering pump cam. Damaged valve cover O-ring seal.	A. CHECK for a leak in the system. PURGE the air from the system. REFER to Steering System in S05017. B. REPAIR or INSTALL a new power steering pump as necessary. REFER to Power Steering in S05017.
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 Power Steering in S05017.
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 Power Steering in S05017.

Table 6 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 TSIs 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.
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 Rear Suspension in S03014.
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 spindle pin bushings. • Worn or damaged stabilizer bar bushings or links.	GO to Pinpoint Test B.
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. • Worn or damaged stabilizer bar bushings or links.	GO to Pinpoint Test C.
Shudder — occurs during acceleration from a slow speed or stop	A. Rear drive axle assembly mispositioned. B. Damaged or worn front suspension components.	A. CHECK the axle mounts and the rear suspension for damage or wear. REPAIR as necessary. B. CHECK for a loose stabilizer bar, damaged or loose shock absorber/bushings. 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 Suspension System in S03014.

Table 7 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 Wheels and Tires in S17002.
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 D.
Tire wobble or shudder — occurs at lower speeds	A. Damaged wheel bearings. B. Damaged wheel. C. Damaged or worn suspension components. D. Loose wheel nuts. E. Damaged or uneven tire wear.	A. SPIN the tire and CHECK for abnormal wheel bearing play or roughness. ADJUST or INSTALL new wheel bearings as necessary. B. INSPECT the wheel for damage. INSTALL a new wheel as necessary. REFER to Front Suspension in S03014. C. INSPECT the suspension components for wear or damage. REPAIR as necessary. D. CHECK the wheel nuts. TIGHTEN to specification. REFER to Wheels and Tires in S17002. E. SPIN the tire and CHECK for abnormal tire wear or damage. INSTALL a new tire as necessary. REFER to Wheels and Tires in S17002.

Table 7 Symptom Chart — Tire Noise/Vibration (cont.)

Condition	Possible Sources	Action
Tire shimmy or shake — occurs at lower speeds	A. Wheel/tire out of balance. B. Uneven tire wear. C. Excessive radial runout of wheel or tire. D. Worn or damaged wheel studs or elongated stud holes. E. Excessive lateral runout of the wheel or tire. F. Foreign material between the brake disc and hub or in the brake disc fins.	A. BALANCE the wheel/tire assembly. B. CHECK for abnormal tire wear. INSTALL a new tire as necessary. REFER to Wheels and Tires in S17002. C. CARRY OUT a radial runout test of the wheel and tire. INSTALL a new tire as necessary. REFER to Wheels and Tires in S17002. D. INSPECT the wheel studs and wheels. INSTALL new components as necessary. REFER to S03014, Front Suspension for the front wheels or Rear Suspension for the rear wheels. E. CARRY OUT a lateral runout test of the wheel and tire. REFER to Wheels and Tires in S17002. CHECK the wheel, tire and hub. REPAIR or INSTALL new components as necessary. F. 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 E.

Table 8 Symptom Chart — Transmission (Automatic) Noise/Vibration

Condition	Possible Sources	Action
Rattle — occurs at idle or at light acceleration from a stop	A. Damaged engine or transmission mounts. B. A loose front exhaust pipe heat shield. C. Loose inspection plate or dust cover plate. D. Loose flexplate to converter nuts.	A. CHECK the powertrain/ drivetrain mounts for damage. REFER to the Engine Service Manual. B. REPAIR or INSTALL a new heat shield as necessary. C. CHECK for loose bolts. TIGHTEN to specifications. REFER to Automatic Transaxle/ Transmission in S13036. D. CHECK for loose nuts. TIGHTEN to specifications. REFER to Automatic Transaxle/ Transmission in S13036.
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 Automatic Transaxle/ Transmission in S13036.

Table 8 Symptom Chart — Transmission (Automatic) Noise/Vibration (cont.)

Condition	Possible Sources	Action
Whine — the pitch changes with engine speed	A. A worn or damaged accessory drive component. B. Incorrect fluid level. C. Partially blocked filter. D. Worn or damaged torque converter. E. Worn or damaged front pump.	A. CARRY OUT the Engine Accessory Test. REPAIR or INSTALL new components as necessary. B. CHECK that the transmission is filled to the correct level. ADD fluid as necessary. REFER to Automatic Transaxle/ Transmission in S13036. C. INSPECT the filter. CLEAN or INSTALL a new filter as necessary. REFER to Automatic Transaxle/ Transmission in S13036. D. CARRY OUT the torque converter service and replacement check. REFER to Automatic Transaxle/ Transmission in S13036. E. INSPECT the front pump. INSTALL a new front pump as necessary. REFER to Automatic Transaxle/ Transmission in S13036.
Whine — pitch changes with vehicle speed	Speedometer cable or gears.	REPAIR or INSTALL new cables or gears as necessary.

Table 8 Symptom Chart — Transmission (Automatic) Noise/Vibration (cont.)

Condition	Possible Sources	Action
Whine/moan type noise — pitch increases or changes with vehicle speed	A. Damaged engine or transmission mount. B. U-joints worn or damaged. C. Damaged or worn differential ring and pinion. D. Planetary gears nicked or chipped.	A. CHECK the powertrain/ drivetrain mounts for damage. REFER to the Engine Service Manual. B. INSPECT the U-joints for wear or damage. INSTALL new U-joints as necessary. REFER to Driveshaft in S06002. C. 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. REFER to Rear Drive Axle/ Differential in S14020. D. CHECK the planetary gears for damage. INSTALL new components as necessary. REFER to Automatic Transaxle/ Transmission in S13036.
Whistle — noise is high pitched, constant. Changes in pitch with throttle position	A. Hydraulic pressure in the main control. B. Incorrect band/clutch apply pressure. C. Worn or damaged torque converter.	A. INSPECT the main control. REPAIR or INSTALL new components as necessary. REFER to Automatic Transaxle/ Transmission in S13036. B. CARRY OUT the line pressure tests. REPAIR or INSTALL components as necessary. REFER to Automatic Transaxle/ Transmission in S13036. C. CARRY OUT the torque converter service and replacement check. REFER to Automatic Transaxle/ Transmission in S13036.

Table 8 Symptom Chart — Transmission (Automatic) Noise/Vibration (cont.)

Condition	Possible Sources	Action
Clunk — occurs when shifting from PARK to a drive or reverse position	A. Damaged powertrain mounts. B. Damaged or worn pinion bearings. C. Worn or galled driveshaft slip yoke splines. D. Worn friction elements or excessive clutch pack end plate play.	A. INSPECT the powertrain mounts for damage. INSTALL new mounts as necessary. REFER to Automatic Transaxle/ Transmission in S13036. B. CHECK for abnormal bearing play or roughness. INSTALL new bearings as necessary. REFER to Rear Drive Axle/ Differential in S14020. C. CLEAN and INSPECT the splines of the yoke. INSTALL a new slip yoke as necessary. REFER to Driveshaft in S06002. D. INSPECT the transmission for wear. CHECK that all end play and clearances are within specification. REPAIR or INSTALL new components as necessary. REFER to Automatic Transaxle/ Transmission in S13036.
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	A. Incorrect driveline angles. B. Worn or damaged main control solenoids or valves.	A. CHECK for correct driveline angles. REPAIR as necessary. REFER to Driveline System(Driveline System — General Information, page 48). B. Using a transmission tester, ACTIVATE the solenoids to duplicate sound. INSTALL new components as necessary. REFER to Automatic Transaxle/ Transmission in S13036.

Table 8 Symptom Chart — Transmission (Automatic) Noise/Vibration (cont.)

Condition	Possible Sources	Action
Vibration — a high frequency (20–80 Hz) that is felt through the seat or gear shifter. Changes with engine speed	A. Transmission cooler lines grounded out. B. Flexplate to torque converter nuts loose. C. Fluid filler tube grounded out. D. Shift cable incorrectly routed, grounded out or loose.	A. CHECK the transmission cooler lines. REPAIR as necessary. B. CHECK the flexplate nuts. TIGHTEN to specification. REFER to Automatic Transaxle/ Transmission in S13036. C. CHECK the fluid filler tube. REPAIR as necessary. D. CHECK the shift cable. REPAIR as necessary. REFER to Automatic Transaxle/ Transmission External Controls in S13036.
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 Automatic Transaxle/ Transmission in S13036. CLEAR the DTCs, ROAD TEST and RERUN on-board diagnostics or self–test.

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. Re-install all components after verifying system operation is normal.

Table 9 PINPOINT TEST A: BRAKE VIBRATION/SHUDDER

Test Step	Result / Action to Take
A1 ROAD TEST THE VEHICLE — LIGHT BRAKING • Check that the wheel and tires are correct for the vehicle. Inspect the tires for abnormal wear patterns. • 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 • 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.
A3 NORMAL ACTUATION OF THE ABS SYSTEM DIAGNOSIS • 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 **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.

Table 9 PINPOINT TEST A: BRAKE VIBRATION/SHUDDER (cont.)

Test Step	Result / Action to Take
A5 CHECK THE FRONT WHEEL BEARINGS • 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 • 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 **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. Road test the vehicle. **Is the vibration/shudder present?**	**Yes** GO to A8. **No** Vehicle is OK.

Table 9 PINPOINT TEST A: BRAKE VIBRATION/SHUDDER (cont.)

Test Step	Result / Action to Take
A8 CHECK THE REAR SUSPENSION • Check the rear suspension for: — Broken or loose bolts. — Damaged or worn springs or spring bushings. — 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 **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 rear brake discs or drums. 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.

Table 10 PINPOINT TEST B: FRONT SUSPENSION NOISE

Test Step	Result / Action to Take
B1 ROAD TEST THE VEHICLE **NOTE:** An assistant will be needed for this road test. • Test drive the vehicle. • During the road test, drive the vehicle over a rough road. Determine from which area/component the noise is originating. **Is there a squeak, creak or rattle noise?**	**Yes** GO to B2. **No** The suspension system is OK. CONDUCT a diagnosis on other suspect systems.

Table 10 PINPOINT TEST B: FRONT SUSPENSION NOISE (cont.)

Test Step	Result / Action to Take
B2 INSPECT THE STEERING SYSTEM **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. • Check the steering system for wear or damage. Carry out a steering linkage test. Refer to Steering System in S05017. • 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 B3.
B3 FRONT SHOCK ABSORBER/STRUT CHECK • Check the front shock absorber/strut mounts for loose bolts or nuts. • Check the front shock absorbers/struts for 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 B4.
B4 CHECK THE FRONT SPRINGS • 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 B5.
B5 CHECK THE STABILIZER BAR/TRACK BAR • Check the stabilizer bar/track bar bushings and links for damage or wear. • Check the stabilizer bar/track bar for damage. • 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.

Table 11 PINPOINT TEST C: REAR SUSPENSION NOISE

Test Step	Result / Action to Take
C1 ROAD TEST THE VEHICLE **NOTE:** An assistant will be needed for this road test. • Test drive the vehicle. • During the road test, drive the vehicle over a rough road. Determine from which area/component the noise is originating. **Is there a squeak, creak or rattle noise?**	**Yes** GO to C2. **No** The suspension system is OK. CONDUCT a diagnosis on other suspect systems.
C2 REAR SHOCK ABSORBER/STRUT CHECK **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. • Check the rear shock absorber/strut mounts for loose bolts or nuts. • 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 C3.
C3 CHECK THE REAR SPRINGS • 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 C4.
C4 CHECK THE STABILIZER BAR/TRACK BAR • Check the stabilizer bar/track bar bushings and links for damage or wear. • Check the stabilizer bar/track bar for damage. • 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.

Table 12 PINPOINT TEST D: WHEEL AND TIRE

Test Step	Result / Action to Take
D1 ROAD TEST THE VEHICLE **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. • 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 or noise?**	**Yes** GO to D2. **No** The wheel and tires are OK. CONDUCT a diagnosis on other suspect systems.
D2 CHECK THE FRONT WHEEL BEARINGS • Check the front wheel bearings. Refer to Wheel Bearing Check in this section. **Are the wheel bearings OK?**	**Yes** GO to D3. **No** INSPECT the wheel bearings. ADJUST or REPAIR as necessary. TEST the system for normal operation.
D3 INSPECT THE TIRES • Check the tires for missing weights. • Check the wheels for damage. • 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 D4.

Table 12 PINPOINT TEST D: WHEEL AND TIRE (cont.)

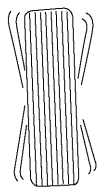
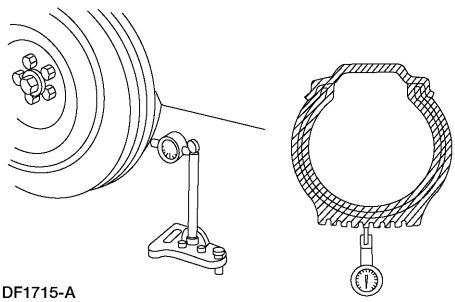
Test Step	Result / Action to Take
D4 TIRE ROTATION DIAGNOSIS • Spin the tires slowly and watch for signs of lateral runout.  DF1713-A • Spin the tires slowly and watch for signs of radial runout.  DF1714-A **Are there signs of visual runout?**	**Yes** GO to D5. **No** CHECK the wheel and tire balance. CORRECT as necessary. TEST the system for normal operation.
D5 RADIAL RUNOUT CHECK ON THE TIRE • Measure the radial runout of the wheel and tire assembly. A typical specification for total radial runout is 1.14 mm (0.045 inch).  DF1715-A **Is the radial runout within specifications?**	**Yes** GO to D8. **No** GO to D6.

Table 12 PINPOINT TEST D: WHEEL AND TIRE (cont.)

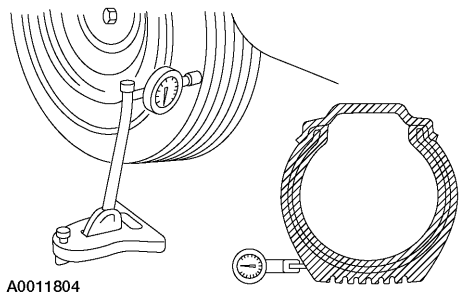
Test Step	Result / Action to Take
D6 RADIAL RUNOUT CHECK ON THE WHEEL • Measure the radial runout of the wheel. A typical specification for total radial runout is 1.14 mm (0.045 inch). **Is the radial runout within specifications?**	**Yes** INSTALL a new tire. TEST the system for normal operation. **No** GO to D7.
D7 CHECK THE HUB/BRAKE DISC OR DRUM PILOT RUNOUT OR BOLT CIRCLE RUNOUT • 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 S03014, Front Suspension for the front wheels or Rear Suspension for the rear wheels.
D8 LATERAL RUNOUT CHECK ON THE TIRE • Measure the lateral runout of the wheel and tire assembly. A typical specification for total lateral runout is 1.14 mm (0.045 inch).  A0011804 **Is the lateral runout within specifications?**	**Yes** Wheel and tires OK. CONDUCT diagnosis on other suspect systems. **No** GO to D9.

Table 12 PINPOINT TEST D: WHEEL AND TIRE (cont.)

Test Step	Result / Action to Take
D9 LATERAL RUNOUT CHECK ON THE WHEEL • 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 D10.
D10 CHECK THE FLANGE FACE LATERAL RUNOUT • 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 S03014, Front Suspension for the front wheels or Rear Suspension for the rear wheels.

Table 13 PINPOINT TEST E: HIGH SPEED SHAKE OR SHIMMY

Test Step	Result / Action to Take
E1 CHECK FOR FRONT WHEEL BEARING ROUGHNESS • Chock the rear wheels. • Raise and support the front end of the vehicle so that the front wheel and tire assemblies can spin. • pin 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 E2.
E2 CHECK THE END PLAY OF THE FRONT WHEEL BEARINGS • Check the end play of the front wheel bearings. Refer to Suspension System in S03014. **Is the end play OK?**	**Yes** GO to E3. **No** ADJUST or REPAIR as necessary. TEST the system for normal operation.

Table 13 PINPOINT TEST E: HIGH SPEED SHAKE OR SHIMMY (cont.)

Test Step	Result / Action to Take
E3 MEASURE THE LATERAL RUNOUT AND THE RADIAL RUNOUT OF THE FRONT WHEELS ON THE VEHICLE • Measure the lateral runout and the radial runout of the front wheels on the vehicle. Refer to Pinpoint Test D. **Are the measurements within specifications?**	**Yes** GO to E4. **No** INSTALL new wheels as necessary and BALANCE the assembly. TEST the system for normal operation.
E4 MEASURE THE LATERAL RUNOUT OF THE FRONT TIRES ON THE VEHICLE • Measure the lateral runout of the front tires on the vehicle. Refer to Pinpoint Test D. **Is the runout within specifications?**	**Yes** GO to E5. **No** INSTALL new tires as necessary and BALANCE the assembly. TEST the system for normal operation.
E5 MEASURE THE RADIAL RUNOUT OF THE FRONT TIRES ON THE VEHICLE • Measure the radial runout of the front tires on the vehicle. Refer to Pinpoint Test D. **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 E6.
E6 MATCH MOUNT THE TIRE AND WHEEL ASSEMBLY • 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 E7.

Table 13 PINPOINT TEST E: HIGH SPEED SHAKE OR SHIMMY (cont.)

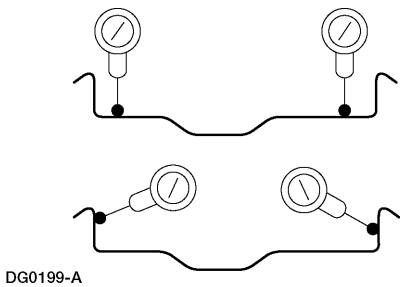
Test Step	Result / Action to Take
E7 MEASURE THE WHEEL FLANGE RUNOUT • Dismount the tire and mount the wheel on a wheel balancer. Measure the runout on both wheel flanges. Refer to Pinpoint Test D.  DG0199-A **Is the runout within specifications?**	**Yes** LOCATE and MARK the low spot on the wheel. INSTALL 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 E8. **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 E8.
E8 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.** • 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 E9.

Table 13 PINPOINT TEST E: HIGH SPEED SHAKE OR SHIMMY (cont.)

Test Step	Result / Action to Take
E9 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.** • Chock the front wheels. • Raise and support the rear end of the vehicle so that the rear wheel and tire assemblies can spin. • Engage the drivetrain and carefully accelerate the drive wheels while checking for vibration. **Is the vibration present?**	**Yes** GO to E10. **No** TEST the system for normal operation.
E10 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.** • Remove the rear wheel and tire assemblies. Refer to Wheels and Tires in S17002. • Secure the brake drums (if equipped), by installing wheel hub bolt nuts, reversed. • 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.

Component Tests — Steering Gear Grunt/Shudder Test

1. Start and run the vehicle to operating temperature.
2. Set engine idle speed to 1200 rpm.

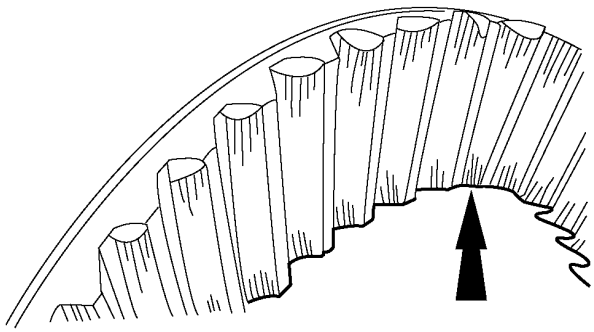
CAUTION: Do not hold the steering wheel against the stops for more than 3 to 5 seconds at a time. Damage to the power steering pump will occur.

3. 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. Refer to Steering System in S05017.

Component Tests — Checking Tooth Contact Pattern and Condition of the Ring and Pinion — All Vehicles

There are 2 basic types of conditions that will produce ring and pinion noise. The first type is a howl or chuckle produced by broken, cracked, chipped, scored or forcibly damaged gear teeth and is usually quite audible over the entire speed range. The second type of ring and pinion noise pertains to the mesh pattern of the gear pattern. This gear noise can be recognized as it produces a cycling pitch or whine. Ring and pinion noise tends to peak in a narrow speed range or ranges, and will tend to remain constant in pitch.

1. Raise and support the vehicle. For additional information, refer to Jacking and Lifting(Jacking and Lifting, page 1).
2. Drain the axle lubricant. Refer to Rear Drive Axle/ Differential in S14020.
3. Remove the carrier assembly or the axle housing cover depending on the axle type. Refer to Rear Drive Axle/ Differential in S14020.
4. Inspect the gear set for scoring or damage.



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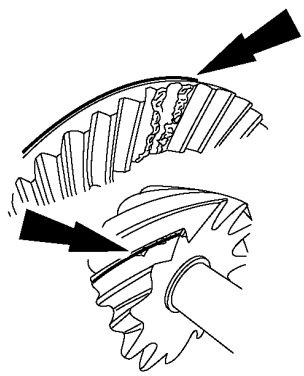


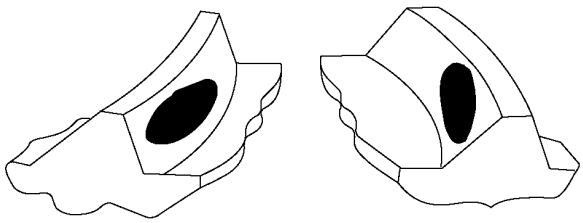
DF1746-A

Component Tests — Checking Tooth Contact Pattern and Condition of the Ring and Pinion

CAUTION: If reusing the differential ring gear and pinion, measure and record the backlash before disassembly. Reassembling the differential ring gear and pinion to the recorded backlash will match the established wear patterns. Hand-rolled patterns will cover less area than the established patterns.

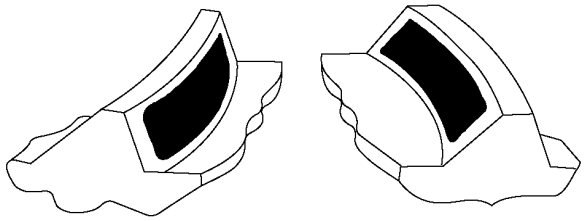
1. Paint one quarter of both the drive and the coast side of the differential ring gear with marking compound.
2. While applying a load, rotate the differential ring gear one complete revolution.

Correct Contact Pattern — Single Index Lightly Loaded



DE2068-A

Correct Contact Pattern — Single Index Heavily Loaded



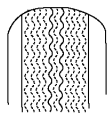
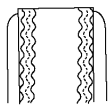
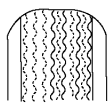
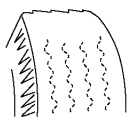
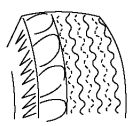
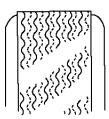
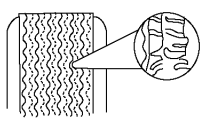
DE2069-A

3. Verify the contact pattern is correct.

   • Tooth contact pattern can move only by adjusting backlash. Tooth contact pattern can move only in the direction of heel-to-toe, and toe-to-heel. Depth of the tooth contact pattern is not adjustable.

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 thread blocks worn.	• Excessive toe on non-drive wheels. • Lack of rotation.

DF1717-A

General Procedures

Powertrain/Drivetrain Mount Neutralizing

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.

1. Raise and support the vehicle with the transmission in NEUTRAL. For additional information, refer to Jacking and Lifting in S10019(Jacking and Lifting, page 1).
2. Loosen, but do not remove, the powertrain/drivetrain mount fasteners.
3. Lower the vehicle.

CAUTION: Do not twist or strain the powertrain/drivetrain mounts.

4. Move the vehicle in FORWARD and REVERSE 0.6-1.2 meters (2-4 ft).
5. Raise and support the vehicle with the transmission in NEUTRAL. For additional information, refer to Jacking and Lifting in S10019(Jacking and Lifting, page 1).
6. Tighten the powertrain/drivetrain mount fasteners.
7. Lower the vehicle.
8. Test the system for normal operation.

Wheel Bearing Check

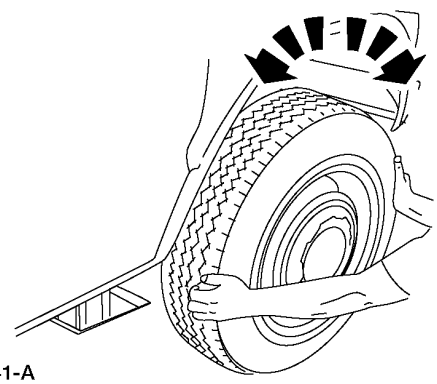
WARNING: The electrical power to the air suspension system must be shut off prior to hoisting, jacking or towing an air suspension vehicle. This can be accomplished by turning off the air suspension switch. Failure to do so can result in unexpected inflation or deflation of the air springs, which can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

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

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

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

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



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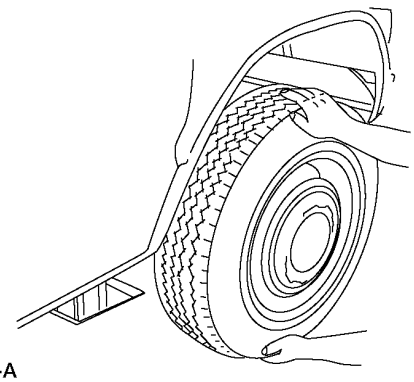
3. Grip each front tire at the top and bottom and move the wheel inward and outward while lifting the weight of the tire off the front wheel bearing.

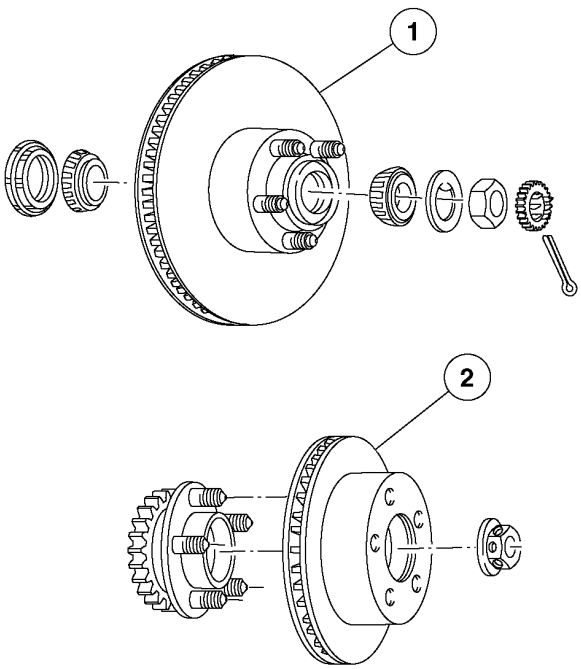


DF1742-A

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.



N0023940

Driveline System — General Information

Driveline System Description and Operation

The source of the drivetrain's power is generated by the engine and delivered to the transmission. The driveline transfers the engine torque through the driveshaft to the rear axle.

There is one type of axle used:

- S110 Dana® full-float, single reduction axle.

There are 2 types of driveshafts used:

- 2-piece rear driveshaft with 3 U-joints, a front coupling shaft, a center bearing and a rear slip-yoke.
- 3-piece rear driveshaft with 4 U-joints, 2 center bearings and a rear slip-yoke.

The rear driveshaft is connected to the output shaft of the transmission or transfer case and to the rear axle. Universal joints are used at both ends of the driveshaft to allow for angular motions. Slip-yokes are used to allow for any changes to the length of the driveshaft. The engine torque enters the axle through the drive pinion, which rotates the ring gear. The ring gear is mounted to the differential case, which contains the gears that transmit power to the rear axle shafts. These shafts rotate the drive wheels.

For additional information on the driveshaft, refer to Driveshaft in S06002.

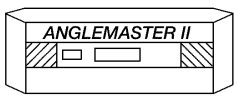
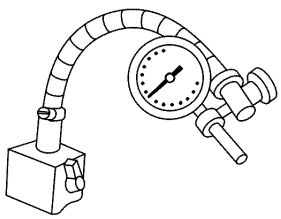
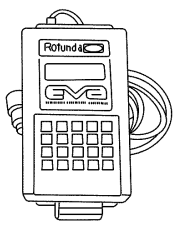
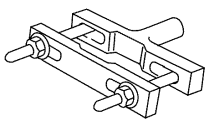
For additional information on the rear axle, refer to Rear Drive Axle/Differential in S14020

CAUTION: The axle identification tag is the official service identifier. Do not damage the tag. Always reinstall the tag after removing it for axle inspection or repair.

Driveline System Diagnosis and Testing

Special Tools

Table 14

 ST1622-A	Inclinometer
 ST1266-A	Dial Indicator Gauge with Holding Fixture
 ST2207-A	Vibration Analyzer ZTSE4580
 ST1802-A	Holding Fixture, Drive Pinion Flange

Driveline System Inspection and Verification

Certain axle and driveline symptoms are also common to the engine, transmission, wheel bearings, tires and other parts of the vehicle. For this reason, make sure that the cause of the trouble is in the axle before disassembling, adjusting or repairing the axle. For additional information, refer to Noise, Vibration and Harshness(Noise, Vibration and Harshness (NVH), page 4).

Noise Acceptability

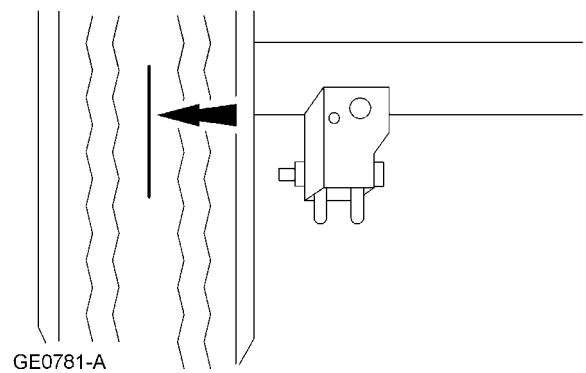
A gear-driven unit will produce a certain amount of noise. Some noise is acceptable and audible at certain speeds or under various driving conditions, such as a newly paved blacktop road. Slight noise is not detrimental to the operation of the axle and is considered normal.

Universal Joint (U-Joint) Inspection

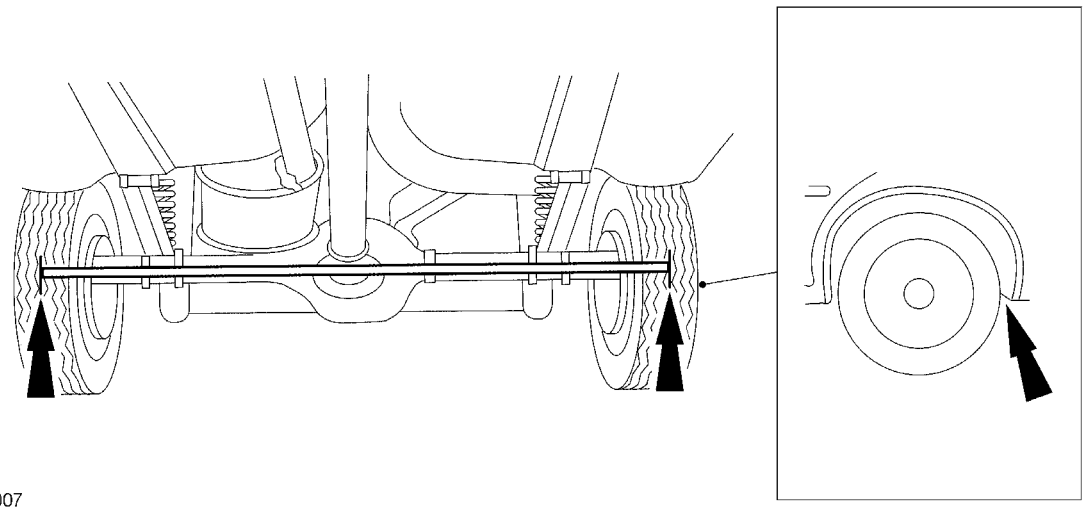
Raise and support the vehicle. Rotate the driveshaft by hand. Install a new U-joint if it shows signs of seizure, excessive wear or incorrect seating. For additional information, refer to Driveshaft in S06002.

Inspection For Bent Rear Axle Housing

1. With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to Jacking and Lifting(Jacking and Lifting, page 1). Allow the axle to be freely suspended.
2. Use white chalk or paint to mark a vertical line on the center of each rear tire.

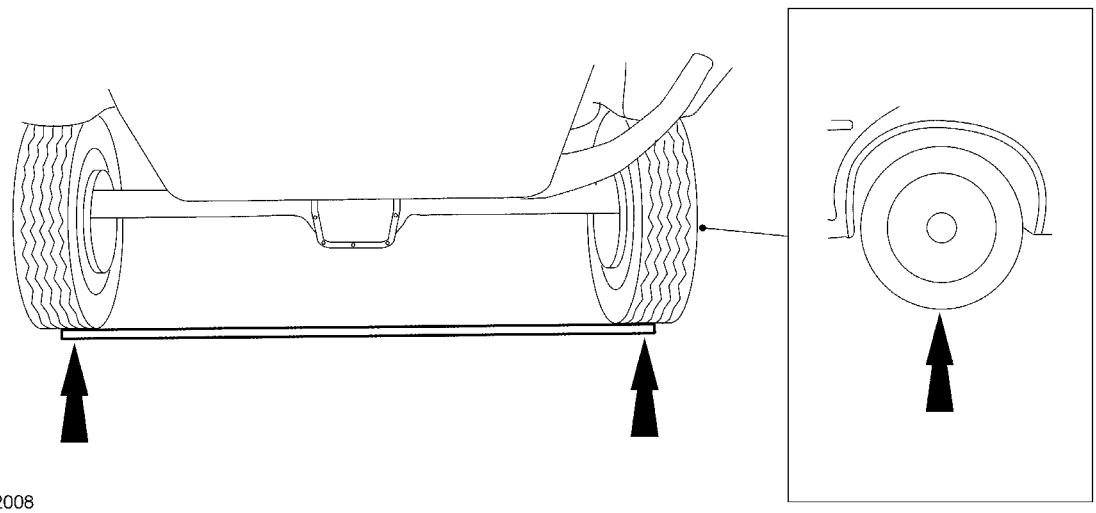

GE0781-A

3. Adjust both wheels so that the markings face the front of the vehicle. With a tape measure, measure the distance between the marks and record this reading (front reading).



A0012007

4. Rotate the rear wheels so the markings are directly underneath the vehicle. Measure the distance between the marks and record this reading (bottom reading).



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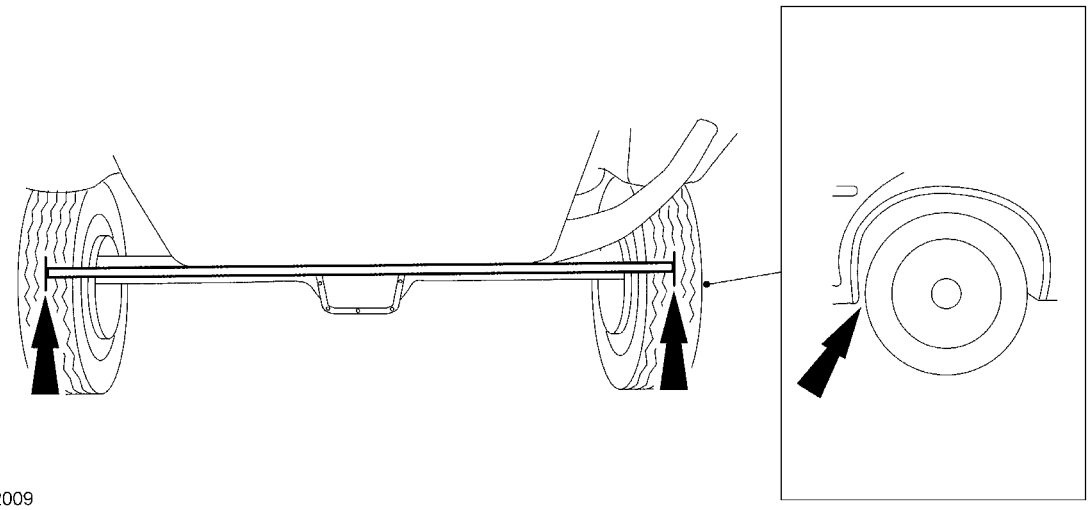
5. Rotate the rear wheels so the markings face the rear of the vehicle. Measure and record the distance between the marks (rear reading).



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6. Compare the front and the rear readings (Steps 3 and 5) to find the toe-in or toe-out condition.

   • Toe-in occurs when the front measurement is less than the rear measurement.

   • Toe-out occurs when the rear measurement is less than the front measurement.

7. To determine camber, find the average of the front and the rear measurements (Steps 3 and 5). Subtract the bottom reading (Step 4) from this number.

8. Positive (+) camber is when the bottom reading is less than the average of the front and rear readings. Negative (-) camber is when the bottom reading is greater than the average of the front and rear readings.

9. The results of the calculations in Steps 6 and 7 must conform to the following specifications:

   Toe-in: 0-1.6 mm (0-1/16 inch).

   Toe-out: 0-4.8 mm (0-3/16 inch).

   Camber: 0 ± 4.0 mm (0 ± 5/32 inch).

   If the differential housing does not meet these specifications, install a new differential housing. For additional information, refer to Rear Drive Axle/Differential in S14020.

Analysis of Leakage

Clean up the leaking area enough to identify the exact source. An axle leak can be caused by the following:

- Axle lubricant level is too high
- Worn or damaged axle shaft seals or differential seals
- Differential housing is cracked
- Flange yoke seal is worn or damaged
- Pinion flange is scored or damaged
- Axle cover is not sealed

Repair the axle as necessary. Make sure the axle lubricant is at the correct level. For additional information, refer to Specifications in this section.

Flange Yoke Seal

Leaks at the drive pinion seal originate for the following reasons:

- Drive pinion seal was installed incorrectly
- Poor quality drive pinion seal journal surface

Any damage to the drive pinion seal bore (dings, dents, gouges or other imperfections) will distort the drive pinion seal casing and allow leakage past the outer edge of the drive pinion seal.

The rubber lips can occasionally become hard and crack at the oil lip contact point. The contact point on the pinion flange may blacken. Marks, nicks, gouges or rough surface texture on the drive pinion seal journal of the pinion flange will also cause leaks.

Install a new pinion flange if any of these conditions exist.

When a drive pinion seal leak occurs, install a new drive pinion seal and check the vent and the vent hose to verify that they are clean and free of foreign material.

Wheel Hub Oil Seals

Wheel hub oil seals are susceptible to the same kinds of damage as drive pinion seals if installed incorrectly. The wheel hub oil seal bore must be clean and the lip handled carefully to avoid cutting or tearing it. The spindle journal surface must be free of nicks, gouges and rough surface texture. For additional information, refer to Wheel Hubs and Bearings in S14020.

Analysis of Vibration

Few vibration conditions are caused by the rear axle. On a vibration concern, follow the diagnosis procedure in Noise, Vibration and Harshness(Noise, Vibration and Harshness (NVH), page 4) unless there is a good reason to suspect the axle.

Tires

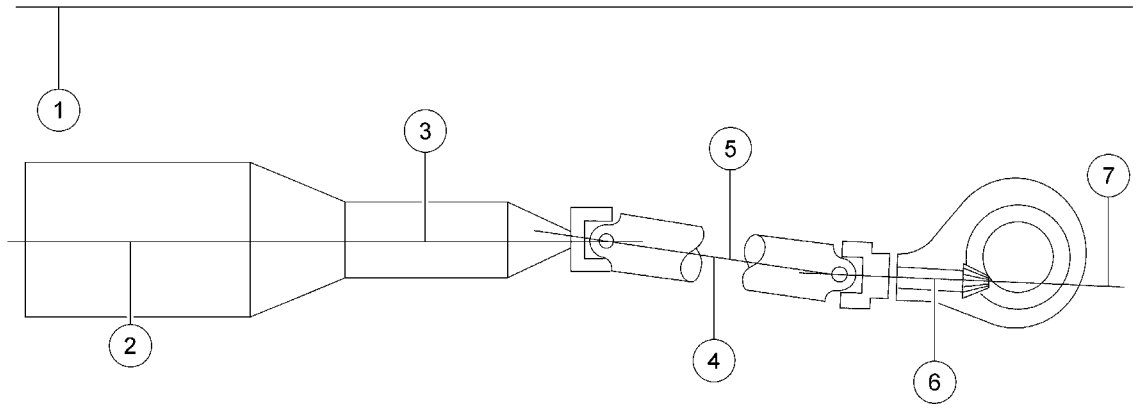
WARNING: Do not balance the wheels and tires while they are mounted on the vehicle. Possible tire disintegration/differential failure could result, causing personal injury/extensive component damage. Use an off-vehicle wheel and tire balancer only.

Most vibration in the rear of the vehicle is caused by tires or driveline angle.

Vibration is a concern with modern, high-mileage tires if they are not "true" both radially and laterally. They are more susceptible to vibration around the limits of radial and lateral runout of the tire and wheel assembly. They also require more accurate balancing. Wheel and tire runout checks, truing and balancing are normally done before an axle inspection. For additional information, refer to Wheels and Tires in S17002.

Driveline Angle

Driveline angularity is the angular relationship between the engine crankshaft, the driveshaft and the axle pinion. Factors determining driveline angularity include ride height, rear spring and engine mounts.



N0020270

Figure 16 Driveline Angle

1. Bottom of the frame (0 degree reference)
2. Engine crankshaft centerline
3. Engine angle (to frame reference)
4. Driveshaft centerline
5. Driveshaft angle (to frame reference)
6. Rear axle pinion centerline
7. Axle pinion angle (to frame reference)

Calculate the driveline operating angles as follows.

1. Preliminary setup procedures.

   A. Inspect the U-joints for correct operation.

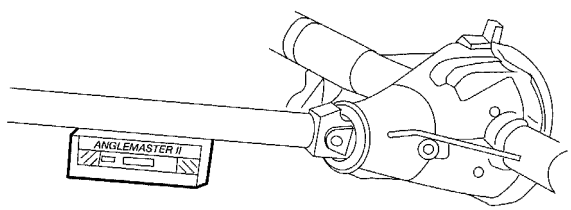
   B. Park the vehicle on a level surface such as a drive-on hoist, or back onto a front end alignment rack.

   C. Verify the curb position ride height is within specifications with the vehicle unloaded, and all of the tires inflated to their normal operating pressures.

   D. Rotate the transmission output yoke until vertical. This will simplify taking measurements.

   E. Calibrate the special tool by placing tool on clean, flat level section of the frame rail and press the ALT-ZERO button.

2. Using the special tool, measure the slope of the components. Record the measurements and the direction of the component's slope.



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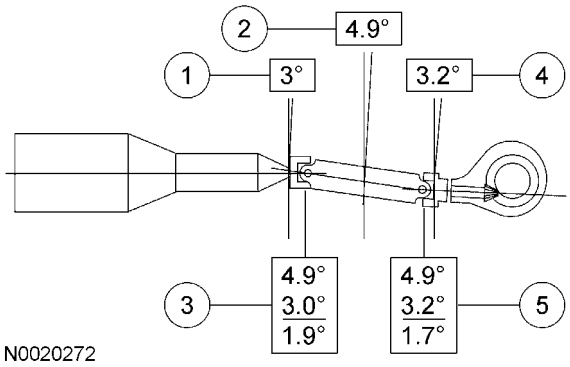


Figure 18 Example for Calculating U-Joint Operating Angles

1. Output yoke slope
2. Driveshaft slope
3. The driveshaft slope minus the output yoke slope equals the transmission/driveshaft operating angle
4. Pinion flange slope
5. The driveshaft slope minus the pinion flange slope equals the driveshaft/axle operating angle

3. Calculate the difference in the slope of the components to determine the U-joint operating angle.

- When 2 connected components slope in the same direction, subtract the smaller number from the larger to find the U-joint operating angle. When 2 connected components slope in the opposite direction, add the measurements to find the U-joint operating angle.
- The U-joint operating angle is the angle formed by 2 yokes connected by a cross and bearing kit. Ideally, the operating angles on each end of the driveshaft must:
  - — be equal or within one degree of each other.
  - — have a 3 degree maximum operating angle.
  - — have at least 1/2 of one degree continuous operating angle.

If the tires and driveline angle are not the cause, carry out the NVH tests to determine whether the concern is caused by a condition in the axle. For additional information, refer to Noise, Vibration and Harshness(Noise, Vibration and Harshness (NVH), page 4).

Drive Pinion Stem and Pinion Flange

Check the pinion flange runout when all other checks have failed to show the cause of vibration.

Coupling Shaft/Center Bearing Alignment

Vehicle noise and vibration can be caused by a dislodged or failed driveshaft center bearing support rubber insulator, a contaminated driveshaft center bearing support or excessive compression of the rubber insulator. For additional information, refer to Driveshaft in S06002.

Bearing Shimming

Drive-away shudder is the predominant symptom associated with driveline angles condition on vehicles with 2-piece driveshafts. Drive-away shudder can usually be corrected by shimming down the driveshaft center bearing bracket. For additional information, refer to Driveshaft in S06002.

If the drive-away shudder cannot be corrected by shimming down the driveshaft center bearing bracket, check the driveline angles as described in this section.

Axle Noise

NOTE: Before disassembling the axle to diagnose and correct gear noise, eliminate the tires, exhaust, trim items, roof racks, axle shafts and wheel bearings as possible causes. Follow the diagnostic procedures in Noise, Vibration and Harshness(Noise, Vibration and Harshness (NVH), page 4).

The noises described as follows usually have specific causes that can be diagnosed by observation as the unit is disassembled. The initial clues are the type of noise heard during the road test.

Gear Howl and Whine

Howling or whining of the differential ring gear and pinion is due to an incorrect gear pattern, gear damage or incorrect bearing preload.

Bearing Whine

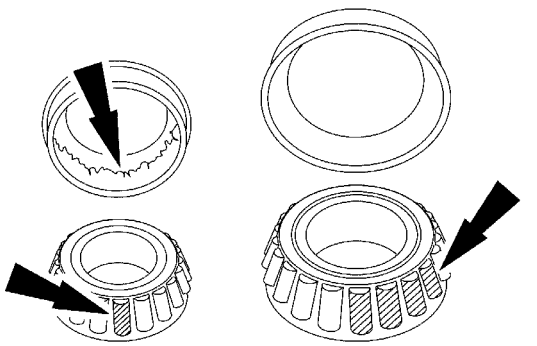
Bearing whine is a high-pitched sound similar to a whistle. It is usually caused by worn/damaged pinion bearings, which are operating at driveshaft speed. Bearing noise occurs at all driving speeds. This distinguishes it from gear whine, which usually comes and goes as speed changes.

As noted, pinion bearings make a high-pitched, whistling noise, usually at all speeds. If, however, there is only 1 pinion bearing that is worn/damaged,

the noise may vary in different driving phases. Do not install new pinion bearings unless bearings are scored or damaged or there is a specific pinion bearing noise. A worn/damaged bearing will normally be obvious at disassembly. Examine the large end of the rollers for wear. If the pinion bearings original blend radius has worn to a sharp edge, install a new pinion bearing.

NOTE: A low-pitched rumble normally associated with a worn/damaged wheel bearing can be caused by the exterior luggage rack or tires.

A wheel bearing noise can be mistaken for a pinion bearing noise. Check the wheel bearing for a spalled cup and spalled/damaged rollers. Install a new wheel bearing and cup if any of these concerns are detected.



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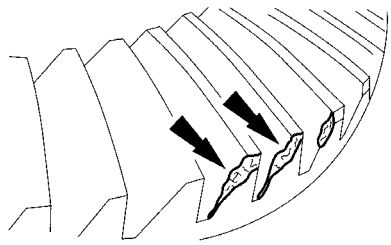
Chuckle

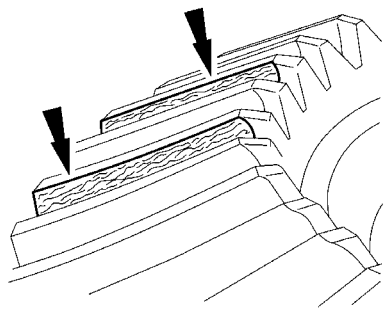
Chuckle that occurs on the coast driving phase is usually caused by excessive clearance between the differential gear hub and the differential case bore.

Damage to a gear tooth on the coast side can cause a noise identical to a chuckle. A very small tooth nick or ridge on the edge of a tooth can cause the noise.

Clean the gear tooth nick or ridge with a small grinding wheel. If the damaged area is larger than 3.2 mm (1/8 inch), install a new gearset.To check the differential ring gear and pinion, remove as much lubricant as possible from the gears with clean solvent. Wipe the gears dry or blow them dry with compressed air. Look for scored or damaged teeth. Also look for cracks or other damage.

If either gear is scored or damaged badly, install a new differential ring gear and pinion.





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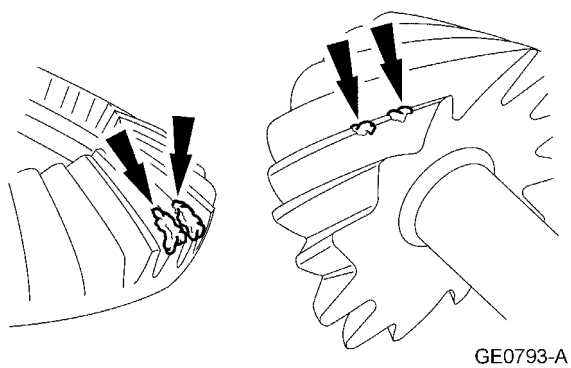
If metal has broken loose, the differential housing must be cleaned to remove particles that will cause damage. At this time, any other damaged components in the differential housing must also be discarded and new components installed.

Knock

Knock, which can occur on all driving phases, has several causes including damaged teeth or gearset.



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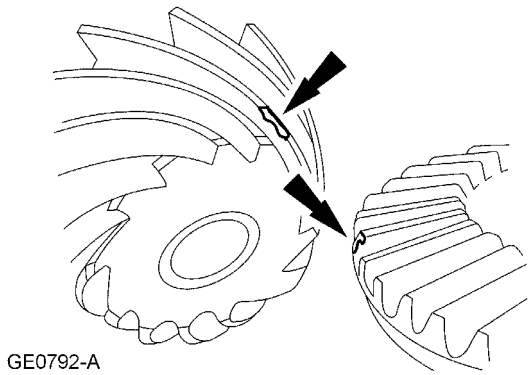
A gear tooth damaged on the drive side is a common cause of the knock. This can usually be corrected by grinding the damaged area.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Clunk

Clunk is a metallic noise heard when the automatic transmission is engaged in REVERSE or DRIVE. The noise may also occur when throttle is applied or released. It is caused by backlash somewhere in the driveline or loose suspension components; it is felt or heard in the axle. For additional information, refer to Total Backlash Check in this section.

Additionally, clunk may be heard upon initial drive-away. This occurs as engine torque shifts vehicle weight, forcing changes in driveline angles, preventing the driveshaft slip-yoke from sliding on the output shaft. To correct this condition, lubricate the slip-yoke splines. For additional information, refer to Driveshaft in S06002.

Bearing Rumble

Bearing rumble sounds like marbles being tumbled. This condition is usually caused by worn/damaged wheel bearing. The lower pitch is because the wheel bearing turns at only about one-third of the driveshaft speed. Wheel bearing noise also may be high-pitched, similar to gear noise, but will be evident in all 4 driving modes.

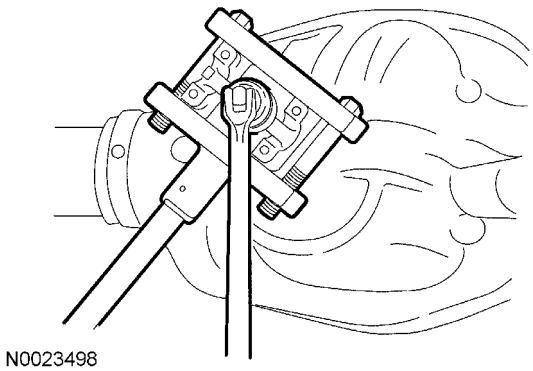
Total Backlash Check

1. Raise and support the vehicle. For additional information, refer to Jacking and Lifting(Jacking and Lifting, page 1).

2. Remove the driveshaft. For additional information, refer to Driveshaft in S06002.

3. Install the special tool.

- Clamp a rigid bar or pipe to the tool. Clamp the other end of the bar or pipe to the frame or a body member in order to prevent movement of the pinion flange.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4. Lower the vehicle so that one rear wheel is resting on a wheel chock to prevent it from turning. The other rear wheel will be used to measure total axle backlash.

5. Rotate the free wheel slowly, by hand, until the feeling of driving the axle is encountered. Place a mark on the side of the tire, 305 mm (12 inches) from the center of the wheel, with a crayon or chalk.

6. While holding the crayon or chalk against the tire, rotate the wheel slowly in the opposite direction until the feeling of driving the axle is encountered again.

7. Measure the length of the crayon or chalk mark on the tire.

- If the length of the mark is 25.4 mm (1 inch) or less, the axle backlash is within allowable limits.
- If the chalk mark is greater than 25.4 mm (1 inch), check for these conditions:
  - — Elongation of the differential pinion shaft and holes in the differential case.
  - — Missing differential pinion thrust washer or differential side gear thrust washer.
  - — Galling of the differential pinion shaft and bore.
  - — Excessive ring gear and pinion backlash. Follow the procedure for the type of axle to check backlash.

Symptom Chart

Table 15

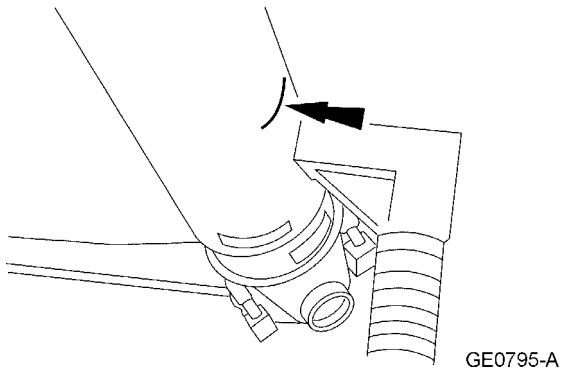
Condition	Possible Sources	Action
Lubricant leaking from the pinion seal, axle shaft oil seals	A. Vent B. Damage in the seal contact area.	A. CLEAN the differential housing vent and the vent hose. B. INSTALL a new seal and mating surface if damage is found.
Differential side gears/pinion gears are scored	A. Insufficient lubrication. B. Incorrect or contaminated lubricant type.	A. INSTALL new gears. REFER to Rear Drive Axle/ Differential in S14020. FILL the axle to specification. B. INSTALL new gears. REFER to Rear Drive Axle/ Differential in S14020. CLEAN and REFILL the axle to specification.
Axle overheating	A. Lubricant level too low. B. Incorrect or contaminated lubricant type. C. Bearing preloads too high. D. Excessive gear wear. E. Incorrect ring gear backlash.	A. CHECK the lubricant level. FILL the axle to specification. B. INSPECT the axle for damage. REPAIR as necessary. CLEAN and REFILL the axle to specification. C. CHECK the ring and pinion for damage. INSPECT the ring and pinion wear pattern. ADJUST the preload as necessary. D. INSPECT all the axle gears for wear or damage. INSTALL new components as necessary. E. INSPECT the ring gear for scoring. INSPECT the ring and pinion wear pattern. ADJUST the ring gear backlash as necessary.
Broken gear teeth on the ring gear or pinion	Overloading the vehicle.	INSTALL a new ring and pinion. REFER to Rear Drive Axle/ Differential in S14020.
Axle shaft broken	A. Overload the vehicle. B. Misaligned axle shaft tube.	A. INSTALL a new axle shaft. REFER to Wheel Hubs and Bearings in S14020. B. INSPECT the axle for damage. CHECK axle shaft tube alignment. INSTALL a new axle shaft. REFER to Wheel Hubs and Bearings in S14020.

Component Tests — Driveline Vibration

NOTE: An analysis of driveline vibration can also be conducted using the Vibration Analyzer and following the manufacturer's directions.

Driveline vibration exhibits a higher frequency and lower amplitude than does high-speed shake. Driveline vibration is directly related to the speed of the vehicle and is usually noticed at various speed ranges. Driveline vibration can be perceived as a tremor in the floor pan or is heard as a rumble, hum or boom. Driveline vibration can exist in all drive modes, but may exhibit different symptoms depending upon whether the vehicle is accelerating, decelerating, floating or coasting. Check the driveline angles if the vibration is particularly noticeable during acceleration or deceleration, especially at lower speeds. Driveline vibration can be duplicated by supporting the axle upon a hoist or upon jack stands, though the brakes may need to be applied lightly in order to simulate road resistance.

1. Raise the vehicle promptly after road testing. Use twin-post hoist or jack stands to prevent tire flat-spotting. Engage the drivetrain and accelerate to the observed road test speed to verify the presence of the vibration. If the vibration is not evident, check the non-driving wheels with a wheel balancer to rule out imbalance as a possible cause. If necessary, balance the non-driving wheels and repeat the road test. If the vibration is still evident, proceed to Step 2.
2. Mark the relative position of the drive wheels to the wheel bolts. Remove the wheels. Install all the wheel nuts in the reversed position (wheel nuts can be installed in their normal orientation on axles with dual rear wheels) and repeat the road speed acceleration. If the vibration is gone, refer to the tire and wheel runout procedure in Wheels and Tires in S17002. If the vibration persists, proceed to Step 3.
3. Inspect the driveshaft(s) (for signs of physical damage, missing balance weight, undercoating, incorrect seating, wear and binding universal joints). Clean the driveshaft and install new universal joints or a driveshaft if damaged. Check the index marks (paint spots) on the rear of the driveshaft and pinion flange. If these marks are more than one quarter turn apart, disconnect the driveshaft and reindex it to align the marks as closely as possible. After any corrections are made, recheck for vibration at the road test speed. If the vibration is gone, reinstall the wheels and road test. If the vibration persists, proceed to Step 4.
4. Raise the vehicle on a hoist and remove the wheels. Rotate the driveshaft by turning the axle and measure the runout at the front, the center and the rear of the driveshaft with the indicator. If the runout exceeds 0.50 mm (0.020 in) at the front or center, install a new driveshaft. If the front and center are within this limit, but the rear runout is not, mark the rear runout high point and proceed to Step 5. If the runout is within the limits at all points, proceed to Step 7.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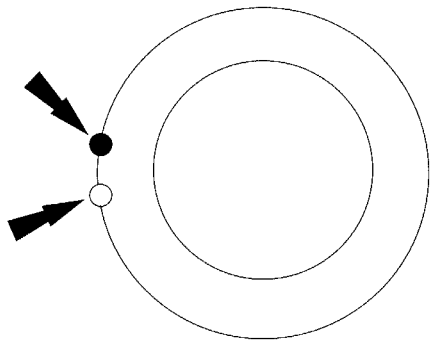
NOTE: Check the U-joints during re-indexing. If a U-joint feels stiff or gritty, install new U-joints.

5. Scribe alignment marks on the driveshaft and the pinion flange. Disconnect the driveshaft, rotate it one-half turn and reconnect it. Circular pinion flanges can be turned in one-quarter increments to fine tune the runout condition; half-round pinion flanges are limited to 2 positions. Check the runout at the rear of the driveshaft. If it is still over 0.50 mm (0.020 inch), mark the high point and proceed to Step 6. If the runout is no longer excessive, check for vibration at the road test speed. If vibration is still present, reindex the driveshaft slip-yoke on the transmission output shaft one-half turn and road test the vehicle. If the vibration persists, proceed to Step 7.
6. Excessive driveshaft runout may originate in the driveshaft itself or in the pinion flange. To determine which, compare the 2 high points marked in Steps 4 and 5. If the marks are close

together, within about 25 mm (1 inch), install a new driveshaft and road test the vehicle.



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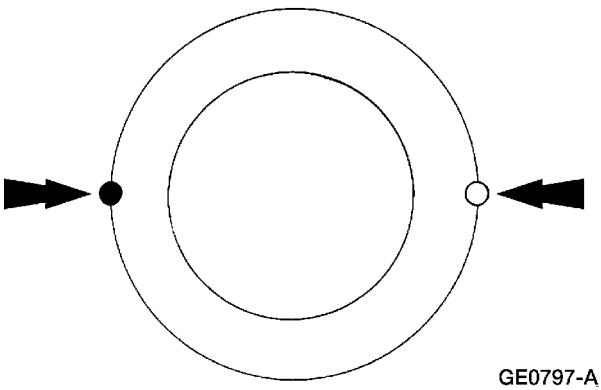
If the marks are on opposite sides of the driveshaft, the pinion flange is responsible for the vibration.



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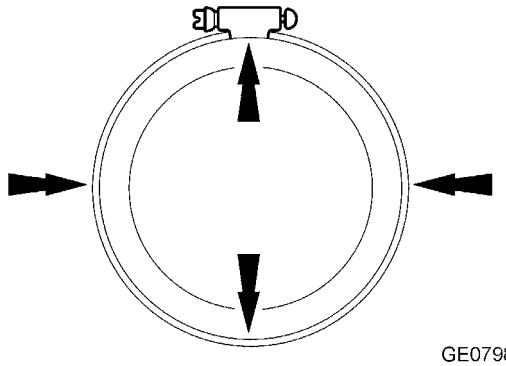
When installing a new pinion flange, the driveshaft runout must not exceed 0.50 mm (0.020 inch). When runout is within limits, recheck for vibration at road speed. If vibration persists, balance the driveshaft.

7. To balance the driveshaft, install 1 or 2 hose clamps on the driveshaft, near the rear. Position of the hose clamp head(s) can be determined by trial-and-error.
8. Mark the rear of the driveshaft into 4 approximately equal sectors and number the marks 1 through 4. Install a hose clamp on the driveshaft with its head at position No. 1.



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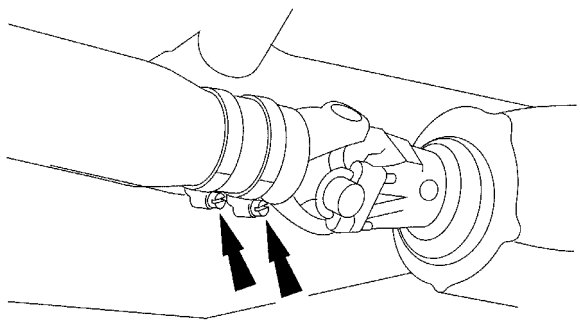
Check for vibration at road speed. Recheck with the clamp at each of the other positions to find the position that shows minimum vibration. If 2 adjacent positions show equal improvement, position the clamp head between them.

9. If the vibration persists, add a second clamp at the same position and recheck for vibration.



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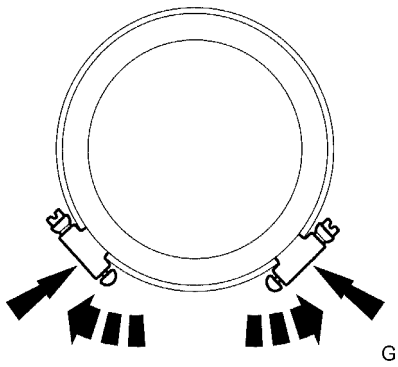
If no improvement is noted, rotate the clamps in opposite directions, equal distances from the best position determined in Step 8. Separate the clamp heads about 13 mm (1/2 inch) and recheck for vibration at the road speed.



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Repeat the process with increasing separation until the best combination is found or the vibration is reduced to an acceptable level.

10. Install the wheels and road test (vibration noticeable on the hoist may not be evident during the road test). If the vibration is still not acceptable, install a new axle driveline vibration damper first, if so equipped. If the vibration is still not acceptable, refer to Rear Drive Axle/ Differential in S14020. For differential case and ring gear runout checks.

Component Tests — Tooth Contact Pattern Check — Gearset

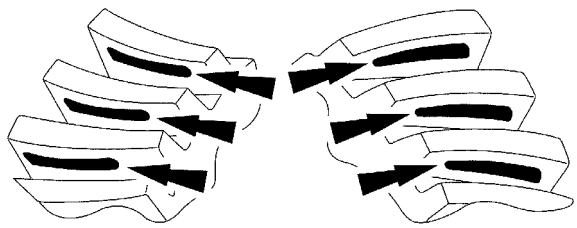
1. To check the gear tooth contact, paint the gear teeth with the special marking compound. A mixture that is too wet will run and smear; a mixture that is too dry cannot be pressed out from between the teeth.
2. Use a box wrench on the ring gear bolts as a lever to rotate the differential ring gear several complete revolutions in both directions or until a clear tooth contact pattern is obtained.
3. Certain types of gear tooth contact patterns on the differential ring gear indicate incorrect adjustment. Incorrect adjustment can be corrected by readjusting the differential ring gear or the pinion.

Contact Pattern Location

In general, desirable ring gear tooth patterns must have the following characteristics:

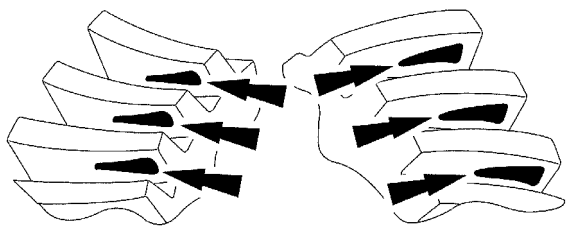
- Drive pattern on the drive side differential ring gear well centered on the tooth
- Coast pattern on the coast side differential ring gear well centered on the tooth
- Clearance between the pattern and the top of the tooth
- No hard lines where the pressure is high

Acceptable differential ring gear tooth patterns for all axles.



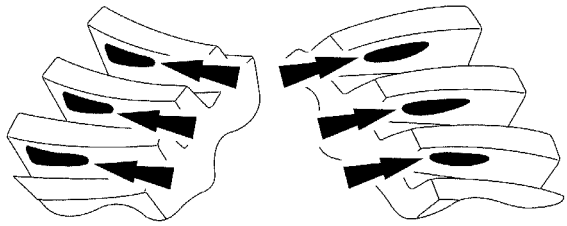
GE0807-A

Correct backlash with a thinner pinion position shim as necessary.



GE0808-A

Correct backlash with a thicker pinion position shim as necessary.



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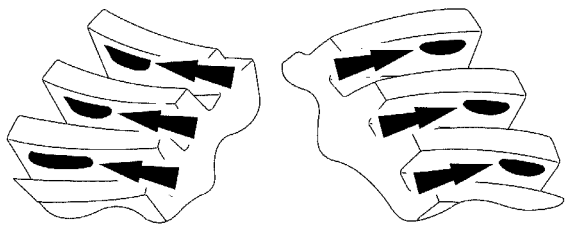
Correct pinion position shim that requires a decrease in backlash.



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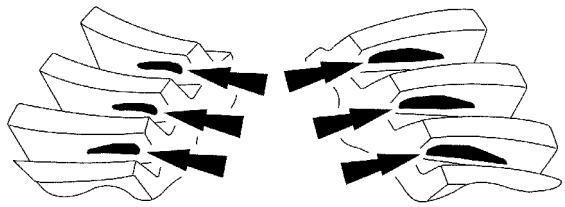
Correct pinion position shim that requires an increase in backlash.



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