

## Steering - ZF System Fault Tracing & Repair

NO: 64-23

DATE G01-25-2007

MODEL: S60, V70, XC70, S80, XC90

MODEL YEAR:

2003- (XC90)

2004- (all other listed models)

SUBJECT: ZF [Power Steering](#) System Fault Tracing and Repair

REFERENCE: TNN 64-24; 64-09; TNN 64-20; TNN 64-21; VIDA

THIS TNN SUPERSEDES TNN 64-23 DATED 07-31-2006. A REFERENCE TO TNN 64-24 HAS BEEN ADDED, AND THE MODEL YEAR RANGE FOR THE S60/V70 HAS BEEN CORRECTED. PLEASE UPDATE YOUR FILES.

**WARNING: These vehicles have pyrotechnical airbags and seat belt tensioners. The components in the SRS system must be treated very carefully during repair. This is to help prevent: 1.Personal injury when carrying out repairs 2.Damage to or malfunction of the SRS system.**

**Refer to VIDA (Information > Repair > General Safety Information) for SRS warnings, information, and instructions.**

MODEL	MODEL YEAR	CHASSIS NO.
S60	2004-	315000-
V70	2004-	349000-
XC70	2004-	123000-
S80	2004-2006	335000-
XC90	2003-	000001-

This Tech Net Note is designed to assist with overall identification and repair of various problems with ZF-manufactured steering systems. ZF [steering gears](#) were factory-equipped on the following models:

**This TNN is divided into three major sections:**

1. The first section, 'Overview', provides a simple description of the [power steering](#) system.
2. The second section, 'Description', defines the various problems, such as noise, leakage, and functionality.
3. The third section, 'Repair', defines the specific repairs for each Description.

The purpose of this TNN is to guide the technician through the proper diagnosis and repair of the ZF [power steering](#) system. As a general guideline, a complete customer description of the concern, followed by confirmation of that concern, are key.

**The customer should be asked the following questions:**

- What is the specific problem?
- How long has the problem existed?
- Is it intermittent or permanent?
- Is the steering complaint affected by any of the following conditions:
  - Stationary vehicle or while driving (and at what speed)?
  - Temperature (outdoor temperature and/or vehicle temperature)?
  - Condition of the road surface?
  - Engine speed?
  - [Steering wheel](#) position?

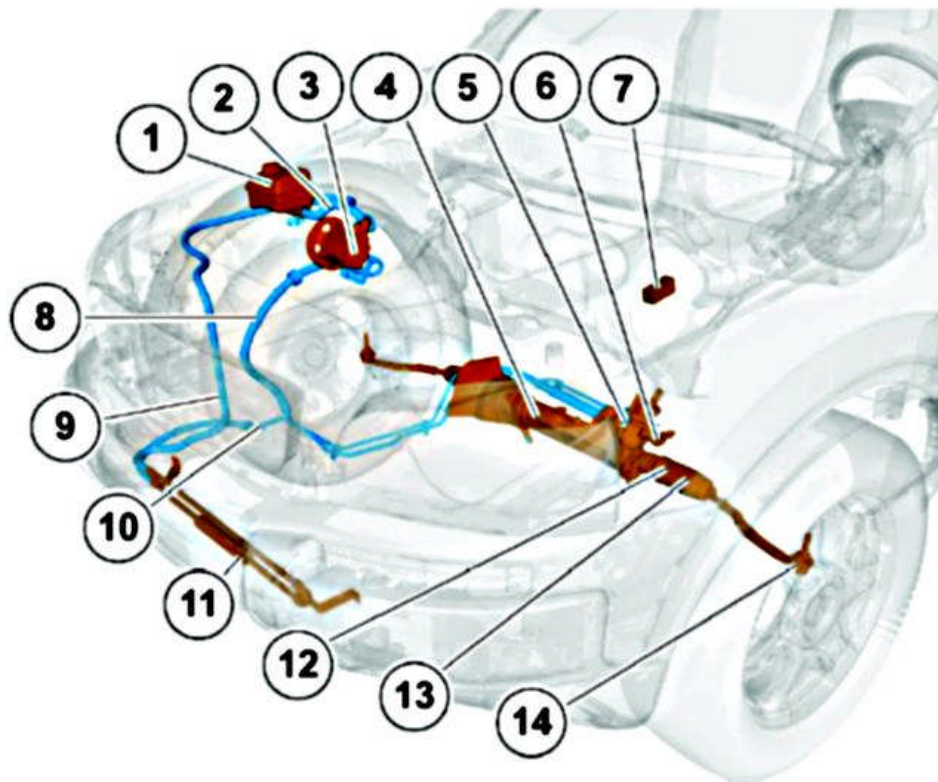
Answers to these questions should be incorporated into the text on the Repair Order as much as possible.

If the complaint is noise-related, a thorough check of the vehicle's entire front end is necessary, with a focus on components which may be worn or loose, before repairing the steering system. Likewise, a fluid leak complaint should be verified by cleaning and testing the affected area first, before any disassembly is begun.

The Section Table of Contents below allows the technician to turn to the appropriate section of this TNN as needed.

It should not be necessary to read the entire TNN every time a steering-related repair is made.

## Section 1



### Power steering system overview

1	Power steering fluid reservoir	6	Solenoid (ECPS only)	11	Oil cooler
2	Suction line	7	Power Steering Control Unit (PSU) (ECPS only)	12	Bellows
3	Pump	8	Delivery line	13	Inner tie rod end
4	Steering gear	9	Return hose	14	Outer tie rod end
5	Valve	10	Return line		

### Overview

A simple description of the [power steering](#) system.

There are two types of [steering gears](#): Standard [power steering](#) or electronically controlled power steering (ECPS). ECPS adapts power steering assistance based on vehicle speed.

Fluid is suctioned from the fluid reservoir (1) through the suction line (2) to the pump (3), which is a rotary vane pump. Pressure is increased in the pump through compression and supplies the [steering gear](#) (4) [power steering fluid](#) under pressure through the delivery line (8).

The [power steering fluid](#) then passes through the return line (10) [and optionally in some models, to the oil cooler (11)] and the return hose (9) back to the fluid reservoir.

The pump is mounted on the engine and is driven by the auxiliaries belt.

**NOTE:** The system is extremely sensitive to contaminants.

## Section 2

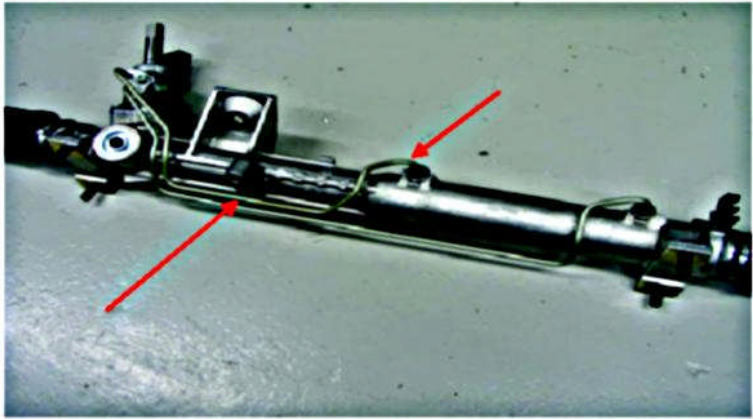
Hydraulic noise		
Problem	Definition	Repair
Grunting/ trumpeting	Loud hydraulic resonance that is heard when the steering wheel is turned when the car is stationary (engine running) or in sharp turns when driving slowly. This noise can also occur when the driver releases the steering wheel after a turn.  Worsens at high engine speed. This noise primarily occurs in systems with speed-dependent steering gears (Servotronic; see TNN 64-20 for identification). The trumpeting noise may cause a light vibration in the steering wheel.	1
Hydraulic knock	<b>Note!</b> This only applies to speed-dependent steering gears (Servotronic; see TNN 64-20 for identification).  Occurs when the car is stationary (engine running) and during quick steering wheel movements back and forth. Loud hydraulic knocking.  The hydraulic knocking can also be felt in the steering wheel.	2

Mechanical noise		
Problem	Definition	Repair
Knocking noise	Low pitched metallic knocking/striking when driving over uneven road surfaces, potholes or the like.  The problem worsens when turning right.	3
Squeak/ grinding	Metallic friction/squeaking/scraping from steering gear area.  The noise occurs during steering wheel movement when the car is stationary or during slow driving.	4
Click	High pitched metallic clicking/striking noise.  Occurs when car is stationary or during slow driving when the steering wheel is moved back and forth quickly.  <b>Note!</b> This noise can also be heard when the engine is off.  Large steering wheel movements make the problem worse.	5

## Description - Noise

### Section 2

Pump leakage		
Problem	Definition	Repair
Suction hose coupling	Leakage between suction hose and pump. Also applies to leakage between suction hose and reservoir.	6
Power steering pump shaft seal	Leakage at pump's output shaft.	7

Steering gear leakage		
Problem	Definition	Repair
Internal pipes	<p>Fluid leak at steering gear's internal pipes.</p> <p>Note! Internal pipes move fluid from the steering gear's valve to its cylinder area, and are routed alongside the gear assembly (see arrows).</p> 	8
Bellows	<p>Fluid leak into steering gear's rubber bellows at tie rods.</p> <p>For left-hand drive vehicles, fluid leaks into the right bellows.</p> <p>Careful removal of the bellows is required to locate and verify this leakage.</p>	9

## Description - Leakage

### Section 2

Power steering fluid		
Problem	Definition	Repair
Fluid level	<p>Fluid type: use Volvo synthetic power steering fluid (Pentosin CHF 11 S) or equivalent.</p> <p>Fluid level in reservoir: Measure when cold, with engine off.</p> <p>Fill the oil until the level is halfway between the 'cold' and 'hot' marks on the dipstick.</p>	10

Sluggish steering		
Problem	Definition	Repair
Parking/driving	The driver must use a lot of force to turn the steering wheel when driving or parking or when the vehicle is stationary. Insufficient assistance from the power steering system.	11

Freeplay		
Problem	Definition	Repair
Play between steering wheel and front wheels	Too much steering wheel movement before the front wheels start to turn.	12
Play in tie rods	Play in steering gear's outer or inner steering tie rods that can be seen or felt.	13
Radial rack bar play.	<b>Note!</b> There is no noise associated with this freeplay. Radial rack bar play without play in tie rod ends. Detected by standing beneath the vehicle and pulling and pressing on the left side steering arm outside of the bellows. If noise is heard during this check, see repair number 5.	14

## Description - Functionality

### Section 3

### Repair – Noise

Repair	Grunting / Trumpeting	
1	A	Some grunting is natural and unavoidable in a hydraulic system. Compare the problem to similar vehicles from the same model year to verify if the noise is abnormal. In the event of abnormal noise, replace the steering gear. <b>Note!</b> You must also replace the lower steering shaft if the car was built <b>before</b> the chassis numbers specified below: S60: 384-499999 V70: 285-529999 XC70: 295-207999 S80: 184-426007 XC90: 275-223999 See: VIDA Removing, replacing, installing Suspension, steering Steering gear, replacing > Steering wheel, steering wheel lock, steering column, shaft

## Hydraulic Noise

### Section 3

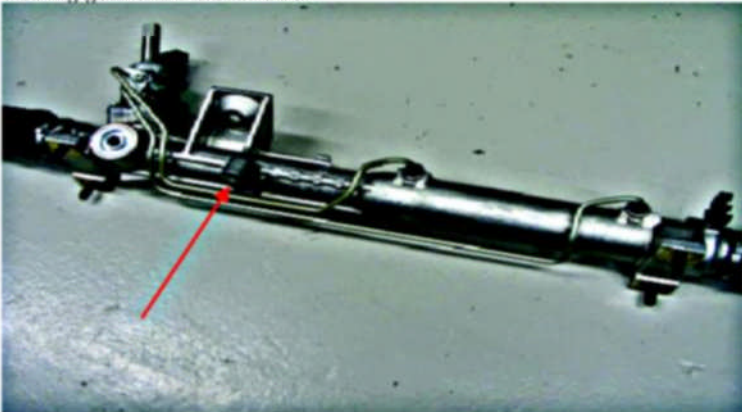
### Repair – Noise

Repair	Hydraulic Knock	
2	A	Some hydraulic knocking is natural and unavoidable in a hydraulic system. Compare the problem to similar vehicles from the same model year to verify if the noise is abnormal.
	B	Adjust the yoke as necessary. See TNN 64-21.
	C	If Step B does not help, replace the steering gear. <b>Note!</b> You must also replace the lower steering shaft if the car was built <b>before</b> the chassis numbers specified below: S60: 384-499999 V70: 285-529999 XC70: 295-207999 S80: 184-426007 XC90: 275-223999 See: VIDA Removing, replacing, installing Suspension, steering Steering gear, replacing > Steering wheel, steering wheel lock, steering column, shaft

**Hydraulic Noise**  
**Section 3**  
**Repair – Noise**

Repair	Knocking Noise	
3	A	Some striking noise is normal. Compare the problem to similar vehicles from the same model year to verify if the noise is abnormal.
	B	Before focusing on the steering system, perform a complete inspection of the front end for obvious mechanical problems. Confirm the source of the noise before any disassembly or repair. As a general guideline, follow the checklist in Step C:
	C	i. Check the front suspension, including all bushings and mounting points.
		ii. Check the drive shafts.
		iii. Check the lower steering shaft and its coupling to the steering gear.
		iv. Check the steering column, including universal joints and bearings. <b>Note!</b> Refer to TNN 64-09.
		v. Check the inner and outer tie rods of the steering gear (take care when removing the rubber bellows of the inner tie rods).
vi. If any loose, worn, or broken components are found during the above checks, make the needed repairs first before continuing with the steering diagnosis.		
D	If there is confirmation of a knocking noise in the steering gear, adjust the yoke as described in TNN 64-21.	
E	If Steps A-D do not help, replace the steering gear. <b>Note!</b> You must also replace the lower steering shaft if the car was built <b>before</b> the chassis numbers specified below: S60: 384-499999 V70: 285-529999 XC70: 295-207999 S80: 184-426007 XC90: 275-223999 See: VIDA Removing, replacing, installing Suspension, steering Steering gear, replacing > Steering wheel, steering wheel lock, steering column, shaft	

**Mechanical Noise**  
**Section 3**  
**Repair – Noise**

Repair	Squeak / Grinding	
4	A	Before focusing on the steering system, perform a complete inspection of the front end for obvious mechanical problems. Confirm the source of the noise before any disassembly or repair. As a general guideline, follow the checklist in Step B:
	B	<ul style="list-style-type: none"> <li>i. Check the front suspension, including all bushings and mounting points.</li> <li>ii. Check the drive shafts.</li> <li>iii. Check the lower steering shaft and its coupling to the steering gear.</li> <li>iv. Check the steering column, including universal joints and bearings. Note! Refer to TNN 64-09.</li> <li>v. Check the inner and outer tie rods of the steering gear (take care when removing the rubber bellows of the inner tie rods).</li> <li>vi. If any loose, worn, or broken components are found during the above checks, make the needed repairs first before continuing with the steering diagnosis.</li> </ul>
	C	Check the seal in the firewall. Repair as necessary.
	D	<p>Loosen the center bolt (located at arrow) which secures the steering gear to the subframe. If the squeak/grinding noise lessens with the bolt loose, add a washer to the bolt between the steering gear and the subframe.</p> 
	E	<p>Detach the steering gear from the steering column and wheel spindles.</p> <p><b>Warning!</b> Normally, the steering wheel should be locked when making repairs or replacing components. If it is necessary to unlock the steering wheel in order to locate the source of the noise, ensure that the steering wheel is not turned more than two full turns in either direction, or the SRS contact reel may be damaged.</p> <p>Locate the problem. Make necessary repairs.</p> <p>Note! Ensure that the steering wheel is centered when reattaching the steering column.</p>



## Mechanical Noise

### Section 3

#### Repair – Noise

Repair	Click	
5	A	Some clicking noise is normal. Compare the problem to similar vehicles from the same model year to verify if the noise is abnormal.
	B	Before focusing on the steering system, perform a complete inspection of the front end for obvious mechanical problems. Confirm the source of the noise before any disassembly or repair. As a general guideline, follow the checklist in Step C:
	C	i. Check the front suspension, including all bushings and mounting points.
		ii. Check the drive shafts.
		iii. Check the lower steering shaft and its coupling to the steering gear.
iv. Check the steering column, including universal joints and bearings. <b>Note!</b> Refer to TNN 64-09.		
D	v. Check the inner and outer tie rods of the steering gear (take care when removing the rubber bellows of the inner tie rods).	
	vi. If any loose, worn, or broken components are found during the above checks, make the needed repairs first before continuing with the steering diagnosis.	
	D	Try to reproduce the noise by tugging and pulling the steering arm on the valve (left) side. If reproduced, adjust the yoke as described in TNN 64-21. Clicking noise, if reproduced in this manner, will be repaired via the yoke adjustment.

## Mechanical Noise

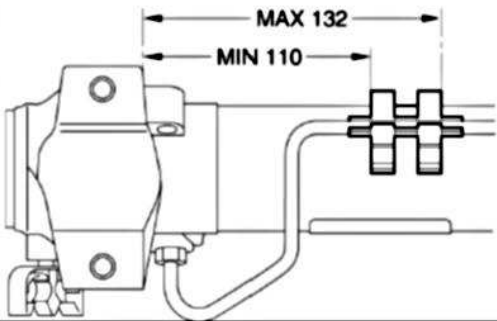
### Section 3

#### Repair – Leakage

Repair	Suction Hose Coupling	
6	A	Check the fluid level in the reservoir. See Repair 10.
	B	Clean the pump, reservoir and hose to confirm the location and source of the leak.
	C	Make sure that the hose clamps are properly fitted. Replace clamps if necessary.
	D	Check the condition of the suction hose. Replace hose if necessary.
	E	Do not replace the pump or reservoir unless there are clear defects in the pump, pump nipple, or reservoir.

Repair	Power Steering Pump Shaft Seal	
7	A	Check the fluid level in the reservoir. See Repair 10.
	B	Verify that the pump leakage is from the pump shaft. Clean the pump and pulley to confirm the location and source of the leak. Apply leak tracer Volvo part #1161560 on the pump. Start the engine and turn the steering wheel back and forth.
	C	<b>Note!</b> Do not replace the pump unless there is verified leakage. Replace the pump if shaft leakage has been verified.
	D	If no shaft seal leakage can be found, check the hose connections and other potential leakage points around the pump.

**Pump Leakage**  
**Section 3**  
**Repair – Leakage**

Repair	Internal Pipes	
8	A	Check the fluid level in the reservoir. See Repair 10.
	B	Verify that the leakage is from the internal pipes (see photo on page 4).
	C	If the leakage is from the internal pipes, replace the internal pipes, by following steps i. through v. below:
	i.	Remove the steering gear, see VIDA: Removing, replacing and installing > Suspension, steering > Steering gear > Steering gear, replacement
	ii.	<b>Note!</b> Seal the inlet and outlet connections from the servo pump with plastic plugs immediately after removal.
	iii.	To remove the old pipes: Remove the protective plate from over the pipes. Seal the inlet and outlet connections using plastic plugs. Carefully clean around the oil pipe connections and blow dry. Remove the pipes. Carefully check that there is no residue of the old sealing rings in the connections on the steering gear.
iv.	To install the new pipes: Install the new sealing rings on the oil pipes. Lubricate the sealing rings using power steering fluid. Carefully install the new pipes with the sealing rings to the steering gear. <b>Note!</b> Use a new bolt for the pipe's holder. Tighten the pipe nuts to 7 Nm (5 Lb-Ft) and the holder screw to 12 Nm (9 Lb-Ft). Install the protective panel over the pipes.	
v.	A support must be installed on the longer of the two oil pipes as illustrated. The illustration shows the location of the support on the steering gear: it should be installed a minimum of 110 mm (4 3/8 in.) and a maximum of 132 mm (5 3/16 in) from the point indicated in the illustration. <b>Note!</b> Only <b>one</b> support must be used, the illustration shows the support in its minimum and maximum positions.	
		

## [Steering Gear](#) Leakage

### Section 3

#### Repair – Leakage

Repair	Bellows	
9	A	Check the fluid level in the reservoir. See Repair 10.
	B	Verify that fluid is leaking into the bellows by carefully detaching the right side bellows.
	C	<p>If there is obvious leakage of fluid into the bellows, replace the steering gear.</p> <p><b>Note!</b> You must also replace the lower steering shaft if the car was built <b>before</b> the chassis numbers specified below:</p> <p>S60: 384-499999 V70: 285-529999 XC70: 295-207999 S80: 184-426007 XC90: 275-223999</p> <p>See: VIDA</p> <p>Removing, replacing, installing</p> <p>Suspension, steering</p> <p>Steering gear, replacing &gt; Steering wheel, steering wheel lock, steering column, shaft</p>

## [Steering Gear](#) Leakage

### Section 3

#### Repair Functionality

Repair	Fluid Level	
10	A	<p>Fill the fluid if it is below specification.</p> <p>Fluid type: use Volvo synthetic power steering fluid (Pentosin CHF 11 S) or equivalent.</p> <p>Fluid level in reservoir: Measure when cold, with engine off.</p> <p>Fill the oil until the level is halfway between the "cold" and "hot" marks on the dipstick.</p>
	B	Check the system for leakage. See Repairs 6, 7, 8, and 9.

## Power Steering Fluid

Repair	Parking / driving	
11	A	Compare the problem to similar vehicles from the same model year to verify if the effort is abnormal. <b>Note!</b> Determine first if vehicle has speed-sensitive steering. See TNN 64-20.
	B	Check the fluid level in the reservoir. See Repair 10.
	C	If the fluid level is low, check for leaks in the system. See Repairs 6, 7, 8, and 9.
	D	Check the belt tensioner and the belt that drives the pump. Repair if necessary.
	E	Check the steering column and other wheel suspension components that move during steering. Make sure that nothing is binding or seizing.
	F	If nothing is binding or seizing, detach the steering gear from the steering column and wheel spindles. <b>Warning!</b> Normally, the steering wheel should be locked when making repairs or replacing components. If it is necessary to unlock the steering wheel in order to locate the source of the sluggishness, ensure that the steering wheel is not turned more than two full turns in either direction, or the SRS contact reel may be damaged. Examine the systems and components separately to locate any potential problem. <b>Note!</b> Ensure that the steering wheel is centered when reattaching the steering column.
	G	If the steering gear is speed sensitive (see TNN 64-20), check the cables and connections between the PSU and the steering gear. Repair as necessary.
	H	Measure the current strength of the signal from the PSU to the steering gear. Make the measurements at the cable connections on the steering gear valve. When the vehicle is stationary, current strength should be 860 mA (AC). Replace the PSU if the current strength is not within the range of 830-890 mA (AC).
	I	Measure pump pressure. See VIDA: Cleaning, checking and adjusting > Suspension, steering > Servo balance/pump pressure, checking Pumps marked 110 bar (on black label on pump): Max should be between 93 and 110 bar. Pumps marked 120 bar (on black label on pump): Max should be between 102 and 120 bar. <b>Note!</b> All XC90s, all S60R/V70R, and S80 MY04- use 120 bar pump. All other vehicles referenced in this TNN use 110 bar pump. Replace the pump if pressure levels lie below the specification.

## Sluggish Steering

### Section 3

#### Repair – Functionality

Repair	Freeplay between steering wheel and front wheels	
12	A	Compare the problem to similar vehicles from the same model year to verify if the freeplay is abnormal.
	B	Raise the vehicle on a front end alignment rack or similar, so that the front tires are loaded, with the engine off. Have another technician assist by turning the steering wheel back and forth. Check the play in the moving parts beneath the vehicle and in the steering column, including the wheel suspension and lower steering shaft. Remedy any problems found. If the problem remains, continue to step C below.
	C	Detach the steering gear from the steering column and wheel spindles. <b>Warning!</b> Normally, the steering wheel should be locked when making repairs or replacing components. If it is necessary to unlock the steering wheel in order to locate the source of the freeplay, ensure that the steering wheel is not turned more than two full turns in either direction, or the SRS contact reel may be damaged. Examine the systems and components separately to locate any potential problem. <b>Note!</b> Ensure that the steering wheel is centered when reattaching the steering column.
	<b>Note!</b> Do not replace the steering gear if radial play is found in the steering gear's rack. See Repair 14.	

<b>Repair</b>	<b>Freeplay in tie rods</b>	
13	A	Verify the problem using Steps B and C in Repair 12. Remove the rubber bellows to correctly assess the inner tie rods.
	B	Replace the tie rod in question.

<b>Repair</b>	<b>Radial rack bar play</b>	
14	A	Some radial rack bar movement on the left side, without an associated noise, is normal. This will not affect steering function. Compare the play to similar vehicles from the same model year to verify if the rack bar play is abnormal.
	B	Verify that there is no play in the steering gear's tie rods, steering column, lower steering shaft or other front assembly components. See Repairs 12 and 13.
	C	Some elastic play in the steering gear's rack is design related. Do not replace the steering gear because of this type of play. If there is a clicking noise during this check, see Repair 5.