2012.0 RANGE ROVER (LM), 211-00

STEERING SYSTEM – GENERAL INFORMATION

DIAGNOSIS AND TESTING

PRINCIPLE OF OPERATION

For a detailed description of the steering system operation, refer to the relevant description and operation sections of the workshop manual.

INSPECTION AND VERIFICATION

CAUTIONS:

- Diagnosis by substitution from a donor vehicle is **NOT** acceptable. Substitution of control modules does not guarantee confirmation of a fault, and may also cause additional faults in the vehicle being tested and/or the donor vehicle
- If a steering gear assembly is returned under warranty with leaking rack bar seals or high friction, but there is also damage to the steering gear boot/boots, tie-rods or rack bar teeth, then the steering gear warranty will be invalid. This is due to the steering gear rack bar seals being damaged due to foreign materials entering the steering gear boot and damaging the steering gear rack bar seals thereafter or because of bending from abusive/accident events

1. Verify the customer concern

1. Visually inspect for obvious signs of damage and system integrity

Visual Inspection

Mechanical	Electrical
▪ Tire condition/pressure ▪ Fluid level	▪ Fuses

1. Check for any steering related DTCs and refer to the relevant DTC index

1. Refer to the relevant symptom chart for further guidance

DTC INDEX

For a list of Diagnostic Trouble Codes (DTCs) that could be logged on this vehicle, please refer to Section 100-00.

For Column Lock DTCs on L319, L320, L322, L359 -

REFER to: Diagnostic Trouble Code (DTC) Index - DTC: Electric Steering Column Lock Control Module (ESCL) (100-00 General Information, Description and Operation

For Additional Column Lock DTCs on L319, L320, L322, L359;

For Column Adjustment Motors or Solenoid DTCs on L319, L320, L322;

For Power Steering Solenoid (Actuator) DTCs on L320, L322;

For Power Steering Calibration DTCs on L319, L320, L322 -

REFER to: Diagnostic Trouble Code (DTC) Index - DTC: Central Junction Box (CJB) (100-00 General Information, Description and Operation).

For Additional Column Lock DTCs on L319, L320, L322, L359;

For Power Steering Calibration DTCs on L320, L322 -

REFER to: Diagnostic Trouble Code (DTC) Index - DTC: Instrument Cluster

(IC) (100-00 General Information, Description and Operation)

SYMPTOM CHARTS

WARNING:

It is not possible to CHECK the torque of a patch lock bolt, if the torque is suspected to be low, the bolt must be REMOVED/DISCARDED and a new bolt MUST be INSTALLED and torque to the correct value.

NOTE:

If the module or a component is suspect and the vehicle remains under manufacturer warranty, refer to the Warranty Policy and Procedures manual, or determine if any prior approval programme is in operation, prior to the installation of a new module/component.

Given the wide and varied nature of potential issues with the vehicle steering system, a series of symptom charts, pinpoint tests and additional diagnostic/remedial procedures are included throughout Section 211 (Steering System). For help in diagnosis of reported steering issue(s), refer to the following sections of the workshop manual:

NOTE:

It is possible that symptoms of a reported issue may appear in one or more of the diagnosis procedures listed below

For power steering system,
REFER to: Power Steering (211-02 Power Steering, Diagnosis and Testing).

For steering linkage,
REFER to: Steering Linkage (211-03 Steering Linkage, Diagnosis and Testing).

For steering column,
REFER to: Steering Column (211-04 Steering Column, Diagnosis and Testing).

For all other steering issues, see below:

GENERAL STEERING ISSUES

SYMPTOM	POSSIBLE CAUSES	ACTION
▪ Veer under braking	▪ Excess play in steering system	▪ REFER to: Pinpoint Tests within Section 211-03 Steering Linkage/Diagnosis and Testing/Steering Linkage
	▪ Contamination of brake pads and discs	▪ Check and rectify the source of the contamination and install new brake pads and discs as required, refer to the new module/component installation note at the top of the symptom charts
	▪ Seized front brake caliper slide pins or piston ▪ Damaged brake discs	▪ Check and rectify sticking slide pins and install new calipers as required, refer to the new module/component installation note at the top of the symptom charts ▪ Check and install new brake discs as required, refer to the new module/component installation note at the top of the symptom charts
	▪ Incorrect geometry settings	**NOTE:** Dealerships must keep a copy of the BEFORE and AFTER

		BEFORE and AFTER geometry figures with job card for future reference ▪ Check and adjust geometry as required (REFER to: Section 204-00 Suspension System - General Information/General Procedures)
▪ Vehicle pulls to one side when driving on a level surface	▪ Uneven tire wear ▪ Incorrect tire pressure	▪ For information on diagnosis of uneven tire wear (REFER to: Section 204-00 Suspension System - General Information/Diagnosis and Testing/Suspension System) ▪ Check and adjust tire pressures as required (REFER to: Section 204-04 Wheels and Tires/Specification)
	▪ Incorrect geometry settings	**NOTE:** Dealerships must keep a copy of the BEFORE and AFTER geometry figures with job card for future reference ▪ Check and adjust geometry as required (REFER to: Section 204-00 Suspension System - General Information/General Procedures)
	▪ Vehicle is unevenly loaded or overloaded	▪ Notify the customer of incorrect vehicle loading
	▪ Excess play in steering system	▪ REFER to: Pinpoint Tests within Section 211-03 Steering

		Steering Linkage/Diagnosis and Testing/Steering Linkage
	▪ Loose, damaged or worn front suspension components	▪ Check/tighten and install new front suspension components as required (REFER to: Section 204-00 Suspension System - General Information/Specification)
	▪ Loose, damaged or worn rear suspension components	▪ Check/tighten and install new rear suspension components as required (REFER to: Section 204-00 Suspension System - General Information/Specification)
	▪ Incorrect brake operation	▪ For information on diagnosis of the brake system (REFER to: Section 206-00 Brake System - General Information/Diagnosis and Testing/Brake System)
	▪ Incorrect underbody alignment	▪ Set underbody alignment (REFER to: Section 502-00 Uni-Body, Subframe and Mounting System/Removal & Installation)
▪ Wheel fight (kick back) - condition where roughness is felt in the steering wheel by the driver when the vehicle is driven over rough surfaces	▪ Loose or worn steering components/bushings	**CAUTION:** DO NOT attempt to adjust the steering gear yoke. Failure to follow this instruction will invalidate the steering gear warranty. ▪ REFER to: Pinpoint Tests within Section 211-03 Steering Linkage/Diagnosis and

		Testing/Steering Linkage
	▪ Loose or worn suspension components/bushings	▪ Tighten and install new suspension components/bushings as required
▪ Nibble (shimmy) - condition where oscillation of the steering wheel occurs (not vertical which is shake). This is driven by road wheel imbalance ▪ Shake - condition where vertical vibration of the steering wheel/column occurs (not oscillation which is nibble)	▪ Road wheel incorrect balance/radial force variation/forcing	▪ REFER to: Section 204-04 Wheels and Tires/Diagnosis and Testing/Wheels and Tires/Symptom - Vehicle Vibration

DESCRIPTION OF TERMS

GENERAL STEERING SYSTEM NOISES

BOOM

Rhythmic sound like a drum roll or distant thunder. May cause pressure on the ear drum

BUZZ

Low-pitched sound, like a bee. Usually associated with vibrations

CHATTER

Rapidly repeating metallic sound

CHUCKLE

Rapid noise that sounds like a stick against the spokes of a spinning bicycle wheel

CHIRP

High pitched rapidly repeating sound, like chirping birds

CLICK

Light sound, like a ball point pen being clicked

CLICK/THUMP

Heavy metal-to-metal sound, like a hammer striking steel

GRIND

Abrasive sound, like a grinding wheel or sandpaper rubbing against wood

GROAN/MOAN

Continuous, low-pitched humming sound

GROAN/HOWL

Low, guttural sound, like an angry dog

HISS

Continuous sound like air escaping from a tire valve

HUM

Continuous sound of varying frequencies, like a wire humming in the wind

KNOCK

Heavy, loud repeating sound like a knock on a door

PING

Similar to knock, except at higher frequency

RATTLE

A sound suggesting looseness, such as marbles rolling around in a can

ROAR

Deep, long, prolonged sound like an animal, or winds and ocean waves

RUMBLE

Low, heavy continuous sound like that made by wagons or thunder

SCRAPE

Grating noise like one hard plastic part rubbing against another

SQUEAK

High-pitched sound like rubbing a clean window

SQUEAL

Continuous, high-pitched sound like running finger nails across a chalkboard

TAP

Light, hammering sound like tapping pencil on edge of table. May be rhythmic or intermittent

WHIRR/WHINE

High-pitched buzzing sound, like an electric motor or drill

WHISTLE

Sharp, shrill sound, like wind passing a small opening

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STEERING SYSTEM – GENERAL INFORMATION

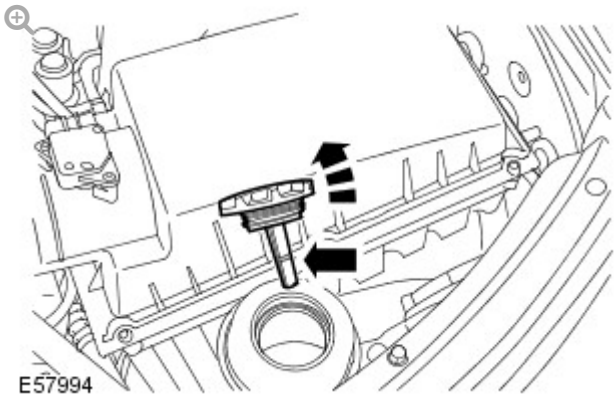
POWER STEERING SYSTEM FILLING AND BLEEDING (G458830)

GENERAL PROCEDURES

1. Check the power steering fluid level.

2. **CAUTION:**

   Fluid must always be present in the reservoir during bleeding.



   Remove the filler cap and fill to the UPPER level mark.

   - Install the reservoir filler cap.

3. Start the engine and allow to run for 10 seconds, stop the engine.

   - Check the power steering fluid, if aerated, wait until fluid is free from bubbles then top-up reservoir to UPPER level mark with recommended fluid.

4. **CAUTION:**

   Do not hold steering on full lock for longer than 10 seconds.

   Start the engine and turn steering fully lock to lock, stop the engine.

   - Check and top-up power steering fluid level.

5. Start and run the engine for 2 minutes, turn the steering fully lock to lock.

   - Check and top-up power steering fluid level.

- Check and top-up power steering fluid level.

POWER STEERING SYSTEM FLUSHING (G1075788)

GENERAL PROCEDURES

NOTES:

- If heavy steering or contamination within the power steering system is found, it is necessary to carry out the system flush procedure as detailed below. If any components have been replaced in the power steering system the procedure below must be carried out in full.
- Some variation in the illustrations may occur, but the essential information is always correct.

1. Remove the power steering fluid reservoir cap.

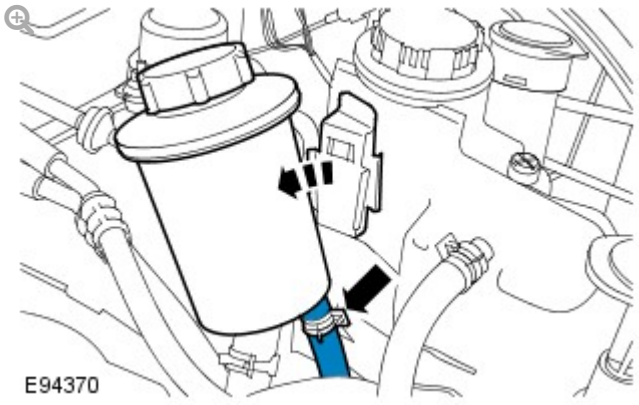
2. Using a suitable syringe, remove the power steering fluid from the power steering fluid reservoir.

3. **CAUTION:**

   Be prepared to collect escaping fluids.

   NOTE:

   Note the orientation of the clip.



Detach the power steering fluid reservoir.

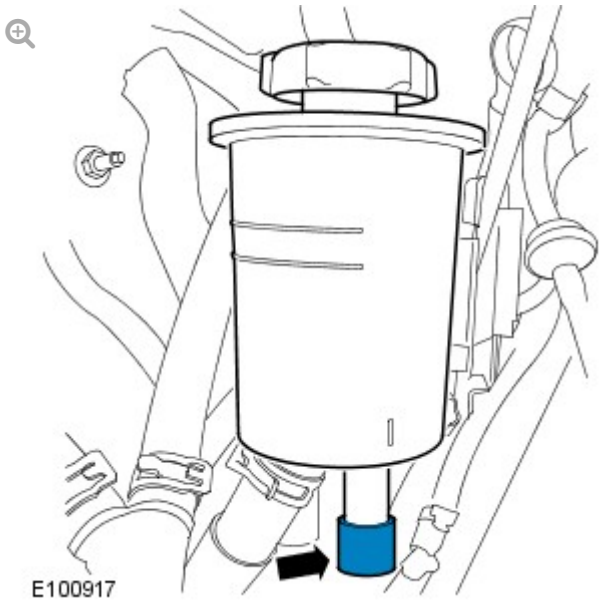
- Detach but do not remove the power steering fluid reservoir.
- Release the power steering fluid return hose from the power steering fluid reservoir.
- If a quick release coupling is fitted to the power steering return hose, release the power steering fluid return hose from the coupling by removing the clip.

4. **CAUTION:**

Be prepared to collect escaping fluids.

NOTE:

Make sure that all openings are sealed. Use new blanking caps.



Using a suitable blanking cap, cap the power steering reservoir return pipe.

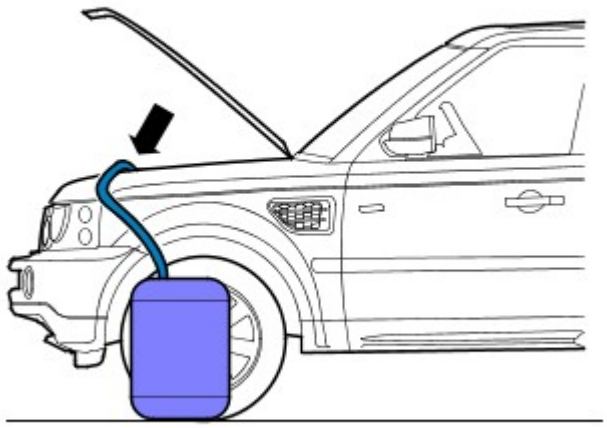
5.

CAUTION:

Be prepared to collect escaping fluids.

NOTE:

Make sure the extended pipe is not kinked or twisted and is correctly secured with hose clips.



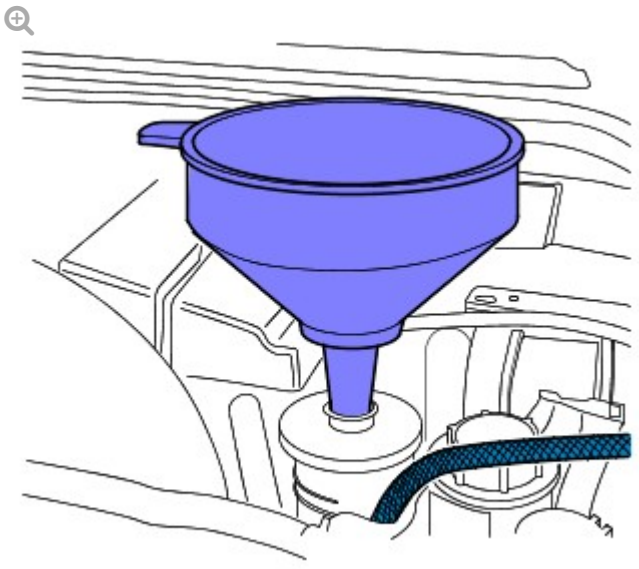
E100918

Attach a suitable pipe to the power steering return hose to allow the fluid to drain.

6.

NOTES:

- The suitable funnel should have the a capacity of 4 litres and O-ring seal
- The suitable funnel must be tightly sealed to the power steering fluid reservoir to avoid fluid leakage.



E94372

Install a suitable funnel onto the power steering fluid reservoir.

7.

WARNING:

Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

Raise and support the vehicle with the wheels just clear of the ground.

8.

CAUTIONS:

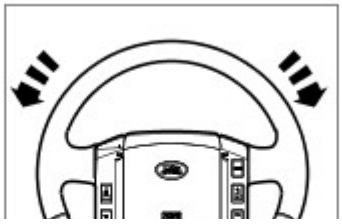
- Steps 8 and 9 must be carried out within 2 - 3 seconds of each other. Failure to follow this instruction may result in damage to the power steering system.
- Be prepared to collect escaping fluids.

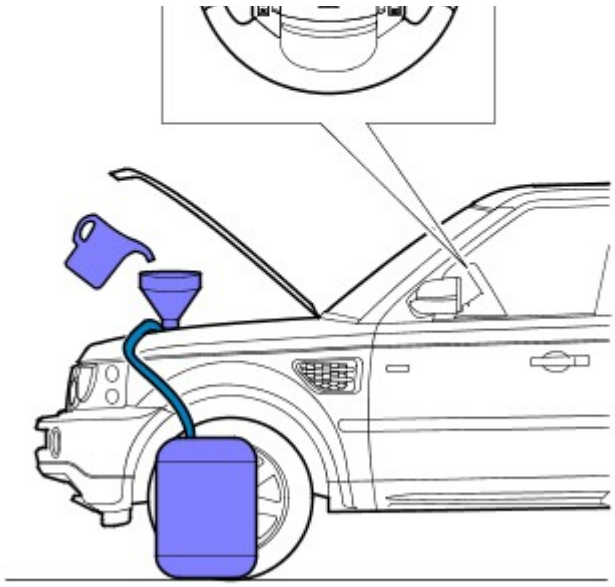
Using the suitable funnel, top up the power steering system with the specified fluid. Make sure the fluid level is maintained at two thirds full in the funnel.

9.

CAUTIONS:

- Be prepared to collect escaping fluids.
- Do not allow the power steering fluid level in the power steering fluid reservoir to fall below the minimum power steering fluid level. Failure to follow this instruction may result in damage to the power steering system.
- Make sure the engine is switched off as soon as the full 4 litres of power steering fluid has entered the power steering fluid reservoir.





E94373

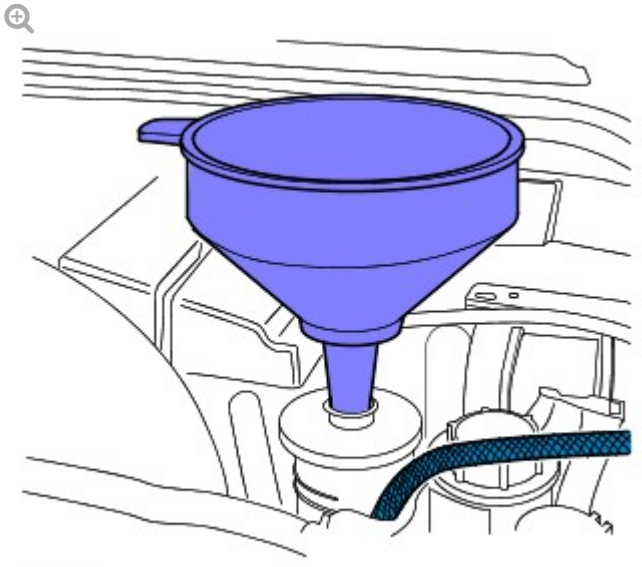
Flush the power steering system.

- Start the engine
- With assistance turn the steering slowly lock to lock 3 times at approximately 1 revolution every 5 seconds.
- Continue to flush the power steering system until 4 litres of power steering fluid has been added to the power steering reservoir. This should take approximately 30 seconds.

10.

CAUTION:

Be prepared to collect escaping fluids.

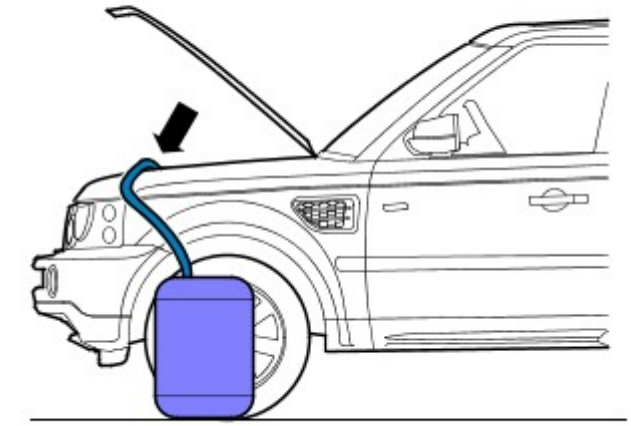


E94372

Remove the suitable funnel.

11. **CAUTION:**

> Be prepared to collect escaping fluids.



E100918

Remove the suitable pipe to the power steering return hose.

12. **CAUTION:**

> Be prepared to collect escaping fluids.

NOTE:

> Note the orientation of the clip.

If a quick release coupling is fitted to the power steering return hose, connect the power steering fluid return hose to the coupling by installing the clip.

13. Install a new power steering fluid reservoir.

For additional information, refer to: Power Steering Fluid Reservoir (211-02, Removal and Installation).

POWER STEERING

SPECIFICATIONS

Power Steering Fluid

ITEM	SPECIFICATION
Recommended power steering fluid	Texaco Cold Climate Fluid 33270

General Specification

ITEM	SPECIFICATION
Type	Power assisted rack and pinion, speed proportional with belt driven pump and remote hydraulic fluid reservoir
Steering wheel diameter	400 mm (15.7 in)
Number of turns - lock to lock	3.44
Turning circle	11.6 m (38 ft)
System ratio	20:1
Pump relief valve operating pressure - Vehicles with diesel engines	122 ± 4 bar (12200 ± 400 kPa) (1769.5 ± 58 lbf/in^2)
Pump relief valve operating pressure - All except vehicles with diesel engines	127 ± 5 bar (12700 ± 500 kPa) (1842 ± 72 lbf/in^2)
Maximum fluid flow rate - constant	10 ± 0.6 litre/min (17.6 ± 1.06 pints/min) (10.57 ± 0.63 US quarts/min)
Steering rack travel	170 mm (6.69 in)
Rack bar diameter	32 mm (1.26 in)

Steering angle sensor make/part number	Panasonic SRO 500110

Torque Specifications

DESCRIPTION	NM	LB-FT
Power steering pump front bolts	48	35
Power steering pump rear bolt	25	18
High pressure line to power steering pump	24	18
++ Low pressure line to steering gear	28	21
++ High pressure line to steering gear	28	21
+ Steering gear to front subframe nuts/bolts	100	74
Steering gear tie rod end ball joint nuts	80	59
** Universal joint to steering gear bolt	24	18
* Steering gear tie rod end locknut	70	52
Stabilizer bar link nut	100	74
Suspension height sensor link arm nut	8	6
Front lower arm nut/bolt:		
Stage 1	165	121
Stage 2	Further 90°	Further 90°
Rear lower arm nut/bolt:		
Stage 1	165	121
Stage 2	Further 90°	Further 90°
Air suspension spring top mount nuts	56	41
Suspension height sensor	3.5	2.5
Engine mount to engine block bolts:		
Stage 1	45	33
Stage 2	Further 60°	Further 60°
Engine mount to front subframe bolts	56	41
Engine mount bracket to engine mount nut/bolt	115	85
Halfshaft support bearing housing bolts	25	18

* New nut(s) must be installed

+ New cage nuts must be installed

** New 'Patchlok' bolt must be installed

++ New sealing washers must be installed

2012.0 RANGE ROVER (LM), 211-02

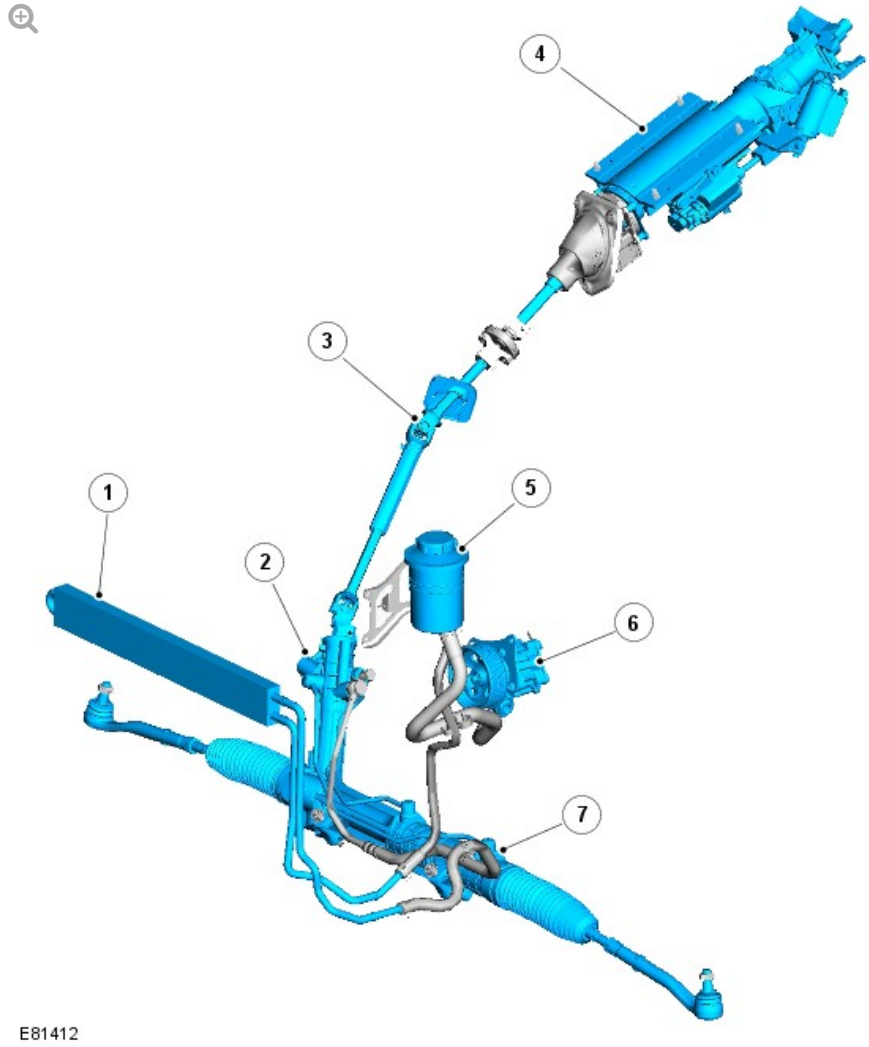
POWER STEERING

DESCRIPTION AND OPERATION

POWER STEERING COMPONENT LOCATION

NOTE:

Generic overview shown; components may differ on some models.



ITEM	DESCRIPTION
1	Fluid cooler (if fitted)
2	Servotronic valve
3	Lower column
4	Upper column
5	Power steering fluid reservoir
6	Power steering pump

7	Steering gear

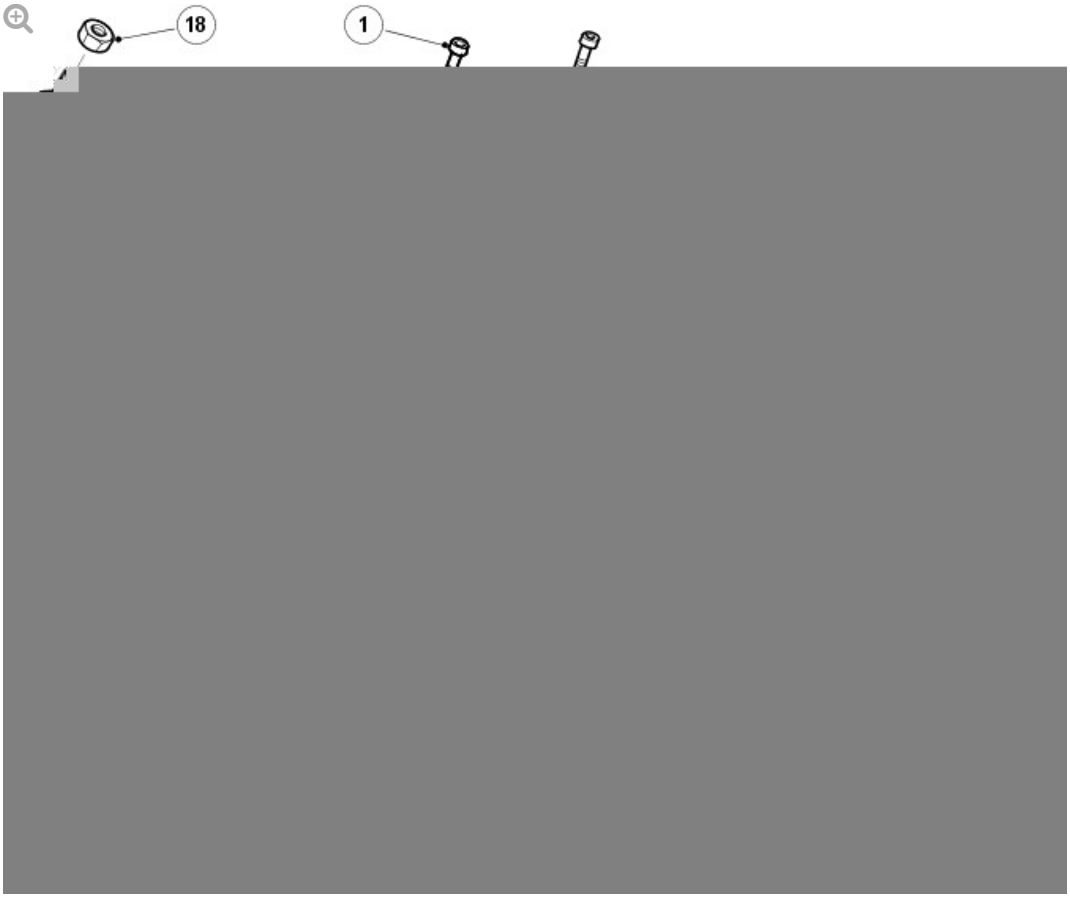
INTRODUCTION

A ZF power steering gear is fitted on the front subframe. The unit is a conventional-end take-off rack and pinion power assisted unit with the addition of ZF Servotronic assistance.

Servotronic adds electronic control and speed sensitive steering to the steering gear. The Servotronic feature provides easy and comfortable steering operation when parking, improved 'road feel' at increased road speeds and adds an integrated, positive centre feel feature which optimizes steering wheel torque during high speed driving.

The Servotronic system is controlled by software which is incorporated into the CJB (central junction box). The software responds to road speed signals and modifies the assistance via a transducer valve located on the steering gear valve.

STEERING GEAR



ITEM	DESCRIPTION
1	Banjo bolt (4 off)
2	Seal (8 off)
3	Pipe
4	Pipe
5	Steering gear
6	Nut M14
7	left-hand (LH) tie rod
8	Spacer
9	Locknut M16
10	Inner tie rod joint
11	Clamp (2 off)
12	Gaiter (2 off)
13	Seal (2 off)
14	Clamp (2 off)
15	Torx bolt M12 (2 off) - rack to subframe mounting
16	Nut M12 (2 off) - rack to subframe mounting
17	right-hand (RH) tie rod
18	Nut M14

The steering system comprises the mechanical steering gear, the valve and an integrated hydraulic power cylinder.

The steering gear uses a rack with an integrated piston which is guided on plain bearings within the gear housing. The pinion, which is attached to the valve runs in bearings and meshes with the rack teeth. The rack is pressed against the pinion by a spring loaded yoke which ensures that the teeth mesh without any play. The pinion is connected to the valve rotor via a

torsion bar.

The rotary motion of the steering wheel is converted into axial movement of the rack by the pinion and is initiated by the valve. This motion is transferred into movement of the wheels by adjustable tie rod arms.

The rotary valve is used to control the pressurized fluid required for power assistance. The valve comprises a valve body, a control bush and a torsion bar. The valve body has eight control grooves in its bore. The control bush also has eight radial grooves which are matched to the valve. The control bush is positively attached to the pinion. The torsion bar is the connecting element between the valve body, the pinion and the control bush.

Torque input from the steering wheel is passed to the valve body and causes a rotary motion of the torsion bar. The valve body changes its relative position to the control bush and subsequently the relative positions of the control grooves is also changed. This allows pressurized fluid to pass via the mismatched grooves to the rack piston and provide the required assistance in the selected direction.

The piston is located at one end of the rack housing. Each side of the piston is connected to fluid pressure or fluid return via a metal external pipe which is connected to the valve housing.

Each end of the rack has a threaded hole which provides for the fitment of an inner tie rod joint. The external ends of the rack are sealed with gaiters which prevent the ingress of dirt and moisture. The inner tie rod joints have a long outer threaded shank which screws into the outer tie rod. The steering toe can be adjusted using the threaded end of the inner tie rod. When the correct toe is achieved, a locknut on the inner tie rod is tightened to prevent further inadvertent movement.

SERVOTRONIC TRANSDUCER VALVE

The Servotronic transducer valve is located in a port on the side of the steering gear valve housing. The valve is sealed in the housing with an O-ring seal and is secured with two long screws into threaded holes in the housing.

The Servotronic valve is a transducer controlled valve which responds to

control signals supplied from the CJB. The CJB contains a microprocessor which receives road speed signals from the anti-lock brake system (ABS) module and calculates the correct controlling signal for the Servotronic valve. The Servotronic software within the CJB has a diagnostic capability which allows an approved Land Rover diagnostic system to check the tune of the steering.

The Servotronic valve determines the hydraulic reaction at the steering rack rotary valve and modifies the input torque required to turn the steering wheel. The Servotronic system allows the steering to be turned with minimum effort when the vehicle is stationary or manoeuvred at slow speed. The hydraulic reaction changes proportional to the vehicle speed, with the required steering effort increasing as the vehicle moves faster. At high speeds, the Servotronic system provides the driver with a good feedback through the steering providing precise steering and improved stability.

A major advantage of the Servotronic system is that fluid pressure and flow through the rotary valve remains constant and allows full steering pressure to be available in an emergency where a sudden and unexpected steering correction may be required.

POWER STEERING PUMP

POWER STEERING PUMP – V8 GASOLINE VEHICLES

The pump is a positive displacement, vane type pump which supplies hydraulic pressure to the steering gear valve unit. The pump is driven by a Poly Vee belt from the crankshaft pulley and output from the pump increases proportionally with engine speed. A self-adjusting tensioner is fitted to maintain the correct tension on the belt.

The pump has an internal pressure relief valve which also incorporates a flow control valve. The pressure relief valve limits the maximum pressure supplied to the steering gear to 127 +/- 5 bar.

The flow control valve controls the flow to 10.0 liters/min regardless of engine speed.

The pump has a displacement of 14cc/rev.

For additional information, refer to: Specifications (211-02, Specifications).

A shaft runs longitudinally through the pump. One end of the shaft is fitted with a pressed-on drive pulley, the opposite end of the shaft is closed by a cover. The shaft runs in bearings located in the body and oil seals at each end of the shaft prevent leakage of hydraulic fluid.

The pump contains ten vanes which rotate within a cam ring and are driven by the shaft. As the vanes rotate, the cam ring causes the space between the vanes to increase. This causes a depression between the vanes and fluid is drawn from the reservoir via the suction hose into the space between the vanes.

As the shaft rotates, the inlet port is closed to the vanes which have drawn in fluid, trapping the fluid between the vanes. The cam ring causes the space between the vanes to reduce and consequentially compresses and pressurizes the hydraulic fluid trapped between them.

Further rotation of the shaft moves the vanes to the outlet port. As the vanes pass the port plate the pressurized fluid passes from the pump outlet port into the pressure hose to the steering gear.

The pressurized fluid is subject to control by the flow control and pressure relief valve. The flow control valve maintains a constant flow of fluid supplied to the steering gear irrespective of engine speed variations. The pressure relief valve modifies the pressure on the output side of the pump. A metering orifice is included in the discharge port of the pump. If the pressure in the orifice reaches a predetermined level, a spring loaded ball in the center of the flow control valve is lifted from its seat and allows pressurized fluid to recirculate within the pump.

The pressure relief valve will operate if the discharge from the pump is restricted; for example, steering held on full lock. If the output from the pump is blocked, all output is recirculated through the pump. In this condition, as no fresh fluid is drawn into the pump from the reservoir, the fluid temperature inside the pump will increase rapidly. Consequentially, periods of operation of the steering gear on full lock should be kept to a minimum to prevent overheating of the pump and the fluid within it.

POWER STEERING PUMP – V8 DIESEL VEHICLES

The pump is a variable displacement, vane type pump which supplies the required hydraulic pressure to the steering gear valve unit. The pump is located at the front of the engine and is driven by a Poly Vee belt which is directly driven from the crankshaft. A self-adjusting tensioner is fitted to maintain the correct tension on the belt.

The pump has an internal pressure relief valve which also incorporates a flow control valve. The pressure relief valve limits the maximum pressure supplied to the steering gear to: 122 +/- 4 bar.

The flow control valve controls the flow to 10.0 liters/min regardless of engine speed.

The pump has a displacement of 9.6cc/rev.

For additional information, refer to: Specifications (211-02, Specifications).

The output from the pump increases proportionally with the load applied to the steering valve unit. Inside the pump, a cartridge set consisting of 11 vanes and a rotor is mounted on the input shaft and is surrounded by the variable displacement cam.

The variable displacement pump maintains a constant fluid output by varying the internal displacement of the pump, unlike a conventional fixed displacement pump which has to use a flow control valve to recirculate the excess flow within the pump. At low engine speeds, the internal displacement of the variable displacement pump is at its maximum to generate the controlled fluid output.

As the pump speed increases with engine speed, the increased flow inside the pump generates a back pressure within the pump. This back pressure causes the cam ring to move and reduce the internal displacement of the pump to maintain the constant fluid flow from the pump. As the internal displacement of the pump decreases, the power and torque required to drive the pump reduces, which leads to improved fuel economy.

FLUID RESERVOIR

The fluid reservoir comprises a body, cap and filter. The purpose of the reservoir is to contain a surplus of the hydraulic fluid in the system to allow for expansion and contraction of the fluid due to temperature variations. The fluid level ensures that the supply connection on the bottom of the reservoir is covered with fluid at all operating vehicle attitudes. Any air which is present in the system is exhausted from the system in the reservoir.

The body is a plastic moulding with two ports at the bottom which provide for the connection of the suction supply and return hoses. Moulded markings on the side of the reservoir denote the upper and lower fluid levels. A non-serviceable, 100 micron nylon mesh filter is fitted in the body. The filter removes particulate matter from the fluid before it is drawn into the pump supply connection.

The cap is rotated counterclockwise for one quarter turn to release from the body. The cap is fitted with an O-ring to prevent fluid leakage. The cap incorporates a breather hole to allow for changes in fluid level during operation and prevent vacuum or pressurization of the reservoir.

FLUID COOLER

The fluid cooler is located in the return line from the steering gear to the reservoir. The cooler comprises a flexible hose and a solid pipe which connect between the reservoir and the return pipe from the steering gear.

The cooler is a fabricated aluminium tube, through which the power steering fluid passes. The outer diameter of the cooler tube has aluminium loops attached to it which dissipate heat. Cool air entering the front of the vehicle passes over the cooler and flows through the loops. The loops act as heat exchangers, conducting heat from the fluid as it passes through the tube.

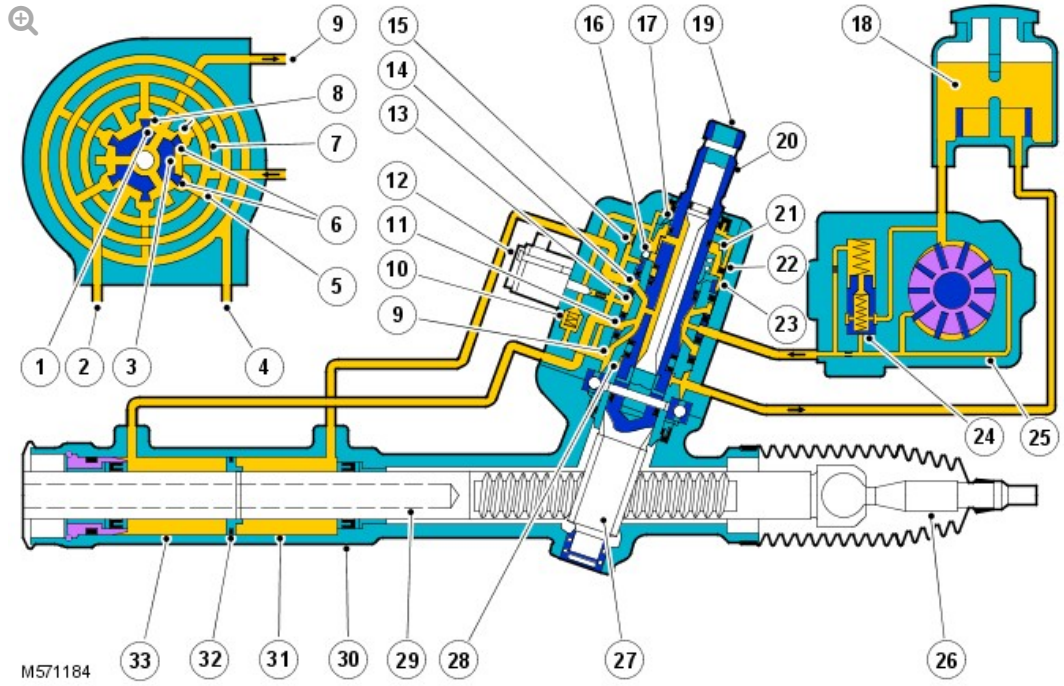
HIGH PRESSURE HOSE

The high pressure hose connecting the pump to the steering gear valve unit contains two attenuators. Each attenuator comprises a bullet shaped restrictor which is secured inside the hose. The restrictors damp pressure pulses from the pump, consequently reducing noise and strain on downstream components. The attenuators are an integral part of the hose and cannot be serviced separately.

HYDRAULIC CIRCUIT OPERATION

The following hydraulic circuits show power steering operation and fluid flow for the steering in a straight ahead, neutral position and when turning right. The circuit diagram for turning left is similar to that shown for turning right.

STEERING IN NEUTRAL POSITION



ITEM	DESCRIPTION
1	Return fluid control groove
2	Radial groove
3	Feed fluid control groove
4	Radial groove
5	Axial groove
6	Feed fluid control edge
7	Feed fluid radial groove
8	Return fluid control edge
9	Return fluid chamber
10	Cut-off valve
11	Radial groove

11	Radial groove
12	Servotronic transducer
13	Feed fluid radial groove
14	Radial groove
15	Orifice
16	Balls
17	Compression spring
18	PAS fluid reservoir
19	Torsion bar
20	Valve rotor
21	Reaction piston
22	Reaction chamber
23	Centering piece
24	Pressure relief/flow limiting valve
25	Power steering pump
26	Inner tie rod
27	Pinion
28	Valve sleeve
29	Steering gear
30	Gear housing
31	Power assist cylinder - right
32	Piston
33	Power assist cylinder - left

When the engine is started, the power steering pump draws fluid from the reservoir down the low pressure suction line. The fluid passes through the pump and is delivered, via a hose, to the steering rack valve unit.

The pressurized fluid flows through a connecting bore in the valve and, via the feed fluid radial groove and the transverse bores in the valve sleeve, passes to the feed fluid control groove of the valve rotor.

In the neutral (straight ahead) position, the fluid passes over the open feed

fluid control edges to all valve sleeve axial grooves. The fluid then passes through the open return fluid control edges and the return fluid control grooves of the valve rotor. The fluid then passes via connecting bores to the return fluid chamber and to the reservoir via an external hose.

Simultaneously, the radial grooves of the valve body and their associated pipes provide a connection between the left and right power assist cylinders.

STEERING IN RIGHT TURN POSITION

ITEM	DESCRIPTION
1	Return fluid control groove
2	Radial groove
3	Feed fluid control groove
4	Radial groove
5	Axial groove
6	Feed fluid control edge
7	Feed fluid radial groove
8	Return fluid control edge
9	Return fluid chamber

10	Cut-off valve
11	Radial groove
12	Servotronic transducer
13	Feed fluid radial groove
14	Radial groove
15	Orifice
16	Balls
17	Compression spring
18	Power steering fluid reservoir
19	Torsion bar
20	Valve rotor
21	Reaction piston
22	Reaction chamber
23	Centering piece
24	Pressure relief/flow limiting valve
25	Power steering pump
26	Inner tie rod
27	Pinion
28	Valve sleeve
29	Steering gear
30	Gear housing
31	Power assist cylinder - right
32	Piston
33	Power assist cylinder - left

When the steering wheel is turned to the right, the steering rack and piston moves to the left in the piston bore. The valve rotor is rotated to the right (clockwise) and pressurized fluid is directed over the further opened feed fluid control edges and to the associated axial grooves, the radial groove and via an external pipe to the left power assist cylinder chamber. The pressure applied to the piston from the left power assist cylinder chamber provides the hydraulic assistance.

provides the hydraulic assistance.

An adaptable pressure build-up is achieved by the partially or fully closed feed fluid control edges restricting or preventing a connection between the fluid pressure inlet and the other axial grooves connected to the radial groove.

Simultaneously, the fluid pressure outlet to the pressurized axial grooves are restricted or partially restricted by the closing return fluid control edges. The fluid displaced by the piston from the right power assist cylinder chamber, flows through an external pipe to the radial grooves. From there the fluid passes to the associated axial grooves and on to the return fluid control grooves, via the further opened return fluid control edges. The return flow of fluid to the reservoir passes via interconnecting bores which lead to the return fluid chamber.

When the steering wheel is turned to the left the operating sequence is as above but the pressure is applied to the opposite side of the piston.

SERVOTRONIC OPERATION

When the vehicle is manoeuvred into and out of a parking space (or other similar manoeuvre), the Servotronic function of the CJB uses road speed data from the ABS module to determine the vehicle speed, which in this case will be slow or stationary. The CJB microprocessor analyses the signals and outputs an appropriate control current to the Servotronic transducer valve. The Servotronic valve closes and prevents fluid flowing from the feed fluid radial groove to the reaction chamber. An orifice also ensures that there is return pressure in the reaction chamber. This condition eliminates any 'reaction' ensuring that the steering is very light to operate, reducing the effort required to turn the steering wheel.

As the vehicle is driven and the road speed increases, the CJB microprocessor analyses the road speed signals from the ABS module and reduces the amount of control current supplied to the Servotronic valve. The Servotronic valve reacts to the control current and opens the valve by an amount appropriate to the road speed. This allows a controlled fluid supply from the feed fluid radial groove to the reaction chamber. The orifice prevents the loss of large amounts of fluid to the return fluid chamber. The higher fluid pressure acting on the reaction piston causes compression of the balls which are located between the reaction piston and the centering

the balls which are located between the reaction piston and the centering piece which in turn is securely connected to the valve sleeve. When driving in a straight line, this has a positive effect on the exact centralizing of the steering valve. When the steering valve is actuated, the balls, with a higher load on them, provide additional torsional resistance to rotation of the valve rotor. This mode of Servotronic assistance requires an established higher steering wheel torque until the hydraulic assistance required in the left or right power assist cylinder is determined.

At high driving speeds; for example on a highway, the Servotronic valve is fully open due to a very low or nonexistent control current supplied from the CJB. This enables maximum pressure supply from the feed fluid radial groove to the reaction piston. When the steering wheel is turned, the reaction pressure increases appropriate to the existing operating pressure and pressurizes the piston in the reaction chamber. As soon as the reaction pressure reaches its upper limit, the fluid is discharged to the return fluid chamber via the cut-off valve and prevents further increases in reaction pressure. This maintains the input torque applied through the steering wheel and provides the driver with an improved 'road feel' allowing precise steering and directional stability.

2012.0 RANGE ROVER (LM), 211-02

POWER STEERING

DIAGNOSIS AND TESTING

PRINCIPLE OF OPERATION

For a detailed description of the power steering system operation, refer to the relevant description and operation sections of the workshop manual.

INSPECTION AND VERIFICATION

CAUTION:

Diagnosis by substitution from a donor vehicle is **NOT** acceptable. Substitution of control modules does not guarantee confirmation of a

fault, and may also cause additional faults in the vehicle being tested and/or the donor vehicle

1. Verify the customer concern

1. Visually inspect for obvious signs of damage and system integrity

Visual Inspection

Mechanical	Electrical
▪ Check the power steering fluid level	▪ Fuses

CAUTION:

If a steering gear assembly is returned under warranty with leaking rack bar seals or high friction, but there is also damage to the steering gear boot/boots, tie-rods or rack bar teeth, then the steering gear warranty will be invalid. This is due to the steering gear rack bar seals being damaged due to foreign materials entering the steering gear boot and damaging the steering gear rack bar seals thereafter or because of bending from abusive/accident events

1. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step

1. If the concern is not visually evident, verify the symptom and refer to the symptom chart

DTC INDEX

For a list of Diagnostic Trouble Codes (DTCs) that could be logged on this vehicle, please refer to Section 100-00.

For Power Steering Solenoid (Actuator) DTCs on L320, L322;

For Power Steering Calibration DTCs on L319, L320, L322 -

REFER to: Diagnostic Trouble Code (DTC) Index - DTC: Central Junction Box (CJB) (100-00 General Information, Description and Operation).

For Power Steering Calibration DTCs on L320, L322 -

REFER to: Diagnostic Trouble Code (DTC) Index - DTC: Instrument Cluster (IC) (100-00 General Information, Description and Operation)

SYMPTOM CHARTS

WARNING:

It is not possible to CHECK the torque of a patch lock bolt, if the torque is suspected to be low, the bolt must be REMOVED/DISCARDED and a new bolt MUST be INSTALLED and torqued to the correct value (refer to the Specifications table in this section)

NOTE:

If the control module or a component is suspect and the vehicle remains under manufacturer warranty, refer to the Warranty Policy and Procedures manual, or determine if any prior approval programme is in operation, prior to the installation of a new module/component

POWER STEERING FLUID LEAKAGE

SYMPTOM	POSSIBLE CAUSES	ACTION
▪ Power steering fluid leakage	▪ Overfilled system	▪ Refer to the Power Steering Fluid Leaks pinpoint tests below GO to Pinpoint Test A.
	▪ Leak from steering gear	
	▪ Damaged fluid cap/reservoir	

	▪ Loose or damaged hoses and fittings ▪ Faulty or missing O-Ring or Dowty seals	
	▪ Leak from power steering fluid cooler	
	▪ Leak from power steering pump	

POWER STEERING PUMP OR STEERING RACK ISSUES CAUSING HEAVY OR UNEVEN STEERING

SYMPTOM	POSSIBLE CAUSES	ACTION
▪ Excessive steering efforts required both when the vehicle is in motion and during stationary manoeuvring	▪ Low power steering fluid or power steering fluid leak	▪ Refer to the Heavy Steering/Steering Has Uneven Effort pinpoint tests below GO to Pinpoint Test **L.**
	▪ Power steering pump output fluid delivery pressure or flow too low	
	▪ Power steering hose, fluid cooler or reservoir restriction	
	▪ Power steering fluid aeration	
	▪ Damaged front end accessory drive belt tensioner	▪ REFER to: Section 303-00 Engine System/General Information/Diagnosis and Testing
	▪ Steering transducer or cable fault	▪ Refer to the Heavy Steering/Steering Has Uneven Effort pinpoint tests below GO to Pinpoint Test **P.**
	▪ Speedometer signal error	

▪ Steering operation is very light when VEHICLE IS IN MOTION AT HIGHER SPEEDS, but when stationary manoeuvring is NORMAL	▪ Steering transducer or cable fault	▪ Refer to the Heavy Steering/Steering Has Uneven Effort pinpoint tests below GO to Pinpoint Test **P.**
	▪ Speedometer signal error	
▪ Steering operation is heavy when stationary manoeuvring, but improves when the engine speed is increased	▪ Power steering pump output fluid delivery pressure or flow too low	▪ Refer to the Heavy Steering/Steering Requires Uneven Effort pinpoint tests below GO to Pinpoint Test **N.**
▪ Steering operation is heavy in one direction	▪ Lower steering column interference	▪ Check the steering column is free from interference from the engine harness, sound proofing or the floor covering
	▪ Incorrect steering geometry/suspension damage	**NOTE:** Dealerships must keep a copy of the BEFORE and AFTER geometry figures with job card for future reference ▪ Check and adjust the front wheel alignment (REFER to: Section 204-00 Suspension System - General Information/General Procedures)
	▪ Faulty steering gear	▪ Refer to the Heavy Steering/Steering Has Uneven Effort pinpoint tests below GO to Pinpoint Test **L.**
	▪ Tire fouling on the wheel arch liner or suspension components	▪ Check for correct installation or damage to wheel arch liner and suspension components. Correctly install and

		install new components as required ▪ Check tire for correct size, type and pressure
	▪ Damaged steering gear transfer pipe	▪ Refer to the Power Steering Fluid Leaks From The Power Steering Rack pinpoint tests below GO to Pinpoint Test **D.**
	▪ Steering column universal joints binding or stiff	▪ REFER to: Pinpoint Tests within Section 211-04 Steering Column/Diagnosis and Testing/Steering Column
▪ Steering operation varies from heavy to light when driving at constant speed	▪ Lower steering column interference	▪ Check the steering column is free from interference from the engine harness, sound proofing or the floor covering
	▪ Steering transducer or cable fault	▪ Refer to the Heavy Steering/Steering Has Uneven Effort pinpoint tests below GO to Pinpoint Test **P.**
	▪ Incorrect speedometer signal	
	▪ Steering column universal joint binding or stiff	▪ REFER to: Pinpoint Tests within Section 211-03 Steering Linkage/Diagnosis and Testing/Steering Linkage
▪ Steering wanders when VEHICLE IS IN MOTION AT HIGHER SPEEDS	▪ Incorrect steering geometry/suspension damage	**NOTE:** Dealerships must keep a copy of the BEFORE and AFTER geometry figures with job card for future reference

		▪ Check and adjust the front wheel alignment (REFER to: Section 204-00 Suspension System - General Information/General Procedures)
	▪ Tie-rod free play	▪ REFER to: Pinpoint Tests within Section 211-03 Steering Linkage/Diagnosis and Testing/Steering Linkage

POWER STEERING PUMP/STEERING RACK NOISE

SYMPTOM	POSSIBLE CAUSES	ACTION
▪ Continuous noise	▪ Low power steering fluid or power steering fluid leak	▪ Refer to the Power Steering Pump/Steering Rack Noise - System Fluid Leak Checks pinpoint tests below, GO to Pinpoint Test **F.**
	NOTE: Look for small air bubbles visible in the fluid, air may also get trapped in the hydraulic system ▪ Air in hydraulic system	▪ Bleed air from system (REFER to: Section 211-00 Steering System - General Information/General Procedures/Power Steering System Bleeding)
	▪ Power steering pipe/hose in contact with the vehicle body	▪ Refer to the Power Steering Pump/Steering Rack Noise – Power Steering System Hose Checks pinpoint tests below, GO to Pinpoint Test **G.**
	▪ Power steering pipe/hose restricted or twisted	

	▪ Power steering pump mounting bolts loose	▪ Check and adjust torque of bolts as required (REFER to: Section 211-02 Power Steering/Specification)
	▪ Power steering pump worn or otherwise defective	▪ Refer to the Power Steering Pump/Steering Rack Noise – Power Steering System Hose Checks pinpoint tests below, GO to Pinpoint Test **G.** ▪ Install a new power steering pump as required (REFER to: Section 211-02 Power Steering/Removal and Installation)
▪ Noise gets worse when system is loaded	**NOTE:** Refer to the power steering pressure check in this section ▪ Low power steering fluid level ▪ Aerated fluid ▪ Low power steering pump pressure	▪ Refer to the Power Steering Pump/Steering Rack Noise - System Fluid Leak Checks pinpoint tests below GO to Pinpoint Test **F.**
▪ Front end accessory drive belt squeal (see definitions of steering system noises below)	▪ Front end accessory drive belt incorrectly tensioned or glazed	▪ Refer to the Power Steering Pump/Steering Rack Noise - Noise Specific Diagnostics (Belt Squeal) pinpoint tests below GO to Pinpoint Test **H.**
▪ Chirp noise (see definitions of steering system noises below) from the steering pump when a load is applied	▪ Loose or worn front end accessory drive belt	▪ Refer to the Power Steering Pump Drive Belt Checks - Belt Damage Checks (Chirp Noise) pinpoint tests below GO to Pinpoint Test **H.**
▪ Knock, creak, rattle or clonk noise (see definitions of steering system noises below)	▪ Steering gear mounting bolts loose or damaged	▪ Check and adjust torque of bolts as required (REFER to: Section 211-02 Power Steering/Specification)

	▪ Tie-rod end joint to steering knuckle loose or damaged	▪ REFER to: Pinpoint Tests within Section 211-03 Steering Linkage/Diagnosis and Testing/Steering Linkage
	▪ Wear in steering gear tie-rod end ball joints	
	▪ Wear in steering gear inner ball joints	
	▪ Excess play in the steering gear	

DIAGNOSTIC PROCEDURES FOR POWER STEERING FLUID LEAKS

CAUTION:

Be aware that leaks in the power steering system may allow power steering fluid may escape from the system under high pressure

CAUTION:

Misting/Dampness around pinions, bellows and on the rack bar can be mis-diagnosed as leaks. This is normal and suspected leaks should always be verified by cleaning and chalking. Refer to Component Checks in this section for guidance on identification of leaks

PINPOINT TEST A : POWER STEERING FLUID LEAKS - ESTABLISHING THE SOURCE OF FLUID LEAKS	
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A1: ESTABLISHING THE SOURCE OF THE LEAK	
	1 Remove any shielding or undertrays as necessary to gain visual access to locate leak. Refer to the relevant sections in the workshop manual for guidance on removal procedures

	2 Using a suitable cleaning solution, thoroughly clean around the affected areas to remove dirt, oil and any other debris
	3 Apply chalk dust to the affected area
	4 Check the level of the power steering system fluid in the reservoir. If level is above the MAX level remove fluid with a suitable device until level is at MAX. If fluid is below the MAX level top up to the MAX level as required
	5 To instigate the leak, start the engine and turn the steering wheel from lock to lock 3 times, re-check fluid level and repeat (Caution: do not hold the steering on full lock)
	Is the power steering fluid leak visually evident? **Yes** For leaks from the power steering fluid reservoir or reservoir hose connection GO to Pinpoint Test **B.** For leaks from the power steering pump body or pump hose connection GO to Pinpoint Test **C.** For leaks from the steering rack or steering rack hose connection GO to Pinpoint Test **D.**

PINPOINT TEST B : POWER STEERING FLUID LEAKS FROM THE POWER STEERING FLUID RESERVOIR	
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B1: LOCATION OF THE RESERVOIR LEAK - LEAKS FROM RESERVOIR BODY	
	1
	Is the leak from the reservoir body? **Yes** Replace the power steering fluid reservoir assembly When all remedial actions have been completed, perform final check for leaks GO to Pinpoint Test **E.** **No** GO to B2.
B2: LOCATION OF THE RESERVOIR LEAK - LEAKS FROM RESERVOIR FILLER CAP	
	1
	Is the leak from the filler reservoir cap? **Yes** Replace the power steering fluid reservoir filler cap assembly When all remedial actions have been completed, perform final check for leaks GO to Pinpoint Test **E.** **No** GO to B3.
B3: LOCATION OF THE RESERVOIR LEAK - LEAKS FROM RESERVOIR HOSES/HOSE CONNECTIONS	
	1

	Is the leak from the hoses or hose connections at (or around) the reservoir? **Yes** Check the hose is located fully onto the spigot and that the securing clip is installed correctly. If a quick connector is used, ensure that it is correctly installed by pushing connector fully onto the spigot, (a small click maybe heard), and then pulling it back to check for a secure connection If a quick connector is used, check inside the connector body for damaged O-Ring(s) and replace hose as required Check the bore of the hose for axial scores, cuts or abrasions and replace defective hose as required When all remedial actions have been completed, perform final check for leaks GO to Pinpoint Test **E.**

PINPOINT TEST C : POWER STEERING FLUID LEAKS FROM THE POWER STEERING FLUID PUMP	
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
C1: LOCATION OF THE PUMP LEAK - LEAKS FROM PUMP BODY	
	1
	Is the leak from the pump body? **Yes** Check the pump front seal for leaks and replace power steering pump as required When all remedial actions have been completed, perform final check for leaks GO to Pinpoint Test **E.** **No** **GO to C2**.
C2: LOCATION OF THE PUMP LEAK - LEAKS FROM PUMP HOSES/HOSE CONNECTIONS	
	1
	Is the leak from the hoses or hose connections at (or around) the pump? **Yes** Check the hose is located fully onto the spigot and that the securing clip is installed correctly Check the bore of the hose for axial scores, cuts or abrasions and replace defective hose as required Check the torque of the power steering hose screws/banjo bolts and adjust as required (for torque settings refer to the Specifications table in this section). If a patch lock screw/bolt is used it should be replaced Check the outlet port of the pump for damage (i.e. scoring or cross threading) and replace pump as required Check the thread on the power steering hose connector for damage and replace hose as required Check hose crimp for leaks and replace hose as required Check inside the quick connector body for damaged O-Ring(s) and replace hose as required Check O-Rings/Dowty Washers on hose for damage and replace as

	required When all remedial actions have been completed, perform final check for leaks GO to Pinpoint Test **E.** **No** GO to Pinpoint Test **D.**

NOTE:

THIS DIAGNOSTIC STEP **ONLY** APPLIES TO L320 & L322, FOR ALL OTHER VEHICLES CONTINUE TO THE NEXT PINPOINT TEST

CAUTIONS:

- If a steering gear assembly is returned under warranty with leaking rack bar seals, but there is also damage to the steering gear boot/boots (refer to Component Tests in this section for guidance on how to check for steering gear boot damage), then the steering gear warranty will be invalid. This is due to the steering gear rack bar seals being damaged due to foreign materials entering the steering gear boot and damaging the steering gear rack bar seals thereafter
- If a steering gear assembly is returned under warranty with leaking rack bar seals, induced by abusive steering loads, the steering gear warranty will be invalid. Guidance on identification of abusive loads via tie-rod inspection can be found in the Tie-Rod Checks in Section 211-03 – Steering Linkage/Diagnosis and Testing/Steering Linkage/Component Tests

PINPOINT TEST D : POWER STEERING FLUID LEAKS FROM THE POWER STEERING RACK	
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
D1: LOCATION OF THE STEERING RACK LEAK - LEAKS FROM THE INPUT SHAFT SEAL	
	1 Check for leaks from the steering rack input shaft seal (refer to Component Checks in this section for guidance in identifying leaks)
	Is the leak from the input shaft seal? Yes

	Yes For all vehicles **EXCEPT L319** - Replace the steering rack **For L319 ONLY** - Replace the input shaft seal using the appropriate service kit (REFER to: Technical Bulletin LTB00154v3 for further guidance) When all remedial actions have been completed, perform final check for leaks GO to Pinpoint Test **E.** **No** GO to D2.

D2: LOCATION OF THE STEERING RACK LEAK - LEAKS FROM THE STEERING GEAR TRANSFER PIPES	
	1
	Is the leak from the steering gear transfer pipes? **Yes** Replace the transfer pipes (REFER to: Section 211-02 Power Steering/Removal and Installation) When all remedial actions have been completed, perform final check for leaks GO to Pinpoint Test **E.** **No** GO to D3.

D3: LOCATION OF THE STEERING RACK LEAK - LEAKS FROM THE STEERING GEAR BOOTS	
	1
	Is the leak from the steering gear boots? **Yes** Remove steering gear boots Check for fluid (either water or hydraulic fluid) inside the steering gear boots. If fluid is present, replace the steering gear When all remedial actions have been completed, perform final check for leaks GO to Pinpoint Test **E.** **No** GO to D4.

D4: LOCATION OF THE STEERING RACK LEAK - LEAKS FROM STEERING RACK HOSES/HOSE CONNECTIONS	
	1
	Is the leak from the hoses or hose connections at (or around) the steering rack? **Yes** Check the torque of the identified power steering hose screws/banjo bolts and adjust as required (for torque settings refer to the Specifications table in this section). If a patch lock screw/bolt is used it should be replaced Check hose crimp for leaks and replace hose as required Check the thread on the power steering hose connector for damage (where applicable) and replace hose as required Check O-Rings/Dowty Washers on hose for damage and replace as required When all remedial actions have been completed, perform final check for leaks GO to Pinpoint Test **E.** **No** When all remedial actions have been completed, perform final check

	When all remedial actions have been completed, perform final check for leaks GO to Pinpoint Test **E.**

PINPOINT TEST E : POWER STEERING FLUID LEAKS - FINAL CHECKS	
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
E1: AFTER COMPLETING THE ACTIONS ABOVE, CHECK AGAIN FOR LEAKS USING THE FOLLOWING PROCEDURES	
	1 Top up power steering fluid to MAX level and bleed the system (REFER to: Section 211-00 Steering System - General Information/General Procedures)
	2 Start the engine and turn the steering wheel fully (lock to lock) 3 times. Switch off engine
	3 Check the level of the power steering fluid in the reservoir and top up as required
	4 Start the engine and turn the steering wheel fully (lock to lock) 3 times. Switch off engine
	5 Visually check for fluid leaks from the power steering system
	Are there any fluid leaks present? **Yes** Repeat diagnostics steps above. GO to Pinpoint Test **A.** **No** No further action required

DIAGNOSTIC PROCEDURES FOR POWER STEERING PUMP/STEERING RACK NOISE

Specific Steering System Noise Types

See below for a glossary of terms describing the most common noises that may indicate a fault with the power steering system:

BELT SQUEAL

Belt squeal is a high frequency air-borne noise generated by slippage of the ribbed Vee belt on the power steering pump pulley. Squeal increases with system loading and at full lock

CHIRP

High pitched rapidly repeating sound, like chirping birds

GRUNT (SQUAWK/WHOOP)

Grunt is a 'honking' sound elicited when coming off one of the steering stops. Grunt is generally excited during parking manoeuvres with a low to medium speed steering input. This noise can occur when the power steering system is hot

KNOCK

Knock is a heavy, loud repeating sound like a knock on a door

MOAN (GROAN)

Moan is the general structure-borne noise of the steering system. Moan is primarily transmitted to the driver via the body structure through the pump mount, engine mounts, power steering lines and power steering brackets. On some vehicles, moan is a loud humming noise, often present when the wheel is turned and the system is loaded. It may change frequency with engine RPM and if the system is loaded or unloaded

RATTLE

A sound suggesting looseness, like marbles rolling around in a can

WHINE

A high-pitched buzzing sound, like an electric motor or drill

ZIP

Zip noise is the air-borne noise generated by power steering pump cavitation when power steering fluid does not flow freely through the suction hose from the reservoir to the pump. Zip primarily occurs during cold weather at start-up

DIAGNOSTIC STEPS FOR POWER STEERING PUMP/STEERING RACK NOISE

PINPOINT TEST F : POWER STEERING PUMP/STEERING RACK NOISE - SYSTEM FLUID LEAK CHECKS	
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	F1: CHECK FOR POWER STEERING FLUID LEAKS
	1 Check that the power steering fluid in the reservoir is not below the MIN mark
	Is the fluid level low?

	Yes Top up the fluid reservoir, then check if the power steering pump/steering rack noise is still evident If the noise symptoms are **no longer** evident, GO to Pinpoint Test **A.** to find and fix fluid leaks If the noise symptoms are **still** evident, first work through the power steering system fluid leak pinpoint test GO to Pinpoint Test **A.** , then GO to Pinpoint Test **G.** **No** GO to Pinpoint Test **G.**

PINPOINT TEST G : POWER STEERING PUMP/STEERING RACK NOISE - NOISE SPECIFIC DIAGNOSTICS (GRUNT/MOAN/WHINE/WHOOP)	
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
G1: IDENTIFY THE SPECIFIC TYPE OF POWER STEERING SYSTEM NOISE PRESENT - GRUNT/MOAN/WHINE/WHOOP DIAGNOSTICS	
	1 Ascertain the specific type of noise present in the power steering system (see glossary of noise terms above)
	Is the noise either a grunt, moan, whine or whoop? **Yes** GO to G2. **No** GO to Pinpoint Test **H.**
G2: GRUNT/MOAN/WHINE/WHOOP DIAGNOSTICS - CHECK THE POWER STEERING SYSTEM FLUID RESERVOIR	
	1 Flush the power steering system
	Is power steering system noise still evident? **Yes** GO to G3. **No** When all remedial actions have been completed, perform final checks for steering system noise GO to Pinpoint Test **K.**
G3: GRUNT/MOAN/WHINE/WHOOP DIAGNOSTICS - POWER STEERING HYDRAULIC SYSTEM BLOCKAGE CHECKS	
	1 Ensure the power steering fluid is cold
	2 Insert a temperature probe into the power steering fluid reservoir and connect to a suitable digital thermometer
	3 Start the engine and allow to idle for 5 minutes. Then check the power steering fluid temperature
	Is the power steering fluid temperature greater than 80 degrees Celsius? **Yes** Check for hydraulic system blocks at the power steering fluid reservoir. Remove a small amount of fluid and use a mirror to visually check the state of the filter in the reservoir (for guidance on filter blockage refer

	to Component Tests in this section). If the filter mesh is more than 30% blocked, then replace the reservoir assembly. When all remedial actions have been completed **GO to G4**. If the filter mesh is less than 30% blocked, check power steering hydraulic hoses for kinks and replace as required. Allow the power steering fluid to cool to 20 degrees Celsius. Start the engine and allow to idle for 5 minutes. Then check the power steering fluid temperature. If the power steering fluid temperature is greater than 80 degrees Celsius, proceed to power steering system pressure checks **GO to G5**. . If the power steering fluid temperature is less than 80 degrees Celsius, **GO to G4**. **No** **GO to G4**.

G4: GRUNT/MOAN/WHINE/WHOOP DIAGNOSTICS - POWER STEERING SYSTEM HOSE CHECKS	
	1 Check that the power steering system hoses are correctly installed and correctly routed and rectify as required
	2 Check the power steering system hoses for damage and rectify as required
	3 Check the integrity of the power steering system hose clips and brackets. Replace any defective clips/brackets as required
	4 Check that the power steering system hoses are securely clipped into position. Rectify as required
	5 Check the torque of the screws/nuts securing the power steering system clips/brackets, the power steering pump and the power steering pump mounting bracket. Adjust or replace fixings as required
	Is the power steering system noise still present? **Yes** If noise is still evident, proceed to power steering system pressure checks, **GO to G5**. **No** When all remedial actions have been completed, perform final checks for steering system noise GO to Pinpoint Test **K.**

G5: GRUNT/MOAN/WHINE/WHOOP DIAGNOSTICS - POWER STEERING SYSTEM PRESSURE CHECKS	
	1 Refer to the relevant section of the workshop manual and conduct a power steering system pressure test
	Is the power steering system pressure within specified tolerances? **Yes** GO to Pinpoint Test **H.** **No** Replace the power steering pump Check again for power steering system noise. If noise is rectified, perform final checks for steering system noise GO to Pinpoint Test **K.** If noise is still evident, GO to Pinpoint Test **H.**

PINPOINT TEST H : POWER STEERING PUMP/STEERING RACK NOISE - NOISE

SPECIFIC DIAGNOSTICS (BELT SQUEAL)	
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
H1: IDENTIFY THE SPECIFIC TYPE OF POWER STEERING SYSTEM NOISE PRESENT	
	1 Ascertain the specific type of noise present in the power steering system (see glossary of noise terms above)
	Is the noise belt squeal? **Yes** GO to H2. **No** GO to Pinpoint Test J.
H2: POWER STEERING PUMP DRIVE BELT CHECKS - FLUID LEAKS	
	1 Check for signs of fluid leakage on to the power steering pump drive belt
	Is there signs of fluid on the power steering pump drive belt? **Yes** GO to H3. **No** GO to H4.
H3: POWER STEERING PUMP DRIVE BELT CHECKS - IDENTIFY SOURCE OF FLUID LEAKS	
	1 Identify the type of fluid that has leaked on to the power steering pump drive belt
	Is it power steering fluid? **Yes** First, work through the power steering system fluid leak pinpoint tests GO to Pinpoint Test F. , then replace the power steering pump drive belt, check and adjust the drive belt alignment as required Check again for power steering system noise. If noise is rectified, perform final checks for steering system noise GO to Pinpoint Test K. If noise is still evident, GO to H4. **No** Clean/remove the leaked fluid from the power steering pump drive belt Identify any other sources of fluid leaks and rectify leaks as required Check again for power steering system noise. If noise is rectified, perform final checks for steering system noise GO to Pinpoint Test K. If noise is still evident, GO to H4.
H4: POWER STEERING PUMP DRIVE BELT CHECKS - BELT DAMAGE CHECKS (CHIRP NOISE)	
	1 Check the integrity of the power steering pump drive belt
	Is the power steering pump drive belt damaged, frayed or glazed? **Yes** Replace the power steering pump drive belt, check and adjust the drive belt alignment as required Check again for power steering system noise. If noise is rectified,

	perform final checks for steering system noise GO to Pinpoint Test **K.** If noise is still evident, GO to Pinpoint Test **I.** **No** The noise issue is not belt squeal, for further diagnostics GO to Pinpoint Test **I.**

NOTE:

THIS DIAGNOSTIC STEP **ONLY** APPLIES TO L320, FOR ALL OTHER VEHICLES CONTINUE TO THE NEXT PINPOINT TEST

PINPOINT TEST I : POWER STEERING PUMP/STEERING RACK NOISE - NOISE SPECIFIC DIAGNOSTICS (SQUEAK)	
THIS DIAGNOSTIC STEP **ONLY** APPLIES TO L320, FOR ALL OTHER VEHICLES CONTINUE TO THE NEXT PINPOINT TEST	
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
I1: IDENTIFY THE SPECIFIC TYPE OF POWER STEERING SYSTEM NOISE PRESENT	
	1 Ascertain the specific type of noise present in the power steering system (see glossary of noise terms above)
	Is the noise squeak? **Yes** Replace the power steering system damper valves (REFER to: Technical Bulletin LTB00021 for further guidance) **No** GO to Pinpoint Test **J.**

PINPOINT TEST J : POWER STEERING PUMP/STEERING RACK NOISE - NOISE SPECIFIC DIAGNOSTICS (CLONK, KNOCK, RATTLE, CREAK)	
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
J1: IDENTIFY THE SPECIFIC TYPE OF POWER STEERING SYSTEM NOISE PRESENT	
	1 Ascertain the specific type of noise present in the power steering system (see glossary of noise terms above)
	Is the noise a clonk, knock, rattle or creak? **Yes** GO to J2.
J2: STEERING RACK BOLT CHECKS	
	1 Refer to the relevant section of the workshop manual and check

	1 Refer to the relevant section of the workshop manual and check that the steering rack bolts are secured to the correct torque specifications (for torque settings refer to the Specifications table in this section)
	Are the steering rack bolts are secured to the correct torque specifications? (for torque settings refer to the Specifications table in this section) **Yes** REFER to: Section 211-04 Steering Column/Diagnosis and Testing/Steering Column/Pinpoint Tests/Steering Column Noise - Noise Specific Diagnostics (Clonk/Column Knock) / Check For Clonk/Column Knock Noise From Lower Steering Column Shaft **No** Remove and replace the steering rack fixings as required. Ensure new fixings are tightened to the correct torque specifications (for torque settings refer to the Specifications table in this section) Check again for power steering system noise. If noise is rectified, perform final checks for steering system noise GO to Pinpoint Test **K.** If noise is still evident, REFER to: Section 211-04 Steering Column/Diagnosis and Testing/Steering Column/Pinpoint Tests/Steering Column Noise - Noise Specific Diagnostics (Clonk/Column Knock) / Check For Clonk/Column Knock Noise From Lower Steering Column Shaft

PINPOINT TEST K : POWER STEERING PUMP/STEERING RACK NOISE - FINAL CHECKS	
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
K1: AFTER COMPLETING THE ACTIONS ABOVE, CHECK AGAIN FOR POWER STEERING SYSTEM NOISE USING THE FOLLOWING PROCEDURES	
	1 Start the engine and turn the steering wheel fully (lock to lock) 3 times. Check for power steering noise during this procedure
	2 Test drive the vehicle and check for power steering noise
	3 Check the temperature of the power steering fluid. Once the power steering temperature exceeds 80 degrees Celsius, repeat steps 1 and 2 above
	Is there still noise emanating from the steering system? **Yes** Repeat the diagnostic steps above, or check other vehicle systems for the source of the noise **No** No further action

DIAGNOSTIC STEPS FOR HEAVY STEERING/STEERING REQUIRES UNEVEN EFFORT

PINPOINT TEST L : HEAVY STEERING/STEERING HAS UNEVEN EFFORT - SYSTEM FLUID LEAK CHECKS	
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
L1: CHECK FOR POWER STEERING FLUID LEAKS	
	1 Check that the power steering fluid in the reservoir is not below the MIN mark
	Is the fluid level low? **Yes** Top up the fluid reservoir, then check if the heavy steering/steering has uneven effort symptoms are still evident If the symptoms are **no longer** evident, GO to Pinpoint Test **A.** to find and fix fluid leaks If the symptoms are **still** evident, first work through the power steering system fluid leak pinpoint tests GO to Pinpoint Test **A.** , then GO to Pinpoint Test **M.** **No** GO to Pinpoint Test **M.**

PINPOINT TEST M : HEAVY STEERING/STEERING REQUIRES UNEVEN EFFORT - CHECK FOR FLUID RESERVOIR BLOCKAGES	
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
M1: POWER STEERING SYSTEM FLUID RESERVOIR CHECKS	
	1 Check for hydraulic system blocks at the power steering fluid reservoir. Remove a small amount of fluid and use a mirror to visually check the state of the filter in the reservoir (for guidance on filter blockage refer to Component Tests in this section). The filter mesh should not be more than 30% blocked
	Is the reservoir filter blocked? **Yes** GO to Pinpoint Test **N.** **No** GO to Pinpoint Test **O.**

PINPOINT TEST N : HEAVY STEERING/STEERING REQUIRES UNEVEN EFFORT - REPLACE FLUID RESERVOIR	
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
N1: REPLACE THE POWER STEERING SYSTEM FLUID RESERVOIR	
	1 Flush the power steering system
	2 Replace the power steering system fluid reservoir
	3 Refill the power steering system to the MAX level using the manufacturer approved power steering fluid

	4 Bleed the power steering system (REFER to: Section 211-00 Steering System - General Information/General Procedures)
	Is the steering still heavy or requiring uneven effort? **Yes** GO to Pinpoint Test **O.** **No** When all remedial actions have been completed, perform final checks for heavy or uneven steering effort GO to Pinpoint Test **Q.**

PINPOINT TEST O : HEAVY STEERING/STEERING REQUIRES UNEVEN EFFORT - POWER STEERING SYSTEM HOSE ROUTING/INTEGRITY CHECKS	
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	O1: HOSE ROUTING/INTEGRITY CHECKS
	1 Check the power steering system hoses for correct routing
	2 Check the power steering system hoses for and damage or kinks
	3 Check the power steering system hoses are securely and correctly clipped into position
	Are there any issues with the routing, security or integrity of the power steering system hoses? **Yes** Rectify as required, ensuring that the clips are in good condition (replace any defective clips) and that clips are securely tightened Check again for heavy steering or steering requiring uneven effort. If fault is rectified, perform final checks for heavy or uneven steering effort GO to Pinpoint Test **Q.** If fault is still evident, proceed to power steering system pressure checks, **GO to O2**. **No** **GO to O2**.
	O2: POWER STEERING SYSTEM PRESSURE CHECKS
	1 Refer to the relevant section of the workshop manual and conduct a power steering system pressure test
	Is the power steering system pressure within specified tolerances? **Yes** GO to Pinpoint Test **P.** **No** Replace the power steering pump Check again for heavy steering or steering requiring uneven effort. If fault is rectified, perform final checks for heavy or uneven steering effort GO to Pinpoint Test **Q.** If fault is still evident, proceed to power steering solenoid checks, GO to Pinpoint Test **P.**

NOTE:

THIS DIAGNOSTIC STEP **ONLY** APPLIES TO L320 & L322, FOR ALL OTHER VEHICLES CONTINUE TO THE NEXT PINPOINT TEST

PINPOINT TEST P : HEAVY STEERING/STEERING REQUIRES UNEVEN EFFORT - POWER STEERING SOLENOID CHECKS	
THIS DIAGNOSTIC STEP **ONLY** APPLIES TO L320 & L322, FOR ALL OTHER VEHICLES CONTINUE TO THE NEXT PINPOINT TEST	
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
P1: CHECK THE OPERATION OF THE POWER STEERING SOLENOID	
	1 Using the manufacturer approved diagnostic system, check for related DTCs and refer to the relevant DTC index
	2 Check the operation of the power steering solenoid
	Is the power steering solenoid functioning correctly? **Yes** REFER to: Section 211-03 Steering Linkage/Diagnosis and Testing/Steering Linkage/Pinpoint Tests/ Heavy Steering/Steering Requires Uneven Effort – Steering System Free Play Checks / Outer Ball Joint Checks / Inner Ball Joint Checks **No** Using the manufacturer approved diagnostic system, check for related DTCs and refer to the relevant DTC index Check again for heavy steering or steering requiring uneven effort. If fault is rectified, perform final checks for heavy or uneven steering effort GO to Pinpoint Test **Q.** If fault is still evident, **GO to P2**.
P2: REPLACE THE STEERING RACK SOLENOID	
	1 Replace the steering rack solenoid
	Is the steering still heavy or requiring uneven effort? **Yes** REFER to: Section 211-03 Steering Linkage/Diagnosis and Testing/Steering Linkage/Pinpoint Tests/ Heavy Steering/Steering Requires Uneven Effort – Steering System Free Play Checks / Outer Ball Joint Checks / Inner Ball Joint Checks **No** When all remedial actions have been completed, perform final checks for heavy or uneven steering effort GO to Pinpoint Test **Q.**

PINPOINT TEST Q : HEAVY STEERING/STEERING REQUIRES UNEVEN EFFORT - FINAL CHECKS	
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS

Q1: AFTER COMPLETING THE ACTIONS ABOVE, CHECK AGAIN FOR HEAVY STEERING OR STEERING REQUIRING UNEVEN EFFORT USING THE FOLLOWING PROCEDURES	
	1 Start the engine and turn the steering wheel fully (lock to lock) 3 times. Check for heavy or uneven steering effort during this procedure
	2 Test drive the vehicle and check for heavy or uneven steering effort
	3 Check the temperature of the power steering fluid. Once the power steering temperature exceeds 80 degrees Celsius, repeat steps 1 and 2 above
	Is there still evidence of heavy or uneven steering effort? **Yes** Repeat the diagnostic steps above, or check other vehicle systems for the source of the problem **No** No further action

COMPONENT TESTS

RESERVOIR BLOCKAGE

Remove reservoir cap and (using a mirror) visually inspect the power steering fluid reservoir filter for signs of blockage. It is normal that a small amount of debris could be on the filter.

The filter mesh should not be more than 30% blocked (as in left-hand picture below), if the mesh is more than 30% blocked (as in the right-hand picture below), the power steering system fluid reservoir should be replaced.

STEERING BOOT DAMAGE

Remove both clips from each boot, stretch and fully rotate each boot and visually check for any holes, cuts or wear in the boots. Damaged boots should be replaced.

STEERING RACK INPUT SHAFT LEAK CHECK

Visually inspect the area around the steering rack input shaft for signs of leaks.

leaks.

NOTE:

> Misting/Dampness around the input shaft seal can be mis-diagnosed as leaks (see top four pictures below). This is normal and suspected leaks should always be verified by cleaning and chalking.

If there is clear evidence of a fluid leak at the steering rack input shaft seal after following the cleaning and chalking techniques described in the pinpoint tests, the steering rack should be replaced.

POWER STEERING FLUID CONDITION CHECK

1. Run the engine for 2 minutes
1. Check the power steering fluid system level
1. Observe the color and the odor. The color under normal circumstances should be red, green or yellow, not brown, black or emulsified with water. The fluid should not have a burnt odor.
1. Using a suitable clean syringe extract a suitable amount of fluid from the reservoir
1. Allow the fluid to drip onto a facial tissue and examine the stain
1. If evidence of solid material is found, the power steering fluid system should be drained for further inspection
1. If fluid contamination or steering component failure is confirmed by the sediment in the power steering fluid system, refer to steering fault diagnosis by symptom charts in this section

POWER STEERING PRESSURE TEST

For details of the correct equipment and procedures for power steering system pressure tests, REFER to: Section 211-02 Power Steering/General Procedures

POWER STEERING

POWER STEERING PRESSURE TEST – V8 5.0L PETROL/V8 S/C 5.0L PETROL (G1508897)

GENERAL PROCEDURES

SPECIAL TOOL(S)

211-011-11

Hose - power steering pressure test

211-011-01(LRT-57-001)

Valve block power

	steering test
	211-287(LRT-57-005) Hose and gauge - power steering pressure test
	211-011-13 Adaptor, Power steering pressure test

NOTE:

Some variation in the illustrations may occur, but the essential information is always correct.

1. Disconnect the battery ground cable.
   For additional information, refer to: Specifications (414-00 Battery and Charging System - General Information, Specifications).

2. Remove the air cleaner assembly.
   For additional information, refer to: Air Cleaner RH (303-12C Intake Air Distribution and Filtering - V8 5.0L Petrol, Removal and Installation).

installation).

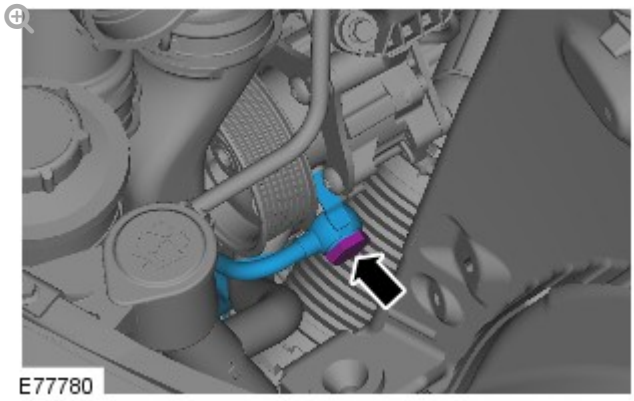
3. Remove the fluid from the power steering reservoir.
   - Remove the power steering fluid reservoir cap.

4. **CAUTION:**

   Before disconnecting or removing the components, make sure the area around the joint faces and connections are clean. Plug open connections to prevent contamination.

   NOTES:

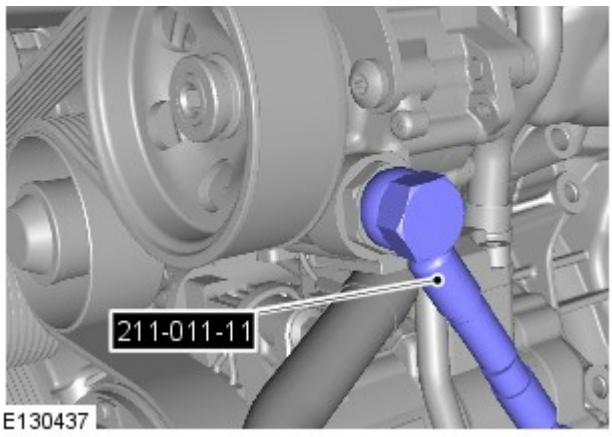
   - Some fluid spillage is inevitable during this operation.
   - Care must be taken to avoid contamination of the accessory drive belt.



Disconnect the power steering high-pressure pipe union.

- Remove the bolt.
- Remove and discard the 2 sealing washers.
- Position a container to collect the fluid.

5. 



Install the special tools to the power steering high-pressure port.

- Install the sealing washers.
- Tighten the bolt to 28 Nm (18 lb.ft).

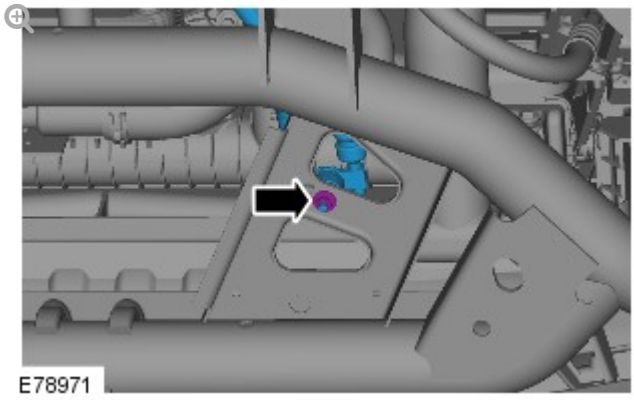
6. **WARNING:**

   Make sure to support the vehicle with axle stands.

   Raise and support the vehicle.

7. Remove the engine undershield.
   For additional information, refer to: Engine Undershield (501-02 Front End Body Panels, Removal and Installation).

8. Remove the front undershield.
   For additional information, refer to: Radiator Splash Shield (501-02 Front End Body Panels, Removal and Installation).

9. 

Release and reposition the power steering high-pressure pipe.

- Remove the nut.

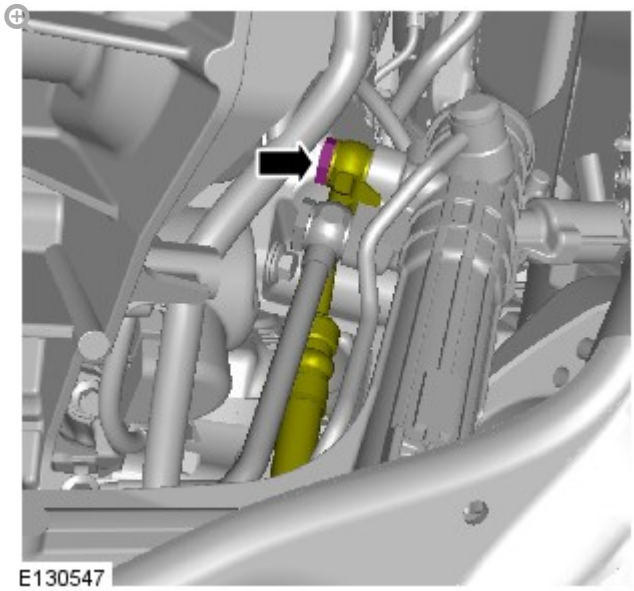
10.

CAUTION:

Before disconnecting or removing the components, make sure the area around the joint faces and connections are clean. Plug open connections to prevent contamination.

NOTES:

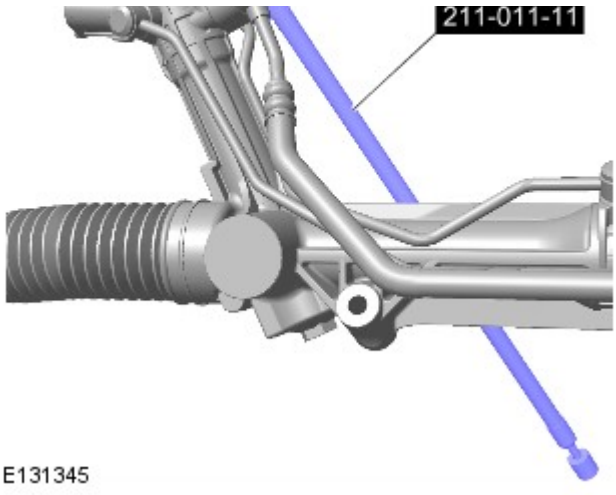
- Some fluid spillage is inevitable during this operation.
- RHD shown, LHD is similar.



Disconnect the power steering fluid line from the steering gear.

- Remove the bolt.
- Remove and discard the 2 sealing washers.
- Position a container to collect the fluid.

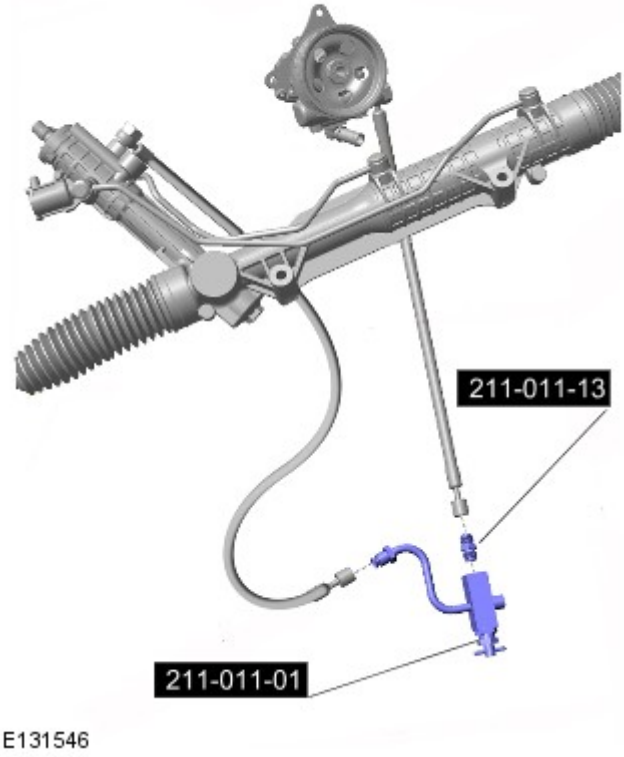
11.



Install the special tool to the steering gear.

- Install the sealing washers.
- Tighten the bolt to 28 Nm (18 lb.ft).

12.

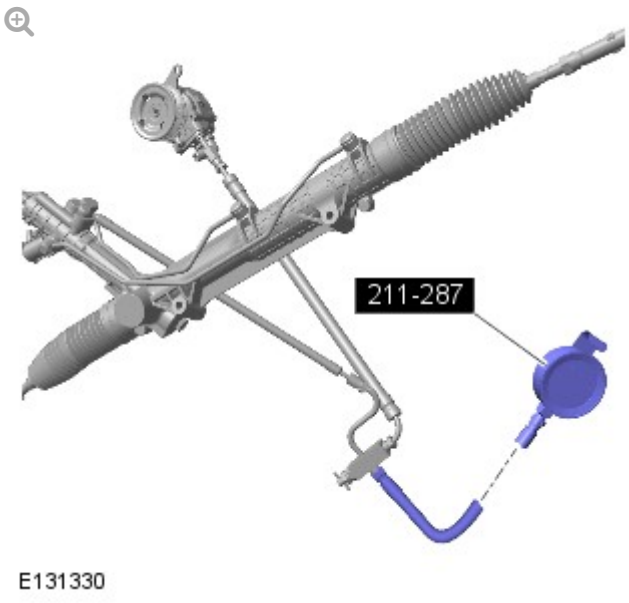


Install the special tool valve block assembly, to the steering gear and pump special tools.

- Connect the special tool lines, to the special tool valve block assembly.
- Tighten the union nuts to 25 Nm (18 lb.ft).

13. **NOTE:**

> Some variation in the illustrations may occur, but the essential information is always correct.



Connect the pressure gauge to the special tool valve block.

- Tighten the union to 25 Nm (18 lb.ft).
- Tie aside under the vehicle.

14. Lower the vehicle on the lift.

15. Fill the power steering reservoir.

16. Install the air cleaner assembly.
For additional information, refer to: Air Cleaner RH (303-12C Intake Air Distribution and Filtering - V8 5.0L Petrol, Removal and Installation).

17. Connect the battery ground cable.
For additional information, refer to: Specifications (414-00 Battery and Charging System - General Information, Specifications).

18. **NOTES:**

- Maintain the maximum fluid level during the test.
- Make sure the steering is in the straight ahead position.
- Make sure the steering components and test equipment are free from leaks.

With the test valve open start the engine.

- Start the engine and turn steering fully lock to lock, stop the engine.
- Top-up the power steering fluid reservoir.
- Install the reservoir filler cap.

19. For correct power steering pressures, refer to the steering specification section.
For additional information, refer to: Specifications (211-02 Power Steering, Specifications).

20. **CAUTION:**

Do not hold steering at full lock for longer than 10 seconds.

With the engine at idle, slowly turn the steering wheel and hold on full lock.

- With assistance record the pressure reading.

21. Repeat the above procedure for the other side.

- Record the pressure reading.

22. **NOTE:**

Make sure the steering is in the straight ahead position.

With the engine at idle, release the steering wheel. The pressure should be, at or below, the pressure specified.

23. Pressure outside this tolerance, indicates a fault.

24. **CAUTION:**

> Pump damage will occur if test valve is closed for longer periods.

To determine if the fault is in the steering pump or the steering rack, close the test valve for a maximum of 5 seconds.

25. If the pressures recorded fall outside the given values, replace the power steering pump.

26. If the maximum pump pressure is correct, then replace the power steering gear.

27. On completion of the test stop the engine.

28. Disconnect the battery ground cable.
For additional information, refer to: Specifications (414-00 Battery and Charging System - General Information, Specifications).

29. Remove the air cleaner assembly.
For additional information, refer to: Air Cleaner RH (303-12C Intake Air Distribution and Filtering - V8 5.0L Petrol, Removal and Installation).

30. Remove the fluid from the power steering reservoir.

31. **NOTES:**

- Some fluid spillage is inevitable during this operation.

- Care must be taken to avoid contamination of the accessory drive belt.

Remove the special tools.

32. Connect the high-pressure line to the power steering pump.
    - Clean the component mating faces.
    - Install 2 new sealing washers.
    - Tighten the bolt to 28 Nm (18 lb.ft).

33. Install the air cleaner assembly.
    For additional information, refer to: Air Cleaner RH (303-12C Intake Air Distribution and Filtering - V8 5.0L Petrol, Removal and Installation).

34. Connect the battery ground cable.
    For additional information, refer to: Specifications (414-00 Battery and Charging System - General Information, Specifications).

35. **WARNING:**

    Make sure to support the vehicle with axle stands.

    Raise and support the vehicle.

36. Connect the high-pressure line to the power steering gear.
    - Clean the component mating faces.
    - Install 2 new sealing washers.
    - Tighten the bolt to 28 Nm (18 lb.ft).

37. Install the front undershield.
    For additional information, refer to: Radiator Splash Shield (501-02 Front End Body Panels, Removal and Installation).

38. Install the engine undershield.
    For additional information, refer to: Engine Undershield (501-02 Front End Body Panels, Removal and Installation).

39. Fill and beed the power steering system.
    For additional information, refer to: Power Steering System Filling and Bleeding (211-00 Steering System - General Information, General Procedures).

2012.0 RANGE ROVER (LM), 211-02

POWER STEERING

POWER STEERING CONTROL VALVE ACTUATOR (6834301)

VALVE ACTUATOR (083420)

REMOVAL AND INSTALLATION

57.10.05	SERVOTRONIC - VALVE - RENEW	ALL DERIVATIVES	0.6	USED WITHINS	+

REMOVAL

1. Disconnect the battery ground cable.
   For additional information, refer to: Specifications - Armoured (414-00 Battery and Charging System - General Information, Specifications).

2. **WARNING:**

   Make sure to support the vehicle with axle stands.

   Raise the vehicle on the lift.

3. Remove the front wheel and tire.

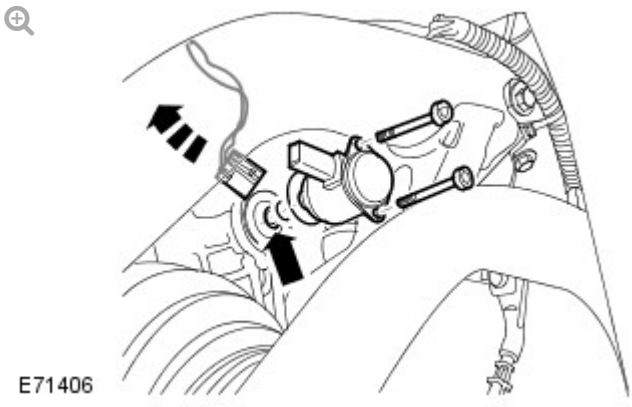
4. **CAUTION:**

   Before disconnecting or removing the components, make sure the area around the joint faces and connections are clean. Plug open connections to prevent contamination.

   NOTES:

   - Note the fitted position.
   - Some variation in the illustrations may occur, but the

essential information is always correct.



Remove the power steering control valve actuator.

- Disconnect the electrical connector.
- Position a container to collect the fluid spillage.
- Remove and discard the 2 Torx screws.
- Remove and discard the 2 O-ring seals.
- Remove and discard the filter.

INSTALLATION

1. **CAUTION:**

   Make sure the working surfaces are thoroughly clean to avoid contamination of the sensitive hydraulic components.

   Clean the component mating faces.

2. Install a new filter to the steering gear.

3. Install new seals to the actuator.

4. **NOTE:**

Align to the position noted on removal.

Install the actuator.

- Tighten the new Torx screws, evenly and progressively, to 3 Nm (2.2 lb.ft).
- Connect the electrical connector.

5. Install the wheel and tire.
   - Tighten the wheel nuts to 140 Nm (103 lb.ft).

6. Connect the battery ground cable.
   For additional information, refer to: Specifications - Armoured (414-00 Battery and Charging System - General Information, Specifications).

7. Refill and bleed the power steering.
   For additional information, refer to: Power Steering System Filling and Bleeding (211-00 Steering System - General Information, General Procedures).

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POWER STEERING

POWER STEERING FLUID COOLER – V8 5.0L PETROL/V8 S/C 5.0L PETROL (G1235831)

REMOVAL AND INSTALLATION

57.15.11	FLUID COOLER – POWER STEERING – RENEW	5000 CC, AJ V8	1.7	USED WITHINS	+

REMOVAL

1. Disconnect the battery ground cable.
   Refer to: Specifications (414-00, Specifications).

2. Refer to: Power Steering Fluid Reservoir - 5.0L (211-02, Removal and Installation).

3. **WARNING:**

   Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

   Raise and support the vehicle.

4. Refer to: Front Bumper Cover (501-19, Removal and Installation).

5. 

6. **CAUTIONS:**

   - Be prepared to collect escaping fluids.
   - Make sure that all openings are sealed. Use new blanking caps.

7. 

INSTALLATION

1. To install, reverse the removal procedure.

POWER STEERING

POWER STEERING FLUID RESERVOIR – V8 5.0L PETROL/V8 S/C 5.0L PETROL (G1226680)

REMOVAL AND INSTALLATION

57.15.08	RESERVOIR – POWER STEERING FLUID – RENEW	ALL DERIVATIVES	0.6	USED WITHINS	+

REMOVAL

WARNING:

If the fluid is spilled on the paintwork, the affected area must be immediately washed down with cold water.

1. Disconnect the battery ground cable.
   Refer to: Specifications (414-00, Specifications).

2. Refer to: Power Steering System Flushing (211-00, General Procedures).

3. **NOTE:**

Some variation in the illustrations may occur, but the essential information is always correct.

Torque: **3.5 Nm**

4. **NOTE:**

Some variation in the illustrations may occur, but the essential information is always correct.

5. **NOTE:**

Some variation in the illustrations may occur, but the essential information is always correct.

6. **WARNING:**

Be prepared to collect escaping fluid.

CAUTION:

Make sure that all open ports are covered to prevent any foreign material ingress.

INSTALLATION

1. **NOTE:**

   Remove and discard the blanking caps.

To install, reverse the removal procedure.

2012.0 RANGE ROVER (LM), 211-02

POWER STEERING

POWER STEERING PUMP –

POWER STEERING PUMP - V8 5.0L PETROL/V8 S/C 5.0L PETROL (G1230280)

REMOVAL AND INSTALLATION

57.20.14	PUMP – STEERING – RENEW	5000 CC, AJ V8	2	USED WITHINS	+

REMOVAL

NOTES:

- Removal steps in this procedure may contain installation details.
- Some variation in the illustrations may occur, but the essential information is always correct.

1. Refer to: Specifications (414-00 Charging System - General Information, Specifications).
2. Refer to: Power Steering Fluid Reservoir - 5.0L NA V8 - AJ133/5.0L SC V8 - AJ133 (211-02 Power Steering, Removal and Installation).
3. Refer to: Air Cleaner Outlet Pipe LH (303-12 Intake Air Distribution and Filtering - 5.0L, Vehicles Without: Supercharger, Removal and Installation).
4. Refer to: Air Cleaner LH (303-12 Intake Air Distribution and Filtering - 5.0L, Vehicles Without: Supercharger, Removal and Installation).
5. Refer to: Air Conditioning (A/C) System Recovery, Evacuation and Charging (412-00 Climate Control System - General Information, General Procedures).
6.

6.

WARNING:

Make sure to support the vehicle with axle stands.

Raise and support the vehicle.

7.

CAUTIONS:

- Make sure that all openings are sealed. Use new blanking caps.
- A new O-ring seal is to be installed.

Torque: **18 Nm**

8.

Torque: **10 Nm**

9.

NOTE:

Do not loosen the bolts more than 2 turns.

Torque: **25 Nm**

10.

11.

12. **CAUTION:**

> Make sure that all openings are sealed. Use new blanking caps.

Torque: **25 Nm**

13. **CAUTIONS:**

> - Make sure that all openings are sealed. Use new blanking caps.
> - A new O-ring seal is to be installed.

Torque:

M8 nut **9 Nm**

M8 **25 Nm**

14. 

Torque: **25 Nm**

15. **CAUTION:**

> Note the fitted position of the component prior to removal.

Torque: **25 Nm**

16. **NOTE:**

> Do not disassemble further if the component is removed for access only.

17. 

INSTALLATION

1. To install, reverse the removal procedure.

2012.0 RANGE ROVER (LM), 211-02

POWER STEERING

STEERING ANGLE SENSOR

(G1081369)

REMOVAL AND INSTALLATION

57.40.02	SENSOR - STEERING ANGLE/COLUMN - RENEW	ALL DERIVATIVES	2.5	USED WITHINS	+

REMOVAL

WARNINGS:

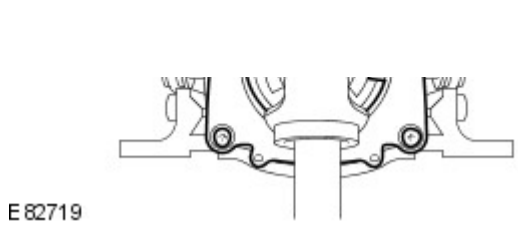
- Persons working on the supplemental restraint system (SRS) must be fully trained and have been issued with the safety guidelines.
- Allow a period of 10 minutes to elapse after disconnecting the battery before undertaking any work on the SRS.
- The SRS electrical connectors are unique. DO NOT force, or attempt to connect electrical connectors to the wrong sockets.
- The correct procedures must always be used when working on SRS components.
- It is imperative that before any work is undertaken on the SRS system, the appropriate information is read thoroughly.
- Always disconnect both battery cables before beginning work on the SRS system. Disconnect the ground cable first. Never reverse connect the battery.
- Take extra care when handling SRS components.

1. Make the SRS system safe.
   For additional information, refer to: Standard Workshop Practices (100-00, Description and Operation).

2. Disconnect the battery ground cable.
   For additional information, refer to: Specifications (414-00, Specifications).

3. Remove the steering column.
   For additional information, refer to: Steering Column (211-04, Removal and Installation).

4. 



Remove the steering angle sensor.

- Remove the 3 screws.

INSTALLATION

1. Install the steering angle sensor.
   - Tighten the screws to 3 Nm (2 lb.ft).
2. Install the steering column.
   For additional information, refer to: Steering Column (211-04, Removal and Installation).
3. Connect the battery ground cable.
   For additional information, refer to: Specifications (414-00, Specifications).
4. Using the Land Rover approved diagnostic system, calibrate the steering angle sensor.

POWER STEERING

STEERING GEAR – V8 S/C 5.0L PETROL, RHD AWD (G1234583)

REMOVAL AND INSTALLATION

57.10.01	STEERING GEAR – RENEW	RIGHT HAND DRIVE, 5000 CC, AJ V8, SUPERCHARGED	4.2	USED WITHINS	+

SPECIAL TOOL(S)

205-735(LRT-54-026)

Remover halfshaft inboard joint

308-626/1

Installer halfshaft oil seal

308-626/2

Installer/Guide halfshaft oil seal

100-012(LRT-99-004)

Impulse extractor

205-754(LRT-54-027)

Ball joint separator

1. **CAUTION:**

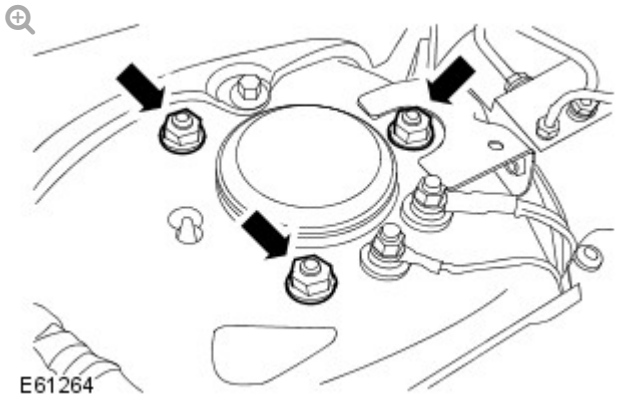
   Do not turn the steering wheel with the steering column lower shaft disconnected as damage to the clockspring and steering wheel switches may occur.

   Align the steering wheel to straight ahead.

2. Disconnect the battery ground cable.
   For additional information, refer to: Specifications (414-00, Specifications).

3. **WARNING:**

   Do not remove the nuts.

   RH front: Release the air suspension spring.

   - Loosen the 3 nuts.

4. Remove the cooling fan and shroud.
   For additional information, refer to: Cooling Fan - Vehicles With: Supercharger (303-03, Removal and Installation).

5. **WARNING:**

Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

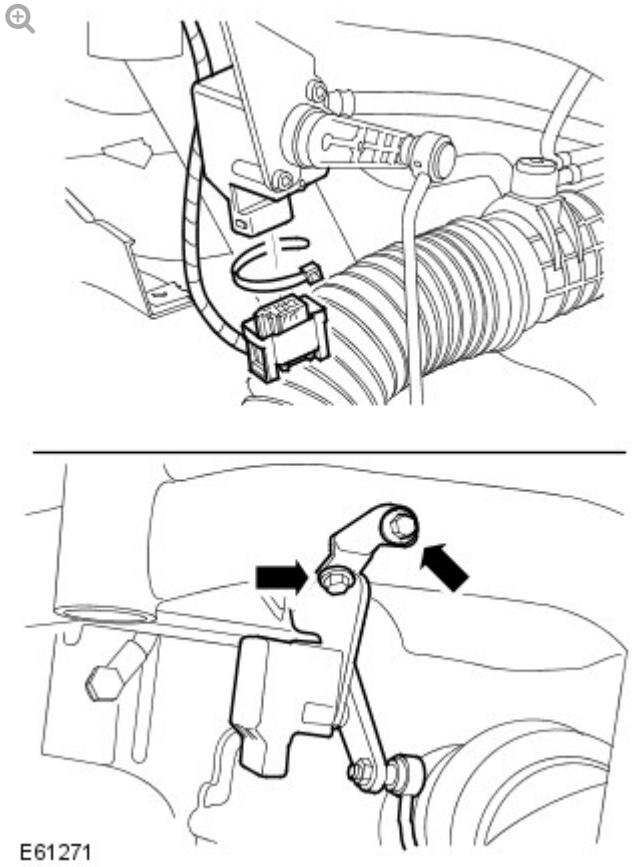
Raise and support the vehicle.

6. Remove the front wheels and tires.

7. Remove the engine undershield.
   For additional information, refer to: Engine Undershield (501-02, Removal and Installation).

8. Remove the radiator splash shield.
   For additional information, refer to: Radiator Splash Shield (501-02, Removal and Installation).

9. Remove the halfshaft support bearing housing.
   For additional information, refer to: Halfshaft Bearing (205-04, Removal and Installation).

10. 

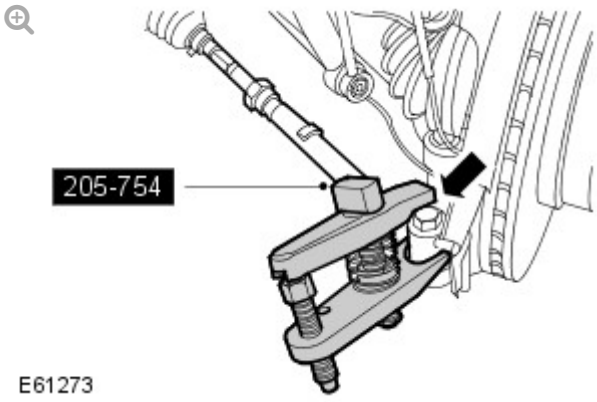
RH front: Remove the suspension height sensor.

- Remove the clip.
- Disconnect the electrical connector.
- Remove the 2 bolts.
- Tie aside.
- Repeat the above procedure for the other side.

11.

CAUTION:

Make sure the ball joint seal is not damaged. A damaged seal will lead to the premature failure of the joint.



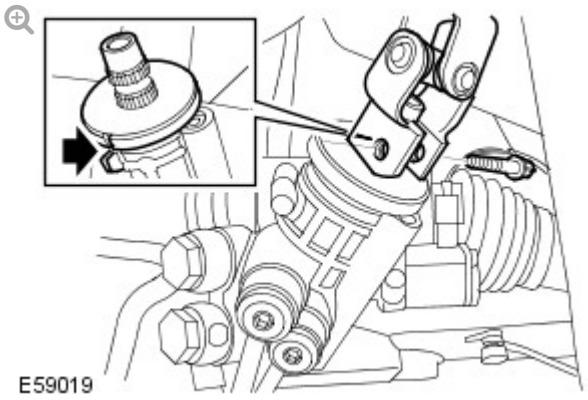
LH front: Disconnect the steering gear tie rod end ball joint.

- Use the special tools.
- Loosen the tie-rod end ball joint retaining nut.
- Discard the nut.

12.

CAUTION:

Do not turn the steering wheel with the steering column lower shaft disconnected as damage to the clockspring and steering wheel switches may occur.



Disconnect the lower steering column from the steering gear.

- Note the fitted position.
- Align the steering wheel to straight ahead.
- Remove and discard the Torx bolt.

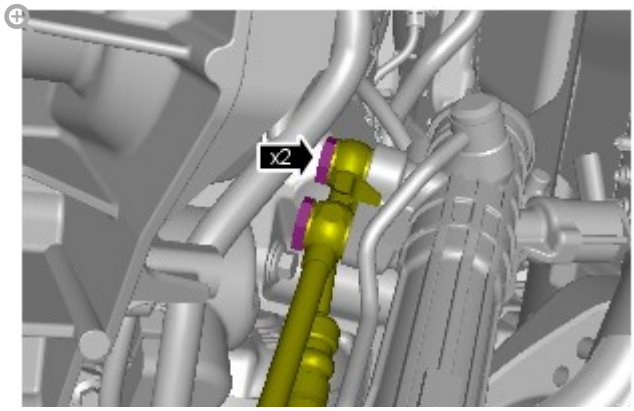
13. Disconnect the steering gear electrical connector.

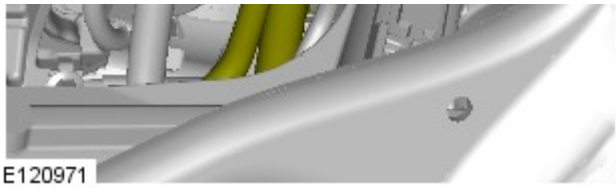
14. **WARNING:**

Fluid loss is unavoidable, use absorbent cloth or a container to collect the fluid.

CAUTION:

Before disconnecting or removing the components, make sure the area around the joint faces and connections are clean. Plug open connections to prevent contamination.

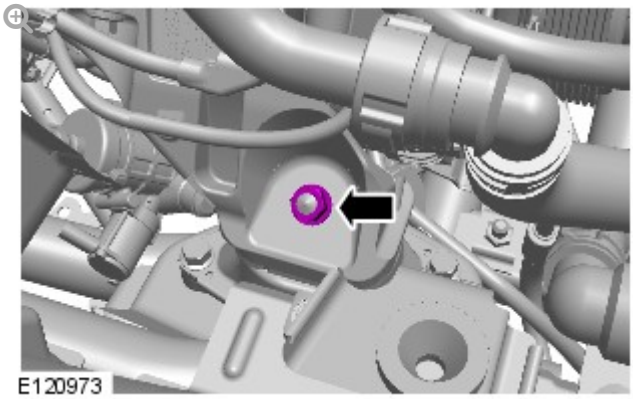



E120971

Disconnect the power steering feed and return fluid lines from the steering gear.

- Note the fitted position.
- Remove the 2 unions.
- Remove and discard the 4 sealing washers.

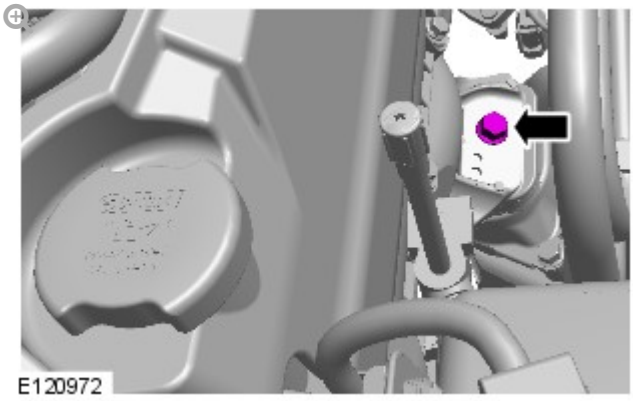
15.


E120973

Release the RH engine mount.

- Support the engine.
- Remove the nut.

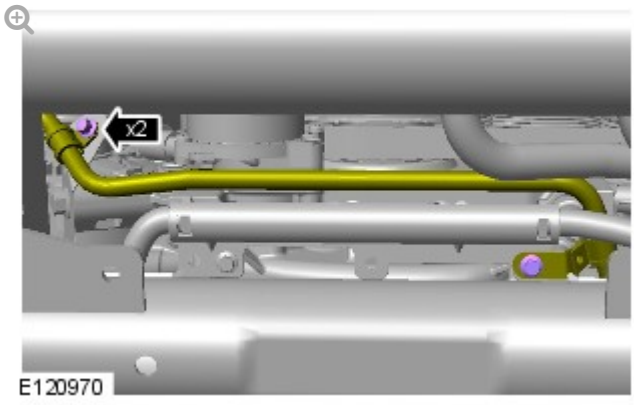
16.


E120972

Release the LH engine mount.

- Remove the bolt.

17.



Release the air conditioning (A/C) line brackets.

- Remove the 2 bolts.

18.

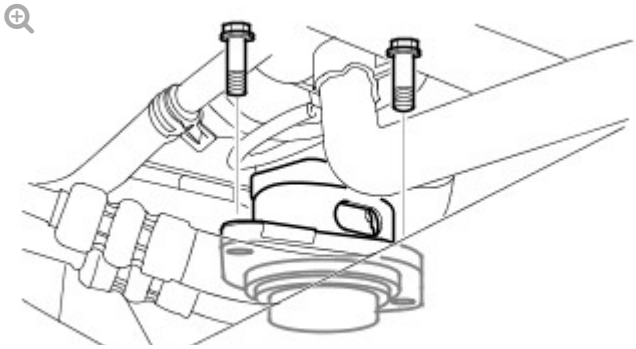
CAUTION:

Protection must be installed to the RH steering gear boot.

Release the steering gear.

- Raise the engine.
- Remove and discard the 2 nuts and Torx bolts.

19.

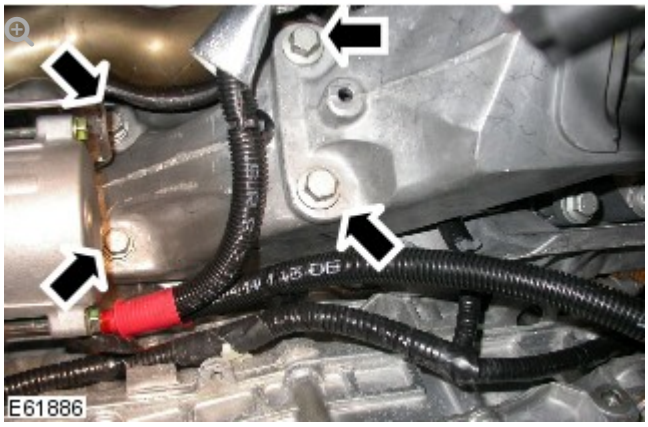


E59196

Remove the engine RH mount.

- Remove the 2 bolts.

20.

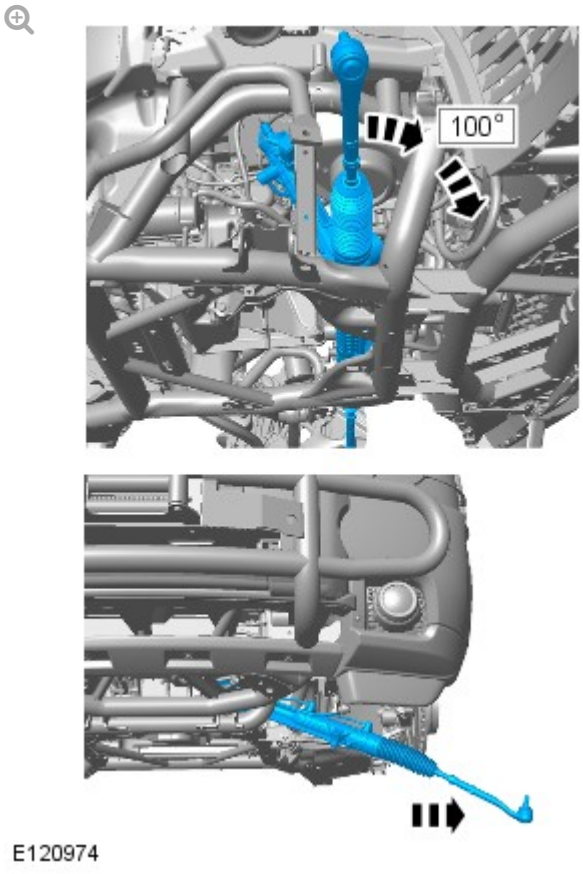


E61886

Remove the RH engine mount bracket.

- Remove the 4 bolts.

21.



E120974

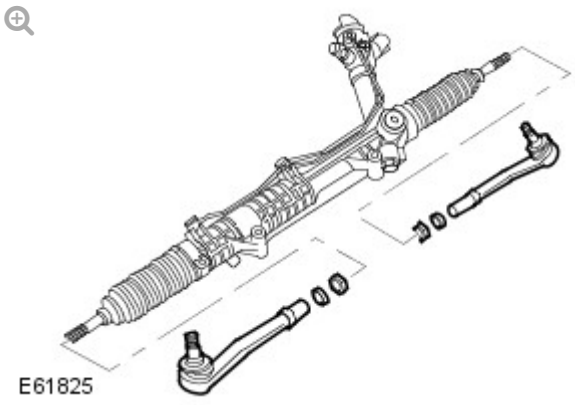
Remove the steering gear.

- With assistance, carefully rotate and release the steering

gear.

22. **NOTE:**

Do not disassemble further if the component is removed for access only.



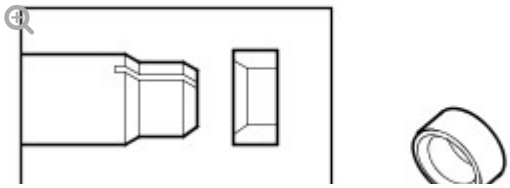
Remove the tie-rod end.

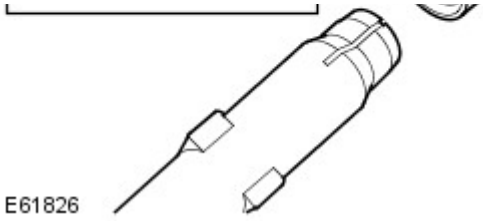
- Note the fitted position.
- Loosen the locknut.
- Remove and discard the locking ring.
- Remove and discard the locknut.
- Repeat the above procedure for the other side.

INSTALLATION

1. **CAUTION:**

Make sure the locking ring taper faces the tie rod end.





Install the tie-rod end.

- Clean the components.
- Install a new locknut.
- Install a new locking ring.
- Tighten the new nut to 80 Nm (59 lb.ft).

2. **CAUTION:**

   Protection must be installed to the RH steering gear boot.

   Install the steering gear.

   - With assistance, carefully rotate and align the steering gear.
   - Tighten the new nuts and Torx bolts to 100 Nm (74 lb.ft).

3. Install the engine mount.
   - Clean the component mating faces.
   - Tighten the bolts to 56 Nm (41 lb.ft).

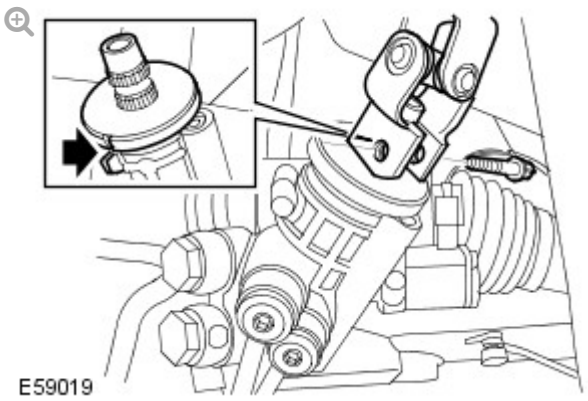
4. Install the RH engine mount bracket.
   - Clean the component mating faces.
   - Tighten the engine mount bracket to engine bolts to 45 Nm (33 lb.ft), then a further 60 degrees.

5. Lower the engine onto its mounts.
   - Tighten the nut and bolt to 115 Nm (85 lb.ft).

6. Secure the A/C line brackets.
   - Tighten the bolts to 6 Nm (4 lb.ft).

7. Connect the power steering feed and return fluid lines.
   - Clean the components.
   - Install new sealing washers.
   - Tighten the M16 union to 28 Nm (21 lb.ft).
   - Tighten the M14 union to 28 Nm (21 lb.ft).

8. Connect the steering gear electrical connector.

9. 

   Attach the lower steering column.
   - Make sure that the steering gear tag is aligned correctly, as shown.
   - Install a new Torx bolt and tighten to 24 Nm (18 lb.ft).

10. **CAUTION:**

    Make sure the ball joint seal is not damaged. A damaged seal will lead to the premature failure of the joint.

    LH front: Connect the steering gear tie rod end ball joint.
    - Clean the component mating faces.
    - Tighten the new nut to 80 Nm (59 lb.ft).

11. LH front: Install the suspension height sensor.

- Tighten the bolts to 3.5 Nm (2.5 lb.ft).
- Connect the electrical connector.
- Install the clip.
- Repeat the above procedure for the other side.

12. Install the halfshaft support bearing housing.
    For additional information, refer to: Halfshaft Bearing (205-04, Removal and Installation).
    - Install a new O-ring seal.
    - Lubricate the O-ring seal with petroleum jelly.
    - Tighten the bolts evenly to 25 Nm (18 lb.ft).

13. Install the front wheels and tires.
    - Tighten the wheel nuts to 140 Nm (103 lb.ft).

14. RH front: Secure the air suspension spring.
    - Tighten the nuts securing the air springs to 56 Nm (41 lb.ft).

15. Install the engine undershield.
    For additional information, refer to: Engine Undershield (501-02, Removal and Installation).

16. Install the cooling fan and shroud.
    For additional information, refer to: Cooling Fan - Vehicles With: Supercharger (303-03, Removal and Installation).

17. Install the radiator splash shield.
    For additional information, refer to: Radiator Splash Shield (501-02, Removal and Installation).

18. Connect the battery ground cable.
    For additional information, refer to: Specifications (414-00, Specifications).

19. Fill and bleed the power steering system.
    For additional information, refer to: Power Steering System Filling

For additional information, refer to: Power Steering System Filling and Bleeding (211-00, General Procedures).

20. Carry out a complete vehicle geometry check and adjustment.

2012.0 RANGE ROVER (LM), 211-03

STEERING LINKAGE

STEERING LINKAGE

SPECIFICATIONS

Torque Specifications

DESCRIPTION	NM	LB-FT
Tie-rod	110	81
* Tie-rod end ball joint nut	70	52
* Tie-rod end locking nut	55	40
Road wheel nuts	140	103

*** New nut must be installed**

2012.0 RANGE ROVER (LM), 211-03

STEERING LINKAGE

DIAGNOSIS AND TESTING

PRINCIPLE OF OPERATION

For a detailed description of the steering linkage, refer to the relevant description and operation sections of the workshop manual.

INSPECTION AND VERIFICATION

CAUTION:

Diagnosis by substitution from a donor vehicle is **NOT** acceptable. Substitution of control modules does not guarantee confirmation of a fault, and may also cause additional faults in the vehicle being tested and/or the donor vehicle

NOTE:

Check DDW for open campaigns. Refer to the corresponding bulletins and SSMs which may be valid for the specific customer complaint and carry out the recommendations as needed

1. Verify the customer concern

1. Visually inspect for obvious signs of damage and system integrity

Visual Inspection

Mechanical	Electrical
▪ Tire condition/pressure ▪ Fluid level	▪ Fuses

1. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step

1. If the concern is not visually evident, verify the symptom and refer to the symptom chart

SYMPTOM CHARTS

NOTE:

If the module or a component is suspect and the vehicle remains under manufacturer warranty, refer to the Warranty Policy and

Procedures manual, or determine if any prior approval programme is in operation, prior to the installation of a new module/component

STEERING LINKAGE ISSUES

SYMPTOM	POSSIBLE CAUSES	ACTION
▪ Excessive free play at steering wheel (refer to the steering linkage inspection and backlash (free play) check in this section)	▪ Steering wheel fixings insecure	▪ Check and tighten the steering wheel retaining bolt as required (REFER to: Section 211-00 Steering System - General Information/Specification)
	▪ Excess play in the steering linkage	▪ Refer to the Heavy Steering/Steering Requires Uneven Effort – Steering System Free Play Checks pinpoint tests below, GO to Pinpoint Test **A.**
	▪ Steering gear not correctly adjusted (causing excessive backlash)	**CAUTION:** DO NOT attempt to adjust the steering gear yoke. Failure to follow this instruction will invalidate the steering gear warranty ▪ Refer to the Heavy Steering/Steering Requires Uneven Effort – Steering System Free Play Checks pinpoint tests below, GO to Pinpoint Test **A.**
	▪ Lower steering column universal joint pinch bolts loose	▪ Check and tighten the lower steering column pinch bolts as required (REFER to: Section 211-00 Steering System - General Information/Specification)

	▪ Excessive wear in steering column universal joints	▪ REFER to: Pinpoint Tests within Section 211-04 Steering Column/Diagnosis and Testing/Steering Column
	▪ Steering gear mounting bolts loose or damaged	▪ Check/tighten and install new steering gear mounting bolts as required (REFER to: Section 211-00 Steering System - General Information/Specification)
	▪ Wear in steering gear tie-rod end ball joints **NOTE:** Inner ball joint wear is rare. The steering gear installed to all vehicles has a spring loaded pinion to ensure the correct level of engagement between the rack and pinion. This play is optimized with the steering gear in the central position and should not be confused with inner ball joint wear. Check for vertical motion in the inner ball joint with the steering gear in the central position. ▪ Wear in steering gear inner ball joints	▪ Refer to the Heavy Steering/Steering Requires Uneven Effort – Steering System Free Play Checks pinpoint tests below, GO to Pinpoint Test **A.**
	▪ Wear in suspension ball joints/bushings	▪ Check and install new components as required
▪ Vehicle wanders from side to side when driven straight ahead and the steering	▪ Incorrect tire pressure or tire size	▪ Check and adjust the tire pressures as required (REFER to: Section 204-04 Wheels and Tires/Specification) ▪ Check and install a new tire as required
	▪ Vehicle is unevenly or excessively	▪ Notify the customer of

wheel is held in a firm position	▪ Vehicle is unevenly or excessively loaded	▪ Notify the customer of incorrect vehicle loading
	▪ Incorrect toe adjustment	▪ Check and adjust as required (REFER to: Section 204-00 Suspension System - General Information/General Procedures)
	▪ Loose or worn steering gear tie-rod end(s)	▪ Refer to the Heavy Steering/Steering Requires Uneven Effort – Steering System Free Play Checks pinpoint tests below, GO to Pinpoint Test **A.**
	▪ Loose or worn suspension ball joint(s)	▪ Check/tighten and install a new suspension ball joint assembly as required (REFER to: Section 204-01 Front Suspension/Specification)
	▪ Steering column universal joint pinch bolt loose	▪ Check/tighten the steering column universal joint pinch bolt to the correct torque (REFER to: Section 211-02 Power Steering/Specification)
	▪ Loose or worn rear suspension components	▪ Check/tighten and install new rear suspension components as required (REFER to: Section 204-02 Rear Suspension/Specification)
▪ Poor self center action of the steering	▪ Incorrect tire pressure, size or type	▪ Check/adjust the tire pressure and install correct tire as required (REFER to: Section 204-04 Wheels and Tires/Specification)
	▪ Incorrect geometry adjustment	**NOTE:** Dealerships must

	keep a copy of the BEFORE and AFTER geometry figures with job card for future reference ▪ Check and adjust as required (REFER to: Section 204-00 Suspension System - General Information/General Procedures)
▪ Steering column/steering column lower shaft interference	▪ Check the steering column and steering column lower shaft are free from interference from the engine harness, sound proofing and floor covering
▪ Steering column shroud fouling on the steering wheel	▪ Correctly install/align as necessary
▪ Steering column universal joints binding or stiff	▪ REFER to: Pinpoint Tests within Section 211-04 Steering Column/Diagnosis and Testing/Steering Column
▪ Steering column lower shaft floor seal incorrectly installed, binding or damaged	▪ Correctly install or install new lower shaft as required.
▪ Binding or damaged steering gear tie-rod(s)	▪ Refer to the Heavy Steering/Steering Requires Uneven Effort – Steering System Free Play Checks pinpoint tests below, GO to Pinpoint Test **A.**
▪ Loose, damaged or worn front suspension components	▪ Check/tighten and install new front suspension components as required (REFER to: Section 204-01 Front Suspension/Specification)

DIAGNOSTIC PROCEDURES FOR STEERING LINKAGE

PINPOINT TEST A : HEAVY STEERING/STEERING REQUIRES UNEVEN EFFORT – STEERING SYSTEM FREE PLAY CHECKS	
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	A1: OUTER BALL JOINT CHECKS
	1 Refer to the tie-rod wear checks guidance in this section and check for excess free play in the outer ball joints - Steering Linkage Inspection and Backlash (Free Play) Check
	Is there excess free play in the outer ball joints? **Yes** Replace the outer ball joints as required Check again for heavy steering or steering requiring uneven effort. If fault is rectified, perform final checks for heavy or uneven steering effort, GO to Pinpoint Test **B.** If fault is still evident, **GO to A2**. **No** **GO to A2**.
	A2: INNER BALL JOINT CHECKS
	1 Refer to the tie-rod wear checks guidance in this section and check for excess free play in the inner ball joints - Steering Linkage Inspection and Backlash (Free Play) Check
	Is there excess free play in the inner ball joints? **Yes** Replace the inner ball joints as required Check again for heavy steering or steering requiring uneven effort. If fault is rectified, perform final checks for heavy or uneven steering effort, GO to Pinpoint Test **B.** If fault is still evident, replace the steering rack assembly. When all remedial actions have been completed, perform final checks for heavy or uneven steering effort, GO to Pinpoint Test **B.** **No** Replace the steering rack assembly. When all remedial actions have been completed, perform final checks for heavy or uneven steering effort, GO to Pinpoint Test **B.**

PINPOINT TEST B : HEAVY STEERING/STEERING REQUIRES UNEVEN EFFORT - FINAL CHECKS	
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B1: AFTER COMPLETING THE ACTIONS ABOVE, CHECK AGAIN FOR HEAVY STEERING OR STEERING REQUIRING UNEVEN EFFORT USING THE FOLLOWING PROCEDURES	

	1 Start the engine and turn the steering wheel fully (lock to lock) 3 times. Check for heavy or uneven steering effort during this procedure
	2 Test drive the vehicle and check for heavy or uneven steering effort
	3 Check the temperature of the power steering fluid. Once the power steering temperature exceeds 80 degrees Celsius, repeat steps 1 and 2 above
	Is there still evidence of heavy or uneven steering effort? **Yes** Repeat the diagnostic steps above, or check other vehicle systems for the source of the problem **No** No further action

COMPONENT TESTS

TIE ROD CHECKS 1: CHECK FOR BENDING OR DEFLECTION OF TIE-ROD SHAFTS

Visually inspect the ends of the tie-rod shafts

The tie-rod shafts should show no signs of bending or deflection anywhere along the length of the entire shaft (as in the two left-hand pictures above).

If there is evidence of bending or deflection anywhere along the length of the entire shaft the tie-rod should be replaced (the two right-hand pictures above show examples of shafts bent in the ball-joint area). If evidence of bending or deflection is noted, then the steering gear should be checked thoroughly for other symptoms that may have been induced by the impact (e.g.: Noisy or heavy steering). If further damage is noted, it may be necessary to replace the steering gear as part of the accident damage/abuse repair

TIE ROD CHECKS 2: CHECK TIE-ROD BALL-JOINT SURFACES AND SEATING MATERIAL

Visually inspect the tie-rod ball-joint surfaces and seating material

The tie-rod seating material surrounding the ball-joints should show no signs of damage. The spaces between the seating sections should be regular and even (as in the top-left picture above) and the seating material should not be extruded beyond the metal cup surface of the joint. If there is evidence of irregular spacing between the seating sections or seating material extrusion (as in the two centre row pictures above) or if there is other evidence of seating material deformation (as in the bottom-left picture above), the tie-rod should be replaced

The visible surfaces of the ball-joints should be inspected for scarring, scratches or other obvious damage. The visible ball-joint surfaces should be free from any scarring, scratches or other obvious damage (as in the top-right picture above). If there is evidence of seat damage, then the steering gear should be checked thoroughly for other symptoms that may have been induced by the impact (e.g.: Noisy or heavy steering). If further damage is noted, it may be necessary to replace the steering gear as part of the accident damage/abuse repair

STEERING LINKAGE INSPECTION AND BACKLASH (FREE PLAY) CHECK

CAUTION:

Steering gear boots must be handled carefully to avoid damage. Use new clamps when installing steering gear boots. Inspect the boots for cuts, deterioration, twisting or distortion. Check the steering gear boots to make sure they are tight. Install new boots or clamps as required

NOTE:

The following steps must be carried out with power steering assistance (with the engine running):

1. With the wheels in the straight ahead position, gently turn the steering

1. With the wheels in the straight ahead position, gently turn the steering wheel to the left and the right to check for free play

1. Free play should be between 0 and 6 mm (0 and 0.24 in) at the steering wheel rim. If the free play exceeds this limit, either the ball joints are worn, or the lower steering column joints are worn (REFER to: Section 211-04 Steering Column/Diagnosis and Testing/Steering Column/Pinpoint Tests/ Noise Specific Diagnostics (Clonk/Column Knock) / Check For Clonk/Column Knock Noise From Lower Steering Column Shaft), or the backlash of the steering gear is excessive

CAUTION:

DO NOT attempt to adjust the steering gear yoke. Failure to follow this instruction will invalidate the steering gear warranty

1. The backlash of the steering gear cannot be adjusted, install new steering gear if excessive backlash is diagnosed after checking for worn ball joints and lower steering column joints

1. Grasp the steering wheel firmly and attempt to move it laterally, both up and down and to the left and the right (without turning the wheel), to check for column bearing wear

STEERING LINKAGE

STEERING GEAR BOOT (G297930)

REMOVAL AND INSTALLATION

57.10.29	BOOT - EACH - RENEW	ALL DERIVATIVES	0.4	USED WITHINS	+

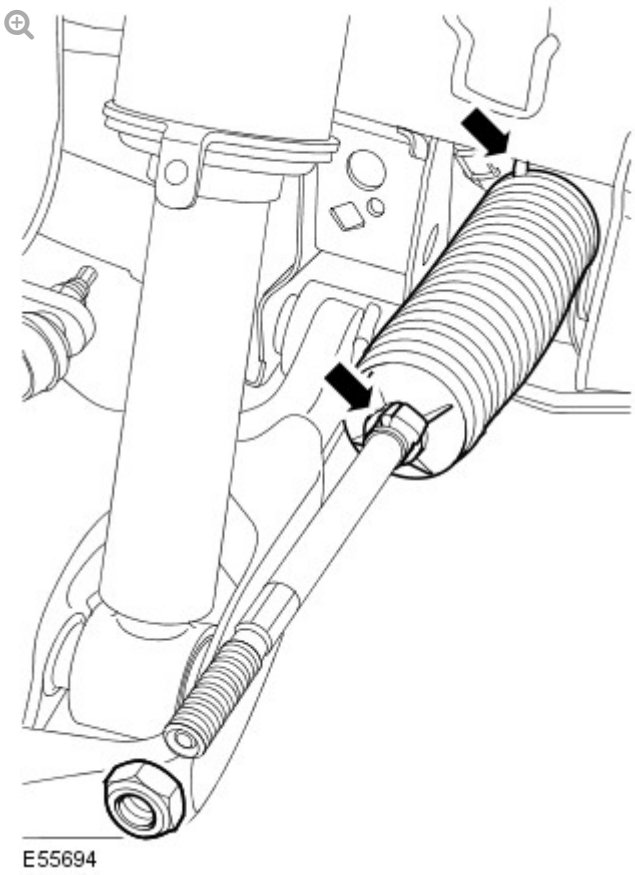
REMOVAL

1. Remove the tie-rod end.
   For additional information, refer to: Tie-Rod End (211-03, Removal and Installation).

2. **NOTE:**

   Note the fitted position.

   Remove the locknut.

3. 

Remove the steering gear boot.

- Release the 2 clips.

INSTALLATION

1. Install the steering gear boot.
   - Clean the component mating faces.
   - Secure with the clips.
2. Install the locknut.
3. Install the tie-rod end.
   For additional information, refer to: Tie-Rod End (211-03, Removal and Installation).

STEERING LINKAGE

TIE ROD END (G926950)

REMOVAL AND INSTALLATION

57.55.07	BALL JOINT - TIE-ROD - EACH - RENEW	ALL DERIVATIVES	0.3	USED WITHINS	+

REMOVAL

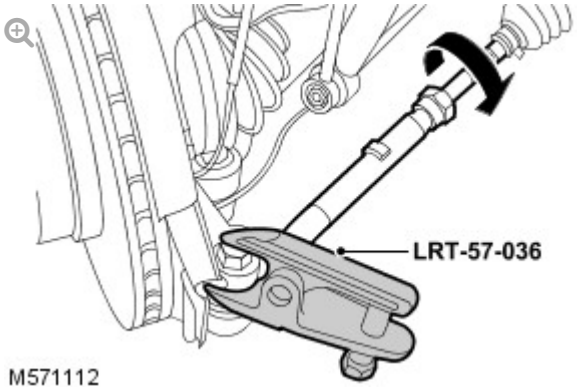
1. **WARNING:**

   Do not work on or under a vehicle supported only by a jack.
   Always support the vehicle on safety stands.

   Raise and support the vehicle.

2. Remove the front wheel and tire.

3. Loosen the tie rod end locking nut.

4. 

   Using the special tool release the tie rod end.

- Remove and discard the nut.

5. **CAUTION:**

   Note the number of turns when removing the tie rod end to aid installation.

   Remove the tie rod end.

   - Remove and discard the locking ring.

INSTALLATION

1. Install the tie rod end.
   - Install a new locking nut.
2. Secure the tie rod end ball joint.
   - Install new nut.
   - Tighten new nut to 70 Nm (59 lb.ft).
3. Secure the tie rod end locking nut.
   - Tighten nut to 55 Nm (41 lb.ft).
4. Install the front wheel and tire.
   - Tighten the wheel nuts to 140 Nm (103 lb.ft).
5. Check, and if necessary, adjust the wheel alignment.
   For additional information, refer to: Four-Wheel Alignment (204-00 Suspension System - General Information, General Procedures).

2012.0 RANGE ROVER (LM), 211-03

STEERING LINKAGE

TIE ROD (G1851272)

REMOVAL AND INSTALLATION

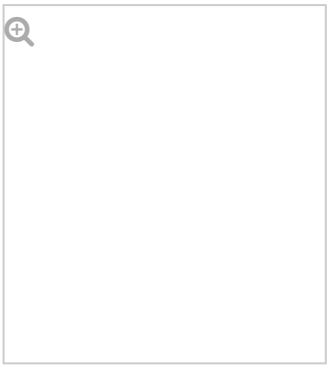
SPECIAL TOOL(S)

JLR-211-342

Steering Gear Clamp

JLR-211-343

Anti-rotation Device



JLR-211-344

Tie Rod Removal and Installation Tool

REMOVAL

NOTES:

- Some variation in the illustrations may occur, but the essential information is always correct.
- Some components shown removed for clarity.

- Removal steps in this procedure may contain installation details.

1. Refer to: Steering Gear Boot (211-03 Steering Linkage, Removal and Installation).

2. **NOTE:**

   Turn the steering on to full lock for access.

Special Tool(s): JLR-211-342, JLR-211-343

3. **CAUTION:**

   Make sure the steering gear rack bar does not rotate.

Special Tool(s): JLR-211-342, JLR-211-343, JLR-211-344
Torque: **110 Nm**

INSTALLATION

1. To install, reverse the removal procedure.

2. Using only four wheel alignment equipment approved by Land Rover, check and adjust the wheel alignment.
   Refer to: Four-Wheel Alignment (204-00 Suspension System - General Information, General Procedures).

2012.0 RANGE ROVER (LM), 211-04

STEERING COLUMN

SPECIFICATIONS

Torque Specifications

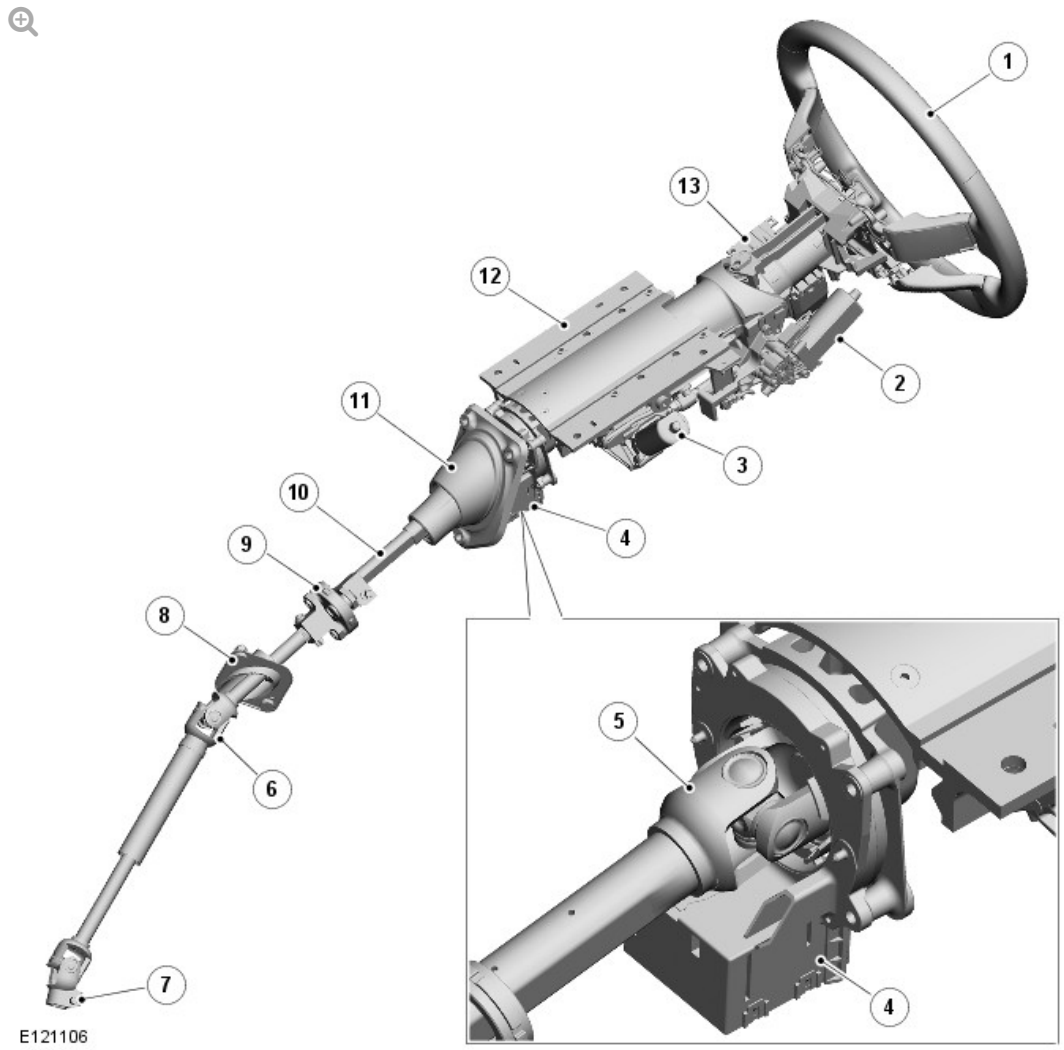
DESCRIPTION	NM	LB-FT
Steering wheel rotation sensor bolt	3	2
Steering column bolts	25	18
* Steering column upper shaft to steering column lower shaft clamp bolt	24	18
*Steering column lower shaft to steering gear clamp bolt	24	18
Steering column telescopic motor bolts	5	4
Steering column tilt motor bolts	6	4
Steering wheel bolt	63	46

*** New bolts/nut must be installed**

STEERING COLUMN

DESCRIPTION AND OPERATION

COMPONENT LOCATION



ITEM	DESCRIPTION
1	Steering wheel
2	Column adjustment motor – tilt
3	Column adjustment motor – reach
4	Steering angle sensor

5	Upper column - upper shaft
6	Lower column - upper shaft
7	Lower column - lower shaft
8	Bulkhead mounting
9	Flexible coupling
10	Upper column - lower shaft
11	Gaitor
12	Adjustable upper column
13	Lock housing/Tilt head

OVERVIEW

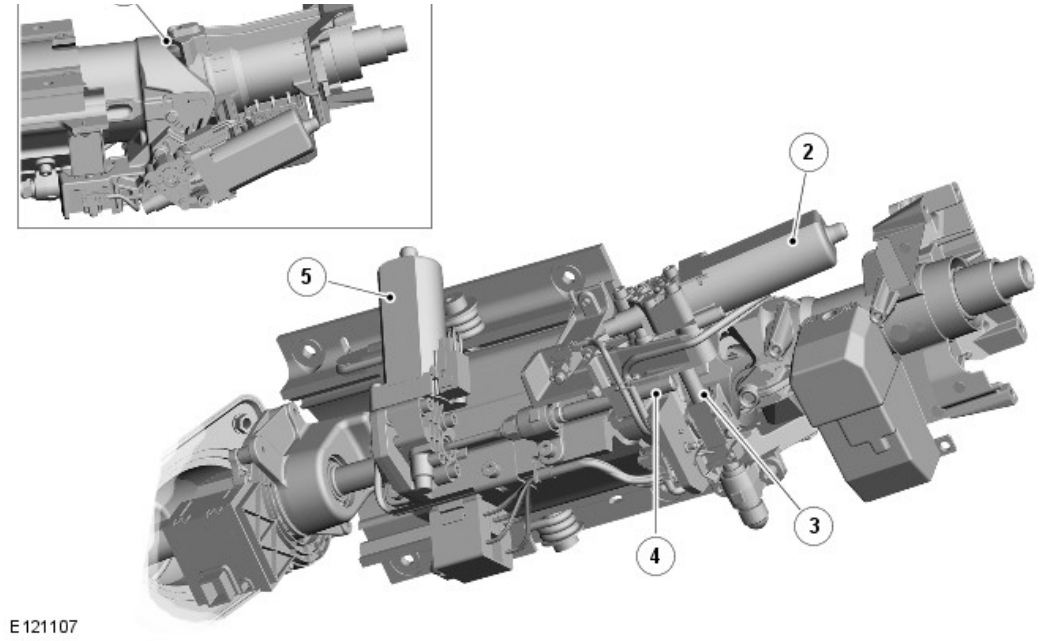
The steering column features fully electrical adjustment for tilt and reach. Steering wheel position is controlled by the CJB (central junction box).

The steering column comprises the upper column assembly, the lower column assembly and the steering wheel. The 3 components are positively connected together to pass driver rotary-input from the steering wheel to a linear output of the steering rack.

The upper column assembly contains electrical adjustment for steering-wheel tilt and reach, the electric steering lock mechanism and the steering angle sensor. Steering adjustment memory positions are stored in the driver's seat module. The column also features a 'tilt away' function which moves the steering column away from the driver allowing easier exit and entry to the vehicle.

Column adjustment is provided by two electric motors; one for tilt and one for reach. Operation of the column adjustment is controlled by a four-way joystick switch located in the column lower shroud. Column adjustment is an integral part of the driver position memory system.

COMPONENT DESCRIPTION



ITEM	DESCRIPTION
1	Vertical adjustment cam
2	Adjustment motor – tilt
3	Drive screw - tilt adjustment motor
4	Drive screw - reach adjustment motor
5	Adjustment motor – reach

WARNING:

Do not attempt to dismantle the steering column. The crash safety of the unit will be compromised.

The lower column comprises upper and lower shafts which are connected together as a sliding fit. The sliding fit allows the shafts to collapse in the event of a frontal collision, preventing column intrusion into the vehicle interior. The upper shaft is connected to a flexible coupling and provides the attachment to the upper column. The lower shaft has internal splines which connect with splines on the steering rack valve input shaft. The upper shaft is fitted with a white coloured sealing ring and a gaitor.

The upper column comprises two shafts which are also connected together as a sliding fit. The shafts are a double 'D' section to prevent rotation. The

sliding fit allows the shafts to collapse in the event of a frontal collision further preventing intrusion into the vehicle interior. The lower shaft is connected to the flexible coupling which transfers torque to the lower column and the steering rack. The upper shaft has a splined internal bore which connects with the adjustable upper column assembly.

The upper column assembly comprises two extruded aluminum sections which connect together and can slide on each other in the event of a frontal impact. The column is attached to the cross-car tube with four bolts. Two straps are bolted to the upper of the two aluminium sections. The straps are coiled around a bush on the upper section and have a hook which locates on the lower section. In the event of a frontal impact, the straps can unwind, allowing the upper column to collapse in a controlled manner absorbing energy.

The upper column also provides the location for the steering angle sensor which is used by the ABS (anti-lock brake system).

The upper column provides the locations for the column adjustment motors and the steering lock. The steering lock operates via a locking bolt which engages with a locking sleeve located around the column shaft. The locking sleeve has a tolerance ring which is located between the sleeve and the column. The tolerance ring allows the locking sleeve to slip on the upper column shaft if a high torque is applied to the steering wheel when the lock is engaged. This prevents the locking bolt from being sheared by someone forcibly turning the steering wheel while the steering lock is engaged, yet still effectively locking the steering.

STEERING COLUMN ADJUSTMENT

Both motors are attached to the lock housing/tilt head assembly and move the column via drive screws.

The reach adjustment motor drives a screw shaft which moves the column in and out for reach adjustment. The adjustment is achieved by two extruded aluminium sections which slide on one another. The tilt adjustment motor also drives a screw shaft. This shaft is connected to a cam, which causes the tilt head to pivot, adjusting the column angle.

Inputs from the column adjustment switch are received by the CJB, which interprets the signals from the switch and operates the requested adjustment motor in the required direction.

The motors used on the steering column have Hall effect sensors. These allow the CJB to calculate and adjust the position of the column when the seat memory store function is used and applies this setting to the applicable ignition key.

ELECTRONIC STEERING COLUMN LOCK

With the passive start system, a conventional steering lock mechanism cannot be used. An electronic system was developed which comprises a steering column assembly locking unit with an integrated control module.

The steering lock is operated with the door locks when the vehicle is locked or unlocked. A control module, located inside the steering column, controls a motor, releasing the steering lock when appropriate.

The upper steering column assembly houses the column lock mechanism and control module. The components are assembled with non-removable pins for security reasons and are therefore non-serviceable. Failure of any steering lock components will require replacement of the upper steering column assembly.

The steering column lock comprises a locking motor and locking bolt. The locking motor drives a cam, which moves the locking bolt into and out of engagement with the locking sleeve on the steering column. The locking motor is fitted with a Hall effect sensor, which informs the control module of the position (locked/unlocked) of the steering lock mechanism.

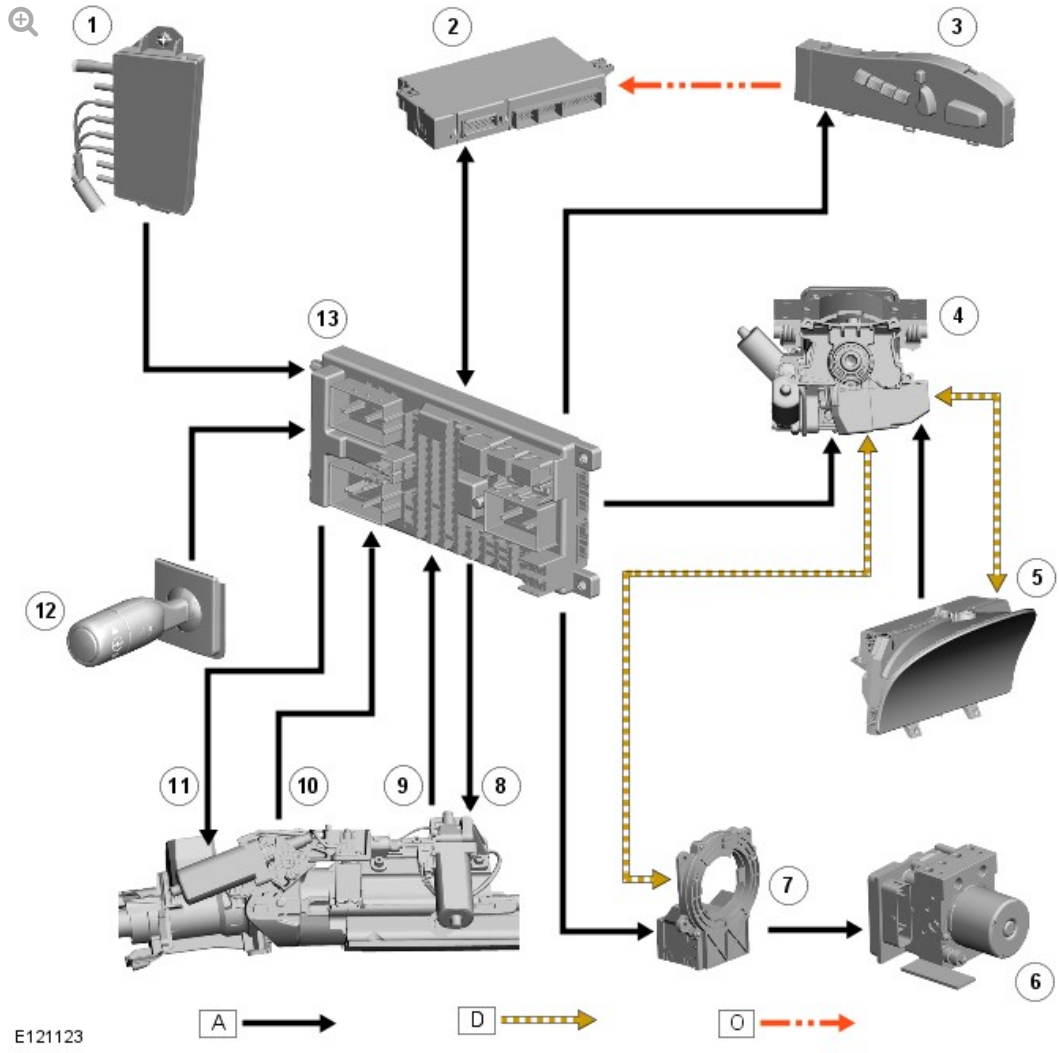
CONTROL DIAGRAM

Steering Column Adjustment and Lock

NOTE:

A = Hardwired; D = High-speed CAN (controller area network) bus; O

= LIN (local interconnect network) bus



ITEM	DESCRIPTION
1	BJB (battery junction box)
2	Driver seat module (position memory)
3	Driver seat switch pack
4	Electronic steering column lock
5	Instrument cluster
6	ABS module
7	Steering angle sensor
8	Reach adjustment motor
9	Reach adjustment hall sensor
10	Tilt adjustment motor

10	Tilt adjustment motor
11	Tilt adjustment hall sensor
12	Steering column switch
13	CJB

2012.0 RANGE ROVER (LM), 211-04

STEERING COLUMN

DIAGNOSIS AND TESTING

PRINCIPLE OF OPERATION

For a detailed description of the steering column, refer to the relevant description and operation sections of the workshop manual.

INSPECTION AND VERIFICATION

CAUTION:

Diagnosis by substitution from a donor vehicle is **NOT** acceptable. Substitution of control modules does not guarantee confirmation of a fault, and may also cause additional faults in the vehicle being tested and/or the donor vehicle

1. Verify the customer concern

1. Visually inspect for obvious signs of damage and system integrity

Visual Inspection

Mechanical	Electrical
▪ Tire condition/pressure ▪ Fluid level	▪ Fuses

1. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step

1. If the concern is not visually evident, verify the symptom and refer to the symptom chart

DTC INDEX

For a list of Diagnostic Trouble Codes (DTCs) that could be logged on this vehicle, please refer to Section 100-00.

For Column Lock DTCs on L319, L320, L322, L359 -

REFER to: Diagnostic Trouble Code (DTC) Index - DTC: Electric Steering Column Lock Control Module (ESCL) (100-00 General Information, Description and Operation

For Additional Column Lock DTCs on L319, L320, L322, L359;

For Column Adjustment Motors or Solenoid DTCs on L319, L320, L322;

REFER to: Diagnostic Trouble Code (DTC) Index - DTC: Central Junction Box (CJB) (100-00 General Information, Description and Operation).

For Additional Column Lock DTCs on L319, L320, L322, L359;

REFER to: Diagnostic Trouble Code (DTC) Index - DTC: Instrument Cluster (IC) (100-00 General Information, Description and Operation)

SYMPTOM CHARTS

NOTE:

If the module or a component is suspect and the vehicle remains under manufacturer warranty, refer to the Warranty Policy and Procedures manual, or determine if any prior approval programme is in operation, prior to the installation of a new module/component

STEERING COLUMN ISSUES

SYMPTOM	POSSIBLE CAUSES	ACTION
▪ Excessive free play at steering wheel (refer to the steering linkage inspection and backlash (free play) check in this section)	▪ Steering wheel fixings insecure	▪ Check and tighten the steering wheel retaining bolt as required (REFER to: Section 211-00 Steering System - General Information/Specification)
	▪ Excess play in the steering linkage	▪ REFER to: Pinpoint Tests within Section 211-03 Steering Linkage/Diagnosis and Testing/Steering Linkage
	▪ Lower steering column universal joint pinch bolts loose	▪ Check and tighten the lower steering column pinch bolts as required (REFER to: Section 211-00 Steering System - General Information/Specification)

	▪ Excessive wear in steering column universal joints	▪ Refer to the Steering Column Noise – Noise Specific Diagnostics (Clonk/Column Knock) pinpoint tests below, GO to Pinpoint Test **A.**
	▪ Steering gear mounting bolts loose or damaged	▪ Check/tighten and install new steering gear mounting bolts as required (REFER to: Section 211-00 Steering System - General Information/Specification)
	▪ Wear in steering gear tie-rod end ball joints	▪ REFER to: Pinpoint Tests within Section 211-03 Steering Linkage/Diagnosis and Testing/Steering Linkage
	▪ Wear in steering gear inner ball joints	
	▪ Wear in suspension ball joints/bushings	▪ Check and install new components as required
▪ Vehicle wanders from side to side when driven straight ahead and the steering wheel is held in a firm position	▪ Incorrect tire pressure or tire size	▪ Check and adjust the tire pressures as required (REFER to: Section 204-04 Wheels and Tires/Specification) ▪ Check and install a new tire as required
	▪ Vehicle is unevenly or excessively loaded	▪ Notify the customer of incorrect vehicle loading
	▪ Incorrect toe adjustment	▪ Check and adjust as required (REFER to: Section 204-00 Suspension System - General Information/General Procedures)
	▪ Loose or worn steering gear tie-rod end(s)	▪ REFER to: Pinpoint Tests within Section 211-03 Steering Linkage/Diagnosis

		and Testing/Steering Linkage
	▪ Loose or worn suspension ball joint(s)	▪ Check/tighten and install a new suspension ball joint assembly as required (REFER to: Section 204-01 Front Suspension/Specification)
	▪ Steering column universal joint pinch bolt loose	▪ Check/tighten the steering column universal joint pinch bolt to the correct torque (REFER to: Section 211-02 Power Steering/Specification)
	▪ Loose or worn rear suspension components	▪ Check/tighten and install new rear suspension components as required (REFER to: Section 204-02 Rear Suspension/Specification)
▪ Poor self center action of the steering	▪ Incorrect tire pressure, size or type	▪ Check/adjust the tire pressure and install correct tire as required (REFER to: Section 204-04 Wheels and Tires/Specification)
	▪ Incorrect geometry adjustment	**NOTE:** Dealerships must keep a copy of the BEFORE and AFTER geometry figures with job card for future reference ▪ Check and adjust as required (REFER to: Section 204-00 Suspension System - General Information/General Procedures)
	▪ Steering column/steering column lower shaft interference	▪ Check the steering column and steering column lower shaft are free from interference from the

		engine harness, sound proofing and floor covering
	▪ Steering column shroud fouling on the steering wheel	▪ Correctly install/align as necessary
	▪ Steering column universal joints binding or stiff	▪ Refer to the Steering Column Noise – Noise Specific Diagnostics (Clonk/Column Knock) pinpoint tests below, GO to Pinpoint Test **A.**
	▪ Steering column lower shaft floor seal incorrectly installed, binding or damaged	▪ Correctly install or install new lower shaft as required.
	▪ Binding or damaged steering gear tie-rod(s)	▪ REFER to: Pinpoint Tests within Section 211-03 Steering Linkage/Diagnosis and Testing/Steering Linkage
	▪ Loose, damaged or worn front suspension components	▪ Check/tighten and install new front suspension components as required (REFER to: Section 204-01 Front Suspension/Specification)
▪ Column will not adjust ▪ Column will not move to memory position	▪ Electrical/electronic failure	▪ Using the manufacturer approved diagnostic system, check for related DTCs and refer to the relevant DTC index ▪ Check fuses/relays ▪ Check instrument cluster for column movement/memory related DTCs and refer to the relevant DTC index ▪ Check condition of wiring and connectors ▪ Carry out column calibration application using the manufacturer approved diagnostic

		approved diagnostic system. The BAR code information is located in the right hand luggage compartment floor area below the carpet ▪ Check seat control memory module
	▪ Motor locked/jammed	▪ Check to see if mechanism has reached hard end stops ▪ Free mechanism ▪ **CAUTION:** This step only applies to L322 09MY or earlier vehicles Replace motor with appropriate service kit
▪ **CAUTION:** This only applies to L322 09MY or earlier vehicles Column easy entry/exit does not function	▪ Electrical/electronic failure	▪ Turn column adjust switch to AUTO position, check that 'Column Adjust AUTO' text is displayed in the instrument cluster message center ▪ Check steering column movement datalogger signal using the manufacturer approved diagnostic system ▪ Check fuses/relays ▪ Check instrument cluster for column movement/memory related DTCs and refer to the relevant DTC index ▪ Check condition of wiring and connectors ▪ Carry out column calibration application using the manufacturer approved diagnostic system. The BAR code information is located in the right hand luggage compartment floor area below the carpet

		below the carpet ▪ Check seat control memory module for DTCs and refer to DTC index
▪ Electromechanical steering column lock will not operate	▪ Internal lock failure	▪ Refer to the electrical circuit diagrams and test steering column lock circuit ▪ Install a new steering column lock as required
▪ Scrape/grind noise from behind steering wheel while steering	▪ Steering column shroud foul condition or clockspring	▪ Correctly install the steering column shroud to eliminate the foul condition ▪ Install a new clockspring as required
	▪ Foreign objects	▪ Remove foreign objects from between steering column shroud and steering wheel/steering column rotating components
▪ Click	▪ Clockspring or steering column multifunction switch LH	▪ Correctly install and install new components as required
	▪ Loose universal joint pinch bolt	▪ Install a new universal joint pinch bolt and tighten to correct specification (REFER to: Section 211-00 Steering System - General Information/Specification)
▪ Squeak	▪ Steering column shroud joints	▪ Apply Krytox spray to steering column shroud joints
	▪ Clockspring	▪ Install new clockspring as required
▪ Knock	▪ Loose fixings (universal joint pinch bolt and steering column fixings)	▪ Tighten fixings to correct specification (REFER to: Section 211-00 Steering System - General Information/Specification)

▪ Rattle	▪ Foreign objects	▪ Remove foreign objects from between steering column shroud and steering wheel/steering column rotating components
	▪ Loose fixings	▪ Tighten steering column fixings to correct specification (REFER to: Section 211-00 Steering System - General Information/Specification)
▪ Noise while adjusting column	▪ Electric motor/solenoid	**NOTE:** Before carrying out repairs/replacement, assess column adjustment noise levels against other vehicles of the same model ▪ Install new components as required
	▪ Motor spindle/lead screw	▪ Lubricate lead screw

COMPONENT TESTS

STEERING LINKAGE INSPECTION AND BACKLASH (FREE PLAY) CHECK

CAUTION:

Steering gear boots must be handled carefully to avoid damage. Use new clamps when installing steering gear boots. Inspect the boots for cuts, deterioration, twisting or distortion. Check the steering gear boots to make sure they are tight. Install new boots or clamps as required

NOTE:

The following steps must be carried out with assistance:

1. With the wheels in the straight ahead position, gently turn the steering wheel to the left and the right to check for free play

1. Free play should be between 0 and 6 mm (0 and 0.24 in) at the steering wheel rim. If the free play exceeds this limit, either the ball joints are worn (Refer to videos shown on SSM41218 for guidance for the procedure to check for worn Outer Ball Joints or Inner Ball Joints), or the lower steering column joints are worn (REFER to: Section 211-04 Steering Column/Diagnosis and Testing/Steering Column/Pinpoint Tests/ Steering Column Noise - Noise Specific Diagnostics (Clonk/Column Knock) / Check For Clonk/Column Knock Noise From Lower Steering Column Shaft), or the backlash of the steering gear is excessive

CAUTION:

DO NOT attempt to adjust the steering gear yoke. Failure to follow this instruction will invalidate the steering gear warranty

1. The backlash of the steering gear cannot be adjusted, install new steering gear if excessive backlash is diagnosed after checking for worn ball joints and lower steering column joints

1. Grasp the steering wheel firmly and attempt to move it laterally, both up and down and to the left and the right (without turning the wheel), to check for column bearing wear

Specific Steering Column Noise Types

See below for a glossary of terms describing the most common noises that may indicate a fault with the steering column:

Clonk/Column Knock

Clonk/column knock is a structure-borne noise heard as a loose-sounding rattle or vibration coming from the steering column. Clonk/column knock can be identified by driving and turning over cobblestones, rough roads, or high frequency bumps such as 25-50 mm tall tar strips. Clonk requires a tie-rod load impact

PINPOINT TEST A : STEERING COLUMN NOISE - NOISE SPECIFIC DIAGNOSTICS (CLONK/COLUMN KNOCK)	
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A1: CHECK FOR CLONK/COLUMN KNOCK NOISE FROM LOWER STEERING COLUMN SHAFT	
	1 Disconnect the lower steering column universal joint from the steering rack input shaft
	2 Discard the screw fixings
	3 Rotate the lower steering column shaft between 90 and 180 degrees
	4 Ascertain the specific type of noise present in the power steering system (see glossary of noise terms above)
	5 Rotate lower steering column shaft to its original position. Failure to do this could lead to damage to the clock spring and misalignment of the steering wheel
	Is there a clonk/column knock noise as the lower steering column shaft is rotated? **Yes** Replace the lower steering column universal joint, lower steering column or upper column as appropriate. For removal and installation of Steering Column & Steering Column Flexible Coupling (REFER to: Section 211-04 Steering Column/Removal and Installation/Steering Column; 211-04 Steering Column/Removal and Installation/Steering Column Flexible Coupling)When all remedial actions have been completed, perform final checks for steering system noise, GO to Pinpoint Test **B.** **No** Reconnect steering column using a new screw and REFER to: Section 211-03 Steering Linkage/Diagnosis and Testing/Steering Linkage/Pinpoint Tests/ Heavy Steering/Steering Requires Uneven Effort – Steering System Free Play Checks / Outer Ball Joint Checks / Inner Ball Joint Checks

PINPOINT TEST B : STEERING SYSTEM NOISE - FINAL CHECKS	
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B1: AFTER COMPLETING THE ACTIONS ABOVE, CHECK AGAIN FOR POWER STEERING SYSTEM NOISE USING THE FOLLOWING PROCEDURES	

STEERING SYSTEM NOISE USING THE FOLLOWING PROCEDURES

	1 Start the engine and turn the steering wheel fully (lock to lock) 3 times. Check for power steering noise during this procedure
	2 Test drive the vehicle and check for power steering noise
	3 Check the temperature of the power steering fluid. Once the power steering temperature exceeds 80 degrees Celsius, repeat steps 1 and 2 above
	Is there still noise emanating from the steering system? **Yes** Repeat the diagnostic steps above, or check other vehicle systems for the source of the noise **No** No further action

STEERING COLUMN (G1235397)

REMOVAL AND INSTALLATION

57.40.01	COLUMN ASSEMBLY - INNER AND OUTER - RENEW	ALL DERIVATIVES	2.5	USED WITHINS	+

REMOVAL

WARNINGS:

- Persons working on the supplemental restraint system (SRS) must be fully trained and have been issued with the safety guidelines.
- Allow a period of 10 minutes to elapse after disconnecting the battery before undertaking any work on the SRS.

- The SRS electrical connectors are unique. DO NOT force, or attempt to connect electrical connectors to the wrong sockets.
- The correct procedures must always be used when working on SRS components.
- It is imperative that before any work is undertaken on the SRS system, the appropriate information is read thoroughly.
- Always disconnect both battery cables before beginning work on the SRS system. Disconnect the ground cable first. Never reverse connect the battery.
- Take extra care when handling SRS components.

1. Make the air bag supplemental restraint system (SRS) safe.
   Refer to: Standard Workshop Practices (100-00, Description and Operation).

2. Disconnect the battery ground cable.
   Refer to: Specifications (414-00, Specifications).

3. **CAUTION:**

   Make sure the steering is in the straight ahead position.

   Remove and discard, the steering column flexible coupling clamp bolt.

4. Remove the clockspring housing assembly.
   Refer to: Clockspring (501-20, Removal and Installation).

5. Remove the instrument panel lower section.
   Refer to: Instrument Panel Lower Section (501-12, Removal and Installation).

6.

Disconnect the steering column lock electrical connector.

7. 

Disconnect the steering column electrical connector.

8. 

Disconnect the steering wheel rotation sensor electrical connector.

9. 

With assistance, remove the steering column.

10. **NOTE:**

> Do not disassemble further if the component is removed for access only.

Remove the steering wheel rotation sensor.

INSTALLATION

1. Install the steering wheel rotation sensor.

2. **CAUTION:**

> Make sure the steering is in the straight ahead position.

With assistance, install the steering column.

3. Connect the steering wheel rotation sensor electrical connector.

4. Connect the steering column electrical connector.

5. Connect the steering column lock electrical connector.

6. Install the instrument panel lower section.
   Refer to: Instrument Panel Lower Section (501-12, Removal and Installation).

7. Install the clockspring.
   Refer to: Clockspring (501-20, Removal and Installation).

8. Install a new steering column flexible coupling clamp bolt.

9. Connect the battery ground cable.
   Refer to: Specifications (414-00, Specifications).

10. Initiate the steering angle sensor using the Land Rover approved diagnostic system.

STEERING COLUMN

STEERING COLUMN SHAFT

(G1235395)

REMOVAL AND INSTALLATION

57.40.22	SHAFT - COLUMN - INTERMEDIATE - RENEW	5000 CC, AJ V8	0.1	USED WITHINS	+

REMOVAL

1. 

   Torque: **24 Nm**

2. 

   Torque: **21 Nm**

3. 

   Torque: **24 Nm**

INSTALLATION

1. To install, reverse the removal procedure.

2012.0 RANGE ROVER (LM), 211-04

STEERING COLUMN

STEERING WHEEL (G1235399)

REMOVAL AND INSTALLATION

STEERING

57.61.01	STEERING WHEEL - RENEW	ALL DERIVATIVES	0.4	USED WITHINS	+

REMOVAL

WARNINGS:

- Persons working on the supplemental restraint system (SRS) must be fully trained and have been issued with the safety guidelines.
- Allow a period of 10 minutes to elapse after disconnecting the battery before undertaking any work on the SRS.
- The SRS electrical connectors are unique. DO NOT force, or attempt to connect electrical connectors to the wrong sockets.
- The correct procedures must always be used when working on SRS components.
- It is imperative that before any work is undertaken on the SRS system, the appropriate information is read thoroughly.
- Always disconnect both battery cables before beginning work on the SRS system. Disconnect the ground cable first. Never reverse connect the battery.
- Take extra care when handling SRS components.

NOTE:

Some variation in the illustrations may occur, but the essential information is always correct.

ℹ	All vehicles

1. Make the air bag supplemental restraint system (SRS) safe.
   Refer to: Standard Workshop Practices (100-00, Description and Operation).

Disconnect the battery ground cable

2. Disconnect the battery ground cable.
   Refer to: Specifications (414-00, Specifications).

3. Remove the driver air bag module.
   Refer to: Driver Air Bag Module (501-20, Removal and Installation).

4. **CAUTION:**

   Make sure that the wheels and tires are in the straight-ahead position. Failure to follow this instruction may result in damage to the components.

   NOTE:

   Note the steering wheel to steering column alignment marks.

Vehicles with 4.4L diesel engine

1. 

2. 

All vehicles

1. 

2. **CAUTION:**

Make sure the wiring harness and electrical connectors are not damaged during this operation.

3. 

4. 

INSTALLATION

All vehicles

1. 

2. 

3. 

4. 

Vehicles with 4.4L diesel engine

1. 

2.

Right-hand drive vehicles

1.

CAUTIONS:

- Make sure that the wheels and tires are in the straight-ahead position. Failure to follow this instruction may result in damage to the components.
- RHD vehicles: With the wheels and tires in the straight-ahead position, the bottom timing mark on the steering column must be aligned with the steering wheel mark, see illustration below.

Left-hand drive vehicles

1.

CAUTIONS:

- Make sure that the wheels and tires are in the straight-ahead position. Failure to follow this instruction may result in damage to the components.
- LHD vehicles: With the wheels and tires in the straight-ahead position, the bottom timing mark on the steering column must be aligned with the steering wheel mark, see illustration below.

	All vehicles

1. 

   Torque: **63 Nm**

2. Install the driver air bag module.
   Refer to: Driver Air Bag Module (501-20, Removal and Installation).

3. Connect the battery ground cable.
   Refer to: Specifications (414-00, Specifications).

2012.0 RANGE ROVER (LM), 211-05

STEERING COLUMN SWITCHES

SPECIFICATIONS

Torque Specifications

DESCRIPTION	NM	LB-FT
Steering column switch Torx screws	3	2

2012.0 RANGE ROVER (LM), 211-05

STEERING COLUMN SWITCHES

DIAGNOSIS AND TESTING

For additional information. REFER to:

Steering System (211-00, Diagnosis and Testing),
Turn Signal, Cornering and Hazard Lamps (417-01, Diagnosis and Testing),
Wipers and Washers (501-16, Diagnosis and Testing).

2012.0 RANGE ROVER (LM), 211-05

STEERING COLUMN SWITCHES

STEERING COLUMN CONTROL SWITCH (G899535)

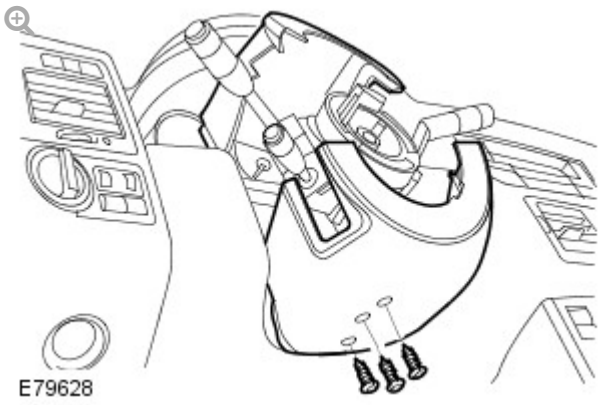
57.41.05	SWITCH - COLUMN ADJUSTMENT - CONTROL - RENEW	ALL DERIVATIVES	0.1	USED WITHINS	+

REMOVAL

1. Release the steering column extension gaiter.
   - Release the 6 clips.

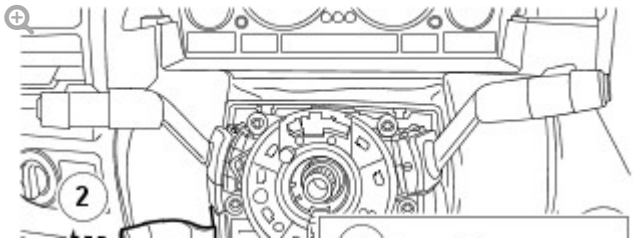
2. **NOTE:**

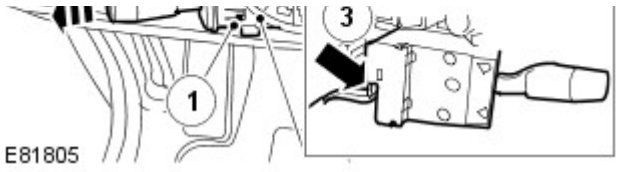
   The steering wheel is shown removed for clarity.



   Remove the steering column lower shroud.
   - Remove the 3 screws.

3. Remove the steering column upper shroud.

4. 



Remove the steering column control switch.

1. Carefully release the clip.
2. Release the steering column control switch.
3. Disconnect the electrical connector.

INSTALLATION

1. Install the steering column control switch.
   - Connect the electrical connector.
2. Install the steering column upper shroud.
3. Install the steering column lower shroud.
   - Install the 3 screws.
4. Attach the steering column extension gaiter.

2012.0 RANGE ROVER (LM), 211-05

STEERING COLUMN SWITCHES

STEERING COLUMN MULTIFUNCTION SWITCH LH

(G1239687)

REMOVAL AND INSTALLATION

86.65.55	SWITCH - COMBINED TURN SIGNAL INDICATOR/HEADLAMP/HORN - RENEW	ALL DERIVATIVES	0.4	USED WITHINS +

REMOVAL

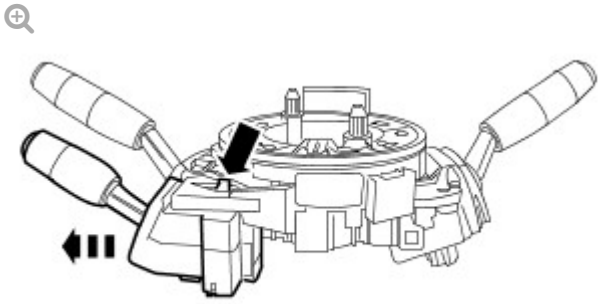
WARNINGS:

- Persons working on the supplemental restraint system (SRS) must be fully trained and have been issued with the safety guidelines.
- Allow a period of 10 minutes to elapse after disconnecting the battery before undertaking any work on the SRS.
- The SRS electrical connectors are unique. DO NOT force, or attempt to connect electrical connectors to the wrong sockets.
- The correct procedures must always be used when working on SRS components.
- It is imperative that before any work is undertaken on the SRS system, the appropriate information is read thoroughly.
- Always disconnect both battery cables before beginning work on the SRS system. Disconnect the ground cable first. Never reverse connect the battery.
- Take extra care when handling SRS components.

1. Make the air bag supplemental restraint system (SRS) safe.
   For additional information, refer to: Standard Workshop Practices (100-00, Description and Operation).

2. Disconnect the battery ground cable.
   For additional information, refer to: Specifications (414-00, Specifications).

3. Remove the clockspring.
   For additional information, refer to: Clockspring (501-20, Removal and Installation).

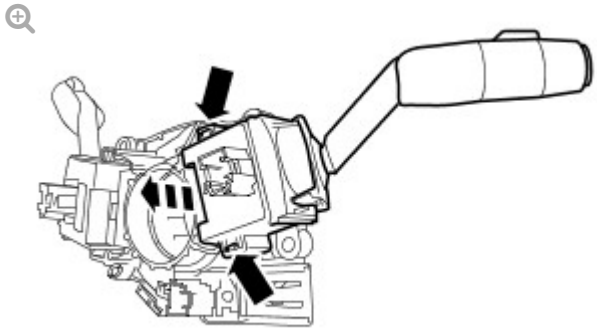
4. 

E79631

Remove the steering column control switch.

- Carefully release the clip.

5.



E79632

Remove the LH steering column multifunction switch.

- Release the 2 clips.

INSTALLATION

1. Install LH steering column multifunction switch.

2. Install the steering column control switch.

3. Install the clockspring.
   For additional information, refer to: Clockspring (501-20, Removal and Installation).

4. Connect the battery ground cable.
   For additional information, refer to: Specifications (414-00, Specifications).

2012.0 RANGE ROVER (LM), 303-00

ENGINE SYSTEM – GENERAL INFORMATION

DIAGNOSIS AND TESTING

12.90.09.01	ENGINE OIL PRESSURE CHECK	AJ V8, SUPERCHARGED	0.9	USED WITHINS	+

SPECIAL TOOL(S)

303-1451

Oil pressure testing adaptor

303-871

Oil pressure testing gauge

PRINCIPLE OF OPERATION

For a detailed description of the 5.0L engine, refer to the relevant Description and Operation sections in the workshop manual. REFER to:

Engine (303-01C Engine - V8 5.0L Petrol, Description and Operation),
Engine (303-01D Engine - V8 S/C 5.0L Petrol, Description and Operation).

INSPECTION AND VERIFICATION

1. Verify the customer concern.

1. Visually inspect for obvious signs of damage and system integrity.

Visual Inspection

MECHANICAL	ELECTRICAL
▪ Coolant leaks ▪ Oil leaks ▪ Leaks in the fuel system ▪ Visibly damaged or worn parts ▪ Loose or missing fixings	▪ Fuses ▪ Loose or corroded electrical connectors ▪ Harnesses ▪ Sensors

1. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.

1. If the concern is not visually evident, verify the symptom and refer to the Symptom Chart, alternatively check for Diagnostic Trouble Codes (DTCs) and refer to the relevant DTC Index.

SYMPTOM CHART

NOTES:

- If an engine is suspect, and the vehicle remains under the Manufacturers warranty refer to the Warranty Policy and Procedure manual (section B1.2), or determine if any prior approval programme is in operation, prior to the installation of a new engine.
- Due to the possibility of loose carbon, that has become trapped between the valve face and seat, effecting the pressure readings, when carrying out a compression test and some cylinders are found to have low pressures, install the spark plugs, road test the vehicle and re-test the suspect cylinders. If the correct pressures are restored, no further action is required.

SYMPTOM	ACTION
All engine related issues	▪ Check ECM for Diagnostic Trouble Codes (DTCs) and refer to DTC Index.
Difficult to start hot and cold	▪ Carry out general engine checks: ▪ Compression test. Refer to component tests in this section. ▪ Valve clearances ▪ Spark plug condition and color
Poor idle	▪ Ensure the air intake system is free from leaks ▪ Carry out general engine checks: ▪ Compression test. Refer to component tests in this section. ▪ Valve clearances ▪ Spark plug condition and color ▪ Check for collapsed catalytic converter/blocked exhaust system ▪ Check long and short term fuel trim datalogger signals ▪ Readings up to 10%: may be considered as acceptable if the readings are equal bank to bank ▪ Positive readings of between 10-20%: check for air leaks in air intake system ▪ Negative readings of between 10-20%: check for over fuelling e.g. leaking injectors, high fuel pressure ▪ Readings above 20%: check for DTCs and refer to DTC Index. ▪ Carry out a vacuum gauge check. Refer to component tests

	in this section

Insufficient power/Insufficient compression	▪ Ensure the air intake system is free from leaks
	▪ Carry out general engine checks:
	  ▪ Compression test. Refer to component tests in this section.
	  ▪ Valve clearances
	  ▪ Spark plug condition and color
	▪ Check for collapsed catalytic converter/blocked exhaust system
	▪ Check long and short term fuel trim datalogger signals
	  ▪ Readings up to 10%: may be considered as acceptable if the readings are equal bank to bank
	  ▪ Positive readings of between 10-20%: check for air leaks in air intake system
	  ▪ Negative readings of between 10-20%: check for over fuelling e.g. leaking injectors, high fuel pressure
	  ▪ Readings above 20%: check for DTCs and refer to DTC Index.
	▪ Carry out a vacuum gauge check. Refer to component tests in this section

Oil consumption	▪ Carry out oil leak check followed by an oil consumption test. Refer to the component tests in this section
	▪ If oil consumption is excessive:
	▪ Check the integrity of the engine breather system
	▪ Carry out general engine checks:
	  ▪ Compression test. Refer to component tests in this section.
	  ▪ Valve clearances
	  ▪ Spark plug condition and color

DTC INDEX

For a list of Diagnostic Trouble Codes (DTCs) that could be logged on this vehicle, please refer to Section 100-00. REFER to: Diagnostic Trouble Code (DTC) Index - V8 5.0L Petrol/V8 S/C 5.0L Petrol (100-00 General Information, Description and Operation).

COMPONENT TESTS

ENGINE OIL LEAKS

NOTE:

> Before installing new gaskets or oil seals, make sure that the fault is clearly established.

If the oil leak cannot be identified clearly by a visual inspection, carry out an Ultraviolet test:

FLUORESCENT OIL ADDITIVE METHOD

1. Clean the engine with a suitable cleaning fluid (brake cleaner).

1. Drain the engine oil and refill with recommended oil, premixed with Diesel Engine Oil Dye or equivalent. Use a minimum 14.8 ml (0.5 ounce) to a maximum 29.6 ml (1 ounce) of fluorescent additive to all engines. If oil is not premixed, fluorescent additive must first be added to the crankcase.

1. Run engine for 15 minutes. Stop the engine and inspect all seal and gasket areas for leaks using a 12 Volt Master UV Diagnostic Inspection Kit or equivalent. A clear bright yellow or orange area will identify leak. For extremely small leaks, several hours may be required for the leak to appear.

1. As necessary, pressurize the main oil gallery system to locate leaks due to incorrectly sealed, loose or cocked plugs. If the flywheel bolts leak oil, look for sealer on the threads.

1. Repair all leaks as necessary.

COMPRESSION TEST

GENERAL REMARKS

NOTES:

- Removing fuses and disconnecting electrical components may cause the Engine Control Module (ECM) to log Diagnostic Trouble Codes (DTCs). After the measurements have been carried out, DTCs should be cleared from memory by connecting to the Manufacturer Approved Diagnostic System.
- Only check the compression pressure with the valves set to the prescribed clearance (if this can be adjusted).

The compression pressure should be checked with the engine at normal operating temperature.

CHECK THE COMPRESSION PRESSURE

WARNING:

Move gear selector lever to 'P' position. Failure to follow this instruction may result in personal injury.

1. Remove the fuel pump relay.
1. Start the engine - the engine will start, run for a few seconds then stall.
1. Remove the spark plugs.
1. Install the compression tester.
1. Install an auxiliary starter switch in the starting circuit. With the ignition switch OFF, using the auxiliary starter switch, crank the engine a minimum of five compression strokes and record the highest reading. Note the approximate number of compression strokes required to obtain the highest reading.
1. Repeat the test on each cylinder, cranking the engine approximately the same number of compression strokes.
1. Install the removed components in reverse order, observing the specified tightening torques.
1. Clear all DTCs from the ECM.

1. Clear all DTCs from the ECM.

INTERPRETATION OF THE RESULTS

NOTE:

> Due to the possibility of loose carbon that has become trapped between the valve face and seat effecting the pressure readings, when carrying out a compression test and cylinders are found to have low pressures, install the spark plugs, road test the vehicle and re-test the suspect cylinders. If the correct pressures are restored, no further action is required.

The minimum cylinder compression reading recorded must be within 10% of the maximum cylinder compression reading recorded.

If the cylinder pressures are found to be low, carry out a leakdown test to determine the location of the fault (if any leakback can be heard through the engine breather system suspect the piston rings, if any leakback can be heard through the inlet system suspect the inlet valve or seat, if any leakback can be heard through the exhaust manifold suspect the exhaust valve or seat. If the measurements for two cylinders next to each other are both too low then it is very likely that the cylinder head gasket between them is burnt through. This can also be recognized by traces of engine oil in the coolant and/or coolant in the engine oil).

OIL CONSUMPTION TEST

The amount of oil an engine uses will vary with the way the vehicle is driven in addition to normal engine-to-engine variation. This is especially true during the first 16,100 km (10,000 miles) when a new engine is being broken in or until certain internal components become conditioned. Vehicles used in heavy-duty operation may use more oil. The following are examples of heavy-duty operation:

- Trailer towing applications
- Severe loading applications

- Sustained high speed operation

Engines need oil to lubricate the following internal components:

- Cylinder block cylinder walls
- Pistons and piston rings
- Intake and exhaust valve stems
- Intake and exhaust valve guides
- All internal engine components

When the pistons move downward, a thin film of oil is left on the cylinder walls. As the vehicle is operated, some oil is also drawn into the combustion chambers past the intake and exhaust valve stem seals and burned.

The following are examples of conditions that can affect oil consumption rates:

- Engine size
- Operator driving habits
- Ambient temperatures
- Quality and viscosity of oil
- Engine is being run in an overfilled condition (check the oil level at least five minutes after a hot shutdown with the vehicle parked on a level surface. The oil level should not be above the top of the cross-hatched area and the letter "F" in FULL).

Operation under varying conditions can frequently be misleading. A vehicle that has been run for several thousand miles on short trips or in below-freezing ambient temperatures may have consumed a "normal" amount of oil. However, when checking the engine oil level, it may measure up to the full mark on the oil level indicator due to dilution (condensation and fuel) in the engine crankcase. The vehicle then might be driven at high speeds on the highway where the condensation and fuel boil off. The next time the engine oil is checked it may appear that a liter of oil was used in about 160 km (100 miles). Oil consumption rate is about one liter per 2,400 km (1,500 miles).

Make sure the selected engine oil meets Jaguar specification and the recommended API performance category "SG" and SAE viscosity grade as shown in the vehicle Owner's Guide. It is also important that the engine oil is changed at the intervals specified for the typical operating conditions.

The following diagnostic procedure is used to determine the source of excessive oil consumption.

NOTE:

Oil use is normally greater during the first 16,100 km (10,000 miles) of service. As mileage increases, oil use decreases. High speed driving, towing, high ambient temperature and other factors may result in greater oil use.

1. Define excessive consumption, such as the number of miles driven per liter of oil used. Also determine customers driving habits, such as sustained high speed operation, towing, extended idle and other considerations.

1. Verify that the engine has no external oil leaks as described under Engine Oil Leaks in this section.

1. Carry out an oil consumption test:
    - Run the engine to normal operating temperature. Switch engine OFF and allow oil to drain back for at least five minutes .
    - With vehicle parked on level surface, check the engine oil level.
    - If required, add engine oil to set level exactly to the FULL mark.
    - Record the vehicle mileage.
    - Instruct the customer to return for a level check after driving the vehicle as usual for 1,610 km (1000 miles).
    - Check the oil level under the same conditions and at the same location as the initial check.

NOTE:

If the oil consumption rate is unacceptable go to Step 4.

1. Check the Positive Crankcase Ventilation (PCV) system. Make sure the system is not plugged.

1. Check for plugged oil drain-back holes in the cylinder head and cylinder block.

1. If the condition still exists after carrying out the above tests go to step 9.

1. Carry out a cylinder compression test. Refer to the Compression Test procedure in this section. This can help determine the source of oil consumption such as valves, piston rings or other areas.

1. Check valve guides for excessive guide clearance. Install new valve stem seals after verifying valve guide clearance.

1. Worn or damaged internal engine components can cause excessive oil consumption. Small deposits of oil on the tips of the spark plugs can be a clue to internal oil consumption.

INTAKE MANIFOLD VACUUM TEST

Bring the engine to normal operating temperature. Connect a vacuum gauge or equivalent to the intake manifold. Run the engine at the specified idle speed.

The vacuum gauge should read between 51-74 kPa (15-22 in-Hg) depending upon the engine condition and the altitude at which the test is performed. Subtract 4.0193 kPa (1 in-Hg) from the specified reading for every 304.8 m (1,000 feet) of elevation above sea level.

The reading should be steady. As necessary, adjust the gauge damper control (where used) if the needle is fluttering rapidly. Adjust damper until needle moves easily without excessive flutter.

INTERPRETING VACUUM GAUGE READINGS

A careful study of the vacuum gauge reading while the engine is idling will help pinpoint trouble areas. Always conduct other appropriate tests before arriving at a final diagnostic decision. Vacuum gauge readings, although helpful, must be interpreted carefully.

Most vacuum gauges have a normal band indicated on the gauge face.

The following are potential gauge readings. Some are normal; others should be investigated further.

1. NORMAL READING: Needle between 51-74 kPa (15-22 in-Hg) and holding steady.

1. NORMAL READING DURING RAPID ACCELERATION: When the engine is rapidly accelerated, the needle will drop to a low (not to zero) reading. When the throttle is suddenly released, the needle will snap back up to a higher than normal figure.

1. NORMAL FOR HIGH-LIFT CAMSHAFT WITH LARGE OVERLAP: The needle will register as low as 51 kPa (15 in-Hg) but will be relatively steady. Some oscillation is normal.

1. WORN RINGS OR DILUTED OIL: When the engine is accelerated, the needle drops to 0 kPa (0 in-Hg). Upon deceleration, the needle runs slightly above 74 kPa (22 in-Hg).

1. STICKING VALVES: When the needle remains steady at a normal vacuum but occasionally flicks (sharp, fast movement) down and back about 13 kPa (4 in-Hg), one or more valves may be sticking.

1. BURNED OR BENT VALVES: A regular, evenly-spaced, downscale flicking of the needle indicates one or more burned or damaged valves. Insufficient hydraulic valve tappet or hydraulic lash adjuster clearance will also cause this reaction.

1. POOR VALVE SEATING: A small but regular downscale flicking can

mean one or more valves are not seating correctly.

1. WORN VALVE GUIDES: When the needle oscillates over about a 13 kPa (4 in-Hg) range at idle speed, the valve guides could be worn. As engine speed increases, the needle will become steady if guides are responsible.

1. WEAK VALVE SPRINGS: When the needle oscillation becomes more violent as engine RPM is increased, weak valve springs are indicated. The reading at idle could be relatively steady.

1. LATE VALVE TIMING: A steady but low reading could be caused by late valve timing.

1. IGNITION TIMING RETARDED: Retarded ignition timing will produce a steady but somewhat low reading.

1. INSUFFICIENT SPARK PLUG GAP: When spark plugs are gapped too close, a regular, small pulsation of the needle can occur.

1. INTAKE LEAK: A low, steady reading can be caused by an intake manifold or throttle body gasket leak.

1. BLOWN HEAD GASKET: A regular drop of fair magnitude can be caused by a blown head gasket or warped cylinder head to cylinder block surface.

1. RESTRICTED EXHAUST SYSTEM: When the engine is first started and is idled, the reading may be normal, but as the engine RPM is increased, the back pressure caused by a clogged muffler, kinked tail pipe or other concerns will cause the needle to slowly drop to 0 kPa (0 in-Hg). The needle then may slowly rise. Excessive exhaust clogging will cause the needle to drop to a low point even if the engine is only idling.

When vacuum leaks are indicated, search out and correct the cause. Excess air leaking into the system will upset the fuel mixture and cause concerns such as rough idle, missing on acceleration or burned valves. If the leak exists in an accessory such as the power brake booster, the unit will not function correctly. Always repair vacuum leaks.

ENGINE OIL PRESSURE CHECK

NOTE:

Prior to checking the engine oil pressure, a road test of 6 miles (10 kilometres), must be carried out. Do not attempt to attain engine normal operating temperature by allowing the engine to idle.

1. Disconnect the battery ground cable. Refer to section 414-00 - Charging System - General Information of the workshop manual

WARNINGS:

- The spilling of hot engine oil is unavoidable during this procedure, care must be taken to prevent scalding.
- Wear protective gloves.

1. Remove the engine oil filter element
   REFER to: Oil Filter Element (303-01C Engine - V8 5.0L Petrol, Removal and Installation).

NOTE:

Ensure the oil filter element is not contaminated during this procedure

1. Install the oil filter element into special tool (Oil filter adapter number 303-1451)

1. Install the special tool (Oil filter adapter number 303-1451) to the engine. Torque: 25 Nm

1. Install the special tool (Oil pressure testing gauge, 303-871) and tighten the union

1. Connect the battery ground cable

1. Refer to owner hand book, check and top-up the engine oil if required

1. Start and run the engine

1. Note the oil pressure readings with the engine running at idle and 3500 RPM

1. Turn off the engine

1. Disconnect the battery ground cable

1. Remove the special tools
    1. Clean the components

1. Install the engine oil filter element
   REFER to: Oil Filter Element (303-01C Engine - V8 5.0L Petrol, Removal and Installation).

NOTE:

Ensure the oil filter element is not contaminated during this procedure

1. Connect the battery ground cable

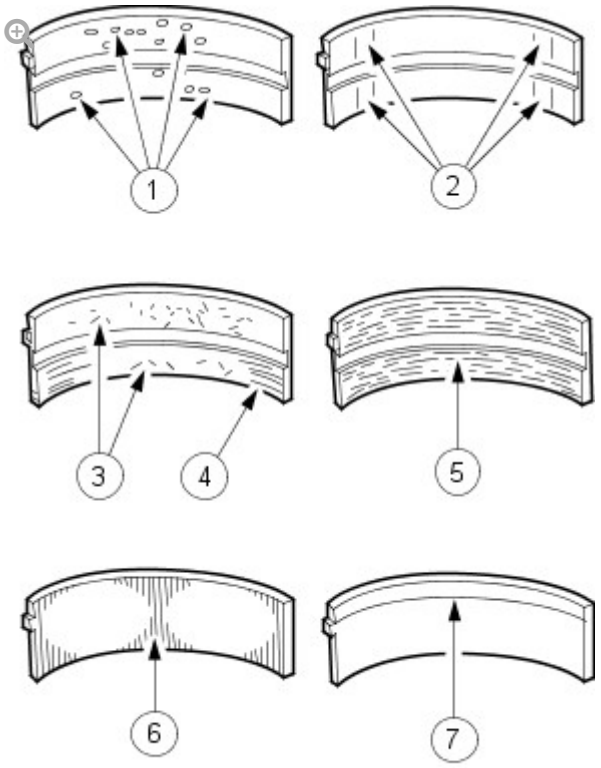
1. Refer to owner hand book, check and top-up the engine oil if required

2012.0 RANGE ROVER (LM), 303-00

ENGINE SYSTEM – GENERAL INFORMATION

BEARING INSPECTION (G61255)

1.



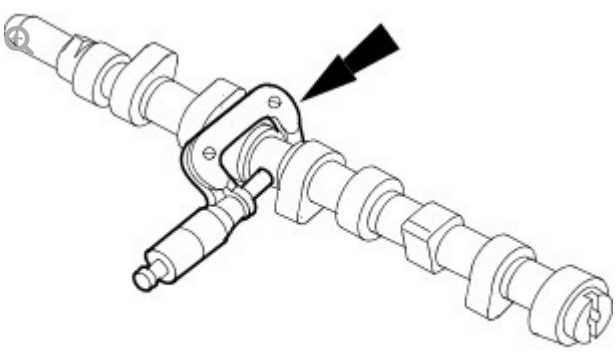
Inspect bearings for the following defects.

1. Cratering - fatigue failure
2. Spot polishing - incorrect seating.
3. Imbedded dirt engine oil.
4. Scratching - dirty engine oil.
5. Base exposed - poor lubrication.
6. Both edges worn - journal damaged.
7. One edge worn - journal tapered or bearing not seated.

CAMSHAFT BEARING JOURNAL DIAMETER (G61234)

GENERAL PROCEDURES

1.



VUJ0001695

Determine the diameter of the camshaft journals.

- Using a micrometer measure the diameter at 90 degrees intervals to determine if the journals are out-of-round.
- Measure at two different points on the journal to determine if there is any tapering.
- If the measurements are out of the specified range, install a new camshaft.

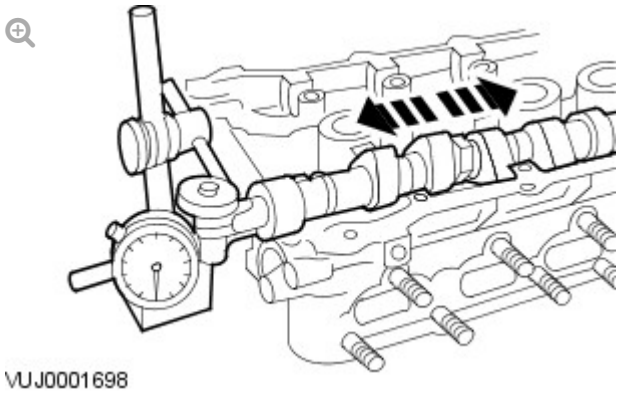
ENGINE SYSTEM – GENERAL INFORMATION

CAMSHAFT END PLAY (G61236)

GENERAL PROCEDURES

1. **NOTE:**

   Make sure that the camshaft is to specification.



Using the special tool, measure the end play.

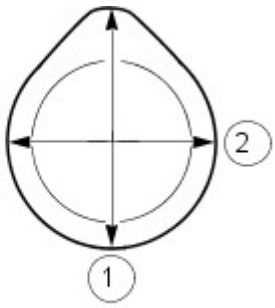
- Slide the camshaft in both directions. Read and note the maximum and minimum values on the dial indicator gauge.
  - End play = maximum value minus minimum value.
- If the measurement is out of specification, install new components.

2012.0 RANGE ROVER (LM), 303-00

ENGINE SYSTEM – GENERAL INFORMATION

CAMSHAFT LOBE LIFT (G61238)

1.



VUJ0001699

Measure the diameter (1) and diameter (2) with a vernier caliper.

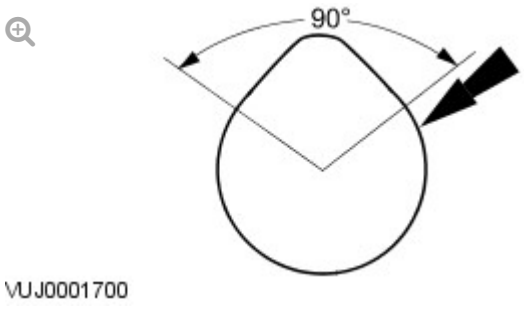
The difference in measurements is the lobe lift.

ENGINE SYSTEM – GENERAL INFORMATION

CAMSHAFT SURFACE INSPECTION (G61237)

GENERAL PROCEDURES

1.



Inspect camshaft lobes for pitting or damage in the active area.

Minor pitting is acceptable outside the active area.

CONNECTING ROD CLEANING

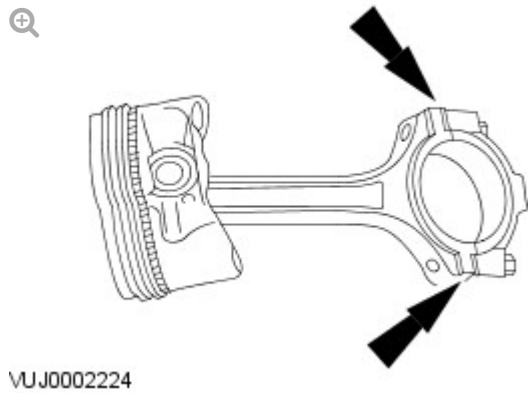
(G61251)

GENERAL PROCEDURES

1.

CAUTION:

Do not use a caustic cleaning solution or damage to connecting rods may occur.



VUJ0002224

Mark and separate the parts and clean with solvent. Clean the oil passages.

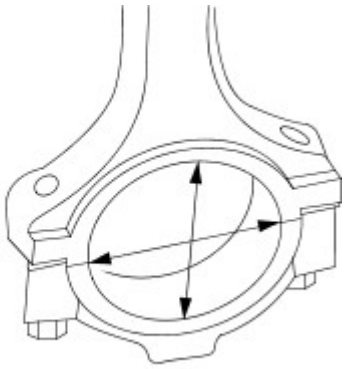
2012.0 RANGE ROVER (LM), 303-00

ENGINE SYSTEM – GENERAL INFORMATION

CONNECTING ROD LARGE END BORE (G61252)

GENERAL PROCEDURES

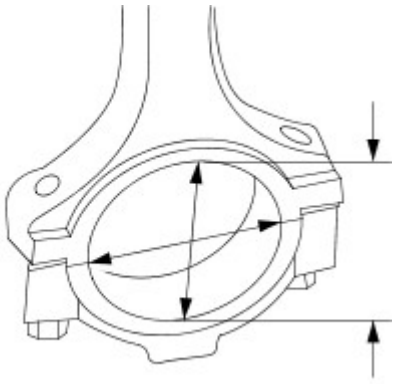
1.



VUJ0002223

Measure the bearing bore in two directions. The difference is the connecting rod bore out-of-round. Verify the out-of-round is within specification.

2.



VUJ0002222

Measure the bearing bore diameter in two directions. Verify the bearing bore is within specification.

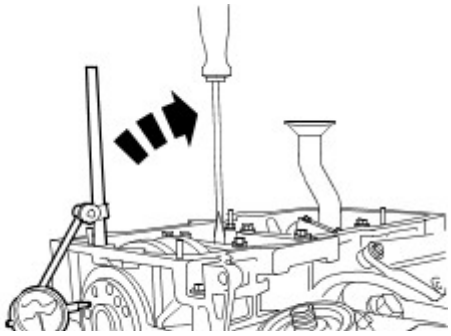
2012.0 RANGE ROVER (LM), 303-00

ENGINE SYSTEM – GENERAL INFORMATION

CRANKSHAFT END PLAY (G61242)

GENERAL PROCEDURES

1.



Using the Dial Indicator Gauge with Brackets, measure the end play.

- Measure the end play by lifting the crankshaft using a lever.
- If the value is out of the specification, install new thrust half rings to take up the end float and repeat the measurement.

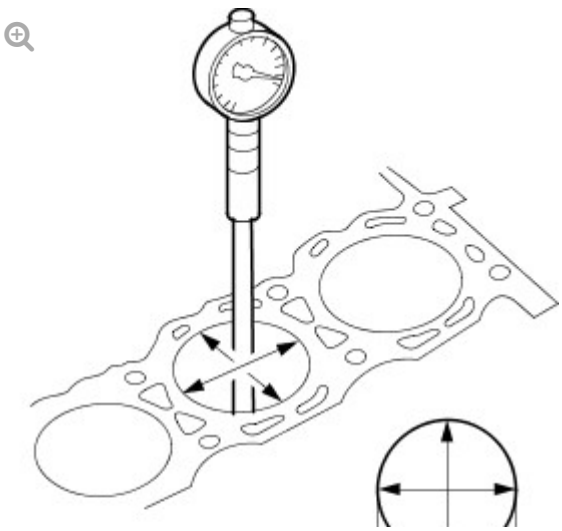
CYLINDER BORE OUT-OF-ROUND (G61243)

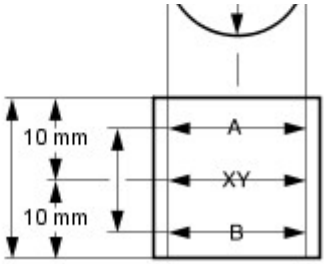
GENERAL PROCEDURES

1.

NOTE:

The main bearing caps or lower crankcase must be in place and tightened to the specified torque; however, the bearing shells should not be installed.





VUJ0002234

Measure the cylinder bore with an internal micrometer.

- Carry out the measurements in different directions and at different heights to determine if there is any out-of-roundness or tapering.
- If the measurement is out of the specified range, hone out the cylinder block or install a new block.

EXHAUST MANIFOLD CLEANING AND INSPECTION

(G61240)

GENERAL PROCEDURES

1. Inspect the cylinder head joining flanges of the exhaust manifold for evidence of exhaust gas leaks.

2. Inspect the exhaust manifold for cracks, damaged gasket surfaces, or other damage that would make it unfit for further use.

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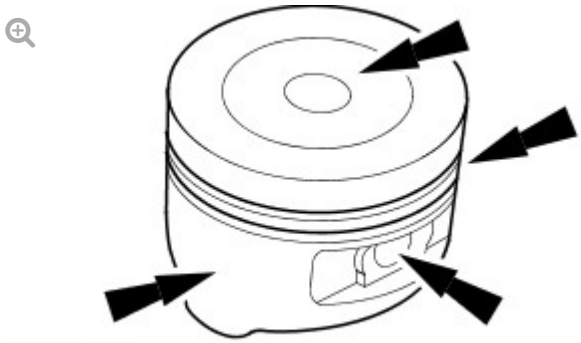
ENGINE SYSTEM – GENERAL INFORMATION

PISTON INSPECTION (G61244)

GENERAL PROCEDURES

1. **CAUTION:**

   Do not use any aggressive cleaning fluid or a wire brush to clean the piston.



VUJ0002233

Carry out a visual inspection.

- Clean the piston skirt, pin bush, ring grooves and crown and check for wear or cracks.
- If there are signs of wear on the piston skirt, check whether the connecting rod is twisted or bent.

ENGINE SYSTEM – GENERAL INFORMATION

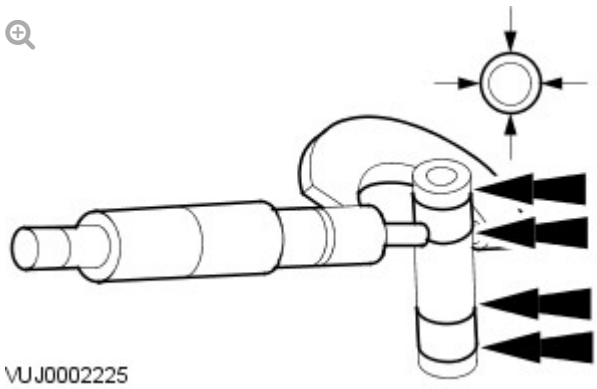
PISTON PIN DIAMETER (G61250)

GENERAL PROCEDURES

1.

NOTE:

The piston and piston pin are a matched pair. Do not mix up the components.



Measure the piston pin diameter.

- Measure the diameter in two directions.

- If the values are not to specification, install a new piston and a new piston pin.

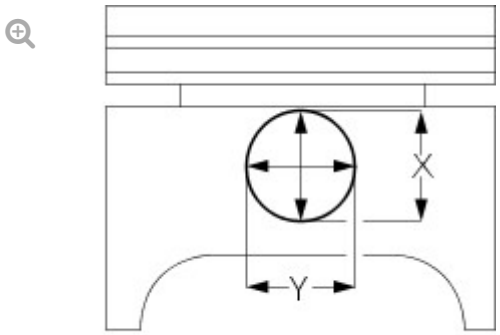
PISTON PIN TO BORE DIAMETER (G61245)

GENERAL PROCEDURES

1.

NOTE:

The piston and piston pin form a matched pair. Do not mix up the components.



VUJ0002232

Measure the diameter of the piston pin bore.

- Measure the diameter in two directions.
- If the values are not to specification, install both a new piston and a new piston pin.

ENGINE SYSTEM – GENERAL INFORMATION

PISTON RING END GAP (G61248)

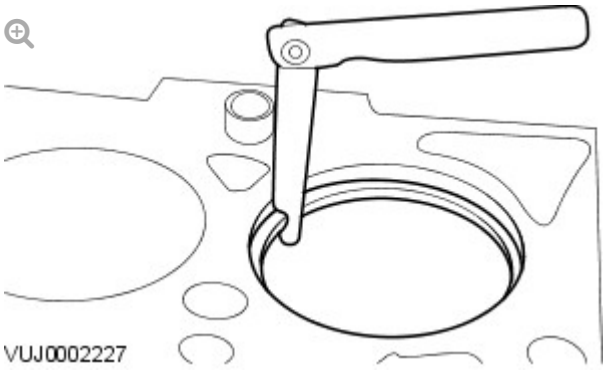
GENERAL PROCEDURES

1.

CAUTION:

Do not mix up the piston rings. Install the piston rings in the

Do not mix up the piston rings. Install the piston rings in the same position and location.



Using the Feeler Gauge, measure the piston ring gap.

- The values given in the specification refer to a gauge ring used during production.

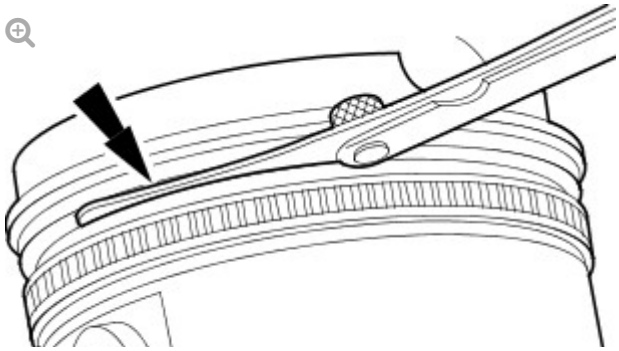
ENGINE SYSTEM - GENERAL INFORMATION

PISTON RING-TO-GROOVE CLEARANCE (G61249)

GENERAL PROCEDURES

1. **NOTE:**

   The piston ring must protrude from the piston groove. To determine the piston ring clearance, insert the Feeler Gauge right to the back of the groove, behind the wear ridge.



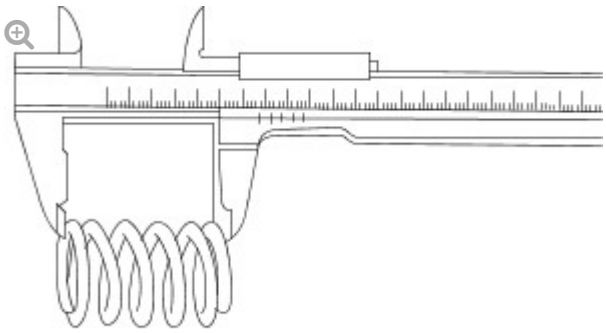
Using the Feeler Gauge, measure the piston ring clearance.

VALVE SPRING FREE LENGTH

(G61254)

GENERAL PROCEDURES

1.



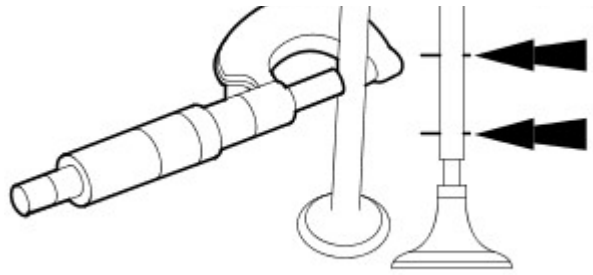
VUJ0002221

Using a vernier gauge, measure the free length of each valve spring. Verify the length is within specification.

VALVE STEM DIAMETER (G61253)

GENERAL PROCEDURES

1.



VUJ0002220

Using a micrometer measure the diameter of the valve stems.

- If the measurements are not to specification, install a new valve.

LEAKAGE TEST USING SMOKE TEST EQUIPMENT

(G1445299)

GENERAL PROCEDURES

CAUTION:

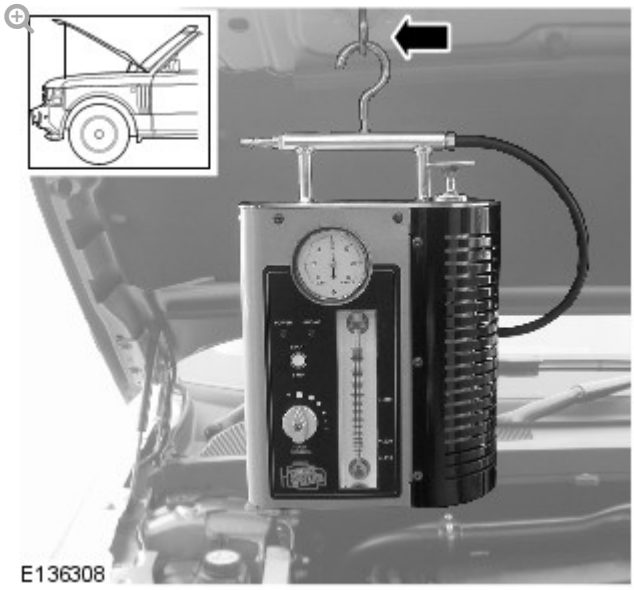
The compressed air line supply pressure must be between 3.5 and 12 bar (50 and 175 psi) for the smoke test equipment to function correctly. Do not exceed this pressure. Failure to follow this instruction may result in damage to the smoke test equipment.

NOTES:

- The vehicle battery must be in good condition and fully charged before carrying out this procedure.
- On vehicles with 3.0L TDV6, it will be necessary to insert smoke at both air cleaner outlet pipes independently if the right hand turbocharger and associated hoses are to be tested.
- In some cases it may be necessary to remove undertrays, trim or engine covers to obtain access to all potential leak locations.
- Some variation in the illustrations may occur, but the essential information is always correct.
- For further information regarding operation of the test equipment refer to the manufacturers operators manual supplied with the kit.

1. **WARNING:**

   Use an additional support to prevent the hood from falling if the smoke test equipment is secured to the hood. Failure to follow this instruction may result in personal injury.



   Install the smoke test equipment to a suitable location under the hood.

2. Connect a suitable compressed air line to the smoke test

equipment.

3. Connect the smoke test equipment positive power cable to the battery positive terminal.

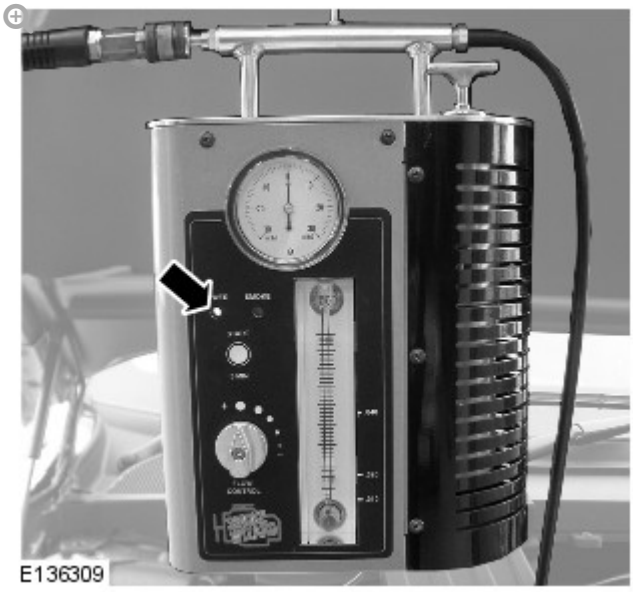
4. **WARNING:**

> Do not connect the smoke test equipment negative cable to the battery negative terminal.

Connect the smoke test equipment negative cable to a suitable body ground point.

5. **NOTE:**

> A flashing green light indicates low battery voltage. In this case, place the battery on charge and make sure that the battery is fully charged before using the smoke test equipment.

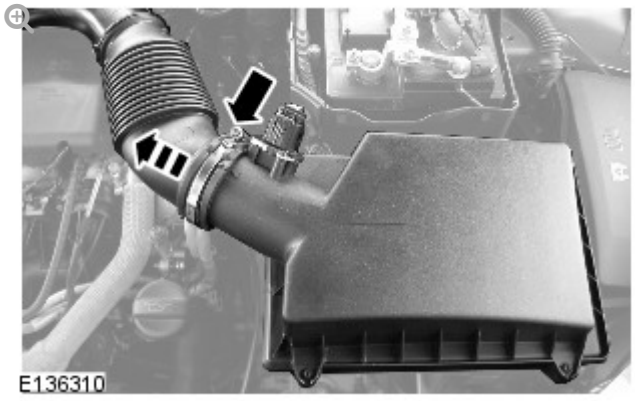


Observe the power indicator lamp on the smoke test equipment. Make sure that a continuous green light is displayed.

6.

NOTES:

- In some cases it may be necessary to remove the air cleaner(s) to allow access to the air cleaner outlet pipes.
- In some cases it will be necessary to cap one of the air cleaner outlet pipes. Use the blanking caps supplied in the kit to cap the open orifice.

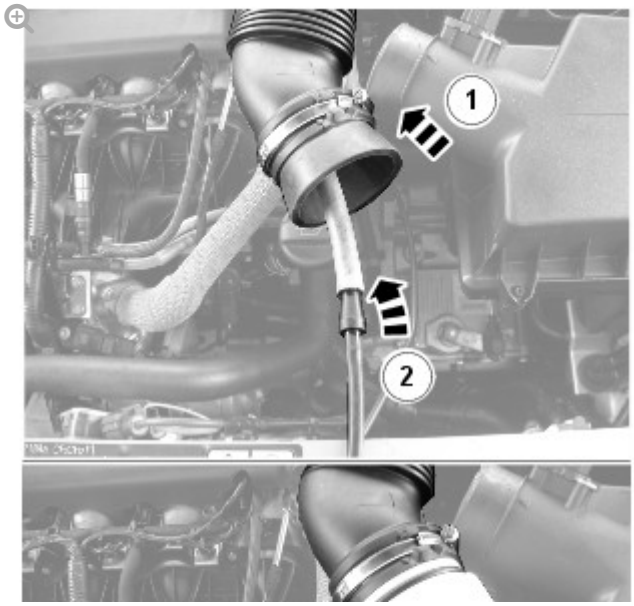


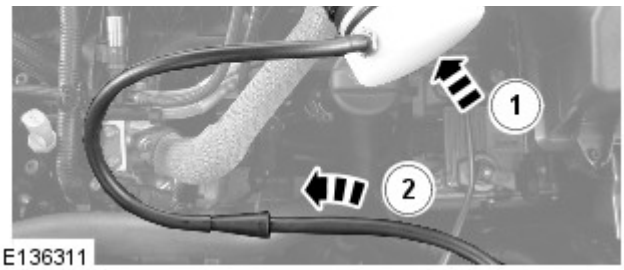
Disconnect the air cleaner outlet pipe(s).

7.

NOTE:

Make sure the smoke test equipment adapter is a good fit to the air cleaner outlet pipe. This must be an air tight seal.





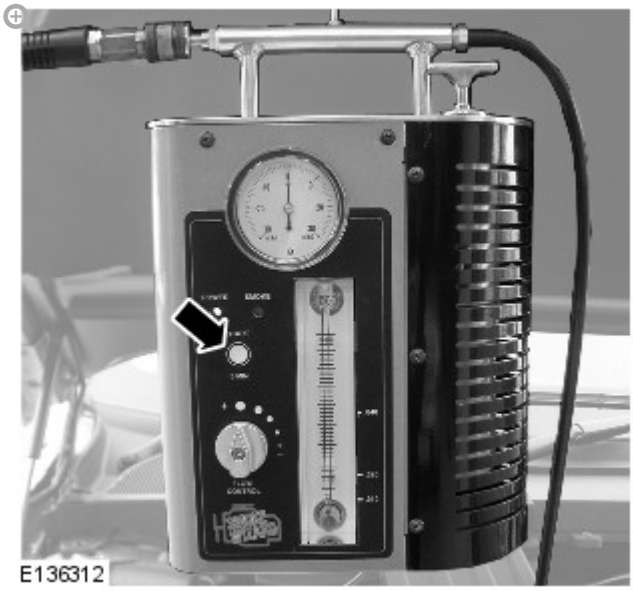
Connect the smoke test equipment supply hose to the air cleaner outlet pipe.

1. Install the appropriate adapter to the air cleaner outlet pipe.
2. Connect the smoke test equipment supply hose to the adapter link hose.

8.

NOTES:

- The flow control valve must be in the fully open position.
- Smoke is produced for 5 minutes. The smoke test equipment will automatically switch off after this period of time.



Switch the smoke test equipment on.

9. Remove the oil filler cap, and observe until a constant flow of smoke is visible leaving the oil filler orifice. Install the oil filler cap.

10.

NOTE:

> The longer smoke is allowed to exit from a leak, the more fluorescent dye will be deposited at a leak location.

Using the torch supplied in the kit set to white light, look for escaping smoke. Alternatively, use the ultraviolet light to look for fluorescent dye deposits at the source of a leak.

ENGINE SYSTEM – GENERAL INFORMATION

CYLINDER HEAD DISTORTION

(G1676086)

GENERAL PROCEDURES

CHECK

1. 

   Using a suitable metallic straight edge and feeler gauge, measure the cylinder head face in the areas illustrated. **Note the maximum value**.

2. **CAUTION:**

   Machine the **minimum** thickness of material from the cylinder head to meet specification. If a selection of cylinder head gaskets are available, increase the thickness of the cylinder head gasket by one size.

   NOTES:

   - Prior to having the cylinder head machined, prior approval is required by Jaguar or Land Rover engineering.
   - If the cylinder head requires machining, this must be carried out by a local engineering company.

If the cylinder head exceeds the maximum value (0.2mm), the cylinder head must be machined.

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ENGINE SYSTEM – GENERAL INFORMATION

CYLINDER COMPRESSION TEST – V8 S/C 5.0L PETROL

(G1770716)

12.25.01	CYLINDERS PRESSURES – CHECK	5000 CC, AJ V8, SUPERCHARGED	1.2	USED WITHINS	+

CHECK

CAUTION:

Before disconnecting or removing components, make sure the area around the joint faces and connections are clean. Plug open connections to prevent contamination.

NOTES:

- Removal steps in this procedure may contain installation details.
- Some variation in the illustrations may occur, but the essential information is always correct.
- The vehicle battery must be in good condition and fully charged before carrying out this procedure.

1. Refer to: Ignition Coil-On-Plug (303-07A Engine Ignition - V8 5.0L Petrol/V8 S/C 5.0L Petrol, Removal and Installation).

2. **CAUTION:**

   Make sure the fuel injection system is disabled before carrying out a cylinder compression test. Failure to follow this step may result in damage to the vehicle.

Repeat procedure for the other side.

3. Crank engine for approximately five seconds to remove any remaining fuel in the cylinders.

4. **NOTE:**

> Dry cylinder compression test.

Install the compression test gauge.

5. **NOTES:**

> - This step requires the aid of another technician.
> - Print graphic number E164747 in step 11. Use this graphic to record each cylinder compression figure.
> - The vehicle battery must be in good condition and fully charged before carrying out this procedure.

Crank the engine for 10 seconds and record the figure displayed on the compression test gauge. Make sure the pressure is released from the compression test gauge after each cylinder recording. Repeat the process for all cylinders.

6. 

Remove the compression test gauge.

7. **NOTE:**

Wet cylinder compression test.

Using a suitable syringe add 10 ml of clean engine oil into the cylinder.

8. 

Install the compression test gauge.

9. **NOTES:**

- This step requires the aid of another technician.
- Print graphic number E164747 in Step 11. Use this graphic to record each cylinder compression figure.
- The vehicle battery must be in good condition and fully charged before carrying out this procedure.

Crank the engine for 10 seconds and record the figure displayed on the compression test gauge. Make sure the pressure is released from the compression test gauge after each cylinder recording. Repeat the process for all cylinders.

10. After each wet cylinder compression test remove the compression test gauge and crank engine for approximately 10 seconds to remove engine oil from the cylinder.

11. **NOTES:**

- A= dry cylinder compression test.
- B= wet cylinder compression test

- B= wet cylinder compression test.

12. **NOTE:**

    Remove and discard all blanking caps.

    To install, reverse the removal procedure.

13. The minimum cylinder compression reading recorded must be within 10% of the maximum cylinder compression reading recorded. If the difference across the cylinders is higher than 10% please contact dealer technical support (DTS) for further assistance.

14. Using Land Rover approved diagnostic equipment, read and clear any diagnostic trouble codes (DTCs).

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ENGINE – V8 S/C 5.0L PETROL

SPECIFICATIONS

Engine Data

ENGINE DESCRIPTION	ENGINE CAPACITY	MAXIMUM ENGINE TORQUE (EEC)	MAXIMUM ENGINE POWER (EEC)	COMPRESSION RATIO	BORE	STROKE
• 90° "Vee" • 8 Cylinder • 32 Valves	4.999 ccm	625 Nm at 2.500 - 5.500 RPM	375 kW at 6.000 - 6.500 RPM	9.5 ± 0.50	92.5 mm	93 mm

Engine Firing Order

FIRING ORDER
1:2:7:3:4:5:6:8

Engine Valve Clearance (cold)

INTAKE VALVE	EXHAUST VALVE
0.20 ±0.02	0.25 ±0.02

Spark Plugs

SPECIFICATION	SPARK PLUG GAP
ILKR6C-10	1 mm

Lubricants, Fluids, Sealers and Adhesives

DESCRIPTION	SPECIFICATION
Engine Oil	WSS-M2C925-A
Sealant	WSE-M4G323-A6
Core plug and stub pipe retainer	WSK-M2G349-A7

Capacities

DESCRIPTION	LITERS
Engine oil, initial fill	9.65
Engine oil, service fill with oil filter change	8.0

Cylinder Head and Valve Train

ITEM	SPECIFICATION
Cylinder head maximum permitted warp (mm) (flatness specification)	0.2
Valve guide inner diameter (mm)	5.51 ± 0.01
Intake valve effective length (mm) (tip to gauge line)	117.21 ± 0.1
Exhaust valve effective length (mm) (tip to gauge line)	94.39 ± 0.1
Valve stem to guide clearance intake diametrical (mm)	0.022 - 0.057
Valve stem to guide clearance exhaust diametrical (mm)	0.03 - 0.065
Valve head diameter intake (mm)	36 ± 0.1

Valve head diameter exhaust (mm)	30 ± 0.1
Intake valve face angle (degrees)	44.875 ± 0.125
Exhaust valve face angle (degrees)	44.875 ± 0.125
Valve stem diameter intake (mm)	5.4705 ± 0.0075
Valve stem diameter exhaust (mm)	5.4625 ± 0.0075
Valve spring free length (mm) - inlet	46.1
Valve spring free length (mm) - exhaust	46.1
Valve spring installed height (mm) - inlet	35.74
Valve spring installed height (mm) - exhaust	35.1
Camshaft lobe lift intake (mm)	10
Camshaft lobe lift exhaust (mm)	9.36
Camshaft journal to cylinder head bearing surface clearance diametrical (mm)	0.025 - 0.065
Camshaft journal diameter - all positions	26.965 ± 0.01
Bearing diameter - all positions	27.01 ± 0.01
Camshaft journal maximum run out limit (mm)	
Camshaft journals to end journals	0.03
Camshaft journals to adjacent journals	0.015
Camshaft journal maximum out of round (mm) - all journals	0.005

Torque Specifications

NOTE:

A = Refer to procedure for correct torque sequence.

DESCRIPTION	NM	LB-FT	LB-IN
Engine cover mounting bolts	10	7	88
Accessory drive belt tensioner retaining bolt	40	30	354
Supercharger belt idler/tensioner bracket retaining bolts	25	18	221
Secondary drive belt idler retaining bolts	40	30	354

Power steering pump pulley retaining bolts	25	18	221
Power steering pump retaining bolts	25	18	221
Power steering pump bracket to engine retaining bolts	25	18	221
Generator retaining bolts	48	35	425
Starter motor retaining bolts	40	30	354
Air conditioning compressor retaining bolts	25	18	221
Engine mounting to engine mounting bracket retaining nuts	100	74	885
Engine mounting to subframe retaining bolts	56	41	496
Engine mounting bracket to engine retaining bolts	45 + 60°	33 + 60°	398 + 60°
Crankshaft damper pulley retaining LH threaded bolt	200 + 270°	148 + 180°	1770 + 270°
Flexplate retaining bolts	45 + 90°	33 + 90°	398 + 90°
Exhaust manifold heat shield retaining bolts	**A**	-	-
Exhaust manifold retaining bolts	**A**	-	-
Engine wiring harness bracket retaining bolts	10	7	88
Coolant outlet pipe	10	7	88
Intercooler retaining bolts	25	18	221
Oil Cooler retaining bolts	13	10	115
Knock sensor (KS) retaining bolt	20	14	177
Ignition coil retaining bolts	8	-	71
Spark plugs	20	15	177
Fuel rail retaining bolts	**A**	-	-
High pressure fuel pipe retaining bolts	**A**	-	-
High pressure fuel pump retaining bolts	12	9	106
Oil filter housing assembly retaining bolts	12	9	106
Oil filter cap	25	18	221
Lifting eye bolts	25 + 90°	18 + 90°	221 + 90°
Manifold absolute pressure and temperature (MAPT) sensor sensor retaining bolts	5	-	44

Coolant pump retaining bolts	12	9	106
Variable valve timing (VVT) oil control solenoid retaining bolts	10	7	88
Camshaft position (CMP) sensor retaining bolts	10	7	88
Camshaft cover retaining bolts	13	10	115
Front upper timing cover retaining bolts	12	9	106
Front lower timing cover retaining bolts	**A**	-	-
Engine rear cover retaining bolts	**A**	-	-
VVT to camshaft retaining bolts	32	24	283
Camshaft bearing caps retaining bolts	11	8	97
Primary timing chain fixed guide retaining bolts	12	9	106
Primary timing chain tensioner retaining bolts	12	9	106
Primary timing chain tensioner guide blade retaining bolts	25	18	221
Auxiliary chain tensioner guide retaining bolts	21	15	186
Auxiliary chain fixed guide retaining bolt	12	9	106
Oil pump sprocket retaining bolt	21	15	186
Cylinder head retaining bolts	**A**	-	-
Engine oil level (EOL) sensor retaining bolt	12	9	106
Crankshaft position (CKP) sensor retaining bolt	10	7	88
Oil sump body to engine retaining bolts	25	18	221
Oil pan drain plug	24	18	212
Oil transfer tube to Oil pan body retaining bolts	11	8	97
Oil pump to engine block retaining bolts	25	18	221
Pick-up pipe to oil pump retaining bolts	12	9	106
Windage tray retaining bolts	25	18	221
Piston cooling jet retaining bolts	12	9	106
Engine block coolant draining plug	50	37	442
Cooling fan pulley	25	18	221
Connecting Rod bolts			
Stage 1	10	7	88

Stage 2	50	37	442
Main bearing cap			
M10 bolt Stage 1	25	18	221
M10 bolt Stage 2	57 + 70°	42 + 70°	504 + 70°
M8 bolt Stage 1	15	11	133
M8 bolt Stage 2	33 + 75°	24 + 75°	292 + 75°