PUBLISHED: 10-SEP-2014
2011.75 XJ RANGE (X351), 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 X152, X351;

For Power Steering Calibration DTCs on X152, X351 -

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

For Power Steering Solenoid (Actuator) DTCs on X150, X250;

For Power Steering Calibration DTCs on X150, X250 -

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 **K.**
	▪ 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 **O.**
	▪ 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 **O.**
	▪ 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 **M.**
▪ 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 **K.**
	▪ 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 **O.**
	▪ 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	▪ Refer to the Power Steering Pump/Steering Rack Noise - System Fluid Leak Checks pinpoint tests below GO to Pinpoint Test **F.**

	▪ Low power steering fluid level ▪ Aerated fluid ▪ Low power steering pump pressure	
▪ 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

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	

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

	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.**

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 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 D2 .
D2: LOCATION OF THE STEERING RACK LEAK - LEAKS FROM THE STEERING GEAR BOOTS	
	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
	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 D3 .
D3: 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** GO to D4 .
D4: LOCATION OF THE STEERING RACK LEAK - LEAKS FROM STEERING RACK 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 steering rack input shaft seal? **Yes** Replace the steering rack **No** 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 J.
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 J.
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 **J.** 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 **I.**
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 **J.** 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 **J.** 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 **J.** 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.**

PINPOINT TEST I : POWER STEERING PUMP/STEERING RACK NOISE - NOISE SPECIFIC DIAGNOSTICS (CLONK, KNOCK, RATTLE, CREAK)	
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 a clonk, knock, rattle or creak? **Yes** GO to I2 .

I2: STEERING RACK BOLT CHECKS	
	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 J. 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 J : POWER STEERING PUMP/STEERING RACK NOISE - FINAL CHECKS	
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
J1: 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 K : HEAVY STEERING/STEERING HAS UNEVEN EFFORT - SYSTEM FLUID LEAK CHECKS	
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
K1: 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 L. **No** GO to Pinpoint Test L.

PINPOINT TEST L : HEAVY STEERING/STEERING REQUIRES UNEVEN EFFORT - CHECK FOR FLUID RESERVOIR BLOCKAGES	
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
L1: 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 **M.** **No** GO to Pinpoint Test **N.**

PINPOINT TEST M : HEAVY STEERING/STEERING REQUIRES UNEVEN EFFORT - REPLACE FLUID RESERVOIR	
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
M1: 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 **N.** **No** When all remedial actions have been completed, perform final checks for heavy or uneven steering effort GO to Pinpoint Test **P.**

PINPOINT TEST N : HEAVY STEERING/STEERING REQUIRES UNEVEN EFFORT - POWER STEERING SYSTEM HOSE ROUTING /INTEGRITY CHECKS	
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
N1: 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 **P.** If fault is still evident, proceed to power steering system pressure checks, **GO to N2** . **No** **GO to N2** .
N2: 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 **O.** **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 **P.** If fault is still evident, proceed to power steering solenoid checks, GO to Pinpoint Test **O.**

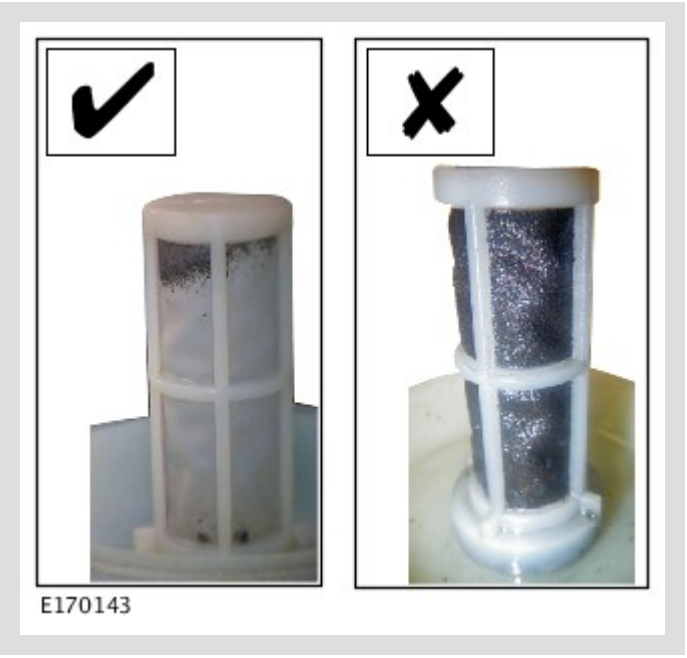
PINPOINT TEST O : HEAVY STEERING/STEERING REQUIRES UNEVEN EFFORT - POWER STEERING SOLENOID CHECKS	
TEST CONDITIONS	**DETAILS/RESULTS/ACTIONS**
O1: CHECK THE OPERATION OF THE POWER STEERING SOLENOID	
	1 Using the manufacturer approved diagnostic system, check for related DTCs and refer to the relevant 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 **P.** If fault is still evident, **GO to O2** .
O2: 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 **P.**

PINPOINT TEST P : HEAVY STEERING/STEERING REQUIRES UNEVEN EFFORT - FINAL CHECKS	
TEST CONDITIONS	**DETAILS/RESULTS/ACTIONS**
P1: 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

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.

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.

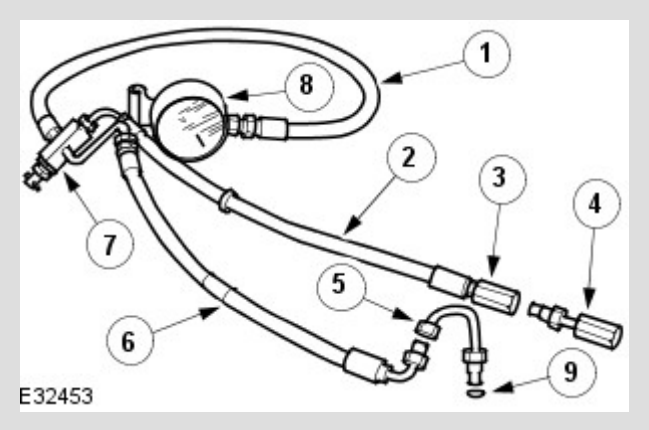
POWER STEERING FLUID CONDITION CHECK

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 dark reddish, not brown or black
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

TEST EQUIPMENT



ITEM	PART NUMBER	DESCRIPTION
1	211-011	Pressure gauge hose
2	211-011-08	Pump return hose
3	211-011-07	Pump return hose connector
4	211-011-03/2	Test equipment to high pressure hose adaptor
5	211-011-03/1	Pump high pressure outlet to hose adaptor
6	211-011-02	Pump adaptor to control valve hose
7	211-011-01	Control valve
8	211-011	Pressure gauge
9	-	'O' ring seal

The measurement of the maximum system pressure, (which is governed by the pressure relief valve) is achieved by inserting the service tool (pressure gauge and adaptors) into the fluid circuit of the power steering system. Run the engine at idle speed, turn the steering from lock to lock and read the maximum pressure recorded on the gauge

INSTALLING TEST EQUIPMENT

To install the pressure test equipment:

- Place a suitable drain tray below the power steering pump
- Install a hose clamp on the reservoir to pump hose prior to disconnecting any hoses, to avoid unnecessary loss of fluid

- Disconnect the hose from the power steering pump high pressure outlet
- Install the pump outlet to hose adaptor (5). Do not omit the 'O' ring seal (9)
- Connect the power steering pump adaptor to control valve hose (6) of the test equipment
- Install the adaptor (4) in the high pressure hose previously removed from the power steering pump outlet
- Connect the connector (3) of the test equipment hose (2) to the adaptor (4)
- Remove the hose clamp from the reservoir hose
- Start the engine to check the system pressure

With the control valve (7) OPEN and the engine idling, the following system pressures may be checked:

- During turning when static (dry parking pressure)
- When the steering is held on full lock (maximum system pressure or pressure relief)
- With the steering at rest (idle pressure or back pressure)

CAUTIONS:

- To avoid excessive heating of the power steering pump when checking the pressure, do not close the valve for more than 5 seconds maximum.
- When checking the pump pressure DO NOT drive the vehicle with the test equipment installed.

With the control valve (7) CLOSED the power steering pump maximum output pressure can be checked

REMOVING TEST EQUIPMENT

To remove the test equipment:

- Install a hose clamp on the reservoir to power steering pump hose
- Removing the test equipment is a reversal of the installation instructions
- Install a new 'O' ring seal (9) to the power steering pump high pressure outlet to hose connection
- Install the original hose to the power steering pump
- Remove the clamp from the reservoir to the power steering pump hose
- Top-up the reservoir fluid

Bleed the power steering system (REFER to: Section 211-00 Steering System - General Information /General Procedures)