**EPS Steering Rack Rattles**

**Lab Test System to Diagnose & Help Resolve Root Causes**

**Electric Power Steering (EPS) offers many advantages over hydraulic power steering:**

- Eliminates power steering pump, saving 5 – 10 horsepower of drag on engine
- Improves fuel economy and reduces weight of pump and hoses (approx. 4 – 6kg)
- Ideal for electric vehicles and many hybrids
- Improves handling and steering refinement by using turning, position, torque & speed sensors plus electronics & control software in the power steering control module (PSCM) plus an electric motor to adjust steering assist under rapidly changing driving conditions

**EPS suffers a few disadvantages:**

- Hydraulics had huge damping effects so one hears noise problems in EPS (without the oil damping to suppress lateral motions in the rack) not heard with hydraulics
- Steering rack rattles in rack & pinion steering systems are more noticeable with column-mounted EPS, compared to rack-mounted, because an isolation joint between the column & rack cannot be employed
- Rattle elimination is often a trade off with steering effort, based on backlash adjustment

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**Steering rack rattles and steering column noises:**

- Rattle or knocking or clunking or shudder noise heard & felt at low speeds (up to 25km/h) during slow turns on loose or rough surfaces caused by backlash in rack and pinion or assist motor gear mechanisms, or elsewhere in column
- Rattles from inside the rack & pinion get worse through wear, resulting in increased clearances in rack/pinion interface and backlash adjuster
- Clunking noise during a turn, very random, independent of steering wheel angle and bumpiness of road caused by poor lubrication of intermediate shaft, or defective shaft

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**JOBS-TO-BE-DONE to minimize steering rack rattles at their source:**

- Diagnose and resolve rack rattle root causes to reduce warranty costs and satisfy customers
- Implement a lab test system (equipment and test methods) used by OEMs and suppliers that quietly, reliably and effectively reproduces the rack rattle phenomena
- Evaluate EPS rattles at component level (easier & more accessible) rather than vehicle level
- Engineer-out root causes of steering rack rattle through systematic troubleshooting, design modifications, and development work
- Assess EPS steering systems on many road surfaces to confirm rattles are engineered out
- Differentiate between different suppliers’ products based on their propensity to rattle and use this as a supplier selection criterion; suppliers do the same for their competing designs
- Utilize a lab test metric to objectively not subjectively evaluate EPS rattle performance
- Comply with "GMW16216 Steering System Squeak & Rattle Performance Evaluation"
**Lab Test Equipment & Specifications:**

- Energizer BLACK or SILVER exciter with Background Noise of 1.5 Sones N10 or <35dBA
- Stiff load support inside Energizers resists large overturning moments due to side loads
- Frequency response of Energizers: DC – 2kHz; Displacement: 50mm p-p
- Energizers capable of vertical as well as horizontal excitation; mobile with air casters (optional)
- 2:1 Lever Arm for BLACK delivers >5.1kN pk-to-pk instantaneous force
- 2:1 Lever Arm for SILVER delivers >10kN pk-to-pk instantaneous force
- S&R Control Console with Time History software control, plus PSD Random and Sine (Win2K5)
- Instrumentation: IEPE accelerometer (100mV/g, 5kHz frequency response), IEPE microphone (1/2" Free-Field with pre-amp, prepolarized, 50 mV/Pa, 6.3-20 kHz), IEPE power supply, strain gage and full-bridge signal conditioner (capable of measuring 10kN pk)
- CommanderACQUIRE 4-Channel data recording (102.4kS/s per channel, 24-bit, 100dB dynamic range, AC/DC coupling) for in-vehicle data acc
- S&R Metrics data analysis software (Hi/Lo/Band pass filtering, resampling, level vs. time feature) for S&R analysis
- Steering Rack Rattle Rig with Rack Stand and Column Stand for mounting any column and any rack in their in-car positions, with interface brackets
- Adaptable for Torsional Rattle System using rotational excitation as well as linear excitation, as shown
- Adaptable to other users’ test methods

**Rack Rattle Road Excitation and Lab Simulation**

- Reproduce chuckhole-type transient events, impacts, and random-like vibration
- Replicate real driving conditions and synthesized events that accentuate rack rattles
- Control to load or acceleration time histories, classical shock pulse events, and PSD random spectra