Tire Vibration Diagnostics Job Aid

This Job Aid is intended as a summarization of the Workshop Manual to assist with the diagnosis of tire/wheel assembly runout and Road Force variation issues, and to inform the technician of proper documentation for tire balancing or replacement under warranty. It is not intended to take the place of the Workshop Manual for any reason. Please consult the Workshop Manual (WSM), Sections 100-04 and 204-04, as well as any applicable TSBs or SSMs, before performing these procedures.

NOTE: *Per the Warranty and Policy Manual (version 2.3, section 1, page 30) "Any and all labor operations/repairs requiring Technician Competency must be completed by a technician that is certified in the required area at the time of the repair. These repairs cannot be sublet, regardless of the Dealership's edit status". Please review Service Labor Time Standards (SLTS) before subletting wheel balance repairs under warranty.*

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Tire Vibration Diagnostics Job Aid

Verifying the Customer's Concern

Before attempting repairs for a vibration related concern, it is necessary to verify the concern. A good way to improve customer satisfaction, as well as "Fix It Right the First Time" is to involve the vehicle owner in the repair process.

1) A revised Noise Vibration and Harshness (NVH) Write-Up Job Aid has been included on page 3.

2) At the bottom of the revised Write-Up Job Aid three new boxes have been added to foster better communication between the vehicle owner and the dealership, as well as improvement in "Fix It Right the First Time".

   a) The first box is intended for the Service Advisor, Shop Foreman, or Service Manager to sign along with the customer once the concern has been verified.

   b) The second box is intended for the Technician to sign to indicate whether or not they have verified the concern.

   c) The third box is intended for the Service Advisor, Shop Foreman, or Service Manager to sign after a repair has been completed, and they have verified with the customer that their concern is resolved.

3) Once the informational portion of the Job Aid is completed, it is recommended to road test the vehicle with the customer so they may point out their exact concern.

4) Check OASIS for any applicable SSMs, or TSBs using the vehicle's VIN.

5) When diagnosing NVH concerns, an important consideration is the characteristic operation of the vehicle. Many NVH related issues occur naturally in vehicles due to different factors such as: vehicle type, road conditions, ambient conditions and the system involved. Attempting to repair a vehicle characteristic typically will not improve or eliminate the condition, and can lead to a dissatisfied customer, as well as potential warranty implications. If you are unsure whether a condition is considered a characteristic, please road test a similarly equipped vehicle under the same conditions. If both vehicles exhibit the same concern, please do not attempt any repairs.

6) Inspect the vehicle for aftermarket wheels or tires. These may be the source of the vibration; however, balancing or replacing them is not a warrantable repair.

7) It is <u>not</u> required to complete the "Write-Up" Job Aid for warranty repairs. It is only intended to assist in diagnosis and communication.

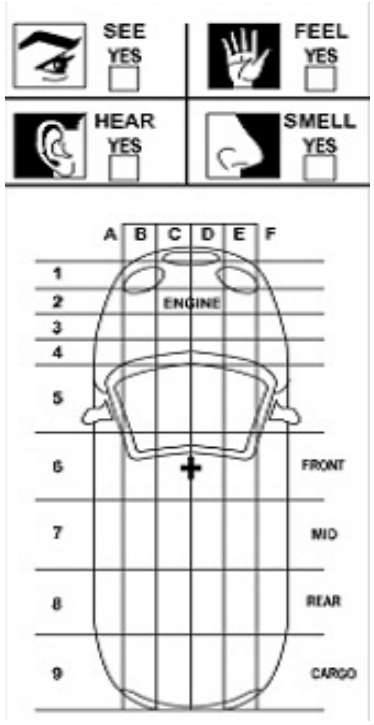
Tire Vibration Diagnostics Job Aid

Noise, Vibration and Harshness "Write –up" Job Aid

Repair Order #:_____
Customer
Last Name: _____

SPECIFIC SENSE IDENTIFICATION AND LOCATION OF THE CONCERN(S) ON THE VEHICLE

Select the sense(s) affected by the concern. Then select the areas on the generic vehicle below where the concern is most easily noticed.



Vehicle Symptom Area	How Often	Vehicle Operating Mode	Vehicle Conditions	Vehicle Speed (mph)	When Vehicle Is?	Ambient Conditions
Front of Vehicle	Always	Start Up	Accessories On	0	Turning Left	Below 0 F (-17C)
Engine Compartment	AM	Idle	Windows Open	1-9	Turning Right	0-32F(-17- 1 C)
Instrument Panel	PM	Gear Selection	4x4	10-19	Over Bumps	33-49 (1-10 C)
Steering Wheel	Weekly	Light Accel.	Hauling	20-29	Up Hills	50-69 (11-20 C)
Accelerator Pedal	Monthly	Mod. Accel.	Towing	30-39	Down Hills	70-89 (21-32 C)
Brake Pedal	Conditional	Heavy Accel.	Snow Plowing	40-49	Shifting	90+ (32+ C)
Clutch Pedal	Intermittent	Steady Speed	Other	50-59	Parked	Sunny
Driver's Seat	Unknown	Deceleration	Engine Cold	60-69	In Traffic	Dry
Passenger's Seat		Neutral	Engine Normal	70+		Windy
Rear Seats		Reverse	Engine Hot			Wet/Humid
Rear of Vehicle		Stopping/Braking				Rain
Top of Vehicle						Snow
Floor Pan						Ice
Under Vehicle						
Other						

Customer Description of the Concern

_____

_____

_____

_____

Concern Verified With Customer?
Yes:_____ No:_____
Dealer Personnel

_____

Customer

_____

Concern Verified By Technician?
Yes:_____ No:_____

Technician

_____

Has The Concern Been Resolved?
Yes:_____ No:_____
Dealer Personnel

_____

Customer

_____

Tire Vibration Diagnostics Job Aid

Vibration Related Terminology

Vibration - Any motion, shaking or trembling, that can be felt or seen when an object moves back and forth or up and down.

Cycle - The process of a vibrating component going through a complete range of motion and returning to the starting point.

Frequency - The measurement of the number of cycles a vibration makes in a specific amount of time. In automotive vibrations, frequency is measured in Hertz (Hz), or the number of vibration cycles in one second. Vibration can also be measured in RPM. If you divide the RPM measurement by 60, you will have the Hertz measurement (2000 RPM ÷ 60=33.33 Hz).

Amplitude - The measurement of the severity, or how harsh a vibration is. In automotive vibrations, this is typically expressed using the G-force, or G's, of a vibration. The higher the G-force, the harsher the vibration will feel.

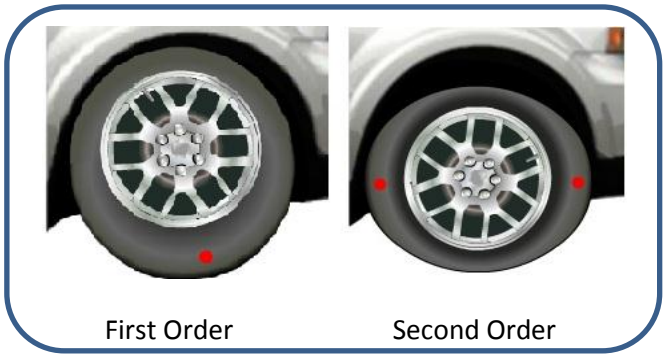
Order - The number of disturbances in one revolution of a vibrating component. For example, a tire with a single high spot will produce one disturbance each time the high spot contacts the ground. This would be considered a "first order" vibration. A tire with two high spots, that produces two disturbances per revolution, would have a "second order" vibration (Figure 1).

Originator - The component producing the vibration.

Conductor - The components that carry (transmit) a vibration frequency from the source to the reactor. This can also be referred to as a "transfer path".

Reactor - The component, or part, that receives a vibration from the originator and conductor, and reacts to the vibration by moving. In the case of a wheel and tire related vibration, the tire is the source of the vibration, the suspension and steering gear are the conductor, and the steering wheel that the customer reports is shaking, is considered the reactor.

(Figure 1)



Tire Vibration Diagnostics Job Aid

Diagnosing the Customer's Concern

- Check OASIS using the vehicle's VIN to see if there are any applicable SSM's or TSB's before attempting any diagnosis or repairs.
- WSM, Sections 100-04 and 204-04 have valuable diagnostic information that can assist in isolating the cause of a vibration.
- Be sure the air pressure in each of the tires is set to the specification on the door placard. Too much or too little air pressure can lead to excessive Road Force or runout variations.
- If your dealership has one, an Electronic Vibration Analyzer (EVA), or MTS 4000 vibration analyzer can quickly establish what the source of the vibration is based on the frequency (Hertz) reading.
- A wheel and tire speed vibration will typically have a measured Hertz (Hz) reading between 10 and 21 Hz, depending on the size of the tire, and the speed of the vehicle.
- A wheel or a tire can be "In Balance" but still have an out-of-round condition that causes a vibration.
- If your dealership has the Hunter Road Force 9700 Series wheel balancer, this should be used to measure tire runout and Road Force variation.
- If your dealership does not have this equipment, it will be necessary to manually measure wheel and tire radial runout using a dial indicator prior to replacing tires under warranty. Please review page 6 for information about this.

NOTE: *Diagnosis of tire/wheel vibration should not be performed on tires with less than 320 km (200 mi). Some initial tire/wheel vibration issues (such as flat spotting) may correct themselves after the tires have been in service for 320 km (200 mi).*

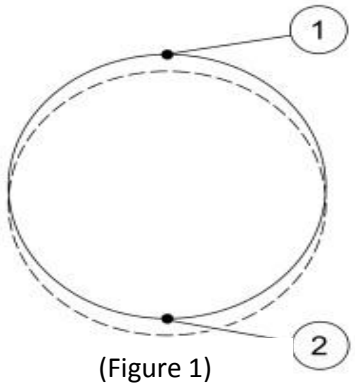
Tire Vibration Diagnostics Job Aid

Measuring Radial Runout

Radial runout is the egg-shaped deviation from a perfect circle (Figure 1). On a wheel and tire assembly, runout is measured using a dial indicator on the center tire tread rib. The center rib is indicative of the condition of the tire as a whole.

Total runout is the difference between the maximum to minimum gauge reading. The high spot is the location of maximum runout.

Runout can be measured with the wheel mounted to a tire balancer (Figure2), or on the vehicle (Figure 3). For tires for a more aggressive tread pattern, a strip of masking tape can be wrapped around the tire, along the center tread rib. Adding a roller contact tip to the dial indicator is recommended for this measurement*.



(Figure 1)


(Figure 2)


(Figure 3)

*- Roller Contact Kit CEN6485 is available through the Rotunda website.

While slowly rotating the wheel and tire assembly, use a dial indicator to measure the radial runout (Figures 2 and 3).

- Note the variance (runout) from 0 on the dial of the gauge.
- If the runout reading of a wheel and tire assembly is greater than 1.14 mm (0.045 in), permanently mark the high spot and runout reading on the inward sidewall of the tire, and carry out the Wheel to Tire Runout Minimization procedure to optimize the wheel and tire assembly.
- If the runout reading of a wheel and tire assembly is less than 1.14 mm (0.045 in), permanently mark the high spot and the runout reading on the inward sidewall of the tire for reference during future wheel and tire service. Balance the assembly and install the wheel and tire on the vehicle using the Wheel-to-Hub Optimization procedure (See Page 9).

Tire Vibration Diagnostics Job Aid

Wheel to Tire Runout Minimization (Match Mounting)

Wheel to tire runout minimization, also known as match mounting, is a technique used to reduce radial runout and Road Force on wheel and tire assemblies. Runout can sometimes be minimized by changing the position of the tire on the wheel. Excessive runout is a source of ride quality complaints and match mounting can be used to minimize the runout.

NOTE: *Make sure the correct wheel balancer adapters are used when mounting the assembly to the wheel balancer, or damage to the wheel may occur.*

NOTE*: For vehicles equipped with TPMS, the sensor may be damaged by incorrect tire mounting or dismounting. Dismount the tire from the wheel as instructed in the procedure. Failure to follow these instructions may result in TPMS component damage.*

NOTE*: It is necessary to document all of the balancing measurements taken during this procedure in the "Technician Comments" section of the repair order hard copy. To assist with the analysis of tires returned under warranty, all Road Force or runout measurements taken should be included in the warranty claim, as well (see page 10 for details).*

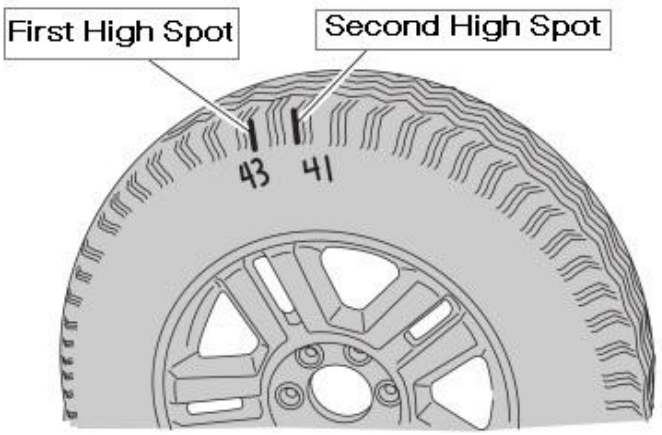
1) Mark the tire at the valve stem (Figure 1). This is to reference the original indexing location.

2) Measure the assembly runout, or Road Force, and mark the measurement (either the Road Force in pounds or the runout measurement, see page 6) and location of the high spot on the tire sidewall. As the assembly is reworked, the value and location on the tire are important.

3) Deflate the tire and break down both beads from the wheel. Lubricate the tire beads using a suitable fast drying, corrosion inhibiting tire bead lubricant. Position the tire 180 degrees (half-way around) on the rim so the valve stem reference mark is now opposite the valve stem.

(Figure 1)

Tire Vibration Diagnostics Job Aid



(Figure 2)

4) Re-inflate the wheel and tire assembly to the specified air pressure and measure the assembly again using a suitable dial indicator or Hunter Road Force 9700 Series Wheel Balancer. Mark the second high spot on the tire (Figure 2).

5) If the runout or Road Force is reduced to within specifications, the concern has been resolved. Balance the assembly and install on the vehicle using the Wheel-to-Hub Optimization procedure (see Page 9).

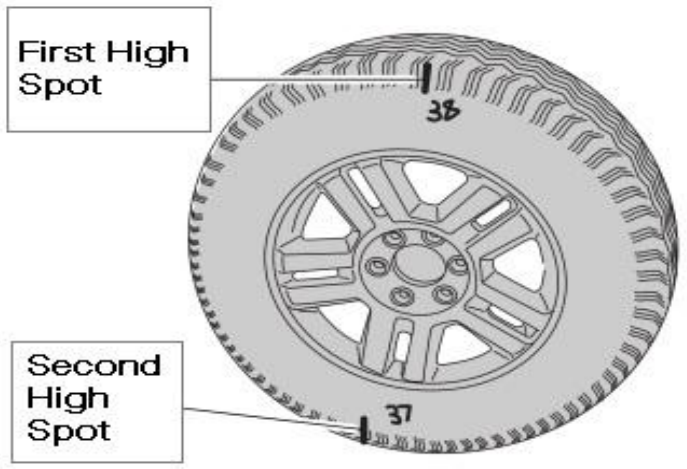
6) If the second runout or Road Force measurement is still not within specification and both high spots are close to each other (within 101.6 mm [4 in]), the root cause is probably the tire (the high spot followed the tire).

7) To be sure that the tire is causing the high runout, it is necessary to have 2 runout or Road Force measurements that are not within specification and the high spots must be in approximately the same location on the tire's sidewall. ***Permanently mark the tire as shown in figure 2 ****, and proceed with installing a new tire. Note the measurements on the repair order hard copy, as well as in the warranty claim (see page 10 for details).

8) If the second high spot is still above specification ***and*** is within 101.6 mm (4 in) of being opposite the first high spot on ***the wheel*** (Figure 3), the root cause is probably the wheel (the high spot followed the wheel).

9) Dismount the tire from the wheel, mount the wheel on a balancer and check the wheel runout. If the wheel runout exceeds 1.14 mm (0.045 in), install a new wheel, balance the assembly and install on the vehicle using the Wheel-to-Hub Optimization procedure (see Page 9).

10) If the second high spot did not follow the wheel or the tire and the runout is still not within specification, improvements may be made by rotating the tire 90 degrees (one-fourth turn).



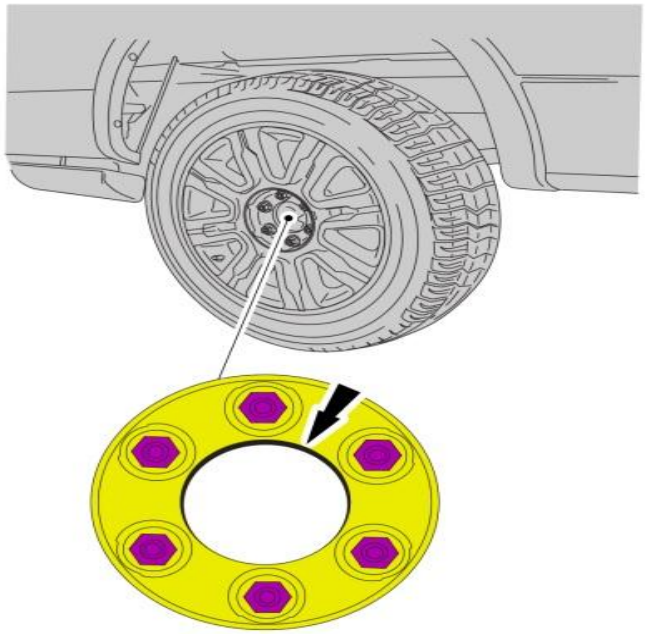
(Figure 3)

*- Tires replaced under warranty must have the high spots permanently marked for further analysis once they are returned. A paint marker is recommended for this.

Tire Vibration Diagnostics Job Aid

Wheel to Hub Runout Optimization

Wheel-to-hub optimization is important. Clearance between the wheel and hub can be used to offset or neutralize the Road Force or runout of the wheel and tire assembly. For every 0.001 inch of wheel-to-hub clearance, the Road Force can be affected between 1 and 3 pounds depending on the tire stiffness. The example below illustrates how the clearance between the wheel and the hub can be used to offset the high spot of radial runout or Road Force. Following the procedure will make sure of the best optimization.



Position the wheel and tire assembly on the vehicle so that the high spot location of radial runout or Road Force is at the 6 o'clock position and install the wheel nuts by hand until snug.

NOTE: *Do not allow the full weight of the vehicle to rest on the tires while tightening the wheel nuts.*

Lower the vehicle until the tires make contact with the ground, slightly loading the suspension, then tighten the wheel nuts.

NOTE: *Refer to WSM, Section 204-04, Wheels and Tires > Removal and Installation for the proper installation procedure and wheel nut torque specification.*

Tire Vibration Diagnostics Job Aid

Completing the Repair Order and Preparing the Tires for Return

Accurately completing the "Technician Comments" section of the repair order helps the Warranty Team understand the issue the vehicle was exhibiting, as well as the steps taken to diagnose and repair the issue. Accurate measurements, and a clear, concise explanation of the work performed will also help ensure that a technician is paid for the time they spent repairing the vehicle. To assist with the analysis of tires returned under warranty, all Road Force or runout measurements taken should be included in the warranty claim, as well as on the repair order hard copy. Per the Warranty and Policy Manual (ver. 2.3, section 1, page 11), it is the technician's responsibility to "*Record key measurements/observations on the hard copy of the claim. Record all DTC codes, pinpoint test, pressure test results, voltage, or any other measurements from any test being performed by the technician to diagnose the customer concern including equipment readings (e.g., wheel alignment).*" Below is a summary of the guidelines presented in this job aid, as well as examples of how to document the repair process and measurements.

Complete Comments

Technician Comments: Road tested and verified a vibration at 55 MPH. Measured tire runout on vehicle, found LF at .005, RF at .007, LR at .055, RR at .052, specification is .045. Removed rear wheels, mounted to a wheel balancer and confirmed LR at .055, and RR and .052. Performed match mounting procedure, moved both tires 180 degrees, and re-measured runout on the balancer. LR now .020, RR now .018. Spin balanced both tires, and installed on vehicle. Road tested and verified vibration is gone.

Technician Comments: Road tested and verified the customer concern of a vibration at 40 MPH. Performed road force measurement, found RF 45 lbs., LF 24 lbs., RR 20 lbs., LR 25 lbs. WSM road force specification is 20 lbs. Performed match mounting on all 4 tires and measured road force again. RF 38 lbs., LF 15 lbs., RR 12 lbs., LR 16 lbs. RF still excessive, attempted match mounting again moved tire 90 degrees and re-measured. RF still has 40 lbs. road force, necessary to replace RF tire. Installed and balanced RF tire and road tested vibration no longer present.

Incomplete Comments

Technician Comments: Road tested, verified vibration. Found rear tires out of round. Replaced both rear tires. Ok now.

Technician Comments: Road tested verified vibration at speed. Balanced tires, RF will not balance. Replaced RF tire, rechecked and vibration is gone.

- Verify the customers concern(s) prior to performing repairs.
- Inspect the vehicle for aftermarket components that could cause a vibration.
- Note any TSBs or SSMs used.
- Note the initial Road Force or runout measured prior to beginning repairs.
- Mark the Road Force or runout on the tire using a paint marker.
- If match-mounting is required, mark the second road force measurement or high spot on the tire as well.
- The second measurements should also be included in the technician comments of the repair order and warranty claim.
- Final Road Force or runout measurements should be noted on the repair order and warranty claim for future use, if the vehicle returns.