> Constellation
> Heritage
> 4700 Models
> 4800 Models
> 4900 Models
> 5900 Models
> 6900 Models

Western Star Service Bulletin

Description of Revisions: *This bulletin replaces the version dated April 2012. Both the troubleshooting information and the worksheet have been revised.*

General Information

Vibration and harsh ride can be difficult to diagnose, so training is essential. Misdiagnosis is a significant problem with vibration issues because so many factors are at play. The right training and the right tools lead to methodical, effective troubleshooting.

A number of best practices and rules of thumb can help isolate the problem area. This service bulletin is designed as a reference for the initial diagnosis of vibration and harsh ride problems, and to identify likely sources. This service bulletin is *not* meant to be comprehensive for all vibration and harsh ride diagnosis and issues.

If available, use a vibration detection tool like the Kent Moore Electronic Vibration Analyzer (EVA) and Vibrate Software with a road test for the best results. This bulletin provides a diagnostic worksheet to identify which systems to start troubleshooting. The worksheet can be used without the EVA tool, but, if available, the EVA tool should be used with the worksheet for the best results.

Use the included worksheets to narrow down the probable systems to investigate and repair. A combination of technician training and workshop manuals should be used for troubleshooting the suspected systems.

⚠ WARNING

Never run a vehicle on jacks stands. The movement generated by the vehicle can lead it to fall off the stands and cause serious personal injury.

IMPORTANT: Dynamometers should never be used when testing for vibration. Dynamometers always generate vibrations of their own, creating a different profile of vibrations than a road test.

IMPORTANT: Never run a vehicle on jack stands to test for vibration—it is dangerous and unnecessary. A vehicle on jack stands will not have the same profile of vibrations as the same vehicle on the road.

Glossary

Use the glossary below for definitions of ride characteristics.

Frame Deflection: Deviation or change from normal or standard configuration; to force or push (e.g. frame deflection under load).

Fore-and-Aft Pitch: A front or rear motion, usually felt in the cab.

Harmonic: Bucking or bouncing motion that continues at a given road speed. The critical road speed is usually within a 10 mph (16 k/h) range (e.g. 55 to 65 mph, or 89 to 104 km/h).

Harsh Ride: The road feels rougher than expected; small cracks and bumps in the road can always be felt. The suspension does not seem to dampen or absorb these forces.

Hop or Bounce: A vertical movement typically felt in the suspension or the axles. Can be caused by unbalanced or out of round tires, or irregularity in the running surface of the tire or the wheel assembly (lateral runout).

Lateral Runout: In-and-out movement or wobble of a rotating component, such as a driveshaft or wheel/tire assembly.

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Shimmy: A condition in the steering system where the front tires can move or oscillate rapidly from side-to-side; springiness and looseness. Shimmy is often diagnosed as vibration.

Radial Force Variation: A soft spot or area of the tire that cannot support its load consistently, causing the load to fall or drop when that spot contacts the road, and to rise when the tire is rotated.

Radial Runout: An out-of-round condition or inconsistency, or a variation in diameter; an egg shape or a large flat spot.

Vibration: A quiver, tremble, or oscillation; a repetitive force throughout the entire vehicle.

Verifying Customer Complaint

1. Prior to test driving the vehicle, get a detailed description of the conditions under which the symptoms occur. Use the worksheet to guide questions as needed.
2. Perform a preliminary inspection of the vehicle. Pay close attention to these possible factors:
    - tire pressure and condition
    - mud, debris, or ice caked on the wheels
    - rocks between dual wheels
    - mud or concrete on the driveline
    - the ride height of the chassis suspension and cab suspension

IMPORTANT: If possible, fill out the Vibration Worksheet with the customer and take the customer along for the test drive.

3. Drive the vehicle and observe the nature of the complaint. Drive the vehicle in all conditions needed to fill out the Harsh Ride/Vibration worksheet completely. The condition must be duplicated in order to make an accurate diagnosis.

NOTE: Air may escape from the leveling valve for quite some time as ride height is adjusted.

4. After the test drive check the ride height again. If it has changed, check the leveling valve mounting for looseness, check the suspension mounting bolts for correct torque, and check any suspension bushings for deterioration. Suspension issues are usually felt as a shimmy or sway.
5. Check the suspected systems for broken, worn, malfunctioning or misadjusted components and repair as needed.

Common Issues and Pitfalls by System

Wheel Ends

Common issues: Brake drum runout, imbalanced wheel end components. Wheels installed off-center from the hub. Steel wheels may become out of round.

Pitfalls: A sight check is not sufficient to check runout. Always use a dial indicator to check runout; check runout of the drums, wheels, and tires before disassembling the wheels.

Suspension

Common issues: Incorrect vehicle ride height.

Pitfalls: Be careful when diagnosing the air ride suspension valve; these valves are often wrongly replaced. Air may escape for quite some time as the valve adjusts the ride height.

Steering

Common issues: Worn tie rod ends.

Pitfalls: Steering issues usually cause a shimmy rather than a vibration, so the Vibration worksheet does not cover them. Vibration analysis tools are also unlikely to be helpful for shimmy. To feel the difference between a shimmy and vibration, a technician must rely on their training.

Drivelines and Axles

Common issues: Driveline runout, balance, or both. Yokes can have high runout or be excessively worn and provide the same result.

Pitfalls: On a brand new truck, transmission/engine mounting angle, incorrect midship bearing mounting, or axle seat issues may cause incorrect driveline angles. Otherwise, driveline angles are rarely the issue once ride height has been adjusted.

Driveline angularity is not necessarily at optimum when the vehicle is in a tare or unloaded condition. For some suspensions, such as the AirLiner™ 40K, the drivelines should be at optimum angles when the vehicle is loaded.

Do not run the vehicle on jack stands with the tires rotating as it will not provide an accurate method for a final diagnosis. Instead, with the vehicle sitting on the floor, remove the axle shafts from both drive axles, then put the transmission in gear with the power divider locked and run the vehicle.

This can be done with manual and Allison transmissions, but not any other automatic transmission. For automated transmissions consult the transmission manufacturer.

If yoke and shaft runout have been checked with a dial indicator and driveline balance is the suspected issue, remove the complete driveline and balance it as a complete unit.

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Engine and Transmission

Common issues: Damaged or deteriorated engine mounts.

Pitfalls: In most cases the EVA tool can be used to identify whether the transfer path is through the engine mounts. Place the EVA sensor on the engine, then the frame rail, and compare the vibrations to determine whether the engine mounts are adequately dampening engine vibration.

Inspect the engine mounts for cracking and for contact between the mounting bolts and frame. If mounting bolts are contacting the frame through the mounting, that will create a vibration transfer path.

In most cases, visual inspection and use of the EVA tool can diagnose engine mounts. Only as a last resort should the engine, clutch, and transmission be isolated in sequence. Isolate the engine, clutch, and transmission systems by disconnecting the driveline at the transmission and running the engine while shifting through the gear range. Then, disconnect the transmission and run the engine. If necessary, run the engine with the clutch removed.

Frame and Cab

Common issues: Longer frame vehicles may have a fore-and-aft pitch at 58 mph (93 km/h) or bounce at 72 mph (116 km/h). This can be difficult to address and may best be remedied with harder front cab mounts and softer cab rear suspension.

Pitfalls: Cab mounting may initially appear fine, but should always be inspected carefully to be sufficiently eliminated as a vibration transfer path.

Broken exhaust brackets and broken or worn out cab suspension may cause the cab to be a vibration transfer path. This may cause a normal vibration to be felt by the driver more than usual, and also may cause a vibration from the front of the vehicle to feel like it is coming from the rear, or the other way around.

Kent Moore EVA Diagnosis Quick Reference

Use the EVA tool in addition to the worksheet when possible, and use as outlined at **www.vibratesoftware.com**.

Install and set-up the EVA tool first on the location where the source of the vibration is felt by the driver (for example, the seat base). For some vibrations, additional locations and rpms may be needed. Record your results on the Electronic Vibration Analyzer Data Form found in this service bulletin and enter the required data from it into Vibrate Software.

NOTE: Preloaded data in the EVA2 is for passenger cars, not trucks.

Use the Vibration Diagnosis Worksheet supplied by the Vibrate Software to categorize the source of the vibration complaint.

Classifications and Possible Sources of Vibration

Tire/Wheel 1st order (check before loosening or removing any wheel-end component)

- Check if the tire is mounted on the wheel incorrectly. GG ring to rim edge variation should not exceed 2/32 inch (1.6 mm) in four spots.
- Check radial and lateral tire runout.
- Check if the wheel is mounted on the hub-piloted assemblies correctly.
- Check for out-of-balance wheel/tire assemblies, drums, and rotors.
- Check the condition of the tires, looking for flat spots, dry rot, chunking.

Tire/Wheel 2nd and 3rd order (check before loosening or removing any wheel-end component)

- Check if the tires, wheels, drums, rotors or hubs are out of round.
- Check for stiff or soft spots (radial force variation, or RFV) in the tire sidewalls.

NOTE: Balance will not cause Tire 2nd order issues.

Driveline or Propeller shaft 1st order

- Check driveline runouts (shaft, yoke, flange, parking brake drum).

- Check the U-joints, slip yokes, and carrier bearings for excessive play.
- Check the yoke and companion flange nuts for looseness.
- Check if driveline balance weights are missing.
- Check for mud or concrete build up, and dents or twists.
- Check for proper phasing (note some driveline assemblies are phased 90 degrees).

Driveline or Propeller shaft 2nd order

- Check if U-joints lack lube, or are loose, worn, or out of phase.
- Check the air ride height.
- Check the driveline working angles.

Engine 1st order

- Check the torsional damper (flywheel or harmonic balancer).
- Check the crankshaft.
- Check the torque converter.
- Check the flex plate.
- Check the clutch assembly.

Engine 2nd order and above

- Check for engine/exhaust vibrations relating to fuel or high torque.
- Check for bad engine/transmission mounts.
- Check for exhaust vibration shorting to cab.

Warranty

This service bulletin is for information only; warranty does not apply.

Vibration Worksheet

Date:_____
Technician's Name:_____
Repair Order:_____

Vehicle Information

VIN:_____ Mileage:_____
In–Service Date:_____
Model:_____ Engine:_____
Axle ratio:_____
Transmission model #:_____
(Axle ratio information and transmission model can be obtained from PartsPro® "Major Components")

Customer Complaint Information: Ask the driver…

1. Where is the symptom felt most? ○ Floor and seat ○ Steering wheel
2. Is the symptom present when the vehicle is stationary with engine running? ○ YES ○ NO
3. Engine rpm at which problem occurs: _____rpm
4. Vehicle speed at which the problem occurs: _____mph
5. Does the problem occur under: ○ Acceleration? ○ Deceleration?
6. When does the problem occur: ○ Vehicle Unloaded ○ Vehicle Loaded
7. When did the symptom first occur? (circle one)
   a. New vehicle, problem existed from the beginning.
   b. After a maintenance or repair procedure – Check all components affected by the procedure
   c. Not sure – Check warranty repair history and check repaired systems/components.
8. Other circumstances where the vibration is most noticeable: _____

Initial Inspection and Vibration Check

1. Any loose, broken or missing parts found on walk-around inspection? ○ YES ○ NO
2. Is the suspension ride height within specifications? ○ YES ○ NO
3. Are all tires inflated to specification? ○ YES ○ NO

Vibration Road Test

Mount the EVA vibration sensor on either the seat base or steering column, based on where the driver reported feeling the strongest vibrations, then perform the Vibration Road Test Procedure. Return the vehicle to strongest-vibration operating conditions—the same vehicle gear, engine RPM, vehicle speed—before each test.

Vibration Road Test Procedure			
Test #	**Condition**	**Action**	**Result (circle)**
Test 1	At strongest vibration condition…	Let off the throttle.	Vibration continues? YES / NO
Test 2	At strongest vibration condition… (same gear, engine RPM, speed)	Shift truck up or down 1 or 2 gears, changing engine speed ONLY, not road speed.	Vibration continues? YES / NO
Test 3	At strongest vibration condition… (same gear, engine RPM, speed)	Shift into Neutral and let off the throttle.	Vibration continues? YES / NO
Test 4	At strongest vibration condition… (same gear, engine RPM, speed)	Shift truck up or down 1 or 2 gears, changing road speed ONLY, not engine speed.	Vibration continues? YES / NO

When the vibrations are most noticeable, write down the following information:

1. Vehicle gear: _____
2. Road speed: _____
3. Engine RPM: _____
4. EVA measured Hz:_____
5. EVA measured Amplitude:_____

In addition, use the EVA to record vibration data when the vibrations are most noticeable.

Assessment Using Road Test Results

Tests where the vibration continued	**Order of Vibration**	**Likely issues based on results of Vibration Road Test**
1, 2, or 3	First Order	Wheel or tire out of balance. Driveline / propshaft out of balance.
4 only	Second Order	Wheel or tire out of round. Driveline / propshaft out of round. Engine vibration through engine or cab mounts.
None	Third Order	Wheel or tire out of round. Driveline / propshaft out of round.

Vibration Analysis – Vibrate Software

Use the Vibrate Software application to narrow down possible sources of vibration and double-check the assessment. When asked for the Transmission Gear Ratio, use the **Help** button to the find the gear ratio for the gear recorded in the road test high-vibration condition. See the Using Vibrate Software section for more detail.

- ○ T1: Tire Speed Related, 1st Order
- ○ T1: Tire Speed Related, 2nd Order
- ○ T1: Tire Speed Related, 3rd Order
- ○ P1: Propshaft Speed Related, 1st Order
- ○ P1: Propshaft Speed Related, 2nd Order
- ○ P1: Propshaft Speed Related, 3rd Order
- ○ E1: Engine Speed Related, 1st Order
- ○ E1: Engine Speed Related, 2nd Order
- ○ E1: Engine Speed Related, 3rd Order