SECTION 2B
WHEEL ALIGNMENT

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DESCRIPTION AND OPERATION

FOUR WHEEL ALIGNMENT

The first responsibility of engineering is to design safe steering and suspension systems. Each component must be strong enough to withstand and absorb extreme punishment. Both the steering system and the front and the rear suspension must function geometrically with the body mass.

The steering and the suspension systems require that the front wheels self-return and that the tire rolling effort and the road friction be held to a negligible force in order to allow the customer to direct the vehicle with the least effort and the most comfort.

A complete wheel alignment check should include measurements of the rear toe and camber.

Four-wheel alignment assures that all four wheels will be running in precisely the same direction.

When the vehicle is geometrically aligned, fuel economy and tire life are at their peak, and steering and performance are maximized.

TOE-IN

Toe-in is the turning in of the tires, while toe-out is the turning out of the tires from the geometric centerline or thrust line. The toe ensures parallel rolling of the wheels. The toe serves to offset the small deflections of the wheel support system which occur when the vehicle is rolling forward. The specified toe angle is the setting which achieves 0 degrees of toe when the vehicle is moving.

Incorrect toe-in or toe-out will cause tire wear and reduced fuel economy. As the individual steering and suspension components wear from vehicle mileage, additional toe will be needed to compensate for the wear.

Always correct the toe dimension last.

CASTER

Caster is the tilting of the uppermost point of the steering axis either forward or backward from the vertical when viewed from the side of the vehicle. A backward tilt is positive, and a forward tilt is negative. Caster influences directional control of the steering but does not affect tire wear. Weak springs or overloading a vehicle will affect caster. One wheel with more positive caster will pull toward the center of the car. This condition will cause the car to move or lean toward the side with the least amount of positive caster. Caster is measured in degrees.

CAMBER

Camber is the tilting of the top of the tire from the vertical when viewed from the front of the vehicle. When the tires tilt outward, the camber is positive. When the tires tilt inward, the camber is negative. The camber angle is measured in degrees from the vertical. Camber influences both directional control and tire wear.

If the vehicle has too much positive camber, the outside shoulder of the tire will wear. If the vehicle has too much negative camber, the inside shoulder of the tire will wear.
**TIRE DIAGNOSIS**

**Irregular and Premature Wear**

Irregular and premature tire wear has many causes. Some of them are incorrect inflation pressures, lack of regular rotation, poor driving habits, or improper wheel alignment.

Rotate the tires if:
- The front tire wear is different from the rear.
- The left and right front tire wear is unequal.
- The left and right rear tire wear is unequal.

Check wheel alignment if:
- The left and right front tire wear is unequal.
- The wear is uneven across the tread of either front tire.
- The front tire treads are scuffed with “feather” edges on the side of the tread ribs or blocks.

**Tread Wear Indicators**

The original equipment tires have built-in tread wear indicators to show when the tires need replacement. These indicators appear as bands when the tire tread depth becomes shallow. Tire replacement is recommended when the indicators appear in three or more grooves at six locations.

**Radial Tire Waddle**

Waddle is side-to-side movement at the front or rear of the vehicle. It is caused by the steel belt not being straight within the tire, or by excessive lateral runout of the tire or wheel.

The vehicle must be road tested to determine which end of the vehicle has the faulty tire. The rear end of the vehicle will shake from side to side or “waddle” if the waddle tire is on the rear of the vehicle. From the driver’s seat, it feels as though someone is pushing on the side of the vehicle.

If the faulty tire is on the front of the vehicle, the waddle is more visual. The front sheet meld appears to be moving back and forth, and the driver’s seat feels like the pivot point in the vehicle.

Waddle can be diagnosed using the method of substituting known good tire and wheel assemblies on the problem vehicle.

1. Road test the vehicle to determine if the waddle is coming from the front or the rear of the vehicle.
2. Install good tires and wheels from a similar vehicle in place of those on the offending end of the problem vehicle. If the source of the waddle is not obvious, change the rear tires.
3. Road test the vehicle. If there is improvement, install the original tires to find the offending tire. If there is no a straight improvement, install good tires in place of all four offending tires.
RADIAL TIRE LEAD/PULL

Lead/pull is the deviation of the vehicle from a straight path on a level road with no pressure on the steering wheel. Lead is usually caused by:

- Incorrect alignment.
- Uneven brake adjustment.
- Tire construction.

The way in which a tire is built can produce lead/pull in the vehicle. Off-center belts on radial tires can cause the tire to develop a side force while the vehicle rolls straight down the road. If one side of the tire has even a little larger diameter than the diameter of the other side, the tire will tend to roll to one side. Unequal diameters will cause the tire to develop a side force which can produce vehicle lead/pull.

The radial lead/pull diagnosis chart should be used to determine whether the problem originates from an alignment problem or from the tires. Part of the lead diagnosis procedure calls for tire rotation that is different from the proper tire rotation pattern. If a medium-to high-mileage tire is moved to the other side of the vehicle, be sure to check for ride roughness. Rear tires will not cause lead/pull.
## Radial Tire Lead/Pull Diagnosis Chart

<table>
<thead>
<tr>
<th>Step</th>
<th>Action</th>
<th>Value(s)</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
</table>
| 1    | 1. Perform wheel alignment preliminary inspection.  
2. Check the brakes for dragging.  
3. Road test the vehicle.  
Does the vehicle lead/pull? | - | Go to Step 2 | System OK |
| 2    | 1. Cross switch the front tire and wheel assemblies.  
2. Road test the vehicle.  
Does the vehicle lead/pull? | - | Go to Step 3 | System OK |
| 3    | Check the front wheel alignment.  
Is the alignment within specifications? | - | Go to Step 4 | Adjust alignment |
| 4    | Compare the front camber and front caster to specifications.  
Are they within specifications? | - | Go to Step 7 | Go to Step 5 |
| 5    | Check the vehicle frame.  
Is the frame bent? | - | Go to Step 6 | Go to Step 1 |
| 6    | Straighten the frame.  
Is the repair complete? | - | Go to Step 3 | - |
| 7    | 1. The probable cause is the tires.  
2. Switch the left front tire and wheel assembly with the left rear tire and wheel assembly.  
3. Road test the vehicle.  
Does the vehicle still lead/pull? | - | Go to Step 9 | Go to Step 8 |
| 8    | Switch the left front tire and wheel assembly with the left rear tire and wheel assembly and replace the left front tire.  
Does the repair complete? | - | System OK | Go to Step 1 |
| 9    | 1. Switch the right front tire and wheel assembly with the right rear tire and wheel assembly.  
2. Road test the vehicle.  
Does the vehicle still lead/pull? | - | Go to Step 1 | Go to Step 10 |
| 10   | Switch the right front tire and wheel assembly with the right rear tire and wheel assembly and replace the right front tire.  
Is the repair complete? | - | System OK | Go to Step 1 |
VIBRATION DIAGNOSIS
Wheel imbalance causes most highway speed vibration problems. A vibration can remain after dynamic balancing because:
- A tire is out of round
- A rim is out of round
- A tire stiffness variation exists
Measuring tire and wheel free runout will uncover only part of the problem. All three causes, known as loaded radial runout, must be checked using method of substituting known good tire and wheel assemblies on the problem vehicle.

Tire Balancing
Balance is the easiest procedure to perform and should be done first if the vibration occurs at high speeds. Do an off-vehicle, two-plane dynamic balance first to correct any imbalance in the tire and wheel assembly. An on-vehicle finish balance will correct any brake drum, rotor, or wheel cover imbalance. If balancing does not correct the high-speed vibration, or if the vibration occurs at low speeds, runout is the probable cause.

Preliminary Checks
Prior to performing any work, always road test the car and perform a careful visual inspection for:
- Obvious tire and wheel runout.
- Obvious drive axle runout.
- Improper tire inflation.
- Incorrect trim height.
- Bent or damaged wheels.
- Debris build-up on the tire or the wheel.
- Irregular or excessive tire wear.
- Improper tire bead seating on the rim,
- Imperfections in the tires, including: tread deformations, separations, or bulges from impact damage. Slight sidewall indentations are normal and will not affect ride quality.
VEHICLE HEIGHT

Adjustment Procedure

1. Check the tire for proper inflation.
2. Measure ‘A’ from the center of the lower arm rear mounting bolt end to the ground.
3. Measure ‘B’ from the center of the steering knuckle shaft to the ground.
4. If the difference between ‘A’ and ‘B’ is not within specification, adjust vehicle height using torsion bar height control bolt.

Adjustment Notice

<table>
<thead>
<tr>
<th>Specification</th>
<th>B - A</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>31 - 36 mm (1.22 - 1.42 inch)</td>
</tr>
</tbody>
</table>

Notice: Before wheel alignment, adjust vehicle height adjustment first.

FRONT TOE-IN ADJUSTMENT

Adjustment Procedure

1. Disconnect the outer tie rods from the knuckle assemblies. Refer to Section 6C, Power Steering Gear.
2. Loosen the front toe adjusting nut.
   Notice: In this adjustment, the right and the left tie rods must be equal in length, or the tires will wear unevenly.
3. Turn the right and the left outer tie rods to align the toe to the proper specifications. Refer to “Wheel Alignment Specifications” in this section.
4. Hold the outer tie rod and tighten the front toe adjusting nut.

Adjustment Notice

| Tightening Torque | 73 N•m (54 lb-ft) |

5. Reconnect the outer tie rods to the knuckle assemblies. Refer to Section 6C, Power Steering Gear.
FRONT CAMBER CHECK

Adjustment Procedure
1. Remove the free wheel hub.
2. Measure camber with a wheel alignment equipment.

Adjustment Notice

| Specification | 0° ± 30′ |

3. If camber measurements are not within specification, adjust it by increasing or decreasing the number of adjusting shims inserted between the upper arm shaft and cross bracket.

Adjustment Notice

<table>
<thead>
<tr>
<th>Adjusting Shims</th>
<th>Increasing 1EA</th>
<th>Decreasing 1EA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.6 Large</td>
<td>+19′</td>
<td>-19′</td>
</tr>
<tr>
<td>3.2 Large</td>
<td>+38′</td>
<td>-38′</td>
</tr>
</tbody>
</table>

Notice: Difference between the left and right should be adjusted within 30′.

FRONT CASTER CHECK

Adjustment Procedure
1. Remove the free wheel hub.
2. Measure caster with a wheel alignment equipment and a turning radius gauge.

Adjustment Notice

| Specification | 2°30′ ± 30′ |

3. If caster measurements are not within specification, adjust it by increasing 1EA (rear) or decreasing 1EA (front).

Adjustment Notice

<table>
<thead>
<tr>
<th>Adjusting Shims</th>
<th>Increasing 1EA</th>
<th>Decreasing 1EA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Front 0.4 Small</td>
<td>-11′</td>
<td>+11′</td>
</tr>
<tr>
<td>1.6 Small</td>
<td>-43′</td>
<td>+43′</td>
</tr>
<tr>
<td>Rear 0.4 Small</td>
<td>+11′</td>
<td>-11′</td>
</tr>
<tr>
<td>1.6 Small</td>
<td>+43′</td>
<td>-43′</td>
</tr>
</tbody>
</table>

Notice: Difference between the left and right should be adjusted within 30′.
## WHEEL ALIGNMENT SPECIFICATIONS

### Camber
- Front: 0° ± 30′
- Rear: -

### Caster
- Front: 2°30′ ± 30′
- Rear: -

### King Pin Inclination
- Front: 12°30′
- Rear: -

### Toe-in (No load)
- Front: 0 - 4 mm
- Rear: -

## FASTENER TIGHTENING SPECIFICATIONS

<table>
<thead>
<tr>
<th>Application</th>
<th>N•m</th>
<th>Lb-Ft</th>
<th>Lb-In</th>
</tr>
</thead>
<tbody>
<tr>
<td>Front Toe Adjusting Nut</td>
<td>73</td>
<td>54</td>
<td>-</td>
</tr>
</tbody>
</table>