SECTION 3A

FRONT WHEEL ALIGNMENT

NOTICE: *Always use the correct fastener in the proper location. When you replace a fastener, use ONLY the exact part number for that application. General Motors will call out those fasteners that require a replacement after removal. General Motors will also call out the fasteners that require thread lockers or thread sealant. UNLESS OTHERWISE SPECIFIED, do not use supplemental coatings (paints, greases, or other corrosion inhibitors) on threaded fasteners or fastener joint interfaces. Generally, such coatings adversely affect the fastener torque and joint clamping force, and may damage the fastener. When you install fasteners, use the correct tightening sequence and specifications. Following these instructions can help you avoid damage to parts and systems.*

CONTENTS

GENERAL DESCRIPTION

Front wheel alignment refers to the angular relationship between the front wheels, the front suspension attaching parts, and the ground.

Proper front wheel alignment must be maintained in order to ensure efficient, good directional stability and to prevent abnormal tire wear.

The most important factors of front wheel alignment are wheel toe-in, wheel camber, and axle caster (Figures 1 and 2).

DEFINITION OF ALIGNMENT TERMS

CONTROL ARM SUSPENSION

Camber (Figure 1)

Camber is the inward or outward tilting of the front wheel from the vertical. It is measured in degrees. When the wheels tilt outward at the top, the camber is

positive. When the wheels tilt inward at the top, the camber is negative. The amount of tilt measured in degrees from the vertical is called the camber angle.

If camber is extreme or unequal between the wheels, improper steering and excessive tire wear will result. Negative camber causes wear on the inboard side of the tire, while positive camber causes wear to the outboard side.

Caster (Figure 1)

Caster is the tilting of the steering axis either forward or backward from the vertical (when viewed from the side of the vehicle). It is measured in degrees. A backward tilt is positive and a forward tilt is negative.

On the short and long arm type suspension, you cannot see a caster angle without a special instrument. However, if you look straight down from the top of the upper control arm to the ground, the ball joints do not line up (fore and aft) when a caster angle other than zero degrees is present. With a positive angle, the lower ball joint would be slightly ahead (toward the front of the vehicle) of the upper ball joint center line.

Toe-In (Figure 1)

Toe-in is the adjustment of the front wheels that angles the tires toward each other. The actual amount of toe-in is normally a fraction of a degree. Toe-in is measured from the center of the tire treads or from the inboard side of the tires. The purpose of toe-in is to ensure parallel rolling of the front wheels and to offset any small deflections of the wheel support system which occurs when the vehicle is rolling forward. Incorrect toe-in results in excessive tire wear and unstable steering. Toe-in is the last alignment to be set in the front wheel alignment procedure.

Frame Angle

The caster, camber, and toe-in dimensions are determined for the vehicle at design load with the frame level. The normal frame angle must be considered when using the alignment equipment. This is most important when making a caster angle check to obtain a true setting.

I-BEAM FRONT AXLE SUSPENSION

King Pin Inclination (Figure 2)

King pin inclination is the amount that the top of the king pin is inclined toward the center of the vehicle. The inclination is designed into the axle end. King pins are inclined to assist front wheel return to center after a turn is made (D, Figure 2).

Camber (Figure 2)

Camber is the measurement in degrees that the front wheels are tilted inward or outward at the top from vertical position. Camber offsets wheel deflection due to wear of front axle parts and prevents a reverse or negative camber condition. If camber is extreme or unequal between the wheels, improper steering and excessive tire wear will result (Figure 2).

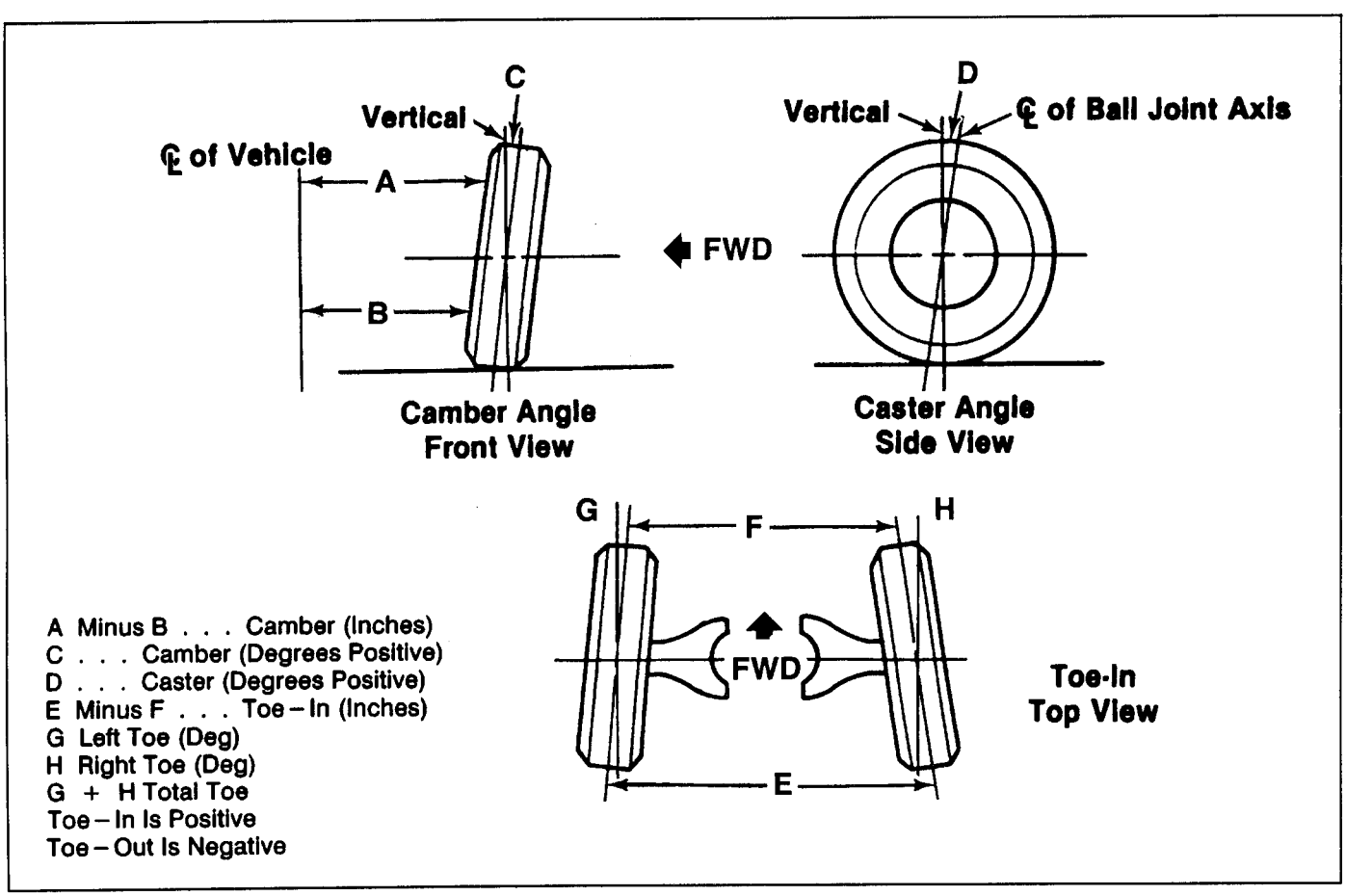

Figure 1—Caster, Camber, and Toe-In

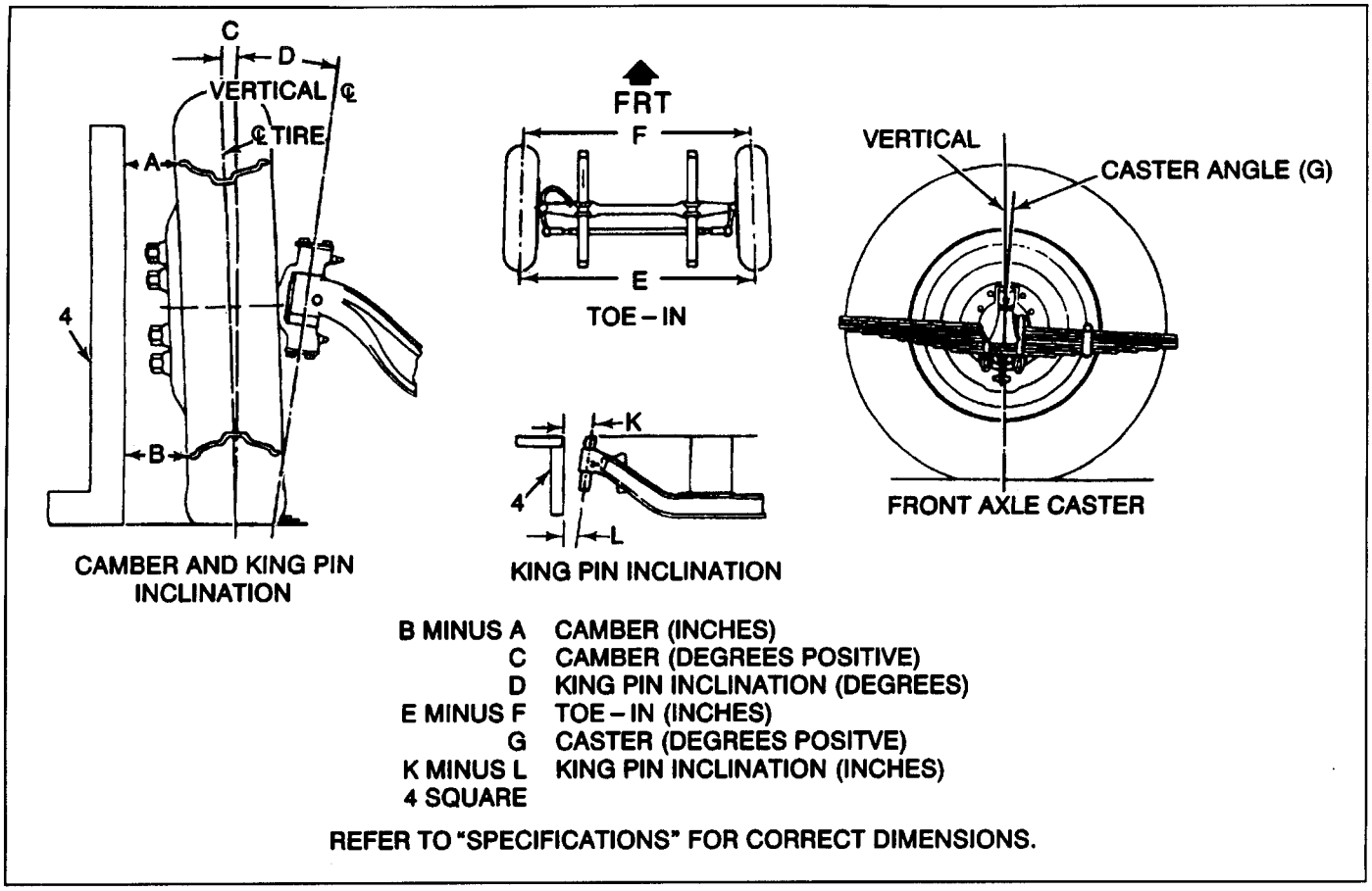

Figure 2—Front Axle I-Beam Alignment Terms

Toe-In (Figure 2)

Toe-in is the adjustment of the front wheels that angles the tires toward each other. The actual amount of toe-in is normally a fraction of a degree. Toe-in is measured from the center of the tire treads or from the inboard side of the tires. The purpose of toe-in is to ensure parallel rolling of the front wheels and to offset any small deflections of the wheel support system which occurs when the vehicle is rolling forward. Incorrect toe-in results in excessive tire wear and unstable steering. Toe-in is the last alignment to be set in the front wheel alignment procedure.

Front Axle Caster (Figure 2)

Caster is the inclination (tilt) of the king pin from vertical to the frame either forward or rearward (G, Figure 2). Incorrect caster may result from sagging springs, bent or twisted axle, or uneven tightening of spring U-bolt nuts. Tighten all U-bolts equally. Refer to SECTION 3C for U-bolt torque specifications. Generally, if the axle is twisted, the caster will be unequal from right to left side.

Frame Angle

The caster, camber, and toe-in dimensions are determined for the vehicle at design load with the frame level. The normal frame angle must be considered when using the alignment equipment. This is most important when making a caster angle check to obtain a true setting.

DIAGNOSIS OF FRONT WHEEL ALIGNMENT

PROBLEM	POSSIBLE CAUSE	CORRECTION
Noisy Front Suspension	1. Worn tie rod ends. 2. Loose suspension bolts. 3. Lack of proper lubrication. 4. Loose shock absorbers or worn bushings. 5. Loose stabilizer shaft or worn insulators.	1. Replace the tie rod ends. 2. Refer to SECTION 3C. 3. Refer to SECTION 0B. 4. Tighten bolts and/or replace the bushings. 5. Tighten bolts and/or replace the insulators.
Wheel Bounce	1. Wheel and tire out of balance. 2. Blister or bump on tire. 3. Improper shock absorber action. 4. Excessive wheel or tire runout. 5. Tire "Lead."	1. Refer to SECTION 3E. 2. Replace the tire. 3. Replace the shock absorber. 4. Refer to SECTION 3E. 5. Refer to SECTION 3E.
Low or Uneven Trim Height	1. Broken or sagging springs. 2. Overloaded or improperly loaded vehicle.	1. Replace the springs. Refer to SECTION 3C. 2. Avoid overloading the vehicle.
Excessive Tire Wear	1. Failure to rotate the tires. 2. Damaged shock absorbers. 3. Improper tire pressure. 4. Incorrect wheel alignment. 5. Overloaded or improperly loaded vehicle. 6. Broken or sagging springs. 7. Loose or worn stabilizer bushings.	1. Refer to SECTION 3E. 2. Replace the shock absorber. 3. Refer to SECTION 3E. 4. Align the wheels. 5. Avoid overloading the vehicle. 6. Replace the springs. Refer to SECTION 3C. 7. Tighten the stabilizer bushing brackets or replace the stabilizer bushings.
Vehicle Leads To One Side Or The Other	1. Keep in mind the road and wind conditions. 2. Front end misaligned. 3. Unbalanced steering gear valve. If this is the cause, steering effort will be very light in direction of lead and heavy in the opposite direction. 4. Steering shaft rubbing the inside diameter of the shaft tube.	1. Test the vehicle, going in both directions, on a flat road. 2. Adjust to specifications. 3. Replace the gear valve. 4. Align or replace the steering column.

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ON-VEHICLE SERVICE

INSPECTION

Before making any adjustments affecting caster, camber or toe-in, the following front end inspection should be made:

Control Arm Front Suspension

Inspect

1. Tires for proper inflation pressure. Refer to SECTION 3E.
2. Front wheel bearing for proper adjustment. Refer to SECTION 3C.
3. Ball joints, tie rod ends, and relay rods. If excessive looseness is noted, correct before adjusting. Refer to SECTION 3B3.
4. Tires and wheels for runout. Refer to SECTION 3E.
5. Adjust the air cylinder pressure to level the vehicle with the vehicle normally loaded. Refer to SECTION 3C. The correction must be made before adjusting caster.
6. Steering gear for looseness at the frame.
7. Shock absorbers for leaks or any noticeable noise. Refer to SECTION 3C.
8. Control arms or stabilizer bar attachments for looseness. Refer to SECTION 3C.
9. Alignment equipment. Follow the manufacturer's instructions.
10. Level of the vehicle. The vehicle must be on a level surface fore and aft and transversely.

I-Beam Front Suspension

Inspect

1. Tires for proper inflation pressure. Refer to SECTION 3E.
2. Front wheel bearing for proper adjustment. Refer to SECTION 3C.
3. Ball joints, tie rod ends, and relay rods. If excessive looseness is noted, correct before adjusting. Refer to SECTION 3B3.
4. Tires and wheels for runout. Refer to SECTION 3E.
5. Steering gear for looseness at the frame.
6. Shock absorbers for leaks or any noticeable noise. Refer to SECTION 3C.
7. I-Beam or stabilizer bar attachments for looseness. Refer to SECTION 3C.
8. Alignment equipment. Follow the manufacturer's instructions.
9. Level of the vehicle. The vehicle must be on a level surface fore and aft and transversely.

FRONT WHEEL ALIGNMENT REQUIREMENTS

Satisfactory vehicle operation may occur over a wide range of front wheel alignment settings. If the settings vary beyond certain tolerances, adjustments are needed. Refer to "Specifications" at the end of this section.

Check front and rear weight for proper distribution. Set the front wheel alignment to specifications while the vehicle is in its normally loaded condition. Vehicles which are consistently operated with heavy loads should have alignment adjustments made with the vehicle under heavy load. This procedure should result in longer tire life.

ALIGNMENT ADJUSTMENTS

Control Arm Suspension

A normal shim pack will leave at least two threads of the bolt exposed beyond the nut. If two threads are not exposed, check for damage to the control arms and related parts. The difference between front and rear shim packs must not exceed 7.62 mm (0.30 inch). The front shim pack must be at least 2.54 mm (0.10 inch).

Access to Shim Packs

Jack up the frame to raise the wheel off the ground. This will allow the upper control arm to drop down far enough to use a socket on the nuts and permit shim adjustment. In some cases, it is necessary to remove the upper control arm bumper for access. Tighten to specifications upon assembly. Refer to SECTION 3C.

Caster

All caster specifications are given with a frame angle of zero. Therefore, it will be necessary to know the angle of the frame (whether "up" or "down" in rear) before a corrected caster reading can be determined. Camber and toe-in can be read "as is" using the alignment equipment.

How to Determine Caster (Figure 3 and 4)

All caster specifications are given with vehicle frame angle of zero.

1. Position the vehicle on a smooth level surface.
2. Use a bubble protractor or inclinometer to measure the frame angle. Frame angle is the degree of tilt in the frame from the level position.
3. Determine whether the frame angle is "up in rear" or "down in rear."
4. Determine the caster angle reading from the alignment equipment.
5. Refer to Figure 3. To determine an "actual (corrected) caster reading" with various frame angles and caster readings, one of the following rules apply:
   A. A "down in rear" frame angle must be subtracted from a positive caster reading.
   B. An "up in rear" frame angle must be added to a positive caster reading.
   C. A "down in rear" frame angle must be added to a negative caster reading.
   D. An "up in rear" frame angle must be subtracted from a negative caster reading.
6. If the actual (corrected) caster angle (Step 5) is not within the recommended caster angle, make the necessary shim changes (Figure 4).

Camber

1. Determine the camber angle using the alignment equipment.
2. Add or subtract shims from both the front and rear bolts to effect a change (Figure 4).

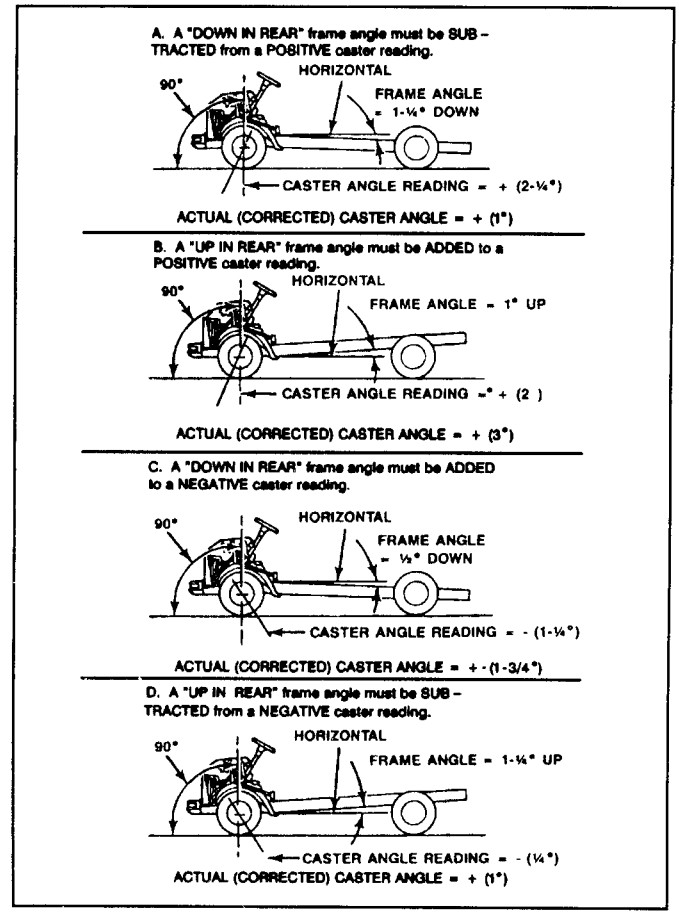

Figure 3—Determining Caster Angle

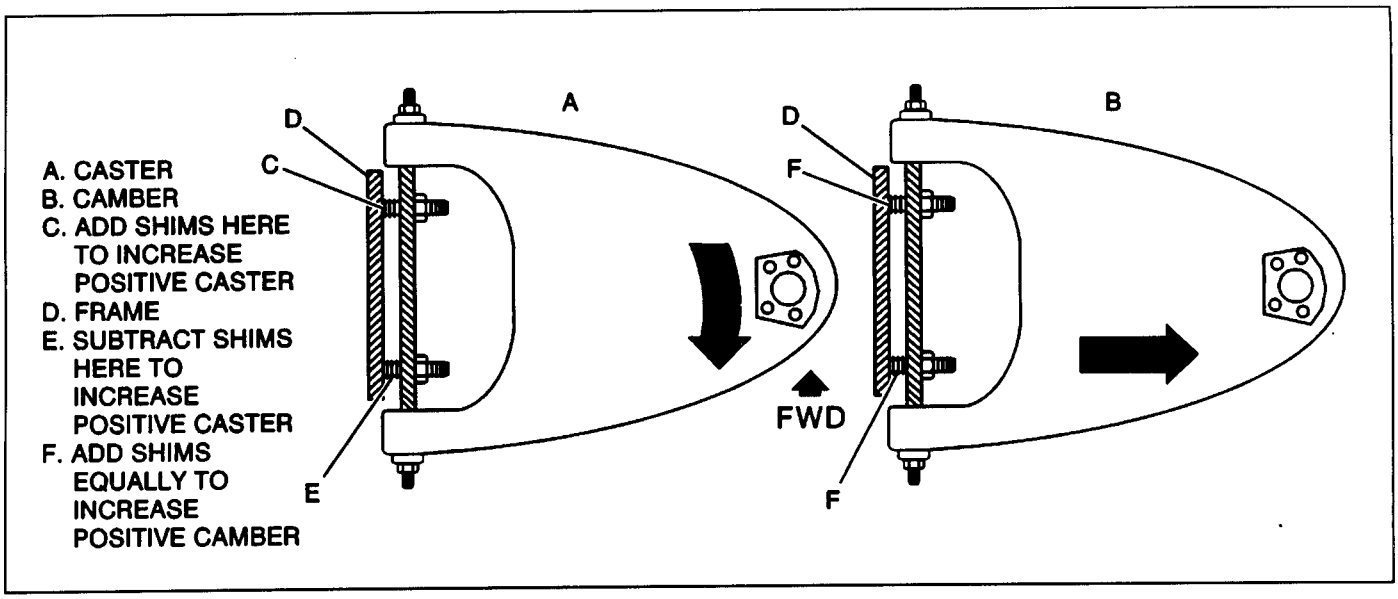

Figure 4—Caster-Camber Adjustment

Toe In (Control Arm and I-Beam Suspensions)

1. Determine the toe settings using the alignment equipment.
2. Change the length of both tie rod sleeves to affect a toe change. Increase or decrease by changing the length of the tie rod ends. A threaded sleeve is provided for this purpose. When the tie rod ends are mounted ahead of the steering knuckle they must be decreased in length in order to increase toe-in. When the tie rod ends are mounted behind the steering knuckle they must be lengthened in order to increase toe-in. Refer to SECTION 3B3 for clamping instructions.

SPECIFICATIONS

CASTER, CAMBER AND TOE SPECIFICATION

Operation	Control Arm Suspension	I-Beam Suspension
Caster	.25° ± .25°	Non-Adjustable
Camber	5.0° ± 0.5°	Non-Adjustable
Sum Toe-In	0.00 in to 0.03 in or 0° to.1°	0.00 in to 0.03 in or 0° to.1°

Note: Vehicle must be at normal load during alignment.

FASTENER TIGHTENING SPECIFICATIONS

Application	N·m	Lb Ft	Lb In
Steering Linkage Tie Rod Adjuster Retaining Nut	25	18	—
Upper Control Arm Bolt	190	140	—