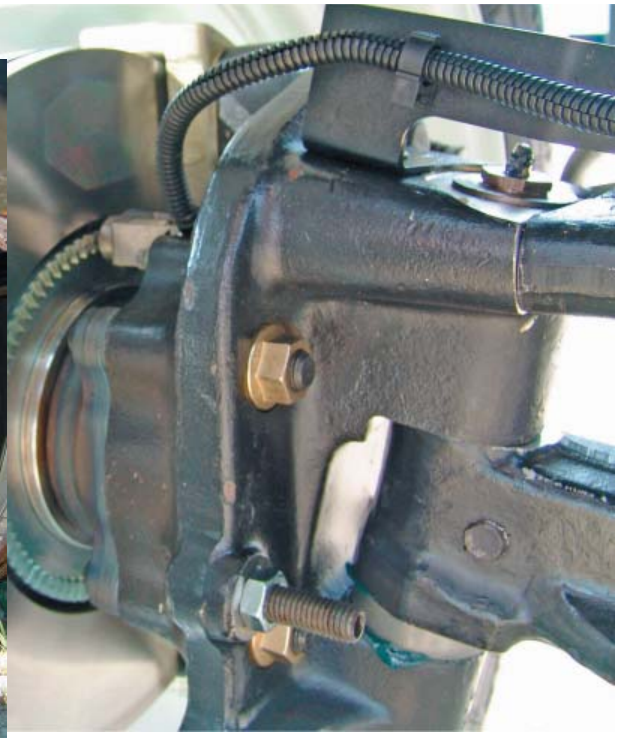
2007
SUSPENSION SYSTEMS



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FASTENER TIGHTENING SPECIFICATIONS

Description	English	Metric
Front Leaf Spring to Hanger Nut	275 N•m	203 lb-ft
Front Leaf Spring to Shackle Nut	275 N•m	203 lb-ft
King Pin Cap	88–129 N•m	65–95 lb ft
Like-Air Auxiliary Spring Mounting Nut	41 N•m	30 lb ft
Lock Pin Nut	68–85 N•m	50–63 lb ft
Rear Leaf Spring to Hanger Nut	480 N•m	354 lb-ft
Rear Leaf Spring to Shackle Nut	480 N•m	354 lb-ft
Shock Absorber Mounting Nut – Front	203 N•m	150 lb ft
Shock Absorber Mounting Nut – Rear	41 N•m	30 lb ft
Stabilizer Bar Clamp Nut	373 N•m	275 lb ft
Steer Arm Slotted Nut**	407–475 N•m	300–350 lb ft
Steering Linkage Tie Rod Adjuster Retaining Nut	25 N•m	18 lb ft
Tierod Arm Slotted Nut**	407–475 N•m	300–350 lb ft
Timken UniPack Wheel Bearing Mounting Cap Screws (52mm Hub/ Bearing Assembly)	183–197 N•m	135–145 lb ft
Timken UniPack Wheel Bearing Lock Nut (58mm Hub/Bearing Assembly)	145–216 N•m	107–159 lb ft
U-bolt Nuts	190 N•m	140 lb ft
Wheel Stud Nut (10-stud wheel)	200 N•m	147 lb ft
Wheel Stud Nut (8-stud wheel)	644 N•m	475 lb ft

WHEEL ALIGNMENT SPECIFICATIONS

Adjustment	Service Checking	Service Setting	Side-to-Side Tolerance
Caster	Not Adjustable	Not Adjustable	Not Adjustable
Camber	Not Adjustable	Not Adjustable	Not Adjustable
Toe	0.03 in. / 0.06° ±0.02 in. / 0.04°	0.03 in. / 0.06° ±0.01 in. / 0.02°	Toe-in equal

TIRE/WHEEL RUNOUT SPECIFICATIONS

Application	Specification	
	Metric	English
Steel Wheel Lateral Runout	1.143 mm	0.045 in
Steel Wheel Radial Runout	1.015 mm	0.040 in
Tire/Wheel Assembly Off-Vehicle (Lateral and Radial)	1.270 mm	0.050 in
Tire/Wheel Assembly On-Vehicle (Lateral and Radial)	1.520 mm	0.060 in
Wheel Stud	0.250 mm	0.010 in
Wheel Hub	0.132 mm	0.0052 in

INTRODUCTION

OBJECTIVES OF THIS SECTION

This section is intended to provide information regarding the suspension systems. This is specific to the W-Series Workhorse Chassis.

Explanations for most components will include purpose, function, operation, and location. Guidance for proper and safe disassembly, inspection, repair, and assembly are provided.

DESCRIPTION AND OPERATION

There are two suspension systems on a Workhorse W-Series chassis:

- Parabolic Leaf Spring System
- Stabil-Ride System

Chassis Series	Suspension System
W16 / W18	Stabil-Ride™
W20 / W22 / W24 / W25	Stabil-Ride™
W42	Parabolic Leaf Spring
W52	Parabolic Leaf Spring

SUSPENSION SYSTEM DESCRIPTION

SUSPENSION SYSTEM COMPONENTS

The suspension system is made up of the following components:

- **Parabolic Leaf Springs**
- **Like-Air™ Auxiliary Springs**
- **Bilstein® Premium Shock Absorbers**
- **Heavy-duty Integral Stabilizer Bar**

Parabolic Leaf Springs

New technology two-leaf parabolic constant rate springs provide excellent force deflection with virtually no inter-leaf friction. This results in an incredibly smooth and stable ride.

Like-Air™ Auxiliary Springs

The unique Like-Air™ auxiliary spring has a three-stage autothane unit that traps air compressing, slowing and controlling the deflection of the parabolic spring, for a smooth, compliant ride while adding side to side stability.

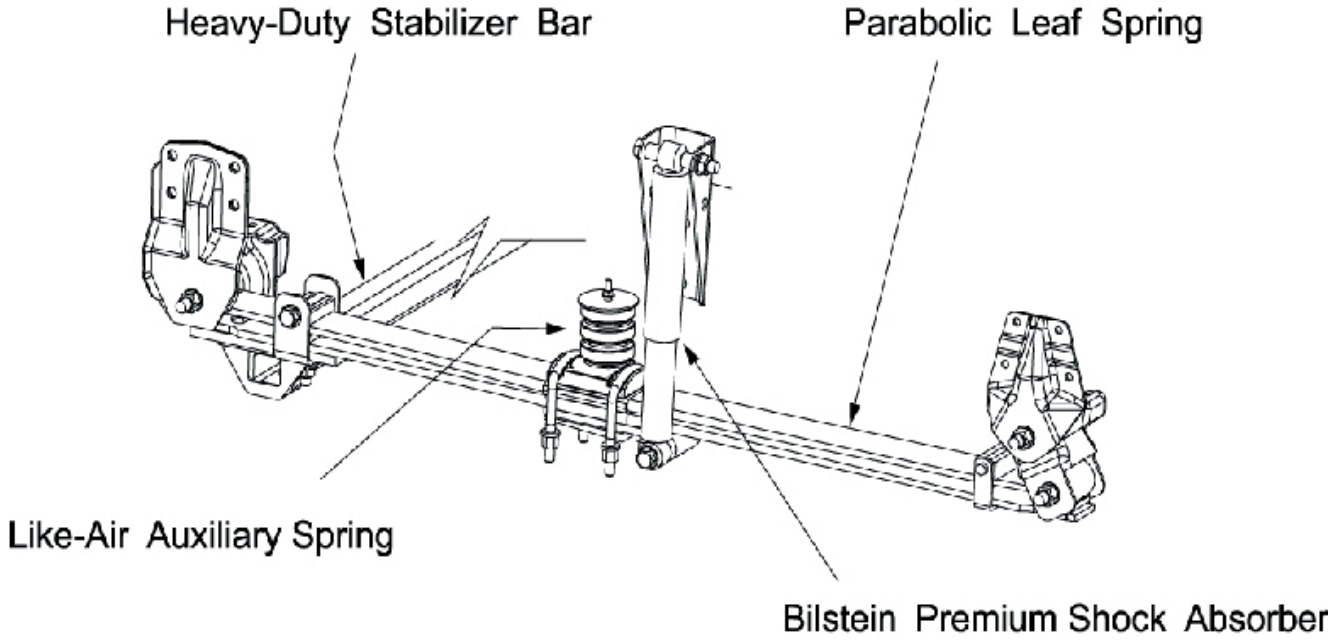
Bilstein® Premium Shock Absorbers

Premium Bilstein® shock absorbers keep the tires firmly on the road, absorbing impacts, so the operator enjoys greater control and comfort.

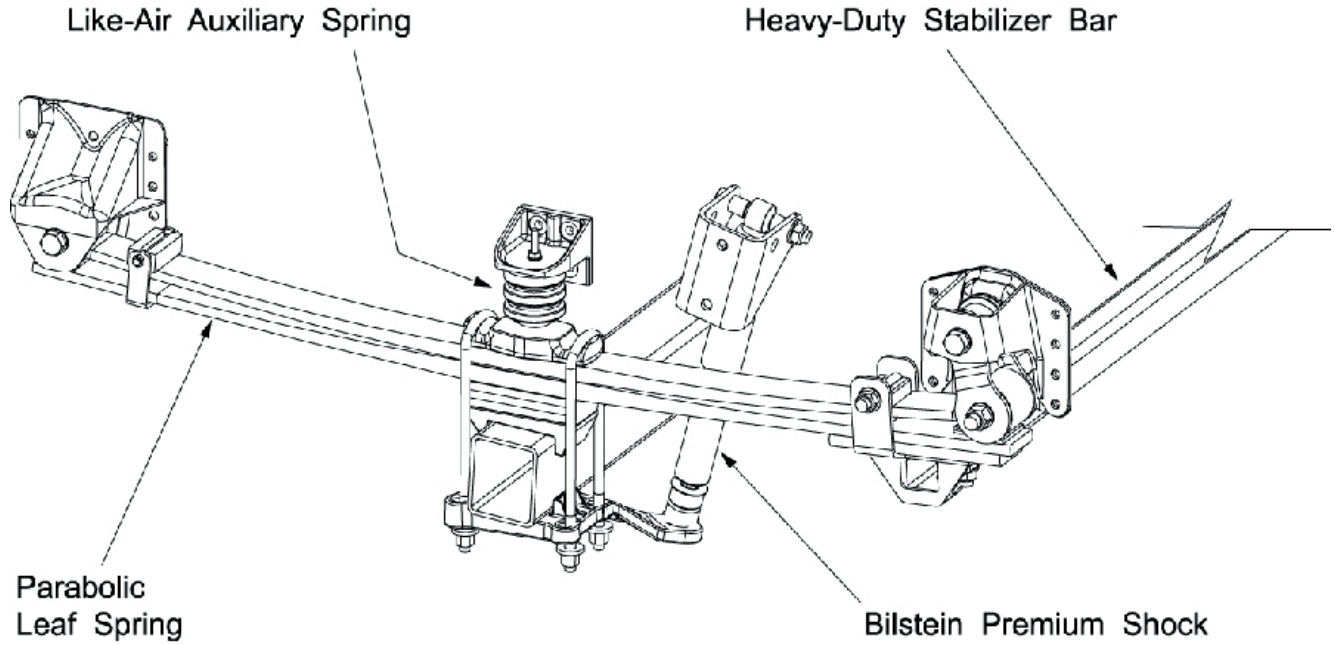
NOTICE:
Prior to March 30, 2004, and VIN 5B4MP67G243392024, Monroe shock absorbers were used.

Heavy-duty Integral Stabilizer Bar

The patented 2.5-inch stabilizer bar quickly controls body roll through integrated steel to steel mounting design - so there's less roll on corners.



Front Suspension Components



Rear Suspension Components

WEIGHT RATINGS

Gross Vehicle Weight Rating (GVWR)

Gross Vehicle Weight Rating (GVWR) also known as GVW is the weight specified by the chassis manufacturer as the maximum loaded weight of the vehicle (including driver and passengers). Sometimes a tag axle (a non-powered rear axle) is added to a chassis by the body manufacturer or by an aftermarket company. This usually is done to increase the GVWR of the chassis. When this is done, it becomes the responsibility of the party that installed the tag axle to post and certify the new GVWR. The addition of axles does not increase GCW.

NOTICE:

Workhorse does not equip the W-Series chassis with tag axles. Any tag axle used would be installed by a body builder or aftermarket upfitter. Any concerns related to, or the result of the addition of a tag axle would be the responsibility of the installer of the tag axle.

Gross Combination Weight Rating (GCWR)

Gross Combination Weight Rating is the maximum amount of combined weight of the chassis including cargo, fluids and passengers as well as any item that is being towed (trailer, boat, vehicle, etc.).

Gross Axle Weight Rating (GAWR)

Gross axle weight rating is specified by the chassis manufacturer as the load carrying capacity of a single-axle system, as measured at the tire-ground interface (in other words, at the place where the tire meets the ground). It is important to note that the GAWR is limited to the lowest individual rating of the tires, the wheels, the springs, or the axle (in other words, whichever component is the weakest link in the chain). Therefore, changing from load range D to load range E or F tires may or may not increase the GAWR, since this rating could be dependent upon other (weaker) components.

The GAWR assumes that the weight is evenly distributed over the axle with 50 percent on the right side and 50 percent on the left side, not 70/30, for instance. In the case of an axle with GAWR of 6,000 pounds, the load distribution should be 3,000 pounds on one side and 3,000 pounds on the other.

Axle weight is both the amount of weight carried by a single axle and the amount of weight transmitted to the highway by one axle. Shipping weight is the average weight of a specific vehicle as it leaves the assembly plant, including grease and oil plus regular production options but without any primary mover engine fuel (gasoline or diesel fuel). Empty weight is defined as the shipping weight of a specific vehicle plus the maximum weight of primary mover engine fuel (gasoline or diesel fuel).

Curb Weight

Curb weight is the weight of the vehicle empty (without payload and driver) but including engine fuel, coolant, engine oil, tools, spare tire, and all other standard equipment. It is determined without water in the tanks or water heater, and with empty LP-gas containers.

(Note: This definition, while accepted within the RV industry, may differ from definitions utilized by governmental regulatory agencies).

Wet Weight

Wet weight is the empty weight of a specific vehicle with the fresh water tanks, water heater, and LP-gas containers full with wastewater holding tanks empty. This weight is particularly significant to vehicle owners, because when this figure is subtracted from the gross vehicle weight rating, a fairly accurate indication of the amount of weight that can be added to the vehicle, including driver and passengers, clothing, food, etc., is provided.

Payload

Payload is a term commonly used in the trucking industry. In the RV industry, the term carrying capacity also is used. Carrying capacity is defined as the average weight that can be added to a specific vehicle without exceeding the GVWR. Carrying capacity can be computed by subtracting the empty weight of the vehicle from the GVWR figure. The addition of any other equipment or cargo and passengers adds to the vehicle from the GVWR figure. The addition of any other equipment or cargo and passengers adds to the vehicle weight and subtracts from the allowable carrying capacity. It is important to remember that the limiting factor in this rating could be the axles, springs, tires, transmission parking pawl, or any other equipment.

Center of Gravity

Center of gravity is the point where the weight of the chassis and/or body, and payload is concentrated. If the vehicle is suspended at that point, it would balance front-to-rear and side-to-side. Cornering, acceleration, and other forces are considered as acting on a vehicle's center of gravity. Thus, it has a great influence on body lean and other handling characteristics. Even if all of the weights fall within the specifications, if they are not distributed properly, the coach could still suffer from excessive body lean or substandard handling characteristics. It should be noted that the center of gravity of a basement model coach would be higher than that of a traditionally designed motor home.

Weight Distribution

Weight distribution is the arrangement of body and payload weight on a vehicle's chassis. It has a very definite bearing on the life of the tires, axles, springs, frame, and other parts. The fact that the total weight of the vehicle does not exceed the recommended

maximum GVWR does not insure that the coach is not overloaded. Overloading can be due to improperly positioning heavy materials so that the load is centered over one rear tire or so far forward on the body that the front axle and tires are overloaded. An understanding of the proper methods of load placement will enable coach owners to prevent an overload condition. It should be noted also that the limiting factor is the weight rating, not the cubic foot capacity of the storage compartments. Some motor home owners may be under the space; it must be acceptable for them to fill each nook and cranny to capacity. This isn't always the case, however. By providing varied and ample storage space, motor coach manufacturers are attempting to meet a multitude of needs.

Weighing a Coach

The only way to be sure to avoid an overload condition is to weigh the coach. To do so accurately, find a scale that has a level area on the side, and develop an excellent rapport with the person doing the weighing. The level side area is very important, because it will be necessary to have 50 percent of the left and right sides of the coach off the scale during some of the weighing. If the side area is not level, side weights will be incorrect. Suitable scales might be found at truck stops, sand and gravel pit operations, or moving companies.

Make a photocopy of the coach weighing worksheet on the next page and use it as a reference at the scale. Weigh the vehicle at an off time, since the entire process can take up to one-half hour. Before weighing the vehicle, it needs to be loaded under normal operating conditions. For motor homes, include food, clothing, fuel, water, propane, etc. For commercial units, include the normal load, fuel, etc.

The worksheet divides the vehicle into four sections. This is done by finding the halfway point between the front and rear tires (axles) and the halfway point between the front tires and then the halfway point between the rear tires. Do not simply use the distance between the front and rear of the coach body; be sure to use the axles as a reference point. Use tape to make the side to-side halfway points on the front bumper and on the rear bumper to make the reference points easily visible. Do the same for the front-to-rear halfway points by applying tape to the side of the coach. Drive the vehicle onto the scale to the point that the front-to-rear tape pieces indicate that one-half of wheelbase is on the scale and one-half is off. Referring to the worksheet, this will be weight number W1.

Next, drive the entire vehicle onto the scale. This will be weight number W2. Then drive off the scale so that the side tape stripe indicates that the rear half of the chassis remains on.

WEIGH IN ORDER USING THE "W" NUMBERS	RATING GAWR/GVWR	ACTUAL WEIGHT	DIFFERENCE + OR -	W4 LEFT FRONT ZONE W4	W5 RIGHT FRONT ZONE W5
W1	FRONT_____	_____	_____	WEIGHT	WEIGHT
W2	REAR _____	_____	_____		
W3	TOTAL_____ GVWR	_____	_____	_____PSI TIRE CHART	_____PSI TIRE CHART
NOTES: Coach should be loaded normally Including passengers				W6 LEFT REAR ZONE W6	W7 RIGHT REAR ZONE W7
				WEIGHT	WEIGHT
				_____PSI TIRE CHART	_____PSI TIRE CHART

This will be weight W3. It is important that one-half of the chassis, not the coach, rests on the scale during weighing.

Weight number W1 should not exceed the GAWR for the front axle. Weight number W2 should not exceed the total GVWR. Weight number W3 should not exceed the rear axle GAWR.

Now comes the time when rapport with the scale attendant and patience come in handy. To make these weights more meaningful, use the side-to-side and front-to-rear tape pieces to divide the chassis up into quarters and then weigh each section: front left, weight zone W4; rear left, weight zone W6; front right, weight zone W5; and finally rear right, weight zone W7.

The weights for zone W4 and zone W5 should be about equal, as should the weights for zones W6 and W7. If this is not the case, try to move items inside the coach to bring the weights close.

When comparing the total weight of the two front quarters to the total axle weight, the figures probably will not be exactly equal, but they should be close. The same applies to the rear axle. It is also possible that the front and rear GAWR when totaled will be more than the GVWR. This is because the limiting factor may be something such as the transmission parking pawl, braking capacity, or another component.

Since tire manufacturers determine pressure recommendations for each individual tire based on the weight that a particular tire is carrying, these quartered weights are very important. Use the front and rear axle weights on the work sheet to determine the proper air pressure by the consulting the tire manufacturer's manual, which should be available at any tire store.

One last word of caution: start with the weight the customer would normally carry when traveling. If the weight places the vehicle over GVWR, remove some weight and weigh the coach again. The importance of weight and weight distribution in terms of safety and the vehicle's overall health cannot be overemphasized. Another term with which vehicle owners should be familiar is gross combination weight rating (GCWR), which is the value specified by the chassis manufacturer as the maximum allowable total loaded weight of the tow vehicle and trailer combination. For our purposes the tow vehicle is the motor home, and the trailer ordinarily is a towed car. To determine what size car can be towed safely behind a motor home, subtract the actual motor home weight, which must be less than the GVWR, from the GCWR. Normally this weight will be approximately 3,000 pounds, in which case the towed car combination (including trailer, dolly or tow bar) should not exceed 3,000 pounds. Weigh the tow car as it is normally towed, and if it is overloaded, remove any weight necessary to bring it into specifications.

PROPER LOADING

Workhorse suggests weighing the vehicle before loading to verify front axle, rear axle and side-to-side weights. Once armed with this information the operator will be able to load the vehicle within specifications of the chassis and possibly correct for any side-to-side weight differences.

After loading Workhorse suggests that the vehicle be weighed again to verify it is within specifications and the weight is properly distributed throughout the coach.

After verifying correct weight distribution of the fully loaded vehicle we suggest the vehicle wheel alignment is checked and adjusted if required. Although the vehicle is aligned at the body manufacturer's assembly plant, the alignment can be affected by normal loading of the contents.

LOADING CONDITIONS AND CORRECTIONS

Unusual load conditions can affect the ride and handling of the vehicle. If unusual loading is apparent, it will usually become visible in the form of a lean and/or low suspension, or through poor handling characteristics.

The importance of a near equal axle-to-frame side-to-side measurement and weights cannot be overstressed. As well as uniformed weight distribution front to rear. Workhorse recommends that the front axle be loaded at least the same percentage of capacity as the rear. For example, if the rear is loaded at 90 percent of rated capacity, the front should be loaded to a minimum of 90 percent of its capacity. A lower percentage of the weight distribution can cause unloading of the front suspension resulting in handling and braking concerns. Even with the preferred weight distribution it is not recommended to have large amounts of weight at the extreme front, rear, or top of the vehicle. A vehicle with an non-uniform weight distribution will directly affect desirable vehicle handling and an acceptable front-end alignment. If there is more weight toward one side of the vehicle, at the extreme rear or the front, repositioning of the load is required to obtain a more uniform weight distribution.

If the vehicle is within the GAWR but heavier on one side having a tendency to lean and weight cannot be shifted due to vehicle build, adjustments may be able to be made.

The addition of a spacer block of sufficient thickness to equalize the left /right axle-to-frame measurement could be installed. Spacer blocks are positioned between the rear axle spring seat and spring pack, never install spacer blocks in the front axle. Spacer blocks are not sold as WCC parts but can generally be fabricated at a local repair facility. Installation of a spacer block and/or spring leaf is not covered by the WCC Limited Warranty and can resolve a lean/sag but may not correct a handling concern.

NOTICE:

The addition of a spacer block/shim can correct for a body lean and retain similar ride quality. These types of adjustments should only be considered if the side-to-side weight variation is less than 600 lbs., if the variation is higher it is recommended to adjust the weight.

NOTICE:

The addition of a spring leaf on chassis with Stabil-Ride spring system should never be considered. Take care when making any adjustment to the leaf springs to ensure axle positioning pins and axle U-Bolts are also adjusted/replaced if needed.

CAUTION:

In making any adjustments, vehicle owners should be cautioned in the use of certain after-market suspension devices. These devices are merchandised as leveling devices to raise the "sagging" of the vehicle that may be caused by an overloading situation or a weight distribution problem. Verify the root cause of the concern prior to the installation of additional suspension components. Also, some of these aftermarket devices can severely limit the wheel travel that was designed into the suspension. Limiting the wheel travel may cause undue stress on other components of the suspension causing premature wear or failure.

WHEEL BEARING DESCRIPTION AND OPERATION

There are two types of front wheel bearings that are used on the front ends of the W-Series chassis.

Standard Front Wheel Bearings

Standard front wheel bearings consist of two tapered roller bearings. The bearings are closed at the outer end by a cap and a gasket. The bearings are closed at the inner end by a seal. These bearings require periodic lubrication with either grease or oil.

Timken UniPack Wheel Bearings

Timken UniPack wheel bearings are only available on the W42 commercial chassis. The UniPack wheel bearings are maintenance free (no lubrication required).

TIRE AND WHEELS DESCRIPTION AND OPERATION

General Description

This section details special service procedures that are not covered in the vehicle's Owner's Manual. For jacking instructions, basic tire changing and rotation instructions, and a detailed explanation of all other owner oriented information, refer to the vehicle's Owner's Manual.

Tire Inflation Description

IMPORTANT:
The use of wheels or tires with higher load capacity ratings than originally equipped on the vehicle will not increase the gross axle weight rating (GAWR) or the gross vehicle weight rating (GVWR) of the vehicle.

The factory installed tires and wheels are designed to handle loads up to and including the rated load capacity, shown on the vehicle certification label, when the tires are inflated to the recommended inflation pressures.

Correct tire pressures and driving techniques affect tire life. Underinflated tires can cause the following conditions:

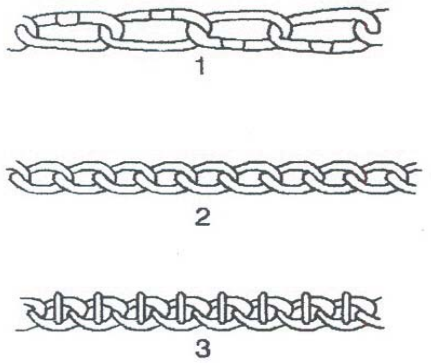
- Handling problems
- Poor fuel economy
- Shortened tire life
- Tire overloading

The following actions can also increase tire wear:

- Heavy cornering
- Excessively rapid acceleration
- Unnecessary braking

Tire Chain Usage Description

When using tire chains, most current vehicles require the following chain types:



Legend

- (1) SAE Class S or 1100 Series, Type P tire chains
- (2) SAE Class U or 1200 Series, Type P tire chains
- (3) 1800 Series Lug Reinforced tire chains

These chains are specially designed to limit the fly-off effect that occurs when the wheel rotates.

Manufacturers of tire chains have a specific chain size for each tire size. These ensure a proper fit when the chains are installed. Purchase the correct chains for the tires on which the chains will be used. Do not use rubber adjusters to take up slack in chains that are loose due to incorrect size. Always follow the chain manufacturer's installation instructions.

Use of chains may adversely affect handling. When using chains, remember the following information:

- Ensure that the vehicle is designed for chain clearance.
- Adjust the speed to road conditions.
- Avoid sharp turns.
- Avoid locked-wheel braking in order to help prevent chain damage to the vehicle.
- Install the chains as tightly as possible on the drive tires. Tighten the chains again after driving 0.4-0.8 km (1/4 - 1/2 mi). Do not use chains on the non-drive tires. These chains may contact and damage the vehicle. If tire chains are used on the non-drive tires, ensure that there is enough clearance.
- Do not exceed 70 km/h (45 mph). Do not exceed the chain manufacturer's speed limit, if lower.
- Drive in a restrained manner. Avoid large bumps, potholes, severe turns, and other maneuvers that cause the tires to bounce up and down.
- Follow any other instructions from the chain manufacturer that do not disagree with the above.

Replacement Tires Description

CAUTION:

Do not mix different types of tires on the same vehicle such as radial, bias, and bias-belted tires except in emergencies because vehicle handling may be seriously affected and may result in loss of control and possible serious injury.

IMPORTANT:

Install new tires in pairs on the same axle. If only one tire requires replacement, the new tire should be paired with the tire that has the most tread.

A Tire Performance Criteria (TPC) specification number is molded in the sidewall near the tire size of all original equipment tires. This number ensures that the tire meets performance standards for traction, endurance, dimension, noise, handling, rolling resistance, and others. A specific TPC number usually is assigned to each tire size.

Replacement tires should be the same size, load range, and construction as the original tires. Replace the original tires with tires that have the same TPC specification number. Use of any other tire size or type may seriously affect the following items:

- Vehicle ride
- Vehicle handling
- Speedometer/odometer calibration
- Vehicle ground clearance
- Tire clearance to the body and chassis

Replace tires when the following conditions are found:

- The tires are worn to a point where 1.6 mm (1/16 in) or less tread remains, or, the cord or fabric shows. The tires may have built-in tread wear indicators that appear between the tread grooves when the tread is 1.6 mm (1/16 in) or less. When the indicators appear in two or more adjacent grooves at three spots around the tire, replace the tire.
- The tread or sidewall is cracked, cut, or snagged deep enough to expose the cord or the fabric.
- The tire has a bump, bulge, or a split. Slight sidewall indentations are normal and this should not affect ride.
- The tire has a puncture, a cut, or other damage that cannot be repaired correctly because of the size or location of the damage.

All Seasons Tires Description

Some vehicles are equipped with all-season radial tires as standard equipment.

These tires have a 37 percent higher average rating for snow traction than non ail-season radial tires previously used. For this reason, these qualify as snow tires. These tires are identified by an M+S, M&S, or M–S molded in the tire sidewall after the size.

P-Metric Sized Tires Description

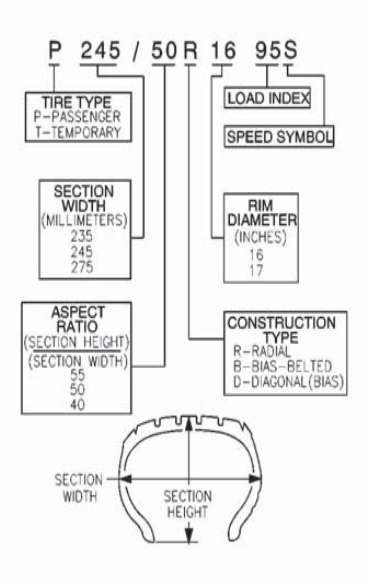
Most P-metric tires do not have exactly corresponding alphanumeric tire sizes. A P205/75R15 is not equal in size and load carrying capacity to an FR78-15.

Because of this, replacement tires should be of the same TPC specification number (size, load range, and construction) as those originally on the vehicle. If P-metric tires must be replaced with other sizes, consult a tire dealer. Tire companies can best recommend the closest match.

Identify radial-ply by the letter R or Radial on the sidewall. Encoded on the side wall are the tire type, the tire size, and the aspect ratio (eg. P245/50R16).

The following are the code designations:

- P is passenger car (LT is light trucks)
- 245 is the section width (1) of the tire
- R is the radial type design construction
- 50 is the aspect ratio (2) (height to width ratio)
- 16 is the rim diameter in inches.



An all-season tire has either M+S, M&S, or M-S imprinted on the sidewall.

Tire Placard Description

The tire information label is on the rear face of the driver's door. Refer to this label for tire information. The label lists the following items:

- Maximum vehicle load
- Tire size
- Cold inflation pressure

WHEELS DESCRIPTION

Replace any wheel when the following conditions apply:

- A bent wheel
- A dented wheel
- Wheels with excessive lateral or radial runout
- The welds leak air
- Elongated bolt holes
- The wheel nuts will not stay tight

Wheels with runout greater than specified may cause objectionable vibrations.

Wheel Repair Description

Do not use heating, welding, or peening to repair wheels. These methods are not approved. Do not use inner tubes to repair leaky wheels or tires. If leaks are found in a steel wheel, replace the wheel with a wheel of original equipment quality.

WHEEL ALIGNMENT DESCRIPTION

Wheel alignment is not set at the Workhorse assembly plant. Due to weight distribution differences from body manufacturer to body manufacturer, each body manufacturer is required to set wheel alignment prior to delivery.

When discussing wheel alignment it is important to understand basic terminology. The terms used are:

- Camber
- Caster
- Lead/Pull
- Memory Steer
- Setback
- Toe
- Wander

Camber Description

The tilting of the top of the wheels inward or outward from the vertical position (when viewed from the front of the vehicle) is called camber. If the wheels tilt outward at the top, then camber is positive (+). If the wheel tilts inward at the top, then camber is negative (-). Camber is measured in degrees from the vertical.

Camber affects the directional control of the vehicle and tire wear.

- Excessive positive camber will result in premature wear on the outside of the tire and cause excessive wear on the suspension parts.
- Excessive negative camber will result in premature wear on the inside of the tire and cause excessive wear on the suspension parts.
- If camber varies wheel-to-wheel (side-to-side) 1 degree or more will result in the vehicle pulling or leading to the side with the most positive camber.

Caster Description

The tilting of the uppermost point of the steering axis either forward or backward, when viewed from the side of the vehicle, is called caster. When the steering axis is tilted rearward at the top, it is considered positive (+). When the steering axis is tilted forward at the top, it is considered negative (-). Caster influences directional control of the steering but does not affect the tire wear. Caster is affected by the vehicle height, therefore it is important to keep the body at its designed height. Overloading the vehicle or a weak or sagging rear spring will affect caster. When the rear of the vehicle is lower than its designated trim height, the front suspension moves to a more positive caster. If the rear of the vehicle is higher than its designated trim height, the front suspension moves to a less positive caster.

With too little positive caster, steering may be touchy at

high speed and wheel returnability may be diminished when coming out of a turn. If one wheel has more positive caster than the other, that wheel will pull toward the center of the vehicle. This condition will cause the vehicle to pull or lead to the side with the least amount of positive caster.

Lead/Pull Description

Lead/pull is described as the amount of effort required at the steering wheel to maintain the vehicle's straight path, while driving at a constant highway speed on a typical straight road,

IMPORTANT:
Vehicles will tend to lead/pull in the direction of the road slope as part of normal operation.

Lead/pull is usually caused by the following factors:

- Road slope
- Variances in tire construction
- Wheel alignment (front cross caster and camber)
- Unbalanced steering gear

Memory Steer Description

If a vehicle wants to lead or pull in the direction the driver previously turned the vehicle, regardless of the direction turned, the condition is called memory steer.

Setback Description

Setback refers to the amount that one wheel may be aligned behind the other wheel on the same axle. Setback may be the result of a road hazard or a collision. The first clue is a caster difference from side-to-side of more than 1 degree.

Toe Description

The front wheels will be turned in or out from a straight-ahead position. This is referred to as toe. When the front of the wheels are turned inward, toe is positive (+). When the front of the wheels are turned outward, toe is negative (-). The purpose of toe is to ensure that the wheels roll parallel.

Toe will typically be set slightly positive with the vehicle at rest. As the vehicle starts rolling forward, road friction and movement of the front suspension/steering components will allow the wheels to deflect so that they will be at 0 toe, or very slightly positive toe

If toe is adjusted incorrectly, premature tire wear and steering instability will be the result.

Toe is measured in degrees and adjustments of toe are normally made in fractions of a degree.

Wander Description

If the vehicle drifts or deviates from the desired straight path, while hand pressure is being applied to steady the steering wheel, this condition is called wander. Wander is a symptom of the vehicle's sensitivity to external disturbances, such as road crown or crosswind. Wander is accentuated by poor on-center steering feel.

DIAGNOSTIC INFORMATION AND PROCEDURES

Suspension System Diagnosis

Vehicle Leads/Pulls (to one side – no braking)

Problem	Action
Tire pressure is low.	Inflate the tires to the recommended pressure.
The front or rear brakes are dragging.	Adjust the brakes.
A front spring is broken or sagging.	Replace the spring.
Vehicle alignment is out of adjustment.	Align the vehicle as needed.

Vehicle Leads/Pulls (leads to either side)

Problem	Action
Wind or road conditions is the cause	Test the vehicle, driving in both directions, on a smooth, flat road, on a calm day.
Vehicle alignment is out of adjustment.	Align the vehicle as needed.
The steering gear is unbalanced (if this is the cause, steering effort will be very light in the direction of the lead, and very heavy in the opposite direction).	Replace the gear valve.
The steering shaft is rubbing the inside diameter of the shaft tube.	Align the steering column. If aligning the steering column does not fix the problem, replace the steering column.

Abnormal or Excessive Tire Wear (Excessive or Uneven)

Problem	Action
Tires are either over or under inflated.	Inflate the tires to the recommended pressure.
Toe setting is out of adjustment.	Align the vehicle as needed.
The wheel and tire are out of balance.	Balance the wheel/tire assembly.
The vehicle operator has used hard driving techniques.	Instruct the operator about proper driving techniques
The vehicle is or has been overloaded.	Weigh the vehicle (four corner weights are preferred). Educate the vehicle operator about proper loading techniques.

Abnormal or Excessive Tire Wear (Cupped Tires)

Problem	Action
The front shock absorbers are worn.	Replace the front shock absorbers.
The wheel bearings are improperly adjusted or worn.	• If the wheel bearings are out of adjustment, adjust them. * If the wheel bearings are worn, replace them.
The wheel/tire assembly are out of balance.	Balance the wheel/tire assembly.
The wheel/tire assembly has excessive runout.	Correct the condition if possible. If it is not possible, replace the wheel/tire assembly.

Abnormal or Excessive Tire Wear (General)

Problem	Action
The tires were not rotated.	Instruct the vehicle operator on proper tire rotation intervals and methods.
The front shock absorbers are worn.	Replace the front shock absorbers.
The tires are not inflated properly.	Inflate the tires to the recommended pressure.
The vehicle is or has been overloaded.	Weigh the vehicle (four corner weights are preferred). Educate the vehicle operator about proper loading techniques.
A spring is broken or sagging.	Replace the spring.
The stabilizer bushing is worn or damaged, or the brackets are loose.	Check the stabilizer bushings. • If the bushing brackets are loose, tighten them to specification. • If the bushing is worn or damaged, replace the stabilizer bushing.

Abnormal or Excessive Tire Wear (Scuffed Tires)

Problem	Action
Toe setting is out of adjustment.	Align the vehicle as needed.
The operator uses excessive speed on turns.	Instruct the operator about proper driving techniques.
The tires are not inflated properly.	Inflate the tires to the recommended pressure.
A suspension component is damaged or worn.	Diagnose the suspension and repair as needed.

Wheel Tramp

Problem	Action
DEFINITION: The wheel and tire bounce onto and off of the road in direct relation to vehicle speed.	
The wheel/tire assembly are out of balance.	Balance the wheel/tire assembly.
The tire is out of round.	Replace the tire.
There are blisters or bumps on the tire.	Replace the tire.
The shock absorber is not working correctly.	Replace the shock absorber.
The wheel/tire assembly has excessive runout.	Refer to Tire and Wheel Vibration Diagnosis and Correction.
The tire leads.	Refer to Vehicle Leads/Pulls (to one side – no braking) or to Vehicle Leads/Pulls (leads to either side)

Noisy Front Suspension

Problem	Action
The tie rod ends are worn.	Replace the tie rod ends.
The suspension bolts are loose.	Tighten the suspension bolts to specification.
The front suspension lacks proper lubrication.	Lubricate the front suspension to specification.
The shock absorbers are loose.	Tighten the shock absorber bolts.
The stabilizer shaft is loose.	Tighten the stabilizer shaft mounting bolts to specification.
The stabilizer shaft insulators are worn or damaged.	Replace the bushing.

Poor Directional Stability

Problem	Action
The steering linkage lacks lubrication.	Lubricate the steering linkage to specification.
Tire pressure is low.	Inflate the tires to specification.
The wheel bearings are improperly adjusted or worn.	• If the wheel bearings are out of adjustment, adjust them. * If the wheel bearings are worn, replace them.
Vehicle alignment is out of adjustment.	Align the vehicle as needed.
A spring is broken or sagging.	Replace the spring.
A shock absorber is not functioning correctly.	Inspect the shock absorber. Replace the shock absorber as needed.
The stabilizer shaft is loose, damaged, or broken.	Inspect the stabilizer shaft. • If the stabilizer shaft is loose, tighten the bracket bolts. * If the stabilizer shaft is damaged or broken, replace it.

Noise Diagnosis – Front Suspension

Problem	Action
The steering linkage needs lubrication.	Lubricate the front suspension to specification.
The shock absorber is loose.	Tighten the shock absorber bolts to specification.
The shock absorber bushings are worn.	Replace the shock absorber.
The wheel bearings are improperly adjusted or worn.	• If the wheel bearings are out of adjustment, adjust them. * If the wheel bearings are worn, replace them.
The stabilizer shaft is loose, damaged, or broken.	Inspect the stabilizer shaft. • If the stabilizer shaft is loose, tighten the bracket bolts. * If the stabilizer shaft is damaged or broken, replace it.
The wheel nuts are loose.	Tighten the wheel nuts to specification.
The spring is improperly positioned.	Reposition the spring.
The king pins and bushings are worn.	Replace the bushings and king pins.

Shock Absorbers Binding (Rear)

Problem	Action
The shock absorber has a scored rod.	Replace the shock absorber.
The shock absorber is dented.	Replace the shock absorber.
The shock absorber is leaking.	Replace the shock absorber.

Shock Absorbers Noisy (Rear)

Problem	Action
The shock absorber has broken mounts.	Replace the shock absorber.
The shock absorber has extreme bushing wear.	Replace the shock absorber.

Spring Noise

Problem	Action
The spring has loose U-bolts	Tighten the U-bolts to specification.
The spring has loose or worn eye bushings.	Replace the eye bushings.
The spring lacks lubrication.	Lubricate to specifications.
The shock absorbers are inoperative.	Replace the shock absorber.

Spring Sags or Bottoms (Rear)

Problem	Action
The shock absorbers are inoperative.	Replace the shock absorbers.
The spring has a broken leaf.	Replace the spring assembly.
The vehicle was used under severe operation or the vehicle has been overloaded.	Check the load capacity rating.

Spring Breakage (Rear)

Problem	Action
The spring has loose U-bolts.	Tighten the U-bolts to specification.
The spring shows normal fatigue.	Replace the spring.
The vehicle is overloaded.	Check the load capacity rating.

Front Wheel Shimmy

Problem	Action
DEFINITION: Vehicle front wheel shimmy or shake while driving on a smooth road.	
The wheel/tire are out of balance.	Balance the tires.
The wheel/tire assembly are out of round.	Check the runout. Replace the wheel/tire as needed.
The wheel bearings are improperly adjusted or worn.	• If the wheel bearings are out of adjustment, adjust them. * If the wheel bearings are worn, replace them.
The king pins and bushings are worn.	Replace the bushings and king pins.
A shock absorber is not functioning correctly.	Inspect the shock absorber. Replace the shock absorber as needed.

Low or Uneven Trim Height

Problem	Action
The springs are broken or sagging.	Replace the springs.
The vehicle is overloaded or improperly loaded.	Instruct the vehicle operator on proper loading techniques.

Shock Absorber Bench Test (Non-Spiral Groove)

Testing Procedure

It is not necessary to purge air from non-spiral groove shock absorbers. These shock absorbers contain a gas filled cell within the shocks reservoir. These shocks differ from spiral groove shocks. Spiral groove shocks contain an air filled cell within the reservoir.

1. Remove the shock absorber from the vehicle.

NOTICE:
Do not clamp the vise jaws on the shock absorber reservoir tube or shaft. Doing so could damage component.

2. Place the shock absorber in a vise. Clamp the jaws on the top mounting stud of the shock. Hold the shock vertically in the vise with the bottom end up.
3. Pump the shock at various rates of speed. Observe the rebound force. The rebound force normally is stronger than the compression force (approximately two to one). The rebound force should be smooth and constant for each stroke rate.
4. Compare this shock with a good shock absorber.
5. Pump the shock one full stroke in both directions. If any of the following conditions occur, replace the shock absorber:

- A skip, or a lag, at reversal near mid-stroke.
- A seizing (except at the extreme ends of travel).
- A noise, a grunt or a squeal, after completing.
- A clicking noise at fast reversal.

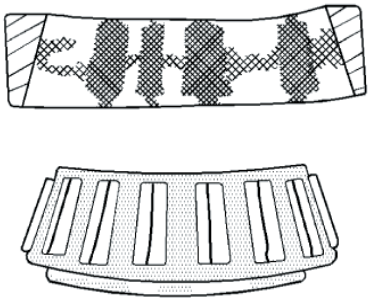
WHEEL BEARING DIAGNOSIS

Tapered Roller Bearing Diagnosis

Diagnosing wheel bearings is done using the following steps:

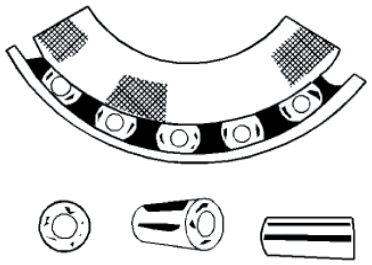
- Make note of the general condition of all parts during disassembly
- Classify the failure with the aid of the illustrations.
- Determine the cause.
- Make all repairs following recommended and inspection procedures.

Abrasive Roller Wear



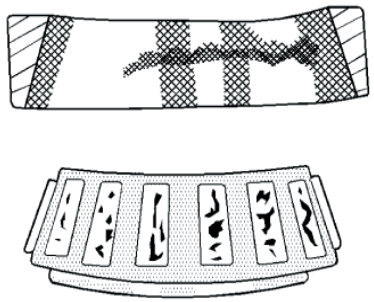
A pattern on the roller ends may be caused by fine abrasives. Clean all of the parts and the housings. Check the seals and the bearings. Replace any leaky, rough, or noisy bearings.

Galling



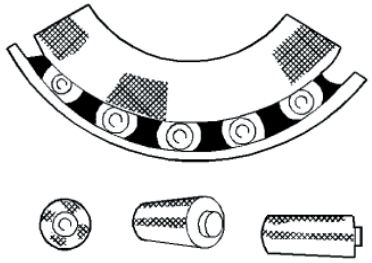
Metal smears on the roller ends may be due to overheating, lubricant failure, or lubricant overload. Replace the bearing. Check the seals. Check for proper lubrication.

Etching



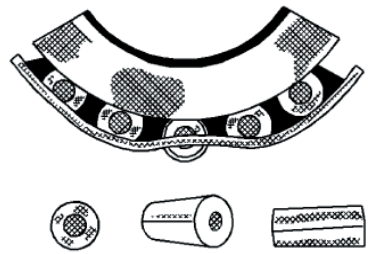
Bearing surfaces may appear gray or grayish black in color; with related etching away of material, usually at the roller spacing. Replace the bearings. Check the seals. Check for proper lubrication.

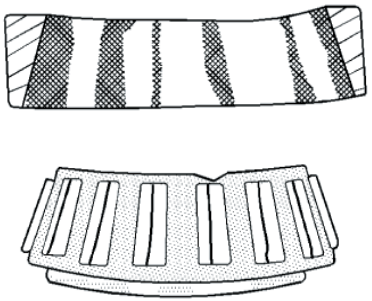
Abrasive Step Wear



A pattern on the roller ends may be caused by fine abrasives. Clean all of the parts and housings. Check the seals and the bearings. Replace the bearing if the bearing is leaking, rough, or noisy.

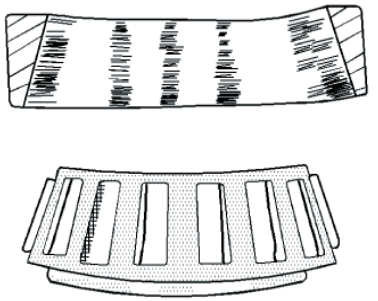
Bent Cage





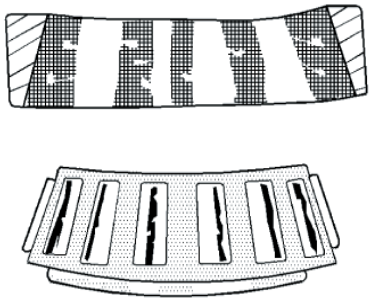
The cage may be damaged due to improper handling or improper tool usage. Replace the bearing.

Cage Wear



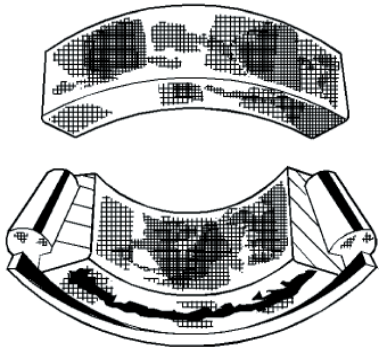
Wear around the outside diameter of the cage and the roller pockets may be caused by abrasive material. Wear may be caused from inefficient lubrication. Clean the related parts and the housings. Check the seals. Replace the bearings.

Indentations



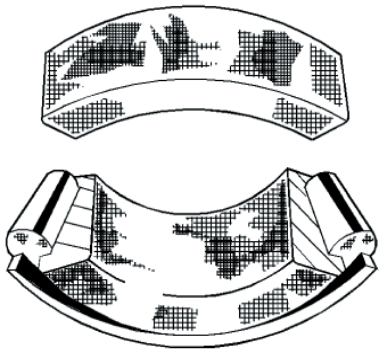
Surface depressions on the race and the rollers may be caused by hard particles of foreign matter. Clean all the parts and the housings. Check the seals. Replace rough or noisy bearings.

Frettage



Corrosion may be caused by a small relative movement of parts with no lubrication. Replace the bearing. Clean the related parts. Check the seals. Check for proper lubrication.

Smears

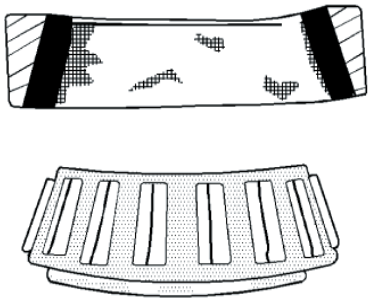


Smearing of the metal may be due to slippage. Slippage can be caused by the following factors:

- Poor fits
- Inadequate lubrication
- Overheating
- Overloads
- Handling damage

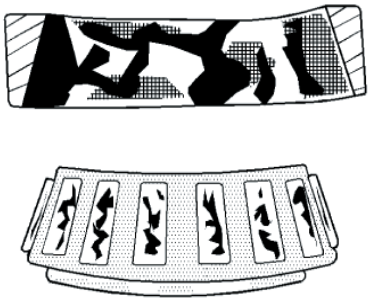
Replace the bearings. Clean the related parts. Check for proper fit and lubrication.

Stain Discoloration



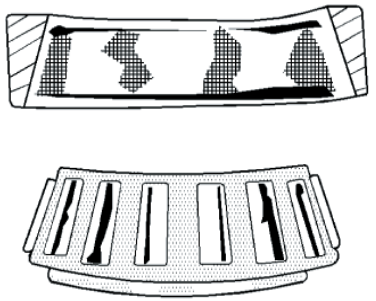
Discoloration, ranging from light brown to black, is caused by incorrect lubrication or moisture. Reuse the bearing if the stains can be removed with light polishing. Reuse the bearing if there is no evidence of overheating. Check the seals and the related parts for damage.

Heat Discoloration



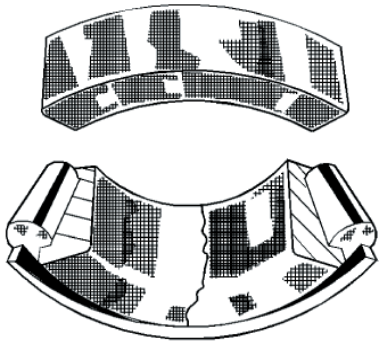
Heat discoloration ranges from faint yellow to dark blue. It is the result of overload or an incorrect lubricant. Excessive heat causes softening of the races or the rollers. To check for loss of temper on the races and the rollers, perform a file test. A file drawn over a tempered part will grab and cut the metal. A file drawn over a hard part will glide readily with no metal cutting. Replace the bearings heat damaged. Check the seals and the other related parts.

Misalignment



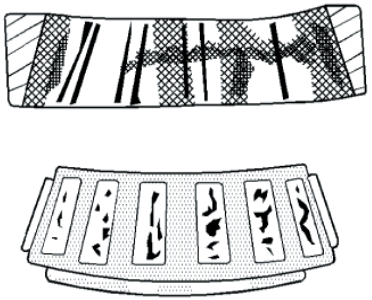
The outer race is misaligned due to a foreign object. Clean the related parts. Replace the bearing. Ensure the races are properly sealed.

Cracked Inner Race



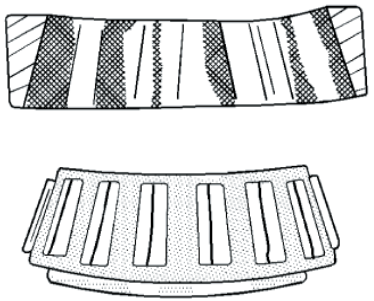
A cracked race may be due to improper fit, cocking, or poor bearing seats. Replace the bearing. Correct the bearing seats.

Fatigue Spalling



Spalling is a result of fatigue and is evidenced by a flaking metal surface. Replace the bearing. Clean all related parts.

Brinelling



Surface indentations in the race way are caused by the rollers under impact loading or are caused from vibration while the bearing is not rotating. Replace a rough or noisy bearing.

Timken Wheel Bearing Diagnosis

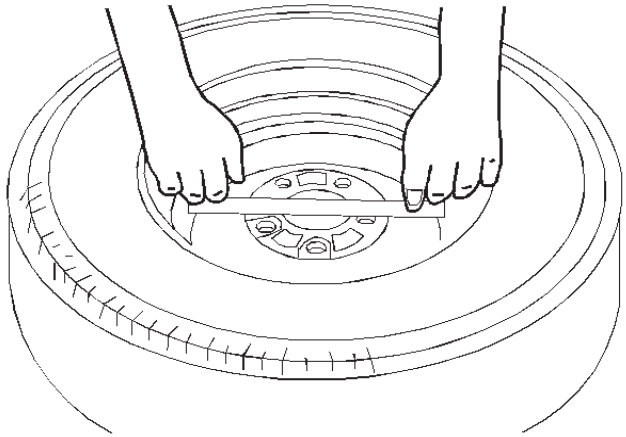
1. Lift and support the front of the vehicle.
2. Rotate the wheel to check for any binding or roughness. If roughness or binding is felt, replace the hub assembly.
3. Remove the wheel and tire assembly. Check the hub assembly for looseness or endplay. If endplay exceeds 0.127 mm (0.005 in), replace the hub assembly.
4. Remove the tire and wheel assembly. Inspect the inboard and outboard seals. If damage is visible, replace the hub assembly.

IMPORTANT:

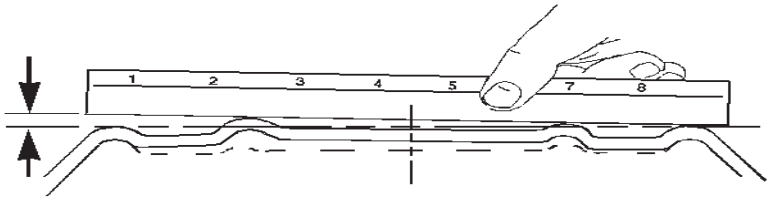
The seals will likely have some purge grease on them. DO NOT wipe this purge grease off of the seals. The purge grease acts as a secondary contamination blocker, effectively sealing out dirt and moisture.

Tire and Wheel Diagnosis

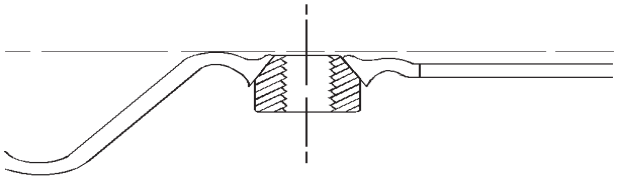
Wheel Mounting Surface Check



1. Use a straight edge 203-229 mm (8-9 in) long. Place the straight edge on the wheel inboard mounting surface. Try to rock the straight edge up and down within the mounting surface.



2. Repeat this procedure on at least 3 or 4 different positions on the inboard mounting surface.
   - The outer ring of the mounting surface normally is raised above everything inside the mounting surface.
   - The mounting surface is raised above the outer ring if the wheel mounting surface is bent on a tire changer.



3. Inspect the mounting wheel nut holes for damage caused from over-torquing the wheel nuts. Inspect for collapsed wheel nut bosses. Inspect for cracked wheel bosses.

NOTICE:
The use of aftermarket reverse-type wheels, designed to extend the wheel away from the body, will increase the scrub radius. An increased scrub radius may greatly increase steering effort and reduce hub bearing life.

IMPORTANT:

- Replacement wheels must be equivalent to the original equipment wheels in the following ways:
  - Load capacity
  - Wheel diameter
  - Rim width
  - Wheel offset
  - Mounting configuration
- A wheel of incorrect size or type may affect the following conditions:
  - Wheel and hub-bearing life
  - Brake cooling
  - Speedometer/odometer calibration
  - Vehicle ground clearance
  - Tire clearance to the body and the chassis

4. Replace the wheel if the wheel is bent. Replace the wheel if the wheel nut boss area is cracked.

Identify steel wheels with a 2 or 3 letter code stamped into the rim near the valve stem.

Measuring Tire/Wheel Runout

Excessive wheel runout can result in vibration. When discussing runout, it can take two forms.

- Radial runout
- Lateral runout

Radial Runout (Tire)

When talking about radial runout, the typical method of measuring runout is with a roller tipped dial indicator.

1. Mount the dial indicator on a stationary component. Typically this is done using a magnetic dial indicator base.
2. Unlock the flexible arm of the dial indicator.
3. Position the tip of the dial indicator on the tread of the tire, with the roller running in the same direction as the tread of the tire.
4. Lock the flexible arm of the dial indicator.

5. Rotate the wheel while monitoring the gauge, until the lowest point is located. Stop rotating the wheel at this specific point.
6. Zero the gauge.
7. Rotate the wheel while monitoring the gauge, until the highest point is located. Make note of this reading.
8. Compare the reading to the specifications. If the reading exceeds specification, replace the tire.

Lateral Runout (Tire)

Lateral runout of a tire is measured using a dial indicator. Follow the steps below:

1. Mount the dial indicator on a stationary component. Typically this is done using a magnetic dial indicator base.
2. Unlock the flexible arm of the dial indicator.
3. Position the tip of the dial indicator on the sidewall of the tire, with the roller running in the same direction as the tire.
5. Lock the flexible arm of the dial indicator.
6. Rotate the tire while monitoring the gauge, until the lowest point is located. Stop rotating the tire at this specific point.
7. Zero the gauge.
8. Rotate the tire while monitoring the gauge, until the highest point is located. Make note of this reading.
9. Compare the reading to the specifications. If the reading exceeds specification, replace the tire.

Lateral Runout (Wheel)

Lateral runout of a wheel can be measured using a dial indicator, or some computerized tire/wheel assembly balancers also have the capability to measure lateral runout.

When measuring lateral runout using a computerized tire/wheel assembly balancer, make sure to follow the instruction manual provided with that balancer.

When using a dial indicator, follow the steps below:

1. Remove any wheel weights on the wheel.
2. Mount the dial indicator on a stationary component. Typically this is done using a magnetic dial indicator base.
3. Unlock the flexible arm of the dial indicator.
4. Position the tip of the dial indicator on the bead of the wheel, with the roller running in the same direction as the wheel.
5. Lock the flexible arm of the dial indicator.
6. Rotate the wheel while monitoring the gauge, until the lowest point is located. Stop rotating the wheel at this specific point.
7. Zero the gauge.
8. Rotate the wheel while monitoring the gauge, until the highest point is located. Make note of this reading.
9. Compare the reading to the specifications. If the reading exceeds specification, replace the wheel.

Balancing the Tire/Wheel Assembly

Workhorse balances all tire/wheel assemblies at the factory during the assembly process. The wheels have a tool mark (indentation) on the rim to indicate that specific wheel's heaviest point. Conversely, the tires are delivered with a paint mark to indicate that specific tire's lightest point. When the tire is mounted on the wheel, these two marks are lined up to help with the final balance procedure.

The only method recommended by Workhorse for balancing tire/wheel assemblies is dynamic balancing. Follow the instructions provided by the manufacturer of the balancer when balancing a tire/wheel assembly.

PRELIMINARY ALIGNMENT INSPECTION

IMPORTANT:
Before making any adjustments affecting the caster, the camber, or the toe-in, inspect the front end thoroughly.

1. Inspect the front wheel bearing for proper adjustment. Refer to Wheel Bearing Adjustment
2. Inspect the following parts:
   - The tie rod ends
   - The relay rods

   Correct excessive looseness before checking wheel alignment.
3. Inspect the tires and the wheels for runout. Refer to Tire and Wheel Vibration Diagnosis and Correction.
4. Inspect the steering gear for looseness at the frame.
5. Inspect the shock absorbers for leaks or any noticeable noise.
6. Inspect the I-Beam or the stabilizer bar attachments for looseness.
7. Inspect the alignment equipment. Follow the manufacturer's instructions.
8. Inspect the level of the vehicle. The vehicle must be on a level surface fore and aft and transversely.

PRELIMINARY ALIGNMENT INSPECTION (FRONT WHEEL ALIGNMENT REQUIREMENTS)

Satisfactory vehicle operation may occur over a wide range of front wheel alignment settings. Adjustments are necessary if the settings vary beyond certain tolerances. Refer to Wheel Alignment Specifications. Check the front and the rear weight for proper distribution. Set the front wheel alignment to specifications while the vehicle is in the normally loaded condition. Vehicles which are consistently operated with heavy loads should have alignment adjustments made with the vehicle under a heavy load. This procedure should result in longer tire life.

WHEEL ALIGNMENT PROCEDURES

When performing a wheel alignment, always follow the instructions provided by the manufacturer of the alignment equipment, using the specifications provided at the front of this section of the service manual.

REPAIR INSTRUCTIONS

SUSPENSION SYSTEM REPAIRS

Wheel Stud Replacement

Removal Procedure

TOOLS REQUIRED

- J 9746-02 Hub/Rotor Support

1. Raise the vehicle. Support the vehicle with suitable safety stands.
2. Remove the tire and wheel assembly. Refer to Tire and Wheel Removal and Installation.
3. Remove the hub/rotor assembly from the vehicle. Refer to Wheel Hub, Bearing, and Seal Replacement.

NOTICE:
Place J 9746-02 between the press bars and the hub/rotor to protect the rotor surfaces.

4. Remove the wheel hub bolts using a press. Support the hub/rotor using the J 9746-02 and the press bars. Do not damage the wheel mounting surface on the hub/rotor flange.

Installation Procedure

1. Install the wheel hub bolts into the hub/rotor (using a press).
   - Support the hub/rotor using the J 9746-02 and the press bars.
   - Do not damage the wheel mounting surface on the hub/rotor flange.

2. Install the hub/rotor on the vehicle. Refer to Wheel Hub, Bearing, and Seal Replacement.
3. Install the tire and wheel assembly. Refer to Tire and Wheel Removal and Installation.
4. Lower the vehicle.

Front Wheel Hub, Bearing, and Seal Replacement (Standard Wheel Bearing)

Removal Procedure

TOOLS REQUIRED

- J 8092 Driver Handle
- J 6368 Outer Bearing Race Installer
- J 9746-02 Hub/Rotor Support

1. Raise and suitably support the front end of the vehicle.
2. Remove the wheel and tire assembly. Refer to Tire and Wheel Removal and Installation.

NOTICE:
Support the brake caliper with a piece of wire to prevent damage to the brake line.

3. Remove the brake caliper. Refer to Brake Caliper Replacement (Front).
4. Remove the drain plug from the hub cap (3) and allow the oil to drain into a suitable container, then replace the drain plug.
5. Remove the bolts, washers, hub cap, and gasket from the hub.
6. Remove the cotter pin, nut, and washer from the spindle.
7. Remove the hub/rotor.
7.1. Pull the hub/rotor free from the spindle. Make sure the outer bearing comes free.
7.2. Be careful not to damage the steering knuckle spindle threads.
7.3. Pull the hub/rotor part way off, then remove the outer bearing.
8. Remove the oil seal and inner bearing. Gently pry out the oil seal.
9. Remove the bearing races using a brass drift.
10. Remove the brake rotor mounting bolts, nuts, and rotor from the hub.
11. Clean any gasket material from the hub cap and hub.
12. Clean the oil from the hub and rotor.

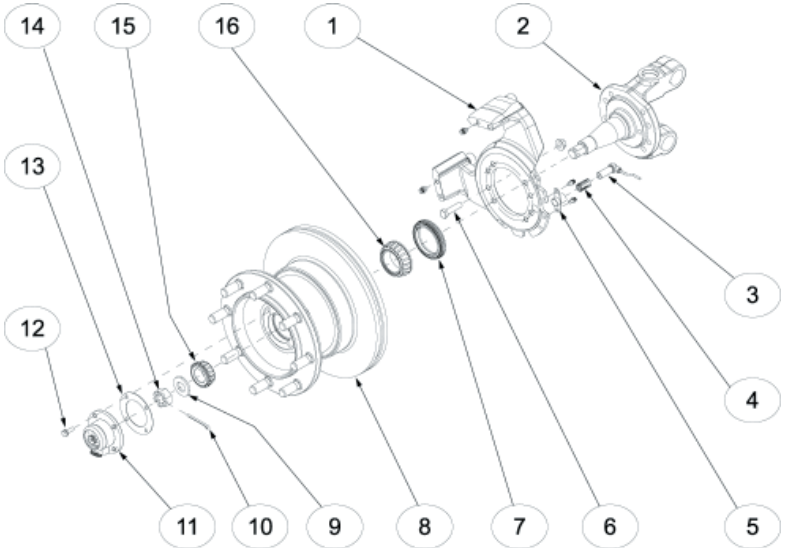
NOTICE:
Do not spin the wheel bearings with compressed air to dry them – the wheel bearings might be damaged.

13. Clean the wheel bearings in a suitable solvent. Use a stiff brush with no loose bristles.
14. Inspect the wheel bearings and races for damage or wear. Refer to Wheel Bearings Diagnosis. If either the bearing or the race is worn, replace the bearing and the race.
15. Inspect the hub and rotor for the following conditions. Replace the hub or rotor as necessary.
- Out of round
- Scored
- Pitting or cracks

CAUTION:

If one wheel stud is damaged, replace all of the wheel studs. A loose running wheel may cause only one stud to break, but the other studs could have metal fatigue. Replacing only the broken stud could cause further damage and personal injury. If the stud holes in the wheels have become enlarged or distorted, replace the wheel.

16. Inspect the wheel studs (11) to see if they are stripped, cracked, broken, or otherwise damaged. Replace wheel studs as required



Legend

1. Anchor plate
2. Steering knuckle
3. Wheel speed sensor
4. Wheel speed sensor clip
5. Wheel speed sensor mounting bracket
6. Anchor plate bolt
7. Inner wheel bearing seal
8. Hub/rotor
9. Washer
10. Cotter pin
11. Hub cap
12. Hub cap bolt
13. Hub cap gasket
14. Spindle nut
15. Outer wheel bearing
16. Inner wheel bearing

Installation Procedure

NOTICE:
Refer to Fastener Notice in Cautions and Notices.

1. Install the brake rotor mounting bolts (11), nuts (9), and rotor (12) to the hub (10).
2. Tighten hub to rotor nuts to 120 N•m (88 lb ft).

NOTICE:
Start the races squarely inside the hub/rotor to avoid distortion and possible cracking.

3. Install the outer bearing race into the bearing hub (10).
3.1. Place the hub/rotor on the J 9746-02 and rest the assembly on the press bars.
3.2. Use the J 6368 in order to drive the outer bearing into position.
3.3. Remove the J 9746-02.

NOTICE:
Using a bar larger than 7.6 cm (3 in) may damage the bearing seal seat.

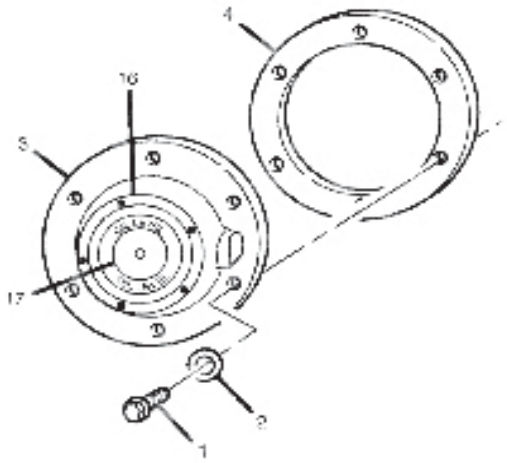
4. Use a 7.6 cm (3 in) diameter bar to drive the inner bearing race into position.
5. Install the inner bearing (14).

IMPORTANT:
Face the seal lip towards the inside of the wheel. Provide enough clearance between the seal and the bearing so that the bearing can turn freely without rubbing against the seal.

6. Install a new oil seal (15).
6.1. In order to ensure that the seal is flush with the hub/rotor flange, use a flat plate or block to install the seal.
6.2. Press the seal into the hub until it seats against the bearing race.
6.3. Lubricate the lip of the oil seal (15) with a light coat of grease.

NOTICE:
Be careful not to damage the steering knuckle spindle threads or the oil seal (15).

7. Install the hub/rotor (10, 12) by sliding the hub/rotor (10, 12) onto the spindle (16) until it seats.
8. Install the outer wheel bearing (8). Slide the bearing cone onto the spindle (16) until it seats against the outer bearing race.
9. Install the washer (7) and the castle nut (5). Do not fully tighten the nut (5) or install the new cotter pin (6).
10. Install the brake caliper. Refer to Brake Caliper Replacement (Front).
11. Install the wheel and tire assembly. Refer to Tire and Wheel Removal and Installation.
12. Adjust the wheel bearings. Refer to Wheel Bearing Adjustment.
13. Install the bolts (1), washers (2), hub cap (3), and new gasket (4) to the hub.
14. Tighten the hub cap mounting bolts (1) evenly to 13 N•m (115 lb in).



15. Fill oil to the level on the window (16).
    15.1. Remove the window plug (17).
    15.2. Fill the oil to the proper level. Refer to Adding Lubricant to the Hub Caps.
    15.3. Install the window plug (17).
16. Lower the vehicle.

Front Wheel Hub, Bearing, and Seal Assembly Replacement (Timken UniPack)

Removal Procedure

1. Raise and suitably support the front end of the vehicle.
2. Remove the wheel and tire assembly. Refer to Tire and Wheel Removal and Installation.

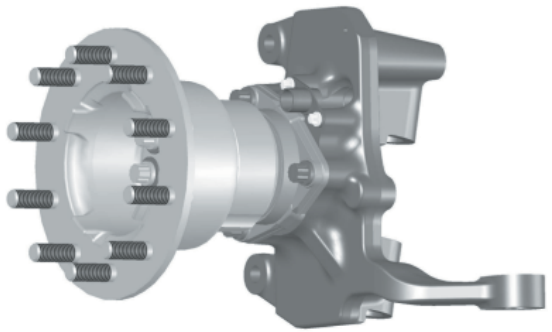
NOTICE:
Support the brake caliper with a piece of wire to prevent damage to the brake line.

3. Remove the brake caliper. Refer to Brake Caliper Replacement (Front).
4. Remove the wheel speed sensor.
5. Remove the splash shield.
6. Remove the brake rotor.
7. Remove the mounting hardware.
   - On 58mm units, the hub/bearing assembly has four studs and is secured to the steering knuckle using locknuts.
   - On 52mm units, the hub/bearing assembly is secured to the steering knuckle using three cap screws.

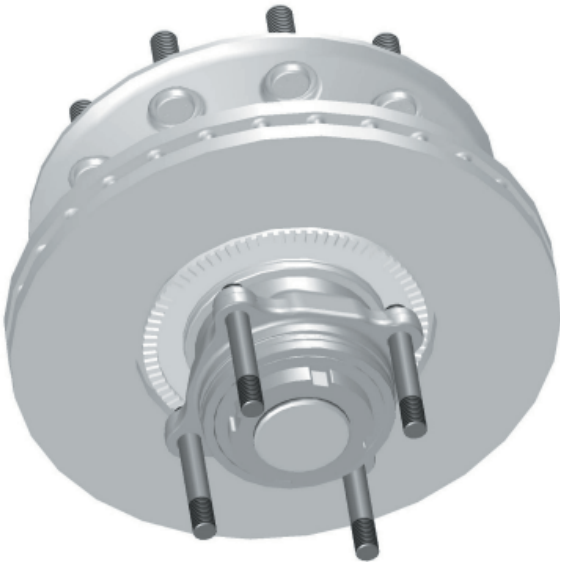
IMPORTANT
On some models, the hub is equipped with four studs and held in place using lock nuts. On other models, the steering knuckle has threaded holes, and the hub assembly is held in place with three cap screws.

8. Remove the hub assembly.

52mm Hub/Bearing Assembly



58mm Hub/Bearing Assembly



Installation Procedure

NOTICE:
Refer to Fastener Notice in Cautions and Notices.

1. Position the hub assembly.
2. Install the hub mounting nuts. Tighten the bolts/nuts as follows:
   - For 52mm units (cap screws), tighten the cap screws to 183–197 N•m (135–145 lb ft).
   - For 58 mm units (four studs with lock nuts), tighten the lock nuts to 145–216 N•m (107–159 lb ft).
3. Install the splash shield.
4. Install the wheel speed sensor.
5. Install the brake rotor.
6. Install the brake caliper.
7. Install the wheel and tire assembly.
8. Lower the vehicle.

Wheel Bearing Adjustment (Standard Bearings)

NOTICE:
Refer to the correct procedure for the axle being serviced. Using the incorrect procedure could result in bearing, spindle, and failure.

NOTICE
Before attempting to adjust any wheel bearing ensure that both the bearing and the race are lubricated with the correct hub lubricant.

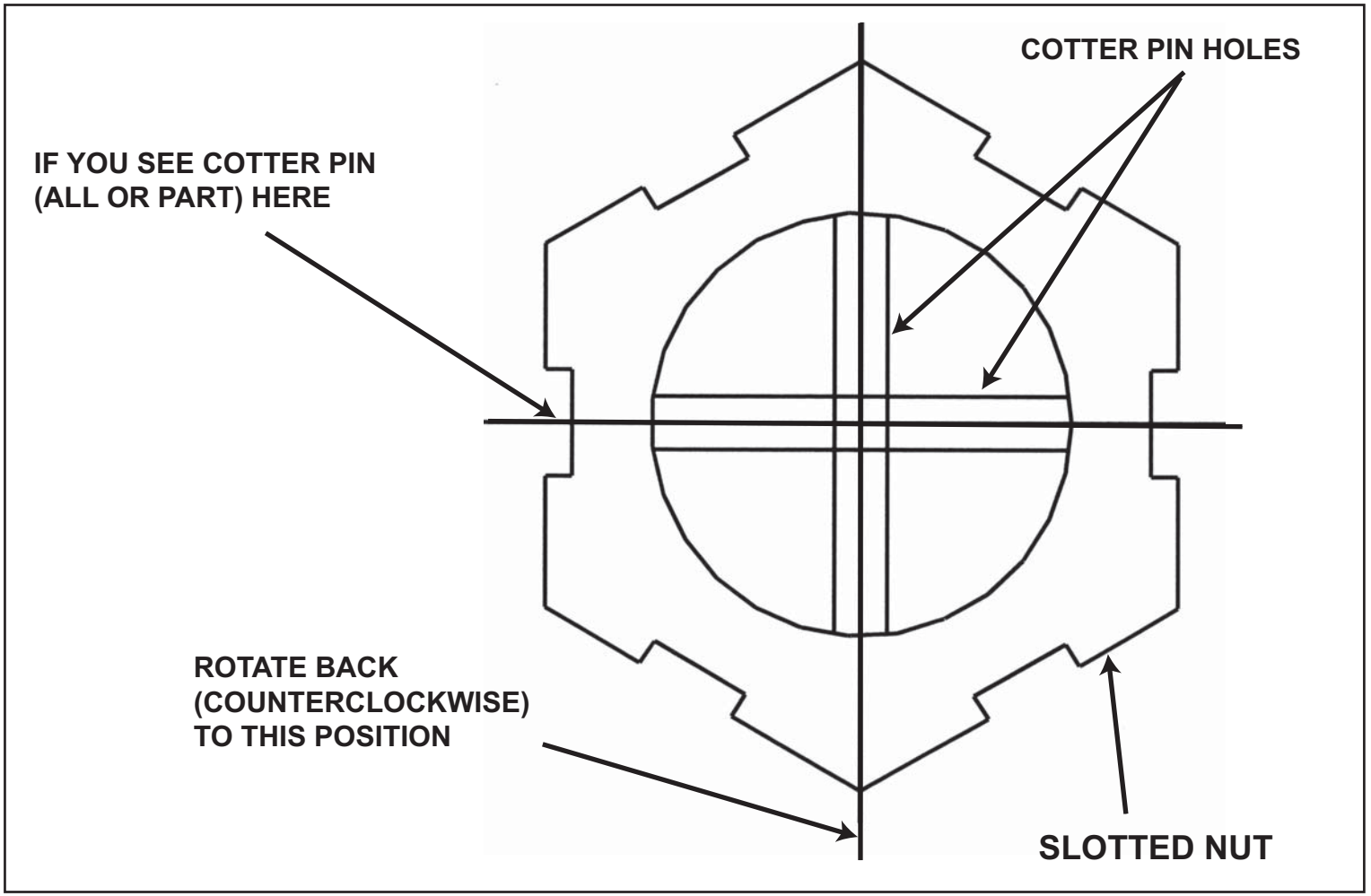
Hex Slotted Nut

TO ADJUST WHEEL BEARINGS:

1. Screw wheel nut against thrust washer while wheel is revolved. Be sure there is sufficient clearance between brake shoe and drum to prevent brake drag.
2. Tighten bearing nut to 200 lb. ft. While rotating wheel in both directions.
3. Back off nut one full turn
4. Tighten bearing nut to 68 N•m (50 lb ft) while rotating wheel in both directions.
5. Back off nut 1/6 to 1/4 turn. Refer to the following diagram for final adjustment.
6. Make sure wheel rotates freely without binding, by checking end play adjustment with a dial indicator:
   - Range should be .001”-.005” repeat process if not achieved.
   - When conditions are met, lock in place with the cotter pin. (Proper adjustment, and presence of cotter pin are both critical characteristics!)

FINAL ADJUSTMENTS

1. After 68 N•m (50 lb ft) of torque, look for cotter pin hole alignment with nut, which can be in vertical or horizontal position.
2. Expose all or part of the cotter pin hole.
3. Rotate this slot counterclockwise to next cotter pin hole.
4. This now equals ¼ turn.



Wheel Bearing Adjustment

Pro-Torq Nut

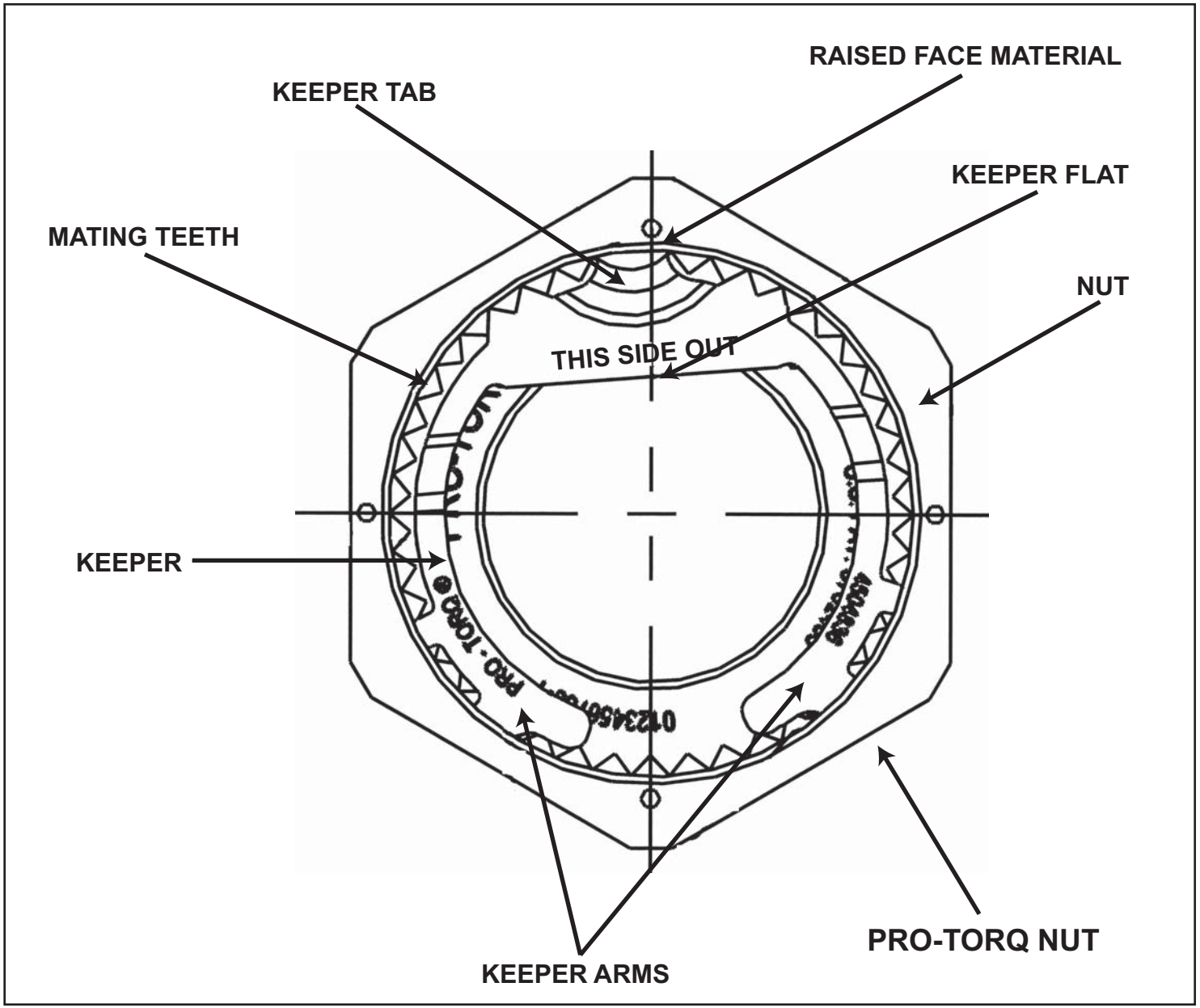
NOTICE

Before attempting to adjust any wheel bearing ensure that both the bearing and the race art lubricated with the correct hub lubricant.

To adjust wheel bearings

1. Remove keeper from nut, a small screwdriver may be used to pry keeper from the nut
2. Seat the bearing
   A. Install nut into spindle
   B. Tighten the nut to 271 N•m (200 lb ft). Spin wheel at least one full rotation
   C. Repeat B
   D. Tighten the nut to 271 N•m (200 lb ft).
   E. Back the nut off until it is loose
3. Adjust the bearing
   A. Tighten the nut to 136 N•m (100 lb ft). Spin wheel at least one full rotation.
   B. Repeat A.
   C. Tighten the nut to 136 N•m (100 lb ft).
   D. Back the nut off one raised face mark, ¼ turn
4. Install Keeper

A. Align flat on keeper with the flat on the spindle
   B. Insert the single keeper tab into the undercut groove of the nut.
   C. Orange side of the keeper must face out
   D. Engage mating teeth
   E. Compress and insert the keeper arms, one at a time, into the undercut groove of the nut. A small screwdriver may be used
5. Inspect installation
   A. Make sure the keeper tabs are fully seated into the undercut of the nut.
6. Verify end play.
   A. Make sure wheel rotates freely without binding. Check end play with a dial indicator. Range should be between .001” -.003”. Repeat process if not achieved.
7. Warning:
   A. Do not install nut, loosen nut or tighten nut onto spindle with keeper in place. Doing so may deform the keeper and allow the nut to unthread during operation
   B. Failure to back off nut will cause the bearings to run hot and be damaged



Installation – Hub/Wheel & Rotor – Oil-Filled Hub

1. For Stemco Guardian seal, apply No. 2 sealant on O.D. of seal surface on the spindle
2. Install seal assembly with the words “Oil bearing side” facing installer. Remove excess sealant.
3. Apply a thin coat of oil to the outer diameter of the seal prior to installation of hub
4. Lubricated inner wheel bearing in oil and install on spindle.
5. Install hub assembly onto spindle. Do not force entirely on.
6. Lubricate outer wheel bearing in oil. Install bearing, thrust washer and nut, or unitized wheel nut on spindle end. Hand tighten to seat assembly.
7. Refer to proper wheel bearing adjustment procedure.
8. Install hub cap and gasket. Torque fasteners as shown – star pattern.
9. Remove fill plug on hub cap, fill hub cavity with E.P. SAE 90 oil (Westport part No. 143699-0018) to fill fine on hub cap face, -0.0/+.12 re-install fill plug.
10. Note! Do not mix petroleum base oil with synthetic base oil!
11. Before assembling wheel equipment make certain the spindle, spindle end thread, cotter pin hole, wheel nut, thrust washer, hub cavity, wheel bearings, and hub cap surface are free of dirt, debris chips, burrs, etc. Contamination can cause premature oil seal and or wheel bearing failure.

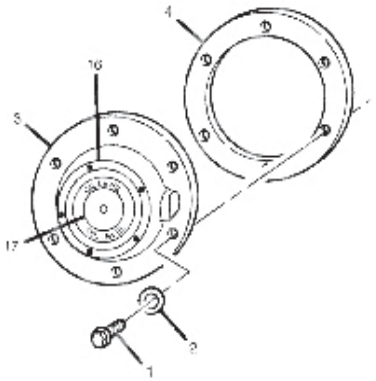
Installation- Hub/Wheel & Rotor – Grease-Packed Bearings

1. For Stemco Guardian seal, apply No. 2 sealant on O.D. of seal surface on the spindle
2. Install seal assembly with the words “Oil bearing side” facing installer. Remove excess sealant.
3. Pre-lube steal lip with small amount of grease prior to installation of hub
4. Pressure or hand pack inner and outer wheel bearings with E.P. NLG1 Grade 2 Grease (Westport part No.143699-0002)
5. Install inner wheel bearing on spindle
6. Pump of hand pack grease into hub cavity’s entire circumference. Fill to level equal to outer bearing cup’s inner diameter.
7. Install hub assembly on to spindle. Do not force entirely on.
8. Install outer bearing, thrust washer, and nut, or unitized wheel nut on end of spindle. Hand tighten to seat assembly.
9. Refer to proper wheel bearing adjustment procedure
10. Coat inside surface of metal hub cap with a thin film of grease. Do not pack!
11. Install hub cap, gasket, and fasteners. Torque fasteners as show – star pattern
12. Before assembling wheel equipment make certain the spindle, spindle end thread, cotter pin hole, wheel nut, thrust washer, hub cavity, wheel bearings, and hub cap surface are free of dirt, debris, chips, burrs, etc. Contamination can cause premature oil seal and or wheel bearing failure.

Hub Cap Replacement

Removal Procedure

1. Remove the drain plug from the hub cap and allow the oil to drain into a suitable container, then replace the drain plug.
2. Remove the bolts, washers, hub cap, and gasket from the hub.
3. Clean any gasket material from the hub cap and hub.



Installation Procedure

NOTICE:
Refer to Fastener Notice in Cautions and Notices.

1. Install the bolts, washers, hub cap, and a new gasket to the hub.
2. Tighten the hub cap mounting bolts evenly to 13 N•m (115 lb in).
3. Fill oil to the level on the window.
3.1. Remove the window plug.
3.2. Fill the oil to the proper level. Refer to Adding Lubricant to the Hub Caps in this supplement.
3.3. Install the window plug.

Adding Lubricant to the Hub Caps

1. With the vehicle in a level position, the oil level should be at the oil level line.
2. If oil is required, do the following:
2.1. Remove the window plug.
2.2. Add lubricant until the fluid is level with the oil level line. Refer to Fluid and Lubricant Recommendations in this supplement.
2.3. Install the window plug.

Front Stabilizer Shaft Replacement

Removal Procedure

1. Raise the vehicle on a hoist.
2. Remove the nuts and washers from the stabilizer shaft clamp and the right front leaf spring.
3. Remove the nuts and washers from the stabilizer shaft clamp and the left front leaf spring, and remove the stabilizer shaft from the vehicle.
4. Remove the clamps from the stabilizer shaft.
5. Remove the insulators from the stabilizer shaft.

Installation Procedure

1. Install the insulators to the stabilizer shaft.
2. Install the clamps to the stabilizer shaft.

NOTICE:
Refer to Fastener Notice in Cautions and Notices.

3. Install the washers and nuts to the stabilizer shaft clamp and the left front leaf spring.
4. Install the washers and nuts to the stabilizer shaft clamp and the right front leaf spring.

5. Tighten the stabilizer shaft clamp nuts to 373 N•m (275 lb ft).
6. Lower the vehicle.

Rear Stabilizer Shaft Replacement

Removal Procedure

1. Raise the vehicle on a hoist
2. Remove the nuts and washers from the stabilizer shaft clamp and the right rear leaf spring.
3. Remove the nuts and washers from the stabilizer shaft clamp and the left rear leaf spring, and remove the stabilizer shaft from the vehicle.
4. Remove the clamps from the stabilizer shaft.
5. Remove the insulators from the stabilizer shaft.

Installation Procedure

1. Install the insulators to the stabilizer shaft.
2. Install the clamps to the stabilizer shaft.

NOTICE:
Refer to Fastener Notice in Cautions and Notices.

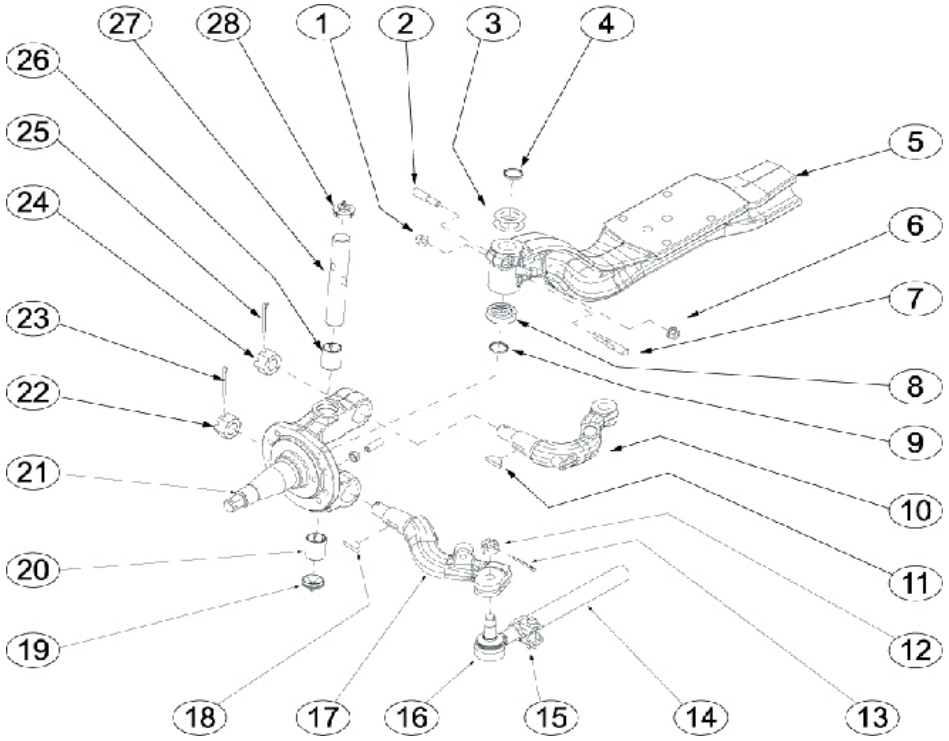
3. Install the washers and nuts to the stabilizer shaft clamp and the left rear leaf spring.
4. Install the washers and nuts to the stabilizer shaft clamp and the right rear leaf spring.
5. Tighten the stabilizer shaft clamp nuts to 373 N•m (275 lb ft).
6. Lower the vehicle.

Steering Knuckle/King Pin Replacement

Removal Procedure

1. Raise and support the vehicle.
2. Remove the tire and wheel assembly. Refer to Tire and Wheel Removal and Installation.
3. Remove the brake caliper. Refer to Brake Caliper Replacement (Front).
4. Remove the hub/rotor assembly. Refer to Wheel Hub, Bearing, and Seal Replacement.
5. Disconnect the wheel speed sensor from the torque plate.
6. Remove the torque plate and the splash shield (if equipped).
7. Disconnect the steering arm from the steering knuckle.
   7.1 Remove the cotter pin.
   7.2 Loosen and remove the slotted nut.
   7.3 Strike the steering arm with a hammer to break the steering arm loose from the steering knuckle.
8. Disconnect the tierod arm from the steering knuckle.
   8.1 Remove the cotter pin.
   8.2 Loosen and remove the slotted nut.
   8.3 Strike the tierod arm with a hammer to break the tierod arm loose from the steering knuckle.
9. Disconnect the brake hose bracket.
10. Remove the brake hose bracket.
11. Remove the caps from the ends of the king pin in the steering knuckle.
12. Remove the nut and washer from the lock pin and remove the lock pin.

13. Remove the king pin from the steering knuckle,
    13.1 Drive out the king pin using a drift.
    13.2 The spacers and the bushings will also come out.
14. Remove the steering knuckle from the axle.
15. Remove the king pin seals, the thrust bearing, and the shims from the axle.
16. Remove the bushings from the steering knuckle.



11. Steering arm woodruff key
12. Tierod arm slotted nut
13. Cotter pin
14. Tierod
15. Tierod end adjustment clamp
16. Tierod end
17. Tierod arm
18. Tierod arm woodruff key
19. Kingpin cap
20. Kingpin bushing
21. Steering knuckle
22. Tierod arm slotted nut
23. Cotter pin
24. Steering arm slotted nut
25. Cotter pin
26. Kingpin bushing
27. Kingpin
28. Kingpin cap

Legend:

1. Lock pin nut
2. Lock pin
3. Shims
4. King pin seal
5. Front axle
6. Lock pin nut
7. Lock pin
8. Thrust bearing
9. King pin seal
10. Steering arm

Installation Procedure

1. Position the steering knuckle.
2. Install the thrust bearing, the shim, and the dust seal. Make sure dust seal is facing outward toward I-beam. Prelube the thrust bearing. Refer to Fluid and Lubricant Recommendations in Maintenance and Lubrication.
3. Install the king pin and the lock pin.
   3.1. Prelube the king pin.
   3.2. Insert the spacers in the proper order.
4. Install the grease cap on each end of the king pin. Tighten the caps to 88-129 N•m (65-95 lb. ft).
5. Install the lock pin, washer, and nut. Tighten the nut to 68-85 N•m (50-63 lb. ft.).
6. Position the brake hose bracket. Install the washer and bolts. Tighten the bolts to 7 N•m (60 lb in).
7. Make sure the woodruff key is installed in the keyway of the steering arm.
8. Insert the end of the steering arm into the steering arm hole in the steering knuckle. Line up the woodruff key with the slot in the steering knuckle.
9. Install the slotted nut on the steering arm. Tighten the nut to 407-475 N•m (300-350 lb. ft.).
10. Make sure the woodruff key is installed in the keyway of the tierod arm.
11. Insert the end of the tierod arm into the tierod arm hole in the steering knuckle. Line up the woodruff key with the slot in the steering knuckle.
12. Install the slotted nut on the tierod arm. Tighten the nut to 407-475 N•m (300-350 lb. ft.).
13. Install the splash shield (if equipped) and the anchor plate. Install the washers and bolts. Tighten the splash shield bolts to 16 N•m (12 lb ft). Tighten the anchor plate bolts to 16 N•m (12 lb ft).
14. Install the hub/rotor assembly, Refer to Wheel Hub, Bearing, and Seal Replacement.
15. Adjust the wheel bearings. Refer to Wheel Bearing Adjustment.
16. Install the caliper. Refer to Brake Caliper Replacement (Front).
17. Install the tire and wheel assembly. Refer to Tire and Wheel Removal and Installation.
18. Lower the vehicle.
19. Check the front wheel alignment. Refer to Wheel Alignment Specifications.

Shock Absorber Replacement

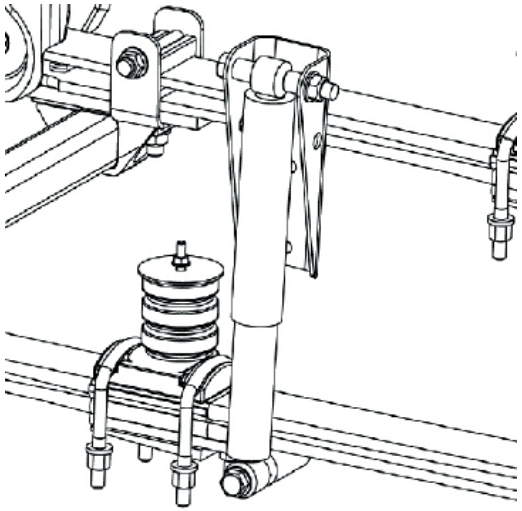
REMOVAL PROCEDURE

1. If necessary, raise and support the vehicle.
2. Remove the nut and washer from the lower shock absorber mounting bolt or stud.
3. Depending on the type of shock absorber, do the following:
   - Remove the lower shock absorber mounting bolt and washer.

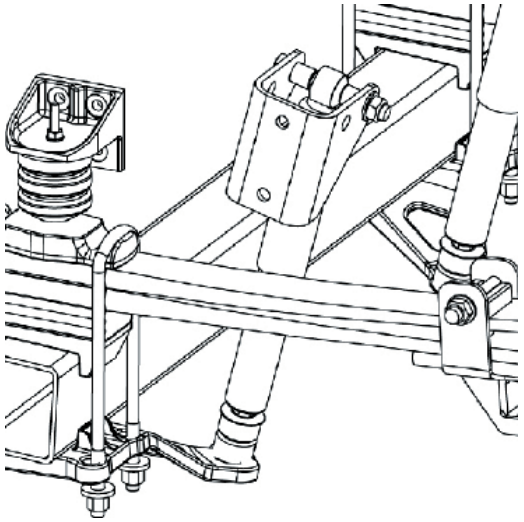
   or
   - Slightly compress the shock so the mounting stud can be pulled free from the lower shock mount.
4. Depending on the type of shock absorber, do the following:
   - While holding the shock absorber, remove the upper shock absorber mounting nut and washer.

   or
   - Remove the nut and washer from the upper shock absorber mounting stud.
5. Remove the shock absorber.

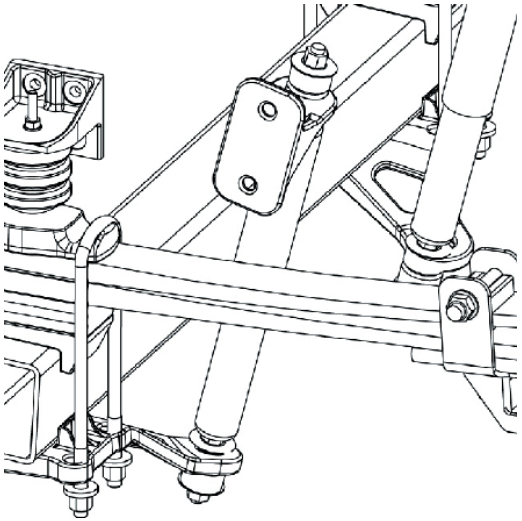
Front Shock Mounts



Rear Shock Mounts (13.5K Rear Axle Shown)



Rear Shock Mounts (15K Rear Axle Shown)



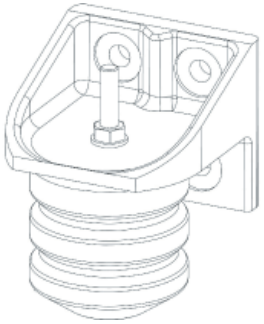
Installation Procedure

1. Position the shock absorber so the upper shock mounting hole is lined up with the holes in the upper shock mount.
2. Install the upper shock mount bolt, washer, and nut. Tighten the nut to 203 N•m (150 lb ft)
3. Position the shock absorber so the lower shock mounting hole is lined up with the hole in the lower shock mount.
4. Install the lower shock absorber mounting bolt, washer, and nut. Tighten the lower shock absorber mounting nut to 203 N•m (150 lb ft).
5. Lower the vehicle.

Like-Air Auxiliary Spring Replacement

Removal Procedure

1. If necessary, raise and support the vehicle.
2. Remove the nut and washer from the Like-Air Auxiliary Spring mounting bolt.
3. Remove the Like-Air Auxiliary Spring.



Installation Procedure

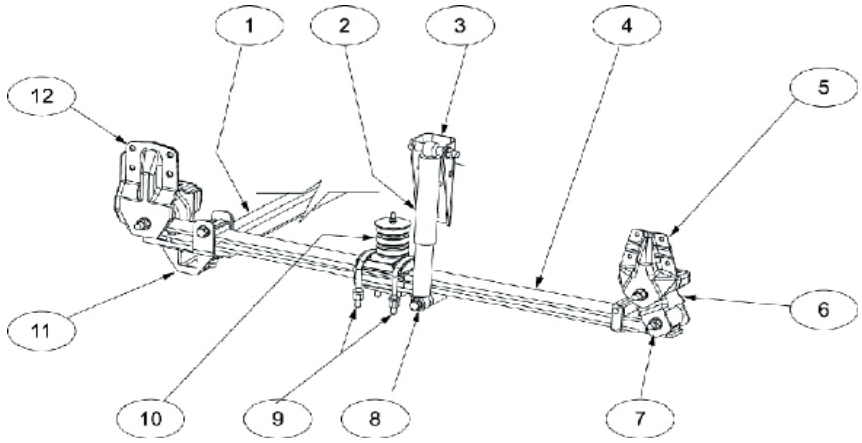
1. Position the Like-Air Auxiliary Spring.
2. Install the washer and nut on the Like-Air Auxiliary Spring mounting bolt.
3. Tighten the nut to 41 N•m (30 lb ft).

Front Leaf Spring Replacement

Removal Procedure

1. Lift and support the front of the vehicle by the frame rails.
2. Place a support under each end of the front axle, just inside of the U-bolts. This is done to eliminate any load on the springs.
3. Remove the tire/wheel assembly on the side where the spring is being removed.

4. Remove the shock absorber on the side where the spring is being removed.
5. Mark or scribe the current position of the spring on the axle.
6. Remove the nuts and washers from the U-bolts.
7. Remove the U-bolts.
8. Remove the nut and washer from the rear leaf spring to shackle mounting bolt.
7. Remove the rear leaf spring to shackle mounting bolt.
8. Remove the nut and washer from the front leaf spring to spring hanger mounting bolt.
9. While holding the leaf spring, remove the front leaf spring to spring hanger mounting bolt.
10. Remove the spring.



Legend:

1. Stabilizer bar
2. Shock absorber
3. Upper shock mount
4. Parabolic leaf spring
5. Rear spring hanger
6. Rear spring shackle
7. Rear spring mounting bolt
8. Lower shock mount
9. U-bolts
10. Like-Air auxiliary spring
11. Stabilizer bar clamp
12. Front spring hanger

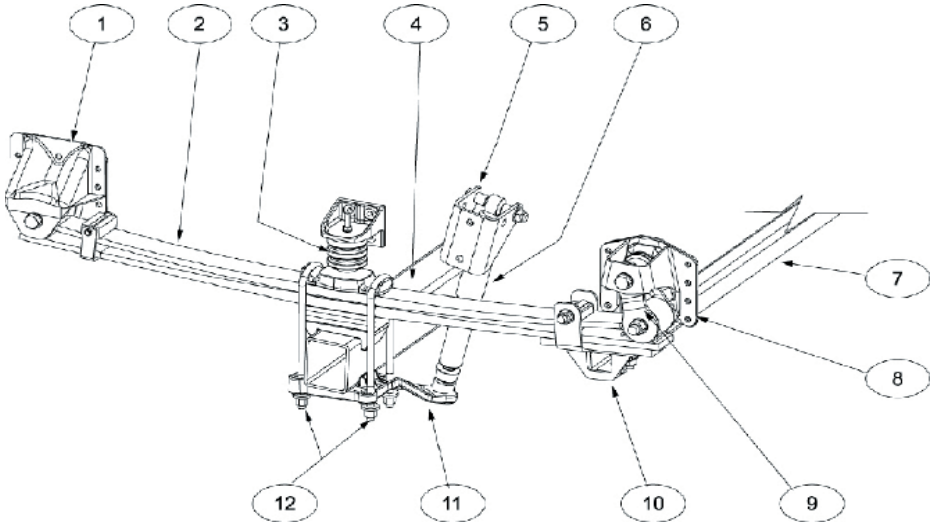
Installation Procedure

1. If a new spring is being installed, lay it on a bench side-by-side with the spring that was just removed. Transfer the marks that were made on the old spring in Step 3 of the removal procedure to the new spring.
2. Position the leaf spring on the axle.
3. Install a washer on the front and rear leaf spring mounting bolts.
4. Line up the front of the spring with the front leaf spring hanger and insert the mounting bolt.
5. Install the washer and nut on the front leaf spring mounting bolt. DO NOT tighten at this time.
6. Line up the rear of the spring with the rear leaf spring shackle and insert the mounting bolt.
7. Install the washer and nut on the rear leaf spring to shackle mounting bolt. DO NOT tighten at this time.
7. Install the U-bolts.
8. Install the washers and nuts on the U-bolts. DO NOT tighten at this time.
9. Check the alignment of all of the components. Adjust as needed.
10. Tighten the nuts/bolts:
- Tighten the front leaf spring to spring hanger nuts/bolts to 275 N•m (203 lb ft).
- Tighten the rear leaf spring to shackle nuts/bolts to 275 N•m (203 lb ft).
- Tighten the U-bolt nuts to 190 N•m (140 lb ft).

Rear Leaf Spring Replacement

Removal Procedure

1. Lift and support the front of the vehicle by the frame rails.
2. Place a support under each end of the front axle, just inside of the U-bolts. This is done to eliminate any load on the springs.
3. Remove the tire/wheel assembly on the side where the spring is being removed.
4. Remove the shock absorber on the side where the spring is being removed.
5. Mark or scribe the current position of the spring on the axle.
6. Remove the nuts and washers from the U-bolts.
7. Remove the U-bolts.
8. Remove the nut and washer from the rear leaf spring to shackle mounting bolt.
7. Remove the rear leaf spring to shackle mounting bolt.
8. Remove the nut and washer from the front leaf spring to spring hanger mounting bolt.
9. While holding the leaf spring, remove the front leaf spring to spring hanger mounting bolt.
10. Remove the spring.



Legend:

1. Front spring hanger
2. Parabolic leaf spring
3. Like-Air auxiliary spring
4. Rear axle housing
5. Upper shock mount
6. Shock absorber
7. Stabilizer bar
8. Rear spring hanger
9. Rear spring shackle
10. Stabilizer bar clamp
11. Lower shock mount
12. U-bolts

Installation Procedure

1. If a new spring is being installed, lay it on a bench side-by-side with the spring that was just removed. Transfer the marks that were made on the old spring in Step 3 of the removal procedure to the new spring.
2. Position the leaf spring on the axle.
3. Install a washer on the front and rear leaf spring mounting bolts.
4. Line up the front of the spring with the front leaf spring hanger and insert the mounting bolt.
5. Install the washer and nut on the front leaf spring mounting bolt. DO NOT tighten at this time.
6. Line up the rear of the spring with the rear leaf spring shackle and insert the mounting bolt.
7. Install the washer and nut on the rear leaf spring to shackle mounting bolt. DO NOT tighten at this time.
8. Install the U-bolts.
9. Install the washers and nuts on the U-bolts. DO NOT tighten at this time.
10. Check the alignment of all of the components. Adjust as needed.
11. Tighten the nuts/bolts:
    - Tighten the front leaf spring to spring hanger nuts/bolts to 480 N•m (354 lb ft).
    - Tighten the rear leaf spring to shackle nuts/bolts to 480 N•m (354 lb ft).
    - Tighten the U-bolt nuts to 190 N•m (140 lb ft).

Front Axle Replacement

Removal Procedure

1. Lift and support the front of the vehicle by the frame rails.
2. Place a support under each end of the front axle, just inside of the U-bolts. This is done to eliminate any load on the springs.
3. Remove the front tire/wheel assemblies.
4. Remove the shock absorbers.
5. Mark or scribe the current position of the spring on the axle.
6. Remove the nuts and washers from the U-bolts.
7. Remove the U-bolts.
8. Remove the front axle from the vehicle.

Installation Procedure

1. If a new front axle is being installed, place the old axle next to the new axle and transfer the spring position to the new axle.
2. Position the new axle under the leaf springs and place supports under the axle.
3. Install the U-bolts.
4. Install the washers and nuts on the U-bolts. DO NOT tighten at this time.
5. Check the alignment of the axle with the springs. Adjust as necessary to make sure they are square.
6. Tighten the nuts on the U-bolts to 190 N•m (140 lb ft)..
7. Install the shock absorbers.
8. Install the tire/wheel assemblies.
9. Remove the supports from under the front axle.
10. Lower the vehicle.
11. Check the wheel alignment.

TIRE AND WHEEL REPAIRS

Tire and Wheel Removal and Installation

CAUTION:

If penetrating oil gets on the vertical surfaces between the wheel and the rotor or drum it could cause the wheel to work loose as the vehicle is driven, resulting in loss of control and an injury accident.

NOTICE:

Never use heat to loosen a tight wheel. It can shorten the life of the wheel, studs, or hub and bearing assemblies. Wheel nuts must be tightened in sequence and to the specified torque to avoid bending the wheel or rotor.

Penetrating oil is not effective in removing tight wheels. However, if used, apply the penetrating oil sparingly to the hub surface only.

Excessive force, such as hammering the wheel or the tire, may cause damage. Lightly tap the tire's sidewall with a rubber mallet.

NOTICE

Sometimes wheels can be difficult to remove from the vehicle due to foreign material or a tight fit between the wheel center hole and the hub or rotor. Use the following procedure to safely remove the wheel:

1. Tighten all of the wheel nuts on the affected wheel.
2. Loosen each wheel nut two turns.
3. Lower the vehicle onto the floor.
4. Rock the vehicle from side to side as hard as possible using one or more person's body weight to loosen the wheel.
5. Rock the vehicle from Drive gear to Reverse gear allowing the vehicle to move several feet in each direction. Apply quick, hard jabs on the brake pedal in order to loosen the wheel.

Removal Procedure

CAUTION:

To avoid eye injury, use approved safety lenses, goggles, or face shield to prevent eye injury when deflating tires.

IMPORTANT:

When removing and demounting any tire and wheel assembly, deflate the tire by removing the valve core. Perform this procedure before removing the tire assembly from the vehicle.

1. Break the wheel nuts loose.
2. Raise the vehicle until the tire clears the floor. Support the vehicle. Refer to Lifting and Jacking the Vehicle in General Information.
3. Remove the wheel nuts.
4. Remove the wheel from the hub.
5. Clean the following components:

- Clean the wheel nuts.
- Clean the studs.
- Clean the wheel.
- Clean the rotor mounting surfaces.

Installation Procedure

CAUTION:

Before installing the wheels, remove any buildup of corrosion on the wheel mounting surface and brake drum or disc mounting surface by scraping and wire brushing. Installing wheels with poor metal-to-metal contact at the mounting surfaces can cause wheel nuts to loosen. This can cause a wheel to come off when the vehicle is moving, causing loss of control and possibly personal injury.

NOTICE:
Wheel hub flanges, wheel studs, and stud nuts should be free of rust, lubricants, dirt, and finish color paint on all contact surfaces to ensure proper torque retention.

1. Apply a thin coat of grease to the hub pads in order to prevent corrosion.
2. Turn the hub so that a hub pad is at a 12 o'clock position.
3. Install the wheel on the hub.

IMPORTANT:
Perform steps 4 and 5 for dual wheel applications only. For single wheel applications proceed to step 6.

4. Install the inner wheel on the hub.
5. Install the outer wheel on the hub with the valve stems of both wheels positioned as close to 180 degrees as possible.

IMPORTANT:
Tighten the wheel nuts progressively using the first specification; then retighten the nuts using the second specification.

NOTICE:
A torque wrench or J 39544 must be used to ensure that wheel nuts are tightened to specification.

Never use lubricants or penetrating fluids on wheel stud, nuts, or mounting surfaces, as this can raise the actual torque on the nut without a corresponding torque reading on the torque wrench. Wheel nuts, studs, and mounting surfaces must be clean and dry.

Failure to follow these instructions could result in wheel, nut, and/or stud damage.

NOTICE:
Refer to fastener Notice in Cautions and Notices.

6. Install the wheel nuts.
7. Tighten the wheel nuts to specifications. Refer to Fastener Tightening Specifications. Tighten the wheel nuts evenly and alternately in order to avoid excessive runout.

Tire Mounting and Dismounting

NOTICE:
Use a tire changing machine in order to dismount tires. Do not use hand tools or tire irons alone in order to remove the tire from the wheel. Damage to the tire beads or the wheel rim could result.

NOTICE:
It is important to note that damage to either the tire mounting surface or the wheel mounting holes can result from the use of improper wheel attachment or tire mounting techniques. It takes 70 seconds for all the air to completely exhaust from a large tire. Failure to follow proper procedures could cause the tire changer to put enough force on the tire to bend the wheel at the mounting surface. Such damage may result in vibration and/or shimmy and under severe usage lead to cracking.

Follow the tire changing machine manufacturer's instructions in order to properly separate the tire from the wheel.

Bias Ply Tire Mounting Procedure

1. Clean the tire bead area.
2. Clean the rim bead seats with a wire brush or coarse steel wool in order to remove lubricants, old rubber, and light rust.
3. Apply an approved tire lubricant to the tire bead area.
4. Attach the tire to the wheel.
   - Use a tire changing machine.
   - Follow the equipment manufacturer's instructions.

CAUTION:

To avoid serious personal injury, do not stand over tire when inflating. The bead may break when the bead snaps over the safety hump. Do not exceed 275 kPa (40 psi) pressure when inflating any tire if beads are not seated. If 275 kPa (40 psi) pressure will not seat the beads, deflate, relubricate the beads and reinflate. Overinflation may cause the bead to break and cause serious personal injury.

5. Install a valve core. Inflate the tire to the specified pressure on the certification label.
   - The locating rings on each side of the tire must show above the rim flanges.
   - Position the rings in direct relation to the wheel, not off-center as compared to the rim.
6. Check the bead seating. Mount and inflate the tires in accordance with the safety precautions included with the tire mounting equipment.

Radial Ply Tire Mounting Procedure

NOTICE:
Failure to follow radial tire inflation procedures can cause bead deformation in both tube and tubeless tires due to incorrect bead seating.

Tubeless Tire Mounting Procedure

NOTICE:
The use of tubes in tubeless tires is not a recommended repair due to the fact that speed ratings are greatly reduced.

IMPORTANT:
Only use rims approved for radial tire usage by the rim manufacturer.

1. Clean the rim. Remove all rust and foreign material.

NOTICE:
Do not use silicone base lubricants-this could cause the tire to slip on the wheel.

2. Lubricate the tire beads and the rim bead seats with an approved rubber lubricant.

3. Inflate the tire to the recommended pressure.
   - Because of the construction of radial truck tires, particularly in the lower sidewall and bead area, difficulty may occur in getting the tire to take air.
   - An inflation aid may be necessary in order to help seat the bead of radial tubeless tires. The following are two types of inflation aids commercially available:
     - Metal rings that use compressed air to seat the beads.
     - Rubber rings that seal between the tire bead and the rim bead seat, allowing the bead to move out and seat.
     - Lubrication is necessary with both aids.

IMPORTANT:
In order to prevent bead deformation, follow this procedure to insure proper bead seating.

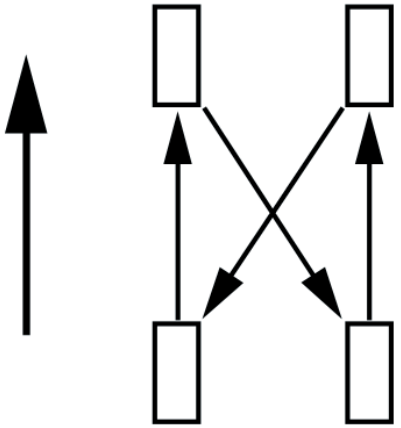
Mount and inflate radial and bias tires in accordance with safety precautions noted in RMA Radial and Bias Truck Tire Service Manuals.

4. Check the spacing between the rim flange and one of the three rings of the lower sidewall rim line, while the tire is laying flat, in order to verify bead seating.
   - Measure each 90 degrees around the circumference of the rim flange.
   - If the spacing is uneven around the bead from side to side, repeat Steps 1 through 3, then recheck.

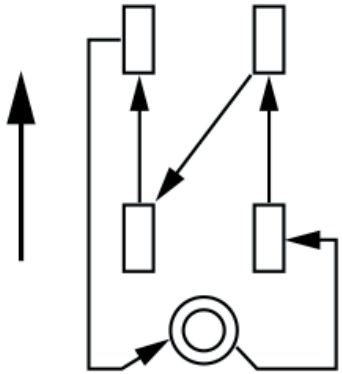
Tire Rotation

In order to equalize wear, rotate the tires at the specified intervals. Refer to Maintenance Schedule in Maintenance and Lubrication. In addition to scheduled rotation, rotate the tire and wheel assembly whenever uneven tire wear is found.

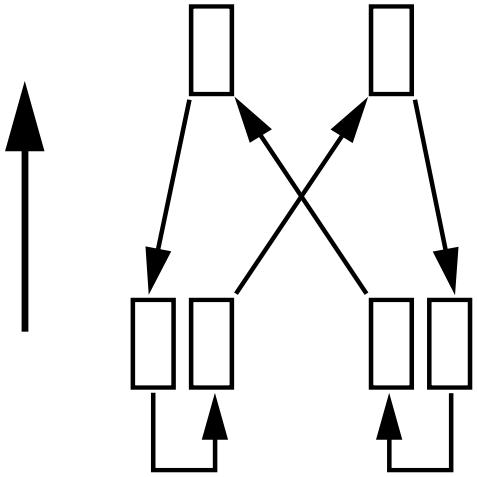
Radial tires tend to wear faster in the shoulder area, particularly in front positions, due to design. Radial tires in non-drive locations may develop an irregular wear pattern that can generate tire noise. This especially makes regular tire rotation necessary.



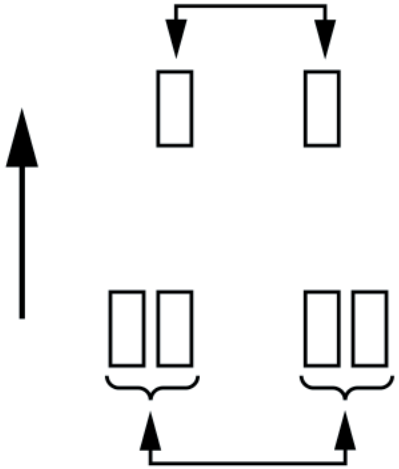
For vehicles with single rear wheels (four tires), rotate the tires as shown.



For vehicles with single rear wheels (five tires), rotate the tires as shown.



For vehicles with dual rear wheels (same tire sizes and load ranges), rotate the tires as shown.



For vehicles with dual rear wheels (different tire sizes and load ranges), rotate the tires as shown.

WHEEL ALIGNMENT ADJUSTMENTS

The only adjustment available on the front end alignment is the Toe setting.

Front Toe Adjustment

1. Determine the toe settings using the alignment equipment.
2. Change the length of both of the tie rod sleeves in order to effect a toe change.
3. Increase or decrease by changing the length of the tie rod ends. A threaded sleeve is provided for this purpose.