Introduction

In the late 1960s, American automakers were engaged in a high-performance war. During that time, manufacturers produced engines so potent they decided not to advertise the actual horsepower ratings. They reasoned that by publishing more conservative figures, insurance premiums would remain affordable; keeping their vehicles within reach of the average customer. Considering the number of muscle cars sold between 1965 and 1969, it appears they were right!

Although the cars from that era were prodigious straight-line performers, they lacked the underpinnings essential for good handling. It seemed as if carmakers overlooked the tires, wheels, suspension and braking systems in their quest for more horsepower. Fortunately, today's vehicles represent a balanced approach to high-performance engineering – right down to the tires and wheels. That's because power must be controlled, and no other components affect vehicle handling more than the tires and wheels.

The wheels center and support the tires under the stresses of acceleration, cornering, and braking. The tires provide the critical link between the vehicle and the road. Even if all other chassis components are functioning normally, they can't disguise a handling problem caused by a bad wheel or tire. For example, new shocks won't compensate for excessive wheel runout, any more than repeated wheel alignments would correct a tire conicity. That's why knowing how to recognize tire and wheel problems is so important. Of course, before you can become proficient at diagnosis, you'll need to learn about tire and wheel construction, as well as how to perform routine service procedures like mounting, balancing, and tire repair. The purpose of this course is to help you acquire all of these skills.

Learning Objectives

After completing this course, you should be able to:

- …understand tire sizing systems and other sidewall information.
- …use different types of vehicle lifting equipment.
- …remove and install tire/wheel assemblies properly.
- …mount and demount tires using rim-clamp or center-post type equipment.
- ...understand the difference between static and dynamic balance.
- …use a computer wheel balancer.
- …determine the causes of abnormal tire wear patterns.
- …identify the cause of excessive tire/wheel runout.
- …perform tire nail hole repairs.

TIA

TIRE INDUSTRY ASSOCIATION

Module One:

Tire & Wheel Basics

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The Rubber Man

Though Firestone came up with the phrase, ‘this is where the rubber meets the road,’ rubber and road may have never met had it not been for an inventor named Charles Goodyear. In the early 1830s, people craved products made from a new waterproof gum known as rubber. To meet the demand, rubber companies sprang up everywhere. However, once people discovered that rubber goods turned rock hard in winter and became like glue in the summer, their desire for rubber turned to disgust. Outraged customers began returning their unusable products by the thousands. With no orders coming in and returns piling up, rubber companies soon went bankrupt. It seemed as if rubber was finished.

Fascinated with the material, and undeterred by critics, Charles Goodyear decided to experiment with rubber. After five years of trial and error, he had little to show for his efforts but a depleted bank account. However, in 1839, Goodyear’s luck changed. Although details are sketchy, the story goes that Goodyear wandered into a local general store to show off the results of his latest experiment. As he touted the significance of his gum and sulfur mixture, chuckles rose up amidst the skeptical patrons. All of a sudden, the normally unflappable inventor became quite upset. As he defiantly waved his fistful of gum in the air, it flew from his grasp and landed on top of a blazing hot potbellied stove. After retrieving it, Goodyear was shocked to see that instead of melting like molasses, the sulfur and gum mixture had become charred like leather. He also noticed that the edges had a dry, spongy consistency of considerable elasticity and strength. At that moment, Goodyear realized that the combination of heat and sulfur could turn pure rubber into a weatherproof material. After another year of experimenting, he created the process known as vulcanization. Vulcanized rubber not only revived the rubber trade, but also proved to be a key factor in the development of the automobile industry.

Although many considered Goodyear’s discovery to be one of history’s most celebrated accidents, the persistent inventor always denied that. “Like Newton’s falling apple,” he said, “the hot stove incident held meaning only for the man whose mind was prepared to draw a conclusion.” Surprisingly, neither Goodyear nor any family member was ever connected with the multi-billion-dollar Goodyear Tire and Rubber Company named in his honor.

Anatomy of a Tire

A tire contains several major components including the casing, beads, innerliner, tread, and sidewalls. The casing, which contains the air that supports the vehicle mass, consists of layers of rubber-impregnated fabric called plies. Depending on the tire, the plies may be rayon, nylon, aramid, polyester, or steel. The plies wrap around a pair of high-strength, bronze-coated steel cables called beads. The beads secure the tire to the wheel and transfer the forces of acceleration, deceleration and cornering from the wheel to the tire. The interior of the casing is protected with an innerliner. This is typically a butyl-rubber material used to keep the casing airtight. On self-sealing tires, the innerliner is coated with a special compound designed to adhere to embedded objects. Once the object is removed, it pulls the compound along with it to seal the opening.

The outside of the casing is covered in a rubber membrane that forms the sidewalls. The sidewall contains brand labelling and the tire's specifications such as size, load capacity, and inflation pressure. The tread provides the contact area, and is made from a variety of natural and synthetic rubber compounds. Grooves in the tread channel water away from under the tire and allow it to flex without scrubbing. The large grooves are called kerfs, while the smaller grooves are known as sipes. The tread also contains wear bars. These are molded into the tread and run perpendicular to the kerfs. Once tread depth reaches 2/32", the wear bars form a strip across the width of the tread, indicating the need for tire replacement.

Belted tires may have two or more layers of material that surround the casing plies. The belts run parallel with the tire beads and reinforce the area directly beneath the tread. The most popular material for modern belts is steel, however, various other materials such as fiberglass, aramid, nylon, polyester, and rayon may also be used.

Tires are manufactured using a mold and press that fuses the structural components together. The points where the parts are joined are known as the splices. A slight indentation is often the sign of a splice.

Tech Tip!

Most tire manufacturers place a mark on the sidewall near the bead to indicate the tire's high spot (area of largest diameter). The mark is often on or near a splice, and may be a paint dot, a stamped ring, or an adhesive label. Similarly, wheel manufacturers indicate the low spot on their wheels by drilling the valve stem hole in the area of the smallest diameter. For optimum balance and minimum radial runout, the mark on the sidewall should be aligned with the valve stem during mounting.

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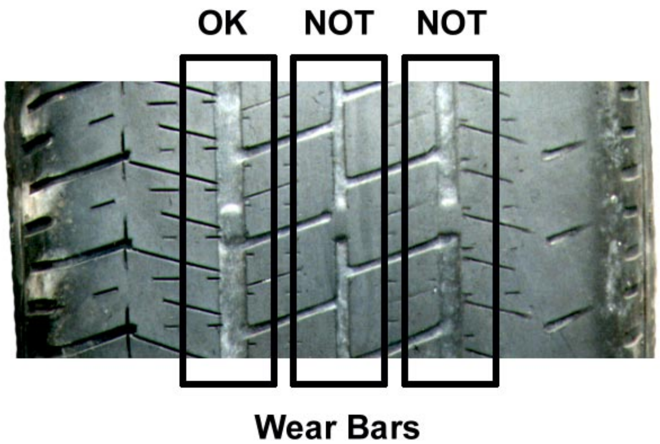
Anatomy of a Tire (continued)



All highway tires have wear bars that are molded into the tread and run perpendicular to the kerfs. Once tread depth reaches 2/32", the wear bars form a bald strip across the width of the tread, indicating the need for tire replacement.

Rolling Resistance

A tire's rolling resistance has a significant effect on fuel economy, since the friction between the tire and road produces drag. When a vehicle accelerates from a stop, the rolling resistance of the tires represents about 15% of the total drag experienced by the vehicle. Overcoming inertia, driveline friction, and wind resistance account for the other 85%. Once the vehicle is moving at a steady speed, the drag produced by the tires rises to about 25%. Because of this, most automobile manufacturers install low rolling resistance tires on their vehicles.

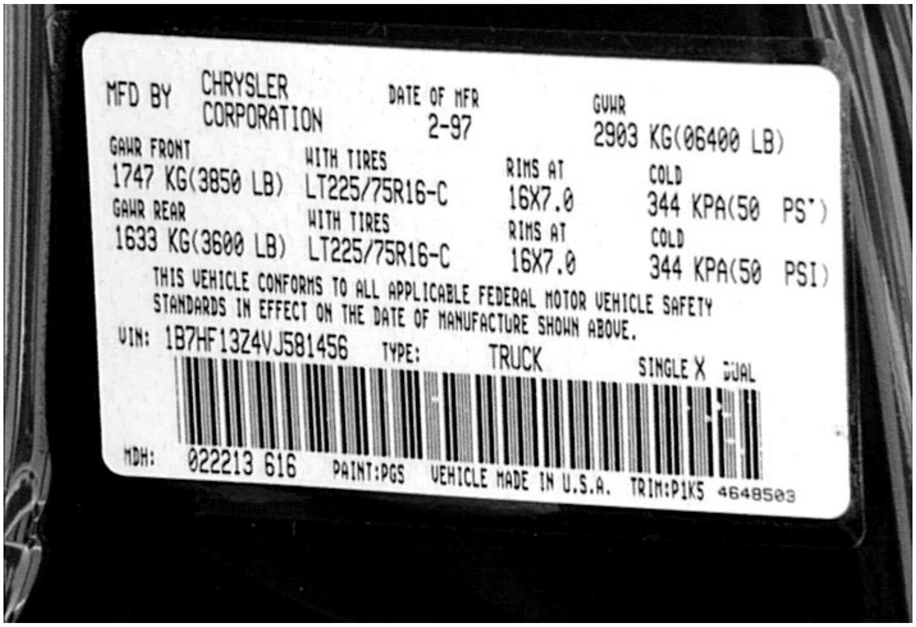
As you might imagine, the most effective way to reduce rolling resistance is to make sure the tires are properly inflated. To illustrate this, consider a set of tires that are supposed to be inflated to 35 psi cold according to the tire placard. If these tires become under inflated to 28 psi, rolling resistance will increase well over 10%.

Tire Placard

Since 1968, cars and light trucks sold in the United States have been required to have a tire information sticker, called a placard. The placard indicates the size of the original equipment tires (including the spare), cold inflation pressure for the tires on both axles as well as the spare, and load capacity. Depending on the vehicle, the tire placard will either be located on the edge of the driver's door, the doorpost, glove box or fuel door. If the tire placard is missing, consult the owner's manual, vehicle manufacturer, or tire manufacturer regarding applicable tire information.

Caution

Never install a replacement tire that is smaller than the original tire or has less load carrying capacity. Always replace original equipment tires according to the sizes indicated on the placard.



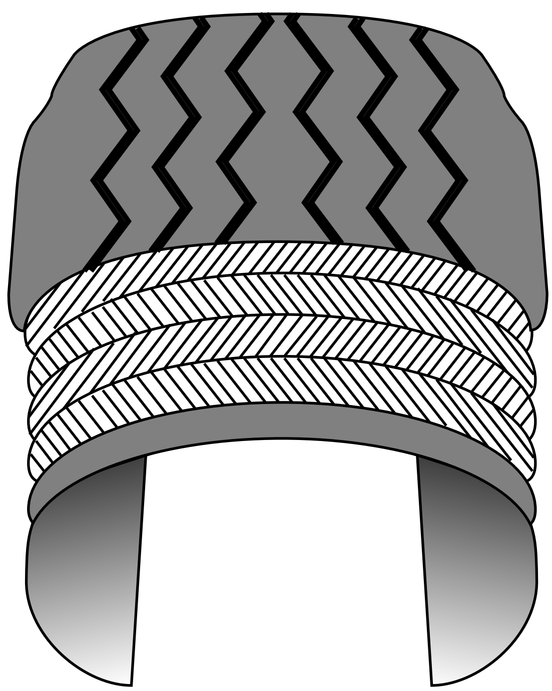
The tire placard is typically attached to the rear of the driver's door.

Tire Designs

While ride comfort and handling are both important, tires are typically designed to favor one or the other. For example, the tires on a luxury sedan might have taller sidewalls to help absorb road shock and provide maximum ride comfort. In contrast, the tires on a sports car usually have short sidewalls to help improve the vehicle's cornering and braking ability. However, overall size is only one of the factors that determine a tire's performance characteristics. Engineers also use a variety of rubber compounds, different ply materials and arrangements, as well as a diversity of tread patterns and depths to achieve the desired result.

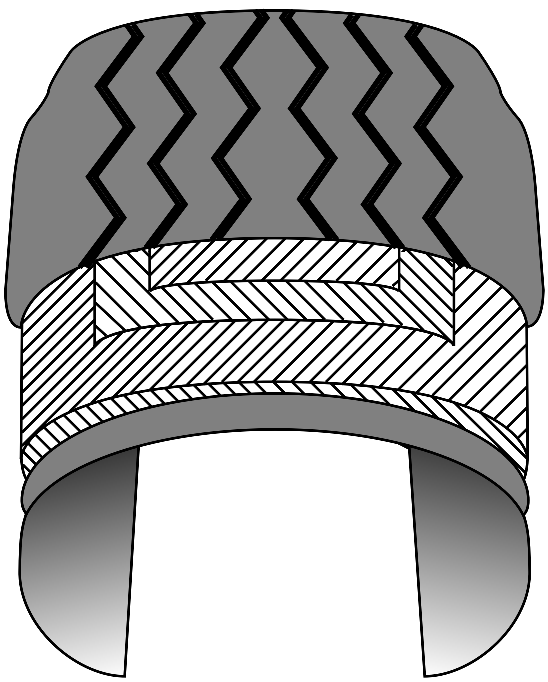
Bias Ply

The oldest tire still in use today is the diagonal ply type, commonly known as a bias ply tire. The term bias means that the casing plies do not run parallel with the beads nor do they run perpendicular. Instead, the plies run between the beads at an angle of 30-45 degrees. Additional layers are run at the same angle only in the opposite direction, forming a criss-cross pattern. The angle of the plies is one factor that contributes to the overall ride and handling of the vehicle. Generally speaking, lower ply angles produce better high-speed handling at the expense of a compliant ride.



Belted-Bias Ply

A belted bias ply tire is similar to the bias ply, except for the addition of one or more belts that wrap around the plies. The belts run parallel with the tire beads, and may be steel, or a fabric such as polyester or nylon. When used in bias ply tires, fabric belts produce a smoother ride than their steel counterparts. In either case, adding belts to the tire helps stabilize the tread and improve sidewall flexibility.



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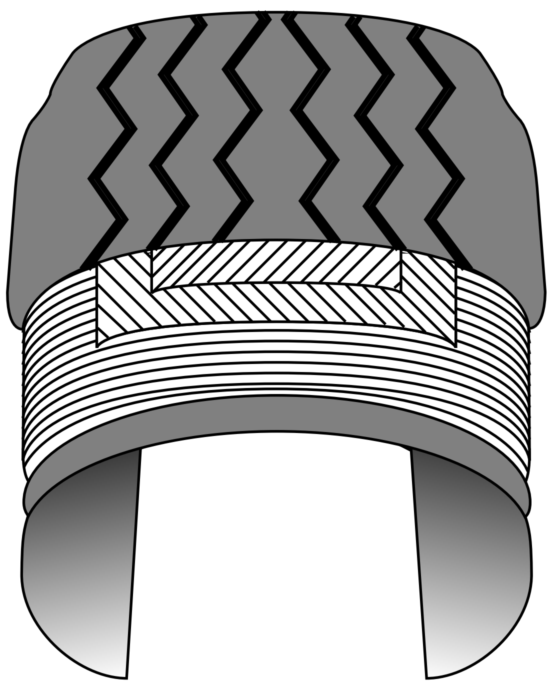
NOTES:

Tire Designs (continued)

Radial Ply

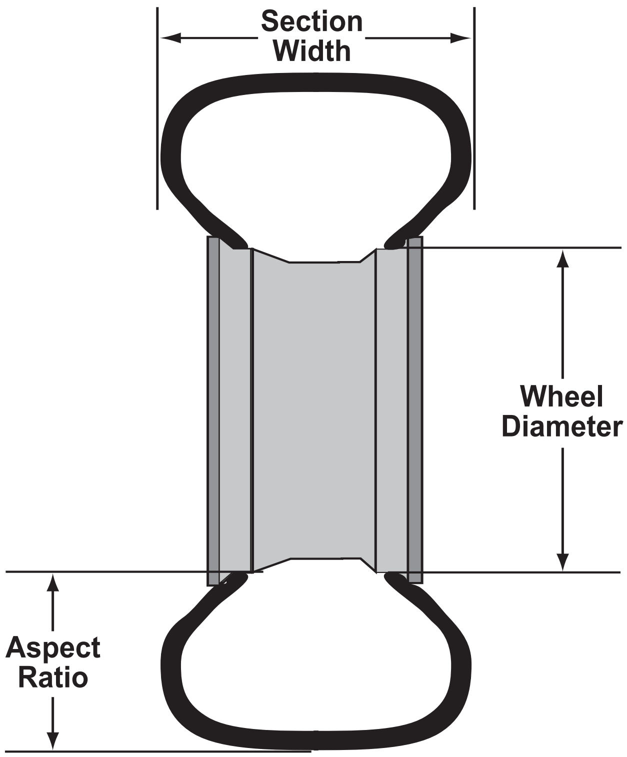
In a radial tire, the casing plies are positioned at right angles to the tire beads. The plies are wrapped in two or more belts that run parallel with the beads. Steel is the most commonly used belt material, which is why the term 'steel-belted radial' has become so popular. Radial tires deliver a greater contact patch, especially during cornering, since the compliant sidewall absorbs lateral thrust without rolling the tread away from the road. Of course, the downside to compliant sidewalls is that radial tires appear to be low on air even when properly inflated. Since radial tires have unique handling characteristics, they should not be installed (except for emergency) alone or in pairs on a vehicle equipped with bias or belted-bias tires.



Understanding Tire Dimensions

There are three critical dimensions imprinted on all radial tires including the section width, aspect ratio, and the wheel diameter. The section width is the actual cross-section of the tire, and is measured between the outermost portions of the sidewalls (excluding raised letters or curb/scuff guards) with the tire at the proper inflation pressure and load. The aspect ratio, also known as the profile or section height, shows the height of the tire's sidewall as a percentage of the tire's width. For instance, the number '75' in the metric rating 185/75R14 means that the sidewall is 75% as high as the tire is wide. To determine the approximate height, multiply the section width by the aspect ratio, which in our example is 185 x .75 = 138.75mm. To convert section height to inches simply divide by 25.4. (138.75 ÷ 25.4 = 5.5"). Wheel diameter refers to the distance measured between the beads seats, which is the same as the inner diameter of the tire.

Tech Tip! *Always replace OE tires with tires of like size, having the same construction and speed rating, or use a manufacturer-approved alternative. Using different size and/or type tires can cause speedometer and odometer inaccuracy, as well as adversely affect vehicle handling or ABS brake systems.*



The three dimensions found on a tire's sidewall include the section width, aspect ratio, and the wheel diameter.

Specialty Tires

Specialty tires provide advantages over conventional tires under specific driving conditions. These tires come in a wide range of styles and tread designs. Some of the most popular types are described below.

Mud & Snow

Perhaps the most familiar of the specialty tires is the all-season mud and snow tire. Available since the late seventies, these tires offer drivers an alternative to having snow tires installed during winter months. The M&S designation indicates that the tire satisfies the requirements for snow tires as defined by the Rubber Manufacturers Association.

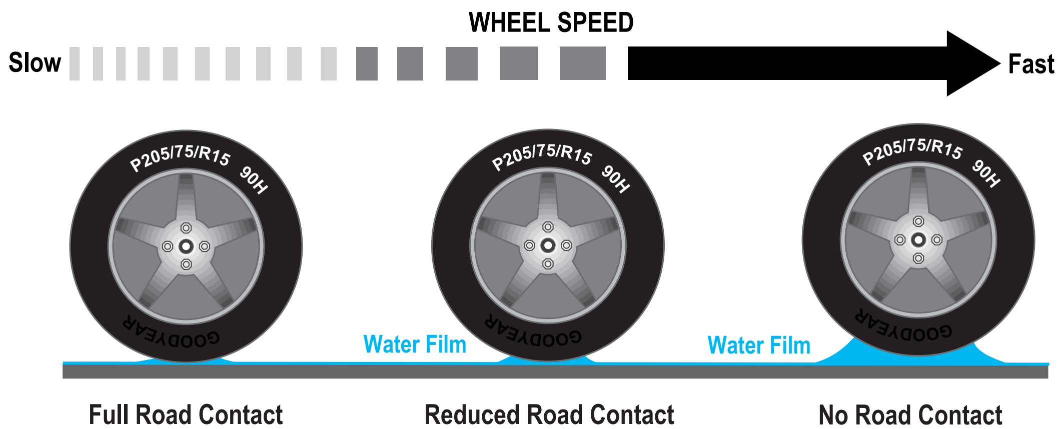
Mud and Snow tires can be identified by the M+S desigation on the sidewall.

Although mud and snow tires provide a significant improvement in traction over regular tires, some drivers still rely on winter tires or studded snow tires to get them through the winter months. If a customer asks to have either type installed on any vehicle, be sure to tell them that snow tires should be installed on both axles. This is because front-drive vehicles can oversteer, a condition in which the rear of the vehicle slides outward during cornering. Installing four snow tires minimizes this condition by providing equal grip at all four corners. Be aware that oversteer is a normal characteristic of front-drive vehicles, since most of the weight is concentrated in the front. On rear-drive vehicles, the weight is more evenly distributed, which is why installing two snow tires on the rear axle is acceptable, but not recommended.

Wet-Weather

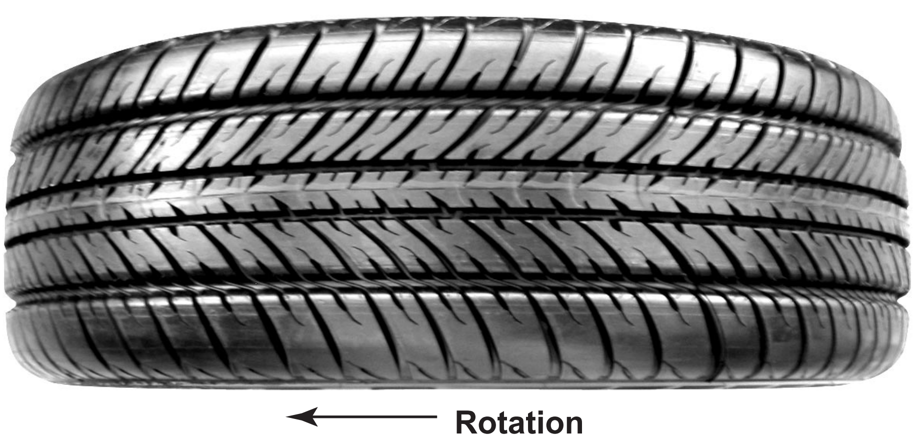
Manufacturers offer wet-weather tires with tread specifically designed to reduce hydroplaning. This condition occurs when the tread fails to channel water away from the tire. Since water is not compressible, the tires lose contact with the road and ride on top of the water. Hydroplaning can occur even at low speeds in a vehicle with worn tires, causing a total loss of steering and braking. Wet-weather tires typically have a wide central groove capable of removing large volumes of water even at highway speeds.

HYDROPLANING



Directional

Some tread designs are engineered to operate in one rotating direction. These directional tires will always include an arrow on the sidewall to indicate the direction of rotation.



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Specialty Tires (continued)

Run-Flat

Run-flats are a new breed of specialty tires intended to prevent accidents caused by blowouts. This technology also allows motorists to drive on a deflated tire to a location where the tire can be safely replaced or repaired. When a conventional tire deflates, the sidewalls collapse, causing the wheel to ruin the tire. Run-flat tires have a reinforced sidewall that maintains enough height for the tire to continue rolling even when deflated.

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Temporary Spare

The temporary-spare is another type of specialty tire. These tires mount on tall narrow rims, and are designed to consolidate trunk space and increase fuel economy by saving weight. Most passenger cars use a high-pressure (60 psi) temporary-spare. These tires should only be used until the full size tire can be repaired or replaced. Never operate a temporary spare at speeds exceeding those marked on the tire or indicated in the vehicle owner's manual. Always check the sidewall for information concerning reparability. In many cases, both the tire and wheel must be discarded if the tire will not retain air pressure.

Using the temporary spare tire on certain ABS-equipped vehicles may trigger the antilock indicator lamp and set a false wheel speed sensor code.

NOTES:

Sidewall Information

The U.S Department of Transportation (DOT) requires certain information to be imprinted on the tire's sidewall. Knowing how to interpret this data allows you to determine whether the tire is appropriate for a particular application. Where tire size is concerned, there are various sizing systems you need to be familiar with including:

- Numeric
- Alpha-Numeric
- P-Metric
- LT-Metric Flotation

Numeric Sizing

Prior to 1967, tire manufacturers used a simple two-digit rating system to designate tire size, such as 8.25-15. With numeric ratings, the first number indicates the approximate width of the tire in inches. The second number shows the diameter of the wheel in inches.

Alpha-Numeric Sizing

The alpha-numeric system begins with a letter that designates the tire's size code, followed by a number indicating the tire's profile. This is followed by a second number for wheel diameter. A typical example would be G78-15. Since all production vehicles use radial tires, the alpha-numeric system is only used for the limited number of tires produced for the classic car market.

The first character in the code, which in our example is a 'G,' corresponds to a specific size and load rating. Sizes and load ratings are listed from A through N, and V through Z. Each letter designation indirectly defines the width of the tire based on the fact that the wider the tire is, the more weight it can support. However, with the alpha-numeric system, an exact dimension of tire width is not indicated on the sidewall. A load rating chart lists the amount of weight a tire can support based on its letter code. You will notice that letters V through Z are the lightest ratings, indicating that these are the narrowest tires.

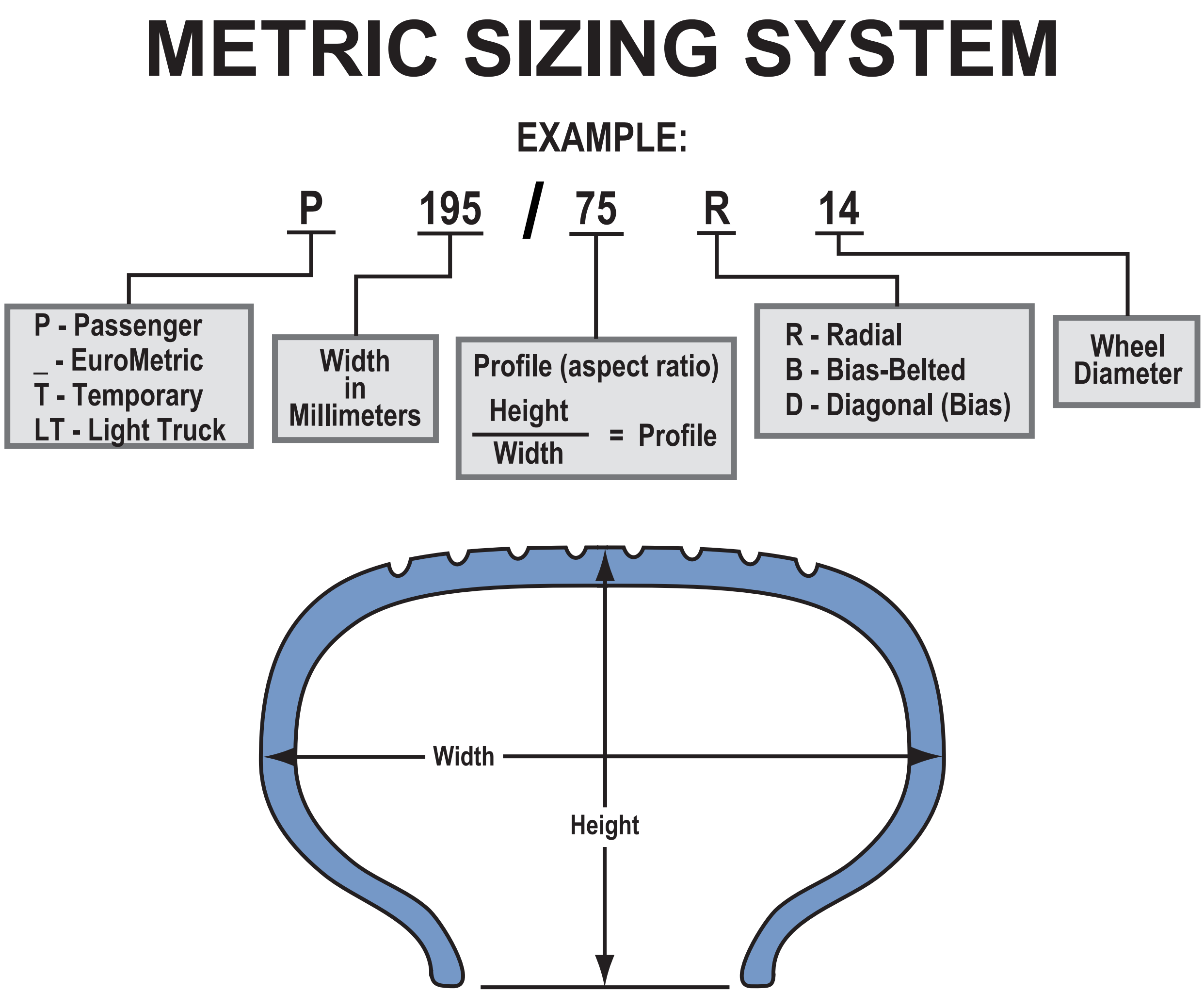
Alpha-Numeric Sizing System Load Index	
Letter Code	Max. Load in Pounds
A	900
B	980
C	1050
D	1120
E	1190
F	1280
G	1380
H	1510
J	1580
K	1620
L	1680
M	1780
N	1880
V	650
W	710
Y	770
Z	830

continued...

Sidewall Information (continued)

P-Metric Sizing

The P-Metric sizing system has been used to classify most tires since 1980. The system includes both P-Metric and Euro Metric sizes. The difference between the two is that P-Metric tires use a qualifier to identify the tire type. A typical example is P195/75R14, where 'P' represents a passenger tire. For other applications, the first letter(s) in the P-Metric rating will either be a 'T' for temporary (mini-spare), or 'LT' for light truck. A comparable Euro Metric tire does not have the first character, as in 195/75R14. The remainder of the metric sizing is the same for both. Tire cross-section (width) is indicated in millimeters, followed by the aspect ratio, and wheel diameter in inches.

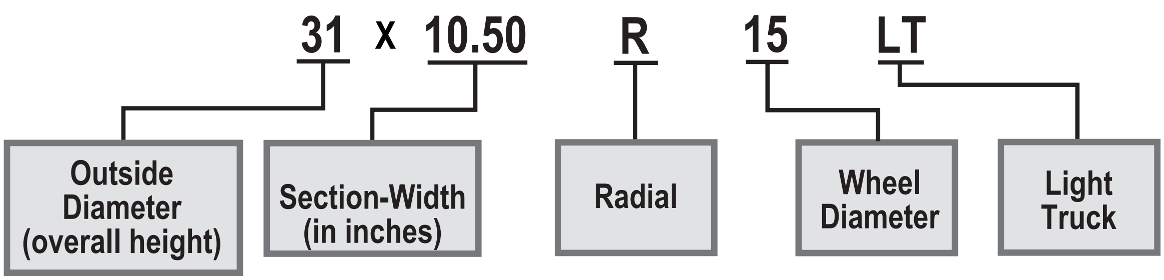


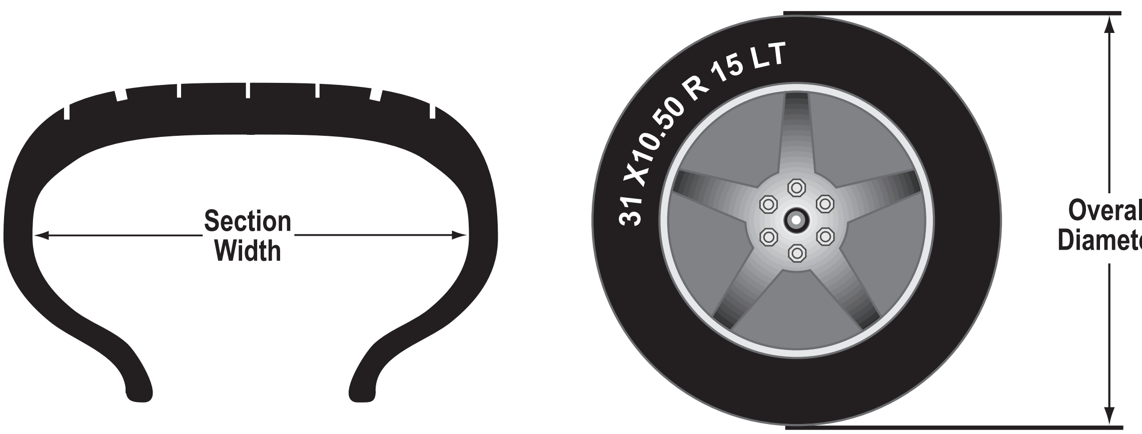
Flotation Sizing

Flotation tires are designed for off-road performance and are generally found on light trucks and large sport utility vehicles. Unlike other sizing systems, the flotation rating does not list an aspect ratio. Instead, it indicates the overall diameter and width of the tire in inches, as in 31 x 10.50.

FLOTATION SIZING

EXAMPLE:





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Sidewall Information (continued)

Service Description

Since 1991, metric sized tires have been labeled with an additional code called the 'service description.' This code consists of a two-digit number followed by a letter, as in '87S.' The number is the load index which indicates the tire's load carrying capacity, while the letter corresponds to the tire's speed rating.

PARTIAL LOAD INDEX

Two-Digit Code	Pounds	Kilograms	Two-Digit Code	Pounds	Kilograms
71	761	345	91	1356	615
72	783	355	92	1389	630
73	805	365	93	1433	650
74	827	375	94	1477	670
75	853	387	95	1521	690
76	882	400	96	1565	710
77	908	412	97	1609	730
78	937	425	98	1653	750
79	963	437	99	1709	775
80	992	450	100	1764	800
81	1019	462	101	1819	825
82	1047	475	102	1874	850
83	1074	487	103	1929	875
84	1102	500	104	1984	900
85	1135	515	105	2039	925
86	1168	530	106	2094	950
87	1201	545	107	2149	975
88	1235	560	108	2205	1000
89	1279	580	109	2271	1030
90	1323	600	110	2337	1060

PARTIAL SPEED RATINGS		
Letter	**km/h**	**MPH**
L	120	75
M	130	81
N	140	87
P	150	93
Q	160	99
R	170	106
S	180	112
T	190	118
U	200	124
H	210	130
V	240	149
Z	240+	149+
W	270	168
Y	300	186

Because speed ratings were originally developed in Europe, the figures were converted from kilometers per hour (km/h) to miles per hour (mph). This is the reason that the mph figures do not increase in multiples of five or ten. Be aware that all speed ratings on today's tires are listed in the service description, except for the 'Z' rating, which continues to be included within the metric tire code. The 'Z' rating was originally intended to be the highest speed rating. However, not long after Z-rated tires were introduced, vehicle manufacturers began producing cars capable of higher. Although the Z-rating represents a speed capability in excess of 149 mph, it does not identify a precise top speed. Because of this, the tire industry established the two additional speed ratings of 'W' and 'Y' to indicate speeds of 168 and 186 mph respectively. Be aware that a W- or Y-rated tire will still include a 'Z' in the metric code. The inclusion of the 'Z' simply shows that the tire is rated for speeds in excess of 149 mph. The precise speed is identified in the service description as in P225/50ZR16 91Y.

Tech Tip! *A tire's indicated speed rating does not apply if the tire is damaged, improperly inflated, or overloaded. In fact, certain tire manufacturers agree that once a tire has been repaired due to a cut or puncture, the speed rating is no longer valid.*

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Sidewall Information (continued)

DOT Code

All tires are required to meet the safety standards established by the U.S. Department of Transportation. Compliance is indicated by the DOT symbol imprinted on the tire's sidewall. Next to the DOT symbol is a code representing the tire manufacturer, the manufacturing location, and the time of manufacture. For tires produced before July of 2000, the time of manufacture is indicated by the code's last three numbers. The first two numbers identify the week, while the last number refers to the year. For example, the number '098' means that the tire was produced in the ninth week (09) of 1998 (8). Beginning with July of 2000, four numbers are used, with the last two numbers identifying the year of manufacture. For example, the number '3402' indicates that the tire was produced during the 34th (34) week of the year 2002 (02).

DOT	ID	C1	XXXX	4800
Meets Department of Transportation Standards	Manufacturer Identification Mark	Tire Size (mold/chamber ID)	Tire Type Code (Optional)	Date of Manufacturer (week/year) Mark

The tire date code not only helps ensure that newly purchased tires are fresh, it can also provide clues to hidden problems, such as vehicle accident damage or odometer rollback. Consider a 1997 car with 12,000 miles on the odometer and virtually no tire wear. With such low mileage, you would expect little wear on the tires. However, a closer inspection reveals that each tire has a date code of '2101,' which means that the tires were produced in the 21st week of the year 2001. At this point, you would have to ask yourself why a car with only 12,000 miles has four brand new tires. There are only two likely explanations. Either the vehicle was involved in an accident and the original tires needed to be replaced, or the vehicle actually has higher mileage than indicated and the original tires wore out. As a result of the TREAD Act, all tires will soon be required to have the manufacturer and date code stamped on both sidewalls.

Additional Sidewall Information

Maximum Load & Inflation Pressure

A passenger tire's load limits and maximum cold inflation pressure must be indicated on the sidewall. For P-Metric tires, this information is listed in both metric and standard units. Since the vehicle manufacturer determines the tire inflation pressure as it applies to a particular vehicle, the pressures listed on the placard may be equal to or less than the pressure listed on the tire. The inflation pressure listed on the placard or owner's manual takes into account vehicle loading, ride, and handling characteristics. Since there are usually multiple applications for any given tire size, vehicle manufacturers may choose different inflation pressures for the same size tire based on the specific vehicle. Under normal conditions, follow the pressure recommendations found in the owner's manual, on the vehicle tire placard, or on the certification label.

Tech Tip! *Because operating pressure is based on a variety of factors, such as load and handling, it may not be the same as the maximum inflation pressure indicated on the tire's sidewall. For example, the U.S. Department of Transportation (DOT) now allows inflation pressures of 35 psi (240 kPa), 44 psi (300 kPa), or 51 psi (350 kPa) for standard load tires. However, the tire may not be loaded beyond the limit listed for 35 psi (240 kPa).*

In addition to size, the Federal Government requires that tires be stamped with information regarding tread wear, traction, and temperature. These ratings are collectively known as the Uniform Tire Quality Grading (UTQG) standards. On some original equipment tires, a single TPC (tire performance criteria) number can be found on the sidewall. This number indicates that the tire meets strict size and performance standards established by the vehicle manufacturer for that particular model. Since replacement tires may not use a TPC number, look at the UTQG ratings to be sure that the tire meets required standards.

Tread Wear

A tire's treadwear rating is a comparative figure, which represents the level of tire wear experienced under controlled conditions on a government test course. For example, a tire with a treadwear rating of 150 will provide one and one half times the wear on the government test course as a tire graded at 100. Be aware that treadwear ratings are only estimates. The actual service life of a tire is subject to driving habits and maintenance practices, as well as variations in road conditions and climate.

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Additional Sidewall Information (continued)

Traction

Tires are graded on traction based on their ability to stop on wet asphalt and concrete under controlled conditions at a government test facility. Currently, there are four traction ratings: AA (highest), A, B, and C.

Warning *A tire's traction rating is based on straight-line braking tests only, and is not an indication of traction ability under acceleration, cornering, hydroplaning or peak traction conditions.*

Temperature

Temperature grades are assigned to tires based on their ability to resist heat buildup when run on a laboratory test wheel under controlled conditions. There are currently three temperature grades including, A (highest), B, and C. Be aware that sustained high temperatures can cause a tire to deteriorate, significantly reducing tire life. Excessive temperatures can also lead to sudden tire failure. According to the Federal Motor Vehicle Safety Standard (FMVSS) No. 109, all passenger tires must at least meet the grade 'C' requirements. 'A' and 'B' rated tires represent higher levels of performance on the laboratory test wheel than the minimum required by law.

Warning *The temperature grade is established for a tire that is properly inflated and not overloaded. Excessive speed, underinflation and/or excessive loading can cause severe heat buildup and possible tire failure.*

Miscellaneous Information

Radial: The word 'radial' will appear on the sidewall of every tire having radial construction.

Tread and Sidewall Plies/Cords: The number of plies under the tread and sidewalls will be indicated along with the materials used for tire ply composition.

Tubeless/Tube Type: The tire will be marked 'tubeless' or 'tube-type.'

Severe Snow Use: Tires designed for use in severe snow conditions are marked on at least one sidewall with the letters 'M' and 'S' along with a pictograph of a mountain with a snowflake.

Standard/Extra Load: Tires that can carry more than the 'Standard Load' for a passenger tire will be marked 'Extra Load,' indicating their ability to carry the additional weight.

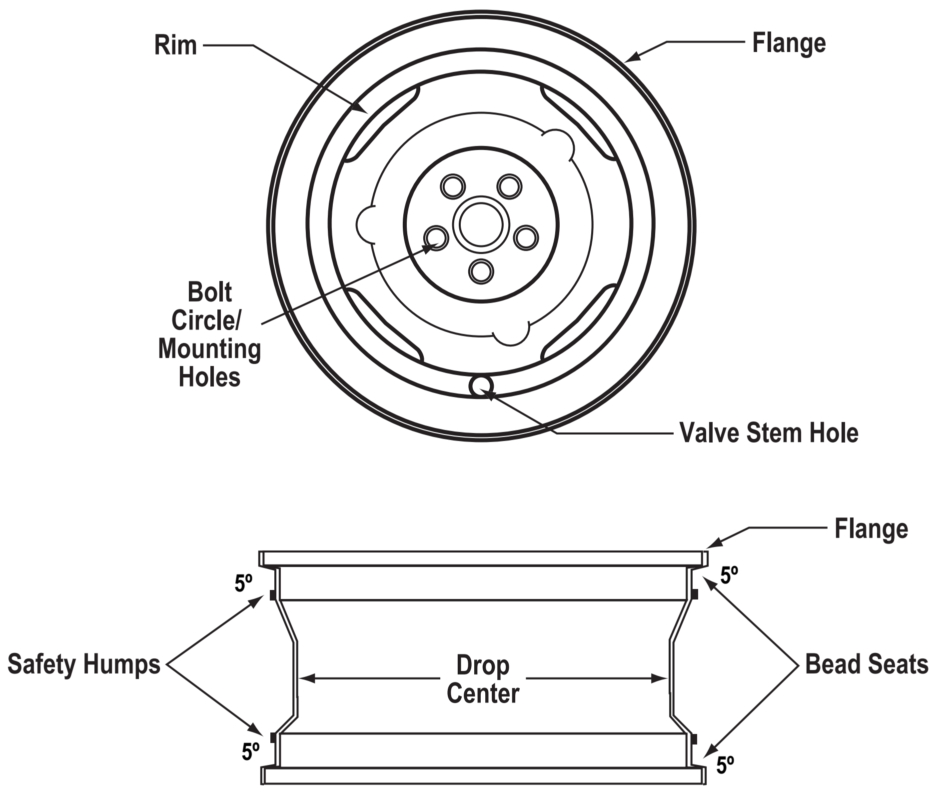
Safety Warnings: Both sidewalls will contain safety warnings that apply to consumers and technicians alike.

Other Markings: Other sidewall markings include brand-specific identifications, country of manufacture, and European standard compliance.

Wheels and Rims

The wheels on today's vehicles are made of steel, aluminum, or aluminum alloy (a combination of two or more metals). Steel wheels are the least expensive to produce, which is why they come as original equipment on many passenger cars and light trucks. The center section includes the bolt circle, or mounting holes, and is used to attach the wheel to the vehicle. The flange is the outermost lip of the rim, and is the area typically used for attaching wheel (balancing) weights. The rim is formed by rolling a strip of metal and then welding the two ends together. The interior section of the rim has a smaller diameter section called a drop center. This area provides the means for removing and installing a tire, since the bead is not designed to stretch. During removal or installation, most of the tire bead is pushed into the drop center so that the exposed portion can be pulled over the rim. The edges of the rim are flared to form the bead seats, which hold the tire and provide the airtight seal. Many rims include safety humps. These are small elevations on the inside of the bead seats. Safety humps help prevent the tire from falling into the drop center during a blowout. This allows the driver to maintain better directional control of a vehicle running on one or more deflated tires.

STEEL WHEEL



continued...

Wheels and Rims (continued)

Some wheels are made of aluminum or aluminum alloy, and may be cast or forged. Casting consists of pouring liquefied metal into a mold, and is the cheaper of the two manufacturing methods. With forging, the metal is heated and then hammered into shape using special equipment. This process yields a much stronger wheel.

Hub-Centric

In a hub-centric design, the wheel's center hole is machined to fit precisely over a raised section on the hub. This arrangement keeps the wheel perfectly centered to the axle, which minimizes the chance of vibration caused by excessive radial runout. A hub-centric design also makes installation easier, since the lugs do not center the tire/wheel assembly on the hub. Most vehicle manufacturers use hub-centric wheels.

Lug-Centric

Wheels with a lug-centric (also known as stud-centric) design have a large center hole. Aftermarket wheels are usually lug-centric since they are required to fit multiple applications. To ensure that lug-centric wheels are properly centered on the hub, the lugs should be torqued with the vehicle off the ground (wheel unloaded). If the wheel is loaded, the weight of the vehicle can force the wheel off-center as the lugs are tightened. Be aware that certain lug-centric wheels can be converted to a hub-centric design using a special hub ring.

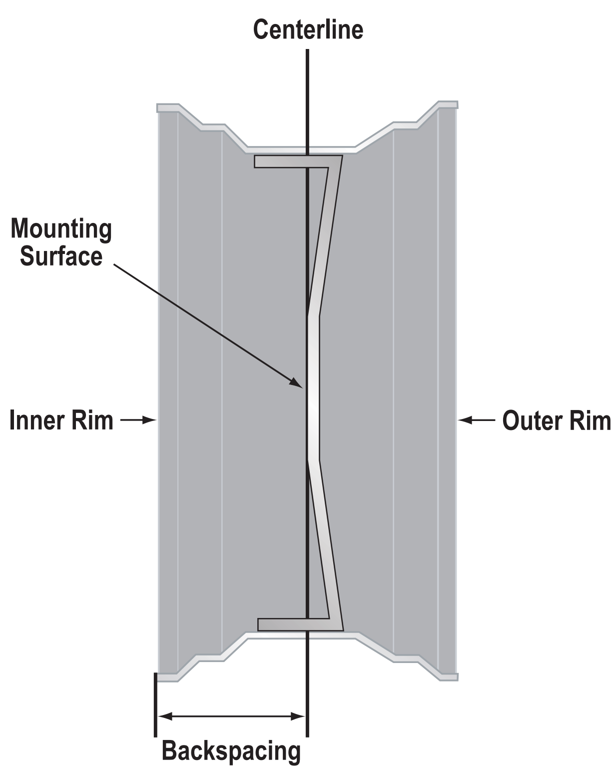
NOTES:

Offset

Offset is the difference between the mounting surface of the wheel and the centerline of the rim. When these points are the same, the offset is zero. In a wheel with positive offset, the mounting surface is closer to the outside of the wheel. Consequently, when a wheel with positive offset is mounted to the vehicle, the greatest portion of the wheel will be inboard of the hub. This reduces overall track width. The wheels used on vehicles with wide tires typically have a positive offset so that the tires can clear the fenderwells.

A wheel with negative offset has a mounting surface that is closer to the inside of the wheel. As a result, the majority of the wheel will be outboard of the hub when mounted to the vehicle. This increases overall track width. Because of their concave design, 'deep dish' wheels typically have a negative offset.

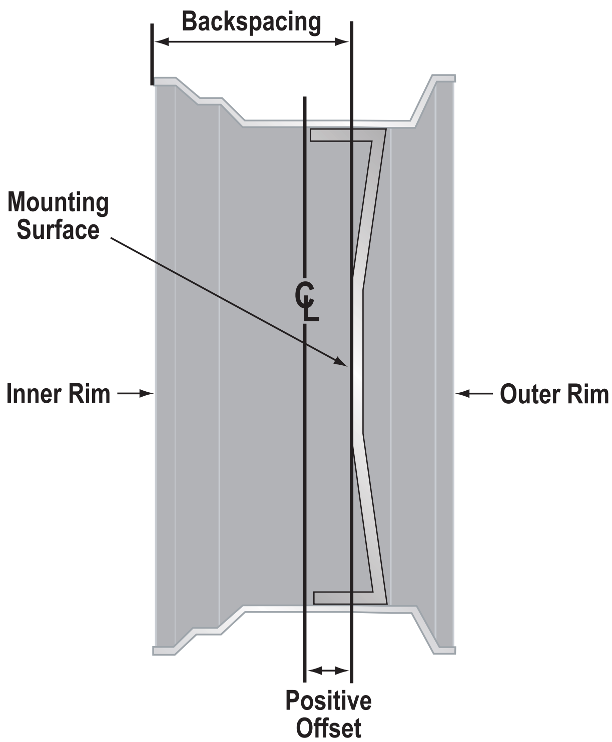
Caution *Using wheels with different offsets from original equipment may adversely affect tire wear and vehicle handling, as well as cause wheel-bearing failure. In addition, improper offset can result in interference between the tire and fenderwell or the tire and suspension components.*



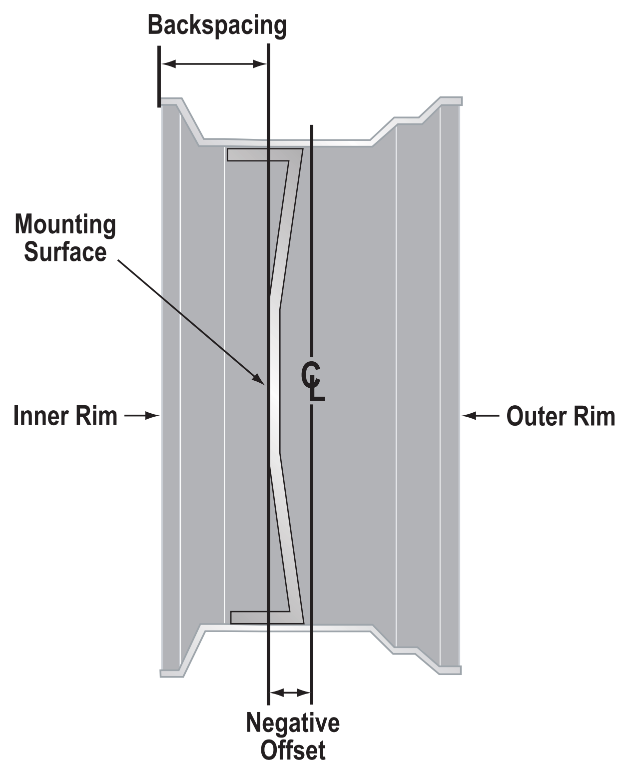
Wheel offset is zero when the mounting surface and the centerline are on the same plane.

continued...

Wheels and Rims (continued)



In a wheel with positive offset, the mounting surface is closer to the outside of the wheel.



In a wheel with negative offset, the mounting surface is closer to the inside of the wheel.

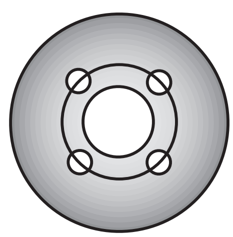
Backspacing

Backspacing refers to the distance between the back side of the wheel's mounting surface and the edge of the wheel. Backspacing is an important consideration when deciding to replace stock wheels with wider aftermarket wheels. To measure backspacing, set the wheel face down on the ground (inside edge facing up). With a straightedge placed across the inside edge of the wheel, measure the distance between the wheel mounting surface and the bottom of the straightedge. This is the wheel's backspacing.

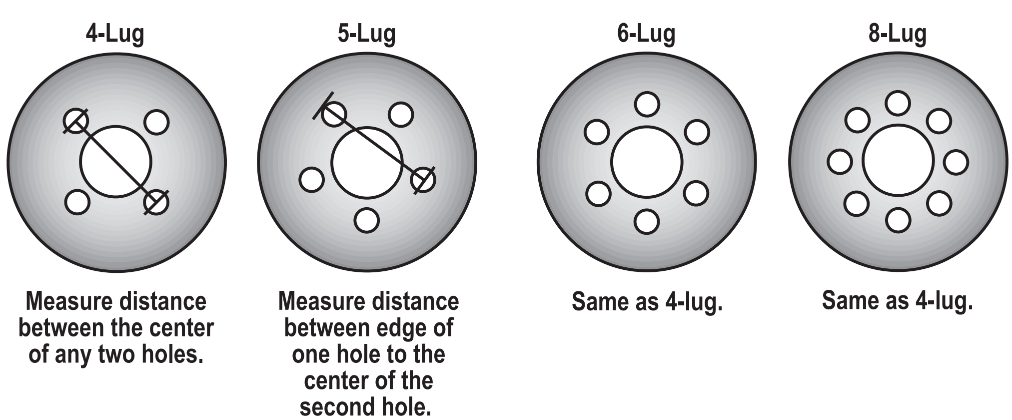
Lug Nuts

Lug nuts secure the wheel to the hub. On most vehicles, the hub contains a series of threaded studs that accept the fasteners. On some import vehicles however, typically compact and mid-size cars, the hubs contain threaded holes that accept lug bolts. The number of lugs used to secure a wheel depends on the size of the vehicle. Passenger cars generally use four or five lugs per wheel, while light trucks have between five and eight. The bolt circle (also known as the lug pattern) refers to the diameter of an imaginary ring drawn through the center of the wheel studs or mounting holes. A specification in an aftermarket wheel catalog, such as 5 on 5", indicates that the wheel uses five lugs within a bolt circle diameter of five inches.

BOLT CIRCLE



MEASURING BOLT CIRCLE

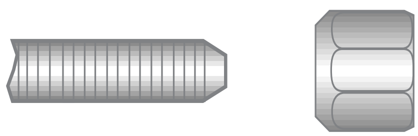


continued...

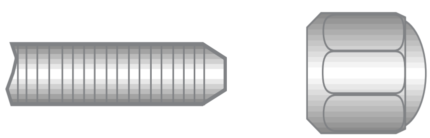
Wheels and Rims (continued)

The lug nuts used for hub-centric wheels are tapered. The taper provides a wedge that locks the lug to the wheel once the proper torque is achieved. The taper also ensures that the lug hole is centered around the stud. Non-tapered lugs are common on aftermarket wheels (lug-centric designs). This type of lug has a long shank, and is used in conjunction with a heavy washer. The washer prevents the lug from damaging the mounting hole as it is tightened. The shank centers the mounting hole on the stud and supports the vehicle's weight. Many alloy wheels are secured with one locking lug to prevent theft. Open-ended locking lugs have randomly placed splines on the outside that fit a matching socket. Closed-ended lugs have a uniquely shaped face that mates with a socket key.

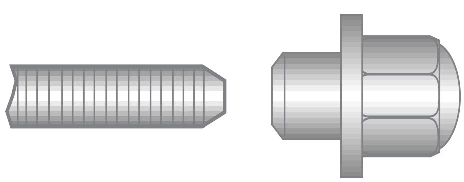
WHEEL LUG NUT STYLES



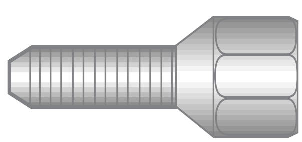
Standard Tapered Lug Nut



Tapered 'Acorn' Lug Nut



Straight Shank Lug Nut with Washer



Lug Bolt

On aluminum wheels with long-shank lugs, applying a small amount of corrosion-inhibiting compound around the shank will prevent electrolysis from developing between the steel lug and aluminum wheel.

Lugs are sized in accordance with the wheel studs and may be either standard or metric. A typical standard lug size is 7/16 – 20 RH, where the fraction indicates the diameter of the wheel stud and the whole number corresponds to the number of threads per inch. The letters ‘RH’ or ‘LH’ stand for right hand or left hand threads. Metric lugs, such as M12 x 1.5, are identified differently. The ‘M’ stands for metric, while the first number indicates the diameter of the wheel stud in millimeters. The final number shows the distance between threads in millimeters. Popular hex sizes for wheel lugs include, 3/4, 13/16, and 7/8 of an inch for standard lugs, and 19 and 21mm for metric lugs.

Tire Size Conversion

Customers often request to have their vehicle's original equipment tires replaced with a different size. When changing tire sizes, several factors must be considered. To begin with, the overall diameter of the replacement tire must be within +/-3% of the OE tire. If the change in diameter exceeds this amount, the accuracy of the speedometer and odometer can be affected. A change in tire diameter outside the acceptable range can also affect the operation of the vehicle's powertrain control, supension/steering, and anti-lock brake systems. Since measuring tire diameter may produce inaccurate results, this critical dimension can be found in the tire manufacturer's Data Book or calculated using the following formula.

Example: P185/60R14.

1. Multiply the section width by the aspect ratio to find the sidewall height.

   (185mm x .60 = 111mm)

2. Convert sidewall height to inches. (25.4mm = 1")

   (111mm ÷ 25.4mm = 4.4")

3. Multiply the sidewall height by 2. This accounts for the top and bottom of the tire.

   (4.4 x 2 = 8.8")

4. Add the total sidewall height to the wheel diameter to find tire diameter.

   (8.8" + 14" = 22.8")

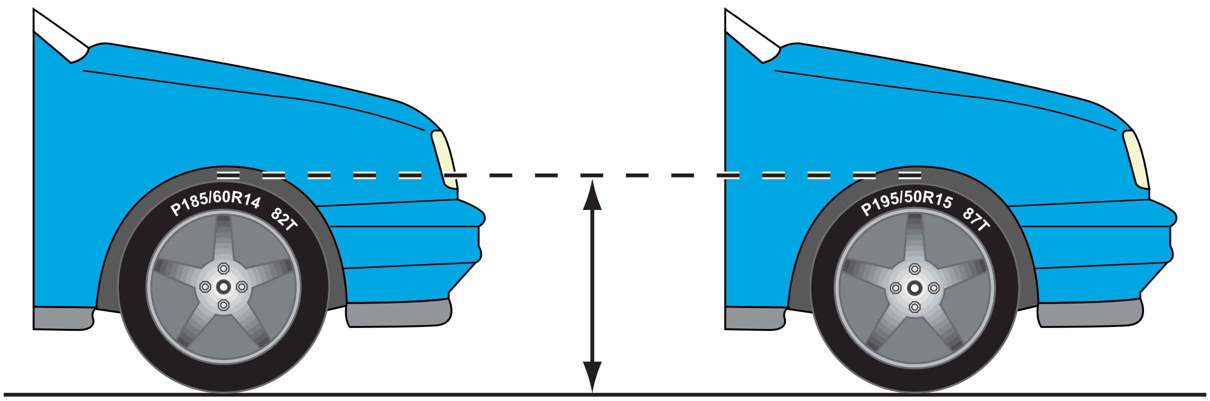
Other factors must be considered when replacing tires. Be sure that replacement tires always meet or exceed the load and speed ratings listed on the vehicle's tire placard. In addition, check the placard to determine if the recommended tire sizes are the same for both axles. Another consideration is the tire's inflation pressure range, which must be equal to or greater than the operating pressures specified on the placard. Remember, never exceed the maximum pressure listed on the sidewall, and be sure all of the tires are the same construction (radial or bias).

NOTES:

Caution

Vehicle manufacturers approve alternate tire sizes for certain vehicles in which the original handling characteristics can still be maintained. However, be aware that tire sizes inconsistent with those listed on tire placard can adversely affect vehicle stability. Always check with the vehicle manufacturer before changing tire sizes.

TIRE SIZE CONVERSION



OE TIRE SIZE
P185/60R14
(Overall Diameter = 22.8")

SIZE EQUIVALENT
P195/50R15
(Overall Diameter = 22.6")

Installing a larger wheel can be accomplished by replacing the OE tire with a lower profile size equivalent. In this case, a P185/60R14 is replaced by a P195/50R15 with only a 0.2" difference in overall height. Since this represents less than a one percent difference in rolling diameter, speedometer and odometer accuracy should not be affected.

NOTES:

TIRE INDUSTRY ASSOCIATION

Module Two:

Raising the Vehicle

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In-Ground Lifts

In-ground lifts are those in which the lifting mechanism and pistons are located underneath the garage floor. Depending on the design, the lifting mechanism may consist of separate air/oil reservoirs, a self-contained air/oil reservoir, or an electric oil-pumping unit. These devices cause the piston(s) to rise out of the floor when the lift is activated. The number of pistons depends on the unit's lifting capacity. Most single- and dual-piston lifts are designed to raise passenger cars and light trucks. Units containing three or more pistons are used for lifting heavy-duty vehicles, such as buses and fire trucks. The use of in-ground lifts for automotive repair has gradually declined since the 1980s, primarily due to environmental concerns. There are three basic types of in-ground lifts including:

- Drive-Through Frame-Contact
- Drive-Over Frame-Contact
- Drive-Over Axle-Engaging

Drive-Through Frame-Contact

The drive-through frame-contact lift uses two pistons placed approximately six feet apart. A platform and swing arm assembly is mounted to the top of each piston. The vehicle rests on adjustable pads mounted to the end of each swing arm. Since the arms are positioned to the sides, the vehicle can be driven between them. This arrangement provides unlimited access to the underside of the vehicle, which is why these lifts are common in many transmission and muffler shops. Another advantage to this type of lift is that the vehicle does not have to be perfectly parallel in order to be raised. This feature makes it easier to lift vehicles that have to be pushed into the service bay.

Drive-Through Frame-Contact Lift

Drive-Over Frame-Contact

In a drive-over frame-contact lift, the four swing arms are attached to a common platform and raised by a single piston. The entire assembly is centrally located so that the vehicle can be driven over it. This arrangement provides a clear floor space around the vehicle when it is on the ground. With the vehicle in the air, the lift provides unobstructed access to the front and rear of the undercarriage.

Drive-Over Frame-Contact Lift

continued...

NOTES:

In-Ground Lifts (continued)

Drive-Over Axle-Engaging

The drive-over axle-engaging lift is a dual-piston design. The pistons are positioned end-to-end with large lift supports mounted on top. The pistons are controlled separately, which makes this lift more difficult to operate than the frame-contact type. When raising the vehicle, the piston supporting the lighter end must be carefully controlled in order to prevent that end from rising too quickly. Otherwise, the vehicle can tip. When lowering the vehicle the opposite piston must be lowered slowly to prevent the heavier end from dropping too fast. Another disadvantage to the axle-engaging lift is that the front lift support limits access to front-end components.

Drive-Over Axle-Engaging Lift

Above-Ground Lifts

Above-ground or surface-mounted lifts fall into two basic categories including, stationary and portable. Stationary lifts are two- or four-post units bolted to the shop floor, while portable units range from low-rise lifts for tire/wheel service, to high-rise multi-service scissors lifts. Above-ground lifts are powered by an electric motor that operates a hydraulic pump. Depending on the design, the pump activates either a screw drive mechanism or one or more cylinders.

Two-Post Lift

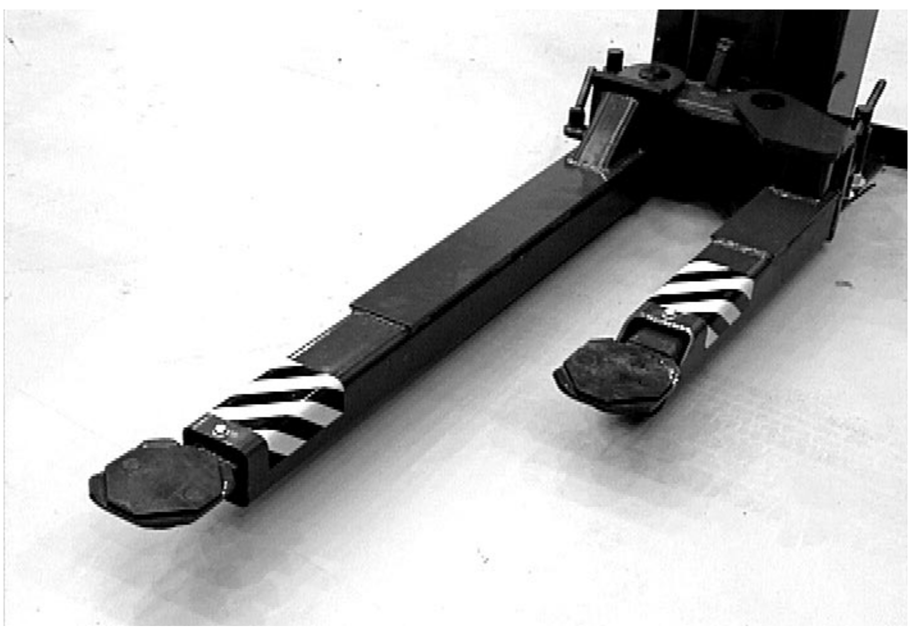
continued...

NOTES:

Above-Ground Lifts (continued)

Two-Post Lifts

Most automotive repair shops use stationary two-post lifts. These units are not only cheaper to purchase and install than in-ground lifts, but eliminate the possibility of environmental damage caused by underground fluid leakage. The swing arms on two-post lifts are similar to those used for their in-ground counterparts. In a symmetrical two-post unit, the swing arms are of equal length, and the vehicle is centered between the posts before being raised. These lifts work exceptionally well for full-size vans and light trucks, since centering these vehicles places the front doors ahead of the posts. However, when a symmetrical lift is used to raise a passenger car, minivan, or small SUV, the posts prevent the front doors from opening very far. This makes it nearly impossible to work inside the vehicle while it is on the lift. To solve this problem, lift manufacturers created the asymmetrical two-post lift. With this design, the rear swing arms are longer than the front, and in some cases, the lift posts are turned at an angle. The asymmetrical design allows the vehicle to be positioned back far enough so that the front doors can be opened all the way.



Asymmetrical Swing Arms

The two-post lifts in most shops are the 'clear-floor' type, which means that there is no base plate used to conceal the hydraulic lines, chains, or cables that run between the two posts. Instead, this hardware is mounted above the posts. The 'clear-floor' design provides an unobstructed path underneath the vehicle, allowing the technician to move tool boxes and other large equipment. Two-post lifts with a base plate are designed for areas with low ceiling height.

Two-Post Lift with Base Plate

continued...

NOTES:

Above-Ground Lifts (continued)

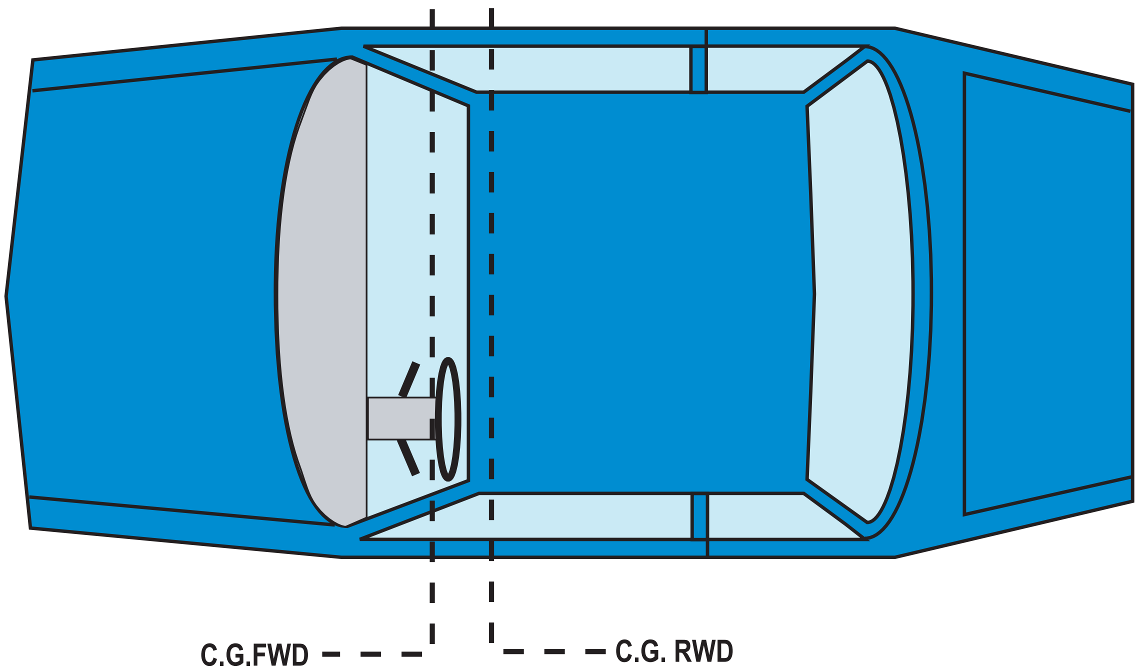
Lift Capacity

The lifting capacity is usually displayed on the nameplate attached to the lift. If the nameplate is missing or too worn to read, check with the manufacturer to determine the unit's rating. Never exceed the lift's rated capacity under any circumstances! In addition, make sure the vehicle you're lifting does not have an extreme front or rear weight bias, since this could overstress the swing arms. For example, a typical surface-mounted lift rated at 7000 pounds means that each arm is designed to support 1750 pounds. Now suppose your going to lift a contractor's pickup truck. The truck is equipped with large side boxes loaded with tools, equipment, and supplies, and the bed is full of lumber. Despite the load, the gross vehicle weight is just within the lift's rated capacity. However, most of the weight is concentrated in the rear. Consequently, the rear swing arms will be overloaded, creating a potentially hazardous situation once the vehicle is in the air.

Vehicle Spotting

In order to lift a vehicle safely, you must also determine its center of gravity. This is the point on the vehicle where the 50/50 weight split occurs. Generally speaking, the center of gravity for front-wheel drive cars is below the steering column. On rear-wheel drive cars, it is below the driver's seat. The vehicle should always be positioned so that the center of gravity is directly between the lift posts. To help locate the vehicle in the correct position, most lifts include a spotting dish. This floor-mounted plate accepts the vehicle's left front tire. However, since the center of gravity is not the same for all vehicles, the spotting dish is usually located in a position that accommodates most passenger cars. For longer vehicles, such as limousines and many light trucks, the left front tire should be ahead of the spotting dish.

CENTER OF GRAVITY



The center of gravity for front-wheel-drive vehicles is usually just in front of the driver's seat, while the center of gravity for rear-wheel-drive vehicles is typically below the driver's seat.

Spotting Dish

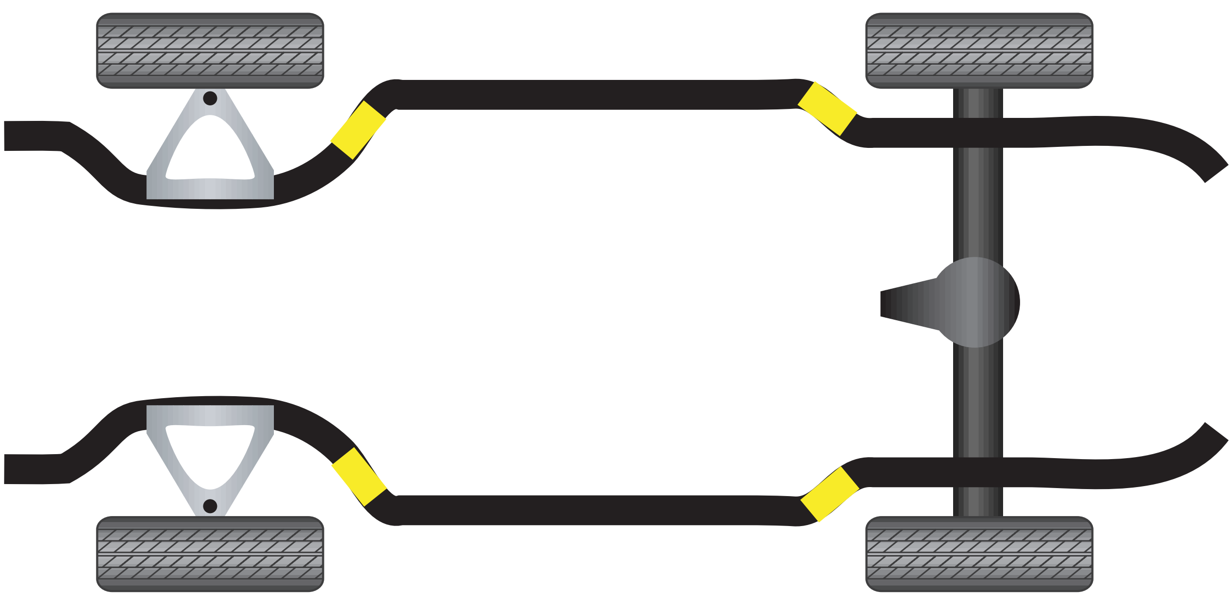
continued...

Above-Ground Lifts (continued)

Lifting Points

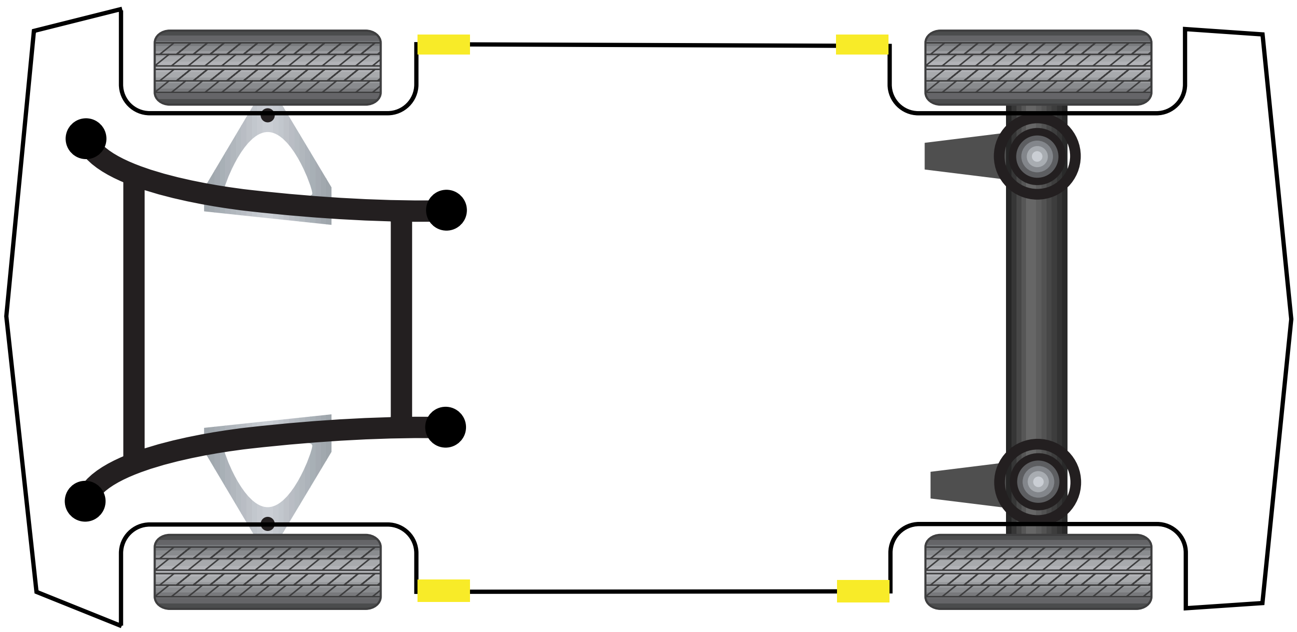
Spotting the vehicle is only the first step in raising it safely. The next step is identifying the lifting points. Lifting points are specific areas on the vehicle underbody designed to support the load. Unless the lift pads are placed within these areas, the vehicle will sustain serious damage. On full-frame vehicles, the lifting points are the areas of the frame just behind the front tires and just ahead of the rear tires. On vehicles with unibody construction, the lifting points are usually located along the side rail pinchwelds. Some 1994 and newer vehicles have a label that identifies the lifting points. The label may be in the glove box, under the hood, or attached to the rear of the driver's door. On many vehicles, the lifting points are indicated by small triangles stamped on the rocker panels. If you are unsure about how to lift a particular vehicle, always consult the appropriate service manual to determine the location of the lifting points.

LIFTING POINTS
(full-frame vehicles)



On full-frame vehicles, the lifting points are just behind the front wheels, and just ahead of the rear wheels.

LIFTING POINTS
(unibody construction)



On vehicles with unibody construction, the lifting points are located on the side rail pinchwelds, just behind the front wheels and just ahead of the rear wheels.

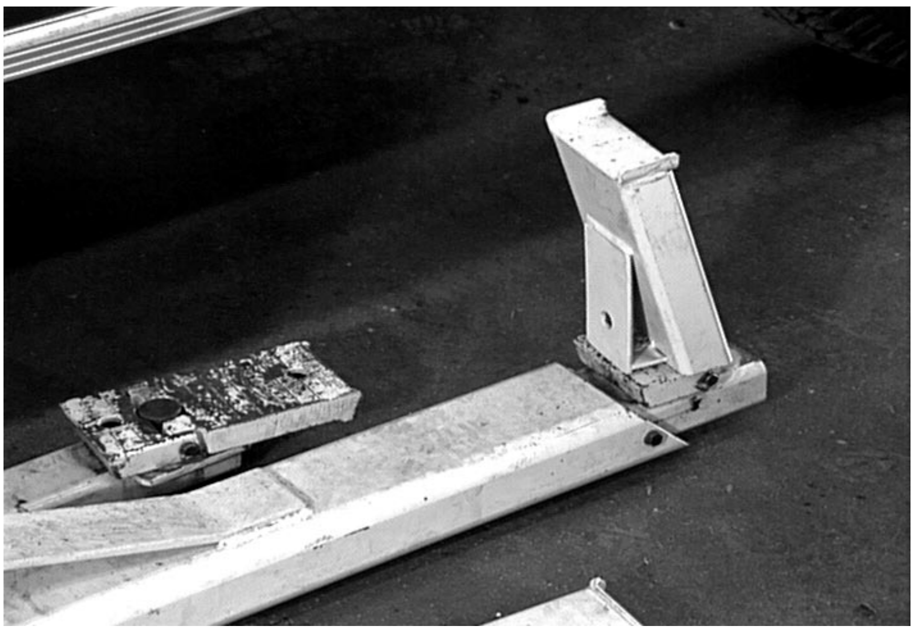
continued...

NOTES:

Above-Ground Lifts (continued)

Lift Pads & Adapters

All frame-contact lifts have adjustable pads at the ends of the swing arms in order to accommodate a wide range of vehicles. The pads may be flip-up, stackable, or threaded. Lifts with flip-up or stackable pads may include adapters that increase pad height. The adapters are usually required when lifting vehicles with high ground clearance. When using flip-up pads, make sure they are securely in position before raising the vehicle. Unsecured pads can collapse, causing the vehicle to become unstable. If your lift has threaded pads, be sure they are adjusted evenly to prevent the vehicle from leaning.



Lift Pad Adapters

Caution *On vehicles with rocker panel moldings, make sure the lift pads are adjusted high enough so that the swing arms do not contact the molding as they are raised. In addition, be sure the lift pads clear the tires and do not interfere with underbody components such as exhaust pipes, brake lines, etc.*

Lift Safety

Once the vehicle is properly spotted and the lift pads are in position, raise the swing arms until the pads just contact the vehicle. At this point, check the position of the pads, making sure they fully contact the recommended lifting points and are not interfering with the tires or any under-body components. Now raise the vehicle about a foot off the ground, and then rock the vehicle at one end to ensure that it is solidly in place. If the vehicle slips or seems the least bit unstable, carefully lower it and readjust the pads as necessary. Once you have determined that the vehicle is stable, raise it to the desired height, and then release the load until the lift's locking mechanism engages. When it is time to lower the vehicle, make sure that the area is clear. This includes the area around the vehicle and underneath of it. Once the vehicle is back on the ground and the swing arms are fully lowered, rotate the arms completely out of the way and adjust the lift pads to the lowest setting. This will provide the vehicle with an unobstructed exit path. Here are some additional safety guidelines:

- Inspect the lift daily for defects. Never use a malfunctioning lift.
- Check the post mounting bolts for looseness at least once a month, and tighten to manufacturer's specifications.
- Lubricate swivel points regularly to ensure the lift pads operate smoothly. Make sure that the tops of the pads are free of oil, grease, and other contaminants.
- Never exceed the lift's rated capacity or raise a vehicle with excessive weight bias.
- Never remove the safety stop on a swing arm to increase its travel.
- If the lift is not raised high enough to engage the safety locks, place four high-reach jack stands at appropriate locations underneath the vehicle.
- Be aware that the removal of certain components can cause the vehicle to shift due to the change in the center of gravity. For example, removing large tires and wheels from the rear of a pickup truck can cause the rear end to lift. To prevent instability, place a suitable jack stand underneath the heavier end of the vehicle prior to component removal.
- Avoid using a breaker bar on tight bolts when the vehicle is in the air. The leverage provided by the bar can cause a dangerous shift in vehicle position. Use an impact wrench instead.

Jacking Equipment

Floor jacks and jack stands are frequently used to supplement the lifting and support chores of in-ground and above-ground lifts. During certain repair procedures for example, a floor jack may be required to raise and lower the engine. The floor jack is also used for quick services, such as tire repair. This is especially true when a lift is unavailable and a customer is waiting.

The wheels on a floor jack obviously allow for easy transport, but they also play another vital role. Remember that the bottom of the lift arm is attached to a horizontally-mounted hydraulic ram. In order to raise a load, the ram forces the bottom of the lift arm away from the jack, causing the top of the arm to move toward the jack. In order for the load to remain squarely on the lift pad, the jack must roll forward slightly as the load is raised. If the wheels are unable to move, the load can slip off the pad. This is why it's important to make sure that nothing is blocking the wheels once the jack is in position, and why faulty wheels should be repaired promptly.

Jack stands are used in a variety of circumstances. High-reach stands may be needed to stabilize a vehicle in the air or support underbody components. Short jack stands, also known as safety stands, are required to support the load whenever a floor jack is used to raise the vehicle. Safety stands are also used to unload the suspension when checking ball joint wear.

A jack stand should always be used to support the load after raising the vehicle with a floor jack. If the vehicle is parked on an asphalt surface, especially on a hot day, the jack stand should be placed on a piece of plywood or steel to prevent it from sinking into the ground.

High-reach jack stands are often used to support the vehicle during major underbody repairs, such as removing the fuel tank.

continued...

NOTES:

Jacking Equipment (continued)

Safety Tips

Accidents involving the use of floor jacks and jack stands are rare. However, they can be devastating when they occur. To prevent personal injury and/or property damage, keep the following safety tips in mind:

- Never exceed the rated capacity of a floor jack or jack stand.
- Make sure the lift pad is free of oil, grease, and other contaminants.
- Always position a floor jack and jack stand on level ground to prevent them from tipping over.
- Make sure that floor jack wheels roll freely as the vehicle is raised. If the wheels are unable to move, the vehicle can slip off the lift pad.
- A floor jack should NOT be used to support the vehicle. Always use a safety stand.
- Always lift and support the vehicle at the recommended lifting points.
- Make sure the locking mechanism is fully engaged before supporting a vehicle with an adjustable safety stand.
- When using a floor jack to support the engine or transmission, make sure the jack handle is not sticking out from the vehicle. This can cause someone to trip and/or move the jack out of position.
- When using safety stands on asphalt, especially on a hot day, place the stand on a piece of thick plywood or steel. This will prevent the stand from sinking into the asphalt.

TIRE INDUSTRY ASSOCIATION

Module Three:

Tire/Wheel Assembly Removal & Installation

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Removing Wheel Covers

Depending on the vehicle, the wheel covers may be attached using a conventional press-fit, the wheel lugs, wheel lug caps, or a special fastener (locking wheel covers). Press-fitted metal covers will typically come off easily when pried with a wheel cover removal tool or a flat-blade screwdriver. However, since plastic press-fitted covers flex when pried, they can be more difficult to remove. To ease removal and avoid breakage, gently pry the edges in the stiffest areas of the cover.

Caution *Always wear safety glasses when removing press-fit plastic wheel covers. The edges of these covers can break when pried, resulting in flying fragments.*

Wheel covers retained by the lugs or lug caps appear the same as the conventional press-fit type. However, the difference will become apparent the moment you try to pry them off! If the cover is secured by lug caps, the wheel cover will come off when you unscrew the caps by hand. If the cover is held on by the lug nuts themselves, you'll find that the caps are concealing several special lugs that secure the cover to the wheel.

Caution *Never use an impact wrench to remove the lug caps on wheel covers or alloy wheels so equipped. Also, be aware that some conventional press-fitted wheel covers have lug caps molded into the cover. These caps are cosmetic only. Do not attempt to remove them.*

Lug-Retained Wheel Covers

Locking wheel covers are retained by a theft-proof fastener that attaches to a baseplate on the wheel. The baseplate is mounted to the wheel using three special lugs. Accessing the fastener is accomplished by prying up on a removable cap in the center of the wheel cover. You'll find that most drivers keep the wheel cover removal tool in the glove box or center console. However, if the tool is not with the vehicle, or the customer has misplaced it, a universal removal tool may be required. These tools are typically part of a locking lug removal kit, and are available from most major tool suppliers.

Locking Wheel Cover

Universal Lug Removal Tool

continued...

Removing Wheel Covers (continued)

In some cases, a wheel cover fastener may become difficult to loosen due to corrosion. Under this condition, the removal tool is usually of little help. In an extreme case, even a universal removal tool may fail to loosen the fastener. If you encounter this situation, try the following:

1. Inform the customer of the problem, and explain the potential for wheel cover damage during removal.
2. With the center cap removed, use the appropriate size chisel to cut a notch into the head of the fastener. Cut the notch deep enough to accept the blade of a large screwdriver.
3. Try removing the lock using the screwdriver. (proceed to the next step if the fastener is still stuck)
4. Place a small chisel against the notch in the fastener.
5. Using a hammer, tap the chisel in a counterclockwise direction to loosen the fastener.

NOTES:

Removing Stuck Wheels

Removing and installing the tire/wheel assembly is a relatively simple task. However, there will be times when a wheel refuses to budge, even after you have removed the lugs. This condition is particularly common on vehicles equipped with cast iron hubs and steel wheels, especially if the wheel covers are missing. This is because the unprotected components are more prone to rust and corrosion. To remove a stuck wheel, follow the procedures described below.

Caution *Always wear an approved pair of safety glasses when working underneath the vehicle.*

Removing Stuck Steel Wheels

1. Partially thread one of the lugs back onto any stud.
2. Raise the vehicle high enough so that you can safely swing a dead-blow hammer.
3. Strike the edge of the rim with one sharp blow from the dead-blow hammer.
4. If the wheel remains stuck, rotate the assembly and repeat the previous step in several different locations until the wheel breaks free.

Removing Stuck Steel or Custom Wheels

1. Replace all of the lugs on the stuck wheel until they are snug.
2. Loosen each lug about two turns.
3. Lower the vehicle to the ground.
4. With the aid of an assistant, rock the vehicle from side-to-side until the wheel breaks free.
5. If the wheel remains stuck, then start the engine and drive the vehicle a few feet in each direction, using sharp stabs on the brake pedal each time to help free the wheel.

Caution *Never drive the vehicle more than a few feet in either direction since the wheel is not secured.*

Replacing Wheel Studs

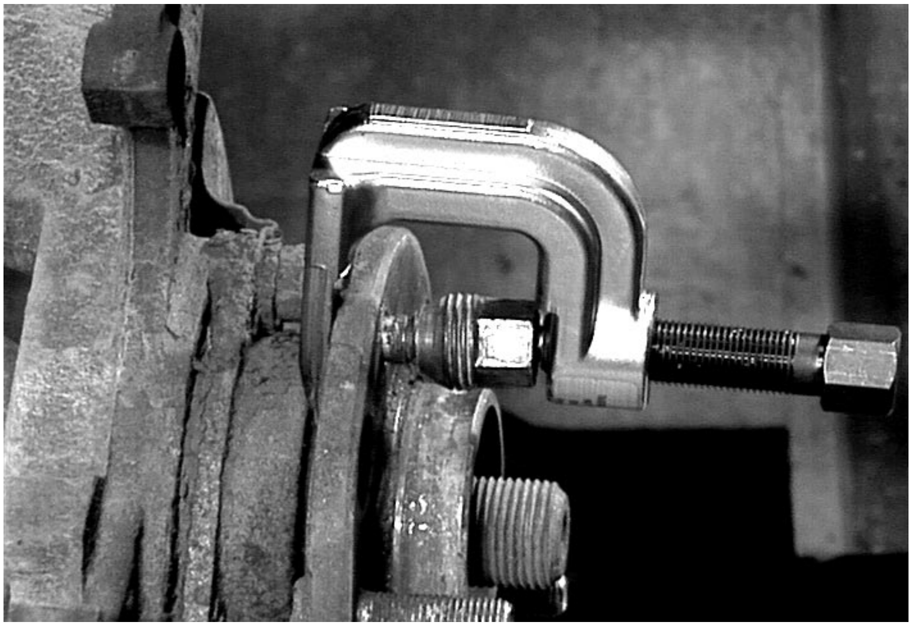
Cross threading and/or over tightening lugs can destroy wheel studs. If only a few threads are damaged, a thread chaser can be used to restore the stud. However, on vehicles where a stud is stripped or broken, the stud must be replaced. The front wheel studs on most rear-drive vehicles are typically press-fitted to the rotor/hub assembly. These studs can usually be removed using a hammer and brass drift. This is best accomplished with the rotor on a concrete floor supported by two blocks of wood. The concrete floor provides a solid base, while the wooden blocks protect the rotor finish.

The studs on most newer vehicles are press-fitted in the hub. Replacing these studs can be accomplished using a special removal tool similar to a C-clamp. The fixed end of the tool is shaped like the letter ‘U.’ This end is placed against the rear of the hub so that the back of the stud is centered within the opening. The movable end (press-bolt) is centered over the top of the stud and tightened securely. With the tool in position, the press-bolt can be tightened with an impact gun until the stud pops out the rear of the hub.

Tech Tip!

When using a portable removal tool to replace a broken wheel stud, try installing a lug a couple of turns before mounting the tool. The lug will keep the press-bolt centered and prevent it from slipping off the stud during removal.

Installing new studs is the same regardless of application. Simply insert the stud through the rear of the mounting hole. Tap the end of the stud lightly so that the serrations keep the stud secured in the hole. Next, place several flat washers over the opposite end of the stud, and then screw the lug on with the tapered end facing out. Finally, use an impact gun to tighten the lug until the stud is fully seated in the hole.



Wheel Stud Removal Tool

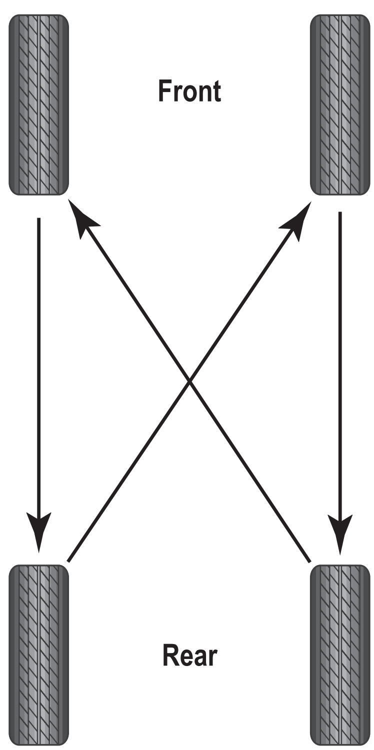
NOTES:

Tire Rotation

The front tires on most vehicles tend to wear out faster than the rear tires. This is due to the effects of steering the vehicle and the weight transfer that occurs during braking. To ensure that all four tires wear evenly, it is important to rotate them on a regular basis. Tire rotation helps maintain balanced handling because it allows all four tires to wear at the same rate. Keep in mind, as tire wear reduces tread depth, it increases the tires' response to driver inputs. Consequently, by equalizing tire wear at all four corners, dry road performance is actually enhanced. Another advantage of regular rotation is that it allows the tires to be replaced in complete sets rather than in pairs. This maintains handling continuity. It also enables drivers to take advantage of the latest in tire technology, instead of trying to match a pair of older tires.

Most manufacturers list rotation intervals in the scheduled maintenance section of the vehicle service manual and/or the owner's manual. Tire rotation patterns can also be found in these books. If this information is unavailable for a particular vehicle, rotate the tires every 5-7,000 miles following the appropriate rotation sequence shown in the illustrations. After completing a tire rotation, be sure to reset inflation pressures to the manufacturer's recommended specifications indicated on the vehicle tire placard.

FWD ROTATION PATTERNS



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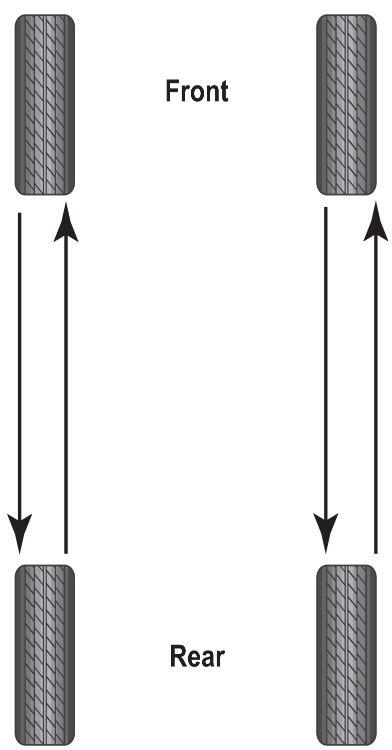
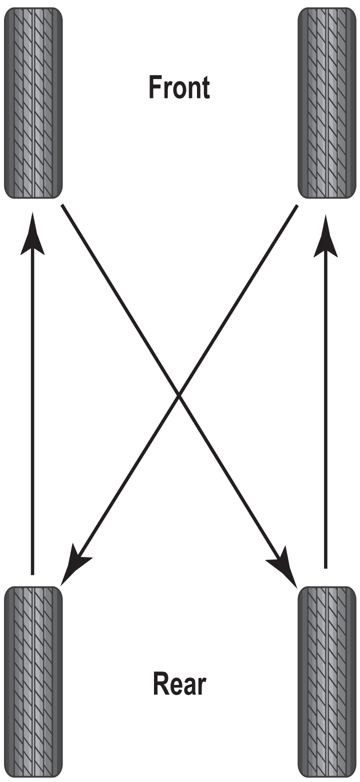
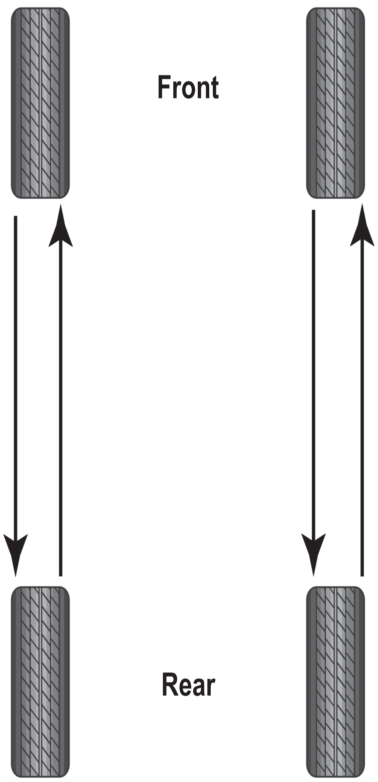


ACCEPTABLE

RWD & 4WD ROTATION PATTERNS





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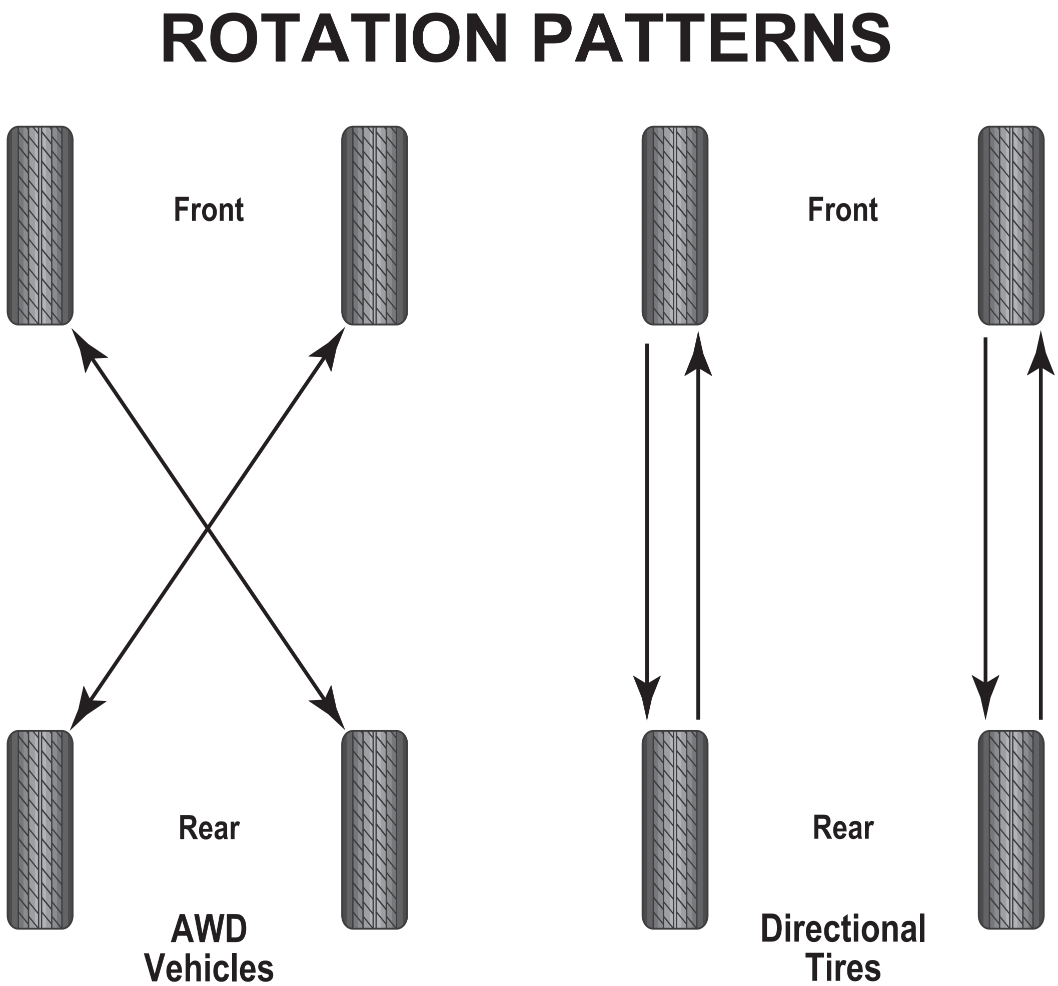
NOTES:

Tire Rotation (continued)



Never rotate directional tires from side-to-side since this will reverse their direction of rotation. Directional tires can only be rotated from front to rear or vice versa. Directional tires are typically used on high-performance cars and can be identified by the arrows imprinted on the sidewall.

Tire Replacement Guidelines

1. Always consult the vehicle tire placard or owner's manual to determine the proper tire size, speed rating, and load capacity before selecting replacement tires.

2. Replacing Less Than Four Tires: In order to maintain optimal vehicle performance, it is recommended that all four tires be replaced at the same time. However, if this is not practical, replacing only one or two tires is considered acceptable.

3. Replacing Two Tires: Whenever a pair of replacement tires is selected with the same size and construction as those on the vehicle, the two newer tires should be installed on the rear axle. This is because the deeper tread of the new tires will grip and evacuate water more effectively than the two tires left on the vehicle. This practice is extremely important for maintaining adequate traction, especially when the driver encounters hydroplaning conditions. Improved traction on the rear axle can prevent an over-steer condition or loss of vehicle stability on wet surfaces.

4. Replacing One Tire: When only one new tire is installed on a vehicle, it can have an adverse effect on the suspension system, gear ratios, transmission, and tire treadwear. If a single tire replacement is unavoidable, it is recommended that the new tire be paired with the tire having the deepest tread. At that point, both tires should be installed on the rear axle. Improved traction on the rear axle is vital for preventing oversteer or loss of vehicle control on wet surfaces.

5. Tire Mixing: In most cases, all four tires on the vehicle should be the same size and construction (radial or bias), and have similar speed ratings. However, in those instances where the vehicle manufacturer requires different sized tires for the front and rear axles, the tires on each axle must match, except when the spare tire is in use. If two radial tires and two bias tires must be used on a vehicle, the radial tires should be installed on the rear axle. If the vehicle placard or owner's manual specifies speed-rated tires, the speed rating of the replacement tires must be equal to or greater than the original tires. If the replacement tires have a lower speed rating than the one specified on the tire placard, the driver must keep vehicle speed within the threshold of the replacement tires. It is also recommended that the tires with the lower speed rating be installed on the front axle to prevent oversteer.

6. Always check the vehicle manufacturer's recommendations for tire size, load capacity, cold inflation pressure, and speed rating before replacing a tire with a different size and construction. NEVER choose a smaller tire with less load carrying capacity than the size indicated on the vehicle tire placard.

continued...

Tire Replacement Guidelines (continued)

7. Winter and Studded Tires: Ideally, winter tires, whether conventional or studded, should be installed on both axles of a vehicle. This is especially true where front-wheel drive vehicles are concerned. This is because front-drive vehicles are prone to oversteer, a condition in which the rear of the vehicle slides outward during cornering. Installing winter tires on both axles minimizes this condition by providing equal grip at all four corners. If only one pair of studded tires is being installed, regardless of vehicle type, they should always be mounted on the rear axle.

8. 4WD and AWD Vehicles: Be sure that all four tires (including speed-rated winter tires) are the same size and have the same construction (radial or bias). In addition, never mix tread patterns, such as all-terrain an all-season, and make sure the outside circumference of all four tires is within the accepted limits specified by the vehicle manufacturer.

NOTES:

Wheel Lug Nut Torque & Clamping Force

By definition, torque is a force that causes torsional movement (twisting motion). To appreciate the importance of wheel lug nut torque, consider this: all wheel studs or lug bolts stretch regardless of their grade or degree of heat treatment. However, as long as the applied tension on the stud/bolt does not exceed its yield point (maximum allowable stretch), it will return to its original length once tension is removed. The yield point of most bolts is reached when the applied tension is high enough to increase its length by 0.2 percent. When the yield point is exceeded, the bolt stretches at an accelerated rate. This causes a reduction in bolt diameter and tensile strength. Once tensile strength has been exceeded, failure is imminent.

Wheel lug nut torque recommendations are designed to limit tension to a point that provides adequate clamping force between the wheel and hub without yielding the stud/bolt. Since clamping force cannot be measured in the field, torque is the only measurement that ensures the wheel is secure enough to support the load. When torque is insufficient, the affected wheel becomes loose and begins to wobble. This elongates the lug holes and puts enormous stress on the wheel studs or lug bolts. Ultimately, the lugs will either fall out or the studs will break off. In either case, this condition could cause a serious accident.

Overtorqued lug nuts typically result in broken studs or warped brake rotors/drums. In fact, when customers complain of a brake pulsation immediately following a tire change, it is usually the result of overtightened lug nuts. At that point, the affected rotor or drum might need to be replaced. As you can see, tightening lugs to the recommended torque setting is extremely important. To ensure that the proper amount of clamping force is applied to each fastener, follow these guidelines:

- Make sure the area around the lug holes, as well as the wheel and hub mating surfaces are clean and dry. A wire brush can be used to remove corrosion and other debris. Wipe the areas clean using a shop rag.
- Inspect the bolt holes for damage. Do not use a wheel if the bolt holes are deformed.
- Inspect the wheel studs and lug nuts or lug bolts and bolt holes (depending on the vehicle) for damage. Replace or repair any damaged or worn components.
- Always follow a star pattern when tightening lugs.

continued...

Wheel Lug Nut Torque & Clamping Force

Although proper wheel lug nut torque is important, it does not guarantee that the required clamping force will be achieved. For example, excessive corrosion on the wheel and hub mating surfaces will result in improper clamping force, even when the lugs are tightened with a calibrated torque wrench. Low clamping force can also occur if the threads are dirty. This is because dirt causes interference between the mating threads. As a result, the torque wrench will register the correct reading but the clamping force will be inadequate. To improve the chances of achieving the precise clamping force between the wheel and hub, proper torque must be applied to clean components in good condition. Specifications for wheel lug nut torque can be found in the 'Tire and Wheel' section of most vehicle service manuals. When specifications are indicated as a range, adjust the torque wrench to the middle of the range to compensate for normal variations in tool calibration.

Impact Wrenches

When wheel lugs are tightened using an impact wrench alone, an overtorqued condition is almost certain. Modern impact wrenches have torque outputs of 300-600 ft lbs, more than three times the average torque required for a typical automobile, sport utility vehicle, or light truck. Although most impact wrenches provide variable power settings, the tool is not an effective torque control device.

Caution

Never use an impact wrench to tighten wheel lugs. Over tightening lugs is a common cause of vehicle vibration problems since it can cause the wheel, brake disc, and/or drum to distort.

NOTES:

Torque Limiting Adapters

A torque limiting adapter, commonly called a torque stick, is essentially a 1/2" drive extension with a built-in wheel lug socket. Unlike a conventional extension however, a torque stick is designed to twist, similar to a torsion bar in a suspension system. The adapter attaches to an impact wrench. Once the amount of force applied to the adapter exceeds its maximum torque rating, the bar begins to twist. This limits the amount of torque applied to the lug. Torque sticks come in a variety of sizes and strengths to accommodate a wide-range of vehicles. The torque rating is stamped on the drive-end of the tool, and the sticks are colored-coded according to lug size. To ensure that the lugs are tightened properly when using a torque limiting adapter, follow these guidelines:

- Make sure running air pressure at the impact wrench is at least 90 psi. Low pressure will result in an undertorqued lug.
- Never wrap your hand around the torque stick while tightening a lug.
- Keep the impact gun running until the torque stick stops turning.
- Always tighten the lugs in a star pattern.

Torque Sticks and "Clicker Style" Torque Wrench

continued...

Wheel Lug Nut Torque & Clamping Force

Torque Wrenches

While using a torque wrench is the most time-consuming method for tightening wheel lugs, it is also the most reliable. A standard ‘clicker’ torque wrench has an accuracy of ± 5%, while beam-type torque wrenches are closer to ± 2%. As long as a torque wrench is used properly and calibrated periodically, the tool will provide a consistent level of twisting force with each application. Because it is a precision instrument, a torque wrench should be kept clean and protected when not in use. To maintain the accuracy of ‘clicker’ style torque wrenches, the tension should be released overnight.

When using a torque wrench to tighten the lugs, the process can be speeded up by snugging the lugs in a star pattern using an impact wrench on the lowest power setting. If the impact wrench does not have variable power settings, the lugs should be secured by hand. Once the lugs are secure, the vehicle should be lowered so that the tire contacts the ground, but the lift is still supporting most of the weight. At that point, the lugs can be torqued in a star pattern. When using a ‘clicker type’ torque wrench, apply force to the end of the tool until the audible click is heard. Stop applying pressure as soon as you hear the click, since additional pressure will cause the lugs to become overtorqued.

Checking Lug Nut Torque

Once the fasteners have been installed, torque levels can be confirmed by measuring the first movement of a torque wrench in the tightening direction. The best type of torque wrench for this purpose is a beam type wrench, or one with a dial indicator and memory needle. To check wheel lug torque, apply steady force to the end of the wrench until the lug nut moves in a tightening direction. The memory needle will indicate the approximate torque

If you are using a clicker torque wrench, increase the torque value in small increments until all of the fasteners move. For example, when checking the torque values on a vehicle with a recommended wheel lug torque of 70 ft lbs, the wrench should be set at 60 ft lb to see if any fasteners were undertorqued. If one of the fasteners moves in a tightening direction with 60 ft lbs applied, the lug is significantly undertorqued. If none of the fasteners move, it indicates that wheel lug torque is higher than the setting on the wrench. Continue to increase the torque setting. Once the wrench is set to the recommended torque, the fastener should not move before the wrench clicks.

Caution

Never bounce on any type of torque wrench. Always apply force slowly but steadily to the end of the tool, and do not use multiple extensions. Be sure sockets are in good condition. In addition, never apply force to the end of a clicker type torque wrench after the ‘click’ is heard, otherwise the fastener will become overtorqued.

TIRE INDUSTRY ASSOCIATION

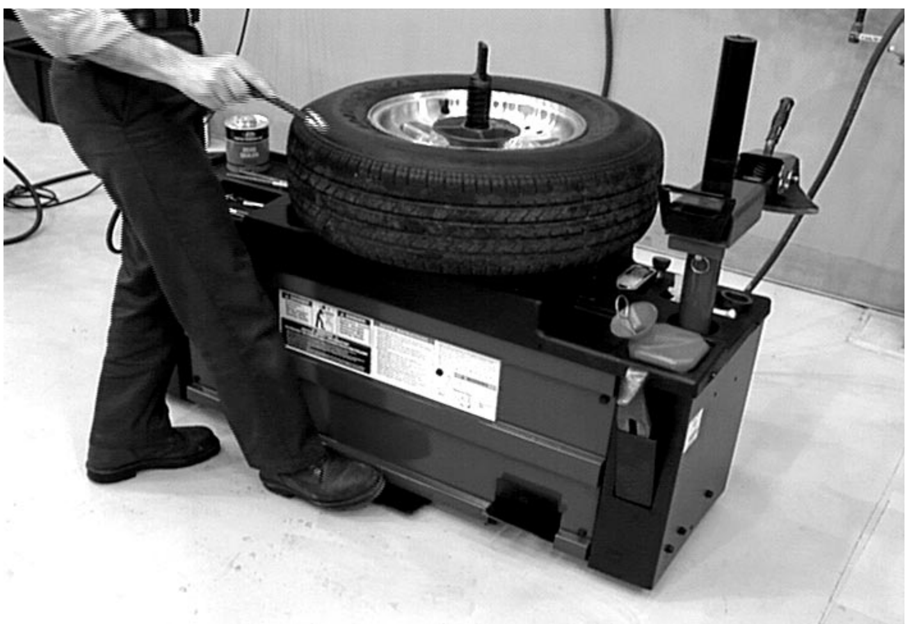
Module Four:

Demounting/Mounting & Inflating

Table of Contents

Overview

Tires and wheels need to be separated for reasons other than just replacement. For example, you'll need to demount the tire to make a nail hole repair. In addition, if a tire/wheel assembly is suspected of causing a vibration problem, the tire may need to be demounted to check wheel runout, or at least have the beads loosened so the tire and wheel can be re-indexed. Regardless of the reason for demounting or mounting the tire, technology has evolved significantly since the days of tire irons and hammers. Today, there are two types of tire machines used in the industry: the rim-clamp style and the center-post type. Although there may be slight differences in each type based on the equipment manufacturer, all rim clamp and center post machines operate similarly.



Center Post Tire Machine

Rim Clamp Tire Machine

NOTES:

Using a Center Post Tire Machine

Demounting

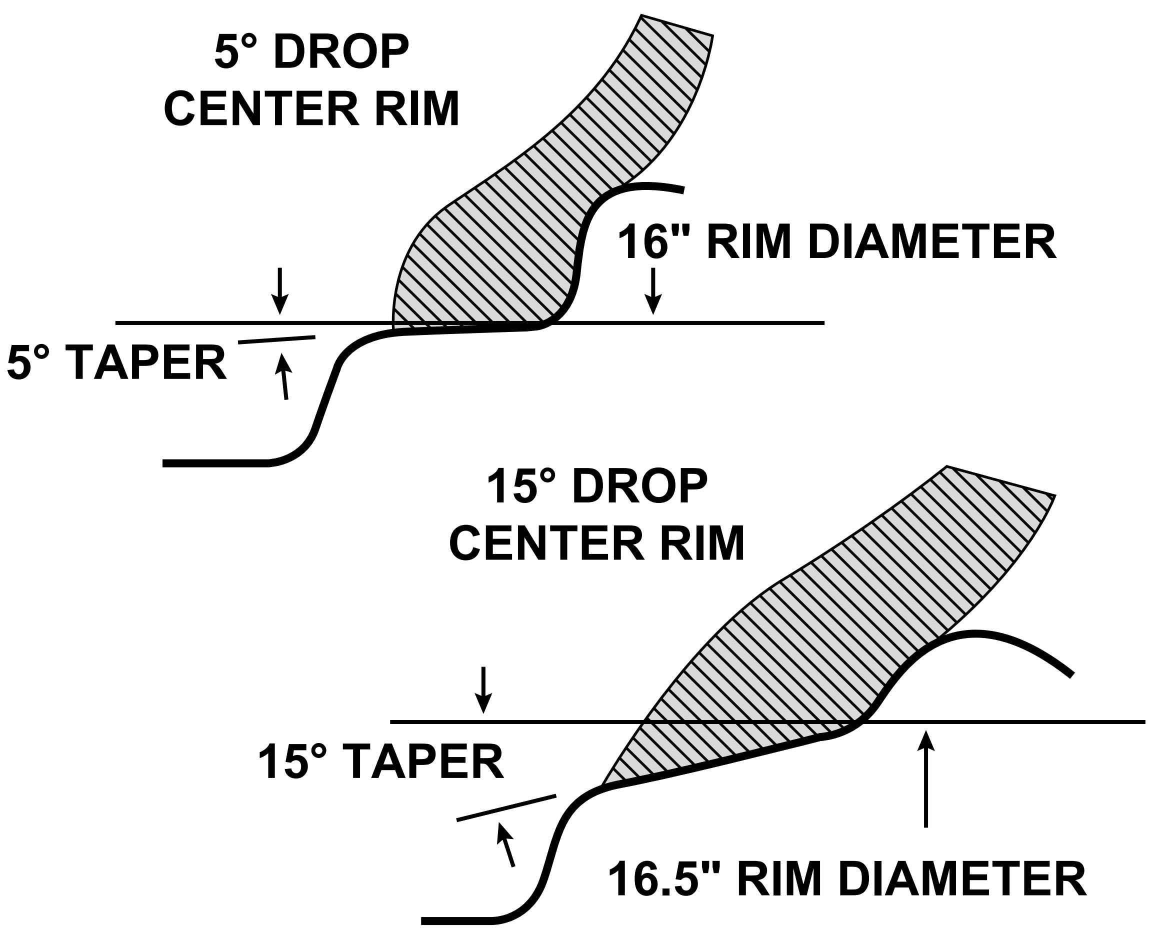
Be sure you are wearing safety glasses!

1. Remove all wheel weights from the tire/wheel assembly.
2. Place the wheel over the center post and engage one of the lug holes with the positioning pin. Make sure the wheel is positioned so that the valve stem is on the opposite side of the upper bead loosener at approximately the seven o'clock position.
3. Secure the wheel using the centering cone. For alloy wheels, use the wheel protection adapter (if available).
4. Remove the valve core to deflate the tire. Insert a wire through the valve stem to ensure the tire is completely deflated.
5. Place the upper bead loosener on top of the tire with the shovel blade resting against the edge of the rim flange. DO NOT place the blade on top of the rim flange!
6. While holding the bead loosener in the correct position, press and hold the appropriate pedal until the upper and lower bead looseners complete their full stroke. If the beads do not loosen on the first attempt, release the pedal to allow the bead looseners to return to the rest position, and then try again.
7. Coat the upper bead with rubber lubricant to ease tire removal.
8. Hold the tire iron so that the long flat end is facing you, and then insert it under the bead.
9. Push the opposite end of the tire iron toward the center post to lift the tire over the rim. Align the slot in the tire iron with the flat on top of the post, and continue to push down until the tire iron bottoms on the shoulder of the post.
10. While holding the tire iron in position, press and hold the appropriate pedal to rotate the center post flat. Maintain pressure on the tire iron until the upper bead is freed from the rim. Pulling up on the tire will ease removal of the upper bead.
11. Remove the tire iron, and then tilt the tire towards you.
12. Use the tire iron to pull the lower bead over the rim.
13. Push the opposite end of the tire iron toward the center post to lift the tire over the rim. Align the slot in the tire iron with the flat on top of the post, and continue to push down until the tire iron bottoms on the shoulder of the post.
14. While holding the tire iron in position, press and hold the appropriate pedal to rotate the center post flat. Maintain pressure on the tire iron until the tire is off the wheel.

After the tire has been removed, replace the valve stem if necessary. Next, carefully inspect the rim, looking for cracks, excessive corrosion, or any other damage. Replace the rim if any of these conditions exist. If there is no damage, use a soft wire brush to remove any dirt, rubber, and/or light corrosion from the bead seats.

Caution

ALWAYS check that the tire's rim diameter matches the diameter of the wheel before mounting! Light truck tires with 16 inch and 16.5 inch rim diameters are easily confused. A 16-inch tire has a 5-degree bead taper while a 16.5-inch tire has a 15-degree bead taper. This slight difference can cause an accident if a technician attempts to inflate a 16-inch tire mounted on a 16.5-inch rim. An accident can also result if a 16.5-inch tire is inflated when mounted on a 16-inch rim.



continued...

Using a Center Post Tire Machine (continued)

Mounting

Be sure you are wearing safety glasses!

1. Apply rubber lubricant to the new valve stem (if applicable), and insert it into the wheel using the appropriate tool.
2. Lubricate both tire beads and the bead seats on the rim.

Caution

Always use an approved rubber lubricant or paste to coat the tire beads. Also, be sure to apply the lubricant in the proper amount. Using too little may cause bead damage, while using too much can cause the tire to rotate on the wheel, causing the tire/wheel assembly to become imbalanced.

3. Place the tire over the wheel at an angle.
4. Place the mounting end of the tire iron over the rim, and engage the slotted section with the flat on top of the center post.
5. Position the lower bead between the tips of the tire iron's mounting end.
6. Grip the tire firmly and rotate it clockwise, trying to force as much of the lower bead into the wheel's drop center as possible.
7. While holding the tire in position, press and hold the appropriate pedal to rotate the center post flat and install the lower bead.
8. With the lower bead installed, rest the upper bead between the tips of the tire iron's mounting end.
9. Grip the tire firmly and rotate it clockwise, trying to force as much of the upper bead into the wheel's drop center as possible.
10. While holding the tire in position, press and hold the appropriate pedal to rotate the center post flat and install the upper bead.

Tech Tip!

To minimize radial runout, be sure the tire and wheel are properly indexed before seating the beads.

11. Remove the core from the valve stem.
12. Connect the air hose to the valve stem.
13. Hold the tire against the rim, making sure the bottom of the valve stem is covered, and then press the air inflation pedal to seat the beads.
14. Install the valve core.
15. Without exceeding 40 psi, add air to fully seat the beads. DO NOT stand over the tire during inflation.
16. Once the beads are seated, continue to add air until the tire is inflated to the recommended pressure indicated on the vehicle's tire placard.

Caution

Exercise care when installing the valve core into a partially inflated tire. To prevent the air blast from launching the core, shield the valve stem with one hand while tightening the core with the other. Make sure you are wearing safety glasses.

NOTES:

Using a Rim Clamp Tire Machine

Demounting

Be sure you are wearing safety glasses!

1. Remove all wheel weights from the tire/wheel assembly.
2. Remove the valve core to deflate the tire. Insert a wire through the valve stem to ensure that the tire is completely deflated.
3. Swing the bead loosening arm out of the way and place the tire against the machine.
4. Pull the bead loosening arm toward the tire.
5. Place the shovel blade as close as possible to the rim flange without making contact.
6. With the bead loosener in position, press and hold the appropriate pedal to collapse the tire and loosen the bead. Release the pedal once the bead is loose.

Tech Tip! *If the bead does not completely separate from the rim after the first attempt, rotate the tire and try loosening the bead in another location.*

7. Turn the tire around so that the opposite side is facing the bead loosener.
8. Position the blade shovel as before and loosen the bead.
9. Place the tire/wheel assembly on the center of the turntable.
10. Press the appropriate pedal to clamp the wheel to the turntable, and then lubricate the bead.
11. With the wheel in place, press and hold the wheel rotation pedal until the valve stem is in the three o’clock position.
12. Pull the swing arm in and lower the mount/demount head. The head should fit around the rim flange without making contact.
13. Once the head is in the proper position, lock it into place.
14. Push down on the sidewall and drop the curved end of the bead lever between the wheel and upper tire bead.
15. Pull the lever towards you to lift the upper bead over the lip of the mount/demount head.
16. While holding the bead lever all the way down, press and hold the wheel rotation pedal until the upper bead is completely freed from the wheel.

17. Tilt the tire toward the mount/demount head.

18. Push down on the sidewall and drop the curved end of the bead lever between the wheel and lower tire bead.

19. Pull the lever towards you to lift the lower bead over the lip of the mount/demount head.

20. While holding the bead lever all the way down, press and hold the wheel rotation pedal until the lower bead is free and the tire can be lifted off the wheel.

After the tire has been removed, replace the valve stem if necessary. Next, inspect the rim for cracks, excessive corrosion, or any other damage. Replace the rim if you find any of these conditions. Clean the bead seats using a soft wire brush. Make sure to remove any dirt, rubber, and/or light corrosion.

Caution

ALWAYS check that the tire's rim diameter matches the diameter of the wheel before mounting!

Mounting

Be sure you are wearing safety glasses!

1. Apply rubber lubricant to the new valve stem, and insert it into the wheel using the appropriate tool.

2. Lubricate both tire beads and rim seats.

Caution

Always use an approved rubber lubricant or paste to coat the tire beads. Also, be sure to apply the lubricant in the proper amount. Using too little may cause bead damage, while using too much can cause the tire to rotate on the wheel, causing the tire/wheel assembly to become imbalanced.

continued...

Using a Rim Clamp Tire Machine (continued)

Mounting (continued)

3. Place the tire over the rim and tilt it forward.
4. Lower the mount/demount head on top of the rim flange.
5. Tilt the tire so that a portion of the lower bead is below the front mounting lip of the mount/demount head.
6. Pull the tire towards you while twisting it clockwise.
7. Push down on the sidewall to allow the lower bead to fall into the rim's drop center.
8. While holding the tire in position, press and hold the wheel rotation pedal to install the lower bead over the rim flange.
9. Tilt the tire so that a portion of the upper bead is below the front mounting lip of the mount/demount head.
10. Pull the tire towards you while twisting it clockwise.
11. Push down on the sidewall to allow the upper bead to fall into the rim's drop center.
12. While holding the tire in position, press and hold the wheel rotation pedal to install the upper bead over the rim flange.

Tech Tip! *To minimize radial runout, be sure the tire and wheel are properly indexed before sealing the beads.*

13. Remove the core from the valve stem.
14. Connect the air hose to the valve stem.
15. Hold the tire against the rim, making sure the bottom of the valve stem is covered, and then press the air inflation pedal to seat the beads.
16. Install the valve core.

17. Without exceeding 40 psi, add air to fully seat the beads. DO NOT stand over the tire during inflation.

18. Once the beads are seated, continue to add air until the tire is inflated to the recommended pressure.

Caution *Exercise care when installing the valve core into a partially inflated tire. To prevent the air blast from launching the core, shield the valve stem with one hand while tightening the core with the other. Make sure you are wearing safety glasses.*

NOTES:

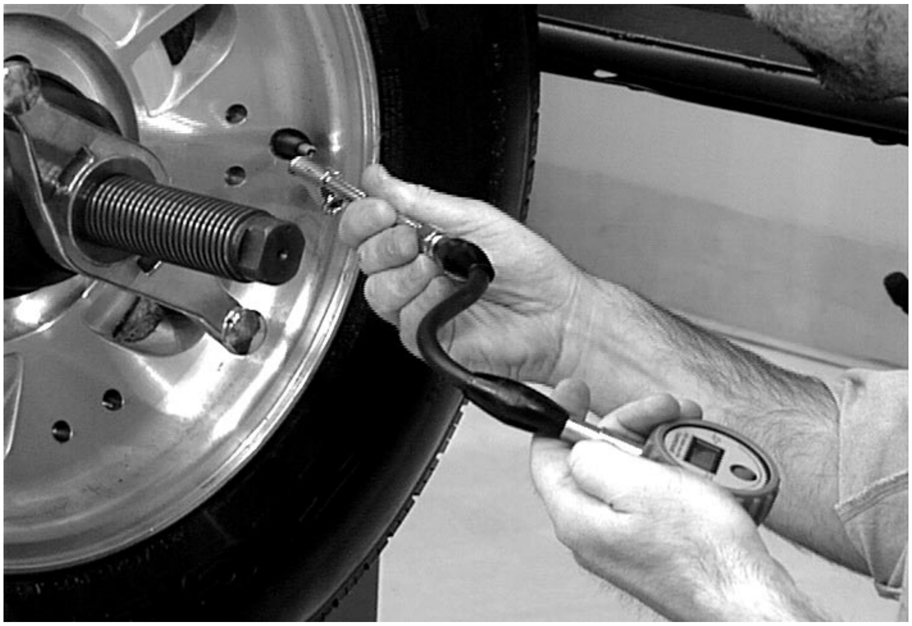
Inflation Pressure

While there are a variety of factors that can jeopardize the safety, performance, and life expectancy of a tire, none has more impact than incorrect inflation pressure. In fact, under inflation is the most common cause of radial tire failures. This is because an under inflated tire generates more heat due to increased sidewall deflection and higher rolling resistance. A tire that is under inflated by only 6 psi can cause rapid shoulder wear and/or a blowout. In contrast, over inflation causes rapid center tread wear, reduced traction, and a harsh ride. This is because there is less rubber on the road when a tire is over inflated.

Although most drivers neglect to check tire pressure, the ones that do usually check the tires when they are hot. This is almost as bad as not checking the tires at all, since the maximum pressure indicated on the sidewall, as well as the recommended pressures listed on the vehicle's tire placard refer to 'cold' inflation. Remember that air is a gas, which means that it expands when heated and contracts when cooled. In fact, it only takes about one mile of driving at moderate speeds to increase tire pressure 2-4 psi. That means if the tires are adjusted to the recommended inflation pressures when they are hot, they will be significantly under inflated once they cool down.

Even if the vehicle is not driven before tire pressures are checked, the ambient temperature must be considered. This is because tire pressure will change about 1 psi for every 10°F change in air temperature. That is a 1 psi increase when temperature rises 10°F, and a 1 psi drop when air temperature falls 10°F. Consequently, if the tires are adjusted to the recommended inflation pressure while the vehicle is parked in the sun on a summer afternoon, the tires will be under inflated by the next morning. That's why it is best to check the tires first thing in the morning with the vehicle parked in the shade. Since it is often difficult to check tires cold in a service environment, add 4 psi to the recommended inflation pressure when checking a hot tire and then check again when the tires are cold. For example, if the recommended pressure is 30 psi, adjust the tire to 34 psi. Also, be aware that a tire's load rating is always based on its cold inflation pressure. Increasing pressure beyond this point in an effort to support more weight can lead to sudden tire failure.

Tech Tip! *On some tires, inflation pressure may be listed in kilopascals (kPa). To convert kilopascals to psi, divide kPa by 6.9. (e.g. 220 kPa ÷ 6.9 = 32 psi).*



Digital Tire Pressure Gauge

NOTES:

Tire Pressure Monitoring Systems (TPMS)

There are two types of TPMS currently available. The more economical of the two is known as indirect TPMS. This system relies on signals from the wheel speed sensors of the vehicle's anti-lock brake system. As the name implies, the speed sensors detect the rotational speed of the wheels. Since an under inflated tire has a smaller diameter, it turns faster than tires running at the correct pressure. Current indirect systems compare the sum of wheel speeds on each diagonal (RF + LR to LF + RR) to determine if a considerable difference in tire pressure exists. This calculation method compensates for the wheel speed differences that normally occur during turns and curves. If the calculated difference in tire pressure exceeds a programmed threshold, the system will alert the driver via an instrument panel telltale. The illumination of the telltale only indicates that one or more tires is improperly inflated. It does not identify a specific tire. In addition to being affordable, typically $13 per vehicle, the indirect system has no programming or maintenance requirements. However, since the system relies on comparative wheel speeds to infer tire pressure, it cannot detect slight differences in pressure, nor can it sense a low pressure condition if all tires are equally under inflated.

The second type of system, known as direct TPMS, uses four separate pressure sensor/transmitters (one inside each wheel) to monitor and report tire pressure information to the driver. Data is sent via radio waves to a wireless receiver mounted inside the vehicle, and then displayed on the instrument panel's message center. The direct system not only indicates when tire pressure is too low or too high, but also allows the driver to check individual tire pressures without leaving the cabin.

NOTES:

Service Precautions

When demounting/mounting tires on vehicles equipped with a direct tire pressure monitoring system, observe the following precautions to prevent damaging the pressure sensors.

- Place the valve cap and valve core in a secure location after removal. These parts are made from corrosion-resistant materials and are not interchangeable with conventional caps and cores.
- Position the valve stem 180 degrees away from the bead separator before breaking the tire bead.
- Once the bead is loose, place the tire on the machine so that the valve stem is slightly behind the mounting/demounting head.
- Keep the tire iron a safe distance from the pressure sensor during tire removal and installation.

The TPMS must be reprogrammed anytime a sensor is replaced or the tires are rotated. The reprogramming procedure allows the TPMS to identify each sensor according to its specific location on the vehicle. The TPMS must also be reprogrammed if the battery is replaced, since the sensor ID codes are lost when the battery is disconnected or battery voltage becomes low. Consult the appropriate service manual regarding TPMS reprogramming.

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TIRE INDUSTRY ASSOCIATION

Module Five:

Balancing

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Overview

Although you may be aware that tire/wheel imbalance is the most common cause of vehicle vibration problems, it may surprise you to learn that imbalance can also accelerate tire wear, cause premature failure of steering and suspension components, and reduce vehicle traction. That is why proper balancing is so important, and why many repair shops urge customers to have their tires rebalanced periodically. There are two methods used to balance a tire/wheel assembly: static balancing and dynamic balancing.

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Static Balancing

Static balancing, also referred to as single plane balancing, affects the distribution of weight around the circumference of the wheel. In a statically balanced wheel, the weight is evenly distributed. This can be seen by raising the vehicle off the ground and spinning the wheel by hand several times. You will notice that each time the wheel comes to a stop, it will be in a different position. However, when a wheel end has a static imbalance, the wheel will not stop in the same place each time. This is because one area of the wheel end assembly is disproportionately heavy. When a statically imbalanced wheel rotates, the heavy spot causes the tire to strike the road with greater force in that particular area. This pounding force increases in direct proportion to rotational speed and the degree of imbalance. In an extreme case, the tire can momentarily leave the road surface during each revolution. This condition is known as wheel tramp or wheel hop. During wheel tramp, a small amount of rubber is scrubbed off the tire each time it recontacts the road. Eventually, scattered bald spots will appear around the entire surface of the tread.

Long before computerized spin-balancers came along, wheels were statically balanced using a bubble-balancer. This piece of equipment consists of a pivoting cone with integral spirit level mounted to the top of a pyramid-shaped base. The spirit level is a device used to determine any deviation from true horizontal. The degree of deviation is based on the position of a bubble inside a tube of liquid. When the tire/wheel assembly is placed on the cone, any static imbalance in the assembly will cause the cone to tilt to the heaviest side. As a result, the bubble will move off-center in the opposite direction. To balance the assembly, place two equal weights on top of the sidewall. Make sure the weights are as close as possible to the rim flange, and placed in the area where the bubble is pointing. Add or subtract the weights in pairs until the bubble is centered. Finally, attach each weight to either side of the rim flange. Dividing the weight equally between both sides of the rim maintains the dynamic balance of the tire/wheel assembly.

A bubble balancer is designed to statically balance the tire and wheel assembly.

Dynamic Balancing

Although a tire/wheel assembly may be statically balanced, it does not necessarily mean that it is in dynamic balance. This is because static balance involves the distribution of weight in a single plane, while dynamic balance involves the distribution of weight in two planes, that is, the weight distribution on either side of the wheel centerline. When wheels are dynamically unbalanced, they wobble from side to side as they rotate. This creates a condition known as wheel shimmy or wheel wobble. If the imbalance is in the front wheels, a vibration will be felt in the steering wheel. When the rear wheels are the source of wheel shimmy, a vibration will be felt in the seats. Although static balancing cannot correct a dynamic imbalance, dynamic balancing corrects both static and dynamic imbalances. This is because in the dynamic mode, a computerized spin balancer automatically determines the lateral (side-to-side) and radial (up and down) forces on each side of the tire/wheel centerline during rotation.

Using a Computerized Spin Balancer

Computerized Spin Balancer

Although there are many styles of computerized spin balancers available, they all operate similarly. Before balancing, remove any stones from the tread and make sure there is no foreign material on the inside of the wheel. It is not uncommon to find excessive dirt on the inside of a wheel, especially one with positive offset. This is because these wheels have a large interior surface. Wheels with positive offset can also collect excess chassis grease from the outer tie rods. If this debris is left in place, the equipment will balance the assembly based on the added weight. Once the vehicle is back on the road, the tire/wheel will go out of balance as soon as the stones are dislodged or rainwater washes away the debris from the inside of the wheel. As you can see, removing foreign material from the tire and wheel is a vital step.

Using a Computerized Spin Balancer (continued)

Centering the wheel correctly is critical to accurate balancing. To obtain the most precise balance, mount the assembly on the balancer according to the wheel design. If the wheel is hub-centric, match the wheel bore with the appropriate centering cone. Spin balancers come with a variety of cones to accommodate a wide range of wheel openings. Install the cone on the shaft before mounting the wheel. If the wheel is a lug-centric design, use a flange plate adapter. Secure the assembly using the large wing nut and attached mounting cup.

Spin balancers come with assorted centering cones to accommodate the many variations found in the size of wheel center holes.

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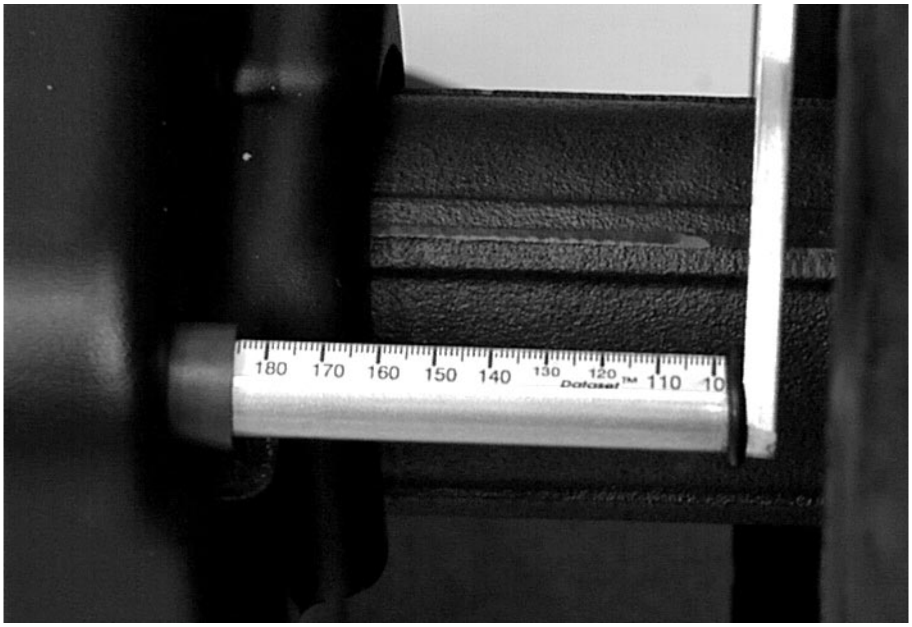
NOTES:

Using a Computerized Spin Balancer (continued)

A flange plate adapter should be used when balancing lug-centric wheels

After the tire/wheel assembly has been properly mounted, the equipment must be programmed with specific information that will enable it to recognize the left and right wheel planes. For a standard balance using clip-on weights, this information includes wheel diameter and wheel width. Wheel width is measured between the rim flanges using a large caliper. Programming information also includes the distance between the inside of the bead seat and a predetermined location on the equipment. This dimension is measured using a built-in sliding scale, and allows the equipment to recognize the left (inside) wheel plane.

A caliper is used to measure the width of the rim, as well as the internal diameter of the wheel when necessary.



The dataset arm measures the distance between the balancer and the appropriate wheel plane.

After programming the equipment with the required information, close the safety hood or press the start button to spin the wheel. Once the equipment brings the assembly to a stop, rotate the tire slowly to find the top dead center position for the left wheel plane. TDC will typically be indicated by a series of flashing LEDs to the left of a simulated wheel on the control panel display. This reading shows the amount of weight that must be installed on the inside of the rim at the 12 o'clock position. After adding the appropriate weight, rotate the tire by hand to locate TDC for the right wheel plane. After applying the indicated weight at 12 o'clock, spin the wheel again to check the balance. A reading of all zeros confirms that the assembly is balanced correctly. In some cases, the balancer may display the need for additional weight, which is normal. If a small amount is called for and its indicated position is close to the existing weight, you can either increase the original weight or move the new weight closer to the 12 o'clock position. However, if the amount and position of the indicated weight varies with each spin, the tire may contain a significant amount of liquid. In this case, demount the tire and remove the liquid before balancing.

continued...

Using a Computerized Spin Balancer (continued)

The balancer will display all zeroes when the tire/wheel assembly is in dynamic balance.

Computerized spin balancers provide the option of single plane (static) or dual plane (dynamic) balancing for aluminum wheels. This feature is helpful when the design of the wheel makes it difficult to attach a clip-on weight, or the customer requests that weights be installed on the inside only to preserve wheel appearance. In either case, select the most appropriate option:

Preferred Option

Select the dynamic balance mode and place the required amount of outside weight (right plane) on the inside flat portion of the wheel. Use an adhesive weight and install it as close to the back-side of the wheel as possible. Place the required amount of inside weight (left plane) on the wheel using a clip-on weight, or install an adhesive weight on the rim flange. Remember, to achieve the best dynamic balance, the wheel weights must be kept as far apart as possible.

Alternate Option

Select the static balance mode and install the required weight on the inside of the wheel with clip-on weights.

Tech Tip!

To ensure that wheels are balanced accurately and equipment performance remains consistent, calibrate the balancer periodically according to the procedure outlined in the user's manual.

Wheel Weights

Wheel weights are used to correct imbalances in the tire/wheel assembly. There are several styles of weights available to fit the wide range of wheels used on today's vehicles. Most clip-on weights come in .25-ounce increments, and have a tongue that hooks over the edge of the rim flange. Steel wheels use standard clip-on weights, while alloy wheels used coated weights with extended tongues. The coating prevents corrosive deposits from forming on the wheel, while the extended tongue allows the weight to fit over the thicker edges of the rim. Clip-on weights are installed using a wheel weight hammer. This tool also contains a hook used to remove the weights. The hook engages a small hole in the tongue, allowing the weight to be pried off easily.

Custom Wheel Weight

continued...

Wheel Weights (continued)

Clip-on weights are installed at the TDC position using a special hammer.

Adhesive weights are backed with double-sided tape and come in long strips scored in .25-ounce increments. The score marks allow the strip to be cut to the desired fractional size. Adhesive weights are typically applied to the inside of the wheel once the contact surface has been thoroughly cleaned.

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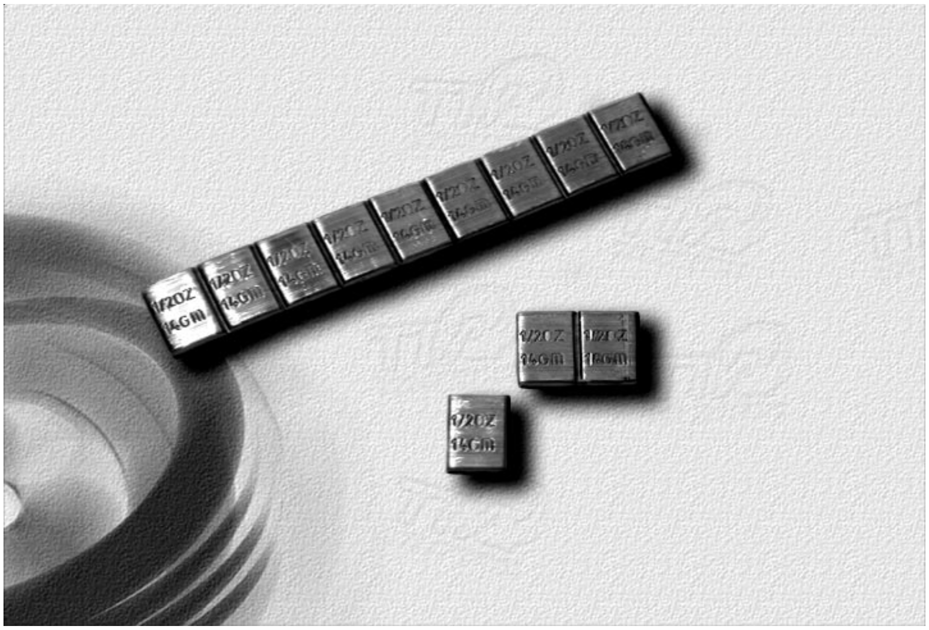

Adhesive Wheel Weights

Tech Tip! *When using adhesive weights, be sure they do not interfere with the brake caliper or rotor shield once the tire/wheel assembly is back on the vehicle.*

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TIRE INDUSTRY
ASSOCIATION

Module Six:

Diagnosing Tire & Wheel Problems

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Tire Wear Patterns

Since the tires link the vehicle with the road, they not only provide important clues about the condition of the steering and suspension system, but the customer's driving habits as well. In order to interpret these clues, you need to become familiar with tire wear patterns.

While there are a variety of causes for premature tire wear, the most common are improper inflation pressure and lack of rotation. Since under inflated tires have increased sidewall flexibility and a greater contact patch, they wear more quickly in the shoulder areas. Under inflated tires also have higher rolling resistance, which lowers vehicle fuel economy. When a tire is over inflated, the sidewalls become stiffer and the shoulders are raised off the ground. This reduces the tire's contact patch and causes rapid wear in the center of the tread. Infrequent tire rotation generally results in premature front tire wear.

Once you have checked inflation pressure and made any necessary adjustments according to the recommendations on the tire placard, measure the tread with a depth gauge and record the reading. Next, gently run the flat of your hand across the width of the tread. Feathered edges are typical of incorrect wheel toe. Toe is an alignment angle that determines the position of the wheels in relation to the vehicle centerline. Next, run your hand over the tread in a parallel direction and feel for any cupping. This type of wear can result from conditions such as tire imbalance, excessive radial runout, or worn shocks. If tire wear is excessive on one shoulder, it indicates that the tire is leaning excessively to that side. This is usually the result of incorrect camber, which is an alignment angle that determines the position of the wheel in relation to an imaginary vertical line.

Caution *Be extremely careful when moving your hand over the tire tread. Exposed steel and/or imbedded objects can cause personal injury.*

Be aware that some tire wear patterns may be characteristic of certain vehicle types. For example, the front tires on many front-wheel-drive vehicles can wear unevenly due to the effects of torque steer. A rear-wheel-drive sports car is another example. These vehicles often have excessive rear tire wear due to repeated jack-rabbit starts. This is why regular tire rotation is so important.

TIRE WEAR PATTERNS	POSSIBLE CAUSES
Feathered or Sawtooth Wear	• excessive toe-in • excessive toe-out • bent steering linkage
Excessive Center Wear	• over inflation • tire too wide for the rim
Excessive Side-to-SIde Wear	• faulty shock/strut on side of worn tire • brakes dragging on side of worn tire • different rated tires
Excessive Shoulder Wear (both sides)	• under inflation • abusive driving • incorrect load range • vehicle is being overloaded
Inside Shoulder Wear	• excessive negative camber
Outside Shoulder Wear	• excessive positive camber • frequent hard cornering
Scattered Bald Spots	• imbalance • excessive radial runout • worn shocks/struts • misadjusted or worn wheel bearings • bent steering knuckle

Feathered or sawtooth tread wear is caused by excessive wheel toe.

continued...

Tire Wear Patterns (continued)

The greatest threat to the life of a tire is improper inflation. Underinflation causes the sidewalls to flex excessively, increasing both the tire's contact-patch, and rolling resistance. Underinflation promotes rapid shoulder wear and significantly reduces the vehicle's fuel economy.

Overinflation causes the center of the tread to wear prematurely.

Shoulder wear on one side of the tire is caused by excessive camber.

Tire cupping can result from a variety of conditions such as worn shocks or static imbalance.

continued...

Tire Wear Patterns (continued)

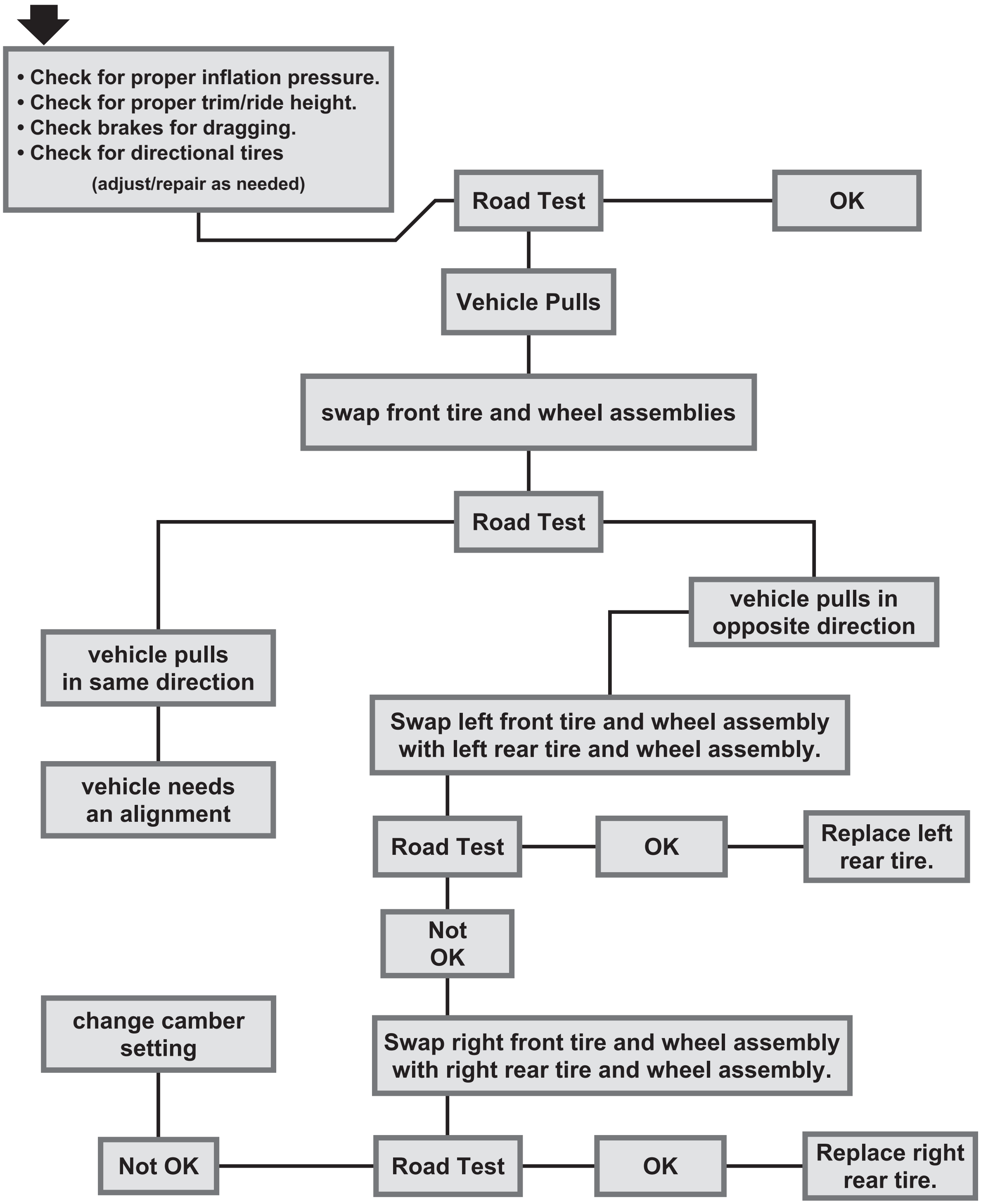
Torque Steer

Many front-wheel-drive vehicles have a tendency to pull under acceleration. This condition, known as torque steer, can be severe in vehicles equipped with unequal length drive axles. This is because the difference in drive axle length creates a corresponding difference in the angles at the CV joints. Under normal conditions, the outer CV joints create a secondary twisting motion as torque is applied to the axles. This force causes the wheels to toe-in slightly. On vehicles with unequal length drive axles, the force applied to the wheel on the shorter axle is greater due to the extreme CV joint angle. This causes that wheel to toe in more than the wheel driven by the longer axle. As a result, the vehicle pulls to the side with the longer axle. On vehicles that use equal length drive axles, or an intermediate shaft to help maintain equivalent CV joint angles, torque steer is less of a concern. This is because the torque toe-in at one wheel effectively cancels the torque toe-in at the opposite wheel. However, if the wheels are not pointing straight ahead when the vehicle is accelerating, the difference in CV joint angles can create some degree of torque steer. If the level of torque steer seems excessive for a particular vehicle, make sure that the front tires are the same diameter and equally inflated.

Conicity

Lateral forces can be generated within the tire as it rolls along the road. As a result, the tire rolls like a cone, causing the vehicle to pull. A ‘pull’ is the deviation of the vehicle from a straight line while traveling on a level road without any steering wheel input. When a vehicle exhibits this behavior, and problems related to alignment, brakes, and torque steer have been ruled out, suspect radial tire conicity. Refer to the chart below to correct vehicle pull/drift.

VEHICLE PULL/DRIFT CORRECTION CHART



Wheel and Tire Runout

The term runout is used to describe any movement of the tire/wheel assembly outside the vertical or horizontal plane. Up and down (vertical) movement is called radial runout, while side-to-side (horizontal) movement is known as lateral runout. Since no tire/wheel assembly runs perfectly true, a slight amount of runout in either direction is considered normal. However, excessive radial runout can cause poor ride quality and abnormal tire wear due to wheel tramp. This is because the tire contacts the road with greater force in a certain area when too much radial runout exists. If lateral runout is too great, it causes vibration and uneven tire wear due to wheel shimmy.

Excessive runout can usually be seen by raising the vehicle off the ground and spinning the suspect tire/wheel. Spin the assembly against a fixed object while looking for any vertical or horizontal movement. If movement is observed, the cause may be a loose wheel bearing (where applicable), or a partially seated tire bead. Be aware that excessive runout can also be caused by flat spots in the tire tread. Flat spots can develop when a vehicle is parked in the same position for an extended period, especially if the vehicle is equipped with bias tires. To remove flat spots, drive the vehicle at highway speed for several miles.

If the previously mentioned items are not causing a runout problem, you'll need to check runout using a dial indicator. This tool measures movement in thousandths of an inch.

Dial Indicator with Magnetic Base

Tech Tip!

The easiest way to isolate the source of excessive runout is to remove the tire/wheel and measure runout with the assembly mounted on a spin balancer. If tire/wheel runout is within acceptable limits, then a problem exists with the wheel hub or axle flange.

Measuring Combined Radial Runout (off-vehicle)

When measuring tire/wheel runout, it is preferable to use a dial indicator with a roller tip rather than the conventional stylus.

1. Mount the tire/wheel assembly on a spin balancer. Make sure the proper size cone is positioned through the back side of the wheel's center pilot hole.
2. Mount the dial indicator so that the roller tip is positioned underneath the center of the tire tread. If the tire has an aggressive tread pattern, wrap the tire with a piece of masking tape to provide a smooth surface for the roller tip.
3. Place the roller tip against the tire and set the dial indicator to zero.
4. Slowly rotate the tire/wheel one revolution and note the lowest reading.
5. Place a mark on the sidewall at this point, and reset the dial indicator to zero.
6. Rotate the tire/wheel another revolution and record the maximum reading. Mark the sidewall at this point (high spot).
7. Compare the reading to the manufacturer's specification for combined tire/wheel radial runout.

Measuring Radial Runout of the Tire/Wheel Assembly

continued...

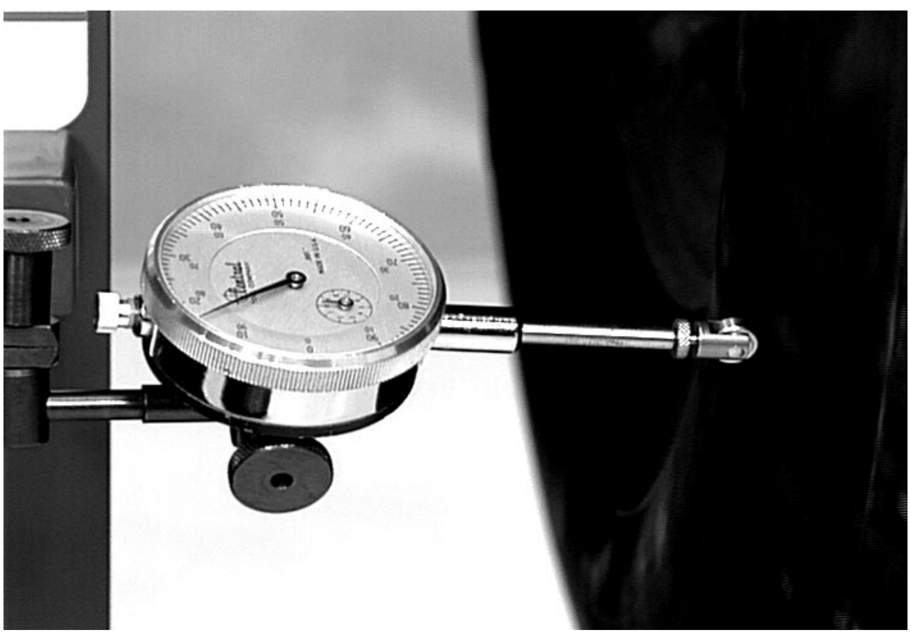
Wheel and Tire Runout (continued)

Measuring Combined Lateral Runout (off-vehicle)

Measuring lateral runout of the tire/wheel assembly is essentially the same as checking radial runout with the exception of the following:

1. Mount the dial indicator so that the roller tip is positioned against the smoothest part of the sidewall as close to the tread as possible
2. With the tip resting against the tire, zero the dial indicator.
3. Slowly rotate the tire/wheel one revolution and note the lowest reading.
4. Reset the dial indicator to zero.
5. Rotate the tire/wheel another revolution and record the maximum reading.
6. Compare the reading to the manufacturer’s specification for combined tire/wheel lateral runout.

Notice *Always check the appropriate service manual for exact runout (radial or lateral) specifications. If combined runout is excessive, remove the tire and measure wheel runout.*



Measuring Lateral Runout of the Tire/Wheel Assembly

Measuring Wheel Runout (off-vehicle)

1. Mount the wheel to the spin balancer.
2. Place the tip of the dial indicator against the bead seat (radial runout check).
3. Rotate the wheel one revolution and note the lowest reading.
4. Reset the dial indicator to zero at the low spot.
5. Rotate the wheel another revolution and record the maximum reading.
6. Move the tip of the dial indicator to the opposite bead seat and repeat steps 3-5.
7. Add the readings together and divide by two to obtain the average radial runout of the wheel.
8. Move the roller tip to the inside edge of the rim flange (lateral runout check).
9. Repeat steps 3-5.
10. Move the roller tip to the opposite rim flange and repeat steps 3-5.
11. Add the readings together and divide by two to obtain the average lateral runout of the wheel.

Notice

Generally speaking, off-vehicle wheel runout (radial or lateral) should not exceed .045 inch for steel wheels and .030 inch for aluminum wheels. Always check the appropriate service manual for exact specifications. If wheel runout is excessive, and a vibration exists that cannot be corrected through balancing, the wheel should be replaced. If wheel runout is OK, the tire is causing the runout problem and should be replaced.

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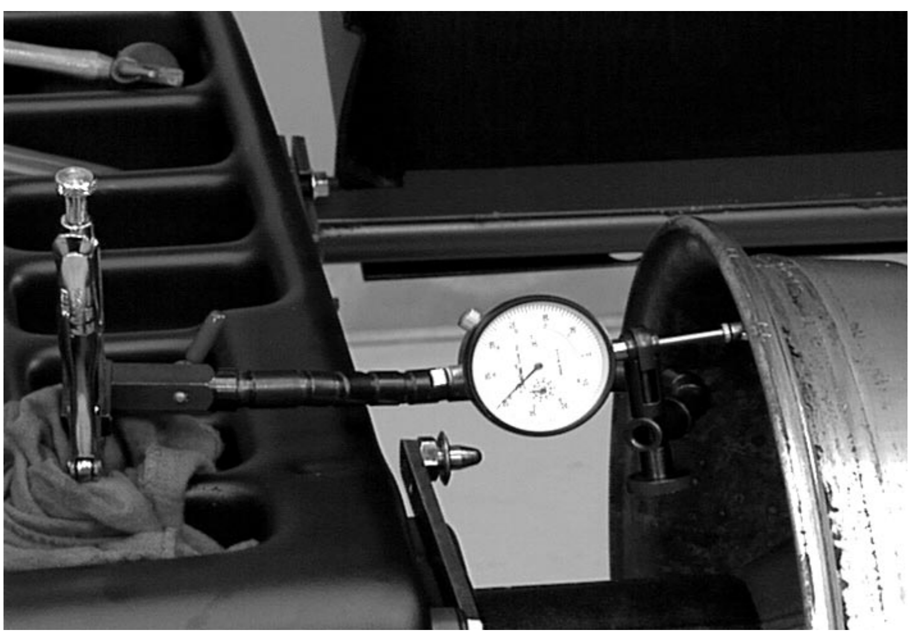
Wheel and Tire Runout (continued)

Measuring Wheel Runout (off-vehicle) (continued)

Measuring Radial Runout of the Wheel



Measuring Lateral Runout of the Wheel

Indexing

In order to minimize radial runout and provide optimum ride quality, tires and wheels on new vehicles are usually indexed at the factory. This means that the stiffest part of the tire (radial high spot) is aligned with the smallest radius (low spot) of the wheel. A tire's high spot may be indicated on the sidewall by a paint mark, adhesive label, or a stamped ring. The low spot of a steel wheel can typically be identified by a paint mark in the dropwell area. On alloy wheels, the low spot is generally the area where the valve stem is located. If the tire has to be demounted and mounted for any reason, the index marks must be realigned. However, since the index markings usually wear off the tire, it is important to place a reference mark on the sidewall at the valve stem prior to demounting. This will ensure that the factory indexing is maintained when the tire is remounted. When mounting replacement tires, look for the index mark on the sidewall and align it with the valve stem (aluminum wheels) or the paint mark inside the dropwell (steel wheels).

Indexing is a procedure in which the high spot of the tire is aligned with the low spot on the wheel.

NOTES:

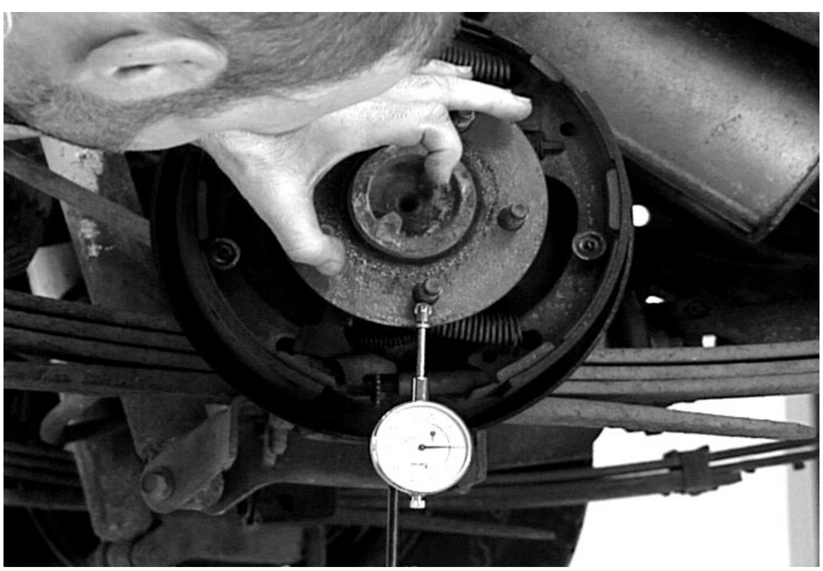
Wheel Hub/Axle Flange Runout

If tire/wheel runout is within the manufacturer's recommended limits, and balancing has failed to correct a vehicle vibration problem, the wheel hub or axle flange may have excessive radial or lateral runout. Occasionally, the wheel studs are drilled incorrectly, placing the bolt circle pattern off-center. Consequently, even if the hub or flange is rotating true, the off-center studs will cause excessive radial runout of the attached tire/wheel assembly. That's why it is important to check the radial runout of the hub/flange at the wheel studs. If runout is within acceptable limits here, then the radial runout of the hub/flange itself has to be good. Other causes of excessive hub/flange runout, either radial or lateral, include a bent axle or bent steering knuckle.

Measuring Wheel Stud Circle Runout (radial runout)

1. Mount the dial indicator so that the roller tip is underneath any wheel stud as close as possible to the hub face.
2. With the roller tip pressing against the stud, set the dial indicator to zero.
3. Rotate the hub so that each stud registers a reading.
4. Zero the dial indicator on the lowest stud.
5. Rotate the hub another revolution and record the maximum reading.

Notice *Generally speaking, wheel stud circle runout should not exceed .010 inch. Always check the appropriate service manual for exact specifications.*



Measuring Wheel Stud Circle Runout

Measuring Hub/Flange Face Runout (lateral runout)

1. Remove the brake rotor or drum (where applicable).
2. Use sandpaper to remove any rust accumulation on the hub/flange face.
3. Mount the dial indicator so that the roller tip is perpendicular to the hub/flange face toward the outer edge.
4. Set the dial indicator to zero.
5. Rotate the hub one revolution and note the lowest reading.
6. Zero the dial indicator at the low spot.
7. Rotate the hub another revolution and record the maximum reading.

Notice *Generally speaking, lateral runout should not exceed .005 inch. Always check the appropriate service manual for exact specifications.*

Measuring Hub/Flange Face Runout

TIRE INDUSTRY ASSOCIATION

Module Seven:

Nail Hole Repair Procedures

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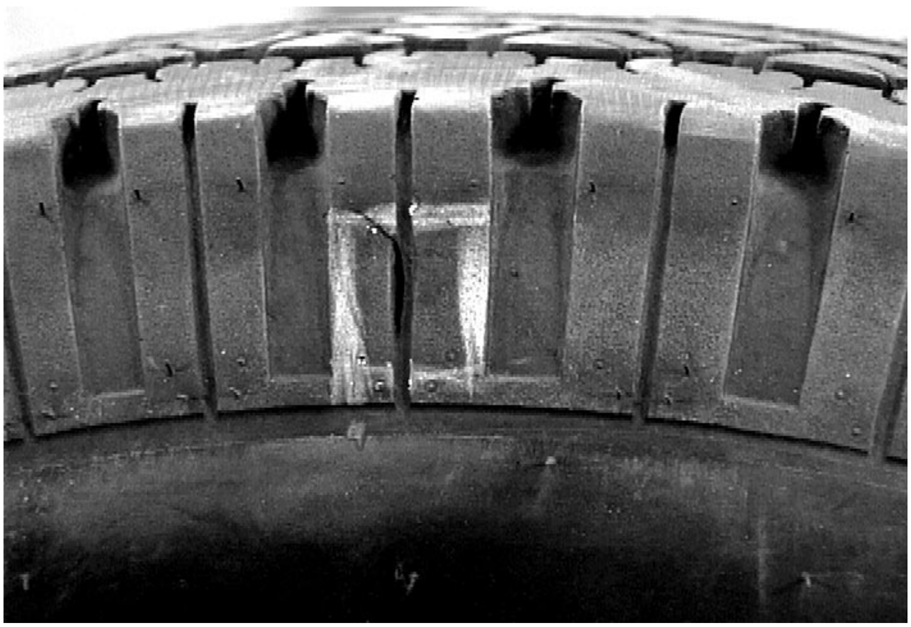
Nail Hole Puncture Injuries

According to Tire Industry Standards, a nail hole injury, or puncture, is defined as any penetration of the casing that originates from the crown area. The crown is defined as the area of tread that extends to within 1-1.5 inches of the shoulders. The size of the injury should not exceed 3/8" for medium and light truck tires, and a 1/4" for passenger tires. If the injury is larger than this and/or is present in the shoulder or sidewall area, the tire should be replaced or referred to a full-service tire repair facility.



If an injury is present in the shoulder or sidewall areas, the tire should be replaced or sent to a full-service tire repair facility.

Tech Tip!

While there is no limit to the number of nail hole repairs that can be made in a tire, remember that each puncture represents a period in which the tire was operated in an underinflated or overloaded condition. For this reason, always inspect the tire thoroughly (inside and outside) for evidence of extended periods of abnormal operation before initiating a repair. In addition, make sure that the correct repair units are selected, installed properly, and do not overlap.

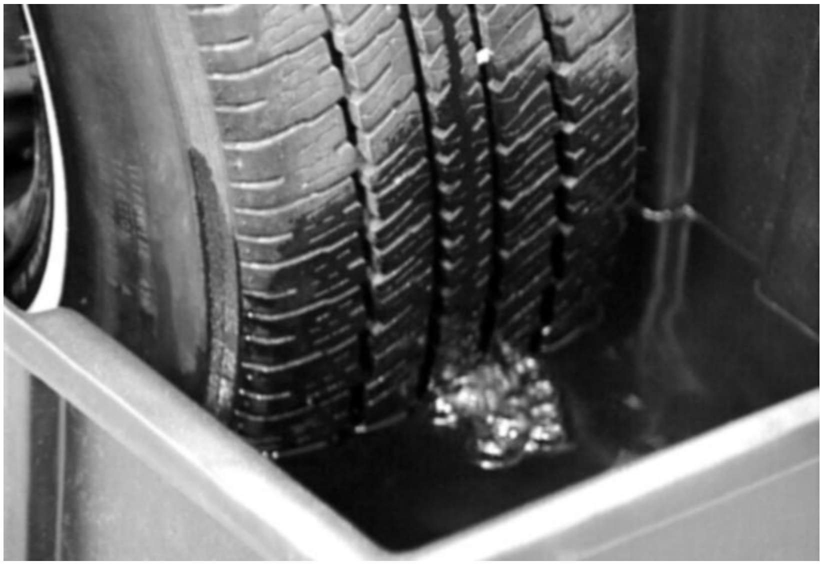
Finding Leaks

Sometimes, the most difficult step in the tire repair process is finding the leak. In the case of severe leaks, the source can easily be identified by inspecting the tread for a nail or other foreign object. Severe leaks can also be located by simply listening for escaping air.

Caution

Never inflate the tire beyond the maximum inflation pressure indicated on the sidewall in an attempt to find a leak. If you cannot locate the leak with the tire at the maximum allowable pressure, demount the tire and inspect it thoroughly. In addition, never use a probe or awl on an inflated tire!

Slow leaks in the tread can often be found by submerging the tire/wheel assembly into a water tank and spinning it slowly. A steady stream of bubbles at the water line will reveal the general location. If a water tank is not available, sponge the tire down thoroughly with soapy water and then look for bubbles to appear at the leak site. If no bubbles appear from the sidewall, shoulder, or tread area, apply the solution around valve stem. Gently rock the stem from side to side to ensure that it is not causing air to escape. Finally, apply the soap solution around the outside of both rim flanges. Any bubbles here indicate that the tire bead is not fully seated or the bead seats are corroded. Once you have located the leak, identify the specific area on the tire using a marking crayon.



Tech Tip!

Advise customers to have slow leaks repaired promptly. Continuing to drive on a tire with a slow leak can damage the tire body and allow moisture to enter through the penetration. If moisture reaches the steel belts, it will cause permanent internal damage, in which case the tire must be removed from service.

Repair Methods

The only approved method for a puncture repair is using a rubber stem to fill the injury and a repair unit to seal the innerliner. The goal is to achieve vulcanization or molecular bonding between the repair material components and the tire. Today's nail hole repair systems restore tires to their original condition because the rubber stem and repair unit actually become part of the tire. There are two types of puncture repair units: one-piece combination, and two-piece. In a one-piece combination unit, the stem and repair unit are a single assembly. With a two-piece repair unit, the stem is separate.

Unfortunately, many shops still repair leaking tires by installing plugs from the outside. While this technique can provide a temporary airtight seal, it does not ensure the tire's structural integrity. In fact, this type of repair is at best incomplete. In most cases, installing a plug from the outside not only fails to achieve vulcanization, it disregards any hidden damaged the puncture may have caused on the interior of the tire. For example, objects that puncture the tread are often long enough to cut the sidewall from the inside. If the tire is repaired externally, this damage will go undetected, making the tire unsafe.

Tech Tip! *According to certain tire manufacturers, speed rated tires lose their original speed rating once they have been repaired due to a cut or puncture.*

Before a tire can be repaired, it must be demounted from the rim and thoroughly inspected on the inside. Remove any foreign objects from the injury, and then use a probe or awl to determine the size of the injury and the angle of penetration.

Caution *Make sure you are wearing safety glasses before removing a nail or other object from a tire.*

One-Piece Combination and Two-Piece Repair Units

If the internal damage exceeds the maximum allowable size for the particular tire type, the tire should be replaced or sent to a full-service tire repair facility. Once you have determined that the tire is repairable, mark the injury on the inside and outside of the tire. Making a nail hole repair involves six basic steps including:

- Cleaning the Innerliner
- Removing the Damage
- Filling the Injury
- Buffing the Innerliner
- Cementing the Innerliner
- Installing the Repair Unit

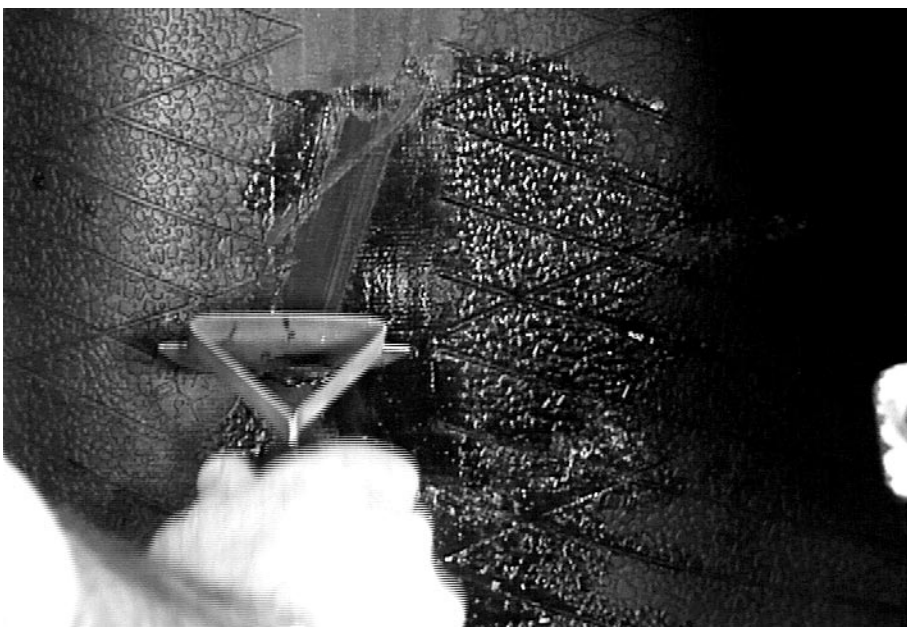
continued...

Repair Methods (continued)

Cleaning the Innerliner

Cleaning the innerliner is one of the most important steps in the tire repair process. Unfortunately, it is usually the most overlooked. During manufacturing, a release lubricant is applied to the inside of the tire to prevent it from sticking to a rubber inflation bladder. The bladder is used to expand the tire so the closing mold will not buckle the tread and sidewalls. Inevitably, the tire will contain traces of the release lubricant. Unless it is removed prior to making a repair, the lubricant will reduce adhesion between the repair unit and innerliner.

To clean the innerliner, use rubber buffer or innerliner cleaner. Cover the area to be repaired thoroughly, and then use a scraper to remove surface debris or other contaminants. The objective is to achieve a dull black appearance, which means that it may be necessary to apply the cleaner and scrape the surface more than once.



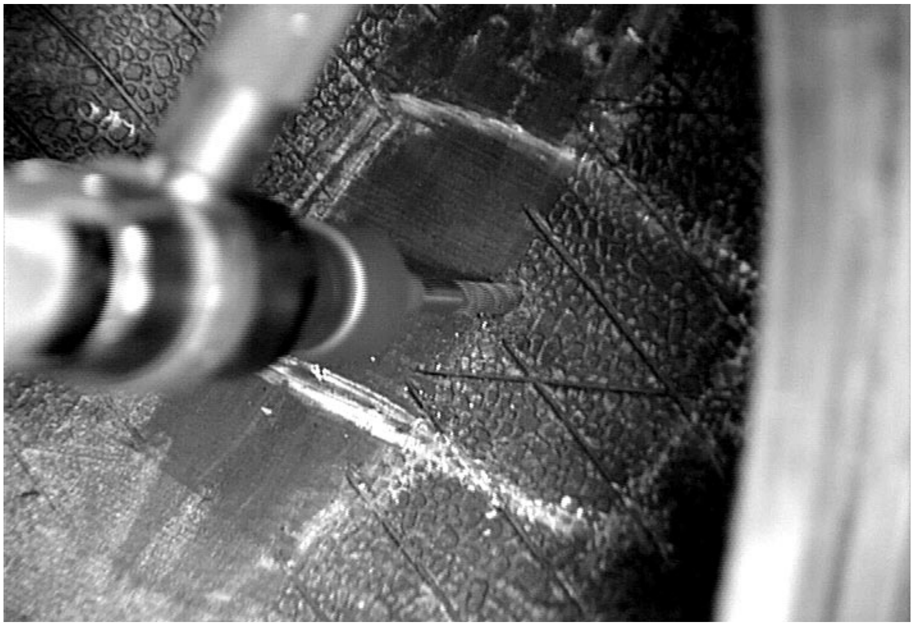
After applying innerliner cleaner, the area is scraped until the surface has a dull black appearance.

Removing the Damage

When an object penetrates the innerliner, it damages the steel cords in the belt package as well as the cords in the body plies. The cords consist of twisted fibers or filaments that fray when broken. As the tire flexes during normal operation, it causes the cords to unwind and ultimately separate. Only by cutting off the cords cleanly and leaving them encased in solid rubber can the damaged area be restored. This can only be accomplished using the appropriate size carbide cutter attached to a low speed air drill (less than 1200 rpm). The age-old method of reaming the injury can actually create more problems than it attempts to solve. This is because it causes the cords to twist even further, resulting in greater damage.

Caution *Reaming an injury by hand on an inflated tire can create sparks and ignite any flammable gasses inside the tire. This can cause the tire to explode, resulting in serious personal injury and even death.*

The importance of using a carbide cutter mounted on a low speed air drill to restore damaged cord material cannot be overstated. If possible, always begin by drilling the injury at least three times from the inside of the tire. Once the injury has been drilled from the inside, repeat the process from the outside of the tire. To ensure that all of the damaged material has been removed, it may be necessary to drill the injury from the inside one more time.



A carbide cutter mounted to a low-speed drill is used to remove the frayed ends of damaged steel cords.

continued...

Repair Methods (continued)

Removing the Damage (continued)

Be aware that using air drills capable of speeds higher than 1200 rpm can scorch the rubber within the injury channel. If smoke appears during the drilling process, it is usually indicative of scorched rubber. Scorching can also occur in tires with thick tread blocks, even when using the proper speed tool. If scorched rubber is present, it should be removed with a spiral brush mounted on a low speed rotary air tool (less than 5000 rpm).

After drilling the tire from the inside, the process is repeated from the outside of the tire to ensure the damage is completely removed.

Filling the Injury

Once the injury channel has been cleaned, restored, and lubricated with vulcanizing cement, a rubber stem is used to fill the void. All rubber stems contain a thin layer of different-colored cushion gum that reacts with the cement to initiate vulcanization. As the rubber stem and tire become vulcanized, a molecular bond is created from the inside of the tire to the outside of the tread surface. This not only provides an airtight seal, but also prevents water from entering the tire body. Be aware that rope, string, and other related products used for filling injuries do not create permanent bonds, and therefore will not seal the injury from the outside.

Caution

Never touch the cushion gum with your fingers, since dirt and oil from the skin will contaminate the surface and create a barrier to adhesion.

Buffing the Innerliner

The interior of a tubeless tire is coated with a thin layer of butyl rubber to create an airtight chamber. Butyl rubber has unique air-retention qualities, making it the perfect innerliner. When the inflation bladder expands the tire during the manufacturing process, it makes an impression in the butyl rubber. This leaves behind mold marks once the rubber cures. Before installing a repair unit, the surface of the innerliner must be smooth and uniform, which means the mold marks must be removed.

This is accomplished by buffing the innerliner with a fine grit cup rasp mounted to a low speed air tool (less than 5000 rpm). The objective is to remove the mold marks and create a flat, uniform surface – without penetrating the innerliner! Buffing through the innerliner will expose the rubber encased body plies directly underneath, in which case the tire must referred to a full service tire repair facility. Since most low speed air tools operate in a clockwise direction, buffing should be performed from right to left. This will cause the clockwise rotation of the cup rasp to push the rubber dust away from the buffed surface. The best texture for nail hole repair units is a smooth, velvet-like RMA #1 or #2 finish.

Buffing the innerliner is necessary to remove the mold marks and provide a smooth uniform surface for the repair unit.

Tech Tip! *Be sure to keep the tool moving while buffing the innerliner. Holding the tool in the same spot for too long will create uneven spots in the buffed surface.*

continued...

Repair Methods (continued)

Buffing the Innerliner (continued)

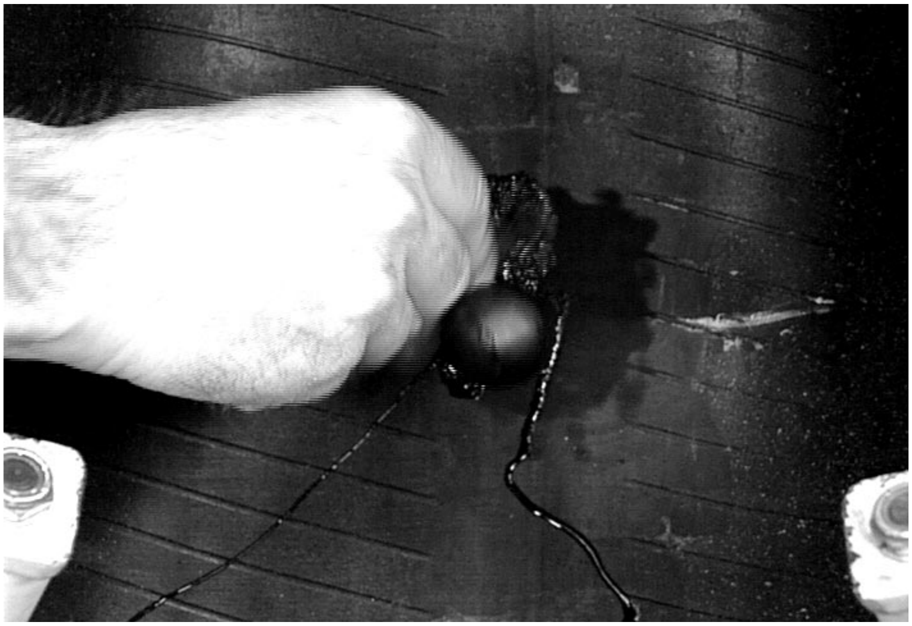
Once the innerliner has been buffed properly, the rubber dust must be removed. This is best accomplished using a soft wire brush mounted to a low speed air tool, followed by several passes with a shop vac. During cleaning, be sure not to touch the buffed surface with your fingers, or the vacuum nozzle. Be aware that most innerliner cleaners are designed to be used prior to buffing, and therefore should never be applied to a buffed surface.

Caution *Applying innerliner cleaner to a buffed surface can create a chemical film that will prevent the repair unit and tire from becoming vulcanized.*

Cementing the Innerliner

Contrary to popular belief, cementing the innerliner is not accomplished with glue. Glue is for school projects and children's toys – not tires! In order for a repair unit to seal the breach in the innerliner and become a permanent part of the tire, a special bonding agent is required. In addition to being strong and flexible, it must also be capable of withstanding winter and summer temperature extremes. This bonding agent is known as vulcanizing cement.

With adhesives like 'super glue,' the strongest bonds are achieved by applying a thin layer to one surface. The same is true for vulcanizing cement. The cement should be applied to the buffed surface in a thin, even layer. However, when using glue, the objects must be pressed together while the glue is wet. In contrast, vulcanizing cement must be allowed to dry to a dull, tacky finish, **before** the repair unit is installed. Installing a repair unit over wet cement causes pockets of air to form as gasses are released during the cement drying process. Once the tire develops enough heat, the gas will expand, forcing the repair unit to separate from the innerliner. Be aware that vulcanizing cement takes longer to dry in low temperature or high humidity conditions. Never attempt to shorten the drying time using a heat lamp, hair dryer, or heat gun.



Applying vulcanizing cement to the buffed surface.

Incidentally, you may hear some technicians claim that the so-called 'hot patch' method is an effective tire repair technique. Nothing could be further from the truth! This is because igniting the cement burns off the chemicals needed to create the molecular bond between the innerliner and the repair unit. In addition, this practice is also extremely dangerous and may result in serious personal injury.

continued...

NOTES:

Repair Methods (continued)

Installing the Repair Unit

Just like rubber stems, all repair units have a thin layer of cushion gum. To protect the cushion gum during storage, the bottom of the repair unit has a split poly-film backing. Naturally, the backing must be removed prior to installing the repair unit. This is accomplished by bending the bottom of the repair unit slightly to snap the poly-film open, and then peeling the sides back halfway without touching the cushion gum. Apply the repair unit by centering it over the injury, and then pressing the center down with your thumb as you remove the poly-film backing. Once the repair unit is in place, stitch it from the center out to remove any trapped air. If the top of the unit has a plastic cover, it can be removed at this time. Re-stitch the repair unit to ensure that the edges are secure, and then apply an innerliner sealer to the buffed area surrounding the unit.

Using a stitching tool to remove trapped air and seal the edges of the repair unit.

Tech Tip! *To prevent contamination, never handle the cushion gum or leave it exposed for extended periods.*

Repairing Bead Leaks

A leak between the rim and tire bead is usually the result of corrosion and/or rubber build-up on the rim surface. Corrosion is particularly common on alloy wheels. To repair a bead leak, remove the rim deposits using a stiff wire brush. Once the rim surface is clean and smooth, remount the tire. For added insurance against future leaks, apply bead sealer to the beads prior to inflating the tire.

Caution

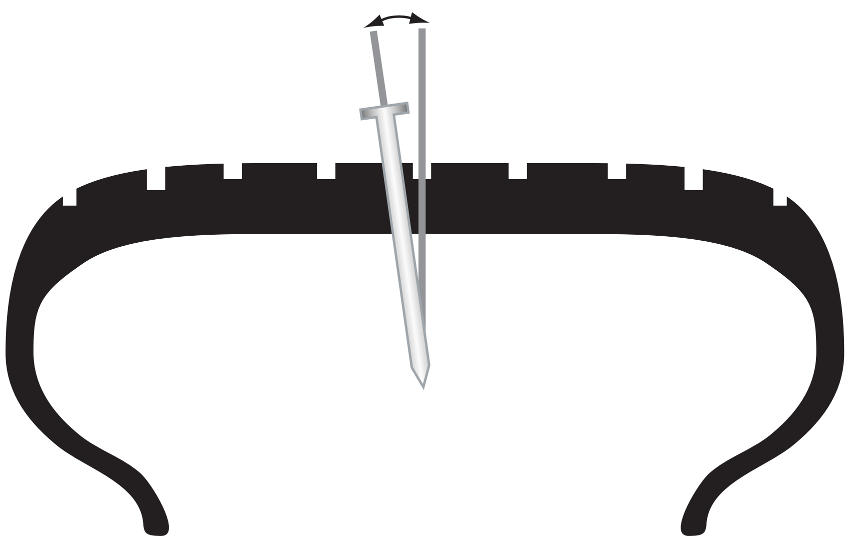
Be aware that innerliner sealer is not designed for sealing the beads on tubeless tires. Using innerliner sealer for this purpose may cause the beads to stick to the rim, making future tire removal almost impossible.

NOTES:

One-Piece Combination Repair Units

The one-piece repair unit is the preferred choice among automotive tire repair facilities. This is because the stem and repair unit are molded into a single component, allowing technicians to fill the injury while simultaneously installing the repair unit. The only drawback to the repair unit's integrated design is that it can only be used for injuries where the angle of penetration is less than 25 degrees. If the injury angle exceeds 25 degrees, a two-piece repair unit must be used.

ANGLE OF PENETRATION < 25 DEGREES



ONE-PIECE REPAIR UNIT ACCEPTABLE

Before installing a one-piece repair unit, remove the object from the tire and inspect the injury to determine size, location, and angle of penetration. Next, mark off the area around the injury approximately 1/2" larger than the top of the repair unit, and then clean the innerliner thoroughly. This is followed by buffing the marked area to a smooth velvet-like RMA #1 or #2 finish using a cup rasp attached to low speed air tool (5000 max. rpm). After buffing the innerliner, drill the injury three times from the inside of the tire using the appropriate size carbide cutter mounted to a low speed drill (1200 max. rpm). Repeat the process from the outside to ensure that all of the damaged belt and ply material has been removed. After cleaning any steel shavings and buffing dust, apply vulcanizing cement to the inside of the injury channel using a clean probe or spiral awl. Leave the tool in place so that the injury channel retains the lubrication necessary for pulling the stem through the tire. Cover the buffed surface with a thin layer of cement.

Once the cement dries to a dull, tacky finish, remove the poly-film backing from the repair unit without touching the cushion gum. Next, apply a thin coat of vulcanizing cement to the tapered portion of the stem.

Tech Tip! *Apply cement to the tapered stem sparingly. Over applying can cause wet cement to become trapped under the repair unit, resulting in reduced adhesion and possible failure.*

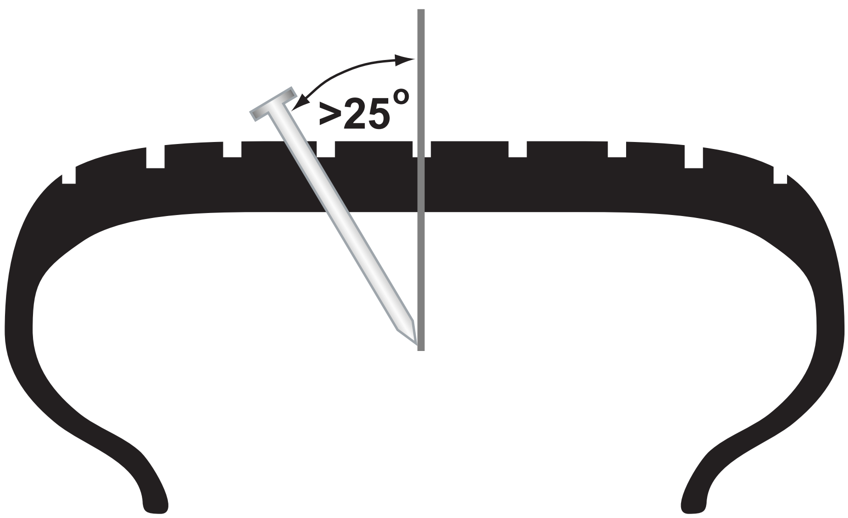
Pull the stem through the injury until a slight dimple is present on the surface of the repair unit. After stitching the repair unit securely, remove the plastic film (if applicable) on top of the unit. Next, cover the buffed area around the repair unit with innerliner sealer. Finally, trim the rubber stem on the outside of the tire approximately 1/8" above the tread surface. Be careful not to pull on the stem while trimming.

Preparing a one-piece combination repair unit for installation.

Two-Piece Repair Units

Unlike the integrated design of the one-piece repair unit, the two-piece repair unit uses a separate stem. Consequently, there is no limit to the injury angle, as long as the injury remains within the crown area of the tread, and the size of the injury is within the recommended limits for the particular tire type.

ANGLE OF PENETRATION > 25 DEGREES

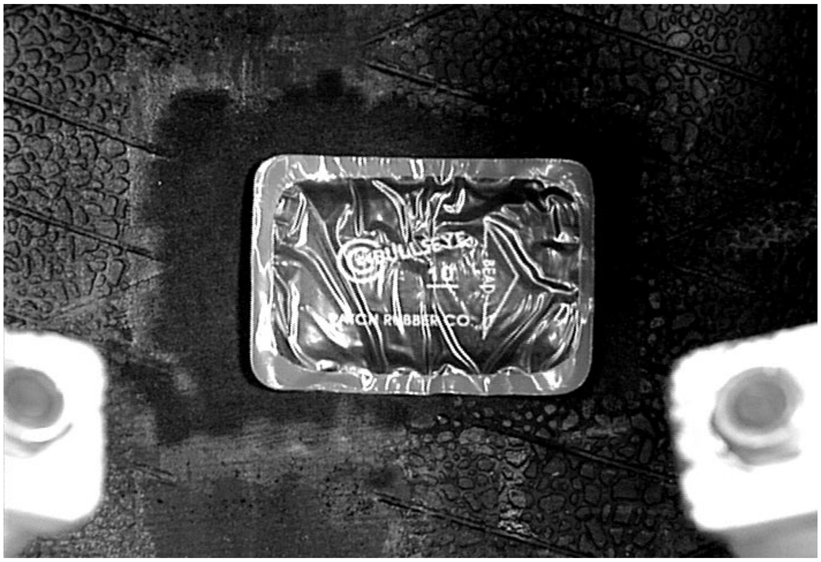


TWO-PIECE REPAIR UNIT REQUIRED

After removing the debris or foreign object from the tire and cleaning the innerliner, drill the injury using the appropriate size carbide cutter attached to a low-speed drill (1200 max. rpm). Once drilling has been completed on both sides of the tire, lubricate the injury with vulcanizing cement using a clean probe or spiral awl. Next, place the pull wire (insertion tool) over the rubber stem and position it about halfway down the tapered portion. If the stem is covered with poly-film, carefully remove it at this time. Be careful not to touch the cushion gum area. Next, apply vulcanizing cement to the tapered portion of the stem. Unlike one-piece stems, there is no risk of over applying cement, since any excess will be removed during the buffing process. Insert the pull wire into the injury and pull the stem through from the outside of the tire.

Once the rubber stem is installed, trim it slightly above the innerliner using a side-cutters or flexible knife. Using a cup rasp mounted on a low-speed air tool (5000 max. rpm), buff an area approximately a 1/2" larger than the repair unit working from right to left. Continue buffing until the stem is flush with the surface and the mold marks on the innerliner have been removed. The result should be a clean and textured, velvet-like RMA #1 or #2 finish. Remove excess buffing dust from the surface using a soft wire brush mounted on a low-speed buffer (5000 max. rpm), followed by a pass with a shop vac. At this point, a thin layer of cement can be applied to the area and allowed to dry to a dull, tacky finish. Now, bend the bottom of the repair unit slightly to snap the poly-film open, and then peel back the sides halfway without touching the cushion gum. Apply the repair unit by centering it over the injury and then pressing the center down with your thumb as you remove the poly-film backing. With the repair unit in place, stitch it from the center out to remove any trapped air. Next, remove the plastic from the top of the repair unit (if applicable), and then re-stitch the repair unit to ensure that the edges are secure. Apply innerliner sealer to the buffed area surrounding the repair unit. Finally, trim the stem on the outside of the tire to within 1/8" above the tread surface.

Trimming the rubber stem of a two-piece repair unit.



Preparing for final installation of a two-piece repair unit.

Tire-Specific vs. Universal Repair Units

One-piece and two-piece repair units may be designed specifically for either radial or bias tires. Bias repair units have reinforcing polyester plies that mimic the tire's bias ply construction. Similarly, radial tire repair units have reinforcing polyester plies that mimic radial ply construction. Repair units specifically designed for either radial or bias tires will have arrows to indicate their orientation relative to the beads. When installing these units, be sure the arrows are perpendicular to the beads so the repair unit will flex at the same rate as the tire. Never use a bias repair unit on a radial tire or vice versa.

Unlike tire-specific repair units, universal repair units do not contain reinforcing plies. Consequently, they can be aligned in any direction and used in any type of tire.

Tech Tip! *Whether you are using a tire-specific or universal repair unit, always check with tire repair material manufacturer to ensure you select the correct type and appropriate size repair unit for the job.*

TIA

TIRE INDUSTRY ASSOCIATION

Frequently Asked Questions

FAQ #1

If you are only replacing two tires on a vehicle, should they go on the front axle or the rear axle?

In most cases, they should be installed on the rear axle. When new tires are installed on the front and worn tires are left on the rear, it creates a handling imbalance that can cause the rear of the vehicle to slide outwards during turns. This condition is known as 'oversteer.' Be aware that certain manufacturers of AWD vehicles recommend that replacement pairs be installed on the front axle only.

FAQ #2

Is it true that the speed rating of replacement tires has to be at least the same as the speed rating indicated on the tire placard?

Yes. The speed rating printed on the tire placard represents the minimum speed rating for replacement tires. Although it's fine to install tires with a higher speed rating, installing tires with a lower speed rating is not an option.

FAQ #3

If all replacement tire sizes must match the sizes printed on the vehicle's tire placard, why do we plus-size assemblies on custom wheels?

Remember, the vehicle's suspension and steering system has been designed specifically for the size tires listed on the placard. Changing tire diameter beyond this point can adversely affect vehicle handling, antilock brake operation, and speedometer accuracy. However, as long as the outside diameter of the original equipment tires is maintained within 1%, the plus-sized custom wheel assembly should not cause any problems.

FAQ #4

Can speed-rated tires be repaired and still maintain their original speed rating?

It depends on the tire manufacturer. Some manufacturers allow tires to maintain their original speed rating following a proper nail hole repair. Always check the manufacturer's tire repair policies and inform the customer if any limitations apply.

FAQ #5

Is it necessary to install four snow tires or studded snow tires on front-wheel drive vehicles?

Yes. Front-wheel drive vehicles have a tendency to oversteer. This is because most of their weight is concentrated in the front. Installing snow tires on both axles minimizes oversteer by providing equal grip at all four corners. Since the weight in a rear-drive vehicle is more evenly distributed, installing two snow tires on the rear axle is acceptable.

FAQ #6

Is it true that the tires on 4WD and AWD vehicles should all be the exact same size and have the same tread pattern?

Yes, especially where AWD vehicles are concerned. This is because driving on mixed tires can damage drivetrain components due to the difference in circumference between the tires on the front and rear axles. That's why the tires on these vehicles must be identical, and why maintaining proper inflation pressure is so important. In fact, some vehicle manufacturers strongly recommend replacing tires in complete sets to insure that tire circumference is the same on both axles.

FAQ #7

Can you mix radial and bias tires on the same vehicle?

Yes, but it is not recommended. As long as the vehicle is NOT a 4WD or AWD model. On front-wheel and rear-wheel drive vehicles, always install the bias tires on the front and the radial tires on the rear to prevent oversteer.

FAQ #8

Can you mix aspect ratios on the same vehicle?

Not if the vehicle is a 4WD or AWD model. On front-wheel and rear-wheel drive vehicles, the tires with the lower aspect ratio should be installed on the rear axle to prevent oversteer.

FAQ #9

If you are only replacing one tire on a vehicle, where should it be installed?

Always pair the new tire with the tire that has the most tread depth, and then install both tires on the rear axle (except certain AWD vehicles). Be sure the replacement tire is the same size and construction as the other tires, and has an equivalent or higher speed rating.

FAQ #10

What causes some tires to smell like ammonia when the valve core is removed?

This smell is usually an indication that the tire contains 'fix-a-flat' or similar injectable sealant. Since many of these products are flammable, a spark generated within the vicinity of the tire can ignite the gas and cause an explosion. To prevent serious personal injury, it is vital that the gas be purged from the tire whenever an ammonia smell is detected. This can be accomplished by inflating and deflating the tire several times before unseating the beads. If the tire is going to be returned to service, clean the inside of the tire thoroughly, making sure all of the sealant has been removed.

FAQ #11

What does it mean to 'double bead' a tire?

The term 'double bead' refers to installing both beads simultaneously. This is not an acceptable tire mounting procedure and should not be attempted.

FAQ #12

Is passenger and light truck tire service covered by OSHA Regulation 29 CFR 1910.177?

No. However, every business is covered by the OSHA General Duty clause, which states that every employer must identify all risks to employees, and provide the necessary training and safety equipment required to protect them from injury.

FAQ #13

Is plugging a tire from the outside an acceptable method for repairing an injury?

No. Repairing a tire properly is actually a six-step process that involves cleaning the innerliner, removing the damage, filling the injury, buffing the innerliner, cementing the innerliner, and installing the appropriate repair unit (one-piece combination or two-piece). This procedure, which obviously requires that the tire be removed from the wheel, is the only approved method for repairing an injury.

FAQ #14

What is the best time of day to check tire inflation pressure?

Since inflation pressure should be checked cold, the best time to check the tires is first thing in the morning with the vehicle parked in the shade. If the vehicle has been driven more than one mile, or has been sitting in the sun on a hot day, the tires should be allowed to cool up to three hours before checking inflation pressure.

FAQ #15

How often should you check tire inflation pressure?

Since it is normal for tires to lose 1-2 psi per month, tire pressure should be checked on a monthly basis.

FAQ #16

How often should the tires be rotated?

While rotation schedules may vary among manufacturers, the general industry standard is every 5000 to 7000 miles.

FAQ #17

One of the tires on a customer's vehicle has a very slow leak. After checking the tire on numerous occasions, I have been unable to locate the problem. Is it possible the wheel could be leaking?

Yes. During the wheel casting process, air bubbles can become trapped in the molten metal. Once the wheel hardens, the air bubbles create tiny pockets (porous areas) that can allow air to escape. These porosity leaks may be so slight that it takes several weeks for the tire to lose a substantial amount of air.

FAQ #18

How do you repair a wheel porosity leak?

Some manufacturers recommend special adhesive/sealers to repair a porosity leak. These products are typically applied in a 1/8" layer to the porous area and require about 12 hours of drying time.

FAQ #19

What is the difference between a thrust angle alignment and a four-wheel alignment?

During an alignment, two benchmarks are used to determine the relationship between the vehicle and the tires. The first is the vertical reference line: an imaginary line that runs through the center of the tire/wheel assemblies. The second is the centerline: an imaginary line that bisects the vehicle lengthwise. Ideally, the centerline and thrust angle will be the same. The thrust angle refers to rear wheel tracking, and provides the basis for front wheel adjustments. If the thrust angle and centerline are different, the vehicle will dog track down the road and the steering wheel will be off-center. On vehicles with non-adjustable rear suspensions, the thrust angle is fixed based on the position of the rear wheels. In a thrust angle alignment, the front wheels are aligned according to the measured thrust angle. This procedure is used for rear-drive vehicles with a solid axle. For vehicles equipped with adjustable rear wheels, a four-wheel alignment can be performed. During this procedure, the thrust angle is adjusted to zero (center) prior to aligning the front wheels.

FAQ #20

Why do top fuel and funny car drivers perform 'burnouts' before every run?

The soft rubber compound used in racing slicks contains several heat-activated chemicals. The chemicals are designed to improve traction, which is essential for winning races. Performing a 'burnout' heats the slicks and allows these chemicals to be released. This causes the tires to become sticky, providing the traction necessary to complete the run and achieve a low ET (elapsed time).

TIRE INDUSTRY ASSOCIATION

Glossary

A – B

Aspect Ratio

The height of a tire's sidewall in relation to its tread width. For example, a '60-series tire indicates that the sidewall is 60 percent as high as the tread is wide.

Bolt Circle

Refers to the diameter of an imaginary ring drawn through the center of the wheel studs or mounting holes.

Beads

High-strength steel cables around the outer edge of the casing that secure the tire to the wheel.

Bead Humps

Small elevations on the bead seats that prevent the tire from falling into the drop center during a blowout.

Bead Seats

The outermost area of the rim. The bead seats secure the tire on the wheel and provide an airtight seal.

Belts

One or more layers of material that surround the body plies. The belts run parallel with the beads and reinforce the area directly beneath the tread.

Bias Ply Tire

A tire in which the plies run between the beads at an angle of greater than 5 degrees.

Body or Casing

The part of the tire that contains the air which supports the vehicle mass.

C – H

Camber

An alignment angle that refers to the tilt of the tire from vertical as viewed from the front of the vehicle.

Cold Inflation Pressure

The air pressure of a tire that has been driven less than 1 mile or has been idle for at least 3 hours.

Cords or Plies

Layers of rubber-impregnated material within the casing, such as polyester or steel.

Crown

The area of tread that extends to within 1-1.5 inches of the shoulders.

Drop Center

The area of the rim with the smallest inner diameter.

Dynamic Balance

A condition that exists when the mass of a rotating tire/wheel assembly is equally distributed around its axis of rotation and centerline. Dynamic balancing is referred to as dual-plane balancing, since it refers to the distribution of weight on both sides of the wheel centerline.

Flange

The outermost lip of the rim where balancing weights are usually attached.

Hub-Centric Wheel

A wheel with a machined center hole that fits precisely over the raised portion of the wheel hub/ or axle flange.

H – R

Hydroplaning

A condition in which the tires lose contact with the road due to the inability of the tread to channel water away from the tire.

Indexing

A procedure in which the tire's high spot is aligned with the wheel's low spot. Indexing is used to compensate for excessive tire/wheel runout.

Innerliner

A rubber-butyl material applied to the inside of the casing during the manufacturing process. The innerliner keeps the casing airtight.Kerfs
The large grooves in the tread.

Lateral Runout

The side-to-side (horizontal) movement of a rotating tire/wheel and hub assembly.

Lug-Centric Wheel

A wheel with a large center hole surrounded by elongated mounting holes. Wheel-to-hub centricity is achieved using specially designed lugs.

Nail Hole Injury

Any nail hole penetration or puncture of the casing that originates from the crown area.

Radial Ply Tire

A tire in which the plies run perpendicular (90-degrees) to the beads.

Radial Runout

The up and down (vertical) movement of a rotating tire/wheel and hub assembly.

Rim

The outer section of a wheel.

S – T

Sidewalls

Flex area between the beads and tread.

Sipes

The small grooves in the tread.

Splice

The point at which the structural components of the tire are overlapped and fused together. There might be a stiff indentation on the sidewall in this area.

Static Balancing

Refers to the distribution of weight around the circumference of the wheel. Also known as single plane balancing.

Tire Placard

A sticker that lists OE tire information including, size, cold inflation pressure, speed rating, and load capacity. The tire placard is typically attached to the rear of the driver's door.

Toe

An alignment angle that refers to the position of the tires in relation to the vehicle's centerline.

Torque Steer

A condition common in front-wheel-drive vehicles with unequal length drive axles. Torque steer causes a change in wheel toe during acceleration that causes the vehicle to pull.

Torque Stick

Common term for a torque-limiting adapter. The adapter attaches to an impact wrench when tightening wheel lugs.

Tread

The part of the tire that provides the contact area. The tread is made from a variety of natural and synthetic rubber compounds.

V – Y

Vulcanization

The process of treating crude rubber with sulfur or sulfur compounds in various proportions and at various temperatures. Vulcanization yields a weatherproof rubber with varying degrees of strength and elasticity.

Wheel Shimmy

A condition that causes a vibration in the steering wheel due to excessive lateral runout.

Wheel Tramp

A condition in which the tire momentarily loses contact with the road during each revolution. Worn shocks are a common cause of wheel tramp.

Yield Point

Refers to a bolt's maximum allowable stretch.

BEST-ONE TIRE & SERVICE / TIRE INDUSTRY ASSOCIATION AUTOMOTIVE TIRE SERVICE SKILLS DEMONSTRATION FORM

Best-One Tire & Service / TIA's Basic Automotive Tire Service (ATS) Program is designed to meet the training needs of technicians with varying levels of experience. In order to fully complete this Program, a student must go through the training, as well as demonstrate the ability to perform the tasks outlined in the training. **The Technician and a Manager or Supervisor must initial and date each skill listed below, then sign and date the bottom of this form**. By doing so, he/she is verifying that the Technician has demonstrated the skills to perform these functions.

Technician Name: ____has demonstrated and maintained the ability to perform the following tasks.

DATE	INITIALS Technician/Manager	SKILL DEMONSTRATED
________	_____/_____	Identify the sidewall markings including size and service description
________	_____/_____	Locate and explain the purpose of the vehicle placard
________	_____/_____	Spot and lift a vehicle using the correct lift points on a drive-over or drive-thru lift
________	_____/_____	Lift and secure a vehicle using a floor jack and jack stand
________	_____/_____	Remove a wheel cover or hubcap
________	_____/_____	Remove a tire/wheel assembly
________	_____/_____	Demount and mount a tire using a center-post or rim-clamp tire changing machine
________	_____/_____	Inflate a tire to the correct inflation pressure for the vehicle
________	_____/_____	Balance a tire/wheel assembly
________	_____/_____	Repair a tire using a one-piece or two-piece repair unit
________	_____/_____	Install a tire/wheel assembly with the correct torque

Technician-Signature____ **Date**___________________

Printed Name of above signature____

Manager/Supervisor - Signature ___________________________________ **Date**___________________

Printed Name of above signature__________________________________**Title**___________________

Company: ____

Company Address: ____

City: ____________________**State:** _________**Zip:**___________________________

Phone: _______________________

Please fax this completed Skills Demonstration Form to
Corene Scheumann at Best-One Tire and Service – Fax Number (866) 404-2589

Please file this Skills Demonstration form in the Employee's file along with the completed Answer Sheet from the Basic ATS Training Final Exam to serve as Documented Proof of Training

A Certificate of Completion will be mailed to you upon Best-One Tire and Service receiving the required fee of $25.00 for this Best-One Tire / TIA Automotive Training