Figure 109-1 (a) A typical tire tread depth gauge. The center movable plunger is pushed down into the groove of the tire.

Figure 109-1 (b) The tread depth is read at the top edge of the sleeve. In this example, the tread depth is 6/32 in.
Figure 109-2 Wear indicators (wear bars) are strips of bald tread that show when the tread depth is down to 2/32 in., the legal limit in many states.

Figure 109-3 The tire tread runs around the circumference of the tire, and its pattern helps maintain traction. The ribs provide grip, while the grooves direct any water on the road away from the surface. The sipes help the tire grip the road.

Figure 109-4 Hydroplaning can occur at speeds as low as 20 mph (32 km/h). If the water is deep enough and the tire tread cannot evacuate water through its grooves fast enough, the tire can be lifted off the road surface by a layer of water. Hydroplaning occurs at lower speeds when the road is wet.
Typical construction of a radial tire. Some tires have only one body ply, and some tires use more than two belt plies.

The major splice of a tire can often be seen and felt on the inside of the tire. The person who assembles (builds) the tire usually places a sticker near the major splice as a means of identification for quality control.

Tire construction is performed by assembling the many parts of a tire together on a tire-building machine.
After the entire tire has been assembled into a completed "green" tire, it is placed into a tire-molding machine where the tire is molded into shape and the rubber is changed chemically by the heat. This nonreversible chemical reaction is called vulcanization.

**FREQUENTLY ASKED QUESTION:** Why Do I Get Shocked by Static Electricity When I Drive a Certain Vehicle?

Static electricity builds up in insulators due to friction of the tires with the road. Newer tires use silica and contain less carbon black in the rubber, which makes the tires electrically conductive. Because the tires cannot conduct the static electricity to the ground, static electricity builds up inside the vehicle and is discharged through the body of the driver and/or passenger whenever the metal door handle is touched.

**NOTE:** Toll booth operators report being shocked by many drivers as money is being passed between the driver and the toll booth operator. Newer tire sidewall designs that use silica usually incorporate carbon sections that are used to discharge static electricity to ground. To help reduce the static charge buildup, spray the upholstery with an antistatic spray available at discount and grocery stores.

**FREQUENTLY ASKED QUESTION:** How Much Does Tire Pressure Change with a Change in Temperature?

As the temperature of a tire increases, the pressure inside the tire also increases. The general amount of pressure gain (when temperatures increase) or loss (when temperatures decrease) is as follows:

- 10°F increase causes 1 PSI increase
- 10°F decrease causes 1 PSI decrease

For example, if a tire is correctly inflated to 35 PSI when cold and then driven on a highway, the tire pressure may increase 5 PSI or more. **CAUTION:** DO NOT LET AIR OUT OF A HOT TIRE! If air is released from a hot tire to bring the pressure down to specifications, the tire will be underinflated when the tire has cooled. The tire pressure specification is for a cold tire. Always check the tire pressures on a vehicle that has been driven fewer than 2 miles (3.2 km).

Air pressure in the tires also affects fuel economy. If all four tires are underinflated (low on air pressure), fuel economy is reduced about 0.1 mile per gallon (mpg) for each 1 PSI low. For example, if all four tires were inflated to 25 PSI instead of 35 PSI, not only is tire life affected but fuel economy is reduced by about 1 mile per gallon (10 X 0.1 = 1 mpg).
Notice that the overall outside diameter of the tire remains almost the same and at the same time the aspect ratio is decreased and the rim diameter is increased.

**Figure 109–9.** Notice that the overall outside diameter of the tire remains almost the same and at the same time the aspect ratio is decreased and the rim diameter is increased.

- ** TIRES AND WHEELS **
- ** TIRES AND WHEELS **
- ** TIRES AND WHEELS **
- ** TIRES AND WHEELS **
The following list indicates selected E.C.E. codes and the countries they represent:

- E13         Luxembourg           E26        Slovakia
- E12         Austria                     E25        Slovenia
- E11         United Kingdom    E24        Croatia
- E9           Spain                       E22        Greece
- E8           Czech Republic     E21        Russian Federation
- E7            Hungary                 E20        Portugal
- E6            Belgium                 E19        Poland
- E5            Sweden                 E18        Romania
- E4            Netherlands         E17        Denmark
- E3            Italy                         E16        Finland
- E2            France                   E15        Norway
- E15        Italy                         E16        Finland

The E.C.E. symbol on a tire signifies that all regulations, including the load index and speed symbol that appear in its service description.

The Economic Commission for Europe (E.C.E.) helps standardize passenger and commercial vehicle components. Most countries have government agencies that regulate standards for motor vehicles sold and/or driven within their jurisdictions. In the United States, the U.S. Department of Transportation and National Highway Traffic Safety Administration are responsible for developing many of the nationwide standards for vehicles. Tires are responsible for developing many of the nationwide standards for vehicles. Tires

FREQUENTLY ASKED QUESTION: What Does the Little “x” Mean on the Sidewall? Most countries have government agencies that regulate standards for motor vehicles sold and/or driven within their jurisdictions. In the United States, the U.S. Department of Transportation and National Highway Traffic Safety Administration are responsible for developing many of the nationwide standards for vehicles. Tires that are certified by their manufacturers to meet U.S. standards are branded with “DOT” (Department of Transportation) preceding the Tire Identification Code on their sidewall.

In Europe, because so much personal and commercial travel extends beyond the borders of any one country, the Economic Commission for Europe (E.C.E.) helps develop uniform motor vehicle standards for its member countries to regulate and standardize passenger and commercial vehicle components.

FREQUENTLY ASKED QUESTION: If I Have an Older Vehicle, What Size Tires Should I Use?

Newer radial tires can be used on older-model vehicles if the size of the tires is selected that best matches the original tires. See the following cross-reference chart.

<table>
<thead>
<tr>
<th>Size</th>
<th>Original Tires</th>
<th>New Tires</th>
</tr>
</thead>
<tbody>
<tr>
<td>195/55R15</td>
<td>165/75R13</td>
<td>215/55R15</td>
</tr>
<tr>
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<td>205/55R16</td>
<td>215/55R16</td>
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<td>225/55R17</td>
<td>235/55R17</td>
</tr>
<tr>
<td>235/45R18</td>
<td>235/55R18</td>
<td>245/55R18</td>
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</tbody>
</table>

This Chart Does Not Imply Complete Interchangeability.
Besides physical specifications, the E.C.E. standards now require tire "pass-by" noise to meet specific limits. These standards were phased-in starting in 2001. The tires must pass noise emission testing, and the standards will continue to expand in scope until 2009, when the standards will be applied to all tires sold in Europe.

The E.C.E. symbol on a tire's sidewall identifies that the manufacturer certifies that the tire meets all regulations, including the load index and speed symbol that appear in its service description. The letter "s" and number code combination (positioned in a circle or rectangle) identify the country originally granting approval, followed by two digits indicating the Regulation Series under which the tire was approved. Tires that have also been tested and meet the "pass-by" noise limits can have a second E.C.E. branding followed by an "-s" (for sound). See Figure 109–12.

The following list indicates selected E.C.E. codes and the countries they represent:

<table>
<thead>
<tr>
<th>Code</th>
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<th>Country</th>
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<tbody>
<tr>
<td>E1</td>
<td>Germany</td>
<td>E14</td>
<td>Norway</td>
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<tr>
<td>E2</td>
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The letter "s" and number code combination (positioned in a circle or rectangle) identify the country originally granting approval, followed by two digits indicating the Regulation Series under which the tire was approved. Tires that have also been tested and meet the "pass-by" noise limits can have a second E.C.E. branding followed by an "-s" (for sound).

**FREQUENTLY ASKED QUESTION: What Does the Little Noise Mean on the Sidewall?**

The small "s" on a tire's sidewall indicates that the tire meets specific noise limits. These standards were phased-in starting in 2004. The tires must pass noise emission testing, and the standards will continue to expand in scope until 2009, when the standards will be applied to all tires sold in Europe.

Besides physical specifications, the E.C.E. standards now require tire "pass-by" noise to meet specific limits. These standards were phased-in starting in 2001. The tires must pass noise emission testing, and the standards will continue to expand in scope until 2009, when the standards will be applied to all tires sold in Europe.

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TIRES AND WHEELS

Figure 109-11 Typical sidewall markings for load index and speed rating following the tire size.

Figure 109-12 The E.C.E. symbol on a sidewall of a tire. Notice the small -s at the end, indicating that the tire meets the "pass-by" noise limits.

Figure 109-13 A typical door placard used on a General Motors vehicle indicating the recommended tire inflation. Note that the information also includes the tire size and speed rating of the tire as well as the recommended wheel size.
Figure 109-14  Conicity is a fault in the tire that can cause the vehicle to pull to one side due to the cone effect (skid) of the tire.

Figure 109-15  Notice the angle of the belt material in this worn tire. The angle of the belt fabric can cause a "ply steer" or slight pulling force toward one side of the vehicle.

FREQUENTLY ASKED QUESTIONS: Is There a Rule-of-Thumb for Rim Size?

According to the Tire and Rim Association, Inc., the answer is no. Each tire size has a designated rim width on which it is designed to be mounted so as to provide the best performance and wear. The width of the specified rim varies with rim diameter. A 235/45 X 17 tire may require a 7.5-in. rim but a 235/45 X 19 tire may require an 8.0-in. rim. A rule-of-thumb that has been used is to multiply the width of the rim by 33.55 to determine the approximate tire size for the rim. For example, consider the following:

Rim width 5.0 in. X 33.55 = 167.85 (165 mm) tire
Rim width 5.5 in. X 33.55 = 184.50 (185 mm) tire
Rim width 6.0 in. X 33.55 = 201.30 (195 mm) tire
Rim width 6.5 in. X 33.55 = 218.00 (215 mm) tire
Rim width 7.0 in. X 33.55 = 234.90 (235 mm) tire
Rim width 7.5 in. X 33.55 = 252.00 (245 mm) tire
Rim width 8.0 in. X 33.55 = 268.00 (265 mm) tire
Rim width 8.5 in. X 33.55 = 285.00 (285 mm) tire
Rim width 9.0 in. X 33.55 = 302.00 (305 mm) tire
Rim width 10.0 in. X 33.55 = 335.60 (335 mm) tire

Always check with the tire manufacturer as to the specified rim width that should be used.
Figure 109-16  Slip angle is the angle between the direction the tire tread is heading and the direction it is pointed.

Figure 109-17  Typical Uniform Tire Quality Grading System (UTQGS) rating imprinted on the tire sidewall.

REAL WORLD FIX: Tire Date Code Information Saved Me Money!
This author was looking at a three-year-old vehicle when I noticed that the right rear tire was almost a year younger than the vehicle. I asked the owner, "Was anybody else in this vehicle tell you the tires were new?" The owner said, "No, but you know that an accident occurred?" I asked the owner, "Did you replace the tires?" The owner responded, "Yes, this was the only tire code left on the vehicle." I told the owner, "Did you replace the tires?" The owner responded, "Yes, this was the only tire code left on the vehicle." I asked the owner, "Did you replace the tires?" The owner responded, "Yes, this was the only tire code left on the vehicle." I asked the owner, "Did you replace the tires?" The owner responded, "Yes, this was the only tire code left on the vehicle."
Figure 109-18  Typical DOT date code. This tire was built the sixth week of 2005.

Figure 109-19  Cutaway of a run-flat tire showing the reinforced sidewalls and the required pressure sensor.

Figure 109-20  A conventional tire on the left and a run-flat tire on the right, showing what happens when there is no air in the tire.
**TECH TIP**

**PAX Replacement Tip**

In most cases, the fastest and easiest approach to follow if a PAX tire requires replacement is to purchase a replacement tire/wheel assembly. While more expensive than replacing just the tire, this approach is often used to help the vehicle owner get back on the road faster without any concerns as to whether the replacement tire was properly installed.

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**Figure 109-21**

The PAX run-flat tire system is composed of three unique components—a special asymmetrical wheel, a urethane support ring, and a special tire.

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**Figure 109-22**

The Tire Performance Criteria (TPC) specification number is imprinted on the sidewall of all tires used on General Motors vehicles from the factory.
FREQUENTLY ASKED QUESTION: What Is a Low-Rolling-Resistance Tire?

Low-rolling-resistance (LRR) tires reduce rolling resistance, which is the power-robbing friction between the tire and crown. The E-metric tire, designated for use on electric or hybrid vehicles, operates at higher inflation pressures, reduced load percentages, and lower rolling resistance. These tires were first used on the GM EV1 electric vehicle.

To soften the ride of tires pumped with additional air, a new tire profile was developed. Narrower rim width and rounder sidewalls make the tire more shock absorbent. To make the tires roll more freely, low-rolling-resistance tread compounds are molded into smaller tread elements that flex easily and with less friction when they touch the road. LRR tires are available from most major tire manufacturers, including Michelin the Energy MXV4 Plus and Goodyear VIVA 2. According to tire engineers, the basic tradeoff of low rolling resistance is poor wet traction performance. To improve wet performance and traction, the tread compound must contain more silica, which increases the cost of the tire. Neither a technician nor a vehicle owner can determine the relative rolling resistance unless the tires are compared using a coast-down test from highway speed to zero or a laboratory testing machine.

Figure 109-23 The size of the wheel is usually cast or stamped into the wheel. This wheel is 7 inches wide. The letter “J” refers to the contour of the bead seat area of the wheel.

Figure 109-24 The wheel rim well provides a space for the tire to fit during mounting; the bead seat provides a tire-to-wheel seating surface; the flange holds the beads in place.
Figure 109-25  A cross section of a wheel showing part designations.

Figure 109-26  Offset is the distance between the centerline of the wheel and the wheel mounting surface.

Figure 109-27  Back spacing (rear spacing) is the distance from the mounting pad to the edge of the rim. Many custom wheels use this measurement method to indicate the location of the mounting pad in relation to the rim.
Bolt circle is the diameter of a circle that can be drawn through the center of each lug hole or stud. The bolt circle is sometimes referred to as PCD for pitch circle diameter.

Measuring the bolt circle on a five-lug wheel is difficult, but a quick and easy way includes measuring as shown to determine the approximate bolt circle of a five-lug wheel.

Measure center-to-center distance and compare the distance to the figures in the chart in the text to determine the diameter for a five-lug bolt circle.
FREQUENTLY ASKED QUESTION

What Does This Mark in a Wheel Mean?
The symbol JWL, for the Japan Wheel Light Metal Standard Mark, means that the wheel meets the technical standards for passenger-car light-alloy wheels. See the mark in Figure 109–31.
The manufacturer is responsible for conducting the inspections set forth in the technical standard, and the JWL mark is displayed on those products that pass the inspection.

Figure 109–31 A typical JWL symbol for the Japan Wheel Light Metal standard mark.

Figure 109–32 (a) A rubber snap-in style tire valve assembly. (b) A metal clamp-on style tire valve assembly used on high-pressure (over 60 PSI) tire applications such as are found on many trucks, buses, and trailers. The internal Schrader valve threads into the valve itself and can be replaced individually, but most experts recommend replacing the entire valve assembly every time the tires are replaced to help prevent air loss.
Figure 109-33 Various styles of lug nuts.

TIRE INSPECTION 1 Check the tire information placard, usually located on the driver’s door or door jamb, for the specified tire size and inflation pressure.

TIRE INSPECTION 2 Visually check the tires for abnormal wear or damage.
TIRE INSPECTION 3
Remove the tire valve cap and visually check the condition of the valve stem.

TIRE INSPECTION 4
Check inflation pressure by pushing the tire pressure gauge straight onto the end of the tire valve. If a "hissing" sound is heard, then the reading will not be accurate.

TIRE INSPECTION 5
Read the pressure and compare to specifications. Use an analog or digital gauge if possible which have been proven to be more accurate than a mechanical pencil-type gauge.
A typical tire tread depth gauge.

The blade of the tire tread depth gauge is pushed down into the groove of the tire at the lowest part.

Remove the gauge from the tire and read the tread depth at the metal housing. Tread depth is usually measured in 1/32nds of an inch.
If the tip of Lincoln’s head is visible, then the tread depth is lower than 2/32 in., the legal limit in many states.