TMC Recommended Practice

RP 656A

VMRS 018

HUB AND SPOKE WHEEL FASTENER MAINTENANCE

PREFACE

The following Recommended Practice is subject to the Disclaimer at the front of TMC's *Recommended Maintenance Practices Manual*. Users are urged to read the Disclaimer before considering adoption of any portion of this Recommended Practice.

PURPOSE AND SCOPE

The purpose of this Recommended Practice (RP) is to provide maintenance guidelines for hub and spoke wheel fasteners for driven and non-driven wheel ends used on Class 6, 7, and 8 commercial vehicles. For information on wheel and/or rim attachment nuts, see TMC RP 222C, *User's Guide to Wheels and Rims.*

INTRODUCTION

Wheel-end fasteners have a finite service life and ~~are often~~ replaced due to wear, damage, excessive corrosion, or failure. ~~There are no industry standards~~ or guidelines for wheel bolt service life since service life will vary by application, duty cycle, geographic location, and maintenance practices. When servicing wheel-end fasteners, technicians should use proper equipment in good working condition such as a calibrated torque wrench and heavy-duty sockets designed for elevated torque settings.

Figure 1

BASIC FASTENER MAINTENANCE

Most fastener problems can be avoided by using a few simple instruments during each wheel end service interval such as a wire brush, an oil dropper, and a calibrated torque wrench. (See **Figures 1-4**.)

Figure 2

Technicians should clean used fasteners prior to installation with a wire brush to remove any existing surface corrosion or debris.

Figure 3

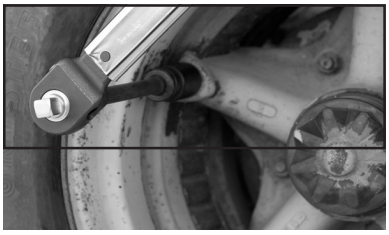

Figure 4

For internal threads, a stiff bristle pipe cleaner can be used to remove corrosion or debris. Before reassembly, all threads should be free of surface corrosion, debris, and paint. Never use paint on fastener threads. Paint decreases a fastener's ability to maintain clamp load and can cause loss of tension over time. For hub piloted wheel systems, apply two drops of SAE 30W oil to the leading threads to prevent future corrosion issues.

NOTE: Do not lubricate stud-piloted wheel mounting systems, or cast spoke wheel studs.

⚠ **WARNING**: Do not apply anti-seize compound to threads during maintenance. Many of these compounds are constructed of inconsistent material that could significantly alter the designed torque-tension relationship between the mating fasteners.

Proper installation torque is critical for optimum fastener performance. All fasteners have a designed installation torque. Technicians should contact the vehicle manufacturer or wheel-end supplier for recommended torque values for specific fasteners. For wheel and rim fasteners, follow the recommended installation procedures outlined in TMC RP 222C. Always verify fastener installation by using a calibrated torque wrench.

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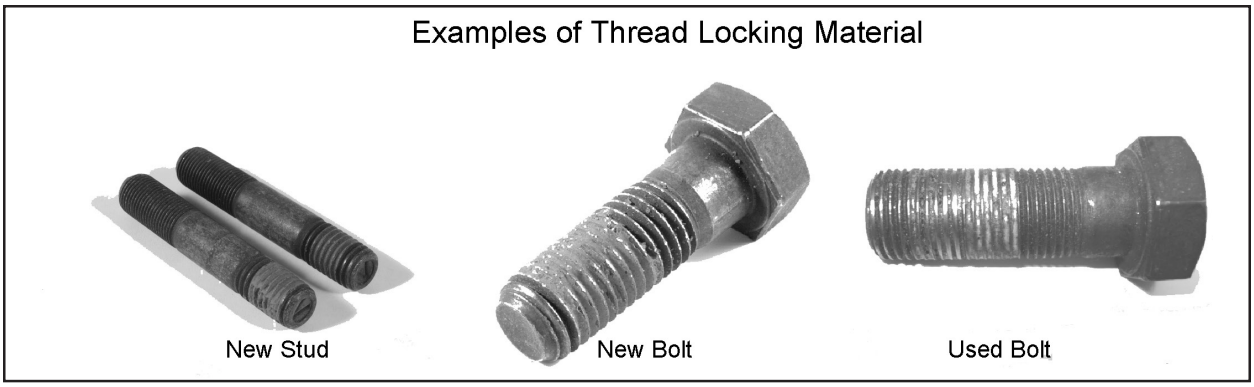


Figure 5

Thread locking materials are often added to the threads of original fasteners used in blind holes for supplemental fastener retention. (See **Figure 5**.) When removing these fasteners, this material will leave a residue between the threads that can easily be removed via wire brush. Thoroughly clean tapped holes with a pipe brush to remove any residual locking material or corrosion inside the t apped holes. Before reinstalling the fastener, apply a new coating of locking material.

NOTE: Locking materials may be temperature sensitive. Contact the vehicle manufacturer for proper material use.

Criteria For Fastener Replacement

Replace any fastener that is bent, broken, damaged, worn, necked, stripped or severely corroded. (See **Figure 6**.) When replacing a broken fastener, also replace both adjacent fasteners. If more than one fastener has failed ~~on a single mounting system~~, replace all fasteners on that bolt circle.

Threaded fasteners should mate without requiring excessive force. Often, new fasteners cannot be easily assembled by hand because of minor burrs remaining from the original manufacturing process. These burrs are normally removed after the first use of the fastener. Assembled fasteners should not exhibit a significant amount of play or slop. Any fastener exhibiting significant play should be replaced. Minor thread damage may be repaired by re-chasing the threads with a thread die ~~or thread file~~; however, TMC does not recommend repairing fasteners with significant thread damage.

Surface corrosion is common on most wheel-end fastener threads. If the corrosion has caused material

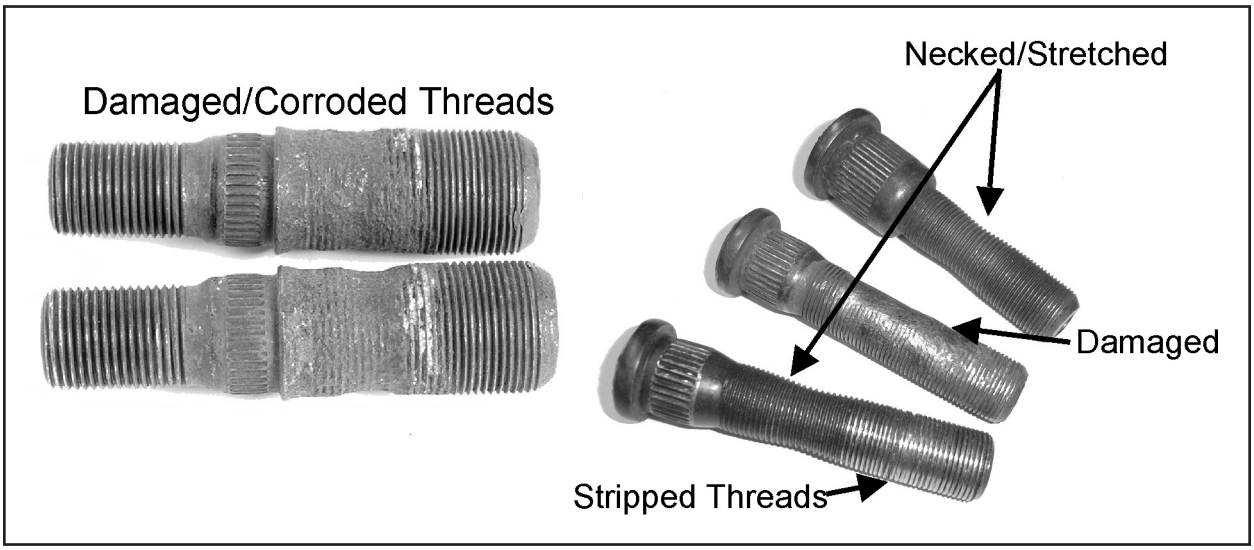


Figure 6

pitting or flaking, the fastener should be replaced. When replacing original equipment fasteners, ensure all critical dimensions match the original fastener.

There are a wide variety of fasteners available for today's wheel ends. Many fasteners may appear identical but have subtle differences that may significantly affect performance. Small changes in overall length may have a large impact on application. There are several thread sizes that may appear identical, but are not. For example, an M20 metric thread size visually compares to a 3/4" English thread size. Ensure the thread pitch (threads per inch) matches the original part. There are several thread sizes available in fine threads versus coarse threads.

NOTE: Many fasteners look alike but may have critical differences in mechanical strength. Technicians should ensure replacement fasteners meet the same specifications as the original fasteners being replaced.

HUBS: WHEEL BOLTS

Wheel Bolts—Identification

~~Periodically, wheel studs may require replacement due to wear, breakage, corrosion or damage~~. When replacing wheel studs, ensure the replacement wheel stud is equivalent to the original wheel stud being removed. There are four important areas of consideration when replacing wheel studs:

1. **Wheel Stud Standout**—Ensure the overall length of the replacement wheel stud matches the length of the wheel stud being replaced. Wheel stud lengths are specifically designed to suit varying disc wheel mounting systems, brake drum mounting face thicknesses, and disc wheel material types. Failure to use the correct length may lead to insufficient clamp load of the disc wheels. If you have insufficient threads for adequate thread engagement, verify the correct stud length with your hub manufacturer.
2. **Wheel Stud Grade**—Replacement wheel studs should be the equivalent material grade as the original wheel studs. Class 6,7, and 8 truck and trailer wheel studs are manufactured to various grades. The grade indicates the fastener's base material, strength properties and performance capabilities.

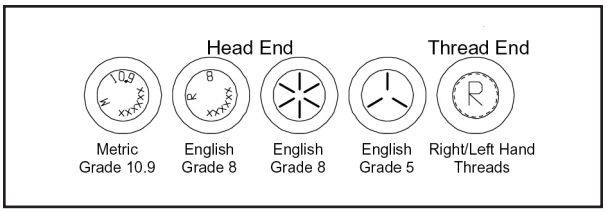


Figure 7

Most wheel studs will have a marking on the head of the stud indicating the material grade. Additional markings such as part number and manufacturer I.D. can be located on the head of the wheel stud. (~~See **Figure 7**.~~)

3. **Wheel Stud Fit**—Wheel studs are designed with a specific press-fit into the flange of the hub to prevent the wheel stud from rotational movement during the disc wheel installation or removal process. Measure the body/shank-diameter, length and serration diameter. The head style of fastener must be match the original application. Make sure the replacement wheel stud matches the original fastener to maintain the designed press fit into the hub and clearance to the disc wheel and/or brake drum (see **Figure 9**).
4. **Thread Size**—Ensure the wheel stud thread size matches the original wheel stud thread size and thread direction. Most English threads have left-hand or right-hand threads. Most metric threads are right-hand threads. Take care not to mix thread sizes as some thread sizes may appear the same (e.g., 3/4" English vs. M20 metric threads).

Hubs with inboard mount brake drums usually have a double-ended shoulder bolt as illustrated in **Figure 8.** These bolts have a thin shoulder that is designed to fit into a recessed groove in the outboard side of the hub flange while the body of the bolt is press-fit

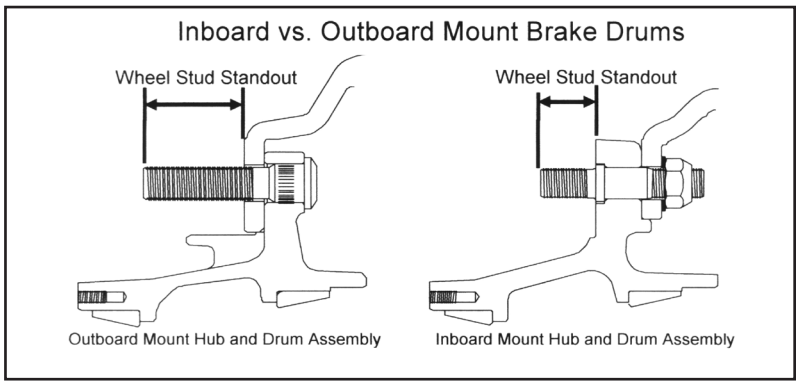


Figure 8

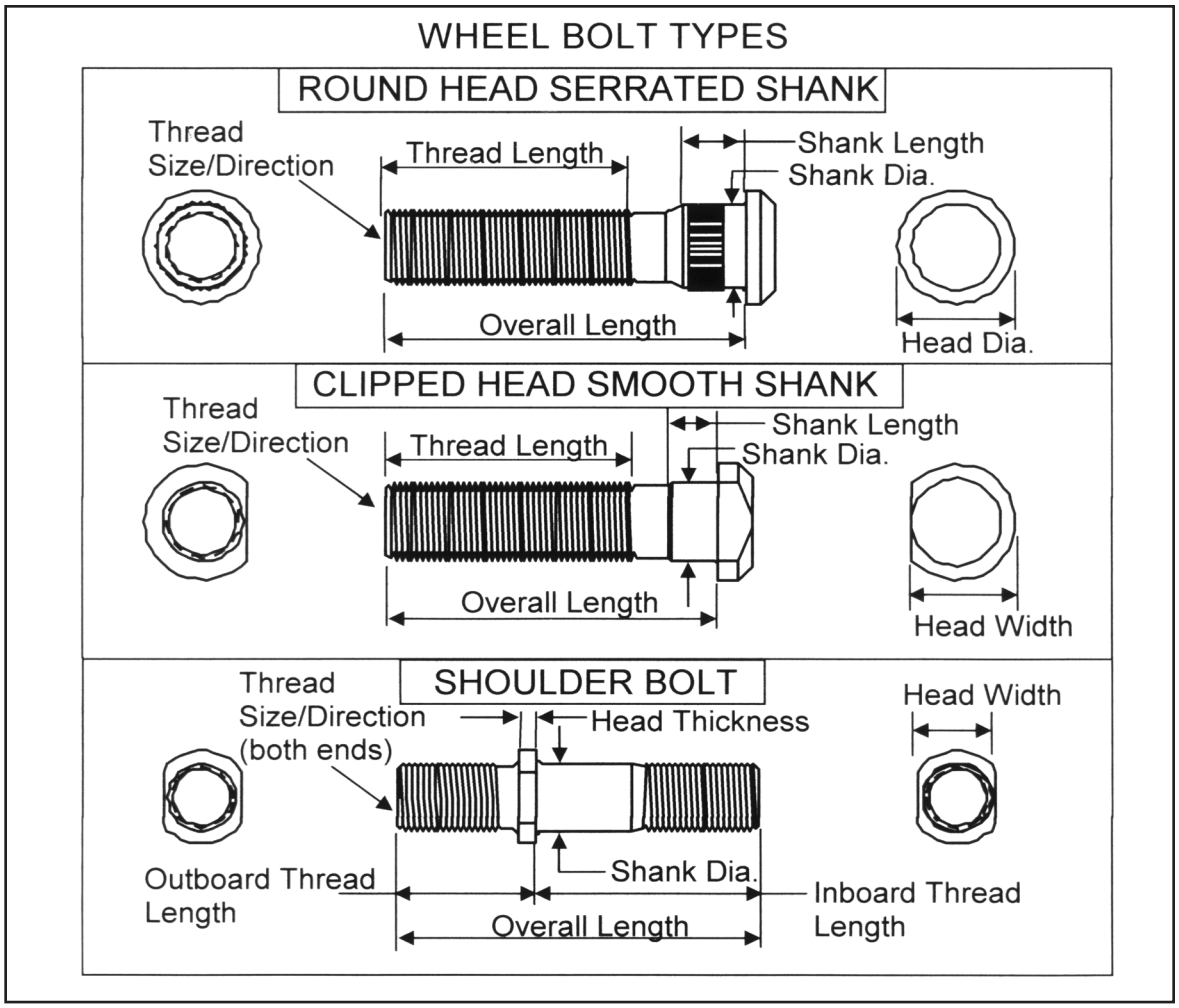


Figure 9

into the hub's bolt holes. The brake drum is secured to the hub using either a locknut/washer combination or a hex nut and lockwasher combination.

There are three basic types of wheel bolts commonly used in Class 6-8 commercial hubs (see **Figure 9)**:

- Round head serrated shank.
- Clipped head smooth shank.
- Shoulder bolts.

It is important to note these three designs are not interchangeable. It is extremely important that key features are maintained when replacing wheel bolts to maintain the integrity of the bolted joint.

Wheel Bolts—Removal/Installation

NOTE: Always use proper safety equipment when servicing wheel bolts.

a. **Outboard Mount Hubs**

NOTE: The use of hammers to remove/install wheel bolts is not recommended.

Replace wheel bolts in outboard mount hubs with the hub removed from the axle to prevent damaging wheel-end assembly components. Once the hub is removed from the axle, use a press to remove/replace the wheel bolts. Support the hub flange evenly around and adjacent to the wheel stud being serviced to avoid ~~bending~~ in the flange area. Avoid damage to the antilock braking system (ABS) ring, seal bore diameter, and hub flange during the replacement process.

Specialty tools are commercially available that are designed for servicing wheel bolts and may also allow the wheel bolts to be serviced on the axle. (See **Figure**

10.) When using specialty tools, exercise caution not to damage either side of the hub flange face.

Figure 10

Before reinstalling wheel bolts, thoroughly clean wheel bolt hole on hub to remove any foreign material. Inspect the bolt hole for any damage that may affect the press-fit between the hole and the wheel stud. After wheel bolts have been reinstalled, a feeler gage should be used under the head of the bolt to ensure the wheel bolts are fully seated. A maximum of 0.002" of gap is normally allowed. (See **Figure 11**.)

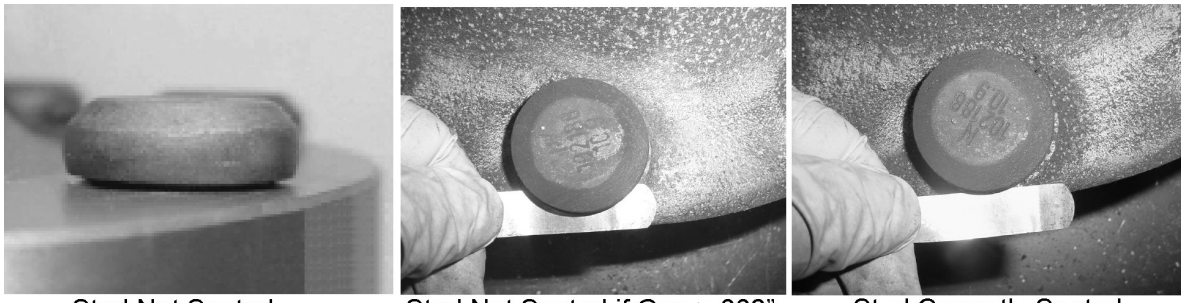
b. Inboard Mount Hubs

NOTE: To remove shoulder bolts, the entire wheel end assembly must first be removed from the axle.

The hub assembly should be placed outboard side down on a clean flat surface to give access to the brake drum mounting hardware. While the hub is in this position, care must be exercised to prevent damage to the hub. Once the brake drum hardware has been removed, the brake drum can be disassembled from the hub.

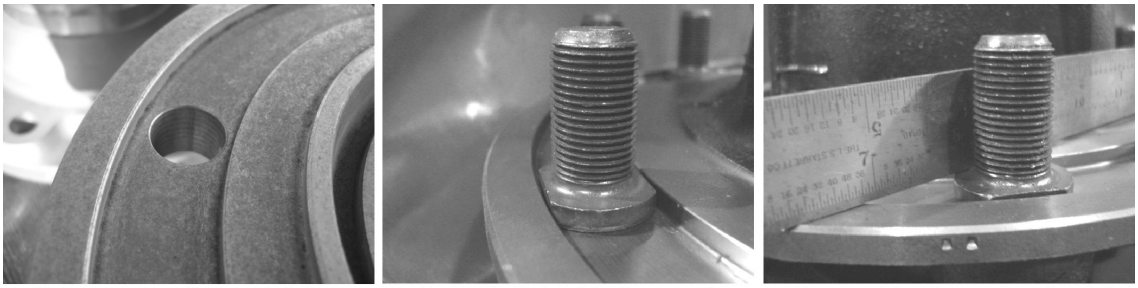
Once the brake drum is removed from the hub, the shoulder bolts can be serviced by using a press. The hub flange should be supported evenly around and adjacent to the shoulder bolt being serviced to avoid bending in the flange area. Specialty tools are commercially available that are designed for servicing wheel bolts; however, inboard mount hubs must always be removed from the axle to service the shoulder studs. When using specialty tools, exercise caution not to damage either side of the hub flange face.

Prior to shoulder bolt reinstallation, remove any debris, corrosion or burrs that may exist in the clipped head channel groove of the hub. Once the new shoulder bolt has been installed, a straight edge should be used to ensure the bolt is correctly seated and the shoulder of the wheel bolt is flush, or recessed below, the outboard flange surface. (See **Figure 12**.)



Stud Not Seated | Stud Not Seated if Gap >.002" | Stud Correctly Seated

Figure 11



Clean groove area thoroughly before installing replacement shoulder studs | Ensure bolt shoulder is properly aligned in hub groove | Use a straight edge to ensure head of stud does not protrude past hub flange

Figure 12

TABLE 1: Torque Values for Brake Drum Mounting Hardware: Hubs and Spoke Wheels					
Thread Size	Rotate	Torque Required - Foot Pounds			
		Phos/Oil Nuts (Black)		Cad/Wax Nuts (Silver)	
		MIN.	MAX.	MIN.	MAX.
5/8”-18 (Tapped Holes)	Rotate Bolt	150	200	—	—-
5/8”-18 (Thru Holes)	Rotate Nut	150	175	95	130
3/4”-10	Rotate Nut	250	275	—	—-
3/4”-16 (Spoke Wheels)	Rotate Nut	275	325	200	250
3/4”-16 (Disc Wheel Hubs)	Rotate Nut	100	225	40	55
1”-14	Rotate Nut	175	225	—	—-
NOTE: Torque values shown are guidelines for brake drum hardware only — not tire/rim attaching nuts. Consult original manufacturer guidelines for any special hardware.					

When replacing brake drum hardware, it is very important to ensure the proper replacement components are used. Never replace a locknut with a standard hex nut and never replace a hardened washer with a standard un-hardened washer. The use of substandard replacement components may lead to a loose brake drum and/or disc wheels.

HUBS: DRIVE STUD HARDWARE

Drive Stud Hardware—Identification

The three common types of fasteners used to secure the drive axle shaft are shown in **Figure 13**. All three systems have variations in fastener type, thread size, and fastener length. Take care to

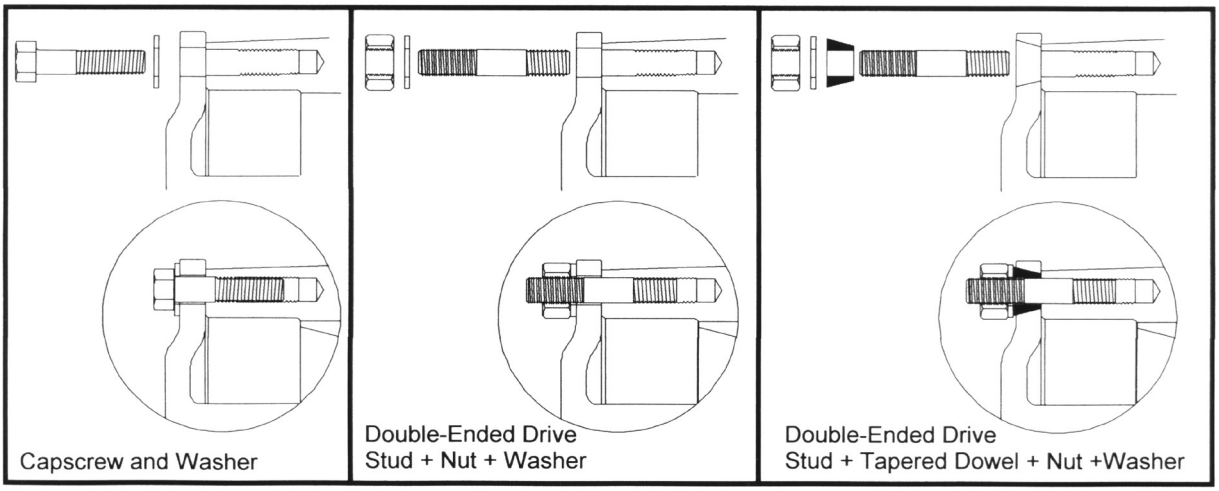


Figure 13: Drive Flange Fastener Options

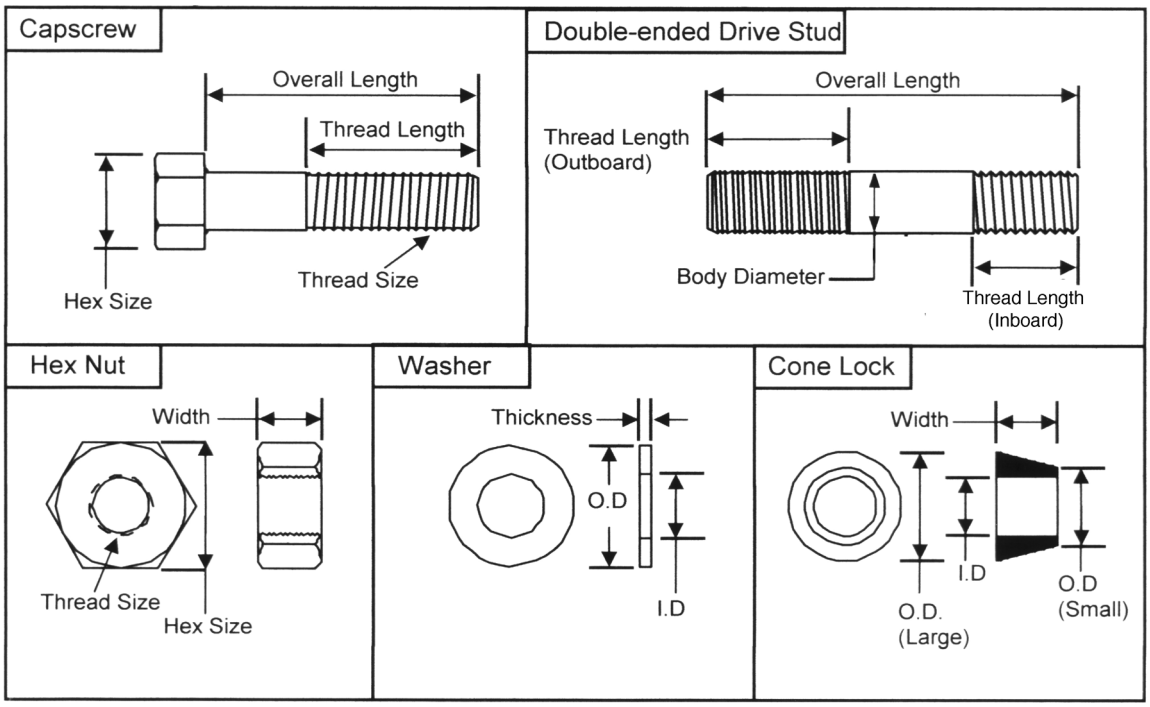


Figure 14: Drive Flange Fastener Key Dimensions

ensure components are not mixed between systems. Key dimensions are illustrated in **Figure 14**.

Drive Stud Hardware—Removal/Installation

Capscrews or nuts should be removed using the correct socket size to prevent rounding of the hex corners. If the nut is frozen to the drive stud, the stud/nut may both back out of the hub during disassembly. For nuts that are frozen to the drive stud, first try to loosen the nut by applying penetrating oil. Do not use any form of heat to loosen frozen fasteners. Exposure to heat may damage fasteners and reduce the strength. When attempting to remove a frozen nut from a drive stud, use a stud puller or vice grips to hold the drive stud in the non-threaded body area. (See **Figure 15**.) Do not use a stud puller or ~~vice grips~~ in the threaded areas. If the nut cannot be removed from the drive stud, both components should be replaced during reassembly. Do not attempt to reinstall a frozen stud/nut assembly.

After the hex nuts have been removed, the axle shaft may be frozen to the hub. Specialty devices known as “axle pullers” are available to assist in axle shaft removal. It is also acceptable to use a brass drift and hammer against the center of the ~~axle shaft~~; however, you should never strike the axle shaft direct to avoid damage to the ~~axle shaft~~ or drive stud fasteners. It is also acceptable to use an impact gun with a blunt nose chisel to loosen the ~~drive~~ shaft from the hub. (See **Figure 16.**)

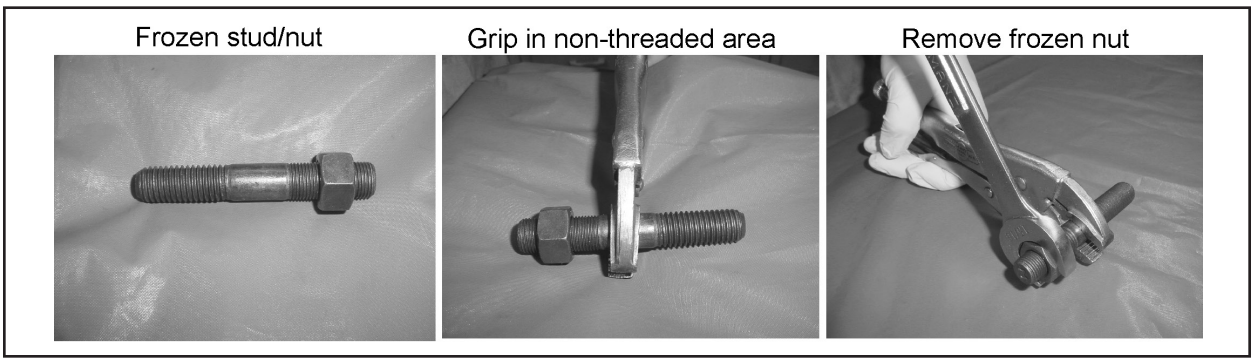


Figure 15

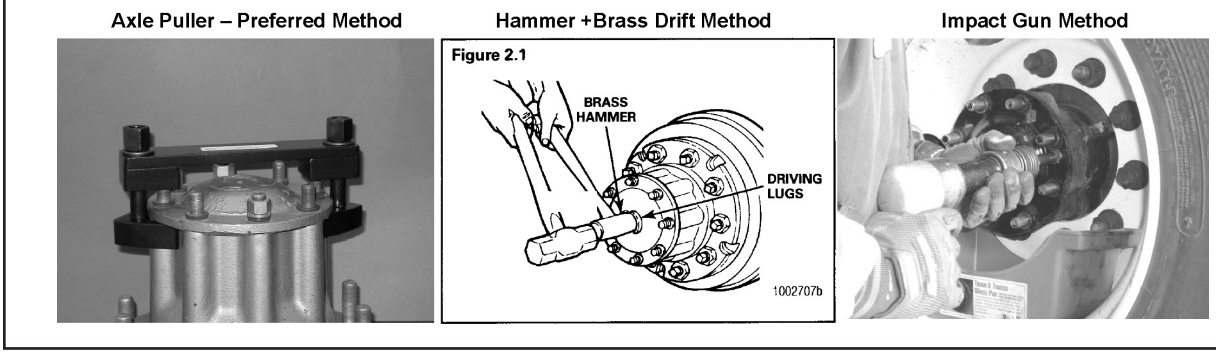


Figure 16

Once the drive shaft has been removed, there are two recommended methods for removing double-ended drive studs from hubs. Under normal conditions, these drive studs have been factory-installed so they cannot be easily removed from the hub. The first method to loosen these drive studs is to use the double jam-nut method. Torque can be applied via open-end wrench to the inboard nut to loosen the drive stud. (See **Figure 17**.)

The second method involves specialty drive-on devices, pliers, or vise grips that assist in drive stud removal; however, these tools cause permanent damage to the threads and prevent further use of the fastener. (See **Figure 18**.)

To install replacement drive studs, the double jam-nut method is once again recommended. Torque can be applied via open-end wrench to the outboard nut to tighten the drive stud. Although uncommon, specialty threaded sockets are also available to assist in drive stud installation. (See **Figure 19**.) Technicians should consult their wheel end supplier for correct drive stud installation torque. Excessive installation torque may deform the drive stud threads and/or the internal hub threads. It is not a recommended practice to install drive studs by using pliers or vise grips.

When replacing double-ended drive stud fasteners, use caution to ensure the correct thread size is inserted into the hub. Some double-ended drive stud

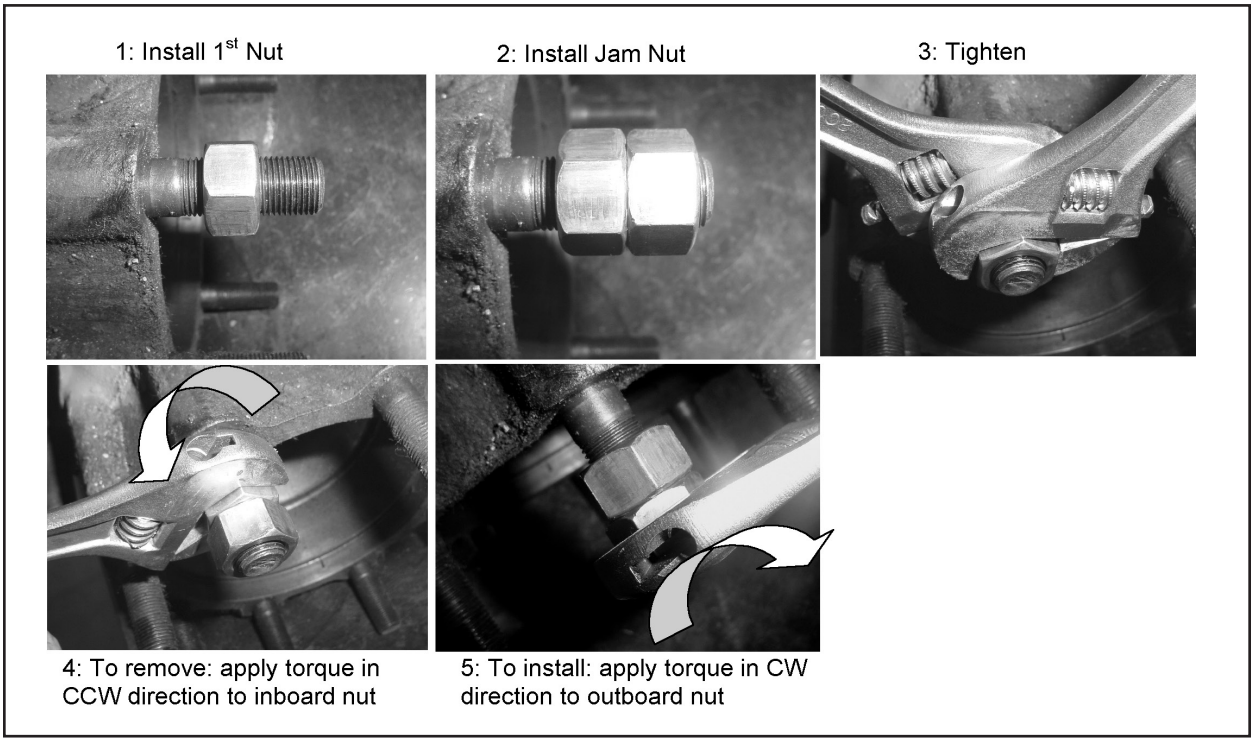


Figure 17: Double-Jam Nut Method for Removal of Externally Threaded Fasteners

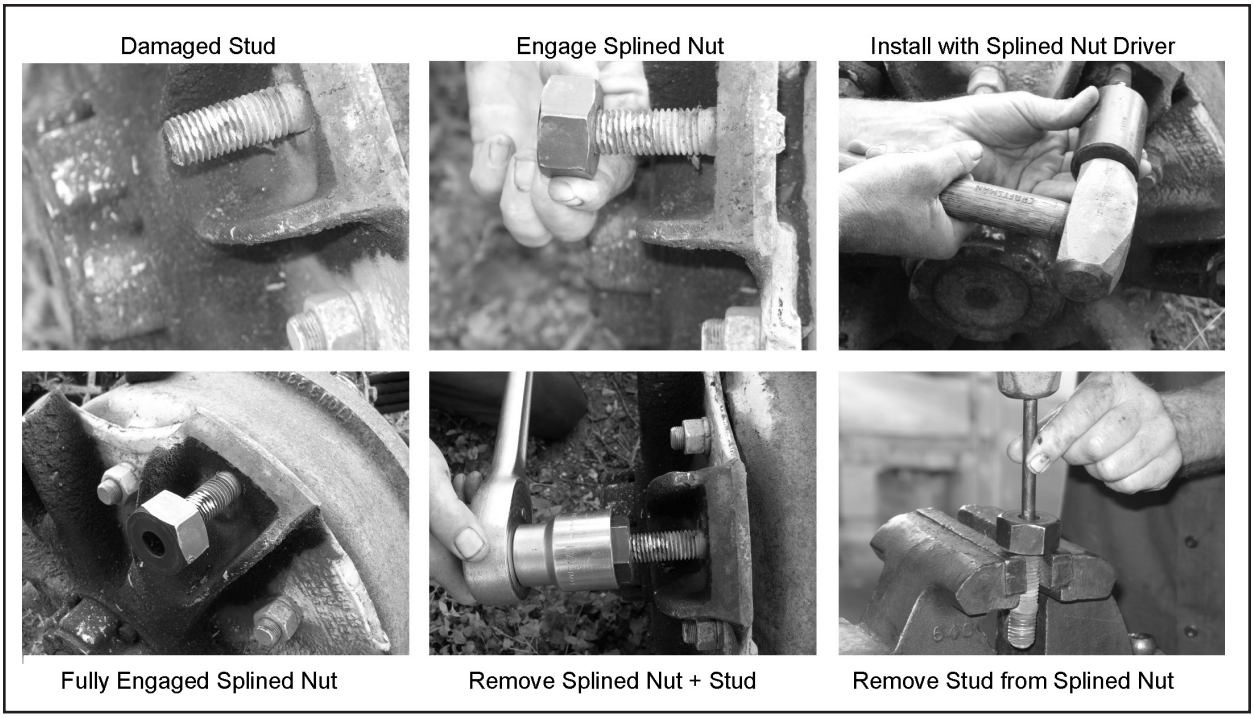


Figure 18

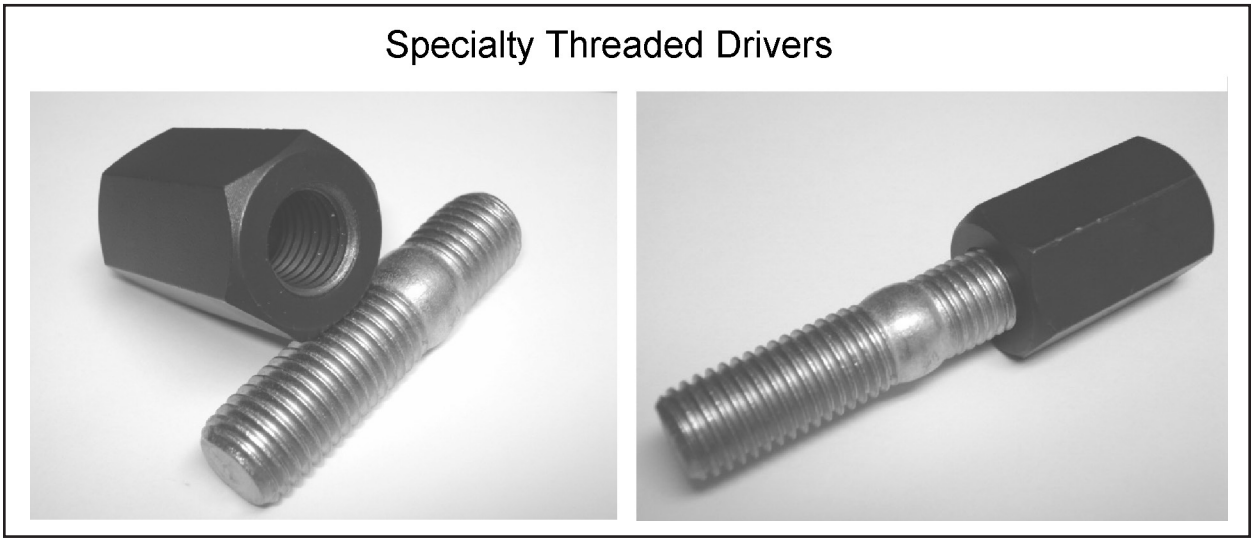


Figure 19

fasteners have similar threads on each end but may differ in thread pitch. During final installation, make sure the ~~drive stud is seated~~ and has the same thread standout as the original fastener. Take note if the drive stud previously had adhesive patch and, if so, clean stud and hole prior to re-installation with properadhesive patch compound.

If drive fasteners have failed or become loose, carefully inspect the drive shaft clearance holes for damage or elongation that may prevent proper operation of the drive shaft. When reinstalling the axle shaft, there should be no binding between the drive studs and the axle shaft ~~clearance~~ holes. Loose fasteners will induce axle flange rotation relative to the hub. This rotation will often cause fastener fatigue failures and damage to the axle shaft by elongating the ~~clearance~~ holes. Ensure the drive stud nuts are tightened ~~to the~~ recommended torque values as shown in **Table 2**.

TABLE 2: Drive Stud Nut Installation Torque Values		
Non-tapered Dowel Applications		
Thread Size	Torque Values - Grade 8 Nuts	
	Plain Nut	Lock Nut
5/8"-18	150-230 ft-lbs	130-190 ft-lbs
3/4"-16	310-400 ft-lbs	270-350 ft-lbs
Tapered Dowel Applications		
Thread Size	Torque Values - Grade 8 Nuts	
	Plain Nut	Lock Nut
7/16"-20	50-75 ft-lbs	40-65 ft-lbs
1/2"-20	75-115 ft-lbs	65-100 ft-lbs
9/16"-18	110-165 ft-lbs	100-145 ft-lbs
5/8"-18	150-230 ft-lbs	130-190 ft-lbs

Most drive stud damage occurs during routine service when the hub is removed from the axle and dropped onto the drive studs. When this occurs, the drive stud threads may be damaged and will require replacement. (See **Figure 20**.)

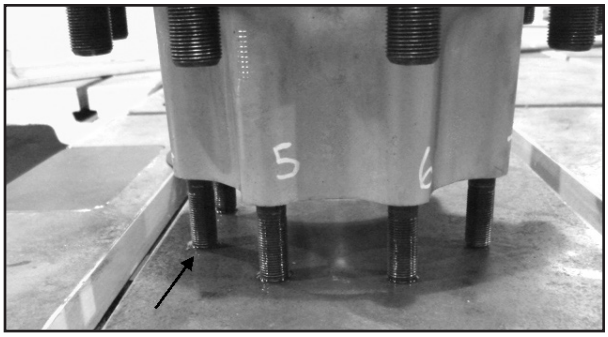


Figure 20

HUBS: ROTOR MOUNTING HARDWARE

Rotor Mounting Hardware – Identification

Figure 21 shows various rotor attachment methods.

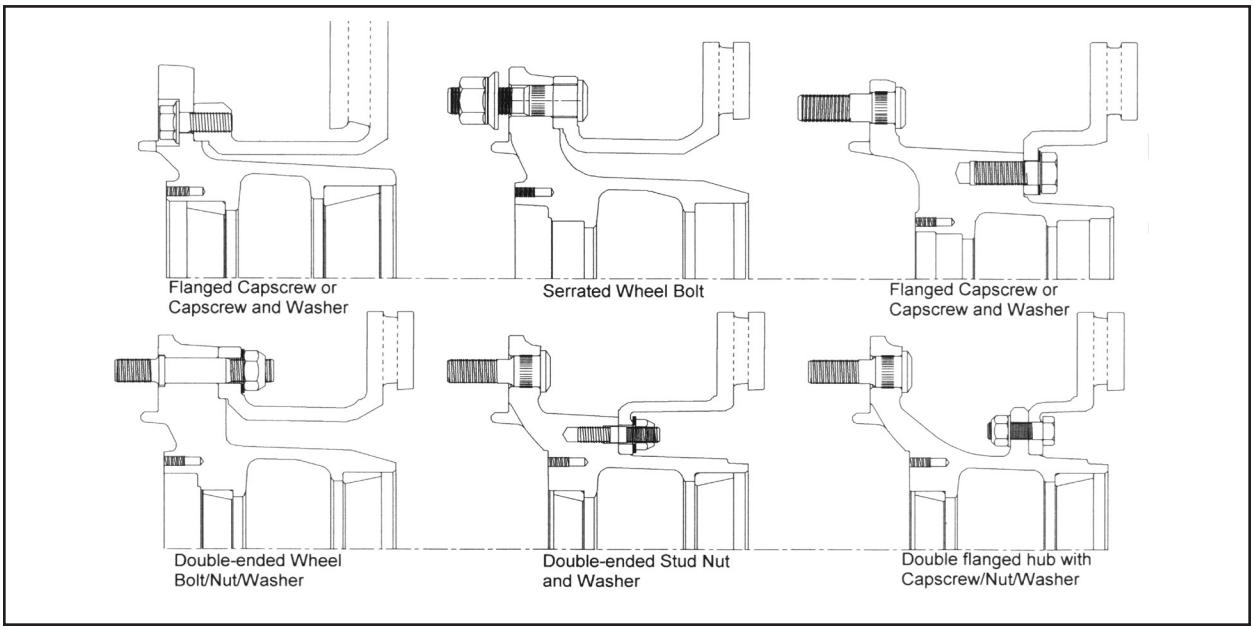


Figure 21: Rotor Mounting Options

Rotor Mounting Hardware—Removal/Installation

NOTE: To service rotor mounting hardware, the entire wheel end assembly must first be removed from the axle.

The hub and rotor assembly should be placed on a clean flat surface to give access to the rotor mounting hardware. While the hub is in this position, care must be exercised to prevent damage to the hub and other fasteners. Capscrews or hexnuts should be removed using the correct socket size to avoid rounding off the corners of the hexes. It may be necessary to remove double-ended studs for a thorough inspection.

There are two recommended methods for removing double-ended studs from hubs. Under normal conditions, these studs have been factory-installed so they cannot be easily removed from the hub. The first method to loosen these studs is to use the double jam-nut method. Torque can be applied via open-end wrench to the inboard nut to loosen the stud. The second method involves specialty drive-on devices that assist in stud removal; however, these tools cause permanent damage to the threads and prevent further use of the fastener. Using pliers or vise grips to remove damaged or severely corroded double ended studs is another alternative but is not recommended to remove working fasteners due to inherent thread damage.

Before reassembly, inspect all fasteners for damage, wear, or excessive corrosion and replace~~/repair~~ as required. Ensure all mating surfaces between the hub and rotor are thoroughly cleaned and free of any form of contamination~~.~~.

To install replacement studs, the double jam-nut method is recommended. Torque can be applied via open-end wrench to the outboard nut to tighten the stud. Consult the wheel end supplier for correct stud installation torque and adhesives.. Excessive installation torque may deform the stud threads and/or the internal hub threads. Although not common, specialty threaded sockets are also available to assist in stud installation.

NOTE: Installing double-ended studs by using pliers or vise grips is ~~not~~ recommended.

Correct capscrew or locknut installation torque is required to ensure proper clamp load. Technicians should consult their vehicle manufacturer or wheel-end supplier for correct installation torque ranges, and any adhesive patches that may be required.

SPOKE WHEELS

Spoke wheel/demountable rim systems use rim clamps to secure rims (which have no center bolting disc) to a cast spoke wheel which may have three, five or six spokes with a 15”, 20”, 22”, or 24” diameter.

The rim clamps, fastened by hex nuts, wedge the rim onto the cast spoke wheel. There are wheel designs with different numbers of rim clamps and various shapes. Each spoke wheel requires rim clamps designed for the specific spoke wheel rim and spacer combination. Dual rims are mounted using a spacer band which holds the two rims apart and provides proper dual spacing for the tires. The cast spoke wheel manufacturer and part number is usually cast into the outboard side of the spokes to aid in identification of proper components. (See **Figures 22-23**.)

Spoke Wheel Hardware—Identification

1. Rim Clamp Identification

There are two styles of spoke wheel rim clamps: those designed for three-spoke wheels and those designed for five-spoke and six-spoke wheels. Most rim clamps have the manufacturer I.D. and part number clearly cast into the part for reference. Some rim clamps may visually appear to be interchangeable; however, they

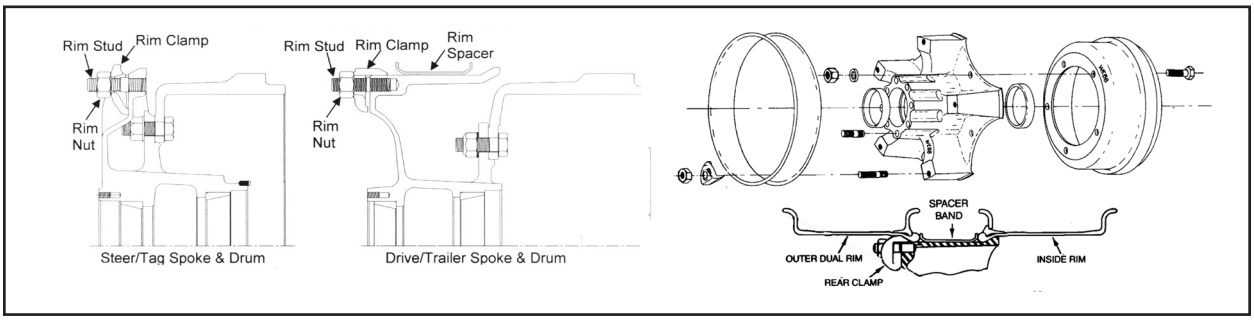


Figure 22: Spoke Wheel Configurations

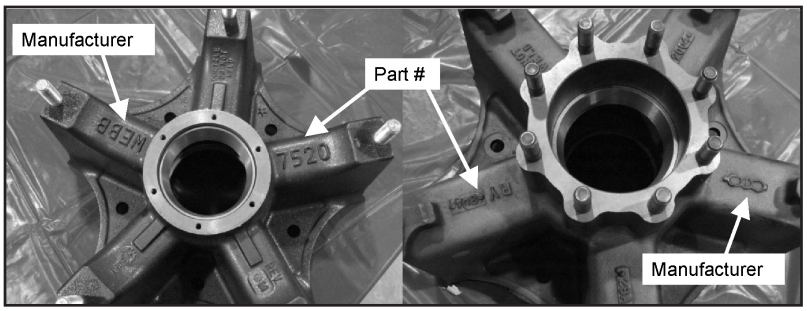


Figure 23: Examples of Spoke Wheel Identification

may have subtle differences in design and function. Technicians should ensure the rim clamp part being installed is the correct component number for the spoke wheel part number, number of spokes, and spoke diameter being serviced. (See **Figure 24**.)

2. Rim Nut Identification

Rim nuts are hex nuts that have a few basic features of thread size, hex size, and overall width. (See **Figure 25**.)

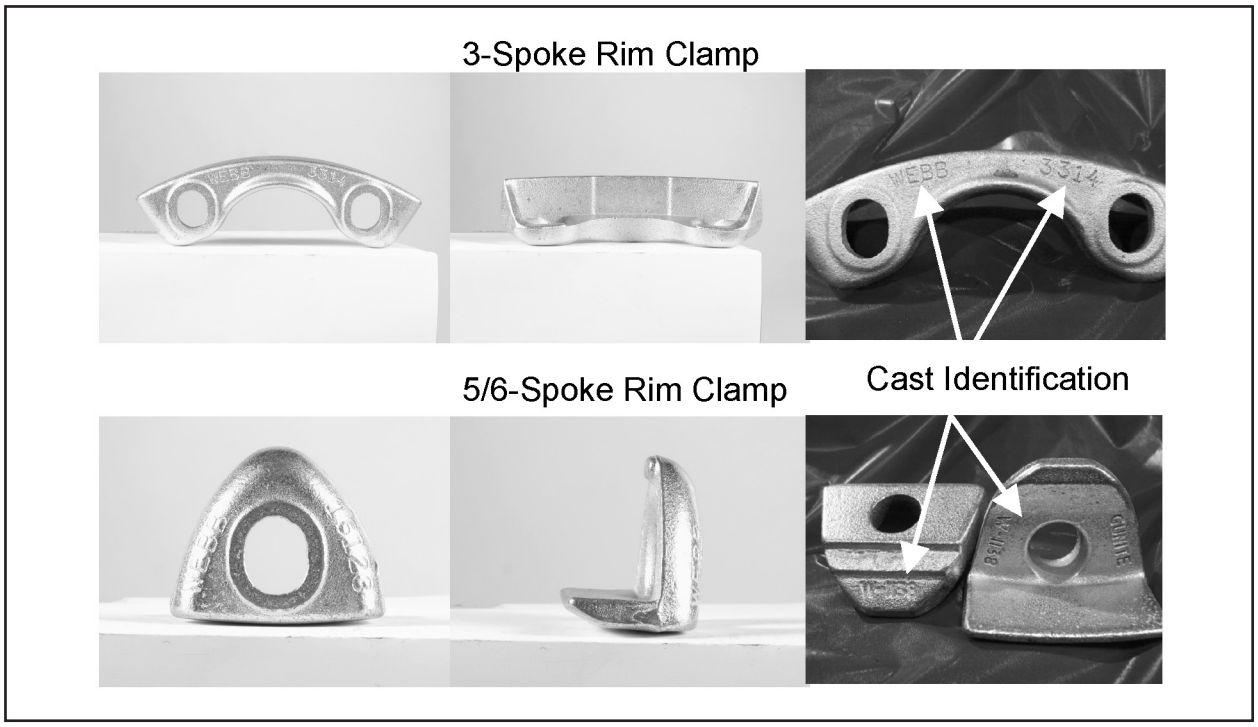


Figure 24

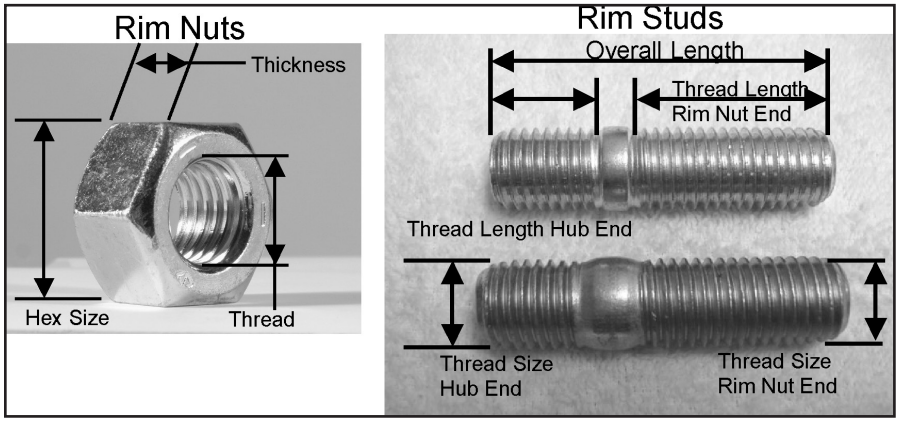


Figure 25

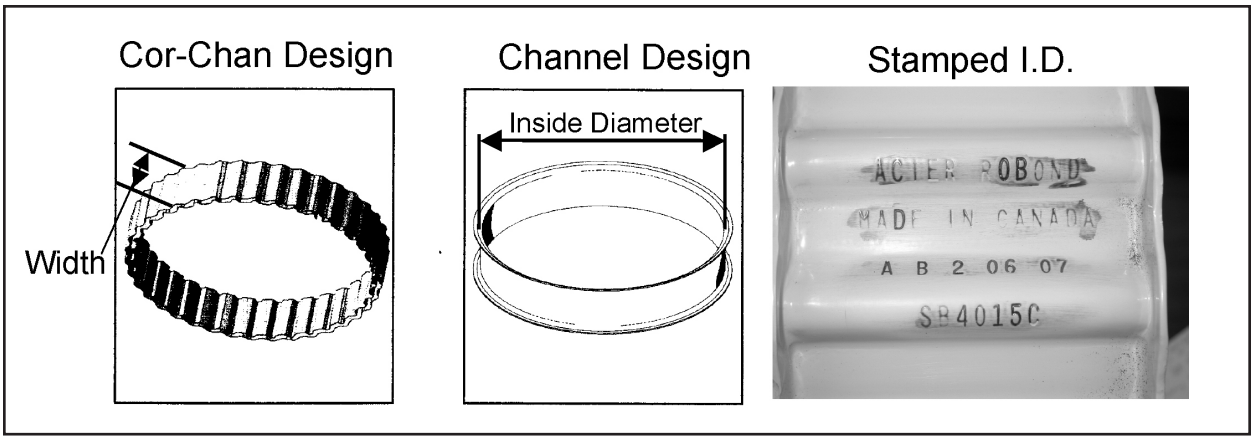


Figure 26

3. Rim Stud Identification
Rim studs have threads on both ends and a pronounced shoulder in-between the threads. The shorter thread length is the inboard side that is threaded into the spoke wheel and the longer thread length is the outboard side where the rim clamp and rim nut are installed.

4. Rim Spacer Identification (Dual Wheels)
Rim spacers have two key features: inside diameter and width and come in two basic design types; Corrugated and Channel design. Most spacers have stamped identification indicating size and manufacturer. (See **Figure 26**.)

Spoke Wheel Hardware—Removal/Installation

WARNING: With the tires completely deflated, loosen the rim nuts without removing them from the cast spoke wheel. Make sure the nuts are fully on the threads before attempting to release stored energy in the rim clamps. Using a rubber mallet or equivalent, hit the inside flange of the outer rim until the stored energy of the clamps between the rim base and cast spoke wheel is released. Failure to do so can result in the entire assembly becoming a projectile striking everything in the trajectory area. The clamps themselves can also become projectiles and cause serious injury.

1. Rim Nuts
When removing rim nuts, ensure the correct socket size is used to avoid rounding off the corners of the hexes. For nuts that are frozen to the rim stud, first try to loosen the nut by applying penetrating oil. Do not use any form of heat to loosen frozen fasteners. Excessive heat may damage the spoke wheel and related components and make them weak. If the rim nut is frozen to the rim stud, the rim stud may back out when torque is applied to the nut. When attempting to remove the rim nut from a loose rim stud, use vice grips to hold the rim stud in the shoulder area between the threads. Do not use vice grips in the threaded areas. If the rim nut cannot be removed from the rim stud, both components should be replaced during reassembly. Inspect rim nuts for signs of wear, thread damage, or excessive corrosion and replace nuts with signs of damage. (See **Figure 27**.)

When reinstalling the rim nuts, ensure all mating threads are clean and free of corrosion or debris. Rim nuts should first be tightened to 50 ft.-lbs. using the torque sequence illustrated below to permit the rims to properly align themselves on the 28° mounting surfaces of the cast spoke wheel. Once the nuts have been tightened to 50 ft-lbs, tighten the nuts to the recommended torque levels listed below. Be sure not to exceed recommended torque values. If the heel of the rear clamps bottom out before reaching 80 percent of recommended torque levels, check to see that proper clamps and spacers are used. (See **Figure 28**.)

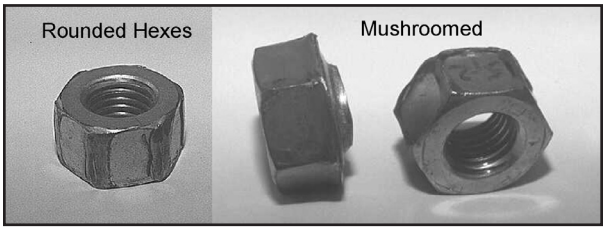
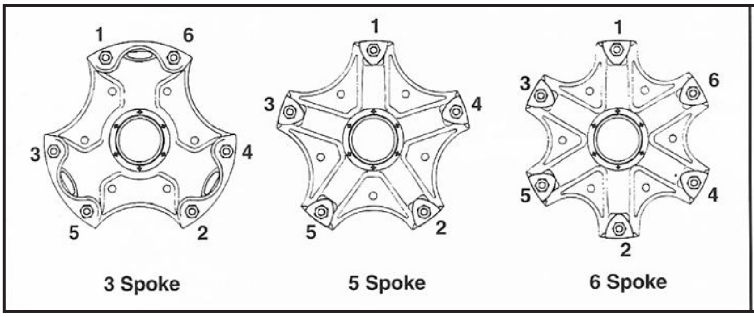


Figure 27



Rim Stud Size	Torque Level Ft-Lbs Dry
5/8"-11	160-200
3/4"-10	200-260

Figure 28

2. Rim Clamps

Once the rim nuts have been removed, the rim clamps can usually be removed by hand by sliding the clamps off the rim studs. If rim clamps are frozen to the spoke wheel and rim, gently tap the rim clamp from the underside using a rubber mallet. Do not use any form of heat to loosen frozen rim clamps. Excessive heat may damage the spoke wheel and related components and make them weak. Carefully inspect the rim clamps upon removal for damage or excessive wear on the 28° wedge surface. Any clamps showing excessive wear on the 28° wedge surface should be replaced. The most common out-of-service condition for rim clamps is wear on the 28° bevel surface. (See **Figure 29**.)

Before reinstalling rim clamps, use a wire brush or emery cloth to remove any corrosion or foreign material on the active 28° mounting surface and the surface where the rim nut force is applied. Do not apply any form of lubricant to any surface of a rim clamp and do not paint any mounting surfaces. For rear clamps, inspect to ensure the leading edge thickness of the 28° mounting surface is no less than 1/16". Any clamps with a thickness less than 1/16" should be replaced.

3. Rim Studs

Before removing rim studs, the stud standout from the face of the spoke wheel should be documented to ensure the replacement fastener has the same

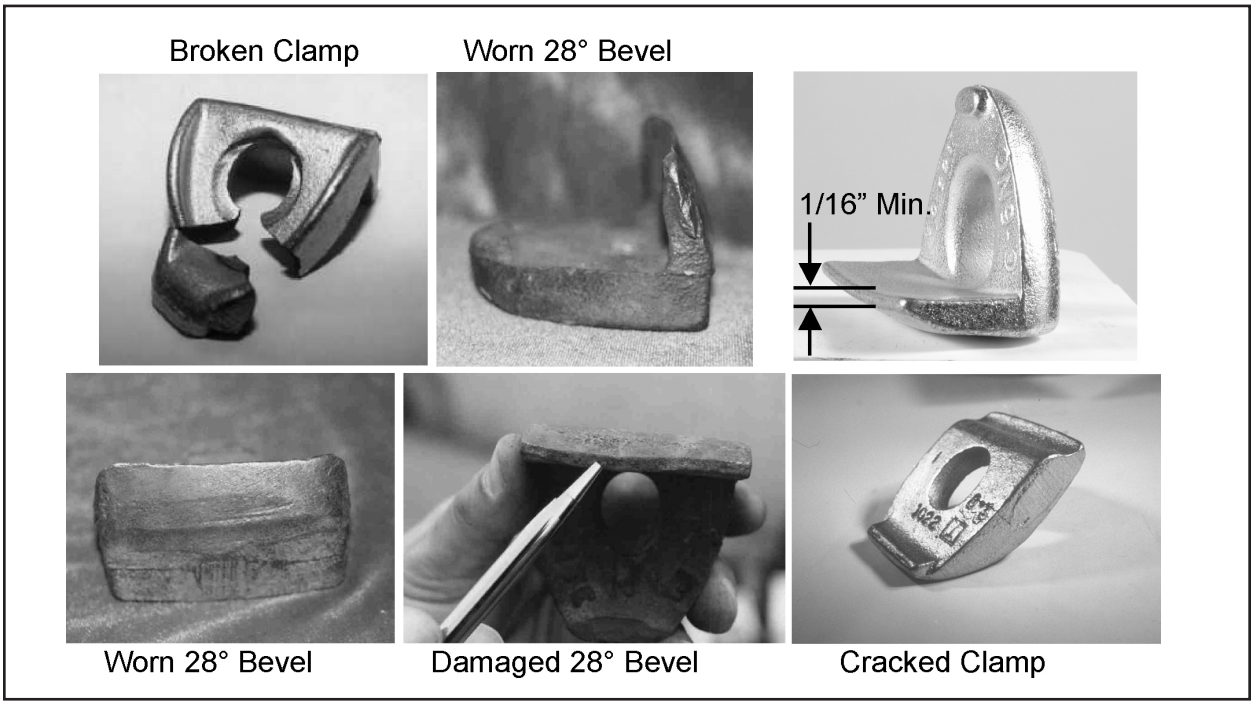


Figure 29

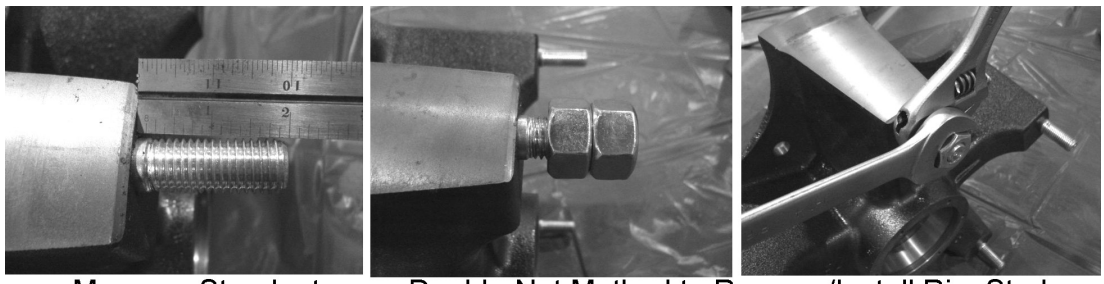


Figure 30

Figure 31

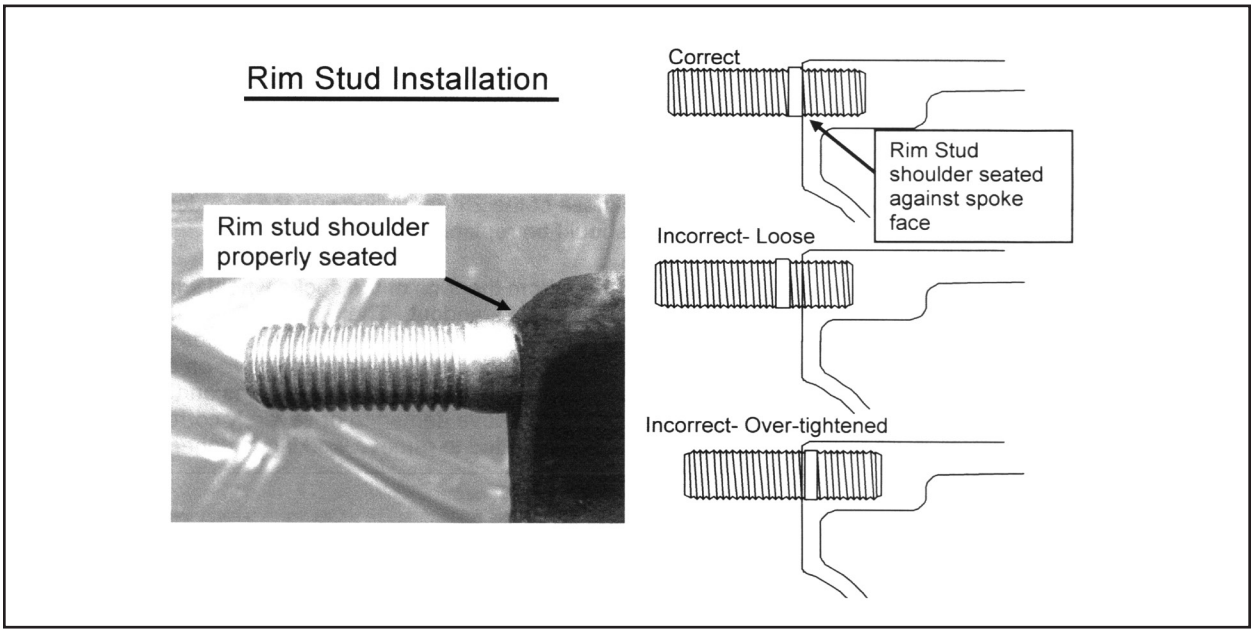


Figure 32

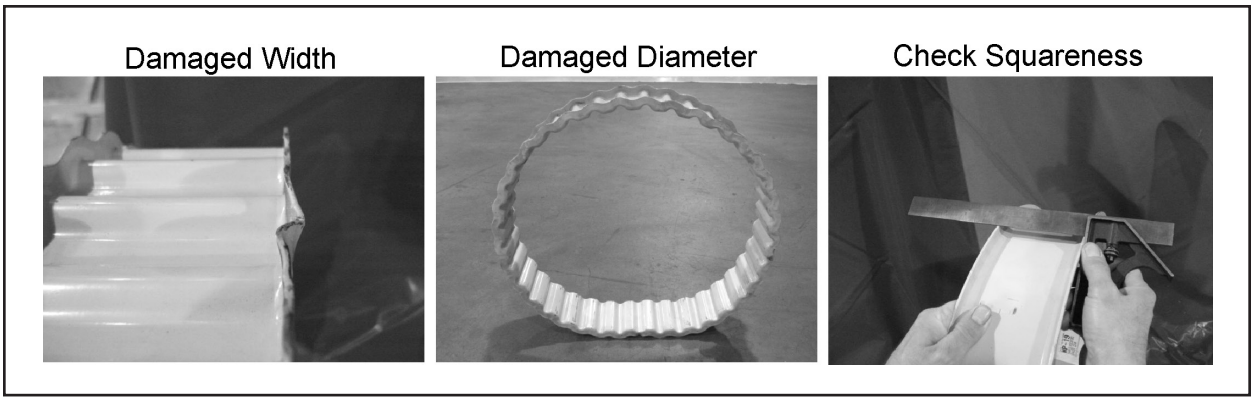


Figure 33

standout. There are two recommended methods for removing double-ended studs from hubs. The first method to loosen these studs is to use the double jam-nut method (see **Figure 30**). The second method involves specialty drive-on devices that assist in stud removal; however, these tools cause permanent damage to the threads and prevent further use of the fastener. The use of pliers or vise grips to remove damaged or severely corroded double ended studs is another alternative but is not recommended to remove working fasteners due to inherent thread damage. (See **Figure 31**.)

Before reinstalling rim studs, thoroughly clean all threaded areas with a wire brush to remove any corrosion or foreign material. Specialty drivers are available for rim stud installation; however, the double-nut method is also recommended for rim stud installation. It is not a recommended practice to use vise grips to install rim studs due to inherent damage caused to the threaded areas. Ensure rim studs are properly seated as illustrated in **Figure 32**.

4. Rim Spacers

Replace any rim spacer with obvious visual damage to the diameter and/or the width.. Before reinstalling rim spacers, use a combination square to check the width in several radial locations to ensure the spacer is not reduced in width or "crushed". An easy method to check a rim spacer for roundness is to check the inside diameter in several locations using a simple tape measure. Do not attempt to bend or push a spacer back into the original shape. Visually inspect welded joints for cracks. (See **Figure 33**.)

REFERENCES

- RP 222C, *User's Guide to Wheels and Rims.*
- RP 608B, *Brake Drums and Rotors.*
- RP 237B, *Retorqing Guidelines for Disc Wheels.*