IT'S TIME TO TORQUE

By Pete Bilotta

This is the torque police! Put down that impact gun and step away from the car until you get a torque wrench to do the job right!

I know what you're thinking. Who has the time to torque engine fasteners-much less wheel lugs? I'll be the first to admit that my air tools saw a lot more daylight than my torque wrench when I was working flat rate. However, it takes only one leaking head gasket or warped brake rotor to convince you that your torque wrench is more than toolbox filler. The fact is, no matter what the size or strength of the fastener you're using, its performance depends on the way it's tightened.

They're not indestructible

Before you can appreciate the importance of using a torque wrench, you must first realize that any bolt will stretch regardless of its grade or degree of heat treatment. However, as long as the applied tension load on the bolt does not exceed its yield diameter shrinks, reducing its tensile strength. Once the tensile strength of the bolt is exceeded, failure is imminent.

When a connection is properly tightened, it means that the clamping force of the fastener is equal to or greater than the maximum operating load, which the assembly will be subjected to. Under this condition, the bolt cannot fail from fatigue because it's not going to experience any change in stress, regardless of the operating load variables. It can't fail from constant static loads (assembly at rest), because once the bolt is torqued correctly, it is already prepared to support peak load conditions.

Consider the life of a cylinder head bolt. The combination of combustion pressure and thermal expansion in the head and block castings creates a tremendous amount of pressure on the bolt. If the bolt is over-tightened, its yield point will be exceeded before the engine is ever started. When the engine begins to run the head bolt will stretch even further as a result of the pressure and thermal loads. Once the bolt is permanently stretched, its clamping force will be reduced as the engine cools and the castings contract. Unfortunately, the head gasket may not be able to recover enough to maintain the sealing load between the head and block. Eventually, the head gasket will begin to leak, and probably get blamed for the failure as well. Gaskets aren't designed to compensate for installation error, which is why proper tightening procedures are so critical.

Torque to yield

The TTY (torque-to-yield) procedure of bolt tightening provides a more uniform clamping force across the sealing surface than the conventional torque method. After tightening each bolt to the proper torque specification, another pass is made rotating each fastener a specific number of degrees. This extra rotation takes the bolt to its yield point and allows each bolt to apply almost the exact same clamping force. The TTY method is very effective, however, it does permanently stretch the bolt. It is an established fact that when any steel is stretched .2 percent of its original length (yield point), permanent set will occur. Because of this, it is always best to replace TTY bolts, even though some manufacturers say these bolts can be reused.

The easiest way to determine if a bolt has been stretched too far is to visually inspect it for thinning or being "necked out." Some technicians will take a new nut and thread it along see if it hangs up on the threads. However, as Bill McKnight, training manager of Dana's Victor-Reintz Gaskets Div., cautions, "Some fasteners are yielded and yet show no visible signs or indications. For instance, a nut can be run up and down the threads of some yielded bolts."

The right turn

Even when the correct torque procedure is followed, a fastener can fail if it is not repaired properly. This is why it is so important that the threads be cleaned thoroughly and lubricated before installation. The torque applied to a fastener is absorbed in three places: approximately 45 percent is lost in thread friction, about 45 percent is lost in under-head friction, and the leftover 10 percent is used to develop clamping force. Installing "dirty" or "dry"

bolts will cause friction levels to increase substantially, invalidating the torque reading. This will result in less applied twist being the entire available for clamping force, and cause low loading on the joint. Lightly oiling the threads and the underside of the bolt head will ensure that faction levels stay as close to normal as possible. Remember that all torque values, unless specified otherwise, are for clean, lubricated threads. The standard lubricant for fasteners in automotive engines is 30-W motor oil. When thread sealant or anti-seize compound is called for, they will act as the proper thread lubricant. Don't use any super slippery, space-age lubricants on the bolt threads.

This practice will reduce rotational friction as the bolt is installed, resulting in an over-tightened joint and even a yielded bolt. Jerry Rosenquist, manager of specialty products engineering at FelPro Inc., warns not to over-oil a bolt, especially in a blind hole. Too much oil can collect at the bottom of the hole and the resultant hydraulic pressure will prevent the bolt from seating properly.

If you can't remember the last time that your torque wrench was calibrated, you should have it done as soon as possible. By the way, your impact gun will probably last a lot longer, now that you're ready to torque!

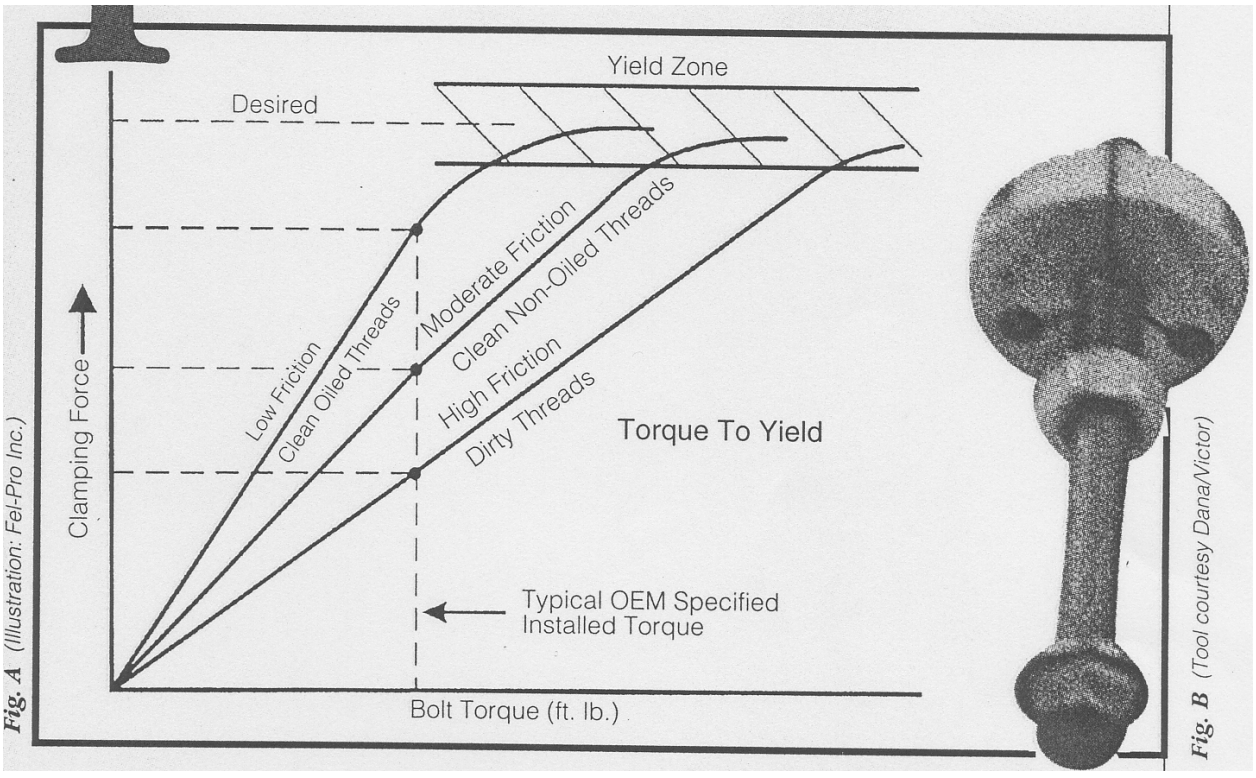

Fig A. Although the torque-to-yield procedure provide a more uniform clamping force, it permanently stretches the bolt. Reusing stretched bolts can lead to sealing (gasket) problems, which is why using recommended TTY bolts is highly-recommended.

Fig B. This photo illustrations why checking for yielder bolts by running a nut up and down the threads is unreliable. Notice that the nut is at the top of the threads, but the ring gauge (special fastener checking tool) stops halfway down the bolt shaft, indicating the bolt is yielded (stretched) beyond acceptable usage limits.