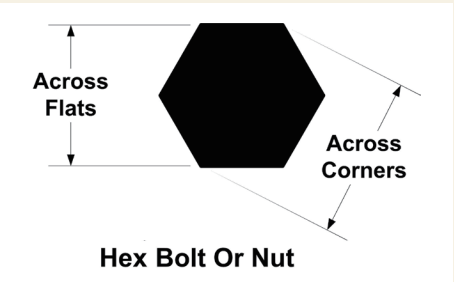
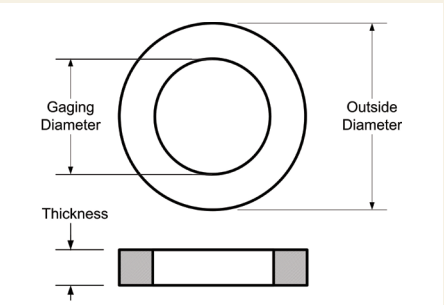
by Larry Borowski

# Wrench Height Gaging for Hex, Hex Washer, and Hex Flange Head Fasteners




**Hex Bolt Or Nut**

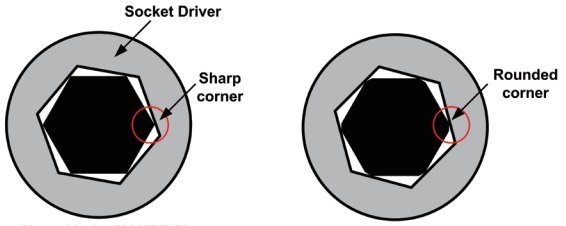
The performance of hex, hex washer head, and hex flange design bolts, nuts, and screws is greatly dependent upon the wrenching height of the hex portion of the design. The wrenching height is defined slightly differently depending on whether the part is a hex, a hex washer, or a hex flange design. Wrenching height is generally the distance from where the hex portion of the head first exceeds the minimum across the corners specification of the hex to the top side of the washer or flange. In other words, the axial distance between the top of the flange/ washer, and the point where the fully formed hex corner starts.




**Hex Gaging Ring**

One, two, or three rings depending on the specification

The wrenching height of a hex design of any type is determined by use of very precisely made gaging rings. The critical portion of the gaging ring is its inside diameter called the "Gaging Diameter". The tolerance on the gaging diameter and ring thickness of these gaging rings is generally .0003 inches and .01 millimeters for inch and metric rings, respectively. The outside diameters are generally just reference dimensions because they do not perform an inspection function.



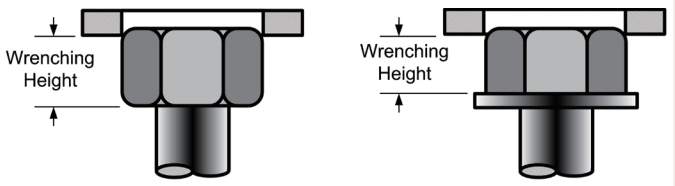

Hex with the MAXIMUM Across Corners (AC) dimension with good driver engagement

Hex with the MINIMUM Across Corners (AC) dimension with poor driver engagement

The reason wrenching height is specified in the standards is because the size and length of the hex portion of the design has a major impact on how effectively the fasteners will engage with mating drive sockets. When the across corners dimension is over the specified minimum size, and the wrenching height is greater than the minimum, the fasteners will drive as they should. All of the torque applied through the drive socket will effectively tighten the fastener.

If the across corners of the hex are below the specified minimum size and/or the length of the properly formed hex portion is too short, the flats of the socket driver are more likely to slip over the corners of the hex instead of rotating the fastener. When this is the case, some, if not most of the torque is absorbed in deforming the fastener head instead of tightening the fastener. This results in under tightened fasteners due to slippage of the socket or wrench along with rounding of the hex corners.

The reason the gaging rings were incorporated into the hex design specifications is because of the difficulty associated with making an accurate measurement of the across corners size with measuring instruments like micrometers and calipers. The measurement of the wrenching height is impossible to make using standard hand instruments or optical comparators.



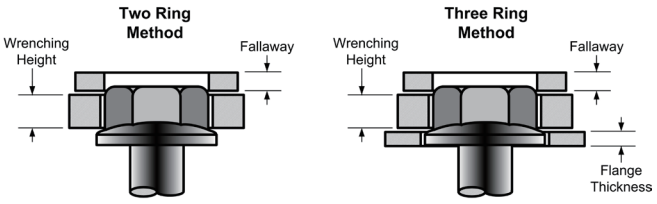

ASME B18.6.3 & ASME B18.6.5M

Wrenching Height gaging for hex and hex washer heads

When using the single gaging ring method, the wrenching height dimension is somewhat difficult to measure, but it can be done with reasonable accuracy and consistency after a little practice. The single ring methods are a little more difficult to use because a measurement from the underside of the ring down to where the hex stops must be measured.

The use of the two ring and three ring methods are simpler, because there use is a GO/NOGO evaluation. When inspecting hex fasteners according to one of the specifications that require the use of the two or three ring gaging methods, the inspector simply stacks the two or three rings on the part in the correct order (the smallest gaging diameter on top, the next larger gaging diameter below the first, and the largest gaging diameter ring on

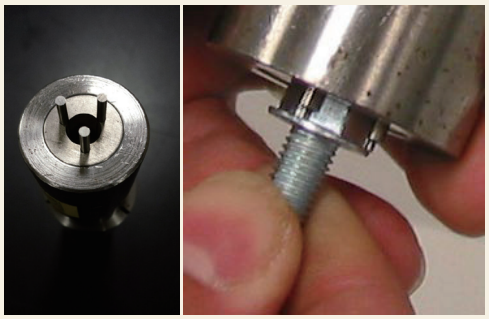
the bottom of the stack), and observes the relationship of the rings to one other. The hex portion of the fastener is acceptable for wrenching height if none of the rings touch one another.




**ASME and ISO Gaging for Metric Hex Flange Head Fasteners**

Generally, the top ring's gaging diameter is the minimum across corners size. This ring's thickness is not critical. The gaging diameter of the second ring is generally the maximum across corners size, and the thickness is equal to the minimum wrenching height requirement. The bottom or third ring gaging diameter is at least the maximum flange diameter size, and the thickness is equal to the maximum flange thickness.

Other gaging has been successfully developed in obtaining wrenching height measurements for use in statistical process control. This gaging can also be quicker and easier to use than the above mentioned ring method. The gage is called a WrencHgt™, and consists of a gage body having a gaging diameter equivalent to the appropriate top gaging ring. Also, protruding from around the gaging hole are three pins positioned to clear the max allowable radius at the head to washer junction.



To perform the measurement, the pins are pressed flat against the face of the gage using a surface plate or any other hard flat surface and the indicator is zeroed. The fastener's hex feature is then aligned with the pins and is pressed up against the gaging diameter. The resultant value shown on the indicator is the wrenching height.

Suppliers of external hex drive fasteners must carefully read the specifications for the parts they supply and use the correct gaging method to evaluate wrenching height. Wrenching height is not an insignificant, or an optional inspection characteristic. As stated earlier, wrenching height is vital to achieving correct and consistent fastener tightness in the final assembly. ■