Even with all the published information out there on the subject of Torque, I continue to get calls quite frequently for help and/or guidance in this area. Probably the most frequent question I get is, “What torque should I use for my fasteners”. The simple response is, “It depends on your application”.

You can search the internet and find a ton of “Torque Charts”, and if you actually read the fine print, you will discover that these charts are general guidelines that apply only to the bolt or screw. In addition, they are of particular material and certain assumptions are made that the mating part is of the same strength material. Not only that, but friction created by surface condition in the assembly is broken down to a theoretical number. These charts do not account for fasteners going into a softer material than the bolt, and should really only be used for reference. The best way would be to develop your intended torque through experiment, which we will get into later. In the absence of a chart to provide a starting reference torque, you can easily do the math yourself. The most commonly used Engineering formula to determine torque is the following:

T = TDK, where
T = Theoretical Target Tightening Torque
D = Nominal Diameter of the Fastener
K = “K” factor or friction factor

- This K factor can vary from .1 to .4 depending on the surface condition. The most commonly used factor is .22 for zinc plating on fasteners.

P = Desired Clamp Load

- This number is typically 75% of Proof Load or Yield Strength of the fastener.
- You can also derive this number using the thread tensile area and the yield strength of the fastener material (also take 75% of the result).

As stated above, this will provide you with a good reference torque that should be close to the optimum torque for your particular application. Where it could change dramatically, would be if the mating thread was of different strength than the bolt, or your assembly includes gaskets, or brittle materials. In these cases experimentation would be highly recommended. The failure mode occurs when any one component fails, not only the fastener.

**How do I set my target torque by experiment?**

There are (2) ways to do this, the simple inexpensive way and the special equipment, more expensive way. Again, it really depends on how critical in nature your application is, or if another component could fail before the fastener does. The simple way is:

- Assemble 10 to 12 joints exactly as they are to be constructed.
- With a calibrated torque wrench, drive the fasteners in the joint to failure and record the maximum torque achieved in all the joints.
- Calculate the average torque failure value for all the tested joints.

- Multiply that average by .6 or 60% to establish the tightening torque value for that given joint.

Another way to determine a target tightening torque is to use special torque/tension equipment available through a couple different sources with various “bells and whistles”. This would be a good choice for critical torque applications in special joints. The same basic procedure stated above applies except:

- The joints are assembled with a load cell in between.
- You can obtain numerical values for the tension applied in the joint as the torque increases.
- You can determine the yield point when the torque and tension begin to decrease.
- The general rule of thumb would be to set your tightening torque at 75% of the yield point.

**What kind of torque tool should I use for assembly?**

Once you have a target torque, you will have to choose a proper tool to administer it in your assembly. To produce torque there are many “Tools” that will meet this basic criteria. The most simplistic being some kind of lever arm attached to a socket or other gripping device. (i.e. wrench or ratchet). The fundamental formula for application of torque is Force x Distance. This means that you fix one end of your wrench onto your fastener and at some distance away on the handle (or lever arm), you apply a force to produce a torque or turning motion. The further you get from the pivot point, the easier it is to turn, and thus the more torque you can apply. This is why we all know that putting a “cheater bar” on the end of a ratchet handle gives us a little more leverage to either “crank down” or loosen that stubborn bolt. This method of torque control is about as crude as you can get. All we have to rely on is our guestimate of force, since we can easily measure the distance our hand is away from the pivot point.

Impact wrenches would be the next step up from a simple socket and ratchet combination. Impact wrenches are great for assembly because they offer very little recoil to the operator and are very quick for installing fasteners. The biggest problem is that end users think that they are controlling the torque when using an impact wrench and fail to verify this. Operators just “know” from the number of “hammers” or by the way it sounds as the fastener is seated. Air driven Impact wrenches not only vary greatly in their output, but are also highly dependent on line pressure. Screws and bolts get put into place, and if a failure occurs upon install, everyone first blames the fastener, and doesn’t think twice about blaming the tool. There is nothing wrong with using Impact tools, unless you are using it as your final verification of torque. If you don’t care what the end result is as long as the fastener is “tight”, using only an impact wrench is perfect. When using Impact tools where torque control is important, it is highly recommended that you follow up with a verification using a better measuring device like an actual Torque Wrench. Use the impact wrench for speed and initial seating, but do the final tightening with a wrench that will read the torque applied.

Going up the chain, Torque wrenches are your most accurate mode of applying torque to fasteners. Torque wrenches come in all different shapes, sizes, and configurations. To name a few, there is the beam style, the “clicker” type, the dial, and the electronic. All have their place, and many times they are chosen for personal preference. I happen to prefer Dial type because I can watch the needle progress to the prescribed torque. Others prefer clicker types, because you just tighten until you feel it or hear it. Some like Electronic because the decimal parts of each increment are visible, and some even have audible sounds as you approach and hit your target torque. Application can also play a role in the type of wrench because of space constraints, increments on the readout, etc. No matter what style you prefer or need to use, you can know that it is a valid method of torque control, where you can point to a number and know that it will be there.

**How to Audit your installation torque:**

Auditing torque in an assembly situation is quite simple and should definitely be done when using simple ratchets, power drivers, or impact tools without proper torque controls. Auditing is done on completed assemblies to verify the torque previously applied. The first thing you have to know is what torque value you are auditing to, assuming that engineering has done the job to properly define it. This is probably outlined on a print or in the assembly instructions. Next, you should apply the torque wrench to the fastener being audited in a clockwise or tightening motion. Apply force slowly and deliberately so you are not “jerking” the wrench giving erroneous results. When the fastener starts to move, the torque value shown is approximately the value that the fastener was previously tightened to. Many times, end users think that they can determine the last torque by loosening the bolt, which is a mis-conception. When you loosen a fastener, the torque “falls off” immediately after it breaks free, and it typically takes much less torque to loosen, than to tighten. When you tighten a fastener, the torque gradually gets higher and higher, so as soon as it starts to move, you are tightening it more, even if only by a single in-lb.

As long as there are fasteners, there will continue to be questions regarding the proper torque for a particular application. The key is to collect as much information about the application and use wisdom in determining the final output. When little to no information is available, the first thing to do would be to define a reference torque. Once you’ve either pulled it off a chart or calculated it by hand, you want to put that number to the test simulating the joint as exactly as you can. This can be tested by simple means or sophisticated equipment, but make sure you do it. Finally, you want to choose a tool that best fits the application. Hopefully, this has offered some guidance so you can do your part to prevent fastener failures in the future, and provide insight to others looking for answers to their fastener tightening applications.