

Torque to Achieve Bolt Utilization (Unlubricated Bolts)

Nominal Diameter (in.)	SAE J429 Grade 5 (ft-lbf)		SAE J429 Grade 8 (ft-lbf)		ASTM A193 Grade B7 (ft-lbf)		ASTM A193 Grade B8 (304SS) (ft-lbf)	
	Yield	50%	70%	50%	70%	50%	70%	50%
1/4	9	12	12	17	10	14	3	4
5/16	17	24	25	34	20	28	6	9
3/8	30	42	42	59	33	47	11	15
7/16	45	65	66	92	53	74	17	23
1/2	75	105	105	145	84	120	27	37
9/16	105	150	150	210	120	165	38	53
5/8	145	205	205	290	165	230	53	74
3/4	255	360	360	505	290	405	92	130
7/8	410	575	575	805	460	645	150	205
1	615	860	860	1205	690	965	220	310

The ability of a gasket material to make and maintain a seal depends not only on the quality of the gasket material, but also on medium being sealed, the flange design, the amount of pressure applied to the gasket by the bolts and how the gasket is assembled into the flanges and tightened.

FOLLOW BASIC GASKET INSTALLATION PROCEDURES:

1. Clean and inspect flanges.
2. Clean and inspect gasket. Make sure the right gasket is used (No substitutes).
3. Install gasket in accordance with instructions for gasket type. Do not apply tape, lubricant or gasket adhesive unless specified.
4. Check flange alignment for parallel and high-low.
5. Install bolts without driving them in. Friction factors are irrelevant when threads are damaged.

CONTROL FRICTION:

1. Check threads on the bolt/stud and nut for damage or flaws. Repair or replace the damaged part. The nut should run on the bolt by hand past the point of travel.
2. If applying lubricant, apply the correct lubricant to the bolt throughout and past the point of travel. Apply lubricant to nut threads and nut face. When using washers, apply lubricant to the washer on nut side. Always apply consistently from bolt to bolt. **This will affect the torque value so be sure to re-calculate torque based on reduced friction factor. Torquing a lubricated fastener using specs for unlubed bolts can cause over-compression.**
3. Use hardened steel washers if specified. The hard surface and increased footprint allow for uniform load from bolt to bolt.
4. Be sure the bolts align properly in the flange holes. Even slight angles on the bolt will affect friction, load and relaxation.

TIGHTENING SEQUENCES:

1. Bolt patterns or tightening sequences are used to help pull in the flange and load the gasket evenly without damaging the gasket. Use star/cross pattern during installation. Clockwise tightening alone can cause canting of the flange.
2. Following a bolt pattern still creates cross-talk between the bolts. A tightening and loosening effect takes place in the other bolts as one bolt tightens. Multiple passes are made during installation and at full torque to counter this effect.

MULTIPLE PASS:

1. For multiple passes, start at a low torque value, usually 20-30% of final torque desired. Complete the first pass and increase torque to 60-70% and repeat pattern. The third pass is done at desired torque or 100%. In some cases a 4th and 5th pass is specified, usually for critical service applications. The fourth pass is at 100% and a chase pattern is used. As if facing a clock, start at 12 moving towards 3, 6, and 9 and back to 12, tightening each fastener at 100% of desired torque. Upon completing the fourth pass at 100% of torque, conduct a 5th pass at desired torque (Chase Pattern), however counter clockwise.

2. Multiple passes can provide the following:
 - a. Control the pressure on the gasket and the load of the bolt,
 - b. Pull the flanges up evenly,
 - c. Allow relaxation to take place as you tighten, and
 - d. Control the relaxation so that you don't see it all at the end of the job.
3. You may have as many passes as you want, however do not use less than 3 star pattern passes and the optional 2 chase (1 clockwise and 1 counter-clockwise).

RELAXATION:

1. Some of the joint relaxation is due to cross-talk in the bolts. Multiple passes, repetition, friction control and good craftsmanship can compensate for this.
2. Another form of relaxation takes place after initial tightening. This is when the majority of thread yielding and gasket creep occurs. The joint is responding to all of the forces that have been applied. Deal with this by repeating the chase patterns before start up (Usually within 24 hours of equipment start up).
3. The most critical form of relaxation takes place during pressurization start up and operation. Additional loads due to temperature and media are introduced. Everything changes but we have built in enough safety factor and control to do the job.
4. Hot torquing is generally not recommended. If hot bolting is required consult fastener, gasket and flange vendor before applying additional loads (be prepared to discuss the application, pressure, temperature and final torque applied to fasteners).