Tool-Box Talk

How to Torque Fasteners

"Human Induced Failures can be mitigated by following known best practices"

Fasteners are utilized in most equipment in our industrial plants and facilities and if stored, installed, and utilized following known best practices equipment reliability is enhanced resulting in less partial and total functional failures.

Failure Mode	Failure Cause	Failure Effect
Male thread fracture	- Poor quality material - Corrosion - Fatigue	Eventual failure from shock, vibration
Broken shank	- Poor quality material - Over-torquing	Immediate failure, fastener replacement
Self loosening	- Under-torquing - Vibration	Loose joint; joint flexure under fatigue
Fractured bolt head, cracked nut	- Excessive preload	Immediate failure, fastener replacement
Thread stripping of external or internal thread	- Production variations in threaded assembly (bellmouthing) - Material tensile/shear strength variations - Radial displacement of nut - Excessive tensile force	Reduced thread strength, eventual failure
Loosening joint over time	- Overloading that exceeds preload - Insufficient preload - Poor quality washers (brinelling)	Severity of loose joint depends on application
Reduced fatigue life	- Bolt too tight - Bolt too loose	Eventual assembly failure
Galling during assembly or removal	- Too fine a thread for application - Incorrect material combination	Inability to remove fastener
Surface bearing deformation	- Bolt too tight	Fluid leakage
Crushed gasket	- Bolt too tight	Fluid leakage

Source: Handbook_of_Reliability_Prediction_Procedures_for_Mechanical_Equipment, 15 May 2011

WORLD CLASS MAINTENANCE

www.worldclassmaintenance.org

Why Torque a Fastener?

Reason #1: To ensure a fastener meets the intent of the equipment owner
Reason #2: To mitigate fastener Failure Modes (see chart on previous page)
Reason #3: To ensure repeatability of work execution in Best Maintenance Repair/Installation Practices by all Maintenance Techs and contractors

General Rules which must be followed:

1. ***On Critical Components or Assets, the replacement of fasteners should be mandatory if premature failure is not acceptable***
2. ***Never over torque a Fastener. To over-torque a Fastener can cause it to stretch beyond normal limits causing Fastener breakage, and/or unwanted loosening of Fastener***
3. ***Never under torque Fasteners because it can cause the Fastener to loosen and break***
4. ***Ensure you know the torque specification (found on procedure) and should be stated whether a fastener should have a lubricant applied or installed dry***
5. ***As a general rule, "Fasteners should not be lubricated" unless manufacturer states otherwise***
6. ***Know how to use a torque wrench. When all else fails read the instructions.***
7. ***When unsure whether a Fastener should be torque to a specification, torque it***
8. ***Do not re-use a Fastener if:***
    1. ***If it was installed with an impact wrench***
    2. ***If a fastener has been torqued (Torque of a Fastener Stretches the threads and thus causing the premature failure of the fasteners)***
    3. ***If an asset or component is critical***

WORLD CLASS MAINTENANCE

www.worldclassmaintenance.org

Definitions:

Torque Wrench:

- **A tool used to precisely apply a specific torque to a fastener such as a nut or Fastener.**

Torque Seal/Paint Marker:

- **A paint marker which provides an inspector if a fastener has loosened prematurely.**

How to Torque a Fastener?

Using the most common torque wrench which is a "click type" follow these steps;

Step 1: Preset torque value on torque wrench as determined by the equipment manufacturer; or if not available a common torque specification chart. (see below)

FASTENER TORQUE CHARTS

BOLT CLAMP LOADS
Suggested Assembly Torque Values

DIAMETER & THREADS PER INCH	USS/SAE GRADE 5					USS/SAE GRADE 8				
	Tensile Strength Min. PSI	Proof Load LB	Clamp Load LB	Torque Dry FT LB	Lubricated FT LB	Tensile Strength Min. PSI	Proof Load LB	Clamp Load LB	Torque Dry FT LB	Lubricated FT LB
1/4-20	120,000	2,700	2,020	8	6.3	150,000	3,800	2,850	12	9
28	120,000	3,100	2,320	10	7.2	150,000	4,350	3,250	14	10
5/16-18	120,000	4,450	3,340	17	13	150,000	6,300	4,700	24	18
24	120,000	4,900	3,700	19	14	150,000	6,950	5,200	27	20
3/8-16	120,000	6,600	4,950	30	23	150,000	9,300	6,980	45	35
24	120,000	7,450	5,600	35	25	150,000	10,500	7,900	50	35
7/16-14	120,000	9,050	6,780	50	35	150,000	12,800	9,550	70	50
20	120,000	10,100	7,570	55	40	150,000	14,200	10,650	80	60
1/2-13	120,000	12,100	9,050	75	55	150,000	17,000	12,750	110	80
20	120,000	13,600	10,200	85	65	150,000	19,200	14,400	120	90
9/16-12	120,000	15,500	11,600	110	80	150,000	21,800	16,350	150	110
18	120,000	17,300	12,950	120	90	150,000	24,400	18,250	170	130
5/8-11	120,000	19,200	14,400	150	110	150,000	27,100	20,350	210	160
18	120,000	21,800	16,350	170	120	150,000	30,700	23,000	240	180
3/4-10	120,000	28,400	21,300	360	200	150,000	40,100	30,100	380	280
16	120,000	31,700	23,780	300	220	150,000	44,800	33,500	420	310
7/8-9	120,000	39,300	29,450	430	320	150,000	55,400	41,600	600	450
14	120,000	43,300	32,450	470	350	150,000	61,100	45,800	670	500
1-8	120,000	51,500	38,600	640	480	150,000	72,700	54,500	910	680
14	120,000	57,700	43,300	720	540	150,000	81,500	61,100	1,020	760

Note: When using anti-seize reduce lube torque value by 20%

Step 2: Torque the Fastener to the point where the desired torque is reached, signaling the desired torque by causing a click sound (some torque wrenches will not allow a Fastener to be torque above the setting however some will, be sure and purchase the best torque wrench possible)

WORLD CLASS MAINTENANCE

www.worldclassmaintenance.org

WARNING: Some components required a specific sequence to torque fasteners on specific components/assets.

The key to reducing these effects in the installation process is by slowly bringing the flanges together in a parallel line, taking a minimum of four bolt tightening passes, and by following the correct bolt tightening sequence. This not only creates a better connection; it also reduces ongoing maintenance costs and increases safety. Use of a Torque Wrench is the preferred tool to use on all critical assets.

It is important to note that gasket thickness is vital. The thicker the material, the higher the gasket creep will be - resulting in torque loss.

Step 3: Mark the fastener with Torque Seal/Paint for use to inspect if fastener torque has changed.

Steps to Success

1. **Educate your team members using this Tool-Box Talk**
2. **Ask your staff if the organization could improve current practices around fasteners and if so, what are their recommendations**
3. **Begin tracking failures with fastener issues**
4. **Inspect Free bin fasteners which may have used or are corroded and replace with new fasteners**
5. **Ensure your staff knows how and when to use a torque wrench**

WORLD CLASS MAINTENANCE

www.worldclassmaintenance.org