Bolt Torquing Guidelines

Tank Farm Maintenance Procedure

MAINTENANCE

USQ N/A-4

Change History (≤ Last 5 Rev-Mods)

<table>
<thead>
<tr>
<th>Rev-Mod</th>
<th>Release Date</th>
<th>Justification</th>
<th>Summary of Changes</th>
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<tr>
<td>G-2</td>
<td>02/14/2018</td>
<td>Engineering Request</td>
<td>Changes Made: Changed Scope to follow ASME Standard. Removed Stables 1, 2, 3, 5, 6, 7. Renamed Table 4, 8 and 9</td>
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<td>G-1</td>
<td>12/21/2017</td>
<td>Periodic Review</td>
<td>Inconsequential Change to Record Section.</td>
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<td>G-0</td>
<td>08/19/2015</td>
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<td>Step 5.1.1 break “and” and “reclose” apart. Numbered step 3.1.2 (Redline didn’t appear when auto number addition was the only change) Deleted “This procedure provides for component calibration check and adjustment of Foxboro Intelligent Pressure transmitter.” from note in 5.0. This is clearly stated in the Purpose of the procedure and need not be repeated. Reworded note so it did not appear as an IF/THEN statement.</td>
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<td>F-1</td>
<td>11/18/2014</td>
<td>CHAMPS Removal</td>
<td>Removed reference to CHAMPS, updated records statements and removed next periodic review date.</td>
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<td>F-0</td>
<td>01/13/2012</td>
<td>Periodic Review</td>
<td>Reworded Steps 1.1, 1.2, 2.1.3, 3.3, 4.2.2, 5.1.2 – 5.1.4. Reword Caution in Table 1, changed bolt size from $\frac{1}{8}$ to $\frac{1}{4}$ on Table 3. Reworded Note on Table 3 for class 150# thru class 300# flanges. Added Warning at 3.1, Equipment Safety at 3.2 and Warning box prior to Step 5.1.3. Struck Step 5.1.2 and “Special Instructions” from Table 9.</td>
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1.0 PURPOSE AND SCOPE

1.1 Purpose

This procedure provides guidelines for bolt torqueing to protect equipment and control material stresses in tank farm bolted pipe flange joint connections within ASME B31 piping code requirements.

1.2 Scope

This procedure applies generically to bolted pipe flange joint connections. Materials (bolts/studs, nuts, gaskets and flanges) and bolted pipe flange joint assembly torque values are to be taken from released Design Documents or Procedures and are NOT identified in this procedure.

2.0 INFORMATION

2.1 General Information

2.1.1 Torque Conversion Law:

The Table 2 - Torque Conversion Law gives the conversion of torque in the units of inch-grams, inch-ounces, inch-pounds, foot-pounds, centimeter-kilograms, and meter-kilograms.

2.1.2 Torque Law and Formula:

Tw = LxF, where Tw = Torque, L = Lever Length, and F = Force. Refer to Table 2 for the application of the torque law.

2.1.3 Recommended Torque Settings When Using Crow Foot Extension

When you put an extension on a torque wrench, like a crow foot, the torque applied to the fastener increases, since the lever arm length increases.

- See Table 3 – Torque Setting When Using Crow Foot Extension for correction factors.
2.1.4 **Recommended Tightening Torques for Flange Bolts**

Bolted Flange Joints are engineered connections that must be torqued to values derived during the design or analysis of a given system to maintain Code compliance. The source for torque values should be approved Design Documents. Installation torque is typically found in drawing notes or data tables on engineering drawings.

2.1.5 If torque values are NOT included on the released drawings, the responsible WRPS Engineering group shall incorporate torque value(s) into work instruction during the planning process in accordance with procedure TFC-OPS-MAINT-C-01, Tank Operations Contractor Work Control.

2.1.6 If bolt (or stud) patterns are NOT shown in Figure 1, Figure 2, and Figure 3, the bolt (or stud) patterns will be incorporated into the work instructions during the planning process in accordance with procedure TFC-OPS-MAINT-C-01.

2.1.7 All pipe flange fasteners SHALL be lubricated with approved lubricant, UNLESS the design documents specifically state that lubricant is NOT to be used.

### 3.0 PRECAUTIONS AND LIMITATIONS

#### 3.1 Personnel Safety

Use thread lubricant approved by Industrial Hygiene and WRPS Engineering.

#### 3.2 Radiation and Contamination Control

Work in radiological areas will be performed using a radiological work permit following review by Radiological Control per ALARA procedure TFC-ESHQ-RP_RWP-C-03.

#### 3.3 Environmental Compliance

Environmental Compliance must be notified of any spills observed as a result of this surveillance. Environmental Compliance will make the appropriate notifications of such releases per WAC 173-303.
4.0 PREREQUISITES

4.1 Special Tools, Equipment, and Supplies

The following supplies may be needed to perform this procedure:

- Calibrated Torque Wrench (Torque range from values given in design documents)
- Bolt lubricant (Bostik Never Seez Regular Compound)
- Nickel-Based Bolt Lubricant (Bostik Never-Seez Pure-Nickel Special, Bostik Never Seez High Temp. Stainless)
- Penetrating Oil (Kroil) (For loosening/removal ONLY)
- Crows Foot (See Table 3 for correction factors)
- Other tools, equipment and supplies as identified by Shift Manager/OE/FWS/User.

4.2 Field Preparation

4.2.1 REVIEW this procedure prior to using material contained in attached figures and tables.

4.2.2 REVIEW lubricant(s) Safety Data Sheet.
5.0 PROCEDURE

5.1 Application of Bolt Torque on Flanged Joint

NOTE - Figure 1, Figure 2, and Figure 3 show bolt torque patterns for 4, 8, and 12 bolt flanges. Sequential and rotational order is diagramed.

5.1.1 Before assembly, CLEAN and EXAMINE flange and fastener surfaces using the following approved methods.

- Check studs, nuts, and flange/nut contact surfaces for cleanliness and burrs. Clean them using a soft wire brush and approved solvents. Use a brush with stainless steel bristles on alloy surfaces.
- Check flange nut bearing surfaces. Clean the flange nut contact surfaces around the entire bolt circle using a soft wire brush and approved solvents. Use a brush with stainless steel bristles on alloy surfaces. Ensure that these contact faces are free of scratches, dirt, scale, burrs, and other protrusions.
- Check condition of flange faces. Indications running radially across the facing are of particular concern. Report any questionable imperfections for appropriate disposition. Clean gasket seating surface on flange face using a wire brush. Use a brush with stainless steel bristles on alloy surfaces. Ensure that the surface is free from scratches, dirt, scale, other protrusions, and remnants of old gaskets (an exception based on experience is flexible graphite that may remain in the surface finish grooves when either a flexible graphite clad or a spiral-wound gasket with flexible graphite filler is to be used as the replacement gasket).

NOTE - Proper alignment of all joint members is the essential element of flange joint assembly. It results in maximum sealing surface contact, maximum opportunity for uniform and design-level gasket loading, and reduced friction between the nut and the flange.

5.1.2 ALIGN component parts and gasket.
5.1 Application of Bolt Torque on Flanged Joint (Cont.)

NOTE - Nuts are generally replaced rather than reconditioned.

NOTE - Different lubricants may vary friction losses significantly, use site-standard Bostik Never-Seez. If stainless steel fasteners are used, nickel-based anti-seize is preferred to prevent galling.

5.1.3 IF bolts (or studs) require cleaning, CLEAN bolts (or studs), with a thread "chasing" nut.

5.1.4 ENSURE bolts (or studs) and nuts are cleaned and dry prior to proceeding.

5.1.5 IF the design documents specifically state that lubricant is NOT to be used, PROCEED to Step 5.1.8.

5.1.6 LUBRICATE bolt (or stud) threads in area of nut engagement, bolt head face, and face of nut.

5.1.7 REMOVE excess lubricant.

5.1.8 INSTALL all bolts and nuts (or studs) finger tight.
5.1 Application of Bolt Torque on Flanged Joint (Cont.)

NOTE - It is preferred to apply the installation torque to the nut versus the head of the bolt if the geometry of the installation permits. The bolt/stud should ideally NOT rotate during installation.

NOTE - If bolt (or stud) patterns are not shown in Figure 1, Figure 2, or Figure 3, the bolt (or stud) patterns will be incorporated into the work instructions during work planning in accordance with procedure TFC-OPS-MAINT-C-01.

5.1.9 IF bolt (or stud) patterns are not shown in Figure 1, Figure 2, or Figure 3, PERFORM the following steps.

5.1.9.1 NUMBER bolts (or studs) so that torquing pattern can be followed.

5.1.9.2 TORQUE all nuts (or bolts); not to exceed 25% of specified values from design documents.

5.1.9.3 TORQUE all nuts (or bolts) in sequential order to 50% of specified value.

5.1.9.4 TORQUE all nuts (or bolts) in sequential order to 75% of specified value.

5.1.9.5 TORQUE all nuts (or bolts) in sequential order to 100% of specified value.

5.1.9.6 FOLLOW rotational order shown in Figure 1, Figure 2, or Figure 3, OR

PERFORM rotation orders per work instructions.

5.1.9.7 COMPLETE a 0-360 degree bolt to bolt check of torque values.

5.2 Records

This procedure is performed within a work package, as such, the procedure in its entirety will be maintained as a record per the Work Control process.

The record custodian identified in the Company-level Records Inventory and Disposition Schedule (RIDS) is responsible for record retention in accordance with TFC-BSM-IRM_DC-C-02.
# Table 1 - Grade Markings

## ASTM AND SAE GRADE MARKING FOR STEEL BOLTS

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### ASTM SPECIFICATIONS

- **A 307** - Low Carbon Steel Externally and Internally Threaded Standard Fasteners.
- **A 325** - High Strength Steel Bolts for Structural Steel Joints, Including Suitable Nuts and Plain Hardened Washers.
- **A 449** - Quenched and Tempered Steel Bolts and Studs.
- **A 354** - Quenched and Tempered Alloy Steel Bolts and Studs with Suitable Nuts.
Table 2 - Torque Conversion/Law

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TORQUE LAW

Torque is based on the fundamental law of the lever, that is, DISTANCE times FORCE equals the moment or TORQUE about a point. If this law is fully understood, all problems of torque relative to torque wrenches and adapters can be solved.

Drawing number 11 represents a torque wrench. The distance between the centerline of the drive square and the centerline of the force being applied at the handle is the lever length of the torque wrench. This is designated as "L".

The arrow pointing downward at the handle of the torque wrench represents a force or pull which is exerted by the operator. The force or pull is designated as "F".

The curve arrow about the drive square of the torque wrench represents the torque which is being applied to the nut or cap screw. This is also the torque which is indicated on the scale of the wrench and will be represented as "T w".

In order to calculate the torque at the drive square, it is necessary to multiply the lever length "L" times the force "F"... this is shown in the following formula.

\[ Tw = L \times F \]

There is one precaution which must be observed. In using the formula, the lever length must be measured at 90° to the direction of the force. This relationship is shown in Drawing No. 11 by the 90° angle. If this precaution is not taken, an erroneous answer will result.
Table 3 – Torque Setting When Using Crow Foot Extension

When you put an extension on a torque wrench, like a crow foot, the torque applied to the fastener increases, since the lever arm increases. Use the formula below to find what value you should set into the wrench to achieve the required fastener torque.

\[
M1 = M2 \times \frac{L1}{L2}
\]

Where:
- \(M1\) is the torque setting of the wrench
- \(M2\) is the actual torque applied to the nut
- \(L1\) is the normal length of the wrench
- \(L2\) is the extended length of the wrench.

**EXAMPLE:**

\begin{align*}
\text{Normal Length} & \quad 9 \quad (L1) \\
\text{Extended Length} & \quad 10.5 \quad (L2) \\
\text{Desired Torque} & \quad 35 \quad (M2) \\
\text{Set wrench to} & \quad 30.0 \quad (M1)
\end{align*}
Bolt Torquing Guidelines

Figure 1 - Four Bolt Arrangement

FOUR BOLT ARRANGEMENT

1. SEQUENTIAL ORDER
   - 1-2
   - 3-4

2. ROTATIONAL ORDER
   - 1
   - 3
   - 2
   - 4

BOLT TORQUE PROCEDURE
Figure 2 - Eight Bolt Arrangement

BOLT TORQUE PROCEDURE

SEQUENCIAL ORDER
1-2
3-4
5-6
7-8

ROTATIONAL ORDER
1
7
3
5
2
8
4
6

EIGHT BOLT ARRANGEMENT
Figure 3 - Twelve Bolt Arrangement

BOLT TORQUE PROCEDURE

SEQUENTIAL ORDER
1-2
3-4
5-6
7-8
9-10
11-12

ROTATIONAL ORDER
1
5
9
3
7
11
2
6
4
8
10
12

TWELVE BOLT ARRANGEMENT

1 12
0° 330°

2

3 10
270° 240°

4 8
300°

5

6 7
210° 180°

7

8

9

10

11

12

Bolt Torquing Guidelines