

## What are the current industry best practices for the assembly of bolted flange connections?

This month's "Sealing Sense" was prepared by FSA member Joel Baulch.

**C**urrent directives to control fugitive emissions and eliminate leakage altogether in piping and pressure vessel assemblies have led to activities geared toward fully understanding the intricacies that impact bolted joint performance. While a bolted flange joint assembly appears relatively simple in nature, joint integrity relies to a large extent on the skill and application of the installer. Proper inspection and selection of materials, along with a controlled, safe, documented assembly technique are fundamental to ensuring a reliable bolted joint assembly. Currently, industrial facilities and organizations are commonly developing general process and specific service bolting procedures and practices. A common thread in the method is a six-step approach:

1. Clean and examine assembly components
2. Align the flanges
3. Install the gasket
4. Control fastener friction
5. Control bolt tightening
6. Compensate for relaxation

### Clean and Examine Assembly Components

Remove all foreign materials from the flange seating surfaces, fasteners, nuts and washers using tools that will not damage the equipment. Flange cleaning must take place in a path or direction that corresponds with the serration path and not across the serrations. Examine flange surfaces for any pitting, corrosion, cracks, radial scores, heavy tool marks or anything that could prohibit proper gasket seating.

Where possible, use a straight edge to check for warping. Remove old paint and lubricant from the nut-bearing surface of the flanges. Examine the fasteners, nuts and washers for defects, such as burrs or cracks. Nuts should run freely past the point on the fastener where it will come to rest after it is installed and tightened. If possible, repair equipment

that is out of optimal condition. Extensive out of tolerance conditions may require equipment replacement.

### Align the Flanges

Align the flange faces and bolt holes without using excessive force, reporting any misalignment in which more force than can be exerted by hand or spud/pin wrenches. Where alignment is not possible without excessive force, acceptable aligning methods include replacement by removing and reinstalling the equipment in the properly aligned position or using uniform heat to relieve the stresses.

Proper alignment of all joint members is at the core of bolted flange connections. Proper alignment enables maximum seating surface contact, maximum opportunity for even gasket loading and reduced friction between the nut and the flange.

### Install the Gasket

Ensure that the gasket is the specified size and material for the assembly. Make sure that the gasket is free from defects. It should be transported to the job site in a way that keeps it protected, up to and including the time of installation.

Fasteners and washers should be checked for proper diameter, length, threads per inch, grade and condition. Carefully insert the gasket, centering it appropriately between the flanges. Do not force the gasket into place.

Some large gaskets may require the use of an adhesive to hold it in place. The adhesive should be approved by the manufacturer, the process engineers and the metallurgist. Grease, tape, petroleum, gasket compounds or release agents are not recommended for this purpose. Care should be taken to keep any unwanted materials out of the process.

Fasteners should be placed into the bolt holes in a way that protects the threads. Nuts should be assembled with the flat bearing surface against the flange or washer. When assembled, the fasteners should have the same profile on both

sides, passing through the flange at right angles. The washers should rest parallel to the flange surface. Bring the flanges together slowly, squarely and gently, ensuring that the gasket is not pinched or damaged.

***For safety reasons, any retightening of bolts must be done with the system off and the gauge pressure at zero.***

### Control Fastener Friction

Use a specified or approved lubricant suited to the service. Apply the lubricant generously and uniformly to all contacting thread, nut and washer load-bearing surfaces. Except when installing into tapped holes, apply lubricant after the fastener is installed in the flanges to ensure that contamination of the flange or gasket face does not occur. Always lubricate an end where a nut is to be turned, and always apply enough lubricant to ensure that the nut does not run dry before it is tight. Apply lubricant to the side of the washer that is against the nut. Applying lubricant to both sides merely ensures that the correct side is lubricated.

### Bolt Tightening Control

The use of manpower to tighten the bolts, by sledgehammer,

striking wrenches and pieces of pipe on the end of the wrench is not recommended, since this offers no accuracy. Consult the torque or tightening specifications

from the gasket manufacturer or the company's engineering department for guidance. First, contact the gasket using only sufficient force to lightly tighten the fasteners and stabilize the assembly.

Tighten the fasteners in a star or cross-bolt pattern (see Figure 1), checking to ensure that the flange remains even at ninety-degree intervals. No significant gasket compression should be occurring at this stage.

Once the assembly is stabilized, apply only a medium tightening force (30 to 50 percent of the target load) using the same star or cross-bolt pattern. In the next pass, increase the force to an ample but restrained force (60 to 70 percent of the target load) using the same star or cross-bolt pattern. Then increase the force to approach full force (90 to 100 percent of the target load) using the same star or cross-bolt pattern. Apply full target load to all nuts in a circular pass, continuing until all the nuts no longer turn.



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## Compensate for Relaxation

While it may be important to note that the retightening process is contingent on specific installation requirements, compensating for initial load loss in the assembly is a critical strategy to consider. The re-torque of fasteners at 100 percent of the target load helps offset relaxation to a significant degree. Again, consult the gasket manufacturer or the engineering department for recommendations on retightening. Do not retighten any elastomeric based gaskets, though, that have been exposed to elevated temperatures unless otherwise specified. For safety reasons, any retightening of bolts must be done with the system off and the gauge pressure at zero. All pertinent lock out/tag out procedures must be followed.

## Conclusions

Each component in a bolted flange connection must be designed, selected and assembled within acceptable limits to ensure reliable, long-term system tightness. Failure to consider all these important aspects can lead to serious product loss and environmental impact. Properly applying

these six installation principals is an essential part of ensuring leak-free service. Consultation with the gasket manufacturer will help provide guidance for specific application conditions.

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