

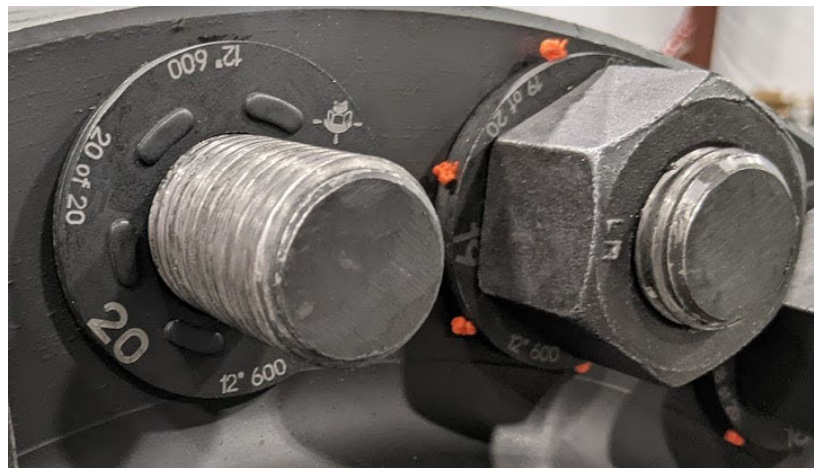
Proudly Designed, Engineered & Made in America Since 1994

Torque a flange in 15 minutes or less!

The **DuraSquirt® Flange System** allows a flange to be torqued in a single pass, utilizing all of the benefits Direct Tension Indicators (DTIs). This is based on an improved Flange Bolt-Up study, sponsored by BP America and the Pressure Vessel Research Council (PVRC)



This is a DTI



DTI on a stud (L) and a fully torqued DTI (R)

In the early 1990s, BP America and The Pressure Vessel Research Council (PVRC) sponsored the University of Akron Ohio, to develop a way to improve flange bolt-up procedures, using experimentally determined elastic interaction coefficients.¹ The study resulted in a way to fully torque a flange, in a single tightening pass, while achieving uniform bolt stresses around the flange. The groundbreaking procedure was made possible, by determining and compensating for elastic interaction between all bolts, within a flange.

Elastic interaction is the phenomenon that occurs between a group of bolts as tightening initializes and progresses throughout the group. As each bolt is tightened, other bolts in the group may tighten or loosen, due to dynamically changing forces within the flange assembly.

¹ Bibel, G. D. and Ezell, R.M. "An Improved Flange Bolt-Up Procedure Using Experimentally Determined Elastic Interaction Coefficients,"

Independently Verified

In 2017, the University of Houston, in cooperation with Bechtel and Carber, spent a year assessing the system. The study's verbatim conclusions appear below.²



A study on ABT-DTI bolting technique was conducted to determine whether it represents a cost-effective improvement to bolted flange connections using the traditional bolting method. The ABT-DTI bolting system was tested and compared to ASME PCC-1 bolting method. The experimental work consisted of bolting and hydro-testing two 12-inch 600 class flanges with raised face sealing surfaces on a small tabletop. A total of 13 bolting tests (9 DTI and 4 ASME legacy) were conducted. For verification purpose, a finite element model was developed and analyzed using ANSYS software to compare between the experimental and computational results.

The following conclusions can be drawn based on the computational and experimental results obtained:

1. ABT-DTI system is significantly faster than the ASME PCC-1 Legacy method by 60 to 70 percent.
2. ABT-DTI system reliably produces a leak free connection upon startup.
3. ABT-DTI system requires 75% fewer movements by the bolting operators.
4. ABT-DTI system does not require the use of precision torques as compared to ASME PCC-1 Legacy technique.
5. ABT-DTI system reliably yield these results with operators who have received minimal training and have limited experience with BFJA's³.



² Braun, Moreno, Pascali, 2018, "Assessment Study of Applied Bolting Technology's Durasquirt® DTIs", University of Houston
³ Using Experimentally Determined Elastic Interaction Coefficients," Journal of Pressure Vessel Technology 114 (Nov. 1992): 439-443. Bolted Flange Joint Assembly

Elastic Interactions Explained

Elastic interactions are determined by monitoring bolt stress continuously throughout the tightening procedure. After several iterations of assembly, disassembly and reassembly, updating elastic interaction data during each attempt, compensated individual bolt loads can be applied to a final tightening effort.

For example, imagine there is a two-bolt flange and the target bolt stress for all bolts is 40ksi (see figure 1)

1. Tighten bolt #1 to 40ksi
2. Tighten bolt #2 to 40ksi.
3. Bolt #1 drops to 30ksi final due to elastic interaction.

In equation form, bolt #2's interaction is expressed as:

$$40 = N - 25\% \text{ of } N \text{ or } 40 = N - .25xN$$

Where N represents how tight we need bolt #1, so when bolt #2's interaction decreases it by 25%, bolt #1 will be at the desired target stress.

Solving for N:

$$N = 53ksi$$

Repeat tightening, compensating for elastic interaction between 1 & 2 (figure 2).

1. Tighten bolt #1 to 53ksi
2. Tighten bolt #2 to 40ksi.
3. Bolt #1 drops 25% to 40ksi leaving both bolts at 40ksi.

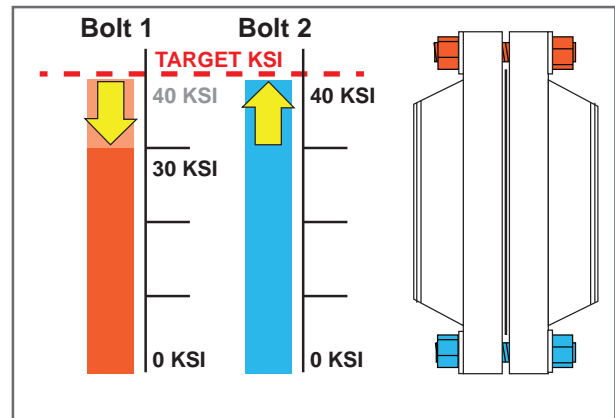


Figure 1

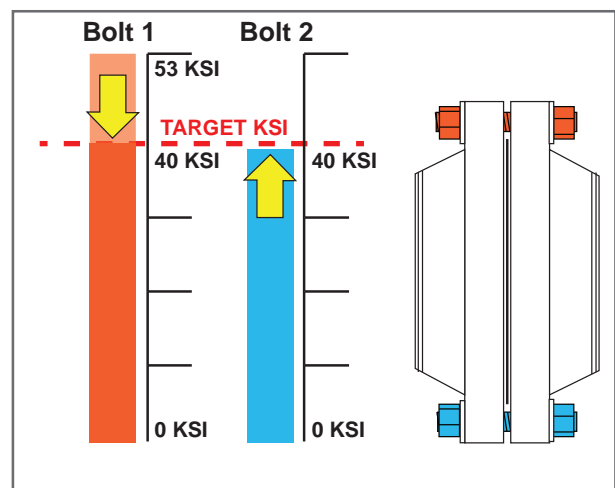


Figure 2

This concept can be extended to all flange sizes and bolt counts. So long as compensated elastic interaction information is applied to subsequent torqueing iterations, eventually, a single tightening pass is possible.

The procedure is remarkably accurate, but repetitive flange monitoring, disassembly and reassembly is not practical for real world implementation. What is needed is a reasonably priced, simple solution. Something that indicates compensated bolt stresses during a single tightening pass, i.e. small, calibrated bolt load cells, established by repetitious testing.

Applied Bolting has been making Direct Tension Indicators, or DTIs, that visually illustrate induced bolt stress for structural applications, since 1994. Since 2016, we have applied this experience to the elastic interaction issue, to enable easy pipe flange bolting. DTIs have been described by ASME’s Guidelines for Pressure Boundary Bolted Flange Joint Assembly, PCC-1, as a core fundamental for bolted joint assembly personnel, since 2013.⁴

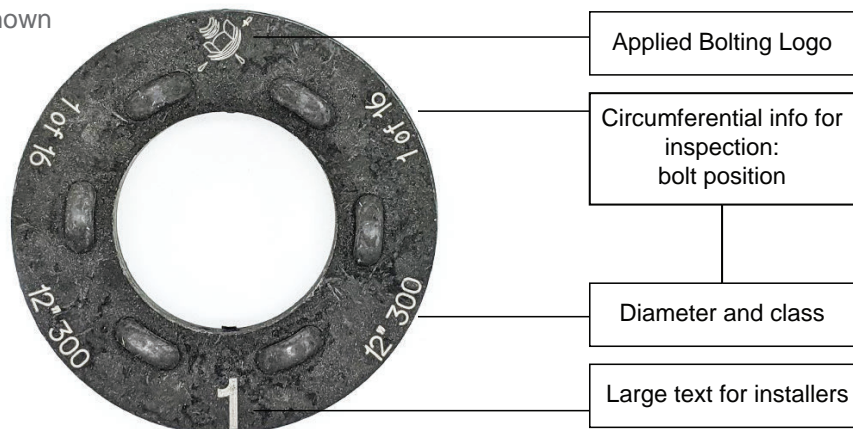
Flange Kits and DTIs

The DuraSquirt® Flange System consists of a kit of DTIs, individually calibrated to account for elastic interactions between each bolt. Like our structural DTIs, each bolt is tightened until DuraSquirt indication media appears. The DTIs are numbered and placed in consecutive order around the flange, and then tightened in numerical order, after an effective snugging operation.⁵



Each DTI is laser marked, detailing the flange diameter, class, and its position number, within the ring. There is a large number for installation crews to position all DTIs around the flange in numerical order, and smaller text along the OD for inspectors, to confirm proper placement.

ABT 12-300 shown



⁴ ASME PCC-1 Appendix A, sec A-2.3 subsection r: Ensuring Correct Use of Additional Joint Components

⁵ An effective snugging operation being defined as applying an accurate torque value determined by an accurate K value, or nut factor, or by utilizing Applied Bolting’s Target Stress DTIs (TS).



The text along the OD is visible even if a nut is threaded on and lists flange diameter and class, as well as the total number of DTIs within the specific flange kit. This prevents DTI kits of the same bolt diameter, and designed for a specific flange, from being used with a flange with a different stud count.

Also, the flange diameter and class label allows inspectors to confirm the proper kit has been deployed in cases where the bolt diameter and count is common across flanges.

Instructions

Each DTI kit includes well-illustrated, easy to read instructions.

Single Pass Flange Instructions
ASME A1t-3 Pattern
16" Class 300 (20pcs)

Recommended setup

WRENCH SIDE

Tightening tool
Recommended but not necessary

Power wrench with capacity of 1600 ft-lb recommended

DuraSquirt DTI (bumps & text face out)

DTI SIDE

Fit-up (no DTIs yet)

1 Insert Four fit-up studs, evenly spaced, one every 4th stud

2 Tighten them to align and stabilize flange.

780 ft-lb (when k=0.15)

Do not bring the flange together with DTIs on fit-up studs. DTIs are for the tightening pass only.

3 Insert and hand tighten the remaining hardware, now including DTIs.

Going counterclockwise from the last fit-up stud place DTI #1 and continue in numerical order, around the flange.

Save and set aside the DTIs for the fit-up studs. They will be installed during the tightening step.

DTIs are counterclockwise so tightening goes clockwise.

Tightening

4 Confirm the DuraSquirt DTIs were installed correctly and the fit-up ones are available, which will get installed in step 6.

5 Tighten #1 DTI (from wrench side) just until it squirts at all six bump locations.

Pro Tip: Make sure stud threads are lubed and wrench is set to max, so it does not stall before squirt indication.

6 Continue in numerical order tightening each DTI until all bumps squirt.

When you reach a fit-up stud, back off the nut, install next DTI, and tighten until squirmed.

Questions? Our experts are here to help. Call us at (802) 460-3100 or email flange@appliedbolting.com

www.appliedbolting.com

7 Continue around, until the last DTI is squirmed. You are done!

Do not re-touch. No multiple passes. Once around and you are done.

Part # 16-300 ABTP-FB-installation guide 10-23-2020

DuraSquirt® Flange System Line Card

Part # 3-300PL = 3" Class 300 Plain DuraSquirt® DTI Flange Kit

Class 300	NPS ⁶ (in)	ABT Kit #	Wt/Kit (lbs.)	Bolt Diameter (in)	# DTIs /Kit
	3	3 - 300	.86	3/4	8
	4	4 - 300	.86	3/4	8
	6	6 - 300	1.30	3/4	12
	8	8 - 300	1.89	7/8	12
	10	10 - 300	3.38	1	16
	12	12 - 300	4.07	1-1/8	16
	14	14 - 300	5.09	1-1/8	20
	16	16 - 300	6.21	1-1/4	20
	18	18 - 300	7.45	1-1/4	24
	20	20 - 300	7.45	1-1/4	24

Class 600	NPS ⁶ (in)	ABT Kit #	Wt/Kit (lbs.)	Bolt Diameter (in)	# DTIs /Kit
	3	3 - 600	.86	3/4	8
	4	4 - 600	1.26	7/8	8
	6	6 - 600	2.54	1	12
	8	8 - 600	3.05	1-1/8	12
	10	10 - 600	4.97	1-1/4	16
	12	12 - 600	6.21	1-1/4	20
	16	14 - 600	9.00	1-1/4	20

DuraSquirt® Flange Systems are only designed to be used with:

1. ASME B16.20 Dual ring spiral wound gaskets, Camprofile Gaskets with Outer Rings, or Camprofile Gaskets with Inner and Outer Rings.
2. ASME B16.5 & ASTM A105 weld neck, raised faced flanges: Weld Neck, Socket Weld, 00000 Threaded, and Blind
3. ASTM A193 B7, A320 L7 and B7M studs.

Each DTI kit is composed of the same number of DTIs as there are bolts in the flange. Kits should be ordered in the same quantity and at the same time as gaskets.

⁶ Nominal Pipe Size

DTI Testing and Compliance

Testing is performed at/in Applied Bolting Technology Products' ISO 9001 accredited laboratory complying with BS EN 10204 Metallic products - Types of inspection documents, Type 3.1.

Testing verified per ASTM E1685, Standard Practice for Measuring the Change in Length of Fasteners Using the Ultrasonic Pulse-Echo Technique.

DTIs sampled per ASTM F1470, Standard Practice for Fastener Sampling for Specified Mechanical Properties and Performance Inspection.

Tested in accordance with ASTM F606, Standard Test Methods for determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, Direct Tension Indicators, and Rivets.

Manufactured in the USA with American made Steel in mercury free environments. Products comply with the requirements of, "Buy America" 49 U.S.C. 5323(j)(1), and the applicable regulations in 49 CFR part 661. DTIs are coated with dry black phosphorous, dry to the touch

ASME PCC-1 2019

10.1 Tightening Method/Load-Control Technique

(e) Proprietary force-sensing devices that can provide accurate and reliable real-time (increasing and decreasing) bolt tension readings/printouts are available from several manufacturers.

APPENDIX A

TRAINING AND QUALIFICATION OF BOLTED JOINT ASSEMBLY PERSONNEL

A-2.3 Training of Fundamentals

(r) ensuring correct use of additional joint components

(4) use of prevailing torque nuts, instrumented studs, reaction washers, tensioning nuts, direct-tension-indicating washers, and other special-purpose accessories.

(5) use of proprietary nuts, washers, etc. There are innovative proprietary nuts, washers, and other mechanical and hydraulic devices that assist the assembly process and may have the capability to improve bolt-load accuracy and reduce scatter. Awareness of those devices should be included. Detailed training on the application of these devices is available from the supplier and/or manufacturer.

.

.