



## **Specification for implementing DuraSquirt® DTIs in accordance with AISC/RCSC 2.12: Alternative-Design Bolting Components, Assemblies and Methods**

DuraSquirt DTIs, are enhanced versions of ASTM F959<sup>1</sup> DTIs that render feeler gages unnecessary. DuraSquirt DTIs are *verification lot* DTIs, per AISC/RCSC section 7, where the *calibrated gap* has been determined per ASTM F606 testing. DuraSquirt DTIs are designed to expel indication media when torquing efforts reduce the *job inspection gap* below the *calibrated gap*. DuraSquirt DTIs are to be installed in accordance with the following, as per the AISC/RCSC 2020 structural bolting specification (AISC A348-20).

Since the *Specification for Structural Joints Using High-Strength Bolts* does not include metric information, additional tables are provided when working with metric fasteners.

### **Pre-Installation Verification Testing**

Three DuraSquirt DTI *bolting assemblies* shall be verified to achieve at least the minimum design tension by the bolting crew and inspector; employing the following procedure: Pre-Installation Verification testing in accordance with AISC/RCSC section 7.1:

1. Insert and snug each *bolting assembly* into a *bolt tension measurement device*, with the DuraSquirt DTI positioned per Figure C-8.1 (b) and AISC/RCSC section 6.2.5.
2. Tighten each *bolting assembly* until the DuraSquirt DTI displays indication media beyond the outer diameter in all bump locations, known as complete indication.
3. Record the achieved tensions compared to AISC/RCSC Table 7.1.
4. A tension that is greater than the value in table 7.1 shall not be cause for rejection.

...it can be expected that a portion of the bolt assembly (the threaded portion of the bolt within the grip length and or the engaged threads of the nut and bolt) will reach the inelastic region of behavior. This permanent distortion has no undesirable effect on the subsequent performance of the bolt.<sup>2</sup> The ultimate shear strength of a bolt is not affected by the pretension in a bolt. Tests on bolted joints indicated that the initial clamping force had no significant effect on the ultimate shear strength.<sup>3</sup>

### **Installation**

Assemblies shall be installed (per connection) by the following procedure and referenced AISC/RCSC sections:

1. Insert and snug *bolting assemblies* in accordance with the requirements of Section 8.1, with the DuraSquirt DTI washer positioned per Figure C-8.1 (b) and AISC/RCSC Section 6.2.5. If complete indications of the DuraSquirt DTIs are achieved while snugging, the identified assemblies shall be replaced.
2. *Bolting assemblies* are then to be fully tensioned from the most rigid part of the joint onward until complete indications are achieved.

---

<sup>1</sup> ASTM F959 3.1.1 *compressible-washer-type direct tension indicator, n*—washer-type element inserted under the bolt head or hardened washer, having the capability of indicating the achievement of a required minimum bolt tension by the degree of direct tension indicator plastic deformation. Hereafter referred to as *direct tension indicator*.

<sup>2</sup> RCSC (2020), *Specification for Structural Joints Using High Strength Bolts*, Research Council on Structural Connections, American Institute of Steel Construction, Chicago, IL. 16.2- 47.

<sup>3</sup> Kulak, G.L., Fisher, J.W., and Struik, J.H.A. (1987), *Guide to Design Criteria for Bolted and Riveted Joints*, (2nd ed.), John Wiley & Sons, New York, NY. pg. 47.



**Inspection**

Routinely inspect DuraSquirt DTIs *bolting assemblies* by the following procedure:

1. Observe the verification testing and adherence to the snug step of installation.
2. After tensioning, confirm complete indication of inspected assemblies. No further evidence or investigation is required in these cases.
3. When prevailing installation methods result in complete bump compression, without complete indication, inspection ratios of complete indication, less than 100%, may be accepted by the site.<sup>4</sup>

**Arbitration**

Assembly installation and inspection may be arbitrated by the bolting crew and inspector by:

1. Tightening 3 assemblies in *bolt tension measurement device* until the device indicates the minimum value specified in AISC/RCSC Table 5.2.
2. Recording the number of locations where indication media appears beyond the outer diameter of the DuraSquirt DTI. The count of indications then forms the minimum for the arbitrated installation and inspection criteria.<sup>4</sup>

<b>Pretension for Pre-Installation Verification Testing per AISC/RCSC Table 7.1, inch series.</b>		
<b>Bolt diameter in.</b>	<b>A325/120 bolts</b>	<b>A490/150/144 bolts</b>
1/2	13	16
5/8	20	25
3/4	29	37
7/8	41	51
1	54	67
1 1/8	67	84
1 1/4	85	107
1 3/8	102	127
1 1/2	124	155

Equal to 105% of minimum bolt pretension, rounded to the nearest kip.

<b>Minimum Bolt Pretension Per AISC/RCSC Table 5.2, inch series.</b>		
<b>Bolt diameter in.</b>	<b>A325/120 bolts</b>	<b>A490/150/144 bolts</b>
1/2	12	15
5/8	19	24
3/4	28	35
7/8	39	49
1	51	64
1 1/8	64	80
1 1/4	81	102
1 3/8	97	121
1 1/2	118	148

Equal to 0.70 times the minimum tensile strength of bolts, rounded to the nearest kip.

<sup>4</sup> Lack of indication may be caused by oversized holes, poor quality hardware, uncured or excessively thick steel coatings, etc. Contact Applied Bolting Technology at (802) 460-3100 or [info@appliedbolting.com](mailto:info@appliedbolting.com) for assistance.



Minimum Bolt Pretension for Pre-Installation Verification Testing, metric series.		
Bolt diameter mm	A325M/8.8 bolts	A490M/10.9 bolts
M12	51	76
M16	96	120
M20	149	188
M22	185	232
M24	215	270
M27	280	351
M30	342	428
M36	499	625

Equal to 105% of minimum bolt pretension, rounded to the nearest kN.

Minimum Bolt Pretension, metric series, per AISC J3.1M.		
Bolt diameter mm	A325M/8.8 bolts	A490M/10.9 bolts
M12	49	72
M16	91	114
M20	142	179
M22	176	221
M24	205	257
M27	267	334
M30	326	408
M36	475	595

Equal to 0.70 times the minimum tensile strength of bolts, rounded to the nearest kN.

### Assembly Lot Details

	Bolt	Nut	Washer	DuraSquirt DTI
Manufacturer				Applied Bolting Technology
Lot Number				
Grade				
Finish				
Diameter				
Length		DuraSquirt DTI Calibrated Gap		



## Verification and Arbitration Results

	Test #1	Test #2	Test #3
Assembly Verification Results (Achieved tensions)			
Indication Count for Arbitration (when needed)			

Site Inspection  
Ratio

--