

## Procedure for Wrench Calibration and Snug Tightening

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### 1. Scope:

This procedure provides the method for calibration of a manual torque wrench or an adjustable impact wrench and the snug tightening procedure to be used in the work.

### 2. Apparatus:

- 2.1 A calibrated bolt tension measuring device.
- 2.2 Spacers and/or washers with proper hole size to adjust bolt length in the tension measuring device.
- 2.3 A rigid mounting for the bolt tension calibrator.
- 2.4 Wrenches, either adjustable impact or manual torque.
- 2.5 An appropriate supply of properly sized, uncoated, lot identified direct tension indicating washers (DTI's) which meet the requirements of ASTM F959. See paragraph 3.3.
- 2.6 Suitable tapered tip flat feeler gauges Range 0.005" to 0.030" in 0.001 inch increments. See paragraph 3.3.
- 2.7 A rigidly mounted steel plate with round hole 1/16" over nominal size of bolts to be installed in structure. Can utilize holes in structural steel members to be erected.
- 2.8 An adequate supply of heavy hex head high strength bolts which meet the requirements of ASTM F3125, nuts and washers to calibrate DTI's. See paragraph 3.3 A.

### 3. Procedure:

- 3.1 Frequency of calibration.
  - A. Each installation wrench shall be calibrated at least once each working day for each bolt diameter, length and grade using fastener assemblies that are being installed in the work.

Wrenches shall be re-calibrated when significant difference is noted in the surface condition or level of lubrication of the bolt threads, nuts or washers. Torque wrenches used for acceptance testing shall be calibrated prior to each test, but not more often than once per day for each bolt diameter length and grade of fastener being tested.

3.2 Calibration procedure, long bolts.

- A. Long bolts shall be of sufficient length so that when installed in the tension measuring device, with a hardened washer under the turned element, at least 3 full threads are exposed between the nut face and the underside of the bolt head when the end of the bolt is at least flush with the outside face of the nut.
- (1) Select 3 bolt, nut and washer assemblies from each diameter, length and grade for which each individual installation wrench is to be calibrated, or for which acceptance testing is to be conducted.
  - (2) Install each bolt, nut and washer assembly into the tension measuring device and install sufficient spacers and/or washers so that at least 3, but not more than 5, full threads are exposed between the nut face and the underside of the bolt head. The element (Nut or bolt head) turned during calibration must be the same as to be turned in the work. A hardened washer must be in place under the turned element.
  - (3) Tighten each assembly using the snug tightening procedure which will be used to snug tight the fasteners in the work. Snug tight is defined as the tightness that exists when the plies of the joint are in firm contact. This may be obtained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Assure the proposed snug tightening procedure does not produce more than 50% of the required fastener tension, as specified by table 1. If so, revise the snug tightening procedure.

Table 1 – Required fastener tension (Kips)

Bolt dia. (Inch)	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2
Grade A325	12	19	28	39	51	56	71	85	103
Grade A490	15	24	35	49	64	80	102	121	148

- (4) When the calibrated installation wrench is to be an adjustable impact wrench, each of the 3 assemblies shall be tightened further and the wrench adjusted or set to cut-out at not less than the minimum tension as shown in table 2. Wrench setting for final installation tightening shall be in the average of the 3 tests.

Table 2

Bolt dia. (Inch)	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2
Grade A325	13	20	29	41	54	59	75	89	108
Grade A490	16	25	37	51	67	84	107	127	155

- (5) When the wrench is to be a manual torque wrench, each of the 3 assemblies shall be tightened further and the torque noted which was required to induce the bolt tension as specified in table 2. Torque shall be measured with the turned element in motion. The torque used for calibration shall be the average of the 3 tests.

### 3.3 Calibration procedure, short bolts.

Short bolts are defined as those lengths which are too short to meet the criteria for long bolts, as described in paragraph 3.2 A.

Wrenches to be used to install short bolts may be calibrated using DTI's. However, DTI's must first be calibrated.

#### A. DTI Calibration.

- (1) Select 3 DTI's of each diameter from the same lot, as identified on the shipping container.
- (2) Using appropriate length bolt, nut and flat washer of the same diameter as DTI, install DTI under bolt head against the face plate of the tension calibrator. Protrusions on DTI must bear on the head of the bolt.
- (3) Install the appropriate adapter in the back of the tension calibrator, to allow flat washer and nut to be installed. Use shims or flat washers to position 3 to 5 full threads between the face of the nut and underside of the bolt head.
- (4) Tighten the nut while holding the bolt head with a suitable wrench, to induce the bolt tension, as shown in table 3.

Table 3

Bolt dia. (inch)	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2
Grade A325	13	20	29	41	54	59	75	89	108
Grade A490	16	25	37	51	67	84	107	127	155

- (5) Using the feeler gauges, measure and record the opening between the DTI face and the underside of the bolt head at each location between the protrusions. The number of protrusions will vary from 4 to 8, depending upon the nominal size of the DTI. Average the measurements for each DTI.
- (6) Average the results from the 3 DTI's. The resulting number becomes the DTI calibration to be used to calibrate wrenches for installation of short bolts of the same diameter as the DTI.

B. Short bolt calibration.

- (1) Select 3 bolt, nut and washer assemblies from each diameter, length and grade for which each individual installation wrench is to be calibrated or for which acceptance testing is to be conducted. Also, select a DTI from the calibrated lot for each bolt assembly.
- (2) Install each bolt, nut, and washer assembly into the proper steel plate (See 2.7) with the DTI under the bolt head. Use sufficient spacers and/or washers, so that at least 3, but not more than 5 threads are exposed between the nut face and the underside of the bolt head.
- (3) With a wrench holding the bolt head, tighten each assembly by turning the nut to obtain a snug tight condition.

Snug tight is defined as the tightness that exists when the plies of the joint are in firm contact. This may be obtained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. See paragraph 3.2 A.(3).

- (4) When the calibrated installation wrench is to be an adjustable impact wrench, each of the 3 assemblies shall be tightened further, until the average clearance under the DTI is equal to the value obtained during DTI calibration. See paragraph 3.3 A.(6). The wrench shall be adjusted or set to cut-out at not less than the DTI calibration clearance.
- (5) When the wrench is to be a manual torque wrench, each of the 3 assemblies shall be tightened further, with the torque wrench, until the average clearance under the DTI is equal to the value obtained during DTI calibration. See paragraph 3.3 A.(6). The torque required to produce this DTI clearance shall be recorded. Torque shall be measured with the nut in motion. The minimum torque used for the final installation tightening shall be the average of the 3 tests.
- (6) DTI's used to calibrate wrenches must be utilized in the same position on the fastener assembly as when they were calibrated on the bolt tension calibrator. Case discussed in paragraph 3.3 A. is the DTI under the bolt head, turn the nut to tighten. This DTI calibration procedure could also be used to calibrate wrenches where the DTI was under the nut and the bolt head was turned. Wrenches cannot be calibrated nor can DTI's be calibrated when the DTI is placed under the turned element.

3.4 Snug tightening procedure.

- A. Bolts shall be installed in all holes of the connection with a hardened washer under the turned element and brought up to a snug tight condition.
- B. Snug tight is defined as the tightness that exists when the plies of the joint are in firm contact. This may be obtained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. The snug tightening procedure used in the work shall be the same snug tightening procedure used when conducting the wrench calibration in paragraph 3.2 A.(3) and 3.3 B.(3).
- C. Snug tightening shall progress systematically from the most rigid part of the connection to the free edges. Start the pattern of each member being spliced at the center of the pattern and work toward all edges of the connection.
- D. Following this initial snug tightening, all bolts in the joint shall again be systematically tightened, as necessary, using a similar pattern until all bolts are simultaneously snug tight and the connection is fully compacted.

**4. Report:**

Report the testing of the bolts in the project diary.

**5. References:**

ASTM F3125  
ASTM F959