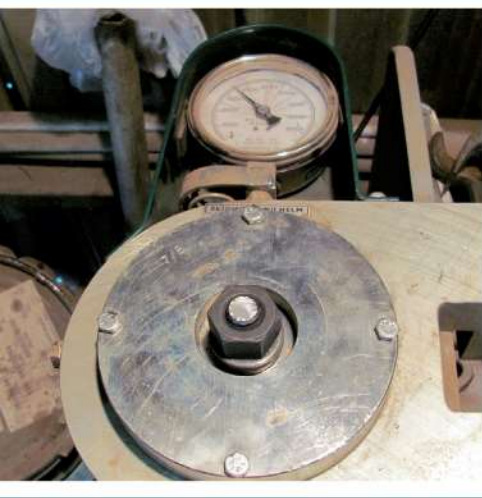




Guidelines for the Qualification of Structural Bolting Inspectors



AASHTO



AASHTO/NSBA Steel Bridge Collaboration

American Association of State Highway
and Transportation Officials

National Steel Bridge Alliance

Preface

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It is intended that Owners adopt and implement Collaboration documents in their entirety to facilitate the achievement of standardization. It is understood, however, that local statutes or preferences may prevent full adoption of the document. In such cases, Owners should adopt these documents with the exceptions they feel are necessary.

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INTRODUCTION

These Guidelines have been developed by the AASHTO/NSBA Steel Bridge Collaboration to define essential factors involved in structural bolting and the qualification of personnel inspecting and monitoring those operations.

This document should be a guide in developing individual training and qualification programs. The recommended elements listed in the Body of Knowledge in Section 5 should be modified to meet specific needs.

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SECTION 1: REFERENCES

The following industry standards and specifications should be used in the development of a qualification and certification program:

- AASHTO *LRFD Steel Bridge Fabrication Specifications*
- American Institute of Steel Construction *Manual of Steel Construction*
- Research Council on Structural Connection (RCSC) *Specification for Structural Joints Using High-Strength Bolts*
- ASTM Standard Specifications as they apply to structural bolting: A563/A563M, F436/F436M, F959/F959M, F3125/F3125M, and F3148.

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SECTION 2: FUNCTIONS

2.1—CAPABILITIES

A qualified Structural Bolting Inspector should be able to perform bolting inspections, conduct audits of field bolting conditions and methods, and ensure that bolting operations conform to project requirements and applicable standards.

The Inspector should be able to identify deficiencies in structural bolting, verify rotational capacity (“rocap” or “RC”) testing, observe pre-installation testing, and verify final bolting conditions.

2.2—DUTIES

Although the Inspector’s duties are defined by each organization, a Structural Bolting Inspector should be able to perform at least all of the following duties:

- a. Interpret drawings and other documents.
- b. Interpret and accept RC test reports, material test reports (MTRs), and manufacturers’ certificates of compliance.
- c. Verify fastener assemblies for correct components, RC lots, material type, grade, and coating; verify bolt head markings and manufacturer and supplier marks, nut markings, and structural washer and washer-type direct tension indicator (DTI) markings, supported by proper documentation.
- d. Verify proper storage conditions.
- e. Verify proper coating (if required), lubrication, and surface condition of bolts, nuts, and washers.
- f. Identify the requirements for washers and ensure adherence.
- g. Verify snug-tight conditions prior to final pretensioning.
- h. Witness performance of pre-installation verification and verify reference marks on components and material before final pretensioning.
- i. Verify the suitability and calibration of equipment used to perform structural bolting activities.
- j. Verify that the knowledge of personnel supervising or performing bolting applications is adequate.
- k. Determine whether bolts may be reused (i.e., loosened and retightened).
- l. Determine and verify required minimum fastener pretension.
- m. Prepare clear, concise reports and verify that pertinent records are maintained.

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SECTION 3: TRAINING/EXPERIENCE REQUIREMENTS

3.1—EDUCATION AND EXPERIENCE

The Structural Bolting Inspector should:

- a. be a high school graduate, or hold a state-approved high school equivalency diploma and
- b. have experience in structural steel bridge fabrication, erection, and/or inspection, and be directly involved with structural bolting operations.

3.2—STRUCTURED TRAINING

Training and qualification recommended by this document may be considered satisfied if documentation can be provided that the Inspector has successfully completed a minimum of eight hours of training offered by an organization or an individual recognized by the Owner. Such documentation should include evidence of satisfying the requirements listed in Section 5.

3.3—EXPERIENCE CREDIT

Structural Bolting Inspectors not meeting the experience guidelines of Article 3.1 should work under the supervision of a qualified Structural Bolting Inspector until such time as the appropriate experience and training is gained.

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SECTION 4: QUALIFICATION

4.1—REQUIREMENTS

The requirements for qualifying a Structural Bolting Inspector under these Guidelines include all of the following:

- a. The Inspector should pass a written test of no less than 50 multiple choice or True/False questions with a minimum of 70 percent correct, proving a general understanding of the Body of Knowledge specified in Section 5.
- b. The Inspector should demonstrate hands-on proficiency by completing or directing the completion of RC testing and pre-installation verification testing using a tension calibration device in the presence of an individual qualified in accordance with this Guide.
- c. The Inspector should remain qualified under these Guidelines, provided that he or she documents ongoing employment involving structural bolting operations and performing inspection duties at least once every six months.

4.2—DOCUMENTATION

The employer of the Inspector should maintain training records (including dates and curricula), completed examinations, evidence of initial demonstrated proficiency, qualification certificates issued, and documentation of inspections performed, including dates, testing, and installation methods.

Qualification certificates should contain all of the following information:

- a. name of the Inspector
- b. statement indicating satisfactory completion of training
- c. statement indicating that the Inspector's qualification is in accordance with this Guide and any other applicable standards
- d. name of trainer and trainer's organization (whether employer or third-party entity)
- e. date of qualification

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SECTION 5: BODY OF KNOWLEDGE

5.1—BOLTED CONNECTION OVERVIEW

This Section delineates code requirements and proper methods for using bolted joints that the Inspector should understand and enforce. The Inspector should understand the terms and definitions used in high-strength bolting, and be familiar with the referenced standards and specifications. The Inspector should also understand the installation and inspection requirements for various types of high-strength bolted joints.

5.1.1—Joint Types

The types of bolted joints commonly used in bridge and highway construction.

5.1.1.1—Slip-Critical

The definition, load transfer method, surface and bolt requirements, typical usage, installation, and inspection of slip-critical joints.

5.1.1.2—Snug-Tightened

The definition, installation requirements, and inspection of snug-tightened joints.

5.1.1.3—Pretensioned

The definition, installation requirements, and inspection of pretensioned joints.

5.1.2—Load Transfer

The difference between various load transfer mechanisms for high-strength bolted joints.

5.1.2.1—Shear/Bearing

Bolts subjected to direct shear at bearing connections in bolted splices.

5.1.2.2—Direct Tension

Effects of direct tension on connections for hangers, prying action, etc.

5.1.2.3—Friction

The types of surface conditions required to obtain proper slip coefficients and the essential variables required for painted surfaces. (See RCSC *Specification for Structural Joints Using High-Strength Bolts*, Appendix A, “Test Method to Determine the Slip Coefficient for Coatings Used in Bolted Joints”.)

5.1.3—Bolt Holes and Slots

The acceptance/rejection quality standards for standard bolt holes, oversized holes, and short- and long-slotted holes including dimensions, reaming, multi-ply alignment, out-of-round, and quality (tears, burrs, etc.). The acceptance/rejection criteria for bolt spacing and edge distance.

5.1.4—Snug-Tightening

The definitions of “snug-tight” for both RC testing and installation. Proper systematic tightening to bring an entire assembly to the snug-tight condition. The acceptable fit-up of bolted parts (flatness, contact) and the condition of faying surfaces.

5.1.5—Bolt Pretension

The principles and methods to tighten bolts in pretensioned and slip-critical joints.

5.2—BOLTING MATERIALS AND USAGE

Know, understand, and be able to properly identify the bolting materials required for a project, ensure the materials’ quality upon receipt and after storage, and select the proper materials and methods for installation.

5.2.1—Bolts

5.2.1.1—Bolt Types

The differences between various types of bolts (heavy hex head, twist-off type, etc.).

5.2.1.2—Material Grades

The differences and common uses for each grade and type of structural bolt (ASTM F3125/F3125M Grades A325, A490, F1852, and F2280 with Types 1 and 3; F3148 with Types 1 and 3), including restricted uses and conditions.

5.2.1.3—Markings, Dimensions, Etc.

The significance of head markings on structural bolts as well as common bolt dimensions and terminology.

5.2.2—Nuts

5.2.2.1—Materials, Markings, Dimensions, Etc.

The significance of markings on structural grade nuts as well as common nut dimensions and terminology.

5.2.2.2—Suitability with Bolts

The acceptable combinations of nuts and bolts for structural bolting applications (see ASTM F3125/F3125M Table 2, F3148 Table 2, and A563/A563M Table X1.1), and the qualification of bolt–nut assemblies.

5.2.3—Washers

5.2.3.1—Material, Dimensions, Etc.

The standard materials and sizes of hardened steel washers for structural applications (see ASTM F436/F436M), and plate or beveled washers for slots or sloping surfaces.

5.2.3.2—Connection Requirements

The correct usage of hardened steel washers in applications with standard, slotted, and oversized holes.

5.2.4—Washer-Type DTIs

5.2.4.1—Material, Dimensions, Etc.

The configuration, interpretation, and sizes of washer-type direct tension indicators used with high-strength bolts (see ASTM F959/F959M).

5.2.4.2—Connection Requirements

The correct installation and verification of washer-type direct tension indicators, including hardened washer requirements based on the turned element, and placement for standard, slotted, and oversized holes.

5.2.5—Coatings

The types of coatings that are acceptable and may be expected to be used on various fasteners (see ASTM F3125/F3125M Table A1.1, F3148 Table 1, and A563/A563M Table A1.1).

5.2.6—Bolt Length/Grip

The correct bolt length for given applications, identify stripping, excessive stick-out, and bottoming-out of nuts.

5.2.7—Reuse of Bolts

The situations in which bolts that have been pretensioned may be reused (see RCSC) and how to check for suitability for reuse.

5.2.8—Storage

Proper job site/shop storage and protection procedures. Include lot segregation and identifying and isolating defective items.

5.2.9—Lubrication

Proper lubrication of nuts and bolts (uncoated, galvanized, and other coatings), the proper methods and materials used for relubrication, and when relubrication is permitted.

5.2.10—Bolted Splices

The requirements for the use of alignment (drift) pins for splice alignment prior to snug-tightening and final tensioning.

5.3—INSPECTION

Know and understand the specific inspection requirements as they apply to the following listed installation methods.

5.3.1—Prior to Installation

Identification of fasteners (type, grade, etc.), proper storage and lubrication, and proper pre-installation verification for the installation method used, including frequency of testing and determination of installation or initial torque if required.

5.3.2—RC Testing

Requirements for RC testing: frequency, number of specimens, procedure, required results, long vs. short bolts, etc. (see ASTM F3125/F3125M, Annex A2 and F3148, Annex A1).

5.3.3—Snug-Tight

Definition of snug-tight and systematic tightening, proper snug-tightening procedures and results, how to identify a snug-tightened condition and verify this condition prior to pretensioning.

5.4—INSTALLATION METHODS

This Article includes items to be verified or observed for specific common fastener installation techniques.

For all methods, understand pre-installation verification, use of correct lengths and sizes of fasteners, correct wrench operation, the difference between torque and tension, proper progression of pretensioning, and use of torque verification if required.

5.4.1—Turn-of-Nut Installation

All requirements of the turn-of-nut installation technique, including proper snug-tightening methods and sequences, match-marking, and required number of turns for the bolts used.

5.4.2—Twist-Off Bolts

All requirements of the installation technique for twist-off bolts, including proper snug-tightening methods and sequences and the required condition of the twist-off splines after snugging and after installation.

5.4.3—Washer-Type DTIs

All requirements of the installation of high-strength bolts using washer-type DTIs.

5.4.3.1—Pre-Installation Verification

Determination of job inspection gap through pre-installation verification, unless gap is specified; thread check after pre-installation verification test.

5.4.3.2—Snugging

Proper snug-tightening methods and sequences, and use of feeler gauge to assess conformance to gap requirements (number of refusals) after snugging.

5.4.3.3—Joint Pretensioning

Use of a feeler gauge or self-indicating features, as permitted, to determine proper bolt pretension based on number of refusals and some visible gap (no “dead flat” washers).

5.4.4—Calibrated Wrench Installation

All requirements of the installation of high-strength bolts using a calibrated torque wrench, including proper snug-tightening methods and sequences, determination of installation torque, frequency of wrench calibration, and proper setting of wrench for achieving installation torque.

5.4.5—Combined (“Torque and Angle”) Method of Installation

All requirements of the installation of high-strength bolts using a combined method of initial torque followed by specified turns of a fastener element, including frequency of wrench calibration, proper setting of wrench for achieving initial torque, application of initial torque to achieve firm contact between plies, match-marking, and required number of turns for the bolts used.

5.5—TIME MANAGEMENT

It is not possible to closely monitor multiple bolting crews. Be aware of crew schedules and indications of good or bad crew technique to determine how often to check each operation for efficient inspection.

5.6—ARBITRATION OF DISPUTES

Be familiar with the correct procedures for arbitrating disputes (see the RCSC section on Arbitration).

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