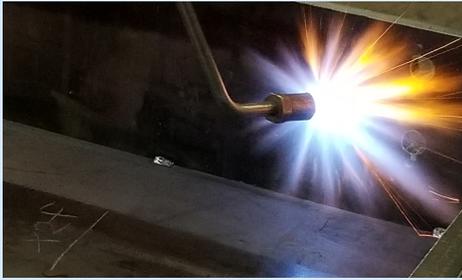


# Steel Bridge Fabrication QC/QA Guidelines G4.1-2019



## PREFACE

This document is a standard developed by the AASHTO/NSBA Steel Bridge Collaboration. The primary goal of the Collaboration is to achieve steel bridge design and construction of the highest quality and value through standardization of the design, fabrication, and erection processes. Each standard represents the consensus of a diverse group of professionals.

It is intended that Owners adopt and implement Collaboration standards 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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## SECTION 1—INTRODUCTION

The purpose of this document is to provide guidance to Owner Agencies, Fabricators, and Contractors for maintaining and ensuring quality inspection and verification standards for fabrication of steel bridges. This document, intended to replace S4.1, provides information that is complementary to applicable welding codes and AISC standards and will be useful for developing a Fabricator Quality Control (QC) System and corresponding Quality System Manual. Duties and responsibilities of the Fabricators and Owner Agencies are addressed. The predecessor to this document, AASHTO–NSBA Steel Bridge Collaboration S4.1, *Steel Bridge Fabrication QC/QA Guide Specification*, described recommended detailed activities for Fabricators and Owners based largely on the AISC certification program, AASHTO/AWS D1.5M/D1.5 *Bridge Welding Code* requirements and a consensus of professionals in the industry. This document has been written with the assumption that applicable welding codes and AISC certification requirements are met. Where AISC certification is not required, Owners and Fabricators should be familiar with applicable AISC requirements and incorporate similar provisions as appropriate. Topics are organized to have similar document structure to the AISC Certification Program for Steel Bridge Fabricators, in order to bring consistency among varying stakeholders and avoid conflicting information. When Sections are referenced herein, they are sections of this document, not the AISC standards. Numbered section references to AASHTO/AWS D1.5 are from the 2015 edition.

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## SECTION 2—DEFINITIONS AND ACRONYMS

Terms used in this document are in accordance with the AASHTO–NSBA Steel Bridge Collaboration standards. Terms that are specifically significant to this document are defined as follows:

**AASHTO**—American Association of State Highway and Transportation Officials

**Acceptance**—All factors used by the Agency (e.g., sampling, testing, and inspection) to evaluate the degree of compliance with Contract requirements and to determine the corresponding value for a given product.

**Agency**—Any organization, constituted under federal, state, or municipal laws that is responsible for administering contracts for highway or transportation construction (see Owner).

**AISC**—American Institute of Steel Construction

**ASTM**—ASTM International

**AWS**—American Welding Society

**BCI**—Bridge Coating Inspector

**CAR**—Corrective Action Report

**CIP**—Coating Inspection Program

**CMTR**—Certified Mill Test Report

**CWI**—AWS Certified Welding Inspector

**Contractor**—The Contractor is responsible for proper completion of all tasks required by the Contract. Subcontractors, including Fabricators, Erectors, and field coaters may be used by the Contractor, but the Contractor retains responsibility for all material, operations, and the final product. The Contractor should permit direct subcontractor interaction with the Owner to expedite the project, but subcontractors must obtain the Contractor’s approval before implementing any proposed modifications to Contract requirements accepted by the Owner.

**Fabricator**—In this document, refers to the facility performing such shop activities as cutting, welding, drilling, punching, bolting, cleaning, and coating of structural steel. The term “Fabricator” also includes project-related agents of the Fabricator, such as those who design proprietary items or prepare shop detail drawings. In some cases the Fabricator may also be the Contractor, but usually the Fabricator is a subcontractor.

**FHWA**—Federal Highway Administration

**Inspection**—The examination by the Owner, Contractor, or Fabricator, of processes and products to verify conformance with Contract requirements.

**Inspector**—When used by itself, the term “Inspector” is to mean either the Owner’s Inspector or the Fabricator’s QC Inspector.

**NACE**—NACE International

**NCR**—Nonconformance Report

**NDE**—Nondestructive Evaluation

**NSBA**—National Steel Bridge Alliance

**Owner**—In this document, “Owner” refers to the Owner Agency paying the Contractor to fulfill the terms of the Contract. The Owner also encompasses those preparing the Contract documents, including the structure’s adequate design, and individuals authorized to represent the Agency during construction, commonly called the “Engineer” and the “Inspector”. The Engineer and Inspector may be employees of the Agency or professional firms contracted by the Agency for the work (see Agency, earlier).

**Owner Inspection**—Inspection and testing are activities carried out by the Owner to confirm that fabricated materials meet the contract documents and the Fabricator is complying with their QSM. Owner inspection could also include acceptance inspection by representatives of a public-private partnership or Design Build entity.

**Owner Inspector**—The Owner’s representative in matters of Owner inspection.

**QC**—Quality Control—The system used by the Contractor/Fabricator to monitor, assess, and adjust their production or placement processes to ensure that the final product will meet the specified level of quality. QC includes sampling, testing, inspection, evaluation, and corrective action (when required) to maintain continuous control of the fabrication or placement process.

**QCI**—Quality Control Inspector—A qualified individual who performs formal QC inspection and testing as defined by the Fabricator’s Quality System Manual.

**QSM**—Quality System Manual—A written document that describes the overall QC operating procedures for the Fabricator. A Fabricator’s QSM documents the internal policies for achieving quality and the assignment of responsibility and accountability for QC within the Fabricator’s organization. It may also describe the minimum QC requirements expected of parties subcontracted to the Fabricator who supply constituent materials or who are involved in handling or processing of the Fabricator’s products. Related terms include Quality Plan, Quality Control Plan, Quality Assurance Manual, and Quality Management.

**RFI**—Request for Information

**SSPC**—Society for Protective Coatings

**Spot Inspection**—The examination of selected portions of the Fabricator’s processes or products to verify conformance with Contract requirements.

## SECTION 3—PLANT CERTIFICATIONS

For the purpose of this guide, plant certification means certification through AISC in the appropriate category for the type of structure being fabricated. This guide also recognizes that the Owner may choose other certification processes as they may deem necessary.

AISC categories for bridge Fabricator are Advanced, Intermediate, and Simple Bridge. There also may be a need for Advanced and Intermediate Bridge certified Fabricators to have the Fracture-Critical endorsement. Refer to Article 2.1 of AASHTO–NSBA S2.1, *Steel Bridge Fabrication Guide Specification* for descriptions of bridge fabrication categories. A Fabricator that supplies bridge components or highway components should be certified to the AISC Metals Component Certification Program.

When a Fabricator applies coatings, the Owner may require certification as defined in Article 3.1 of AASHTO–NSBA S8.1, *Guide Specification for Application of Coating Systems with Zinc-Rich Primers to Steel Bridges*.

It is the responsibility of the Contractor to select a Fabricator that has the correct certifications and endorsements for the work proposed in the Contract documents. It is the responsibility of the Owner to verify that the Fabricator has the correct certifications and endorsements for the work proposed in the Contract documents.

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## **SECTION 4—REFERENCE DOCUMENTS AND PERSONNEL QUALIFICATIONS**

### **4.1—REFERENCE DOCUMENTS**

Contractors, Fabricators, and Owners should have the reference documents and standards necessary to make personnel aware of work requirements. These documents should be consistent with the requirements as defined in the Contract documents and be readily available to those who need them.

### **4.2—PERSONNEL QUALIFICATIONS**

#### **4.2.1—Fabricator**

Personnel should be well-qualified and experienced for the duties they are expected to perform and products they will be fabricating. For example, welding personnel that are qualified and experienced with pipe work may not be suitable to weld bridge work without some additional training and certification. This is applicable for all personnel within a facility. Minimum experience is recommended for all personnel. All personnel must be properly evaluated to ensure familiarity with code and common requirements.

Bridge fabrication generally requires the presence of a CWI when welding operations occur; however, a new CWI employee that comes from a different industry may not be appropriate to perform all phases of inspection.

The following table is a recommendation for minimum amount of bridge fabrication inspection experience. Inspectors who have less experience than recommended should work under the oversight of an Inspector having the recommended experience.

<b>Project Type</b>	<b>Inspection Experience</b>
Simple Bridge	1 year
Intermediate Bridge	2 years
Advanced Bridge	3 years
Fracture-critical members	3 years, where at least 1 of the 3 years shall include fracture-critical inspection.

Coatings Inspectors should have at least one year of experience in surface preparation and coating inspection and have documented training in materials preparation, coatings application, and inspection. Inspectors who have less experience should work under the oversight of an Inspector having those qualifications.

The following is a recommendation for the minimum qualifications for lead coatings Inspectors:

- NACE CIP, Level 2 or 3, or
- SSPC BCI, Level II, or
- 5 years of applicable complex coatings inspection experience in the types of coating systems regularly applied by the Fabricator, or as specified by Contract documents, or
- as defined in the AISC Sophisticated Paint Endorsement when applicable.

Coatings Inspectors must be trained in accordance with applicable AASHTO–NSBA Steel Bridge Collaboration documents.

#### **4.2.2—Owner**

The Owner should visit fabrication facilities to obtain firsthand knowledge of the facilities' qualifications to ensure that minimum standards are maintained. When welding inspection is required, it is recommended that the Owner or their representatives be qualified in accordance with Clause 6 of AASHTO/AWS D1.5. When coating inspection is required, the Owner or their representative should be qualified as a lead Inspector in accordance with Article 4.2.1.

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## **SECTION 5—MANAGEMENT RESPONSIBILITIES**

### **5.1—TEAM EFFORT**

Fabricators and Owners should approach quality control and Owner Acceptance activities as a team effort to facilitate acceptable and timely fabrication.

All parties should cooperate and maintain open lines of communication so that problems can be addressed and resolved in a timely manner.

Owner Acceptance inspection does not relieve the Fabricator from the responsibility to perform required QC testing and inspection.

### **5.2—OWNER**

The Owner should institute specifications requiring Contractors and Fabricators to develop, implement, and maintain Quality Control systems that will result in the fabrication and construction of acceptable products.

The Owner should review a copy of the Fabricator's QSM and maintain on file for future reference. All efforts should be taken to keep the QSM confidential.

Owner Inspection is the prerogative of the Owner. The Owner may monitor the Fabricator's processes and verify conformity of the work with the Contract requirements.

If the Owner opts to inspect, then the Inspector will observe fabrication and perform testing of materials and fabricated products as necessary to confirm the effectiveness of the Fabricator's Quality System Manual (QSM).

The Inspector has the right to observe all phases of the work, from initial receipt and preparation of raw materials through welding, NDE, assembly, cleaning, coating, and shipping.

The frequency and nature of inspection will vary with the type of structure, the experience and abilities of the Fabricator, and other factors that affect the quality of the work.

The Inspector will verify that production quality and fabrication processes satisfy Contract requirements, including the QSM, and accept materials that satisfy the Contract requirements.

The Inspector will not waive items that are contractual obligations of the Fabricator and will not accept material that does not conform to the Contract requirements. However, based on experience and knowledge of the specific situation, the Owner may accept materials and products that are not in conformance with the Contract and may allow material substitutions. Permitted deviations from the Contract are to be documented by the Fabricator, and the Inspector notified that the Owner has accepted the deviation.

The Inspector will not direct the Fabricator's work. However, the Inspector should advise the Fabricator, through designated channels, to discontinue any operation that would result in noncompliance with the Contract requirements.

The Inspector will direct all official communications through designated channels and will not convey judgments about shop quality or employee competence to production personnel.

The Inspector will not divulge a Fabricator's proprietary information to another Fabricator and will not distribute any proprietary information received from the Fabricator except for the contractual needs of the Owner.

### **5.3—FABRICATOR**

The Fabricator's management should define and adopt a commitment to quality. Management should develop, implement, and maintain a QSM that includes a quality policy that is understood, implemented, and maintained at all levels of the Fabricator's organization. Management at all levels should commit to supporting the QSM and should provide the organization and resources necessary to implement and maintain the QSM.

A QSM should be developed to ensure the effective planning, operation, and control of the Fabricator's processes. The QSM should reflect a commitment to quality and describe the quality control activities that will be employed on each project. The QSM should be implemented to ensure that the finished product meets or exceeds Contract requirements.

The Fabricator should provide the Owner with a copy of the QSM.

The Fabricator should provide qualified QCIs who report to personnel responsible for quality control as defined by the QSM. QCIs should not report to production management.

The Fabricator should notify the Owner prior to cutting materials ordered for the Owner's project. Present all documents for the Owner Inspector. They should be organized in a manner that will allow a thorough review of the documentation.

The Fabricator should provide the Owner Inspector full access to shop facilities where the work is being stored, fabricated, or assembled. The Fabricator should make available all materials necessary for inspection of components and assemblies.

The Fabricator should keep the Owner Inspector informed about the production scheduling, QC inspection activities, and pending nondestructive examinations.

## SECTION 6—FABRICATOR CONTRACT DOCUMENTATION REVIEW AND COMMUNICATION

### 6.1—GENERAL

The Fabricator should have a clear understanding of the Owner’s project as it is defined through specifications, design drawings, and general Contract documents, and convey the Owner’s project requirements to the appropriate personnel in order to deliver the project as specified.

### 6.2—CONTRACT REVIEW

The Fabricator should address the following recommendations and assure Contract review and project specifications are readily available to appropriate personnel.

Thoroughly review all applicable original Contract documents, revised Contract documents, and changes received through clarification at the time a project is accepted. Perform the review process again when Contract requirements are revised by clarifications from an RFI, a response to an RFI, or other official communication from the Contractor. Require this review only for the areas affected by the changes.

Contract and project specification review is conducted for each project. The review should identify and address critical project requirements that have impact on project quality and that satisfy the Contract requirements and schedule.

Perform the initial review no later than the Fabricator’s acceptance of responsibility for performing the work. Begin the review during the project estimation or bid process.

In the review, identify, determine, plan, and record the specific project requirements. Define distribution of the record to the responsible individuals in the organization and identify new documented quality procedures that must be created for the work. Consider any issue that affects the Fabricator’s capability to perform the work, including manufacturing, fabrication, and coating requirements.

Conduct and organize the review and the methods to communicate the review results to the next steps in the process. Ensure that the managers and staff with responsibility for execution fully understand the applicable Contract requirements. The distribution process and methods should verify receipt, monitor progress, and establish completion schedules.

### 6.3—CONTRACT REVIEW RECORD

Show in a Contract review record how these items were reviewed:

- **Management of Project**—Record decisions during communications with the Owner, Contractor, and Fabricator during the project, and at completion. Record the Contract revisions that define the project and the revisions of the codes and standards that affect the scope of work. Record the decisions on coordination and follow up with the Owner Inspector. Show evidence of the review of the fabrication/manufacturing schedule.
- **Requests for Information (RFIs)**—Record items during the review and subsequent pre-fabrication meetings that identify RFIs necessary to aid the production of shop and erection drawings.
- **Purchasing**—Record the review of the required materials, sourcing guidelines, FHWA Buy America, and vendor approval, and identify difficult lead times. Identify the need for subcontracting and notify the Owner where applicable. Consider including how material is protected, packaged, or handled for delivery to the shop; certificates of conformance; material test reports; or other details.
- **Detailing**—Review and note the sequencing and delivery requirements. Note the planning necessary to obtain required field measurements and the timing for assembly requirements. Show review of the assembly requirements and required tolerances. Clearly identify the submittals required and the timing necessary to satisfy the Owner’s requirements.

- **Material Identification and Traceability**—Record any deviations from shop standard identification, as well as requirements for the involvement of an Owner’s representative (present for the material traceability and review of Certified Mill Test Reports (CMTR), etc.). Record project-specific requirements related to material identification and traceability.
- **Fabrication/Manufacturing Process**—Review capability and load on equipment and work stations. Consider the relevance and impact of various manufacturing processes on the project.
- **Inspection**—Note any NDE requirements, including frequency or documentation, and unique inspection requirements for coatings. Note any deviations from standard practices, procedures, and methods. Note any independent testing or witnessing requirements.

Show the review and consideration of shift coverage for the Fabricator’s inspection personnel. Appraise the personnel experience required and any requirements for documenting the technical experience and certification of personnel.

- **Training and Qualification**—Identify qualifications needed beyond current levels to meet Contract requirements.

#### 6.4—PROJECT COMMUNICATION

The Fabricator should determine the means of communication as part of the Contract review and before work begins. Record contact information and any specific communication requirements mandated by Contract documents. Identify appropriate personnel for communication with the Owner, Contractor, and the Owner’s Inspector.

Pre-fabrication meetings are one form of communication that facilitates effective quality control and Owner acceptance. Hold pre-fabrication meetings for projects when required by the Contract documents or when any stakeholder calls for a pre-fabrication meeting. The Fabricator may also conduct internal pre-fabrication meetings without the attendance of the Owner, or other stakeholders.

Pre-fabrication meetings should be conducted as described in AASHTO–NSBA Steel Bridge Collaboration S2.1, *Steel Bridge Fabrication Guide Specification*.

If a project pre-fabrication meeting is held, include the pre-fabrication meeting record, including a description of decisions, as part of the Contract Review Record. Conduct the meeting at a time agreeable to all parties.

## SECTION 7—SHOP DETAILING

In addition to Section 7, Detailing, of the AISC Certification Program for Steel Bridge Fabricators, see the following publications for additional guidance:

- G1.1, *Shop Detail Drawing Review/Approval Guidelines*
- G1.3, *Shop Detail Drawing Presentation Guidelines*

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## SECTION 8—FABRICATOR DOCUMENT AND DATA CONTROL

Development of written procedures is crucial for document and data control, and to the overall performance of the Fabricator's QC system. Addressing such items as the QSM and other Contract documents provides direction for the coordination of the Fabricator QC and Owner Inspector interaction. This written procedure should clearly define what and how documents are controlled.

The written procedure should be the master document with headings which address:

- The QSM.
- Contract documents (dissemination and revision control).
- Shop and erection framing drawings.
- Detailing standards.
- All documented procedures related to the fabrication of a project.

### 8.1—REVIEW AND APPROVAL

Prior to issue and release, documents are reviewed for adequacy, correctness, and conformity to quality policies. A document is considered to be formally issued when it is authorized and approved for release by the issuing authority. Documents that require more than one approval signature should clearly indicate how many and which signatures are required for approval and issue.

If electronic copies are used, only accepted and authorized electronic documents should be posted in the controlled files on a network.

Some document forms that are used for data gathering (e.g., traveler, inspection forms) may not directly identify the approving and releasing authority. These document forms should be controlled. A record of the approval and release is maintained by a system administrator or another authorized person who posts the document on the network or in a master file.

A master file of all types of documents should be maintained. The master file can be made up of lists in the form of a log, catalog cards, computer database, etc. The file should identify each issued document by its title, code/number, date of issue, the last revision level, and distribution (if not otherwise provided).

Data records that are specified in the QSM, such as completed travelers and NDE reports, are generated at the shop floor level. The completed data form should be made readily available to the Owner Inspector for review. Signatures/initials by authorized personnel indicate accuracy of the data.

Unnecessarily long, complicated, and bureaucratic procedures should be avoided. Documents must be readily understandable by those who are expected to use them.

The scope of the Fabricator's review of Contract documents and subsequent changes would typically include information being complete and accurate, with identification of any revisions, the most current revision level, and verification that the document has been accepted by the Owner's issuing authority. A path of action should be defined by the Fabricator if errors are detected or completeness is lacking which could cause confusion.

When shop drawings have been prepared, accepted, and released for fabrication, it is not suitable to introduce Owner's documents, especially drawings, on the production floor in their original form. Any consolidated and re-interpreted documents are reviewed and accepted prior to release. These should be controlled as if they were original Owner's documents. Original Owner's documents should be preserved and be readily available for reference.

Only accepted documents may be used in production or inspection operations. The acceptance is indicated by a note stating that the document is accepted for production use and a signature of authorized personnel as defined by the QSM.

### 8.2—REVISION CONTROL

It is common that someone other than the originator of a document would request the issue of a new document or revision of an existing one. A draft of the proposed document or revision should be submitted to the responsible manager to review, approve, and re-issue. Final revisions should always rest with the same function and authority level that authorized the original document, unless specifically designated otherwise. Revisions can be made by handwritten corrections but must be signed and dated. Issuing of revised documents should follow the same rules that

apply to initial issues. Revisions of documents are distributed to the same personnel and locations as the original issues. Access should be limited to files with superseded revisions of controlled documents.

It is important to clearly define, in the revision procedure, when a document is considered to be formally issued. Typically, this is when it is authorized with the required approval signatures.

All active quality procedures and documents must show the latest revision. Ideally, a master index should reflect all active procedures and documents along with their revision level. Contract documents, including design drawings and Owner change orders, must show the latest revision level. Any shop and erection framing drawings must show the latest revision level of each document.

It may be customary to print paper copies of electronic documents for reference or use. It is difficult to control printed copies. How the Fabricator chooses to deal with uncontrolled printed copies should be addressed in the QSM.

### **8.3—ACCESS**

Electronic controlled documents can be posted on the network and made available for viewing and printing from computers and terminals. Uncontrolled copies of documents should not be used by personnel or outside parties who manage or verify work.

### **8.4—OBSOLESCENCE**

Masters and copies of obsolete documents are sometimes retained for preservation of knowledge or legal reasons.

Archives of historical documents such as old drawings, specifications, reports, standards, samples, and so forth can be considered inactive, and neither maintained nor controlled unless as specified in Article 9.1.

### **8.5—TRANSMITTAL**

A transmittal system to indicate the status and distribution of controlled documents should be defined in the QSM.

## SECTION 9—FABRICATOR CONTROL OF QUALITY RECORDS

The Fabricator should develop a documented procedure that identifies all controllable records, their location (plus backup location if electronic), who maintains the records, retention period, and method of disposal. The matrix table shown below is one way to record this information. The table provides an **example** of some typical quality records, which is not necessarily all-inclusive.

Identification	Collection (list of items in category)	Storage (location)	Retrieval and backup of electronic data (location)	Maintenance	Retention (time duration)	Disposal (method)
Contract review						
Contract clarifications						
Design change records, including Contract construction changes and addenda						
RFIs with Owner responses						
Drawing logs						
Mill and consumable purchase orders						
Manufacturers' Test Reports						
Certificates of Compliance						
Inspection records						
NDE reports						
Radiographs, if retained by the Fabricator rather than the Owner						
Records or summaries of nonconformance reports						
Corrective action reports						
Training records						
Subcontractor and supplier qualifications and evaluations						
Internal and external audit records						

Records are identifiable to the product, person, or event to which they pertain. Records are dated and identify the person who established the record.

For projects that are small or simple, Fabricators sometimes prefer to keep records on shop drawings rather than creating additional forms for documentation. This practice is acceptable as long as all pertinent information can reasonably be maintained and conveyed.

**9.1—RETENTION OF QUALITY RECORDS**

Retention times of the various quality records, specified in the QSM, should be documented in a procedure for control of quality records. The retention periods should be at least long enough to permit evaluation of the records during the course of project construction unless a longer period is required by Contract or government regulation, and not less than the duration of any warranty provided by the Fabricator.

**9.2—AVAILABILITY OF QUALITY RECORDS**

Specific quality records required by Contract or regulation should be made available for review and evaluation by either Fabricator QC staff or Owner Acceptance staff during the length of time specified in the Quality Plan or Contract documents.

## **SECTION 10—FABRICATOR PURCHASING**

Purchasing and subcontracting are essential tasks for all Fabricators. It is essential that the Purchasing function be formalized to support the quality initiatives of the Fabricator and provide a platform to ensure the Subcontractors and material suppliers engaged are held, at a minimum, to a similar level of accountability.

### **10.1—FABRICATION, COATING, DETAILING, AND THE NDE SUBCONTRACTOR**

A robust and detailed purchasing program can mitigate the risks of subcontracting and promote effective partnering. If the Fabricator chooses to subcontract fundamental tasks that are considered intrinsic to their own operation, it is imperative that the same level of certification is to be expected of their vendor partner. Ongoing assessment and evaluation are key elements to effective active management of the relationship with the Subcontractor.

It is recommended that the Fabricator forge a relationship with its Subcontractors to ensure that the relevant portions of the Fabricator's QSM are fully embraced by the Subcontractor.

### **10.2—SELECTION AND EVALUATION OF SUBCONTRACTORS AND SUPPLIERS**

It is in the best interests of all parties to take proper steps to ensure subcontractors and suppliers acknowledge and take no exceptions to the quality initiatives conveyed by the Fabricator. The QSM of the Fabricator as it relates to subcontractor requirements should be accepted in its entirety or with mutually-accepted modifications. If modifications are made, they must be documented. Suppliers that provide products that affect the quality of the Fabricator's product should have their own quality policies that will meet the objectives of the Fabricator's QSM. Evaluation and selection, as well as ongoing review, are the responsibility of the Fabricator to ensure compliance to the QSM. Continued compliance remains an active objective of both the vendor and the Fabricator. Evaluations could take the form of, but not be limited to, independent audits, self-audits, and reviews of the subcontractors' and suppliers' quality records.

### **10.3—PURCHASE ORDERS AND SUBCONTRACTS**

Purchase orders and subcontracts are tools for conveying the requirements of the contractual relationship between the Fabricator and the material suppliers and service providers. They are not limited to a singular format, but can reflect variable formats as required to properly define the terms and conditions of the purchase and supply agreement. This document should be detailed and reflect all pertinent information as defined by industry standards to convey the project requirements the Fabricator is bound to, as well as the scope of supply agreed to by the Fabricator and the vendor.

### **10.4—ACCEPTANCE OF PURCHASED PRODUCT, MATERIALS, AND SERVICES**

The Fabricator's QSM must include provisions for acceptance of the material or finished product beyond that of receipt. These provisions should be defined as it relates to the products or services provided and should be conveyed as part of the purchasing process. All documents deemed essential by the Fabricator should be maintained for future reference as defined in the Fabricator's documented procedure covered in Section 9 for control of quality records.

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## **SECTION 11—MATERIAL IDENTIFICATION BY FABRICATOR**

The Fabricator's material identification procedure should describe how materials must be marked for identification from the point of receipt of material, through fabrication, and final shipment of the product to assure incorporation of the correct material into the final product.

Receipt inspection by the Fabricator should verify the material received is in conformance with the purchase order and project specifications. During the fabrication process, the Fabricator should identify and track material for all members requiring traceability. This includes the correlation of mill-identified materials with shop drawing piece marks. The Fabricator should maintain a documented procedure or a marking method that will identify material type and grade which provides traceability. Suggested ways to provide traceability include piece, assembly, or group numbering. The Fabricator should mark individual pieces during assembly and issue cutting instructions using a system that will maintain the identity of the original piece. Transfer of the material heat numbers by use of permanent paint markings or by low-stress stencils should be per the Fabricator's approved identification system. The process of transferring the heat numbers should be performed as soon as the material enters the shop and carry all markings on each piece throughout final fabrication. All numbers should be transferred before cutting primary structural steel bridge members into smaller sections. A loss of traceability of material for primary bridge members may render the section unacceptable for use.

A final report should detail the identification of fabricated material along with the approved CMTR. Logs recording required material identification for the component parts of finished pieces should be included in the final documentation package to the Owner.

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## **SECTION 12—FABRICATION PROCESS CONTROL**

The Fabricator should develop documented procedures for process control necessary to consistently produce an acceptable product. The procedure should show inspection points. If inspection is at less than 100 percent frequency, and the frequency is not defined in the Contract documents, the procedure should include a sampling plan.

The means and methods, where possible, should follow industry standards, Manufacturer's recommendations, product data sheets, and Contract documents. When conflicting situations develop, agreement must be achieved between the Fabricator and Owner regarding the defining constraints.

Innovative and progressive technologies are essential for mutual benefit and growth of the industry. These should always be considered by the Fabricator and Owner.

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## SECTION 13—INSPECTION AND TESTING

### 13.1—INSPECTION

The Fabricator should define quality control actions to address requirements for inspection as listed in this section.

Quality control may require formal, documented inspection activities by the QCI. Alternatively, informal monitoring activities conducted by production personnel may suffice if all of the following conditions are met:

- Production personnel are trained in acceptance criteria
- Production personnel are trained to be responsible for evaluating the work and noting noncompliance items. All non-compliances should be documented and turned over to QCI for further action.
- QCI monitors production personnel performing inspection.
- QCI performs spot inspection of the work

If applicable, include the inspection or monitoring frequency established by the Fabricator. The extent of monitoring may be less than 100 percent, provided the following criteria are considered:

- Contract documents, code, and specification requirements
- The defined sampling plan
- The demonstrated consistency or variability of the process
- Recent history of documented nonconformances.

The Fabricator should describe QCI recordkeeping. For inspection, records must be detailed and must be initialed by QCIs indicating conformance with Contract requirements and agreed-upon corrective actions required for NCRs.

### 13.2—NONDESTRUCTIVE EVALUATION

The Fabricator should establish and follow a practice that satisfies Contract requirements and conforms to the AASHTO/AWS D1.5M/D1.5 *Bridge Welding Code* or other applicable welding code and applicable ASNT SNT-TC-1A requirements and should include the following:

- Identification of a certified ASNT Level III in the applicable methods (may be an employee or a consultant)
- Written practices approved by the Level III
- NDE Level II certification of practicing Inspectors in the applicable methods
- NDE Level I certification of apprentice Inspectors, with proper Level II oversight
- Applicable code requirements for procedures.
- Where contracted services are used for NDE, ensure that the NDE agency's staff also satisfies the applicable ASNT requirements and that copies of current NDE certifications are on file.
- Provide a copy of the written NDE practices to the Owner upon request.
- Make NDE training and certification records available for the Owner's review.

The Owner's Inspector should be notified of all NDE to facilitate witnessing. Copies of all QC test results and records should be readily available for the Owner's Inspector upon request.

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## **SECTION 14—FABRICATOR’S CALIBRATION AND VERIFICATION OF INSPECTION MEASURING AND TESTING EQUIPMENT**

### **14.1—INSPECTION AND TESTING EQUIPMENT**

- Check and calibrate testing equipment in accordance with applicable standards, codes, and Contract requirements.
- Verify the accuracy of the equipment at the frequency designated in the QSM.
- Maintain calibration records and make them readily accessible.
- Where appropriate, identify the personnel and entities responsible for the calibration and record keeping of various types of equipment.

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## SECTION 15—CONTROL OF NONCONFORMANCE

The Fabricator's QSM should include procedures to cover nonconformances. These procedures should be implemented when any aspect of the Fabricator's processes, or the results of the processes, do not conform to the QSM or the Contract requirements. The nonconformance procedures should ensure the following:

- The responsibilities and authorities for the management of nonconformances are identified. This applies to both product and process nonconformances.
- Nonconforming processes are identified and evaluated, and corrective action is taken as necessary.
- Nonconforming products are identified and, if necessary, separated from conforming product if future tasks are impacted by the nonconforming condition.
- Nonconformance documentation can be initiated by the Fabricator, the Owner or any stakeholder bound by the Contract requirements. It is the responsibility of the party documenting the nonconformance to identify the portion of the Contract requirements that the process or product does not satisfy.
- When the Fabricator proposes accepting a nonconformance "as-is" or with remediation not fully meeting Contract requirements, the Fabricator, Owner, and the Contractor (if it impacts them), should conduct an evaluation of the proposed action by the Fabricator to determine its acceptability. Upon acceptance, revised drawings should be provided to all affected parties. If the proposal is not accepted, the nonconformance should be corrected to meet Contract requirements, which could include replacement of the product.
- Final acceptance of any remediation effort is typically by the Owner.
- Completed documentation includes product identification, the nature of the nonconforming work, disposition of nonconformance, and the review and approval status of nonconforming work.
- Where the evaluation indicates that nonconformances could recur or there is doubt about the compliance of the Fabricator's operations with its own QSM, the corrective action procedures in Section 16 are followed.

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## **SECTION 16—CORRECTIVE ACTION**

The Fabricator should have procedures for corrective action in response to nonconformances. The procedures should include a method of tracking corrective actions.

Corrective actions should match the significance of the nonconformance. Corrective actions should be selected that will most likely eliminate or prevent the nonconformance from reoccurring. Corrective actions should have a timeline for completion.

A corrective action plan should start with an investigation into the root cause of the nonconformance. Appropriate personnel should be designated to author the corrective action plan and implement a corrective action for nonconformance. The Fabricator should submit the completed corrective action documentation to the Owner for review and acceptance, if required. Corrective actions resulting from internal audits need not be submitted to the Owner.

The Fabricator should implement, monitor for effectiveness, and document the results of the corrective action.

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## **SECTION 17—HANDLING, STORAGE, AND DELIVERY OF PRODUCT AND MATERIALS**

All product and materials should be handled with proper equipment and rigging, as well as stored and loaded for shipment using proper dunnage and restraints to ensure compliance with all applicable regulations.

The Fabricator should develop a documented procedure to promote safe and repeatable material handling, and storage, and delivery techniques. Any items that are unique, or non-standard, should be addressed by customized product- and/or project-specific handling, storage, and delivery guidelines.

Final shipment of fabricated structural steel will be approved by the Fabricator's QC personnel designated within their QSM, and may also include the Owner's representative. A final report detailing final acceptance of fabricated material along with signed bills of lading and approved shipping reports should be included in the final documentation package to the Owner.

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## SECTION 18—FABRICATOR TRAINING

### 18.1—GENERAL

AISC requires that personnel responsible for functions that affect quality, including detailers, machine operators, fitters, welding personnel, coating applicators, and Inspectors shall receive initial and periodic documented training. Inspectors should be trained in all facets of the fabrication they will be responsible for inspecting, but hands-on training in the use of fabrication tools and equipment is not necessary.

Training, comprehension, and retention is a shared responsibility among all personnel in the organization, and accountability for application is essential for the long-term success in terms of building quality into the product. Personnel providing training should have appropriate training or experience in the subject they are teaching. Evaluate student comprehension of course material and document successful completion.

Training records are quality records controlled as described in Section 9.

The following outlines general training requirements and topics that the Fabricator should consider in their training program in addition to employees' individual relevant prior experience. Topics should include training in the following areas:

#### 18.1.1—Specifications, Codes, and Standards

Personnel should be trained and familiar with the specifications, codes, and standards commonly applicable to their role in the fabrication process. Some examples include:

- AASHTO/AWS D1.5M/D1.5 or other applicable welding code
- ASNT SNT-TC-1A or CP-189
- AISC certification programs
- AASHTO–NSBA Steel Bridge Collaboration documents
- Owner standard specifications
- Various SSPC, NACE, and ASTM standards as referenced in the Contract documents

#### 18.1.2—Material Handling

Personnel should know the provisions of ASTM A6/A6M. Personnel should be familiar with the QSM regarding traceability and procurement documentation of incoming material. Personnel should be given on-the-job training with the appropriate tools and equipment for material handling.

All personnel should be trained in the proper methods to handle, support, and secure material to mitigate damage and associated repair.

Proper tie-down and use of softeners should also be part of the training program.

#### 18.1.3—Material Preparation

On-the-job training with the appropriate tools and equipment for material preparation (cutting, drilling, punching, etc.) should provide the personnel an awareness of proper preparation techniques and appearance of properly prepared materials. The personnel should also know the appropriate preparation tolerances involved.

#### 18.1.4—Fitting, Fastening, and Shop Assembly

Personnel should be given on-the-job training with the tools used in fitting. This training should include proper fitting techniques, appearance of properly fitted assemblies, and knowledge of the appropriate tolerances involved.

The personnel must be capable of reading shop drawings and assembly diagrams, including match-marking systems for components of bolted field splices. Personnel involved in bolting operations should be trained and knowledgeable in proper bolting and tensioning methods. Training should include rotational capacity testing and preinstallation verification testing.

### 18.1.5—Welding

The personnel should have knowledge of welding procedures, welding procedure specification requirements, types of welding and welding limitations. They should also have knowledge of good welding workmanship. Visual inspection is the primary weld inspection method, and welding personnel should receive on-the-job training in this area from a qualified Inspector. The personnel should receive training in the use of weld inspection tools, such as fillet weld and cam type gages. The personnel must learn what constitutes satisfactory welds and what constitutes unsatisfactory welds. Personnel should also be trained in the usage of meters and gauges used to verify the parameters of the welding operations.

### 18.1.6—Nondestructive Evaluation

Personnel performing required NDE including the following methods should be certified at the appropriate level:

- visual testing
- liquid penetrant testing
- magnetic particle testing
- ultrasonic testing
- radiographic testing
- phased array ultrasonic testing

### 18.1.7—Surface Preparation and Shop Coating

Personnel should receive training for surface preparation related to coating requirements, machining, and faying surfaces for slip-critical connections.

Personnel should receive training in the use of various surface comparators and measuring tools. Training should also include cleanliness and profile requirements of the various coating systems.

Personnel should receive training and experience in the use of instruments that measure dew point, relative humidity, surface and ambient temperatures, and their importance to the various coating systems and Manufacturers' recommendations. Personnel should also be trained in the use of wet and dry film thickness measuring devices.

### 18.1.8—Reporting and Documentation

Personnel should receive training regarding the importance of accurate and detailed reports issued in a timely manner.

Final documentation is important to a complete project. Training should include the importance of traceability of material and material test reports from the mill.

## **SECTION 19—AUDITS**

### **19.1—FABRICATOR**

The Fabricator should perform an internal audit of its QSM annually to evaluate the degree of production compliance and effectiveness of implementation. Different areas of the QSM may be audited independently and at different times and frequencies, as long as each area of the QSM receives an audit at least once every 12 months.

A management representative or other qualified individual should conduct the audit. Auditors typically do not have direct responsibility or involvement for the areas they audit. Exceptions may be made under circumstances requiring a specific skill or special knowledge of a process.

The auditor should prepare a written audit report detailing the audit, including observed findings and nonconforming conditions. A written record of each audit should be provided by the auditor and should be kept on file as defined in the Fabricator's documented procedure covered in Section 9.

Where findings are identified that require corrective actions, they should be implemented in accordance with Sections 15 and 16. Follow-up of the corrective actions is necessary in order to verify the effectiveness of the actions. The follow-up timing should be defined as an element of the corrective action documentation.

### **19.2—OWNER**

Owners may choose to perform audits of Fabricators' QSMs in response to specific or systemic problems identified during fabrication, as a general monitoring method, or as part of a process to approve Fabricators to perform work. The Owner may require either a full audit on all areas of the QSM, or a partial audit on specific areas of concern or emphasis.

The auditor should prepare a written audit report detailing the audit, including observed findings and nonconforming conditions. After the Owner evaluates all findings and the status of corrective actions for findings and nonconforming conditions, a summary should be forwarded to the Fabricator so that corrective actions may be planned and implemented. The results of those actions should be documented and submitted to the Owner.

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