



Steel Bridge Fabrication QC/QA Guide Specification

AASHTO/NSBA Steel Bridge Collaboration



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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AASHTO Document No: NSBASBFQC-1-OL

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2001–2002

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Steel Bridge Fabrication QC/QA Guide Specification

Table of Contents

Introduction	1
Part A – General	2
Section 1: Definitions	2
1.1 Contractor	2
1.2 Engineer	2
1.3 Fabricator	2
1.4 Inspection	2
1.5 Owner	2
1.6 Quality Assurance (QA)	2
1.7 Quality Assurance Inspector (QAI)	2
1.8 Quality Assurance Plan (QAP)	3
1.9 Quality Control (QC)	3
1.10 Quality Control Inspector (QCI)	3
1.11 Quality Control Plan (QCP)	3
1.12 Spot Inspection	3
Section 2: Responsibilities	4
2.1 Team Effort	4
2.2 Fabricator	4
2.3 Owner	4
2.4 Prefabrication Meetings	5
Section 3: Qualifications and Equipment	6
3.1 QCI and QAI Fabrication Inspection Experience	6
3.2 QCI and QAI Coatings Inspection Experience	6
3.3 Recommended Inspection Equipment	6
Part B – Quality Control	8
Section 4: General	8
4.1 Quality Control Plan	8
4.2 QAI Facilities	8
4.3 Inspection and Testing Equipment	9
4.4 Control of raw materials	9
4.5 Welding Procedures and Consumables	9
4.6 Nondestructive Examination	9
4.7 Nonconformance Control	10
Section 5: Certifications and Qualifications	11
5.1 QCP Requirements	11
5.2 Fabricator Certifications	11
5.3 QCI Certifications and Qualifications	11
5.4 Welder/Welding Operator Qualifications	11
Section 6: Documentation	13
6.1 QCP Requirements	13
6.2 Records	13
6.3 Material Traceability	13

Steel Bridge Fabrication QC/QA Guide Specification

Section 7: Inspection Procedures	14
7.1 QCP Requirements for Inspection.....	14
7.2 Preparation of Material.....	14
7.3 Fitting	14
7.4 Welding	14
7.5 Cambering, Curving and Straightening.....	15
7.6 Shop Assembly of Main Members.....	15
7.7 Cleaning	15
7.8 Coating	15
7.9 High-Strength Fastener Shop Installation	16
7.10 Loading and Shipping of Fabricated Members	16
Part C – Quality Assurance	17
Section 8: General	17
8.1 Qualifications of the QAI	17
8.2 Scheduling.....	17
Section 9: QAI Responsibilities	18
9.1 Role of the QAI	18
9.2 Interaction with the Fabricator Quality Control Inspector	18
9.3 Interaction with the Engineer	18
9.4 Interpretation of the Contract	18
9.5 Fabrication Observation	18
9.6 Nonconforming Materials and Workmanship	18
9.7 Final Acceptance of the Work.....	19
Section 10: Documentation and References.....	20
10.1 Familiarization with Requirements.....	20
10.2 Required Documents	20
10.3 Use of Non-Approved Shop Drawings.....	20
10.4 Quality Assurance Inspector Records and Reporting	21
10.5 Mill Test Reports	21
Section 11: Quality Assurance Functions	23
11.1 Inspection of Raw Materials	23
11.2 Inspection of Fabricated Members	23
11.3 Assembly	24
11.4 Welding.....	24
11.5 Use of Approved Welding Consumables	25
11.6 Nondestructive Evaluation.....	25
11.7 Coatings	25
11.8 Bolting	26
11.9 Final Inspection and Loading for Shipment	26
Commentary	27

Introduction

This document is divided into three parts:

Part A: General – Describes general requirements and guidelines applicable to both Owners and Fabricators.

Part B: Quality Control – Includes minimum requirements for a Fabricator’s quality control program, with emphasis on the development and implementation of a quality control plan. The Fabricator should have one plan for all work, comprehensive enough to address all of the points covered in Part B, but flexible enough to apply to the variety of projects that will be fabricated. The Fabricator may want to include addenda to address specialty work.

Fabricators should provide a copy of their quality control plan to Owners to build the Owner’s confidence in the Fabricator’s means and method for achieving work that will satisfy Contract requirements. Owners may offer comments to the Fabricator about the plan as appropriate.

However, the Owner must recognize that successful implementation of the plan depends on keeping the plan simple and flexible so that it may apply effectively to the wide variety of projects undertaken in the shop. Fabricators should not have to rewrite a plan for each project or for each Owner.

Part C: Quality Assurance – Includes minimum requirements for an Owner’s quality assurance program. The Owner may implement Part C as a quality assurance plan directly. Future Collaboration work will include a “Quality Assurance Practice” that will provide more detail about the work to be performed by the quality assurance Inspector.

Should conflicts arise between any requirements in this manual and the Contract documents, the Contract documents take precedence in all instances.

Part A – General

Section 1 Definitions

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 below.

1.1 Contractor

The Contractor is responsible for proper completion of all tasks required by the Contract. Subcontractors, including fabricators, erectors, and field painters, 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 inform the Contractor of any proposed modifications to Contract requirements accepted by the Owner.

1.2 Engineer

In this document, the Engineer is the Owner’s authorized representative, responsible for monitoring of the Fabricator’s work, and other duties and responsibilities detailed by the Owner. The Engineer has the authority to allow exceptions to Contract document requirements.

1.3 Fabricator

In this document, “Fabricator” refers to the facility(ies) performing such shop activities as cutting, welding, drilling, punching, cleaning and painting of structural steel. “Fabricator” also includes any agents of the Fabricator, such as those who prepare shop detail drawings. In some cases the Fabricator may also be the Contractor, but usually the Fabricator is a subcontractor.

1.4 Inspection

The examination by the Owner or the Fabricator of processes and products to verify conformance with Contract requirements.

1.5 Owner

In this document, “Owner” refers to the entity paying the Contractor to fulfill the terms of the Contract. The Owner also encompasses the following: those preparing the Contract documents, including those responsible for the structure’s adequate design; and those authorized to represent the Owner during construction, commonly called the “Engineer” and the “Inspector”. The Engineer and Inspector may be employees either of the Owner or of professional firms contracted for the work.

1.6 Quality Assurance (QA)

Quality assurance encompasses the activities undertaken by the Owner to verify that the final product satisfies Contract requirements, including verifying that quality control is performed effectively.

1.7 Quality Assurance Inspector (QAI)

The Owner’s representative responsible for duties specified in the Quality Assurance Plan, with the authority to accept work that meets Contract requirements.

Steel Bridge Fabrication QC/QA Guide Specification

1.8 Quality Assurance Plan (QAP)

The formal written document (based on Part C of this standard) that establishes the activities the QAI will follow to monitor fabrication and verify that specified criteria are achieved.

1.9 Quality Control (QC)

The activities undertaken by the Contractor/Fabricator to ensure a product is provided that meets Contract requirements.

1.10 Quality Control Inspector (QCI)

A qualified employee of the Fabricator who performs inspection as defined by the Fabricator's Quality Control Plan.

1.11 Quality Control Plan (QCP)

The formal written document (based on Part B of this standard) prepared by the Fabricator that describes the policies and procedures used to verify that fabricated steel will satisfy the Contract requirements.

1.12 Spot Inspection

The random examination of the Fabricator's processes or products for verification of conformance with Contract requirements.

Section 2 Responsibilities

2.1 Team Effort

- 2.1.1 The Contractor, Fabricator, and the Owner will approach quality control and quality assurance as a team effort to facilitate accurate and timely construction.
- 2.1.2 All parties will cooperate and maintain open lines of communication so that problems can be quickly addressed and resolved.
- 2.1.3 The QAI's verifications do not relieve the Fabricator from the responsibility to perform required testing and inspection and produce a product satisfying the Contract.

2.2 Fabricator

- 2.2.1 Provide quality control to ensure that the finished product meets or exceeds Contract requirements.
- 2.2.2 Develop and implement a QCP that reflects a commitment to quality and describes the quality control activities that will be employed on each project.
- 2.2.3 Provide the Owner with a copy of the QCP.
- 2.2.4 Provide qualified QCIs who report to personnel responsible for quality control as defined by the QCP.
- 2.2.5 Notify the Owner at least two weeks prior to cutting materials on all new projects.
- 2.2.6 Present all material for the QAI's acceptance in a manner that will allow a thorough inspection of components and assemblies.
- 2.2.7 Provide the QAI full access to shop facilities where the work is being stored, fabricated, or assembled.
- 2.2.8 Keep the QAI informed about the production scheduling, QC inspection activities and pending nondestructive examination.

2.3 Owner

- 2.3.1 The Owner will monitor the Fabricator's control of the operations and verify conformity of the work with the Contract requirements.
- 2.3.2 The Owner will keep the Fabricator's QCP confidential.
- 2.3.3 The QAI will observe fabrication (either on a schedule or at random) and perform testing of materials and fabricated products as necessary to confirm the effectiveness of the Fabricator's QCP.
- 2.3.4 The QAI has the right to observe all phases of the work, from initial receipt and preparation of raw materials through welding, nondestructive testing, assembly, cleaning, coating, and shipping.
- 2.3.5 The frequency and nature of QA inspection will vary with the type of structure, experience of the Fabricator, strength of the Fabricator's QC organization, and other similar factors that affect the quality of the work.
- 2.3.6 The QAI will verify that production quality and fabrication processes generally satisfy Contract requirements, including the QCP.
- 2.3.7 The QAI will accept materials that satisfy the Contract requirements.
- 2.3.8 The QAI 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 Engineer may accept materials and products that are not in conformance with the Contract and may allow material substitutions.

Steel Bridge Fabrication QC/QA Guide Specification

- 2.3.9 The QAI will not direct the Fabricator's work. However, the QAI should advise the Fabricator to discontinue any operation that would result in noncompliance with the Contract.
- 2.3.10 The QAI will direct all official communications to the Fabricator's quality control or management.
- 2.3.11 The QAI will not convey directives or personal judgments about overall shop quality or concerns about employee competence to production personnel.
- 2.3.12 The QAI will not divulge a fabricator's proprietary information to another fabricator.
- 2.3.13 The QAI will not publish, copy or distribute any proprietary information, documents, or forms received from the Fabricator for any purpose other than the contractual needs of the Owner.

2.4 Prefabrication Meetings

Prefabrication meetings facilitate effective quality control and quality assurance and should be conducted as described in section 2.4 of AASHTO/NSBA Steel Bridge Collaboration S2.1, "Steel Bridge Fabrication Guide Specification".

Section 3 Qualifications and Equipment

3.1 QCI and QAI Fabrication Inspection Experience

3.1.1 In addition to the certification requirements of 5.3 and 8.2, the following minimum years of experience in steel bridge fabrication are recommended:

Project Type	Minimum Recommended Years of Experience
Rolled beam bridges	1 year
Welded plate girders (I sections, box sections, etc.)	2 years
Complex structures, such as trusses, arches, cable-stayed bridges, and moveable bridges	3 years
Fracture critical (FC) members	3 years

3.1.2 Inspectors who have less experience than that specified in 3.1.1 should work under the guidance of an inspector having those qualifications.

3.1.3 Experience in rolled beam bridge inspection should not be counted towards the experience needed for plate girders, complex structures, or fracture-critical members.

3.1.4 Every inspector must be proficient with inspection of the typical fabrication processes described in Section 7 of this document.

3.2 QCI and QAI Coatings Inspection Experience

3.2.1 Documented training in materials preparation, coatings application, and inspection is required for the QC and QA coatings inspectors. Acceptable training includes one or more of the following:

- American Institute of Steel Construction (AISC) – Application and Inspection of Sophisticated Coatings
- National Association of Corrosion Engineers (NACE) - International Coating Inspector training and Certification Program Session I: Coating Inspection Training
- Society for Protective Coatings (SSPC) - C-1 Fundamentals of Protective Coatings for Industrial Structures
- National Highway Institute (NHI) - Bridge Coating Inspection Course No. 13079
- Other training acceptable to the Engineer.

3.2.2 The QA and QC coatings inspectors should each have at least one year of experience in surface preparation and painting inspection. Inspectors who have less experience should work under the guidance of an inspector having those qualifications.

3.3 Recommended Inspection Equipment

The following equipment is recommended for the QAI and QCI:

- sling psychrometer
- tape measure, 25 ft. (7 m), 1/32” or 1-mm increments.
- bevel gauge

Steel Bridge Fabrication QC/QA Guide Specification

- blast profile comparator or replica tape for direct measurements and a permanent record
- camera, QAI to use only with the approval of the Fabricator, digital recommended
- dry film thickness gauge
- feeler gauges
- fillet weld gauges
- flashlight and spare batteries
- pocket metal ruler(s), 1/32" or 1-mm increments
- metal tape measure, 100 ft. (30 m), 1/8-inch or 0.01-ft (5-mm) increments
- micrometer
- NDE tools, if applicable
- skewed fillet weld gauge
- surface roughness gauges for machine and flame cutting
(Ref. ANSI B41 or AWS C4.1-G)
- temperature-indicating crayons for 30°F (15°C) above and below desired temperatures or surface pyrometer
- thermometers for determining air, paint and metal surface temperatures
- undercut gauge
- mirror for examining restricted access areas (such as snipes)
- tools for checking surface anomalies, coating adhesion, etc.
- surface profile comparator for media (sand, shot or grit) used and/or deformable replica tape and micrometer to check profile depth before coating.

Part B – Quality Control

Section 4 General

Part B of this standard describes the minimum quality control requirements for a steel bridge Fabricator. The requirements form the basis for the Fabricator's QCP.

4.1 Quality Control Plan

- 4.1.1 Prepare, maintain, and follow a QCP that details the QC procedures, personnel, policies, equipment, and records used during planning, ordering, fabrication, inspection, cleaning, painting, and shipping of fabricated members.
- 4.1.2 The QCP shall describe the means and methods for ensuring satisfactory materials and workmanship, including the following:
 - procurement, maintenance and calibration of testing equipment and supplies needed for inspection, measurement, and tests (see 4.3)
 - conformance of all raw materials to Contract requirements (see 4.4)
 - preparation and use of welding procedure specifications (WPSs) and control of welding consumables (see 4.5)
 - proper performance of nondestructive examination (NDE) (see 4.6)
 - handling of nonconformances, including use of standard shop repair methods and preapproved procedures for weld repairs (see 4.7)
 - use of the latest approved version of shop drawings and approved fabrication procedures
 - other required means and methods described in Sections 5, 6 and 7.
- 4.1.3 Provide the signature of the Quality Control Manager indicating the Fabricator's intent and commitment to implement the QCP to achieve a quality product.
- 4.1.4 Include a statement signed by the Fabricator's management affirming that all personnel will implement the QCP to achieve quality.
- 4.1.5 Describe the Fabricator's organization, including the following:
 - clearly established lines of authority
 - position titles and the names of the individuals assigned to the positions
 - functions and duties of each position.
- 4.1.6 Describe the structure of the QC Department. Include an organization chart showing the functions, duties, responsibilities, position titles and lines of authority within the QC department.
- 4.1.7 Describe in detail the responsibilities of QCIs, including inspecting material, welding, assembly, coating preparation and application, and nondestructive examination.

4.2 QAI Facilities

- 4.2.1 Provide and maintain office facilities for QAIs that ensure a reasonable amount of privacy and that are clean, properly illuminated, heated or air-conditioned as necessary, and reasonably free of shop noise, dust, and odors.
- 4.2.2 Locate the office reasonably close to the work and provide access any time fabrication is in progress.
- 4.2.3 Provide a desk, chair, and secure storage (e.g., locking file cabinet) for each inspector.

Steel Bridge Fabrication QC/QA Guide Specification

- 4.2.4 Provide a telephone within the office with an outside line suitable for modem communication.
- 4.2.5 Provide ready access to the following:
 - clean, Fabricator-maintained restrooms
 - fax and copy machines
 - adequate parking.

4.3 Inspection and Testing Equipment

- 4.3.1 Check and calibrate testing equipment in accordance with applicable standards.
- 4.3.2 Maintain calibration records readily accessible by the QAI.

4.4 Control of raw materials

- 4.4.1 Inspect all incoming raw materials.
- 4.4.2 Verify that no repairs have been performed at the producing mill except grinding or welded repairs as allowed in ASTM A 6. Fracture-critical materials must not include any welded repairs unless authorized in writing by the Owner.
- 4.4.3 Verify material surface quality prior to start of fabrication.
- 4.4.4 Establish:
 - inspection points (locations)
 - responsible party for inspection
 - acceptance criteria
 - procedures to repair defects.

4.5 Welding Procedures and Consumables

- 4.5.1 Establish procedures for welding control that address the following:
 - responsible parties for welding of test plates, witnessing and documenting welding parameters, preparing specimens, conducting testing, and preparing the reports
 - format and use of forms, including the system for numbering or identifying WPSs
 - responsible party to prepare and submit WPSs for approval
 - distribution of the approved WPSs in the fabricating shop
 - use of the approved WPSs by production and QC personnel
 - procedure for revision of WPSs.
- 4.5.2 Establish procedures for control of welding consumables that address the following:
 - use of approved consumables
 - warehouse storage, including inventory and stock rotation
 - storage in the fabricating shop of consumables used for welding fracture-critical and non-fracture-critical members
 - procedures for holding and re-drying shielded metal arc welding (SMAW) electrodes
 - control for time out of storage oven of SMAW electrodes
 - drying and recycling of submerged arc welding (SAW) flux
 - storage of SAW flux and electrodes
 - storage and moisture control for flux-cored arc welding (FCAW) electrodes
 - storage of gas metal arc welding (GMAW) electrodes.

4.6 Nondestructive Examination

- 4.6.1 Establish and follow a practice that conforms to AASHTO/AWS D1.5, *Bridge Welding Code*, and applicable American Society of Nondestructive Testing (ASNT)

Steel Bridge Fabrication QC/QA Guide Specification

SNT-TC-1A requirements for each NDE method employed in the shop. Include the following:

- identification of a certified ASNT Level III in the applicable method(s)
 - a written practice approved by the Level III
 - ASNT Level II certification of practicing inspectors in the applicable method(s)
 - ASNT Level I certification of apprentice inspectors, with proper Level II oversight
 - applicable code requirements for procedures.
- 4.6.2 Where contracted services are used for NDE, ensure that the NDE agency's staff also satisfies the applicable ASNT requirements.
- 4.6.3 Provide a copy of the written NDE practices to the Owner upon request.
- 4.6.4 Make NDE training and certification records available for the Owner's review.
- 4.6.5 Permit QAI access to the Fabricator's testing facilities and records upon request.

4.7 Nonconformance Control

- 4.7.1 Establish and maintain an effective system for controlling nonconforming material, including procedures for identification, isolation, and disposition.
- 4.7.2 Establish standard shop repair methods. Standard repair welding procedures must be preapproved by the Owner.
- 4.7.3 Describe the equipment, inspections, reports, and systems necessary to segregate materials requiring corrective work.
- 4.7.4 Follow these steps when a problem is identified that will require a repair approved by the Engineer:
- Determine the cause for the defect
 - Initiate appropriate action to prevent additional deficiencies.
 - Submit a written proposal to the Engineer documenting the situation, suggesting corrective actions for repairs or replacement, and, if applicable, recommending alternate methods for subsequent production to avoid further defects.
 - Provide the QAI with copies of appropriate correspondence.
 - Be prepared to provide support information if requested by the Engineer.
 - Notify the Contractor as required.
- 4.7.5 Reclaim or rework nonconforming materials only in accordance with procedures acceptable to the Owner.

Section 5 Certifications and Qualifications

5.1 QCP Requirements

- 5.1.1 Describe the plant's level of AISC certification (see 5.2).
- 5.1.2 Describe certification and qualification requirements for all QCIs (see 5.3).
- 5.1.3 Describe procedures for qualifying tackers, welders, and welding operators and for updating and maintaining their qualification documentation (see 5.4).

5.2 Fabricator Certifications

- 5.2.1 Certification by AISC in the category appropriate for the type of work being performed is required. These categories include:
 - Simple Steel Bridge Structures (Sbr) - Required for overhead sign trusses, bridge parts such as cross frames, and for un-spliced rolled beam bridges
 - Major Steel Bridges (Cbr) - Required for all bridges other than unspliced rolled beam bridges
 - Fracture Critical (F) - Required for fabrication of fracture critical members
 - Sophisticated Paint Endorsement (P) - Required for shop priming or shop application of multi-coat systems to steel components (see applicable coating specification for exceptions). The Society for Protective Coating's SSPC-QP 3, *Standard Procedure for Evaluating Qualifications of Shop Painting Contractors*, may be substituted for the AISC Sophisticated Paint Endorsement.
- 5.2.2 Resolve any findings noted in the AISC exit interview reports prior to fabrication.
- 5.2.3 Allow the Owner to review the AISC or SSPC certification records upon request.
- 5.2.4 If Owner acceptance is required by the Contract, allow formal review of operations by the Owner and secure acceptance prior to fabrication.

5.3 QCI Certifications and Qualifications

- 5.3.1 A QCI performing welding inspection must be a Certified Welding Inspector (CWI) or equivalent, in accordance with the *Bridge Welding Code*.
- 5.3.2 QCIs performing NDE must have either an ASNT Level II certification or a Level I certification with Level II oversight for the NDE method being applied, in accordance with *Bridge Welding Code* requirements.
- 5.3.3 QCIs for coatings must be qualified in accordance with Section 3.

5.4 Welder/Welding Operator Qualifications

- 5.4.1 Document and maintain the following as a minimum:
 - the name of the department or position responsible for administering and maintaining documentation on the qualification test program
 - the extent to which independent testing laboratories will be employed in qualification
 - the extent to which the QC department will be involved in qualification
 - the responsible party for selecting and testing qualification plates, authentication of test reports, and the disposition of specimens
 - appropriate forms and records
 - fabricator method for documenting continuing experience (see the "Period of Effectiveness" portion of the *Bridge Welding Code*)
 - the Fabricator's master list of qualified welders, welding operators, and tack welders

Steel Bridge Fabrication QC/QA Guide Specification

- qualification actions taken when new equipment or consumables are introduced in the shop.
- 5.4.2 Make all welder qualification test results available for the Owner's review.

Section 6 Documentation

6.1 QCP Requirements

- 6.1.1 Describe procedures for maintaining records (see 6.2).
- 6.1.2 Describe handling and control of material certifications, mill test reports (MTRs), and other records required for material or weld traceability and verification (see 6.3).
- 6.1.3 Identify shop personnel responsible for preparation of records and reports.
- 6.1.4 Include sample forms.

6.2 Records

- 6.2.1 Maintain current and complete records of inspections, measurements, and tests. Shop drawings or standard detail drawings may be used to document inspection.
- 6.2.2 Make records available to the QAI during all work periods.
- 6.2.3 Document, report, and keep records of reportable nonconformances. (Minor grinding, paint repairs, etc. do not require documentation.) For nonconformance reports, include at least:
 - the number, location, and type of deficiencies found
 - the nature and frequency of any repairs and corrective actions taken
 - a summary of the dispositions (corrected and approved, or rejected)
- 6.2.4 For items that require full or partial shop assemblies, submit to the QAI signed reports of required measurements, indication of compliance or deviations noted, and pictures if available.
- 6.2.5 Provide test reports and summaries of all required NDE to the QAI.

6.3 Material Traceability

- 6.3.1 Review MTRs for specification compliance and for accuracy, completeness, and specific project applicability before submittal.
- 6.3.2 Control, identify, and reproduce MTRs for steel materials used from the Fabricator's stock or from warehouse purchases. Include the MTRs in the project file and provide them to the Engineer or QAI as requested.
- 6.3.3 Identify and trace material for primary members throughout fabrication.
- 6.3.4 Correlate mill-identified materials with shop drawing piece marks, and supply a copy of this information to the QAI.

Section 7 Inspection Procedures

This section includes general requirements for the QCP (7.1) and then a series of points that must be addressed in the QCP (7.2 through 7.10)

7.1 QCP Requirements for Inspection

7.1.1 Define quality control actions to address all points listed in 7.2 through 7.10. For some points, quality control may require formal, documented inspection activities by the QCI, but for others informal monitoring activities conducted by production personnel may suffice, provided:

- formal quality control is not required by Contract
- production personnel are trained in acceptance criteria
- production personnel are trained to be responsible for evaluating the work and noting noncompliance items
- the QCI will perform spot inspection of the work.

7.1.2 If applicable, include the inspection or monitoring frequency established by the fabricator for all points in 7.2 through 7.10. The extent of monitoring may be less than 100% provided its basis considers the following criteria:

- the potential effects of undiscovered deficiencies incorporated in the final structure
- the production delays and possible problems caused by stopping processes for inspection hold points
- the demonstrated consistency or variability of the process
- recent history of documented nonconformance.

7.1.3 Describe QCI record-keeping. For inspection, records must be detailed and must be initialed by QCIs indicating conformance with Contract requirements. Monitoring of quality by production personnel does not require record-keeping, but a general record must be made of the QCI's inspections.

7.2 Preparation of Material

- Identification and marking of materials
- Quality of cut and sheared edges
- Plate quality, with notation of surface and internal defects and repair
- NDE requirements and acceptance criteria for repairs
- Dimensional accuracy of component parts, whether fabricated or premanufactured

7.3 Fitting

- Dimensional accuracy and fit of all components
- Specified tolerance of members prior to welding
- "Mill to bear" and "tight fit" conditions

7.4 Welding

- Cleanliness (absence or condition of unacceptable mill scale, rust, or contaminants)
- Joint preparation
- Properly cleaned tack welds of suitable quality and size
- Use of approved welding procedures
- Weld quality and soundness requirements per *Bridge Welding Code*
- Welders qualified for process and position to be welded
- Interpass cleaning and temperature

Steel Bridge Fabrication QC/QA Guide Specification

- Weld backgouging and cleaning
- Fillet weld size, placement and profile
- Groove weld reinforcement
- Grinding or finishing of welds
- Avoiding, precompensating for, and correcting welding-induced distortion
- Visual weld quality
- Postheat as required
- Storage, handling, and reuse of SAW flux and SMAW electrodes

7.5 Cambering, Curving and Straightening

- Adequate blocking elevations and intervals
- Following Engineer-approved calculations for locations of applied external forces or restraints, when required by the contract
- Size and locations of heating patterns
- Maximum temperatures and proper temperature monitoring
- Controlled cooling
- Final dimensions

7.6 Shop Assembly of Main Members

- Dimensional accuracy of each piece (deviation from specified length, camber, sweep)
- Individual member distortion, local and overall (twist, sweep, out-of-flatness of flange or web)
- Clearance or bearing fit of adjacent members in assembly
- Assembly blocking dimensions and curve and camber offsets and elevations
- Splice plate and secured fill plate dimensions and fit (gaps, non-parallel)
- Bolt hole accuracy, including adequate edge distances
- Bolt hole condition, including shape and squareness to faying surface
- Match-marking of splice plates and correct location of all piece marks
- Removal of drilling burrs
- Preparation and documentation of “as built” shop assembly report

7.7 Cleaning

- Proper solvent cleaning to remove surface contamination prior to mechanical cleaning
- Blast media gradation and cleanliness
- Verification and documentation of required surface cleanliness and profile
- Checking the compressed air system for contaminants, especially if used to remove shot
- Proper functioning of automated blasting equipment
- Treatment of material defects (scabs, fins, slivers) exposed by blasting, including reblasting if necessary after repairs
- Proper corner and edge treatment as required for coating system

7.8 Coating

- Coating sampling by manufacturer or at the Fabricator, including witnessing and delivery to the Engineer.
- Use of Owner-approved coating batches
- Maintenance of air-line oil and air moisture traps
- Equipment for mixing, application, repair, film measurement, and safety
- Mixing and agitation
- Monitoring pot life

Steel Bridge Fabrication QC/QA Guide Specification

- Application methods: spray nozzles, patterns, and sequencing for typical configurations and for areas inaccessible for spraying (snipes, restricted)
- Coating repair for damage, dry spray, runs, sags, and under- or over-thickness
- Control of thinning, when permitted
- Ambient temperature, steel temperature, relative humidity, and dew point
- Control of millage, wet and/or dry, as applicable (millage control per SSPC PA2)
- Intervals between coating applications
- Cure assessment
- Documentation for materials used, ambient conditions, cure verification, dry film thickness and/or wet film thickness readings, and problems and corrections

7.9 High-Strength Fastener Shop Installation

- Material verification (manufacturer certifications, tensile tests, chemistries, hardness, rotational capacity test results, evidence of domestic origin) prior to installation
- Fastener markings
- Contact surface and hole quality
- Function and calibration of fastener tension device and torque wrench
- Execution of rotational capacity testing
- Check-torque for verification of proper tightening.
- Fastener dimensions and condition, especially proper lubrication
- Use of hardened washer under the turned element during installation
- Verification that all fasteners in a joint are brought to snug-tight condition prior to final tightening
- Verification that fasteners are tightened from the most rigid part of a joint towards its free edges and that the wrench is returned to previously tightened bolts to “touch up” any bolts which may have been relaxed from tightening other bolts in the joint
- Verification of full engagement of bolts (tip flush or beyond nut face)

7.9.1 Turn-of-nut tightening

- Proper snug-tight sequence
- Nut rotation (marks on bolt tip and nut)
- Verification of proper tightening

7.9.2 Calibrated wrench tightening

- Torque-to-tension relationship
- Verification that wrenches are set to provide proper fastener tension and are calibrated at proper intervals
- Recalibration of wrenches when necessary
- Maximum allowable fastener head or nut rotation

7.9.3 Alternate Fastener Methods

- Verification of load-indicating washer characteristics
- Placement and interpretation of load-indicating washers
- Snug-tightening cycles before twist-off of control or indicator element
- Procedures for snugging and full tensioning with lock pin and collar bolts

7.10 Loading and Shipping of Fabricated Members

- Written acknowledgement of QA acceptance before loading
- Loading, blocking, cushioning, and securing
- Repair of all areas where shop protective coating has been damaged
- Visual inspection of all loaded members

Part C – Quality Assurance

Section 8 General

Part C of this standard provides a QAP that the Owner's QAIs will follow, including both inspection personnel employed by the Owner and contracted inspection personnel acting as agents to the Owner. The role of the QAI is defined, and general guidelines are provided for monitoring QC procedures, fabrication personnel, qualifications, inspection status, equipment condition, record-keeping, and final acceptance of the work.

QAP Overview

QAIs will use this plan to verify conformance of the work with Contract requirements. The QAP is general in nature, to meet a wide variety of conditions and differing requirements in project plans and specifications. It is an inspection practice; it is not a part of the Contract and does not supersede any project specifications or other job requirements.

This plan is intended to be comprehensive for typical fabrication specification requirements. However, omission of a quality requirement in this plan does not relieve the QAI from inspection if that requirement is part of the Contract. Contracts, through Owner standard specifications, typically address quality assurance inspection as the prerogative of the Owner. Quality assurance functions emphasize the review of QC work but also include independent inspections. Owner quality assurance is not a substitute for the Fabricator's quality control.

8.1 Qualifications of the QAI

- 8.1.1 The QAI must be qualified in accordance with *Bridge Welding Code* requirements. QAIs who interpret and perform NDE must be certified in accordance with the applicable ASNT SNT-TC-1A requirements for each NDE method being used.
- 8.1.2 The QAI for coatings must be qualified in accordance with Section 3.

8.2 Scheduling

The scheduling of inspection and other QA functions can have a significant impact on the project. The QAI shall follow these guidelines:

- Coordinate with the QCI for anticipated production scheduling to anticipate timing and staffing needs. Discuss the progress of the work with appropriate Fabrication personnel designated during the prefabrication conference (see 2.1.2 & 2.4.3).
- Schedule inspections in a timely manner to facilitate fabrication progress, especially if multiple shifts are used.
- Discuss with the Engineer whether additional presence in the shop is required.
- Document problems with scheduling inspection, including inaccurate information from fabrication personnel and production delays.

Section 9 QAI Responsibilities

9.1 Role of the QAI

- 9.1.1 Perform verification tests, measurements, inspection, or observations to ensure that fabricated items conform to the Contract requirements. Although the QAI does not perform QC work, some QA activities may duplicate a portion of QC activity for verification.
- 9.1.2 If there are questions about a requirement or level of quality, contact the Engineer and, if appropriate, alert the Fabricator.
- 9.1.3 Conduct consistent inspections based on the Contract requirements while providing guidance to the Fabricator concerning interpretation of the plan details and specification mandates. Obtain assistance from the Engineer as needed.
- 9.1.4 Be familiar with the QCP to better understand the QC operations of the shop.

9.2 Interaction with the Fabricator Quality Control Inspector

- 9.2.1 Verify the effectiveness of the QCI's evaluation of the work.
- 9.2.2 Perform verification inspection after the QCI has completed inspection and testing in accordance with the QCP. However, serious problems noted at any time or stage of fabrication must be immediately pointed out to the QCI.
- 9.2.3 Though QA inspection may include all aspects of fabrication, the QAI must not supersede QC, which is the responsibility of the Fabricator. If QC is not accomplishing its role, the Engineer and Fabricator must determine the necessary corrections.

9.3 Interaction with the Engineer

If the Fabricator's inquiries involve design questions, material substitutions, alternate fabrication methods, or items that are beyond the authority of the QAI, refer them to the Engineer.

9.4 Interpretation of the Contract

Review Contract requirements. If conflicts arise regarding their interpretation or adequacy, seek guidance from the Engineer. Inform the QCI of the results of this discussion.

9.5 Fabrication Observation

- 9.5.1 Establish a pattern of regular and frequent observations during the progress of work to verify satisfactory workmanship without delaying production or missing critical operations.
- 9.5.2 Coordinate verifications with the QCI and accomplish them with minimal additional material handling by the Fabricator and with as little interference with the work in process as possible.
- 9.5.3 Though there are not designated points during fabrication when the suitability of materials must be checked, problems should be discovered and addressed as early as possible.

9.6 Nonconforming Materials and Workmanship

- 9.6.1 Bring any nonconformances to the attention of the Fabricator immediately upon discovery, and, for more serious deficiencies, notify the Engineer. However, do not direct corrective action. If the Fabricator fails to take corrective action, or continues

Steel Bridge Fabrication QC/QA Guide Specification

to operate in an unacceptable manner, document the event, notify the QCI that the work may be rejected and contact the Engineer.

- 9.6.2 Verbal notification of nonconformance is usually sufficient, but if halting an operation must be recommended, convey this in writing. Before taking this action, discuss the situation with the QCI and obtain direction from the Engineer. If the Fabricator continues the operation after receiving the recommendation to cease, all subsequent production by that method and the Owner's potential rejection without QA inspection will be at the Fabricator's risk.
- 9.6.3 For significant problems, the Fabricator must submit a written proposal concerning the issue, providing documentation of the situation and proposed actions to address the issue. When the Fabricator's proposal is received, reply or, for more serious deficiencies, forward the problem to the Engineer. For such serious deficiencies, the Fabricator may write directly to the Engineer, Contractor, or both, as directed, and send a copy to the QAI.
- 9.6.4 When the Engineer's approval is required for a repair, review and confirm the Fabricator's proposed methods of repair and description of the existing material conditions. Seek guidance from the Engineer for clarification when necessary. Follow up to verify that all required corrections and applicable NDE have been accomplished.

9.7 Final Acceptance of the Work

- 9.7.1 When fabrication is complete and inspection results demonstrate that all Contract requirements for the Fabricator have been satisfied, the materials are conditionally accepted, with final acceptance at the jobsite, in accordance with the Owner's customary practice.
- 9.7.2 Affix the Owner's stamp or mark on the piece (or a group of parts bundled or contained together), if required, during preparation of a member/component for shipping, indicating that a representative of the Owner has inspected and accepted the work. Presence of this stamp does not relieve the Contractor of responsibility for proper loading, shipping, final fit, and acceptable final condition of the member or component.

Section 10 Documentation and References

10.1 Familiarization with Requirements

10.1.1 Become familiar with applicable portions of the Contract documents covering the work to be inspected. Study the plans and specifications before fabrication commences to provide ample opportunity to coordinate with the Engineer.

10.1.2 Have thorough knowledge of the following references:

- applicable current standard specifications, supplements, special provisions, special specifications, and addenda
- approved shop drawings (see 10.3)
- applicable provisions of the *AREMA Manual for Railway Engineering*, if required for the project
- AASHTO/AWS D1.5, *Bridge Welding Code*
- fabricator's QCP.

10.1.3 Be familiar with the following references:

- AWS D1.1, *Structural Welding Code*
- AWS A2.4, *Symbols for Welding and Nondestructive Testing*
- AWS A3.0, *Standard Welding Terms and Definitions*
- applicable ASTM or AASHTO specifications
- applicable coating test methods
- applicable SSPC Specifications
- prefabrication meeting minutes, if any
- metrication conversion tables, if required.

10.2 Required Documents

Acquire the following documents:

- MTRs for material used in fabrication
- list of qualified welders, welding operators, and tack welders
- approved WPSs
- approved welding procedure qualification records (PQRs)
- copy of approved nondestructive testing procedures
- list of qualified NDE technicians for the project
- NDE reports for all work on this project that has been inspected and accepted by NDE
- project record log sheets.

10.3 Use of Non-Approved Shop Drawings

Fabrication should proceed only with approved shop drawings. However, if the Fabricator must proceed prior to receipt of approved shop drawings (performing work at their own risk), ensure that the Engineer is aware of this activity and proceed with preliminary or basic QA functions using non-approved shop drawings. Later, verify notes against approved drawings.

Steel Bridge Fabrication QC/QA Guide Specification

10.4 Quality Assurance Inspector Records and Reporting

- 10.4.1 Maintain a narrative report for each project, as directed by the Owner. The report should either be legibly hand-written in a permanently bound book, or be maintained in an electronic log with automatic date and time recording. Record the Fabricator's activity on the work inspected, including both positive and negative comments, suggestions given to the Fabricator, and any agreements made. Make entries as soon possible after the events or conversations.
- 10.4.2 The Engineer may require a periodic status report. If so, include information about the status of the work performed, shop activities, and other events of interest to the Engineer. Number the reports consecutively until completion of the work, with the last report noted "final".
- 10.4.3 Make notes, letters, faxes, reports, and memoranda clear and brief, and keep them on file.
- 10.4.4 Do not make or release photographs or digital images without the Fabricator's approval.
- 10.4.5 Documentation is not a substitute for appropriate dialogue with the Fabricator, but should provide a record of important discussions. Sign on-site correspondence as its originator. Correspondence may also be sent to the Fabricator from the Engineer's office. In some cases, the QAI is more familiar with the events or issues and therefore should review and comment on draft copies of the Engineer's correspondence.

10.5 Mill Test Reports

- 10.5.1 Verify use of proper materials by checking a copy of the MTRs when the material arrives and by monitoring heat numbers during fabrication until the material is joined into a piece-marked item.
- 10.5.2 Obtain MTRs from the Fabricator in accordance with the Owner's customary practice, including the number of copies and when and to whom MTRs should be submitted.
- 10.5.3 Periodically verify the following information on MTRs:
 - product description (specifications, grade, H or P testing frequency)
 - chemistry
 - physical test results, including Charpy V-Notch when applicable
 - applicable "Buy America" certification requirements
 - heat number
 - certification signature (Quality Control Department and Notary, when required)

This information will be checked by the Fabricator.

- 10.5.4 Do not accept material if the Fabricator cannot furnish appropriate certifications to establish compliance with the required material properties and "Buy America" requirements, if required in the Contract.
- 10.5.5 Maintain a record of heat number identification for main members.
- 10.5.6 Accept structural steel based on MTRs. Miscellaneous hardware or other associated products may be accepted based on certifications of compliance.
- 10.5.7 The Owner may require additional independent physical and chemical tests of the material's properties. If so, these tests must be performed as soon as practical, and prior to fabrication. If the independent tests indicate noncompliance, do not allow use of the material until an agreement is reached between the Owner and the

Steel Bridge Fabrication QC/QA Guide Specification

Fabricator as to its acceptability. Bring such noncompliance to the attention of the QCI for evaluation and disposition.

- 10.5.8 MTRs and laboratory reports must be accepted by the Owner before the material can obtain final approval. Verify compliance of MTRs with the requirements of the relevant ASTM or AASHTO specification (see 11.1.1).

Section 11 Quality Assurance Functions

The QAI must verify that fabricated steel bridge members meet Contract requirements by performing the functions listed in this section.

11.1 Inspection of Raw Materials

11.1.1 Steel bridge material specifications require conformance with applicable requirements of ASTM A 6 (AASHTO M 160), although some Contracts refer to ASTM A 20 for certain alloy steels. These specifications cover common requirements for hot-rolled plates, shapes, sheet piling and bars, and are also used for material acceptance inspection and repairing certain surface defects.

11.1.2 Check materials for surface defects and discontinuities, both initially and as material is being worked. Check rolled sections and steel castings for dimensions, straightness, twist, fins, scabs, and rolling defects, prior to fabrication. Monitor steel plate during cutting for internal defects or other problems.

11.2 Inspection of Fabricated Members

During fabrication the QAI should monitor and spot-check that the work performed by the fabricator meets the contract requirements, including, as a minimum, the following:

- straightness no unauthorized corrections made by welding or manual thermal cutting
- size and quality of punches and dies
- proper setup and securing of drilling or reaming templates
- bolt hole location, edge distance, and diameter
- cylindrical and perpendicular bolt holes
- absence of burrs, tears, and chips in bolt holes
- thickness of plates, clearances, fitup accuracy, alignment of holes, and proper size of sections at field connections
- shop assembly of girders or other parts required for reaming or drilling of field splice holes: positioning, securing, match marking members and splice plates, splice plate orientation (flange splice plates' rolling direction parallel to flanges), fills in assembly, and all plies in contact when assembled
- flatness of flanges at bearing areas
- bearing plates and bearing assemblies, including rockers and shoes for structural steel and expansion joints
- proper surface finish and protection of machined surfaces
- contact condition of milled bearing surfaces
- camber blocking during girder assembly, prior to drilling and QAI acceptance for disassembly
- records of final sweep or camber
- inspection and installation of fasteners in the shop
- location of stiffeners and connection plates
- match-marking of assembled members
- preparation of match-mark diagrams
- control and use of heat and/or pressure to obtain or correct sweep and camber in accordance with shop's QCP, and avoidance of buckles, twists, kinks or other defects
- legibility and position of erection and shipping marks
- no unacceptable twists, bends, kinks, or sweep in finished members
- proper number of pieces

Steel Bridge Fabrication QC/QA Guide Specification

- small parts properly packaged or otherwise secured against loss or damage in transit
- loose pieces fastened in place for shipment
- application of rust-preventive material when required, and covering to prevent contamination of painted surfaces.

11.3 Assembly

- 11.3.1 Periodically observe laydowns and shop assembly.
- 11.3.2 Verify the Fabricator's geometry control methods and measurements. For full or partial shop assemblies, receive the QCI's signed reports of measurements for the Owner's records. For full assemblies, photographs should also be included in the QAI's report (see 10.4.4).

11.4 Welding

- 11.4.1 Monitor these criteria prior to welding:
 - appropriate equipment in acceptable condition and periodically calibrated per QCP
 - proper functioning of drying and baking ovens
 - Qualified welders, welding operators, and tack welders
 - appropriate, approved welding procedures for detailed joint
 - joint details, including root face and opening, bevel angle, and alignment of parts within appropriate welding code tolerances
 - proper application of extension tabs (run-on and run-off)
 - cleanliness of surfaces to be welded
 - proper condition and storage of welding consumables
 - size, quality and location of tack welds.
- 11.4.2 Monitor these consumable-handling criteria:
 - storage, condition, and exposure times of welding consumables
 - re-drying and recycling limits.
- 11.4.3 Monitor these criteria during welding:
 - following approved welding procedure specifications (WPSs): amperage, voltage, speed of travel, electrode extension, shielding gas flowrate, and preheat, interpass, and/or post-heat temperatures within applicable welding code and WPS tolerances
 - workmanship of individual welders
 - use of proper repair procedures for fabrication errors, including, when required, the Engineer's approval
 - weld starts and stops, securing and removing runon and runoff tabs, stopping short of snipes or plate edges, and ending without craters
- 11.4.4 Monitor these final weld quality criteria:
 - size, profile, and contour of fillet and groove welds
 - no defects in welds or parent metal
 - accurate interpretation by QCIs for the acceptance or rejection of welds
 - cleaning and backgouging of welds, including thorough removal of unsound metal and gouging contamination (copper, carbon).

Steel Bridge Fabrication QC/QA Guide Specification

11.5 Use of Approved Welding Consumables

- 11.5.1 Review the consumable manufacturer's certificate of conformance maintained by the Fabricator for all consumables used. Obtain copies for project file if required by Owner's policy.
- 11.5.2 If the Owner maintains a list of approved electrodes, verify that all consumables used by the Fabricator are on the list.

11.6 Nondestructive Evaluation

- 11.6.1 Review and approve the qualification documentation of those performing NDE for the Fabricator.
- 11.6.2 Periodically witness NDE, review the test results, and verify that reports are complete and legible.
- 11.6.3 For radiographic testing (RT), conduct the following activities:
 - Interpret test results in accordance with Contract requirements.
 - Verify that final edges may be properly interpreted. (If the plate will be cut after RT, the final edge may be within the plate on the RT film.)
 - Verify proper application of edge blocks if necessary (plate edge is final edge in structure).
 - Verify that each radiograph represents a unique section or piece by comparing punch marks or other approved methods of marking the work and corresponding marks on the film.
- 11.6.4 Periodically observe or conduct, if necessary, ultrasonic testing (UT) to verify the Fabricator's NDE results. The QAI will determine intervals for observation of verification testing unless otherwise directed by the Engineer.
- 11.6.5 For magnetic particle testing (MT), conduct the following activities:
 - Periodically observe the application and interpret the results of MT performed on primary members to verify that they satisfy *Bridge Welding Code* requirements.
 - On ancillary, secondary or miscellaneous items, periodically observe and interpret MT when required by the Contract.
 - Observe MT when needed to verify visual findings.
 - Observe and interpret MT applied to evaluate removal of defects and welded shop repairs for base metal and deficient welds.
- 11.6.6 For liquid penetrant testing (PT), periodically observe technique and interpret results.

11.7 Coatings

- 11.7.1 When sampling:
 - Coordinate coating sampling in the shop with the Fabricator.
 - Conduct sampling as early as possible.
 - Witness sampling, including mixing or stirring if required for uniformity.
 - Ensure that the required samples are delivered to the Owner in suitable containers.
- 11.7.2 If the Owner maintains a list of pre-tested, pre-approved coatings so sampling is not required, check the list to ensure that the actual batches or lots of the paint to be used are acceptable.
- 11.7.3 If the Owner obtains coating samples directly from the manufacturer, and the batches are approved prior to shipment to the Fabricator or jobsite, verify that the

Steel Bridge Fabrication QC/QA Guide Specification

batch numbers received correspond to the approved list, and, if applicable, that approval stamps are present.

11.7.4 Prior to coating application, verify the following:

- Coating containers are properly marked with a batch number.
- Batches have been properly strained and mixed (note when pot life initiates).

11.7.5 Do not accept coated girders until the Owner's lab accepts the coating.

11.7.6 For coating application inspection, verify the following:

- proper cleaning and surface preparation of base metal prior to coating
- application of coating in accordance with manufacturer and/or Contract requirements
- adequate curing of each coat as demonstrated by the prescribed test and, when multi-coat systems are used, prior to the application of subsequent coats
- thickness of coating, wet or dry, as specified for each system and type
- sufficient drying of coating prior to loading for shipment
- absence of dry spray, runs, sags and other defects
- proper coating of inaccessible and limited access areas
- proper treatment of faying surfaces.

11.8 Bolting

11.8.1 If fasteners to be tested by the Owner are sampled at the Fabricator's facility, witness and document sampling of components for fastener assemblies in accordance with the Owner's practice.

11.8.2 Verify that all fasteners are properly stored and segregated.

11.8.3 When fasteners are installed in the shop, ensure that installation and verification testing procedures are properly followed.

11.8.4 Witness the rotational capacity and verification testing for shop-installed high-strength fasteners.

11.9 Final Inspection and Loading for Shipment

11.9.1 When all work is complete, conduct a final visual examination of the work.

11.9.2 The QCI will provide copies of reports covering the materials to be shipped. Verify that all data are correct.

11.9.3 Randomly observe handling and loading of the work to verify that the methods and supports used will prevent significant damage during shipping.

Commentary

C1.2 In fabrication, there are two distinct engineering roles played by the Owner. One is the designer, and the other has responsibility for accepting fabricated members. In general, the fabrication engineer works with the QA inspectors to ensure the quality of fabricated work, and can also judge acceptability of work not fully satisfying the contract, such as material or weld defects. The designer must be consulted if there are to be any changes that may affect the behavior of the structure.

Open communication between the Fabricator, the fabrication engineer, and the designer is important; however, communication between the designer and the fabrication engineer must be coordinated to avoid confusion. A good rule of thumb is that prior to shop drawing submittal, the Fabricator should communicate directly with the designer to resolve any technical questions, so that resulting agreements will be reflected in the shop drawings. After the shop drawings have been approved, the Fabricator should communicate with the fabrication engineer because the QA and QC inspectors will be checking the work based on the shop drawings and they must be informed of all changes.

C2.1 All parties involved in fabrication must have a common objective: to provide steel meeting all contract requirements in a timely fashion with minimum repairs. To this end, the Owner and the Fabricator should work together in a cooperative spirit, and develop relationships based on mutual respect and trust.

C2.3.12 The Fabricator should inform the QAI when information is proprietary to avoid confusion. In general, the QAI should respect the fabricator's intellectual property and not discuss operations with other fabricators, even if the information is not proprietary.

C3.1 The objective of this provision is to ensure that the inspector has the experience and knowledge necessary to effectively fulfill the position's responsibilities. The amount of experience needed varies with the complexity and criticality of the work. Though these time periods should be sufficient to familiarize the inspector with steel bridge fabrication, more time may be needed to ensure that the inspector has the capability to carry the full responsibility of the inspector.

These time limits normally apply to the inspector with full responsibility for acceptance of the work. For the fabricator, this may include the QC manager and lead inspectors in each work area (preparation, welding, painting). For the Owner, this is the project's lead inspector who provides final acceptance of the work. These recommendations should not preclude inspectors with less experience working under the guidance of more qualified inspectors.

These time limits are recommended and not required because the amount of time it takes for an inspector to be ready to carry the full responsibility for inspection varies from person to person. The Engineer or Fabricator should carefully consider the integrity and the abilities of the individual before assigning responsibilities for inspection. The time needed for an individual to gain adequate competency could be more or less than the recommendations.

C3.1.3 Usually rolled beam bridges are not very complex and so the guide recommends that experience with rolled beams not be counted. However, some rolled beam bridges, especially continuous-span bridges, are rather complex, and experience on such structures may be considered.

C4.4.1 Material quality should be verified before use. However, not all surfaces of material are accessible during receipt inspection, and the Fabricator does not need to move materials just for

Steel Bridge Fabrication QC/QA Guide Specification

this inspection. Evaluation of surface quality continues through the fabrication cycle and is performed by production as well as inspection personnel.

C4.5.2 Approved consumables are either on the Owner's list of approved consumables or as permitted in the Contract, based on Procedure Qualification Test Report (PQR) test data and certificates of conformance from the consumable manufacturer.

C4.7.4 When problems are found during fabrication that require the involvement of the fabrication engineer or the designer, questions should be submitted through the fabrication engineer. There should be only one Owner representative who coordinates all corrections and changes to the work. However, when the designer needs to be involved, the fabrication engineer should coordinate direct, informal communication between the fabricator and the designer to facilitate a quick resolution to the problem.

C5.2 The Collaboration requirements for the Fabricator's QCP are intended to be compatible with the AISC certification program requirements. QCP requirements should not contradict the AISC certification requirements; duplicate work is not desired where the Collaboration and AISC programs have like requirements.

C5.4 Under the *Bridge Welding Code*, qualification of welders is the Fabricator's responsibility. The Owner is not required to provide or approve welder qualification testing.

C6.2.1 For projects that are small or non-complex, 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.

C7.1 There are many ways a Fabricator can help ensure quality. This section divides Fabricator activities into two parts: (1) "formal" activities, which include the various functions of the QC department, including those stipulated by Contract, such as NDE; and (2) "informal" quality control, such as production personnel checking their own work. Detailing the formal QC activities is a primary purpose of the QCP, but it does not need to stipulate the informal activities of the production personnel. The QCP should reflect the fact that production personnel are responsible for the quality of their work and should be mindful of their work, but does not need to detail production personnel activities to ensure quality.

C7.7 Though corner grinding or breaking has long been a requirement, recent research reflects that corner grinding is not needed for fatigue performance, nor for proper performance of many coatings. The inspector should check the Contract for any specific corner-grinding requirements and inspect the work accordingly.

C8.2.1 QAIs should be knowledgeable and appropriately trained or certified to properly conduct their duties. The QAI routinely observes and reviews the work performed by the fabricator, including NDE, on behalf of the owner. If the QAI performs NDE or interprets the NDE results provided by the fabricator, the QAI should be certified in the NDE method. Radiographic testing (RT) is an exception, since the QAI may be able to interpret an RT film without being qualified to perform RT.

C8.3 Schedule coordination between the QAI and the shop is important. Owners want to be present for important production events, but it may be unnecessary and impractical for the Owner to be present during all production. The plant should provide sufficient information to the Owner about the production schedule, and the QAI should make every effort to be present when needed in the plant.

Steel Bridge Fabrication QC/QA Guide Specification

C9.1 In steel bridge fabrication customary practice, “quality assurance” (QA) generally refers to the role performed by the Owner’s inspectors, and “quality control” (QC) is the responsibility of, and therefore performed by, the Fabricator’s inspectors. Generally speaking, the Fabricator performs QC to be sure the work is good. Some QC is specifically prescribed by the Contract, but beyond the prescribed work there are many other QC functions that must be performed to ensure that the bridge is correctly fabricated. QA work is not intended to be as detailed as QC work. An important QA function is ensuring that the QC department is properly checking, documenting and correcting work. However, this does not preclude inspection by the QAI, and the QAI should perform some actual measurement and evaluation of the work. However, the Owner and Fabricator must be careful to ensure that the QAI does not take on the role of the QCI. This can occur especially in less experienced shops without a fully developed and experienced QC department. Knowing that the QAI will be checking the work, the Fabricator may feel that the QA check will be enough and QC is not needed. This is erroneous, both because quality is the Fabricator’s responsibility, and, perhaps more importantly, because to be truly effective QC must be proactive and involved in the work from the start and throughout production.

C9.4 An unrealistic or too literal interpretation of the specifications can disrupt the project.

C9.6 The resolutions for some problems originate elsewhere, but all issues should be routed through the fabrication engineer, particularly after shop drawings are approved. In cases where the designer’s input or approval is needed, the Fabricator may send advance copies of proposed resolutions directly to the designer, but the formal submittal should still be through the fabrication engineer. The designer should reply directly to the fabrication engineer, who in turn replies to the Fabricator and ensures that everyone involved is informed of the resolution.

C10.3 Fabricators should have approved shop drawings before fabrication begins, but often shop drawings are not yet approved when the Fabricator wants to begin work. Shop drawings should be returned within a reasonable amount of time (see review time recommendations in AASHTO/NSBA Steel Bridge Collaboration G1.1, “Shop Detail Drawing Review/Approval Guidelines”) but Owners sometimes take much longer, even several months. In such cases Fabricators may request approval to begin fabrication without having approved shop drawings, taking responsibility for any changes. Because holding up the Fabricator may delay progress in the field, Owners should allow the Fabricator to proceed, provided the Fabricator has submitted the shop drawings and provides copies of the submitted drawings to the QAI. The QAI should use the Fabricator’s drawings as submitted until the approved drawings are provided. Then the QAI and QCI should coordinate with the Fabricator’s detailer to define any drawing revisions and verify that changes are incorporated into the work.

C11.4.2 The QAI must ensure that approved welding procedures are followed. This includes observing the QCI periodically monitoring the current and voltage. The QAI should be aware that voltage varies over the length of the welding leads and that welding machine gauges often cannot be trusted. Therefore, current and voltage should be verified as close to the work as possible using calibrated ampere and volt meters. Travel speed and wire feed speed should be checked using a tape measure or ruler and a watch with a second hand.