

Vermont Agency of Transportation
Project Delivery Bureau
Quality Assurance Manual for
Metal Fabrication
April 15th, 2018



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Quality Assurance Manual for

Metal Fabrication

Purpose:

This manual provides guidance for the development and implementation of the Vermont Agency of Transportation (VTrans) Quality Assurance (QA) program for the fabrication of steel and other miscellaneous metal products. This manual standardizes the inspection and acceptance process of metal products for VTrans projects statewide.

Scope:

This document outlines the general guidelines for the VTrans Structural Steel Fabrication Engineer and the Consultant Inspectors to carry out structural steel fabrication quality assurance inspections.

Quality Control:

Quality Control is the inspection, testing and management of operating procedures necessary for producing quality products that meet the requirements of a contract with VTrans and is solely the responsibility of each fabricator or manufacturer.

Quality Assurance:

Quality Assurance is the inspection and documentation by the VTrans Structural Steel Fabrication Engineer and/or the Consultant Quality Assurance Inspector (QAI) to ensure product acceptability and conformance. In addition to the contract provisions, this manual documents and clarifies the authority, responsibilities and duties of an inspector performing QA inspection for the Agency.

Roles and responsibilities of the VTrans Structural Steel Fabrication Engineer:

The VTrans Structural Steel Fabrication Engineer has the authority and responsibility to:

- Review Fabricator's AISC Certifications to verify they are qualified for the items being fabricated.
 - Certified Bridge Fabricator - Advanced (ABR)
 - Bridge Component Certification (CPT)
 - Fracture Critical Endorsement (FC)
 - Sophisticated Paint Endorsement (SPE)
- Report any conflicts or discrepancies found on the plans, fabrication drawings, or other contract provisions to the project manager/project engineer
- Review all fabrication shop drawings for compliance with current welding codes, specifications, etc.
- Verify that all steel bridge members and member components designated on the contract plans as fracture critical are also designated as fracture critical on the shop drawings.
- Approve/reject all weld procedures and PQRs
- Approve/reject all repair procedures
- Approve/reject all heat curving, cambering, and straightening procedures
- Determine if a prefabrication meeting is necessary. Factors influencing this decision include, but are not limited to:
 - Fabricator's knowledge/experience with applicable codes and specifications
 - Working experience between VTrans and fabricator
 - Complexity of project
- Assign quality assurance inspection in the fabrication shops as needed. For reference, see flow chart at the end of this manual
- Address fabrication issues/difficulties encountered during production
- Consult with the design engineer to determine if fabricator proposed changes are acceptable (when applicable).
- Approve/reject fabricator Non Conformance Reports (NCRs)
- Reject nonconforming material when necessary
- Assist the Resident Engineer (when applicable) with:
 1. review and approval of field welding procedures
 2. verification of welder certifications
 3. spot check work in progress
 4. review and report on problems involving field welding

Requirements of the Consultant Inspector (QAI)

The VTrans Consultant Inspector responsible for Quality Assurance shall be an AWS Certified Welding Inspector (CWI) currently certified in accordance with the provisions of AWS QC 1. QAIs who interpret and/or perform NDT must be Level II certified in accordance with the applicable ASNT SNT-TC-1A requirements for each NDT method being used in accordance with the latest edition of the *AASHTO/AWS D1.5M/D1.5: Bridge Welding Code*.

a) Roles and responsibilities

The QAI has the authority and responsibility to:

- Become familiar with applicable portions of the Contract Documents and plans covering the work to be inspected. Study the fabrication drawings before fabrication commences to provide ample opportunity to coordinate with the VTrans Structural Steel Fabrication Engineer
- Report any fabrication performed prior to the receipt of approved shop drawings (performing work at their own risk)
- Maintain neat and orderly records for each project
- Maintain a narrative report for each project, as directed by the VTrans Structural Steel Fabrication Engineer. The report should be an electronic log with date and time information. Documentation is not a substitute for appropriate dialogue with the Fabricator, but should provide a record of important discussions
- Verify that production quality and fabrication processes satisfy the Contract Documents.
- Verify that the fabricator has Quality Control Inspection (QCI) performing inspection functions during all fabrication operations
- Perform QA inspections in accordance with this manual and other instructions by the VTrans Structural Steel Fabrication Engineer
- Communicate with the VTrans Structural Steel Fabrication Engineer and recommend the frequency of in progress fabrication inspection and extent of hourly coverage needed
- Verify that materials satisfy the Contract Documents. Do not waive items that are contractual obligations of the Fabricator and do not accept material that does not conform to the Contract Documents. Report all nonconforming material to the VTrans Structural Steel Fabrication Engineer.
- Perform verification tests, measurements, inspection, or observations to ensure that fabricated items conform to the Contract Documents
- Conduct consistent inspections based on the Contract Documents while providing input to the Fabricator concerning interpretation of the plan details and Contract Document mandates. Obtain assistance from the VTrans Structural Steel Fabrication Engineer as needed.
- Be familiar with the Fabricator's QCP to better understand the QC operations of the shop. Verify that the shop is conducting operations in accordance with their QCP
- Witness NDT, review the test results, and verify that reports are complete, legible and completed in a timely manner

b) Inspection Documents and Equipment

The QAI shall have, or have available the following documents and equipment (if applicable for the items being fabricated), and is responsible for verifying that it is current, properly calibrated, and in good working order:

- AASHTO/AWS D1.5, Bridge Welding Code
- AWS D1.1, Structural Welding Code
- tape measure, 25 ft., 1/32" increments
- pocket metal ruler(s), 1/32" increments
- flashlight and spare batteries
- digital camera (QAI to use only with the approval of the fabricator)
- feeler gauges
- undercut gauge
- bevel gauge
- mirror for examining restricted access areas (such as snipes)
- NDT tools, if applicable
- surface roughness gauges for machine and flame cutting (Ref. AWS C4.1 Criteria for Describing Oxygen-Cut Surfaces, and Oxygen Cutting Surface Roughness Gauge)
- sling psychrometer or similar device for measuring relative humidity

Requirements of the Fabricator

a) Documentation:

The VTrans Structural Steel Fabrication Engineer and/or the Consultant QAI shall obtain or have available the following documentation from the fabrication shop:

- Fabricator's current AISC Certification (and any other applicable certifications)
- Applicable current Vermont Standard Specifications for Construction, special provisions, supplemental agreements or change orders
- Approved, stamped shop drawings with current revisions
- Fabricator's Quality Control Plan (QCP), which is to include the company's Non-Destructive Testing (NDT) written practice
- Fabricator's Fracture Control Plan (FCP) if applicable
- Prefabrication meeting minutes, if meeting was held
- Applicable provisions of the AREMA Manual for Railway Engineering, if required for the project
- AWS A2.4, Symbols for Welding and Nondestructive Evaluation
- AWS A3.0, Standard Welding Terms and Definitions
- Applicable ASTM or AASHTO specifications
- Copy of approved coatings submittals when required
- Applicable coating test methods

- Applicable Steel Structures Painting Council (SSPC) Specifications
- Mill Test Reports (MTRs) for material used in fabrication
- List of qualified welders, welding operators, and tack welders, and their certifications
- Approved Weld Procedure Specifications (WPSs)
- Approved Welding Procedure Qualification Records (PQRs)
- Applicable approved repair procedures
- Applicable pre-approved Fracture Critical Member (FCM) repair procedures
- Qualification documents for all Certified Welding Inspectors (CWIs) and NDT QC personnel
- NDT reports for all work on each project that has been inspected and accepted by NDT QC personnel
- Project record log sheets

b) Inspection Equipment:

The fabricator shall have the following tools/equipment available (if applicable for the items being fabricated), and verify that it is properly calibrated and in working order for the QAI to use:

- 10 ft. steel tape
- 100 ft. steel tape
- 6 ft. straightedge
- 2 ft. level (minimum)
- 2 ft. carpenter's square
- weld gauges
- micrometer
- temperature-indicating crayons for applicable temperatures based on the heating being performed, or surface pyrometer
- thermometers for determining air, paint and metal surface temperatures
- dry and wet film paint gauge

Control of Materials and Work

Prior to startup of fabrication:

- a) **Prefabrication Conference:** The QAI(s) assigned to a project is/are expected to attend any scheduled prefabrication conference. This meeting is the responsibility of the VTrans Fabrication Engineer. All parties involved in the fabrication of the material should be in attendance. This includes but is not limited to the VTrans Structural Steel Fabrication Engineer, Consultant Inspector, Fabricator's Quality Control Inspector, Production Manager, Shop Foreman, etc. This conference provides VTrans and the fabricator an opportunity to:
 - discuss any anticipated difficulties
 - review codes and specifications requiring conformance
 - establish communication between VTrans, Fabricator, and QAI
 - review the importance of Requests for Information (RFIs)
 - establish proper handling and storage of materials during the fabrication process

- b) **Work Start Up:** Fabrication should not commence prior to the approval of all applicable fabrication drawings, welding procedures, heat curving and cambering procedures, etc. Verification must be made that all materials comply with the contract requirements.

- c) **Mill Test Reports:** Generally, all materials are ordered to comply with specific chemical and physical requirements. The mill test reports will indicate actual values from tests for each batch (heat number) or lot of material. The QAI shall check incoming or stored material mill test reports against the applicable AASHTO, ASTM, etc., requirements for compliance. Mill test reports are Type D certification information referred to in the current *Vermont Agency of Transportation Standard Specifications for Construction: section 700.02 MATERIALS CERTIFICATIONS*. The QAI shall verify that the material meets the minimum values for tensile strength, yield strength, elongation, Charpy V Notch test, and where applicable, drop weight tear test. In addition, the QAI shall verify that the material is within the minimum and maximum limits established for the chemical composition of the steel grade specified, as well as that the Buy America requirements are met. All steel bridge members and member components designated on the plans as fracture critical shall be subject to the additional provisions of the latest edition of the *AASHTO/AWS D1.5: Bridge Welding Code: Section 12. AASHTO/AWS Fracture Control Plan (FCP) For Non Redundant Members*

- d) **Welding Consumables Certificates of Conformance:** Welding electrodes for the SMAW process, the electrode-flux combination for the SAW process and the electrode shielding gas or gas mixture combination for the FCAW or GMAW process requires a manufacturer's certification. The QAI should verify the certificate of conformance values against the appropriate code and buy America requirements.

- e) **Welder Qualifications:** Welder and welding operator qualification certifications and continuity logs are the responsibility of the fabricator or contractor. It is the responsibility of the QAI to verify that the variables used in production (process, position of welding, direction of welding (vertical welds), use of backing material, thickness of material and the shielding medium (when applicable)), by each welder or operator are within his/her qualifications and limitations.

- f) **Material Storage:** Material shall be stored above the ground on platforms, skids or other supports. It shall be kept free from dirt, grease, corrosion and other foreign material. The QAI is responsible to periodically check the storage of materials, both unfabricated and fabricated, and see that it is properly stored. The QAI shall verify that any material placed in storage, pending shipment, shall comply with the contract requirements and the current *Vermont Agency of Transportation Standard Specifications for Construction: section 506.16 MARKING, STORING, AND SHIPPING*. Any material improperly stored shall be reported to the fabricator or manufacturer. If corrective action is not taken, the concerns shall be reported to the VTrans Fabrication Engineer or the Structures Engineer.

- g) **Material Identification:** It is the manufacturer's / fabricator's responsibility to establish a process for ensuring the identification and traceability of the material they are using. It is the QAI's responsibility to verify the origin of all material and its traceability through the production process. The VTrans Fabrication Engineer shall approve/reject the manufacturer's / fabricator's plan for maintaining the identity of materials.

- h) **Material Verification:** Incoming materials or materials from storage shall have verifiable test reports and identification. Materials that do not comply with contract requirements shall be rejected. Steel material that has laminations or cracks shall be rejected unless a repair procedure is approved by the VTrans Fabrication Engineer. Steel material that is out of tolerance or does not meet the requirements of ASTM A6 shall be rejected unless a method of correction is approved by the VTrans Fabrication Engineer.

During Fabrication

- a) **General:** The QAI shall perform his/her activities/duties in compliance with the *AASHTO/AWS D1.5M/D1.5:2010 Bridge Welding Code: Section 6*, and in a manner that will not impede the manufacturer or fabricator.

- b) **Process or Procedure Qualification Tests:** The VTrans Fabrication Engineer / QAI shall witness any process or procedure qualification tests performed by a manufacturer or fabricator. The QAI shall report the acceptance or rejection of any tests to the VTrans Fabrication Engineer.

- c) **Preparation of Base Metal:** The QAI shall witness and approve any nondestructive testing performed in accordance with the current *Vermont Agency of Transportation Standard Specifications for Construction: section 506.09 PREPARATION of BASE METAL*. He/she shall also witness and report on any special tests or repairs performed on base metal material.
- d) **Assembly:** The QAI is responsible for checking all welding operations, fit-up, machining or finishing operations, cambering or any other operations performed by the manufacturer or fabricator to ensure that they comply with the contract requirements.

The QAI shall verify the fit-up of all primary member connections (shall include cross frames of curved girders). Primary members are defined in the current *Vermont Agency of Transportation Standard Specifications for construction: section 714.01 GENERAL REQUIREMENTS*.

The QAI shall spot check and verify the geometry and fit-up dimensioning of secondary members such as cross frames and lateral bracing. Generally any given structure will have groups of diaphragms and lateral bracing members that have the same geometric dimensions. The fabricator will usually make up jigs for quick positioning of member components that have the same geometric dimensions. Verification of the layout for each different group will usually be adequate for quality assurance.

Dimension tolerances for welded members or components are specified in the latest edition of the *AASHTO/AWS D1.5M/D1.5: Bridge Welding Code: Section 3.5*.

The “as fabricated” tolerances for camber, sweep and cross section of members not covered in the latest edition of the *AASHTO/AWS D1.5M/D1.5: Bridge Welding Code* shall be limited to the permissible mill variations specified in ASTM A6.

- e) **Welding:** The storage and use of low hydrogen SMAW Electrodes shall comply with the latest edition of the *AASHTO/AWS D1.5M/D1.5: Bridge welding Code: Section 4.5*.

The QAI shall visually spot check all welding being performed, both during and after completion.

Measurement of Preheat: The QAI shall spot check preheat temperatures used for material up to and including 1-1/2 inches in thickness and more frequently check preheat temperatures for materials over 1-1/2 inches in thickness.

The QAI shall witness all Nondestructive Testing (NDT). The QAI is responsible for verification that all NDT performed meets the requirements of the latest edition of the *AASHTO/AWS D1.5M/D1.5: Bridge Welding Code: section 6* and all applicable ASTM requirements.

- f) **Member Approval:** All members, components and/or assemblies shall be inspected and conformance verified prior to shipment.

When applicable, the QAI shall verify that the material has been adequately marked to ensure its location and position during erection.

Any areas damaged shall be repaired to the satisfaction of the QAI.

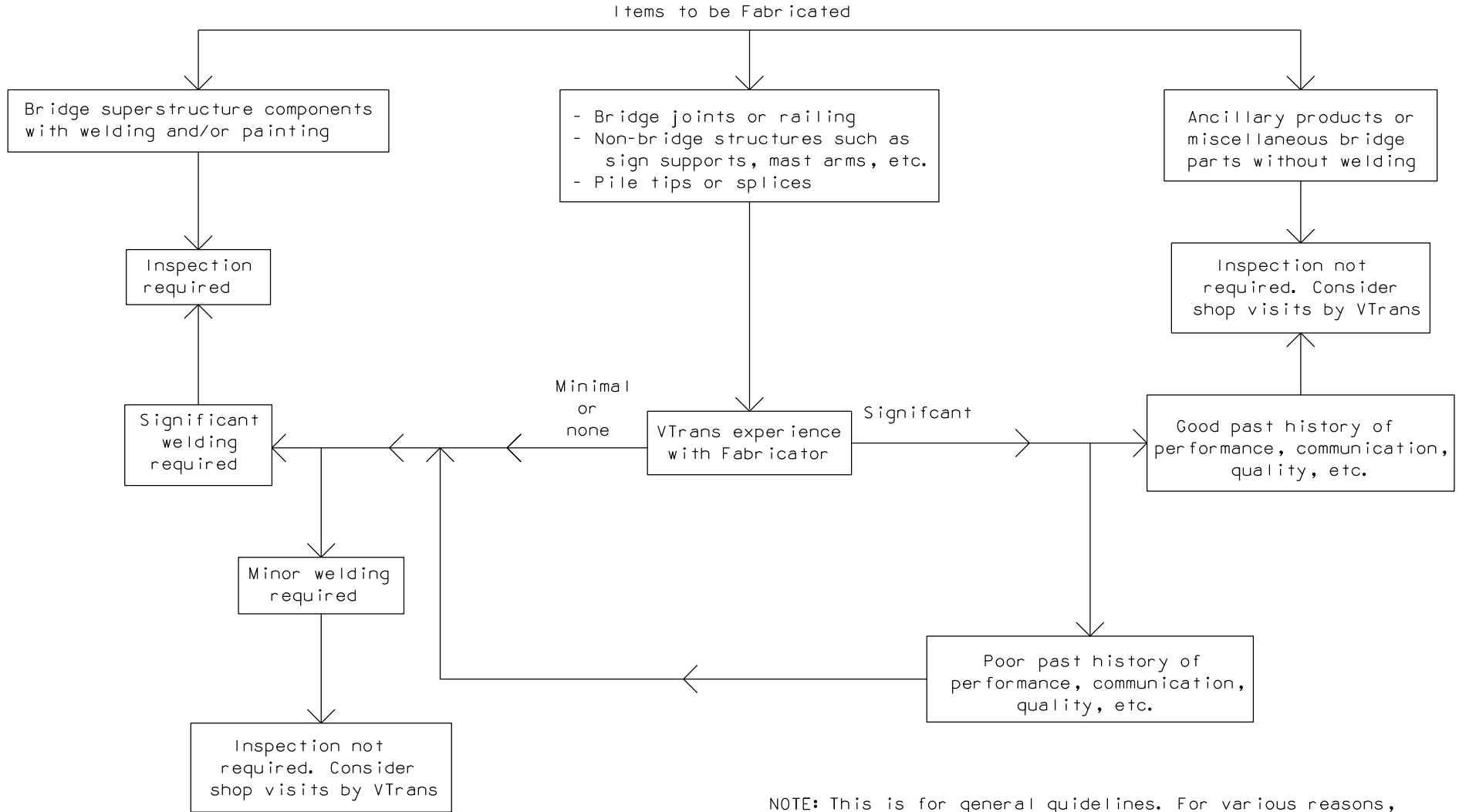
When the QAI is satisfied that the members, components and/or assemblies comply with all applicable contract requirements, he/she shall stamp the item with his/her seal of approval.

Shipping

- a) The QAI shall approve the loading, placement and anchorage of all material to be shipped. Any concerns for the safety of the material during shipment or probable damage to any members due to the method of placement or anchorage shall be brought to the attention of the fabricator or manufacturer.

QAI FLOW CHART FOR METAL FABRICATION

(To determine if QAI is necessary)



NOTE: This is for general guidelines. For various reasons, inspection coverage may occasionally be increased or decreased from this chart. Factors include but are not limited to:

- Size of project/amount of fabrication
- working relationship between management, QC and QA
- complexity of fabrication or paint system
- working experience between VTrans and fabricator
- fabricator's knowledge/experience with applicable codes, specifications and coatings
- fabrication issues/errors on previous projects
- personnel changes, such as QC or production managers