Guide for AWS Visual Weld Inspection

Overview & Contents

Scope
This guide is intended to assist Owner/Operators, Contractors, Authority Having Jurisdiction (AHJ) personnel, Inspectors, Manufacturers and Contractors/Fabricators in recognizing what is an appropriate weld inspection program and to audit their own current weld inspection program to determine if it is effective and compliant to AWS standards.

Background
Precisioneering is a company specializing in project management, welding consulting, inspection & qualification of welders. This document was created to address the Who, What, Why, and When in regard to visual weld inspection requirements on projects that reference AWS standards.

Introduction
During years of performing inspections on static/cyclically-loaded structures, owners, manufacturers and other fabricators would be under the assumption that they were fabricating or making weld repairs in accordance with AWS standards. After further discussion or after auditing the weld programs to the actual AWS Standards, deficiencies would ultimately be discovered within these programs.

After repetitively discovering similar deficiencies among many of these weld programs, it eventually lead to the creation of this guide. The intention is to share this information with the members of the industry, with the hope of improving knowledge of these standards. Compliance to these standards leads to a safer industry.

Contents
This guidance will address:

• WHO can be an AWS inspector
• WHAT type of inspection(s) should be performed
• WHY do we follow AWS when welding
• WHEN does the inspector actually have to conduct the inspection
• Summary & Conclusion
WHO can be an AWS Inspector?

The following information was taken from AWS D1.1 (2015) Section 6.1.4.1:

Inspector Qualifications: states the requirements for all inspectors responsible for acceptance or rejection of material and workmanship shall be qualified. The basis of Inspector qualifications shall be documented.

- Current or previous certification as an AWS Certified Welding Inspector (CWI).
- Current or previous qualification by the Canadian Welding Bureau (CWB).
- (*) An individual who, by training or experience, or both, in metals fabrication, inspection and testing, is competent to perform inspection of the work.

(*) The basis of training or experience shall be documented. Companies can also train their internal inspectors in accordance with AWS “Welding Inspector Specialist program”.

WHAT type of Inspection(s) should be performed?

Type of Inspections

Section 6.1.2 states there are two types of weld inspections, “Contractor’s Inspection” and “Verification Inspection”.

- Contractor’s Inspection (*) (Section 1.3.3.1): “Contractor’s Inspector” shall be defined as the duly designated person who acts for, and on behalf of, the contractor on all inspection and quality matters within the scope of the code and of the contract documents. (*) Described as “Fabrication/Erection” Inspection in previous AWS D1.1 publishing.
- Verification Inspector (Section 1.3.3.2): “Verification Inspector” shall be defined as the duly designated person who acts for, and on behalf of, the Owner or Engineer on all inspection and quality matters specified by the Engineer.
- Inspector(s) (Section 1.3.3.3): When the term “Inspector” is used without further qualifications as the specific Inspector category described above, it applies equally to the Contractor’s Inspector and the Verification Inspector within the limits of responsibility described in 6.1.2 (Section 6.1.2), “For the purpose of this code, fabrication/erection inspection and testing, and verification inspection and testing shall be separate functions”.
- Contractor: Shall be defined as any company, or that individual representing a company, responsible for the fabrication, erection, manufacturing, or welding, in conformance with the provision of this code (Section 1.3.2)

AWS Code Term

(*) Code Term “Shall”: Code provisions that uses “shall” are mandatory unless specifically modified in contract documents by the Engineer (Section 1.3.6.1).
WHY do we follow AWS when welding?

ASTM F24 Standards

International Building Code (IBC), American Institute of Steel Construction (AISC) and ASTM F24 standards reference AWS standards when welding is required. This statement carries a lot of weight, as one AWS code (D1.1/2015) contains over 500 pages and has a multitude of information.

AWS Standards

The following was taken from one AWS codebook (Structural Steel D1.1: 2015) that identifies the visual welding requirements and qualifications. With that in mind, information has to be taken from several different areas, which include; Section #6 Inspection, Section #5 Fabrication (5.26 repairs), Section #1, etc.

*Note: Section 8 “Strengthening and Repairing Existing Structures” also references Section 5.26 for weld repairs.*

WHEN does the Inspector actually have to conduct the inspection?

Frequency of Inspection

This is probably the number one question asked. Numerous owner/operators and manufacturers don’t know all of the inspection requirements. Inspector’s responsibility described in Section 6.1.5 states “The Inspector shall ascertain that all fabrication and erection by welding is performed in conformance with the requirements of the contract documents (Drawing(s), Manufacturer Requirements, etc.). A lack of proper welding inspection offers the potential for quality problems, life safety issues and liabilities.

When fabrication and weld repairs are performed without the required inspection, we face the issue of visual “after the fact” weld inspections. The manufacturer, contractor or owner/operator may assume the lack of continuous weld inspections can be easily solved by having an inspector come out and do a visual inspection for all completed weldments(s). This is where the problem begins. Yes, a welding inspector can, in most cases, conduct a visual “after the fact” limited weld inspection. However, this type of inspection cannot verify many of the critical weld variables as specified by the Engineer, WPS and other documentation and so the inspector should provide a “limited” report to protect him/her and the inspector’s employer from liabilities for not performing the inspections within the AWS code requirements.

The integrity and quality of welds cannot be positively verified without performing all required welding inspection tasks. Even though the overall appearance of the welds may meet the visual acceptance criteria, it cannot be assumed that they meet the minimum quality requirements of the code or minimum design requirements specified on the approved drawings.

The following weld inspection requirements are from AWS D1.1 Section 6 and C-6.1:

- The inspector shall be notified in advance of the start of operations subject to inspection and verification (Section 6.1.7).
  
  **Conducted Before Welding**

  *Note: This indicates that the weld inspector(s) need to know about all welding including weld repairs before welding occurs.*

- The Contractor Inspector shall ensure that only materials and equipment conforming to the requirements of this code shall be used (Section 6.2).
  
  **Conducted Before Welding**

  *Note: This indicates that the weld inspector(s) shall verify all material(s) and equipment before welding occurs.*

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Ø All Contractor Inspectors shall ensure all prequalified WPS’s to be used for the work conform with the requirements Clause 3, Clause 5, and the contract documents. All WPS’s also have to conform to Clauses 4 and 5 (Section 6.3.1).

**Conducted Before Welding**

*Note: This indicates that the weld inspector(s) shall review and approve the use of all PWPS/WPS’s before welding occurs.*

Ø All Contractor Inspectors shall ensure that all welding operation is performed in conformance with WPS’s that meet the requirements of this code and the contract documents (Section 6.3.3).

**Conducted Before and During Welding**

*Note: This indicates that the inspectors are verifying the proper use of the PWPS/WPS’s during the welding process. The inspector can only accomplish this task by being in the immediate vicinity of the welding. The following are some WPS verification requirements.*

- Welding Process
- Base Material
- Joint Configuration
- Filler Metals
- Joint Design
- Shielding Gas
- Weld Position
- Technique
- Volts, Amps & Travel Speed
- Electrode Diameter & Classification
- Electrical Characteristics
- Pre & Post Heat Recommendation

The Inspector shall allow welding to be performed only by welders, welding operators, and tack welders who are qualified in conformance with the requirements of Clause 4, or shall ensure that each welder, welding operator, or tack welder has previously demonstrated such qualifications under other acceptable supervision and approved by the Engineer in conformance with 4.2.2.1 (Section 6.4.1).

**Conducted Before Welding**

*Note: This indicates that the inspector has to verify the Welder Qualification Records (WQR’s) before welding occurs. The inspector shall ensure the welder is qualified for the following essential welding parameters:*

- Welding Process
- Thickness Limitations
- Joint Type
- Type of Electrodes
- Backing Limitations
- Referenced AWS code
- Vertical Progression

The Inspector shall ensure that the size, length, and location of all welds conform to the requirements of this code and to the detail drawings and that no unspecified welds have been added without the approval of the Engineer (Section 6.5.1).

**Conducted During and After Welding**

*Note: This indicates that the inspector shall ensure all applicable drawings and repair procedures were followed correctly. This has to be accomplished during and after welding occurs.*

The Inspector shall, at suitable intervals, observe joint preparation (before welding), assembly practice (before welding), the welding technique (during welding), and performance of each welder, welding operator, and tack welders to ensure that the applicable requirements of the code are met (during welding) (Section 6.5.2).

**Conducted Before and During Welding**

*Note: This indicates that the inspector has to inspect before and during the welding process. An inspector cannot accomplish these tasks without being on-site during the welding process or repair. The following are some joint preparation, assembly and weld practices.*

- Root Opening
- Joint Alignment
- Groove Angle
- Stringer / Weave Technique
- Root Face Dimension
- Root Pass Inspection

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The Inspector shall examine the work to ensure that it meets the requirements of this code. Other acceptance criteria, different from those described in the code, may be used when approved by the Engineer. Size and contour of welds shall be measured with suitable gauges. Visual inspection for cracks in the welds and base metal and other discontinuities should be aided by a strong light, magnifiers, or such other devices as may be found helpful (Section 6.5.3).

Conducted During and After Welding

Note: This indicates that the inspector has to verify all weld sizes, locations and contours, which include root passes (first pass of a groove joint) for cracks. This can only be accomplished if the inspector is on-site during the welding. AWS D1.1 Table 6.1 and figure 5.4 shall be followed for all visual acceptance requirements under this code.

AWS Inspection Requirements (Continued)

Inspectors shall identify with a distinguishing mark or other recording methods all parts and joints that they have inspected and accepted. Any recording method that is mutually agreeable may be used (Section 6.5.4).

Conducted During and After Welding

Note: Inspectors shall generate an inspection report for all welds that were inspected. Since numerous inspection hold point requirements are actually performed before, during and after welding has occurred. Inspector should be onsite while all welding is being conducted including weld repairs. Documentation is the best representation that the weld repairs were completed in accordance with the applicable AWS standard.

The Inspector shall keep a record of qualifications of all welders, welding operators, and tack welders; all WPS qualifications or other tests that are made; and such other information as may be required (Section 6.5.5).

Conducted After Welding

Note: Inspectors shall maintain all the documentation and reference these documents in the weld inspection report.

Summary and Conclusion

Summary

As described in “WHEN does the inspector actually have to conduct the inspection?” the inspector must be on-site before, during and after for all welding and weld repairs. If weld inspector(s) are signing off on weldments without being on-site during the welding process, the inspector is not inspecting in accordance with AWS standards and will be submitting a report that does not meet AWS D1.1-15 Section 6 requirements.

All Inspector(s) shall inspect welds in accordance with the referenced standard and document all inspection results. An owner/operator, contractor, engineer should be aware of all limitations including potential quality problems, life safety issues and liabilities that may occur when asking for or accepting “after the fact” welding inspection reports.

Conclusion

Attached to this document is an AWS D1.1-15 compliant visual inspection form that will assist manufacturers and owner/operators in completing welding tasks in accordance with AWS standards. Thank you for taking the time to review this document and hopefully the referenced AWS inspection requirements are currently being conducted at your facility.

Sincerely,

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All inspection requirements shall be conducted in accordance with AWS D1.1 - 15 requirements. Inspector qualifications shall also be in accordance with AWS D1.1-15 section 6.1.4.1 requirements.