

## 9. QUALITY CONTROL/QUALITY ASSURANCE

Quality control is principally the responsibility of the contractor, while Quality Assurance is performed at the prerogative of the owner and as mandated by the Building Code. Key parts of the Quality Control program include assuring that all parties understand what is to be constructed, and the standards that apply. All workers and inspectors should be adequately qualified to perform the required work, and should have written procedures, approved by the engineer, for the work that is to be performed.

### 9.1 Quality Control

Fabrication/erection inspection and testing should be the responsibility of the contractor, unless otherwise provided for in the Contract Documents.

#### 9.1.1 General

A pre-job meeting or series of meetings should be held with the owner's representatives, the engineer, the Fabricator/Erector's production and QC personnel to plan and discuss the project and fabrication procedures. Welders and welding operators should also be involved at some level, either by a meeting or direct dissemination of the information. Fabrication/erection inspection and testing should be performed prior to assembly, during assembly, fit-up, tacking, welding and after welding to ensure that the materials and workmanship meet the requirements of the Contract Documents. The fitters and welders should have the applicable WPS document and drawings for each connection and joint at their assembly station.

#### 9.1.2 Inspector Qualification

Inspectors responsible for acceptance or rejection of materials and workmanship should be qualified in accordance with Sections 10 and 11 of these Guidelines. The engineer should have the authority and duty to verify the qualifications of the inspectors.

#### 9.1.3 Duties

The inspector should ascertain that all materials comply with the Contract Documents, either by mill certifications or testing. The inspector should verify that all fabrication and erection welding is performed in accordance with the Contract Documents. Detailed duties are further described in Section 10 of these Guidelines.

#### 9.1.4 Records

The QC inspector should insure that each welder has a unique identification mark or die stamp to identify his or her welds. The inspector should also mark the welds/parts/ joints that have been inspected and accepted with a distinguishing mark or die stamp, or alternatively, maintain records

indicating the specific welds inspected by each person. The NDT technician should use the weld identification system given in AWS D1.1, Sections 6.19.1 and 6.19.2. The inspector should keep a record of all welders, welding operators and tack welders; all procedure and operator qualifications; all accepted parts; the status of all rejected joints; NDT test reports; and other such information as may be required.

### **9.1.5 Engineer Obligations**

The structural engineer or designated welding engineer should perform a review of the Fabricator/Erector's Quality Control program, equipment condition, and availability of equipment and qualified personnel. The review should include the following:

- a) Interview with Fabricator/Erector's designated Quality Control personnel.
- b) Review of Fabricator/Erector's written quality procedure manual.
- c) Review of Fabricator/Erector's Procedure Qualification Records (PQR's) and WPS applicable to the specific project.
- d) Review of Welder Performance Records.
- e) Review of the Fabricator/Erector's NDT procedures, equipment calibration records, and personnel training records. Alternatively, the Fabricator/Erector may contract with an outside Quality Control company for NDT services; however, this should not take the place of the owner's QA responsibility for NDT.
- f) Designate any specific NDT requirements which apply to the project and which are beyond those required by the Code.
- g) A meeting with the owner's representative, fabricator/erector's Quality Control personnel and the welder, to review the WPS.

### **9.1.6 Contractor Obligations**

The contractor should make available to the inspector and NDT Technician all drawings, project specifications, mill certifications, welder qualifications, WPSs and PQRs applicable to the project. The contractor should cooperate fully with requests from inspection and testing personnel for access to the connections and joints to be inspected or tested. This includes beam and column turning in the shop, weld backing removal and access platforms or scaffolding as required to perform the work safely. The contractor should be responsible for all necessary corrections of deficiencies in materials and workmanship. The contractor should comply with all requests of the inspector to correct deficiencies. The NDT Technician should be apprised of any repairs made by the contractor. Inspections should be performed in a timely manner. Disputes should be resolved by the structural engineer of record, or by a welding engineer.

### 9.1.7 Extent of Testing

Information furnished to the bidding contractors should clearly identify the extent of inspection and testing to be performed by the contractor. Weld joints requiring testing by Contract Documents shall be tested for their full length, unless partial or spot testing is specified. When partial or spot testing is specified, the location and lengths of welds or categories of weld to be tested should be clearly designated in the Contract Documents. Each spot test should cover at least 4 inches of the weld length. When spot testing reveals indications of rejectable discontinuities that require repair, the extent of those discontinuities should be explored. Two additional spots in the same segment of weld joint should be taken at locations away from the original spot. When either of the two additional spots show defects that require repair, the entire segment of weld represented by the original weld should be completely tested.

Where spot testing or percentage sampling is specified on certain welds, the contract drawings and shop drawings should so state using NDT symbols in conjunction with the welding symbols. On projects where a sliding sampling scale is specified, based on the UT reject level of individual welders, the inspector should keep records on each welder or welding operator. These records will be used as a basis for sampling rate reduction.

*Commentary: AWS D1.1 uses the term "Fabrication/Erection Inspection" synonymously with the classical "Quality Control" function of other industries. A basic premise of Quality Control is to have the production, engineering and Quality Control departments independent of one another.*

*The contractor should be responsible for establishing the Quality Control program and for in-progress Quality Control of work. Part of this effort is to require that welders meet established minimum requirements. Execution of critical welds requires skilled welders who will follow the project welding requirements. An important part of any Quality Control program is assuring that the workers have the appropriate qualifications to perform the work. Welds executed by welders who do not satisfy the welder performance qualifications should be considered rejectable. Important aspects of a QC program should include as a minimum:*

- 1. Welders shall be qualified for the work they will be doing per AWS D1.1, Section 5, Part C.*
- 2. The qualifications of each welder should be certified by an appropriate authority and verified by the contractor and Special Inspector. The engineer should establish whether there are certifications from selected jurisdictions that will or will not be accepted as acceptable substitutions.*

*The Quality Control function of the contractor should be isolated from the production department and the QC Manager should report directly to a high level company officer to avoid conflicts of interest with production.*

## **9.2 Quality Assurance & Special Inspection**

Verification inspection and testing should be the responsibility of the owner and/or the engineer unless otherwise provided for in the Contract Documents. The Quality Assurance designate should act for and in behalf of the owner or engineer on all inspection, NDT and quality matters that are within the scope of the Contract Documents.

### **9.2.1 General**

Verification inspection and testing are the prerogatives of the owner who may perform this function or, when provided for in the Contract Documents, waive independent verification, or stipulate that both inspection and verification shall be performed by the contractor. In municipalities that have adopted the UBC, verification inspection and testing is mandated for structural welding, and is designated as “Special Inspection.”

The QA inspector should be included in the pre-job meetings for fabrication and erection discussions referenced in 9.1.1. Fabrication/erection verification inspection and testing should be performed concurrently with the Quality Control inspection and testing to ensure that the contractor's QC program is meeting the requirements of the Contract Documents. The QA inspector should ensure that the fitters and welders have the applicable WPS document and required information for each connection and joint at their assembly station.

### **9.2.2 Inspector Qualification**

Inspectors responsible for acceptance or rejection of materials and workmanship should be qualified in accordance with Chapters 10 and 11 of these Interim Guidelines. The engineer should have the authority and duty to verify the qualifications of the inspectors. The inspector may use assistants who are formally designated, aware of their assigned responsibility and the acceptance criteria, and work under the direct supervision and monitoring of a qualified inspector.

### **9.2.3 Duties**

The QA inspector should verify the qualifications of the QC inspectors and the NDT technicians. The inspector should verify that the mill certifications for all materials are being checked by the QC inspector and that they comply with the Contract Documents. The inspector should verify that all fabrication and erection welding is performed in accordance with the Contract Documents. Detailed duties are further described in Chapter 10 of these Interim Guidelines.

### **9.2.4 Records**

The inspector should ensure that each welder, NDT technician and QC inspector has a unique identification mark or die stamp to identify his or her welds/weld tests/weld inspections. The QA Inspector should ensure that the QA and NDT personnel are keeping the proper records of all welders, welding operators and tack welders; all procedure and operator qualifications; all

accepted parts; the status of all rejected joints; NDT test reports; and other such information as may be required.

### **9.2.5 Engineer Obligations**

The structural engineer or designated welding engineer should perform a complete review of the QA Agency. This review should encompass personnel qualification, written procedures manual, and availability of equipment and qualified personnel. The Agency should employ an American Society for Nondestructive Testing (ASNT) Level III qualified person who oversees equipment calibration and personnel certification and training for the project on a full time basis. Reviews should be performed in a timely manner. Disputes should be resolved by a qualified welding engineer.

### **9.2.6 Contractor Obligations**

The contractor should make available to the QA Inspector and QA NDT Technician (if applicable) all drawings, project specifications, mill certifications, welder qualifications, WPSs and PQRs applicable to the project. The contractor should cooperate fully with requests from inspection and testing personnel for access to the connections and joints to be inspected or tested. This includes beam and column turning in the shop, weld backing removal and access platforms or scaffolding as required to perform the work safely. The contractor should be responsible for all necessary corrections of deficiencies in materials and workmanship. The contractor should comply with all requests of the QA Inspector to correct deficiencies. The QA NDT Technician should be apprised of any repairs made by the contractor.

### **9.2.7 Extent of QA Testing**

The QA representative may perform independent inspecting and testing to the extent established in the contract documents. When conditions exist that make further testing advisable, the QA representative, with the concurrence of the structural engineer of record, may perform additional independent inspection and testing, to the degree his/her judgment suggests as appropriate. Acceptance criteria should be mutually agreeable to the inspector and contractor. Discrepancies between the QC and QA decisions should be resolved by the engineer.

*Commentary: AWS D1.1 uses the term "Verification Inspection" synonymously with the "Quality Assurance" function of other industries. The purpose of QA programs is to provide an oversight to the contractor's QC program. This may range from simple records/report reviews to a full testing and inspection program, depending on the effectiveness of the Fabricator/Erector's QC program, and the requirements of the building code. Often this cannot be established until the contractor is selected.*

*The owner must ensure that an adequate Quality Control program is in place, and is responsible for the Quality Assurance program. The use of "licensed" or*

*“qualified” fabrication shops in lieu of requiring independent Quality Assurance provided by the owner is not recommended. However, a fabrication shop that is licensed or qualified by a recognized program, such as the AISC Quality Certification Program, does provide a minimum assurance of capability of good performance.*

*The owner is responsible for establishing the Quality Assurance program. Elements in an acceptable Quality Assurance program should conform to those required by the UBC.*

*Since most owners have little expertise or knowledge related to construction, this often means that the engineer must advise the owner, and, in many cases, establish the program. Example Quality Assurance requirements might include the following:*

- 1. The lead welding inspector should be a Certified Welding Inspector (CWI) per AWS-QC-1 Standards, and, where applicable, should be certified by the responsible jurisdiction as a qualified inspector for structural steel welding. Other welding inspectors performing visual inspection under the supervision of the lead welding inspector should hold an active and appropriate certification. Not more than four non-CWIs should be under the supervision of a CWI.*
- 2. All welding should be inspected visually as required by AWS D1.1 (See AWS D1.1 Section 8.15.1).*
- 3. All complete and partial joint penetration welds should be inspected ultrasonically as required by AWS D1.1 (See AWS D1.1 Section 8.15.4) after the weld is completed and has cooled down. The inspector and NDT technician should perform the following tasks for each weld.*
  - a. Verify material identification per approved shop drawings and specifications.*
  - b. Perform a UT lamination check of the column and beam as required by AWS D1.1 or at least within a 6 in. radius around the weld. As a minimum this check should be performed after welding, however, if performed before welding as well, this may save some rework effort.*
  - c. Verify that an approved welding procedure specification (WPS) has been provided and that the WPS has been reviewed with each welder performing the weld. A copy of the appropriate WPSs should be at each joint. Welds not executed in conformance with the WPS should be considered rejectable (See AWS D1.1 Section 6.3.1).*
  - d. Identify welding consumables per approved shop drawings and approved WPS (See AWS D1.1 Sections 6.2 and 6.5.3).*
  - e. Verify welder identification and certification. Verify that required supplemental qualification tests have been passed (See AWS D1.1 Section 6.4) and mock-ups, if required by the Contract Documents, have been executed.*

- f. *Verify proper amperage and voltage of the welding process by using a hand held calibrated amp and volt meter. (Similar equipment should also be used by the fabricator.) Amperage and voltage should be measured at the arc with this equipment.*
- g. *Visually inspect all required welds in accordance with AWS D1.1. Verify and document the fabrication sequence including the following per approved shop drawings and approved WPS (See AWS D1.1 Section 6.5.4):*
  - 1. *Fit-up;*
  - 2. *Preheat and interpass temperatures;*
  - 3. *Welding machine settings. Voltage should be determined at the arc and amperage on the cables. Welds executed outside of the parameters contained in the approved WPS should be considered rejectable;*
  - 4. *Weld sequence;*
  - 5. *Weld pass sequence and size of weld bead;*
  - 6. *Peening, if required;*
  - 7. *Removal of backup and weld (extension) tabs, preparatory grinding and cleaning, and execution of reinforcing fillet weld, as required by the WPS;*
  - 8. *Application and maintenance of postheat or insulation to completed weld as required by the WPS.*
- h. *Ultrasonically inspect in accordance with AWS D1.1. Attempt to pass sound through the entire weld volume from two crossing directions where possible. In particular, inspect the beam bottom flange from both "A" and "B" faces. This will require adequate staging to be provided by the contractor to permit safe access by the inspector. This is normally not a problem in existing buildings; however, it may be more difficult on buildings under construction.*

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