
PART VI
Appendix O
Quality Assurance Plan

O.1 Scope

Quality control (QC) and quality assurance (QA) shall be provided as specified in this Section.

O.2 Inspection and Nondestructive Testing Personnel

Visual welding inspection and nondestructive testing (NDT) shall be conducted in accordance with a written practice by personnel qualified in accordance with Appendix S.

Bolting inspection shall be conducted in accordance with a written practice by qualified personnel.

O.3 Contractor Documents

The following documents shall be submitted for review by the engineer of record or designee, prior to fabrication or erection, as applicable:

- (1) Shop drawings.
- (2) Erection drawings.
- (3) Welding Procedure Specifications (WPS), which shall specify all applicable essential variables of AWS D1.1 and the following, as applicable.
 - (a) power source (constant current or constant voltage).
 - (b) for demand critical welds, electrode manufacturer and trade name.
- (4) Copies of the manufacturer's typical certificate of conformance for all electrodes, fluxes and shielding gasses to be used. Certificates of conformance shall satisfy the applicable AWS A5 requirements.
- (5) For demand critical welds, applicable manufacturer's certifications that the filler metal meets the supplemental notch toughness requirements, as applicable. Should the filler metal manufacturer not supply such supplemental certifications, the contractor shall have the necessary testing performed and provide the applicable test reports.
- (6) Manufacturer's product data sheets or catalog data for SMAW, FCAW and GMAW composite (cored) filler metals to be used. The data sheets shall describe the product, limitations of use, recommended or typical welding parameters, and storage and exposure requirements, including baking, if applicable.

The following documents shall be available for review by the engineer of record or designee prior to fabrication or erection, as applicable, unless specified to be submitted:

- (1) Material test reports for structural steel, bolts, shear connectors, and welding materials.
- (2) Inspection procedures.
- (3) Nonconformance procedure.
- (4) Material control procedure.
- (5) Bolt installation procedure.
- (6) Welder performance qualification records (WPQR), including any supplemental testing requirements.
- (7) QC Inspector qualifications.

O.4 Quality Assurance Agency Documents

The agency responsible for quality assurance shall submit the following documents to the authority having jurisdiction, the engineer of record, and the owner or owner's designee:

- (1) QA agency's written practices for the monitoring and control of the agency's operations. The written practice shall include:
 - (a) The agency's procedures for the selection and administration of inspection personnel, describing the training, experience and examination requirements for qualification and certification of inspection personnel, and
 - (b) The agency's inspection procedures, including general inspection, material controls, and visual welding inspection.
- (2) Qualifications of management and QA personnel designated for the project.
- (3) Qualification records for Inspectors and NDT technicians designated for the project.
- (4) NDT procedures and equipment calibration records for NDT to be performed and equipment to be used for the project.
- (5) Daily or weekly inspection reports.
- (6) Nonconformance reports.

O.5 Inspection Points and Frequencies

Inspection points and frequencies of quality control (QC) and quality assurance (QA) tasks and documentation for the seismic load resisting system (SLRS) shall be as provided in the following Tables.

The following entries are used in the Tables:

Observe (O) - The inspector shall observe these functions on a random, daily basis. Welding operations need not be delayed pending observations.

Perform (P) - These inspections shall be performed prior to the final acceptance of the item. Where a task is noted to be performed by both QC and QA, it shall be permitted to coordinate the inspection function between QC and QA so that the inspection functions need be performed by only one party. Where QA is to rely upon inspection functions performed by QC, the approval of the engineer of record and the authority having jurisdiction is required.

Document (D) - The inspector shall prepare reports indicating that the work has been performed in accordance with the contract documents. The report need not provide detailed measurements for joint fit-up, WPS settings, completed welds, or other individual items listed in the Tables in Sections O.5.1, O.5.3, or O.5.4. For shop fabrication, the report shall indicate the piece mark of the piece inspected. For field work, the report shall indicate the reference grid lines and floor or elevation inspected. Work not in compliance with the contract documents and whether the noncompliance has been satisfactorily repaired shall be noted in the inspection report.

O.5.1 Visual Welding Inspection

Visual inspection of welding shall be the primary method used to confirm that the procedures, materials, and workmanship incorporated in construction are those that have been specified and approved for the project. As a minimum, welding inspection tasks shall be as follows:

Table 6.O.1: Visual Welding Inspection Tasks

Visual Inspection Tasks Before Welding	QC		QA	
	Task	Doc.	Task	Doc.
Material identification (Type/Grade)	O	–	O	–
Fit-up of Groove Welds (including joint geometry)	P/O**	–	O	–
– Joint preparation				
– Dimensions (alignment, root opening, root face, bevel)				
– Cleanliness (condition of steel surfaces)				
– Tacking (tack weld quality and location)				
– Backing type and fit (if applicable)				
Configuration and finish of access holes	O	–	O	–
Fit-up of Fillet Welds	P/O**	–	O	–
– Dimensions (alignment, gaps at root)				
– Cleanliness (condition of steel surfaces)				
– Tacking (tack weld quality and location)				
** Following performance of this inspection task for ten welds to be made by a given welder, with the welder demonstrating adequate understanding of requirements and possession of skills and tools to verify these items, the Perform designation of this task shall be reduced to Observe, and the welder shall perform this task. Should the inspector determine that the welder has discontinued adequate performance of this task, the task shall be returned to Perform until such time as the Inspector has reestablished adequate assurance that the welder will perform the inspection tasks listed.				

Visual Inspection Tasks During Welding	QC		QA	
	Task	Doc.	Task	Doc.
WPS followed	O	–	O	–
– Settings on welding equipment				
– Travel speed				
– Selected welding materials				
– Shielding gas type/flow rate				
– Preheat applied				
– Interpass temperature maintained (min./max.)				
– Proper position (F, V, H, OH)				
– Intermix of filler metals avoided unless approved				
Use of qualified welders	O	–	O	–
Control and handling of welding consumables	O	–	O	–
– Packaging				
– Exposure control				
Environmental conditions	O	–	O	–
– Wind speed within limits				
– Precipitation and temperature				
Welding techniques	O	–	O	–
– Interpass and final cleaning				
– Each pass within profile limitations				
– Each pass meets quality requirements				
No welding over cracked tacks	O	–	O	–

Visual Inspection Tasks After Welding	QC		QA	
	Task	Doc.	Task	Doc.
Welds cleaned	O	–	O	–
Welder identification legible	O	–	O	–
Verify size, length, and location of welds	O	–	O	–
Visually inspect welds to acceptance criteria	P	D	P	D
– Crack prohibition				
– Weld/base-metal fusion				
– Crater cross-section				
– Weld profiles				
– Weld size				
– Undercut				
– Porosity				
Placement of reinforcement fillets	P	D	P	D
Backing bars removed and weld tabs removed and finished (if required)	P	D	P	D
Repair activities	P	–	P	D

O.5.2 Nondestructive Testing (NDT) of Welds

Nondestructive testing of welds shall be performed by quality assurance personnel.

(1) Procedures

Ultrasonic testing shall be performed by QA according to the procedures prescribed in Appendix S, Sec S.4.1.

Magnetic particle testing shall be performed by QA according to procedures prescribed in Appendix S, Sec S.4.2.

(2) Required NDT**(a) k-Area NDT**

When welding of doubler plates, continuity plates, or stiffeners has been performed in the k-area, the web shall be tested for cracks using magnetic particle testing (MT). The MT inspection area shall include the k-area base metal within 75 mm of the weld.

(b) CJP Groove Weld NDT

Ultrasonic testing shall be performed on 100 percent of CJP groove welds in materials 8 mm thick or greater. Ultrasonic testing in materials less than 8 mm thick is not required. Magnetic particle testing shall be performed on 25 percent of all beam-to-column CJP groove welds.

(c) Base Metal NDT for Lamellar Tearing and Laminations

After joint completion, base metal thicker than 38 mm loaded in tension in the through thickness direction in tee and corner joints, where the connected material is greater than 19 mm and contains CJP groove welds, shall be ultrasonically tested for discontinuities behind and adjacent to the fusion line of such welds. Any base metal discontinuities found within $t/4$ of the steel surface shall be accepted or rejected on the basis of criteria of AWS D1.1 Table 6.2, where t is the thickness of the part subjected to the through-thickness strain.

(d) Beam Cope and Access Hole NDT

At welded splices and connections, thermally cut surfaces of beam copes and access holes shall be tested using magnetic particle testing or penetrant testing, when the flange thickness exceeds 38 mm for rolled shapes, or when the web thickness exceeds 38 mm for built-up shapes.

(e) Reduced Beam Section Repair NDT

Magnetic particle testing shall be performed on any weld and adjacent area of the reduced beam section (RBS) plastic hinge region that has been repaired by welding, or on the base metal of the RBS plastic hinge region if a sharp notch has been removed by grinding.

(f) Weld Tab Removal Sites

Magnetic particle testing shall be performed on the end of welds from which the weld tabs have been removed, except for continuity plate weld tabs.

(g) Reduction of Percentage of Ultrasonic Testing

The amount of ultrasonic testing is permitted to be reduced if approved by the engineer of record and the authority having jurisdiction. The nondestructive testing rate for an individual welder or welding operator may be reduced to 25 percent, provided the reject rate is demonstrated to be 5 percent or less of the welds tested for the welder or welding operator. A sampling of at least 40 completed welds for a job shall be made for such reduction evaluation. Reject rate is the number of welds containing rejectable defects divided by the number of welds completed. For evaluating the reject rate of continuous welds over 1 m in length where the effective throat thickness is 25 mm or less, each 300 mm increment or fraction thereof shall be considered as one weld. For evaluating the reject rate on continuous welds over 1 m in length where the effective throat thickness is greater than 25 mm, each 150 mm of length or fraction thereof shall be considered one weld.

(h) Reduction of Percentage of Magnetic Particle Testing

The amount of MT on CJP groove welds is permitted to be reduced if approved by the engineer of record and the authority having jurisdiction. The MT rate for an individual welder or welding operator may be reduced to 10 percent, provided the reject rate is demonstrated to be 5 percent or less of the welds tested for the welder or welding operator. A sampling of at least 20 completed welds for a job shall be made for such reduction evaluation. Reject rate is the number of welds containing rejectable defects divided by the number of welds completed. This reduction is not permitted on welds in the k-area, at repair sites, weld tab and backing removal sites and access holes.

(3) Documentation

All NDT performed shall be documented. For shop fabrication, the NDT report shall identify the tested weld by piece mark and location in the piece. For field work, the NDT report shall identify the tested weld by location in the structure, piece mark, and location in the piece.

O.5.3 Inspection of Bolting

Observation of bolting operations shall be the primary method used to confirm that the procedures, materials, and workmanship incorporated in construction are those that have been specified and approved for the project. As a minimum, the tasks shall be as follows:

Inspection Tasks Prior to Bolting	QC		QA	
	Task	Doc.	Task	Doc.
Proper bolts selected for the joint detail	O	–	O	–
Proper bolting procedure selected for joint detail	O	–	O	–
Connecting elements are fabricated properly, including the appropriate faying surface condition and hole preparation, if specified, meets applicable requirements	O	–	O	–
Pre-installation verification testing conducted for fastener assemblies and methods used	P	D	O	D
Proper storage provided for bolts, nuts, washers, and other fastener components	O	–	O	–

Inspection Tasks During Bolting	QC		QA	
	Task	Doc.	Task	Doc.
Fastener assemblies placed in all holes and washers (if required) are properly positioned	O	–	O	–
Joint brought to the snug tight condition prior to the pretensioning operation	O	–	O	–
Fastener component not turned by the wrench prevented from rotating	O	–	O	–
Bolts are pretensioned progressing systematically from most rigid point toward free edges	O	–	O	–

Inspection Tasks After Bolting	QC		QA	
	Task	Doc.	Task	Doc.
Document accepted and rejected connections	P	D	P	D

O.5.4 Other Inspections

Where applicable, the following inspection tasks shall be performed:

Other Inspection Task	QC		QA	
	Task	Doc.	Task	Doc.
Reduced beam section (RBS) requirements, if applicable	P	D	P	D
– contour and finish				
– dimensional tolerances				
Protected zone – no holes and unapproved attachments made by contractor	P	D	P	D

PART VI Appendix P

Seismic Design Coefficients and Approximate Period Parameters

P.1 Scope

This appendix contains design coefficients, system limitations and design parameters for seismic load resisting systems (SLRS) that are included in these provisions but not yet defined in the applicable building code for buckling-restrained braced frames (BRBF) and special plate shear walls (SPSW). The values presented in Tables 6.P.1 and 6.P.2 in this Appendix shall only be used where neither the applicable building code nor SEI/ASCE 7 contain such values.

P.2 Symbols

The following symbols are used in this appendix.

C_d	Deflection amplification factor
C_r, x	Parameters used for determining the approximate fundamental period
Ω_o	System overstrength factor
R	Response modification coefficient

P.3 Coefficients and Factors for Basic Seismic Load Resisting Systems

TABLE 6.P.1 Design Coefficients and Factors for Basic Seismic Load Resisting Systems

Basic Seismic Load Resisting System	Response Modification/ Reduction Coefficient R	System Overstrength Factor Ω_o	Deflection Amplification Factor C_d	Height Limit (m)	
				Seismic Design Category	
				B & C	D
Building Frame Systems					
Buckling-Restrained Braced Frames, non-moment-resisting beam-column connections	7	2	5½	NL	48
Special Plate Shear Walls	7	2	6	NL	48
Buckling-Restrained Braced Frames, moment-resisting beam-column connections	8	2½	5	NL	48
Dual Systems with Special Moment Frames Capable of Resisting at Least 25% of the Prescribed Seismic Forces					
Buckling-Restrained Braced Frame	8	2½	5	NL	NL
Special Plate Shear Walls	8	2½	6½	NL	NL

(NL = Not Limited)

P.4 VALUES OF APPROXIMATE PERIOD PARAMETERS

Table 6.P.2 Values of Approximate Period Parameters C_r and x

Structure Type	C_r	x
Buckling-Restrained Braced Frames	0.03	0.75
Special Plate Shear Walls	0.02	0.75