

PART I

RECOMMENDED SPECIFICATIONS

Note: Recommendations for new requirements applicable to the construction of seismic-force-resisting systems are indicated in these *Recommendations* by underlined text.

Part I: RECOMMENDED SPECIFICATIONS

1. GENERAL

1.1 Scope

The provisions of Part I apply to fabrication, erection and inspection of steel moment frames as follows:

- new Ordinary Moment Frames (OMF) or Special Moment Frames (SMF) designed in accordance with the recommended criteria of *FEMA-350*;
- upgrade of existing steel moment frames designed in accordance with the recommended criteria of *FEMA-351*; or
- repair of damaged steel moment frames designed in accordance with the recommended criteria of *FEMA-352*.

Fabrication, erection and inspection shall be as shown on the approved drawings, including schedules, notes and details, and as further provided in the specifications of Part I.

Commentary: Throughout Part I, references are made to sections in Part II of these Recommendations, Chapters 1 to 6, where pertinent supplemental information may be found. These references are provided for information only and the supplemental information itself should not typically be included within the body of specifications, nor should the references to this information.

1.2 Governing Specifications

Structural steel framing shall comply with the requirements of the governing specifications listed in the subsections that follow.

Commentary: In some cases, several alternative specifications may apply. In these cases, the alternatives are preceded by a sequence letter, e.g., (a), (b), (c). In such cases, the specifier should select the entry appropriate to the individual project. Specifications without a sequence letter should always be included in project specifications.

1.2.1 American Institute of Steel Construction

- (a) *Load and Resistance Factor Design Specification for Structural Steel Buildings*, December 1, 1993, with *Supplement No. 1*, January 30, 1998; or
- (b) *Metric Load and Resistance Factor Design Specification for Structural Steel Buildings*, December 1, 1994, with *Supplement No. 1*, January 30, 1998; or
- (c) *Specification for Structural Steel Buildings (Allowable Stress Design and Plastic Design)*, June 1, 1989.

- *Seismic Provisions for Structural Steel Buildings*, April 15, 1997, with *Supplement No. 1*, February 15, 1999;
- *Code of Standard Practice for Steel Buildings and Bridges*, March 7, 2000.

1.2.2 American Welding Society

- (a) AWS D1.1-98 *Structural Welding Code – Steel*, 1998; or
- (b) AWS D1.1:2000 *Structural Welding Code – Steel*, 2000.

1.2.3 Research Council on Structural Connections

- (a) *LRFD Specification for Structural Joints Using ASTM A325 and A490 Bolts*, June 3, 1994; or
- (b) *Allowable Stress Design Specification for Structural Joints Using ASTM A325 or A490 Bolts*, November 13, 1985, reaffirmed June 3, 1994.

1.2.4 Building Code

- (a) *ICC International Building Code – 2000*; or
- (b) *ICBO Uniform Building Code – 1997*; or
- (c) *BOCA National Building Code – 1999*; or
- (d) *SBCCI Standard Building Code – 1997*; or
- (e) the locally applicable building code.

Commentary: In addition to referencing the above building codes, these Recommendations make reference to, or are referenced by, the following Federal Emergency Management Agency publications. Reference to the following publications should not normally be included in project specifications.

FEMA-350 – Recommended Seismic Design Criteria for New Steel Moment-Frame Buildings

FEMA-351 – Recommended Seismic Evaluation and Upgrade Criteria for Existing Welded Steel Moment-Frame Buildings

FEMA-352 – Recommended Postearthquake Evaluation and Repair Criteria for Welded Steel Moment-Frame Buildings

1.3 Definitions

1.3.1 Building Official

The term Building Official is applied to the regulatory agency having jurisdiction of the building. (See Part II, Section 1.2.9)

1.3.2 Contractor

The Contractor is the firm performing the fabrication or erection of the structural steel framework. The Contractor may be the steel fabricator responsible for the shop fabrication of the structural steel, and/or the steel erector, responsible for all field erection and field welding. (See Part II, Section 1.2.8)

1.3.3 Contract Documents

The Contract Documents include the design drawings, including schedules, notes and details, the project specifications, and the Quality Assurance Plan. (See Part II, Section 1.2.5)

1.3.4 Engineer

The Engineer is the registered design professional in responsible charge of the design of the structural steel framing system. (See Part II, Section 1.2.7)

Commentary: Section 202 of the International Building Code (IBC) defines a Registered Design Professional as being the person responsible for design. Throughout this specification, the term Engineer is used for this person.

1.3.5 Heavy Structural Sections

The following rolled sections and built-up sections shall be considered as Heavy Sections, subject to special notch toughness, fabrication, welding and inspection requirements as specified herein.

- ASTM A6 Group 3 shapes with flanges thicker than 1-1/2 in.
- ASTM A6 Group 4 and Group 5 shapes
- Welded built-up members with web or flange plates exceeding 2 inches in thickness.

Commentary: The requirements of this section as applied to Group 3 shapes with flanges thicker than 1-1/2 in. is contained in the AISC Seismic Provisions (AISC, 1997, 1999). The requirement for Group 4 and 5 shapes is contained in AISC LRFD and the AISC Seismic Provisions.

1.3.6 Hold Point

A stage in the work beyond which the work shall not proceed until the designated inspector has completed specified inspection tasks. (See Part II, Section 1.2.16 and Table 5-5)

1.3.7 Nondestructive Testing

Nondestructive testing (NDT) includes magnetic particle testing (MT), penetrant testing (PT), radiographic testing (RT), and ultrasonic testing (UT). The terms nondestructive examination (NDE) and nondestructive testing (NDT) are synonymous. (See Part II, Section 1.2.13)

1.3.8 Observation Point

A stage in the work beyond which the work may proceed after the workman has completed his or her own inspection, with special inspection provided by the designated special inspector through observation of the work operations on a routine, occasional, random basis. (See Part II, Section 1.2.17 and Table 5-5)

1.3.9 Owner

The Owner is the entity responsible for providing Quality Assurance. (See Part II, Section 1.2.6)

1.3.10 Quality Assurance

Quality Assurance (QA) consists of those inspection and testing services to be performed by an agency or firm other than the Contractor to ensure that the material and workmanship of structural steel construction meet the project specifications, applicable standards, and the Quality Assurance Plan. (See Part II, Section 1.2.2)

1.3.11 Quality Assurance Agency

The Quality Assurance (QA) Agency is the independent testing organization selected by the Owner, or Owner's designee, to perform the Quality Assurance inspection and testing required by the Quality Assurance Plan, specifications and contract documents. (See Part II, Section 1.2.10)

1.3.12 Quality Assurance Plan

The Quality Assurance Plan ("Plan") is the written requirements containing the set of procedures that are to be followed to confirm compliance with these requirements. The Quality Assurance Plan shall be part of the Contract Documents. (See Part II, Section 1.2.4)

Commentary: QA Plans are required by IBC Section 1705.1

1.3.13 Quality Control

Quality Control includes those functions to be performed by the Contractor to ensure that the material and workmanship of structural steel construction meet the project specifications, applicable standards, and the Quality Assurance Plan. (See Part II, Section 1.2.1)

1.3.14 Quality Control Plan

The Quality Control (QC) Plan is the written statement, prepared by the Contractor, of all measures that will be taken to ensure that construction conforms to the applicable standards, project specifications, and the Quality Assurance Plan. (See Part II, Sections 1.2.3, and 2.2)

Commentary: QC Plans are required by IBC Section 1704.2.1

1.3.15 Special Inspection

Special Inspection is a Quality Assurance activity comprising inspection of the installation, fabrication, erection or placement of components and connections requiring special expertise to ensure adequacy. (See Part II, Section 1.2.12)

Commentary: Special Inspection is defined in IBC Section 1702. Note that Special Inspection is one of several types of inspection that should be performed as part of structural steel construction. Refer to Part II of these Recommendations for supplemental information on the various types of inspection that should be performed.

1.3.16 Special Inspector

The Special Inspector is the individual or firm employed by the Owner, to provide the special inspection required. In most cases, the Special Inspector and the Quality Assurance Agency are the same entity. (See Part II, Section 1.2.11)

1.3.17 Seismic-Force-Resisting System

The Seismic-Force-Resisting System (SFRS) is defined as the assembly of structural elements in the building that resists seismic forces. Included in the SFRS are the columns, beams, girders and braces, and the connections between these elements, specifically designed to resist seismic forces, as designated on the contract documents. The SFRS does not include members that provide out-of-plane bracing to components of the SFRS, nor does it include other structural members designed to resist only gravity loads.

Commentary: The construction documents should clearly identify those members and connections that are part of the Seismic-Force-Resisting System (SFRS) so that the extent of applicability of special fabrication, erection and inspection requirements may be fully understood by all parties. Failure to designate the extent of the SFRS could result in substantial construction cost premiums.

1.3.18 Seismic Weld Demand and Seismic Weld Consequence Categories

Structural welds that are a part of the Seismic-Force-Resisting System are identified on the design drawings as Seismic Weld Demand Category A, B or C, and as Seismic Weld Consequence Category H, M and L. (See Part II, Tables 5-1 and 5-2)

Commentary: The required extent of inspection and special inspection of welded joints in this specification is keyed to the Seismic Weld Demand Category, the Seismic Weld Consequence Category and the primary loading direction. The contract documents must clearly identify the Seismic Weld Demand Category and Seismic Weld Consequence Category for all welded joints in the SFRS. In addition, each such welded joint should be identified as to whether the primary loading of the joint is longitudinal or transverse. If a welded joint is subjected to loading in both directions, it should be classified as that direction in which the

loading is most severe. If the loading severity in both directions is comparable, loading direction should be classified as transverse.

FEMA-350, FEMA-351, and FEMA-352 provide recommended Seismic Weld Demand Category, Seismic Weld Consequence Category, and Loading Direction classifications for welds in prequalified connections and repairs. These classifications are of the form AH/T where the first letter (A, B, or C) represents the Seismic Weld Demand Category, the second letter (H, M, or L) represents the Seismic Weld Consequence Category and the final letter (T or L) represents the primary loading direction. Refer also to Part II of these Recommendations, Chapter 5, for additional information on this classification system.

1.3.19 Structural Observation

Structural Observation is the visual observation of the structural system by a registered design professional, for general conformance to the approved construction documents, at significant construction stages and at completion of the structural system. (See Part II, Section 1.2.14)

Commentary: Structural Observation is defined in IBC Section 1702 and in FEMA-302, Section 3.5.

1.3.20 Structural Steel Framing

Structural steel framing shall be as defined in the AISC *Code of Standard Practice*, Section 2.1.

1.3.21 Written Practice

The Written Practice is the Quality Assurance Agency's procedures for determining and ensuring the acceptability of the structure in accordance with the applicable codes, standards, specifications and procedures, including general inspection, material controls, visual welding inspection, and bolting inspection. The Written Practice also describes the selection and administration of inspection personnel, and the training, experience and examination requirements for qualification and certification of inspection personnel. (See Part II, Sections 1.2.15, and 3.4)

1.4 Submittals

1.4.1 Shop Drawings

The Contractor shall submit to the Engineer detailed, coordinated and checked shop drawings for all structural steel for review prior to the start of fabrication and/or erection. (See Part II, Section 1.4) Shop drawings shall show:

1. size and location of all structural members and connection material,

2. complete information necessary for the fabrication of members including cuts, copes, holes, doubler plates, stiffeners, and camber,
3. type, size and location of bolts and welds,
4. surface preparation and finishes,
5. details of assembly,
6. the Seismic Weld Demand Category and Seismic Weld Consequence Category of welded joints in the Seismic-Force-Resisting System,
7. identification of shop-installed high-strength bolted connections as snug-tight, pretensioned or slip-critical, as required by the Contract Documents, and
8. identification of Welding Procedure Specification (WPS) applicable to each shop weld.

Welded connections shall be identified using standard AWS symbols as given in *AWS A2.4, Standard Symbols for Welding, Brazing and Nondestructive Testing*, and shall clearly distinguish between shop and field welds.

1.4.2 Erection Drawings

The Contractor shall submit to the Engineer detailed, coordinated and checked erection drawings for all structural steel for review prior to the start of fabrication and/or erection. (See Part II, Section 1.4) Erection drawings shall be submitted that show:

1. location of all structural material,
2. identification mark of members,
3. orientation and relation of members to appropriate grid lines,
4. setting elevations for column bases,
5. standard and special details for bolted and welded field connections,
6. Seismic Weld Demand Category and Seismic Weld Consequence Category for field-welded joints in the Seismic-Force-Resisting System,
7. identification of field-installed high strength bolted connections as snug-tight, pretensioned or slip-critical, as required by the Contract Documents, and
8. identification of WPS applicable to each field weld.

Welded connections shall be identified using standard AWS symbols as given in *AWS A2.4, Standard Symbols for Welding, Brazing and Nondestructive Testing*, and shall clearly identify field welds.

1.4.3 Erection Plans

Prior to starting erection, the Contractor shall submit to the Engineer, for record purposes, a description of the methods, scheme of erection, sequence of erection, and type of equipment proposed for use in erecting the structural steel work. Included shall be design information, plans

and elevations showing proposed temporary bracing and shoring systems, with the magnitudes, locations and directionality of construction loads imposed on the permanent structure. The Engineer will have no responsibility to review this submittal nor to approve of the Contractors means and methods.

The steel erector shall also submit for record purposes, written procedures indicating field welding sequences for each type of welded moment connection, and field welding sequences for moment connections at each level. The Engineer will have no responsibility to review this submittal nor to approve of the Contractors means and methods.

Commentary: The Engineer is not obligated to review and provide comment on these submittals. Rather, the purpose of the submittal is to ensure that the Contractor actually does prepare these documents prior to performing the work.

1.4.4 Contractor's Statement of Responsibility

Each Contractor responsible for the work shall submit a written Statement of Responsibility to the Owner and Building Official prior to commencement of the work. (See Part II, Section 2.3) The statement shall contain the following:

- acknowledgment of awareness of the special requirements contained in the Quality Assurance Plan,
- acknowledgment that control will be exercised to obtain conformance with the construction documents,
- procedures for exercising control within the Contractor's organization, the method and frequency of reporting, and the distribution of reports, and
- identification and qualifications of the persons exercising such control and their positions in the organization.

Commentary: The requirement for Contractor's Statement of Responsibility is contained in IBC Section 1705.3 and FEMA-302, Section 3.2.2.

1.4.5 Certificates of Compliance

Coincident with the submittal of manufacturer's test reports and certifications for structural steel, fasteners, welding filler metals, and shear studs, the Contractor shall submit a letter stating that the Contractor has reviewed the submitted manufacturer's certifications and test reports, and that the materials being furnished for the project are in conformance with the applicable standards, specifications and project documents. (See Part II, Sections 4.2, 5.2.1, and 6.2.1)

Commentary: Requirements for Certificates of Compliance are contained in IBC Section 1702.1 and Table 1704.3.

1.4.6 Manufacturer's Test Reports

1.4.6.1 Structural Steel

The fabricator shall submit, for record, copies of material test reports, commonly called mill test reports, for all structural steel in the Seismic-Force-Resisting System. Material test reports shall comply with the requirements of *ASTM A6*. Material test reports shall be accompanied by a Certificate of Compliance from the fabricator. (See Part II, Section 4.2)

Commentary: Requirements for Manufacturer's Test Reports for structural steel are contained in IBC Section 1702.1 and Table 1704.3(3). However, submittal to the Engineer is not required under the IBC.

1.4.6.2 Fastening Material

The Contractor supplying fastener products shall submit, for record, copies of all Manufacturer's Certifications for all fastener components, including bolts, nuts, washers, and direct tension indicators, if used in the Seismic-Force-Resisting System. Fastener Manufacturer's Certifications shall be accompanied by a Certificate of Compliance from the Contractor. (See Part II, Section 6.2.1)

Manufacturer certifications for bolts shall contain at least the following information:

- heat analysis, heat number, and a statement certifying that heats having prohibited elements intentionally added were not used to produce the bolts,
- results of hardness, tensile, and proof load tests, as required and performed,
- if galvanized, the results of rotational capacity tests, including the test method used (solid plate or tension measuring device) and the lubricant present,
- if galvanized, measured zinc coating weight or thickness,
- results of visual inspection for bursts,
- statement of compliance with dimensional and thread fit requirements,
- lot number and purchase order number,
- complete mailing address of responsible party, and
- title and signature of the individual assigned certification responsibility by the company officers.

For A490 bolts, only the Production Lot Method of testing and certification is acceptable. The Shipping Lot Method is unacceptable.

Commentary: Requirements for Manufacturer's Test Reports for fastening materials are contained in IBC Section 1702.1 and Table 1704(1). The suggested list of information to be provided is based on the certification requirements contained in ASTM A325. The IBC does not require submittal of these reports.

1.4.6.3 Welding Material

The Contractor supplying welding filler metal and shielding gas products shall submit copies of all Manufacturer's Certifications for all electrodes, fluxes and shielding gasses to be used. Certifications shall satisfy the applicable AWS A5 requirements. The welding material's Manufacturer's Certifications shall be accompanied by a Certificate of Compliance from the Contractor supplying the materials. (See Part II, Section 5.2.1)

The Contractor shall also submit the applicable manufacturer's supplemental certifications that the product meets any additional requirements of the project beyond that required by standard AWS A5 specification. Should the welding material manufacturer not supply such supplemental certifications as required, the Contractor shall have the necessary testing performed and provide the applicable test reports.

Commentary: Basic requirements for Manufacturer's Certificates for welding materials are contained in IBC Section 1702.1 and Table 1704.3(4).

1.4.6.4 Shear Connectors (Shear Studs)

The Contractor shall submit the following items:

- stud manufacturer's Manufacturer's Certification that the studs, as supplied, meet the requirements of AWS D1.1, Sections 7.2 and 7.3,
- certified copies of the stud manufacturer's test reports covering the last completed set of in-plant quality control mechanical tests for the diameter supplied, and
- certified material test reports from the steel supplier indicating diameter, chemical properties and grade on each heat number supplied.

The stud manufacturer's Manufacturer's Certification shall be accompanied by a Certificate of Compliance from the Contractor. (See Part II, Sections 4.2 and 5.2)

Commentary: Requirements for Manufacturer's Certification of Shear Connectors are contained in IBC 1702.1 and AWS D1.1, Section 7.3.3. AWS D1.1 does not require submittal of these certifications unless requested by the Engineer.

1.4.7 Procedures

Procedures shall assign responsibility to a person or position in the organization and shall contain enough detail to be useful to the workforce without reference to governing specifications. The procedures need not act as work instructions. Procedures shall be dated and indicate the person or position that has the authority to maintain the procedure.

1.4.7.1 Fastener Installation Procedures

The Contractor shall submit written procedures for the pre-installation testing, installation, snugging, pretensioning , and post-installation inspection of fasteners. The procedures shall meet

all requirements of the Research Council on Structural Connections (RCSC) Specification and the project documents. Procedures need be submitted only for the methods of installation to be used by the Contractor, which may include the turn-of-nut, calibrated wrench, twist-off type tension control bolt, and direct tension indicator methods. (See Part II, Section 6.2.2)

1.4.7.2 Welding Procedure Specifications (WPSs)

The Contractor shall submit all Welding Procedure Specifications (WPSs) to be used by the Contractor on the project. For WPSs that are not prequalified per AWS D1.1, the supporting Procedure Qualification Record (PQR) shall also be submitted with the WPS. The Contractor shall also submit the manufacturer's product data sheets for all welding material to be used. The data sheets shall describe the product, limitations of use, recommended welding parameters, and storage and exposure requirements, including baking and rebaking, if applicable. (See Part II, Section 5.2.2)

Welding Procedure Specifications (WPSs) shall be categorized by and specify the following items:

- steel specifications and grades to be welded,
- thickness range of material to be joined,
- type of joint,
- type of weld (groove, fillet, plug, slot),
- size of weld, and
- position of welding.

Based upon the application, the WPS shall specify, as a minimum, the following items, as applicable for the welding process:

- power supply (constant current or constant voltage),
- welding electrode, flux, and shielding gas classifications,
- welding electrode and flux manufacturer and trade name,
- electrode diameter,
- voltage (except for shielded metal arc welding),
- current (amperage) or wire feed speed,
- electrical stick-out or contact tube-to-work distance (wire fed),
- travel speed,
- minimum preheat and interpass temperatures,
- maximum preheat and interpass temperatures (if applicable),
- number and placement of passes,

- technique (stringer or weave bead),
- shielding gas flow rate,
- for groove welds, the joint configuration and tolerances, and
- other pertinent information specific to the weld to be made.

Tolerances, or the acceptable range of values, applicable to the various welding parameters shall also be noted in the WPS.

Commentary: AWS D1.1 Section 4.1.1 requires WPS submittal only for nonprequalified procedures. The AISC Seismic Provisions, Section 7.3a requires submittal for all procedures.

1.4.7.3 Welding Performance Qualification Records (WPQRs)

The Contractor shall submit written Welding Performance Qualification Records (WPQRs) for all welding personnel under the Contractor's supervision who will be performing services on the project. The WPQR shall document the successful completion of the appropriate welding personnel qualification test. All welder qualification testing shall be performed in accordance with the current or a previous version of AWS D1.1. The Contractor shall also submit additional documentation that the welder has passed all designated supplemental welder qualification testing required for the types of welding to be performed. (See Section Part II, 5.2.3)

Should the WPQR testing have been performed more than six months prior to the start of the welding by the welder, documentation shall also be submitted showing that the welder has continued to use the applicable welding process on an ongoing basis since the test was conducted, with no lapse in service exceeding six months.

The Welding Performance Qualification Records shall, as a minimum, provide the following information:

- welding process,
- type of weld,
- welding position,
- thickness of test plate,
- thickness and nominal diameter of tubular test piece, if applicable,
- if vertical position, whether upward or downward progression,
- electrode group (F-number) classification (if SMAW),
- test results,
- signature of Contractor's individual responsible for the test, and
- date of test.

If the supplemental testing in Appendix B is required, the Contractor shall submit additional WPQRs for those tests.

Commentary: AWS D1.1, Section 4.1.2 sets the requirements for WPQRs, although submittal is not required under that document.

1.4.7.4 Inspector Qualifications

The Contractor shall submit written qualifications for all inspectors to be assigned Quality Control functions for the structural steel work, including general inspection, bolting inspection, welding inspection, and nondestructive testing. (See Part II, Section 2.2)

1.4.7.5 Contractor's Quality Control Plan

The Contractor shall submit the contractor's written Quality Control Plan, including any required modifications to satisfy the requirements for the project, and the Quality Assurance Plan. (See Part II, Section 2.2)

Commentary: IBC Section 1704.2.1 requires that the Contractor have a Quality Control Plan, although it does not require submittal.

1.4.7.6 Samples

Material samples shall be provided as requested by the Engineer or Quality Assurance Agency. Routine physical verification of structural steel, fastener, or welding material composition or mechanical properties is not required. (See Part II, Section 4.5)

Commentary: It is not common to require submittal of sample materials of structural steel or connection materials. If the Engineer desires such samples, this requirement and the number and type of samples required must specifically be identified in the Contract Documents.

1.5 Pre-Fabrication / Pre-Erection Conferences

Prior to performing any fabrication or erection work, the Engineer, Quality Assurance Agency, and Special Inspector, together with Steel Fabricator personnel and Steel Erector personnel supervising the shop, field and Quality Control work shall hold a Pre-Fabrication and Pre-Erection Conference to review welding procedures, bolting procedures, and inspection requirements for all welding and bolting operations. (See Part II, Section 1.3)

Commentary: Conferences between the Engineer, Special Inspector and fabrication and erection personnel are not required by code but are an effective means of ensuring that all responsible parties understand the quality requirements of the project and how they are to be monitored. It is advisable to hold this conference early in the project, before any actual construction work starts. In most cases, it may be appropriate to hold separate conferences with shop fabrication and field erection personnel. Welding Procedure Specifications,

*Quality Control (QC) Plan and Quality Assurance (QA) Written Practice
submittals and reviews should be made before the conferences.*