

AWS D1.1/D1.1M:2006
An American National Standard



Structural Welding Code— Steel



American Welding Society



**AWS D1.1/D1.1M:2006
An American National Standard**

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Structural Welding Code— Steel

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Prepared by the
American Welding Society (AWS) D1 Committee on Structural Welding

Under the Direction of the
AWS Technical Activities Committee

Approved by the
AWS Board of Directors

Abstract

This code covers the welding requirements for any type of welded structure made from the commonly used carbon and low-alloy constructional steels. Sections 1 through 8 constitute a body of rules for the regulation of welding in steel construction. There are ten normative and twelve informative annexes in this code. A Commentary of the code is included with the document.



American Welding Society

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Foreword

This foreword is not a part of AWS D1.1/D1.1M:2006, *Structural Welding Code—Steel*, but is included for informational purposes only.

The first edition of the *Code for Fusion Welding and Gas Cutting in Building Construction* was published by the American Welding Society in 1928. The first bridge welding specification was published separately in 1936. The two documents were consolidated in 1972 into the D1.1 document but were once again separated in 1988 when the joint AASHTO/AWS D1.5, *Bridge Welding Code*, was published to address the specific requirements of State and Federal Transportation Departments. Coincident with this, the D1.1 code changed references of buildings and bridges to statically loaded and dynamically loaded structures, respectively, in order to make the document applicable to a broader range of structural configurations.

Underlined text in the subsections, tables, or figures indicates an editorial or technical change from the 2004 edition. A vertical line in the margin next to a figure drawing indicates a revision from the 2004 edition.

The following is a summary of the most significant technical revisions contained in D1.1/D1.1M:2006:

Section 2.3.1.4 and Table 2.1—Revised and clarified the requirements for the effective size of flare-groove welds.

Table 2.4, Case 4.1—A correction was made to base metal thickness.

Table 3.1 and Table 3.2—New prequalified steels were added to the table.

Figure 3.3—New prequalified joint for flare-V-groove welds was added.

Section 4.1.2.1 and C-4.1.2.1—Section was revised and commentary was added.

Section 4.18 and Table 4.9—Revisions were made to address qualification of welding operators for all positions.

Section 4.8.1—The visual inspection acceptance criteria for welding procedure and welder performance tests was revised to differentiate between fillet and groove weld tests.

Table 4.5—Changes were made to essential variables regarding constant voltage, constant current, voltage, heat input, travel speed, and mode of transfer.

Table 4.11—Table was revised to allow for qualification on pipe grooves less than 4 inches in diameter. A new figure was added.

Section 5.3.1.3—Requirement for dew point was referenced back to source standard.

Section 5.4.1—Limitation on the use of ESW and EGW was revised.

Sections 5.15.2 and 5.14.4—Section was revised to clarify use of plasma arc gouging.

Section 5.30—The allowable equipment used for interpass cleaning was clarified.

Sections 6.2, 6.3, and 6.5—Sections were reorganized to clarify inspector's duties. Sections 6.3.2, 6.5.2, and 6.5.3 were deleted; however, issues addressed in those sections are now addressed in 6.2 and 6.3.

Section 6, Part G—Entire section on advanced NDT techniques was reorganized and revised.

Table 6.2—Table was revised to clarify requirements.

Section 7.4.5—Spacing requirements for stud shear connectors was clarified.

Table 7.1—Type B stud diameter was added to Note b.

Annexes—Annexes were renumbered (see page 276).

Annex III—Content was moved to Section 4, Part D.

Annex IV—Annex on WPS Requirements was deleted.

Annex I, Table I.2—A new note was added to clarify table's intent.

Annex A—Content was moved to commentary, C-3.2.1.

Annex M—Annex on code approved base metals was moved into Section 4 of the code.

Section C-4.7—New commentary was added to this section.

AWS B4.0, *Standard Methods for Mechanical Testing of Welds*, provides additional details of test specimen preparation and details of test fixture construction.

Commentary. The Commentary is nonmandatory and is intended only to provide insightful information into provision rationale.

Normative Annexes. These annexes address specific subjects in the code and their requirements are mandatory requirements that supplement the code provisions.

Informative Annexes. These annexes are not code requirements but are provided to clarify code provisions by showing examples, providing information, or suggesting alternative good practices.

Index. As in previous codes, the entries in the Index are referred to by subsection number rather than by page number. This should enable the user of the Index to locate a particular item of interest in minimum time.

Errata. It is the Structural Welding Committee's Policy that all errata should be made available to users of the code. Therefore, in the Society News Section of the *AWS Welding Journal*, any errata (major changes) that have been noted will be published in the July and November issues of the *Welding Journal* and posted on the AWS web site at: <http://www.aws.org/technical/d1/>.

Suggestions. Your comments for improving AWS D1.1/D1.1M:2006, *Structural Welding Code—Steel* are welcome. Submit comments to the Managing Director, Technical Services Division, American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126; telephone (305) 443-9353; fax (305) 443-5951; e-mail info@aws.org; or via the AWS web site <<http://www.aws.org>>.

Interpretations. Official interpretations of any of the technical requirements of this standard may only be obtained by sending a request, in writing, to the Managing Director, Technical Services, American Welding Society. A formal reply will be issued after it has been reviewed by the appropriate personnel following established procedures (see Annex O).

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Structural Welding Code—Steel

1. General Requirements

1.1 Scope

This code contains the requirements for fabricating and erecting welded steel structures. When this code is stipulated in contract documents, conformance with all provisions of the code shall be required, except for those provisions that the Engineer (see 1.4.1) or contract documents specifically modifies or exempts.

The following is a summary of the code sections:

1. General Requirements. This section contains basic information on the scope and limitations of the code, key definitions, and the major responsibilities of the parties involved with steel fabrication.

2. Design of Welded Connections. This section contains requirements for the design of welded connections composed of tubular, or nontubular, product form members.

3. Prequalification. This section contains the requirements for exempting a WPS (Welding Procedure Specification) from the WPS qualification requirements of this code.

4. Qualification. This section contains the requirements for WPS qualification and the qualification tests required to be passed by all welding personnel (welders, welding operators, and tack welders) to perform welding in accordance with this code.

5. Fabrication. This section contains general fabrication and erection requirements applicable to welded steel structures governed by this code, including the requirements for base metals, welding consumables, welding technique, welded details, material preparation and assembly, workmanship, weld repair, and other requirements.

6. Inspection. This section contains criteria for the qualifications and responsibilities of inspectors, acceptance criteria for production welds, and standard procedures for performing visual inspection and NDT (nondestructive testing).

7. Stud Welding. This section contains the requirement for the welding of studs to structural steel.

8. Strengthening and Repair of Existing Structures. This section contains basic information pertinent to the welded modification or repair of existing steel structures.

1.2 Limitations

The code is not intended to be used for the following:

(1) Steels with a minimum specified yield strength greater than 100 ksi [690 MPa]

(2) Steels less than 1/8 in. [3 mm] thick. When base metals thinner than 1/8 in. [3 mm] thick are to be welded, the requirements of AWS D1.3, *Structural Welding Code—Sheet Steel*, should apply. When used in conjunction with AWS D1.3, conformance with the applicable provisions of this code shall be required.

(3) Pressure vessels or pressure piping

(4) Base metals other than carbon or low-alloy steels. AWS D1.6, *Structural Welding Code—Stainless Steel*, should be used for welding stainless steel structures. Whenever contract documents specify AWS D1.1 for welding stainless steel, the requirements of AWS D1.6 should apply.

1.3 Definitions

The welding terms used in this code shall be interpreted in conformance with the definitions given in the latest edition of AWS A3.0, *Standard Welding Terms and Definitions*, supplemented by Annex K of this code and the following definitions:

1.3.1 Engineer. “Engineer” shall be defined as a duly designated individual who acts for, and in behalf of, the Owner on all matters within the scope of the code.

1.3.2 Contractor. “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 provisions of this code.

1.3.3 Inspectors

1.3.3.1 Contractor's Inspector. "Contractor's Inspector" shall be defined as the duly designated person who acts for, and in behalf of, the Contractor on all inspection and quality matters within the scope of the code and of the contract documents.

1.3.3.2 Verification Inspector. "Verification Inspector" shall be defined as the duly designated person who acts for, and in behalf of, the Owner or Engineer on all inspection and quality matters specified by the Engineer.

1.3.3.3 Inspector(s) (unmodified). When the term "Inspector" is used without further qualification 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.

1.3.4 OEM (Original Equipment Manufacturer). "OEM" shall be defined as that single Contractor that assumes some or all of the responsibilities assigned by this code to the Engineer.

1.3.5 Owner. "Owner" shall be defined as the individual or company that exercises legal ownership of the product or structural assembly produced under this code.

1.3.6 Code Terms "Shall," "Should," and "May." "Shall," "should," and "may" have the following significance:

1.3.6.1 Shall. Code provisions that use "shall" are mandatory unless specifically modified in contract documents by the Engineer.

1.3.6.2 Should. The word "should" is used to recommend practices that are considered beneficial, but are not requirements.

1.3.6.3 May. The word "may" in a provision allows the use of optional procedures or practices that can be used as an alternative or supplement to code requirements. Those optional procedures that require the Engineer's approval shall either be specified in the contract documents, or require the Engineer's approval. The Contractor may use any option without the Engineer's approval when the code does not specify that the Engineer's approval shall be required.

1.4 Responsibilities

1.4.1 Engineer's Responsibilities. The Engineer shall be responsible for the development of the contract documents that govern products or structural assemblies pro-

duced under this code. The Engineer may add to, delete from, or otherwise modify, the requirements of this code to meet the particular requirements of a specific structure. All requirements that modify this code shall be incorporated into contract documents. The Engineer shall determine the suitability of all joint details to be used in a welded assembly.

The Engineer shall specify in contract documents, as necessary, and as applicable, the following:

(1) Code requirements that are applicable only when specified by the Engineer.

(2) All additional NDT that is not specifically addressed in the code.

(3) Verification inspection, when required by the Engineer.

(4) Weld acceptance criteria other than that specified in Section 6.

(5) CVN toughness criteria for weld metal, base metal, and/or HAZ when required.

(6) For nontubular applications, whether the structure is statically or cyclically loaded.

(7) All additional requirements that are not specifically addressed in the code.

(8) For OEM applications, the responsibilities of the parties involved.

1.4.2 Contractor's Responsibilities. The Contractor shall be responsible for WPSs, qualification of welding personnel, the Contractor's inspection, and performing work in conformance with the requirements of this code and contract documents.

1.4.3 Inspector's Responsibilities

1.4.3.1 Contractor Inspection. Contractor inspection shall be supplied by the Contractor and shall be performed as necessary to ensure that materials and workmanship meet the requirements of the contract documents.

1.4.3.2 Verification Inspection. The Engineer shall determine if Verification Inspection shall be performed. Responsibilities for Verification Inspection shall be established between the Engineer and the Verification Inspector.

1.5 Approval

All references to the need for approval shall be interpreted to mean approval by the Authority having Jurisdiction or the *Engineer*.

1.6 Welding Symbols

Welding symbols shall be those shown in the latest edition of AWS A2.4, *Symbols for Welding, Brazing, and Nondestructive Examination*. Special conditions shall be fully explained by added notes or details.

1.7 Safety Precautions

This technical document does not address all welding and health hazards. However, pertinent information can be found in the following documents:

- (1) ANSI Z49.1, *Safety in Welding, Cutting, and Allied Processes*
- (2) Manufacturer's safety literature on equipment and materials
- (3) Other pertinent documents as appropriate.

These documents shall be referred to and followed as required (also see Annex R, Safe Practices).

Note: This code may involve hazardous materials, operations, and equipment. The code does not purport to address

all of the safety problems associated with its use. It is the responsibility of the user to establish appropriate safety and health practices. The user should determine the applicability of any regulatory limitations prior to use.

1.8 Standard Units of Measurement

This standard makes use of both U.S. Customary Units and the International System of Units (SI). The measurements may not be exact equivalents; therefore, each system shall be used independently of the other without combining in any way. The standard with the designation D1.1:2006 uses U.S. Customary Units. The standard designation D1.1M:2006 uses SI Units. The latter are shown within brackets [].

1.9 Reference Documents

Annex U contains a list of all documents referenced in this code.