

AWS D1.1/D1.1M:2020
An American National Standard



Structural Welding Code — Steel



second printing, March 2022



AWS D1.1/D1.1M:2020
An American National Standard

Approved by the
American National Standards Institute
December 9, 2019

Structural Welding Code—Steel

24th Edition

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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. Clauses 1 through 11 constitute a body of rules for the regulation of welding in steel construction. There are eight normative and eleven informative annexes in this code. A Commentary of the code is included with the document.



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Foreword

This foreword is not part of AWS D1.1/D1.1M:2020, *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 and called Code 1 Part A. It was revised in 1930 and 1937 under the same title. It was revised again in 1941 and given the designation D1.0. D1.0 was revised again in 1946, 1963, 1966, and 1969. The 1963 edition published an amended version in 1965, and the 1966 edition published an amended version in 1967. The code was combined with D2.0, *Specifications for Welding Highway and Railway Bridges*, in 1972, given the designation D1.1, and retitled *AWS Structural Welding Code*. D1.1 was revised again in 1975, 1979, 1980, 1981, 1982, 1983, 1984, 1985, 1986, 1988, 1990, 1992, 1994, 1996, 1998, 2000, 2002, 2004, 2006, 2008 and 2010. A second printing of D1.1:2010 was published in 2011. From 1972 to 1988, the D1.1 code covered the welding of both buildings and bridges.

In 1988, AWS published its first edition of AASHTO/AWS D1.5, *Bridge Welding Code*; 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 applications. After the publishing of the 2010 edition, it was decided that the *AWS Structural Welding Code—Steel* would be published on a five year revision cycle instead of a two year revision cycle. This was done in order to sync the publication cycle of AWS Structural Welding Code-Steel with the publication cycles of the AISC Steel Building Specification and the International Building Code. This 2020 edition is the 24th edition of D1.1.

Changes in Code Requirements, underlined text in the clauses, subclauses, tables, figures, or forms indicates a change from the 2015 edition. A vertical line in the margin of a table or figure also indicates a change from the 2015 edition.

The following is a summary of the most significant technical changes contained in D1.1/D1.1M:2020:

Summary of Changes	
Clause/Table/Figure/Annex	Modification
Clause 1	
Clause 2	This is a new clause listing normative references. It replaces subclause 1.9 and Annex S from the previous edition.
Clause 3	This is a new clause that provides terms and definitions specific to this standard. It replaces subclause 1.3 and Annex J from the previous edition.
Clause 4	Clause 4 was presented as Clause 2 in the previous edition. Annex A Figures in the previous edition were incorporated into Clause 4.
Clause 5	Clause 5 was presented as Clause 3 in the previous edition. The Clause has also been restructured to follow the normal progression of writing a prequalified WPS. Table 5.2 has been editorially renamed and reorganized to list WPS essential variables. Additional requirements have been added when using shielding gases and a new Table 5.7 was added on shielding gases. New materials have been added to Tables 5.3 and 5.8.
Clause 6	Clause 6 was presented as Clause 4 in the previous edition. Revisions include the requirements for the qualification of WPSs using waveform technology. All the CVN testing requirements have been added to Table 6.7, so they now are all contained in a single place. The WPS retest requirements have been clarified. The PJP Groove weld clause has been reorganized to clarify the qualification of PJP Groove welds using the Joint Details in Figure 5.2. Part D of the Clause has been reorganized to better align the testing procedures and qualification of CVNs with the order that they would be accomplished.

(Continued)

Summary of Changes (Continued)

Clause/Table/Figure/Annex	Modification
Clause 7	Clause 7 was presented as Clause 5 in the previous edition. Revisions were made to the weld restoration of base metal with mislocated holes.
Clause 8	Clause 8 was presented as Clause 6 in the previous edition. Revisions were made to the qualification requirements for inspection personnel to ensure that all welding inspectors are qualified. The Engineer's responsibilities as it relates to Inspection were also clarified. Digital radiography has been added to Radiographic Testing. The limitations for geometric unsharpness have been added to the Code and the equation has been revised to match the equation in ASME <i>Boiler and Pressure Vessel Code</i> , Section V, Article 2. The methodology to determine the attenuation factor has been updated to reflect that UT instruments are now capable of reporting a fractional value for dB.
Clause 9	Clause 9 was presented as Clause 7 in the previous edition. The code was updated to require the manufacturer's permanent identification on headed studs and deformed anchor bars. Revisions were made to provide weld procedure requirements for fillet welding of studs.
Clause 10	Clause 10 was presented as Clause 9 in the previous edition. The calculations for static strength of welded tubular connections were removed in deference to AISC design provisions.
Clause 11	Clause 11 was presented as Clause 8 in the previous edition.
Annex A	Annex A was presented as Annex B in the previous edition.
Annex B	Annex B was presented as Annex H in the previous edition.
Annex D	Annex D was presented as Annex F in the previous edition.
Annex E	Annex E was presented as Annex D in the previous edition.
Annex F	Annex F was presented as Annex E in the previous edition.
Annex H	New Annex that addresses phased array ultrasonic testing (PAUT)
Annex J	Annex J was presented as Annex M in the previous edition.
Annex K	Annex K was presented as Annex P in the previous edition.
Annex L	Annex L was presented as Annex T in the previous edition.
Annex M	Annex M was presented as Annex U in the previous edition.
Annex N	Annex N was presented as Annex K in the previous edition.
Annex O	Annex O was presented as Annex Q in the previous edition.
Annex P	Annex P was presented as Annex L in the previous edition.
Annex Q	Annex Q was presented as Annex O in the previous edition.
Annex R	Annex R has been modified to contain preliminary design of circular tube connections previously contained in the Tubular Structures clause as well as ovalizing parameter alpha.
Annex T	Annex T was presented as Annex N in the previous edition.
C-Annex H	Commentary was added for Annex H

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 subclause number rather than by page number. This should enable the user of the Index to locate a particular item of interest in minimum time.

(Continued)

Errata. It is the Structural Welding Committee's Policy that all errata should be made available to users of the code. Therefore, any significant errata will be published in the Society News Section of the *Welding Journal* and posted on the AWS web site at: <http://www.aws.org/standards/page/errata>.

Suggestions. Your comments for improving AWS D1.1/D1.1M:2015, *Structural Welding Code—Steel* are welcome. Submit comments to the Secretary of the D1Q Subcommittee, American Welding Society, 8669 NW 36 St, # 130, Miami, FL 33166.

Errata

The following Errata have been identified and are incorporated in this reprint.

Page 9, term ***dihedral angle**: a return is missing between “See local dihedral angle” and “discontinuity”

***dihedral angle**. See **local dihedral angle**.

discontinuity. An interruption of the typical structure of a material, such as a lack of homogeneity in its mechanical or metallurgical, or physical characteristics. A discontinuity is not necessarily a defect.

Page 11, the symbol should be ϕ not θ .

***groove angle, ϕ (tubular structures)**. **The angle between opposing faces of the groove to be filled with weld metals, determined after the joint is fit-up.**

Page 11, the term **interpass temperature** is missing the asterisk.

***interpass temperature**. In a multipass weld, the temperature of the weld area between weld passes.

Page 12, the symbol should be Ψ not θ .

***local dihedral angle, Ψ (tubular structures)**. The angle, measured in a plane perpendicular to the line of the weld, between tangents to the outside surfaces of the tubes being joined at the weld. The exterior dihedral angle, where one looks at a localized section of the connection, such that the intersecting surfaces may be treated as planes.

Page 13, the term **preheat temperature, welding** is missing the asterisk.

***preheat temperature, welding**. The temperature of the base metal in the volume surrounding the point of welding immediately before welding is started. In a multiple-pass weld, it is also the temperature immediately before the second and subsequent passes are started.

Page 14, top of page ***single electrode**, ***parallel electrode**, *** multiple electrode moved** to below the definition of SAW.

Submerged arc welding (SAW). An arc welding process that uses an arc or arcs between a bare metal electrode or electrodes and the weld pool. The arc and molten metal are shielded by a blanket of granular flux on the workpieces. The process is used without pressure and with filler metal from the electrode and sometimes from a supplemental source (welding rod, flux, or metal granules).

***single electrode**. One electrode connected exclusively to one power source which may consist of one or more power units.

***parallel electrode**. Two electrodes connected electrically in parallel and exclusively to the same power source. Both electrodes are usually fed by means of a single electrode feeder. Welding current, when specified, is the total for the two.

***multiple electrodes**. The combination of two or more single or parallel electrode systems. Each of the component systems has its own independent

Page 42, Table 4.5 entitled “Fatigue Stress Design Parameters (see 4.14.1)”

-Description 5.6 replace “Formula 4” with “Formula 5”

-Description 5.7 replace “Formula 4” with “Formula 5”

-Description 8.2 replace “Formula 3” with “Formula 4”

-Description 8.4 replace “Formula 3” with “Formula 4”

Page 63, Clause 5.4.1

-Replace the reference “5.4.1.1” with “5.4.1.1 through 5.4.1.9.”

Page 69, Table 5.2 entitled “Essential Variables for Prequalified WPSs (see 5.2.1)”

-item (4) Base Metal Preheat Category(s) replace “(See Table 5.4)” with “(See Table 5.8)”.