AISC Live Webinars

Getting the Welds You Need

July 30, 2020

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Course Description

Getting the Welds You Need
July 30, 2020

Many are familiar with welded structural connections but struggle to accurately convey design details and to ensure mechanical properties and quality are achieved. This webinar will provide guidance regarding welding symbols; joint details; document submittals; welding procedure specification (WPS) review; and inspection and nondestructive testing, following the requirements of AISC 360, AISC 341, AWS D1.1 and AWS D1.8.

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Learning Objectives

- Explain how to properly communicate welded joint requirements on contract documents.
- List parameters required to be provided in a weld procedure specification.
- Explain how to properly specify inspection and testing requirements using AISC and AWS requirements.
- List nondestructive testing methods and identify what discontinuities each might detect.

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Getting the Welds You Need

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AISC Specifications Committee, TC12, TC6 (past member)
AISC Connections Prequalification Review Panel
AWS D1 Committee, D1.1, D1.8
International Institute of Welding
- Commission XVIII on Quality Management, Chair
- Commission XV on Design, Analysis and Fabrication of Welded Structures, Past Chair

ISO TC167/WG3, ISO/XX 17607 Steel Structures
RCSC Specifications Committee
ASTM F16 Fasteners Committee

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Getting the Welds You Need

Many are familiar with welded structural connections but may struggle with accurately conveying design details and ensuring that mechanical properties and quality are achieved. This webinar will provide guidance regarding

- welding symbols,
- joint details,
- document submittals,
- welding procedure specification (WPS) review, and
- inspection and nondestructive testing, following the requirements of AISC 360, AISC 341, AWS D1.1 and AWS D1.8.

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- **welding symbols**
- **joint details**
- **document submittals**
- **welding procedure specification (WPS) review**
- **inspection**
- **nondestructive testing**

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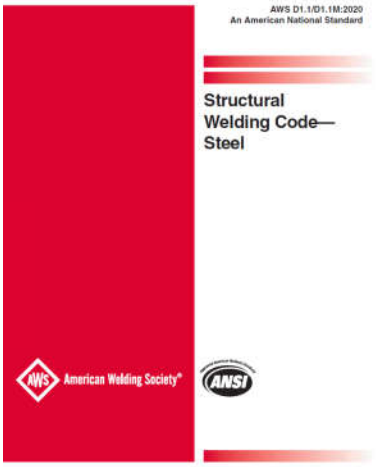
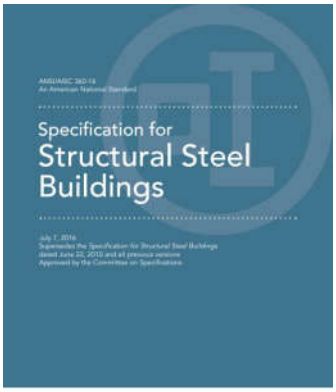
AWS D1.1/D1.1M:2020

www.aws.org



AISC 360-16

www.aisc.org



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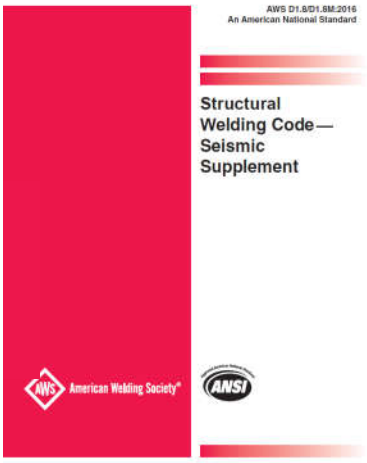
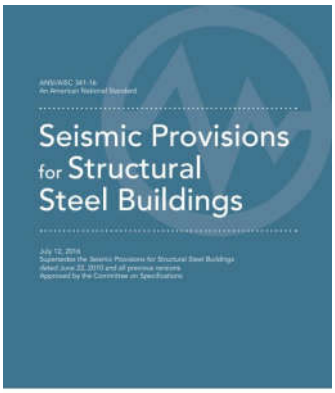
AWS D1.8/D1.8M:2016



AISC 341-16



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Specification for Structural Steel Buildings

A GENERAL PROVISIONS

A4 STRUCTURAL DESIGN DRAWINGS AND SPECIFICATIONS

The structural design drawings and specifications shall meet the requirements of the *Code of Standard Practice*.

User Note:
Provisions in this Specification contain information that is to be shown on design drawings. These include:

- Section A3.1c: Rolled heavy shapes where alternate core Charpy V-notch toughness (CVN) is required
- Section A3.1d: Built-up heavy shapes where CVN toughness is required

Other information needed by the fabricator or erector should be shown on design drawings, including:

- Fatigue details requiring nondestructive testing
- Risk category (Chapter N)
- Indication of complete-joint-penetration (CJP) groove welds subject to tension (Chapter N)

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Code of Standard Practice for Steel Buildings and Bridges

3 DESIGN DOCUMENTS AND SPECIFICATIONS

3.1 Structural Design Documents and Specifications

Commentary:

…
However, critical requirements that are necessary to protect the owner's interest, that affect the integrity of the structure or that are necessary for the fabricator and the erector to proceed with their work must be included in the contract documents.

Some examples of critical information may include, when applicable:

- Special material requirements to be reported on the material test reports.
- Welded-joint configuration.
- Weld-procedure qualification.
- Final disposition of backing and runoff tabs.
- Shop and field inspection requirements.
- Nondestructive testing requirements, including acceptance criteria.

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Structural Welding Code—Steel 2020

1 General Requirements
1.5 Responsibilities
1.5.1 Engineer's Responsibilities

The ***Engineer*** shall be responsible for the development of the contract documents that govern products or structural assemblies produced 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.

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Getting the Welds You Need

Structural Welding Code—Steel 2020

1 General Requirements
1.5 Responsibilities
1.5.1 Engineer's Responsibilities

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) Extent of verification inspection, when required.
(4) Weld acceptance criteria other than that specified in Clause 8.
(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) Which welded joints are loaded in tension.
(8) All additional requirements that are not specifically addressed in the code.
(9) For OEM applications, the responsibilities of the parties involved.

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Structural Welding Code—Steel 2020

4 Design of Welded Connections
Part A Common Requirements for Design of Welded Connections (Nontubular and Tubular Members)
4.3 Contract Plans and Specifications
4.3.1 Plan and Drawing Information

Complete information regarding base metal specification designation (…) and location, type, size, and extent of all welds shall be clearly shown on the contract plans and specifications, hereinafter referred to as the contract documents.

If the ***Engineer*** requires specific welds to be performed in the field, they shall be designated in the contract documents.

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Getting the Welds You Need

Structural Welding Code—Steel 2020

4 Design of Welded Connections
Part A Common Requirements for Design of Welded Connections (Nontubular and Tubular Members)
4.3 Contract Plans and Specifications
4.3.2 Notch Toughness Requirements

If notch toughness of welded joints is required, the ***Engineer*** shall specify the minimum absorbed energy with the corresponding test temperature for the filler metal classification to be used, or the ***Engineer*** shall specify that the WPSs be qualified with CVN tests.

If WPSs with CVN tests are required, the ***Engineer*** shall specify the minimum absorbed energy, the test temperature and whether the required CVN test performance is to be in the weld metal, or both in the weld metal and the HAZ (…).

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Structural Welding Code—Steel 2020

4 Design of Welded Connections
Part A Common Requirements for Design of Welded Connections (Nontubular and Tubular Members)
4.3 Contract Plans and Specifications
4.3.3 Specific Welding Requirements

The ***Engineer***, in the contract documents, and the ***Contractor***, in the shop drawings, shall indicate those joints or groups of joints in which the ***Engineer*** or Contractor require a specific assembly order, welding sequence, welding technique or other special precautions. …

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Getting the Welds You Need

Structural Welding Code—Steel 2020

4 Design of Welded Connections
Part C Specific Requirements for Design of Nontubular Connections (Cyclically Loaded)
4.13.3 Engineer's Responsibility

The ***Engineer*** shall provide either complete details, including weld sizes, or shall specify the planned cycle life and the maximum range of moments, shears, and reactions for the connections in contract documents.

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Getting the Welds You Need

Structural Welding Code—Steel 2020

1 General Requirements
1.7 Mandatory and Nonmandatory Provisions
1.7.1 Code Terms "Shall," "Should," and "May"
1.7.1.1 Shall

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

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Getting the Welds You Need

Structural Welding Code—Steel 2020

1 General Requirements
1.7 Mandatory and Nonmandatory Provisions
1.7.1 Code Terms "Shall," "Should," and "May"
1.7.1.2 Should

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

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Getting the Welds You Need

Structural Welding Code—Steel 2020

1 General Requirements
1.7 Mandatory and Nonmandatory Provisions
1.7.1 Code Terms "Shall," "Should," and "May"
1.7.1.3 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.

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Structural Welding Code—Steel 2020

11 Strengthening and Repair of Existing Structures
11.1 Scope
Strengthening or repairing an existing structure shall consist of modifications to meet design requirements specified by the ***Engineer***. …

11.2 General
The ***Engineer*** shall prepare a comprehensive plan for the work.

Such plans shall include, but are not limited to, design, workmanship, inspection and documentation.

…

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Getting the Welds You Need

Seismic Provisions for Structural Steel Buildings

A GENERAL REQUIREMENTS
A4 STRUCTURAL DESIGN DRAWINGS AND SPECIFICATIONS
A4.1 General

Structural design drawings and specifications shall indicate the work to be performed, and include items required by the *Specification*, the AISC *Code of Standard Practice for Steel Buildings and Br*idges, the applicable building code, and the following, as applicable:

(a) Designation of the SFRS
(b) Identification of the members and connections that are part of the SFRS
(c) Locations and dimensions of protected zones
(d) Connection details between concrete floor diaphragms and the structural steel elements of the SFRS
(e) Shop drawing and erection drawing requirements not addressed in Section I1

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Getting the Welds You Need

Seismic Provisions for Structural Steel Buildings

A GENERAL REQUIREMENTS
A4 STRUCTURAL DESIGN DRAWINGS AND SPECIFICATIONS
A4.2 Steel Construction

In addition to the requirements of Section A4.1, structural design drawings and specifications for steel construction shall indicate the following items, as applicable:

(a) Configuration of the connections
(b) Connection material specifications and sizes
(c) Locations of demand critical welds
(d) Locations where gusset plates are to be detailed to accommodate inelastic rotation
(e) Locations of connection plates requiring Charpy V-notch toughness in accordance with Section A3.3(b)
(f) Lowest anticipated service temperature of the steel structure, if the structure is not enclosed and maintained at a temperature of 50°F (10°C) or higher

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Seismic Provisions for Structural Steel Buildings

A GENERAL REQUIREMENTS
A4 STRUCTURAL DESIGN DRAWINGS AND SPECIFICATIONS
A4.2 Steel Construction

...

(g) Locations where weld backing is required to be removed
(h) Locations where fillet welds are required when weld backing is permitted to remain
(i) Locations where fillet welds are required to reinforce groove welds or to improve connection geometry
(j) Locations where weld tabs are required to be removed
(k) Splice locations where tapered transitions are required
(l) The shape of weld access holes, if a shape other than those provided for in the *Specification* is required
(m) Joints or groups of joints in which a specific assembly order, welding sequence, welding technique, or other special precautions are required, where such items are designated to be submitted to the engineer of record

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Getting the Welds You Need

1 General Requirements
1.4 Responsibilities
1.4.1 Engineer's Responsibilities

Structural Welding Code—Seismic Supplement 2016

In addition to the items listed in AWS D1.1/D1.1M, the Engineer shall provide the following information in the Contract Documents:

(1) Connection configuration, material specifications, and part sizes required to provide the needed seismic performance (see 1.5)

(2) Identification of members that comprise the Seismic Force Resisting System (SFRS) and that are subject to the provisions of this code (see Clause 3)

(3) The location of the Protected Zone for members of the SFRS (see Clause 3)

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Getting the Welds You Need

1 General Requirements
1.4 Responsibilities
1.4.1 Engineer's Responsibilities

Structural Welding Code—Seismic Supplement 2016

In addition to the items listed in AWS D1.1/D1.1M, the Engineer shall provide the following information in the Contract Documents:

(4) Welds designated as "Demand Critical" and subject to specific provisions of this code (see Clause 3)

AWS D1.8/D1.8M:2016 Commentary
Figures C-1.1, 1.2 and 1.3 — Example …C-Demand Critical Welds

AISC 341-16, Commentary A3.4, pg 9.1-166
Demand critical welds are generally complete-joint-penetration groove (CJP) welds so designated because they are subjected to yield level or higher stress demand and located in a joint whose failure would result in significant degradation in the strength or stiffness of the SFRS.

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Getting the Welds You Need

1 General Requirements
1.4 Responsibilities
1.4.1 Engineer's Responsibilities

Structural Welding Code—Seismic Supplement 2016

In addition to the items listed in AWS D1.1/D1.1M, the Engineer shall provide the following information in the Contract Documents:

(5) Locations where the removal of backing is required (see 6.13)

(6) Locations where fillet welds are required when backing is permitted to remain (see 6.15)

(7) Locations where the removal of weld tabs is required (see 6.16.3 and 6.16.4)

(8) Locations where fillet welds are required to reinforce groove welds, or to improve connection geometry (see 6.14)

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Getting the Welds You Need

1 General Requirements
1.4 Responsibilities
1.4.1 Engineer's Responsibilities

Structural Welding Code—Seismic Supplement 2016

In addition to the items listed in AWS D1.1/D1.1M, the Engineer shall provide the following information in the Contract Documents:

(9) Locations of access holes and the required shape, whether standard AWS D1.1/D1.1M geometry (see 6.11.1.1), standard alternate geometry (see 6.11.1.2), or a special geometry designated by the Engineer (see 6.11.1.3)

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Getting the Welds You Need

1 General Requirements
1.4 Responsibilities
1.4.1 Engineer's Responsibilities

Structural Welding Code—Seismic Supplement 2016

In addition to the items listed in AWS D1.1/D1.1M, the Engineer shall provide the following information in the Contract Documents:

(10) The Lowest Anticipated Service Temperature (LAST) of the steel structure for structures that are not normally enclosed and maintained at a temperature of 50°F [10°C] or higher (see Clause 3 and 6.2.2)

lowest anticipated service temperature (LAST). The lowest one (1) hour average temperature with a 100-year mean recurrence interval.

***AISC 341-16**, Lowest anticipated service temperature (LAST).* Lowest daily minimum temperature, or other suitable temperature, as established by the engineer of record.

***Commentary A3.4, pg 9.1-167** – For purposes of the Provisions, the LAST may be considered to be the lowest one-day mean temperature (LODMT) compiled from National Oceanic and Atmospheric Administration (NOAA) data.*

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Getting the Welds You Need

1 General Requirements
1.4 Responsibilities
1.4.1 Engineer's Responsibilities

Structural Welding Code—Seismic Supplement 2016

In addition to the items listed in AWS D1.1/D1.1M, the Engineer shall provide the following information in the Contract Documents:

(11) Butt joints subject to tension where tapered transitions are required (see 4.2)

(12) Those joints or groups of joints in which a specific assembly order, welding sequence, welding technique, or other special precautions are required (see AWS D1.1/D1.1M subclauses 2.3.3 and 5.20)

(13) Quality Assurance Plan (QAP) for the project (see Clause 3 and 7.1)

(14) Any additional provisions applicable to the specific project not governed by AWS D1.1/D1.1M or this code.

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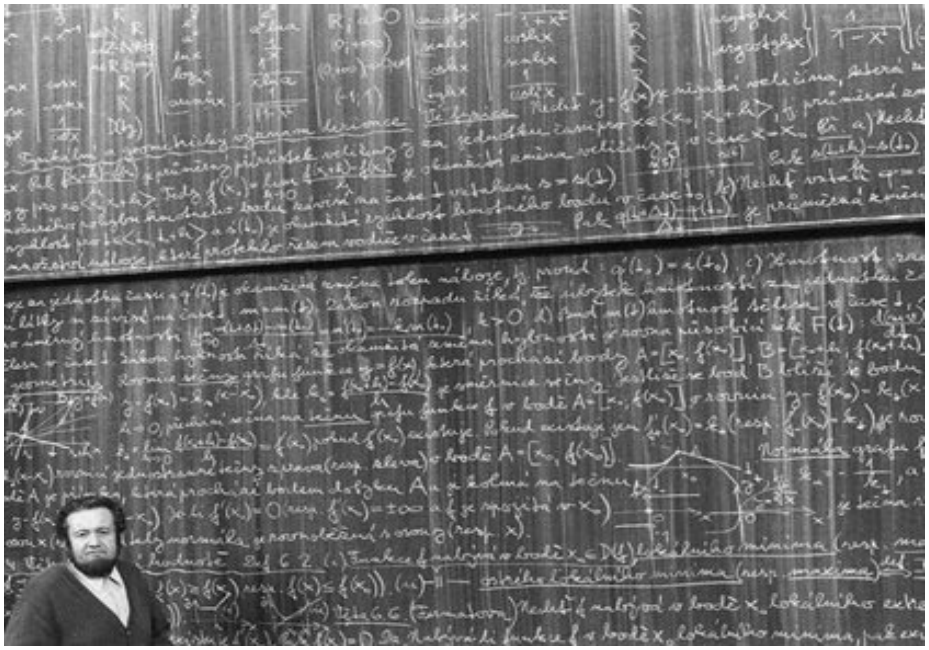
Getting the Welds You Need



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- welding symbols
- joint details
- document submittals
- welding procedure specification (WPS) review
- inspection
- nondestructive testing

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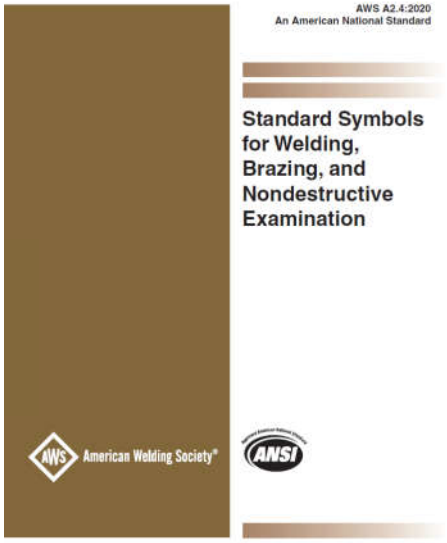
2020
Standard Symbols

AWS A2.4:2020



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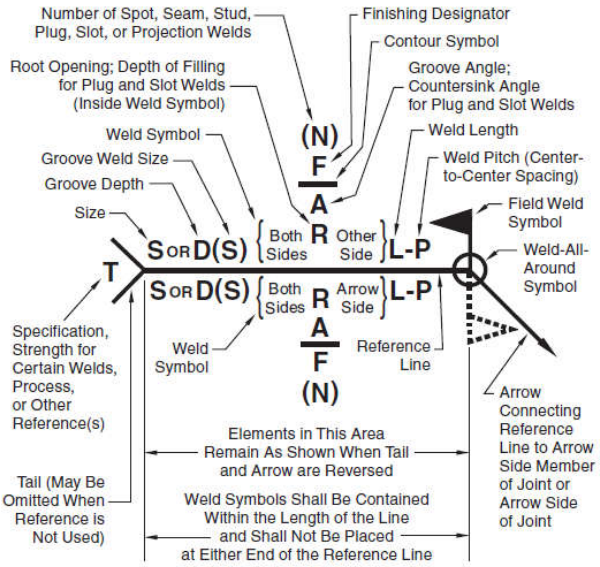
Getting the Welds You Need

2020 Standard Symbols

- **Figure 4.3 Standard Location of the Elements of a Welding Symbol**
- **Annex E (Informative) Welding Symbol Chart**



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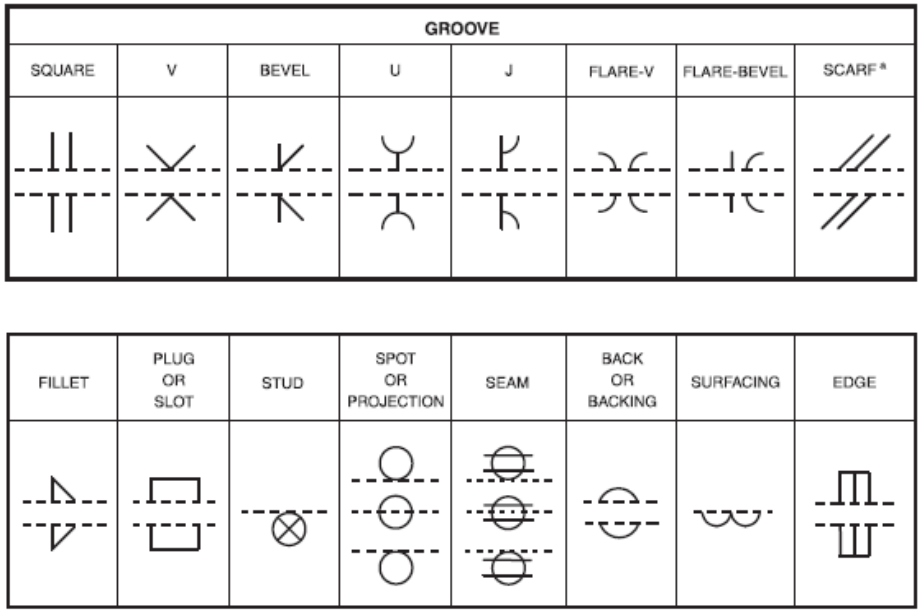
Getting the Welds You Need

2020 Standard Symbols

Figure 4.1 Weld Symbols



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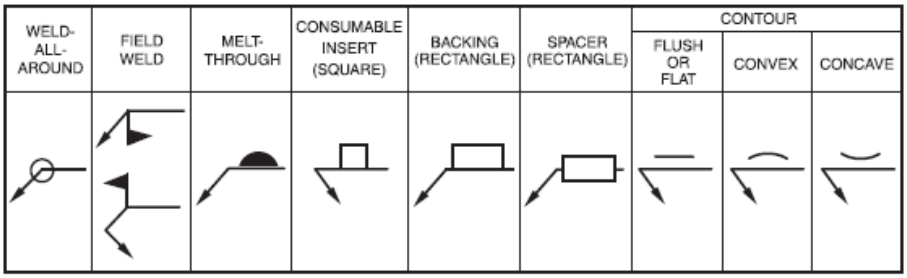
2020 Standard Symbols

Figure 4.2 Supplementary Symbols



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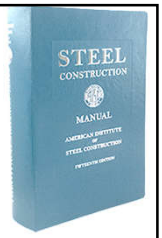

Table 8-2 (continued)
Prequalified Welded Joints

Basic Weld Symbols									
			Groove or Butt						
Back	Fillet	Plug or Slot	Square	V	Bevel	U	J	Flare V	Flare Bevel
									

Supplementary Weld Symbols						
				Contour		For other basic and supplementary weld symbols, see AWS A2.4 (2007).
Backing	Spacer	Weld All Around	Field Weld	Flush	Convex	
						

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Getting the Welds You Need

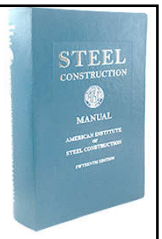

Table 8–2 (continued)
Prequalified Welded Joints

Basic Weld Symbols									
			Groove or Butt						
Back	Fillet	Plug or Slot	Square	V	Bevel	U	J	Flare V	Flare Bevel

Supplementary Weld Symbols						
				Contour		
Backing	Spacer	Weld All Around	Field Weld	Flush	Convex	For other basic and supplementary weld symbols, see AWS A2.4

Note:
Size, weld symbol, length of weld, and spacing must read in that order, from left to right, along the reference line. Neither orientation of reference nor location of the arrow alters this rule.

The perpendicular leg of ◺, V, Y, ◸, weld symbols must be at left.

Dimensions of fillet welds must be shown on both the arrow side and the other side.

Symbols apply between abrupt changes in direction of welding unless governed by the "all around" symbol or otherwise dimensioned.

These symbols do not explicitly provide for the case that frequently occurs in structural work, where duplicate material (such as stiffeners) occurs on the far side of a web or gusset plate. The fabricating industry has adopted this convention: that when the billing of the detail material discloses the existence of a member on the far side as well as on the near side, the welding shown for the near side shall be duplicated on the far side.

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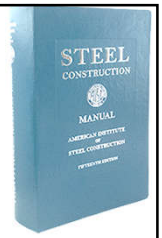
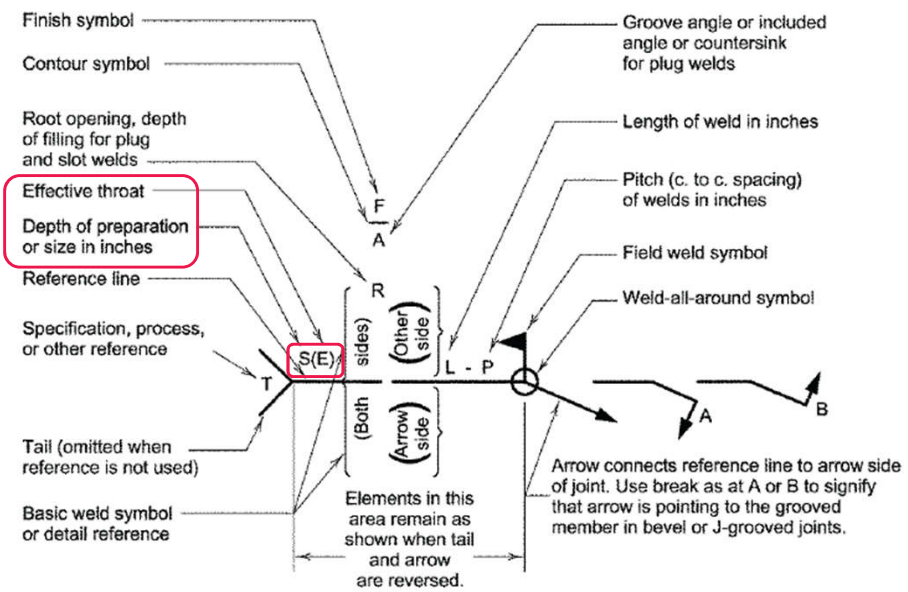
Getting the Welds You Need



Standard Location of Elements of a Welding Symbol



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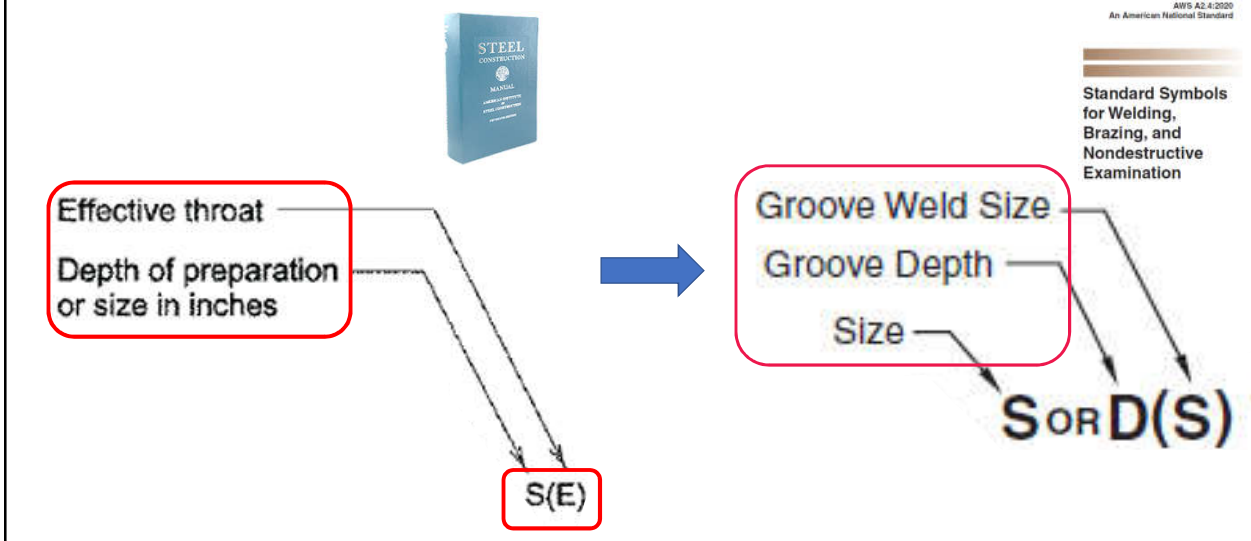

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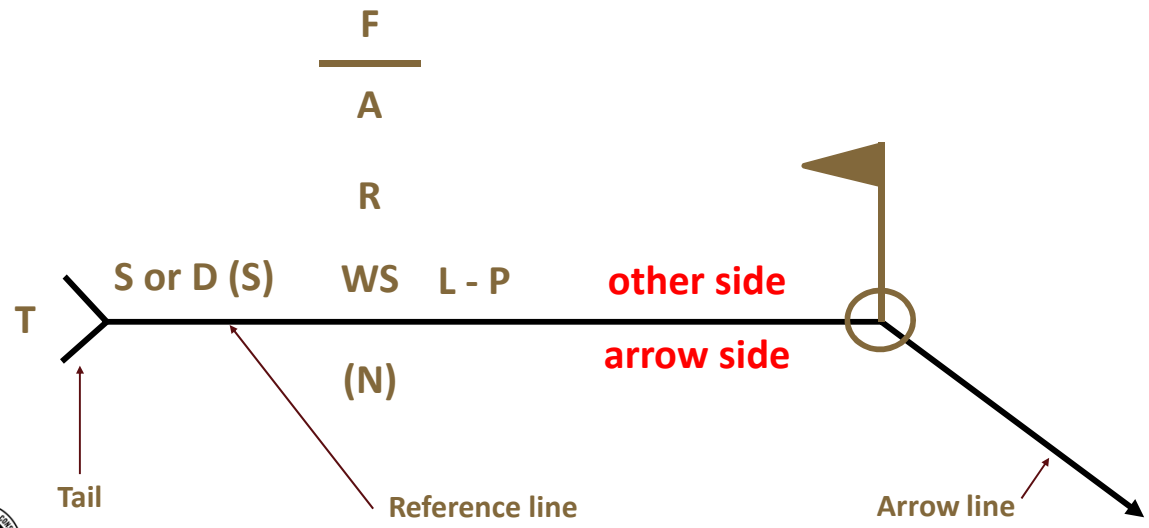
Getting the Welds You Need

2020 Standard Symbols

Welding Symbols



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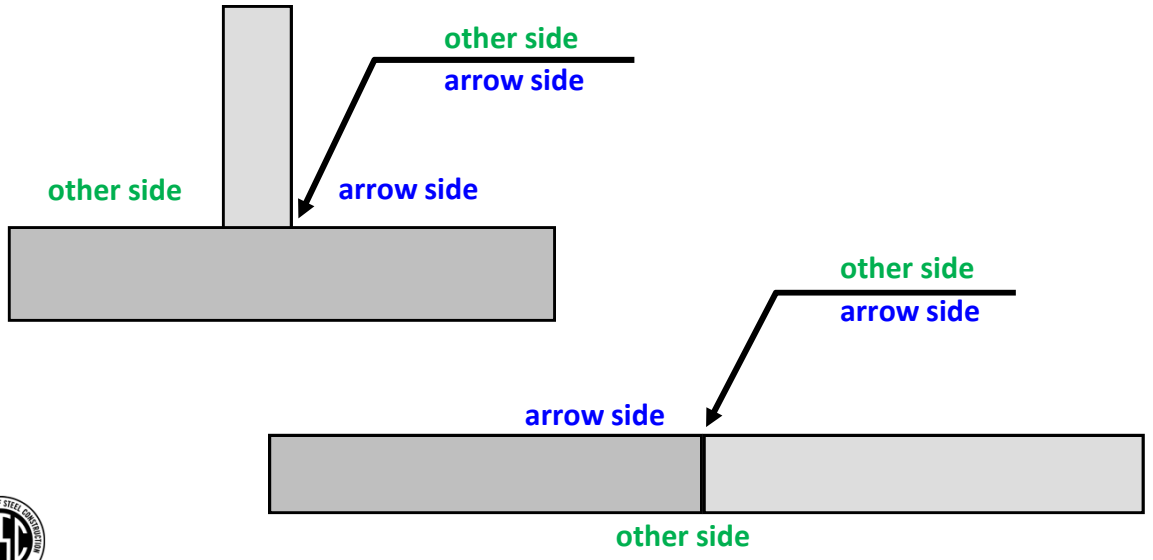
Getting the Welds You Need

2020 Standard Symbols

6.1 Arrow Location Significance

6.2 Weld Location with Respect to the Joint



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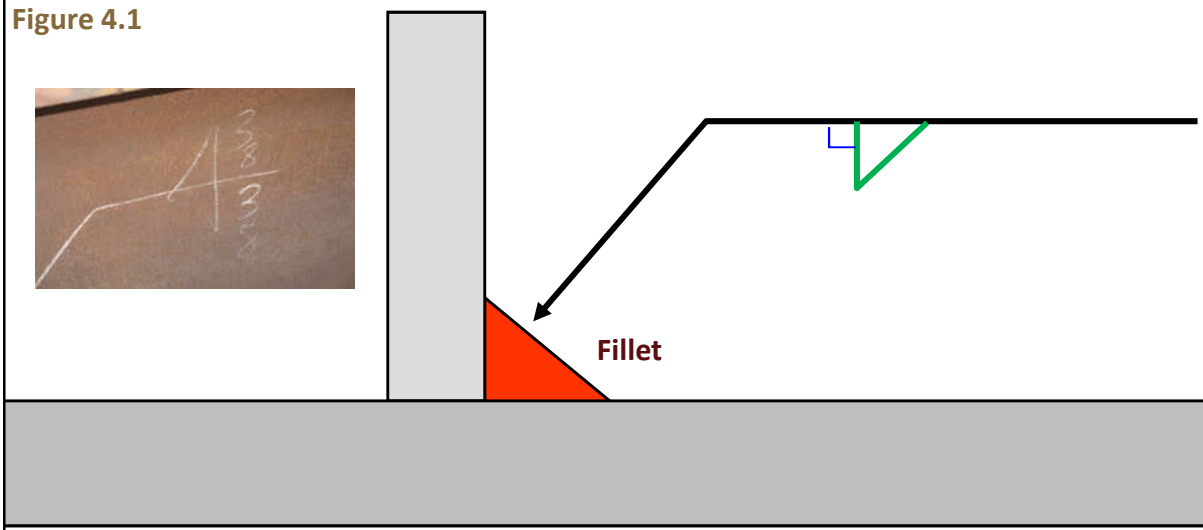
Getting the Welds You Need

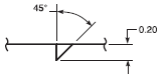
2020 Standard Symbols

8 Fillet Welds

Figure 4.1



Annex B (Informative) – Design of Standard Symbols (U.S. Customary Units)



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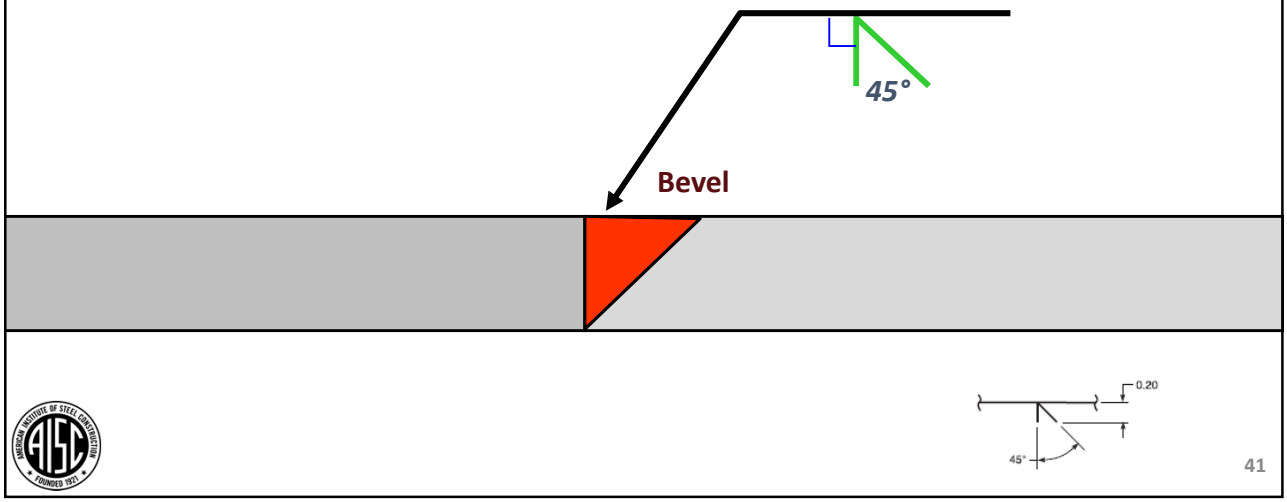
Getting the Welds You Need

2020 Standard Symbols

7 Bevel Groove Weld
Figure 4.1



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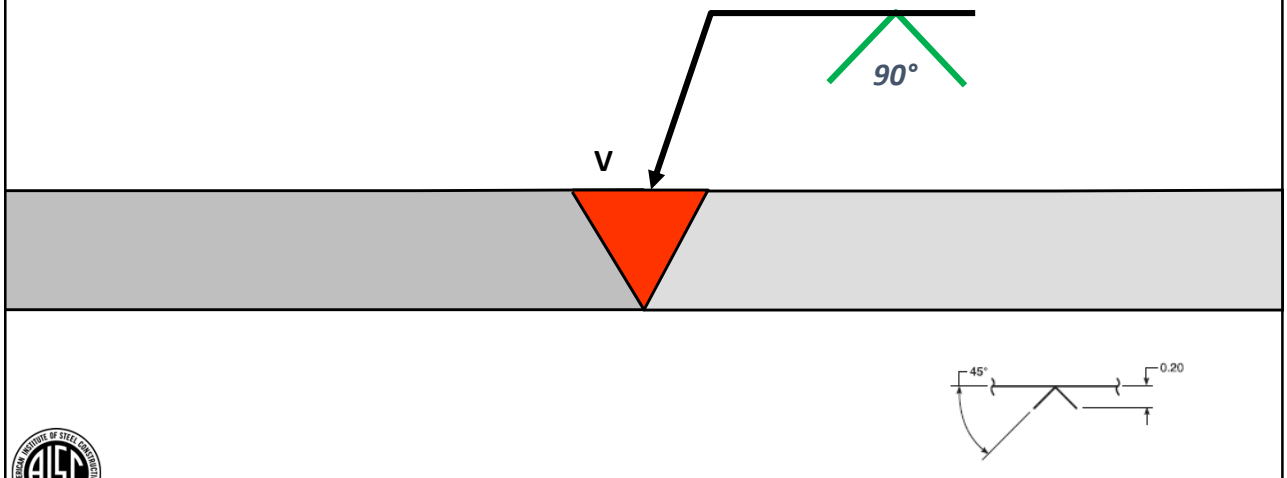
Getting the Welds You Need

2020 Standard Symbols

7 V Groove Weld
Figure 4.1



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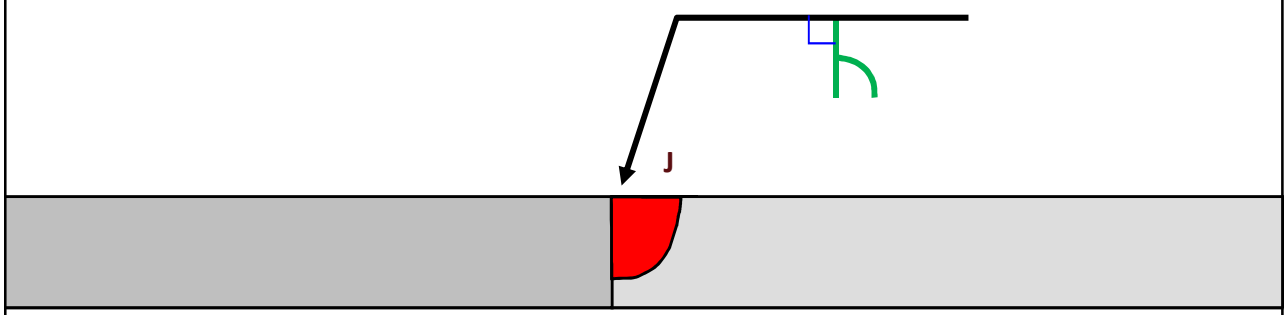
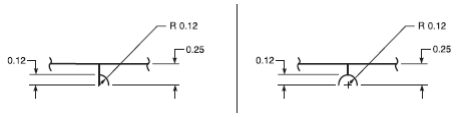
Getting the Welds You Need

2020 Standard Symbols

J Groove Weld
Figure 4.1





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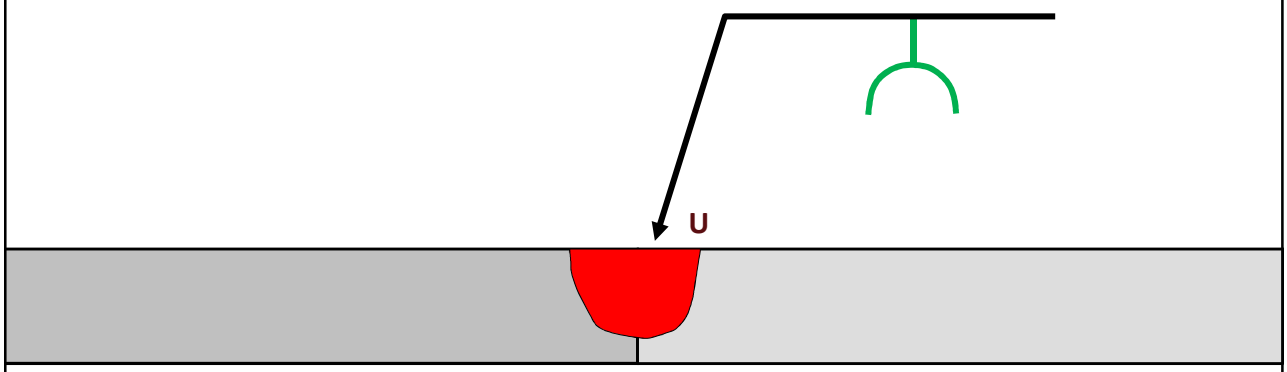
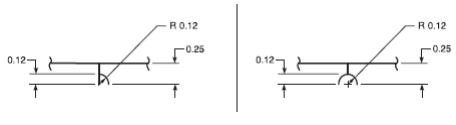
Getting the Welds You Need

2020 Standard Symbols

7 U Groove Weld
Figure 4.1



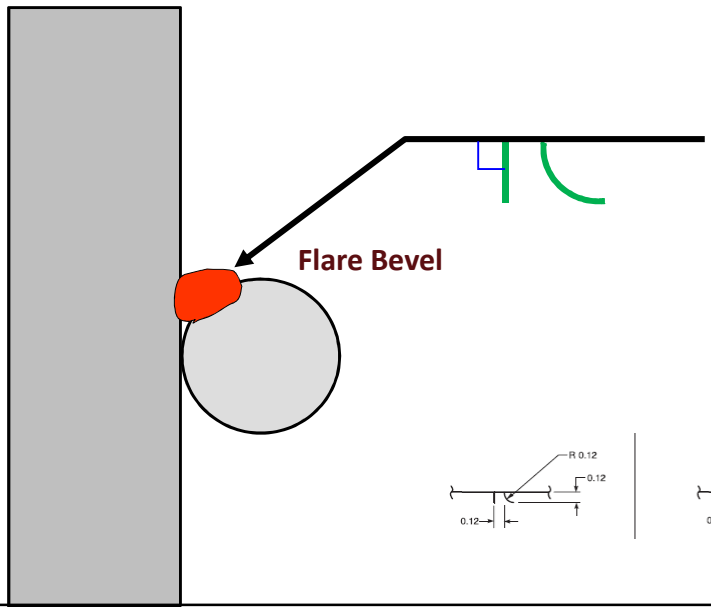


44

Getting the Welds You Need

2020 Standard Symbols

7 Flare Bevel Groove Weld
Figure 4.1



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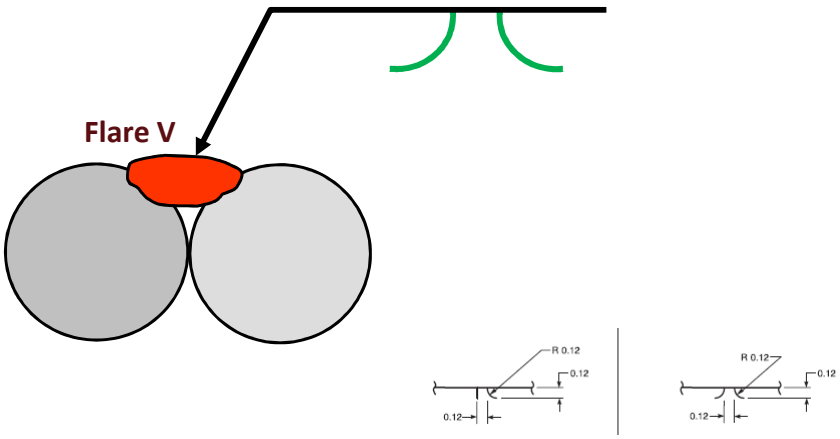
Getting the Welds You Need

2020 Standard Symbols

7 Flare V Groove Weld
Figure 4.1



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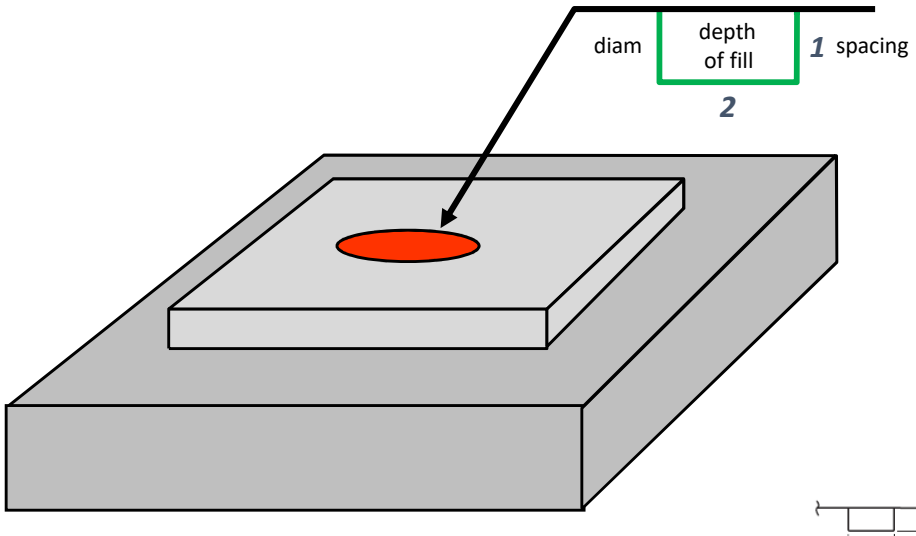
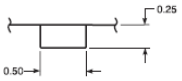
Getting the Welds You Need

2020 Standard Symbols

9 Plug Welds





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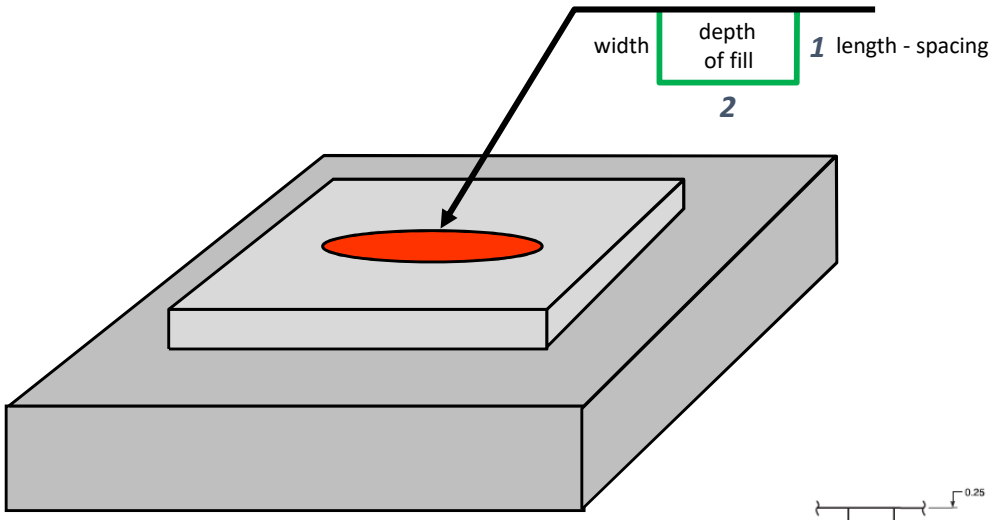
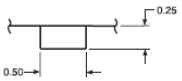
Getting the Welds You Need

2020 Standard Symbols

10 Slot Welds





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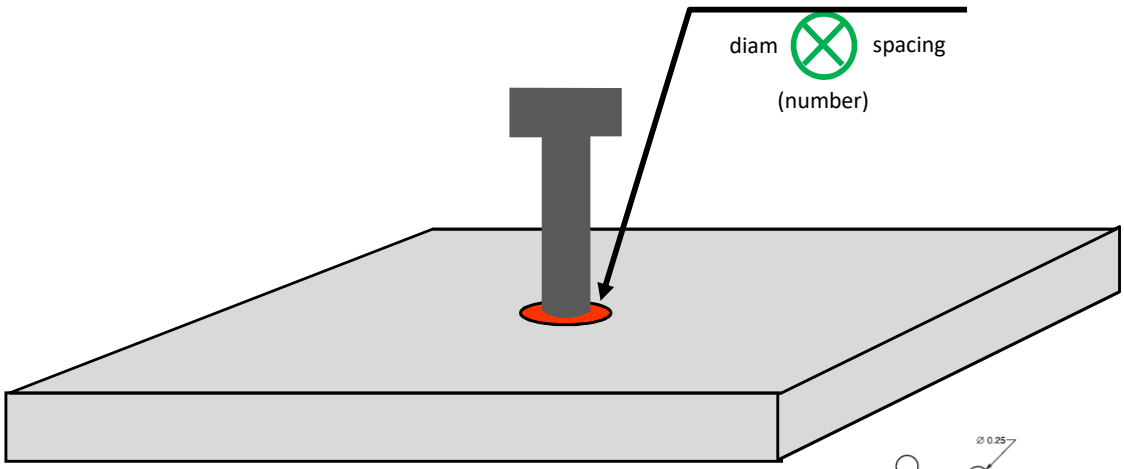
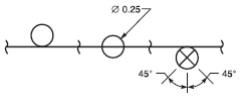
Getting the Welds You Need

2020 Standard Symbols

14 Stud Welds





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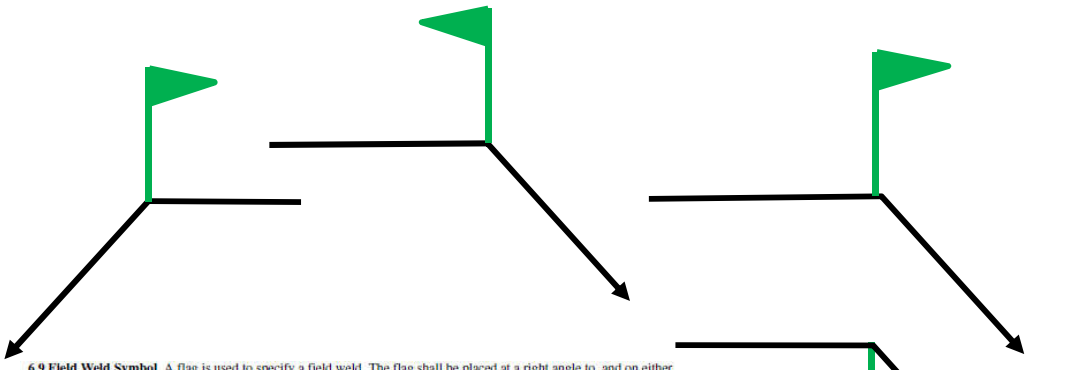
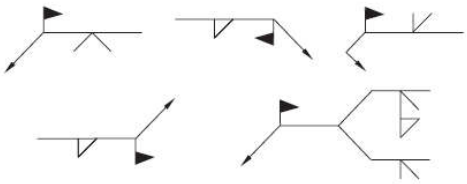
Getting the Welds You Need

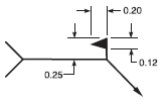
2020 Standard Symbols

6.9 Field Weld Symbol



6.9 Field Weld Symbol. A flag is used to specify a field weld. The flag shall be placed at a right angle to, and on either side of, the reference line at the junction with the arrow (see Annex D6.9). The flag may point in either direction.





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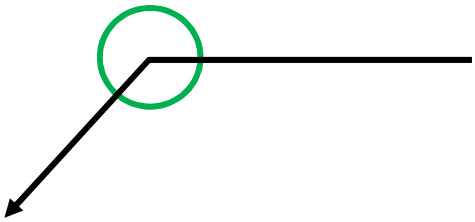
Getting the Welds You Need

2020 Standard Symbols

6.11 Weld All Around Symbol



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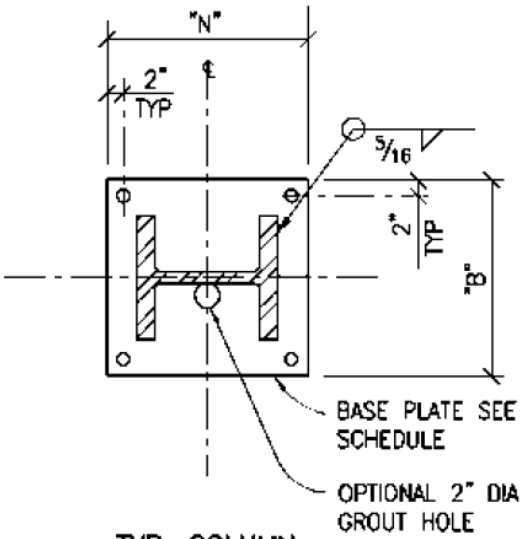
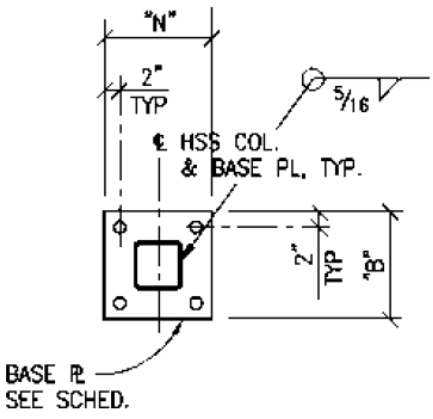
Getting the Welds You Need

2020 Standard Symbols

Weld All Around



TYP. COLUMN PLAN



HSS COLUMN PLAN

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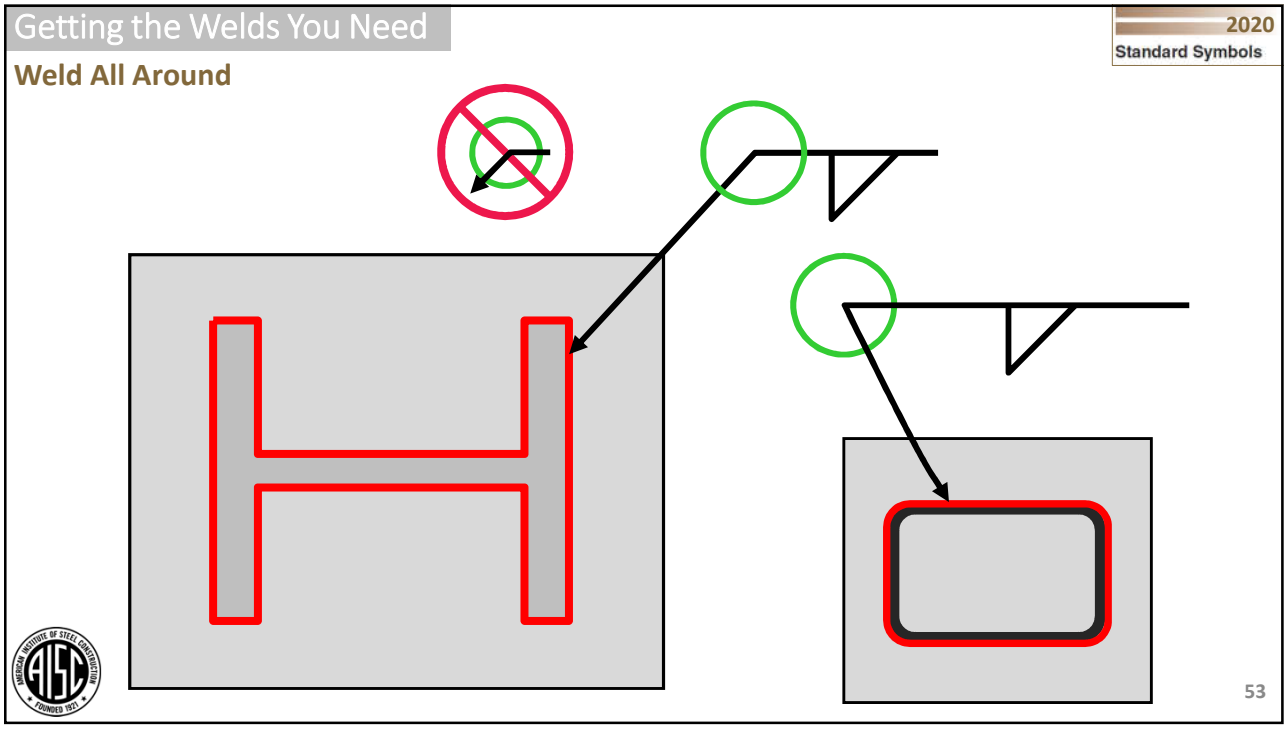
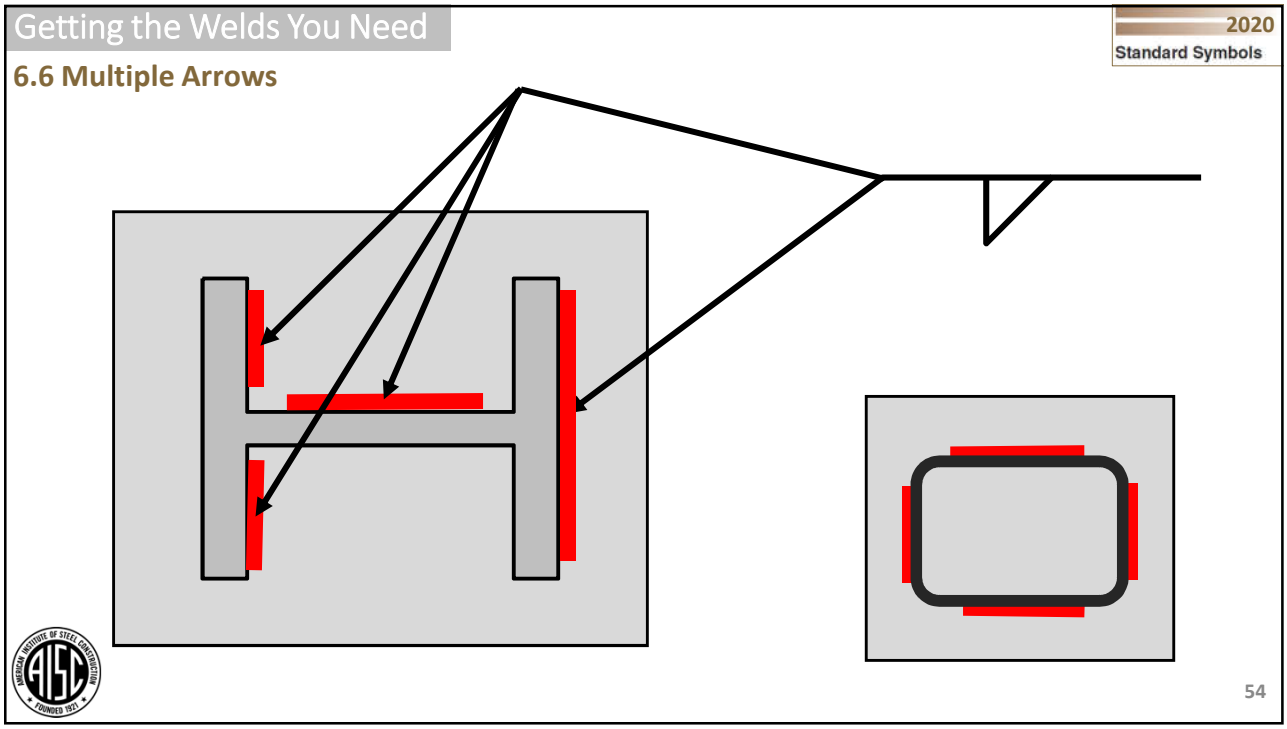
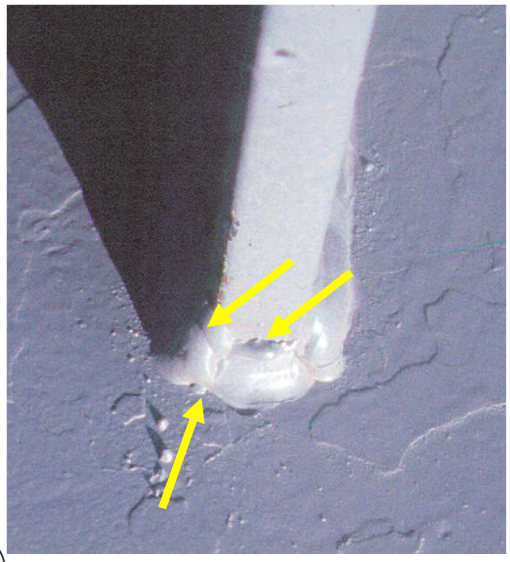


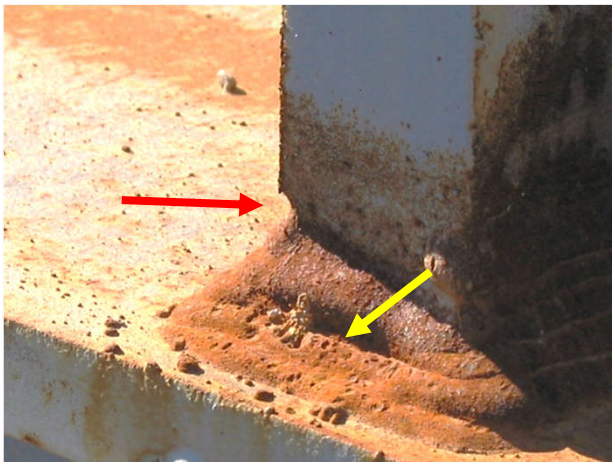


Getting the Welds You Need

2020 Standard Symbols

Weld All Around





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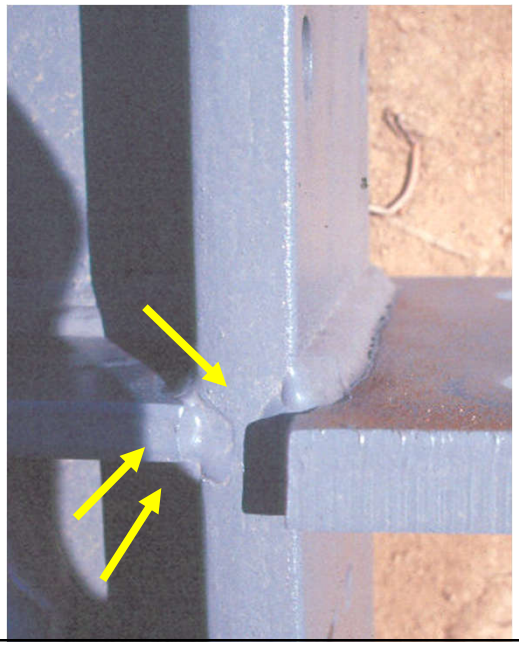
Getting the Welds You Need

2020 Standard Symbols

Weld All Around



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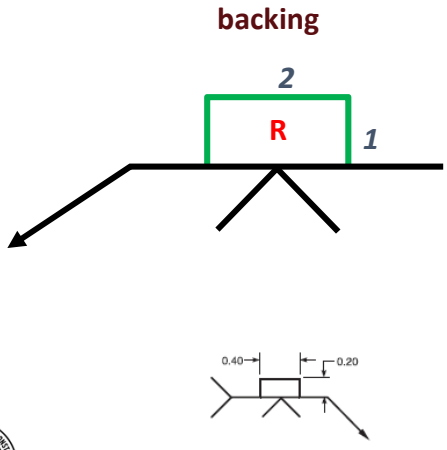
Getting the Welds You Need

2020 Standard Symbols

7.8 Joints with Backing



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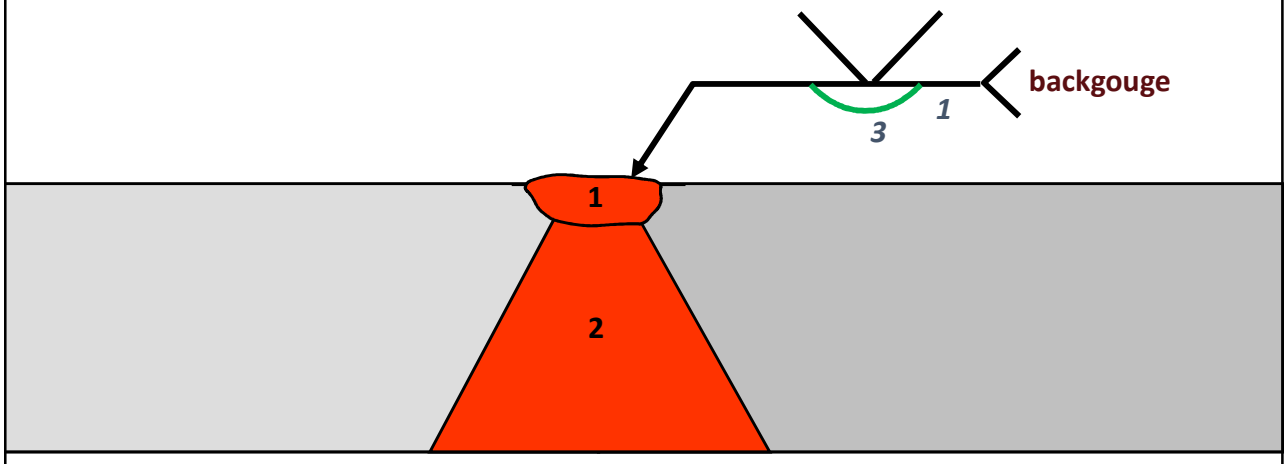
Getting the Welds You Need

2020 Standard Symbols

7.7 Back and Backing Welds



NOTE: MELT-THROUGH, BACK WELD, AND BACKING WELD SYMBOL HAVE THE SAME DIMENSIONS

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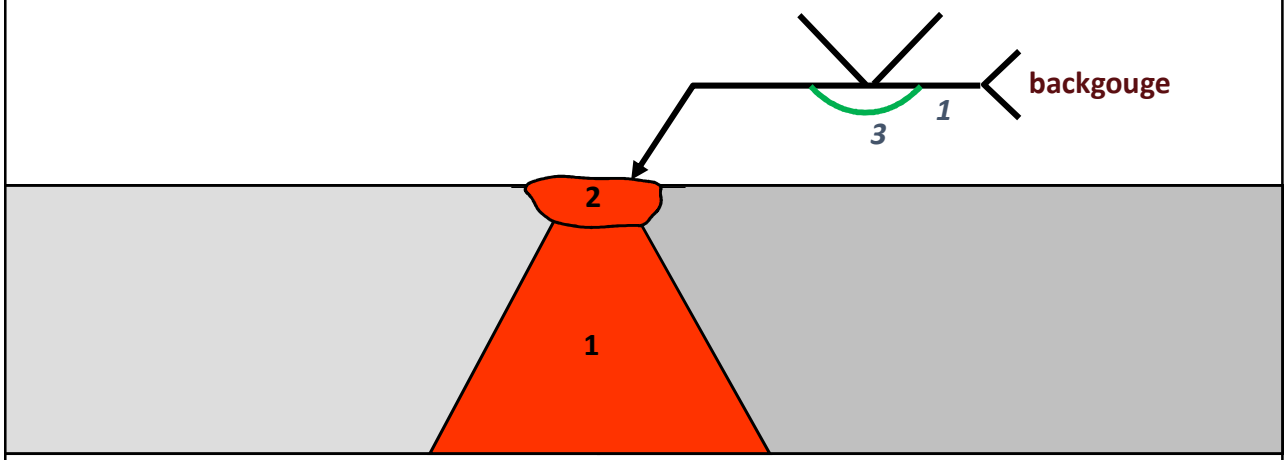
Getting the Welds You Need

2020 Standard Symbols

7.7 Back and Backing Welds



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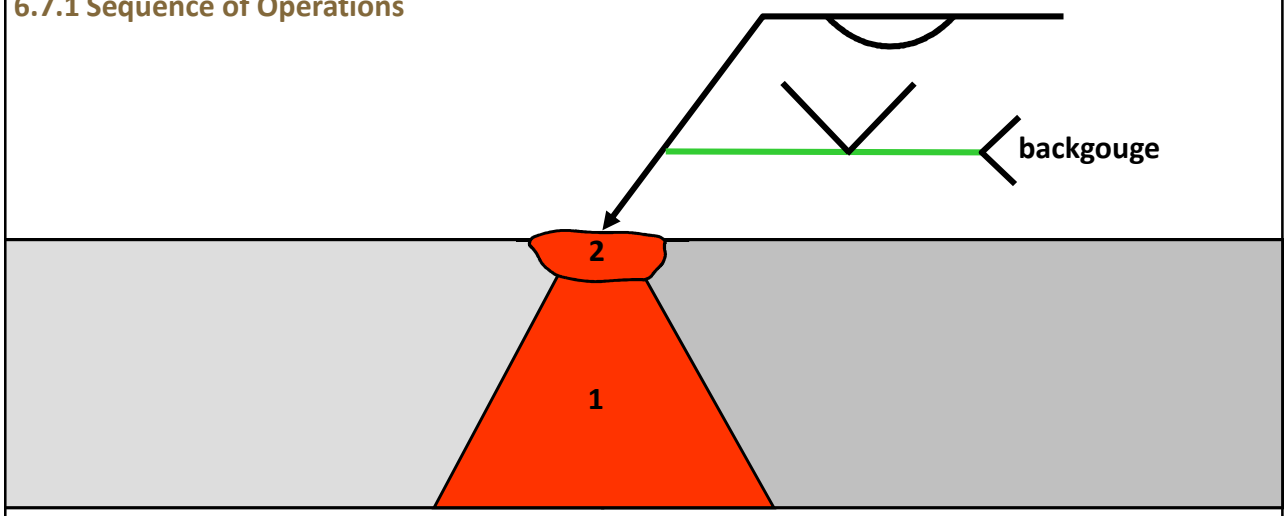
Getting the Welds You Need

2020 Standard Symbols

6.7 Multiple Reference Lines
6.7.1 Sequence of Operations



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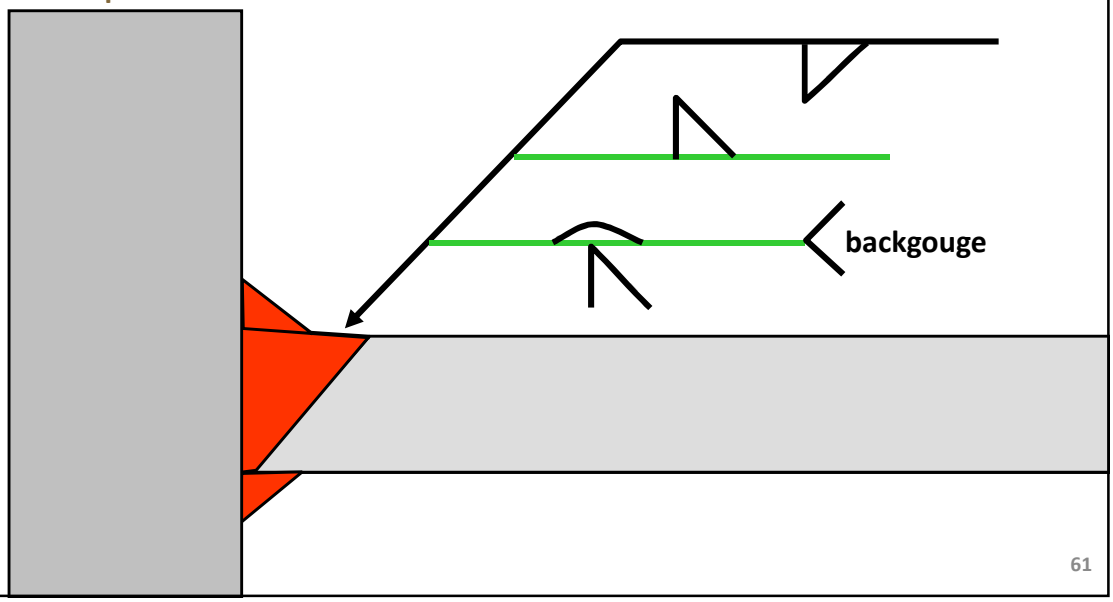
Getting the Welds You Need

2020 Standard Symbols

6.7 Multiple Reference Lines
6.7.1 Sequence of Operations



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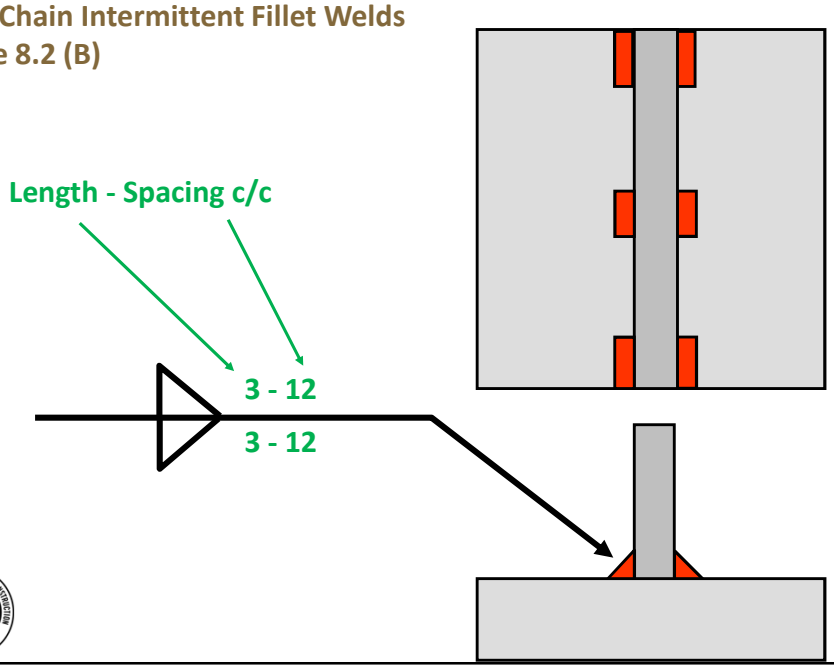
Getting the Welds You Need

2020 Standard Symbols

8.4.3 Chain Intermittent Fillet Welds
Figure 8.2 (B)



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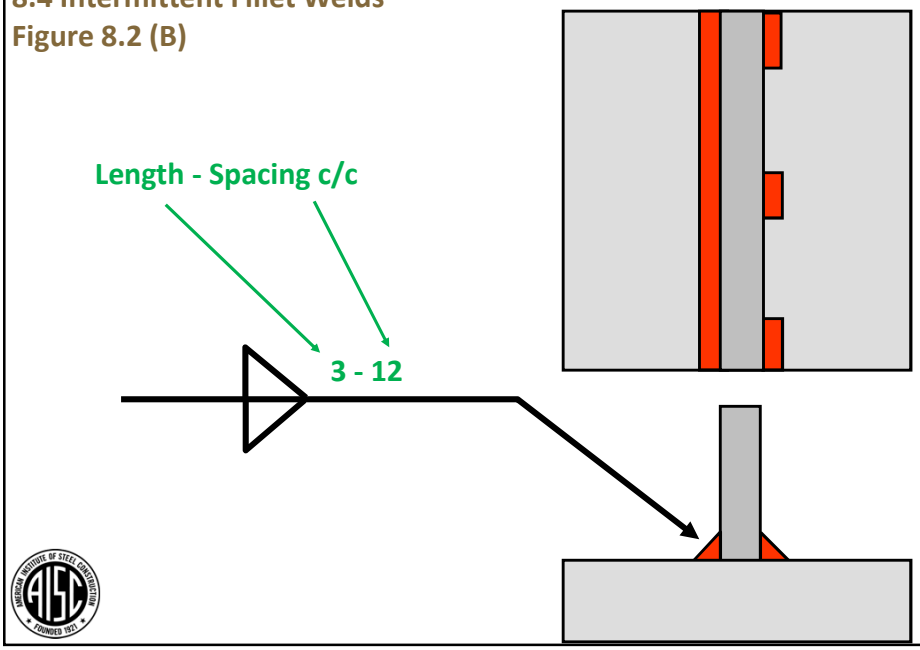
Getting the Welds You Need

2020 Standard Symbols

8.4 Intermittent Fillet Welds
Figure 8.2 (B)



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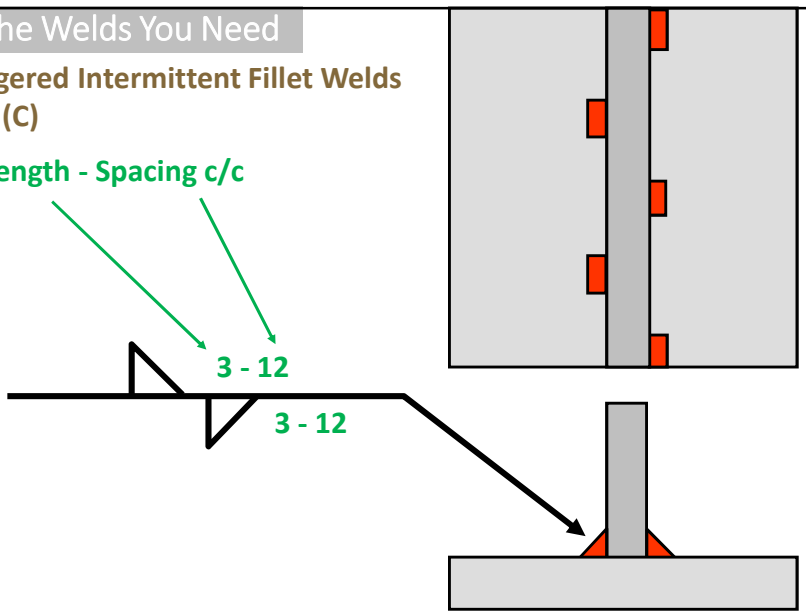
Getting the Welds You Need

2020 Standard Symbols

8.4.4 Staggered Intermittent Fillet Welds
Figure 8.2 (C)



8.4.4 Staggered Intermittent Fillet Welds. The dimensions of staggered intermittent fillet welds shall be specified on both sides of the reference line, and the fillet weld symbols shall be offset on opposite sides of the reference line. The segments of staggered intermittent fillet welds shall be symmetrically spaced on both sides of the joint [see Figure 8.2(C)].

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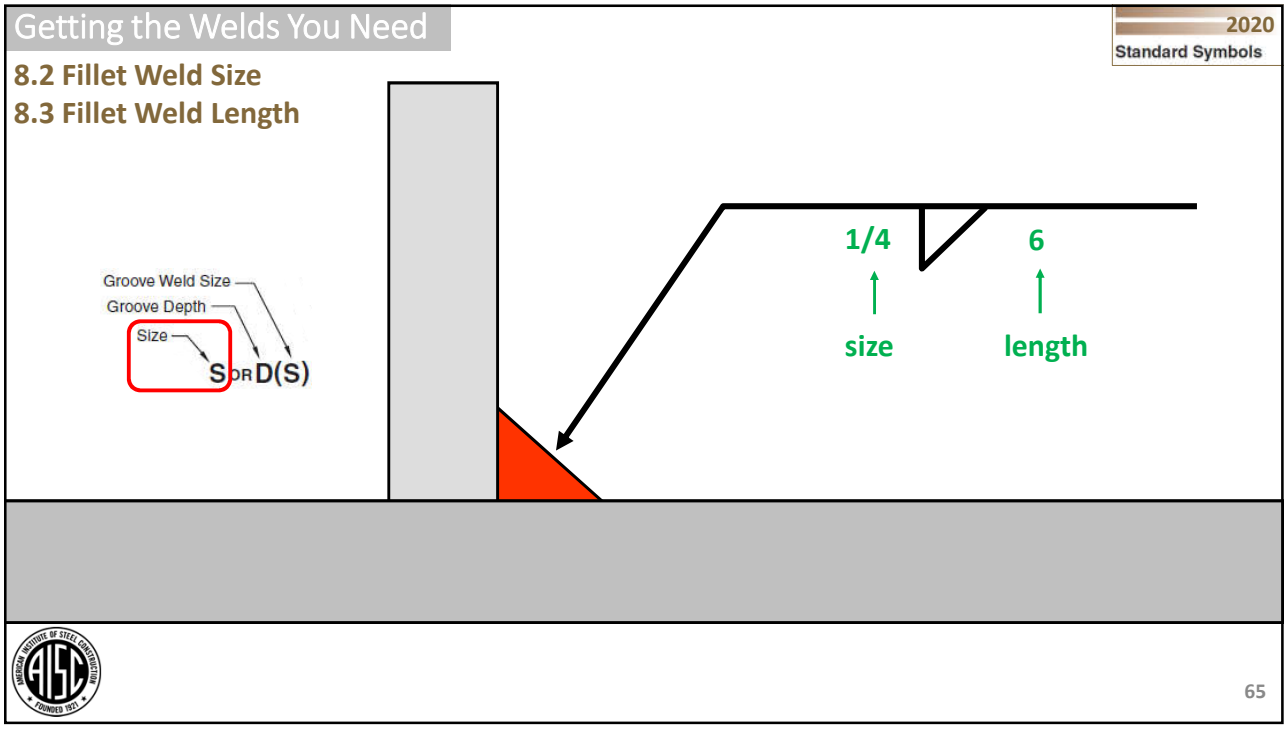
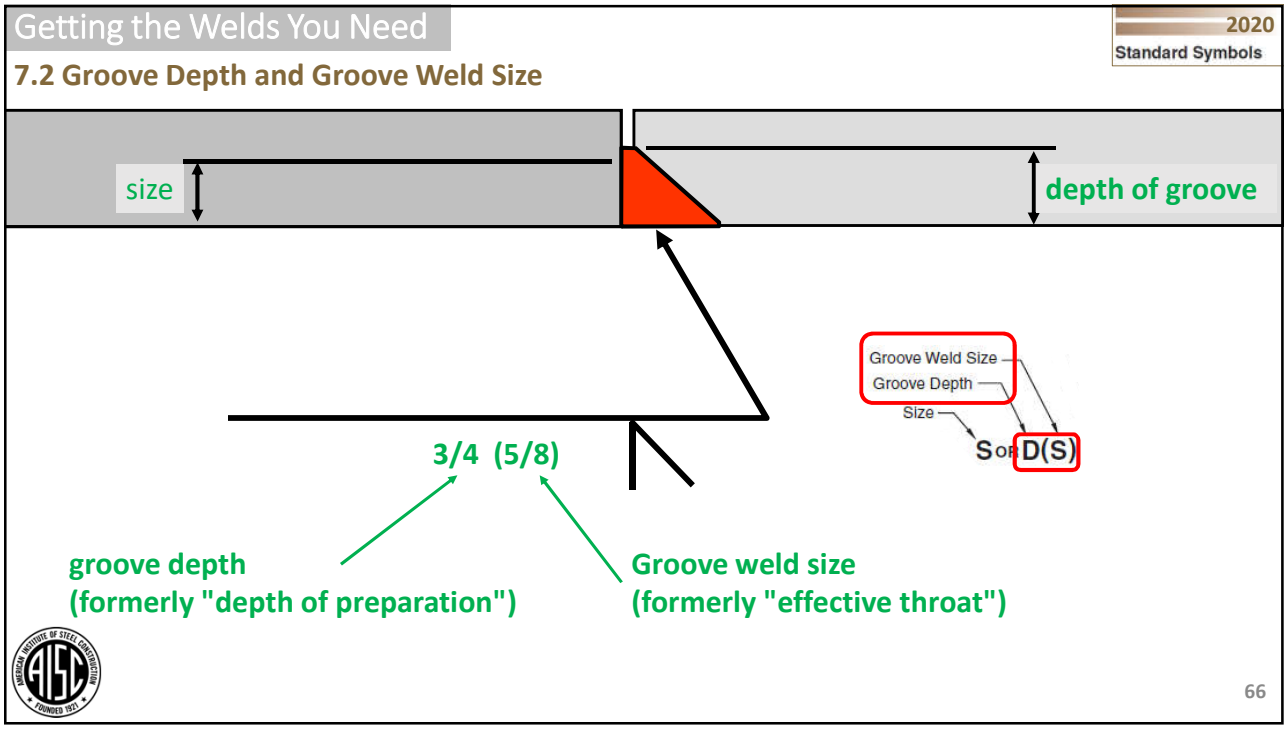
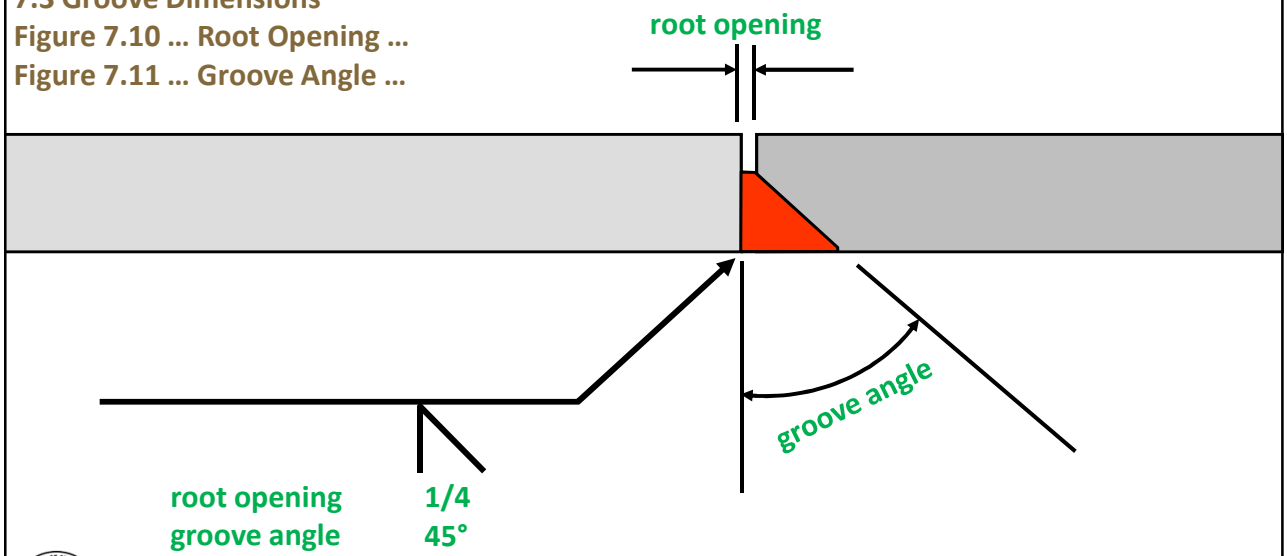




Getting the Welds You Need

2020 Standard Symbols

7.3 Groove Dimensions
Figure 7.10 … Root Opening …
Figure 7.11 … Groove Angle …



root opening 1/4
groove angle 45°

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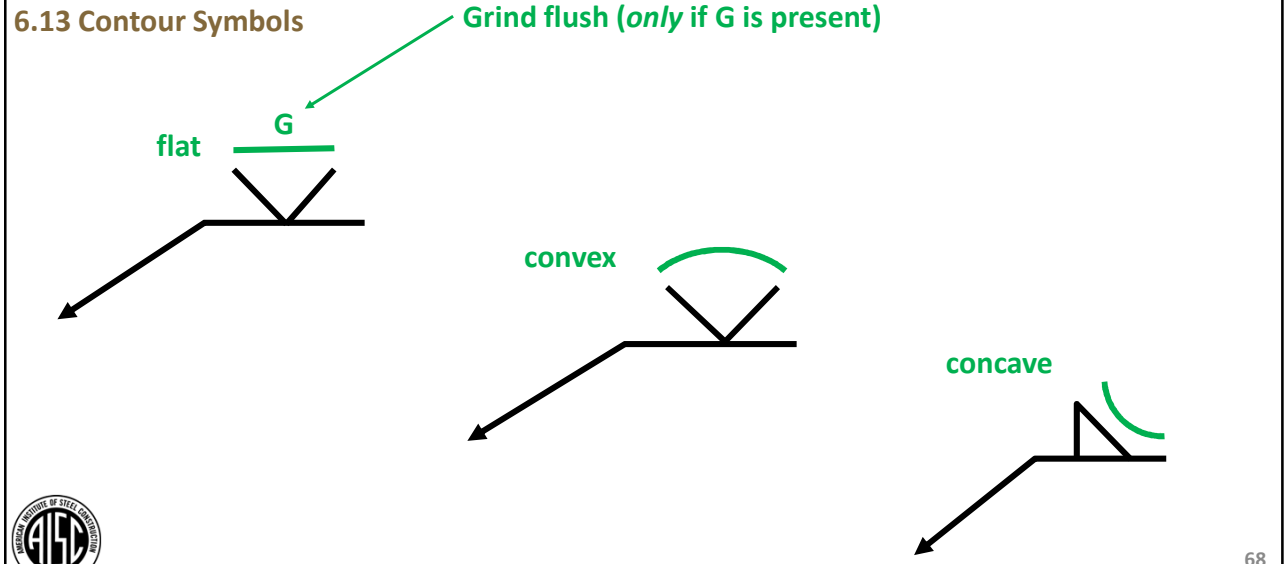
Getting the Welds You Need

2020 Standard Symbols

7.6 Groove Weld Contour and Finish
8.6 Fillet Weld Contour and Finish
6.13 Contour Symbols



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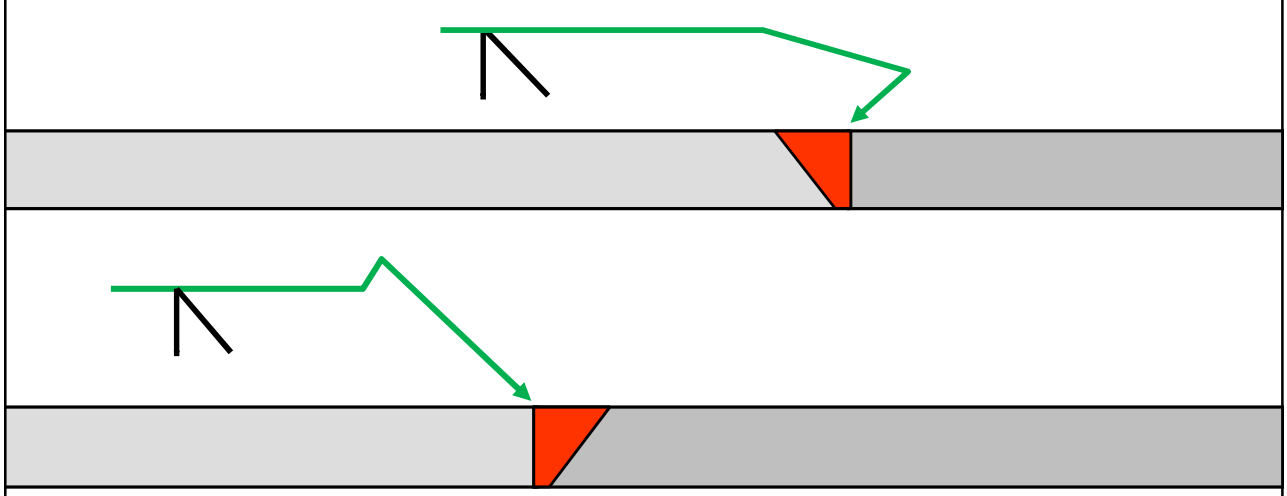
Getting the Welds You Need

2020 Standard Symbols

6.4 Break in the Arrow



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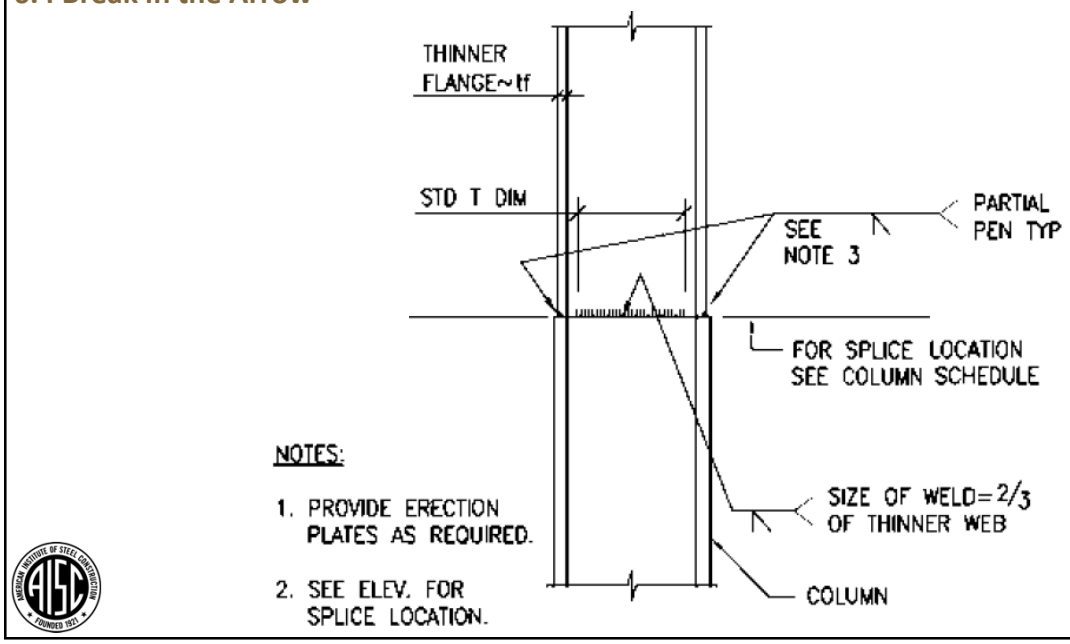
Getting the Welds You Need

2020 Standard Symbols

6.4 Break in the Arrow



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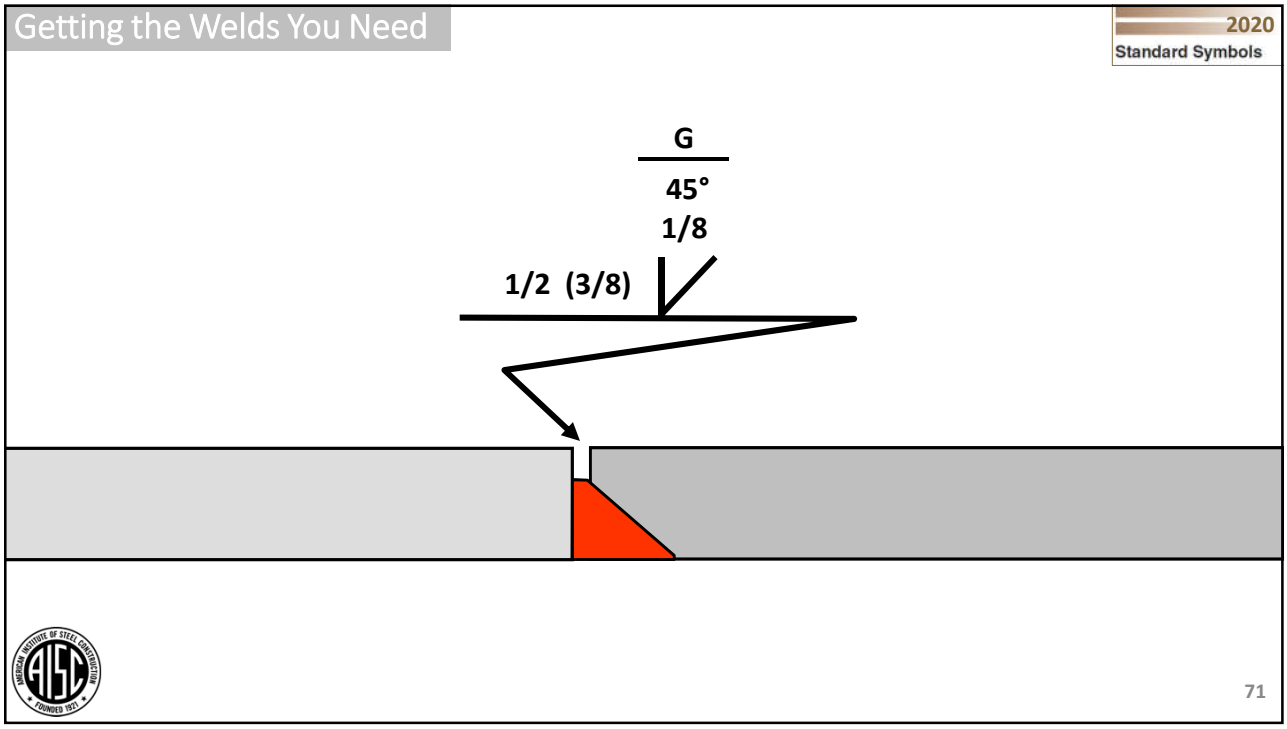
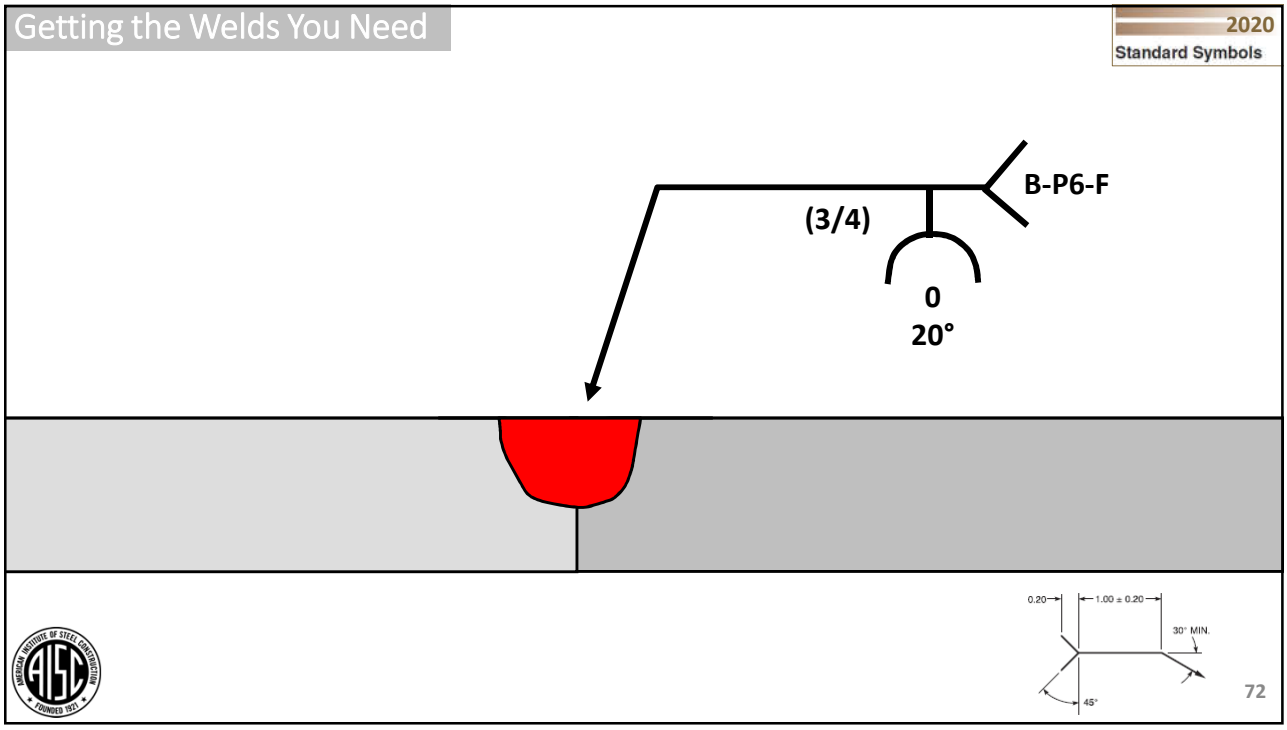
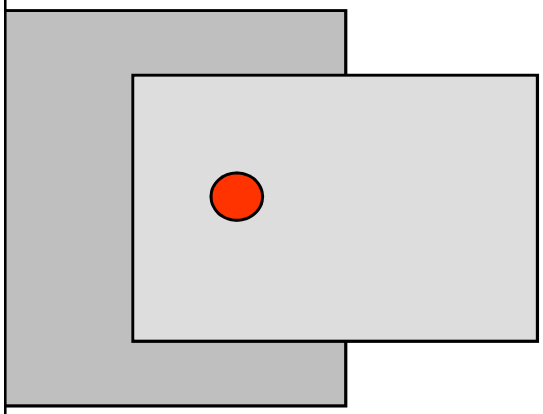




Getting the Welds You Need

2020 Standard Symbols

11. Spot Welds



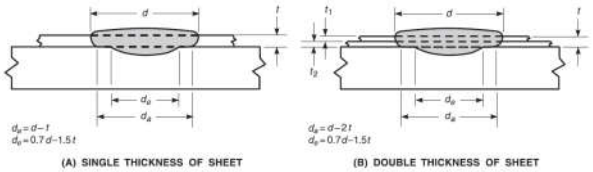
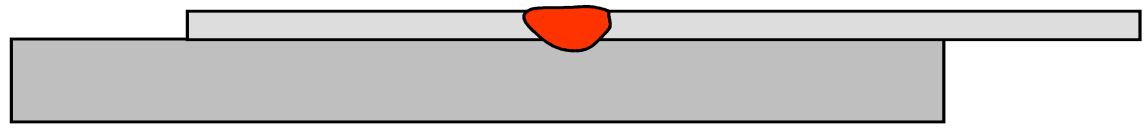


Figure 4.4—Arc Spot Welds (see 4.2.4)

diam

See AWS D1.3 for diameter *d* v effective diameter d_e

$d_e = 0.7d - 1.5t$



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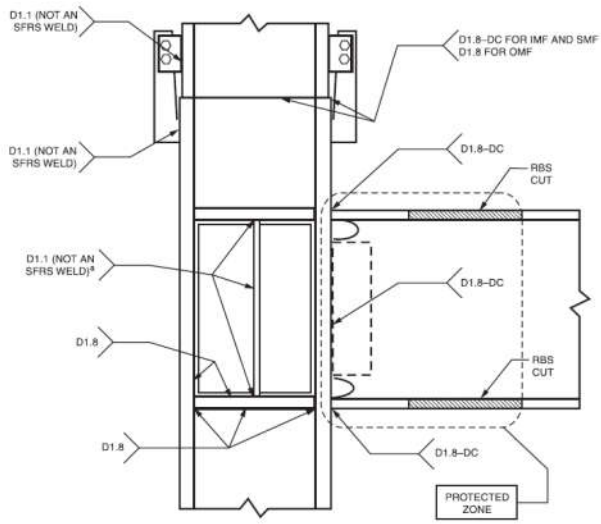
Getting the Welds You Need

Structural Welding Code—Seismic Supplement



[a] As shown, the member connecting to the weak axis is not an SFRS member.

Notes:
1. D1.8–DC indicates welds commonly designated Demand Critical joints.
2. D1.8 indicates joints subject to the requirements of D1.8, but not commonly designated Demand Critical welds.
3. D1.1 indicates joints subject to the requirements of D1.1 only.

Figure C-1.1—Example RBS/Column Strong Axis Connection (see C-1.4.1 Items 2, 3, and 4)

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Getting the Welds You Need

Structural Welding Code—Steel 2020

4 Design of Welded Connections
Part A Common Requirements for Design of Welded Connections (Nontubular and Tubular Members)
4.3 Contract Plans and Specifications
4.3.5 Shop Drawing Requirements
4.3.5.3 Welding Symbols

The **contract documents** shall show CJP or PJP groove weld requirements.

Contract documents do not need to show groove type or groove dimensions.

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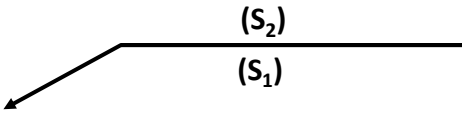
Getting the Welds You Need

Structural Welding Code—Steel 2020

4 Design of Welded Connections
Part A Common Requirements for Design of Welded Connections (Nontubular and Tubular Members)
4.3 Contract Plans and Specifications
4.3.5 Shop Drawing Requirements
4.3.5.3 Welding Symbols

The welding symbol without dimensions and with "CJP" in the tail designates a CJP weld …

The welding symbol without dimension and without CJP in the tail designates a weld that will develop the adjacent base metal strength in tension and shear.



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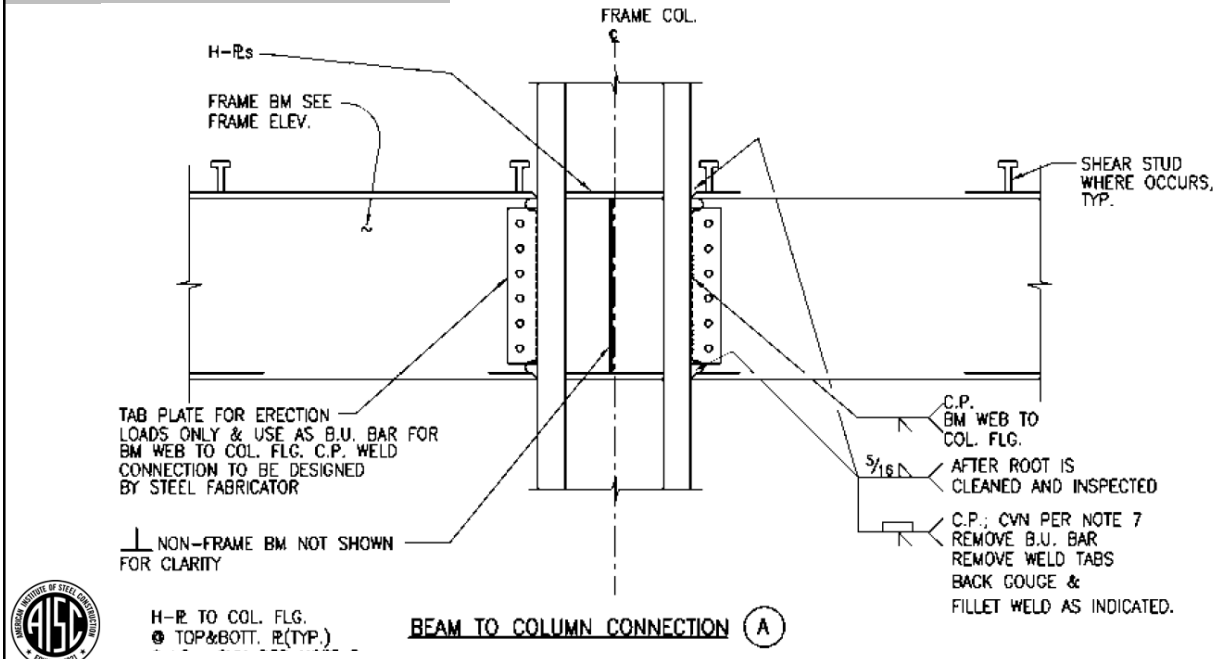
Getting the Welds You Need



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Getting the Welds You Need

- **welding symbols**
- **joint details**
- **document submittals**
- **welding procedure specification (WPS) review**
- **inspection**
- **nondestructive testing**

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Getting the Welds You Need

Specification for Structural Steel Buildings

J2 WELDS

All provisions of the Structural Welding Code—Steel (AWS D1.1/D1.1M), hereafter referred to as AWS D1.1/D1.1M, apply under this Specification, with the exception that the provisions of the listed Specification sections apply under this Specification in lieu of the cited AWS provisions as follows:

(a) Section J1.6 in lieu of AWS D1.1/D1.1M clause 5.16
(b) Section J2.2a in lieu of AWS D1.1/D1.1M clauses 2.4.2.10 and 2.4.4.4
(c) Table J2.2 in lieu of AWS D1.1/D1.1M Table 2.1
(d) Table J2.5 in lieu of AWS D1.1/D1.1M Table 2.3
(e) Appendix 3, Table A-3.1 in lieu of AWS D1.1/D1.1M Table 2.5
(f) Section B3.11 and Appendix 3 in lieu of AWS D1.1/D1.1M clause 2, Part C
(g) Section M2.2 in lieu of AWS D1.1/D1.1M clauses 5.14 and 5.15

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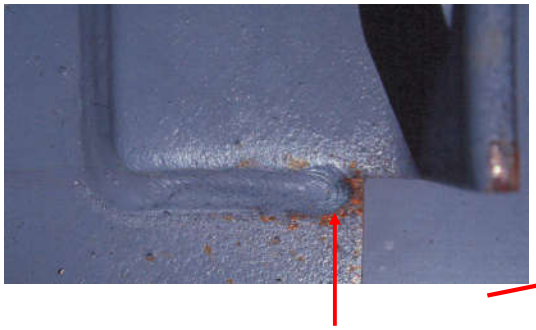
Getting the Welds You Need

Structural Welding Code—Steel 2020

4 Design of Welded Connections
Part B Specific Requirements for Design of Nontubular Connections (Statically or Cyclically Loaded)
4.9 Joint Configuration and Details - Fillet Welded Joints
4.9.3 Fillet Weld Terminations



4.9.3.1 General
Fillet weld terminations may extend to the ends or sides of parts or may be stopped short or may have end returns except as limited by the following cases: …

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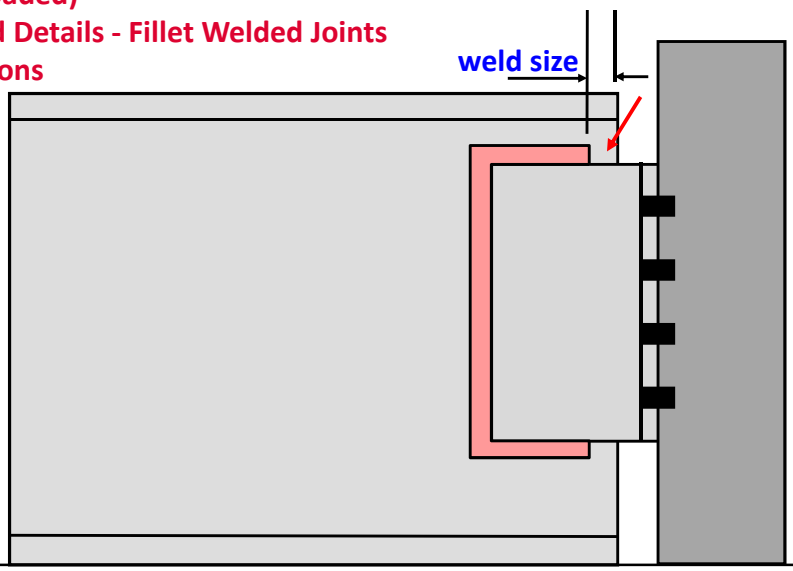
Getting the Welds You Need

Structural Welding Code—Steel 2020

4 Design of Welded Connections
Part B Specific Requirements for Design of Nontubular Connections (Statically or Cyclically Loaded)
4.9 Joint Configuration and Details - Fillet Welded Joints
4.9.3 Fillet Weld Terminations



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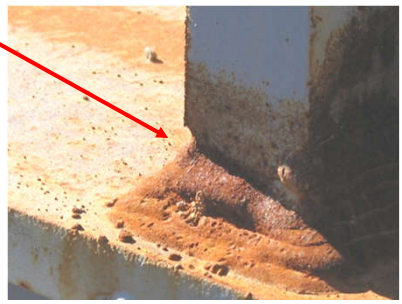
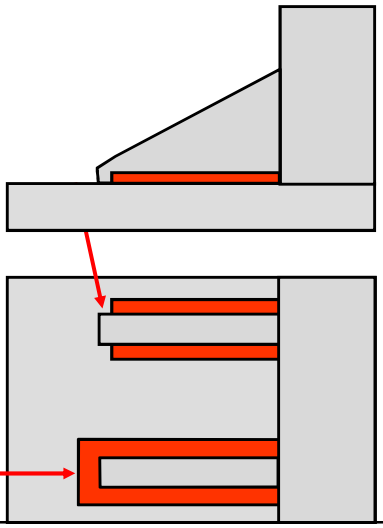
Getting the Welds You Need

Structural Welding Code—Steel 2020

4 Design of Welded Connections
Part B Specific Requirements for Design of Nontubular Connections (Statically or Cyclically Loaded)
4.9 Joint Configuration and Details - Fillet Welded Joints
4.9.3 Fillet Weld Terminations





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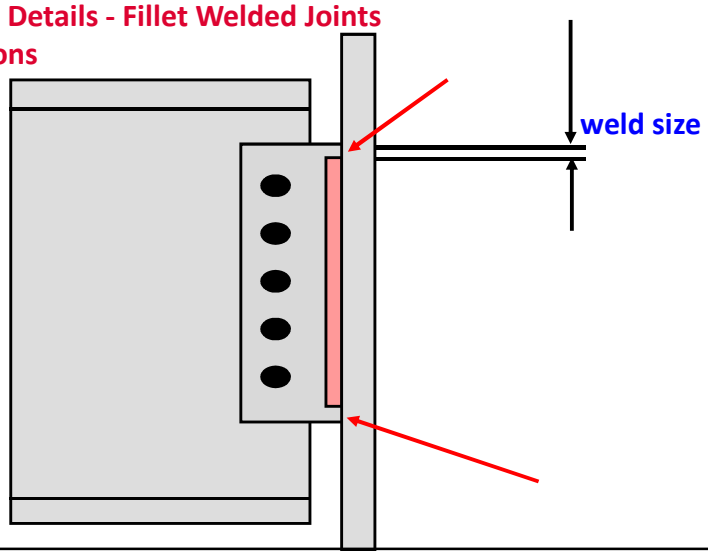
Getting the Welds You Need

Structural Welding Code—Steel 2020

4 Design of Welded Connections
Part B Specific Requirements for Design of Nontubular Connections (Statically or Cyclically Loaded)
4.9 Joint Configuration and Details - Fillet Welded Joints
4.9.3 Fillet Weld Terminations



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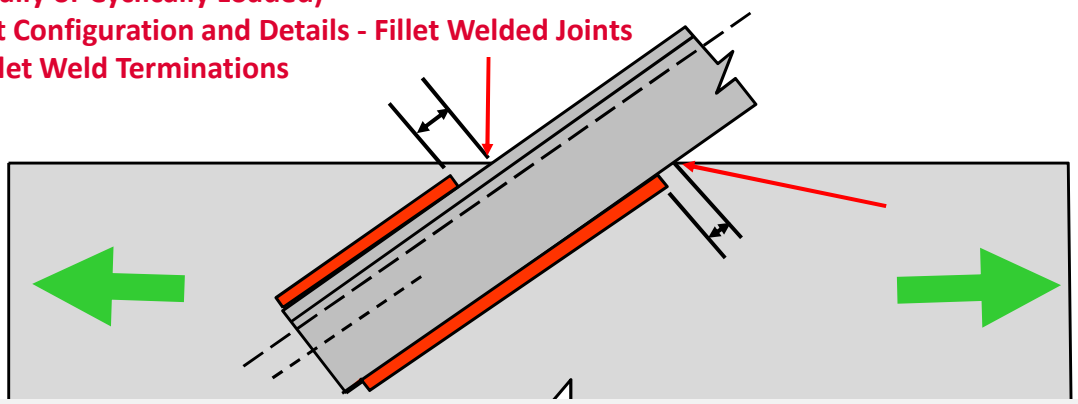
Getting the Welds You Need

Structural Welding Code—Steel 2020

4 Design of Welded Connections
Part B Specific Requirements for Design of Nontubular Connections (Statically or Cyclically Loaded)
4.9 Joint Configuration and Details - Fillet Welded Joints
4.9.3 Fillet Weld Terminations



4.9.3.2 Lap Joints Subject to Tension

In lap joints in which one part extends beyond the edge or side of a part subject to calculated tensile stress, fillet welds **shall** terminate not less than the size of the weld from the start of the extension (see Figure 4.11).

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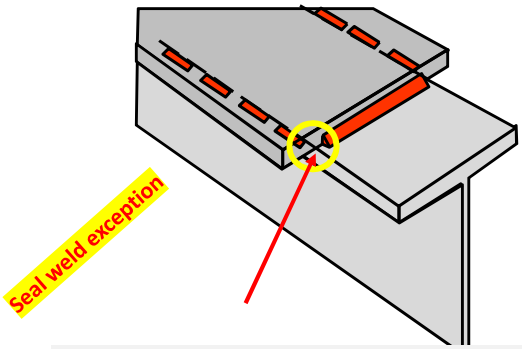
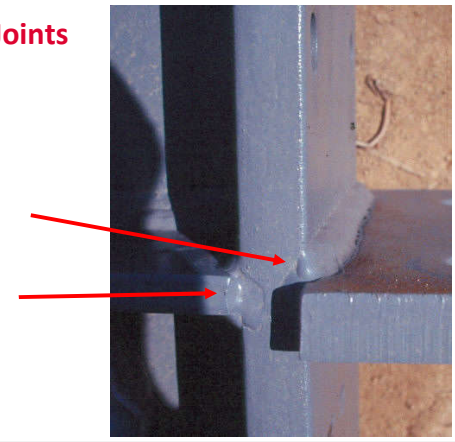
Getting the Welds You Need

Structural Welding Code—Steel 2020

4 Design of Welded Connections
Part B Specific Requirements for Design of Nontubular Connections (Statically or Cyclically Loaded)
4.9 Joint Configuration and Details - Fillet Welded Joints
4.9.3 Fillet Weld Terminations





4.9.3.5 Opposite Sides of Common Plane
Fillet welds on the opposite sides of a common plane **shall** be interrupted at the corner common to both welds (see Figure 4.13).

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Getting the Welds You Need

Structural Welding Code—Steel 2020

4 Design of Welded Connections
Part B Specific Requirements for Design of Nontubular Connections (Statically or Cyclically Loaded)
4.9 Joint Configuration and Details - Fillet Welded Joints
4.9.3 Fillet Weld Terminations

Changing planes

4.9.3.5 Opposite Sides of Common Plane
Fillet welds on the opposite sides of a common plane **shall be interrupted** at the corner common to both welds (see Figure 4.13), except as follows:
When joints are required to be sealed, or when a continuous weld is needed for other reasons, the contract documents shall specify where these welds are required to be continuous.

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Getting the Welds You Need

Structural Welding Code—Steel 2020

4 Design of Welded Connections
Part B Specific Requirements for Design of Nontubular Connections (Statically or Cyclically Loaded)
4.9 Joint Configuration and Details - Fillet Welded Joints
4.9.3 Fillet Weld Terminations

4.9.3.3 Maximum End Return Length
Welded joints shall be arranged to allow the flexibility assumed in the connection design. If the outstanding legs of connection base metal are attached with end returned welds, the length of the end return shall not exceed four times the nominal size of the weld (see Figure 4.12 for examples of flexible connections).

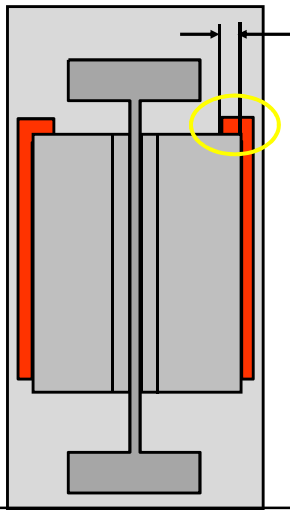

Figure 4.12
- **Min 2 x weld size**
- **Max 4 x weld size**

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Getting the Welds You Need

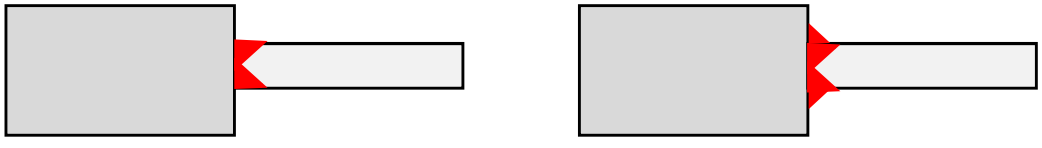
Structural Welding Code—Steel 2020

4 Design of Welded Connections
Part B Specific Requirements for Design of Nontubular Connections (Statically or Cyclically Loaded)
4.8 Joint Configuration and Details—Groove Welds

4.8.1 Transitions in Thicknesses and Widths

For statically loaded structures, surface contouring fillet welds need not be provided.

When surface contouring fillet welds are required by the **Engineer**, they shall be specified in the **contract documents** (…).



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Getting the Welds You Need

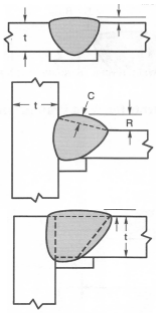
Structural Welding Code—Steel 2020

7 Fabrication
7.9 Backing

7.9.1 Attachment of Steel Backing
- **7.9.1.1 Fusion**
- **7.9.1.2 Full-Length Backing**
- **7.9.1.3 Backing Thickness**
- **7.9.1.4 Cyclically Loaded Nontubular Connections**
- **7.9.1.5 Statically Loaded Connections**

7.9.2 Backing Welds

7.9.3 Non-Steel Backing



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Getting the Welds You Need

Structural Welding Code—Steel 2020

4 Design of Welded Connections
Part C Specific Requirements for Design of Nontubular Connections (Cyclically Loaded)
4.17 Detailing, Fabrication, and Erection
4.17.2 Backing

4.17.2.1 Welds for Attaching Steel Backing

Requirements for welds for attaching steel backing and whether the backing shall be removed or left in place shall be determined as described in …, and the stress range categories of Table 4.5.

The ***Engineer*** shall note the fatigue stress category on the **contract drawings**.

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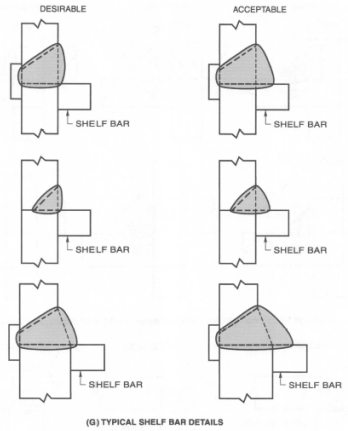
Getting the Welds You Need

Structural Welding Code—Steel 2020

7 Fabrication
7.23 Weld Profiles
7.23.4 Shelf Bars

Shelf bars shall conform to the requirements of 7.9.1.1 through 7.9.1.5.

Shelf bars may be left in place only for statically loaded members.



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Getting the Welds You Need

Structural Welding Code—Steel 2020

7 Fabrication
7.30 Weld Tabs (See 7.2.2)
7.30.1 Use of Weld Tabs

Welds shall be terminated at the end of a joint in a manner that will ensure sound welds.

Whenever necessary, this shall be done by use of weld tabs aligned in such a manner to provide an extension of the joint preparation.

7.30.2 Removal of Weld Tabs for Statically Loaded Nontubular Structures

For statically loaded nontubular structures, weld tabs need not be removed unless required by the ***Engineer***.

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Getting the Welds You Need

Structural Welding Code—Steel 2020

7 Fabrication
7.30 Weld Tabs (See 7.2.2)

7.30.2 Removal of Weld Tabs for Statically Loaded Nontubular Structures

For statically loaded nontubular structures, weld tabs need not be removed unless required by the ***Engineer***.

7.30.3 Removal of Weld Tabs for Cyclically Loaded Nontubular Structures

For cyclically loaded nontubular structures, weld tabs shall be removed upon completion and cooling of the weld, and the ends of the weld shall be made smooth and flush with the edges of abutting parts.

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Getting the Welds You Need

Structural Welding Code—Steel 2020

7 Fabrication
7.17 Tack Welds and Construction Aid Welds

7.17.2 Exclusions

Tack welds and construction aid welds are permitted except that:
…
(2) On members made of quenched and tempered steel with specified yield strength greater than 70 ksi [485 MPa], tack welds outside the final weld and construction aid welds shall require the approval of the ***Engineer***.

7.17.3 Removal

At locations other than 7.17.2, tack welds and construction aid welds, not incorporated into final welds, shall be removed when required by the ***Engineer***.

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Getting the Welds You Need

Structural Welding Code—Steel 2020

7 Fabrication
7.12 Conformance with Design

The sizes and lengths of welds shall be no less than those specified by design requirements and detail drawings, except as allowed in Table 8.1 or Table 10.15.

The location of welds shall not be changed without approval of the ***Engineer***.

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Getting the Welds You Need

Structural Welding Code—Steel 2020

7 Fabrication
7.25 Repairs
7.25.3 Engineer's Approval

Prior approval of the ***Engineer*** shall be obtained for
- repairs to base metal (other than those required by 7.14),
- repair of major or delayed cracks,
- repairs to ESW and EGW with internal defects, or
- for a revised design to compensate for deficiencies.

The ***Engineer*** shall be notified before welded members are cut apart.

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Getting the Welds You Need

- welding symbols
- joint details
- document submittals
- welding procedure specification (WPS) review
- inspection
- nondestructive testing

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Getting the Welds You Need

Structural Welding Code—Steel 2020

7 Fabrication
7.3 Welding Consumables and Electrode Requirements
7.3.1 General

7.3.1.1 Certification for Electrodes or Electrode-Flux Combinations

When requested by the Engineer, the Contractor or fabricator shall furnish certification that the electrode or electrode-flux combination conforms to the requirements of the classification.

7.3.1.3 Shielding Gas

… **When requested by the Engineer**, the Contractor or fabricator shall furnish the gas manufacturer's certification that the gas or gas mixture conforms to the dew point requirements of AWS A5.32. …

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Getting the Welds You Need

Structural Welding Code—Steel 2020

7 Fabrication
7.20 Control of Distortion and Shrinkage
7.20.3 Contractor Responsibility

On members or structures where excessive shrinkage or distortion could be expected, the **Contractor shall** prepare a written welding sequence for that member or structure which meets the quality requirements specified.

The welding sequence and distortion control program **shall be submitted to the *Engineer***, for information and comment, before the start of welding on the member or structure in which shrinkage or distortion is likely to affect the adequacy of the member or structure.

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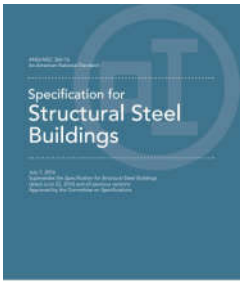
Getting the Welds You Need

CHAPTER N
QUALITY CONTROL AND QUALITY ASSURANCE

N1. General Provisions
N2. Fabricator and Erector Quality Control Program
N3. Fabricator and Erector Documents
N4. Inspection and Nondestructive Testing Personnel
N5. Minimum Requirements for Inspection of Structural Steel Buildings
N6. Approved Fabricators and Erectors
N7. Nonconforming Material and Workmanship



Smarter. Stronger. Steel.

100

Getting the Welds You Need

Specification for Structural Steel Buildings

N3 FABRICATOR AND ERECTOR DOCUMENTS
N3.2 Available Documents for Steel Construction

The following documents **shall be available** in electronic or printed form for review by the ***EOR*** or the ***EOR's designee*** prior to fabrication or erection, as applicable, unless otherwise required in the contract documents to be submitted:

(a) For main structural steel elements, copies of material test reports in accordance with Section A3.1.
(b) For steel castings and forgings, copies of material test reports in accordance with Section A3.2.
(c) For fasteners, copies of manufacturer's certifications in accordance with Section A3.3.
(d) For anchor rods and threaded rods, copies of material test reports in accordance with Section A3.4.

…

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Getting the Welds You Need

Specification for Structural Steel Buildings

N3 FABRICATOR AND ERECTOR DOCUMENTS
N3.2 Available Documents for Steel Construction

…

(e) For welding consumables, copies of manufacturer's certifications in accordance with Section A3.5

(f) For headed stud anchors, copies of manufacturer's certifications in accordance with Section A3.6

(g) Manufacturer's product data sheets or catalog data for welding filler metals and fluxes 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.

…

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Getting the Welds You Need

Specification for Structural Steel Buildings

N3 FABRICATOR AND ERECTOR DOCUMENTS
N3.2 Available Documents for Steel Construction

…
(h) Welding procedure specifications (WPS)

(i) Procedure qualification records (PQR) for WPS that are not prequalified in accordance with *Structural Welding Code—Steel* (AWS D1.1/D1.1M), hereafter referred to as AWS D1.1/D1.1M, or *Structural Welding Code—Sheet Steel* (AWS D1.3/D1.3M), as applicable.

(j) Welding personnel performance qualification records (WPQR) and continuity records
…

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Getting the Welds You Need

Specification for Structural Steel Buildings

N3 FABRICATOR AND ERECTOR DOCUMENTS
N3.2 Available Documents for Steel Construction

…
(k) Fabricator's or erector's, as applicable, written QC manual, that shall include, as a minimum:
- (1) Material control procedures
- (2) Inspection procedures
- (3) Nonconformance procedures

(l) Fabricator's or erector's, as applicable, QCI qualifications.

(m) Fabricator NDT personnel qualifications, if NDT is performed by the fabricator

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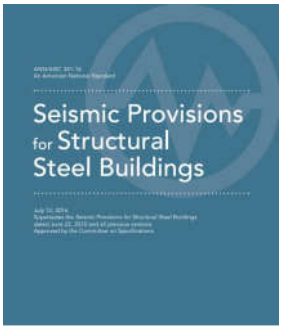
Getting the Welds You Need

AISC 341-16
J QUALITY CONTROL AND QUALITY ASSURANCE

J1 Scope
J2 Fabricator and Erector Documents
J3 Quality Assurance Agency Documents
J4 Inspection and Nondestructive Testing Personnel
J5 Inspection Tasks
J6 Welding Inspection and Nondestructive Testing
J7 Inspection of High-Strength Bolting
J8 Other Steel Structure Inspections
J9 Inspection of Composite Structures
J10 Inspection of Piling



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Getting the Welds You Need

Seismic Provisions for Structural Steel Buildings

J2 Fabricator and Erector Documents
J2.1 Documents to be Submitted for Steel Construction

In addition to the requirements of *Specification* Section N3.1, the following documents shall be **submitted** for review by the ***engineer of record (EOR) or the EOR's designee***, prior to fabrication or erection of the affected work, as applicable:

(a) Welding Procedure Specifications (WPS)

(b) Copies of the manufacturer's typical certificate of conformance for all electrodes, fluxes and shielding gasses to be used

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Getting the Welds You Need

Seismic Provisions for Structural Steel Buildings

J2 Fabricator and Erector Documents
J2.1 Documents to be Submitted for Steel Construction

c) For demand critical welds, applicable manufacturer's certifications that the filler metal meets the supplemental notch toughness requirements, as applicable. When the filler metal manufacturer does not supply such supplemental certifications, the fabricator or erector, as applicable, shall have the necessary testing performed and provide the applicable test reports.

(d) Manufacturer's product data sheets or catalog data for SMAW, FCAW and GMAW composite (cored) filler metals to be used

(f) Specific assembly order, welding sequence, welding technique, or other special precautions for joints or groups of joints where such items are designated to be submitted to the engineer of record

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Getting the Welds You Need

Seismic Provisions for Structural Steel Buildings

J2 Fabricator and Erector Documents
J2.2 Documents to be Available for Review for Steel Construction

Additional documents ***as required by the EOR*** in the contract documents shall be ***available*** by the fabricator and erector ***for review by the EOR or the EOR's designee*** prior to fabrication or erection, as applicable.

The fabricator and erector shall retain their document(s) for at least one year after substantial completion of construction.

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Getting the Welds You Need

Seismic Provisions for Structural Steel Buildings

J3 Quality Assurance Agency Documents

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

(a) QA agency's written practices for the monitoring and control of the agency's operations. The written practice shall include:
  (1) 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
  (2) the agency's inspection procedures, including general inspection, material controls, and visual welding inspection.

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Getting the Welds You Need

Seismic Provisions for Structural Steel Buildings

J3 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:

(b) Qualifications of management and QA personnel designated for the project.

(c) Qualification records for Inspectors and NDT technicians designated for the project.

(d) NDT procedures and equipment calibration records for NDT to be performed and equipment to be used for the project.

(e) For composite construction, concrete testing procedures and equipment.

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Getting the Welds You Need

- welding symbols
- joint details
- document submittals
- welding procedure specification (WPS) review
- inspection
- nondestructive testing

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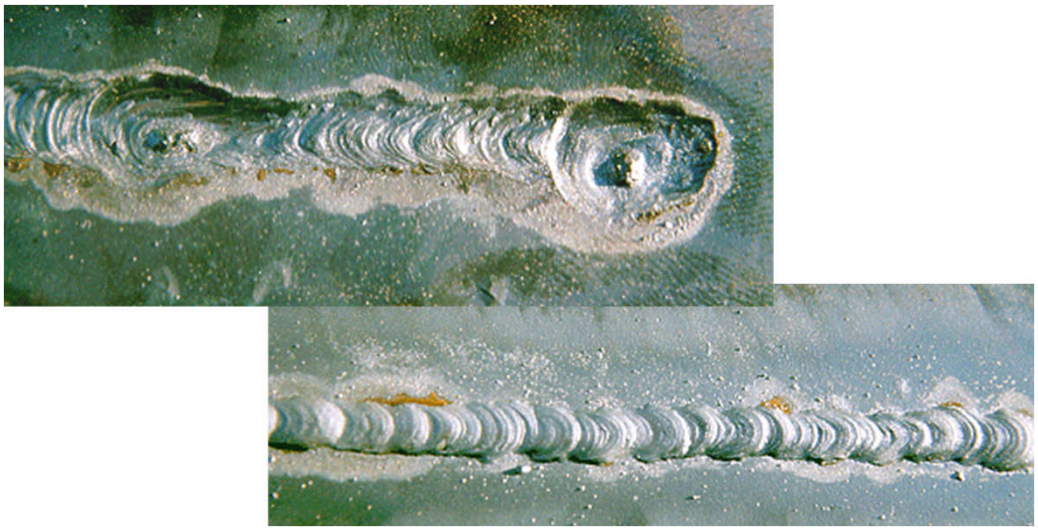
Getting the Welds You Need



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Getting the Welds You Need

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Getting the Welds You Need

WPSs and WPS Qualification: Guidance for Engineers, Fabricators, and Erectors [O3]

This session is for engineers who want to learn more about WPSs and WPS qualification as well as for fabricators and erectors who want to learn more about writing WPSs and conducting WPS qualification testing. We'll look at governing standards such as AISC 360, AISC 341, AWS D1.1, and AWS D1.8 and discuss things like how to write and review a WPS and when to consider WPS qualification even if it isn't required. What are the responsibilities of engineers, fabricators, and erectors regarding WPSs and WPS qualification when qualification is required? What are the limits to prequalification in AWS D1.1 and AWS D1.8? When should--or can--requirements for WPS qualification be waived? We'll answer all of that and more.

https://www.aisc.org/education/continuingeducation/education-archives/wpss-and-wps-qualification-guidance-for-engineers-fabricators-and-erectors-o3/

https://cloud.aisc.org/nascc/2020/O3_NASCC2020.mp4

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Getting the Welds You Need

Welding Procedure Specification (WPS)

A document providing the detailed methods and practices involved in the production of a weldment.

- ❑ base metal
- ❑ base metal thickness
- ❑ type of joint
- ❑ type of weld
- ❑ position
- ❑ size of weld
- ❑ electrode class
- ❑ electrode size
- ❑ flux / shielding gas
- ❑ preheat / interpass temperature
- ❑ voltage
- ❑ polarity
- ❑ amperage (wire feed speed)
- ❑ shielding gas flow rate
- ❑ travel speed
- ❑ heat input
- ❑ progression
- ❑ number & position of passes
- ❑ stickout

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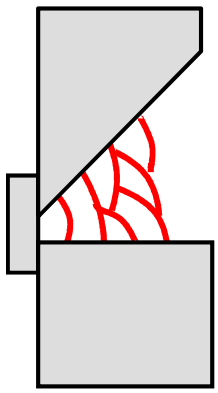
Getting the Welds You Need

Sample WPS using SMAW

Groove	B-U4a
Position	Horizontal
Thickness	3/4
Groove Angle	45°
Root Opening	1/4
Electrode	E7018
Polarity	DCEP



Pass	First	2 - 11
Electrode	3/16	3/16
Travel Speed	5.5 - 6.5	6.2 - 6.8
Amperage	240	240

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Getting the Welds You Need

Structural Welding Code—Steel 2020

5 Prequalification of WPSs
5.1 Scope

- Prequalification of WPSs (Welding Procedure Specifications) shall be defined as exempt from the WPS qualification testing required in Clause 6.
- All prequalified WPSs shall be written.
- In order for a WPS to be prequalified, conformance with all of the applicable requirements of **Clause 5** shall be required.
- WPSs that do not conform to the requirements of **Clause 5** may be qualified by tests in conformance with **Clause 6**.
- For convenience, **Annex K** lists provisions to be included in a prequalified WPS, and which should be addressed in the fabricator's or Contractor's welding program.

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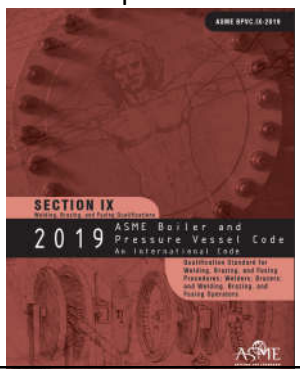
Getting the Welds You Need

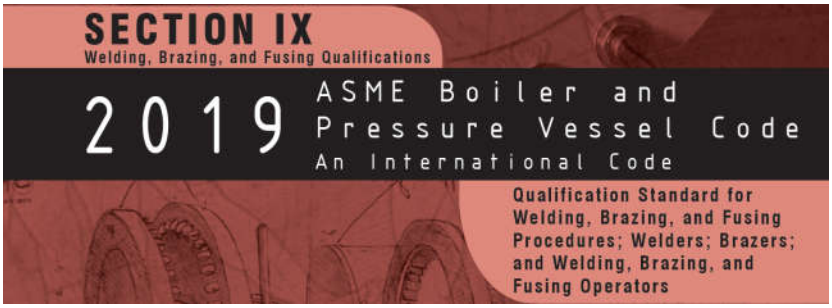
Structural Welding Code—Steel 2020

6 Qualification
Part A General Requirements
6.2 General
6.2.1 Welding Procedure Specification (WPS)

6.2.1.2 WPS Qualification to Other Standards

The acceptability of qualification to other standards is the ***Engineer's*** responsibility, to be exercised based upon either the specific structure or service conditions, or both.





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Getting the Welds You Need

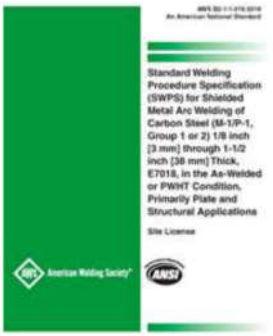
Structural Welding Code—Steel 2020

6 Qualification
Part A General Requirements
6.2 General
6.2.1 Welding Procedure Specification (WPS)

6.2.1.2 WPS Qualification to Other Standards

…

AWS B2.1-X-XXX Series on *Standard Welding Procedure Specifications* may, in this manner, be accepted for use in this code.…



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Getting the Welds You Need

Structural Welding Code—Steel 2020

6 Qualification
Part B Welding Procedure Specification (WPS) Qualification
6.8 Essential Variables
6.8.3 Base Metal Qualification

WPSs requiring qualification that use base metals listed in Table 5.3 shall qualify other base metal groups in conformance with Table 6.8. WPSs for base metals not listed in Table 5.3 or Table 6.9 shall be qualified in conformance with Clause 4.

The use of unlisted base metals shall be approved by the ***Engineer***.

…

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Getting the Welds You Need

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ARCHIVES

https://www.aisc.org/modernsteel/archives/

A look at materials and products that are not included in the AISC *Specification's* list of approved materials.

steelwise
UNLISTED MATERIALS – PART 1
BY LARRY S. MUIR, PE, AND THOMAS J. SCHLAFLY

In this second of three articles, we continue the discussion of evaluating unlisted materials based on a list of factors provided in the Commentary to Section A3 of the AISC *Specification*.

steelwise
UNLISTED MATERIALS – PART 2
BY LARRY S. MUIR, PE, AND THOMAS J. SCHLAFLY

In this third and final article in our series, we continue the discussion about unlisted materials, this time focusing in on considerations beyond those listed in the Commentary to the AISC *Specification*.

steelwise
UNLISTED MATERIALS – PART 3
BY LARRY S. MUIR, PE, AND THOMAS J. SCHLAFLY

Getting the Welds You Need

AWS D1.1:2010 Annex N

Structural Welding Code—Steel
2010

ANNEX N — AWS D1.1/D1.1M:2010

WELDING PROCEDURE SPECIFICATION (WPS) Yes ☐
PREQUALIFIED _____ QUALIFIED BY TESTING _____
or PROCEDURE QUALIFICATION RECORDS (PQR) Yes ☐

Company Name _____
Welding Process(es) _____
Supporting PQR No.(s) _____

Identification # _____
Revision _____ Date _____ By _____
Authorized by _____ Date _____
Type—Manual ☐ Semiautomatic ☐
Mechanized ☐ Automatic ☐

JOINT DESIGN USED
Type:
Single ☐ Double Weld ☐
Backing: Yes ☐ No ☐
Backing Material:
Root Opening _____ Root Face Dimension _____
Groove Angle: _____ Radius (J–U) _____
Back Gouging: Yes ☐ No ☐ Method _____

BASE METALS
Material Spec. _____
Type or Grade _____
Thickness: Groove _____ Fillet _____
Diameter (Pipe) _____

FILLER METALS
AWS Specification _____
AWS Classification _____

SHIELDING
Flux _____ Gas _____
Composition _____
Electrode-Flux (Class) _____ Flow Rate _____
Gas Cup Size _____

POSITION
Position of Groove: _____ Fillet: _____
Vertical Progression: Up ☐ Down ☐

ELECTRICAL CHARACTERISTICS
Transfer Mode (GMAW) Short-Circuiting ☐
Globular ☐ Spray ☐
Current: AC ☐ DCEP ☐ DCEN ☐ Pulsed ☐
Power Source: CC ☐ CV ☐
Other _____
Tungsten Electrode (GTAW)
Size: _____
Type: _____

TECHNIQUE
Stringer or Weave Bead: _____
Multi-pass or Single Pass (per side) _____
Number of Electrodes _____
Electrode Spacing Longitudinal _____
Lateral _____
Angle _____
Contact Tube to Work Distance _____
Peening _____
Interpass Cleaning: _____

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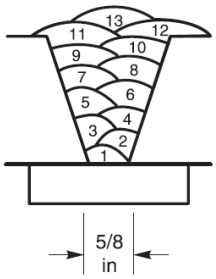
Getting the Welds You Need

AWS D1.1:2010 Annex N

Structural Welding Code—Steel 2010

WELDING PROCEDURE SPECIFICATION (WPS) Yes [X]
PREQUALIFIED ___X___ QUALIFIED BY TESTING _____
or PROCEDURE QUALIFICATION RECORDS (PQR) Yes [ ]

WELDING PROCEDURE

Pass or Weld Layer(s)	Process	Filler Metals		Current		Volts	Travel Speed	Joint Details
		Class	Diam.	Type & Polarity	Amps or Wire Feed Speed			
1-n	SAW	EM12K	5/32"	DC+	45 ipm 550 Amps ±10%	28 V ±7%	16 ipm ±15%	

B-U2-s

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Getting the Welds You Need

AWS D1.1:2020 Annex J

Structural Welding Code—Steel 2020

Example WPS (Single-Process)
WELDING PROCEDURE SPECIFICATION (WPS)

RED Inc. (Company Name)	2010 (WPS No.)	0 (Rev. No.)	12/01/2020 (Date)
J. Jones (Authorized by)	12/01/2015 (Date)	231 (Supporting PQR(s))	No (CVN Report)

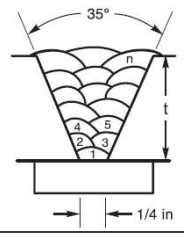
BASE METALS	Specification	Type or Grade	AWS Group No.
Base Material	ASTM A131	A	I
Welded To	ASTM A131	A	I
Backing Material	ASTM A131	A	I
Other			

BASE METAL THICKNESS	As-Welded	With PWHT
CJP Groove Welds	3/4–1-1/2 in	–
CJP Groove w/CVN	–	–
PJP Groove Welds	–	–
Fillet Welds	–	–
DIAMETER	–	–

JOINT DETAILS	
Groove Type	Single V Groove Butt Joint
Groove Angle	35° included
Root Opening	1/4 in
Root Face	–
Backgouging	None
Method	–

POSTWELD HEAT TREATMENT	
Temperature	None
Time at Temperature	–
Other	–

JOINT DETAILS (Sketch)



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Getting the Welds You Need

AWS D1.1:2020 Annex J

Structural Welding Code—Steel 2020

PROCEDURE	
Weld Layer(s)	All
Weld Pass(es)	All
Process	**FCAW**
Type *(Semiautomatic, Mechanized, etc.)*	Semiauto
Position	OH
Vertical Progression	–
Filler Metal (AWS Spec.)	A5.20
AWS Classification	E71T-1C
Diameter	0.045 in
Manufacturer/Trade Name	–
Shielding Gas (Composition)	100% CO_2
Flow Rate	45–55 cfh
Nozzle Size	#4
Preheat Temperature	60° min.
Interpass Temperature	60°–350°
Electrical Characteristics	—
Current Type & Polarity	DCEP
Transfer Mode	–
Power Source Type (*cc, cv, etc.*)	CV
Amps	180–220
Volts	25–26
Wire Feed Speed	(Amps)
Travel Speed	8–12 ipm
Maximum Heat Input	–
Technique	—
Stringer or Weave	Stringer
Multi or Single Pass (per side)	Multipass
Oscillation (*Mechanized, Automatic*)	–
Number of Electrodes	1
Contact Tube to Work Dist.	1/2–1 in
Peening	None
Interpass Cleaning	Wire Brush
Other	–

Form J-2

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Getting the Welds You Need

Table 5.8 Prequalified Minimum Preheat and Interpass Temperature (see 5.7)

Category B

Structural Welding Code—Steel 2020

Table 5.8
Prequalified Minimum Preheat and Interpass Temperature (see 5.7)

CATEGORY	Steel Specification		Welding Process	Thickness of Thickest Part at Point of Welding		Minimum Preheat and Interpass Temperature	
				in	mm	°F	°C
B	ASTM A139	Grade B	SMAW with low-hydrogen electrodes, SAW, GMAW, FCAW	1/8 to 3/4 incl.	3 to 20 incl.	32[a]	0[a]
	ASTM A381	Grade Y35					
	ASTM A500	Grades A, B, C		Over 3/4 thru 1-1/2 incl.	Over 20 thru 38 incl.	50	10
	ASTM A501	Grades A, B					
	ASTM A516	Grades 55, 60, 65, 70					
	ASTM A524	Grades I, II					
	ASTM A529	Grades 50, 55		Over 1-1/2 thru 2-1/2 incl.	Over 38 thru 65 incl.	150	65
	ASTM A537	Classes 1, 2					
	ASTM A572	Grades 42, 50, 55					
	ASTM A573	Grades 58, 65					
	ASTM A588			Over 2-1/2	Over 65	225	110

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Getting the Welds You Need

Table 5.8 Prequalified Minimum Preheat and Interpass Temperature (see 5.7)

Category C

Structural Welding Code—Steel 2020

Table 5.8
Prequalified Minimum Preheat and Interpass Temperature (see 5.7)

CATEGORY	Steel Specification		Welding Process	Thickness of Thickest Part at Point of Welding in	Thickness of Thickest Part at Point of Welding mm	Minimum Preheat and Interpass Temperature °F	Minimum Preheat and Interpass Temperature °C
C	ASTM A709[b]	Grade HPS70W	SMAW with low-hydrogen electrodes, SAW, GMAW, FCAW	1/8 to 3/4 incl.	3 to 20 incl	50	10
	ASTM A710	Grade A, Class 2 ≤ 2 in [50 mm]					
	ASTM A710	Grade A, Class 3 > 2 in [50 mm]		Over 3/4 thru 1-1/2 incl.	Over 20 thru 38 incl.	150	65
	ASTM A913	Grades 60, 65, 70					
	ASTM A1018 HSLAS	Grade 60 Class 2					
		Grade 70 Class 2		Over 1-1/2 thru 2-1/2 incl.	Over 38 thru 65 incl.	225	110
	ASTM A1018 HSLAS-F	Grade 60 Class 2					
		Grade 70 Class 2					
	ASTM A1066	Grades 60, 65, 70		Over 2-1/2	Over 65	300	150

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Getting the Welds You Need

Table 5.8 Prequalified Minimum Preheat and Interpass Temperature (see 5.7)

Category D

Structural Welding Code—Steel 2020

Table 5.8
Prequalified Minimum Preheat and Interpass Temperature (see 5.7)

CATEGORY	Steel Specification		Welding Process	Thickness of Thickest Part at Point of Welding in	Thickness of Thickest Part at Point of Welding mm	Minimum Preheat and Interpass Temperature °F	Minimum Preheat and Interpass Temperature °C
D	ASTM A710	Grade A (All classes)	SMAW, SAW, GMAW, and FCAW with electrodes or electrode-flux combinations capable of depositing weld metal with a maximum diffusible hydrogen content of 8 ml/100 g (H8), when tested according to AWS A4.3.	All thicknesses Over 1/8 in	All thicknesses Over [3 mm]	32[a]	0[a]
	ASTM A913	Grades 50, 60, 65					

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Getting the Welds You Need

Table 5.8 Prequalified Minimum Preheat and Interpass Temperature (see 5.7)

Structural Welding Code—Steel 2020

Category E

Table 5.8
Prequalified Minimum Preheat and Interpass Temperature (see 5.7)

CATEGORY	Steel Specification	Welding Process	Thickness of Thickest Part at Point of Welding		Minimum Preheat and Interpass Temperature	
			in	mm	°F	°C
E	ASTM A1066 Grades 50, 60, 65	SMAW, SAW, GMAW, and FCAW with electrodes or electrode-flux combinations capable of depositing weld metal with a maximum diffusible hydrogen content of 8 ml/100 g (H8), when tested according to AWS A4.3.	1/8 to 1 incl.	3 to 25 incl.	50	10
			Over 1	Over 25	120	50

ASTM A1066 / A1066M – High-Strength Low-Alloy Structural Steel Plate Produced by Thermo-Mechanical Controlled Process (TMCP)

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Getting the Welds You Need

Preheat

AWS D14.8M:2009
(ISO/TR 17844:2004 IDT)
An American National Standard

Standard Methods for the Avoidance of Cold Cracks

3 *CET*-method

3.1 Cracking test method
3.2 Parent metal composition range
3.3 Plate thickness
3.4 Hydrogen level and welding process
3.5 Heat input
3.6 Influence of residual stress
3.7 Determination of preheat
3.8 Special considerations

$$T_p = T_{pCET} + T_{pd} + T_{pHD} + T_{pQ}$$

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Getting the Welds You Need

INNERSHIELD® WIRES PRODUCT CATALOG

Self-Shielded, Flux-Cored Wires

LINCOLN ELECTRIC

OUTERSHIELD® WIRES

Gas-Shielded Flux-Cored & Metal-Cored Wires

LINCOLN ELECTRIC

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Getting the Welds You Need

INNERSHIELD NR-232 AWS A5.20-95: E71T-8

TYPICAL OPERATING PROCEDURES

Wire, Polarity Electrical Stickout Wire Weight	Wire Feed Speed in/min (m/min)	Arc Voltage (volts)	Approx. Current (amps)	Melt-Off Rate lbs/hr (kg/hr)	Deposition Rate lbs/hr (kg/hr)	Efficiency (%)
.068" DC- 1/2-1" (12-25mm) .755 lbs/1000"	110 (2.7)	19	195	5.0 (2.3)	3.9 (1.8)	78
	130 (3.3)	20	225	6.2 (2.8)	4.6 (2.0)	74
	150 (3.8)	20	250	7.1 (3.2)	5.3 (2.4)	75
	170 (4.3)	21	270	7.8 (3.5)	6.1 (2.8)	78
	195 (5.0)	23.5	300	9.4 (4.3)	7.0 (3.2)	74
	250 (6.4)	23.5	350	11.8 (5.4)	9.0 (4.0)	76
	320 (7.4)	26	400	15.2 (6.9)	11.4 (5.2)	75
.072" DC- 1/2-1" (12-25mm) .778 lbs/1000"	80 (2.0)	17	130	4.0 (1.8)	3.3 (1.5)	83
	140 (3.6)	19.5	225	6.8 (3.1)	5.5 (2.5)	81
	155 (3.9)	20.5	240	7.2 (3.3)	6.0 (2.7)	83
	170 (4.3)	21.5	255	8.0 (3.6)	6.5 (2.9)	81
	250 (6.4)	23	315	11.7 (5.3)	9.6 (4.3)	82
	290 (7.4)	24	350	13.6 (6.2)	11.0 (5.0)	81
5/64" DC- 1/2-1" (12-25mm) 1.000 lbs/1000"	60 (1.5)	16.5	145	3.7 (1.7)	2.7 (1.2)	73
	115 (2.9)	19.5	260	7.0 (3.2)	5.5 (2.5)	78
	120 (3.0)	19.5	270	7.3 (3.3)	5.7 (2.6)	78
	130 (3.3)	20.5	285	7.8 (3.5)	6.2 (2.8)	79
	180 (4.6)	22.5	365	10.9 (5.0)	8.7 (3.9)	80

NOTE: Above typical operating procedures are starting points and may be adjusted as required.

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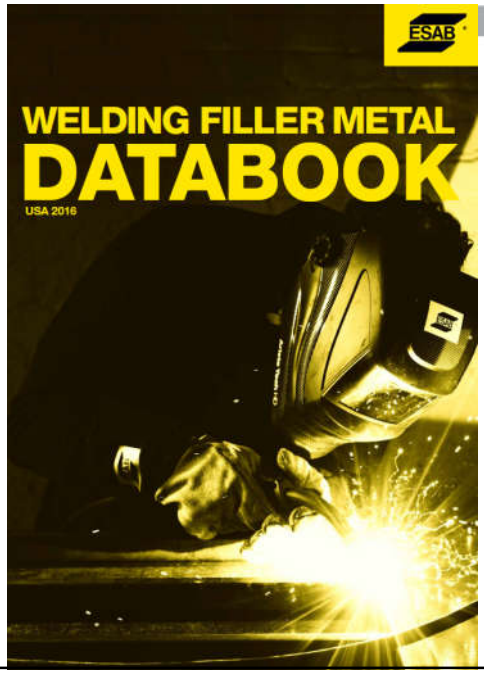
Getting the Welds You Need



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Getting the Welds You Need

Heat Input

$$\text{Heat Input} = \frac{\text{Voltage} * \text{Current} * 60}{\text{Travel Speed} * 1000}$$

Example:

$$\frac{27\ \text{V} * 350\ \text{A} * 60}{12\ \text{inch / min} * 1000} = 47\ \text{kJ / inch}$$

5/16-inch fillet weld

Cross-sectional area ~ 0.05 square inch

0.001 square inch weld metal per kJ/inch heat input

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Getting the Welds You Need

What Every Engineer Should Know about Welding Procedures

PROCEEDINGS

SPONSORED BY
AMERICAN INSTITUTE OF STEEL CONSTRUCTION

Reviewing and Approving Welding Procedure Specifications

NASCC 2003

Duane K. Miller

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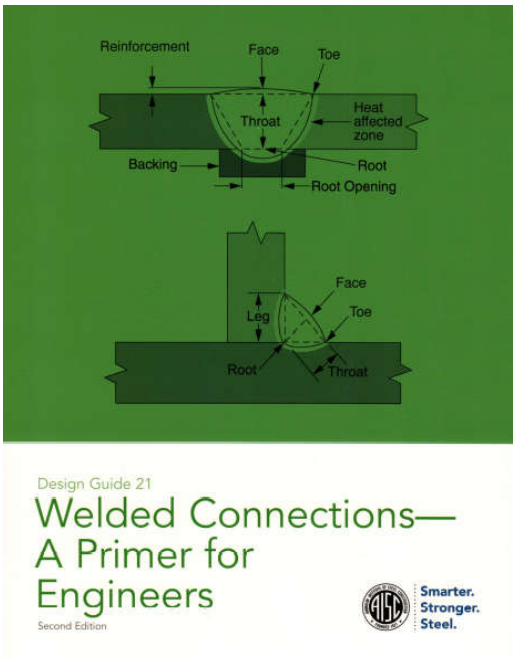
Getting the Welds You Need



Chapter 8
Welding Procedure Specifications

Duane K. Miller

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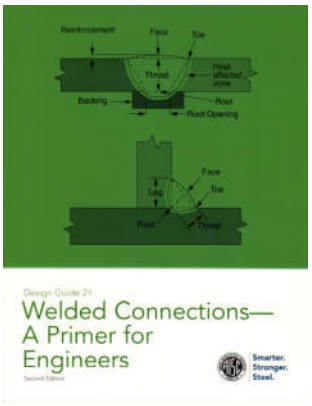
Getting the Welds You Need

CHAPTER 8
WELDING PROCEDURE SPECIFICATIONS

8.1 INTRODUCTION
8.2 WRITING WELDING PROCEDURE SPECIFICATIONS
8.3 USING WELDING PROCEDURE SPECIFICATIONS
8.4 PREQUALIFIED WELDING PROCEDURE SPECIFICATIONS
8.5 QUALIFIED WELDING PROCEDURE SPECIFICATIONS
8.6 WPS AND AWS D1.5
8.7 WPS AND AWS D1.8
8.8 EFFECTS OF WPS VARIABLES
8.9 SAMPLE FORMS
8.10 CODE-COMPLIANT VERSUS USEFUL WPS



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Getting the Welds You Need

- **welding symbols**
- **joint details**
- **document submittals**
- **welding procedure specification (WPS) review**
- **inspection**
- **nondestructive testing**

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Getting the Welds You Need

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Getting the Welds You Need

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Getting the Welds You Need

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Getting the Welds You Need

International Building Code

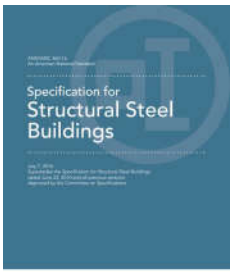
17 Special Inspections and Tests
1705.2 Steel construction
1705.2.1 Structural steel

Special inspections and nondestructive testing of *structural steel elements* in buildings, structures and portions thereof shall be in accordance with the quality assurance inspection requirements of **AISC 360**.

2015

Chapter N

2018



Smarter. Stronger. Steel.

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Getting the Welds You Need

Specification for Structural Steel Buildings

N5 MINIMUM REQUIREMENTS FOR INSPECTION OF STRUCTURAL STEEL BUILDINGS
N5.4 Inspection of Welding

Observation of welding operations and visual inspection of in-process and completed welds shall be the primary method to confirm that the materials, procedures and workmanship are in conformance with the construction documents.

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Getting the Welds You Need

Specification for Structural Steel Buildings

N5 MINIMUM REQUIREMENTS FOR INSPECTION OF STRUCTURAL STEEL BUILDINGS
N5.4 Inspection of Welding

As a minimum, welding inspection tasks shall be in accordance with Tables N5.4-1, N5.4-2 and N5.4-3. In these tables, the inspection tasks are as follows:

(a) **Observe (O):** The inspector shall observe these items on a random basis. Operations need not be delayed pending these inspections.

(b) **Perform (P):** These tasks shall be performed for each welded joint or member.

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Getting the Welds You Need

Specification for Structural Steel Buildings

N5 MINIMUM REQUIREMENTS FOR INSPECTION OF STRUCTURAL STEEL BUILDINGS
N5.4 Inspection of Welding – Table N5.4-1

Inspection Tasks Prior to Welding	QC	QA
Welder qualification records and continuity records	P	O
WPS available	P	P
Manufacturer certifications for welding consumables available	P	P
Material identification (type/grade)	O	O
Welder identification system [a]	O	O
…		
Check welding equipment	O	-

[a] The fabricator or erector, as applicable, shall maintain a system by which a welder who has welded a joint or member can be identified. Stamps, if used, shall be the low-stress type

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Getting the Welds You Need

Specification for Structural Steel Buildings

N5 MINIMUM REQUIREMENTS FOR INSPECTION OF STRUCTURAL STEEL BUILDINGS
N5.4 Inspection of Welding – Table N5.4-1

Inspection Tasks Prior to Welding	QC	QA
Fit-up of groove welds (including joint geometry) • Joint preparations • Dimensions (alignment, root opening, root face, bevel) • Cleanliness (condition of steel surfaces) • Tacking (tack weld quality and location) • Backing type and fit (if applicable)	O	O
Fit-up of CJP groove welds of HSS T-, Y- and K-joints without backing (including joint geometry) • Joint preparations • Dimensions (alignment, root opening, root face, bevel) • Cleanliness (condition of steel surfaces) • Tacking (tack weld quality and location)	P	O

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Getting the Welds You Need

Specification for Structural Steel Buildings

N5 MINIMUM REQUIREMENTS FOR INSPECTION OF STRUCTURAL STEEL BUILDINGS
N5.4 Inspection of Welding – Table N5.4-1

Inspection Tasks Prior to Welding	QC	QA
Configuration and finish of access holes	O	O
Fit-up of fillet welds • Dimensions (alignment, gaps at root) • Cleanliness (condition of steel surfaces) • Tacking (tack weld quality and location)	O	O

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Getting the Welds You Need

Specification for Structural Steel Buildings

Commentary TABLE C-N5.4-1
Reference to AWS D1.1/D1.1M 2015
Clauses for Inspection Tasks Prior to Welding

Inspection Tasks Prior to Welding	AWS D1.1/D1.1M References
Welder qualification records and continuity records	6.4 (welder qualification)
WPS available	6.3
Manufacturer certifications for welding consumables available	6.2
Material identification (type/grade)	6.2
Welder identification system	identification system not required by AWS D1.1/D1.1M
Check welding equipment	6.2, 5.10

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Getting the Welds You Need

Specification for Structural Steel Buildings

N5 MINIMUM REQUIREMENTS FOR INSPECTION OF STRUCTURAL STEEL BUILDINGS
N5.4 Inspection of Welding – Table N5.4-2

Inspection Tasks During Welding	QC	QA
Control and handling of welding consumables • Packaging • Exposure control	O	O
No welding over cracked tack welds	O	O
Environmental conditions • Wind speed within limits • Precipitation and temperature	O	O
…		
Placement and installation of steel headed stud anchors	P	P

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Getting the Welds You Need

Specification for Structural Steel Buildings

N5 MINIMUM REQUIREMENTS FOR INSPECTION OF STRUCTURAL STEEL BUILDINGS
N5.4 Inspection of Welding – Table N5.4-2

Inspection Tasks During Welding	QC	QA
WPS followed • 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)	O	O
Welding techniques • Interpass and final cleaning • Each pass within profile limitations • Each pass meets quality requirements	O	O

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Getting the Welds You Need

Specification for Structural Steel Buildings

N5 MINIMUM REQUIREMENTS FOR INSPECTION OF STRUCTURAL STEEL BUILDINGS
N5.4 Inspection of Welding – Table N5.4-3

Inspection Tasks After Welding	QC	QA
Welds cleaned	O	O
Size, length, and location of welds	P	P
Welds meet visual acceptance criteria • Crack prohibition • Weld/base-metal fusion • Crater cross-section • Weld profiles • Weld size • Undercut • Porosity	P	P
Arc strikes	P	P
…		

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Getting the Welds You Need

Specification for Structural Steel Buildings

N5 MINIMUM REQUIREMENTS FOR INSPECTION OF STRUCTURAL STEEL BUILDINGS
N5.4 Inspection of Welding – Table N5.4-3

Inspection Tasks After Welding	QC	QA
…		
k-area [a]	P	P
Weld access holes in rolled heavy shapes and built-up heavy shapes [b]	P	P
Backing removed and weld tabs removed (if required)	P	P
Repair activities	P	P
Document acceptance or rejection of welded joint or member	P	P
No prohibited welds have been added without the approval of the EOR	O	O

[a] When welding of doubler plates, continuity plates, or stiffeners has been performed in the k-area, visually inspect the web k-area for cracks within 3 in. [75 mm] of the weld.

[b] After rolled heavy shapes (see Section A3.1c) and built-up heavy shapes (see Section A3.1d) are welded, visually inspect the weld access hole for cracks.

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Getting the Welds You Need

Structural Welding Code—Steel 2020

8 Inspection
Part A General Requirements
8.1.2 Inspection and Contract Stipulations

8.1.2.1 Contractor's Inspection

This type of inspection and test shall be performed as necessary
- prior to assembly,
- during assembly,
- during welding, and
- after welding

to ensure that materials and workmanship meet the requirements of the contract documents.

Fabrication/erection inspection and testing shall be the responsibilities of the **Contractor** unless otherwise provided in the contract documents.

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Getting the Welds You Need

Structural Welding Code—Steel 2020

8 Inspection
Part A General Requirements
8.1.2 Inspection and Contract Stipulations

8.1.2.2 Verification Inspection

This type of inspection and testing shall be performed and their results reported to the Owner and Contractor in a timely manner to avoid delays in the work.

Verification inspection and testing are the **prerogatives of the Owner** who
- may perform this function or,
- when provided in the contract,
  - waive independent verification, or
  - stipulate that both inspection and verification shall be performed by the **Contractor**.

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Getting the Welds You Need

Structural Welding Code—Steel 2020

8 Inspection
Part A General Requirements
8.1.3 Definition of Inspection Categories

8.1.3.1 Contractor's Inspector

This inspector is the duly designated person who **acts for, and in behalf of, the Contractor** on all inspection and quality matters within the scope of the contract documents.

8.1.3.2 Verification Inspector

This inspector is the duly designated person who **acts for, and in behalf of, the Owner or Engineer** on all inspection and quality matters within the scope of the contract documents.

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Getting the Welds You Need

Structural Welding Code—Steel 2020

1 General Requirements
1.5 Responsibilities
1.5.3 Inspector's Responsibilities

1.5.3.1 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.

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Getting the Welds You Need

Structural Welding Code—Steel 2020

1 General Requirements
1.5 Responsibilities
1.5.3 Inspector's Responsibilities

1.5.3.2 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***.

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Getting the Welds You Need

Structural Welding Code—Steel 2020

8 Inspection
Part A General Requirements
8.2 Inspection of Materials and Equipment

The Contractor's Inspector shall ensure that only materials and equipment conforming to the requirements of this code shall be used.

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Getting the Welds You Need

Structural Welding Code—Steel 2020

8 Inspection
Part A General Requirements
8.3 Inspection of WPSs

8.3.1 Prequalified WPS
The Contractor's Inspector shall ensure that all prequalified WPSs to be used for the work conform with the requirements Clause 5, 7, 10 (if tubular), and the contract documents.

8.3.2 WPSs Qualified by Test
The Contractor's Inspector shall ensure that all WPSs qualified by test conform with the requirements of Clauses 6, 7, 10 (if tubular), and contract documents.

8.3.3 WPSs in Production
The Contractor's Inspector shall ensure that all welding operations are performed in conformance with WPSs that meet the requirements of this code and the contract documents.

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Getting the Welds You Need

Structural Welding Code—Steel 2020

8 Inspection
Part A General Requirements
8.4 Inspection of Welder, Welding Operator, and Tack Welder Qualifications
8.4.1 Determination of Qualification

The Inspector shall allow welding to be performed only by welders, welding operators, and tack welders who are qualified in conformance with the requirements of Clause 6, or Clause 10 for tubulars,

or shall ensure that each welder, welding operator, or tack welder has previously demonstrated such qualification under other acceptable supervision and approved by the ***Engineer*** in conformance with 6.2.2.1.

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Getting the Welds You Need

Structural Welding Code—Steel 2020

8 Inspection
Part A General Requirements
8.5 Inspection of Work and Records
8.5.1 Size, Length, and Location of Welds

The Inspector shall ensure that the
- size,
- length, and
- location

of all welds conform to the requirements of this code and to the detail drawings and that no unspecified welds have been added without the approval of the ***Engineer***.

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Getting the Welds You Need

Structural Welding Code—Steel 2020

8 Inspection
Part A General Requirements
8.5 Inspection of Work and Records
8.5.2 Scope of Examinations

The Inspector shall, at suitable intervals, observe
- joint preparation,
- assembly practice,
- the welding techniques, and
- performance of each welder, welding operator, and tack welder

to ensure that the applicable requirements of this code are met.

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Getting the Welds You Need

Structural Welding Code—Steel 2020

8 Inspection
Part A General Requirements
8.5 Inspection of Work and Records
8.5.3 Extent of Examination

The Inspector shall examine the work to ensure that it meets the requirements of this code.

Other acceptance criteria, different from those described in the code, may be used when approved by the ***Engineer***.

Size and contour of welds shall be measured with suitable gages.

Visual inspection for cracks in welds and base metal and other discontinuities should be aided by a strong light, magnifiers, or such other devices as may be found helpful.

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Getting the Welds You Need

Structural Welding Code—Steel 2020

8 Inspection
Part A General Requirements
8.5 Inspection of Work and Records
8.5.4 Inspector Identification of Inspections Performed

Inspectors shall identify with a distinguishing mark or other recording methods all parts or joints that they have inspected and accepted.

Any recording method which is mutually agreeable may be used.

Die stamping of cyclically loaded members without the approval of the ***Engineer*** shall be prohibited.

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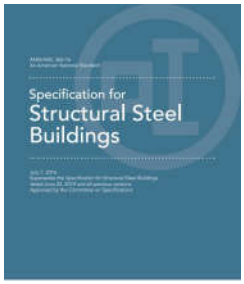
Getting the Welds You Need

CHAPTER N
QUALITY CONTROL AND QUALITY ASSURANCE



Smarter. Stronger. Steel.

- **N1 General Provisions**
- **N2 Fabricator and Erector Quality Control Program**
- **N3 Fabricator and Erector Documents**
- **N4 Inspection and Nondestructive Testing Personnel**
- **N5 Minimum Requirements for Inspection of Structural Steel Buildings**
- **N6 Approved Fabricators and Erectors**
- **N7 Nonconforming Material and Workmanship**

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Getting the Welds You Need

Structural Welding Code—Steel 2020

8 Inspection
Part A General Requirements
8.1.4 Qualification of Inspection Personnel

8.1.4.1 Engineer's Responsibilities

If the ***Engineer*** requires a specific basis of inspection personnel qualification other than those listed in 8.1.4.2, the basis shall be designated in the contract documents.

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Getting the Welds You Need

Structural Welding Code—Steel 2020

8 Inspection
Part A General Requirements
8.1.4 Qualification of Inspection Personnel

8.1.4.2 Basis for Qualification of Welding Inspectors

Inspectors responsible for acceptance or rejection of material and workmanship on the basis of visual inspection shall be qualified.

The acceptable qualification basis shall be one of the following:

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Getting the Welds You Need

Structural Welding Code—Steel 2020

8 Inspection
Part A General Requirements
8.1.4 Qualification of Inspection Personnel

8.1.4.2 Basis for Qualification of Welding Inspectors

(1) Current or previous certification as an AWS Certified Welding Inspector (CWI) or Senior Certified Welding Inspector (SCWI) in conformance with the requirements of AWS QC1, *Standard for AWS Certification of Welding Inspectors*,

AWS QC1: 2016-AMD1

Specification for AWS Certification of Welding Inspectors

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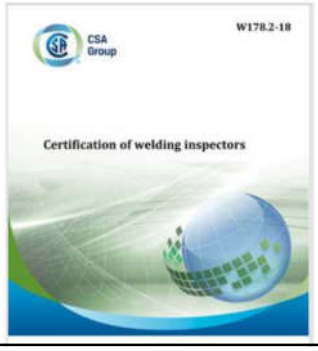
Getting the Welds You Need

Structural Welding Code—Steel 2020

8 Inspection
Part A General Requirements
8.1.4 Qualification of Inspection Personnel

8.1.4.2 Basis for Qualification of Welding Inspectors

(2) Current or previous certification as a Level 2 or Level 3 Welding Inspector in conformance with the requirements of Canadian Standards Association (CSA) Standard W178.2, *Certification of Welding Inspectors*,



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Getting the Welds You Need

Structural Welding Code—Steel 2020

8 Inspection
Part A General Requirements
8.1.4 Qualification of Inspection Personnel

8.1.4.2 Basis for Qualification of Welding Inspectors

(3) Current or previous qualification as a Welding Inspector (WI) or Senior Welding Inspector (SWI) in conformance with the requirements of AWS B5.1, *Specification for the Qualification of Welding Inspectors*,

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Getting the Welds You Need

Structural Welding Code—Steel 2020

8 Inspection
Part A General Requirements
8.1.4 Qualification of Inspection Personnel

8.1.4.2 Basis for Qualification of Welding Inspectors

(4) Current or previous qualification as an ASNT SNT-TC-1A-VT Level II in conformance with the requirements of ASNT Recommended Practice No. SNT-TC- 1A, *Personnel Qualification and Certification in Nondestructive Testing*, or ANSI/ASNT CP-189, *ASNT Standard for Qualification and Certification of Nondestructive Personnel*, or

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Getting the Welds You Need

Structural Welding Code—Steel 2020

8 Inspection
Part A General Requirements
8.1.4 Qualification of Inspection Personnel

8.1.4.2 Basis for Qualification of Welding Inspectors

(5) An individual who, by training or experience, or both, in metals fabrication, inspection and testing, is competent to perform inspection of the work.

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Getting the Welds You Need

Structural Welding Code—Steel 2020

8 Inspection
Part A General Requirements
8.1.4 Qualification of Inspection Personnel

8.1.4.3 Alternative Inspector Qualifications

The basis of alternative qualification for inspection personnel shall be specified in contract documents if different than the requirements in 8.1.4.2.

When requested by the ***Engineer***, or an authorized representative of the owner, documentation of the specified alternative qualification of inspection personnel shall be submitted for verification and approval.

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Getting the Welds You Need

Structural Welding Code—Steel 2020

8 Inspection
Part A General Requirements
8.1.4 Qualification of Inspection Personnel

8.1.4.5 Basis for Qualification of Assistant Inspectors

Assistant Inspectors shall be qualified to perform the specific functions to which they are assigned.

The acceptable qualification basis shall be one of the following:
(1) Certified Associate Welding Inspector (CAWI) or higher (AWS QC1)
(2) Level 1 Welding Inspector or higher (CSA W178.2)
(3) Associate Welding Inspector (AWI) or higher (AWS B5.1)
(4) VT Level 1 (ASNT SNT-TC-1A, ANSI/ASNT CP-189)
(5) An individual who is qualified by training and experience to perform the specific functions they are assigned.

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Getting the Welds You Need

Structural Welding Code—Steel 2020

8 Inspection
Part A General Requirements
8.1.4 Qualification of Inspection Personnel

8.1.4.7 Term of Effectiveness

The qualification of an Inspector shall remain in effect indefinitely, provided the Inspector
- remains active in inspection of welded steel fabrication and
- their eye examinations are current,

unless there is specific reason to question the Inspector's ability.

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Getting the Welds You Need

Specification for Structural Steel Buildings

N4 INSPECTION AND NONDESTRUCTIVE TESTING PERSONNEL

N4.1 Quality Control Inspector Qualifications

N4.2 Quality Assurance Inspector Qualifications

N4.3 NDT Personnel Qualifications

GLOSSARY
Quality control inspector (QCI). Individual designated to perform quality control inspection tasks for the work being performed.

Quality assurance inspector (QAI). Individual designated to provide quality assurance inspection for the work being performed.

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Getting the Welds You Need

Specification for Structural Steel Buildings

N4 INSPECTION AND NONDESTRUCTIVE TESTING PERSONNEL
N4.1 Quality Control Inspector Qualifications

QC welding inspection personnel shall be qualified to the satisfaction of the fabricator's or erector's QC program, as applicable, and in accordance with either of the following:

(a) Associate welding inspectors (AWI) or higher as defined in *Standard for the Qualification of Welding Inspectors (*AWS B5.1), or

(b) Qualified under the provisions of AWS D1.1/D1.1M clause 6.1.4.

AWS B5.1:2013-AMD1
An American National Standard

Specification for the Qualification of Welding Inspectors

AWS D1.1/D1.1M:2015
An American National Standard

Structural Welding Code—Steel

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Getting the Welds You Need

Specification for Structural Steel Buildings

N4 INSPECTION AND NONDESTRUCTIVE TESTING PERSONNEL
N4.2 Quality Assurance Inspector Qualifications

QA welding inspectors shall be qualified to the satisfaction of the QA agency's written practice, and in accordance with either of the following:

(a) Welding Inspectors (WIs), or Senior Welding Inspectors (SWIs), as defined in *Standard for the Qualification of Welding Inspectors* (AWS B5.1), except AWI are permitted to be used under the direct supervision of WI, who are on the premises and available when weld inspection is being conducted, or

(b) Qualified under the provisions of AWS D1.1/D1.1M clause 6.1.4.

AWS B5.1:2013-AMD1
An American National Standard

Specification for the Qualification of Welding Inspectors

AWS D1.1/D1.1M:2015
An American National Standard

Structural Welding Code—Steel

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Getting the Welds You Need

- welding symbols
- joint details
- document submittals
- welding procedure specification (WPS) review
- inspection
- nondestructive testing

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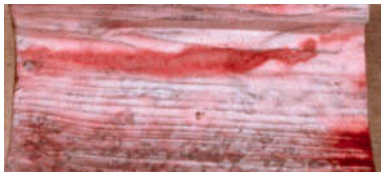
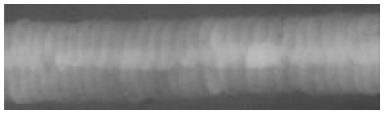
Getting the Welds You Need

Specification for Structural Steel Buildings

N5 MINIMUM REQUIREMENTS FOR INSPECTION OF STRUCTURAL STEEL BUILDINGS
N5.5 Nondestructive Testing of Welded Joints
N5.5a Procedures

Ultrasonic testing (UT), magnetic particle testing (MT), penetrant testing (PT) and radiographic testing (RT), where required, shall be performed by QA in accordance with AWS D1.1/D1.1M.



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Getting the Welds You Need

Visual Testing *(after welding)*		
Discontinuity	**Ability**	
Cracks	A	(1)
Laminations	A	(1,3)
Porosity	A	(1)
Overlap	O	
Undercut	A	
Inadequate joint preparation	U	
Incomplete fusion	U	
Slag Inclusions	U	
A - Applicable O - Marginal U - Generally Inapplicable (1) Surface only (3) Weld preparation or base edge		

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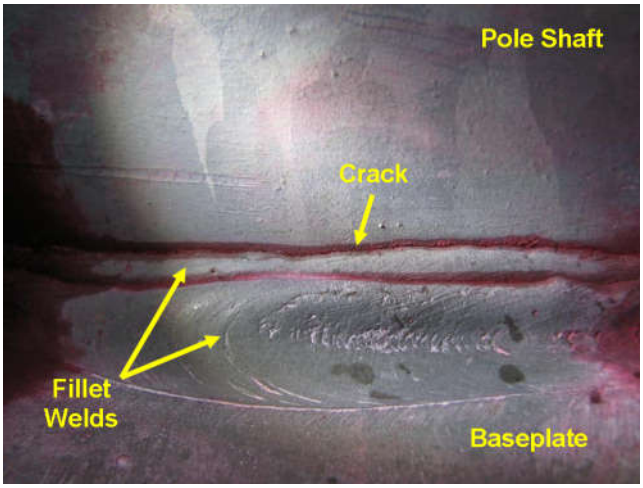
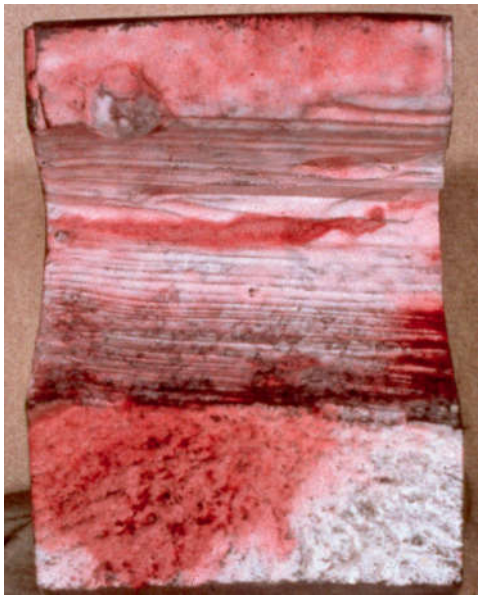
Getting the Welds You Want and Need

Penetrant Testing





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Getting the Welds You Need

Penetrant Testing		
Discontinuity	**Ability**	
Cracks	A	(1)
Laminations	A	(1,3)
Porosity	A	(1)
Overlap	A	
Undercut	O	
Inadequate joint preparation	U	
Incomplete fusion	U	
Slag Inclusions	U	
A - Applicable O - Marginal U - Generally Inapplicable (1) Surface only (3) Weld preparation or base edge		

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Getting the Welds You Need

Magnetic Particle Testing

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Getting the Welds You Need

Magnetic Particle Testing		
Discontinuity	**Ability**	
Cracks	A	(2)
Laminations	A	(2,3)
Porosity	O	(2)
Overlap	A	
Undercut	O	
Inadequate joint preparation	U	
Incomplete fusion	U	
Slag Inclusions	O	(2)
A - Applicable O - Marginal U - Generally Inapplicable (2) Surface and slightly subsurface (3) Weld preparation or base edge		

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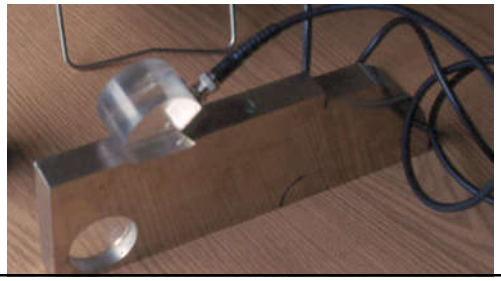
Getting the Welds You Need

Ultrasonic Testing



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Getting the Welds You Need

Ultrasonic Testing		
Discontinuity	**Ability**	
Cracks	A	
Laminations	A	
Porosity	O	
Overlap	O	
Undercut	O	
Inadequate joint preparation	A	
Incomplete fusion	A	
Slag Inclusions	A	
A - Applicable O - Marginal U - Generally Inapplicable		

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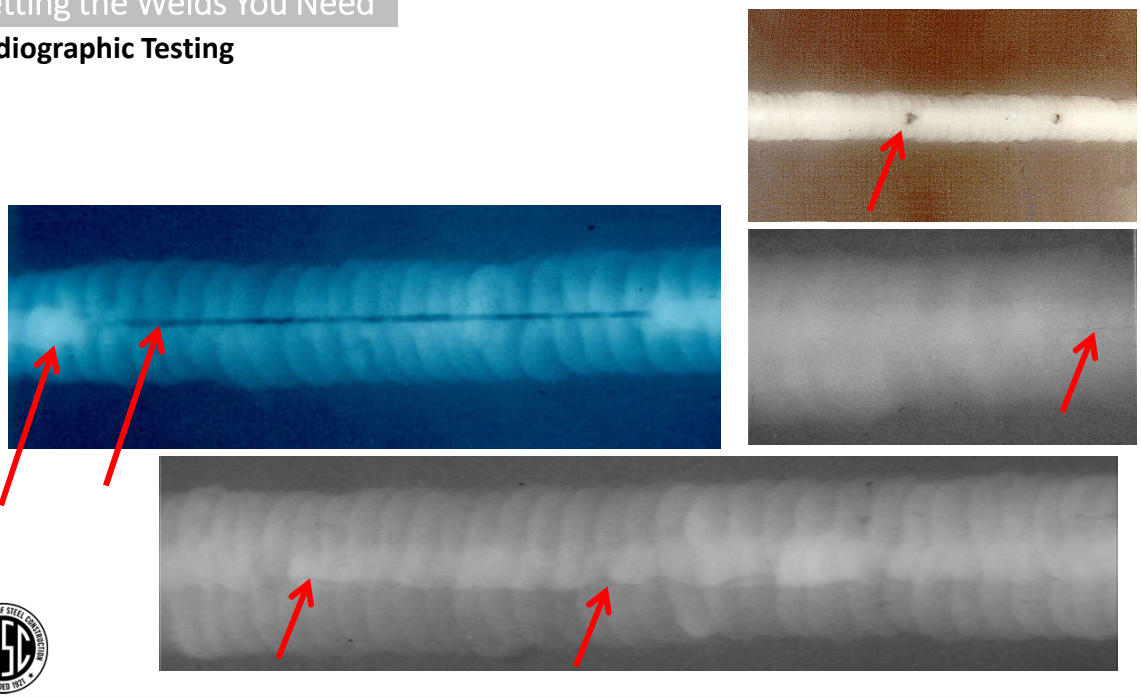
Getting the Welds You Need

Radiographic Testing



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Getting the Welds You Need

Radiographic Testing		
Discontinuity	**Ability**	
Cracks	O	
Laminations	U	
Porosity	A	
Overlap	U	
Undercut	A	
Inadequate joint preparation	A	
Incomplete fusion	O	
Slag Inclusions	A	
A - Applicable O - Marginal U - Generally Inapplicable		

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Getting the Welds You Need

Structural Welding Code—Steel 2020

8 Inspection
Part D NDT Procedures
8.15 Extent of Testing

8.15.1 Full Testing
Weld joints requiring testing by contract specification shall be tested for their full length, unless partial or spot testing is specified.

8.15.2 Partial Testing
When partial testing is specified, the location and lengths of welds or categories of weld to be tested shall be clearly designated in the contract documents.

8.15.3 Spot Testing
number of spots in each designated category of welded joint to be specified
minimum spot test length 4 in. [100 mm]
● if passes, ok ● if fails, explore & test two more spots ● if fails, test entire segment of weld

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Getting the Welds You Need

Specification for Structural Steel Buildings

N5 MINIMUM REQUIREMENTS FOR INSPECTION OF STRUCTURAL STEEL BUILDINGS
N5.5 Nondestructive Testing of Welded Joints
N5.5b CJP Groove Weld NDT

For structures in Risk Category III or IV, UT shall be performed by QA on all CJP groove welds subject to transversely applied tension loading in butt, T- and corner joints, in materials 5/16 in. [8 mm] thick or greater.

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Getting the Welds You Need

Specification for Structural Steel Buildings

N5 MINIMUM REQUIREMENTS FOR INSPECTION OF STRUCTURAL STEEL BUILDINGS
N5.5 Nondestructive Testing of Welded Joints
N5.5b CJP Groove Weld NDT

For structures in Risk Category II, UT shall be performed by QA on 10% of CJP groove welds in butt, T- and corner joints subject to transversely applied tension loading, in materials 5/16 in. [8 mm] thick or greater.

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Getting the Welds You Need

Specification for Structural Steel Buildings

N5 MINIMUM REQUIREMENTS FOR INSPECTION OF STRUCTURAL STEEL BUILDINGS
N5.5 Nondestructive Testing of Welded Joints
N5.5c Welded Joints Subjected to Fatigue

When required by Appendix 3, Table A-3.1, welded joints requiring weld soundness to be established by radiographic or ultrasonic inspection shall be tested by QA as prescribed.

Reduction in the rate of UT is prohibited.

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Getting the Welds You Need

Structural Welding Code—Steel 2020

4 Design of Welded Connections
Part C Specific Requirements for Design of Nontubular Connections (Cyclically Loaded)
4.19 Inspection

Fatigue categories B and C require that the ***Engineer*** ensure that CJP groove welds subject to cyclic transverse applied stress into the tensile range be inspected using Radiographic Testing (RT) or Ultrasonic Testing (UT).

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Getting the Welds You Need

Specification for Structural Steel Buildings

N5 MINIMUM REQUIREMENTS FOR INSPECTION OF STRUCTURAL STEEL BUILDINGS
N5.5 Nondestructive Testing of Welded Joints
N5.5e Reduction of Ultrasonic Testing Rate

… The rate of UT is permitted to be reduced if approved by the ***EOR*** and the ***AHJ***.

Where the initial rate for UT is 100%, the NDT rate for an individual welder or welding operator is permitted to be reduced to 25%, provided the rejection rate, the number of welds containing unacceptable defects divided by the number of welds completed, is demonstrated to be 5% or less of the welds tested for the welder or welding operator.

A sampling of at least 40 completed welds shall be made for such reduced evaluation on each project.

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Getting the Welds You Need

Seismic Provisions for Structural Steel Buildings

J6 WELDING INSPECTION AND NONDESTRUCTIVE TESTING
J6.2 NDT of Welded Joints

In addition to the requirements of *Specification* Section N5.5, nondestructive testing of welded joints shall be as required in this section.

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Getting the Welds You Need

Seismic Provisions for Structural Steel Buildings

J6 WELDING INSPECTION AND NONDESTRUCTIVE TESTING
J6.2 NDT of Welded Joints
J6.2a CJP Groove Weld NDT

Ultrasonic testing shall be performed on 100% of CJP groove welds in materials 5/16 in. [8 mm] thick or greater.

Ultrasonic testing in materials less than 5/16 in. [8 mm] thick is not required.

Magnetic particle testing shall be performed on 25% of all beam-to-column CJP groove welds.

Exception: For ordinary moment frames in risk categories I or II, UT and MT of CJP groove welds are required only for demand critical welds.

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Getting the Welds You Need

Seismic Provisions for Structural Steel Buildings

J6 WELDING INSPECTION AND NONDESTRUCTIVE TESTING
J6.2 NDT of Welded Joints
J6.2d 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 1-1/2 in. [38 mm] in rolled shapes, or when the web thickness exceeds 1-1/2 in. [38 mm] for built-up shapes.

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Getting the Welds You Need

7 Inspection
7.4 Wide-Flange k-Area Inspection

Structural Welding Code—Seismic Supplement

When required by the QAP, MT of the member web shall be performed after welding of doubler plates, continuity plates or stiffeners in the k-area.

The member web area to be tested for cracks using MT shall include the k-area base metal within 3 in [75 mm] of the weld.

The MT shall be performed no sooner than 48 hours following completion of the welding.

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Getting the Welds You Need

Structural Welding Code—Steel 2020

8 Inspection
Part D NDT Procedures
8.14 Procedures
8.14.6 Personnel Qualification
8.14.6.1 ASNT Requirements

Personnel performing NDT other than visual shall be qualified in conformance with the current edition of the American Society for Nondestructive Testing Recommended Practice No. SNT-TC-1A.

Individuals who perform NDT shall be qualified for:
(1) NDT Level II, or
(2) NDT Level I working under the NDT Level II

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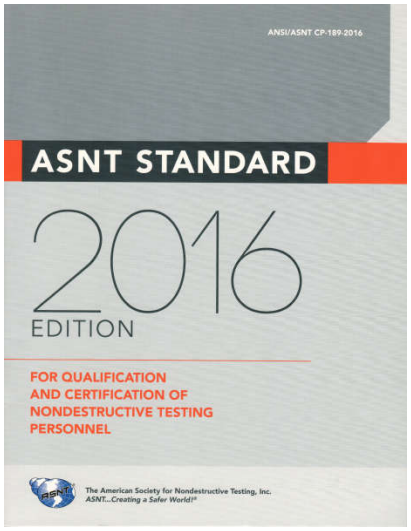
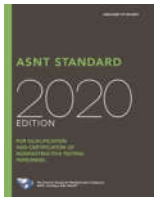
Getting the Welds You Need

Recommended Practice No. SNT-TC-1A



ANSI/ASNT Standard CP-189



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Getting the Welds You Need

Structural Welding Code—Steel 2020

8 Inspection
Part F Ultrasonic Testing (UT) of Groove Welds
8.19 General
8.19.2 Variations

Annex O and Annex H specify alternative ultrasonic techniques for performing conventional UT and phased array UT examination of groove welds.

Other variations in testing procedures, equipment, and acceptance standards not included in Part F of Clause 8 may be used with the approval of the ***Engineer***.

Such variations include other thicknesses, weld geometries, transducer sizes, frequencies, couplant, painted surfaces, testing techniques, etc.

Such approved variations shall be recorded in the inspection records.

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Getting the Welds You Need

Structural Welding Code—Steel 2020

Annex H (Normative)
Phased Array Ultrasonic Testing (PAUT)

H1. Introduction

This annex provides mandatory requirements that shall apply when phased array ultrasonic testing (PAUT) is used. The alternative techniques presented in this annex require written procedures, advanced personnel training and qualification, and calibration methods specific to PAUT.

H2. Scope

The procedures and standards set forth in this annex govern PAUT examinations of groove welds, including heat-affected zones (HAZ), for thicknesses between 3/16 in and 8 in [5 mm and 200 mm] using encoded linear scanning.

These procedures and standards exclude the PAUT examination of tubular T, Y, and K connection welds.

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Getting the Welds You Need

Structural Welding Code—Seismic Supplement

7 Inspection
7.10 Ultrasonic Testing
7.10.1 Technique

Ultrasonic testing (UT) of welds required by the Quality Assurance Plan shall be performed according to the procedures prescribed in AWS D1.1/D1.1M Clause 6, Part F, following a written procedure containing the elements prescribed in AWS D1.1/D1.1M Clause Q3 of Annex Q, UT Examination of Welds by Alternative Techniques.

AWS D1.1/D1.1M Clause 6, Part F procedures shall be qualified using weld mock-ups having 1.5 mm diameter side drilled holes similar to Annex Q Figure Q.3 of AWS D1.1/D1.1M.

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Getting the Welds You Need

Structural Welding Code—Seismic Supplement

7 Inspection
7.10 Ultrasonic Testing
7.10.1 Technique

AWS D1.1 – Annex Q
UT Examination of Welds by Alternative Techniques

Q3	**UT Procedure**
Q4	UT Operator & Equipment
Q5	Reference Standard
Q6	Calibration Methods
Q7	Scanning
Q8	Weld Discontinuity Characterization Methods
Q9	Weld Discontinuity Sizing and Location Methods
Q10	Problems with Discontinuities
Q11	Discontinuity Amplitude Levels and Weld Classes Discontinuity Amplitude Levels
Q12	Acceptance / Rejection Criteria
Q13	Preparation and Disposition of Reports

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Getting the Welds You Need

Structural Welding Code—Seismic Supplement

7 Inspection
7.2 Inspector Qualifications
7.2.4 UT Technicians

Ultrasonic testing (UT) for QA shall be performed only by UT technicians:

(1) Certified as Level II or Level III by their employer, or
(2) Certified as ASNT Level III through examination by the ASNT.

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Getting the Welds You Need

Structural Welding Code—Seismic Supplement

7 Inspection
7.2 Inspector Qualifications
7.2.4 UT Technicians

Annex F Supplemental Ultrasonic Technician Testing

D = detected flaws / number flaws
F = false indications / total indications
n = number of flaws

$$R = \frac{n - 2}{2\,(n - 1)}\,(1 + D - F)$$

R_{min} = 80%

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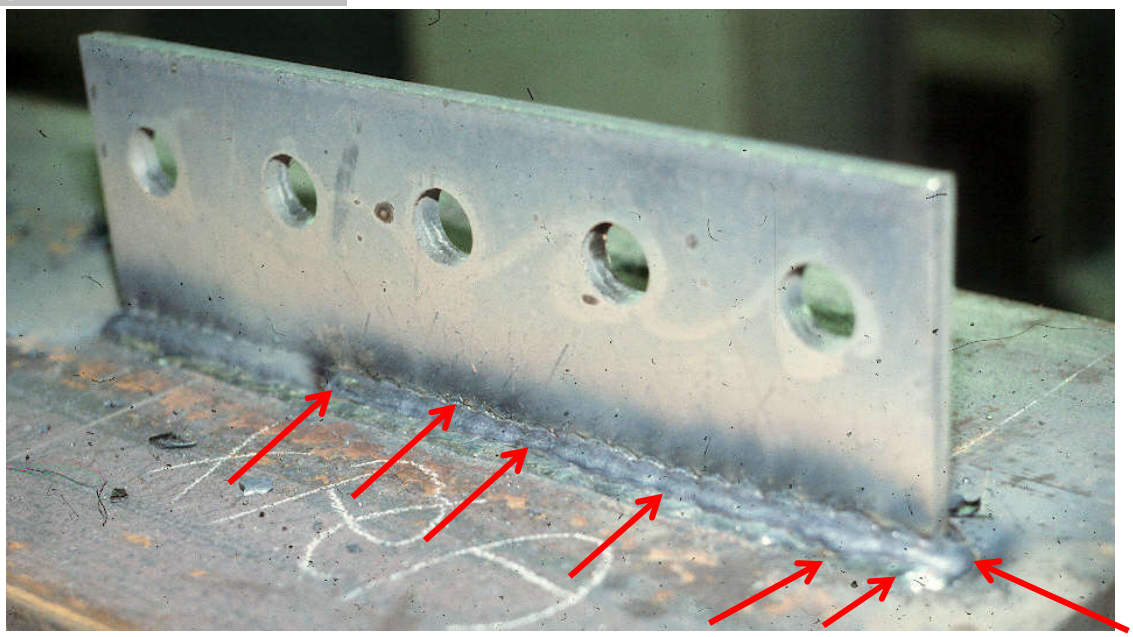
Getting the Welds You Need



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Getting the Welds You Need

Structural Welding Code—Steel 2020

1 General Requirements
1.5 Responsibilities
1.5.1 Engineer's Responsibilities

The Engineer shall be responsible for the development of the contract documents that govern products or structural assemblies produced 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.

…

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Getting the Welds You Need

Structural Welding Code—Steel 2020

1 General Requirements
1.5 Responsibilities
1.5.1 Engineer's Responsibilities

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

…
(4) Weld acceptance criteria other than that specified in Clause 8.
…

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Getting the Welds You Need

Structural Welding Code—Steel 2020

8 Inspection
Part C Acceptance Criteria
8.8 Engineer's Approval for Alternate Acceptance Criteria

The fundamental premise of the Code is to provide general stipulations applicable to most situations.

Acceptance criteria for production welds different from those described in the Code may be used for a particular application, provided they are suitably documented by the proposer and approved by the ***Engineer***.

These alternate acceptance criteria can be based upon evaluation of suitability of service using past experience, experimental evidence or engineering analysis considering material type, service load effects, and environmental factors.

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Getting the Welds You Need

Structural Welding Code—Steel 2020

8 Inspection
Part C Acceptance Criteria
C8.8 Engineer's Approval for Alternate Acceptance Criteria

The criteria provided in section 7, Fabrication, of the Code are based upon knowledgeable judgement of what is achievable by a qualified welder.

The criteria in section 7 should not be considered as a boundary of suitability for service. Suitability for service analysis would lead to widely varying workmanship criteria unsuitable for a standard code.

Furthermore, in some cases, the criteria would be more liberal than what is desirable and producible by a qualified welder.

...

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Getting the Welds You Need

Structural Welding Code—Steel 2020

8 Inspection
Part C Acceptance Criteria
C8.8 Engineer's Approval for Alternate Acceptance Criteria

…

In general, the appropriate quality acceptance criteria and whether a deviation produces a harmful product should be the Engineer's decision.

When modifications are approved, evaluation of suitability for service using modern fracture mechanics techniques, a history of satisfactory service in similar structures, or experimental evidence is recognized as a suitable basis for alternate acceptance criteria for welds.

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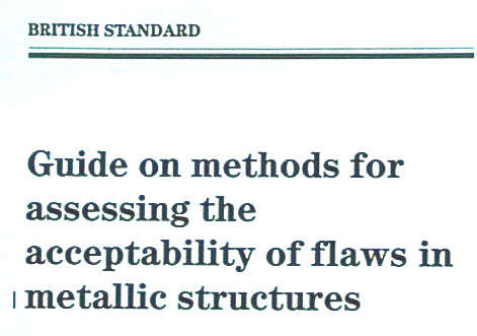
Getting the Welds You Need



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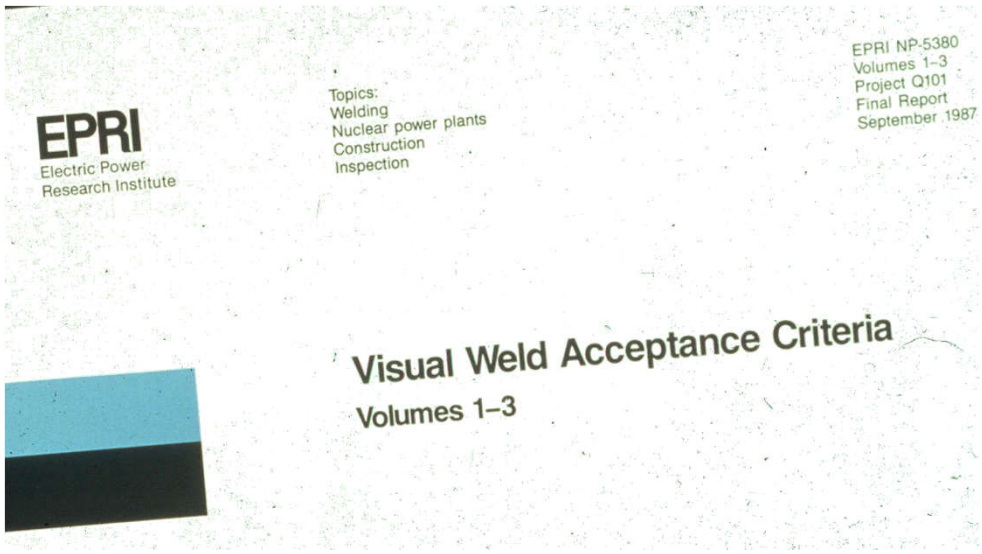
Getting the Welds You Need



EPRI NP-5380
https://www.epri.com/#/pages/product/NP-5380-V1-V3(SET)/?lang=en

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Getting the Welds You Need

- **welding symbols**
- **joint details**
- **document submittals**
- **welding procedure specification (WPS) review**
- **inspection**
- **nondestructive testing**

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Getting the Welds You Need

Engineers

- Start with *AISC 360* (and *AISC 341* and *AISC 358*, if seismic) ….
  then look at *AWS D1* Structural Welding Codes
- Make sure your contract documents satisfy *AISC 303*
- Write project specifications for the specific project –
  don't use a "collection" from previous projects with excessive req'ts
- Seek advice from prospective fabricators and erectors, or use a welding consultant, to review your project specifications and your welded connections during design development
- Listen to the suggestions from your fabricator and erector
- Consider using a welding consultant to assist with difficult welded details, reviewing WPS submittals, responding to complex RFIs, addressing nonconformances

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Getting the Welds You Need

Fabricators and Erectors

- Review your Quality Management System, including procedures and personnel, regarding the project
- Review project specifications and design documents thoroughly, repeat
- Review complex welded connections, plan your assembly sequence, and be proactive in suggesting improvements to the details to the Engineer
- Make sure you have and use experienced welding supervision, not leaving the assembly sequence and details to the welders and welding operators alone
- Remember, the Code contains minimum requirements, and you may need to do more
- Consider using a welding consultant to assist with difficult welded details, reviewing WPSs prior to submittal, submitting complex RFIs, and addressing nonconformances and repairs

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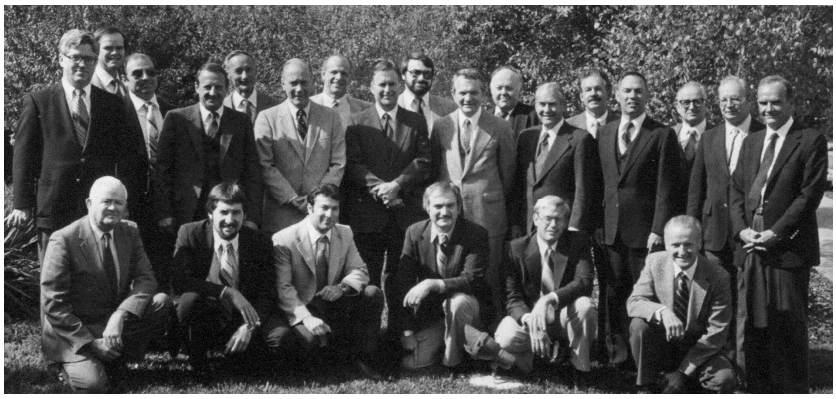
Getting the Welds You Need



AISC Regional Engineer Staff Meeting, 1982

AISC Associate Director of Education
1986 - 1990

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Getting the Welds You Need

Getting the Welds You Need

Robert E. Shaw, Jr., PE
President
Steel Structures Technology Center, Inc.
Howell, Michigan

AISC | Questions?

Smarter. Stronger. Steel.

PDH Certificates

- You will receive an email on how to report attendance from: registration@aisc.org.
- Be on the lookout: Check your spam filter! Check your junk folder!
- Completely fill out online form. Don't forget to check the boxes next to each attendee's name!

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PDH Certificates

- Reporting site (URL will be provided in the forthcoming email).
- Username: Same as AISC website username.
- Password: Same as AISC website password.

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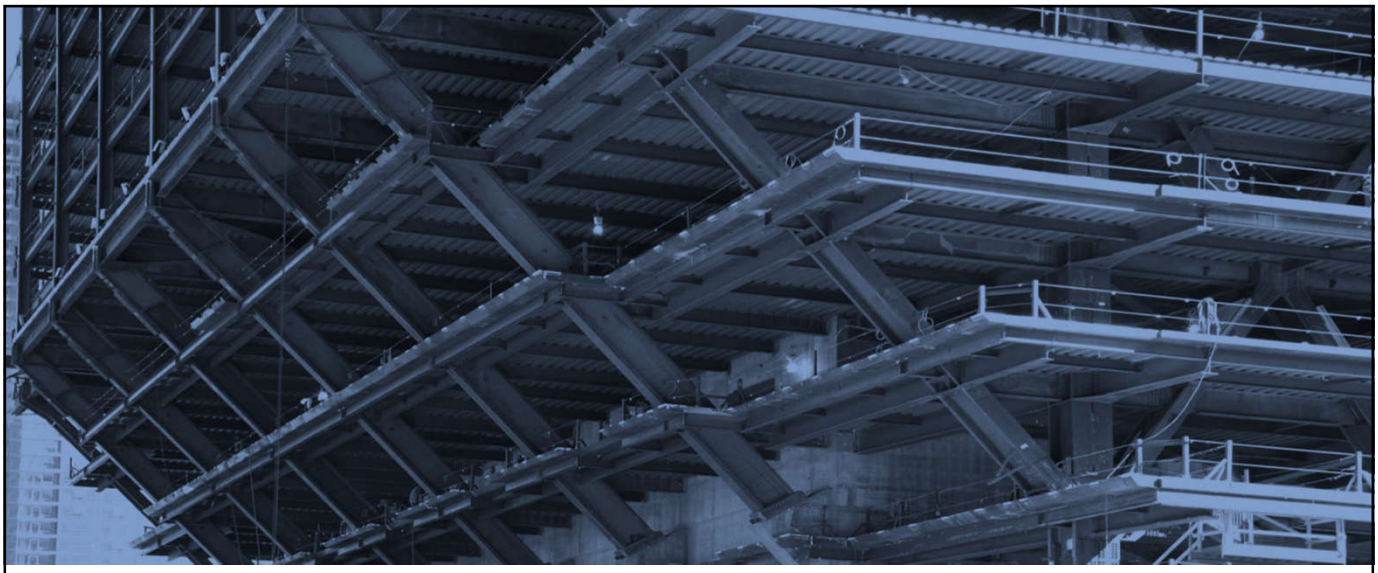

AISC | Thank you

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