



AWS D1.1 Structural Welding Code: **You Specify It- Do You Know What It Really Says?**

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“All welding shall be done in conformance with AWS D1.1”

- a **minimum** mandatory welding requirement
- for welded structures made from **commonly used** carbon and low alloy constructional steels (i.e. typical structural buildings).

IS THAT ENOUGH FOR THE HIGH PERFORMANCE, NON-REDUNDANT, FRACTURE CRITICAL WELDING, WE REQUIRE IN A TYPICAL TUBULAR STEEL TRANSMISSION POLE DESIGN?



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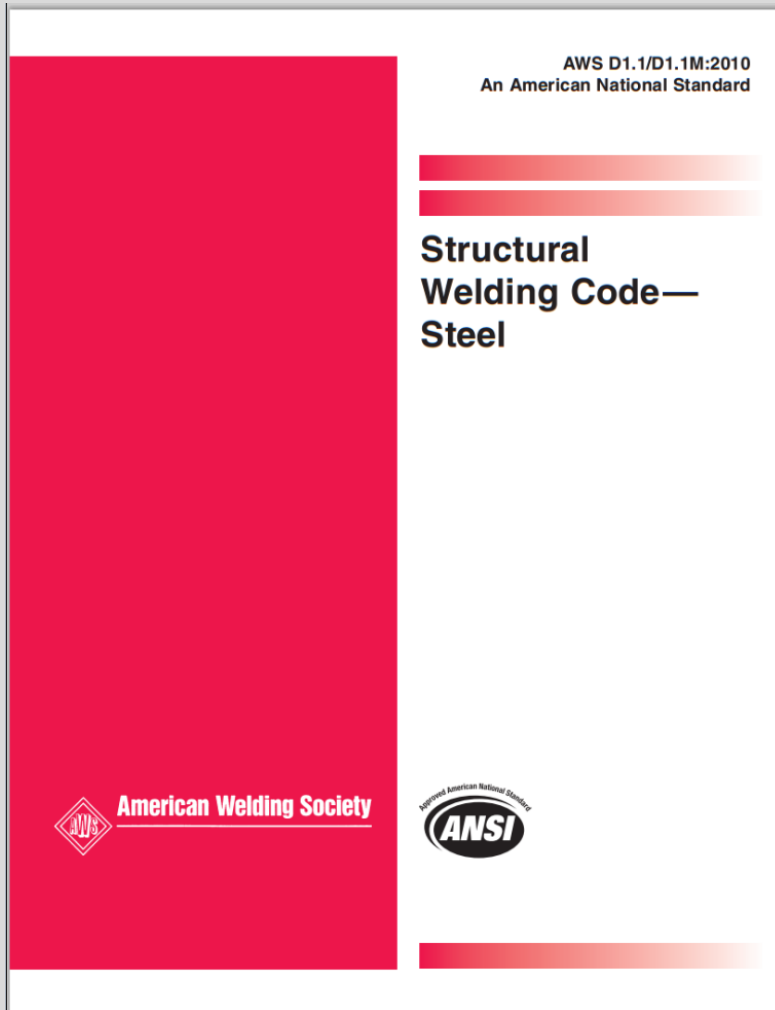
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Poles you purchase should be fabricated to a standard that exceeds the **MINIMUM** AWS D1.1 requirements.



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**You have to read it to
know what's in it!**

Consists of (540) Pages organized into:

- (8) “Clauses” (Chapters)
- (9) “Normative” Annexes
- (12) “Informative” Annexes
- Commentary
- Index



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Let's look at the Eight Chapters called "Clauses" of AWS D1.1:

Clause 1: General Requirements

- Basic Information on the scope and limitations of the code,
- Key definitions, and,
- Identifies the **major responsibilities of the parties involved** with steel fabrication.



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AWS D1.1: Paragraph 1.4 Responsibilities:

“The Engineer” (meaning the **Owner or Owner’s Engineer**) “shall specify”. . . :

- Code Requirements
- All NDT Requirements
- Any verification inspection required (other than fabricator’s inspection)
- **Weld acceptance criteria (if different from clause 6 of the code)**
- **CVN toughness criteria for weld metal, base metal, and/or HAZ when required.**
- **Whether the structure is statically or cyclically loaded**
- **All additional requirements not specifically addressed in the code**
- Responsibilities of the parties involved.



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Clause 2: Design of Welded Connections

- Contains the requirements for the design of welded connections composed of **tubular, or nontubular** , product form members.



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AWS D1.1: Paragraph 2.3.2 Notch Toughness Requirements

“The Engineer” (again meaning the Owner or Owner’s Engineer) shall specify that the Weld Procedure Specifications (WPS’s) be qualified with CVN tests.



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Clause 3: Prequalification of WPS's (Weld Procedure Specifications)

- Clause contains the requirements for exempting a WPS from the WPS qualification requirements of this code.



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In my opinion, **we should not allow ANY exemptions** from the requirement to qualify a Weld Procedure Specification (WPS).

Why?

- Prequalified WPS's do not reflect CVNL testing requirements in the weld metal, and HAZ (heat affected zone).
- Prequalified WPS's do not reflect heat control during welding (maximum interpass temperature).



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Clause 4: Qualification

- Contains the requirements for **Weld Procedure Specification (WPS's)** including **Procedure Qualification Records (PQR's)**, and qualification tests for all welding personnel (**welders, welding operators, and tack welders**).



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Clause 4: Qualification

Weld Procedure Specification (WPS's)

A formal written document describing a specific welding procedure, which provides clear and unambiguous direction to the welder or welding operators performing the weld. Purpose is to achieve confidence in quality and repeatability.

Procedure Qualification Records (PQR's)

The detailed record of a demonstration weld made by a specific procedure (WPS) can meet prescribed standards of weld performance.



WPS:
How you plan to weld this joint.

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

Company Name LECO
 Welding Process(es) SAW
 Supporting PQR No.(s) Prequalified

Identification # W2081
 Revision 2 Date 1-3-89 By R. Jones
 Authorized by C. W. Hayes Date 1-3-89
 Type—Manual Semiautomatic
 Mechanized Automatic

JOINT DESIGN USED
 Type: Butt
 Single Double Weld
 Backing: Yes No
 Backing Material: ASTM A 36
 Root Opening 5/8" Root Face Dimension -
 Groove Angle: 20° Radius (J-U) -
 Back Gouging: Yes No Method -

POSITION
 Position of Groove: F Fillet: -
 Vertical Progression: Up Down

BASE METALS
 Material Spec. ASTM A 36
 Type or Grade -
 Thickness: Groove 1" Fillet -
 Diameter (Pipe) -

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

FILLER METALS
 AWS Specification A5.17
 AWS Classification EM12K

TECHNIQUE
 Stringer or Weave Bead: Stringer
 Multi-pass or Single Pass (per side) Multipass
 Number of Electrodes 1
 Electrode Spacing Longitudinal -
 Lateral -
 Angle -

SHIELDING
 Flux 860 Gas -
 Composition -
 Electrode-Flux (Class) F7A2-EM12K Flow Rate -
 Gas Cup Size -

Contact Tube to Work Distance 1-1/4"
 Peening None
 Interpass Cleaning: Slag Removed

PREHEAT
 Preheat Temp., Min. 150°F
 Interpass Temp., Min. 150°F Max. 350°F

POSTWELD HEAT TREATMENT
 Temp. N.A.
 Time -

| 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% | |



PQR:
How you actually welded this joint.

Would include the test results required:

- Tensile tests
- Root Bend Test
- CVNL Tests (if required)

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

Identification # PQR 231
 Revision 1 Date 12-1-87 By W. Lye
 Authorized by J. Jones Date 1-18-88
 Type—Manual Semiautomatic
 Mechanized Automatic

Company Name RED Inc.
 Welding Process(es) FCAW
 Supporting PQR No.(s) —

JOINT DESIGN USED
 Type: Butt
 Single Double Weld
 Backing: Yes No
 Backing Material: ASTM A 131A
 Root Opening 1/4" Root Face Dimension —
 Groove Angle: 35° Radius (J-U) —
 Back Gouging: Yes No Method —

POSITION
 Position of Groove: 4G Fillet: —
 Vertical Progression: Up Down

BASE METALS
 Material Spec. ASTM A 131
 Type or Grade A
 Thickness: Groove 1" Fillet —
 Diameter (Pipe) —

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

FILLER METALS
 AWS Specification A5.20
 AWS Classification E71T-1

TECHNIQUE
 Stringer or Weave Bead: Stringer
 Multi-pass or Single Pass (per side) Multipass
 Number of Electrodes 1
 Electrode Spacing Longitudinal —
 Lateral —
 Angle —
 Contact Tube to Work Distance 3/4-1"
 Peening None
 Interpass Cleaning: Wire Brush

SHIELDING
 Flux — Gas CO₂
 Composition 100% CO₂
 Electrode-Flux (Class) — Flow Rate 45CFH
 Gas Cup Size #4

PREHEAT
 Preheat Temp., Min. 75° (Ambient)
 Interpass Temp., Min. 75° Max. 350°F

POSTWELD HEAT TREATMENT
 Temp. N.A.
 Time —

| Pass or Weld Layer(s) | WELDING PROCEDURE | | | | | | | |
|-----------------------|-------------------|---------------|-------|-----------------|---------------------------|-------|--------------|---------------|
| | Process | Filler Metals | | Current | | Volts | Travel Speed | Joint Details |
| | | Class | Diam. | Type & Polarity | (Amps) or Wire Feed Speed | | | |
| 1 | FCAW | E71T-1 | .045" | DC+ | 180 | 26 | 8 | |
| 2-8 | " | " | " | " | 200 | 27 | 10 | |
| 9-11 | " | " | " | " | 200 | 27 | 11 | |
| 12-15 | " | " | " | " | 200 | 27 | 9 | |
| 16 | " | " | " | " | 200 | 27 | 11 | |



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Weld Procedure Specification (WPS) Qualification

Table 4.2
WPS Qualification—CJP Groove Welds: Number and Type of Test Specimens and Range of Thickness and Diameter Qualified (see 4.5) (Dimensions in Inches)

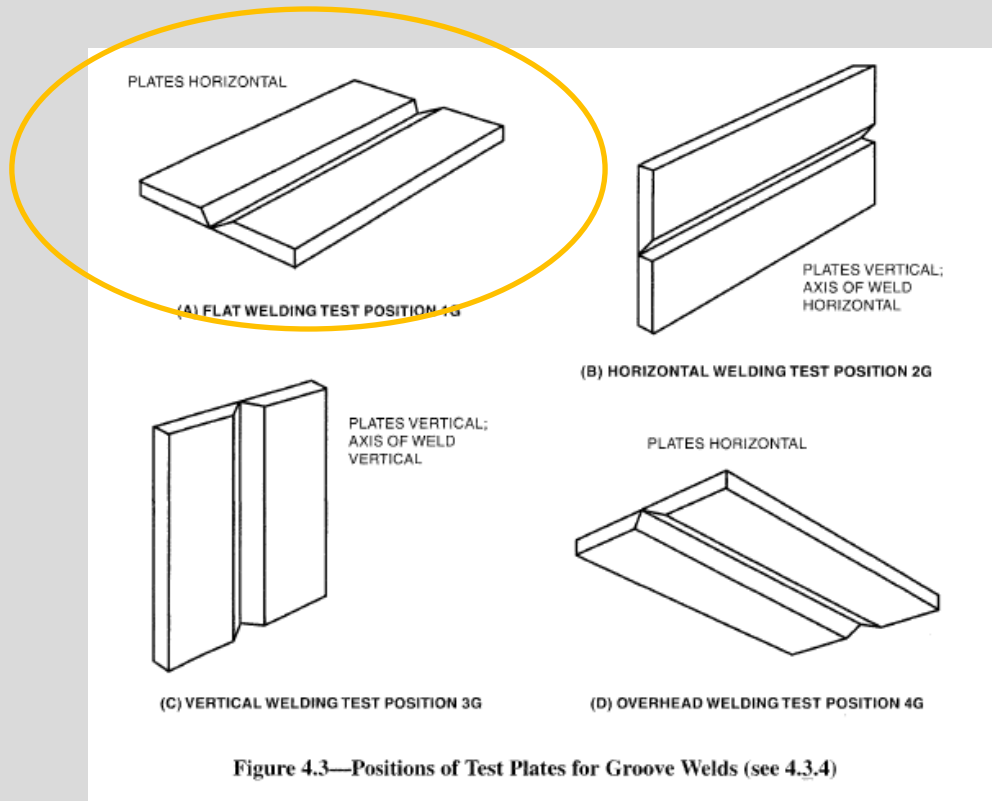
1. Tests on Plate^{a, b}

| Nominal Plate Thickness (T) Tested, in | Number of Specimens | | | | Nominal Plate, Pipe or Tube Thickness ^{c, d} Qualified, in | |
|--|---|---------------------------|---------------------------|---------------------------|---|-----------|
| | Reduced Section Tension (see Fig. 4.14) | Root Bend (see Fig. 4.12) | Face Bend (see Fig. 4.12) | Side Bend (see Fig. 4.13) | Min. | Max. |
| $1/8 \leq T \leq 3/8$ | 2 | 2 | 2 | (Note i) | 1/8 | 2T |
| $3/8 < T < 1$ | 2 | — | — | 4 | 1/8 | 2T |
| 1 and over | 2 | — | — | 4 | 1/8 | Unlimited |



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Weld Procedure Specification (WPS) Qualification





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Weld Procedure Specification (WPS) Qualification

Does welding two 1 inch thick plates together really simulate the issues we have with welding thin plates (pole or arm shafts) to thick plates (base plates to flanges):

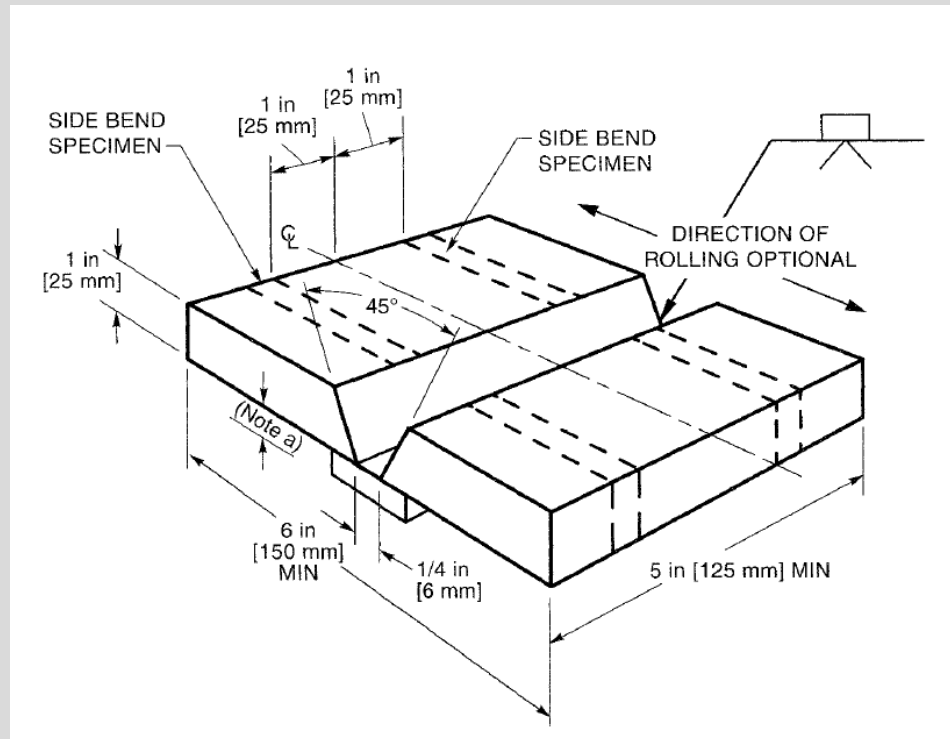
- **Restrained Joints,**
- **Heat Input Distortion,**
- **Differential Cooling Rates?**

The Bridge Welding Code is far more stringent in this area.



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Welder/Operator/Tack Welder Performance Qualification Record (WPQR):





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Clause 5: Fabrication

- General fabrication and erection requirements applicable to welded structures governed by this code, including
 - **base metals**
 - **welding consumables**
 - **welding technique**
 - **welded details**
 - **material preparation and assembly**
 - **workmanship**
 - **weld repair**
 - **and other requirements**



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Heat Input:

(Values are from the WPS/PQR):

Preheat and interpass temperatures shall be maintained for a distance of “**not less than 3 inches** in all directions from the point of welding”.



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Clause 6: Inspection

- Contains the criteria for the qualifications and responsibilities of inspectors ,
- Acceptance criteria for production welds,**
- Standard procedures for performing visual inspections and NDT (nondestructive testing)

AWS D1.1 has very liberal visual inspection acceptance criteria!



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Clause 7: Stud Welding

- Requirements for welding studs to structural steel

Clause 8: Strengthening and Repairing Existing Structures

- Basic information pertinent to welded modification or repair of existing structures.



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1928: First Edition published (as Code A, Part 1)

1941: Revised and renamed D1.0

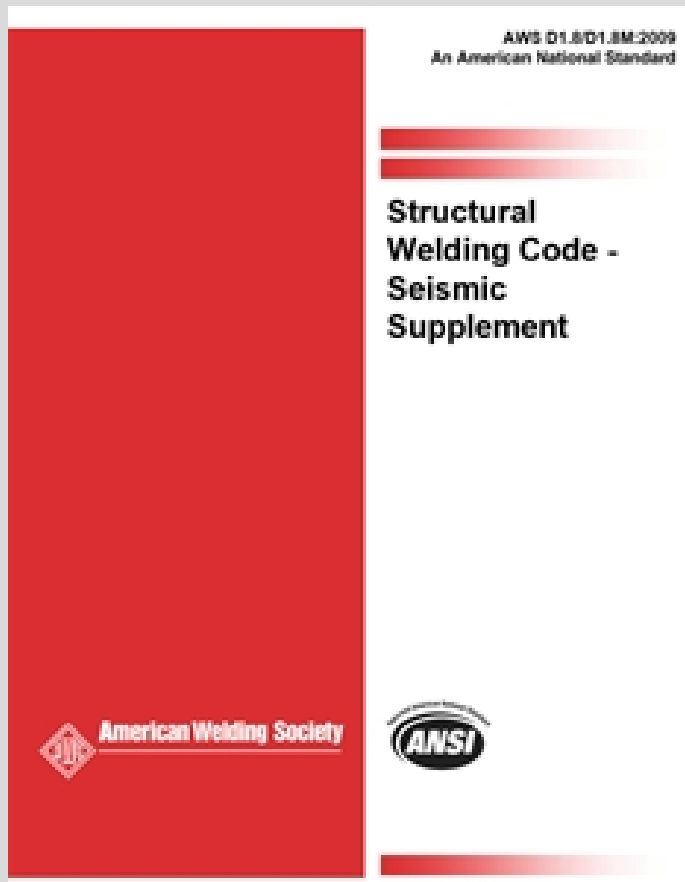
1972: Combined with D2.0 (Highway & Railway Bridges) and renamed D1.1: Structural Welding Code.

1988: Bridges separated out into D1.5 Bridge Welding Code
(In response to a need to accommodate specific AASHTO bridge welding requirements into the AWS Codes)

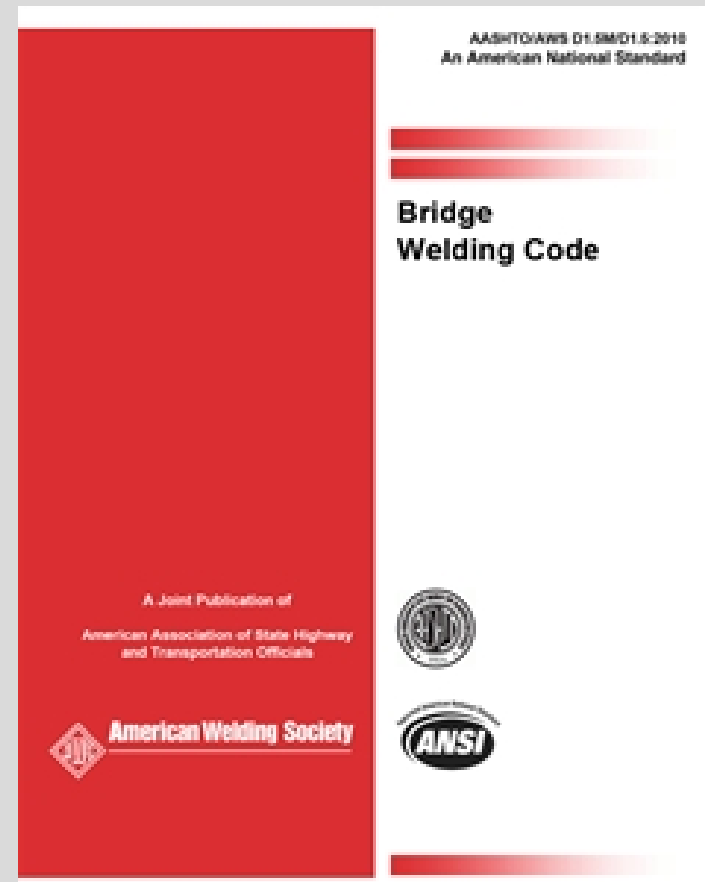
2005: D1.5 the Seismic Supplement to AWS D1.1 was introduced
(In response to the 1994 Northridge earthquake in California).



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**AWS D1.8 Structural Welding Code
- Seismic Supplement
Introduced In 2005**



**AWS D1.5 Bridge Welding Code
Introduced in 1988**



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“All welding shall be done in conformance with AWS D1.1”.

It is certainly better than no requirement, but don't let this statement give you great comfort!

AWS D1.1 alone does not insure worry free welds in our poles!



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Thank you!