

Section 12

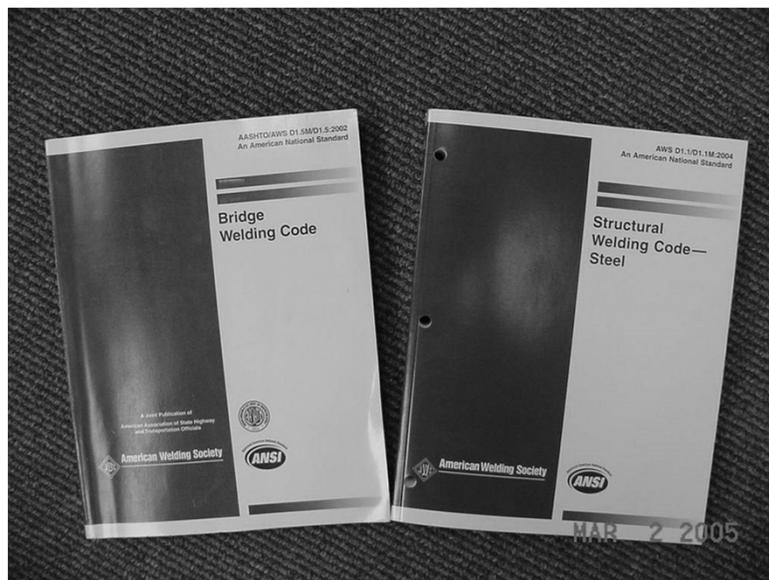
Welding

12.1	Field Welding	1
	Welding Processes	5
	Stud Welding	8
	Welding Positions	17

Field Welding

- Bridge Structures – AWS D1.5 (00560.26(a))
- Reinforcement – AWS D1.4 (00530.42(d))
- Non-Bridge Structures – AWS D1.1 (00560.26(b))
 - Sign Supports
 - Luminaire Poles
 - Expansion Joints
 - Bridge Rail
 - Seismic Retrofit

Welding Codes



Special Provisions

Check Special Provisions for project specific requirements.

Documentation

- WPS – Welding Procedure Specifications
- PQR – Procedure Qualification Records
- WQTR – Welder Qualification Test Records
- MTR – Mill Test Reports

Welding Procedure Specifications (WPS)

- “Recipe” welders follow.
- Includes following variables:
Base Metal Material, Process, Position, Volts, Amps, Travel speed, Preheat, Interpass Temperature, Joint Configuration, Shielding Gas etc.
- Also lists allowable ranges for those variables. These values are taken from the PQR.

Procedure Qualification Records (PQR)

- Contains all weld parameters for the weld procedure qualification:
Base Metal Material, Process, Position, Volts, Amps, Travel speed, Preheat, Interpass Temperature, Joint Configuration, Shielding Gas etc.
- This document serves as written confirmation of the WPS.

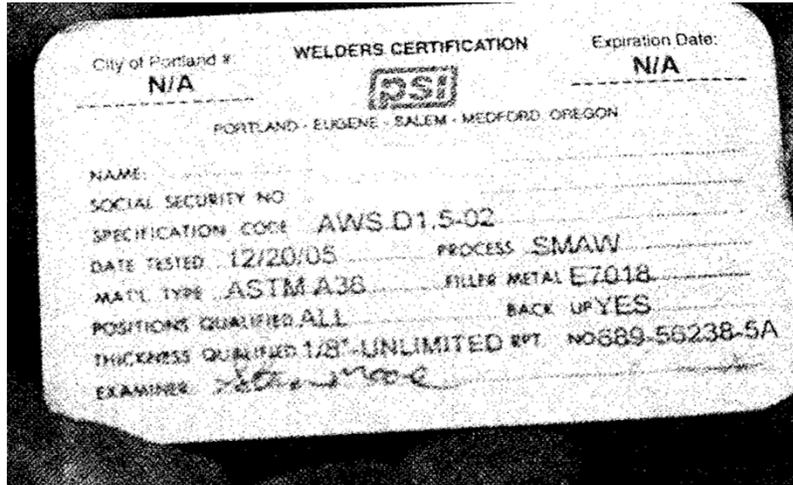
Welder Qualification Test Records (WQTR)

Welder Test Record results qualifying the individual for specific weld processes, materials, joint configurations, positions, etc.

Mill Test Reports (MTR)

Test indicating material composition, strength, physical properties, etc. for material being welded.

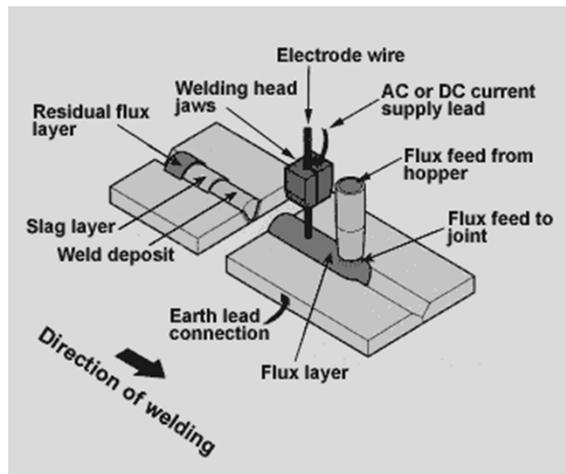
Welding Certification Card



Welding Processes

SMAW**Shielded Metal Arc Welding (Stick welding):**

An arc is generated between the electrode and the weld pool. The electrode flux coating decomposition provides the shielding gas.

**SAW****Submerged Arc Welding:**

A process that generates an arc between a bare metal electrode and weld pool. The arc and molten metal are shielded by granular flux.

GMAW

Gas Metal Arc Welding (MIG):

A semi or full automatic process with a continuous, consumable wire electrode and shielding gas fed through a welding gun.

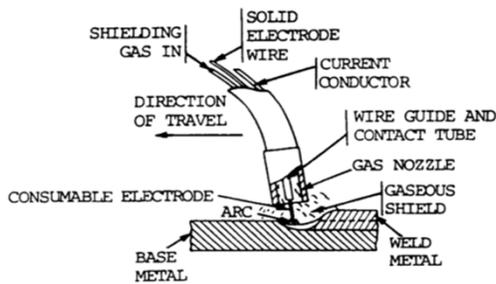
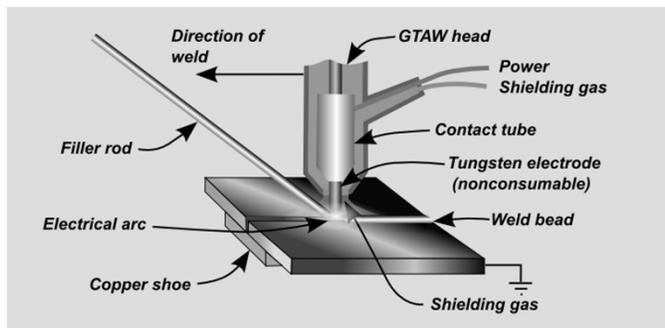


Figure 10-44. Gas metal arc welding process.

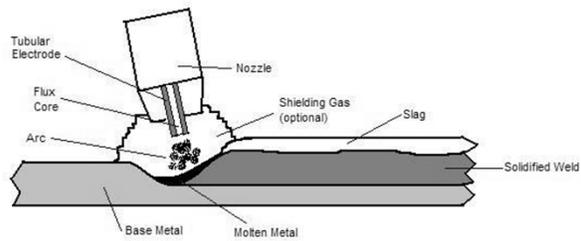
GTAW



Gas Tungsten Arc Welding (TIG):

Creates an arc between a tungsten electrode and the weld pool. Shielding is from an external gas source.

FCAW

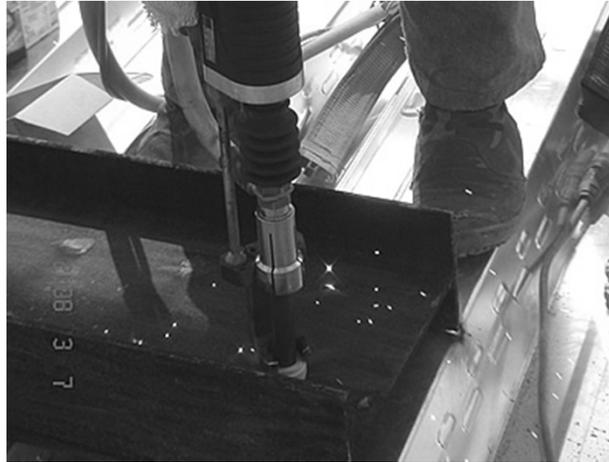


Flux Cord Arc Welding:

Continuous, consumable tubular electrode containing the flux. Constant voltage or current power supply.

Stud Welding

Stud Welding



Stud Welding:

Automatically timed equipment with a ferrule base.

Tests

- Stud Welding Application Qualification Test
- Pre-production Test
- Production Bend Test

Stud Welding Application Qualification Test (AWS D1.5 Chapter 7.6)



Stud Welding Application Qualification Test (AWS D1.5 Chapter 7.6)

- 10 stud specimens to qualify welding Process/Operator.
- 90° Bend Test or 30° & 30° Bend Test on all 10 studs.
- If any of the 10 specimens fail, the test must be repeated.
- Certified Welding Inspector (CWI) will be required to perform bend tests, review the procedure and write a report after completion of welding.

Pre-production Test



Pre-production Test

- 2 stud test specimens required.
- 30 Degree Bend (one way) prior to beginning production welding each day or shift change or when any modification to the welding setup occurs.

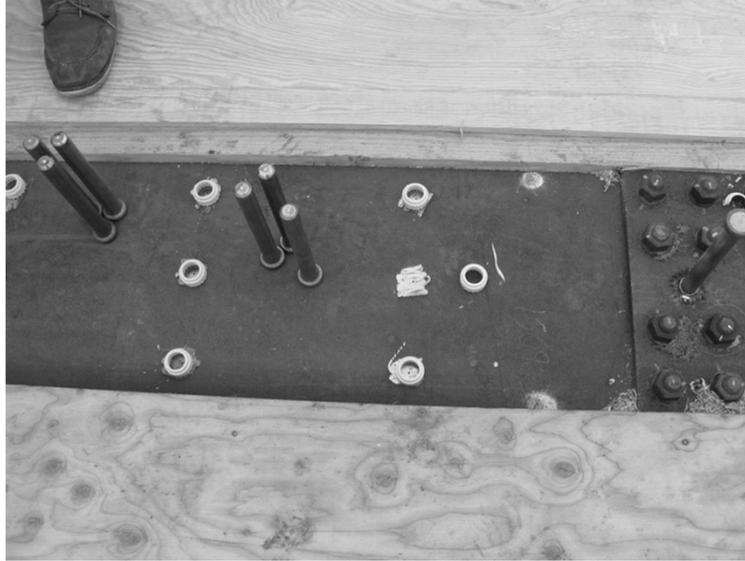
Production Bend Test

- Bend 15 Degrees (one way) any specimen that weld does not go completely around the stud.

Stud Welding

- Stud welding has typically been done in the fabrication shops but now is done in the field on steel girders.
- Keep Studs free of rust, oil, moisture (Chp. 7.4.1)
- Keep Ferrules dry. If wet, oven dry at 250^o for 2 hours (Chp. 7.4.4)
- Repair failed stud locations so surface is smooth and flush (Chp. 7.5)

Prep Surface



Install In Dry



Remove Ferrules & Check Welds



Check Welds

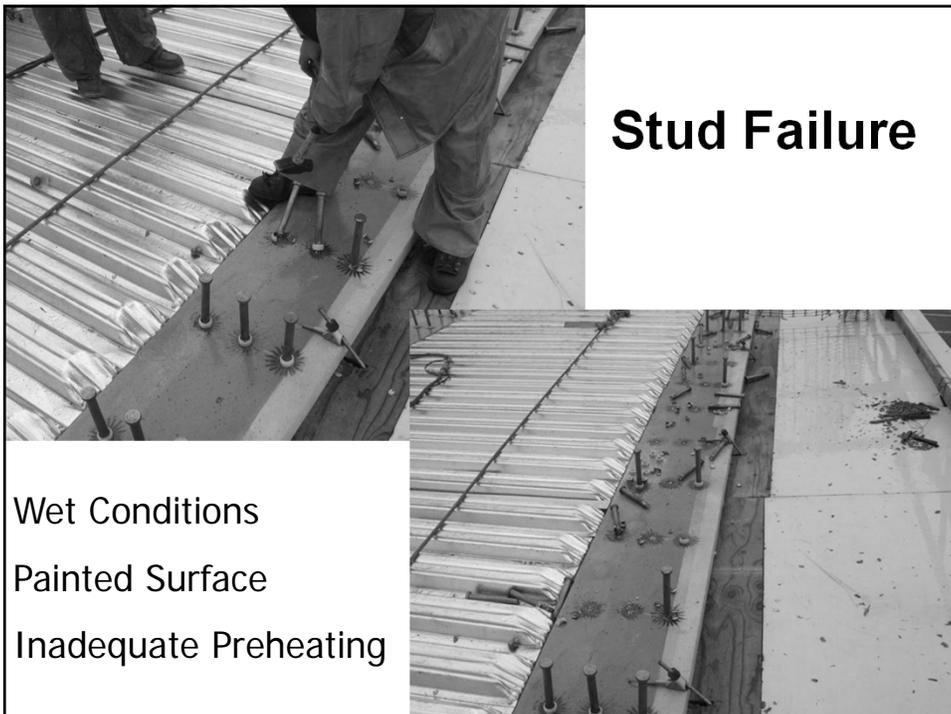


Check Weld

15 Degree
Bend Test
If Not
Complete



Stud Failure



Wet Conditions
Painted Surface
Inadequate Preheating

Stud Failure

- Failure Left Pits & Ridges
- Repair Pits
- Grind Smooth



Stud Failure On A1010 Steel Girder

- Divots left up to 3/8" deep



Repaired Shear Stud Area

AWS 1.5

7.7.5 Repair Tension
Members Flush

7.7.5.2 Compression
members may be faired
by grinding if removal is
lessor of 1/8" or 7% of
material thickness

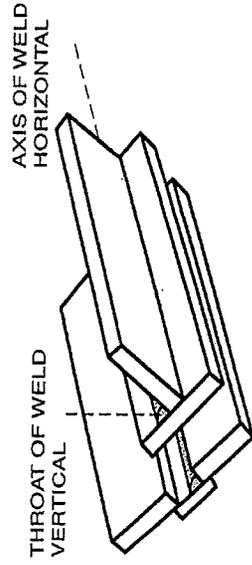


Welding Positions

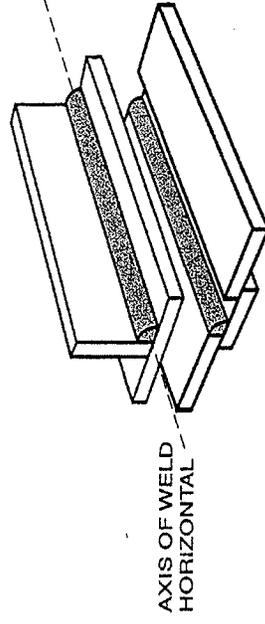
Fillet Weld Positions - AWS D1.5 & D1.1

CLAUSE 4. QUALIFICATION

AWS D1.1/D1.1M:2008

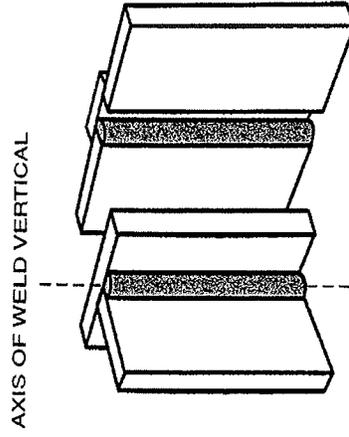


(A) FLAT WELDING TEST POSITION 1F

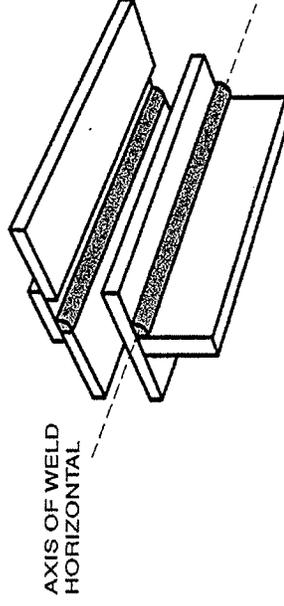


Note: One plate must be horizontal.

(B) HORIZONTAL WELDING TEST POSITION 2F



(C) VERTICAL WELDING TEST POSITION 3F

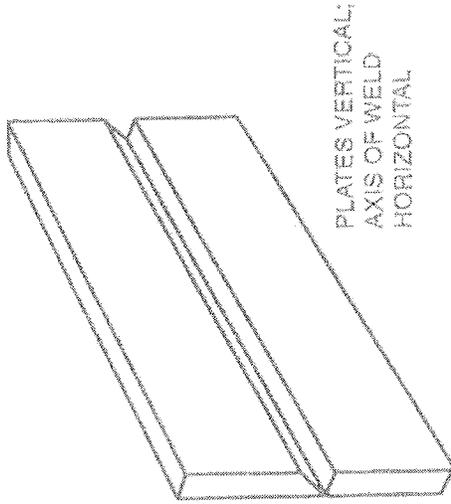


Note: One plate must be horizontal.

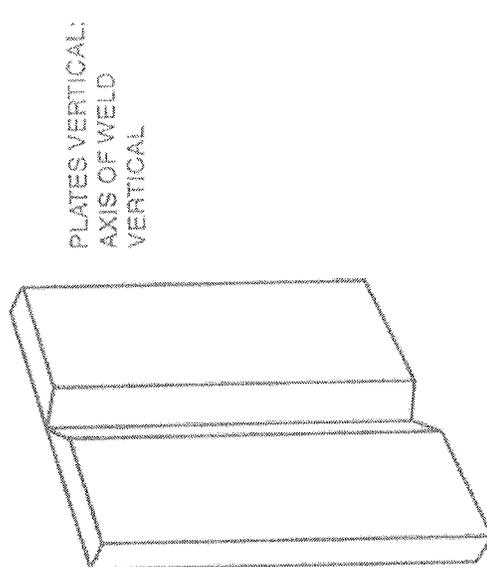
(D) OVERHEAD WELDING TEST POSITION 4F

Figure 4.5—Positions of Test Plate for Fillet Welds (see 4.2.4)

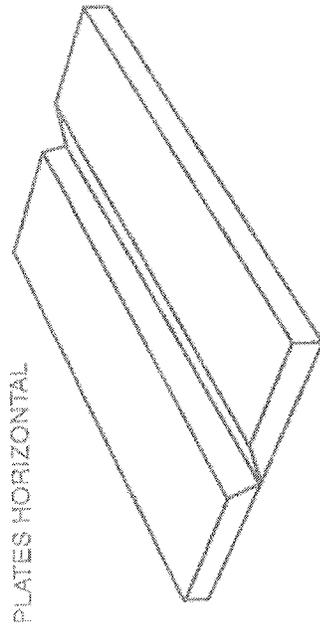
Groove Weld Positions - AWS D1.5 & D1.1



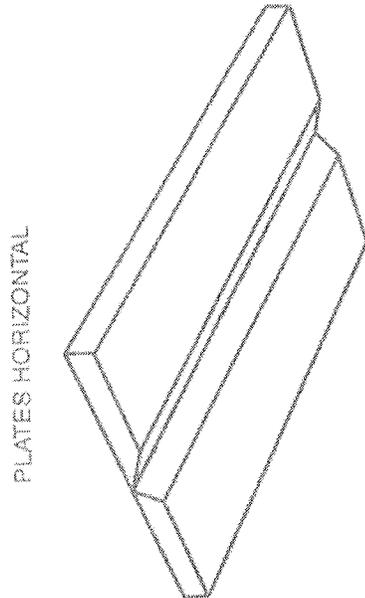
(B) HORIZONTAL WELDING TEST POSITION 2G



(C) VERTICAL WELDING TEST POSITION 3G



(A) FLAT WELDING TEST POSITION 1G



(D) OVERHEAD WELDING TEST POSITION 4G

Table 4.10
Welder and Welding Operator Qualification—Production Welding Positions Qualified by Plate, Pipe, and Box Tube Tests (see 4.18.1)

Qualification Test		Production Plate Welding Qualified			Production Pipe Welding Qualified			Production Box Tube Welding Qualified		
Weld Type	Positions ^a	Groove	Groove	Filllet	Butt Joint		T, Y, K-Connections		Filllet	
		CJP	PJP	Fillet	CJP	PJP	CJP	PJP		
Groove ^b	1G	F	F ^c	(F, H) ^h	F ^c	F ^c	F ^c	F ^c	(F, H) ^h	
	2G	F, H	(F, H) ^c	(F, H) ^h	(F, H) ^{c,e}	(F, H) ^h	(F, H) ^c	(F, H) ^h	(F, H) ^h	
	3G	F, H, V	(F, H, V) ^c	(F, H, V) ^h	(F, H, V) ^{c,e}	(F, H, V) ^h	(F, H, V) ^c	(F, H, V) ^h	(F, H, V) ^h	
	4G	F, OH	(F, OH) ^c	(F, H, OH) ^h	(F, OH) ^{c,e}	(F, H, OH) ^h	(F, OH) ^c	(F, OH) ^h	(F, H, OH) ^h	
	3G + 4G	All	All ^c	All ^h	All ^{c,e}	All ^h	All ^c	All ^h	All ^h	
Fillet	1F			F ^h					F ^h	
	2F			(F, H) ^h					(F, H) ^h	
	3F			(F, H, V)					(F, H, V) ^h	
	4F			(F, H, OH) ^h					(F, H, OH) ^h	
	3F + 4F			All ^h					All ^h	
Plug										
Qualifies Plug and Slot Welding for Only the Positions Tested										
Groove ^a (Pipe or Box)	1G Rotated ⁱ	F	F ^f	(F, H) ^h	F ^f	F ^f	F	F	(F, H) ^h	
	2G ^j	F, H	(F, H) ^f	(F, H) ^h	(F, H) ^{g,f}	(F, H) ^h	(F, H)	(F, H)	(F, H) ^h	
	5G ^j	F, V, OH	(F, V, OH) ^f	(F, V, OH) ^h	(F, V, OH) ^{g,f}	(F, V, OH) ^h	(F, V, OH)	(F, V, OH)	(F, V, OH) ^h	
	6G ^j	All	All ^f	All ^h	All ^{g,f}	All ^h	All	All	All ^h	
	(2G + 5G) ^j	All	All ^f	All ^h	All ^{g,f}	All ^h	All	All	All ^h	
Pipe Fillet	6GR (Fig. 4.27)	All	All ^{d,f}	All ^h	All ^{g,f}	All ^h	All	All	All ^h	
	6GR (Fig. 4.27 & 4.29)	All	All ^{d,f}	All ^h	All ^{g,f}	All ^h	All	All	All ^h	
Pipe Fillet	1F Rotated			F ^h					F ^h	
	2F Rotated			(F, H) ^h					(F, H) ^h	
	4F			(F, H, OH) ^h					(F, H, OH) ^h	
	5F			All ^h					All ^h	

CJP—Complete Joint Penetration; PJP—Partial Joint Penetration

^a See Figures 4.3, 4.4, 4.5, and 4.6.

^b Groove weld qualification shall also qualify plug and slot welds for the test positions indicated.

^c Only qualified for pipe equal to or greater than 24 in [600 mm] in diameter with backing, backgouging, or both.

^d Not qualified for joints welded from one side without backing, or welded from two sides without backgouging.

^e Not qualified for welds having groove angles less than 30° (see 4.12.4.2).

^f Qualification using box tubing (Figure 4.27) also qualifies welding pipe over 24 in [600 mm] in diameter.

^g Pipe or box tubing is required for the 6GR qualification (Figure 4.27). If box tubing is used per Figure 4.27, the macroetch test may be performed on the corners of the test specimen (similar to Figure 4.29).

^h See 4.25 and 4.28 for dihedral angle restrictions for plate joints and tubular T, Y, K-connections.

ⁱ Qualification for welding production joints without backing or backgouging shall require using the Figure 4.24(A) joint detail. For welding production joints with backing or backgouging, either the Figure 4.24(A) or Figure 4.24(B) joint detail may be used for qualification.

^j The qualification of welding operators for electroslag welding (ESW) or electrogas welding (EGW) shall only apply for the position tested.

Notes:

1. Not applicable for welding operator qualification (see Table 4.12).

2. Footnotes shown at the bottom of a column box apply to all entries:

Girder Stiffener To Web Was Welded With SAW Process

- Groove or Fillet Weld?
- What Position Qualifies this weld?
- Welder is qualified SAW 2F, Is he qualified?



Pile Exercise

SMAW (Stick) Welding Process.



Groove or Fillet Weld?

**AWS D1.1 or D1.5?
(00520.43(f)(1))**

What Position Qualifies This Weld?

Welder is Qualified SMAW 1G & 2F. Is He Qualified?

Steel Plate Girder Exercise



**Girder on side & flange
being welded on by SAW.**

Groove Weld or Fillet Weld?

AWS D1.1 or D1.5?

Welding Position?

**Welder is Qualified SMAW
1G & 2F. Is He Qualified?**

Field Welding

Contractor Responsibilities:

AWS D1.5 & D1.1 Section 6 – Inspection:

Contractor shall perform inspection and testing prior to assembly, during assembly, during welding and after welding (NDT) as necessary to assure material and workmanship conform to the requirements of the contract documents.

Field Welding

ODOT QA Inspector Responsibilities:

- Review submittal package – Assure proper documentation is provided (includes WPS, PQR, MTR's, WQTR, etc.).
- Forward copies of welding submittals to: Steve Lovejoy (503-986-3326).
- Welding submittals for QA Inspection to: Jim Sabel (971-673-7007)

Field Welding

ODOT QA Inspector Responsibilities:

- Assure proper QC Inspection by the Contractor.
- Perform appropriate QA Inspection including but not limited to:

Fit Up, Equipment Setup, In Process Welding, WPS Compliance, Post Welding Visual (including Weld Size, Profile, Defects etc.), review NDT Reports as necessary.



American Welding Society Welding Symbol Chart

Basic Welding Symbols and Their Location Significance								
Location Significance	Fillet	Plug or Slot	Spot or Projection	Stud	Seam	Back or Backing	Surfacing	Edge
Arrow Side								
Other Side				Not Used			Not Used	
Both Sides		Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	
No Arrow Side or Other Side Significance	Not Used	Not Used		Not Used		Not Used	Not Used	Not Used
Location Significance	Square	V	Bevel	Groove			Scarf for Brazed Joint	
Arrow Side								
Other Side								
Both Sides								
No Arrow Side or Other Side Significance		Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used
Supplementary Symbols				Location of Elements of a Welding Symbol				
Basic Joints				Identification of Arrow Side and Other Side Joint				
Butt Joint		Corner Joint						
T-Joint	Lap Joint	Edge Joint	Letter Designations	<p>Where letter designations are to be included in the tail of the welding symbol, reference is made to Table 1, Letter Designations of Welding and Allied Processes and Their Variations, of AWS A2.4-98.</p> <p>American Welding Society 550 N.W. LeJeune Road Miami, Florida 33126</p>				

