Welding Procedure Specification's (WPS)

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What Is Welding?

AWS defines welding as:

“ The art and science of joining metals by using the intrinsic adhesive and cohesive forces of attraction that exist within metals”.

Welding, Brazing, Soldering

Does not include mechanical fastening such as bolts, rivets, screws, etc.

When Did Welding Begin?

Pressure Welding of Noble Metals

Over 2,000 years ago

Forge Welding

Blacksmiths

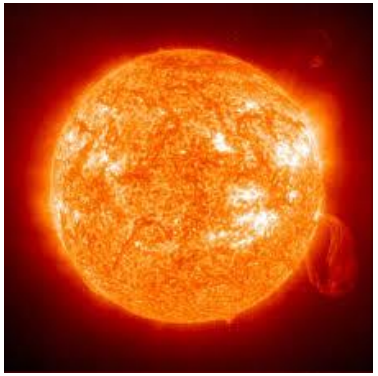
Over 1,000 years ago

Modern Welding

1880’s

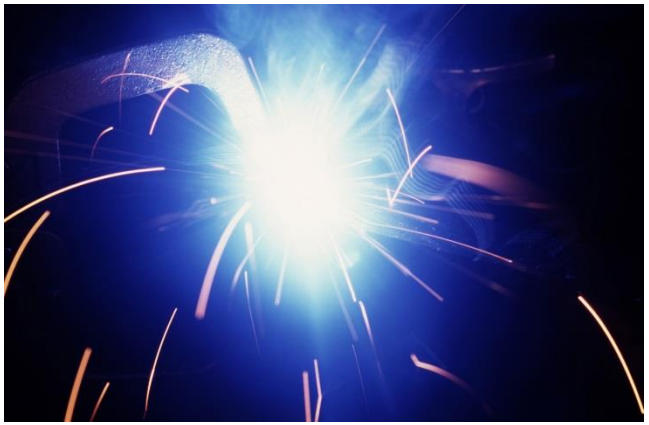
Interesting Fact

Temperature Of The Sun?



9,941°F

Temperature Of The Arc?



12,632°F

WELDING PROCEDURES

- What Is a Welding Procedure?
- Why Have Welding Procedures?
- Who Should Have Welding Procedures?
- What Information Should Procedures Contain?
- How do we know If Our Procedures Are Good?

What Is A Welding Procedure?

- A document that contains important variables on how to make the weld in question.

Welding Procedure Specification

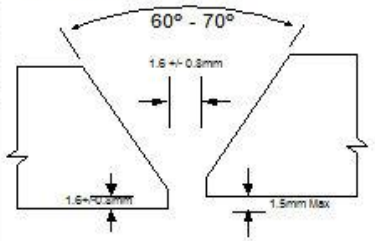
Client:	**Mobil**	Project:	**221010Goatee**	REF No.	**WPS 6 R1**

Procedure Description:	**12" Heavy Wall Offshore Tie-in**			**0290/1/WPS5**	
Material:	**AS3679.1 Grade 250API 5L X65**	Diameter:	**168.3**	Thickness:	**18.3**
Position:	**6G**	Clamp Type:	**Internal**		
Preheat °C (Min):	**100**	Interpass °C (Max):	**300**		

	ROOT	**HOT PASS**	**FILL & CAP**
Welding Process	**SMAW**	**SMAW**	**SMAW**
Welding Direction	Vertical Down	Vertical Down	Vertical Down
Filler	Lincoln SA70+	Lincoln SA70+	Bohler BVD90M
Polarity	DC +ve	DC +ve	DC +ve
Shielding Gas	N/A	N/A	N/A
Purge Gas	N/A	N/A	N/A

Pass No	Filler Size (mm)	Amps	Volts	Speed (mm/sec)	Heat Input (kJ/mm)
1	3.2mm	70-130	18-33	3.3-6.6	0.4-0.8
2	4.0mm	110-210	18-35	2.9-6.8	0.6-1.3
FILL	4.0mm	145-260	16-27	1.6-7.0	0.6-2.2
CAP	4.0mm	130-230	16-26	1.8-5.3	0.6-1.7

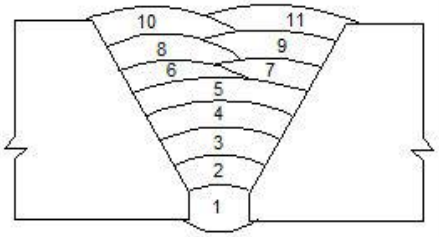
Weld Preparation



NOTES

1. API Std 1104BP3094-SP-PL-3010R1
2. Clamp removal stage : **100% completion of root (external clamp may be used in the event of a breakdown – removed after 50% minimum completion of the root.)**
3. Time lapse between root and second pass : **16 Minutes**
4. Time lapse between second pass and 1st fill : **12 Minutes**
5. Minimum number of passes before pipe movement : **2 passes**
6. Minimum number of passes before break in welding : **3 passes**
7. Minimum Number of welders- **Root & second pass: 2 , Fill & Cap : 1**
8. Method of cleaning : **Grinder / Wire brush**
9. Method of Preheat : **Gas Torch**
10. Qualification reference number : **48280/PP/WP6 R1**

Pass Location



Company Welding Engineer Approved ..... **Approved for Client** .....

Why Have Welding Procedures?

- Required By Code
- Proves To Engineers & Regulators You Know What You Are Doing
- Helps To Produce Quality Welds

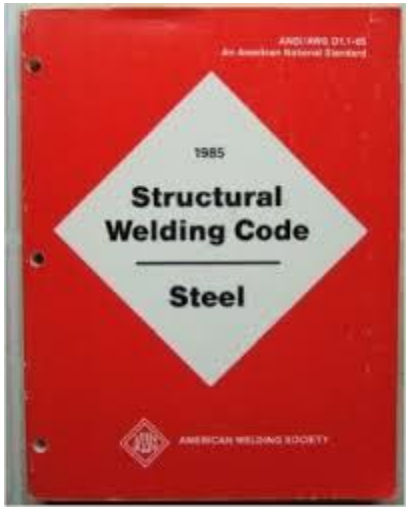
Who Should Have Welding Procedures?

- Manufacturing
  - Automotive
  - Heavy Equipment
- Pipeline Industry
- Construction

What Information Should I Include?

Important Information

- Governing Code
  - API, AWS, ASME, ISO
  - Foreign Codes



Important Information

- Material Parameters
  - Spec & Grade
  - Wall Thickness
  - Size (Diameter)
  - Yield/Tensile Strength
  - Metallurgical Concerns

Important Information

- Welding Process
  - GMAW (MIG), GTAW (TIG), SMAW (STICK)
  - Automated Or Not?

Important Information

- Process Parameters
  - Volts, Amps, Travel Speed
  - Travel Direction
  - Polarity
  - Wire Welding Transfer Mode
    - Globular, Spray, Short Circuit, Plasma
    - Flux Core or Shielding Gas
  - Number of Passes
  - Number of Welders
  - Electrodes

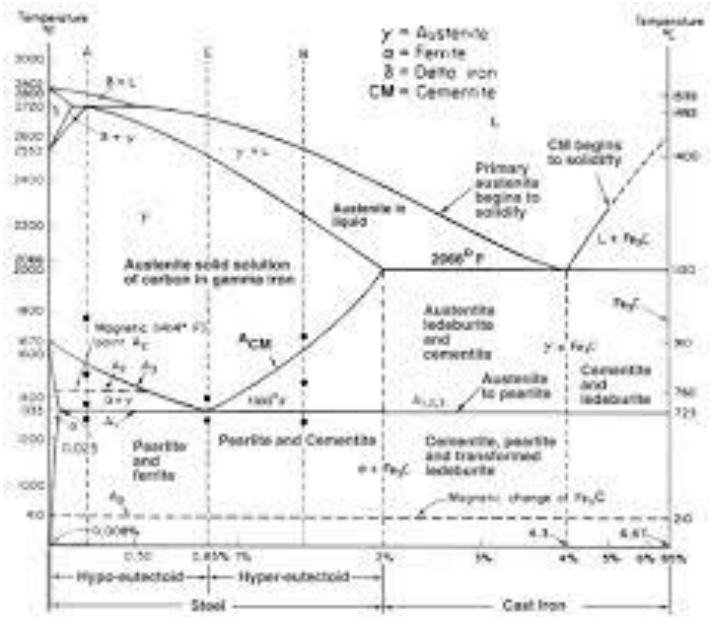
    Size

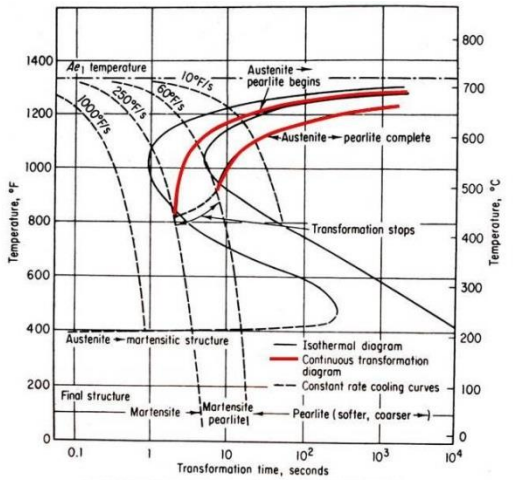
    Group Number = 1, 2, 3, etc.

    AWS Specification = A5.1, A5.5, etc.

Important Information

- Pre/Post Weld Heat Treatment
  - Temps
  - Time
  - Cooling Rates
  - Heat Input
  - Time Interval Between Passes

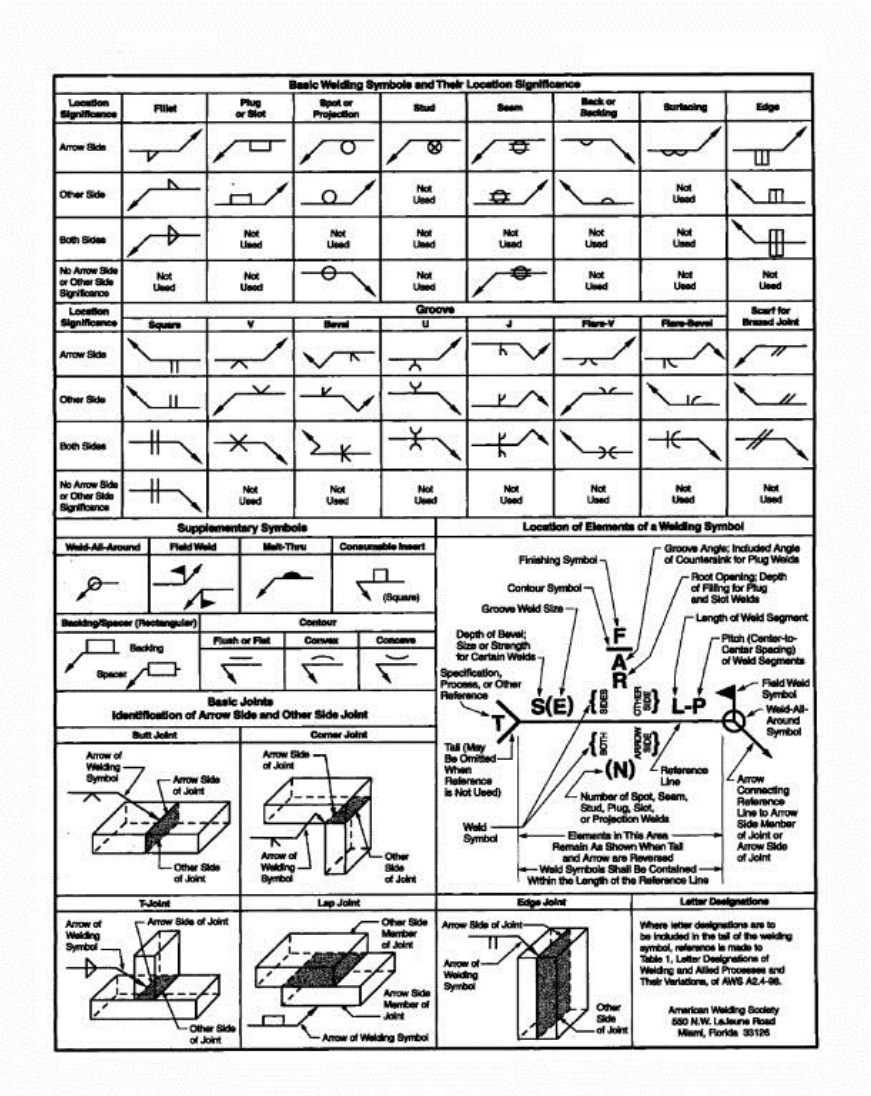




Continuous Cooling-Transformation (C-T) Diagram
(Derived from the isothermal-transformation diagram for a plain-carbon eutectoid steel)

Important Information

- Joint Design
  - Material Thickness
  - Joint Type
  - Bevel Angles
  - Root Opening Dimension
  - Backer Rods
  - Etc.



Important Information

- Filler Metals

E 6010

E = Electrode

60 = Tensile Strength (60,000psi)

1 = All Position

0 = Type Of Coating & Polarity

Cellulose, Low Hydrogen, Potassium, etc.

Important Information

- Cleanliness
  - Joint Cleaning
  - Coating Removal
  - How to Remove Coatings
- Joint Fit Up
  - Line Up Clamps
  - Internal or External

Procedure Qualification Record

- Lab Report
  - Parameters/Materials
  - Info Made for Each Pass
  - Ambient Conditions

SAMPLE PROCEDURE QUALIFICATION RECORD (PQR)
for SAW, SMAW, GMAW, GTAW, FCAW

Company _____ Approved by _____ (Signature Required)
PQR No. _____ Date _____
Welding Process(es) _____ Type(s) _____ (Manual, Semiautomatic, Automatic, Robotic, Mechanized)

Joints (see 4.14.1)

Joint Type _____
Backing _____
Backing Material (Type) _____
Groove Angle _____
Root Opening Radius: U ☐ J ☐
Root Face _____
Backgouging: Yes ☐ No ☐
Backgouging Method _____

Joint Details

Sketches, production drawings, welding symbols, or written description should show the general arrangement of the parts to be welded. Where applicable, the root details of the weld groove may be specified.

Base Metals (see 4.14.2)

M-No. _____ Group No. _____ or to M-No. _____ Group No. _____
Specification Type and Grade _____ to Specification Type and Grade _____
Thickness Range of Base Metal: Groove _____ Fillet _____
Pipe Diameter Range: Groove _____ Fillet _____
Other _____

Filler Metals (see 4.14.3)

Filler Metal F-No. _____ Other _____
AWS Classification _____ AWS Specification _____
Weld Metal Analysis A-No. _____ Other _____
Filler Metal Size _____ Electrode Flux (Class) _____
Weld Metal Thickness _____ Flux Trade Name _____
Consumable Insert _____ Other _____

Positions (see 4.14.4)

Position(s) of Groove _____
Position(s) of Fillet _____
Weld Progression _____

Preheat (see 4.14.5)

Preheat Temperature (Min.) _____
Temperature (Max.) _____

PWHT (see 4.14.6)

Temperature _____ Time _____

Shielding (see 4.14.7)

	Torch Shielding	Root Shielding	Trailing	Environmental Shielding
Gas(es)				
Composition				
Flow Rate				

Figure F.3—Example of a Procedure Qualification Record

Procedure Qualification Record

Testing Reports

AWS B2.1/B2.1M:2009

Electrical Characteristics and Welding Parameters (see 4.13.8)

Current Type/Polarity _____
Pulsing: Yes ☐ No ☐
Current (Range) _____
Voltage (Range) _____
Wire Feed Speed (Range) _____
Travel Speed (Range) _____
Tungsten Electrode Size/Type _____
Transfer Mode _____
Pulsing Parameters _____
Heat Input _____
Other _____

Other Variables (see 4.14.9)

Cup or Nozzle Size _____
Collet Body ☐ or Glass Lens ☐
Cleaning Method _____
Technique: Stringer ☐ or Weave Bead ☐
Number of Electrodes _____
Number of Passes per Side _____
Other _____

Test Results

Visual Test Results _____

Tensile Results

Specimen No.	Width	Thickness	Area	Results				Failure Type and Location
				Yield Load	Yield Strength	Tensile Load	Tensile Strength	

Guided Bend Tests	Qualification Results for Toughness Application
Type and Figure Number	Type and Figure Number
Results	Results

Fillet Weld Tests	Other Tests
Type and Figure Number	Type and Figure Number
Results	Results

We, the undersigned, certify that the statements in this record are correct and the test welds were prepared, welded, and tested in accordance with the requirements of AWS B2.1/B2.1M, (_____), *Specification for Welding Procedure and Performance Qualification.*
(year)

Manufacturer or Contractor _____

Date _____ By _____ _____
Please Print Signature Required

Figure F.3 (Continued)—Example of a Procedure Qualification Record

Welder Qualification

- Three Welder Testing Procedures

  API 1104

  Field Welding

  ASME Section 9

  Fab Shop Welding

  Part 192-Appendix C

  Low Stress

  12 Inch And Less Pipe

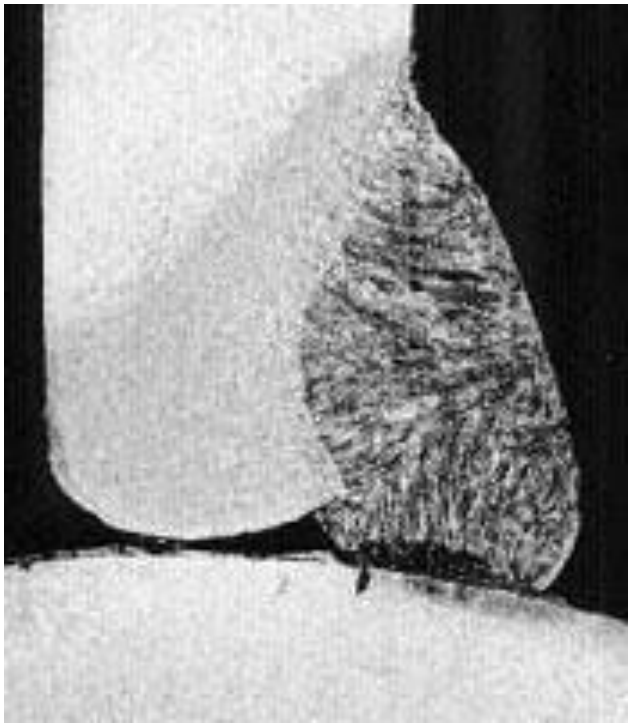
Welder Qualification

- Initial Test
  - Initial Test = Destructive
- 6 Month Retest
  - Non Destructive
  - Compressor Station & Components
    - » Part 192.229
    - » Destructive Only
- If a Welder Performs a Procedure Qualification, Is The Welder Also Qualilfied?

Weld Quality

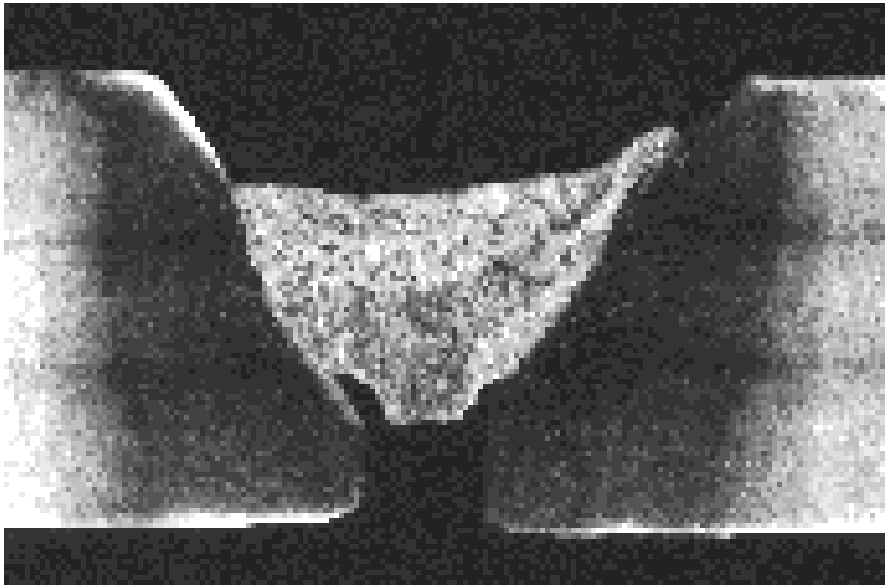
Weld Quality

- Lack of Fusion



Weld Quality

- Lack of Penetration



Weld Quality

- Porosity

Weld Quality

- Under Cut

Welding Safety

- Eye Safety
    - Wear a Hood
- Skin Safety
    - Burns
        - » Wear Sun Screen - SPF 45
- White Wall Effect

Conclusion

- Comments Or Questions?