WLD 225
Gas Tungsten Arc Welding (Mild Steel) Pipe II

Index

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Course Assignments

Reading
Welding Principles and Applications, by Larry Jeffus
Gas Tungsten Arc Welding of Pipe
Packet Information Sheets

Writing Work Sheets
Welding Vocabulary

Video Training
Pipe Welding Made Easy GTAW/SMAW 6G and 5G

Welding Projects
6G Butt - Single Vee Grove Weld - Open Root (pipe)
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Final Exam
Part One (Closed Book Exam)
Part Two (Practical Exam)

Required Texts
Welding Principles and Application, by Larry Jeffus

Outcome Assessment Policy:
The student will be assessed on their ability to demonstrate the achievement of course outcomes. The methods of assessment may include one or more of the following: oral or written examinations, quizzes, written assignments, visual inspection techniques, welding tests, safe work habits, task performance and work relations.

Math

on

Metal

The Welding Fabrication Industry needs qualified welder fabricators who can deal with a variety of situations on the job. This portion of the training packet explores math as it relates to industry requirements.

Calculating Welding Consumable Costs for Gas Tungsten Arc Welding

Welding consumables are materials that are used up or consumed in the process of welding. They include electrodes, filler rod, flux, wire and shielding gases, etc. Consumable costs will be different for each different type of welding and for each individual job. The consumable costs, when added to labor, overhead and power costs will give you the total cost of a job.

In calculating consumable costs you need to look at the cost of:

- Electrodes
- Filler rods
- Shielding gas

Electrodes and Filler Rods

There are two types of electrodes. Those that are consumable (i.e. stick electrodes) and those that you use with filler rods (i.e. E70S-6). Non-consumable electrodes still get used up because they eventually are damaged in the welding process. The less experience a welder has the more electrodes they will use.

Electrode consumption per foot of weld is preferably taken from floor experience. Remember only about 65% to 75% of the consumable electrode is actually deposited in the weld. (***This is called deposition efficiency***.) The rest is lost to coating, spatter and stub loss. Stub loss ranges from 2 inches up to 4 inches per length of filler metal in TIG welding. A typical stub loss length considered reasonable for stick electrode welding is 2 inches and 4 inches for TIG welding. When you are figuring out how many sticks you need you must remember that about 1/3 of the filler metal will not be used.

This holds true for filler rod. 25%-35% of a typical rod is lost to coating, spatter and stub loss.

The following rods are among the most common ones used in the PCC's welding shop.

The following specifications are for 1/8" diameter rod.

7018 13 pieces per pound. Deposit rate of 1.7 pounds per hour with an efficiency rate of 66.3%

7024 9 pieces per pound. Deposit rate of 4.2 pounds per hour with an efficiency rate of 71.8%

6010 17.3 pieces per pound. Deposit rate of 2.1 pounds per hour with an efficiency rate of 76.3%

6011 17.3 pieces per pound. Deposit rate of 1.3 pounds per hour with an efficiency rate of 70.7%

6013 17.1 pieces per pound. Deposit rate of 2.1 pounds per hour with an efficiency rate of 73%

Determining the Amount of Consumable Electrode or Filler Rod You Will Use

To figure out how many rods you would actually use in an hour, given the rate of deposition (the amount of material laid down in the weld) and the efficiency rate (the percentage of the rod that is laid down in the weld), we will again use the box method.

Look at the first example of 1/8" filler rod E7018. It states that the deposit rate is 1.7 lbs per hour and the efficiency rate is 66.3%.

Another way to say this is that we know that 1.7 lbs per hour is 66.3% of the filler rod that was used in an hour. You need to determine how many lbs of rod were actually used, or what equals 100%. (the amount laid down + the amount wasted)

#of lbs per hr.	%	
1.7	66.3	= (1.7 x 100) ÷ 66.3
?	100	= 2.56 lbs per hour

let's try one more.

E6011 filler rod has a deposit rate of 1.3 lbs per hour and an efficiency rate of 70.7%. What is the total amount of filler rod used in one hour?

#of lbs per hr.	%	
1.3	70.7	= (1.3 x 100) ÷ 70.7
?	100	= 1.84 lbs per hour

If the weld job required more than one hour, you would multiply the number of hours by the total amount used per hour.

Try one more on your own.

#7024 rod has a deposition rate of 4.2 lbs per hour and an efficiency rate of 71.8%. What is the total amount of filler rod used?

#of lbs per hr.	%
	100

__________lbs per hour

To calculate the cost of non-consumable electrodes you must know the following.

- Type of electrode
- Electrode diameter
- Cost per stick
- How many sticks you will use for a given job

How many sticks you use in a given job of course depends on the size of the weld but also on the experience of the welder. A new student could easily go through a stick a day because of contamination and the need to re-sharpening the stick every time it sticks to the metal, whereas an experienced welder might make the same stick last for 40 hours.

In order to calculate the cost of a consumable electrode you must know:

- Type of consumable electrode or stick
- Number of sticks per lb
- Deposit rate in lbs per hour
- Efficiency rate
- Cost per lb

In order to calculate the cost of filler rod you must know:

- Type of filler rod
- Number of rods per lb
- Deposit rate in lbs per hour
- Efficiency rate
- Cost per lb

To calculate the cost of shielding gas you need to know:

- Type of gas
- Required flow rate in cubic feet per hour (cfh)
- Amount of time you will be spend welding on a given job
- Number of cubic feet per bottle
- Cost per bottle

Sample Calculation

Let's figure out what the consumables will cost for a typical job that requires 24 hours of welding. The following is a list of some things you should know about the materials we would use on this sample job.

- Non-consumable electrode
- Electrode diameter ---3/32"
- Cost per stick----------$2.
- How many electrodes you will use for a given job------3 sticks (inexperienced welder)
- Type of filler rod you will use- E7OS-6
- Filler rod diameter 1/8"
- How many lbs of filler rod you will consume given deposition efficiency?

- Cost per lb of filler rod \$2.50
- Type of gas---------- Argon
- Flow rate in cubic feet per hour (cfh) 30 cfh
- Number of cubic feet per bottle---------270cf per bottle
- Cost per bottle---------\$29

Cost of electrode = estimated number of electrodes you will use **x** cost of each electrode.

= 3 electrode x \$2.00 = \$6.00

Cost of filler Rod = estimated number of lbs of rod you will consume per hour x number of hours x cost per lb.

Say we use 1/8" rod E70S-6 with an average deposit rate of 1.7 lbs per hour and an efficiency rate of 66.3%.

The job requires 24 hours of welding

The filler rods cost \$2.50 per lb.

#of lbs per hr.	**%**	
1.7	66.3	= (1.7 x 100) ÷ 66.3
?	100	= 2.56 lbs per hour

2.56 x 24 x \$2.50 = cost of filler rod for this job
= \$ 153.60

Number of bottles of gas needed = numbers of hours of welding **x** flow rate ÷ cubic feet per bottle.

= (24hrs. **x** 30 cfh) ÷ 270cf

= (720) ÷ 270

= 2.66 bottles (Note: you must round this number up to the next whole bottle because you cannot purchase partial bottles.)

= 3 bottles

Cost of shielding gas = 3 bottles **x** \$29 per bottle

= \$87

Total Cost of welding consumables for this job:

Cost of electrode + cost of filler rods + cost of shielding gas = total cost
\$6.00 + \$153.60 + 87 = \$246.60

Calculating the Cost of Electrodes, Filler Rods and Shielding Material in WLD 225 #1

Name: ___________________________________ Date: ______________

This packet specifies that you will use:

- 1/8” 2% Thoriated Tungsten Electrodes -- $4.73 per stick
- Argon shielding gas set at 20-25 cubic feet per hour (cfh)--$29 per 270 cf bottle
- Filler rods (filler metals) ER-70S-6 and E-7018

For the purposes of this lab we will calculate the cost of materials after you have completed the welding.

Record the following:

1. Amount of time you spent actually welding: _________________________hrs.

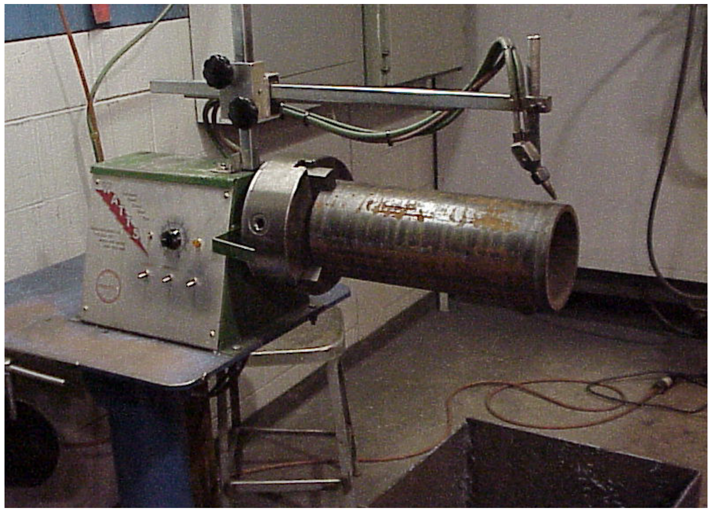
2. Number of electrodes you consumed in the welding process:______________sticks

3. Number of filler rods you consumed in the welding process________________rods

When you have completed the welding calculate the cost of the electrodes, filler rod and shielding gas that you have used.

4. Cost of filler rods ___________________________________
5. Cost of shielding gas_________________________________

Watts Pipe Cutter Information Sheet



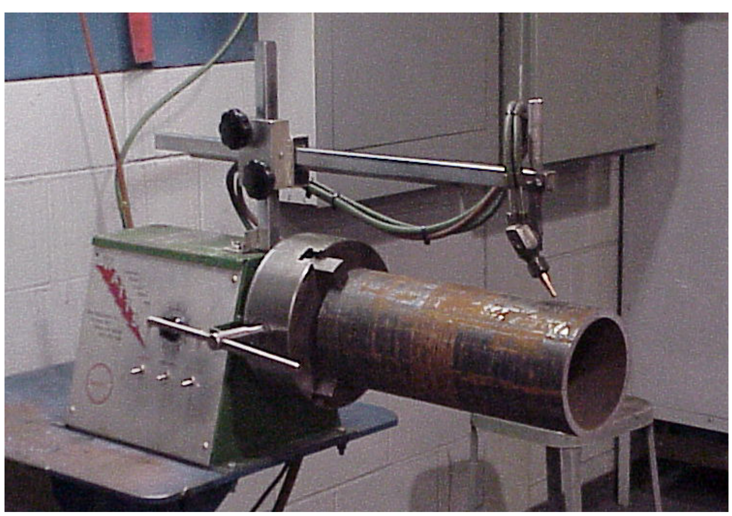
- The Watts pipe beveler uses oxygen and acetylene gas to flame cut pipe bevels. All safety procedures that apply to the track burners and hand torches will apply with this pipe beveler.

- Place pipe in jaws and snug jaws down with T-bar wrench.

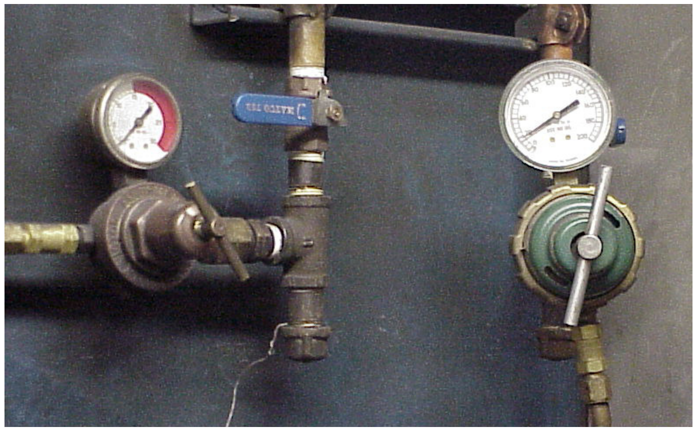
- Swivel cutting head over pipe ensuring there is approximately ¾" clearance between the cutting tip and pipe.

- Slowly hand rotates the pipe referencing the cutting tip to pipe wall distance. For a quality cut this variation should not exceed 1/16". Make adjustments when necessary.

- Tighten jaws after alignment is completed.

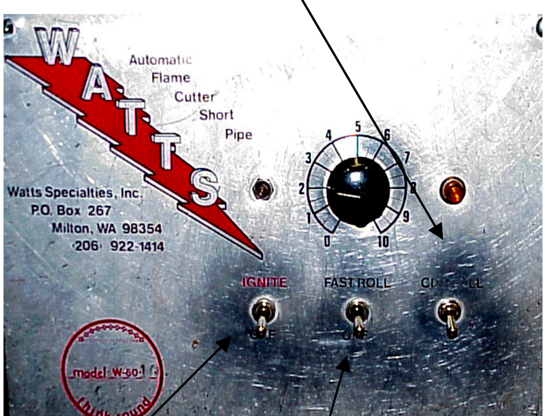


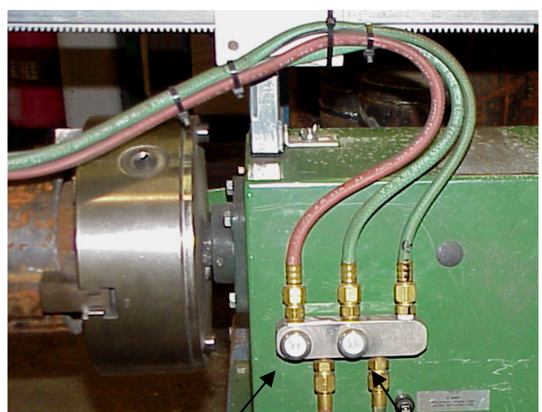
- Turn on manifold and adjust cutting pressures. A good starting point is 5 psi for Acetylene and 40 psi for Oxygen.



- Turn the *Ignite toggle switch* ON and open the acetylene needle valve on the backside of the unit. Light the torch and adjust the acetylene flame so the heavy soot disappears.

Cut Roll Switch





Ignite Switch **Fast Roll Switch**
Front Side

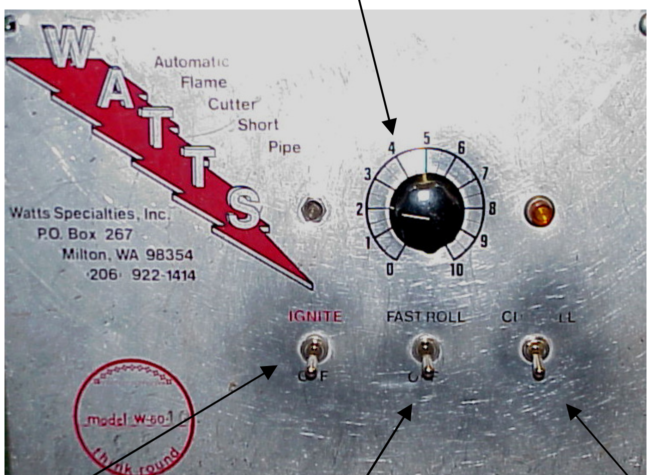
Acetylene Valve **Oxygen Valve**
Back Side

- Add oxygen, and adjust to a neutral flame.

- Turn the *Cut and Roll toggle switch* ON and adjust to a neutral flame. When adding the cutting oxygen, the fuel gas to oxygen ratio changes, thus requiring the need to readjust to a neutral flame.

- Once flame is adjusted, the manual needle valves do not need to be turned off each time. Use the *Ignite toggle switch* to turn ON and OFF the torch.

Rotation Speed Control



Ignite Toggle Switch **Fast Roll Switch** **Cut Roll Switch**

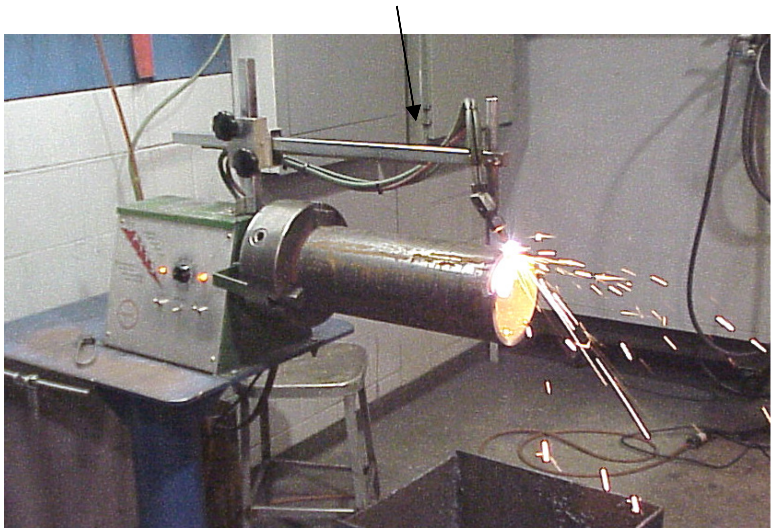
- Light torch and align head over the pipe. Use the *Fast Roll toggle* switch and preheat the pipe by having it rotate 360 degrees. Once pipe is preheated let the torch set idle over one area to heat the kindling temperature (cherry red).

  Helpful Hint: Clamp vice grips at the cutting start point. This is a good visual reference for when the pipe cut will be completed as well as a tool to catch the pipe coupon.

- Once pipe is cherry red, turn the *Cut and Roll toggle switch* on and the cut will begin.

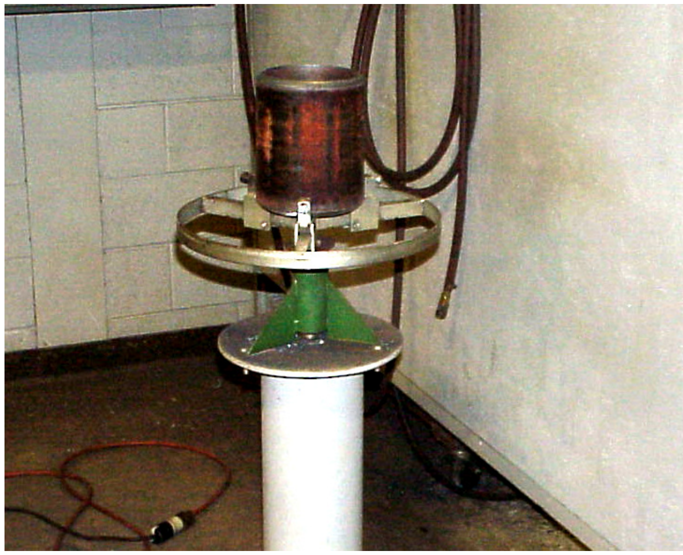
  Helpful Hint: Once flame pierces through the pipe, adjust the torch back slightly to remove the starting flaw.

Torch Extension Arm



- Once pipe cut is completed, adjust torch extension arm back to make additional cuts or remove pipe coupon and replace with next coupon and complete the cutting process.

Watt's Pipe Grinding Station Information Sheet



- Ensure pipe is cool enough to touch before handling it.
- Mount pipe in the rotating fixture ensuring that it is mounted concentrically.
- Tighten the thumbscrew ensuring that the pipe is secure.

Thumb Screws

- Hand starts the pipe fixture rotation and then begin grinding the groove face.
- Ensure grinder has enough clearance, so it does not hit or catch on the rotating fixture.

- Do not let the fixture rotate too fast. Slow it down frequently so that the pipe is not thrown from the fixture.

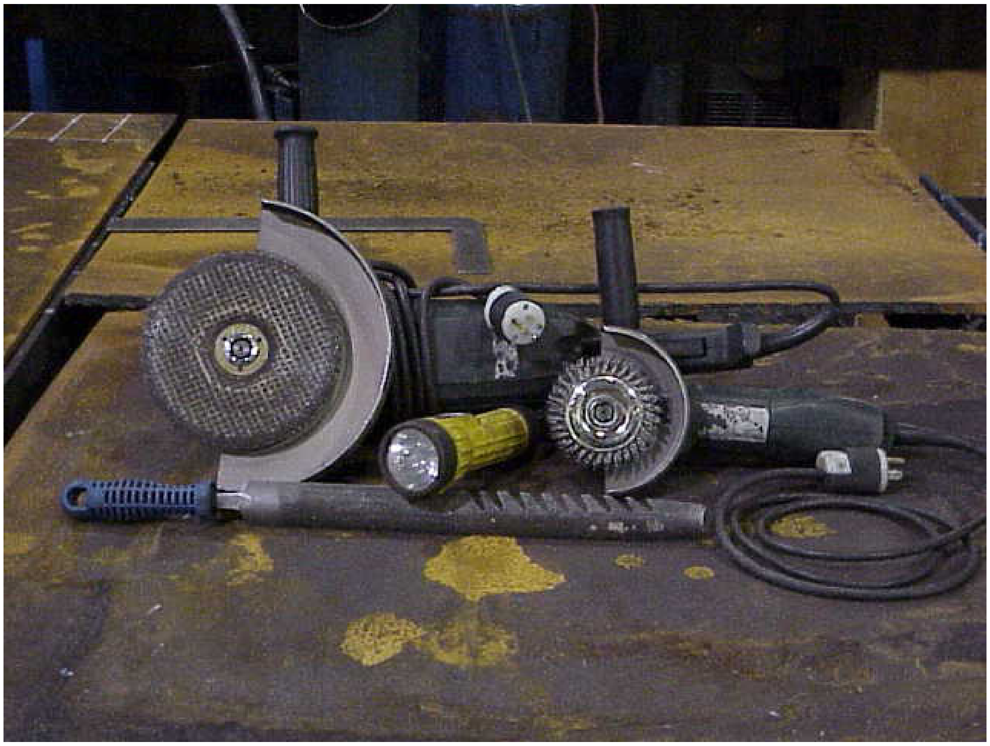
- Ensure the grinder is placed in such a manor that the sparks are shooting downward.

- Ensure screens are in place so no by standers are showered with sparks.

- Grind the groove face to a mirror image. Also, polish the internal and external surfaces to prevent contamination pick up. Remember to grind the groove face to a "knife edge." In general, no root face is needed for the GTAW root pass application unless the welder prefers

- Once the grinding and polishing operation is completed, remove pipe coupon and replace with next coupon and complete the preparation process again.

Pipe Welding Power Tools



At a minimum a pipe welder should have:

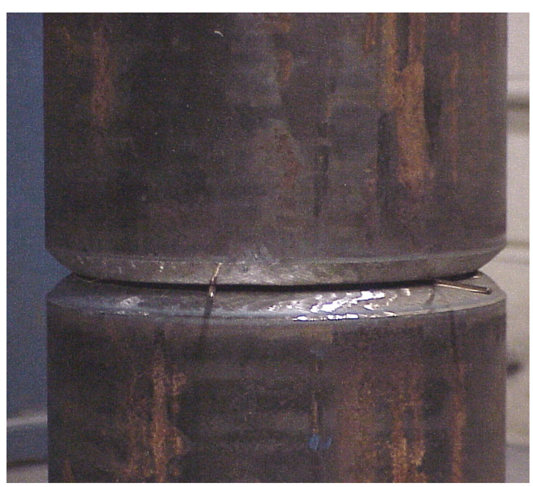
- Two 9 inch grinder for pipe that is 6 inches and larger (one with a notching wheel and one with a wire wheel).
- Two 4 ½ inch grinder for 4 inch pipe and smaller (one with a notching wheel and one with a wire wheel).
- File with "teeth ground in it" used for slag removal and for smoothing the toes of the cover pass ***(Do Not Use a Chipping hammer on Pipe)***.
- Flash light for inspection purposes.

Fitting up the Pipe

"Dry" fit pipe together by rotating top pipe on the bottom one to determine best fit-up to eliminate high-low condition and excessive root opening. Once the best fit up is determined, draw a soap stone line to indicate placement of pipe coupons once the spacer is put into place.

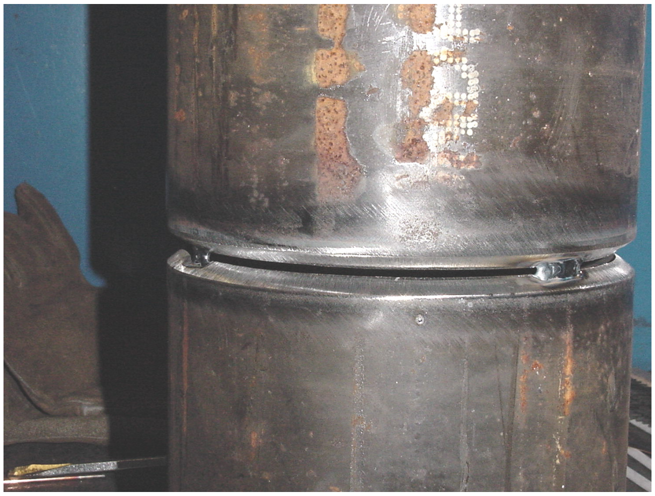
High Low
A ***high-low*** condition refers to the pipe material being offset at the root area. This is due to each pipe coupon not being a perfect circle. The ASME Code only allows 1/16" for high low.

Place a spacer wire between the pipes for the proper root opening and place the pipe coupons back together as previously determined.



Make the first tack weld ¼" to ½" long between the open ends of the spacer wire. The first tack should be a maximum of ½" long to help control distortion. The remaining three tacks should be ¾" long for 6 inch diameter pipe.

Remove the spacer wire and reposition it as shown and weld the second tack opposite of the first tack (this is referred to as *diametrically opposed* to the first tack).



Tack weld the two remaining sides starting with the wider of the two sides. At this point the pipe should have one tack weld at 12, 3, 6 and 9 o'clock positions.

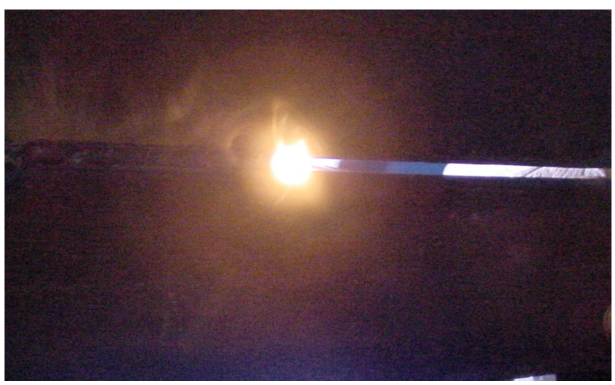
Use a hand grinder with a 1/8" thick notching wheel to feather (ramp) the tacks. Too much grinding on the ends of the tack will potentially cause burn through when welding the root pass.

Minimal grinding is all that is needed for each end of the tack.

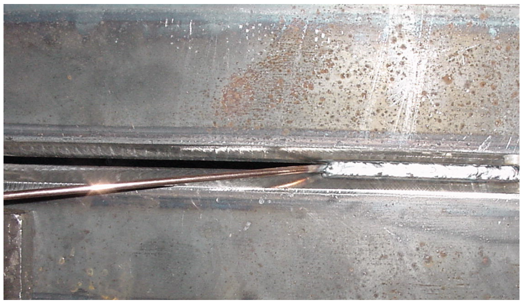
5G and 6G Gas Tungsten Arc Welding Technique for the Root and Second Passes

Place the pipe in the fixture in the 5G or 6G position to be welded.

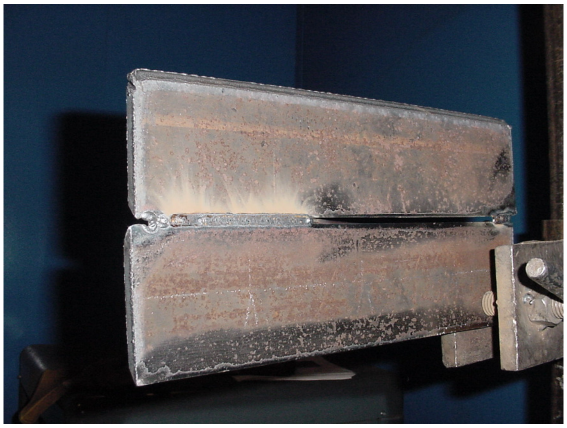
Place the filler metal at the end of the tack weld and strike the arc over the tack weld. Start "walking the cup" to advance the torch forward. Once the tungsten melts the end of the tack weld push the filler metal into the tack weld slightly to ensure complete penetration. Using a slight rotating pushing technique will assist in adding the filler metal to achieve complete penetration at this junction. Be careful to not add too much filler metal at this point because this will lead to excessive penetration.



Advance the torch forward by wiggling/walking the cup and consuming the wire. This technique requires the wire to be submerged into the puddle while the arc oscillates over it fusing it into the knife-edges of the root.



There is ***no distinctive sound*** as an indicator of 100% penetration while applying the root pass with the GTAW process. The welder has to ensure the filler metal is centered in the bottom of the root and is being fused to the root surface. An indicator that 100% penetration is being obtained is a line that develops in the center of the root bead while welding is taking place. If the welder can view this during welding, s/he will know 100% penetration is being obtained.



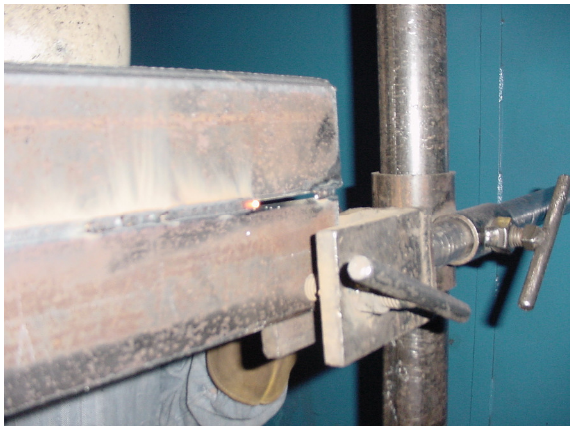
There are six variables to control when running the open root pass with the GTAW process:

- Addition of filler metal
- Root opening
- Amperage
- Arc length
- Travel speed
- Root face vs. knife edge

Suggestions for the root pass are:

- Center the filler metal in the bottom of the joint and add a slight amount of pressure to it. Be careful not to add too much pressure because the filler metal may push through without fusing into the root. Thus, leaving a portion of unconsumed filler metal protruding through the backside of the root. This would deem the weld rejectable.
- Keep the torch moving to keep the bead advancing.

- Vary filler metal size for differences in root opening. Use 3/32" diameter filler metal for tight areas and 1/8" filler metal for wide areas. For excessively wide root openings the 1/8" filler metal can be hammered flat. This will flatten the filler metal so it will catch the edges of the root opening so the filler metal will rest in the joint and not fall through the root opening.



Regardless of what pass the welder is applying, feeding the filler metal into the puddle and being able to advance the filler metal in your hand without breaking the arc is an essential function of GTA welding. Pictured to the right is one technique where the filler metal is "clamped" with three fingers and advanced with the thumb and the index finger.

Stopping techniques for the GTAW process.

Porosity tends to develop in the crater when terminating a weld with an air-cooled torch, without the aid of high frequency. Use one of the following techniques to avoid this.

Technique #1 ***Chilling the Weld***
This is where the welder will extend the arc length slowly until the arc is terminated. Using this technique, the puddle will freeze and porosity will be avoided. This is an excellent technique for carbon steel applications.
Technique #2 ***Walking the Wire (Lay Wire)***
This is where the welder quickly walks the torch up the groove face and the filler metal. This increase in travel speed will reduce the puddle size and puddle will solidify without developing porosity.

Either technique will take practice to ensure high quality welds.

Root Pass inspection

A quality root pass.

Note that the filler metal is slightly protruding through the root opening. This is an indication of a correctly fit up pipe.

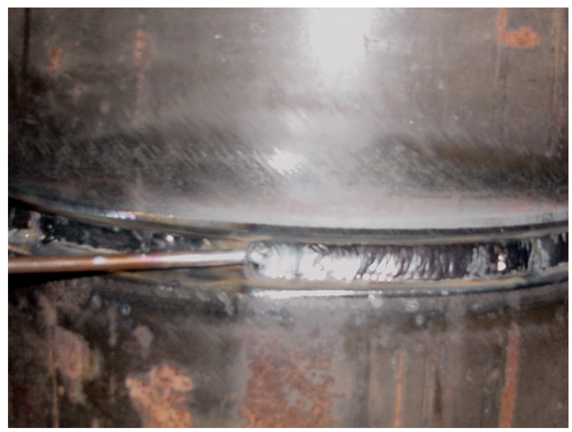
- Essentially there will be no slag on the GTAW root pass side. However, the root pass will still need to be inspected for complete penetration, undercut and excessive penetration. See Craftsmanship Expectations for inspection criteria.

Applying the Second Pass (the *Cold Pass*)

- The second pass, which is known in SMAW pipe welding as the "hot pass", is critical for a sound root pass. It is important to not over heat the root pass thus destroying its internal contour. Therefore, the second pass will be referred to as the cold pass in this training packet.
- Clean the face of the root bead with a hand grinder with a wire brush prior to applying the cold pass. Cleanliness is very important in the GTAW process, ensure that the wire brush is stainless steel and is not contaminated.

- Increase amperage approximately 5 to 10 amps above root bead setting. This will allow for increased travel speed.
- Change out gas nozzle to a larger size than the root pass (number 7 cup). Use the "wiggling" cup walking technique to apply the second pass. Keep the filler metal in the middle of the root pass while maintaining a consistent arc length and emphasize the side walls when welding. Keeping a steady forward travel speed is important so the root pass is not over heated and the internal contour is destroyed.
- Using the "Cup Walking" technique, place the filler metal in the middle of the root bead while welding regardless of the plate/pipe's position. Walk the cup forward consuming the filler metal. It is important, keep the filler metal submerged into the puddle. While welding, do not pause the tungsten electrode in the center of the joint. This will over heat the root bead thus destroying the internal root bead contour. It is important to emphasize the side walls with out slowing down across the middle of the weld while applying the second pass.

Purpose for the second pass is to provide additional thickness to the root bead so the first SMAW E7018 layer does not burn through the root pass.



6G Shielded Metal Arc Welding Technique

- Secure the pipe in the fixture in the 6G position to be welded.

6G Position
Pipe axis is inclined 45 degrees from the horizontal plane

Low Hydrogen Fill and Cover Pass Technique

A tight arc is essential when welding with E7018. The puddle relies on the vaporization of the flux and the molten slag for shielding. Keep the electrode in the puddle at all times, ***No Whipping Out of the Puddle***, to produce a sound weld.

Failure to follow these techniques will result in porosity, undercut, slag inclusions, or lower impact strength.

Starting Technique with the SMAW Process

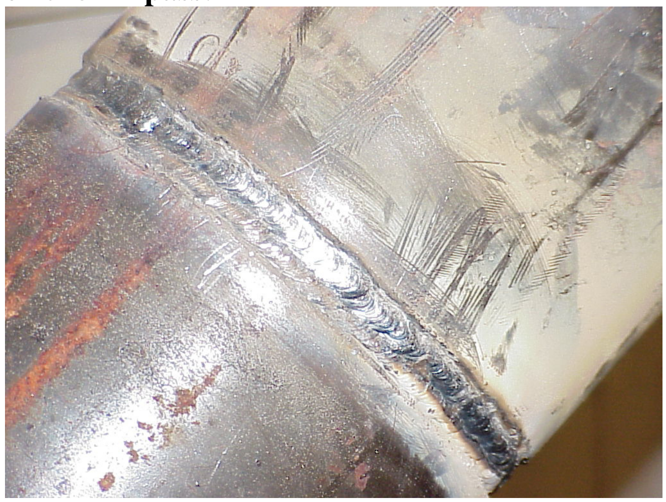
Use the two-handed technique to strike the arc. This will help eliminate arc strikes on the pipe wall that will render the pipe useless when welding with the SMAW process.

This technique is sometimes referred to as "shooting pool."

First layer of the 7018-fill pass

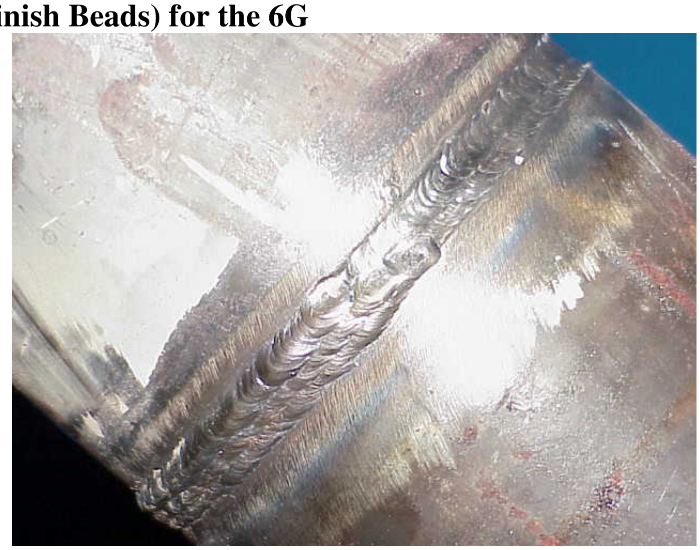
- Use the slant loop technique to cover the whole cold pass. Pause at the sidewalls and not the middle of the puddle.
- Remove all slag prior to applying next layer

Second layer of the 7018 fill pass:



- Use the slant loop multiple pass stringer bead technique for the second layer of fill beads.
- Ensure to leave enough area for the second pass on this layer. If the first bead is too large there will not be enough room for the second bead to go in with out trapping slag.
- Remove all slag prior to applying next layer.

Cover Passes (Finish Beads) for the 6G



- Use the Slant Loop Stringer Bead Technique
- For the 6G weld, the maximum bead width should not be more than ½" wide. Excessively wide beads will lead to over lap.
- Remove all slag with a wire wheel. Note that a hand file can be used to smooth out undercut at the weld and the pipe wall interface (toe). Excessive filing will not be permitted because it reduces the pipe wall thickness.

5G Shielded Metal Arc Welding Techniques

1. Tack weld pipe coupons together and secure the pipe in the fixture in the 5G position to be welded.

5G Position
Pipe axis is parallel to the horizontal plane
and the pipe is *not* rotated

Low Hydrogen Fill and Cover Pass Technique

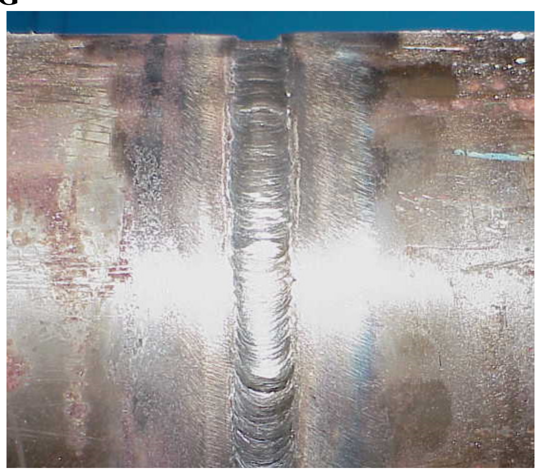
A tight arc essential when welding with E7018. The puddle relies on the vaporization of the flux and the molten slag for shielding. Keep the electrode in the puddle at all times, *No Whipping Out of the Puddle*, to a produce a sound weld.

Failure to follow these techniques may result in porosity, undercut, slag inclusions, or lower impact strength.

First layer of the E7018 fill pass
- Use the side-to-side weave technique to cover the whole hot pass. Emphasize the side walls when welding not the middle of the puddle.
- Remove all slag prior to applying next layer

Second layer of the E7018 fill pass:
- Use the side-to-side weave bead technique for the second layer fill bead.
- Ensure to leave enough area for the cover pass.
- Remove all slag prior to applying next layer.

Cover Passes for the 5G



- Use the Side-to-Side Weave Bead Technique
- For the 5G weld, the maximum bead width should not be more than 1/8 larger than the groove opening. Excessively wide beads will lead to a sloppy appearance and a waste of time and filler material.
- Remove all slag with a wire wheel. Note that a hand file can be used to smooth out undercut at the weld and pipe wall interface (toe). Excessive filing will not be permitted.

Welding Vocabulary #2

Name: ______________________________ Date: ____________________

Directions:
Define the following terms. Use the Welding Principles and Application textbook or the internet.

1. 2G
2. 5G
3. 6G
4. Root Opening
5. Root Face (Root Land)
6. Inadequate Penetration

7. Collet and Collet Body

8. Backing Gas

9. Concavity

10. Consumable Insert

Welding #3

Name: ______________________________ Date: ____________________

1. Why are stringer beads used in the 6G position kept small?

2. Why is argon ease of ionization a benefit?

3. Why is excessive a torch angle detrimental?

4. What is the purpose of backing gas for pipe welding?

5. What is a consumable insert and why would a welder use them?

6. Sketch the 5 common consumable inserts:

7. What are the 4 benefits of walking the cup?

ASME Craftsmanship Expectations for Welding Projects

ASME B31.1 Power Piping gives no specific dimensional tolerance for excessive root penetration. However, when a weld is to receive RT you must refer to 127.4.2 C5 that addresses the condition of a weld root where if there is an abrupt density change it must be corrected. Refer to acceptance criteria for a visual examination and for radiography in 136.4.2 and 136.4.5, respectively.

The Code states that there shall be full penetration for the root pass. ***Anything beyond full penetration at the weld root provides no benefit and can be harmful in certain fluid and high pressure steam applications.***

The acceptance criteria is usually specified by the Client or Owner who takes into consideration the application and design of the system. These company/manufacturer specifications can call out for internal root reinforcement to be 0"-1/16". Superheat tubes spec out at no more than 1/32" internal reinforcement. No suck back is allowed. Also, any piping that falls under ASME Section I, VIII, B31.1 are to be GTAW roots.

Pipe welding in the refineries allow up to 1/8" root penetration if the root thickness is uniform -- internal weld reinforcement shall be fused with and shall merge smoothly into the component surface.

As a welder yourself you know how tacks go in heavier than the rest of the root weld so be mindful to place the tacks a bit more on the light side as to give the remainder a consistent thickness.

ASME B31.3, “Process Piping” Acceptance Criteria

1.0 ACCEPTANCE CRITERIA FOR COMPLETED WELDS

1.1 Butt Welds

1.1.1 As-welded surfaces are permitted; however, the surface of welds shall be sufficiently free from coarse ripples, grooves, overlaps, abrupt ridges, undercut, and valleys.

1.1.2 The surface condition of the finished welds shall be suitable for the proper interpretation of radiographic and other nondestructive examinations when nondestructive examinations are required. In those cases where there is a question regarding the surface condition on the interpretation of a radiographic film, the film shall be compared to the actual weld surface for interpretation and determination of acceptability.

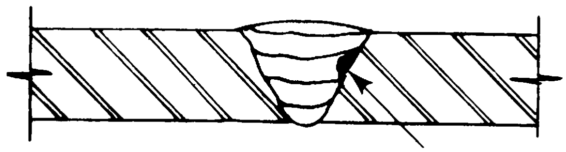
1.1.3 Undercuts shall not exceed 1/32 in. and shall not encroach on the minimum required section thickness.

1.1.4 For single-welded joints (i.e., butt joints welded from one side), concavity of the root surface shall not reduce the total thickness of the joint, including reinforcement, to less than the nominal thickness of the thinner component being joined. (This applies only when inside surface of the weld is readily accessible or the weld has been radiographed.)

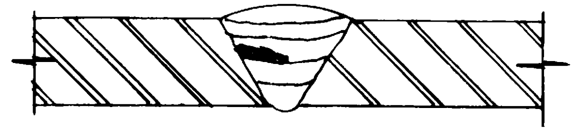
1.1.5 **Excess root penetration shall be limited to the lesser of 1/8 in. or 25 % of the nominal wall thickness of the thinner component being joined, down to ¼ in. wall thickness. For any nominal wall thickness, less than ¼ in., the excess penetration shall be limited to 1/16 in.**

ASME B31.3-2004

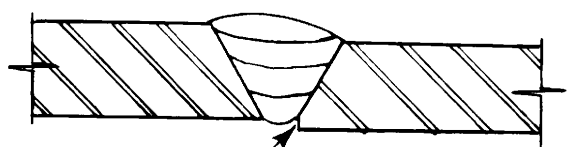
Fig. 341.3.2 Typical Weld Imperfections



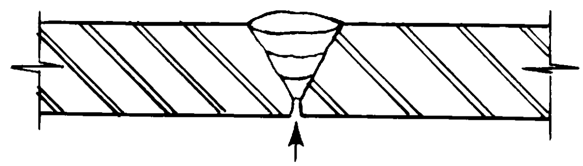
(a) Side Wall Lack of Fusion



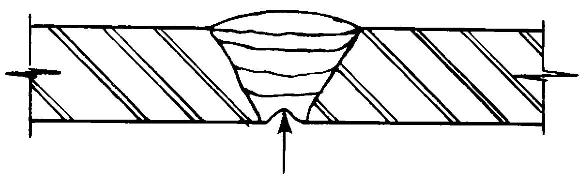
(b) Lack of Fusion Between Adjacent Passes



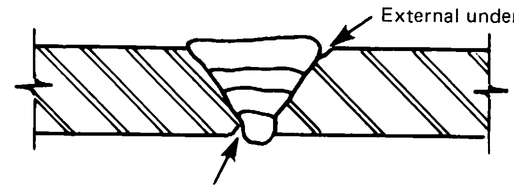
(c) Incomplete Penetration due to Internal Misalignment



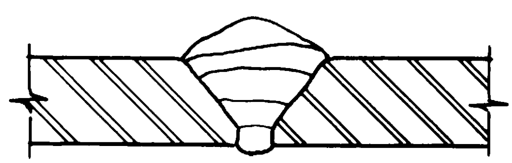
(d) Incomplete Penetration of Weld Groove



(e) Concave Root Surface (Suck-Up)



(f) Undercut



(g) Excess External Reinforcement

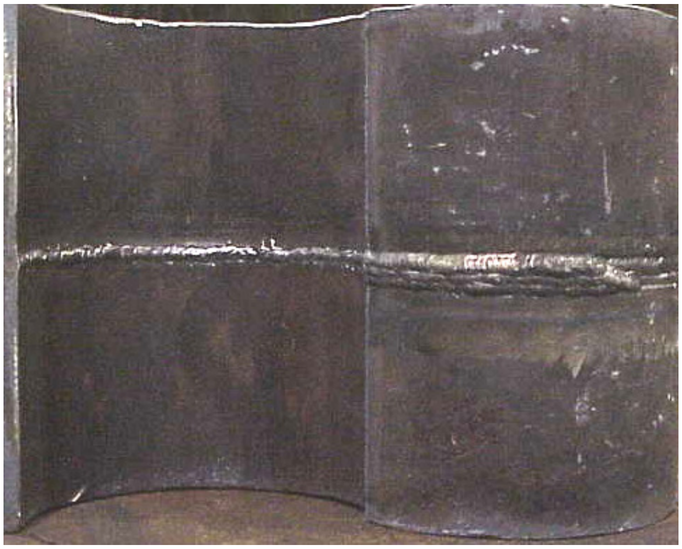
Craftsmanship Expectations for Welding Projects

The student should complete the following tasks prior to welding.

1. Thoroughly read each drawing.
2. Make a cutting list for each project. Cut at least two project's assemblies at a time. This will save a great amount of time.
3. Assemble the welding projects per drawing specifications.
4. Review Welding Procedure portion of the prints to review welding parameter information.
6. See your instructor for the evaluation and assistance.

Factors for grading welding projects are based on the following criteria:

Metal Preparation	**Project Layout**	**Post Weld Clean-up**
Oxyfuel Cut quality	Accurate (+/- 1/16")	Remove Slag/Spatter
Grind all cut surfaces clean	Limit waste	Remove sharp edges



Weld Quality per ASME Section IX

VT Criteria	**Root Pass**	**Cover Pass**
Reinforcement	Flush to 1/16"	Flush to 1/8"
Undercut	1/32" deep	1/32" deep
Bead Contour	Smooth Transition	Smooth Transition
Penetration	Complete Joint Penetration	N/A
Cracks	None Allowed	None Allowed
Arc Strikes	None Allowed	None Allowed
Fusion	Complete Fusion Required	Complete Fusion Required
Porosity	None Allowed	None Allowed

GTAW/SMAW Butt Joint- Single Vee (6G) Project #1

Welding Sequence

GTAW --Root Pass	Utilize the cup walking technique to apply the root.
GTAW –"Cold Pass"	Increase amperage approximately 10 amps above the root bead setting.
SMAW E7018-- Fill and Cap	A tight arc is essential with the E7018, keep the electrode in the puddle-**No Whipping**. Use a stringer bead technique for the 6G position.

Side view of the 6G groove weld

Weld Quality per ASME Section IX

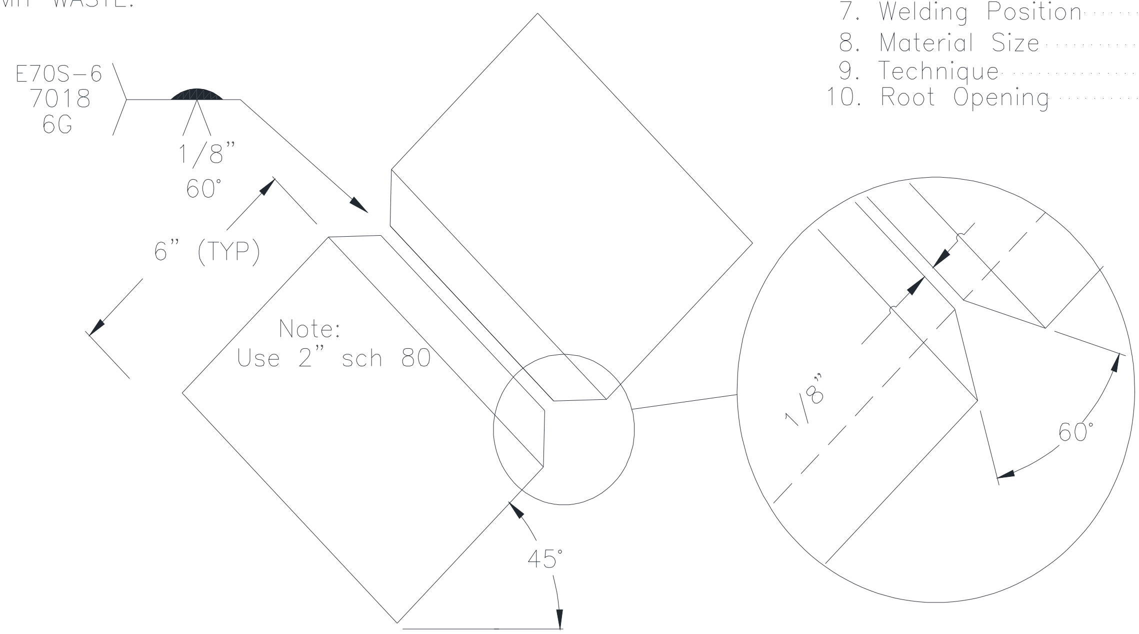
VT Criteria	Root Pass/Cover pass #1	Root Pass/Cover Pass #2
Reinforcement		
Undercut		
Bead Contour		
Penetration		
Cracks		
Arc Strikes		
Fusion		
Porosity		
Grade and Date		

Wld 225
Butt Joint
(6G)

NOTES:
START WITH 6" LONG COUPONS AND CUT OUT THE WELD WITH THE WATTS PIPE BEVELER TO LIMIT WASTE.

Welding Procedure

1. Electrode ER70S-6/E7018
2. Electrode Diameter .... 1/8"-3/32"
3. Polarity .... DCSP/DCRP
4. Amperage .... 70 to 90
5. Root Face .... 0"
6. Arc Length .... 1/16"
7. Welding Position .... (6G)
8. Material Size .... 2" Sch 80
9. Technique .... Stringer bead
10. Root Opening .... 1/8"±1/16"



Inch	MM
1/16"	1.6
1/8"	3.2
1/4"	6.4
1/2"	12.7
1"	25.4

Part	No. Required	Size (WxHxT)	S.I. Conversion

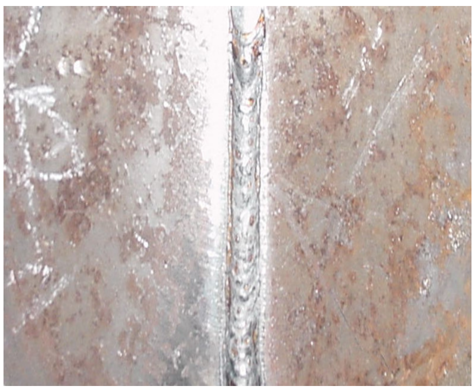
Portland Community College
Welding Technology

Tolerance (Unless otherwise Specified) Dimensional ± 1/16" Angle± 5°	WLD 225-01		
Drawn By: John Deering	Size:	Qc No.	Rev.
Chk By: TANNER Date: 21/15/15	Approve	Date	Sheet

GTAW/SMAW Butt Joint- Single Vee (5G) Project #2

Welding Sequence

GTAW --Root Pass	Utilize the cup walking technique to apply the root.
GTAW –"Cold Pass"	Increase amperage approximately 10 amps above the root bead setting.
SMAW E7018-- Fill and Cap	A tight arc is essential with the E7018, keep the electrode in the puddle-No Whipping. Use a weave bead technique for the 5G position.



Root Pass View

Cover Pass View

Weld Quality per ASME Section IX

VT Criteria	Root Pass/Cover Pass #1	Root Pass/Cover Pass #2
Reinforcement		
Undercut		
Bead Contour		
Penetration		
Cracks		
Arc Strikes		
Fusion		
Porosity		
Grade and Date		

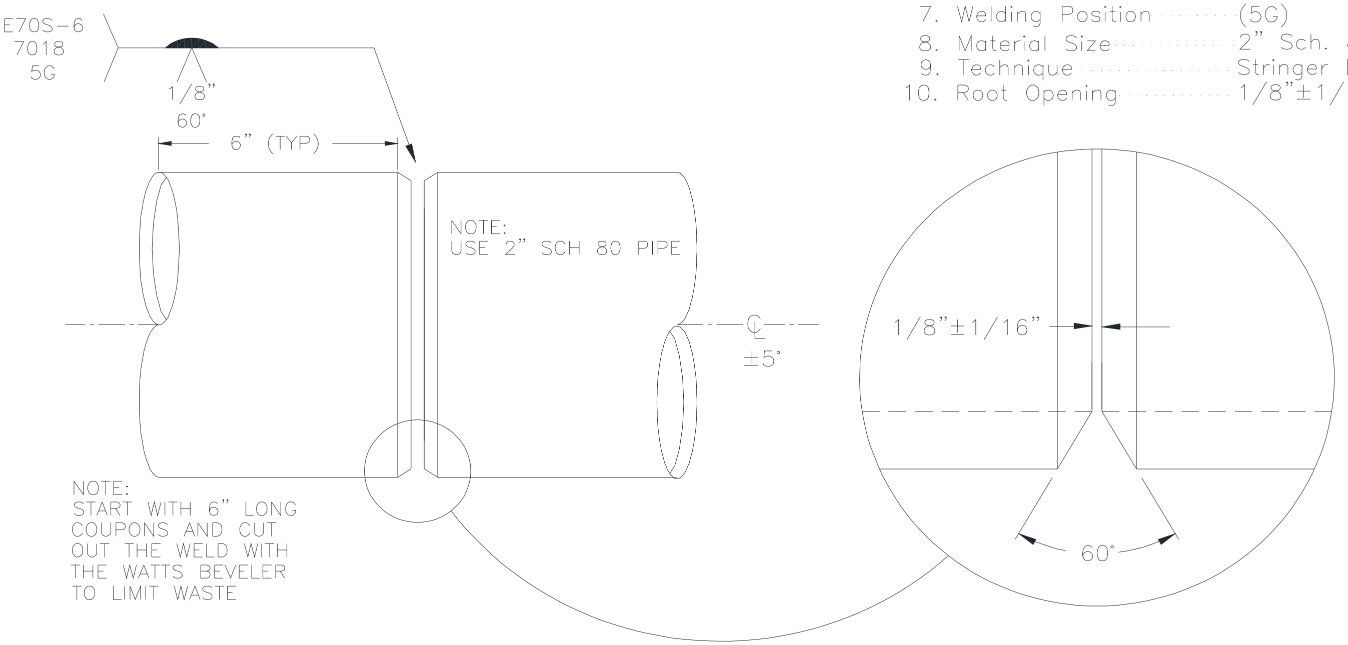
WLD 225

Butt Joint

(5G)

Welding Procedure

1. Electrode E70S-6/E7018
2. Electrode Diameter .... 1/8"-3/32"
3. Polarity .... DCSP/DCRP
4. Amperage .... 70 to 90
5. Root Face .... 0"
6. Arc Length .... 1/16" to 1/8"
7. Welding Position .... (5G)
8. Material Size .... 2" Sch. 80
9. Technique .... Stringer Bead
10. Root Opening .... 1/8"±1/16"



NOTE:
START WITH 6" LONG COUPONS AND CUT OUT THE WELD WITH THE WATTS BEVELER TO LIMIT WASTE

Inch	MM
1/16"	1.6
1/8"	3.2
1/4"	6.4
1/2"	12.7
1"	25.4

Part	No. Required	Size (WxHxT)	S.I. Conversion

Portland Community College

Welding Technology

Tolerance (Unless otherwise Specified)
Dimentional ± 1/16" Angle± 5°

Drawn By: John Deering

Chk By: TANNER Date: 12/15/15

WLD 225-02

Size:	Qc No.	Rev.
Approve Date		Sheet

Final Exam

Part One
This portion of the final exam is a closed book test. Consult with your instructor to determine items that you may need to review. Complete the exam and write all answers on the answer sheet provided. Once completed, return the exam and answer sheet to your instructor.

Study Guide

Safety

- OAC, SMAW and GTAW safety
- Hand Tool Safety

SMAW and GTAW Processes

- Power source specifics
  - Polarity
  - Current out put
  - High Frequency
  - Shielding gases
- AWS electrode classification

Welding Symbols and Blueprints

- Orthographic views
- Isometric views
- Welding symbol
  - Weld symbols
  - Reference line
  - Tail

Math and Math conversions

- Adding and subtracting fractions
- Reading a tape measure
- Metric conversions

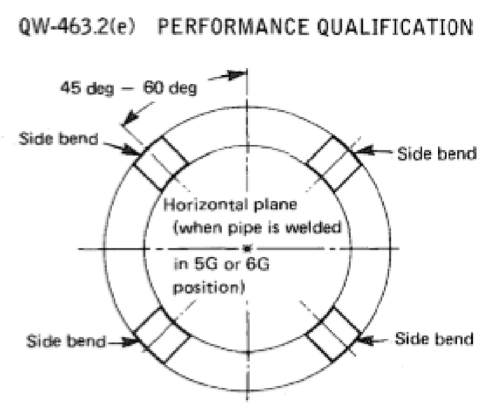
Practical Exam

Part Two

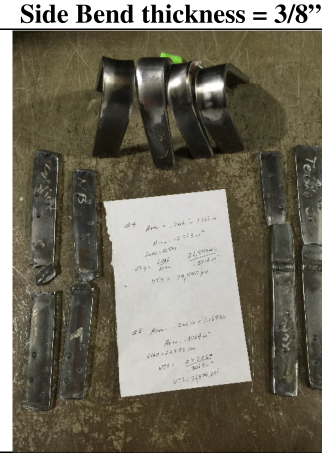
This portion of the exam is a practical test where you will fabricate and weld a 2” Schedule 80 pipe test. The evaluation of this portion of the exam will be based on quality requirements set forth in ASME Section IX.

Use the following Diagram to lay out destructive tests.

See the ASME Sec. IX for more information if needed.



Side Bend thickness = 3/8”



Portland Community College Welding Technology Department ASME Sec IX Welding Procedure Specification	

WPS # PCC-ASME Sec IX -2016	Rev # 0	Process: GTAW/SMAW	Date: 09-21-2010

ASME Sec IX Qualified Ranges

Diameter: 2.375 od through 12.75 OD	Filler Metal Group:
Thickness: .188” thru 7.50”	Joint Type: Sleeve/fillet/butt full penetration
Material: Yield less than 42 ksi	Progression: Uphill
Positions: Fixed (5G and 6G)	

Weld Joint

Type: Sleeve/fillet/butt – 30 degrees (+7.5 degrees) Class: Full and Partial Penetration
Joint Description: Single V Groove Weld
Sketch Number: See drawing

Filler Metal

AWS Classification: E70S-6/E7018	Number of Beads: 5 passes
SFA Classification: 5.1/5.5	
Size: 1/8” and 5/32”	

Base Metal

Specification: A53B	Thickness Welded: .154” to .750”
Pipe Diameter: 6 inch	Qualification Range: 2.375” to 12.75”
Time between passes: 5 minutes between root and hot pass	

Position

Position: 5G and 6G	Progression: Uphill
Preheat: 70 F	PWHT: None

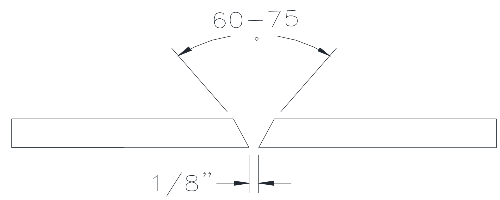
Electrical Characteristics

Current: Direct Current	Polarity: DC-/DC+	Amps 90-125
Transfer Mode: N./A	WFS/IPM: N/A	Volts 18-25
Electrode size and type: E70S-6/E7018 – 3/32” to 1/8”	Travel IPM: 5-13 IPM	Shielding Gas: Argon (15-30CFH)

Welding Technique

Technique and number of passes: Stringer/Weave beads with multiple passes
Cleaning: Grind and wire brush as necessary

Joint Sketch and Bead Number and Sequence



Note: Weld layers are representative only – actual number of passes and layer sequence may vary due to variation in the joint design, thickness and fit-up.

Typical Welding Parameters

Pass #	Filler/Electrode	Diameter	Polarity	Amps	Volts	Travel Speed
1	E70S-6	1/8"	DCEN	80-115	18-25	5-10
2	E70S-6	1/8"	DCEN	90-115	18-25	5-10
3	E7018	1/8"	DCEP	85-120	18-25	5-10
4	E7018	1/8"	DCEP	85-120	18-25	5-10
5	E7018	1/8"	DCEP	85-120	18-25	5-10

WPS Welded By: Date:

Prepared by: Date:

We certify that the statements herein are correct and that the tests were conducted in accordance with ASME Section IX.

Authorized by: Date:

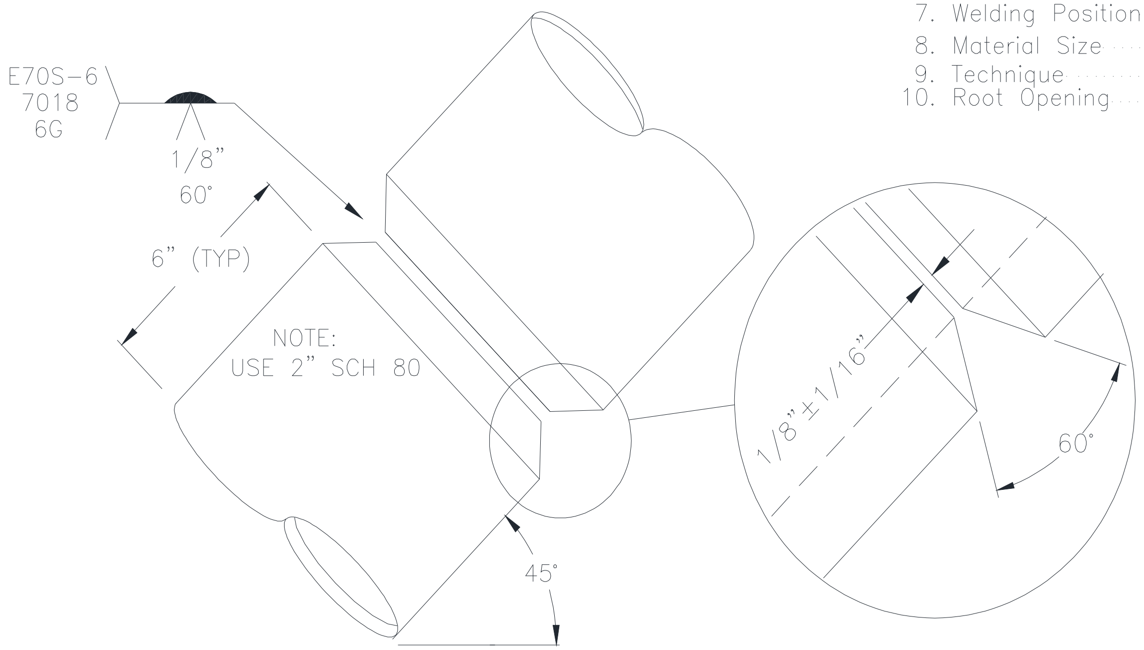
Wld 225

Butt Joint Final Exam

(6G)

Welding Procedure

1. Electrode ER70S-6/E7018
2. Electrode Diameter .... 1/8"-3/32"
3. Polarity .... DCSP/DCRP
4. Amperage .... 70 to 90
5. Root Face .... 0"
6. Arc Length .... 1/16"
7. Welding Position .... (6G)
8. Material Size .... 2" Sch 80
9. Technique .... Stringer bead
10. Root Opening .... 1/8"±1/16"



Inch	MM
1/16"	1.6
1/8"	3.2
1/4"	6.4
1/2"	12.7
1"	25.4

Part	No. Required	Size (WxHxT)	S.I. Conversion

Portland Community College — Welding Technology			
Tolerance (Unless otherwise Specified) Dimensional ± 1/16" Angle± 5°	WLD 225 Final Project		
Drawn By: John Deering	Size:	Qc No.	Rev.
Chk By: TANNER Date: 12/15/15	Approve	Date	Sheet

Name____

WLD 225 Grading Rubric for the Practical Exam

Hold Points

Hold Points are mandatory points in the fabrication process which require the inspector to check your work. You will have the following hold points.

Points	***Hold Point***	***Instructor's Evaluation***
5 points	**Blueprint Interpretation and Material Cut List** 5 points = 0 errors, all parts labeled and sized correctly 3 points = 1 error in part sizing and/or identification 2 points = 2 errors or more rework required (max points)	__________
10 points	**Material Layout and Cutting (Tolerances +/- 1/16")** 10 points Layout and cutting to +/-1/16" Smoothness of cut edge to 1/32" 7 points Layout and cutting to +/- 1/8" Smoothness of cut edge to 1/16" 5 points (Rework Required max points) Layout and cutting to +/-3/16" Smoothness of cut edge to 3/32"	___________
10 points	**Fit-up and Tack weld (Tolerances +/- 1/16")** 10 points Tolerances +/- 1/16" Straight and square to +/-1/16" 7 Points Tolerances +/- 1/8" Straight and square to +/-1/8" 5 Points (Rework Required—Max points) Tolerances +/- 3/16" Straight and square to +/-3/16"	____________
15 points	**Weld Quality** Subtract 1 point for each weld discontinuity, incorrect weld size and incorrect spacing sequence.	____________
28 points	*Minimum points acceptable. This equates to the minimum ASME and AWS D1.1 Code requirements.*	

Total Points ____________