

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



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Video Training

*Pipe Welding Made Easy –
GTAW - 2G*

Located in Welding Resource Room



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Opinions expressed are those of the authors
And not necessarily those of the Foundation

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 Groove Weld - Open Root (pipe)
5G Butt - Single Vee Groove Weld - Open Root (pipe)

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 his/her 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.

Grading criteria:

The student's assessment will be based on the following criteria:
15% of grade is based on Safe work habits and shop practices.
20% of grade is based on Completion of written and reading assignments.
15% of grade is based on demonstrating professional work ethics.
40% of grade is based on completion of welding exercises.
10% of grade is based on final exam/project

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
?	100

$$= (1.7 \times 100) \div 66.3$$
$$= 2.56 \text{ lbs per hour}$$

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
?	100

$$= (1.3 \times 100) \div 70.7$$
$$= 1.84 \text{ lbs per hour}$$

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

In order 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

In order 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- E70S-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.

$$= 3 \text{ electrode} \times \$2.00 = \$6.00$$

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 = 2.56 lbs per hour
?	100	

$$2.56 \times 24 \times \$2.50 = \text{cost of filler rod for this job}$$

$$= \$ 153.60$$

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

$$= (24\text{hrs.} \times 30 \text{ cfh}) \div 270\text{cf}$$

$$= (720) \div 270$$

$$= 2.66 \text{ bottles}$$

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

$$= 3 \text{ bottles}$$

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

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:

Amount of time you spent actually welding:_____hrs.

Number of electrodes you consumed in the welding process:_____sticks

Number of filler rods you consumed in the welding process_____rods

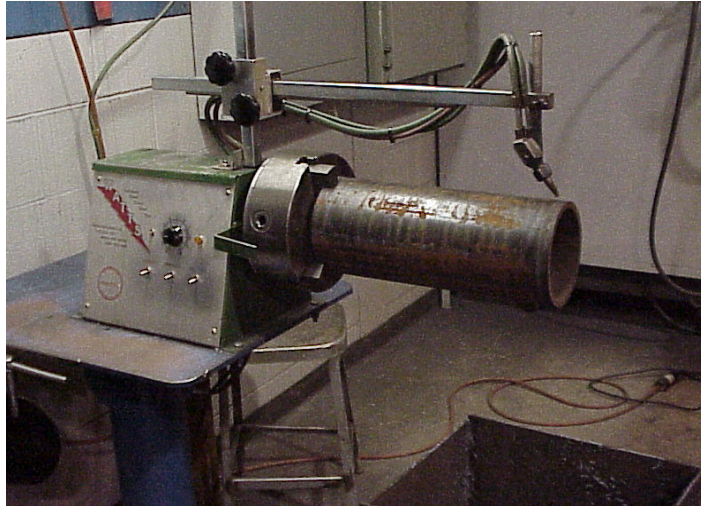
When you have completed the welding calculate the cost of the electrodes, filler rod and shielding gas that you have used.

Cost of electrodes_____

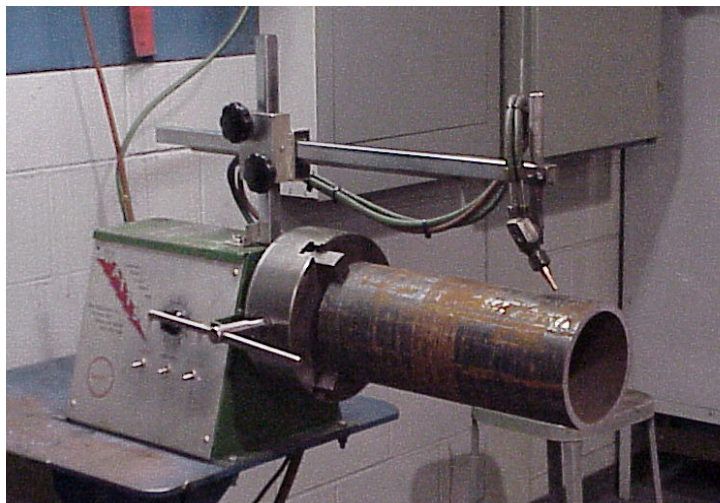
Cost of filler rods_____

Cost of shielding gas_____

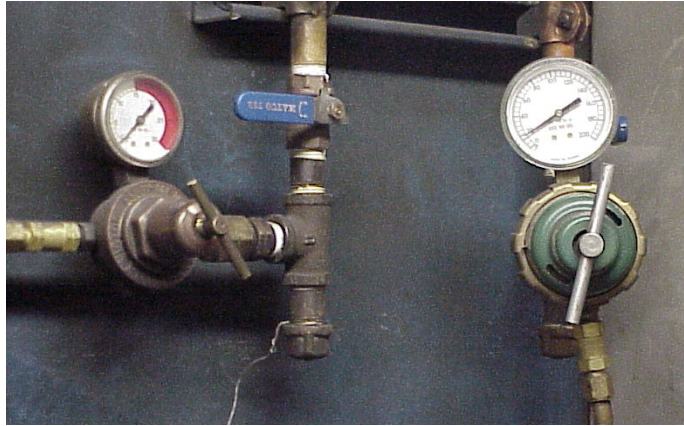
Watts Pipe Cutter Information Sheet



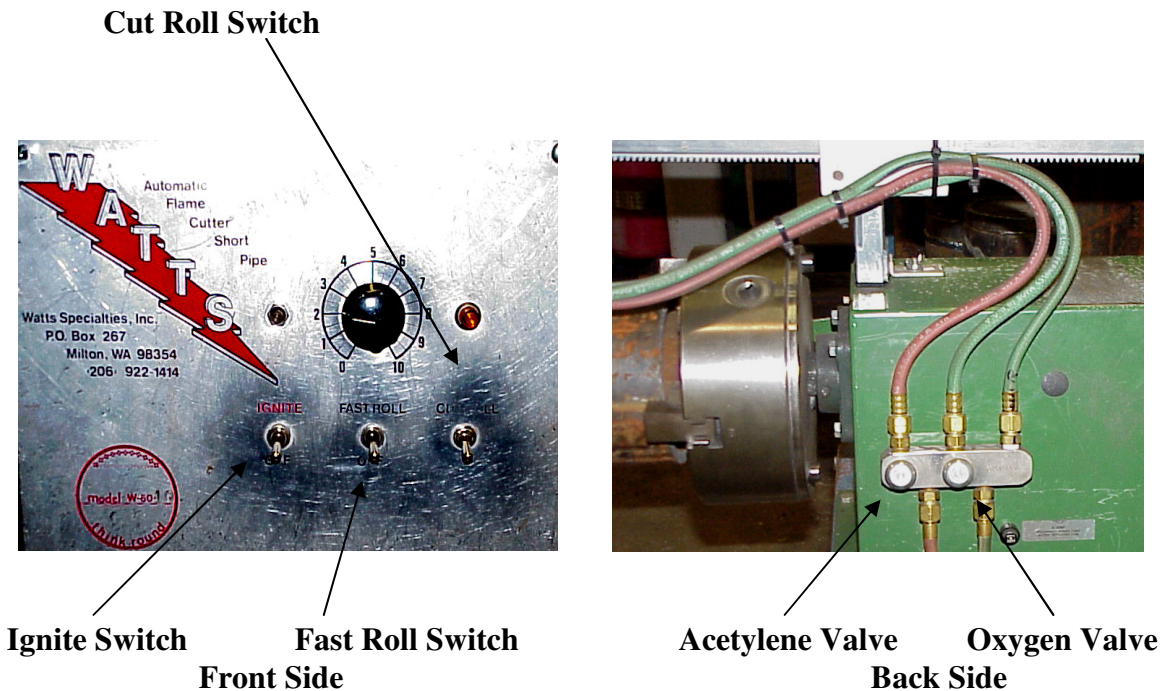
- The Watts pipe beveler uses oxygen and acetylene gas to flame cut pipe bevels. All safety procedures that apply to the track burners and hand torches will apply with this pipe beveler.
- Place pipe in jaws and snug jaws down with T-bar wrench.
- Swivel cutting head over pipe ensuring there is approximately $\frac{3}{4}$ " 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 $\frac{1}{16}$ ". 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.

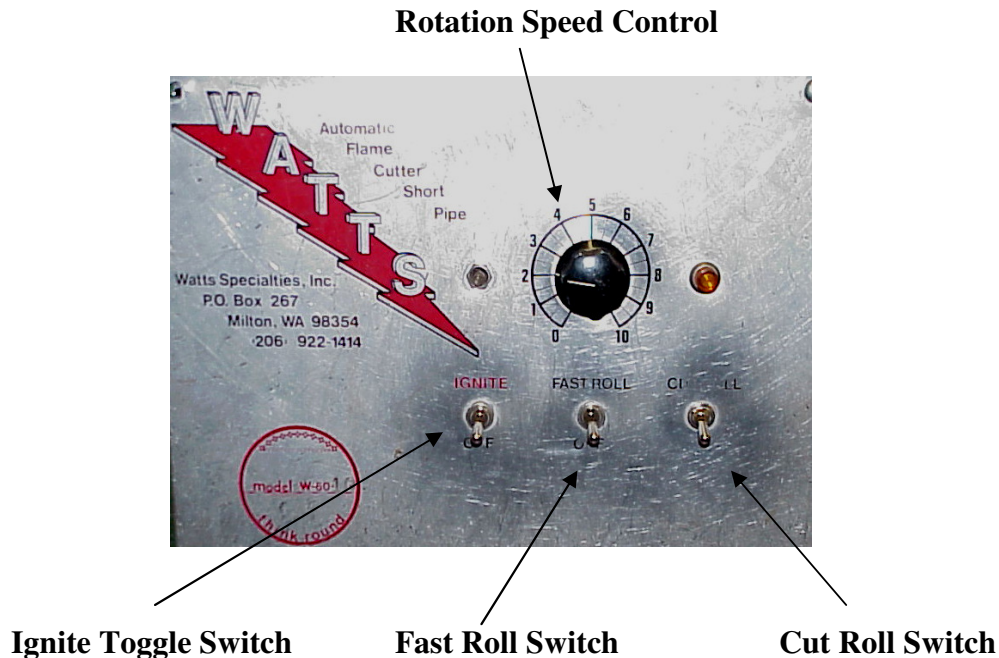


- Turn the *Ignite toggle switch* ON and open the acetylene needle valve on the backside of the unit. Light the torch and adjust the acetylene flame so the heavy soot disappears.



- 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.



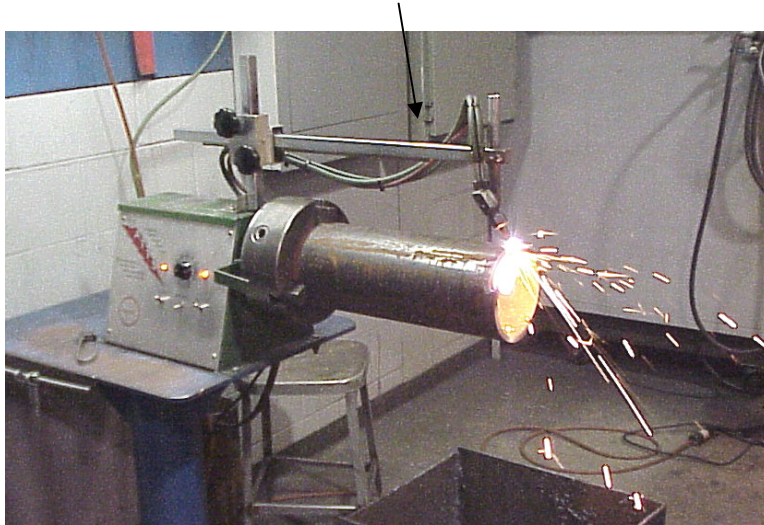
- Light torch and align head over the pipe. Use the *Fast Roll toggle switch* and preheat the pipe by having it rotate 360 degrees. Once pipe is preheated let the torch set idle over one area to heat the kindling temperature (cherry red).

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.

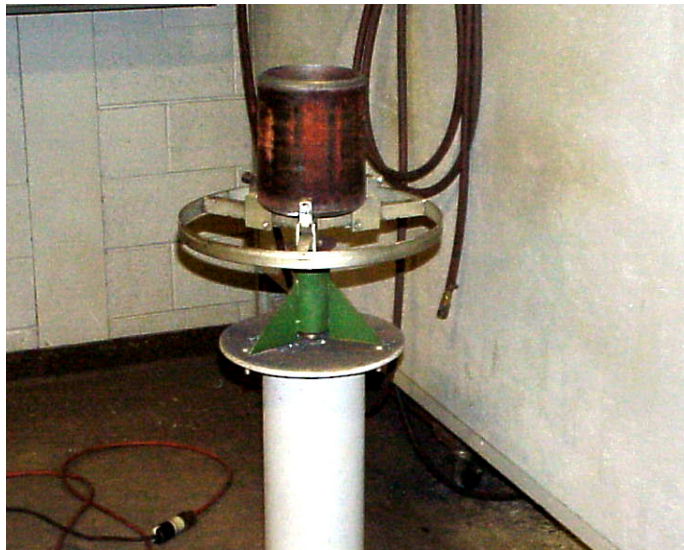
Helpful Hint: Once flame pierces through the pipe, adjust the torch back slightly to remove the starting flaw.

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.

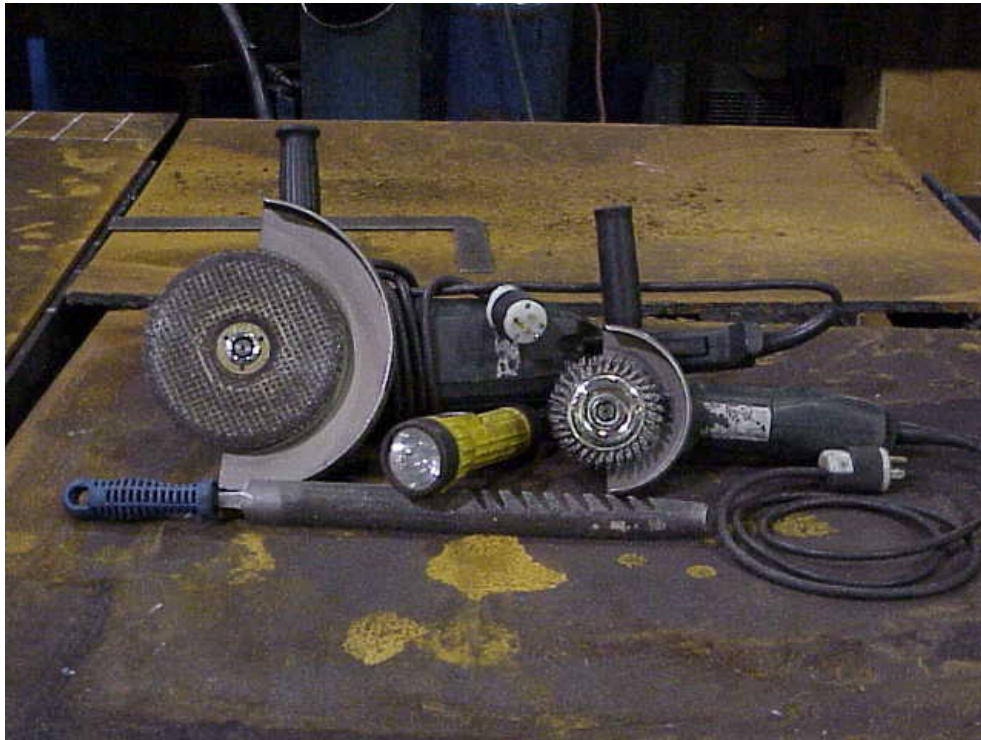


- Do not let the fixture rotate too fast. Slow it down frequently so that the pipe is not thrown from the fixture.
- Ensure the grinder is placed in such a manor that the sparks are shooting downward.
- Ensure screens are in place so no by standers are showered with sparks.
- Grind the groove face to 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.



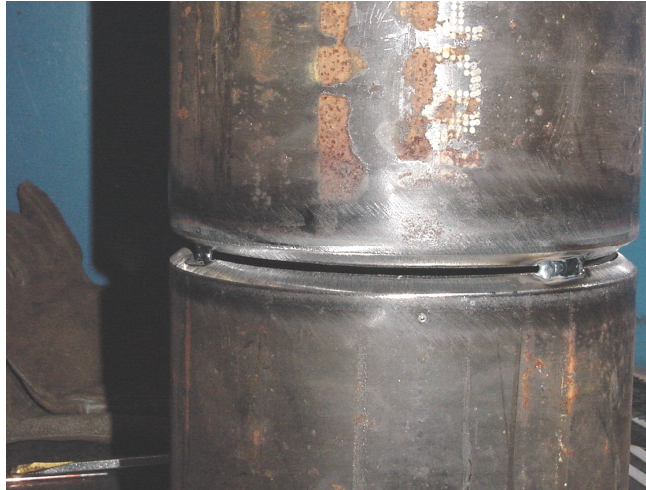
Place a spacer wire between the pipes for the proper root opening and place the pipe coupons back together as previously determined.



Make the first tack weld $\frac{1}{4}$ " to $\frac{1}{2}$ " long between the open ends of the spacer wire. The first tack should be a maximum of $\frac{1}{2}$ " long to help control distortion. The remaining three tacks should be $\frac{3}{4}$ " 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

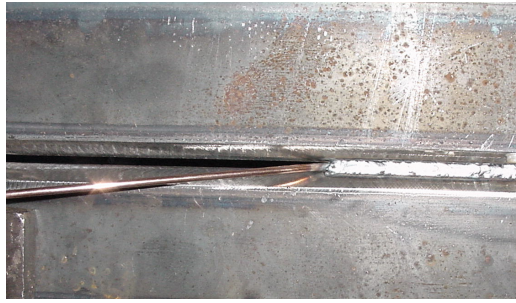
Place the pipe in the fixture in the 5G or 6G position to be welded.



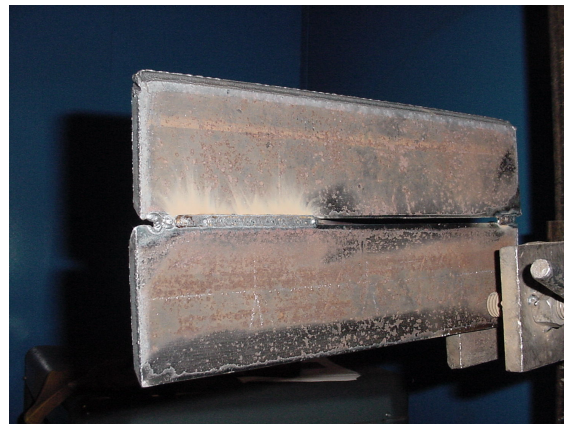
Place the filler metal at the end of the tack weld and strike the arc over the tack weld. Start “walking the cup” to advance the torch forward. Once the tungsten melts the end of the tack weld push the filler metal into the tack weld slightly to ensure complete penetration. Using a slight rotating pushing 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:

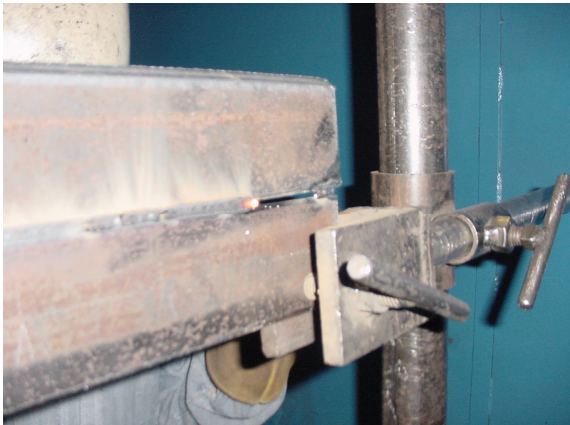
- Addition of filler metal
- Root opening
- Amperage
- Arc length
- Travel speed
- Root face vs. knife edge

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 has a tendency 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 up the 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 1/2" 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 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

Name: _____

Date: _____

Directions:

Define the following terms. Use the text books in the Welding Resource Room (Bldg 2/132a) if these terms are not in The Procedure Handbook of Arc Welding.

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

8. Tungsten Electrode

9. Collet

10. Collet Body

11. Backing Gas

12. Concavity

13. Consumable Insert

14. Stress Points

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

Oxyfuel Cut quality

Grind all cut surfaces clean

Project Layout

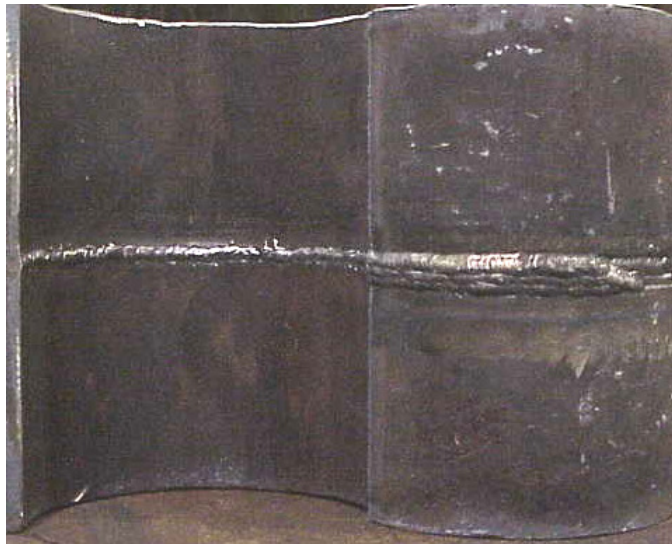
Accurate (+/- 1/16")

Limit waste

Post Weld Clean-up

Remove Slag/Spatter

Remove sharp edges



Weld Quality per ASME Section IX and AWS D1.1

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

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-- A tight arc is essential with the E7018, keep the electrode in the puddle-**No Whipping**. Use a stringer bead technique for the horizontal position.
Fill and Cap



Side view of the 6G groove weld

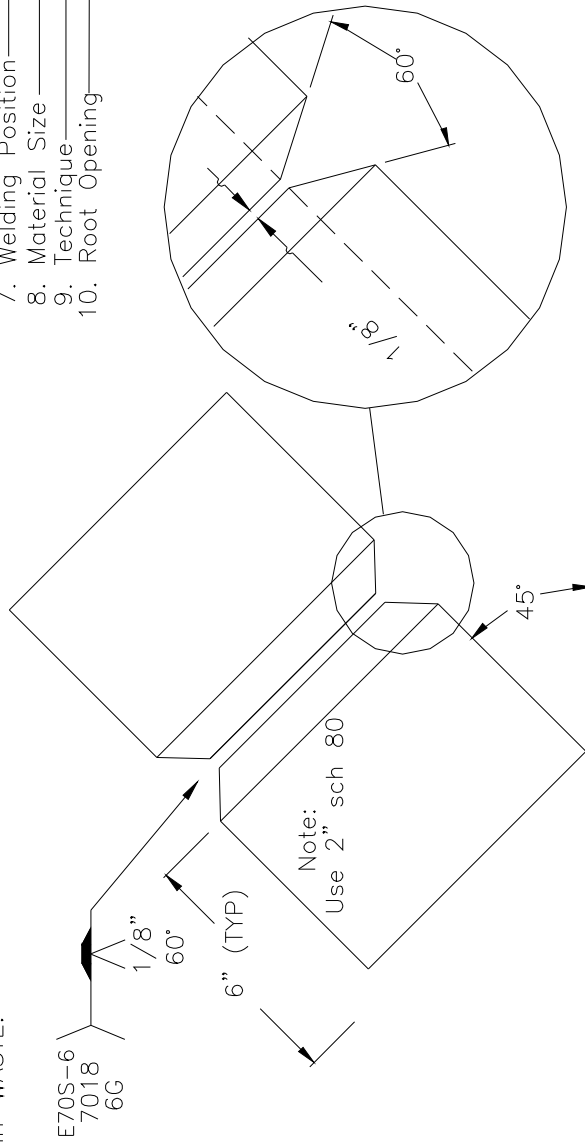
Weld Quality per ASME Section IX and AWS D1.1

VT Criteria	Root Pass	Cover Pass
Reinforcement		
Undercut		
Bead Contour		
Penetration		N/A
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)	WLD 225-01
Dimensional ± 1/16" Angle ± 5°	
Drawn By: John Deering	Size: Qc No. Rev.
Chk By: TANNER S. Date: 8/19/08	Approve Date Sheet

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-- A tight arc is essential with the E7018, keep the electrode in the puddle-No Whipping. Use a stringer bead technique for the horizontal position.
Fill and Cap

**Root Pass View****Cover Pass View****Weld Quality per ASME Section IX and AWS D1.1**

VT Criteria	Root Pass	Cover Pass
Reinforcement		
Undercut		
Bead Contour		
Penetration		N/A
Cracks		
Arc Strikes		
Fusion		
Porosity		
Grade and Date		

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)		WLD 225-02	
Dimensional $\pm 1/16"$ Angle $\pm 5^\circ$		Size:	Qc No.
Drawn By: John Deering		Rev.	
Chk By: TANNER SCOTT	Date: 7/6/09	Approve	Date
			Sheet

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" $\pm 1/16"$		

WLD 225
Butt Joint
(5G)

E70S-6
7018
5G

1/8"
60°
6" (TYP)

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

NOTE: USE 2" SCH 80 PIPE

1/8" $\pm 1/16"$
60°
 $\pm 5^\circ$

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

WLD 225 Answer Sheet

Name: _____

Date: _____

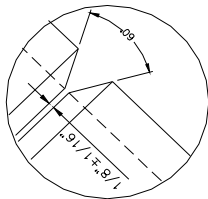
1.	11.
2.	12.
3.	13.
4.	14.
5.	15.
6.	16.
7.	17.
8.	18.
9.	19.
10.	20.

Part Two

This portion of the exam is a practical test where you will fabricate and weld a weldment from the drawing attached to the final exam. The evaluation of this portion of the exam will be based on the grading rubric attached.



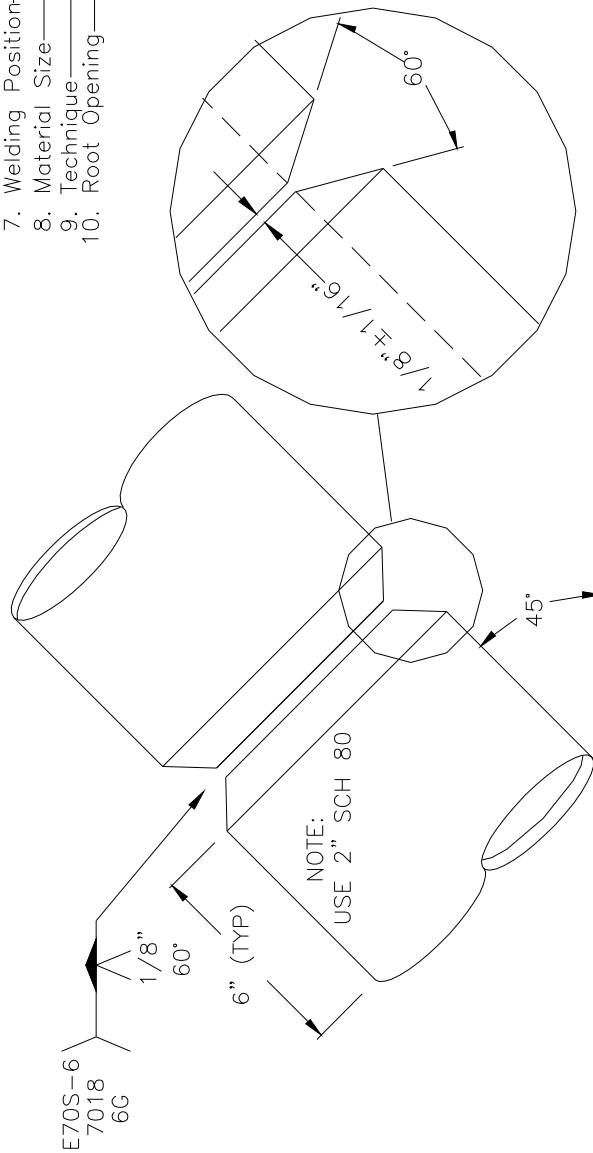
Welding Procedure Specification ASME Sec. IX Job No.:		WPS Number: Rev. Number Original Date: PQR Number:
Title: Gas Tungsten Arc and Shielded Metal Arc—Open Root Groove		
Welding Process: GTA and SMAW		Type: Manual Mode:
Prepared by:	Date:	Approved by: Date:
JOINT DESIGN Type: Single Groove Single or Double Weld: Single Backing: None Backing Material: N/A Root Opening-R: 1/8" Land-L: 0-1/16" Radius (J-U): N/A		PREHEAT Preheat Temp. Min. 60° Interpass Temp. Min: 60° F Max: 400°F
BASE METALS Metal Specification: A53 Type or Grade: Grade A Group 1 Pipe Schedule: 80 Fillet: All Diameter (Pipe) 24" and up Wall 1/8" and up		TECHNIQUE/ OTHER <input checked="" type="checkbox"/> Stringer or <input type="checkbox"/> Weave Beads <input type="checkbox"/> Multipass or <input type="checkbox"/> Single pass/ side <input type="checkbox"/> Single or <input type="checkbox"/> Multiple Electrodes Contact Tube to Work Distance: N/A Peening: None on root/cover pass Initial Cleaning: All areas to be welded shall be cleaned for oil, grease, paint, etc., for at least two (2) inches from the toes of the weld Interpass Cleaning: Remove all oxides and slag with a clean wire brush and/or chipping hammer Notes: 1. A stringer or slight weave may be used as required to provide proper bead shape and side wall wetting. 2. Initial and interpass cleaning shall be accomplished by wire brushing, chipping, and/ or grinding. 3. Welder shall accomplish a visual inspection of previously deposited weld metal, prior to depositing the next bead.
FILLER METALS Classification: ER-70S-6 and E-7018 Specification No. AWS 5.18 & AWS 5.1		
SHIELDING Gas: Argon Composition: 100% Flow Rate: 20 cfh Gas Cup Size: 4-7 Electrode-Flux (Class): N/A Flux: N/A		

POSITION Position of Groove: 6G Vertical Progression: Up				4. Welding electrode shall be stored in portable heated rod ovens, located in close proximity to the work area.				
				5. Preheating shall be accomplished using oxy-fuel torches.				
POSTWELD HEAT TREATMENT Temperature Range: N/A Time: N/A				6. Weld shall be allowed to cool slowly, keeping air drafts to a minimum.				
Pass or Weld Layer(s)	Process	Filler Metals		Current		Volts	Travel Speed (IPM)	
		Class	Dia.	Type and Polarity	Amps or wire feed speed			
All	GTAW	ER70S-6	1/8"	DCEN	50-120A	14-22	2-5	
All	SMAW	E-7018	3/32"	DCEP	90-170A	19-27	4-6	

Wld 225
Butt Joint Final Exam
(6G)


Welding Procedure

1. Electrode _____ ER70S-6/E7018
2. Electrode Diameter _____ 1/8"–3/32"
3. Polarity _____ DCSF/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)	WLD 225	Final	Project
	Dimensional $\pm 1/16"$ Angle $\pm 5^\circ$	Size:	Qc No.	Rev.
Drawn By: John Deering	Date: 8/19/08		Approve	Sheet
Chk By: TANNER S.				

Grading Traveler for the WLD 225 Practical Exam

Name: _____

Date: _____

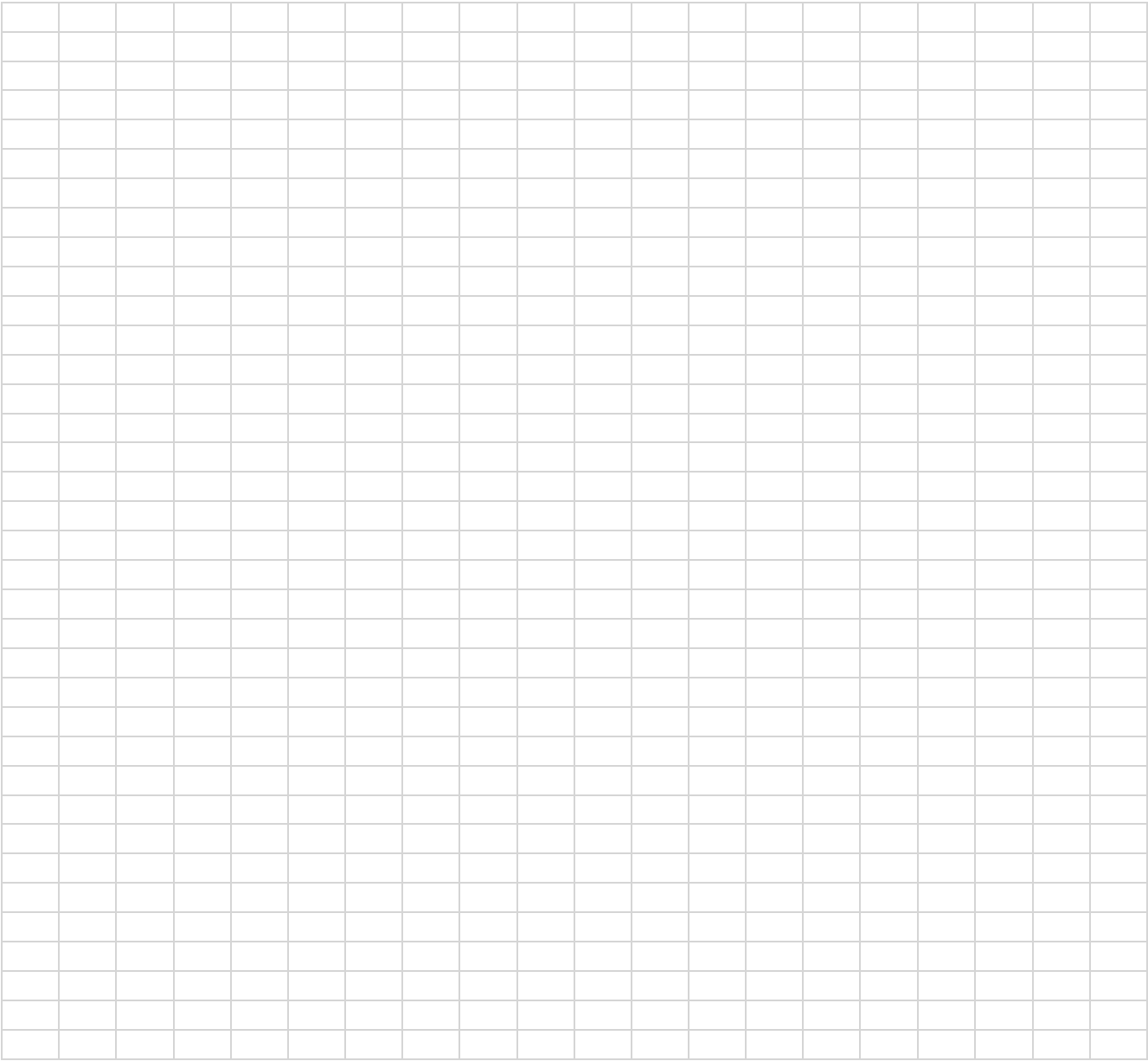
Hold Points are mandatory points in the fabrication process, which require the inspector to check your work. You will have the following hold points that you instructor will check.

Points Possible	Hold Points	<i>Instructor's Evaluation</i>
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	Using the orthographic drawing convert it to an isometric sketch	
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.	
35 points	<i>Minimum points acceptable. This equates to the minimum AWS D1.1 Code requirements.</i>	
	Total Points	/50

WLD 225 Isometric Drawing

Name: _____

Date: _____



Final Grades - WLD 225

Name: _____

Instructor: _____

Date: _____

Welding Projects = 40%

Out of	Out of	Out of
Out of	Out of	Out of
Out of	Out of	Out of
Out of	Out of	Out of
Out of	Out of	Out of
Out of	Out of	Out of
A Total Project pts. _____ / Total pts. Possible _____ X 40 = _____ %		

Written Work = 20%

Out of	Out of	Out of
Out of	Out of	Out of
Out of	Out of	Out of
B Total Project pts. _____ / Total pts. Possible _____ X 20 = _____ %		

Safety = 15% Each day of attendance is worth 3 points earned. Any safety violation will result in 0 points for the day.

Out of	Out of	Out of	Out of	Out of	Out of
Out of	Out of	Out of	Out of	Out of	Out of
Out of	Out of	Out of	Out of	Out of	Out of
C Total pts. earned _____ / Total pts. Possible _____ X 15 = _____ %					

Employability Skills = 15% The following attributes will be assessed - attendance, attitude, time management, team work, interpersonal skills, etc.. Daily points (there are no excused absences, hence no points earned for days missed) 3 pts = present and working for the entire shift; 2 pts = late; 1 pt = late and left early; 0 pts = no show.

Out of	Out of	Out of	Out of	Out of	Out of
Out of	Out of	Out of	Out of	Out of	Out of
Out of	Out of	Out of	Out of	Out of	Out of
D Total pts. earned _____ / Total pts. Possible _____ X 15 = _____ %					

Final Exam 10%

Written Exam	Out of
Practical Exam	Out of
E Total Project pts. _____ / Total pts. Possible _____ X 10 = _____ %	
Add Lines A + B + C + D + E. This will give you your Final Grade TOTAL % _____ FINAL GRADE _____	