WLD 114
Shielded Metal Arc Welding:
Mild Steel III (E6011)

Index

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by the
National Science Foundation
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Course Assignments

Reading
Welding Principles and Applications,7th edition by Larry Jeffus

Chapter 18, Shop Math and Weld Cost
Chapter 27, Filler Metal Selection

Math
Practical Problems in Mathematics 6th edition by Robert Chasan

Chapter 13, Addition and Subtraction of Decimal Fractions
Chapter 14, Multiplication of Decimals
Chapter 15, Division of Decimals
Chapter 16, Decimal Fractions and Common Fraction Equivalents

Recommended assignments

Complete review question following each assigned chapter

Quizzes

Complete Interactive Quiz in CourseMate for each assigned chapter

Welding Projects

Bead Plate - Flat Position
2F T-Joint
2F Lap
2F Corner
3F T-Joint

Final Exam
Part One (Closed Book, Open Note Exam)
Part Two (Practical Exam)

Timeline:
The open-entry, open-exit instructional format allows the students to work at their own pace. It is the student's responsibility to complete all assignments in a timely manner. See your instructor for assistance.

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.

Accessing the Interactive ebook for Principles and Applications and Practical Problems in Mathematics

Here is a link to the publishers website that goes over some "getting started" procedures with CourseMate.
http://www.cengage.com/tlconnect/client/product/fcis.do?productId=535

For New Students
Your book bundle will contain an access code for both your Principles and Applications book and the Practical Problems in Mathematics.

For Returning Students
If you have the Seventh Edition of the Principles and Applications book you should have an access code. If not see your instructor. For the math book you will have to go to this site
http://www.cengagebrain.com/shop/isbn/9781111313593 and rent the ebook for either a six month or one year option.
Your math quizzes will be accessible through Desire 2 Learn. Your Instructor will assist you in accessing this.

Course Key There will be a master course key containing all of the courses available on CourseMate. You will find the course you are currently taking and enter the corresponding number in the appropriate area in CourseMate.

Note For each class there will be separate Access code and course key for Principles and Applications and Practical Problems in Mathematics

Information Sheet on Selecting an Electrode

Things to Consider

Metal Thickness

- Position
- Condition (oily, greasy, painted)
- Joint design

Service Application

- Part goes into a static or dynamic situation (i.e. how does it handle vibration stresses).

Bead Appearance

Metal's Susceptibility to Cracking

- High carbon content (above0.35% Caron)

What does the Welding Procedure Specification (WPS) specify

Electrode Characteristics Chart

	6010 or 6011	**7018**	**7024**
As Welded Tensile Strength	60,000 psi tensile strength	70,000 psi tensile strength	70,000 psi tensile strength
Welding Positions	All Position	All Position	Flat and Horizontal
Flux Type	Cellulose	Lime - Fluorine	Rutile
Current	6010 = DCRP 6011 = AC or DCRP	DCRP	DCRP
Arc Characteristics	Aggressive	Medium	Soft
Depth of Penetration	Deep	Medium	Minimum
Slag Consistency	Light	Medium	Heavy
Toughness vibratory stress	Good	Excellent	Good

EXX10 and EXX11
Fast Freeze Electrode Information

General Uses

- Welding Carbon Steel (mild steel)
- General purpose fabrication and maintenance welding
- Out of position welding
- X-ray quality
- Pipe welding - cross-country, in-plant, and non-critical small diameter piping
- Best choice for the following steel conditions: Galvanized, plated, dirty, painted, or greasy material
- Joints requiring deep penetration

Arc Characteristics

- Truly all-purpose: particularly good for vertical and overhead.
- Light slag with little slag interference for easy arc control.
- Deep penetration with maximum admixture.
- Appearance: flat beads with distinct ripples.

Welding Techniques

Polarity

Unless otherwise specified, use DCEP, with Exx10 and DCRP or AC with Exx11. The Exx11 electrodes can also be used with AC. Always adjust current for proper arc action and control of weld puddle.

Flat Position

Hold a 1/8" or shorter arc or touch the work lightly with the electrode tip. Move fast enough to stay ahead of the molten pool. Use currents in the middle and higher portion of the range.

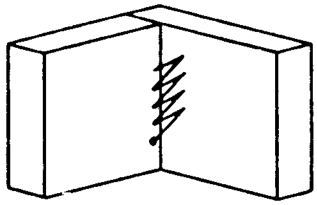
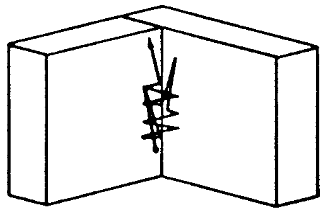
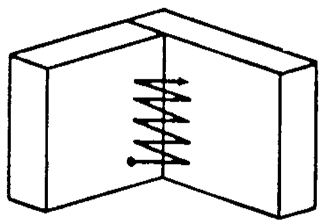
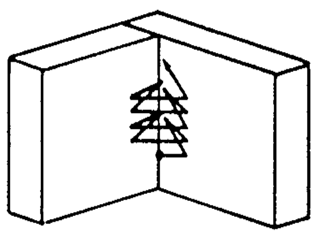
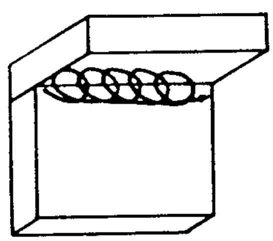
Vertical Position

Use 3/16" or smaller electrodes. Vertical down drag techniques are used by pipeliners and for single pass welds on thin steel. Vertical up is used for most plate welding applications. Make the first vertical-up pass with the whip and pause technique. Apply succeeding passes with a box or straight weave, pausing slightly at the edges to ensure penetration and proper wash-in. Use currents in the lower portion of the range.

Overhead and Horizontal Butt Welds

Use 3/16" or smaller electrode. These welds are best made with a series of stringer beads using a whip and pause technique.

Common EXX10 and EXX11 Electrode Oscillation Techniques

Technique	Diagram	Typical Application
Whip and Pause		Used with fast freeze electrodes to make welds in all positions
Whip and Pause (using a side to side motion in the crater)		Used with fast freeze electrodes primarily in the vertical position.
Straight side to side weave		Used with fast freeze electrodes to make a fill pass in the vertical position.
Triangular Weave		Used with fast freeze electrodes for the root pass on fillet welds and groove welds
Circular Motion		Used with fast freeze electrodes to make overhead welds. A Whip and Pause technique can be incorporated into this technique too, to help control the puddle.

Restarting Technique for Sound Welds

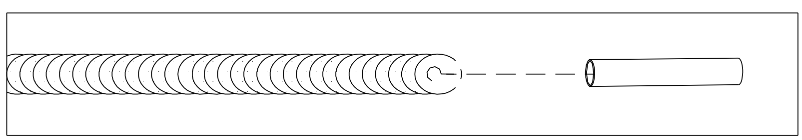
Strike the arc directly ahead of the crater in line with the "new weld." Once the arc is started, establish an extended arc length (long arc). The purpose of this is to:

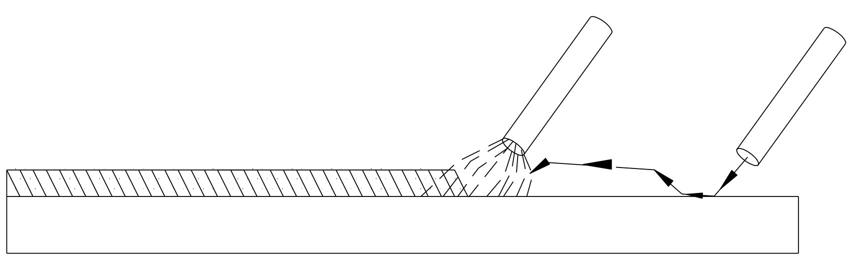
- Preheat the base metal.
- Allow gaseous shield to be established.
- Allows the amperage to flow so the heat will build up.
- Gives off light to find the crater (flash light effect).

Once the arc is established, go back to the and drop the electrode into its normal arc length and circle in the crater and then start to travel with the normal travel speed. By circling in the crater you accomplish two things:

1. It's a timing device used to fill the crater flush with the bead.
2. It will help drive out any slag/porosity that may have otherwise become entrapped.

REMEMBER practice makes perfect.





Helpful Hints for Preventing Common Flaws

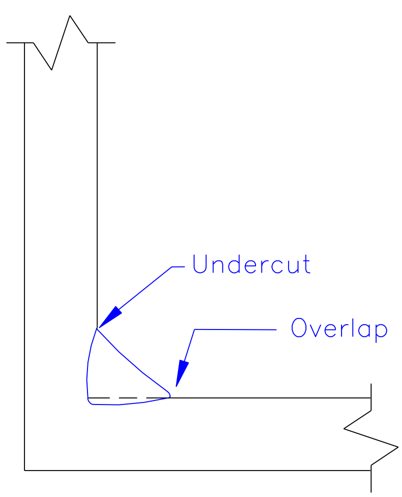
Eliminating Undercut

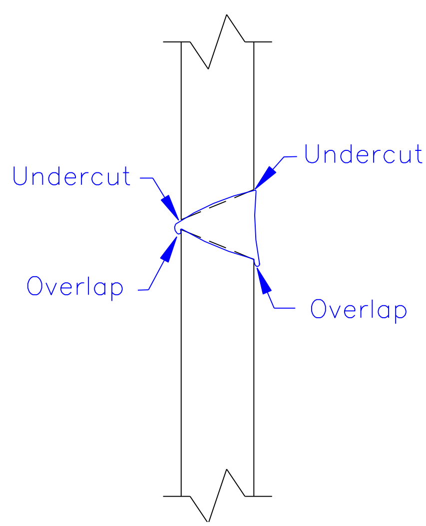
Undercut is a condition where the base metal has been melted away during the welding operation and there is insufficient filler metal deposited to adequately fill the resulting depression. These grooves will vary in depth and length. Undercut can be present at a weld to weld junction or a weld to base metal junction (toe of weld). Undercut causes a stress concentration point (stress riser) which is a potential starting point for weld cracking.

Undercut is common with the EXX10 and EXX11 electrodes due to their aggressive (digging) arc. One or more of the following items can aid in controlling
undercut:

- Reducing arc length
- Reducing travel speed
- Reducing amperage
- Pausing at the sides of the puddle
- Changing work angle
- Avoiding excessive weaving
- Allowing base metal to cool

Maximum allowed is 1/32" in depth for Welder Qualification per AWS D1.1.

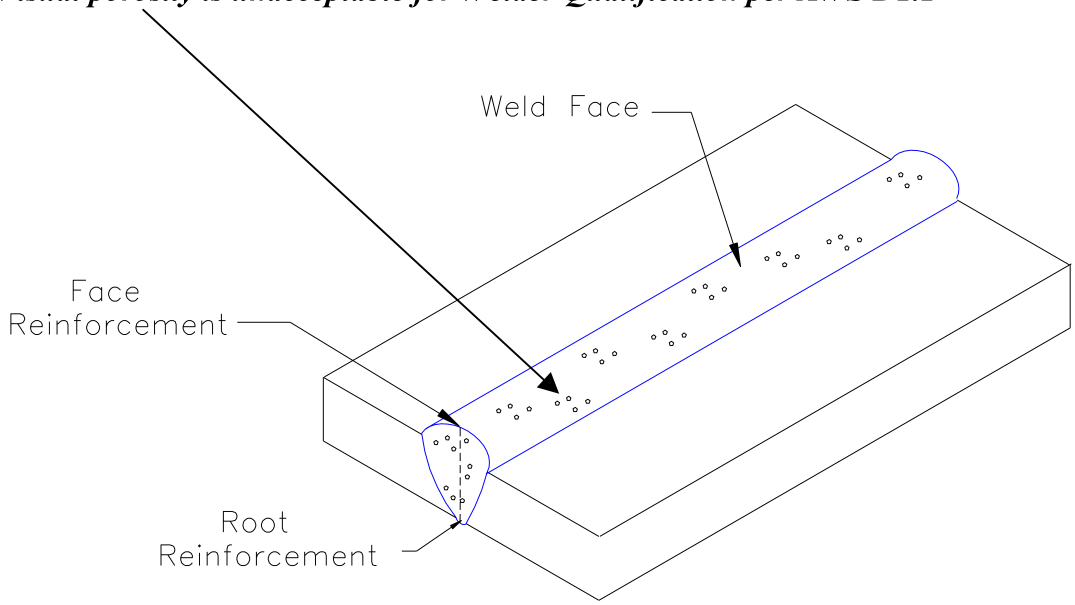




Surface Porosity

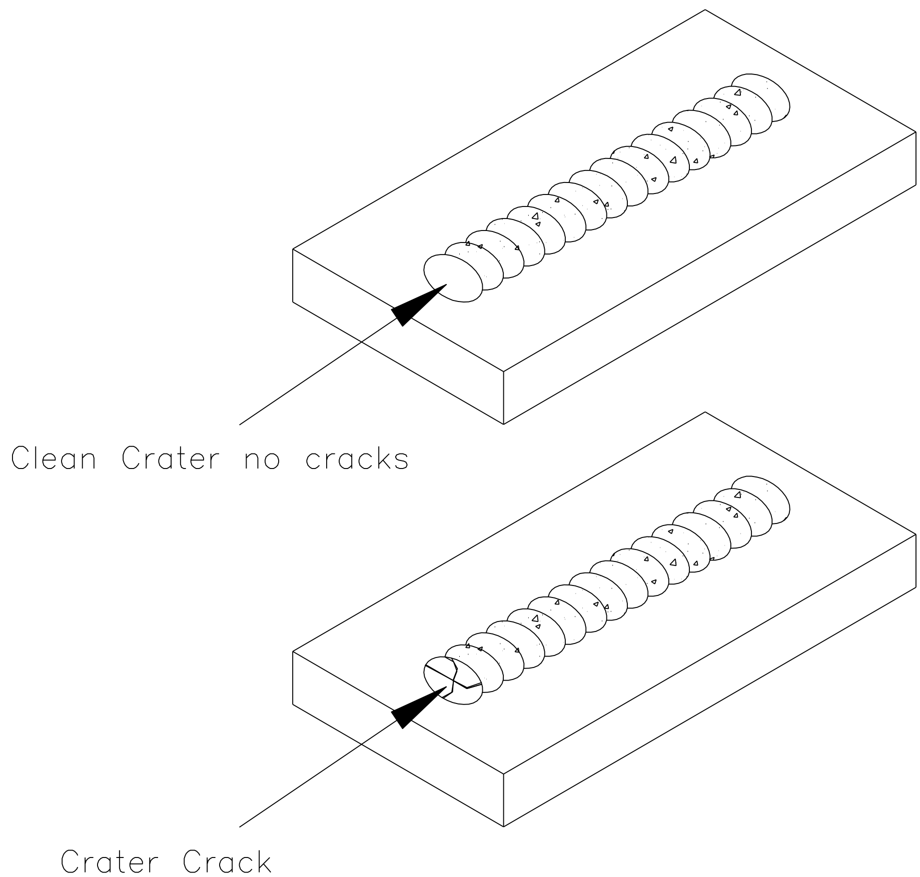
Fast Freeze electrodes have a tendency to develop surface porosity at the top of the chevrons (freeze lines) upon weld solidification. This is due to the weld metal solidifying while gas is still escaping from the metal. This leaves ***surface porosity***. This can be corrected while welding by simply “popping” the electrode back into the puddle and re-melting the puddle. This technique requires a “watchful eye.”

Visual porosity is unacceptable for Welder Qualification per AWS D1.1



Ending or Stopping the Weld **(also known as Terminating or Cratering Out)**

With the fast freeze electrode, the welder must watch out for crater cracks when ending the weld. Crater cracks are due to terminating the weld too quickly. To help eliminate this problem, the welder should whip back into the crater twice before terminating. This "double pumping" will help ensure that the crater is filled, and allow the crater to solidify without a crack.



Science

on

Steel

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 science as it relates to industry requirements.

Contents of this Packet

Characteristics of E6011 Electrodes

E6011 is a fast-freeze, all-position AC-DC electrode. For most applications, E7011 is used with AC current primarily to avoid arc blow problems. This electrode is typically used with a medium to short arc length, with a travel angle of 5° to 15° in the direction of travel. It is a low-slag electrode for tack welding, for vertical-down welding, making stringer beads, bridging gaps, AC pipe welding, square edge butt welding, welding on galvanized steel, sheet metal edge, corner and butt welding, and many other applications. The molten weld metal is protected from the surrounding air primarily by the rapidly expanding gases and a thin slag layer, which must be removed after each pass. The gas component of shielding is provided by 20%-40% cellulose in the flux coating of E6011 electrodes, as shown in Table 1. With substantial gaseous protection, open roots can be welded with E6011, even though E6011 does not have the deep penetration power of the E6010 electrode.

Although E6010 can penetrate steel greater than similar E6011 electrodes, both E6010 and E6011 electrodes are considered to be deep-penetration electrodes, because of the high cellulose content in the flux cover. As shown in Table 1, E6011 contains much more potassium than does E6010 because E6011 is designed for AC welding. The potassium provides arc stability during the arc-off times during the AC current cycle. Potassium is added to the E6011 flux cover in the form of potassium titanate and potassium silicate as shown in Table 1. Potassium provides outstanding arc stability for AC welding because potassium has such a low ionization potential that it remains conductive in the arc atmosphere even though the arc shut off 120 times per second.

Table 1 Ingredients in Flux Covering on E6011 Electrodes for SMAW
(Olson et al, ASM International Handbook, 1993, Vol. 6, pp. 55-63)

Ingredient	Purpose
25-40% Cellulose	gas shielding
10-20% Rutile	slag former & arc stabilizer
2-5% Potassium titanate	arc stabilizer for AC current
10-20% Asbestos	slag former & extrusion
5-10% Ferromanganese	alloying & deoxidizer
20-30% Potassium silicate	arc stabilizer & binder

In the arc, the cellulose immediately breaks down into carbon dioxide (CO_2) and hydrogen (H_2) gases, which both promote deep penetration. CO_2 and particularly H_2 have high ionization voltages to provide the highest penetration. That is, CO_2 and H_2 require high voltages to establish a stable conducting arc. As a result, this higher voltage provides substantially increased arc energy input (or heat input) during welding. Arc energy input (H) is defined as:

H =	**E I / v**
Where:	"E" is the arc voltage in volts
	"I" is the arc current in amps
	"v" is the travel speed in mm/s

Using E6011 and E6010 electrodes, the penetration increases with increasing cellulose content. Since E6011 is designed to be used primarily with AC power, the cellulose content and resulting penetration provided by E6011 is less than that for E6010. As mentioned above, potassium is absolutely necessary to provide arc stability for AC welding with E6011. Although E6011 is primarily an AC electrode, it can still be used in many open root pipe welding applications and is immune to arc blow situations.

Why is E6011 a High-Hydrogen Electrode?

Although cellulosic electrodes have excellent operability, arc characteristics, and "welder appeal", many codes ban the use of E6010 and E6011 electrodes because of their uncontrollably high hydrogen content. Unlike low-hydrogen electrodes like E7018, the high-hydrogen E6011 electrodes may cause hydrogen-assisted cracking in the weld metal and heat-affected zone of thick and high strength steels.

The single greatest source of hydrogen in welds deposited by E6011 electrodes is the cellulose flux covering. Other less voluminous sources of hydrogen contamination, which are avoidable with good workmanship practices, include: oil, grease, paint, dirt, moisture-absorbing rust and other hydrogen-containing materials. Cellulose as well as oil and grease are hydrocarbons, which dissociate into atomic hydrogen and carbon dioxide during welding. Although hydrogen improves penetration and arc stability, it does cause serious cracking in the heat-affected zones of welds deposited on thick and/or high strength steels. Thus, E6011 electrodes can only be used on low carbon mild steels particularly in thin sections.

How is Heat-Affected Zone Cracking Possible?

Although most hydrogen enters the weld metal via the cellulosic flux, hydrogen cracking usually takes place in the higher strength heat-affected zone. How is it possible for the heat-affected zone to crack when the hydrogen comes from the weld metal? Hydrogen is the smallest atom in the universe and is "interstitial" in iron, so hydrogen can diffuse in steel rapidly even at room temperature. In a matter of minutes large quantities of hydrogen atoms diffuse into the heat-affected zone during and after welding. These interstitial hydrogen atoms are so small compared to the iron atoms that they can diffuse between the iron atoms. That is, the iron atoms do not move while the hydrogen atoms diffuse between the iron atoms even at room temperature. As a result, both the weld metal and heat-affected zone of a steel weld are susceptible to hydrogen-assisted cracking. Usually, the heat-affected zone is much higher hardness than the weld metal so the heat-affected zone is more susceptible to hydrogen assisted cracking. Because it takes time for hydrogen to diffuse through the weld and heat-affected zone, cracking is usually “delayed” and may take place up to 72 hours after welding. Thus, hydrogen-assisted cracking is also called “delayed cracking”.

Mechanical Properties of Weld Metal deposited by SMAW with E6011

The specified composition and mechanical properties of weld metal deposited by E6011 are listed in Table 2. Weld metal deposited by SMAW using E6011 electrodes provides excellent strength, ductility and soundness, but not Charpy v-notch impact toughness and not resistance to hydrogen-assisted cracking. As a result, the specification AWS A5.1 does not specify either Charpy impact toughness or weld metal composition as shown in Table 2.

Codes Accepting E6011 Cellulosic Electrodes

Most pipe welding codes and AWS D1.1 Structural Welding Code allow E6011 electrodes for SMAW applications in fabrication, construction and pipe welding. Because E6011 is a “high” hydrogen electrode, weld metal and heat-affected zones will be susceptible to hydrogen assisted cracking. To prevent such cracking, preheating of thick sections must be performed in strict accordance with Table 3. From Table 3, only the steels listed are permitted to be welded by E6011 electrodes. For example, if E6011 is used to weld 1-inch thick A36 steel, the required preheat temperature in Table 3 is 150°F (minimum). If this same steel were welded with a low hydrogen electrode like E7018, no preheating would be required (as long as ambient temperature is 50°F or greater).

Table 2 Composition and Mechanical Properties of Weld Metal Required by AWS A5.1 deposited by SMAW using E6011 Electrodes

	Required by AWS A5.1	**Typical**
E6011 Composition of Weld Metal (wt %)	C: not specified S: not specified P: not specified Mn: not specified Si: not specified	C: 0.10 S: 0.016 P: 0.014 Mn: 0.37 Si: 0.16
Mechanical Properties of Weld Metal	Tensile Strength: 62ksi (430MPa) min Yield Strength: 50ksi (340MPa) min % Elongation: 22% min CVN Toughness: Not Specified	Tensile Strength: 77 ksi (531MPa) Yield Strength: 67 ksi (462MPa) % Elongation: 22% CVN Toughness: 25ft-lbs @ -20° F

Cellulose is a major ingredient in the flux coating of the E6011 electrode. Unlike E7018 low-hydrogen electrodes, E6011 electrodes provide substantial gaseous shielding but little slag shielding. E6011 is designed primarily for AC welding; however, it can be use with DCRP (DCep) when additional penetration is needed.

Welding codes, that require high toughness weld metal, strictly prohibit the use of any cellulosic electrodes. For example, the use of E6010 and E6011 are forbidden in bridge construction per AASHTO/AWS D1.5 Bridge Welding Code. Cellulosic electrodes are allowed in pipe lines for two important reasons: (1) outstanding operability of E6010 and E6011 electrodes particularly for root passes, and (2) preheating in pipeline welding is commonly applied to eliminate the possibility of hydrogen-assisted cracking.

Hydrogen Designators by AWS

Currently, there is no definition that specifies the amount of hydrogen that is permitted in cellulosic as-deposited weld metal. Cellulosic electrodes like E6011 typically produce large volumes of hydrogen; for example, 35ml/100g of weld metal. For comparison, "Low hydrogen" electrodes can actually mean a wide range of hydrogen from 2 to more than 12ml/10g. It has been shown that "low" hydrogen levels as high as 12 ml/100g can cause extensive severe cracking in high strength steels; while, similar welds deposited with electrodes containing only 4ml/100g of hydrogen is crack-free. As a result, the American Welding Society (AWS) developed a new optional Hydrogen Designator System. These designators, however, do not apply to high hydrogen electrodes like E6010 and E6011.

Table 3 Steel Types and Minimum Preheat/Interpass Temperatures for SMAW with

E6011 Electrodes specified by AWS D1.1 Structural Welding Code

Steel Specification and Grade	Thickness Range	Minimum Preheating Temperature
ASTM A36; ASTM A53; B ASTM A106; B ASTM A131; A, B, CS, D, DS, E ASTM A139; B ASTM A381; Y35 ASTM A500; A, B ASTM A501 ASTM A516 ASTM A524; I, II ASTM A529 ASTM A570; all grades ASTM A573; 65 ASTM A709; 36 ASTM A808 API 5L; B, X42 ABS; A, B, D, CS, D, DS, E	Up to ¾ in. (19mm) Over ¾ in. (19mm) thru 1 ½ in. (38.1mm) Over 1 ½ in. (38.1mm) thru 2 ½ in. (63.5mm) Over 2 ½ in (63.5mm)	None 150° F (66° C) 225° F (107° C) 300° F (150° C)

Baking of E6011 Electrodes is Forbidden

Unlike E7018 low hydrogen electrodes, baking of E6010 and E6011 electrodes is forbidden. The cellulose and moisture in E6011 are degraded with baking. Baking causes the flux cover to shrink and crack excessively. This is why E6010 and E6011 electrodes are stored in open-air containers. Conversely, E7018 electrodes are stored in baking ovens to maintain low hydrogen.

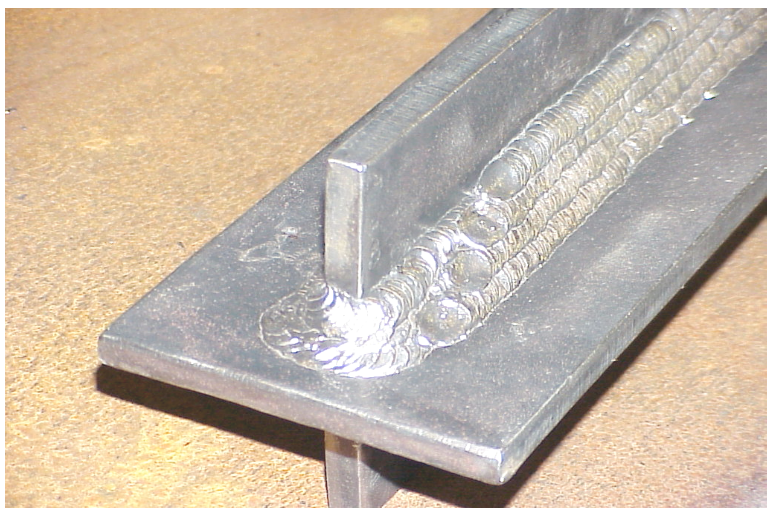
Craftsmanship Expectations for Welding Projects

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 assemblies of metal at a time. This will save a great amount of time.
3. Assemble the welding projects per drawing specifications.
4. Review the Welding Procedure portion of the prints to review welding parameter information.
5. See the instructor for the evaluation.

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

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



An example of a High Quality weld.

Weld Quality per AWS D1.1 Welder Qualification

VT Criteria	Cover Pass
Reinforcement (groove welds)	Flush to 1/8"
Fillet Weld Size	See specification on drawing
Undercut	1/32" max depth
Weld Contour	Smooth Transition
Penetration	N/A
Cracks	None Allowed
Arc Strikes	None Allowed
Fusion	Complete Fusion Required
Porosity	None Allowed

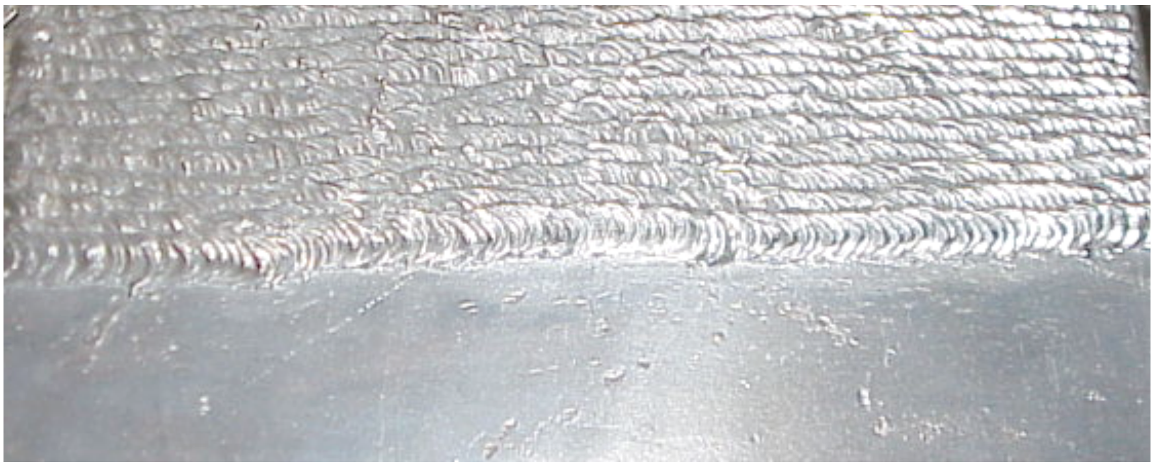
E6011 Bead Plate (Surfacing) Project #1

Technique

Use a straight ***whip and pause*** technique. Allow the puddle to obtain a 3/8" to 1/2" width and step/surge rod in and out of puddle in a rhythm to keep puddle size consistent. The step distance should be approximately 1/2 the puddle length and no more than 1 1/2 the puddle length.

Welding Sequence

Alternate directions of welding for each pass.



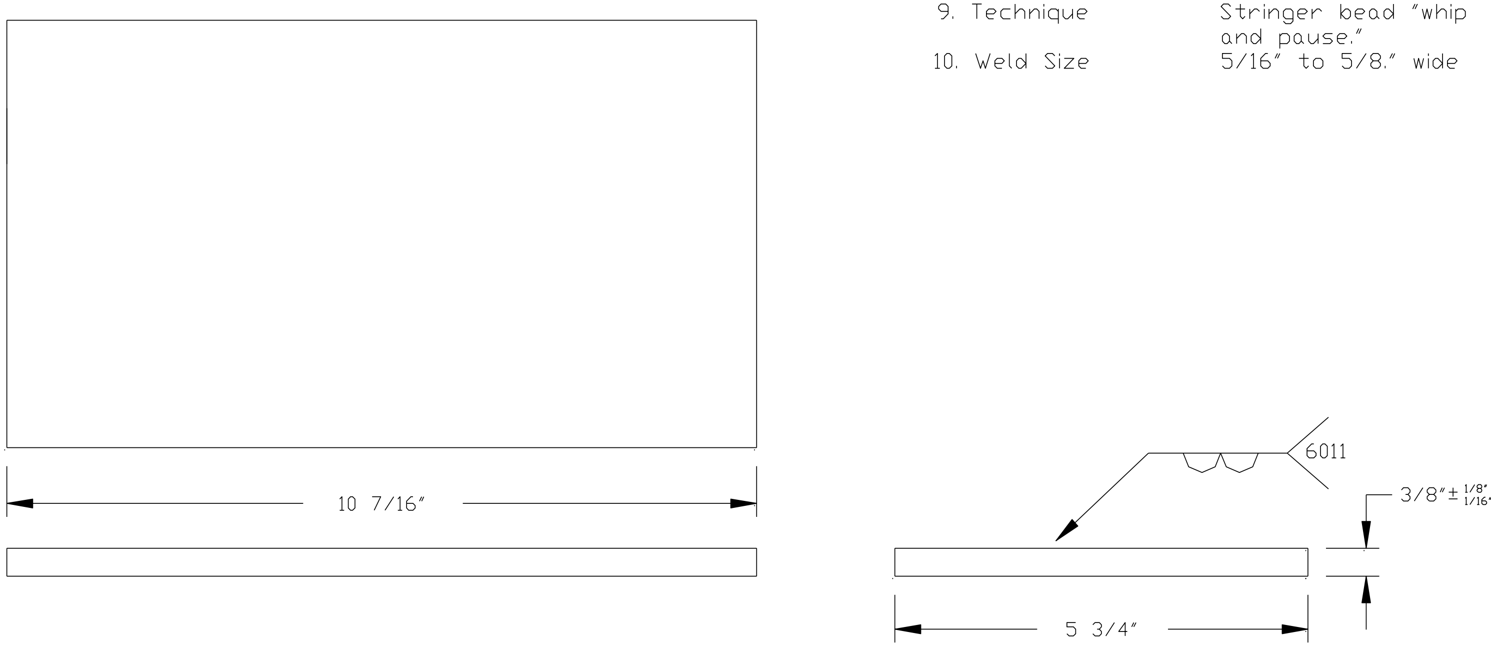
Flat Position Bead Plate

VT Criteria	Student Assessment	Instructor Assessment
Reinforcement (0” –1/8”)		
Fillet Weld Size		
Undercut (1/32”)		
Bead Contour (smooth)		
Penetration		
Cracks (none)		
Arc Strikes (none)		
Fusion (complete)		
Porosity (none)		
		Grade Date

E6011
Flat Position
Bead Plate

Welding Procedure:

1. Electrode — 6011
2. Diameter — 1/8″
3. Polarity — DCRP
4. Amperage — 80 to 95 Amps
5. Arc Length — 1/16″-1/8″
6. Welding Position — Flat
7. Travel Angle — 20°
8. Work Angle — 90° to 75°
9. Technique — Stringer bead "whip and pause."
10. Weld Size — 5/16″ to 5/8.″ wide



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 (TxWxL)	S.I. Conversion
1			

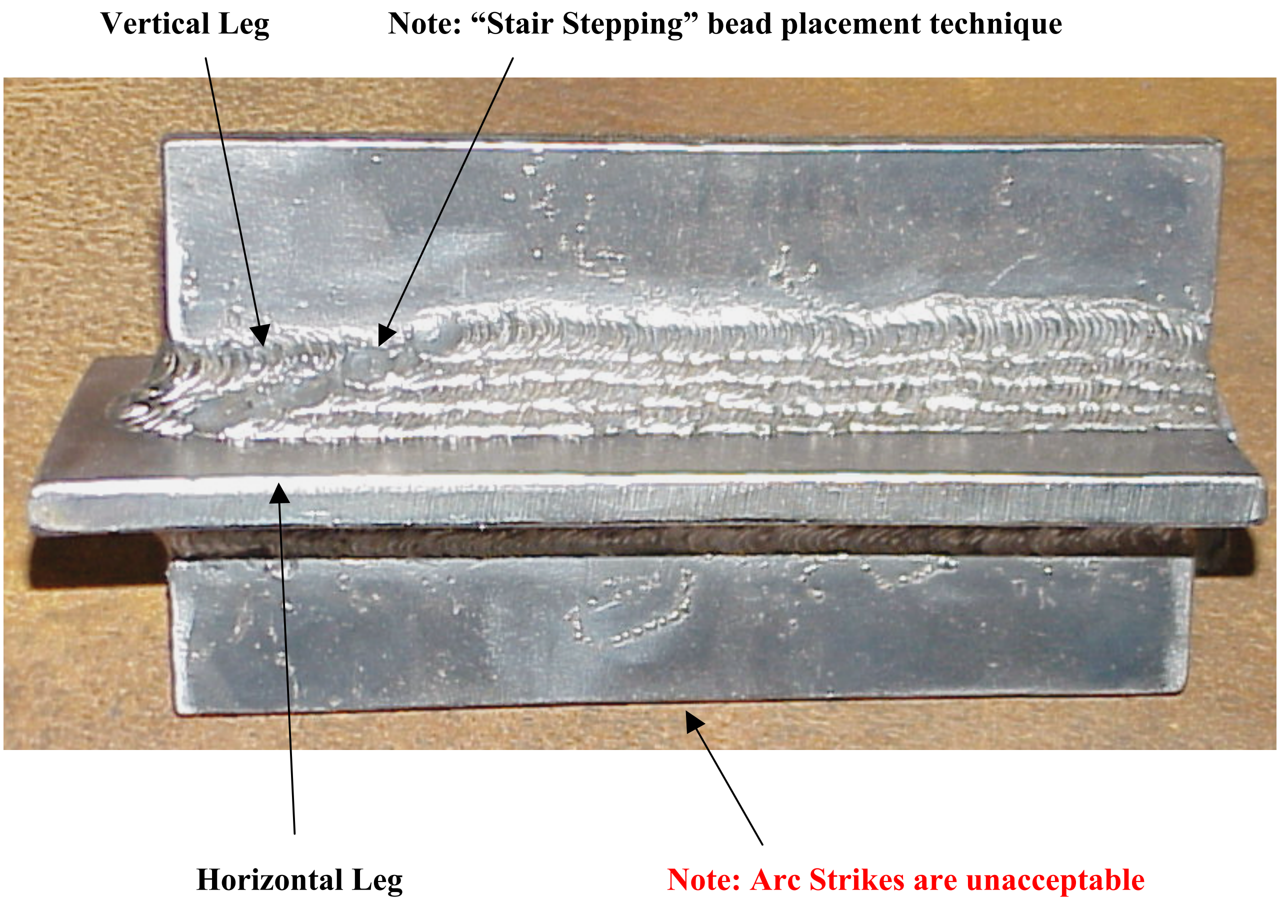
Portland Community College
Welding Technology

Tolerance (Unless otherwise Specified) Dimensional ± 1/16″ Angle ± 5°	WLD 114-01		
Drawn By: John Deering	Size:	QC NO.	Rev.
Chk By: Date: 03/01/04	Approve	Date	Sheet

E6011 T-Joint   Project #2

Welding Sequence

When welding in the horizontal position, start your welding sequence from the horizontal leg of the joint and work up the vertical leg of the joint (stair stepping). Wrap the weld around the corner. Use the boxing technique, and do not stop or restart at the corner.



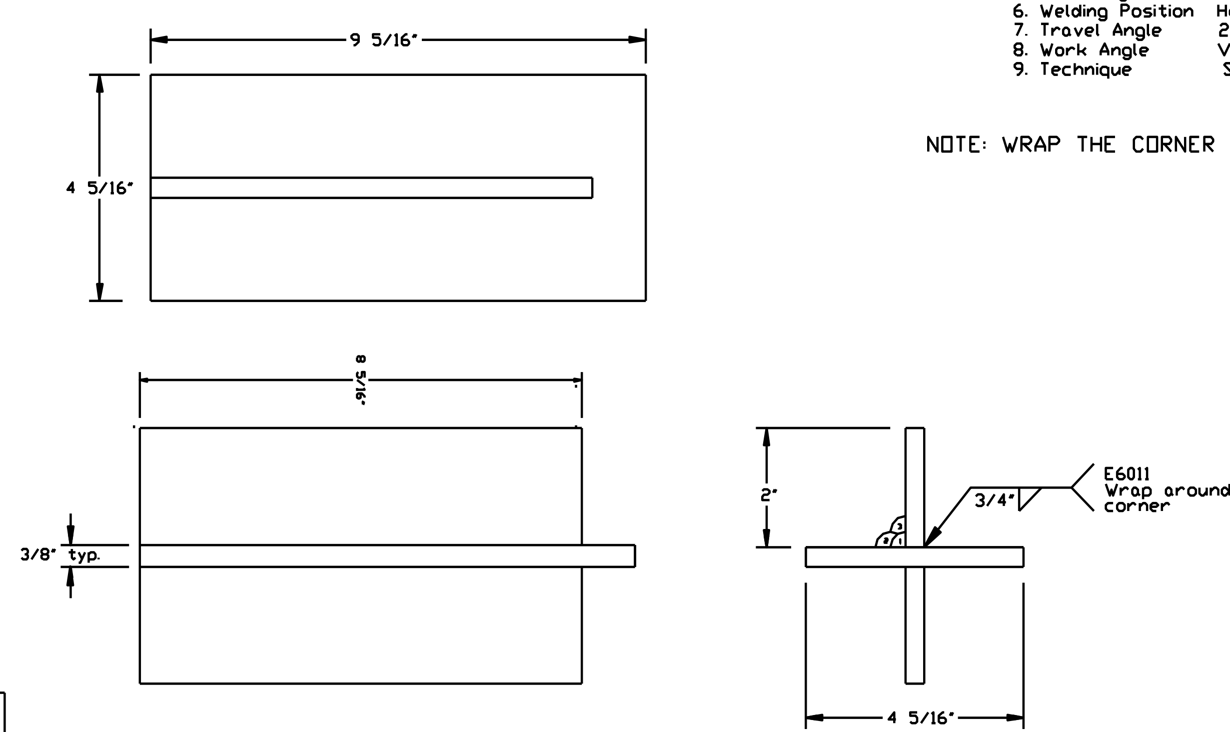
VT Criteria	Student Assessment	Instructor Assessment
Reinforcement (0" –1/8")		
Fillet Wed Size		
Undercut (1/32")		
Bead Contour (smooth)		
Penetration		
Cracks (none)		
Arc Strikes (none)		
Fusion (complete)		
Porosity (none)		
		Grade Date

E6011
Horizontal Position (2F)
T-Joint

Welding Procedure

1. Electrode	6011
2. Diameter	1/8"
3. Polarity	DCRP
4. Amperage	70 to 90 Amps
5. Arc Length	1/16" to 1/8"
6. Welding Position	Horizontal (2F)
7. Travel Angle	20° to 30°
8. Work Angle	Varies
9. Technique	Stringer Bead

NOTE: WRAP THE CORNER



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 (TxWxL)	S.I. Conversion

Portland Community College
Welding Technology

Tolerance (Unless otherwise Specified) Dimensional ± 1/16" Angle ± 5°	WLD 114-02		
Drawn By: John Deering	Size:	Qc No.	Rev.
Chk By: Date: 03/01/04	Approve	Date	Sheet

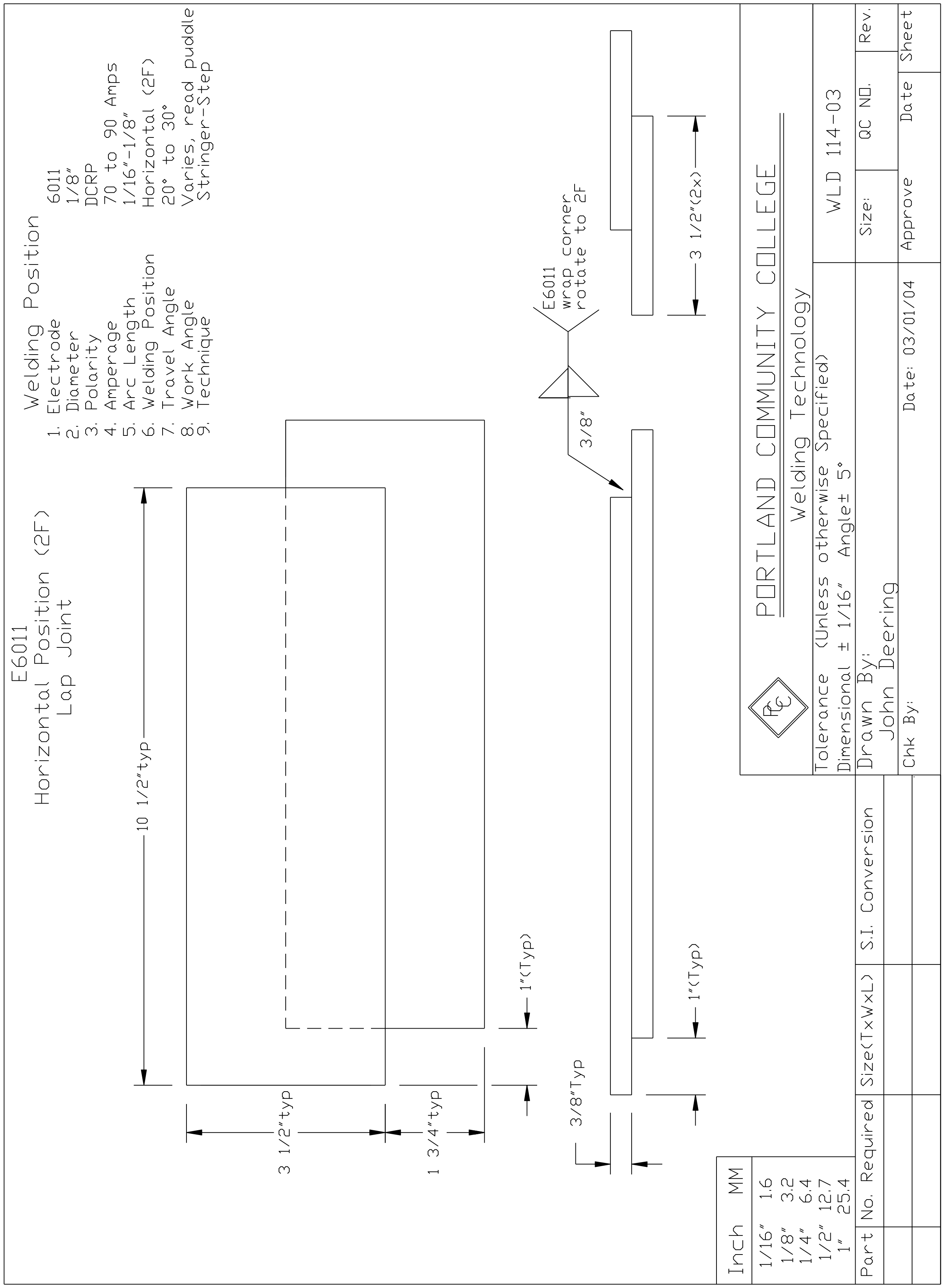
E6011 Lap Joint (2F) Project #3

Welding Sequence

When welding the lap joint in the horizontal position remember to start your welding sequence from the horizontal leg of the joint and work up the vertical leg of the joint (stair stepping). Wrap the weld around the corner. Use the boxing technique and do not stop and restart at the corner.

Horizontal Lap Joint

VT Criteria	Student Assessment	Instructor Assessment
Reinforcement (0" –1/8")		
Fillet Weld Size		
Undercut (1/32")		
Bead Contour (smooth)		
Penetration		
Cracks (none)		
Arc Strikes (none)		
Fusion (complete)		
Porosity (none)		
		Grade Date

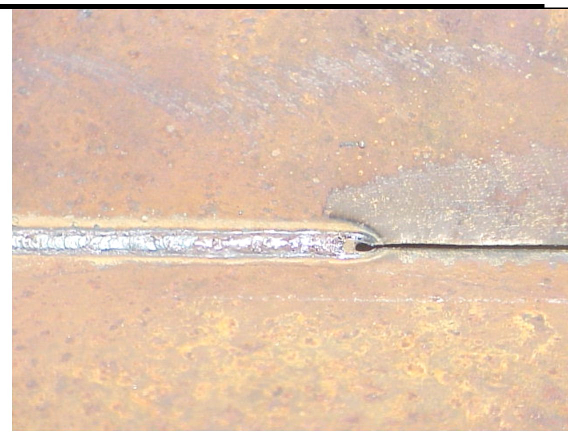

E6011
Horizontal Position (2F)
Lap Joint
Welding Position
1. Electrode 6011
2. Diameter 1/8"
3. Polarity DCRP
4. Amperage 70 to 90 Amps
5. Arc Length 1/16"-1/8"
6. Welding Position Horizontal (2F)
7. Travel Angle 20° to 30°
8. Work Angle Varies, read puddle
9. Technique Stringer-Step
10 1/2"typ
3 1/2"typ
1 3/4"typ
1"(Typ)
3/8"Typ
3/8"
E6011
wrap corner
rotate to 2F
3 1/2"(2x)
1"(Typ)
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(TxWxL)
S.I. Conversion
PORTLAND COMMUNITY COLLEGE
Welding Technology
Tolerance (Unless otherwise Specified)
Dimensional ± 1/16" Angle± 5°
Drawn By:
John Deering
Date: 03/01/04
Chk By:
Approve
WLD 114-03
Size:
QC NO.
Date
Rev.
Sheet

E6011 Corner Joint (2F) Project #4

Welding Sequence

Use the “key hole” technique when welding the root pass to obtain complete joint penetration (CJP). Start your next pass at horizontal leg of the joint and work up the vertical leg of joint (stair stepping). The difficulty with this joint configuration is that there is a limited area in which to weld because of the thickness of the plate. It is important to limit the size of the welds to ensure equal and smooth fill. The ***actual throat*** of the weld should equal the thickness of the plate material.

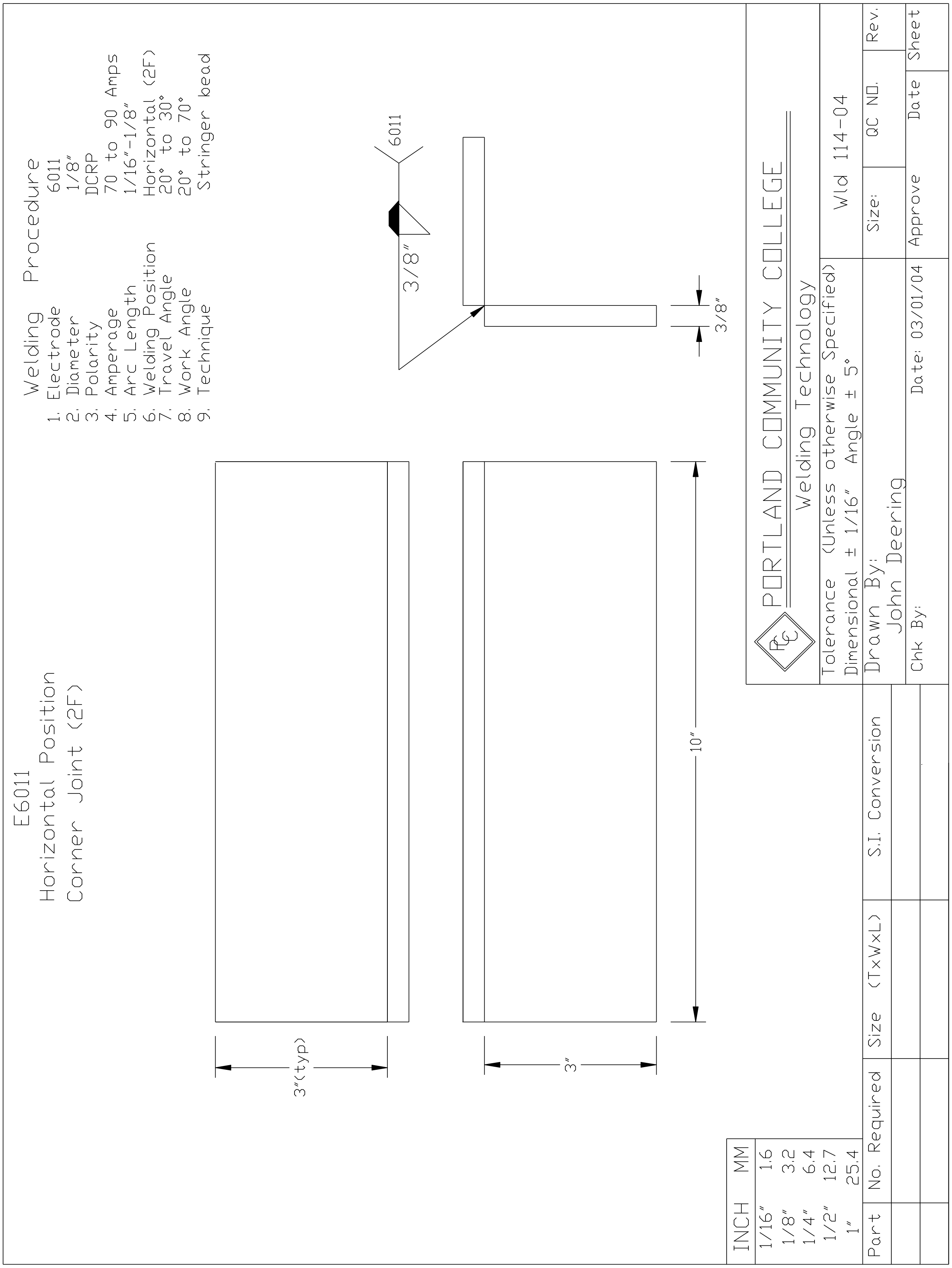
Front Side



Back Side (Root Pass)

Corner Joint

VT Criteria	Student Assessment	Instructor Assessment
Reinforcement (0” –1/8”)		
Fillet Weld Size		
Undercut (1/32”)		
Bead Contour (smooth)		
Penetration		
Cracks (none)		
Arc Strikes (none)		
Fusion (complete)		
Porosity (none)		
		Grade Date



E6011
Horizontal Position
Corner Joint (2F)
Welding Procedure
1. Electrode 6011
2. Diameter 1/8"
3. Polarity DCRP
4. Amperage 70 to 90 Amps
5. Arc Length 1/16"-1/8"
6. Welding Position Horizontal (2F)
7. Travel Angle 20° to 30°
8. Work Angle 20° to 70°
9. Technique Stringer bead
6011
3/8"
3/8"
10"
3"(typ)
3"
PORTLAND COMMUNITY COLLEGE
Welding Technology
Tolerance (Unless otherwise Specified)
Dimensional ± 1/16" Angle ± 5°
Wld 114-04
Drawn By:
John Deering
Size:
QC NO.
Rev.
Chk By:
Date: 03/01/04
Approve
Date
Sheet
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 (TxWxL)
S.I. Conversion

E6011 T-Joint (3F) *Project #5*

Technique

When welding in the vertical position, it is important to control the heat input into the base metal. Three primary ways to accomplish this is by:

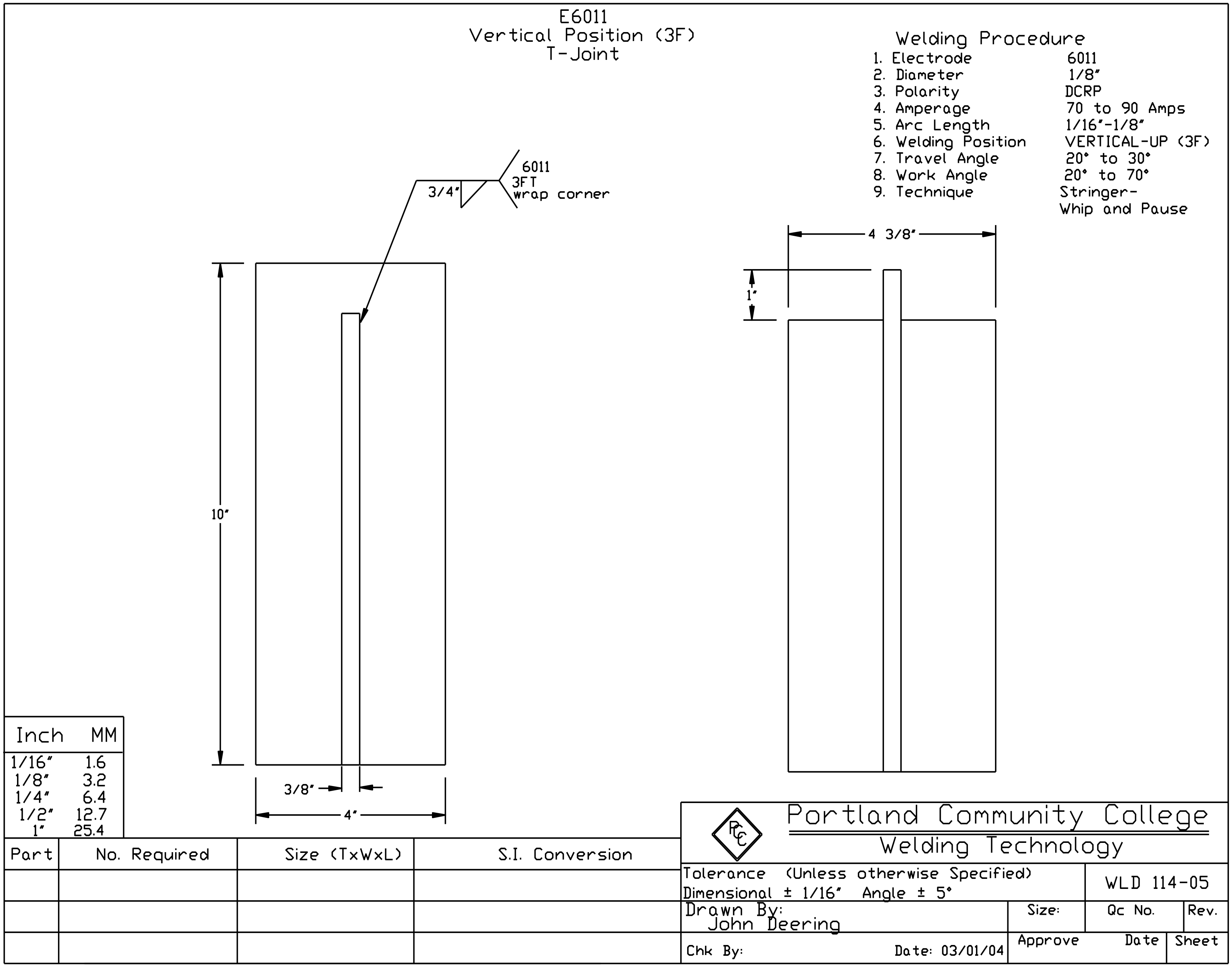
- using lower amperage
- quench the project often
- exaggerate the step technique to allow the puddle to solidify quickly.

Welding Sequence

Wrap the weld around the corner.

Vertical Up T-Joint

VT Criteria	Student Assessment	Instructor Assessment
Reinforcement (0" –1/8")		
Fillet Weld Size		
Undercut (1/32")		
Bead Contour (smooth)		
Penetration		
Cracks (none)		
Arc Strikes (none)		
Fusion (complete)		
Porosity (none)		
		Grade Date


E6011
Vertical Position (3F)
T-Joint
Welding Procedure
1. Electrode 6011
2. Diameter 1/8"
3. Polarity DCRP
4. Amperage 70 to 90 Amps
5. Arc Length 1/16"-1/8"
6. Welding Position VERTICAL-UP (3F)
7. Travel Angle 20° to 30°
8. Work Angle 20° to 70°
9. Technique Stringer-
Whip and Pause
3/4"
6011
3FT
wrap corner
10"
3/8"
4"
4 3/8"
1"
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 (TxWxL)
S.I. Conversion
Portland Community College
Welding Technology
Tolerance (Unless otherwise Specified)
Dimensional ± 1/16" Angle ± 5°
WLD 114-05
Drawn By:
John Deering
Size:
Qc No.
Rev.
Chk By:
Date: 03/01/04
Approve
Date
Sheet

Final Exam

Part One
This portion of the final exam is a closed book test. You may use the review questions you completed at the end of the assigned chapters as a cheat sheet. Consult with your instructor to determine items that you may need to review. Once you determine that you are ready for the exam, see your instructor.

Study Guide

Safety

- **Oxyacetylene safety**
- **SMAW safety**
- **Hand Tool Safety**
-

SMAW and OAC Processes

- **Power source specifics**
  - **Electricity**
    - **Volts, amps, ohms, WATTS**
    - **Transformers and rectifiers**
  - **Polarity**
  - **Current out put**
  - **Arc blow**
- **AWS electrode classification**
  - **Flux composition**
  - **Electrode properties**
  - **Purpose of the Flux**
  - **Welding techniques**
  - **Bead profiles**
- **Base metal**
  - **Joint configurations**
  - **Base metal properties and metallurgy**
- **OAC**
  - **Theory of cutting**
  - **Flame types**
  - **Safety**

Welding Symbols and Blueprints

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

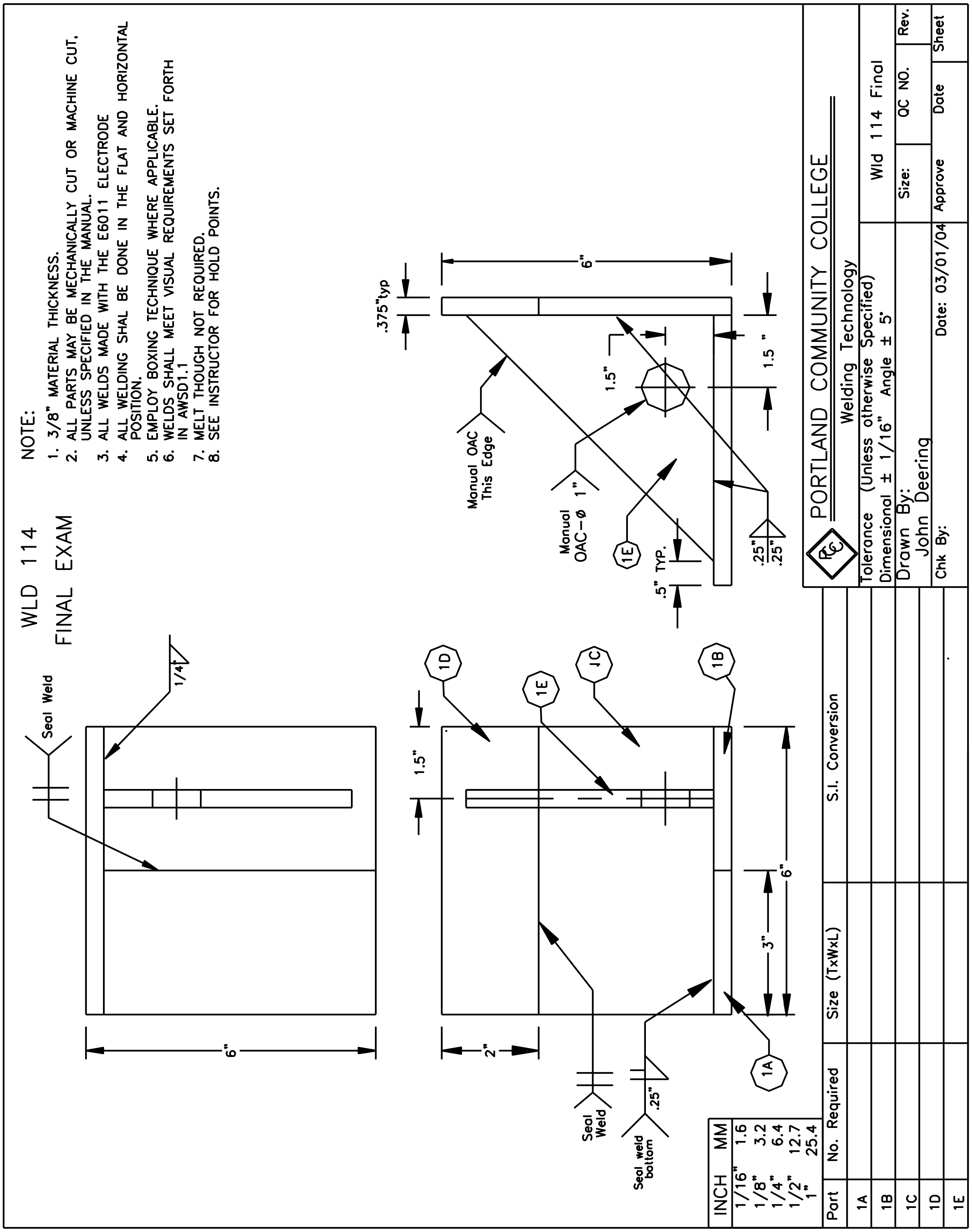
Weld Joint Vocabulary

Math and Math conversions

- **Adding and subtracting fractions and decimals**
- **Reading a tape measure**
- **Metric conversions**
- **Order of operations (Please Excuse My Dear Aunt Sally)**

Part Two

This portion of the exam is a practical test where you will fabricate and weld out a weldment from the drawing attached to the final exam (see picture below). The evaluation of this portion of the exam will be based on the grading ***Traveler*** in this training packet.



WLD 114
FINAL EXAM
NOTE:
1. 3/8" MATERIAL THICKNESS.
2. ALL PARTS MAY BE MECHANICALLY CUT OR MACHINE CUT, UNLESS SPECIFIED IN THE MANUAL.
3. ALL WELDS MADE WITH THE E6011 ELECTRODE
4. ALL WELDING SHAL BE DONE IN THE FLAT AND HORIZONTAL POSITION.
5. EMPLOY BOXING TECHNIQUE WHERE APPLICABLE.
6. WELDS SHALL MEET VISUAL REQUIREMENTS SET FORTH IN AWSD1.1
7. MELT THOUGH NOT REQUIRED.
8. SEE INSTRUCTOR FOR HOLD POINTS.
Seal Weld
1/4
6"
1.5"
2"
3"
6"
.375"typ
1.5"
1.5 "
Manual OAC This Edge
Manual OAC-Ø 1"
.5" TYP.
.25"
.25"
Seal Weld
Seal weld bottom
.25"
1A
1B
1C
1D
1E
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 (TxWxL)
S.I. Conversion
PORTLAND COMMUNITY COLLEGE
Welding Technology
Tolerance (Unless otherwise Specified)
Dimensional ± 1/16" Angle ± 5°
Wld 114 Final
Drawn By:
John Deering
Size:
QC NO.
Rev.
Chk By:
Date: 03/01/04
Approve
Date
Sheet

Grading Traveler for the WLD 114 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*	**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.	
35 points	***Minimum points acceptable. This equates to the minimum AWS D1.1 Code requirements.***	
	Total Points	**/40**

Final Grades - WLD 114

Name: __________________ Instructor: ____________________ Date: ___________________

Welding Projects = 40%

Out of 10	~~Out of~~	~~Out of~~
Out of 10	~~Out of~~	~~Out of~~
Out of 10	~~Out of~~	~~Out of~~
Out of 10	~~Out of~~	~~Out of~~
Out of 10	~~Out of~~	~~Out of~~
~~Out of~~	~~Out of~~	~~Out of~~

A Total Project pts. ________ / Total pts. Possible _______ X 40 = **_______ %**

Quizzes = 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 = **_______ %**

Attendance = 10% 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 10 = **_______ %**

Final Exams 30%

Written Exam	Out of
Practical Exam	Out of

E Total Project pts. ________ / Total pts. Possible _______ X 30 = **_______ %**

Add Lines A + B + C + D + E. This will give you your Final Grade TOTAL % _________

FINAL GRADE _________