WLD 112
Shielded Metal Arc Welding: Mild Steel I (E7018)

This project was supported, in part, by the *National Science Foundation*
Opinions expressed are those of the authors And not necessarily those of the Foundation.

PCC/ CCOG / WLD

Course Number:
WLD 112

Course Title:
Shielded Metal Arc Welding: Mild Steel I (E7018)

Credit Hours:
4

Lecture Hours:
0

Lecture/Lab Hours:
80

Lab Hours:
0

Special Fee:
$24.00

Course Description

Develops knowledge and skills in the use of E7018 mild steel electrodes when performing various welds in the flat, horizontal and vertical positions. Prerequisites: Department permission required. Audit available.

Addendum to Course Description

This is a outcome based course utilizing a lecture/lab format. This course includes classroom discussions, videotapes, and lab demonstrations of technical skills. Course outcomes will include: theoretical concepts, lay out, fabrication, welding, oxy-fuel cutting and safety.

Intended Outcomes for the course

Upon completion of the course students will be able to:

- Function safely in the PCC Welding lab.
- Operate oxy-fuel portable and track cutting systems in accordance with industry standards.
- Understand and apply fundamentals of SMAW E7018 operations.
- Interpret blueprints to accurately lay out, prepare, and assemble weld joints.
- Weld common joint assemblies with the E7018 electrode to AWS D1.1 Structural Steel Welding Code.
- Apply visual examination principles and practices in accordance with AWS D1.1.

Course Activities and Design

Welding lec/lab courses are Open Entry and Open Exit (OE/OE) and are offered concurrently. Courses are designed to meet the needs of the students with flexible scheduling options. Students may attend full time or part time. This is an OE/OE course which does not align with the normal academic calendar.

Outcome Assessment Strategies

The student will be assessed on his/her ability to demonstrate the development of course outcomes. The methods of assessment may include one or more of the following: oral or written examinations, quizzes, written assignments, visual inspection, welding tests and task performance.

Course Content (Themes, Concepts, Issues and Skills)

Function safely in the PCC Welding Lab.

- Understand and practice personal safety by using proper protective gear
- Understand and practice power tool safety
- Understand and practice equipment safety for welding and oxy-fuel cutting systems
- Understand and maintain a safe work area
    - Recognize and report dangerous electrical and air/gas hose connections
    - Understand and practice fire prevention

Operate oxy-fuel portable and track cutting systems in accordance with industry standards.

- Demonstrate correct setup, operation and shutdown procedures for oxy-fuel hand cutting
- Demonstrate correct setup, operation and shutdown procedures for oxy-fuel track cutting

Understand and apply fundamentals of SMAW E7018 operations.

- Describe and demonstrate equipment setup, shut down, and operation
- Identify Electrode Characteristics
- Demonstrate proper Arc Length and Travel speed
- Demonstrate correct starting, stopping and restarting techniques
- Demonstrate proper bead placement

Interpret blueprints to accurately lay out, prepare, and assemble weld joints.

- Interpret lines, symbols, views and notes
- Lay out material per specifications
- Use the oxy-fuel cutting process to cut material to specified dimensions
- Assemble project per specifications

Weld common joint assemblies with the E7018 electrode to AWS D1.1 Structural Steel Welding Code in the following joint configurations and positions.

- Flat position
    - Bead plate
    - T-joint
    - Corner joint
- Horizontal position
    - T-joint
    - Lap joint
    - Outside corner joint
    - Single V-groove
- Vertical position
    - T-joint

Apply visual examination principles and practices in accordance with AWS D1.1.

- Evaluate welds using appropriate welding inspection tools
- Assess weld discontinuities causes and corrections

Introductory Statement

Weld 112, ***Shielded Metal Arc Welding: Mild Steel I (E7018)*** is an intermediate welding course offered at Portland Community College. This class will assist the student in developing the techniques needed when using low hydrogen electrodes. This course utilizes a lecture/lab format includes classroom discussions and lab demonstrations.

Course Assignments

Reading

Welding Principles and Applications, Jeffus, Larry.

Work Sheets

Welding Carbon and Low Alloy Steels with SMAW
Introduction to Welding Procedures
Arc Blow
Power Sources

Video Training

See pcc.edu/library for a complete list of Hobart videos
Delmar's Shielded Metal Arc Welding Video number two (2).

Cutting Projects

Complete Bill of Materials

Welding Projects

E7018 Bead Plate (Surfacing)
E7018 T-Joint (1F)
E7018 Lap Joint (1F)
E7018 Corner Joint (1F)
E7018 T-Joint (2F)
E7018 Lap Joint (2F)
E7018 Corner Joint (2F)
E7018 Single V Grove Weld
(2G) E7018 T-Joint (3F)

Final Exam

Part One (Closed Book Exam) Part Two (Practical Exam)

Required Text

Welding Principles and Applications, Jeffus, Larry.

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 test, safe work habits and task performance.

Low Hydrogen Information Sheet

SMAW is a process where a constant current power sources converts high voltage and low amperage into low voltage and high amperage current used to melt the base metal through the electrode arc to make a weld. The power source depending upon quality will produce either alternating current or alternating current and direct current.

The electrodes that are used with SMAW are approximately 14 inches long and will be consumed into the weld. These electrodes are flux covered and it's this flux that distinguishes its arc characteristics and its ability to weld out of position.

The electrode flux has several functions. These include:

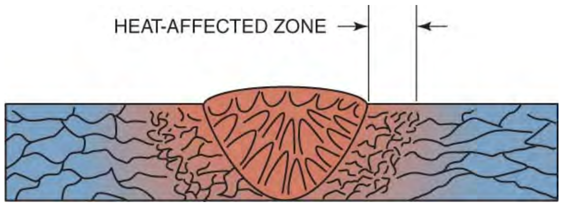
- **Gas shielding**
- **Controls Penetration**
- **Helps remove oxides**
- **Alloy additions**
- **Provides Arc Stabilizers**
- **Increases deposition rates**

If flux is missing from the rod, the electrode should be considered useless and discarded.

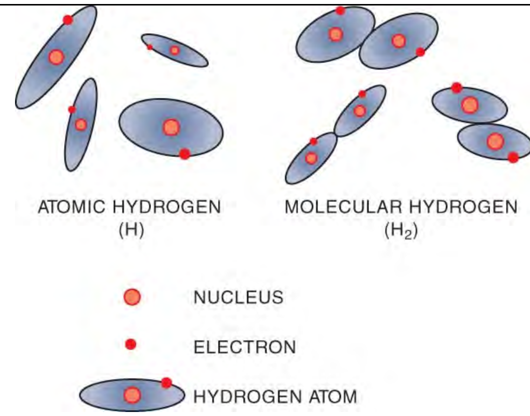
Low Hydrogen Electrodes

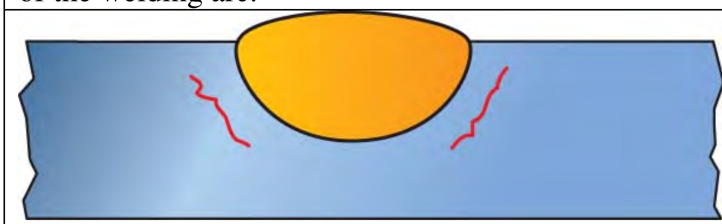
Low-hydrogen electrodes must be dry if they are to perform properly. Electrodes in unopened, hermetically sealed containers remain dry indefinitely in good storage conditions. Opened cans should be stored in a cabinet at 250 F to 300 F. Low-hydrogen electrodes pick up moisture. The moisture, depending upon the amount absorbed, impairs weld quality in the following ways.

- A small amount of moisture may cause internal porosity. Detection of this porosity requires X-ray inspection or destructive testing. A high amount of moisture causes visible external porosity in addition to internal porosity.
- Severe moisture pickup can cause weld cracks or under-bead cracking in addition to severe porosity.

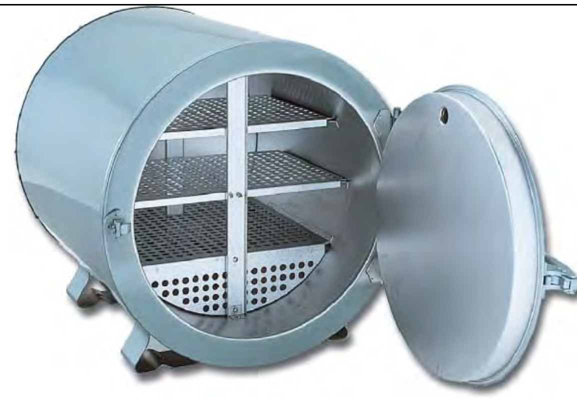


Heat Affected Zone (HAZ = the area next to the weld that is changed at the microstructure level by the heat of the welding arc.





The cracks, indicated by the red lines, are considered under bead cracking and are due to Hydrogen escaping from moisture in the electrode, air, material commination and causes cracks. Especially in crack sensitive material (T1 Steel = Quenched and Tempered = A514 or A517).



Typical rod oven used to dry electrodes to prevent water (H20) from getting into the weld/HAZ zone.

- If the base metal has high hardenability even a small amount of moisture can contribute to under-bead cracking.

Low-hydrogen Electrodes are available with fast fill and fast freeze Characteristics.

When welding out-of-position the molten metal tends to spill out of the joint. To offset this tendency, an electrode with a fast-freezing deposit is needed, even though the slag stays molten and tends to spill out.

Applications for low-hydrogen electrodes include:

- X-ray-quality welds or welds requiring high mechanical properties.
- Crack-resistant welds in medium-carbon to high-carbon steels; welds that resist hot-short cracking in phosphorus steels; and welds that minimize porosity in sulfur-bearing steels.
- Welds in thick sections or in restrained joints in mild and alloy steels where shrinkage stresses might promote weld cracking.
- Welds in alloy steel requiring a minimum tensile strength of 70,000 psi or more.
- Multiple-pass vertical, and overhead welds in mild steel.

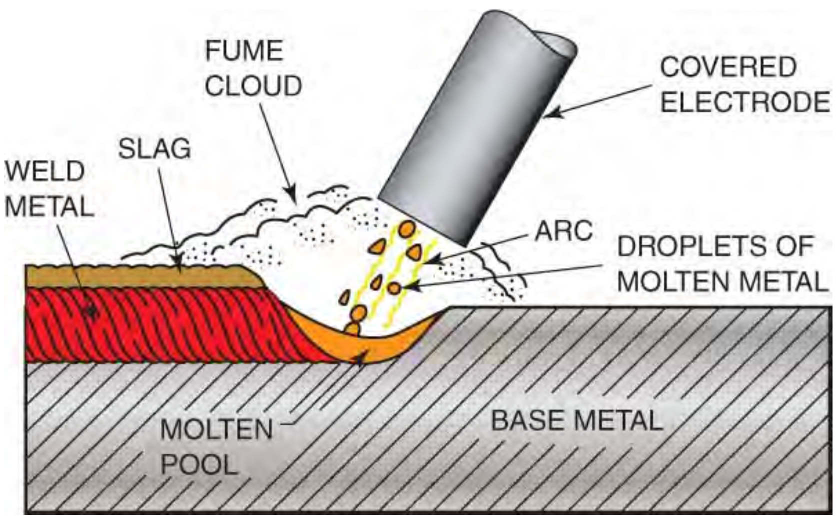
Helpful Hints

Arc Length E7018

Due to the nature of low hydrogen electrodes it is critical to maintain a short and consistent arc length. This will maximize the shielding gas coverage for the weld puddle. Arc length can be determined by sight and sound.

1st If the arc is to long you will see the globular transfer.
2nd If it is too short you will see slag wanting to explode from the puddle and you'll hear an electrical humming sound.
3rd The correct arc length will be between those two indicators.

Remember: The recommended Arc Length is equal to electrode diameter. It should not exceed the diameter of the electrode at any time. If you remember this, you'll never have trouble with porosity.



Starting/Restarting Technique

When starting, or restarting the arc it is important to obtain a sound weld.
Therefore, the following technique should be employed.

1st Locate where you want to start. This is important so that you do not have arc strikes all over the parent material.
2nd Utilize the tap or scratch method to initiate the arc.
3rd Start the arc directly ahead of the crater.
Once arc is started establish a long arc with an upward stroke initiation. It is here where an extra quick movement is necessary because the E7018 has a high likelihood of sticking, you will need to pull the electrode away quickly but yet maintain a short enough arc to keep it going. This balance is difficult at first, but will come with time. The purpose of this is as follows:

A. Preheats the parent metal
B. Allows gaseous shield to be established
C. Allows the amperage to flow so the heat will build up
D. Gives off light to find the crater

4th Precede back to the crater. Once there, 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:

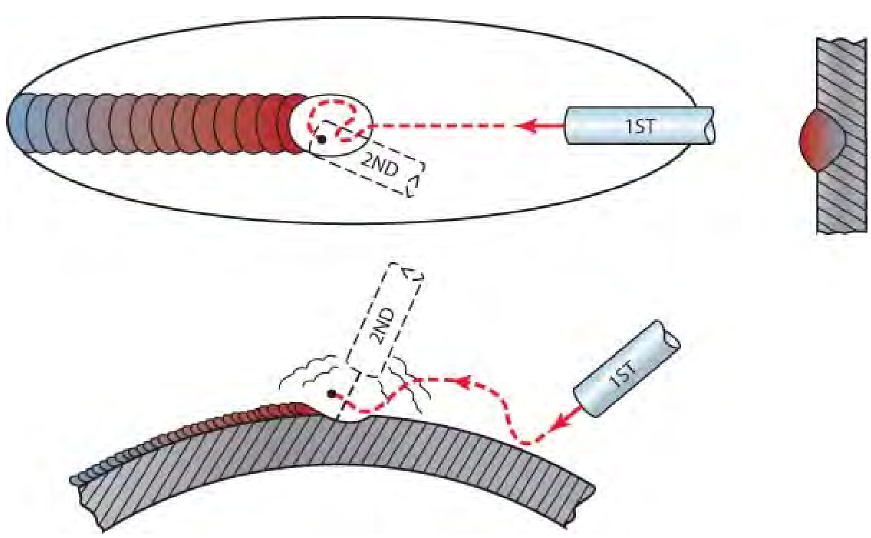
A. Its a timing device used to fill the crater flush with the weld bead.
B. It will help drive out any slag/porosity that may of otherwise it becomes entrapped.

The E7018 is easier to initiate with a new rod than a used rod. However, when restarting a used rod, it is important to note that the flux surpasses the core wire. The core wire also tends to have a slag covering on it as well. These two items make it more difficult to initiate the arc. Hence, if you scrap the end of the rod off before striking it will light up easier. Take care not to break away any excessive coatings off the end of the rod. The flux coatings help stabilize the arc without the flux it will make arc initiation troublesome.

Quick flick technique when terminating your arc will allow a globular ball to fly off the end of the electrode. This glob will take the slag off the end of the rod. Thus, allowing an easier restart.

5th **REMEMBER:**

The quality of welds produced depends largely upon the skill of the welder. Developing the necessary skill level requires Practice. However, practicing the welds repeatedly without changing techniques will not aid in developing the required skills. Each time a weld is completed it should be evaluated, and then a change should be made in the technique to improve the next weld.



Contents of this Packet

Characteristics of E7018 Low-Hydrogen Electrodes compared to E7010
Why "Low-Hydrogen" prevents Cracking in Welds
Advantages of E7018 Electrode for SMAW
Disadvantages of E7018 Electrodes for SMAW
Mechanical Properties of Weld Metal deposited by SMAW with E7018
Codes Requiring E7018 Low-Hydrogen Electrodes
Hydrogen Designators by AWS
Flux Composition of E7018 Electrode
Alloy Variations of E7018 Electrodes
Iron Powder in E7018 Electrode
Baking of E7018 Electrodes
Arc Length and Arc Voltage
Arc Starting

Characteristics of E7018 Low-Hydrogen Electrodes compared to E7010

Although an all-position electrode, the E7018 electrode provides moderate penetration and build-up. The slag layer is heavy and hard, but easily removed. The iron powder in the flux coating provides about double the deposition rate compared to E7010 electrodes. The molten weld metal is protected from the surrounding air primarily by the molten slag layer and not by the rapidly expanding gases, which is the primary shielding for E7010 cellulosic electrodes. Since E7018 provides only limited gaseous protection and less penetration compared to cellulosic electrodes (for example: E7010), E7018 is not suited for open root passes. Without substantial gaseous protection the open root is susceptible to both hydrogen contamination and porosity because of air and moisture contamination from the back-side of the root. In addition, the weld starting location of an E7018 weld deposit is very susceptible to porosity because of the time-lag associated with the build-up of the thick slag shielding. A short starting tab is recommended when using E7018.

Why "Low-Hydrogen" prevents Cracking in Welds

Hydrogen is in undesirable impurity in weld metal. The primary source of hydrogen contamination is moisture content (H_2O) of the flux coating. Unfortunately, hydrogen is very difficult to eliminate in any flux welding process, such as SMAW, FCAW or SAW, because all fluxes absorb moisture to some extent. When moisture passes through the arc, it dissociates into hydrogen and oxygen as shown:

$$H_2O = 2H + O$$

Other sources of ***hydrogen*** contamination, which are avoidable with good workmanship practices, include: ***oil, grease, paint, dirt, moisture-absorbing rust*** and other hydrogen-containing materials. ***Oil and grease*** are hydrogen-carbons, which dissociate into free hydrogen and carbon dioxide during welding. Although hydrogen does not impair arc stability, it does cause serious cracking in the heat-affected zones of welds deposited on thick and/or high strength steels.

Hydrogen is the smallest atom in the universe and is an "interstitial" (a crystalline lattice containing smaller atoms of a different element within its interstices, voids or holes between the atoms and the lattice) in iron, so hydrogen can diffuse in steel rapidly even at and below room temperature. Interstitial atoms like hydrogen are so small compared to iron 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. Because the flux coating can absorb moisture from the air, E7018 electrodes that have been removed from their hermetically sealed, moisture/water tight containers must be stored in a baking oven. The electrode exposure to the atmosphere shall not exceed: Four (4) hours maximum. (Table 5.1. AWS D1.1. The oven is set at a temperature recommended by the manufacturer, which is within the temperature range specified by the welding code of interest. For example, the D1.5 Bridge Welding Code specifies baking temperature for E7018 in the range from 250°F to 500°F. Generally, the manufacture's recommendation will fall within this range. The reason for baking the electrodes is to effectively evaporate all traces of water or moisture from the flux coating.

Advantages of E7018 Electrode for SMAW

The E7018 electrode for SMAW is often called "lime" electrode, "basic" electrode and "low-hydrogen" electrode. The three primary functions of E7018 electrodes are to provide (1) all-position capability, (2) weld metal with low hydrogen content for greatest cracking resistance, and (3) Charpy impact toughness typically required for all code work. Outstanding features of E7018 electrode include:

- All-position welding
- Low hydrogen weld deposits
- Tough weld metal (having high Charpy V-notch (CVN) impact toughness)
- Iron powder addition for improved deposition rate
- Required for all welding codes to join thick steel and high strength steels to prevent hydrogen-assisted cracking
- Sound weld deposits (X-ray quality)
- Reduced preheating requirements
- Either DCEP (reverse polarity) of AC can be used
- Moderately heavy slag which is easy to remove

Disadvantages of E7018 Electrodes for SMAW

Compared to the cellulosic Exx10 electrodes such as E6010, the E7018 electrodes have the following disadvantages:

- Can not deposit the root pass on an open root steel pipe as well as E6010
- Can not penetrate as deep as E6010
- Porosity can occur during arc starting
- Susceptible to undercut in up-hill welding

Mechanical Properties of Weld Metal deposited by SMAW with E7018

The specified composition and mechanical properties of weld metal deposited by E7018 are listed in Table 1. Weld metal deposited by SMAW using E7018 electrodes provides excellent strength, ductility, soundness, and most importantly resistance to hydrogen-assisted cracking.

Table 1 Composition and Mechanical Properties of Weld Metal deposited by SMAW using modern E7018-H4 electrodes

E7018 Composition of Weld Metal (wt %)	<u>AWS A5.1</u> C: not specified S: not specified P: not specified Ni: not specified Mn: 1.60 max Si: 0.75 max Cr: 0.20 max Mo: 0.30 max	<u>Typical</u> C: 0.05 S: 0.009 P: 0.015 Mn: 1.40 Si: 0.45 Cr: 0.05 Ni 0.05 Mo: 0.03
Mechanical Properties of Weld Metal	Tensile Strength: 72ksi (500MPa) min Yield Strength: 60ksi (420MPa) min % Elongation: 22% min CVN Toughness: 20ft-lbs @ -20°F min	Tensile Strength: 84 ksi (MPa) Yield Strength: 70 ksi (MPa) % Elongation: 30% CVN Toughness: 120ft-lbs @ -20° F
Radiographic Soundness per AWS A5.1	Grade 1 (highest level of integrity)	
Diffusible Hydrogen	H4 (4 ml/100g max)	3 ml/100g

Flux Composition of E7018 Electrode

E7018 is a low-hydrogen electrode containing a completely different flux coating composition compared to the E6010, E6011 cellulosic electrodes and the E6012 and E6013 rutile electrodes. The mineral flux coating on low-hydrogen E7018 electrodes does not produce much gas shielding but does produce a thick slag that primarily consists of calcium carbonate and calcium fluoride to provide:

- A thick basic slag to cover the molten weld pool with adequately high melting temperature and viscosity to:
    - Protect the molten pool from air contamination, and
    - Assist with out-of-position welding
- Only limited gas shielding to protect against air contamination
- Very low contamination by moisture and hydrogen; for example 4ml/100g (that is: 4ml of hydrogen gas in 100grams of deposited weld metal).
- Low density slag which quickly floats to the top of the weld pool
- Directional mass transfer through the arc for out-of-position welding
- Alloying elements, as needed
- Deoxidizers and desulfurizers to improve weld metal toughness
- Capability to use either DCEP or AC
- Readily detachable slag
- Smooth flat to slightly convex weld contour
- Nearly spatter-free and light fumes

Alloy Variations of E7018 Electrodes

Although all E7018 electrodes possess the same essential properties shown in Table 1, electrodes designated as E7018-1, E7018M, E7018-A1 and E7018-B2L have specific enhancements. Compared to E7018 electrode, weld metal deposited with E7018-1 must provide greater Chary V Notch impact toughness than that shown in Table 1; namely, a minimum of 20ft-lbs (27 J) at -50° F (-10° C). E7018-M is designed for extra low levels of diffusible hydrogen as specified in military code MIL-E-0022200/10. Typical diffusible hydrogen content in weld metal will be less than 4 ml/100g (of deposited weld metal). E7018-A1 contains 0.5Mo for added yield strength and is designed for welding high yield strength steels used in the boiler and pressure vessel industry. Finally, E7018-B2L is a Cr-Mo alloyed electrode with extra low carbon content. It is designed to welding the 1%Cr-.5%Mo steels in boilers, pressure piping, castings and forgings.

Iron Powder in E7018 Electrode

The use of from 25 to 40% iron powder in E7018 has two very beneficial effects. First, the deposition rate of E7018 is nearly doubled compare to all-position electrodes without iron powder, such as E7010. Second, the beneficial effect is the improved arc behavior and reduced spatter with iron powder additions. The reason why iron powder affects the performance of the E7018 electrode is because the iron powder in the covering causes the covering to become electrically conductive near the arc. As a result, the arc tends to spread out radially and deposits over a wider area. The diffuse arc area provides many conductive paths (to the weld pool), thereby limiting current surges when molten metal globules short circuit between the electrode wire and the weld so that spatter is greatly reduced.

Baking of E7018 Electrodes

Unlike Exx10 and Exx11 cellulosic electrodes, the E7018 low-hydrogen must be kept dry for maximum resistance to weld metal cracking. The electrodes are dried at the manufacturing plant and then immediately packed in hermetically sealed steel cans to preserve the low moisture (low hydrogen) properties. However, as soon as the hermetically sealed can is opened and E7018 electrodes are redrawn for use, humidity in the air slowly deposits moisture in the coating. This is why AWS D1.1 Structural Welding Code allows E7018 electrodes to be exposed to the atmosphere for only 4 hours. After 4 hours, the unused electrodes must be returned to the baking oven for the required re-drying cycle. There is no limit to the number of times that the E7018 electrodes can be taken out for 4 hours and returned back to the drying oven.

Arc Length and Arc Voltage

When using E7018 electrodes, it is important keep a relative short arc since there is very little shielding gas produced by the basic flux coating. Since all SMAW is performed with constant current power sources, variations in arc length will cause variations in arc voltage. For example, as the arc length is increased (by raising the electrode), the arc voltage also increases. This is because all of the electric circuits obey Ohm's Law which states:

$$E = I\,R$$

Where: E is the arc voltage
I is the arc current in amperes
R is the electrical resistance of the arc

As the arc is lengthened, the arc becomes colder due to radiation to the atmosphere, which in turn increases the electrical resistance of the arc by decreasing the amount of ionized atoms to conduct current. Since the power circuits try to maintain constant current as the arc is lengthened and the resistance is increasing, the resulting voltage also increases.

Arc Starting

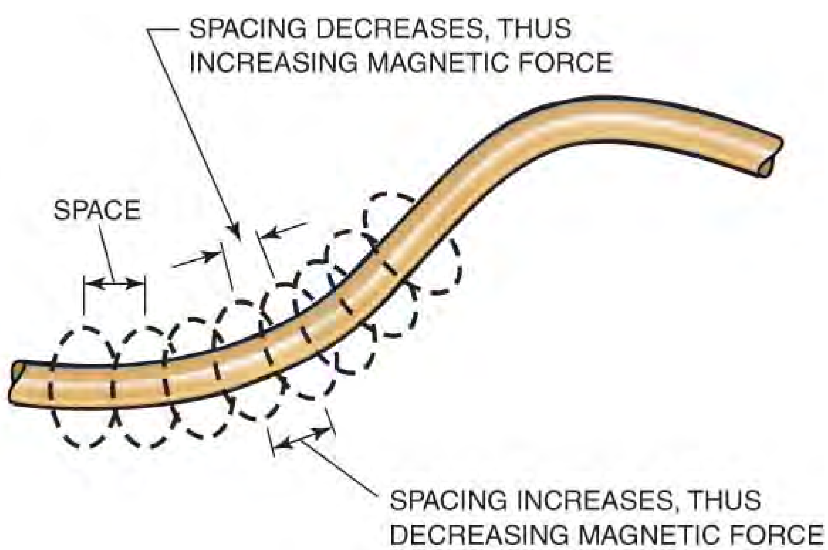
Because E7018 electrode is low moisture, low hydrogen electrode, there is very little gas shielding. Therefore arc starts or strikes typically contain some porosity and is preferably performed on a run-off tab, if possible. However, when E7018 electrode is started on the work-piece itself, it is advisable to work the puddle to build up the molten pool size and its slag cover. In this way, the initial porosity will have time to float to the top of the pool while the protective slag is thickening. Once the weld pool size and slag cover are established, the porosity problem will disappear. A few electrode manufacturers actually sell electrodes with "starting tips" on their E7018 electrodes to facilitate porous-free arc strikes.

Arc Blow

The welding current flowing through a plate or any residual magnetic fields in the plate will result in uneven flux lines. These uneven flux lines can, in turn, cause an arc to move during a weld. This movement of the arc is called ***arc blow***. Arc blow makes the arc drift as a string would drift in the wind Arc blow is more noticeable in corners, at the ends of plates and when the work lead is connected to only one side of a plate. If arc blow is a problem, it can be controlled by connecting the work lead to the end of the weld joint and making the weld in the direction toward the work lead. Another way of controlling arc blow is to use two work leads, on each side of the weld. The best way to eliminate arc blow is to use alternating current. A very short arc length can help control arc blow.

Arc blow is a phenomenon encountered in DC arc welding when the arc stream does not follow the shortest path between the electrode and the work-piece but is deflected forward or backward from the direction of travel or, less frequently, to one side. Unless the arc blow is controlled arc blow can cause the welder some difficulties in controlling the weld pool and slag. You will have excessive spatter, possibly cause lack of fusion, slower welding speed, excessive undercut and will cause weld pool to boil out and leave a large mound of weld in the center of your weld bead or drip down leaving an ice cycle below your crater.

When electrons flow they create lines of magnetic force that circle around the line of flow. Lines of magnetic force are referred to as magnetic flux lines. These lines space themselves evenly along a current-carrying wire. If the wire is bent, the flux lines on one side are compressed together, and those on the other side are stretched out. The unevenly spaced flux lines try to straighten the wire so that the lines can be evenly spaced once again. The force that they place on the wire or cable is usually small. However, when welding with very high amperages, 600 amps or more, the force may cause the wire or cable to move.



Ways to control Arc Blow

1. Reduce the welding current which may require you to slower travel speed

2. Change angle of electrode with the work opposite the direction of arc blow

3. Weld away from the ground to reduce back blow weld toward the ground to reduce forward blow

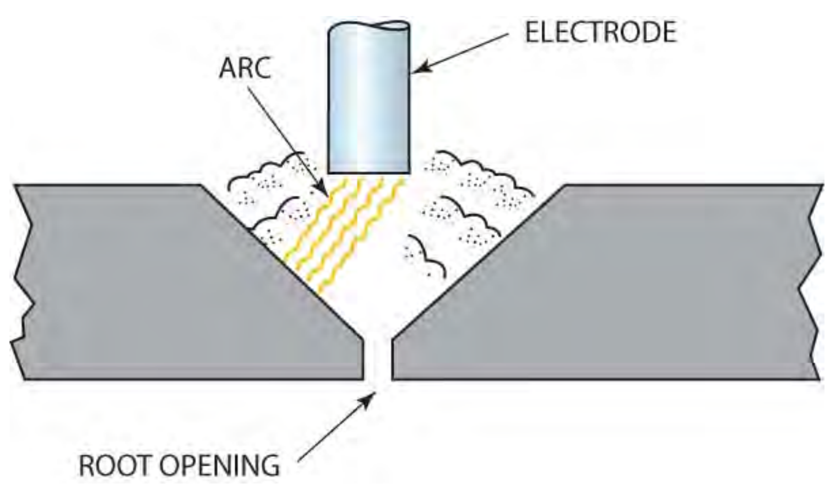
4. Wrap ground cable around the work piece and pass ground current through it in such a direction the magnetic field causing the arc blow

Back blow is indicated by:

Spatter
Undercut, either continuous or intermittent
Narrow, high bead, usually with undercut
An increase in penetration
Surface porosity at the finish end of welds on sheet metal

Forward Blow

A wide bead, irregular in width
Wavy bead
Undercut, usually intermittent
A decrease in penetration



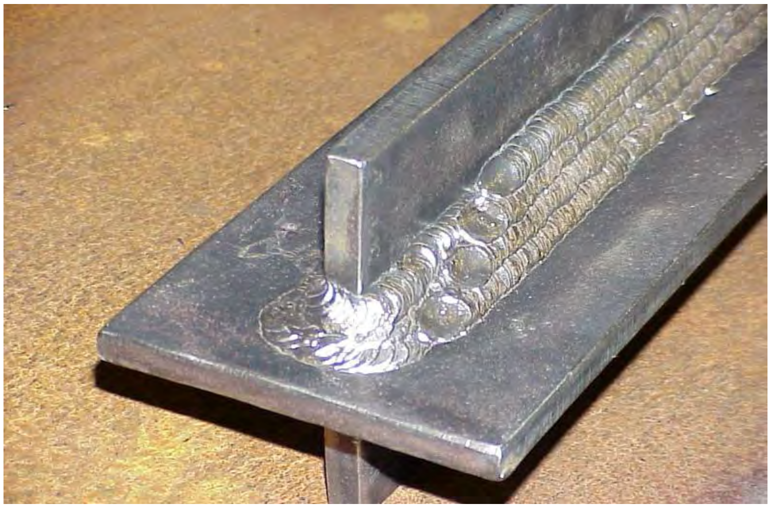
Craftsmanship Expectations for Welding Projects

The student should complete the following tasks prior to welding:

1. Thoroughly read each drawing.
2. Make a cut list for each project. (Cut enough material for two projects). Check Oxyacetylene tip for any obstructions clean if necessary for precise cuts.
3. Practice welding scrap to check setting.
4. Assemble the welding project to Blue Print Specifications.
5. Review Welding Procedure in upper right hand corner of print.
6. 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



Example of a High Quality Weld

Weld Quality per AWS D1.1

VT Criteria	Cover Pass
Reinforcement	Flush to 1/8"
Undercut	1/32" deep
Weld Bead Contour	Smooth Transition
Overlap	None Allowed
Cracks	None Allowed
Arc Strikes	None Allowed
Fillet Weld Size	See Specification on Print
Porosity	None Allowed

E7018 Bead Plate (Surfacing) ___ _ Project #1

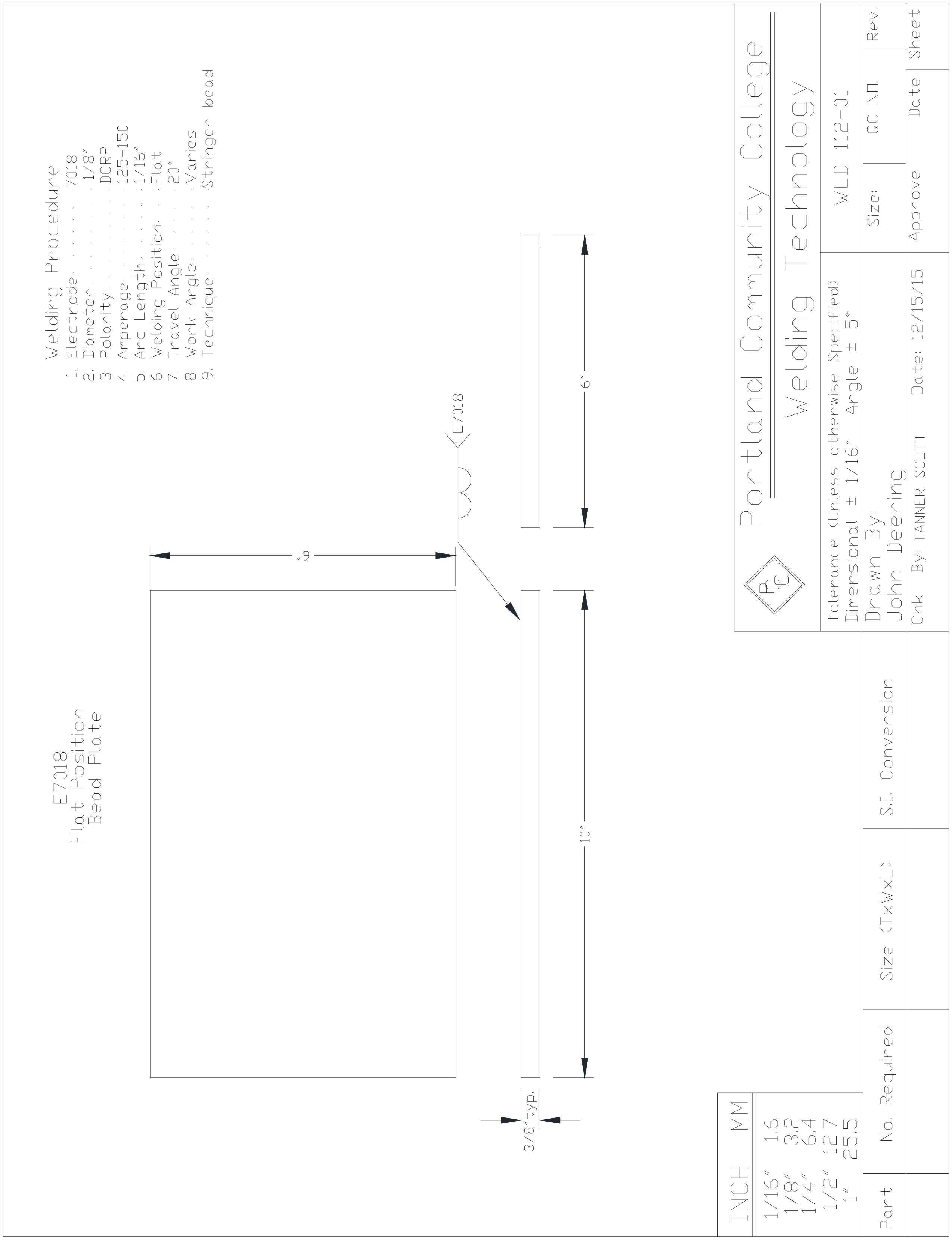
Technique

Employ a straight stringer bead technique holding a tight arc length. Allow the puddle to obtain a 3/8" to 1/2 "width and adjust travel speed to keep puddle size consistent. See info sheet on ***Striking Arc*** for helpful hints.

Welding Sequence: Alternate direction of welding for each pass. Weld full length of plate.

Alternate direction with each pass

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


E7018
Flat Position
Bead Plate
Welding Procedure
1. Electrode 7018
2. Diameter 1/8"
3. Polarity DCRP
4. Amperage 125-150
5. Arc Length 1/16"
6. Welding Position Flat
7. Travel Angle 20°
8. Work Angle Varies
9. Technique Stringer bead
E7018
6"
6"
10"
3/8"typ.
INCH MM
1/16" 1.6
1/8" 3.2
1/4" 6.4
1/2" 12.7
1" 25.5
Part
No. Required
Size (TxWxL)
S.I. Conversion
Portland Community College
Welding Technology
Tolerance (Unless otherwise Specified)
Dimensional ± 1/16" Angle ± 5°
WLD 112-01
Drawn By:
John Deering
Size:
QC NO.
Rev.
Chk By: TANNER SCOTT
Date: 12/15/15
Approve
Date
Sheet

E7018 Flat Position-Joint ___ _ Project #2

Technique

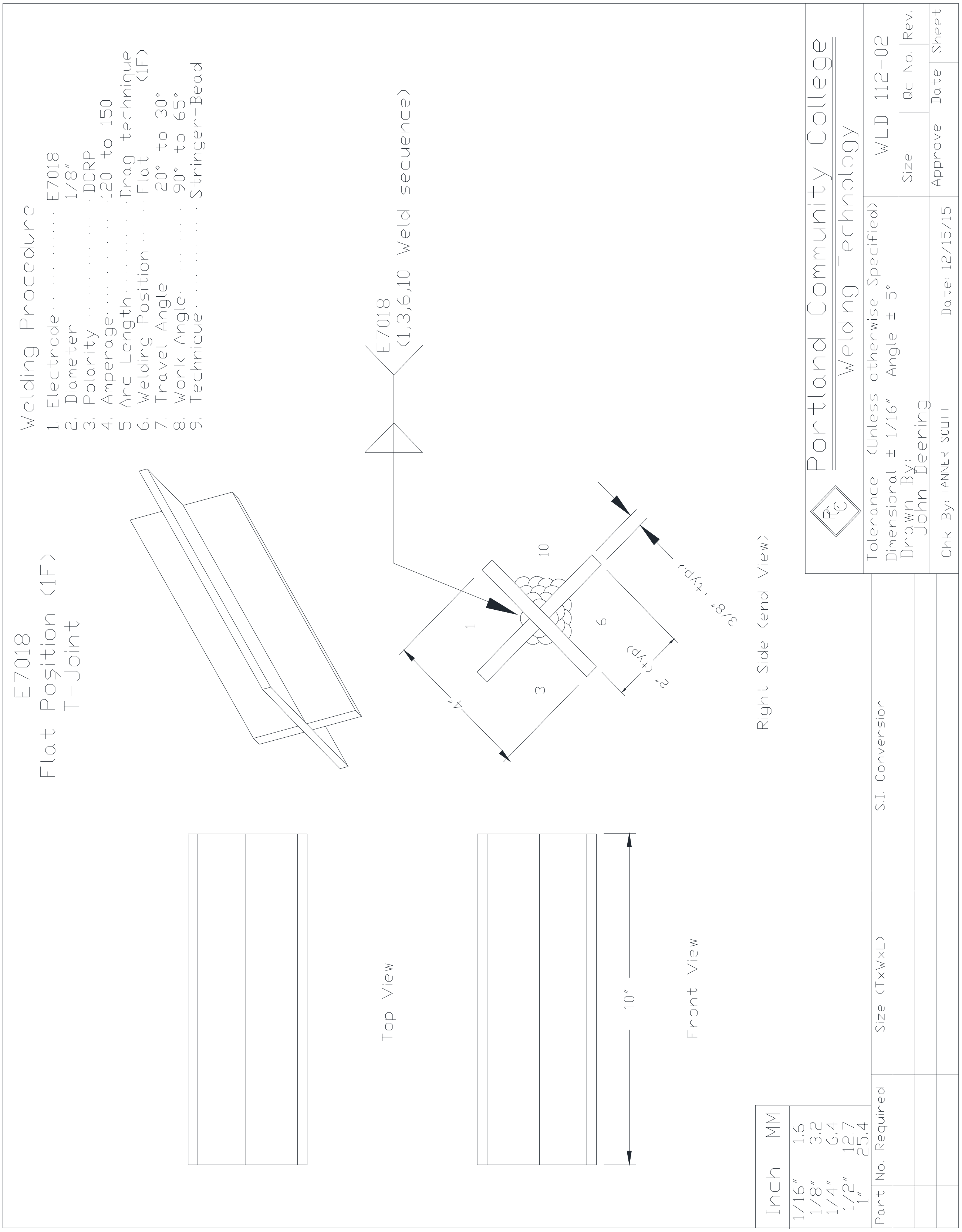
When running the first pass (root pass) it is important to center the weld so that it has equal legs on each piece of metal. This is accomplished by adjusting the work angle so that the bead centers itself. The next pass(es) should then be laid down to allow the weld deposits to flow equally on the previous pass(es) and to the base metal. The key is to make each individual pass tie into the previous pass(es) and or base metal so that a flat to convex surface is obtained. When welding any of the passes in the T-joint, it is important to not let any of the slag float ahead of the electrode. This will cause slag inclusions because the E7018 arc is not forceful enough to "burn out" the slag (see helpful hints section for technique in dealing with this problem).

Welding Sequence

1. Weld the root pass on all four sides of the joint. Rotate the work so that all the welding is completed in the flat position. Select your best bead and do not weld over it.
2. Weld two bead layer over the three remaining sides. Select your best layer and do not weld over it.
3. Weld three bead layer over the remaining two sides. Select your best layer and do not weld over it.
4. Weld four bead layer over the last side. Inspect your work based on the criteria listed in the inspection criteria section.

Student should fill out visual inspection criteria assessment below.

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


E7018
Flat Position (1F)
T-Joint
Welding Procedure
1. Electrode E7018
2. Diameter 1/8"
3. Polarity DCRP
4. Amperage 120 to 150
5 Arc Length Drag technique
6. Welding Position Flat (1F)
7. Travel Angle 20° to 30°
8. Work Angle 90° to 65°
9. Technique Stringer-Bead
E7018
(1,3,6,10 Weld sequence)
1
3
6
10
4"
2" (typ)
3/8" (typ)
Right Side (end View)
Top View
Front View
10"
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 112-02
Drawn By:
John Deering
Size:
Qc No.
Rev.
Chk By: TANNER SCOTT
Date: 12/15/15
Approve
Date
Sheet

Corner Joint 1F   Project #3

Technique:

Use a stringer bead with tight arc. Center the weld in the first pass (root pass) so that it is equally distributed on to each piece of metal. This is accomplished by adjusting the work angle so that the bead centers itself. The additional passes should then be laid down to allow the weld deposits to flow equally on the previous passes and to the parent material. Desired outcome is to make each individual pass tie into the previous pass(es) and/or parent metal so that a convex weld is achieved.

Welding Sequence

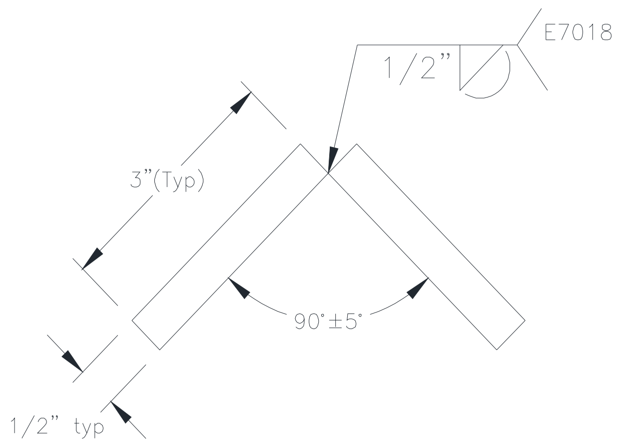
Alternate directions of welding for each pass.

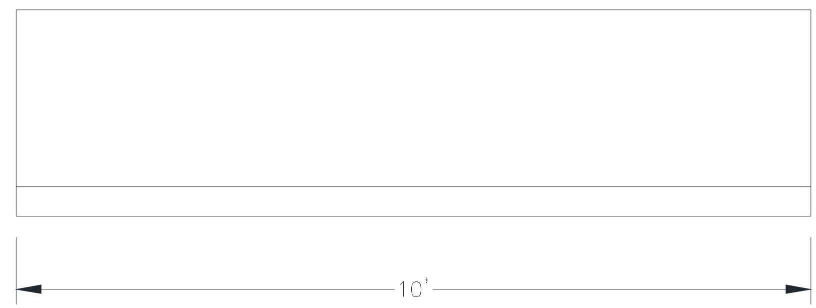
VT Criteria	Student Assessment	Instructor Assessment
Reinforcement (0" –1/8")		
Undercut (1/32")		
Weld Bead Contour		
Penetration		
Cracks (none)		
Arc Strikes (none)		
Fusion (complete)		
Porosity (none)		
		Grade Date

E7018
Flat Position (1F)
Corner Joint

Welded Procedure

1. Electrode 7018
2. Diameter . . . . 1/8"
3. Polarity . . . . DCRP
4. Amperage . . . . 125 – 150
5. Arc Length . . . . . . 1/16"
6. Welding Position . . Flat (1F)
7. Travel Angle . . . . Drag
8. Work Angle . . . . . . Varies
9. Technique . . . . Stringer





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

Portland Community College

Welding Technology

Part	No. Required	Size (TxWxL)	S.I. Conversion	Tolerance (Unless otherwise Specified) Dimensional ± 1/16" Angle ± 5°	WLD 112-04		
				Drawn By: John Deering	Size:	QC NO.	Rev.
				Chk By: TANNER SCOTT Date: 12/15/15	Approve	Date	Sheet

E7018 T-Joint 2F Project #4

Technique:

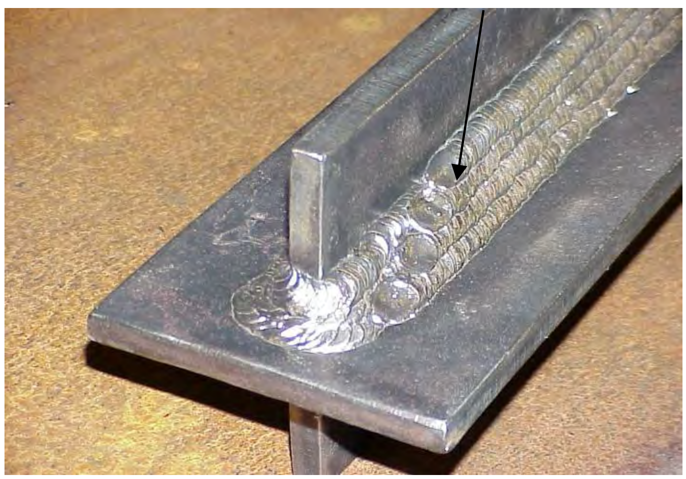
Use a string bead technique with a tight arc length. When running the first pass (root weld) it is important to center the weld so that it has equal distribution onto each piece of metal. This is accomplished by adjusting the work angle so that the bead centers itself. Additional passes should then be laid down to allow the weld deposits to flow equally on the previous passes and to the parent material. The key is to make each individual pass tie into the previous pass(es) and or parent metal so that a flat to convex surface is obtained.

When welding any of the passes in the T-joint it is critical to not let any of the slag float ahead of the electrode. This will cause slag inclusions because the arc is not forceful enough to remove the slag (see helpful hints section for technique in dealing with this problem). Corners must be wrapped.

Welding Sequence

Weld the root pass on all four sides of the joint. Rotate the work so that all the welding is completed in the horizontal position. Notice bead placement starting at the bottom and "stair stepping" towards top of parent metal.

"Stair Stepping"



Do Not Weld Like Photo

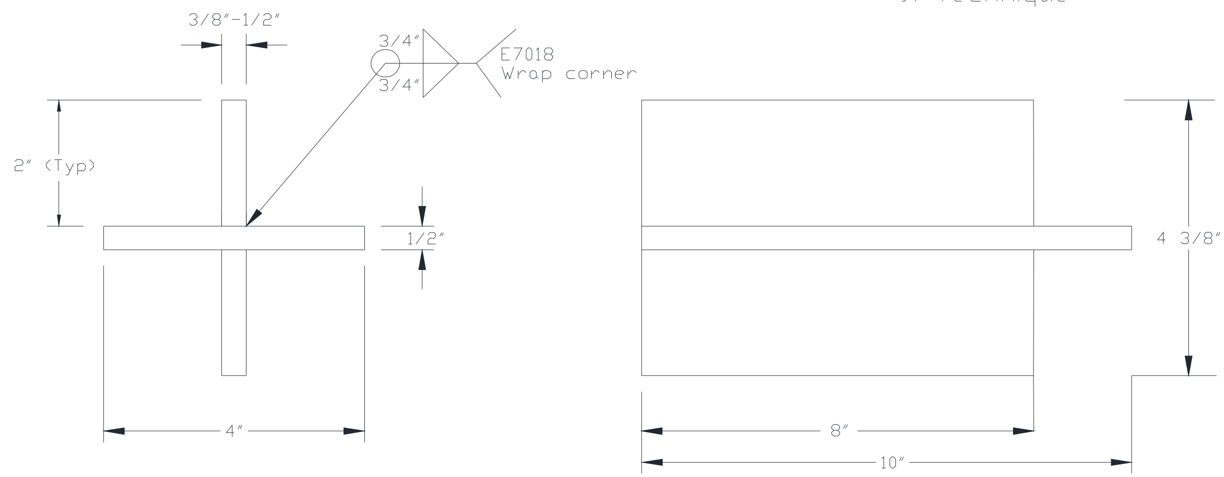
Photo Only Shows Bead Placement

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

E7018
Horizontal Position (2F)
T-Joint

Welding Procedure

1. Electrode E7018
2. Diameter .... 1/8″
3. Polarity .... DCRP
4. Amperage .... 125 to 150
5. Arc Length .... 1/16″
6. Welding Position .... horizontal (2F)
7. Travel Angle .... 20° to 30°
8. Work Angle .... Varies
9. Technique .... Stringer-Bead



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 217-02

Drawn By:
John Deering

Size: | QC NO. | Rev.

Chk By: TANNER SCOTT Date: 12/15/15

Approve | Date | Sheet

E7018 Lap Joint (2F) Project #5

Technique

When running the first pass (root weld) it is important to center the weld so that it has equal legs on each piece of metal. This is accomplished by adjusting the work angle so that the bead centers itself. It is important to lower the work angle enough to prevent undercut from happening on the top toe of the weld bead. The next pass(es) should then be placed to allow the weld deposits to flow equally on the previous pass (es) and or base metal so that a flat to convex surface is obtained. With the lap joint it is important to keep the bottom leg equal to the top leg so that no excess weld metal is deposited.

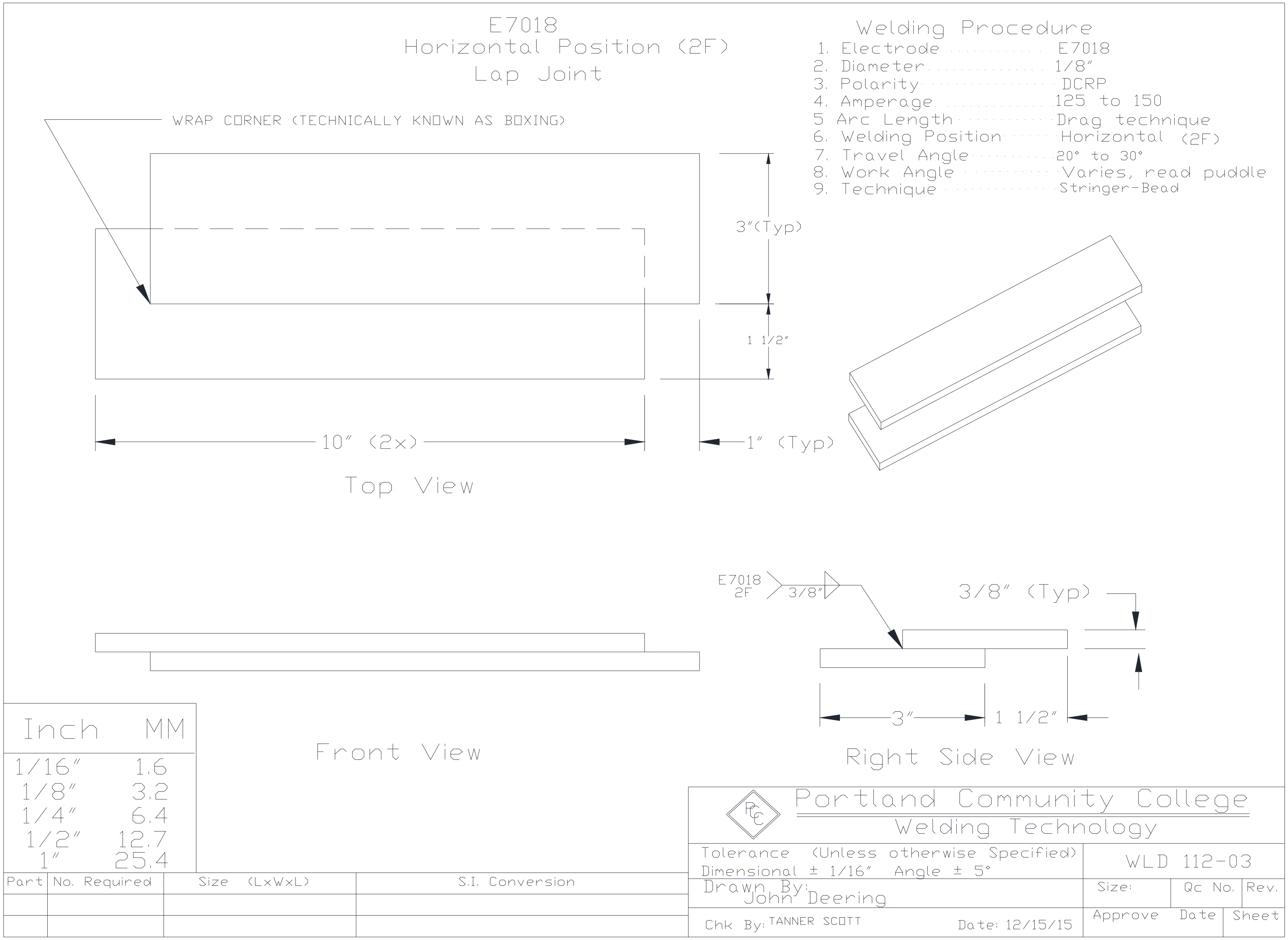
When welding with the E7018 in the lap joint, it is important to not let any of the slag float ahead of the electrode. This will cause slag inclusions because the E7018 arc is not forceful enough to remove the slag (see helpful hints section for the technique in dealing with this problem).

Welding Sequence

1. Remember when welding in the horizontal position to start your welding sequence from the horizontal leg of the joint and work to the vertical joint (see joint detail).
2. Wrap the weld around the corner. Using this boxing technique the welder should not stop or restart at the corner.

Student should fill out visual inspection criteria assessment below.

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


E7018
Horizontal Position (2F)
Lap Joint
Welding Procedure
1. Electrode E7018
2. Diameter 1/8"
3. Polarity DCRP
4. Amperage 125 to 150
5 Arc Length Drag technique
6. Welding Position Horizontal (2F)
7. Travel Angle 20° to 30°
8. Work Angle Varies, read puddle
9. Technique Stringer-Bead
WRAP CORNER (TECHNICALLY KNOWN AS BOXING)
3"(Typ)
1 1/2"
10" (2x)
1" (Typ)
Top View
Front View
E7018
2F
3/8"
3/8" (Typ)
3"
1 1/2"
Right Side View
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 (LxWxL)
S.I. Conversion
Portland Community College
Welding Technology
Tolerance (Unless otherwise Specified)
Dimensional ± 1/16" Angle ± 5°
WLD 112-03
Drawn By:
John Deering
Size:
Qc No.
Rev.
Chk By: TANNER SCOTT
Date: 12/15/15
Approve
Date
Sheet

E7018 Horizontal Corner Joint (2F) Project #6

Technique

Center the weld in the first pass (root pass) so that it has equal dilution into each piece of metal. This is accomplished by adjusting the work angle so that the bead centers itself. It is important to lower the work angle enough to prevent undercut from happening on the top toe of the weld bead. The next pass(es) should then be placed to allow the weld deposits to flow equally on the previous pass (es) and or base metal so that a flat to convex surface is obtained. With the lap joint it is important to keep the bottom leg equal to the top leg so that no excess weld metal is deposited.

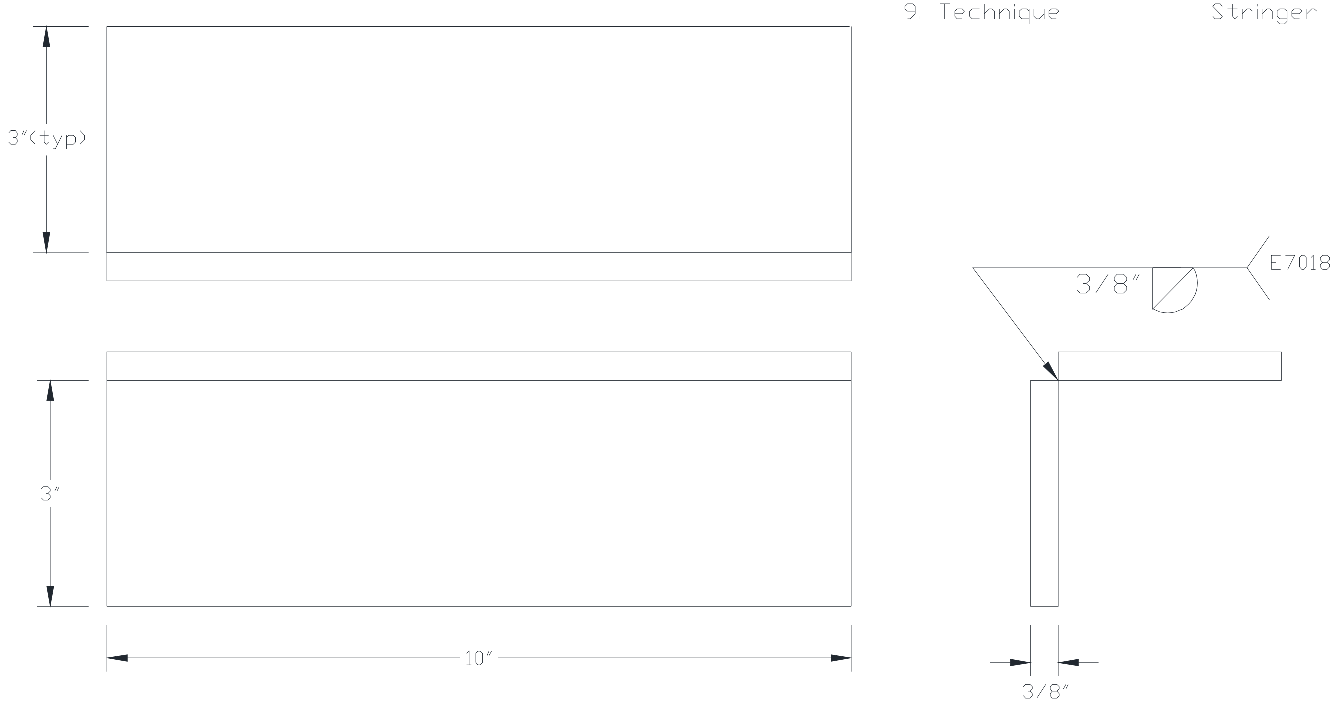
When welding with the E7018 in the outside corner joint, it is important to not let any of the slag float ahead of the electrode. This will cause slag inclusions because the E7018 arc is not forceful enough to remove the slag (see helpful hints section for the technique in dealing with this problem).

Student should fill visual inspection criteria assessment below.

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

E7018
Horizontal Position
Corner Joint (2F)

Welding	Procedure
1. Electrode	7018
2. Diameter	1/8"
3. Polarity	DCRP
4. Amperage	125 to 150
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



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

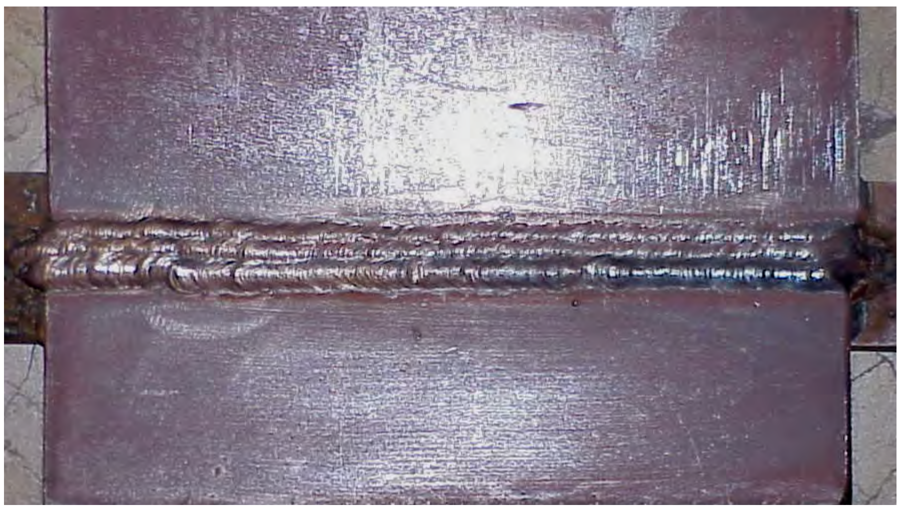
PORTLAND COMMUNITY COLLEGE
Welding Technology

Tolerance (Unless otherwise Specified) Dimensional ± 1/16" Angle ± 5°	Wld 112-06		
Drawn By: John Deering	Size:	QC NO.	Rev.
Chk By: Date: 12/15/15	Approve	Date	Sheet

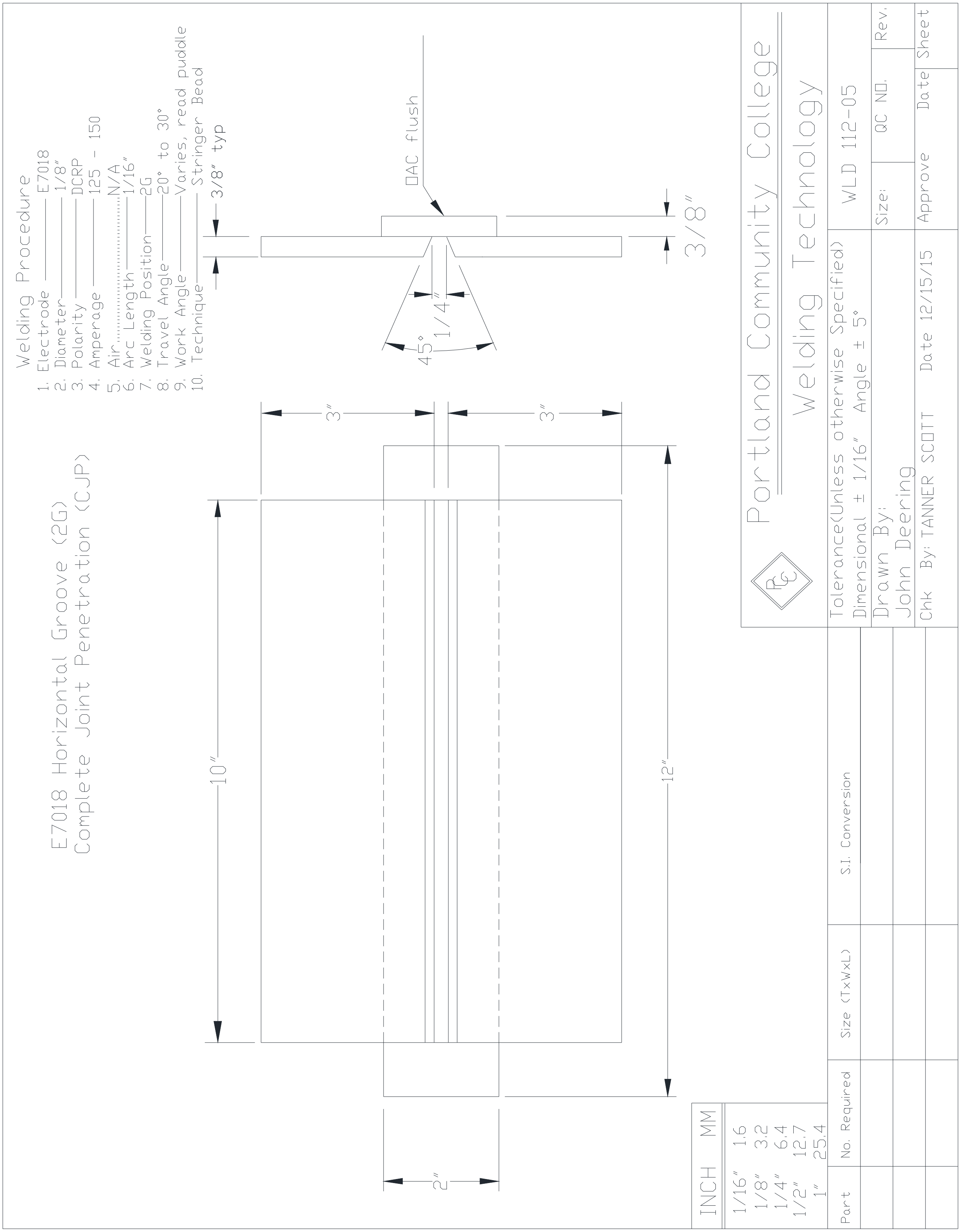
E7018 Horizontal V Groove (2G) Project #7

Welding Sequence

When running the first pass (root weld) it is important to center the weld so that it has equal distribution into each piece of metal. This is accomplished by adjusting the work angle so that the bead centers itself. It is important to drop the angle enough to prevent undercut from happening on the top toe of the weld bead. Additional passes should then be laid down to allow the weld deposits to flow equally on the previous passes and to the parent material. Start with the bottom pass first and use the previous pass as a shelf. This approach is much like walking up a set of stairs-start at the bottom first. The key is to make each individual pass tie into the previous pass(es) and or parent metal so that a flat to convex surface is obtained. Don't let your welds develop "cold lap" because this can cause slag to be trapped. .



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


E7018 Horizontal Groove (2G)
Complete Joint Penetration (CJP)
Welding Procedure
1. Electrode — E7018
2. Diameter — 1/8"
3. Polarity — DCRP
4. Amperage — 125 - 150
5. Air — N/A
6. Arc Length — 1/16"
7. Welding Position — 2G
8. Travel Angle — 20° to 30°
9. Work Angle — Varies, read puddle
10. Technique — Stringer Bead
3/8" typ
AC flush
1/4"
45°
3/8"
3"
3"
10"
12"
2"
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 112-05
Drawn By:
John Deering
Chk By: TANNER SCOTT
Date 12/15/15
Size:
QC NO.
Rev.
Approve
Date
Sheet

Oxy-Acetylene Hand Flushing Back Strap

Project #8

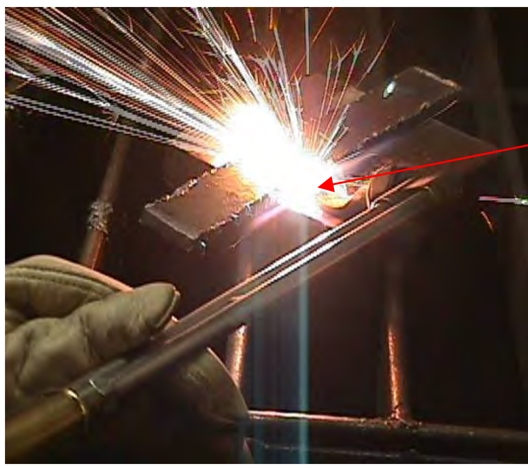
Step 1

Hold the cutting attachment or torch handle comfortably in both hands. Stabilize the torch with one hand. Position cutting tip preheat flames approximately 1/8" from the base metal (this is known as coupling distance or stand off). The other hand is free to depress the cutting oxygen lever.

Step 2

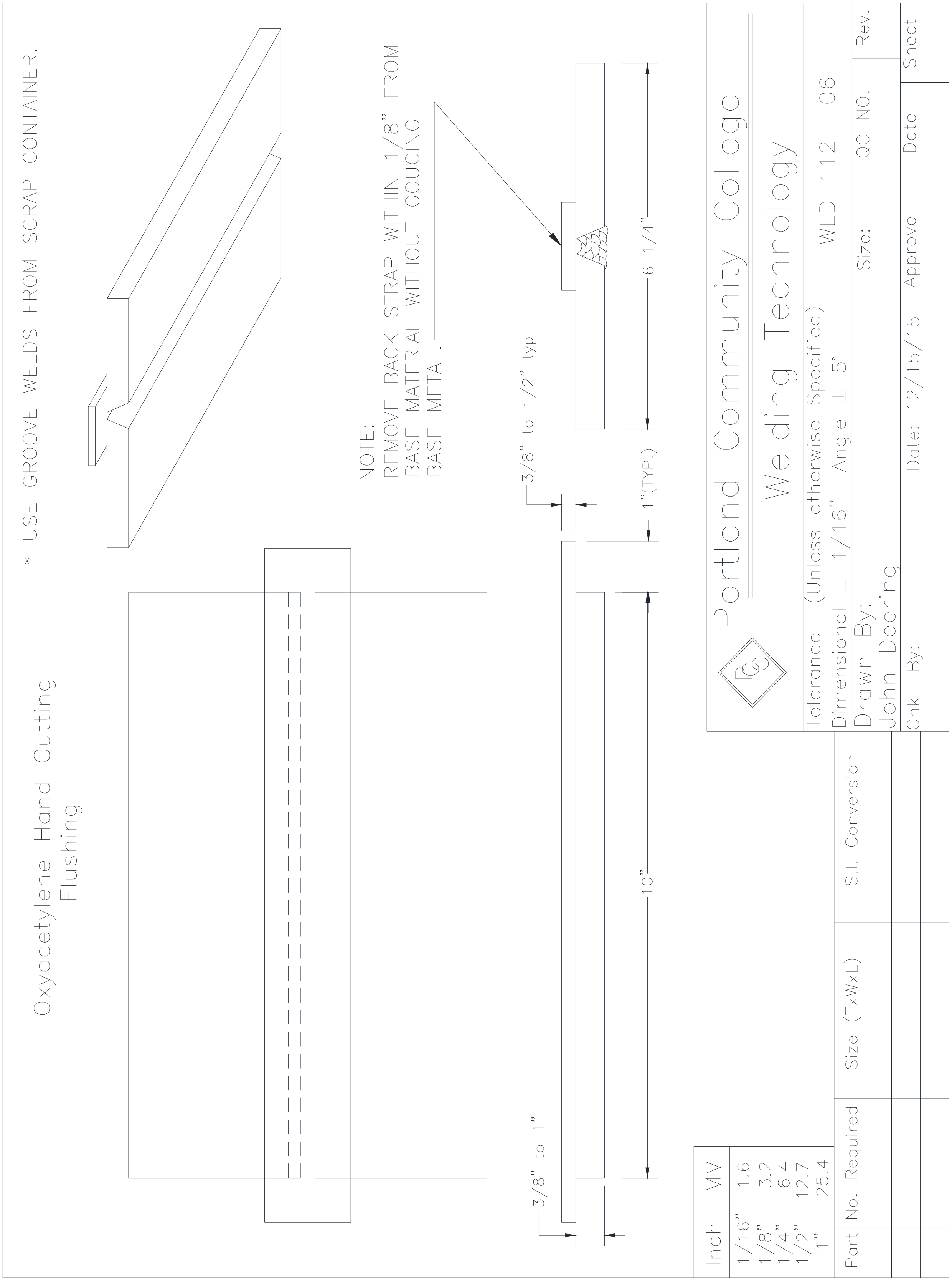
Direct the preheat flame on the spot where you want to start the flushing. Before the cutting action can start, preheat the base metal to a bright cherry red. When the red spot appears, squeeze the oxygen cutting lever slowly and completely.

Start flushing with a slow up and down or rocking motion on back strap down to within 1/8 of an inch of base material to prevent gouging into base material.



Tip pointing up then rock down or lower tip to bottom of back strap.

Once tip has been lowered or rocked move forward start flushing wall of back strap starting with first step and repeat.


Oxyacetylene Hand Cutting
Flushing
* USE GROOVE WELDS FROM SCRAP CONTAINER.
NOTE:
REMOVE BACK STRAP WITHIN 1/8" FROM
BASE MATERIAL WITHOUT GOUGING
BASE METAL.
3/8" to 1/2" typ
1"(TYP.)
6 1/4"
10"
3/8" to 1"
Portland Community College
Welding Technology
WLD 112- 06
Tolerance (Unless otherwise Specified)
Dimensional ± 1/16" Angle ± 5°
Drawn By:
John Deering
Chk By:
Date: 12/15/15
Size:
QC NO.
Rev.
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

E7018 T-Joint (3F) Project #9

Welding Sequence

Vertical up welding requires special attention to heat control. See ***Vertical Up Info*** Sheet for helpful hints.

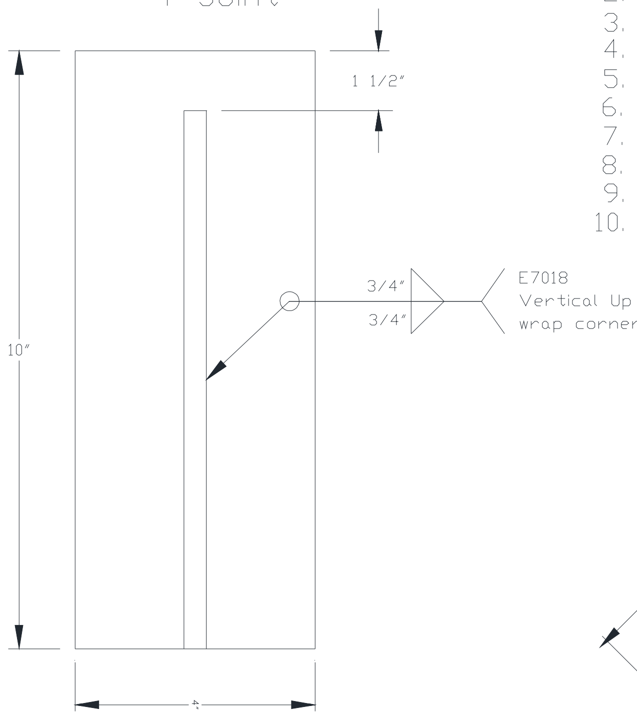
For multi pass welds first deposit a fillet weld bead by using a slight weave continue up over the top for a wrap. Deposit additional layers with a slight side to side weave hesitating at the sides long enough to minimize undercut. When "weaving," do not spend time in the middle of the puddle. It takes care of itself. Do not use a whip technique or take the electrode out of the molten pool. Travel slowly enough to maintain the shelf without causing metal to spill. Use currents in the lower portion of the range. You can use a weave or a straight stringer bead.

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

E7018

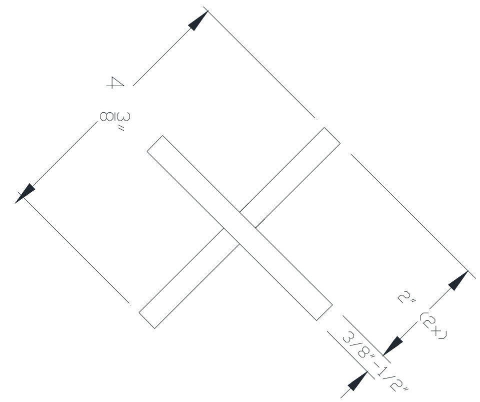
Vertical-Up Position (3F)

T-Joint



Welding Procedure

1. Electrode E7018
2. Diameter .... 1/8"
3. Polarity .... DCRP
4. Amperage .... 125 - 150
5. Arc Length .... 1/16"
6. Welding Position .... Vertical (3F)
7. Travel Angle .... 0-15° push angle
8. Work Angle .... Varies, read puddle
9. Technique .... Stringer
10. Progression .... Vertical Up



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 112-07
Drawn By: John Deering	Size: / Qc No. / Rev.
Chk By: TANNER SCOTT Date: 12/15/15	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. Once you determine that you are ready for the exam see your instructor to get your test.

Study Guide

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

SMAW and OAC Processes
- **Power source specifics**
    - **Electricity**
        - **Volts, Amps, Ohms, WATTS**
        - **Transformers/rectifiers etc.**
    - **Polarity**
        - **DCSP, DCRP, Max penetration**
    - **Current out put**
    - **Amperage settings and bead profiles (for different size electrodes too)**
    - **Arc blow**
    - **Duty Cycle**
- **AWS electrode classification**
- **OAC**
    - **Theory of cutting**
    - **Flame types**
    - **Safety**

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 weldment from a "blue print". The evaluation of this portion of the exam will be based on the ***Traveler***.

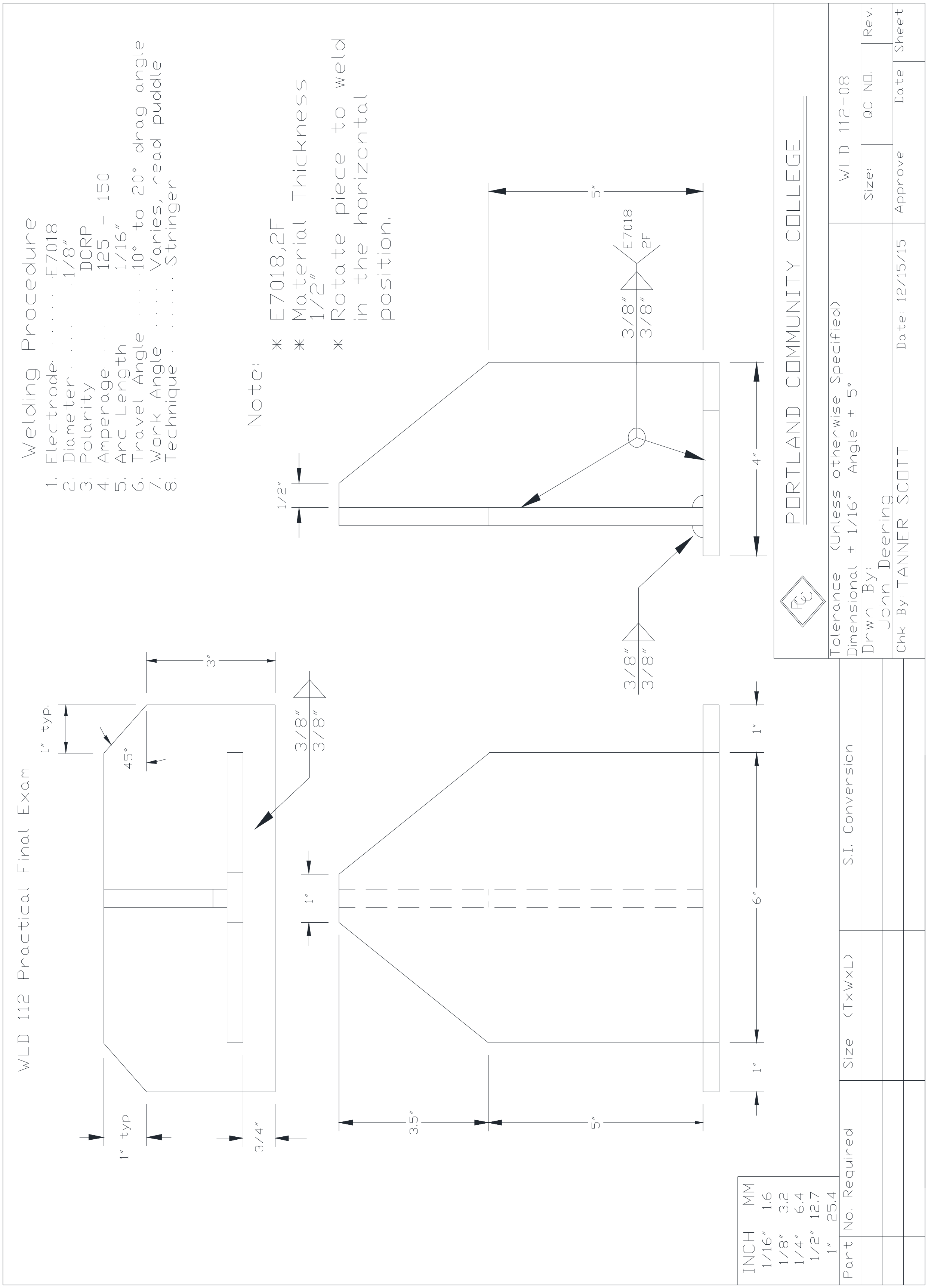
Your instructor will evaluate every step of assembly of this part.

1st step. **Blueprint Interpretation and Material Cut List**

2nd step **Material Layout and Cutting (Tolerances +/- 1/16")**

3rd step **Fit-up and Tack weld (Tolerances +/- 1/16")**

4th step **Weld Quality**



WLD 112 Practical Final Exam
Welding Procedure
1. Electrode E7018
2. Diameter 1/8"
3. Polarity DCRP
4. Amperage 125 - 150
5. Arc Length 1/16"
6. Travel Angle 10° to 20° drag angle
7. Work Angle Varies, read puddle
8. Technique Stringer
Note:
* E7018,2F
* Material Thickness 1/2"
* Rotate piece to weld in the horizontal position.
PORTLAND COMMUNITY COLLEGE
WLD 112-08
Tolerance (Unless otherwise Specified)
Dimensional ± 1/16" Angle ± 5°
Drwn By: John Deering
Chk By: TANNER SCOTT
Date: 12/15/15
Size:
QC NO.
Rev.
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

WLD 112- Work Sheet

Name ___________________________________ Date ________________________

Directions:

Use the Weld Principles and Applications text, and utilize that information to complete the questions on this work sheet. Answer the questions using ***complete sentences***. Do not hesitate to reference other section in the text to find and answer.

1. Why is it important to have a good cover pass?

2. What can watching the back edge of a weld pool help you determine?

3. What stresses must a welded joint withstand?

4. List the five joint types used in welding.

   a)

   b)

   c)

   d)

   e)

WLD 112 Work Sheet

Name ______________________________ Date ____________________

Directions:

Use the Weld Principles and Applications text, and utilize that information to complete the questions on this work sheet. Answer the questions using ***complete sentences***. Do not hesitate to reference other section in the text to find and answer.

1. Why is it usually better to make a weld in the flat position?

2. Why are some joints back gouged?

3. What is a pre-qualified joint per *AWS D1.1 Structural Steel Welding Code*?

4. How does joint design effect labor costs?

5. What is contained in a set of drawings?

6. What information can be included in the title box of a drawing?

7. How does a welding transformer work?

8. What are taps on a welding transformer?

9. What are the advantages of the inverter type welding power supply?

10. What is the difference between the welding current produced by alternators and by generators?

Vocabulary Terms
WLD 112

Name: ___________________________________ Date: ________________________

Directions:
Define the following terms. Use the Welding Principles and Applications text, internet or other sources

1. Constant current power source

2. Constant voltage power source

3. Open Circuit Voltage (OCV)

4. Operating Voltage

5. Overlap

6. Undercut

7. Spatter

8. Crack

9. Porosity

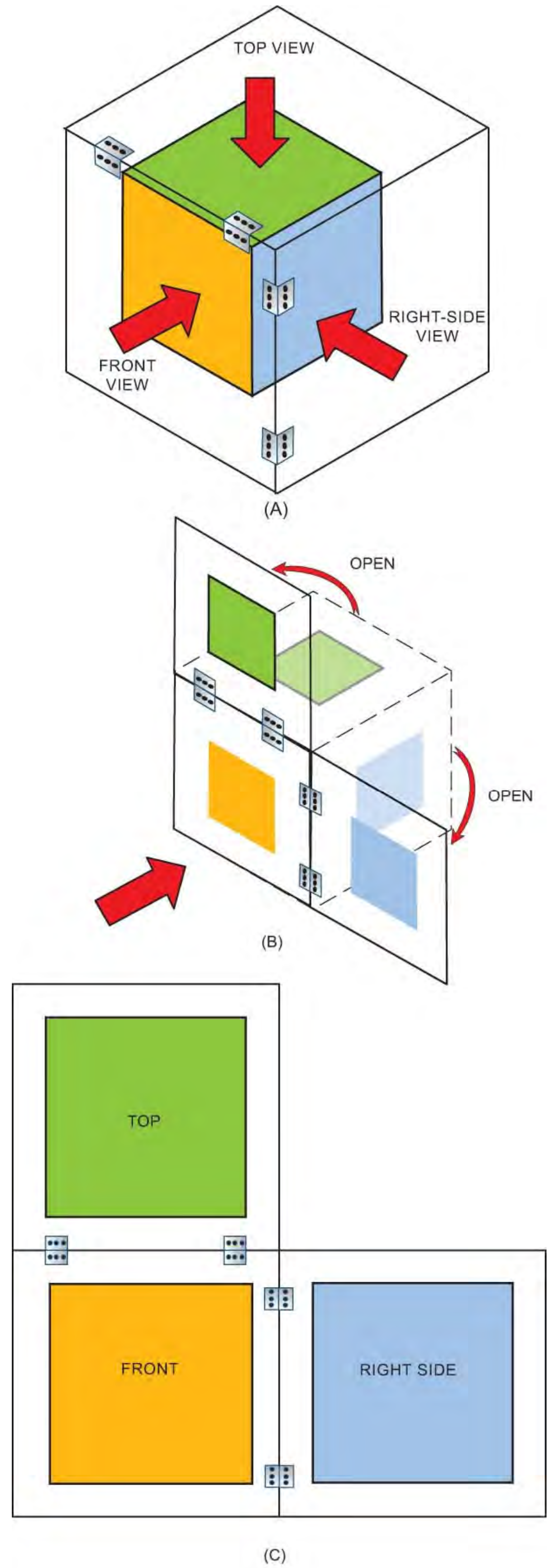
10. Electrode Size

Orthographic Blueprints

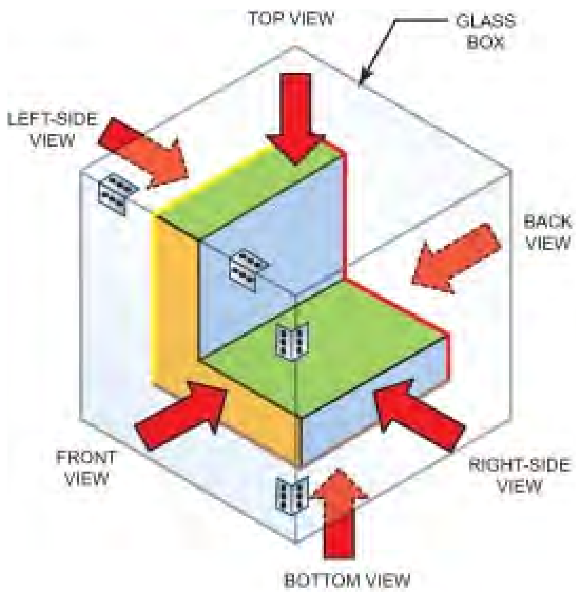
Orthographic (ortho) views are two-dimensional drawings used to represent or describe three-dimensional objects. The ortho views represent the exact shape of an object seen from one side at a time as you are looking perpendicularly to it without showing any depth to the object.

Primarily, three ortho views (top, front, and right) adequately depict the necessary information to illustrate the object. Sometimes, only two ortho views are needed as in a cylinder. The diameter of the cylinder and its length are the only dimension information needed to complete the drawing. A sphere only needs the diameter. It is the same from all angles and remains a perfect circle in the ortho drawing.

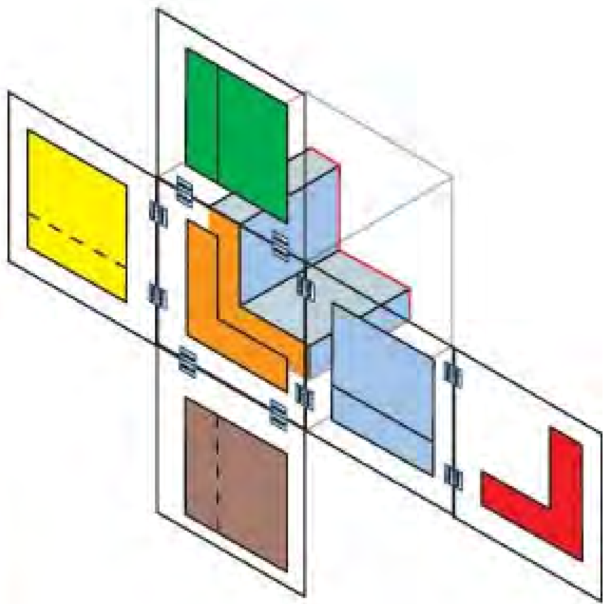
The "six" side method is a process of making six primary ortho views that represent the entire image. This method gives you all the information to create the object from different isometric views



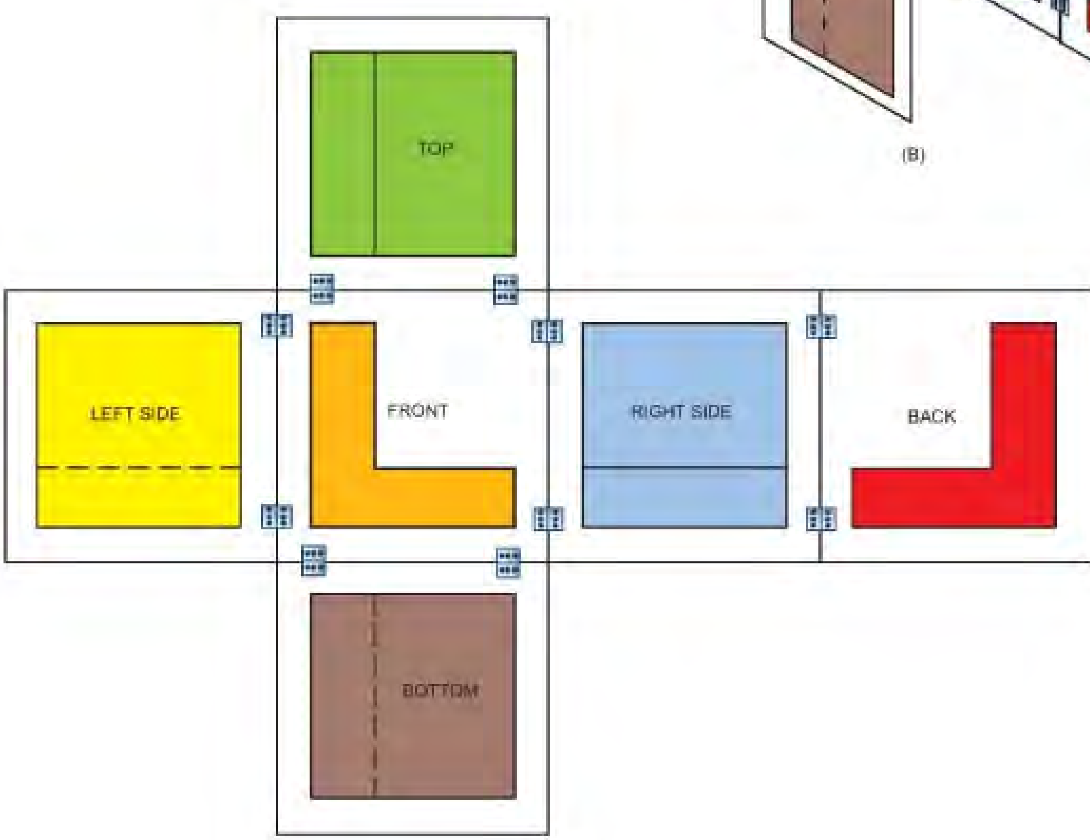
.


TOP VIEW
GLASS BOX
LEFT-SIDE VIEW
BACK VIEW
FRONT VIEW
RIGHT-SIDE VIEW
BOTTOM VIEW

(A)



(B)


TOP
LEFT SIDE
FRONT
RIGHT SIDE
BACK
BOTTOM

(C)

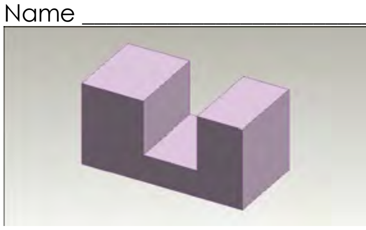
Pictorial Drawings to Orthographic Projections #6

In this section the student is to convert the pictorial drawing to an orthographic view by using the correct lay out technique.

Portland Community College

Welding Technology Class Project –
Convert the pictorial drawing to an orthographic projection.

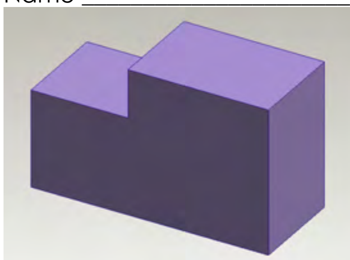
Name ______________________________________ Date ____________



Portland Community College

Welding Technology Class Project –
Convert the pictorial drawing to an orthographic projection.

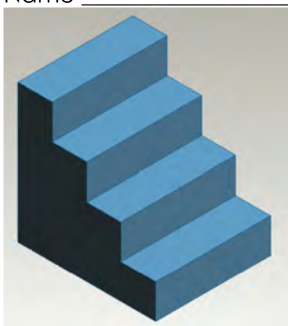
Name ____ Date _____________



Portland Community College

Welding Technology Class Project –
Convert the pictorial drawing to an orthographic projection.

Name ____ Date _____________

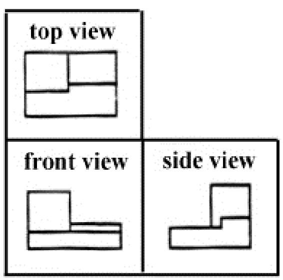


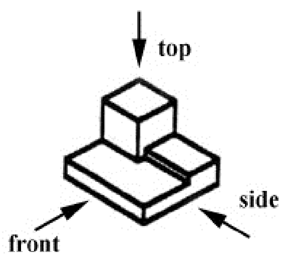
Orthographic Blueprints

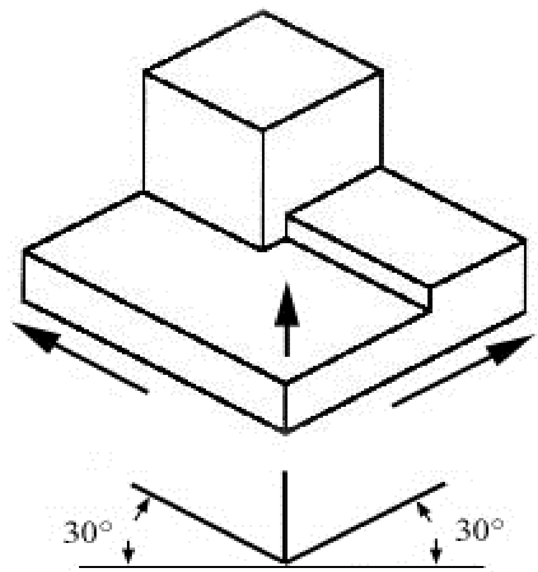
Isometric means "equal measurement". The true dimension of the object is used to construct the drawing. You get the true dimension from either orthographic views or by measuring the object. Because of the convenience of using actual measurements to create the isometric image, it has become the industry standard for parts manuals, technical proposals, patent illustrations and maintenance publications.

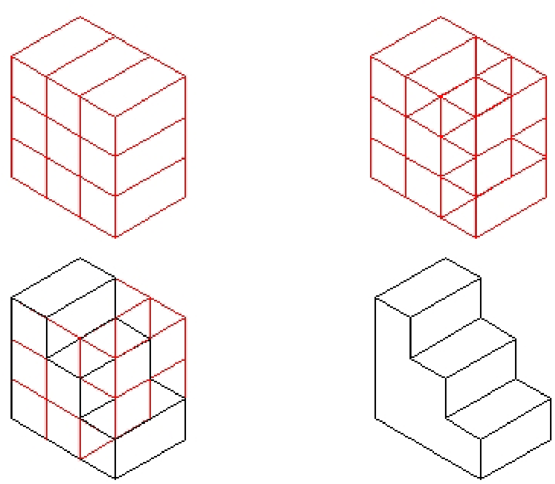
The height of the object is measured along vertical lines. The width and depth of the object are measured along the 30 degree to the horizontal plane.

Orthographic Views | **Isometric Views**









Isometric Construction Process

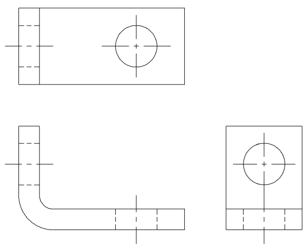
Orthographic Drawings to Isometric Projections #7

In this section, the student is to convert the orthographic drawing to an isometric view by using the correct lay out technique

Portland Community College

Welding Technology Class Project

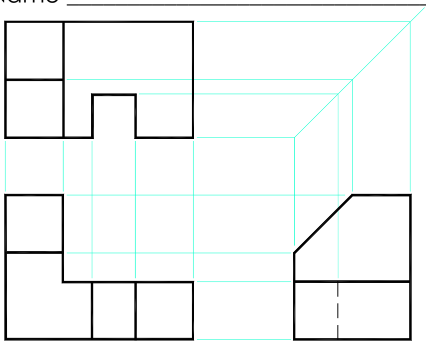
Name ______________________________________ Date ____________



Portland Community College

Welding Technology Class Project

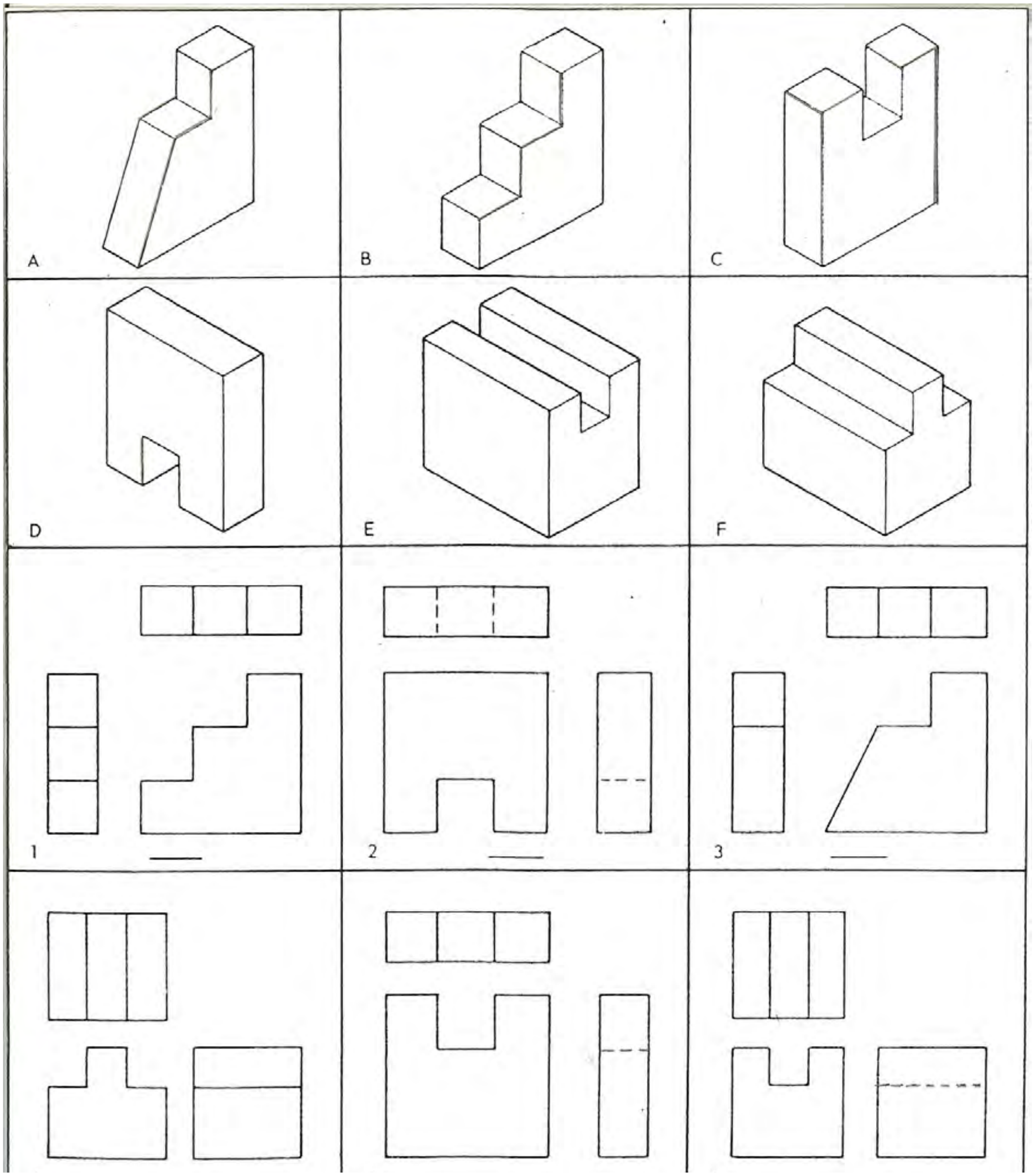
Name ______________________________________ Date ____________



Matching the Drawings #8

Name ____ Date ______________

Study the pictorial views and match each orthographic drawing with its pictorial drawing by inserting the correct letter in the space provided.



Science on Steel Questions for WLD 112

Name: ______________________________ Date ____________________

Directions:
Read the Science Section and Weld Principles and Applications text, and utilize that information to complete the questions on this work sheet. Answer the questions using ***complete sentences***. Do not hesitate to reference other section in the text to find and answer.

1. Compare/contrast E7018 to E7010.

2. List 5 advantages of the E7018

3. How much iron powder is added into the flux of an E7018.

4. Why are 7018 electrodes baked in dry heat?

5. Define arc blow and give 3 ways to control it.

UNDERSTANING FRACTIONS

The welding fabrication industry requires the everyday use of fractions. Besides simple tape rule measurement, it is often necessary to add, subtract, multiply and divide fractions. Before practicing performing these kinds of calculations, it's a good idea to know a few other fraction skills.

Look at this bar. Notice that it has 4 sections. Three of the sections are shaded, the fourth is white.

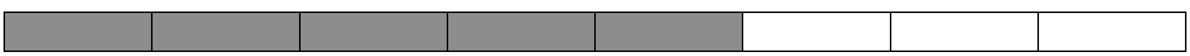
Take a look at this fraction: 3/4

The number on the bottom always represents the number of parts that an object has been divided into. In this case the bar has been divided into 4 parts.

The number on the top tells you how many parts you are concerned with. In this case 3. (There are 3 shaded parts.)

An inch on a ruler may be divided into 8 parts, 16 parts or 32 parts. Sometimes they are divided into 64 parts.

If your inch is divided into 8 parts, then each fraction of that inch will have an 8 on the bottom. Examples are 1/8, 3/8, 5/8, 6/8

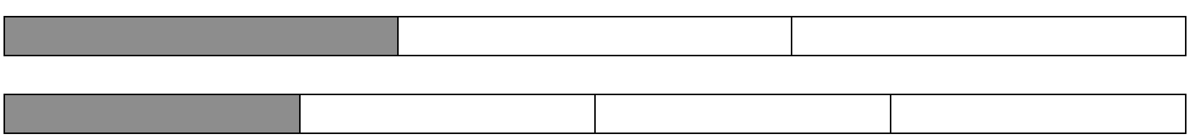


This bar represents 5/8ths, because 5 of the 8 sections are shaded

If your inch is divided into 16 parts, then each fraction of that inch will have 16 on the bottom. Examples are 4/16, 8/16, 11/16

In each case the numbers on the top of the fraction let you know how many parts of the whole thing that you have. If you had 8/8 or 16/16ths, you would have the whole thing or one (1). If you had 4/8 or 8/16ths you would have half (1/2) of the whole thing.

If you have two bars that are the same size and one is divided in thirds, 3 pieces, and the other is divided into 4ths, 4 pieces, which is bigger 1/3 or 1/4th?



Fractions Work Sheets

Name: ____________________________________ Date: _________________

Show all work when solving the following problems.

1. 3 5/8” + 2 ½” =

2. ½” + 2/8” =

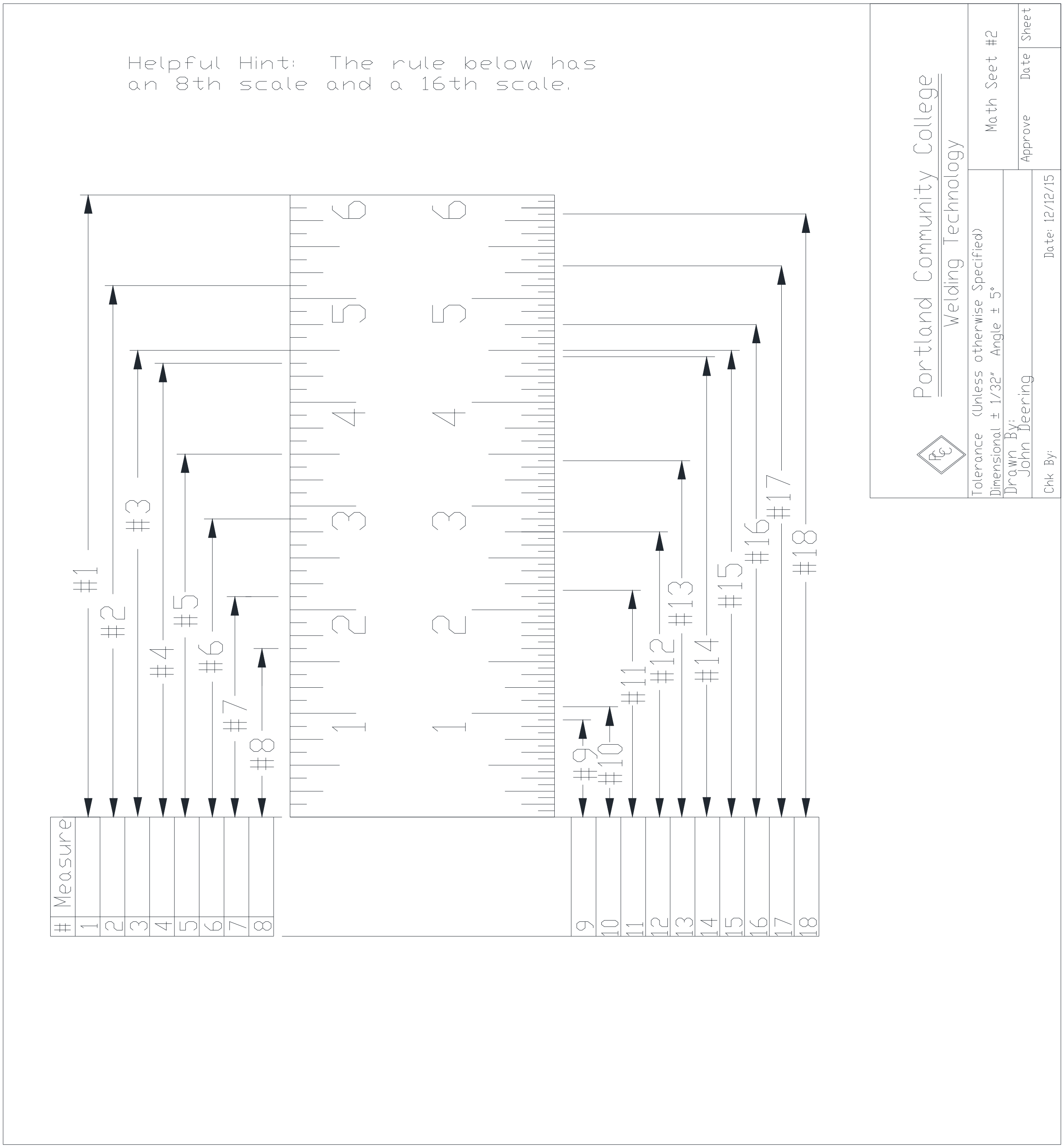
3. 4 5/16” – 2 ¾” =

4. 1’ 5 3/16” – 1’ 2 9/16” =

5. 9 5/8” -3 9/16” =

Tape Measure Work Sheet

Name: ______________________________ Date: ____________



RELATIVE SIZE OF FRACTIONS

Name: ______________________________ Date: __________________

Answer the following to see if you understand the relative size of common fractions used in measuring. Check your answers at the bottom of the page

Circle the fraction in each pair that is larger

1. 3/8 or 5/8

2. 5/16 or 3/8

3. ¾ or 7/8

4. 1/8 or ½

5. 4/16 or ¼

Re-order the fraction from smallest to largest

6. 7/8, 5/32, 32/64, 9/16

7. ¾, 5/8, 52/64, 1/8,

8. 1 ¾, 15/16, 28/32

Circle the fraction in each pair that is smaller

9. 2/4 or ¼

10. 3/16 or 4/32

REDUCING FRACTIONS TO LOWEST TERMS

A fraction such as 6/8 is often easier to read on the tape measure if you reduce it to its simplest terms: ¾ ; there are fewer lines to count for reduced fractions. For this reason, the first fraction skill we will review is how to reduce fractions to lowest terms.

The first thing to really know and understand about reduced fractions is that they are no different in value or size than their non-reduced counterparts. For instance, 2/4" and ½" (its reduced fraction) are exactly equal in size. The same is true for 4/8 and ½; and also 4/16 and ¼. When you reduce fractions, you never change their value or size, just the way they look.

The next thing is to know *when* fractions can to be reduced. Fractions need to be reduced when there is some integer greater than 1 {2, 3, 4, 5 . . .} which can be evenly divided into both the bottom and the top of the fraction.

Examples: 14/16 can be reduced because both 14 and 16 can be divided by 2.

{Note: with measurements in inches, 2 is the first number you should always try to reduce your fraction by}

12/16 can also be reduced because both 12 and 16 can be divided by 2. Better yet, they can both be divided by 4, but we'll get to that later.

7/8 cannot be reduced as there is no integer other than 1 which will divide evenly into both 7 and 8.

Finally, we need to know how to reduce. Because we have the fraction key which will do this conversion for us, this part of the packet reading is for those who want to review the skill without the calculator. When doing the exercises, you may choose to do them 'by hand' and then check them by calculator, or just use the calculator. As always, should you choose to do them only by the calculator, it is a good idea to do each problem twice to eliminate input or "typing" errors.

Let's take the example of 12/16 ". We know that both 12 and 16 can be divided by 2 (at least), so it must be reducible. If we divide both the top and bottom by 2, we get 6/8. But 6/8 is also reducible; both 6 and 8 can also be divided by 2 to get ¾. This is fine and a perfectly correct way to do it, but it's not the fastest way. It's always good to check to see if 2 will divide evenly into both top and bottom, but if it can, you should see if a bigger number like 4 or 8 (or 3 or 5 if you're not just talking about inches) can divide into them. In the case of 12/16, we divided by 2 twice, when we could have just divided by 4 once. If we divide 12 and 16 both by 4, we get ¾, which is our final answer from the slower method. The lesson learned from this is to choose not just any number which will divide evenly into both top and bottom, but the ***largest*** number which will divide into both of them.

Final Grading Rubric for practical exam
Class Name: WLD 112

Name: ________________________________ Date: _______________________

Hold Points are mandatory points in the fabrication process, which require the inspector to check your work. You are required to follow the hold points.

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 1 point = 3 errors 0 points = 4 or more errors	
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 **REWORK REQUIRED IF OUT OF TOLERANCE BY MORE THAN 1/8 INCH**	
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" **REWORK REQUIRED IF OUT OF TOLERANCE BY MORE THAN 1/8 INCH**	
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 AWS D1.1 Code requirements.***	
	Total Points	**/40**

WLD 112 SMAW 7024: Project Assessment Form

Student Name:_________________ Date_________

Flat Position	Assessment	Instructor Signature/Date
Bead Plate		
Outside Corner		
T-Joint		

Horizontal Position	Assessment	Instructor Signature/Date
T-Joint		
Lap Joint		
Outside Corner		
V-Groove		
Flushing Back Strap		

Vertical Position	Assessment	Instructor Signature/Date
T-Joint		