WLD 111
Shielded Metal Arc Welding (E7024) and Oxyacetylene Cutting

Course Number:
WLD 111

Course Title:
Shielded Metal Arc Welding (E7024) and Oxy-acetylene Cutting

Credit Hours:
4

Lecture Hours:
0

Lecture/Lab Hours:
80

Lab Hours:
0

Special Fee:
$24.00

Course Description

Covers uses, safety, nomenclature, equipment operation, set-up and shutdown procedures for SMAW and OAC. 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, videos, and lab demonstrations technical skills. Course outcomes will include: theoretical concepts, layout, fabrication, welding, oxy-fuel cutting, and safety.

Intended Outcomes for the course

Upon completion of the course students should 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 E7024 operations
- Interpret blueprints to accurately lay out, prepare, and assemble weld joints
- Weld common joint assemblies with E7024 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 E7024 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 E7024 to AWS D1.1 Structural Steel Welding Code in the following joint configurations and positions.

- Flat position:
  - Bead plate
  - T-joint
  - Lap joint
- Horizontal position:
  - T-joint
  - Lap joint
  - Out side corner 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 111, *Shielded Metal Arc Welding (E7024) and Oxyacetylene Cutting* is a course intended as an introduction to the welding profession. This course utilizes a lecture/lab format, which includes classroom discussions and lab demonstrations. Topics covered will include safety, uses, nomenclature, equipment operation and set-up and shutdown procedures for oxyacetylene cutting and shielded metal arc welding.

Course Assignments

Reading

Welding Principles and Applications: By Larry Jeffus

- Safety in Welding
- Shielded Metal Arc Equipment, Setup, and Operation
- Shielded Metal Arc Welding of Plate
- Flame Cutting

Video Training -

See pcc.edu/library for a complete list of Hobart videos Delmar's Oxyacetylene Welding and Cutting Video's Delmar's Shielded Metal Arc Welding

Cutting Projects

Straight Cut by hand
Combination Cut by hand
Straight Cut by machine

Welding Projects

E7024 Bead Plate (Surfacing)
E7024 T-Joint (1F)
E7024 Lap Joint (1F)
E7024 T-Joint (2F)
E7024 Lap Joint (2F)
E7024 Outside Corner (2F)

Final Exam

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

Required Text

The Welding Principles and Applications: by Larry Jeffus

Outcome Assessment Policy:

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

Science on Steel

Contents of this Packet

SMAW with E7024 Electrode

As-Deposited Composition of E7024

E7024 electrode is compatible with a wide variety of steel compositions such as those used in earthmoving equipment, mining machinery, plate fabrication, structural components in bridges, ships and buildings. These steels include ASTM A36, A53, A106, A381, A500, A573, A709 bridge steels, A131 & ABS shipbuilding steels, API 5L pipe steels and many others. The compatibility between the E7024 electrode and the steel to be welded is based on approximately matching tensile strength.

The weld metal composition may change depending on the amount of base metal that is melted and mixed into the molten weld pool. This weld metal composition is called the "admixture". However, in multi-pass welds, the composition of the weld metal will approach that of the E7024 electrode shown above, even though the composition of the steels (listed above) are different.

Mechanical Properties of E7024

E7024 electrode will deliver the following mechanical properties for multiple-pass weld metal:

	Typical	AWS A5.1 Specification
Tensile Strength	82,000psi	70,000psi (min)
Yield Strength	72,000psi	58,000psi (min)
Elongation (% in 2")	25%	17% (min)
CVN* impact toughness	42 ft-lbs at 0° F	not specified

*CVN is Charpy V-notch

Again, these mechanical properties are for multi-pass weld metal, which contains essentially all as-deposited E7024 electrode material. If any base metal is mixed into the molten weld pool, particularly in the root pass, the properties of the weld metal may be different than those shown above.

Operating Range for E7024

This electrode contains a thick flux cover and iron powder for high deposition rates. It is designed to be used at high amperage values for high deposition. Because these conditions produce very large molten weld pools, E7024 can only be deposited:

- In the flat position and
- In horizontal fillet joints where equal leg fillets are desirable.

Welding in the vertical, horizontal groove, and overhead positions is not permitted, because the weld pool is so large and heavy that gravity overcomes surface tension resulting in molten metal dropping out of the pool. The correct operating range for E7024 electrode depends on electrode diameter as shown below:

3.2mm (1/8 inch)	130-150 amps
4.0mm (5/32 inch)	180-225 amps
4.8mm (3/16 inch)	200-280 amps
5.6mm (7/32 inch)	250-320 amps
6.4mm (1/2 inch)	300-360 amps

Greater deposition rate is achieved at higher current settings. However, the maximum amount of current that an electrode can carry without causing an unstable arc is proportional to the wire diameter.

Fluxes for E7024 Electrode

E7024 is an AC-DC electrode with a rutile flux and iron powder for very high deposition rates. If only a bare steel electrode were used, many defects such as lack of fusion and porosity would result in the weld. In addition, the arc would be difficult to start and maintain even with DC power. The resulting weld would contain oxides and nitrides due to the absorption of oxygen and nitrogen from the air. The resulting weld metal would be brittle with little strength. Thus, a flux is essential to provide sound weld metal with excellent and consistent mechanical properties.

Since E7024 is designed for high current and high deposition rate, it can only be used in the flat position and horizontal fillet position. E7024 is specified by the American Welding Society specification AWS A5.1. Also, E7024 has an ASME SFA 5.1 F-2 classification, which places it in the high deposition group with iron powder. When E7024 is operated between 230A and 340A, the deposition rate will be between 7 to 9 pounds/hour, which is about 3 times higher than the deposition rates for E6010, E6011, E6012 and E6013. Weld metal deposited with E7024 will develop the mechanical properties shown in the table above.

Impact Toughness of E7024 Weld Metal

Because of the high heat input used for welds made with E7024 electrode, the CVN impact toughness would not be as high as welds deposited with all-position electrodes such as: E6010, E6011, E7015, E7016 and E7018. High heat input causes weld metal to solidify and cool very slowly resulting in a large grain size and undesirable microstructure. CVN impact toughness of E7024 weld metal is generally low, and is not specified by AWS A5.1. Thus, E-7024 electrode can not be used for any application where the weld metal must pass a CVN impact requirement.

Arc Stability and Slag Removal

For welding to take place, the arc must form and carry current between the E7024 electrode and the base metal. This can only happen when the atmosphere between the electrode and base metal is in an "ionized" state. Different ingredients in the E7024 flux have different "ionization potentials". For welding purposes, it is essential that some of the ingredients in the flux are easily ionized in order to maintain high arc conductivity. For this purpose, E7024 contains compounds of titanium (rutile), potassium (potassium silicate and mica). Because of its "acid" rutile-based coating, the welding characteristics E7024 electrode include:

- Excellent arc stability
- Excellent detachability (slag removal)
- Excellent weld appearance

Arc Length for E7024

Arc length is the distance between the electrode core wire and the surface of the molten weld pool. Arc length increases with increasing electrode diameter and amperage. Generally, the arc length should not exceed the diameter of the core wire of the electrode. For electrodes with thick coatings like the iron powder E7024 electrode, the arc length is usually shorter than the diameter of the metal core. Too short an arc will cause the arc to be erratic and possibly short-circuit during metal transfer. Too long an arc will cause lack of direction, excess spatter, and ineffective shielding of the weld pool by the evolved shielding gasses. For E7024, the proper arc length can be maintained by simply dragging the electrode. The thick coating provides a good measure for arc length.

Possibility of Hydrogen-Assisted Cracking with E7024

E7024 produces excellent crack-free welds when welding mild steels in thicknesses less than ¾ inch (19mm) thick. There is an ever-present danger of hydrogen-assisted cracking (also known as underbead cracking and delayed cracking) in the heat-affected zone of the base metal when using E7024 to join thick steels and/or high strength steels. This is because E7024 electrode produces weld metal with "unlimited" diffusible hydrogen, which is typically about 25ml/100g of weld metal. E7024 electrode can only be safely used to weld mild or low-strength steels in relative thin sections. For example, AWS D1.1 Structural Welding Code allows E7024 to be used to weld A36 mild steel if the thickness is less than ¾ inch (19mm). If A36 steel is thicker than ¾ inch, a preheating temperature of 150° F (66° C) if mandatory. Table 2 lists many of the steels, thicknesses, and preheat temperatures (when needed) that can be safely used with E7024 electrodes.

Table 2 Minimum Preheat and Interpass Temperatures for SMAW with E7024 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 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)

The reason why E7024 electrode produces so much hydrogen is due to its cellulose and rutile flux ingredients. Both of these ingredients provide excellent arc welding characteristics, because during welding cellulose liberates hydrogen and CO_2 while rutile releases hydrogen from entrapped moisture. But, the hydrogen can cause cracking under certain circumstances in the heat-affected zones of mild steel over ¾ inch thick and/or high strength steels. In some codes like the AWS D1.5 Bridge Welding Code, high hydrogen electrodes like E7024 are banned because of the danger of hydrogen-assisted cracking in bridge structures.

Iron Powder Addition

Approximately half of the coating weight is iron powder for E7024 electrodes. When the covering of any electrode contains more than 40% iron powder, it produces a molten pool with such excessive fluidity and mass that the electrode can only be used in the flat or near-flat positions. With E7024 electrodes gravity controls the molten weld pool more than surface tension and fast freeze aspects of the flux.

Oxyacetylene Cutting

Chemical Reactions in Oxy-Fuel Cutting of Steel and Cast Iron

There are many fuel that can be used for oxy-fuel cutting; such as acetylene, propane, propylene, Mathyl-acetylene-propadien (MPS) and Natural Gas. The best fuel is acetylene because it has the highest flame temperature, among other reasons. Oxy-acetylene cutting can only be used on all carbon steels, alloy steels, cast irons and to some extent titanium. The principle of oxy-acetylene or oxy-fuel cutting of steel is based entirely on the highly exothermic reaction between oxygen (O) and iron (Fe) shown as follows:

First Reaction:	$Fe + O$	$\rightarrow$	FeO + heat	(267 kJ)
Second Reaction:	$3Fe + 2O_2$	$\rightarrow$	Fe_3O_4 + heat	(1120 kJ)
Third Reaction:	$2Fe + 1.5O_2$	$\rightarrow$	Fe_2O_3 + heat	(825 kJ)

These reactions are oxidation reactions. Of course, when oxygen and iron come together at room temperature, only very slow rusting reactions take place. In order for these highly exothermic reactions to proceed, the steel must be initially heated with the oxy-acetylene portion of the torch to an ignition temperature of 870º C (1600º F). Above this temperature, the activation energy necessary for oxygen and iron atoms to combine spontaneously is achieved. At this point, the oxygen lance is turned on and the heat liberated by the reaction between Fe and O is enough provide self-sustaining cutting over several inches of thickness of steel. Thus, you do not need to melt the steel to ignite the cutting action; you only need to heat the steel up to "yellow" heat.

The reason why exothermic reaction are possible in the first place is because there is a great decrease in the free energy of iron oxide (Fe_2O_3, Fe_3O_4, and FeO) compared to the high free energies of elemental Fe and O. So, when iron oxide forms to reduce the free energy of the system, where does the difference in free energy between the iron oxide and elemental Fe + O go? The answer is heat in the form of a heat of reaction or exothermic reaction.

Oxy-Acetylene Cutting of Stainless Steel and Titanium

It is known that oxy-acetylene cutting can not cut stainless steel very well. This is because there is insufficient iron in the stainless steel to produce enough heat to effectively cut. Remember, stainless contains less than 70% Fe. Before the days of plasma cutting, stainless steel used to be cut by sprinkling iron powder into the flame and over the area to be cut to increase the iron content of cut zone. In this way, the heat liberated by the oxidation of pure iron provides enough heat to allow cutting of stainless steel.

Titanium can also be cut by oxy-acetylene, but not as efficiently as steel. Like iron and steel, the oxidation of titanium is exothermic; so it is possible to cut titanium by oxy-acetylene. Because the amount of heat liberated by the exothermic oxidation reactions are less than those of steel, the cutting action for titanium is slow and very rough. Thus, virtually all cutting of titanium, titanium alloys and stainless steels is performed by plasma arc techniques.

Welding Symbols

The use of welding symbols enables a designer to indicate clearly to the welder important detailed information regarding the weld. The information in the welding symbol can include the following details for the weld: Length, depth of penetration, height of reinforcement, groove type, groove dimensions, location, process, filler metal, strength, number of welds, weld shape, and surface finishing. All this information would normally be included on the welding assembly drawings.

Indicating Types of Welds

Weld types are classified as follows: fillets, grooves, flange, plug or slot, spot or protecting, seam, back or backing, and surfacing. Each type of weld has a specific symbol that is used on drawings to indicate the weld. A fillet weld, for example, is designated by a right triangle.

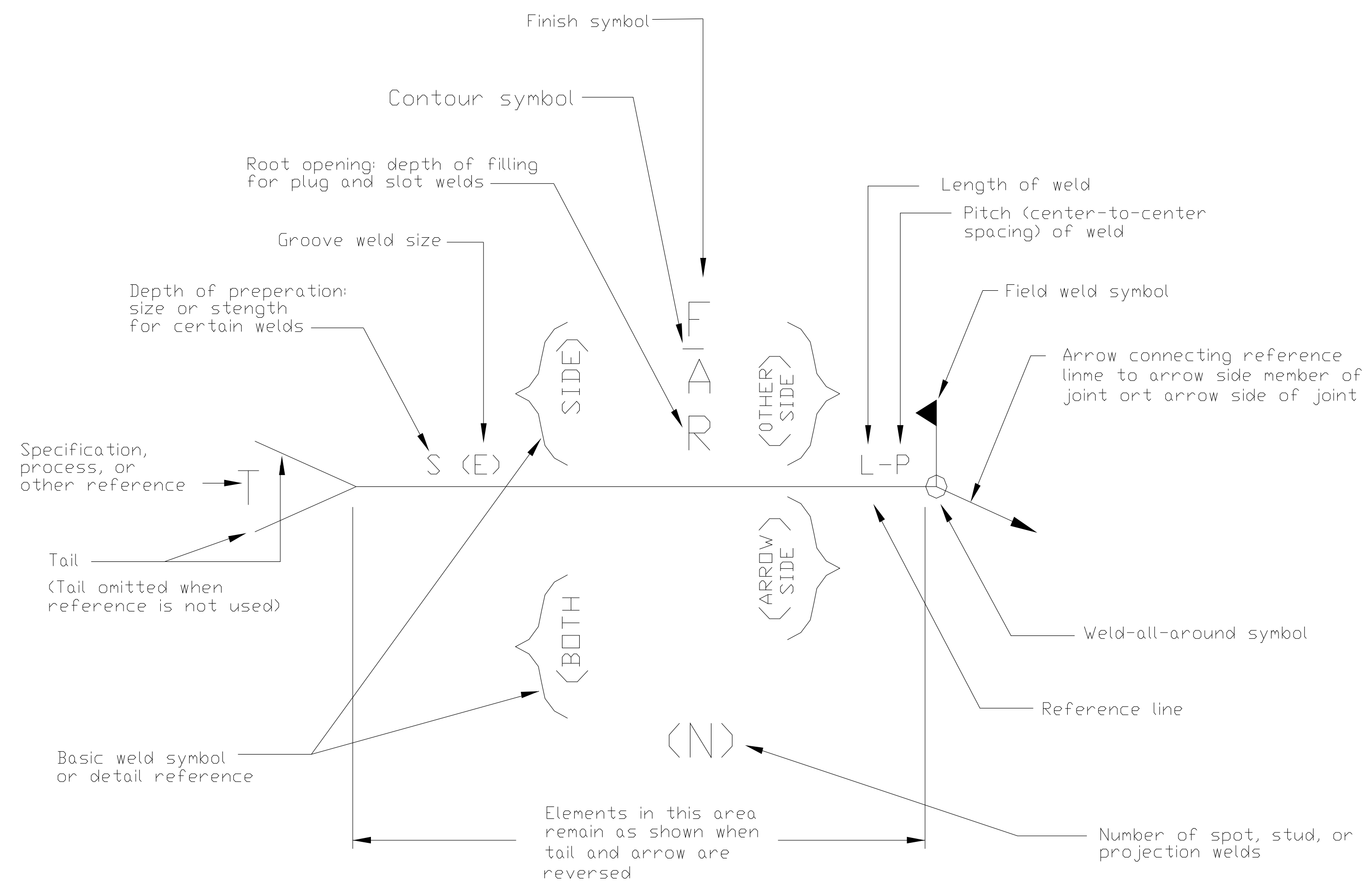
Weld Location

Welding symbols are applied to the joint as the basic reference. All joints have an arrow side (near side) and another side (far side). Accordingly, the terms arrow side, other side, and both sides are used to indicate the *weld location* with respect to the joint. The reference line is always drawn horizontally. An arrow line is drawn from one end or both ends of a reference line to the location of the weld. The arrow line can point to either side of the joint and extend either upward or downward.

Location Significance of the Arrow

In the case of fillet and groove welding symbols, the arrow connects the welding symbol reference line to one side of the joint. The surface of the joint the arrow point actually touches is considered to be the arrow side of the joint. The side opposite the arrow side of the joint is the other (far) side of the joint.

Location of Elements of a Welding Symbol



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

Portland Community College
Welding Technology

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

WLD 111 Location of Elements of a Weld Symbol

Drawn By: John Deering

Size: | Qc No. | Rev.

Chk By: Date: 8/08/05

Approve | Date | Sheet

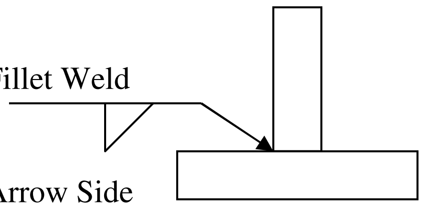
Welding Symbols Work Sheet #11

Name: ____________________________________ Date: ________________

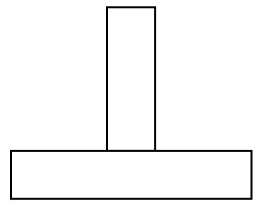
Draw in where the weld goes in the significance Column.

Fillet Weld

Arrow Side

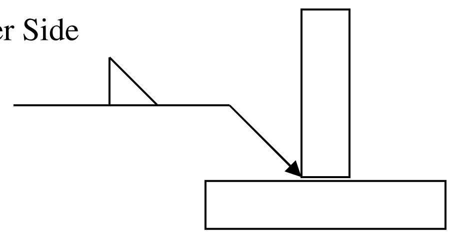


Symbol



Significance

Other Side



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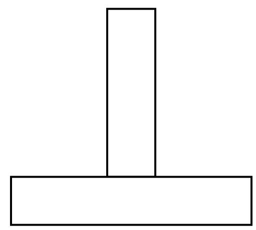
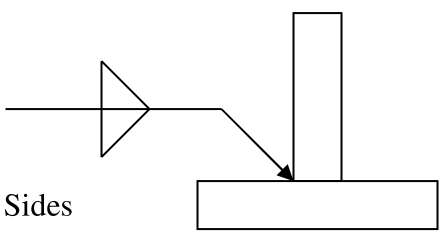
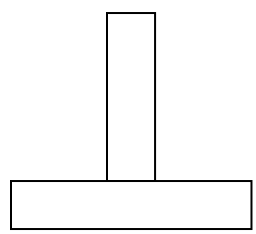


Significance

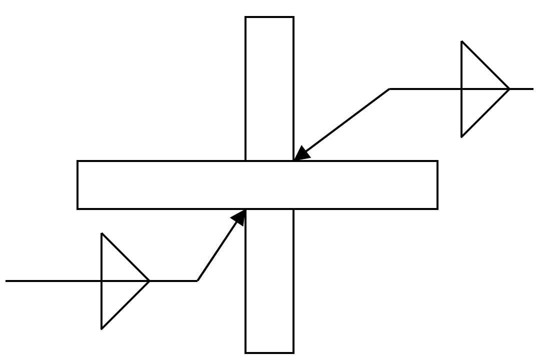
Both Sides

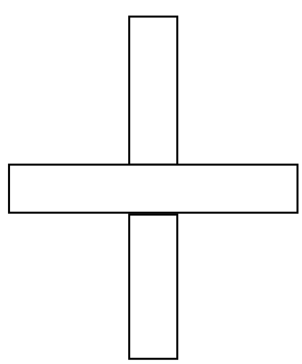


Symbol

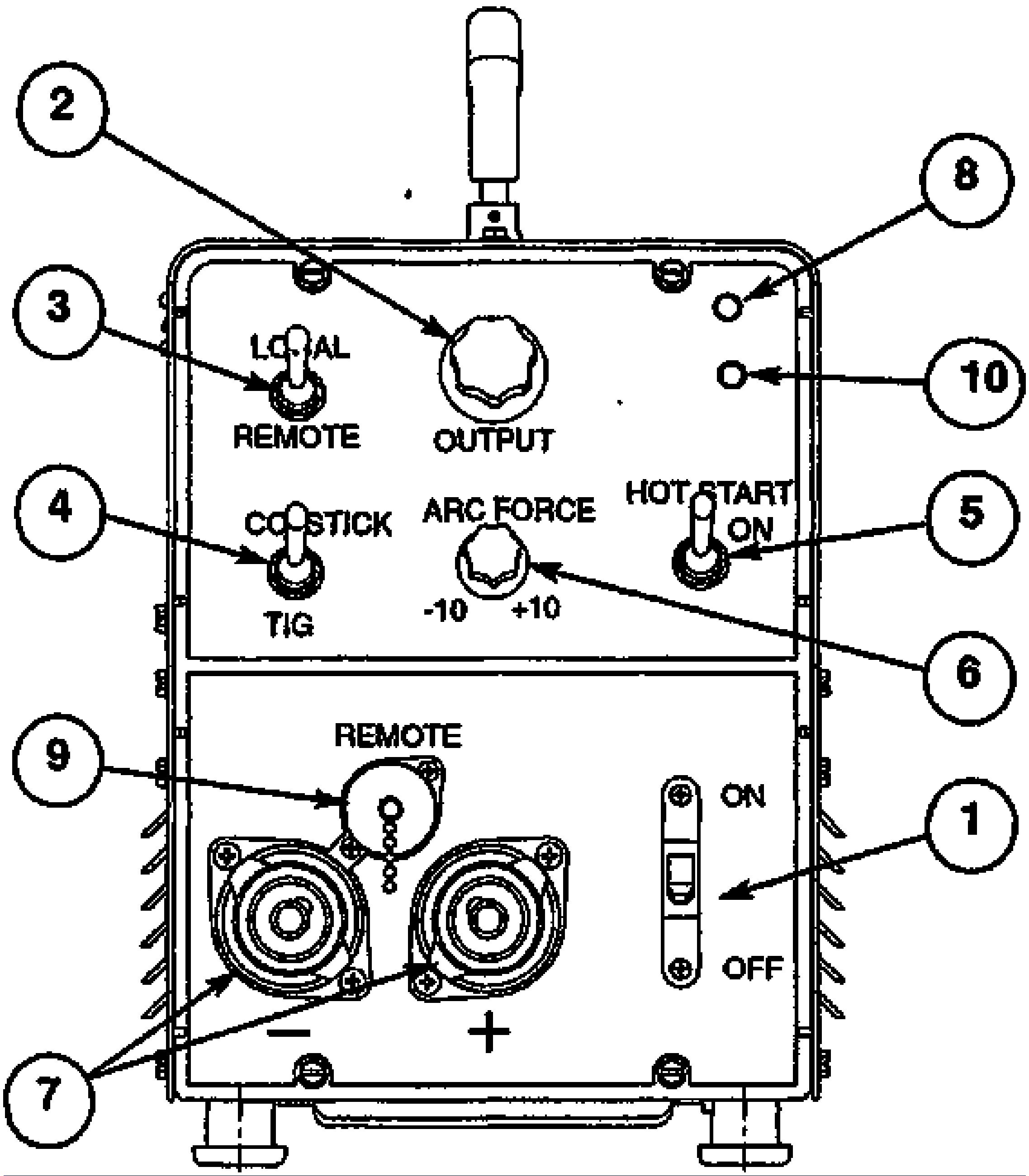


Significance





Lincoln Electric's Invertec 275



Note: #7 indicates where the electrode leads will plug into. This determines polarity. Plugging the electrode holder into the Negative pole = DCEN/DCSP and plugging the electrode holder into the Positive pole = DCEP/DCRP.

Lincoln Electric's Invertec 275

1. **POWER SWITCH** - Place the lever in the "ON" position to energize the machine. When the power is on the output will be energized in STICK (SMAW) mode and TIG (GTAW) if the remote is set to local control. At power up the thermal Light and Fan will turn on for approximately 3 seconds.
2. **OUTPUT CONTROL** - This controls the output current. Control is provided over the entire output range of the power source with (1) turn of the control knob. This control may be adjusted while under load to change power source output. When using remote control this function becomes the limit setting.
3. **LOCAL/REMOTE SWITCH** - Place in the "LOCAL" position to allow output adjustment at the machine. Place in the "REMOTE" position to allow output adjustment at remote pot or amptrol. In Remote, the machine output control pot is the limit setting for remote control.
4. **MODE SWITCH**

CC -Stick (SMAW) Use this mode for all stick welding. Output energized when machine is on.
TIG (GTAW) Optimized for touch start use. Short circuit current is limited to approximately 20 amps to aid in touch starting.
In TIG (GTAW) mode, the Local/Remote switch also controls if the output is energized.

MODE	LOCAL/REMOTE SWITCH	OUTPUT
GTAW	LOCAL	ENERGIZED
GTAW	REMOTE	CONTROL BY REMOTE ARC SWITCH
SMAW	LOCAL & REMOTE	ENERGIZED

5. **HOT START** - Controls the amount of starting energy in CC Stick (SMAW). The Hot Start can be either turned on or off. When on, it provides a striking current at 160% of the set current or 275A whichever is larger then quickly reverts to the set current in 0.4 second.

OPERATION

1. **ARC FORCE** - This control functions in CC Stick SMAW modes to adjust the Arc Force. The arc is soft at the mini mum settings and more forceful or driving at the maximum settings. Higher spatter levels may be present at the maxi mum settings. Full range is from ***-10(Soft) to +10(Crisp)***
2. **OUTPUT TERMINALS** - These quick *disconnect* terminals provide connection points for the electrode and work cables. Refer to Output Connection in the Installation chapter for proper cable sizes. For positive polarity welding connect the electrode cable to the positive terminal and the work cable to the negative terminal. To weld negative polarity, reverse the electrode and work cables.
3. **THERMAL SHUTDOWN INDICATOR** - This light will illuminate if an internal thermostat has been activated. Machine output will return after the internal components have returned to a normal operating temperature. See Thermal Protection later in this Operation chapter.

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SMAW Helpful Hints

Restarting Technique for Sound Welds

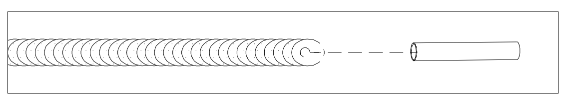
Strike the arc directly ahead of the crater and in line with the "new weld." Once the arc is started, establish an extended arc length ("long arc"). The purpose is to:
follows:

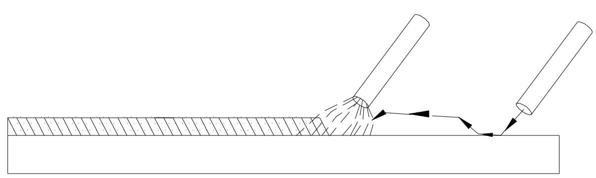
1. Preheat the base metal.
2. Allow gaseous shield to be established.
3. Allows the amperage to flow so the heat will build up.
4. Gives off light to find the crater (flash light effect).

Proceed 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:

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.





Arc Characteristics of E7024 (Fast Fill Group)

The E7024 electrode has a very heavy slag in conjunction with a soft arc. This can create problems for the welder if the slag gets ahead of the rod. In this case, the welder needs to react quickly using one or more of the following techniques.

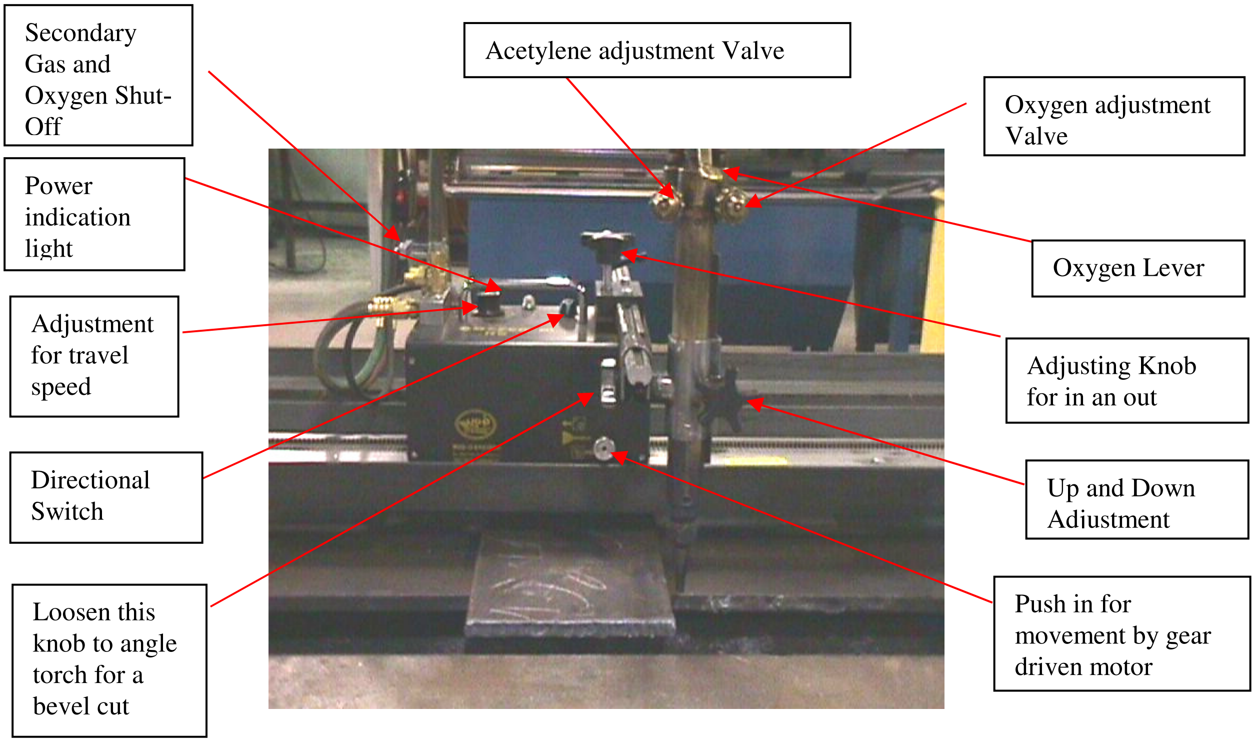
1st Add more downward pressure to the end of the electrode. This closes the arc length so the slag cannot go forward.

2nd Increase travel angle. This utilizes the arc force to push the slag back.

3rd Twist your wrist back and forth. This tends to break up the magnetic field that is present and allows the slag to clear the puddle.

Doing these three things simultaneously will allow the welder to react to the arc without having to stop welding and still produce a sound weld.

5. **Straight Cut** (Use material sizes from cutting projects in this packet.)



OAC Information

Acetylene (C_2H_2) PSI	5-7
Oxygen (O_2) PSI	40
Stand off	1/8" to ¼"
Tip Size for 3/8" – ½" material (Victor)	0

Oxyacetylene Cutting #1

Name: __________________________ Date: _______________ Grade________

Directions:
Locate the following questions in your Welding Principles and Applications. Review Oxyacetylene Cutting and other chapters and utilize that information to complete the questions on this work sheet. Answer the questions using ***complete sentences***, and do not hesitate to reference other sections in the text to find an answer.

1. If a cutting tip should stick in the cutting head, how should it be removed?

2. List four different fuel gasses in rank order according to their temperature.

3. What type of cutting fuel is used in the PCC Welding shop?

4. What is a combination welding-cutting torch?

5. What is a mixing chamber? Where is it located?

1. Define Flashback

2. Define Back Fire

3. What are three common causes of a flash back or back fire?

4. Which is a more dangerous condition: a flash back or a backfire and WHY?

5. Why should you keep your torch tip clean?

Oxyacetylene Cutting #3

Name: ________________________ Date: _____________ Grade: ______

Directions: Circle the correct answer.

1. In oxyfuel cutting, a material is heated to its _________temperature and is then burned.

   A. Boiling
   B. Kindling
   C. Melting
   D. Hardening

2. The______ flame is produced by the small orifices around the outside of the cutting tip.

   A. Preheat
   B. Post heat
   C. Cutting
   D. Welding

3. The _____valve is slightly opened while the ____is held at an angle next to the tip prior to lighting.

   A. Fuel, Match
   B. Oxygen, Striker
   C. Acetylene, Striker
   D. Acetylene, Cigarette

4. Before cutting, the flame must be adjusted until the preheat flames are______.

   A. Orange
   B. Neutral
   C. Oxidizing
   D. Carbonizing

5. There should be ________materials around the work area prior to cutting.

   A. Plastic-covered
   B. Loose
   C. No flammable
   D. Non-Liquid

6. Along the bottom of the cut, there should be little or no________________________.

A. Slag
B. Dross
C. Kerf
D. Flash

7. ______the plate is when you begin a cut in the center of the plate or make a hole in it.

A. Piercing
B. Punching
C. Burning
D. Boring

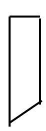
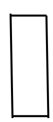
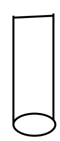
8. Greater _________consumption is the result of higher cutting pressure.

A. Metal
B. Acetylene
C. Nitrogen
D. Oxygen

9. At about _______degrees Fahrenheit, mild steel will begin to burn in pure oxygen.

A. 4,500
B. 5,400
C. 1,600
D. 11,000

10. Which would be the proper end shape of soapstone that is to be used for marking metal?

A.  B.  C. 

WLD 111—SMAW #4

Name ___________________________ Date _____________

Locate the following questions in your Welding Principles and Applications Text: Review the Oxyacetylene Cutting and SMAW chapters or other books listed on the Reference List and utilize that information to complete the questions on this work sheet. Answer the questions using ***complete sentences***, and do not hesitate to reference other sections in the text to find an answer.

1. Just before striking an arc what should you say?

2. Describe two methods of striking an arc with an electrode.
   a.

   b.

3. Why is it important to strike the arc only in the weld joint?

4. What problems may result by using an electrode at too low a current setting?

5. What problems may result by using an electrode at too high a current setting?

6. True or False is direct current electrode negative the same as reverse polarity?

7. What makes some spatter "hard"?

8. Why should you never change the current setting during a weld?

9. What factors should be considered when selecting an electrode size?

10. What can a welder do to control overheating of the metal pieces being welded?

WLD 111—SMAW #6

Name ___________________________ Date _____________

Locate the following questions in your Welding Principles and Applications Text: Review the Oxyacetylene Cutting and SMAW chapters or other books listed on the Reference List and utilize that information to complete the questions on this work sheet. Answer the questions using ***complete sentences***, and do not hesitate to reference other sections in the text to find an answer.

1. Why is the SMAW power source output current referred to as *constant current*?

2. How does arc blow affect welding?

3. How can arc blow be controlled?

4. What is meant by a *welder's duty cycle?*

5. Why must a welding machine's duty cycle never be exceeded?

6. Why must the electrode holder be correctly sized?

7. What can cause a properly sized electrode holder to overheat?

8. What are three steps a welder can take to prevent a weld from being too hot?

9. How can a welder prevent slag inclusions when using then E7024 electrode?

10. List four welding positions for plate welding

    a.

    b.

    c.

    d.

Vocabulary Terms #7

Name: ________________________ Date: _____________________

Directions:

Locate the following terms in your Welding Principles and Applications Text: or other books listed on the Reference List and utilize that information to complete the questions on this work sheet. Answer the questions using ***complete sentences***, and do not hesitate to reference other sections in the text to find an answer.

1. Fillet Weld Size

2. Fillet Weld Leg

3. Base Metal

4. Work Angle (sketch)

5. Travel Angle (sketch)

6. Kerf

7. Neutral Flame

8. Push Angle

9. Molten weld pool (Puddle)

10. Arc Length

.

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.

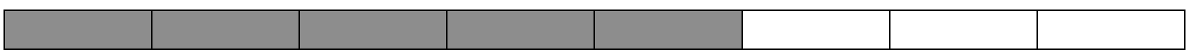
Look at this fraction: 3/4

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

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

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

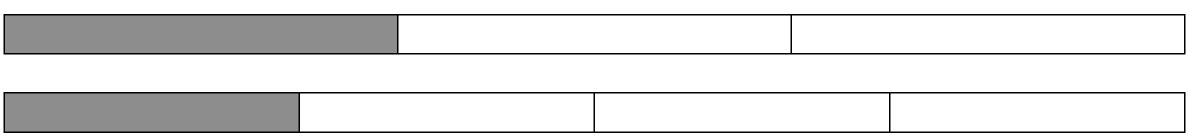


This bar represents 5/8ths, because 5 of the 8 sections are shaded

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 $1/4^{th}$?



Reducing Common Fractions Worksheet #8

Name: ____ Date: __________

Example 1: Express 30/32 in lowest terms.

Solution: Find the largest number that will go into each number. Divide that number into each number of the fraction.

30 ÷ 2 =15
32 ÷ 2 =16 Ans. = 15/16

Example 2: Express $^{12}/_{16}$ in lowest terms.
The largest number that will go into each number is 4.

12 ÷ 4 =3
16 ÷ 4 =4 Ans. = 3/4

Notes: If both numbers are even, the fraction is always reducible by 2.

In example 2, what if you could not see that 4 was the largest number and you reduced by 2?

12 ÷ 2 = 6
16 ÷ 2 = 8 Ans. = 6/8

They are both still even and must be reduced again.

6 ÷ 2 = 3
8 ÷ 2 = 4 Ans. = 3/4

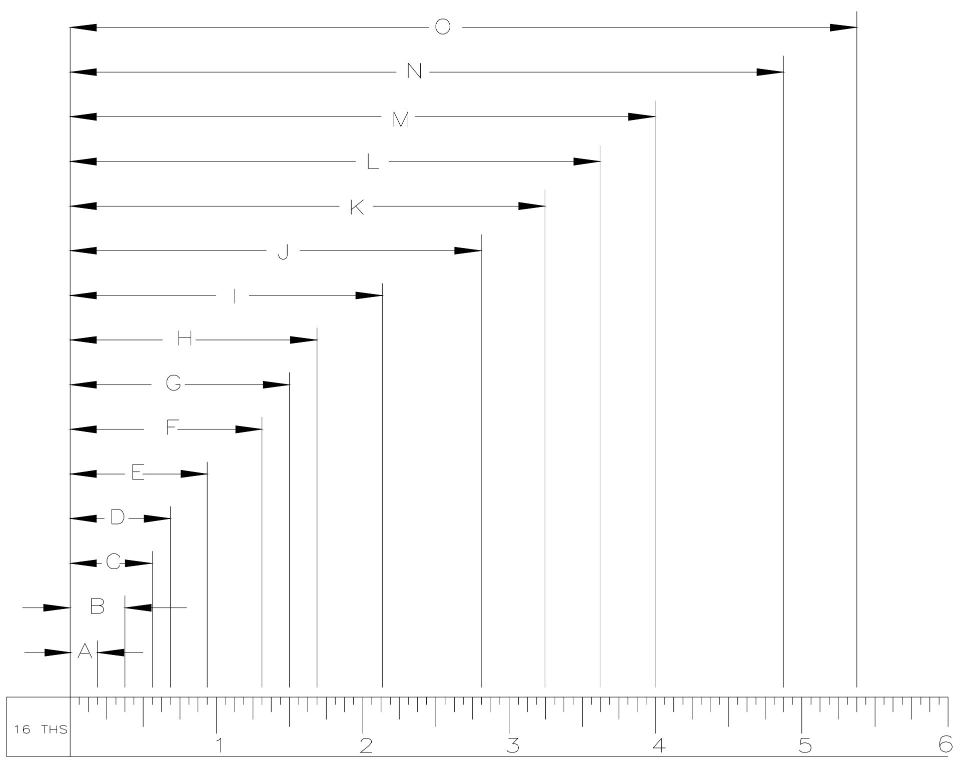
Practice:

1. 4/8
2. 8/16
3. 14/16
4. 8/32
5. 6/16
6. 2/8
7. 2/4
8. 6/8
9. 10/16
10. 24/32

Expressing Common Fractions in Higher Terms
Work Sheet #10

Name: ____________________________________ Date: ____________________

Drawn below is a 6 inch rule, divided into 1/16 inch in– crements. You need to correctly identify the distances indicated by the arrows, and place your answers in the proper space below. Example: The distance indicated by the arrows marked "M" is 4 inches. Place 4" in the space along answere "M".



Portland Community College
Welding Technology
Math Sheet #1
Sheet
Date
Approve
Date: 10/01/03
Tolerance (Unless otherwise Specified)
Dimensional ± 1/32" Angle ± 5°
Drawn By: John Deering
Chk By:

ANSWERS:

A ______________ H ______________
B ______________ I ______________
C ______________ J ______________
D ______________ K ______________
E ______________ L ______________
F ______________ M ______________
G ______________ N ______________
O ______________

Cut List WLD 111

Tolerances:	Fractional	Decimal
Linear:	+/- 1/16"	0.0625"
Angular:	+/- 2°30'	2.5°

Bead Plate

Quantity	Thickness	Width	Tolerance	Length	Tolerance

1F T-Joint

Quantity	Thickness	Width	Tolerance	Length	Tolerance

1F Lap-Joint

Quantity	Thickness	Width	Tolerance	Length	Tolerance

2F T-Joint

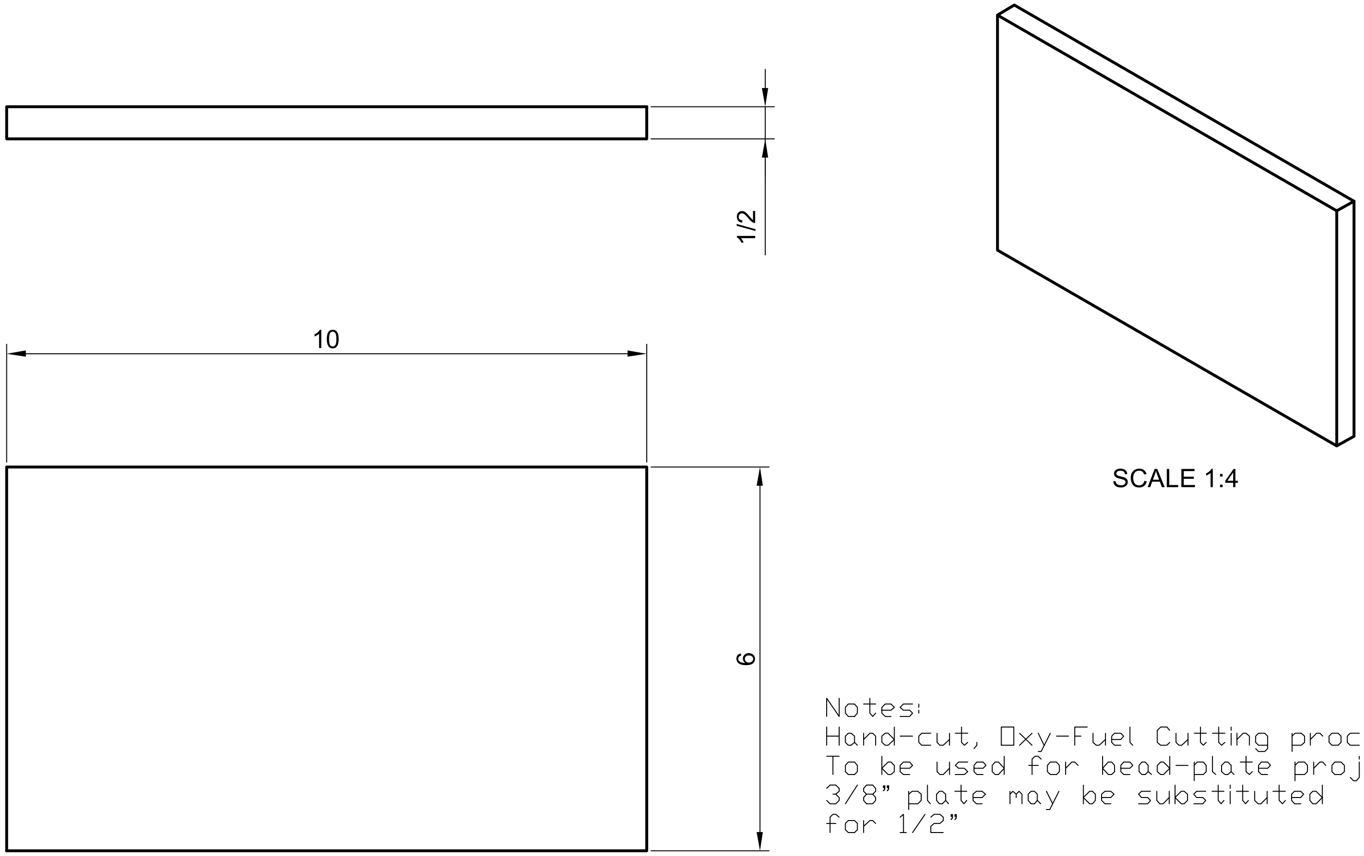
Quantity	Thickness	Width	Tolerance	Length	Tolerance

2F Lap-Joint

Quantity	Thickness	Width	Tolerance	Length	Tolerance

2F Outside Corner

Quantity	Thickness	Width	Tolerance	Length	Tolerance



Notes:
Hand-cut, Oxy-Fuel Cutting process
To be used for bead-plate project.
3/8" plate may be substituted
for 1/2"

Bead Plate					
Quantity	Thickness	Width	Tolerance	Length	Tolerance

TITLE
Oxy-Fuel Hand cut project one

LAST UPDATED	UNITS	SHEET
06/14/21	in	1 / 1

THIRD ANGLE PROJECTION

Tolerances:	Fractional	Decimal
Linear:	+/- 1/16"	0.0625"
Angular:	+/- 2°30'	2.5°

E7024 Bead Plate (Surfacing)

Technique - Ask your instructor for a demonstration. The bead to bead contour should be flat or nearly flat when finished. Make sure the edge of your puddle just barely reaches the high point of your previous bead. Preventing valleys shows the ability to place the weld bead where you intend it to be.
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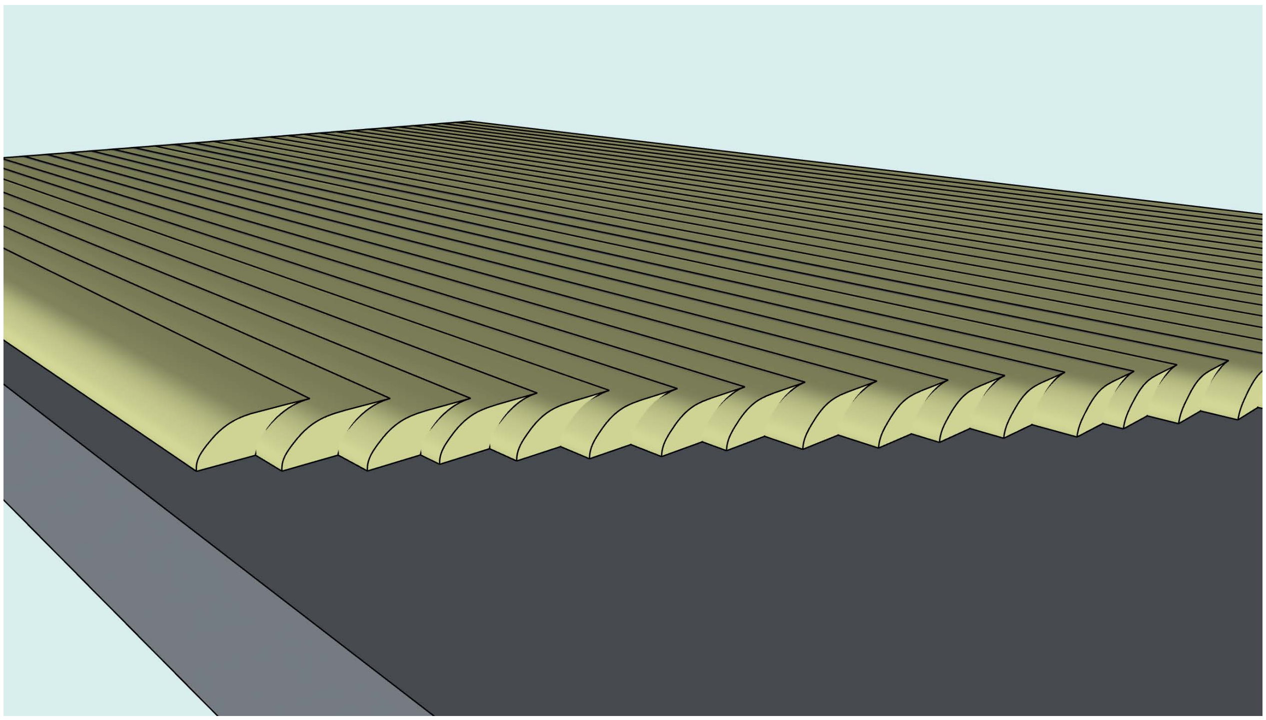
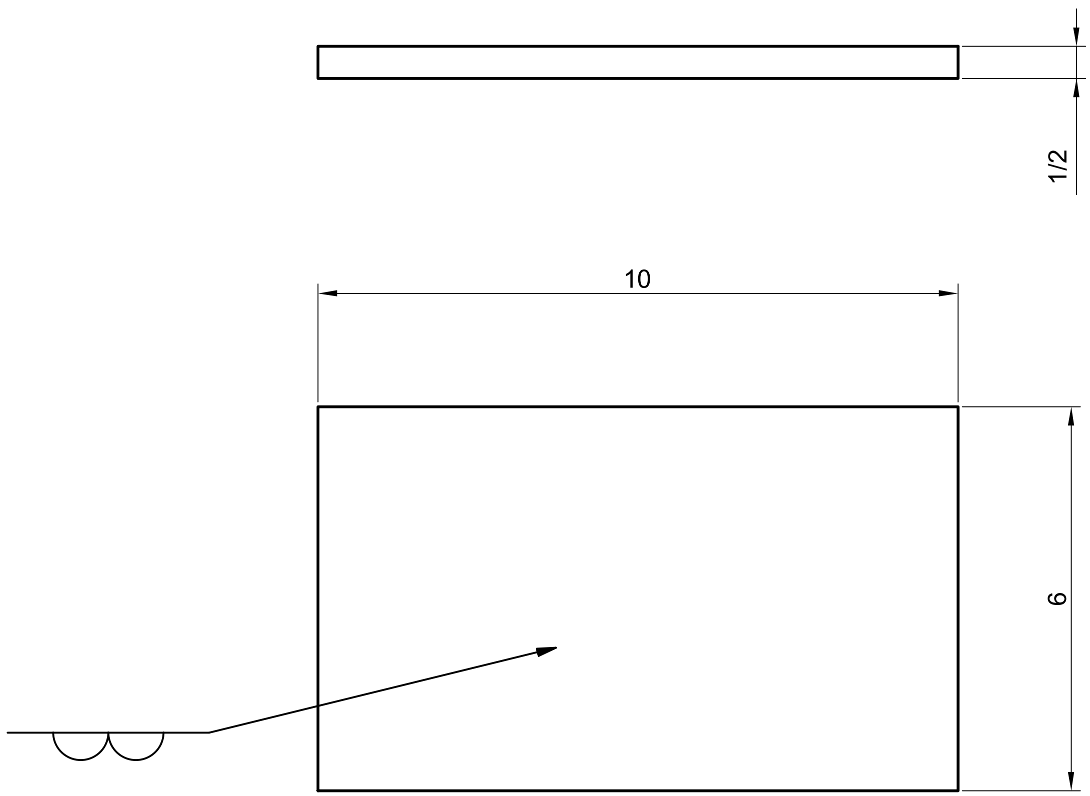
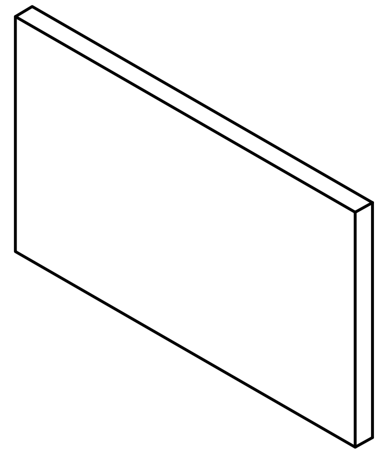


ASSESSMENT assembly	Yes	No
Was the material cut within the 1/16 inch tolerance?		
Were the parts fit-up and tacked within the 1/16" tolerance?		

ASSESSMENT Weld Quality - did you prevent the following?	Yes	No
Improper weld size		
Poor bead contour		
Porosity		
Slag Inclusion		
Incomplete fusion		
undercut		
Excessive spatter		
Unequal Leg size		





SCALE 1:4

Note: Use 6 x 10 hand cut plate from project one. Minimize or eliminate valleys with proper bead placement.

TITLE

Flat Position Bead Plate

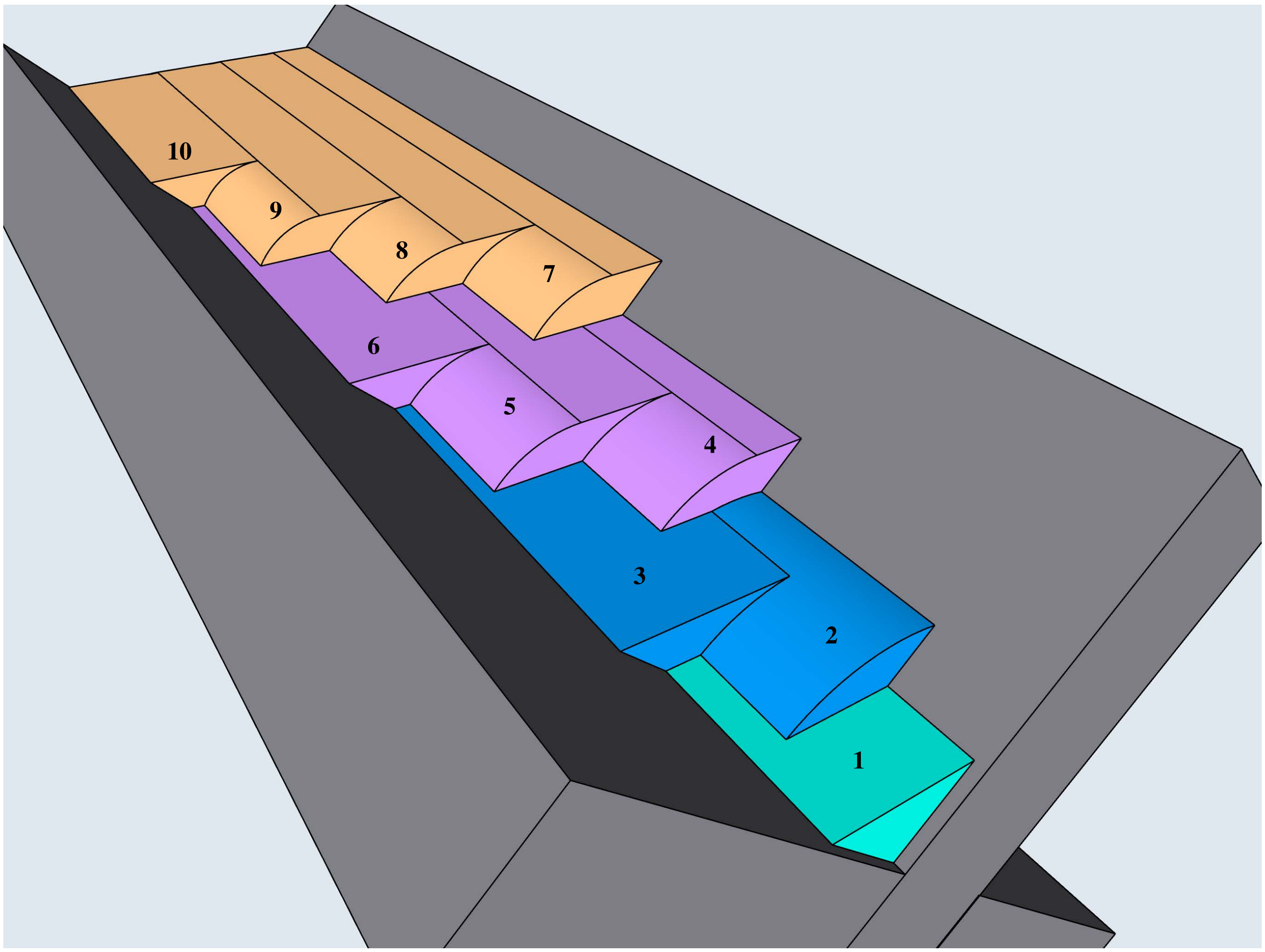
LAST UPDATED	UNITS	SHEET
06/14/21	in	1 / 1

THIRD ANGLE PROJECTION

Tolerances:	Fractional	Decimal
Linear:	+/- 1/16"	0.0625"
Angular:	+/- 2°30'	2.5°

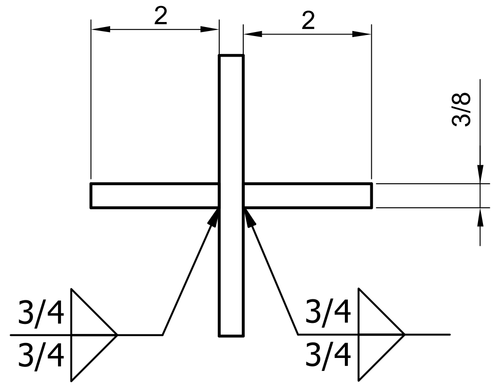
E7024 1F T-Joint

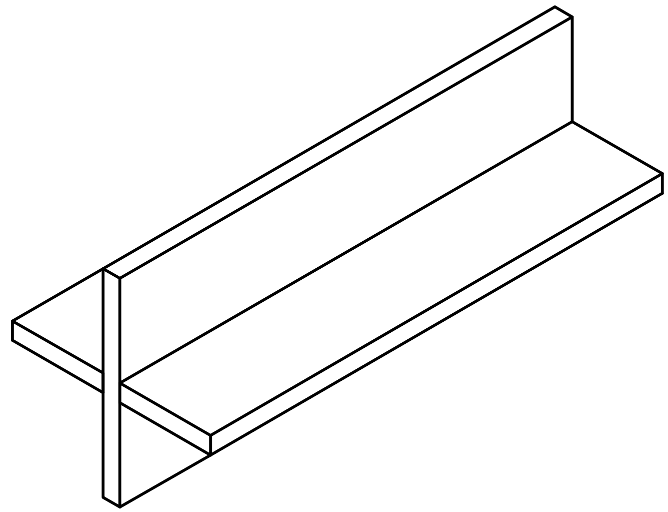
Technique
Ask your instructor for a demonstration. Each set of beads n the 1,3,6,10 progression should be flat when complete. Make sure that you do not creep up the sides of the plates. Bead to bead contour should be flat when complete.



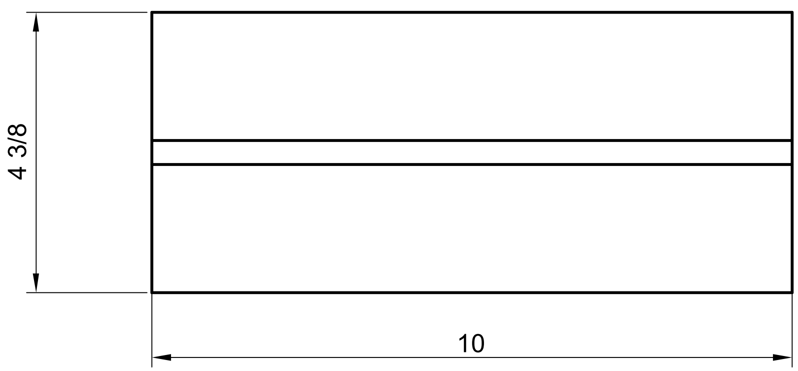
ASSESSMENT assembly	Yes	No
Was the material cut within the 1/16 inch tolerance?		
Were the parts fit-up and tacked within the 1/16" tolerance?		

ASSESSMENT Weld Quality - did you prevent the following?	Yes	No
Improper weld size		
Poor bead contour		
Porosity		
Slag Inclusion		
Incomplete fusion		
undercut		
Excessive spatter		
Unequal Leg size		





Note:
Isometric not shown in flat position.
Rotate 45 degrees for 1F position



1F T-Joint					
Quantity	Thickness	Width	Tolerance	Length	Tolerance

TITLE

111 Flat Position T-joint

LAST UPDATED	UNITS	SHEET
06/15/21	in	1 / 1

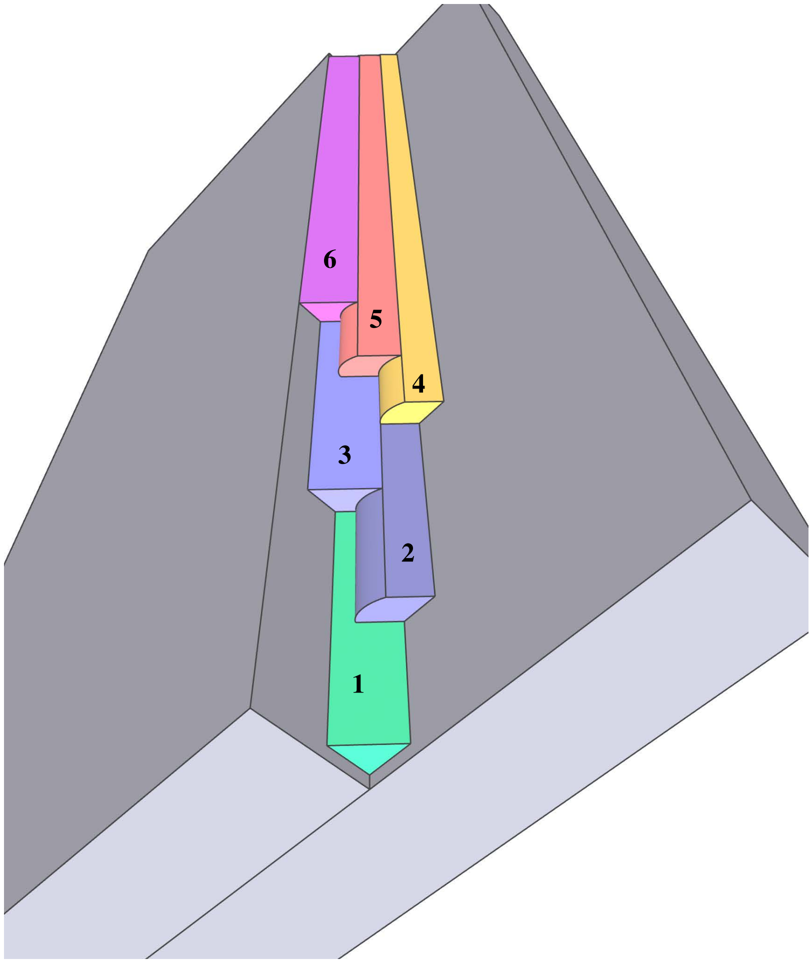
THIRD ANGLE PROJECTION

Tolerances:	Fractional	Decimal
Linear:	+/- 1/16"	0.0625"
Angular:	+/- 2°30'	2.5°

E7024 1F-Lap

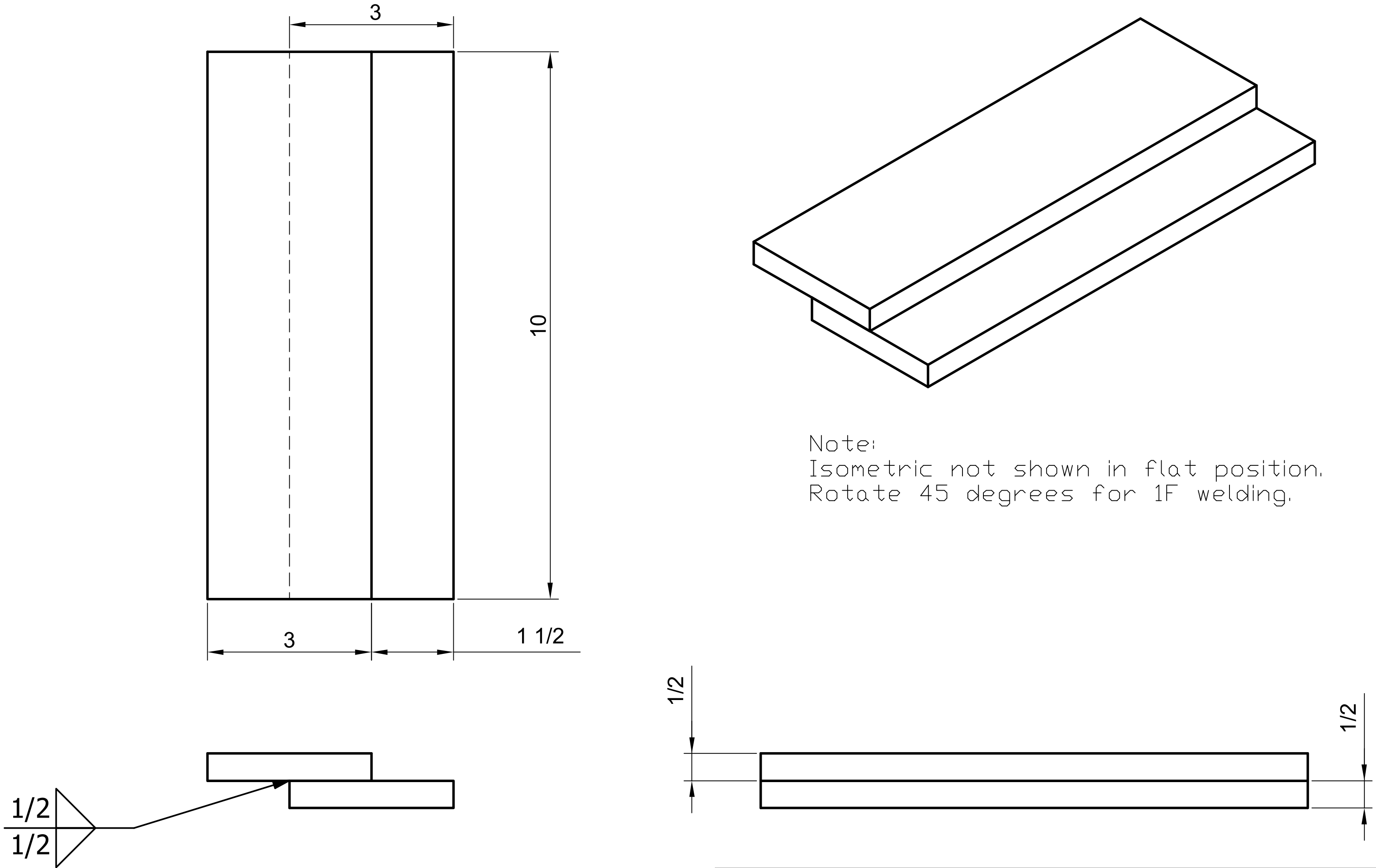
Technique

Ask your instructor for a demonstration. Each layer should be flat when finished.



ASSESSMENT assembly	Yes	No
Was the material cut within the 1/16 inch tolerance?		
Were the parts fit-up and tacked within the 1/16" tolerance?		

ASSESSMENT Weld Quality - did you prevent the following?	Yes	No
Improper weld size		
Poor bead contour		
Porosity		
Slag Inclusion		
Incomplete fusion		
undercut		
Excessive spatter		
Unequal Leg size		



TITLE

Lap Joint Flat Position

LAST UPDATED	UNITS	SHEET
06/14/21	in	1 / 1

THIRD ANGLE PROJECTION

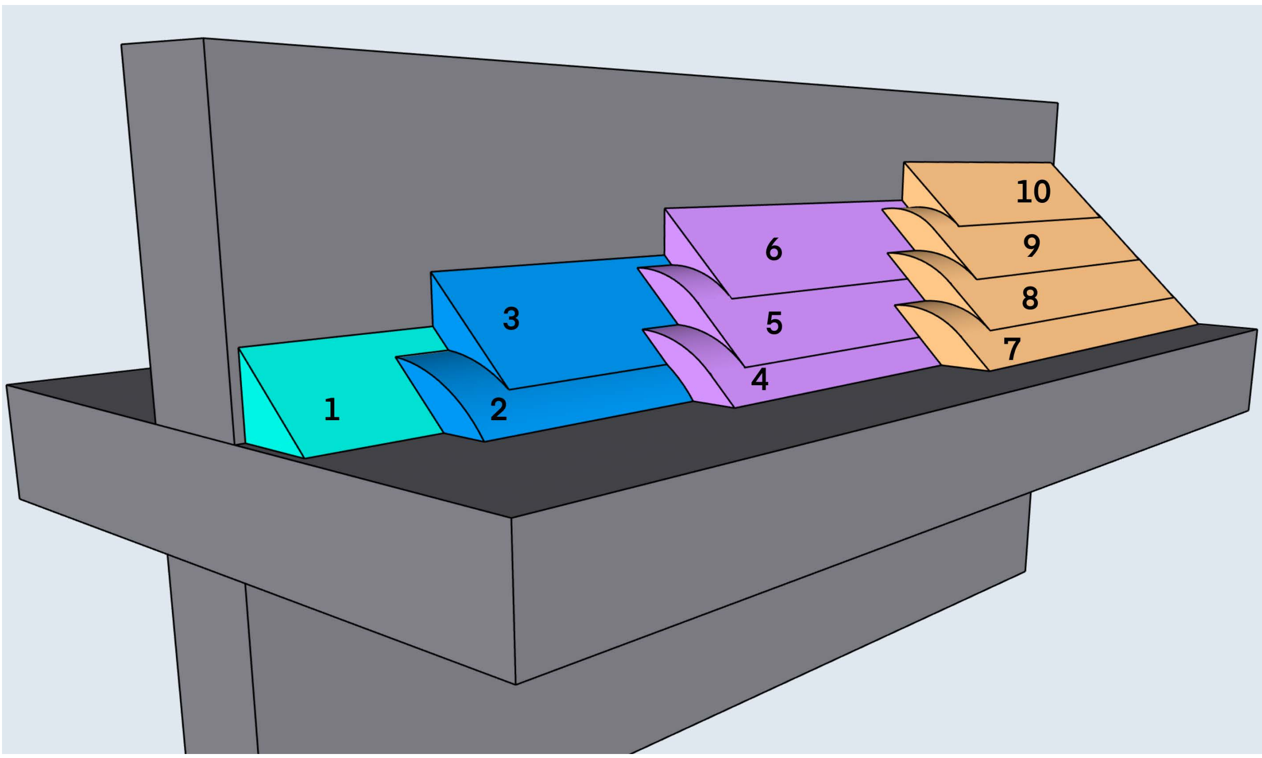
Tolerances:	Fractional	Decimal
Linear:	+/- 1/16"	0.0625"
Angular:	+/- 2°30'	2.5°

1F Lap-Joint

Quantity	Thickness	Width	Tolerance	Length	Tolerance

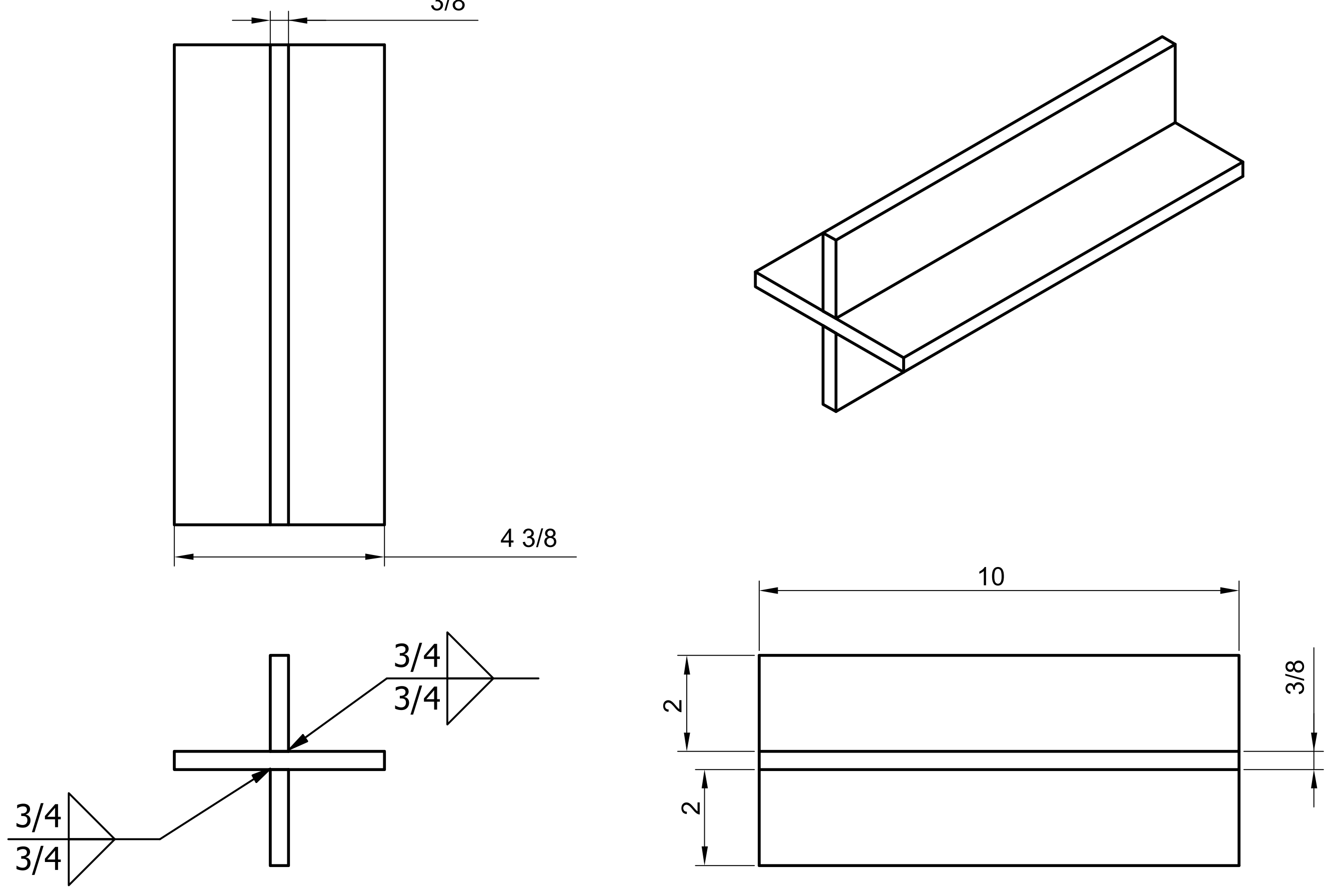
E7024 T-Joint (2F)

Technique:
Ask your instructor for a demonstration. The illustration shows the proper bead placement of your weld progression. Each layer should be flat when finished, with no valleys between beads.



ASSESSMENT assembly	Yes	No
Was the material cut within the 1/16 inch tolerance?		
Were the parts fit-up and tacked within the 1/16" tolerance?		

ASSESSMENT Weld Quality - did you prevent the following?	Yes	No
Improper weld size		
Poor bead contour		
Porosity		
Slag Inclusion		
Incomplete fusion		
undercut		
Excessive spatter		
Unequal Leg size		



2F T-Joint					
Quantity	Thickness	Width	Tolerance	Length	Tolerance

TITLE

111 T-Joint Horizontal Position

LAST UPDATED	UNITS	SHEET
06/14/21	in	1 / 1

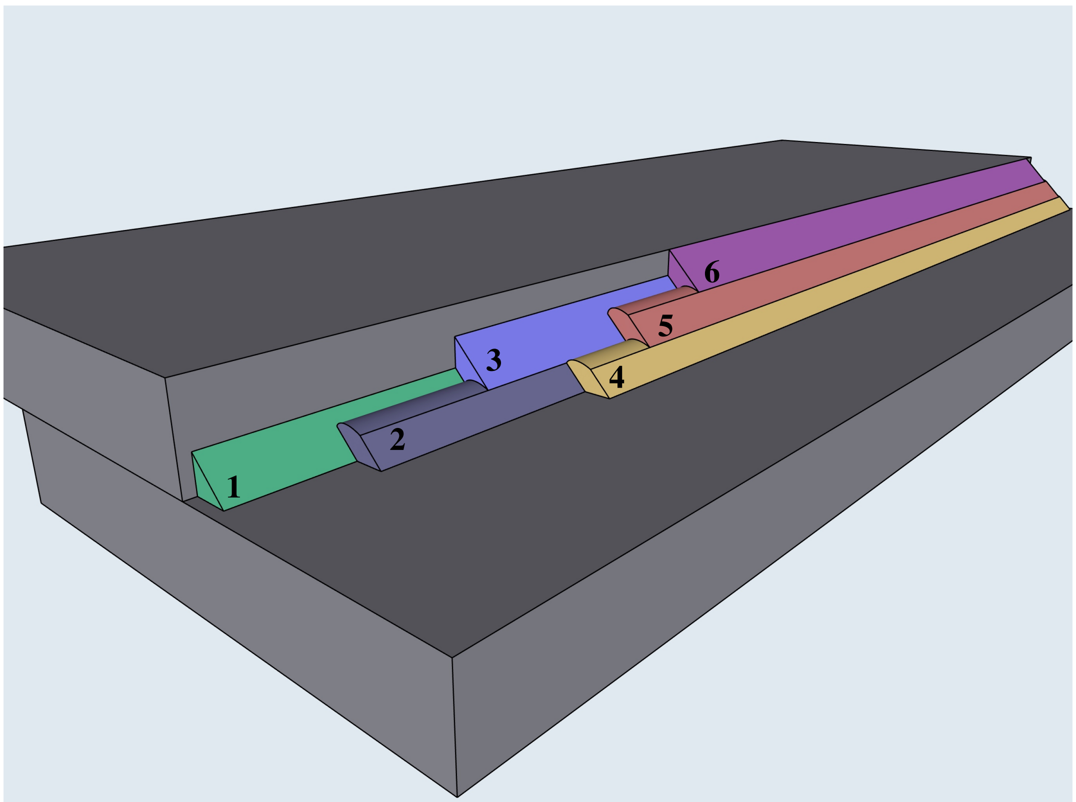
THIRD ANGLE PROJECTION

Tolerances:	Fractional	Decimal
Linear:	+/- 1/16"	0.0625"
Angular:	+/- 2°30'	2.5°

E7024 Lap Joint (2F)

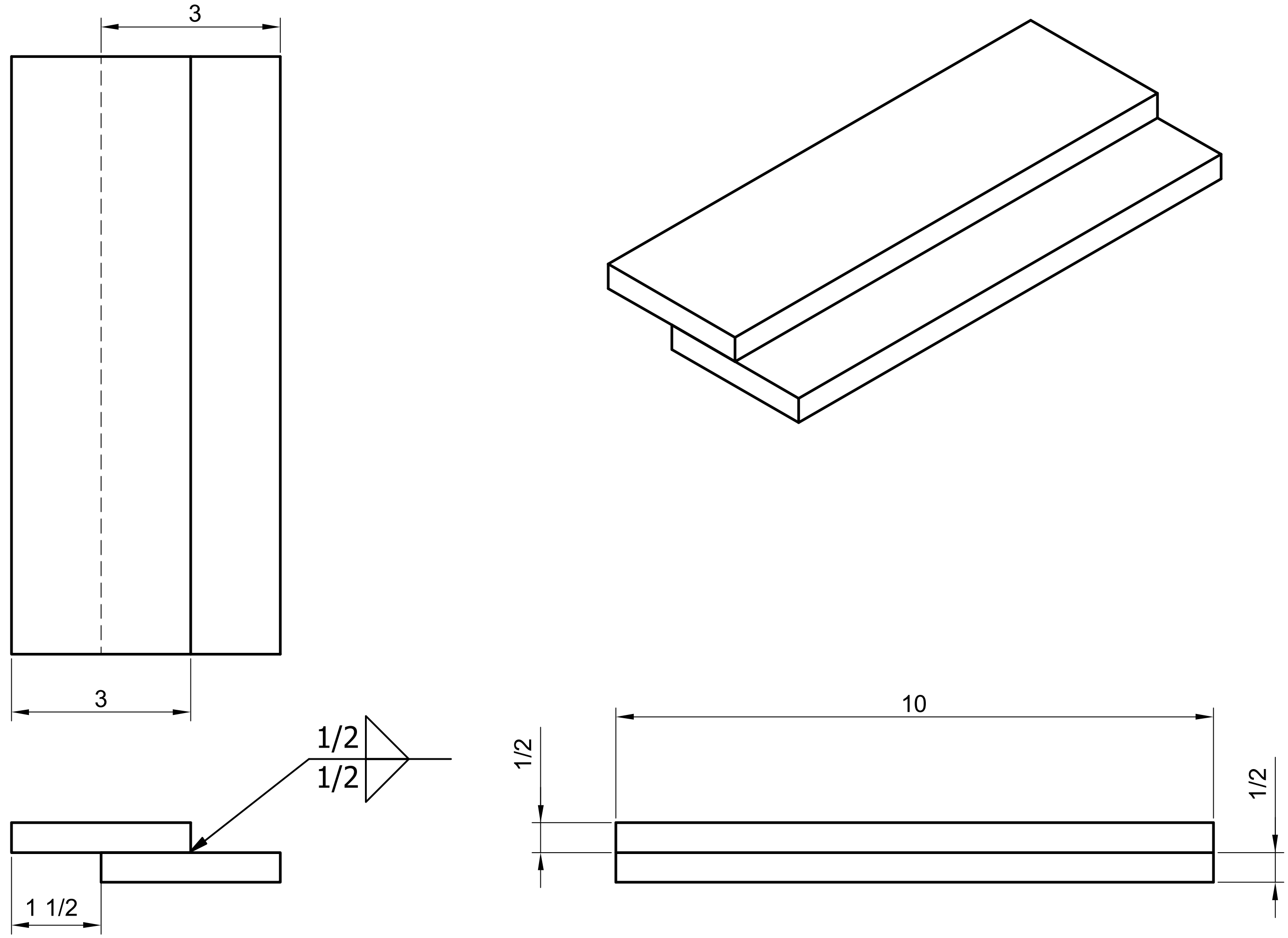
Technique

Ask your instructor for a demonstration. Practice your bead placement on scrap material. The joint can be welded with few passes if you make the beads larger. See what works best for you.



ASSESSMENT assembly	Yes	No
Was the material cut within the 1/16 inch tolerance?		
Were the parts fit-up and tacked within the 1/16" tolerance?		

ASSESSMENT Weld Quality - did you prevent the following?	Yes	No
Improper weld size		
Poor bead contour		
Porosity		
Slag Inclusion		
Incomplete fusion		
undercut		
Excessive spatter		
Unequal Leg size		



2F Lap-Joint

Quantity	Thickness	Width	Tolerance	Length	Tolerance

TITLE

Drawing

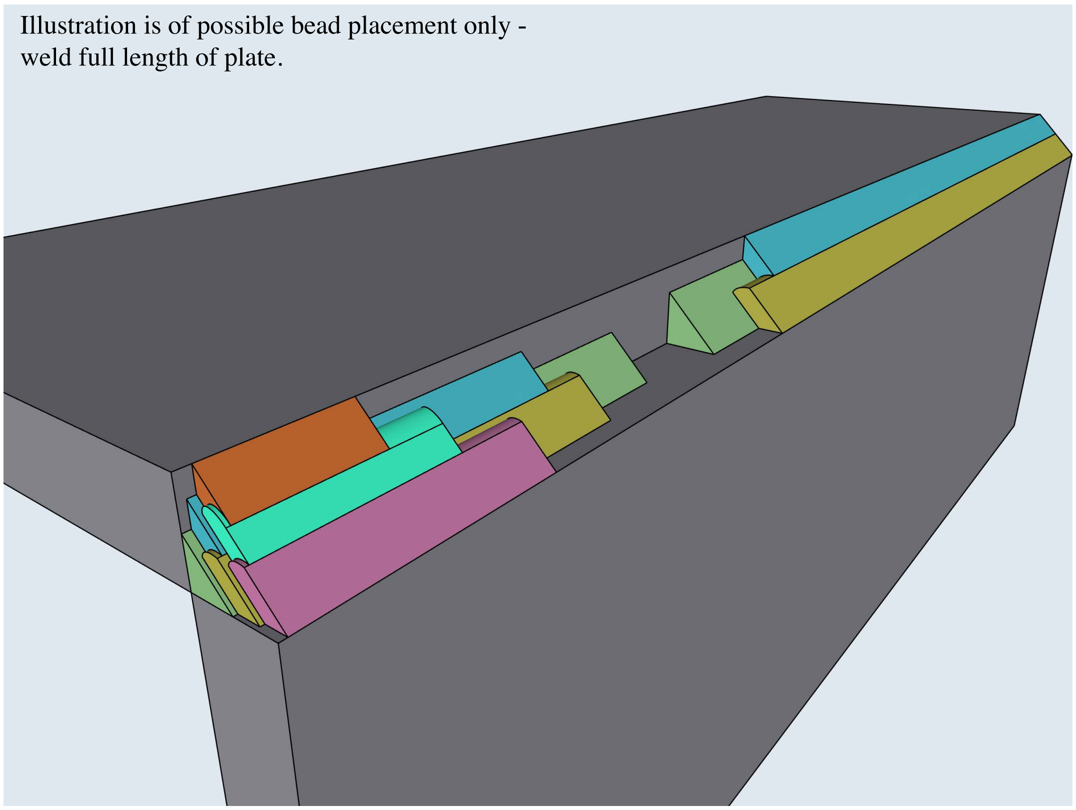
LAST UPDATED	UNITS	SHEET
06/16/21	in	1 / 1

THIRD ANGLE PROJECTION

Tolerances:	Fractional	Decimal
Linear:	+/- 1/16"	0.0625"
Angular:	+/- 2°30'	2.5°

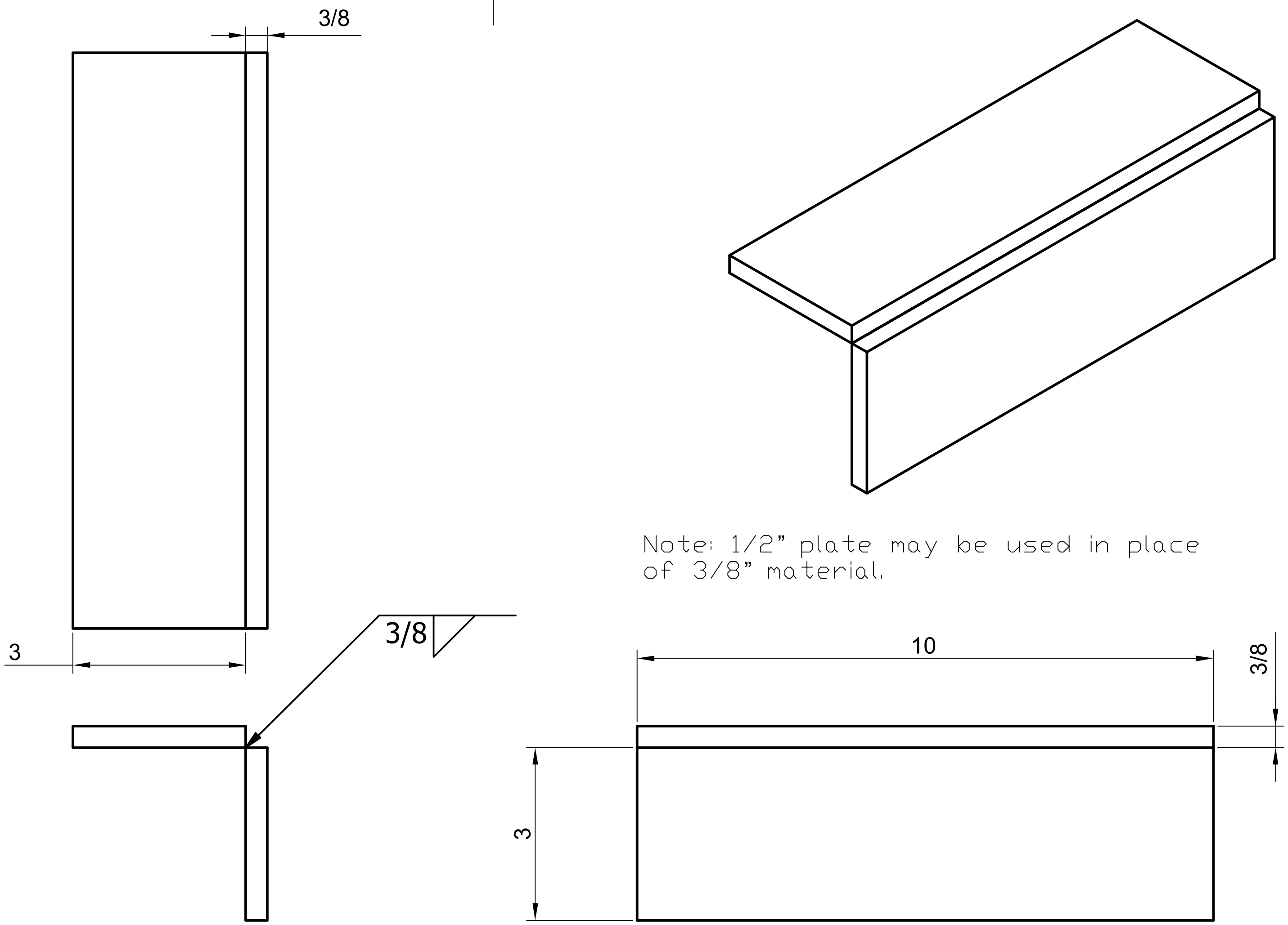
E7024 Outside Corner (2F)

Technique
Ask your instructor for a demonstration. Remember to move your eye position below the welding rod to watch the placement of the bootom edge of your cover layer.



ASSESSMENT assembly	Yes	No
Was the material cut within the 1/16 inch tolerance?		
Were the parts fit-up and tacked within the 1/16" tolerance?		

ASSESSMENT Weld Quality - did you prevent the following?	Yes	No
Improper weld size		
Poor bead contour		
Porosity		
Slag Inclusion		
Incomplete fusion		
undercut		
Excessive spatter		
Unequal Leg size		



TITLE

111 Outside Corner 2F ...

LAST UPDATED	UNITS	SHEET
06/15/21	in	1 / 1

THIRD ANGLE PROJECTION

Tolerances:	Fractional	Decimal
Linear:	+/- 1/16"	0.0625"
Angular:	+/- 2°30'	2.5°

2F Outside Corner

Quantity	Thickness	Width	Tolerance	Length	Tolerance

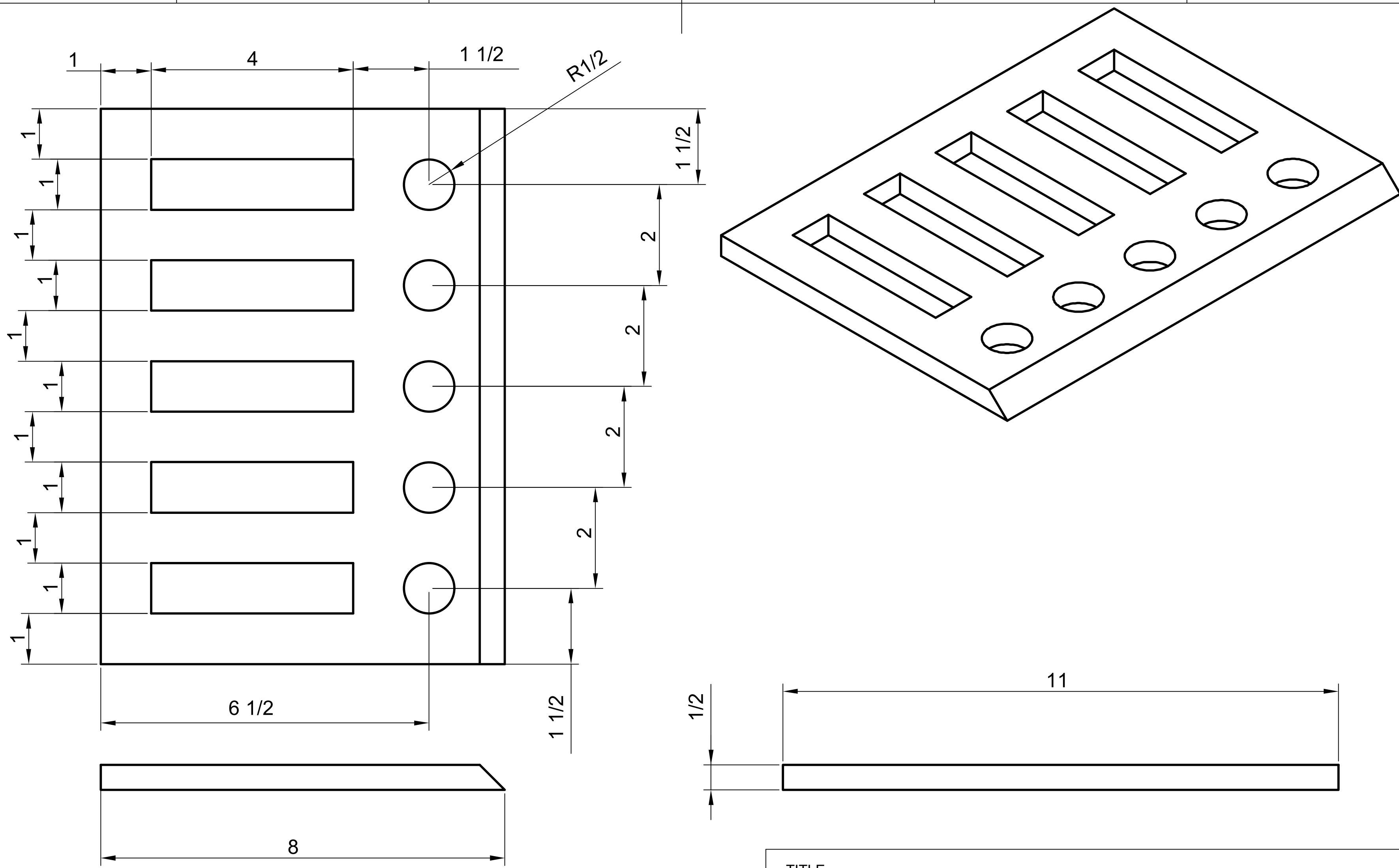
2. **Combination Cut** Material Size 3/8" to 1/2" by 6" by 8"
Practice on Scrap Metal First

Example of a Bevel Cut

Example of Piercing

OAC Information

Acetylene (C2H2) PSI	5-7
Oxygen (O2) PSI	40
Stand off	1/8" to ¼"
Tip Size for 3/8" – ½" material (Victor)	0



Notes:
Hand cut, Oxy-Fuel cutting process.
Beveled edge to be 45 degrees.
All holes to be one inch diameter.
All slots to be 4 inches by 1 inch.
1/8 inch tolerance for outside dimensions.
1/16 inch tolerance for inside dimensions.

TITLE

111 Pierce/Bevel/Slots Hand Cut

LAST UPDATED
06/14/21

UNITS
in

SHEET
1 / 1

THIRD ANGLE PROJECTION

Tolerances:	Fractional	Decimal
Linear:	+/- 1/16"	0.0625"
Angular:	+/- 2°30'	2.5°

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. Once completed, return the exam to your instructor.

Study Guide

Safety

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

SMAW and OAC Processes

- **Power source specifics**
    - **Polarity**
    - **Current out put**
    - **Arc blow**
- **AWS electrode classification**
- **OAC**
    - **Theory of cutting**
    - **Flame types**
    - **Safety**

Welding Symbols and Blueprints

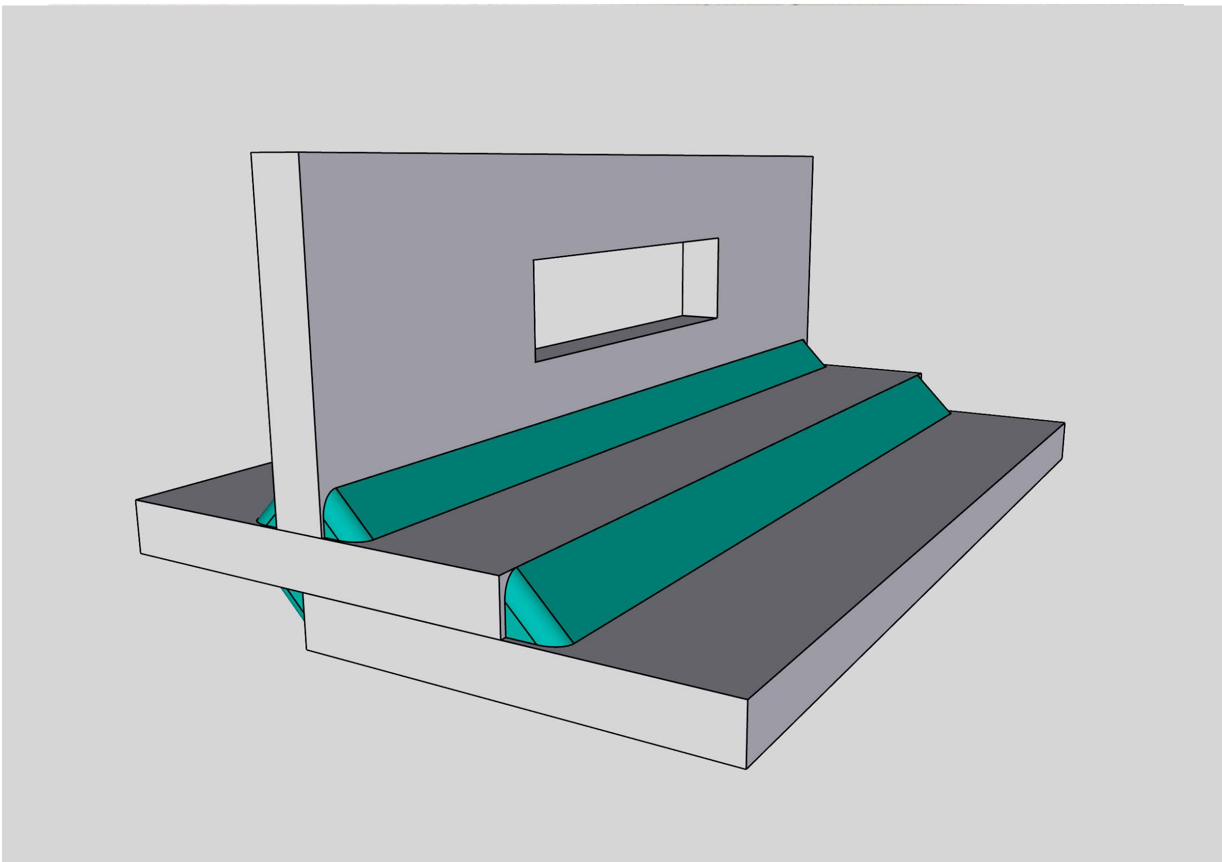
- **Orthographic views**
- **Isometric views**
- **Welding symbol**
    - **Weld symbols**
    - **Reference line**
    - **Tail**

Math and Math conversions

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

Final 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*** located after the print.



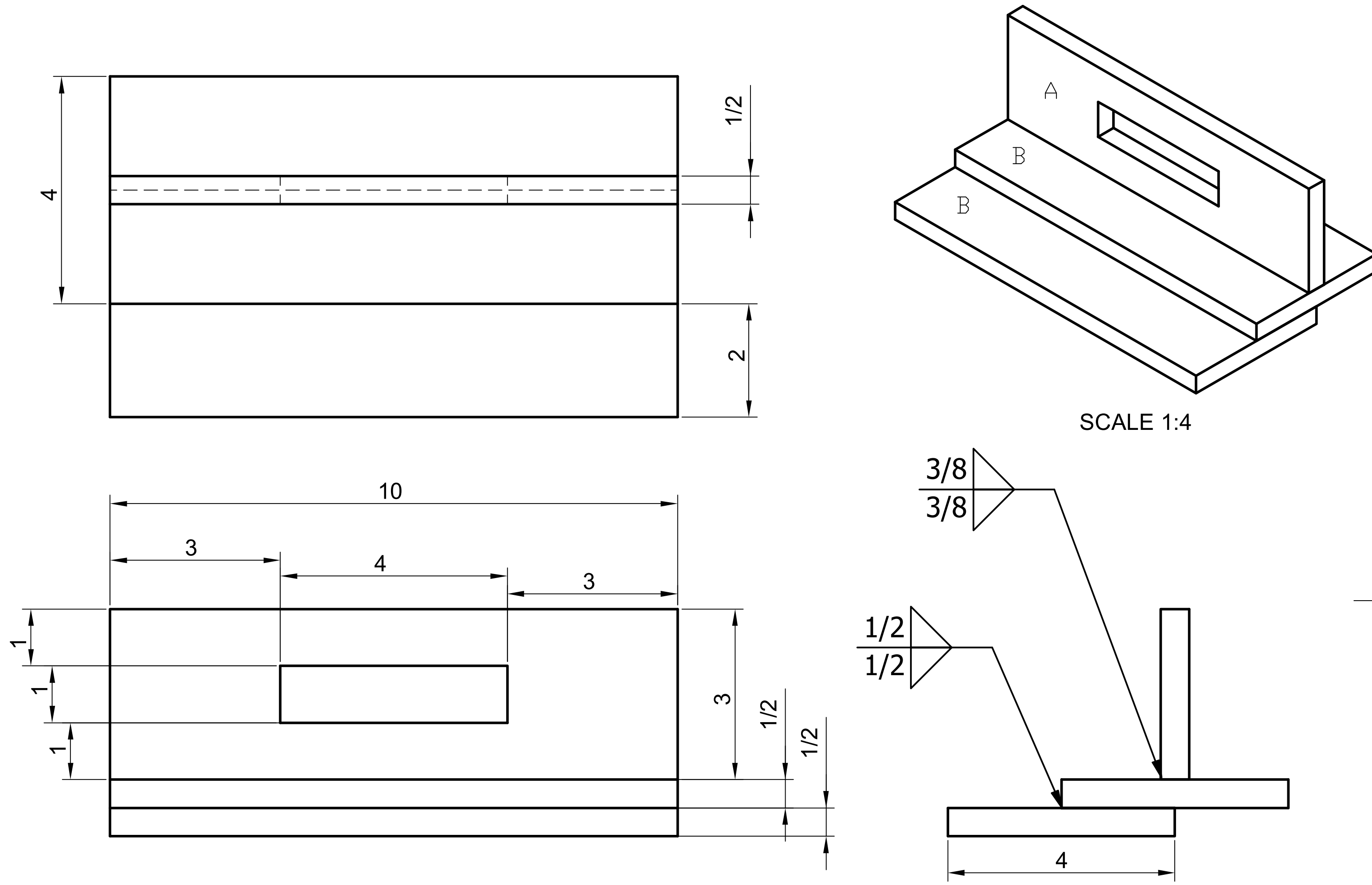
Your instructor will evaluate every step of assembly of this part.

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**



FINAL

Quantity	Thickness	Width	Tolerance	Length	Tolerance

TITLE

111 Final

LAST UPDATED

06/14/21

UNITS

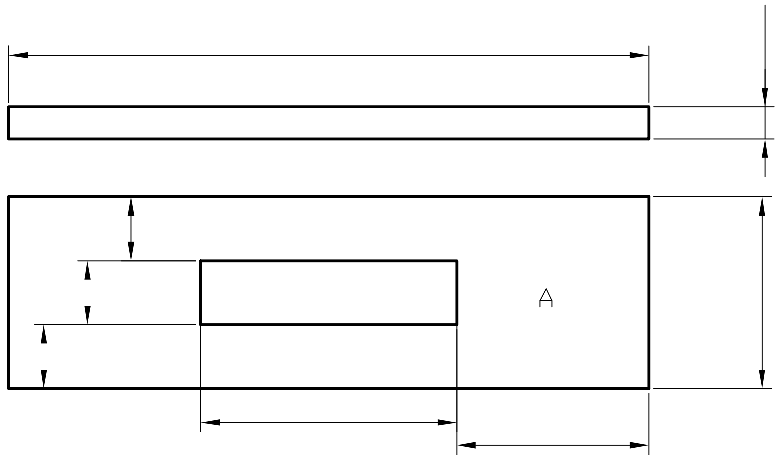
in

SHEET

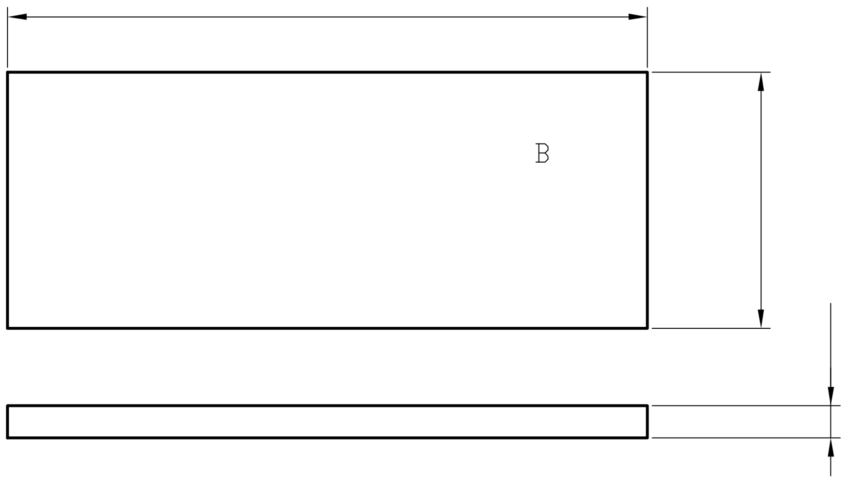
1 / 1

THIRD ANGLE PROJECTION

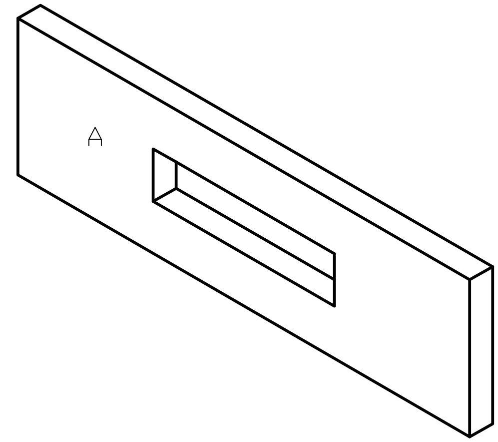
Tolerances:	Fractional	Decimal
Linear:	+/- 1/16"	0.0625"
Angular:	+/- 2°30'	2.5°

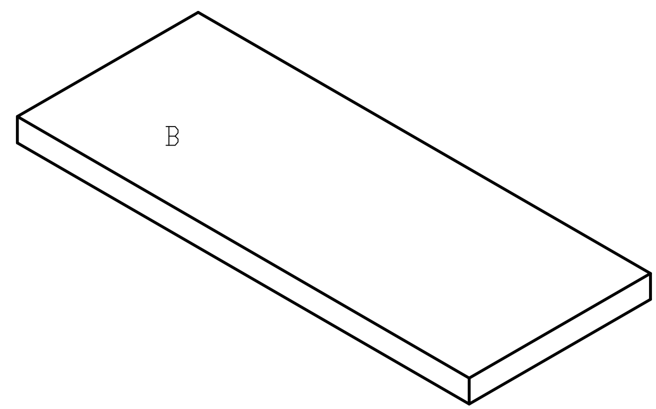


Part A



Part B





TITLE

Cut List Sheet for WLD111 Final

LAST UPDATED	UNITS	SHEET
06/14/21	in	1 / 1

THIRD ANGLE PROJECTION

Tolerances:	Fractional	Decimal
Linear:	+/- 1/16"	0.0625"
Angular:	+/- 2°30'	2.5°

Grading Rubric for the WLD 111 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 your 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	
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" **Out of tolerance +/-1/8" Rework Required**	
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" **Out of tolerance +/-1/8" Rework Required**	
15 points	**Weld Quality/Workmanship** Subtract 1 point for each weld flaw. (*note: significant point deduction may require rework.*) *See Discontinuity Checklist.*	
28 points (70%)	***Minimum points acceptable. This equates to the minimum AWS D1.1 Code requirements.***	
	Total Points	**/40**

WLD 111 SMAW 7024: Project Assessment Form
Student Name:_________________ Date_________

Joint - Position	Assessment	Instructor Signature/Date
Oxy-Fuel Hand Cut 6x10 Plate		
Bead Plate 1F		

T-Joint 1F		
Lap Joint 1F		
T-Joint 2F		
Lap – Joint 2F		

Outside Corner 2F		
Oxy-Fuel Pierce/Slot/Bevel		