

Common Welding Joints

Curriculum



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Curriculum Structure

The *Common Welding Joints* curriculum is composed of the following lessons. Approximate lesson times are included.

Lesson	Title	Approximate Time
One	Welding Safety	1 hour
Two	Types of Welding	1 hour
Three	Weld Techniques	1 hour
Four	Common Welding Joints	1 hour
	Total	4 hours

Lesson Structure

Each lesson begins with a Lesson Overview, Lesson Objectives, and a Lesson at a Glance table that lists lesson activities, materials required, suggested preparation steps, and approximate class time.

Lesson Sections

The actual lesson follows the overview, which contains some of the sections described below.

FOCUS

Every lesson begins with a FOCUS activity intended to capture participants' attention. This may be in the form of a small or large class discussion, a game, a demonstration, or a review of previous lesson information. During this activity, participants are introduced to the topic of the lesson.

LEARN

The LEARN activity in each lesson varies in its presentation mode. It may be a slide presentation, group activity, or demonstration.

REVIEW

The majority of lessons end with a REVIEW activity intended to briefly review the lesson's key messages or main points.

Lesson One – Welding Safety

Lesson Overview

This lesson introduces the various bodily hazards in welding and the Personal Protection Equipment (PPE) required by OSHA in helping to avoid injury.

Lesson Objectives

After completing this lesson, participants will be able to:

- Identify the potential hazards to eyes, face, head, hearing, feet, hands, and body
- Identify the Personal Protection Equipment (PPE) required by OSHA whenever hazards are present

Lesson at a Glance

Activity	Materials	Preparation	Approximate class time
FOCUS	• White board and markers • <i>PPE Stick Person Student Activity Sheet</i>	1. Print/photocopy <i>PPE Stick Person Student Activity Sheet</i> (one per participant).	10 minutes
LEARN	• <i>Safety: Personal Protective Equipment Welding</i> slide presentation • <i>PPE Presentation Student Notes Sheet</i> • <i>Personal Protective Equipment Fact Sheet</i>	1. Prepare to show <i>Safety: Personal Protective Equipment Welding</i> slide presentation. 2. Print/photocopy <i>PPE Presentation Student Notes Sheet</i> and <i>Personal Protective Equipment Fact Sheet</i> (one per participant).	30-40 minutes
REVIEW	• <i>Welding Safety Quiz</i> • <i>Welding Safety Quiz – Answer Key</i>	1. Print/photocopy the <i>Welding Safety Quiz</i> (one per participant).	10-15 minutes

Lesson One – Welding Safety

FOCUS: Personal Protective Equipment Brainstorming

10 minutes

Purpose:

This activity will begin the discussion about Personal Protective Equipment (PPE) required to avoid injury.

Materials:

- White board and markers
- *PPE Stick Person Student Activity Sheet*

Facilitation Steps:

1. Ask students to pair up.
2. Hand out the *PPE Stick Person Student Activity Sheet*. Each pair should take five minutes and write down as many items of welding personal protective equipment that they can think of in the designated areas of the activity page (sections include head, face, body, hands, and feet).
3. After five minutes, call the group back together. Get each pair to volunteer a few answers and make a master list on the white board for each section. Tell students that they will be learning about many types of PPE, perhaps many more than they were aware of.

Name: _____ Class: _____

PPE Stick Person Student Activity Sheet

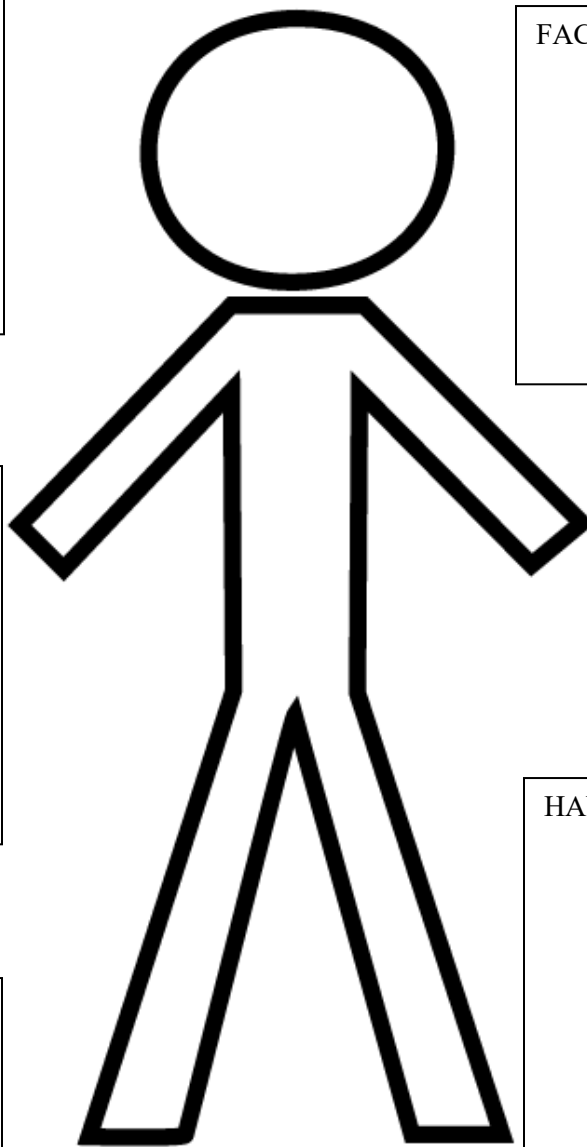
HEAD:

FACE:

BODY:

HANDS:

FEET:



Lesson One – Welding Safety

LEARN: Introduction to Types of Welding

30-40 minutes

Purpose:

The purpose of this activity is to have participants take a closer look at many types of required PPE.

Materials:

- *Safety: Personal Protective Equipment* slide presentation
- *PPE Presentation Student Notes Sheet*
- *Personal Protective Equipment Fact Sheet*

Facilitation Steps:

1. Prepare the *Safety: Personal Protective Equipment* slide presentation for viewing in class. If desired, print out the presentation as a notes page for your reference as you discuss.
2. Hand out the *PPE Presentation Student Notes Sheet* slide to each student. Students should insert information from the presentation as you discuss. This will help them focus and retain information.
3. Hand out the *Personal Protective Equipment Fact Sheet*. This contains all the detailed information from the presentation and is a good reference sheet for students to prepare for the assessment.

Personal Protective Equipment Fact Sheet

Hazard Assessment		
Hazard type	Examples of Hazard	Common Related Tasks
<u>Impact</u>	Flying objects such as large chips, fragments, particles, sand, and dirt.	Chipping, grinding, machining, masonry work, wood working, sawing, drilling, chiseling, powered fastening, riveting, and sanding.
<u>Heat</u>	Anything emitting extreme heat.	Furnace operations, pouring, casting, hot dipping, and welding.
<u>Chemicals</u>	Splash, fumes, vapors, and irritating mists.	Acid and chemical handling, degreasing, plating, and working with blood.
<u>Dust</u>	Harmful Dust.	Woodworking, buffing, and general dusty conditions.
<u>Optical Radiation</u>	Radiant energy, glare, and intense light	Welding, torch-cutting, brazing, soldering, and laser work.
 TOP		

PPE Protects:

- Eyes and Face
- Head
- Hearing
- Feet
- Hands
- Body

Eye and Face Hazards:

- Flying particles: dust, dirt, metal or wood chips from chipping, grinding, sawing, hammering
- Chemical splashes: corrosive substances, hot liquids, solvents, or other hazardous solutions
- Objects swinging into eye or face: chains, tools, or ropes
- Light radiation: welding, lasers, other radiant light, heat, glare, sparks, splash and flying particles

Types of Eye and Face PPE which Must Comply with ANSI Z87.1:

- Safety glasses with side shields
- Goggles
- Face shields
- Welding hoods
- Cutting goggles

Safety Glasses and Goggles:

- Must be worn in the welding lab at all times
- If you wear glasses, you must wear goggles over them, or buy special glasses that meet ANSI Z87.1 standards



Face Shields:

- Extra protection for eyes
- Safety glasses need to be worn under face shields
- Protects the face from grinding sparks, dust, and chemical hazards (NOT impact)



Welding Helmets and Cutting Goggles:

- Must use the proper filter lens
- Arc welding: 10-11
- Oxy fuel cutting: 5
- Plasma cutting: 5-9



Skull Cap or Welding Hat:

- Welders are exposed to flying sparks that can burn your hair and skull
- Skull caps and welding hats will protect your head from sparks



Earplugs and Earmuffs:

- Grinding, machining, and some welding operations can create enough noise to damage hearing



Foot Hazards:

- Falling or rolling objects
- Sharp objects/objects piercing the sole
- Exposure to electrical hazards
- Molten metal or sparks splashing on feet
- Hot surfaces
- Slippery or wet surfaces

Shoe Precautions:

- NEVER wear open toe shoes while welding; molten metal sparks and arc rays can burn exposed skin
- Tennis shoes or open-toed shoe styles are NOT recommended while welding; molten metal can easily burn through the top of the shoe and burn the foot

Safety Shoes for Welding:

- Steel toe leather safety shoes
- Steel toe safety shoes with metatarsal guards
- Safety shoes that are nonconductive with heat resistant soles



Hand Hazards:

- Cuts or lacerations
- Abrasions
- Punctures
- Thermal burns
- Harmful temperature extremes
- Potentially injurious light radiation (arc rays)

Welding Gloves:

- Leather gauntlet style, flame retardant welding gloves are ideal for welding
- Be sure to keep welding gloves dry; wet gloves can cause electrical shock or steam burn while welding



Body Hazards:

- Temperature extremes
- Potentially injurious light radiation (arc rays)
- Hot splashes from molten metals
- Impacts from tools, machinery, and materials
- Hazardous chemicals
- Contact with potentially infectious materials, like blood

Types of PPE for the Body:

- Clothing made of wool
- Clothing made of 100% cotton
- Clothing that has a tag identifying it as flame retardant
- Leather welding jackets
- Flame retardant welding jackets
- Leather welding aprons
- Welding sleeves
- Heavy 100% cotton denim jeans
- Leather chaps
- 100% cotton socks
- Flame retardant 100% cotton bibs or overalls

Clothing Precautions:

- No cuffs in clothing
 - Molten metal will fall into cuffs and catch fire
 - Pant legs need to extend over the top of safety shoes
- Never weld in clothes with holes or frayed material
 - Frayed material catches fire quickly
- No pockets in the front of shirts
 - Molten metal will fall into front pockets and catch fire
- Always check the tags of your clothes:
- No clothing made of synthetic (manmade) fibers or synthetic blends
 - Synthetic material is any material other than wool or cotton
 - Synthetic material will melt upon contact with molten metal and can melt to the skin, causing serious burns
- Clothing should be free from grease, oil, or other combustible chemicals or materials
- Reduce exposure to oxygen
 - Exposure to oxygen can saturate clothing with oxygen, making the clothing combustible

Skin Precautions:

- Make sure all skin is covered by flame-retardant treated material, leather, wool or 100% cotton
- Any exposed skin will be burned by arc rays

Other Precautions:

- Certain products, such as flammable hairsprays, should be avoided
- Never weld under the influence of substances (drugs, alcohol, certain medications, etc.) as they may make you drowsy or interfere with your coordination and reaction time

Name: _____ Class: _____

PPE Presentation Student Notes Sheet

PPE Protects:

-
-
-
-
-
-

Eye and Face Hazards:

-
-
-
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Types of Eye and Face PPE that Must Comply with ANSI Z87.1:

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Additional Protection for Head and Hearing:

-
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Foot Hazards:

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Common Welding Joints Curriculum

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Foot Precautions:

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Safety Shoes:

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Hand Hazards:

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Welding Gloves:

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Body Hazards:

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Types of PPE for the Body:

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Common Welding Joints Curriculum

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Clothing Precautions:

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Skin Precautions:

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Other Precautions:

-
-

Lesson One – Welding Safety

REVIEW: Welding Safety Quiz

10-15 minutes

Purpose:

To review what the students have learned about various pieces of Personal Protective Equipment.

Materials:

- *Welding Safety Quiz*
- *Welding Safety Quiz – Answer Key*

Facilitation Steps:

1. Go back to the discussion about PPE started at the beginning of the lesson. Compare the original suggestions from pairs with the information on the fact sheet. Are students surprised at the breadth of PPE required?
2. Hand out the *Welding Safety Quiz*. Give students 10 minutes to complete it in class or assign it to take home and return.
3. Use the *Welding Safety Quiz – Answer Key* to correct the quiz.

Name: _____ Class: _____

Welding Safety Quiz

1. Name six body areas that PPE protects.
 - a.
 - b.
 - c.
 - d.
 - e.
 - f.
2. Name four eye and face hazards.
 - a.
 - b.
 - c.
 - d.
3. What must be worn in the welding lab at all times?
_____ or _____
4. Name an example of something that can create enough noise to damage hearing.
5. Always wear open-toe shoes while welding. True or False (circle one)
6. Name four hand hazards.
 - a.
 - b.
 - c.
 - d.
7. What can wet gloves cause? Choose all that apply.
 - a. Mold
 - b. Electric shock
 - c. Steam
 - d. Reverse arc

8. Identify types of PPE for the body. Circle all that apply.
 - a. Clothing made of plastic
 - b. Clothing made of 100% cotton
 - c. Rayon welding apron
 - d. Leather chaps
 - e. Polyester socks
 - f. Flame retardant 100% cotton or bib overalls
 - g. Leather welding jacket
 - h. Clothing made of satin
9. Clothing should be made of man-made fibers or synthetic blends. True or False (circle one)
10. Any exposed skin will be burned by arc rays. True or False (circle one)

Welding Safety Quiz – Answer Key

1. Name six body areas that PPE protects.

a. Eyes and face

c. Hearing

e. Hands

b. Head

d. Feet

f. Body

2. Name four eye and face hazards.

a. Objects swinging into the eye

c. Flying particles

b. Light radiation

d. Chemical splashes

3. What must be worn in the welding lab at all times?

Safety glasses or goggles

4. Name an example of something that can create enough noise to damage hearing.

Grinding, machining and some welding operations.

5. Always wear open toe shoes while welding. True or **False** (circle one)

6. Name four hand hazards.

a. Cuts or lacerations

c. Punctures

b. Abrasions

d. Thermal burns

(Also could include harmful temperature extremes and potentially injurious light radiation.)

7. What can wet gloves cause? Choose all that apply.

a. Mold

b. Electric shock

c. Steam

d. Reverse arc

8. Identify types of PPE for the body. Circle all that apply.

a. Clothing made of plastic

e. Polyester socks

b. Clothing made of 100% cotton

f. Flame retardant 100% cotton or bib overalls

c. Rayon welding apron

g. Leather welding jacket

d. Leather chaps

h. Clothing made of satin

9. Clothing should be made of man-made fibers or synthetic blends. True or **False** (circle one)

10. Any exposed skin will be burned by arc rays. **True** or False (circle one)

Lesson Two – Types of Welding

Lesson Overview

The lesson introduces the various types of welding and their applications.

Lesson Objectives

After completing this lesson, participants will be able to:

- Define Gas Metal Arc Welding (GMAW) and describe its applications
- Define Flux Core Arc Welding (FCAW) and describe its applications
- Define Shielded Metal Arc Welding (SMAW) and describe its applications
- Define Gas Tungsten Arc Welding (GTAW) and describe its applications

Lesson at a Glance

Activity	Materials	Preparation	Approximate class time
FOCUS	• Whiteboard and markers • <i>Types and Applications of Welding K-W-L</i>	1. Print/photocopy the <i>Types and Applications of Welding K-W-L Student Notes Sheet</i> (one per participant).	10 minutes
LEARN	• <i>Types and Applications of Welding</i> slide presentation • <i>Background Information and References</i> • <i>Types and Applications of Welding Student Notes Sheet</i> • <i>Types and Applications of Welding Student Notes Sheet – Answer Key</i> • <i>Types and Applications of Welding Fact Sheet</i>	1. Prepare to show slide presentation. 2. Print the <i>Background Information and References</i> for reference. 3. Print/photocopy the <i>Types and Applications of Welding Student Notes Sheet</i> and <i>Types and Applications of Welding Fact Sheet</i> (one per participant).	30-40 minutes
REVIEW	• <i>Types and Applications of Welding Quiz</i> • <i>Types and Applications of Welding Quiz – Answer Key</i>	1. Print/photocopy the <i>Types and Applications of Welding Quiz</i> (one per participant).	10-15 minutes

Lesson Two – Types of Welding

FOCUS: K-W-L Activity

10 minutes

Purpose:

This activity will begin the discussion about various types of welding and find out what students already know.

Materials:

- Whiteboard and markers
- *Types and Applications of Welding K-W-L*

Facilitation Steps:

- Make a chart on a whiteboard with three columns: K-W-L. Hand out the *Types and Applications of Welding K-W-L* to students to write in the information you discuss.

What I <u>K</u> now	What I <u>W</u> ant to Know	What I <u>L</u> earned

4. Ask students, “What types of welding are you familiar with?” Under the “K” column, write student answers about the types of welding that they *KNOW* about.
5. Next ask students what they *WANT* to know about types of welding. Write these suggestions under the “W” column.
6. Save the “L” column for the end of the lesson. You will write about what they *LEARNED* about in that column.

Name: _____ Class: _____

Types and Applications of Welding K-W-L

What I K now	
What I W ant to Know	
What I L earned	

Lesson Two – Types of Welding

LEARN: Introduction to Types of Welding

30-40 minutes

Purpose:

The purpose of this activity is to have participants take a closer look at five types of welding and their applications.

Materials:

- *Types and Applications of Welding* slide presentation
- *Background Information and References*
- *Types and Applications of Welding Student Notes Sheet*
- *Types and Applications of Welding Student Notes Sheet – Answer Key*
- *Types and Applications of Welding Fact Sheet*

Facilitation Steps:

1. Prepare the *Types and Applications of Welding* slide presentation for viewing in class. If desired, print out the Background Information and Resources pages for reference as you go through the slide presentation.
2. Hand out the *Types and Applications of Welding Student Notes Sheet* worksheet to each student. Students should insert information from the presentation as you discuss. This will help them focus and retain information.
3. Hand out the *Types and Applications of Welding Fact Sheet*. This contains all the detailed information from the presentation and is a good reference sheet for students in preparing for the assessment.

Background Information and References

GMAW: Gas Metal Arc Welding; [MIG (Metal Inert Gas) or wire-feed welding]

This is the most common form of welding and uses a wire consumable electrode that matches the base metal and uses a shielding gas to protect the arc. There are several types of wire and several types of shielding gas, which are selected based on a variety of factors. There are four common modes of GMAW transfer: short circuit, globular, spray, and pulse. These processes are used in industry based on the application. GMAW is found in most welding shops, especially for production and fabrication applications. It is also commonly found in custom welding shops, maintenance departments, and sometimes in construction.

FCAW: Flux Core Arc Welding

This is a wire-feed process that uses a special type of wire. Flux core wire is a hollow consumable wire with flux on the inside that helps shield the arc and add properties to the weld. There are two main categories of flux core wire: FCAW-S and FCAW-G. FCAW-S is a self-shielding wire, meaning that it does not require shielding gas. This type of wire is beneficial for welding outdoors and commonly used in construction, because it provides the efficiency of GMAW without having to worry about wind blowing away shielding gas and causing weld defects. FCAW-G wire is often referred to as dual shield because it requires an external shielding gas along with the flux on the inside. This type of wire is commonly used in structural welding that is done in a shop and is beneficial because it provides the strength of FCAW with a better appearance than FCAW-S.

SMAW: Shielded Metal Arc Welding; [arc or stick welding]

This welding process uses a consumable electrode, a.k.a. welding rod, which consists of a metal core wire covered with flux. There are several types of SMAW electrodes that are used for different applications, depending on the specific properties of the electrode and the type of base metal being welded on. SMAW is commonly used in construction and maintenance because it requires minimal equipment and can be used outdoors. SMAW is also common in pipe welding because of the portability and the ability of the electrodes to penetrate better than other welding processes.

GTAW: Gas Tungsten Arc Welding; [TIG (Tungsten Inert Gas)]

This welding process uses a non-consumable electrode made of tungsten to create an arc and an inert shielding gas, typically argon, to protect the arc. The welder often uses a filler wire that matches the base metal and is added to the molten weld puddle to add size and strength to the weld. This type of welding is commonly used to weld light gauge stainless steel, aluminum, and magnesium. It is commonly used in the food industry and for thin, stainless steel pipe. It is also used for welding on bicycles, motorcycles, boats, ships, etc.

OAW: Oxyacetylene Welding

This welding process uses a flame produced with oxygen and acetylene gasses through a torch, which melts the base metal. The welder often uses a filler wire that matches the base metal and is added to the molten weld puddle to add size and strength to the weld. This process has mostly been replaced with faster, stronger welding processes, especially in a production setting, but is still used for certain applications. Oxyacetylene welding is commonly used today for brazing applications but is sometimes used for certain pipe welding or general welding.

Robotic welding:

This type of welding is used in production and only beneficial with applications where the same part needs to be welded repeatedly. It is important that a robotic welder is programmed and operated by a welder, because welders understand how welds are supposed to look and need to be able to repair a weld in case the robot malfunctions. Robotic welding can use most of the arc processes, including GMAW, GTAW and SMAW. Robotic welding can also perform laser and spot (projection) welding. ***This process will not be included in the curriculum, but may be introduced in the lesson.***

Name: _____ Class: _____

Types and Applications of Welding Student Notes Sheet

GMAW is _____ a.k.a. _____.

This welding process uses a _____ that matches the base metal, and a shielding gas to protect the arc.

There are four common modes of GMAW transfer:

-
-
-
-

GMAW is found in most welding shops, especially for _____ and _____ applications.

FCAW is _____.

This is a _____ process that uses a special type of wire. Flux core wire is a _____ wire with flux on the inside that helps shield the arc and add properties to the weld.

There are two main categories of flux core wire:

-
-

SMAW is _____ a.k.a. _____.

This welding process uses a _____, a.k.a. _____, which consists of a metal core wire that is covered with flux.

SMAW is commonly used in _____ and _____ because it requires minimal equipment and can be used outdoors. SMAW is also common in _____ because of the portability and the ability of the electrodes to penetrate better than other welding processes.

GTAW is _____ a.k.a. _____.

This welding process uses a _____ electrode made of _____ to create an arc and an _____ gas, typically _____, to protect the arc.

This type of welding is commonly used to weld light gauge _____, _____, and _____.

Some common industry uses are:

-
-
-
-

Types and Applications of Welding Student Notes Sheet – Answer Key

GMAW is **Gas Metal Arc Welding** a.k.a. **MIG**

This welding process uses a **wire consumable electrode** that matches the base metal, and a shielding gas to protect the arc.

There are four common modes of GMAW transfer:

- **Short circuit**
- **Globular**
- **Spray**
- **Pulse**

GMAW is found in most welding shops, especially for **production** and **fabrication** applications.

FCAW is **Flux Core Arc Welding**

This is a **wire feed** process that uses a special type of wire. Flux core wire is a **hollow** wire with flux on the inside that helps shield the arc and add properties to the weld.

There are two main categories of flux core wire:

- **FCAW – S (self-shielding)**
- **FCAW – G (dual-shielding)**

SMAW is **Shielded Metal Arc Welding** a.k.a. **STICK**.

This welding process uses a **consumable electrode**, a.k.a. **welding rod**, which consists of a metal core wire that is covered with flux.

SMAW is commonly used in **construction** and **maintenance** because it requires minimal equipment and can be used outdoors. SMAW is also common in **pipe welding** because of the portability and the ability of the electrodes to penetrate better than other welding processes.

GTAW is **Gas Tungsten Arc Welding** a.k.a. **TIG**.

This welding process uses a **non-consumable** electrode made of **tungsten** to create an arc and an **inert shielding** gas, typically **argon**, to protect the arc.

This type of welding is commonly used to weld light gauge **stainless steel**, **aluminum** and **magnesium**. Some common industry uses are:

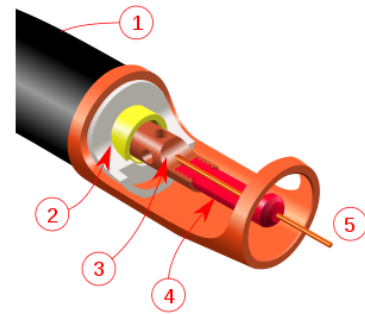
- **Bicycles**
- **Motorcycles**
- **Boats**
- **Ships**

Types and Applications of Welding Fact Sheet

GMAW: Gas Metal Arc Welding; a.k.a. MIG (Metal Inert Gas) or wire-feed welding

This is the most common form of welding and uses a wire consumable electrode that matches the base metal and uses a shielding gas to protect the arc. There are several types of wire and several types of shielding gas, which are selected based on a variety of factors. There are four common modes of GMAW transfer: short circuit, globular, spray, and pulse. These processes are used in industry based on the application. GMAW is found in most welding shops, especially for production and fabrication applications. It is also commonly found in custom welding shops, maintenance departments, and sometimes in construction.

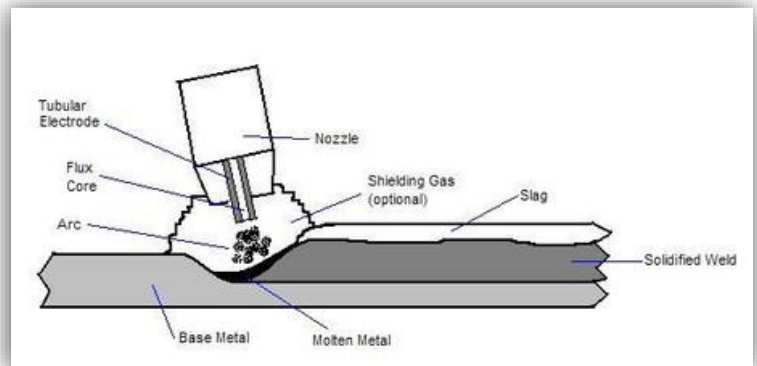
Shielding of the arc and the molten weld pool is often obtained by using inert gases such as argon and helium, and this is why GMAW is also called the metal-inert gas (MIG) welding process. Since non-inert gases, particularly CO₂, are also used, GMAW seems a more appropriate name. This is the most widely used arc welding process for aluminum alloys.



GMAW torch nozzle cutaway image. (1) Torch handle, (2) Molded phenolic dielectric (shown in white) and threaded metal nut insert (yellow), (3) Shielding gas diffuser, (4) Contact tip, (5) Nozzle output face

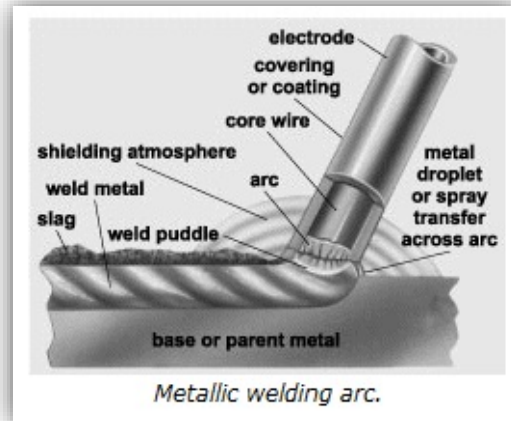
FCAW: Flux Core Arc Welding

This is a wire-feed process that uses a special type of wire. Flux core wire is a hollow consumable wire with flux on the inside that helps shield the arc and add properties to the weld. There are two main categories of flux core wire: FCAW-S and FCAW-G. FCAW-S is a self-shielding wire, meaning that it does not require shielding gas. This type of wire is beneficial for welding outdoors and commonly used in construction, because it provides the efficiency of GMAW without having to worry about wind blowing away shielding gas and causing weld defects. FCAW-G wire is often referred to as dual shield because it requires an external shielding gas along with the flux on the inside. This type of wire is commonly used in structural welding that is done in a shop and is beneficial because it provides the strength of FCAW with a better appearance than FCAW-S.



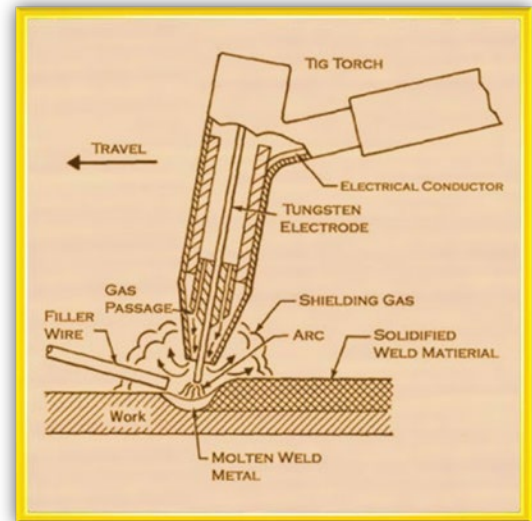
SMAW: Shielded Metal Arc Welding; a.k.a. arc or stick welding

This welding process uses a consumable electrode, a.k.a. welding rod, which consists of a metal core wire covered with flux. There are several types of SMAW electrodes that are used for different applications, depending on the specific properties of the electrode and the type of base metal being welded on. SMAW is commonly used in construction and maintenance because it requires minimal equipment and can be used outdoors. SMAW is also common in pipe welding because of the portability and the ability of the electrodes to penetrate better than other welding processes.



GTAW: Gas Tungsten Arc Welding; a.k.a. TIG (Tungsten Inert Gas)

This welding process uses a non-consumable electrode made of tungsten to create an arc and an inert shielding gas, typically argon, to protect the arc. The welder often uses a filler wire that matches the base metal and is added to the molten weld puddle to add size and strength to the weld. This type of welding is commonly used to weld light gauge stainless steel, aluminum, and magnesium. It is commonly used in the food industry and for thin, stainless steel pipe. It is also used for welding on bicycles, motorcycles, boats, ships, etc.



Lesson Two – Types of Welding

REVIEW: Take Home Quiz

10-15 minutes

Purpose:

To review what the students have learned about types of welding and their applications.

Materials:

- *Types and Applications of Welding Quiz*
- *Types and Applications of Welding Quiz – Answer Key*

Facilitation Steps:

1. Go back to the K-W-L activity started at the beginning of the lesson. Ask for students to volunteer what they have learned about various types and applications of welding. Write this in the “L” column.

What I K now	What I W ant to Know	What I L earned

2. Hand out the *Types & Applications of Welding Quiz*. Give students 10 minutes to complete it in class or assign it to take home and return.
3. Use the *Types & Applications of Welding Quiz – Answer Key* to correct the quiz.

Name: _____ Class: _____

Types and Applications of Welding Quiz

1. Name three of the four Arc Welding types.
 - a.
 - b.
 - c.
2. Name three of the four types of GMAW modes of transfer.
 - a.
 - b.
 - c.
3. What is another name for GMAW?
 - a. TIG
 - b. MIG
 - c. FLUX CORE
 - d. STICK
4. Name one benefit of using GMAW.
5. What two types of Arc welding have slag?
 - a. MIG/TIG
 - b. MIG/STICK
 - c. FLUX/STICK
 - d. MIG/FLUX
6. What is another name for a welding rod?
 - a. Flux
 - b. Slag
 - c. Tungsten
 - d. Electrode
7. What is another name for SMAW welding?
 - a. STICK
 - b. MIG
 - c. TIG
 - d. FLUX

Common Welding Joints Curriculum

8. Name one common usage for TIG welding.
9. Tungsten is a consumable electrode in TIG welding. True or False (circle one)
10. STICK welding produces slag with the welding process. True or False (circle one)

Types and Applications of Welding Quiz – Answer Key

1. Name three of the four Arc Welding Types. (All answers could be considered acceptable)
 - a. **GMAW (Gas Metal Arc Welding) / MIG**
 - b. **FCAW (Flux Core Arc Welding) / FLUX CORE**
 - c. **SMAW (Shielded Metal Arc Welding / STICK**
 - d. **GTAW (Gas Tungsten Arc Welding / TIG**
2. Name three of the four types of GMAW modes of transfer.
 - a. **Short Circuit**
 - b. **Globular**
 - c. **Spray**
 - d. **Pulse**
3. What is another name for GMAW?
 - a. TIG
 - b. **MIG**
 - c. FLUX CORE
 - d. STICK
4. Name one benefit of using GMAW. *Answers may include:*
 - **Less welder skill required**
 - **Easy clean up**
 - **High deposition rates**
 - **Can be used on a variety of metal types and thicknesses**
5. What two types of Arc welding have slag?
 - a. MIG/TIG
 - b. MIG/STICK
 - c. **FLUX/STICK**
 - d. MIG/FLUX
6. What is another name for a welding rod?
 - a. Flux
 - b. Slag
 - c. Tungsten
 - d. **Electrode**
7. What is another name for SMAW welding?
 - a. **STICK**
 - b. MIG
 - c. TIG
 - d. FLUX
8. Name one common usage for TIG welding. *Answers may include:*
 - **Food industry**
 - **Thin stainless steel pipe**
 - **Bicycles, motorcycles, boats, ships**
9. Tungsten is a consumable electrode in TIG welding. True or **False** (circle one)
10. STICK welding produces slag with the welding process. **True** or False (circle one)

Lesson Three – Weld Techniques

Lesson Overview

Making a good weld takes practice. There are a lot of tips and tricks that students will acquire along the way. This lesson teaches students the five essentials to making a good weld. Students should think about these before and during a weld, and then reflect on them while inspecting their weld bead.

Lesson Objectives

After completing this lesson, participants will be able to:

- Understand the standard requirements in the five essentials to making a good weld: heat, distance, angle, speed, and manipulation

Lesson at a Glance

Activity	Materials	Preparation	Approximate class time
FOCUS	• Whiteboard and markers • Common Welding Joints Kit • Common Welding Joints Flashcards • <i>Weld Parts Guide</i> • <i>Weld Positions Guide</i>	1. Print/photocopy the <i>Weld Parts Guide</i> and the <i>Weld Positions Guide</i> (one per participant).	10 minutes
LEARN	• <i>Welding Basics</i> slide presentation • <i>Welding Basics Student Notes Sheet</i> • <i>Welding Basics Fact Sheet</i>	1. Prepare to show <i>Welding Basics</i> slide presentation. 2. Print/photocopy the <i>Welding Basics Student Notes Sheet</i> and the <i>Welding Basics Fact Sheet</i> (one per participant).	30-40 minutes
REVIEW	• <i>Welding Basics Quiz</i> • <i>Welding Basics Quiz – Answer Key</i>	1. Print/photocopy the <i>Welding Basics Quiz</i> (one per participant).	10-15 minutes

Lesson Three – Weld Techniques

FOCUS: Brainstorming discussion: What does it take to make a good weld?

10 minutes

Purpose:

This activity will begin the discussion of what it takes to make a good weld versus a poor weld. Students will brainstorm an initial list and see if they are right.

Materials:

- Whiteboard and markers
- Common Welding Joints Kit
- Common Welding Joints Flashcards
- *Weld Parts Guide*
- *Weld Positions Guide*

Facilitation Steps:

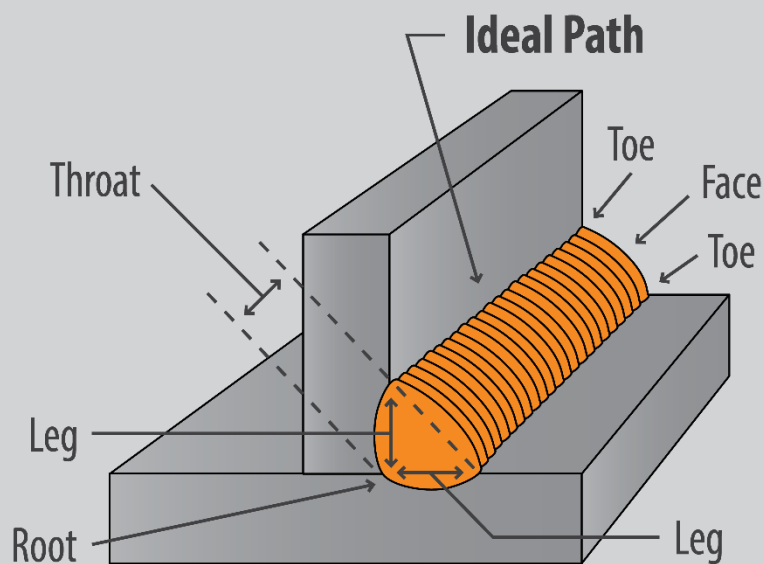
1. Display the Common Welding Joints Kit on a table for students to see the different types of welds that you will be talking about in Lesson 3 and Lesson 4.
2. Optional: Hand welds around so students can touch the different welds and get a good look at welds that have been welded correctly.
3. Hand out the *Weld Parts Guide* and *Weld Positions Guide*.
4. Ask students what makes a good weld versus a poor weld. Write the observations on the board.
5. Tell students that they are going to look at the five basic essentials to making a good weld.

6. Start with the *Weld Parts Guide* and ask students what would be most difficult to weld, in their opinion. Then ask students to brainstorm/discuss what weld positions may be most difficult while referencing the *Weld Positions Guide*.
7. Write the observations from the students on the board.

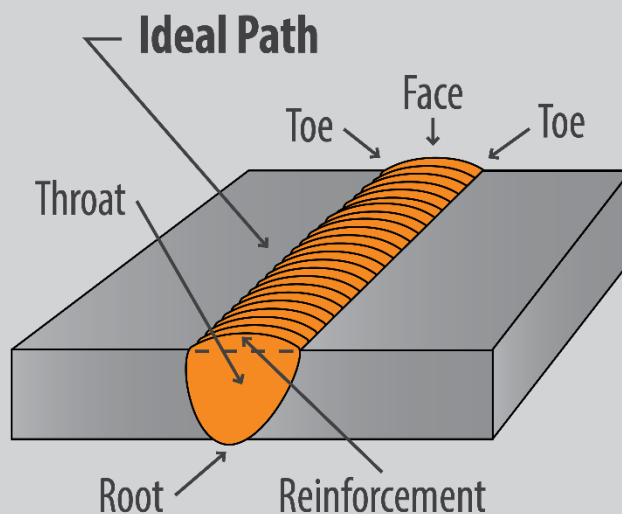
NOTE: Keep/save the observations on the board; you will want to use them to refresh knowledge before the Review section of this lesson.

Weld Parts Guide

Fillet Welds



Groove Welds



Terms & Definitions

Face: The exposed surface of the weld.

Leg: The distance from the root to the toe of the weld.

Reinforcement: Excess filler required to fill the throat of a weld.

Root: The area of the weld or throat opening where the nearest base metals contact is located. This may be a point, line or area.

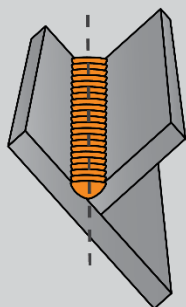
Throat: The open area required to be filled by the weld.

Toe: The intersection between the face of the weld and the base metal.

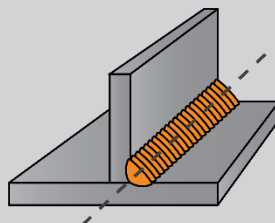
Weld Positions Guide

Fillet Welds

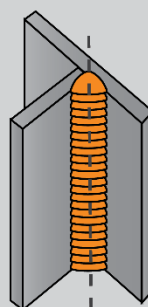
1F
FLAT POSITION



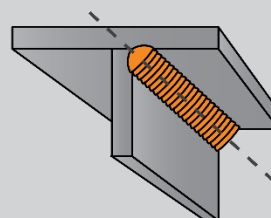
2F
HORIZONTAL POSITION



3F
VERTICAL POSITION

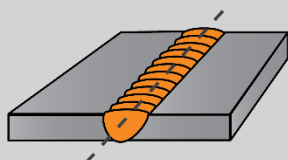


4F
OVERHEAD POSITION

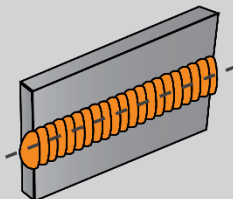


Groove Welds

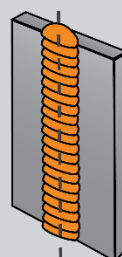
1G
FLAT POSITION



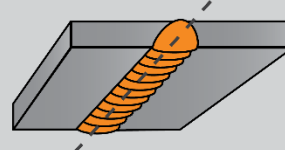
2G
HORIZONTAL POSITION



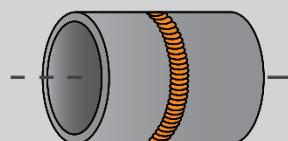
3G
VERTICAL POSITION



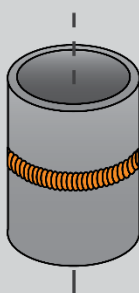
4G
OVERHEAD POSITION



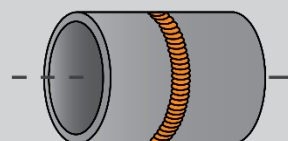
1G FLAT
Pipe is turned or rolled while welding.



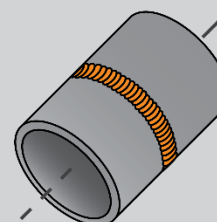
2G HORIZONTAL



5G POSITION
Pipe is not turned or rolled while welding.



6G POSITION



Lesson Three – Weld Techniques

LEARN: Welding Basics

30-40 minutes

Purpose:

The purpose of this activity is to have participants learn the five basics to good GMAW and SMAW welding: heat, distance, angle, speed, and manipulation.

Materials:

- *Welding Basics* slide presentation
- *Welding Basics Student Notes Sheet*
- *Welding Basics Fact Sheet*

Facilitation Steps:

1. Prepare the *Welding Basics* slide presentation for viewing in class. Use the information on the slide presentation as you present to the class.
2. Hand out the *Weld Basics Student Notes Sheet* slide presentation to each student. Students should insert information from the presentations as you discuss. This will help them focus and retain information.
3. Hand out the *Welding Basics Fact Sheet*. This contains all the detailed information from the presentations and is a good reference sheet for students to prepare for the assessment.

Name: _____ Class: _____

Welding Basics Presentation Student Notes Sheet

Five Basics

- 1.
- 2.
- 3.
- 4.
- 5.

Welding Machine Settings

GMAW Settings Troubleshooting

SMAW Settings Troubleshooting

Distance

GMAW Distance

SMAW Distance

Angle

Two types:

-
-

Travel Angle

Work Angle

Speed

Manipulation

Welding Basics Fact Sheet

As you begin your journey as a welder, know that making a good weld takes practice. There are a lot of tips and tricks that you will acquire along the way. This lesson will give you the five essentials to making a good weld. Think about these before and during a weld, and then reflect on them while inspecting your weld bead. These five basics are historically taught for SMAW and GMAW welding.

Five Basics

1. Welding Machine Settings
2. Distance (arc length/wire stick-out)
3. Angle (work and travel)
4. Speed (travel speed)
5. Manipulation

Welding Machine Settings

- How a welding machine is set is imperative to a good weld.
- Observe welding machine settings charts based on material thickness, electrode type, and electrode diameter.
- GMAW welders use volts and wire feed speed settings
- SMAW welders use amperage settings

Distance

- Distance refers to the arc length while welding
- With GMAW, this can mean the distance from the contact tube to the base metal (electrode stick out), but voltage affects arc length while welding
- Distance or arc length is directly related to the heat of the arc
- Lengthening the arc results in hotter arc and a wider, flatter bead
- Shortening the arc results in a cooler arc and a narrower, more built-up bead

GMAW Distance

- Distance refers to the arc length while welding and is directly related to the heat of the arc:
 - Lengthening the arc results in hotter arc and a wider, flatter bead
 - Shortening the arc results in a cooler arc and a narrower, more built-up bead
- The distance from the contact tube of the welding gun to the base metal (electrode “stick out”)
 - Voltage affects arc length while welding

SMAW Distance

- Distance refers to the arc length while welding
 - With SMAW, this means the distance from the electrode’s core wire to the base metal
 - Distance or arc length is directly related to the heat of the arc
 - Lengthening the arc results in hotter arc and a wider, flatter bead
 - Shortening the arc results in a cooler arc and a narrower, more built-up bead

Angle

- There are two types of angles that deal with welding:
- **Work angle** is the angle of the electrode in relation to the weld joint
- **Travel angle** is the angle of the electrode in relation to the direction of travel
- Work angles should be adjusted so there are equal amounts of weld metal on either side of the joint
- Work angles are typically 90 degrees or 45 degrees depending on the joint design and position
- Travel angles typically range 0-30 degrees and can be either a push or drag angle depending on the welding process and position
 - Push angle: top of electrode or torch is tipped away from the direction of travel
 - Pull angle: top of electrode or torch is tipped toward the direction of travel
- Work and travel angles directly affect penetration
- Off-center work angles will result in shallow penetration and the weld metal will penetrate off-center of the joint
 - Too-low travel angles will result in shallow penetration and risk slag inclusions in SMAW

Speed

- Travel speed directly affects penetration and is measured in inches per minute
- Travel speed required is dependent on the electrode type and diameter, joint type and position, and the size of the desired weld, or as specified on a procedure
- **Watch the puddle** to determine travel speed
- Maintain a speed that effectively melts the base metal to the desired depth of penetration and adds weld metal to the desired size
- If the ripple pattern is long and the bead is narrow, the travel speed may be too fast
- If the bead is wide and paired with undercut or overlap, the travel speed may be too slow

Manipulation

- There are many ways in which an electrode can be manipulated
- Welding a straight stringer bead, using little or no manipulation, is ideal
- Unnecessary or improper manipulation techniques may result in:
 - Uneven or excessive heat distribution
 - Uneven penetration
 - Slag inclusions (SMAW)
- Weaving is a very common manipulation technique
- Weaving is used to make bigger welds, usually as a cover pass on top of stringer beads
- Weaving is typically used when welding in the vertical position
- Weaving in the horizontal or overhead position is not recommended (think gravity!)

Lesson Three – Weld Techniques

REVIEW: Welding Basics Quiz

10-15 minutes

Purpose:

To review what students have learned about the five basics to making a good weld.

Materials:

- *Welding Basics Quiz*
- *Welding Basics Quiz – Answer Key*

Facilitation Steps:

1. Remind students of their original answers to the question, “What makes a good weld versus a poor weld?” How did their answers compare to what they learned during the lesson?
2. Hand out the *Welding Basics Quiz*. Give students 10 minutes to complete it in class or assign it to take home and return.
3. Use the *Welding Basics Quiz – Answer Key* to correct the quiz.

Name: _____ Class: _____

Welding Basics Quiz

1. Name the five basics to making a good weld.
 - a.
 - b.
 - c.
 - d.
 - e.
2. Name two types of angles that deal with welding.
 - a.
 - b.
3. What is the typical range in degrees for travel angle?
 - a. 0-45
 - b. 0-30
 - c. 15-30
 - d. 0-90
4. What two travel angle welding methods can GMAW welders use?
 - a.
 - b.
5. Distance is also known as what?
C _____ T _____ W _____ D _____
6. What is speed measured in?
 - a. Inches per foot
 - b. Inches per hour
 - c. Inches per minute
 - d. Feet per hour

7. Unnecessary or improper manipulation techniques may result in:
 - a.
 - b.
8. How do you determine the proper travel speed, beside using an accurate technique?
9. SMAW welding machines use amperage settings for heat. True or False (circle one)
10. The distance from the electrode's core wire in SMAW to the base metal should be about an inch away from each other when welding. True or False (circle one)

Welding Basics Quiz – Answer Key

1. Name the five basics to making a good weld.
a. Heat
b. Distance
c. Angle
d. Speed
e. Manipulation
2. Name two types of angles that deal with welding.
a. Work angle
b. Travel angle
3. What is the typical range in degrees for GMAW travel angle?
a. 0-45
b. 0-30
c. 15-30
d. 0-90
4. What two travel angle welding methods can GMAW welders use?
a. Push
b. Pull (“Drag” also acceptable)
5. Distance is also known as what?
Contact To Work Distance
6. What is speed measured in?
a. Inches per foot
b. Inches per hour
c. Inches per minute
d. Feet per hour
7. Unnecessary or improper manipulation techniques may result in: *(need 2 of the 3 answers)*
a. Uneven or excessive heat distribution
b. Uneven penetration
c. Slag inclusions
8. How do you determine the proper travel speed, beside using an accurate technique?
WATCH THE PUDDLE
9. SMAW welding machines use amperage settings for heat. **True** or False (circle one)
10. The distance from the electrode’s core wire in SMAW to the base metal should be about an inch away from each other when welding. True or **False** (circle one)

Lesson Four – Common Welding Joints

Lesson Overview

This lesson focuses on main welding joints that are used to practice and learn proper welding technique. This lesson focuses on ten different types of weld that you can learn using SMAW or GMAW welding processes.

Lesson Objectives

After completing this lesson, participants will:

- Learn main welding joint terminology and understand how to weld these joints
- Understand the importance of learning proper technique for each weld
- Gain knowledge on how each weld is put together and important checks for when doing these types of welds

Lesson at a Glance

Activity	Materials	Preparation	Approximate class time
FOCUS	• Pen/Pencil • <i>Common Welding Joints Intro</i>	1. Print/photocopy <i>Common Welding Joints Intro</i> (one per participant).	10 minutes
LEARN	• Pen/Paper • Projector & Computer • <i>Common Welding Joints</i> slide presentation • <i>Common Welding Joints Student Notes</i> • Common Welding Joint Flashcards Set • Common Welding Joints Kit	1. Print/photocopy <i>Common Welding Joints Student Notes</i> (one per participant) 2. Prepare <i>Common Welding Joints</i> slide presentation for viewing.	30-40 minutes
REVIEW	• Pen/Pencil • <i>Common Welding Joints Review</i> • Common Welding Joint Flashcards Set • Common Welding Joints Kit	1. Print/photocopy <i>Common Welding Joints Review</i> (one per participant).	10-20 minutes

Lesson 4 – Common Welding Joints

FOCUS: Introduction to Common Welding Joints

10 minutes

Purpose:

Participants will work to identify five main types of welding joints that most beginner welders will be welding. The focus is to help them start to use welding vocabulary and also focus their welding knowledge on basic welding concepts.

Materials:

- Pen/Pencil
- *Common Welding Joints Intro*

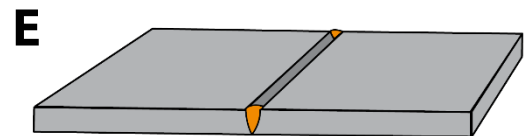
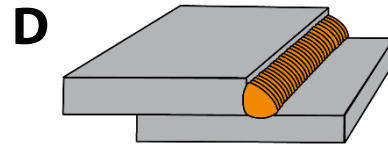
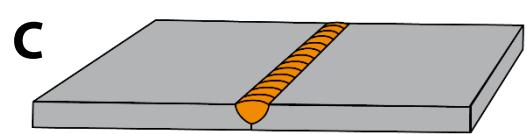
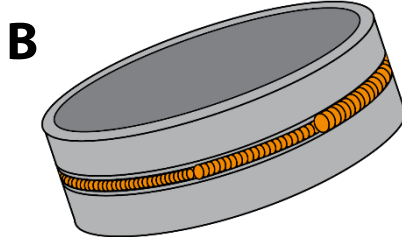
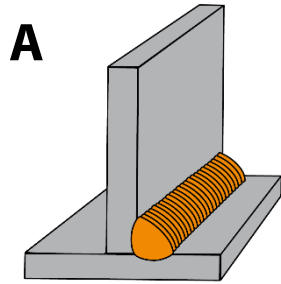
Facilitation Steps:

1. Copy and hand out *Common Welding Joints Intro* to each participant in the class.
2. Have each student take about 5 minutes to fill in the *Common Welding Joints Intro* worksheet on their own. This is to give them pre-assessment knowledge of where they are in understanding their ideas on welding.
3. Once it seems like students are done with the questions, do a correction of the sheet during class. This is a time for students to see how their pre-knowledge of the topic is and to see if they want to ask questions. It is a good place to get prepped for the Learn part of the lesson.
4. Optional: This could be a graded worksheet, but there will be a more robust version of this pre-assessment at the end of the lesson that may be a better graded assessment tool.

Name: _____ Class: _____

Common Welding Joints Intro

Take a few moments and look at each of the following welds. Match the weld types with the correct picture.



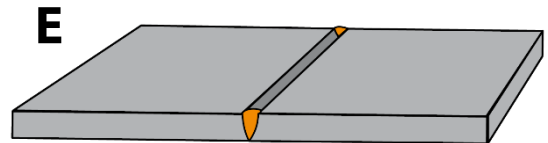
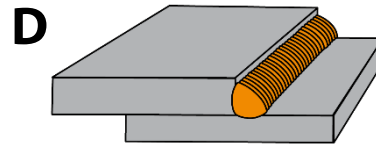
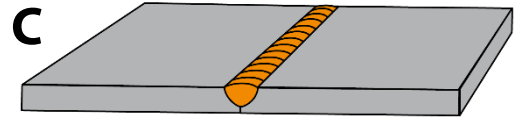
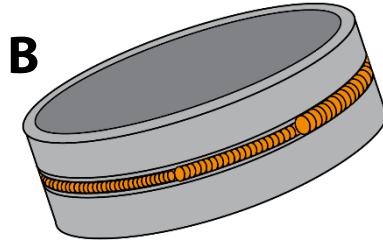
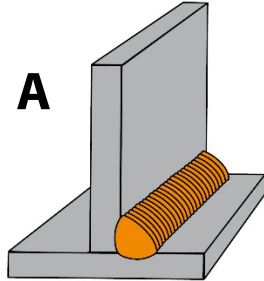
1. Butt Joint _____
2. Lap Joint _____
3. V-Groove Joint _____
4. Pipe Weld _____
5. Tee Joint _____

Fill in the letter of the weld type that matches the welding definition below:

6. When two pieces of material are “butted” together to create a longer unit. _____
7. When a piece of material overlaps another piece of material in a parallel format. _____
8. When two pieces of material intersect at a 90-degree angle. _____
9. When two pieces are butted together, but one or both edges have a beveled or angled edge. _____
10. This is not a joint, but a type of weld that uses a butt joint to complete the weld. _____

Common Welding Joints Intro – Answer Key

Take a few moments and look at each of the following welds. Match the weld types with the correct picture.



1. Butt Joint **C**
2. Lap Joint **D**
3. V-Groove Joint **E**
4. Pipe Weld **B**
5. Tee Joint **A**

Fill in the letter of the weld type that matches the welding definition below:

6. When two pieces of material are “butted” together to create a longer unit. **C**
7. When a piece of material overlaps another piece of material in a parallel format. **D**
8. When two pieces of material intersect at a 90-degree angle. **A**
9. When two pieces are butted together, but one or both edges have a beveled or angled edge. **E**
10. This is not a joint, but a type of weld that uses a butt joint to complete the weld. **B**

Lesson 4 – Common Welding Joints

LEARN: Common Welding Joints Presentation

30-40 minutes

Purpose:

Participants will learn about ten common welding joints to help with skill development and proper technique training for welders. The focus is on getting a standard understanding of these ten welds and how to properly weld for skill development.

Materials:

- Pen and/or paper
- Projector and computer
- *Common Welding Joints* slide presentation
- *Common Welding Joints Student Notes*
- Common Welding Joint Flashcards Set
- Common Welding Joints Kit

Facilitation Steps:

1. Project the Common Welding Joints slide presentation and go through the slideshow one at a time.
2. For each slide, you can use the Common Welding Joint Flashcards Set and the Common Welding Joints Kit to share what each weld looks like and the features that make it a quality weld.
3. While going over each welding joint, feel free to pass around the corresponding welding joint from the Common Welding Joints Kit and the Common Welding Joint Flashcard that also corresponds.
4. There are nine different types of welds as there are two different groove joints, one being SMAW and the other GMAW.

Slide Notes:

Slide 2: Butt Joint – Tack Only

- A square groove butt joint is typically used on materials less than a ¼” or where full joint penetration isn’t required

- It is important to remember that this joint can be welded in one pass, but it can also be welded with a two-pass application by making a pass on each side

Slide 3: Butt Joint

- When two pieces of material are “buted” together to create a longer unit; you might see these joints used in pipeline construction, structural applications, or machinery manufacturing.
- They are used for various projects, including when attaching full lengths of material together.

Slide 4: Lap Joint

- A lap joint is formed when a piece of material overlaps another piece of material in a parallel format
- Due to the area to be welded meeting at ninety degrees, it uses a fillet weld to complete and may be welded on both sides if accessible

Slide 5: V-Groove Butt Joint – 6-inch Pipe

- Pipe welding often utilizes a V-groove butt joint to connect the ends of pipes together to create a pipeline or join shorter pieces to make a pipe spool that will meet the piping requirement
- Depending on material thickness, the material has different requirements for edge prep
- When welding via manual methods, the pipe is often welded from the outside and uses a V-groove joint configuration

Slide 6: Groove Joint – SMAW – 2 Pass

- A V-groove has 3 main parts to it:
 - Bevel angle (combined to create the V feature called groove angle)
 - Root opening (the gap between the plates)

- Root face if applicable (the flat at the bottom of the joint)
- If the material thickness requires it, you can have a double V-groove

Slide 7: Groove Joint – GMAW – 2 pass

- A V-groove has 3 main parts:
 - Bevel angle (combined to create the V feature called groove angle)
 - Root opening (the gap between the plates)
 - Root face if applicable (the flat at the bottom of the joint)
- If the material thickness requires it, you can have a double V-groove

Slide 8: Groove Joint – Tack Only

- A V-groove butt joint is used when a welder cannot easily get access to both sides of the joint; the weld zone is tapered to create a “V” shape to meet required standards
- Tacked at the ends to maintain the root opening as designated by a WPS; depending on welding process, the root opening will vary
- A commonly seen variant of a V-groove has a backing bar tacked onto the back of the weld zone, which supports the molten weld puddle
- This type of joint can be welded with one or many passes depending on material thickness

Slide 9: Tee Joint – Staggered Intermittent Weld

- A staggered intermittent weld is made when the weld joint doesn’t require a full-length weld, but the welds are offset from each other on the opposite sides of the weld joint
- Like an intermittent fillet weld, the welding symbol will have a weld length and pitch length defined, as well as which side of the joint will have the first increment of weld

Slide 10: Tee Joint – Chain Intermittent Weld

- An intermittent weld is made when the weld joint doesn’t require a full-length weld
- This may be used to prevent warpage of a finished component or when materials of difficult thicknesses meet

Slide 11: Tee Joint – Chain Intermittent Weld (cont.)

- These welds might be called “skip welds” on the shop floor
- There are two types of intermittent welds that you might encounter where the welds are exactly opposite of each other, or where they have a staggered offset from each other
- Regardless of the type designated, they both have a weld length and pitch length defined in the weld symbol

Slide 12: Tee Joint

- A tee joint weld is when two pieces of material intersect at a 90-degree angle, which results in the weld being made on the edge of one piece and the face of the other piece
- While called a tee joint, it doesn’t have to be oriented like a “T”
- The tee joint is a fillet weld; other fillet welds are a lap joint and corner joint

Name: _____ Class: _____

Common Welding Joints Student Notes

Follow along with the Common Welding Joints Presentation and fill in the missing notes.

Butt Joint – Tack Only

- A square groove butt joint is typically used on materials less than a _____ or where full joint penetration isn't required
- It is important to remember that this joint can be welded in _____ pass, but it can also be welded with a _____ - _____ application by making a pass on each side

Butt Joint

- When two pieces of material are “ _____ ” together to create a longer unit; you might see these joints used in _____ construction, structural applications, or machinery manufacturing
- They are used for various projects, including when attaching full lengths of material together.

Lap Joint

- A lap joint is formed when a piece of material _____ another piece of material in a parallel format.
- Due to the area to be welded meeting at _____, it uses a fillet weld to complete and may be welded on both sides if accessible

V-Groove Butt Joint – 6-inch Pipe

- Pipe welding often utilizes a V-groove _____ joint to connect the ends of pipes together to create a pipeline or join shorter pieces to make a pipe spool that will meet the piping requirement
- Depending on _____, the material has different requirements for edge prep

- When welding via manual methods, the pipe is often welded from the _____ and uses a V-groove joint configuration

Groove Joint – SMAW – 2 pass

- A V-groove has 3 main parts to it:
 - Bevel _____ combined to create the V feature called groove angle)
 - _____ (the gap between the plates)
 - _____ if applicable (the flat at the bottom of the joint)
- If the material thickness requires it, you can have a double V-groove

Groove Joint – GMAW – 2 pass

- A V-groove has 3 main parts to it:
 - Bevel angle (combined to create the V feature called _____)
 - Root opening (the _____ between the plates)
 - Root face if applicable (the _____ at the bottom of the joint)
- If the material thickness requires it, you can have a _____ V-groove

Groove Joint – Tack Only

- A V-groove butt joint is used when a welder cannot easily get access to both sides of the joint; the _____ is tapered to create a “V” shape to meet required standards
- They are _____ at the ends to maintain the root opening as designated by a WPS. Depending on welding process, the root opening will vary
- A commonly seen variant of a V-groove has a _____ tacked onto the back of the weld zone, which supports the molten weld puddle
- This type of joint can be welded with _____ or _____ passes depending on material thickness

Tee Joint – Staggered Intermittent Weld

- A staggered _____ weld is made when the weld joint doesn’t require a full-length weld, but the welds are _____ from each other on the opposite sides of the weld joint

- Like an intermittent fillet weld, the welding symbol will have a weld length and pitch length defined, as well as which _____ of the joint will have the first increment of weld

Tee Joint – Chain Intermittent Weld

- An intermittent weld is made when the weld joint doesn't require a _____ - _____ weld; this may be used to prevent _____ of a finished component or when materials of difficult thicknesses meet

Tee Joint – Chain Intermittent Weld (cont.)

- These welds might be called “_____” on the shop floor; these are two types of intermittent welds that you might encounter where the welds are exactly opposite of each other, or where they have a staggered offset from each other
- Regardless of the type designated, they both have a _____ length and _____ length defined in the weld symbol

Tee Joint

- A tee joint weld is when two pieces of material intersect at a _____ - _____ angle which results in the weld being made on the edge of one piece and the face of the other piece
- While called a tee joint, it doesn't have to be oriented like a T; the tee joint is a fillet weld and other fillet welds are a lap joint and corner joint

Common Welding Joints Student Notes – Answer Key

Follow along with the Common Welding Joints presentation and fill in the missing notes.

Butt Joint – Tack Only

- A square groove butt joint is typically used on materials less than a $\frac{1}{4}$ " or where full joint penetration isn't required
- It is important to remember that this joint can be welded in **one** pass, but it can also be welded with a **two-pass** application by making a pass on each side

Butt Joint

- When two pieces of material are "**butted**" together to create a longer unit; you might see these joints used in **pipeline** construction, structural applications, or machinery manufacturing
- They are used for various projects, including when attaching full lengths of material together

Lap Joint

- A lap joint is formed when a piece of material **overlaps** another piece of material in a parallel format
- Due to the area to be welded meeting at **ninety degrees**, it uses a fillet weld to complete and may be welded on both sides if accessible

V-Groove Butt Joint – 6-inch Pipe

- Pipe welding often utilizes a V-groove **butt** joint to connect the ends of pipes together to create a pipeline or join shorter pieces to make a pipe spool that will meet the piping requirement
- Depending on **material thickness**, the material has different requirements for edge prep
- When welding via manual methods, the pipe is often welded from the **outside** and uses a V-groove joint configuration

Groove Joint – SMAW – 2 pass

- A V-groove has 3 main parts to it:
 - Bevel angle (combined to create the V feature called groove angle)
 - **Root opening** (the gap between the plates)
 - **Root face** if applicable (the flat at the bottom of the joint)
- If the material thickness requires it, you can have a double V-groove

Groove Joint – GMAW – 2 pass

- A V-groove has 3 main parts to it:
 - Bevel angle (combined to create the V feature called **groove angle**)
 - Root opening (the **gap** between the plates)
 - Root face if applicable (the **flat** at the bottom of the joint)
- If the material thickness requires it, you can have a **double** V-groove

Groove Joint – Tack Only

- A V-groove butt joint is used when a welder cannot easily get access to both sides of the joint; the **weld zone** is tapered to create a “V” shape to meet required standards
- They are **tacked** at the ends to maintain the root opening as designated by a WPS; depending on welding process, the root opening will vary
- A commonly seen variant of a V-groove has a **backing bar** tacked onto the back of the weld zone, which supports the molten weld puddle
- This type of joint can be welded with **one** or **many** passes depending on material thickness

Tee Joint – Staggered Intermittent Weld

- A staggered **intermittent** weld is made when the weld joint doesn’t require a full-length weld, but the welds are **offset** from each other on the opposite sides of the weld joint
- Like an intermittent fillet weld, the welding symbol will have a weld length and pitch length defined, as well as which **side** of the joint will have the first increment of weld

Tee Joint – Chain Intermittent Weld

- An intermittent weld is made when the weld joint doesn’t require a **full-length** weld; this may be used to prevent **warpage** of a finished component or when materials of difficult thicknesses meet

Tee Joint – Chain Intermittent Weld (cont.)

- These welds might be called “**skip welds**” on the shop floor; these are two types of intermittent welds that you might encounter where the welds are exactly opposite of each other, or where they have a staggered offset from each other
- Regardless of the type designated, they both have a **weld** length and **pitch** length defined in the weld symbol

Tee Joint

- A tee joint weld is when two pieces of material intersect at a **90-degree** angle; this results in the weld being made on the edge of one piece and the face of the other piece
- While called a tee joint, it doesn’t have to be oriented like a “T;” the tee joint is a fillet weld and other fillet welds are a lap joint and corner joint

Lesson 4 – Common Welding Joints

REVIEW: Common Welding Joints Review

10–20 minutes

Purpose:

Participants will work in groups to go over the flashcards and test each other on their knowledge of the ten different common welds. They can then either work on the review worksheet together or on their own.

Materials:

- Pen and/or pencil
- *Common Welding Joints Review*
- Common Welding Joints Flashcards
- Common Welding Joints Kit

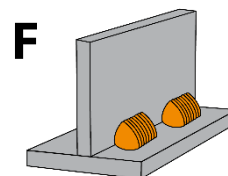
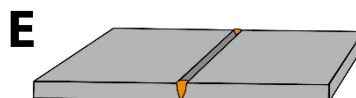
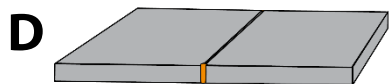
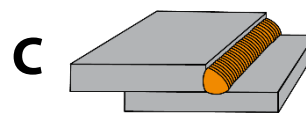
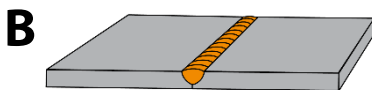
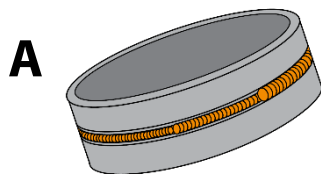
Facilitation Steps:

1. Print off and hand out the *Common Welding Joints Review* to each participant
2. Have each student work on the worksheet on their own, with a partner, or in groups, however you want to facilitate.
3. Give students time to fill out the worksheet.
4. Once they have completed the worksheet, allow for students to correct in class or as a graded assignment. Work through any questions that might come about.
5. Optional: You may want to have the Common Welding Joints Kit and Flashcards in a place where students can access the joints if they have questions.

Name: _____ Class: _____

Common Welding Joints Review

Take a few moments and look at each of the following welds. Match the weld types with the correct picture.



1. _____ Lap Joint

2. _____ Tee Joint

3. _____ Butt Joint

4. _____ Pipe Weld

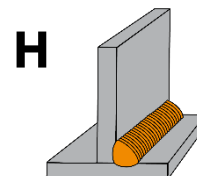
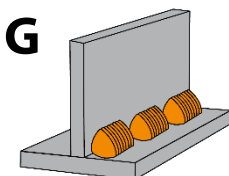
5. _____ V-Groove Joint

6. _____ Tee Joint – Staggered Intermittent Weld

7. _____ Tee Joint – Chain Intermittent Weld

8. _____ Butt Joint – Tack Only

9. _____ Groove Joint – Tack Only



Fill in the weld type that matches the welding definition below:

Word Bank: Butt Joint
Lap Joint

Tee Joint
Groove Joint

V-Groove Butt Joint – 6 Inch Pipe
Tee Joint – Chain Intermittent Weld

10. Welding for pipes, depending on different material thicknesses _____

11. When two pieces of material are “butted” together to create a longer unit _____

12. This weld can also be called a “skip weld.” _____

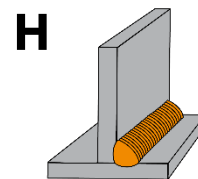
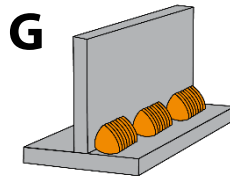
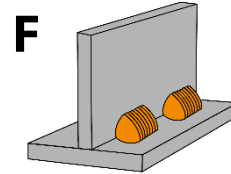
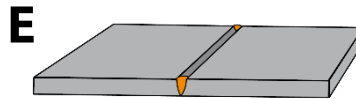
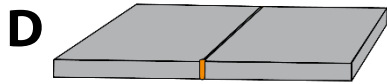
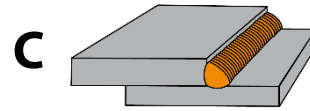
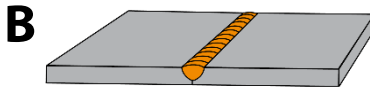
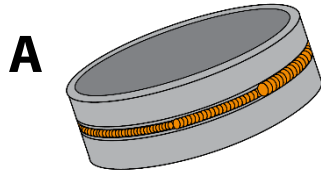
13. When a piece of material overlaps another piece of material in a parallel format. _____

14. When two pieces of material intersect at a 90-degree angle. _____

15. When two pieces are butted together, but one or both edges have a beveled or angled edge.

Common Welding Joints Review – Answer Key

Take a few moments and look at each of the following welds. Match the weld types with the correct picture.



16. **C** Lap Joint
17. **H** Tee Joint
18. **B** Butt Joint
19. **A** Pipe Weld
20. **E** V-Groove Joint
21. **F** Tee Joint – Staggered Intermittent Weld
22. **G** Tee Joint – Chain Intermittent Weld
23. **D** Butt Joint – Tack Only
24. **E** Groove Joint – Tack Only

Fill in the weld type that matches the welding definition below:

Word Bank: Butt Joint Tee Joint V-Groove Butt Joint – 6 Inch Pipe
Lap Joint Groove Joint Tee Joint – Chain Intermittent Weld

1. Welding for pipes, depending on different material thicknesses.

V-Groove Butt Joint – 6-inch Pipe

2. When two pieces of material are “butted” together to create a longer unit. **Butt Joint**
3. This weld can also be called a “skip weld.” **Tee Joint – Chain Intermittent Weld**
4. When a piece of material overlaps another piece of material in a parallel format. **Lap Joint**
5. When two pieces of material intersect at a 90-degree angle. **Tee Joint**
6. When two pieces are butted together, but one or both edges have a beveled or angled edge.

Groove Joint