Course	Agricultural Science II
Unit	Agricultural Mechanics II
Subunit	Arc Welding
Lesson	Safety and Maintenance Procedures for Arc Welding
Estimated Time	50 minutes

Student Outcome

Identify basic safety and maintenance procedures for arc welding.

Learning Objectives

1. Identify the safety and health risks associated with arc welding.
2. Explain how electric shock can be avoided when welding.
3. Explain how burns and fire can be avoided when welding.
4. Explain how hazards from arc rays can be avoided when welding.
5. Explain how breathing hazards can be avoided when welding.
6. Describe the care and maintenance required for the arc welding equipment.

Grade Level Expectations

SC/ME/1/H/09-11/d

Resources, Supplies & Equipment, and Supplemental Information

Resources

1. PowerPoint Slides
   - PPt 1 – Protective Clothing for Welding
   - PPt 2 – Protective Eyewear
   - PPt 3 – Respirators Used for Welding
2. Activity Sheet
   - AS 1 – Arc Welding Safety
3. *Agricultural Mechanics Unit for Agricultural Science II* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 2002.
4. *Curriculum Enhancement for Agricultural Mechanics Unit for Agricultural Science II*, "Unit II – Arc Welding." University of Missouri-Columbia: Instructional Materials Laboratory, 2004.

Supplemental Information

1. Internet Sites
   - Arc Welding Safety Resources. Lincoln Electric. Accessed November 12, 2007, from http://www.lincolnelectric.com/community/safety/.
   - Hexavalent Chromium. Safety and Health Topics. Occupational Safety and Health Administration. U. S. Department of Labor. Accessed October 2, 2007, from http://www.osha.gov/SLTC/hexavalentchromium/index.html.
   - Safety and Health Fact Sheets. American Welding Society. Accessed October 2, 2007, from http://www.aws.org/technical/facts/.

- ❑ Welding Calculators. Miller Electric Manufacturing Co. Accessed October 2, 2007, from http://www.millerwelds.com/education/calculators/.

2. Print
   - ❑ Althouse, A., C. Turnquist, W. Bowditch, and K. Bowditch. *Modern Welding.* Tinley Park, IL: Goodheart-Willcox, 2000.
   - ❑ Jeffus, L. *Welding Principles and Applications.* 5th ed. Clifton Park, NY: Thomson-Delmar Learning, 2004.
   - ❑ Phipps, L., and G. Miller. *Introduction to Agricultural Mechanics.* Upper Saddle River, NJ: Prentice Hall Interstate, 2004.
3. Electronic Media
   - ❑ Smartflix offers a line of videos related to metalworking that can be rented from their Web site. Accessed September 12, 2007, from http://smartflix.com/store/category/115/Metalworking.

Interest Approach

Have students discuss shop safety procedures they are already familiar with and how these might apply specifically to welding. Then discuss what additional safety procedures they would anticipate needing to take. One example would be protective eye wear. Clear safety glasses are needed when cleaning slag from welds, but shaded lenses are also needed for the actual welding process.

Communicate the Learning Objectives

1. Identify the safety and health risks associated with arc welding.
2. Explain how electric shock can be avoided when welding.
3. Explain how burns and fire can be avoided when welding.
4. Explain how hazards from arc rays can be avoided when welding.
5. Explain how breathing hazards can be avoided when welding.
6. Describe the care and maintenance required for the arc welding equipment.

Instructor Directions	Content Outline
Objective 1 *Safety and health risks associated with arc welding are discussed at right.*	**Identify the safety and health risks associated with arc welding.** 1. Electric shock – Arc welders produce relatively low voltage, but they can produce enough to kill a person by electric shock. 2. Burns and fire – The arc produced by an arc welder can reach temperatures in excess of 9,000°F. 3. Burns from arc rays – The welding arc emits rays that can cause first- and second-degree burns of skin within minutes and flash burns of the eyes within seconds. These rays cannot be seen, and their effects are not felt until after exposure has occurred. Reflected light from welding is as dangerous as direct light. 4. Breathing hazards from oxygen displacement and from toxic fumes and gases – The arc, flame, fumes, or gases can reduce or replace oxygen if the area is not adequately ventilated. Toxic fumes and gases given off in the welding process can also pose a hazard.
Objective 2 *Although welding can be done with relatively low voltage, it nevertheless poses the danger of electric shock. Discuss ways to avoid shock hazards.*	**Explain how electric shock can be avoided when welding.** Make sure the welder is installed and hooked up properly. 1. Make sure the welder is properly grounded. Do not confuse the grounding device with the ground clamp that attaches to the work.

Instructor Directions	Content Outline
	2. Make sure the power disconnect switch is within close reach of the operator. 3. Make sure the welder is on its own circuit with a fuse or breaker of the appropriate size. Inspect equipment for damage or a defect. 1. Keep connections tight and clean. Bad connections can heat up and cause dangerous arcs or melting. 2. Do not use electrode holders that are damaged or display poor insulation. Disconnect the welder from the power source before making any repairs. Do not change the polarity switch or the current setting while the machine is under a load, that is, when there is an arc between the electrode and the work. Keep clothing, gloves, and equipment dry and do not stand on a wet surface or on a conductive material. 1. Stand on a dry board or a rubber mat if work must be done in a wet area or if standing must be done on a conductive material, such as steel. 2. Wear rubber gloves under the welding gloves if the area is wet or the operator is perspiring. Do not change the electrode while wearing wet gloves or standing on a wet surface. Do not put the electrode holder in water to cool it. Do not use water to extinguish an electrical fire or any fire near the welder. Remove the electrode from the holder when work is finished.
Objective 3 *The welding arc and the high temperatures it produces can cause burns or fires. Discuss measures to prevent burns and fires. Refer to PPt 1.*	**Explain how burns and fire can be avoided when welding.** Make the work area as fire resistant as possible. 1. Construct the welding booth of fireproof or fire-resistant materials, such as metal sheeting or concrete blocks.

Instructor Directions	Content Outline
☐ PPt 1 – Protective Clothing for Welding	2. Keep the work area clean and free of trash, grease, oil, and other flammable materials. 3. Keep a fire extinguisher, first-aid kit, and safety equipment within easy reach. Take precautions when handling hot work pieces. 1. Use tongs or pliers, not hands, to pick up hot metal. 2. Use caution to avoid steam burns when cooling metal pieces in water. 3. Write the word "HOT" with soapstone or chalk on the work if a piece of hot metal must be left where others could be in contact with it. 4. Do not walk around the shop holding hot metal. Wear appropriate clothing and safety gear. 1. Wear leather gauntlet-style gloves and high-top leather shoes to protect the hands and feet. 2. Wear only wool or cotton clothing that is dark and tightly woven to help protect the skin from fire and to help block arc rays. 3. Do not wear synthetic materials, which can burn readily and give off poisonous gases. 4. Wear only long-sleeved shirts that button at the sleeves and collar. Keep the sleeves and shirt buttoned, including the top button at the collar. 5. Wear pants that come down over the top of the boots and do not have cuffs. Sparks could get caught in the cuffs. 6. Long-sleeved fire-resistant coveralls are recommended. Other types of protective clothing, such as leather aprons and leather sleeves, are also available and should be worn as needed. 7. Do not wear clothing with torn or frayed areas that could leave the skin exposed or could easily catch fire from sparks. 8. Wear safety glasses or goggles when chipping hot slag from welds. Wear additional head and eye protection, such as a flameproof skullcap or face shield, as needed to avoid burns from sparks or hot metal spatter. 9. Do not have items in pockets that could catch fire or explode, such as matches or butane lighters.

Instructor Directions	Content Outline
	Do not attempt to heat, cut, or weld containers such as tanks, drums, and barrels.
Objective 4 *Light from the welding arc can burn the eyes within seconds. Discuss procedures for avoiding light burns of the eyes. Refer to PPt 2.* ☐ PPt 2 – Protective Eyewear	**Explain how hazards from arc rays can be avoided when welding.** Wear a welding helmet with a filter lens classified as no. 10 or higher, depending on the work being done. Consult the manufacturer's recommendations for appropriate lens. 1. Wear safety glasses if the helmet does not have a lens made of safety glass. Welding helmets are available in different types, including some that have a flip-up or fixed shaded lens. A flip-up lens allows work such as chipping to be done without removing the helmet. If a flip-up lens helmet is not used, safety glasses must be worn under the helmet. 2. Inspect the helmet and lens assembly to make sure they are undamaged and gaskets fit properly. A damaged helmet or loose gaskets could allow light leaks. Warn others in the area that you are going to begin welding by saying "Cover up!" Make sure all persons in the welding area are wearing eye protection, such as flash glasses, to avoid eye injury from the reflected light.
Objective 5 *Discuss the hazards of inadequate ventilation and exposure to gases and fumes. Refer to PPt 3. After discussing the various safety hazards in welding, assign AS 1 to have students do a safety inspection of the shop.* ☐ PPt 3 – Respirators Used for Welding AS 1 – Arc Welding Safety	**Explain how breathing hazards can be avoided when welding.** 1. Work in an adequately ventilated area. 2. Use forced ventilation if natural ventilation is not sufficient. 3. Supplement ventilation as needed with an appropriate respirator. 4. Clean the metal before welding. Cleaning the metal helps remove any chemicals that might mix with the fumes produced by welding. It also is safer and easier to establish an arc on a clean surface. 5. Operate engine-powered welders only in well-ventilated areas or with the exhaust vented directly outdoors.

Instructor Directions	Content Outline
Objective 6	**Describe the care and maintenance required for the arc welding equipment.** 1. Inspect the electrode holder frequently to be sure it is not damaged or in need of repair. 2. Keep cables free of oil and grease. 3. Run cables so that they will not be damaged or cause a tripping hazard. In temporary work sites, cables can be protected with C-channel. 4. To avoid damaging the welder, do not shut off or start the welder with the electrode or electrode holder in contact with the work or the welding table. Hang the holder from an insulated hanger when not in use. 5. Keep the welder and electrodes dry. 6. Do not allow dust to accumulate on the transformer coils.
Application: AS 1 – Arc Welding Safety	Answers to AS 1 Answers will vary, depending on the procedures assigned by the instructor and on the setup of the individual shop. Other activities 1. Obtain safety lenses of different shade numbers and show students the difference in the darkness of each shade. Show them how they can identify the shade number. Instruct students on the safe and proper use of safety lenses. 2. Have students collect additional information about arc welding and arc welding safety and present it to the class. Encourage them to consult a variety of sources. Possible sources include other agricultural mechanics textbooks, the Internet, safety information from manufacturers, and conversations with individuals who weld, either for personal use or professionally. Discuss their findings. If some of the information varies or seems to contradict other information, discuss possible causes for these differences and then identify the safest course of action.

Instructor Directions	Content Outline
Closure/Summary	Arc welding demands strict attention and adherence to safe practices. Specific dangers include electric shock, burns and fire, arc rays, and breathing hazards. Avoid these dangers by properly installing and maintaining equipment, promoting and maintaining a fire-resistant work area, wearing appropriate clothing and safety gear, and ventilating the work area.
Evaluation: Quiz	Answers: 1. d 2. b 3. b 4. a 5. d 6. a 7. c 8. b 9. b 10. a. Electric shock Instructor should use discretion. Some possible answers are the following: 1. Ensure proper installation and hookup of the welder. 2. Inspect equipment for damage or defects. 3. Disconnect the welder from the power source before making any repairs. 4. Do not change the current setting while the machine is under a load. 5. Keep clothing, gloves, floor, and equipment dry. 6. Do not put the electrode holder in water to cool it. 7. Do not use water to put out electrical fires or any fire near the welder. 8. Remove the electrode from the holder when the work is finished and disconnect the welder from the power source. b. Burns and fire 1. Make the work area as fire resistant as possible. 2. Be careful with hot work pieces. 3. Wear appropriate clothing and safety gear.

Instructor Directions	Content Outline
	4. Do not attempt to heat, cut, or weld containers such as tanks, drums, and barrels. c. Burns from arc rays 1. Wear a welding helmet with a filter lens classified as no. 10 or higher, depending on the work being done. 2. Wear dark, tightly woven clothing that covers the body. 3. Warn others in the area to cover up before you begin to weld. 4. Persons in the welding area should also wear eye protection. d. Breathing hazards 1. Work in an area with adequate ventilation. 2. Use forced ventilation if natural ventilation is not sufficient. 3. Supplement ventilation as needed with an appropriate respirator. 4. Clean metal before welding. 5 Operate engine-powered welders in well-ventilated areas or with the exhaust vented directly outdoors.