

<b>Course</b>	Agricultural Science II
<b>Unit</b>	Agricultural Mechanics II
<b>Subunit</b>	Arc Welding
<b>Lesson</b>	Welding Out of Position
<b>Estimated Time</b>	Seven 50-minute blocks
<b>Student Outcome</b>	

Demonstrate the procedures for making out-of-position welds using a shielded metal arc welder.









### Learning Objectives

1. Identify the basic types of weld joints.
2. Explain the positions used in arc welding.
3. Demonstrate what techniques can be used to improve results in out-of-position welds.

### Grade Level Expectations

### Resources, Supplies & Equipment, and Supplemental Information

#### Resources

1. PowerPoint Slides
  - ☐ PPt 1 – Types of Joints
  - ☐ PPt 2 – Welding Positions
  - ☐ PPt 3 – Basic Joint Types in Different Positions
  - ☐ PPt 4 – Angles for Horizontal Welding
  - ☐ PPt 5 – Angles for Vertical Welding
  - ☐ PPt 6 – Angles for Overhead Welding
2. Activity Sheets
  -  AS 1 – Welding a Butt Joint in the Horizontal Position (Instructor)
  -  AS 1 – Welding a Butt Joint in the Horizontal Position (Student)
  -  AS 2 – Making a Downhill Fillet Weld (Instructor)
  -  AS 2 – Making a Downhill Fillet Weld (Student)
  -  AS 3 – Making an Uphill Fillet Weld (Instructor)
  -  AS 3 – Making an Uphill Fillet Weld (Student)
  -  AS 4 – Welding a Butt Joint in the Overhead Position (Instructor)
  -  AS 4 – Welding a Butt Joint in the Overhead Position (Student)
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.

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### Supplies & Equipment

- ☐ See AS 1 through AS 4 for materials and equipment needed to complete the Activity Sheets.

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### Supplemental Information

#### 1. 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. *Mechanics in Agriculture*. 4th ed. Danville, IL: Interstate Publishers, 1992.
  - ☐ Phipps, L., and G. Miller. *Introduction to Agricultural Mechanics*. Upper Saddle River, NJ: Prentice Hall Interstate, 2004.
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### Interest Approach

Identify or have students identify various types of welded joints in the shop. Ask them if they think the joints were made in a flat, vertical, or overhead position. Why? Ask them what they think would change for each type of weld should the position change.



### Communicate the Learning Objectives

1. Identify the basic types of weld joints.
2. Explain the positions used in arc welding.
3. Demonstrate what techniques can be used to improve results in out-of-position welds.

Instructor Directions	Content Outline
<p><b>Objective 1</b></p> <p><i>Introduce the lesson by discussing the different types of joints made in welding. Refer to PPt 1.</i></p> <p><input type="checkbox"/> PPt 1 – Types of Joints</p>	<p><b>Identify the basic types of weld joints.</b></p> <p>Butt joint – Pieces are joined edge to edge in the same plane.</p> <p>Lap joint – One piece overlaps another.</p> <p>Corner joint – Pieces are joined at the edges at an angle, usually a right angle.</p> <p>Tee joint – Pieces are joined at an angle to form a “T” shape.</p> <p>Edge joint – Pieces are positioned parallel or nearly parallel to each other and joined edge to edge.</p>
<p><b>Objective 2</b></p> <p><input type="checkbox"/> PPt 2 – Welding Positions</p> <p><input type="checkbox"/> PPt 3 – Basic Joint Types in Different Positions</p>	<p><b>Explain the positions used in arc welding.</b></p> <p>Flat – The weld axis (imaginary line through the center of the weld) and weld face (surface of the weld on the welding side) are both approximately horizontal (flat) in front of the welder.</p> <p>Horizontal – The weld axis is horizontal and the weld face and base metal are approximately vertical (up and down).</p> <p>Vertical – The weld axis and weld face are both approximately vertical.</p> <ol style="list-style-type: none"><li>1. Uphill or vertical up – The weld is performed from the bottom of the joint to the top.</li><li>2. Downhill or vertical down – The weld is performed from the top of the joint to the bottom.</li></ol>

Instructor Directions	Content Outline
	<p>Overhead – The weld is performed from the underside of the joint, with the weld axis and face approximately horizontal.</p> <p>Welding in positions other than flat is called welding out of position.</p> <p>Whenever possible, welds should be made in the flat position.</p> <p>In positions other than flat, the welder is working against the force of gravity.</p> <p>When welds cannot be made in the flat position, the welder must be able to make welds out of position that are as strong as those made in the flat position.</p> <p>All of the joint types can be made in all four positions.</p>
<p><b>Objective 3</b></p> <p><i>General techniques for welding out of position are discussed in the outline. Refer to PPTs 4-6. When students have reviewed and discussed these and any other arc welding safety and use procedures recommended by the instructor, the instructor versions of AS 1-4 can be used to demonstrate the correct way to make out-of-position welds using the arc welder. The student versions of AS 1-4 can be assigned to evaluate student competency.</i></p> <p><input type="checkbox"/> PPT 4 – Angles for Horizontal Welding</p> <p><input type="checkbox"/> PPT 5 – Angles for Vertical Welding</p>	<p><b>Demonstrate what techniques can be used to improve results in out-of-position welds.</b></p> <p>Use a smaller diameter electrode.</p> <ol style="list-style-type: none"> <li>1. Allows lower amperage to be used</li> <li>2. Makes a smaller weld pool</li> <li>3. Creates a weld pool that is more easily managed</li> </ol> <p>Use a fast-setting electrode to keep the weld from sagging (e.g., E6010, E6011, and E7018).</p> <p>Adjust the electrode in the holder to a convenient angle. Do not bend the electrode into position. This can cause the flux to break off, resulting in a loss of shielding gas and in substandard welds.</p> <p>For horizontal welds</p> <ol style="list-style-type: none"> <li>1. For butt welds, hold the electrode roughly 5 to 10 degrees below perpendicular, so that the electrode is pointed up at the weld. This is the work angle.</li> <li>2. Lean the electrode approximately 20 degrees in the direction of travel. This is the lead angle.</li> <li>3. For different joints, reposition the electrode as needed.</li> </ol>

Instructor Directions	Content Outline
<p>☐ PPt 6 – Angles for Overhead Welding</p> <p>📄 AS 1 – Welding a Butt Joint in the Horizontal Position</p> <p>📄 AS 2 – Making a Downhill Fillet Weld</p> <p>📄 AS 3 – Making an Uphill Fillet Weld</p> <p>📄 AS 4 – Welding a Butt Joint in the Overhead Position</p>	<ol style="list-style-type: none"> <li>Maintain a shorter arc length to ensure better transfer of filler material.</li> </ol> <p>For vertical welds</p> <ol style="list-style-type: none"> <li>For butt welds, hold the electrode at a right angle to the base metal and inclined down approximately 10 to 15 degrees, so that the electrode is pointed up in relation to the base metal.</li> <li>For different joints, reposition the electrode as needed.</li> <li>To keep the weld pool from getting too hot, use a flipping or whipping motion. To do this, move the electrode forward, lift it slightly, and bring it back to the weld pool without breaking the arc.</li> <li>Hold a shorter arc length to ensure better transfer of filler.</li> <li>Downhill or vertical down welding generally works best on thinner material.</li> </ol> <p>For overhead welds</p> <ol style="list-style-type: none"> <li>For overhead butt welds, the electrode is approximately perpendicular to the base metal and tilted 15 to 20 degrees in the direction of travel.</li> <li>For different joints, reposition the electrode as needed.</li> <li>A flipping motion can be used to control the weld pool and keep the filler from dropping out.</li> </ol> <p>In addition to the usual welding safety procedures, the welder must be sure to take extra steps to protect against falling molten metal, particularly when welding overhead. The welder should wear a cap, be sure that pant legs cover the tops of the shoes, and follow any other guidelines from the instructor.</p>
<p><b>Application:</b></p> <p>📄 AS 1 – Welding a Butt Joint in the Horizontal Position</p> <p>📄 AS 2 – Making a Downhill Fillet Weld</p>	<p>AS 1 – AS 4</p> <p>Results will vary.</p>

Instructor Directions	Content Outline
<p> AS 3 – Making an Uphill Fillet Weld</p> <p> AS 4 – Welding a Butt Joint in the Overhead Position</p>	<p>Other activities</p> <ol style="list-style-type: none"> <li>1. After students have completed the activity sheets, demonstrate how to safely and correctly perform destructive testing on the joints they have made. Show them examples of well-made welds and welds with flaws, such as inclusions and porosity. Discuss ways to improve these defects. Have students examine their welds and write down their observations. Include aspects that are well done, as well as any changes they would make. The instructor's comments should give the students feedback both on their welds and their assessment of the welds.</li> <li>2. Ask a professional welder in the community to visit the class and provide information about welding out of position. The presenter could demonstrate the techniques he or she uses to produce sound welds. Have the students prepare questions for the presenter before the visit.</li> <li>4. Create a display board that has examples of good out-of-position welds produced by students. It can be a "wall of fame" that gives recognition to students for a job well done.</li> </ol>
<b>Closure/Summary</b>	<p>Flat is the preferred position in arc welding, because the weld axis and the weld face are both approximately horizontal in front of the welder. Horizontal, vertical, and overhead approaches are called out of position welds, and the welder must work against gravity to make them. All of the basic types of weld joints (butt, lap, corner, tee, and edge) can be made in all four positions. To improve results in out-of-position welds, use a smaller diameter electrode, use a fast-setting electrode, or adjust the electrode in the holder to a convenient angle. When making out-of-position welds, the welder should follow all the usual welding safety procedures and take any additional steps necessary to protect against falling molten metal, particularly when welding overhead.</p>

Instructor Directions	Content Outline
<p><b>Evaluation: Quiz</b></p>	<p>Answers:</p> <ol style="list-style-type: none"> <li>1. c</li> <li>2. a</li> <li>3. b</li> <li>4. d</li> <li>5. c</li> <li>6. Flat position is the only position in which the welder does not have to use special techniques to keep the force of gravity from pulling the molten metal out of place.</li> <li>7. Students should list three of the following.               <ol style="list-style-type: none"> <li>a. Maintaining a shorter arc length</li> <li>b. Using a smaller diameter electrode</li> <li>c. Using an electrode with fast-setting filler</li> <li>d. Adjusting the electrode to specific work and lead angles</li> <li>e. Using a whipping motion for vertical and overhead welds</li> </ol> </li> </ol>