Module Overview

This module covers the basics of aluminum metallurgy. It also explains how to make fillet and V-groove welds on aluminum plate in all positions using GMAW equipment, aluminum wire, and shielding gas.

Prerequisites

Prior to training with this module, it is recommended that the trainee shall have successfully completed Core Curriculum; Welding Level One; Welding Level Two; and Welding Level Three.

Objectives

Upon completion of this module, the trainee will be able to do the following:

1. Identify and explain aluminum metallurgy and the characteristics of aluminum.
2. Explain GMAW and how to set up GMAW equipment to weld aluminum.
3. Build a pad with stringer beads and weave beads, using GMAW equipment, aluminum wire, and shielding gas.
4. Perform multiple-pass fillet welds on aluminum plate in the following positions, using GMAW equipment, aluminum wire, and shielding gas:
   - 1F
   - 2F
   - 3F
   - 4F
5. Perform multiple-pass V-groove welds on aluminum plate with backing in the following positions, using GMAW equipment, aluminum wire, and shielding gas:
   - 1G
   - 2G
   - 3G
   - 4G

Performance Tasks

Under the supervision of the instructor, the trainee should be able to do the following:

1. Make selected GMAW welds on aluminum plate:
   - Stringer beads
   - Weave beads
   - Weld restarts
   - Weld terminations
   - Overlapping beads
2. Make selected GMAW fillet welds on aluminum plate in the following positions:
   - 1F
   - 2F
   - 3F
   - 4F
3. Make selected GMAW V-groove welds on aluminum plate with backing in the following positions:
   - 1G
   - 2G
   - 3G
   - 4G
Materials and Equipment

- Pencils and scratch paper
- Whiteboard/chalkboard
- Markers/chalk
- Advanced Topics in Welding: Aluminum
  PowerPoint® Presentation Slides
- Multimedia projector and screen
- Desktop or laptop computer
- Appropriate personal protective equipment
- Fully charged fire extinguishers for the labs
- GMAW welding equipment
- A supply of the following:
  - Shielding gas
  - Aluminum filler wire
  - Aluminum plate for coupons ⅜”-thick
    (or substitute ⅝”- to ¾”-thick plate)
  - Aluminum for backing strips
- Cleaning materials for aluminum coupons
- MSDS for each cleaning agent used
- Welding bench with arm for position work
- Portable grinders with extra grinding discs
- Bevel gauges
- Levels
- Framing squares
- Precision measurement devices
  (micrometers and calipers)
- Soapstone
- Tape measures
- Pliers
- Half-round bastard files

Stainless steel wire brushes
Chipping hammers
Workpiece clamps
Examples of the following:
- Heat-treatable and nonheat-treatable aluminum
- Cast and wrought aluminum
- Welds with burn-through and melt-through
- Broken apart or sawed apart aluminum welds showing porosity
- Aluminum welds with solidification and liquation cracking
- Aluminum fillet welds cut apart to show acceptable and unacceptable weld profiles
- Aluminum V-groove welds cut apart to show acceptable and unacceptable weld profiles
- Beads created with different welding voltage and amperage settings
- Beads created with different travel speed settings and gun angles
- Acceptable and unacceptable GMAW stringer and weave beads
- Properly and improperly terminated welds
- Proper and improper overlapping beads
- Fillet and groove welds from all four welding positions
- Root passes before and after grinding

Module Examinations*
Performance Profile Sheets*

* Single-module AIG purchases include the printed exam and performance task sheet. If you have purchased the perfect-bound version of this title, download these materials from the IRC using your access code.

Safety Considerations

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. Trainees will be required to make fillet and V-groove welds on aluminum plate using GMAW. Ensure that trainees are properly briefed on the safe use of GMAW equipment and are familiar with all appropriate safety precautions and procedures. Verify that all labs are equipped with charged fire extinguishers.

Additional Resources

This module is intended to present thorough resources for task training. The following reference works are suggested for both instructors and motivated trainees interested in further study. These are optional materials for continued education rather than for task training.

- Lincoln Electric website: http://www.lincolnelectric.com offers sources for products and training.
An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 30 hours are suggested to cover GMAW – Aluminum Plate. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of trainees may be noted during these exercises for Performance Testing purposes. The laboratory portion should take approximately 22½ hours or 9 sessions.

### Session I. Introduction; Safety Summary; Aluminum Metallurgy; Characteristics of Aluminum Welding; Welding Preparation

<table>
<thead>
<tr>
<th>Topic</th>
<th>Planned Time</th>
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<tbody>
<tr>
<td>A. Introduction</td>
<td></td>
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<tr>
<td>B. Safety Summary</td>
<td></td>
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<tr>
<td>1. Protective Clothing and Equipment</td>
<td></td>
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<tr>
<td>2. Fire/Explosion Prevention</td>
<td></td>
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<tr>
<td>3. Work Area Ventilation</td>
<td></td>
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<tr>
<td>C. Aluminum Metallurgy</td>
<td></td>
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<tr>
<td>1. Nonheat-Treatable Alloys</td>
<td></td>
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<td>2. Heat-Treatable Alloys</td>
<td></td>
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<tr>
<td>3. Filler Metal Alloys</td>
<td></td>
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<td>4. Cast Aluminum</td>
<td></td>
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<td>5. Wrought Aluminum</td>
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<tr>
<td>D. Characteristics of Aluminum Welding</td>
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<tr>
<td>1. Surface Preparation</td>
<td></td>
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<tr>
<td>2. Weld Problems</td>
<td></td>
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<td>E. Welding Preparation</td>
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<tr>
<td>1. Practice Welding Coupons</td>
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<tr>
<td>2. The Welding Machine</td>
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</table>

### Sessions II-IV. Welding Beads; Laboratory and Performance Testing

<table>
<thead>
<tr>
<th>Topic</th>
<th>Planned Time</th>
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<tbody>
<tr>
<td>A. Welding Beads</td>
<td></td>
</tr>
<tr>
<td>1. Bead Types</td>
<td></td>
</tr>
<tr>
<td>2. Weld Restarts</td>
<td></td>
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<tr>
<td>3. Weld Terminations</td>
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<td>4. Overlapping Beads</td>
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<td>B. Laboratory</td>
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<tr>
<td>1. Have trainees practice setting up GMAW equipment to weld aluminum.</td>
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<tr>
<td>2. Have trainees prepare aluminum plate coupons for fillet welds.</td>
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<tr>
<td>3. Have trainees practice making selected GMAW welds (stringer beads, weave beads, weld restarts, weld terminations, overlapping beads, and building a pad) on aluminum plate coupons. This laboratory corresponds to Performance Task 1.</td>
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</tbody>
</table>
Sessions V–VII. Practicing Fillet Welds in the 1F, 2F, 3F, and 4F Positions; Laboratory and Performance Testing

A. Practicing Fillet Welds in the Flat (1F), Horizontal (2F), Vertical (3F), and Overhead (4F) Positions

B. Laboratory
1. Have trainees prepare aluminum plate coupons for fillet welds.
2. Have trainees practice making selected GMAW fillet welds on aluminum plate in the following positions: (This laboratory corresponds to Performance Task 2.)
   - 1F
   - 2F
   - 3F
   - 4F

Sessions VIII–X. Practicing Groove Plate Welds in the 1G, 2G, 3G, and 4G Positions; Laboratory and Performance Testing

A. Practicing Groove Plate Welds in the Flat (1G), Horizontal (2G), Vertical (3G), and Overhead (4G) Positions

B. Laboratory
1. Have trainees prepare aluminum plate coupons with backing for groove welds.
2. Have trainees make selected GMAW V-groove welds on aluminum plate with backing in the following positions: (This laboratory corresponds to Performance Task 3.)
   - 1G
   - 2G
   - 3G
   - 4G

Sessions XI–XII. Review and Testing; Performance Accreditation Tasks

A. Module Review

B. Module Examination
1. Trainees must score 70% or higher to receive recognition from NCCER.
2. Record the testing results on Training Report Form 200, and submit the results to the Training Program Sponsor.

C. Performance Testing
1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements.
2. Record the testing results on Training Report Form 200, and submit the results to the Training Program Sponsor.

D. Performance Accreditation Tasks – Have trainees complete PAT 1 through PAT 9, according to the acceptance criteria.
1. Have trainees perform PAT 1, Weld a Pad on Aluminum Plate in the Flat (G) Position using GTAW Stringer Beads. PAT 1 has no AWS correlation.
2. Have trainees perform PATs 2, 3, 4, and 5, Make Multiple-Pass Fillet Welds on Aluminum Plate in the 1F, 2F, 3F, and 4F Positions. These tasks correspond to AWS EG3.0-96: 3.3.6.2, Unit #2, GMAW, Learning Objective #6, (1F, 2F, 3F, and 4F).
3. Have trainees perform PATs 6, 7, 8, and 9, Make Multiple-Pass V-Groove Welds with Backing on Aluminum Plate in the 1G, 2G, 3G, and 4G Positions. These tasks correspond to AWS EG3.0-96: 3.3.6.2, Unit #2, GMAW, Learning Objective #7, (1G, 2G, 3G, and 4G – with backing).
Module Overview

This module covers GTAW equipment setup. It also explains how to make fillet and V-groove welds on aluminum plate in all positions using GTAW equipment and aluminum filler metal.

Prerequisites

Prior to training with this module, it is recommended that the trainee shall have successfully completed Core Curriculum; Welding Level One; Welding Level Two; Welding Level Three; and Advanced Topics in Welding: Aluminum, Module 29401-10.

Objectives

Upon completion of this module, the trainee will be able to do the following:

1. Explain GTAW and how to set up GTAW equipment to weld aluminum plate.
2. Explain and demonstrate GTAW techniques used to weld aluminum.
3. Build a pad with stringer beads and weave beads, using GTAW equipment and aluminum filler metal.
4. Make multiple-pass fillet welds on aluminum plate in the following positions, using GTAW equipment and aluminum filler metal:
   • 1F
   • 2F
   • 3F
   • 4F
5. Make multiple-pass V-groove welds on aluminum plate with backing in the following positions, using GTAW equipment and aluminum filler metal:
   • 1G
   • 2G
   • 3G
   • 4G

Performance Tasks

Under the supervision of the instructor, the trainee should be able to do the following:

1. Set up GTAW equipment to make fillet and V-groove welds on aluminum plate.
2. Weld a pad on aluminum plate in the flat position using GTAW stringer beads.
3. Make multiple-pass fillet welds on aluminum plate in the following positions using GTAW equipment and aluminum filler metal:
   • 1F
   • 2F
   • 3F
   • 4F
4. Make multiple-pass V-groove welds on aluminum plate with backing in the following positions using GTAW equipment and aluminum filler metal:
   • 1G
   • 2G
   • 3G
   • 4G
Materials and Equipment

Pencils and scratch paper
Whiteboard/chalkboard
Markers/chalk
Advanced Topics in Welding: Aluminum
PowerPoint® Presentation Slides
Multimedia projector and screen
Desktop or laptop computer
Appropriate personal protective equipment
Fully charged fire extinguishers for the labs
Welding curtains or shields
GTAW welding equipment
A supply of the following:
  • Applicable shielding gases
  • Applicable aluminum filler metal rods
  • Aluminum plate for coupons ½”-thick
    (or substitute ¼”- to ½”-thick plate)
  • Aluminum for backing strips
  • Cleaning materials for aluminum coupons
MSDS for each cleaning agent used
Welding bench with arm for position work
Portable grinders with extra grinding discs
Bevel gauges
Levels
Framing squares
Precision measurement devices
  (micrometers and calipers)
Soapstone
Tape measures

* Single-module AIG purchases include the printed exam and performance task sheet. If you have purchased the perfect-bound version of this title, download these materials from the IRC using your access code.

Safety Considerations

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. Trainees will be required to make fillet and V-groove welds on aluminum plate using GTAW equipment. Ensure that trainees are properly briefed on the safe use of GTAW welding equipment and are familiar with all appropriate safety precautions and procedures. Verify that all labs are equipped with charged fire extinguishers.

Additional Resources

This module is intended to present thorough resources for task training. The following reference works are suggested for both instructors and motivated trainees interested in further study. These are optional materials for continued education rather than for task training.

Lincoln Electric website: http://www.lincolnelectric.com offers sources for products and training.
### Teaching Time for this Module

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 21/2 hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 30 hours are suggested to cover \textit{GTAW – Aluminum Plate}. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of trainees may be noted during these exercises for Performance Testing purposes. The laboratory portion should take approximately 221/2 hours or 9 sessions.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Planned Time</th>
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<tbody>
<tr>
<td><strong>Session I. Introduction; Safety Practices; Welding Equipment Setup</strong></td>
<td></td>
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<tr>
<td>A. Introduction</td>
<td></td>
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<tr>
<td>B. Safety Practices</td>
<td></td>
</tr>
<tr>
<td>1. Protective Clothing and Equipment</td>
<td></td>
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<tr>
<td>2. Fire/Explosion Prevention</td>
<td></td>
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<tr>
<td>3. Work Area Ventilation</td>
<td></td>
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<tr>
<td>C. Welding Equipment Setup</td>
<td></td>
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<tr>
<td>1. Preparing the Welding Area</td>
<td></td>
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<tr>
<td>2. Selecting Aluminum Filler Metals</td>
<td></td>
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<tr>
<td>3. Preparing Welding Coupons</td>
<td></td>
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<tr>
<td>4. Selecting Shielding Gas</td>
<td></td>
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<tr>
<td>5. Welding Equipment</td>
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<tr>
<td><strong>Session II. GTAW Techniques; Bead Types</strong></td>
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<tr>
<td>A. GTAW Techniques</td>
<td></td>
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<tr>
<td>1. Torch Travel Speed and Arc Length</td>
<td></td>
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<td>2. Torch Angles</td>
<td></td>
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<tr>
<td>3. Torch and Filler Metal Handling Techniques</td>
<td></td>
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<td>B. Bead Types</td>
<td></td>
</tr>
<tr>
<td>1. Practicing Weave Beads</td>
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<td>2. Weld Restarts</td>
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<td>3. Weld Terminations</td>
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<td>4. Overlapping Beads</td>
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<td>5. Building a Pad with Stringer or Weave Beads</td>
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<tr>
<td><strong>Session III–IV. Laboratory and Performance Testing</strong></td>
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<tr>
<td>A. Laboratory</td>
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<tr>
<td>1. Have trainees set up the welding area for GTAW on aluminum plate.</td>
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<td>2. Have trainees select, inspect, clean, repair, and store filler metal rods.</td>
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<tr>
<td>3. Have trainees prepare aluminum plate coupons and backing strips for practice welds.</td>
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<tr>
<td>4. Have trainees start, terminate, restart, and overlap GTAW welds on aluminum plate.</td>
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<tr>
<td>B. Performance Laboratory</td>
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<tr>
<td>1. Have trainees set up GTAW equipment to make fillet and V-groove welds on aluminum plate. This laboratory corresponds to Performance Task 1.</td>
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<tr>
<td>2. Have trainees weld a pad on aluminum plate in the flat position, using GTAW stringer beads. This laboratory corresponds to Performance Task 2.</td>
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</tbody>
</table>
Sessions V–VII. Fillet Welds (1F, 2F, 3F, and 4F); Laboratory and Performance Testing

A. Practicing Fillet Welds in the Flat (1F), Horizontal (2F), Vertical (3F), and Overhead (4F) Positions

B. Laboratory
1. Have trainees practice making multiple-pass fillet welds on aluminum plate in the 1F, 2F, 3F, and 4F positions using GTAW equipment and aluminum filler metal. This laboratory corresponds to Performance Task 3.

Sessions VIII–XI. V-Groove Plate Welds (1G, 2G, 3G, and 4G); Laboratory and Performance Testing

A. V-Groove Plate Welds
1. Root Pass
2. V-Groove Weld Positions
3. Acceptable and Unacceptable V-Groove Welds with Backing

B. Practicing V-Groove Welds with Backing in the Flat (1G), Horizontal (2G), Vertical (3G), and Overhead (4G) Positions

C. Laboratory
1. Have trainees make multiple-pass V-groove welds on aluminum plate with backing in the 1G, 2G, 3G, and 4G positions using GTAW equipment and aluminum filler metal. This laboratory corresponds to Performance Task 4.

Session XII. Review and Testing; Performance Accreditation Tasks

A. Module Review

B. Module Examination
1. Trainees must score 70% or higher to receive recognition from NCCER.
2. Record the testing results on Training Report Form 200, and submit the results to the Training Program Sponsor.

C. Performance Testing
1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements.
2. Record the testing results on Training Report Form 200, and submit the results to the Training Program Sponsor.

D. Performance Accreditation Tasks – Have trainees complete PAT 1 through Pat 9, according to the acceptance criteria.
1. Have trainees perform PAT 1, Weld a Pad on Aluminum Plate in the Flat (1G) Position using GTAW Stringer Beads. This PAT has no AWS correlation.
2. Have trainees perform PATs 2 and 3, Make Multiple-Pass Fillet Welds on Aluminum Plate in the 1F and 2F Positions. PATs 2 and 3 correspond to AWS EG2.0:2006 3.3.1, Module 7, Key Indicator 15, (1F and 2F).
3. Have trainees perform PATs 4 and 5, Make Multiple-Pass Fillet Welds on Aluminum Plate in the 3F and 4F Positions. PATs 4 and 5 correspond to AWS EG3.0-96: 3.3.6.4, Unit #4, GTAW, Learning Objective #6, (3F and 4F).
4. Have trainees perform PAT 6, Make Multiple-Pass V-Groove Welds on Aluminum Plate with Backing in the 1G Position. PAT 6 corresponds to AWS EG2.0:2006 3.3.1, Module 7, Key Indicator 16, (1G).
5. Have trainees perform PATs 7, 8, and 9, Make Multiple-Pass V-Groove Welds on Aluminum Plate with Backing in the 2G, 3G, and 4G Positions. PATs 7, 8, and 9 correspond to AWS EG3.0-96: 3.3.6.4, Unit #4, GTAW, Learning Objective #7 (2G, 3G, and 4G).
Module Overview

This module covers welding area setup and gas tungsten arc welding techniques. It also explains how to make GTAW V-groove and modified U-groove welds on aluminum pipe in the 2G, 5G, and 6G positions.

Prerequisites

Prior to training with this module, it is recommended that the trainee shall have successfully completed Core Curriculum; Welding Level One; Welding Level Two; Welding Level Three; and Advanced Topics in Welding: Aluminum, Modules 29401-10 and 29402-10.

Objectives

Upon completion of this module, the trainee will be able to do the following:
1. Prepare GTAW equipment for V-groove and modified U-groove welds on aluminum pipe.
2. Identify and explain V-groove and modified U-groove welds on aluminum pipe with GTAW equipment.
3. Perform V-groove and modified U-groove welds on aluminum pipe in the following positions using GTAW equipment:
   - 2G
   - 5G
   - 6G

Performance Tasks

Under the supervision of the instructor, the trainee should be able to do the following:
1. Set up GTAW equipment to weld aluminum pipe.
2. Make GTAW V-groove and modified U-groove welds on aluminum pipe in the following positions:
   - 2G
   - 5G
   - 6G

Materials and Equipment

- Pencils and scratch paper
- Whiteboard/chalkboard
- Markers/chalk
- Advanced Topics in Welding: Aluminum
- Multimedia projector and screen
- Desktop or laptop computer
- Appropriate personal protective equipment
- Fully charged fire extinguishers for the labs
- Welding curtains or shields
- GTAW welding equipment
- A supply of the following:
  - Shielding gas
  - Applicable aluminum filler metal rods
  - Aluminum pipe for coupons (3” to 12” diameter Schedule 40)
  - Cleaning materials for coupons
  - Cleaning materials for coupons (continued)

MSDS for each cleaning agent used
- Welding bench with arm for position work
- Portable grinders with extra grinding discs
- Bevel gauges
- Levels
- Hi-Lo gauges
- Framing squares
- Precision measurement devices (micrometers and calipers)
- Soapstone
- Tape measures
- Pliers
- Half-round bastard files
- Stainless steel wire brushes
- Chipping hammers
- Workpiece clamps

(continued)
Examples of the following:
- V-groove and modified U-groove pipe coupons
- Backing rings used for 6GR welds
- Acceptable and unacceptable beads created with different travel speeds, arc lengths, and gun angles

- Prepared aluminum pipe coupons with ring for 6GR welds
- V-groove and modified U-groove welds from all four positions

Module Examinations*
Performance Profile Sheets*

* Single-module AIG purchases include the printed exam and performance task sheet. If you have purchased the perfect-bound version of this title, download these materials from the IRC using your access code.

Safety Considerations

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. Trainees will be required to make V-groove and modified U-groove welds on aluminum pipe with GTAW equipment. Ensure that trainees are properly briefed on the safe use of GTAW equipment and are familiar with all appropriate safety precautions and procedures. Verify that all labs are equipped with charged fire extinguishers.

Additional Resources

This module is intended to present thorough resources for task training. The following reference works are suggested for both instructors and motivated trainees interested in further study. These are optional materials for continued education rather than for task training.


Lincoln Electric website: http://www.lincolnelectric.com offers sources for products and training.


Teaching Time for this Module

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 50 hours are suggested to cover GTAW – Aluminum Pipe. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of trainees may be noted during these exercises for Performance Testing purposes. The laboratory portion should take approximately 40 hours or 16 sessions.

### Topic Planned Time

#### Sessions I–II. Introduction; Safety Summary; Welding Preparation; GTAW Techniques; Groove Welds

<table>
<thead>
<tr>
<th>Topic</th>
<th>Planned Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Introduction</td>
<td></td>
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<td></td>
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<tr>
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<td>3. Work Area Ventilation</td>
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<td>C. Welding Preparation</td>
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<tr>
<td>1. Practice Pipe Weld Coupons</td>
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<td>2. The Welding Machine</td>
<td></td>
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<td>3. Filler Metals</td>
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<tr>
<td>D. Gas Tungsten Arc Welding Techniques</td>
<td></td>
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<tr>
<td>1. Torch Travel Speed and Arc Length</td>
<td></td>
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<td>2. Torch Angles</td>
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<tr>
<td>E. V-Groove and Modified U-Groove Pipe Welds</td>
<td></td>
</tr>
<tr>
<td>1. Techniques for Aluminum Pipe GTAW</td>
<td></td>
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<tr>
<td>2. Pipe Groove Weld Test Positions</td>
<td></td>
</tr>
<tr>
<td>3. Acceptable and Unacceptable Pipe Weld Profiles</td>
<td></td>
</tr>
</tbody>
</table>

#### Session III. Laboratory and Performance Testing

<table>
<thead>
<tr>
<th>Topic</th>
<th>Planned Time</th>
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<tbody>
<tr>
<td>A. Laboratory</td>
<td></td>
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<tr>
<td>Have trainees prepare the area and set up GTAW equipment to weld aluminum pipe. This laboratory corresponds to Performance Task 1.</td>
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<td>B. Laboratory</td>
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<tr>
<td>Have trainees practice preparing pipe coupons, running GTAW beads using the freehand and walking-the-cup techniques, and inspecting GTAW beads.</td>
<td></td>
</tr>
</tbody>
</table>

#### Sessions IV–VIII. Practicing V-Groove or Modified U-Groove Pipe Welds (2G); Laboratory and Performance Testing

<table>
<thead>
<tr>
<th>Topic</th>
<th>Planned Time</th>
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</thead>
<tbody>
<tr>
<td>A. Practicing Horizontal (2G) Position Groove Welds</td>
<td></td>
</tr>
<tr>
<td>B. Laboratory</td>
<td></td>
</tr>
<tr>
<td>Have trainees prepare aluminum pipe coupons for GTAW groove welds in the 2G position.</td>
<td></td>
</tr>
<tr>
<td>C. Laboratory</td>
<td></td>
</tr>
<tr>
<td>Have trainees practice making GTAW V-groove and modified U-groove welds on aluminum pipe in the 2G position. This laboratory corresponds to Performance Task 2.</td>
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</tbody>
</table>
Sessions IX–XIII. Practicing V-Groove or Modified U-Groove Pipe Welds (5G); Laboratory and Performance Testing

A. Practicing Multiple (5G) Position Groove Welds

B. Laboratory
   Have trainees prepare aluminum pipe coupons for GTAW groove welds in the 5G position.

C. Laboratory
   Have trainees practice making GTAW V-groove and modified U-groove welds on aluminum pipe in the 5G position. This laboratory corresponds to Performance Task 2.

Sessions XIV–XVIII. Practicing V-Groove or Modified U-Groove Pipe Welds (6G); Laboratory and Performance Testing

A. Practicing Multiple Inclined (6G) Position Groove Welds

B. Laboratory
   Have trainees prepare aluminum pipe coupons for GTAW groove welds in the 6G position.

C. Laboratory
   Have trainees practice making GTAW V-groove and modified U-groove welds on aluminum pipe in the 6G position. This laboratory corresponds to Performance Task 2.

Sessions XIX–XX. Review and Testing; Performance Accreditation Tasks

A. Module Review

B. Module Examination
   1. Trainees must score 70% or higher to receive recognition from NCCER.
   2. Record the testing results on Training Report Form 200, and submit the results to the Training Program Sponsor.

C. Performance Testing
   1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements.
   2. Record the testing results on Training Report Form 200, and submit the results to the Training Program Sponsor.

D. Performance Accreditation Tasks – Have trainees complete PAT 1 through PAT 3, according to the acceptance criteria.
   1. Have trainees perform PAT 1, Make V-Groove or Modified U-Groove Welds on Aluminum Pipe in the 2G Position. This task corresponds to AWS EG3.0-96: 3.3.6.4, Unit #4, GTAW, Learning Objective #14, (2G and 5G).
   2. Have trainees perform PAT 2, Make V-Groove or Modified U-Groove Welds on Aluminum Pipe in the 5G Position. This task corresponds to AWS EG3.0-96: 3.3.6.4, Unit #4, GTAW, Learning Objective #14, (2G and 5G).
   3. Have trainees perform PAT 3, Make V-Groove or Modified U-Groove Welds on Aluminum Pipe in the 6G (or 6GR) Position. This task corresponds to AWS EG3.0-96: 3.3.6.5, Unit #5, GTAW, Learning Objective #12 (6G with backing ring).
Module Overview

This module explains how to make V-groove welds on aluminum pipe with backing in all positions using GMAW equipment, aluminum filler wire, and shielding gas.

Prerequisites

Prior to training with this module, it is recommended that the trainee shall have successfully completed Core Curriculum; Welding Level One; Welding Level Two; Welding Level Three; and Advanced Topics in Welding: Aluminum, Modules 29401-10 through 29403-10.

Objectives

Upon completion of this module, the trainee will be able to do the following:
1. Explain GMAW preparations associated with making V-groove welds on aluminum pipe.
2. Perform V-groove welds on aluminum pipe with backing in the following positions, using GMAW equipment, aluminum wire, and shielding gas:
   • 2G
   • 5G
   • 6G

Performance Tasks

Under the supervision of the instructor, the trainee should be able to do the following:
1. Make selected V-groove welds on aluminum pipe with backing in the following positions, using GMAW equipment:
   • 2G
   • 5G
   • 6G

Materials and Equipment

Pencils and scratch paper
Whiteboard/chalkboard
Markers/chalk
Advanced Topics in Welding: Aluminum PowerPoint® Presentation Slides
Multimedia projector and screen
Desktop or laptop computer
Appropriate personal protective equipment
Fully charged fire extinguishers for the labs
Welding curtains or shields
GMAW welding equipment
A supply of the following:
   • Shielding gas
   • Applicable aluminum filler wire
   • Aluminum pipe for coupons (6” to 12” diameter Schedule 40)
   • Cleaning materials for coupons
   • MSDS for each cleaning agent used
   • Welding bench with arm for position work
   • Portable grinders with extra grinding discs
   • Bevel gauges
   • Levels
   • Hi-Lo gauges
   • Framing squares
   • Precision measurement devices:
     (micrometers and calipers)
   • Soapstone
   • Tape measures
   • Pliers
   • Half-round bastard files
   • Stainless steel wire brushes
   • Chipping hammers
   • Workpiece clamps

(continued)
Examples of the following:
- Beads/welds created with different voltage and amperage settings
- Beads/welds created with different travel speeds and gun angles
- Welds made with different electrode extensions, stickouts, and standoff distances
- V-groove aluminum pipe coupons with backing

- Aluminum pipe coupons with ground and unground tack welds
- V-groove welds with backing from all four positions
- Backing rings used for 6GR welds
- Prepared aluminum pipe coupons with ring for 6GR welds

Module Examinations*  
Performance Profile Sheets*

* Single-module AIG purchases include the printed exam and performance task sheet. If you have purchased the perfect-bound version of this title, download these materials from the IRC using your access code.

Safety Considerations

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. Trainees will be required to make V-groove welds on aluminum pipe with backing using GMAW equipment. Ensure that trainees are properly briefed on the safe use of GMAW equipment and are familiar with all appropriate safety precautions and procedures. Verify that all labs are equipped with charged fire extinguishers.

Additional Resources

This module is intended to present thorough resources for task training. The following reference works are suggested for both instructors and motivated trainees interested in further study. These are optional materials for continued education rather than for task training.


Lincoln Electric website: http://www.lincolnelectric.com offers sources for products and training.


An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 50 hours are suggested to cover GMAW – Aluminum Pipe. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of trainees may be noted during these exercises for Performance Testing purposes. The laboratory portion should take approximately 40 hours or 16 sessions.

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**Session I. Introduction; Safety Summary; Welding Preparation**

A. Introduction

B. Safety Summary

1. Protective Clothing and Equipment
2. Fire/Explosion Prevention
3. Work Area Ventilation
4. Housekeeping and Fall Protection
5. Electrical Hazards

C. Welding Preparation

1. The Welding Machine
2. Practice Welding Coupons

**Session II. Laboratory**

A. Laboratory

Have trainees prepare the area and set up GMAW equipment for welding aluminum pipe.

B. Laboratory

Have trainees prepare aluminum pipe coupons for V-groove welds with backing.

**Sessions III–IV. Practicing V-Groove Pipe Welds (1G-ROTATED); Laboratory**

A. Practicing Flat (1G-ROTATED) Position V-Groove Welds

B. Laboratory

Have trainees prepare aluminum pipe coupons for GMAW V-groove welds in the 1G-ROTATED position.

C. Laboratory

Have trainees practice making selected V-groove welds on aluminum pipe with backing in the flat (1G-ROTATED) position using GMAW equipment.

**Sessions V–VIII. Practicing V-Groove Pipe Welds (2G); Laboratory and Performance Testing**

A. Practicing Horizontal (2G) Position V-Groove Welds

B. Laboratory

Have trainees prepare aluminum pipe coupons for GMAW V-groove welds in the 2G position.

C. Laboratory

Have trainees practice making selected V-groove welds on aluminum pipe with backing in the horizontal (2G) position using GMAW equipment. This laboratory corresponds to Performance Task 1.
Sessions IX–XIII. Practicing V-Groove Pipe Welds (5G); Laboratory and Performance Testing

A. Practicing Multiple (5G) Position V-Groove Welds

B. Laboratory
   Have trainees prepare aluminum pipe coupons for GMAW V-groove welds in the 5G position.

C. Laboratory
   Have trainees practice making selected V-groove welds on aluminum pipe with backing in the multiple (5G) position using GMAW equipment. This laboratory corresponds to Performance Task 1.

Sessions XIV–XIX. Practicing V-Groove Pipe Welds (6G); Laboratory and Performance Testing

A. Practicing Multiple Inclined (6G) Position V-Groove Welds

B. Laboratory
   Have trainees prepare aluminum pipe coupons for GMAW V-groove welds in the 6G position.

C. Laboratory
   Have trainees practice making selected V-groove welds on aluminum pipe with backing in the multiple inclined (6G) position using GMAW equipment. This laboratory corresponds to Performance Task 1.

Session XX. Review and Testing; Performance Accreditation Tasks

A. Module Review

B. Module Examination
   1. Trainees must score 70% or higher to receive recognition from NCCER.
   2. Record the testing results on Training Report Form 200, and submit the results to the Training Program Sponsor.

C. Performance Testing
   1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements.
   2. Record the testing results on Training Report Form 200, and submit the results to the Training Program Sponsor.

D. Performance Accreditation Tasks – Have trainees complete PAT 1 through PAT 3, according to the acceptance criteria.
   1. Have trainees perform PAT 1, Make V-Groove Welds on Aluminum Pipe with Backing in the 2G Position. This task has no AWS correlation.
   2. Have trainees perform PAT 2, Make V-Groove Welds on Aluminum Pipe with Backing in the 5G Position. This task has no AWS correlation.
   3. Have trainees perform PAT 3, Make V-Groove Welds on Aluminum Pipe with Backing in the 6G (or 6GR) Position. This task corresponds to AWS EG4.0-96: 3.3.6.3, Unit #3, GMAW, Learning Objective #8 (6G).