

## Module Overview

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This module explains how to prepare SMAW equipment for open-root V-groove pipe welds. It also covers how to make open-root V-groove pipe welds in all positions using SMAW equipment.

## Prerequisites

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

## Objectives

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

1. Prepare SMAW equipment for open-root V-groove pipe welds.
2. Identify and explain open-root V-groove pipe weld techniques with SMAW equipment.
3. Perform open-root V-groove pipe welds in the following positions using SMAW equipment:
  - 1G-ROTATED
  - 2G
  - 5G
  - 6G

## Performance Tasks

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

1. Prepare SMAW equipment for open-root pipe welds.
2. Make pipe welds in the 1G-ROTATED position.
3. Make pipe welds in the 2G position.
4. Make pipe welds in the 5G position.
5. Make pipe welds in the 6G position.

## Materials and Equipment List

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Markers/chalk	Adjustable pipe stands with rollers
Pencils and scratch paper	Portable grinders with extra grinding discs
Whiteboard/chalkboard	Fully-charged fire extinguishers for the labs
Welding 3 PowerPoint® Presentation Slides (ISBN 978-0-13-214725-5)	Welding curtains or shields
Multimedia projector and screen	Bevel gauges
Desktop or laptop computer	Hi-Lo gauges
Appropriate personal protective equipment	Levels
A legal safety harness with lanyards	Framing squares
SMAW welding equipment	Soapstone
A supply of 1/8" E6010 and 1/8" or 3/32" E7018 electrodes	Tape measures
Rod holder	Precision measurement devices (micrometers and calipers)
Electrode oven	Pliers
A supply of 3" to 12" diameter Schedule 40 or Schedule 80 carbon steel pipe for coupons	Half-round bastard files
Cleaning materials for cleaning coupons	Wire brushes
MSDS for each cleaning material used	Chipping hammers
Welding bench with arm for position work	Workpiece clamps
	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

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Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. Trainees will be required to set up SMAW equipment and perform open-root V-groove pipe welds. Ensure that trainees are properly briefed on the safe use of SMAW welding equipment and are familiar with all appropriate safety precautions and procedures, including electrical safety. Ensure that all labs are equipped with charged fire extinguishers.

## Additional Resources

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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.

- AWS B1.10:1999 Guide for the Nondestructive Examination of Welds.* Miami, FL: American Welding Society.
- AWS B1.11:2000 Guide for the Visual Examination of Welds.* Miami, FL: American Welding Society.
- AWS C5.6-1989 Recommended Practices for Gas Metal Arc Welding.* Miami, FL: American Welding Society.
- AWS D3.5-93R: Guide for Steel Hull Welding.* Miami, FL: American Welding Society, 1993.
- AWS F4.1:1999 Recommended Safe Practices for Preparation for Welding and Cutting of Containers and Piping.* Miami, FL: American Welding Society.
- AWS PCWC:2001 Preparing Containers for Welding or Cutting.* Miami, FL: American Welding Society.
- Lincoln Electric website: <http://www.lincolnelectric.com> offers sources for products and training.
- Modern Welding Technology.* Howard B. Cary and Scott Helzer. Englewood Cliffs, NJ: Prentice Hall, Inc., 2005.
- OSHA 1910.269, Appendix C, Protection from Step and Touch Potentials.* Latest edition. Washington, DC: Occupational Safety & Health Administration.
- OSHA 1926.351, Arc Welding and Cutting.* Latest edition. Washington, DC: Occupational Safety & Health Administration.
- The Procedure Handbook of Arc Welding.* Cleveland, OH: The James F. Lincoln Arc Welding Foundation, 2000.
- Welding Handbook.* Volume 1. *Welding Science & Technology.* Miami, FL: American Welding Society, 2001.
- Welding Handbook.* Volume 2, Part 1: *Welding Processes.* Miami, FL: American Welding Society, 2004.
- Welding Pressure Pipelines and Piping Systems.* Cleveland, OH: The Lincoln Electric Company, 2000.

## Teaching Time for this Module

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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 100 hours are suggested to cover *SMAW – Open-Root Pipe Welds*. 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 90 hours or 36 sessions.

Topic	Planned Time
<b>Session I. Introduction; Arc Welding Equipment Setup</b>	
A. Introduction	_____
B. Arc Welding Equipment Setup	_____
1. Safety Practices	_____
2. Preparing the Welding Area	_____
3. Preparing Pipe Weld Coupons	_____
4. Electrodes	_____
5. Preparing the Welding Machine	_____

**Session II. Laboratory and Performance Testing**

A. Laboratory

Have trainees practice setting up the welding area and SMAW equipment for open-root V-groove pipe welds. This laboratory corresponds to Performance Task 1.

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B. Laboratory

Have trainees prepare pipe coupons for open-root pipe welds.

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**Session III. Open-Root V-Groove Pipe Welds**

A. Open-Root V-Groove Pipe Welds

- 1. Open-Root Pass
- 2. Pipe Groove Weld Test Positions
- 3. Acceptable and Unacceptable Pipe Weld Profiles

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B. SMAW of Open-Root V-Groove Welds

- 1. Flat (1G-ROTATED) Position Open-Root V-Groove Pipe Welds

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**Sessions IV–XIII. Laboratory and Performance Testing**

A. Laboratory (1 session)

Have trainees prepare coupons and equipment for welds in the 1G-ROTATED position.

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B. Laboratory (9 sessions)

Have trainees practice making SMAW pipe welds in the 1G-ROTATED position. This laboratory corresponds to Performance Task 2.

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**Sessions XIV–XXI. Horizontal (2G) Position Open-Root V-Groove Pipe Welds; Laboratory and Performance Testing**

A. Horizontal (2G) Position Open-Root V-Groove Pipe Welds (1 session)

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B. Laboratory (1 session)

Have trainees prepare coupons for SMAW pipe welds in the 2G position.

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C. Laboratory (6 sessions)

Have trainees practice making SMAW pipe welds in the 2G position. This laboratory corresponds to Performance Task 3.

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**Sessions XXII–XXX. Multiple (5G) Position Open-Root V-Groove Pipe Welds; Laboratory and Performance Testing**

A. Multiple (5G) Position Open-Root V-Groove Pipe Welds (1 session)

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B. Laboratory (1 session)

Have trainees prepare coupons for SMAW pipe welds in the 5G position.

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C. Laboratory (7 sessions)

Have trainees practice making SMAW pipe welds in the 5G position. This laboratory corresponds to Performance Task 4.

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**Sessions XXXI–XXXIX. Multiple Inclined (6G) Position Open-Root V-Groove Pipe Welds; Laboratory and Performance Testing**

A. Multiple Inclined (6G) Position Open-Root V-Groove Pipe Welds (1 session)

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B. Laboratory (1 session)

Have trainees prepare coupons for SMAW pipe welds in the 6G position.

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C. Laboratory (7 sessions)

Have trainees practice making SMAW pipe welds in the 6G position. This laboratory corresponds to Performance Task 5.

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**Session XXXX. Review and Testing; Performance Accreditation Tasks**

A. Module Review

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B. Module Examination

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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 4, according to the acceptance criteria.

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1. Have trainees perform PAT 1, Make an Open-Root V-Groove Pipe Weld in the 1G-ROTATED Position. This task has no AWS correlation.
2. Have trainees perform PATs 2, 3, and 4, Make Open-Root V-Groove Pipe Welds in the 2G, 5G, and 6G positions. These tasks correspond to AWS EG3.0-96: 3.3.6.1, Unit #1, SMAW, Learning Objective #10.

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## Module Overview

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This module explains how to prepare GMAW equipment for open-root V-groove pipe welds. It also covers how to make open-root V-groove pipe welds in all positions using GMAW equipment.

## Prerequisites

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Prior to training with this module, it is recommended that the trainee shall have successfully completed the following: *Core Curriculum; Welding Level One; Welding Level Two; and Welding Level Three, Module 29301-10.*

## Objectives

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

1. Prepare GMAW equipment for open-root V-groove pipe welds.
2. Identify and explain open-root V-groove pipe weld techniques with GMAW equipment.
3. Perform open-root V-groove pipe welds in the following positions using GMAW equipment:
  - 1G-ROTATED
  - 2G
  - 5G
  - 6G

## Performance Tasks

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

1. Set up GMAW equipment for open-root V-groove pipe welds.
2. Make GMAW open-root V-groove pipe welds in the 1G-ROTATED position using applicable filler metal and shielding gas.
3. Make GMAW open-root V-groove pipe welds in the 2G position using applicable filler metal and shielding gas.
4. Make GMAW open-root V-groove pipe welds in the 5G position using applicable filler metal and shielding gas.
5. Make GMAW open-root V-groove pipe welds in the 6G position using applicable filler metal and shielding gas.

## Materials and Equipment List

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Markers/chalk	Antispatter compound
Pencils and scratch paper	MSDS for each cleaning agent used and for the antispatter compound
Whiteboard/chalkboard	Welding bench with arm for position work
Welding 3 PowerPoint® Presentation Slides (ISBN 978-0-13-214725-5)	Portable grinders with extra grinding discs
Multimedia projector and screen	Bevel gauges
Desktop or laptop computer	Levels
Appropriate personal protective equipment	Hi-Lo gauges
Fully charged fire extinguishers for the labs	Framing squares
Welding curtains or shields	Precision measurement devices (micrometers and calipers)
GMAW welding equipment	Soapstone
Shielding gas	Tape measures
Solid or composite wire	Pliers
A supply of 4" to 12" diameter Schedule 40 or Schedule 80 carbon steel pipe for coupons	Half-round bastard files
Backing materials for carbon steel pipe	Wire brushes
Cleaning materials for coupons	

(continued)

Chipping hammers

Workpiece clamps

Examples of the following:

- Beads created with different welding voltage and amperage settings
- Beads created with different travel speed settings and gun angles

- Welds made with different electrode extensions, stickout lengths, and standoff distances
- Broken apart or sawed apart open-root V-groove weld

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

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

## Additional Resources

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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.

*API 1104 – Welding of Pipelines and Related Facilities.* Washington, DC: American Petroleum Institute, 2005.

*ASME Boiler and Pressure Vessel Code, Section IX: Welding and Brazing Qualifications.* New York, NY: ASME International.

*AWS B1.10:1999 Guide for the Nondestructive Examination of Welds.* Miami, FL: American Welding Society, 2007.

*AWS B1.11:2000 Guide for the Visual Examination of Welds.* Miami, FL: American Welding Society.

*AWS C5.6-1989 Recommended Practices for Gas Metal Arc Welding.* Miami, FL: American Welding Society.

*AWS D3.5-93R Guide for Steel Hull Welding.* Miami, FL: American Welding Society, 1993.

*AWS D10.11M/D10.11:2007 Guide for Root Pass Welding of Pipe Without Backing.* Miami, FL: American Welding Society.

*AWS F4.1:1999 Recommended Safe Practices for Preparation for Welding and Cutting of Containers and Piping.* Miami, FL: American Welding Society.

*AWS PCWC:2001 Preparing Containers for Welding or Cutting.* Miami, FL: American Welding Society.

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

*MIG Welding Handbook.* Florence, SC: ESAB, 1994.

*Modern Welding Technology.* Howard B. Cary and Scott Helzer. Englewood Cliffs, NJ: Prentice Hall, Inc., 2005.

*OSHA 1910.269, Appendix C, Protection from Step and Touch Potentials.* Current edition. Washington, DC: Occupational Safety & Health Administration.

*OSHA 1926.351, Arc Welding and Cutting.* Current edition. Washington, DC: Occupational Safety & Health Administration.

*The Procedure Handbook of Arc Welding.* Cleveland, OH: The James F. Lincoln Arc Welding Foundation, 2000.

*Welding Handbook. Volume 1. Welding Science & Technology.* Miami, FL: American Welding Society, 2001.

*Welding Handbook. Volume 2, Part 1: Welding Processes.* Miami, FL: American Welding Society, 2004.

*Welding Pressure Pipelines and Piping Systems.* Cleveland, OH: The Lincoln Electric Company, 2000.

## Teaching Time for this Module

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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 60 hours are suggested to cover *GMAW – 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 50 hours or 20 sessions.

Topic	Planned Time
<b>Session I. Introduction; Safety Summary; Welding Preparation</b>	
A. Introduction	_____
B. Safety Summary	_____
1. Protective Clothing and Equipment	_____
2. Fire/Explosion Prevention	_____
3. Work Area Ventilation	_____
C. Welding Preparation	_____
1. Practice Pipe Weld Coupons	_____
2. The Welding Machine	_____
<b>Session II. Laboratory and Performance Testing</b>	
A. Laboratory	_____
Have trainees practice setting up GMAW equipment for open-root V-groove pipe welds. This laboratory corresponds to Performance Task 1.	
B. Laboratory	_____
Have trainees prepare pipe coupons for open-root V-groove pipe welds.	
<b>Session III. Open-Root V-Groove Pipe Welds</b>	
A. Open-Root V-Groove Pipe Welds	_____
1. GMAW Welding Techniques	_____
2. Pipe Groove Weld Test Positions	_____
3. Acceptable and Unacceptable Pipe Weld Profiles	_____
B. Practicing Open-Root V-Groove Welds	_____
1. Flat (1G-ROTATED) Position	_____
<b>Sessions IV–VII. Laboratory and Performance Testing</b>	
A. Laboratory (1 session)	_____
Have trainees prepare coupons and support equipment for pipe welds in the 1G-ROTATED position.	
B. Laboratory (3 sessions)	_____
Have trainees practice making GMAW open-root V-groove pipe welds in the 1G-ROTATED position using applicable filler metal and shielding gas. This laboratory corresponds to Performance Task 2.	
<b>Sessions VIII–XII. Horizontal (2G) Position Open-Root V-Groove Welds; Laboratory and Performance Testing</b>	
A. Horizontal (2G) Position (1 session)	_____
B. Laboratory (1 session)	_____
Have trainees prepare coupons for GMAW pipe welds in the 2G position.	
C. Laboratory (3 sessions)	_____
Have trainees practice making GMAW open-root V-groove pipe welds in the 2G position using applicable filler metal and shielding gas. This laboratory corresponds to Performance Task 3.	

**Sessions XIII–XVII. Multiple (5G) Position Open-Root V-Groove Welds;  
Laboratory and Performance Testing**

A. Multiple (5G) Position (1 session) \_\_\_\_\_

B. Laboratory (1 session) \_\_\_\_\_

Have trainees prepare coupons for GMAW pipe welds in the 5G position.

C. Laboratory (3 sessions) \_\_\_\_\_

Have trainees practice making GMAW open-root V-groove pipe welds in the 5G position using applicable filler metal and shielding gas. This laboratory corresponds to Performance Task 4.

**Sessions XVIII–XXIII. Multiple Inclined (6G) Position Open-Root V-Groove  
Welds; Laboratory and Performance Testing**

A. Multiple Inclined (6G) Position (1 session) \_\_\_\_\_

B. Laboratory (1 session) \_\_\_\_\_

Have trainees prepare coupons for GMAW pipe welds in the 6G position.

C. Laboratory (4 sessions) \_\_\_\_\_

Have trainees practice making GMAW open-root V-groove pipe welds in the 6G position using applicable filler metal and shielding gas. This laboratory corresponds to Performance Task 5.

**Session XXIV. 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 4 according to the acceptance criteria.

1. Have trainees perform PAT 1, Make an Open-Root V-Groove Pipe Weld in the 1G-ROTATED Position. This task has no AWS correlation. \_\_\_\_\_
2. Have trainees perform PATs 2 and 3, Make Open-Root V-Groove Pipe Welds in the 2G and 5G Positions. These task corresponds to AWS EG3.0-96: 3.3.6.2, Unit #2, GMAW, Learning Objective #11. \_\_\_\_\_
3. Have trainees perform PAT 4, Make an Open-Root V-Groove Pipe Weld in the (6G) Position. This task corresponds to AWS EG4.0-96: 3.3.6.3, Unit #3, GMAW, Learning Objective #7. \_\_\_\_\_



## Module Overview

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This module explains how to prepare FCAW equipment for open-root V-groove pipe welds and how to make open-root V-groove pipe welds in all positions using FCAW equipment.

## Prerequisites

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Prior to training with this module, it is recommended that the trainee shall have successfully completed the following: *Core Curriculum*; *Welding Level One*; *Welding Level Two*; and *Welding Level Three*, Modules 29301-10 and 29302-10.

## Objectives

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

1. Prepare FCAW equipment for open-root V-groove pipe welds.
2. Identify and explain open-root V-groove pipe weld techniques with FCAW equipment.
3. Perform open-root V-groove pipe welds in the following positions using FCAW equipment:
  - 1G-ROTATED
  - 2G
  - 5G
  - 6G

## Performance Tasks

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

1. Set up FCAW equipment for open-root V-groove pipe welds.
2. Make FCAW open-root V-groove pipe welds in the 1G-ROTATED position.
3. Make FCAW open-root V-groove pipe welds in the 2G position.
4. Make FCAW open-root V-groove pipe welds in the 5G position.
5. Make FCAW open-root V-groove pipe welds in the 6G position.

## Materials and Equipment List

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Markers/chalk  
Pencils and scratch paper  
Whiteboard/chalkboard  
Welding 3 PowerPoint® Presentation Slides  
(ISBN 978-0-13-214725-5)  
Multimedia projector and screen  
Desktop or laptop computer  
Appropriate personal protective equipment  
Fully charged fire extinguishers for the labs  
Welding curtains or shields  
FCAW welding equipment  
Shielding gas  
Flux-cored wire  
A supply of 3" to 12" diameter Schedule 40 or  
Schedule 80 carbon steel pipe for coupons  
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  
Wire brushes  
Chipping hammers  
Workpiece clamps  
Examples of the following:

- Beads created with different welding voltage and amperage settings
- Beads created with different travel speed settings and different gun angles
- Welds made with different electrode extensions, stickout lengths, and standoff distances
- Broken apart or sawed apart open-root V-groove weld

Module Examinations\*  
Performance Profile Sheets\*

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## Safety Considerations

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

## Additional Resources

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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.

- API 1104 – Welding of Pipelines and Related Facilities.* Washington, DC: American Petroleum Institute, 2005.
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- AWS B1.11:2000 Guide for the Visual Examination of Welds.* Miami, FL: American Welding Society.
- AWS D3.5-93R: Guide for Steel Hull Welding.* Miami, FL: American Welding Society, 1993.
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## Teaching Time for this Module

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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 60 hours are suggested to cover *FCAW – 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 50 hours or 20 sessions.

Topic	Planned Time
<b>Session I. Introduction; Safety Summary; Welding Preparation</b>	
A. Introduction	_____
B. Safety Summary	_____
1. Protective Clothing and Equipment	_____
2. Fire/Explosion Prevention	_____
3. Work Area Ventilation	_____
C. Welding Preparation	_____
1. Practice Pipe Weld Coupons	_____
2. The Welding Machine	_____

**Session II. Laboratory and Performance Testing**

A. Laboratory

Have trainees practice setting up FCAW equipment for open-root V-groove pipe welds. This laboratory corresponds to Performance Task 1.

B. Laboratory

Have trainees prepare pipe coupons for open-root V-groove pipe welds.

**Session III. Open-Root V-Groove Pipe Welds**

A. Open-Root V-Groove Pipe Welds

- 1. FCAW Welding Techniques
- 2. Pipe Groove Weld Test Positions
- 3. Acceptable and Unacceptable Pipe Weld Profiles

B. Practicing Open-Root V-Groove Welds

- 1. Flat (1G-ROTATED) Position

**Sessions IV–VII. Laboratory and Performance Testing**

A. Laboratory (1 session)

Have trainees prepare coupons and support equipment for pipe welds in the 1G-ROTATED position.

B. Laboratory (3 sessions)

Have trainees practice making FCAW open-root V-groove pipe welds in the 1G-ROTATED position using applicable filler wire and shielding gas, if required. This laboratory corresponds to Performance Task 2.

**Sessions VIII–XII. Horizontal (2G) Position Open-Root V-Groove Welds; Laboratory and Performance Testing**

A. Horizontal (2G) Position (1 session)

B. Laboratory (1 session)

Have trainees prepare coupons for FCAW pipe welds in the 2G position.

C. Laboratory (3 sessions)

Have trainees practice making FCAW open-root V-groove pipe welds in the 2G position using applicable filler wire and shielding gas, if required. This laboratory corresponds to Performance Task 3.

**Sessions XIII–XVII. Multiple (5G) Position Open-Root V-Groove Welds; Laboratory and Performance Testing**

A. Multiple (5G) Position (1 session)

B. Laboratory (1 session)

Have trainees prepare coupons for FCAW pipe welds in the 5G position.

C. Laboratory (3 sessions)

Have trainees practice making FCAW open-root V-groove pipe welds in the 5G position using applicable filler wire and shielding gas, if required. This laboratory corresponds to Performance Task 4.

**Sessions XVIII–XXIII. Multiple Inclined (6G) Position Open-Root V-Groove Welds; Laboratory and Performance Testing**

A. Multiple Inclined (6G) Position (1 session)

B. Laboratory (1 session)

Have trainees prepare coupons for FCAW pipe welds in the 6G position.

C. Laboratory (4 sessions)

Have trainees practice making FCAW open-root V-groove pipe welds in the 6G position using applicable filler wire and shielding gas, if required. This laboratory corresponds to Performance Task 5.

**Session XXIV. 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 PATs 1 and 2, Make Open-Root V-Groove Pipe Welds in the 2G and 5G Positions. These tasks correspond to *AWS EG3.0-96: 3.3.6.3, Unit #3, FCAW, Learning Objective #7.* \_\_\_\_\_
2. Have trainees perform PAT 3, Make an Open-Root V-Groove Pipe Weld in the 6G Position. This task corresponds to *AWS EG4.0-96: 3.3.6.4, Unit #4, FCAW, Learning Objectives #7 & #8.* \_\_\_\_\_

## Module Overview

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This module explains how to prepare GTAW equipment for open-root V-groove welds on carbon steel pipe. It also covers how to make open-root V-groove welds on carbon steel pipe in all positions using GTAW equipment.

## Prerequisites

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Prior to training with this module, it is recommended that the trainee shall have successfully completed the following: *Core Curriculum*; *Welding Level One*; *Welding Level Two*; and *Welding Level Three*, Modules 29301-10 through 29303-10.

## Objectives

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

1. Prepare GTAW equipment for open-root V-groove welds on carbon steel pipe.
2. Identify and explain open-root V-groove pipe weld techniques with GTAW equipment.
3. Perform open-root V-groove welds on carbon steel pipe in the following positions using GTAW equipment:
  - 2G
  - 5G
  - 6G

## Performance Tasks

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

1. Set up GTAW equipment to create open-root V-groove welds on carbon steel pipe using the appropriate filler metal and argon gas.
2. Make GTAW open-root V-groove welds on carbon steel pipe in the 2G position using carbon steel filler metal and argon gas.
3. Make GTAW open-root V-groove welds on carbon steel pipe in the 5G position using carbon steel filler metal and argon gas.
4. Make GTAW open-root V-groove welds on carbon steel pipe in the 6G position using carbon steel filler metal and argon gas.

## Materials and Equipment List

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Markers/chalk  
Pencils and scratch paper  
Whiteboard/chalkboard  
Welding 3 PowerPoint® Presentation Slides  
(ISBN 978-0-13-214725-5)  
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  
Shielding gas  
Carbon steel filler metal  
A supply of 2" to 6" diameter Schedule 40 or  
Schedule 80 carbon steel pipe for coupons  
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  
Wire brushes  
Chipping hammers  
Workpiece clamps

(continued)

Examples of acceptable and unacceptable welds as follows:

- Welds resulting from different travel speeds and arc lengths
- Welds resulting from different torch work and travel angles

- Broken apart or sawed apart open-root V-groove welds showing profiles

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

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Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. Trainees will be required to make open-root V-groove pipe welds 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. Check to be sure that all labs are equipped with charged fire extinguishers.

## Additional Resources

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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.

*API 1104 – Welding of Pipelines and Related Facilities.* Washington, DC: American Petroleum Institute, 2005.

*ASME Boiler and Pressure Vessel Code, Section IX: Welding and Brazing Qualifications.* New York, NY: ASME International, 2007.

*AWS B1.10:1999 Guide for the Nondestructive Examination of Welds.* Miami, FL: American Welding Society.

*AWS B1.11:2000 Guide for the Visual Examination of Welds.* Miami, FL: American Welding Society.

*AWS D10.11M/D10.11:2007 Guide for Root Pass Welding of Pipe Without Backing.* Miami, FL: American Welding Society.

*Gas Tungsten Arc Welding Guide Book.* John Gerken, Ph.D. Cleveland, OH: The James F. Lincoln Arc Welding Foundation, 2004.

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

*Modern Welding Technology.* Howard B. Cary and Scott Helzer. Englewood Cliffs, NJ: Prentice Hall, Inc., 2005.

*OSHA 1910.269, Appendix C, Protection from Step and Touch Potentials.* Current edition. Washington, DC: Occupational Safety & Health Administration.

*OSHA 1926.351, Arc Welding and Cutting.* Current edition. Washington, DC: Occupational Safety & Health Administration.

*The Procedure Handbook of Arc Welding.* Cleveland, OH: The James F. Lincoln Arc Welding Foundation, 2000.

*Welding Handbook.* Volume 1. *Welding Science & Technology.* Miami, FL: American Welding Society, 2001.

*Welding Handbook.* Volume 2, Part 1: *Welding Processes.* Miami, FL: American Welding Society, 2004.

*Welding Pressure Pipelines and Piping Systems.* Cleveland, OH: The Lincoln Electric Company, 2000.

## Teaching Time for this Module

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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 80 hours are suggested to cover *GTAW – Carbon Steel 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 65 hours or 26 sessions.

Topic	Planned Time
<b>Session I. Introduction; Safety Summary; Welding Preparation</b>	
A. Introduction	_____
B. Safety Summary	_____
1. Protective Clothing and Equipment	_____
2. Fire/Explosion Prevention	_____
3. Work Area Ventilation	_____
C. Welding Preparation	_____
1. Practice Pipe Weld Coupons	_____
2. The Welding Machine	_____
3. Filler Metals	_____
D. Gas Tungsten Arc Welding Techniques	_____
1. Torch Travel Speed and Arc Length	_____
2. Torch Angles	_____
3. Torch and Filler Metal Handling Techniques	_____
<b>Session II. Laboratory</b>	
A. Laboratory	_____
Have trainees practice setting up GTAW equipment for open-root V-groove welds on carbon steel pipe using the appropriate filler metal and argon gas. This laboratory corresponds to Performance Task 1.	
B. Laboratory	_____
Have trainees prepare pipe coupons for open-root V-groove pipe welds.	
<b>Session III. Open-Root V-Groove Pipe Welds</b>	
A. Root Pass	_____
B. Pipe Groove Weld Test Positions	_____
C. Acceptable and Unacceptable Pipe Weld Profiles	_____
D. Practicing Open-Root V-Groove Welds	_____
1. Flat (1G-ROTATED) Position	_____
<b>Sessions IV–X. Laboratory and Performance Testing</b>	
A. Laboratory (1 session)	_____
Have trainees prepare coupons and support equipment for pipe welds in the 1G-ROTATED position.	
B. Laboratory (6 sessions)	_____
Have trainees practice making GTAW open-root V-groove welds on carbon steel pipe in the 1G-ROTATED position using carbon steel filler metal and argon gas.	

**Sessions XI–XVII. Horizontal (2G) Position Open-Root V-Groove Pipe Welds;  
Laboratory and Performance Testing**

- A. Horizontal (2G) Position (1 session) \_\_\_\_\_
- B. Laboratory (1 session) \_\_\_\_\_  
Have trainees prepare coupons for GTAW pipe welds in the 2G position.
- C. Laboratory (5 sessions) \_\_\_\_\_  
Have trainees practice making GTAW open-root V-groove welds on carbon steel pipe in the 2G position using carbon steel filler metal and argon gas. This laboratory corresponds to Performance Task 2.

**Sessions XVIII–XXIV. Multiple (5G) Position Open-Root V-Groove Pipe Welds;  
Laboratory and Performance Testing**

- A. Multiple (5G) Position (1 session) \_\_\_\_\_
- B. Laboratory (1 session) \_\_\_\_\_  
Have trainees prepare coupons for GTAW pipe welds in the 5G position.
- C. Laboratory (5 sessions) \_\_\_\_\_  
Have trainees practice making GTAW open-root V-groove welds on carbon steel pipe in the 5G position using carbon steel filler metal and argon gas. This laboratory corresponds to Performance Task 3.

**Sessions XXV–XXXI. Multiple Inclined (6G) Position Open-Root V-Groove Pipe  
Welds; Laboratory and Performance Testing**

- A. Multiple Inclined (6G) Position (1 session) \_\_\_\_\_
- B. Laboratory (1 session) \_\_\_\_\_  
Have trainees prepare coupons for GTAW pipe welds in the 6G position.
- C. Laboratory (5 sessions) \_\_\_\_\_  
Have trainees practice making GTAW open-root V-groove welds on carbon steel pipe in the 6G position using carbon steel filler metal and argon gas. This laboratory corresponds to Performance Task 4.

**Session XXXII. Review and Testing; Performance Accreditation Tasks**

- A. 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 PATs 1 and 2, Make Open-Root V-Groove Pipe Welds in the 2G and 5G Positions. These tasks correspond to AWS EG3.0-96: 3.3.6.4, Unit #4, GTAW, Learning Objective #14. \_\_\_\_\_
  - 2. Have trainees perform PAT 3, Make an Open-Root V-Groove Pipe Weld in the 6G Position. This task corresponds to AWS EG4.0-96: 3.3.6.5, Unit #5, GTAW, Learning Objective #10. \_\_\_\_\_



## Module Overview

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This module explains how to make open-root V-groove welds on stainless and low-alloy (or carbon) steel pipe in the 2G, 5G, and 6G positions using GTAW equipment.

## Prerequisites

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Prior to training with this module, it is recommended that the trainee shall have successfully completed the following: *Core Curriculum*; *Welding Level One*; *Welding Level Two*; and *Welding Level Three*, Modules 29301-10 through 29304-10.

## Objectives

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

1. Prepare GTAW equipment to create welds with low-alloy and/or stainless steel filler metal on carbon or stainless steel pipe.
2. Identify and explain open-root V-groove pipe weld techniques with GTAW equipment.
3. Perform open-root V-groove welds on low-alloy and stainless steel pipe in the following positions using GTAW equipment:
  - 2G
  - 5G
  - 6G

## Performance Tasks

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

1. Prepare the area for GTAW.
2. Set up GTAW equipment to create welds on carbon or stainless steel pipe with the appropriate filler metal.
3. Make GTAW open-root V-groove welds on appropriate metal pipe in the 2G position using low-alloy and stainless steel filler metal.
4. Make GTAW open-root V-groove welds on appropriate metal pipe in the 5G position using low-alloy and stainless steel filler metal.
5. Make GTAW open-root V-groove welds on appropriate metal pipe in the 6G position using low-alloy and stainless steel filler metal.

## Materials and Equipment List

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Markers/chalk  
Pencils and scratch paper  
Whiteboard/chalkboard  
Welding 3 PowerPoint® Presentation Slides  
(ISBN 978-0-13-214725-5)  
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  
Shielding gas  
Low-alloy and stainless steel filler metal

A supply of 2" to 6" diameter Schedule 10 or  
Schedule 40 stainless, low-alloy, or carbon steel  
pipe for coupons  
Cleaning materials for coupons  
MSDS for each cleaning agent used  
Backing gas  
Backup flux  
Consumable inserts  
Welding bench with arm for position work  
Portable grinders with extra grinding discs  
Bevel gauges  
Levels  
Hi-Lo gauges

(continued)

Framing squares  
Precision measurement devices  
(micrometers and calipers)  
Soapstone  
Tape measures  
Pliers  
Half-round bastard files  
Wire brushes  
Chipping hammers  
Workpiece clamps  
Pipe sections with backing devices to install

Welds showing the results of improper heating processes on low-alloy steel  
Examples of acceptable and unacceptable welds:

- Welds created with different travel speeds and arc lengths
- Welds resulting from different torch work and travel angles
- Broken apart or sawed apart open-root V-groove welds showing profiles

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

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Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. Trainees will be required to make open-root V-groove welds on low-alloy and stainless steel pipe using GTAW. Ensure that trainees are properly briefed on the safe use of GTAW welding equipment and are familiar with all appropriate safety precautions and procedures. Check to be sure that all labs are equipped with charged fire extinguishers.

## Additional Resources

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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.

- API 1104 – Welding of Pipelines and Related Facilities*. Washington, DC: American Petroleum Institute, 2005.
- ASME Boiler and Pressure Vessel Code, Section IX: Welding and Brazing Qualifications*. New York, NY: ASME International, 2007.
- AWS B1.10:1999 Guide for the Nondestructive Examination of Welds*. Miami, FL: American Welding Society.
- AWS B1.11:2000 Guide for the Visual Examination of Welds*. Miami, FL: American Welding Society.
- AWS D10.11M/D10.11:2007 Guide for Root Pass Welding of Pipe Without Backing*. Miami, FL: American Welding Society.
- Gas Tungsten Arc Welding Guide Book*. John Gerken, Ph.D. Cleveland, OH: The James F. Lincoln Arc Welding Foundation, 2004.
- Lincoln Electric website: <http://www.lincolnelectric.com> offers sources for products and training.
- Modern Welding Technology*. Howard B. Cary and Scott Helzer. Englewood Cliffs, NJ: Prentice Hall, Inc., 2005.
- OSHA 1910.269, Appendix C, Protection from Step and Touch Potentials*. Current edition. Washington, DC: Occupational Safety & Health Administration.
- OSHA 1926.351, Arc Welding and Cutting*. Current edition. Washington, DC: Occupational Safety & Health Administration.
- The Procedure Handbook of Arc Welding*. Cleveland, OH: The James F. Lincoln Arc Welding Foundation, 2000.
- Welding Handbook*. Volume 1. *Welding Science & Technology*. Miami, FL: American Welding Society, 2001.
- Welding Handbook*. Volume 2, Part 1: *Welding Processes*. Miami, FL: American Welding Society, 2004.
- Welding Pressure Pipelines and Piping Systems*. Cleveland, OH: The Lincoln Electric Company, 2000.

## Teaching Time for this Module

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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 70 hours are suggested to cover *GTAW – Low-Alloy and Stainless Steel 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 55 hours or 22 sessions.

Topic	Planned Time
<b>Session I. Introduction; Safety Summary; Root Back Side Protection; Welding Preparation</b>	
A. Introduction	_____
B. Safety Summary	_____
1. Protective Clothing and Equipment	_____
2. Fire/Explosion Prevention	_____
3. Work Area Ventilation	_____
C. Root Back Side Protection	_____
1. Backing Gas	_____
2. Backup Flux	_____
3. Consumable Inserts	_____
D. Welding Preparation	_____
1. Practice Pipe Weld Coupons	_____
2. The Welding Machine	_____
3. Filler Metals	_____
<b>Session II. Laboratory</b>	
A. Laboratory	_____
Have trainees prepare the area and set up GTAW equipment for open-root V-groove pipe welds on carbon or stainless steel pipe. This laboratory corresponds to Performance Tasks 1 and 2.	
B. Laboratory	_____
Have trainees prepare pipe coupons for open-root V-groove pipe welds.	
<b>Session III. GTAW Techniques; Open-Root V-Groove Pipe Welds</b>	
A. GTAW Techniques	_____
B. Torch Travel Speed and Arc Length	_____
C. Torch Angles	_____
D. Torch and Filler Metal Handling Techniques	_____
E. Welding Stainless Steel	_____
1. Austenitic Stainless Steels	_____
2. Martensitic Stainless Steels	_____
3. Ferritic Stainless Steels	_____
F. Welding Low-Alloy Steel	_____
1. Controlling the Heat Cycle	_____
2. Protecting the Root	_____
G. Open-Root V-Groove Pipe Welds	_____
H. Root Pass	_____
I. Pipe Groove Weld Test Positions	_____
J. Acceptable and Unacceptable Pipe Weld Profiles	_____

**Session IV. Laboratory**

A. Laboratory

Have trainees practice controlling GTAW travel speed, arc length, and torch angles.

B. Laboratory

Have trainees practice torch and filler metal handling techniques on low-alloy and stainless steel coupons.

**Sessions V–XIII. Practicing Open-Root V-Groove Welds in the Horizontal (2G) Position; Laboratory and Performance Testing**

A. Horizontal (2G) Position (1 session)

B. Laboratory (1 session)

Have trainees prepare coupons for GTAW pipe welds in the 2G position.

C. Laboratory (7 sessions)

Have trainees practice making GTAW open-root V-groove welds on appropriate metal pipe in the 2G position using low-alloy and stainless steel filler metal.

This laboratory corresponds to Performance Task 3.

**Sessions XIV–XX. Practicing Open-Root V-Groove Welds in the Multiple (5G) Position; Laboratory and Performance Testing**

A. Multiple (5G) Position (1 session)

B. Laboratory (1 session)

Have trainees prepare coupons for GTAW pipe welds in the 5G position.

C. Laboratory (5 sessions)

Have trainees practice making GTAW open-root V-groove welds on appropriate metal pipe in the 5G position using low-alloy and stainless steel filler metal.

This laboratory corresponds to Performance Task 4.

**Sessions XXI–XXVII. Practicing Open-Root V-Groove Welds in the Multiple Inclined (6G) Position; Laboratory and Performance Testing**

A. Multiple Inclined (6G) Position (1 session)

B. Laboratory (1 session)

Have trainees prepare coupons for GTAW pipe welds in the 6G position.

C. Laboratory (5 sessions)

Have trainees practice making GTAW open-root V-groove welds on appropriate metal pipe in the 6G position using low-alloy and stainless steel filler metal.

This laboratory corresponds to Performance Task 5.

**Session XXVIII. 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 PATs 1 and 2, Make Open-Root V-Groove Pipe Welds in the 2G and 5G Positions. These tasks correspond to *AWS EG3.0-96: 3.3.6.4, Unit #4, GTAW, Learning Objective #15.*
2. Have trainees perform PAT 3, Make an Open-Root V-Groove Pipe Weld in the 6G Position. This task corresponds to *AWS EG4.0-96: 3.3.6.5, Unit #5, GTAW, Learning Objective #11 (partial).*

## Module Overview

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This module explains how to make SMAW open-root V-groove welds on stainless steel plate and pipe in all positions.

## Prerequisites

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Prior to training with this module, it is recommended that the trainee shall have successfully completed the following: *Core Curriculum; Welding Level One; Welding Level Two; and Welding Level Three, Modules 29301-10 through 29305-10.* Module 29306-10 is not required for successful level completion, but may be included as part of this training program.

## Objectives

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

1. Identify and explain stainless steel metallurgy.
2. Identify and explain the selection of electrodes for welding stainless steel.
3. Explain welding variations for stainless steel.
4. Prepare SMAW equipment for stainless steel welds.
5. Explain open-root V-groove welds on stainless steel plate.
6. Make open-root V-groove welds on stainless steel plate in the following positions using SMAW equipment and electrodes:
  - 1G
  - 2G
  - 3G
  - 4G
7. Explain open-root V-groove welds on stainless steel pipe.
8. Make open-root V-groove welds on stainless steel pipe in the following positions using SMAW equipment and electrodes:
  - 1G-ROTATED
  - 2G
  - 5G
  - 6G

## Performance Tasks

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

1. Prepare SMAW equipment for stainless steel welds.
2. Make open-root V-groove welds on stainless steel plate joints in the 1G position using SMAW equipment and electrodes.
3. Make open-root V-groove welds on stainless steel plate joints in the 2G position using SMAW equipment and electrodes.
4. Make open-root V-groove welds on stainless steel plate joints in the 3G position using SMAW equipment and electrodes.
5. Make open-root V-groove welds on stainless steel plate joints in the 4G position using SMAW equipment and electrodes.
6. Make open-root V-groove welds on stainless steel pipe joints in the 1G-ROTATED position using SMAW equipment and electrodes.
7. Make open-root V-groove welds on stainless steel pipe joints in the 2G position using SMAW equipment and electrodes.
8. Make open-root V-groove welds on stainless steel pipe joints in the 5G position using SMAW equipment and electrodes.
9. Make open-root V-groove welds on stainless steel pipe joints in the 6G position using SMAW equipment and electrodes.

## Materials and Equipment List

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Markers/chalk  
Pencils and scratch paper  
Whiteboard/chalkboard  
Welding 3 PowerPoint® Presentation Slides  
(ISBN 978-0-13-214725-5)  
Multimedia projector and screen  
Desktop or laptop computer  
Appropriate personal protective equipment  
Fully charged fire extinguishers for the labs  
Welding curtains or shields  
SMAW welding equipment  
SMAW electrodes for stainless steel  
Oven for electrodes  
Heat treatment equipment  
Pipe stands with rollers  
Heat sensing devices with indicators  
A supply of 2" to 12" diameter Schedule 40 or  
Schedule 80 stainless or carbon steel pipe for  
coupons  
Cleaning materials for coupons  
MSDS for each cleaning agent used  
Backing materials  
Stainless steel filler wire  
Stainless steel shims  
A copy of the following:  
• *AWS A5.4:2006, Specification for Stainless Steel  
Electrodes for Shielded Metal Arc Welding*  
• *ASME Boiler and Pressure Vessel Code, Section  
IX: Welding and Brazing Qualifications*  
• Any other standards discussed  
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  
Wire brushes  
Chipping hammers  
Workpiece clamps  
Magnets  
Examples of the following:  
• Austenitic, martensitic, and ferritic stainless  
steels  
• Heat-treated stainless steel  
• Specialty steels  
• Backing rings  
• Stabilized stainless steel base and filler metal  
• Low-carbon stainless steel base and filler  
metal  
• Stainless steel samples with indications of hot  
cracking  
• Electrodes with different AISI numbers and  
alloy designation letters  
• Electrodes with welding guides from different  
manufacturers  
• Acceptable and unacceptable welds on ferritic  
stainless steel  
• Acceptable and unacceptable welds on carbon  
steel and stainless steel coupons  
• Root passes that were properly and improv-  
erly ground  
• SMAW welds that have been cut apart to  
expose the weld profiles  
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

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Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. Trainees will be required to make open-root V-groove welds on stainless steel plate and pipe using SMAW equipment. Ensure that trainees are properly briefed on the safe use of SMAW equipment and are familiar with all appropriate safety precautions and procedures. Check to be sure that all labs are equipped with charged fire extinguishers.

## Additional Resources

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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.

- API 1104 – Welding of Pipelines and Related Facilities.* Washington, DC: American Petroleum Institute, 2005.
- ASME Boiler and Pressure Vessel Code, Section IX: Welding and Brazing Qualifications.* New York, NY: ASME International, 2007.
- AWS B1.10:1999 Guide for the Nondestructive Examination of Welds.* Miami, FL: American Welding Society.
- AWS B1.11:2000 Guide for the Visual Examination of Welds.* Miami, FL: American Welding Society.
- AWS D1.6-99 Structural Welding Code – Stainless Steel.* Miami, FL: American Welding Society.
- AWS D10.11M/D10.11:2007 Guide for Root Pass Welding of Pipe Without Backing.* Miami, FL: American Welding Society.
- Lincoln Electric website: <http://www.lincolnelectric.com> offers sources for products and training.
- Modern Welding Technology.* Howard B. Cary and Scott Helzer. Englewood Cliffs, NJ: Prentice Hall, Inc., 2005.
- OSHA 1910.269, Appendix C, Protection from Step and Touch Potentials.* Current edition. Washington, DC: Occupational Safety & Health Administration.
- OSHA 1926.351, Arc Welding and Cutting.* Current edition. Washington, DC: Occupational Safety & Health Administration.
- The Procedure Handbook of Arc Welding.* Cleveland, OH: The James F. Lincoln Arc Welding Foundation, 2000.
- Welding Handbook.* Volume 1. *Welding Science & Technology.* Miami, FL: American Welding Society, 2001.
- Welding Handbook.* Volume 2, Part 1: *Welding Processes.* Miami, FL: American Welding Society, 2004.
- Welding Pressure Pipelines and Piping Systems.* Cleveland, OH: The Lincoln Electric Company, 2000.

## Teaching Time for this Module

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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 100 hours are suggested to cover *SMAW – Stainless Steel Groove Welds*. 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 67.5 hours or 27 sessions.

<b>Topic</b>	<b>Planned Time</b>
<b>Session I. Introduction; Stainless Steel Metallurgy; Stainless Steel Electrodes</b>	
A. Introduction	_____
B. Stainless Steel Metallurgy	_____
1. Stainless Steel Categories	_____
2. Carbide Precipitation and Hot Cracking	_____
3. AISI Stainless Steel Table	_____
C. Stainless Steel Electrodes	_____
1. AWS Filler Metal Specification System	_____
2. Classification	_____
4. Storing Stainless Steel Electrodes	_____
5. Electrode Selection Considerations	_____
<b>Session II. Basic Welding Variations for Stainless Steel; Welding Preparations</b>	
A. Basic Welding Variations for Stainless Steel	_____
1. Welding Austenitic Stainless Steels	_____
2. Welding Martensitic Stainless Steels	_____
3. Welding Ferritic Stainless Steels	_____
4. Welding Carbon Steels to Stainless Steels	_____

B. Welding Preparations

1. Safety Practices
2. Preparing the Welding Area
3. Preparing the Practice Weld Coupons
4. Electrodes
5. Preparing the Welding Machine

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**Session III. Laboratory and Performance Testing**

A. Laboratory

Have trainees prepare SMAW equipment for stainless steel welds. This laboratory corresponds to Performance Task 1.

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B. Laboratory

Have trainees prepare stainless steel coupons.

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**Session IV. Open-Root V-Groove Welds; Practicing Open-Root V-Groove Welds on Plate**

A. Open-Root V-Groove Welds

1. Root Pass
2. Groove Weld Positions
3. Acceptable and Unacceptable Groove Weld Profiles

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B. Practicing Open-Root V-Groove Welds on Plate

1. Practicing Flat (1G) Position Open-Root V-Groove Welds

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**Sessions V–IX. Laboratory and Performance Testing**

A. Laboratory (1 session)

Have trainees prepare stainless steel plate coupons for SMAW welding in the 1G position.

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B. Laboratory (4 sessions)

Have trainees make open-root V-groove welds on stainless steel plate joints in the 1G position using SMAW equipment and electrodes. This laboratory corresponds to Performance Task 2.

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**Sessions X–XIII. Practicing Horizontal (2G) Position Open-Root V-Groove Welds; Laboratory and Performance Testing**

A. Practicing Horizontal (2G) Position Open-Root V-Groove Welds (1 session)

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B. Laboratory (1 session)

Have trainees prepare stainless steel plate coupons for SMAW welding in the 2G position.

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C. Laboratory (2 sessions)

Have trainees make open-root V-groove welds on stainless steel plate joints in the 2G position using SMAW equipment and electrodes. This laboratory corresponds to Performance Task 3.

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**Sessions XIV–XVII. Practicing Vertical (3G) Position Open-Root V-Groove Welds; Laboratory and Performance Testing**

A. Practicing Vertical (3G) Position Open-Root V-Groove Welds (1 session)

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B. Laboratory (1 session)

Have trainees prepare stainless steel plate coupons for SMAW welding in the 3G position.

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C. Laboratory (2 sessions)

Have trainees make open-root V-groove welds on stainless steel plate joints in the 3G position using SMAW equipment and electrodes. This laboratory corresponds to Performance Task 4.

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**Sessions XVIII–XXI. Practicing Overhead (4G) Position Open-Root V-Groove Welds; Laboratory; and Performance Testing**

- A. Practicing Overhead (4G) Position Open-Root V-Groove Welds (1 session) \_\_\_\_\_
- B. Laboratory (1 session) \_\_\_\_\_  
Have trainees prepare stainless steel plate coupons for SMAW welding in the 4G position.
- C. Laboratory (2 sessions) \_\_\_\_\_  
Have trainees make open-root V-groove welds on stainless steel plate joints in the 4G position using SMAW equipment and electrodes. This laboratory corresponds to Performance Task 5.

**Session XXII. Preparing Practice Pipe Weld Coupons; Open-Root V-Groove Pipe Welds**

- A. Preparing Practice Pipe Weld Coupons \_\_\_\_\_
  - 1. Requirements \_\_\_\_\_
  - 2. Cleaning Coupons \_\_\_\_\_
  - 3. Shaping and Aligning Coupons \_\_\_\_\_
  - 4. Backing Rings for Pipe Welds \_\_\_\_\_
- B. Open-Root V-Groove Pipe Welds \_\_\_\_\_
  - 1. Root Pass \_\_\_\_\_
  - 2. Pipe Groove Weld Test Positions \_\_\_\_\_
  - 3. Acceptable and Unacceptable Pipe Weld Profiles \_\_\_\_\_

**Sessions XXIII–XXVII. Practicing Open-Root V-Groove Welds on Pipe; Laboratory and Performance Testing**

- A. Practicing Open-Root V-Groove Welds on Pipe (1 session) \_\_\_\_\_
  - 1. Practicing Flat (1G-ROTATED) Position Open-Root V-Groove Pipe Welds \_\_\_\_\_
- B. Laboratory (1 session) \_\_\_\_\_  
Have trainees prepare stainless steel pipe coupons for SMAW welding in the 1G-ROTATED position.
- C. Laboratory (3 sessions) \_\_\_\_\_  
Have trainees make open-root V-groove welds on stainless steel pipe joints in the 1G-ROTATED position using SMAW equipment and electrodes. This laboratory corresponds to Performance Task 6.

**Sessions XXVIII–XXXI. Practicing Horizontal (2G) Position Open-Root V-Groove Pipe Welds; Laboratory and Performance Testing**

- A. Practicing Horizontal (2G) Position Open-Root V-Groove Pipe Welds (1 session) \_\_\_\_\_
- B. Laboratory (1 session) \_\_\_\_\_  
Have trainees prepare stainless steel pipe coupons for SMAW welding in the 2G position.
- C. Laboratory (2 sessions) \_\_\_\_\_  
Have trainees make open-root V-groove welds on stainless steel pipe joints in the 2G position using SMAW equipment and electrodes. This laboratory corresponds to Performance Task 7.

**Sessions XXXII–XXXV. Practicing Multiple (5G) Position Open-Root V-Groove Pipe Welds; Laboratory and Performance Testing**

- A. Practicing Multiple (5G) Position Open-Root V-Groove Pipe Welds (1 session) \_\_\_\_\_
- B. Laboratory (1 session) \_\_\_\_\_  
Trainees prepare stainless steel pipe coupons for SMAW welding in the 5G position.
- C. Laboratory (2 sessions) \_\_\_\_\_  
Have trainees make open-root V-groove welds on stainless steel pipe joints in the 5G position using SMAW equipment and electrodes. This laboratory corresponds to Performance Task 8.

**Sessions XXXVI–XXXIX. Multiple Inclined (6G) Position Open-Root V-Groove Pipe Welds; Laboratory and Performance Testing**

- A. Practicing Multiple Inclined (6G) Position Open-Root V-Groove Pipe Welds (1 session) \_\_\_\_\_
- B. Laboratory (1 session) \_\_\_\_\_  
Have trainees prepare stainless steel pipe coupons for SMAW welding in the 6G position.
- C. Laboratory (2 sessions) \_\_\_\_\_  
Have trainees make open-root V-groove welds on stainless steel pipe joints in the 6G position using SMAW equipment and electrodes. This laboratory corresponds to Performance Task 9.

**Session XXXX. 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 5, according to the acceptance criteria.
  - 1. Have trainees perform PAT 1, Make Open-Root V-Groove Welds on Stainless Steel Plate Joints in the Flat (1G) Position. This task corresponds to AWS EG3.0-96: 3.3.6.1, Unit #1, SMAW, Learning Objective #7. \_\_\_\_\_
  - 2. Have trainees perform PAT 2, Make Open-Root V-Groove Welds on Stainless Steel Plate Joints in the Horizontal (2G) Position. This task corresponds to AWS EG3.0-96: 3.3.6.1, Unit #1, SMAW, Learning Objective #7. \_\_\_\_\_
  - 3. Have trainees perform PAT 3, Make Open-Root V-Groove Welds on Stainless Steel Plate Joints in the Vertical (3G) Position. This task corresponds to AWS EG3.0-96: 3.3.6.1, Unit #1, SMAW, Learning Objective #7. \_\_\_\_\_
  - 4. Have trainees perform PAT 4, Make Open-Root V-Groove Welds on Stainless Steel Plate Joints in the Overhead (4G) Position. This task corresponds to AWS EG3.0-96: 3.3.6.1, Unit #1, SMAW, Learning Objective #7. \_\_\_\_\_
  - 5. Have trainees perform PAT 5, Make Open-Root V-Groove Welds on Stainless Steel Pipe in the Multiple Inclined (6G) Position. This task corresponds to AWS EG4.0-96: 3.3.6.2, Unit #2, SMAW, Learning Objective #8 (with backing). \_\_\_\_\_