Module One (29301-16) presents shielded metal arc welding (SMAW) of open-root pipe joints. SMAW is a well-established form of welding used extensively in commercial and industrial applications around the world. One routine use of SMAW is for joining pipe of various thicknesses and diameters. The most common joint used for these applications is the open-root V-groove joint. This module describes how to prepare and perform open-root V-groove welds on pipe in all positions using SMAW equipment and electrodes.

**Objectives**

**Learning Objective 1**
- State the basic concepts of open-root SMAW and how to prepare for welding.
  - a. State the basic concepts of open-root SMAW of pipe.
  - b. Identify common welding safety practices.
  - c. Explain how to prepare the area, materials, and equipment for SMAW of pipe.

**Learning Objective 2**
- Describe open-root pipe welding positions and related SMAW techniques.
  - a. Identify and describe the four pipe welding positions and acceptable weld profiles.
  - b. Describe the SMAW techniques for root and fill passes on pipe.
  - c. Describe the techniques required to produce open-root SMAW pipe welds in all positions.

**Performance Tasks**

**Performance Task 1**
(learning Objective 2)
- Make open-root pipe welds in the 1G-ROTATED position.

**Performance Task 2**
(learning Objective 2)
- Make open-root pipe welds in the 2G position.

**Performance Task 3**
(learning Objective 2)
- Make open-root pipe welds in the 5G position.

**Performance Task 4**
(learning Objective 2)
- Make open-root pipe welds in the 6G position.

**Teaching Time: 100 hours**
(Forty 2.5-Hour Sessions)
Session time may be adjusted to accommodate your class size, schedule, and teaching style.

**Before You Begin**
As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the PowerPoint® presentation), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

Using your access code, download the written examinations and Performance Profile sheets from [www.nccerirc.com](http://www.nccerirc.com). The passing score for submission into NCCER’s Registry is 70% or above for the written examination; performance testing is graded pass or fail.
Safety Considerations
This module requires that trainees work with and around equipment that generates high voltages, extremely high temperatures, and intense ultraviolet radiation. Safety must be emphasized at all times. Trainees should be carefully observed to ensure that they wear the proper PPE, follow safe practices, and give due respect to unseen hazards related to welding and the welding environment. Any deficiencies must be corrected to ensure the future safety of all trainees. All practice sessions and Performance Tasks must be completed under your direct supervision.

Classroom Equipment and Materials
- Whiteboard
- Dry-erase markers
- A variety of standard marker sizes
- Pencils and paper
- Poster board
- Flip chart
- Welding Level Three PowerPoint® Presentation
- LCD projector and screen
- Computer (Internet access optional)
- Module Review answer key
- Copies of the Module Examination and Answer Key (for paper-based exams)
- Performance Profile sheets

Equipment and Materials for Laboratories and Performance Testing
- Minimum safety equipment:
  - Appropriate flame-retardant clothing
  - Safety glasses
  - Face shields
  - Work gloves
  - Welding gloves
  - Welding hood with a lens of the appropriate shade
  - Proper footwear as directed by the instructor or training facility provider
  - Hearing protection as directed by the instructor or training facility provider
  - Hard hat as directed by the instructor or training facility provider
  - Welding machines compatible with SMAW and capable of DC welding, complete with electrode holders, workpiece clamps, and cables
- Sufficient supply of carbon-steel pipe for practice, 3" to 12" (DN80 to DN300) Schedule 40 or Schedule 80 pipe
- Welding bench with arm suited for position work; alternatively, a welding positioner may be used
- Sufficient supply of E6010 and E7018 electrodes
- Metal cutting equipment (mechanical or thermal)
- Angle grinders
- Grinding wheels
- Squares
- Tape measures or steel rules
- Soapstone
- Files
- Chipping hammers
- Wire brushes
- Common hand tools

Additional Resources
This module presents thorough resources for task training. The following resource material is suggested for further study.


There are a number of online resources available for trainees who would like more information on open-root pipe welding using the SMAW process. A search for additional information may be assigned as homework to interested trainees. Instructors should view any videos that may be identified in the lesson plan before using them to ensure their suitability. The videos can provide teachable moments in both proper and improper work processes and behaviors. Be prepared to stop the videos at appropriate times to point out and discuss both proper and improper conduct and techniques.

Numerous videos related to the topic are available on the Internet. These can be located by searching “SMAW pipe welding” or similar terms, and using the Video tab on the results page of your preferred search engine.

Instructors are encouraged to locate additional audiovisual aids available on the Internet, make personal videos, and take still pictures related to the subject matter and add them to the presentations throughout the program.
The Lesson Plan for this module is divided into forty 2.5-hour sessions. This time includes 10 minutes for administrative tasks and a 10-minute break per session.

**SESSION ONE**

Session One provides information on welding safety practices and the required preparations for SMAW pipe welding. This session covers Section 1.0.0.

1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to refresh trainees’ memories about the SMAW process.
4. Describe how to prepare the welding area, welding coupons, and the welding equipment.
5. Identify the four primary pipe-welding positions.
6. Review the characteristics of an acceptable weld profile.
7. Use the Section Review questions to review the topics of this session.

**SESSION TWO**

Session Two describes the techniques used to produce SMAW open-root V-groove pipe welds. This session covers Section 2.0.0. Trainees will also complete the Module Review questions and the Module Examination during this session.

1. Show the Session Two PowerPoint® presentation.
2. Use the Kickoff Activity to review multiple-inclined position 6G SMAW techniques using a video.
3. Review the techniques required to apply the root pass.
4. Describe the electrodes and techniques required for the remaining passes.
5. Discuss the details related to each pipe-welding position.
6. Use the Section Review questions to review the topics of this session.
7. Go over the Module Review questions to prepare trainees for the Module Exam.
8. Administer the module exam. Record the testing results on the Registration of Training Modules form and submit the form to your Training Program Sponsor.

**SESSIONS THREE THROUGH FORTY**

Sessions Three through Forty are laboratory sessions that provide trainees with an opportunity to practice and complete the Performance Tasks associated with this module.

1. Note that no slide presentation is associated with these laboratory sessions.
2. Demonstrate how to complete SMAW open-root V-groove pipe welds on pipe coupons.
3. Have trainees practice and complete the requirements of Performance Tasks 1 through 4.
4. Document successful Performance Task completions for each trainee on the Performance Profile sheet and submit the results to the Training Program Sponsor.
# Materials Checklist for Module 29301-16, SMAW Open-Root Pipe Welds

<table>
<thead>
<tr>
<th>Equipment and Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Personal protective equipment:</strong></td>
</tr>
<tr>
<td>Squares</td>
</tr>
<tr>
<td>Appropriate flame-retardant clothing</td>
</tr>
<tr>
<td>Safety glasses</td>
</tr>
<tr>
<td>Face shields</td>
</tr>
<tr>
<td>Work gloves</td>
</tr>
<tr>
<td>Welding gloves</td>
</tr>
<tr>
<td>Welding hood with a lens of the appropriate shade</td>
</tr>
<tr>
<td>Proper footwear as directed by the instructor or training facility provider</td>
</tr>
<tr>
<td>Hearing protection as directed by the instructor or training facility provider</td>
</tr>
<tr>
<td>Hard hat as directed by the instructor or training facility provider</td>
</tr>
<tr>
<td>Whiteboard</td>
</tr>
<tr>
<td>Dry-erase markers</td>
</tr>
<tr>
<td>A variety of standard marker sizes</td>
</tr>
<tr>
<td>Pencils and paper</td>
</tr>
<tr>
<td>Poster board</td>
</tr>
<tr>
<td>Flip chart</td>
</tr>
<tr>
<td><strong>Welding Level Three PowerPoint® Presentation</strong></td>
</tr>
<tr>
<td>LCD projector and screen</td>
</tr>
<tr>
<td>Computer (Internet access optional)</td>
</tr>
<tr>
<td>Module Review answer key</td>
</tr>
<tr>
<td>Copies of the Module Examination and answer key</td>
</tr>
<tr>
<td>Performance Profile Sheets</td>
</tr>
</tbody>
</table>

To the extent possible, and as required for performance testing, provide a selection of the tools listed for each session; alternatively, photos may be used to teach tool identification.
Module Two (29302-16) presents gas metal arc welding (GMAW)—a form of welding that joins two metals together using a filler metal wire electrode and a shielding gas. GMAW is an effective method for making high-quality, open-root V-groove welds on pipe. This module covers some basic concepts of open-root GMAW of pipe and describes how to prepare and perform open-root V-groove welds on medium- and thick-walled pipe in all positions.

### Objectives

**Learning Objective 1**
- State the basic concepts of open-root GMAW of pipe and how to prepare for welding.
  - a. State the basic concepts of GMAW.
  - b. Identify common welding safety practices.
  - c. Explain how to prepare the area and materials for GMAW pipe welding.
  - d. Explain how to prepare the equipment for GMAW pipe welding.

**Learning Objective 2**
- Describe open-root V-groove pipe welding positions and GMAW techniques.
  - a. Identify and describe the four pipe welding positions and acceptable weld profiles.
  - b. Describe the technique for GMAW of the root and fill passes.
  - c. Describe the techniques required to produce open-root GMAW pipe welds in all positions.

### Performance Tasks

**Performance Task 1**
(Learning Objective 2)
- Make GMAW open-root V-groove pipe welds in the 1G-ROTATED position using the correct filler metal and shielding gas.

**Performance Task 2**
(Learning Objective 2)
- Make GMAW open-root V-groove pipe welds in the 2G position using the correct filler metal and shielding gas.

**Performance Task 3**
(Learning Objective 2)
- Make GMAW open-root V-groove pipe welds in the 5G position using the correct filler metal and shielding gas.

**Performance Task 4**
(Learning Objective 2)
- Make GMAW open-root V-groove pipe welds in the 6G position using the correct filler metal and shielding gas.

### Teaching Time: 60 hours
(Twenty-Four 2.5-Hour Sessions)
Session time may be adjusted to accommodate your class size, schedule, and teaching style.

### Before You Begin
As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the PowerPoint® presentation), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

Using your access code, download the written examinations and Performance Profile sheets from [www.nccerirc.com](http://www.nccerirc.com). The passing score for submission into NCCER’s Registry is 70% or above for the written examination; performance testing is graded pass or fail.
Safety Considerations
This module requires that trainees work with and around equipment that generates high voltages, extremely high temperatures, and intense ultraviolet radiation. Trainees must also handle shielding gases under high pressure. Safety must be emphasized at all times. Trainees should be carefully observed to ensure that they wear the proper PPE, follow safe practices, and give due respect to unseen hazards related to welding and the welding environment. Any deficiencies must be corrected to ensure the future safety of all trainees. All practice sessions and Performance Tasks must be completed under your direct supervision.

Classroom Equipment and Materials
- Whiteboard
- Dry-erase markers
- A variety of standard marker sizes
- Pencils and paper
- Poster board
- Flip chart
- *Welding Level Three* PowerPoint® Presentation
- LCD projector and screen
- Computer (Internet access optional)
- Module Review answer key
- Copies of the Module Examination and Answer Key (for paper-based exams)
- Performance Profile sheets

Equipment and Materials for Laboratories and Performance Testing
- Minimum safety equipment:
  - Appropriate flame-retardant clothing
  - Safety glasses
  - Face shields
  - Work gloves
  - Welding gloves
  - Welding hood with a lens of the appropriate shade
  - Proper footwear as directed by the instructor or training facility provider
  - Hearing protection as directed by the instructor or training facility provider
  - Hard hat as directed by the instructor or training facility provider
- Welding machines capable of GMAW, complete with welding guns, cables, and shielding gas hoses
- Wire feeders
- Sufficient supply of shielding gas
- Sufficient supply of carbon-steel pipe for practice, 3" to 12" (DN80 to DN300) Schedule 40 or Schedule 80 pipe
- Welding bench with arm suited for position work; alternatively, a welding positioner may be used
- Metal cutting equipment (mechanical or thermal)
- Angle grinders
- Grinding wheels
- Squares
- Tape measures or steel rules
- Soapstone
- Files
- Chipping hammers
- Wire brushes
- Common hand tools

Additional Resources
This module presents thorough resources for task training. The following resource material is suggested for further study:


There are a number of online resources available for trainees who would like more information on open-root pipe welding using the GMAW process. A search for additional information may be assigned as homework to interested trainees. Instructors should view any videos that may be identified in the lesson plan before using them to ensure their suitability. The videos can provide teachable moments in both proper and improper work processes and behaviors. Be prepared to stop the videos at appropriate times to point out and discuss both proper and improper conduct and techniques. Numerous videos related to the topic are available on the Internet. These can be located by searching “GMAW pipe welding” or similar terms, and using the Video tab on the results page of your preferred search engine.

Instructors are encouraged to locate additional audiovisual aids available on the Internet, make personal videos, and take still pictures related to the subject matter and add them to the presentations throughout the program.
Session Outline for 29302-16

GMAW – PIPE

The Lesson Plan for this module is divided into twenty-four 2.5-hour sessions. This time includes 10 minutes for administrative tasks and a 10-minute break per session.

SESSION ONE

Session One provides information on welding safety practices and the required preparations for GMAW pipe welding. This session covers Section 1.0.0.

1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to review Lincoln Electric’s STT approach to GMAW welding.
3. Review the basic concepts of GMAW pipe welding.
4. Review common welding safety practices, emphasizing any GMAW-specific safety issues.
5. Describe how to prepare the welding area, welding coupons, and the welding equipment.
6. Use the Section Review questions to review the topics of this session.

3. Review the primary pipe-welding positions and acceptable and unacceptable weld profiles.
4. Review the techniques required to apply the root pass and techniques required for the remaining passes.
5. Discuss the details related to each pipe-welding position.
6. Use the Section Review questions to review the topics of this session.
7. Go over the Module Review questions to prepare trainees for the Module Exam.
8. Administer the module exam. Record the testing results on the Registration of Training Modules form and submit the form to your Training Program Sponsor.

SESSION TWO

Session Two describes the techniques used to produce GMAW open-root V-groove pipe welds. This session covers Section 2.0.0. Trainees will also complete the Module Review questions and the Module Examination during this session.

1. Show the Session Two PowerPoint® presentation.
2. Use the Kickoff Activity to review the application of a GMAW root pass on pipe in the 1G-ROTATED position.

1. Note that no slide presentation is associated with these laboratory sessions.
2. Demonstrate how to complete GMAW open-root V-groove pipe welds on pipe coupons.
3. Have trainees practice and complete the requirements of Performance Tasks 1 through 4.
4. Document successful Performance Task completions for each trainee on the Performance Profile sheet and submit the results to the Training Program Sponsor.
Materials Checklist for Module 29302-16, GMAW – Pipe

<table>
<thead>
<tr>
<th>Equipment and Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Personal protective equipment:</strong></td>
</tr>
<tr>
<td>Squares</td>
</tr>
<tr>
<td>Metal cutting equipment (mechanical or thermal)</td>
</tr>
<tr>
<td>Wire feeders</td>
</tr>
<tr>
<td>Sufficient supply of electrode wire</td>
</tr>
<tr>
<td>Sufficient supply of shielding gas</td>
</tr>
<tr>
<td>Angle grinders</td>
</tr>
<tr>
<td>Grinding wheels</td>
</tr>
<tr>
<td>Welding machines capable of GMAW, complete with welding guns, cables, and shielding gas hoses</td>
</tr>
<tr>
<td>Welding bench with arm suited for position work; alternatively, a welding positioner may be used</td>
</tr>
<tr>
<td>Welding hood with a lens of the appropriate shade</td>
</tr>
<tr>
<td>Proper footwear as directed by the instructor or training facility provider</td>
</tr>
<tr>
<td>Hearing protection as directed by the instructor or training facility provider</td>
</tr>
<tr>
<td>Hard hat as directed by the instructor or training facility provider</td>
</tr>
<tr>
<td>Whiteboard</td>
</tr>
<tr>
<td>Files</td>
</tr>
<tr>
<td>Dry-erase markers</td>
</tr>
<tr>
<td>Chipping hammers</td>
</tr>
<tr>
<td>A variety of standard marker sizes</td>
</tr>
<tr>
<td>Wire brushes</td>
</tr>
<tr>
<td>Pencils and paper</td>
</tr>
<tr>
<td>Common hand tools</td>
</tr>
<tr>
<td>Poster board</td>
</tr>
<tr>
<td>Soapstone</td>
</tr>
<tr>
<td>Flip chart</td>
</tr>
<tr>
<td>Tape measures or steel rules</td>
</tr>
<tr>
<td>Welding Level Three</td>
</tr>
<tr>
<td>PowerPoint® Presentation</td>
</tr>
<tr>
<td>LCD projector and screen</td>
</tr>
<tr>
<td>Computer (Internet access optional)</td>
</tr>
<tr>
<td>Module Review answer key</td>
</tr>
<tr>
<td>Copies of the Module Examination and answer key</td>
</tr>
<tr>
<td>Performance Profile Sheets</td>
</tr>
</tbody>
</table>

To the extent possible, and as required for performance testing, provide a selection of the tools listed for each session; alternatively, photos may be used to teach tool identification.
Lesson Plans for Module 29303-16
FCAW – PIPE

Module Three (29303-16) presents the flux-core arc welding (FCAW) process. It is excellent for pipe welding, although the root pass is seldom applied using FCAW. FCAW is a versatile process than can be done with or without a shielding gas, depending upon the wire electrode used. This module describes the two primary approaches to FCAW and provides guidance to practice the techniques.

Objectives

Learning Objective 1
• State the basic concepts of FCAW of pipe and how to prepare for welding.
  a. State the basic concepts of FCAW.
  b. Identify common welding safety practices.
  c. Explain how to prepare the area and materials for FCAW pipe welding.
  d. Explain how to prepare the equipment for FCAW pipe welding.

Learning Objective 2
• Describe V-groove pipe welding positions and FCAW techniques.
  a. Identify and describe the four pipe welding positions and acceptable weld profiles.
  b. Describe the technique for FCAW of the root and fill passes.
  c. Describe the techniques required to produce FCAW pipe welds in all positions.

Performance Tasks

Performance Task 1
(Learning Objective 2)
• Make FCAW open-root V-groove pipe welds in the 1G-ROTATED position.

Performance Task 2
(Learning Objective 2)
• Make FCAW open-root V-groove pipe welds in the 2G position.

Performance Task 3
(Learning Objective 2)
• Make FCAW open-root V-groove pipe welds in the 5G position.

Performance Task 4
(Learning Objective 2)
• Make FCAW open-root V-groove pipe welds in the 6G position.

Teaching Time: 60 hours
(Twenty-Four 2.5-Hour Sessions)
Session time may be adjusted to accommodate your class size, schedule, and teaching style.

Before You Begin
As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the PowerPoint® presentation), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

Using your access code, download the written examinations and Performance Profile sheets from www.nccerirc.com. The passing score for submission into NCCER’s Registry is 70% or above for the written examination; performance testing is graded pass or fail.
Safety Considerations
This module requires that trainees work with and around equipment that generates high voltages, extremely high temperatures, and intense ultraviolet radiation. Safety must be emphasized at all times. Trainees should be carefully observed to ensure that they wear the proper PPE, follow safe practices, and give due respect to unseen hazards related to welding and the welding environment. Any deficiencies must be corrected to ensure the future safety of all trainees. All practice sessions and Performance Tasks must be completed under your direct supervision.

Classroom Equipment and Materials
Whiteboard
Dry-erase markers
A variety of standard marker sizes
Pencils and paper
Poster board
Flip chart
Welding Level Three PowerPoint® Presentation
LCD projector and screen
Computer (Internet access optional)
Module Review answer key
Copies of the Module Examination and Answer Key (for paper-based exams)
Performance Profile sheets

Equipment and Materials for Laboratories and Performance Testing
Minimum safety equipment:
- Appropriate flame-retardant clothing
- Safety glasses
- Face shields
- Work gloves
- Welding gloves
- Welding hood with a lens of the appropriate shade
- Proper footwear as directed by the instructor or training facility provider
- Hearing protection as directed by the instructor or training facility provider
- Hard hat as directed by the instructor or training facility provider
- Welding machines capable of FCAW and GMAW, complete with welding guns, cables, and shielding gas hoses. If root passes are to be done with SMAW, the appropriate equipment and E6010 electrodes for that process will also be required.
- Wire feeders

Sufficient supply of appropriate electrode wire
Sufficient supply of shielding gas (instructor option)
Sufficient supply of carbon-steel pipe for practice, 3” to 12” (DN80 to DN300)
Schedule 40 or Schedule 80 pipe
Welding bench with arm suited for position work; alternatively, a welding positioner may be used
Metal cutting equipment (mechanical or thermal)
Angle grinders
Grinding wheels
Squares
Tape measures or steel rules
Soapstone
Files
Chipping hammers
Wire brushes
Common hand tools

Additional Resources
This module presents thorough resources for task training. The following resource material is suggested for further study:


There are a number of online resources available for trainees who would like more information on pipe welding using the FCAW process. A search for additional information may be assigned as homework to interested trainees.

Instructors should view any videos that may be identified in the lesson plan before using them to ensure their suitability. The videos can provide teachable moments in both proper and improper work processes and behaviors. Be prepared to stop the videos at appropriate times to point out and discuss both proper and improper conduct and techniques.

Numerous videos related to the topic are available on the Internet. These can be located by searching “FCAW pipe welding” or similar terms, and using the Video tab on the results page of your preferred search engine.

Instructors are encouraged to locate additional audiovisual aids available on the Internet, make personal videos, and take still pictures related to the subject matter and add them to the presentations throughout the program.
The Lesson Plan for this module is divided into twenty-four 2.5-hour sessions. This time includes 10 minutes for administrative tasks and a 10-minute break per session.

**SESSION ONE**

Session One introduces trainees to welding safety practices and the required preparations for FCAW pipe welding. This session covers Section 1.0.0.

1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to provide trainees an opportunity to see FCAW pipe welding in progress and listen to the thoughts of welding professionals as the weld progresses.
3. Review the basic concepts of FCAW pipe welding.
4. Review common welding safety practices, emphasizing any FCAW-specific safety issues.
5. Describe how to prepare the welding area, welding coupons, and the welding equipment.
6. Use the Section Review questions to review the topics of this session.

**SESSION TWO**

Session Two reviews the techniques needed to produce FCAW open-root V-groove pipe welds. This session covers Sections 2.0.0.

1. Show the Session Two PowerPoint® presentation.
2. Use the Kickoff Activity to provide trainees with a greater understanding of the various wire electrode products available to them.
3. Review the primary pipe-welding positions.
4. Discuss acceptable and unacceptable weld profiles.
5. Review the techniques required to apply the root pass, emphasizing that the root pass is done with a different process.
6. Review the techniques required for the remaining passes.
7. Review the details related to each pipe-welding position.
8. Use the Section Review questions to review the topics of this session.
9. Go over the Module Review to prepare trainees for the module exam.
10. Administer the module exam. Record the testing results on the Registration of Training Modules form and submit the form to your Training Program Sponsor.

**SESSIONS THREE – TWENTY-FOUR**

Sessions Three through Twenty-Four are laboratory sessions that provide trainees with an opportunity to practice and complete the Performance Tasks associated with this module.

1. Note that no slide presentation is associated with these laboratory sessions.
2. Demonstrate how to complete FCAW open-root V-groove pipe welds on pipe coupons.
3. Have trainees practice and complete the requirements of Performance Tasks 1 through 4.
4. Document successful Performance Task completions for each trainee on the Performance Profile sheet and submit the results to the Training Program Sponsor.
# Materials Checklist for Module 29303-16, FCAW – Pipe

## Equipment and Materials

<table>
<thead>
<tr>
<th>Personal protective equipment:</th>
<th>Scales</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appropriate flame-retardant clothing</td>
<td>Metal cutting equipment (mechanical or thermal)</td>
</tr>
<tr>
<td>Safety glasses</td>
<td>Wire feeders</td>
</tr>
<tr>
<td>Face shields</td>
<td>Sufficient supply of electrode wire</td>
</tr>
<tr>
<td>Work gloves</td>
<td>Sufficient supply of shielding gas</td>
</tr>
<tr>
<td>Welding gloves</td>
<td>Angle grinders</td>
</tr>
<tr>
<td>Welding hood with a lens of the appropriate shade</td>
<td>Grinding wheels</td>
</tr>
<tr>
<td>Proper footwear as directed by the instructor or training facility provider</td>
<td>Welding machines capable of FCAW and GMAW, complete with welding guns, cables, and shielding gas hoses</td>
</tr>
<tr>
<td>Hearing protection as directed by the instructor or training facility provider</td>
<td>If root passes are to be done with SMAW, the appropriate equipment and E6010 electrodes for that process will also be required.</td>
</tr>
<tr>
<td>Hard hat as directed by the instructor or training facility provider</td>
<td>Sufficient supply of shielding gas (instructor option)</td>
</tr>
</tbody>
</table>

| Whiteboard | Sufficient supply of carbon-steel pipe for practice, 3” to 12” (DN80 to DN300) Schedule 40 or Schedule 80 pipe |
| Dry-erase markers | Welding bench with arm suited for position work; alternatively, a welding positioner may be used |

| A variety of standard marker sizes | Files |
| Pencils and paper | Chipping hammers |
| Poster board | Wire brushes |
| Flip chart | Common hand tools |
| *Welding Level Three* PowerPoint® Presentation | Soapstone |
| LCD projector and screen | Tape measures or steel rules |
| Computer (Internet access optional) | |
| Module Review answer key | |
| Copies of the Module Examination and answer key | |
| Performance Profile Sheets | |

To the extent possible, and as required for performance testing, provide a selection of the tools listed for each session; alternatively, photos may be used to teach tool identification.
Module Four (29304-16) presents gas tungsten arc welding (GTAW), a unique welding process that requires the welder to coordinate the use of both hands since the filler metal is fed manually. GTAW can be used on critical piping and may sometimes be used for the root pass on pipe welds when other processes have been directed for the remaining passes. GTAW is also excellent for welding thin materials such as auto bodies. This module provides instruction in the use of GTAW for carbon steel pipe welding, including guided practice.

Objectives

Learning Objective 1
- State the basic concepts of open-root GTAW of carbon-steel pipe and explain how to prepare for welding.
  a. State the basic concepts of GTAW.
  b. Identify common welding safety practices.
  c. Explain how to prepare the area, materials, and equipment for GTAW carbon-steel pipe welding.

Learning Objective 2
- Describe open-root V-groove pipe welding positions and GTAW pipe-welding techniques.
  a. Identify and describe the four pipe welding positions and acceptable weld profiles.
  b. Describe the techniques for GTAW and how to make the root and fill passes.
  c. Describe the techniques required to produce GTAW open-root V-groove carbon-steel pipe welds in all positions.

Performance Tasks

Performance Task 1
(Learning Objective 2)
- Make GTAW open-root V-groove carbon-steel pipe welds in the 1G-ROTATED position using carbon-steel filler metal and argon gas.

Performance Task 2
(Learning Objective 2)
- Make GTAW open-root V-groove carbon-steel pipe welds in the 2G position using carbon-steel filler metal and argon gas.

Performance Task 3
(Learning Objective 2)
- Make GTAW open-root V-groove carbon-steel pipe welds in the 5G position using carbon-steel filler metal and argon gas.

Performance Task 4
(Learning Objective 2)
- Make GTAW open-root V-groove carbon-steel pipe welds in the 6G position using carbon-steel filler metal and argon gas.

Teaching Time: 80 hours
(Thirty-Two 2.5-Hour Sessions)
Session time may be adjusted to accommodate your class size, schedule, and teaching style.

Before You Begin
As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the PowerPoint® presentation), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

Using your access code, download the written examinations and Performance Profile sheets from www.nccerirc.com. The passing score for submission into NCCER’s Registry is 70% or above for the written examination; performance testing is graded pass or fail.
### Safety Considerations

This module requires that trainees work with and around equipment that generates high voltages, extremely high temperatures, and intense ultraviolet radiation. Safety must be emphasized at all times. Trainees should be carefully observed to ensure that they wear the proper PPE, follow safe practices, and give due respect to unseen hazards related to welding and the welding environment. Any deficiencies must be corrected to ensure the future safety of all trainees. All practice sessions and Performance Tasks must be completed under your direct supervision.

### Classroom Equipment and Materials

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whiteboard</td>
<td></td>
</tr>
<tr>
<td>Dry-erase markers</td>
<td></td>
</tr>
<tr>
<td>A variety of standard marker sizes</td>
<td></td>
</tr>
<tr>
<td>Pencils and paper</td>
<td></td>
</tr>
<tr>
<td>Poster board</td>
<td></td>
</tr>
<tr>
<td>Flip chart</td>
<td></td>
</tr>
<tr>
<td><strong>Welding Level Three PowerPoint®</strong></td>
<td></td>
</tr>
<tr>
<td>Presentation</td>
<td></td>
</tr>
<tr>
<td>LCD projector and screen</td>
<td></td>
</tr>
<tr>
<td>Computer (Internet access optional)</td>
<td></td>
</tr>
<tr>
<td>Module Review answer key</td>
<td></td>
</tr>
<tr>
<td>Copies of the Module Examination</td>
<td></td>
</tr>
<tr>
<td>and Answer Key (for paper-based exams)</td>
<td></td>
</tr>
<tr>
<td>Performance Profile sheets</td>
<td></td>
</tr>
</tbody>
</table>

### Equipment and Materials for Laboratories and Performance Testing

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum safety equipment:</td>
<td></td>
</tr>
<tr>
<td>Appropriate flame-retardant clothing</td>
<td></td>
</tr>
<tr>
<td>Safety glasses</td>
<td></td>
</tr>
<tr>
<td>Face shields</td>
<td></td>
</tr>
<tr>
<td>Work gloves</td>
<td></td>
</tr>
<tr>
<td>Welding gloves</td>
<td></td>
</tr>
<tr>
<td>Welding hood with a lens of the appropriate shade</td>
<td></td>
</tr>
<tr>
<td>Proper footwear as directed by the instructor or training facility provider</td>
<td></td>
</tr>
<tr>
<td>Hearing protection as directed by the instructor or training facility provider</td>
<td></td>
</tr>
<tr>
<td>Hard hat as directed by the instructor or training facility provider</td>
<td></td>
</tr>
<tr>
<td>Common hand tools</td>
<td></td>
</tr>
<tr>
<td>Welding machines compatible with GTAW, complete with torches, workpiece clamps, shielding gas hoses, and cables</td>
<td></td>
</tr>
<tr>
<td>Sufficient volume of shielding gas with regulators/flowmeters</td>
<td></td>
</tr>
<tr>
<td>Sufficient supply of filler metal rods for carbon steel</td>
<td></td>
</tr>
<tr>
<td>Sufficient supply of carbon-steel pipe for practice, 2” to 6” (DN50 to DN150)</td>
<td></td>
</tr>
<tr>
<td>Schedule 40 or Schedule 80 pipe</td>
<td></td>
</tr>
<tr>
<td>Welding bench with arm suited for position work; alternatively, a welding positioner may be used</td>
<td></td>
</tr>
<tr>
<td>Metal cutting equipment (mechanical or thermal)</td>
<td></td>
</tr>
<tr>
<td>Angle grinders</td>
<td></td>
</tr>
<tr>
<td>Grinding wheels</td>
<td></td>
</tr>
<tr>
<td>Squares</td>
<td></td>
</tr>
<tr>
<td>Tape measures or steel rules</td>
<td></td>
</tr>
<tr>
<td>Soapstone</td>
<td></td>
</tr>
<tr>
<td>Files</td>
<td></td>
</tr>
<tr>
<td>Chipping hammers</td>
<td></td>
</tr>
<tr>
<td>Wire brushes</td>
<td></td>
</tr>
</tbody>
</table>

### Additional Resources

This module presents thorough resources for task training. The following resource material is suggested for further study:


There are a number of online resources available for trainees who would like more information on open-root pipe welding using the GTAW process. A search for additional information may be assigned as homework to interested trainees. Instructors should view any videos that may be identified in the lesson plan before using them to ensure their suitability. The videos can provide teachable moments in both proper and improper work processes and behaviors. Be prepared to stop the videos at appropriate times to point out and discuss both proper and improper conduct and techniques. Numerous videos related to the topic are available on the Internet. These can be located by searching “GTAW pipe welding” or similar terms, and using the Video tab on the results page of your preferred search engine.

Instructors are encouraged to locate additional audiovisual aids available on the Internet, make personal videos, and take still pictures related to the subject matter and add them to the presentations throughout the program.
The Lesson Plan for this module is divided into thirty-two 2.5-hour sessions.
This time includes 10 minutes for administrative tasks and a 10-minute break per session.

**SESSION ONE**

Session One introduces trainees to welding safety practices and the required preparations for GTAW pipe welding. This session covers Section 1.0.0.

1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to expose trainees to the relationships between all primary forms of welding in a unique way.
3. Review the basic concepts of GTAW and how it differs from other processes.
4. Review common welding safety practices, emphasizing any GTAW-specific safety issues.
5. Describe how to prepare the welding area, welding coupons, and the welding equipment.
6. Identify the four primary pipe-welding positions.
7. Review the characteristics of an acceptable weld profile.
8. Use the Section Review questions to review the topics of this session.

**SESSION TWO**

Session Two reviews the techniques needed to produce GTAW open-root V-groove pipe welds. The module exam is also completed during this session. This session covers Section 2.0.0.

1. Show the Session Two PowerPoint® presentation.
2. Use the Kickoff Activity to inform trainees of the many photographic examples of welding available to them through social media sites such as Instagram.
3. Review travel speed, arc length, torch angles, and other important characteristics of the GTAW process.
4. Discuss methods of handling the filler metal rod.
5. Review the techniques required to apply the root pass.
6. Review the techniques required for the hot and remaining passes.
7. Review the details related to each pipe-welding position.
8. Use the Section Review questions to review the topics of this session.
9. Go over the Module Review to prepare trainees for the module exam.
10. Administer the module exam. Record the testing results on the Registration of Training Modules form and submit the form to your Training Program Sponsor.

**SESSIONS THREE – THIRTY-TWO**

Sessions Three through Thirty-Two are laboratory sessions that provide trainees with an opportunity to practice and complete the Performance Tasks associated with this module.

1. Note that no slide presentation is associated with these laboratory sessions.
2. Demonstrate how to complete GTAW open-root V-groove pipe welds on pipe coupons.
3. Have trainees practice and complete the requirements of Performance Tasks 1 through 4.
4. Document successful Performance Task completions for each trainee on the Performance Profile sheet and submit the results to the Training Program Sponsor.
# Materials Checklist for Module 29304-16, GTAW – Carbon Steel Pipe

<table>
<thead>
<tr>
<th>Equipment and Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Personal protective equipment:</strong></td>
</tr>
<tr>
<td>Squares</td>
</tr>
<tr>
<td>Metal cutting equipment (mechanical or thermal)</td>
</tr>
<tr>
<td>Angle grinders</td>
</tr>
<tr>
<td>Grinding wheels</td>
</tr>
<tr>
<td>Welding machines compatible with GTAW, complete with torches, workpiece clamps, shielding gas hoses, and cables</td>
</tr>
<tr>
<td>Sufficient supply of filler metal rods for carbon steel</td>
</tr>
<tr>
<td>Sufficient volume of shielding gas with regulators/flowmeters</td>
</tr>
<tr>
<td>Sufficient supply of carbon-steel pipe for practice, 2&quot; to 6&quot; (DN50 to DN150) Schedule 40 or Schedule 80 pipe</td>
</tr>
<tr>
<td>Welding bench with arm suited for position work; alternatively, a welding positioner may be used</td>
</tr>
<tr>
<td>Files</td>
</tr>
<tr>
<td>Chipping hammers</td>
</tr>
<tr>
<td>Wire brushes</td>
</tr>
<tr>
<td>Common hand tools</td>
</tr>
<tr>
<td>Soapstone</td>
</tr>
<tr>
<td>Tape measures or steel rules</td>
</tr>
<tr>
<td><strong>Files</strong></td>
</tr>
<tr>
<td><strong>PowerPoint® Presentation</strong></td>
</tr>
<tr>
<td><strong>LCD projector and screen</strong></td>
</tr>
<tr>
<td><strong>Computer (Internet access optional)</strong></td>
</tr>
<tr>
<td><strong>Module Review answer key</strong></td>
</tr>
<tr>
<td><strong>Copies of the Module Examination and answer key</strong></td>
</tr>
<tr>
<td><strong>Performance Profile Sheets</strong></td>
</tr>
</tbody>
</table>

To the extent possible, and as required for performance testing, provide a selection of the tools listed for each session; alternatively, photos may be used to teach tool identification.
Module Five (29305-16) reveals that low alloy and stainless steel materials can be more challenging to weld, as the weld puddle tends to be more fluid and harder to manage. With practice and the proper technique however, sound and reliable welds can be created using the GTAW process. This module presents information regarding GTAW of these materials and their unique characteristics. A significant amount of time is devoted to practice in a variety of positions.

**Objectives**

**Learning Objective 1**
- State the basic concepts of open-root GTAW of low alloy and stainless steel pipe and how to prepare for welding.
  a. State the basic concepts of low alloy and stainless steel pipe welding using the GTAW process.
  b. Identify common welding safety practices.
  c. Explain how to prepare the area, materials, and equipment for low alloy and stainless steel pipe welding using the GTAW process.

**Learning Objective 2**
- Describe open-root V-groove pipe welding positions and GTAW pipe-welding techniques.
  a. Describe the techniques used to apply GTAW to low alloy and stainless steel pipe.
  b. Describe how to make the root pass with a gas backing.
  c. Describe the techniques required to produce open-root GTAW low alloy and stainless steel pipe welds in various positions.

**Performance Tasks**

**Performance Task 1**
*(Learning Objective 2)*
- Make GTAW open-root V-groove low alloy or stainless steel pipe welds in the 2G position using the appropriate filler metal and a gas backing.

**Performance Task 2**
*(Learning Objective 2)*
- Make GTAW open-root V-groove low alloy or stainless steel pipe welds in the 5G position using the appropriate filler metal and a gas backing.

**Performance Task 3**
*(Learning Objective 2)*
- Make GTAW open-root V-groove low alloy or stainless steel pipe welds in the 6G position using the appropriate filler metal and a gas backing.

**Teaching Time: 70 hours**

(Twenty-Eight 2.5-Hour Sessions)
Session time may be adjusted to accommodate your class size, schedule, and teaching style.

**Before You Begin**
As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the PowerPoint® presentation), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

Using your access code, download the written examinations and Performance Profile sheets from www.nccerirc.com. The passing score for submission into NCCER’s Registry is 70% or above for the written examination; performance testing is graded pass or fail.
Safety Considerations
This module requires that trainees work with and around equipment that generates high voltages, extremely high temperatures, and intense ultraviolet radiation. Safety must be emphasized at all times. Trainees should be carefully observed to ensure that they wear the proper PPE, follow safe practices, and give due respect to unseen hazards related to welding and the welding environment. Any deficiencies must be corrected to ensure the future safety of all trainees. All practice sessions and Performance Tasks must be completed under your direct supervision.

Classroom Equipment and Materials
Whiteboard
Dry-erase markers
A variety of standard marker sizes
Pencils and paper
Poster board
Flip chart
Welding Level Three PowerPoint® Presentation
LCD projector and screen
Computer (Internet access optional)
Module Review answer key
Copies of the Module Examination and Answer Key (for paper-based exams)
Performance Profile sheets

Equipment and Materials for Laboratories and Performance Testing
Minimum safety equipment:
- Appropriate flame-retardant clothing
- Safety glasses
- Face shields
- Work gloves
- Welding gloves
- Welding hood with a lens of the appropriate shade
- Proper footwear as directed by the instructor or training facility provider
- Hearing protection as directed by the instructor or training facility provider
- Hard hat as directed by the instructor or training facility provider
- Welding machines compatible with GTAW, complete with torches, workpiece clamps, shielding gas hoses, and cables
- Sufficient volume of shielding gas with regulators/flowmeters
- Sufficient volume of backing (purge) gas with regulators/flowmeters

Sufficient supply of stainless steel or low alloy pipe for practice, 2” to 6’ (DN50 to DN150) Schedule 40 or Schedule 80
Sufficient supply of filler metal rods for the stainless steel or low alloy material in use
- Welding bench with arm suited for position work; alternatively, a welding positioner may be used
- Metal cutting equipment (mechanical or thermal)
- Angle grinders
- Grinding wheels
- Squares
- Tape measures or steel rules
- Soapstone
- Files
- Chipping hammers
- Wire brushes
- Common hand tools

Additional Resources
This module presents thorough resources for task training. The following resource material is suggested for further study:


There are a number of online resources available for trainees who would like more information on using the GTAW process to weld low alloy and stainless steel materials. A search for additional information may be assigned as homework to interested trainees.

Instructors should view any videos that may be identified in the lesson plan before using them to ensure their suitability. The videos can provide teachable moments in both proper and improper work processes and behaviors. Be prepared to stop the videos at appropriate times to point out and discuss both proper and improper conduct and techniques.

Numerous videos related to the topic are available on the Internet. These can be located by searching “GTAW stainless pipe welding” or similar terms, and using the Video tab on the results page of your preferred search engine.

Instructors are encouraged to locate additional audiovisual aids available on the Internet, make personal videos, and take still pictures related to the subject matter and add them to the presentations throughout the program.
The Lesson Plan for this module is divided into twenty-eight 2.5-hour sessions. This time includes 10 minutes for administrative tasks and a 10-minute break per session.

**SESSION ONE**

Session One introduces trainees to GTAW of stainless steel and low alloy materials, as well as the required preparations for GTAW pipe welding. This session covers Section 1.0.0.

1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to initiate a discussion of distortion in stainless steel materials and how to deal with it.
3. Review the basic concepts of GTAW of stainless steel and low alloy materials, and how it differs from other processes.
4. Review common welding safety practices, emphasizing any GTAW-specific safety issues.
5. Describe how to prepare the welding area, welding coupons, and the welding equipment.
6. Review the torch and filler metal techniques required for GTAW of pipe.
7. Use the Section Review questions to review the topics of this session.

**SESSION TWO**

Session Two reviews the techniques needed to produce GTAW low alloy and stainless steel pipe welds. The module exam is also completed during this session. This session covers Section 2.0.0.

1. Show the Session Two PowerPoint® presentation.
2. Use the Kickoff Activity to introduce trainees to the concepts of fusion welding, also known as autogenous welding.
3. Review the techniques required to apply the root pass.
4. Discuss the application of a backing gas for open-root pipe welds.
5. Introduce backup flux products and consumable inserts for pipe welds.
6. Review the pipe-welding positions and appropriate weld profiles.
7. Review the techniques required to complete welds in three positions.
8. Use the Section Review questions to review the topics of this session.
9. Go over the Module Review to prepare trainees for the module exam.
10. Administer the module exam. Record the testing results on the Registration of Training Modules form and submit the form to your Training Program Sponsor.

**SESSIONS THREE – TWENTY-EIGHT**

Sessions Three through Twenty-Eight are laboratory sessions that provide trainees with an opportunity to practice and complete the Performance Tasks associated with this module.

1. Note that no slide presentation is associated with these laboratory sessions.
2. Demonstrate how to complete GTAW open-root V-groove pipe welds on stainless steel or low alloy pipe coupons, using a backing gas.
3. Have trainees practice and complete the requirements of Performance Tasks 1 through 3.
4. Document successful Performance Task completions for each trainee on the Performance Profile sheet and submit the results to the Training Program Sponsor.
## Materials Checklist for Module 29305-16, GTAW – Low Alloy and Stainless Steel Pipe

<table>
<thead>
<tr>
<th>Equipment and Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Personal protective equipment:</strong></td>
</tr>
<tr>
<td>Squares</td>
</tr>
<tr>
<td>Metal cutting equipment (mechanical or thermal)</td>
</tr>
<tr>
<td>Appropriate flame-retardant clothing</td>
</tr>
<tr>
<td>Angle grinders</td>
</tr>
<tr>
<td>Safety glasses</td>
</tr>
<tr>
<td>Face shields</td>
</tr>
<tr>
<td>Welding machines compatible with GTAW, complete with torches, workpiece clamps, shielding gas hoses, and cables</td>
</tr>
<tr>
<td>Work gloves</td>
</tr>
<tr>
<td>Welding machines compatible with GTAW, complete with torches, workpiece clamps, shielding gas hoses, and cables</td>
</tr>
<tr>
<td>Welding gloves</td>
</tr>
<tr>
<td>Sufficient supply of filler metal rods for the stainless steel or low alloy material in use</td>
</tr>
<tr>
<td>Welding hood with a lens of the appropriate shade</td>
</tr>
<tr>
<td>Sufficient volume of shielding gas with regulators/flowmeters</td>
</tr>
<tr>
<td>Proper footwear as directed by the instructor or training facility provider</td>
</tr>
<tr>
<td>Sufficient volume of backing (purge) gas with regulators/flowmeters</td>
</tr>
<tr>
<td>Hearing protection as directed by the instructor or training facility provider</td>
</tr>
<tr>
<td>Sufficient supply of stainless steel or low alloy pipe for practice, 2” to 6” (DN50 to DN150) Schedule 40 or Schedule 80</td>
</tr>
<tr>
<td>Hard hat as directed by the instructor or training facility provider</td>
</tr>
<tr>
<td>Welding bench with arm suited for position work; alternatively, a welding positioner may be used</td>
</tr>
<tr>
<td>Whiteboard</td>
</tr>
<tr>
<td>Files</td>
</tr>
<tr>
<td>Dry-erase markers</td>
</tr>
<tr>
<td>Chipping hammers</td>
</tr>
<tr>
<td>A variety of standard marker sizes</td>
</tr>
<tr>
<td>Wire brushes</td>
</tr>
<tr>
<td>Pencils and paper</td>
</tr>
<tr>
<td>Common hand tools</td>
</tr>
<tr>
<td>Poster board</td>
</tr>
<tr>
<td>Soapstone</td>
</tr>
<tr>
<td>Flip chart</td>
</tr>
<tr>
<td>Tape measures or steel rules</td>
</tr>
<tr>
<td><strong>Welding Level Three PowerPoint® Presentation</strong></td>
</tr>
<tr>
<td>LCD projector and screen</td>
</tr>
<tr>
<td>Computer (Internet access optional)</td>
</tr>
<tr>
<td>Module Review answer key</td>
</tr>
<tr>
<td>Copies of the Module Examination and answer key</td>
</tr>
<tr>
<td>Performance Profile Sheets</td>
</tr>
</tbody>
</table>

To the extent possible, and as required for performance testing, provide a selection of the tools listed for each session; alternatively, photos may be used to teach tool identification.
Lesson Plans for Module 29306-16

SMAW – STAINLESS STEEL PLATE AND PIPE GROOVE WELDS

Module Six (29306-16) will help welders understand the differences between welding stainless steel and other metals. The various types of stainless steel require different welding techniques, filler metal composition, and heat treatments. This module covers stainless steel metallurgy and the required SMAW electrodes. An ample amount of time is dedicated to practicing open-root V-groove welds on both stainless steel plate and pipe using the SMAW process.

Objectives

Learning Objective 1
• State special considerations for SMAW of various types of stainless steel and identify compatible electrodes.
  a. Describe various types of stainless steel.
  b. Describe methods for controlling carbide precipitation.
  c. Identify various types of SMAW electrodes compatible with stainless steel.
  d. Describe the selection and storage of stainless steel electrodes.

Learning Objective 2
• State the basic concepts of SMAW of stainless steel and how to prepare for welding.
  a. State the basic concepts of SMAW of stainless steel.
  b. Identify common welding safety practices.
  c. Explain how to prepare the area, materials, and equipment for SMAW of stainless steel.

Learning Objective 3
• Describe open-root V-groove plate and pipe welding positions and SMAW stainless steel welding techniques.
  a. Identify and describe plate and pipe welding positions and acceptable weld profiles.
  b. State general electrode handling considerations for SMAW of stainless steel.
  c. Describe how to make the root pass.
  d. Describe the techniques required to produce open-root V-groove SMAW stainless steel plate welds in four positions.
  e. Describe the techniques required to produce open-root V-groove SMAW stainless steel pipe welds in four positions.

Performance Tasks

Performance Task 1
(Learning Objective 3)
• Make open-root V-groove welds on stainless steel plate in the 1G position.

Performance Task 2
(Learning Objective 3)
• Make open-root V-groove welds on stainless steel plate in the 2G position.

Performance Task 3
(Learning Objective 3)
• Make open-root V-groove welds on stainless steel plate in the 3G position.

Performance Task 4
(Learning Objective 3)
• Make open-root V-groove welds on stainless steel plate in the 4G position.

Performance Task 5
(Learning Objective 3)
• Make open-root V-groove welds on stainless steel pipe in the 1G-ROTATED position.

Performance Task 6
(Learning Objective 3)
• Make open-root V-groove welds on stainless steel pipe in the 2G position.

Performance Task 7
(Learning Objective 3)
• Make open-root V-groove welds on stainless steel pipe in the 5G position.

Performance Task 8
(Learning Objective 3)
• Make open-root V-groove welds on stainless steel pipe in the 6G position.

Elective

Module 29306-16 is an elective for Welding Level Three. It is not required for successful level completion.
Teaching Time: 100 hours
(Forty 2.5-Hour Sessions)
Session time may be adjusted to accommodate your class size, schedule, and teaching style.

Before You Begin
As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the PowerPoint® presentation), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

Using your access code, download the written examinations and Performance Profile sheets from www.nccerirc.com. The passing score for submission into NCCER’s Registry is 70% or above for the written examination; performance testing is graded pass or fail.

Safety Considerations
This module requires that trainees work with and around equipment that generates high voltages, extremely high temperatures, and intense ultraviolet radiation. Safety must be emphasized at all times. Trainees should be carefully observed to ensure that they wear the proper PPE, follow safe practices, and give due respect to unseen hazards related to welding and the welding environment. Any deficiencies must be corrected to ensure the future safety of all trainees. All practice sessions and Performance Tasks must be completed under your direct supervision.

Classroom Equipment and Materials
Whiteboard
Dry-erase markers
A variety of standard marker sizes
Pencils and paper
Poster board
Flip chart
Welding Level Three PowerPoint® Presentation
LCD projector and screen
Computer (Internet access optional)
Module Review answer key
Copies of the Module Examination and Answer Key (for paper-based exams)
Performance Profile sheets

Equipment and Materials for Laboratories and Performance Testing
Minimum safety equipment:
- Appropriate flame-retardant clothing
- Safety glasses
- Face shields
- Work gloves
- Welding gloves
- Welding hood with a lens of the appropriate shade
- Proper footwear as directed by the instructor or training facility provider
- Hearing protection as directed by the instructor or training facility provider
- Hard hat as directed by the instructor or training facility provider
- Welding machines compatible with SMAW and capable of DC welding, complete with electrode holders, workpiece clamps, and cables
- Sufficient supply of ¼” to ⅝” (6 to 20 mm) thick stainless steel plate
- Appropriate plate backing strips (optional)
- Sufficient supply of stainless steel pipe for practice, 2” to 12” (DN50 to DN300)
- Schedule 40 or Schedule 80 pipe
- Appropriate pipe backing rings (optional)
- Welding bench with arm suited for position work; alternatively, a welding positioner may be used
- Sufficient supply of appropriate SMAW electrodes
- Metal cutting equipment (mechanical or thermal)
- Angle grinders
- Grinding wheels
- Squares
- Tape measures or steel rules
- Soapstone
- Files
- Chipping hammers
- Wire brushes
- Common hand tools
Additional Resources
This module presents thorough resources for task training. The following resource material is suggested for further study.


There are a number of online resources available for trainees who would like more information on stainless steel welding using the SMAW process. A search for additional information may be assigned as homework to interested trainees.

Instructors should view any videos that may be identified in the lesson plan before using them to ensure their suitability. The videos can provide teachable moments in both proper and improper work processes and behaviors. Be prepared to stop the videos at appropriate times to point out and discuss both proper and improper conduct and techniques.

Numerous videos related to the topic are available on the Internet. These can be located by searching “SMAW stainless welding” or similar terms, and using the Video tab on the results page of your preferred search engine.

Instructors are encouraged to locate additional audiovisual aids available on the Internet, make personal videos, and take still pictures related to the subject matter and add them to the presentations throughout the program.
The Lesson Plan for this module is divided into forty 2.5-hour sessions. This time includes 10 minutes for administrative tasks and a 10-minute break per session.

**SESSION ONE**

Session One provides a refresher on stainless steel metallurgy and presents the SMAW electrodes used for stainless steel. This session covers Section 1.0.0.

1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to encourage discussion and thought about the use of SMAW on stainless steel.
3. Compare and contrast the various types of stainless steel.
4. Review carbide precipitation, its causes, and its effects.
5. Discuss stainless steel electrodes and their storage requirements.
6. Use the Section Review questions to review the topics of this session.

**SESSION TWO**

Session Two reviews the basic concepts of SMAW on stainless steel. In addition, safety practices and welding preparations are presented. This session covers Sections 2.0.0 through 3.1.3.

1. Show the Session Two PowerPoint® presentation.
2. Use the Kickoff Activity to share stainless steel SMAW tips from an industry expert with the class.
3. Discuss information relevant to the use of SMAW on stainless steel.
4. Review common welding safety practices, emphasizing any practices directly related to SMAW.
5. Describe how to prepare the welding area, equipment, and both plate and pipe coupons.
6. Identify the four primary welding positions for both plate and pipe.
7. Review the characteristics of an acceptable weld profile.
8. Use the Section Review questions to review the topics of this session.

**SESSION THREE**

Session Three provides specific guidance to be used during plate and pipe welding practice. This session covers Sections 3.2.0 through 3.5.4.

1. Show the Session Three PowerPoint® presentation.
2. Use the Kickoff Activity to share stainless steel SMAW tips from a second industry expert, providing an opportunity for trainees to compare the opinions and techniques of multiple experts.
3. Review the techniques required to apply an SMAW root pass on stainless steel.
4. Review the details related to each plate- and pipe-welding position.
5. Use the Section Review questions to review the topics of this session.
6. Go over the Module Review to prepare trainees for the module exam.
7. Administer the module exam. Record the testing results on the Registration of Training Modules form and submit the form to your Training Program Sponsor.

**SESSIONS FOUR THROUGH FORTY**

Sessions Four through Forty are laboratory sessions that provide an opportunity for trainees to practice and complete the Performance Tasks associated with this module.

1. Note that no slide presentation is associated with these laboratory sessions.
2. Demonstrate how to complete SMAW V-groove plate welds on plate coupons.
3. Have trainees practice and complete the requirements of Performance Tasks 1 through 4.
4. Demonstrate how to complete SMAW V-groove pipe welds on pipe coupons.
5. Have trainees practice and complete the requirements of Performance Tasks 5 through 8.
6. Document successful Performance Task completions for each trainee on the Performance Profile sheet and submit the results to the Training Program Sponsor.
### Materials Checklist for Module 29306-16, SMAW – Stainless Steel Plate and Pipe Groove Welds

<table>
<thead>
<tr>
<th>Personal protective equipment:</th>
<th>Equipment and Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appropriate flame-retardant clothing</td>
<td>Squares</td>
</tr>
<tr>
<td>Safety glasses</td>
<td>Tape measures or steel rules</td>
</tr>
<tr>
<td>Face shields</td>
<td>Soapstone</td>
</tr>
<tr>
<td>Work gloves</td>
<td>Sufficient supply of appropriate SMAW electrodes</td>
</tr>
<tr>
<td>Welding gloves</td>
<td>Metal cutting equipment (mechanical or thermal)</td>
</tr>
<tr>
<td>Welding hood with a lens of the appropriate shade</td>
<td>Angle grinders</td>
</tr>
<tr>
<td>Proper footwear as directed by the instructor or training facility provider</td>
<td>Grinding wheels</td>
</tr>
<tr>
<td>Heaing protection as directed by the instructor or training facility provider</td>
<td>Welding machines compatible with SMAW and capable of DC welding, complete with electrode holders, workpiece clamps, and cables</td>
</tr>
<tr>
<td>Hard hat as directed by the instructor or training facility provider</td>
<td>Sufficient supply of stainless steel pipe for practice, 2&quot; to 12&quot; (DN50 to DN300) Schedule 40 or Schedule 80 pipe</td>
</tr>
<tr>
<td>Whiteboard</td>
<td>Welding bench with arm suited for position work; alternatively, a welding positioner may be used</td>
</tr>
<tr>
<td>Dry-erase markers</td>
<td>Appropriate plate backing strips (optional)</td>
</tr>
<tr>
<td>A variety of standard marker sizes</td>
<td>Appropriate pipe backing rings (optional)</td>
</tr>
<tr>
<td>Pencils and paper</td>
<td>Files</td>
</tr>
<tr>
<td>Poster board</td>
<td>Chipping hammers</td>
</tr>
<tr>
<td>Flip chart</td>
<td>Wire brushes</td>
</tr>
<tr>
<td>Welding Level Three PowerPoint® Presentation</td>
<td>Common hand tools</td>
</tr>
<tr>
<td>LCD projector and screen</td>
<td></td>
</tr>
<tr>
<td>Computer (Internet access optional)</td>
<td></td>
</tr>
<tr>
<td>Module Review answer key</td>
<td></td>
</tr>
<tr>
<td>Copies of the Module Examination and answer key</td>
<td></td>
</tr>
<tr>
<td>Performance Profile Sheets</td>
<td></td>
</tr>
</tbody>
</table>

To the extent possible, and as required for performance testing, provide a selection of the tools listed for each session; alternatively, photos may be used to teach tool identification.